CORRESPONDENCE COVER SHEET
WASTE PERMITS DIVISION
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Date: 01/20/2022
Facility Name: Pirkey Power Plant
Permit or Registration No.: Pending

Nature of Correspondence:
☒ Initial/New
☐ Response/Revision*

*If Response/Revision, please provide previous TCEQ Tracking No.:
(Previous TCEQ Tracking No. can be found in the Subject line of the TCEQ's response letter to your original submittal.)

This cover sheet should accompany all correspondences submitted to the Waste Permits Division and should be affixed to the front of your submittal as a cover page. Please check the appropriate box for the type of correspondence being submitted. For questions regarding this form, please contact the Waste Permits Division at (512) 239-2335.

Table 1 - Municipal Solid Waste

APPLICATIONS	REPORTS and RESPONSES
☐ New Notification	☐ Closure Report
☐ New Permit (including Subchapter T)	☐ Groundwater Alternate SRC Demonstration
☐ New Registration (including Subchapter T)	☐ Groundwater Corrective Action
☐ Major Amendment	☐ Groundwater Monitoring Report
☐ Minor Amendment	☐ Groundwater Statistical Evaluation
☐ Limited Scope Major Amendment	☐ Landfill Gas Corrective Action
☐ Notice Modification	☐ Landfill Gas Monitoring
☐ Non-Notice Modification	☐ Liner Evaluation Report
☐ Transfer/Name Change Modification	☐ Soil Boring Plan
☐ Temporary Authorization	☐ Special Waste Request
☐ Voluntary Revocation	☐ Other:
☐ Subchapter T Workplan	
☐ Other:	

Table 2 - Industrial & Hazardous Waste

APPLICATIONS	REPORTS and RESPONSES
☒ New	☐ Annual/Biennial Site Activity Report
☐ Renewal	☐ CfPT Plan/Result
☐ Post-Closure Order	☐ Closure Certification/Report
☐ Major Amendment	☐ Construction Certification/Report
☐ Minor Amendment	☐ CPT Plan/Result
☐ Class 3 Modification	☐ Extension Request
☐ Class 2 Modification	☐ Groundwater Monitoring Report
☐ Class 1 ED Modification	☐ Interim Status Change
☐ Class 1 Modification	☐ Interim Status Closure Plan
☐ Endorsement	☐ Soil Core Monitoring Report
☐ Temporary Authorization	☐ Treatability Study
☐ Voluntary Revocation	☐ Trial Burn Plan/Result
☐ 335.6 Notification	☐ Unsaturated Zone Monitoring Report
☒ Other: CCR Unit Registration	☐ Waste Minimization Report
	☐ Other:

Volume 1

- TCEQ Application
- Section 2 Supplement – TCEQ ePay
- Section 13 Supplement – Property and Legal Description
- Section 17 Supplement – Legal Authority
- Maps and Drawings
- Attachment 1 – Location Restrictions and Geology Reports
- Attachment 2 – Design Criteria for CCR Landfills and Surface Impoundments
- Attachment 3 – Operating Criteria for CCR Landfills and Surface Impoundments

TCEQ Application

Texas Commission on Environmental Quality

Registration Application for Coal Combustion Residuals (CCR) Waste Management

I. General Information

1. Reason for Submittal

Type of Registration Application

☒ New ☐ Major Amendment ☐ Minor Amendment

☐ Notice of Deficiency (NOD) Response ☐ Transfer ☐ Name Change

☐ Other

2. Application Fees (See Section 2 Supplement)

☒ $150 Application Fee

Payment Method

☐ Check ☒ Online through ePay portal <www3.tceq.texas.gov/epay/>

If paid online, enter ePay Trace Number: 582EA000467916

3. Facility Information

Facility information must match regulated entity information on the Core Data Form.

Applicant: ☐ Owner ☐ Operator ☒ Owner/Operator

Facility TCEQ Solid Waste Registration No: 33240

Facility EPA ID: TXD000726380

Regulated Entity Reference No. (if issued): RN 100214287

Facility Name: Pirkey Power Plant

Facility (Area Code) Telephone Number: 903-927-5883

Facility physical street address (city, state, zip code, county): 2400 FM 3251, Hallsville, TX 75650-7634

Facility mailing address (city, state, zip code, county): 2400 FM 3251, Hallsville, TX 75650-7634

Latitude (Degrees, Minutes Seconds): 32.4625

Longitude (Degrees, Minutes Seconds): -94.482777

4. Publicly Accessible Website

Provide the URL address of a publicly accessible website where the owner or operator of a CCR unit will post information.
http://www.aep.com/environment/ccr/Pirkey

5. Facility Landowner(s) Information

Facility landowner(s) name: American Electric Power/ Southwestern Electric Power Company

Facility landowner mailing address: 2400 FM 3251

City: Hallsville State: Texas Zip Code: 75650-7634

(Area Code) Telephone Number: 903-927-5883

Email Address (optional):

6. CCR Waste Management Unit(s)

☒ Landfill Unit(s) ☒ Surface Impoundment(s)

For each existing landfill, new landfill and lateral expansion, existing surface impoundment, and new surface impoundment and lateral expansion(s) provide information on type of waste, the registered unit(s) in which they are managed, and sampling and analytical methods.

Submit the following tables:

Table I.6. – CCR Waste Management Units;

Table I.6.A. – Waste Management Information;

Table I.6.B. – Waste Managed in Registered Units; and

Table I.6.C. – Sampling and Analytical Methods.

7. Description of Proposed Activities or Changes to Existing Facility

Provide a brief description of the proposed activities if application is for a new facility, or the proposed changes to an existing facility or registration conditions, if the application is for an amendment.
Single unit lignite-fired steam electric power generation plant utilizing 4 CCR management units

8. Primary Contact Information

Contact Name: Leslie Fuerschbach Title: Engineer

Contact mailing address: 502 North Allen Ave.
City: Shreveport County: Caddo State: LA Zip Code: 71102
(Area Code) Telephone Number: 318-673-2744

Email Address (optional): lefuerschbach@aep.com

9. Notice Publishing

Party responsible for publishing notice:
☒ Applicant ☐ Consultant ☐ Agent in Service

Contact Name: Leslie Fuerschbach Title: Engineer

Contact mailing address: 502 N. Allen Ave.
City: Shreveport County: Caddo State: LA Zip Code: 71102
(Area Code) Telephone Number: 318-673-2744

10. Alternative Language Notice

Is an alternative language notice required for this application? For determination, refer to Alternative Language Checklist on the Public Notice Verification Form (TCEQ-20244-Waste-NORI).

☐ Yes ☒ No

11. Public Place Location of Application

Name of the Public Place: Marshall Public Library
Physical Address: 300 South Alamo
City: Marshall County: Harrison State: TX Zip Code: 75670
(Area code) Telephone Number: (903) 935-4465

12. Ownership Status of the Facility

☒ Corporation ☐ Limited Partnership
☐ Sole Proprietorship ☐ General Partnership ☐ Other (specify):

Does the Site Owner (Permittee/Registrant) own all the CCR units and all the facility property?

☒ Yes ☐ No

13. Property / Legal Description Information (See Section 13 Supplement)

Provide a legal description and supporting documents of the property where the management of CCR waste will occur; including a survey plat and a boundary metes and bounds description (30 TAC §352.231(g)).

Submit the following documents:

a. Property Legal Description
b. Property Metes and Bounds Description
c. Metes and Bounds Drawings
d. On-Site Easements Drawings

14. Operator Information

Identify the entity who will conduct facility operations, if the owner and operator are not the same.

Operator Name: Same as Facility operator

Operator mailing address:

City: State: Zip Code:

(Area Code) Telephone Number:

Email Address (optional):

15. Confidential Documents

Does the application contain confidential documents?

☐ Yes ☒ No

If "Yes", cross-reference the confidential documents throughout the application and submit as a separate attachment in a binder clearly marked "CONFIDENTIAL."

16. Permits and Construction Approvals

Permit or Approval	Received	Pending	Not Applicable
Hazardous Waste Management Program under the Texas Solid Waste Disposal Act	☐	☐	☒
Underground Injection Control Program under the Texas Injection Well Act	☐	☐	☒
National Pollutant Discharge Elimination System Program under the Clean Water Act and Waste Discharge Program under Texas Water Code, Chapter 26	☒	☐	☐
Prevention of Significant Deterioration Program under the Federal Clean Air Act (FCAA). Nonattainment Program under the FCAA	☒	☐	☐
National Emission Standards for Hazardous Air Pollutants Preconstruction Approval under the FCAA	☒	☐	☐
Other (describe)	☐	☐	☐
Other (describe)	☐	☐	☐
Other (describe)	☐	☐	☐

17. Legal Authority (See Section 17 Supplement)

The owner and operator of the facility shall submit verification of their legal status with the application. This shall be a one-page certificate of incorporation issued by the secretary of state. The owner or operator shall list all persons having over a 20% ownership in the facility.

18. TCEQ Core Data Form CN 600126767 RN 100214287

The TCEQ requires that a Core Data Form (TCEQ-10400) be submitted on all incoming applications, unless a Regulated Entity and Customer Reference Number has been issued by the TCEQ and no core data information has changed. For more information regarding the Core Data Form, call (512) 239-5175 or visit the TCEQ Website.

19. Other Governmental Entities Information

Coastal Management Program

Is the facility within the Coastal Management Program boundary?

☐ Yes ☒ No

Local Government Jurisdiction (If Applicable)
Within City Limits of:
Within Extraterritorial Jurisdiction of:

Is the facility located in an area in which the governing body of the municipality or county has prohibited the storage, processing or disposal of municipal or industrial solid waste?

☐ Yes ☒ No If "Yes", provide a copy of the ordinance or order as an attachment.

20. Attachments (See Maps and Drawings)

Does the application include the following?

General Maps	☒ Yes	☐ No
General Topographic Map	☒ Yes	☐ No
Facility Layout Map	☒ Yes	☐ No
Surrounding Features Map	☒ Yes	☐ No
Process Flow Diagram	☒ Yes	☐ No
Land Ownership Map	☒ Yes	☐ No
Land Ownership List	☒ Yes	☐ No
Pre-printed Mailing Labels	☒ Yes	☐ No

Maps and drawings shall be legible and easily readable by eye without magnification. Scales and paper size shall be chosen based on the type of map submitted, the land area covered, and the amount of detail to be shown. See instructions for details regarding maps and drawings to be submitted in application.

21. Verification of Compliance

Does the owner and operator verify that the design, construction, and operation of CCR landfill(s) and surface impoundment(s) meets the requirements of 30 TAC §352.231(f) (30 TAC §352.2; 40 CFR §257.52, and 40 CFR §§257.3-1 – 257.3-3).

☒ Yes ☐ No

II. Location Restrictions and Geology

See Instructions and Technical Guidance

22. Location Restrictions (See Attachment 1 – 1.1 to 1.4)

Submit certifications and technical reports demonstrating compliance of CCR unit(s) with applicable location restrictions (30 TAC 352, Subchapter E) and comply with 30 TAC §352.231(d) and 30 TAC §352.4 for submission of engineering and geoscientific information.

A. **Placement above the uppermost aquifer** (30 TAC §352.601) (40 CFR §257.60). For those CCR units whose base is less than five feet above the upper limit of the uppermost aquifer, please submit a copy of the demonstration showing evidence of compliance with 40 CFR §257.60(a) – (c).

B. **Wetlands** (30 TAC §352.611) (40 CFR §257.61). For CCR units located in wetlands, please submit a copy of the demonstration showing evidence of compliance with 40 CFR §257.61(a) – (c).

C. **Fault areas** (30 TAC §352.621) (40 CFR §257.62). For CCR units located within 200 feet of the outermost damage zone of a fault, please submit a copy of the demonstration showing evidence of compliance with 40 CFR §257.62(a) – (c).

D. **Seismic impact zones** (30 TAC §352.631) (40 CFR §257.63). For CCR units located in a seismic impact zone, please submit a copy of the demonstration showing evidence of compliance with 40 CFR §257.63(a) – (c).

E. **Unstable areas** (30 TAC §352.641) (40 CFR §257.64). For CCR units located in unstable areas, please submit a copy of the demonstration showing evidence of compliance with 40 CFR §257.64(a) – (d).

23. Geology Summary Report (See Attachment 1 – 1.1 to 1.4, Section 2.4 of each Location Restriction Report)

Submit a summary of the geologic conditions at the facility, including the relation of the geologic condition to each CCR unit. The summary must include enough information and data and include sources and references for the information. Include all groundwater monitoring data required by 40 CFR Part 257, Subpart D, (30 TAC §352.241, §352.601, §352.621, §352.631, and §352.641) and submitted in accordance of 30 TAC §352.4.

Note: Previously prepared documents may be submitted but must be supplemented or updated as necessary to provide the requested information (30 TAC §352.241(b)).

III. Fugitive Dust Control Plan

24. Fugitive Dust Control Plan (See Attachment 3 – 3.1 and 3.2)

A. **Submit a copy of the CCR Fugitive Dust Control Plan** (30 TAC §352.801) (40 CFR §257.80(b)), or the most recently amended plan. The initial plan or subsequent amended plan must be certified by a qualified Texas licensed professional engineer (Texas P.E.) that the plan meets the requirements of 30 TAC Chapter 352.

B. Submit the most recent Annual CCR Fugitive Dust Control Report (30 TAC §352.801) (40 CFR §257.80(c)) and include the report information.

IV. Landfill Criteria

See Instructions and Technical Guidance – No. 30 Coal Combustion Residuals Landfill

25. Landfill(s) for CCR Waste (See Attachments 1, 2 and 3, more detail below)

Provide the following information below if there is a landfill; if there is more than one landfill, separate information is required for each landfill.

A. Landfill Characteristics (Attachment 1 – 1.3 and 1.4, Section 2.2 of Location Restriction Reports; Attachment 2 – 2.1)

Describe the design, installation, construction, and operation of the landfill and submit a completed Table IV.A. – Landfill Characteristics.

B. Liner Design (Attachment 2 – 2.1)

1. For existing landfills, provide attachments describing how the facility will comply with 30 TAC 352, Subchapter F (Design Criteria).
2. For new landfills or lateral expansions of existing landfills, submit pages describing how the facility will comply with 30 TAC §352.261 and 30 TAC §352.701.
3. Complete Table IV.B. - Landfill Liner System and specify the type of liner used for the landfill.
4. Provide attachments describing the design, installation, and operation of the liner and leak detection system. The description must demonstrate that the liner and leak detection system will prevent discharge to the land, groundwater, and surface water. Submit a quality assurance project plan (QAPP) to ensure that each analysis is performed appropriately.

C. Leachate Collection and Removal (Attachment 2 – 2.1)

Submit design information and description of leachate collection and removal system in accordance with 30 TAC §352.701.

Complete Table IV.C. - Landfill Leachate Collection System

D. Design of Liner and Leachate Collection and Removal System. (Attachment 2 – 2.1)

For a new landfill or lateral expansion of a CCR landfill, provide a qualified Texas P.E. certification and technical report that the design of the liner and the leachate collection and removal system meets the requirements of 30 TAC §352.711.

E. Run-on and Run-off Controls (Attachment 3 – 3.3 and 3.4)

At time of application, attach pages describing how the facility will comply with the run-on and run-off system plan for an existing, new, or lateral expansion of a CCR landfill information. Provide a qualified Texas P.E. certification and technical report that the run-on and run-off control system plans meet the requirements of 30 TAC §352.811.

F. Inspection for Landfills (Attachment 3 – 3.7 and 3.8)

At time of application, attach pages describing how the facility will comply 30 TAC §352.841 and complete Table IV.D. – Inspection Schedule for Landfills. For existing CCR landfills, provide the most recent inspection report. All CCR landfills and any lateral expansions of a CCR landfill must be inspected for any structural weakness, malfunction, deterioration conditions which are disrupting or have the potential to disrupt the operation or safety of the CCR unit, or any other conditions which may cause harm to human health and environment at a frequency specified in 40 CFR §257.84(a) and (b).

V. Surface Impoundment Criteria

See Instructions and Technical Guidance – No. 31 Coal Combustion Residuals Surface Impoundment

26. Surface Impoundment(s) for CCR Waste (See Attachments 2 and 3, more detail below)

Provide the following information below if there is a surface impoundment; if there is more than one surface impoundment, separate information is required for each surface impoundment.

A. General Surface Impoundment(s) Characteristics (Attachment 2 – 2.5)

Provide information about the characteristics of the surface impoundment(s): incised, surface area (acres), storage volume (acres-feet), and depth (feet).

For all surface impoundment(s), include the following information:

1. Complete Table V.A. - Surface Impoundments Characteristics. List the surface impoundment(s) to be registered as a CCR unit(s), the wastes managed in each unit, and the rated capacity or size of each unit.
2. Describe the surface impoundment(s) and provide a plan view drawing with cross-sections, if available.
3. Specify the minimum freeboard to be maintained and the basis of the design to prevent overtopping resulting from normal or abnormal operation; overfilling; wind and wave action; rainfall; run-on; malfunctions of level controllers, alarms, and other equipment; and human error. Show that adequate freeboard will be available to prevent overtopping from a 100-year, 24-hour storm.
4. Waste Flow
   Describe the means that will be used to immediately shut off the flow of waste to the impoundment in the event of liner failure or to prevent overtopping.
5. Dike Construction ☒ Yes ☐ No

   If Yes, submit the dike certification (located at the end of the application).

   The structural integrity of the dike system must be certified by a qualified Texas P.E. before the registration is issued. If the impoundment is not being used, the dike system must be certified before it can be put into use. The certification must be sealed by a qualified Texas P.E., along with the engineering firm's name and registration number (30 TAC §352.4).

A report shall accompany the dike certification which summarizes the activities, calculations, and laboratory and field analyses performed in support of the dike certification. Describe the design basis used in construction of the dikes. A QAPP should be included in the report to ensure that each analysis is performed appropriately and include:

(1) Slope Stability Analysis

(2) Hydrostatic and Hydrodynamic Analysis

(3) Storm Loading

(4) Rapid Drawdown

Earthen dikes should have a protective cover to minimize wind and water erosion and to preserve the structural integrity of the dike. Describe the protective cover used and describe its installation and maintenance procedures.

B. Liner Design (Attachment 2 – 2.2 and 2.3)

For surface impoundment(s), provide information about how the facility will comply with 30 TAC §352.711 for existing CCR surface impoundments. For new and lateral expansion of CCR surface impoundments provide information on how the facility will comply with 30 TAC §352.261, and 30 TAC §352.721, see Instructions and Technical Guidance No. 31 Coal Combustion Residuals Surface Impoundment. The qualified Texas P.E. must certify that the design of the liner complies with the requirements of 30 TAC Chapter 352 and 40 CFR Part 257, Subpart D, where required.

Is the CCR surface impoundment unlined? ☒ Yes ☐ No

If "Yes", the CCR unit is subject to the closure requirements under 30 TAC Chapter 352 and 40 CFR §257.101(a) to retrofit or close. A notification must be prepared stating that an assessment of corrective measures has been initiated.

1. Complete Table V.B. - Surface Impoundment Liner System for each surface impoundment to be registered.
2. Describe the design, installation and operation of liner and leak detection components. The description must demonstrate that the liner and leak detection system will prevent discharge to the land and surface water. Submit a QAPP report to ensure that each analysis is performed appropriately.
3. For new or laterally expansions of existing surface impoundments, provide a subsurface soil investigation report that must include:
    a. A description of all borings drilled, at the unit location, to test soils and characterize groundwater;
    b. A unit map drawn to scale showing the surveyed locations and elevations of the borings, including location of permanent identification markers ((30 TAC §352.731) and (40 CFR §257.73(a)(1));
    c. Cross-sections prepared from the borings depicting the generalized strata at the unit;
    d. Boring logs, including a description of materials encountered, and any discontinuities such as fractures, fissures, slickensides, lenses or seams;
    e. A description of the geotechnical data and the geotechnical properties of the subsurface soil materials, including the suitability of the soils and strata for the intended uses; and

f. A demonstration that all geotechnical tests were performed in accordance with industry practices and recognized procedures.

C. Hazard Potential Classification (Attachment 2 – 2.4 and 2.8)

Provide the current hazard potential classification assessment and associated documentation, as required by 30 TAC §352.731 or §352.741 and 40 CFR §257.73(a)(2) or §257.74(a)(2). The qualified Texas P.E. must certify that the initial hazard potential classification and any subsequent periodic classification was conducted in accordance with the requirements of 30 TAC Chapter 352, where required.

Hazard Potential Classification: **Both the EBAP and WBAP are Low Hazard Potential**

D. Emergency Action Plan for High or Significantly High Hazard Potential (not applicable)

Provide the current Emergency Action Plan that has been certified by a qualified Texas P.E. and includes the following requirements from 30 TAC 352, Subchapter F and 40 CFR §257.73(a)(3)(i)(A) - (E) or 40 CFR §257.74 (a)(3)(i)(A) - (E). The qualified Texas P.E. must certify that the written Emergency Action Plan and any subsequent amendment of the plan complies with the requirements of 30 TAC 352, Subchapter F, where required.

Complete Table V.J. - Inspection of Surface Impoundments

E. Inflow Design Flood Control System Plan (Attachment 3 – 3.5)

Describe how the surface impoundment(s) system will manage stormwater run-on away from the surface impoundment(s) (30 TAC §352.821 and 40 CFR §257.82(a) and (c)). Stormwater run-on must be diverted away from a surface impoundment, based on the hazard potential. Where dikes are used to divert run-on, they must be protected from erosion. Include all analyses used to calculate run-on volumes. Provide the inflow design flood control system plan. Provide qualified Texas P.E. certification that the initial and periodic inflow design flood control system plans meet the requirements of 30 TAC §352.821, where required.

F. History of Construction for Existing CCR Surface Impoundment(s), or the Design and Construction Plans for New and Lateral Expansions (Attachment 2 – 2.5)

Provide information on the history of construction for each existing CCR surface impoundment (30 TAC §352.731 and 40 CFR §257.73(c)) or the design and construction plans for new and lateral expansions of each CCR surface impoundment (30 TAC §352.741) and (40 CFR §257.74(c)).

G. Structural Stability Assessment (Attachment 2 – 2.6)

Provide the most recent structural stability assessment of the surface impoundments. Include the combined capacity of all surface impoundment spillways with calculations; the peak discharge the unit must meet for all combined spillways; probable maximum flood-high hazard, 1,000-yr-significant high hazard, 100-yr-low hazard; identify if there were any structural stability deficiencies in last assessment; identify how these deficiencies were managed and corrected; and qualified Texas P.E. certification. The structural stability assessment must include all information required in 30 TAC §352.731 for existing surface impoundments or 30 TAC §352.741 for new or laterally expanding surface impoundments.

H. **Safety Factor Assessment (Attachment 2 – 2.7 and 2.9)**

The current safety factor assessment must be submitted with the application. It must include documentation that demonstrates whether the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified in 30 TAC 352, Subchapter F and 40 CFR §257.73(e)(1)(i) - (iv) and 40 CFR §257.74(e)(1)(i) - (iv) for the critical cross-section of the embankment. The critical cross-section is the cross-section anticipated to be the most susceptible to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations and certified by a qualified Texas P.E.

VI. Groundwater Monitoring and Corrective Action (30 TAC 352, Subchapter H)

See Instructions and Technical Guidance – No. 32 Coal Combustion Residuals Groundwater Monitoring and Corrective Action

27. Groundwater Monitoring System (See Attachment 4 – 4.1 to 4.4)

A. Complete Table VI.A. - Unit Groundwater Detection Monitoring System.

B. Provide a map showing location of wells, groundwater elevations, and groundwater flow direction.

C. Provide attachments describing how the facility will comply with the requirements in 30 TAC §352.911 and provide a certification by a qualified Texas P.E or qualified Texas P.G. that the groundwater monitoring system design and construction meet the requirements of 30 TAC Chapter 352.

D. Provide a figure showing the geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities and effective porosities.

E. For a multiunit groundwater monitoring system, demonstrate that the groundwater monitoring system will be equally as capable of detecting monitored constituents at the waste boundary of the CCR unit as the individual groundwater monitoring system for each CCR unit by providing at minimum the following information:

1. Number, spacing, and orientation of each CCR unit;
2. Hydrogeologic setting; and
3. Site history.

F. Has there been any sampling concentrations of one or more constituents listed in Appendix IV detected at statistically significant levels above the groundwater protection standard (GWPS)? ☒ Yes ☐ No

G. Provide information on how monitoring wells have been constructed and cased in a manner that maintains the integrity of the monitoring well borehole and to prevent contamination of samples and the groundwater.

28. Groundwater Monitoring Sampling and Analysis Program (See Attachment 4 – 4.5 and 4.6)

Provide a sampling and analysis plan that includes procedures and techniques; sampling and analytical methods that are appropriate for groundwater sampling; and that address the requirements of 30 TAC §352.931 and 40 CFR §257.93. Provide a P.E or P.G. certification that describes the statistical method selected to evaluate the groundwater monitoring data and certifies that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. Refer to TG-32 for information and guidance.

29. CCR Unit(s) in a Detection Monitoring Program (See Attachment 4 – 4.7 to 4.9)

Does the facility have CCR unit(s) in a Detection Monitoring Program?

☒ Yes ☐ No

If "Yes", Submit the following information:

A. Submit Table VI.C. – Facility CCR Units Under Detection Monitoring.

B. Provide a Background Evaluation Report.

C. Provide a report with the results of semiannual monitoring events.

1. Has a statistically significant increase (SSI) been detected for one or more of the constituents listed in Appendix III at any monitoring well?

   ☐ Yes ☒ No

2. Has a notification to the executive director been sent within 14 days?

   ☐ Yes ☒ No

3. Date assessment monitoring program will start: NA
4. Do you plan to provide an alternative source demonstration (ASD)?

   ☐ Yes ☒ No

30. CCR Unit(s) in an Assessment Monitoring Program (See Attachment 4 – 4.10 to 4.18)

Does the facility have CCR unit(s) in an Assessment Monitoring Program?

☒ Yes ☐ No

If "Yes", Submit information related for units.

A. Complete Table VI.D. – CCR Units Under Assessment Monitoring.

B. Provide, for each well in assessment monitoring status, the recorded concentrations lab sheets and results in a tabulated form.

C. Have the concentrations of all constituents listed in Appendices III and IV been at or below background values, using the statistical procedures in 30 TAC §352.931 and 40 CFR §257.93(g), for two consecutive sampling events for the CCR unit(s)? ☐ Yes ☒ No

If answer to above is yes, detection monitoring may resume. The owner or operator must prepare a notification stating that detection monitoring is resuming for the CCR unit and obtain written approval from the executive director.

D. Are there any concentrations of any constituent in Appendices III and IV above background values? ☒ Yes ☐ No

1. Has a notification to the executive director been sent within 14 days?

   ☒ Yes ☐ No

E. Date assessment of corrective measures will be initiated (must be within **90 days** of finding a statistically significant level above the GWPS) for the CCR unit(s):
NA

F. Will you provide an ASD (see TG-32 for an acceptable submittal)? ☒ Yes ☐ No

G. Date assessment of corrective measures will be initiated if ASD is not accepted?
90 days after receiving TCEQ's denial of the submitted ASD

H. Complete Table VI.D-2. - Groundwater Detection Monitoring Parameters

Note: Refer to TG-32 regarding establishing a GWPS for each constituent in Appendix IV detected in the groundwater and attach as table.

I. Have you completed the assessment of corrective measures? ☐ Yes ☒ No
If "Yes", date assessment of corrective measures was completed:
If "No", date assessment of corrective measures will be completed:
Expected date of submittal of amendment (see note below):
Provide completed assessment of corrected measures materials.

Note: Within **30 days** of completing the assessment of corrective measures, and before remedy implementation, the owner or operator shall submit an application for amendment to the registration. In some circumstances, the assessment of corrective measures and selected remedy may be approved as part of the initial application for the CCR unit registration.

J. Have you selected a remedy? ☐ Yes ☒ No

Provide public meeting documentation under 30 TAC §352.961 and a report under 30 TAC §352.971 and 40 CFR §257.97.

VII. Closure and Post-Closure Care

See Instructions and Technical Guidance

Submit a full closure plan and post-closure plan and all information describing how the owner or operator will comply with 30 TAC 352, Subchapter J and 40 CFR §§257.100 - 257.104. The owner of property on which an existing disposal facility is located, following the closure of a unit, must also submit documentation that a notation has been placed in the deed to the facility that will in perpetuity notify any potential purchasers of the property that the land has been used to manage CCR wastes and its use is restricted (30 TAC §352.1221 and 40 CFR §257.102(i)). For CCR units, closed after October 19, 2015, that were closed before submission of the application, the applicant should submit documentation to show that notices required under 30 TAC 352, Subchapter K and 40 CFR §257.105 or §257.106 have been filed.

31. Closure Plan (See Attachment 5 – 5.1 to 5.4)

This section applies to the owners and operators of all CCR units required to be registered. The applicant must close the facility in a manner that minimizes need for further maintenance and controls, or eliminates, to the extent necessary to protect human health and the environment, the post-closure release of CCR waste, chemical constituents of concern, leachate, contaminated rainfall, or waste decomposition products to the groundwater, surface waters, or to the atmosphere.

The type of unit to be closed can determine the level of detail sufficient for a closure plan. CCR units which have been certified closed after October 19, 2015, must provide documentation to demonstrate compliance with state and federal regulations.

For each unit to be registered, complete Table VII.A.1. - Unit Closure and list the CCR Unit components to be decontaminated, possible methods of decontamination, and possible methods of disposal of wastes and waste residues generated during unit closure. All ancillary components must be decontaminated, and the generated waste disposed of appropriately.

Information about CCR units closed or to be closed under alternative closure requirements must be provided in Table VII.A.2. - CCR Units Under Alternative Closure Notification.

Guidance on design of a closure cap and final cover for non-hazardous industrial solid wastes landfills is provided in EPA publication 530-SW-85-014, TCEQ Technical Guidance No. 3 and TCEQ publication, RG-534, “Guidance for Liner Construction and Testing for a Municipal Solid Waste Landfill”.

32. Post-Closure Care Plan (See Attachment 6 – 6.1 to 6.3)

Provide a post-closure care plan that complies with the requirements of 30 TAC §352.1241. Post-closure care of each CCR unit must continue for at least 30 years after the date of completing closure of the unit and must consist of monitoring and reporting of the groundwater monitoring systems, in addition to the maintenance and monitoring of CCR unit. Continuation of certain security requirements may be necessary after the date of closure. Post-closure use of property on or in which waste remains after closure must never be allowed to disrupt the integrity of the containment system. In addition, submit the following information:

- The name, address, and phone number of the person or office to contact about the CCR unit during the post-closure period; and
- A discussion of the future use of the land associated with each unit.

Landfills and surface impoundments which have been certified closed after October 19, 2015, must be included in post-closure care plans, unless they have been determined to have been closed by waste removal equivalent to the closure standards in 30 TAC §352.1221 and 40 CFR §257.102 or 30 TAC §352.1231 and 40 CFR §257.103. If such a demonstration has been made pursuant to 40 CFR §257.102 or §257.103, but an equivalency determination has not been made, please submit a copy of the demonstration documentation. If an equivalency determination has been made, applicant should submit a copy of this determination.

VIII. Financial Assurance

33. Post-Closure Care Cost Estimate (See Attachment 7)

Financial assurance for post-closure care (30 TAC §352.1101) applies to owners or operators of all CCR units, except CCR units from which the owner or operator intends to remove wastes and perform clean closure. Provide a written cost estimate in current dollars of the total cost of the 30-year (or longer, if applicable under 30 TAC §352.1101(d)) post-closure care period to perform post-closure care requirements as prescribed in 30 TAC §352.1241. The cost estimate must be based on the costs of hiring a third party to conduct post-closure care maintenance.

Complete Table VIII.A.1 – Post-Closure Cost Summary for Existing Registered Units

Complete Table VIII.A.2. - Post-Closure Cost Summary for Proposed Registered Units

34. Financial Assurance Mechanism

The financial assurance for post-closure care is required in accordance with 30 TAC §352.1101. The applicant shall demonstrate the financial assurance within 90 days after approval of the registration with a financial mechanism acceptable to TCEQ in compliance with 30 TAC §352.1101(c) and 30 TAC §37, Subchapters A through D, except as indicated in 30 TAC §352.1111, in an amount no less than the amount specified in the approved Post-Closure Care Cost Summary. Provide a description of the proposed financial assurance mechanism.

Complete Table VIII.B. - Post-Closure Period, for the authorized post-closure period, to meet the requirements of 30 TAC §352.1241(a) through (c).

Pirkey_TCEQ Registration App_Compiled 18.pdf

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E-Signature Summary

E-Signature 1: Gary O. Spitznogle (GOS)
January 19, 2022 11:09:04 -8:00 [F437CC7A6114] [65.27.154.195]
gospitznogle@aep.com (Principal) (Personally Known)

E-Signature Notary: S. Smithhisler (SRS)
January 19, 2022 11:09:04 -8:00 [0046313612C1] [161.235.221.103]
srsmithhisler@aep.com
I, S. Smithhisler, did witness the participants named above electronically sign this document.

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Signature Page

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Applicant Signature: ______________________________ Date: _____________

Name and Official Title (type or print):____________________________________

Owner or Operator Signature: Gary O. Spitznogle Date: 01/19/2022

Name and Official Title (type or print): Gary O. Spitznogle, VP Environmental Services

To be completed by the owner or operator if the application is signed by an authorized representative for the operator

I, ________________________ hereby designate ____________________________
(operator) (authorized representative)

as my representative and hereby authorize said representative to sign any application, submit additional information as may be requested by the Commission; and/or appear for me at any hearing or before the Texas Commission on Environmental Quality in conjunction with this request for a CCR waste management registration. I further understand that I am responsible for the contents of this application, for oral statements given by my authorized representative in support of the application, and for compliance with the terms and conditions of any registration which might be issued based upon this application.

____
Printed or Typed Name of Applicant or Principal Executive Officer

____
Signature

(Note: Application Must Bear Signature & Seal of Notary Public)

Subscribed and sworn to before me by the said Gary O. Spitznogle on this

19th day of January, 2022.

My commission expires on the 29th day of April, 2024.

Sarah Smithhisler
Commission # 2019-RE-775042
Electronic Notary Public
State of Ohio
My Comm Exp. Apr 29, 2024

Notarial act performed by audio-visual communication

S Smithhisler
Notary Public in and for Franklin County, Ohio

(Seal)

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Registration Application for Coal Combustion Residuals Waste Management

(See instructions for P.E/P.G. seal requirements.)

Attachments and Tables	Attachment No.
General Information	**NA**
Attachments	**Maps and Drawings**
Technical Report and Certification	**NA**
Location Restrictions Certifications	**1**
Placement above the uppermost aquifer	**1**
Wetlands	**1**
Fault Areas	**1**
Seismic impact zones	**1**
Unstable areas	**1**
Geology Summary	**1**
CCR Fugitive Dust Control Plan	**3**
Annual CCR Fugitive Dust Control Report	**3**
Landfill Design and Operating Criteria	**1, 2, 3**
Landfill Characteristics	**1, 2**
Liner Design	**2**
Leachate Collection and Removal	**2**
Run-on and Run-off Controls	**3**
Inspection for Landfills	**3**
Surface Impoundment Design and Operating Criteria	**2, 3**
General Surface Impoundment Characteristics	**2**
Liner Design	**2**
Hazard Potential Classification	**2**
Emergency Action Plan	**NA**
Inflow Design Flood Control System Plan	**3**
Construction History/Design Plans	**2**
Structural Stability Assessment	**2**
Safety Factor Assessment	**2**
Groundwater Monitoring and Corrective Action	**4**
Groundwater Monitoring System	**4**
Groundwater Monitoring Sampling and Analysis Program	**4**
Detection Monitoring Program	**4**
Assessment Monitoring Program	**4**
Assessment of Corrective Measures	**NA**
Remedy Report	**NA**
Closure and Post-Closure Care	**5, 6**
Closure Plan	**5**
Post-Closure Care	**6**
Financial Assurance	**7**

Tables

Tables	Submitted	Not Applicable
Table I.6. - CCR Waste Management Units	☒	☐
Table I.6.A. - Waste Management Information	☒	☐
Table I.6.B. - Wastes Managed in Registered Units	☒	☐
Table I.6.C. - Sampling and Analytical Methods	☒	☐
Table IV.A. - Landfill Characteristics	☒	☐
Table IV.B. - Landfill Liner System	☒	☐
Table IV.C. - Landfill Leachate Collection System	☒	☐
Table IV.D. - Inspection Schedule of Landfills	☒	☐
Table V.A. - Surface Impoundments Characteristics	☒	☐
Table V.B. - Surface Impoundment Liner System	☐	☒
Table V.J. - Inspection of Surface Impoundments	☒	☐
Table VI.A. - Unit Groundwater Detection Monitoring System	☒	☐
Table VI.C. - CCR Units Under Detection Monitoring	☒	☐
Table VI.D. - CCR Units Under Assessment Monitoring	☒	☐
Table VI.D-2. - Groundwater Detection Monitoring Parameters	☒	☐
Table VII.A.1. - Unit Closure	☒	☐
Table VII.A.2. - CCR Units Under Alternative Closure Notification	☒	☐
Table VIII.A.1. - Post-Closure Cost Summary for Existing Registered Units	☒	☐
Table VIII.A.2. - Post-Closure Cost Summary for Proposed Registered Units	☐	☒
Table VIII.B. - Post-Closure Period	☒	☐
Engineering Certification(s) - Dike Construction	☒	☐

Additional Attachments as Applicable - Select all those apply and add as necessary

☐ TCEQ Core Data Form(s)
☐ Signatory Authority Delegation
☒ Fee Payment Receipt
☐ Confidential Documents
☐ Certificate of Fact (Certificate of Incorporation)
☐ Assumed Name Certificate

Table I.6. – CCR Waste Management Units

CCR Unit No.[1]	Unit Name	N.O.R. No.[1]	Unit Description[3]	Capacity	Unit Status[2]
	East Bottom Ash Pond (EBAP)	005	Ash transport Wastewater Pond	300,000 cubic yards	Active
	West Bottom Ash Pond (WBAP)	005	Ash transport Wastewater Pond	300,000 cubic yards	Active
	Landfill (LF)	003	Ash Landfill	16.5 million cubic yards	Active
	FGD Stackout Area (FGDSA)	023	Radial Stack Out Area and Conveyor Belts	30,000 cubic yards	Active

1 Registered Unit No. and N.O.R. No. cannot be reassigned to new units or used more than once.
2 Unit Status options: Active, Closed, Inactive (built but not managing waste), Proposed (not yet built), Never Built, Transferred, Post-Closure.
3 If a unit has been transferred, the applicant should indicate which facility/permit it has been transferred to in the Unit Description column.

Table I.6.A. – Waste Management Information
East Bottom Ash Pond

Waste No.[1]	Waste Type(s)	Source	Volume (tons/year)
0016	Solid	Generated on-site from a product process or service activity	278,781
0019	Liquid	Generated on-site from a product process or service activity	Water is recirculated as part of plant process
0024	Liquid	Generated on-site from a product process or service activity	Water is recirculated as part of plant process
0212	Liquid	Generated on-site from a product process or service activity	Water is recirculated as part of plant process
0230	Solid	Generated on-site from a product process or service activity	Included in flyash (0015)

[1] Assign waste number sequentially. Do not remove waste number wastes which are no longer generated.

Table I.6.A. – Waste Management Information
West Bottom Ash Pond

Waste No.[1]	Waste Type(s)	Source	Volume (tons/year)
0016	Solid	Generated on-site from a product process or service activity	278.781
0019	Liquid	Generated on-site from a product process or service activity	Water is recirculated as part of plant process
0024	Liquid	Generated on-site from a product process or service activity	Water is recirculated as part of plant process
0212	Liquid	Generated on-site from a product process or service activity	Water is recirculated as part of plant process
0230	Solid	Generated on-site from a product process or service activity	Included in flyash (0015)

1 Assign waste number sequentially. Do not remove waste number wastes which are no longer generated.

Table I.6.A. – Waste Management Information
Landfill

Waste No.[1]	Waste Type(s)	Source	Volume (tons/year)
0015	Solid	Generated on-site from a product process or service activity	80,674
0016	Solid	Generated on-site from a product process or service activity	278.781
0018	Solid	Generated on-site from a product process or service activity	300,171
0054	Solid	Generated on-site from a product process or service activity	0
0059	Solid	Generated on-site from a product process or service activity	17
0069	Solid	Generated on-site from a product process or service activity	0
0071	Solid	Generated on-site from a product process or service activity	5
0076	Solid	Generated on-site from a product process or service activity	0
0081	Solid	Generated on-site from a product process or service activity	34
0085	Solid	Generated on-site from a product process or service activity	Included in flyash (0015)
0206	Solid	Generated on-site from a product process or service activity	2.4
0225	Solid	Generated on-site from a product process or service activity	0
0230	Solid	Generated on-site from a product process or service activity	Included in flyash (0015)
0232	Solid	Generated on-site from a product process or service activity	0
0233	Solid	Generated on-site from a product process or service activity	0
0235	Solid	Generated on-site from a product process or service activity	0

1 Assign waste number sequentially. Do not remove waste number wastes which are no longer generated.

Table I.6.A. – Waste Management Information
FGD Stackout Area

Waste No.[1]	Waste Type(s)	Source	Volume (tons/year)
0015	Solid	Generated on-site from a product process or service activity	80,674
0016	Solid	Generated on-site from a product process or service activity	278.781
0018	Solid	Generated on-site from a product process or service activity	300,171
0054	Solid	Generated on-site from a product process or service activity	0
0059	Solid	Generated on-site from a product process or service activity	17
0069	Solid	Generated on-site from a product process or service activity	0
0071	Solid	Generated on-site from a product process or service activity	5
0076	Solid	Generated on-site from a product process or service activity	0
0081	Solid	Generated on-site from a product process or service activity	34
0085	Solid	Generated on-site from a product process or service activity	Included in flyash (0015)
0206	Solid	Generated on-site from a product process or service activity	2.4
0225	Solid	Generated on-site from a product process or service activity	0
0230	Solid	Generated on-site from a product process or service activity	Included in flyash (0015)
0232	Solid	Generated on-site from a product process or service activity	0

1 Assign waste number sequentially. Do not remove waste number wastes which are no longer generated.

Table I.6.B. – Wastes Managed in Registered Units
East Bottom Ash Pond

Waste No.[1]	Waste	TCEQ Waste Form Codes and Classification Codes
0016	Bottom Ash Recycling	304 2
0019	Water, Ash Transport/ Sluicing of Bottom Ash to pond	114 2
0024	Demineralizer regenerate	114 2
0212	Low Volume Wastewater	114 2
0230	Removal of coarse particulate ash and boiler slag from interior of coal-fired utility boiler.	304 2

1 from Table I.6.A., first column

Table I.6.B. – Wastes Managed in Registered Units
West Bottom Ash Pond

Waste No.[1]	Waste	TCEQ Waste Form Codes and Classification Codes
0016	Bottom Ash Recycling	304 2
0019	Water, Ash Transport/ Sluicing of Bottom Ash to pond	114 2
0024	Demineralizer regenerate	114 2
0212	Low Volume Wastewater	114 2
0230	Removal of coarse particulate ash and boiler slag from interior of coal-fired utility boiler.	304 2

1 from Table I.6.A., first column

Table I.6.B. – Wastes Managed in Registered Units
Landfill

Waste No.[1]	Waste	TCEQ Waste Form Codes and Classification Codes
0015	Fly Ash used as feedstock/ingredient	304 2
0016	Bottom Ash Recycling	304 2
0018	Stabilized sludge mixed	392 2
0054	Spent Carbon Granules	404 2
0059	Spent Demineralizer Resins	403 2
0069	Spent boiler insulation	390 2
0071	Spent Blasting Grit	389 2
0076	Plant trash	999 2
0081	Ecology Pit sediment	391 2
0085	Mill rejects from coal	319 2
0206	Traveling Screen Debris	409 2
0225	Sulfur Spill Clean-up Debris	319 2
0230	Removal of coarse particulate ash and boiler slag from interior of coal-fired utility boiler.	304 2
0232	DBA Spill Debris	319 2
0233	Inorganic Debris mixed	319 2
0235	Spill debris from spill of BCCW	319 2

1 from Table I.6.A., first column

Table I.6.B. – Wastes Managed in Registered Units
FGD Stackout Area

Waste No.[1]	Waste	TCEQ Waste Form Codes and Classification Codes
0015	Fly Ash used as feedstock/ingredient	304 2
0016	Bottom Ash Recycling	304 2
0018	Stabilized sludge mixed	392 2
0054	Spent Carbon Granules	404 2
0059	Spent Demineralizer Resins	403 2
0069	Spent boiler insulation	390 2
0071	Spent Blasting Grit	389 2
0076	Plant trash	999 2
0081	Ecology Pit sediment	391 2
0085	Mill rejects from coal	319 2
0206	Traveling Screen Debris	409 2
0225	Sulfur Spill Clean-up Debris	319 2
0230	Removal of coarse particulate ash and boiler slag from interior of coal-fired utility boiler.	304 2
0232	DBA Spill Debris	319 2

1 from Table I.6.A., first column

Table I.6.C – Sampling and Analytical Methods

Waste No.[1]	Sampling Location	Sampling Method	Frequency	Parameter	Test Method	Desired Accuracy Level
0015	Fly ash were collected from the outlet of the Pirkey Power Plant Fly Ash Silo as it enters the pug mill used for mixing ash with flue gas desulfurization filter cake.	Grab	6/8/94 10/4/06	TCLP extraction Texas Table 1 metals pH	1311/1610B 1:1 pH	
0016	Bottom ash samples were collected from the currently in-use Primary Ash Pond #1 at the Pirkey Power Plant.	Grab	6/9/94	TCLP extraction Texas Table 1 metals 1:1 pH 7 day leaching(metals/TDS)	1311/1610B 1311/7470A 6010B 7470A SM 2540C 9045 C	
0018	FGD Sludge Filter Cake/Fly Ash Mixture samples were collected from the outlet of the FGD Sludge/Fly Ash mixing unit (NOR Unit 012) at the Pirkey Power Plant.	Grab	Once upon determination (6/9/94)	TCLP extraction Texas Table 1 metals pH	1311/1610B pH meter	
0054	The waste sample was collected from the spent carbon as it was removed from the carbon filter in the Wilkes Power Plant water treatment system.	Grab/ composite.	Once upon determination (12/8/94)	TCLP extraction Texas Table 1 metals pH	1311/1610B pH meter	
0059	An identical wastestream was sampled at the Arsenal Hill Power Plant. The Arsenal Hill Power	Grab	Once upon determination (12/7/95)	TCLP extraction Texas Table 1 metals TCLP volatiles/semivolatiles	1311/1610B 1311/8260 1311/8270	

Waste No.[1]	Sampling Location	Sampling Method	Frequency	Parameter	Test Method	Desired Accuracy Level
	Plant spent demineralizer resin bead samples were collected from the Arsenal Hill Power Plant demineralizer					
0069	A representative composite sample was taken from ten discrete locations at varying heights of the waste pile.	Grab/composite	Each time newly generated before disposal (2/20/01) 10/10/01	TCLP extraction Texas Table 1 metals 1:1 pH 7 day leaching(metals/TDS) Asbestos	1311/1610B 6010B 160.1 150.1	
0071	The sample was collected from a covered pile of the material at the precipitator house and at the thickener building.	Grab	Each time newly generated before disposal 6/24/97 7/9/97	TCLP extraction Texas Table 1 metals pH	1311/1610B pH meter	
0076	Plant trash	Waste classified based on generator's knowledge of the waste.				
0081	Based on an identical wastestream at the Knox Lee Power Plant-Knox Lee Ecology Pit sediment	Grab/composite	1/11/98	TCLP extraction Texas Table 1 metals pH	1311/1610B pH meter	
0085	Waste pile accumulated from coal grinding mills used to process coal for boiler fuel	Grab/composite	11/06/00	TCLP extraction Texas Table 1 metals 1:1 pH	1311/1610B 150.1	

Waste No.[1]	Sampling Location	Sampling Method	Frequency	Parameter	Test Method	Desired Accuracy Level
0206	Traveling Screen Debris	Waste classified based on generator's knowledge of the waste.				
0225	Waste in bucket accumulated from the clean-up of solidified sulfur under the molten sulfur tank's fill line.	Grab/composite	11/4/06	TCLP extraction Texas Table 1 metals Reactivity	1311/1610B SW 846 7.0	
0230	Removal of coarse particulate ash and boiler slag from interior of coal-fired utility boiler. This was a reclassification of waste 0016 in 2009 resulting in a change from class 2 to class 3.	Grab/composite	6/12/09 Resampled again 2016.	TCLP extraction Texas Table 1 metals TX 7-daydistilled water leachate 1:1 soil pH	1311/6010B SM 2540C	
0232	A combined grab sample was collected from the debris inside the containment area	Grab/composite	(3/12/14) (3/19/14)	TCLP extraction Texas Table 1 metals	1311/1610B	
0233	A combined grab sample was collected from the debris inside the containment area	Grab/composite	7/31/2015	Texas Table 1 metals pH	1311/1610B SM 4500-H+B-2011	
0235	A grab sample from the spill debris was taken with a scoop	Grab/composite	11/15/2016	TCLP extraction Texas Table 1 metals	1311/1610B	

1 from Table I.6.A., first column

Table IV.A. – Landfills Characteristics

Registered Unit No.	Landfill	N.O.R. No.	Waste Nos.[1]	Rated Capacity	Dimensions[2]	Distance from lowest liner to groundwater	Action Leakage Rate (if required)	Unit will manage CCR Waste and non-CCR Waste (state all that apply)
	Landfill	003	0015 0016 0018 0054 0059 0069 0071 0076 0081 0085 0206 0225 0230 0232 0233 0235	16.5 million cubic yards	157 acres; L = 2750 ft W= 2500 ft Depth range: 60-140 ft	>5 feet	NA	Both CCR waste and non-CCR waste

Registered Unit No.	Landfill	N.O.R. No.	Waste Nos.[1]	Rated Capacity	Dimensions[2]	Distance from lowest liner to groundwater	Action Leakage Rate (if required)	Unit will manage CCR Waste and non-CCR Waste (state all that apply)
	FGD Stackout Area	023	0015 0016 0018 0054 0059 0069 0071 0076 0081 0085 0206 0225 0230 0232	30,000 cubic yards	4 acres L= 450 ft W= 400 ft Depth range; 0–25 ft	NA	NA	Both CCR waste and non-CCR waste

1 From Table I.6.A., first column
2 Dimensions should be provided as average length, width and depth, also include the surface acreage for the unit.

Table IV.B. – Landfill Liner System

Registered Unit No.*	Landfill	Geomembrane Liner Material	Geomembrane Liner Permeability (cm/sec)	Geomembrane Liner Thickness	Soil Liner Material	Soil Liner Permeability (cm/sec)	Soil Liner Thickness
	Landfill	HDPE	<1X10-7 CM/SEC	60 MIL	CLAY	<1X10-7 CM/SEC	2 FT
	FGDSA	NA	NA	NA		NA	

* This number should match the Registration Unit No. given on Table IV.A.

Table IV.C. – Landfill Leachate Collection System

Registered Unit No.	Landfill Name	Drainage Media	Collection Pipes (including risers)	Filter Fabric	Geofabric	Sump Material
	Landfill	Bottom ash	18-36 inch corrugated and solid wall HDPE pipes	8oz nonwoven	NA	NA
	FGDSA	NA	NA	NA	NA	NA

Table IV.D. – Inspection Schedule of Landfills
Landfill and FGD Stackout Area

Facility Unit(s) and Basic Elements	Possible Error, Malfunction, or Deterioration	Frequency of Inspection
Landfill	Discolored Discharge	7 Days
Landfill	Unexplained Increase or Decrease in Discharge	7 Days
Landfill	Uncontrolled Seepage/Leachate Outbreak	7 Days
Landfill	Unintended Ponded Water at Toe of Slope	7 Days
Landfill	Wet Surface on Slope (Indication of Potential Seepage)	7 Days
Embankment	Ruts, Depressions, Settlement, or Misalignment	7 Days
Embankment	Cracks, Bulges, or Slope Failure	7 Days
Control Features	Damage or Blockage to Drainage Feature	7 Days
Control Features	Malfunctioning Gate, Valve, Stop Log, Pump, or Related Structures	7 Days
Control Features	Unintended Ponded Water Along Ditch or Channel	7 Days
Surface	Minor or Major Erosion	7 Days
Surface	Displaced Riprap or Stone	7 Days
Surface	Visible Fugitive Dust	7 Days
Surface	Animal Activity	7 Days
Surface	Excessive Vegetation	7 Days
Surface	Bare or Missing Vegetation	7 Days
Surface	Damage to Stairs, Walkways, Ramps, Platforms, or Liners	7 Days

Table V.A. – Surface Impoundment Characteristics

Registered Unit No.	Surface Impoundment Name	N.O.R. No.	Waste Nos.[1]	Rated Capacity	Dimensions[2]	Distance from lowest liner to groundwater	Action Leakage Rate (if required)	Unit will manage CCR Waste and non-CCR Waste (state all that apply)
	EBAP	005	0016 0019 0024 0212 0230	300,00 cubic yards	30 acres; L = 1180 ft W = 1100 ft D = 7.5 ft	NA	NA	Both CCR and non-CCR waste
	WBAP	005	0016 0019 0024 0212 0230	300,00 cubic yards	30 acres; L = 1380 ft W = 950 ft D = 7.5 ft	NA	NA	Both CCR and non-CCR waste

1 From Table I.6.A., first column
2 Dimensions should be provided as average length, width and depth, also include the surface acreage for the unit.

Table V.B. – Surface Impoundment Liner System

Registered Unit No.*	Surface Impoundment Name	Geomembrane Liner Material	Geomembrane Liner Permeability (cm/sec)	Geomembrane Liner Thickness	Soil Liner Material	Soil Liner Permeability (cm/sec)	Soil Liner Thickness
	EBAP	NA	NA	NA			
	WBAP	NA	NA	NA			

* This number should match the Registration Unit No. given on Table V.A.

Table V.J. – Inspection Schedule of Surface Impoundments

Facility Unit(s) and Basic Elements	Possible Error, Malfunction, or Deterioration	Frequency of Inspection
EBAP/WBAP	Discolored Discharge	7 Days
EBAP/WBAP	Unexplained Increase or Decrease in Discharge	7 Days
EBAP/WBAP	Uncontrolled Seepage/Leachate Outbreak	7 Days
EBAP/WBAP	Unintended Ponded Water at Toe of Slope	7 Days
EBAP/WBAP	Wet Surface on Slope (Indication of Potential Seepage)	7 Days
Embankment	Ruts, Depressions, Settlement, or Misalignment	7 Days
Embankment	Cracks, Bulges, or Slope Failure	7 Days
Control Features	Damage or Blockage to Drainage Feature	7 Days
Control Features	Malfunctioning Gate, Valve, Stop Log, Pump, or Related Structures	7 Days
Control Features	Unintended Ponded Water Along Ditch or Channel	7 Days
Surface	Minor or Major Erosion	7 Days
Surface	Displaced Riprap or Stone	7 Days
Surface	Visible Fugitive Dust	7 Days
Surface	Animal Activity	7 Days
Surface	Excessive Vegetation	7 Days
Surface	Bare or Missing Vegetation	7 Days
Surface	Damage to Stairs, Walkways, Ramps, Platforms, or Liners	7 Days

Table VI.A. – Unit Groundwater Detection Monitoring Systems

Waste Management Unit/Area Name[1]	**EBAP**					
Well Number(s):	AD-2	AD-4	AD-12	AD-18	AD-31	AD-32
Hydrogeologic Unit Monitored	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit
Type (e.g., point of compliance, background, observation, etc.)	poc	background	background	background	poc	poc
Up or Down Gradient	down	up	up	up	down	down
Casing Diameter and Material	4” Sch. 40 PVC	4” Sch. 40 PVC	4” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC
Screen Diameter and Material	4” Sch. 40 PVC-slotted	4” Sch. 40 PVC-slotted	4” Sch. 40 PVC-slotted	2” Sch. 40 PVC-slotted	2” Sch. 40 PVC-slotted	2” Sch. 40 PVC-slotted
Screen Slot Size (in.)	0.010	0.010	0.010	0.010	0.010	0.010
Top of Casing Elevation (Ft, Mean Sea Level *[MSL]*)	344.04	366.79	381.99	363.42	360.75	359.18
Grade or Surface Elevation (Ft, MSL)	341.25	363.69	378.84	360.48	357.75	357.23
Well Depth (Ft, Below Grade Surface *[BGS]*)	40	46	51	25	35	33
Well Depth (Ft, Below Top of Casing *[BTOC]*)	42.79	49.1	54.15	27.94	38	34.95
Screen Interval From (Ft, BGS) To (Ft, BGS)	20 40	26 46	31 51	15.0 25.0	20.0 35.0	13.0 33.0

Waste Management Unit/Area Name[1]	**EBAP**					
Screen Interval From (Ft, BTOC)	22.79	29.1	34.15	17.94	23	14.95
To (Ft, BTOC)	42.79	49.1	54.15	27.94	38	34.95

1 From Tables in Section I.; *MSL*: Mean Sea Level; *BGS*: Below Grade Surface; *BTOC*: Below Top of Casing

Table VI.A. – Unit Groundwater Detection Monitoring Systems

Waste Management Unit/Area Name[1]	WBAP					
Well Number(s):	AD-3	AD-12	AD-17	AD-18	AD-28	AD-30
Hydrogeologic Unit Monitored	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit
Type (e.g., point of compliance, background, observation, etc.)	background	background	poc	background	poc	poc
Up or Down Gradient	up	up	down	up	down	down
Casing Diameter and Material	4” Sch. 40 PVC	4” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC
Screen Diameter and Material	4” Sch. 40 PVC	4” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC
Screen Slot Size (in.)	0.010	0.010	0.010	0.010	0.010	0.010
Top of Casing Elevation (Ft, Mean Sea Level *[MSL]*)	375.30	381.99	346.09	363.42	339.40	342.02
Grade or Surface Elevation (Ft, MSL)	372.76	378.84	342.65	360.48	335.92	339.04
Well Depth (Ft, Below Grade Surface *[BGS]*)	57	51	30	25	40	25
Well Depth (Ft, Below Top of Casing *[BTOC]*)	59.54	54.15	33.44	27.94	43.48	27.98
Screen Interval From (Ft, BGS) To (Ft, BGS)	37 57	31 51	10.0 30.0	15.0 25.0	15.0 35.0	10.0 25.0
Screen Interval From (Ft, BTOC) To (Ft, BTOC)	39.54 59.54	34.15 54.15	13.44 33.44	17.94 27.94	18.48 38.48	12.98 27.98

1 From Tables in Section I.; *MSL*: Mean Sea Level; *BGS*: Below Grade Surface; *BTOC*: Below Top of Casing

Table VI.A. – Unit Groundwater Detection Monitoring Systems

Waste Management Unit/Area Name[1]	**FGDSA**				
Well Number(s):	AD-7	AD-12	AD-13	AD-22	AD-33
Hydrogeologic Unit Monitored	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit
Type (e.g., point of compliance, background, observation, etc.)	poc	background	background	poc	poc
Up or Down Gradient	down	up	up	down	down
Casing Diameter and Material	4” Sch. 40 PVC	4” Sch. 40 PVC	4” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC
Screen Diameter and Material	4” Sch. 40 PVC	4” Sch. 40 PVC	4” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC
Screen Slot Size (in.)	0.010	0.010	0.010	0.010	0.010
Top of Casing Elevation (Ft, Mean Sea Level *[MSL]*)	362.79	381.99	364.76	358.51	362.37
Grade or Surface Elevation (Ft, MSL)	359.61	378.84	361.98	355.57	359.30
Well Depth (Ft, Below Grade Surface *[BGS]*)	40	51	40.5	30	30
Well Depth (Ft, Below Top of Casing *[BTOC]*)	43.18	54.15	43.28	32.94	33.07
Screen Interval From (Ft, BGS) To (Ft, BGS)	20 40	31 51	30.5 40.5	10.0 30.0	15.0 30.0
Screen Interval From (Ft, BTOC) To (Ft, BTOC)	23.18 43.18	34.15 54.15	33.28 43.28	12.94 32.94	18.07 33.07

1 From Tables in Section I.; *MSL*: Mean Sea Level; *BGS*: Below Grade Surface; *BTOC*: Below Top of Casing

Table VI.A. – Unit Groundwater Detection Monitoring Systems

Waste Management Unit/Area Name[1]	LF						
Well Number(s):	AD-8	AD-12	AD-16	AD-23	AD-27	AD-34	AD-36
Hydrogeologic Unit Monitored	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit	Uppermost Water-Bearing Unit
Type (e.g., point of compliance, background, observation, etc.)	background	background	background	poc	background	poc	poc
Up or Down Gradient	up	up	up	down	up	down	down
Casing Diameter and Material	4” Sch. 40 PVC	4” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC
Screen Diameter and Material	4” Sch. 40 PVC-slotted	4” Sch. 40 PVC-slotted	2” Sch. 40 PVC-slotted	2” Sch. 40 PVC-slotted	2” Sch. 40 PVC-slotted	2” Sch. 40 PVC-slotted	2” Sch. 40 PVC-slotted
Screen Slot Size (in.)	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Top of Casing Elevation (Ft, Mean Sea Level *[MSL]*)	359.84	381.99	360.05	350.10	352.62	307.61	309.20
Grade or Surface Elevation (Ft, MSL)	356.92	378.84	356.81	346.72	349.83	304.64	306.5
Well Depth (Ft, Below Grade Surface *[BGS]*)	35	51	35	35	37.5	25	15
Well Depth (Ft, Below Top of Casing *[BTOC]*)	37.92	54.15	38.24	38.38	40.29	27.97	17.70

Waste Management Unit/Area Name[1]	**LF**						
Screen Interval From (Ft, BGS) To (Ft, BGS)	20 35	31 51	15.0 35.0	15.0 35.0	17.5 37.5	10.0 25.0	5.0 15.0
Screen Interval From (Ft, BTOC) To (Ft, BTOC)	22.92 37.92	34.15 54.15	18.24 38.24	18.38 38.38	20.29 40.29	12.97 27.97	7.70 17.70

[1] From Tables in Section I.; *MSL*: Mean Sea Level; *BGS*: Below Grade Surface; *BTOC*: Below Top of Casing

Table VI.C. – CCR Units Under Detection Monitoring

N.O.R. Unit No.	Unit Description[1,2]	Well(s)	Constituent(s)	Date of SSI Determination	Date of Assessment Monitoring Notification[3]
003	Landfill	AD-23	Boron	2/27/2018	ASD (1/7/2020)
003	Landfill	AD-34	TDS	2/27/2018	ASD (1/7/2020)
003	Landfill	AD-34	Sulfate	2/27/2018	ASD (1/7/2020)
003	Landfill	AD-34	Fluoride	10/2/2020	ASD (12/31/2020)

1 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been requested pursuant to 40 CFR §257.103.

2 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been made pursuant to 40 CFR §257.103.

3 Enter month, day, and year.

Table VI.D. – CCR Units Under Assessment Monitoring

N.O.R. Unit No.	Unit Description[1,2]	Well(s)	Constituent(s)	Date of SSL Determination	Date of Assessment of Corrective Measures Notification[3]
005	EBAP	AD-2, AD-31, AD-32 AD-2, AD-31, AD-32 AD-2, AD-32 AD-2, AD-31, AD-32 AD-2, AD-31, AD-32 AD-31, AD-32	Cobalt	12/26/2018 7/12/2019 1/3/2020 10/2/2020 3/3/2021 9/27/2021	NA- ASD 4/24/2019 ASD (9/23/2019) ASD (4/2/2020) ASD (12/31/2020) ASD (5/3/2021) ASD (12/22/2021)
005	EBAP	AD-31, AD-32 AD-31, AD-32 AD-31, AD-32 AD-31, AD-32 AD-31, AD-32 AD-31, AD-32	Lithium	12/26/2018 7/12/2019 1/3/2020 10/2/2020 3/3/2021 9/27/2021	NA- ASD (7/22/2019) ASD (9/23/2019) ASD (4/2/2020) ASD (12/31/2020) ASD (5/3/2021) ASD (12/22/2021)
005	EBAP	AD-32	Mercury	10/2/2020	ASD (12/31/2020)
023	FGDSA	AD-22 AD-7, AD-22 AD-7, AD-22 AD-7, AD-22	Beryllium	7/11/2019 1/3/2020 10/2/2020 3/3/2021	NA- ASD (10/3/2019) ASD (4/2/2020) ASD (12/31/2020) ASD (5/28/2021)

N.O.R. Unit No.	Unit Description[1,2]	Well(s)	Constituent(s)	Date of SSL Determination	Date of Assessment of Corrective Measures Notification[3]
		AD-7, AD-22		9/27/2021	ASD (12/22/2021)
023	FGDSA	AD-22	cobalt	1/3/2020 10/2/2020 3/3/2021 9/27/2021	NA- ASD(4/2/2020) ASD (12/31/2020) ASD (5/28/2021) ASD (12/22/2021)
023	FGDSA	AD-22	mercury	12/26/2018	NA- ASD (2/14/2019)
005	WBAP	AD-28	cobalt	12/26/2018 7/10/2019 1/3/2020 10/2/2020 3/3/2021 9/27/2021	NA- ASD (3/26/2019) ASD (9/23/2019) ASD (4/2/2020) ASD (12/31/2020) ASD (5/28/2021) ASD (12/22/2021)

1 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been requested pursuant to 40 CFR §257.103.
2 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been made pursuant to 40 CFR §257.103.
3 Enter month, day, and year

Table VI.D-2. – Groundwater Detection Monitoring Parameters Landfill

Parameter	Sampling Frequency	Analytical Method	Practical Quantification Limit (units)	Concentration Limit[1]
Boron	Semi annual	EPA 200.8-1994, Rev. 5.4	0.05 ppb	0.0433 AD-23 0.145 AD-34 0.0702 AD-36
Calcium	Semi annual	EPA 200.7-1994, Rev. 4.4	0.3 ppb	0.536 AD-23 42.8 AD-34 0.0304 AD-36
Chloride	Semi annual	EPA 300.1-1997 Rev 1.0	0.04 ppb	8.88 AD-23 9.35 AD-34 9.54 AD-36
Fluoride	Semi annual	EPA 300.1-1997 Rev 1.0	0.06 ppb	1.00 AD-23 1.29 AD-34 0.0800 AD-36
Sulfate	Semi annual	EPA 300.1-1997 Rev 1.0	0.4 ppb	14.5 AD-23 1280 AD-34 4.20 AD-36
TDS	Semi annual	EPA 300.1-1997 Rev 1.0	100 ppb	111 AD-23 1700 AD-34 98.5 AD-36
pH	Semi annual	Field test		5.2-2.8 AD-23 4.2-2.9 AD-34 5.7-3.5 AD-36

Table VI.D-2. – Groundwater Detection Monitoring Parameters East Bottom Ash Pond

Parameter	Sampling Frequency	Analytical Method	Practical Quantification Limit (units)	Concentration Limit[1]
Boron	Semi annual	EPA 200.8-1994, Rev. 5.4	0.05 ppb	0.0374
Calcium	Semi annual	EPA 200.7-1994, Rev. 4.4	0.3 ppb	2.94
Chloride	Semi annual	EPA 300.1-1997 Rev 1.0	0.04 ppb	9.10
Fluoride	Semi annual	EPA 300.1-1997 Rev 1.0	0.06 ppb	1.00
Sulfate	Semi annual	EPA 300.1-1997 Rev 1.0	0.4 ppb	24.7
TDS	Semi annual	EPA 300.1-1997 Rev 1.0	100 ppb	174
pH	Semi annual	Field test		4.8-3.5 AD-2 5.3-3.0 AD-31 4.5-2.7 AD-32
Antimony	Semi annual	EPA 200.8-1994, Rev. 5.4	0.1 ppb	0.006 ppm
Arsenic	Semi annual	EPA 200.8-1994, Rev. 5.4	0.1 ppb	0.011 ppm
Barium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.2 ppb	2.00 ppm
Beryllium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.1 ppb	0.000400 ppm
Cadmium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.05 ppb	0.005 ppm
Chromium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.2 ppb	0.100 ppm
Cobalt	Semi annual	EPA 200.8-1994, Rev. 5.4	0.05 ppb	0.00940 ppm
Fluoride	Semi annual	EPA 300.1-1997 Rev 1.0	0.06 ppb	4.0 ppm
Lead	Semi annual	EPA 200.8-1994, Rev. 5.4	0.2 ppb	0.0050 ppm
Lithium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.0002 ppm	0.0590 ppm
Mercury	Semi annual	EPA 245.7-2005, Rev. 2.0	0.005 ppb	0.002 ppm
Molybdenum	Semi annual	EPA 200.8-1994, Rev. 5.4	2 ppb	0.04 ppm

Parameter	Sampling Frequency	Analytical Method	Practical Quantification Limit (units)	Concentration Limit[1]
Selenium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.2 ppb	0.05 ppm
Thallium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.5 ppb	0.002 ppm
Radium 226+228	Semi annual	SW-846 9320-2014,Rev. 1.0/SW-846 9315-1986,Rev. 0	0.5 pCi/L	5pCi/L

1 The concentration limit is the basis for determining whether a release has occurred from the CCR unit/area.

Table VI.D-2. – Groundwater Detection Monitoring Parameters West Bottom Ash Pond

Parameter	Sampling Frequency	Analytical Method	Practical Quantification Limit (units)	Concentration Limit[1]
Boron	Semi annual	EPA 200.8-1994, Rev. 5.4	0.05 ppb	0.0742
Calcium	Semi annual	EPA 200.7-1994, Rev. 4.4	0.3 ppb	1.63 AD-17 3.21 AD-28 1.74 AD-30
Chloride	Semi annual	EPA 300.1-1997 Rev 1.0	0.04 ppb	9.22
Fluoride	Semi annual	EPA 300.1-1997 Rev 1.0	0.06 ppb	1.00
Sulfate	Semi annual	EPA 300.1-1997 Rev 1.0	0.4 ppb	9.05 AD-17 27.2 AD-28 31.6 AD-30
TDS	Semi annual	EPA 300.1-1997 Rev 1.0	100 ppb	111 AD-17 133 AD-28 206 AD-30
pH	Semi annual	Field test		4.8-3.3 AD-2 5.6-3.5 AD-31 5.4-4.0 AD-32
Antimony	Semi annual	EPA 200.8-1994, Rev. 5.4	0.1 ppb	0.006 ppm
Arsenic	Semi annual	EPA 200.8-1994, Rev. 5.4	0.1 ppb	0.01 ppm
Barium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.2 ppb	2 ppm
Beryllium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.1 ppb	0.004 ppm
Cadmium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.05 ppb	0.005 ppm
Chromium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.2 ppb	0.1 ppm
Cobalt	Semi annual	EPA 200.8-1994, Rev. 5.4	0.05 ppb	0.009 ppm
Fluoride	Semi annual	EPA 300.1-1997 Rev 1.0	0.06 ppb	4.0 ppm
Lead	Semi annual	EPA 200.8-1994,	0.2 ppb	0.0050 ppm

Parameter	Sampling Frequency	Analytical Method	Practical Quantification Limit (units)	Concentration Limit[1]
		Rev. 5.4		
Lithium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.0002 ppm	0.11 ppm
Mercury	Semi annual	EPA 245.7-2005, Rev. 2.0	0.005 ppb	0.002 ppm
Molybdenum	Semi annual	EPA 200.8-1994, Rev. 5.4	2 ppb	0.005 ppm
Selenium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.2 ppb	0.05 ppm
Thallium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.5 ppb	0.002 ppm
Radium 226+228	Semi annual	SW-846 9320-2014,Rev. 1.0/SW-846 9315-1986,Rev. 0	0.5 pCi/L	5pCi/L

1 The concentration limit is the basis for determining whether a release has occurred from the CCR unit/area.

Table VI.D-2. – Groundwater Detection Monitoring Parameters FGD Stackout Area

Parameter	Sampling Frequency	Analytical Method	Practical Quantification Limit (units)	Concentration Limit[1]
Boron	Semi annual	EPA 200.8-1994, Rev. 5.4	0.05 ppb	0.0818
Calcium	Semi annual	EPA 200.7-1994, Rev. 4.4	0.3 ppb	AD-7 6.55 AD-22 17.6 AD-33 2.18
Chloride	Semi annual	EPA 300.1-1997 Rev 1.0	0.04 ppb	42.3
Fluoride	Semi annual	EPA 300.1-1997 Rev 1.0	0.06 ppb	1.00
Sulfate	Semi annual	EPA 300.1-1997 Rev 1.0	0.4 ppb	83.4
TDS	Semi annual	EPA 300.1-1997 Rev 1.0	100 ppb	AD-7 343 AD-22 682 AD-33 212
pH	Semi annual	Field test		5.1-3.4
Antimony	Semi annual	EPA 200.8-1994, Rev. 5.4	0.1 ppb	0.006 ppm
Arsenic	Semi annual	EPA 200.8-1994, Rev. 5.4	0.1 ppb	0.010 ppm
Barium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.2 ppb	2.00 ppm
Beryllium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.1 ppb	0.000400 ppm
Cadmium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.05 ppb	0.005 ppm
Chromium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.2 ppb	0.10 ppm
Cobalt	Semi annual	EPA 200.8-1994, Rev. 5.4	0.05 ppb	0.0560 ppm
Fluoride	Semi annual	EPA 300.1-1997 Rev 1.0	0.06 ppb	4.0 ppm
Lead	Semi annual	EPA 200.8-1994, Rev. 5.4	0.2 ppb	0.005 ppm
Lithium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.0002 ppm	0.0170 ppm

Parameter	Sampling Frequency	Analytical Method	Practical Quantification Limit (units)	Concentration Limit[1]
Mercury	Semi annual	EPA 245.7-2005, Rev. 2.0	0.005 ppb	0.0020 ppm
Molybdenum	Semi annual	EPA 200.8-1994, Rev. 5.4	2 ppb	0.005 ppm
Selenium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.2 ppb	0.050 ppm
Thallium	Semi annual	EPA 200.8-1994, Rev. 5.4	0.5 ppb	0.002 ppm
Radium 226+228	Semi annual	SW-846 9320-2014,Rev. 1.0/SW-846 9315-1986,Rev. 0	0.5 pCi/L	5pCi/L

1 The concentration limit is the basis for determining whether a release has occurred from the CCR unit/area.

Table VII.A.1. – Unit Closure

For each unit to be registered, list the unit components to be decontaminated, the possible methods of decontamination, and the possible methods of disposal of wastes and waste residues generated during unit closure.

Equipment or CCR Unit	Possible Methods of Decontamination[1]	Possible Methods of Disposal[1]
Landfill	Closure in place	Landfill
FGD Stackout Area	Closure by removal	Landfill

1 Applicants may list more than one appropriate method.

Registration No.: 33240
Registrant: American Electric Power/Southwestern Power Company

Table VII.A.2. – CCR Units Under Alternative Closure Notification

Registered Unit No.	N.O.R. Unit No.	Unit Description[1,2]	Date of Receipt of Last Waste[3]	Date of Closure Notification[3]
	005	EBAP		
	005	WBAP		

1 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been requested pursuant to 40 CFR §257.103.

2 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been made pursuant to 40 CFR §257.103.

3 Enter month, day, and year.

Table VIII.A.1. – Post-Closure Cost Summary for Existing Registered Units

Unit	Cost
Landfill (see attached spreadsheet for details)	$102,500 (annually)
Total Existing Unit Post-Closure Cost Estimate	$3,075,000(in 2021 Dollar)[1]

Table VIII.A.2. - Post-Closure Cost Summary for Proposed Registered Units

Unit	Cost

1 As units are added or deleted from these tables through future registration amendments, the remaining itemized unit costs should be updated for inflation when re-calculating the revised total cost in current dollars.

Table VIII.B. – Post-Closure Period

Unit Name	Date Certified Closed	Authorized Post-Closure Period (Yrs.)	Earliest Date Post-Closure Ends (See Note 1)
Landfill		30 years	

Note 1 – Post-Closure Care shall continue beyond the specified date until the Executive Director has approved the applicant's request to reduce or terminate the post-closure period, consistent with 30 TAC §352.1241 – Post-Closure Care Requirements.

Pirkey Power Plant
Southwestern Electric Power Company
East Bottom Ash Pond

"I, Gary F. Zych (licensed Professional Engineer), Texas P.E. License Number #127152, of Registered Firm American Electric Power Service Corporation, Registered Firm No. F-3341, certify under penalty of law that I have personally examined and am familiar with the design and construction of the dikes that are a portion of the East Bottom Ash Pond based on the available documents related to this surface impoundment.

I further certify that I have evaluated the dike design and materials of construction using accepted engineering procedures, and have determined that the dike, including the portion of the dike providing freeboard, has structural integrity, and is constructed in accordance with applicable surface impoundment criteria per the following:

Existing Diked Surface Impoundment – 40 CFR 257.73 and 30 TAC Section 352.731.

Gary F. Zych

Gary F. Zych
Manager – Geotechnical Engineering Section
American Electric Power Service Corporation

Date: 1/3/2022

GARY F. ZYCH
127152

Pirkey Power Plant
Southwestern Electric Power Company
West Bottom Ash Pond

"I, Gary F. Zych (licensed Professional Engineer), Texas P.E. License Number #127152, of Registered Firm American Electric Power Service Corporation, Registered Firm No. F-3341, certify under penalty of law that I have personally examined and am familiar with the design and construction of the dikes that are a portion of the West Bottom Ash Pond based on the available documents related to this surface impoundment.

I further certify that I have evaluated the dike design and materials of construction using accepted engineering procedures, and have determined that the dike, including the portion of the dike providing freeboard, has structural integrity, and is constructed in accordance with applicable surface impoundment criteria per the following:

Existing Diked Surface Impoundment – 40 CFR 257.73 and 30 TAC Section 352.731.

Gary F. Zych

Gary F. Zych
Manager – Geotechnical Engineering Section
American Electric Power Service Corporation

Date: 1/3/2022

GARY F. ZYCH
127152

SECTIONS 2, 13, AND 17 SUPPLEMENTS

Section 2 Supplement

TCEQ ePay Receipt

Section 13 Supplement

Property Legal Description
Property Metes and Bounds Description
Survey Plat
Metes and Bounds Drawing

Section 17 Supplement

Verification of Legal Status

Section 2 Supplement

Application Fees

TCEQ ePay Receipt

TCEQ ePay Receipt

Transaction Information

Trace Number: 582EA000467916
Date: 01/06/2022 06:46 PM
Payment Method: CC - Authorization 0000092282
ePay Actor: LESLIE FUERSCHBACH
TCEQ Amount: $150.00
Texas.gov Price:: $153.64*

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Payment Contact Information

Name: LESLIE FUERSCHBACH
Company: AEP
Address: 502 N ALLEN AVE, SHREVEPORT, LA 71101
Phone: 318-464-3123

Cart Items

Voucher	Fee Description	AR Number	Amount
551607	COAL COMBUSTION RESIDUALS-NEW OR AMENDMENT		$100.00
551608	30 TAC 305.53B CCR NOTIFICATION FEE		$50.00
		TCEQ Amount:	**$150.00**

Section 13 Supplement

Property and Legal Description

Property Legal Description

8038BA92

Pirkey_TCEQ Registration App_Compiled 69.pdf

DocVerify ID:	8038BA92-D081-4F33-A27D-E469665BD09C
Created:	January 18, 2022 14:06:28 -8:00
Pages:	1
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E-Signature Summary

E-Signature 1: Gary O. Spitznogle (GOS)
January 19, 2022 11:09:05 -8:00 [56AAC73573C0] [65.27.154.195]
gospitznogle@aep.com (Principal) (Personally Known)

E-Signature Notary: S. Smithhisler (SRS)
January 19, 2022 11:09:05 -8:00 [7E30A4D4010A] [161.235.221.103]
srsmithhisler@aep.com
I, S. Smithhisler, did witness the participants named above electronically sign this document.

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All visible electronic signatures contained in this document are symbolic representations of the persons signature, and not intended to be an accurate depiction of the persons actual signature as defined by various Acts and/or Laws.

13. Property / Legal Description Information

Provide a legal description and supporting documents of the property where the management of CCR waste will occur; including a survey plat and a boundary metes and bounds description (30 TAC §352.231(g) – property owner information shall be provided in the application in accordance with 330.59(d) of this title, except 330.59(d)(2)(B) of this title.)

SECTION 330.59. Contents of Part I of the Application

(d) Property owner information. Property owner information shall include the following:

(1) the legal description of the facility;

(A) the legal description of the property and the county, book, and page number or other generally accepted identifying reference of the current ownership record;

(B) for property that is platted, the county, book, and page number or other generally accepted identifying reference of the final plat record that includes the acreage encompassed in the application and a copy of the final plat, in addition to a written legal description;

(C) a boundary metes and bounds description of the facility signed and sealed by a registered professional land surveyor (D) drawings of the boundary metes and bounds description; and

(2) a property owner affidavit signed by the owner that includes the following:

(A) acknowledgment that the State of Texas may hold the property owner of record either jointly or severally responsible for the operation, maintenance, and closure and post-closure care of the facility; and

(C) acknowledgment that the facility owner or operator and the State of Texas shall have access to the property during the active life and post-closure care period, if required, after closure for the purpose of inspection and maintenance:

"I Gary O. Spitznogle as Vice President of Environmental Services
(print Signatory Name) (Signatory Capacity)

as authorized signatory for **Pirkey Power Plant**, acknowledge that the State of Texas may hold me either jointly or severally responsible for the operation, maintenance and closure and post-closure care of the facility. For the facility where waste will remain after closure, I acknowledge that I have a responsibility to file with the county deed records an affidavit to the public advertising that the land will be used for a solid waste facility prior to the time that the facility actually begins operating and to file a final recording upon completion of disposal operations and closure of the landfill unit(s) in accordance with **Title 30 Texas Administrative Code 352.1221**, **Criteria for Conducting the Closure or Retrofit of Coal Combustion Residual Units**. I further acknowledge that I or the operator at the State of Texas shall have access to the property during the active life and post-closure care period."

Gary O. Spitznogle 01/19/2022
(Property Owner's Signature) (Date)

8038BA92-D081-4F33-A27D-E469665BD09C --- 2022/01/18 14:06:28 -8:00 --- Remote Notary

Property Metes and Bounds Description

FILE NO. 6695 -

CONVEYANCE AND BILL OF SALE

FILED FOR RECORD
84 JUN 14 A 9:50
GLENN L[illegible]
CO CLERK, HARRISON CO
BY ________ DEP

THE STATE OF TEXAS

COUNTY OF HARRISON

KNOW ALL MEN BY THESE PRESENTS:

THAT, Southwestern Electric Power Company, a Delaware corporation authorized to do business in the State of Texas, (herein sometimes called Grantor and sometimes called SWEPCO, for a valuable and adequate consideration paid by Northeast Texas Electric Cooperative, Inc., a cooperative corporation organized and existing under the laws of the State of Texas, hereinafter sometimes called Grantee and sometimes called NTEC (the address of which is P.O. Box 70, Gilmer, Texas, 75644), has GRANTED, SOLD and CONVEYED, and does by these presents GRANT, SELL and CONVEY unto the said Northeast Texas Electric Cooperative, Inc., its successors and assigns, subject to the conditions, exceptions and reservations set out herein, an undivided 11.72% of Grantor's right, title and interest in the following property and rights, to-wit:

A. Grantor's right, title and interest in and to the lands described in Exhibit "A" attached hereto and made a part hereof, reference to which is here made for a better description thereof, which said Exhibit "A" describes 2,933.979 acres of land, more or less, in the Winny Mann Survey, A-439, Wm. Watson Survey, A-748, Zion Roberts Survey, A-595, L. B. Blankenship Survey, A-71, and J. B. Hill Survey, A-298, all in Harrison County, Texas, and 92.459 acres of land in the L. B. Blankenship Survey, A-71, and the J. M. Dorr Survey, A-4, Harrison County, Texas, for a total of 3026.438 acres, more or less.

B. Grantor's right, title and interest in and to any and all easements, permits, licenses, servitudes, and Agreements used or useful or held for future use in connection with said Exhibit "A" land, including but not limited to the water rights under and pursuant to that certain Agreement dated December 5, 1977, by and between Northeast Texas Municipal Water District and SWEPCO, and permits related thereto, except, however, this conveyance does not cover or include any interest in SWEPCO's transmission line and substation easements and related facilities located on or used in connection with said Exhibit "A" land.

C. Grantor's right, title and interest in and to any and all improvements, buildings, structures and appurtenances located on or used in connection with said Exhibit "A" lands including, but not limited to the facilities described in Exhibit "B" attached hereto and made a part hereof.

The interests and rights hereinabove described are herein referred to as the "Conveyed Properties."

TO HAVE AND TO HOLD the Conveyed Properties, together with all and singular all rights, appurtenances and hereditaments thereto in anywise belonging unto Grantee, its successors and assigns, subject, however, to the following conditions, reservations and exceptions, to-wit:

1. This conveyance does not cover or include the SWEPCO interest in the water and air pollution control facilities and solid waste disposal facilities covered by and described in the Installment Sales Agreement dated October 15, 1981 between The Sabine River Authority of Texas and SWEPCO, but this conveyance does cover all of the 11.72% interest therein which was retained by SWEPCO and excepted from said October 15, 1981 Agreement.

2. This Conveyance and Bill of Sale is subject to all of the terms, conditions, and provisions contained in that certain Ownership, Construction and Operating Agreement between Southwestern Electric Power Company and Northeast Texas Electric Cooperative, Inc. dated the 8th day of April, 1982, and amended January 13, 1983, and amended March 12, 1984, covering and relating to the HENRY W. PIRKEY UNIT NO. 1, a copy of which said Agreement can be examined for relevant purposes in the office of SWEPCO or in the office of NTEC.

3. It is understood and agreed that within the lands described in said Exhibit "A" there are certain tracts of land and interests in certain tracts of land which have not yet been acquired by SWEPCO. This conveyance covers an 11.72% of the interest which is owned by SWEPCO and which might hereafter be acquired by SWEPCO within the confines of the lands described in said Exhibit "A".

4. This conveyance is without any warranties, expressed or implied. All warranties from manufacturers, suppliers and contractors shall extend to NTEC to the extent of its ownership interest.

5. This conveyance is subject to any valid, existing easement, right-of-way, or oil, gas and mineral lease, or oil, gas or mineral conveyance or reservation of record in the Office of the County Clerk of Harrison County, Texas, and is further subject to the provisions of any Deed, Award of Special Commissioners, or Judgment in eminent domain proceedings in which SWEPCO acquired title to said land.

With reference to said Conveyed Properties, it is understood and agreed that under the terms of said OWNERSHIP, CONSTRUCTION AND OPERATING AGREEMENT referred to, as amended, from February 1, 1983 until April 1, 1983, NTEC paid 100% of the monthly costs, charges, and expenses connected with the acquisition, construction and maintenance of said Conveyed Properties, thereby acquiring an equitable right to 100% of the Conveyed Properties acquired from February 1, 1983 to April 1, 1983, and as a material part of the consideration for this Conveyance and Bill of Sale, NTEC has and does hereby ASSIGN, QUITCLAIM and CONVEY unto SWEPCO, its successors and assigns all of NTEC's right, title and interest in and to said Conveyed Properties over and above the undivided 11.72% owned by and vested in NTEC through this Conveyance and Bill of Sale, thereby vesting title to said Conveyed Properties in the following proportions:

SWEPCO:	88.28%
NTEC:	11.72%

EXECUTED the 14th day of June, 1984.

SOUTHWESTERN ELECTRIC POWER COMPANY

BY Leslie E. Dillahunty
Leslie E. Dillahunty, Vice President
and Superintendent of Power

ATTEST:

Shirley Johnson
Secretary

NORTHEAST TEXAS ELECTRIC COOPERATIVE, INC.

BY

ATTEST:

Secretary

THE STATE OF Texas
Co. OF Gregg

This instrument was acknowledged before me by LESLIE E. DILLAHUNTY, in his capacity stated for SOUTHWESTERN ELECTRIC POWER COMPANY, on this the 14th day of June, 1984.

Sharon F. Beall, PLS
NOTARY PUBLIC

SHARON F. BEALL, PLS
Notary Public, State of Texas
My Commission Expires July 7, 1988

THE STATE OF Texas
Co. OF Gregg

This instrument was acknowledged before me by J. L. Johns, in his capacity stated for NORTHEAST TEXAS ELECTRIC COOPERATIVE, INC., on this the 14th day of June, 1984.

Sharon F. Beall, PLS
NOTARY PUBLIC

SHARON F. BEALL, PLS
Notary Public, State of Texas
My Commission Expires July 7, 19 88

EXHIBIT "A"

The attached pages consist of the following:

1. Field notes and plat of 2958.889 acre Plant-Lake Site, less three excepted tracts, thus leaving 2933.979 acres, more or less, and

2. Field notes and plat of additional 92.459 acre portion of Plant-Lake Site,

thereby making a total of approximately 3026.438 acres.

8176

VOL 1038 PAGE 549

Hart Engineering Company
415 NORTH CENTER STREET
POST OFFICE BOX 2804
ESTABLISHED 1934
LONGVIEW, TEXAS 75606
(214) 758-016

November 23, 1982

FIELD NOTES OF PLANT-LAKE SITE 2958.889 ACRES OF LAND, less three excepted tracts, thus leaving 2933.979 acres, more or less,

Being 2958.889 acs. of land located in the Winny Mann Survey, A-439, Wm. Watson Survey, A-748, Zion Roberts Survey, A-595, L. B. Blankenship Survey, A-71 and J. B. Hill Survey, A-298, Harrison County, Texas, said 2958.889 acs. being more particularly described as follows:

BEGINNING at a point for the occupied SE Corner of the Zion Roberts Survey A-595, the SW Corner of the J. B. Hill Survey A-298 and in the North line of Winny Mann Survey A-439, THENCE N 87° 30' E, 250.0 feet along the SBL of the J. B. Hill Survey and the NBL of the Winny Mann Survey to the place of BEGINNING of the herein described 2958.889 acs. of land;

THENCE N 87° 30' E, 300.0 feet along the NBL of the Winny Mann Survey to a point for Corner;

THENCE S 02° 00' E, 354.93 feet; S 02° 00' 48" E, 620.0 feet; S 87° 59' 59" W, 113.58 feet; S 48° 15' W, 181.89 feet; S 04° 22' W, 98.53 feet; S 51° 06' E, 68.40 feet; S 16° 19' E, 82.74 feet; S 77° 35' W, 80.75 feet; S 58° 26' W, 86.90 feet; N 74° 39' W, 107.61 feet; S 02° 00' 48" E, 837.35 feet to a point for Corner, said point being S 88° 00' 13" W, 322.36 feet from the EBL of the Winny Mann Survey and the WBL of the F. Calvillo Survey A-142;

THENCE S 87° 59' 54" W, 705.22 feet; N 02° 39' 51" W, 313.9 feet; S 87° 59' 54" W, 277.7 feet; N 02° 39' 51" W, 712.14 feet; S 88° 13' 14" W, 997.14 feet; S 44° 20' 28" W, 898.69 feet; S 02° 59' 35" E, 400.0 feet; S 87° 44' 28" W, 346.06 feet; S 33° 13' W, 1644.94 feet; S 04° 09' 34" W, 320.41 feet; S 72° 43' 15" W, 494.88 feet; S 76° 37' 49" W, 202.44 feet; N 04° 22' 03" W, 11.03 feet; S 75° 05' W, 550.30 feet; S 75° 44' W, 265.30 feet; S 85° 20' W, 64.0 feet; South 53.2 feet; N 87° 20' W, 1036.0 feet; S 02° 12' 08" E, 120.22 feet; S 00° 23' 20" E, 1639.8 feet; S 87° 27' 32" W, 317.8 feet; S 87° 48' 36" W, 216.15 feet; N 46° 33' 44" W, 411.61 feet; S 79° 35' 45" W, 41.81 feet; S 87° 43' 35" W, 190.57 feet; S 88° 01' 29" W, 499.85 feet to a point for Corner in the WBL of the Winny Mann Survey and the EBL of the Wm. Watson Survey;

THENCE N 03° 05' 35" W, 669.21 feet; N 37° 13' 47" W, 99.0 feet; N 52° 00' W, 897.44 feet; S 88° 12' 31" W, 110.36 feet; N 01° 16' 31" W, 257.01 feet; N 88° 35' 34" E, 293.52 feet; N 34° 54' 13" W, 209.88 feet; N 74° 43' 31" W, 409.74 feet;

N 02° 06' 27" W, 639.85 feet; N 74° 26' 18" W, 755.21 feet; N 02° 21' 40" W, 1078.97 feet; N 02° 15' 14" W, 414.35 feet; S 88° 21' 05" W, 1508.15 feet; N 02° 02' 13" W, 206.1 feet; N 88° 18' 20" E, 1182.36 feet; N 02° 41' 20" W, 414.5 feet; N 88° 12' 45" E, 328.1 feet; N 02° 14' 15" W, 275.46 feet; N 03° 32' 09" W, 348.58 feet; S 88° 05' 36" W, 325.0 feet; N 02° 41' 12" W, 982.63 feet; N 88° 05' 36" E, 317.48 feet; N 01° 49' 49" W, 788.8 feet; N 87° 54' 59" E, 1436.34 feet; N 34° 45' 02" W, 100.34 feet; N 20° 59' 01" E, 274.55 feet; N 06° 59' 03" W, 179.55 feet; N 16° 38' 28" W, 184.72 feet; S 88° 15' 11" W, 1174.99 feet; N 02° 13' 17" W, 1689.51 feet; N 88° 28' 08" E, 928.50 feet; N 01° 15' 35" W, 1502.94 feet to a point for Corner in the Northernmost SBL of the Zion Roberts Survey and the NBL of the Wm. Watson Survey;

THENCE S 86° 49' 14" E, 230.33 feet along said Survey lines to a point for Corner, said point being N 89° 48' 37" W, 392.22 feet from the NE Corner of the Wm. Watson Survey;

THENCE crossing the Roberts Survey N 06° 43' 13" E, 266.27 feet; N 00° 53' 44" W, 616.23 feet; N 02° 56' 53" W, 109.46 feet; N 83° 39' 39" E, 184.4 feet; N 01° 04' 17" W, 221.94 feet; S 66° 02' 57" W, 197.86 feet; N 17° 56' 18" W, 35.75 feet; N 63° 00' E, 311.60 feet; N 03° 32' 13" W, 398.75 feet; N 89° 40' W, 276.88 feet; S 86° 16' 47" W, 1449.21 feet; S 88° 47' 02" W, 389.44 feet; N 01° 42' 11" E, 744.66 feet; N 08° 05' 46" W, 315.44 feet; N 87° 04' 20" E, 293.56 feet; N 00° 34' 47" W, 361.57 feet to a point for Corner in the NBL of said Zion Roberts Survey, same being in the SBL of the L. B. Blankenship Survey;

THENCE S 73° 09' 36" E, 88.85 feet along the above mentioned Survey line to a point for Corner;

THENCE N 00° 30' 59" W, 671.39 feet; N 03° 36' 47" W, 586.33 feet; N 04° 37' 05" W, 682.44 feet; N 87° 17' 37" E, 3067.68 feet; N 01° 47' 22" W, 501.49 feet; N 03° 51' 37" W, 340.31 feet; S 76° 01' 54" E, 882.27 feet; S 75° 30' 16" E, 189.41 feet; S 00° 02' 46" W, 37.34 feet; S 87° 06' 54" E, 175.24 feet; S 62° 47' 27" E, 23.07 feet; N 80° 18' 55" E, 269,69 feet; N 62° 35' 55" E, 129.89 feet; N 40° 55' 14" E, 275.83 feet; N 56° 44' 40" E, 219.03 feet; N 81° 46' 01" E, 706.57 feet; S 00° 12' 19" E, 1732.03 feet; S 01° 37' 24" E, 217.72 feet; N 87° 14' 31" E, 865.47 feet; N 87° 14' 15" E, 61.83 feet; N 87° 14' 31" E, 1204.93 feet and S 01° 14' 03" E, 1012.02 feet to a point for Corner in the SBL of the above mentioned L. B. Blankenship Survey, same being in the NBL of said Zion Roberts Survey;

THENCE S 01° 40' 02" E, 150.63 feet and S 63° 28' E, 483.42 feet to the P. C. of a curve to the right having a chord of S 49° 58' 38" E, 914.44 feet, a radius of 1960.08 feet and a length of 922.94 feet to the P. T. of curve;

THENCE N 88° 33' 42" E, 251.15 feet; S 02° 14' 33" E, 1055.1 feet; S 87° 43' 42" W, 211.66 feet; S 02° 14' 33" W, 1960.19 feet; N 87° 00' E, 541.32 feet; S 01° 17' 46" E, 487.8 feet; S 87° 00' W, 374.84 feet; S 76° 21' W, 255.5 feet; S 49° 03' W, 309.7 feet; S 57° 22' W, 258.5 feet; S 31° 20' E, 241.1 feet; S 52° 58' E, 187.8 feet and N 86° 18' 27" E, 1316.32 feet to a point for Corner in the EBL of said Zion Roberts Survey, same being in the WBL of the J. B. Hill Survey;

THENCE S 01° 17' 46" E, 201.56 feet along the above mentioned Survey line to a point for Corner;

THENCE N 88° 07' 20" E, 1033.06 feet; S 21° 15' 59" E, 129.36 feet; S 74° 11' 30" E, 442.54 feet; S 58° 23' 45" E, 218.48 feet; S 16° 03' 40" E, 195.19 feet; S 02° 10' 21" E, 322.02 feet; S 21° 33' 42" E, 249.47 feet; N 88° 07' 25" E, 236.34 feet; S 00° 16' 59" E, 481.66 feet; S 01° 43' 11" E, 116.29 feet; S 04° 06' 57" E, 217.77 feet; S 03° 16' 58" E, 317.29 feet; S 88° 06' 07" W, 1389.99 feet; S 63° 47' 56" W, 402.36 feet and S 02° 09' 12" E, 816.44 feet to the place of BEGINNING of the herein described 2958.889 acres of land, SAVE AND EXCEPT from the above described tract the following described three tracts of land;

Tract 1 - BEGINNING at a point that is S 00° 12' 19" E, 1732.03 feet; S 01° 37' 24" E, 217.72 feet and S 03° 59' W, 850.4 feet from the Northernmost Corner of the above described 2958.889 acre tract, said BEGINNING point being the Southernmost NE Corner of the herein described 14.12 acres of land;

THENCE South 682 feet to a point for Corner;

THENCE West 847 feet to a point for Corner;

THENCE North 787 feet to a point for Corner;

THENCE East 362 feet to a point for Corner;

THENCE South 105 feet to a point for Corner;

THENCE East 485 feet to the place of BEGINNING of the herein described Tract No. 1 and containing 14.12 acres of land.

Tract 2 - BEGINNING at a point that is S 09° 38' W, 3337.1 feet from the NW Corner of the Winny Mann Survey, said BEGINNING point being the NW Corner of an 8.64 acre tract;

THENCE S 75° 37' 44" E, 287.15 feet; S 79° 26' 14" E, 430.35 feet and S 81° 10' 54" E, 11.4 feet to a point for Corner;

THENCE S 00° 22' 45" E, 617.18 feet to a point for Corner;

THENCE S 86° 23' 54" W, 336.87 feet to a point for Corner;

THENCE N 33° 24' 06" W, 333.35 feet; N 23° 03' 10" W, 499.97 feet and N 01° 22' 37" W, 51.92 feet to the place of BEGINNING of the herein described Tract 2 containing 8.64 acres of land.

Tract 3- BEGINNING at the NE Corner of Tract 2, said point also being the place of BEGINNING of herein described 2.15 acres of land;

THENCE N 02° 14' 47" W, 215.84 feet to a point for Corner;

THENCE N 86° 04' 45" E, 273.33 feet to a point for Corner;

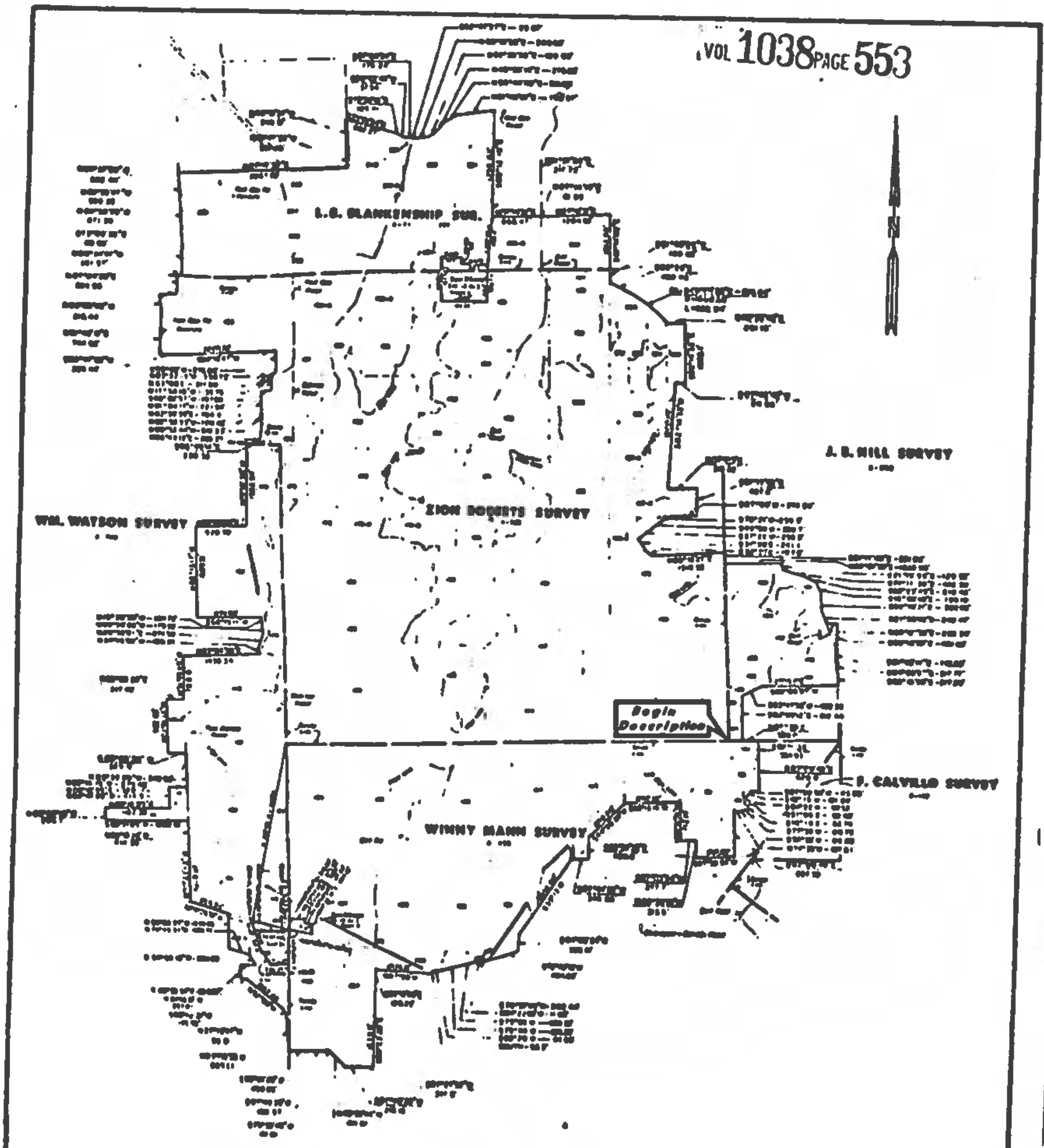
THENCE S 05° 42' 34" E, 98.91 feet to a point for Corner;

THENCE N 88° 40' 59" E, 127.04 feet to a point for Corner;

THENCE S 04° 27' 10" E, 204.16 feet to a point for Corner;

THENCE N 81° 10' 54" W, 421.92 feet to a point for Corner and the place of BEGINNING of the herein described Tract 3 and containing 2.15 acres of land.

After removing the above SAVE & EXCEPT three tracts, leaving a total net acres of 2,933.979 acres in the SWEPCO Henry W. Pirkey Plant-Lake Site.



SOUTHWESTERN ELECTRIC POWER
COMPANY

2933.979 ACRES

HENRY W. PIRKEY POWER PLANT
& LAKE SITE
(SOUTH HALLSVILLE AREA)

EX. "A" - Plat 1

FIELD NOTES OF 92.459 ACRES OF LAND

Being 92.459 acres of land located in the L. B. Blankenship Survey A-71 and the J. M. Dorr Survey A-4, Harrison County, Texas, said 92.459 acres being more particularly described as follows:
BEGINNING at the NE Corner of the Zion Roberts Survey, A-595, said point being in the SBL of the L. B. Blankenship Survey; THENCE West 8,223.6 feet and North 1,647.2 feet to a 3/8" iron rod for the SW Corner and the place of BEGINNING of the herein described 92.459 acres of land for Railroad ROW;
THENCE along the West side of said ROW the following bearing and distances along a chord of a curve to the left N 34° 18' 05" W, 578.51 feet; S 87° 00' W, 517.85 feet; N 03° 37' 20" W, 498.58 feet; N 02° 38' 59" W, 32.67 feet; N 44° 30' 30" W, 355.09 feet; N 35° 12' 14" W, 123.56 feet; N 44° 30' 30" W, 493.01 feet; S 02° 24' 10" E, 487.09 feet; S 85° 05' 01" W, 100 feet; N 02° 24' 10" W, 631.85 feet; N 44° 30' 40" W, 658.88 feet; N 19° 54' 28" W, 565.22 feet; N 02° 00' W, 1220.15 feet; N 35° 12' 47" W, 1161.63 feet; N 04° 31' 07" W, 567.01 feet; N 04° 30' W, 370.02 feet; N 05° 16' 24" W, 348.06 feet; N 04° 57' 36" W, 1081.2 feet; N 13° 33' W, 1638.26 feet; N 00° 43' W, 645.76 feet; N 82° 42' E, 65 feet; N 21° 05' E, 209.53 feet; N 29° 53' E, 992.71 feet; N 20° 25' E, 496.67 feet; N 10° 26' E, 1188.81 feet; N 00° 39' W, 653.68 feet; N 25° 35' W, 488.62 feet; N 29° 17' W, 936.37 feet; N 29° 12' W, 357.91 feet; Along a chord of a curve to the left N 72° 35' W, 1155.75 feet; S 73° 35' W, 333.39 feet to a 3/8" iron rod for Corner in the South ROW of the Missouri Pacific Railroad;
THENCE N 59° 49' 30" E, 1039.1 feet along the South ROW of the existing Missouri Pacific Railroad to a 3/8" iron rod for Corner, said point being S 59° 11' W, 1821.41 feet from the NE Corner of 168 acre tract recorded in Vol. 566 Page 669 Deed Records of Harrison County, Texas;
THENCE along the East ROW line of the herein described ROW the following bearings and distances: S 25° 05' E, 92.37 feet; along a cord of a curve to the right S 52° 20' E, 908 feet; S 28° 00' E, 1376.61 feet; along a cord of a curve to the right S 07° 42' E, 1167.78 feet; S 12° 52' W, 1339.07 feet; S 26° 41' W, 1130.38 feet; S 27° 17' W, 280.02 feet; along a cord of a curve to the right S 02° 42' W, 864.53 feet; S 13° 04' E, 1253.52 feet; S 16° 37' E, 75.6 feet, S 13° 13' 37" E, 322.57 feet; S 08° 13' 05" W, 1003.65 feet; S 03° 56' 43" E, 306.96 feet; S 04° 30' 30" E, 502.48 feet; along the cord of a curve to the left S 14° 15' 57" E, 361.37 feet; S 51° 50' 26" E, 547.96 feet; S 20° 30' 36" E, 699.34 feet; S 02° 42' 06" E, 242.28 feet; S 02° 00' E, 1158.63 feet; along a cord of a curve to the left S 29° 13' 16" E, 562.25 feet; S 44° 30' 30" E, 200.0 feet; N 88° 16' 34" E, 720.6 feet; S 02° 32' 45" E, 183.63 feet; S 03° 56' 28" E, 465.73 feet; S 02° 39' 05" E, 125.9 feet; S 40° 24' 29" E, 268.19 feet; S 44° 30' 30" E, 636.12 feet; S 48° 22' E, 334.49 feet; S 18° 46' 16" E, 216.73 feet along a chord of a curve to the right; S 26° 12' E, 200.68 feet and S 87° 17' 37" W, 172.0 feet to the place of BEGINNING of the herein described Railroad ROW SAVE AND EXCEPT 1.36 acres for the crossing of Interstate Highway No. 20 and 0.33 acre for the crossing of Highway 968 and leaving a total of 92.459 net acres.

I, Lee W. Newman, Registered Public Surveyor, do hereby certify that the above plat and field notes correctly represent the results of a survey made on the ground.

WITNESS MY HAND AND SEAL this the 12th day of January, 1983.

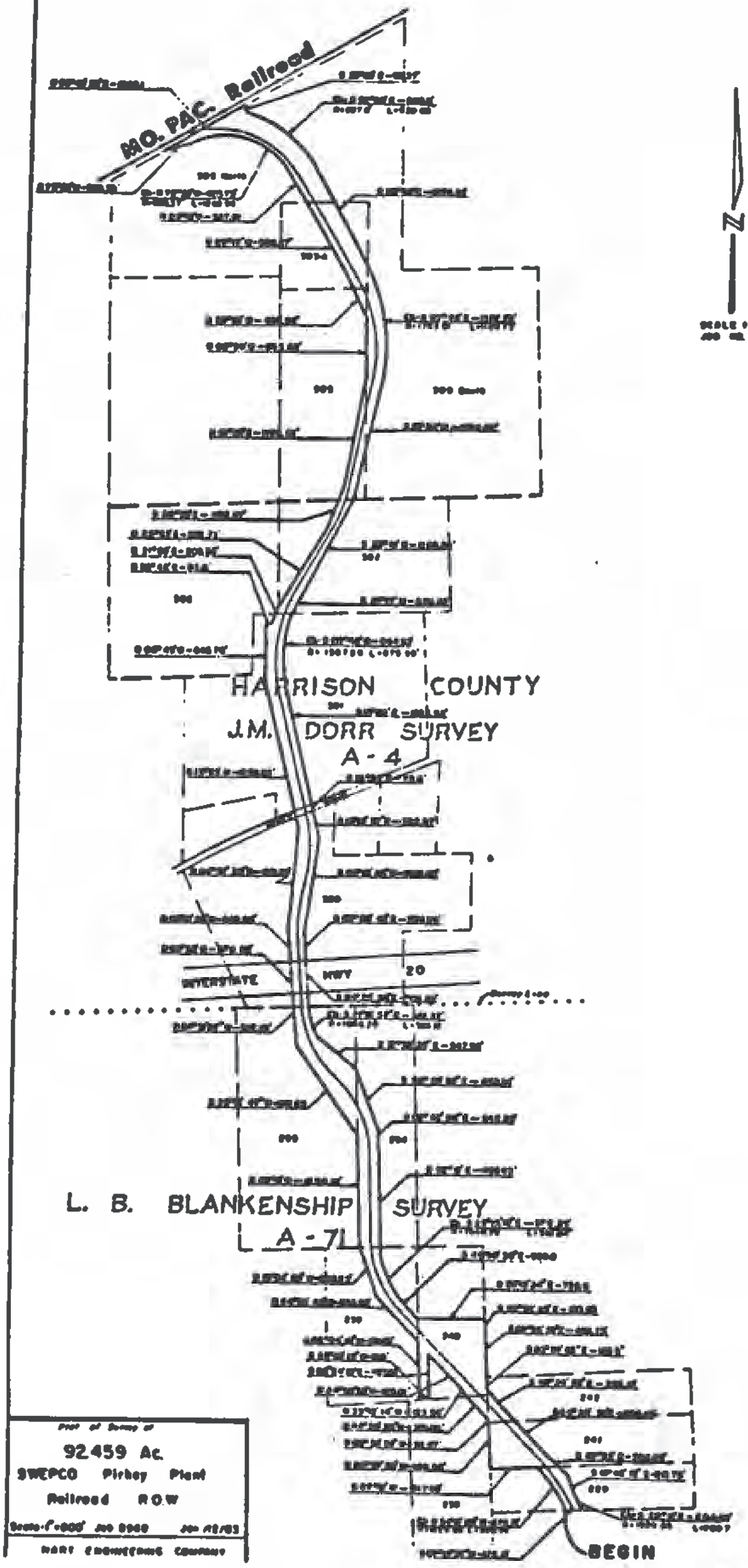
Lee W. Newman

REGISTERED PUBLIC SURVEYOR - NO. 3444

LEE W. NEWMAN
3444

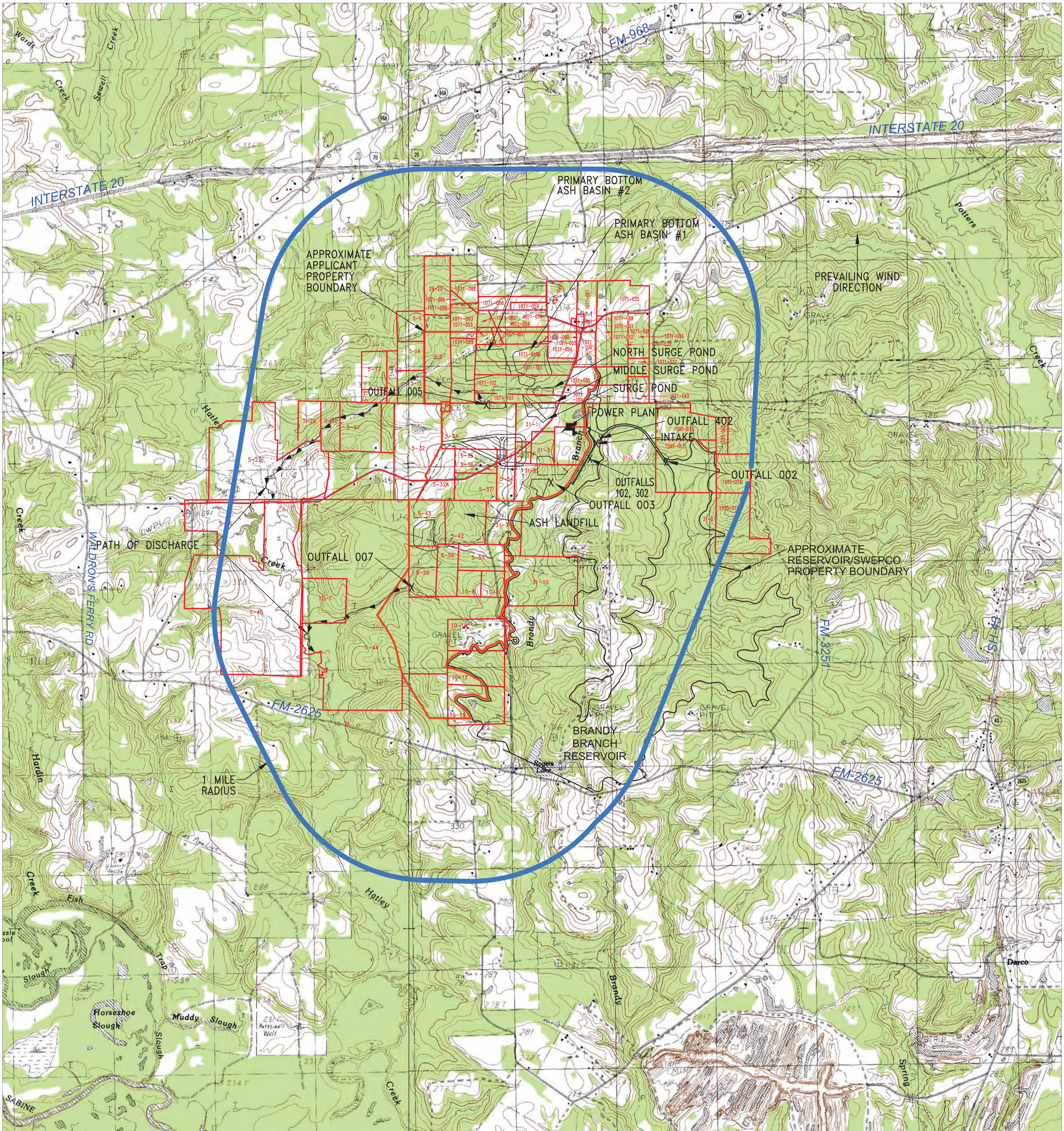
HART ENGINEERING COMPANY

LONGVIEW, TEXAS 75606


MO. PAC. Railroad
N
HARRISON COUNTY
J.M. DORR SURVEY
A - 4
INTERSTATE
HWY 20
L. B. BLANKENSHIP SURVEY
A - 71
BEGIN
Plat of Survey of
92.459 Ac.
SWEPCO Pirkey Plant
Railroad R.O.W.
Scale 1"=600'
HART ENGINEERING COMPANY

EX. "A" - Plat 2

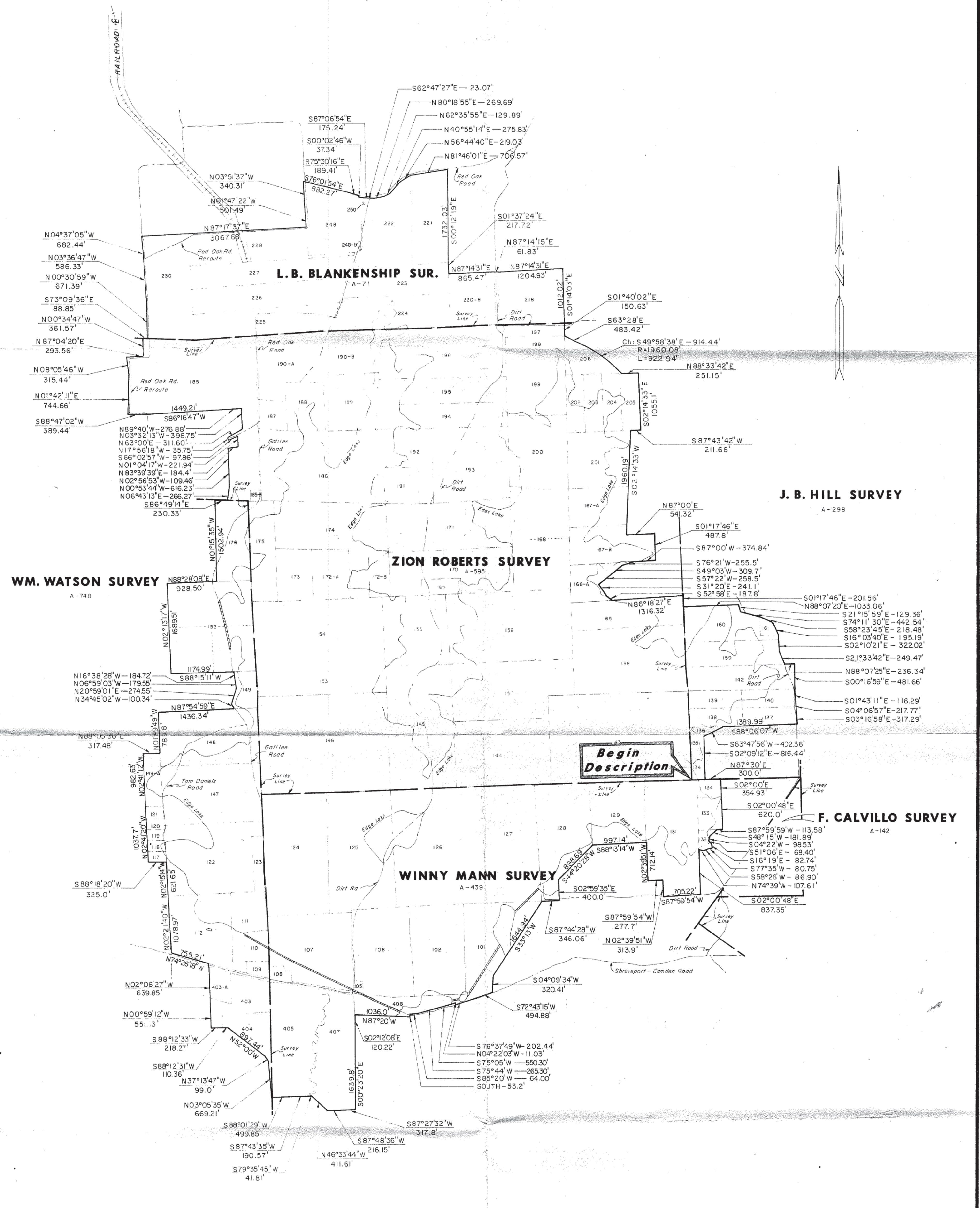
Survey Plat



AEP AMERICAN ELECTRIC POWER

PIRKEY POWER PLANT
SURVEY PLAT

Metes and Bounds Drawing



STATE of TEXAS
COUNTY of GREGG

I, FRED A PRATT, REGISTERED PUBLIC SURVEYOR, DO HEREBY CERTIFY THAT THIS PLAT CORRECTLY REPRESENTS THE RESULTS OF A SURVEY MADE ON THE GROUND

Fred A Pratt
REGISTERED PUBLIC SURVEYOR NO. 764

SOUTHWESTERN ELECTRIC POWER COMPANY

2960.05 ACRES

HENRY W. PIRKEY POWER PLANT & LAKE SITE (SOUTH HALLSVILLE AREA)

L. B. BLANKENSHIP, ZION ROBERTS, J.B. HILL, WINNY MANN & WM. WATSON SURVEYS
HARRISON COUNTY, TEXAS

Scale: 1" = 800'   Job No. 8176   Jan. 26, 1981

HART ENGINEERING COMPANY
P.O. Box 2804   LONGVIEW, TEXAS 75606

Section 17 Supplement

Legal Authority

Verification of Legal Status

Corporations Section
P.O.Box 13697
Austin, Texas 78711-3697

Ruth R. Hughs
Secretary of State

Office of the Secretary of State

Certificate of Fact

The undersigned, as Secretary of State of Texas, does hereby certify that the document, Application for Certificate of Authority for SOUTHWESTERN ELECTRIC POWER COMPANY (file number 1211806), a DELAWARE, USA, Foreign For-Profit Corporation, was filed in this office on June 04, 1947.

It is further certified that the entity status in Texas is in existence.

In testimony whereof, I have hereunto signed my name officially and caused to be impressed hereon the Seal of State at my office in Austin, Texas on March 09, 2021.

Ruth R. Hughs
Secretary of State

MAPS and DRAWINGS

General Maps: (30 TAC 352.231(e)) General location map in accordance with 305.45(a)(6) and 30 TAC 330.59(c)

Topographic Map – show regional surface water flow direction to area streams, rivers, ponds and lakes.

Facility Layout Map: show property boundary; all CCR unit outlines with name and location.

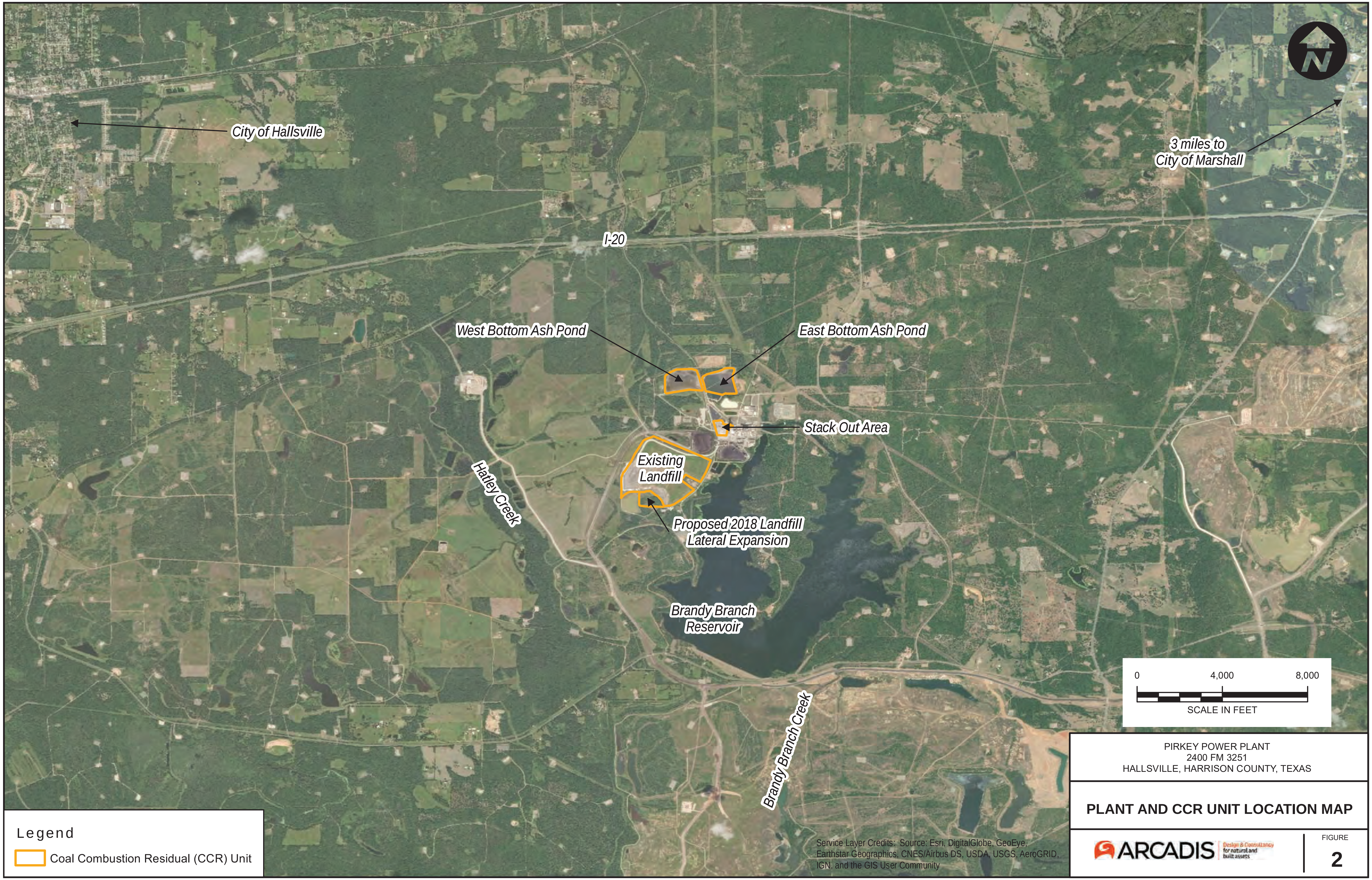
NA- Surrounding Features Map: show area streams, rivers, ponds, lakes and area at least 1000 feet beyond property. – (This is displayed on the TOPO MAP therefore there is no additional map)

Process Flow Diagram: provide word descriptions of the CCR process flow, depicting the handling, collection, storage and disposal of all CCR material within the facility from the boiler to the CCR units and other locations.

¼ mile Surrounding Land Ownership Map

Land Ownership List

General Map



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

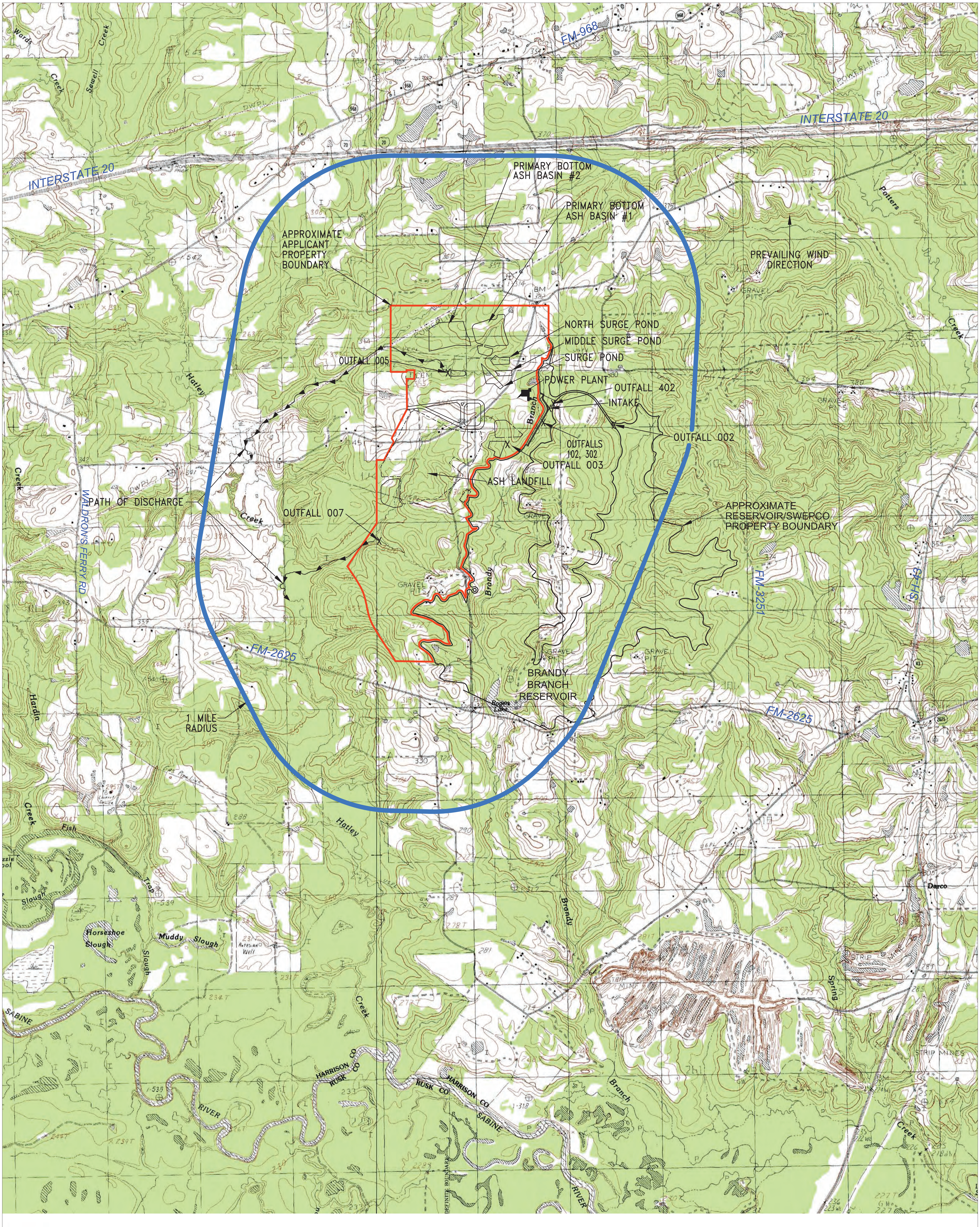
PLANT AND CCR UNIT LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

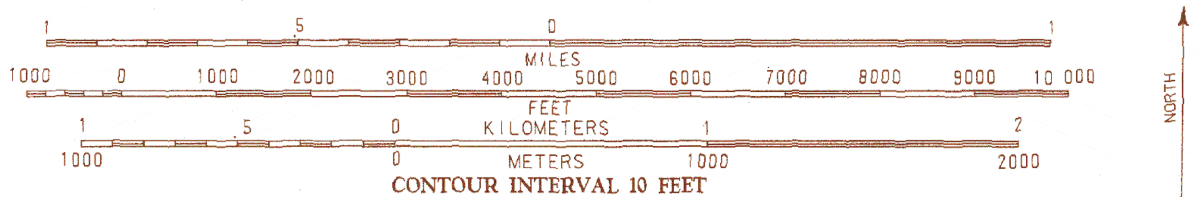
FIGURE
2

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd

General Topographic Map



PIRKEY POWER PLANT GENERAL LAYOUT AND TOPOGRAPHIC MAP



Facility Layout Map

PRELIMINARY - NOT FOR CONSTRUCTION

- - - - LIMITS OF CCR UNIT

no.	date	by	ckd	description	no.	date	by	ckd	description
A	06/22/20	KTM	MDB	ISSUED FOR EXTENSION REQUEST					

Z:\Clients\ENR\AEPSvc\AEPCCRELG\120792_PirkeyCCRELG\Design\Civil\Dwgs\Sketches\120792SK-C501.dgn

BURNS McDONNELL
9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Company, Inc.
Firm Reg. No. F-845

designed R. OWENS | detailed J. RIDDER

AMERICAN ELECTRIC POWER
BOUNDLESS ENERGY℠

CCR / ELG COMPLIANCE PROJECT
PIRKEY POWER PLANT
HARRISON COUNTY, TEXAS

CCR UNIT LOCATION MAP

project 120792
contract

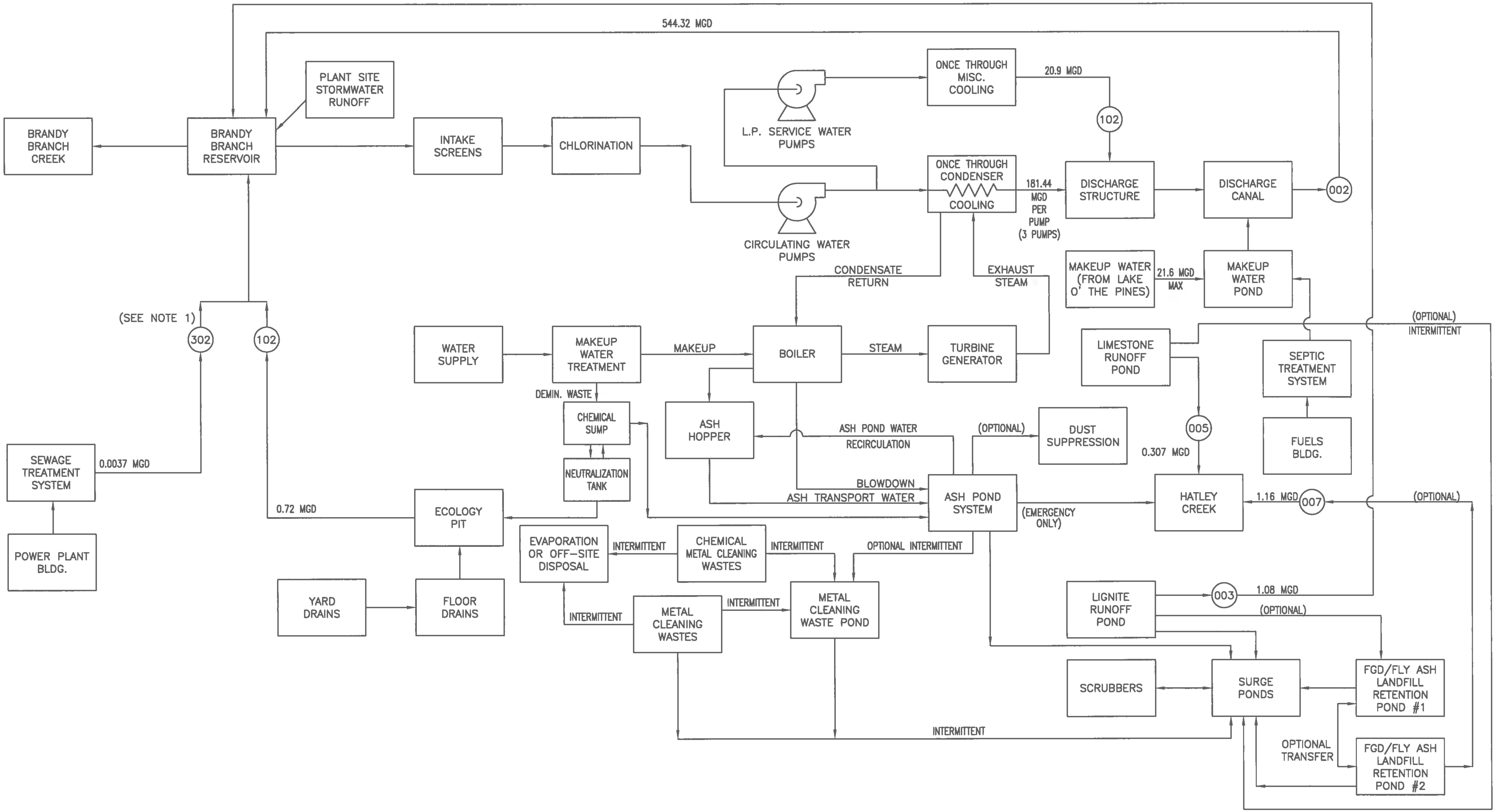
drawing SK - C501 — rev. A

sheet of sheets

file 120792SK-C501.DGN

6/22/2020

Process Flow Diagram



DATE	NO.	DESCRIPTION	APPD.
	4	ISSUED FOR REVISION	

PRELIMINARY - REFERENCE ONLY

REVISIONS

THIS DRAWING IS CLASSIFIED AS:

AEP CONFIDENTIAL

REFERENCE AEP's CORPORATE INFORMATION SECURITY POLICY

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SOUTHWESTERN ELECTRIC POWER COMPANY

HENRY W.PIRKEY PLANT

SOUTH HALLSVILLE TEXAS

ENVIRONMENTAL

SCHEMATIC OF WATER FLOW

UNIT: 1

DRAWING NUMBER: SWP07

REV: 4

SCALE:
DR:
CH:
SUP:
ENG:
DATE: SEE REV 0

CIVIL ENGINEERING

APPROVED BY

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

PLOT DATE: DD-MMM-YYYY
PLOT TIME: HOUR:MINUTE

Process Flow Description

Pirkey Power Plant

Water Balance Narrative (refer to Water Balance Diagram)

CCR Wastestreams:

The Bottom Ash Complex receives approximately 6.5 million gallons per day of sluiced water containing economizer and bottom ash. Pyrites, a non-CCR wastestream, are also managed with the CCR wastestreams.

AEP evaluated each CCR wastestream placed in the EBAP and WBAP at Pirkey Power Plant. For the reasons discussed below and in Table 1, the following CCR wastestreams must continue to be placed in the EBAP and WBAP due to lack of alternative capacity both on and off-site.

Table 1: Pirkey Power Plant CCR Wastestreams

CCR Wastestream	Average Flow (gpd)	Current Configuration	Alternative Capacity Currently Available? Yes/No	AEP Notes
Bottom Ash	6,500,000 (includes economizer ash and pyrites)	Bottom ash is currently alternately sluiced to the EBAP and WBAP. Ash from the pond not receiving sluice flows is cleaned with ash being transported to the onsite landfill.	No	There are currently no alternative CCR compliant ponds onsite and extensive modifications would be required to manage the bottom ash so that it could be disposed in the onsite landfill. These alternatives are not practicable for generating units that will retire in 2023.
Economizer Ash	Included with Bottom Ash flows	Sluiced to the existing EBAP and WBAP with bottom ash	No	There are currently no alternative CCR compliant ponds onsite and extensive modifications would be required to manage the economizer ash so that it could be disposed in the onsite landfill. These alternatives are not practicable for generating units that will retire in 2023.

CCR Wastestream	Average Flow (gpd)	Current Configuration	Alternative Capacity Currently Available? Yes/No	AEP Notes
Pyrites (non-CCR but handled with CCR wastestreams)	Included with Bottom Ash flows	Sluiced to the existing EBAP and WBAP using the existing bottom ash pumps and piping.	No	No alternate system is available for collection of pyrites which are comingled with bottom and economizer ash. Extensive modifications would be required to manage the pyrites so that it could be disposed in the onsite landfill. These alternatives are not practicable for generating units that will retire in 2023.

Pirkey Power Plant does not have an existing alternate impoundment on-site that meets the liner or aquifer separation requirements of EPA's CCR regulation, and considerable modifications to plant equipment, facilities, and processes will be necessary before Pirkey Power Plant can cease sluicing CCR and placing non-CCR wastestreams into the EBAP and WBAP. CCR sluicing flows are treated in the EBAP and WBAP to remove solids and then are recycled back to the plant for reuse. In order to meet the water quality requirements to support the plant operation and provide space for collection of solids, a new CCR compliant impoundment approximately 12 acres in size would be required. Since Pirkey Power Plant has elected to pursue the option to permanently cease combusting coal by a date certain, developing alternative disposal capacity is counterproductive to the work to retire the boilers and close the CCR surface impoundments. As EPA explained in the preamble of the 2015 rule, it is not possible for sites that sluice CCR material to an impoundment to eliminate the impoundment and dispose of the material offsite. See 80 Fed. Reg. 21,301, 21,423 (Apr. 17, 2015) ("[W]hile it is possible to transport dry ash off-site to [an] alternate disposal facility that is simply not feasible for wet-generated CCR. Nor can facilities immediately convert to dry handling systems."). A new CCR compliant impoundment would be required to treat the CCR flows as noted above.

If temporary frac tanks were used for treatment of the CCR sluice water and if 24 hours would provide sufficient residence time for the settling of the fine solids in the CCR wastestreams, approximately 650 frac tanks would be required to store and treat the bottom ash transport water. The number of tanks required was estimated by taking the total sluice flow (6.5 MGD) divided by the frac tank capacity (21,000 gallons) and doubling it to account for the 24 hours settling time requirement which resulted in 610 frac tanks. Because approximately 50 of these frac tanks would need to be rotated out of service each day for solids removal and disposal in the Pirkey landfill, an allowance, or emergency margin, of 50 frac tanks was added to this value, which resulted in a total of 660 tanks being required. These tanks would cover over 10 acres of the site. The tanks would require significant amounts of interconnecting piping which could create an unacceptable potential for significant leaks or spills.

For off-site disposal, 6.5 MGD on average would require approximately 866 trucks per day based on 7,500 gallons per truck to haul off and dispose of the water collected. This operation would need to take place 24 hours a day and 7 days a week and poses significant safety risks both on and off-site due to the truck traffic and is impossible to achieve.

The most likely facility type capable of managing industrial wastewaters are publicly-owned or private treatment works, underground injection wells, or publicly available waste management facilities capable of solidifying liquid wastes for disposal in a landfill. Given the volume and characteristics of the CCR wastestreams, increases in permitted capacity or other modifications to the permitted pretreatment programs of a public or private wastewater treatment facility would likely be required to manage this flow, if one were available. Off-site disposal is not an option for Pirkey Power Plant CCR material.

As a result, the conditions at Pirkey Power Plant satisfy the demonstration requirement in 40 CFR § 257.103(f)(2)(i) and in the interim period (prior to permanent cessation of the coal-fired boilers) Pirkey Power Plant must continue to use the EBAP and WBAP due to the absence of alternative disposal capacity both on and off-site of the facility.

Non-CCR Wastestreams:

Approximately 100,000 gallons per event of demineralizer regeneration waste.

AEP evaluated this non-CCR wastestream that is placed in the EBAP and WBAP at Pirkey Power Plant. For the reasons discussed below and in Table 2, this non-CCR wastestream must continue to be placed in the EBAP or WBAP due to lack of alternative capacity both on and off-site.

Table 2: Pirkey Power Plant non-CCR Wastestreams

Non-CCR Wastestream	Average Flow (gallons per event)	Current Configuration	AEP Notes
Demineralizer Regeneration Waste	100,000	Flows to the existing EBAP or WBAP	Regeneration of the existing anion and cation exchange resin beads occurs on a weekly basis as a batch treatment. The EBAP or WBAP provides treatment for this wastestream which allows it to be neutralized prior to returning to the plant. No alternative capacity exists for treatment.

Pirkey Power Plant does not have an existing alternate impoundment on-site that can be utilized for treatment of the non-CCR wastestream. As stated previously, since AEP has elected to pursue the option to permanently cease the use of the coal fired boilers by a certain date, developing alternative disposal capacity is “illogical,” to use EPA’s words, and also counterproductive to the work to retire the boilers and close the impoundments

There is currently no existing installed infrastructure at the plant to support reroute of these flows. Although this volume is significantly lower than the much larger volume of bottom ash transport water, rerouting this wastestream would require construction of additional treatment and storage capacity at the site, subject the facility to additional permitting obligations, and therefore is inconsistent with the work required to retire the unit and close the ponds.

Relative to the off-site disposal capacity for this non-CCR wastestream, the acidic nature of the wastestream makes it unacceptable at most off-site facilities without prior treatment. The most likely facility type capable of managing industrial wastewaters are publicly-owned or private treatment works, underground injection wells, or publicly available waste management facilities capable of solidifying liquid wastes for disposal in a landfill. Given the volume and characteristics of this non-CCR wastestream, increases in permitted capacity or other modifications to the permitted pretreatment programs of a public or private wastewater treatment facility would likely be required to manage this flow, if one were available.

There is neither on-site nor off-site capacity available to manage this non-CCR wastestream. Consequently, in order to continue to operate and generate electricity, Pirkey Power Plant must continue to use the Bottom Ash Complex to manage the non-CCR wastestream due to lack of alternative capacity both on and off-site.

Based on the evaluation of alternative disposal options, AEP selected the following options for compliance at Pirkey Power Plant:

- Cessation of the coal burning boilers
- Closure of the EBAP by CCR material removal.
- Closure of the WBAP by CCR material removal.

This strategy can be implemented in the least amount of time and accommodates the unique site features, quantity of wastestreams, and the lack of off-site disposal facilities.

Land Ownership Map


LEGEND
Green = SWEPCO Fee
Red = Partial Fee
Blue = AEP Plant Property
Yellow = Lease
N
0
400'
800'
1"=400'
1071-062
1071-079
1071-058
1071-057
1071-059
1071-049
1071-051
1071-079
1071-063
1071-053
1071-055
1071-090
1071-050
1071-106
1071-052
1071-100
1071-101
1071-099
1071-105
1071-102
1071-103
1071-104
RED OAK ROAD
5-5
5-14
5-17
5-16
5-15
5-18
5-33
5-31
5-32
5-34
31-01
31-2
5-35
5-36
31
5-32B
5-39A
5-38
5-37
5-32A
31-7
5-43
5-42
31-9
5-56
10-9
10-10

Land Ownership List

Tract ID	Name	Street Address	City	State	Zip Code
1071-089	Tommy Wobbington	9122 Red Oak Rd.	Hallsville	TX	75650
1071-087	Curtis Jones	600 Roberson	Hallsville	TX	75650
1071-051	Mt. Zion Free Will Baptist Church	9198 Red Oak Rd.	Hallsville	TX	75650
1071-049	James Earl Byers	9200 Red Oak Rd	Hallsville	TX	75650
1071-059	Jerry Michael and Annette McMullen	2700 Finklea Rd.	Hallsville	TX	75650
1071-058	Jerry Michael and Annette McMullen	2700 Finklea Rd.	Hallsville	TX	75650
1071-079	E. Johnson and Carrie Jones	3219 O Bannon Dr.	Dallas,	TX	75224
5-33	MT ZION CEMETERY	NO KNOWN ADDRESS			
5-32	Rene Vinces	628 Pumpkin Center Rd.	Marshall	TX	75672

ATTACHMENT 1

Location Restrictions and Geology Reports

30 TAC §352.241- Geology

Location Restriction Reports containing a summary of the geologic conditions at the facility and were prepared and signed in accordance with 30 TAC §352.4. All groundwater monitoring data is located in the annual Groundwater Monitoring and Corrective Action Reports (see, Attachment 4b).

30 TAC §352.251 - Location Restriction Application Submission

These Location Restriction reports contain documentation demonstrating compliance with applicable location restrictions in Subchapter E of 30 TAC §352 and information required by Placement above the uppermost aquifer (30 TAC §352.601/40 CFR §257.60), Wetlands (30 TAC §352.611/40 CFR §257.61), Fault Areas (30 TAC §352.621/40 CFR §257.62), Seismic impact zones (30 TAC §352.631/40 CFR §257.63), and Unstable areas (30 TAC §352.641/40 CFR §257.64) were applicable.

Terms used in these reports comport with 30 TAC §352.3/40 CFR §257.53

Geology Summary Report – See Section 2.4 in the Location Restriction Report

Submit a summary of the geologic conditions at the facility, including the relation of the geologic condition to each CCR unit. The summary must include enough information and data and include sources and references for the information. Include all groundwater monitoring data required by 40 CFR Part 257, Subpart D, (30 TAC §352.241, §352.601, §352.621, §352.631, and §352.641) and submitted in accordance of 30 TAC §352.4.

1.1 – East Bottom Ash Pond – CCR Location Restriction Evaluation, July 6, 2016

ARCADIS

East Bottom Ash Pond – CCR Location Restriction Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Kenneth J. Brandner
Geology
1787

Kenneth Brandner

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matthew J. Lamb

Matthew J. Lamb
Project Manager

John Holm

John Holm, P.E.
Principal Engineer

Prepared for:
AEP

Prepared by:
ARCADIS U.S., Inc.
100 E Campus View Blvd
Suite 200
Columbus
Ohio 43235-1447
Tel 614 985 9100
Fax 614 985 9170

Our Ref.:
OH015976.0010

Date:
July 6, 2016

Table of Contents

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
PTI	Permit to Install
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the location of the East Bottom Ash Pond relative to the location restrictions included in the Coal Combustion Residual (CCR) requirements, as specified in the Code of Federal Regulations (CFR) 40 CFR 257.60 to 257.64, at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zones, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West Bottom Ash Pond (BAP), East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the location restriction criteria at the East BAP (Site). The evaluation of the groundwater monitoring well network in the uppermost aquifer for the East BAP is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the East BAP CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on documents reviewed and will further describe the uppermost aquifer.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant East BAP.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The East BAP CCR unit is located at the north end of the Plant and approximately 2,000 feet north-northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of East Bottom Ash Pond CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the East BAP.

2.2.1 Embankment Configuration

The East BAP is partially incised into native soils with an embankment height of approximately 4 feet (AMEC, 2011). The East BAP embankments are constructed of compacted clay on a 3:1 slope (3 feet horizontal, 1 foot vertical) (Sargent & Lundy, 1983). The elevation of the top of the embankment around the perimeter of the East BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, May 2011). The interior bottom elevation of the East BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Johnson & Pace, June 2011).

2.2.2 Area/Volume

The East BAP is approximately 31.5 acres in size. The design maximum ash storage capacity of the East BAP is 188 acre feet (Sargent & Lundy, 1983). Johnson & Pace calculated the East BAP ash storage capacity in 2011 at 161 acre feet at an elevation of 355 feet amsl (maximum operating level) (Johnson & Pace, June 2011).

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant East BAP was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, flue gas desulfurization sludge) have been generated. The East BAP, which was placed into operation in 1985, receives bottom ash and economizer ash sluiced from the power plant boiler (**Figure 3**). Clear water overflow from the East BAP discharges into the Clearwater Pond located directly south of the East BAP. Bottom ash and economizer ash are periodically excavated from the East BAP and hauled by truck to either the on-site landfill for disposal, or for beneficial re-use.

The base of the East BAP was constructed in 1983 with a compacted clay liner (Sargent & Lundy, 1983). Following installation of the compacted clay liner, soil borings S-4 through S-7 were advanced below the base of the East BAP to total depths of six feet in September 1983 (Southwestern Laboratories, 1984). The lithologic data from soil borings S-4 through S-7 confirm at least six feet of clay is present below the base of the East BAP (Sargent & Lundy, 1984).

2.2.4 Surface Water Control

Surface water elevation in the East BAP is controlled by a weir box and a manually operated gate valve on a 36-inch-diameter discharge pipe at the southwest corner of the pond. Clear water overflow from the East BAP discharges through the 36-inch-diameter pipe into the 2.7- acre Clearwater Pond located directly south of the East BAP (Figure 3). Water in the Clearwater Pond is either pumped (re-circulated) back into the boiler ash hopper, or gravity discharged through a pipe at the southwest corner of the Clearwater Pond into an unnamed intermittent tributary of Hatley Creek via Outfall 006 in accordance with Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0002496000.

2.3 Previous Investigations

The initial soils investigation and design of the East BAP was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, and design of the East BAP. As discussed above in Section 2.2.3, the design included installation of a clay liner below the East BAP.

In September-October 1983, Southwestern Laboratories conducted a soil investigation at the Plant, including advancement of four soil borings (S-4 through S-7) below the East BAP (Southwestern Laboratories, 1984).

In 1984, Sargent & Lundy conducted an evaluation of the East BAP. This report included evaluation of soil sample geotechnical data, and concluded a low-permeability clay liner was present below the East BAP (Sargent & Lundy, 1984).

In 2009, ETTL Engineers & Consultants (ETTL) conducted a geotechnical investigation of the East BAP earthen embankment. The investigation included installation of two soil borings through the embankment (E1, E2), completion of the soil borings as piezometers PE-1 and PE-2, respectively, and collection of soil samples for geotechnical analyses. The report concluded the embankment was stable and the existing embankment slopes were acceptable if conditions are maintained (ETTL, 2010). The conditions to be maintained included embankment protection from erosion (vegetative cover), removal of brush and trees two feet or more in height, and control of animal burrowing.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed a hydraulic analysis of the East BAP for a 10-year, 24-hour rainfall event in accordance with the TCEQ TPDES permit design criteria. The report concluded the storage capacity of the East BAP is hydraulically adequate (Johnson & Pace, May 2011).

In 2015, Auckland Consulting further expended the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-30 through AD-35 (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the East BAP area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the East BAP, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow groundwater flow direction in the area of the East BAP is west-southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The East BAP is located approximately 2,000 feet north-northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the area of the East BAP does not discharge into Brandy Branch Reservoir. Brandy Branch Reservoir likely recharges the uppermost water bearing unit in the southern portion of the Plant, where the pool level in the Reservoir (340 feet amsl) is higher than water level elevations in monitoring wells located southwest (downslope) of the Reservoir.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 500 feet south (side gradient) of the East BAP in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile southwest (downgradient) of the East BAP for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (up gradient) of the Pirkey Power Plant.

3. Isolation from the Uppermost Aquifer

CCR Rule 40 CFR Part 257.60 requires that the base of new and existing CCR surface impoundments be constructed such that the base of the unit is no less than 5 ft above the top of the uppermost aquifer, or that if the base is within 5 ft of the uppermost aquifer, that there will not be hydraulic connection between the base of the unit and the uppermost aquifer.

3.1 Uppermost Aquifer and Piezometric Analysis

3.1.1 Piezometric Analysis

3.1.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost water bearing unit in the area of the East BAP is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 15 feet that is located between an elevation of approximately 325 and 340 feet amsl (**Appendix A**). The base of the East BAP is at an elevation of 347 feet amsl. Therefore the separation distance between the uppermost water-bearing unit and the base of the East BAP is approximately seven feet. This separation distance is further illustrated on cross section A-A' (**Figure 4)** and cross section E-E' (**Figure 8**).

3.1.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost water bearing unit (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness (approximately 15 feet), the yield of the uppermost water-bearing unit is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Available groundwater elevations are summarized on **Table 1** for 2011 through 2016. The most recent comprehensive groundwater data set from January 2016 is depicted on **Figure 9**. The groundwater flow is west-southwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

3.1.2 Uppermost Aquifer

3.1.2.1 CCR Rule Definition

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers, that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural groundwater surface to which the aquifer rises during the wet season.

3.1.2.2 Common definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.1.3 Identified onsite hydrostratigraphic unit

The identified Site hydrostratigraphic unit in the area of the East BAP is the clayey and silty sand stratum that is located between an elevation of approximately 325 and 340 feet amsl.

3.2 Compliance with Isolation Distance

The uppermost water-bearing unit underlying the East BAP meets the regulatory definition of an aquifer. As shown on the cross-sections presented on **Figures 4** and **8**, the base of the East BAP is six feet or more above this aquifer. Therefore, this CCR Unit complies with the requirement for placement above the uppermost aquifer. Also, four soil borings (S-4 through S-7) were advanced six feet below the base of the East BAP in 1983 following installation of the clay liner, and these four soil borings confirm the presence of the clay liner below the East BAP.

4. Wetlands

CCR Rule 40 CFR Part 257.61 requires that existing and new CCR surface impoundments must not be located in wetlands.

4.1 Local Wetlands

Based on the August 19, 2015 site visit and review of available published information, the East BAP is not located within an area that exhibited wetland characteristics that might be classified as a regulated wetland. Photos of the East BAP area are included in **Appendix B**, and **Figure 10** is a map showing wetlands locations in the CCR unit area.

4.2 Compliance with Wetland Restrictions

Based on the August 19, 2015 site visit and review of available information, the East BAP does not contain wetlands. Therefore, this CCR Unit complies with the requirement for not being located in a wetlands.

5. Fault Areas

CCR Rule 40 CFR Part 257.62 requires that existing and new CCR surface impoundments must not be located within 200 feet of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates that an alternate setback will prevent damage to the structural integrity of the CCR unit.

5.1 Description of Regional Geologic Structural Features

Regional geologic publications were reviewed to determine structural features for the Site. A regional fault map is provided on **Figure 11**. The U.S. Geological Survey Open File Report 88-450K shows the Site is located within the East Texas Basin, with faulting north of the basin (Talco Fault Zone) and south of the basin (Elkhart-Mt. Enterprise Fault Zone). No faulting was identified in the Site area (USGS, 1988). Texas Water Development Board Report 27, and the University of Texas at Austin Bureau of Economic Geology Geologic Atlas of Texas – Tyler Sheet show no faulting at the Site (Broom, 1966; Flawn, 1965).

A previous evaluation of geologic structural features at the Site was conducted by ETTL, and no evidence of faulting was identified (ETTL, 2010).

5.2 Compliance with Fault Area Restrictions

A review of available geologic reports and maps has indicated that the Site is not located near any faults with displacement in the Holocene. Therefore, the CCR unit complies with the requirement for not being located within 200 feet of the outermost damage zone of a fault that has had displacement in Holocene time.

6. Seismic Impact Zone

CCR Rule 40 CFR Part 257.63 requires that existing and new CCR surface impoundments must not be located within a seismic impact zone unless the owner or operator demonstrates that all structural components of the CCR unit are designed to withstand the maximum horizontal acceleration in lithified earth material for the site.

6.1 Definition of Seismic Impact Zone

CCR Rule 40 CFR Part 257.53 defines a seismic impact zone as an area having a 2% or greater probability that the maximum horizontal acceleration expressed as a percentage of the earth's gravitational pull (g) will exceed 0.10 g in 50 years.

6.2 Compliance with Seismic Impact Zone Restriction

Figure 12 presents the seismic hazard map for Texas, as published by the USGS. As shown on **Figure 12**, the Site falls within the zone having a maximum horizontal acceleration of 0.04 to 0.06 g. Therefore, the CCR unit complies with the requirement for not being located in a seismic impact zone.

7. Unstable Areas

CCR Rule 40 CFR Part 257.64 requires that existing and new CCR surface impoundments must not be located within an unstable area unless the owner or operator demonstrates that the design of the unit will ensure the integrity of the structural components of the unit.

7.1 Definition of Unstable Area and local Conditions

7.1.1 CCR Rule Definition

CCR Rule 40 CFR Part 257.53 defines an unstable area as a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of the CCR unit. These may include poor foundation conditions, areas susceptible to mass movements (landslides), and karst terrains.

7.1.2 Poor Foundation Soils

The East BAP design report was prepared by Sargent & Lundy in 1983 (Sargent & Lundy, 1983). The East BAP was constructed in 1983 using compacted clay. The specifications included installation of clay embankments with 3:1 slopes (3 feet horizontal, 1 foot vertical) around the perimeter of the pond with a crest (top of embankment) elevation of 357 feet amsl, and compaction of the clay embankments to ≥95% standard proctor density. The specifications also included emplacement of a compacted cohesive clay lining below the pond base elevation of 347 feet amsl.

ETTL conducted a geotechnical investigation of the East BAP earthen embankment in 2009. The investigation included installation of two soil borings through the embankment (E1, E2), completion of the soil borings as piezometers PE-1 and PE-2, respectively, and collection of soil samples for geotechnical analyses. The report noted the East BAP was cut (incised) into native soils with minimal embankment heights. The report concluded the embankment was stable and the existing embankment slopes were acceptable if conditions are maintained (ETTL, 2010). The conditions to be maintained included embankment protection from erosion (vegetative cover), removal of brush and trees two feet or more in height, and control of animal burrowing.

7.1.3 Mass Movements

The East BAP is not located within an area subject to mass movements. This conclusion is supported by the ETTL soil stability report (ETTL, 2010).

7.1.4 Karst

The site area is located on the outcrop of unconsolidated Cretaceous Formations consisting predominantly of sand and clay (Broom, 1966; Flawn, 1965). The East BAP is not located in a karst area.

7.1.5 Subsurface Mining

No subsurface mines are known to exist below the CCR units at the Site.

7.2 Compliance with Unstable Areas Restriction

Based on our site visit and review of available information, the East BAP is not located within unstable areas. Therefore, this CCR unit complies with the requirement of not being located in an unstable area.

8. Summary, Conclusions, and PE Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, as well as the evaluations discussed within this report, the H.W. Pirkey Power Plant East Bottom Ash Pond complies with the requirements of the location restrictions sections of 40 CFR 257 Subpart D that apply to surface impoundments and therefore the CCR unit is not located in a restricted location.

Kenneth J. Brandner
Printed Name of Registered Professional Engineer

Kenneth J Brandner
Signature

KENNETH J. BRANDNER
69586

69586
Registration No.

Texas
Registration State

7-6-16
Date

9. References

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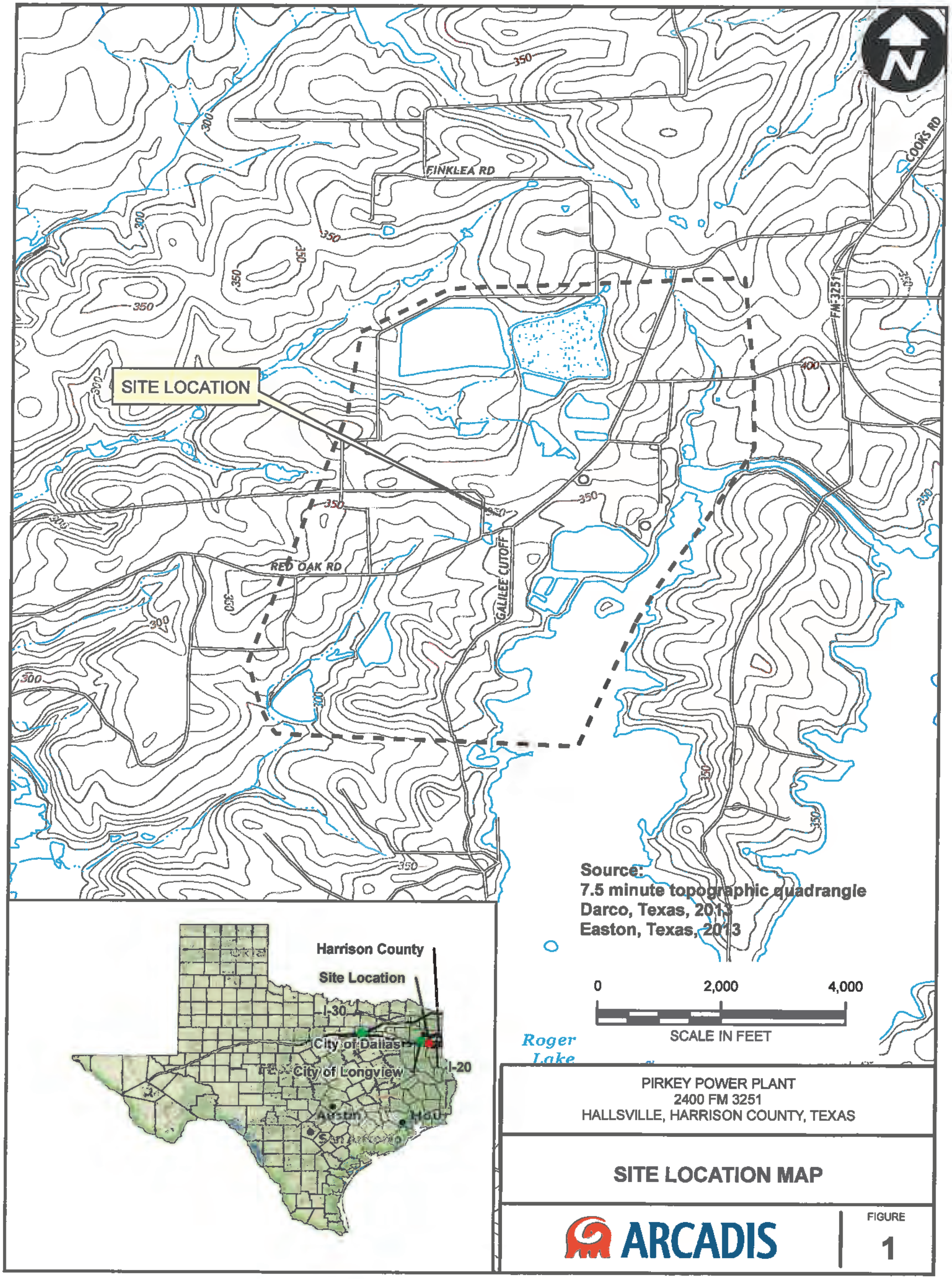
Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen(b)		Bottom of Screen(b)		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers(c)																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
NM - Not Measured



Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

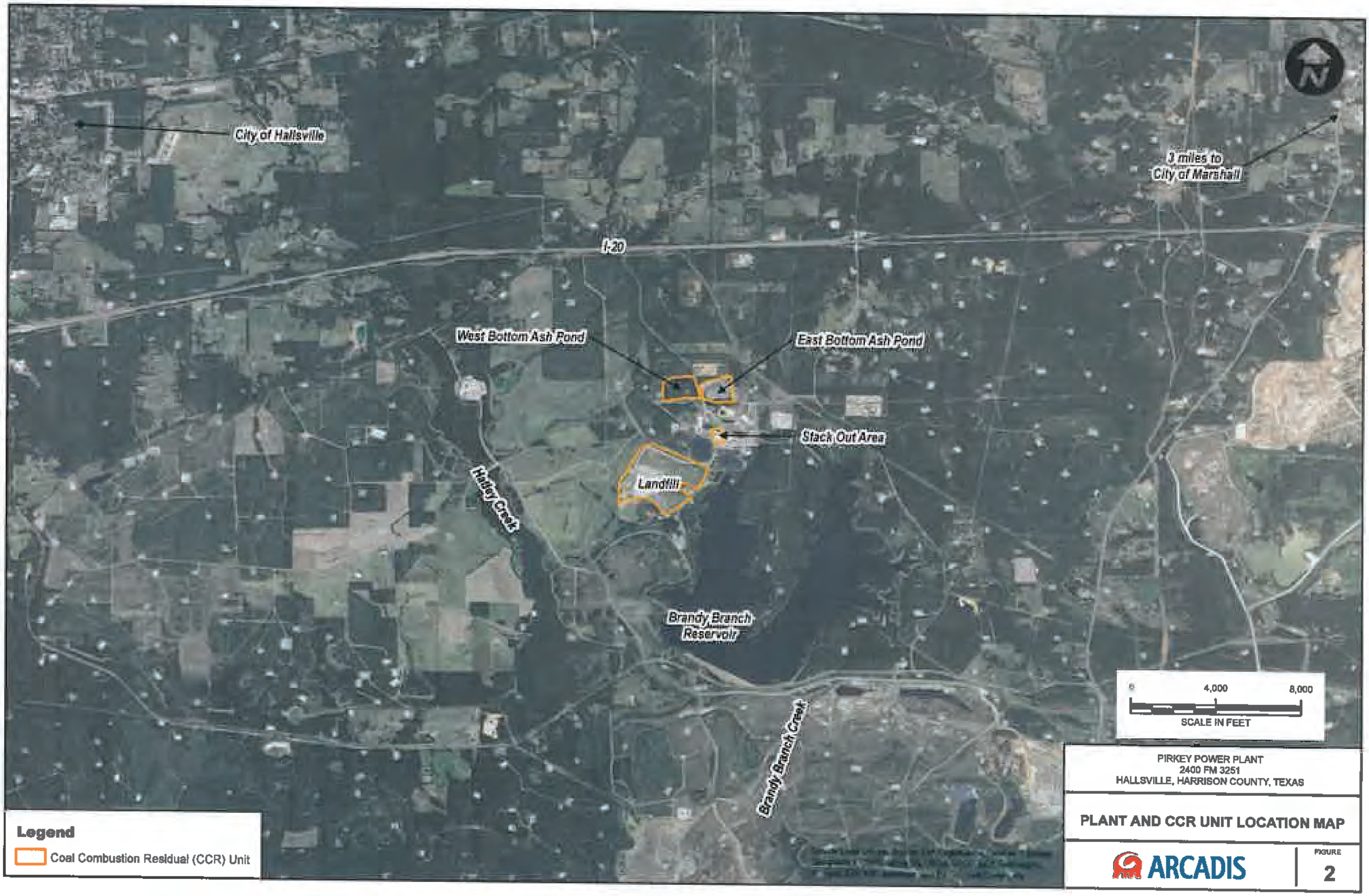
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENVAEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd



Legend

▭ Coal Combustion Residual (CCR) Unit

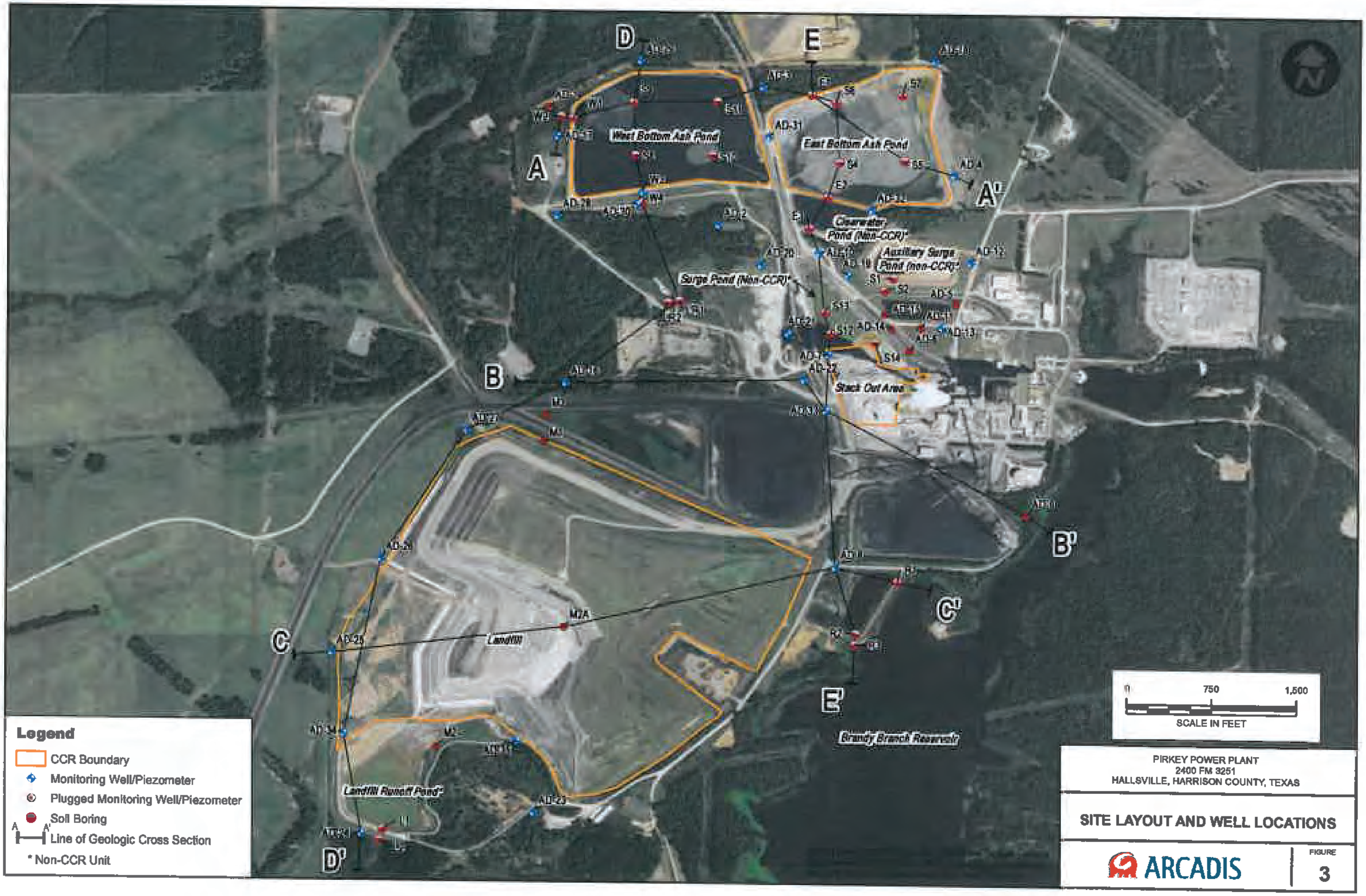
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



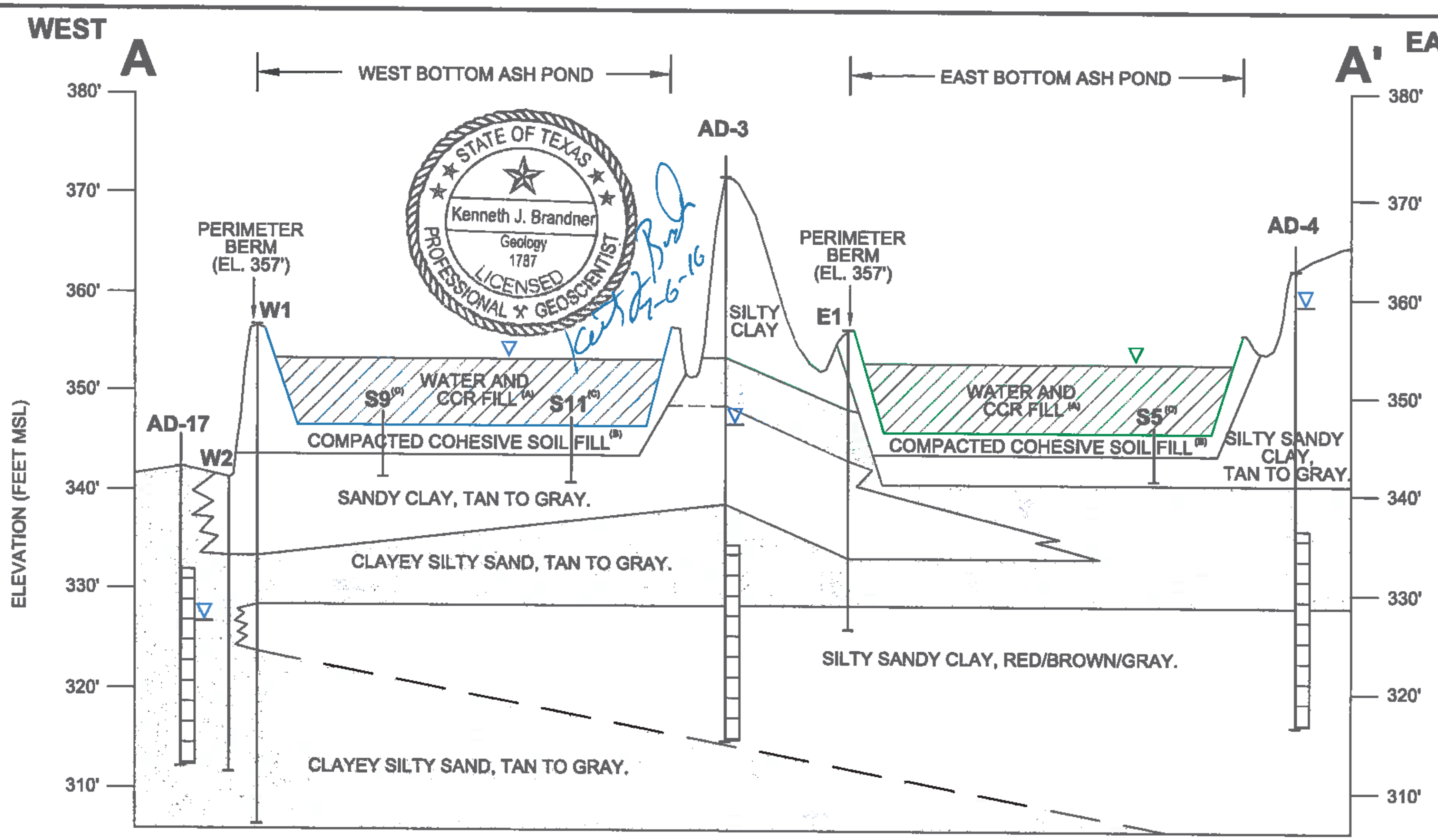
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE
3

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



Kenneth J. Brandner
Geology
1787

4-6-16

0 300'
HORIZONTAL SCALE

LEGEND

▯	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).

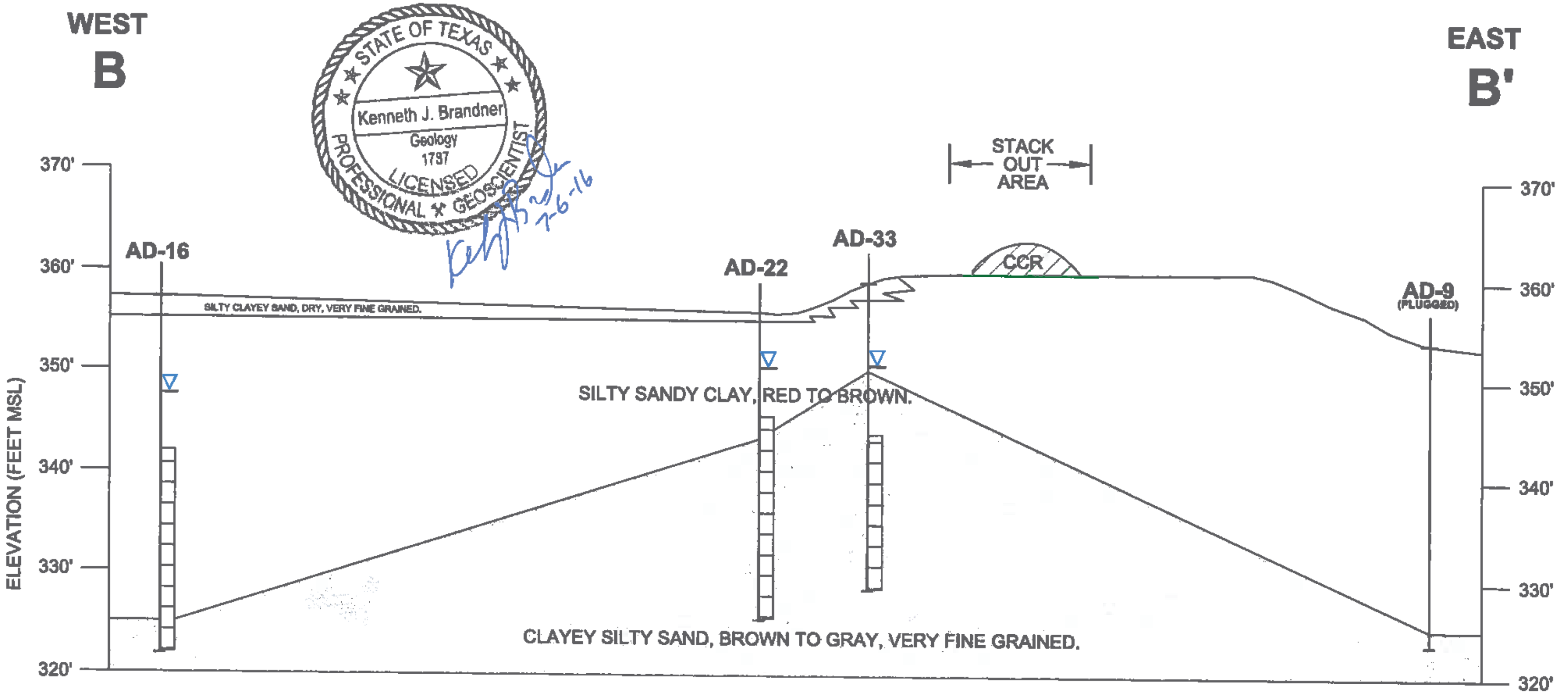
C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4



Kenneth J. Brandner
Geology
1797

7-6-16

LEGEND

- ▯ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

NOTES:
A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
LAYOUT: MODEL SAVED: 2/18/2016 1:49 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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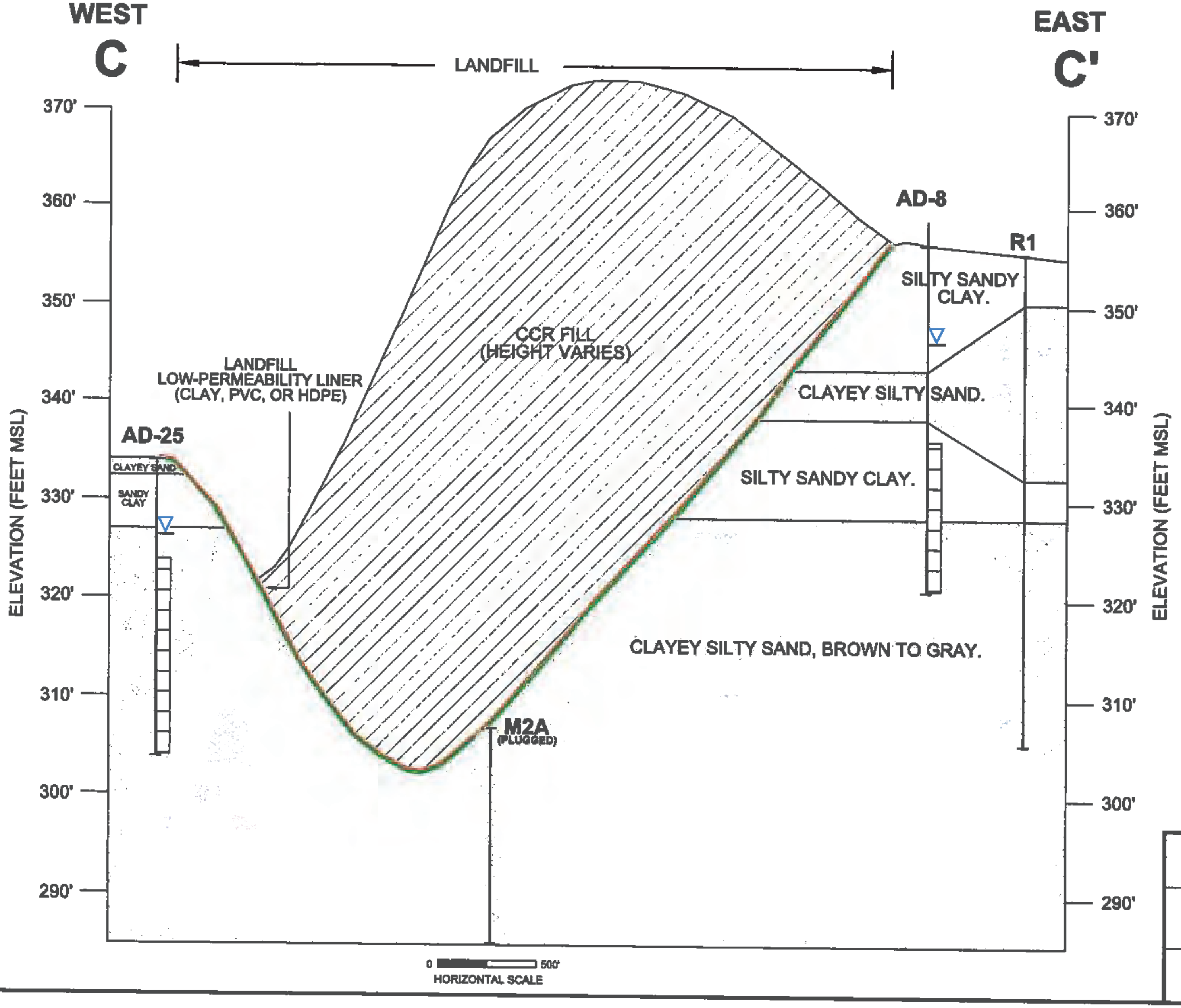


LEGEND

- ▯ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

Kenneth J. Brandner
Geology
1787

Kenneth J Brandner 7-6-16

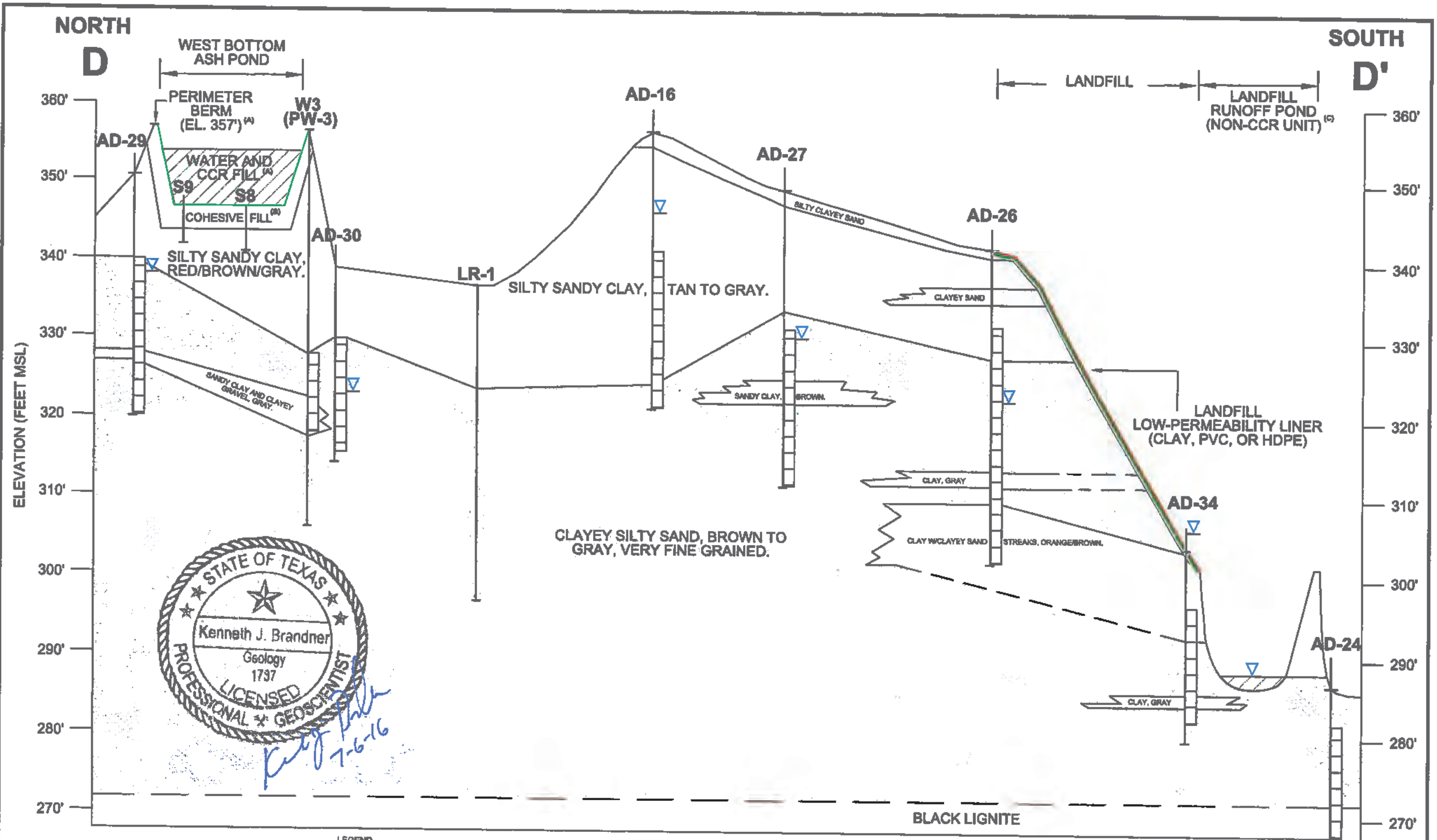
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6

CITY: DIVGROUP: DB: LD: AM: PO: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\CHD18878 - CCR Rpt Assessment\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 2/18/2016 2:28 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
— PLOTTED: 2/22/2016 11:18 AM BY: LEASE, DIANA



Kenneth J. Brandner
Geology
1737
7-6-16

LEGEND

- ▯ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

0 600'
HORIZONTAL SCALE

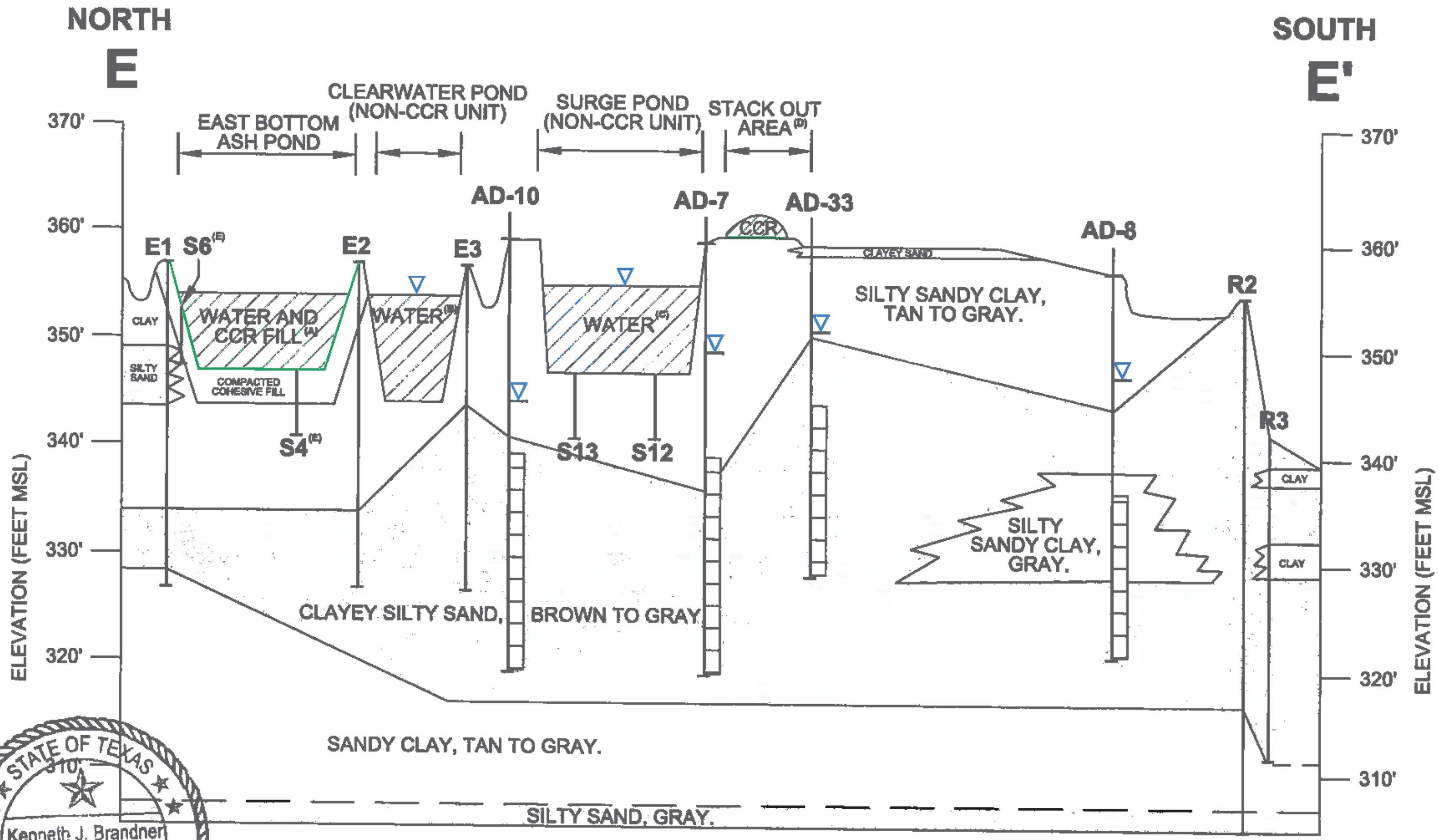
NOTES:
A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL, NORMAL OPERATING LEVEL 286' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS

FIGURE
7



Kenneth J. Brandner
Geology
1787

KJB 7-6-16

0 500'
HORIZONTAL SCALE

LEGEND

⌸	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

NOTES:

A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).

C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".

D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.

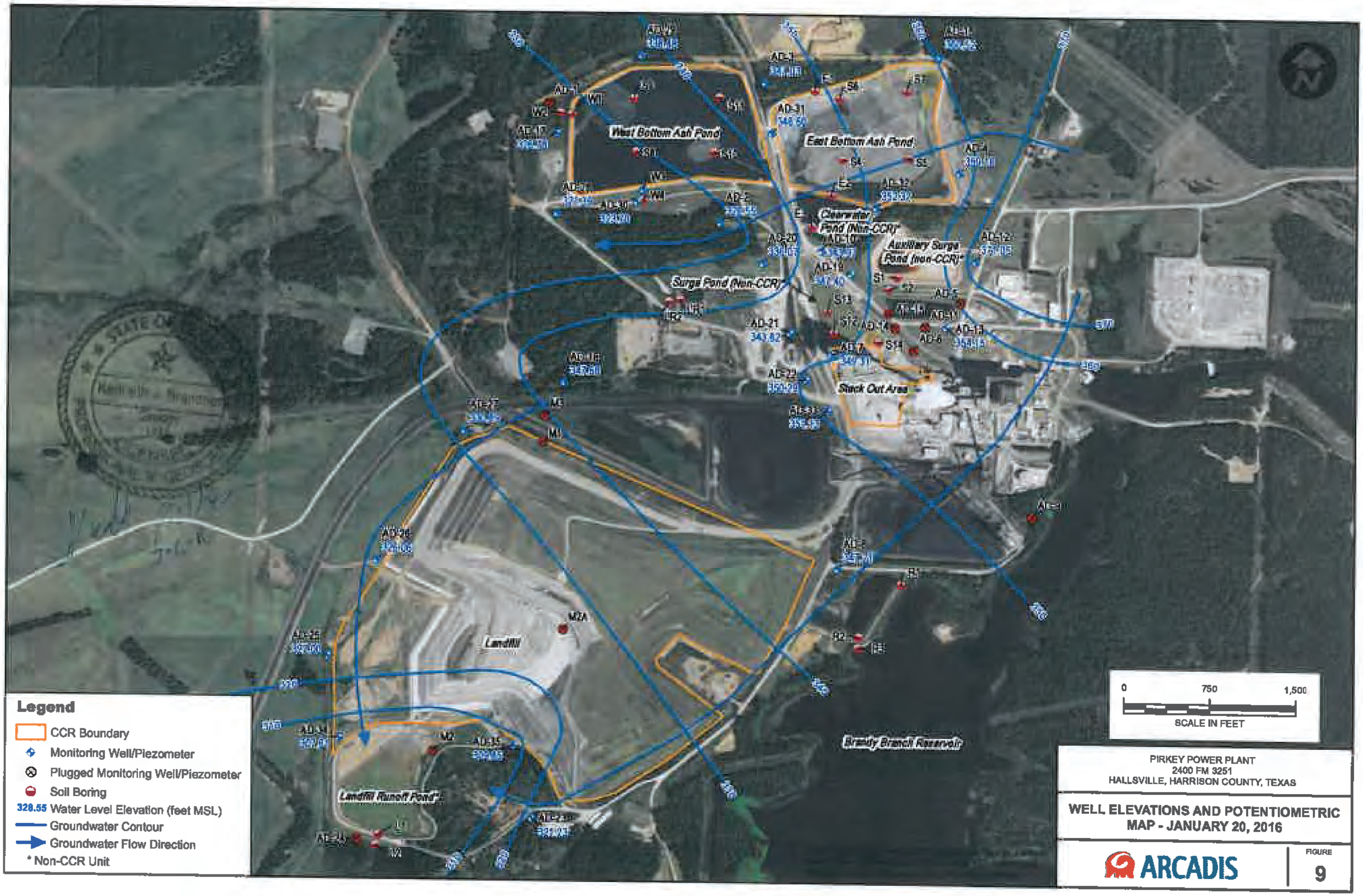
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8



Legend

- 🟧 CCR Boundary
- ◆ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ● Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- — Groundwater Contour
- ➔ Groundwater Flow Direction
- * Non-CCR Unit

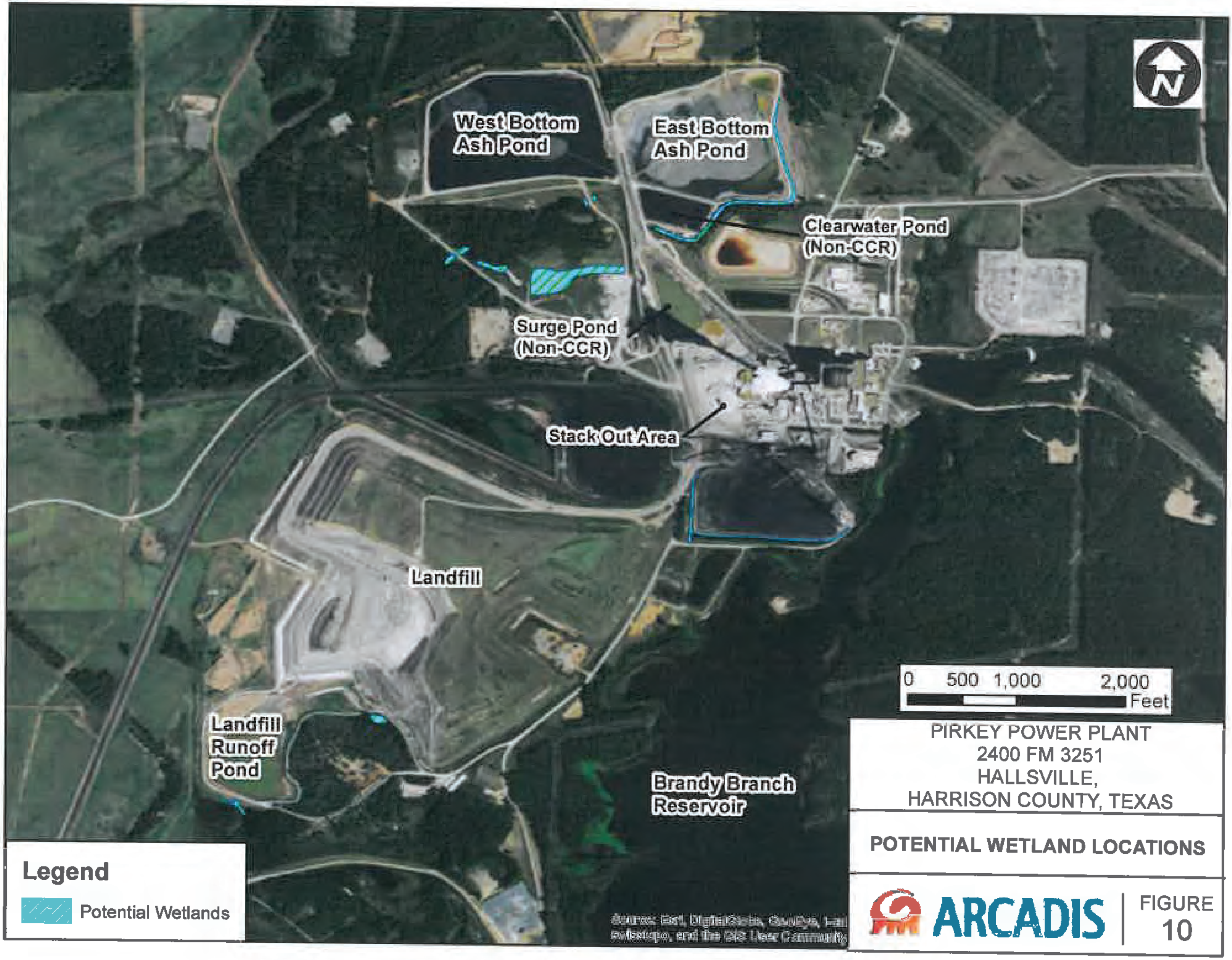
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

ARCADIS

FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd

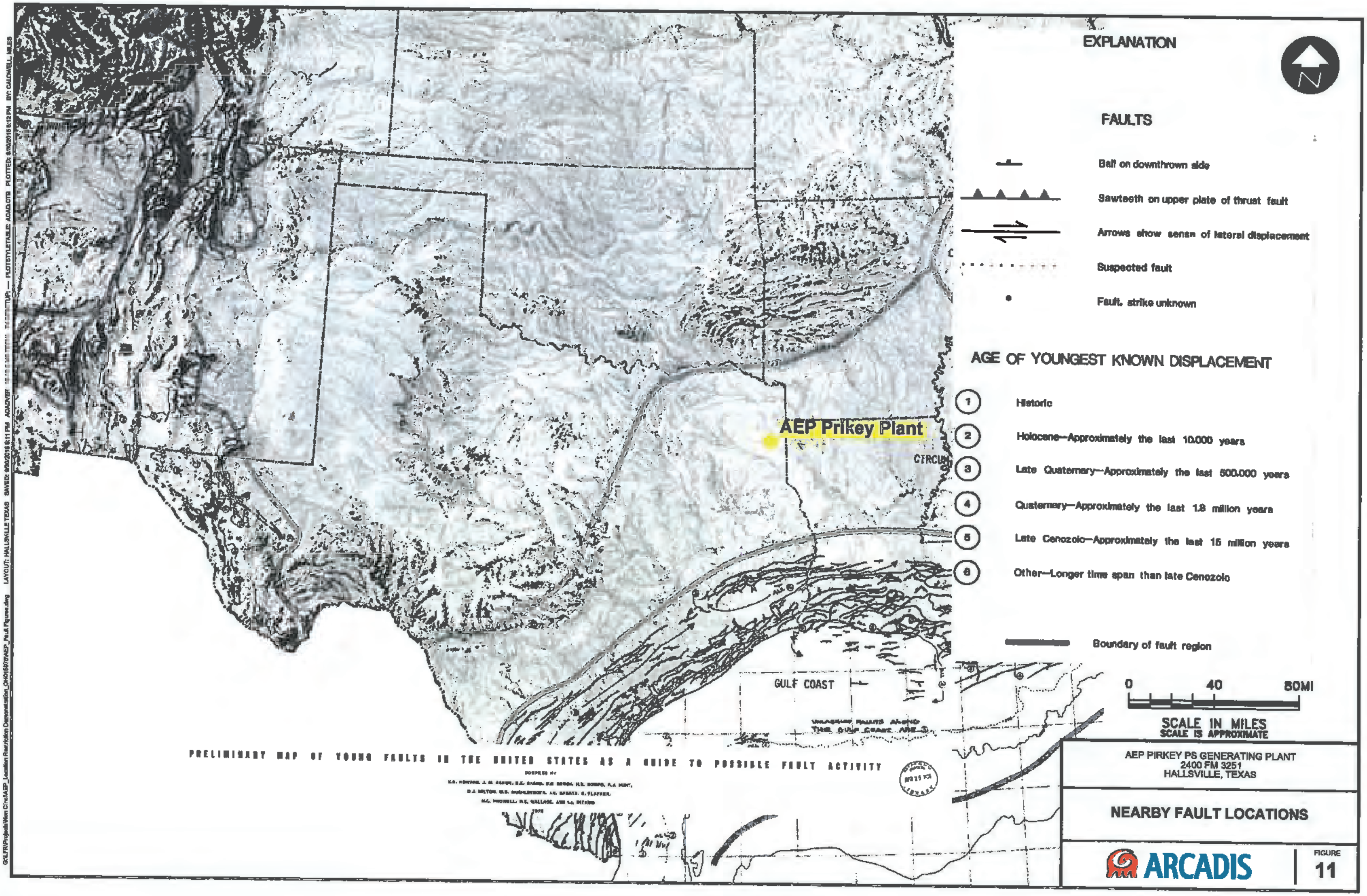


PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE,
HARRISON COUNTY, TEXAS

POTENTIAL WETLAND LOCATIONS

ARCADIS

FIGURE
10



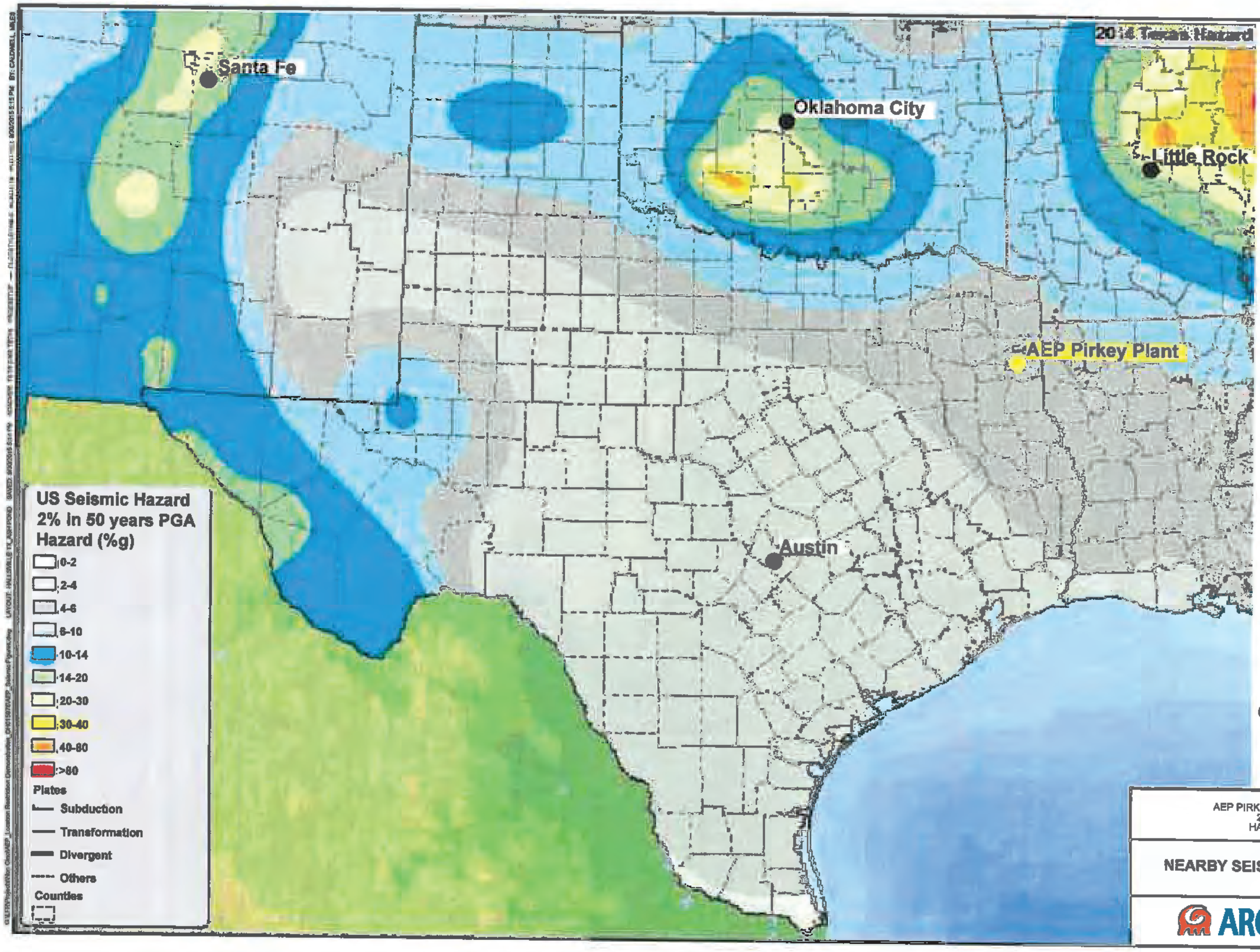
AEP PIRKEY PS GENERATING PLANT
2400 FM 3251
HALLSVILLE, TEXAS

NEARBY FAULT LOCATIONS

ARCADIS

FIGURE
11

G:\LFR\Projects\Non Cinc\AEP_Location Restriction Demonstration_OH016370\AEP_Fault Figures.dwg LAYOUT: HALLSVILLE TEXAS SAVED: 9/30/2016 5:11 PM ACADVER: PAGESETUP: — PLOTSTYLETABLE: ACAD.CTB PLOTTED: 9/30/2016 5:12 PM BY: CALDWELL, MILES



SOURCE:
USGS Earthquake Hazards Program,
Texas: 2014 Seismic Hazard Map

0 60 120

SCALE IN MILES
SCALE IS APPROXIMATE

AEP PIRKEY PLANT ASH POND
2400 FM 3251
HALLSVILLE, TX

NEARBY SEISMIC IMPACT ZONES

ARCADIS

FIGURE
12

Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

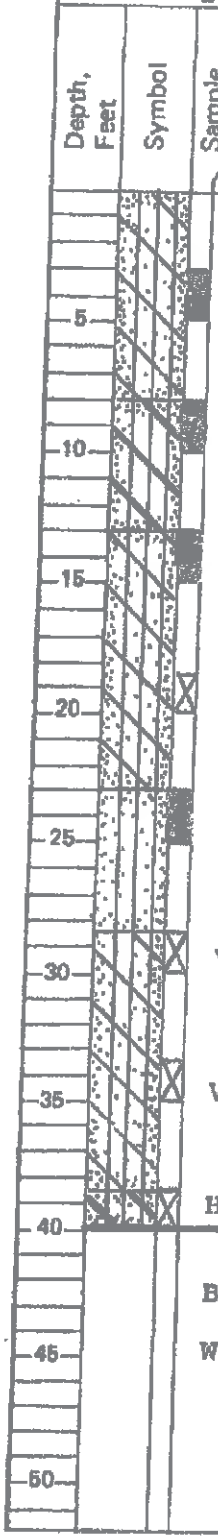
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-2
LOCATION: Hallsville

Date: 10-7-83
Type: Auger
Ground Elevation:

Legend:

■ Sample X Penetration ▼ Water



Description of Stratum

Firm tan clayey silty sand

Medium tan and grey very sandy silty clay

Dense tan and grey clayey silty sand

Dense tan clayey silty sand 10-15-16 31 B/F

Dense tan silty sand

Very dense grey clayey silty sand 15-35=12" 50 B/F

Very dense grey clayey silty sand 21-29=9" 50 B/9"

Hard grey sandy silty clay 20-30=12" 50 B/F

Bottom of boring at 40 feet.

Water encountered at 25 feet.

832964

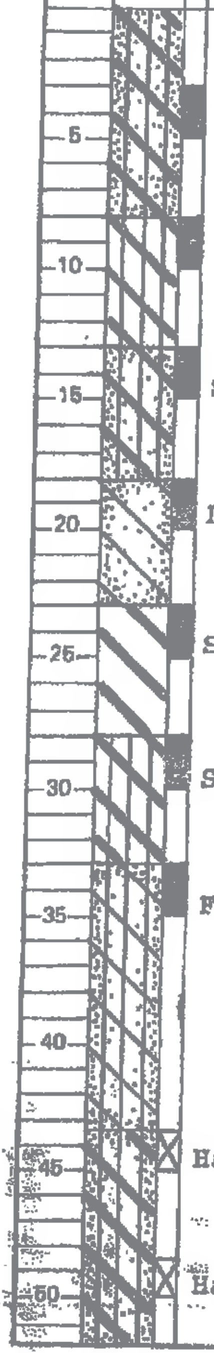
LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO
BORING NO.: MW-3
LOCATION: Hallsville, TX

Date: 11-4-83 **Type:** Auger **Ground Elevation:**

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum



Stiff red, brown and grey sandy silty clay

Stiff red, tan and grey silty clay lenses w/iron ore

Stiff brown and grey sandy silty clay

Firm brown and grey sand w/clay lenses

Stiff brown and grey clay

Stiff brown and grey clay w/silt lenses

Firm grey clayey silty sand

Hard grey clay w/silty sand lenses 43-7=6" 50 B/6"

Hard brown and grey silty sandy clay 21-29=12" 50 B/F

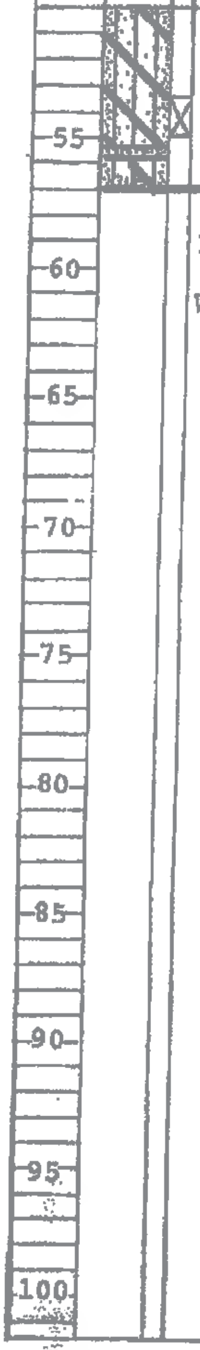
832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO
BORING NO.: MW-3
LOCATION: Hallsville,TX

Date: 11-4-83 **Type:** Auger **Ground Elevation:**

Legend: ■ Sample ✕ Penetration ▼ Water



Description of Stratum

Hard grey silty sandy clay 28-22=10" 50 B/10"

Bottom of boring at 57 feet.

Water encountered at 42 feet.

832964

LOG OF BORING

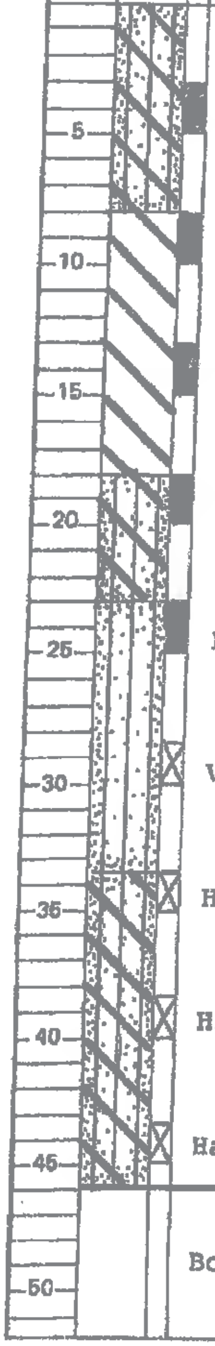
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-4
LOCATION: Hallsville

Date: 10-10-83 Type: Auger Ground Elevation:

Legend:
■ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff tan and grey silty sandy clay w/iron ore

Very stiff tan and grey clay

Very stiff tan and grey clay w/iron ore seam

Stiff tan and grey silty sandy clay lenses

Firm grey silty sand

Very dense grey silty sand 30-20=12" 50 B/F

Hard grey silty sandy clay 30-20=8" 50 B/8"

Hard grey silty sandy clay 25-25=8" 50 B/8"

Hard grey silty sandy clay 25-25=10½" 50 B/10½"

Bottom of boring at 46 feet.

APEX PROJECT NO.: 110-089
☐ **BORING**
BORING NUMBER: ____
■ **MONITOR WELL**
MONITOR WELL NUMBER: AD-18

FACILITY NAME: AEP- Pirkey Power Plant
FACILITY ID NO.: N/A

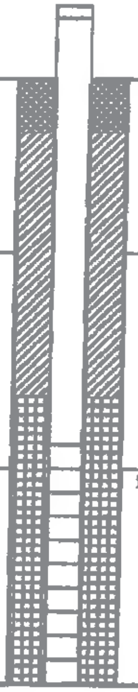
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.
COMPLETION DATE: 1/3/2011

PREPARED BY: Jeff Sammons
LOGGED BY: Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.154' Datum: WGS-84
LONGITUDE: W94°29.108'
WELL LOCATION: Northeast of Bottom Ash Pond #1

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
							
1 2 3 4 5 6 7			0-7	SM	Sandy Silt, some clay, very fine grained, gray, light brown, light brownish red, yellowish brown	None	Dry
8 9 10 11 12 13 14 15 16			7-16	CL	Clay, some sand, light gray, reddish gray, stiff, yellowish brown -iron oxide fracture at 9.5' -increasing sand content at 14', thin lenses of iron-oxide cemented sand at 14.5', 15', 15.5', stiff	None	Dry Moist
17 18 19 20 21 22 23 24 25			▽ 16-25	SM	Silty sand, some clay, gray, yellowish brown, dense, abundant gypsum crystals, abundant iron oxide cemented sandstone gravel in layers, saturated 19-21' -dark gray at 21' -clayey at 21-23' -greenish gray, trace clay, at 23' -clay lense, hard, dry, (shale), at 24.5-25'	None None None None None	Moist to V. Moist Saturated Dry
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40					Boring Terminated at 25'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 25 feet
Filter Sand (Size/Interval): 13-25'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-15'
Screen Interval: 15-25'
Water level: ____
Above Ground 3'

Note: This log is not to be used separate from this report.

Hydrex
ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-31

JDS 1-21-16
JEFFREY D. SAMMONS
GEOLOGY
#10070

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-94-1021
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/08/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

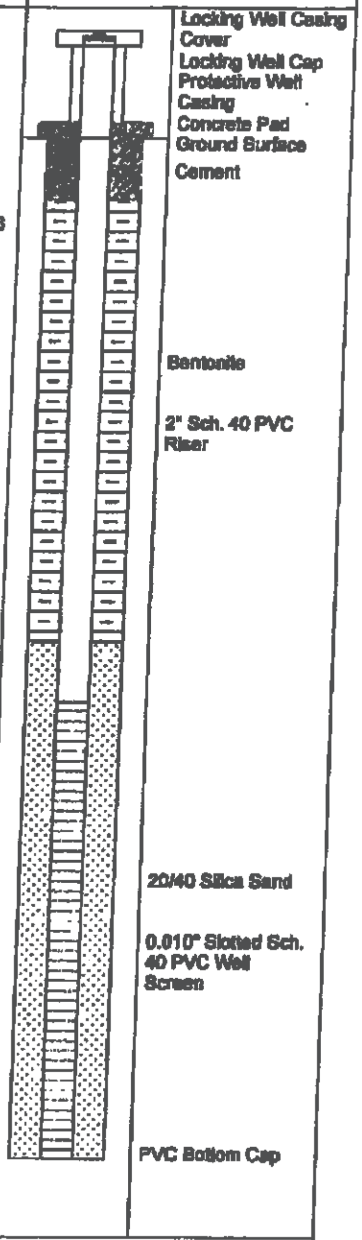
DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	60089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	350.75 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 28' 2.48"
LONGITUDE	94 29' 29.96"

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
SANDY CLAY AND GRAVEL: dark reddish brown, moist	CH	0–1							
FAT CLAY WITH SAND: some laminations of very fine to fine sand, reddish brown and light gray	CH	3		■	22	81	51	15	36
FAT CLAY: some silt with trace very fine to fine sand laminations, reddish brown, yellowish brown and light gray	CH								
- light gray with laminations of light reddish brown silt and very fine sand at 11'		12	▼	■	26	95	68	31	37
CLAYEY SAND: very fine to fine sand, light reddish brown and light gray, very moist to saturated	SC	18	▽						
		21		■	28	44	36	21	15
- dark gray and gray clay with thin seams of light reddish brown very fine sand at 22' to 23'									
SILTY SAND: fine to very fine sand, some clay lenses and thin layers of partially cemented sandstone, gray and dark gray with light reddish brown, very moist to saturated - dark gray and reddish brown at 29', saturated - trace clay, light brown at 30'	SM								
		32		■	24	5	24	NP	-
CLAYEY SAND: very fine sand, dark gray, very moist to saturated	SC								

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-32

STATE OF TEXAS
JDS 1-21-16
JEFFREY D. SAMMONS
GEOLOGY
#10070
LICENSED
PROFESSIONAL GEOSCIENTIST

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1021
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/11/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

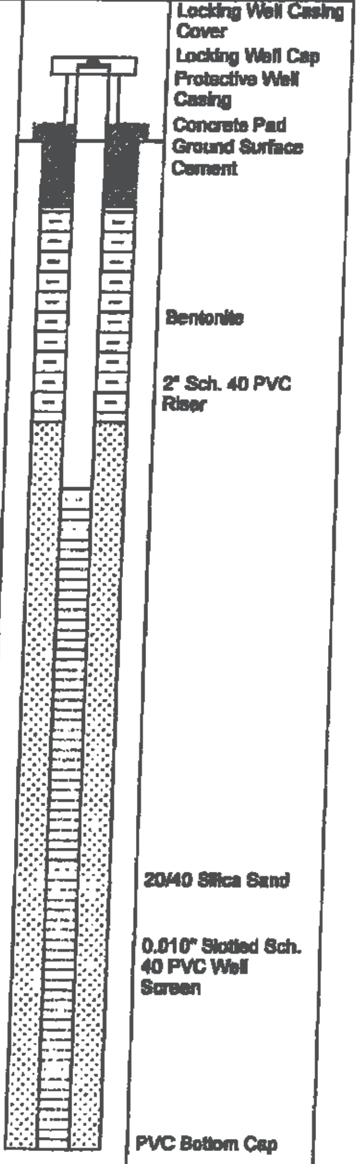
DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	60089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	359.18 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 27' 58.20"
LONGITUDE	94 29' 11.96"

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	SOIL SYMBOLS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
			-4 to 0							
CLAYEY SAND: very fine to fine sand, dark reddish brown, moist	SC		0							
- Interbeds of sand and clay, yellowish brown and light gray at 1'			1							
- reddish brown and light gray at 2'			2							
			3		■	25	46	35	22	13
- light gray and yellowish brown at 4',			4	▼						
- grayish brown and light gray at 6'			6							
- grayish brown, light gray, and reddish brown at 7'			7		■	26	44	37	20	17
			12	▽						
SANDY LEAN CLAY: some gravel seams and thin interbeds of cemented sand, light yellowish brown and light gray, moist to saturated within gravel seams	CL		13							
- some iron ore gravel at 16', very moist to saturated			16		■	28	54	37	22	15
SILTY SAND: very fine to fine sand, trace clay, brownish gray and dark brownish gray, saturated	SM		18							
- reddish brown and brown at 20'			20							
SANDY LEAN CLAY: gray and dark gray, very moist	CL		21		■	26	51	37	24	13
CLAYEY SAND: fine to very fine sand, gray and dark gray, very moist to saturated	SC		25							
			26		■	26	47	41	22	19
SANDY LEAN CLAY: gray and dark gray, very moist	CL		31		■	26	59	35	21	14
			33							

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

Page 1 of 1

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING E-1

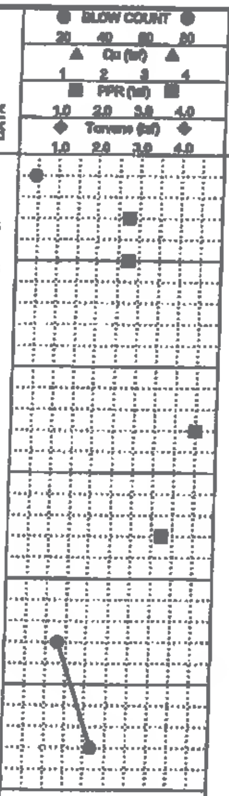
PROJECT: Pinkey Power Plant
Hallsville, Texas

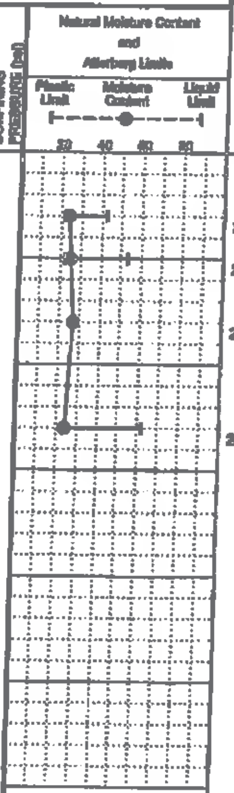
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

SURFACE ELEVATION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; yellow and gray	N=9										
	--very stiff; yellow and white	P=2.75					24	42	22	20	68	+40 Sieve=5%, +4 Sieve=0%
CH	SANDY FAT CLAY(CH) very stiff; yellow and tan; with ferric joints	P=2.75					25	53	22	31	63	+40Sieve=13%, +4 Sieve=1%
SM	SILTY SAND(SM) yellow	SF					27				41	+40 Sieve=3%, +4 Sieve=1%
CH	FAT CLAY WITH SAND(CH) hard; brown and yellow; with ferric joints; with iron oxide cemented sandstone	P=4.5+					24	62	24	38	74	+40Sieve=10%, +4 Sieve=8%
	--very stiff; brownish yellow; with ferric joints	P=3.75										
SC	CLAYEY SAND(SC) medium dense; gray	N=26										
CL	LEAN CLAY(CL) hard; gray	N=43										
	Bottom of Boring @ 30'											





Water Level Est: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 10' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING E-2

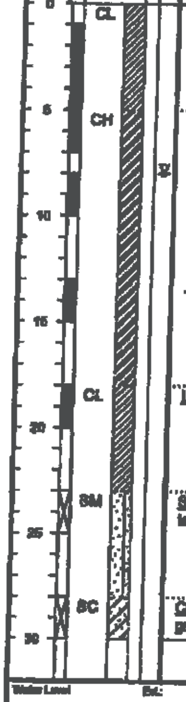
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

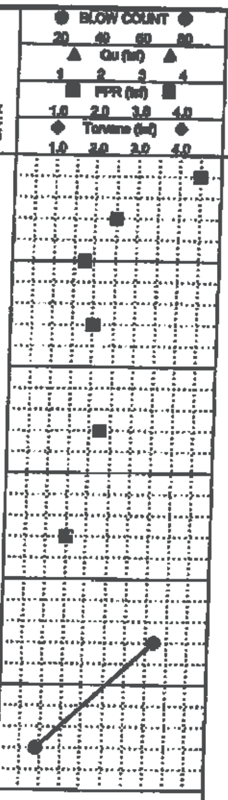
BORING TYPE: Flight Auger

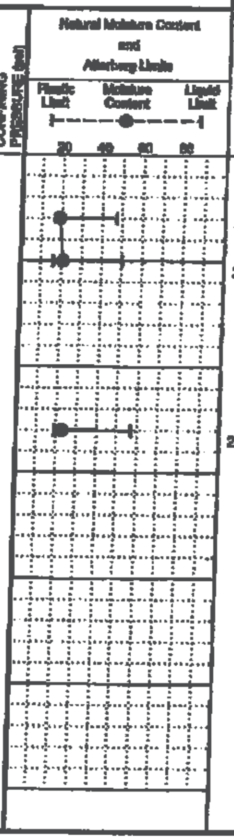
DATE 10/20/09

SURFACE ELEVATION



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY(CL) hard; gray and red; with gravel	P=4.5+										
	--very stiff; tan and red	P=2.5					16	47	17	30	69	+40Sieve=14%, +4 Sieve=5%
CH	SANDY FAT CLAY(CH) stiff; red and tan	P=1.75					21	50	16	34	69	+40 Sieve=8%, +4 Sieve=1%
	--red and gray	P=2.0										
	--very stiff; red, gray, and tan	P=2.25					23	57	19	38	71	+40 Sieve=6%, +4 Sieve=0%
CL	LEAN CLAY(CL) stiff; red and gray	P=1.5										
SM	SILTY SAND(SM) very dense; gray, red, and tan; saturated	N=74										
SC	CLAYEY SAND(SC) medium dense; greenish gray	N=16										
	Bottom of Boring @ 30'											





Water Level Est.: ▽ Measured: ▽ Perched: ▽

Water Observations: Seepage @ 8' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

832964

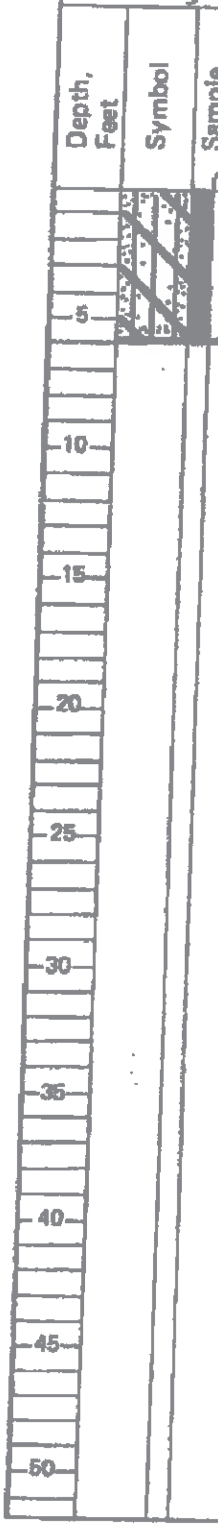
LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-4
LOCATION: Hallsville,TX

Date: 9-14-83
Type:
Ground Elevation: 347.3

Legend:
■ Sample
X Penetration
▼ Water



Description of Stratum

Red and grey sandy silty clay

Red and grey sandy silty clay

Red and grey sandy silty clay w/iron ore

Bottom of boring at 6 feet.

No water encountered.

SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-5
LOCATION: Hallsville,TX

Date: 9-14-83
Type:
Ground Elevation: 347.1

Legend:

■ Sample
X Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
		■	Red and grey silty sandy clay w/iron ore
		■	Red and grey silty sandy clay w/iron ore
5		X	Red and grey silty sandy clay 7-13-15 28 B/F
10			Bottom of boring at 6 feet. No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-6
LOCATION: Hallsville,TX

Date: 9-14-83 **Type:** **Ground Elevation:** 353.6

Depth, Feet | Symbol | Sample

Legend:

■ Sample X Penetration ▼ Water

Description of Stratum

Red and grey silty clay lenses w/iron ore

Red and grey silty sandy clay w/iron ore

Red and grey silty clay

-5-
-10-
-15-
-20-
-25-
-30-
-35-
-40-
-45-
-50-

Bottom of boring at 6 feet.

No water encountered.

SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-7
LOCATION: Hallsville,TX

Date: 9-14-83
Type:
Ground Elevation: 346.9

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
			Red, brown and grey silty clay
			Red, brown and grey silty clay w/silt lenses and iron ore
5			Red, brown and grey silty sandy clay
			Bottom of boring at 6 feet.
10			No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	**Location:**	**Project No.**
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	**Date:**
1	8/19/2015

Direction Photo Taken:

South

Description:

P8190374
Vegetative strip adjacent to East Ash Pond. Under new rule this potential wetland is likely non-jurisdictional.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	**Location:**	**Project No.**
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	**Date:**
2	8/19/2015

Direction Photo Taken:

Description:

P8190372
AD- 4 Ground water monitoring well. East Bottom Ash Pond embankment in background.

ARCADIS **PHOTOGRAPHIC LOG**

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 3	**Date:** 8/19/2015

Direction Photo Taken:

South

Description:

P8190378
View across East and West Botton Ash Pond.

ARCADIS **PHOTOGRAPHIC LOG**

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 4	**Date:** 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190379
Road side ditch, not considered a wetland, due to lack of hydric vegetation and connectivity.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No. 5

Date: 8/19/2015

Direction Photo Taken:

North

Description:

P8190380
AD-18 Ground water monitoring well.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No. 6

Date: 8/19/2015

Direction Photo Taken:

North

Description:

P8190381
AD-18 Ground water monitoring well.

1.2 – West Bottom Ash Pond – CCR Location Restriction Evaluation, July 6, 2016

ARCADIS
Infrastructure · Water · Environment · Buildings

American Electric Power Service Corporation

West Bottom Ash Pond - CCR Location Restriction Evaluation

H. W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

July 6, 2016

ARCADIS

STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST

Kenneth Brandner

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matthew J. Lamb
Project Manager

John Holm, P.E.
Principal Engineer

West Bottom Ash Pond – CCR Location Restriction Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
AEP

Prepared by:
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Fax 614 985 9170

Our Ref.:
OH015976.0010

Date:
July 6, 2016

Table of Contents

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
PTI	Permit to Install
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the location of the West Bottom Ash Pond (BAP) relative to the location restrictions included in the Coal Combustion Residual (CCR) requirements, as specified in the Code of Federal Regulations (CFR) 40 CFR 257.60 to 257.64, at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zones, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the location restriction criteria at the West BAP (Site). The evaluation of the groundwater monitoring well network in the uppermost aquifer for the West BAP is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the West BAP CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on documents reviewed and will further describe the uppermost aquifer.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant West BAP.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The West BAP CCR unit is located at the north end of the Plant and approximately 3,000 feet northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of West BAP CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the West BAP.

2.2.1 Embankment Configuration

The West BAP embankments have a maximum height of approximately 25 feet and are constructed of compacted clay on a slope ranging from 2.5:1 (2.5 feet horizontal, 1 foot vertical) to 3:1 (Sargent & Lundy, 1983). The elevation at the top of the embankment around the perimeter of the West BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, 2011). The interior bottom elevation of the West BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Akron Consulting, 2012).

2.2.2 Area/Volume

The West BAP is approximately 30.9 acres in size. The design maximum ash storage capacity of the West BAP is 188 acre feet at an elevation of 354 feet amsl (normal operating level) and 216.5 acre feet at an elevation of 355 feet amsl (maximum operating level) (Sargent & Lundy, 1983; Akron Consulting, 2012).

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant West BAP was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, flue gas desulfurization sludge) have been generated. The West BAP, which was placed into operation in 1985, receives bottom ash and economizer ash sluiced from the power plant boiler (**Figure 3**). Clear water overflow from the West BAP discharges into the Clearwater Pond located southeast of the West

BAP. Bottom ash and economizer ash are periodically excavated from the West BAP and hauled by truck to either the on-site landfill for disposal, or for beneficial re-use.

The base of the West BAP was constructed in 1983 with a compacted clay liner (Sargent & Lundy, 1983). Following installation of the compacted clay liner, soil borings S-8 through S-11 were advanced below the base of the West BAP to total depths of six feet in September 1983 (Southwestern Laboratories, 1984). The lithologic data from soil borings S-8 through S-11 confirm at least six feet of clay is present below the base of the West BAP (Sargent & Lundy, 1984).

2.2.4 Surface Water Control

Surface water elevation in the West BAP is controlled by a weir box and a manually operated gate valve on a 36-inch-diameter discharge pipe at the southeast corner of the pond. Clear water overflow from the West BAP discharges through the 36-inch-diameter pipe into the 2.7- acre Clearwater Pond located southeast of the West BAP (Figure 3). Water in the Clearwater Pond is either pumped (re-circulated) back into the boiler ash hopper, or gravity discharged through a pipe at the southwest corner of the Clearwater Pond into an unnamed intermittent tributary of Hatley Creek via Outfall 006 in accordance with Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0002496000.

2.3 Previous Investigations

The initial soils investigation and design of the West BAP was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, and design of the West BAP. As discussed above in Section 2.2.3, the design included installation of a clay liner below the West BAP.

In September-October 1983, Southwestern Laboratories conducted a soil investigation at the Plant, including advancement of four soil borings (S-8 through S-11) below the West BAP (Southwestern Laboratories, 1984).

In 1984, Sargent & Lundy conducted an evaluation of the West BAP. This report included evaluation of soil sample geotechnical data, and concluded a low-permeability clay liner was present below the West BAP (Sargent & Lundy, 1984).

In 2009, ETTL Engineers & Consultants (ETTL) conducted a geotechnical investigation of the West BAP earthen embankment. The investigation included installation of two soil borings through the embankment (W1, W3) and two soil borings along the outer toe of the embankment (W2, W4), completion of soil borings W1 and W3 as piezometers PW-1 and PW-3, respectively, and collection of soil samples for geotechnical analyses. The report concluded the embankment was stable and the existing embankment slopes were acceptable if conditions are maintained (ETTL, 2010). The conditions to be maintained included embankment protection from erosion (vegetative cover), removal of brush and trees two feet or more in height, and control of animal burrowing.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed a hydraulic analysis of the West BAP for a 10-year, 24-hour rainfall event in accordance with the TCEQ TPDES permit design criteria. The report concluded the storage capacity of the West BAP is hydraulically adequate (Johnson & Pace, 2011).

In 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-30 through AD-35 (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the West BAP area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure** 4 (A-A') through **Figure 8** (E-E').

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the West BAP, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow groundwater flow direction in the area of the West BAP is west-southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The West BAP is located approximately 3,000 feet northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the area of the West BAP does not discharge into Brandy Branch Reservoir. Brandy Branch Reservoir likely recharges the uppermost water bearing unit in the southern portion of the Plant, where the pool level in the Reservoir (340 feet amsl) is higher than water level elevations in monitoring wells located southwest (downslope) of the Reservoir.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 500 feet southeast (sidegradient) of the West BAP in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile south (side gradient) of the West BAP for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (up gradient) of the Pirkey Power Plant.

3. Isolation from the Uppermost Aquifer

CCR Rule 40 CFR Part 257.60 requires that the base of new and existing CCR surface impoundments be constructed such that the base of the unit is no less than 5 ft above the top of the uppermost aquifer, or that if the base is within 5 ft of the uppermost aquifer, that there will not be hydraulic connection between the base of the unit and the uppermost aquifer.

3.1 Uppermost Aquifer and Piezometric Analysis

3.1.1 Piezometric Analysis

3.1.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost water bearing unit in the area of the West BAP is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 15 feet that is located between an elevation of approximately 325 and 340 feet amsl (**Appendix A**). The base of the West BAP is at an elevation of 347 feet amsl. Therefore the separation distance between the uppermost water-bearing unit and the base of the West BAP is approximately seven feet. This separation distance is further illustrated on cross section A-A' (**Figure 4)** and cross section D-D' (**Figure 7**).

3.1.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost water bearing unit (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness (approximately 15 feet), the yield of the uppermost water-bearing unit is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Available groundwater elevations are summarized on **Table 1** for 2011 through 2016. The most recent comprehensive groundwater data set from January 2016 is depicted on **Figure 9**. The groundwater flow is west-southwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

3.1.2 Uppermost Aquifer

3.1.2.1 CCR Rule Definition

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers, that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural groundwater surface to which the aquifer rises during the wet season.

3.1.2.2 Common definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.1.3 Identified onsite hydrostratigraphic unit

The identified Site hydrostratigraphic unit in the area of the West BAP is the clayey and silty sand stratum that is located between an elevation of approximately 325 and 340 feet amsl.

3.2 Compliance with Isolation Distance

The uppermost water-bearing unit underlying the West BAP meets the regulatory definition of an aquifer. As shown on the cross-sections presented on **Figures 4** and **7**, the base of the West BAP is seven feet or more above this aquifer. Therefore, this CCR Unit complies with the requirement for placement above the uppermost aquifer. Also, four soil borings (S-8 through S-11) were advanced six feet below the base of the West BAP in 1983 following installation of the clay liner, and these four soil borings confirm the presence of the clay liner below the West BAP.

4. Wetlands

CCR Rule 40 CFR Part 257.61 requires that existing and new CCR surface impoundments must not be located in wetlands.

4.1 Local Wetlands

Based on the August 19, 2015 site visit and review of available published information, the West BAP is not located within an area that exhibited wetland characteristics that might be classified as a regulated wetland. Photos of the West BAP area are included in **Appendix B**, and **Figure 10** is a map showing wetlands locations in the CCR unit area.

4.2 Compliance with Wetland Restrictions

Based on the August 19, 2015 site visit and review of available information, the West BAP does not contain wetlands. Therefore, this CCR Unit complies with the requirement for not being located in a wetlands.

5. Fault Areas

CCR Rule 40 CFR Part 257.62 requires that existing and new CCR surface impoundments must not be located within 200 feet of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates that an alternate setback will prevent damage to the structural integrity of the CCR unit.

5.1 Description of Regional Geologic Structural Features

Regional geologic publications were reviewed to determine structural features for the Site. A regional fault map is provided on **Figure 11**. The U.S. Geological Survey (USGS) Open File Report 88-450K shows the Site is located within the East Texas Basin, with faulting north of the basin (Talco Fault Zone) and south of the basin (Elkhart-Mt. Enterprise Fault Zone). No faulting was identified in the Site area (USGS, 1988). Texas Water Development Board Report 27 and the University of Texas at Austin Bureau of Economic Geology Geologic Atlas of Texas – Tyler Sheet show no faulting at the Site (Broom, 1966; Flawn, 1965).

A previous evaluation of geologic structural features at the Site was conducted by ETTL, and no evidence of faulting was identified (ETTL, 2010).

5.2 Compliance with Fault Area Restrictions

A review of available geologic reports and maps has indicated that the Site is not located near any faults with displacement in the Holocene. Therefore, the CCR unit complies with the requirement for not being located within 200 feet of the outermost damage zone of a fault that has had displacement in Holocene time.

6. Seismic Impact Zone

CCR Rule 40 CFR Part 257.63 requires that existing and new CCR surface impoundments must not be located within a seismic impact zone unless the owner or operator demonstrates that all structural components of the CCR unit are designed to withstand the maximum horizontal acceleration in lithified earth material for the site.

6.1 Definition of Seismic Impact Zone

CCR Rule 40 CFR Part 257.53 defines a seismic impact zone as an area having a 2% or greater probability that the maximum horizontal acceleration expressed as a percentage of the earth's gravitational pull (g) will exceed 0.10 g in 50 years.

6.2 Compliance with Seismic Impact Zone Restriction

Figure 12 presents the seismic hazard map for Texas, as published by the USGS. As shown on **Figure 12**, the Site falls within the zone having a maximum horizontal acceleration of 0.04 to 0.06 g. Therefore, the CCR unit complies with the requirement for not being located within a seismic impact zone.

7. Unstable Areas

CCR Rule 40 CFR Part 257.64 requires that existing and new CCR surface impoundments must not be located within an unstable area unless the owner or operator demonstrates that the design of the unit will ensure the integrity of the structural components of the unit.

7.1 Definition of Unstable Area and local Conditions

7.1.1 CCR Rule Definition

CCR Rule 40 CFR Part 257.53 defines an unstable area as a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of the CCR unit. These may include poor foundation conditions, areas susceptible to mass movements (landslides), and karst terrains.

7.1.2 Poor Foundation Soils

The West BAP design report was prepared by Sargent & Lundy in 1983 (Sargent & Lundy, 1983). The West BAP was constructed in 1983 using compacted clay. The specifications included installation of clay embankments around the perimeter of the pond with a crest (top of embankment) elevation of 357 feet amsl, and compaction of the clay embankments to ≥95% standard proctor density. The specifications also included emplacement of a compacted cohesive clay lining below the pond base elevation of 347 feet amsl.

ETTL conducted a geotechnical investigation of the West BAP earthen embankment in 2009. The investigation included installation of two soil borings through the embankment (W1, W3) and two soil borings along the outer toe of the embankment (W2, W4), completion of soil borings W1 and W3 as piezometers PW-1 and PW-3, respectively, and collection of soil samples for geotechnical analyses. The report concluded the embankment was constructed with layers of cohesive soils consisting primarily of lean clay and/or fat clay with no obvious seams of soft or loose soils, and the embankment was stable and the existing embankment slopes were acceptable if conditions are maintained (ETTL, 2010). The conditions to be maintained included embankment protection from erosion (vegetative cover), removal of brush and trees two feet or more in height, and control of animal burrowing.

7.1.3 Mass Movements

The West BAP is not located within an area subject to mass movements. This conclusion is supported by the ETTL soil stability report (ETTL, 2010).

7.1.4 Karst

The site area is located on the outcrop of unconsolidated Cretaceous Formations consisting predominantly of sand and clay (Broom, 1966; Flawn, 1965). The West BAP is not located in a karst area.

7.1.5 Subsurface Mining

No subsurface mines are known to exist below the CCR units at the Site.

7.2 Compliance with Unstable Areas Restriction

Based on our site visit and review of available information, the West BAP is not located within unstable areas. Therefore, this CCR unit complies with the requirement of not being located within an unstable area.

8. Summary, Conclusions, and PE Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, as well as the evaluations discussed within this report, the H.W. Pirkey Power Plant West Bottom Ash Pond complies with the requirements of the location restrictions sections of 40 CFR 257 Subpart D that apply to surface impoundments and therefore the CCR unit is not located in a restricted location.

Kenneth J. Brandner

Printed Name of Registered Professional Engineer

Kenneth J Brandner

Signature

KENNETH J. BRANDNER
69586

69586

Registration No.

Texas

Registration State

7-6-16

Date

9. References

Akron Consulting, LLC, “West BAP August 2012 As-Built Plan & Profile”, August 2012.

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Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen(b)		Bottom of Screen(b)		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers(c)																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).

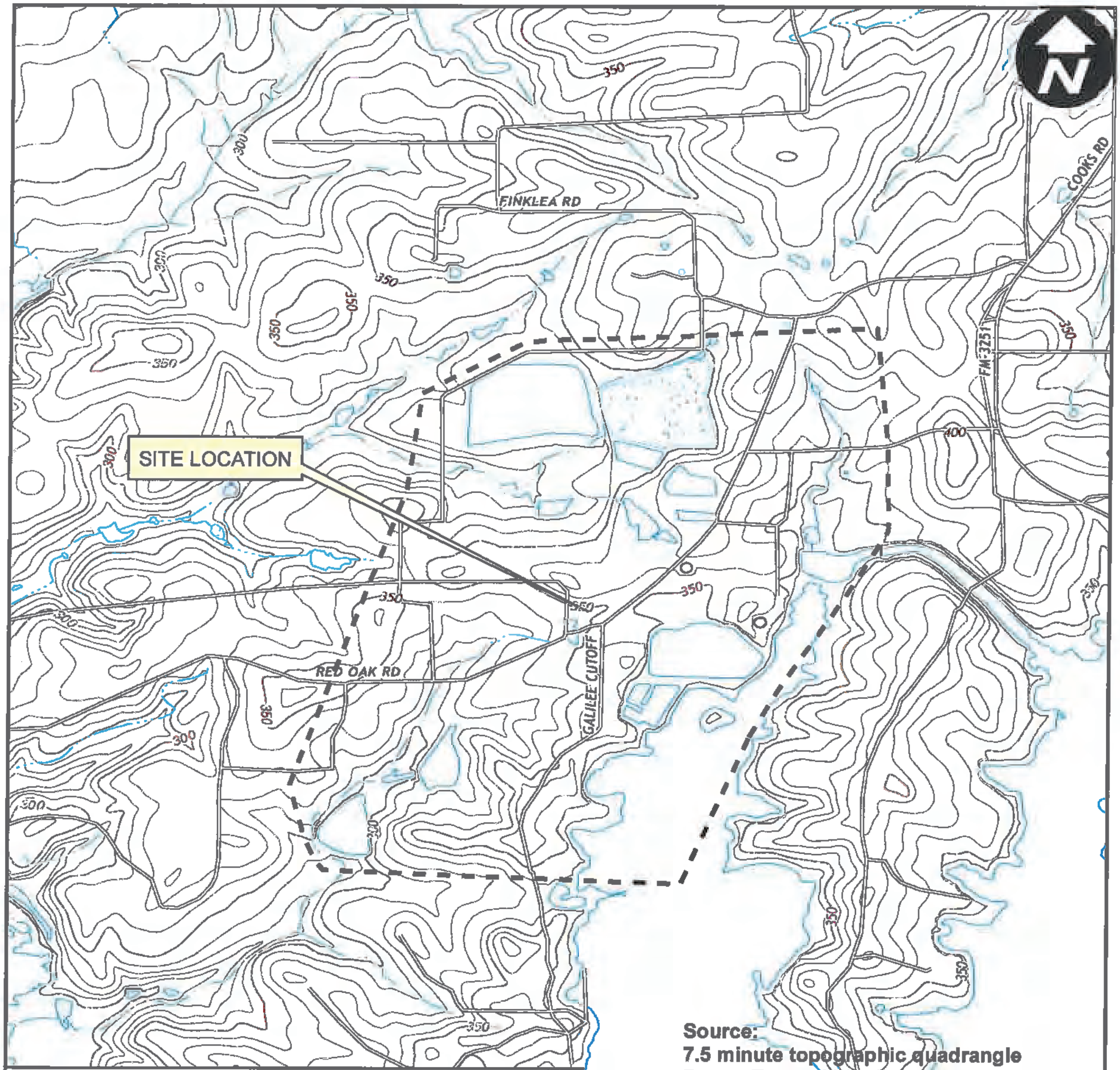
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).

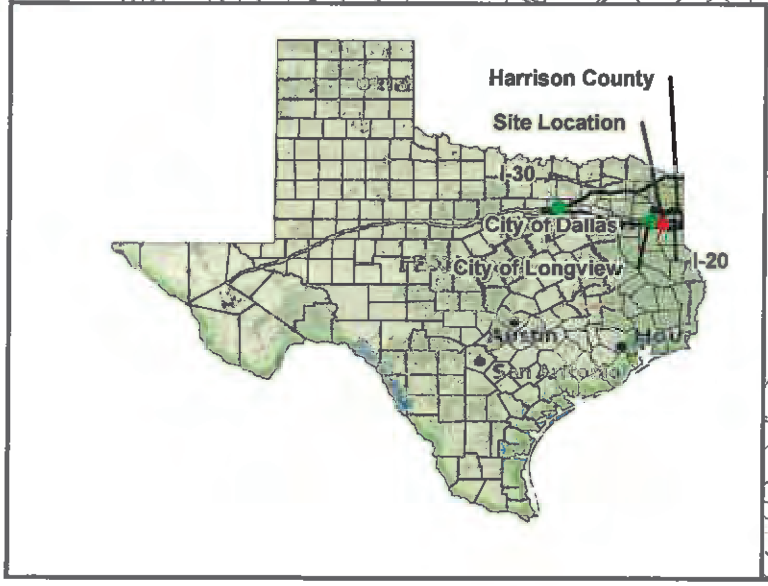
(c) Souce: EETL (October 2010).

(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.

Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.

NM - Not Measured





Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

0 2,000 4,000
SCALE IN FEET

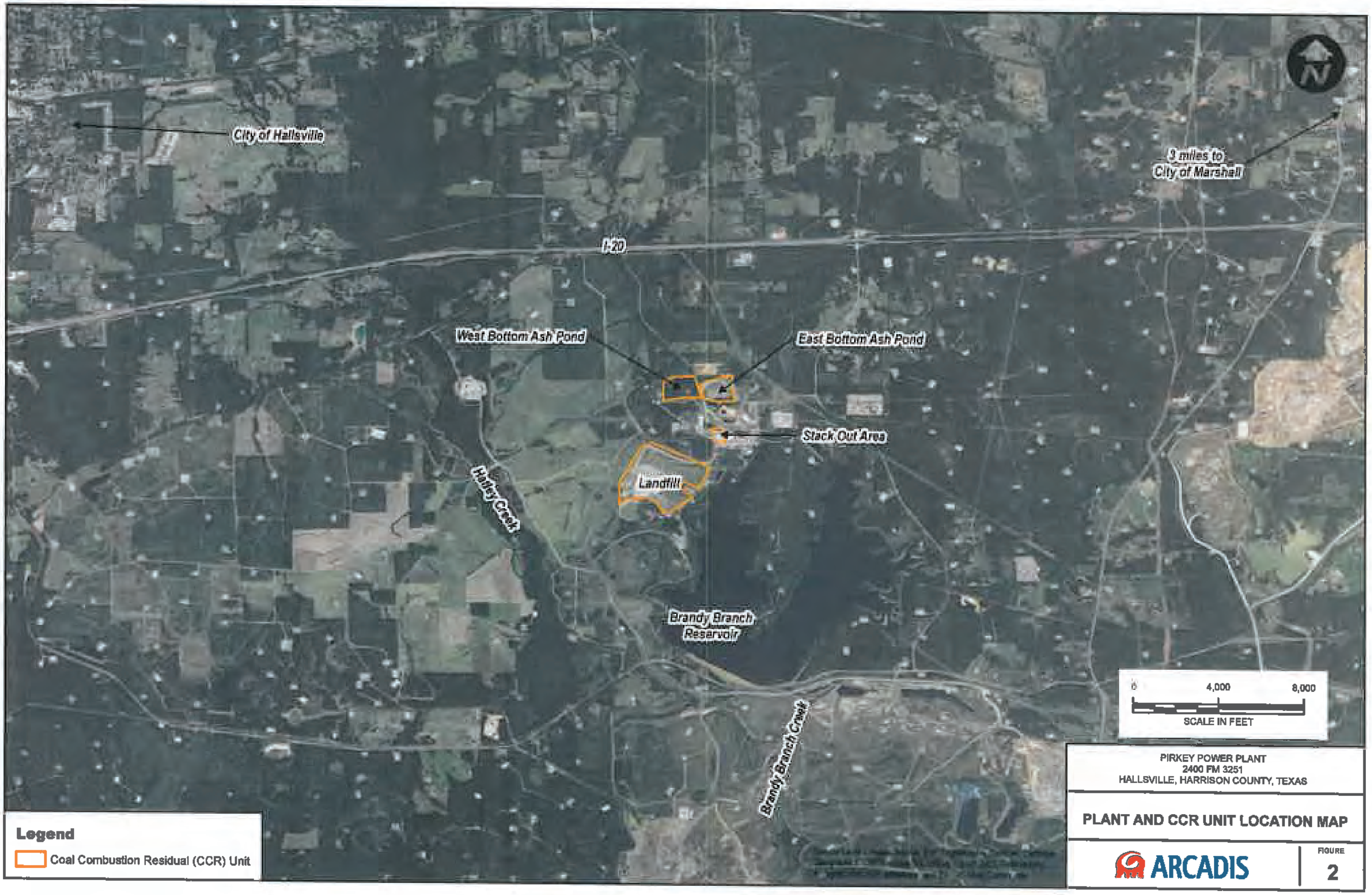
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd



Legend

🟧 Coal Combustion Residual (CCR) Unit

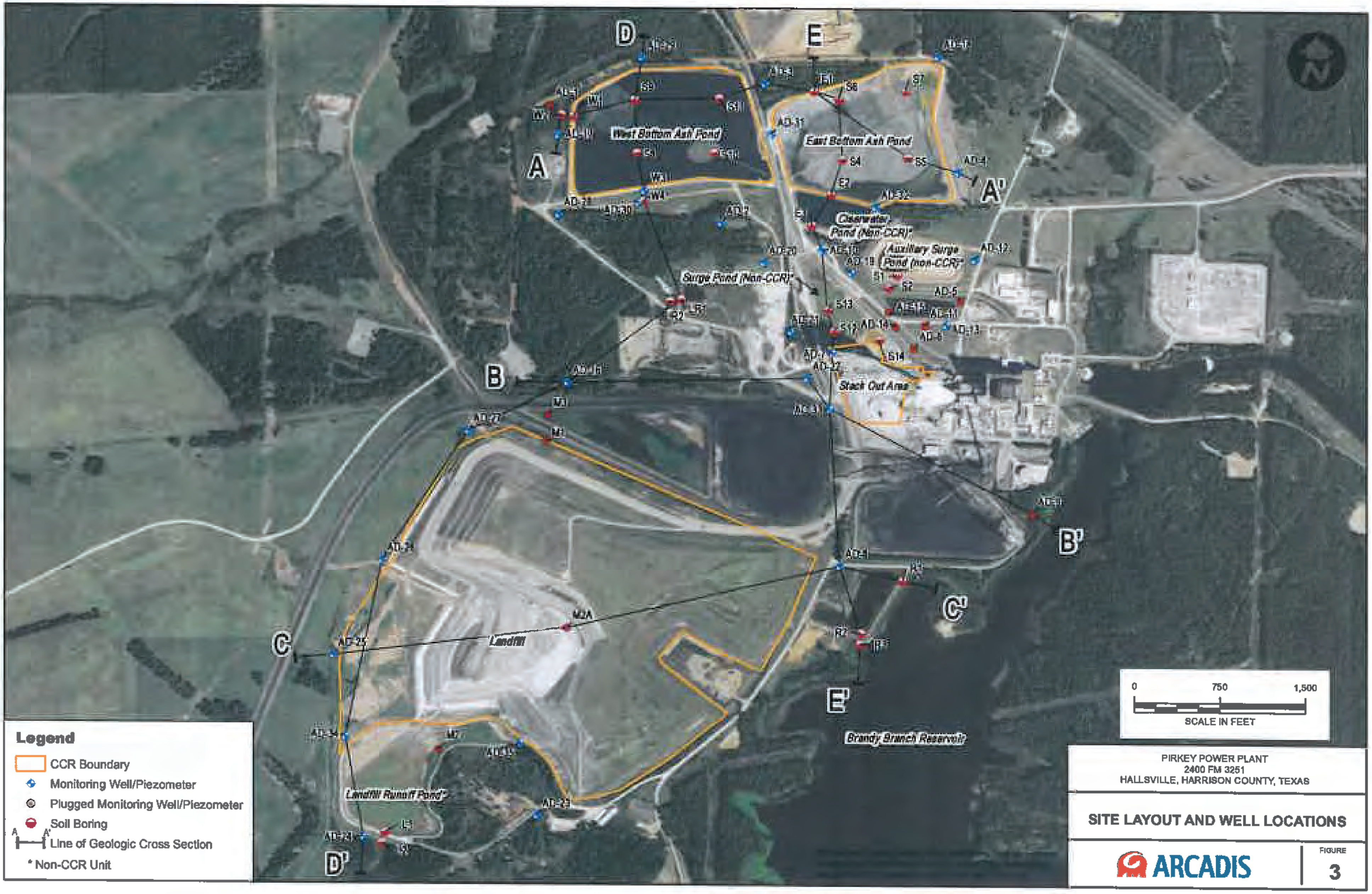
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



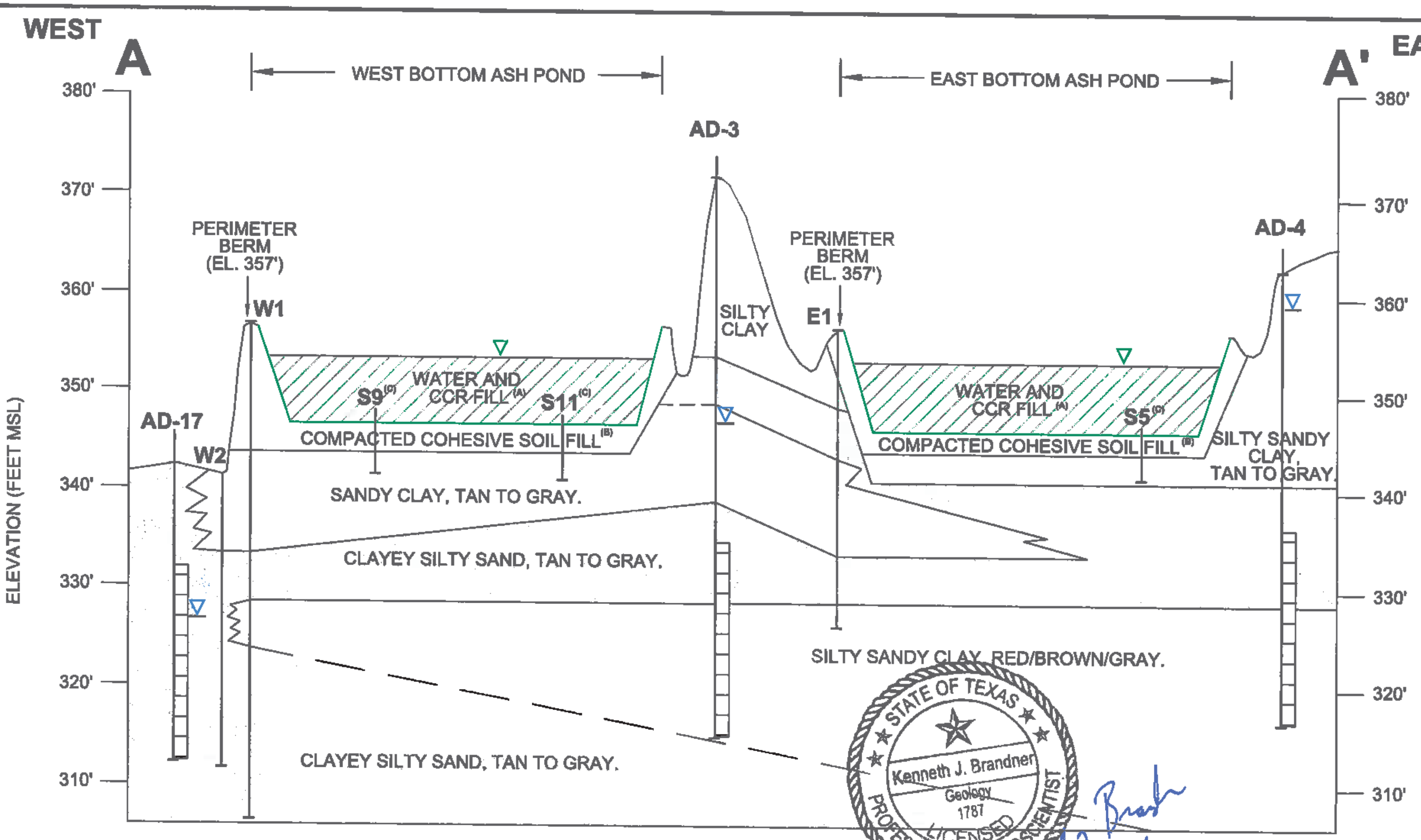
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE
3

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



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1787

4-6-16

LEGEND

☐	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).

C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

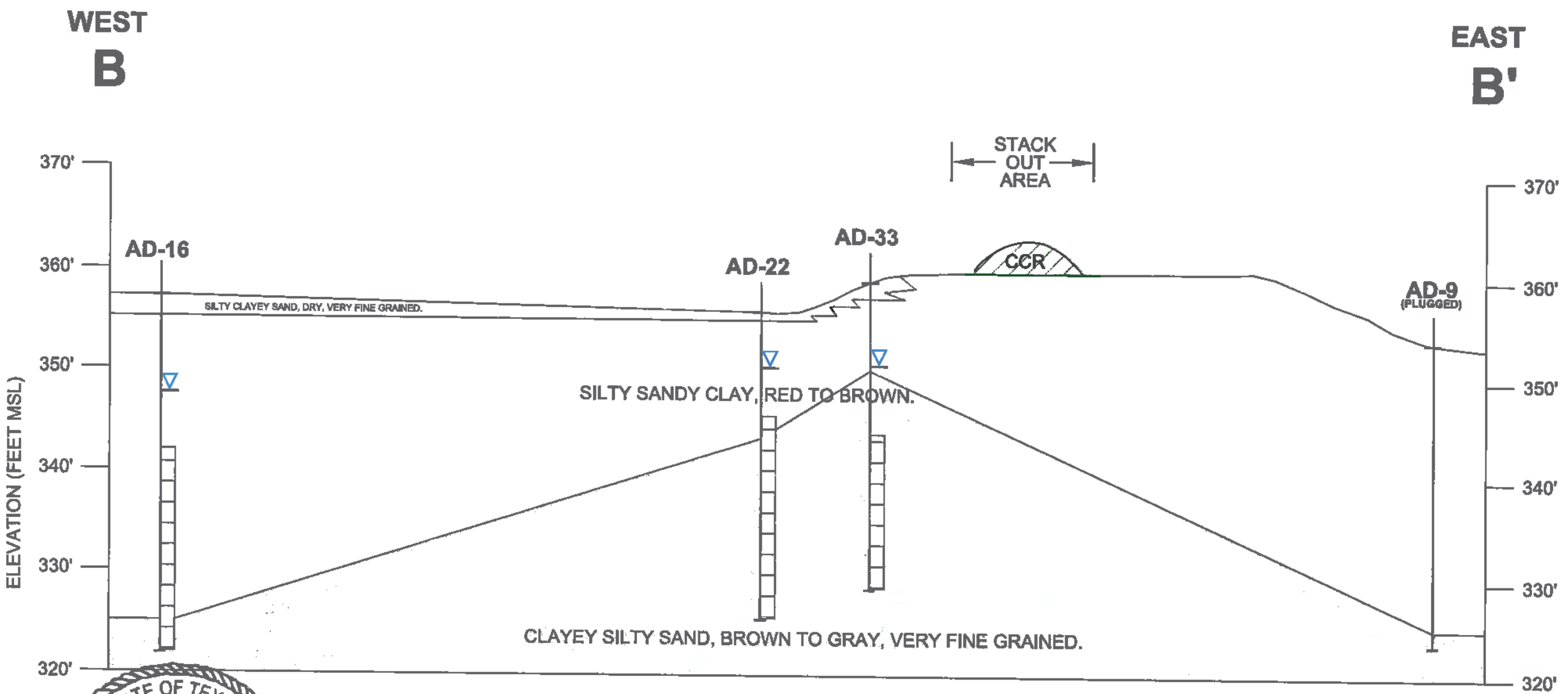
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\CH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2015 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 2/18/2016 2:18 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
— PLOTTED: 2/22/2016 11:17 AM BY: LEASE, DIANA



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Geology
1787

Kenneth J. Brandner
1-6-16

0 300'
HORIZONTAL SCALE

LEGEND

▯	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

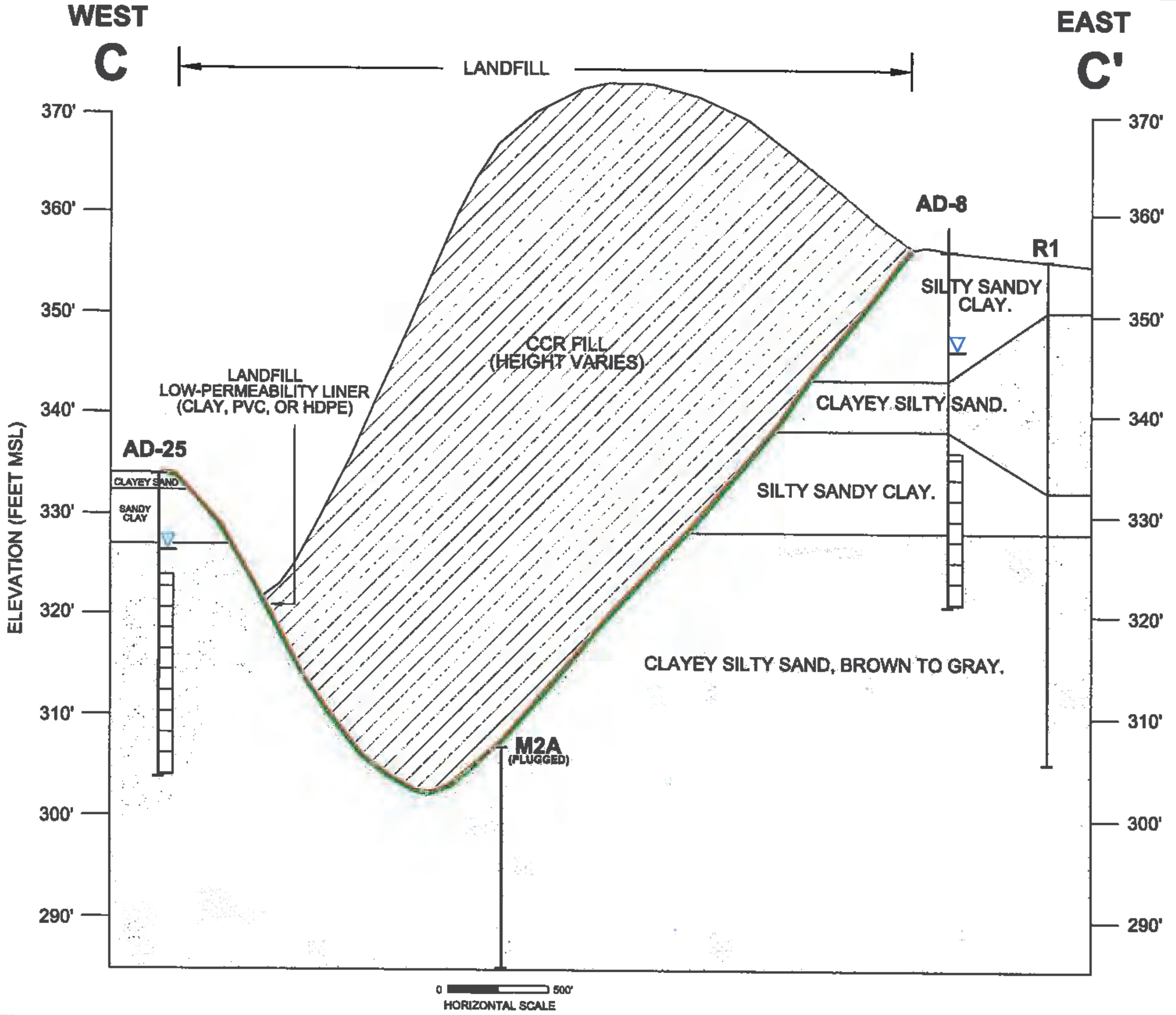
NOTES:
A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE, ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5



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Geology
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Kenneth J Brandner
7-6-16

LEGEND

- MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- BASE OF CCR UNIT

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015878 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\Wet Bottom Ash Pond Location Restriction\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 2/18/2016 2:25 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE: —
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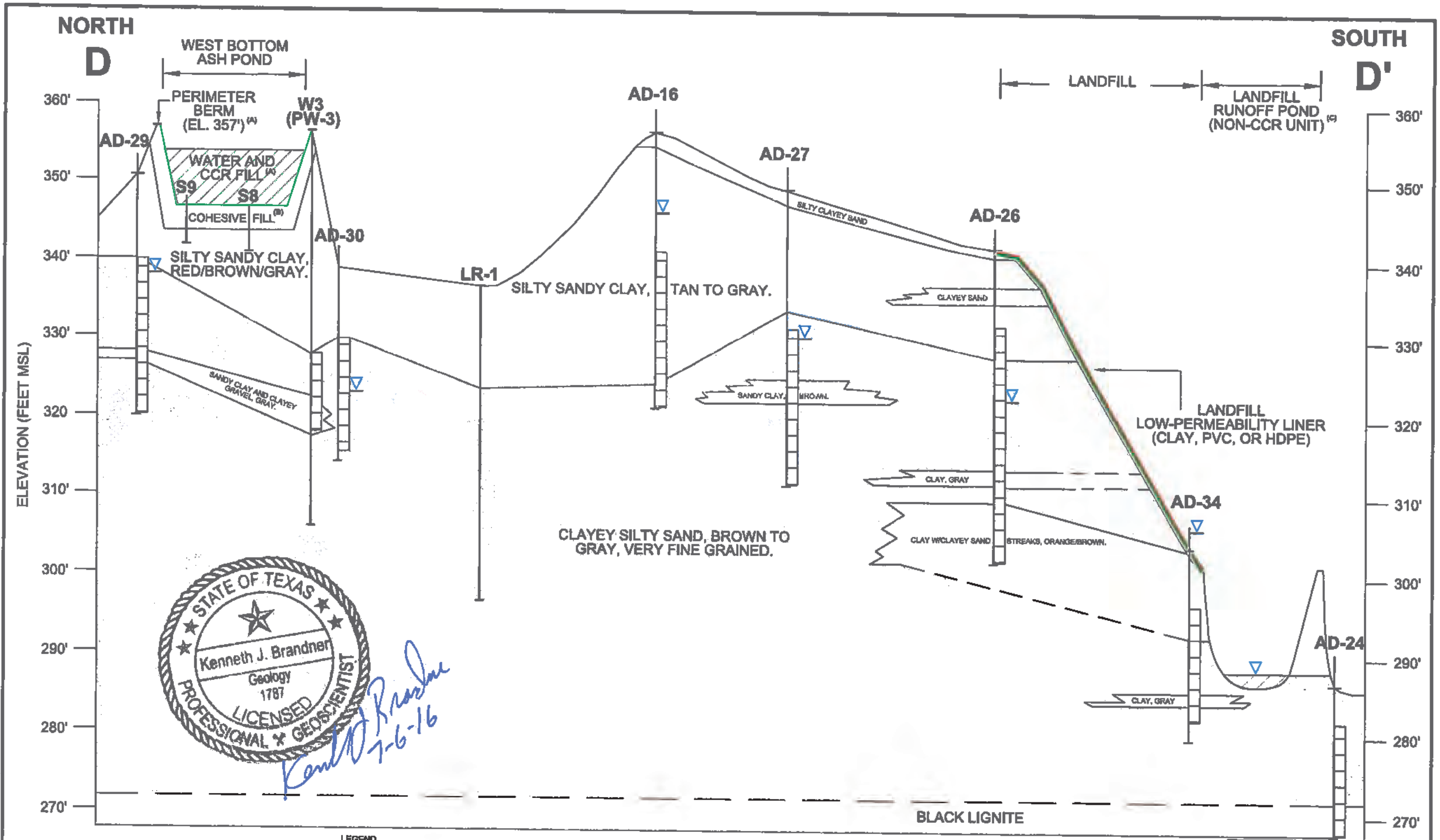

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Geology
1787

7-6-16

LEGEND

- ▯ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- 🟩 BASE OF CCR UNIT

0 600'
HORIZONTAL SCALE

NOTES:

A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL, NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS

FIGURE
7

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH016970 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 7 Cross Section D-D'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:30 PM ACADVER: 18.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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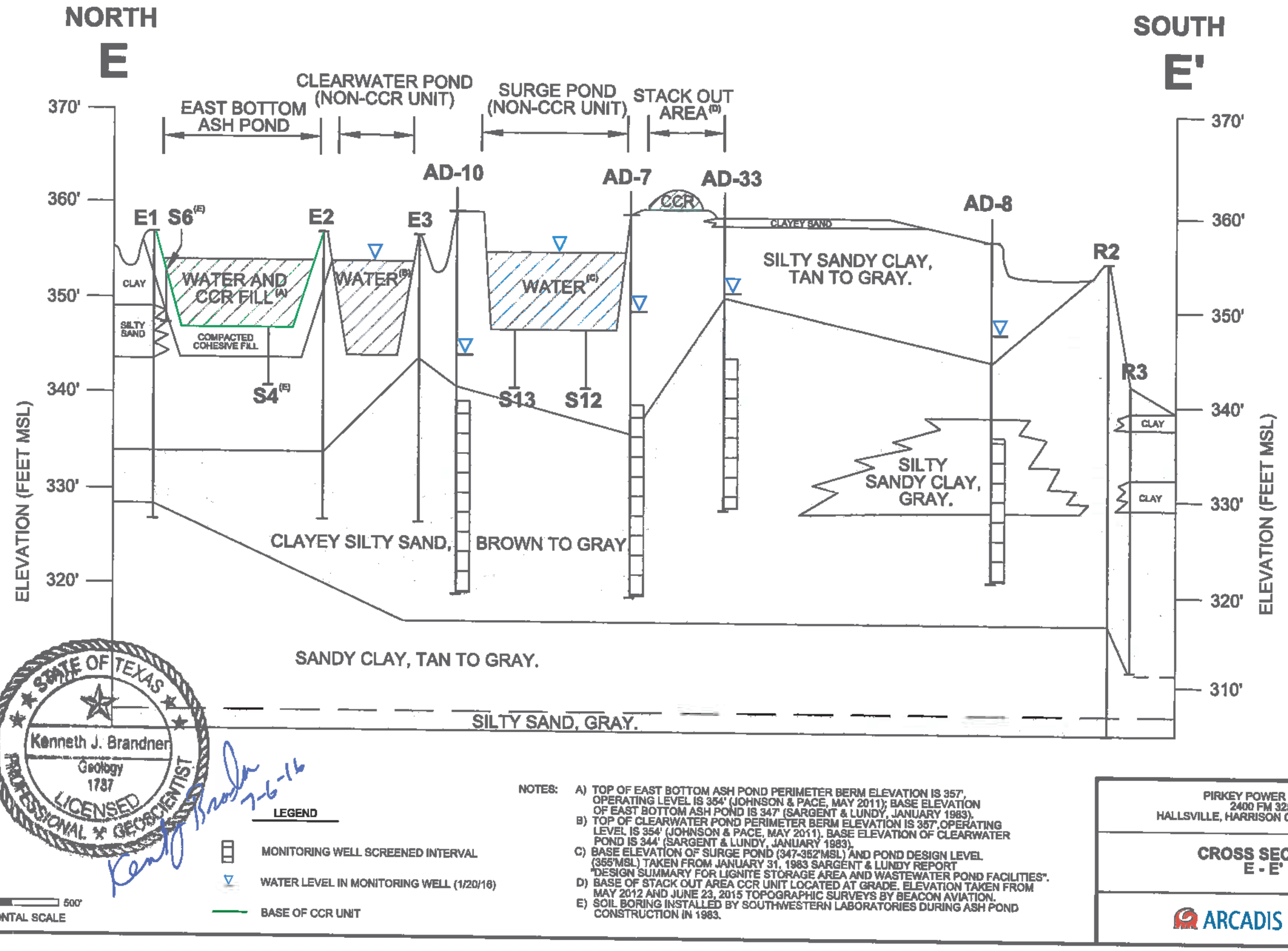


Kenneth J. Brandner
Geology
1737

Kenneth Brandner 7-6-16

LEGEND

- ▤ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

NOTES:

A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).

C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".

D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.

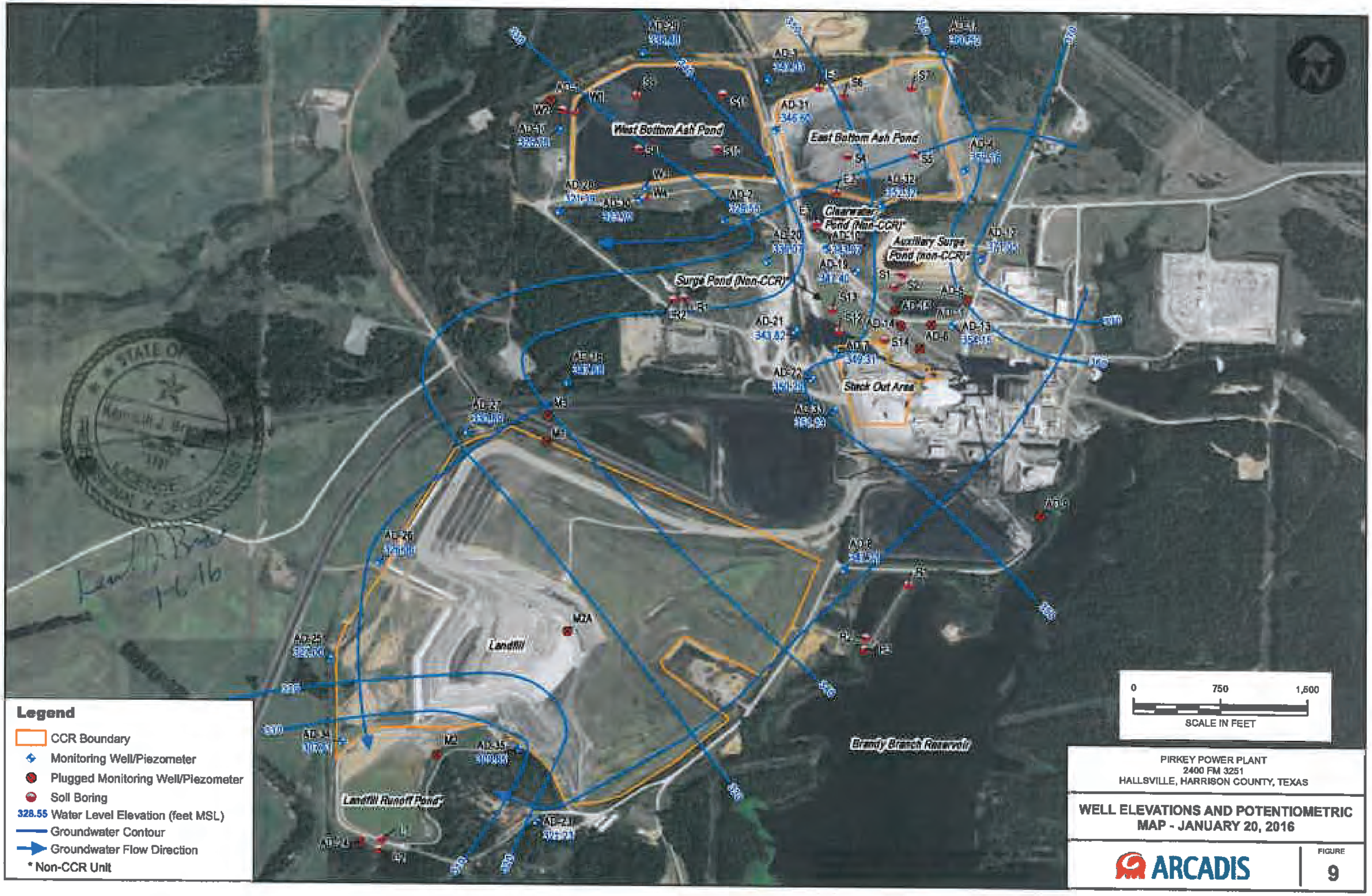
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8



Legend

🟧 CCR Boundary

◆ Monitoring Well/Piezometer

● Plugged Monitoring Well/Piezometer

● Soil Boring

328.55 Water Level Elevation (feet MSL)

— Groundwater Contour

➔ Groundwater Flow Direction

* Non-CCR Unit

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

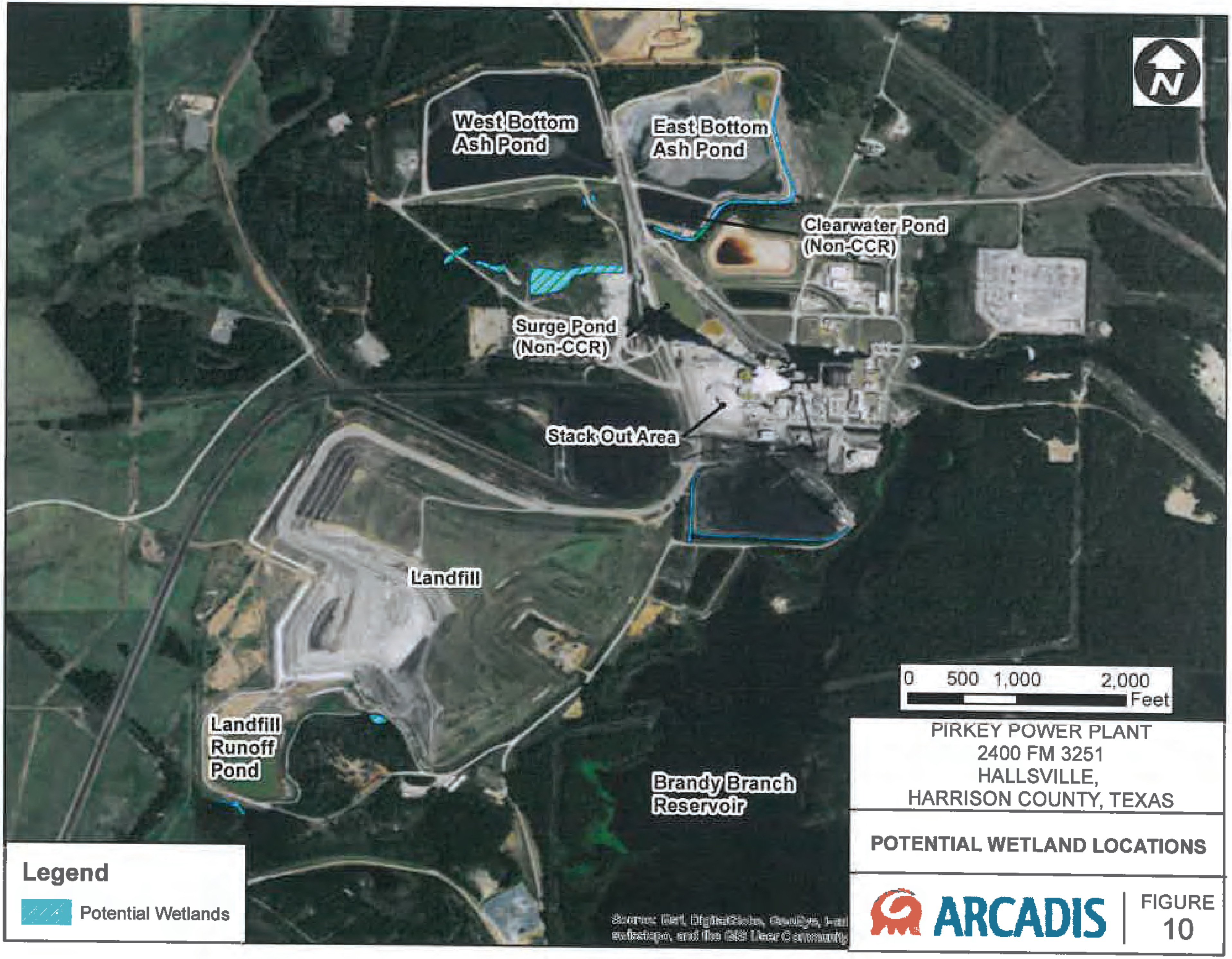
WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

ARCADIS

FIGURE
9

1-6-16

Document Path: Z:\GIS\PROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



Source: Esri, DigitalGlobe, GeoEye, Ear
swisstopo, and the GIS User Community

Legend

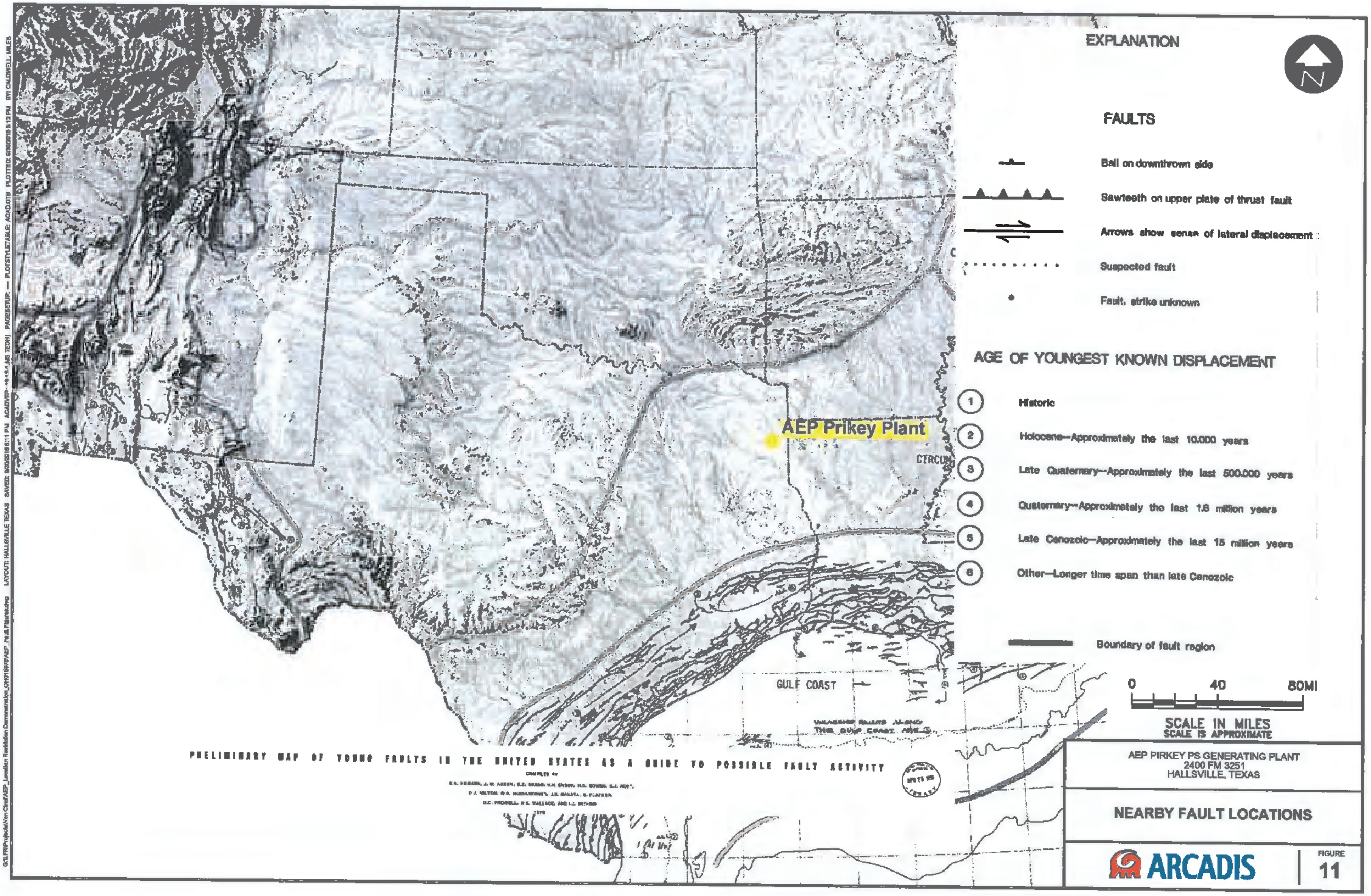
▨ Potential Wetlands

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE,
HARRISON COUNTY, TEXAS

POTENTIAL WETLAND LOCATIONS

ARCADIS

FIGURE
10



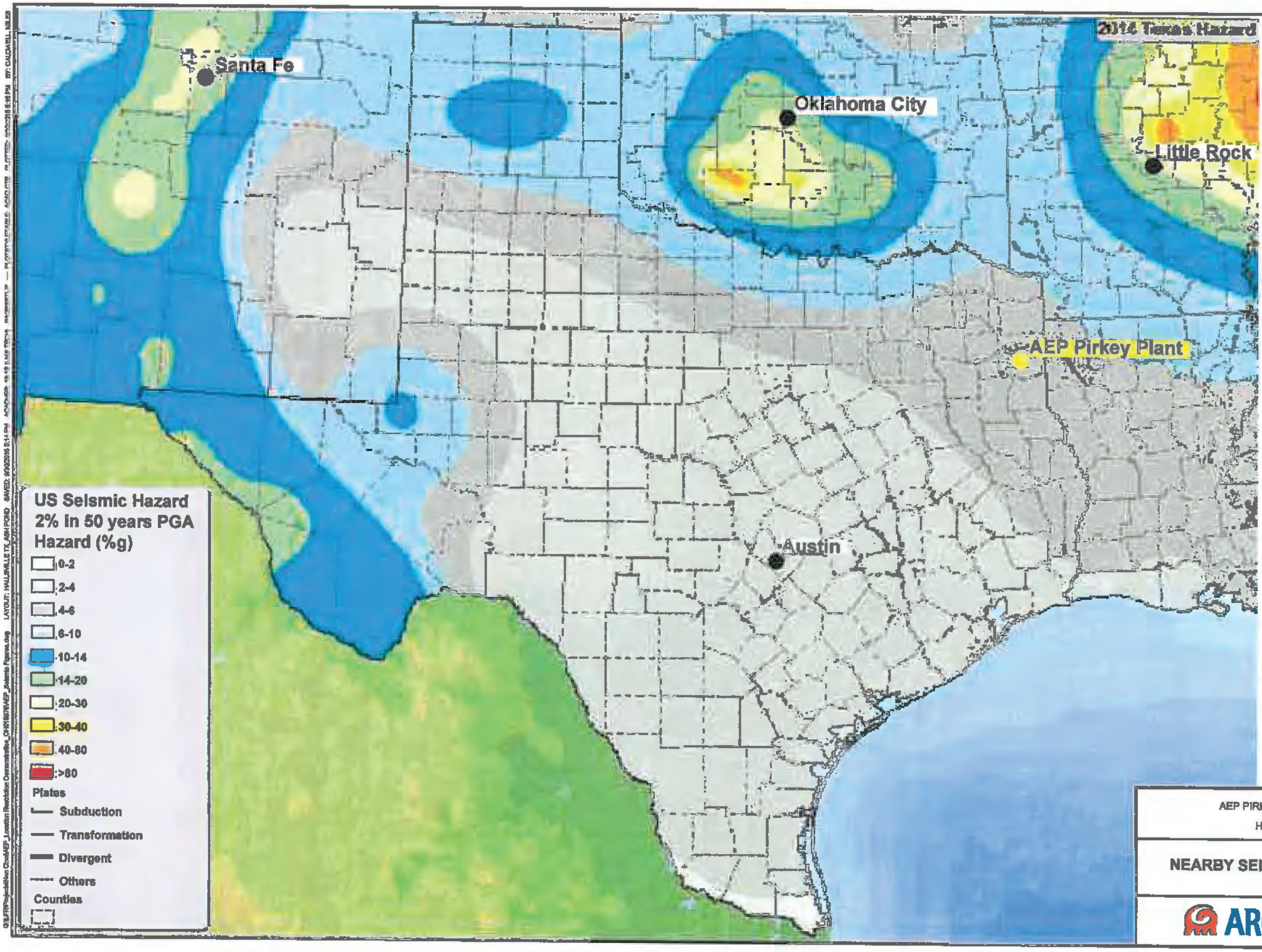
AEP PIRKEY PS GENERATING PLANT
2400 FM 3251
HALLSVILLE, TEXAS

NEARBY FAULT LOCATIONS

ARCADIS

FIGURE
11

G:\LFR\Projects\Non Chad\AEP_Location Restriction Demonstration_OH015970\AEP_Fault Figure.dwg LAYOUT: HALLSVILLE TEXAS SAVED: 8/30/2016 6:11 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE: ACAD.CTB PLOTTED: 8/30/2016 5:12 PM BY: CALDWELL, MILES



SOURCE:
USGS Earthquake Hazards Program,
Texas: 2014 Seismic Hazard Map

0 60 120
SCALE IN MILES
SCALE IS APPROXIMATE

AEP PIRKEY PLANT ASH POND
2400 FM 3251
HALLSVILLE, TX

NEARBY SEISMIC IMPACT ZONES

ARCADIS

FIGURE
12

Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

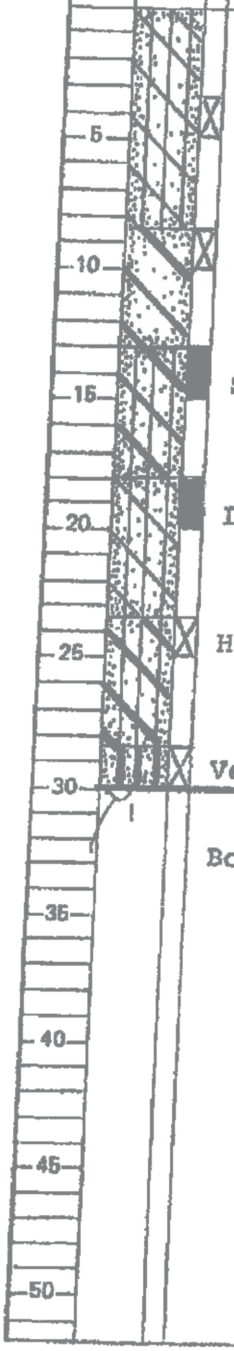
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-1
LOCATION: Hallsville

Date: 10-6-83
Type: Auger
Ground Elevation:

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Very dense brown and grey clayey silty sand w/clay seam
33-17=7" 50 B/7"

Very stiff tan and grey very sandy clay w/iron ore
6-9-21 30 B/F

Stiff grey silty sandy clay

Loose grey clayey silty sand

Hard grey silty sandy clay lenses 30-20=11" 50 B/11"

Very dense grey clayey sandy silt 19-31=11½" 50 B/11½"

Bottom of boring at 30 feet.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

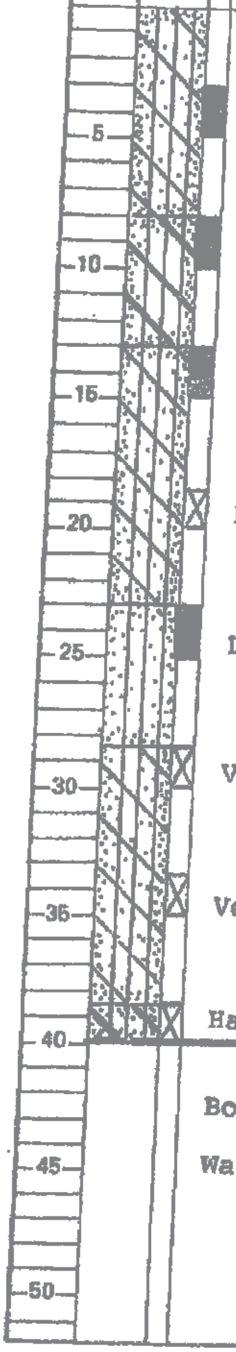
BORING NO.: MW-2
LOCATION: Hallsville

Date: 10-7-83 Type: Auger Ground Elevation:

Legend: ■ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample

Description of Stratum



Firm tan clayey silty sand

Medium tan and grey very sandy silty clay

Dense tan and grey clayey silty sand

Dense tan clayey silty sand 10-15-16 31 B/F

Dense tan silty sand

Very dense grey clayey silty sand 15-35=12" 50 B/F

Very dense grey clayey silty sand 21-29=9" 50 B/9"

Hard grey sandy silty clay 20-30=12" 50 B/F

Bottom of boring at 40 feet.

Water encountered at 25 feet.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

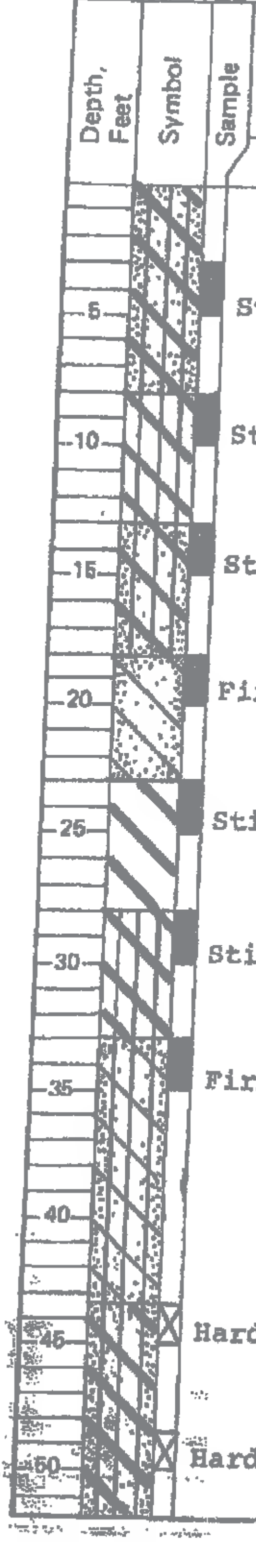
BORING NO.: MW-3
LOCATION: Hallsville, TX

Date: 11-4-83 Type: Auger Ground Elevation:

Legend:

■ Sample X Penetration ▼ Water

Description of Stratum



Stiff red, brown and grey sandy silty clay

Stiff red, tan and grey silty clay lenses w/iron ore

Stiff brown and grey sandy silty clay

Firm brown and grey sand w/clay lenses

Stiff brown and grey clay

Stiff brown and grey clay w/silt lenses

Firm grey clayey silty sand

Hard grey clay w/silty sand lenses 43-7=6" 50 B/6"

Hard brown and grey silty sandy clay 21-29=12" 50 B/F

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-3
LOCATION: Hallsville, TX

Date: 11-4-83
Type: Auger
Ground Elevation:

Legend:
■ Sample
× Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
55	▨	×	Hard grey silty sandy clay 28-22=10" 50 B/10"
60			Bottom of boring at 57 feet. Water encountered at 42 feet.
65			
70			
75			
80			
85			
90			
95			
100			

APEX PROJECT NO.: 110-089
☐ **BORING**
BORING NUMBER: ______
■ **MONITOR WELL**
MONITOR WELL NUMBER: AD-17

FACILITY NAME: AEP- Pirkey Power Plant
FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.
COMPLETION DATE: 12/30/2010

PREPARED BY: Jeff Sammons
LOGGED BY: Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.039 Datum: WGS-84
LONGITUDE: W94°29.659'
WELL LOCATION: West of Bottom Ash Pond #2

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
							
1 2 3 4 5			0-5.5	SM	Silty sand, trace clay, reddish brown, brown, light gray, loose to dense -clayey at 0.5-1.5'	None	Moist
6 7 8 9 10			5.5-10	SC	Clayey sand, reddish brown, yellowish brown, laminated iron ore, iron ore concretions	None	Moist
11 12 13 14 15 16 17 18			10-18.5	SM	Silty sand, light reddish brown, yellowish brown, dense, some clay -trace clay, yellowish brown, 15-16' -iron ore concretions at 16' -light yellowish brown, light gray at 17' -laminated iron ore at 18.5'	None	V. Moist
19 20 21 22 23 24 25 26 27 28 29 30			18.5-30	SC	Clayey sand, yellowish brown, light gray, saturated sand lenses -gravelly at 21' -laminated ironstone at 22.5' -very dense, gray, light gray at 25' -some clay at 27.5, greenish gray, gray, to boring termination	None	Saturated Dry to Moist
31 32 33 34 35 36 37 38 39 40					Boring Terminated at 30'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground
Riser Interval: +3 (ags)-10'
Screen interval: 10-30'
Water level: 23.26
Above Ground 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ______ ■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-18

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

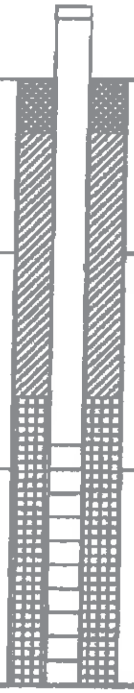
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 1/3/2011

PREPARED BY: Jeff Sammons **LOGGED BY:** Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.154' Datum: WGS-84 **WELL LOCATION:** Northeast of Bottom Ash Pond #1
LONGITUDE: W94°29.108'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
							
1			0-7	SM	Sandy Silt, some clay, very fine grained, gray, light brown, light brownish red, yellowish brown	None	Dry
2							
3							
4							
5							
6							
7							
8			7-16	CL	Clay, some sand, light gray, reddish gray, stiff, yellowish brown	None	Dry
9					-iron oxide fracture at 9.5'		
10							
11							
12							
13							
14					-increasing sand content at 14', thin lenses of iron-oxide cemented sand at 14.5', 15', 15.5', stiff		Moist
15							
16							
17			16-25	SM	Silty sand, some clay, gray, yellowish brown, dense, abundant gypsum crystals, abundant iron oxide cemented sandstone gravel in layers, saturated 19-21'	None	Moist to V. Moist
18							
19			▽			None	Saturated
20							
21					-dark gray at 21'	None	
22					-clayey at 21-23'		
23					-greenish gray, trace clay, at 23'	None	
24							
25					-clay lense, hard, dry, (shale), at 24.5-25'	None	Dry
26							
27					Boring Terminated at 25'		
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 25 feet
Filter Sand (Size/Interval): 13-25'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-15'
Screen Interval: 15-25'
Water level: ______
Above Ground 3'

Note: This log is not to be used separate from this report.

☐ BORING ■ MONITOR WELL

APEX PROJECT NO.: 110-089 **BORING NUMBER:** ______ **MONITOR WELL NUMBER:** AD-28

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/28/2010

PREPARED BY: Jeff Sammons **LOGGED BY:** Jeff Sammons

LATTITUDE: N 32°27.926' Datum: WGS-84 **WELL LOCATION:** Southwest of Primary Bottom Ash Pond #2
LONGITUDE: W94°29.658'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SM	Silty sand, light brown, very fine grained, loose	None	Moist
2			0.5-10	CL	Sandy clay, reddish brown, yellowish brown, stiff, hard, some	None	Dry
3					iron ore gravel at .5-1.5'		
4							
5					-light gray, dark reddish brown at 5'		
6					-iron oxide cemented stone at 6.5'		
7							
8							
9							
10							
11			10-16	SM	Silty sand, very fine grained, some clay, light yellowish brown,	None	Moist to V. Moist
12					light gray, medium dense		
13					-light yellowish brown at 11.5'		
14							
15							
16							
17			16-40	SC	Clayey sand, dark gray, medium dense	None	Moist
18							
19							
20			▽		-dark gray at 20'		
21					-cemented sandstone at 21'		
22					-no recovery from 22' to 35'		
23							
24							V. Moist to Saturated
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35					-1.5" layer of cemented sandstone at 35'		
36							Dry to Moist
37							
38							
39							
40							
					Boring Terminated at 40'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet **Riser Interval:** +3 (ags)-15'
Filter Sand (Size/Interval): 13-35' **Screen Interval:** 15-35'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13' **Water level:** 19.98'
Surface Completion ☐ Flush ☒ Above Ground 3.5'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089

☐ **BORING**
BORING NUMBER:

■ **MONITOR WELL**
MONITOR WELL NUMBER: AD-29

FACILITY NAME: AEP- Pirkey Power Plant

FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.

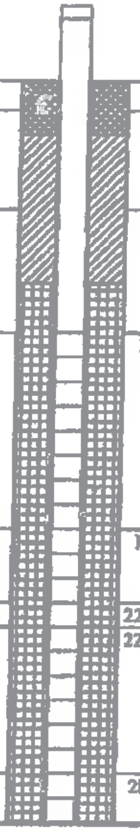
COMPLETION DATE: 1/3/2011

PREPARED BY: Jeff Sammons

LOGGED BY: Jeff Sammons

LATTITUDE: N 32°28.139'
LONGITUDE: W94°29.534
Datum: WGS-84

WELL LOCATION: North of Bottom Ash Pond #2

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			 0-0.5	SM	Silty sand, brown, light brown, very fine grained	None	Moist
2 3 4 5			0.5-5	CL	Clay, some sand, red, reddish brown, light gray, stiff	None	Dry
6 7 8 9 10			5-10	CL	Sandy clay, light gray, light red -abundant iron ore, yellowish brown, yellow, dry	None	Dry
11 12 13 14 15 16 17 18			10-18	SC	Clayey sand, yellowish brow, reddish brown, light gray, medium dense -light gray, yellow, at 11' -4" saturated sand seam, trace clay at 13' -purple, yellowish brown, reddish brown, medium dense to loose	None	Moist
19 20 21		▽	18-22	SM	Silty sand, reddish brown to red -some iron ore gravel, some clay, saturated, gypsum crystals, at 20'	None	V. Moist
22			22-22.5	CL	Sandy clay, dark gray, stiff	None	Dry
23 24 25 26 27 28			22.5-28	SM	Silty sand, saturated, greenish gray, loose	None	Dry to Moist
29 30			28-30	SC	Clayey sand, greenish gray, dark gray, dark brown, dry, very dense, slightly cemented	None	Dry to Moist
31 32 33 34 39 40					Boring Terminated at 30'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level:
Above Ground 3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-30

JSS 1-21-16
JEFFREY D. SAMMONS
GEOLOGY
#10070

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1821
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/08/2015
DEVELOPMENT:	12/10/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

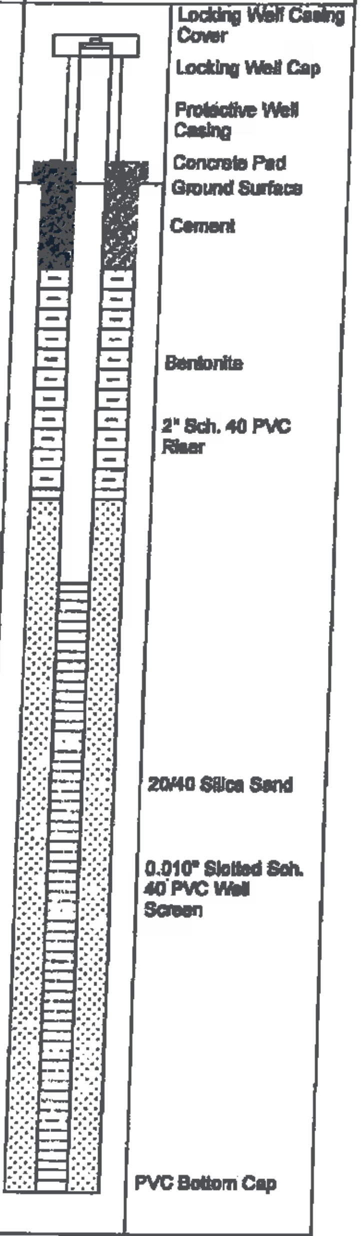
DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	50086
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	342.02 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 27' 56.49"
LONGITUDE	94 29' 32.53"

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
SANDY LEAN CLAY: light reddish brown and light gray	CL	0							
		2		■	17	84	24	17	7
- trace sand and silt at 3.0' to 3.5', light reddish brown		3							
- some iron ore gravel at 7', light gray, reddish brown, light reddish brown, increasing sand content with depth		7		■	14	53	38	24	14
CLAYEY SILTY SAND: very fine to fine sand, reddish brown, light brown, and light gray	SM-SC	9							
SILTY SAND: very fine to fine sand, some lenses of clay and partially cemented sand, reddish brown and light gray, moist	SM	11							
		13		■	10	13	28	NP	-
CLAYEY SAND: very fine to fine sand with some fine to coarse iron ore gravel and partially cemented sand, reddish brown and light gray, moist	SC	14	▼						
		16		■	20	26	34	24	10
SILTY SAND: very fine to fine sand, some clay, light gray and reddish brown, saturated	SM	17	▽						
- some iron ore gravel at 19', gray and reddish brown, increasing clay content with depth, very moist		19							
SILTY CLAYEY SAND: fine to very fine sand, some clay lenses, gray and dark gray, moist	SM-SC	22							
		23		■	20	49	30	22	8

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING LR-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

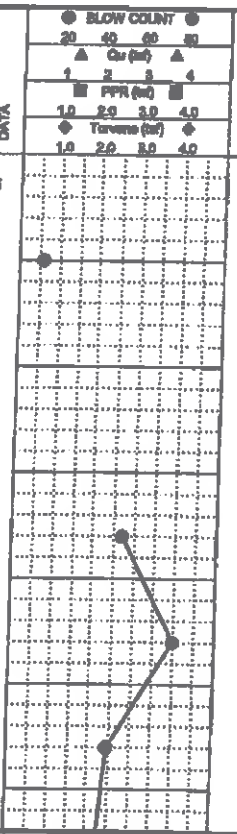
BORING TYPE: Flight Auger

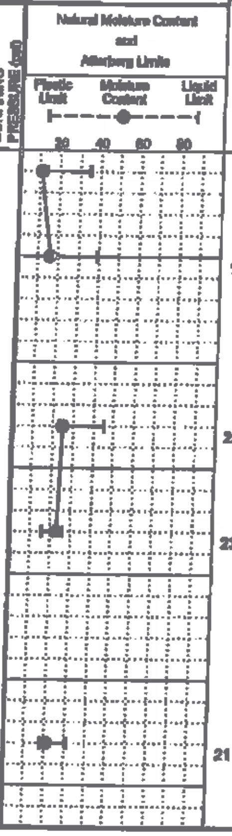
DATE 10/20/09

SURFACE ELEVATION 337.2

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	LEAN CLAY WITH SAND(CL) very stiff; tan	P=3.5	11	35	13	22	70	+40 Sieve=3%, +4 Sieve=1%
		--tan and orange							
5		--stiff; red and tan	N=12	15	39	16	23	66	+40 Sieve= 4%, +4 Sieve=2%
	CH	SANDY FAT CLAY(CH) tan and orange							
10									
	SC	CLAYEY SAND(SC) gray; with clay and sand seams	SF	26	45	23	22	44	+40Sieve=13%, +4 Sieve=6%
15	SM	SILTY SAND(SM) dark gray							
	SC	CLAYEY SAND(SC) very dense; gray; with small clay seams	N=54	23	26	16	10	20	+40 Sieve=2%, +4 Sieve=0%
20									
		--dark gray	N=60						
25									
		--dense; gray and brown	N=49	21	31	18	13	29	+40 Sieve=1%, +4 Sieve=0%
30									

Columns with no entries: SAMPLES, GEOLOGIC UNIT, WATER LEVEL, DRY DENSITY (pcf), COMPRESSIVE STRENGTH (tsf), FAILURE STRAIN (%), CONFINING PRESSURE (psi)





Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 13' while drilling. Water level @ 11' and open to 38' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.804', W 94°29.482'

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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING LR-1

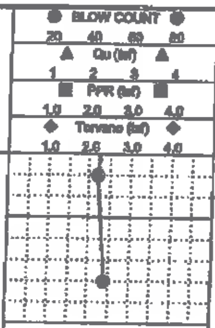
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/08

SURFACE ELEVATION 337.2

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	☒	▨			--gray	N=44										
35		▨														
	☒	▨				N=48										
40					Bottom of Boring @ 40'											



Natural Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
20 40 60 80

ATTERBERG LIMITS(%)

Water Level: Std.: ▽ Measured: ▽ Perched: ▽

Water Observations: Seepage @ 13' while drilling. Water level @ 11' and open to 38' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.804', W 94°29.482'

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING LR-2

PROJECT: Pirkey Power Plant
Hallsville, Texas

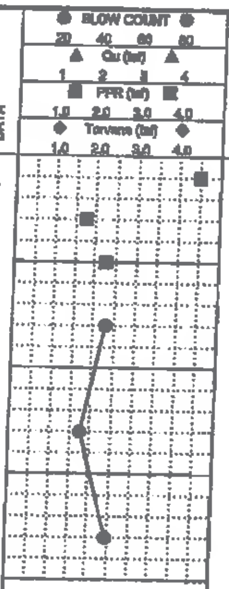
PROJECT NO.: G3241-095

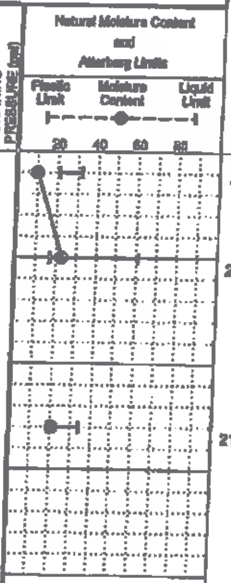
BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 326.0

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	GC	CLAYEY GRAVEL(GC) medium dense; tan, gray, and red; with ferric seams	P=4.5+					10	32	21	11	6	+40Sieve=84%, +4 Sieve=77%
	CL	SANDY LEAN CLAY(CL) stiff; tan and gray	P=1.75										
5	SC	CLAYEY SAND(SC) very stiff; tan and gray; with ferric seams; with iron oxide cemented sandstone	P=2.25					23	61	17	44	41	+40Sieve=6%, +4 Sieve=0%
10	SM	SILTY SAND(SM) dense; gray	N=46										
15	SC	CLAYEY SAND(SC) dense; gray	N=35					21	34	19	15	31	+40Sieve=2%, +4 Sieve=0%
			N=49										
20		Bottom of Boring @ 20'											





Water Level Est.: ▽ Measured: ▽ Perched: ▽

Water Observations: Seepage @ 3' while drilling. Water level @ 1' and open to 15' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.801', W 94°29.491'

LOG OF BORING W-1

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.5

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH	FAT CLAY WITH SAND(CH) tan and red	P=3.75	21	62	21	41	79	+40 Sieve=6%, +4 Sieve=0%
		P=3.75						
	~red	P=4.5	18	60	21	39	75	+40 Sieve=7%, +4 Sieve=1%
CL	SANDY LEAN CLAY(CL) reddish yellow	P=4.0						
CH	FAT CLAY(CH) red and tan	P=4.25						
CH	FAT CLAY WITH SAND(CH) red and yellow	P=3.75	18	56	18	38	71	+40 Sieve=5%, +4 Sieve=0%
	~red	P=3.5						
SC	CLAYEY SAND(SC) reddish brown	P=2.0	10	28	18	10	25	+40Sieve=21%, +4 Sieve=11%
CL	LEAN CLAY(CL) red; with sand seams	P=1.0						

Column headings also printed: DEPTH (ft) (0, 5, 10, 15, 20, 25, 30); SAMPLES; GEOLOGIC UNIT; WATER LEVEL; BLOW COUNT 20 40 60 80; Qu (tsf) 1 2 3 4; PPR (tsf) 1.0 2.0 3.0 4.0; Torvane (tsf) 1.0 2.0 3.0 4.0; DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi); Natural Moisture Content and Atterberg Limits — Plastic Limit, Moisture Content, Liquid Limit — 20 40 60 80; ATTERBERG LIMITS(%)

Water Level Init.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 15' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

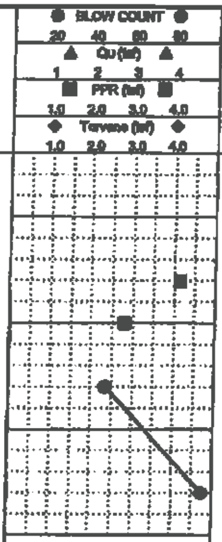
PROJECT NO.: G3241-095

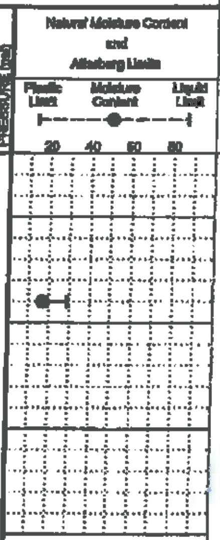
BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 358.5

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		SC			CLAYEY SAND(SC) grayish brown	N=32										
					--tannish gray	P=4.15					17	29	19	10	25	+40 Sieve=1%, +4 Sieve=0%
40						P=2.5										
					--gray	N=47										
45																
50		SM SC			SILTY CLAYEY SAND(SM-SC) gray	N=50/5"										
					Bottom of Boring @ 50'											





Water Level Est.: ▽ Measured: ▼ Perched: ▽
Water Observations: Seepage @ 15' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL ENGINEERS & CONSULTANTS

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-2

PROJECT: Pirkey Power Plant
Hallsville, Texas

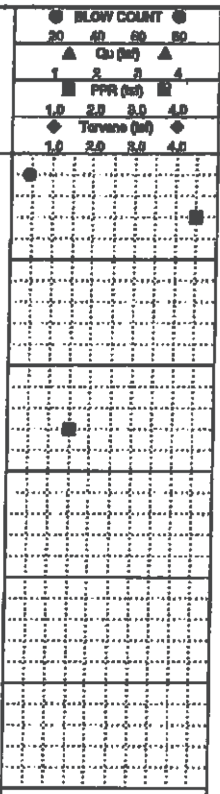
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

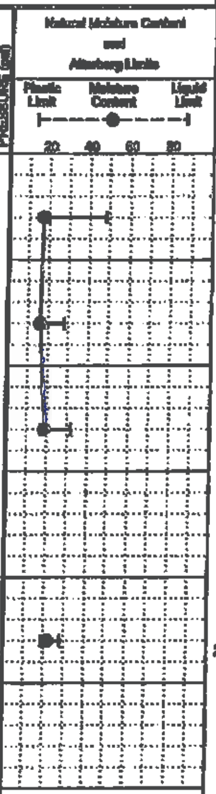
DATE 10/21/09

SURFACE ELEVATION 341.7

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; red and gray	N=9						
	--hard	P=4.5+	17	48	19	29	65	+40 Sieve=6%, +4 Sieve=2%
	--gray, red, and tan	N=50						
SC	CLAYEY SAND(SC) very dense; red and tan	N=50/5"	16	26	16	10	27	+40 Sieve=7%, +4 Sieve=2%
	--medium dense; tan and gray	P=1.5	19	32	17	15	31	+40Sieve=13%, +4 Sieve=6%
	--very dense; gray and tan	N=62						
	--green	N=50/5"	22	25	16	9	33	+40 Sieve=6%, +4 Sieve=2%
		N=56						
	Bottom of Boring @ 30'							

Columns: DEPTH (ft) 0, 5, 10, 15, 20, 25, 30 | SAMPLES | GEOLOGIC UNIT | WATER LEVEL | DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)





Water Level Gal: ▽ Measured: ▽ Perched: ▽

Water Observations: Seepage @ 13' while drilling. Water level @ 21' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-3

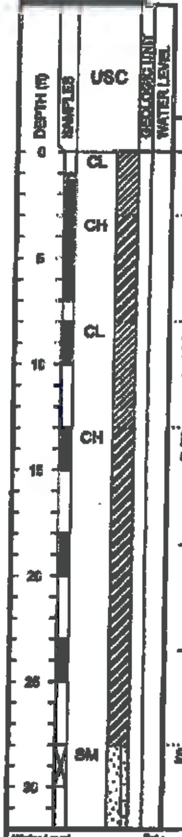
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

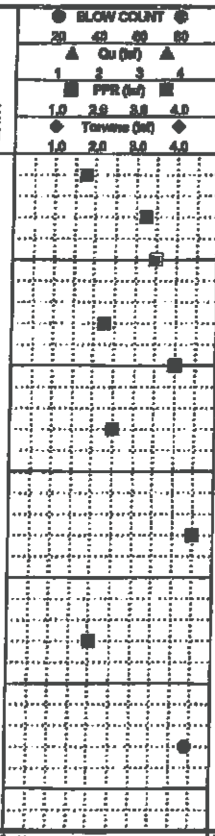
BORING TYPE: Flight Auger

DATE 10/20/09

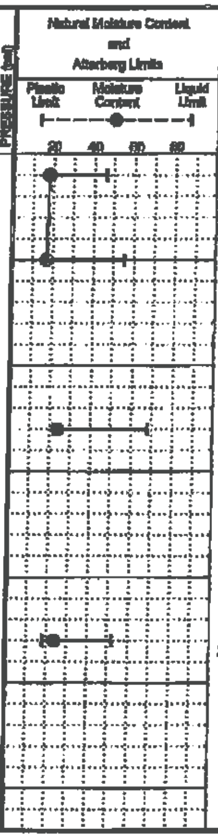
SURFACE ELEVATION 355.3



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	**SANDY LEAN CLAY**(CL) stiff; white and tan	P=1.75	18	46	17	29	61	+40 Sieve=7%, +4 Sieve=2%
CH	**SANDY FAT CLAY**(CH) very stiff; red, tan, and white	P=3.25						
	--white, tan, and red	P=3.5	17	55	18	37	68	+40 Sieve=5%, +4 Sieve=0%
CL	**SANDY LEAN CLAY**(CL) very stiff; red and yellow	P=2.25						
	--hard; red and yellow	P=4.0						
CH	**FAT CLAY WITH SAND**(CH) very stiff; red and yellow	P=2.5	24	68	22	46	80	+40 Sieve=5%, +4 Sieve=0%
	--hard	P=4.5+						
	--stiff	P=2.0	24	52	18	34	69	+40 Sieve=4%, +4 Sieve=0%
SM	**SILTY SAND**(SM) very dense; yellow and red	N=68						



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 34' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-3

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

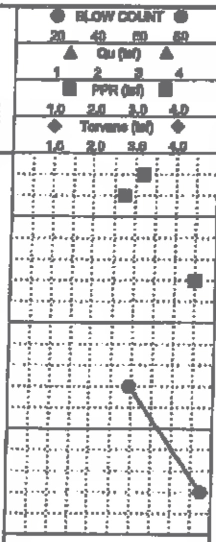
BORING TYPE: Flight Auger

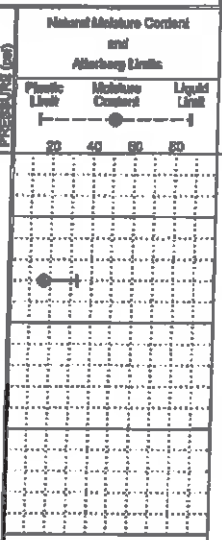
DATE 10/20/09

SURFACE ELEVATION 358.3

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	CL	SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel	P=3.25						
40	SC	CLAYEY SAND(SC) very dense; dark gray	P=4.5+	17	33	17	16	38	+40 Sieve=1%, +4 Sieve=0%
45	SM SC	SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated	N=59						
50	SC	CLAYEY SAND(SC) very dense; dark gray	N=50/4"						
		Bottom of Boring @ 50'							

Columns: SAMPLES; GEOLOGIC UNIT; WATER LEVEL; DRY DENSITY (pcf); COMPRESSIVE STRENGTH (tsf); FAILURE STRAIN (%); CONFINING PRESSURE (psi)





Water Level: Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 34' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ENVIRONMENTAL LOG

Client: Pirkey Power Plant

Project No: G3241-095 **Phase** **Task**

Well No. PW-3 (W3)

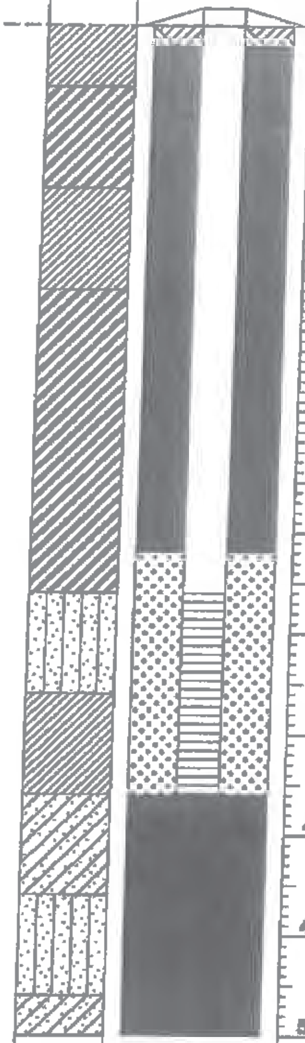
Location Hallsville, Texas

Surface Elev.

Page 1 **of** 1

Depth Feet	Sampler	Overburden/Lithologic Description	FID (ppm)	Depth Feet	Well Construction Details
					T.O.C. Elev. .
0		Ground Surface		0	
	▮	SANDY LEAN CLAY(CL) stiff; white and tan			
	▮	SANDY FAT CLAY(CH) very stiff; red, tan, and white			
5	▮	--white, tan, and red		5	
10	▮	SANDY LEAN CLAY(CL) very stiff; red and yellow		10	
	▮	--hard; red and yellow			
15	▮	FAT CLAY WITH SAND(CH) very stiff; red and yellow		15	
20	▮			20	
25	▮			25	
30	▮	SILTY SAND(SM) very dense; yellow and red		30	
35	▮	SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel		35	
40	▮	CLAYEY SAND(SC) very dense; dark gray		40	
45		SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated		45	
50		CLAYEY SAND(SC) very dense; dark gray		50	
		Bottom of Boring @ 50'			

Graphic Log / **Well Construction Graphics**



Driller Doug Hinds	**Drilling Method** Flight Augers	**Bentonite Seal** 1-26' & 38-50'
Logged By Blake Hobbs	**Borehole Diameter** 6.5"	**Filter Pack Qty.** 26-38'
Drilling Started 10/20/09	**Well Casing** 2.0" **Dia.** 0.0' **to** 28.0'	**Filter Pack Type** 20/40 Sand
Drilling Completed	**Casing Type** PVC	**Static Water Level**
Construction Completed	**Well Screen** 2.0" **Dia.** 28.0' **to** 38.0'	
Development Completed	**Screen Type** Slotted	**Notes:**
Type of Well	**Slot Size** 0.010"	
	Grout Type Bentonite	

ETTL Engineers & Consultants Inc.

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-4

PROJECT: Pirkey Power Plant
Hallsville, Texas

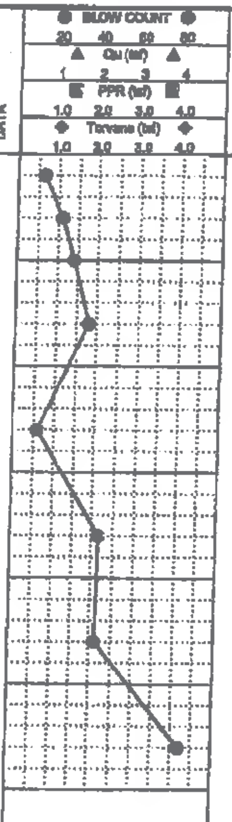
PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

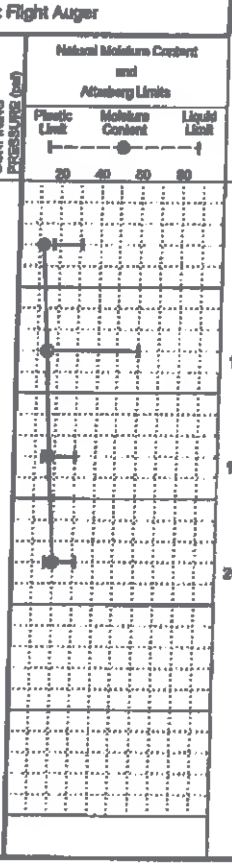
DATE 10/20/06

SURFACE ELEVATION 338.0

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) stiff; brown, red, and yellow	N=13						
	--with gravel	N=22	12	31	17	14	35	+40Sieve=31% +4 Sieve=16%
	--red and tan; with iron oxide cemented sandstone	N=28						
	--dense; red and white; with clay seams	N=36	15	60	16	44	39	+40Sieve=11% +4 Sieve=4%
	--medium dense; orangish gray; with gravel	N=12	17	30	14	16	22	+40Sieve=26% +4 Sieve=17%
GC	CLAYEY GRAVEL(GC) dense; dark grey	N=43	20	31	16	15	7	+40Sieve=68% +4 Sieve=62%
SM	SILTY SAND(SM) dense; dark grey	N=42						
CL	SANDY LEAN CLAY(CL) very dense; gray	N=64						
	Bottom of Boring @ 30'							



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



DEPTH (ft) 0–30 | SAMPLES | GEOLOGIC UNIT | WATER LEVEL

Water Level Est.: ▽ Measured: ▽ Trended: ▽

Water Observations: Seepage @ 19' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-8
LOCATION: Hallsville,TX

Date: 9-15-83
Type:
Ground Elevation: 347.1

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
	▨	■	Red and brown slightly sandy silty clay
	▨	■	Red and brown silty clay with silt lenses
5	▨	■	Red and brown silty sandy clay
10			Bottom of boring at 6 feet. No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			

SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-9
LOCATION: Hallsville,TX

Date: 9-15-83
Type:
Ground Elevation: 348.1

Legend:
▆ Sample
X Penetration
▼ Water

Depth, Feet	Description of Stratum
	Red and grey silty clay with silty sand
	Red and grey silty sandy clay
5	Red and grey silty sandy clay
	Bottom of boring at 6 feet.
10	No water encountered.
15	
20	
25	
30	
35	
40	
45	
50	

SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

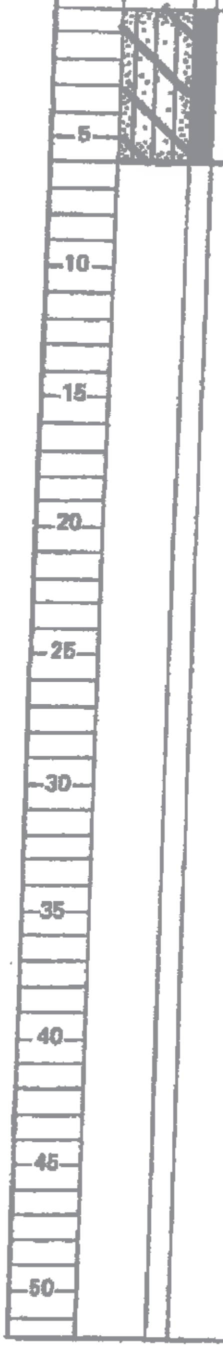
BORING NO.: S-10
LOCATION: Hallsville

Date: 10-6-83 Type: Auger Ground Elevation: 347.4

Legend:

■ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Very stiff tan and brown sandy silty clay

Very stiff tan and grey sandy silty clay

Stiff tan and grey sandy silty clay

Bottom of boring at 6 feet.

No water encountered.

SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-11
LOCATION: Hallsville

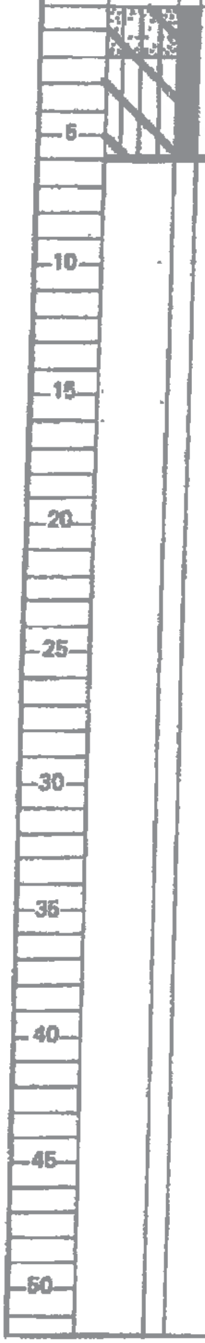
Date: 10-6-83 Type: Auger Ground Elevation: 347.0

Depth, Feet | Symbol | Sample

Legend:

■ Sample X Penetration ▼ Water

Description of Stratum



Very stiff tan and grey sandy silty clay lenses

Very stiff tan and grey silty clay lenses

Very stiff tan and grey silty clay lenses

Bottom of boring at 6 feet.

No water encountered.

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 1	**Date:** 8/19/2015

Direction Photo Taken:

South

Description:

P8190378
View across East and West Botton Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 2	**Date:** 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190379
Road side ditch, not considered a wetland, due to lack of hydric vegetation and connectivity.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 3	**Date:** 8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190383
Upland forest bordering north of West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 4	**Date:** 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190385
Pizometer along West Bottom Ash Pond perimeter embankment road.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. **5**	**Date:** 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190386
Pizometer along West Bottom Ash Pond perimeter embankment road.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. **6**	**Date:** 8/19/2015

Direction Photo Taken:

North

Description:

P8190387

AD-3 in the wooded area east of West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 7

Date: 8/19/2015

Direction Photo Taken:

Description:

P8190390
Dry (non-wetland) ditch adjacent to railroad and West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 8

Date: 8/19/2015

Direction Photo Taken:

West Northwest

Description:

P8190392
West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
9	8/19/2015

Direction Photo Taken:

East Southeast

Description:

P8190396
West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
10	8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190399
Upland drainage at the toe of the West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – Pirkey Power Plant

Location:
Hallsville, Harrison County, Texas

Project No.
OH015976.0001

Photo No.
11

Date:
8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190403
Vegetated strip around culvert that drains East and West BAPs. This potential wetland may be jurisdictional and is associated with an intermittent stream.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – Pirkey Power Plant

Location:
Hallsville, Harrison County, Texas

Project No.
OH015976.0001

Photo No.
12

Date:
8/19/2015

Direction Photo Taken:

Southwest

Description:

P8190411
Small vegetated strip adjacent to access road south of southeast corner of West Botton Ash Pond.

ARCADIS **PHOTOGRAPHIC LOG**

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 13

Date: 8/19/2015

Direction Photo Taken:

West Northwest

Description:

P8190414
Looking across West Bottom Ash Pond

ARCADIS **PHOTOGRAPHIC LOG**

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 14

Date: 8/19/2015

Direction Photo Taken:

South Southeast

Description:

P8190417
West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	**Location:**	**Project No.**
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	**Date:**
15	8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190419
Small vegetated strip in outside corner of access road south of southeast corner of West Botton Ash Pond.

1.3 – 2018 Landfill Lateral Expansion – CCR Location Restriction Evaluation, October 26, 2018

ARCADIS Design & Consultancy for natural and built assets

American Electric Power Service Corporation

2018 Landfill Lateral Expansion - CCR Location Restriction Evaluation

H. W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

October 26, 2018

ARCADIS Design & Consultancy for natural and built assets

STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST

Kenneth J Brandner

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matthew J. Lamb / KJB

Matthew J. Lamb
Project Manager

2018 Landfill Lateral Expansion CCR Location Restriction Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
AEP

Prepared by:
ARCADIS U.S., Inc.
100 E Campus View Blvd
Suite 200
Columbus
Ohio 43235-1447
Tel 614 985 9100
Fax 614 985 9170

Our Ref.:
TX015976.0003

Date:
October 26, 2018

Table of Contents

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
BGL	below ground surface
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations

EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
PTI	Permit to Install
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the location of the 2018 Lateral Expansion of the existing on-site Landfill relative to the location restrictions included in the Coal Combustion Residual (CCR) requirements, as specified in the Code of Federal Regulations (CFR) 40 CFR 257.60 to 257.64, at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zone, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West Bottom Ash Pond (BAP), East BAP, Stack Out Area, and Landfill (**Figure 2**). The initial CCR Location Restriction Evaluation for the existing Landfill was prepared in 2016 (Arcadis, 2016). This report has been prepared for the 2018 Lateral Expansion of the existing Landfill (Site) and includes an updated evaluation of the location restriction criteria. The evaluation of the groundwater monitoring well network in the uppermost aquifer for the 2018 Lateral Expansion of the existing Landfill is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the Landfill CCR unit, as well as publicly-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on documents reviewed and will further describe the uppermost aquifer.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant Landfill.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas (**Figure 1**). The existing Landfill CCR unit is currently approximately 130 acres in size and is located in the southern portion of the Plant. The 2018 Landfill Lateral Expansion will cover approximately 15 acres directly south of the existing Landfill (**Figures 2** and **3**). Following completion of the 2018 Lateral Expansion, the Landfill will be approximately 145 acres in size.

2.2 Description of Landfill CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the Landfill.

2.2.1 Embankment Configuration

The Landfill was constructed in the southwestern portion of the Plant, and as shown on the U.S. Geological Survey 1983 topographic map (**Figure 1**), the southwestern portion of the Plant contained an unnamed intermittent tributary of Hatley Creek prior to Landfill construction in 1984. The Landfill was constructed within the unnamed tributary creek which had a bottom elevation ranging from approximately 290 feet amsl on the south side of the Landfill to 300 feet amsl on the north side of the Landfill. The native soil sidewalls of the tributary creek at the Landfill location have a maximum elevation of approximately 355 feet amsl. Therefore, as shown on Geologic Cross Section C-C' (**Figure 6**), the Landfill is partially incised within the tributary creek, and the tributary creek native soil sidewalls serve as a natural embankment for the lower portion of the Landfill.

The original Landfill design included emplacement of CCR materials in the Landfill with 3:1 slopes (3 feet horizontal, 1 foot vertical) with an approximate 10 foot wide bench for every 20 foot vertical rise of CCR material (VFL Technology Corporation, 1984). Apex Geoscience conducted a geotechnical investigation of the Landfill CCR materials in 2012, and concluded the CCR material embankments would be stable on 3:1 slopes (Apex Geoscience, 2013).

In addition to the Landfill CCR material embankments, earthen embankments are present around portions of the Landfill to control storm water flow. The earthen embankments are constructed using compacted clay on 3:1 slopes. ETTL Engineers & Consultants Inc (ETTL) conducted a geotechnical evaluation of the perimeter embankments in 2005 and concluded the perimeter embankments would be stable on slopes no steeper than 3:1 unless the slopes are stabilized with geogrid reinforcement (ETTL, 2005).

The Landfill Stormwater Runoff Pond (non-CCR Unit) was constructed downslope (south) of the Landfill in 1993 and 1994. The Landfill Stormwater Runoff Pond has perimeter compacted soil embankments up to approximately 19 feet in height. Apex Geoscience conducted a geotechnical investigation of the Landfill Stormwater Runoff Pond embankments in 2011. Apex Geoscience recommended raising the elevation of the Landfill Stormwater Runoff Pond embankments to an elevation of 302 feet amsl using soils compacted to at least 95% standard proctor density, with an emergency spillway at a crest elevation of 298 feet amsl. The Apex Geoscience report concluded the Landfill Stormwater Runoff Pond embankments would be stable (Apex Geoscience, April 2011).

The 2018 Landfill Lateral Expansion will cover approximately 15 acres directly south of the existing Landfill. In 2016, Auckland Consulting conducted a stability assessment of the 2018 Lateral Expansion area and concluded the embankments would be stable on slopes no steeper than 3:1 (Auckland, November 2016). The 2016 Auckland Consulting report stated the northern and eastern extents of the 2018 Lateral Expansion will be constructed contiguous to the existing Landfill disposal area, and ash disposal will be completed in multiple lifts, each with an approximate height of 20 feet, integrated with safety benches, and maximum side slopes of 3:1 to a maximum waste height of 120 feet.

2.2.2 Area/Volume

The existing Landfill is approximately 130 acres in size and was designed to receive 12,207,000 cubic yards (7,566 acre feet) of CCR materials including fly ash, bottom ash, economizer ash, and stabilized FGD sludge (VFL Technology Corporation, 1984). The design maximum CCR material height in the existing Landfill is approximately 140 feet (Apex Geoscience, 2013). As discussed above in Section 2.2.1, the 2018 Landfill Lateral Expansion will cover an area of approximately 15 acres to a maximum waste height of 120 feet. The design capacity of the CCR materials to be placed within the 2018 Lateral Expansion is approximately 2,200,000 cubic yards.

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, stabilized FGD sludge) have been generated. The CCR materials that are not taken offsite for beneficial reuse are disposed of in the Landfill. The Landfill was constructed in several phases beginning with the northeast portion (Phase 1) in 1984. The Landfill was expanded (east-central portion) in 1985 and 1987. The Landfill was subsequently expanded to the west and south during the 1990's, including construction of the Landfill Stormwater Runoff Pond (non-CCR unit) directly south of the Landfill in 1993 and 1994. The Landfill was further expanded to the west between 2005 and 2015 to its current size of approximately 130 acres as shown on **Figure 3**.

In 2005, ETTL conducted a geotechnical evaluation of the Landfill and Landfill Stormwater Runoff Pond, including installation of 30 soil borings, ten cone penetration test (CPT) borings, and geotechnical testing of soil samples. The ETTL report concluded the Landfill CCR materials would be stable at 3:1 slopes; and foundation settlement would be within acceptable limits (ETTL, 2005). The ETTL report recommended that Landfill expansion activities include a composite liner system consisting of a 2-foot-thick compacted clay liner or geosynthetic clay liner (GCL) as the bottom component; and a top liner component consisting of a PVC, high-density polyethylene (HDPE), or a very low density polyethylene (VLDPE) liner. ETTL also recommended Landfill expansion activities include installation of a Landfill leachate collection system consisting of permeable bottom ash emplaced above the Landfill liner. These recommendations were implemented during Landfill expansion phases between 2005 and 2015.

The 2018 Landfill Lateral Expansion design includes emplacement of up to 120 feet of CCR materials with maximum side slopes of 3:1 above the Landfill liner system which will consist of a 60-mil HDPE top liner underlain by a 2-foot-thick compacted clay bottom liner. Prior to installation of the liner system, approximately 10 to 15 feet of cut into the existing soils will occur along the topographically higher southern portion of the Lateral Expansion, and emplacement of these soils (clayey sands, silty clayey sand and/or lean clays) as fill materials below the liner system in the topographically lower central and northern portions of the Lateral Expansion. As detailed below in Section 3, the fill materials emplaced in the topographically lower portions of the Lateral Expansion will extend in height at least five feet above the water table, thereby providing the required separation distance of at least five feet between the base of the CCR unit and the top of the uppermost aquifer.

2.2.4 Surface Water Control

Surface water in the area of the existing Landfill flows in a general southerly direction to the Landfill Stormwater Runoff Pond located directly southwest of the existing Landfill. Surface water in the area of the 2018 Landfill Lateral Expansion flows in a general westerly direction to the Landfill Stormwater Runoff Pond. The Landfill Stormwater Runoff Pond, which is approximately 16 acres in size, also receives (1) Landfill leachate that is gravity drained from the existing Landfill via underground lateral perforated pipes and permeable bottom ash materials that were installed above portions of the existing Landfill liner, (2) Landfill leachate that will gravity drain via underground lateral perforated pipes that will be installed above the 2018 Landfill Lateral Expansion liner system, and (3) shallow groundwater that will gravity drain via underground lateral perforated HDPE underdrain pipes that will be installed in permeable bottom ash materials approximately seven feet below the 60-mil HDPE liner of the 2018 Landfill Lateral Expansion.

An emergency spillway is present at the southern end of the Landfill Stormwater Runoff Pond at an elevation of approximately 298 feet amsl. The top of the Landfill Stormwater Runoff Pond is located at an elevation of approximately 302 feet amsl, therefore the Landfill Stormwater Runoff Pond has approximately four feet of freeboard (Apex Geoscience, April 2011). Water in the Landfill Stormwater Runoff Pond discharges into an unnamed intermittent tributary of Hatley Creek via Outfall 004 in accordance with Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0002496000.

2.3 Previous Investigations

The initial soils investigation and design of the Plant was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, including the Landfill Area.

A soils investigation of the Landfill was conducted by Southwestern Laboratories in 1984. The investigation included installation of 45 soil borings and geotechnical analyses of soil samples. The report recommended installation of three feet of compacted clay as the bottom liner for the Landfill (Southwestern Laboratories, July 1984).

An engineering design report for the Landfill was prepared by VFL Technology Corporation in 1984. The Landfill design included a bottom compacted clay liner three feet in thickness, and Landfill side slopes of 3:1 (VFL Technology Corporation, 1984).

In 1985, Southwestern Laboratories conducted a geotechnical evaluation of the clay liner that was installed at the base of the Landfill, including installation of four soil borings and permeability testing of soil samples. The report concluded the clay liner was three feet thick with a permeability less than 1×10^{-7} centimeters per second (cm/sec) (Southwestern Laboratories, 1985).

In 1993, Alliance Inc. conducted a geotechnical investigation of the clay liner installed at the base of the Landfill following a Landfill expansion phase in 1993. The report concluded the clay liner was three feet or more in thickness, and the clay liner met the permeability specifications of $<1 \times 10^{-7}$ cm/sec (Alliance Inc., 1993).

In 1995, Central and South West Services prepared design specifications for Landfill expansion to the west and south. The design specifications included a geosynthetic clay liner overlain by a 0.060 inch (60 mil) HDPE liner (Central and South West Services, 1995).

In 2005, ETTL conducted a geotechnical evaluation of the Landfill and Landfill Stormwater Runoff Pond, including installation of 30 soil borings, ten CPT borings, and geotechnical testing of soil samples. The geotechnical data was obtained to design Landfill expansions in 2005 through 2007. The ETTL report concluded the Landfill CCR materials would be stable at 3:1 slopes; and foundation settlement would be within acceptable limits (ETTL, 2005). The ETTL report recommended the Landfill expansion include a composite liner system consisting of a 2-foot-thick compacted clay liner or GCL as the bottom component; and a top liner component consisting of a PVC, HDPE, or a VLDPE liner. ETTL also recommended the Landfill expansion include a leachate collection system consisting of permeable bottom ash emplaced above the Landfill liner. These recommendations were implemented during Landfill expansion phases between 2005 and 2015.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, March 2011).

In 2011, Apex Geoscience conducted a geotechnical investigation of the Landfill Stormwater Runoff Pond. The report recommended raising the elevation of the Landfill Stormwater Runoff Pond embankments to an elevation of 302 feet amsl using soils compacted to at least 95% standard proctor density, and an emergency spillway with a crest elevation of 298 feet amsl (Apex Geoscience, April 2011). These recommendations were implemented during subsequent Landfill Stormwater Runoff Pond construction activities.

In 2012, Apex Geoscience conducted a geotechnical investigation for Landfill expansion activities at the western portion of the Landfill where surface lignite mining operations had previously been conducted to a depth of 50 to 100 feet using a dragline, and the spoils (reclaimed soil) were returned to the excavation. The report concluded the Landfill embankments would be stable with side slopes of 3:1 (Apex Geoscience, 2013).

In 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-30 through AD-35 (Auckland Consulting, 2016).

In 2016, Auckland Consulting conducted a geotechnical evaluation of the 2018 Landfill Lateral Expansion area, including installation of eight soil borings (B1 through B8) with total depths ranging from 40 to 62 feet below ground level (bgl). Soil boring locations are shown on **Figure 11**, and copies of the soil boring logs are provided in **Appendix C.** Based on the results of the 2016 geotechnical evaluation, including slope stability modeling and settlement analysis, Auckland Consulting concluded the 2018 Landfill Lateral Expansion will be structurally stable with maximum side slopes of 3:1 to a maximum disposal height of 120 feet (Auckland, November 2016).

In 2018, Auckland Consulting installed seven piezometers (PZ-1 through PZ-7) within the 2018 Landfill Lateral Expansion area to obtain detailed depth to groundwater and groundwater flow direction data prior to construction of the Lateral Expansion. The piezometers were completed in the uppermost water-bearing unit with total depths ranging from 14 to 20 feet bgl. Piezometer locations are shown on **Figure 11**, and piezometer completion data is provided in **Appendix C.**

2.4 Hydrogeologic Setting

2.4.1 General

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Site in the area of the Landfill Stormwater Runoff Pond. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of up to approximately 100 feet in Harrison county, Texas (Broom, 1966). As shown on Geologic Cross Sections C-C’ (**Figure 6**) and D-D’ (**Figure 7**), a thick sand stratum is located below and adjacent to the Landfill between an elevation of approximately 270 feet and 330 feet amsl. This sand stratum likely corresponds to the Carrizo Sand based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

The Carrizo Sand is underlain by the Eocene-age Wilcox Formation, which outcrops in topographically low areas near the Sabine River to the south and southeast of the Plant (Flawn, 1965). The Wilcox Formation consists of interbedded sand and clay with seams of lignite and attains a thickness of approximately 700 feet (Broom, 1966). As shown on Geologic Cross Section D-D’ (**Figure 7**), a lignite seam was encountered below an elevation of approximately 270 feet amsl during drilling of monitoring well AD-24 at the south end of the Site. This lignite seam likely corresponds to the top of the Wilcox Formation based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

These features are further illustrated on five lines of cross section that were prepared through the existing Landfill Area, with three lines trending from west to east (A-A’; B-B’; C-C’), and the other two lines trending from north to south (D-D’; E-E’). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A’) through **Figure 8** (E-E’).

2.4.2 2018 Landfill Lateral Expansion Area

Based on the hydrogeologic data obtained from soil borings, monitoring wells, and piezometers installed in the 2018 Landfill Lateral Expansion area, three lines of cross section were prepared through the 2018 Landfill Lateral Expansion area. The cross section location map is included as **Figure 11** and the lines of cross section are included as **Figure 12** (F-F'), **Figure 13** (G-G'), and **Figure 14** (H-H').

As shown on **Figures 12** through **14**, a reddish-brown to gray clayey and silty sand stratum is located below the Lateral Expansion area between an elevation of approximately 280 feet and 330 feet amsl. This sand stratum likely corresponds to the Carrizo Sand based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

As shown on **Figures 12** through **14**, a clay stratum with an average thickness of approximately 10 feet is located below the sand stratum, and a lignite seam is present below the clay stratum at an elevation of approximately 270 feet amsl. As discussed above in Section 2.4.1, this lignite seam likely corresponds to the top of the Wilcox Formation based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

2.4.3 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1˚ Fahrenheit (F) in January to 83.8˚F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.4 Regional and Local Geologic Setting

The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant where the existing Landfill, 2018 Landfill Lateral Expansion, and Landfill Stormwater Runoff Pond are located (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.5 Surface Water and Surface Water Groundwater Interactions

Figures 9 and **10** are potentiometric surface maps based on January 2016 and August 2017 water level data, respectively, for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figures 9** and **10**, shallow groundwater flow direction in the Landfill area is southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The Landfill is located approximately 400 feet west of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figures 9** and **10**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the Landfill area does not discharge into Brandy Branch Reservoir. Brandy Branch Reservoir likely recharges the uppermost water bearing unit in the southern portion of the Site, where the pool level in the Reservoir (340 feet amsl) is higher than water level elevations in monitoring wells located southwest (downslope) of the Reservoir.

Figure 15 is a current potentiometric surface map for the 2018 Landfill Lateral Expansion area, and water level elevations for the 2018 Landfill Lateral Expansion area piezometers are summarized on **Table 2**. As shown on **Figure 15**, shallow groundwater flow direction in the 2018 Landfill Lateral Expansion area is westerly toward the Landfill Stormwater Runoff Pond at a hydraulic gradient of approximately 0.02 foot per foot. Water level elevations in the 2018 Landfill Lateral Expansion area piezometers are higher than the surface water elevation of the Landfill Stormwater Runoff Pond (approximately 298 feet amsl), which indicates shallow groundwater in the 2018 Landfill Lateral Expansion area discharges into the Landfill Stormwater Runoff Pond.

2.4.6 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled directly east of the Landfill in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 330 to 426 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled directly south of the Landfill by Amoco Production Company in 1991 for use as an oil field rig supply well. The water well was screened from 163 to 243 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The third closest water well was reportedly drilled approximately 200 feet southwest of the Landfill by Matador Operating in 2000 for use as an industrial well. The water well was screened from 340 to 420 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (up gradient) of the Pirkey Power Plant.

3. Isolation from the Uppermost Aquifer

CCR Rule 40 CFR Part 257.60 requires that the base of new and existing CCR surface impoundments be constructed such that the base of the unit is no less than 5 ft above the top of the uppermost aquifer, or that if the base is within 5 ft of the uppermost aquifer, that there will not be hydraulic connection between the base of the unit and the uppermost aquifer.

3.1 Uppermost Aquifer and Piezometric Analysis

3.1.1 Piezometric Analysis

3.1.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed in the 2018 Landfill Lateral Expansion area show the uppermost aquifer is a reddish-brown to gray clayey and silty sand stratum located between an elevation of approximately 280 feet and 330 feet amsl. As shown on **Figure 15** and **Table 2**, this sand stratum is saturated at an elevation ranging from approximately 298 feet amsl (PZ-1) in the topographically low northwest portion of the Lateral Expansion area to approximately 320 feet amsl (AD-23) in the topographically high southeast portion of the Lateral Expansion area.

As discussed above in Section 2.2.3, the 2018 Landfill Lateral Expansion design includes a liner system which will consist of a 60-mil HDPE top liner underlain by a 2-foot-thick compacted clay bottom liner. Prior to installation of the liner system, approximately 10 to 15 feet of cut into the existing soils will occur along the topographically higher southern portion of the Lateral Expansion, and emplacement of these soils (clayey sands, silty clayey sand and/or lean clays) as fill materials below the liner system in the topographically lower central and northern portions of the Lateral Expansion. The fill materials emplaced in the topographically lower portions of the Lateral Expansion will extend in height at least five feet above the water table, thereby providing the required separation distance of at least five feet between the base of the CCR unit and the top of the uppermost aquifer. This separation distance is illustrated on **Figure 16** which shows the elevation of the HDPE liner at the base of the Lateral Expansion. The elevation of the HDPE liner in the topographically low northwest portion of the Lateral Expansion will range from approximately 311 to 314 feet amsl, which is more than five feet higher than the elevation of the piezometric surface in this area (approximately 298 to 304 feet amsl).

3.1.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost water bearing unit (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 1 x 10^{-4} cm/sec (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness (approximately 20 to 30 feet), the yield of the uppermost water-bearing unit in the Lateral Expansion area is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Current groundwater elevations in the Lateral Expansion area are summarized on **Table 2**, and a recent piezometric surface map is depicted on **Figure 15**. The piezometric surface map is based on water level elevations measured on June 22, 2018 when water levels were high due to a recent rainfall event. The June 22, 2018 water level elevations are more than 5 feet below the planned Lateral Expansion HDPE liner elevation, indicating the base of the CCR unit is more than 5 feet above the uppermost aquifer.

3.1.2 Uppermost Aquifer

3.1.2.1 CCR Rule Definition

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers, that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural groundwater surface to which the aquifer rises during the wet season.

3.1.2.2 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.1.3 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the area of the 2018 Landfill Lateral Expansion area is the reddish-brown to gray clayey and silty sand stratum located between an elevation of approximately 280 feet and 330 feet amsl.

3.2 Compliance with Isolation Distance

The uppermost water-bearing unit underlying the 2018 Landfill Lateral Expansion meets the regulatory definition of an aquifer. As shown on **Figure 16**, the HDPE liner below the base of the CCR unit will be more than 5 feet above this aquifer. Therefore, this CCR Unit complies with the requirement for placement above the uppermost aquifer. Also, underground lateral perforated HDPE underdrain pipes will be installed in permeable bottom ash materials approximately seven feet below the 60-mil HDPE liner of the 2018 Landfill Lateral Expansion. These undrains will collect shallow groundwater when the water table is seasonally high, and gravity drain the groundwater into the Landfill Stormwater Runoff Pond, which will maintain the separation distance of at least 5 feet below the base of the CCR unit.

4. Wetlands

CCR Rule 40 CFR Part 257.61 requires that new CCR Landfill Lateral Expansions not be located in wetlands.

4.1 Local Wetlands

Based on review of available published information, including the National Hydrography Dataset (NHD) and National Wetland Inventory (NWI) maps, there are no jurisdictional wetlands in the 2018 Landfill Lateral Expansion area (USFWS, 2018; USGS, 2018). The topographically low northwest portion of the Lateral Expansion area has no connections to jurisdictional waters of the U.S. (WOTUS) and is non-jurisdictional. **Figure 17** is a map showing wetlands locations in the CCR unit area.

4.2 Compliance with Wetland Restrictions

Based on review of available information, the 2018 Landfill Lateral Expansion area does not contain wetlands. Therefore, the 2018 Landfill Lateral Expansion complies with the requirement for not being located in a wetland.

5. Fault Areas

CCR Rule 40 CFR Part 257.62 requires that new CCR Landfill Lateral Expansions must not be located within 200 feet of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates that an alternate setback will prevent damage to the structural integrity of the CCR unit.

5.1 Description of Regional Geologic Structural Features

Regional geologic publications were reviewed to determine structural features for the Site. A regional fault map is provided on **Figure 18**. The U.S. Geological Survey Open File Report 88-450K shows the Site is located within the East Texas Basin, with faulting north of the basin (Talco Fault Zone) and south of the basin (Elkhart-Mt. Enterprise Fault Zone). No faulting was identified in the Site area (USGS, 1988). Texas Water Development Board Report 27, and the University of Texas at Austin Bureau of Economic Geology Geologic Atlas of Texas – Tyler Sheet show no faulting at the Site (Broom, 1966; Flawn, 1965).

A previous evaluation of geologic structural features at the Site was conducted by ETTL, and no evidence of faulting was identified (ETTL, 2010).

5.2 Compliance with Fault Area Restrictions

A review of available geologic reports and maps has indicated that the Site is not located near any faults with displacement in the Holocene. Therefore, the Landfill Lateral Expansion complies with the requirement for not being located within 200 feet of the outermost damage zone of a fault that has had displacement in Holocene time.

6. Seismic Impact Zone

CCR Rule 40 CFR Part 257.63 requires that new CCR Landfill Lateral Expansions must not be located within a seismic impact zone unless the owner or operator demonstrates that all structural components of the CCR unit are designed to withstand the maximum horizontal acceleration in lithified earth material for the site.

6.1 Definition of Seismic Impact Zone

CCR Rule 40 CFR Part 257.53 defines a seismic impact zone as an area having a 2% or greater probability that the maximum horizontal acceleration expressed as a percentage of the earth’s gravitational pull (g) will exceed 0.10 g in 50 years.

6.2 Compliance with Seismic Impact Zone Restriction

Figure 19 presents the seismic hazard map for Texas, as published by the USGS. As shown on **Figure 19**, the Site falls within the zone having a maximum horizontal acceleration of 0.04 to 0.06 g. Therefore, the Landfill Lateral Expansion complies with the requirement for not being located in a seismic impact zone.

7. Unstable Areas

CCR Rule 40 CFR Part 257.64 requires that existing and new CCR landfills and lateral expansions must not be located within an unstable area unless the owner or operator demonstrates that the design of the unit will ensure the integrity of the structural components of the unit.

7.1 Definition of Unstable Area and local Conditions

7.1.1 CCR Rule Definition

CCR Rule 40 CFR Part 257.53 defines an unstable area as a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of the CCR unit. These may include poor foundation conditions, areas susceptible to mass movements (landslides), and karst terrains.

7.1.2 Poor Foundation Soils

ETTL conducted a geotechnical investigation and foundation settlement evaluation of the Landfill foundation in 2005. The investigation included evaluation of the western portion of the Landfill where lignite mining operations previously occurred. The ETTL evaluation concluded the predicted Landfill settlement would not exceed approximately 4.3 feet and would not adversely affect the performance of the Landfill liner or leachate collection system, and the Landfill excavation, interim fill, and final cover would be stable on slopes of 3:1 or 4:1 (ETTL, 2005).

Apex Geoscience conducted a geotechnical investigation and foundation settlement evaluation of the Landfill in 2012, including advancement of two CPT borings in the western portion of the Landfill where lignite mining operations had previously occurred. The report predicted estimated settlement of 39.07 inches (3.26 feet) and concluded the Landfill would be stable with side slopes of 3:1 (Apex Geoscience, 2013).

Auckland Consulting conducted geotechnical evaluation of the 2018 Landfill Lateral Expansion area in 2016, including advancement of eight soil borings (B1 through B8) through the Lateral Expansion area, and a settlement analysis based on CCR material loading to the maximum design waste height of 120 feet. The report predicted estimated settlement of up to 43.96 inches (3.66 feet) and concluded the Lateral Expansion would be stable with side slopes of 3:1 (horizontal to vertical) and bench widths of approximately 16 feet (Auckland Consulting, 2016). The report also stated the fill soils to be emplaced below the liner system in the topographically lower central and northern portions of the Lateral Expansion will be placed in loose lifts not exceeding 8 inches and compacted to a minimum 95% of the maximum density as determined by Standard Proctor test ASTM D 698 (Auckland Consulting, 2016).

7.1.3 Mass Movements

Geotechnical evaluations of the Landfill by ETTL in 2005, Apex Geoscience in 2012, and Auckland Consulting in 2016 concluded the Landfill would not be subject to mass movements that could impair the integrity of the Landfill based on side slopes of 3:1 (ETTL, 2005; Apex Geoscience, 2013; Auckland Consulting, 2016).

7.1.4 Karst

The site area is located on the outcrop of unconsolidated Cretaceous Formations consisting predominantly of sand and clay (Broom, 1966; Flawn, 1965). The Landfill is not located in a karst area.

7.1.5 Subsurface Mining

Naturally occurring lignite is present in portions of the Site area, and a naturally occurring lignite seam was identified at an elevation of approximately 270 feet amsl at monitoring well AD-24 as shown on Geologic Cross Section D-D’ (**Figure 7**). The Texas Water Development Board Ground-Water Resources Report for Harrison County, Texas, states that the Wilcox Formation, which underlies the Carrizo Sand, contains lignite (Broom, 1966).

Lignite mining operations using a drag line had occurred in the western portion of the Landfill prior to Landfill construction in this area (VFL Technology Corporation, 1984). The drag line mining method is a surface mining method. A geotechnical evaluation of the previously mined western portion of the Landfill was conducted by ETTL in 2005. The ETTL report indicated the western portion of the Landfill had been mined in the past to a depth of 50 to 100 feet using a dragline, and the spoils (reclaimed soil) were returned to the excavation. The geotechnical evaluation included installation of 30 soil borings, ten CPT borings, and geotechnical testing of soil samples. The ETTL report concluded the Landfill would be stable based on the Landfill liner system (compacted clay or GCL overlain by HDPE or VLDPE), leachate drainage system (lateral underdrain consisting of permeable bottom ash), and Landfill side slopes no steeper than 3:1 (ETTL, 2005).

No subsurface mining is known to exist below the 2018 Landfill Lateral Expansion area.

7.2 Compliance with Unstable Areas Restriction

Based on our review of available information, including the 2005 geotechnical evaluation of the Landfill by ETTL, the 2012 geotechnical evaluation of the Landfill by Apex Geoscience, and the 2016 geotechnical evaluation of the Lateral Expansion Area by Auckland Consulting, this CCR unit complies with the requirement for not being located in an unstable area.

8. Summary, Conclusions, and PE Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, as well as the evaluations discussed within this report, the H.W. Pirkey Power Plant 2018 Landfill Lateral Expansion complies with the requirements of the location restrictions sections of 40 CFR 257 Subpart D that apply to landfills and therefore the CCR unit is not located in a restricted location.

Kenneth J. Brandner
Printed Name of Registered Professional Engineer

Kenneth J Brandner
Signature

KENNETH J. BRANDNER
69586

69586
Registration No.

Texas
Registration State

10-25-18
Date

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Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen(b)		Bottom of Screen(b)		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016	1/12/2017	3/1/2017	4/11/2017	8/24/2017
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																									
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55	327.65	327.96	329.09	327.63
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03	344.19	345.53	345.53	343.49
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16	353.27	355.38	356.62	353.58
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31	347.04	347.96	347.87	347.40
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21	345.74	346.00	345.81	346.31
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97	---	---	---	---
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05	365.11	368.79	372.97	367.68
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15	352.01	352.81	352.68	352.62
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68	343.09	344.54	344.69	342.71
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78	324.70	326.27	326.27	324.18
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52	357.06	359.21	358.63	358.23
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40	---	---	---	---
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07	---	---	---	---
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82	---	---	---	---
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29	347.20	348.52	348.45	347.37
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23	320.99	321.00	320.85	320.77
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---	---	---	---	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00	---	---	---	---
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06	---	---	---	---
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89	330.04	331.59	331.24	330.05
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39	320.27	320.51	320.69	320.07
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48	---	---	---	---
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70	322.23	322.85	322.88	322.04
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60	343.78	344.53	344.58	343.57
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32	347.44	348.44	349.09	349.73
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13	348.56	349.32	349.25	349.31
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61	307.61	307.61	307.61	307.61
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85	310.42	310.82	311.27	310.28
Piezometers(c)																									
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	---	---	---	---	---	---	---	---	---	---	---	---	---

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
--- Not Measured

Table 2
Piezometer Water Level Data - 2018 Landfill Lateral Expansion Area
AEP Pirkey Power Plant
Hallsville, Harrision County, Texas

Piezomenter Completion Information

Piezometer ID:	PZ1	PZ2	PZ3	PZ4	PZ5	PZ6	PZ7	AD-23	AD-35
Northing	6871372.73	6871442.96	6871218.9	6871018.52	6870962.73	6870939.86	6871250.41		
Easting	3203056.63	3203345.4	3203322.02	3203009.98	3203281.7	3203544.92	3202996.36		
Screen length	10	10	10	10	10	10	10	20	15
TD (from GS)	14	14	14	14	20	20	14	37.44	18
Sand pack, top (from GS)	3	3	3	3	8	8	3		
Elev, GS								346.72	334.15
Elev, TOC	308.85	312.74	307.35	311.53	328.3	328.78	303.73	350.1	318.95

Piezometer Depth to Water Measurements (feet) below TOC

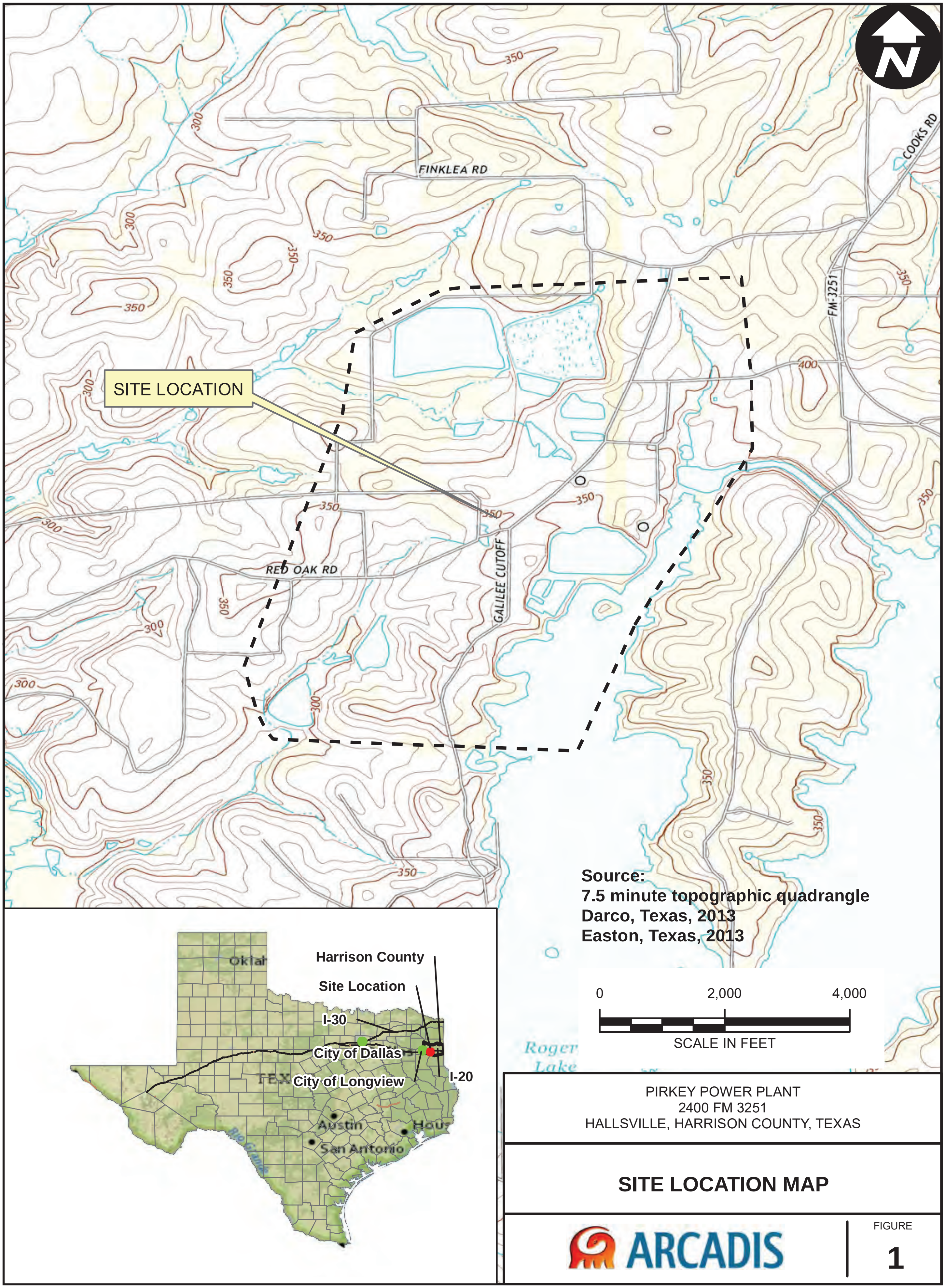
Date	PZ1	PZ2	PZ3	PZ4	PZ5	PZ6	PZ7	AD-23	AD-35
6/20/2018	9.98	9.99	4.29	8.66	20.47	13.23	2.84		
6/21/2018	9.99	9.95	4.07	8.37	20.47	13.24	2.75	29.4	7.95
6/22/2018	9.99	9.91	3.98	8.31	20.47	13.25	2.76	29.42	7.92
6/29/2018	10.01	10.1	4.34	8.85	20.63	13.4	2.98	29.39	8.14
7/6/2018	10.02	10.23	4.45	8.92	20.75	13.52	3.21	29.43	8.23

Piezometer Potentiometric Surface (Water Table) Elevations (feet AMSL)

Date	PZ1	PZ2	PZ3	PZ4	PZ5	PZ6	PZ7	AD-23	AD-35
6/20/2018	298.87	302.75	303.06	302.87	307.83	315.55	300.89		
6/21/2018	298.86	302.79	303.28	303.16	307.83	315.54	300.98	320.70	311.00
6/22/2018	298.86	302.83	303.37	303.22	307.83	315.53	300.97	320.68	311.03
6/29/2018	298.84	302.64	303.01	302.68	307.67	315.38	300.75	320.71	310.81
7/6/2018	298.83	302.51	302.9	302.61	307.55	315.26	300.52	320.67	310.72

Legend

GS	Ground surface	TOC	Top of piezometer casing
TD	Total depth	AMSL	Above mean sea level



Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

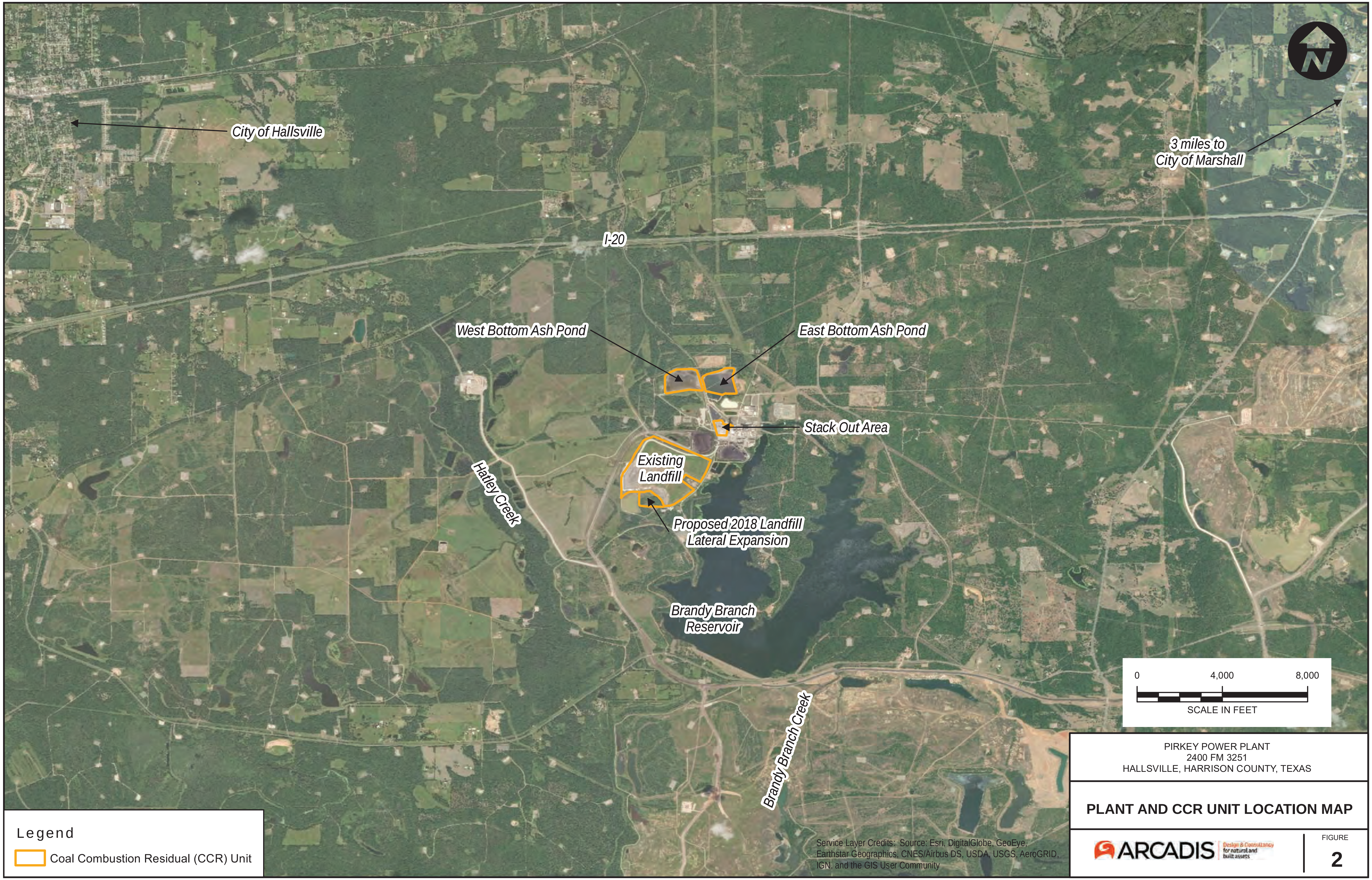
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd



Legend

🟧 Coal Combustion Residual (CCR) Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

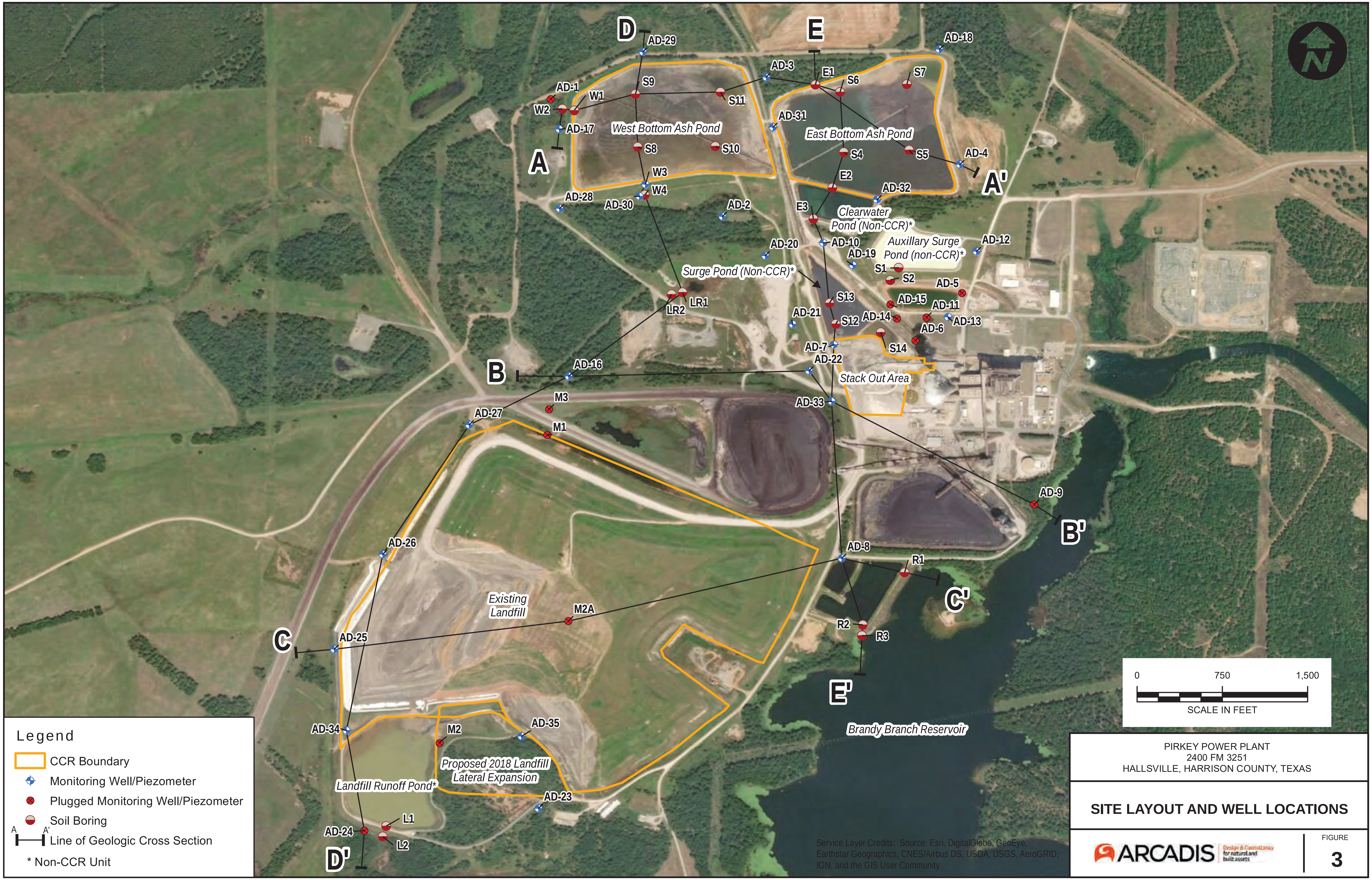
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS Design & Consultancy for natural and built assets

FIGURE
2

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



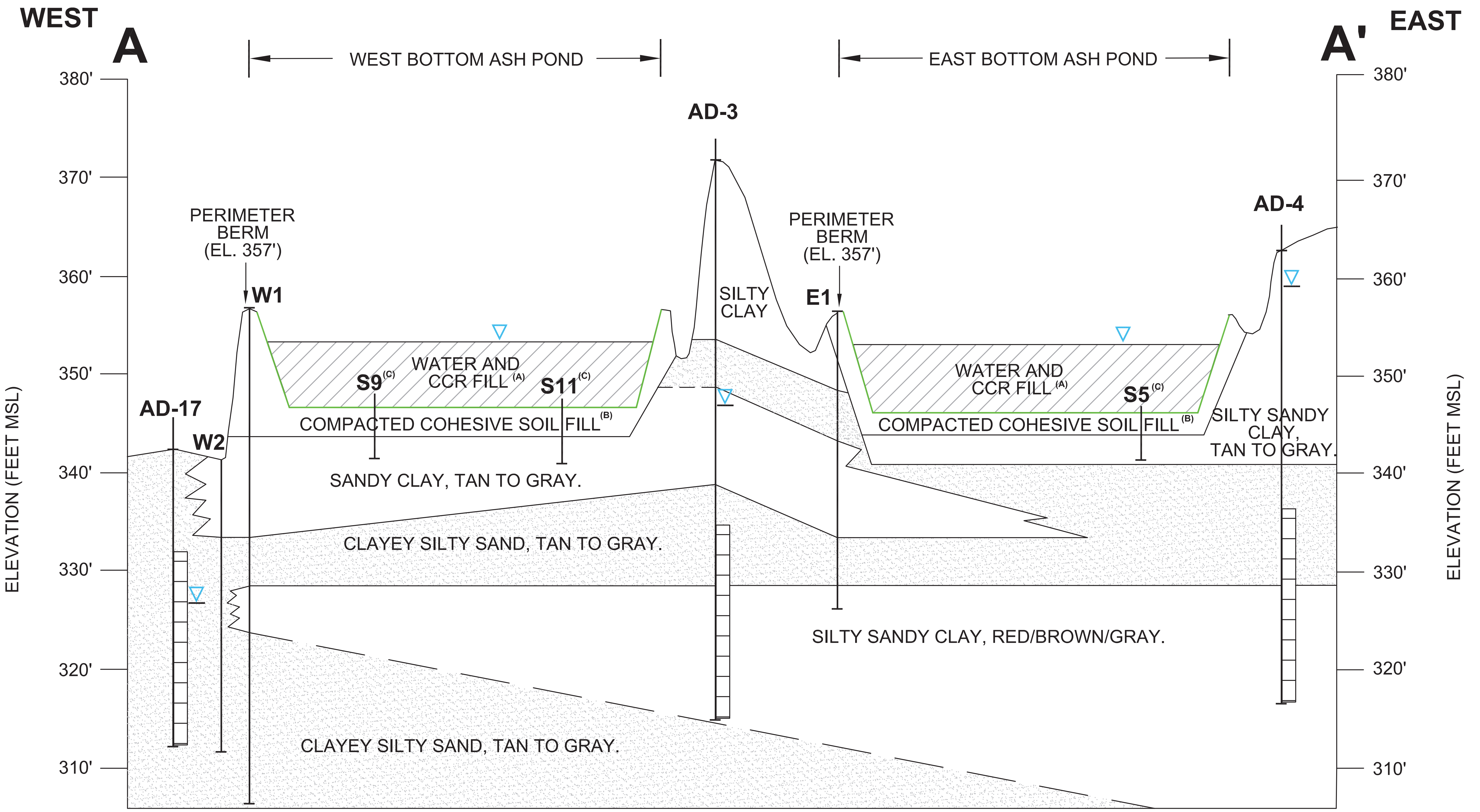
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS Design & Consultancy for natural and built assets

FIGURE
3

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



0 300'
HORIZONTAL SCALE

LEGEND

▯	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
🟩	BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).

C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

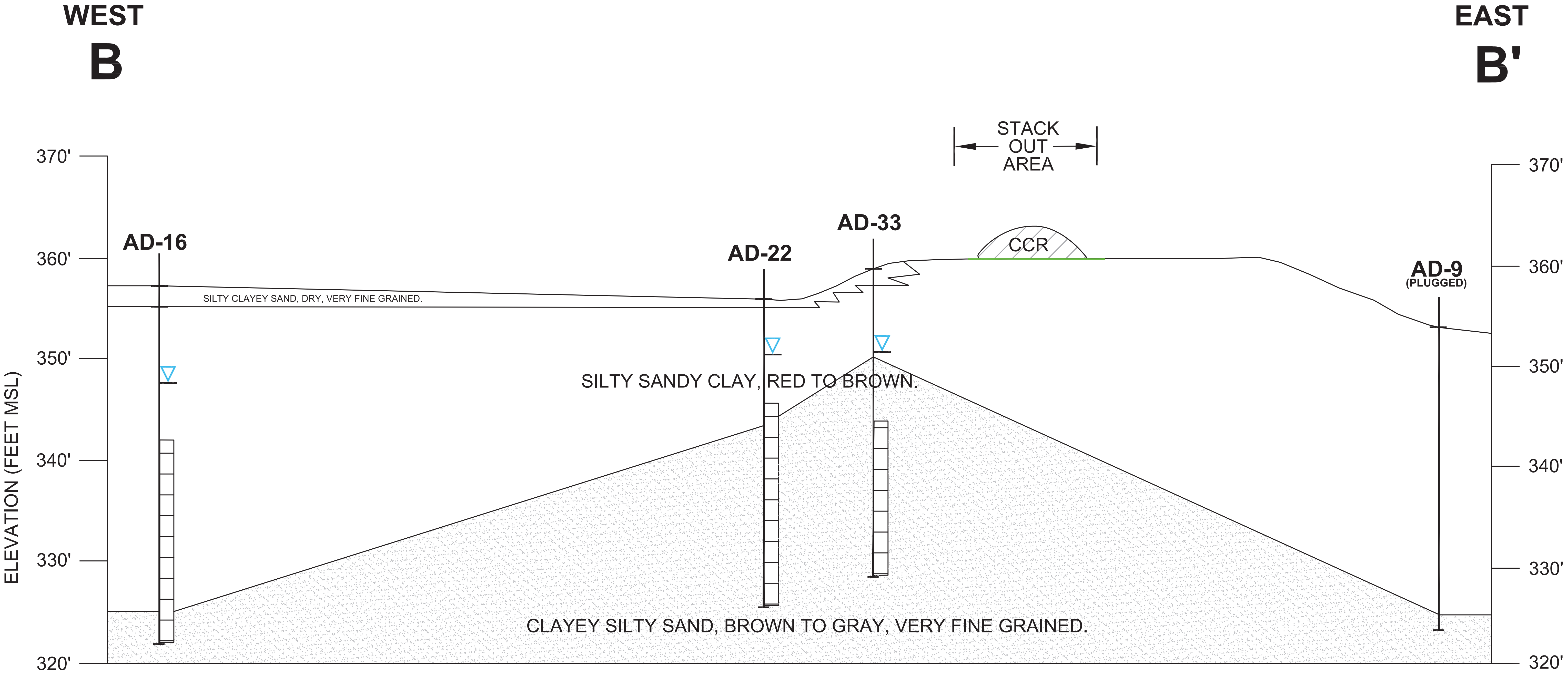
CROSS SECTION
A - A'

ARCADIS

FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:18 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
---- PLOTTED: 2/22/2016 11:17 AM BY: LEASE, DIANA

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 5 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 2/16/2016 1:49 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
---- PLOTTED: 2/19/2016 2:21 PM BY: LEASE, DIANA



LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

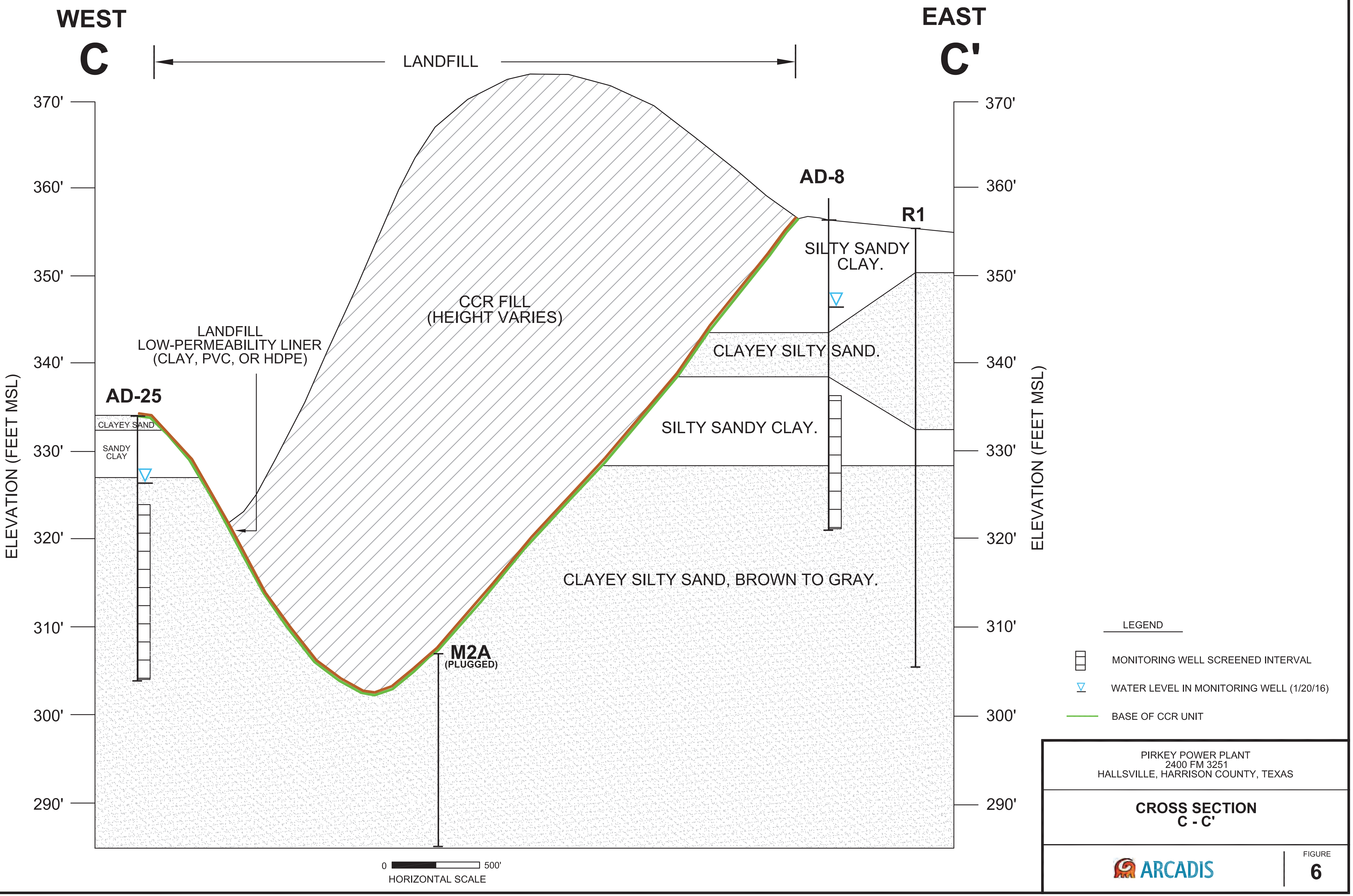
NOTES:
A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE, ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5



PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:25 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ----
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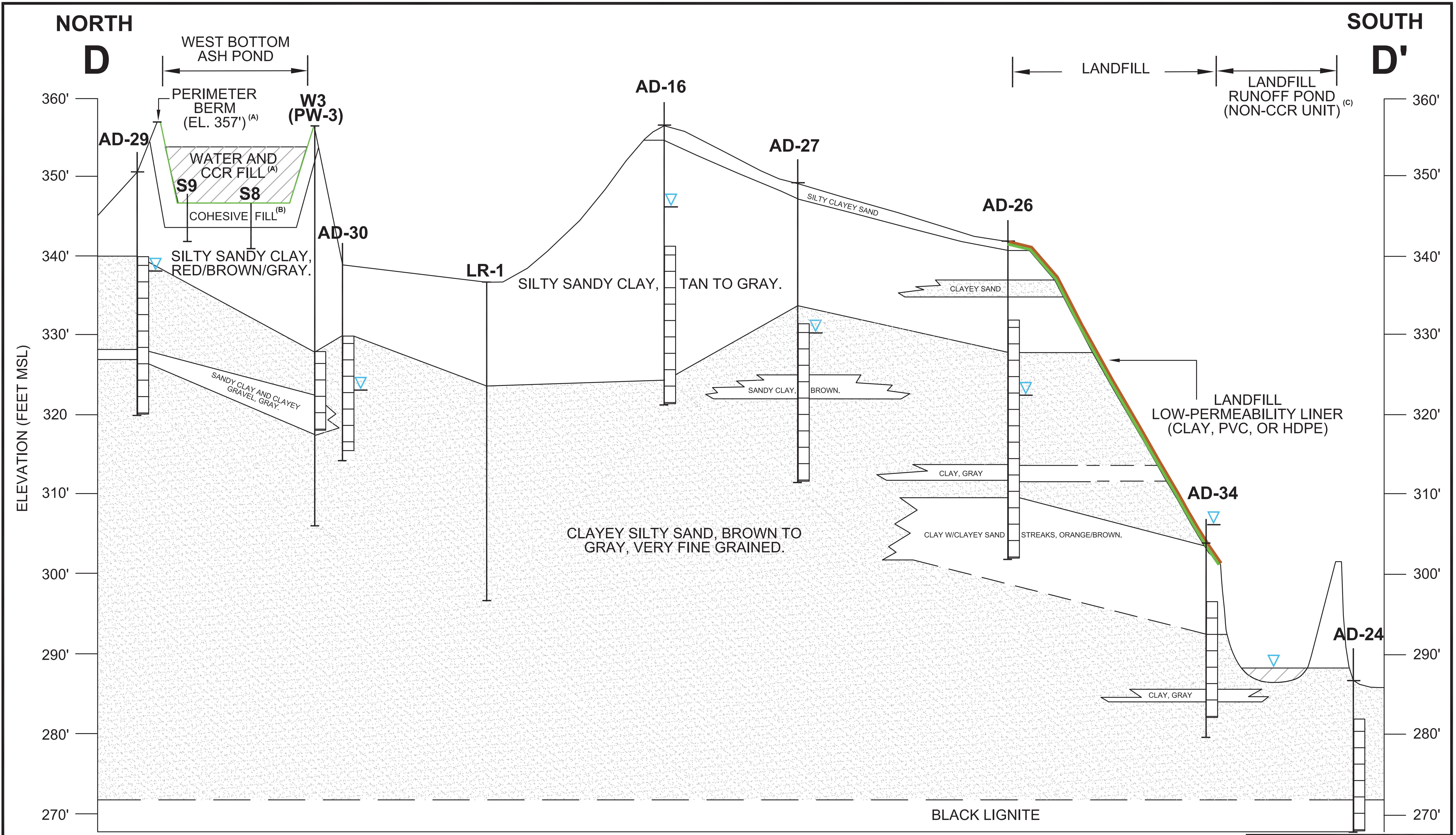

LEGEND

- ☐ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- ― BASE OF CCR UNIT

0 600'

HORIZONTAL SCALE

NOTES:

A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).

C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS

FIGURE
7

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 7 Cross Section D-D'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:30 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
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CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 8 Cross Section E-E'.dwg LAYOUT: MODEL SAVED: 2/22/2016 11:26 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
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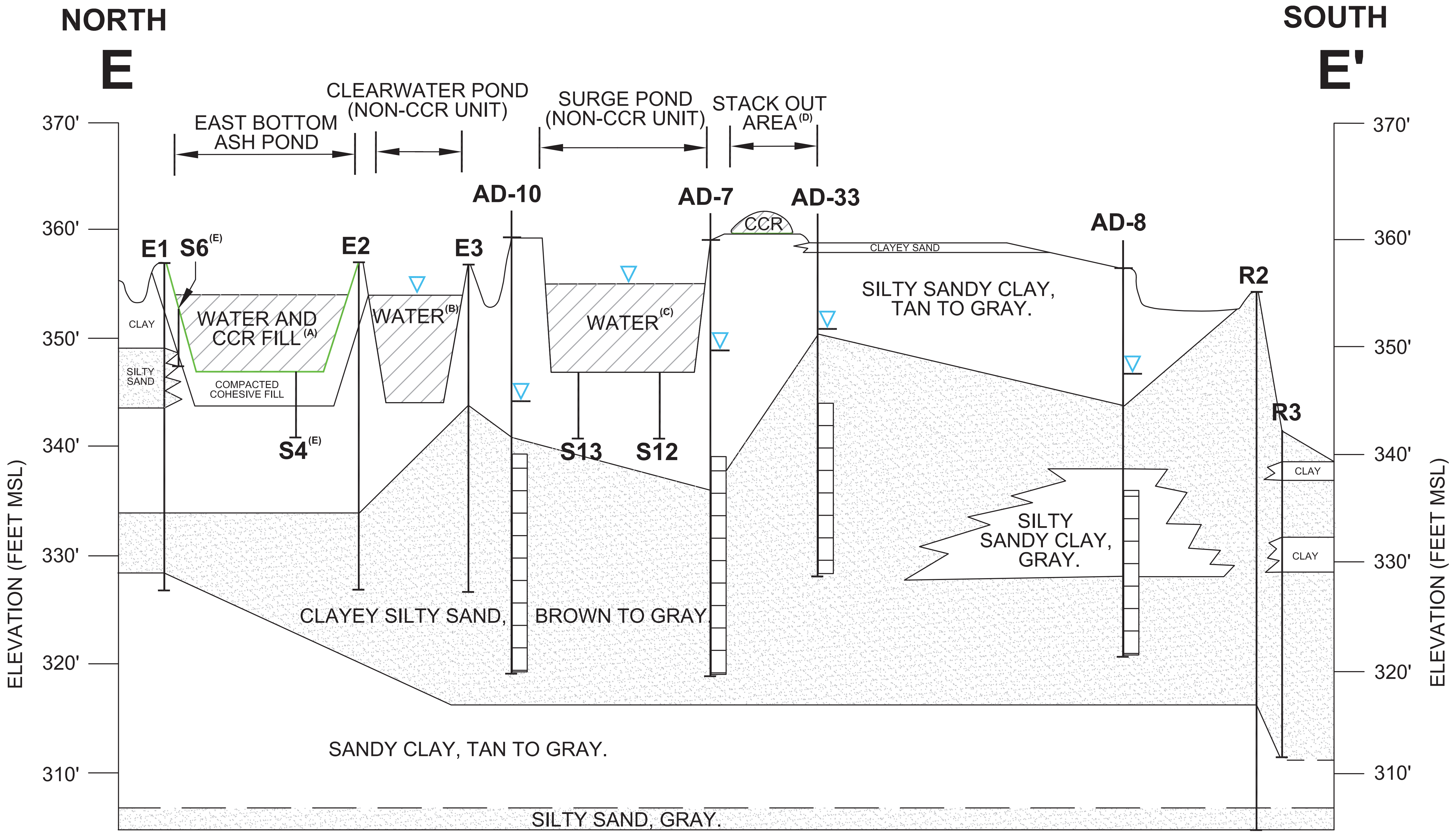


NOTES:

A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).
C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".
D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

LEGEND

▤ MONITORING WELL SCREENED INTERVAL
▽ WATER LEVEL IN MONITORING WELL (1/20/16)
— BASE OF CCR UNIT

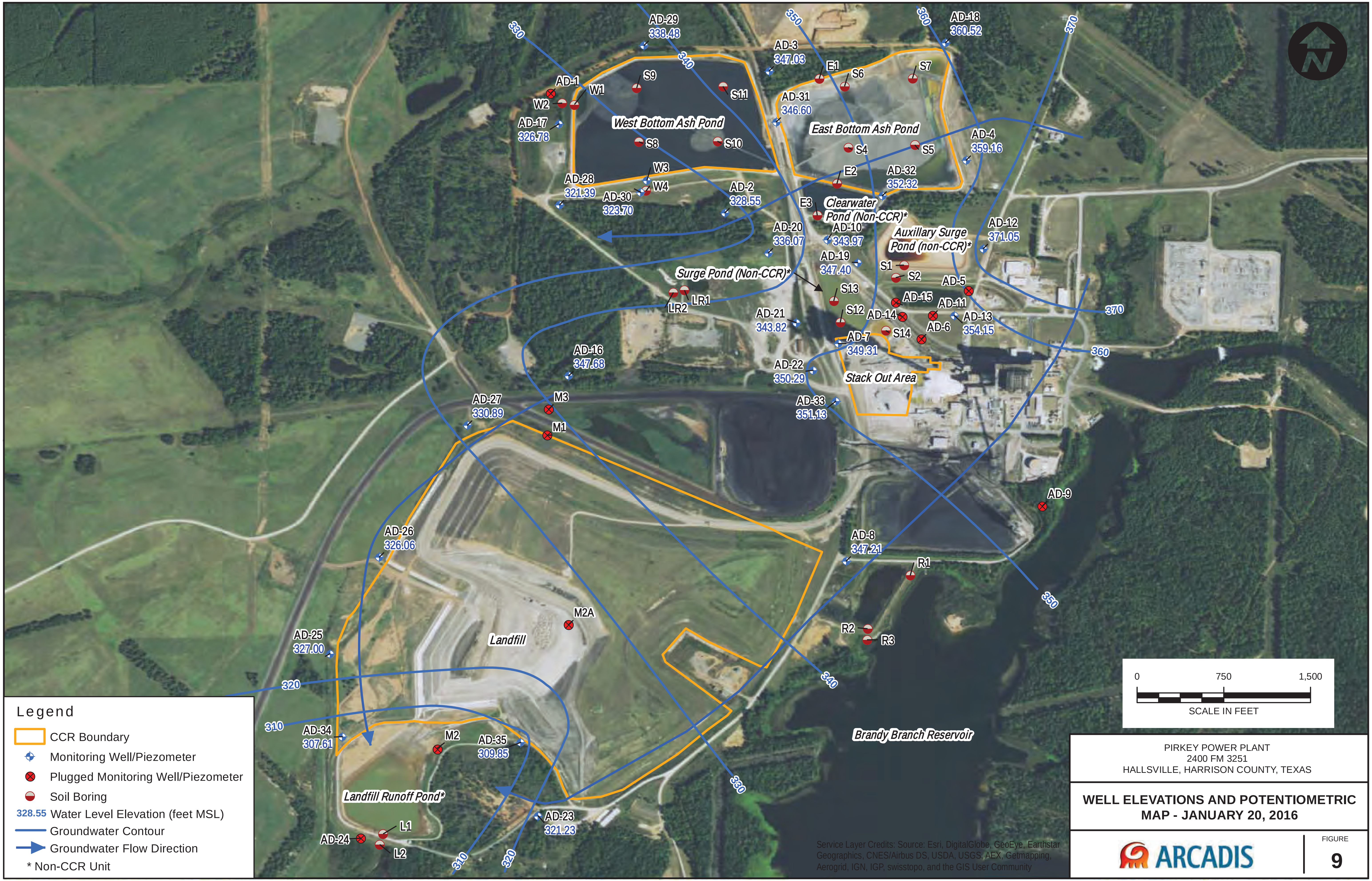
0 ▬ 500'
HORIZONTAL SCALE

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8



Legend

▭	CCR Boundary
⊕	Monitoring Well/Piezometer
⊗	Plugged Monitoring Well/Piezometer
◓	Soil Boring
328.55	Water Level Elevation (feet MSL)
—	Groundwater Contour
→	Groundwater Flow Direction
*	Non-CCR Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

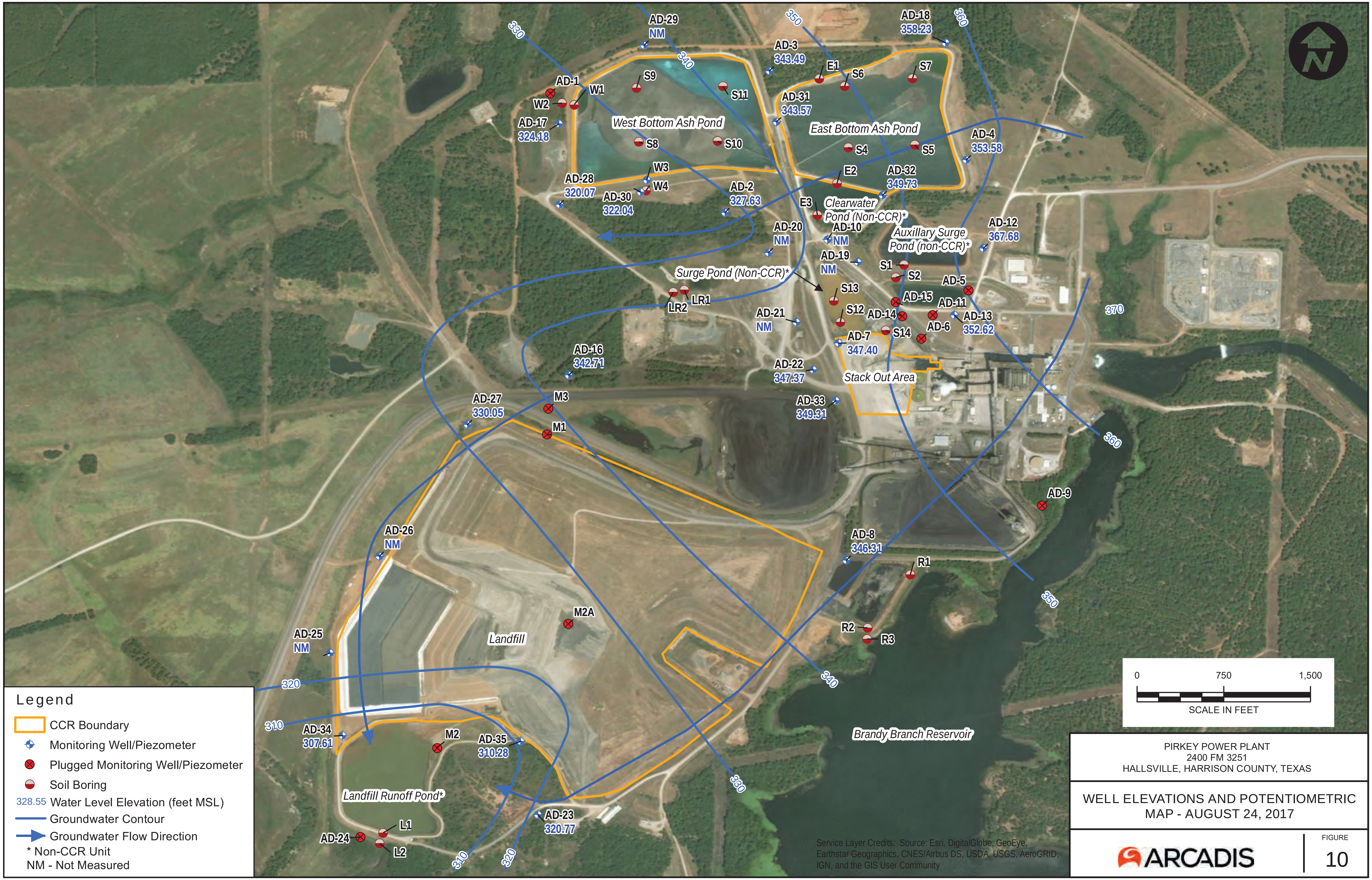
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

ARCADIS

FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - AUGUST 24, 2017

ARCADIS

FIGURE
10

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 10 - Well Elevations and Potentiometric Map - August 24, 2017.mxd

Legend

- ▭ Existing CCR Boundary
- ▭ Proposed 2018 Cell Boundary
- ⊕ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ◓ Soil Boring
- F├─┤F' Line of Geologic Cross Section

* Non-CCR Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

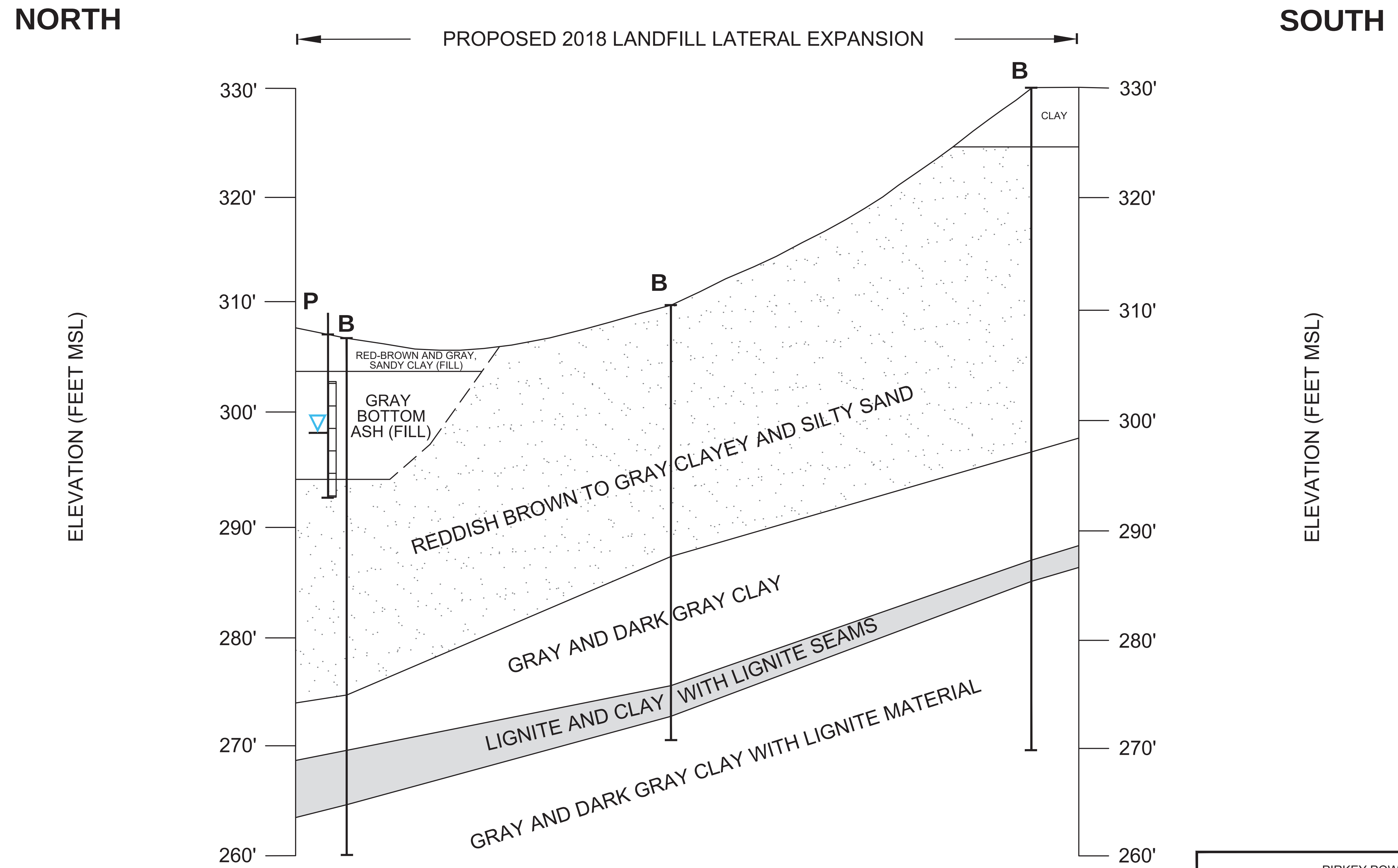
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

LANDFILL - PPROPOSED 2018 LATERAL EXPANSION AREA

ARCADIS Design & Consultancy for natural and built assets

FIGURE
11

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 11 - Landfill - 2018 Cell Expansion.mxd



0 100'

HORIZONTAL SCALE

LEGEND

⌸ MONITORING WELL /PIEZOMETER SCREENED INTERVAL

▽ WATER LEVEL IN PIEZOMETER/MONITORING WELL (6/22/18)

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

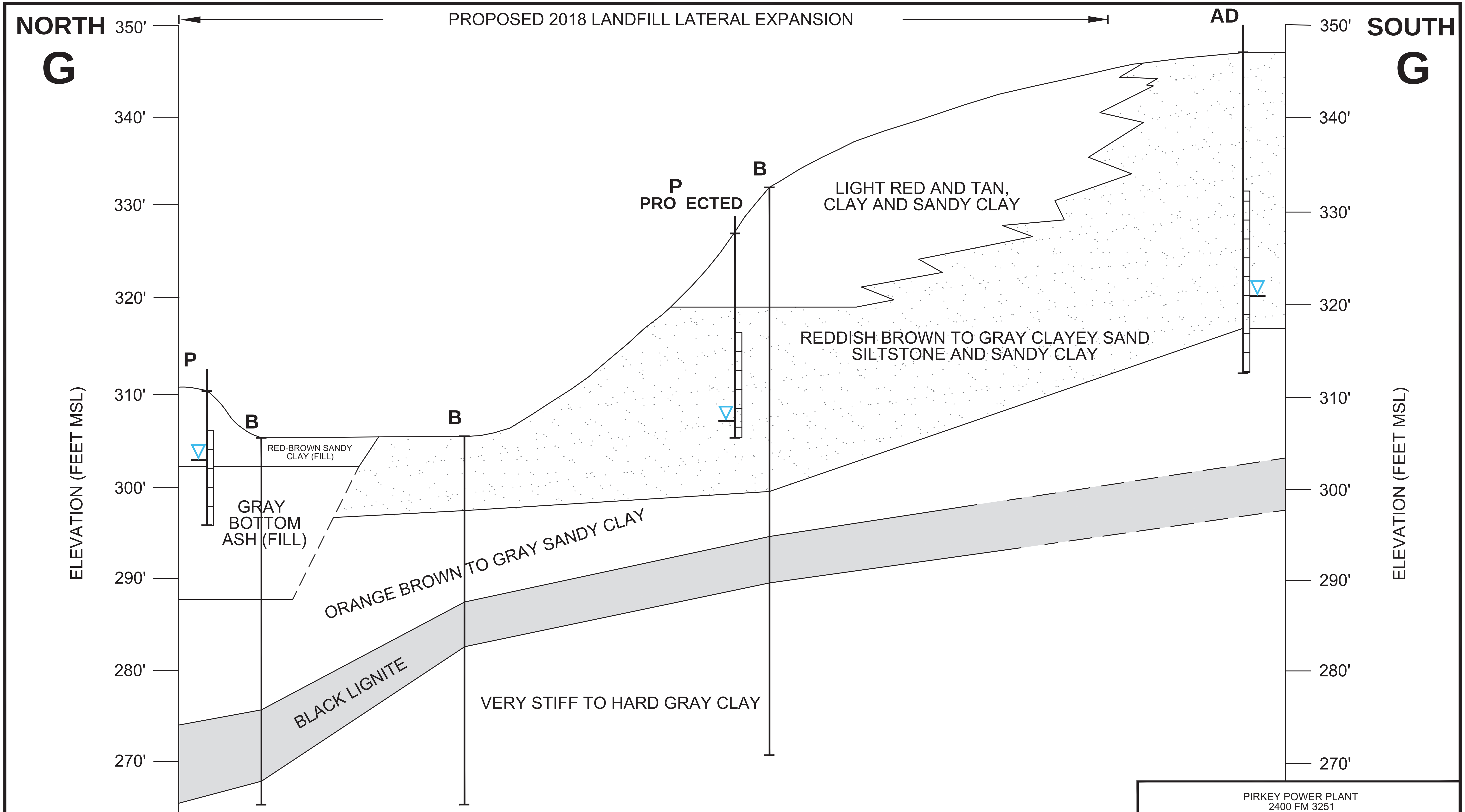
CROSS SECTION

ARCADIS Design & Consultancy for natural and built assets

FIGURE

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0003 - Pirkey Landfill Expansion\Landfill Expansion Location Restriction Report\Figures-Maps\Figure 12 Cross-Sec F-F'.dwg LAYOUT: MODEL SAVED: 9/19/2018 3:27 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/19/2018 4:40 PM
BY: LEASE, DIANA

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0003 - Pirkey Landfill Expansion\Landfill Expansion Location Restriction Report\Figures-Maps\Figure 13 Cross Sec G-G'.dwg LAYOUT: MODEL SAVED: 9/19/2018 4:47 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/20/2018 2:28 PM
BY: LEASE, DIANA



0 100'
HORIZONTAL SCALE

LEGEND

- ▯ MONITORING WELL/PIEZOMETER SCREENED INTERVAL
- ▽ WATER LEVEL IN PIEZOMETER/MONITORING WELL (6/22/18)

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
G G

ARCADIS Design & Consultancy for natural and built assets

FIGURE

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0003 - Pirkey Landfill Expansion\Landfill Expansion Location Restriction Report\Figures-Maps\Figure 14 Cross Sec H-H'.dwg LAYOUT: MODEL SAVED: 9/19/2018 4:08 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/19/2018 4:52 PM
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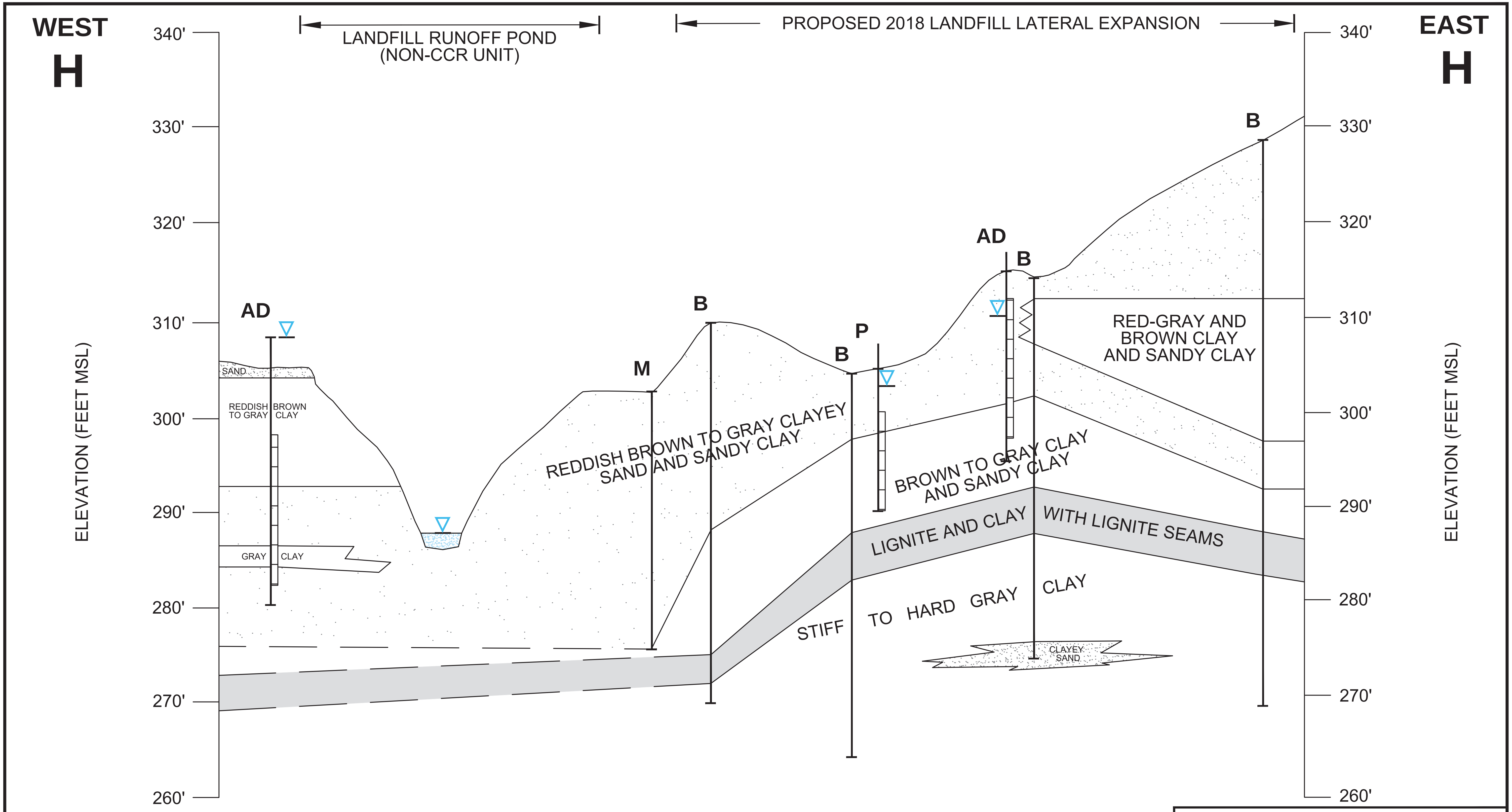


LEGEND

⊟ MONITORING WELL/PIEZOMETER SCREENED INTERVAL

▽ WATER LEVEL IN PIEZOMETER/MONITORING WELL (6/22/18)

0 200'
HORIZONTAL SCALE

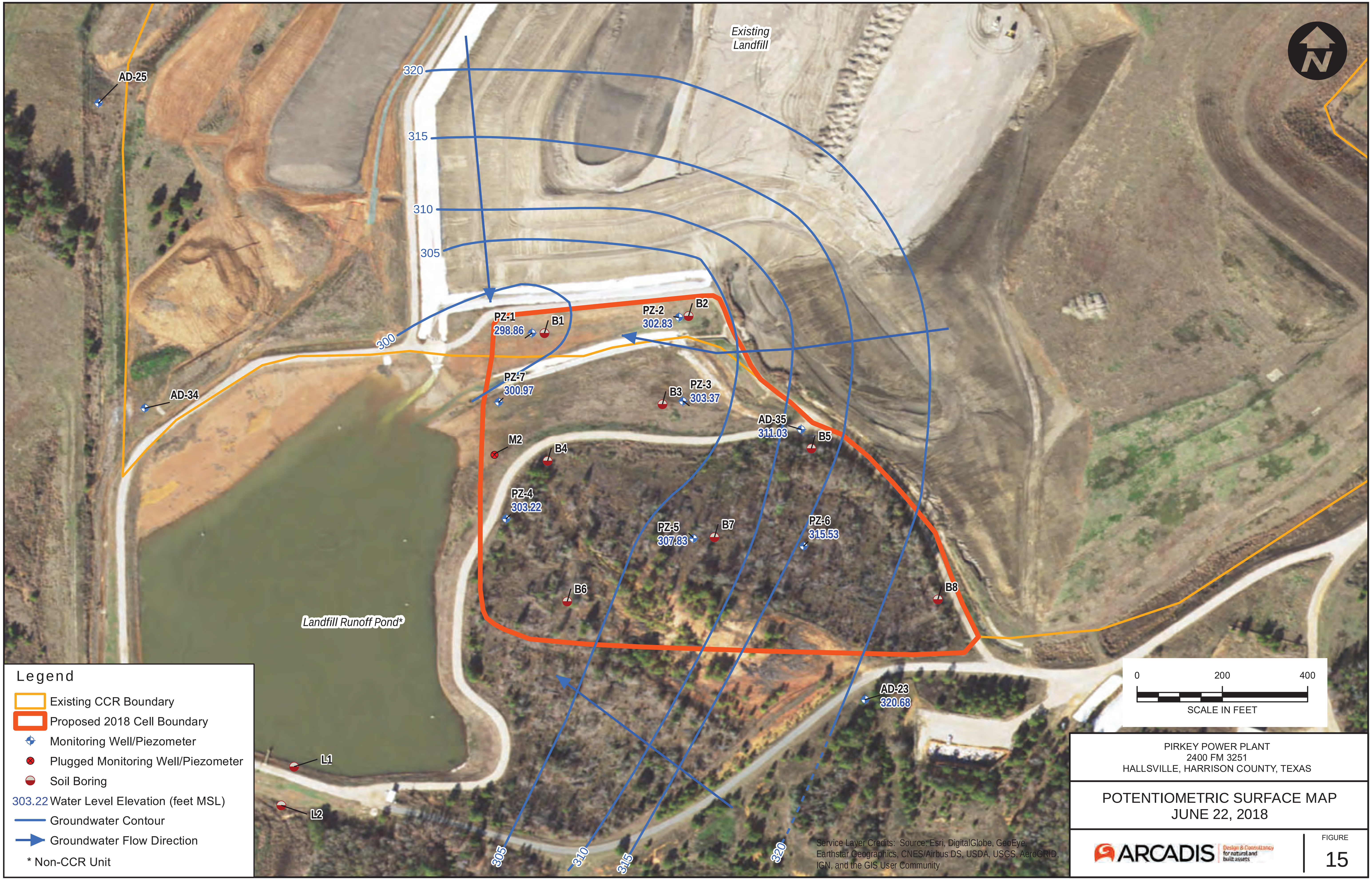
NOTE: LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
H H

ARCADIS Design & Consultancy for natural and built assets

FIGURE



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

POTENTIOMETRIC SURFACE MAP
JUNE 22, 2018

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FIGURE
15

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 15 - Potentiometric Surface Map June 22_2018.mxd

GENERAL NOTES

LEGEND

◐	PIEZOMETER
⊙	MONITORING WELL
312	PROPOSED HDPE LINER ELEVATION (FEET AMSL)

REFERENCE DRAWINGS

SHEETS 1-3494 TO 1-3495
ALL SECTION VIEWS ARE
SHOWN ON THESE SHEETS

SHEETS 1-3496 TO 1-3498
LEACHATE PIPE FLOWPATH

NOTES:

1. WATER TABLE ELEVATIONS MEASURED 6/22/18
2. SEPARATION DISTANCE BETWEEN HDPE LINER AND UPPERMOST AQUIFFER SHOWN IN FEET.

2018 LANDFILL LATERAL
EXPANSION PROPOSED
HDPE LINER ELEVATIONS

THIS DOCUMENT IS RELEASED FOR REVIEW PURPOSES **ONLY** UNDER THE AUTHORITY OF LANDON COLE ALLEN, P.E. 119170 ON SEPTEMBER 12, 2018. IT IS **NOT** TO BE USED FOR CONSTRUCTION. A CERTIFIED PLAN SET WILL BE ISSUED PRIOR TO CONSTRUCTION.

AKRON CONSULTING, LLC.
431 N. CENTER ST.
LONGVIEW, TX 75601
TBPE Firm Reg. # 14014
(O) 903-236-9744
(F) 903-236-9745
www.akron-consulting.com

2018 LF EXPANSION FINISHED GRADE OF HDPE LINER GRADING PLAN

DWG NO: 1–3491

SCALE: AS SHOWN

DR:
CH:
SUP:
ENG:
DATE: APR,13
APPROVED BY

FIGURE 16

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

U.S. Fish and Wildlife Service

National Wetlands Inventory

National Wetlands Inventory Map

September 13, 2018

Wetlands

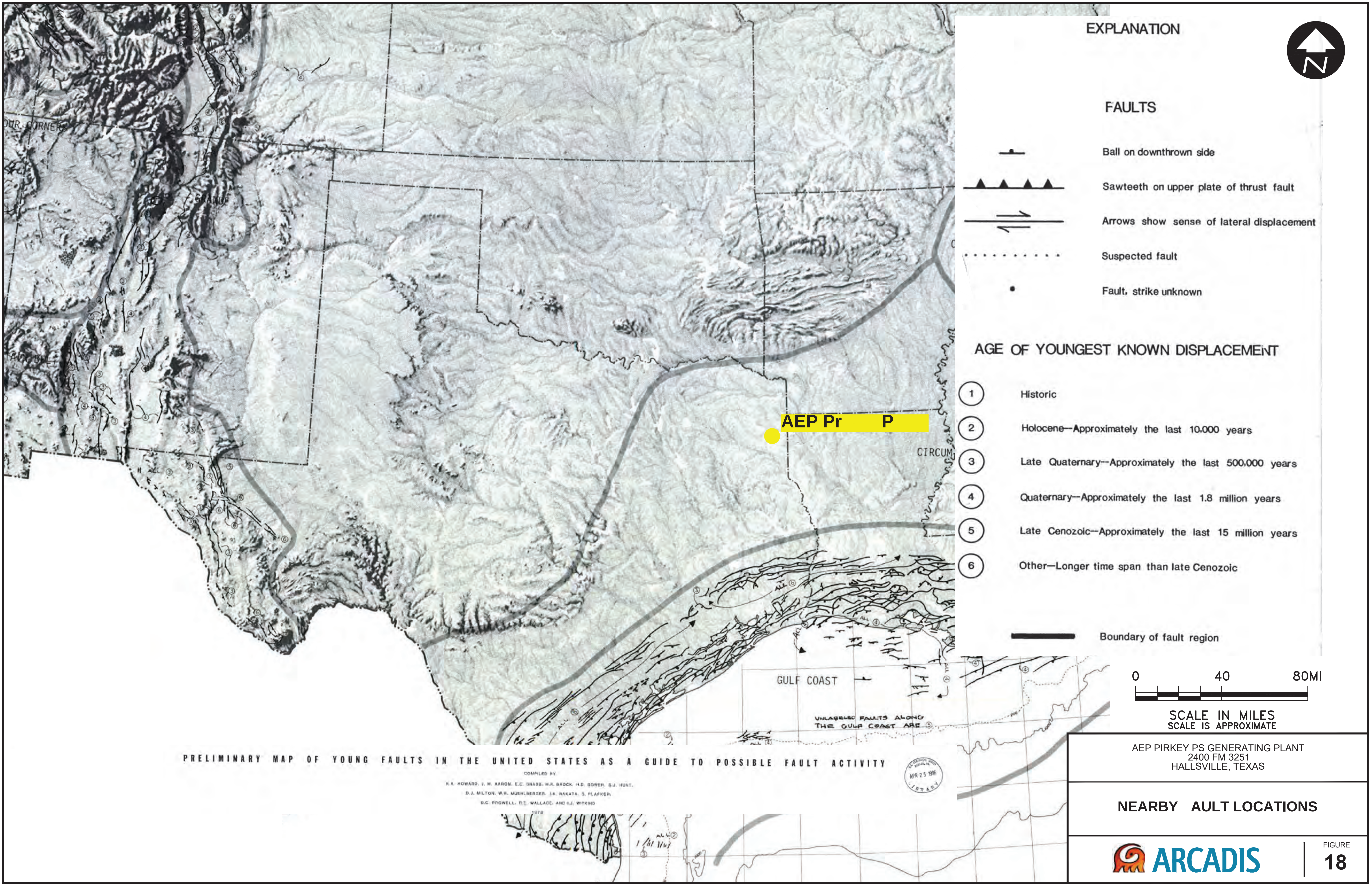
- 🟦 Estuarine and Marine Deepwater
- 🟩 Estuarine and Marine Wetland
- 🟩 Freshwater Emergent Wetland
- 🟩 Freshwater Forested/Shrub Wetland
- 🟦 Freshwater Pond
- 🟪 Lake
- 🟫 Other
- 🟦 Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

National Wetlands Inventory (NWI)
This page was produced by the NWI mapper

FIGURE 17

G:\LFR\Projects\Non Cinci\AEP_Location Restriction Demonstration_OH015976\AEP_Fault Figures.dwg LAYOUT: HALLSVILLE TEXAS SAVED: 9/30/2015 5:11 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ACAD.CTB PLOTTED: 9/30/2015 5:12 PM BY: CALDWELL, MILES



PRELIMINARY MAP OF YOUNG FAULTS IN THE UNITED STATES AS A GUIDE TO POSSIBLE FAULT ACTIVITY

COMPILED BY

K.A. HOWARD, J. M. AARON, E.E. BRABB, M.R. BROCK, H.D. GOWER, S.J. HUNT,
D.J. MILTON, W.R. MUEHLBERGER, J.K. NAKATA, G. PLAFKER,
D.C. PROWELL, R.E. WALLACE, AND I.J. WITKIND
1978

APR 25 1996
LIBRARY

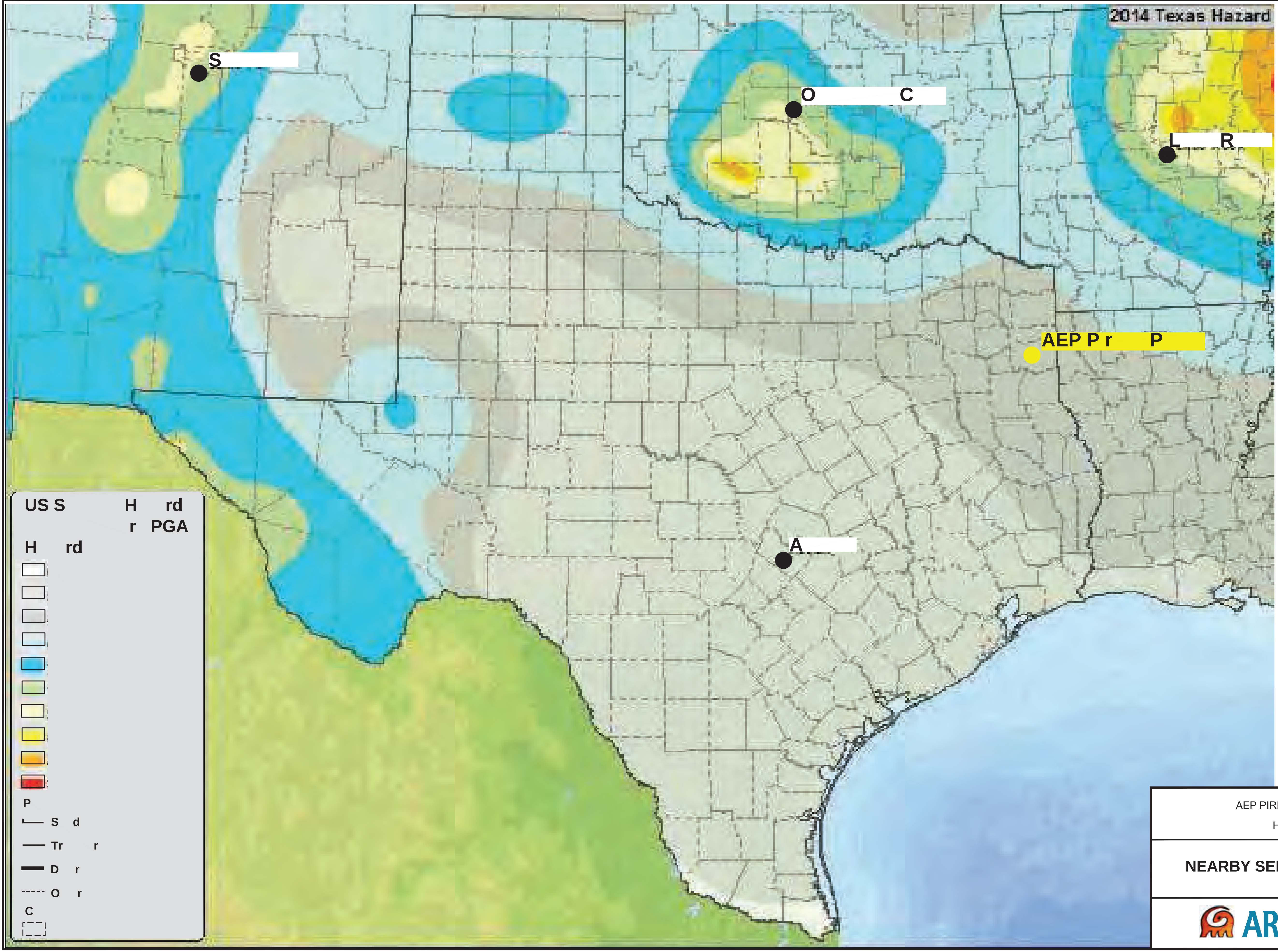
AEP PIRKEY PS GENERATING PLANT
2400 FM 3251
HALLSVILLE, TEXAS

NEARBY AULT LOCATIONS

ARCADIS

FIGURE
18

G:\LFR\Projects\Non Cinci\AEP_Location Restriction Demonstration_OH015976\AEP_Seismic Figures.dwg LAYOUT: HALLSVILLE TX_ASH POND SAVED: 9/30/2015 5:14 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ACAD.CTB PLOTTED: 9/30/2015 5:15 PM BY: CALDWELL, MILES



SOURCE:
USGS Earthquake Hazards Program,
Texas: 2014 Seismic Hazard Map

SCALE IN MILES
SCALE IS APPROXIMATE

AEP PIRKEY PLANT ASH POND
2400 FM 3251
HALLSVILLE, TX

NEARBY SEISMIC IMPACT ONES

ARCADIS

FIGURE
9

Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

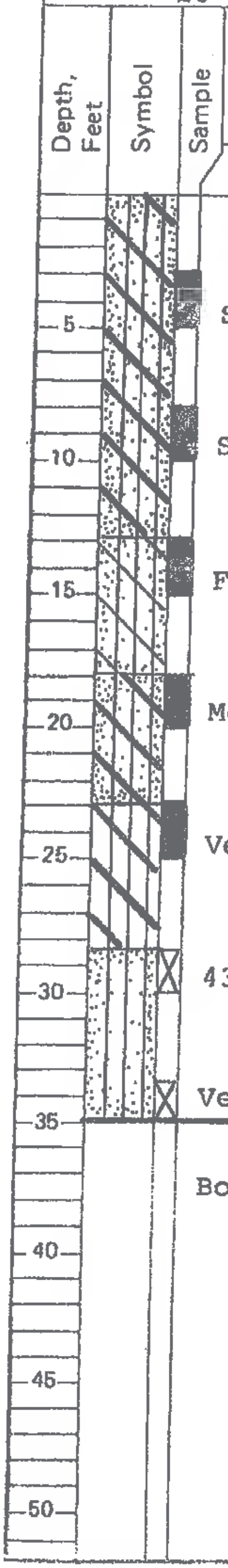
BORING NO.: MW-8
LOCATION: Hallsville

Date: 10-4-83 Type: Auger Ground Elevation:

Legend:

■ Sample X Penetration ▼ Water

Description of Stratum



Stiff tan silty sandy clay w/iron ore

Stiff tan and grey silty sandy clay w/iron ore

Firm tan and grey clayey silty sand

Medium tan and grey very silty sandy clay w/iron ore

Very stiff grey silty clay lenses

43-7=5½" 50 B/5½"

Very dense tan and grey silty sand 50 B/5½"

Bottom of boring at 35 feet.

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ☒ MONITOR WELL MONITOR WELL NUMBER: AD-16

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/30/2010

PREPARED BY: Jeff Sammons LOGGED BY: Matt Lyon/Jeff Sammons

LATTITUDE: N 32°27.680' Datum: WGS-84 WELL LOCATION: North of Mine Haul Road

LONGITUDE: W94°29.642'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1 2			0-2	SM	Silty sand, very fine grained, light brown	None	Dry
3 4 5 6 7 8			2-8	CL	Sandy clay, yellowish brown, reddish brown -some iron oxide concretions at 2.5' -light gray at 5'	None	Dry
9 10			8-10	CL	Clay, red, light yellowish brown, gray, fat, hard, some very fine laminated sand seams	None	Dry
11			10-11	CL	Sandy clay, red, light gray, yellowish brown, stiff to hard	None	Dry
12 13 14			11-14.25	CL	Clay, yellowish brown, some sand, reddish brown, light gray, hard -clayey sand seam at 14-14.25', yellowish brown, light gray	None	Dry Moist
15 16 17 18			14.25-18	CL	Sandy clay, red, light gray, gray, very thin sand lenses interbedded in clay	None	Moist to V. Moist
19 20 21 22 23 24 25 26 27 28 29 30 31 32			18-29.5 ▽	CL	Clay, reddish gray, light gray, yellowish brown, hard, gray -2" reddish brown iron oxide cemented sand laminations at 19.75' -very moist, 1" gravelly sand lense, very fine gypsum crystals at 21' -sandy 22', 22.5', 24' -gray, yellowish brown at 24-24.5' - dark gray, very fine gypsum crystals, trace sand, hard, dry, at 25'	None	Moist V. Moist Dry
33 34 35			32-35	SC	Clayey sand, greenish gray, light gray, some very fine gypsum crystals, dense	None	Moist
36 37 38 39 40					Boring Terminated at 35'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 35 feet Riser Interval: +3 (ags)-15'

Filter Sand (Size/Interval): 13-35' Screen Interval: 15-35'

Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13' Water level: 23.37'

Surface Completion ☐ Flush ☒ Above Ground 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-23

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

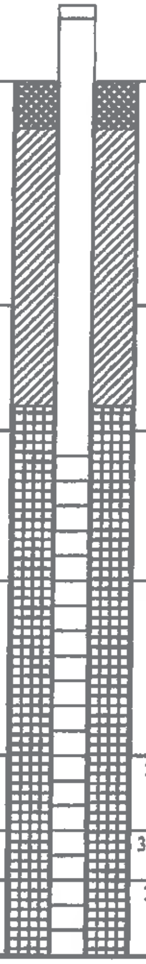
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/15/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 **WELL LOCATION:**
LONGITUDE: W94°29'41.3"

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
							
1 2 3 4 5 6 7 8 9			0-9	SC	Clayey sand, brown, with yellowish brown and orangish brown laminations, very fine grained, very silty, few light gray clay streaks	None	Moist
10 11 12 13 14			9-14	ML	Siltstone with light gray clay streaks, light gray with orangish brown streaks, few small iron ore pebbles	None	Moist
15 16 17 18 19 20			14-20	SM	Sand, light gray with orangish brown streaks, very silty, very fine grained, few clay laminations	None	Slightly Moist
21 22 23 24 25 26 27			20-27	ML	Siltstone, light gray with orangish brown streaks	None None	Very Moist V. Moist
28 29 30			27-30.5	SM	Sand, light brown mottled with orangish brown, very fine grained, very silty	None	Wet
31 32			▽ 30.5-31.5	SC	Slightly sandy clay, orangish brown mottle with orangish brown, silty, very fine grained (30-31.5')	None	Moist
33 34 35			31.5-35	CL	Lean clay, dense, small sandy streaks, dark gray, very fine grained (31.5-35')	None	Moist
36 37 38 39 40					Boring Terminated at 35'		

▩ Cement ▨ Bentonite ▦ Filter Sand Water Level

Apex geoscience inc.

Total Depth:	35 feet	Riser Interval:	+3 (ags)-15'
Filter Sand (Size/Interval):	13-35'	Screen Interval:	15-35'
Grout (Type/Interval):	Grout from 0-2'; Bentonite from 2-13'	Water level:	30.83
Surface Completion	Flush ■	Above Ground	3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089

☐ **BORING**
BORING NUMBER:

■ **MONITOR WELL**
MONITOR WELL NUMBER: AD-24

FACILITY NAME: AEP- Pirkey Power Plant

FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.

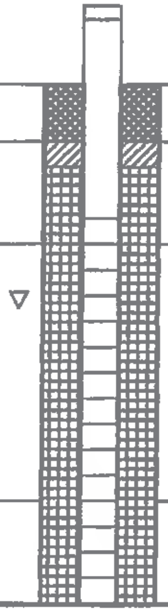
COMPLETION DATE: 12/27/2010

PREPARED BY: Jeff Sammons

LOGGED BY: Jeff Sammons

LATTITUDE: N 32°27.024'
Datum: WGS-84
LONGITUDE: W94°29.940'

WELL LOCATION: South of LF pond dam

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS		USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
								
1				0-1.5	SM	Silty sand, very fine grained, some clay, brown and reddish	None	Moist
2						brown, medium dense		
3				1.5-6.5	SC	Clayey sand, silty, gray, yellowish brown, reddish brown,	None	Dry
4						very fine grained, dense		
5						-some iron oxide concretions and gravel at 5-6', trace organic		Moist
6						matter at 6', gray, dark gray, reddish brown, loose to med. dense		
7				6.5-16	SM	Silty sand, very fine grained, red, loose, trace clay	None	Saturated
8								
9								
10						-some gravel at 10'		
11						-hard cemented sandstone with iron oxide at 11'		
12								
13								
14								
15						- some clay at 15-16', medium dense, gray, dark gray		Moist
16								
17				16-20	Lignite	Lignite, black, loose, saturated at 16-17'	None	Saturated
18						- medium dense, moist at 17-20'		
19								
20								
21								
22						Boring Terminated @ 20'		
23								
24								
25								
26								
27								
28								
29								
30								

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 20 feet
Filter Sand (Size/Interval): 3-20'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-3'
Surface Completion ☐ Flush ■ Above Ground 3'

Riser Interval: +3 (ags)-5'
Screen Interval: 5-20'
Water level: 8.4

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089
☐ **BORING** **BORING NUMBER:**
■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-25

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

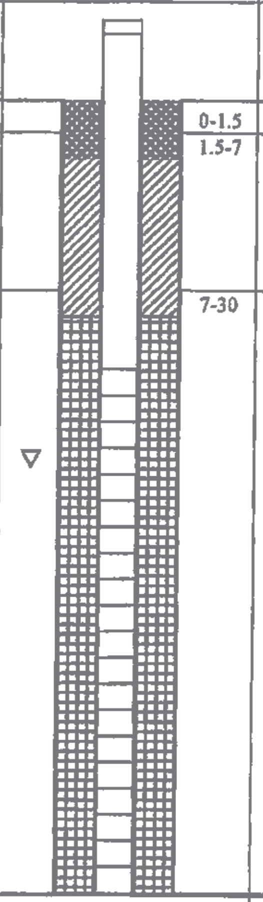
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/14/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'17.2" Datum: WGS-84 **WELL LOCATION:** S. of Diesel ASTs
LONGITUDE: W94°29'59.1"



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-1.5	SC	Clayey sand, brown, silty, very fine grained, moist	None	Moist
2			1.5-7	CH	Fat sandy clay, orangish brown, very fine grained, moist	None	Moist
3							
4							
5							
6							
7							
8			7-30	SC	Clayey sand, orangish brown mottled with dark gray, very fine grained, few light gray clay inclusions	None	Moist
9							
10							
11							
12							
13							
14			▽		Wet @ 14'		Wet
15							
16					15-20' - few pieces of dark gray cystalline rock		
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32					Boring Terminated at 30'		
33							
34							
35							

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground 3'

Riser interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 12.69'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ______ ☒ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-26

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

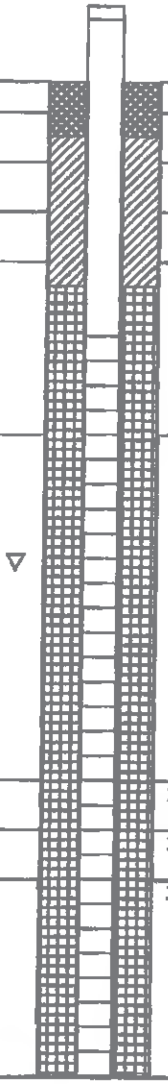
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/14/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'25.3" Datum: WGS-84 **WELL LOCATION:** By silt fence and plastic lined trench
LONGITUDE: W94°29'54.8"



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-1	SC	Slightly clayey sand, light brown, very fine grained, silty	None	Moist
2 3			1-3	CL	Sandy clay, lean, very fine grained, reddish brown	None	Moist
4 5			3-5	CL	Lean, slightly sandy clay with clayey sand streaks, orangish brown, small coal pieces, very fine grained	None	Moist
6 7			5-7	SC	Clayey sand, orangish brown, very fine grained, brown clay inclusions	None	Moist
8 9 10 11 12 13 14			7-14	CL	Lean clay, orangish brown mottled with brown/light gray clayey sand streaks, very fine grained, few coal pieces	None	Moist
15 16 17 18 19 20 21 22 23 24 25 26 27 28			14-28	SC	Clayey sand, dark brown with orangish brown streaks, very fine grained, coal pieces 20-22' - Large clay inclusions, brown Wet from 25-26'	None	Slightly Wet Wet Very Moist
29 30			28-30	CL	Lean clay, light gray with orangish brown streaks, few small sandy streaks, very fine grained	None	V. Moist
31 32			30-32	SC	Clayey sand, light black, very fine grained, small pieces mica Wet from 30-30.5'	None	Wet Moist
33 34 35 36 37 38 39 40			32-40	CL	Lean clay, orangish brown, small clayey sand streaks, very fine grained, brown streaks	None	Moist Slightly Wet
					Boring Terminated at 40'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet
Filter Sand (Size/Interval): 8-40'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ☒ Above Ground 3'

Riser Interval: +3 (ags)-10'
Screen Interval: 10-40'
Water level: 19.45'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089	☐ **BORING** **BORING NUMBER:**	■ **MONITOR WELL** **MONITOR WELL NUMBER:**	AD-27
FACILITY NAME: AEP- Pirkey Power Plant		**FACILITY ID NO.:** N/A	
FACILITY ADDRESS: Hallsville, Texas			
DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig			
DRILLER: Ed Wilson, Apex Geoscience Inc.		**COMPLETION DATE:** 12/15/2010	
PREPARED BY: David Bedford		**LOGGED BY:** David Bedford	
LATTITUDE: N 32°27'36.8" Datum: WGS-84 **LONGITUDE:** W94°29'47.3"		**WELL LOCATION:** By corner lined ditch	

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1 2			0-2	SC	Clayey sand, orangish brown with dark gray laminations, very fine grained	None	Slightly Moist
3 4 5 6 7 8 9 10 11 12 13 14 15			2-15.5	CL	Lean clay, dense, few thin sandy streaks, reddish orange, very fine grained, mottled with light brownish gray Orange to brown with orangish brown streaks, at 10' becomes brittle	None	Slightly Moist
16 17 18 19 20 21 22 23			15.5-23	SC	Clayey sand, greenish brown with orangish brown streaks, few thin tan clay streaks, very fine grained	None	Moist
24			23-24	SM	Sand, orangish brown, silty, very fine grained	None	Wet
25 26 27			24-27 ▽	CH	Fat clay, brown with orangish brown streaks, many sandy streaks, very fine grained	None	Very Moist
28 29 30			27-30	SM	Sand, greenish gray with orangish brown streaks, very fine to fine grained, wet	None	Wet
31 32 33 34 35 36 37			30-37.5	SC	Clayey sand with clay streaks, light greenish black, very fine grained Wet red brittle shale from 35-35.2	None	Slightly Wet
38 39 40					Boring Terminated at 37.5'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet
Filter Sand (Size/Interval): 15.5-37.5'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-15.5'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-17.5'
Screen Interval: 17.5-37.5'
Water level: 26.73'
Above Ground: 3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-34

JDS 1-21-16
JEFFREY D. SAMMONS
GEOLOGY
#10070

PROJECT INFORMATION

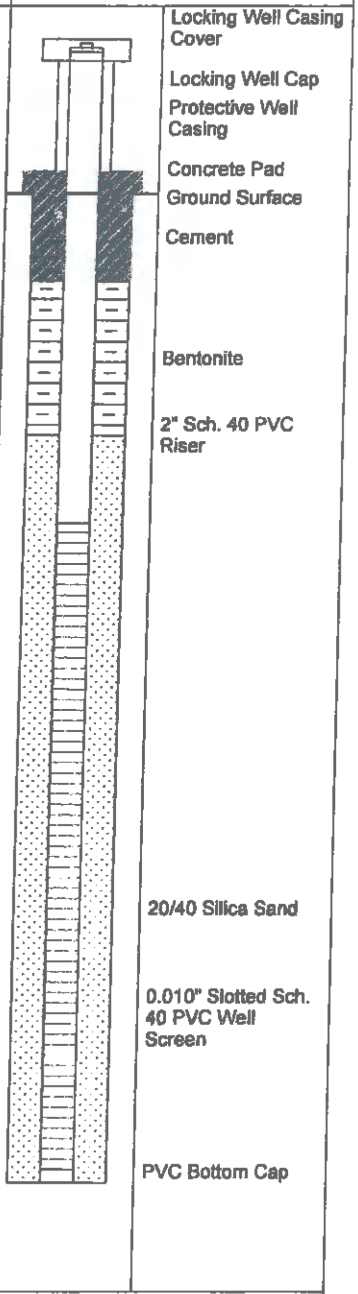
PROJECT: **Pirkey Power Plant**
PROJECT NO.: **I-04-1021**
LOGGED BY: **Jeffrey D. Sammons, P.G.**
SUPERVISING PG: **Jeffrey D. Sammons, P.G.**
COMPLETION: **12/11/2015**
DEVELOPMENT: **12/16/2015**
SITE LOCATION: **2400 FM 3251, Hallsville, Texas**
WELL OWNER: **AEP**

DRILLING INFORMATION

DRILLER: **Buford Collier**
DRILLER'S LICENSE NO.: **50089**
RIG TYPE: **Geoprobe 3230DT**
METHOD OF DRILLING: **Hollow Stem Auger**
SAMPLING METHODS: **Split Core**
SURFACE ELEVATION: **307.61 (Top of Casing)**
HOLE DIAMETER: **8.25"**
LATITUDE **32 27' 10.13"** LONGITUDE **94 29' 57.93"**

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ▨ Geotechnical Lab Sample TBPG No. 50027

DESCRIPTION	USCS	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
		▼						
CLAYEY SAND: very fine to fine sand, some silt, reddish brownish, light reddish brown, light gray, moist	SC							
FAT CLAY: trace sand and silt, some iron oxide concretions, dark reddish brown, reddish brown, and and light gray, moist	CH		▨	31	89	63	23	40
- some silt and very fine to fine sand at 5', light gray, light reddish brown, and light yellowish brown, moist to very moist								
SANDY LEAN CLAY: some very fine to fine sand, dark gray, moist	CL							
- reddish brown, dark reddish brown, dark gray, light gray at 10' to 12.5'		▽	▨	23	64	26	18	8
SILTY SAND: very fine to fine sand, some clay, gray and dark gray, saturated	SM		▨	22	29	25	NP	-
- increasing clay content with depth								
FAT CLAY: trace sand and silt, gray, moist	CH		▨	23	90	55	27	28
CLAYEY SAND: fine to very fine sand, dark gray, moist to very moist	SC							



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

Page 1 of 1

Hydrex
ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-35**

STATE OF TEXAS
JDS 1-21-16
JEFFREY D. SAMMONS
GEOLOGY
#10070
LICENSED
PROFESSIONAL GEOSCIENTIST

PROJECT INFORMATION

PROJECT:	**Pirkey Power Plant**
PROJECT NO.:	**I-04-1021**
LOGGED BY:	**Jeffrey D. Sammons, P.G.**
SUPERVISING PG:	**Jeffrey D. Sammons, P.G.**
COMPLETION:	**12/11/2015**
DEVELOPMENT:	**12/16/2015**
SITE LOCATION:	**2400 FM 3251, Hallsville, Texas**
WELL OWNER:	**AEP**

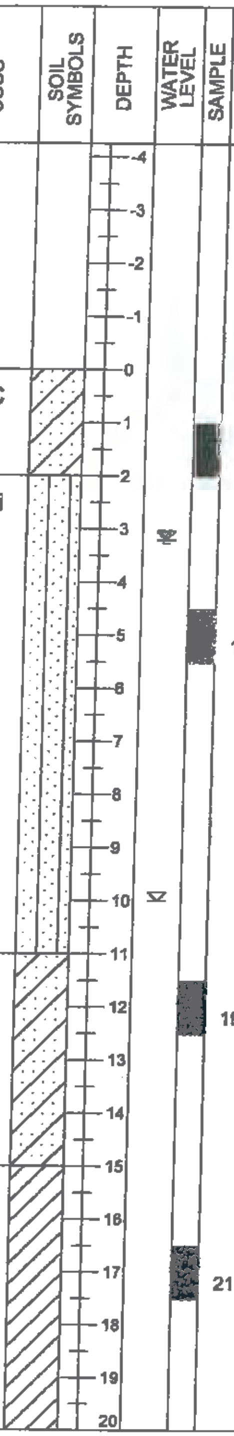
DRILLING INFORMATION

DRILLER:	**Buford Collier**
DRILLER'S LICENSE NO.:	**50089**
RIG TYPE:	**Geoprobe 3230DT**
METHOD OF DRILLING:	**Hollow Stem Auger**
SAMPLING METHODS:	**Split Core**
SURFACE ELEVATION:	**318.95 (Top of Casing)**
HOLE DIAMETER:	**8.25"**
LATITUDE	**32 27' 9.64"**
LONGITUDE	**94 29' 42.74"**

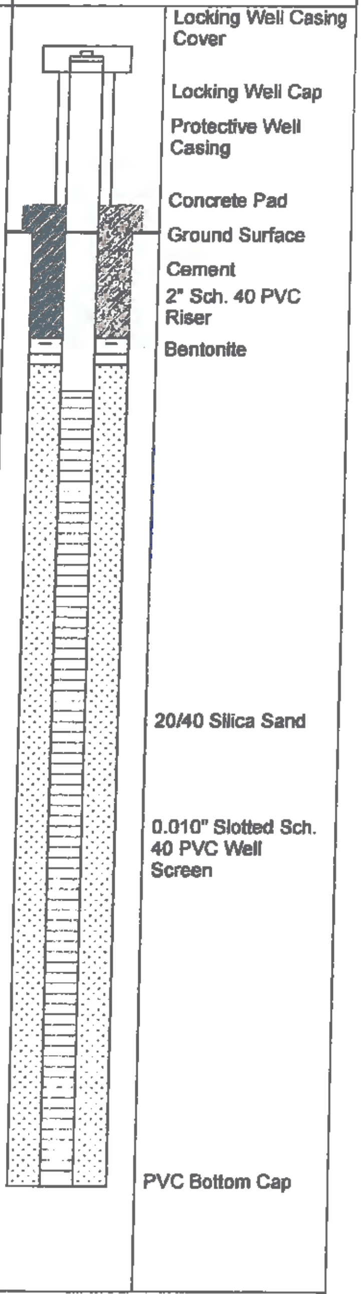
▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, some iron ore gravel, reddish brownish, dark reddish brown, yellowish brown, gray, moist	SC	13	46	32	15	17
SILTY SAND: very fine to fine sand, trace clay, trace iron ore gravel, light reddish brown, moist, increasing moisture content with depth - saturated at 10' to 11'	SM	12	26	16	NP	
CLAYEY SAND: very fine to fine sand, trace iron ore gravel, light reddish brown, very moist - thin seams of saturated very fine sand with trace of clay at 12.25' to 12.5' - light reddish brown and light gray, moist to very moist at 12.5' to 15'	SC	19	33	31	18	13
LEAN CLAY: intebedded clays and silts with laminations of very fine sand, light gray, gray and light reddish brown, moist to very moist - thin lenses of very moist very fine sand and partially cemented very fine sand at 17.5' and 18', reddish brown	CL	21	93	34	20	14



WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

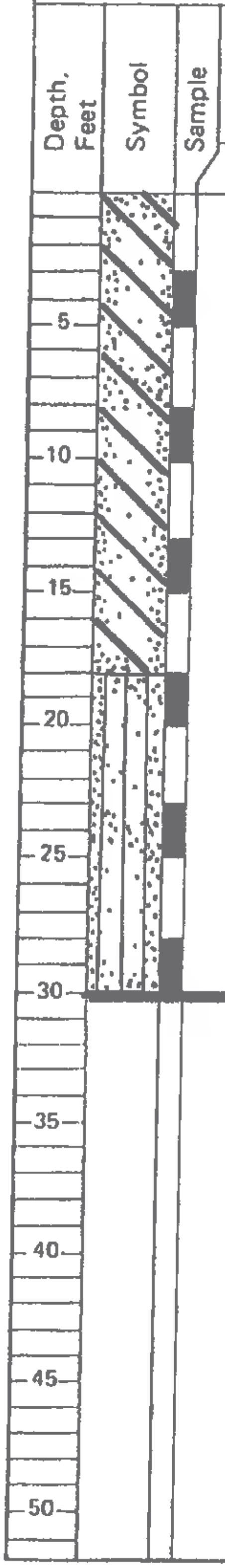
852164

LOG OF BORING

PROJECT:	Monitoring Well Instllation	BORING NO.:	M-1
CLIENT:	Southwestern Electric Power Company	LOCATION:	Hallsville, TX
			S 12+32.79; W 35+34.55
Date:	1/29/86 Type: Rotary	Ground Elevation:	337.67

Legend:

■ Sample X Penetration ▼ Water



Description of Stratum

Brown and tan sandy clay

Brown and tan sandy clay w/iron ore

Brown and tan sandy clay w/iron ore

Gray silty sand

Gray silty sand

Gray silty sand

Bottom of Boring at 30 feet.
Water encountered at 10 feet.

SOUTHWESTERN LABORATORIES

852164

LOG OF BORING

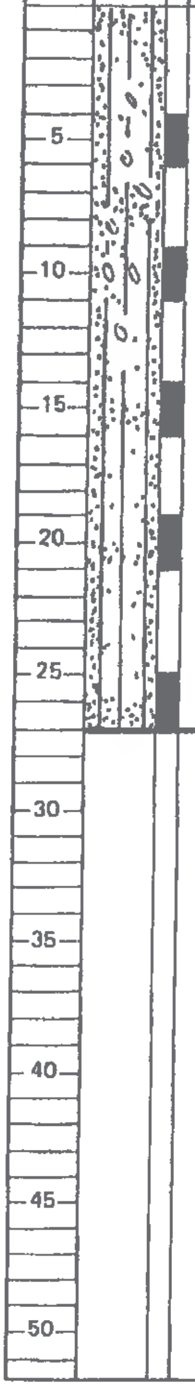
PROJECT: Monitoring Well Installation
CLIENT: Southwestern Electric Power Company
BORING NO.: MW-2
LOCATION: Hallsville, TX
S 38+86.22; W 45+76.41
Date: 1/29/86
Type: Rotary
Ground Elevation: 302.19

Legend:

■ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample

Description of Stratum



Brown silty sand w/iron ore

Brown silty sand w/iron ore

Brown and gray silty sand

Gray silty sand

Gray silty sand

Bottom of Boring at 27 feet.
Water encountered at 11 feet.

SOUTHWESTERN LABORATORIES

LOG OF BORING

852164
PROJECT: Sludge Disposal Area
CLIENT: Southwestern Electric Power Company

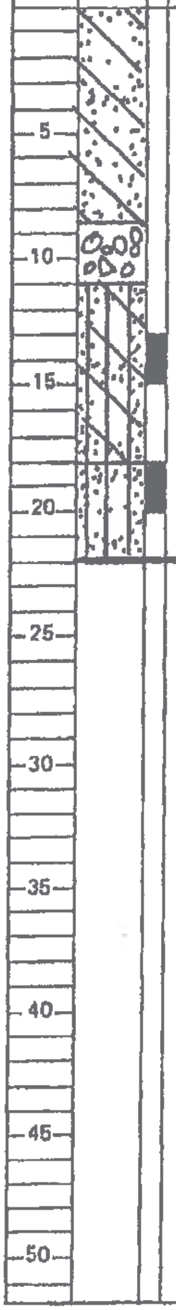
BORING NO.: M. 2A
LOCATION: Hallsville, TX

Date: 6/20/85
Type: Auger
Ground Elevation: 308.40

Legend:
Plant Site Coordinates: South S 27+55.45
West W 36+47.44

▇ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Red-brown clayey sand

Gravel

Gray clayey silty sand

Gray silty sand

Bottom of Boring at 22 feet.
Water encountered at 12 feet.

Bottom of Casing at 22 feet.
Screen length 15 feet.

SOUTHWESTERN LABORATORIES

Log of Boring

Number: M-3

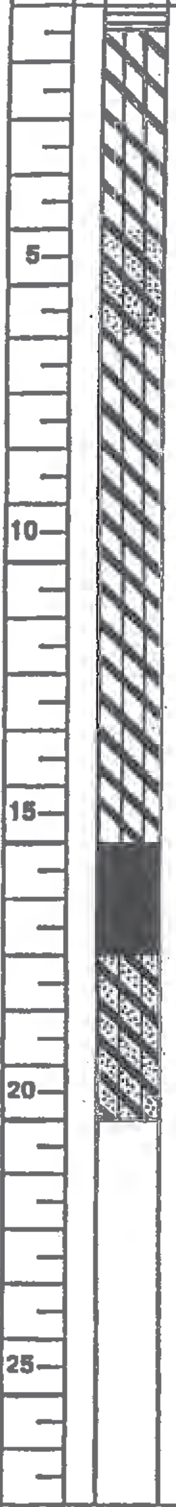
Location: Harrison Co., miles SW Marshall City Ha

Project: New Monitor Well Installation, H.W. Pirkey Power Plant

Type: Groundwater Monitor Well

Surface Elevation: 275.0'

Depth Feet	Samples	Hand Penetrometer (Tons/Sq. Ft.)	Standard Penetration (Blows/Foot)	STRATUM DESCRIPTION



Sod

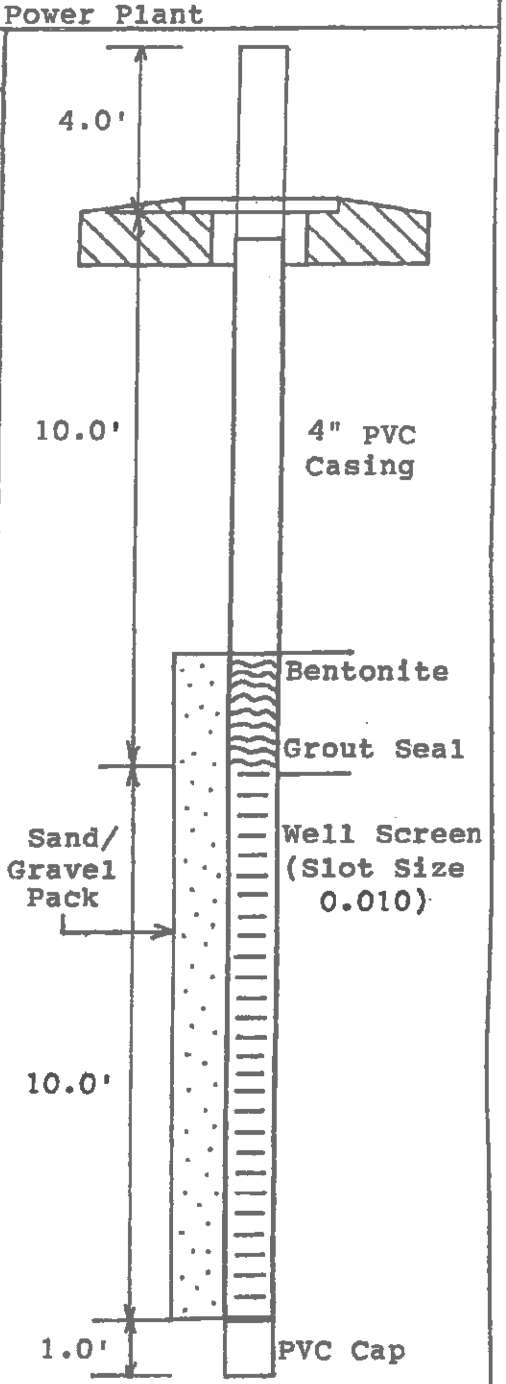
Brown Silty Clay

Brown Silty Sandy Clay

Red & Gray Silty Clay

Lignite

Tan Silty Sandy Clay



Completion Depth: 20'

Date: 7-1-93

Water Observations: Water Encountered at 10.0'

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING L-1

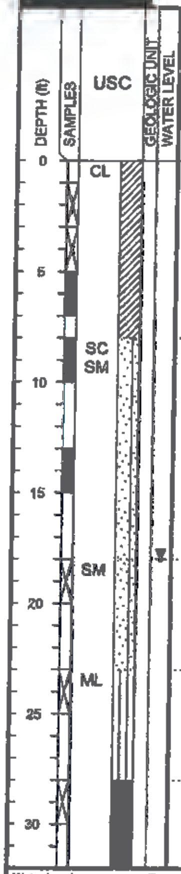
PROJECT: Pirkey Power Plant
Hallsville, Texas

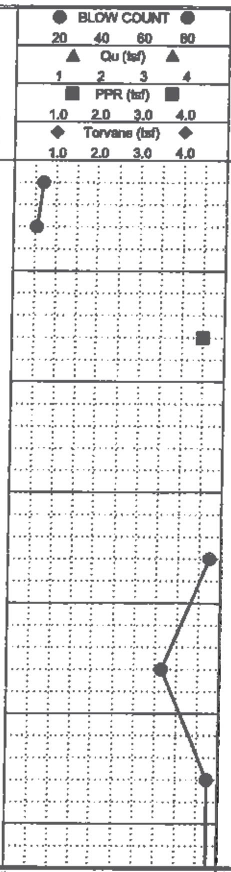
PROJECT NO.: G3241-095

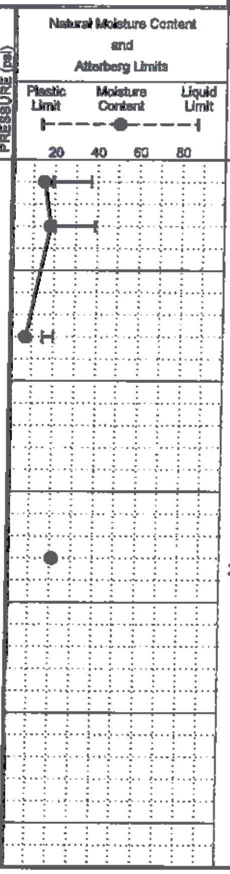
BORING TYPE: Flight Auger

DATE 10/19/09

SURFACE ELEVATION 296.0







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; orangish gray	N=14					15	37	19	18	74	+40 Sieve=7%, +4 Sieve=2%
	--reddish brown	N=11					18	39	20	19	74	+40 Sieve=11%, +4 Sieve=3%
SC SM	SILTY CLAYEY SAND(SC-SM) reddish brown; with gravel	P=4.5+					7	20	15	5	32	+40 Sieve=61%, +4 Sieve=33%
	--reddish tan; with iron oxide cemented sandstone	SF										
SM	SILTY SAND(SM) very dense; dark gray; laminated; saturated	N=50/3"					21				30	+40 Sieve=0%, +4 Sieve=0%
ML	SANDY SILT(ML) very dense; dark gray; with lignite @ 24'	N=73										
	LIGNITE very dense; black	N=50/0.5"										

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 17' while drilling. Water level @ 18' and open upon completion.

Key to Abbreviations:
- N - SPT Data (Blows/Ft)
- P - Pocket Penetrometer (tsf)
- T - Torvane (tsf)
- L - Lab Vane Shear (tsf)

Notes:

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING L-1

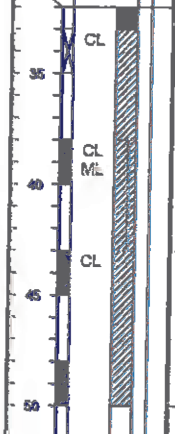
PROJECT: Pirkey Power Plant
Hallsville, Texas

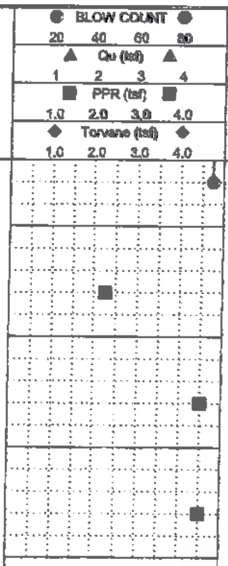
PROJECT NO.: G3241-095

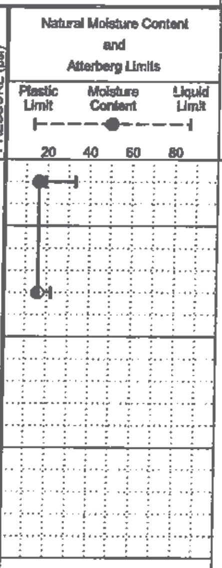
BORING TYPE: Flight Auger

DATE 10/19/08

SURFACE ELEVATION 296.0







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY(CL) hard; light grey; with vertical black silty seam	N=50/3"					16	33	19	14	97	+40 Sieve=0%, +4 Sieve=0%
CL-ML	SANDY SILT CLAY(CL-ML) hard; gray	P=2.25 P=4.5+					16	22	16	6	51	+40 Sieve=0%, +4 Sieve=0%
CL	LEAN CLAY(CL) hard; dark brown laminated	P=4.5+										
		P=4.5+										
	Bottom of Boring @ 50'											

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 17' while drilling. Water level @ 18' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

**ETTL
ENGINEERS &
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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

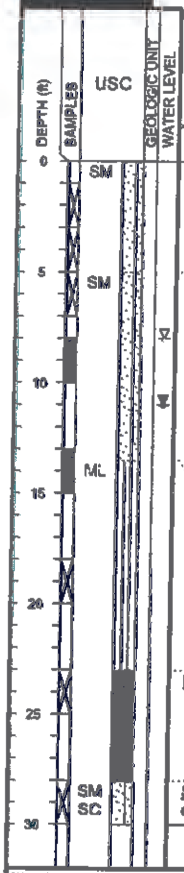
LOG OF BORING L-2

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

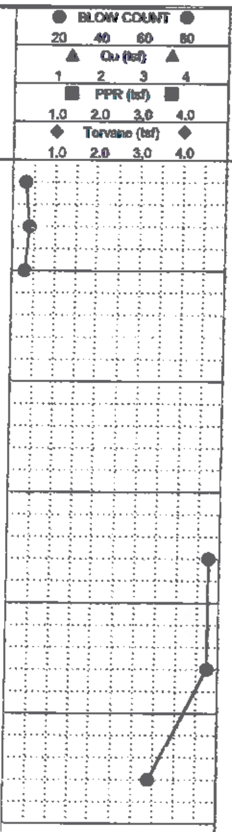
DATE 10/19/09

SURFACE ELEVATION 291.4

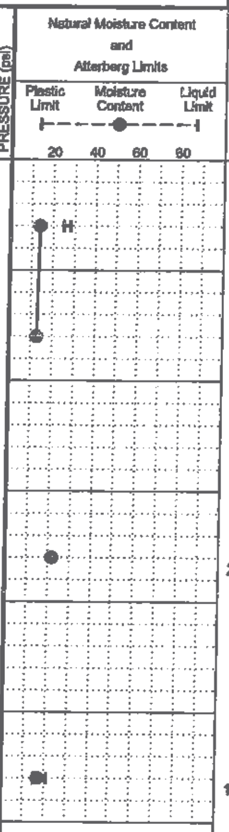


MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SM	SILTY SAND(SM) loose; tan	N=6						
		N=8	14	28	25	3	45	+40 Sieve=22%, +4 Sieve=17%
SM	SILTY SAND(SM) loose; tan	N=6						
	--red and gray	SF	13				15	+40 Sieve=61%, +4 Sieve=45%
	--with gravel							
ML	--dark gray SANDY SILT(ML) dark gray	SF						
		N=50/4"	22				61	+40 Sieve=0%, +4 Sieve=0%
	LIGNITE very dense; black	N=50/3"						
SM SC	SILTY CLAYEY SAND(SM-SC) very dense; dark gray; laminated with gray silt	N=68	17	21	15	6	49	+40 Sieve=0%, +4 Sieve=0%
	Bottom of Boring @ 30'							



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

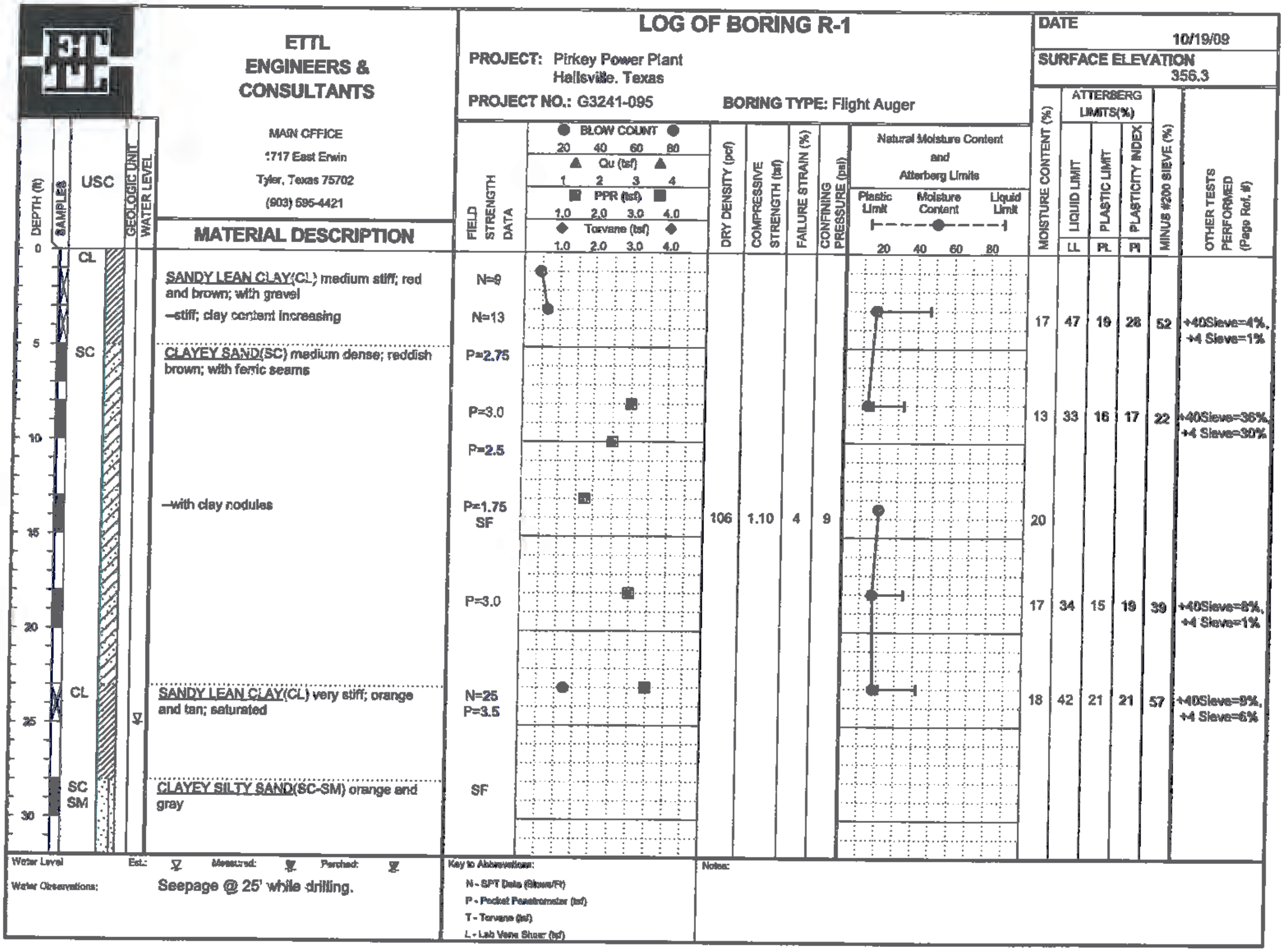


Water Level Est.: ∇ Measured: ▼ Perched: ∇

Water Observations: Seepage @ 8' while drilling. Water level @ 26' and open to 26' upon completion. Water level @ 11' and open to 28' after

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.034', W 94°29.952'



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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING R-1

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 356.3

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) medium stiff; red and brown; with gravel	N=9										
	—stiff; clay content increasing	N=13					17	47	19	28	52	+40Sieve=4%, +4 Sieve=1%
SC	CLAYEY SAND(SC) medium dense; reddish brown; with ferric seams	P=2.75										
		P=3.0					13	33	16	17	22	+40Sieve=36%, +4 Sieve=30%
		P=2.5										
	—with clay nodules	P=1.75 SF	106	1.10	4	9	20					
		P=3.0					17	34	15	19	39	+40Sieve=8%, +4 Sieve=1%
CL	SANDY LEAN CLAY(CL) very stiff; orange and tan; saturated	N=25 P=3.5					18	42	21	21	57	+40Sieve=9%, +4 Sieve=6%
SC SM	CLAYEY SILTY SAND(SC-SM) orange and gray	SF										

Water Level Est.: ∇ Measured: ∇ Perched: ∇

Water Observations: Seepage @ 25' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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LOG OF BORING R-1

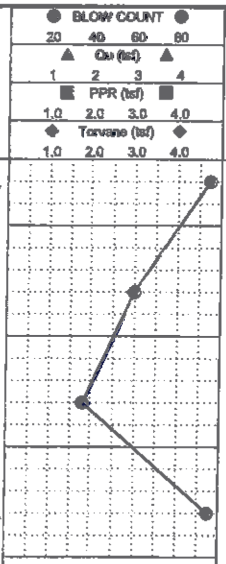
PROJECT: Pirkey Power Plant
Hallsville, Texas

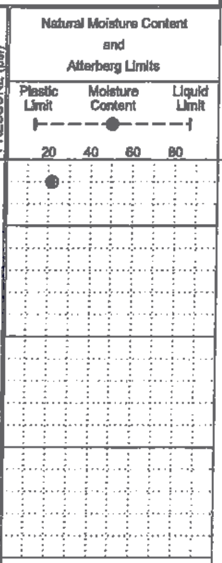
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 356.3

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	☒	SM			SILTY SAND(SM) very dense; gray; with gravel	N=50/5.5"					22				16	+40Sieve=2%, +4 Sieve=1%
35																
	☒				--orange and gray	N=60										
40																
	☒				--brown	N=36										
45																
	☒				--brown and gray	N=50/5.75"										
50					Bottom of Boring @ 50'											





Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 25' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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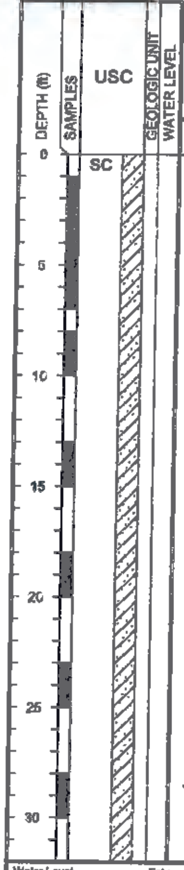
LOG OF BORING R-2

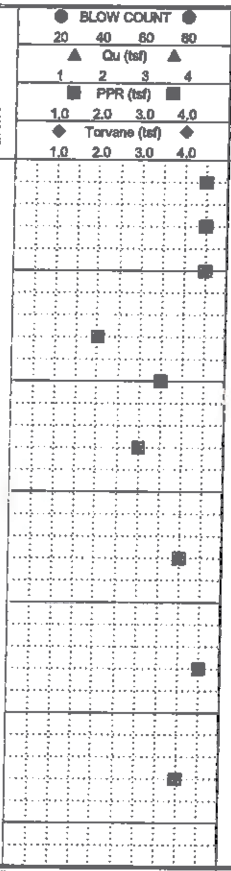
PROJECT: Pirkey Power Plant
Hallsville, Texas

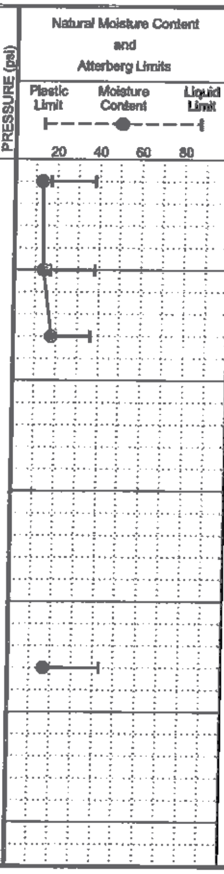
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 355.1







MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
<u>CLAYEY SAND</u>(SC) medium dense; reddish tan; with gravel	P=4.5+					13	38	17	21	44	+40Sieve=6%, +4 Sieve=2%
	P=4.5+										
–red and orangish gray; with clay lenses	P=4.5					14	38	17	21	41	+40Sieve=9%, +4 Sieve=3%
–gravelly and ferric seams	P=2.0					18	36	18	18	44	+40Sieve=12%, +4 Sieve=5%
	P=3.5										
–orange and red	P=3.0										
	P=4.0										
–red and tan	P=4.5+					17	43	18	25	42	+40Sieve=6%, +4 Sieve=0%
–red and orange	P=4.0										

Water Level Est.: ▽ Measured: ▼ Perched: ⊻

Water Observations: Seepage @ 38' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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LOG OF BORING R-2

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 355.1

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35				P=4.5	22	34	15	19	39	+40Sieve=7%, +4 Sieve=3%
	CL	∇	SANDY LEAN CLAY(CL) soft; tan and gray	P=0.2						
40										
			--stiff; gray and tan	P=1.3						
45										
	SM		SILTY SAND(SM) gray	SF						
50			Bottom of Boring @ 50'							

Chart scales: ● BLOW COUNT ● 20 40 60 80; ▲ Qu (tsf) ▲ 1 2 3 4; ■ PPR (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (tsf) ◆ 1.0 2.0 3.0 4.0

DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit — 20 40 60 80

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 38' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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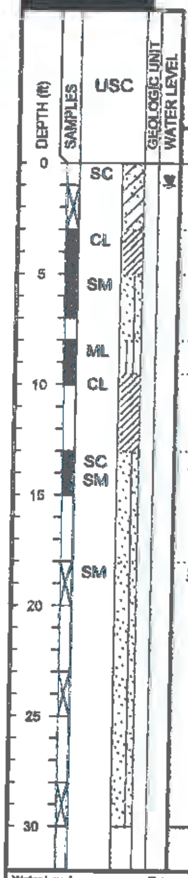
LOG OF BORING R-3

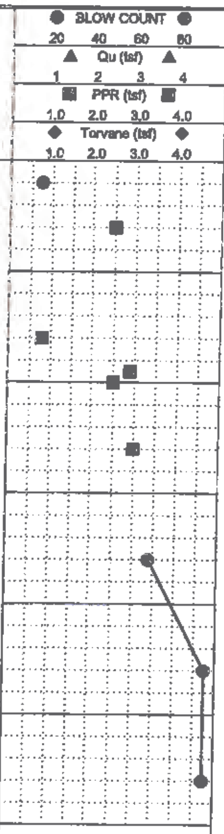
PROJECT: Pirkey Power Plant
Hallsville, Texas

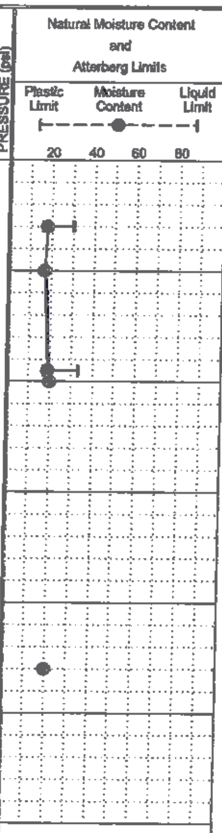
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 342.5







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) medium dense; tan	N=15										
CL	LEAN CLAY(CL) very stiff; tan and gray; laminated	P=2.5					18	30	16	14	88	+40Sieve=5%, +4 Sieve=1%
SM	SILTY SAND(SM) tan; with gravel	SF					17				30	+40Sieve=16%, +4 Sieve=9%
ML	SANDY SILT(ML) very loose; tan	P=0.8										
CL	LEAN CLAY(CL) very stiff; tan	P=2.5 P=2.9	108	1.60	7	7	19 20	33	17	16	86	+40Sieve=1%, +4 Sieve=0%
SC SM	SILTY CLAYEY SAND(SC-SM) medium dense; tan and gray	P=3.0										
SM	SILTY SAND(SM) very dense; tan and gray	N=68										
		N=50/6"					20				21	+40Sieve=1%, +4 Sieve=0%
		N=50/4"										
	Bottom of Boring @ 30'											

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 6' while drilling. Water level @ 1' and open to 26' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.313', W 94°29.240'

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 1

Date: 8/19/2015

Direction Photo Taken:

South

Description:

P8190454
Upland drainage area along southeastern side of Landfill.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 2

Date: 8/19/2015

Direction Photo Taken:

South

Description:

P8190467
Lining for new landfill expansion cell

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	**Location:**	**Project No.**
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No. 3

Date: 8/19/2015

Direction Photo Taken:

East Northeast

Description:

P8190470
Lining for new landfill expansion cell

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	**Location:**	**Project No.**
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No. 4

Date: 8/19/2015

Direction Photo Taken:

East Northeast

Description:

P8190475
Upland ditch on east side of landfill.

Appendix C

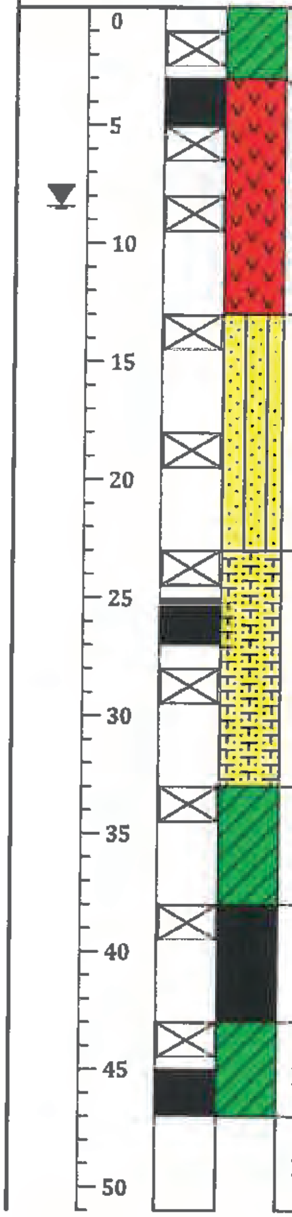
Soil Boring Logs and Piezometers - 2018 Landfill Lateral Expansion Area

Auckland Consulting LLC

LOG OF BORING B1

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/07/2016

GPS Coordinates: N32° 27' 12.0" W94° 29' 48.6"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Medium Stiff, red, brown and gray, Sandy Lean Clay (CL), mottled, few gravel	8			52	16	39	13	26	
Gray, Bottom Ash		N/A			15				64
	13								
	6								
Very Loose, brown, gray and red, Silty Clayey Sand (SC-SM), mottled, with organics (roots)	3			49	24	22	16	6	
- red, tan and gray at 18 ft	1								
Very Loose, light gray, red and tan, Silty Sand (SM), mottled	1			36	19	NP	NP	NP	
		N/A							
- loose, few clay below 28 ft	10			31	19				
Very Stiff, dark gray and gray, Sandy Lean Clay (CL)	24			55	21	29	13	16	
Black, Lignite	50/2								
Hard, dark gray and gray, Lean Clay (CL), laminated, few lignitic material	61								
		4.5		97	20	38	20	18	105
Boring terminated at 47 feet.									

Additional Information/Comments:

Logger: D. Diduch

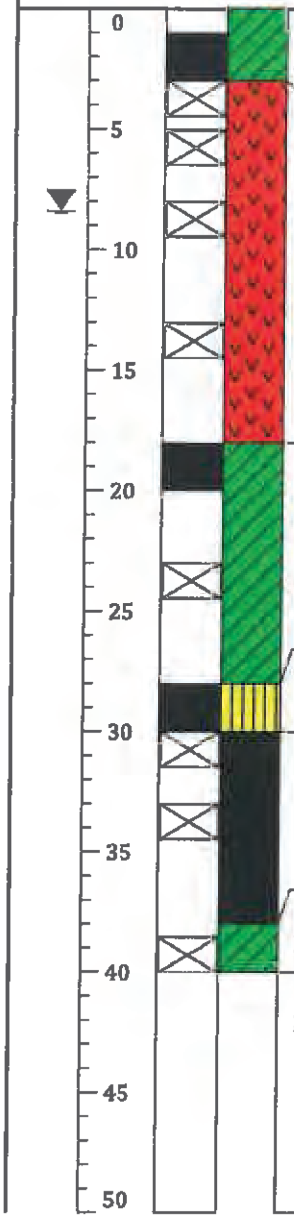
Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 8 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B2

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/06/2016

GPS Coordinates: N32° 27' 12.3" W94° 29' 45.3"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Very Stiff, red and brown, Sandy Lean Clay (CL), mottled, few gravel		2.5		57	18	30	12	18	
Gray, Bottom Ash	4								
	3								
	1								
	2								
Soft, dark gray, Sandy Lean Clay (CL)		0.5		62	20	34	13	21	91
- very soft below 23 ft	1								
Very Stiff, dark gray and gray, Sandy Silty Clay (CL-ML), with lignitic material		3.0		50	15	20	16	4	117
Black, Lignite	50/3								
	50/3								
Hard, gray and dark gray, Lean Clay (CL), laminated, trace gypsum	44			95	22	38	17	21	
Boring terminated at 40 feet.									

Additional Information/Comments:

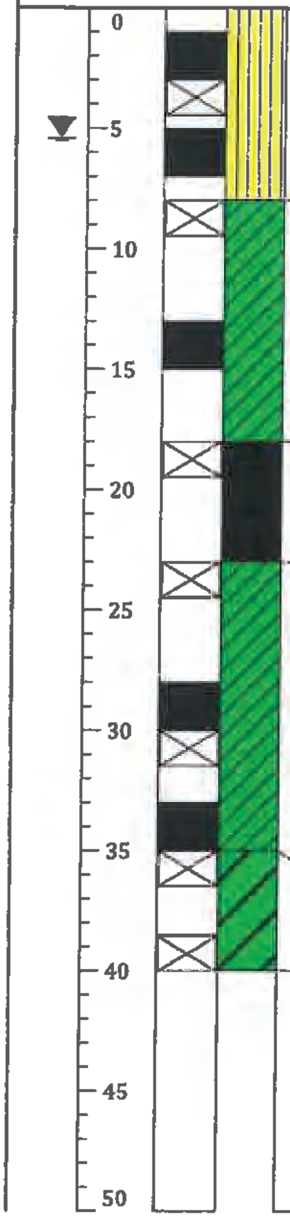
Logger: D. Diduch
Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 8 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B3

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/08/2016

GPS Coordinates: N32° 27' 10.3" W94° 29' 45.9"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Soft, brown, tan and red, Sandy Silty Clay (CL-ML), mottled, with few organics		N/A							
	4			53	19	20	15	5	
		N/A							
Very Stiff, brown and gray, Lean Clay with Sand (CL), mottled, laminated	24			77	19	29	17	12	
- stiff below 13 ft		1.5		75	22	31	17	14	103
Black, Lignite	50/3.75								
Hard, gray, Lean Clay (CL), mottled, laminated, few lignitic material	55								
- very stiff between 28 ft and 30 ft		2.5		99	17	38	18	20	117
- hard below 30 ft	33								
- attempted, no recovery		N/A							
Very Stiff, gray, Fat Clay (CH), mottled, laminated, trace gypsum	27			97	23	51	17	34	
	26								
Boring terminated at 40 feet.									

Additional Information/Comments:

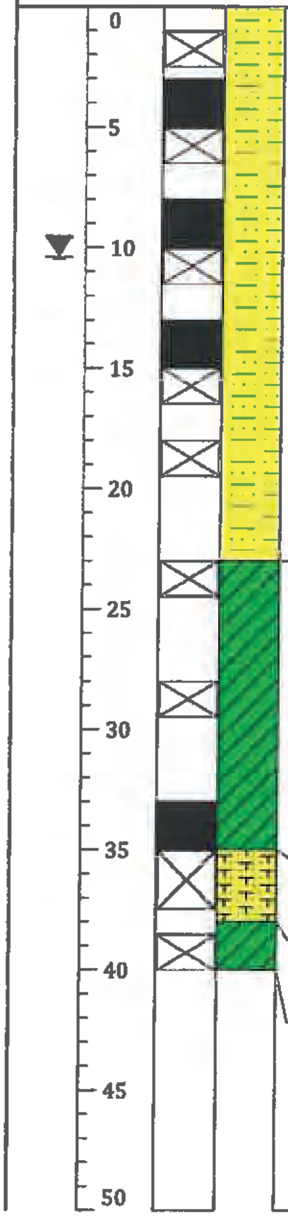
Logger: D. Diduch
Notes/Comments: Seepage encountered at 5 ft during drilling. Water level at 5 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B4

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/12/2016

GPS Coordinates: N32° 27' 9.0" W94° 29' 48.6"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Very Loose, reddish brown, Clayey Sand (SC), mottled	2								
- medium dense between 3 ft and 10 ft		3.5		27	14	23	14	9	
- few gravel below 5 ft	15								
		2.5		49	18	28	13	15	115
- loose between 10 ft and 15 ft	5								
		0.5		49	20	29	15	14	
- medium dense between 15 ft and 18 ft	27								
- very dense below 18 ft	60								
Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	32								
- very stiff at 28 ft	17			88	22	45	16	29	
- attempted, no recovery		N/A							
Very Dense, gray and tan, Silty Sand (SM), with lignitic material	50/2								
Hard, gray, dark gray and black, Lean Clay (CL), mottled, with lignitic material	95/11								
Boring terminated at 40 feet.									

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 10 ft during drilling. Water level at 10 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B5

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/09/2016

GPS Coordinates: N32° 27' 9.2" W94° 29' 42.4"
Surface Elevation: N/A
Drilling Method: HSA

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0	☒	🟨	Loose, reddish brown, Clayey Sand (SC), mottled	8								
	5	■ ☒	🟩	Very Stiff, red and brown, Sandy Lean Clay (CL), mottled, few gravel	19	4.0	6.6	51	16	34	14	20	116
	10	■ ☒	🟨	Dense, red, tan and brown, Clayey Sand (SC), mottled	34	4.0		40	20				
▼	15	☒	🟩	Very Stiff, gray and tan, Lean Clay (CL), mottled, laminated	17			96	21	41	16	25	
	20	■ ☒	🟩	Very Stiff, gray and dark gray, Lean Clay with Sand (CL), mottled	38	3.0		55	18	29	17	12	
	25	☒	⬛	Black, Lignite	50/6								
	30	■ ☒	🟩	Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	39	4.0		99	21				
	35	☒	🟩	- very stiff at 33 ft	24								
	40	■ ☒	🟨	Medium Dense, gray and dark gray, Clayey Sand (SC)	27	2.5		45	27	36	16	20	
	45 50			Boring terminated at 42 feet.									

Additional Information/Comments:

Logger: D. Diduch

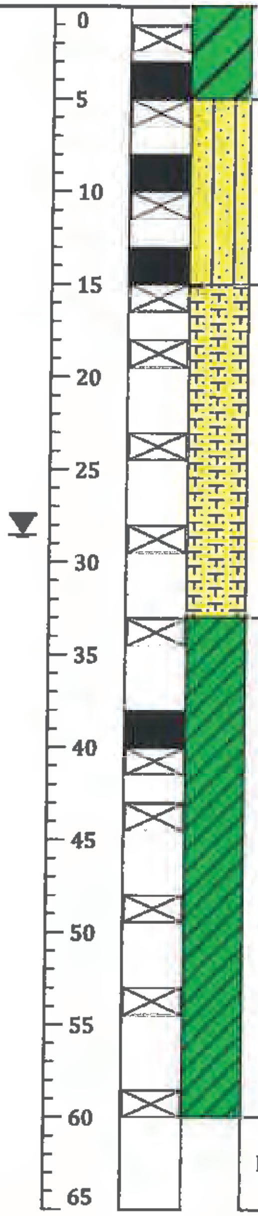
Notes/Comments: Seepage encountered at 13 ft during drilling. Water level at 13 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B6

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/16/2016

GPS Coordinates: N32° 27' 5.7" W94° 29' 48.0"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Very Stiff, red and brown, Sandy Fat Clay (CH), mottled	17			55	19	61	25	36	
		4.5							
Medium Dense, light red, tan and brown, Silty Clayey Sand (SC-SM), mottled	28			48	11				
		3.5							
- tan, light red and gray below 8 ft, with few gravel between 8 ft and 10 ft	19								
		2.5		33	12	19	15	4	
Very Dense, tan, light red and gray, Silty Sand (SM), mottled	88/10								
	42								
- dense between 18 ft and 23 ft									
- medium dense between 23 ft and 28 ft	28								
- very dense below 28 ft	85/11			17	22	NP	NP	NP	
Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	72								
- little recovery, few sand between 38 ft and 40 ft	48	N/A		97	22	42	17	25	
- gray, dark gray and black, with lignitic material, laminated between 43 ft and 45 ft	50/3								
	40								
	60								
	40			98	19	42	17	25	
Boring terminated at 60 feet.									

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 28 ft during drilling. Water level at 28 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B7

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/14/2016

GPS Coordinates: N32° 27' 7.1" W94° 29' 44.6"
Surface Elevation: N/A
Drilling Method: HSA

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0	☒	🟩	Stiff, light red and tan, Sandy Lean Clay (CL), mottled	13			51	19				
		■				N/A							
	5	☒		Very Stiff, light tan, red and brown, Lean Clay (CL), mottled	20			85	17	29	14	15	
		■				N/A							
	10	☒			21								
		■	🟨	Very Dense, light gray, Silty Sand (SM)		N/A							
	15	☒			87/10			45	10	NP	NP	NP	
		☒		Very Dense, red, brown and gray, Silty Sand (SM)	60								
	20												
	25	☒			84/11			18	21				
▼	30	☒			50/2								
	35	☒	🟩	Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	40								
	40	☒	■	Black, Lignite	50/5								
	45	☒	🟩	Hard, dark gray, Lean Clay (CL), mottled, laminated, trace gypsum	81								
	50	☒			64								
	55	☒			35			95	18	43	17	26	
	60	■		- attempted, no recovery		N/A							
		☒			77								
	65			Boring terminated at 62 feet.									

Additional Information/Comments:

Logger: D. Diduch

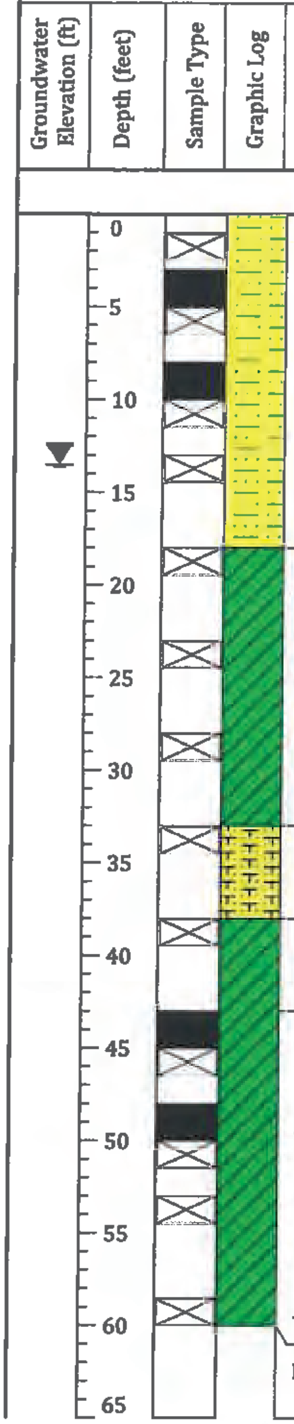
Notes/Comments: Seepage encountered at 28 ft during drilling. Water level at 28 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B8

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/13/2016

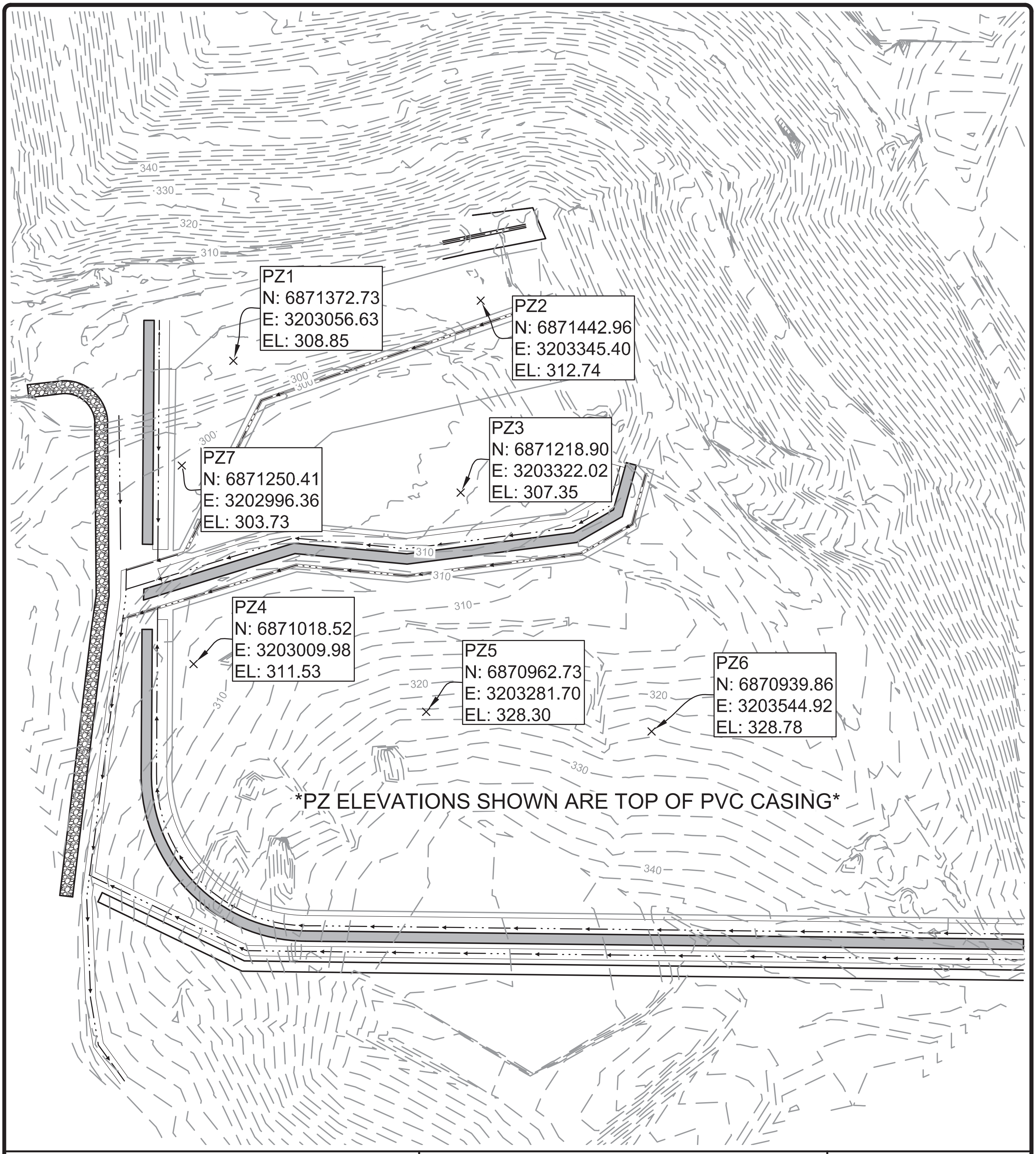
GPS Coordinates: N32° 27' 5.7" W94° 29' 39.6"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Loose, red, tan, and brown, Clayey Sand (SC)	6								
		2.0		39	13	19	12	7	
	7								
		N/A							
- medium dense, light gray, red and tan below 8 ft	18			37	23				
	15								
Very Stiff, gray and brown, Lean Clay (CL), mottled, laminated	22			91	25	42	16	26	
- hard below 23 ft	79								
	79/11								
Very Dense, dark gray, Silty Sand (SM)	76/11			43	30	NP	NP	NP	
Very Stiff, gray and dark gray, Lean Clay (CL), mottled, laminated	21			97	23				
Stiff, gray and dark gray, Sandy Lean Clay (CL), mottled, with occasional lignitic seams		1.5		59	25	33	18	15	93
	22								
- attempted, no recovery		N/A							
	16			48	30				
	22								
- laminated at 58 ft	29			62	25	44	21	23	
Boring terminated at 60 feet.									

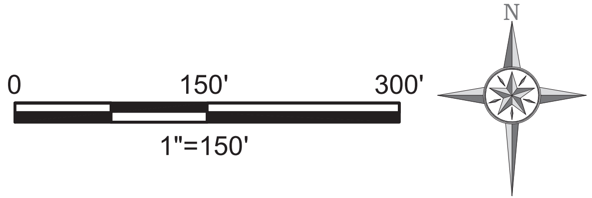
Additional Information/Comments:

Logger: D. Diduch
Notes/Comments: Seepage encountered at 13 ft during drilling. Water level at 13 feet upon completion.
N/A: Not Attempted



PZ ELEVATIONS SHOWN ARE TOP OF PVC CASING

AKRON CONSULTING, LLC.
431 N. CENTER ST.
LONGVIEW, TX 75601
TBPE Firm Reg. # 14014
(O) 903-236-9744
(F) 903-236-9745
www.akron-consulting.com



PZ WELL
AS-BUILT
LOCATIONS

STATE OF TEXAS WELL REPORT for Tracking #482280

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-1**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 11.79" N**
		Longitude:	**094° 29' 48.1" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/14/2018** Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **Michael Aaron Dodson**

Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482283

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-2**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 12.36" N**
		Longitude:	**094° 29' 44.64" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Piezometer**

Drilling Start Date: **6/14/2018** Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **Michael Aaron Dodson**

Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**4**	**14**

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482286

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-3**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
		Latitude:	**32° 27' 10.18" N**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Longitude:	**094° 29' 45.15" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/14/2018** Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**4**	**14**

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482290

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-4**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
		Latitude:	**32° 27' 08.3" N**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Longitude:	**094° 29' 48.73" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/15/2018**

Drilling End Date: **6/15/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**4**	**14**

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482295

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-5**
Address:	**502 N. Allen Strrreet Shreveport, LA 71101**	Grid #:	**35-37-4**
		Latitude:	**32° 27' 07.7" N**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Longitude:	**094° 29' 45.72" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Piezometer**

Drilling Start Date: **6/15/2018** Drilling End Date: **6/15/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**20**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**20**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**8**	**Bentonite 4 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Sandy Clay**
5	**10**	**Very Soft Red/Brown Clay**
10	**15**	**Very Soft Red/Tan Sandy Clay**
15	**20**	**Tan/Red Silty Sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**10**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**10**	**20**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482297

Owner: **American Electric Power Company**

Address: **502 N. Allen Strreet**
Shreveport, LA 71101

Well Location: **2400 Farm Road**
Hallsville, TX 75650

Well County: **Harrison**

Owner Well #: **PZ-6**

Grid #: **35-37-4**

Latitude: **32° 27' 07.69" N**

Longitude: **094° 29' 42.56" W**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/15/2018** Drilling End Date: **6/15/2018**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	0	20

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
8	20	Sand	20/40

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	1	Cement 1 Bags/Sacks
1	8	Bentonite 4 Bags/Sacks

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **Michael Aaron Dodson**

Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Sandy Clay**
5	**10**	**Very Soft Red/Brown Clay**
10	**15**	**Very Soft Red/Tan Sandy Clay**
15	**20**	**Tan/Red Silty Sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**10**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**10**	**20**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482288

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-7**
Address:	**502 N. Allen Strreet** **Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road** **Hallsville, TX 75650**	Latitude:	**32° 27' 10.81" N**
		Longitude:	**094° 29' 48.7" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/14/2018** Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

1.4 – Stack Out Area – CCR Location Restriction Evaluation, July 6, 2016

ARCADIS
Infrastructure · Water · Environment · Buildings

American Electric Power Service Corporation

Stack Out Area - CCR Location Restriction Evaluation

H. W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

July 6, 2016

ARCADIS

STATE OF TEXAS
Kenneth J. Brandner
Geology
1737
LICENSED
PROFESSIONAL GEOSCIENTIST

Kenneth Brandner

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matthew J

Matthew J. Lamb
Project Manager

John Holm, P.E.
Principal Engineer

Stack Out Area – CCR Location Restriction Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
AEP

Prepared by:
ARCADIS U.S., Inc.
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Ohio 43235-1447
Tel 614 985 9100
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Our Ref.:
OH015976.0010

Date:
July 6, 2016

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
PTI	Permit to Install
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the location of the existing Stack Out Area relative to the location restrictions included in the Coal Combustion Residual (CCR) requirements, as specified in the Code of Federal Regulations (CFR) 40 CFR 257.60 through 257.64, at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zones, or in an unstable area. However, because the subject CCR unit for this report (Stack Out Area) is an existing above-grade CCR pile/landfill, this CCR unit is subject to one location restriction: unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West Bottom Ash Pond (BAP), East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the location restriction criteria at the existing Stack Out Area (Site). The evaluation of the groundwater monitoring well network in the uppermost aquifer for the Stack Out Area is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the Stack Out Area CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on documents reviewed and will further describe the uppermost aquifer.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant Stack Out Area.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The Stack Out Area CCR unit is located in the central portion of the Plant, and approximately 1,200 feet northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of Stack Out Area CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the Stack Out Area.

2.2.1 Embankment Configuration

The Stack Out Area is an approximate 7-acre storage area for stabilized flue gas desulfurization (FGD) sludge. As shown on **Figure 3**, the Stack Out Area is located directly south of the Surge Pond, directly west of Thickener Tanks 1A and 1B, and directly east of a road that runs south to the on-site Landfill. The dimensions of the Stack Out Area are approximately 650 feet from north to south by 450 feet from east to west.

Stabilized FGD sludge is temporarily stockpiled directly above natural ground surface (native clay) in the Stack Out Area using a radial stacker. The maximum height of the stabilized FGD sludge piles are approximately 41 feet above ground surface. There are no embankments in the Stack Out Area. The stabilized FGD sludge piles are located no closer than approximately 50 feet from the perimeter of the Stack Out Area, thereby preventing the stabilized FGD sludge from migrating beyond the boundaries of the Stack Out Area.

2.2.2 Area/Volume

The Stack Out Area is approximately 7 acres in size. However, as discussed above in Section 2.2.1, the CCR piles in the Stack Out Area are located no closer than approximately 50 feet from the perimeter of the Stack Out Area, therefore the effective storage area of the Stack Out Area is approximately 4.4 acres (550 feet by 350 feet), and the maximum CCR storage volume based on a maximum CCR pile height of 41 feet is 180 acre feet.

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, FGD sludge) have been generated. The Stack Out Area receives stabilized FGD sludge (**Figure 3**). Prior to storing the FGD sludge in the Stack Out Area, the FGD sludge is dewatered using belt presses, and the dewatering fluid is routed to the Surge Pond for reuse as FGD makeup water. The stabilized FGD sludge is then stockpiled in the Stack Out Area using a radial stacker with an approximate 3-foot-wide by 120-foot-long conveyor belt.

The stabilized FGD sludge is temporarily stored at the Stack Out Area. The stabilized FGD sludge is removed using front-end loaders or similar equipment, placed into trucks, and disposed of at the on-site Landfill CCR Unit located near the south end of the Plant.

Lithologic data from soil borings and monitoring wells confirm the native soils underling the Stack Out Area consist of low-permeability clay. As shown on Geologic Cross Sections B-B' (**Figure 5**) and E-E' (**Figure 8**), the native clay directly below the Stack Out Area extends from the surface to an average depth of approximately 20 feet. Therefore, as shown on **Figures 5** and **8**, the separation distance between the base of the Stack Out Area and uppermost aquifer exceeds 5 feet.

2.2.4 Surface Water Control

The Stack Out Area contains dewatered FGD sludge that is stockpiled using a radial stacker, therefore no sluice water is present in the Stack Out Area. Storm water in the Stack Out Area follows surface topography via gravity sheet flow. The ground surface elevation in the Stack Out Area ranges from approximately 360 to 365 feet amsl (Akron Consulting, 2015). Storm water flow in the Stack Out Area is in a general northerly direction to the Surge Pond, which is a below-grade (incised) non-CCR unit.

2.3 Previous Investigations

The initial soils investigation and design of the Plant was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, including the Stack Out Area.

In 2009, ETTL Engineers & Consultants (ETTL) conducted geotechnical investigations of earthen embankments associated with several ponds at the Plant. The Stack Out

Area was not included in this evaluation because there are no earthen embankments in the Stack Out Area (ETTL, 2010).

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed hydraulic analysis of several ponds at the Plant. The Stack Out Area was not included in this evaluation because there is no impounded water in the Stack Out Area (Johnson & Pace, May 2011).

In 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-30 through AD-35 (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the Stack Out Area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the Stack Out Area, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow groundwater flow direction in the Stack Out Area is westerly to northwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The Stack Out Area is located approximately 1,200 feet northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the Stack Out Area does not discharge into Brandy Branch Reservoir. Brandy Branch Reservoir likely recharges the uppermost water bearing unit in the southern portion of the Plant, where the pool level in the Reservoir (340 feet amsl) is higher than water level elevations in monitoring wells located southwest (downslope) of the Reservoir.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 1,000 feet north of the Stack Out Area in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile west (downgradient) of the Stack Out Area for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (upgradient) of the Pirkey Power Plant.

3. Unstable Areas

CCR Rule 40 CFR Part 257.64 requires that existing landfills must not be located within an unstable area unless the owner or operator demonstrates that the design of the unit will ensure the integrity of the structural components of the unit. The Stack Out Area consists of stabilized FGD sludge which is stockpiled in above-ground piles, and is a CCR landfill.

3.1 Definition of Unstable Area and local Conditions

3.1.1 CCR Rule Definition

CCR Rule 40 CFR Part 257.53 defines an unstable area as a location that is susceptible to natural or human-induced events or forces capable of impairing the integrity of the CCR unit. These may include poor foundation conditions, areas susceptible to mass movements (landslides), and karst terrains.

3.1.2 Poor Foundation Soils

Lithologic data from soil borings and monitoring wells show the foundation of the Stack Out Area consists of native clay from the base of the CCR unit (ground surface) to a depth ranging from approximately 10 to 20 feet below ground surface. As shown on

Geologic Cross Section B-B' (**Figure 5**) and E-E' (**Figure 8**), the uppermost clay stratum is underlain by a clayey and silty sand stratum. These native sediments provide a stable foundation for the CCR materials that are temporarily stockpiled in the Stack Out Area prior to disposal in the on-site Landfill.

3.1.3 Mass Movements

The Stack Out Area is not located within an area subject to mass movements. This conclusion is supported by the ETTL soil stability report (ETTL, 2010).

3.1.4 Karst

The site area is located on the outcrop of unconsolidated Cretaceous Formations consisting predominantly of sand and clay (Broom, 1966; Flawn, 1965). The Stack Out Area is not located in a karst area.

3.1.5 Subsurface Mining

No subsurface mines are known to exist below the CCR units at the Site.

3.2 Compliance with Unstable Areas Restriction

Based on our site visit and review of available information, the Stack Out Area is not located within unstable areas. Therefore, this CCR unit complies with the requirement for not being located in an unstable area.

4. Summary, Conclusions, and PE Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, as well as the evaluations discussed within this report, the H.W. Pirkey Power Plant Stack Out Area complies with the requirements of the location restrictions sections of 40 CFR 257 Subpart D that apply to existing landfills and therefore the CCR unit is not located in a restricted location.

Kenneth J. Brandner

Printed Name of Registered Professional Engineer

Kenneth J. Brandner

Signature

KENNETH J. BRANDNER
69586

69586

Registration No.

Texas

Registration State

7-6-16

Date

5. References

Akron Consulting, Ltd., "October 2015 Stackout Aerial", October 2015.

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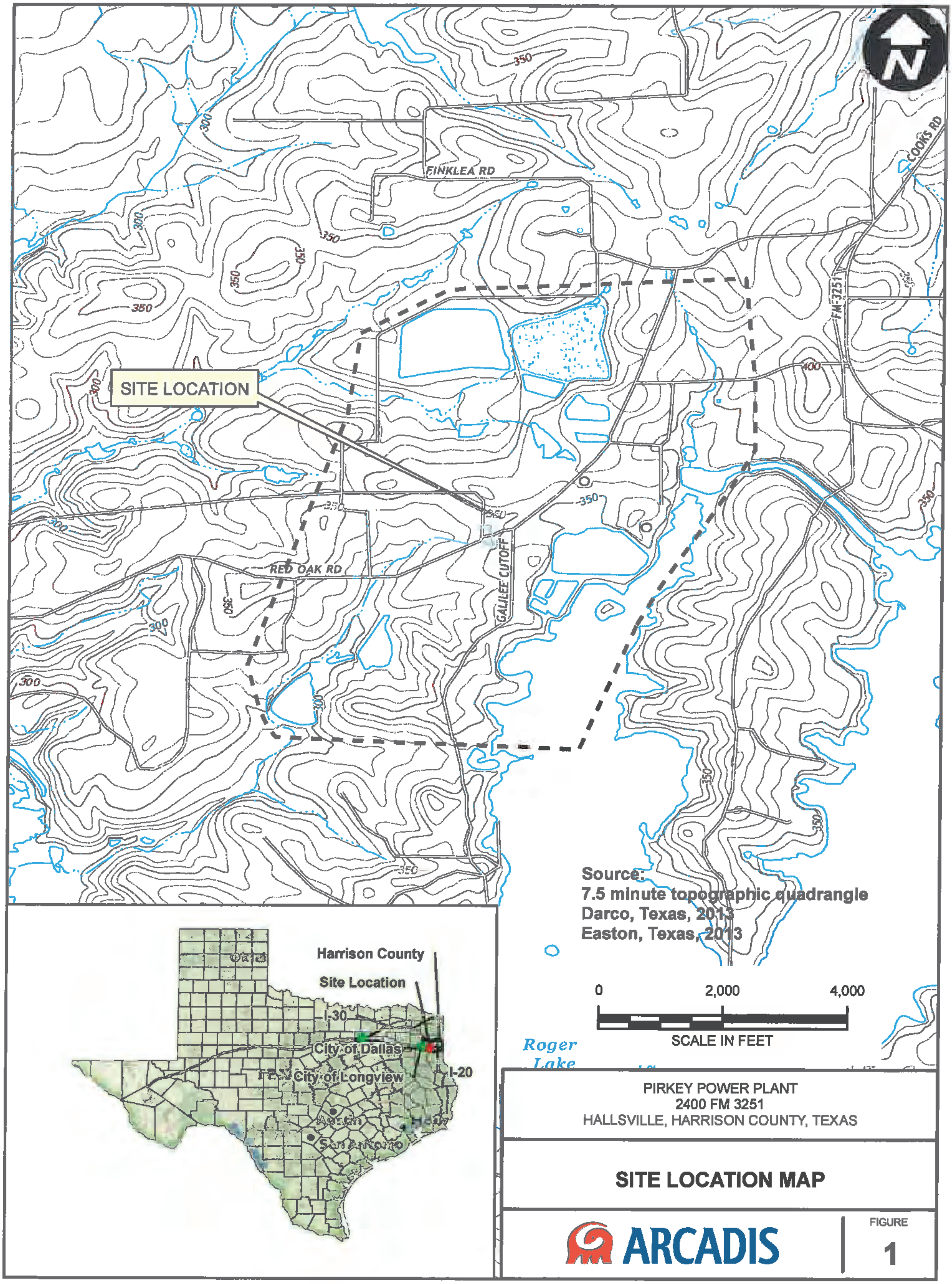
Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen(b)		Bottom of Screen(b)		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers(c)																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
NM - Not Measured



Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

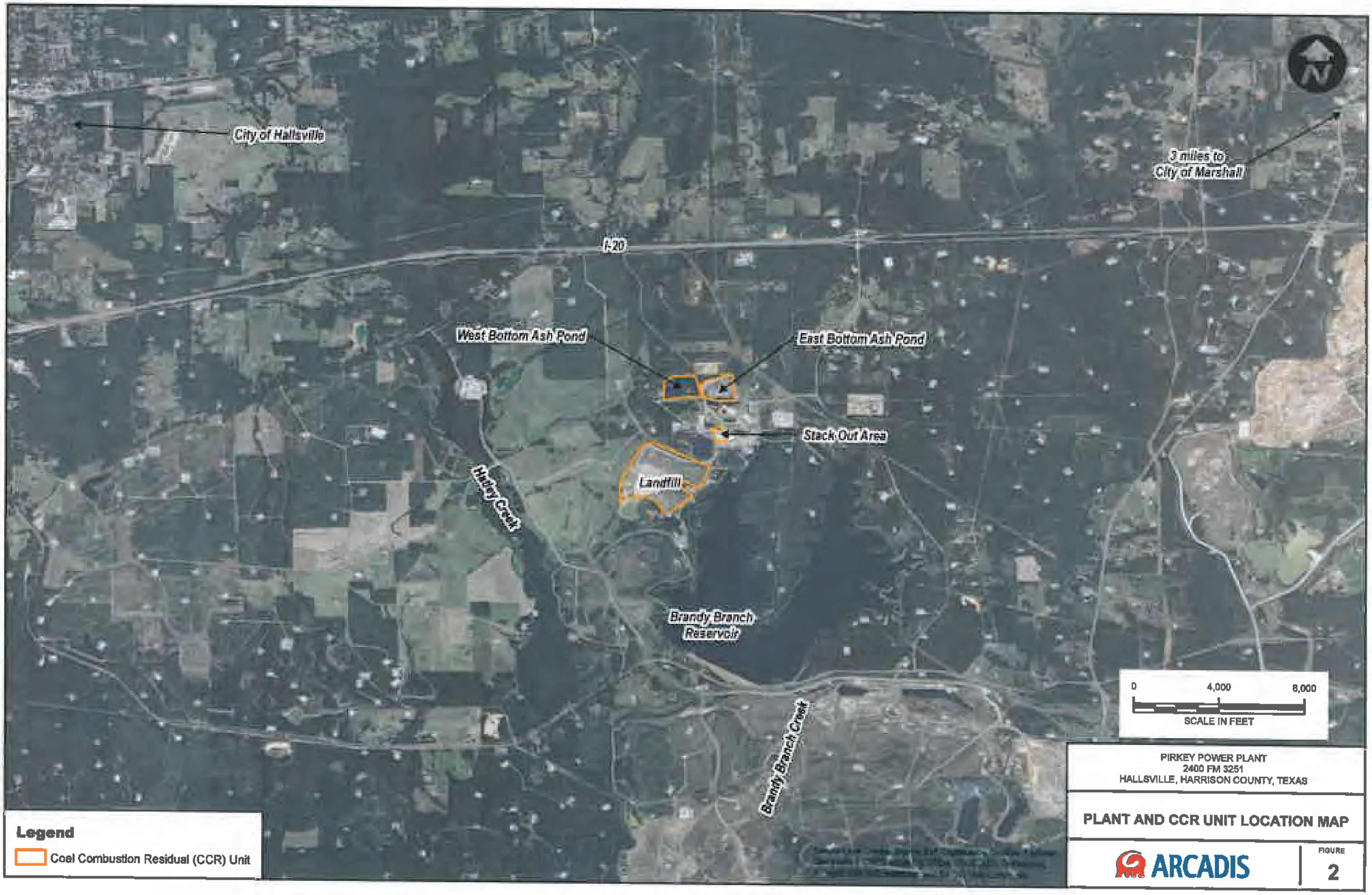
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENVAEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd



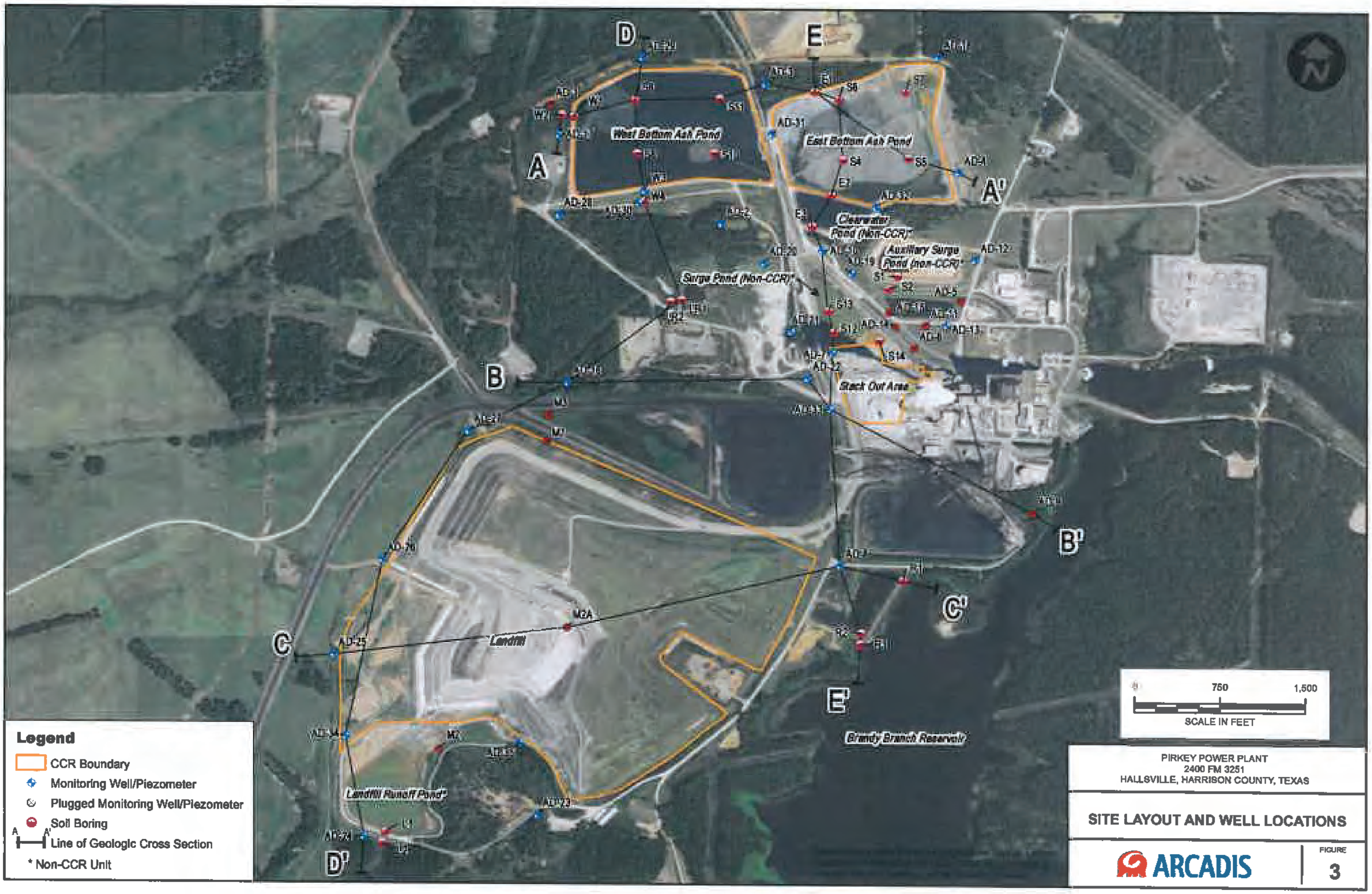
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



Legend

- ▭ CCR Boundary
- ◆ Monitoring Well/Piezometer
- ⊘ Plugged Monitoring Well/Piezometer
- ● Soil Boring
- A ├─┤ A' Line of Geologic Cross Section
- * Non-CCR Unit

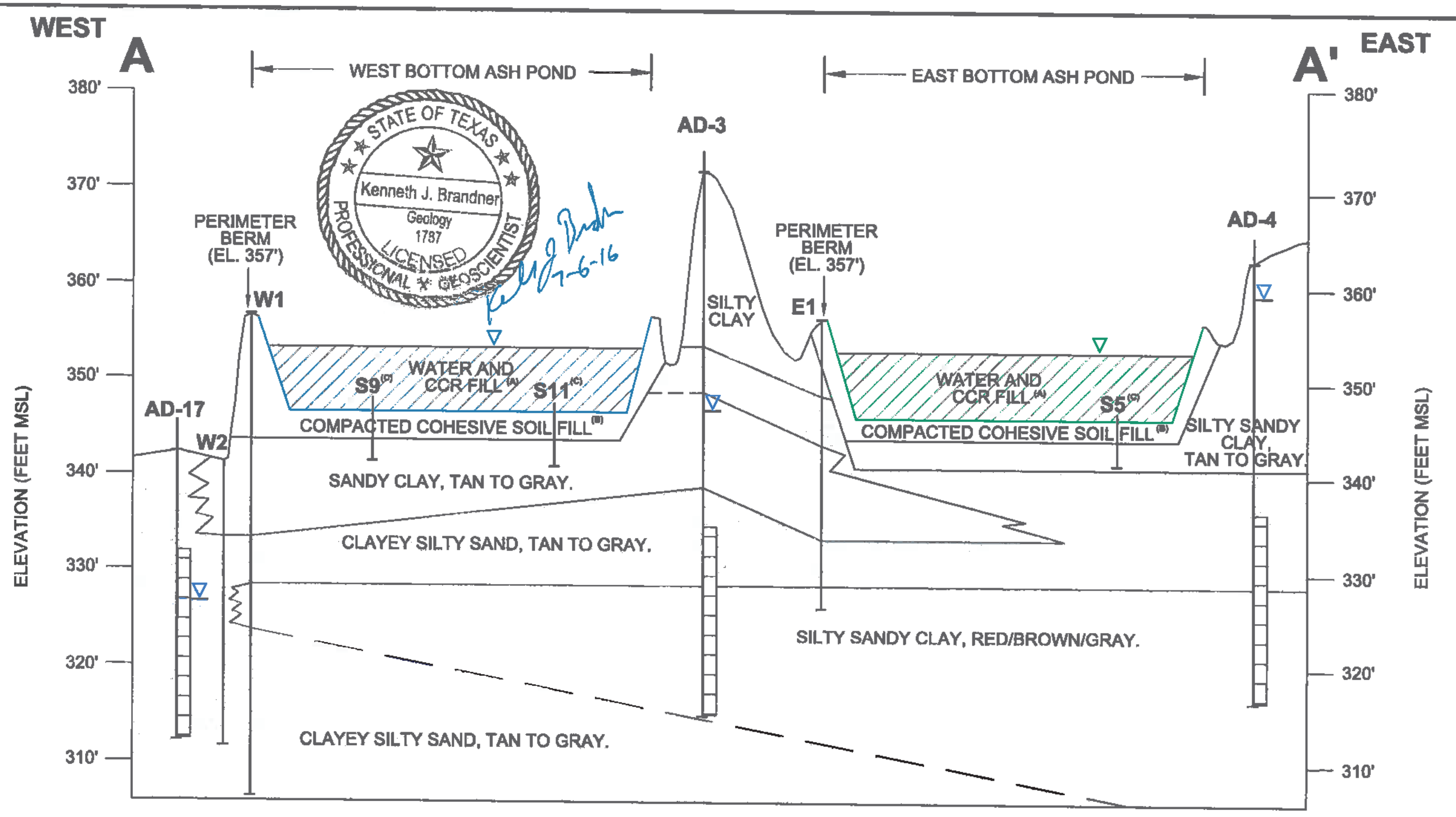
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE
3

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



STATE OF TEXAS
Kenneth J. Brandner
Geology
1737
LICENSED
PROFESSIONAL GEOSCIENTIST

K J Brandner 7-6-16

LEGEND

▯	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

NOTES:

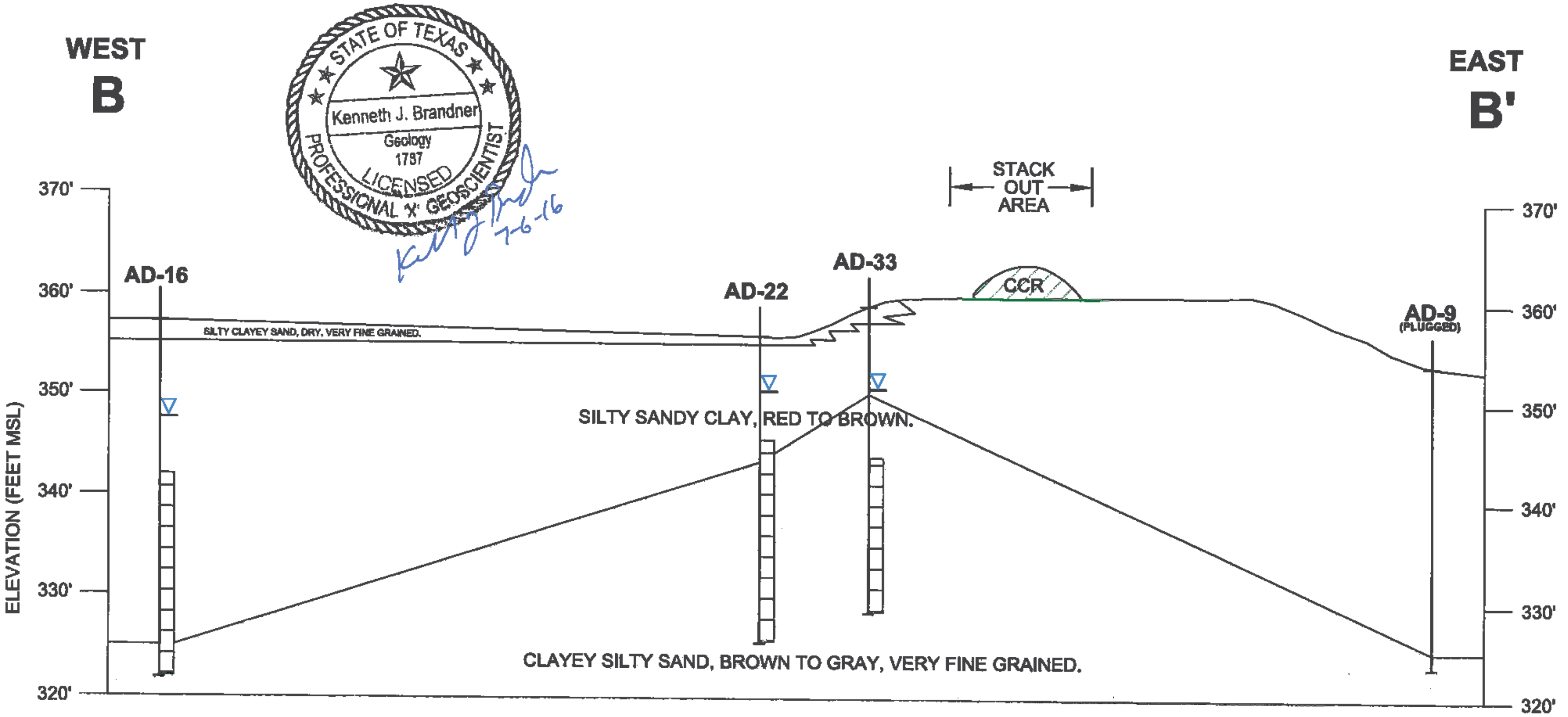
A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).
C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4



Kenneth J. Brandner
Geology
1737

Kenneth J. Brandner 7-6-16

LEGEND

- ▤ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

NOTES:

A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE, ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.

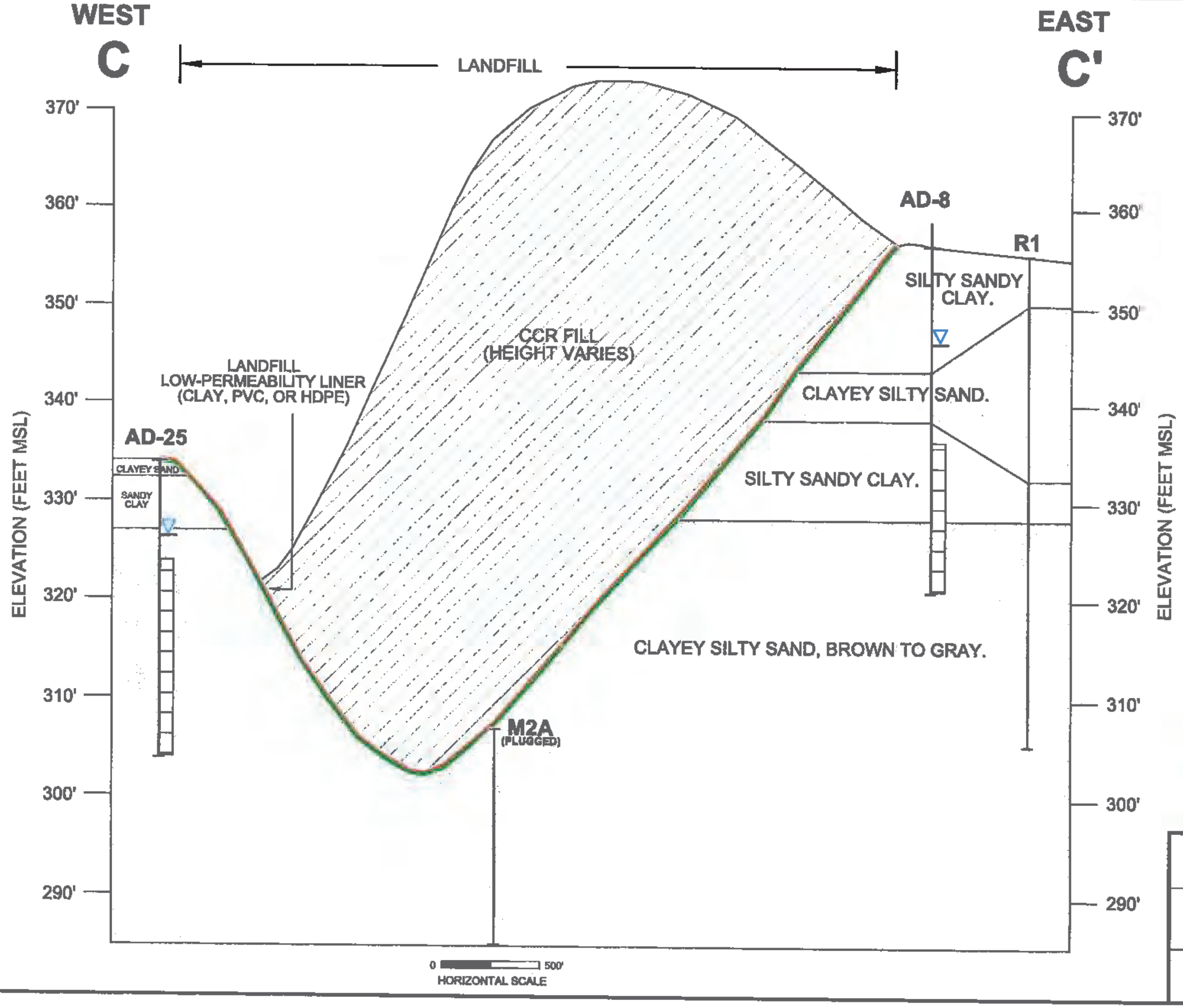
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5



Kenneth J. Brandner
Geology
1787

Kenneth J. Brandner
7-6-16

LEGEND

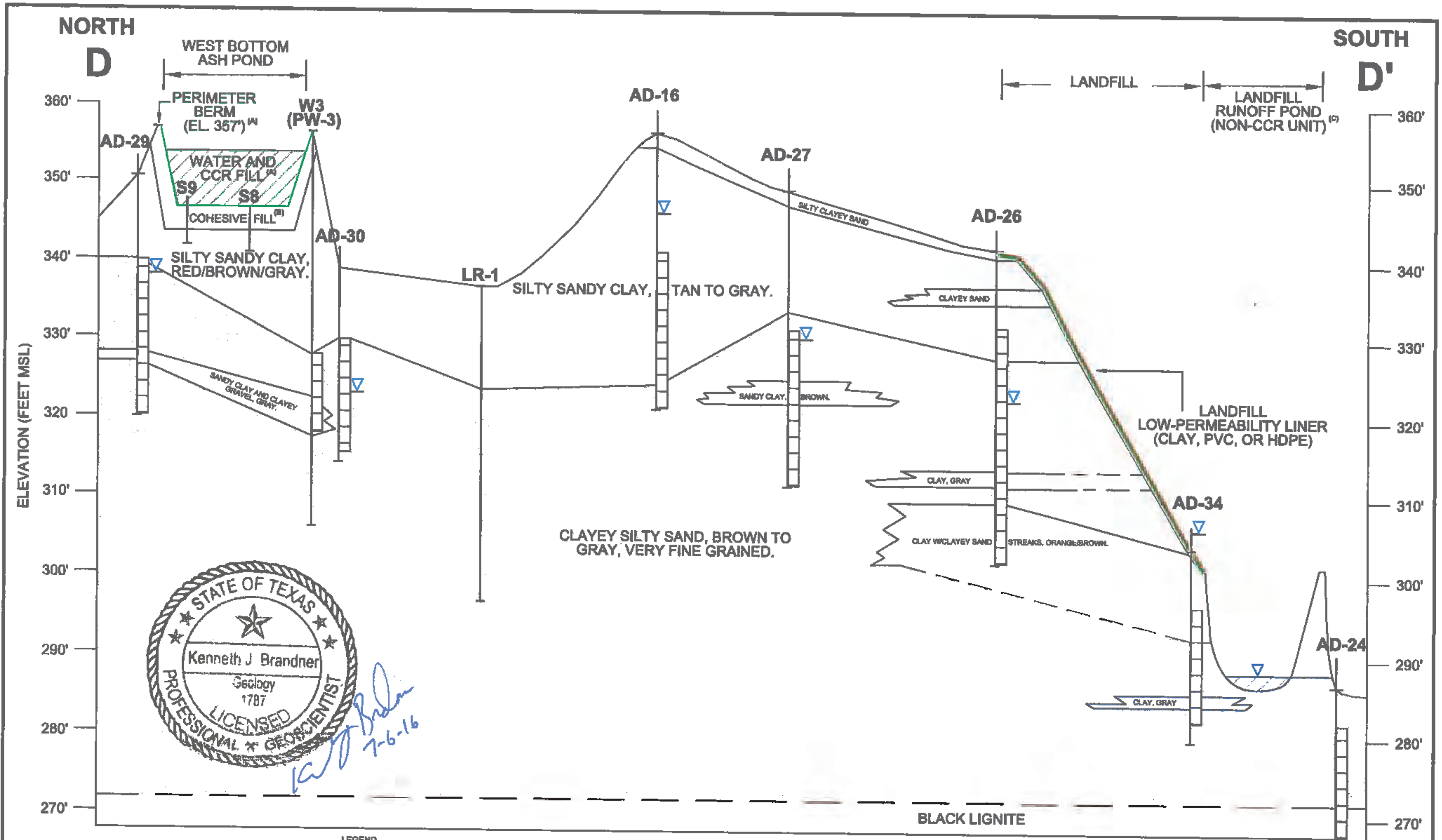
- ⌸ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6



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LEGEND

- 目 MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

0 ▬▬ 800'
HORIZONTAL SCALE

NOTES:

A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).

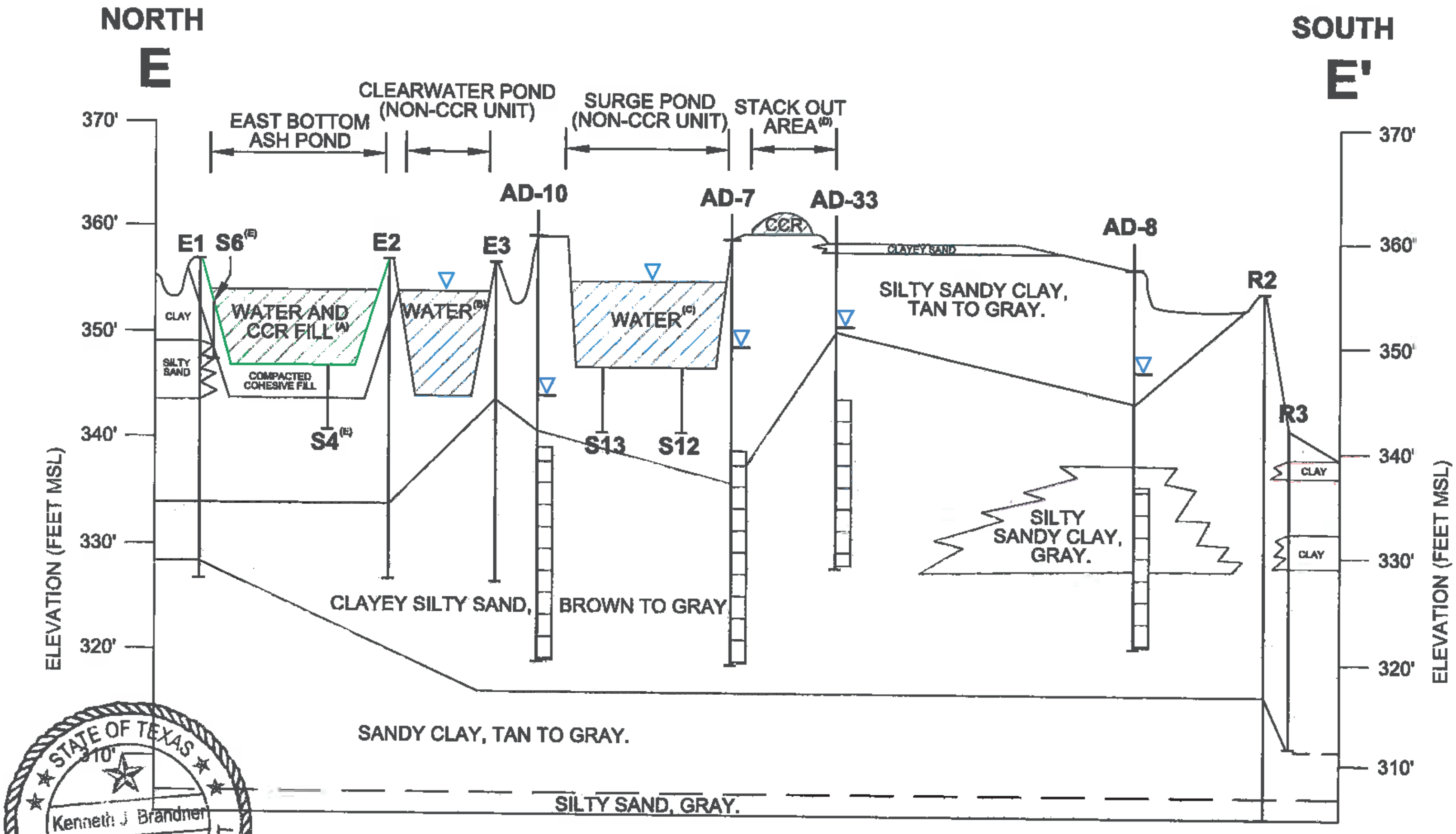
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS

FIGURE
7



0 500'
HORIZONTAL SCALE

Kenneth J. Brandner
Geology
1787

KJB 7-6-16

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

NOTES:

A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).
C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".
D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

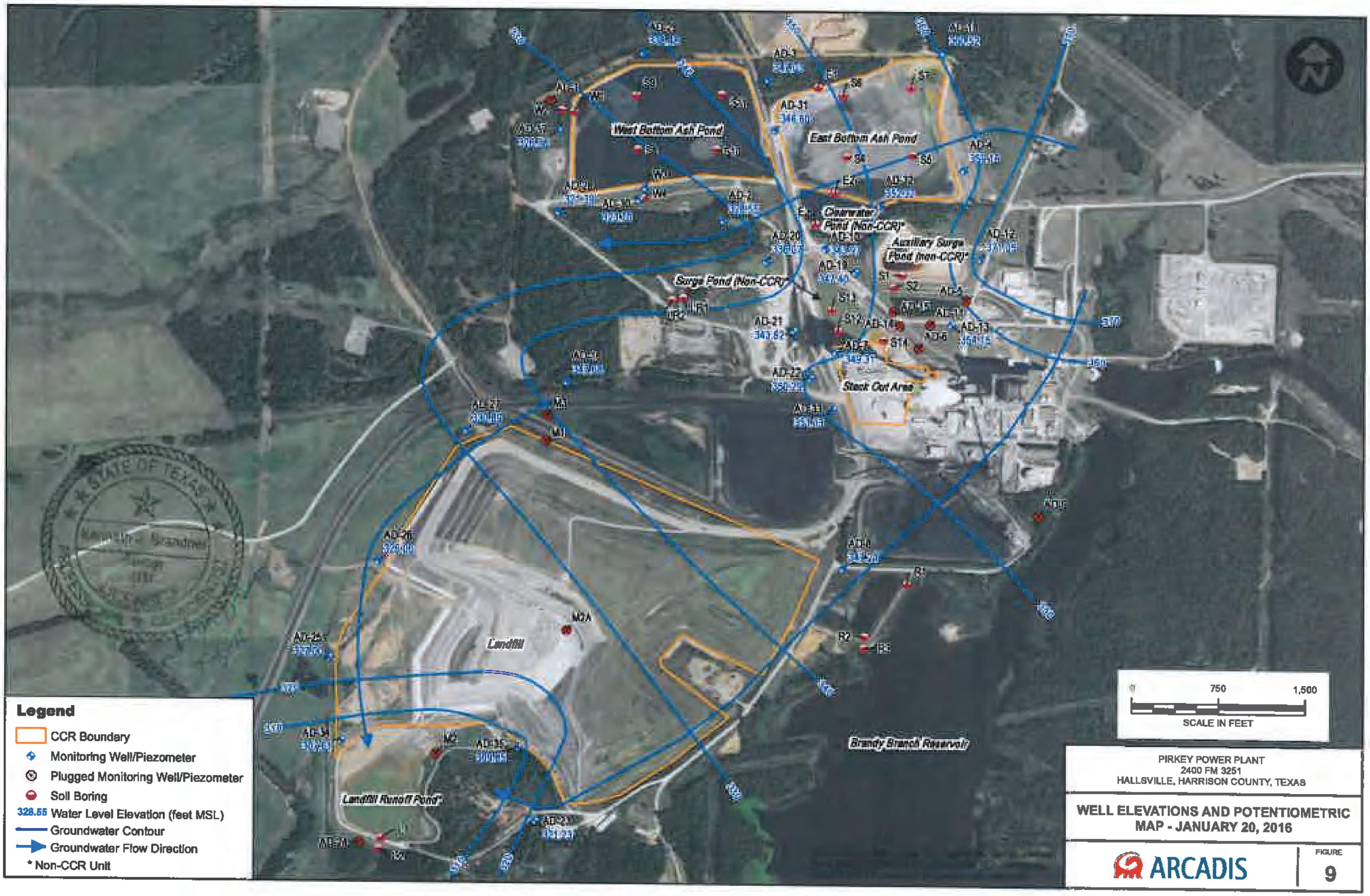
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\CH\016978 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Mxds\Figure 8 Cross Section E-E'.dwg LAYOUT: MODEL SAVED: 2/22/2016 11:26 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
— PLOTTED: 2/22/2016 11:57 AM BY: LEASE, DIANA



Legend

- ▭ CCR Boundary
- ◆ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ● Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- — Groundwater Contour
- ➜ Groundwater Flow Direction
- * Non-CCR Unit

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

ARCADIS

FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd

Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

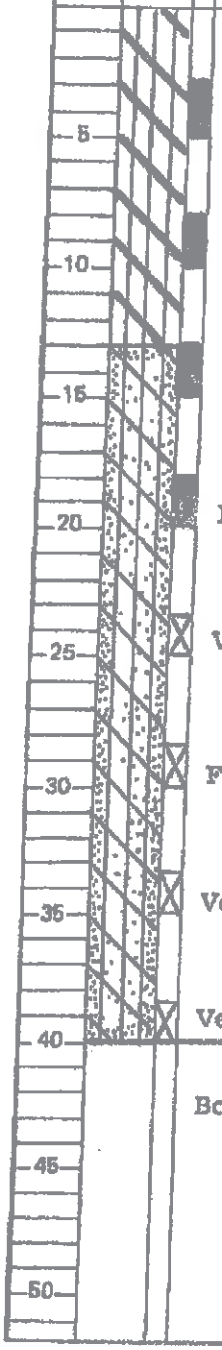
PROJECT: Waste Water Ponds
CLIENT: SWEPCO
BORING NO.: MW-6
LOCATION: Hallsville

Date: 10-3-83
Type: Auger
Ground Elevation:

Legend:

▨ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff tan and grey clay w/silt lenses and iron ore

Very stiff tan and grey clay w/silt lenses and iron ore

Firm tan and grey clayey silty sand

Loose brown and grey clayey silty sand

Very dense grey clayey silty sand 25-25=11½" 50 B/11½"

Firm grey clayey silty sand 7-7-17 24 B/F

Very dense grey clayey silty sand 25-25=9" 50 B/9"

Very dense grey clayey silty sand 18-32=10½" 50 B/10½"

Bottom of boring at 40 feet.

832964

LOG OF BORING

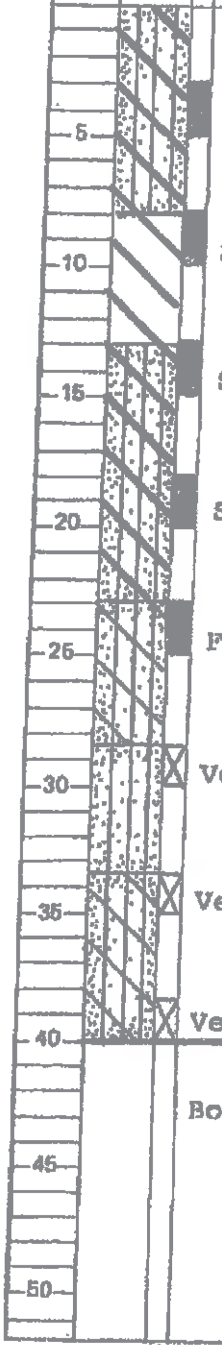
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-7
LOCATION: Hallsville

Date: 10-3-83
Type: Auger
Ground Elevation:

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff red, tan and grey sandy silty clay w/iron ore

Stiff tan and grey clay w/iron ore

Stiff tan and grey silty sandy clay lenses w/iron ore

Stiff tan and grey very sandy silty clay

Firm tan and grey clayey silty sand

Very dense grey silty sand 23-27=12" 50 B/F

Very dense grey clayey silty sand 17-35=12" 50 B/F

Very dense grey clayey silty sand 25-25=10½" 50 B/10½"

Bottom of boring at 40 feet.

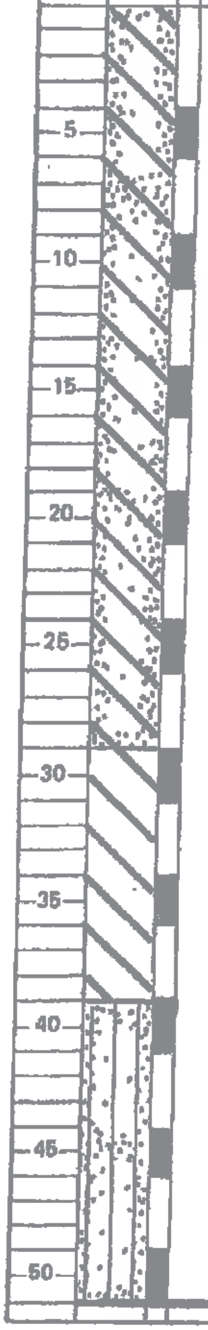
832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond BORING NO.: MW-12
CLIENT: Southwestern Electric Power Company LOCATION: Hallsville, TX
N 6+13.25; W-6+90.36
Date: 1/30/86 Type: Rotary Ground Elevation: 378.41

Legend:
■ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Brown and tan sandy clay

Brown, tan and gray sandy clay

Tan and gray sandy clay

Brown and tan sandy clay

Gray and tan sandy clay

Brown and gray clay

Brown and gray clay

Gray silty sand

Gray silty sand

Gray silty sand

Water encountered at 27.5 feet.
Bottom of Boring at 51 feet.

SOUTHWESTERN LABORATORIES

Observation Well Installation Report

Location Pirkey Power Plant	Date 2-23-88	Station # Elev. 361.85 0+33.3N, 8+84.7 W	City Hallsville, Texas
Project 880284	Observation Well Number MW-13	Location	
Type of Rig CME 55	Installed By DS, DY, LM	Date 2-23-88	Time

Method of Installation
Hollow-stem auger

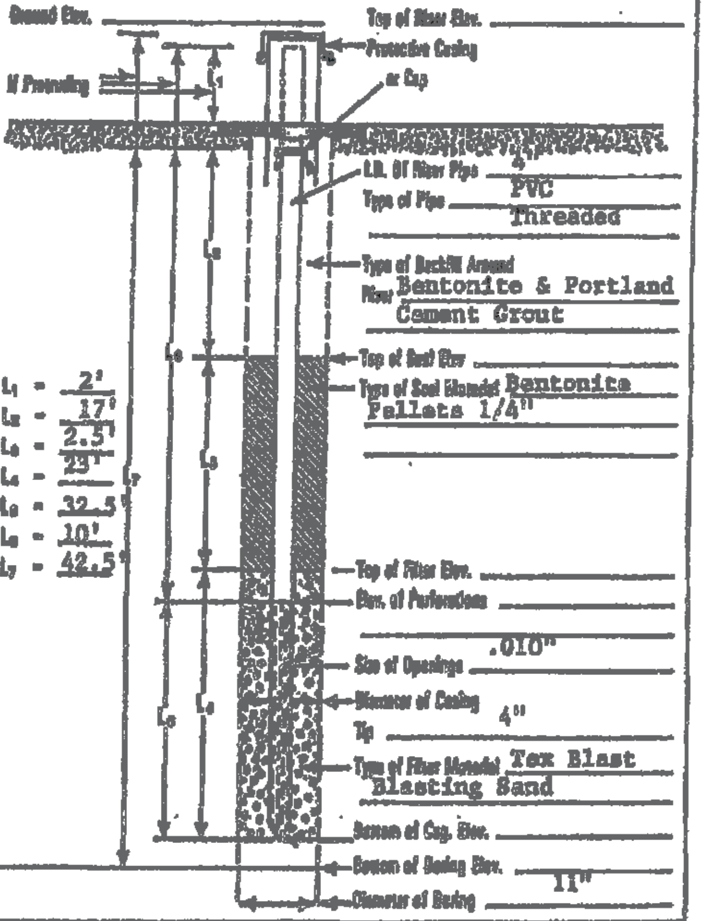
Log of Boring and Observation Well

Boring

Depth in ft.	Cored Interval	Description

Observation Well

Type of Observation Well: ☐ Flush ☒ Freestanding ☒ Locking Cap ☐ Manhole



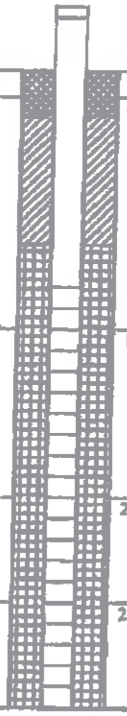
Top of Riser Elev.
I.D. Of Riser Pipe 4
Type of Pipe PVC Threaded
Type of Backfill Around Riser Bentonite & Portland Cement Grout
Top of Seal Elev.
Type of Seal Material Bentonite Pellets 1/4"
Top of Filter Elev.
Elev. of Perforations
Size of Openings .010"
Diameter of Casing 4"
Tip
Type of Filter Material Tex Blast Blasting Sand
Bottom of Csg. Elev.
Bottom of Boring Elev.
Diameter of Boring 11"

L_1 = 2'
L_2 = 17'
L_3 = 2.5'
L_4 = 23'
L_5 = 32.5'
L_6 = 10'
L_7 = 42.5'

Remarks
L2, L5, L7 are measured from the top of the PVC pipe, which protrudes 2' above the ground surface.

Inspected By

APEX PROJECT NO.: 110-089	☐ **BORING** **BORING NUMBER:**	■ **MONITOR WELL** **MONITOR WELL NUMBER:**	AD-22
FACILITY NAME: AEP- Pirkey Power Plant		**FACILITY ID NO.:** N/A	
FACILITY ADDRESS: Hallsville, Texas			
DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig			
DRILLER: Ed Wilson, Apex Geoscience Inc.		**COMPLETION DATE:** 12/16/2010	
PREPARED BY: David Bedford		**LOGGED BY:** David Bedford	
LATTITUDE: N 32°27'03.3" **LONGITUDE:** W94°29'41.3"	Datum: WGS-84	**WELL LOCATION:** Triangle- South side Quansit Hut	

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
							
1			0-0.5	SC	Clayey sand, light brown, very fine grained	None	Moist
2 3 4 5 6 7 8 9 10 11 12			0.5-12	CL	Lean clay, light brown mottled with light gray Few iron ore (small) pebbles in clayey sandy streaks	None	Slightly Moist
13 14 15 16 17 18 19 20			▽ 12-20	SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained Slightly wet @ 12.5' from seepage Large amount of iron ore 15-17' Very firm 18-18.5'	None	Slightly Wet
21 22 23 24 25			20-25	SC	(Dense crystalline rock 21-21.1'), light brown clayey sand, greenish black, mica, black clay streaks, very fine grained, wet @ 20'	None	Wet
26 27 28 29 30			25-30	SM	Sand, greenish brown (1') grading to orangish brown, silty, very fine grained	None	Wet
31 32 33 34 35 36 37 38 39 40					Boring Terminated at 30'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience Inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 12.5'
Above Ground 3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-33

JEFFREY D. SAMMONS
GEOLOGY
#10070
JDS 1.21.16

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1021
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/11/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

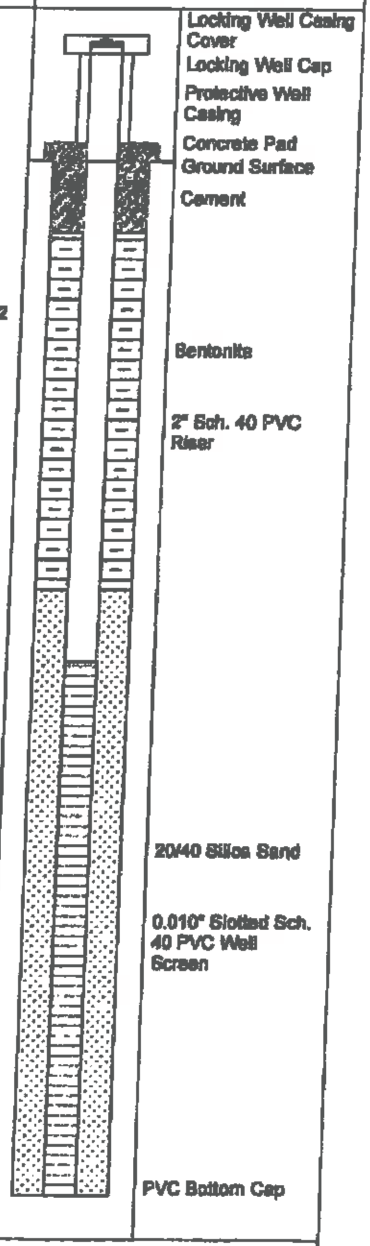
DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	60089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	382.37 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 27' 38.70"
LONGITUDE	94 29' 15.82"

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
		-4							
CLAYEY SAND: very fine to fine sand, some silt, dark brownish black and brown, very moist	SC	0							
FAT CLAY: trace sand and silt, reddish brown and light gray - some iron ore gravel at 2.0' - some silt and ironstone in thin seams at 2.5', light gray, yellowish brown, and reddish brown,	CH	4		■	29	93	74	32	42
CLAYEY SAND: interbedded clays and fine to very fine sand and silt, some iron ore gravel, light reddish brown and light gray	SC	8	▼						
- some clay and trace of iron ore gravel at 11', light gray and reddish brown, moist		11		■	21	35	35	23	12
- trace clay at 13', thin saturated ironstone and gravel seams at 13' to 16', reddish brown, light reddish brown, and light gray - dark reddish brown at 15' - clay lense at 15.5' to 16.5', light reddish brown and light gray		13	▽						
SILTY CLAYEY SAND: very fine to fine sand, reddish brown, very moist to saturated - some clay lenses and iron ore gravel at 20' - clayey at 20.5' to 21' - trace clay at 21', light gray, saturated	SM-SC	21		■	23	19	27	18	9
- some iron ore gravel at 28', reddish brown, very moist		28							
CLAYEY SAND: very fine to fine sand, dark gray and gray, moist	SC	29		■	23	30	25	18	7
		30							

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

832964

LOG OF BORING

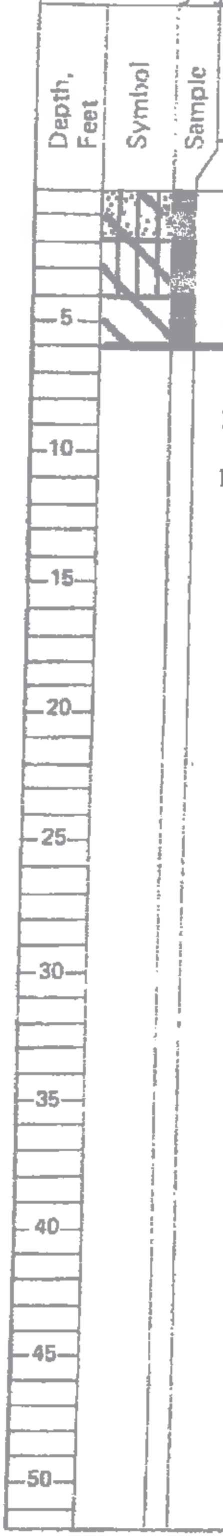
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-12
LOCATION: Hallsville, TX

Date: 9-15-83
Type:
Ground Elevation: 348.3

Legend:
■ Sample
X Penetration
▼ Water

Description of Stratum



Red and grey sandy silty clay

Red and grey clay w/silt lenses

Red and grey clay

Bottom of boring at 6 feet.

No water encountered.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-14
LOCATION: Hallsville, TX

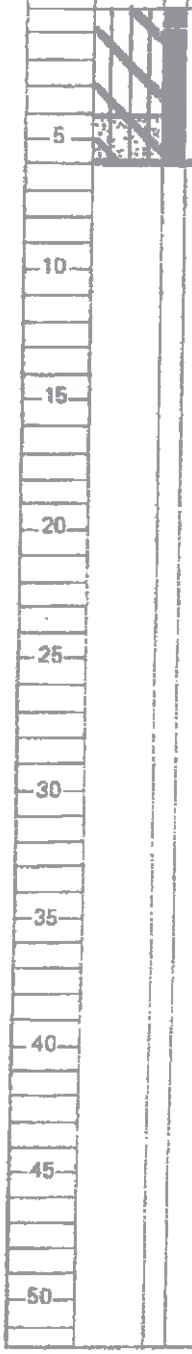
Date: 9-15-83
Type:
Ground Elevation: 352.9

Legend:

■ Sample
X Penetration
▼ Water

Depth, Feet
Symbol
Sample

Description of Stratum



Brown and red clay w/silt lenses

Brown and red slightly silty clay

Brown and red sandy silty clay

Bottom of boring at 6 feet.

No water encountered.

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. **1**	**Date:** 8/19/2015

Direction Photo Taken:

East Southeast

Description:

P8190405
AD-21 Ground water monitoring well northeast of Stack Out Area.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. **2**	**Date:** 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190438
Stack Out Area

1.5 – Arcadis Texas Engineering Services and Geoscientist Firm Registration Numbers

Leslie Fuerschbach
AEP Land Environmental and Remediation Services
502 N. Allen Avenue
Shreveport, LA 71101-2669

Date: December 28, 2021
Our Ref: 30113038
Subject: H.W. Pirkey Power Plant
2400 FM 3251
Hallsville, Texas

Arcadis U.S., Inc.
711 North Carancahua
Suite 904
Corpus Christi
Texas 78401
Phone: 361 883 1353
Fax: 361 883 7565
www.arcadis.com

TX Engineering License # F-533
TX Geoscientist License # 50158

Dear Ms. Fuerschbach,

Please see the below supplementary information regarding the Arcadis U.S. Inc. Texas engineering license information including the engineering firm's name and registration number in accordance with 30 TAC §352.4:

- Arcadis U.S. Inc.
- Engineering Services firm registration number F-533
- Professional Geoscientist firm registration number 50158

Please contact Ken Brandner at 361.533.2780 or Matt Lamb at 614.985.9134 if you have any questions.

Sincerely,
Arcadis U.S., Inc.

KENNETH J. BRANDNER
69586

12-28-21

Kenneth J. Brandner, P.E. #69586, Exp. 03.31.22
Geological Engineer

Kenneth J. Brandner
Geology
1787

12-28-21

Kenneth J. Brandner, P.G. #1787, Exp. 03.31.22
Geological Engineer

Email: Ken.Bradner@arcadis.com
Direct Line: 361 533 2780

ATTACHMENT 2

Design Criteria for CCR Landfills and Surface Impoundments

Landfill(s) For CCR Waste

NA-30 TAC §352.261 – Design Criteria Application Submission
Submit documentation demonstrating compliance with applicable design criteria in Subchapter F: Design Criteria (30 TAC §352.701-741)

30 TAC §352.701/40 §CFR 257.70 – Design Criteria for Coal Combustion Residuals Landfill – (only for new and lateral expansions)

Surface Impoundment(s) For CCR Waste

30 TAC §352.711/40 §CFR 257.71 – Liner Design Criteria for Existing CCR Surface Impoundments.

EBAP - Certification of liner system
WBAP - Certification of liner system

NA- 30 TAC §352.721/40 §CFR 257.72 – Liner Design Criteria for New and Lateral expansion of CCR Surface Impoundments

30 TAC §352.731/40 §CFR 257.73 – Structural Integrity Criteria for Existing CCR Surface Impoundments.

EBAP - Periodic Hazard Potential (Attachment 2.4)
- **NA**-Emergency Action Plan
- Construction History/Design Plans
- Structural Stability Assessment
- Safety Factor Assessment

WBAP - Periodic Hazard Potential
- **NA**-Emergency Action Plan
- Construction History/Design Plans
- Structural Stability Assessment
- Safety Factor Assessment

NA - 30 TAC §352.741/40 §CFR 257.74 – Structural Integrity Criteria for New and Lateral Expansions CCR Surface Impoundments

2.1 – 2018 Landfill Cell Liner and Leachate Collection Construction Certification, January 2022

2018 LANDFILL CELL

LINER AND LEACHATE COLLECTION CONSTRUCTION CERTIFICATION

January 2022

Prepared for:

H.W. Pirkey Power Plant
2400 FM 3251
Hallsville, Texas 75650

Prepared by:

Akron Consulting, LLC
431 N Center St.
Longview, Texas 75601
TBPE Firm # 14014

TABLE OF CONTENTS

2018 LANDFILL CELL
LINER AND LEACHATE COLLECTION CONSTRUCTION CERTIFICATION

LIST OF EXHIBITS

Introduction and Purpose

The H.W. Pirkey Power Plant, operated by Southwestern Electric Power Company (SWEPCO), a unit of American Electric Power (AEP), recently completed construction of a new +/-4 acre lateral expansion of their CCR landfill, generally referred to as the 2018 Landfill Cell. As required in section 40 CFR 257.70 (f), the purpose of this report is to certify that the composite liner and the leachate collection and removal system were constructed in accordance with the requirements of § 257.70 for the 2018 Landfill Cell.

Facility Location Description

SWEPCO owns and operates a coal-fired power plant (H.W. Pirkey Power Plant), which is located approximately 5.9 miles southeast of Hallsville in Harrison County, Texas. The power plant produces up to 700 Megawatts (MW) of electrical power utilizing local lignite from the Sabine Mining Company. The existing landfill is used for disposal of scrubber sludge, fly ash, bottom ash, and other byproducts from the coal-fired power plant. The waste materials are considered non-hazardous. A Site Location Map, as well as a Plant and CCR Unit Map have been included for reference at the end of this report.

2018 Landfill Cell Design Criteria for New CCR Lateral Expansion: (§ 257.70)

The existing Pirkey Landfill consists of several cells that have been constructed periodically over the last thirty plus years. Several of the cells have already been capped, and the most recent cell was constructed in 2015 (please refer to the Site Layout Map for the capped and active area locations). As per § 257.70, all new CCR landfills and any lateral expansions must be designed, constructed, operated, and maintained with a composite liner system and a leachate collection and removal system. The details of this system have been described in more detail below and illustrated on the last page of this document, entitled 2018 Landfill Cell Details.

Composite Liner System Requirements: § 257.70 (b) (1-4)

The composite liner system for the 2018 Landfill Cell consists of an upper and lower component. The upper component consists of a 60 mil HDPE geomembrane, and the lower component consists of a 2-foot compacted clay liner system with a hydraulic conductivity of no more than 1×10^{-7} cm/sec. The upper component was installed in direct and uniform contact with the lower component. The composite liner system also meets all the requirements as outlined in § 257.70 (b) (1-4).

Leachate Collection and Removal System § 257.70 (d) (1-3)
(Not Installed for Lined Area to the South)

The leachate collection and removal system was installed for the 2018 Landfill Cell. This leachate system consists of a minimum 2-foot thick leachate drainage layer above the 60-mil HPDE liner to maintain less than a 30 cm depth of leachate over the liner. The purpose of this system is to collect and remove the leachate from the landfill during the active life and post-closure care period. The leachate system was constructed of materials that are chemically resistant to the CCR and of sufficient strength to prevent collapse from the future overlying waste. Leachate pipes, also made from HDPE material, were installed in the low areas of the liner system to remove the leachate from the leachate drainage layer. The trenches around these leachate pipes were backfilled with coarse aggregate and wrapped with filter fabric to minimize clogging. Chimney drains were also installed into the leachate piping to better drain the landfill during its active life. Therefore, the leachate collection and removal system meets all the requirements as outlined in § 257.70 (d) (1-3). This system was not installed on the lined area to the south of the 2018 Landfill Cell due to current ash projections. Consequently, this area is not included as part of this certification.

Summary

SWEPCO owns and operates a landfill at the H.W. Pirkey Power Plant and recently constructed the 2018 Landfill Cell. As outlined in this report, the liner and leachate collection and removal system were constructed in accordance with the requirements of § 257.70 for the 2018 Landfill Cell.

Certification

By means of this certification, I attest that (i) this report was prepared by me or under my direct supervision, (ii) I am a duly Licensed Professional Engineer in the State of Texas, and (iii) to the best of my knowledge, information and belief, the composite liner and the leachate collection and removal system for the 2018 Landfill Cell meets the requirements as set forth in 40 CFR 257.70.

Lane Roberts
Printed Name of Registered Professional Engineer

Signature

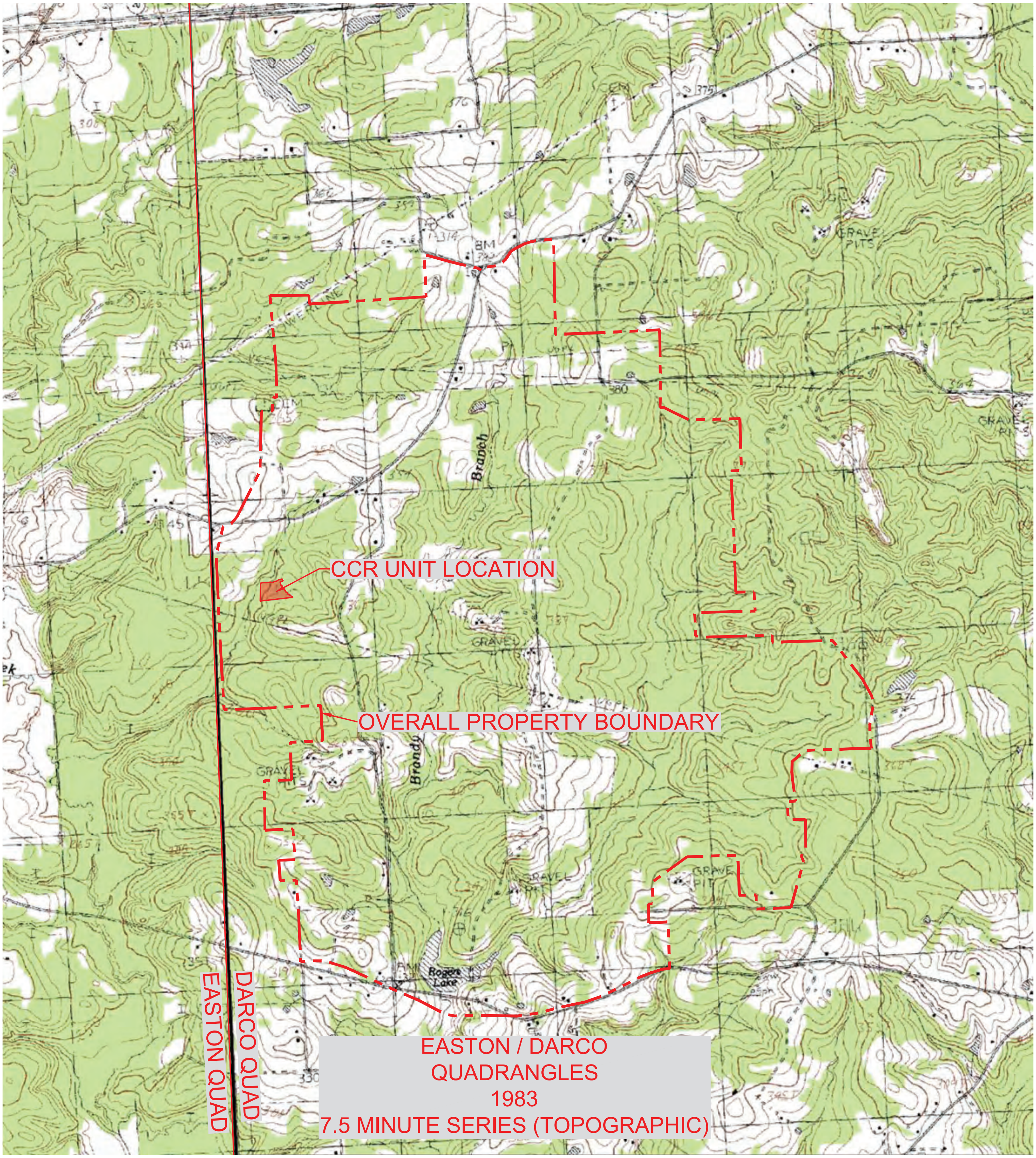
105135	Texas	01-12-2022
Registration No.	Registration State	Date

LANE D. ROBERTS
105135

(Seal)

Akron Consulting, LLC
431 N Center St.
Longview, TX 75601
(903) 236-9744
Firm Information

14014
TBPE Firm #



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LONGVIEW, TX 75601
TBPE Firm Reg. # 14014
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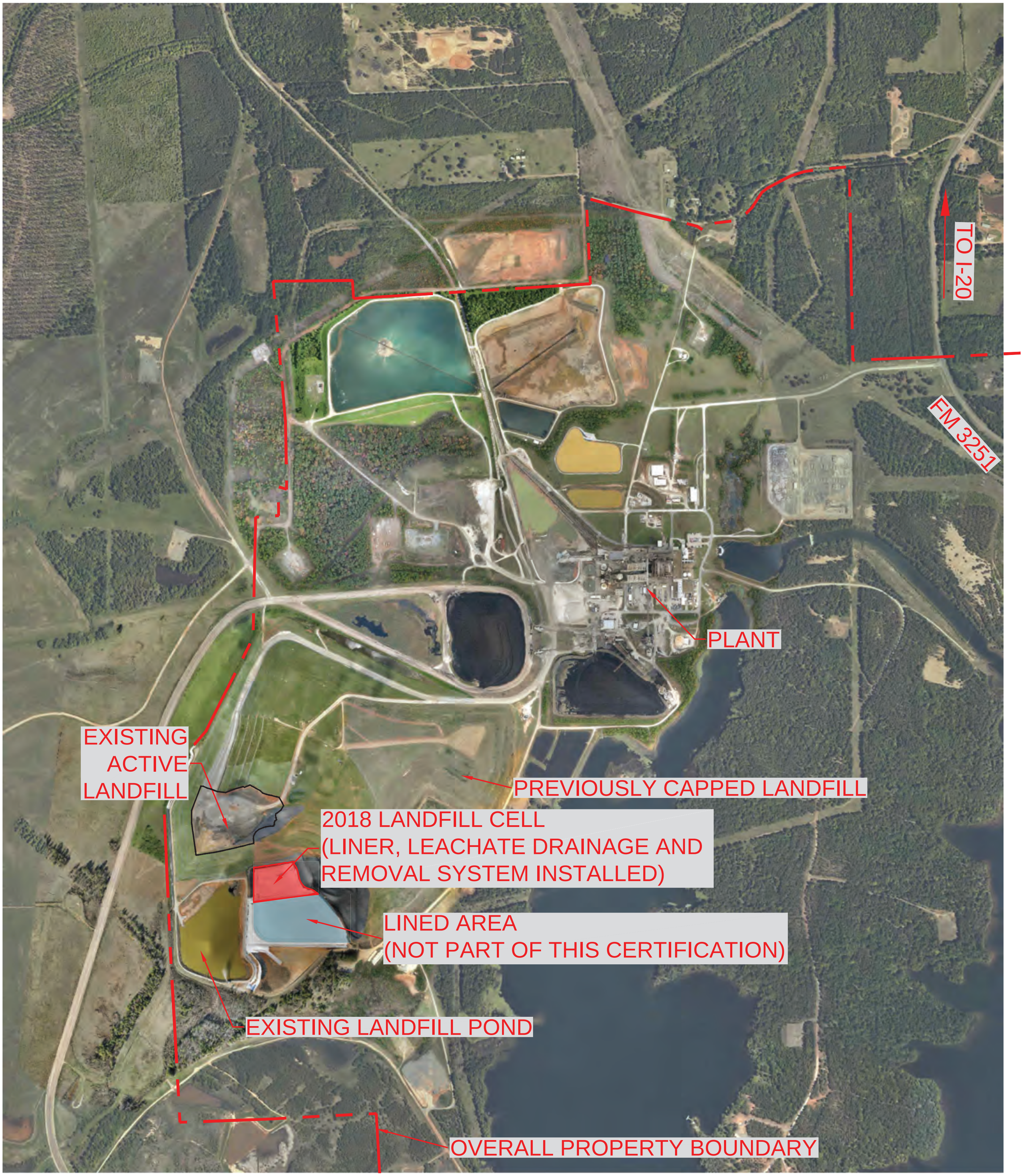
(F) 903-236-9745
www.akron-consulting.com

0 $\frac{1}{2}$ MI 1 MI

1" = $\frac{1}{2}$ MI

N

2018 LANDFILL CELL SITE LOCATION MAP



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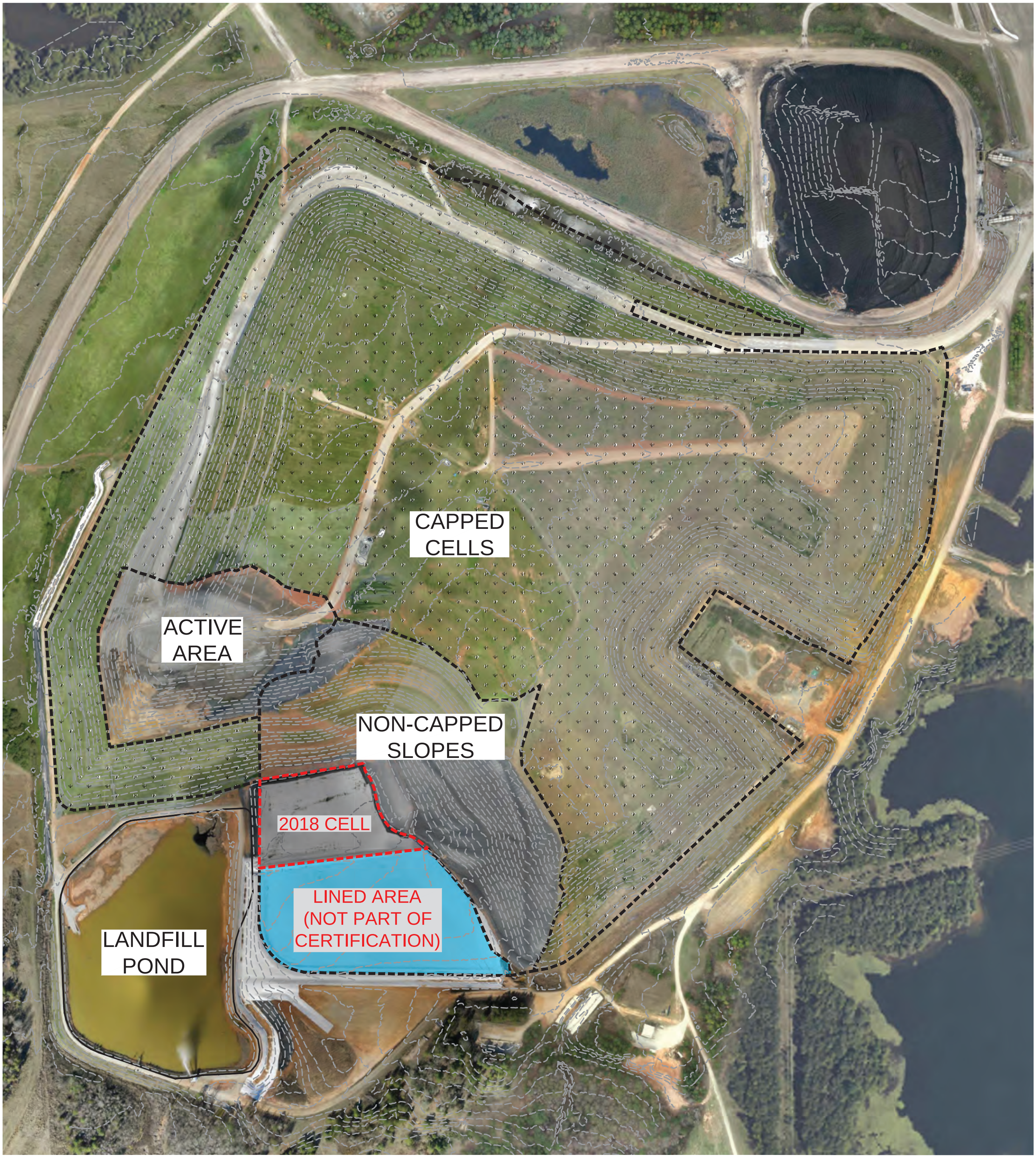
0 $\frac{1}{4}$ MI $\frac{1}{2}$ MI
1" = $\frac{1}{4}$ MI

N

2018 LANDFILL CELL PLANT AND CCR UNIT MAP



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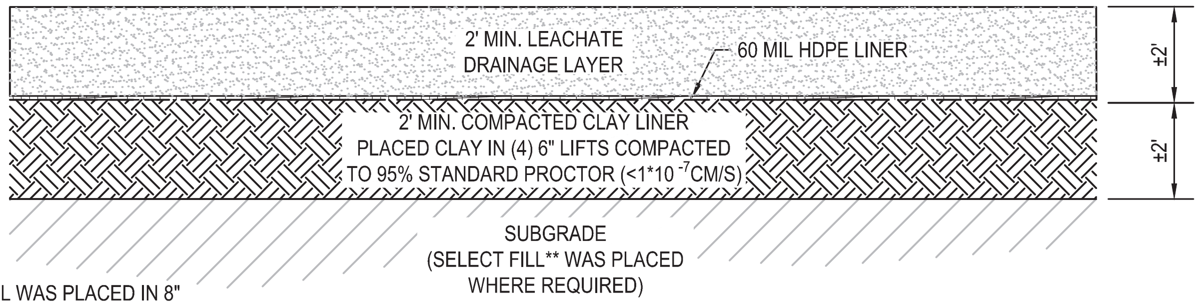
0 $\frac{1}{4}$ MI $\frac{1}{2}$ MI

1" = $\frac{1}{4}$ MI

N

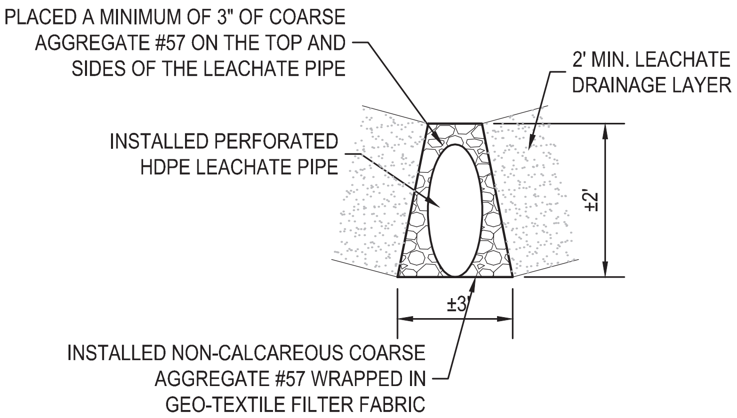
2018 LANDFILL CELL SITE LAYOUT MAP



**SELECT FILL WAS PLACED IN 8"
MAX LIFTS AND COMPACTED TO
95% OF STANDARD PROCTOR

COMPOSITE LINER AND LEACHATE COLLECTION DETAIL

NOT TO SCALE



PERFORATIONS FOR HDPE PIPE
FACTORY PERFORATED PIPE
WAS UTILIZED

LEACHATE REMOVAL SYSTEM DETAIL

NOT TO SCALE

AKRON CONSULTING, LLC.
431 N. CENTER ST.
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(F) 903-236-9745
www.akron-consulting.com

2018 LANDFILL
CELL DETAILS

2.2 – East Bottom Ash Pond Liner Certification, September 2016

Professional Engineer's Certification:

I certify that I have reviewed the design/construction records related to the CCR unit noted below or discussed the construction of such unit with personnel to attest that it was not constructed with a liner meeting the requirements of section 40 CFR 257.71 (a).

Southwestern Electric Power Company
Pirkey Power Plant, Hallsville, Texas
East Bottom Ash Pond

Shah Baig

Shahriyar S. Baig, P.E.
American Electric Power Service Corporation
Engineering Services

09-23-2016

STATE OF TEXAS
SHAHRIYAR S. BAIG
92172
LICENSED PROFESSIONAL ENGINEER

2.3 – West Bottom Ash Pond Liner Certification, September 2016

Professional Engineer's Certification:

I certify that I have reviewed the design/construction records related to the CCR unit noted below or discussed the construction of such unit with personnel to attest that it was not constructed with a liner meeting the requirements of section 40 CFR 257.71 (a).

Southwestern Electric Power Company
Pirkey Power Plant, Hallsville, Texas
West Bottom Ash Pond

Shah Baig

Shahriyar S. Baig, P.E.
American Electric Power Service Corporation
Engineering Services

09-23-2016

SHAHRIYAR S. BAIG
92172

2.4 – East Bottom Ash Pond Hazard Potential Classification Assessment, July 2021

Southwestern Electric Power Company
Pirkey Power Station
East Bottom Ash Pond

Hazard Potential Classification Assessment

AEP has performed an evaluation to classify the above CCR Surface Impoundment in accordance with FEMA's Hazard Potential Classification System for Dams. These guidelines evaluate the consequences of a potential failure not the likelihood of a failure. Guidelines that were developed and utilized are included below.

Hazard Potential Classification Systems (from FEMA 333, April 2004)

1. **Low Hazard Potential**
   Dams assigned the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
2. **Significant Hazard Potential**
   Dams assigned the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
3. **High Hazard Potential**
   Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life.

The AEP H.W. Pirkey Power Station is located at 2400 FM 3251, Hallsville, TX 75650. The plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas.

The East Bottom Ash Pond is located at the north end of the Plant and approximately 2,000 feet north-northwest of Brandy Branch Reservoir. Loss of human life is not probable in the event of a catastrophic failure of the embankment and a failure of the embankment is expected to have a low economic and environmental impact. The US EPA CCR Impoundment Assessment Report has listed this ash pond as Low Hazard.

There has been no changes in classification by the State Dam Safety nor has there been any other physical changes that would warrant a change in the classification.

Based on the FEMA Hazard Potential Classification Systems for Dams and on the above discussion, Pirkey East Bottom Ash Pond Dam is classified as a **Low Hazard Potential Dam**.

Professional Engineer's Certification:

I certify that this Hazard Potential Classification Assessment is in accordance with the requirements of section 30 TAC 352.731.

Gary F. Zych, P.E.

Gary F. Zych
7/29/2021

GARY F. ZYCH
127152

2.5 – History of Construction, East and West Bottom Ash Pond Complex, October 2016

HISTORY OF CONSTRUCTION

CFR 257.73(c)(1)

East & West Bottom Ash Pond Complex

Pirkey Plant
Hallsville, Texas

October, 2016

Prepared for: AEP/SWEPCO - Pirkey Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

GERS – 16 – 032

Table of CONTENTS

Attachments

- Attachment A – Location Map
- Attachment B – Design Reports
- Attachment C – Design Drawings
- Attachment D – Instrumentation Location Map
- Attachment E – Hydrology and Hydraulic Report

1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of CCR 257.73(c)(1) with an evaluation of the facility.

2.0 DESCRIPTION OF CCR THE IMPOUNDMENT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas.
It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for storing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP).

The East BAP is located directly adjacent to and east of the West BAP. The East BAP receives sluiced bottom ash and has a surface area of 30.9 acres and a storage capacity of 188 acre-feet. The pond is almost entirely incised, with a reported maximum embankment height of 4 feet.

The West BAP, which also receives sluiced bottom ash, is located northwest of the main plant buildings and shares its eastern border with the western border of the East BAP. The West BAP receives sluiced bottom ash and has a surface area of 30 acres and a storage capacity of 188 acre-feet. The maximum embankment height is 25 feet. Design material include in the provided documentation indicate that the main upstream embankment slopes are 3 feet horizontal to 1 foot vertical (3:1 H:V); while the main downstream slopes area 2.5:1 H:V.

3.0 SUMMARY OF OWNERSHIP 275.73(c)(1)(i)

[The name and address of the person(s) owning or operating the CCR unit: the name associated with the CCR unit: and the identification number of the CCR unit if one has been assigned by the state.]

The AEP H.W. Pirkey Power station is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The Plant Power Station Address is 2400 FM 3251, Hallsville, Texas . It is owned and operated by Southwestern Electric Power Company (SWEPCO). The facility Bottom Ash Complex operates two surface impoundments for storing CCR and a clear water pond for decant water.

4.0 LOCATION OF THE CCR UNIT 275.73 (c)(1)(ii)

[The location of the CCR unit identified on the most recent U.S. Geological Survey (USGS) 7 ½ minute or 15 minute topographic quadrangle map, or a topographic map of equivalent scale if a USGS map is not available.]

A location map is included in Attachment A.

5.0 STATEMENT OF PURPOSE 275.73 (c)(1)(iii)

[A statement of the purpose for which the CCR unit is being used.]

The Bottom Ash Pond Complex is a surface impoundment for storing CCR. The Bottom Ash Ponds within the complex are used for primary settling and storage of bottom ash. The decant water from the Bottom Ash ponds flow s into a secondary pond that provides storage of decant water.

6.0 NAME AND SIZE OF WATERSHED THE CCR UNIT IS LOCATED 275.73 (c)(1)(iv)

[The name and size in acres of the watershed within which the CCR unit is located.]

The Pirkey East BAP and West BAP are comprised of diked embankments on all sides which direct stormwater away from the impoundment and limit runoff to that which falls directly on the water surface. Therefore, the areas surrounding the impoundments do not contribute any runoff. The watershed for the ponds is equal to the surface areas of the ponds and is approximately 61 acres.

The bottom ash ponds are located within the Region 12 - Texas Gulf Region Watershed and are part of the sub group HUC = 12010002 Middle Sabine watershed area. The area is approximately 1770009.6 acres.

7.0 DESCRIPTION OF THE FOUNDATION AND ABUTMENT MATERIALS 275.73(c)(1)(v)

[A description of the physical and engineering properties of the foundation and abutment materials on which the CCR unit is located.]

The foundaion materials for the East BAP are native soils which consist of stiff to very stiff sandy lean clay (CL) and sandy fat clay (CH) with intermittent layers of medium dense to dense silty sand (SM) and clayey sand (SC). Atterburg Plasticity Indices of tested soils ranged between a low of 16 to a high of 39.

The foundation materials for the West BAP are native soils which consist primarily of medium dense to very dense clayey sand (SC) with layers of of dense clayey gravel (GC) and very dense silty clayey sand (SC-SM). Atterburg Plasticity Indices of tested soils ranged between a low of 9 to a high of 46. The engineering properties of the foundation soils had a cohesion that ranged between 290 psf and 430 psf and a friction angle that ranged between 17 degrees and 28 degrees. Additioanl details on the engineering properties of the foundaiton soils is in the design reports presented in Attachment B.

8.0 DESCRIPTION OF EACH CONSTRUCTED ZONE OR STAGE OF THE CCR UNIT 275.73 (c)(1)(vi)

[A statement of the type, size, range, and physical and engineering properties of the materials used in constructing each zone or stage of the CCR unit; and the approximate dates of construction of each successive stage of construction of the CCR unit.]

The East BAP is primarily incised into native soils with an embankment height of approximately 4 feet (AMEC, 20110). The East BAP embankments are constructed of compacted clay on a 3:1 slope (3 feet horizontal, 1 foot vertical) (Sargent & Lundy, 1983). The embankment soils are stiff to very stiff sandy lean clay (CL) and sandy fat clay (CH) with intermittent layers of medium dense to dense silty sand (SM) and clayey sand (SC). The elevation of the top of embankment around the perimeter of the East BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, May 2011). The interior bottom elevation of the East BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Johnson & Pace, June 2011. A copy of the referenced design documents and design drawings are presented in attachment B & C.

The West BAP embankments have maximum height of approximately 25 feet and are constructed of compacted clay on a slope ranging from 2.5:1 (2.5 feet horizontal, 1 foot vertical) to 3:1 (Sargent & Lundy). The elevation at the top of the embankment around the perimeter of the West BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, 2011). The embankment fill materials are stiff to very stiff lean clay (CL) and/or fat clay (CH), overlying native soils consisting of dense to very dense clayey sand (SC) with intermittent layers of dense gravel (GC) and very dense silty clayey sand (SC-SM). The interior bottom elevation of the West BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Akron Consulting, 2012). The engineering properties of embankment soils had a cohesion of 590 psf and a friction angle of 16 degrees. Additioanl details on the engineering properties of the foundaiton soils is in the design reports presented in Attachment B.

A copy of the referenced design documents and design drawings are presented in attachment B & C.

9.0 ENGINEERING STRUCTURES AND APPURTENANCES, 275.73 (c)(1)(vii)

[At a scale that details engineering structures and appurtenances relevant to the design, construction, operation, and maintenance of the CCR unit, detailed dimensional drawings of the CCR unit, including a plan view and cross sections of the length and width of the CCR unit, showing all zones, foundation improvements, drainage provisions, spillways, diversion ditches, outlets, instrument locations, and slope protection…]

The bottom ash from the plant is sluiced to the Ash Ponds using sluice pumps that convey the ash slurry through a pipeline which discharges the slurry into the middle of the pond. The slurry is sluiced at the rate of 3,000 gallons per minute (GPM) per pump. During normal operations only one pump is used at a time. The bottom ash settles, and the decant water is discharged from the Ash Ponds using either a portable pump or by overflowing into the Secondary Pond through a vertical box weir structure that contains a 36-inch diameter corrugated metal pipe (CMP) and manually operated gate valve. Additional discharge outlets convey relatively minor quantities into the ponds, including the boiler blowdown outlet which conveys about 35 GPM to the Secondary Pond. None of the ponds have a designated emergency spillway. The decant water from the Secondary Pond is re-used by pumping it out of the pond using the ash recirculation pumps (housed in a pump 4 house structure). Of the four recirculation pumps, only three are normally operated and convey average flows of about 2,000 GPM each. Flow to and from the ponds is balanced by conveying the water from the recirculation pumps to a suction tank that is used by the sluice pumps to remove the ash from the boiler and then return it to the Ash Ponds. A permitted outfall valve is located near the southwest corner of the Secondary Pond and discharges into a runoff ditch on the south side of the pond that eventually conveys water to Hatley Creek. The gate valve is typically closed.

For location and details of all appurtenances see design drawings presented in Attachment C and for a map of the instrumentation locations see Attachment D.

10.0 SUMMARY OF POOL SURFACE ELEVATIONS, AND MAXIMUM DEPTH OF CCR, 275.73 (c)(1)(vii)

[…in addition to the normal operating pool surface elevation and the maximum pool elevation following peak discharge from the inflow design flood, the expected maximum depth of CCR within the CCR surface impoundment.]

The table below describes the normal pool elevations and maximum pool elevations as well as maximum depth of CCR within the impoundment. The Inflow Design Flood is the 100-year storm event.

	West Bottom Ash Pond	East Bottom Ash Pond
Normal Pool Elevation	354.0	354.0
Maximum Pool Elevation following peak discharge from inflow design flood	355.01	354.99
Expected Maximum depth of CCR within impoundment	7.5 ft	7.5 ft

11.0 FEATURES THAT COULD ADVERSELY AFFECT OPERATION DUE TO MALFUNCTION OR MIS-OPERATION (275.73 (c)(1)(vii))

[…and any identifiable natural or manmade features that could adversely affect operations of the CCR unit due to malfunction or mis-operation]

In the event of malfunction or mis-operation of any of the pond’s appurtenances the ponds operations could be adversely affected. These structures include weir structures and piping between pond cells, low water discharge gated structures, gated weir structures, effluent return piping and pump structures and influent sluicing piping and structures. See design drawings in Attachment C for location and details of all appurtenances.

<u>12.0</u> DESCRIPTION OF THE TYPE, PURPOSE AND LOCATION OF EXISTING INSTRUMENTATION 275.73 (c)(1)(viii)

[A description of the type, purpose, and location of existing instrumentation.]

The East BAP has no instrumentation.

The West BAP has 2 piezometers located within the structure of the dam. These piezometers are read every 30 days for the purpose of determining the phreatic water level within the dike. A location map is provided in Attachment D.

<u>13.0</u> AREA – CAPACITY CURVES FOR THE CCR UNIT 275.73 (c)(1)(ix)

[Area-capacity curves for the CCR unit.]

The area capacity curves for the Bottom Ash Pond Complex are included in the Hydrology and Hydraulic Analysis Report by Aukland, 2015 in Attachment E.

<u>14.0</u> 275.73 (c)(1)(x) DESCRIPTION OF EACH SPILLWAY AND DIVERSION

[A description of each spillway and diversion design features and capacities and calculations used in their determination.]

Complete details of each spillway structure are included with the design drawings in Attachment C. Hydrology and Hydraulic Analysis which include calculations for each spillway structure are included in Attachment E.

The surface water elevation in the East BAP is controlled by a weir box and a manually operated gate valve on a 36-inch diameter discharge pipe at the southwest corner of the pond. Clear water overflow from the East BAP discharges through the 36-inch diameter pipe into a 2.7 acre Clearwater Pond located directly south of the East BAP. Water in the Clearwater Pond is either pumped (re-circulated) back into the boiler ash hopper, or gravity discharged through a pipe at the southwest corner of the Clearwater Pond into an unnamed intermittent tributary of Hatley Creek via outfall 006 in accordance with Texas Pollutant discharge Elimination system (TPDES) Permit no. WQ0002496000.

The surface water elevation in the West BAP is controlled by a weir box and a manually operated gate valve on a 36-inch-diameter discharge pipe at the southeast corner of the pond. Clear water overflow from the West BAP discharges through the 36-inch diameter pipe into a 2.7 acre Clearwater Pond located southeast of the West BAP. Water in the Clearwater Pond is either pumped (re-circulated) back into the boiler ash hopper, or gravity discharged through a pipe at the southwest corner of the Clearwater Pond into an unnamed intermittent tributary of Hatley Creek via outfall 006 in accordance with Texas Pollutant discharge Elimination system (TPDES) Permit no. WQ0002496000.

<u>15.0</u> SUMMARY CONSTRUCTION SPECIFICATIONS AND PROVISIONS FOR SURVEILLANCE, MAINTENANCE AND REPAIR 275.73 (c)(1)(xi)

[The construction specifications and provisions for surveillance, maintenance, and repair of the CCR unit.]

Readily available portions of the original construction specifications are included in Appendix B.

As required by the CCR rules the East and West Bottom Ash Ponds are inspected at least every 7 days by a qualified person. Instrumentation data is collected at least every 30 days and reviewed by AEP Engineering Services. Also as a requirement of the CCR rules the impoundment is also inspected annual by a professional engineer.

If repairs are found to be necessary during any inspection they will be completed as needed.

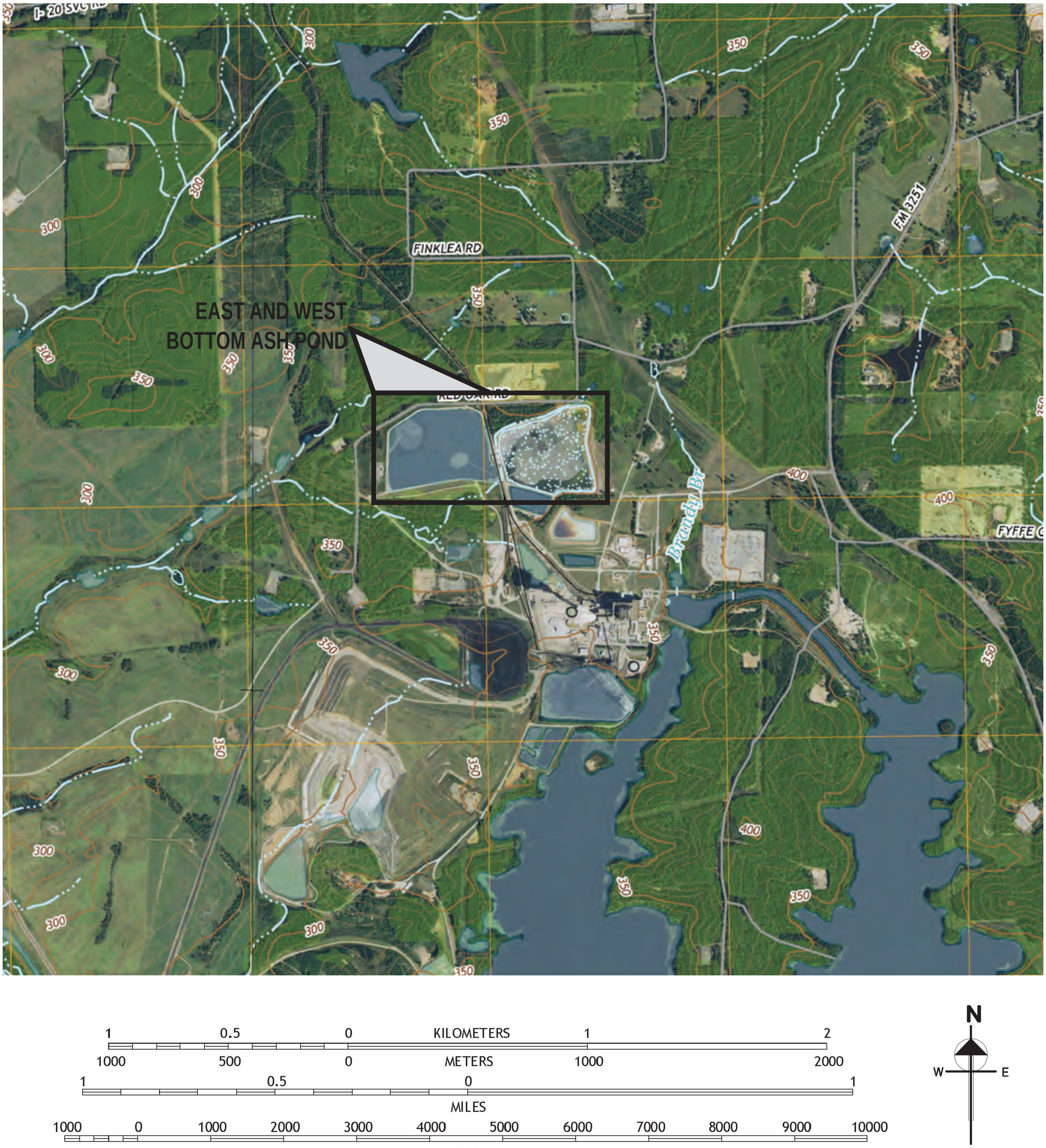
16.0 RECORD OR KNOWLEDGE OF STRUCTURAL INSTABILITY 275.73 (c)(1)(xii)

[Any record or knowledge of the structural instability of the CCR unit.]

To date there has been no known record of knowledge of the structural instability of the CCR unit.

ATTACHMENT A

LOCATION MAP



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SOUTHWESTERN ELECTRIC POWER CO

HENRY W. PIRKEY

SOUTH HALLSVILLE TEXAS

EAST/WEST BOTTOM ASH POND

USGS TOPO MAP

7.5-MINUTE SERIES

UNIT: 1

DRAWING NUMBER: LOCATION MAP

REV: 1

SCALE: 1"=2000'

CIVIL ENGINEERING

DR:

CH:

SUP:

ENG:

DATE: 10/12/16

AEP AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

ATTACHMENT B

DESIGN REPORTS

HENRY W. PIRKEY POWER PLANT

DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES

REPORT PREPARED FOR

SOUTHWESTERN ELECTRIC POWER COMPANY

JANUARY 31, 1983

TABLE OF CONTENTS

LIST OF EXHIBITS

HENRY W. PIRKEY POWER PLANT
DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES

SOUTHWESTERN ELECTRIC POWER COMPANY

I INTRODUCTION

This report is prepared by Sargent & Lundy (S&L) at Southwestern Electric Power Company's (SWEPCO) request to summarize the design of the lignite storage area and the wastewater pond facilities with regard to technical guidelines and requirements of the Texas Department of Water Resources (TDWR). The technical guidelines referenced in this report are Technical Guide Nos. 4 and 6 titled Ponds and Lagoons, and Monitoring/Leachate Collection Systems respectively. Guide No. 4 was revised March 1, 1978 and Guide No. 6 March 21, 1980. We understand that the TDWR has the responsibility of preparing and issuing document approval for disposal of wastes. Requirements concerning waste storage and disposal and concerning the design, construction, and monitoring of wastewater pond facilities are discussed in this report.

The wastewater pond facilities discussed in this report and shown in Exhibit 1 are the lignite pile runoff basin, surge pond, two bottom ash storage basins, secondary settling pond, and the metal cleaning waste pond. Discussion of other waste treatment facilities such as the sanitary sewage treatment plant, the cooling pond, and the final treated Flue Gas Desulfurization (FGD) sludge disposal site are not within the scope of this report and, therefore, not included.

II SUMMARY AND CONCLUSIONS

Based on the evaluation of the site subsurface soil and water conditions, it is concluded that the design of the Henry W. Pirkey wastewater ponds conforms with the technical guidelines and requirements of the TDWR.

Nine groundwater monitoring wells will be located adjacent to the wastewater ponds. These wells will be designed and installed to requirements equal to or exceeding those suggested by the TDWR.

A summary of design guidelines and requirements suggested by the TDWR and those used for design of the Henry W. Pirkey wastewater ponds is given in Exhibit 2.

III DESIGN OF LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES

A. General

The general site layout is shown in Exhibit 1. The plant water usage and waste water scheme is shown on Exhibit 3. The lignite storage area, lignite pile runoff basin, metal cleaning waste pond, and surge pond have been sized to accommodate two units. Each bottom ash basin will accommodate storage of hydraulically placed ash for two units for 6 months. When one bottom ash basin is filled, storage will begin in the second basin while the first basin is being emptied and readied for reuse. The in-service bottom ash basin will also receive the discharge from the ash hopper pit sump pumps.

Effluent from the bottom ash basins will discharge to the secondary settling pond. Blowdown from the main and auxiliary boilers will also be routed to the secondary pond. Water collected in the secondary settling pond will be recirculated back to the plant to transport bottom ash. Excess water is pumped to the waste water treatment plant for treatment prior to release.

Drainage from the lignite and limestone storage areas and handling systems will be collected via ditches and routed to the lignite pile runoff basin. The contents of the lignite pile runoff basin will normally not require more treatment than sedimentation. Once the suspended solids are within acceptable limits, the basin contents will be discharged to the cooling pond by means of a sluice gate. If treatment other than gravity settling is required, the contents of the lignite pile runoff basin will be pumped to the wastewater treatment plant prior to release.

The surge pond is divided into two sections: the main surge pond and an auxiliary surge pond. The auxiliary surge pond is a collection and settling pond for scrubber waste slurry, either from the FGD system waste slurry pumps, thickener underflow pumps, or filtrate overflow sump pumps. These slurry flows will be routed to the auxiliary surge pond only under emergency conditions and allowed to thicken by gravity settling. The sludge formed when the slurry thickens will be removed by front end loader and conveyed to the sludge treatment system for stabilization. The water decanted from the thickened slurry, and not evaporated, will drain to the surge pond. In emergencies, the auxiliary surge pond overflows to the surge pond.

The main surge pond is a collection basin for various FGD waste streams. Drains, overflows, backwash, blowdown, and surface drainage from the FGD system will drain to the surge pond. The reclaim water sump will overflow to the surge pond.

Rainwater runoff from the sludge truck load out area, from under the sludge conveyors, and from the sludge reclaim area will drain to the surge pond by gravity. The water decanted from the auxiliary surge pond will drain to the surge pond. The collected water in the surge pond will be pumped to the thickeners for removal of sediment and used as make-up for the SO_2 scrubbers. Drainage entering the surge pond will not leave the plant except as makeup to the scrubbers, as water hydrated with the stabilized FGD sludge, or through evaporation.

Waste from air heater wash, precipitator wash and boiler chemical cleaning is discharged to the metal cleaning pond for storage. This pond is designed to accommodate all the wastewater containing heavy metals generated in 24 hours by cleaning all the three air heaters associated with one unit. Water collected in the metal cleaning waste pond will be pumped to the waste water treatment system for processing before being discharged to the cooling pond.

B. Lignite Storage Area and Runoff Basin Design

The location and layout of the lignite storage area and lignite pile runoff basin are shown on Exhibit 1. Five borings have been drilled in this area and their locations are shown on Exhibits 4 and 5. Copies of the boring logs are included in Appendix A. Based on the results of the boring data, the lignite storage area and lignite pile runoff basin are located over surface soil deposits of dense silty sand and sandy silt (SM and ML Unified Soil Classification). A summary of the laboratory test results on samples from these borings is given in Exhibit 6. All soil borings and soil laboratory test results given in this report, with the exception of Boring B14, have been drilled and tested by NFS/National Soil Services, Inc., Dallas, Texas. Boring B14 was drilled and tested by East Texas Testing Laboratory, Inc., Tyler, Texas. Complete laboratory index property and permeability test results for all samples from borings located in or near wastewater pond facilities are included in Exhibit 6. Also included for reference are index property and permeability values for various types of soils from other onsite borings.

The lignite pile runoff basin is an above and below ground pond designed to store lignite pile and limestone pile runoff. Plan and cross sections are shown in Exhibit 5. The lignite storage pile will be underlain by two feet of compacted cohesive fill (SC, CL, and CH Unified Soil Classification). The drainage ditches transporting runoff from the storage area to the basin will be lined with minimum 18 inches of compacted cohesive fill. The runoff basin will be lined on the bottom and side slopes with a minimum three feet of compacted cohesive fill. The dike fill, including lining, will be compacted as specified to a minimum 95 percent maximum density in accordance with ASTM D698. These requirements are in accordance with the guidelines suggested by the TDWR for wastewater ponds.

A summary of the parameters used for the lignite pile runoff basin design in comparison to those parameters and guidelines suggested by the TDWR is given in Exhibit 2. The runoff basin design parameters equal or exceed the minimum recommended values except for depth to the water table. Average or median parameter values are given where several individual tests or measurements were made. The only suggested parameter not obtainable is the TDWR recommendation that the bottom of the basin be 10 feet above the water table. The water table varies throughout the site, and with normal pool of the cooling pond at elevation 340.0 ft., it is possible that the static water table may be located within 3 feet of the bottom of the clay lining of any of the plant's wastewater ponds. Despite this, the presence of relatively homogeneous impermeable in situ and compacted clay layers should provide sufficient lining and protection of the groundwater.

Compacted clay linings are required on the bottom and side slopes of the lignite pile runoff basin and beneath the lignite storage pile. Project specifications require these compacted linings to be cohesive soils with minimum 40% passing the no. 200 sieve and having a minimum plasticity index of 15. The linings are to be compacted to minimum 95% maximum density in accordance with ASTM D698. The permeability of the compacted linings is estimated to be less permeable than or equal to 1.0×10^{-7} cm/sec. This will be verified by SWEPCO by testing field samples in the laboratory during or after construction.

C. Surge Pond Design

The location and layout of the surge pond are shown on Exhibit 1. Four borings have been drilled in this area and their locations are shown on Exhibits 4 and 7. Copies of the boring logs are included in Appendix A. Based on the results of the boring data, the surge pond is located within or above a thick surface deposit of silty and sandy clay (CL and CH Unified Soil Classification). The thickness of the in situ clay soils below the bottom of the pond (approximately elevation 350 ft) ranges from two and one half to 16 feet. A summary of the laboratory test results on samples from the surge pond borings is given in Exhibit 6.

The surge pond (including auxiliary surge pond) is an above and below ground pond. Dikes and excavated slopes are designed with three horizontal to one vertical side slopes. Dike fill will be cohesive soil compacted to a minimum 95 percent maximum density in accordance with ASTM D698. Typical surge pond cross sections are shown on Exhibit 7.

In situ cohesive soils will be used to function as the pond lining. Verification of the quality and thickness of the in situ lining will be made during or after construction by SWEPCO. As previously stated, the borings indicate that the thickness of the in situ lining ranges from approximately two and one half to 16 feet. Any compacted cohesive linings required will meet the density, index property, and permeability requirements as given for the lignite runoff basin.

Exhibit 2 summarizes the TDWR suggested parameters and guidelines and those parameters used for the surge pond design. Comparison of the design parameters obtained and those suggested indicate that in almost every case the obtained parameters equaled or exceeded the suggested value. The only suggested parameter not obtainable is the recommended 10 ft. depth to the groundwater table. It is possible that the groundwater table could eventually be located within 3 ft. of the bottom of the clay lining of the pond, as previously discussed.

Six laboratory permeability tests were performed on samples of undisturbed clay soil from the surge pond area. Results are given in Exhibit 8 and indicate a median permeability value of 5.1×10^{-8} cm/sec. The permeability test values ranged from 2.1×10^{-6} cm/sec. to 7.4×10^{-9} cm/sec.

D. Bottom Ash Basin and Secondary Pond Design

The location and layout of the bottom ash basins and secondary pond are shown on Exhibit 1. Plan and cross sections are shown in Exhibit 9. Nine borings have been drilled in this area. Their locations are given in Exhibits 4 and 9. Copies of the boring logs are included in Appendix A. Based on the results of the boring data, the secondary pond, bottom ash basin no. 1 and the east half of bottom ash basin no. 2 are located within or above a thick surface deposit of silty and sandy clay. These soils are classified as SC, CL, and CH material. A summary of the laboratory test results on samples from those borings is given in Exhibit 6. Results of approximately 23 tests on cohesive soils representing in situ lining indicate average fines content and plasticity index values of 78% and 36, respectively. These values significantly exceed the minimum values suggested by the TDWR.

Bottom ash basin no. 1 is an above and below ground pond located entirely in a cohesive soil deposit. The thickness of the cohesive soil below the bottom of the pond is greater than 5 feet. The plan and cross sections are given in Exhibit 9. A compacted clay lining is shown and will be used where required. In situ lining of acceptable quality and thickness exist in most of the area. This will be verified in the field during construction by SWEPCO. Shallow borings, test pits, and laboratory testing will be performed as necessary.

Bottom ash basin no. 2 is also an above and below ground pond.

A portion of this pond (west half) will require a minimum three feet thick compacted clay lining. The location where an acceptable in situ lining does not exist and where the compacted lining begins will be determined and verified in the field by SWEPCO.

The secondary pond has a bottom elevation of 344 feet. This is three feet or more below the lowest point in either bottom ash basin. During borrow excavation and construction of the embankment, the existing clay may be completely removed from areas within the pond. Where this occurs, a three foot thick compacted clay lining will be installed to the requirements of project specifications and the technical guidelines suggested by the TDWR. This will be verified in the field by SWEPCO.

Exhibit 2 summarizes the TDWR parameters and guidelines and those parameters used for the design of the bottom ash basins and the secondary pond. As indicated in Exhibit 2, the design parameters meet or exceed nearly all of the suggested values. The only suggested parameter not obtainable is the recommended depth to the groundwater table as previously discussed. The median permeability from ten laboratory tests on samples of in situ cohesive soils (generally CH classification) is approximately $7.5x10^{-9}$ cm/sec. The permeability of clay soils used for compacted cohesive linings (SC, CL, and CH classification) is estimated to be less than or equal to $1.0x10^{-7}$ cm/sec. The permeability of the compacted lining will be verified by

SWEPCO by testing field samples in the laboratory during and after construction.

E. Metal Cleaning Waste Pond

The location and layout of the metal cleaning waste pond are shown on Exhibit 1 and 10. The pond lies between the surge pond and the bottom ash basins. Borings located near the metal cleaning waste pond are shown in Exhibit 4. Review of the boring data indicates that the pond is located within or above a thick surface deposit of silty and sandy clay. Evaluation of the boring data is similar to that of the bottom ash basins.

The metal cleaning waste basin is an above and below ground pond. Plan and cross sections are given in Exhibit 10. The pond will require a minimum three feet thick clay lining where sufficient in situ clay does not exist at the design elevation. SWEPCO will verify the quality and acceptability of the lining, whether in situ or compacted.

IV GROUNDWATER MONITORING PROGRAM

Nine groundwater monitoring wells are to be installed at locations adjacent to the wastewater pond facilities. The wells will be installed after completion of pond construction. The approximate locations of these wells are given in Exhibit 12.

Four-inch diameter monitoring wells will be used because they permit use of a portable submersible pump for obtaining samples for water quality analysis. Each slotted screen for each well will be located in the most permeable soils occurring below the water table. A soil boring will be drilled at each well location to accurately define the soil strata adjacent to the well and to finalize the location and design of the well. The soils are very dense and range from a medium fine sand and silty sand to clayey sand and silty clay. The length of the screens have not yet been determined but are expected to range from 15 to 25 feet.

Technical Guide No. 6, published by the TDWR, presents guidelines for design and installation of monitoring wells. The H. W. Pirkey monitoring wells will equal or exceed these guidelines.

The groundwater monitoring program will consist of measuring and recording groundwater levels and obtaining samples for water quality analysis. The frequency for measuring levels and obtaining samples has not yet been determined. Measurements and samples will be obtained by SWEPCO and should begin at least two years before the power plant begins operation. This will allow for sufficient background data against which to compare all subsequent measurements and analyses of samples taken at the site.

STATE OF TEXAS
KENNETH T. KOSTAL

Kenneth T. Kostal

Sargent & Lundy, by

D. G. Bodine

D. G. Bodine
Supervisor,
Geotechnical Division

EXHIBIT 2

SUMMARY OF PARAMETERS SUGGESTED AS GUIDELINES AND PARAMETERS OBTAINED FOR DESIGN OF HENRY W. PIRKEY WASTEWATER PONDS

Parameter (1)	Suggested Guideline (1)	Parameter Values Used for Design of Pirkey Wastewater Ponds		
		Lignite Runoff Basin	Surge Pond	Bottom Ash Basins, Secondary Settling Pond and Metal Cleaning Waste Pond
Above Ground Dikes & Berms Fill Compaction Fill Classification (5) Fill Permeability Dike or Excavation Slopes	$C_r \geq 95\%$ Standard Proctor CL, CH, and SC $K \leq 1\times10^{-7}$ cm/sec 3H to 1V	Specified $C_r \geq 95\%$ CL, CH, and SC $Km \leq 1.0\times10^{-7}$ cm/sec(2) 3H to 1V	Specified $C_r \geq 95\%$ CL & CH $Km \leq 1.0\times10^{-7}$ cm/sec(2) 3H to 1V	Specified $C_r \geq 95\%$ CL & CH (lined Slope) $Km \leq 1.0\times10^{-7}$ cm/sec(2) 3H to 1V
Pond Compacted or Insitu Cohesive Lining Thickness Permeability, K	3 ft. $K \leq 1\times10^{-7}$ cm/sec	$\geq$ 3 ft. (compacted) $Km \leq 1.0\times10^{-7}$ cm/sec(2)	5 to 17 ft. (insitu) $Km \cong 5.1\times10^{-8}$ cm/sec(3)	3 to 17 ft. (insitu & compacted) $Km \leq 1.0\times10^{-7}$ cm/sec $Km \cong 7.5\times10^{-9}$ cm/sec (insitu)(4)
Liquid Limit, LL Plasticity Index, PI Fines Content, FC Classification	$LL \geq 30\%$ $PI \geq 15$ $FC \geq 30\%$ CL, CH, OH, and SC	$LL > 30\%$ $PI > 15$ $FC \geq 40\%$ CL, CH, & SC	average LL = 54% average PI = 36 specified $FC \geq 40\%$ CL & CH	average LL = 78% average PI = 36 average FC = 78% CL & CH
Below Ground Pond Permeability, K Liquid Limit, LL Plasticity Index, PI Fines Content, FC Classification	$K \leq 1\times10^{-7}$ cm/sec $LL \geq 30\%$ $PI \geq 15$ $FC \geq 30\%$ CL, CH, OH, and SC	Below ground area of pond will be lined with 3 ft. of compacted cohesive material CL & CH material	Values given above are representative of insitu cohesive soils	Values given above are representative of insitu cohesive soils. Compacted lining 3 ft. in thickness will be placed where required
Groundwater Monitoring Well Depth to Water Table Below Pond	Yes, Required 10 ft. Recommended	Two 4 in. Diameter Gravel Pack Wells Approximately 3 ft., See Report Text	Two 4 in. Diameter Gravel Pack Wells Approximately 3 ft., See Report Text	Two and Five 4 in. Diameter Gravel Pack Wells for Metal Cleaning Waste Pond and Bottom Ash Basins, respectively. Approximately 3 ft., See Report Text

NOTES:

(1) Parameters and Guidelines given are suggestions stated in the Texas Department of Water Resources Technical Guides No. 4 revised March 1, 1978, and No. 6 revised March 21, 1980.

(2) Estimated. To be verified by SWEPCo during or after construction.

(3) Median permeability from six tests on undisturbed cohesive soil samples.

(4) Median permeability from ten tests on undisturbed soil cohesive soil samples.

(5) Classification symbols used in this Exhibit are in accordance with the Unified Soil Classification System and ASTM D2487.

(6) Standard Proctor Test performed in accordance with ASTM D698.

SUMMARY OF LABORATORY TEST RESULTS ON SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE AREA AND WASTEWATER POND DESIGN (1)

Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (°/o Passing) (2)				Atterberg Limits (3)			Unified Soil Classification Symbol	Field Water Content (°/o)(4)	Dry Density lbs/ft^3	Laboratory Permeability cm/sec
		No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Liquid Limit (°/o)	Plastic Limit (°/o)	Plasticity Index				
B-14, J-2	3.0-4.5					38	18	20	CL	22.0		
T-4	9.5-11.0					56	26	30	CH	35.9	91.9	
J-5	13.0-14.5					51	22	29	CH	29.8		
J-6	18.0-19.5					28	22	6	SM-SC	26.6		
J-7A	23.0-24.0					25	21	4	SM-SC	29.6		
P-108, Bag 1	0-1.0					38	14	24	CL			
Bag 2	1.0-3.5								CL			
T-3	3.5-5.0					65	21	44	CH	26.9	98.8	$3.2x10^{-8}$ (5)
T-4	8.5-10.0					45	17	28	CH	21.7	101.7	$2.6x10^{-7}$ (5)
J-5	13.5-15.0					76	21	55	CH	35.7	87.9	
J-6	13.5-15.0								CH			
J-7	13.5-15.0								CH			
J-8	18.5-20.0								CH			
J-9	18.5-20.0					73	23	50	CH	32.0		
J-10	18.5-20.0								CH			
J-11	23.5-25.0					51	20	31	CH			
J-12	23.5-25.0								SC			
J-13	23.5-25.0								SC			
J-14	28.5-30.0								SC			
J-15	28.5-30.0				37				SC	30.2		
J-16	28.5-30.0								SC			
J-17	33.5-35.0								SC			
J-18	33.5-35.0				33				SC	25.6		

NOTES:

(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas Texas for OW and P-Series Borings. Laboratory testing performed by East Texas Testing Laboratory, Inc., Tyler, Texas for B-Series Borings.

(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and ASTM D1140.

(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and ASTM D424.

(4) Moisture Content of Soils performed in accordance with ASTM D2216.

(5) Laboratory Permeability Test performed on undisturbed Shelby tube sample. Sample tested in oedometer using Falling Head Test procedure in accordance with EM 1110-2-1906.

SUMMARY OF LABORATORY TEST RESULTS ON SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE AREA AND WASTEWATER POND DESIGN (1)

(continued)

		Particle Size Analysis (°/o Passing) (2)				Atterberg Limits (3)						
Boring No. Sample No.	Sample Depth, Ft	No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Liquid Limit (°/o)	Plastic Limit (°/o)	Plasticity Index	Unified Soil Classification Symbol	Field Water Content (°/o) (4)	Dry Density lbs/ft^3	Laboratory Permeability cm/sec
P-108, J-20	38.0-39.5								SM	25.0		
J-21	43.5-45.0								SM			
J-23	43.5-45.0					30	11	19	SC	18.6		
J-24	48.5-50.0					34	18	16	SC	19.8		
J-25	53.0-54.5					19	12	7	SM-SC	20.3		
J-26	58.0-59.5								SC			
J-27	58.0-59.5					28	13	15	SC	22.2		
P-109, Bag 1	0-1.0								SC			
Bag 2	1.0-3.5								SC			
T-3	3.5-5.0					51	20	31	CH	20.9	105.7	$4.8x10^{-8}$ (5)
T-4	8.5-10.0					74	23	51	CH	33.1	89.3	$7.4x10^{-9}$ (5)
J-6	13.5-15.0								CH			
J-7	13.5-15.0					73	20	53	CH	29.8		
J-10	18.5-20.0					63	19	44	CH	27.7		
J-11	18.5-20.0											
J-12	23.5-25.0		87	84	38				SC	25.1		
J-13	23.5-25.0											
J-16	28.5-30.0		91	87	44				SC	27.7		
J-18	33.5-35.0								CH	37.0		
J-19	33.5-35.0											
J-20	38.5-40.0		100	98	23				SC	22.2		
J-21	38.5-40.0											

NOTES:
(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas, Texas for OW and P-Series Borings.
(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and ASTM D1140.
(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and ASTM D424.
(4) Moisture Content of Soils performed in accordance with ASTM D2216.
(5) Laboratory Permeability Test performed on undisturbed Shelby tube sample. Sample tested in oedometer using Falling Head Test Procedure in accordance with EM 1110-2-1906.

SUMMARY OF LABORATORY TEST RESULTS ON SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE AREA AND WASTEWATER POND DESIGN (1)

(continued)

Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (^{o}/o Passing) (2)				Atterberg Limits (3)			Unified Soil Classification Symbol	Field Water Content (^{o}/o)(4)	Dry Density lbs/ft^3	Laboratory Permeability cm/sec
		No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Liquid Limit (^{o}/o)	Plastic Limit (^{o}/o)	Plasticity Index				
OW-9, Bag 1	0-1.0								CL			
Bag 2	1.0-3.5								CL			
T-1	3.5-5.0								CL			
T-2	7.0-8.5		100	99	51	39	15	24	CL	13.2	110.9	
T-3	9.5-11.0								CL			
T-4	13.5-14.0		97	95	57	37	19	18	CL			2.07x10^{-6} (5)
J-5	15.5-16.5				15				SM	26.7		
J-6	18.5-19.5											
J-7	18.5-19.5					77	25	52	CH	33.6		
J-8	18.5-19.5											
J-9	23.5-25.0											
J-10	23.5-25.0		100	95	30				SC	22.3		
J-11	23.5-25.0											
J-12	28.5-30.0											
J-13	28.5-30.0		100	97	45				SC	18.9		
J-14	33.5-35.0											
J-15	38.5-40.0											
J-16	38.5-40.0		100	99	84				CL	20.8		
P-126, T-1	0-2.0		95	93	72	51	17	34	CH	13.0		
T-2	3.0-6.0		95	93	89	62	21	41	CH	25.3 19.3	101.6	5.84x10^{-9} (6) 3.07x10^{-9} (5)
T-3	6.0-8.0											
T-4	9.0-12.0		98	98	89	63	23	39	CH			7.12x10^{-9} (5)
J-5	13.5-15.0					45	20	25	CL	27.0		

NOTES:

(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas Texas for OW and P-series Borings.
(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and ASTM D1140.
(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and ASTM D424.
(4) Moisture Content of Soils performed in accordance with ASTM D2216.
(5) Laboratory Permeability Test performed on undisturbed Shelby tube sample. Sample tested in oedometer using Falling Head Test Procedure in accordance with EM 1110-2-1906.
(6) Laboratory Permeability determined using remolded sample. Sample tested in oedometer using Falling Head Test Procedure in accordance with EM 1110-2-1906.

Exhibit 6

SUMMARY OF LABORATORY TEST RESULTS ON SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE AREA AND WASTEWATER POND DESIGN (1)
(continued)

Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (°/o Passing) (2) No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Atterberg Limits (3) Liquid Limit (°/o)	Plastic Limit (°/o)	Plasticity Index	Unified Soil Classification Symbol	Field Water Content (°/o)(4)	Dry Density lbs/ft^3	Laboratory Permeability cm/sec
P-126, J-7	13.5-15.0											
J-8	18.5-20.0				59	41	22	19	CL	29.8		
J-10	18.5-20.0											
J-11	23.5-24.0				40				SM	28.5		
J-12	28.5-29.5				7				SM	26.7		
J-13	33.0-34.0					34	19	15	SC	22.7		
J-15	34.0-35.0		99	94	24				SC			
J-16	38.5-40.5								SC	19.4		
J-19	43.5-44.5				19				SC	26.6		
P-130, T-1	0-2.0								SM			
T-2	3.0-6.0		99	99	55	40	20	20	CL			$5.1x10^{-8}$ (5)
T-3	6.0-9.0								CL			
T-4	9.0-12.0		98	97	96	68	27	41	CH	33.2		$1.4x10^{-8}$ (5)
J-5	13.5-15.0								CH	31.6		
J-7	13.5-15.0											
J-8	18.5-20.0				34	37	21	16	SC	26.7		
J-10	18.5-20.0											
J-11	23.5-25.0				64	54	25	29	CH	25.4		
J-13	23.5-25.0											
J-14	28.5-30.0								SM	27.6		
J-16	33.5-40.0				29				SM	24.1		
J-18	43.5-45.0				25				SM	24.1		
J-22	48.5-50.0								SM	23.6		

NOTES:

(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas Texas for OW and P-series Borings.
(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and ASTM D1140.
(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and ASTM D424.
(4) Moisture Content of Soils performed in accordance with ASTM D2216.
(5) Laboratory Permeability Test performed on undisturbed Shelby tube sample. Sample tested in oedometer using Falling Head Test Procedure in accordance with EM 110-2-1906.

SUMMARY OF LABORATORY TEST RESULTS ON SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE AREA AND WASTEWATER POND DESIGN (1)
(continued)

Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (°/o Passing) (2) No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Atterberg Limits (3) Liquid Limit (°/o)	Plastic Limit (°/o)	Plasticity Index	Unified Soil Classification Symbol	Field Water Content (°/o)(4)	Dry Density lbs/ft³	Laboratory Permeability cm/sec
P-141, T-1	3.0-6.0		99	99	98	94	35	69	CH			9.5x10⁻¹⁰ (5)
T-2	9.0-12.0								SM			
T-3	15.0-18.0				98	74	25	49	CH			1.3x10⁻⁸ (5)
J-4	18.0-19.0					73	25	48	CH	33.0		
J-6	19.0-20.0		100	96	93				CH			
J-7	23.5-25.0				87	64	25	39	CH	16.6		
J-9	23.5-25.0											
J-10	28.5-30.0				77	56	28	28	CH	37.5		
J-12	28.5-30.0											
J-13	33.5-35.0				22				SM	28.7		
J-14	44.0-45.0								SC	22.3		
P-143, T-1	0-1.5									20.4		
T-2	1.5-3.0				75	59	19	40	CH	18.6		
T-3	3.0-5.5				89	72	23	49	CH	22.9	104.4	
T-4	5.5-8.0				97	49	18	31	CL	23.8	100.6	6.6x10⁻⁹ (5)
T-5	8.0-11.0				94	71	21	50	CH	22.6	104.4	7.79x10⁻⁹ (5)
T-6	11.0-12.5				37	30	15	15	SC	19.4		
J-8	13.5-15.0											
J-9	13.5-15.0				61				CH	23.9		
J-11	13.5-15.0											
J-12	18.5-20.0				19				SM	25.2		
J-14	23.5-25.0			99	26				SM	24.5		
J-17	28.5-30.0								SM	21.9		
J-20	33.5-35.0				25	35	16	19	SC	19.2		
J-22	33.5-35.0											
J-23	38.5-40.0			100	92				ML	24.0		

NOTES:

(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas, Texas for OW and P-Series Borings.
(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and ASTM D1140.
(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and ASTM D424.
(4) Moisture Content of Soils performed in accordance with ASTM D2216.
(5) Laboratory Permeability Test performed on undisturbed Shelby tube sample. Sample tested in oedometer using Falling Head Test Procedure in accordance with EM 1110-2-1906.

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SUMMARY OF LABORATORY TEST RESULTS ON SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE AREA AND WASTEWATER POND DESIGN (1)

(continued)

Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (°/o Passing) (2) No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Atterberg Limits (3) Liquid Limit (°/o)	Plastic Limit (°/o)	Plasticity Index	Unified Soil Classification Symbol	Field Water Content (°/o)(4)	Dry Density lbs/ft^3	Laboratory Permeability cm/sec
P-124, T1	3.0-6.0		99	98	77	44	17	27	CL	16.6		
T2	9.0-12.0											
J3	13.5-15.0		100	99	77	53	17	36	CH	24.8		
J5	18.5-20.0											
J7	18.5-20.0				22	26	12	14	SC	25.5		
J8	23.5-25.0									26.9		
J10	23.5-25.0											
J11	28.5-30.0									21.4		
J13	28.5-30.0											
J14	33.5-35.0				47	30	14	16	SC	20.6		
J16	33.5-35.0											
J17	38.5-40.0									24.3		
J19	43.5-45.0				39				SM	19.4		
P-138, T1	0-2.0								SM			
T2	3.0-6.0		94	90	30				SM	12.4		
T3	9.0-12.0					20			SM		110.7	
J4	13.5-15.0				29	33	12	21	SC	21.1		
J6	13.5-15.0											
J7	18.5-20.0									22.8		
J9	18.5-20.0											
J10	23.5-25.0				25				SM	23.9		
J12	28.5-29.5									20.4		
J13	33.5-35.0									18.7		
J14	43.5-45.0				98	77	40	37	CH	32.8		
J16	43.5-45.0											

NOTES:

(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas Texas for OW and P-Series Borings. Laboratory testing performed by East Texas Testing Laboratory, Inc., Tyler, Texas for B-Series Borings.

(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and D1140.

(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and ASTM D422.

(4) Moisture Content of Soils performed in accordance with ASTM D2216.

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SUMMARY OF LABORATORY TEST RESULTS ON
SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE
AREA AND WASTEWATER POND DESIGN (1)
(continued)

Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (°/o Passing) (2)				Atterberg Limits (3)			Unified Soil Classification Symbol	Field Water Content (°/o)(4)	Dry Density lbs/ft³	Laboratory Permeability cm/sec
		No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Liquid Limit (°/o)	Plastic Limit (°/o)	Plasticity Index				
OW-10, Bag 1	0-1.5											
Bag 2	1.5-3.0											
Bag 2A	3.0-3.5											
J-3	3.5-5.0				40	43	17	26	SC	23.0		
J-4	8.5-9.5	87	75	67	35	52	19	33	SC	26.6		
J-6	13.5-15.0				36				SC	31.1		
J-8	18.5-20.0									21.4		
J-10	18.5-20.0									26.6		
J-11	23.5-25.0		100	99	28				SM	22.8		
J-13	23.5-25.0											
J-14	28.5-29.5		99	99	45				SM	18.1		
J-16	33.5-35.0		100	100	97				ML	17.9		
J-18	33.5-35.0											
J-19	38.5-39.5	99	98	97	32				SM	25.3		
P-139, Bag 1	0-2.0											
Bag 2	2.0-3.5											
J-3	3.5-5.0											
J-4	3.5-5.0	96	92	89	35				SM	15.0		
J-5	3.5-5.0											
J-6	8.5-10.0											
J-7	8.5-10.0											
J-8	8.5-10.0				80	29	14	15	CL	23.6		
J-9	13.5-15.0											
J-10	13.5-15.0											
J-11	13.5-15.0		100	100	99	48	20	28	CL	21.5		

NOTES:
(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas, Texas for OW and P-Series Borings.
(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and ASTM D1140.
(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and ASTM D424.
(4) Moisture Content of Soils performed in accordance with ASTM D2216.

SUMMARY OF LABORATORY TEST RESULTS ON SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE AREA AND WASTEWATER POND DESIGN (1)

(continued)

Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (°/o Passing) (2)				Atterberg Limits (3)			Unified Soil Classification Symbol	Field Water Content (°/o)(4)	Dry Density lbs/ft^3	Laboratory Permeability cm/sec
		No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Liquid Limit (°/o)	Plastic Limit (°/o)	Plasticity Index				
P-139, J-12	18.5-20.0		100	100	68				ML	19.2		
J-13	18.5-20.0											
J-14	23.5-25.0											
J-15	23.5-25.0											
J-16	23.5-25.0				50				ML	16.3		
J-17	28.5-29.0	100	99	99	11				SP	23.1		
J-18	34.0-35.0											
J-19	34.0-35.0		100	100	46				SM	23.4		
J-20	38.5-39.0											
J-21	38.5-39.0		100	100	21				SM	21.8		
J-22	48.5-49.0				21				SM	25.8		
J-23	53.5-54.0				15				SM	22.4		
J-24	58.5-59.0									23.1		
J-25	63.5-64.0									24.6		
J-26	73.5-74.0											
J-27	73.5-74.0				30				SM	24.7		
J-28	78.5-79.0				83				ML	19.1		
J-29	88.5-90.0											
J-30	88.5-90.0											
J-31	88.5-90.0				100	44	20	24	CL	19.8		
J-32	93.5-95.0									24.8		
J-33	98.5-100.0											
J-34	98.5-100.0											
J-35	98.5-100.0				100	71	24	47	CH	24.8		
J-36	108.5-110.0									33.3		
J-37	118.0-119.0									33.5		
J-38	128.0-129.0											
J-39	128.0-129.0											
J-40	128.0-129.0				82	53	20	33	CH	21.4		
J-41	138.5-139.0											
J-42	138.5-139.0									69.1		
J-44	148.0-149.0									21.5		

NOTES:
(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas, Texas for OW and P-Series Borings.
(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and ASTM D1140.
(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and ASTM D424.
(4) Moisture Content of Soils performed in accordance with ASTM D2216.

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SUMMARY OF LABORATORY TEST RESULTS ON SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE AREA AND WASTEWATER POND DESIGN (1)

(continued)

Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (°/o Passing) (2)				Atterberg Limits (3)			Unified Soil Classification Symbol	Field Water Content (°/o)(4)	Dry Density lbs/ft^3	Laboratory Permeability cm/sec
		No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Liquid Limit (°/o)	Plastic Limit (°/o)	Plasticity Index				
P-139, J-45	158.0-159.0											
J-46	158.0-159.0					58	23	35	CH	19.4		
J-47	168.0-169.0				80				CH	23.3		
J-48	168.0-169.0											
J-49	178.5-179.0									25.7		
J-50	188.5-190.0				99				CL	24.2		
J-52	198.0-199.0									25.9		
P-140, Bag 1	0-2.0											
Bag 2	2.0-4.0											
T-3	4.0-5.0				50	32	15	17	CL	13.7	110.0	3.7×10^{-8} (5)
J-4	8.5-10.0											
J-6	8.5-10.0		98	96	61				CL	17.8		
J-7	14.0-15.0											
J-8	14.0-15.0		100	99	55				CL	18.4		
J-10	19.0-20.0		100	100	27				SM	20.1		
J-12	23.5-25.0				58				CL	23.0		
J-13	23.5-25.0											
J-14	28.0-29.0				30				SM	22.0		
J-15	33.5-34.0	99	99	98	17				SM	24.6		
J-16	38.5-39.5											
J-17	38.5-39.5	97	96	96	19				SM	27.0		
J-18	43.5-44.5	98	97	97	16				SM	25.9		
J-19	49.0-50.0				21				SM	28.2		
J-20	58.0-59.0				27				SM	23.9		
J-22	79.0-80.0											
J-23	79.0-80.0									24.5		
J-24	79.0-80.0								CH			

NOTES:
(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas, Texas for OW and P-Series Borings.
(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and ASTM D1140.
(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and ASTM D424.
(4) Moisture Content of Soils performed in accordance with ASTM D2216.
(5) Laboratory Permeability Test performed on undisturbed Shelby tube sample. Sample tested in oedometer using Falling Head Test Procedure in accordance with EM 110-2-1906.

SUMMARY OF LABORATORY TEST RESULTS ON SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE AREA AND WASTEWATER POND DESIGN (1)

(continued)

Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (°/o Passing) (2)				Atterberg Limits (3)			Unified Soil Classification Symbol	Field Water Content (°/o) (4)	Dry Density lbs/ft^3	Laboratory Permeability cm/sec
		No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Liquid Limit (°/o)	Plastic Limit (°/o)	Plasticity Index				
P-144, Bag 1	0-2.0											
Bag 2	2.0-3.0		94	91	56	32	14	18	CL	12.2		
J- 3	4.0-5.0											
J- 4	4.0-5.0		100	99	72				ML	12.1		
J- 5	9.0-10.0											
J- 6	10.0-11.0			100	46				SM	13.4		
J- 7	14.0-15.0											
J- 8	14.0-15.0		100	99	29				SM	22.7		
J- 9	19.0-20.0											
J-10	19.0-20.0				20				SM	19.5		
J-11	23.5-24.5											
J-12	23.5-24.5		100	99	24				SM	23.2		
J-13	29.0-30.0											
J-14	29.0-30.0				16				SM	23.7		
J-15	34.0-35.0									32.6		
J-16	34.0-35.0											
J-17	39.0-40.0											
J-18	39.0-40.0									21.5		
J-19	44.0-45.0									25.7		
J-20	44.0-45.0											
J-21	49.0-50.0									27.3		
J-22	49.0-50.0											
P-148, Bag 1	0-2.0				37				SM	0.7		
J- 2	3.5-5.0											
J- 3	3.5-5.0		99	99	21				SM	7.9		
J- 4	8.5-10.0		100	99	41				SM	15.3		
J- 5	8.5-10.0											
J- 6	13.5-15.0		100	99	31				SM	21.5		
J- 7	18.5-20.0											

NOTES:

(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas, Texas for OW and P-Series Borings.
(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and ASTM D1140.
(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and ASTM D424.
(4) Moisture Content of Soils performed in accordance with ASTM D2216.

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SUMMARY OF LABORATORY TEST RESULTS ON SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE AREA AND WASTEWATER POND DESIGN (1)
(continued)

Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (°/o Passing) (2) No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Atterberg Limits (3) Liquid Limit (°/o)	Plastic Limit (°/o)	Plasticity Index	Unified Soil Classification Symbol	Field Water Content (°/o) (4)	Dry Density lbs/ft³	Laboratory Permeability cm/sec
P-148, J-8	18.5-20.0		99	98	40				SM	21.5		
J-9	23.5-24.0											
J-10	23.5-24.0									21.7		
J-11	33.5-34.0									23.3		
J-12	33.5-34.0											
J-15	39.0-40.0											
J-16	39.0-40.0									20.1		
T-6	13.5-15.0		100	99	31				SM			
OW-5, Bag 1	0-1.5											
Bag 2	1.5-3.5											
J-3	3.5-4.5				36				SM	13.1		
J-4	8.5-10.0				31				SM	22.1		
J-5	13.5-15.0				41				SM	14.6		
J-7	18.5-20.0				79				ML	22.6		
J-9	18.5-20.0											
J-10	23.5-24.5		92	90	69				ML			
J-11	28.5-30.0		100	100	98				ML	27.2		
J-13	28.5-30.0											
J-14	33.5-35.0	100	100	99	93				ML	18.8		
J-16	33.5-35.0											
J-17	38.5-40.0				24.1				SM	19.4		
P-119, Bag 8	10.0-11.0		99	99	35				SC	15.1	114.3	2.88×10^{-7} (6)
Bag 8a	10.0-11.0		99	99	35				SC	15.1	118.1	3.07×10^{-8} (7)
Bag 12	16.0-18.0		100	99	58				ML	16.3	116.4	7.58×10^{-8} (7)
Bag 16	22.0-24.0				40				SM	11.9	116.2	2.35×10^{-7} (7)

NOTES:
(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas, Texas for OW and P-Series Borings.
(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and ASTM D1140.
(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and ASTM D424.
(4) Moisture Content of Soils performed in accordance with ASTM D2216.
(6) Laboratory Permeability Test performed on remolded sample using Back Pressure Method in Triaxial Test.
(7) Laboratory Permeability Test performed on sample recompacted to approximately 95 percent standard compaction.

SUMMARY OF LABORATORY TEST RESULTS ON SOIL BORING SAMPLES RELATED TO LIGNITE STORAGE AREA AND WASTEWATER POND DESIGN (1)

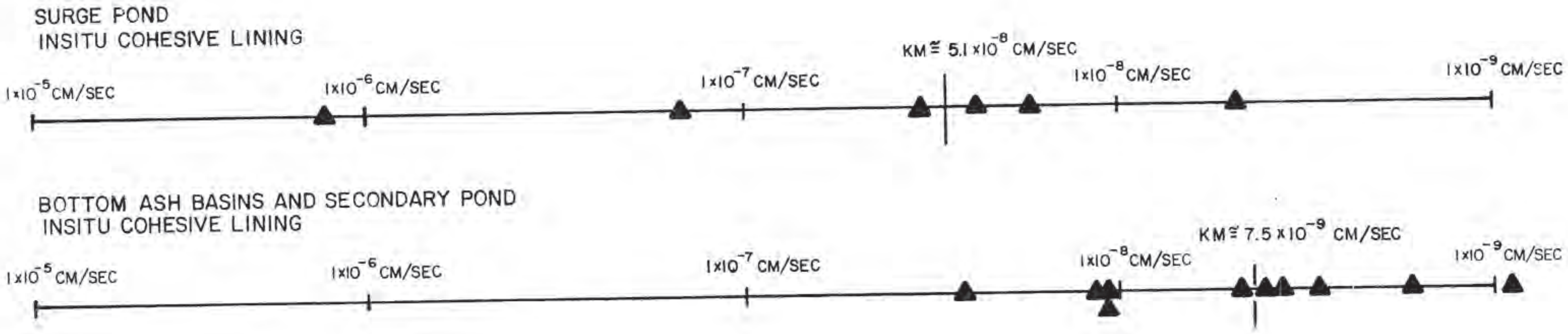
(continued)

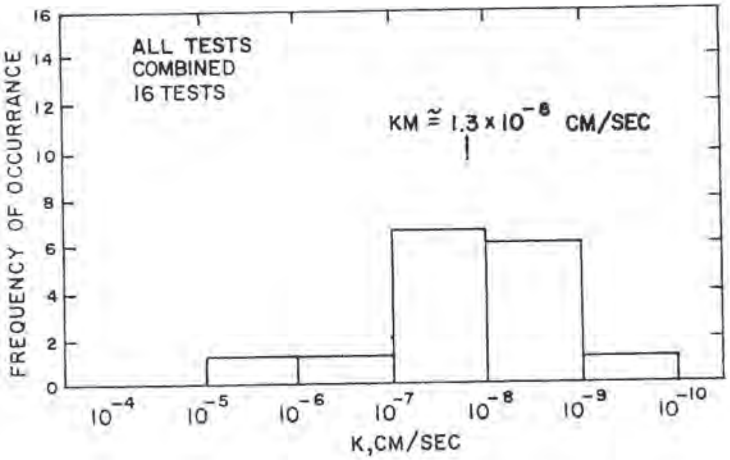
Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (°/o Passing) (2)				Atterberg Limits (3)			Unified Soil Classification Symbol	Field Water Content (°/o)(4)	Dry Density lbs/ft^3	Laboratory Permeability cm/sec
		No. 4 Sieve	No. 10 Sieve	No. 40 Sieve	No. 200 Sieve	Liquid Limit (°/o)	Plastic Limit (°/o)	Plasticity Index				
P-119, Bag 20	28.0-30.0				47				SM	16.6	114.7	2.12x10^{-7} (7)
Bag 24	34.0-36.0				35				SM	9.9	117.0	2.11x10^{-7} (7)
P-120, T-4	8.5-10.0				89	25	11	14	CL	19.7	110.3	2.3x10^{-8} (5)
J-8	18.5-20.0		100	100	29				SM	25.2		
P-125, J-5	13.5-15.0				63	41	17	24	CL	24.9	106.1	2.36x10^{-8} (6)
J-7	13.5-15.0											
P-129, T-3	3.0-5.0								SM	15.8	118.2	5.7x10^{-8} (8)
P-137, T-3	3.5-5.5					37	16	21	SC	18.7	107.5	1.1x10^{-7} (5)
P-137A, T-4	9.5-10.5		100	99	26	31	15	16	SC	10.5		2.75x10^{-6} (5)
OW-7, J-3	3.5-5.0					51	17	34	CH	28.2		
										27.2	97.6	
J-4	9.5-10.0					25	14	11	CL	23.2	96.3	
										20.8		
OW-11 J-6	13.5-15.0		99	97	85	68	23	45	CH	30.7		
J-8	18.5-20.0		89	84	79	61	21	40	CH	27.5	95.5	1.34x10^{-8} (6)
J-10	18.5-20.0								CH	34.3		

NOTES:

(1) Laboratory testing performed by NFS/National Soil Services, Inc., Dallas, Texas for OW and P-Series Borings.
(2) Laboratory Particle Size Analysis Tests performed in accordance with ASTM D422 and ASTM D1140.
(3) Laboratory Atterberg Limit Tests performed in accordance with ASTM D423 and D424.
(4) Moisture Content of Soils performed in accordance with ASTM D2216.
(5) Laboratory Permeability Test performed on undisturbed Shelby tube sample. Sample tested in oedometer using Falling Head Test Procedure in accordance with EM 1110-2-1906.
(7) Laboratory Permeability Test performed on sample recompacted to approximately 95 percent standard compaction.
(8) Laboratory Permeability Test performed on undisturbed sample using back pressure in Triaxial Test.

EXHIBIT 8





NOTES:

(1) KM = MEDIAN PERMEABILITY IN CM/SEC

(2) SEE EXHIBIT 5 FOR DESCRIPTION OF PERMEABILITY TEST PERFORMED

(3) ALL LABORATORY PERMEABILITY TESTING PERFORMED BY NFS/NATIONAL SOILS SERVICE, INC., DALLAS, TEXAS

SUMMARY OF LABORATORY PERMEABILITY TEST RESULTS ON COHESIVE SOILS INTENDED FOR USE AS INSITU
CLAY LININGS

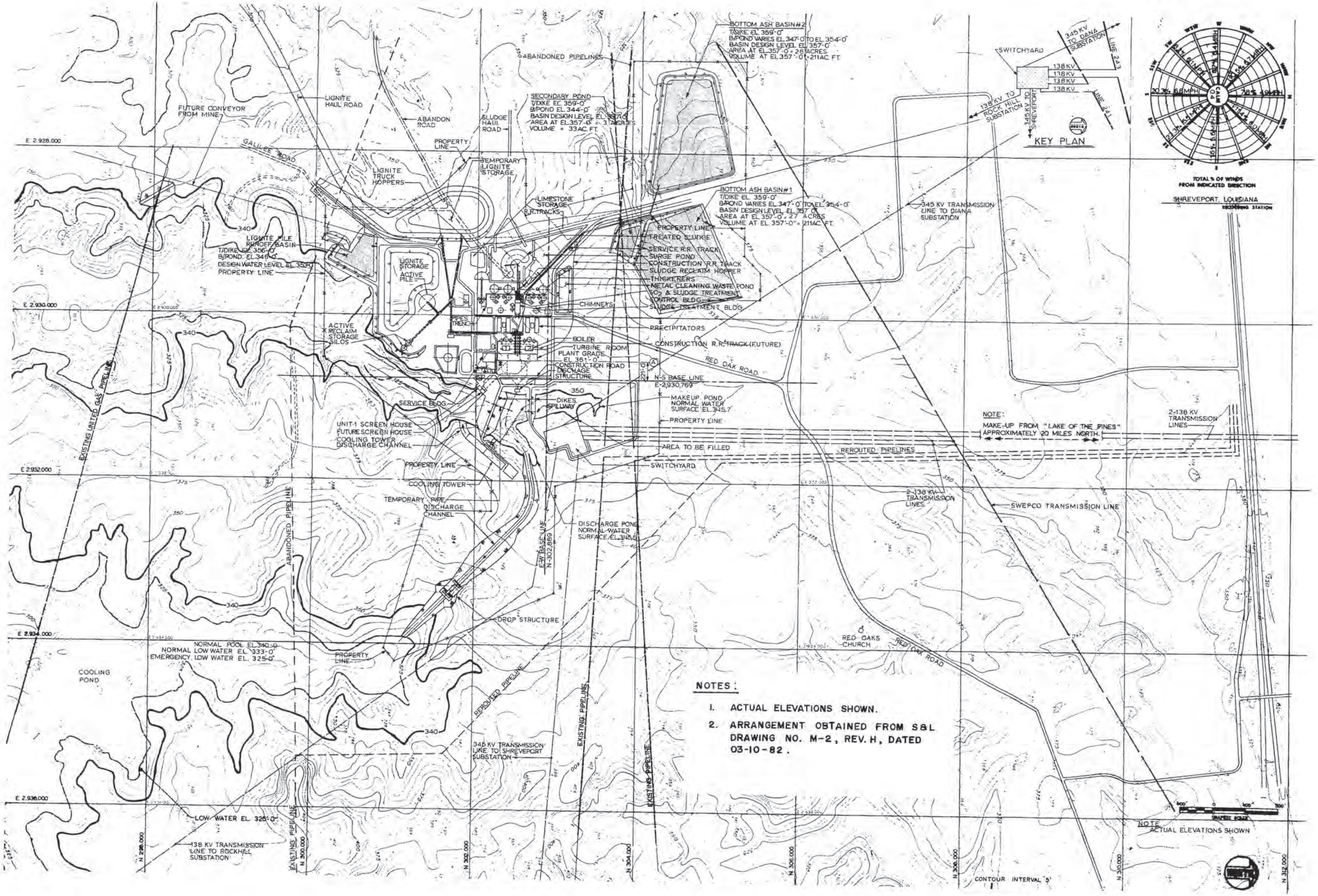
Exhibit 11

SUMMARY OF WASTEWATER POND SIZING DATA

Pond	Top of Dike Elevation, Ft.	Pond Design Level Ft.	Bottom Level, Ft.	Volume @ NOL or PDL Acre Ft.	NOL or PDL Acres	Sizing Basis
Bottom Ash Basin #1	357.0	354.6	347.0	188 (1)	31.0 (2)	541 TPH burn rate, 70% load factor, 20% average ash, 65 pcf ash density, 1 year storage for 1 unit plus 1.5 ft. freeboard over one in 100 year rainfall
Bottom Ash Basin #2	357.0	354.6	347.0	188 (1)	30.8 (2)	
Secondary Pond	359-357	352.0	344.0	12	2.6	
Surge Pond	358-359	355.0	347 - 352	21	4.0	Waste slurry flow from one unit's scrubber at full load for 4 days; 657,148 lb/hr slurry discharge
Lignite Pile Runoff Basin	356.0	353.0	346.0	28.6	45.0	To store 10 year - 24 hour runoff from lignite and limestone piles, material handling structures and limestone preparation area.
Metal Cleaning Waste Pond	360 .0	356.5	348.0	12.0	1.9	To store a volume of 12.0 acre-ft plus the runoff from a once-in-ten-year 24-hour rainfall event

NOTES: (1) Maximum ash capacity.
(2) Surface area at maximum pool.

EXHIBIT I



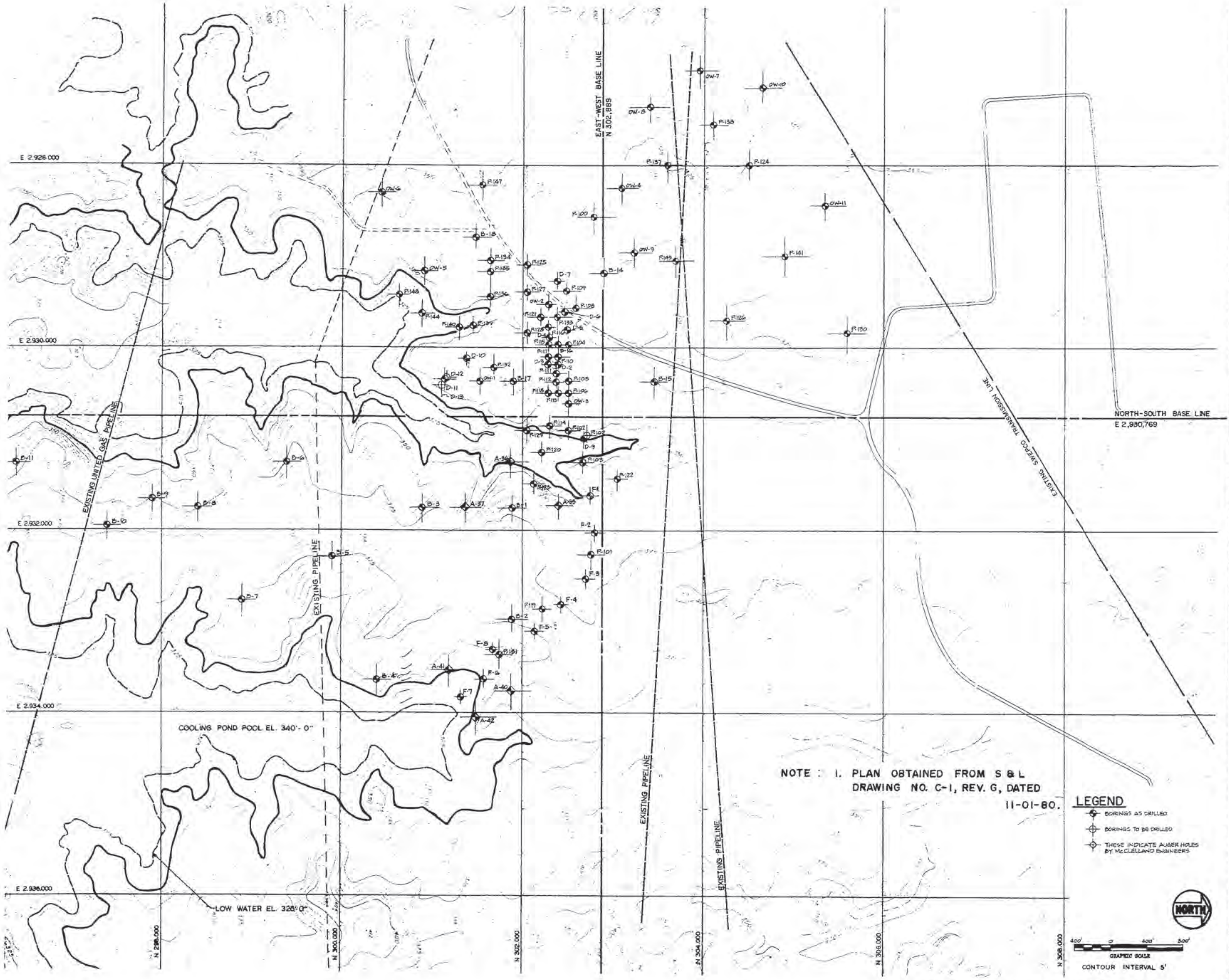
NOTES:

1. ACTUAL ELEVATIONS SHOWN.
2. ARRANGEMENT OBTAINED FROM S&L DRAWING NO. M-2, REV. H, DATED 03-10-82.

GENERAL SITE LAYOUT

SARGENT & LUNDY
ENGINEERS

EXHIBIT 4



NOTE : 1. PLAN OBTAINED FROM S & L DRAWING NO. C-1, REV. G, DATED 11-01-80.

LEGEND

- BORINGS AS DRILLED
- BORINGS TO BE DRILLED
- THESE INDICATE AUGER HOLES BY McCLELLAND ENGINEERS

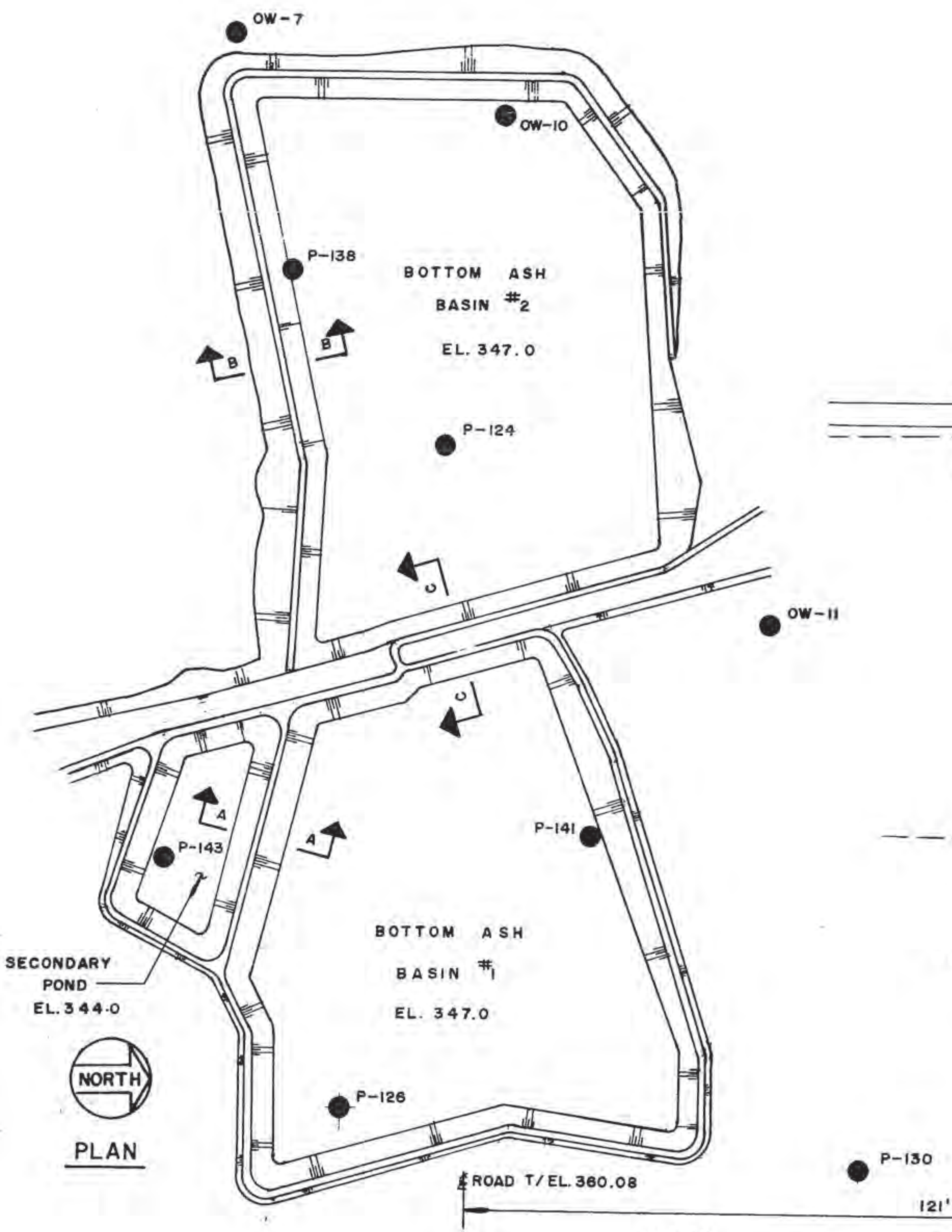
BORING SCHEDULE

BORING No	LOCATION NORTH	LOCATION EAST	DEPTH IN FEET	REMARKS
B-1	301,889	2,931,769		COMPLETED OCT. 1977
B-2	301,889	[illegible]		
B-3	300,889	[illegible]		
B-4	300,389	2,933,269		
B-5	299,889	2,932,269		
B-6	299,389	2,931,269		
B-7	298,839	[illegible]		
B-8	298,389	2,931,769		
B-9	297,889	[illegible]		
B-10	297,389	2,931,969		
B-11	296,589	2,931,269		COMPLETED OCT. 1977
B-12	299,989	2,928,269		NOT DRILLED
B-13	297,889	2,937,769		COMPLETED OCT. 1977
B-14	302,889	2,929,169		COMPLETED JAN. 1978
B-15	303,449	2,930,369		
B-16	302,339	2,929,969		
B-17	301,889	2,930,369		
B-18	301,469	2,928,769		COMPLETED JAN. 1978
P-100	302,789	2,928,569	40	
P-101	302,769	2,932,269	40	
P-102	302,719	2,930,969	50	
P-103	302,669	2,931,269	50	
P-104	302,559	2,929,969	100	
P-105	302,539	2,930,379	79	COMPLETED AUG. 1978
P-106	302,509	2,930,509	79	COMPLETED AUG. 1978
P-107	302,509	2,930,919	40	
P-108	302,589	2,929,579	60	
P-109	302,489	2,929,359	40	
P-110	302,389	2,930,109	80	
P-111	302,374	2,930,289	80	
P-112	302,374	2,930,379	100	
P-113	302,389	2,930,509	79	COMPLETED AUG. 1978
P-114	302,309	2,930,869	60	
P-115	302,289	2,929,969	200	CHIMNEY
P-116	302,289	2,929,789	80	
P-117	302,289	2,930,109	80	
P-118	302,289	2,930,509	100	
P-119	302,229	2,932,859	40	
P-120	302,219	2,931,149	80	
P-121	302,209	2,929,669	80	
P-122	303,050	2,931,450	60	
P-123	302,129	2,931,499	80	
P-124	304,500	[illegible]	50	PERCOLATION TEST @ 5', 7' & 10'
P-125	302,049	2,929,089	50	
P-126	[illegible]	2,929,700	50	PERCOLATION TEST @ 5', 7' & 10'
P-127	302,049	2,929,389	80	
P-128	302,049	2,929,859	80	
P-129	302,049	2,930,919	80	
P-130	[illegible]	[illegible]	50	PERCOLATION TEST @ 6' & 10'
P-131	301,759	2,933,369	60	
P-132	301,689	2,930,219	80	
P-133	302,389	2,929,669	100	
P-134	301,649	2,929,044	30	
P-135	301,649	2,929,169	50	
P-136	301,649	2,929,444	50	
P-137	303,600	[illegible]	50	REGULAR SAMPLING
P-138	304,100	2,927,550	50	PERCOLATION TEST @ 5', 7' & 10'
P-139	301,459	2,929,759	200	LIGNITE SOILS
P-140	301,309	2,929,779	80	
P-141	304,400	2,929,000	50	PERCOLATION TEST [illegible]
P-142	303,700	2,929,050	40	PERCOLATION TEST @ 5', 7' & 10'
P-144	300,889	2,929,629	50	
P-147	301,559	2,926,219	40	
P-148	300,629	2,929,429	40	
OW-1	301,539	2,930,369	15' BELOW WATER TABLE	1¼" DIA. OBSERVATION WELL
OW-2	302,289	2,929,529	15' BELOW WATER TABLE	1¼" DIA. OBSERVATION WELL
OW-3	302,509	2,930,619	15' BELOW WATER TABLE	1¼" DIA. OBSERVATION WELL
OW-4	303,000	2,928,250	15' BELOW WATER TABLE	4" DIA. OBSERVATION WELL FOR WATER QUALITY
OW-5	300,919	2,929,169	15' BELOW WATER TABLE	
OW-6	300,430	2,928,300	15' BELOW WATER TABLE	
OW-7	303,950	2,926,950	15' BELOW WATER TABLE	
OW-8	303,410	[illegible]	15' BELOW WATER TABLE	
OW-9	303,239	2,928,969	15' BELOW WATER TABLE	
OW-10	304,650	2,927,150	15' BELOW WATER TABLE	
OW-11	305,350	2,928,450	5' BELOW WATER TABLE	4" DIA. OBSERVATION WELL FOR WATER QUALITY
A-35	302,400	2,931,750		
A-36	301,880	2,931,260		
A-37	301,380	2,931,750		
A-40	301,890	2,933,780		
A-41	301,200	2,933,540		
A-42	301,500	2,934,050		
D-2	302,394	2,930,189	35	COMPLETE JUNE 1979
D-3	302,284	2,930,189	35	
D-4	302,300	[illegible]	35	
D-5	302,499	2,929,324	38	
D-6	302,464	[illegible]	35	
D-7	302,389	[illegible]	40	
D-9	[illegible]	[illegible]	35	
D-10	302,559	2,930,119	40	
D-11	[illegible]	2,930,359	50	COMPLETE JUNE 1979
D-12	301,159	2,930,339	120	
D-13	301,104	2,930,414	120	
F-1	302,752.92	2,931,638.42	75	
F-2	302,806.67	2,932,066.23	75	
F-3	302,705.94	2,932,549.30	75	
F-4	302,432.26	2,932,830.88	75	
F-5	302,158.33	2,933,125.12	70	
F-6	301,968.05	2,933,689.32	65	
F-7	301,316.63	2,933,891.99	65	
F-8	301,673.63	2,933,350.89	65	

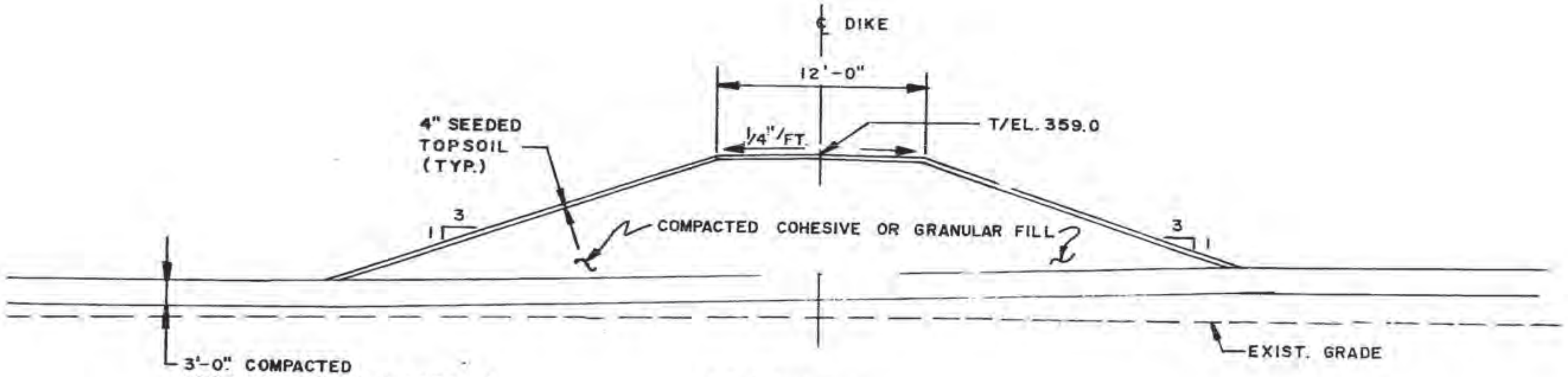
BORING LOCATION PLAN

SARGENT & LUNDY
ENGINEERS

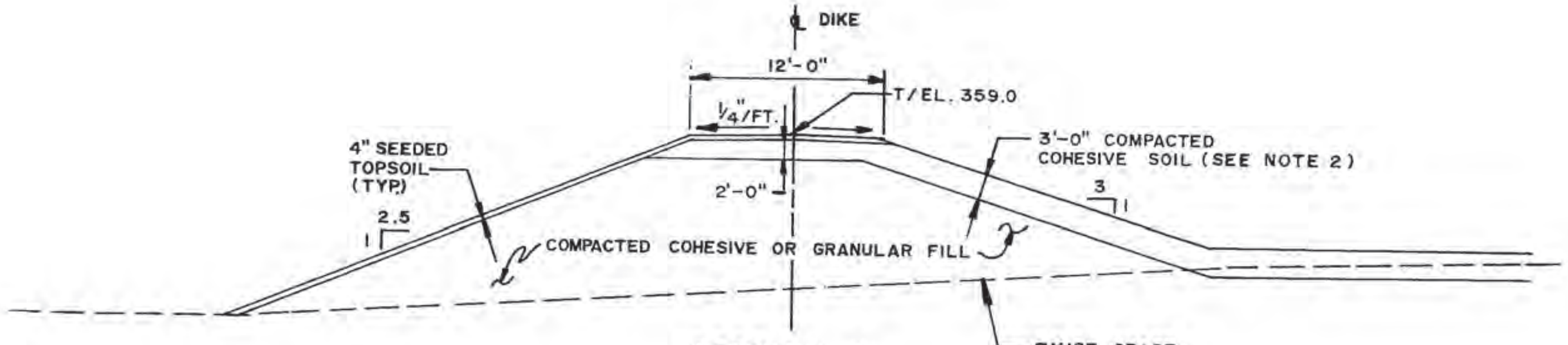
EXHIBIT 9



PLAN

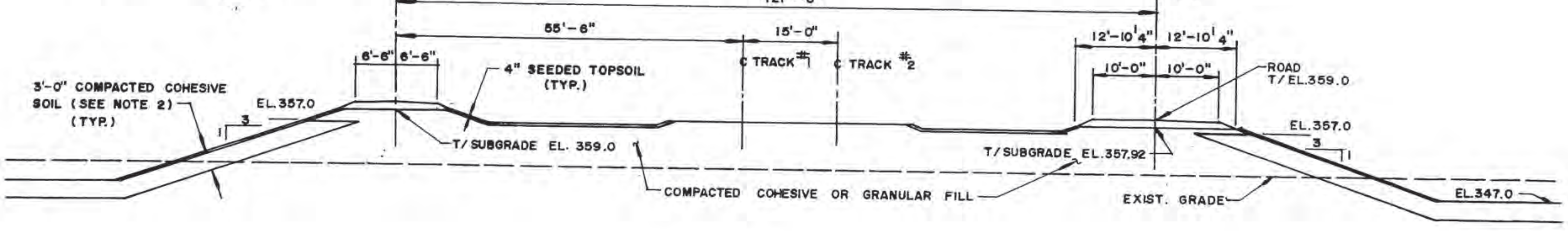


SECTION A



SECTION B

NOTES:
1. PLAN AND SECTIONS OBTAINED FROM S&L DRAWING NOS. & REVISIONS, C-19-D, C-20-G, C-21-D, AND C-22-F, DATED 08-25-81.
2. COMPACTED COHESIVE LINING REQUIRED ONLY IN AREAS WHERE DIKE FILL IS GRANULAR OR WHERE POND BOTTOM IS NON-COHESIVE. SOIL BORINGS INDICATE THAT BASIN #1 AND EAST SIDE OF BASIN #2 ARE LOCATED IN NATURAL COHESIVE. DEPOSITS (CL AND CH MATERIAL).
3. SOIL BORING LOCATIONS ARE APPROXIMATE, SEE EXHIBIT 4 FOR EXACT LOCATIONS.
4. PLAN AND SECTIONS NOT TO SCALE.

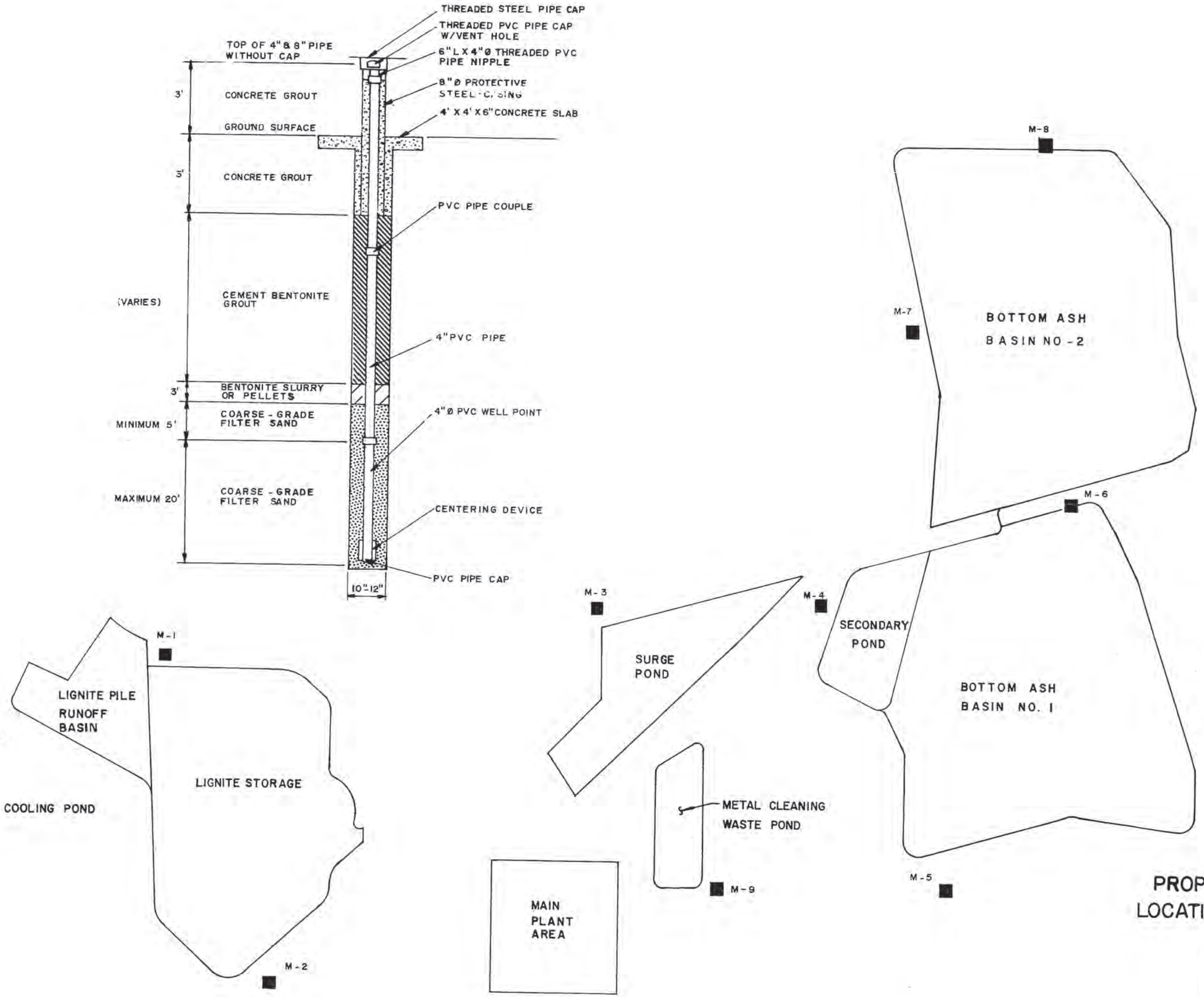


SECTION C

BOTTOM ASH BASINS AND
SECONDARY POND PLAN
AND CROSS SECTIONS

SARGENT & LUNDY
ENGINEERS

EXHIBIT 12



LEGEND

■ LOCATION OF PROPOSED MONITORING WELLS

NOTES:

1. LOCATION OF WELLS ARE APPROXIMATE.
2. DRAWING NOT TO SCALE.

PROPOSED MONITORING WELLS LOCATIONS AND TYPICAL DETAILS

SARGENT & LUNDY ENGINEERS

SARGENT & LUNDY
ENGINEERS
CHICAGO

Southwestern Electric Power Company
Henry W. Pirkey Power Plant

COHESIVE LINING CONSTRUCTION VERIFICATION PROGRAM FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES

I. INTRODUCTION

Southwestern Electric Power Company (SWEPCo) has committed to providing verification that their insitu and compacted cohesive linings for the lignite storage area and wastewater pond facilities have been constructed in accordance with project specifications and guidelines suggested by the Texas Department of Water Resources (TDWR). The wastewater pond facilities requiring verification are the lignite pile runoff basin, surge pond, two bottom ash storage basins, secondary settling pond, and the metal cleaning waste pond. Also requiring verification is the compacted cohesive lining placed beneath the lignite storage pile and for ditches transporting runoff from the pile to the runoff basin.

A summary of the design of the lignite storage area and wastewater pond facilities with respect to the guidelines suggested by the TDWR was presented in a report for SWEPCo dated January 31, 1983. In this report, which may have been submitted to the TDWR, SWEPCo has committed to the verification. This report should be reviewed concerning the applicable guidelines suggested by the TDWR and the lining and dike requirements specified. The wastewater pond facilities and lignite storage area earthwork construction is included in the scope of project specification H-4533.

II. SCOPE

The cohesive lining construction verification program will include the following for each of the wastewater pond facilities and lignite storage area.

a. A listing of all the field density tests performed on cohesive lining material during construction. A statistical summary of field dry density, field water content, and percent compaction.

b. Results of any laboratory testing performed on samples representing cohesive lining material during construction.

c. Results of laboratory testing on^continuous undisturbed samples obtained from the in-place (compacted or insitu) cohesive lining after construction. The laboratory testing will consist of sample classification, grain size, atterberg limit, and falling or con^s tant head permeability tests. If construction of the lining has not been completed at the time this program begins, as is the case with the Metal Cleaning Waste Pond, samples should be obtained during construction.

Results of the laboratory testing and field density test summary will be compared to project specifications and TDWR guidelines to document compliance. Details of the laboratory test program are given in Section III of this report.

III. LABORATORY TEST PROGRAM FOR COHESIVE LINING SAMPLES

Twenty-two undisturbed shelby tube samples shall be obtained from the cohesive lining of the six wastewater ponds and lignite storage area. The thin-walled shelby tube samples shall be in accordance with ASTM D1587. The tube shall be 3 inches outside diameter and having a length such that a minimum 24-inch sample can be obtained. Tubes may be field extruded, unless otherwise directed by the purchaser. If extruded, the entire sample shall be placed in approved containers, properly labeled and transported to the laboratory. A field log shall be prepared for all extruded samples.

Dwg. HP-56 shows the approximate location of all test samples. These locations will be staked and surveyed by the purchaser prior to beginning field work. Any pond containing water will have to be pumped dry. Most samples are located within the bottom lining of the pond or area. Some samples are located in the lining of the dike slope. Drilling or other suitable equipment shall be used to obtain the samples.

The testing contractor shall inspect the site prior to beginning the sampling, but after the locations are staked to ensure that the proper equipment is brought to the site.

After sampling each or a group of locations, each borehole shall be filled with CH clay obtained on site and compacted in 6-inch layers with suitable heavy hand tampers. Testing contractor shall make with purchaser all necessary arrangements to assure that all holes are properly filled and compacted to prevent any future pond leakage due to sampling.

The required laboratory testing is given in Table 1. All samples shall be properly classified and test results reported as required in standards.

TABLE I - LABORATORY TEST REQUIREMENTS

Sample Number	Laboratory Classification ASTM D 2487	Atterberg Limits ASTM D 423 & D 424	Grain Size Analysis ASTM D 422 Hydrometer	Grain Size Analysis ASTM D 1140 Fines Content	Laboratory Permeability (2) EM 1110-2-1906
S-1	X	X	X		X
S-2	X	X		X	X
S-3	X	X		X	X
S-4	X	X	X		X
S-5	X	X		X	X
S-6	X	X		X	X
S-7	X	X		X	X
S-8	X	X	X		X
S-9	X	X		X	X
S-10	X	X		X	X
S-11	X	X		X	X
S-12	X	X	X		X
S-13	X	X		X	X
S-14	X	X		X	X
S-15	X	X	X		X
S-16	X	X		X	X
S-17	X	X		X	X
S-18	X	X	X		X
S-19	X	X		X	X
S-20	X	X		X	X
S-21	X	X	X		X
S-22	X	X		X	X

Southwestern Electric Power Company
Henry W. Pirkey Power Plant

Ground Water Monitoring Program for Lignite Storage Area and Wastewater Pond Facilities

I. INTRODUCTION

The Lignite Storage Area and Wastewater Pond Facilities at the H. W. Pirkey Station are situated generally west of the main plant area. The original topography ranges in elevation from 325 feet to 375 feet, mean sea level. The ponds are underlain by a series of stiff clay strata and dense silty sand strata. Pond and basin linings consist of in-situ cohesive soils, where available, or compacted cohesive fill where the in-situ lining thickness is less than 3 feet.

Groundwater occurs under water table conditions between elevations varying from 320 ft. in the low lying areas to 350 feet in the higher elevations. Recharge of the water table is primarily from infiltration of precipitation. Groundwater discharge is to Brandy Branch Creek, which drains the site south and east of the lignite storage area, and to Hatleys Creek, which drains the area north and west of the lignite storage area. Brandy Branch Creek will be dammed to provide a cooling pond.

The proposed ground water monitoring program consists of two phases:

1) A pre-operational phase during which baseline data are established and interpreted.

2) An operational phase during which ground water levels and ground water quality are monitored in order to identify the impact of the various ponds and drainage basins.

The proposed ground water monitoring program includes periodic measurement of groundwater levels and groundwater quality in monitoring wells installed specifically for these purposes within the area. Additional data collected for the groundwater monitoring program should include daily cooling pond level and precipitation measurements.

II. OBJECTIVES

The objectives of the proposed groundwater monitoring program are:

1) Identification of the potentiometric surface, general direction of groundwater movement, and hydraulic gradient for the aquifer(s), including seasonal fluctuations, in the vicinity of the ponds;

2) Establishment of baseline groundwater quality data prior to operation of the plant;

3) Monitoring of changes in groundwater levels that may result from infiltration from the various ponds and drainage basins;

4) Monitoring of groundwater quality during plant operation;

5) Early detection and determination of the level of contamination and general direction of movement away from the source.

III. PHYSICAL ARRANGEMENT

Single-level groundwater monitoring wells are proposed at ten locations. The locations of these monitoring wells are indicated on Dwg. HP-56. Construction details for the single-level monitoring wells are shown on Exhibit 2.

The single-level monitoring wells are screened in the upper portions of the water table or confined aquifers where the concentration of contaminants should be highest. In addition, the concentration of contaminants should decrease through the saturated thickness of the aquifer as a result of hydrodynamic dispersion.

The well locations have been chosen so that one well is located hydraulically upgradient from the active portion of the facilities and at least one monitoring well is installed hydraulically downgradient of the active area. The upgradient well will yield samples representative of the background quality of the groundwater which flows under the facility. The downgradient well is located as close as possible to the facility where it will provide the greatest opportunity for interception of migrating leachate and provide an early warning of groundwater contamination..

The proposed single-level monitoring well, shown on Exhibit 2, is a 10-inch by 4-inch, sand-pack installation. The 4-inch diameter CPVC casing is preferable to a 2-inch diameter casing because the larger diameter will facilitate collecting groundwater samples using a portable submersible pump rather than by bailing of the well. The upper portion of the annular space will be backfilled with an impermeable material to prevent surface water from entering the well bore.

IV. INSTALLATION OF GROUNDWATER MONITORING WELLS

A. Contractor shall drill a 10-inch minimum diameter borehole as indicated on the attached exhibits. The borehole shall be fully cased during drilling with a temporary 10-inch minimum diameter steel casing. Larger diameter borehole and casing may be used only if approved in advance by the Consulting Engineers and the Purchaser. The use of bentonite drilling mud to hold the borehole open will not be permitted. Once the designated depth has been reached, Contractor shall flush the casing with clear water until clear water returns to the surface. The use of biodegradable drilling mud (revert) in lieu of a fully cased borehole to hold the hole open will be permitted if Contractor can show to the satisfaction of the Purchaser and the Consulting Engineers that he can satisfactorily install and disinfect the monitoring well.

B. Contractor shall collect representative split-spoon soil samples at five foot intervals and at changes in strata during drilling. Contractor shall prepare a boring log showing the stratigraphy and groundwater level during drilling.

C. Option: Contractor may drill an initial borehole of diameter less than 10-inches to collect samples and then ream to a large diameter for the installation of the well screen, casing, and sand pack.

D. Once the soil stratigraphy and groundwater level have been determined, Purchaser's representative shall confirm the intended installation details for the groundwater monitoring well as indicated in Exhibit 2. These details shall include stratigraphy, total depth, screened interval, length and depth of granular backfill, thickness and depth of the bentonite seal, and length of grout seal. Purchaser shall approve the installation details prior to the installation.

E. Contractor shall construct the groundwater monitoring well from 4-inch diameter CPVC 4120, Schedule 40 casing as specified in ASTM F441 attached to a 20-foot length of 4-inch diameter PVC well screen with a bottom cap. Solvent cement and pipe cleaner for joining sections of CPVC pipe, fittings, and the PVC well screen shall be a type specifically intended for its use. The slot size of the well screen shall be 0.010 inch. A 9-inch diameter perforated PVC disk or equivalent device shall be attached to the bottom of the well point to permit centering of the well point in the borehole.

F. Upon placement of the CPVC casing and well screen in the borehole, Contractor shall fill the annular space between the CPVC casing-well screen assembly and 10-inch temporary casing with clean concrete sand (graded per ASTM C-33) to 5 feet above the top of the PVC well screen. The backfill material may be allowed to settle through the water in the steel casing. The 10-inch diameter casing shall be pulled back to 3 feet above the well screen while backfilling with the clean, concrete sand. During the sand backfilling the casing shall not be pulled back above the top of the sand.

G. After placement of the sand backfill, Contractor shall settle the backfill around the well point by pumping water from the PVC well screen. Sufficient sand shall be added to the annular space to maintain the level of sand backfill at 5 feet above the top of the well screen. Pumping shall continue intermittently until the discharge water is clear and soil free or until pumping is stopped by Purchaser's representative. Disposal of water discharged from the monitoring well during pumping shall be as directed by Purchaser.

H. After settlement of the sand backfill, place two feet of bentonite in the annular space between the CPVC casing and the outer casing to prevent any movement of the cement grout into the granular backfill. If granular bentonite is used, it shall be placed through a conductor pipe using the tremie or other method as approved by the Purchaser. If bentonite pellets are used, they may be allowed to settle through the water around the CPVC casing. If the water table is below the bentonite seal, add clear water during this process to hydrate the bentonite. When bentonite pellets are used, sufficient length of time shall be allowed for the bentonite to form a seal over the sand backfill before placing grout. After placement and hydration of the bentonite seal, the outer casing shall be pulled to one foot below the top of the bentonite seal.

I. After placement of the bentonite seal, Contractor shall fill the remaining annular space between the CPVC casing and borehole with cement-bentonite grout, placed by the tremie method from the bottom upward or by an alternative method approved by Purchaser. The 10-inch steel casing shall be pulled simultaneously with placement of the grout. A positive head of grout shall be maintained in the temporary casing at all times during the placement. The grout mix shall be approximately 7 gallons of water with 3 pounds of powdered bentonite per 94-pound sack of Portland cement. The bentonite and water shall be mixed first to provide a smooth slurry, then the cement shall be added to the slurry and blended to a smooth consistency.

J. Contractor shall terminate the CPVC casing 3 feet above grade and shall install a vented, removable PVC cap such that the CPVC casing is not restricted by the cap or coupling. Contractor shall cut a small notch in the rim of the CPVC casing to mark the point from which all level measurements are to be made. This point shall be clearly marked on the CPVC casing with an indelible marking.

K. Contractor shall install a 6-foot length of 8-inch diameter protective steel casing 3 feet into the cement-bentonite grout. Contractor shall fill the annular space between casings with cement-bentonite grout to within 6 inches of the top of the CPVC casing. A threaded steel cap with ventilation hole shall be provided for the protective casing. An 18-inch long rebar shall be welded to the top of the steel cap to facilitate its removal during groundwater sampling. Contractor shall paint the protective casing and its cap with florescent type paint. Contractor shall clearly and permanently mark the protective casing with the appropriate alphanumeric designation.

L. Contractor shall construct a concrete apron at the ground surface to provide drainage away from the monitoring well, to prevent movement of water down the side of the steel casing, to prevent erosion, and to provide permanence to the monitoring well. The concrete apron shall be at least 2 feet in diameter and 6 inches in thickness.

M. After the monitoring wells are installed, Contractor shall survey the locations and the elevations of the measuring points on the well casings.

V. DISINFECTION OF WELLS

A. Immediately after completion of well, disinfect it by circulating a chlorine solution through the well, let set for the period specified, then pump the solution from the well, and discharge it as directed.

B. Disinfecting Agent:

a. The disinfecting agentt shall be liquid sodium hypochlorite, NaOCl, or granular calcium hypochlorite, $Ca(ClO)_2$. Calcium hypochlorite shall not be used where the concentration of calcium in the groundwater will exceed 300 ppm after addition of the disinfecting solution. The choice of disinfecting agent is subject to approval by the Consulting Engineer.

b. The disinfecting agent used in the solution shall be delivered to the Project Site in the original, unopened dated containers. Prior to use, the disinfecting agent shall not be exposed to air or direct sunlight.

C. Disinfection Procedure:

a. Determine depth to water and depth to the bottom of the well from a common measuring point. Calculate the height of the water column in the well (depth to bottom of well minus depth to water, in feet).

b. Calculate the total volume of water ($V=V_1+V_2$) in both the well (V_1 in gallons) and sand pack (V_2 in gallons) where V (in gallons) equals the height of the water column times 1.5.

c. With the pump intake located as near the water level as possible, pump the well to remove at least 5 volumes of water, 5x(V). Pump until discharge water is clear. Then, lower the pump intake to the bottom of the well. Pump at least 1.5 volumes of water, 1.5x(V), until discharge water is clear. Additional pumping levels may be required at the discretion of the Consulting Engineer. This step may be deleted if disinfection is performed immediately after well installation.

d. Mix a solution of disinfectant by adding a measured amount of calcium or sodium hypochlorite to a known volume of clear water to provide at least a 200 ppm chlorine solution when mixed with the total volume, V, of water in the well. The amount of disinfecting agent to be added to clear water depends on the initial concentration of hypochlorite. The volume of clear water added shall be no less than the total volume of water, V.

e. After approval of the disinfection solution mix by the Consulting Engineer, place the solution in the well in such a manner that it is thoroughly distributed throughout the entire column of water in the well. Add an extra dosage to the bottom of the well. Make certain that the dry portion of the well casing above the water level is also wetted. This may be accomplished by tremie or by pumping the solution through a hose moved through the well from the bottom up, or by another acceptable method as approved by the Consulting Engineer. Well disinfection by pouring the solution from the top of the well is not acceptable.

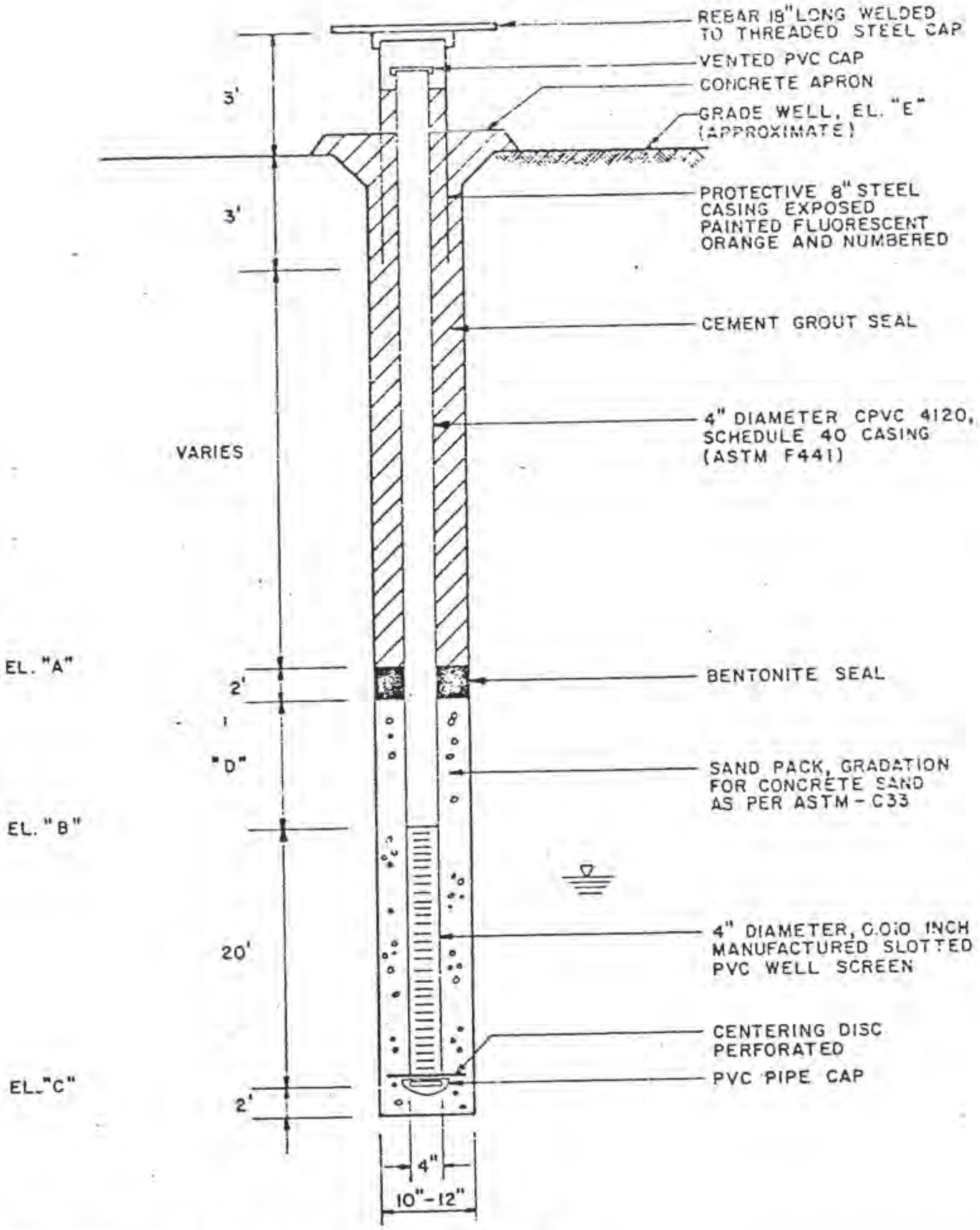
f. Recirculate the solution in the well by pumping from the bottom of the well and reintroducing the discharged solution into the top of the well. During recirculation, the portion of the well casing above the water table shall be maintained in a wet condition with the solution. The length of the recirculation period will be determined by the Consulting Engineer, but will not be less than 30 minutes nor more than two hours. Measure the residual free chlorine concentration at the end of the recirculation period.

g. After recirculation, the solution shall remain in the well for a minimum of eight hours. Replace the well caps for this period.

h. After the eight hour or longer period, the well shall be pumped to clean it of solution. Purchaser will determine the residual free chlorine concentration at the beginning of pumping to assure that complete disinfection has occurred. The method of determining the concentration shall be approved by the Consulting Engineer.

i. If the residual free chlorine concentration is greater than or equal to 1.0 ppm, the disinfection of the well will be assumed to be complete. The well shall then be pumped for at least two hours, but not more than four hours, to remove the solution from the well and surrounding aquifer. Vary the depth of the pump intake in the well while pumping, from the top of the water column to the bottom of the well, and back to the top again. Dispose of the water pumped from the well as directed by Purchaser.

j. If the residual free chlorine concentration is less than 1.0 ppm, pump the solution from the well as indicated in step "c." above and repeat the disinfection procedure.



WELL No.	EL."A"	EL."B"	EL."C"	"D"	EL."E"
MW-1	330	323	303	5'	334
MW-2	327	320	300	5'	339
MW-3	342	335	315	5'	370
MW-4	347	340	320	5'	364
MW-5	347	340	320	5'	362.5
MW-6	347	340	320	5'	361
MW-7	347	340	320	5'	358.3
MW-8	351	344	324	5'	356.3
MW-9	348	344	324	2'	353.1
MW-10	347	340	320	5'	357.6

NOTES

1. DRAWING NOT TO SCALE.
2. WELL SHALL BE DISINFECTED UPON COMPLETION.
3. LOCATION OF GROUNDWATER QUALITY MONITORING WELLS IS SHOWN ON EXHIBIT 1.

EXHIBIT 2
GROUNDWATER QUALITY MONITORING
WELL DETAIL
HENRY W. PIRKEY POWER PLANT
SOUTHWESTERN ELECTRIC POWER CO.

SARGENT & LUNDY
ENGINEERS
FOUNDED 1891
55 EAST MONROE STREET
CHICAGO, ILLINOIS 60603
(312) 269-2000
TWX 910-221-2807

April 25, 1984
Project No. 5555-02
File No. 5.8.1

Southwestern Electric Power Company
Henry W. Pirkey Power Plant
Unit 1

Wastewater Ponds Permit
Data Report - Revisions

Mr. M. J. Scott
Southwestern Electric Power Company
P. O. Box 21106
Shreveport, Louisiana 71156

Dear Mr. Scott:

Enclosed are two copies of the Wastewater Ponds Permit Data Report which has been revised per your letter, dated December 20, to Mr. F. J. Emmett. The revisions address overflows from the ponds which are not bounded by the permit. The revisions have been indicated in the righthand margin with an "R". Please review the revisions and return any comments you have to us so that we can reissue the appropriate number of copies for your use.

Yours very truly,

Charles J. Nelson

Charles J. Nelson
Structural Project Engineer

CJN:jg
Enclosure
Copies:
W. H. Holley (1/1)
A. I. Melson (1/1)
R. J. Pruett (1/1)
F. J. Emmett (1/1)
E. R. Weaver (1/1)
D. G. Bodine (1/1)
J. A. Wilson (1/1)

RECEIVED
APR 30 1984
OFFICE OF
W. H. HOLLEY

HENRY W. PIRKEY POWER PLANT

DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES

REPORT PREPARED FOR

SOUTHWESTERN ELECTRIC POWER COMPANY

JANUARY 31, 1983

REVISED: APRIL 25, 1984

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LIST OF EXHIBITS

HENRY W. PIRKEY POWER PLANT
DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES

SOUTHWESTERN ELECTRIC POWER COMPANY

I INTRODUCTION

This report is prepared by Sargent & Lundy (S&L) at Southwestern Electric Power Company's (SWEPCO) request to summarize the design of the lignite storage area and the wastewater pond facilities with regard to technical guidelines and requirements of the Texas Department of Water Resources (TDWR). The technical guidelines referenced in this report are Technical Guide Nos. 4 and 6 titled Ponds and Lagoons, and Monitoring/Leachate Collection Systems respectively. Guide No. 4 was revised March 1, 1978 and Guide No. 6 March 21, 1980. We understand that the TDWR has the responsibility of preparing and issuing document approval for disposal of wastes. Requirements concerning waste storage and disposal and concerning the design, construction, and monitoring of wastewater pond facilities are discussed in this report.

The wastewater pond facilities discussed in this report and shown in Exhibit 1 are the lignite pile runoff basin, surge pond, two bottom ash storage basins, secondary settling pond, and the metal cleaning waste pond. Discussion of other waste treatment facilities such as the sanitary sewage treatment plant, the cooling pond, and the final treated Flue Gas Desulfurization (FGD) sludge disposal site are not within the scope of this report and, therefore, not included.

II SUMMARY AND CONCLUSIONS

Based on the evaluation of the site subsurface soil and water conditions, it is concluded that the design of the Henry W. Pirkey wastewater ponds conforms with the technical guidelines and requirements of the TDWR.

Nine groundwater monitoring wells will be located adjacent to the wastewater ponds. These wells will be designed and installed to requirements equal to or exceeding those suggested by the TDWR.

A summary of design guidelines and requirements suggested by the TDWR and those used for design of the Henry W. Pirkey wastewater ponds is given in Exhibit 2.

III DESIGN OF LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES

A. General

The general site layout is shown in Exhibit 1. The plant water usage and waste water scheme is shown on Exhibit 3. The lignite storage area, lignite pile runoff basin, metal cleaning waste pond, and the surge pond have been sized to accommodate two units. Each bottom ash basin will accommodate storage of hydraulically placed ash for two units for 6 months. When one bottom ash basin is filled, storage will begin in the second basin while the first basin is being emptied and readied for reuse. The in-service bottom ash basin will also receive the discharge from the ash hopper pit sump pumps.

Effluent from the bottom ash basins will discharge to the secondary settling pond. Blowdown from the main and auxiliary boilers will also be routed to the secondary pond. Water collected in the secondary settling pond will be recirculated back to the plant to transport bottom ash. R

The ash basins and secondary pond, acting as a system, have been provided with additional capacity above the normal operating level to capture and hold the 10 year-24 hour runoff from the basin and pond drainage areas. A spillway has been R provided for the secondary pond to discharge inflows in excess of the 10 year-24 hour runoff in conformance with the NPDES permit. The quality of those overflows is not subject to permit limitations. To protect the basin and pond dikes from damage, the spillway has been designed to discharge excess runoff from the 100 year-24 hour runoff and freeboard has been provided above the maximum water level resulting from the 100 year-24 hour runoff. Excess water accumulated in the secondary pond due to rainfall runoff will be pumped to the wastewater treatment plant for treatment prior to discharge.

Drainage from the lignite and limestone storage areas and handling systems will be collected via ditches and routed to the lignite pile runoff basin.

The lignite pile runoff basin has been designed to capture and hold the entire 10 year-24 hour runoff from the basin drainage area with no outflow. An auxiliary spillway has been provided to discharge inflows in excess of the 10 year-24 hour runoff in conformance with the NPDES permit. The quality of these overflows is not subject to permit limitations. To protect basin dikes from damage due to overflow, the spillway has been designed to discharge excess runoff from the 100 year-24 hour runoff and freeboard has been provided above the maximum water level due to the 100 year-24 hour runoff.

Water captured in the lignite pile runoff basin will not normally require more treatment than sedimentation to lower the total suspended solids content prior to release. Once the suspended solids are within acceptable limits, the basin contents will be discharged to the cooling pond by gravity in a normally closed pipe outlet. However, if treatment other than gravity settling is required, the contents of the lignite pile runoff basin will be pumped to the wastewater treatment plant prior to release.

The surge pond is divided into two sections: the main surge pond and the auxiliary surge pond. The auxiliary surge pond is a collection and settling pond for scrubber waste slurry, from the FGD system waste slurry pumps, thickener underflow pumps, and filtrate overflow sump pumps. These slurry flows will be routed to the auxiliary surge pond only under emergency conditions and allowed to thicken by gravity settling. The sludge formed when the slurry thickens will be removed by front end loader and conveyed to the sludge treatment system for stabilization. The water decanted from the thickened slurry, and not evaporated, will overflow to the surge pond.

The main surge pond is a collection basin for overflows from the auxiliary surge pond and several additional waste streams. Surface drainage from the FGD system and the reclaim water sump overflow will also drain into the surge pond. Rainwater runoff from the sludge truck load out area, from under the sludge conveyors, and from the sludge reclaim area will drain to the surge pond by gravity. The water decanted from the auxiliary surge pond will drain to the surge pond. The collected water in the surge pond will be pumped to the thickeners for removal of sediment and used as make-up for the SO_2 scrubbers. Drainage entering the surge pond will not leave the plant except as makeup to the scrubbers, as water hydrated with the stabilized FGD sludge, or through evaporation.

Waste from air heater wash, precipitator wash and boiler chemical cleaning is discharged to the metal cleaning pond for storage. This pond is designed to accommodate all the wastewater containing heavy metals generated in 24 hours by cleaning all the three air heaters associated with one unit. Water collected in the metal cleaning waste pond will be pumped to the waste water treatment system for processing before being discharged to the cooling pond.

B. Lignite Storage Area and Runoff Basin Design

The location and layout of the lignite storage area and lignite pile runoff basin are shown on Exhibit 1. Five borings have been drilled in this area and their locations are shown on Exhibits 4 and 5. Copies of the boring logs are included in Appendix A. Based on the results of the boring data, the lignite storage area and lignite pile runoff basin are located over surface soil deposits of dense silty sand and sandy silt (SM and ML Unified Soil Classification). A summary of the laboratory test results on samples from these borings is given in Exhibit 6. All soil borings and soil laboratory test results given in this report, with the exception of Boring B14, have been drilled and tested by NFS/National Soil Services, Inc., Dallas, Texas. Boring B14 was drilled and tested by East Texas Testing Laboratory, Inc., Tyler, Texas. Complete laboratory index property and permeability test results for all samples from borings located in or near wastewater pond facilities are included in Exhibit 6. Also included for reference are index property and permeability values for various types of soils from other onsite borings.

The lignite pile runoff basin is an above and below ground pond designed to store lignite pile and limestone pile runoff. Plan and cross sections are shown in Exhibit 5. The lignite storage pile will be underlain by two feet of compacted cohesive fill (SC, CL, and CH Unified Soil Classification). The drainage ditches transporting runoff from the storage area to the basin will be lined with minimum 18 inches of compacted cohesive fill. The runoff basin will be lined on the bottom and side slopes with a minimum three feet of compacted cohesive fill. The dike fill, including lining, will be compacted as specified to a minimum 95 percent maximum density in accordance with ASTM D698. These requirements are in accordance with the guidelines suggested by the TDWR for wastewater ponds.

A summary of the parameters used for the lignite pile runoff basin design in comparison to those parameters and guidelines suggested by the TDWR is given in Exhibit 2. The runoff basin design parameters equal or exceed the minimum recommended values except for depth to the water table. Average or median parameter values are given where several individual tests or measurements were made. The only suggested parameter not obtainable is the TDWR recommendation that the bottom of the basin be 10 feet above the water table. The water table varies throughout the site, and with normal pool of the cooling pond at elevation 340.0 ft., it is possible that the static water table may be located within 3 feet of the bottom of the clay lining of any of the plant's wastewater ponds. Despite this, the presence of relatively homogeneous impermeable in situ and compacted clay layers should provide sufficient lining and protection of the groundwater.

Compacted clay linings are required on the bottom and side slopes of the lignite pile runoff basin and beneath the lignite storage pile. Project specifications require these compacted linings to be cohesive soils with minimum 40% passing the no. 200 sieve and having a minimum plasticity index of 15. The linings are to be compacted to minimum 95% maximum density in accordance with ASTM D698. The permeability of the compacted linings is estimated to be less permeable than or equal to 1.0×10^{-7} cm/sec. This will be verified by SWEPCO by testing field samples in the laboratory during or after construction.

C. Surge Pond Design

The location and layout of the surge pond are shown on Exhibit 1. Four borings have been drilled in this area and their locations are shown on Exhibits 4 and 7. Copies of the boring logs are included in Appendix A. Based on the results of the boring data, the surge pond is located within or above a thick surface deposit of silty and sandy clay (CL and CH Unified Soil Classification). The thickness of the in situ clay soils below the bottom of the pond (approximately elevation 350 ft) ranges from two and one half to 16 feet. A summary of the laboratory test results on samples from the surge pond borings is given in Exhibit 6.

The surge pond (including auxiliary surge pond) is an above and below ground pond. Dikes and excavated slopes are designed with three horizontal to one vertical side slopes. Dike fill will be cohesive soil compacted to a minimum 95 percent maximum density in accordance with ASTM D698. Typical surge pond cross sections are shown on Exhibit 7.

In situ cohesive soils will be used to function as the pond lining. Verification of the quality and thickness of the in situ lining will be made during or after construction by SWEPCO. As previously stated, the borings indicate that the thickness of the in situ lining ranges from approximately two and one half to 16 feet. Any compacted cohesive linings required will meet the density, index property, and permeability requirements as given for the lignite runoff basin.

Exhibit 2 summarizes the TDWR suggested parameters and guidelines and those parameters used for the surge pond design. Comparison of the design parameters obtained and those suggested indicate that in almost every case the obtained parameters equaled or exceeded the suggested value. The only suggested parameter not obtainable is the recommended 10 ft. depth to the groundwater table. It is possible that the groundwater table could eventually be located within 3 ft. of the bottom of the clay lining of the pond, as previously discussed.

Six laboratory permeability tests were performed on samples of undisturbed clay soil from the surge pond area. Results are given in Exhibit 8 and indicate a median permeability value of $5.1\text{x}10^{-8}$ cm/sec. The permeability test values ranged from $2.1\text{x}10^{-6}$ cm/sec. to $7.4\text{x}10^{-9}$ cm/sec.

D. <u>Bottom Ash Basin and Secondary Pond Design</u>

The location and layout of the bottom ash basins and secondary pond are shown on Exhibit 1. Plan and cross sections are shown in Exhibit 9. Nine borings have been drilled in this area. Their locations are given in Exhibits 4 and 9. Copies of the boring logs are included in Appendix A. Based on the results of the boring data, the secondary pond, bottom ash basin no. 1 and the east half of bottom ash basin no. 2 are located within or above a thick surface deposit of silty and sandy clay. These soils are classified as SC, CL, and CH material. A summary of the laboratory test results on samples from those borings is given in Exhibit 6. Results of approximately 23 tests on cohesive soils representing in situ lining indicate average fines content and plasticity index values of 78% and 36, respectively. These values significantly exceed the minimum values suggested by the TDWR.

Bottom ash basin no. 1 is an above and below ground pond located entirely in a cohesive soil deposit. The thickness of the cohesive soil below the bottom of the pond is greater than 5 feet. The plan and cross sections are given in Exhibit 9. A compacted clay lining is shown and will be used where required. In situ lining of acceptable quality and thickness exist in most of the area. This will be verified in the field during construction by SWEPCO. Shallow borings, test pits, and laboratory testing will be performed as necessary.

Bottom ash basin no. 2 is also an above and below ground pond. A portion of this pond (west half) will require a minimum three feet thick compacted clay lining. The location where an acceptable in situ lining does not exist and where the compacted lining begins will be determined and verified in the field by SWEPCO.

The secondary pond has a bottom elevation of 344 feet. This is three feet or more below the lowest point in either bottom ash basin. During borrow excavation and construction of the embankment, the existing clay may be completely removed from areas within the pond. Where this occurs, a three foot thick compacted clay lining will be installed to the requirements of project specifications and the technical guidelines suggested by the TDWR. This will be verified in the field by SWEPCO.

Exhibit 2 summarizes the TDWR parameters and guidelines and those parameters used for the design of the bottom ash basins and the secondary pond. As indicated in Exhibit 2, the design parameters meet or exceed nearly all of the suggested values. The only suggested parameter not obtainable is the recommended depth to the groundwater table as previously discussed. The median permeability from ten laboratory tests on samples of in situ cohesive soils (generally CH classification) is approximately $7.5\text{x}10^{-9}$ cm/sec. The permeability of clay soils used for compacted cohesive linings (SC, CL, and CH classification) is estimated to be less than or equal to $1.0\text{x}10^{-7}$ cm/sec. The permeability of the compacted lining will be verified by SWEPCO by testing field samples in the laboratory during and after construction.

E. Metal Cleaning Waste Pond

The location and layout of the metal cleaning waste pond are shown on Exhibit 1 and 10. The pond lies between the surge pond and the bottom ash basins. Borings located near the metal cleaning waste pond are shown in Exhibit 4. Review of the boring data indicates that the pond is located within or above a thick surface deposit of silty and sandy clay. Evaluation of the boring data is similar to that of the bottom ash basins.

The metal cleaning waste basin is an above and below ground pond. Plan and cross sections are given in Exhibit 10. The pond will require a minimum three feet thick clay lining where sufficient in situ clay does not exist at the design elevation. SWEPCO will verify the quality and acceptability of the lining, whether in situ or compacted.

IV GROUNDWATER MONITORING PROGRAM

Nine groundwater monitoring wells are to be installed at locations adjacent to the wastewater pond facilities. The wells will be installed after completion of pond construction. The approximate locations of these wells are given in Exhibit 12.

Four-inch diameter monitoring wells will be used because they permit use of a portable submersible pump for obtaining samples for water quality analysis. Each slotted screen for each well will be located in the most permeable soils occurring below the water table. A soil boring will be drilled at each well location to accurately define the soil strata adjacent to the well and to finalize the location and design of the well. The soils are very dense and range from a medium fine sand and silty sand to clayey sand and silty clay. The length of the screens have not yet been determined but are expected to range from 15 to 25 feet.

Technical Guide No. 6, published by the TDWR, presents guidelines for design and installation of monitoring wells. The H. W. Pirkey monitoring wells will equal or exceed these guidelines.

The groundwater monitoring program will consist of measuring and recording groundwater levels and obtaining samples for water quality analysis. The frequency for measuring levels and obtaining samples has not yet been determined. Measurements and samples will be obtained by SWEPCO and should begin at least two years before the power plant begins operation. This will allow for sufficient background data against which to compare all subsequent measurements and analyses of samples taken at the site.

Sargent & Lundy, by

D. G. Bodine

D. G. Bodine
Supervisor,
Geotechnical Division

Kenneth J. Kostal

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SEP 20 1984
OFFICE OF
R. A. NEAL

September 14, 1984
Project No. 5555-02
File No. 5.8.1

Southwestern Electric Power Company
Henry W. Pirkey Power Plant
Unit 1

HP-56

Wastewater Ponds - Liner
Verification & Monitoring Wells

Mr. M. J. Scott
Southwestern Electric Power Company
P. O. Box 21106
Shreveport, Louisiana 71156

Dear Mr. Scott:

We have completed our review of the boring logs and results of the laboratory tests made on samples from the borings which you transmitted to us. This work was performed as part of the liner verification program transmitted to Mr. R. A. Neal with a letter, dated February 25, 1983.

Enclosed is a copy of Table #1 which was developed by combining the information contained on the field logs and the results of the laboratory test data. From the information contained in Table #1, Table #2 was prepared and summarizes our analysis of the test results for each individual pond or lined area.

Our analysis indicates that the cohesive linings for the surge pond, metal cleaning waste pond, bottom ash basins No. 1 and No. 2 and beneath the lignite storage pile are in general accordance with the guidelines suggested by the Texas Department of Water Resources. The average permeability reported for bottom ash basin No. 1 is 2.4×10^{-6} cm/sec. This value is higher than desired because it is significantly influenced by one out of the eight tests run. This one test yielded a 1.1×10^{-5} cm/sec flow rate for a CH clay sample which leads one to believe that the test may be in error due to a leak in the testing apparatus or a miscalculation. You may want to run this by the laboratory for a check.

SWL
&
SL

COPY

The cohesive lining for the secondary pond appears to be very sandy or contains sand pockets more so on the east side of the pond. The area should be inspected and repaired if necessary to improve its cohesive lining.

done

The borings and testing for the lignite pile runoff basin was not yet completed when you transmitted the data. Please forward this data to us as soon as it becomes available so that the tables can be completed. Also boring S-17 in the Metal Cleaning Pond was not yet drilled.

done
S-15
wk. of 10/8

Part of this verification program was also to consist of a review of the field density test records for the lining made during construction so that a statistical summary could be performed. This data was included in your previous transmittal. Please forward us this data at your convenience.

SWEPCO

We have also enclosed a marked up copy of the boring logs correcting the soil classification based on our review of the laboratory test data. Please have the laboratory make the indicated corrections and re-issue the logs.

SWL

We also received the boring logs for the ten monitoring wells. A review of these logs indicates that if the wells are installed per the detail proposed in the monitoring well program, they will encounter pervious sandy soils. Well MW-9 may, however, need to be installed approximately five feet deeper than proposed to intersect a thicker layer of sands.

SWL
& StL

After you review the data being transmitted to you and with your concurrence we will formalize the data into an Appendix which can be added to the Wastewater Pond Data Report.

Yours very truly,

CHARLES J. NELSON

Charles J. Nelson
Structural Project Engineer

Check elev. of
S-16

Add Ground elev. to
Logs.

CJN:jg
Enclosure
Copies:
R. A. Neal (1/1)
W. H. Holley (1/1)
J. A. Pruett (1/1)
F. J. Emmett (1/1)
E. R. Weaver (1/1)
D. G. Bodine (1/1)
J. A. Wilson (1/1)

HP.56

COPY

NEAL

SUMMARY OF LABORATORY TEST RESULTS FOR COHESIVE LINING VERIFICATION PROGRAM (1)

Facility	Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (%) Passing) (2)				Atterberg Limits (3)			Unified Soil Classification Symbol	Field Water Content (%) (4)	Dry Density lbs/ft^3	Laboratory Permeabilit cm/sec
			No. 4 Sieve	No.10 Sieve	No.40 Sieve	No.200 Sieve	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index				
Secondary Pond	S-1	0-2	95	91	88	60	32	18	14	CL-Silty Clay	18.9	–	$2.2x10^{-8}$
		2-4	91	88	85	63	28	18	10	CL-Silty Clay	18.3	–	$8.5x10^{-8}$
		4-6	–	–	–	–	28	18	10	CL-Sandy Clay	20.3	–	–
		6.5-8	–	–	–	26	28	18	10	SC-Clayey Sand	22.2	–	–
		8.5-10	–	–	–	–	–	–	–	CL-Sandy Clay	27.1	–	–
	S-2	0-2	–	–	–	–	29	17	12	CL-Sandy Clay	19.0	–	$7.2x10^{-8}$
		2-4	–	–	–	–	35	18	17	CL-Sandy Clay	23.0	–	$7.6x10^{-8}$
		4.5-6	–	–	–	–	42	21	21	CL-Sandy Clay	23.1	–	–
		6.5-8	–	–	–	–	33	18	15	CL-Silty Clay	24.1	–	–
		8.5-10	–	–	–	–	35	18	17	CL-Sandy Clay	23.4	–	–
	S-3	0-2	–	–	–	32	28	18	10	SC-Clayey Sand	20.4	–	$8.7x10^{-6}$
		2-4	–	–	–	–	31	19	12	SC-Clayey Sand	23.7	–	$1.1x10^{-5}$
		4-6	–	–	–	37	31	18	13	SC-Clayey Sand	23.9	–	–
		6.5-8	–	–	–	–	–	–	–	CL-Sandy Clay	26.9	–	–
		8.5-10	–	–	–	–	–	–	–	CL-Sandy Clay	30.0	–	–
BA-B#1	S-4	0-2	100	100	100	75	36	19	17	CL-Silty Clay	21.2	–	$6.8x10^{-9}$
		2-4	100	100	100	76	34	18	16	CL-Silty Clay	19.4	–	$1.8x10^{-8}$
		4-6	–	–	–	–	–	–	–	CL-Silty Clay	19.3	–	–

Notes:
1. Laboratory Testing Performed by Southwestern Laboratories, Shreveport, LA.
2. Laboratory Particle Size Analysis Tests - ASTM D422 or D1140.
3. Laboratory Atterberg Limit Tests - ASTM D423 and D424.
4. Laboratory Moisture Content of Soils - ASTM D2216.

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS FOR COHESIVE LINING VERIFICATION PROGRAM (1)

Facility	Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (%) Passing) (2)				Atterberg Limits (3)			Unified Soil Classification Symbol	Field Water Content (%)(4)	Dry Density lbs/ft^3	Laboratory Permeabilit cm/sec
			No. 4 Sieve	No.10 Sieve	No.40 Sieve	No.200 Sieve	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index				
Surge Pond	S-12	0-2	-	-	99	92	39	19	20	CL-Silty Clay	23.7	-	1.4×10^{-8}
		2-4	-	-	98	95	52	22	30	CH-Silty Clay	26.3	-	1.1×10^{-8}
		4-6	-	-	-	-	61	23	38	CH-Silty Clay	23.2	-	-
	S-13	0-2	-	-	-	76	38	20	18	CL-Sandy Clay	21.3	-	3.6×10^{-8}
		2-4	-	-	-	69	32	17	15	CL-Sandy Clay	19.1	-	6.6×10^{-8}
		4-6	-	-	-	-	-	-	-	CL-Sandy Clay	17.7	-	-
	S-14	0-2	-	-	-	99	51	20	31	CH-Silty Clay	31.4	-	9.2×10^{-8}
		2-4	-	-	-	98	48	20	28	CL-Silty Clay	29.8	-	1.3×10^{-8}
		4-6	-	-	-	-	-	-	-	CL-Silty Clay	29.2	-	-
Metal Cleaning Pond	S-15	Not Drilled Yet											
	S-16	0-2	-	-	-	59	44	21	23	CL-Sandy Clay	23.6	-	2.7×10^{-8}
		2-4	-	-	-	80	45	20	25	CL-Sandy Clay	23.1	-	1.3×10^{-8}
		4-6	-	-	-	-	29	19	10	SC-Clayey Sand	23.5	-	-
	S-17	0-2	-	-	-	89	48	20	28	CL-Silty Clay	27.8	-	6.1×10^{-8}
		2-4	-	-	-	93	49	20	29	CL-Silty Clay	27.2	-	4.3×10^{-8}
		4-6	-	-	-	-	23	17	6	SC-Clayey Sand	18.1	-	-

Notes:
1. Laboratory Testing Performed by Southwestern Laboratories, Shreveport, LA.
2. Laboratory Particle Size Analysis Tests - ASTM D422 or D1140.
3. Laboratory Atterberg Limist Tests - ASTM D423 and D424.
4. Laboratory Moisture Content of Soils - ASTM D2216.

TABLE 1 (Continued)

SUMMARY OF LABORATORY TEST RESULTS FOR COHESIVE LINING VERIFICATION PROGRAM (1)

Facility	Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (%) Passing) (2)				Atterberg Limits (3)			Unified Soil Classification Symbol	Field Water Content (%) (4)	Dry Density lbs/ft^3	Laboratory Permeabilit cm/sec
			No. 4 Sieve	No.10 Sieve	No.40 Sieve	No.200 Sieve	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index				
Bottom Ash Basin #1	S-5	0-2	–	–	–	81	38	19	19	CL-Sandy Clay	20.9	–	$4.9x10^{-7}$
		2-4	–	–	–	75	36	18	18	CL-Sandy Clay	21.5	–	$8.1x10^{-8}$
		4.5-6	–	–	–	–	–	–	–	CL-Sandy Clay	24.3	–	–
	S-6	0-2	–	–	–	–	32	17	15	CL-Silty Clay	22.4	–	$7.4x10^{-6}$
		2-4	–	–	–	55	43	20	23	CL-Sandy Clay	22.2	–	$7.1x10^{-8}$
		4-6	–	–	–	–	54	21	33	CH-Silty Clay	25.2	–	–
	S-7	0-2	–	–	–	97	46	20	26	CL-Silty Clay	30.4	–	$2.0x10^{-8}$
		2-4	–	–	–	90	51	20	31	CH-Silty Clay	30.4	–	$1.1x10^{-5}$
		4-6	–	–	–	–	–	–	–	CL-Sandy Clay	27.7	–	–
Bottom Ash Basin #2	S-8	0-2	99	98	97	65	49	20	29	CL-Silty Clay	15.3	–	$4.3x10^{-8}$
		2-4	–	–	98	92	53	20	33	CH-Silty Clay	31.4	–	$7.5x10^{-9}$
		4-6	–	–	–	–	33	18	15	CL-Sandy Clay	18.3	–	–
	S-9	0-2	–	–	–	90	51	20	31	CH-Silty Clay	28.8	–	$6.1x10^{-8}$
		2-4	–	–	–	80	38	19	19	CL-Sandy Clay	21.6	–	$3.2x10^{-8}$
		4-6	–	–	–	–	29	18	11	CL-Sandy Clay	19.1	–	–
	S-10	0-2	–	–	–	80	34	18	16	CL-Silty Clay	18.2	112	$6.5x10^{-8}$
		2-4	–	–	–	74	38	19	19	CL-Silty Clay	18.9	115	$1.2x10^{-8}$
		4-6	–	–	–	–	30	18	12	CL-Silty Clay	19.1	112	–
	S-11	0-2	–	–	–	81	41	20	21	CL-Silty Clay	28.8	96	$1.5x10^{-7}$
		2-4	–	–	–	94	43	20	23	CL-Silty Clay	31.4	91	$1.8x10^{-8}$
		4-6	–	–	–	–	–	–	–	CL-Silty Clay	28.8	95	–

Notes:
1. Laboratory Testing Performed by Southwestern Laboratories, Shreveport, LA.
2. Laboratory Particle Size Analysis Tests - ASTM D422 or D1140.
3. Laboratory Atterberg Limit Tests - ASTM D423 and D424.
4. Laboratory Moisture Content of Soils - ASTM D2216.

TABLE 1 (Continued)

SUMMARY OF LABORATORY TEST RESULTS FOR COHESIVE LINING VERIFICATION PROGRAM (1)

Facility	Boring No. Sample No.	Sample Depth, Ft	Particle Size Analysis (%) Passing) (2)				Atterberg Limits (3)			Unified Soil Classification Symbol	Field Water Content (%) (4)	Dry Density lbs/ft^3	Laboratory Permeabilit cm/sec
			No. 4 Sieve	No.10 Sieve	No.40 Sieve	No.200 Sieve	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index				
Lignite Storage Pile	S-18	0-2	91	90	89	48	33	18	15	SC-Clayey Sand	13.4	-	$1.3x10^{-6}$
		2-4	-	99	97	78	35	18	17	CL-Silty Clay	20.4	-	$7.2x10^{-8}$
		4-6	-	-	-	-	-	-	-	CL-Sandy Clay	17.9	-	-
	S-19	0-2	-	-	-	-	37	17	20	CL-Sandy Clay	20.5	-	$8.7x10^{-8}$
		2-4	-	-	-	-	24	17	7	SC-Clayey Sand	11.6	-	$2.4x10^{-7}$
		4.5-6	-	-	-	-	33	18	15	CL-Sandy Clay	13.3	-	-
	S-20	0-2	-	-	-	-	33	18	15	CL-Sandy Clay	16.3	-	$3.7x10^{-8}$
		2-4	-	-	-	-	25	18	7	ML-CL Clayey Silt	14.9	-	$3.8x10^{-7}$
		4-6	-	-	-	-	33	18	15	CL-Sandy Clay	17.7	-	-
Lignite Run-off Pond	S-21	Not Drilled Yet											
	S-22	Not Drilled Yet											

Notes:
1. Laboratory Testing Performed by Southwestern Laboratories, Shreveport. LA.
2. Laboratory Particle Size Analysis Tests - ASTM D422 or D1140.
3. Laboratory Atterberg Limit Tests - ASTM D423 and D424.
4. Laboratory Moisture Content of Soils - ASTM D2216.

TABLE 1 (Continued)

SUMMARY OF ANALYSIS OF LABORATORY TEST RESULTS FOR COHESIVE LINING VERIFICATION PROGRAM

Facility	Lining Soil Type	Lining Thickness Ft	Average Permeability k, cm/sec	Average Fines Content FC, %	Average Liquid Limit LL, %	Average Plasticity Index PI
Surge Pond	CL&CH	≥ 4	3.8×10^{-8}	88	43	24
Secondary Pond	SC&CL	≥ 4	3.8×10^{-6}	52	30	12
Bottom Ash Basin #1	CL&CH	≥ 4	2.4×10^{-6}	92	40	21
Bottom Ash Basin #2	CL&CH	≥ 4	4.8×10^{-8}	82	43	24
Metal Cleaning Waste Pond	CL&CH	≥ 4	3.8×10^{-8}	80	46	26
Lignite Runoff Pond		Boring	Not	Drilled	Yet	
Lignite Storage Pile	SC, CL ML&CL	≥ 4	3.5×10^{-7}	63	31	14
Suggested Guideline (TDWR)	CL, CH & SC	≥ 3	$\leq 1\times10^{-7}$	≥ 30	≥ 30	≥ 15

TABLE 2

Southwestern Electric Power Company

FOR COMPANY BUSINESS ONLY

SUBJECT Waste Water Ponds Lining Verification and Monitoring Wells

DATE February 6, 1984

LOCATION Henry W. Pirkey Power Plant, Unit #1

Mr. Jay Pruett

Attached please find one copy of the "Waste Water Ponds Lining Verification and Monitoring Wells" report of work performed to date. In order to complete this project, the following must be accomplished:

A. perform borings S-21 and S-22 in lignite pile run-off basin

B. perform boring S-15 in metal waste cleaning pond

C. re-drill borings S-1, S-2 and S-3 in secondary pond.

This work will be performed during the summer of 1984.

Please advise if you have any comments regarding this report.

W. H. Holley
W. H. Holley

WHH/bs

Attachment

cc: C. J. Nelson (S&L) w/attachment

SWL

SOUTHWESTERN LABORATORIES

Materials, environmental and geotechnical engineering, nondestructive, metallurgical and analytical services

P.O. Box 37577 • 7222 Greenwood Rd. • Shreveport, LA 71103 • 318/636-3673

September 7, 1984

Southwestern Electric Power Company
P.O. Box 21106
Shreveport, Louisiana 71156

Attention: Mr. Winston Holley

Reference: Subsurface Exploration
Waste Water Ponds
Pirkey Power Plant
Hallsville, Texas

Gentlemen:

Attached is our Subsurface Exploration Report for the above referenced project.

It has been a pleasure to perform this work for you. If, during the course of this project, we can be of any further assistance, please do not hesitate to call on us.

Very truly yours,

SOUTHWESTERN LABORATORIES

Gene Gardner

Gene Gardner, P.E.

GG:awd
Attachment
3 cc: Southwestern Electric Power Company

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SEP 13 1984

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W. H. HOLLEY

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SWL

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Materials, environmental and geotechnical engineering, nondestructive, metallurgical and analytical services
P.O. Box 37577 • 7222 Greenwood Rd. • Shreveport, LA 71103 • 318/636-3673

August 20, 1984

File No. 832964

Southwestern Electric Power Company
P. O. Box 21106
Shreveport, LA 71156

Attention: Mr. Winston Holley

Reference: Subsurface Exploration
Waste Water Ponds
Pirkey Power Plant
Hallsville, Texas

Gentlemen:

Enclosed is our Subsurface Exploration Report on Borings S-1, S-2 and S-3. These are redrilled for verification of the lining for the pond. The locations of the borings are shown on your drawing number HP-56A.

It has been a pleasure to perform this work for you. If, during the course of this project, we can be of any further assistance, please do not hesitate to call on us.

Very truly yours,

SOUTHWESTERN LABORATORIES

Gene Gardner

Gene Gardner, P.E.

GG:kw
Enclosure
3 cc: Southwestern Electric Power Company

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HOUSTON • DALLAS • FORT WORTH • ARLINGTON • BEAUMONT • TEXAS CITY • TEXARKANA • MIDLAND

Bill Porter

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Materials, environmental and geotechnical engineering, nondestructive, metallurgical and analytical services

P.O. Box 37577 • 7222 Greenwood Rd. • Shreveport, LA 71103 • 318/636-3673

December 27, 1983

File No. 832964

Southwestern Electric Power Company
P. O. Box 21106
Shreveport, LA 71156

Attention: Mr. Winston Holley

Reference: Waste Water Ponds
Pirkey Power Plant
Hallsville, Texas

Gentlemen:

The above referenced report was dated October 5, 1983. In accordance with Bill Porter's request dated December 22, I have revised the boring schedule for this report.

These revisions are based on the revised survey by Hart Engineering which was reported to you on October 11, 1983, by Mr. Nealy of Hart Engineering.

Data on the following borings was revised: S-10, S-11, MW-2, MW-4 and MW-10.

Very truly yours,

SOUTHWESTERN LABORATORIES

Gene Gardner

Gene Gardner, P.E.

GG:kw

Enclosure

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DEC 29 1983

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P.O. Box 37577 • 7222 Greenwood Rd. • Shreveport, LA 71103 • 318/636-3673

December 19, 1983

File No. 832964

Southwestern Electric Power Company
P.O. Box 21106
Shreveport, Louisiana 71156

Attention: Mr. Winston Holley

Reference: Subsurface Exploration
Waste Water Ponds
Pirkey Power Plant
Hallsville, Texas

Gentlemen:

Enclosed is our Summary of Laboratory Test Data and Log of Boring for Boring MW-3 of the above referenced project.

To summarize, all borings for this project have been completed, with the exception of S-15, S-21, and S-22, and the re-drills of S-1, S-2, and S-3. These borings are on indefinite hold at you request.

The ten (10) monitor wells have been installed. However, the steel protective caps have not been installed.

It has been a pleasure to perform this work for you. If we can be of any further assistance, please do not hesitate to call on us.

Very truly yours,

SOUTHWESTERN LABORATORIES

Gene Gardner

Gene Gardner, P.E.

GG:jwe
Enclosure
3 cc: Southwestern Electric Power Company

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Materials, environmental and geotechnical engineering, nondestructive, metallurgical and analytical services

P.O. Box 37577 • 7222 Greenwood Rd. • Shreveport, LA 71103 • 318/636-3673

October 21, 1983

File No. 832964

Southwestern Electric Power Company
P.O. Box 21106
Shreveport, Louisiana 71156

Attention: Mr. Winston Holley

Reference: Subsurface Exploration
Waste Water Ponds
Pirkey Power Plant
Hallsville, Texas

Gentlemen:

Enclosed is our Subsurface Exploration Report for the above referenced project. Monitor well MW-3 has not yet been installed. It will be installed soon. At that time, we will also re-drill Borings S-1, S-2 and S-3. Borings S-15, S-21 and S-22 have not been drilled and are on hold at your request.

It has been a pleasure to perform this work for you. If we can be of any further assistance, please do not hesitate to call on us.

Very truly yours,

SOUTHWESTERN LABORATORIES

Roy D. Jones, P.E.
Geotechnical Manager

Gene Gardner

Gene Gardner, P.E.

RDJ;GG:jwe
Enclosure
3 cc: Southwestern Electric Power Company

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OCT 26 1983

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Materials, environmental and geotechnical engineering, nondestructive, metallurgical and analytical services

P.O. Box 37577 • 7222 Greenwood Rd • Shreveport, LA 71103 • 318/636-3673

October 5, 1983

File No. 832964

Southwestern Electric Power Company
P.O. Box 21106
Shreveport, Louisiana 71156

Attention: Mr. Winston Holley

Reference: Waste Water Ponds
Pirkey Power Plant
Hallsville, Texas

Gentlemen:

Enclosed is our Subsurface Exploration Report for the above referenced project. Borings S-10, S-11, S-15, S-21 and S-22 have not yet been drilled at this time. Results from those borings will be sent to you at a later date. Boring Logs and Summaries of Laboratory Test Data for the monitor well installations (MW-1 through MW-10) will also be sent to you at a later date.

It has been a pleasure to perform this work for you. If, during the course of this project, we can be of any further assistance, please do not hesitate to call on us.

Very truly yours,

SOUTHWESTERN LABORATORIES

Roy D. Jones, P.E.
Geotechnical Manager

Gene Gardner

Gene Gardner, P.E.

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W. H. HOLLEY

RDJ;GG:jwe
Enclosure
3 cc: Southwestern Electric Power Company

BORING SCHEDULE

Boring No.	Location*		Depth	Surface Elevation
S-1	N9+69.8	W18+99.5	10	343.6
S-2	N10+20	W17+30.8	10	343.9
S-3	N9+12.6	W16+13.6	10	343.8
S-4	N14+99.3	W17+01	6	347.3
S-5	N15+ 00.8	W11+30.6	6	347.1
S-6	N19+99.9	W16+99.9	6	353.6
S-7	N20+00.2	W11+29.9	6	346.9
S-8	N14+88.3	W32+91	6	347.1
S-9	N20+11.4	W32+74.9	6	348.1
S-10	N15+00	W26+00	6	347.4
S-11	N20+00	W26+00	6	347.0
S-12	N0+00.2	W16+99.9	6	348.3
S-13	N3+00.3	W17+91.5	6	348.9
S-14	S1+38.2	W13+70.5	6	352.9
S-15	N2+00	W8+80	6	
S-16	N1+36	W11+52.9	6	357.0
S-17	N2+12.6	W12+86.2	6	348.1
S-18	S15+27	W8+89.3	6	357.2
S-19	S19+01.1	W6+05.3	6	356.7
S-20	S18+01.7	W13+55.4	6	357.6
S-21	S23+20	W16+20	6	
S-22	S23+20	W13+50	6	
MW-1	N18+55.2	W38+59.8	33	334.0
MW-2	N9+88.5	W25+85.4	41	341.0
MW-3	N19+99.7	W22+75	57	370.0
MW-4	N13+76.4	W8+34.4	46	363.4
MW-5	N2+61.5	W7+82.2	44.5	362.5
MW-6	S1+84.6	W10+60.5	43	361.0
MW-7	S2+23.9	W17+24.45	40.5	358.3
MW-8	S21+04.6	W16+11.9	34.5	356.3
MW-9	S15+48	W1+88.5	31	353.1
MW-10	N6+56.9	W18+31.3	39.5	358.6

* Locations are based on the power plant grid coordinate system.

832964 **SUMMARY OF LABORATORY TEST DATA**

PROJECT Waste Water Ponds Pirkey Power Plant

DATE 9-29-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
S-1	0 - 2	Silty sandy clay w/iron ore	18.9		32	18	14					* **
	2 - 4	Silty sandy clay w/iron ore	18.3		28	18	10					* **
	4½- 6	Very silty sandy clay	20.3		28	18	10					28 B/F
	6½- 8	Clayey silty sand	22.2		28	18	10					26% Finer 50 B/10"
	8½-10	Silty sandy clay w/gravel	27.1									50 B/3½"
S-2	0 - 2	Silty sandy clay	19.0		29	17	12					**
	2 - 4	Silty sandy clay w/iron ore	23.0		35	18	17					* **
	4½- 6	Silty sandy clay	23.1		42	21	21					23 B/F
	6½ - 8	Sandy silt clay	24.1		33	18	15					50 B/11"
	8½-10	Silty sandy clay w/gravel	23.4		35	18	17					24 B/F

* Hydrometer analysis results attached.

** Permeability results attached.

SOUTHWESTERN LABORATORIES

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SUMMARY OF LABORATORY TEST DATA

PROJECT Waste Water Ponds Pirkey Power Plant

DATE 9-29-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
S-3	0 - 2	Clayey silty sand w/iron ore	20.4		28	18	10					32% Finer **
	2 - 4	Sandy silty clay w/iron ore	23.7		31	19	12					
	4 - 6	Silty sandy clay w/iron ore	23.9		31	18	13					37% Finer **
	6½- 8	Silty sandy clay w/iron ore	26.9									50 B/F
	8½-10	Silty sandy clay	30.0									50 B/11"
S-4	0 - 2	Silty sandy clay	21.2		36	19	17					* **
	2 - 4	Silty sandy clay	19.4		34	18	16					* **
	4 - 6	Silty sandy clay w/iron ore	19.3									
S-5	0 - 2	Silty sandy clay w/iron ore	20.9		38	19	19					81% Finer **
	2 - 4	Silty sandy clay w/iron ore	21.5		36	18	18					75% Finer **
	4½- 6	Silty sandy clay	4.3									28 B/F

* Hydrometer analysis results attached.
** Permeability results attached.

832964 **SUMMARY OF LABORATORY TEST DATA**

PROJECT Waste Water Ponds Pirkey Power Plant

DATE 9-29-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	COMPRESSION TEST COMPRESSION psf	COMPRESSION TEST STRAIN %	COMPRESSION TEST LATERAL PRESSURE psi	COMPRESSION TEST TYPE FAILURE	REMARKS
S-6	0 - 2	Sandy silty clay lenses w/iron ore	22.4		32	17	15					**
	2 - 4	Silty sandy clay w/iron ore	22.2		43	20	23					55% Finer **
	4 - 6	Clay	25.2		54	21	33					
S-7	0 - 2	Silty clay	30.4		46	20	26					97% Finer **
	2 - 4	Clay w/silt lenses and iron ore	30.4		51	20	31					90% Finer **
	4 - 6	Silty sandy clay	27.7									
S-8	0 - 2	Slightly silty sandy clay	15.3		49	20	29					* **
	2 - 4	Clay w/silt lenses	31.4		53	20	33					* **
	4 - 6	Silty sandy clay	18.3		33	18	15					
S-9	0 - 2	Clay w/silty sand	28.8		51	20	31					90% Finer **
	2 - 4	Silty sandy clay	21.6		38	19	19					80% Finer **
	4 - 6	Silty sandy clay	19.1		29	18	11					

* Hydrometer analysis results attached.
** Permeability results attached.

SOUTHWESTERN LABORATORIES

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SUMMARY OF LABORATORY TEST DATA

PROJECT Waste Water Ponds, Pirkey Power Plant

DATE 10-11-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
S-10	0 - 2	Very stiff sandy silty clay	18.2	112	34	18	16	6056	3.3		Vert. Shear	80% Finer -8 k=6.5x10
	2 - 4	Very stiff sandy silty clay	18.9	115	38	19	19	7947	4.0		Yield	74% Finer -8 k=1.2x10
	4 - 6	Stiff sandy silty clay	19.1	112	30	18	12	3448	1.7		Vert. Shear	
S-11	0 - 2	Very stiff sandy silty clay lenses	28.8	96	41	20	21	5906	2.3		45° Shear	81% Finer k=1.5x10
	2 - 4	Very stiff silty clay lenses	31.4	91	43	20	23	5128	3.5		Vert. Shear	94% Finer -8 k=1.8x10
	4 - 6	Very stiff silty clay lenses	28.8	95				5418	3.5		45° Shear	

832964

SUMMARY OF LABORATORY TEST DATA

PROJECT Waste Water Ponds Pirkey Power Plant

DATE 9-29-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
S-12	0 - 2	Sandy silty clay	23.7		39	19	20					* **
	2 - 4	Clay w/silt lenses	26.3		52	22	30					* **
	4 - 6	Clay	23.2		61	23	38					
S-13	0 - 2	Silty sandy clay	21.3		38	20	18					76% Finer **
	2 - 4	Silty sandy clay	19.1		32	17	15					69% Finer **
	4 - 6	Silty sandy clay	17.7									
S-14	0 - 2	Clay w/silt lenses	31.4		51	20	31					99% Finer **
	2 - 4	Slightly silty clay	29.8		48	20	28					98% Finer **
	4 - 6	Sandy silty clay	29.2									
S-16	0 - 2	Silty sandy clay w/iron ore	23.6		44	21	23					59% Finer **
	2 - 4	Silty sandy clay	23.1		45	20	25					80% Finer **
	4 - 6	Clayey silty sand	23.5		29	19	10					

* Hydrometer analysis results attached.
** Permeability results attached.

SOUTHWESTERN LABORATORIES

832964 **SUMMARY OF LABORATORY TEST DATA**

PROJECT Waste Water Ponds Pirkey Power Plant

DATE 9-29-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
S-17	0 - 2	Slightly silty clay w/iron ore	27.8		48	20	28					89% Finer **
	2 - 4	Slightly silty clay w/iron ore	27.2		49	20	29					93% Finer **
	4 - 6	Clayey silty sand	18.1		23	17	6					
S-18	0 - 2	Silty sandy clay w/iron ore	13.4		33	18	15					* **
	2 - 4	Sandy silty clay	20.4		35	18	17					* **
	4 - 6	Silty sandy clay w/gravel	17.9									
S-19	0 - 2	Silty sandy clay	20.5		37	17	20					75% Finer **
	2 - 4	Clayey silty sand	11.6		24	17	7					26% Finer **
	4½- 6	Silty sandy clay	13.3		33	18	15					37 B/F
S-20	0 - 2	Silty sandy clay w/gravel	16.3		33	18	15					53% Finer **
	2 - 4	Clayey sandy silt w/gravel	14.9		25	18	7					61% Finer **
	4 - 6	Silty sandy clay w/iron ore	17.7		33	18	15					

* Hydrometer analysis results attached.
** Permeability results attached.

SOUTHWESTERN LABORATORIES

SUMMARY OF LABORATORY TEST DATA

PROJECT Waste Water Ponds

DATE 8/20/84

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	Permeability (cm/sec)
S1	0-2	Medium slightly silty clay	32.2	85	48	20	28	1762	5.0		Vert. Shear	
	2-4	Stiff silty sandy clay	17.7	105	30	18	12	2096	6.0		Vert. Shear	$3.0x10^{-9}$
	6-8	Clayey silty sand w/iron ore	22.8		24	18	6					
S2	0-2	Medium slightly silty clay	35.3	82				1030	5.0		Vert. Shear	$5.9x10^{-9}$
	2-4	Silty sandy clay w/iron ore	21.7		32	18	14					
	4-6	Stiff silty sandy clay w/iron ore	21.6	110	33	18	15	2825	5.0		Vert. Shear	
	6-8	Silty sandy clay w/iron ore	23.8									
S3	0-2	Medium slightly silty clay	34.6	82	49	20	29	1230	6.0		Vert. Shear	$5.8x10^{-9}$
	2-4	Medium silty sandy clay	22.8	101				1157	6.0		Vert. Shear	$8.8x10^{-9}$
	4-6	Medium silty sandy clay w/iron ore	29.4	92				1203	6.0		Vert. Shear	

SOUTHWESTERN LABORATORIES

SUMMARY OF LABORATORY TEST DATA

832964
PROJECT Waste Water Ponds Pirkey Power Plant

DATE 09-29-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				k, Coefficient of Permeability cm/sec
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
S-4	0-2	Silty sandy clay										6.8×10^{-9}
	2-4	Silty sandy clay										1.8×10^{-8}
S-5	0-2	Silty sandy clay w/iron ore										4.9×10^{-7}
	2-4	Silty sandy clay w/iron ore										8.1×10^{-8}

SOUTHWESTERN LABORATORIES

832964

SUMMARY OF LABORATORY TEST DATA

PROJECT Waste Water Ponds Pirkey Power Plant

DATE 9-29-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				k, Coefficient of Permeability cm/sec
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
S-6	0 - 2	Sandy silty clay lenses w/iron ore										7.4×10^{-6}
	2 - 4	Silty sandy clay w/iron ore										7.1×10^{-8}
												2.0×10^{-8}
S-7	0 - 2	Silty clay										
	2 - 4	Clay w/silt lenses and iron ore										1.1×10^{-5}
S-8	0 - 2	Slightly silty sandy clay										4.3×10^{-8}
	2 - 4	Clay w/silt lenses										7.5×10^{-9}
S-9	0 - 2	Clay w/silty sand										6.1×10^{-8}
	2 - 4	Silty sandy clay										3.2×10^{-8}
S-12	0 - 2	Sandy silty clay										1.4×10^{-8}
	2 - 4	Clay w/silt lenses										1.1×10^{-8}

SOUTHWESTERN LABORATORIES

832964

SUMMARY OF LABORATORY TEST DATA

PROJECT Waste Water Ponds Pirkey Power Plant

DATE 9-29-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				k, Coefficient of Permeability cm/sec
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
S-13	0 - 2	Silty sandy clay										3.6×10^{-8}
	2 - 4	Silty sandy clay										6.6×10^{-8}
S-14	0 - 2	Clay w/silt lenses										9.2×10^{-8}
	2 - 4	Slightly silty clay										1.3×10^{-8}
S-16	0 - 2	Silty sandy clay w/iron ore										2.7×10^{-8}
	2 - 4	Silty sandy clay										1.3×10^{-8}
S-17	0 - 2	Slightly silty clay w/iron ore										6.1×10^{-8}
	2 - 4	Slightly silty clay w/iron ore										4.3×10^{-8}
S-18	0 - 2	Silty sandy clay w/iron ore										1.3×10^{-6}
	2 - 4	Sandy silty clay										7.2×10^{-8}

832964 **SUMMARY OF LABORATORY TEST DATA**

PROJECT Waste Water Ponds Pirkey Power Plant

DATE 9-29-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				k, Coefficient of Permeability cm/sec
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
S-19	0 - 2	Silty sandy clay										8.7×10^{-8}
	2 - 4	Clayey silty sand										2.4×10^{-7}
S-20	0 - 2	Silty sandy clay w/gravel										3.7×10^{-8}
	2 - 4	Clayey sandy silt w/gravel										3.8×10^{-7}

SOUTHWESTERN LABORATORIES

SUMMARY OF LABORATORY TEST DATA

PROJECT 832964

DATE 9-4-84

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				Permeability,k (cm/sec)
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
S-21	0-2	Stiff silty clay with iron ore	26.6	95				2160	6.0		Vert. Shear	1.00×10^{-8}
	2-4	Stiff silty clay with iron ore	22.9	100	39	19	20	3222	4.0		Vert. Shear	
	4-6	Very stiff silty clay w/iron ore	21.3	81	38	19	19	4910	3.0		Vert. Shear	
S-22	0-2	Stiff clay with iron ore	26.7	93	51	21	30	3947	5.0		Vert. Shear	
	2-4	Stiff silty clay w/ iron ore	22.3	102	39	19	20	3153	6.0		Vert. Shear	4.3×10^{-9}
	4-5	Firm clayey sand w/iron ore	18.8	106	22	18	4	1785	3.0		Vert. Shear	
S-23	0-2	Stiff slightly sandy clay w/iron ore	28.6	92				2285	5.0		Vert. Shear	2.1×10^{-8}
	2-4	Stiff slightly sandy clay w/iron ore	27.5	88	48	20	28	3222	4.0		Vert. Shear	
	4-6	Stiff sandy clay with iron ore	19.5	104	35	19	16	2212	4.0		Vert. Shear	
S-24	0-2	Stiff silty sandy clay w/iron ore	27.5	100				2841	5.0		Vert. Shear	
	2-4	Stiff sandy clay with iron ore	20.4	105	37	19	18	3765	3.0		Vert. Shear	1.6×10^{-8}
	4-6	Firm very sandy clay w/iron ore	14.4		28	17	11					

832964 **SUMMARY OF LABORATORY TEST DATA**

PROJECT Waste Water Ponds, Pirkey Power Plant

DATE 10-11-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
MW-1	3½-5	Very dense clayey silty sand w/clay seam	13.5									50 B/7"
	8½-10	Very stiff very sandy clay w/iron ore	17.6									30 B/F
	13-15	Stiff silty sandy clay	21.2	113				2842	4.8		Vert. Shear	
	18-20	Loose clayey silty sand	22.5	102				694	2.0		Vert. Shear	
	23½-25	Hard silty sandy clay lenses	14.9									50 B/11"
	28½-30	Very dense clayey sandy silt	19.7									50 B/11½"
MW-2	3 - 5	Firm clayey silty sand	12.2									
	8 - 10	Medium very sandy silty clay	18.0	116				1726	3.0		Vert. Shear	
	13-15	Dense clayey silty sand	23.3									
	18½-20	Dense clayey silty sand	22.2									31 B/F
	23-25	Dense silty sand	19.2									
	28½-30	Very dense clayey silty sand	24.7									50 B/F
	33½-35	Very dense clayey silty sand	23.5									50 B/9"
	38½-40	Hard sandy silty clay	17.7									50 B/F

SOUTHWESTERN LABORATORIES

832964 **SUMMARY OF LABORATORY TEST DATA**

PROJECT Waste Water Ponds Pirkey Power Plant

DATE 11-15-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
MW-3	3 - 5	Stiff sandy silty clay	21.0	107				2394	2.7		Vert. Shear	
	8 - 10	Stiff silty clay lenses w/iron ore	29.4	95				2981	3.0		Vert. Shear	
	13-15	Stiff sandy silty clay	25.7	103				1972	3.3		Vert. Shear	
	18-20	Firm sand w/clay lenses	30.2	95				800	2.3		Vert. Shear	
	23-25	Stiff clay	31.2	91				3485	3.0		45 Shear	Slickinsided
	28-30	Stiff clay w/silt lenses	28.3	95				3686	4.5		Vert. Shear	
	33-35	Firm clayey silty sand	20.5	103				1447	4.0		Vert. Shear	
	43½-45	Hard clay w/silty sand lenses	31.0									50 B/6"
	48½-50	Hard silty sandy clay	20.3									50 B/F
	53½-55	Hard silty sandy clay	20.4									50 B/10"

SOUTHWESTERN LABORATORIES

832964

SUMMARY OF LABORATORY TEST DATA

PROJECT Waste Water Ponds, Pirkey Power Plant

DATE 10-13-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
MW-4	3 - 5	Stiff silty sandy clay w/iron ore	27.0	98				3947	4.0		45° Shear	
	8 - 10	Very stiff clay	31.6	91				5143	2.0		45° Shear	
	13-15	Very stiff clay w/iron ore seam	32.0	91				5865	2.0		45° Shear	
	18-20	Stiff silty sandy clay lenses	30.5	96				2010	2.3		Vert. Shear	
	23-25	Firm silty sand	26.5	101				1234	1.3		Vert. Shear	
	28½-30	Very dense silty sand	25.5									50 B/F
	33½-35	Hard silty sandy clay	22.1									50 B/8"
	38½-40	Hard silty sandy clay	22.7									50 B/8"
	43½-45	Hard silty sandy clay	27.3									50 B/10½"

SOUTHWESTERN LABORATORIES

832964 **SUMMARY OF LABORATORY TEST DATA**

PROJECT Waste Water Ponds, Pirkey Power Plant

DATE 10-5-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
MW-5	3 - 5	Very stiff clay w/iron ore	29.0	96				4500	2.3		45° Shear	
	8 - 10	Very stiff clay	36.0	86				4583	1.0		45° Shear	Slickinsided
	13-15	Very stiff clay w/silty sand lenses	32.5	87				5469	3.3		45° Shear	
	18-20	Firm clayey silty sand	20.3	108				2031	1.7		Vert. Shear	
	23-25	Firm clayey silty sand	19.2									
	28½-30	Very dense silty sand w/clay pockets	28.7									50 B/7"
	33½-35	Very dense clayey silty sand	21.6									50 B/11"
	38½-40	Very dense clayey silty sand	21.9									50 B/9"
	43½-45	Very dense clayey silty sand	36.0									50 B/11½"

SOUTHWESTERN LABORATORIES

832964 **SUMMARY OF LABORATORY TEST DATA**

PROJECT Waste Water Ponds, Pirkey Power Plant

DATE 10-5-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS LL	PL	PI	COMPRESSION TEST COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	REMARKS
MW-6	3 - 5	Stiff clay w/silt lenses and iron ore	35.5	88				3500	1.0		45° Shear	Slickinsided
	8 - 10	Very stiff clay w/silt lenses and iron ore	27.7	97				4554	4.0		45° Shear	
	13-15	Firm clayey silty sand	26.8	100				2190	2.3		45° Shear	
	18-20	Loose clayey silty sand	22.4	102				746	3.4		Vert. Shear	
	23½-25	Very dense clayey silty sand	28.4									50 B/11½"
	28½-30	Firm clayey silty sand	23.6									24 B/F
	33½-35	Very dense clayey silty sand	23.3									50 B/9"
	38½-40	Very dense clayey silty sand	22.1									50 B/10½"

832964 **SUMMARY OF LABORATORY TEST DATA**

PROJECT Waste Water Ponds, Pirkey Power Plant

DATE 10-5-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
MW-7	3 - 5	Stiff sandy silty clay w/iron ore	22.5	108				3151	3.0		Vert. Shear	
	8 - 10	Stiff clay w/iron ore	27.8	96				3657	1.7		Vert. Shear	
	13-15	Stiff silty sandy clay lenses w/iron ore	25.1	103				3953	1.7		Vert. Shear	
	18-20	Stiff very sandy silty clay	21.8	110				2192	2.8		Vert. Shear	
	23-25	Firm clayey silty sand	27.1	102				1477	5.6		Vert. Shear	
	28½-30	Very dense silty sand	28.3									50 B/F
	33½-35	Very dense clayey silty sand	21.4									50 B/F
	38½-40	Very dense clayey silty sand	21.6									50 B/10½"

SOUTHWESTERN LABORATORIES

832964 **SUMMARY OF LABORATORY TEST DATA**

PROJECT Waste Water Ponds, Pirkey Power Plant

DATE 10-11-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
MW-8	3 - 5	Stiff silty sandy clay w/iron ore	18.1	112				3183	2.7		Vert. Shear	
	8 - 10	Stiff silty sandy clay w/iron ore	13.3	118				3240	4.0		Vert. Shear	
	13-15	Firm clayey silty sand	20.6	103				1929	2.0		Vert. Shear	
	18-20	Medium very silty sandy clay w/iron ore	16.7	121				1385	3.0		Vert. Shear	
	23-25	Very stiff silty clay lenses	23.0	106				5468	5.0		Vert. Shear	
	33½-35	Very dense silty sand	18.5									50 B/5½"
MW-9	3 - 5	Stiff silty sandy clay w/iron ore	13.6									
	8½-10	Very stiff silty sandy clay	15.2									46 B/F
	13½-15	Medium very silty clay	20.2									15 B/F
	18-20	Stiff silty clay lenses	23.3	107				2153	5.0		Vert. Shear	
	23-25	Stiff very silty clay lenses	21.6									
	28½-30	Very dense silty sand	22.9									50 B/11"

832964 **SUMMARY OF LABORATORY TEST DATA**

PROJECT Waste Water Ponds, Pirkey Power Plant

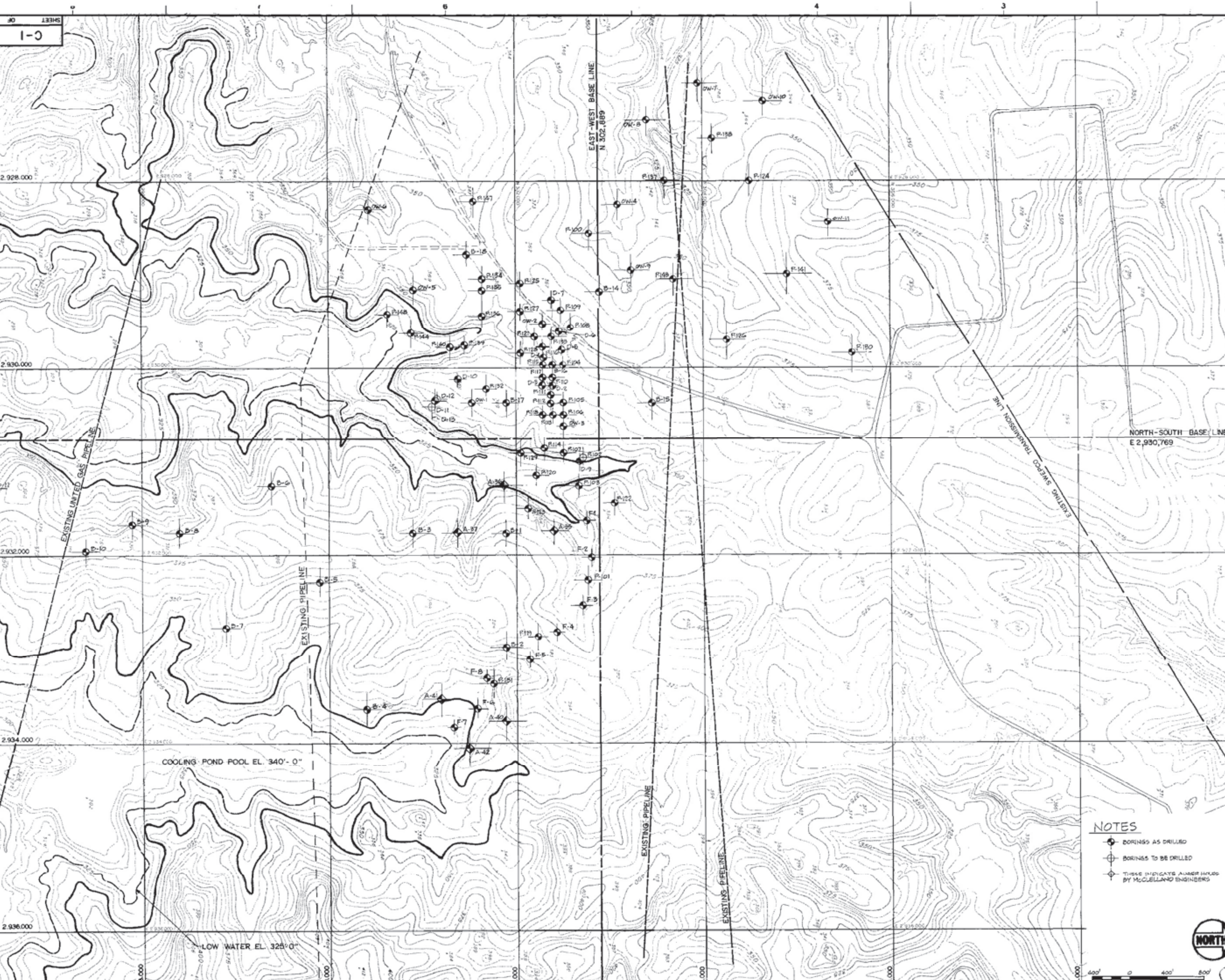
DATE 10-11-83

BORING NO	DEPTH IN FEET	TYPE OF MATERIAL	MOISTURE CONTENT %	DRY DENSITY pcf	ATTERBERG LIMITS			COMPRESSION TEST				REMARKS
					LL	PL	PI	COMPRESSION psf	STRAIN %	LATERAL PRESSURE psi	TYPE FAILURE	
MW-10	3 - 5	Stiff silty clay w/iron ore	23.6	102				3040	2.3		Vert. Shear	
	8 - 10	Hard silty clay	22.0	110				8319	3.3		Yield	
	13-15	Stiff silty clay w/iron ore	18.0	115				2925	3.0		Vert. Shear	
	18½-20	Dense silty sand w/iron ore	18.0									34 B/F
	23½-25	Firm clayey silty sand	20.9									22 B/F
	28½-30	Dense clayey silty sand	23.2									40 B/F
	33½-35	Very dense clayey silty sand	22.4									50 B/11"
	38½-40	Very dense clayey silty sand	19.2									50 B/10"

SOUTHWESTERN LABORATORIES

ATTACHMENT C

DESIGN DRAWINGS



BORING SCHEDULE

BORING Nº	LOCATION NORTH	LOCATION EAST	DEPTH IN FEET	REM
B-1	301,889	2,931,769		COMPLETED
B-2	301,889	2,932,969		
B-3	300,889	2,931,769		
B-4	300,889	2,933,269		
B-5	299,889	2,932,269		
B-6	299,389	2,931,269		
B-7	298,889	2,932,769		
B-8	298,389	2,931,769		
B-9	297,889	2,931,669		
B-10	297,389	2,931,969		
B-11	296,389	2,931,269		COMPLETED
B-12	299,989	2,938,269		NOT DRI
B-13	297,889	2,937,769		COMPLETED
B 14	302,889	2,929,169		COMPLETED
B-15	303,449	2,930,369		
B-16	302,389	2,929,969		
B-17	301,889	2,930,369		
B-18	301,469	2,928,769		COMPLETED
P-100	302,789	2,928,569	40	
P-101	302,769	2,932,269	40	
P-102	302,719	2,930,969	50	
P-103	302,669	2,931,269	50	
P-104	302,509	2,929,969	100	
P-105	302,509	2,930,379	79	COMPLETED
P-106	302,509	2,930,509	79	COMPLETED
P-107	302,509	2,930,919	40	
P-108	302,589	2,929,579	60	
P-109	302,489	2,929,389	40	
P-110	302,389	2,930,109	80	
P 111	302,374	2,930,289	80	
P-112	302,374	2,930,379	100	
P-113	302,389	2,930,509	79	COMPLETED
P-114	302,309	2,930,869	80	
P-115	302,289	2,929,969	200	CHIMN
P-116	302,289	2,929,789	80	
P-117	302,289	2,930,109	80	
P-118	302,289	2,930,509	100	
P-119	302,229	2,932,859	40	
P-120	302,219	2,931,149	80	
P 121	302,209	2,929,669	80	
P-122	303,050	2,931,450	60	
P-123	302,129	2,931,499	80	
P-124	304,500	2,928,500	50	PERCOLAT @ 5', 7'&
P-125	302,049	2,929,089	30	
P-126	304,550	2,929,700	50	PERCOLAT @ 5', 7 &
P-127	302,049	2,929,389	80	
P 128	302,049	2,929,889	80	
P-129	302,049	2,930,919	80	
P-130	305,600	2,929,850	50	PERCOLAT @ 6' & 10'
P-131	301,759	2,933,369	60	
P-132	301,689	2,930,219	80	
P 133	302,389	2,929,669	100	
P-134	301,649	2,929,044	80	
P-135	301,649	2,929,169	50	
P-136	301,649	2,929,444	50	
P-137	303,600	2,927,330	50	RELOCATED
P-138	304,100	2,927,550	50	PERCOLAT @ 5', 7' &
P-139	301,459	2,929,759	200	LIGNITE
P-140	301,309	2,929,779	80	
P-141	304,900	2,929,000	50	PERCOLAT @ 10' & 15'
P-143	303,700	2,929,050	40	PERCOLAT @ 5', 7'&
P-144	300,889	2,929,929	50	
P 147	301,559	2,928,219	40	
P-148	300,629	2,929,429	40	
OW-1	301,559	2,930,369	15' BELOW WATER TABLE	1½" DIA.
OW-2	302,289	2,929,529	15' BELOW WATER TABLE	1¼" DIA.
OW-3	302,509	2,930,619	15' BELOW WATER TABLE	1¼" DIA.
OW-4	303,000	2,928,250	15' BELOW WATER TABLE	2" DIA. OBS FOR WAT
OW-5	300,919	2,929,169	15' BELOW WATER TABLE	
OW-6	300,430	2,928,300	15' BELOW WATER TABLE	
OW-7	303,950	2,926,950	15' BELOW WATER TABLE	
OW-8	303,410	2,927,350	15' BELOW WATER TABLE	
OW-9	303,239	2,928,909	15' BELOW WATER TABLE	
OW-10	304,650	2,927,150	15' BELOW WATER TABLE	
OW-11	305,350	2,928,450	5' BELOW WATER TABLE	4" DIA. OBSE FOR WAT
A-35	302,400	2,931,750		
A-36	301,880	2,931,260		
A-37	301,380	2,931,750		
A-40	301,890	2,933,780		
A-41	301,200	2,933,540		
A-42	301,500	2,934,050		
D-2	302,394	2,930,189	35	COMPLETED
D-3	302,284	2,930,189	35	
D-4	302,300	2,929,906	33	
D-5	302,499	2,929,824	38	
D-6	302,464	2,929,629	35	
D-7	302,389	2,929,281	40	
D-9	302,642	2,930,995	30	
D-10	302,389	2,930,119	40	
D-11	301,139	2,930,359	50	COMPLETED
D-12	301,159	2,930,389	120	
D-13	301,104	2,930,414	120	
F-1	302,752.92	2,931,698.42	75	
F-2	302,806.67	2,932,046.23	75	
F-3	302,705.34	2,932,549.30	75	
F-4	302,492.26	2,932,880.88	75	
F-5	302,188.38	2,933,128.12	75	
F-6	301,568.05	2,933,689.32	45	
F-7	301,316.68	2,933,851.59	45	
F-8	301,673.63	2,933,330.89	45	

G

DRAWING RELEASE RECORD

DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
	Alex P. Odishoo Jr.			ADDED BORINGS F-1 THRU F-8.	

DRAWING RELEASE RECORD

FILM	REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
	A	07-10-78	Al Stach		McLaughlin	FOR DRILLING	✓
	B	09-14-78	Al Stach		C. J. Nelson	REVISED BORING LOCATIONS, RELEASED HOLD	✓
	C	10-05-78	Al Stach		C. J. Nelson	ADDED BORINGS; P-124, 126, 130, 141, AND OBSERVATION WELLS OW-9, 10 & 11	✓
	D	10-20-78	Al Stach		C. J. Nelson	RELOCATED BORINGS P-137, P-138, P-143 & OBSERVATION WELLS OW-4, 7, 8, 9, 10 & 11, BECAUSE	✓
						OF RELOCATED ASH PONDS	
	E	11-01-79	Al Stach		C. J. Nelson	ADDED BORINGS; D-2 THRU D-7, D-9, D-10 & D-11; FOR BIDS, SPEC. H-4570	✓
	F	10-15-80	Al Stach	J. A. Edwards	C. J. Nelson	ADDED BORINGS; D-12 AND D-13	✓
	F	11-01-80	Al Stach			FOR BIDS, SPEC. H-4570	✓

J. M. McLAUGHLIN
37586

SEAL

SCALE	1" = 400'
PROJECT NUMBER	5555-03

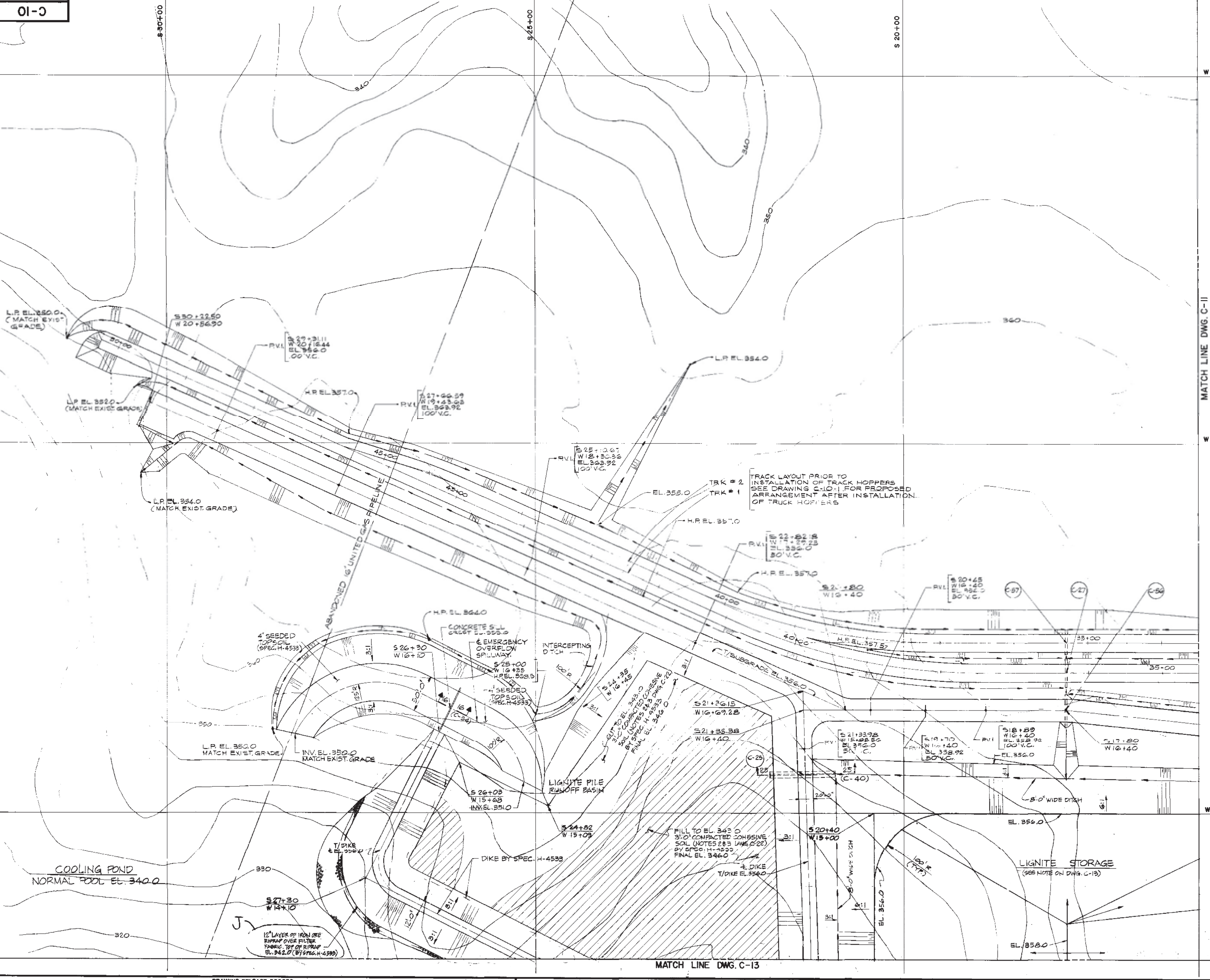
BORING LOCATION PLAN

HENRY W. PIRKEY
POWER PLANT UNIT 1
SOUTHWESTERN ELECTRIC POWER CO.
SOUTH HALLSVILLE, TEXAS

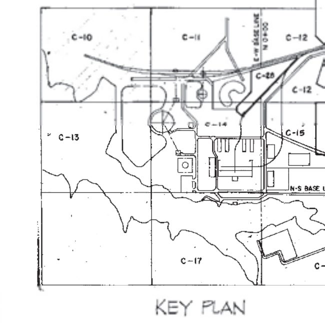
SARGENT & LU
ENG
CHI

DRAWING NO.
C-1
SHEET OF

2-CC4



COMPILED BY PHOTOGRAMMETRIC METHODS
TOBIN RESEARCH, INC. SAN ANTONIO, TEXA
DATE OF PHOTOGRAPHY 2-12-75
DATE OF COMPILATION 5-1-75
VERTICAL ACCURACY OF CONTOURS
90%-± 2.5' & 10% ± 5.0'
HORIZONTAL ACCURACY OF WELL DEFINED
90%-± 1"/5 & 10%-± 1"/2.5
GRID BASED ON TEXAS STATE-PLANE COORD
SYSTEM NORTH CENTRAL ZONE
ELEVATIONS ARE BASED ON 1929 MEAN S
DATUM.



KEY PLAN

NOTES

1. FOR GENERAL NOTES, SPEC. H-4530, SEE DRAWING
2. FOR GENERAL NOTES, SPEC. H-4533, SEE DRAWING
3. FOR TRACKWORK GENERAL NOTES, SEE DRAWING
4. ALL WORK SHOWN ON THIS DRAWING SHALL BE DONE SITEWORK CONTRACTOR IN ACCORDANCE WITH SPEC. UNLESS NOTED OTHERWISE.

REFERENCE DRAWINGS

C-6	GENERAL ARRANGEMENT - SHEET 1
C-20	BOTTOM ASH BASIN PLAN - SHEET 2
C-34	GRADING SECTIONS - SHEET 4
C-35	TRACKWORK PLAN
C-37	TRACK & ROAD TYPICAL SECTIONS
C-40	CULVERT SCHEDULE
C-13	SITE DEVELOPMENT - GRADING & DRAINAGE PLAN
C-22	BOTTOM ASH BASIN - SECTIONS & DETAILS

DRAWING RELEASE RECORD

V.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
	8-25-81	~~[illegible]~~ Al Slach		C.J. Nelson	REVISED ROADWAY AND CULVERTS C-27, 56 & 57, CONSTRUCTION SPEC. H-4570	✓
					CONSTR. REV. - ADDED IRON ORE RIPRAP, DELETED SOIL CEMENT, SPEC. H-4533	

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
A	09-01-78			[redacted]	FOR BIDS, SPEC. H-4530	X
B	03-12-79		R.P. Pahati	[redacted]	FOR CONSTRUCTION, SPEC. H-4530	X
C	04-16-79	Al Slach	R.P. Pahati	[redacted]	DECREASED PLANT GRADE BY 2'-0", PLACED HOLD ON LIGNITE STORAGE AREA, SPEC. H-4530	
D	05-01-79	Al Slach			FOR BIDS, SPEC. H-4533	X
E	08-01-79		R.P. Pahati	C.J. Nelson	FOR CONSTRUCTION, SPEC. H-4533	X
F	12-14-79		R.P. Pahati	C.J. Nelson	REVISED CONCRETE RIPRAP TO STONE RIPRAP, SPECS. H-4530 & H-4533	X
G	11-01-80				FOR BIDS, SPEC. H-4570	
G	02-09-81			C.J. Nelson	~~REVISED TRACKS, ROAD AND DRAINAGE, SPECS. H-4530 & H-4533~~	X

J. M. McLAUGHLIN 37586

SEAL

SCALE	1"=50'-0"
PROJECT NUMBER	5555-03

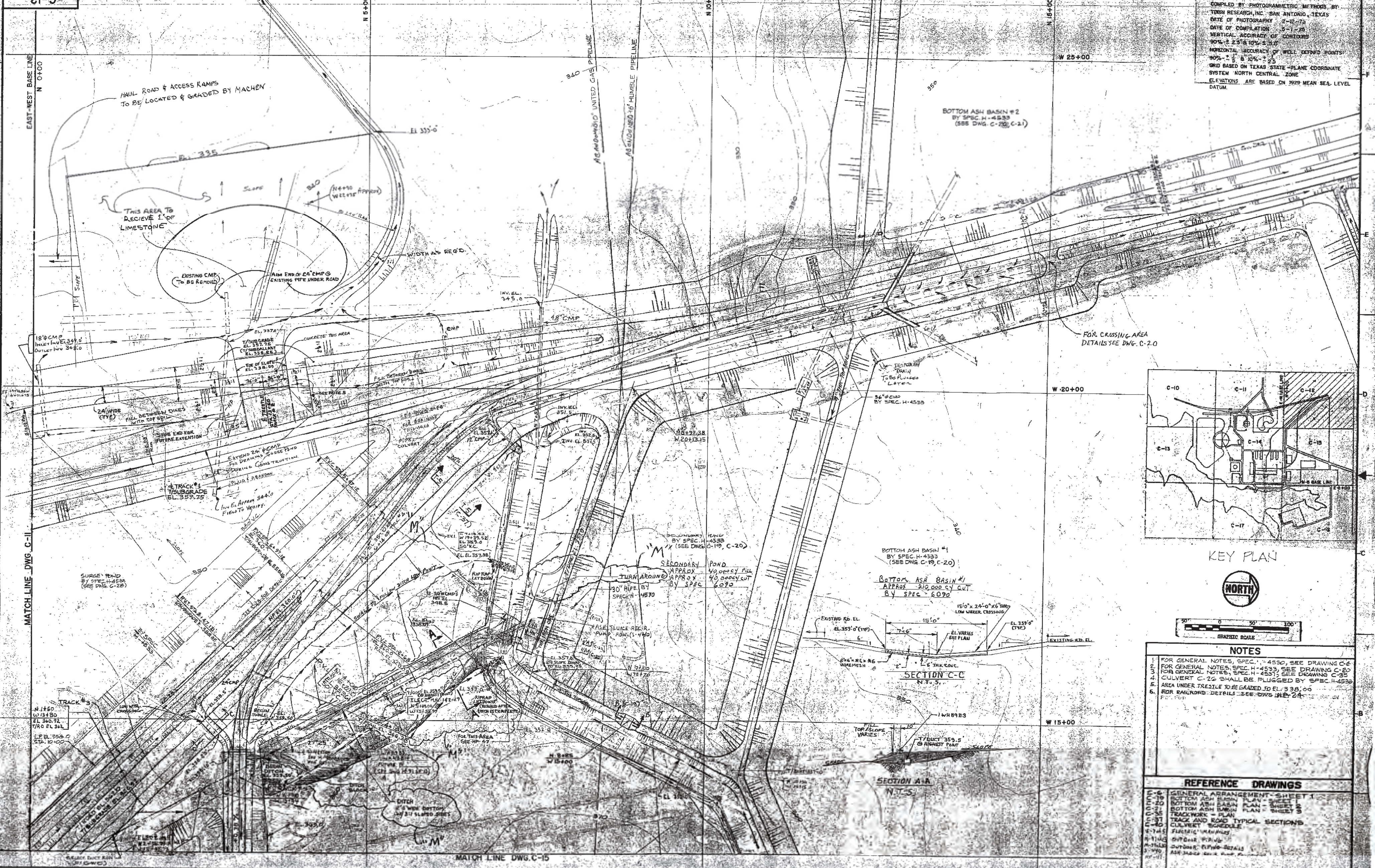
SITE DEVELOPMENT
GRADING & DRAINAGE PLAN- SHEET 1

HENRY W. PIRKEY
POWER PLANT UNIT 1
SOUTHWESTERN ELECTRIC POWER CO.
SOUTH HALLSVILLE, TEXAS

SARGENT & LU

DRAWING NO.
C-10

SHEET OF



COMPILED BY PHOTOGRAMMETRIC METHODS BY:
TOBIN RESEARCH, INC. SAN ANTONIO, TEXAS
DATE OF PHOTOGRAPHY 2-12-75
DATE OF COMPILATION 3-1-75
VERTICAL ACCURACY OF CONTOURS
90% ± 2.5' & 10% ± 5.0'
HORIZONTAL ACCURACY OF WELL DEFINED POINTS
90% ± 1/5" & 10% ± 1/25"
GRID BASED ON TEXAS STATE-PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE
ELEVATIONS ARE BASED ON 1929 MEAN SEA LEVEL DATUM.

NOTES

1. FOR GENERAL NOTES, SPEC. H-4530, SEE DRAWING C-6
2. FOR GENERAL NOTES, SPEC. H-4533, SEE DRAWING C-20
3. FOR GENERAL NOTES, SPEC. H-4537, SEE DRAWING C-35
4. CULVERT C-26 SHALL BE PLUGGED BY SPEC. H-4533
5. AREA UNDER TRESTLE TO BE GRADED TO EL. 338.00
6. FOR RAILROAD DETAILS SEE DWG. RB-24

REFERENCE DRAWINGS

C-6	GENERAL ARRANGEMENT - SHEET 1
C-19	BOTTOM ASH BASIN PLAN - SHEET 1
C-20	BOTTOM ASH BASIN PLAN - SHEET 2
C-21	BOTTOM ASH BASIN PLAN - SHEET 3
C-35	TRACKWORK - PLAN
C-37	TRACK AND ROAD TYPICAL SECTIONS
C-40	CULVERT SCHEDULE
E-7445	ELECTRIC MANHOLES
M-7144	OUTDOOR PIPING
M-7145	OUTDOOR PIPING-DETAILS
S-440	ASH SLUICE RECIR. PUMP FOUNDATION
RP-47	

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
I	7-16-81				Gen. Rev. For Const.	
J	8-30-83	R. A. Gordon			Added metal cleaning ponds & revised drainage	
K	5-6-83	R. A. Gordon			For Spec 6090 Earthwork Phase II For Bids	
L	7-18-83				For Const. 6090 - Revised grading at recirc. pump area	
L	10-1-83				Revised Drainage	
M	8-22-85		F. E. Smith		Released for Final Settlement	

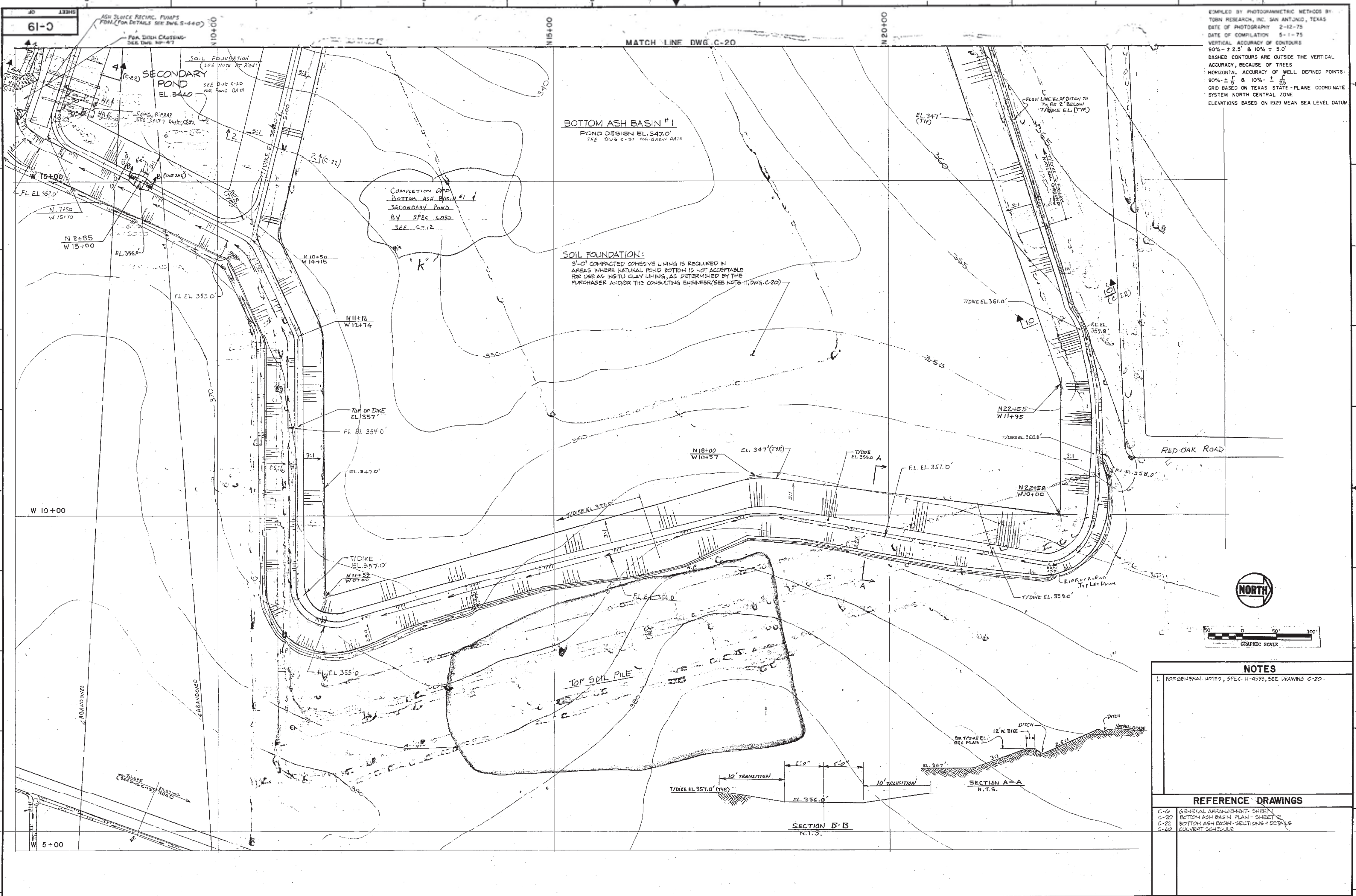
DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
A	05-01-78				FOR BIDS, SPEC. H-4530	
B	05-12-79		R. P. Pickart		FOR CONSTRUCTION, SPEC. H-4530	
C	04-16-79		R. P. Pickart		DECREASED PLANT GRADE BY 2'-0", SPEC. H-4530	
D	05-01-79				FOR BIDS, SPEC. H-4533	
E	08-01-79		R. P. Pickart		FOR CONSTRUCTION, SPEC. H-4533	
F	9-16-80				Rel. for Const. of Trestle Approaches	
G	10-2-80				Rel. for Railroad Grading (Not for Remaining Plant Site Work)	
H	12-19-80				Released Limestone Hardening Areas for Construction	

SCALE 1"=50'-0"
PROJECT NUMBER 5565-03

SITE DEVELOPMENT
GRADING & DRAINAGE PLAN - SHEET 3
HENRY W. PIRKEY
POWER PLANT UNIT 1
SOUTHWESTERN ELECTRIC POWER CO.
SOUTH HALLSVILLE, TEXAS

DRAWING NO. C-12
REV. M
SHEET OF



COMPILED BY PHOTOGRAMMETRIC METHODS BY
TOBIN RESEARCH, INC. SAN ANTONIO, TEXAS
DATE OF PHOTOGRAPHY 2-12-75
DATE OF COMPILATION 5-1-75
VERTICAL ACCURACY OF CONTOURS
90% - ± 2.5' & 10% ± 5.0'
DASHED CONTOURS ARE OUTSIDE THE VERTICAL ACCURACY, BECAUSE OF TREES
HORIZONTAL ACCURACY OF WELL DEFINED POINTS:
90% - ± 1"/5 & 10% - ± 1"/2.5
GRID BASED ON TEXAS STATE-PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE
ELEVATIONS BASED ON 1929 MEAN SEA LEVEL DATUM

SOIL FOUNDATION:

3'-0" COMPACTED COHESIVE LINING IS REQUIRED IN AREAS WHERE NATURAL POND BOTTOM IS NOT ACCEPTABLE FOR USE AS INSITU CLAY LINING, AS DETERMINED BY THE PURCHASER AND/OR THE CONSULTING ENGINEER (SEE NOTE 11, DWG. C-20)

NOTES

1. FOR GENERAL NOTES, SPEC. H-4533, SEE DRAWING C-20

REFERENCE DRAWINGS

C-6	GENERAL ARRANGEMENT - SHEET 1
C-20	BOTTOM ASH BASIN PLAN - SHEET 2
C-22	BOTTOM ASH BASIN - SECTIONS & DETAILS
C-40	CULVERT SCHEDULE

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
H	2-16-81				Gen. Rev. For Const.	
J	3-30-83	R. A. GEDEON		W.H. Holley	REVISED DRAINAGE DITCH	
K	5-6-83	R.A. GEDEON			FOR SPEC 6090 EARTHWORK PHASE II For Bids	
K1	6-30-83				FOR CONST. 6090	
L	7-7-83			W.H. Holley	REVISED ASH SLUICE RECIRC. PUMPS FDN.	

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
A	05-01-79				FOR BIDS, SPEC. H-4533	X
B	08-01-79	Al Slack	R.F. Pochat		FOR CONSTRUCTION, SPEC. H-4533	X
C	12-14-79	Al Slack	R.F. Pochat	C.J. Nelson	ADDED COORDINATES, SPECS. H-4530 & H-4533	X
D	12-01-80				FOR CLIENT'S COMMENTS	X
D	12-18-80			C.J. Nelson	REVISED ASH POND & ADDED DITCH, SPEC. H-4533	
E	1-9-81	Bill Porter			Release Ash Basin For Construction	
F	1-12-81	Bill Porter			Add Corner Coordinates	
G	1-26-81	Bill Porter			Revised Ditch Location	

SCALE	1" = 50'-0"
PROJECT NUMBER	5555-03

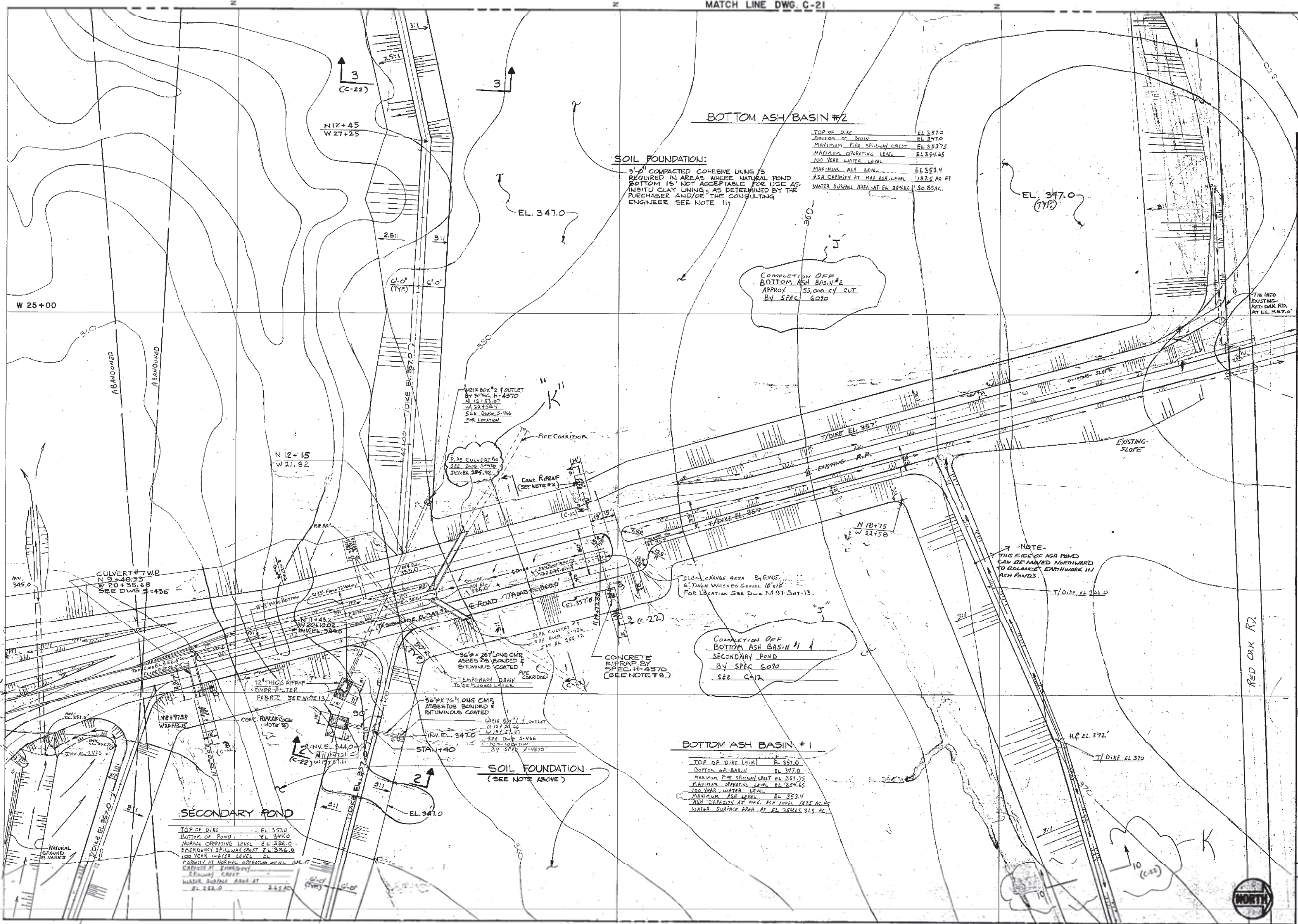
BOTTOM ASH BASIN
PLAN – SHEET 1
HENRY W. PIRKEY
POWER PLANT UNIT 1
SOUTHWESTERN ELECTRIC POWER CO.
SOUTH HALLSVILLE, TEXAS

DRAWING NO.	REV.
C-19	L

SHEET OF

COMPILED BY PHOTOGRAMMETRIC METHODS BY
TOBIN RESEARCH, INC. SAN ANTONIO, TEXAS
DATE OF PHOTOGRAPHY 2-12-75
DATE OF COMPILATION 5-1-75
VERTICAL ACCURACY OF CONTOURS
90% – ± 2.5' & 10% ± 5.0'
DASHED CONTOURS ARE OUTSIDE THE VERTICAL ACCURACY, BECAUSE OF TREES.
HORIZONTAL ACCURACY OF WELL DEFINED POINTS:
90% – ± 1"/5 & 10% – ± 1"/25
GRID BASED ON TEXAS STATE-PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE
ELEVATIONS BASED ON 1929 MEAN SEA LEVEL DATUM

MATCH LINE DWG. C-21



BOTTOM ASH BASIN #2

TOP OF DIKE	EL 357.0
BOTTOM OF BASIN	EL 347.0
MAXIMUM PIPE SPILLWAY CREST	EL 353.75
MAXIMUM OPERATING LEVEL	EL 354.65
100 YEAR WATER LEVEL	
MAXIMUM ASH LEVEL	EL 353.4
ASH CAPACITY AT MAX ASH LEVEL	187.5 AC·FT
WATER SURFACE AREA AT EL 354.65	30.85 AC.

BOTTOM ASH BASIN #1

TOP OF DIKE (MIN.)	EL 357.0
BOTTOM OF BASIN	EL 347.0
MAXIMUM PIPE SPILLWAY CREST	EL 353.75
MAXIMUM OPERATING LEVEL	EL 354.65
100 YEAR WATER LEVEL	
MAXIMUM ASH LEVEL	EL 353.4
ASH CAPACITY AT MAX. ASH LEVEL	187.5 AC.FT
WATER SURFACE AREA AT EL 354.65	31.5 AC

SOIL FOUNDATION
(SEE NOTE ABOVE)

SECONDARY POND

TOP OF DIKE	EL 357.0
BOTTOM OF POND	EL 344.0
NORMAL OPERATING LEVEL	EL 352.0
EMERGENCY SPILLWAY CREST	EL 356.0
100 YEAR WATER LEVEL	EL
CAPACITY AT NORMAL OPERATING LEVEL	AC.FT
CAPACITY AT EMERGENCY SPILLWAY CREST	
WATER SURFACE AREA AT EL 352.0	2.65 AC

MATCH LINE DWG. C-19

SPEC. H-4533

GENERAL NOTES

1. ALL WORK SHOWN ON THIS DRAWING AND ON DRAWINGS REFERRED TO THESE GENERAL NOTES SHALL BE DONE BY THE EARTHWORK CONTRACTOR IN ACCORDANCE WITH SPEC. H-4533 UNLESS NOTED OTHERWISE.
2. ALL FILL MATERIALS FOR DIKE WORK AND POND LINING SHALL BE OBTAINED FROM SITEWORK EXCAVATION. WHEN ENOUGH SUITABLE MATERIAL IS NOT AVAILABLE, BORROW MATERIALS SHALL BE OBTAINED FROM AREAS INDICATED ON THE DRAWINGS OR FROM AREAS APPROVED BY OWNER.
3. AREAS UNDER THE DIKES SHALL BE STRIPPED TO A MINIMUM OF ONE FOOT, OR AS REQUIRED BY OWNER.
4. TOPSOIL SHALL BE STOCKPILED IN AREAS APPROVED BY OWNER.
5. ALL SPOILS SHALL BE DISPOSED IN THE AREA SHOWN ON THE DRAWING OR IN OTHER AREAS APPROVED BY OWNER.
6. ALL ELEVATIONS SHOWN ON THE DRAWINGS ARE FINISHED GRADE ELEVATIONS UNLESS NOTED OTHERWISE.
7. ALL DRAINAGE DITCHES SHALL BE PROVIDED WITH 4 INCHES OF SEEDED TOPSOIL, UNLESS NOTED OTHERWISE.
8. ALL CONCRETE RIPRAP SHALL BE OF "CLASS B CONCRETE" AS SPECIFIED FOR "CONCRETE FOR STRUCTURES" IN ITEM 421 AND ITS REINFORCING SHALL BE 6"x6"x W2.1 x W2.1 WIRE MESH, AS SPECIFIED IN ARTICAL 432.9 OF ITEM 432 OF "TEXAS HIGHWAY DEPARTMENT" 1972 STANDARD SPECIFICATION FOR CONSTRUCTION OF HIGHWAYS, STREETS & BRIDGES.
9. ALL CULVERT PIPES SHALL BE BITUMINOUS COATED CORRUGATED METAL PIPE (C.M.P.) WITH 2⅔"x½" CORRUGATION, UNLESS NOTED.
10. FOR SOIL CEMENT DETAIL, SEE DRAWING C-34.
11. THE SURGE POND, ASH BASINS AND SECONDARY POND SHALL BE EXCAVATED TO THE FINISHED GRADE INDICATED. PURCHASER AND/OR CONSULTING ENGINEER SHALL VERIFY ACCEPTABILITY OF THE INSITU POND BOTTOM. IF THE INSITU MATERIAL IS ACCEPTABLE, NO FURTHER EXCAVATION WILL BE NECESSARY. IF THE INSITU MATERIAL IS NOT ACCEPTABLE EXCAVATE A SUFFICIENT AMOUNT OF MATERIAL SO THAT A 3'-0" THICK COMPACTED COHESIVE LINING CAN BE INSTALLED TO BRING THE BOTTOM OF THE POND UP TO THE FINISHED GRADE INDICATED ON THESE DRAWINGS.
12. ALL FILL SLOPES & CUT SLOPES SHALL BE PROVIDED WITH 4" SEEDED TOPSOIL UNLESS NOTED OTHERWISE.
13. TYPE OF FILTER FABRIC SHALL BE APPROVED BY PURCHASER AND INSTALLED PER MANUFACTURES REQUIREMENT.

REFERENCE DRAWINGS

C-6	GENERAL ARRANGEMENT - SHEET 1
C-22	BOTTOM ASH BASIN - SECTIONS & DETAILS
C-34	GRADING SECTIONS - SHEET 4

GRAPHIC SCALE 50 0 50 100

DRAWING RELEASE RECORD

REV.	DATE REL'D	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
H	3-30-83	R.A. GIDEON		W.H. Holley	REVISED DRAINAGE, POND DATA	
I	4-22-83	MJS		W.H. Holley	REVISED GRADING AT PIPE CORRIDOR	
J	5-6-83	R. A. GIDEON			FOR SPEC 6090 EARTHWORK PHASE II FOR BIDS	
J1	6-30-83	BP		WHH By MJS	FOR CONST. 6090	
K	12-1-83	BP		WHH By MJS	ADDED SECTION "10-10" & REVISED CULVERT ELEVATION	

DRAWING RELEASE RECORD

REV.	DATE REL'D	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
A	05-01-79				FOR BIDS, SPEC. H-4533	☒
B	08-01-79		R.P. Pohoski		FOR CONSTRUCTION, SPEC. H-4533	☒
C	11-01-79				FOR BIDS, SPEC. H-4570	☒
D	12-14-79	D. Quijano	R.P. Pohoski	B.J. Nelson	ADDED NOTE, SPECS. H-4530 & H-4533	
	12-19-80				Revised Dwg @ R.R. For Corrosion	
E	1-9-81	Bill Pole			Release Ash Basin For Construction	
F	1-21-81	Bill Pole			Revised Ditch Location	
G	2-16-81				Gen Rev For Const	

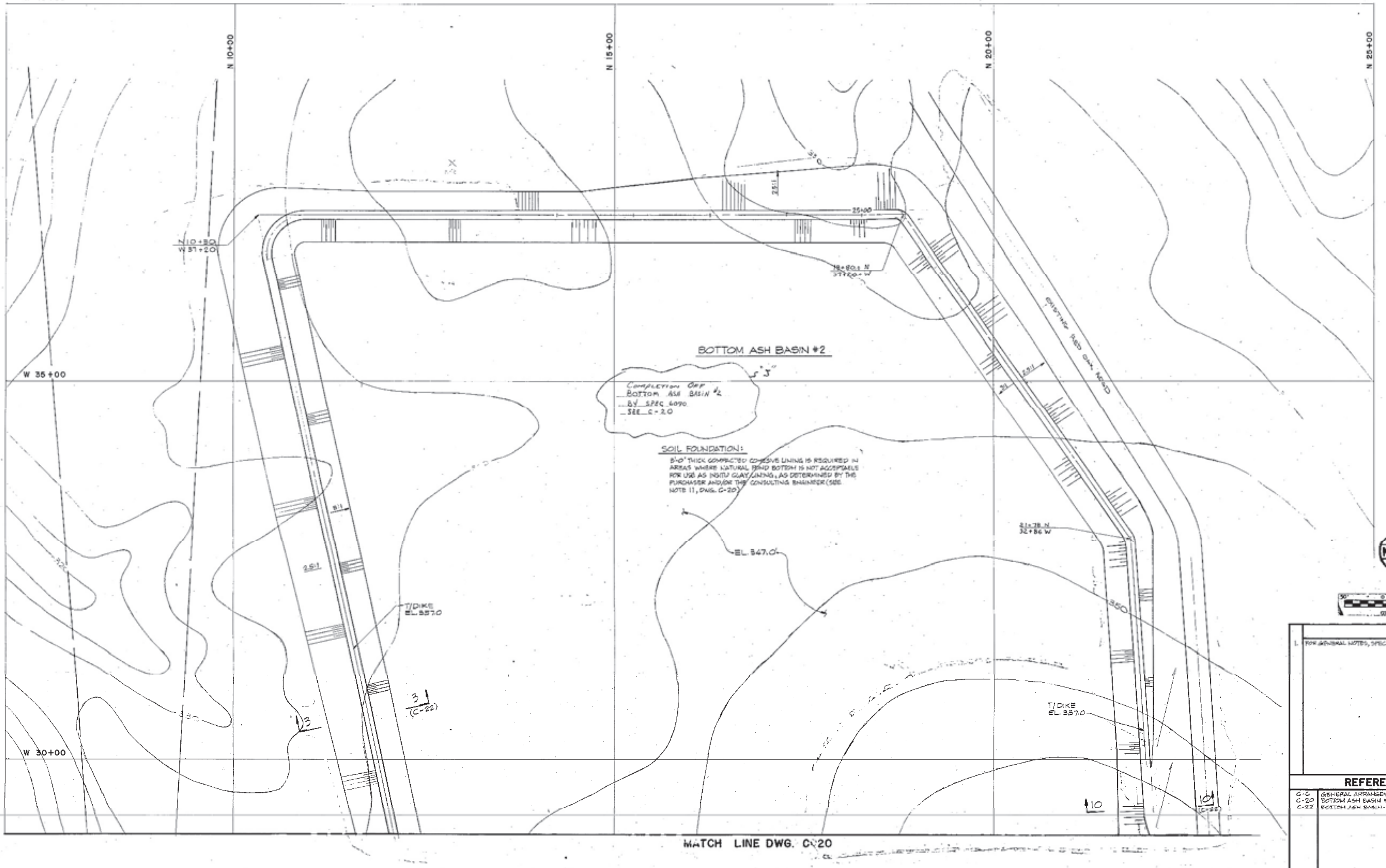
SCALE	1" = 50'-0"
PROJECT NUMBER	5555-03

BOTTOM ASH BASIN
PLAN – SHEET 2
HENRY W. PIRKEY
POWER PLANT UNIT 1
SOUTHWESTERN ELECTRIC POWER CO.
SOUTH HALLSVILLE, TEXAS

DRAWING NO. C-20
REV. K
SHEET OF

C-21

COMPILED BY PHOTOGRAMMETRIC METHODS BY
TOBIN RESEARCH, INC SAN ANTONIO, TEXAS
DATE OF PHOTOGRAPHY 2-12-75
DATE OF COMPILATION 5-1-75
VERTICAL ACCURACY OF CONTOURS -
90% - ± 2.5' & 10% ± 5.0'
DASHED CONTOURS ARE OUTSIDE THE VERTICAL
ACCURACY, BECAUSE OF TREES
HORIZONTAL ACCURACY OF WELL DEFINED POINTS -
90% - ± $\frac{r}{5}$ & 10% - ± $\frac{r}{25}$
GRID BASED ON TEXAS STATE-PLANE COORDINATE
SYSTEM NORTH CENTRAL ZONE
ELEVATIONS BASED ON 1929 MEAN SEA LEVEL DATUM



BOTTOM ASH BASIN #2

"J"

COMPLETION OFF
BOTTOM ASH BASIN #2
BY SPEC 6090
SEE C-20

SOIL FOUNDATION:

8'-0" THICK COMPACTED COHESIVE LINING IS REQUIRED IN AREAS WHERE NATURAL POND BOTTOM IS NOT ACCEPTABLE FOR USE AS INSITU CLAY LINING, AS DETERMINED BY THE PURCHASER AND/OR THE CONSULTING ENGINEER (SEE NOTE 11, DWG. C-20)

NOTES

1. FOR GENERAL NOTES, SPEC. H-4535, SEE DRAWING C-20

REFERENCE DRAWINGS

C-6	GENERAL ARRANGEMENT - SHEET 1
C-20	BOTTOM ASH BASIN PLAN - SHEET 2
C-22	BOTTOM ASH BASIN - SECTIONS & DETAILS

DRAWING RELEASE RECORD

REV.	DATE RELD.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
H	7-30-85			W.H. Holley	UP-DATED	
J	5-6-83	R.A. GEDEON			FOR SPEC 6090 EARTHWORK PHASE II - FOR BIDS	
J1	6-30-83				FOR CONST. 6090	

DRAWING RELEASE RECORD

REV.	DATE RELD.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
A	08-01-79				FOR BIDS, SPEC. H-4535	X
B	08-01-79		R.F. Pahel		FOR CONSTRUCTION, SPEC. H-4535	X
C	12-14-79		R.F. Pahel	C.J. Nelson	REVISED COORDINATES, SPECS. H-4530 & H-4535	
D	12-04-80				FOR CLIENTS COMMENTS	
D	12-15-80			C.J. Nelson	REVISED ASH POND, SPEC. H-4535	
E	1-9-81	Bill Foster			Release Ash Basin For Contracts	
F	2-18-81				Gen Rev For Const.	
G	3-16-81	Bill Foster			Revised Data, Location on Dwg (Record Only)	

SCALE	1" = 50'-0"
PROJECT NUMBER	5555-03

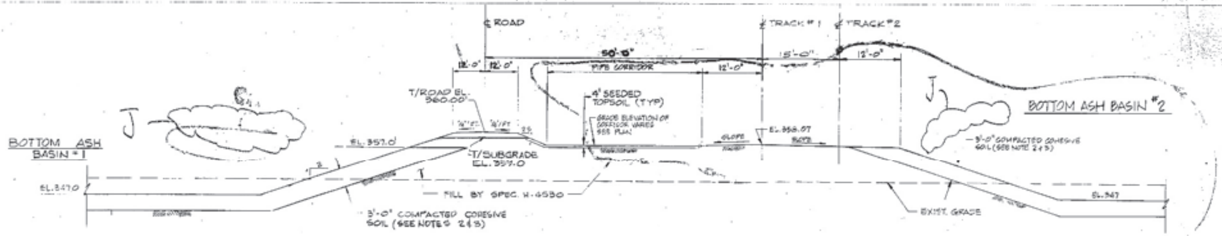
BOTTOM ASH BASIN
PLAN - SHEET 3

HENRY W. PIRKEY
POWER PLANT UNIT 1
SOUTHWESTERN ELECTRIC POWER CO.
SOUTH HALLSVILLE, TEXAS

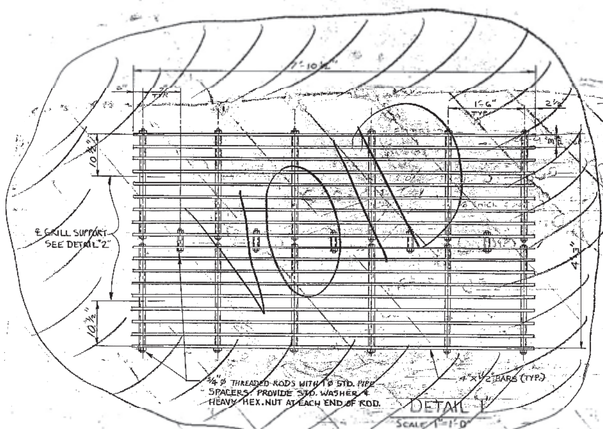
DRAWING NO.	REV.
C-21	J

SHEET OF

SECTION 10 (C-19 & C-20)
SCALE: N.T.S.



SECTION 1 (C-20)
SCALE: 1" = 10'-0"



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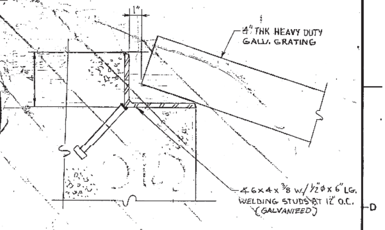

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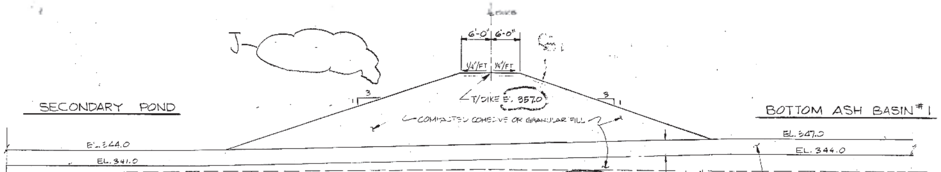

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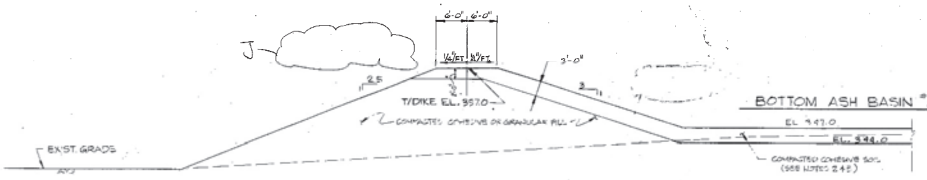

SECTION 3

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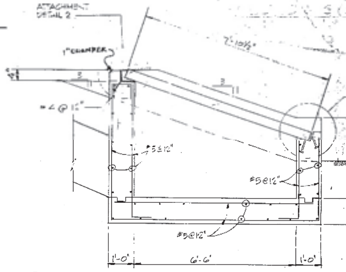

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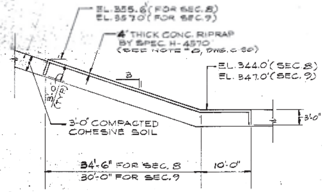

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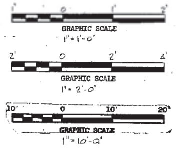
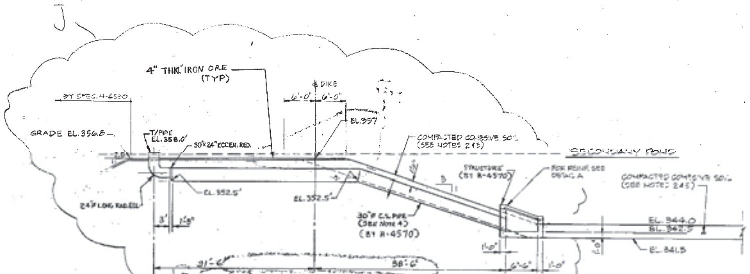
SCALE: 1" = 10'-0"





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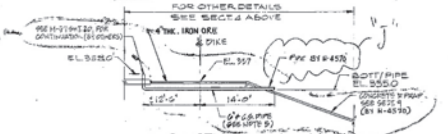

SECTION 4A (C-19) (C-12)
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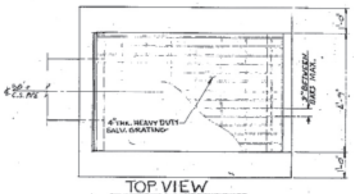

TOP VIEW OF DETAIL "A"
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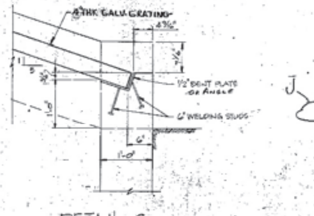

DETAIL C
SCALE: 1" = 1'-0"

NOTES

1. FOR GENERAL NOTES SPEC. H-4533, SEE DRAWING C-20.
2. COMPACTED COHESIVE LINING AT THE BOTTOM OF THE POND AND BASINS MAY BE OMITTED IF THE EXISTING SOIL IS SUITABLE AS AN INSITU COHESIVE LINING AS DETERMINED BY PURCHASER AND/OR THE CONSULTING ENGINEER. NO LINING SHALL BE OMITTED UNLESS IT IS APPROVED IN ADVANCE.
3. COMPACTED COHESIVE SOIL USED FOR IMPERVIOUS LINING SHALL HAVE A MINIMUM OF 40% PASSING Nº 200 U.S. STANDARD SIEVE AND A MINIMUM PLASTICITY INDEX (P.I.) OF 15%. J
4. C.S. PIPE SHALL BE ⅜" WALL THICK NOM. (STD. WT.) PIPE PER S & L STD. PIPING DESIGN TABLE 100, OR ⅜" - A-53 STRAIGHT SEAM WELDED PLATE PIPE J
5. 6" ⌀ SCHEDULE 80 C.S. PIPES PER S & L STD. PIPING DESIGN TABLE 103.
6. ALL BURIED PIPE SHALL BE COATED & WRAPPED J

REFERENCE DRAWINGS

C-19	BOTTOM ASH BASIN PLAN - SHEET 1
C-20	BOTTOM ASH BASIN PLAN - SHEET 2
C-21	BOTTOM ASH BASIN PLAN - SHEET 3
C-40	CULVERT SCHEDULE

DRAWING RELEASE RECORD

REV.	DATE REL'D	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
A	05-01-79				FOR BIDS, SPEC. H-4533	X
B	08-01-79		R.P. Pohyl		FOR CONSTRUCTION, SPEC. H-4533	
C	12-14-79		R.P. Pohyl	C.J. Nelson	ADDED DETAILS ON PUMP INLET STRUCTURE, SPECS. H-4533 & H-4539	
~~D~~	~~10-3-80~~				~~REVISED ASH POND DIKES & ADDED SECTIONS 8, 9 & 10, SPEC. H-4533~~	
D	01-09-81				FOR BIDS, SPEC. H-4570	
E	8-25-81			C.J. Nelson	REVISED SEC. 1, FOR CONSTRUCTION SPEC. H-4570	
F	10-20-81			C.J. Nelson	REVISIONS AS PER ASH PIPE CULVERTS, SPEC. H-4535.	
G	2-10-83				CONSTR. REV. - REVISED SECTS. 1, 2, 3, 4, 4A & 10, ADDED SECTS. 5, 6 & 7, SPEC. H-4535	
H	3-30-83			W.H.	REVISED MISC. SECTIONS	
J	12-1-83			W.H.	REVISED 30" ⌀ SECTION PIPE ROUTING & SLOPE TREATMENTS	

SCALE
AS SHOWN
PROJECT NUMBER
5855-03

BOTTOM ASH BASIN
SECTIONS & DETAILS
HENRY W. PIRKEY
POWER PLANT UNIT 1
SOUTHWESTERN ELECTRIC POWER CO.
SOUTH HALLSVILLE, TEXAS

DRAWING NO. C-22
REV. J
SHEET OF

HORIZONTAL ACCURACY OF WELL DEFINED POINTS
90% - ± 1"/20 & 10% - ± [illegible]
GRID BASED ON TEXAS STATE PLANE COORDINATE SYSTEM NORTH CENTRAL ZONE
ELEVATIONS ARE BASED ON 1929 MEAN SEA LEVEL DATUM.

SPEC. H-4530

GENERAL NOTES

1. ALL COORDINATES SHOWN ON THE DESIGN DRAWINGS ARE BASED ON PLANT GRID COORDINATE SYSTEM WITH THE ORIGIN AT N 302,888 AND E 2,930,[illegible] TEXAS STATE PLANE [illegible] SYSTEM NORTH CENTRAL ZONE
2. ALL ELEVATIONS ARE IN FEET AND BASED ON [illegible] MEAN SEA LEVEL DATUM.
3. ALL WORK [illegible] DRAWING AND ON OTHER DRAWINGS REFERENCED TO THESE GENERAL NOTES SHALL BE DONE BY THE [illegible] CONTRACTOR IN ACCORDANCE WITH SPEC [illegible] UNLESS NOTED OTHERWISE.
4. SITE CLEARING [illegible] AND [illegible] OF EXISTING STRUCTURES [illegible] SHALL BE DONE BY SITEWORK CONTRACTOR [illegible] ACCORDANCE WITH [illegible] AND AS [illegible]
5. BENCH MARKS SHALL BE ESTABLISHED AT THE PLANT SITE AS DIRECTED BY OWNER. SEE DWG. [illegible] FOR BENCH MARK DETAILS
6. AREAS UNDER [illegible] ROAD BED AND TRACK BED SHALL BE STRIPPED [illegible] MINIMUM OF ONE FOOT, OR AS REQUIRED BY OWNER. DEPTH OF STRIPPING IN OTHER AREAS SHALL BE DETERMINED IN THE FIELD AND APPROVED BY OWNER.
7. TOPSOIL SHALL BE STOCKPILED IN DESIGNATED AREAS SHOWN ON THE DRAWING, OR IN OTHER AREAS APPROVED BY OWNER
8. ALL SPOILS SHALL BE DISPOSED IN THE AREA SHOWN ON THE DRAWING, OR IN OTHER AREAS APPROVED BY OWNER
9. [illegible] MATERIAL SHALL BE OBTAINED FROM [illegible]

[illegible]

15. ROADWAYS DESIGNATED AS CONSTRUCTION ROADS WILL BE INSTALLED, ALONG WITH ANY REQUIRED DITCHES AND CULVERTS AT THE DIRECTION OF THE RESIDENT ENGINEER AND BY THE SITEWORK CONTRACTOR. THE CONSTRUCTION ROADS HAVE BEEN INDICATED ON THE PLAN VIEWS ONLY.

BORING SCHEDULE

Date Installed	Boring	Plant Site Coordinates		Depth (Ft)	Surface Elevation
	S-1	N969.8	W1899.5	10	343.6
	S-2	N1020	W1730.8	10	343.9
	S-3	N912.6	W1613.6	10	343.8
	~~S-4~~	N1499.3	W1701	6	347.3
	S-5	N1500.8	W1130.6	6	347.1
	S-6	N1999.9	W1699.9	6	353.6
	S-7	N2000.2	W1129.9	6	346.9
	S-8	N1488.3	W3291	6	347.1
	S-9	N2011.4	W3274.9	6	348.1
	S-10	N1500	W2600	6	347.4
	S-11	N2000	W2600	6	347.0
	S-12	N000.2	W1699.9	6	348.3
	S-13	N300.3	W1791.5	6	348.9
	S-14	S138.2	W1370.5	6	352.9
	S-15	N200	W880	6	
	S-16	N135	1152.9	6	357.0
	S-17	N212.6	W1286.2	6	348.1
	S-18	S1327	W889.3	6	357.2
	S-19	S1901.1	W605.3	6	356.7
	S-20	S1801.7	W1355.4	6	357.6
	S-21	S2209.09	W1529.07	6	345.9
	S-22	S2346.71	W1615.67	6	345.7
	S-23	S2416.52	W1477.93		345.8
	S-24	S2241.18	W1312.81		345.9
10/83	MW-1	N1855.2	W3859.8	30	334.0
	MW-2	N988.5	W2585.4	40	341.0
	MW-3	N1999.7	W2275	57	370.0
	MW-4	N1376.4	W834.4	46	363.4
	MW-5	N261.5	W782.2	45.5	362.5
	MW-6	S184.6	W1060.5	40	361.0
	MW-7	S223.9	W1724.45	40	358.3
	MW-8	S2104.6	W1611.9	35	356.3
	MW-9	S1548	W188.9	30	353.1
	MW-10	N656.9	W1831.3	40	358.6
[illegible]	MW-11	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	MW-12	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	MW-13	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	MW-14	[illegible]	[illegible]	42.5	[illegible]
[illegible]	MW-15	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	M-1	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	M-2	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	M-1A	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	M-2A	[illegible]	[illegible]	[illegible]	[illegible]
	M-3	[illegible]	[illegible]	[illegible]	[illegible]

REFERENCE DRAWINGS

C-4	CLEARING AND GRUBBING - SHEET 1
C-5	CLEARING AND GRUBBING - SHEET 2
[illegible]	GENERAL ARRANGEMENT - SHEET [illegible]
C-31	GRADING SECTIONS - SHEET 1
C-32	GRADING SECTIONS - SHEET 2
[illegible]	GRADING SECTIONS - SHEET 3
[illegible]	TRACKWORK PLAN
[illegible]	SECTIONS AND DETAILS
[illegible]	DISCHARGE CHANNEL - PROFILE, SECTIONS & DETAILS
C-20	BOTTOM ASH BASIN PLAN - SHEET 2
C-26	DISCHARGE STRUCTURE PLAN, SECTIONS & DETAILS
S-257	MAKE-UP WATER PUMP FOUNDATION - PLAN & SECTIONS
S-458	SURGE POND PUMP STRUCTURE - PLAN, SECTIONS & DETAILS
[illegible]	[illegible]

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
	8-5-81				RELEASED FOR RIPRAP WORK	
	9-27-82	Bill Porter			REVISED DISCHARGE CHANNEL	
	10-6-82				FOR BID SPEC. 6014	
	3-30-83	Bill Porter		W.H. Holley	REVISE R.R. TRACK, ADDED TURNAROUND & MISC. UP-DATE	
	9-12-83	BILL PORTER		W.H. Holley	WASTE WATER PONDS LINING VERIFICATION & MONITORING WELLS FOR CONSTRUCTION	
A	9-16-83	BILL PORTER		W.H. Holley	REVISED TO SHOW ACTUAL LOCATIONS OF BORINGS & WELLS	
B	10-13-83	Bill Porter		W.H. Holley	REMOVED HOLD ON S-10, S-11 REVISED LOCATIONS ON MW 2, MW4 & MW 10	
C	8-30-84	Bill Porter		W.H. Holley	REMOVED HOLD ON S-21 & S-22 ADDED S-23 & S-24	

DRAWING RELEASE RECORD

REV.	DATE REL'D.	PREPARED	REVIEWED	APPROVED	PURPOSE	FILM
D	9-5-84	Bill Porter			REVISED LOCATION OF BORING S-22	
E	8-31-86	MJS			ADDED MW-11 [illegible]	
F	12-4-86	MJS			REV MW11R (WAS M-11810), ADD M-1, 2, 1A, 2A, ADD SURGE POND (NORTH) & SLUDGE AREA INFO	
G	4-7-88	MJS			ADDED MW-13, MW-14, MW-15 ADDED M-3, CLOSED M-2A	

SCALE 1" = 200'
PROJECT NUMBER 3555-03

WASTE WATER PONDS
LINING VERIFICATION AND MONITORING WELLS

HENRY W. PIRKEY
POWER PLANT UNIT 1
SOUTHWESTERN ELECTRIC POWER CO.
SOUTH HALLSVILLE, TEXAS

DRAWING NO. HP-56
REV. 2
SHEET OF

ATTACHMENT D

INSTRUMENTATION LOCATION MAP

Provided by Google Earth.

New Piezometer Location Map – West Bottom Ash Pond

Scale: N/A	**Pirkey Power Generating Station** **New Piezometer Location – 2015** **Hallsville, Texas**
Auckland Project No. 2015-016	

ATTACHMENT E

HYDROLOGY AND HYDROLOGIC REPORT

Auckland Consulting LLC

December 17, 2015

Mr. Brett Dreger, P.E.
American Electric Power Company
1 Riverside Plaza
Columbus, Ohio 43215
Email: badreger@aep.com

RE: West Ash and East Ash Pond – Hydrology and Hydraulic Analysis
Pirkey Power Generating Station
Hallsville, Texas

Dear Mr. Dreger:

Auckland Consulting, LLC (Auckland) is pleased to provide the attached Hydrology and Hydraulic Report for both the West Ash and East Ash Ponds located at the Pirkey Power Generating Station near Hallsville, Texas. The analysis covers both the 25-year, 24-hour and 100-year, 24-hour storm events as required by 40 CFR §257.82(a). As indicated through various phone conversations and email correspondence, the West Ash and East Ash Ponds were identified as the only CCR impoundments requiring this demonstration.

Please do not hesitate to contact us with any questions or comments.

Best regards,

John J. Tayntor, P.E.
Auckland Consulting LLC
TBPE Firm Registration No. F-16721, Expires 2/29/2016

Attachments

HYDROLOGY & HYDRAULIC REPORT

EAST & WEST ASH PONDS

H.W. PIRKEY POWER PLANT – HALLSVILLE, TX

December 2015

Prepared for:

H.W. Pirkey Power Plant
2400 FM 3251
Hallsville, Texas 75650

Prepared by:

Akron Consulting, LLC
431 N. Center St.
Longview, Texas 75601
TBPE Firm # 14014

LANDON COLE ALLEN
119170

12/15/15 e

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HYDROLOGY & HYDRAULIC REPORT

Page No.

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LIST OF FIGURES

HYDROLOGIC & HYDRAULIC CALCULATIONS

APPENDIX - A

Introduction

H.W. Pirkey Power Plant which is located in Hallsville, Texas is a subsidiary of American Electric Power. Plant operation requires a series of water impoundments utilized in the process of power generation, including the bottom ash ponds. The purpose of this report is to analyze and document the Hydrologic & Hydraulic characteristics of the East and West Bottom Ash Ponds at Pirkey Power Plant.

Hydrologic Methodology

This section describes the general outline of the hydrologic methodologies used to evaluate the total runoff tributary to the ponds. Specific characteristics of each pond are discussed under individual subheadings later in this report.

The East & West Ash Ponds are total containment ponds. Watershed areas contributing to the flow into these ponds are the ponds and berms/access roads themselves; in other words, these ponds have no additional runoff areas tributary to them. Therefore, a conservative approach is to adopt a curve number 100 and to consider that every inch of rainfall will directly increase the water surface elevation.

According to Natural Resource Conservation Service (formerly SCS) Technical Release 55, the peak flow is calculated using the formula:

$Q = (P-0.2S)^2 / (P+0.8S)$

where,

Q = runoff (inches)

P = rainfall (inches)

S = potential maximum retention after runoff begins (inches) = (1000/curve number) – 10

Applying a curve number of 100 to the formula above will ultimately result in $Q = P$ (because $S=0$); which implies that the total runoff contributing to the flow in each of the ponds is directly a function of the rainfall event.

Hydraulic Methodology

This section describes the general outline of the hydraulic methodologies used to analyze the storage capacity of the ponds. Specific characteristics of each pond are discussed under individual subheadings later in this report.

The plant's CCR rules require that the ponds be able to accommodate the rainfall volume from a

100 year 24 hour storm without over topping. The normal operating level for each pond is established by other regulations, and it is set to 3 feet below the top of the embankment. Using actual field survey data, an elevation-area-storage table was developed for the ponds and is included in the tables section of this report. Hydraflow Hydrographs was utilized to evaluate storage capacity and the water surface elevations in each pond during the 100 year 24 hour rainfall event. The 25 year 24 hour rainfall event was analyzed as well.

Detailed Hydrologic & Hydraulic characteristics of the ponds are discussed below.

EAST ASH POND:

The East Ash Pond is located to the east of the rail road track and north of the Pirkey Power Plant. This is a coal combustion waste pond used to settle bottom ash that has been sluiced from the plant boiler. Field survey of the embankment around the impoundment indicates that the top of the embankment is at a minimum elevation of 357.0msl, which is consistent with original design drawings. Therefore, based on this top of embankment elevation, the normal operating level was established at 354.0msl. The watershed area contributing to the flow into this pond was estimated to be 29.63 acres.

The storage capacity for each pond was analyzed for a 100-yr, 24-hr rainfall event, which is 10.3 inches. Multiplying the acreage times the inches, the calculated volume of the rainfall event is 1,107,836 cf of water. When this rainfall event was modeled in Hydraflow Hydrographs, it generated a more conservative rainfall volume of 1,142,455 cf.

The storage capacity was also analyzed for a 25-yr, 24-hr rainfall event, which is 8.2 inches. The calculated volume of the rainfall event is 881,967 cf of water. When this rainfall event was modeled in Hydraflow Hydrographs, it generated a more conservative rainfall volume of 909,528 cf.

Water surface elevation was then calculated for the 100-yr, 24-hr rainfall event with a normal operating level (354.0msl) as the baseline elevation. Results from Hydraflow Hydrograph indicates that the water surface elevation during the 100-yr, 24-hr rainfall will be 354.99msl which is less than 357.0msl (embankment top). Results from the 25-yr, 24-hr rainfall event indicate the water surface elevation will be 354.79msl which is also less than 357.0msl (embankment top).

WEST ASH POND:

The West Ash Pond is located to the west of the rail road track and adjacent to the east ash pond. This is a coal combustion waste pond used to settle bottom ash that has been sluiced from the plant boiler. Field survey of the embankment around the impoundment indicates that the top of the embankment is at a minimum elevation of 357.0msl, which is consistent with original design drawings. Therefore, based on this top of embankment elevation, the normal operating level was established at 354.0msl. The watershed area contributing to the flow into this pond was estimated to be 33.44 acres.

As mentioned earlier the storage capacity for each pond was analyzed for a 100-yr, 24-hr rainfall event, which is 10.3 inches. Multiplying the acreage times the inches, the calculated volume of the rainfall event is 1,250,228 cf of water. When this rainfall event was modeled in Hydraflow Hydrographs, it generated a more conservative rainfall volume of 1,289,360 cf.

The storage capacity was also analyzed for a 25-yr, 24-hr rainfall event, which is 8.2 inches. The calculated volume of the rainfall event is 995,376 cf of water. When this rainfall event was modeled in Hydraflow Hydrographs, it generated a more conservative rainfall volume of 1,026,480 cf.

Water surface elevation was then calculated for the 100-yr, 24-hr rainfall event with a normal operating level (354.0msl) as the baseline elevation. Results from Hydraflow Hydrograph indicates that the water surface elevation during the 100-yr, 24-hr rainfall will be 355.01msl which is less than 357.0msl (embankment top). Results from the 25-yr, 24-hr rainfall event indicate the water surface elevation will be 354.81msl which is also less than 357.0msl (embankment top).

Summary

Water surface elevations calculated from Hydraflow Hydrographs are tabulated below:

SUMMARY OF POND HYDRAULIC CHARACTERISTICS				
	TOP OF EMBANKMENT	OPERATING LEVEL	100YR-24HR WSEL	25YR-24HR WSEL
EAST ASH POND	357.0	354.0	354.99	354.79
WEST ASH POND	357.0	354.0	355.01	354.81

As evident from the table above, it is the opinion of Akron Consulting that the East & West Ash Ponds will serve to adequately contain the calculated rainfall events.

TABLE 1

Runoff Curve Numbers for Hydrologic Soil-Cover Complexes
(Antecedent Moisture Condition II, and Ia= 0.2 S)
(Adapted from NRCS Technical Release 55)

Land Use	Treatment or Practice	Hydrologic Condition	Hydrologic Soil Group A	B	C	D
Fallow	Straight Row	----	77	86	91	94
Row Crops	Straight Row	Poor	72	81	88	91
	Straight Row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Contoured and Terraced	Poor	66	74	80	82
	Contoured and Terraced	Good	62	71	78	81
Small Grain	Straight Row	Poor	65	76	84	88
	Straight Row	Good	63	75	83	87
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Contoured and Terraced	Poor	61	72	79	82
	Contoured and Terraced	Good	59	70	78	81
Close-Seeded, Legumes, Rotation Meadow	Straight Row	Poor	66	77	85	89
	Straight Row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Contoured and Terraced	Poor	63	73	80	83
	Contoured and Terraced	Good	51	67	76	80
Pasture Or Range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads/Facilites		----	74	84	90	92

TABLE 2
EAST ASH POND ELEVATION-AREA-STORAGE TABLE
H.W. PIRKEY POWER PLANT
EXISTING CONDITION
NORMAL OPERATING POOL AT 354.0

ELEVATION (ft)	AREA (Acres)	STORAGE (Ac-Ft)	STORAGE (Cubic Feet)	STORAGE (Million Gallons)
352.00	25.70	na	na	na
353.00	25.99	na	na	na
354.00	26.29	0.00	0	0.00
355.00	26.59	26.44	1,151,730	232.61
356.00	26.88	53.18	2,316,300	467.82
357.00	27.19	80.21	3,493,950	705.67

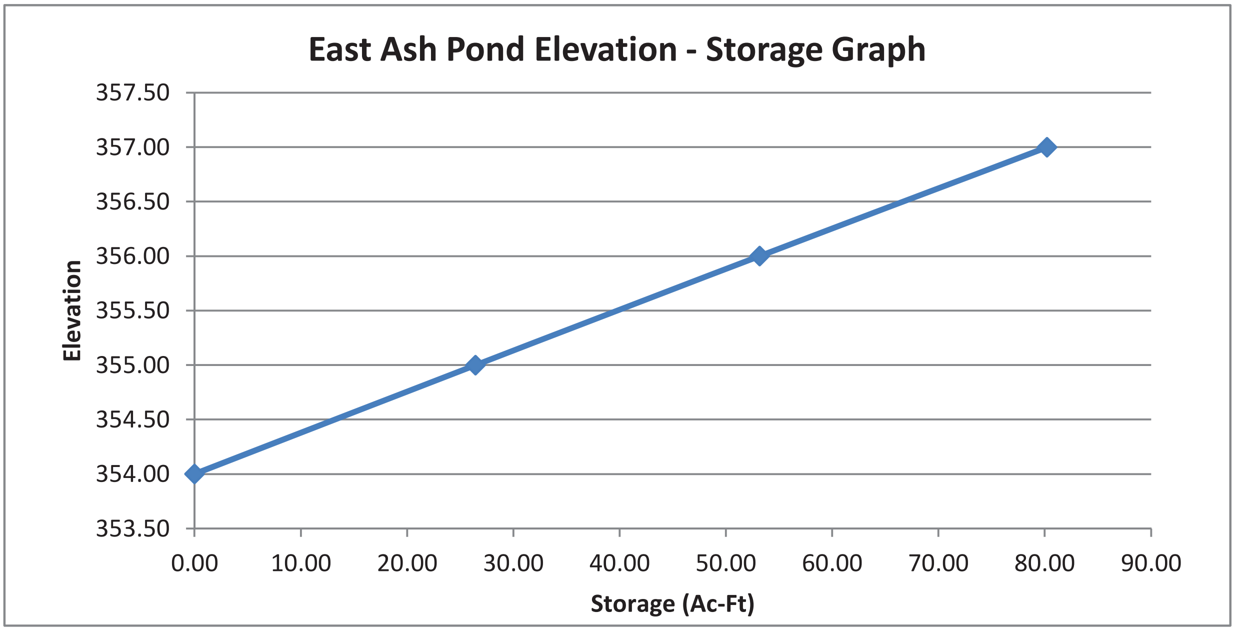
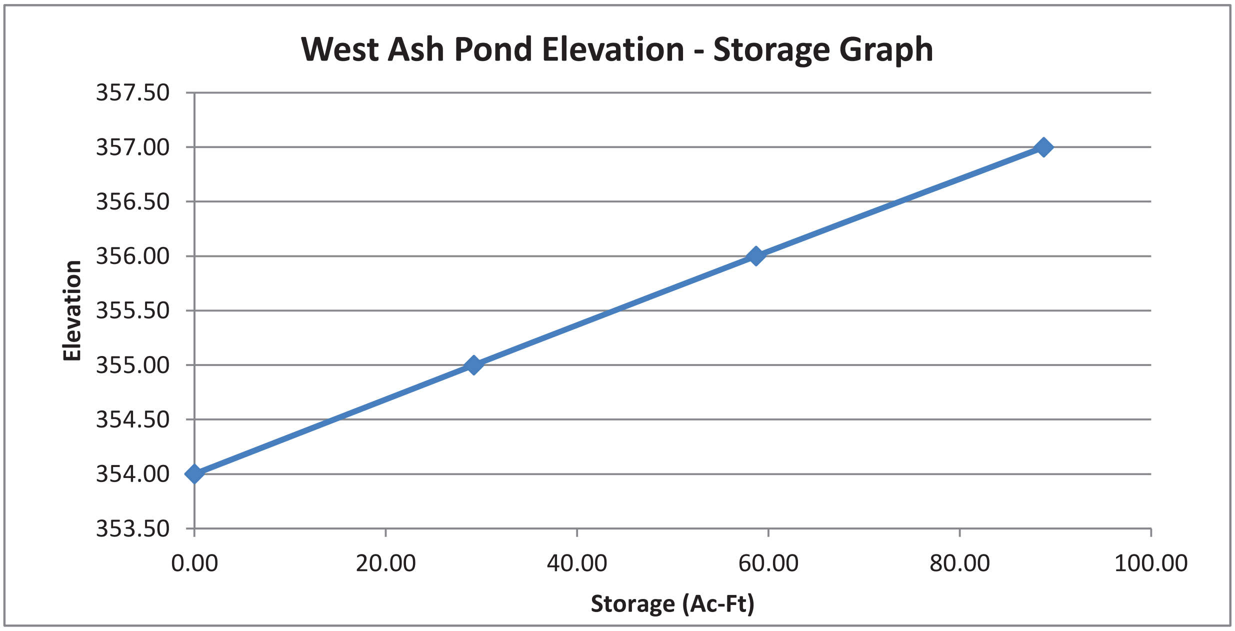
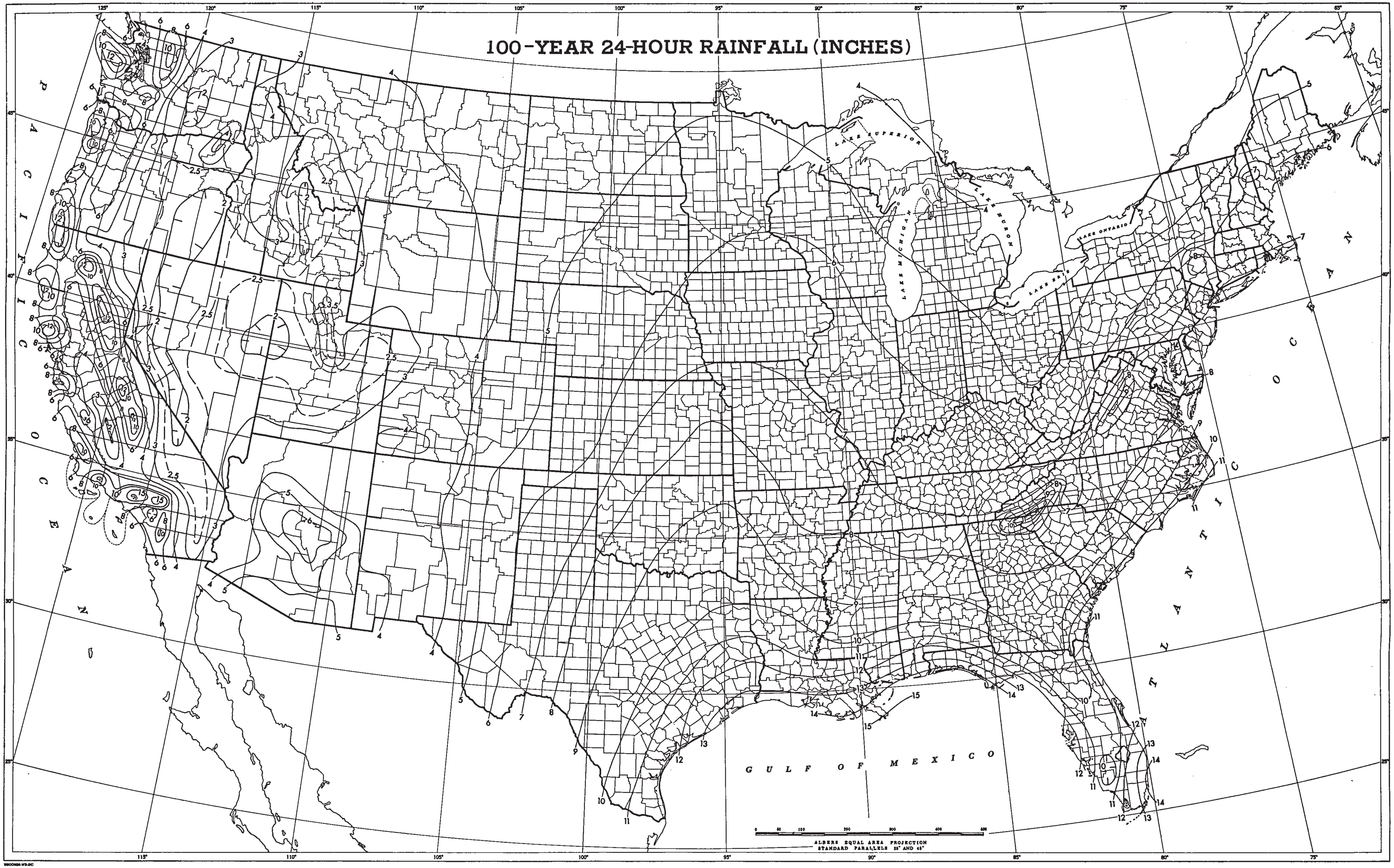


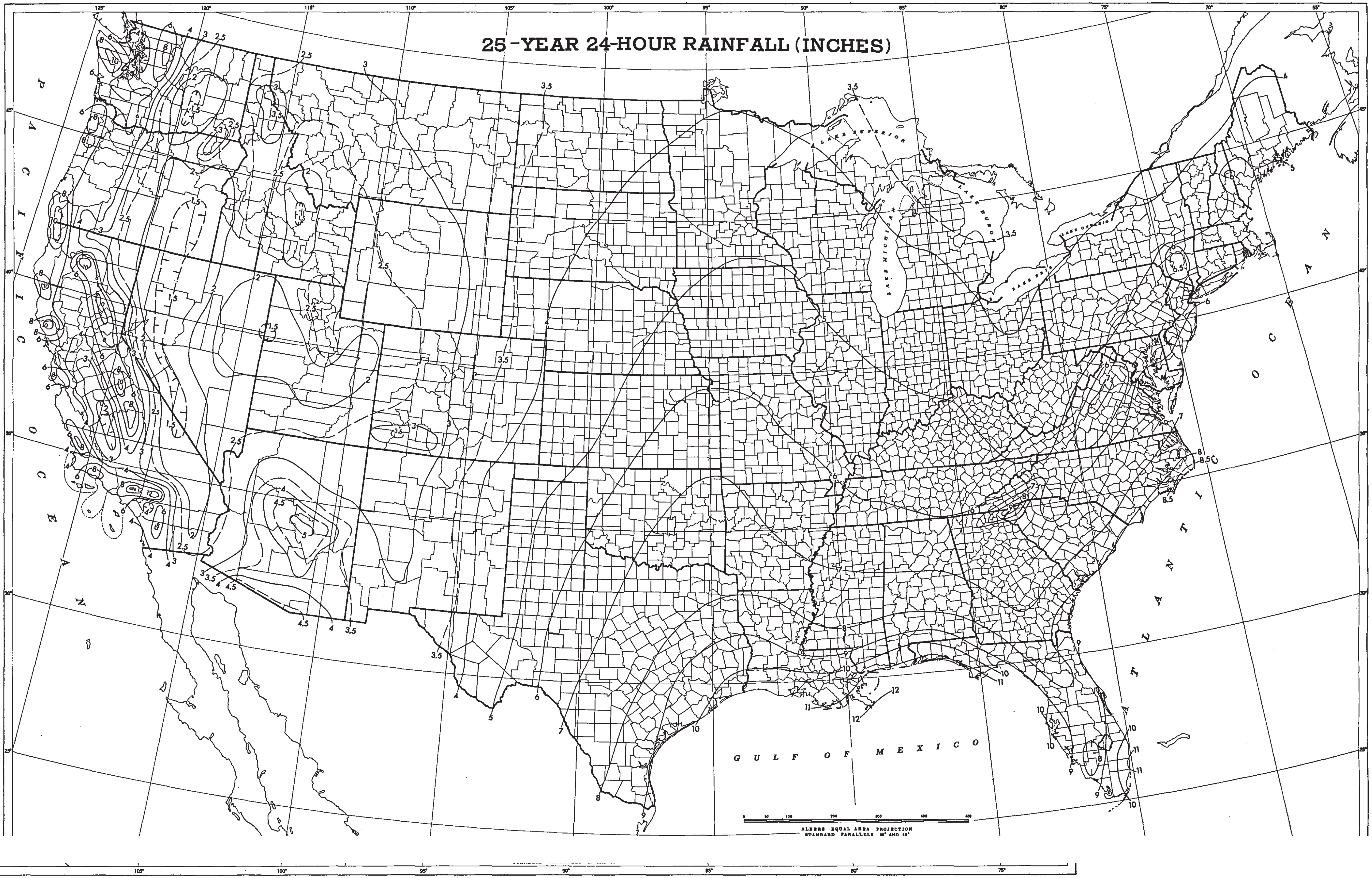
TABLE 3
WEST ASH POND ELEVATION-AREA-STORAGE TABLE
H.W. PIRKEY POWER PLANT
EXISTING CONDITION
NORMAL OPERATING POOL AT 354.0

ELEVATION (ft)	AREA (Acres)	STORAGE (Ac-Ft)	STORAGE (Cubic Feet)	STORAGE (Million Gallons)
352.00	28.43	na	na	na
353.00	28.74	na	na	na
354.00	29.05	0.00	0	0.00
355.00	29.36	29.21	1,272,170	256.94
356.00	29.67	58.72	2,557,840	516.61
357.00	30.47	88.79	3,867,690	781.16





100-YEAR 24-HOUR RAINFALL (INCHES)



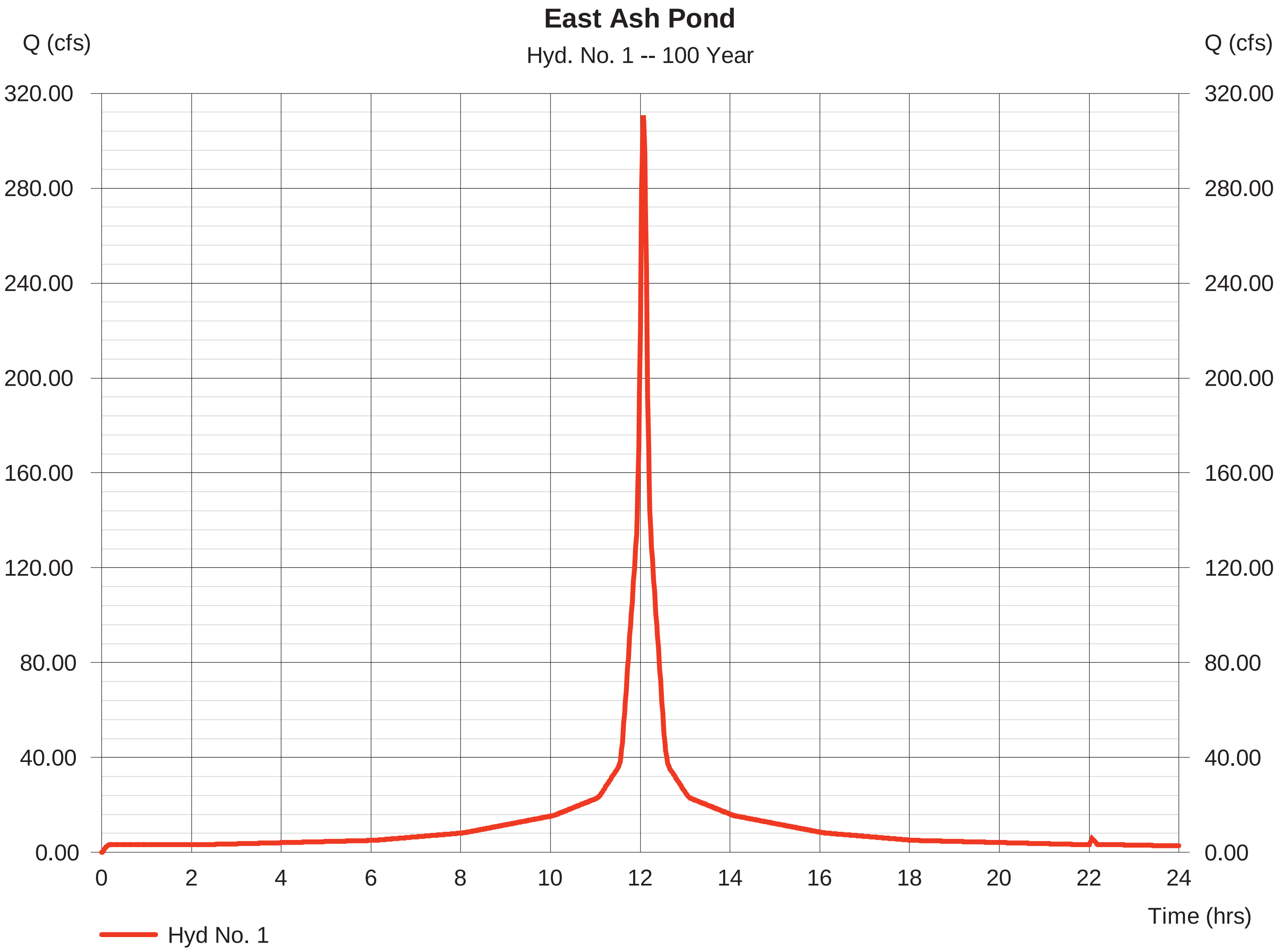
25-YEAR 24-HOUR RAINFALL (INCHES)

Hydrograph Report

Hyd. No. 1

East Ash Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 310.73 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 1 min	Hyd. volume	= 1,142,455 cuft
Drainage area	= 29.630 ac	Curve number	= 100
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 10.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



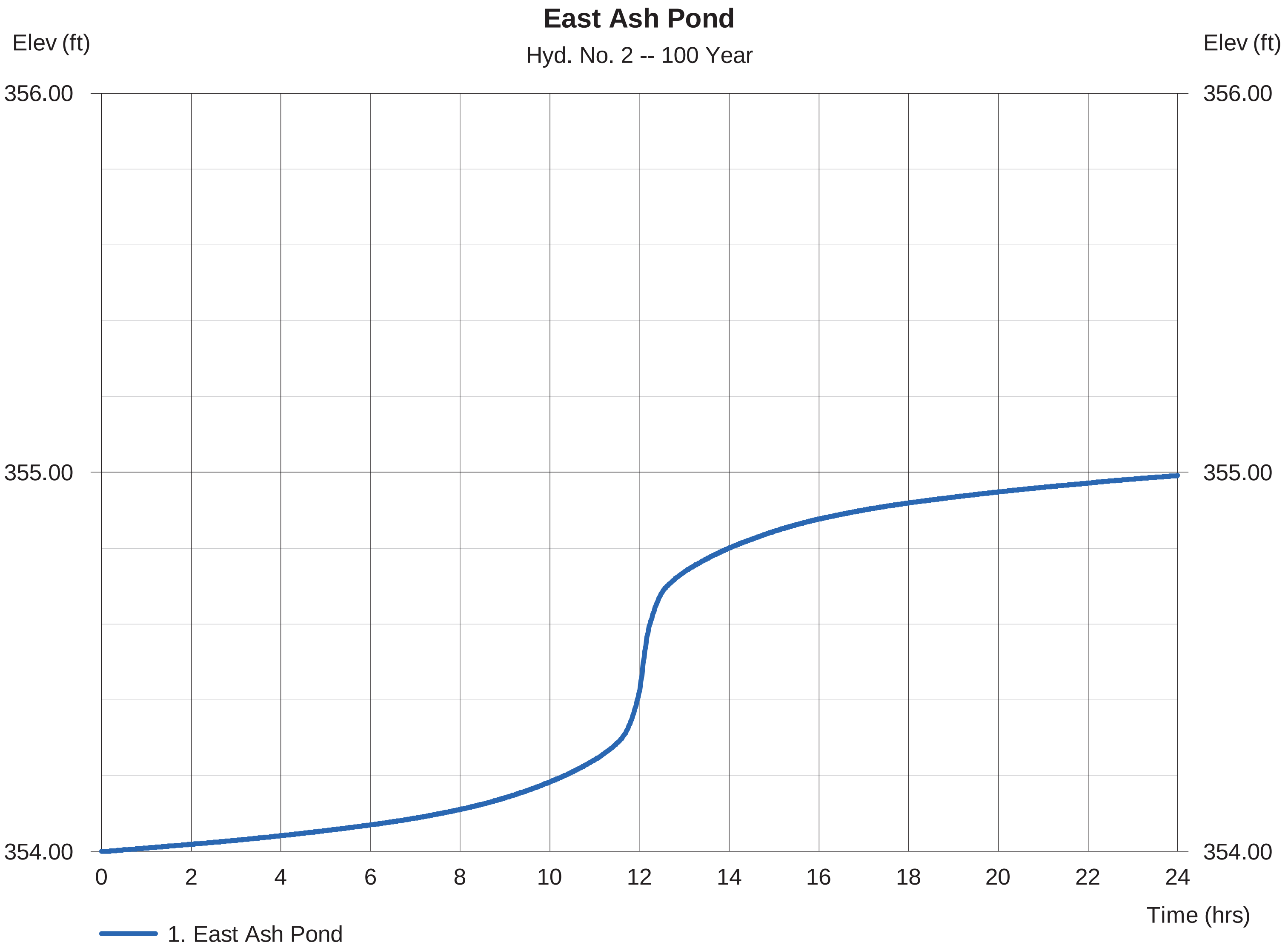
Hydrograph Report

Hyd. No. 2

East Ash Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 100 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - East Ash Pond	Max. Elevation	= 354.99 ft
Reservoir name	= East Ash Pond		

Storage Indication method used. Wet pond routing start elevation = 354.00 ft.

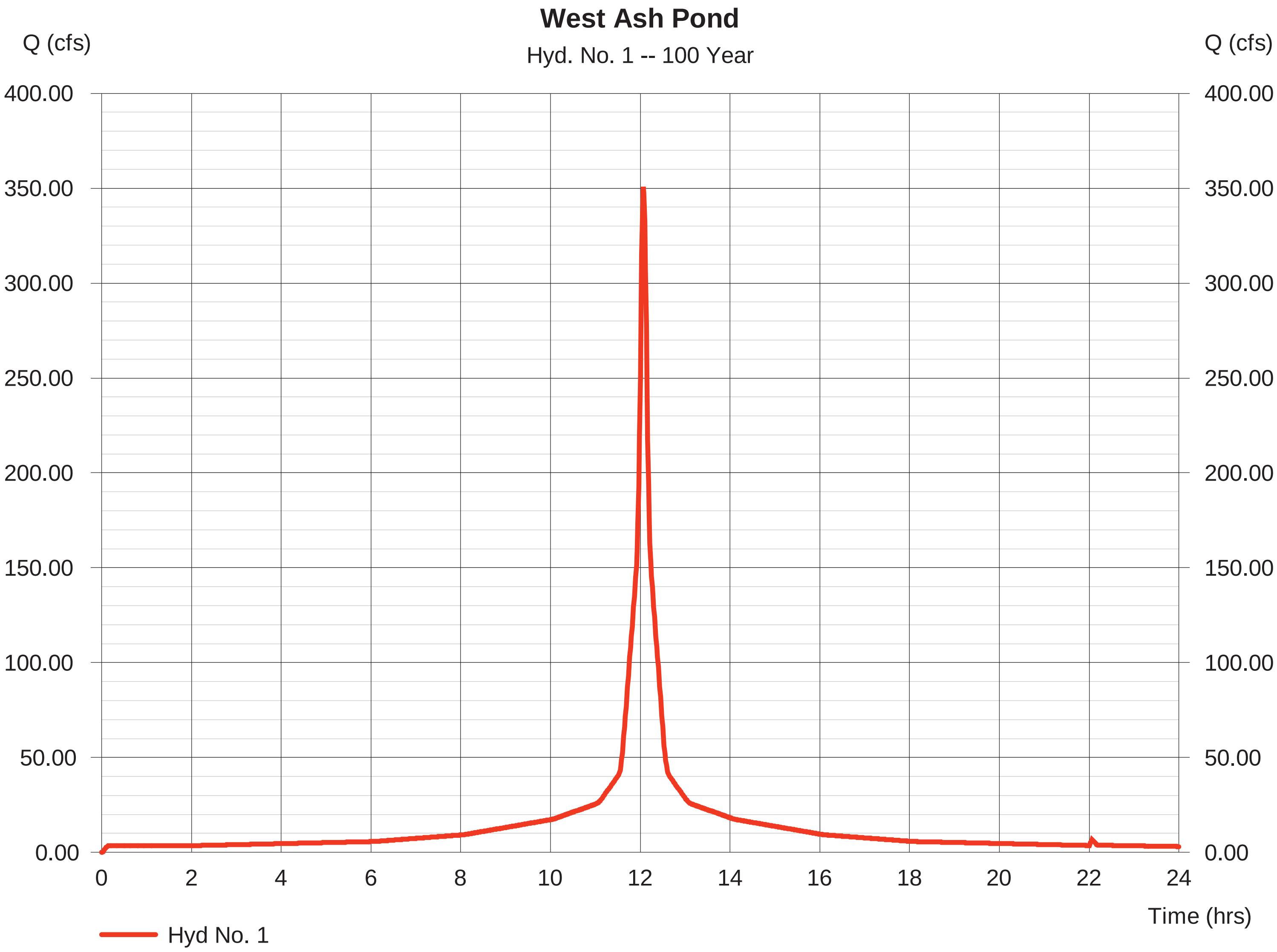


Hydrograph Report

Hyd. No. 1

West Ash Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 350.69 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 1 min	Hyd. volume	= 1,289,360 cuft
Drainage area	= 33.440 ac	Curve number	= 100
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 10.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



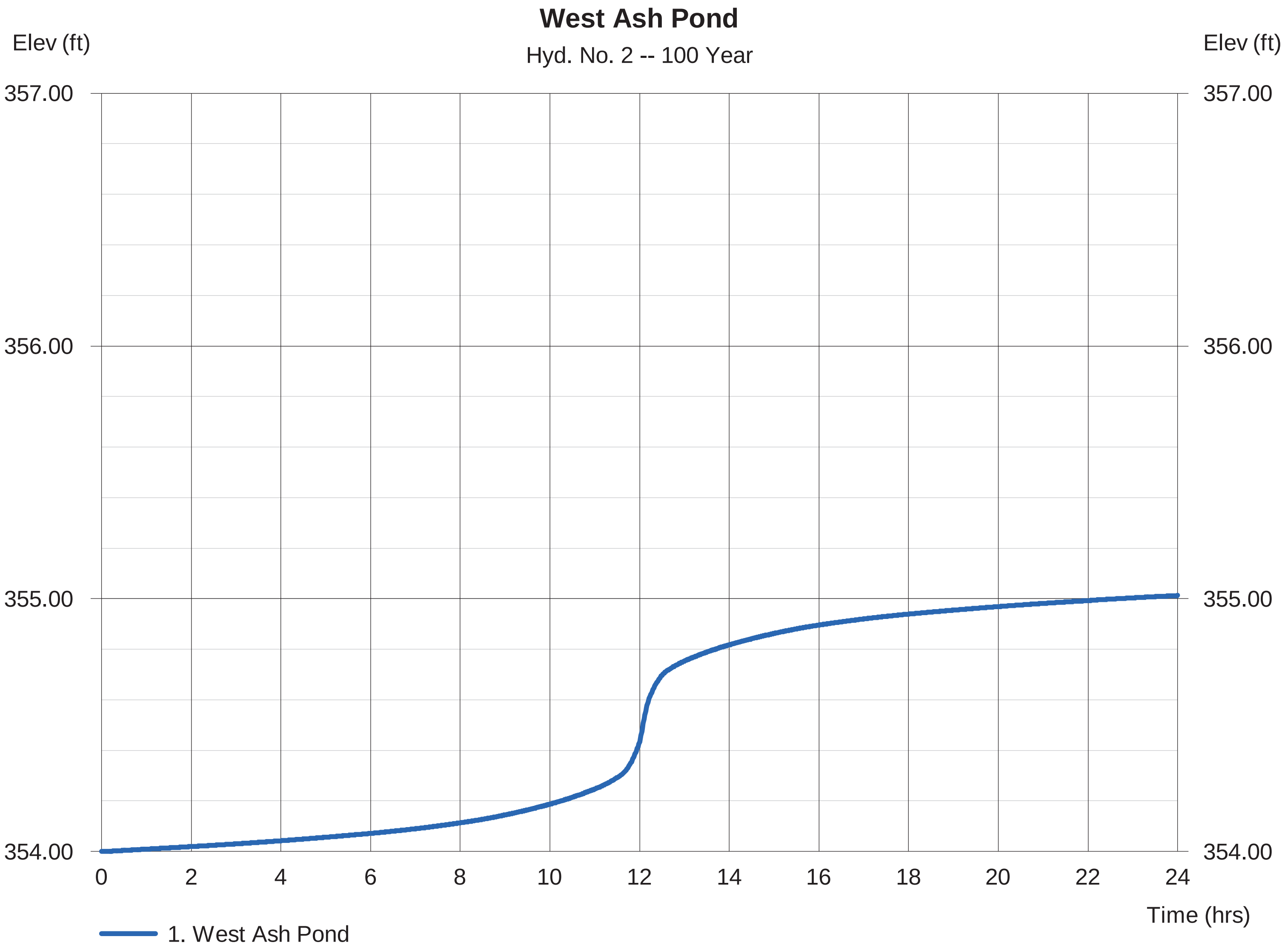
Hydrograph Report

Hyd. No. 2

West Ash Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 100 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - West Ash Pond	Max. Elevation	= 355.01 ft
Reservoir name	= West Ash Pond		

Storage Indication method used. Wet pond routing start elevation = 354.00 ft.



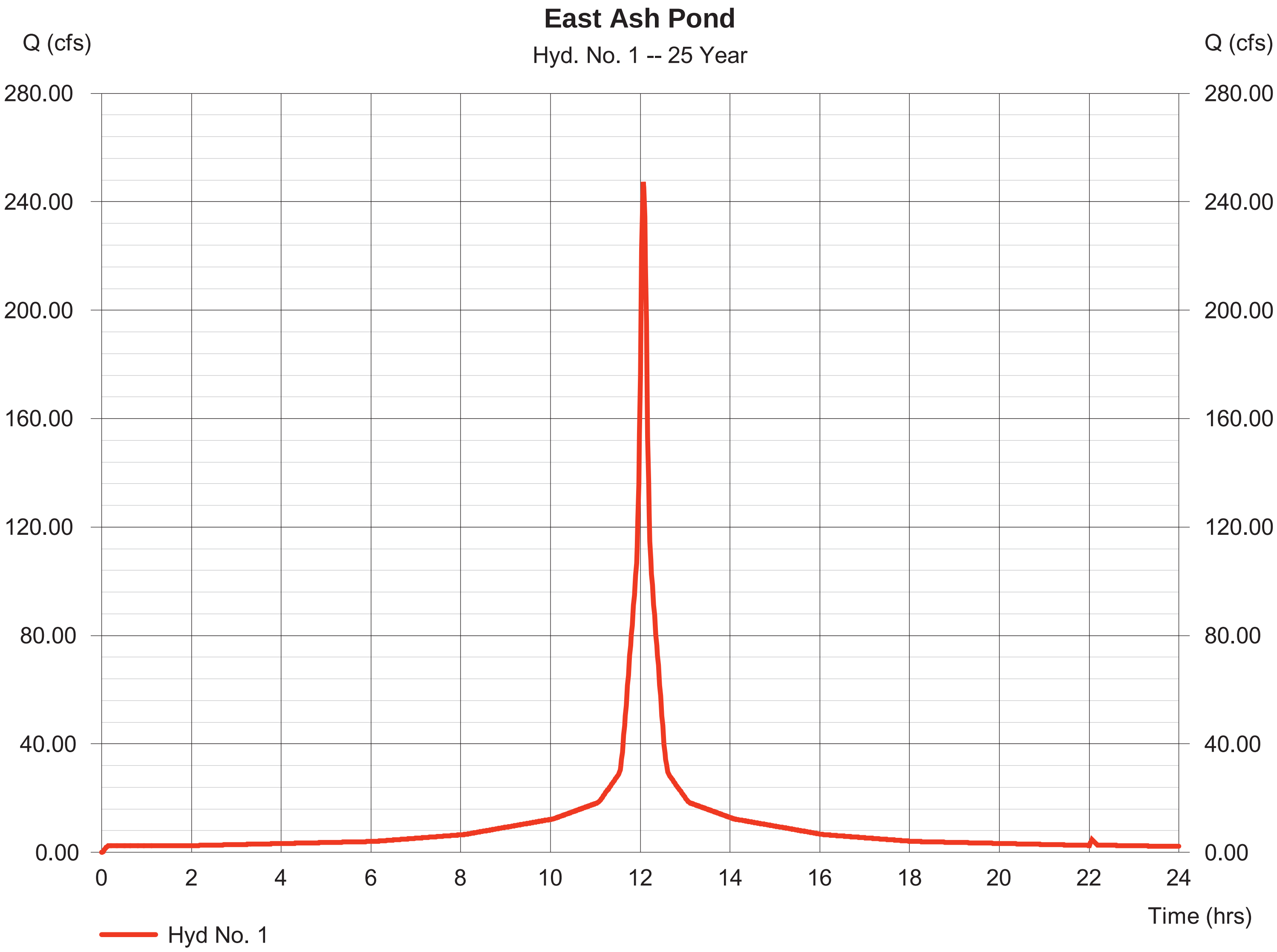
Hydrograph Report

Hyd. No. 1

East Ash Pond

Hydrograph type = SCS Runoff
Storm frequency = 25 yrs
Time interval = 1 min
Drainage area = 29.630 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 8.20 in
Storm duration = 24 hrs

Peak discharge = 247.38 cfs
Time to peak = 12.07 hrs
Hyd. volume = 909,528 cuft
Curve number = 100
Hydraulic length = 0 ft
Time of conc. (Tc) = 5.00 min
Distribution = Type III
Shape factor = 484



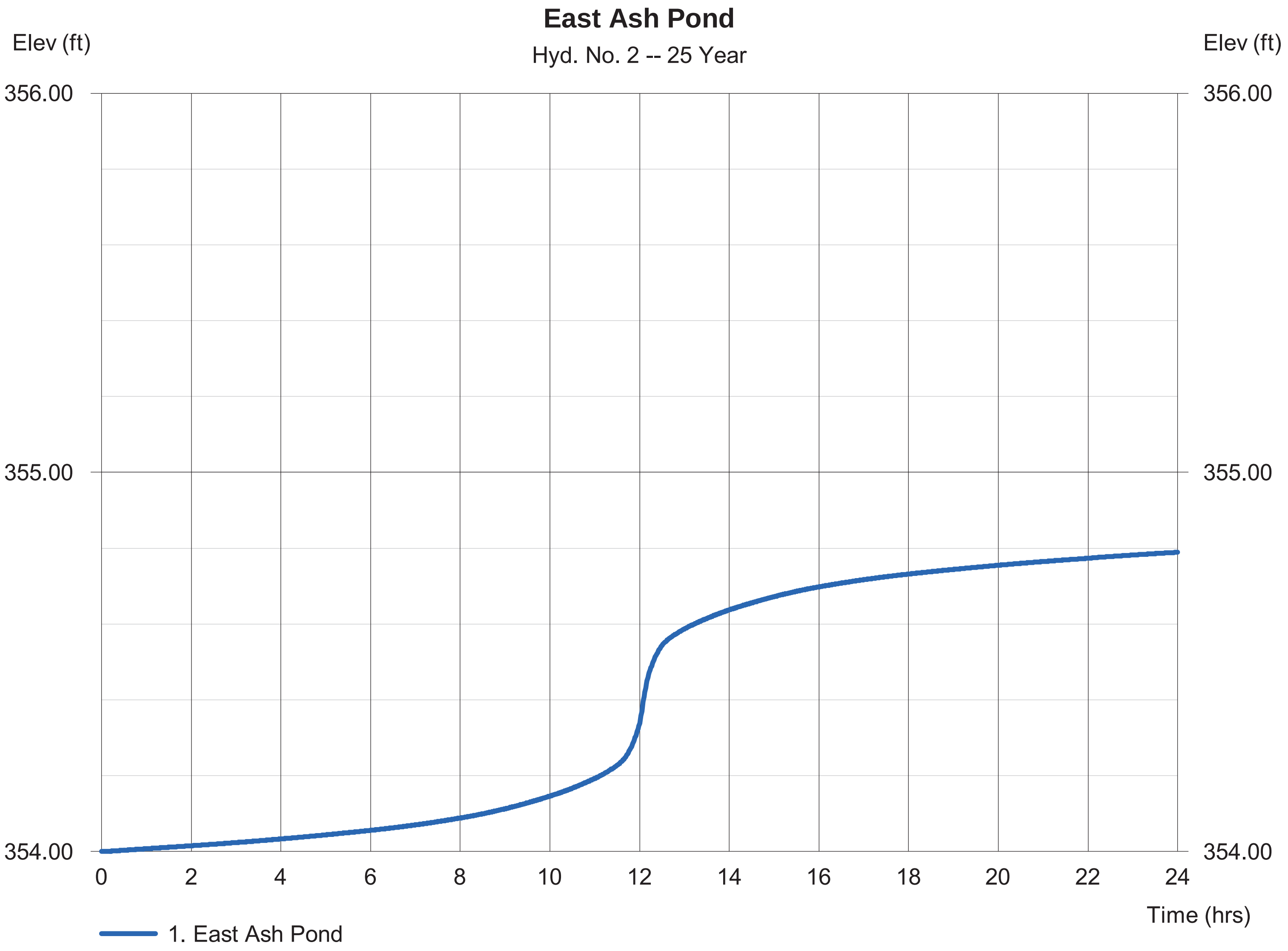
Hydrograph Report

Hyd. No. 2

East Ash Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 25 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - East Ash Pond	Max. Elevatioo	= 354.79 ft
Reservoir name	= East Ash Pond		

Storage Indication method used. Wet pond routing start elevation = 354.00 ft.



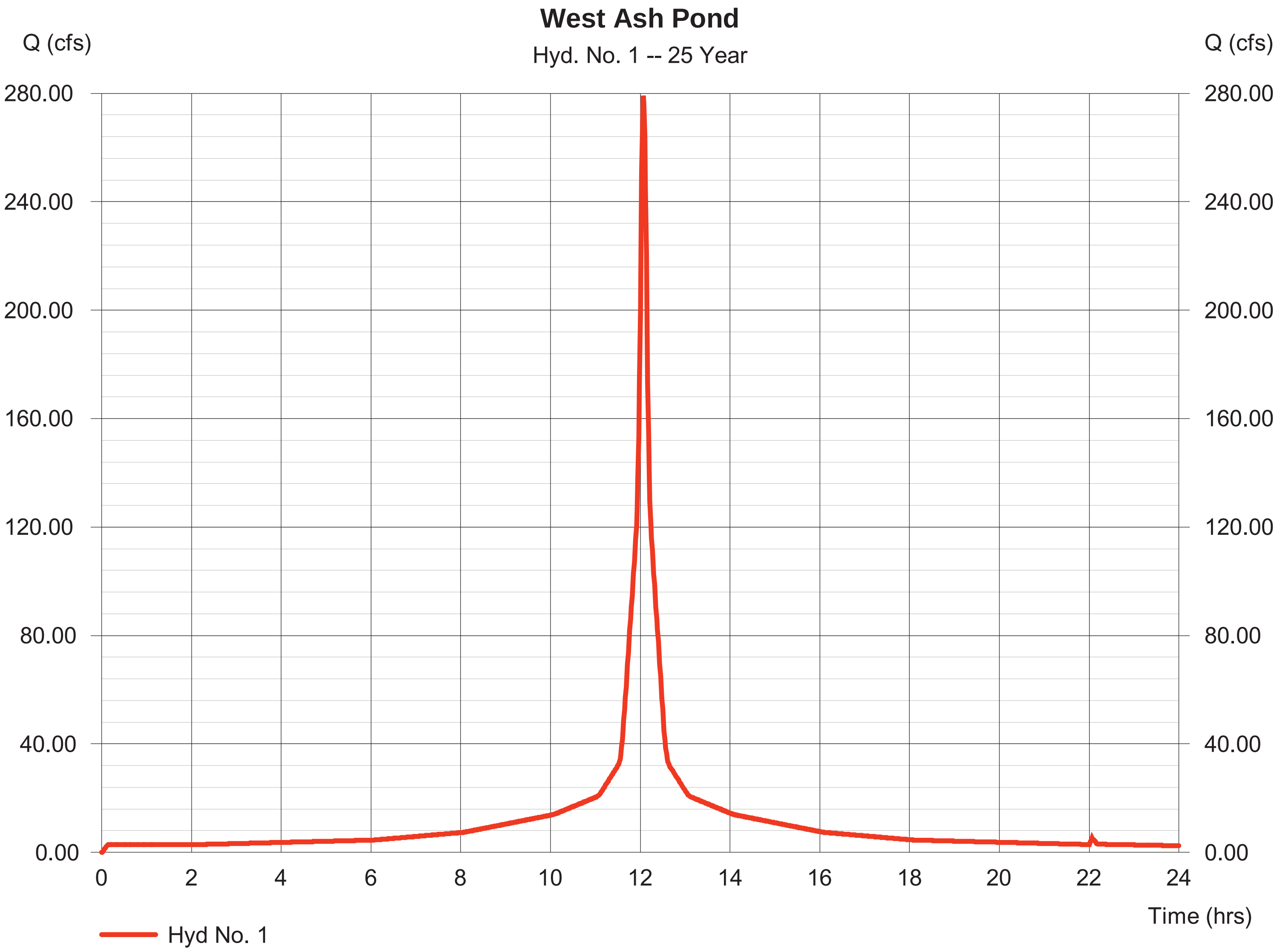
Hydrograph Report

Hyd. No. 1

West Ash Pond

Hydrograph type = SCS Runoff
Storm frequency = 25 yrs
Time interval = 1 min
Drainage area = 33.440 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 8.20 in
Storm duration = 24 hrs

Peak discharge = 279.19 cfs
Time to peak = 12.07 hrs
Hyd. volume = 1,026,480 cuft
Curve number = 100
Hydraulic length = 0 ft
Time of conc. (Tc) = 5.00 min
Distribution = Type III
Shape factor = 484



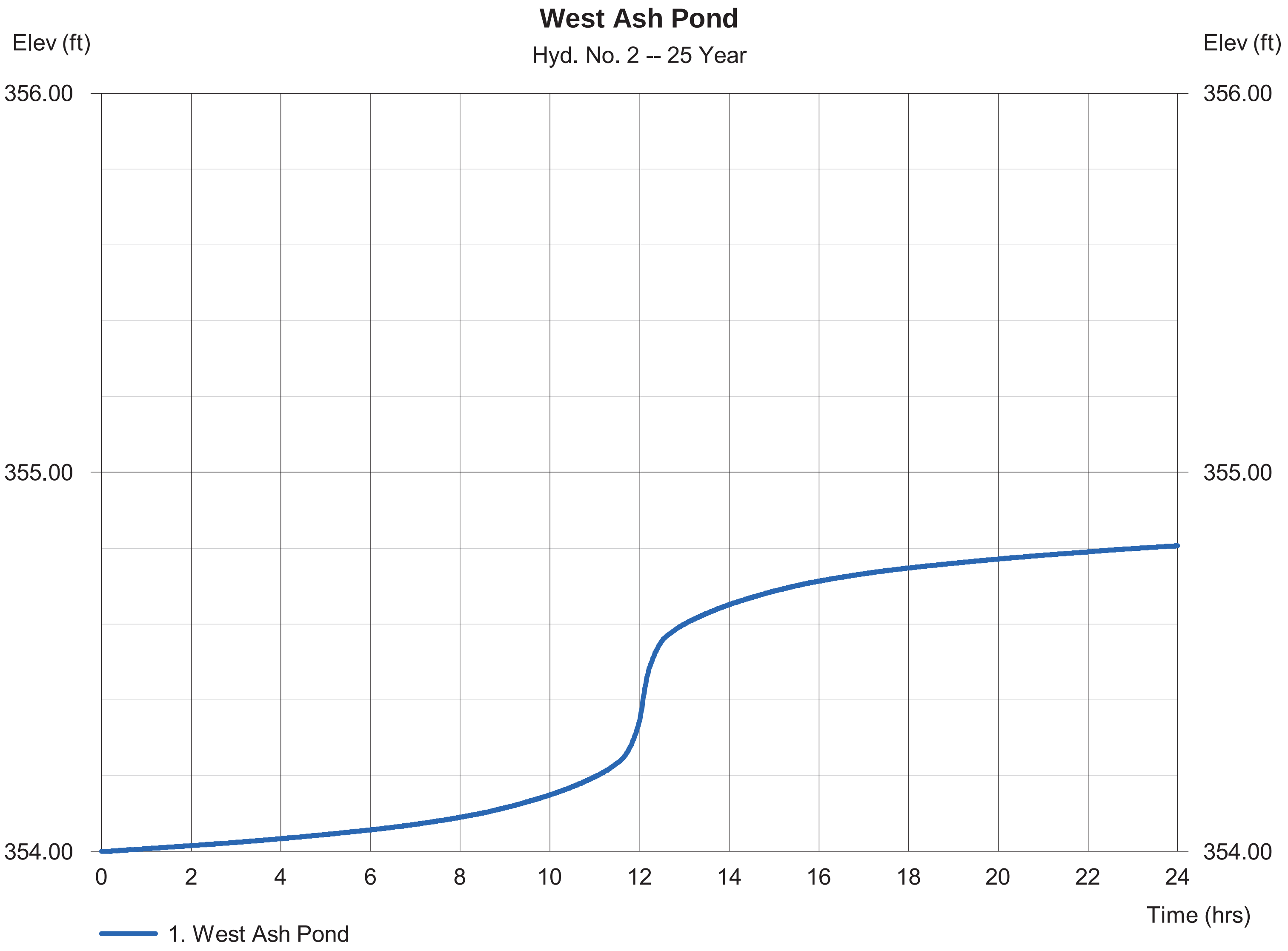
Hydrograph Report

Hyd. No. 2

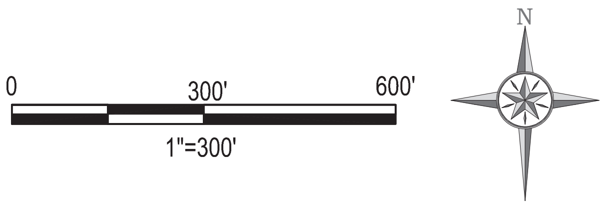
West Ash Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 25 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - West Ash Pond	Max. Elevation	= 354.81 ft
Reservoir name	= West Ash Pond		

Storage Indication method used. Wet pond routing start elevation = 354.00 ft.

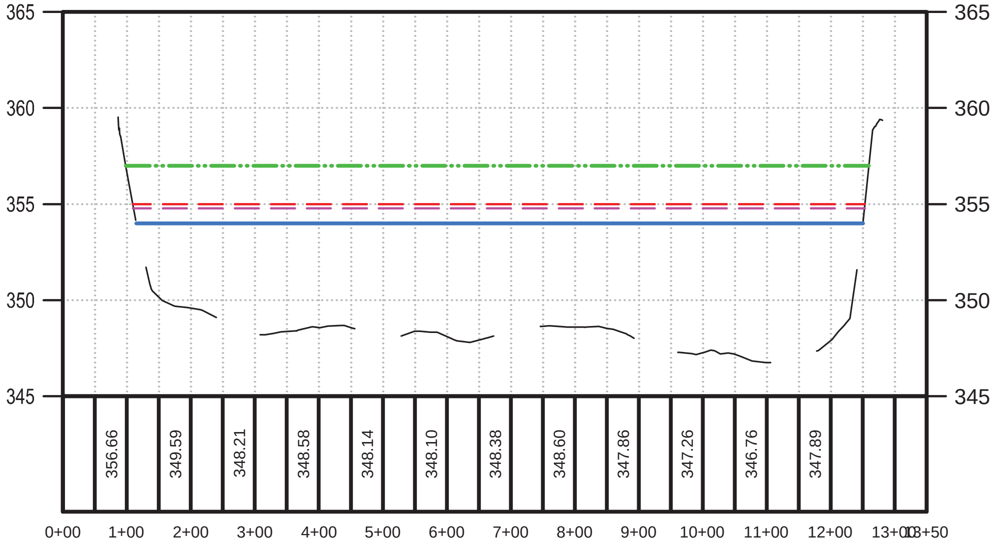


PLAN VIEW
SCALE: 1"=200'



LEGEND

▬ ▬ ▬	WATERSHED BOUNDARY



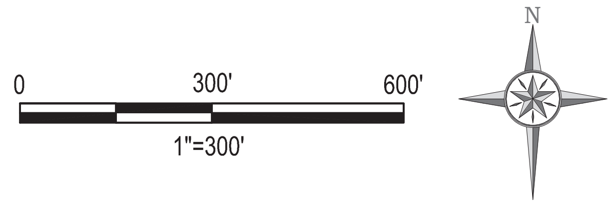
SECTION A-A
HORIZ. SCALE: 1"=300'
VERT. SCALE: 1"=30'

LEGEND

—·—·—	TOP OF EMBANKMENT ELEV.= 357.00
— — —	100 YEAR 24 HOUR WSEL ELEV.= 354.99
— — —	25 YEAR 24 HOUR WSEL ELEV.= 354.79
———	NORMAL OPERATING LEVEL= 354.00

AKRON CONSULTING, LLC.
431 N. CENTER ST.
LONGVIEW, TX 75601
TBPE Firm Reg. # 14014
(O) 903-236-9744
(F) 903-236-9745
www.akron-consulting.com

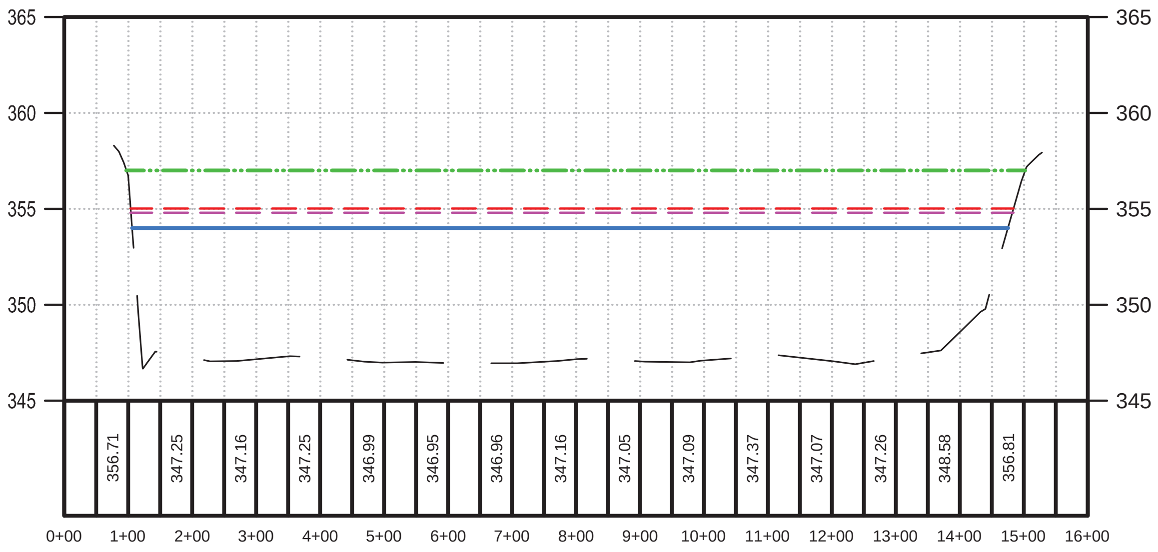
EAST ASH POND WATER SURFACE EXHIBIT



LEGEND

▬ ▬ ▬ WATERSHED BOUNDARY

PLAN VIEW
SCALE: 1"=300'



SECTION B-B
HORIZ. SCALE: 1"=300'
VERT. SCALE: 1"=30'

LEGEND

TOP OF EMBANKMENT ELEV.= 357.00

100 YEAR 24 HOUR WSEL ELEV.= 355.01

25 YEAR 24 HOUR WSEL ELEV.= 354.81

NORMAL OPERATING LEVEL= 354.00

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WEST ASH POND WATER SURFACE EXHIBIT

2.6 – Structural Stability Assessment Periodic 5-Year Review, East and West Bottom Ash Pond, October 2021

STRUCTURAL STABILITY ASSESSMENT
PERIODIC 5-YR REVIEW

30 TAC 352.731 (40 CFR 257.73(d))

East and West Bottom Ash Pond

Pirkey Plant
Hallsville, Texas

October, 2021

Prepared for: Southwest Electric Power Company (SWEPCO) - Pirkey Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

Document No. GERS-21-033

Structural Stability Assessment
Periodic 5-Yr Review
CFR 257.73(d)
Pirkey Plant
East and West Bottom Ash Pond

PREPARED BY Brett A. Dreger DATE 9/30/2021
Brett A. Dreger, P.E.

REVIEWED BY DATE 09-30-2021
Shah S. Baig, P.E.

APPROVED BY Gary Zych DATE 10/1/2021
Gary Zych, P.E.
Manager – AEP Geotechnical Engineering

Gary F. Zych
STATE OF TEXAS
GARY F. ZYCH
127152
LICENSED
PROFESSIONAL ENGINEER
10/1/2021

I certify to the best of my knowledge, information and belief that the information contained in this structural stability assessment meets the requirements of (40 CFR 257.73(d)

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1.0 OBJECTIVE 257.73(d)

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of 30 TAC 352.731 (40 CFR 257.73(d)) and document whether the design, construction, operations, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices. This is the first periodic 5-year review of the initial assessment as per the rule.

Note: There has not been any changes to the diking structures or the discharge weir boxes and discharge pipes passing through the dikes since the initial assessment.

2.0 NAME AND DESCRIPTION OF CCR SURFACE IMPOUNDMENT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for storing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP).

The East BAP is located directly adjacent to and east of the West BAP. The East BAP receives sluiced bottom ash and has a surface area of 30.9 acres and a storage capacity of 188 acre-feet. The pond is almost entirely incised, with a reported maximum embankment height of 4 feet.

The West BAP, which also receives sluiced bottom ash, is located northwest of the main plant and shares its eastern border with the western border of the East BAP. The West BAP receives sluiced bottom ash and has a surface area of 30 acres and a storage capacity of 188 acre-feet. The maximum embankment height is 25 feet. Design documents indicate that the main upstream embankment slopes are 3 feet horizontal to 1 foot vertical (3:1 H:V); while the main downstream slopes are 2.5:1 H:V.

3.0 STABLE FOUNDATION AND ABUTMENTS 257.73(d)(1)(i)

[Was the facility designed for and constructed on stable foundations and abutments? Describe any foundation improvements required as part of construction.]

The foundaion materials for the East BAP are native soils which consist of stiff to very stiff sandy lean clay (CL) and sandy fat clay (CH) with intermittent layers of medium dense to dense silty sand (SM) and clayey sand (SC). Atterberg Plasticity Indices of tested soils ranged between a low of 16 to a high of 39. Based on the subsurface investigation and engineering properties of the subsurface soils, it is concluded that the East Bottom Ash Pond dikes are supported on a stable foundation base.

The foundation materials for the West BAP are native soils which consist primarily of medium dense to very dense clayey sand (SC) with layers of of dense clayey gravel (GC) and very dense silty clayey sand (SC-SM). Atterberg Plasticity Indices of tested soils ranged between a low of 9 to a high of 46. Based on the subsurface investigation and engineering properties of the subsurface soils, it is concluded that the West Bottom Ash Pond dikes are supported on a stable foundation base.

Operation of the impoundment is performed so as to not adversely affect the foundation and abutments. As required by the CCR rules the East and West Bottom Ash Ponds are inspected at least every 7 days by a qualified person. Also as a requirement of the CCR rules, the impoundment is also inspected annually by a professional engineer. Maintenance items are addressed as they are discovered as a part of those inspections.

4.0 SLOPE PROTECTION 257.73(D)(1)(II)

[DESCRIBE THE SLOPE PROTECTION MEASURES ON THE UPSTREAM AND DOWNSTREAM SLOPES.]

The east and west CCR impoundments have a layer of bottom ash on the interior slopes of the ash ponds that provide protection from erosion and wave action. The exterior slopes consist of vegetative cover. Any erosion that may occur is repaired within a timely period.

5.0 EMBANKMENT CONSTRUCTION 257.73 (d)(1)(iii)

[Describe the specifications for compaction and/or recent boring to give a relative comparison of density.]

The East BAP is primarily incised into native soils with an embankment height of approximately 4 feet (AMEC, 2010). The East BAP embankments are constructed of compacted clay on a 3:1 slope (3 feet horizontal, 1 foot vertical) (Sargent & Lundy, 1983). The soils are primarily stiff to very stiff sandy lean clay (CL) and sandy fat clay (CH) with intermittent layers of medium dense to dense silty sand (SM) and clayey sand (SC). The elevation of the top of embankment around the perimeter of the East BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, May 2011). The interior bottom elevation of the East BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Johnson & Pace, June 2011). Based on the subsurface investigation and the engineering properties of the subsurface soils, it is concluded that the East bottom Ash Pond embankments are adequately constructed.

The West BAP embankments have maximum height of approximately 25 feet and are constructed of compacted clay on a slope ranging from 2.5:1 (2.5 feet horizontal, 1 foot vertical) to 3:1 (Sargent & Lundy 1983). The elevation at the top of the embankment around the perimeter of the West BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, 2011). The embankment fill materials are primarily stiff to very stiff lean clay (CL) and/or fat clay (CH), overlying native soils consisting of primarily dense to very dense clayey sand (SC) with layers of dense gravel (GC) and very dense silty clayey sand (SC-SM). The interior bottom elevation of the West BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Akron Consulting, 2012). Based on the slope stability evaluation and the engineering properties of the subsurface soils, it is concluded that the West Bottom Ash Pond embankments are adequately constructed.

6.0 VEGETATION CONTROL 257.73 (d)(1)(iv)

[Describe the maintenance plan for vegetative cover.]

The vegetative slopes/areas are mowed to facilitate inspections and maintain the growth of the vegetative layer; and prevent the growth of woody vegetation.

7.0 SPILLWAY SYSTEM 257.73(d)(1)(v)

[Describe the spillway system and its capacity to pass the Inflow Design Flood as per its Hazard Classification.]

Hydrology and Hydraulic Analysis which includes calculations for each spillway structure are included in Inflow Design Flood Control Plan. The Inflow Design Flood for the East and West Bottom Ash Ponds is the 100-year storm event.

The surface water elevation in the East BAP is controlled by a weir box and a manually operated gate valve installed on a 36-inch diameter discharge pipe at the southwest corner of the pond. Clear water overflow from the East BAP discharges through the 36-inch diameter pipe into a 2.7 acre Clearwater Pond located directly south of the East BAP. Water in the Clearwater Pond is either pumped (re-circulated) back into the boiler ash hopper, the FGD make up system or pumped back to the Sabine mine for beneficial reuse as dust suppression water.

The surface water elevation in the West BAP is controlled by a weir box and a manually operated gate valve installed on a 36-inch-diameter discharge pipe at the southeast corner of the pond. Clear water overflow from the West BAP discharges through the 36-inch diameter pipe into a 2.7 acre Clearwater Pond located southeast of the West BAP. Water in the Clearwater Pond is either pumped (re-circulated) back into the boiler ash hopper, the FGD make up system or pumped back to the Sabine mine for beneficial reuse as dust suppression water.

Based on the Hydrology and Hydraulic analysis the East and West BAP’s spillway system can handle the 100-year storm event.

<u>8.0</u> BURIED HYDRAULIC STRUCTURES 257.73 (d)(1)(vi)

[Describe the condition of the sections of any hydraulic structure that in buried beneath and/or in the embankment.]

Clear water overflow from the East BAP discharges through a 36-inch diameter corrugated steel pipe that passes into a 2.7 acre Clearwater Pond located directly south of the East BAP. The 36-inch diameter corrugated steel pipe passes under the embankment that separates the East Bottom Ash Pond from the clear water pond. In 2012 when the clear Water pond was completely drained exposing the outfall end of the pipe, the 36 CMP appeared to be in stable and functional condition.

Clear water overflow from the West BAP discharges through a 36-inch diameter corrugated steel pipe that passes into a 2.7 acre Clearwater Pond located directly southeast of the West BAP. The 36-inch diameter corrugated steel pipe passes under the embankment that separates the West Bottom Ash Pond from the clear water pond. In 2012 when the clear water pond was completely drained exposing the outfall end of the pipe, the 36 CMP appeared to be in stable and functional condition.

There are no signs of settlement or sinkholes on the ground surface above the pipes. The discharge pipes have not shown signs of excess corrosion or deterioration based on exterior visual inspections since the initial assessment.

<u>9.0</u> SUDDEN DRAWDOWN 257.73 (d)(1)(vii)

[If the downstream slope is susceptible to inundation, discuss the stability due to a sudden drawdown.]

The downstream slopes of the Bottom Ash Pond dikes will not be inundated from any adjacent water bodies. There have not been any changes to the downstream slope areas of the Bottom Ash Ponds since the initial assessment.

2.7 – Safety Factor Assessment Periodic 5-Year Review, East Bottom Ash Pond, October 2021

SAFETY FACTOR ASSESSMENT
PERIODIC 5-YEAR REVIEW

30 TAC 352.731 (40 CFR 257.73e)

East Bottom Ash Pond

Pirkey Plant
Hallsville, Texas

October, 2021

Prepared for: Southwest Electric Power Company (SWEPCO) – Pirkey Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

GERS-21-050

SAFETY FACTOR ASSESSMENT
PERIODIC 5-YEAR REVIEW
CFR 257.73(e)
PIRKEY PLANT
EAST BOTTOM ASH POND

PREPARED BY Brett A. Dreger DATE 10/6/2021
Brett A. Dreger, P.E.

REVIEWED BY DATE 10/6/2021
Mohammad A. Ajlouni, Ph.D., P.E.

APPROVED BY Gary F. Zych DATE 10/6/2021
Gary F. Zych, P.E.
Section Manager – AEP Geotechnical Engineering

Gary F. Zych
STATE OF TEXAS
GARY F. ZYCH
127152
LICENSED PROFESSIONAL ENGINEER
10/6/2021

I certify to the best of my knowledge, information, and belief that the information contained in this safety factor assessment meets the requirements of 40 CFR § 257.73(e)

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1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of 30 TAC 352.731 (40 CFR 257.73(e)) for the safety factor assessment of CCR surface impoundments. This is the first periodic 5-year review of the safety factor assessment.

2.0 DESCRIPTION OF THE CCR UNIT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for storing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP). This report addresses the East Bottom Ash Pond.

The East BAP is located directly adjacent to and east of the West BAP. The East BAP receives sluiced bottom ash and has a surface area of 30.9 acres and a storage capacity of 188 acre-feet. The East BAP is almost entirely incised on three sides with a reported maximum embankment height of 4 feet and a splitter dike on the west side that is shared with the West BAP. Design documents indicate that the main upstream embankment slopes are 3 feet horizontal to 1 foot vertical (3:1 H:V); while the main downstream slopes are 2.5:1 H:V. The East BAP embankments have the same crest width and slopes and are constructed of the same materials with the same compaction and strength characteristics as the West BAP embankments. Since the soil characteristic and foundation conditions of the East BAP are similar to the soil characteristics and foundation conditions of the West BAP, it is concluded that the East BAP embankments would be covered under West BAP stability report titled Initial Safety Factor Assessment – West Bottom Ash Pond. A copy of the West BAP Safety Factor assessment report is attached.

3.0 SAFETY FACTOR ASSESSMENT 257.73(e)

As mentioned above, it was concluded that the safety factor assessment of the East BAP would be covered under the West BAP stability report titled Initial Safety Factor Assessment – West Bottom Ash Pond. Additionally, since the maximum embankment height of the East BAP is 4 feet while the maximum embankment height of the West BAP is 25 feet it is concluded that the factor of safety for the East BAP embankments would be equal to or better than the West BAP embankments. Therefore, the periodic 5-year review was conducted to evaluate if any physical changes have been made to the earthen dike and/or operating changes that could impact the loading on the structure. The assumptions, material properties and operating pools defined in the initial assessment were reviewed. The review concluded that there have been no changes that would impact the stability analyses that were previously conducted. Therefore, the previous report and analyses are still applicable to the current conditions of the facility. The results indicate that the calculated factors of safety meet or exceed the minimum values defined in Section 257.73(e).

ATTACHMENT A

Initial Safety Factor Assessment – West Ash Pond

Initial Safety Factor Assessment – West Ash Pond

Pirkey Power Generating Station
Hallsville, Texas

Auckland Project No. 2015-008C (Revision No. 2)
January 14, 2016

Prepared For:

American Electric Power Company
1 Riverside Plaza
Columbus, Ohio 43215

Prepared By:

Auckland Consulting, LLC
Jacksonville, Texas

TBPE Firm Registration No. F-16721
Expires 2/29/2016

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Appendix

1.0 Introduction and Embankment Information

1.1 Introduction

The following report and evaluation provides the Initial Safety Factor Assessment of the West Ash Pond, an existing CCR impoundment (as defined by 40 CFR §257.2) located at the Pirkey Power Station near Hallsville, Texas. In accordance with 40 CFR §257.73(e)(1)(i) through (iv) this initial assessment provides field and laboratory data, model outputs (detailing multiple stability conditions) and summary of safety factors for the West Ash Pond. In accordance with 40 CFR §257.73(e)(2) this report provides the Initial Safety Factor Assessment certification for the West Ash Pond.

1.2 Referenced Information and Data

Soils data, comprised of field and laboratory testing, utilized in the preparation of this assessment were completed by ETTL Engineers and Consultants, Inc. and documented in the report *Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas* dated October 12, 2010. Based on a review of the provided field and laboratory data, it appears to be accurate and appropriate for use in the initial structural stability assessment of the West Ash Pond [40 CFR §257.73(e)(1)]. Furthermore, based on a recent site visit (October 2015), no modifications or elevation alterations have been made to the embankment since the referenced investigation. No additional field or laboratory activities were conducted. Soil data utilized in this evaluation is provided in the Appendix of this report.

To supplement existing data collected in the above reference report, an additional eight (8) Cone Penetrometer Test (CPT) soundings were advanced both along the crest and southern toe of the West Ash Pond. Sounding depths ranged between approximately 14 feet and 40 feet before encountering refusal. The data collected generally supports the findings from the 2010 study and confirms that embankment and foundation soils are relatively consistent. The location of and data from these CPT soundings are provided in the Appendix of this report.

The impoundment pool elevation data cited herein were provided in a separate hydrology and hydraulic (H&H) analysis report completed by Akron Consulting, LLC titled *Hydrology & Hydraulic Report, East & West Ash Ponds, H.W. Pirkey Power Plant – Hallsville, Texas,* dated December 15, 2015 (not included herein). The referenced report generally meets the demonstration requirements of 40 CFR §257.82(a).

Embankment profile dimensions and elevations were determined by using existing information provided by the client or representatives of the client. This information is also included in the Appendix of this report.

1.3 Embankment Evaluation Criteria

Based on information provided by the client, the existing embankment is constructed of lean clay (CL) and fat clay (CH) with existing side slopes (both up- and downstream) of approximately 3:1 (H:V), maximum embankment height of 20 feet and top of dam elevation of 358.0 feet (MSL). The upstream base elevation of the impoundment is approximately 347.0 feet (MSL). The crest width of the embankment is approximately 25 feet. Two (2) critical sections were evaluated for this initial safety factor assessment. Section No. 1 represents the northwest corner of the West Ash embankment and Section No. 2 represents the southern berm of the embankment.

It is our understanding that the maximum storage elevation of impounded CCR ash is 355.0 feet (MSL); however, the facility is managed to maintain an ash level less than this maximum level. The downstream toe of the West Ash Pond is not adjacent to other water bodies and therefore not subject to 40 CFR §257.73(d)(1)(A)(3)(vii).

In accordance with 40 CFR §257.73(e)(1)(i) and (ii), the maximum storage pool elevation for the West Ash Pond as determined by the 25-year, 24-hour storm event is 354.81 feet (MSL). For the purposes of this evaluation, the maximum storage pool elevation of 355.0 feet (MSL) was utilized. Likewise, the maximum (or flood) surcharge loading elevation as determined by the 100-year, 24-hour event is 355.01 feet (MSL), for this evaluation a maximum surcharge loading elevation of 355.0 feet (MSL) was utilized. Storage pool elevations were determined in accordance with 40 CFR §257.82(a).

2.0 Slope Stability Analyses

2.1 General

Soil parameters used for stability analyses of the existing embankment are based on findings of previous laboratory and field testing programs. The probable failure planes were analyzed using the analytical slope stability software, SLIDE by Rocscience, Inc. Methods of evaluation used in SLIDE are considered to be limited equilibrium methods of analysis, where each individual shear plane is evaluated to determine the resulting shear stress at the point of failure. For the purposes of this evaluation the Bishop Method of analysis, which analyzes circular failure planes through the slope was utilized.

Per 40 CFR §257.73(e)(1)(i) through (iii), three (3) modeled scenarios (presented below) were utilized to evaluate the stability of the existing embankment: steady state seepage (long term) condition under maximum storage pool, steady state seepage (long term) condition under maximum surcharge pool, and steady state seepage condition with seismic loading under maximum storage pool conditions. The following minimum factors of safety (FS) and soil stress parameters were utilized in modeling. Minimum factors of safety are based on demonstration requirements provided in 40 CFR §257.73(e)(1).

Summary of Embankment Condition and Factor of Safety		
Embankment Condition	**Soil Parameters**	**Minimum Factor of Safety**
Steady State Seepage – Maximum Pool	Effective Stress	1.50
Steady State Seepage – Surcharge Pool	Effective Stress	1.40
Steady State Seepage (Seismic) – Maximum Pool	Total Stress	1.00
NOTE: Minimum factors of safety based on demonstration requirements provided in 40 CFR §257.82 (e)(1).		

For evaluation of steady state seepage (long term) conditions with seismic, peak ground acceleration for this location was obtained from the USGS National Seismic Hazard Mapping Project (http://earthquake.usgs.gov/hazards). Based on the seismic survey data, the anticipated site specific peak ground acceleration (PGA) of 0.06g (acceleration at rock sites) for two (2) percent probability of exceedance in 50 years (40 CFR Part 257, Preamble page 21384). Correcting for acceleration at soft soil sites (Seismic Site Classification D) yields an estimated PGA of 0.13g. The seismic coefficient (k) used for pseudo static analysis is determined by reducing the estimated PGA by 50% yielding a seismic coefficient of 0.065g.

2.2 Liquefaction Assessment

Liquefaction of soils occurs when horizontal shearing stresses exceed the strength of existing loose, saturated sand. This sudden loss of shear strength and subsequent soil structure is typically associated with earthquake-induced horizontal movement. Recent engineering publications[1] provide criteria to assess liquefaction potential of sands (little to no fines) and clayey soils of low plasticity (e.g. clayey sands, silts). These criteria indicate that water content of fine-grained or cohesive soils needs to be high (≥ 0.85 *Liquid Limit [LL]), a clay fine content (defined as grains smaller than 0.002 mm) of less than 10 percent (< 10%), and relatively low soil density (assessed in terms of SPT blow counts). In addition, the accepted minimum seismic threshold acceleration to cause liquefaction in loose sands is 0.10g, the anticipated site specific PGA for this site is 0.06g.

Native fine grained (or cohesive) material underlying the West Ash Pond generally consist of medium dense to very dense clayey sand (SC), clayey gravel (GC) and silty clayey sand (SC-SM) Based on these soil characteristics and that the West Ash Pond is located in a zone of low peak ground acceleration (PGA), the risk of either embankment or underlying soils liquefying are negligible [40 CFR §257.73(e)(1)(iv)].

---

[1] Seed, R.B., et al, Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework, 26th Annual ASCE Los Angeles Spring Seminar, April 2003

2.3 Embankment and Foundation Stratigraphy

The models developed for this evaluation are based on the existing embankment geometry, results of field and laboratory testing and hydrologic site information provided by the client and recent field activities. Selection of critical slope sections (Section Nos. 1 and 2) was based on both height and subsurface sensitivity to loading. The following tables provide a summary of soil parameters used for these analyses. Specific soil parameters used for each model are presented in the Appendix.

Summary of Long Term, Total Stress Soil Parameters, Section No. 1:

Material Type	Unit Weight (pcf)	Consolidated-Undrained Cohesion (psf)	Consolidated-Undrained Angle of Internal Friction (degrees)
Embankment Fill	125	450	12
Lean Clay/Fat Clay (CL/CH)	125	530	13
Silty Sand/Clayey Sand (SM/SC)	125	0	28
Ash	100	0	30

NOTE: Properties used for Steady State Seepage with Seismic analysis.

Summary of Long Term, Effective Stress Soil Parameters, Section No. 1

Material Type	Unit Weight (pcf)	Consolidated-Drained Cohesion (psf)	Consolidated-Drained Angle of Internal Friction (degrees)
Embankment Fill	125	590	16
Lean Clay/Fat Clay (CL/CH)	125	320	17
Silty Sand/Clayey Sand (SM/SC)	125	430	28
Ash	100	0	30

NOTE: Properties used for Steady State Seepage analysis. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing.

Summary of Long Term, Total Stress Soil Parameters, Section No. 2			
Material Type	**Unit Weight (pcf)**	**Consolidated-Undrained Cohesion (psf)**	**Consolidated-Undrained Angle of Internal Friction (degrees)**
Embankment Fill	125	450	12
Lean Clay/Fat Clay (CL/CH)	125	530	13
Clayey Sand/Silty Sand (SC/SM)	125	0	28
Lean Clay (CL)	125	260	20
Ash	100	0	30
NOTE: Properties used for Steady State Seepage with Seismic analysis.			

Summary of Long Term, Effective Stress Soil Parameters, Section No. 2			
Material Type	**Unit Weight (pcf)**	**Consolidated-Drained Cohesion (psf)**	**Consolidated-Drained Angle of Internal Friction (degrees)**
Embankment Fill	125	590	16
Lean Clay/Fat Clay (CL/CH)	125	320	17
Clayey Sand/Silty Sand (SC/SM)	125	0	28
Lean Clay (CL)	125	290	22
Ash	100	0	30
NOTE: Properties used for Steady State Seepage analysis. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing.			

2.4 Seepage Analysis Parameters

The analysis of embankment seepage is based on laboratory results and estimated values for permeability for various embankment and native foundation soils. These soil parameters were utilized in the models to establish a long term steady state condition and corresponding phreatic surface in the embankment. Hydraulic conductivity test results are provided in the Appendix. Hydraulic conductivity properties utilized in the seepage analysis are provided in the below table.

Hydraulic Conductivity of Embankment Soils, Section Nos. 1 and 2	
Material Type	**Permeability (ft/sec)**
Embankment Fill	1×10^{-8}
Lean Clay/Fat Clay (CL/CH)	1×10^{-8}
Clayey Sand/Silty Sand (SC/SM)	1×10^{-5}
Lean Clay (CL)	1×10^{-8}
Ash	1×10^{-4}

2.5 Stability Analysis Results

The following tables provides the results of the stability analysis for each of the conditions cited herein, as required by 40 CFR §257.73(e)(1)(i) through (iii). The graphical representations of each analysis are included in the Appendix.

Summary of Stability Analyses – Safety Factors, Section No. 1		
Modeled Condition	**Factor of Safety**	
	Actual	**Minimum**
Steady State Seepage – Maximum Pool	2.21	1.50
Steady State Seepage – Surcharge Pool	2.21	1.40
Steady State Seepage with Seismic – Maximum Pool	1.35	1.00

Summary of Stability Analyses – Safety Factors, Section No. 2		
Modeled Condition	Factor of Safety	
	Actual	Minimum
Steady State Seepage – Maximum Pool	1.83	1.50
Steady State Seepage – Surcharge Pool	1.83	1.40
Steady State Seepage with Seismic – Maximum Pool	1.50	1.00

Based on the findings of this analysis, the evaluated embankments appear to be stable under the modeled conditions and demonstrate the minimum safety factors, as required by 40 CFR §257.73(e)(1)(i) through (iii).

3.0 Report Limitations

This report has been prepared for the exclusive use of our client for the specific application to the project discussed and has been prepared in accordance with the generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. The analyses contained in the report are based on the data obtained from the referenced soil borings performed within the project site. This report does not reflect variations that may occur between borings or across the site. Soil borings do not necessarily reflect strata variations that may exist at other locations within the project site.

4.0 Initial Structural Stability Assessment Certification

By means of this certification, (i) I have reviewed the requirements of 40 CFR §257.73(e)(1) – *Periodic Safety Factor Assessments*, (ii) I or my agent has visited and examined the facility, (iii) the referenced data used in this evaluation to the best of my knowledge appears correct and appropriate for use, (iv) and this Initial Safety Factor Assessment for the West Ash Pond (Pirkey Power Station) has been prepared to the best of my knowledge in accordance with §257.73(e)(1).

By: ______________________

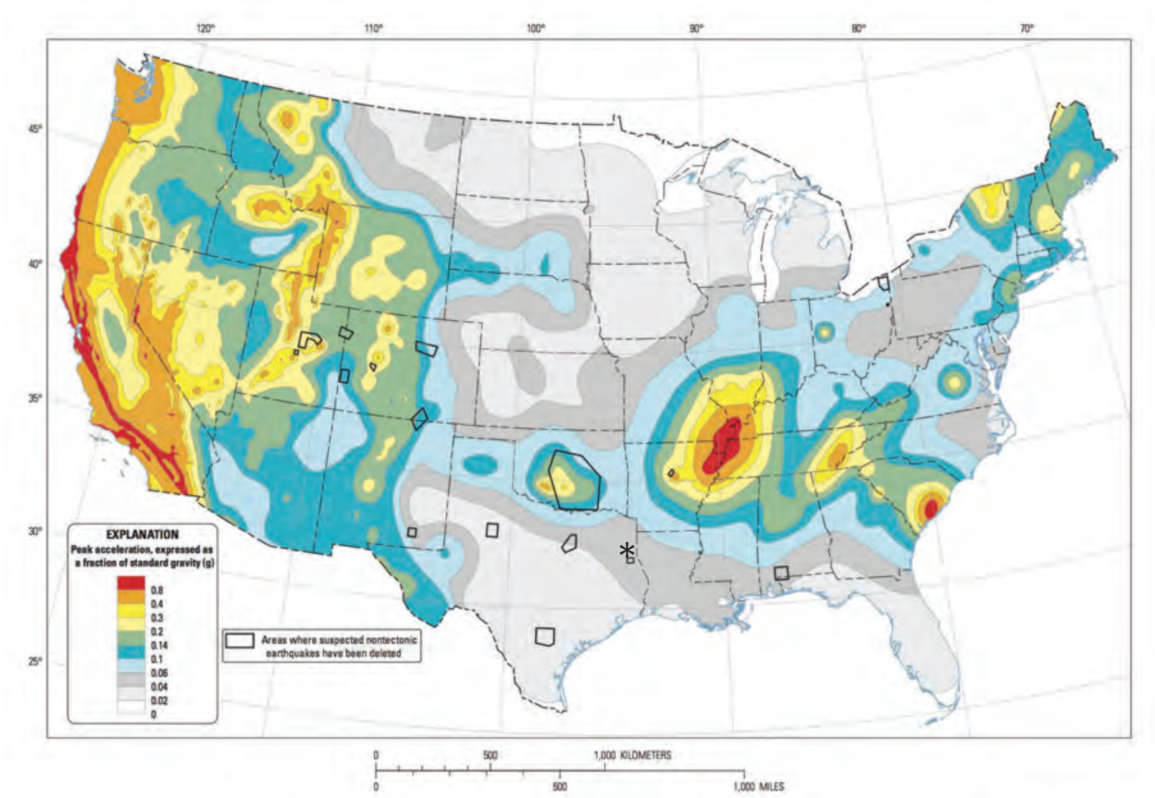
Dated: January 14, 2016

JOHN J. TAYNTOR
99202

TBPE Firm Registration No. F-16721
Expires 2/29/2016

Appendix

Stability Analyses
Reference Data



Two-percent probability of exceedance in 50 years map of peak ground acceleration

* Approximate location of Pirkey Power Generating Station

Provided by USGS National Seismic Hazard Mapping Project.

Seismic Probability Map

Scale: N/A	**Pirkey Power Generating Station** **Initial Safety Factor Assessment - West Ash Pond** **Hallsville, Texas**
Auckland Project No. 2015-008C	

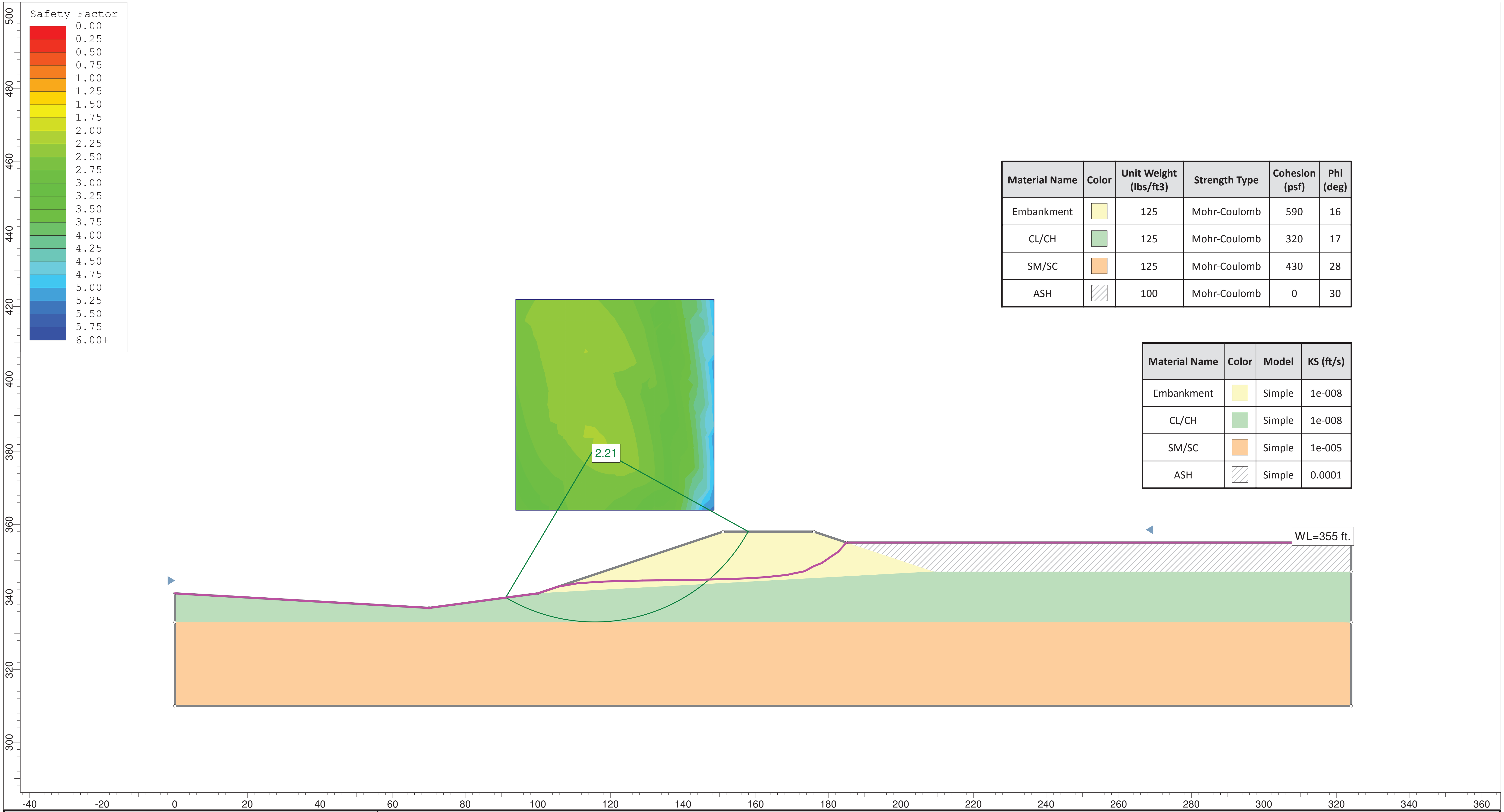
Provided by Google Earth.

Cone Penetrometer Test (CPT) Location Map

Scale: N/A

Auckland Project No. 2015-008C

Pirkey Power Generating Station
Initial Safety Factor Assessment - West Ash Pond
Hallsville, Texas



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	590	16
CL/CH	🟩	125	Mohr-Coulomb	320	17
SM/SC	🟧	125	Mohr-Coulomb	430	28
ASH	▨	100	Mohr-Coulomb	0	30

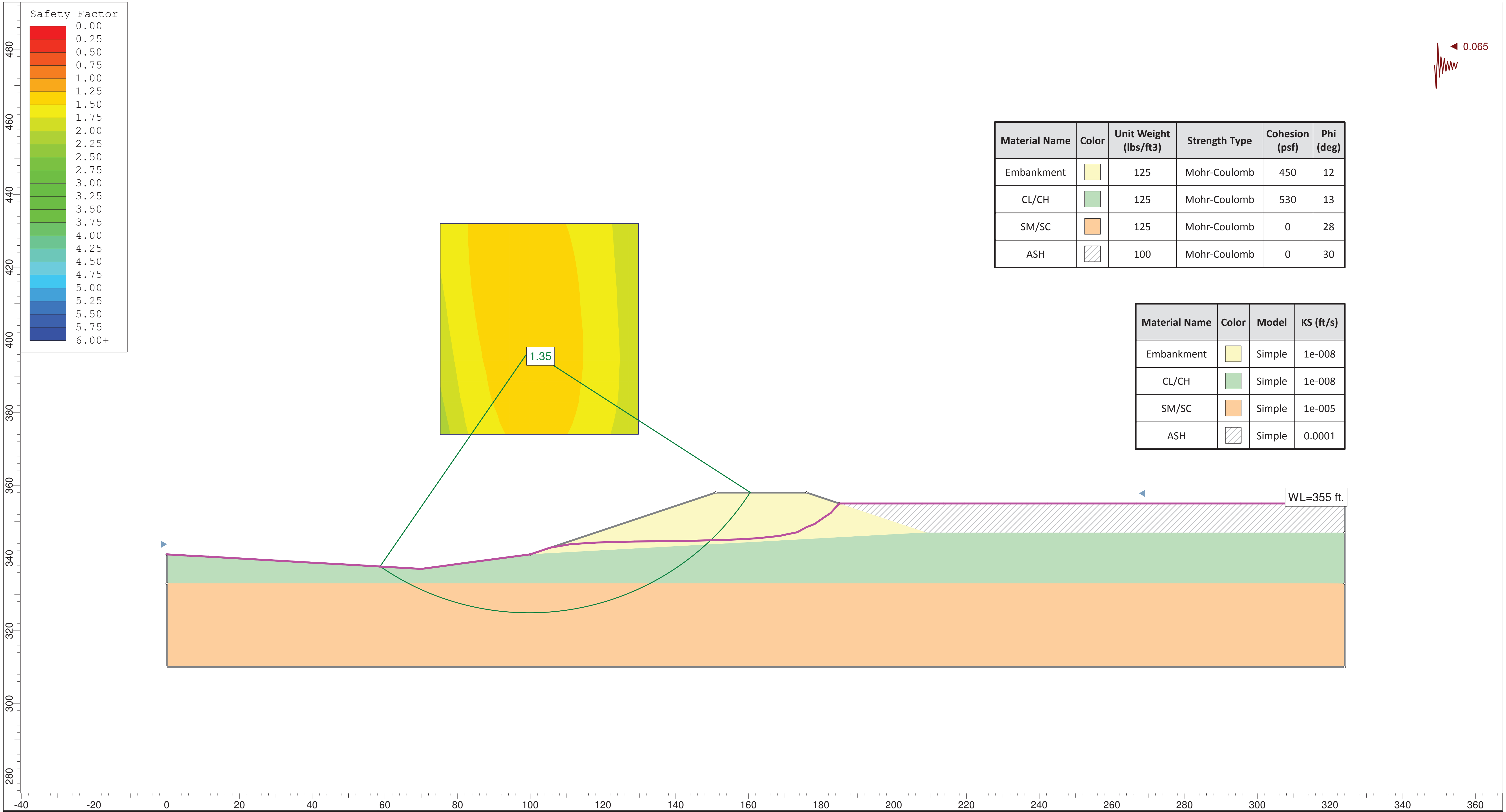
Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SM/SC	🟧	Simple	1e-005
ASH	▨	Simple	0.0001

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 1
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool

Drawn By	JJT	*Company*	
Date	12/15/2015	*File Name*	WEST ASH_Section 1_SSS_25yr.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	450	12
CL/CH	🟩	125	Mohr-Coulomb	530	13
SM/SC	🟧	125	Mohr-Coulomb	0	28
ASH	▨	100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SM/SC	🟧	Simple	1e-005
ASH	▨	Simple	0.0001

Auckland Consulting LLC
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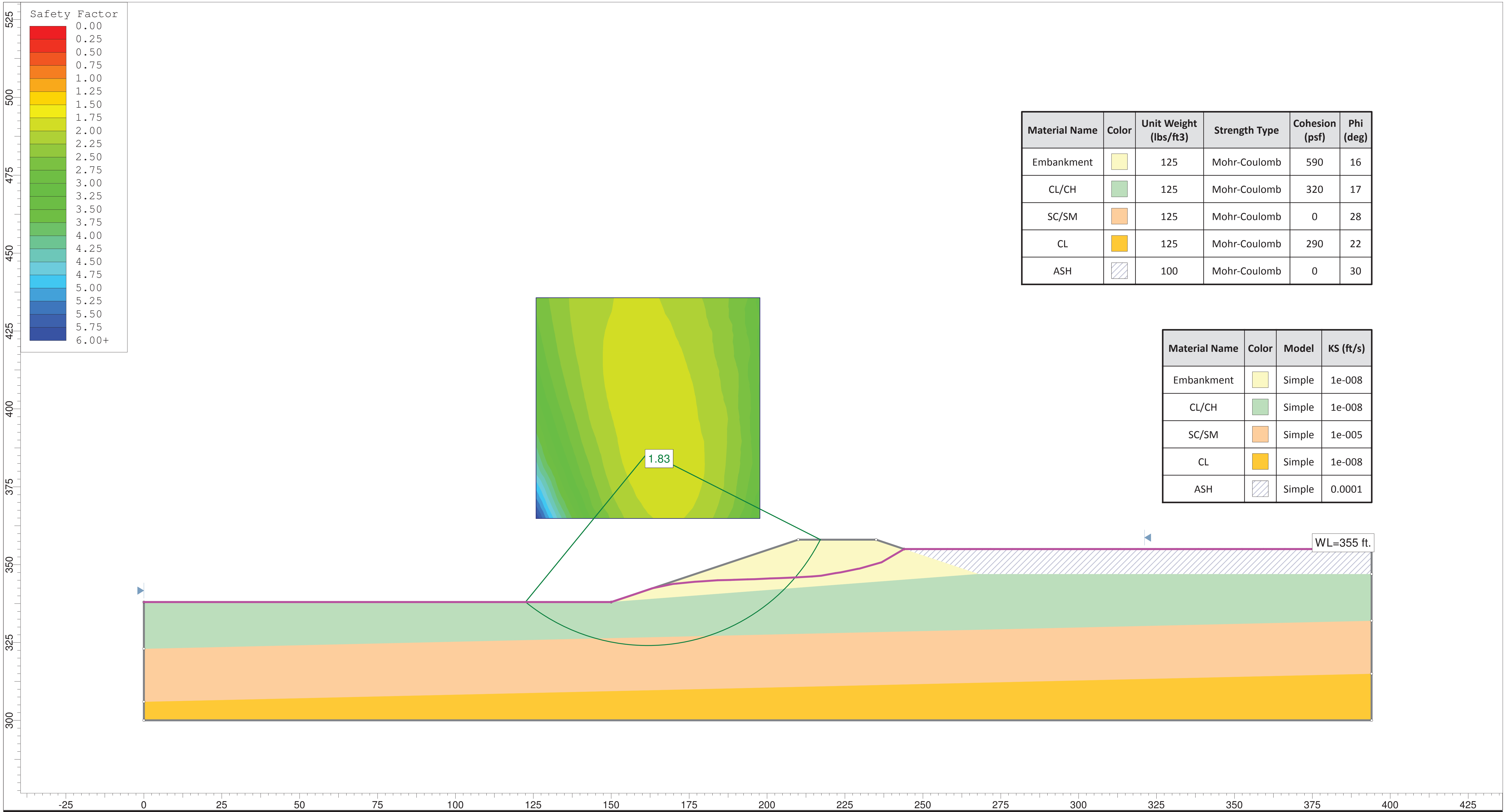
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 1
Analysis Description	Steady State Seepage at Maximum Pool, Seismic Analysis

Drawn By	JJT	*Company*	
Date	12/23/2015	*File Name*	WEST ASH_Section 1_SSS_25yr_seismic.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	590	16
CL/CH	🟩	125	Mohr-Coulomb	320	17
SC/SM	🟧	125	Mohr-Coulomb	0	28
CL	🟨	125	Mohr-Coulomb	290	22
ASH	▨	100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SC/SM	🟧	Simple	1e-005
CL	🟨	Simple	1e-008
ASH	▨	Simple	0.0001

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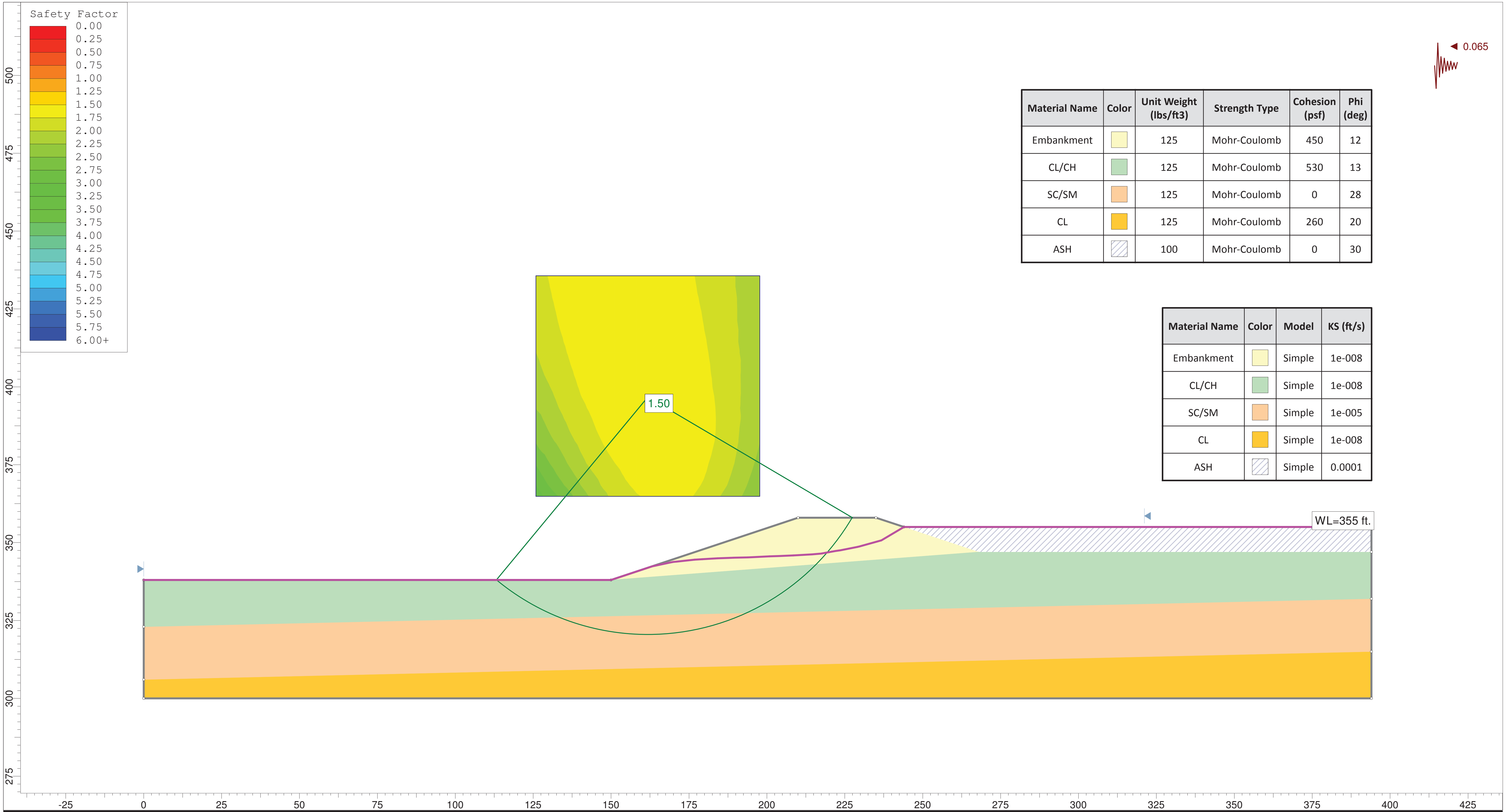
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 2
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool
Drawn By	JJT
Company	
Date	12/15/2015
File Name	WEST ASH_Section 2_SSS_25yr.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	450	12
CL/CH	🟩	125	Mohr-Coulomb	530	13
SC/SM	🟧	125	Mohr-Coulomb	0	28
CL	🟨	125	Mohr-Coulomb	260	20
ASH	▨	100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SC/SM	🟧	Simple	1e-005
CL	🟨	Simple	1e-008
ASH	▨	Simple	0.0001

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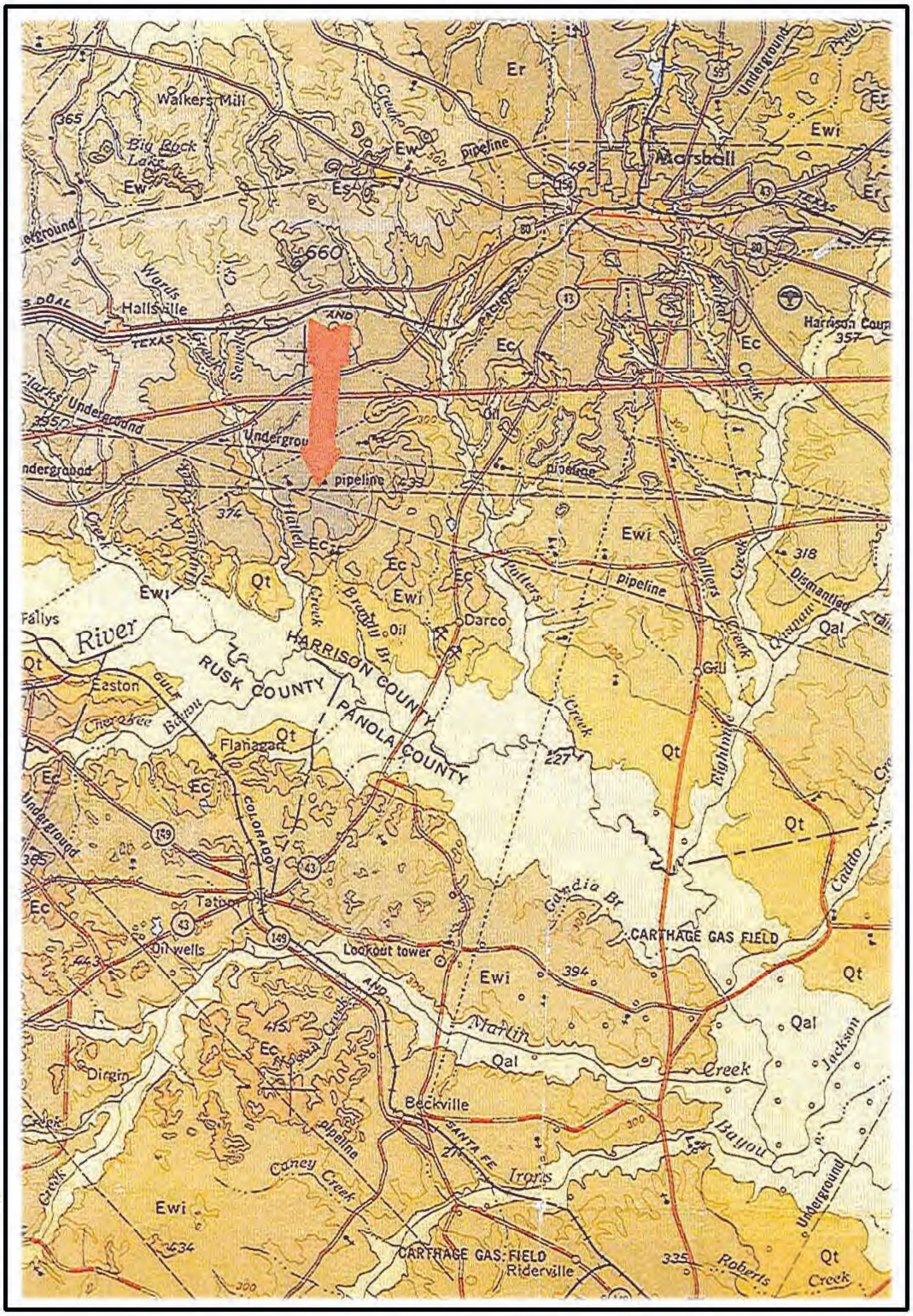
SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 2
Analysis Description	Steady State Seepage at Maximum Pool, Seismic Analysis
Drawn By JJT	*Company*
Date 12/23/2015	*File Name* WEST ASH_Section 2_SSS_25yr_seismic.slim



EXPLANATION

SEDIMENTARY ROCKS

QUATERNARY

Recent

Qal
Alluvium
Flood-plain deposits

Pleistocene

Qt
Fluviatile terrace deposits undivided

TERTIARY

Eocene

Etg / Es
Sparta Sand
Quartz sand, fine to medium grained, light gray to brownish gray, slightly cohesive from silt and clay matrix, massive, locally cross-bedded, interbeds of sandy clay more abundant upward, locally carbonaceous; weathers various shades of light gray, at base hard, brown, ferruginous sandstone; lower part 170± feet thick, upper part absent. Locally includes Tyler Greensand Member, Etg, quartz-glauconite greensand, grayish green, massive, locally cross-bedded; weathers dark reddish brown, abundant ironstone concretions

Ew
Weches Formation
Glauconite and quartz sand, grayish green to grayish olive green, thin bedded, locally cross-bedded to lenticular, clay interbeds light brown to moderate light gray, silty, muscovitic, thin bedded; weathers moderate to dark reddish brown, locally forms limonitic and sideritic iron ore and clay ironstone concretions; marine megafossils in southern part; 25± feet thick, range 0–70 feet

Eqc
Queen City Sand
Quartz sand, fine grained to locally medium grained, light gray to brownish gray, locally carbonaceous, and clay, gray to brown, silty, slightly lignitic, sand most abundant to west; weathers red and white mottled, ironstone concretions and ledges common; local beds of glauconite-quartz greensand, cross-bedded, weathers to ferruginous ledges and rubble; 100–400 feet thick, thins southeastward

Er
Reklaw Formation
Upper 100± feet, clay, brownish black to brownish gray, silty, muscovitic, carbonaceous, laminated, interbeds of moderate reddish-brown clay; weathers light brown, ironstone concretions common; a few marine fossils. Lower 15± feet, quartz sand, fine to very fine grained, grayish green, glauconitic, argillaceous, massive, locally cross-bedded; weathers moderate brown to dark yellowish orange with clay ironstone ledges and rubble; fossils, clay ironstone, and clay decrease northward

Ec
Carrizo Sand
Upper part, very fine sand, silt, clayey silt, silty clay, medium to dark gray, carbonaceous; weathers moderate yellowish brown to dark reddish brown, indurated ledges of dark brownish-gray ironstone common. Lower part, quartz sand, fine to medium grained, light brownish gray, weakly cohesive, massive, locally cross-bedded; weathers light gray to various shades of red. Thickness 20–100 feet

Ewi
Wilcox Group undivided
Mostly silty and sandy clay, various shades of gray, local beds of clay, lignite, silt, and quartz sand, in part carbonaceous, laminated to massive, locally cross-bedded, weathers to various shades of gray, brown, yellow, and red. Calcareous siltstone and ironstone concretions common; abundant plant fossils, a few marine fossils in southeastern part; 300–1,000 feet thick.

E
Eocene rocks undivided
Reklaw Formation, Carrizo Sand, Wilcox Group, and Midway Group on Brooks dome, not separately shown

Ewp
Wills Point Formation
Clay, medium bluish gray, greenish gray, grayish green, brownish gray, silt increases upward, laminated to locally massive, glauconitic near base, rough calcareous siltstone concretions common in upper part, locally lignitic in upper part, thin bed of [illegible] limestone near middle; weathers medium gray to yellowish gray; fossiliferous; 500± feet thick

Ek
Kincaid Formation
Clay, medium gray to dark gray, greenish gray, brownish gray, glauconitic, calcareous, selenitic, locally silty or sandy, locally phosphatic near base, thin beds of limestone in upper part, gray, hard, detrital; weathers medium gray; fossiliferous; 180± feet thick

CRETACEOUS

Upper Cretaceous

Kk
Kemp Clay
Clay, dark gray to bluish gray, calcareous, silty, glauconitic, calcareous concretions common; weathers dark greenish gray and black; upper part only crops out

Ku
Upper Cretaceous rocks undivided
Navarro Group, Taylor Group, and Austin Chalk on Brooks dome not separately shown

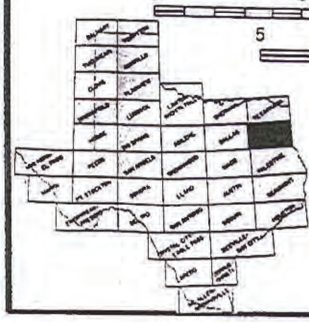
Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

5 0 5 10 Nautical Miles

CONTOUR INTERVAL 100 FEET
WITH SUPPLEMENTARY CONTOURS AT 50 FOOT INTERVALS



ETTL ENGINEERS & CONSULTANTS
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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PLATE 2

SITE SURFACE GEOLOGY

JOB No.: G3241-095

DATE: DEC. 2009

SCALE: 1:250,000

LOG OF BORING W-1

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095

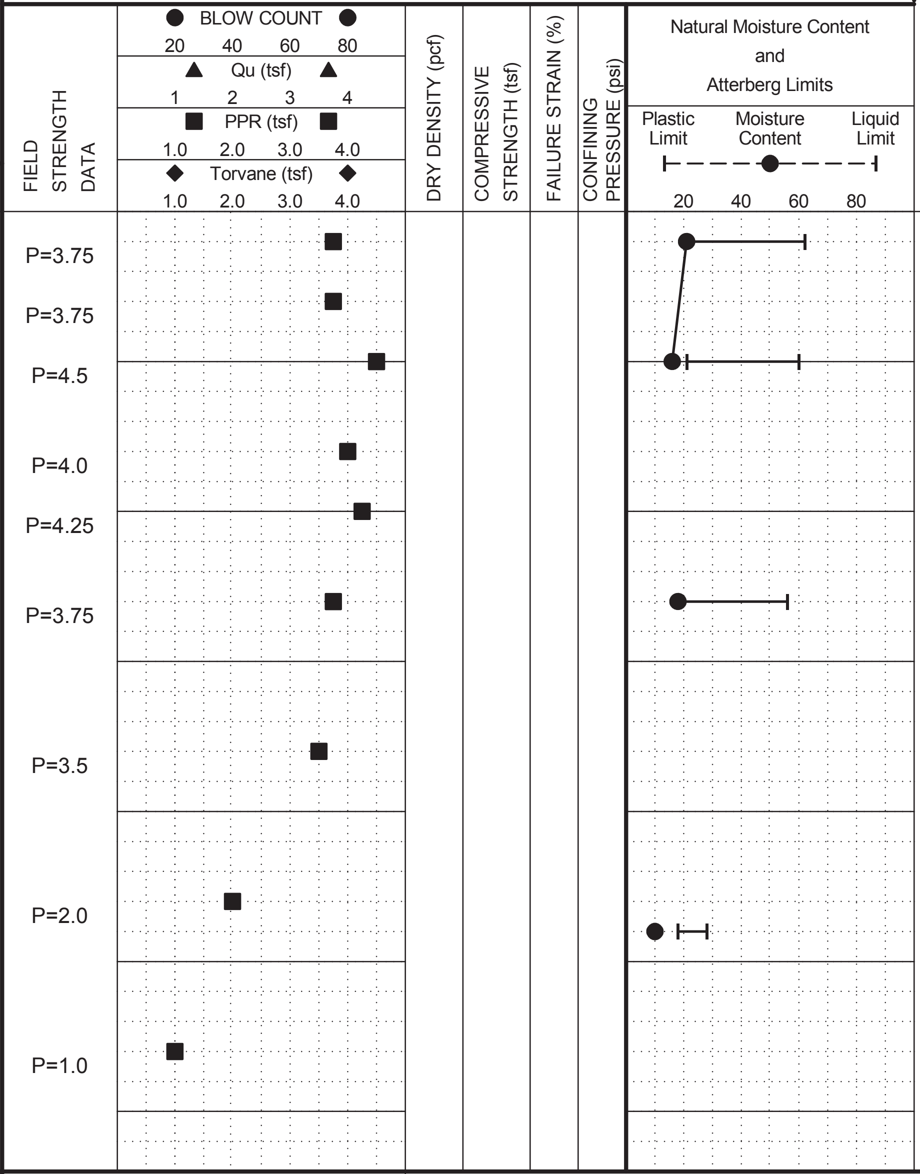
BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.5

MATERIAL DESCRIPTION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CH	FAT CLAY WITH SAND(CH) tan and red	P=3.75	21	62	21	41	79	+40 Sieve=6%, +4 Sieve=0%
			P=3.75						
5		--red	P=4.5	16	60	21	39	75	+40 Sieve=7%, +4 Sieve=1%
	CL	SANDY LEAN CLAY(CL) reddish yellow	P=4.0						
10	CH	FAT CLAY(CH) red and tan	P=4.25						
	CH	FAT CLAY WITH SAND(CH) red and yellow	P=3.75	18	56	18	38	71	+40 Sieve=5%, +4 Sieve=0%
15									
		--red	P=3.5						
20									
	SC	CLAYEY SAND(SC) reddish brown	P=2.0	10	28	18	10	25	+40Sieve=21%, +4 Sieve=11%
25									
	CL	LEAN CLAY(CL) red; with sand seams	P=1.0						
30									



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

LOG OF BORING W-1

ETTL ENGINEERS & CONSULTANTS

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PROJECT: Pirkey Power Plant
Hallsville. Texas

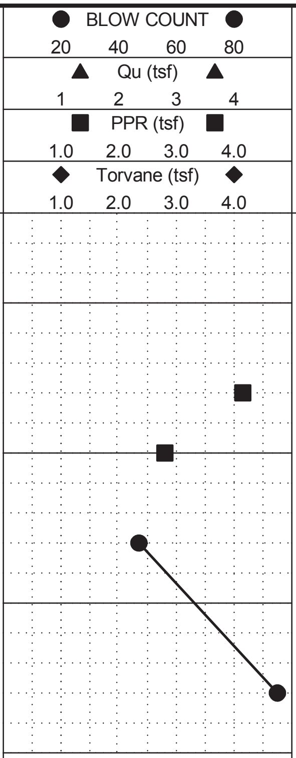
PROJECT NO.: G3241-095

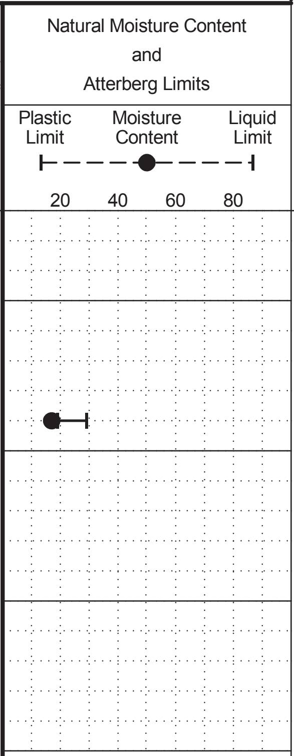
BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.5

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
33–35	SC	CLAYEY SAND(SC) grayish brown	N=32						
38–40		--tannish gray	P=4.15	17	29	19	10	25	+40 Sieve=1%, +4 Sieve=0%
40			P=2.8						
43–45		--gray	N=47						
48–50	SM SC	SILTY CLAYEY SAND(SM-SC) gray	N=50/6"						
50		Bottom of Boring @ 50'							





DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL
ENGINEERS &
CONSULTANTS

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-2

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/21/09

SURFACE ELEVATION 341.7

● BLOW COUNT ● 20 40 60 80
▲ Qu (tsf) ▲ 1 2 3 4
■ PPR (tsf) ■ 1.0 2.0 3.0 4.0
◆ Torvane (tsf) ◆ 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit ├ – – ● – – ┤ Liquid Limit; Moisture Content 20 40 60 80

DEPTH (ft)	USC	GEOLOGIC UNIT / WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL		SANDY LEAN CLAY(CL) stiff; red and gray	N=9										
			--hard	P=4.5+					17	48	19	29	65	+40 Sieve=6%, +4 Sieve=2%
5			--gray, red, and tan	N=50										
	SC		CLAYEY SAND(SC) very dense; red and tan	N=50/5"					16	28	18	10	27	+40 Sieve=7%, +4 Sieve=2%
10														
		∇	--medium dense; tan and gray	P=1.5					19	32	17	15	31	+40Sieve=13%, +4 Sieve=5%
15														
			--very dense; gray and tan	N=62										
20		▼												
			--green	N=50/5"					22	28	19	9	33	+40 Sieve=6%, +4 Sieve=2%
25														
				N=56										
30			Bottom of Boring @ 30'											

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling. Water level @ 21' and open upon completion.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

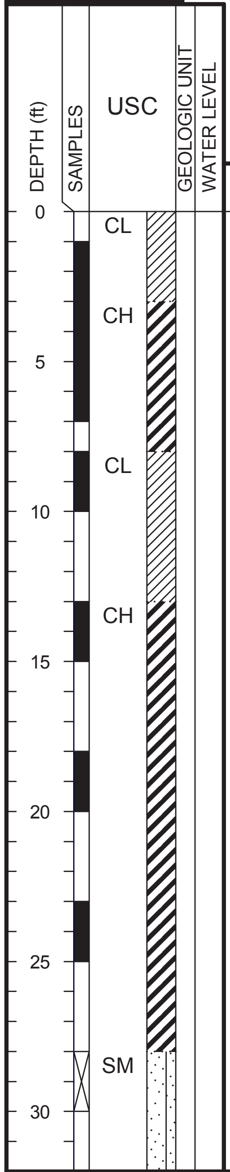
LOG OF BORING W-3

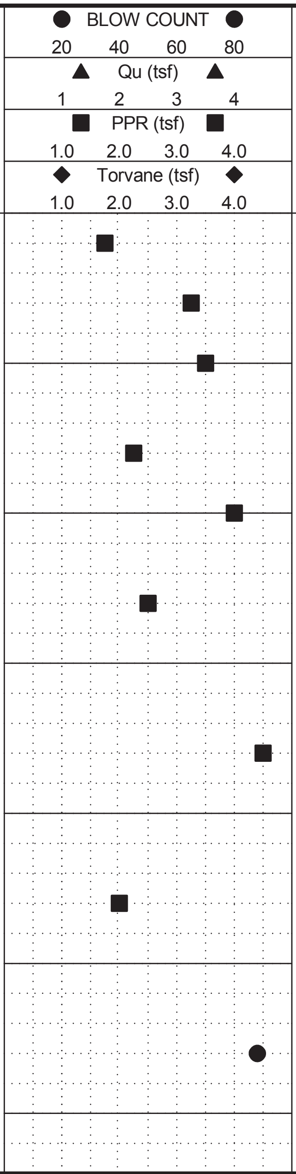
PROJECT: Pirkey Power Plant
Hallsville. Texas

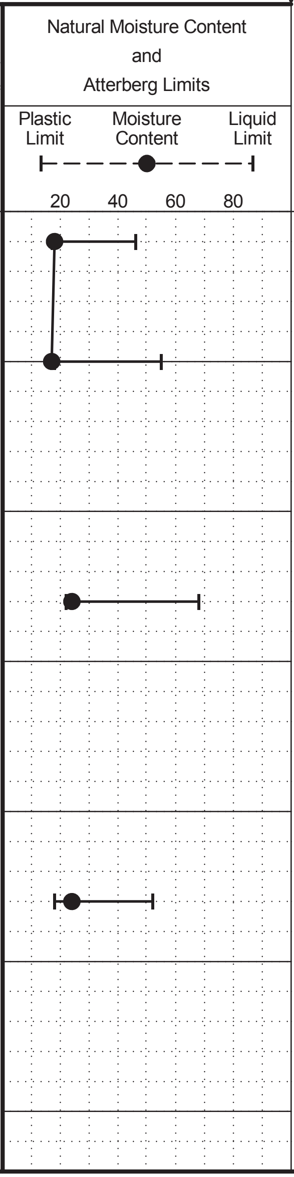
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.3







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; white and tan	P=1.75					18	46	17	29	61	+40 Sieve=7%, +4 Sieve=2%
CH	SANDY FAT CLAY(CH) very stiff; red, tan, and white	P=3.25										
	--white, tan, and red	P=3.5					17	55	18	37	68	+40 Sieve=5%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) very stiff; red and yellow	P=2.25 P=4.0										
	--hard; red and yellow											
CH	FAT CLAY WITH SAND(CH) very stiff; red and yellow	P=2.5					24	68	22	46	80	+40 Sieve=6%, +4 Sieve=0%
	--hard	P=4.5+										
	--stiff	P=2.0					24	52	18	34	69	+40 Sieve=4%, +4 Sieve=0%
SM	SILTY SAND(SM) very dense; yellow and red	N=88										

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 34' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-3

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095

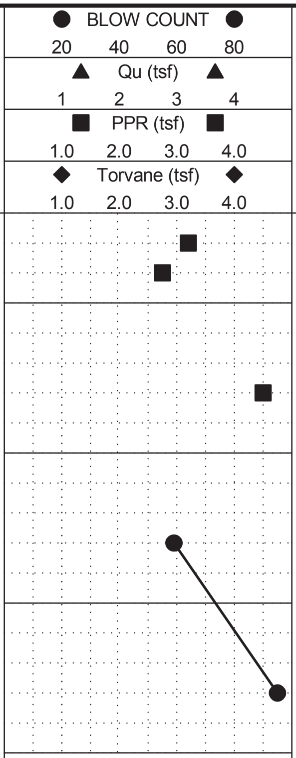
BORING TYPE: Flight Auger

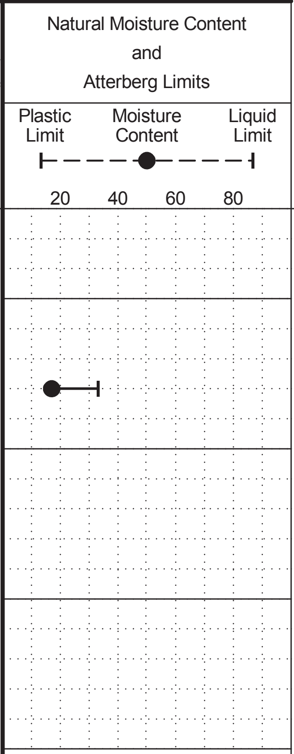
DATE 10/20/09

SURFACE ELEVATION 356.3

DEPTH (ft)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	■	CL	∇	SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel	P=3.25										
40	■	SC		CLAYEY SAND(SC) very dense; dark gray	P=4.5+					17	33	17	16	38	+40 Sieve=1%, +4 Sieve=0%
45	☒	SM SC		SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated	N=59										
50	☒	SC		CLAYEY SAND(SC) very dense; dark gray	N=50/4"										

Bottom of Boring @ 50'





Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 34' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-4

PROJECT: Pirkey Power Plant
Hallsville. Texas

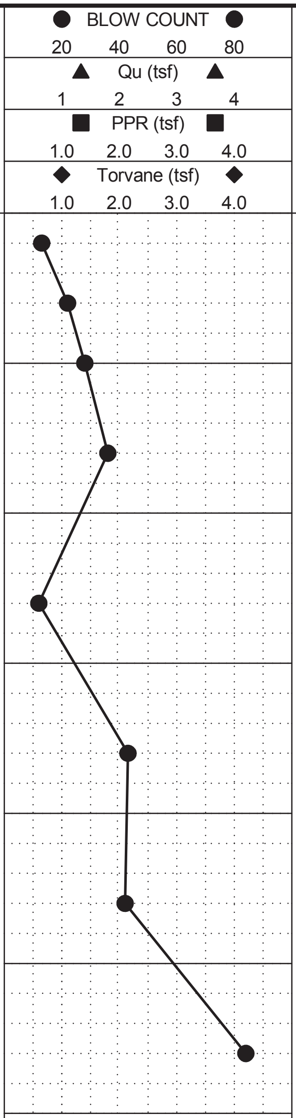
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

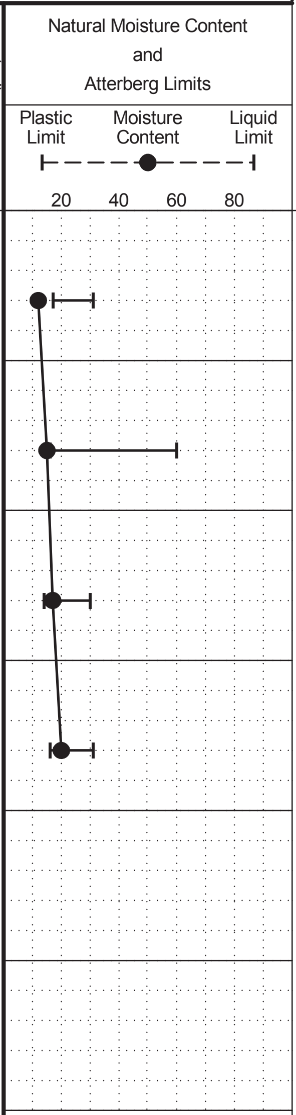
SURFACE ELEVATION 338.0

USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC		CLAYEY SAND(SC) stiff; brown, red, and yellow	N=13						
		--with gravel	N=22	12	31	17	14	35	+40Sieve=31%, +4 Sieve=16%
		--red and tan; with iron oxide cemented sandstone	N=28						
		--dense; red and white; with clay seams	N=36	15	60	16	44	39	+40Sieve=11%, +4 Sieve=4%
		--medium dense; orangish gray; with gravel	N=12	17	30	14	16	22	+40Sieve=28%, +4 Sieve=17%
GC	∇	CLAYEY GRAVEL(GC) dense; dark gray	N=43	20	31	16	15	7	+40Sieve=68%, +4 Sieve=52%
SM		SILTY SAND(SM) dense; dark gray	N=42						
CL		SANDY LEAN CLAY(CL) very dense; gray	N=84						

Bottom of Boring @ 30'



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

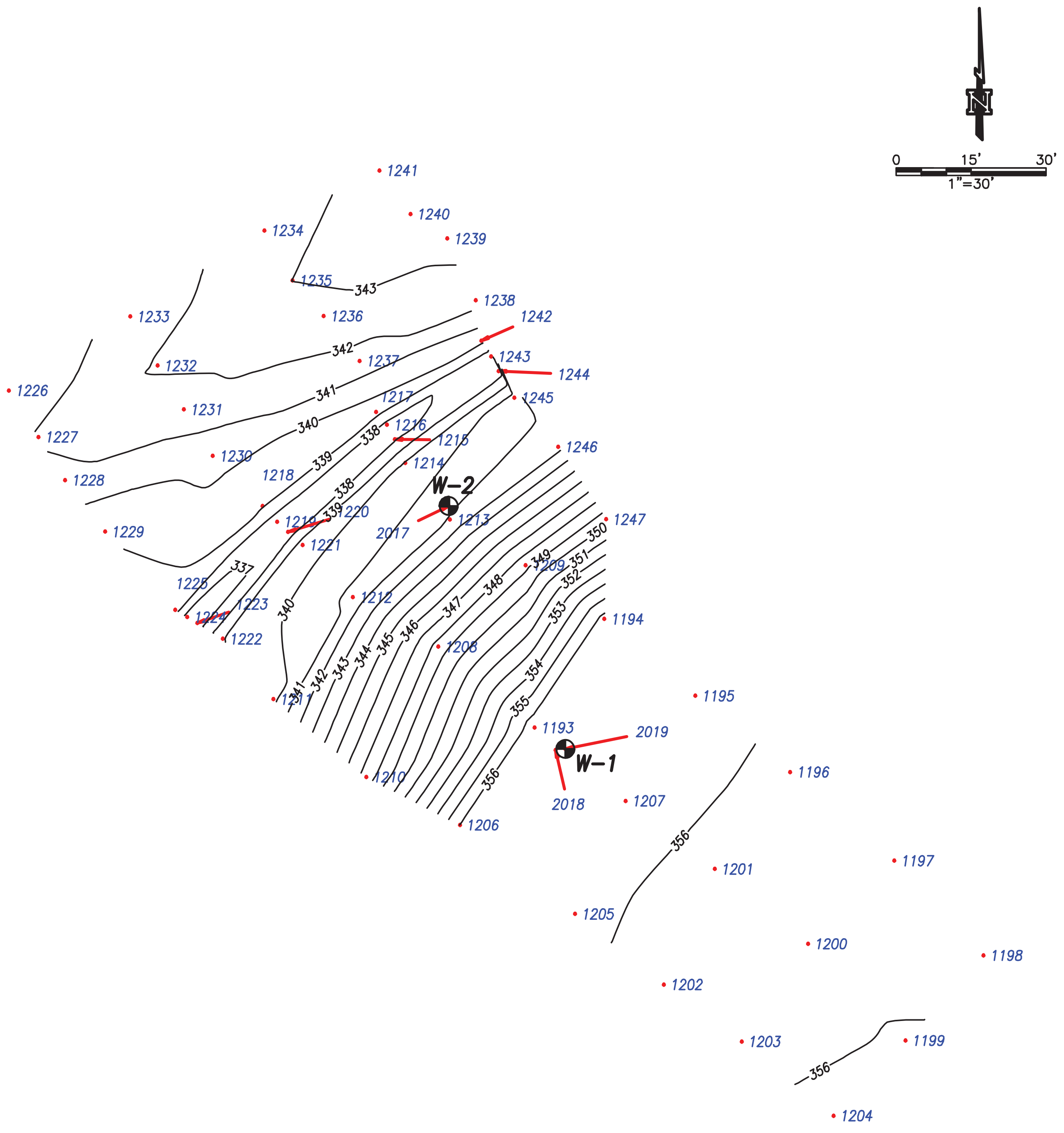


Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 19' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

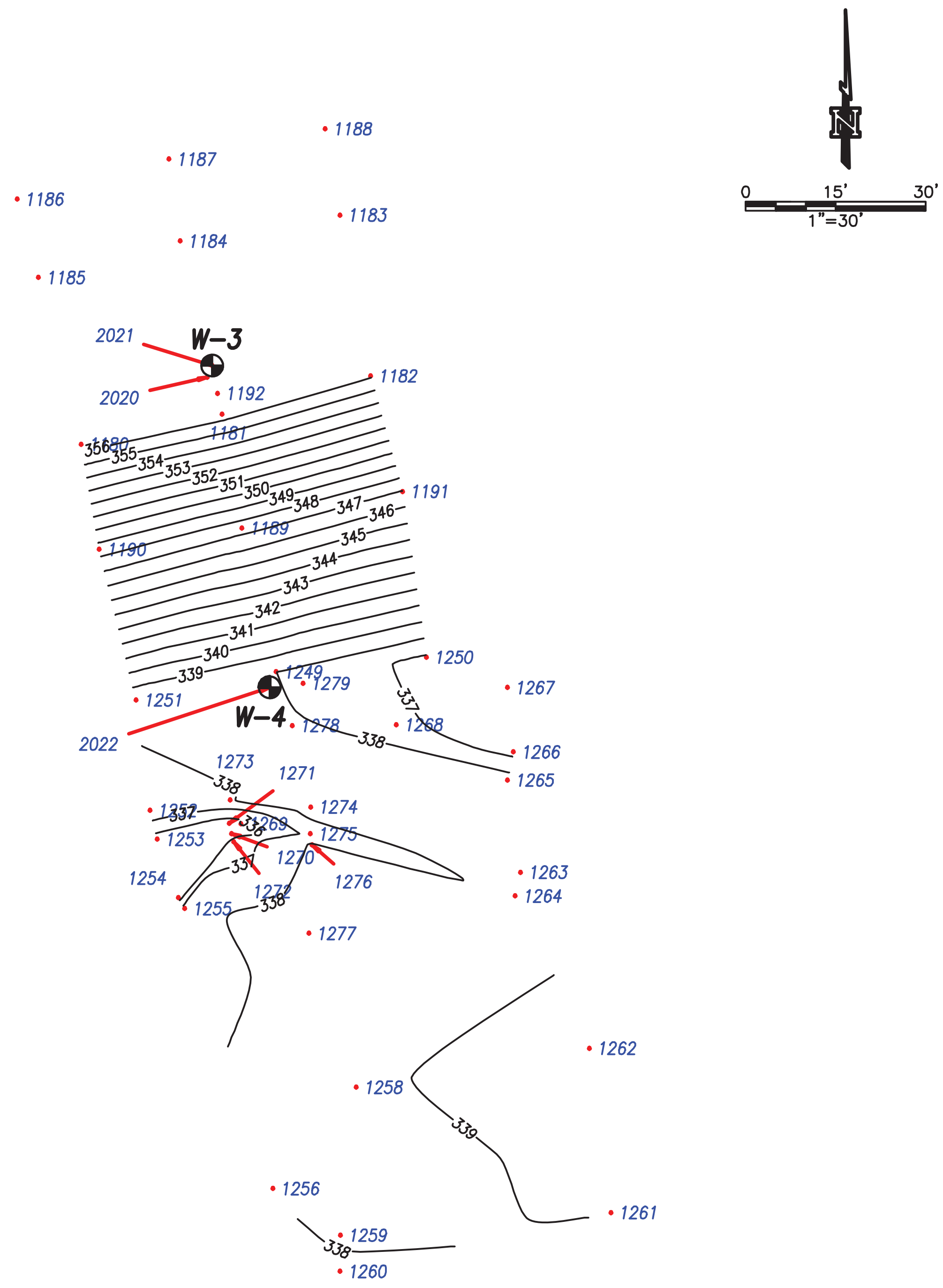
Notes:



JOHNSON & PACE INCORPORATED
ENGINEERING ● ARCHITECTURE ● SURVEYING
1201 NW LOOP 281, LB1, LONGVIEW, TEXAS 75604
(903)753-0663 FAX (903)753-8803
website: www.johnsonpace.com
JOB NO: 2313-013 FIELD BOOK: XXX/XXX DATE: NOV. 2009

EXHIBIT "I"

W-1 AND W-2 BOREHOLES
PIRKEY POWER PLANT
HALLSVILLE, TEXAS



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JOB NO: 2313-013 FIELD BOOK: XXX/XXX DATE: NOV. 2009

EXHIBIT "J"

W-3 AND W-4 BOREHOLES
PIRKEY POWER PLANT
HALLSVILLE, TEXAS

ETTL Engineers & Consultants Inc.
GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : Pirkey Power Plants Embankments, Hallsville, Texas
Date: 11/3/2009 Panel Number : P 2 ; ASTM D 5084
Project No. : G 3241-09 Permometer Data

						Set Mercury to Pipet Rp at		
Boring No.:	W - 2	ap =	0.031416 cm2			Equilibrium	1.8	cm3
Sample:		aa =	0.767120 cm2			Pipet Rp	**6.7**	cm3
Depth (ft):	13' to 16'	M1 =	0.030180	C =	0.00043252	Annulus Ra	1.5	cm3
Other Location:		M2 =	1.040953	T =	0.203782344			

Material Description : Tan & Gray Clayey Sand

SAMPLE DATA

Wet Wt. sample + ring or tare :			571.51	g
Tare or ring Wt. :			0.0	g
Wet Wt: of Sample :			571.51	g
Diameter :	2.78	in	7.06	cm2
Length :	2.78	in	7.06	cm
Area:	6.06	in^2	39.10	cm2
Volume :	16.85	in^3	276.12	cm3
Unit Wt.(wet):	**129.15**	pcf	**2.07**	g/cm^3
Unit Wt.(dry):	**107.87**	pcf	**1.73**	g/cm^3

	Before Test		After Test
Tare No.:	T 13	Tare No.:	T 16
Wet Wt.+tare:	660.71	Wet Wt.+tare:	733.72
Dry Wt.+tare:	588.03	Dry Wt.+tare:	625.10
Tare Wt:	219.71	Tare Wt:	151.95
Dry Wt.:	368.32	Dry Wt.:	473.15
Water Wt.:	72.68	Water Wt.:	108.62
% moist.:	**19.7**	% moist.:	**23.0**

Specific Gravity:	**2.80**	Max Dry Density(pcf) =	107.9147	OMC =	19.732841
		% of max =	100.0	+/- OMC =	0.00
Calculated % saturation:	103.59	Void ratio (e) =	**0.62**	Porosity (n)=	**0.38**

TEST READINGS

Z1(Mercury Height Difference @ t1): 5.1 cm Hydraulic Gradient = 9.12

Date	elapsed t (seconds)	Z (pipet @ t)	$\Delta Z\pi$ (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
11/3/2009	76	4.5	2.1571965	24.5	0.899	2.96E-06	8.40E-03	
11/3/2009	106	4	2.6571965	24.5	0.899	2.86E-06	8.11E-03	
11/3/2009	140	3.5	3.1571965	24.5	0.899	2.87E-06	8.12E-03	
11/3/2009	182	3	3.6571965	24.5	0.899	2.92E-06	8.29E-03	

SUMMARY

ka = 2.90E-06 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	2.96E-06	cm/sec	2.1	%
k2 =	2.86E-06	cm/sec	1.4	%
k3 =	2.87E-06	cm/sec	1.3	%
k4 =	2.92E-06	cm/sec	0.7	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

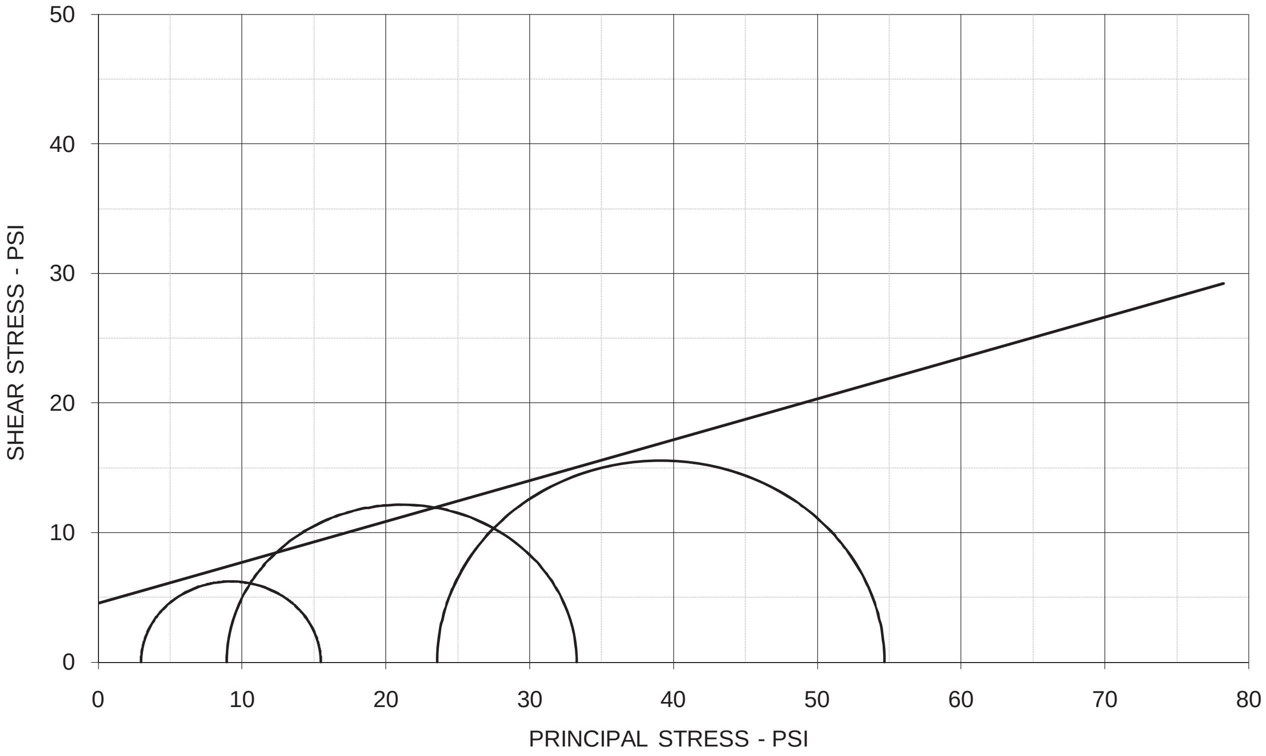
Hydraulic conductivity	k =	**2.90E-06**	cm/sec	**8.23E-03**	ft/day
Void Ratio	e =	**0.62**			
Porosity	n =	**0.38**			
Bulk Density	γ =	**2.07**	g/cm3	**129.2**	pcf
Water Content	W =	**0.34**	cm3/cm3	(at 20 deg C)	
Intrinsic Permeability	kint =	**2.97E-11**	cm2	(at 20 deg C)	

Liquid Limit LL		
Plastic Limit PL		
Plasticity Index PI		
- 200 Sieve		%
+ No 40 Sieve		%
+ No 4 Sieve		%

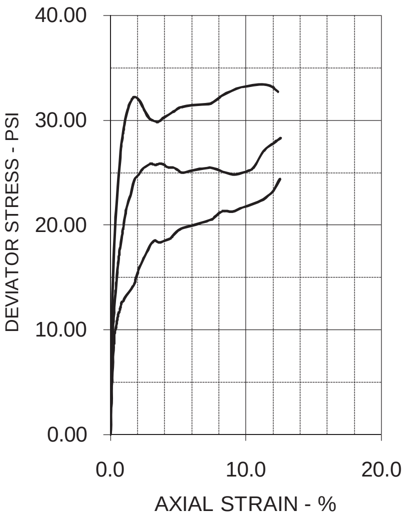
Respectfully Submitted

Robert M. Duke, P.E.

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ ' = 17.5 deg	c' = 4.6 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	25.3	23.6	23.9	
Dry Density - pcf	96.5	100.5	101.1	
Diameter - inches	2.05	2.02	2.04	
Height - inches	3.98	4.00	3.95	
AT TEST				
Final Moisture - %	28.8	28.1	24.5	
Dry Density - pcf	96.5	102.9	104.0	
Calculated Diameter (in.)	2.07	2.01	2.03	
Height - inches	4.02	3.98	3.91	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.49	24.34	31.06	
Total Pore Pressure - psi	57.0	61.1	66.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	2.1	1.5	
σ_1' Failure - psi	15.49	33.26	54.65	
σ_3' Failure - psi	3.00	8.92	23.59	

TEST DESCRIPTION

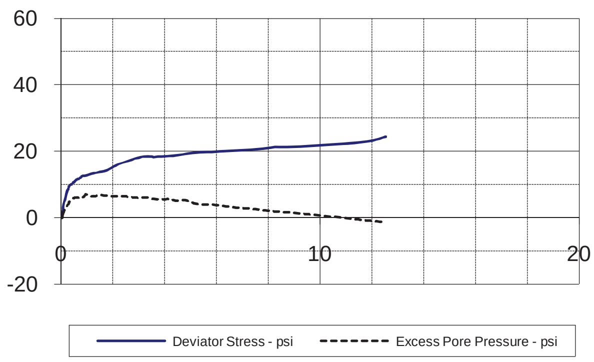
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-1 13' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 5%
LL: 56 PL: 18 PI: 38 Percent -200: 71%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

PROJECT INFORMATION

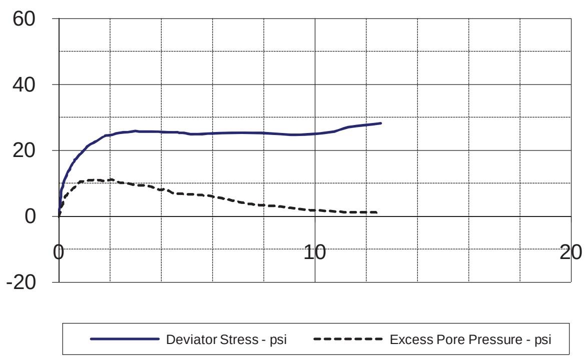
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

ETTL ENGINEERS & CONSULTANTS PLATE: B.1

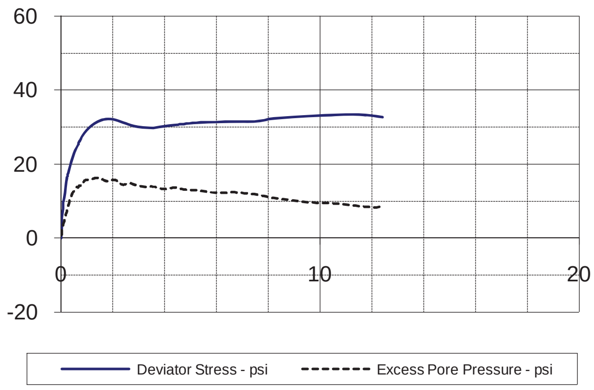
SPECIMEN NO. 1



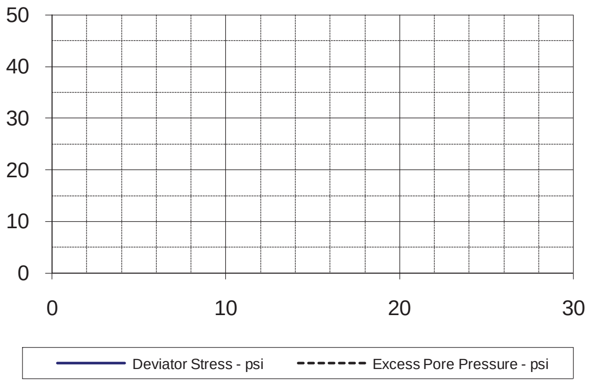
SPECIMEN NO. 2



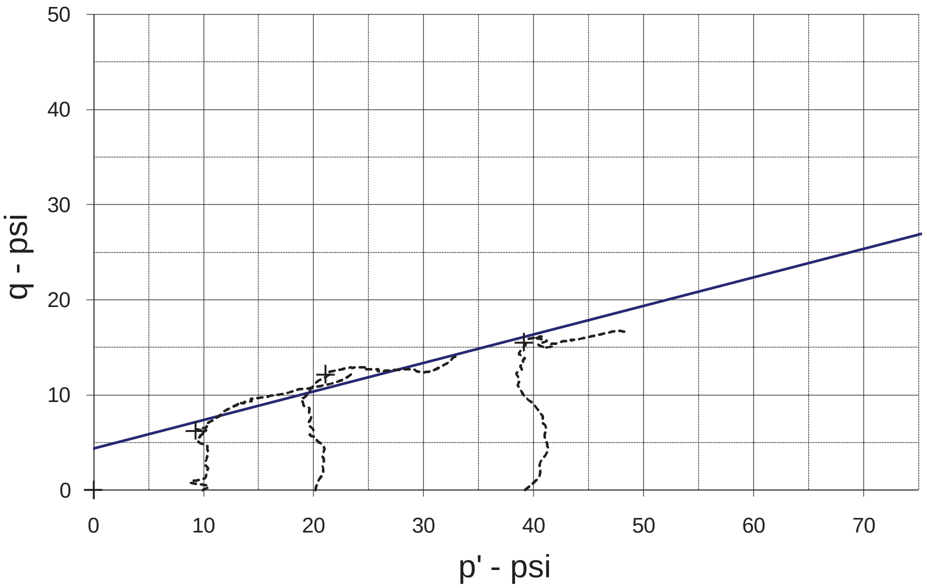
SPECIMEN NO. 3



SPECIMEN NO. 4

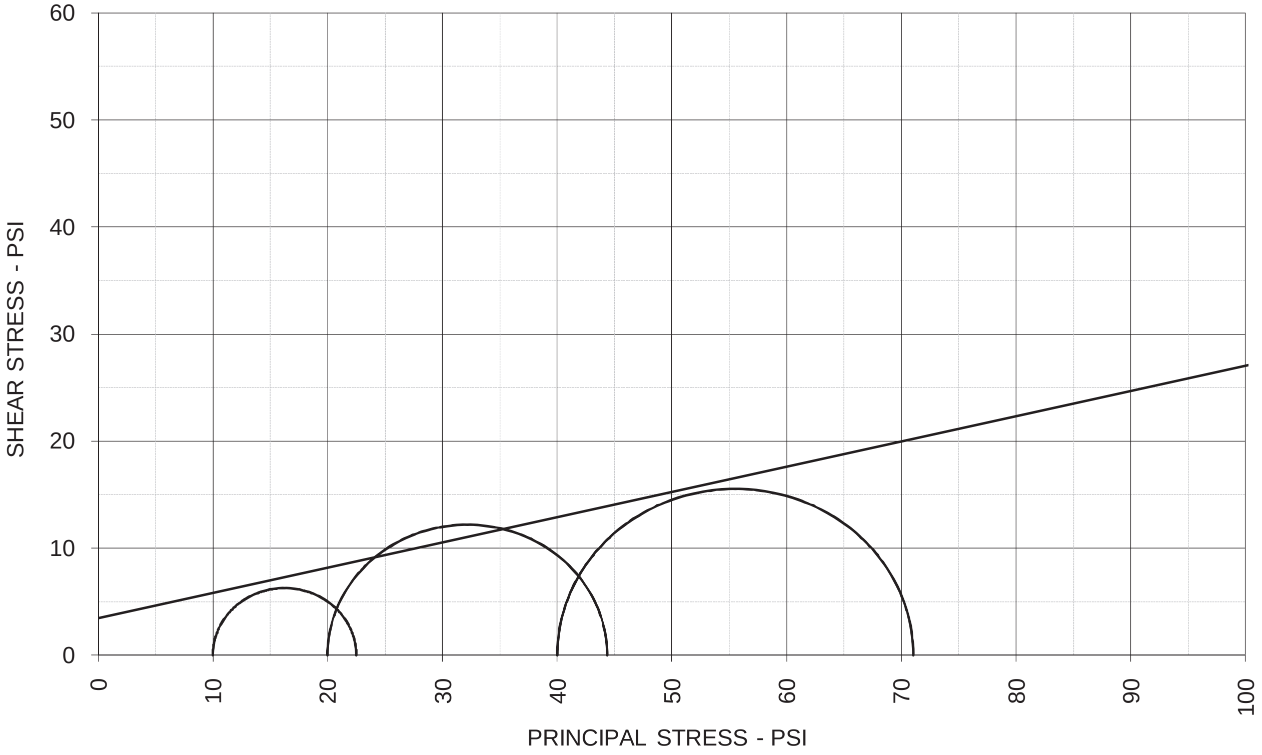


p - q DIAGRAM

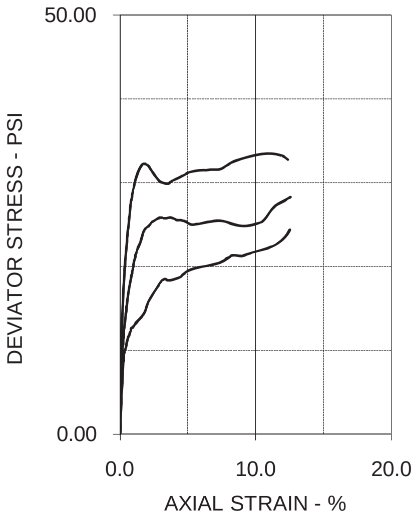


EFFECTIVE STRESS PARAMETERS	$R^2 = 0.93$	α (deg) = 16.7	a (psi) = 4.4
PROJECT: Pirkey Power Plant Embankments		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3241 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand			

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	φ = 13.3 deg	c = 3.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	25.3	23.6	23.9	
Dry Density - pcf	96.5	100.5	101.1	
Diameter - inches	2.05	2.02	2.04	
Height - inches	3.98	4.00	3.95	
AT TEST				
Final Moisture - %	28.8	28.1	24.5	
Dry Density - pcf	96.5	102.9	104.0	
Calculated Diameter (in.)	2.07	2.01	2.03	
Height - inches	4.02	3.98	3.91	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.49	24.34	31.06	
Total Pore Pressure - psi	57.0	61.1	66.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	2.1	1.5	
σ_1 Failure - psi	22.49	44.34	71.06	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-1 13' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 5%
LL: 56 PL: 18 PI: 38 Percent -200: 71%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

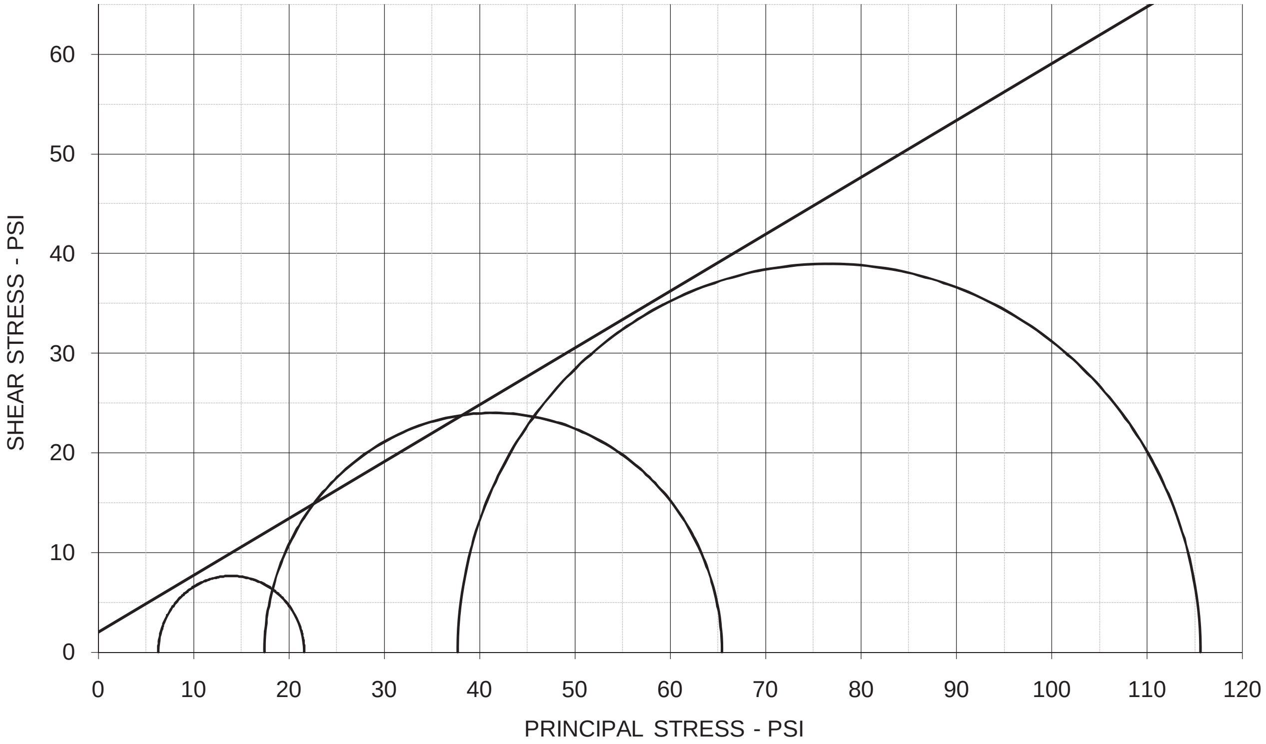
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

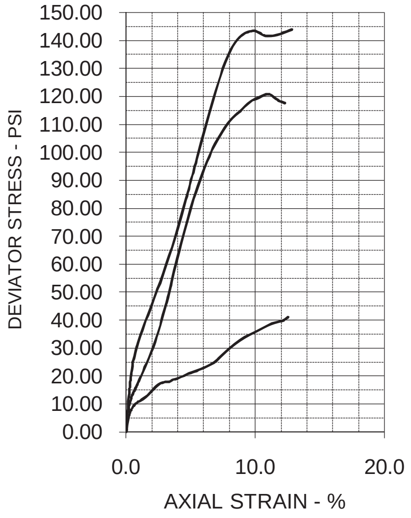
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ ' = 29.7 deg	c' = 2.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	18.7	19.2	18.5	
Dry Density - pcf	108.5	105.5	104.8	
Diameter - inches	2.04	2.04	2.02	
Height - inches	4.25	4.18	4.37	
AT TEST				
Final Moisture - %	21.3	21.7	20.7	
Dry Density - pcf	108.9	106.7	106.7	
Calculated Diameter (in.)	2.03	2.02	2.00	
Height - inches	4.21	4.13	4.31	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.27	47.96	77.89	
Total Pore Pressure - psi	63.7	52.6	52.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.1	3.2	4.3	
σ_1' Failure - psi	21.58	65.38	115.61	
σ_3' Failure - psi	6.31	17.42	37.72	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP

SAMPLE TYPE: Native Shelby Tube Sample

DESCRIPTION: Dark Gray Clayey Sand

Sampled on Site, W-1 38' to 41' deep

ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 1%

LL: 29 PL: 19 PI: 10 Percent -200: 25%

REMARKS: Diameter and Both Ends Trimmed. + # 4 Sieve 0%

PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments

LOCATION: Hallsville, Texas

PROJECT NO: G 3241 - 095

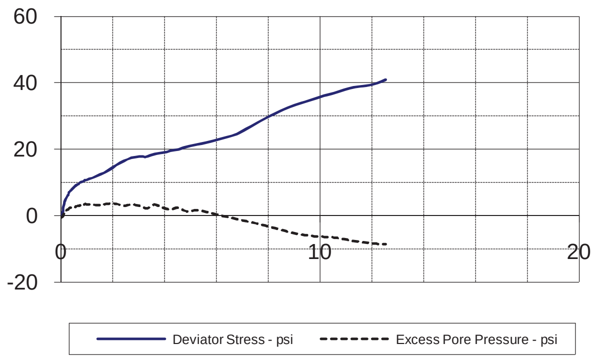
CLIENT:

November 2009

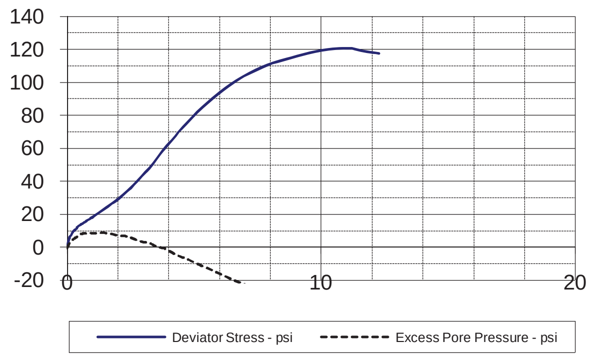
ETTL ENGINEERS & CONSULTANTS

PLATE: B.1

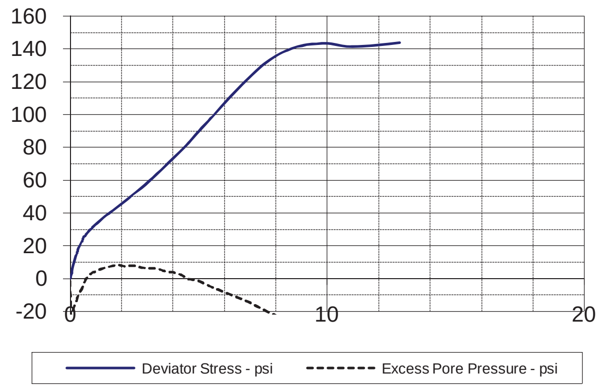
SPECIMEN NO. 1



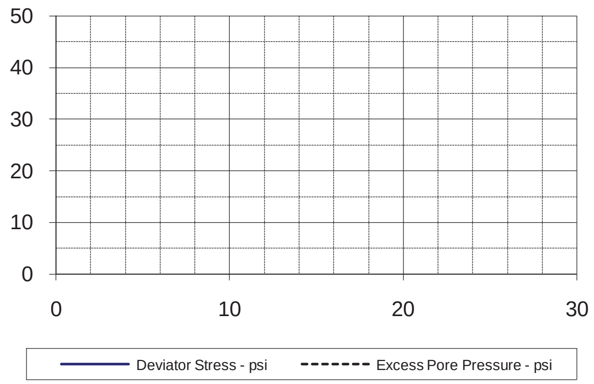
SPECIMEN NO. 2



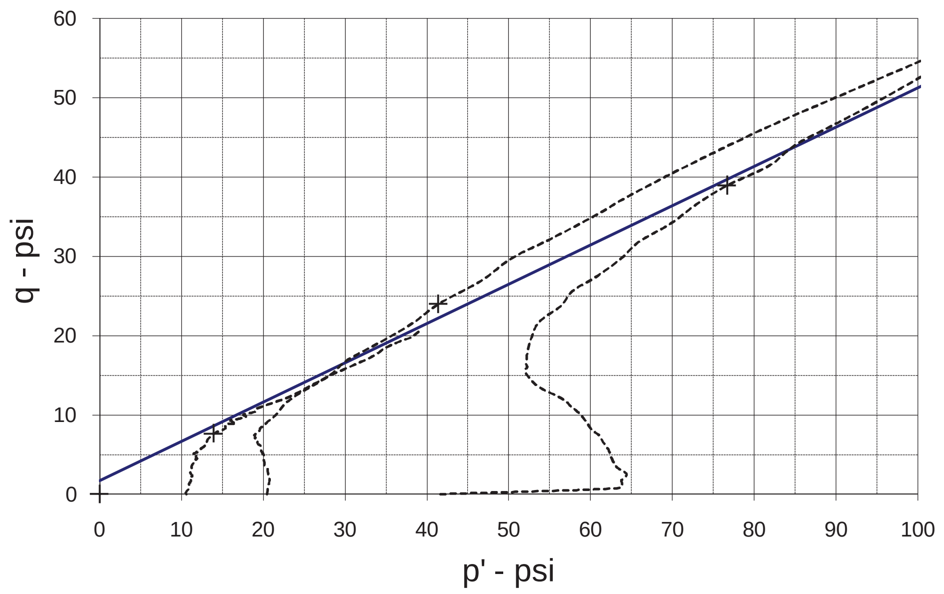
SPECIMEN NO. 3



SPECIMEN NO. 4

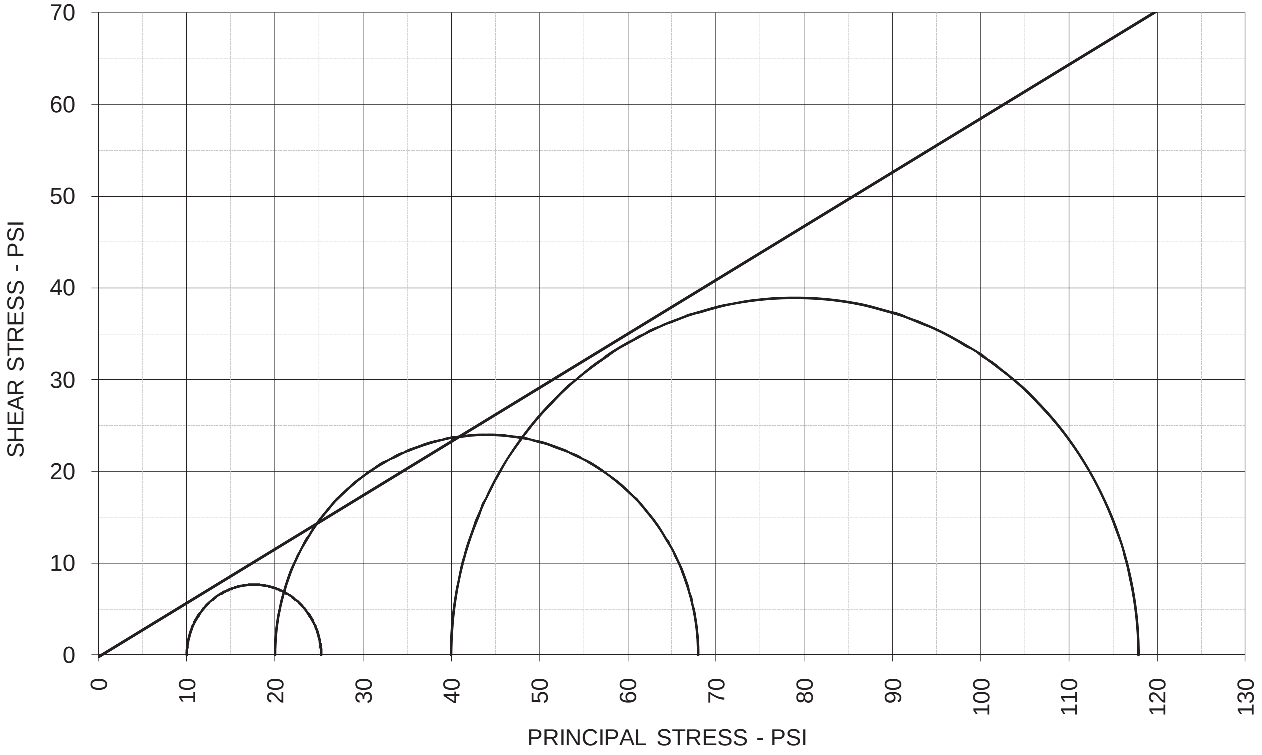


p - q DIAGRAM

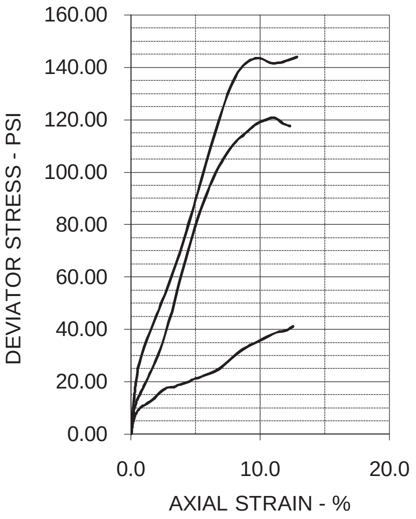


EFFECTIVE STRESS PARAMETERS	R^2 = 0.99	α (deg) = 26.4	a (psi) = 1.7
PROJECT: Pirkey Power Plant Embankments		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3241 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Dark Gray Clayey Sand			

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	φ = 30.4 deg	c = -0.2 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	18.7	19.2	18.5	
Dry Density - pcf	108.5	105.5	104.8	
Diameter - inches	2.04	2.04	2.02	
Height - inches	4.25	4.18	4.37	
AT TEST				
Final Moisture - %	21.3	21.7	20.7	
Dry Density - pcf	108.9	106.7	106.7	
Calculated Diameter (in.)	2.03	2.02	2.00	
Height - inches	4.21	4.13	4.31	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.27	47.96	77.89	
Total Pore Pressure - psi	63.7	52.6	52.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.1	3.2	4.3	
σ_1 Failure - psi	25.27	67.96	117.89	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Dark Gray Clayey Sand
Sampled on Site, W-1 38' to 41' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 1%
LL: 29 PL: 19 PI: 10 Percent -200: 25%
REMARKS: Diameter and Both Ends Trimmed. + # 4 Sieve 0%

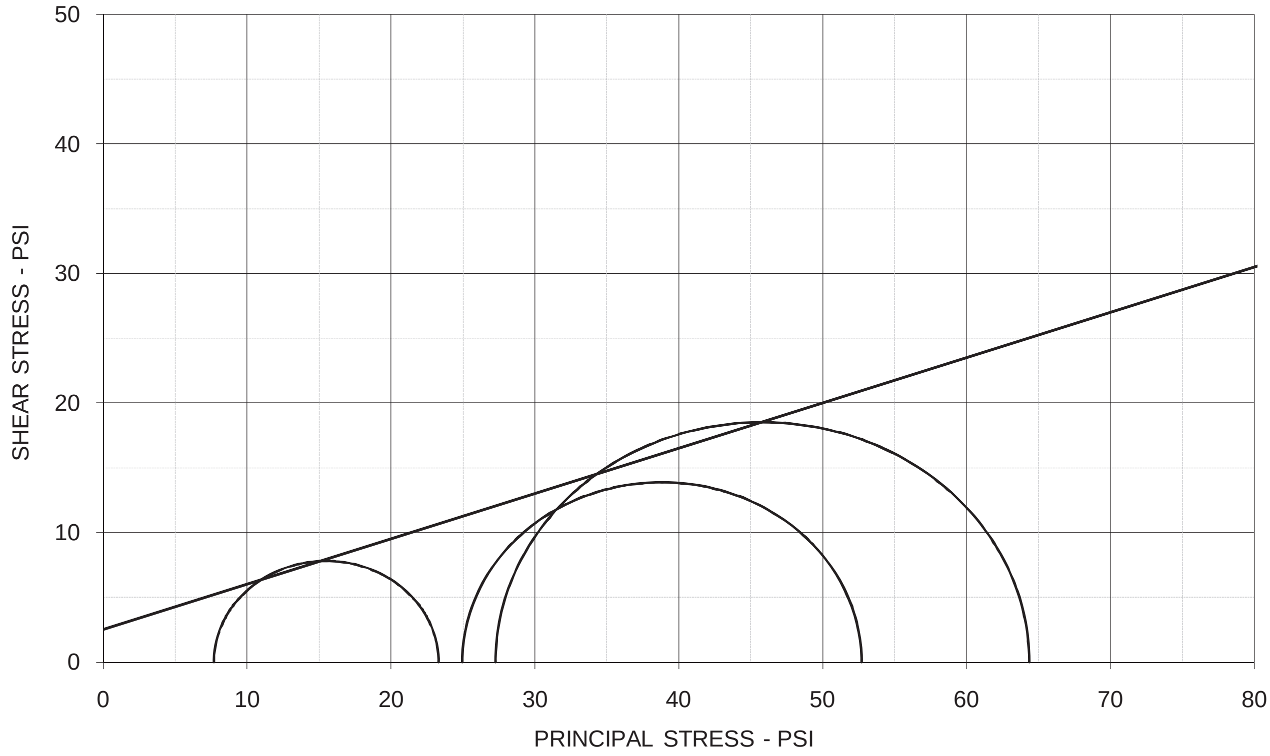
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

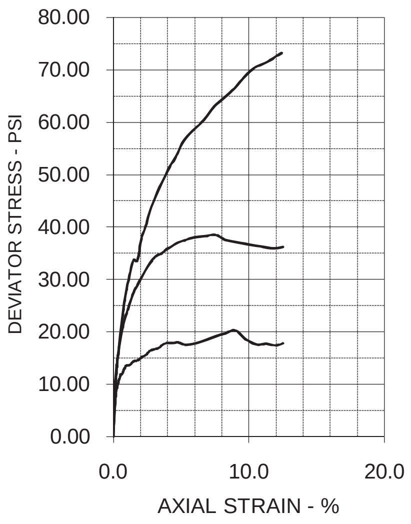
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ ' = 19.3 deg	c' = 2.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.4	21.5	23.6	
Dry Density - pcf	99.0	104.7	98.6	
Diameter - inches	1.99	2.01	2.00	
Height - inches	4.01	3.99	4.01	
AT TEST				
Final Moisture - %	27.8	20.6	27.1	
Dry Density - pcf	99.4	105.8	99.5	
Calculated Diameter (in.)	1.98	2.01	1.99	
Height - inches	3.99	3.97	3.98	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.62	27.77	37.08	
Total Pore Pressure - psi	52.3	45.0	62.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	1.0	4.8	
σ_1' Failure - psi	23.30	52.73	64.35	
σ_3' Failure - psi	7.68	24.96	27.27	

TEST DESCRIPTION

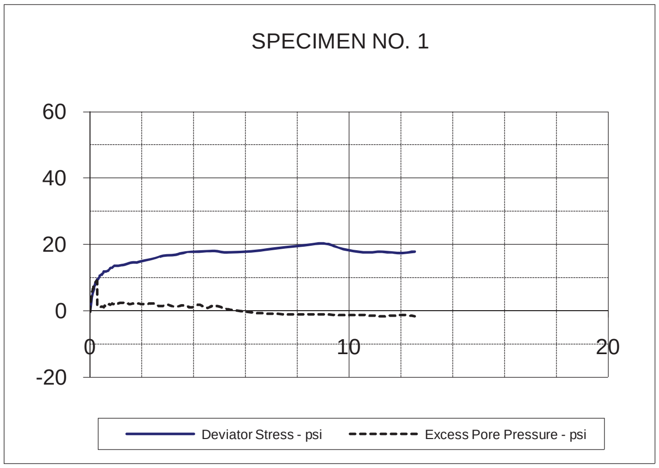
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-3 10' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 6%
LL: 68 PL: 22 PI: 46 Percent -200: 80%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

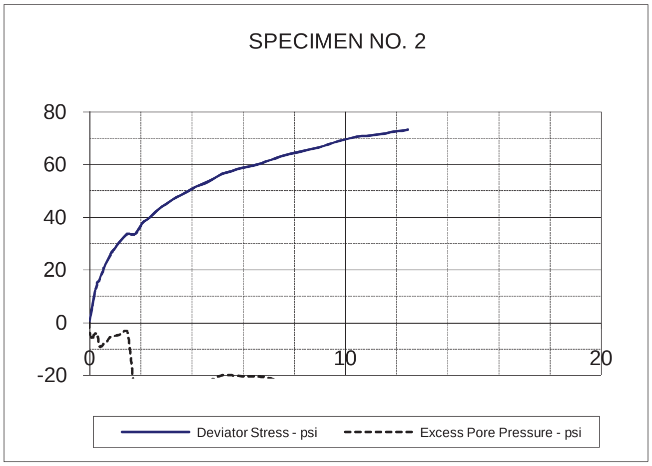
PROJECT INFORMATION

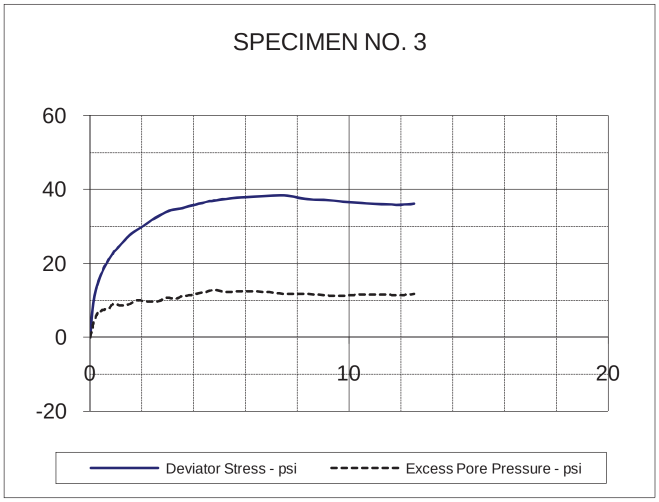
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

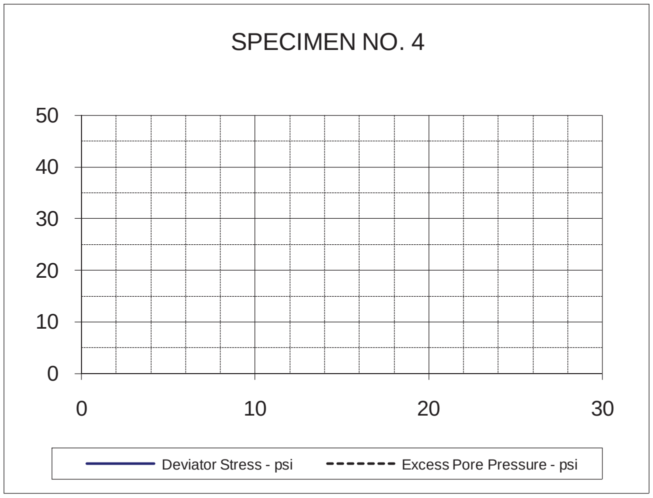
ETTL ENGINEERS & CONSULTANTS

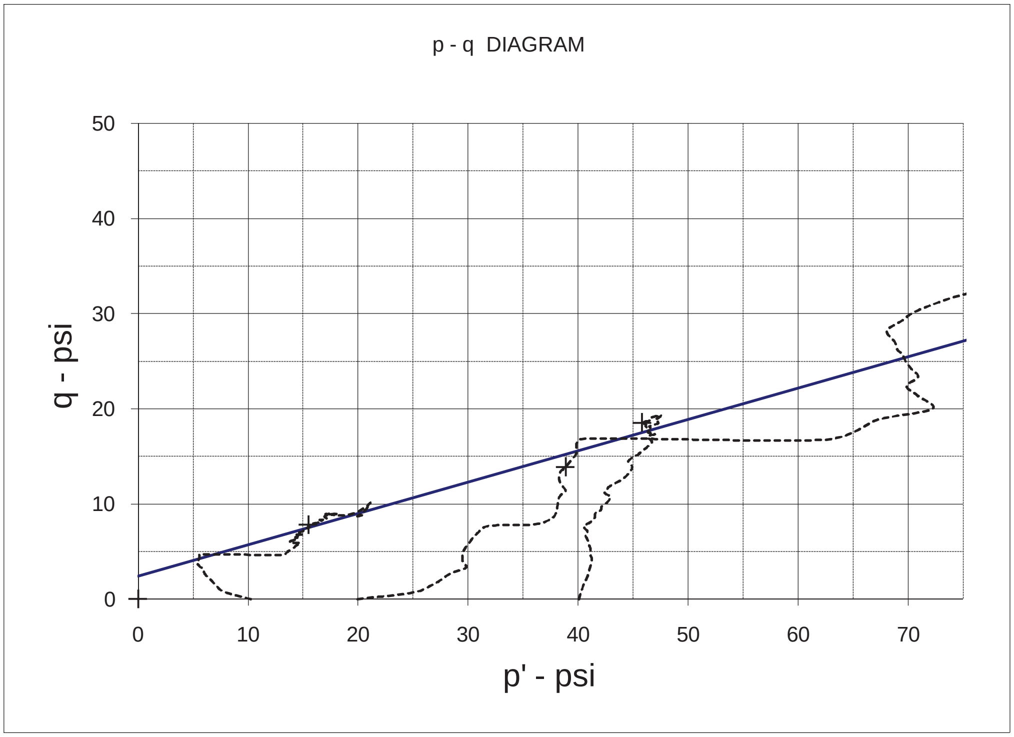
PLATE: B.1


SPECIMEN NO. 1


SPECIMEN NO. 2

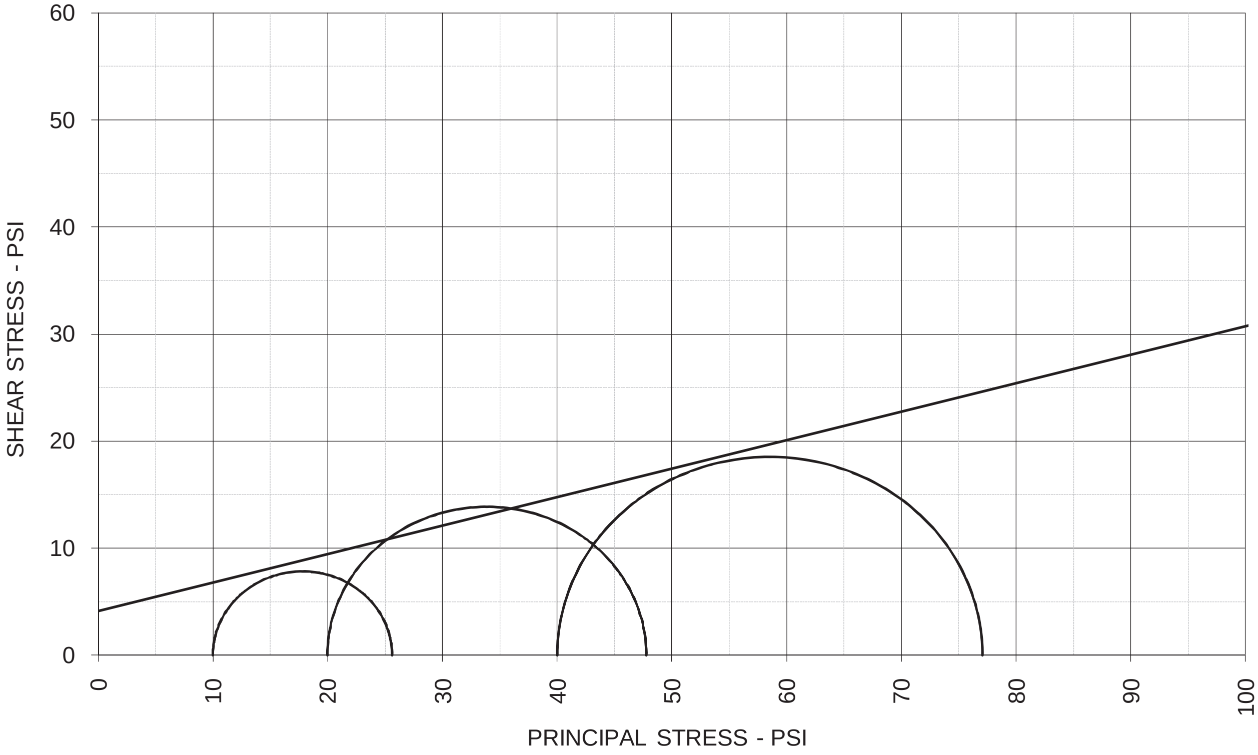

SPECIMEN NO. 3


SPECIMEN NO. 4

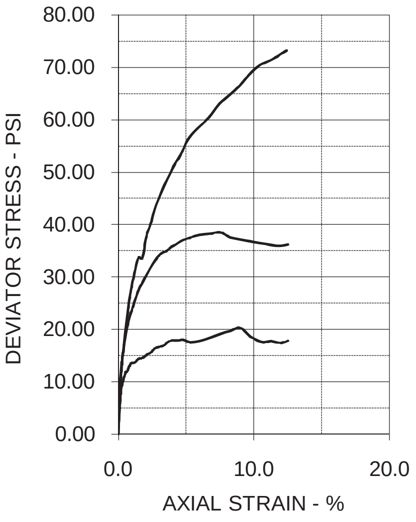

p - q DIAGRAM

EFFECTIVE STRESS PARAMETERS	R^2 = 0.95	α (deg) = 18.3	a (psi) = 2.4
PROJECT: Pirkey Power Plant Embankments		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3241 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand			

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ =	14.9 deg	c =	4.1 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.4	21.5	23.6	
Dry Density - pcf	99.0	104.7	98.6	
Diameter - inches	1.99	2.01	2.00	
Height - inches	4.01	3.99	4.01	
AT TEST				
Final Moisture - %	27.8	20.6	27.1	
Dry Density - pcf	99.4	105.8	99.5	
Calculated Diameter (in.)	1.98	2.01	1.99	
Height - inches	3.99	3.97	3.98	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.62	27.77	37.08	
Total Pore Pressure - psi	52.3	45.0	62.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	1.0	4.8	
σ_1 Failure - psi	25.62	47.77	77.08	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-3 10' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 6%
LL: 68 PL: 22 PI: 46 Percent -200: 80%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

PROJECT INFORMATION

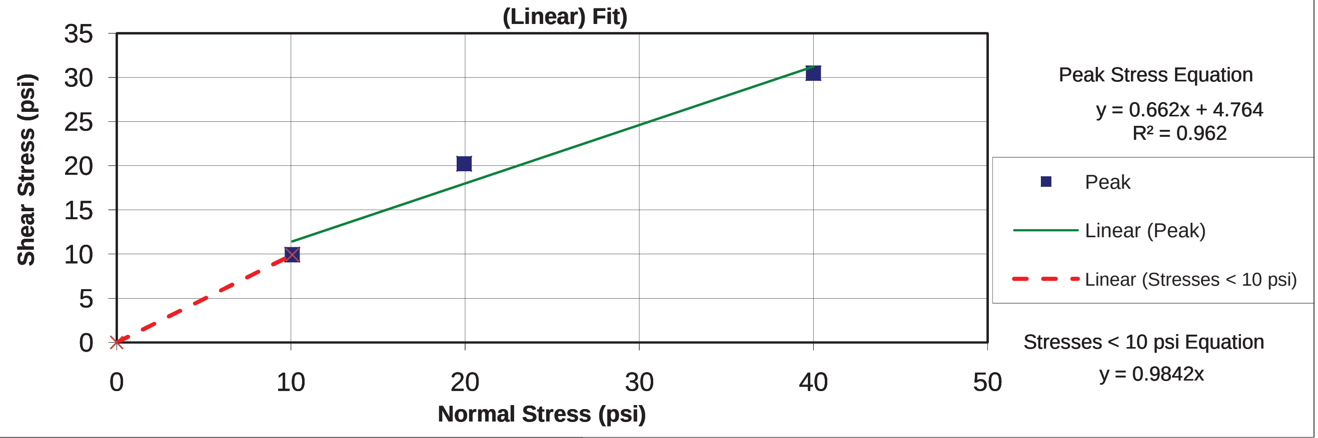
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

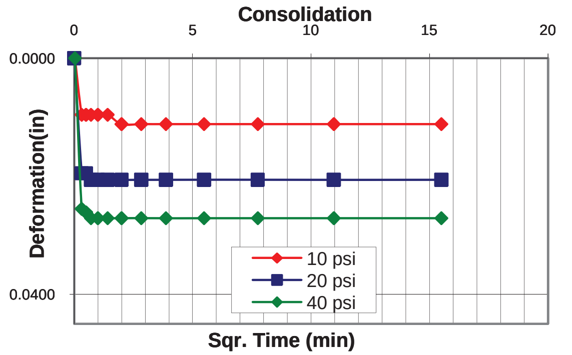
ETTL ENGINEERS & CONSULTANTS

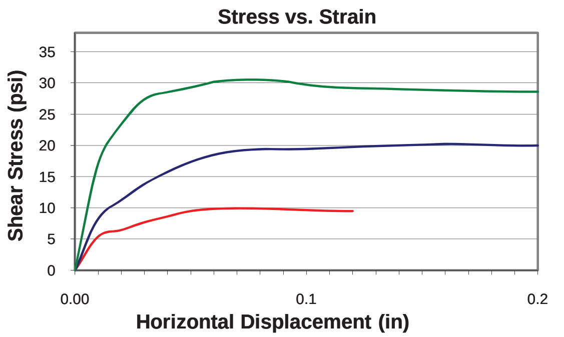
PLATE: B.3

ETTL Engineers & Consultants Inc.
GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

ASTM 3080 Direct Shear Test Report







Peak Strength Parameters

	Peak		Residual	
Friction Angle	33.5		-	
	(deg)		(deg)	
Cohesion	4.76	686.0	-	-
	(psi)	(psf)	(psi)	(psf)
Friction Angle Stresses < 10psi			44.5	(deg)

Specimen Number	1	2	3
Initial			
Moisture Content - %	18.5%	18.8%	21.4%
Dry Density- lb/ft^3	103.6	105.7	104.5
Height-inches	1.008	1.008	1.008
Diameter- inches	2.50	2.50	2.50
Final			
Moisture Content - %	24.4%	22.1%	24.1%
Dry Density- lb/ft^3	105.6	172.8	108.2
Height after shear-(inches)	0.997	0.620	0.978
Height after consolidation (inches)	0.997	0.987	0.981
Normal Stress-(psi)	10	20	40
Peak Failure Stress-(psi)	9.92	20.23	30.49
Residual Failure Stress-(psi)	-	-	-
Strain Rate - (inches/min)	0.0029	0.0027	0.0029

Project Information

Project :	Pirkey Power Plant Embankments	**LL**	**PL**	**PI**
Client:	AEP	32	17	15
Material Origin:	Hallsville, Tx			
Material Description:	Tan & Brown Clayey Sand with ferric seams	**-200%**	31	

Job No:	G 3241-095	**Technician:**	Owen Sanderson
Boring No:	W-2	**Sample Type:**	Shelby Tube
Depth:	13'-16'	**Sampling method:**	Shelby Tube
Date:	October 31, 2009	**Testing Device:**	Soiltest B-124BY 2.5 in. round

Remarks

When Calculating stresses < 10 psi: use appropriate Equation above (assuming no Cohesion)

C. Brandon Quinn, P.E.

C. Brandon Quinn

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

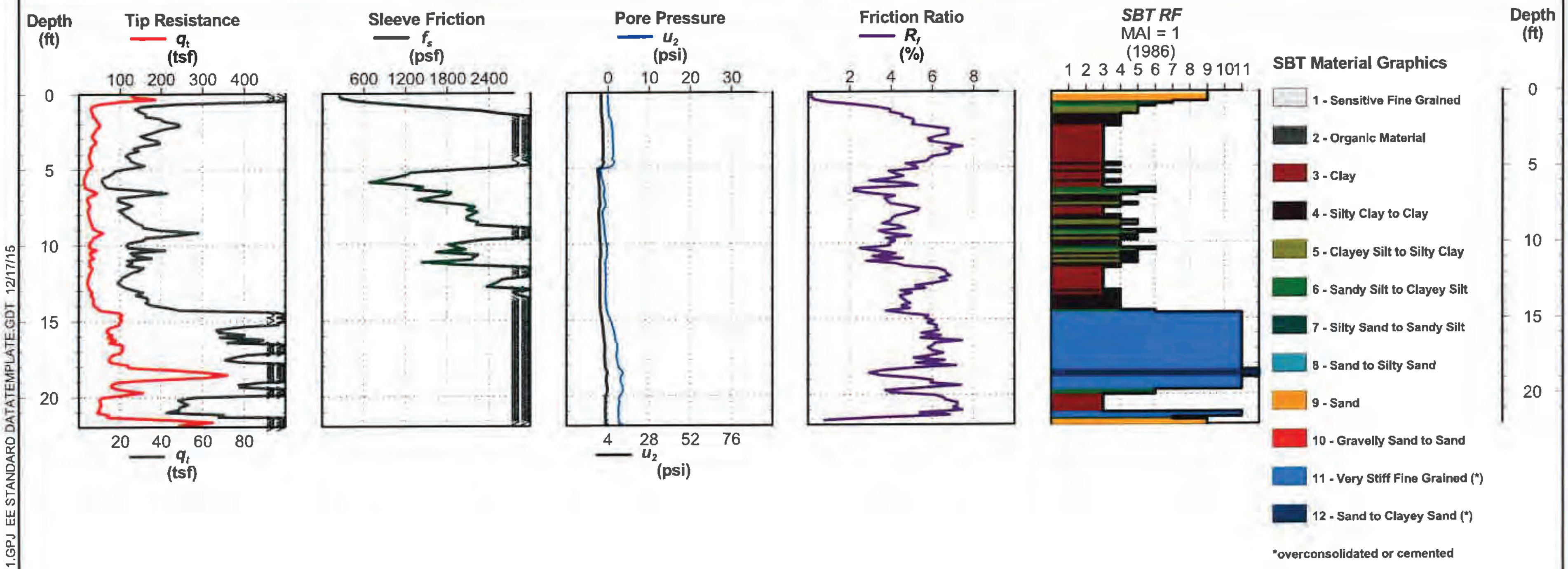
Cone Penetration Test

CPT-1

Latitude: 32.46619
Longitude: -94.48989

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 22.0 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

Electronic Filename: L0441CPT-1.cpt

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

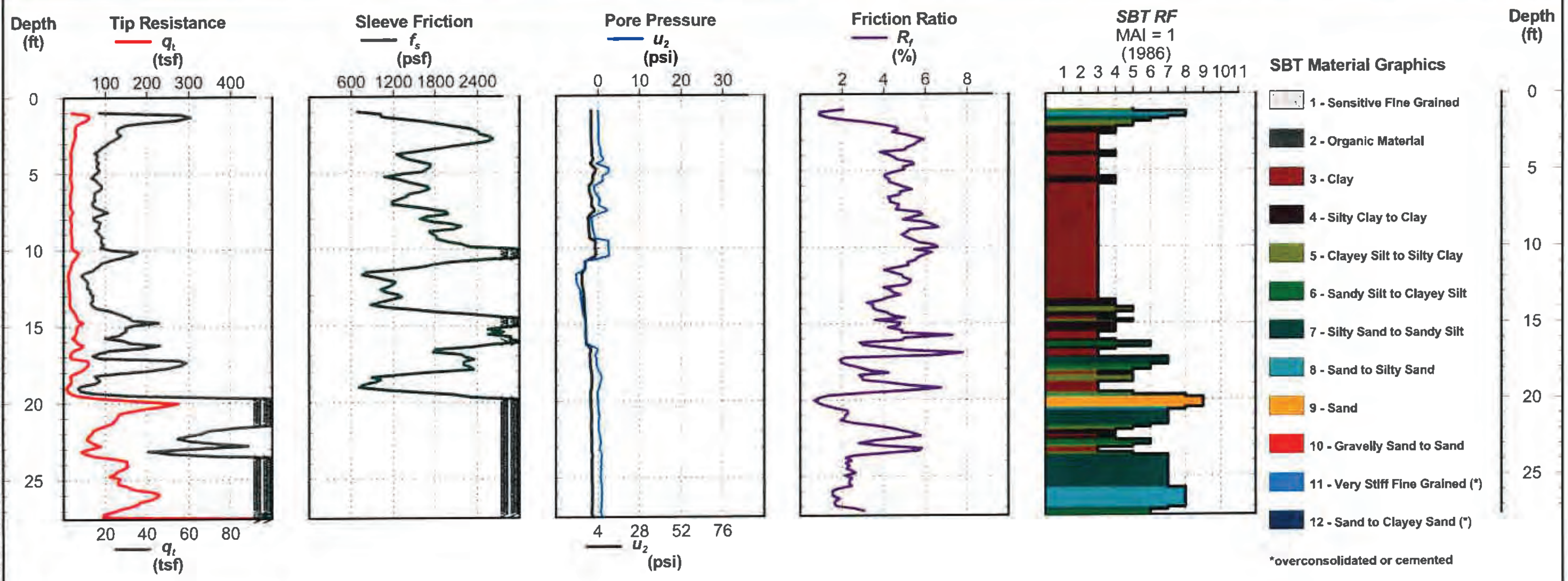
Cone Penetration Test

CPT-2

Date: 12/8/15
Operator: P. Thurmond

Latitude: 32.46613
Longitude: -94.49157

Water Depth: See Text
Total Depth: 27.6 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

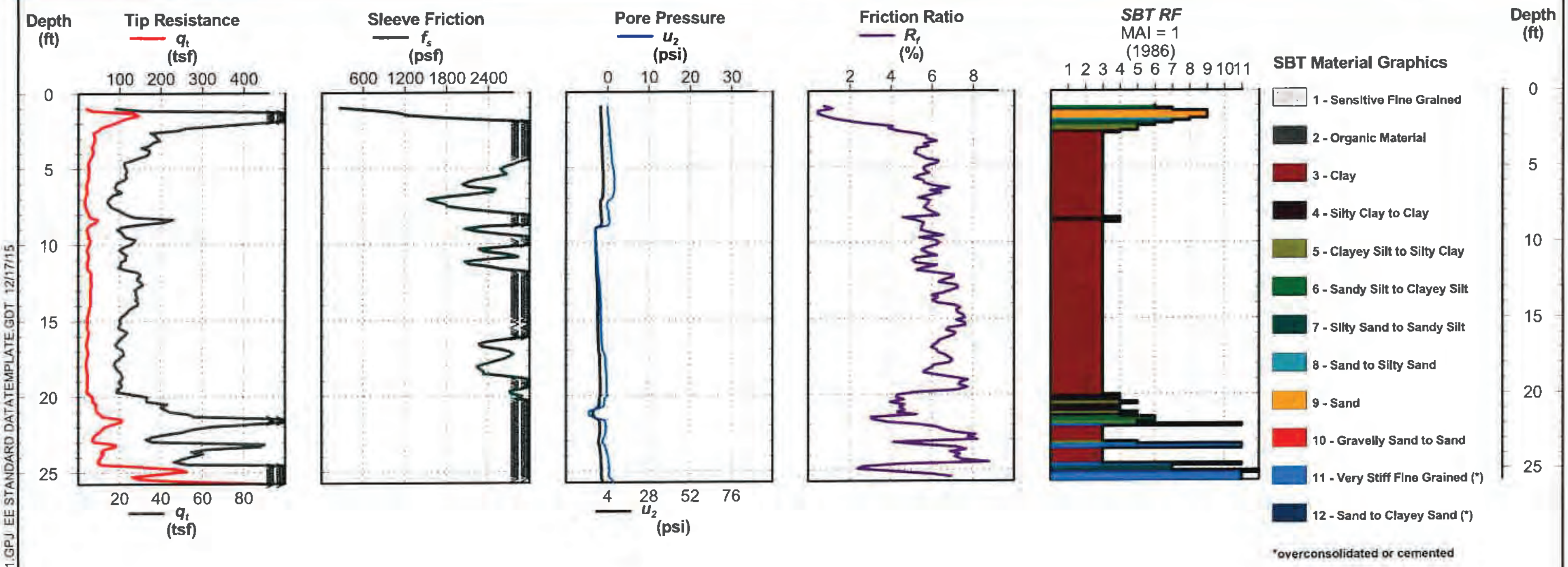
Cone Penetration Test

CPT-3

Latitude: 32.46587
Longitude: -94.49313

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 25.8 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Electronic Filename: L0441CPT-3.cpt

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

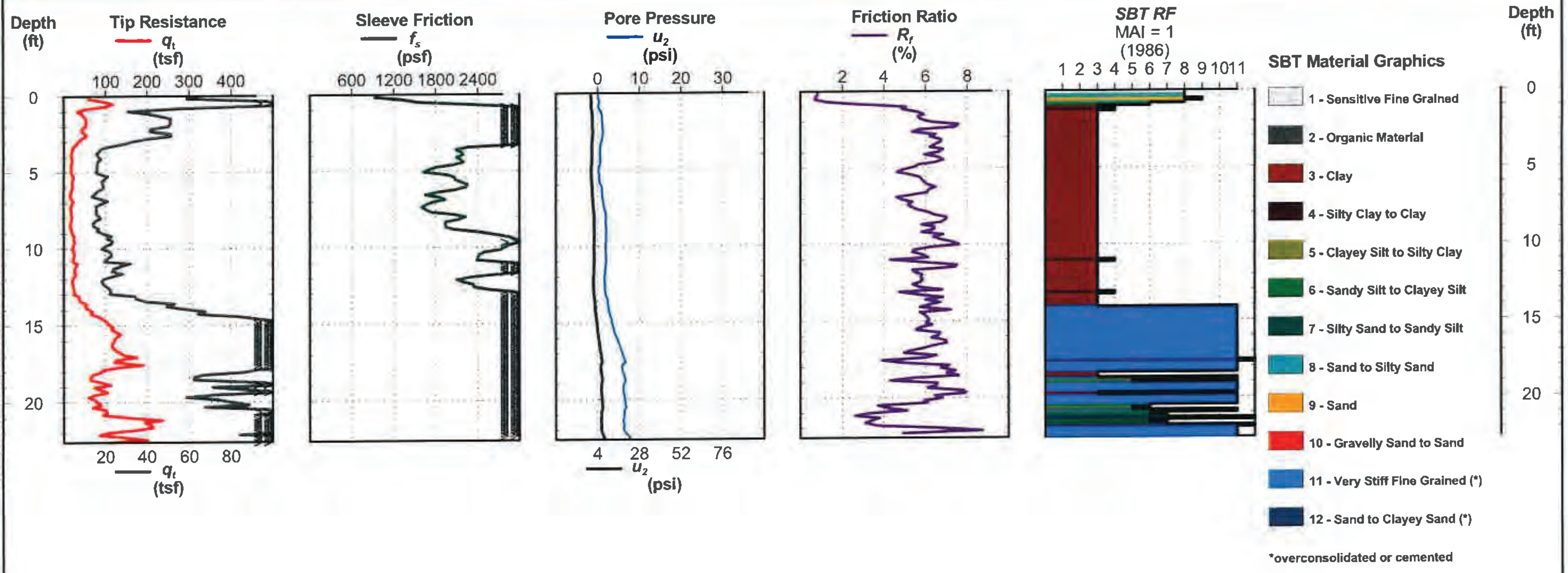
Cone Penetration Test

CPT-4

Latitude: 32.46672
Longitude: -94.49400

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 22.6 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Electronic Filename: L0441CPT-4.cpt

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

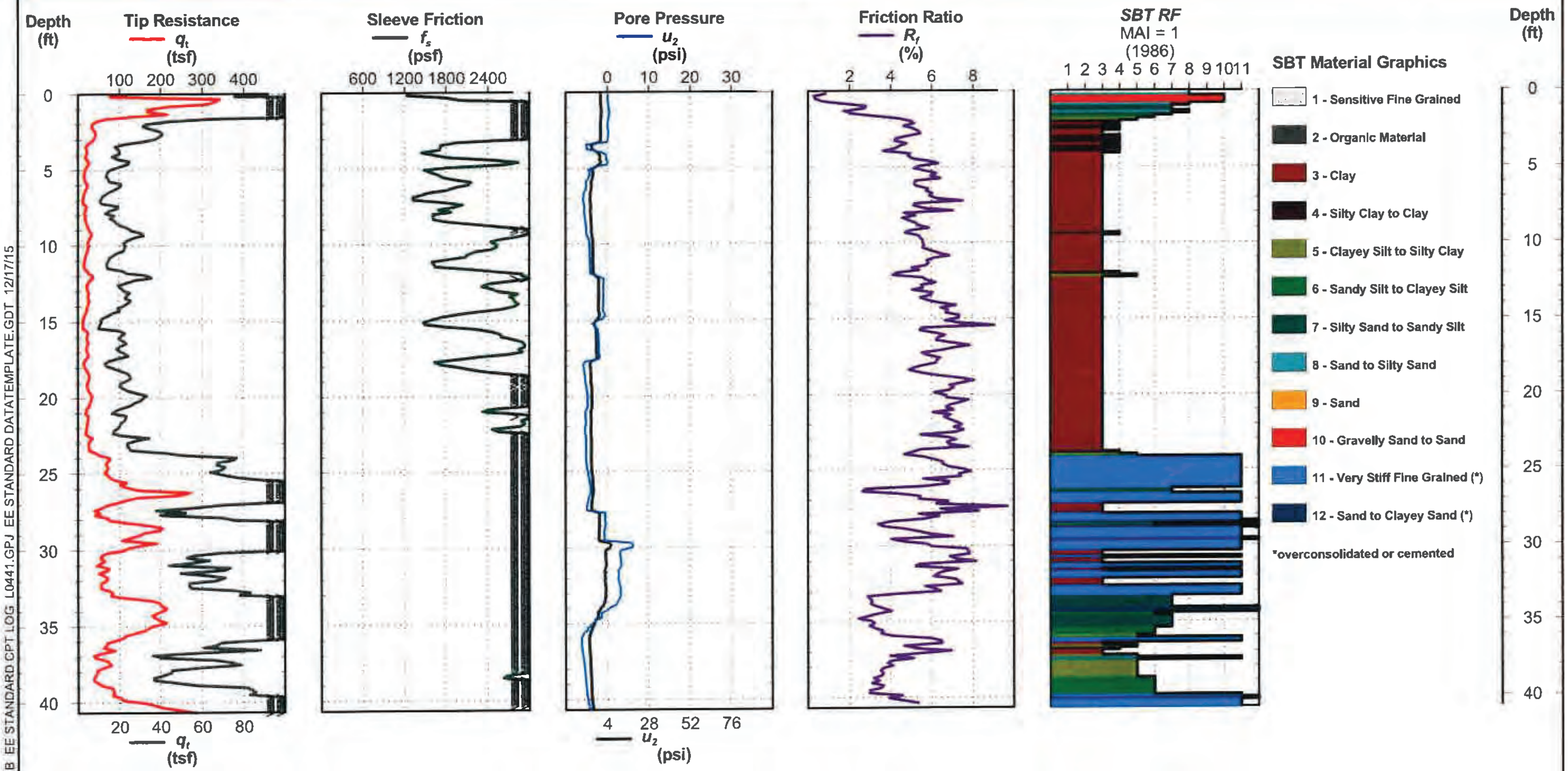
Cone Penetration Test

CPT-5

Latitude: 32.46803
Longitude: -94.49390

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 40.7 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

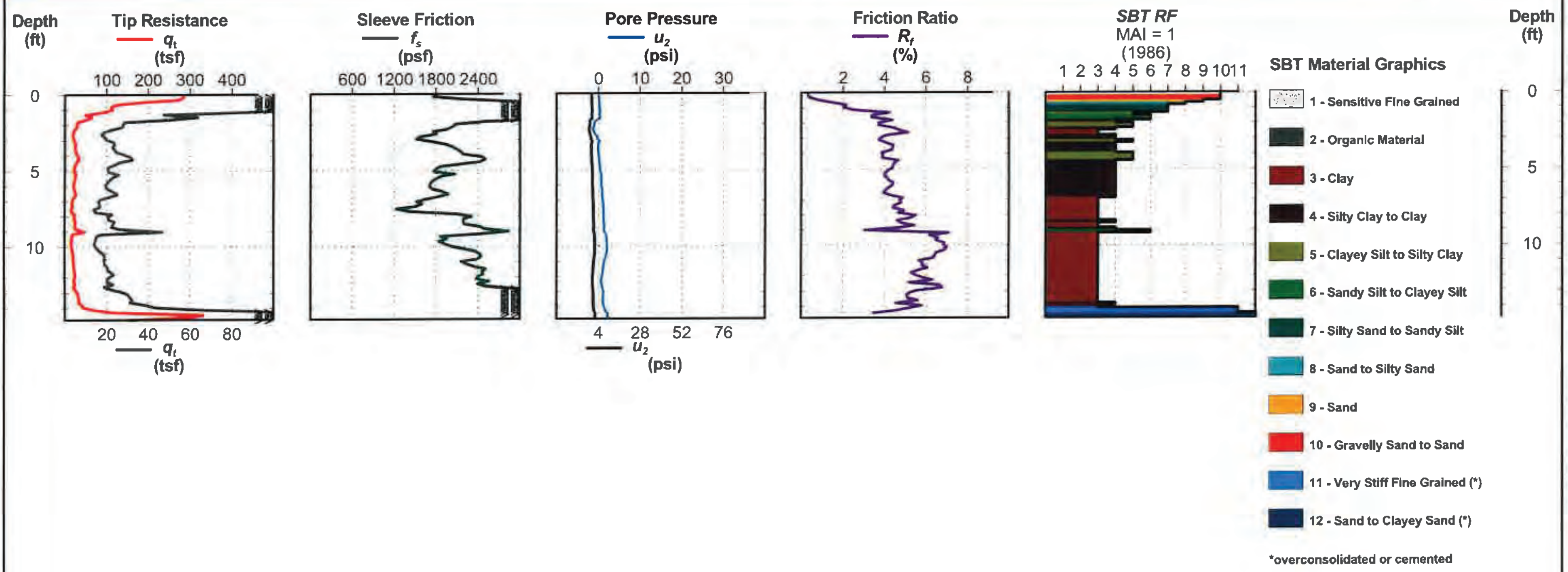
Cone Penetration Test

CPT-6

Latitude: 32.46887
Longitude: -94.49243

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 14.8 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

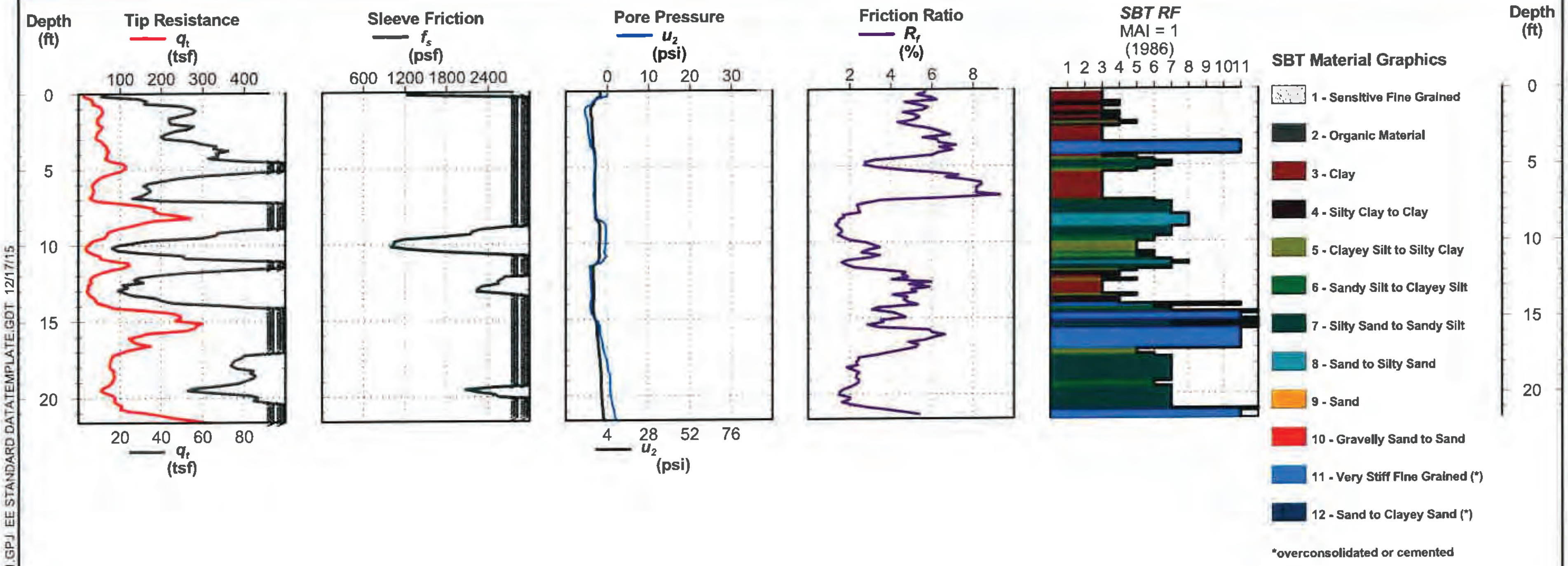
Cone Penetration Test

CPT-7

Latitude: 32.46572
Longitude: -94.49256

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 21.7 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Electronic Filename: L0441CPT-7.cpt

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

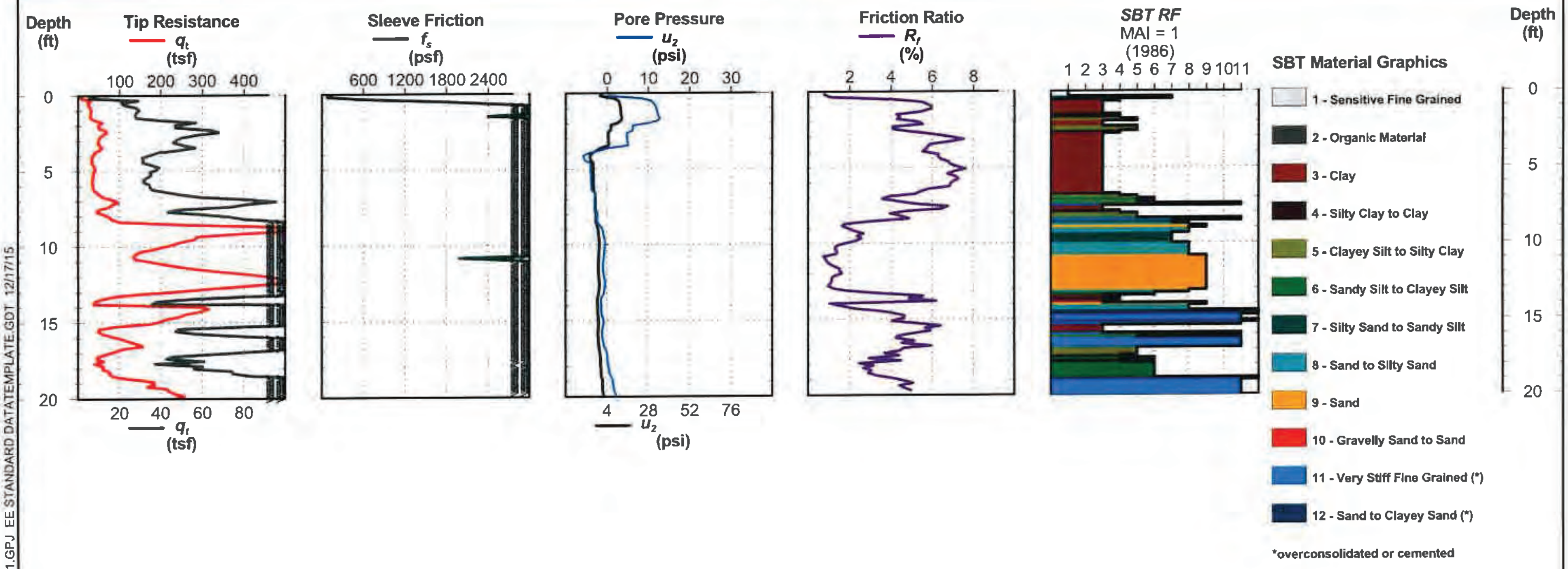
Cone Penetration Test

CPT-8

Latitude: 32.46603
Longitude: -94.49087

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 20.0 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Electronic Filename: L0441CPT-8y.cpt

2.8 – West Bottom Ash Pond Hazard Potential Classification Assessment, July 2021

Southwestern Electric Power Company
Pirkey Power Station
West Bottom Ash Pond

Hazard Potential Classification Assessment

AEP has performed an evaluation to classify the above CCR Surface Impoundment in accordance with FEMA's Hazard Potential Classification System for Dams. These guidelines evaluate the consequences of a potential failure not the likelihood of a failure. Guidelines that were developed and utilized are included below.

Hazard Potential Classification Systems (from FEMA 333, April 2004)

1. **Low Hazard Potential**
   Dams assigned the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
2. **Significant Hazard Potential**
   Dams assigned the significant hazard potential classification are those dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
3. **High Hazard Potential**
   Dams assigned the high hazard potential classification are those where failure or mis-operation will probably cause loss of human life.

The AEP H.W. Pirkey Power Station is located at 2400 FM 3251, Hallsville, TX 75650. The plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas.

The West Bottom Ash Pond is located at the north end of the Plant and approximately 3,000 feet northwest of Brandy Branch Reservoir. Loss of human life is not probable in the event of a catastrophic failure of the embankment and a failure of the embankment is expected to have a low economic and environmental impact. The US EPA CCR Impoundment Assessment Report has listed this ash pond as Low Hazard.

There has been no changes in classification by the State Dam Safety nor has there been any other physical changes that would warrant a change in the classification.

Based on the FEMA Hazard Potential Classification Systems for Dams and on the above discussion, Pirkey West Bottom Ash Pond Dam is classified as a **Low Hazard Potential Dam**.

Professional Engineer's Certification:

I certify that this Hazard Potential Classification Assessment is in accordance with the requirements of section 30 TAC 352.731.

Gary F. Zych, P.E.

Gary F. Zych

7/29/2021

STATE OF TEXAS
GARY F. ZYCH
127152
LICENSED PROFESSIONAL ENGINEER

2.9 – Safety Factor Assessment Periodic 5-Year Review, West Bottom Ash Pond, October 2021

SAFETY FACTOR ASSESSMENT
PERIODIC 5-YEAR REVIEW

30 TAC 352.731 (40 CFR 257.73e)

West Bottom Ash Pond

Pirkey Plant
Hallsville, Texas

October, 2021

Prepared for: Southwest Electric Power Company (SWEPCO) – Pirkey Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

GERS-21-049

SAFETY FACTOR ASSESSMENT
PERIODIC 5-YEAR REVIEW
CFR 257.73(e)
PIRKEY PLANT
WEST BOTTOM ASH POND

PREPARED BY Brett A. Dreger DATE 10/1/2021
Brett A. Dreger, P.E.

REVIEWED BY DATE 10/3/2021
Mohammad A. Ajlouni, P.E.

APPROVED BY Gary F. Zych DATE 10/4/2021
Gary F. Zych, P.E.
Section Manager – AEP Geotechnical Engineering

Gary F. Zych
STATE OF TEXAS
GARY F. ZYCH
127152
LICENSED
PROFESSIONAL ENGINEER
10/4/2021

I certify to the best of my knowledge, information, and belief that the information contained in this safety factor assessment meets the requirements of 40 CFR § 257.73(e)

Table of CONTENTS

1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of 30 TAC 352.731 (40 CFR 257.73(e)) for the safety factor assessment of CCR surface impoundments. This is the first periodic 5-year review of the safety factor assessment.

2.0 DESCRIPTION OF THE CCR UNIT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas.
It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for storing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP).

The West BAP is located northwest of the main plant and shares its eastern border with the western border of the East BAP. The West BAP receives sluiced bottom ash and has a surface area of 30 acres and a storage capacity of 188 acre-feet. The maximum embankment height is 25 feet. Design documents indicate that the main upstream embankment slopes are 3 feet horizontal to 1 foot vertical (3:1 H:V); while the main downstream slopes are 2.5:1 H:V.

3.0 SAFETY FACTOR ASSESSMENT 257.73(e)

The periodic 5-year review was conducted to evaluate if any physical changes have been made to the earthen dike and/or operating changes that could impact the loading on the structure. The assumptions, material properties and operating pools defined in the initial assessment were reviewed. The review concluded that there have been no changes that would impact the stability analyses that were previously conducted. Therefore, the previous report and analyses are still applicable to the current conditions of the facility. The results indicate that the calculated factors of safety meet or exceed the minimum values defined in Section 257.73(e).

ATTACHMENT A

Initial Safety Factor Assessment – West Ash Pond

Initial Safety Factor Assessment – West Ash Pond
Pirkey Power Generating Station
Hallsville, Texas

Auckland Project No. 2015-008C (Revision No. 2)
January 14, 2016

Prepared For:

American Electric Power Company
1 Riverside Plaza
Columbus, Ohio 43215

Prepared By:

Auckland Consulting, LLC
Jacksonville, Texas

TBPE Firm Registration No. F-16721
Expires 2/29/2016

Table of Contents

Appendix

1.0 Introduction and Embankment Information

1.1 Introduction

The following report and evaluation provides the Initial Safety Factor Assessment of the West Ash Pond, an existing CCR impoundment (as defined by 40 CFR §257.2) located at the Pirkey Power Station near Hallsville, Texas. In accordance with 40 CFR §257.73(e)(1)(i) through (iv) this initial assessment provides field and laboratory data, model outputs (detailing multiple stability conditions) and summary of safety factors for the West Ash Pond. In accordance with 40 CFR §257.73(e)(2) this report provides the Initial Safety Factor Assessment certification for the West Ash Pond.

1.2 Referenced Information and Data

Soils data, comprised of field and laboratory testing, utilized in the preparation of this assessment were completed by ETTL Engineers and Consultants, Inc. and documented in the report *Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas* dated October 12, 2010. Based on a review of the provided field and laboratory data, it appears to be accurate and appropriate for use in the initial structural stability assessment of the West Ash Pond [40 CFR §257.73(e)(1)]. Furthermore, based on a recent site visit (October 2015), no modifications or elevation alterations have been made to the embankment since the referenced investigation. No additional field or laboratory activities were conducted. Soil data utilized in this evaluation is provided in the Appendix of this report.

To supplement existing data collected in the above reference report, an additional eight (8) Cone Penetrometer Test (CPT) soundings were advanced both along the crest and southern toe of the West Ash Pond. Sounding depths ranged between approximately 14 feet and 40 feet before encountering refusal. The data collected generally supports the findings from the 2010 study and confirms that embankment and foundation soils are relatively consistent. The location of and data from these CPT soundings are provided in the Appendix of this report.

The impoundment pool elevation data cited herein were provided in a separate hydrology and hydraulic (H&H) analysis report completed by Akron Consulting, LLC titled *Hydrology & Hydraulic Report, East & West Ash Ponds, H.W. Pirkey Power Plant – Hallsville, Texas,* dated December 15, 2015 (not included herein). The referenced report generally meets the demonstration requirements of 40 CFR §257.82(a).

Embankment profile dimensions and elevations were determined by using existing information provided by the client or representatives of the client. This information is also included in the Appendix of this report.

1.3 Embankment Evaluation Criteria

Based on information provided by the client, the existing embankment is constructed of lean clay (CL) and fat clay (CH) with existing side slopes (both up- and downstream) of approximately 3:1 (H:V), maximum embankment height of 20 feet and top of dam elevation of 358.0 feet (MSL). The upstream base elevation of the impoundment is approximately 347.0 feet (MSL). The crest width of the embankment is approximately 25 feet. Two (2) critical sections were evaluated for this initial safety factor assessment. Section No. 1 represents the northwest corner of the West Ash embankment and Section No. 2 represents the southern berm of the embankment.

It is our understanding that the maximum storage elevation of impounded CCR ash is 355.0 feet (MSL); however, the facility is managed to maintain an ash level less than this maximum level. The downstream toe of the West Ash Pond is not adjacent to other water bodies and therefore not subject to 40 CFR §257.73(d)(1)(A)(3)(vii).

In accordance with 40 CFR §257.73(e)(1)(i) and (ii), the maximum storage pool elevation for the West Ash Pond as determined by the 25-year, 24-hour storm event is 354.81 feet (MSL). For the purposes of this evaluation, the maximum storage pool elevation of 355.0 feet (MSL) was utilized. Likewise, the maximum (or flood) surcharge loading elevation as determined by the 100-year, 24-hour event is 355.01 feet (MSL), for this evaluation a maximum surcharge loading elevation of 355.0 feet (MSL) was utilized. Storage pool elevations were determined in accordance with 40 CFR §257.82(a).

2.0 Slope Stability Analyses

2.1 General

Soil parameters used for stability analyses of the existing embankment are based on findings of previous laboratory and field testing programs. The probable failure planes were analyzed using the analytical slope stability software, SLIDE by Rocscience, Inc. Methods of evaluation used in SLIDE are considered to be limited equilibrium methods of analysis, where each individual shear plane is evaluated to determine the resulting shear stress at the point of failure. For the purposes of this evaluation the Bishop Method of analysis, which analyzes circular failure planes through the slope was utilized.

Per 40 CFR §257.73(e)(1)(i) through (iii), three (3) modeled scenarios (presented below) were utilized to evaluate the stability of the existing embankment: steady state seepage (long term) condition under maximum storage pool, steady state seepage (long term) condition under maximum surcharge pool, and steady state seepage condition with seismic loading under maximum storage pool conditions. The following minimum factors of safety (FS) and soil stress parameters were utilized in modeling. Minimum factors of safety are based on demonstration requirements provided in 40 CFR §257.73(e)(1).

Summary of Embankment Condition and Factor of Safety		
Embankment Condition	**Soil Parameters**	**Minimum Factor of Safety**
Steady State Seepage – Maximum Pool	Effective Stress	1.50
Steady State Seepage – Surcharge Pool	Effective Stress	1.40
Steady State Seepage (Seismic) – Maximum Pool	Total Stress	1.00
NOTE: Minimum factors of safety based on demonstration requirements provided in 40 CFR §257.82 (e)(1).		

For evaluation of steady state seepage (long term) conditions with seismic, peak ground acceleration for this location was obtained from the USGS National Seismic Hazard Mapping Project (http://earthquake.usgs.gov/hazards). Based on the seismic survey data, the anticipated site specific peak ground acceleration (PGA) of 0.06g (acceleration at rock sites) for two (2) percent probability of exceedance in 50 years (40 CFR Part 257, Preamble page 21384). Correcting for acceleration at soft soil sites (Seismic Site Classification D) yields an estimated PGA of 0.13g. The seismic coefficient (k) used for pseudo static analysis is determined by reducing the estimated PGA by 50% yielding a seismic coefficient of 0.065g.

2.2 Liquefaction Assessment

Liquefaction of soils occurs when horizontal shearing stresses exceed the strength of existing loose, saturated sand. This sudden loss of shear strength and subsequent soil structure is typically associated with earthquake-induced horizontal movement. Recent engineering publications[1] provide criteria to assess liquefaction potential of sands (little to no fines) and clayey soils of low plasticity (e.g. clayey sands, silts). These criteria indicate that water content of fine-grained or cohesive soils needs to be high (≥ 0.85 *Liquid Limit [LL]), a clay fine content (defined as grains smaller than 0.002 mm) of less than 10 percent (< 10%), and relatively low soil density (assessed in terms of SPT blow counts). In addition, the accepted minimum seismic threshold acceleration to cause liquefaction in loose sands is 0.10g, the anticipated site specific PGA for this site is 0.06g.

Native fine grained (or cohesive) material underlying the West Ash Pond generally consist of medium dense to very dense clayey sand (SC), clayey gravel (GC) and silty clayey sand (SC-SM) Based on these soil characteristics and that the West Ash Pond is located in a zone of low peak ground acceleration (PGA), the risk of either embankment or underlying soils liquefying are negligible [40 CFR §257.73(e)(1)(iv)].

---

[1] Seed, R.B., et al, Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework, 26th Annual ASCE Los Angeles Spring Seminar, April 2003

2.3 Embankment and Foundation Stratigraphy

The models developed for this evaluation are based on the existing embankment geometry, results of field and laboratory testing and hydrologic site information provided by the client and recent field activities. Selection of critical slope sections (Section Nos. 1 and 2) was based on both height and subsurface sensitivity to loading. The following tables provide a summary of soil parameters used for these analyses. Specific soil parameters used for each model are presented in the Appendix.

Summary of Long Term, Total Stress Soil Parameters, Section No. 1:

Material Type	Unit Weight (pcf)	Consolidated-Undrained Cohesion (psf)	Consolidated-Undrained Angle of Internal Friction (degrees)
Embankment Fill	125	450	12
Lean Clay/Fat Clay (CL/CH)	125	530	13
Silty Sand/Clayey Sand (SM/SC)	125	0	28
Ash	100	0	30

NOTE: Properties used for Steady State Seepage with Seismic analysis.

Summary of Long Term, Effective Stress Soil Parameters, Section No. 1

Material Type	Unit Weight (pcf)	Consolidated-Drained Cohesion (psf)	Consolidated-Drained Angle of Internal Friction (degrees)
Embankment Fill	125	590	16
Lean Clay/Fat Clay (CL/CH)	125	320	17
Silty Sand/Clayey Sand (SM/SC)	125	430	28
Ash	100	0	30

NOTE: Properties used for Steady State Seepage analysis. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing.

Summary of Long Term, Total Stress Soil Parameters, Section No. 2			
Material Type	**Unit Weight (pcf)**	**Consolidated-Undrained Cohesion (psf)**	**Consolidated-Undrained Angle of Internal Friction (degrees)**
Embankment Fill	125	450	12
Lean Clay/Fat Clay (CL/CH)	125	530	13
Clayey Sand/Silty Sand (SC/SM)	125	0	28
Lean Clay (CL)	125	260	20
Ash	100	0	30
NOTE: Properties used for Steady State Seepage with Seismic analysis.			

Summary of Long Term, Effective Stress Soil Parameters, Section No. 2			
Material Type	**Unit Weight (pcf)**	**Consolidated-Drained Cohesion (psf)**	**Consolidated-Drained Angle of Internal Friction (degrees)**
Embankment Fill	125	590	16
Lean Clay/Fat Clay (CL/CH)	125	320	17
Clayey Sand/Silty Sand (SC/SM)	125	0	28
Lean Clay (CL)	125	290	22
Ash	100	0	30
NOTE: Properties used for Steady State Seepage analysis. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing.			

2.4 Seepage Analysis Parameters

The analysis of embankment seepage is based on laboratory results and estimated values for permeability for various embankment and native foundation soils. These soil parameters were utilized in the models to establish a long term steady state condition and corresponding phreatic surface in the embankment. Hydraulic conductivity test results are provided in the Appendix. Hydraulic conductivity properties utilized in the seepage analysis are provided in the below table.

Hydraulic Conductivity of Embankment Soils, Section Nos. 1 and 2	
Material Type	**Permeability (ft/sec)**
Embankment Fill	1×10^{-8}
Lean Clay/Fat Clay (CL/CH)	1×10^{-8}
Clayey Sand/Silty Sand (SC/SM)	1×10^{-5}
Lean Clay (CL)	1×10^{-8}
Ash	1×10^{-4}

2.5 Stability Analysis Results

The following tables provides the results of the stability analysis for each of the conditions cited herein, as required by 40 CFR §257.73(e)(1)(i) through (iii). The graphical representations of each analysis are included in the Appendix.

Summary of Stability Analyses – Safety Factors, Section No. 1		
Modeled Condition	**Factor of Safety**	
	Actual	**Minimum**
Steady State Seepage – Maximum Pool	2.21	1.50
Steady State Seepage – Surcharge Pool	2.21	1.40
Steady State Seepage with Seismic – Maximum Pool	1.35	1.00

Summary of Stability Analyses – Safety Factors, Section No. 2		
Modeled Condition	**Factor of Safety**	
	Actual	**Minimum**
Steady State Seepage – Maximum Pool	1.83	1.50
Steady State Seepage – Surcharge Pool	1.83	1.40
Steady State Seepage with Seismic – Maximum Pool	1.50	1.00

Based on the findings of this analysis, the evaluated embankments appear to be stable under the modeled conditions and demonstrate the minimum safety factors, as required by 40 CFR §257.73(e)(1)(i) through (iii).

3.0 Report Limitations

This report has been prepared for the exclusive use of our client for the specific application to the project discussed and has been prepared in accordance with the generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. The analyses contained in the report are based on the data obtained from the referenced soil borings performed within the project site. This report does not reflect variations that may occur between borings or across the site. Soil borings do not necessarily reflect strata variations that may exist at other locations within the project site.

4.0 Initial Structural Stability Assessment Certification

By means of this certification, (i) I have reviewed the requirements of 40 CFR §257.73(e)(1) – *Periodic Safety Factor Assessments*, (ii) I or my agent has visited and examined the facility, (iii) the referenced data used in this evaluation to the best of my knowledge appears correct and appropriate for use, (iv) and this Initial Safety Factor Assessment for the West Ash Pond (Pirkey Power Station) has been prepared to the best of my knowledge in accordance with §257.73(e)(1).

By: ____________________

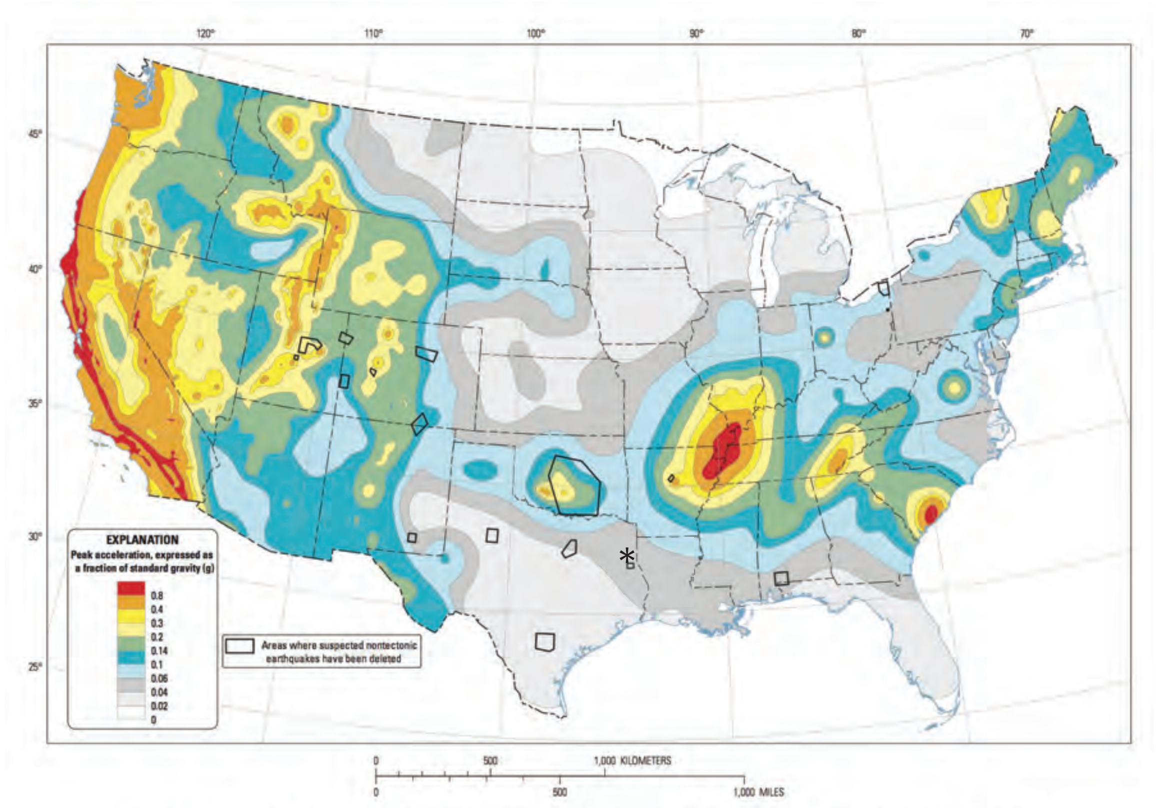
Dated: January 14, 2016

STATE OF TEXAS
JOHN J. TAYNTOR
99202
LICENSED
PROFESSIONAL ENGINEER

TBPE Firm Registration No. F-16721
Expires 2/29/2016

Appendix

Stability Analyses
Reference Data



Two-percent probability of exceedance in 50 years map of peak ground acceleration

* Approximate location of Pirkey Power Generating Station

Provided by USGS National Seismic Hazard Mapping Project.

Seismic Probability Map

Scale: N/A

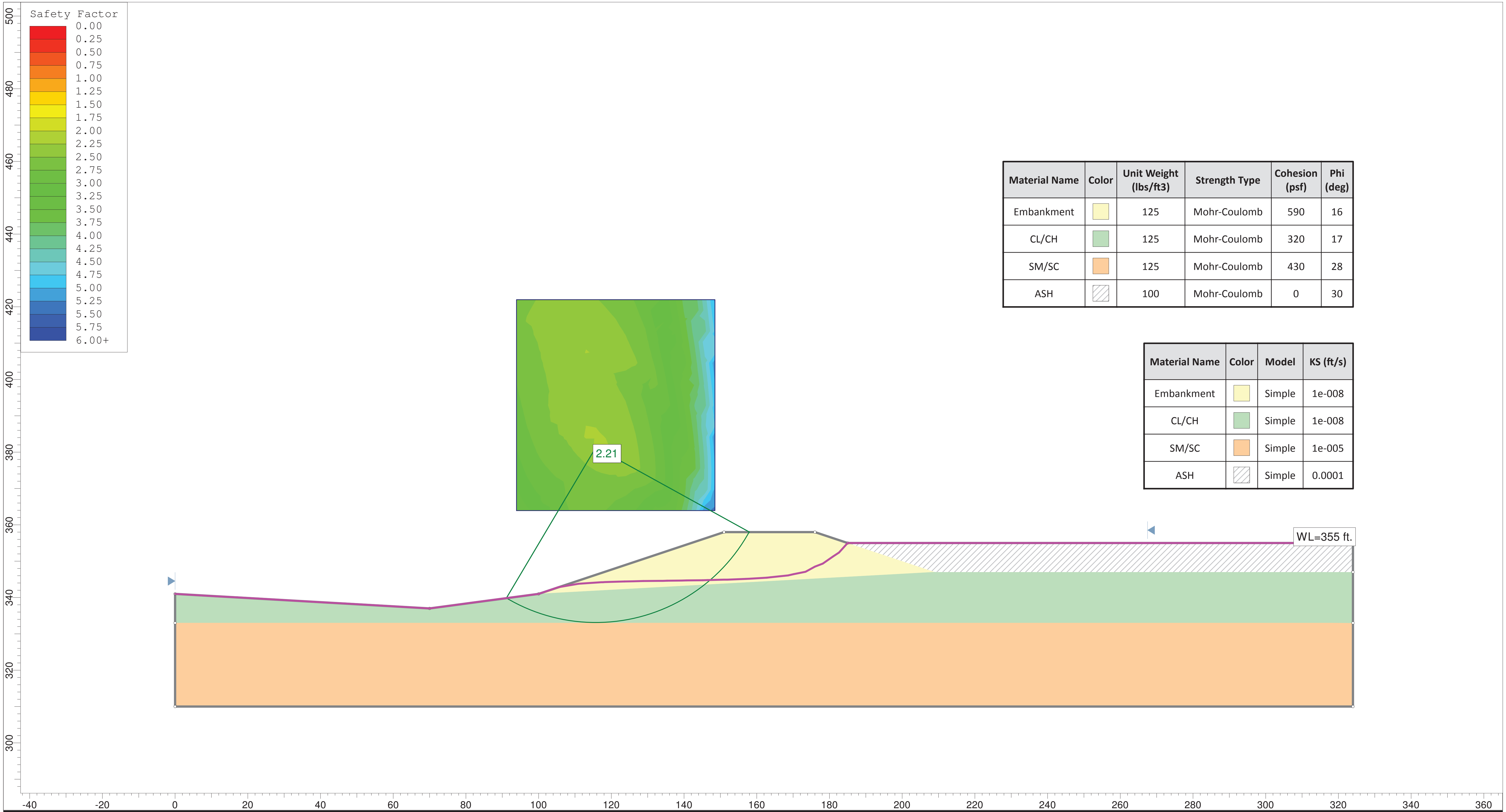
Auckland Project No. 2015-008C

Pirkey Power Generating Station
Initial Safety Factor Assessment - West Ash Pond
Hallsville, Texas

Provided by Google Earth.

Cone Penetrometer Test (CPT) Location Map

Scale: N/A	**Pirkey Power Generating Station** **Initial Safety Factor Assessment - West Ash Pond** **Hallsville, Texas**
Auckland Project No. 2015-008C	



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	590	16
CL/CH	🟩	125	Mohr-Coulomb	320	17
SM/SC	🟧	125	Mohr-Coulomb	430	28
ASH	▨	100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SM/SC	🟧	Simple	1e-005
ASH	▨	Simple	0.0001

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project
Pirkey Power Station - West Ash Pond, Section No. 1

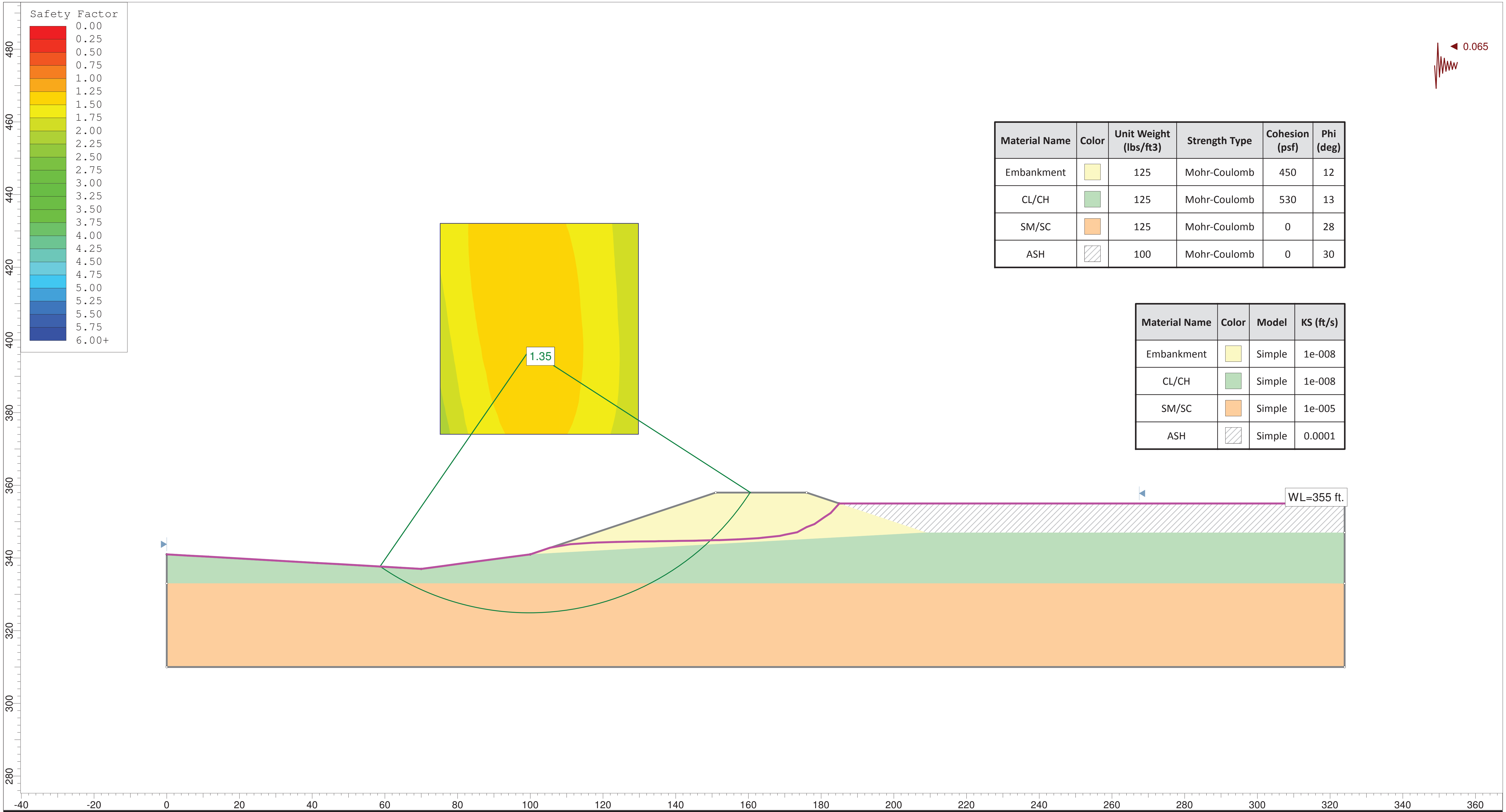
Analysis Description
Steady State Seepage at Maximum and Surcharge Pool

Drawn By
JJT

Company

Date
12/15/2015

File Name
WEST ASH_Section 1_SSS_25yr.slim



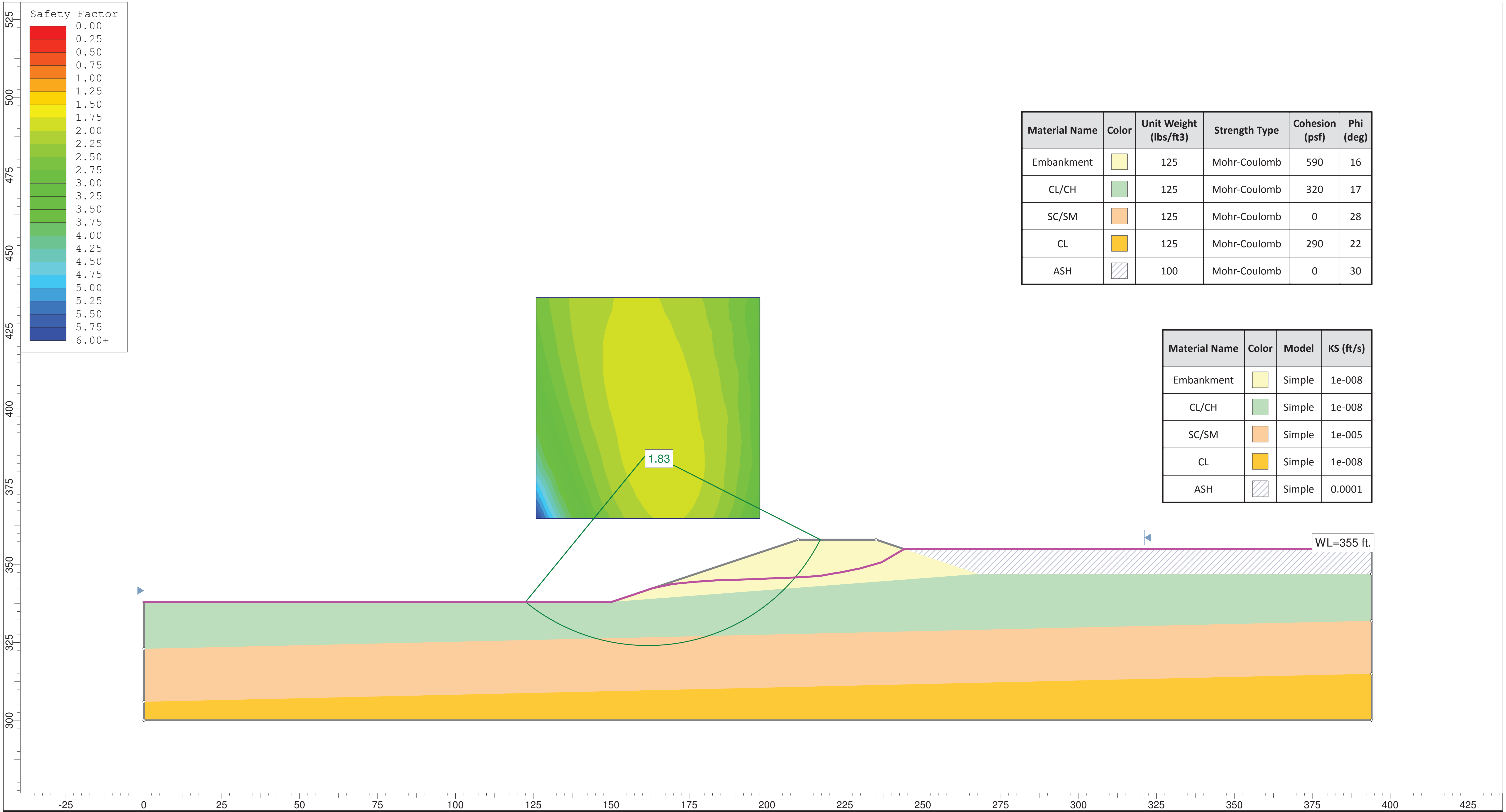
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	450	12
CL/CH	🟩	125	Mohr-Coulomb	530	13
SM/SC	🟧	125	Mohr-Coulomb	0	28
ASH	▨	100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SM/SC	🟧	Simple	1e-005
ASH	▨	Simple	0.0001

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 1
Analysis Description	Steady State Seepage at Maximum Pool, Seismic Analysis
Drawn By	JJT
Company	
Date	12/23/2015
File Name	WEST ASH_Section 1_SSS_25yr_seismic.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	590	16
CL/CH	🟩	125	Mohr-Coulomb	320	17
SC/SM	🟧	125	Mohr-Coulomb	0	28
CL	🟨	125	Mohr-Coulomb	290	22
ASH	▨	100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SC/SM	🟧	Simple	1e-005
CL	🟨	Simple	1e-008
ASH	▨	Simple	0.0001

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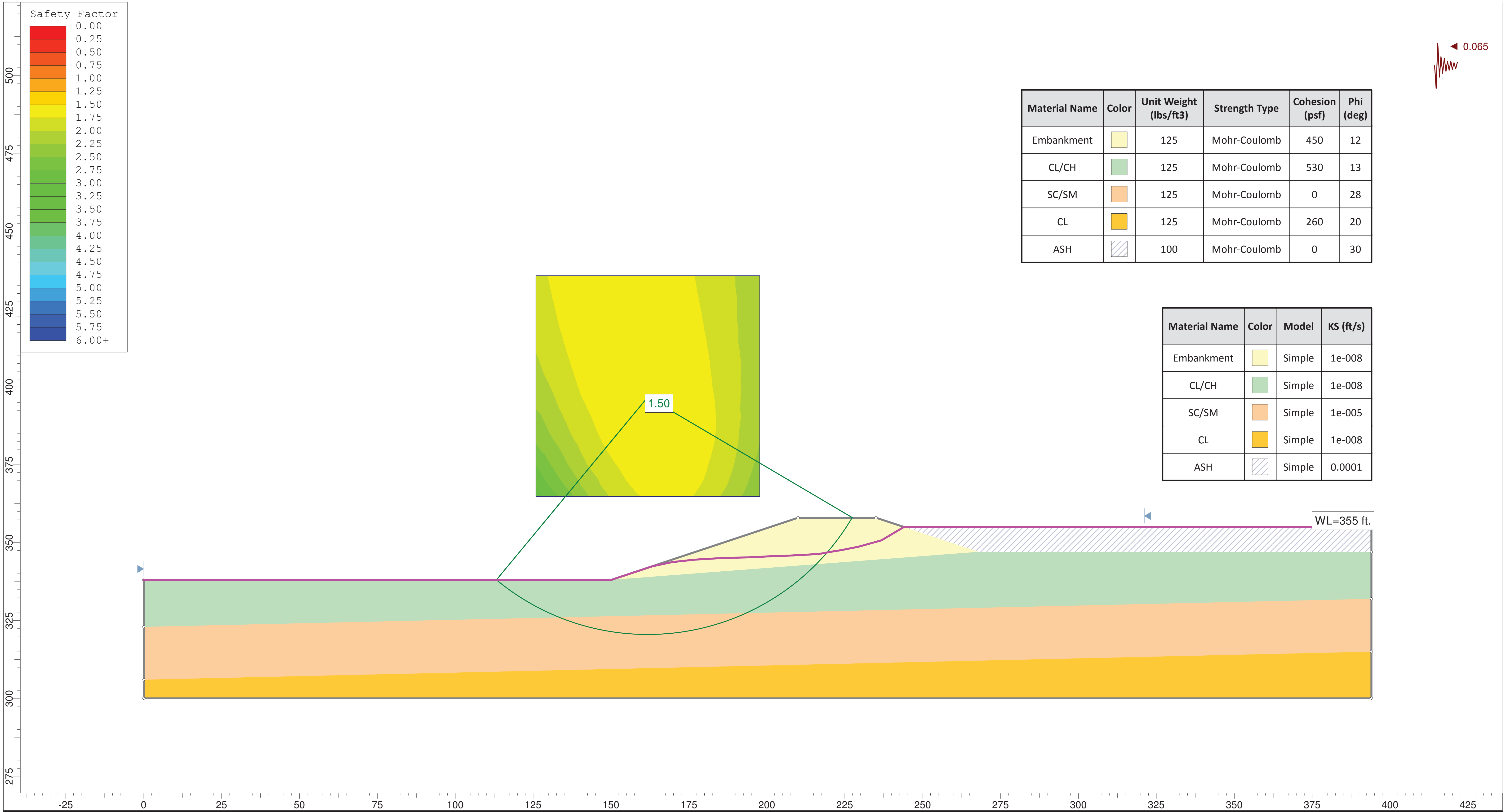
SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 2
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool

Drawn By	JJT	*Company*	
Date	12/15/2015	*File Name*	WEST ASH_Section 2_SSS_25yr.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	450	12
CL/CH	🟩	125	Mohr-Coulomb	530	13
SC/SM	🟧	125	Mohr-Coulomb	0	28
CL	🟨	125	Mohr-Coulomb	260	20
ASH	▨	100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SC/SM	🟧	Simple	1e-005
CL	🟨	Simple	1e-008
ASH	▨	Simple	0.0001

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SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 2
Analysis Description	Steady State Seepage at Maximum Pool, Seismic Analysis
Drawn By	JJT
Company	
Date	12/23/2015
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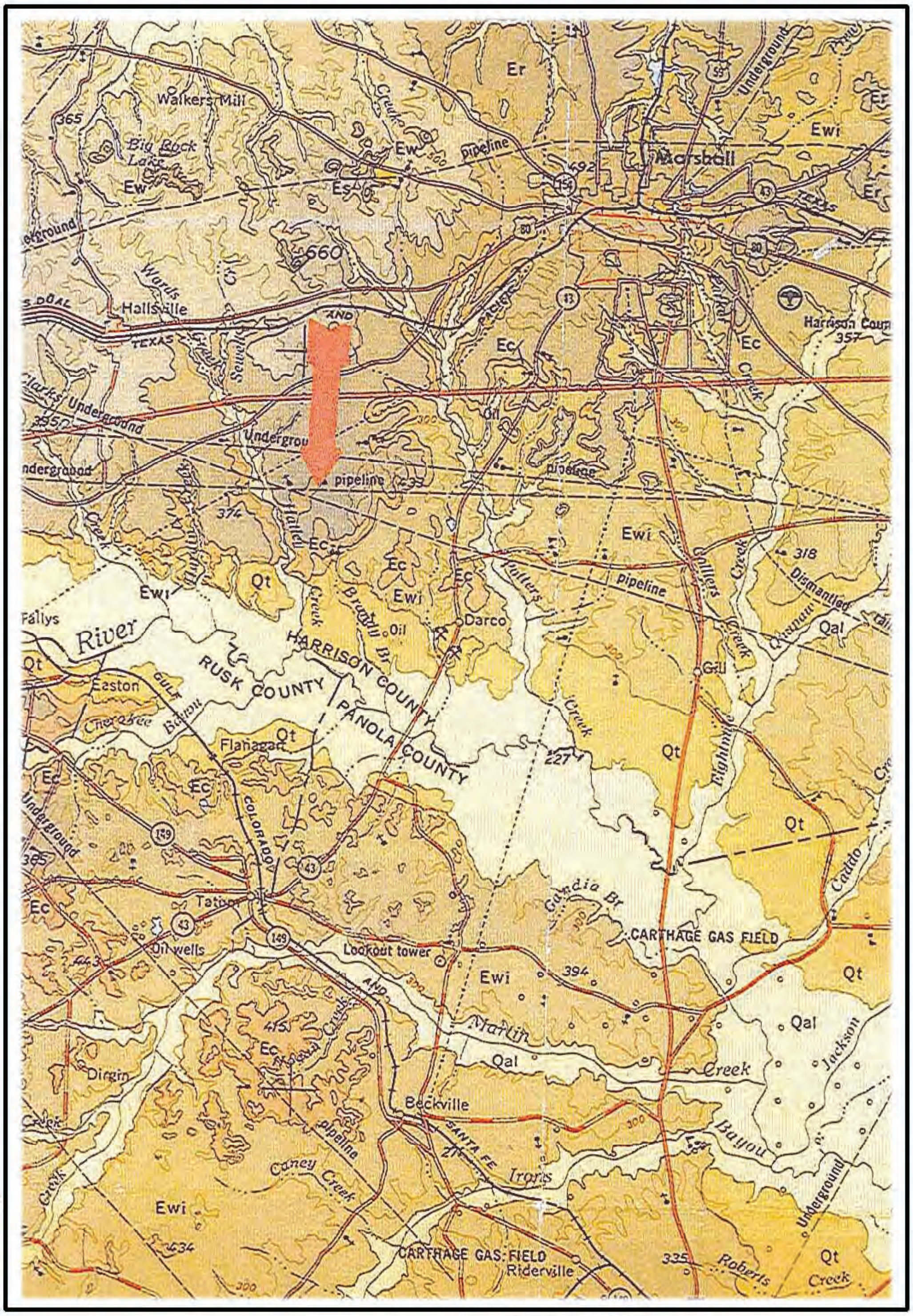


EXPLANATION

SEDIMENTARY ROCKS

QUATERNARY

Pleistocene Recent

Qal

Alluvium

Flood-plain deposits

Qt

Fluviatile terrace deposits undivided

TERTIARY

Eocene

Etg / Es

Sparta Sand

Quartz sand, fine to medium grained, light gray to brownish gray, slightly cohesive from silt and clay matrix, massive, locally cross-bedded, interbeds of sandy clay more abundant upward, locally carbonaceous; weathers various shades of light gray, at base hard, brown, ferruginous sandstone; lower part 170± feet thick, upper part absent. Locally includes Tyler Greensand Member, Etg, quartz-glauconite greensand, grayish green, massive, locally cross-bedded; weathers dark reddish brown, abundant ironstone concretions

Ew

Weches Formation

Glauconite and quartz sand, grayish green to grayish olive green, thin bedded, locally cross-bedded to lenticular, clay interbeds light brown to moderate light gray, silty, muscovitic, thin bedded; weathers moderate to dark reddish brown, locally forms limonitic and sideritic iron ore and clay ironstone concretions; marine megafossils in southern part; 25± feet thick, range 0–70 feet

Eqc

Queen City Sand

Quartz sand, fine grained to locally medium grained, light gray to brownish gray, locally carbonaceous, and clay, gray to brown, silty, slightly lignitic, sand most abundant to west; weathers red and white mottled, ironstone concretions and ledges common; local beds of glauconite-quartz greensand, cross-bedded, weathers to ferruginous ledges and rubble; 100–400 feet thick, thins southeastward

Er

Reklaw Formation

Upper 100± feet, clay, brownish black to brownish gray, silty, muscovitic, carbonaceous, laminated, interbeds of moderate reddish-brown clay; weathers light brown, ironstone concretions common; a few marine fossils. Lower 15± feet, quartz sand, fine to very fine grained, grayish green, glauconitic, argillaceous, massive, locally cross-bedded; weathers moderate brown to dark yellowish orange with clay ironstone ledges and rubble; fossils, clay ironstone, and clay decrease northward

Ec

Carrizo Sand

Upper part, very fine sand, silt, clayey silt, silty clay, medium to dark gray, carbonaceous; weathers moderate yellowish brown to dark reddish brown, indurated ledges of dark brownish-gray ironstone common. Lower part, quartz sand, fine to medium grained, light brownish gray, weakly cohesive, massive, locally cross-bedded; weathers light gray to various shades of red. Thickness 20–100 feet

Ewi

Wilcox Group undivided

Mostly silty and sandy clay, various shades of gray, local beds of clay, lignite, silt, and quartz sand, in part carbonaceous, laminated to massive, locally cross-bedded, weathers to various shades of gray, brown, yellow, and red. Calcareous siltstone and ironstone concretions common; abundant plant fossils, a few marine fossils in southeastern part; 500–1,000 feet thick.

E

Eocene rocks undivided

Reklaw Formation, Carrizo Sand, Wilcox Group, and Midway Group on Brooks dome not separately shown

Ewp

Wills Point Formation

Clay, medium bluish gray, greenish gray, grayish green, brownish gray, silt increases upward, laminated to locally massive, glauconitic near base, rough calcareous siltstone concretions common in upper part, locally lignitic in upper part, thin bed of coquina limestone near middle; weathers medium gray to yellowish gray; fossiliferous; 500± feet thick

Ek

Kincaid Formation

Clay, medium gray to dark gray, greenish gray, brownish gray, glauconitic, calcareous, selenitic, locally silty or sandy, locally phosphatic near base, thin beds of limestone in upper part, gray, hard, detrital; weathers medium gray; fossiliferous; 150± feet thick

CRETACEOUS

Upper Cretaceous

Kke

Kemp Clay

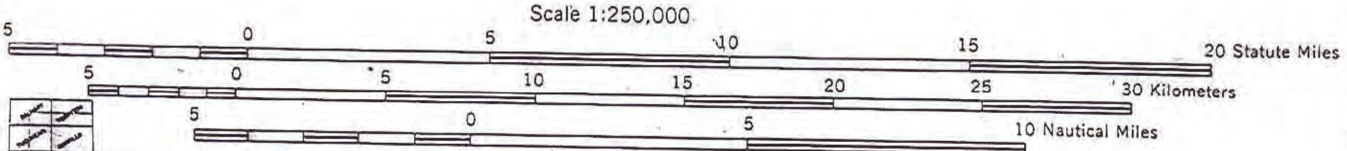
Clay, dark gray to bluish gray, calcareous, silty, glauconitic, calcareous concretions common; weathers dark greenish gray and black; upper part only crops out

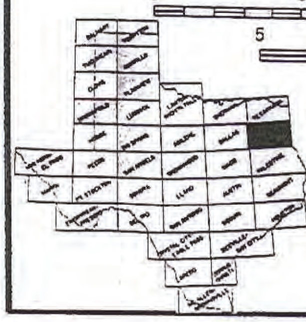
Ku

Upper Cretaceous rocks undivided

Navarro Group, Taylor Group, and Austin Chalk on Brooks dome not separately shown

Scale 1:250,000





CONTOUR INTERVAL 100 FEET
WITH SUPPLEMENTARY CONTOURS AT 50 FOOT INTERVALS

ETTL ENGINEERS & CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PLATE 2

SITE SURFACE GEOLOGY

JOB No.: G3241-095

DATE: DEC. 2009

SCALE: 1:250,000

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

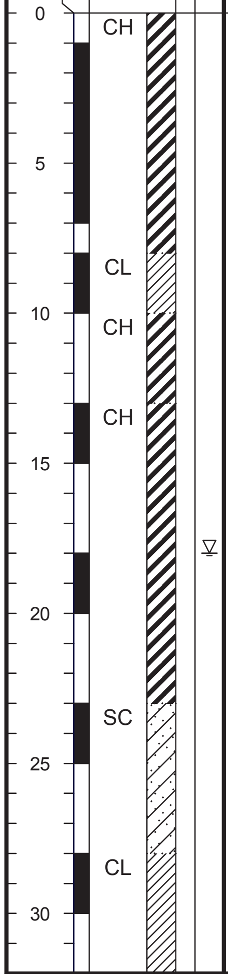
LOG OF BORING W-1

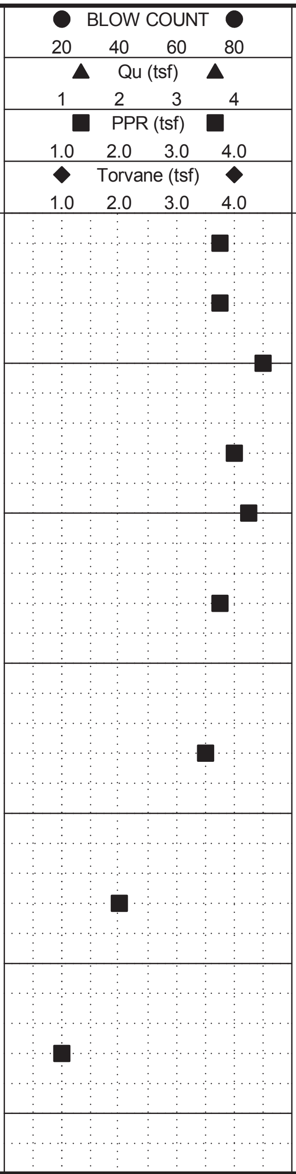
PROJECT: Pirkey Power Plant
Hallsville. Texas

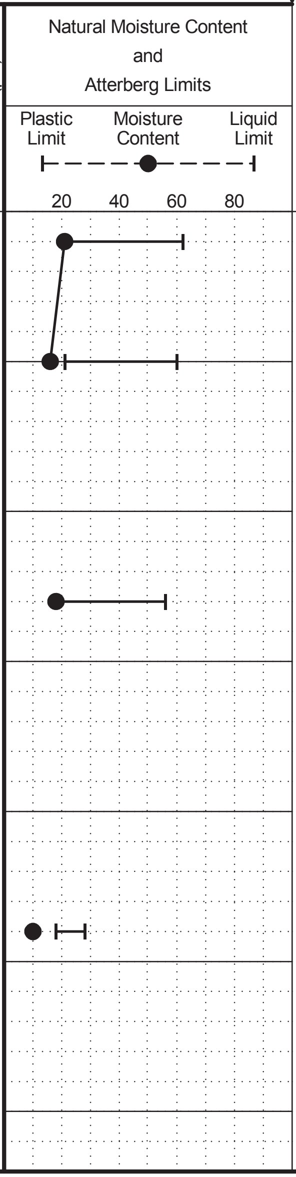
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.5







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH	FAT CLAY WITH SAND(CH) tan and red	P=3.75					21	62	21	41	79	+40 Sieve=6%, +4 Sieve=0%
		P=3.75										
	--red	P=4.5					16	60	21	39	75	+40 Sieve=7%, +4 Sieve=1%
CL	SANDY LEAN CLAY(CL) reddish yellow	P=4.0										
CH	FAT CLAY(CH) red and tan	P=4.25										
CH	FAT CLAY WITH SAND(CH) red and yellow	P=3.75					18	56	18	38	71	+40 Sieve=5%, +4 Sieve=0%
	--red	P=3.5										
SC	CLAYEY SAND(SC) reddish brown	P=2.0					10	28	18	10	25	+40Sieve=21%, +4 Sieve=11%
CL	LEAN CLAY(CL) red; with sand seams	P=1.0										

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-1

PROJECT: Pirkey Power Plant
Hallsville. Texas

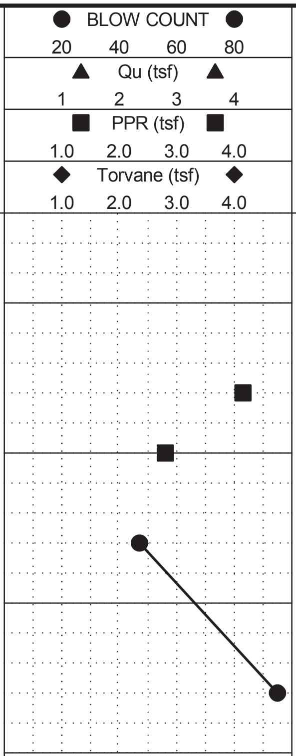
PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

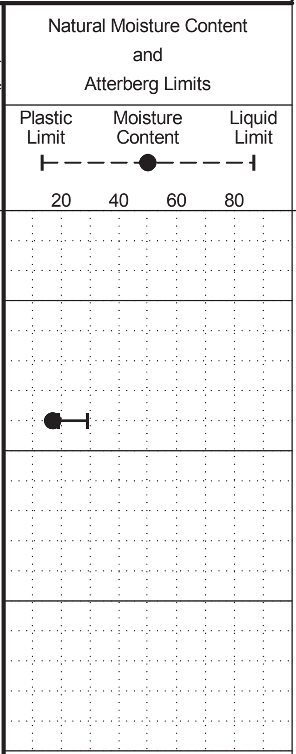
DATE 10/20/09

SURFACE ELEVATION 356.5

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	SC	CLAYEY SAND(SC) grayish brown	N=32						
35									
		--tannish gray	P=4.15	17	29	19	10	25	+40 Sieve=1%, +4 Sieve=0%
40			P=2.8						
		--gray	N=47						
45									
	SM SC	SILTY CLAYEY SAND(SM-SC) gray	N=50/6"						
50		Bottom of Boring @ 50'							



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbrevations:
- N - SPT Data (Blows/Ft)
- P - Pocket Penetrometer (tsf)
- T - Torvane (tsf)
- L - Lab Vane Shear (tsf)

Notes:

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

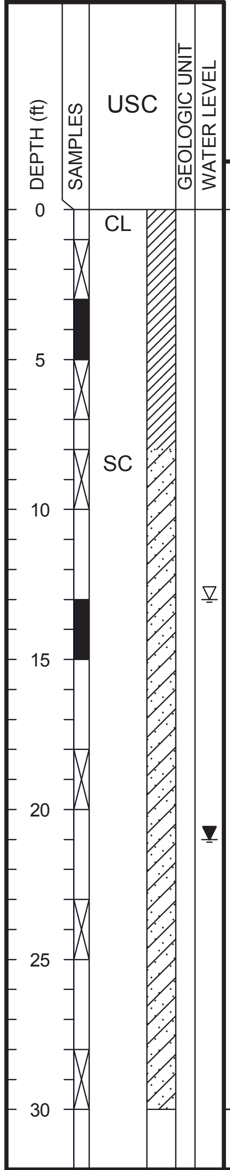
LOG OF BORING W-2

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

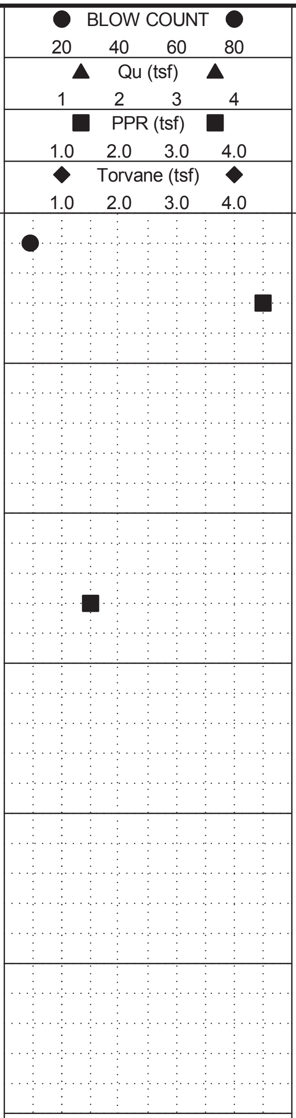
DATE 10/21/09

SURFACE ELEVATION 341.7

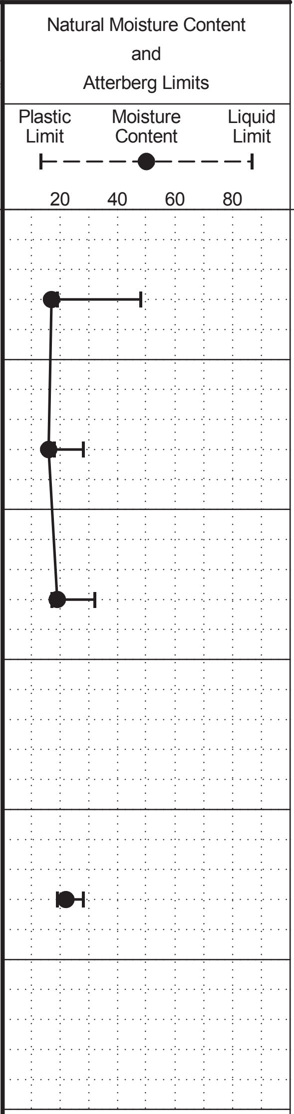


USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; red and gray	N=9						
	--hard	P=4.5+	17	48	19	29	65	+40 Sieve=6%, +4 Sieve=2%
	--gray, red, and tan	N=50						
SC	CLAYEY SAND(SC) very dense; red and tan	N=50/5"	16	28	18	10	27	+40 Sieve=7%, +4 Sieve=2%
	--medium dense; tan and gray	P=1.5	19	32	17	15	31	+40Sieve=13%, +4 Sieve=5%
	--very dense; gray and tan	N=62						
	--green	N=50/5"	22	28	19	9	33	+40 Sieve=6%, +4 Sieve=2%
		N=56						

Bottom of Boring @ 30'



DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling. Water level @ 21' and open upon completion.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

LOG OF BORING W-3

ETTL ENGINEERS & CONSULTANTS

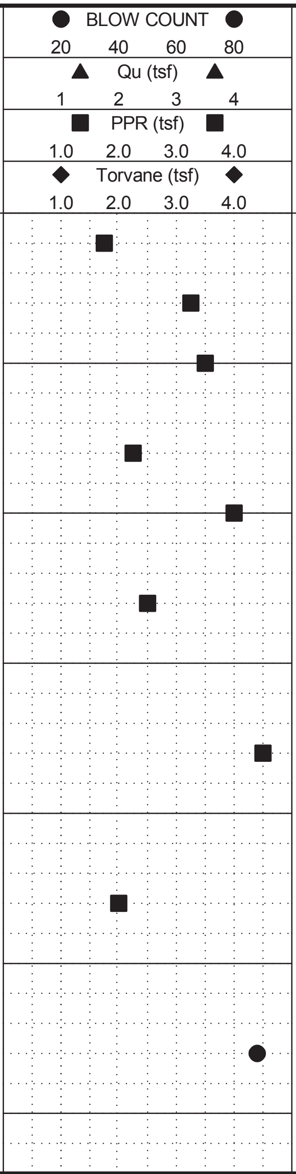
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

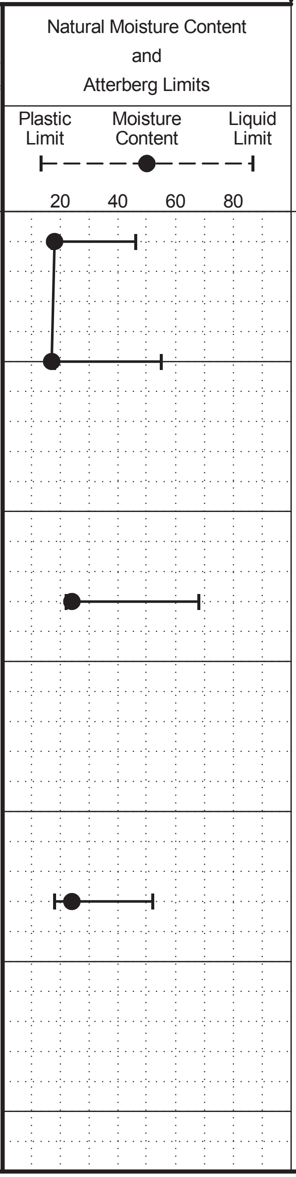
PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.3





DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LL	PL	PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CL	<u>SANDY LEAN CLAY</u>(CL) stiff; white and tan	P=1.75					18	46	17	29	61	+40 Sieve=7%, +4 Sieve=2%
	CH	<u>SANDY FAT CLAY</u>(CH) very stiff; red, tan, and white	P=3.25										
5		--white, tan, and red	P=3.5					17	55	18	37	68	+40 Sieve=5%, +4 Sieve=0%
	CL	<u>SANDY LEAN CLAY</u>(CL) very stiff; red and yellow	P=2.25 P=4.0										
10		--hard; red and yellow											
	CH	<u>FAT CLAY WITH SAND</u>(CH) very stiff; red and yellow	P=2.5					24	68	22	46	80	+40 Sieve=6%, +4 Sieve=0%
15													
		--hard	P=4.5+										
20													
		--stiff	P=2.0					24	52	18	34	69	+40 Sieve=4%, +4 Sieve=0%
25													
	SM	<u>SILTY SAND</u>(SM) very dense; yellow and red	N=88										
30													

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 34' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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(903) 595-4421

LOG OF BORING W-3

PROJECT: Pirkey Power Plant
Hallsville. Texas

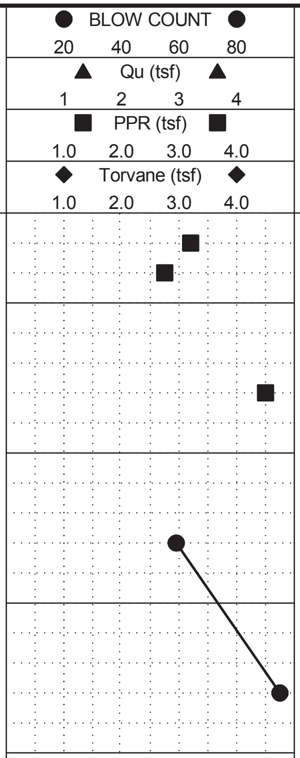
PROJECT NO.: G3241-095

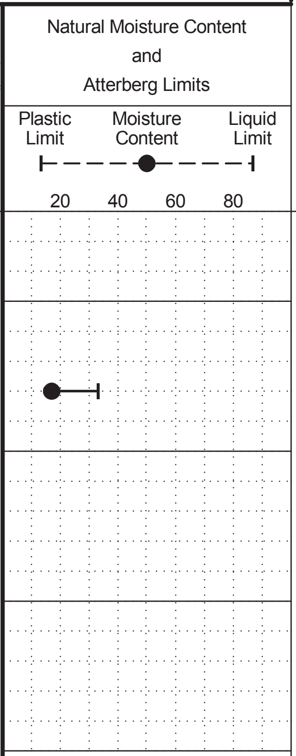
BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.3

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	■	CL		∇	SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel	P=3.25										
40	■	SC			CLAYEY SAND(SC) very dense; dark gray	P=4.5+					17	33	17	16	38	+40 Sieve=1%, +4 Sieve=0%
45	☒	SM SC			SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated	N=59										
50	☒	SC			CLAYEY SAND(SC) very dense; dark gray	N=50/4"										
					Bottom of Boring @ 50'											





Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 34' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-4

PROJECT: Pirkey Power Plant
Hallsville. Texas

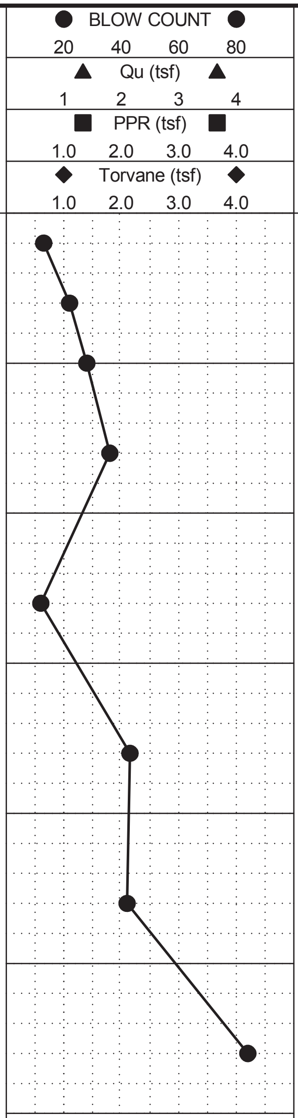
PROJECT NO.: G3241-095

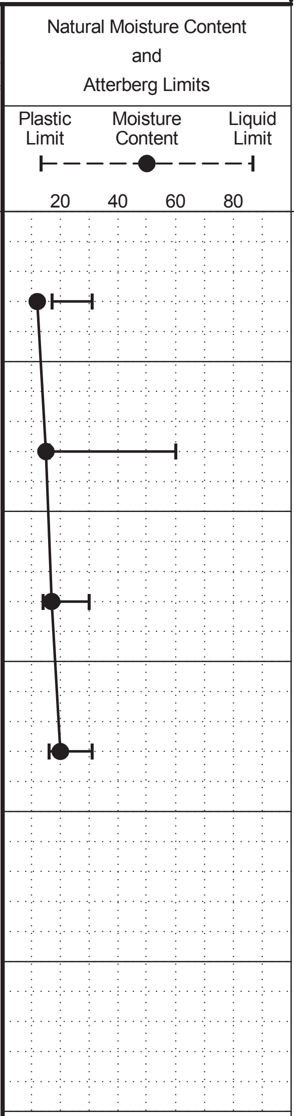
BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 338.0

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SC	<u>CLAYEY SAND</u>(SC) stiff; brown, red, and yellow	N=13										
		--with gravel	N=22					12	31	17	14	35	+40Sieve=31%, +4 Sieve=16%
5		--red and tan; with iron oxide cemented sandstone	N=28										
		--dense; red and white; with clay seams	N=36					15	60	16	44	39	+40Sieve=11%, +4 Sieve=4%
10													
		--medium dense; orangish gray; with gravel	N=12					17	30	14	16	22	+40Sieve=28%, +4 Sieve=17%
15													
	GC	<u>CLAYEY GRAVEL</u>(GC) dense; dark gray	N=43					20	31	16	15	7	+40Sieve=68%, +4 Sieve=52%
20													
	SM	<u>SILTY SAND</u>(SM) dense; dark gray	N=42										
25													
	CL	<u>SANDY LEAN CLAY</u>(CL) very dense; gray	N=84										
30		Bottom of Boring @ 30'											





Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 19' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
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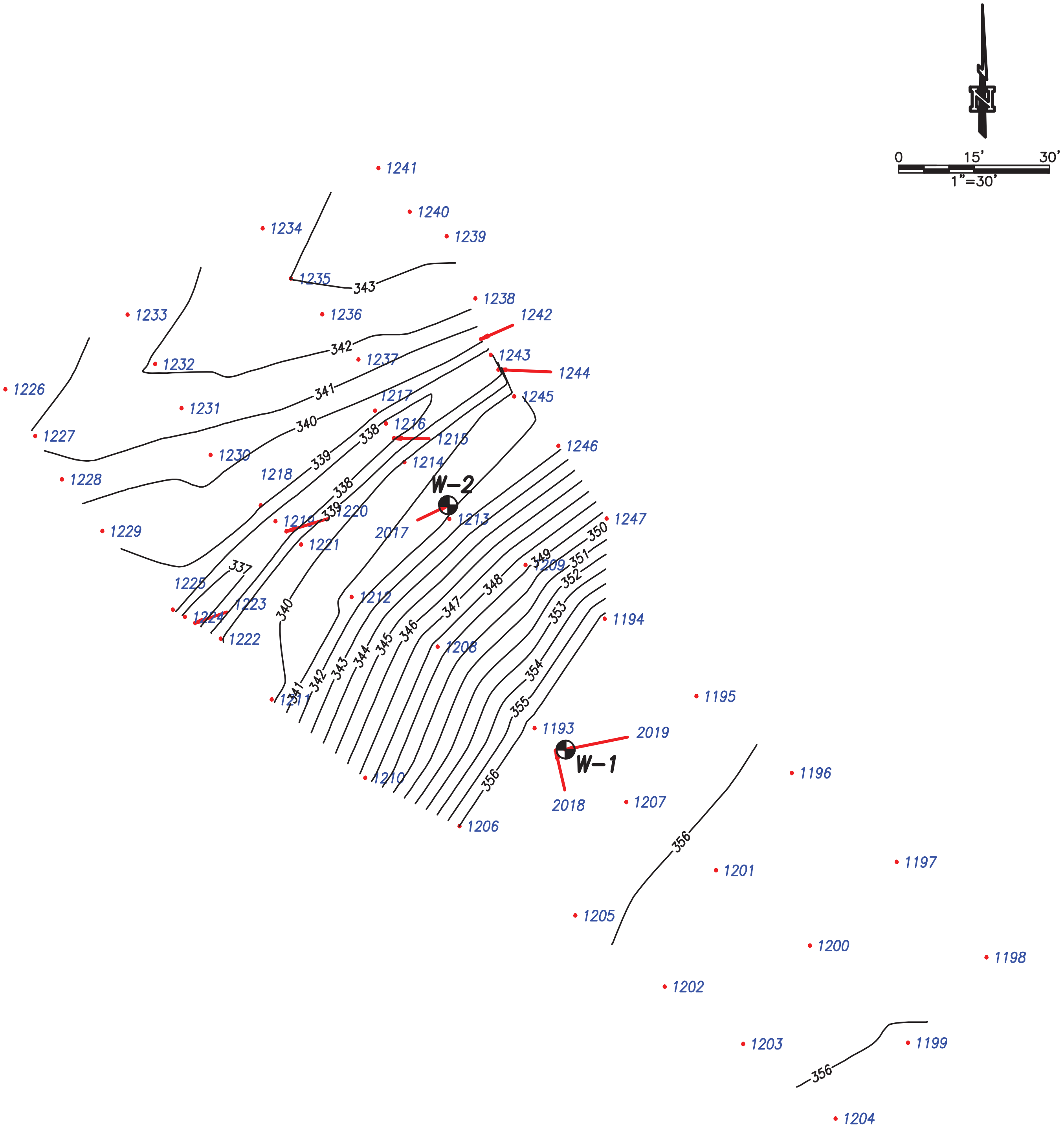
L - Lab Vane Shear (tsf)

Notes:



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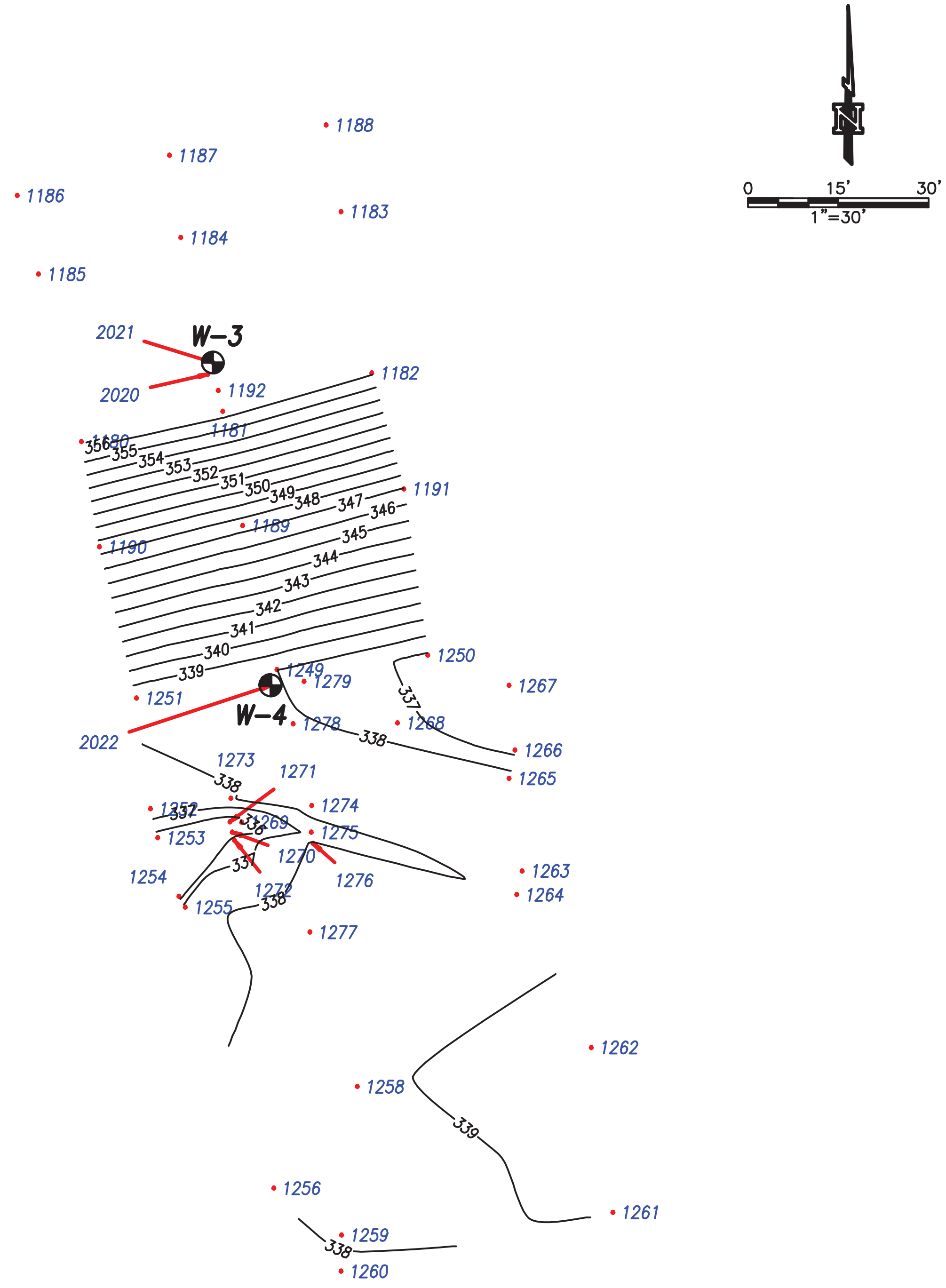
ENGINEERING • ARCHITECTURE • SURVEYING
1201 NW LOOP 281, LB1, LONGVIEW, TEXAS 75604
(903)753-0663 FAX (903)753-8803
website: www.johnsonpace.com
JOB NO: 2313-013 FIELD BOOK: XXX/XXX DATE: NOV. 2009

EXHIBIT "I"

W-1 AND W-2 BOREHOLES
PIRKEY POWER PLANT
HALLSVILLE, TEXAS



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1201 NW LOOP 281, LB1, LONGVIEW,TEXAS 75604
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website: www.johnsonpace.com
JOB NO: 2313-013 FIELD BOOK: XXX/XXX DATE: NOV. 2009

EXHIBIT "J"

W-3 AND W-4 BOREHOLES
PIRKEY POWER PLANT
HALLSVILLE, TEXAS

ETTL Engineers & Consultants Inc.

GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : Pirkey Power Plants Embankments, Hallsville, Texas
Date: 11/3/2009 Panel Number : P 2 ; ASTM D 5084
Project No. : G 3241-09 Permometer Data

Boring No.:	W - 2	ap =	0.031416 cm2	Set Mercury to Pipet Rp at		Equilibrium	1.8	cm3
Sample:		aa =	0.767120 cm2			Pipet Rp	**6.7**	cm3
Depth (ft):	13' to 16'	M1 =	0.030180	C =	0.00043252	Annulus Ra	1.5	cm3
Other Location:		M2 =	1.040953	T =	0.203782344			

Material Description : Tan & Gray Clayey Sand

SAMPLE DATA

Wet Wt. sample + ring or tare :			571.51	g
Tare or ring Wt. :			0.0	g
Wet Wt: of Sample :			571.51	g
Diameter :	2.78	in	7.06	cm2
Length :	2.78	in	7.06	cm
Area:	6.06	in^2	39.10	cm2
Volume :	16.85	in^3	276.12	cm3
Unit Wt.(wet):	**129.15**	pcf	**2.07**	g/cm^3
Unit Wt.(dry):	**107.87**	pcf	**1.73**	g/cm^3

Before Test		After Test	
Tare No.:	T 13	Tare No.:	T 16
Wet Wt.+tare:	660.71	Wet Wt.+tare:	733.72
Dry Wt.+tare:	588.03	Dry Wt.+tare:	625.10
Tare Wt:	219.71	Tare Wt:	151.95
Dry Wt.:	368.32	Dry Wt.:	473.15
Water Wt.:	72.68	Water Wt.:	108.62
% moist.:	**19.7**	% moist.:	**23.0**

Specific Gravity: **2.80** Max Dry Density(pcf) = 107.9147 OMC = 19.732841
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 103.59 Void ratio (e) = **0.62** Porosity (n)= **0.38**

TEST READINGS

Z1(Mercury Height Difference @ t1): 5.1 cm Hydraulic Gradient = 9.12

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZπ (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
11/3/2009	76	4.5	2.1571965	24.5	0.899	2.96E-06	8.40E-03	
11/3/2009	106	4	2.6571965	24.5	0.899	2.86E-06	8.11E-03	
11/3/2009	140	3.5	3.1571965	24.5	0.899	2.87E-06	8.12E-03	
11/3/2009	182	3	3.6571965	24.5	0.899	2.92E-06	8.29E-03	

SUMMARY

ka = 2.90E-06 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	2.96E-06	cm/sec	2.1	%
k2 =	2.86E-06	cm/sec	1.4	%
k3 =	2.87E-06	cm/sec	1.3	%
k4 =	2.92E-06	cm/sec	0.7	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

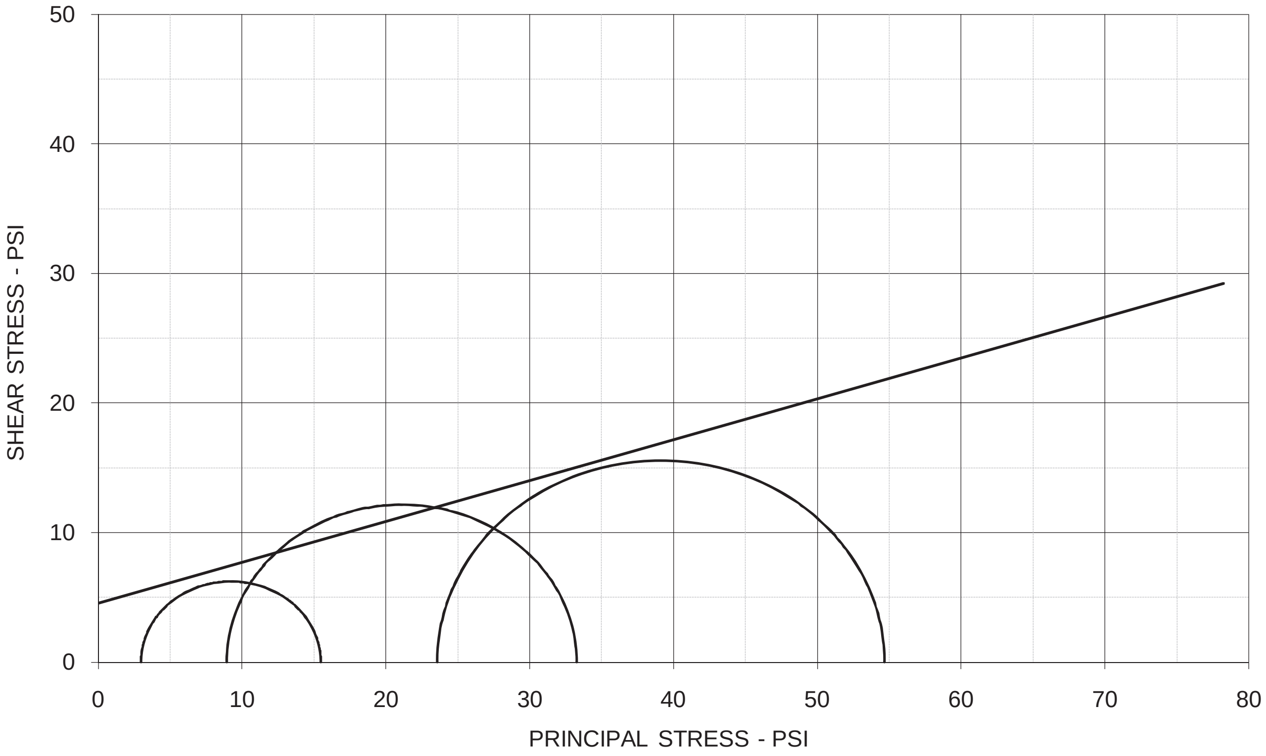
Hydraulic conductivity	k =	**2.90E-06**	cm/sec	**8.23E-03**	ft/day
Void Ratio	e =	**0.62**			
Porosity	n =	**0.38**			
Bulk Density	γ =	**2.07**	g/cm3	**129.2**	pcf
Water Content	W =	**0.34**	cm3/cm3	(at 20 deg C)	
Intrinsic Permeability	kint =	**2.97E-11**	cm2	(at 20 deg C)	

Liquid Limit LL		
Plastic Limit PL		
Plasticity Index PI		
- 200 Sieve		%
+ No 40 Sieve		%
+ No 4 Sieve		%

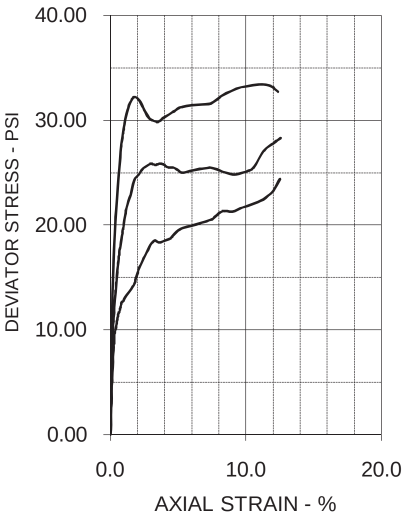
Respectfully Submitted

Robert M. Duke, P.E.

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ' = 17.5 deg	c' = 4.6 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	25.3	23.6	23.9	
Dry Density - pcf	96.5	100.5	101.1	
Diameter - inches	2.05	2.02	2.04	
Height - inches	3.98	4.00	3.95	
AT TEST				
Final Moisture - %	28.8	28.1	24.5	
Dry Density - pcf	96.5	102.9	104.0	
Calculated Diameter (in.)	2.07	2.01	2.03	
Height - inches	4.02	3.98	3.91	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.49	24.34	31.06	
Total Pore Pressure - psi	57.0	61.1	66.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	2.1	1.5	
σ_1' Failure - psi	15.49	33.26	54.65	
σ_3' Failure - psi	3.00	8.92	23.59	

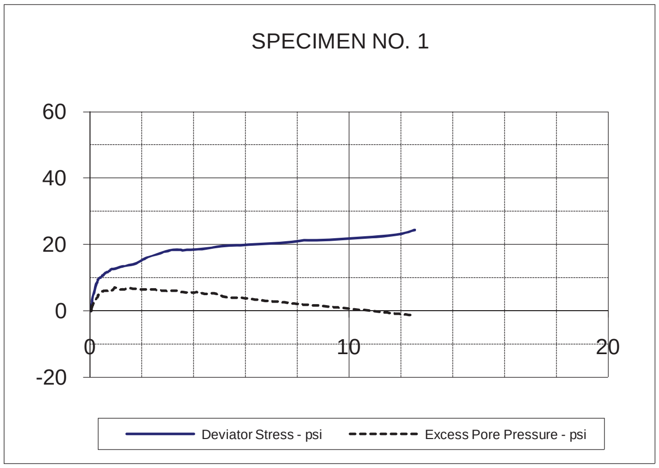
TEST DESCRIPTION

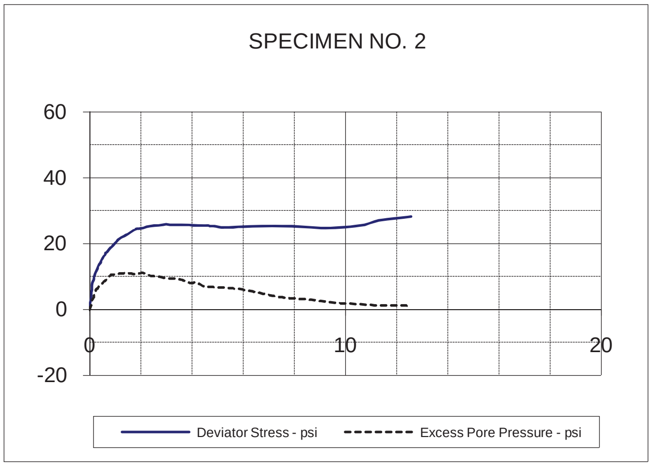
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-1 13' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 5%
LL: 56 PL: 18 PI: 38 Percent -200: 71%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

ETTL ENGINEERS & CONSULTANTS PLATE: B.1


SPECIMEN NO. 1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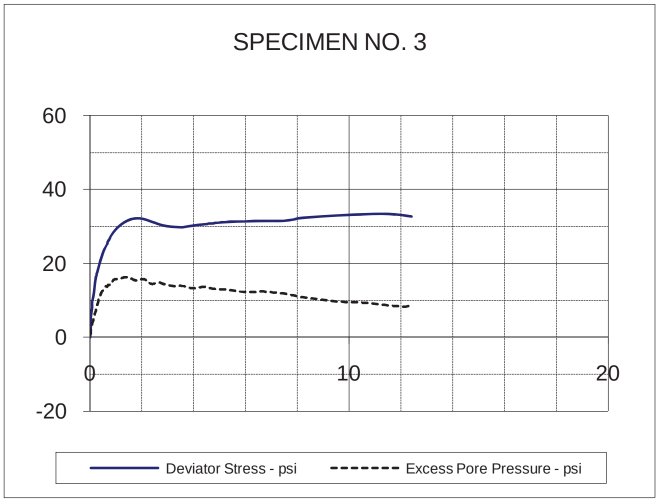
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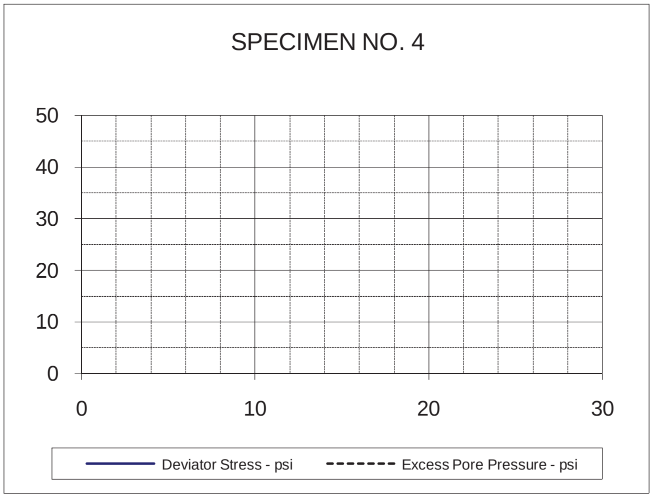
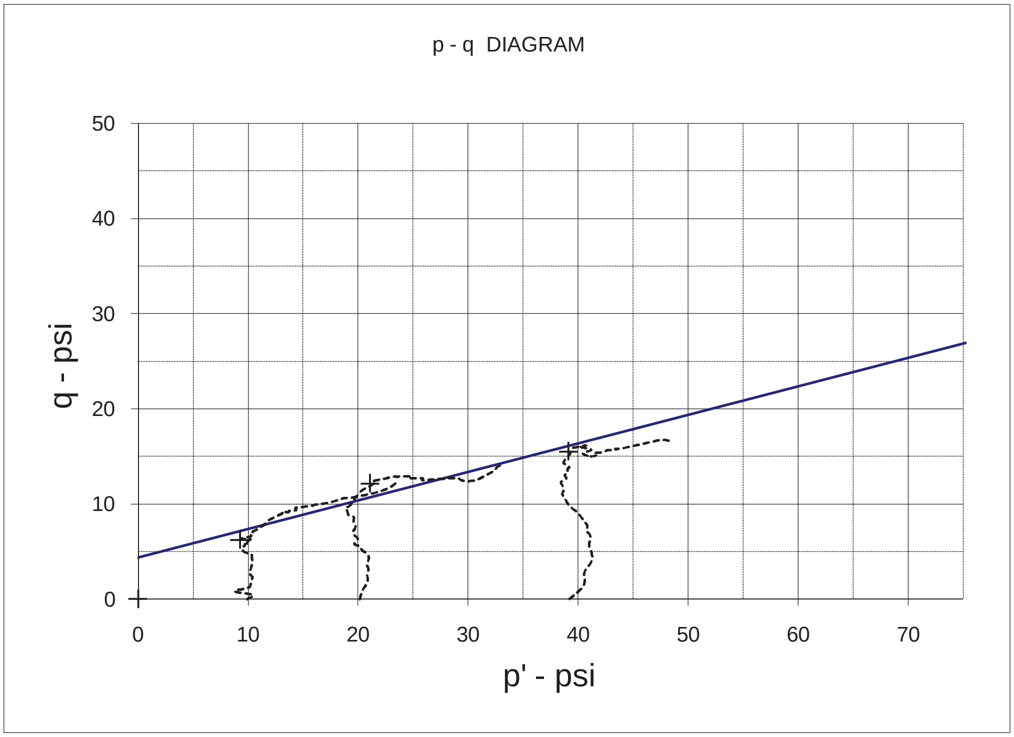
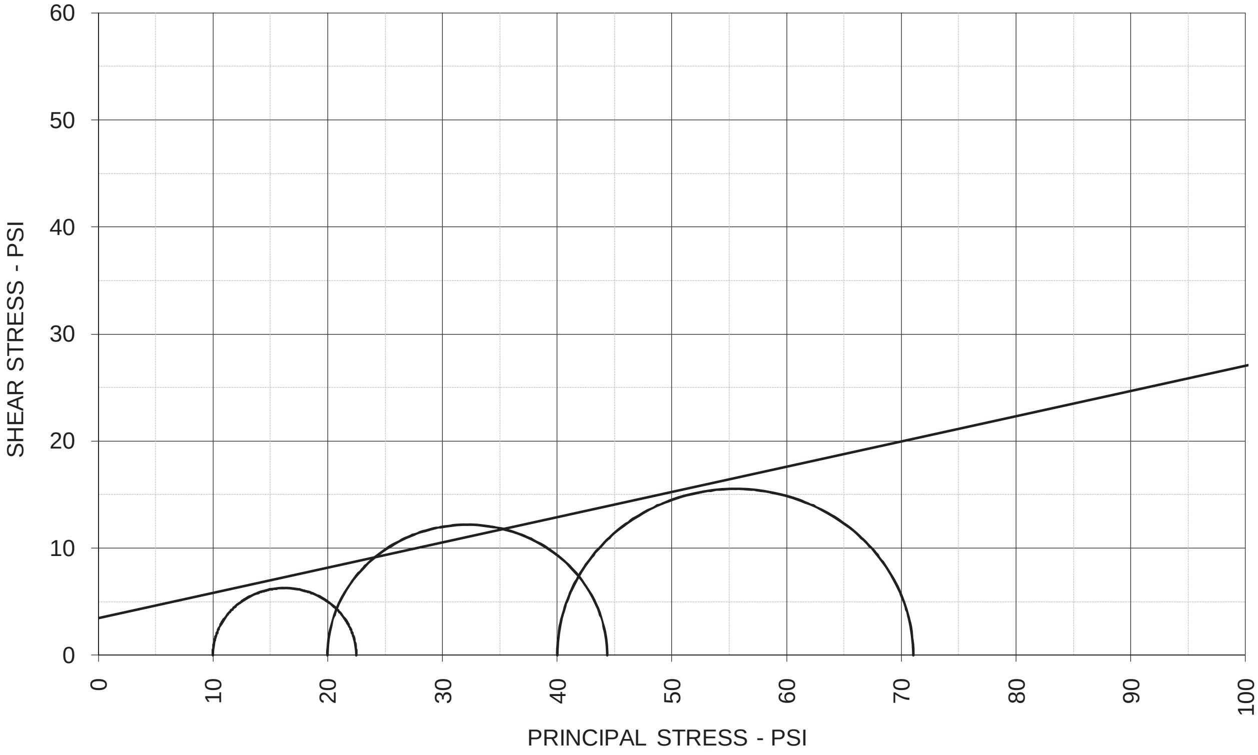

SPECIMEN NO. 4

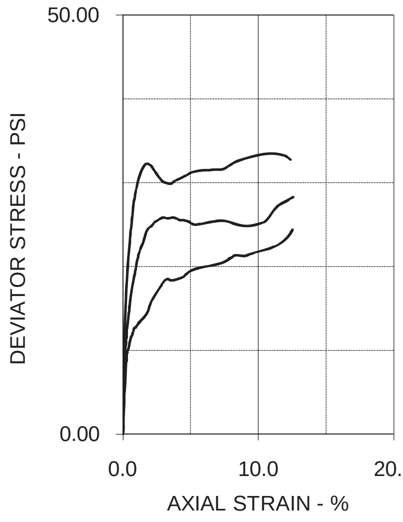

p - q DIAGRAM

EFFECTIVE STRESS PARAMETERS	R^2 = 0.93	α (deg) = 16.7	a (psi) = 4.4
PROJECT: Pirkey Power Plant Embankments		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3241 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand			

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 13.3 deg	c = 3.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	25.3	23.6	23.9	
Dry Density - pcf	96.5	100.5	101.1	
Diameter - inches	2.05	2.02	2.04	
Height - inches	3.98	4.00	3.95	
AT TEST				
Final Moisture - %	28.8	28.1	24.5	
Dry Density - pcf	96.5	102.9	104.0	
Calculated Diameter (in.)	2.07	2.01	2.03	
Height - inches	4.02	3.98	3.91	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.49	24.34	31.06	
Total Pore Pressure - psi	57.0	61.1	66.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	2.1	1.5	
σ_1 Failure - psi	22.49	44.34	71.06	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-1 13' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 5%
LL: 56 PL: 18 PI: 38 Percent -200: 71%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

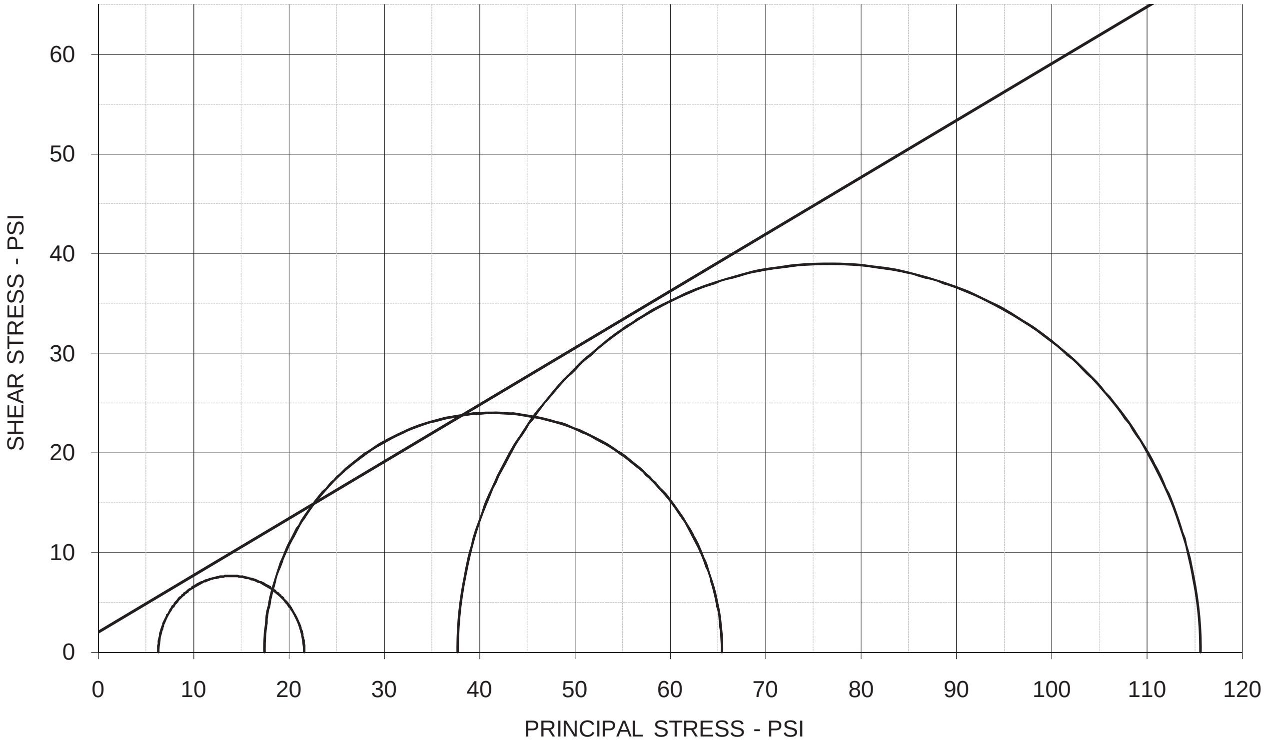
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

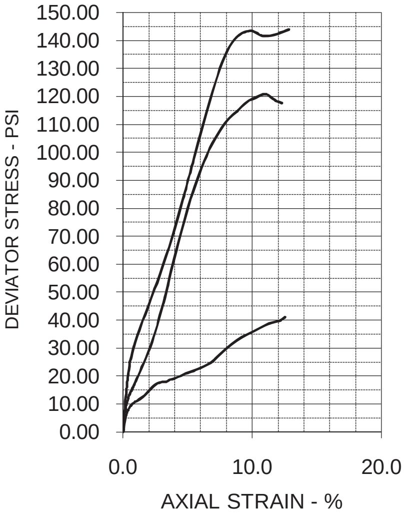
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ ' = 29.7 deg	c' = 2.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	18.7	19.2	18.5	
Dry Density - pcf	108.5	105.5	104.8	
Diameter - inches	2.04	2.04	2.02	
Height - inches	4.25	4.18	4.37	
AT TEST				
Final Moisture - %	21.3	21.7	20.7	
Dry Density - pcf	108.9	106.7	106.7	
Calculated Diameter (in.)	2.03	2.02	2.00	
Height - inches	4.21	4.13	4.31	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.27	47.96	77.89	
Total Pore Pressure - psi	63.7	52.6	52.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.1	3.2	4.3	
σ_1' Failure - psi	21.58	65.38	115.61	
σ_3' Failure - psi	6.31	17.42	37.72	

TEST DESCRIPTION

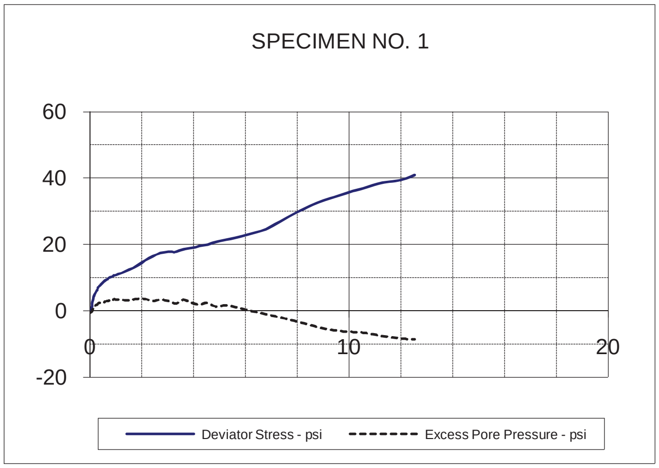
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Dark Gray Clayey Sand
Sampled on Site, W-1 38' to 41' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 1%
LL: 29 PL: 19 PI: 10 Percent -200: 25%
REMARKS: Diameter and Both Ends Trimmed. + # 4 Sieve 0%

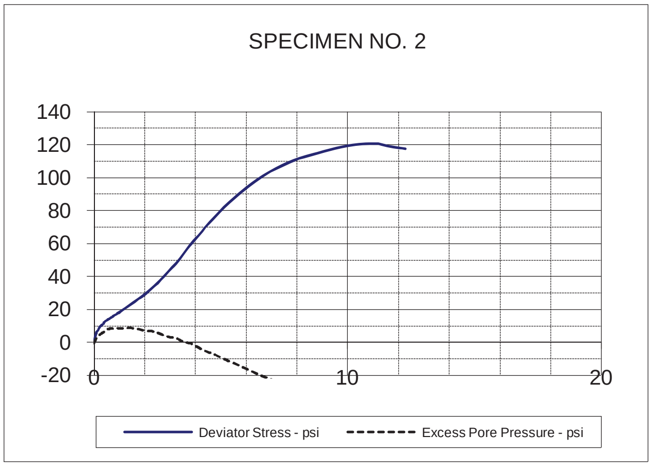
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

ETTL ENGINEERS & CONSULTANTS

PLATE: B.1


SPECIMEN NO. 1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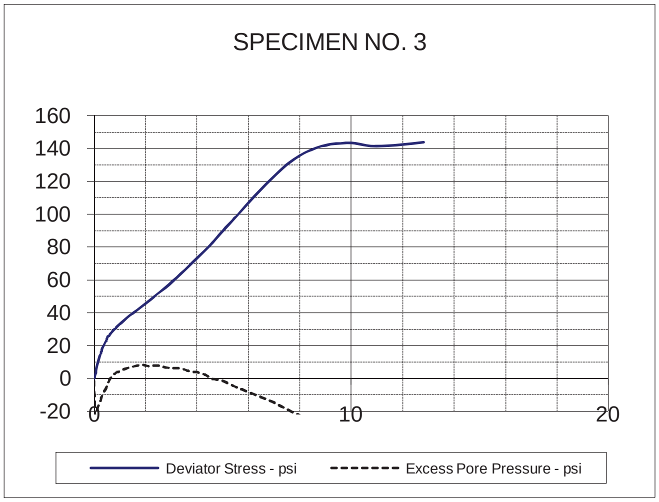
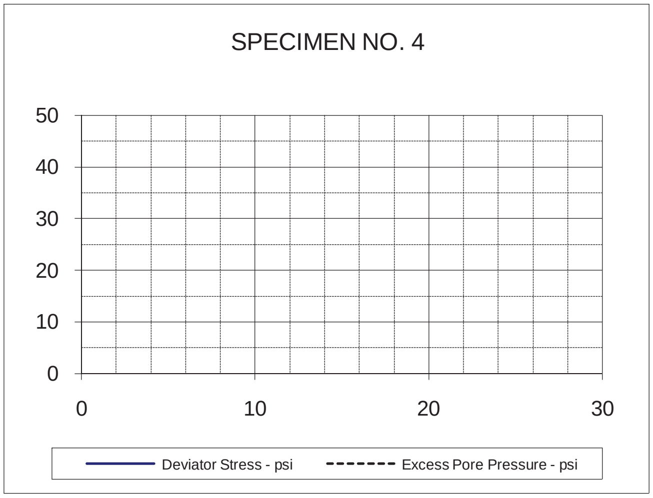
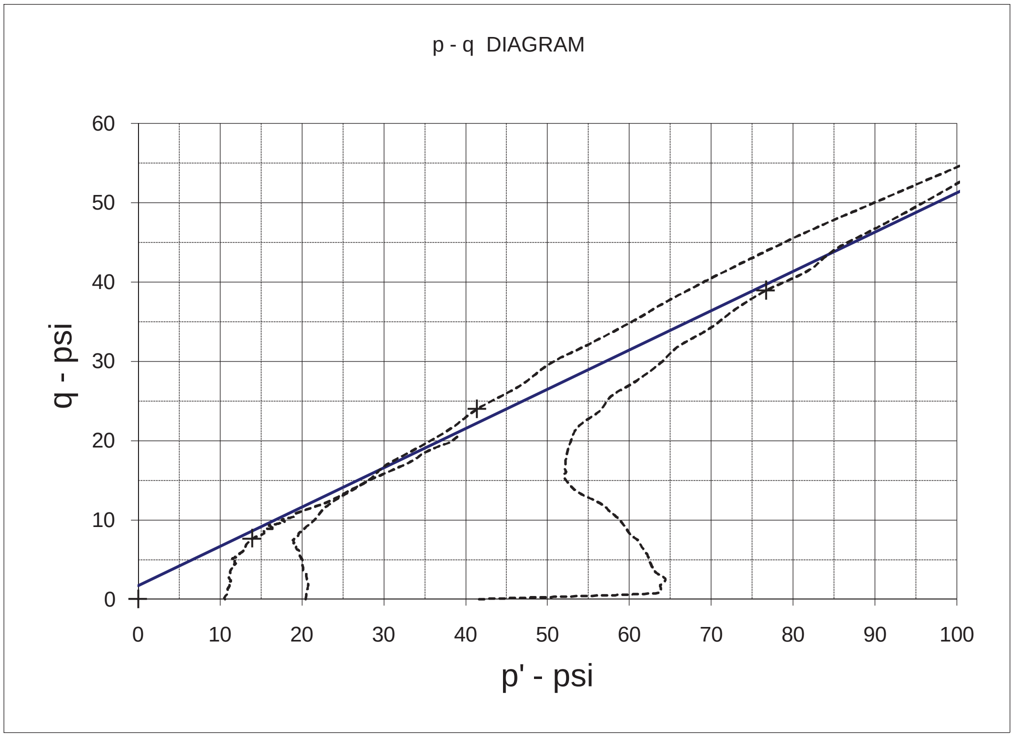
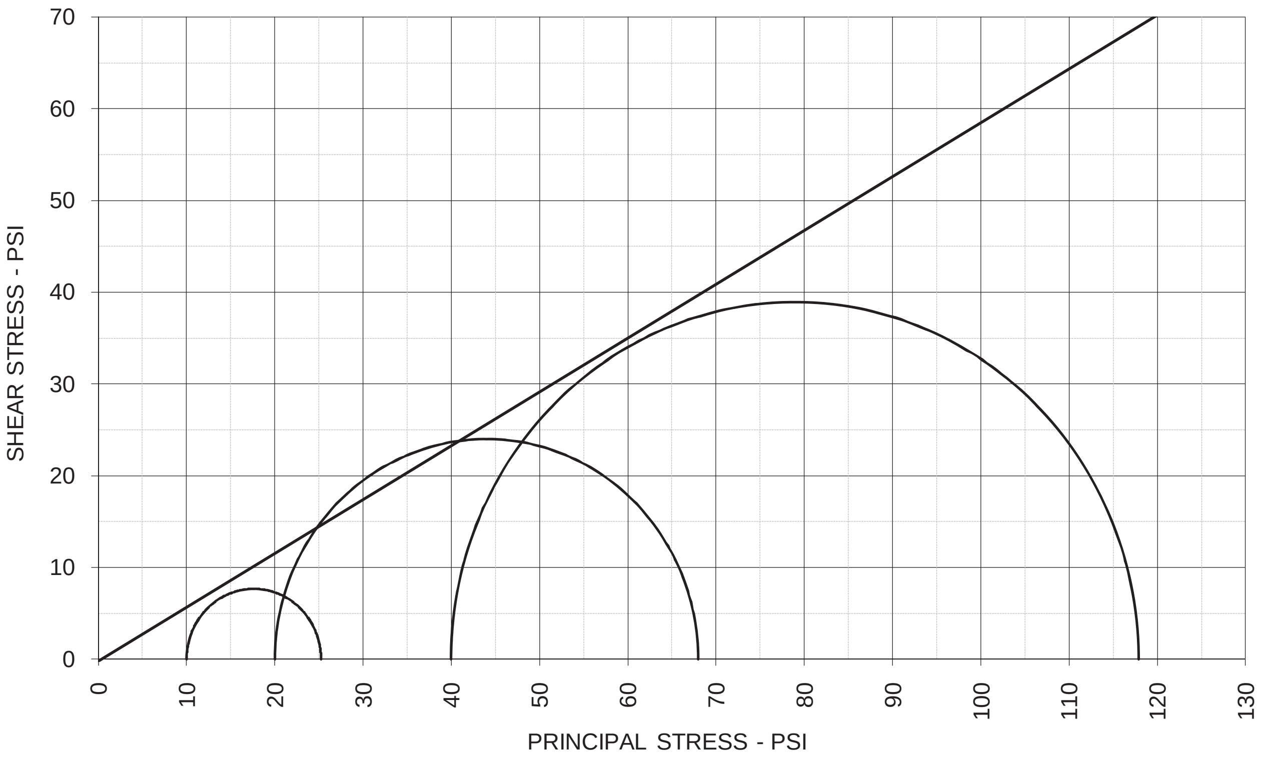

SPECIMEN NO. 3


SPECIMEN NO. 4

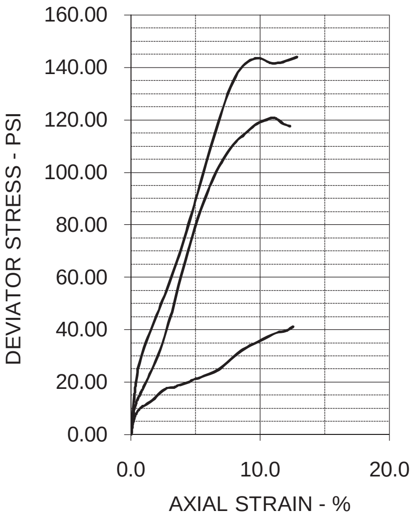

p - q DIAGRAM

EFFECTIVE STRESS PARAMETERS	R^2 = 0.99	α (deg) = 26.4	a (psi) = 1.7
PROJECT: Pirkey Power Plant Embankments		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3241 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Dark Gray Clayey Sand			

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	φ = 30.4 deg	c = -0.2 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	18.7	19.2	18.5	
Dry Density - pcf	108.5	105.5	104.8	
Diameter - inches	2.04	2.04	2.02	
Height - inches	4.25	4.18	4.37	
AT TEST				
Final Moisture - %	21.3	21.7	20.7	
Dry Density - pcf	108.9	106.7	106.7	
Calculated Diameter (in.)	2.03	2.02	2.00	
Height - inches	4.21	4.13	4.31	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.27	47.96	77.89	
Total Pore Pressure - psi	63.7	52.6	52.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.1	3.2	4.3	
σ_1 Failure - psi	25.27	67.96	117.89	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Dark Gray Clayey Sand
Sampled on Site, W-1 38' to 41' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 1%
LL: 29 PL: 19 PI: 10 Percent -200: 25%
REMARKS: Diameter and Both Ends Trimmed. + # 4 Sieve 0%

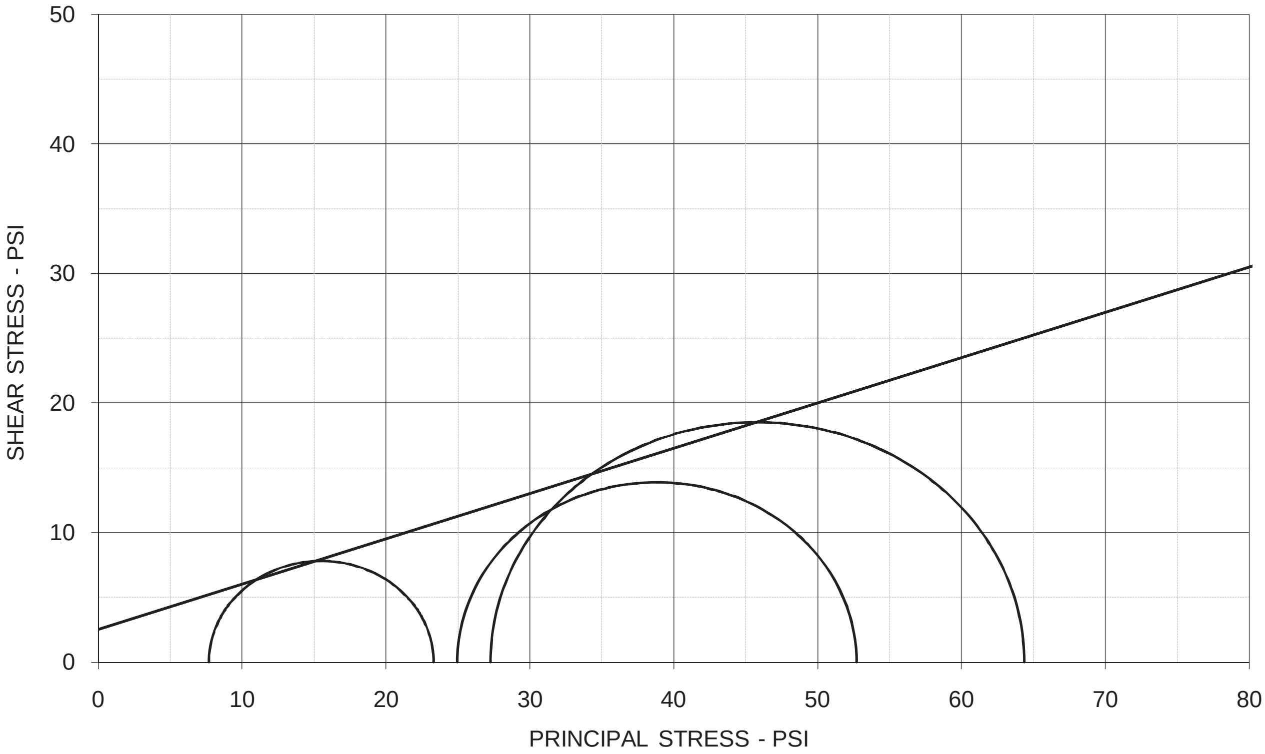
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

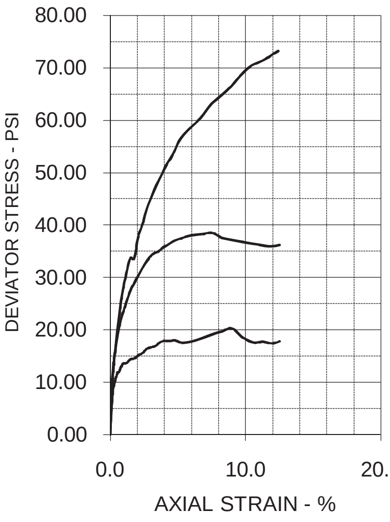
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ ' = 19.3 deg	c' = 2.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.4	21.5	23.6	
Dry Density - pcf	99.0	104.7	98.6	
Diameter - inches	1.99	2.01	2.00	
Height - inches	4.01	3.99	4.01	
AT TEST				
Final Moisture - %	27.8	20.6	27.1	
Dry Density - pcf	99.4	105.8	99.5	
Calculated Diameter (in.)	1.98	2.01	1.99	
Height - inches	3.99	3.97	3.98	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.62	27.77	37.08	
Total Pore Pressure - psi	52.3	45.0	62.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	1.0	4.8	
σ_1' Failure - psi	23.30	52.73	64.35	
σ_3' Failure - psi	7.68	24.96	27.27	

TEST DESCRIPTION

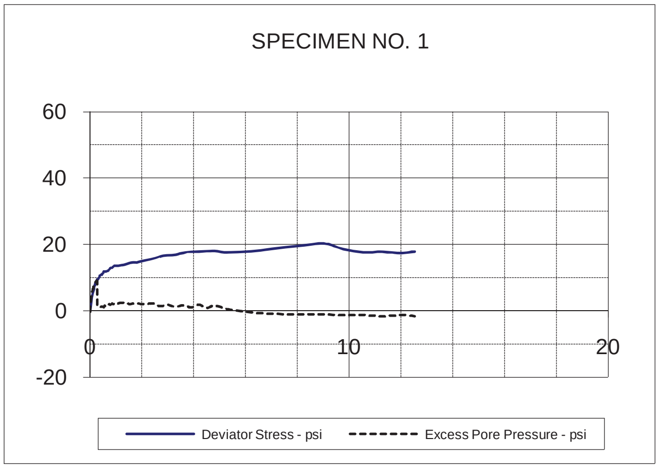
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-3 10' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 6%
LL: 68 PL: 22 PI: 46 Percent -200: 80%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

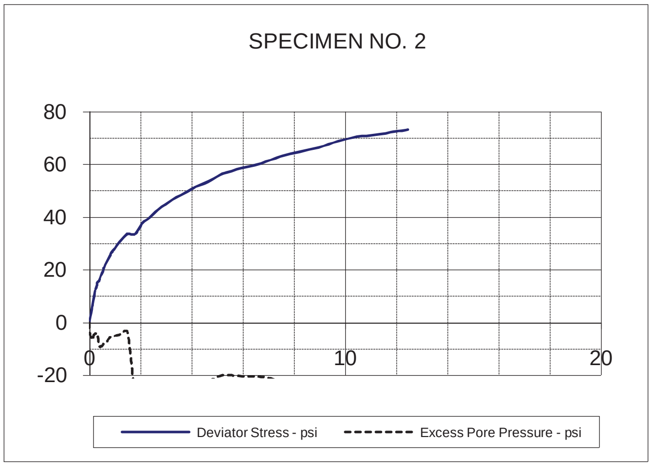
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

ETTL ENGINEERS & CONSULTANTS

PLATE: B.1


SPECIMEN NO. 1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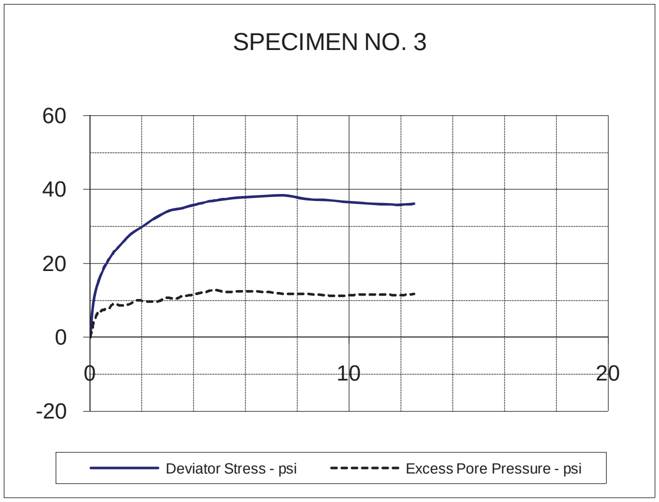
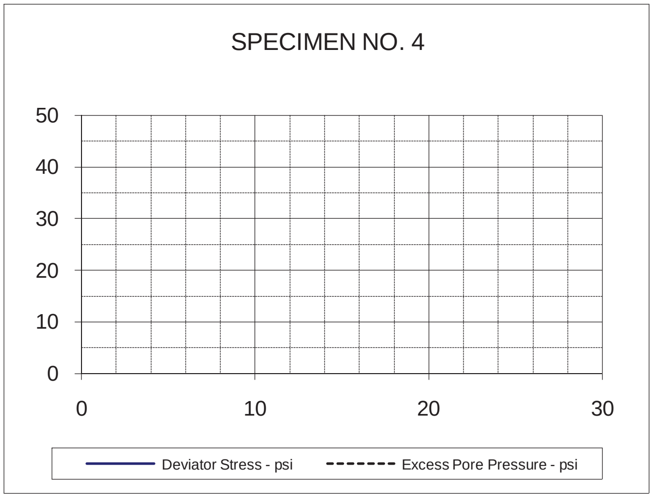
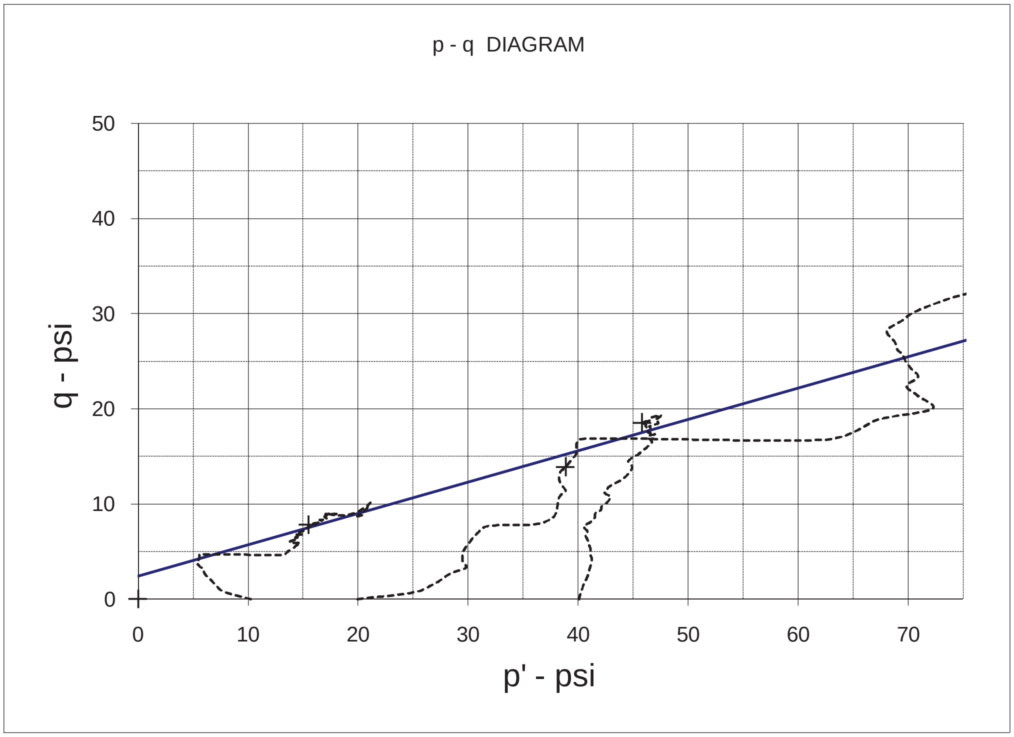

SPECIMEN NO. 3

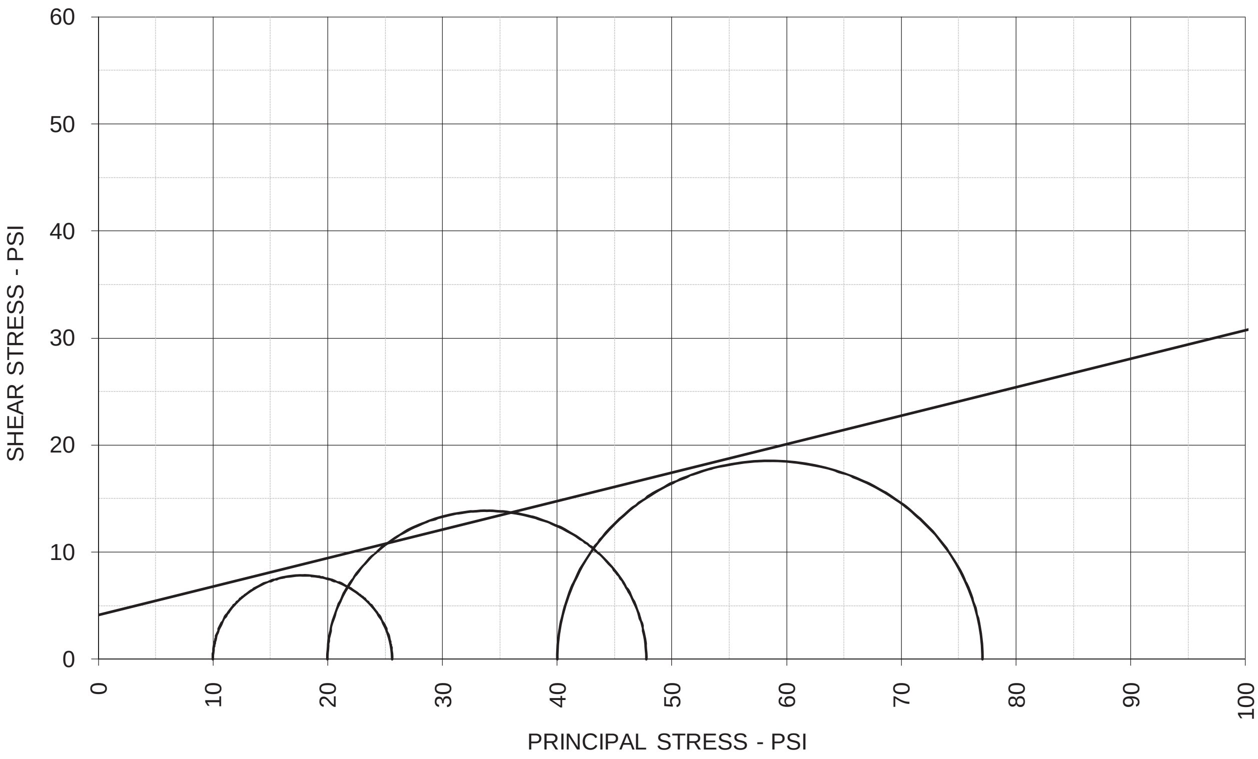

SPECIMEN NO. 4


p - q DIAGRAM

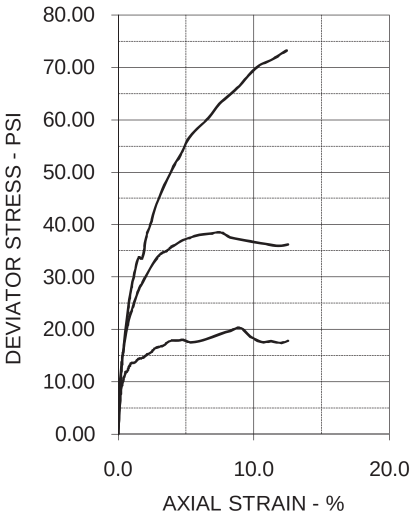
EFFECTIVE STRESS PARAMETERS	R^2 = 0.95	α (deg) = 18.3	a (psi) = 2.4
PROJECT: Pirkey Power Plant Embankments		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3241 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand			

G 3241-095, W-3 10'-20'.xls

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	ϕ = 14.9 deg	c = 4.1 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.4	21.5	23.6	
Dry Density - pcf	99.0	104.7	98.6	
Diameter - inches	1.99	2.01	2.00	
Height - inches	4.01	3.99	4.01	
AT TEST				
Final Moisture - %	27.8	20.6	27.1	
Dry Density - pcf	99.4	105.8	99.5	
Calculated Diameter (in.)	1.98	2.01	1.99	
Height - inches	3.99	3.97	3.98	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.62	27.77	37.08	
Total Pore Pressure - psi	52.3	45.0	62.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	1.0	4.8	
σ_1 Failure - psi	25.62	47.77	77.08	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-3 10' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 6%
LL: 68 PL: 22 PI: 46 Percent -200: 80%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

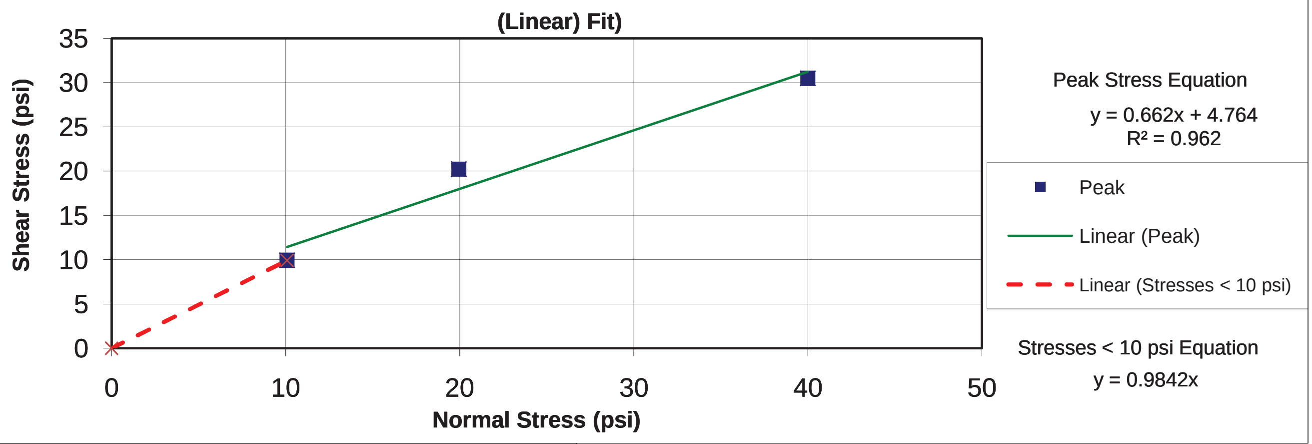
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

ETTL Engineers & Consultants Inc.

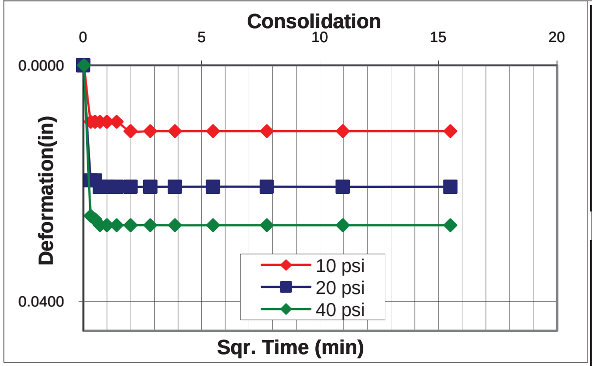
GEOTECHNICAL ✶ MATERIALS ✶ ENVIRONMENTAL ✶ DRILLING ✶ LANDFILLS

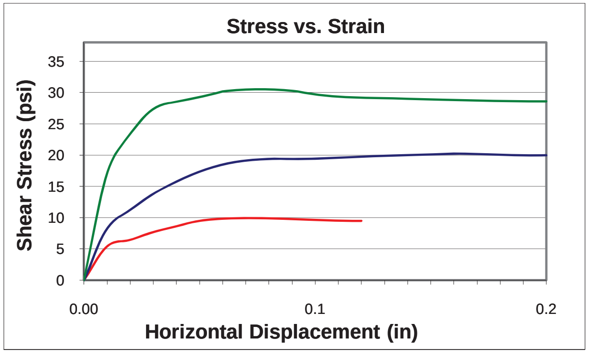
ASTM 3080 Direct Shear Test Report


(Linear) Fit)

Peak Stress Equation
$y = 0.662x + 4.764$
$R^2 = 0.962$

Stresses < 10 psi Equation
$y = 0.9842x$


Consolidation


Stress vs. Strain

Peak Strength Parameters

	Peak		Residual	
Friction Angle	33.5		-	
	(deg)		(deg)	
Cohesion	4.76	686.0	-	-
	(psi)	(psf)	(psi)	(psf)
Friction Angle Stresses < 10psi			44.5	(deg)

Specimen Number	1	2	3
Initial			
Moisture Content - %	18.5%	18.8%	21.4%
Dry Density- lb/ft^3	103.6	105.7	104.5
Height-inches	1.008	1.008	1.008
Diameter- inches	2.50	2.50	2.50
Final			
Moisture Content - %	24.4%	22.1%	24.1%
Dry Density- lb/ft^3	105.6	172.8	108.2
Height after shear-(inches)	0.997	0.620	0.978
Height after consolidation (inches)	0.997	0.987	0.981
Normal Stress-(psi)	10	20	40
Peak Failure Stress-(psi)	9.92	20.23	30.49
Residual Failure Stress-(psi)	-	-	-
Strain Rate - (inches/min)	0.0029	0.0027	0.0029

Project Information

		LL	PL	PI
Project :	Pirkey Power Plant Embankments	32	17	15
Client:	AEP			
Material Origin:	Hallsville, Tx			
Material Description:	Tan & Brown Clayey Sand with ferric seams	-200%	31	

				Remarks
Job No:	G 3241-095	**Technician:**	Owen Sanderson	When Calculating stresses < 10 psi: use appropriate Equation above (assuming no Cohesion)
Boring No:	W-2	**Sample Type:**	Shelby Tube	
Depth:	13'-16'	**Sampling method:**	Shelby Tube	
Date:	October 31, 2009	**Testing Device:**	Soiltest B-124BY 2.5 in. round	

C. Brandon Quinn, P.E.

C. Brandon Quinn

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

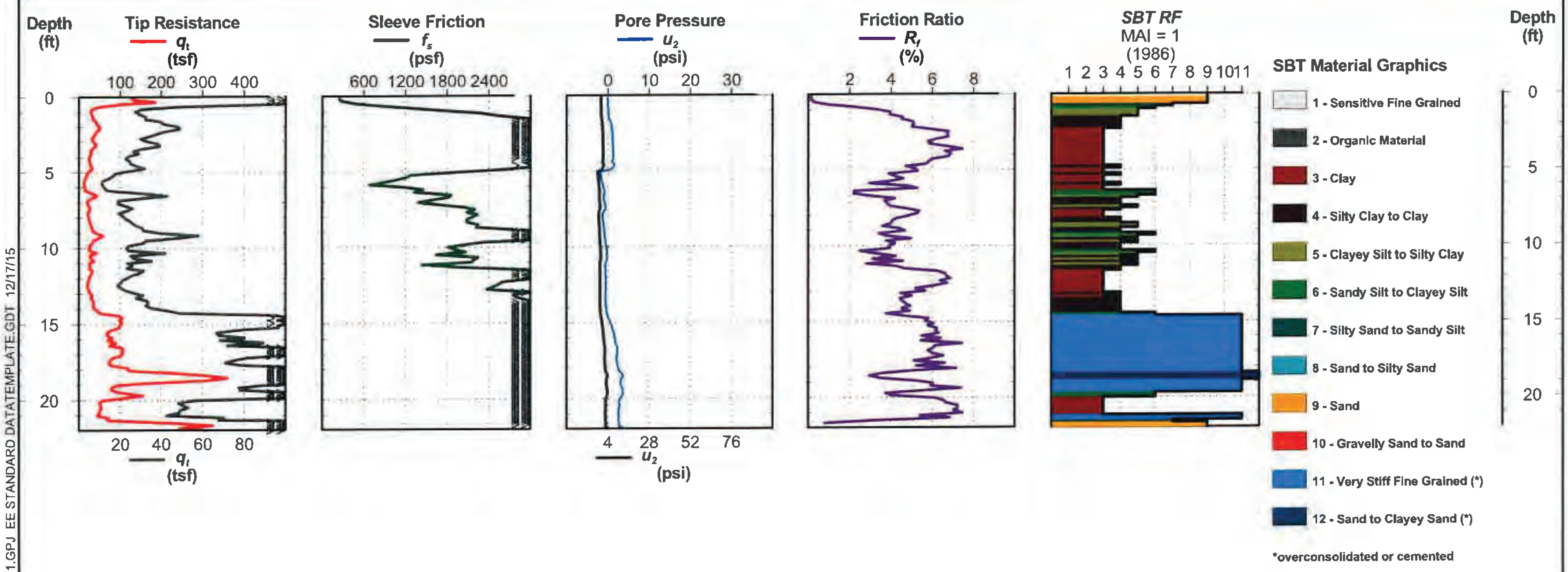
Cone Penetration Test

CPT-1

Latitude: 32.46619
Longitude: -94.48989

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 22.0 ft



SBT Material Graphics

- ⬜ 1 - Sensitive Fine Grained
- ⬛ 2 - Organic Material
- 🟥 3 - Clay
- ⬛ 4 - Silty Clay to Clay
- 🟩 5 - Clayey Silt to Silty Clay
- 🟩 6 - Sandy Silt to Clayey Silt
- 🟩 7 - Silty Sand to Sandy Silt
- 🟦 8 - Sand to Silty Sand
- 🟧 9 - Sand
- 🟥 10 - Gravelly Sand to Sand
- 🟦 11 - Very Stiff Fine Grained (*)
- 🟦 12 - Sand to Clayey Sand (*)

*overconsolidated or cemented

Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Electronic Filename: L0441CPT-1.cpt

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

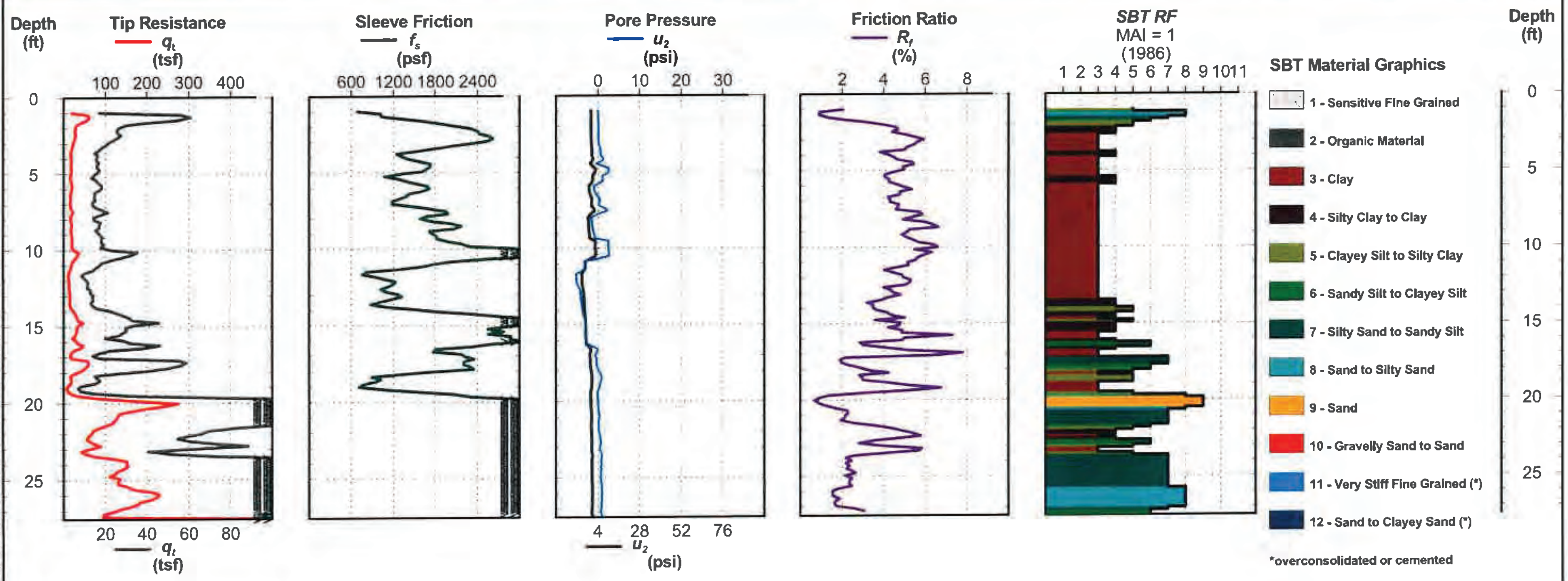
Cone Penetration Test

CPT-2

Latitude: 32.46613
Longitude: -94.49157

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 27.6 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

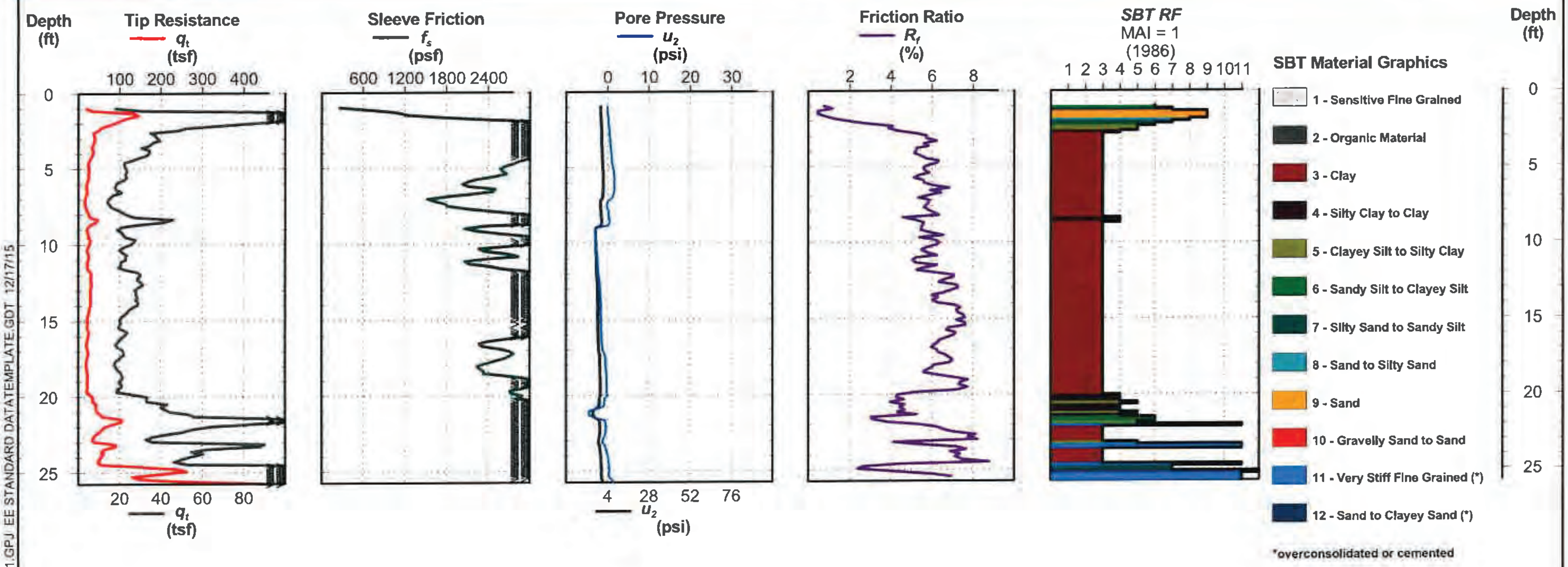
Cone Penetration Test

CPT-3

Latitude: 32.46587
Longitude: -94.49313

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 25.8 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

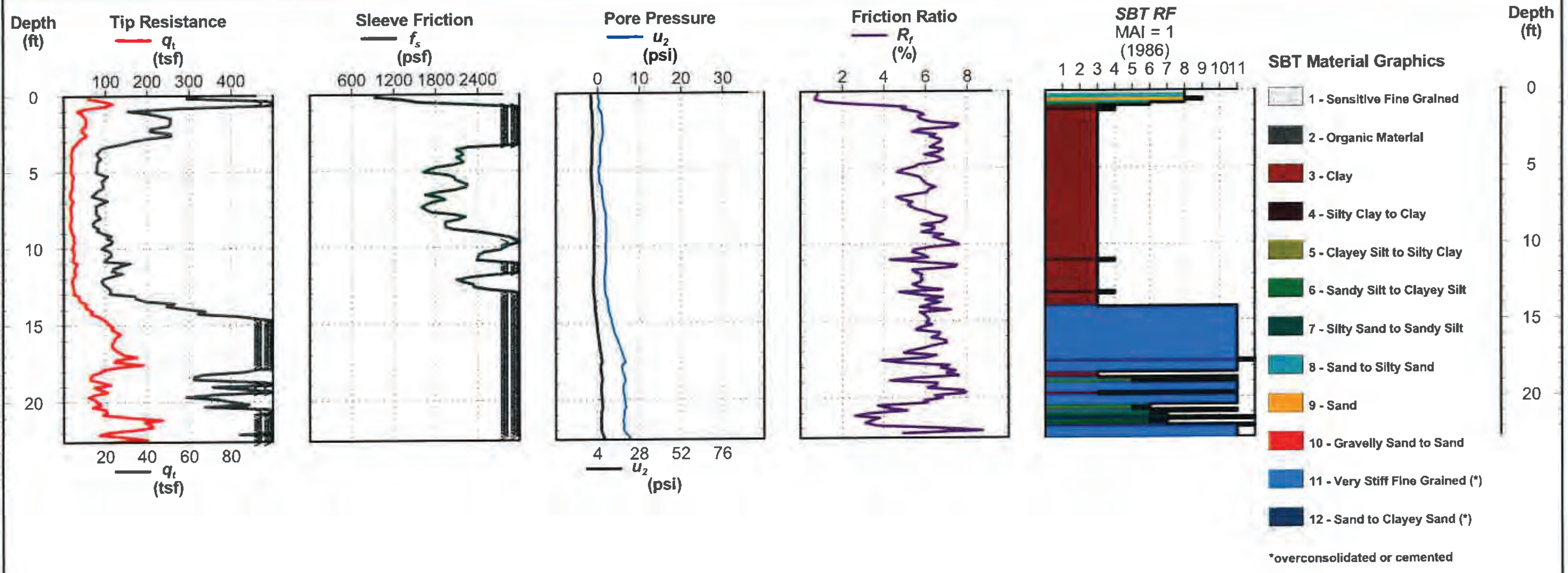
Cone Penetration Test

CPT-4

Latitude: 32.46672
Longitude: -94.49400

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 22.6 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

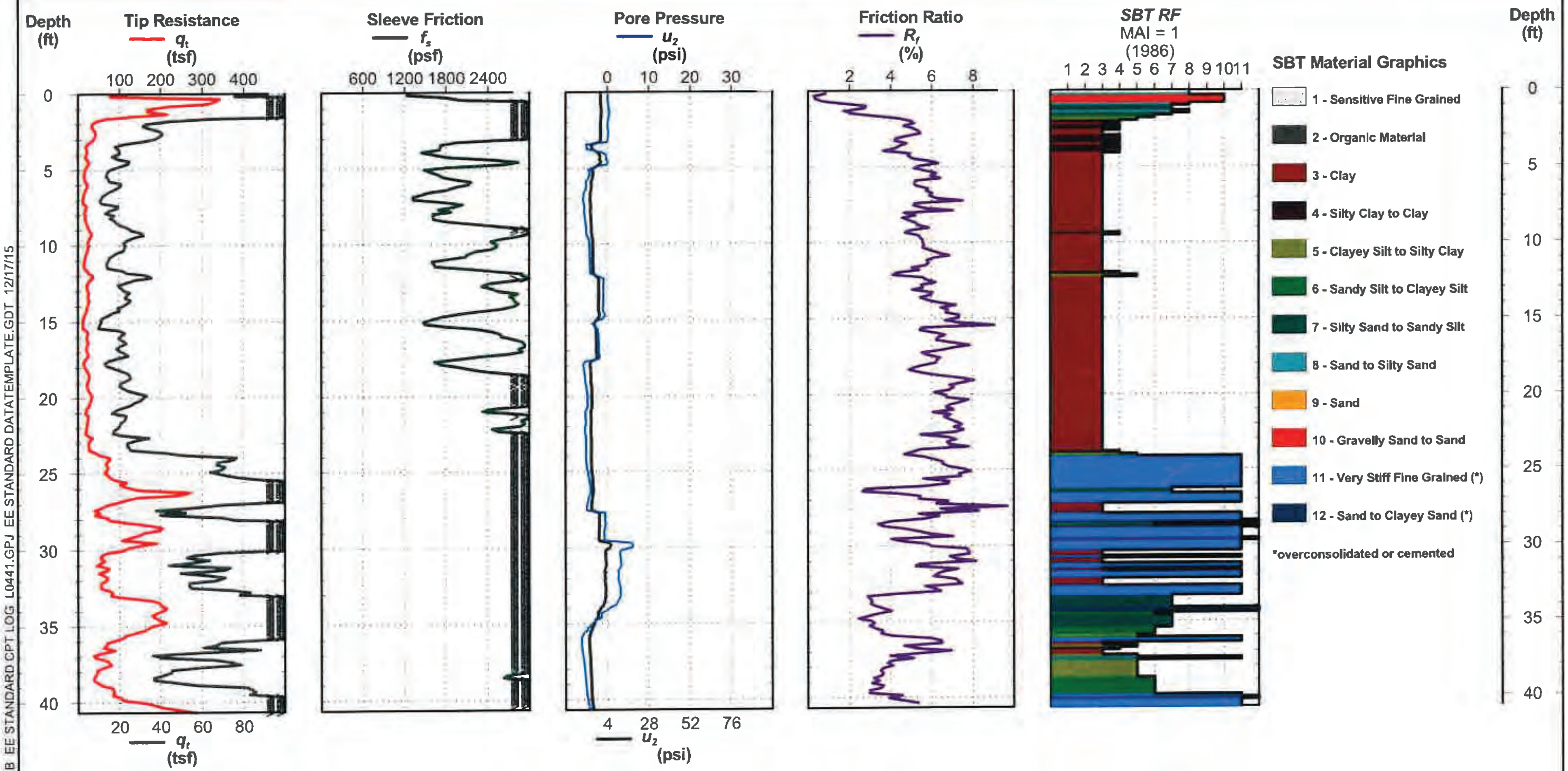
Cone Penetration Test

CPT-5

Latitude: 32.46803
Longitude: -94.49390

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 40.7 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Electronic Filename: L0441CPT-5 cpt

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

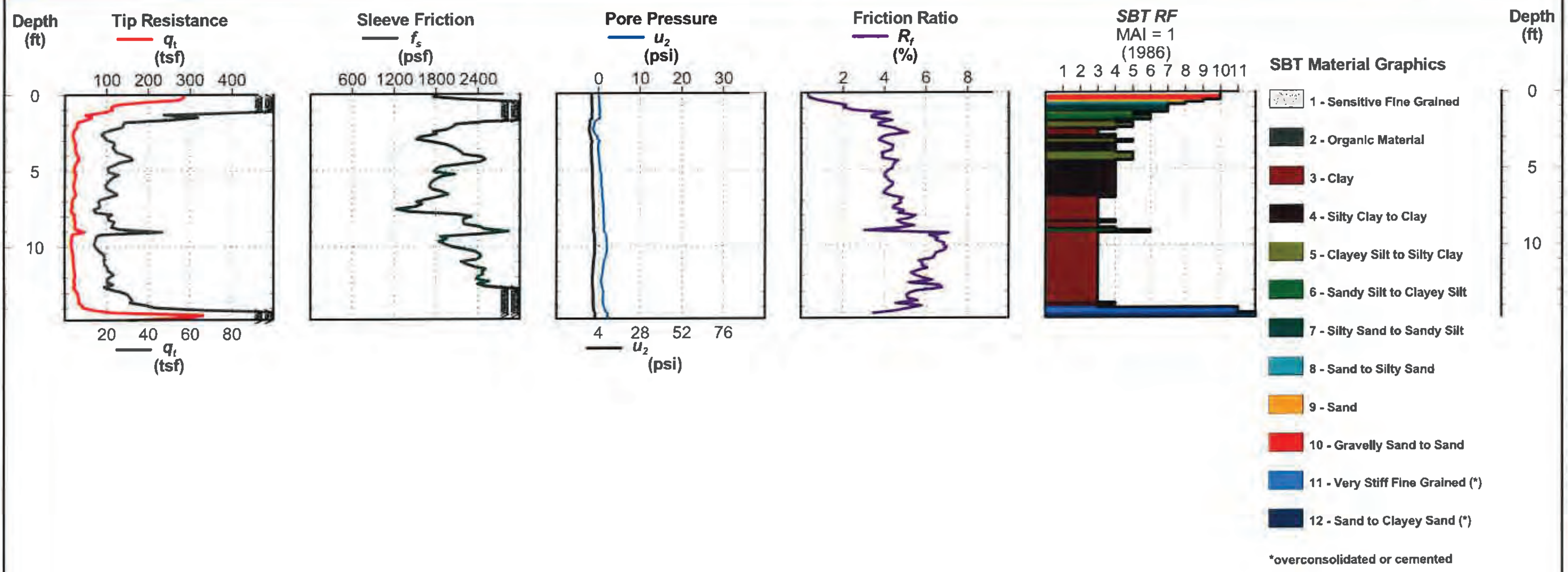
Cone Penetration Test

CPT-6

Latitude: 32.46887
Longitude: -94.49243

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 14.8 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

Cone Penetration Test

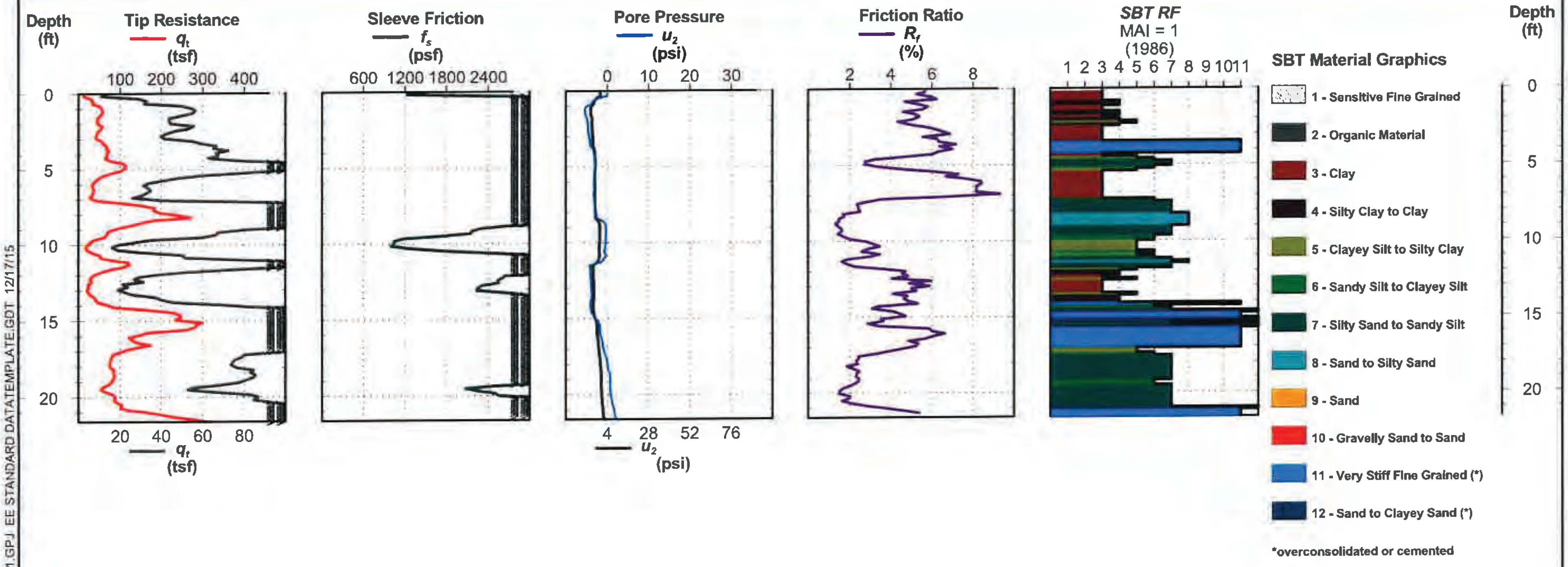
CPT-7

Latitude: 32.46572
Longitude: -94.49256

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 21.7 ft

CPT ID/Net Area Ratio: DSG0709 / 0.8



EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

Electronic Filename: L0441CPT-7.cpt

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

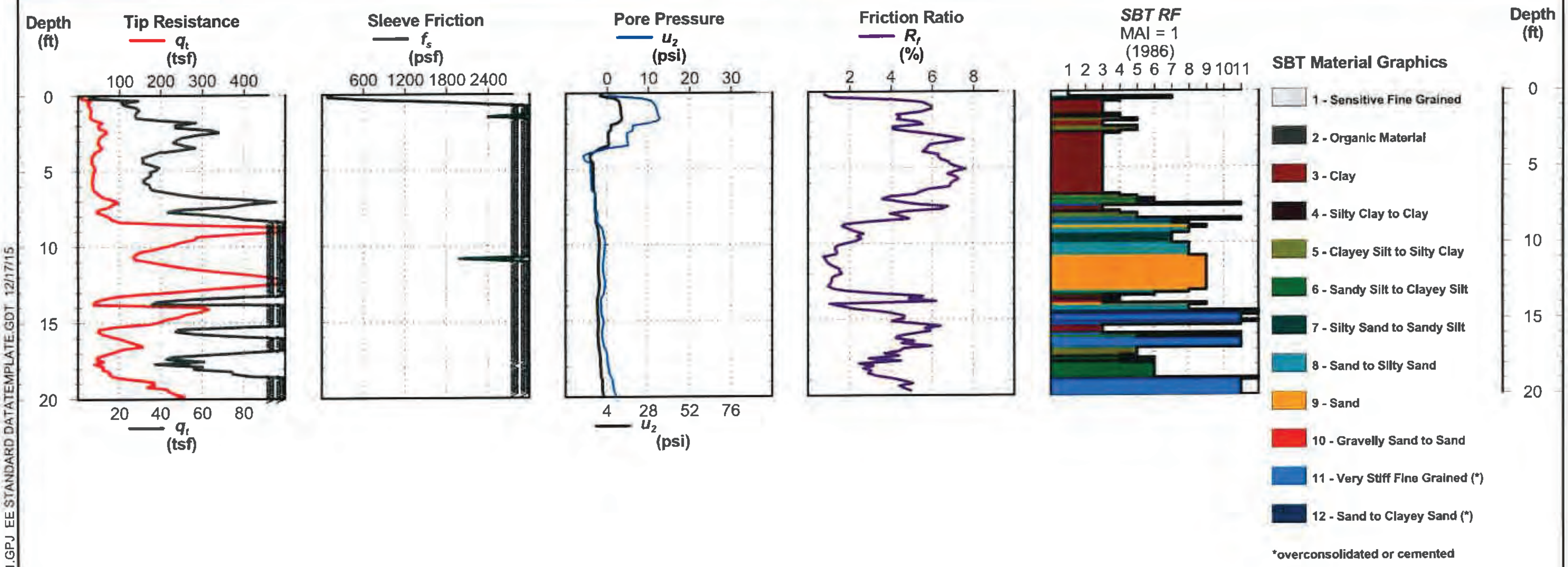
Cone Penetration Test

CPT-8

Latitude: 32.46603
Longitude: -94.49087

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 20.0 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Electronic Filename: L0441CPT-8y.cpt

ATTACHMENT 3

Operating Criteria for CCR Landfills and Surface Impoundments

30 TAC §352.271 – Operating Criteria Application Submission
Submit documentation demonstrating compliance with Subchapter G: Operating Criteria

30 TAC §352.801/40 CFR §257.80 – Air Criteria

- Submit Current Certified CCR Fugitive Dust Control Plan and Annual CCR Fugitive Dust Control Report

30 TAC §352.811/40 CFR §257.81 – Run-on and run-off controls for CCR landfills.

- Submit LF – Run-on and run-off control system plan
- Submit FGDSA – Run-on and run-off control system plan

30 TAC §352.821/40 CFR §257.82 – Hydrologic and hydraulic capacity requirements of CCR Surface impoundments.

- Submit EBAP - Inflow Design Flood Control System Plan
- Submit WBAP – Inflow Design Flood Control System Plan

30 TAC §352.831/40 CFR §257.83 – Inspection Requirements for CCR Surface Impoundments.

- Submit EBAP – Annual Inspection Report
- Submit WBAP – Annual Inspection Report

30 TAC §352.841/40 CFR §257.84 – Inspection Requirements for CCR Landfills.

- Submit LF – Annual Inspection Report
- Submit FGDSA – Annual Inspection Report

NA - 30 TAC §352.851 – Pre-Opening Inspection

3.1 – Fugitive Dust Control Plan for East Bottom Ash Pond, West Bottom Ash Pond, FGD Stackout Area, and Landfill, November 2021

SOUTHWESTERN ELECTRIC POWER COMPANY

H.W. PIRKEY POWER PLANT

FUGITIVE DUST CONTROL PLAN

for
East Bottom Ash Pond
West Bottom Ash Pond
FGD Stackout Area
Landfill

Prepared By:

Southwestern Electric Power Company
H.W. Pirkey Power Plant
2400 FM 3251
Hallsville, TX 75650

and

American Electric Power Service Corporation
Environmental Services
Environmental Services - Floor 17
1 Riverside Plaza Columbus OH 43215

Revision 0 – October 2015
Revision 2 – November 2021

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Appendices

Professional Engineer's Certification

By means of this certification, I certify that I have reviewed this CCR Fugitive Dust Control Plan and it meets the requirements of section 40 CFR 257.80(b).

DAVID ANTHONY MILLER

Printed Name of Registered Professional Engineer

DAVID ANTHONY MILLER
112498

David Anthony Miller

Signature

112498
Registration No.

TEXAS
Registration State

11.18.21
Date

1.0 INTRODUCTION

This CCR Fugitive Dust Control Plan (Plan) has been prepared pursuant to the air criteria of 40 CFR part 257.80 (see Appendix A). The Plan has been prepared in accordance with the air criteria and following good engineering practices to include measures that will effectively minimize CCR from becoming airborne at the facility. The Plan and subsequent amendments will be placed in the operating record and retained in the office of the Pirkey Plant Environmental Coordinator (PEC). The Plan and subsequent amendments will also be placed on Pirkey Plant's publicly accessible internet website titled "CCR Rule Compliance Data and Information." The plan will be amended whenever there is a change in conditions that would substantially affect the written plan in effect, such as the construction and operation of a new CCR unit. Where appropriate, the Plan incorporates fugitive dust control requirements as contained in the TCEQ air permits issued for the plant.

There are two CCR surface impoundments, one CCR pile and one CCR landfill located at Pirkey Plant that are subject to the Plan. The surface impoundments are the east and west bottom ash ponds; the CCR pile, called the FGD Stackout Area, is the area where the scrubber sludge and flyash is stacked out before it is trucked to the onsite landfill; and the Residual Waste Landfill (Landfill) receives both scrubber sludge/flyash mixture and bottom ash which is periodically removed from the bottom ash ponds. The Plan addresses these CCR units and the associated unpaved roadways.

2.0 FACILITY DESCRIPTION AND CONTACT INFORMATION

2.1 Facility Information

Facility Information
Name of Facility: H.W. Pirkey Power Plant
Street: 2400 FM 3251
City, State, ZIP Code: Hallsville, TX 75650
County: Harrison
Latitude: 32º 27'43'' N Longitude: 94º 29' 07'' W

2.2 Contact Information

Facility Operator:
Name: Southwestern Electric Power Company
Attention: Joel Endsley - Plant Manager
Address: 2400 FM 3251
City, State, Zip Code: Hallsville, TX 75650

Facility Owner:
Name: Southwestern Electric Power Company
Northwest Texas Electric Cooperative, Inc.
Oklahoma Municipal Power Authority
Attention: William Hildeson – Environmental Guru
Address: Environmental Services – Floor 17
City, State, Zip Code: 1 Riverside Plaza Columbus OH 43215

Plan Contact:
Name: Samantha McDonald – Pirkey Plant Environmental Coordinator
Address: 2400 FM 3251
City, State, Zip Code: Hallsville, TX 75650
Telephone number: 903-927-5853
Email address: ssmcdonald@aep.com

2.3 Activities at the Facility

The Pirkey Power Plant is located in Northeast Texas. The H. W. Pirkey plant made history for AEP SWEPCO as the first plant built by the company to use lignite as its primary fuel source. Compared to other forms of coal, lignite contains a smaller amount of fixed carbon and has a lower heating value, but is plentiful and close to the surface where it is mined. Sabine Mining Company, a subsidiary of North American Coal Corporation, provides the lignite burned at Pirkey. Pirkey, a 675 MW plant, is co-owned by AEP SWEPCO, Northeast Texas Electric Cooperative and Oklahoma Municipal Power Authority. AEP-SWEPCO manages and operates the plant on behalf of its co-owners.

Pirkey is equipped with a flue gas desulfurization (FGD) system or scrubber that uses a limestone-water slurry to remove up to 95% of the SO_2 that results from lignite combustion. The FGD sludge from this process is combined with the flyash (that isn’t marketed to outside vendors) and transported by truck to the plant’s onsite Landfill.

Bottom ash is produced by the unit and is wet sluiced to the BAP during unit operations. The bottom ash is routinely reclaimed from the pond, loaded into trucks and transported to the Landfill for disposal.

The fly ash handling system is enclosed. Electrostatic Precipitators (ESP) remove more than 99% of all the flyash particles produced by coal combustion. In the precipitators, fly ash from burning coal passes through electrically-charged plates, which pull the ash particles out of the exhaust gas stream. The ash can be marketed for use in land reclamation, in concrete and lightweight aggregate and in the production of roofing and other products.

2.4 Site Maps

A Pirkey Pant property boundary aerial view map is included in Appendix B. Appendix C contains an aerial view that includes the bottom ash ponds, FGD Stackout area, and the Landfill.

3.0 FUGITIVE DUST CONTROL SELECTION

3.1 Paved and Unpaved Roadways

3.1.1 Overview

Trucks are used to transport CCR to the Landfill from the FGD Stackout Area and Bottom Ash Ponds.

3.1.2 Landfill and Plant Roadways

The primary appropriate and applicable fugitive dust control measures for roadways are watering and speed controls. Water trucks are used as needed based on routine evaluations and other observations to minimize or eliminate fugitive dust. Chemical suppressants or stabilizers may also be used on unpaved roadways depending on specific site conditions. Posted speed limits are 15 mph for paved and unpaved roads. Earth or other materials that may be deposited onto unpaved roadways from trucks will be promptly removed to minimize fugitive emissions. Implementation of control measures will not be necessary for roadways that are covered with snow and/or ice or if sufficient precipitation occurs to minimize or eliminate fugitive dust. Implementation of any control measures may be suspended if unsafe or hazardous driving conditions would be created by its use.

3.2 CCR Stackout Area and Landfill

3.2.1 Overview

The CCR Stackout Area is a CCR pile where FGD/Flyash Sludge is stacked out or placed into the CCR Stackout Area using a conveyor system. The CCR material is then loaded and trucked to the Landfill.

The Landfill receives FGD/Flyash Sludge and bottom ash from the Pirkey Plant. Both materials contain moisture (conditioned) but water is added at the landfill as necessary to minimize fugitive dust emissions.

The Landfill activities are subject to the plant's TCEQ Title V Operating Permit (O31). The permit also includes visible particulate emissions limits as well as monitoring, recordkeeping and reporting requirements. [**Note**: "conditioned" CCR means the material has sufficient moisture content to prevent wind dispersal but will not result in free liquids]

3.2.2 Loading, Unloading and Placement

The FGD/Flyash Sludge typically contains moisture, but there may be fugitive emissions from the pile at the FGD Stackout area or during truck loading activities. A review of potential control measures concluded that the applicable and appropriate options consist of wetting the sludge before loading and minimizing the drop height when the sludge is being placed in the trucks.

FGD/Flyash Sludge is unloaded from trucks in the active fill area of an open Landfill cell where a bulldozer or similar equipment will spread and compact the materials. A roller may also be used for compaction. Bottom ash is unloaded from trucks into a storage pile for use in construction or disposal within the Landfill. The fugitive dust control measures for truck unloading includes maintaining moisture in the material and taking precautionary measures (minimize drop height). The measures for spreading and compacting include maintaining vehicle speed and watering materials.

3.2.3 Wind Erosion

Wind erosion at the CCR Stackout Area is mitigated by maintaining the moisture content of the Sludge at a level which minimizes dusting. The radial stacker in the Stack out Area is equipped with a sprinkler system and utilized to minimize fugitive dust emissions.

Generally, landfill disposal areas can be classified as closed or open. Closed areas have received final cover and vegetation has been established. Open areas contain both the active fill area and areas that have been compacted but not yet received final cover. The open area fugitive dust control measures include: precautionary measures such as minimizing the amount of open area and pile height; compacting material as it is unloaded and watering. The bottom ash storage pile fugitive dust emissions are minimized by watering, and pile height control.

3.3 Bottom Ash Ponds

Pirkey Plant bottom ash is produced by the unit and is wet sluiced to the East or West BAP during unit operations. The bottom ash is routinely reclaimed from the ponds, loaded into trucks and transported to the Landfill for storage. While the bottom ash typically remains wet, depending on the amount of moisture remaining in the ash and seasonal conditions, there may be fugitive emissions from the pile or truck loading activities. A review of potential control measures concluded that the applicable and appropriate options consist of: watering and minimizing drop height. Water is applied to the pile to minimize fugitive emissions as needed.

4.0 PLAN ASSESSMENT

The Plan will be periodically assessed to verify its effectiveness, and if necessary, amended in accordance with Section 7.0 below. The Landfill, BAPs and associated unpaved roadways are routinely evaluated to determine if the control measures for each CCR unit as described above are being implemented as necessary to minimize or eliminate fugitive emissions. The PEC will include the control measure evaluations during the annual assessment of the Plan and determine if additional or modified measures are warranted. No evaluations are necessary if the surface is covered with snow and/or ice or if precipitation has occurred that is sufficient to minimize or eliminate fugitive emissions. Implementation of any control measure may be suspended if unsafe or hazardous driving conditions would be created by its use.

5.0 CITIZEN COMPLAINT LOG

5.1 Plant Contacts

Generally, complaints made to the plant are by telephone and received by the PEC (Plan Contact). In the case of holiday, weekends, or other times when the PEC may not be onsite, the plant guard houses or plant general phone number may receive complaint information by telephone that is provided to the PEC at the earliest convenience. Complaints may also be made to TCEQ who in turn will contact the PEC.

5.2 Follow-up

All complaints will be entered into a log by the PEC with details noted such as the nature of the complaint, date, time, and other relevant details. All complaints will be followed up which may include: checking plant operations at the time of the event, reviewing inspection records, discussing with other plant personnel, reviewing weather data, collecting samples and contacting the person making the complaint to obtain additional information.

5.3 Corrective Action and Documentation

Corrective actions will be taken as needed and documented. If it is determined that the Plan needs to be amended as a result of the corrective actions, it will be amended in accordance with the Plan. If necessary, the PEC will follow-up with the complainant and/or TCEQ to explain the findings of the complaint investigation, corrective actions or sampling results. Citizen complaints will be recorded in the Annual Report.

6.0 ANNUAL REPORT

The Annual CCR fugitive dust control report (Annual Report) will be prepared which includes the following components: description of actions taken to control CCR fugitive dust; a record of all citizen complaints; and a summary of any corrective measures taken. The initial Annual Report will be completed no later than 14 months after placing the initial CCR fugitive dust control plan in the facility's operating record. The deadline for completing subsequent reports is one year after the date of completing the previous report. The Annual Report will be deemed complete when the plan has been placed in the facility's operating record as described in Section 8.0.

7.0 PLAN AMENDMENTS

This Plan is a "living" document and will be amended, as necessary, whenever there is a change in condition that would substantially affect the written plan in effect. The Plan will be amended in the case of construction and operation of a new CCR unit. Amendments made to the Plan will be documented in Appendix D. The amended Plan will be placed into the facility's operating record as described in Section 8.0.

8.0 RECORDKEEPING, NOTIFICATION and INTERNET REQUIREMENTS

8.1 Recordkeeping

The Plan and files of all related information will be maintained in a written operating record at the facility for at least five years following the date of each occurrence, measurement, maintenance, corrective action, report, record or study. Files may be maintained on a computer or storage system accessible by a computer. One recordkeeping system may be used for the BAPs, Stackout Area, and Landfill if the system identifies each file by the name of each unit (i.e. BAPs, Stackout Area or Landfill). The Plan (and any subsequent amendment of the plan) and the Annual Report will be kept in the facility's operating record as they become available. Only the most recent Plan must be maintained in the record.
[§ 257.105]

8.2 Notification

TCEQ will be notified within 30 days of when the Plan (or any subsequent amended Plan) or the Annual Report is placed in the operating record and on the publicly available internet site. This notification will be made before the close of business on the day the notification is required to be completed. “Before the close of business day” means the notification must be postmarked or sent by e-mail. If the notification deadline falls on a weekend or federal holiday, the notification is automatically extended to the next business day. [§ 257.106]

8.3 Internet Site Requirements

The most recent Plan and Annual Report will be placed on the facility’s CCR website titled “CCR Rule Compliance Data and Information” within 30 days of placing them in the operating record. [§ 257.107]

Appendix A

40 CFR Part 257.80 Operating Criteria

§ 257.80 Air criteria.

(a) The owner or operator of a CCR landfill, CCR surface impoundment, or any lateral expansion of a CCR unit must adopt measures that will effectively minimize CCR from becoming airborne at the facility, including CCR fugitive dust originating from CCR units, roads, and other CCR management and material handling activities.

(b) CCR fugitive dust control plan.

The owner or operator of the CCR unit must prepare and operate in accordance with a CCR fugitive dust control plan as specified in paragraphs (b)(1) through (7) of this section. This requirement applies in addition to, not in place of, any applicable standards under the Occupational Safety and Health Act.

(1) The CCR fugitive dust control plan must identify and describe the CCR fugitive dust control measures the owner or operator will use to minimize CCR from becoming airborne at the facility. The owner or operator must select, and include in the CCR fugitive dust control plan, the CCR fugitive dust control measures that are most appropriate for site conditions, along with an explanation of how the measures selected are applicable and appropriate for site conditions. Examples of control measures that may be appropriate include: Locating CCR inside an enclosure or partial enclosure; operating a water spray or fogging system; reducing fall distances at material drop points; using wind barriers, compaction, or vegetative covers; establishing and enforcing reduced vehicle speed limits; paving and sweeping roads; covering trucks transporting CCR; reducing or halting operations during high wind events; or applying a daily cover.

(2) If the owner or operator operates a CCR landfill or any lateral expansion of a CCR landfill, the CCR fugitive dust control plan must include procedures to emplace CCR as conditioned CCR. Conditioned CCR means wetting CCR with water to a moisture content that will prevent wind dispersal, but will not result in free liquids. In lieu of water, CCR conditioning may be accomplished with an appropriate chemical dust suppression agent.

(3) The CCR fugitive dust control plan must include procedures to log citizen complaints received by the owner or operator involving CCR fugitive dust events at the facility.

(4) The CCR fugitive dust control plan must include a description of the procedures the owner or operator will follow to periodically assess the effectiveness of the control plan.

(5) The owner or operator of a CCR unit must prepare an initial CCR fugitive dust control plan for the facility no later than October 19, 2015, or by initial receipt of CCR in any CCR unit at the facility if the owner or operator becomes subject to this subpart after October 19, 2015. The owner or operator has completed the initial CCR fugitive dust control plan when the plan has been placed in the facility’s operating record as required by § 257.105(g)(1).

(6) Amendment of the plan. The owner or operator of a CCR unit subject to the requirements of this section may amend the written CCR fugitive dust control plan at any time provided the revised plan is placed in the facility's operating record as required by § 257.105(g)(1). The owner or operator must amend the written plan whenever there is a change in conditions that would substantially affect the written plan in effect, such as the construction and operation of a new CCR unit.

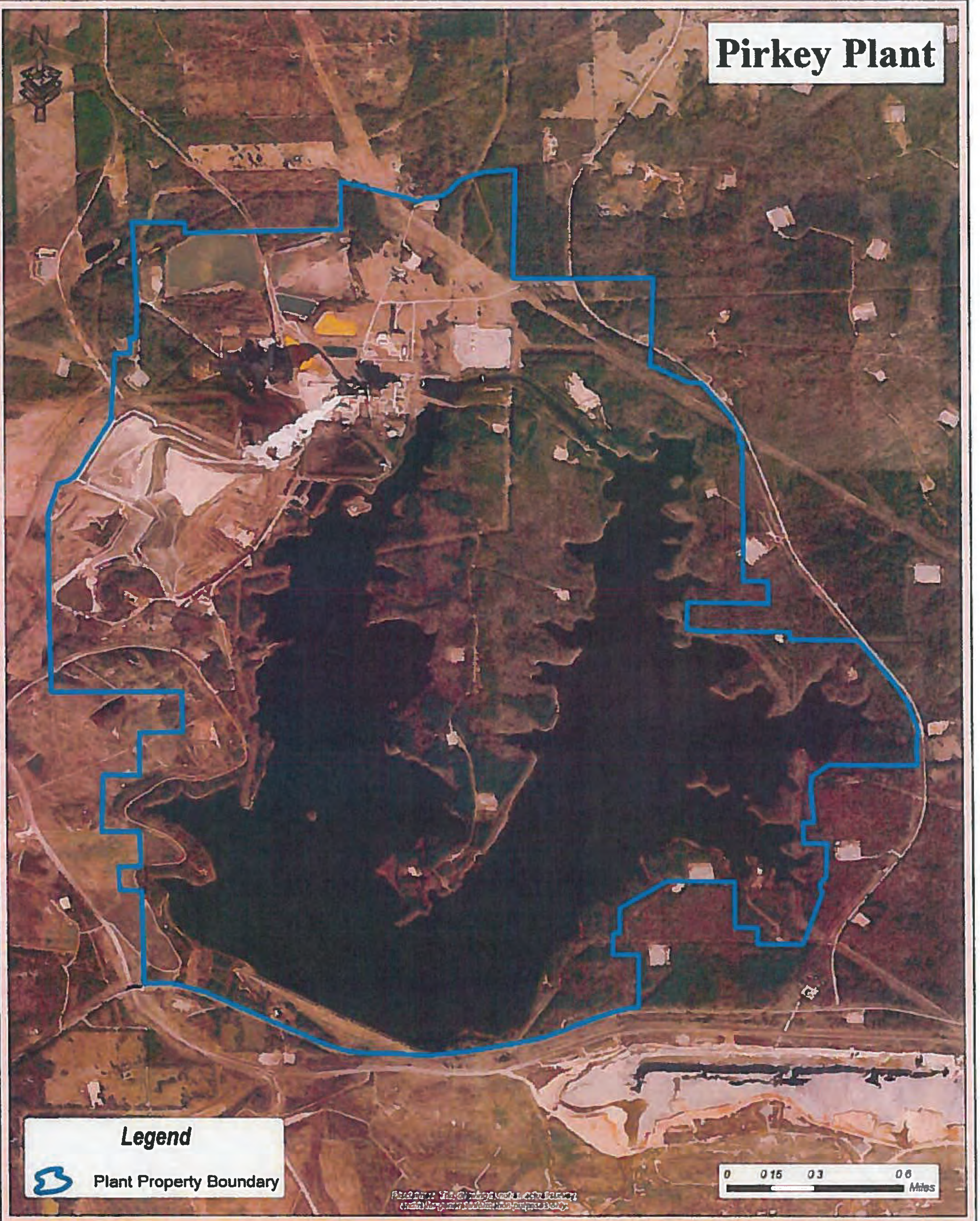
(7) The owner or operator must obtain a certification from a qualified professional engineer that the initial CCR fugitive dust control plan, or any subsequent amendment of it, meets the requirements of this section.

(c) Annual CCR fugitive dust control report. The owner or operator of a CCR unit must prepare an annual CCR fugitive dust control report that includes a description of the actions taken by the owner or operator to control CCR fugitive dust, a record of all citizen complaints, and a summary of any corrective measures taken. The initial annual report must be completed no later than 14 months after placing the initial CCR fugitive dust control plan in the facility's operating record. The deadline for completing a subsequent report is one year after the date of completing the previous report. For purposes of this paragraph (c), the owner or operator has completed the annual CCR fugitive dust control report when the plan has been placed in the facility's operating record as required by § 257.105(g)(2).

(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(g), the notification requirements specified in § 257.106(g), and the internet requirements specified in § 257.107(g).

Appendix B

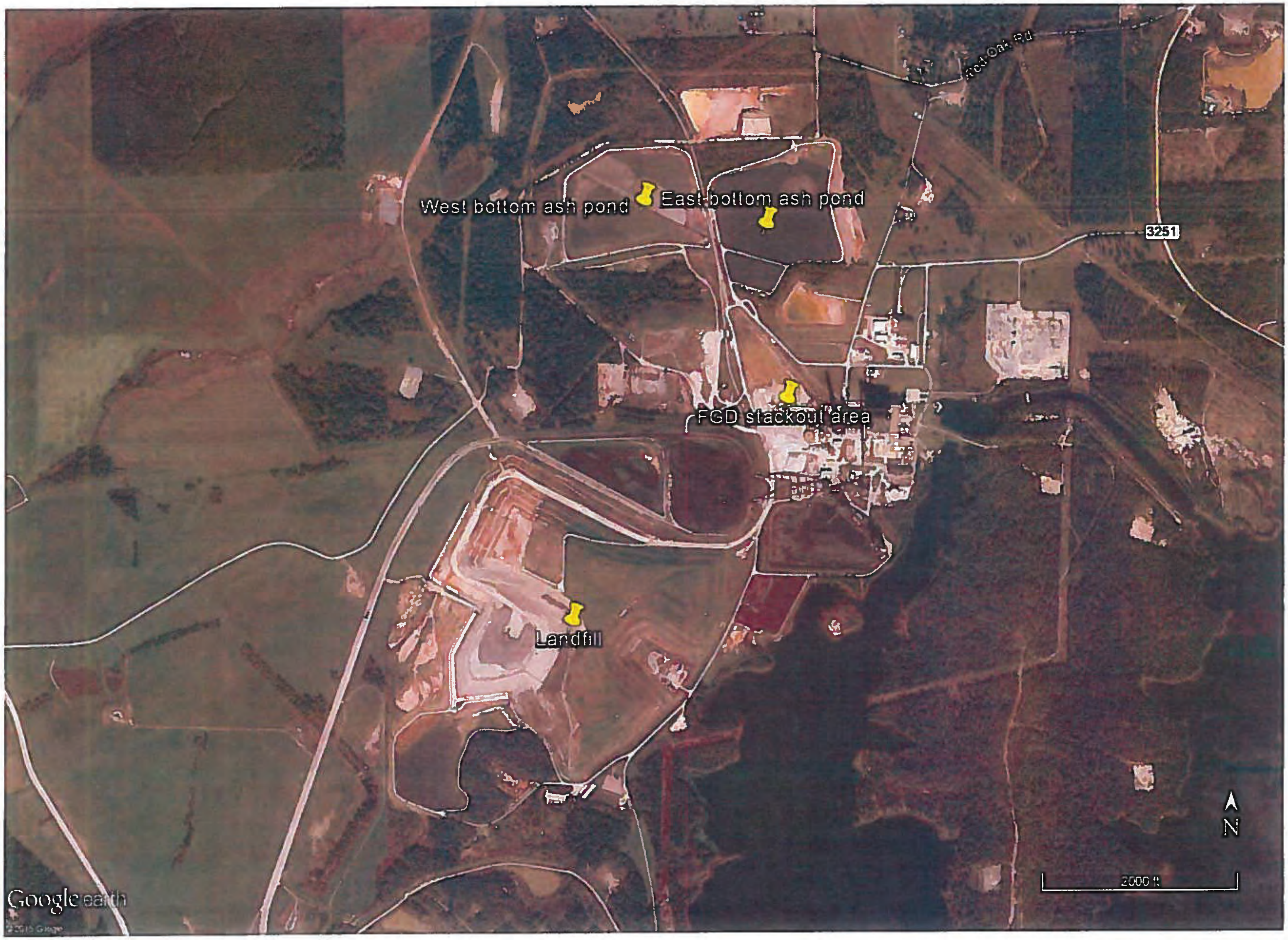
Pirkey Plant



March 8, 2010

Cartography: AEP Real Estate Asset Management Dept.

Appendix C



Pirkey Plant Aerial View

Appendix D

Record of Plan Revisions		
Revision Number	Date	Revision Description
0	10/14/2015	Initial Plan
1	10/16/2016	New Plant Manager
2	7/22/2020	New AQS Dallas Supervisor/address
3	11/04/2021	New AQS Facility Owner and Address

3.2 – Annual CCR Fugitive Dust Control Report, September 2021

SOUTHWESTERN ELECTRIC POWER COMPANY

H.W. PIRKEY POWER PLANT

SOUTHWESTERN
ELECTRIC POWER
COMPANY™
An AEP Company
BOUNDLESS ENERGY™

ANNUAL CCR FUGITIVE DUST CONTROL REPORT

Prepared By:

Southwestern Electric Power Company
H.W. Pirkey Power Plant
2400 FM 3251
Hallsville, TX 75650

and

American Electric Power Service Corporation
Environmental Services
1201 Elm Street, Suite 4100
Dallas, TX 75270

September 2021

Table of Contents

1.0 INTRODUCTION

This Annual CCR Fugitive Dust Control Report (Annual Report) has been prepared pursuant to the air criteria of 40 CFR Part 257.80. The Annual Report summarizes activities described in the CCR fugitive dust control plan (Plan) and includes the following components: description of actions taken to control CCR fugitive dust; a record of all citizen complaints; and a summary of any corrective measures taken.

The initial H.W. Pirkey Power Plant CCR fugitive dust control plan was placed into the operating record on October 14, 2015. This Annual Report addresses the period from September 20, 2020 to September 21, 2021. The Annual Report is deemed complete when it is placed in the facility's operating record as described in Section 6.0. The deadline for completing subsequent Annual Reports is one year after the date of completing the previous report.

The Annual Report will be placed in the operating record and retained in the office of the Pirkey Plant Environmental Coordinator (PEC). The Plan will also be placed on Pirkey Plant's publicly accessible internet website titled "CCR Rule Compliance Data and Information" as described in Section 6.0.

2.0 FACILITY DESCRIPTION AND CONTACT INFORMATION

2.1 Facility Information

General Information:

Name of Facility: Southwestern Electric Power Company – H.W. Pirkey Power Plant
Street: 2400 FM 3251
City, State, Zip Code: Hallsville, TX 75650
County: Harrison
Latitude: 32º 27'43'' N Longitude: 94º 29' 07'' W

2.2 Contact Information

Facility Operator:

Name: Southwestern Electric Power Company – H.W. Pirkey Power Plant
Attention: Joel Endsley - Plant Manager
Address: 2400 FM 3251
City, State, Zip Code: Hallsville, TX 75650

Facility Owner:
Name: Southwestern Electric Power Company.
Northwest Texas Electric Coop, Inc.
Oklahoma Municipal Power Authority
Attention: William Hildeson – Environmental Specialist
Address: 1201 Elm Street, Suite 4100
City, State, Zip Code: Dallas, TX 75270

Plan Contact:
Name: Samantha McDonald – Pirkey Plant Environmental Coordinator (PEC)
Address: 2400 FM 3251
City, State, Zip Code: Hallsville, TX 75650
Telephone number: 903-927-5853
Email address: ssmcdonald@aep.com

2.3 Facility Description

The Pirkey Power Plant is located in Northeast Texas. The H.W. Power Plant made history for AEP-SWEPCO as the first plant built by the company to use lignite as its primary fuel source. Compared to other forms of coal, lignite contains a smaller amount of fixed carbon and has a lower heating value, but is plentiful and close to the surface where it is mined. Sabine Mining Company, a subsidiary of North American Coal Corporation, provides the lignite burned at Pirkey. Pirkey, a 675 MW plant, is co-owned by AEP SWEPCO, Northeast Texas Electric Coop. and Oklahoma Municipal Power Authority. AEP-SWEPCO manages and operates the plant on behalf of its co-owners.

See the Plan for a further description of plant activities and fugitive dust controls.

3.0 FUGITIVE DUST CONTROLS

The following fugitive dust control measures were implemented during the period addressed by this Annual Report:

Plant Activity	Fugitive Dust Control Measures
Plant and Landfill Roadways	Roadways were watered as needed and speed control measures were implemented; material carried off plant property and deposited onto public highways by vehicular traffic or erosion by water was removed and disposed of properly.
CCR – Stackout Area	Emissions from this area are controlled by maintaining moisture in the material and watering as needed.
Landfill – unloading and placement of material	Unloading emissions were controlled by maintaining moisture in the material, taking precautionary measures (minimizing drop height) and watering as needed; spreading and compacting emissions were controlled by maintaining vehicle speed, maintaining moisture in the material, and watering as needed.
Landfill – wind erosion	Wind erosion control measures for open areas included: precautionary measures such as minimizing the amount of open area and pile height; compacting material as it was unloaded; maintaining moisture content of the materials, and watering as needed.
Bottom Ash Pond	Emissions were controlled by the inherent moisture of the material and timely loading of trucks; and watering as needed.

Note: *Implementation of control measures will not be necessary for roadways that are covered with snow and/or ice or if sufficient precipitation occurs to minimize or eliminate fugitive dust. Implementation of any control measures may be suspended if unsafe or hazardous driving conditions would be created by its use.*

4.0 CITIZEN COMPLAINT LOG

4.1 Plan Contacts

Generally, complaints made to the plant are by telephone and received by the PEC (Plan Contact). In the case of holiday, weekends, or other times when the PEC may not be onsite, the plant guard houses or plant general phone number may receive complaint information by telephone that is provided to the PEC at the earliest convenience. Complaints may also be made to TCEQ who in turn will contact the PEC. **No complaints were received by the Plant PEC during the period addressed by this Annual Report.**

4.2 Follow-up

All complaints will be entered into a log by the PEC with details noted such as the nature of the complaint, date, time, and other relevant details. All complaints will be followed up which may include: checking plant operations at the time of the event, reviewing inspection records, discussing with other plant personnel, reviewing weather data, collecting samples and contacting the person making the complaint to obtain additional information. **No complaint follow-up was necessary during the period addressed by this Annual Report.**

4.3 Corrective Action and Documentation

Corrective actions will be taken as needed and documented. If it is determined that the Plan needs to be amended as a result of the corrective actions, it will be amended in accordance with the Plan. If possible, the PEC will follow-up with the complainant and/or TCEQ to explain the findings of the complaint investigation, corrective actions or sampling results. Citizen complaints will be recorded in the annual Report. **No corrective actions due to complaints were necessary during the period addressed by this Annual Report.**

5.0 PLAN ASSESSMENT

The Plan will be periodically assessed to verify its effectiveness, and if necessary, amended. **The PEC reviewed the inspection records when preparing this Annual Report to assess the effectiveness of the Plan and determined that no additional or modified measures were warranted.**

6.0 RECORDKEEPING, NOTIFICATION and INTERNET REQUIREMENTS

6.1 Recordkeeping

The Annual Report and the Plan (and any subsequent amendment of the plan) will be kept in the facility's operating record as they become available. The Plan and files of all related information will be maintained in a written operating record at the facility for at least five years following the date of each occurrence, measurement, maintenance, corrective action, report, record or study. Only the most recent Plan must be maintained in the record. Files may be maintained on a computer or storage system accessible by a computer. One recordkeeping system may be used for multiple units if the system identifies each file by the name of each unit

6.2 Notification

The Director of the TCEQ will be notified within 30 days of when the Annual Report is placed in the operating record and on the publicly available internet site. This notification will be made before the close of business on the day the notification is required to be completed. "Before the close of business day" means the notification must be postmarked or sent by e-mail. If the notification deadline falls on a weekend or federal holiday, the notification is automatically extended to the next business day.

6.3 Internet Site Requirements

The most recent Annual Report will be placed on the facility's CCR website titled "CCR Rule Compliance Data and Information" within 30 days of placing it in the operating record.

3.3 – Run-on and Run-off Control System Plan, H.W. Pirkey Power Plant Landfill, October 2021

Run-on and Run-off Control System Plan

H.W. Pirkey Power Plant Landfill
Hallsville, Harrison County, Texas

October 6, 2021
Akron Project Number: 237P-2109

Prepared for:
American Electric Power
1 Riverside Plaza
Columbus, Ohio 43215

Prepared by:
Akron Consulting, LLC
431 N Center St.
Longview, Texas 75601
TBPE Firm # 14014

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1.0 INTRODUCTION

30 TAC 352.811 (Federal Regulation Title 40, Part 257.81) requires the owner or operator of an existing or new CCR landfill or any lateral expansion of an existing CCR landfill to comply with the following:

1. A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm.
2. A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.
3. Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under §257.3-3.
4. Prepare initial and periodic run-on and run-off control system plans for the CCR unit according to the following timeframes:
   a. For existing CCR landfills, the owner or operator of the CCR unit must prepare the initial run-on and run-off control system plan no later than October 17, 2016.
   b. The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans every five (5) years.
5. Obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section.
6. Comply with the recordkeeping requirements specified in §257.105(g), the notification requirements specified in §257.106(g), and the internet requirements specified in §257.107(g).

This Plan represents the 5-year revision of the original Run-on and Run-off Control System Plan, dated October 2016, and presents the regulatory-required materials as noted above. It is prepared for the existing landfill at AEP's H.W. Pirkey Power Plant in Hallsville, Texas. The landfill operation has installed and is maintaining the planned storm water control measures discussed in this plan. Attached Figure 1 – Overall Landfill Exhibit illustrates the landfill complex showing the storm water drainage systems as of October 2021.

2.0 RUN-ON CONTROLS

The purpose of run-on controls is to prevent the flow of water onto the active portion of the landfill during the peak discharge from a 24-hour, 25-year storm. The controls may be permanent or temporary, and their function may also change over time as landfill development proceeds. Controls must consider site conditions outside of the landfill footprint as well as site conditions within the landfill footprint.

2.1 Run-On Controls Outside the Landfill Footprint

2.1.1 Stormwater Perimeter Ditches

Perimeter drainage ditches around the active landfill provide controls to handle run-on from outside the active landfill footprint. The perimeter ditches define the limits of the active landfill ash disposal area/footprint. The perimeter ditches direct stormwater around the landfill pond to the south, and stormwater enters an unnamed tributary that flows 0.8 mile to Hatley Creek.

The perimeter ditches were designed to adequately handle the peak flow from a 24-hour, 25-year storm event. The design calculations are provided in Figure 3. Locations of the perimeter collection and diversion channels are also shown on Figure 1 – Overall Landfill Exhibit.

2.2 Run-On Controls Inside the Landfill Footprint

Run-on controls inside the landfill footprint are in place to ensure that stormwater from closed landfill cells does not enter the active landfill footprint.

2.2.1 Landfill Phasing and Construction Practices

The landfill at H.W. Pirkey Power Plant is broken into multiple cells, which are named based on the year they were constructed. Currently the active landfill cells are the 2012 Cell and 2015 Cell, and all other landfill cells have been capped and covered and are now closed. The closed landfill cells are graded to divert stormwater away from the active landfill cell, and into a storm sewer system with letdowns to capture water from the benches of the cell as well. See the figures in the appendix for the landfill configuration.

2.2.1.1 *Active Filling – 2012 and 2015 Cells*

Active filling currently occurs in the 2012 and 2015 Landfill Cells. Prior to the construction of the 2020 Cap & Cover Project, the access road along the west side of the cell served as a stormwater diversion berm. All capped and covered cells adjacent to the active area to the north and east are graded to divert water away from the active cell and ultimately into stormwater perimeter ditches that bypass the landfill pond. Run-on controls within the landfill footprint consist of underdrain systems. The underdrain system for the 2012 Cell discharges into the landfill pond, and the underdrain system for the 2015 Cell by-passes the pond. Run-off controls consist of a berm on the south and west sides of the active landfill cell. Also, a leachate collection system and a contact stormwater system serve to collect contact water from the cell and carry the water to the landfill pond.

2.2.1.2 *Future Filling – 2018 Cell*

Future filling will occur in Phase I of the 2018 Landfill Cell. The 2018 Cell is already constructed; however, active filling will only commence once the 2015 Cell is at capacity. Once the 2015 Cell is closed, it will slope away from the active landfill to a storm water letdown system that carries water to a perimeter ditch that bypasses the landfill pond. Run-on controls within the landfill footprint consist of an underdrain system that will discharge into a ditch that bypasses the landfill pond. Run-off controls consist of a perimeter HDPE lined ditch on the south and west sides of the landfill cell. Also, a leachate collection system will serve to collect leachate and contact stormwater from the cell and carry the contact water to the landfill pond.

2.2.2 Underdrain System

Underneath the active HDPE lined landfill cells, an underdrain system was installed to convey groundwater to perimeter ditches or the landfill pond. The underdrain systems consist of perforated HDPE pipes that are wrapped in SB57 rock, and then wrapped in filter fabric. The pipe systems are in a drainage layer that directs groundwater to the pipe systems, which are located under low areas or valleys in the liner, generally directly underneath the leachate pipe systems and perimeter stormwater ditches.

3.0 RUN-OFF CONTROLS

The run-off control system prevents flow (contact water) from leaving the active portion of the landfill during the peak discharge from a 24-hour, 25-year storm. Run-off control consists of the following aspects:

- Perimeter ditches
- Leachate collection system
- Landfill Pond
- Ash filling operation

Stormwater from the active landfill travels to the landfill pond via perimeter ditches, a contact stormwater pipeline, or through the leachate collection system via chimney drains. The leachate collection system is similar to the underdrain system, but differs in that it is located in a drainage layer above the HDPE liner of the cell, and conveys leachate from the active landfill cell to the landfill pond. Chimney drains in the 2015 Cell are utilized to capture stormwater from the top of the active landfill cell, and these chimney drains tie directly into the leachate system. Ash filling operation is managed such that contact water is directed to the chimney drains. The run-off control features are presented on the attached figures in the appendix. The following further describes the run-off control components.

3.1 Perimeter Ditches

Perimeter ditches are constructed around the active-phase and future filling areas. These ditches serve to convey stormwater from the active landfill to the landfill pond. All ditches were designed to adequately convey the water volume resulting from a 24-hour, 25-year storm event. The leachate collection system and ash filling operation use the ditches as part of their control systems as described below. The design calculations for the perimeter ditches are provided on Figure 3.

3.2 Leachate Collection System

The leachate collection system consists of 2-ft-thick minimum drainage layer over the landfill composite liner system and a network of perforated collection pipes. The composite liner system is sloped to promote drainage to the leachate collection pipe network, and the leachate collection pipe network discharges into the landfill pond. The leachate collection pipe network spacing is a function of the base grade liner slope, drainage layer permeability, and flow distance to collection pipes. The Hydraulic Evaluation of Landfill Performance (HELP) model was used in evaluating the pipe spacing with respect to contact water percolation to the leachate collection drainage layer, the minimum liner slope, and a selected pipe spacing or flow distance to a collection pipe.

Design of the chimney drains considered a 24-hour, 25-year storm event and a drainage area of approximately 10 acres for the active area. This resulted in a controlled discharge of storm water into the chimney drains and down to the leachate collection pipes.

3.3 Landfill Pond

All stormwater from the active landfill discharges into the landfill pond. The landfill pond was designed for the 24-hour, 25-year storm. However, the current landfill pond is serving as a total containment pond, meaning that stormwater that is collected in the pond is not treated and released downstream. Instead, water from the pond is pumped to the plant for evaporation. Also, an evaporator system is locally utilized in the pond. In case of emergencies, the pond does have an emergency spillway that can be utilized.

3.4 Ash Filling Operation

The ash filling operation must be performed in a manner to provide run-off control within the disposal cell such that the contact surface water reaches the leachate collection system. This involves grading the placed ash in a controlled manner to direct contact surface water flow toward the chimney drain structures in the interior portions of the disposal area. Ash grading must be directed away from the outside slopes, which have been capped.

4.0 PLAN REVIEW AND CHANGES IN FACILITY OPERATION

Landfill Owner and/or Operator will review and evaluate this Plan every five (5) years from initial plan preparation and when there are changes in the facility design, construction, operation, or maintenance that materially affect the facility's potential for run-on and run-off control. Amendments to the Plan made to address changes of this nature are referred to as technical or major amendments, and must be certified by a P.E. Non-technical amendments can be performed by the facility owner and/or operator. This Plan represents the 5-year revision of the original Run-on and Run-off Control System Plan, dated October 2016.

Technical and administrative amendments to the Plan have been and will continue to be documented on the Plan Review Log. Owner/Operator will make the necessary revisions to the Plan as soon as possible, but no later than six months after the change occurs. The Plan must be implemented as soon as possible following a technical amendment, but no later than six months from the date of the amendment. The Designated Person is responsible for initiating and coordinating revisions to the SPCC Plan.

Scheduled reviews and Plan amendments will be recorded in the Plan Review Log provided in Appendix 2. The log will be completed even if no amendment is made to the Plan as a result of the review.

5.0 PROFESSIONAL ENGINEER CERTIFICATION

This revised Plan, and all subsequent reviews and amended plans, must obtain certification from a qualified P.E. stating that the initial and subsequent run-on and run-off control system plans meet the requirements of 40 CFR 257. This certification in no way relieves the owner or operator of the facility of his/her duty to fully implement this Plan. The Professional Engineer Certification page is provided in Appendix C.

APPENDIX A:
Figures and Calculations

Figure 1: Overall Landfill Exhibit

Figure 2: Active and Future Landfill

Figure 3: Hydrology Exhibit

Associated Calculations

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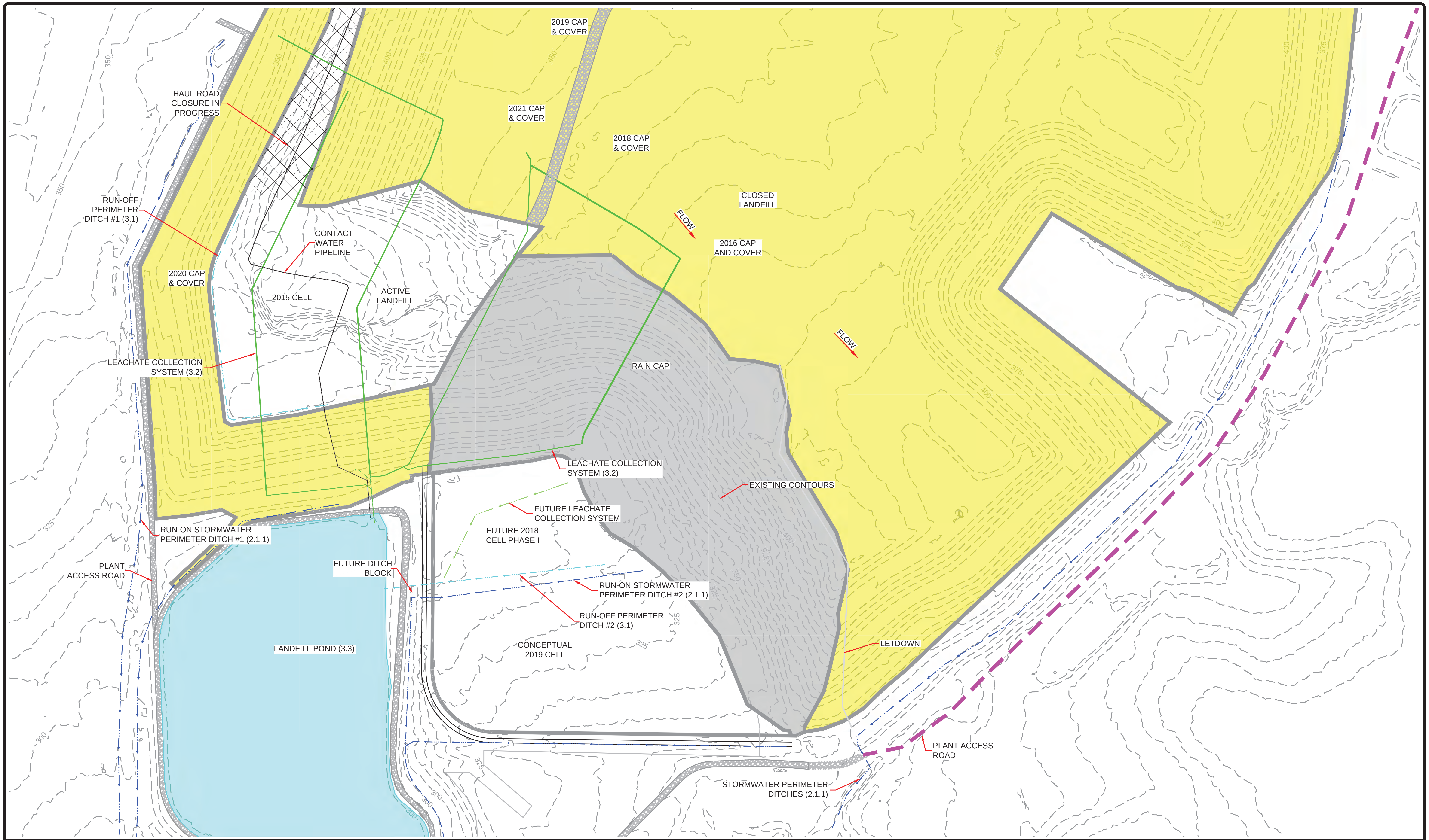
0 500' 1000'
1"=500'

N

FIGURE 1
OVERALL LANDFILL EXHIBIT



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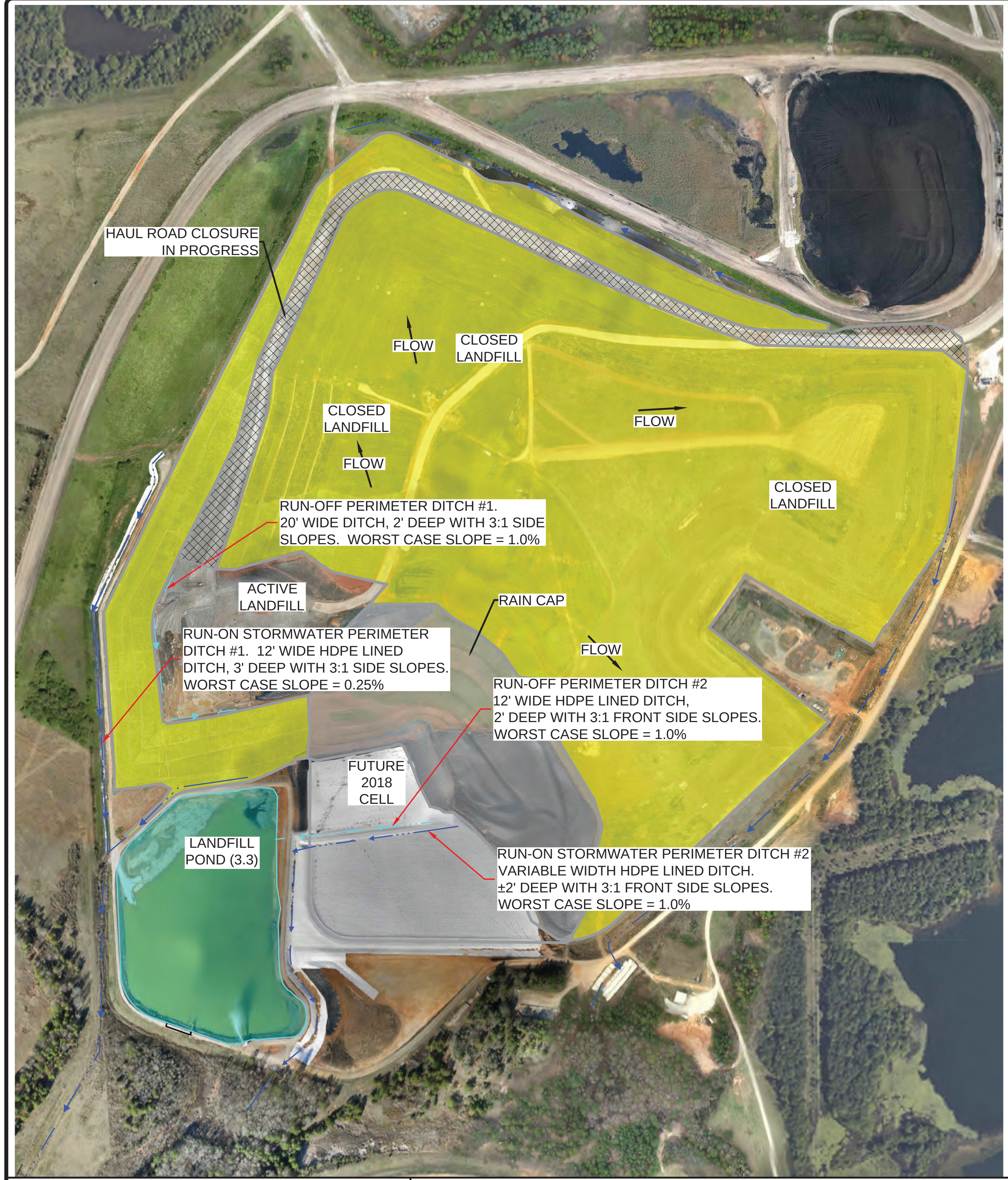
0 250' 500'
1"=250'

N

FIGURE 2
ACTIVE & FUTURE LANDFILL



DITCH DESCRIPTION	CAPACITY	25 YR, 24 HR FLOW
RUN-ON STORMWATER PERIMETER DITCH #1	626 CFS	*150 CFS
RUN-OFF PERIMETER DITCH #1	527 CFS	70 CFS
RUN-ON STORMWATER PERIMETER DITCH #2	568 CFS	61 CFS
RUN-OFF PERIMETER DITCH #2	453 CFS	25 CFS

*FLOW WAS ESTIMATED FROM PREVIOUS HYDROLOGIC & HYDRAULIC MODELS FOR UPSTREAM PIPE SYSTEM.

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0 500' 1000'
1"=500'

N

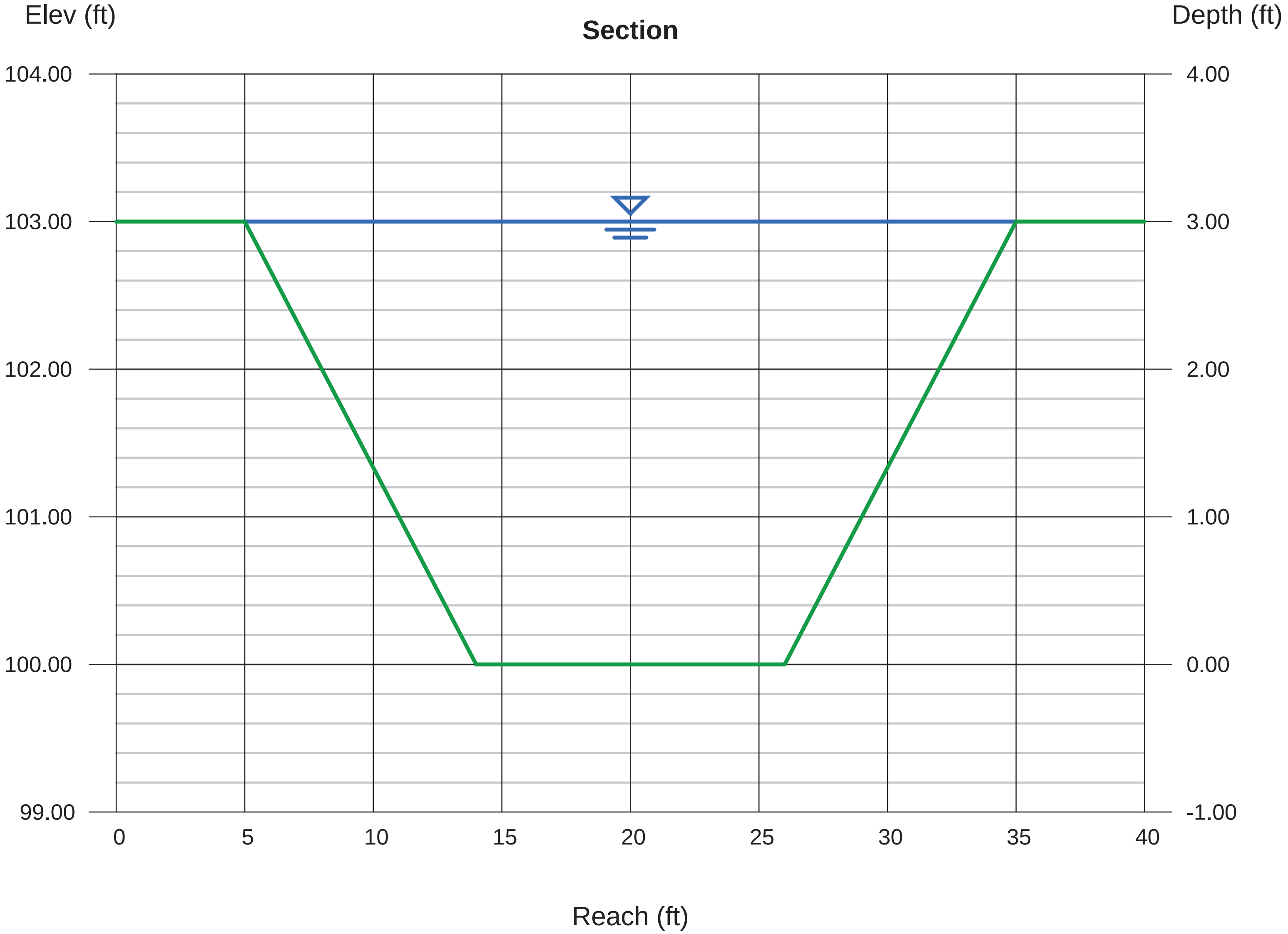
FIGURE 3
HYDROLOGY
EXHIBIT

Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Friday, Oct 1 2021

Run-on Stormwater Perimeter Ditch #1

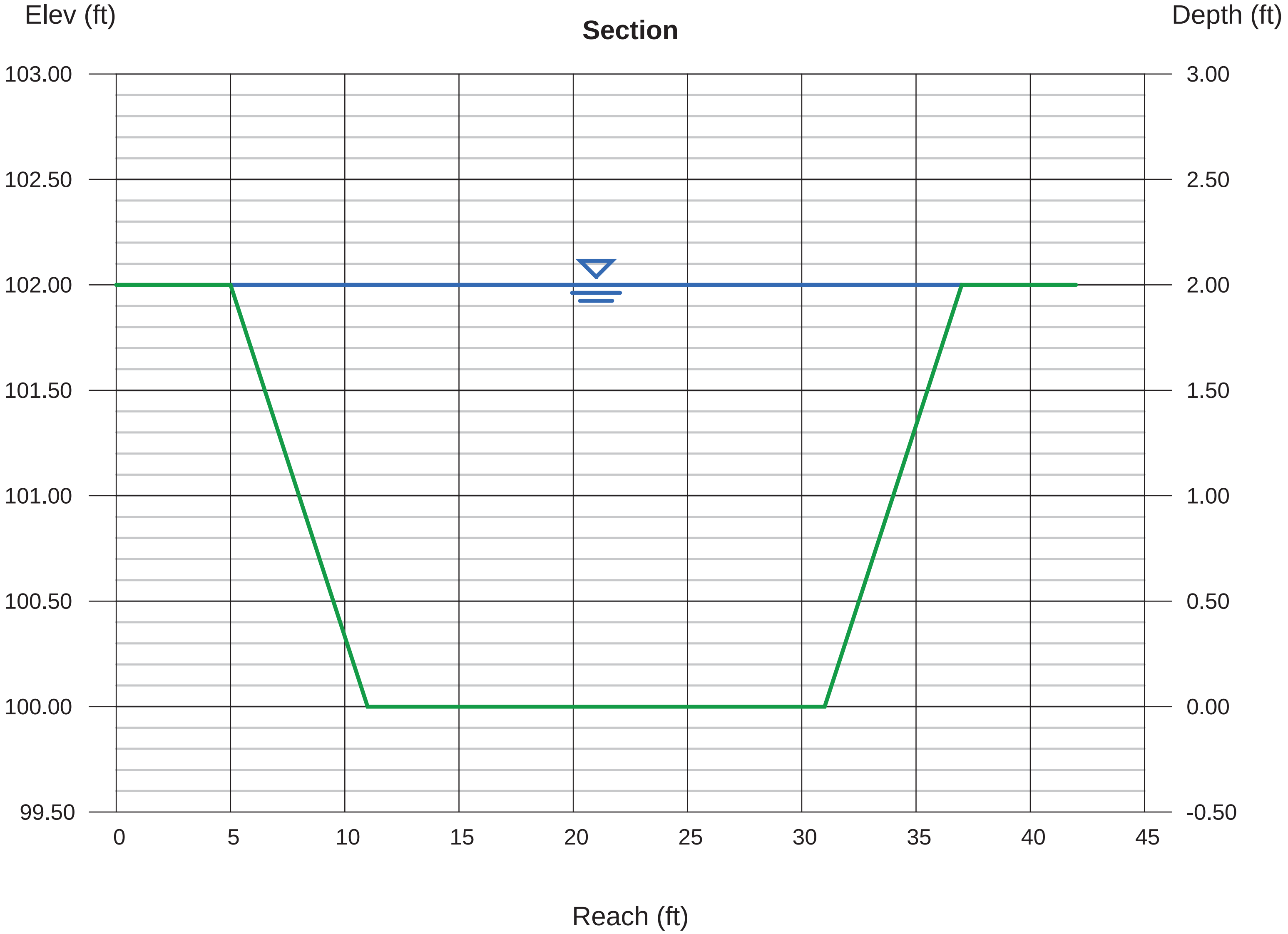
Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 12.00	Depth (ft)	= 3.00
Side Slopes (z:1)	= 3.00, 3.00	Q (cfs)	= 626.35
Total Depth (ft)	= 3.00	Area (sqft)	= 63.00
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 9.94
Slope (%)	= 0.25	Wetted Perim (ft)	= 30.97
N-Value	= 0.012	Crit Depth, Yc (ft)	= 3.00
		Top Width (ft)	= 30.00
Calculations		EGL (ft)	= 4.54
Compute by:	Known Depth		
Known Depth (ft)	= 3.00		



Channel Report

Run-off Perimeter Ditch #1

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 20.00	Depth (ft)	= 2.00
Side Slopes (z:1)	= 3.00, 3.00	Q (cfs)	= 527.00
Total Depth (ft)	= 2.00	Area (sqft)	= 52.00
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 10.13
Slope (%)	= 1.00	Wetted Perim (ft)	= 32.65
N-Value	= 0.020	Crit Depth, Yc (ft)	= 2.00
		Top Width (ft)	= 32.00
Calculations		EGL (ft)	= 3.60
Compute by:	Known Depth		
Known Depth (ft)	= 2.00		



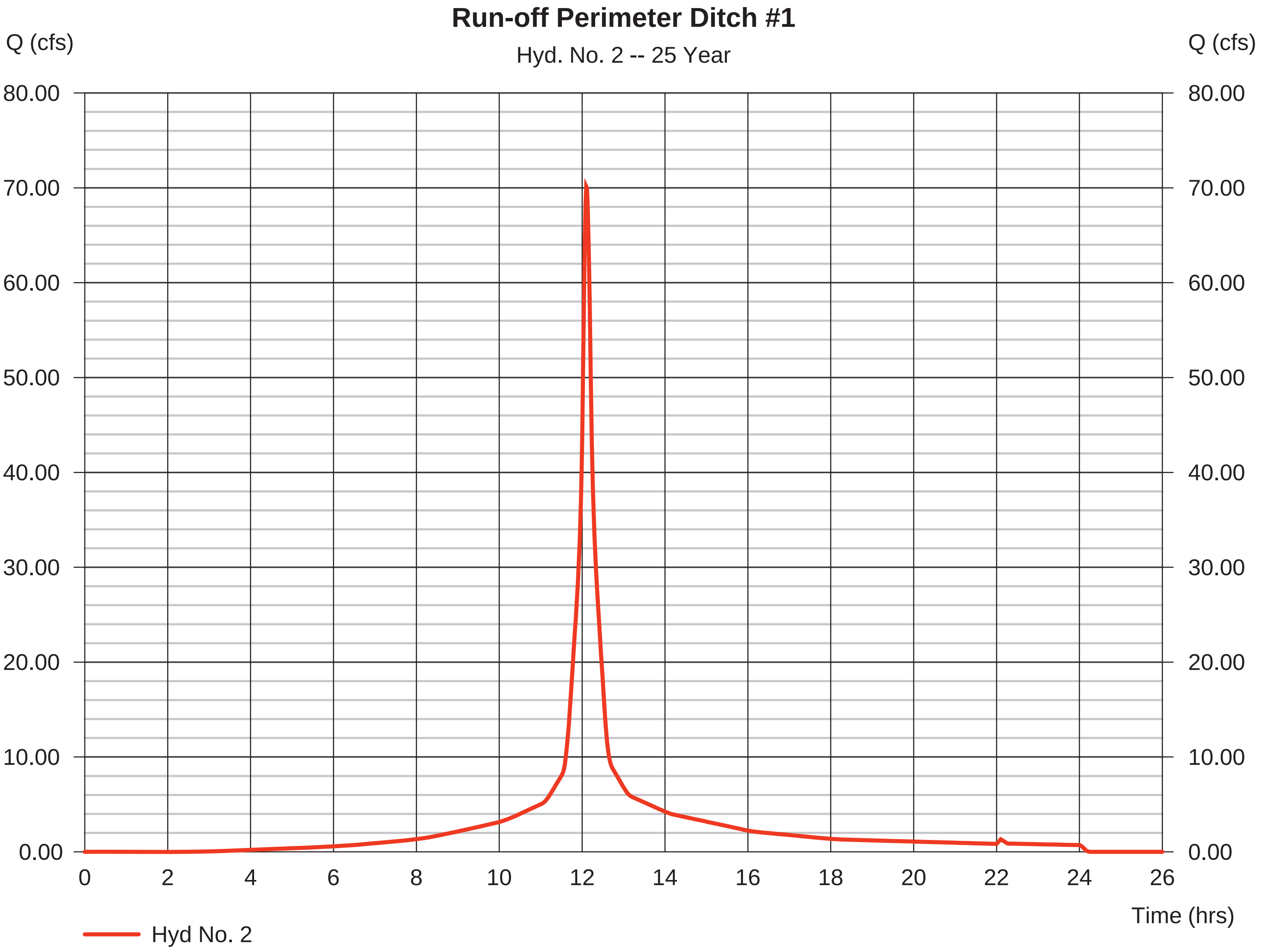
Hydrograph Report

Hyd. No. 2

Run-off Perimeter Ditch #1

Hydrograph type = SCS Runoff
Storm frequency = 25 yrs
Time interval = 1 min
Drainage area = 10.000 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 8.30 in
Storm duration = 24 hrs

Peak discharge = 70.13 cfs
Time to peak = 12.10 hrs
Hyd. volume = 5.918 acft
Curve number = 90
Hydraulic length = 0 ft
Time of conc. (Tc) = 10.00 min
Distribution = Type III
Shape factor = 484



Channel Report

Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Friday, Oct 1 2021

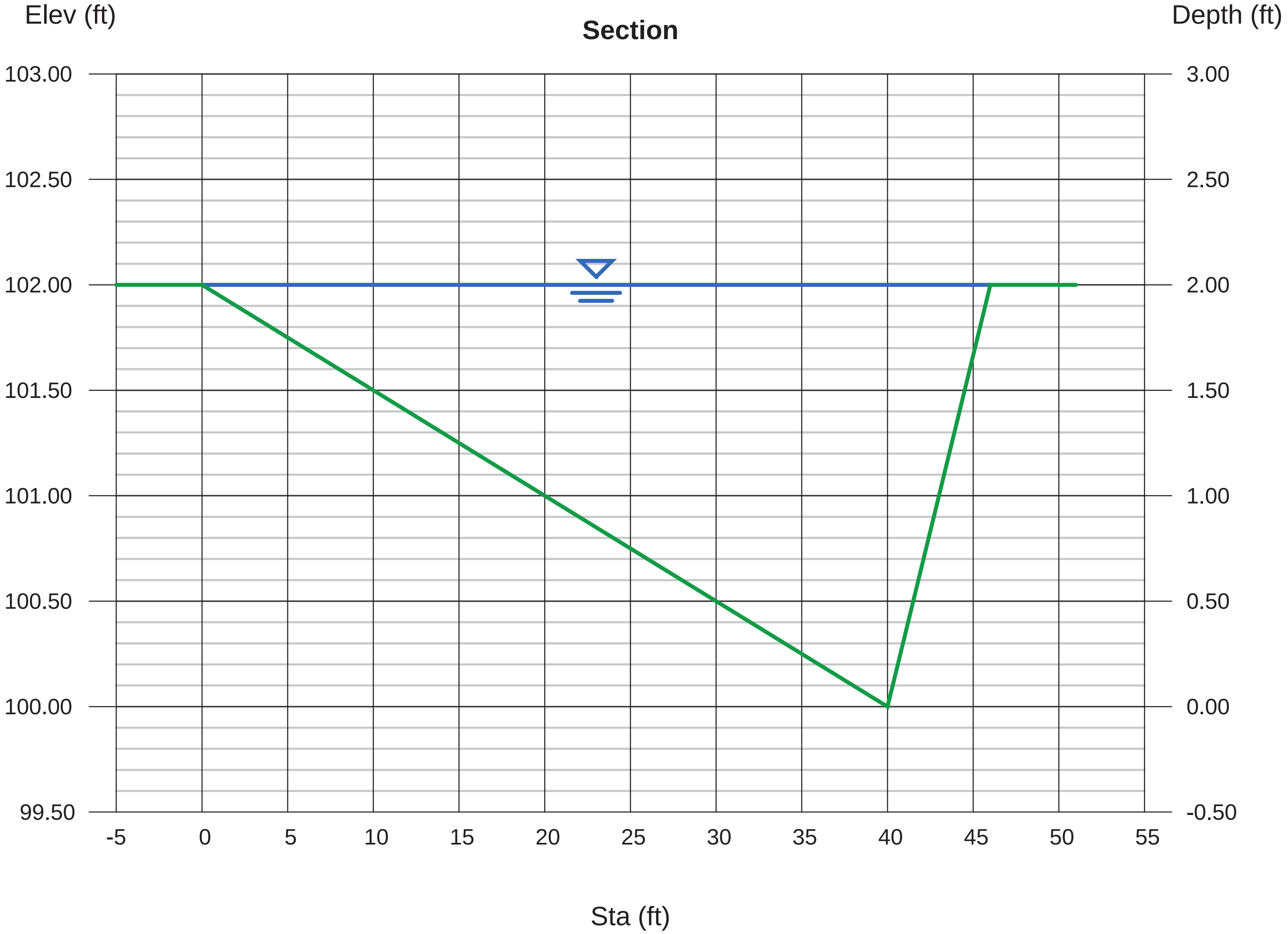
Run-on Stormwater Perimeter Ditch #2

User-defined	
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= Composite
Calculations	
Compute by:	Q vs Depth
No. Increments	= 1

Highlighted	
Depth (ft)	= 2.00
Q (cfs)	= 567.81
Area (sqft)	= 46.00
Velocity (ft/s)	= 12.34
Wetted Perim (ft)	= 46.37
Crit Depth, Yc (ft)	= 0.01
Top Width (ft)	= 46.00
EGL (ft)	= 4.37

(Sta, El, n)-(Sta, El, n)...

(0.00, 102.00)-(40.00, 100.00, 0.012)-(46.00, 102.00, 0.012)

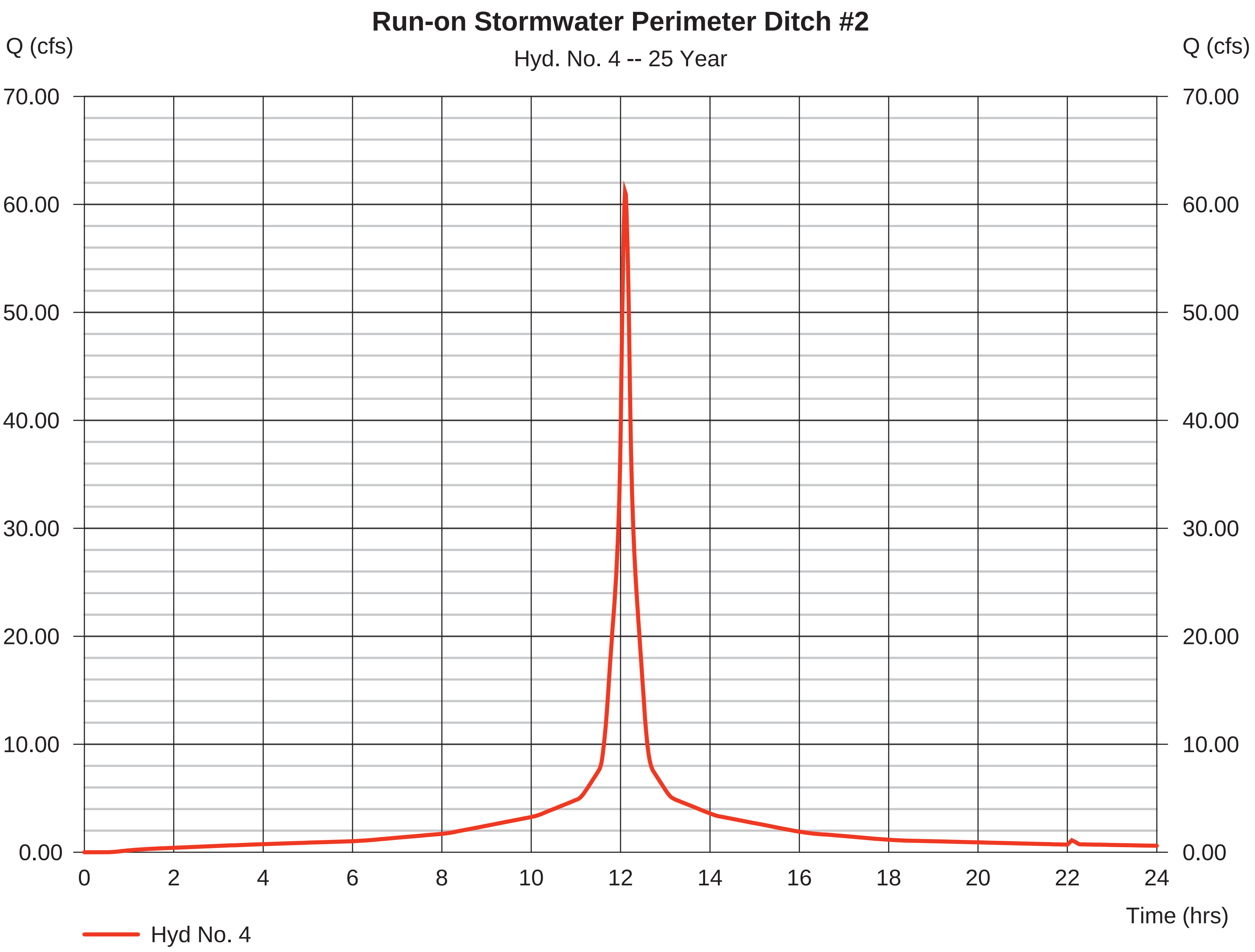


Hydrograph Report

Hyd. No. 4

Run-on Stormwater Perimeter Ditch #2

Hydrograph type	= SCS Runoff	Peak discharge	= 61.16 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.10 hrs
Time interval	= 1 min	Hyd. volume	= 5.575 acft
Drainage area	= 8.300 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 8.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Channel Report

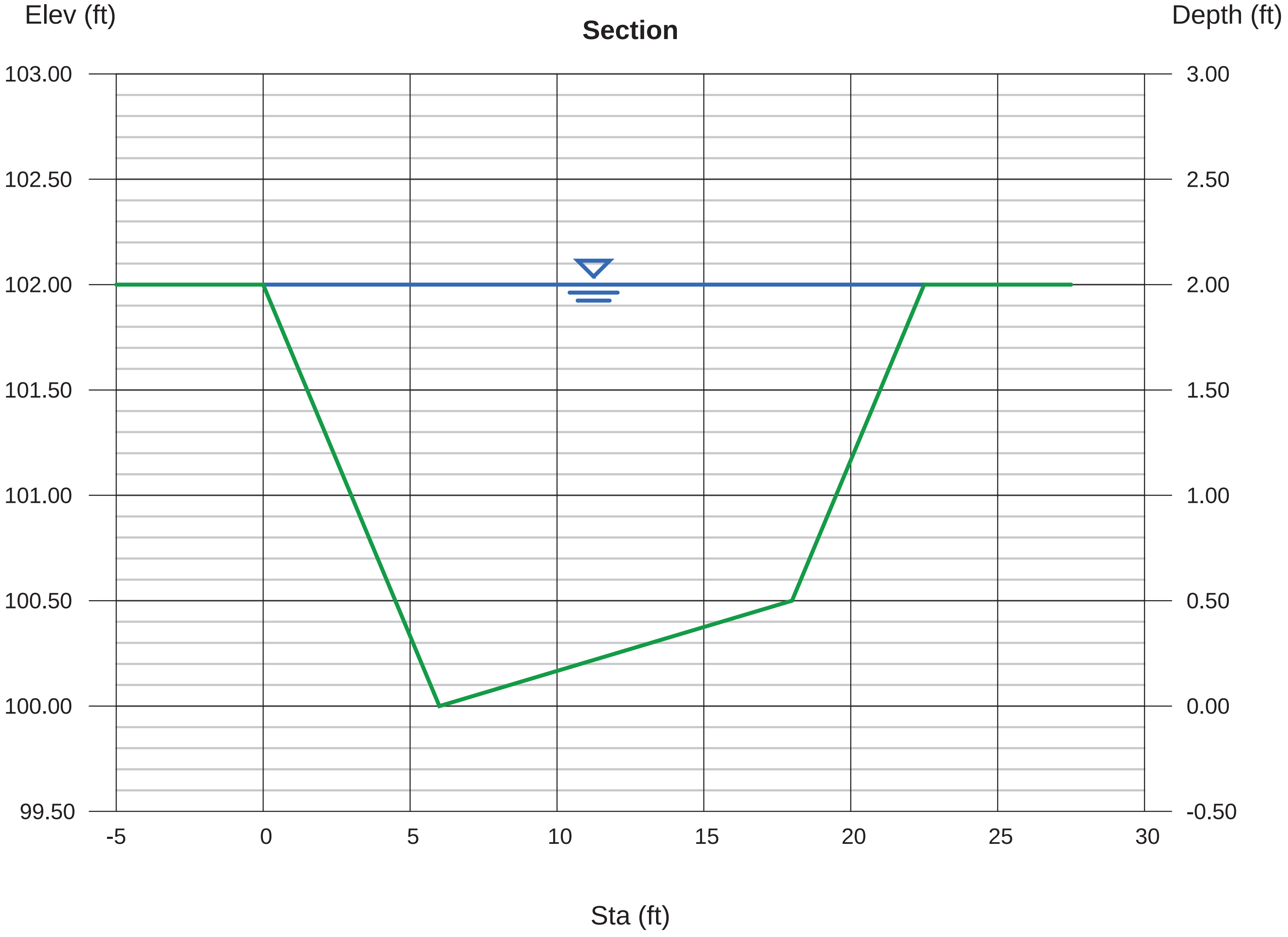
Run-off Perimeter Ditch #2

User-defined
Invert Elev (ft) = 100.00
Slope (%) = 1.00
N-Value = Composite

Calculations
Compute by: Q vs Depth
No. Increments = 1

(Sta, El, n)-(Sta, El, n)...
(0.00, 102.00)-(6.00, 100.00, 0.012)-(18.00, 100.50, 0.012)-(22.50, 102.00, 0.012)

Highlighted
Depth (ft) = 2.00
Q (cfs) = 452.79
Area (sqft) = 30.38
Velocity (ft/s) = 14.91
Wetted Perim (ft) = 23.08
Crit Depth, Yc (ft) = 0.01
Top Width (ft) = 22.50
EGL (ft) = 5.45



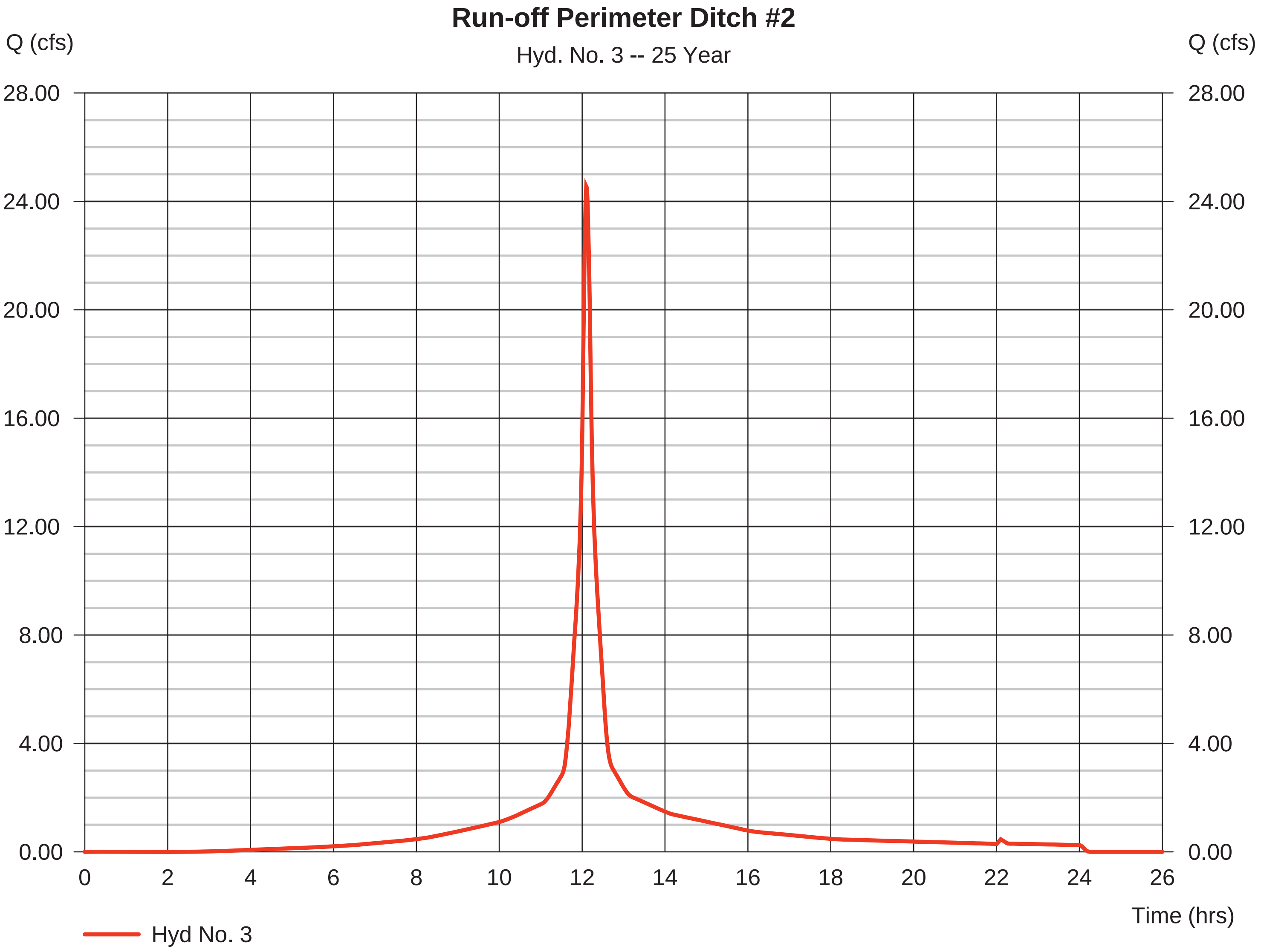
Hydrograph Report

Hyd. No. 3

Run-off Perimeter Ditch #2

Hydrograph type = SCS Runoff
Storm frequency = 25 yrs
Time interval = 1 min
Drainage area = 3.500 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 8.30 in
Storm duration = 24 hrs

Peak discharge = 24.55 cfs
Time to peak = 12.10 hrs
Hyd. volume = 2.071 acft
Curve number = 90
Hydraulic length = 0 ft
Time of conc. (Tc) = 10.00 min
Distribution = Type III
Shape factor = 484



APPENDIX B:

Run-On and Run-Off Plan Review Log

Plan Review and Changes in Facility Configuration

Scheduled reviews and Plan amendments shall be recorded in the Plan Review Log below. This log must be completed even if no amendment is made to the Plan as a result of the review.

By	Date	Amendment Description	P.E. Certification Required?	P.E. Name	Licensing State: Registration No.
Akron Consulting, LLC	10/14/2016	Initial Plan	Yes	Landon C. Allen	TX 119170
Akron Consulting, LLC	10/06/2021	5-Year Plan Revision	Yes	Lane D. Roberts	TX 105135

APPENDIX C:

Professional Engineer Certification

Professional Engineer Certification

The Run-on and Run-off System Control Plan for the H.W. Pirkey Power Plant Landfill was prepared by Akron Consulting, LLC (TBPE Firm #14014). This Certification/Statement of Professional Opinion is limited to the information available to Akron at the time the Plan was written. On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the State of Texas, that the Plan has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances and at the time and in the same locale. It is my professional opinion that the Plan was prepared, reviewed, and revised in accordance with the current requirements of 30 TAC 352.811 (Federal Regulation Title 40, Part 257.81).

The use of the words "certification" and/or "certify" in this document shall be interpreted and construed as a Statement of Professional Opinion, and is not and shall not be interpreted or construed as a guarantee, warranty or legal opinion. This certification in no way relieves the Owner or Operator of the facility of his/her duty to fully implement this Plan.

Engineer: Lane D. Roberts

Registration Number: 105135

State: Texas

Date: 10/06/2021

LANE D. ROBERTS
105135

P.E. certification is required for the original Plan and Plan reviews and amendments.

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3.4 – Run-on and Run-off Control System Plan, H.W. Pirkey Power Plant Stack-Out Pad, October 2021

Run-on and Run-off Control System Plan

H.W. Pirkey Power Plant Stack-Out Pad
Hallsville, Harrison County, Texas

October 6, 2021
Akron Project Number: 237P-2109

Prepared for:
American Electric Power
1 Riverside Plaza
Columbus, Ohio 43215

Prepared by:
Akron Consulting, LLC
431 N Center St.
Longview, Texas 75601
TBPE Firm # 14014

Table of Contents

1.0 INTRODUCTION

30 TAC 352.811 (Federal Regulation Title 40, Part 257.81) requires the owner or operator of an existing or new CCR landfill or any lateral expansion of an existing CCR landfill to comply with the following:

1. A run-on control system to prevent flow onto the active portion of the CCR unit during the peak discharge from a 24-hour, 25-year storm.
2. A run-off control system from the active portion of the CCR unit to collect and control at least the water volume resulting from a 24-hour, 25-year storm.
3. Run-off from the active portion of the CCR unit must be handled in accordance with the surface water requirements under §257.3-3.
4. Prepare initial and periodic run-on and run-off control system plans for the CCR unit according to the following timeframes:
   a. For existing CCR landfills, the owner or operator of the CCR unit must prepare the initial run-on and run-off control system plan no later than October 17, 2016.
   b. The owner or operator of the CCR unit must prepare periodic run-on and run-off control system plans every five (5) years.
5. Obtain a certification from a qualified professional engineer stating that the initial and periodic run-on and run-off control system plans meet the requirements of this section.
6. Comply with the recordkeeping requirements specified in §257.105(g), the notification requirements specified in §257.106(g), and the internet requirements specified in §257.107(g).

This Plan represents the 5-year revision of the original Run-on and Run-off Control System Plan, dated October 2016, and presents the regulatory-required materials as noted above. It is prepared for the stack-out pad at AEP's H.W. Pirkey Power Plant in Hallsville, Texas.

2.0 RUN-ON CONTROLS

The purpose of run-on controls is to prevent storm water from entering into the stack-out pad from a 24-hour, 25-year storm.

2.1 Run-On Controls Outside the Stack-Out Pad

2.1.1 Diversion Dikes and Berms

An HDPE lined berm is located around the southern, western, and eastern sides of the stack-out pad. This berm provides a barrier that will not allow stormwater from the plant to enter the stack-out pad.

2.1.2 Stormwater Perimeter Ditches

A stormwater ditch to the east of the stack-out pad directs run-on water away from the proposed berm to the Auxiliary Surge Pond. See Appendix A for calculations. Stormwater to the south surface drains away from the berm to the south. Stormwater on the west side of the stack-out pad flows to the north.

3.0 RUN-OFF CONTROLS

The run-off control system prevents flow (contact water) from leaving the stack-out pad during a 24-hour, 25-year storm. Run-off control consists of the following aspects:

- Perimeter HDPE lined berm
- Perimeter Ditches
- Surge Pond

Stormwater from the stack-out pad travels to the surge pond via perimeter ditches. Perimeter HDPE lined berms help to ensure that stormwater is directed to these ditches and does not leave the stack-out pad. The surge pond accepts all stormwater from the stack-out pad, and water from the surge pond is utilized by the power plant in the FGD system.

3.1 Perimeter HDPE Lined Berm

The entire stack-out pad is surrounded on three sides by an HDPE lined berm. The berm is 1.5’ tall, with a 3’ top width. Not only does the berm prevent run-on from entering the stack-out pad, it directs stormwater inside the stack-out pad to enter perimeter ditches that carry contact water to the surge pond. The design calculations for the Perimeter HDPE lined berms are a function of the perimeter ditches, and calculations for the perimeter ditches are provided in Figure 1.

3.2 Perimeter Ditches

Perimeter ditches inside the stack-out pad transport contact water to the surge pond. One perimeter ditch on the west side of the stack-out pad discharges directly into the surge pond, while another perimeter ditch on the east side discharges into a culvert which discharges into a ditch that enters the auxiliary surge pond. The stack-out pad is graded to divert stormwater to these ditches. Design calculations for the perimeter ditches are provided in Figure 1.

3.3 Surge Pond

All stormwater from the stack-out pad enters the surge pond. Water in the surge pond is utilized by the power plant in the FGD system.

4.0 PLAN REVIEW AND CHANGES IN FACILITY OPERATION

Stack-out Pad Owner and/or Operator will review and evaluate this Plan every five (5) years from initial plan preparation and when there are changes in the facility design, construction, operation, or maintenance that materially affect the facility’s potential for run-on and run-off control. Amendments to the Plan made to address changes of this nature are referred to as technical or major amendments, and must be certified by a P.E. Non-technical amendments can be performed by the facility owner and/or operator. This Plan represents the 5-year revision of the original Run-on and Run-off Control System Plan, dated October 2016.

Technical and administrative amendments to the Plan have been and will continue to be documented on the Plan Review Log. Owner/Operator will make the necessary revisions to the Plan as soon as possible, but no later than six months after the change occurs. The Plan must be implemented as soon as possible following a technical amendment, but no later than six months from the date of the amendment. The Designated Person is responsible for initiating and coordinating revisions to the SPCC Plan.

Scheduled reviews and Plan amendments will be recorded in the Plan Review Log provided in Appendix 2. The log will be completed even if no amendment is made to the Plan as a result of the review.

5.0 PROFESSIONAL ENGINEER CERTIFICATION

This revised Plan, and all subsequent reviews and amended plans, must obtain certification from a qualified P.E. stating that the initial and subsequent run-on and run-off control system plans meet the requirements of 40 CFR 257. This certification in no way relieves the owner or operator of the facility of his/her duty to fully implement this Plan. The Professional Engineer Certification page is provided in Appendix C.

APPENDIX A:

Figures and Calculations

DITCH DESCRIPTION	CAPACITY	25 YR, 2□ HR FLOW
RUN-OFF PERIMETER DITCH □1	65 CFS	11.6□ CFS
RUN-OFF PERIMETER DITCH □2	5□ CFS	5.□2 CFS
CULVERT FOR DITCH □2	6.6 CFS	5.□2 CFS
STORMWATER PERIMETER DITCH	5□ CFS	6.□5 CFS
CULVERT FOR STORMWATER DITCH	10 CFS	6.□5 CFS

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0 100' 200'
1"=100'

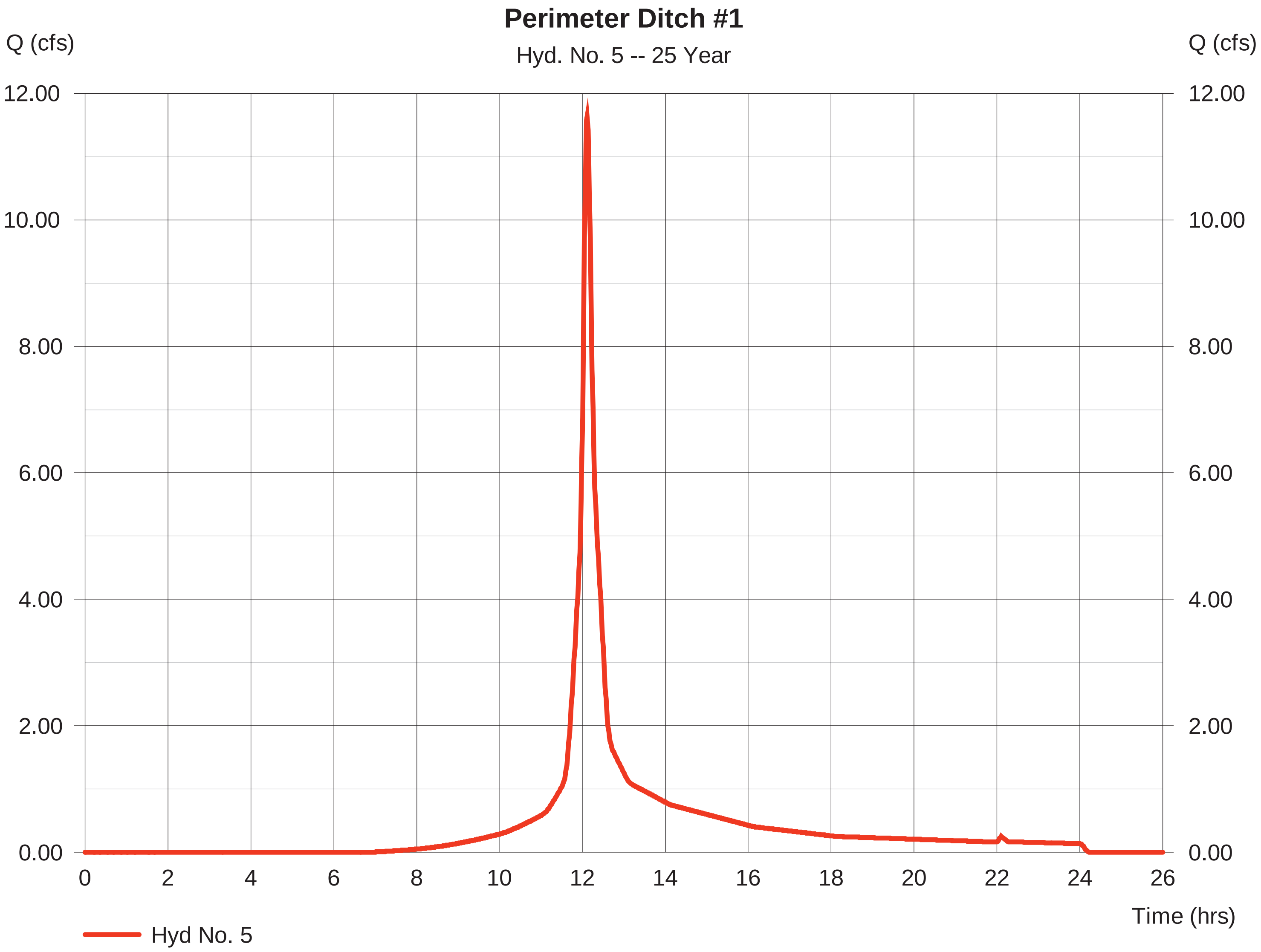
N

FIGURE 1
OVERALL STACKOUT EXHIBIT

Hydrograph Report

Perimeter Ditch #1

Hydrograph type	= SCS Runoff	Peak discharge	= 11.63 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.12 hrs
Time interval	= 1 min	Hyd. volume	= 39,978 cuft
Drainage area	= 2.120 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 8.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Channel Report

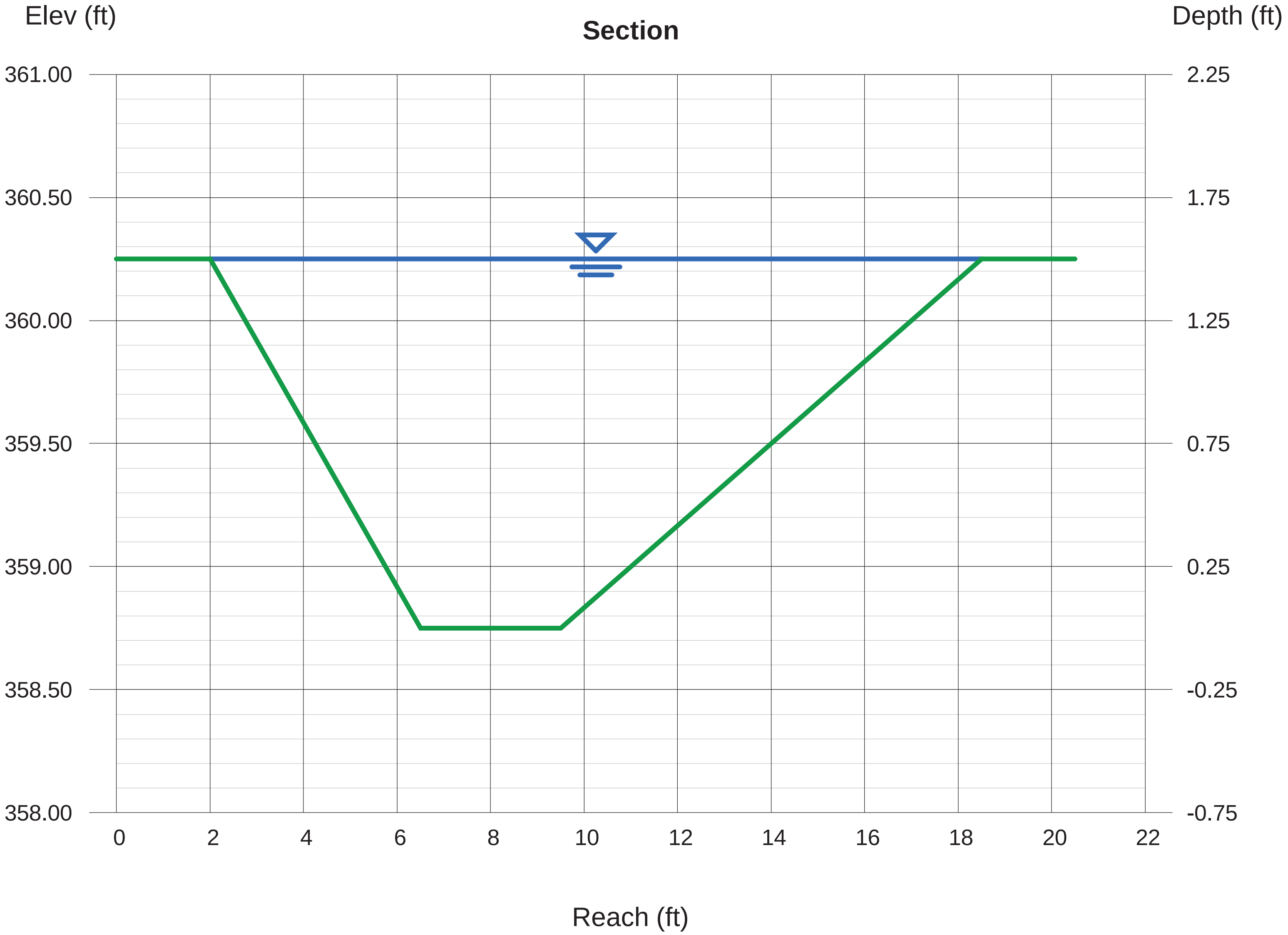
Hydraflow Express Extension for AutoCAD® Civil 3D® 2012 by Autodesk, Inc. Wednesday, Sep 28 2016

Run-off Perimeter Ditch #1

Trapezoidal	
Bottom Width (ft)	= 3.00
Side Slopes (z:1)	= 3.00, 6.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 358.75
Slope (%)	= 1.00
N-Value	= 0.030

Calculations	
Compute by:	Known Depth
Known Depth (ft)	= 1.50

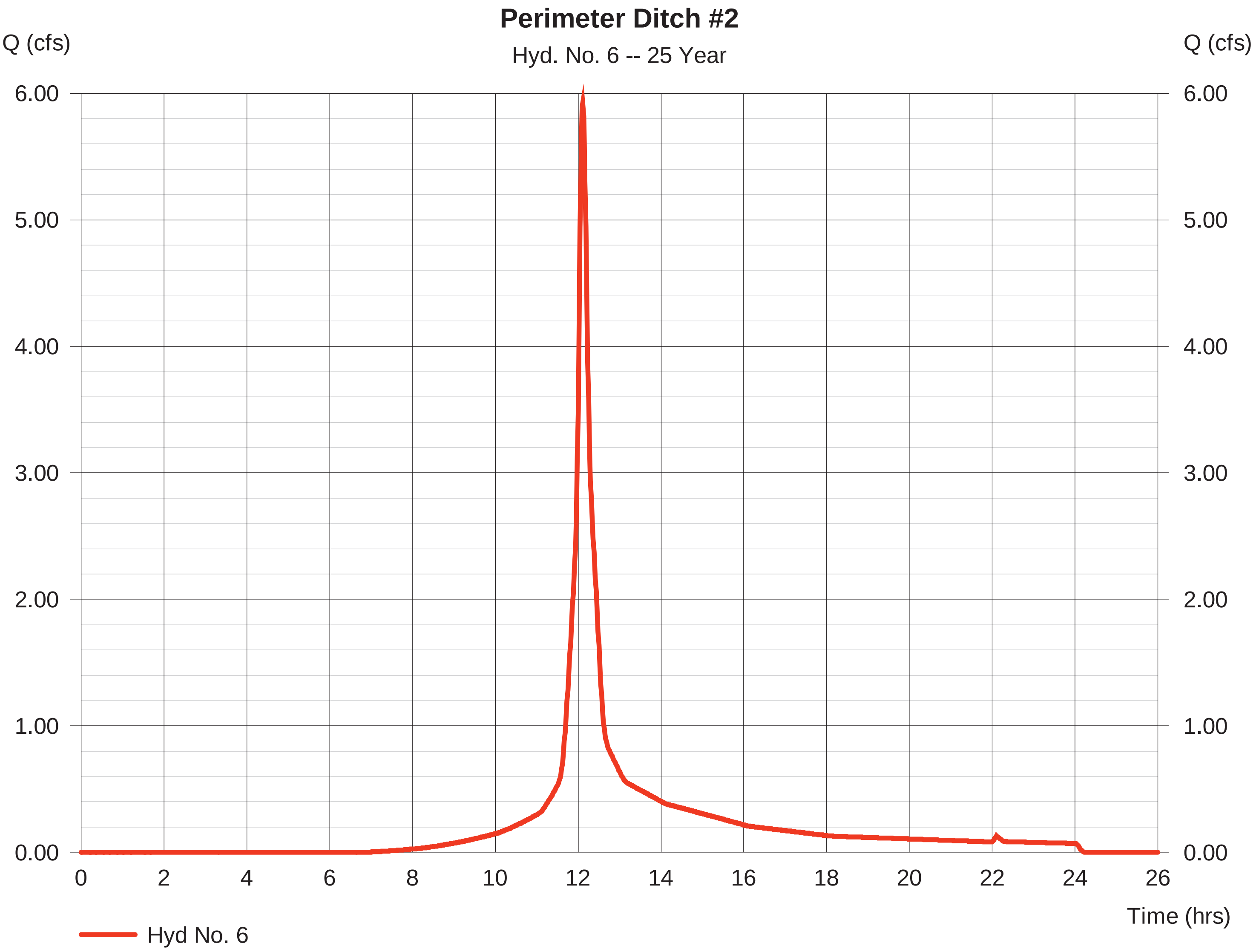
Highlighted	
Depth (ft)	= 1.50
Q (cfs)	= 65.87
Area (sqft)	= 14.63
Velocity (ft/s)	= 4.50
Wetted Perim (ft)	= 16.87
Crit Depth, Yc (ft)	= 1.39
Top Width (ft)	= 16.50
EGL (ft)	= 1.82



Hydrograph Report

Perimeter Ditch #2

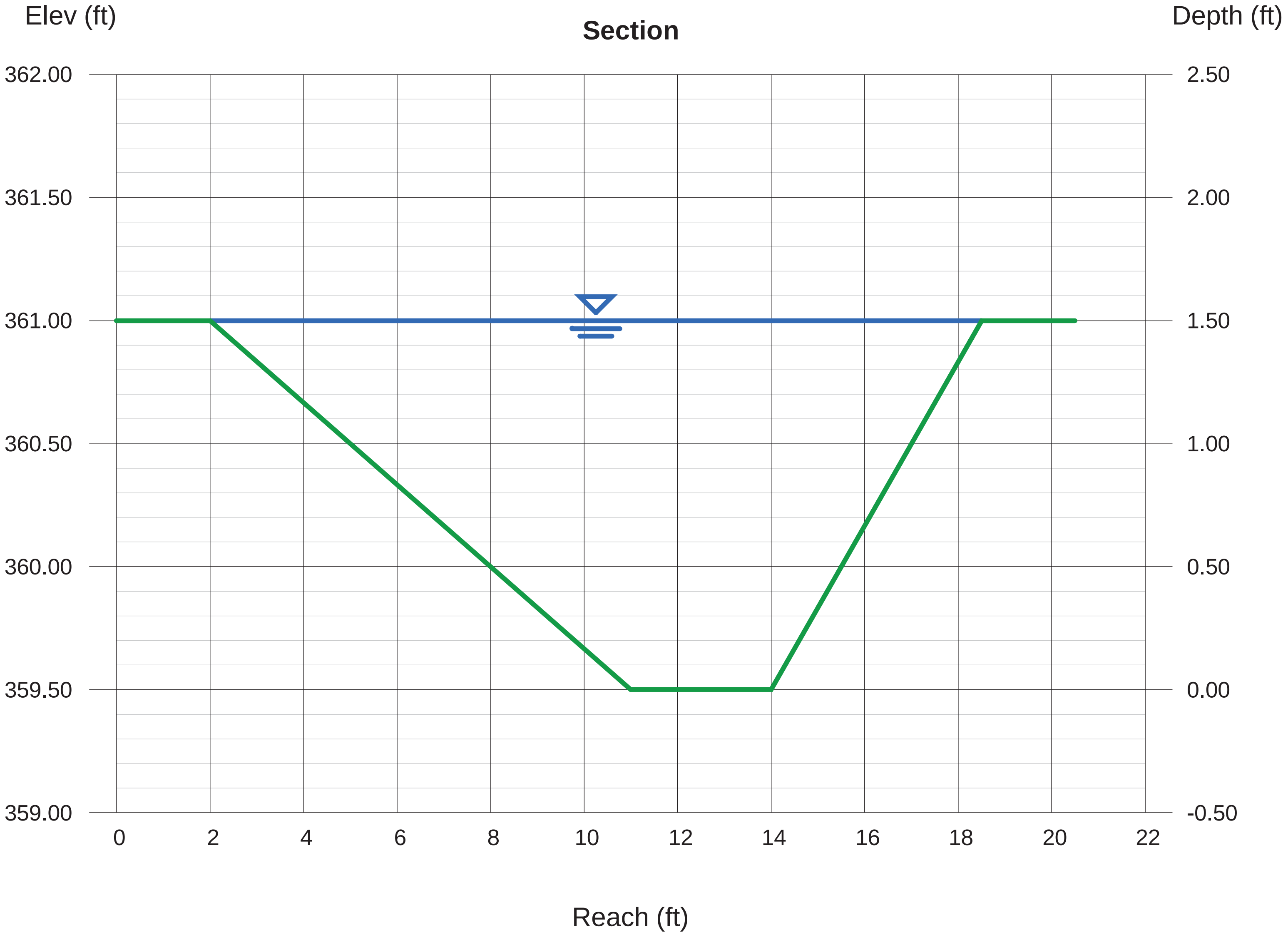
Hydrograph type	= SCS Runoff	Peak discharge	= 5.923 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.12 hrs
Time interval	= 1 min	Hyd. volume	= 20,366 cuft
Drainage area	= 1.080 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 8.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Channel Report

Run-off Perimeter Ditch #2

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 3.00	Depth (ft)	= 1.50
Side Slopes (z:1)	= 6.00, 3.00	Q (cfs)	= 53.10
Total Depth (ft)	= 1.50	Area (sqft)	= 14.63
Invert Elev (ft)	= 359.50	Velocity (ft/s)	= 3.63
Slope (%)	= 0.65	Wetted Perim (ft)	= 16.87
N-Value	= 0.030	Crit Depth, Yc (ft)	= 1.25
		Top Width (ft)	= 16.50
Calculations		EGL (ft)	= 1.70
Compute by:	Known Depth		
Known Depth (ft)	= 1.50		



Culvert Report

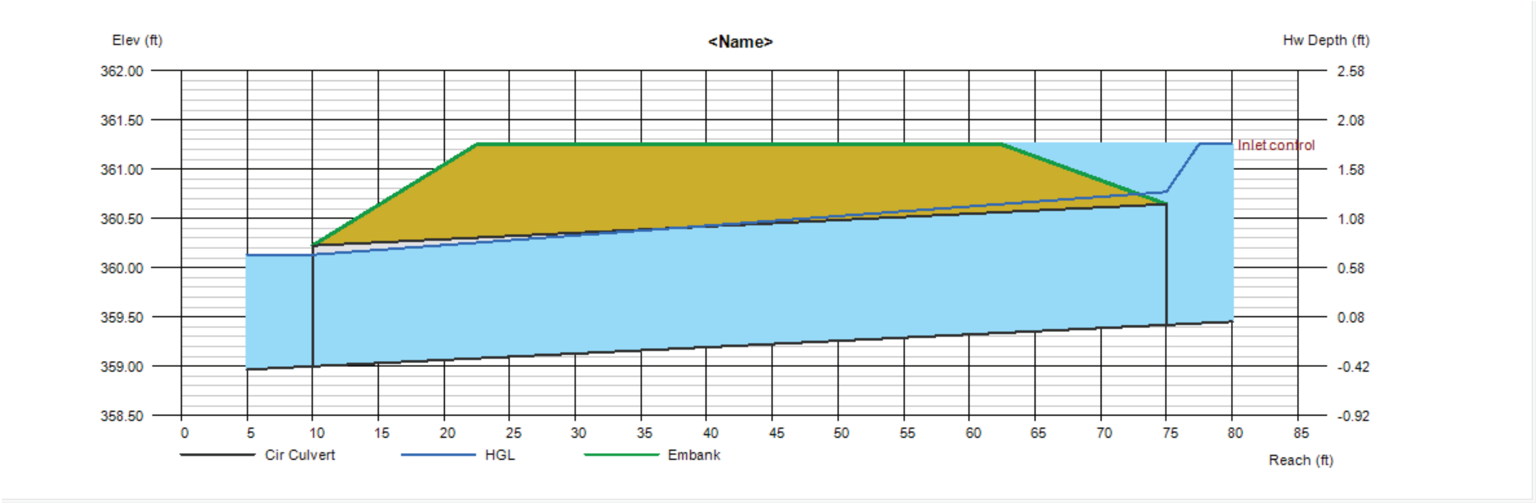
Perimeter Ditch #2 Culvert

Invert Elev Dn (ft) = 359.00
Pipe Length (ft) = 65.00
Slope (%) = 0.65
Invert Elev Up (ft) = 359.42
Rise (in) = 14.7
Shape = Cir
Span (in) = 14.7
No. Barrels = 1
n-Value = 0.012
Inlet Edge = Projecting
Coeff. K,M,c,Y,k = 0.0045, 2, 0.0317, 0.69, 0.5

Embankment
Top Elevation (ft) = 361.25
Top Width (ft) = 40.00
Crest Width (ft) = 20.00

Calculations
Qmin (cfs) = 6.60
Qmax (cfs) = 6.60
Tailwater Elev (ft) = (dc+D)/2

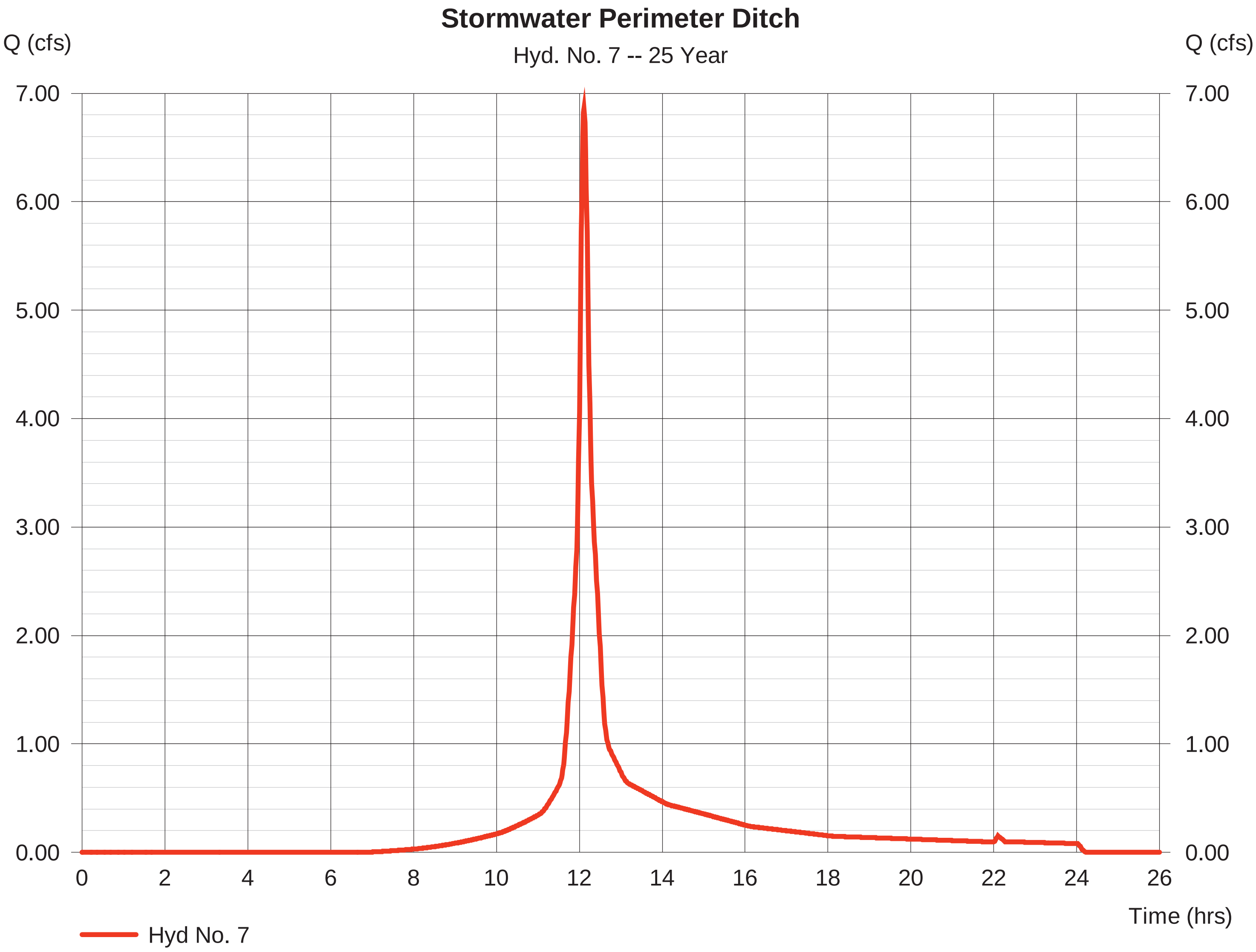
Highlighted
Qtotal (cfs) = 6.60
Qpipe (cfs) = 6.60
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 5.80
Veloc Up (ft/s) = 5.60
HGL Dn (ft) = 360.13
HGL Up (ft) = 360.77
Hw Elev (ft) = 361.26
Hw/D (ft) = 1.50
Flow Regime = Inlet Control



Hydrograph Report

Stormwater Perimeter Ditch

Hydrograph type	= SCS Runoff	Peak discharge	= 6.855 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.12 hrs
Time interval	= 1 min	Hyd. volume	= 23,572 cuft
Drainage area	= 1.250 ac	Curve number	= 74
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 8.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

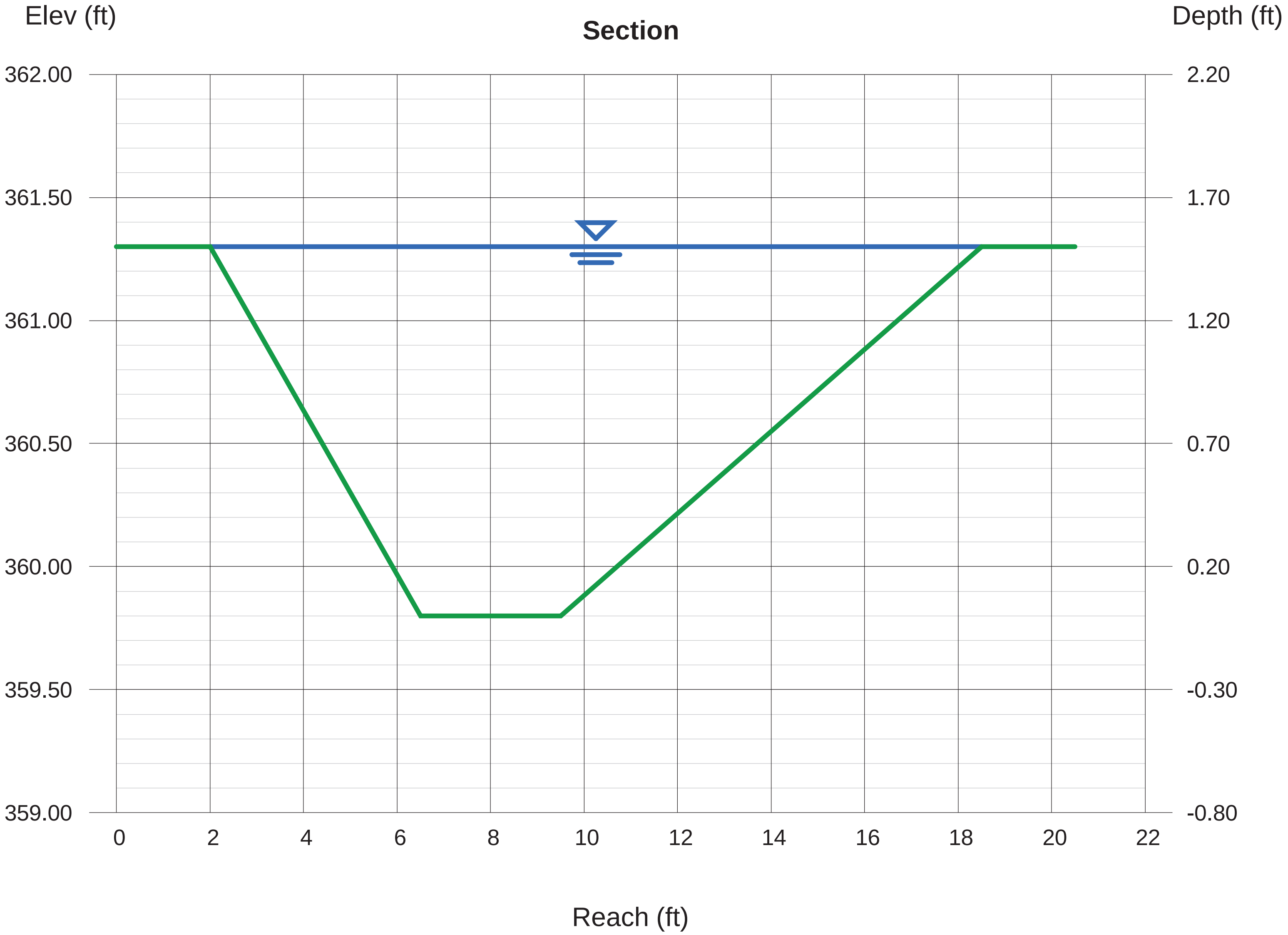


Channel Report

Run-on Perimeter Ditch

Trapezoidal	
Bottom Width (ft)	= 3.00
Side Slopes (z:1)	= 3.00, 6.00
Total Depth (ft)	= 1.50
Invert Elev (ft)	= 359.80
Slope (%)	= 0.80
N-Value	= 0.030
Calculations	
Compute by:	Known Depth
Known Depth (ft)	= 1.50

Highlighted	
Depth (ft)	= 1.50
Q (cfs)	= 58.91
Area (sqft)	= 14.63
Velocity (ft/s)	= 4.03
Wetted Perim (ft)	= 16.87
Crit Depth, Yc (ft)	= 1.32
Top Width (ft)	= 16.50
EGL (ft)	= 1.75



Culvert Report

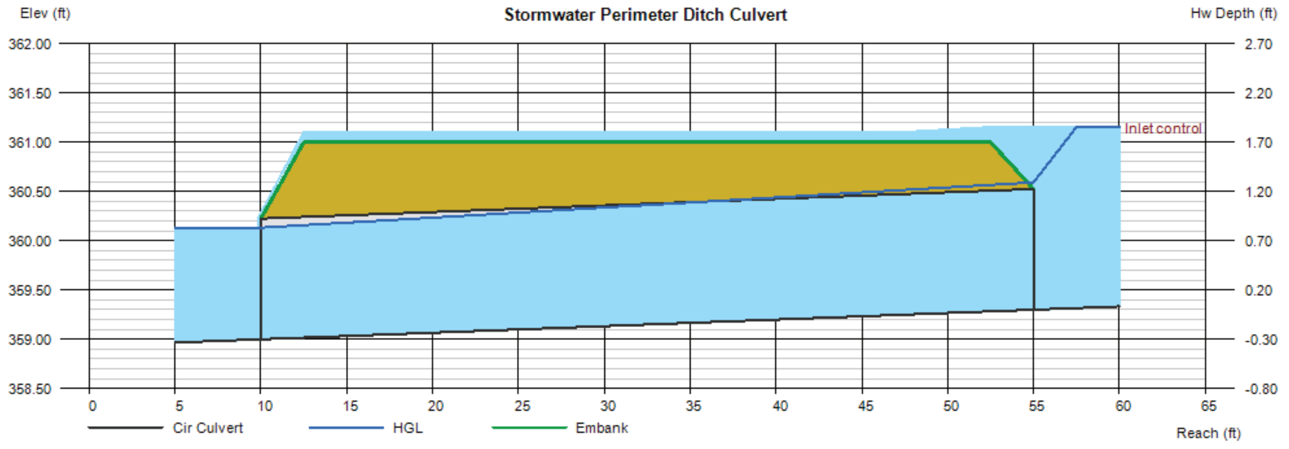
Stormwater Perimeter Ditch Culvert

Invert Elev Dn (ft) = 359.00
Pipe Length (ft) = 45.00
Slope (%) = 0.67
Invert Elev Up (ft) = 359.30
Rise (in) = 14.7
Shape = Cir
Span (in) = 14.7
No. Barrels = 1
n-Value = 0.012
Inlet Edge = Projecting
Coeff. K,M,c,Y,k = 0.0045, 2, 0.0317, 0.69, 0.5

Embankment
Top Elevation (ft) = 361.00
Top Width (ft) = 40.00
Crest Width (ft) = 20.00

Calculations
Qmin (cfs) = 10.00
Qmax (cfs) = 10.00
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 10.00
Qpipe (cfs) = 6.66
Qovertop (cfs) = 3.34
Veloc Dn (ft/s) = 5.85
Veloc Up (ft/s) = 5.65
HGL Dn (ft) = 360.13
HGL Up (ft) = 360.59
Hw Elev (ft) = 361.15
Hw/D (ft) = 1.51
Flow Regime = Inlet Control



APPENDIX B:

Run-On and Run-Off Plan Review Log

Plan Review and Changes in Facility Configuration

Scheduled reviews and Plan amendments shall be recorded in the Plan Review Log below. This log must be completed even if no amendment is made to the Plan as a result of the review.

By	Date	Amendment Description	P.E. Certification Required?	P.E. Name	Licensing State: Registration No.
Akron Consulting, LLC	10/14/2016	Initial Plan	Yes	Landon C. Allen	TX 119170
Akron Consulting, LLC	10/06/2021	5-Year Plan Revision	Yes	Lane D. Roberts	TX 105135

APPENDIX C:

Professional Engineer Certification

Professional Engineer Certification

The Run-on and Run-off System Control Plan for the H.W. Pirkey Power Plant Stack-Out Pad was prepared by Akron Consulting, LLC (Akron). This Certification/Statement of Professional Opinion is limited to the information available to Akron at the time the Plan was written. On the basis of and subject to the foregoing, it is my professional opinion as a Professional Engineer licensed in the State of Texas, that the Plan has been prepared in accordance with good and accepted engineering practices as exercised by other engineers practicing in the same discipline(s), under similar circumstances at the time, and in the same locale. It is my professional opinion that the Plan was prepared, reviewed, and revised in accordance with the current requirements of 30 TAC 352.811 (Federal Regulation Title 40, Part 257.81).

The use of the words “certification” and/or “certify” in this document shall be interpreted and construed as a Statement of Professional Opinion, and is not and shall not be interpreted or construed as a guarantee, warranty or legal opinion. This certification in no way relieves the Owner or Operator of the facility of his/her duty to fully implement this Plan.

Engineer: Lane D. Roberts

Registration Number: 105135

State: Texas

Date: 10/06/2021

LANE D. ROBERTS
105135

P.E. certification is required for the original Plan and Plan reviews and amendments.

AKRON CONSULTING, LLC
431 N. CENTER ST.
LONGVIEW, TX 75601
TBPE Firm Reg. # 14014
(O) 903-236-9744
(F) 903-236-9745
www.akron-consulting.com

3.5 – Inflow Design Flood Control Plan Periodic 5-Year Review, East and West Bottom Ash Pond, October 2021

INFLOW DESIGN FLOOD CONTROL PLAN
PERIODIC 5-YEAR REVIEW

30 TAC 352.821 (40 CFR 257.82)

East and West Bottom Ash Pond

Pirkey Power Plant
Hallsville, Texas

October, 2021

Prepared for: Southwest Electric Power Company – Pirkey Power Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

GERS – 21 – 052

INFLOW DESIGN FLOOD CONTROL PLAN
PERIODIC 5-YEAR REVIEW
CFR 257.82
PIRKEY POWER PLANT
EAST AND WEST BOTTOM ASH POND

PREPARED BY Brett A. Dreger DATE 10/5/2021
Brett A. Dreger, P.E.

REVIEWED BY DATE 10-05-2021
Shahriyar S. Baig, P.E.

APPROVED BY Gary F. Zych DATE 10/6/2021
Gary F. Zych, P.E.
Manager – AEP Geotechnical Engineering

Gary F. Zych
STATE OF TEXAS
GARY F. ZYCH
127152
LICENSED
PROFESSIONAL ENGINEER
10/6/2021

I certify to the best of my knowledge, information, and belief that the information contained in this Inflow Design Flood Control Plan meets the requirements of 40 CFR § 257.82

Table of CONTENTS

Attachment A: Hydrology and Hydraulic Report East and West bottom Ash Ponds

1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of 30 TAC 352.821 (40 CFR 257.82) for the hydrologic and hydraulic evaluation of CCR surface impoundments. This report is a summary of the periodic 5-year review of the initial evaluation.

2.0 DESCRIPTION OF THE CCR UNIT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas.
It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for storing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP).

The East BAP is located directly adjacent to and east of the West BAP. The East BAP receives sluiced bottom ash and has a surface area of 30.9 acres and a storage capacity of 188 acre-feet. The pond is almost entirely incised, with a reported maximum embankment height of 4 feet.

The West BAP, which also receives sluiced bottom ash, is located northwest of the main plant buildings and shares its eastern border with the western border of the East BAP. The West BAP receives sluiced bottom ash and has a surface area of 30 acres and a storage capacity of 188 acre-feet. The maximum embankment height is 25 feet. The main upstream embankment slopes are 3 feet horizontal to 1 foot vertical (3:1 H:V); while the main downstream slopes area 2.5:1 H:V.

3.0 INFLOW DESIGN FLOOD 257.82(a)(3)

The facility is classified as a Low Hazard Potential Dam. This classification has not changed since the initial evaluation. The Inflow Design Flood is the 100-year storm event which is 10.3 inches during a 24 hour period.

4.0 FLOOD CONTROL PLAN 257.82(c)

The only inflows from the inflow design flood is the direct rainfall within the ponds dikes. The design to safely pass the inflow design flood without overtopping the crest of the dam is based on the normal pool being at maximum normal operating pool and utilizing the principal spillway and emergency spillway to handle the 100-year design storm without overtopping the crest of the dike.

The analysis in Attachment A includes related excerpts from the 2015 Pirkey H&H Analysis report that provides the description of the spillway system, flood storage capacity, inflow peak discharge and volume, peak discharge from the facility and maximum pool elevation.

There has not been any changes to spillway system, flood storage capacity or rainfall estimates that would change the results presented in Attachment A.

The calculations show that the facility has the capacity to manage the inflow design flood, as well as large flood events.

ATTACHMENT A

Hydrology and Hydraulic Report

East and West Ash Ponds

H.W. Pirkey Power Plant

HYDROLOGY & HYDRAULIC REPORT

EAST & WEST ASH PONDS

H.W. PIRKEY POWER PLANT – HALLSVILLE, TX

December 2015

Prepared for:

H.W. Pirkey Power Plant
2400 FM 3251
Hallsville, Texas 75650

Prepared by:

Akron Consulting, LLC
431 N. Center St.
Longview, Texas 75601
TBPE Firm # 14014

LANDON COLE ALLEN
119170

12/15/15 e

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HYDROLOGY & HYDRAULIC REPORT

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HYDROLOGIC & HYDRAULIC CALCULATIONS

APPENDIX - A

Introduction

H.W. Pirkey Power Plant which is located in Hallsville, Texas is a subsidiary of American Electric Power. Plant operation requires a series of water impoundments utilized in the process of power generation, including the bottom ash ponds. The purpose of this report is to analyze and document the Hydrologic & Hydraulic characteristics of the East and West Bottom Ash Ponds at Pirkey Power Plant.

Hydrologic Methodology

This section describes the general outline of the hydrologic methodologies used to evaluate the total runoff tributary to the ponds. Specific characteristics of each pond are discussed under individual subheadings later in this report.

The East & West Ash Ponds are total containment ponds. Watershed areas contributing to the flow into these ponds are the ponds and berms/access roads themselves; in other words, these ponds have no additional runoff areas tributary to them. Therefore, a conservative approach is to adopt a curve number 100 and to consider that every inch of rainfall will directly increase the water surface elevation.

According to Natural Resource Conservation Service (formerly SCS) Technical Release 55, the peak flow is calculated using the formula:

$Q = (P-0.2S)^2 / (P+0.8S)$

where,

Q = runoff (inches)

P = rainfall (inches)

S = potential maximum retention after runoff begins (inches) = (1000/curve number) – 10

Applying a curve number of 100 to the formula above will ultimately result in $Q = P$ (because $S=0$); which implies that the total runoff contributing to the flow in each of the ponds is directly a function of the rainfall event.

Hydraulic Methodology

This section describes the general outline of the hydraulic methodologies used to analyze the storage capacity of the ponds. Specific characteristics of each pond are discussed under individual subheadings later in this report.

The plant’s CCR rules require that the ponds be able to accommodate the rainfall volume from a

100 year 24 hour storm without over topping. The normal operating level for each pond is established by other regulations, and it is set to 3 feet below the top of the embankment. Using actual field survey data, an elevation-area-storage table was developed for the ponds and is included in the tables section of this report. Hydraflow Hydrographs was utilized to evaluate storage capacity and the water surface elevations in each pond during the 100 year 24 hour rainfall event. The 25 year 24 hour rainfall event was analyzed as well.

Detailed Hydrologic & Hydraulic characteristics of the ponds are discussed below.

EAST ASH POND:

The East Ash Pond is located to the east of the rail road track and north of the Pirkey Power Plant. This is a coal combustion waste pond used to settle bottom ash that has been sluiced from the plant boiler. Field survey of the embankment around the impoundment indicates that the top of the embankment is at a minimum elevation of 357.0msl, which is consistent with original design drawings. Therefore, based on this top of embankment elevation, the normal operating level was established at 354.0msl. The watershed area contributing to the flow into this pond was estimated to be 29.63 acres.

The storage capacity for each pond was analyzed for a 100-yr, 24-hr rainfall event, which is 10.3 inches. Multiplying the acreage times the inches, the calculated volume of the rainfall event is 1,107,836 cf of water. When this rainfall event was modeled in Hydraflow Hydrographs, it generated a more conservative rainfall volume of 1,142,455 cf.

The storage capacity was also analyzed for a 25-yr, 24-hr rainfall event, which is 8.2 inches. The calculated volume of the rainfall event is 881,967 cf of water. When this rainfall event was modeled in Hydraflow Hydrographs, it generated a more conservative rainfall volume of 909,528 cf.

Water surface elevation was then calculated for the 100-yr, 24-hr rainfall event with a normal operating level (354.0msl) as the baseline elevation. Results from Hydraflow Hydrograph indicates that the water surface elevation during the 100-yr, 24-hr rainfall will be 354.99msl which is less than 357.0msl (embankment top). Results from the 25-yr, 24-hr rainfall event indicate the water surface elevation will be 354.79msl which is also less than 357.0msl (embankment top).

WEST ASH POND:

The West Ash Pond is located to the west of the rail road track and adjacent to the east ash pond. This is a coal combustion waste pond used to settle bottom ash that has been sluiced from the plant boiler. Field survey of the embankment around the impoundment indicates that the top of the embankment is at a minimum elevation of 357.0msl, which is consistent with original design drawings. Therefore, based on this top of embankment elevation, the normal operating level was established at 354.0msl. The watershed area contributing to the flow into this pond was estimated to be 33.44 acres.

As mentioned earlier the storage capacity for each pond was analyzed for a 100-yr, 24-hr rainfall event, which is 10.3 inches. Multiplying the acreage times the inches, the calculated volume of the rainfall event is 1,250,228 cf of water. When this rainfall event was modeled in Hydraflow Hydrographs, it generated a more conservative rainfall volume of 1,289,360 cf.

The storage capacity was also analyzed for a 25-yr, 24-hr rainfall event, which is 8.2 inches. The calculated volume of the rainfall event is 995,376 cf of water. When this rainfall event was modeled in Hydraflow Hydrographs, it generated a more conservative rainfall volume of 1,026,480 cf.

Water surface elevation was then calculated for the 100-yr, 24-hr rainfall event with a normal operating level (354.0msl) as the baseline elevation. Results from Hydraflow Hydrograph indicates that the water surface elevation during the 100-yr, 24-hr rainfall will be 355.01msl which is less than 357.0msl (embankment top). Results from the 25-yr, 24-hr rainfall event indicate the water surface elevation will be 354.81msl which is also less than 357.0msl (embankment top).

<u>Summary</u>

Water surface elevations calculated from Hydraflow Hydrographs are tabulated below:

SUMMARY OF POND HYDRAULIC CHARACTERISTICS

	TOP OF EMBANKMENT	OPERATING LEVEL	100YR-24HR WSEL	25YR-24HR WSEL
EAST ASH POND	357.0	354.0	354.99	354.79
WEST ASH POND	357.0	354.0	355.01	354.81

As evident from the table above, it is the opinion of Akron Consulting that the East & West Ash Ponds will serve to adequately contain the calculated rainfall events.

TABLE 1

Runoff Curve Numbers for Hydrologic Soil-Cover Complexes
(Antecedent Moisture Condition II, and Ia= 0.2 S)
(Adapted from NRCS Technical Release 55)

Land Use	Treatment or Practice	Hydrologic Condition	Hydrologic Soil Group A	B	C	D
Fallow	Straight Row	----	77	86	91	94
Row Crops	Straight Row	Poor	72	81	88	91
	Straight Row	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	Contoured	Good	65	75	82	86
	Contoured and Terraced	Poor	66	74	80	82
	Contoured and Terraced	Good	62	71	78	81
Small Grain	Straight Row	Poor	65	76	84	88
	Straight Row	Good	63	75	83	87
	Contoured	Poor	63	74	82	85
	Contoured	Good	61	73	81	84
	Contoured and Terraced	Poor	61	72	79	82
	Contoured and Terraced	Good	59	70	78	81
Close-Seeded, Legumes, Rotation Meadow	Straight Row	Poor	66	77	85	89
	Straight Row	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	Contoured	Good	55	69	78	83
	Contoured and Terraced	Poor	63	73	80	83
	Contoured and Terraced	Good	51	67	76	80
Pasture Or Range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads/Facilites		----	74	84	90	92

TABLE 2
EAST ASH POND ELEVATION-AREA-STORAGE TABLE
H.W. PIRKEY POWER PLANT
EXISTING CONDITION
NORMAL OPERATING POOL AT 354.0

ELEVATION (ft)	AREA (Acres)	STORAGE (Ac-Ft)	STORAGE (Cubic Feet)	STORAGE (Million Gallons)
352.00	25.70	na	na	na
353.00	25.99	na	na	na
354.00	26.29	0.00	0	0.00
355.00	26.59	26.44	1,151,730	232.61
356.00	26.88	53.18	2,316,300	467.82
357.00	27.19	80.21	3,493,950	705.67

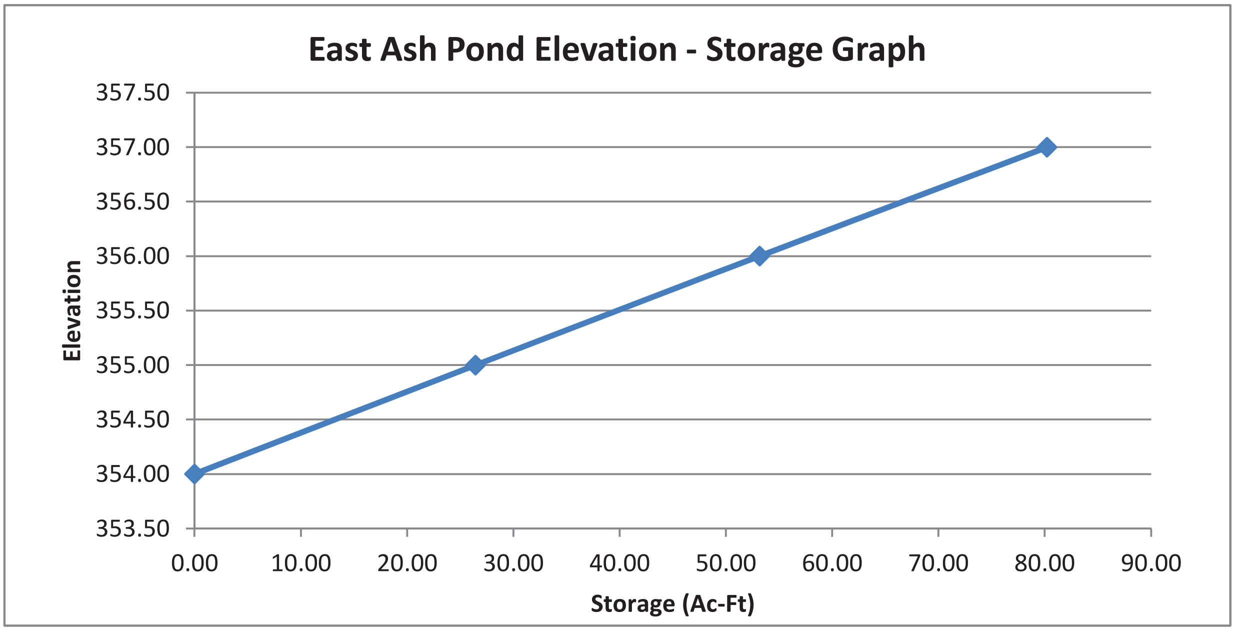
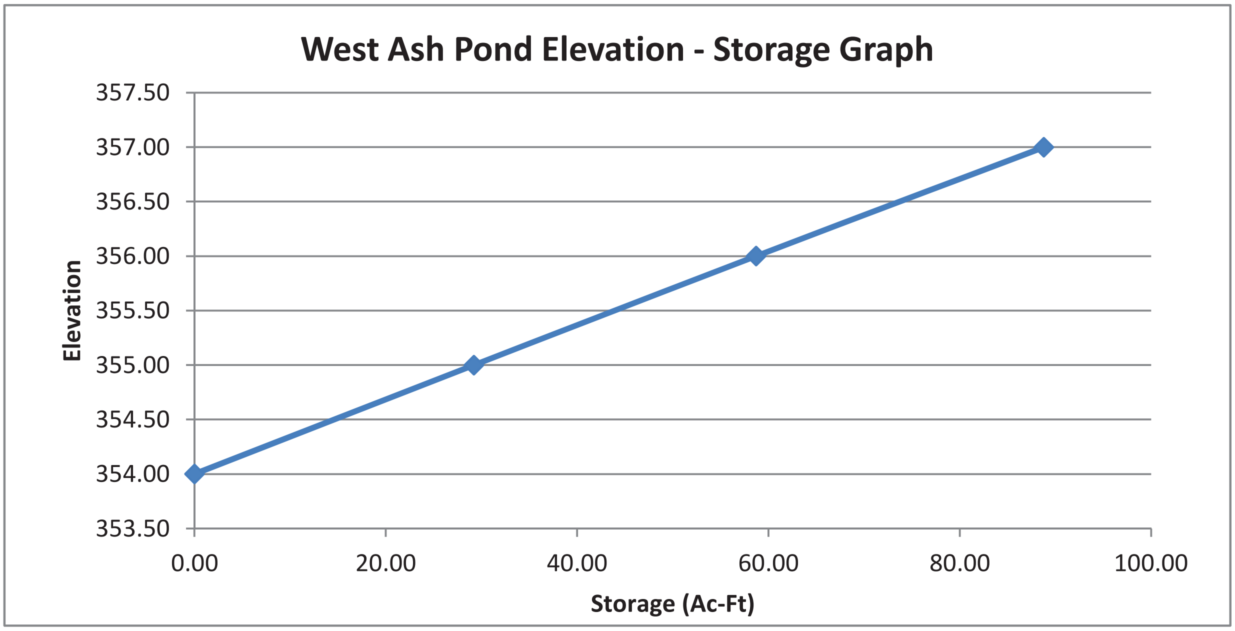
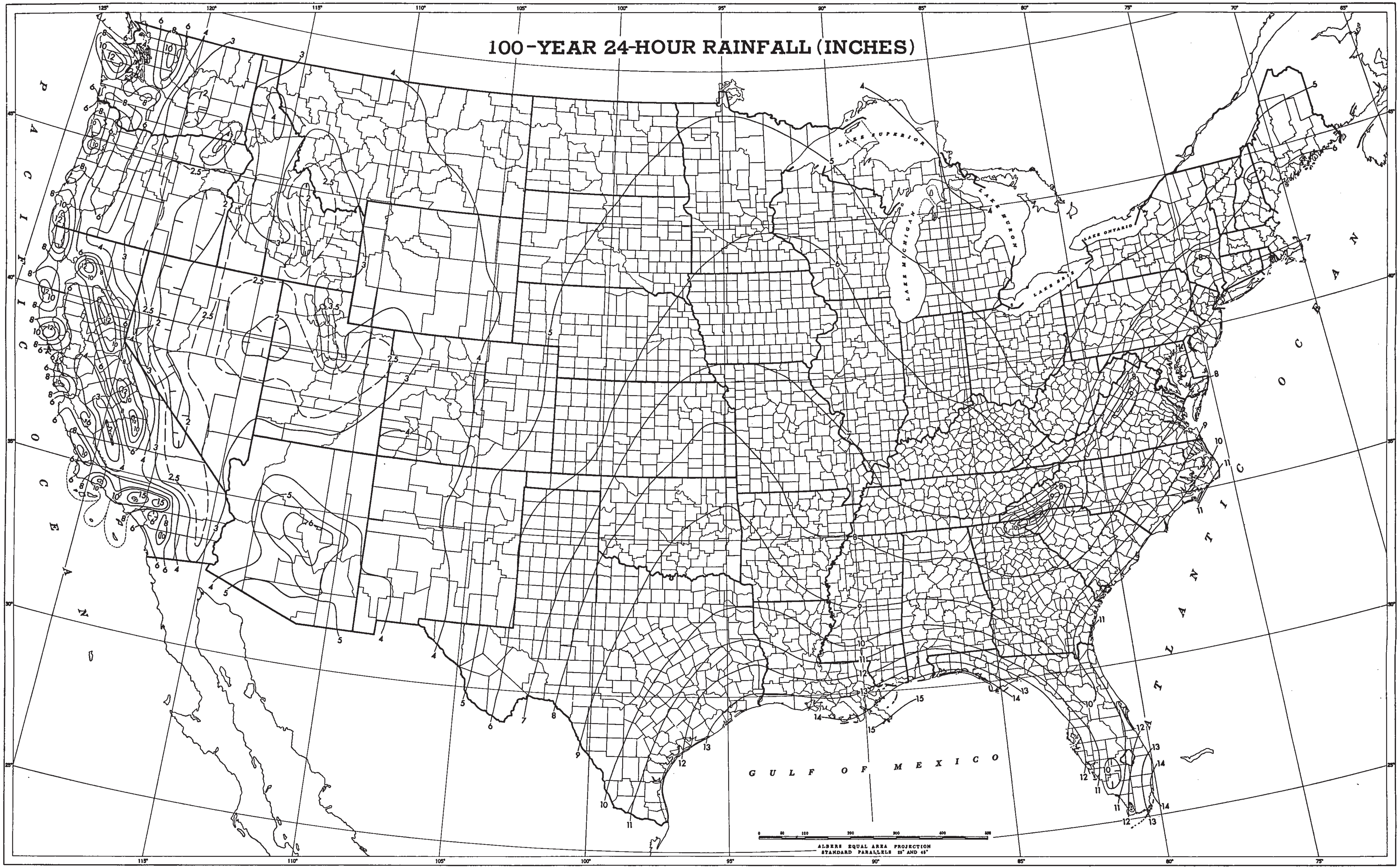


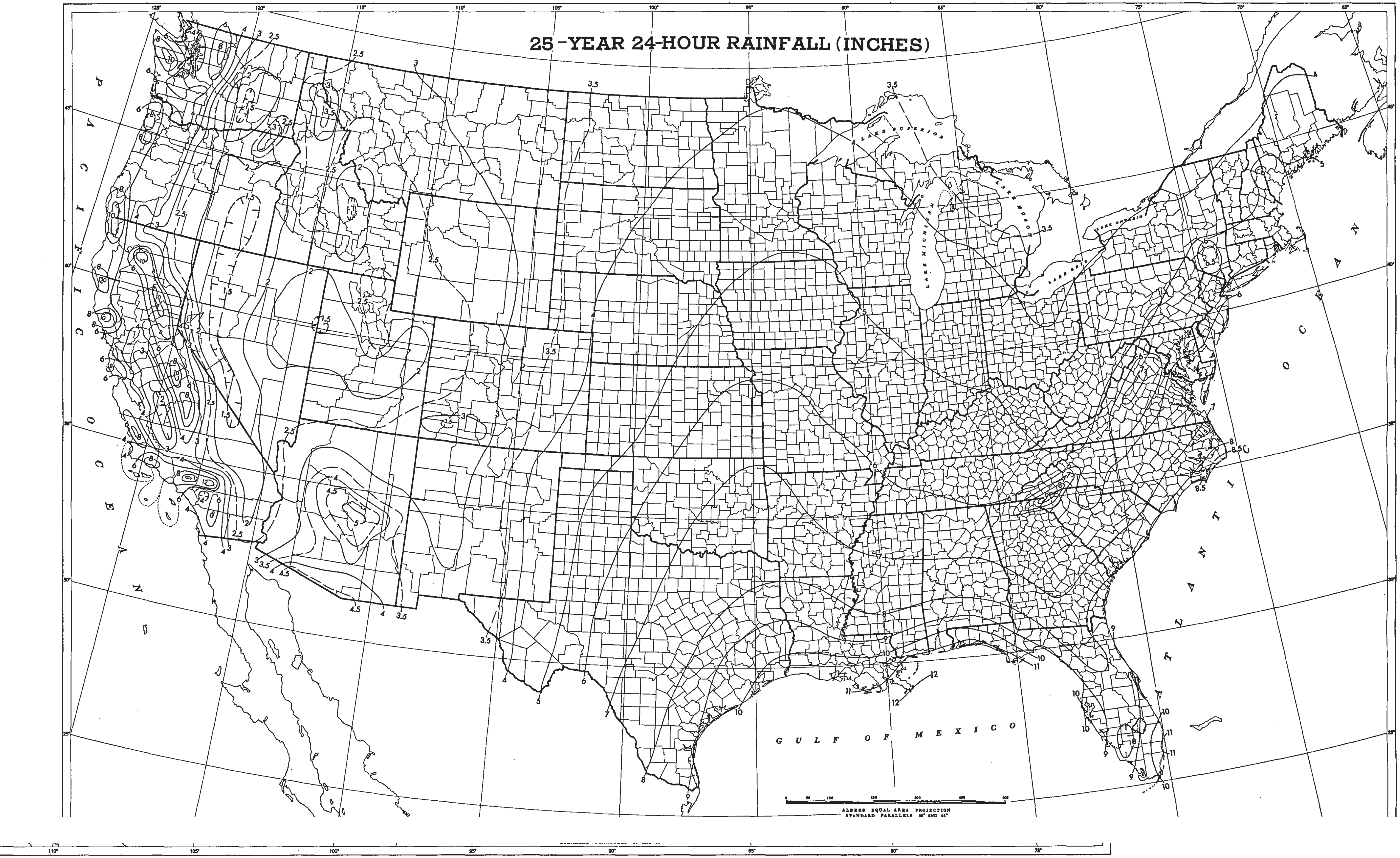
TABLE 3
WEST ASH POND ELEVATION-AREA-STORAGE TABLE
H.W. PIRKEY POWER PLANT
EXISTING CONDITION
NORMAL OPERATING POOL AT 354.0

ELEVATION (ft)	AREA (Acres)	STORAGE (Ac-Ft)	STORAGE (Cubic Feet)	STORAGE (Million Gallons)
352.00	28.43	na	na	na
353.00	28.74	na	na	na
354.00	29.05	0.00	0	0.00
355.00	29.36	29.21	1,272,170	256.94
356.00	29.67	58.72	2,557,840	516.61
357.00	30.47	88.79	3,867,690	781.16





100-YEAR 24-HOUR RAINFALL (INCHES)

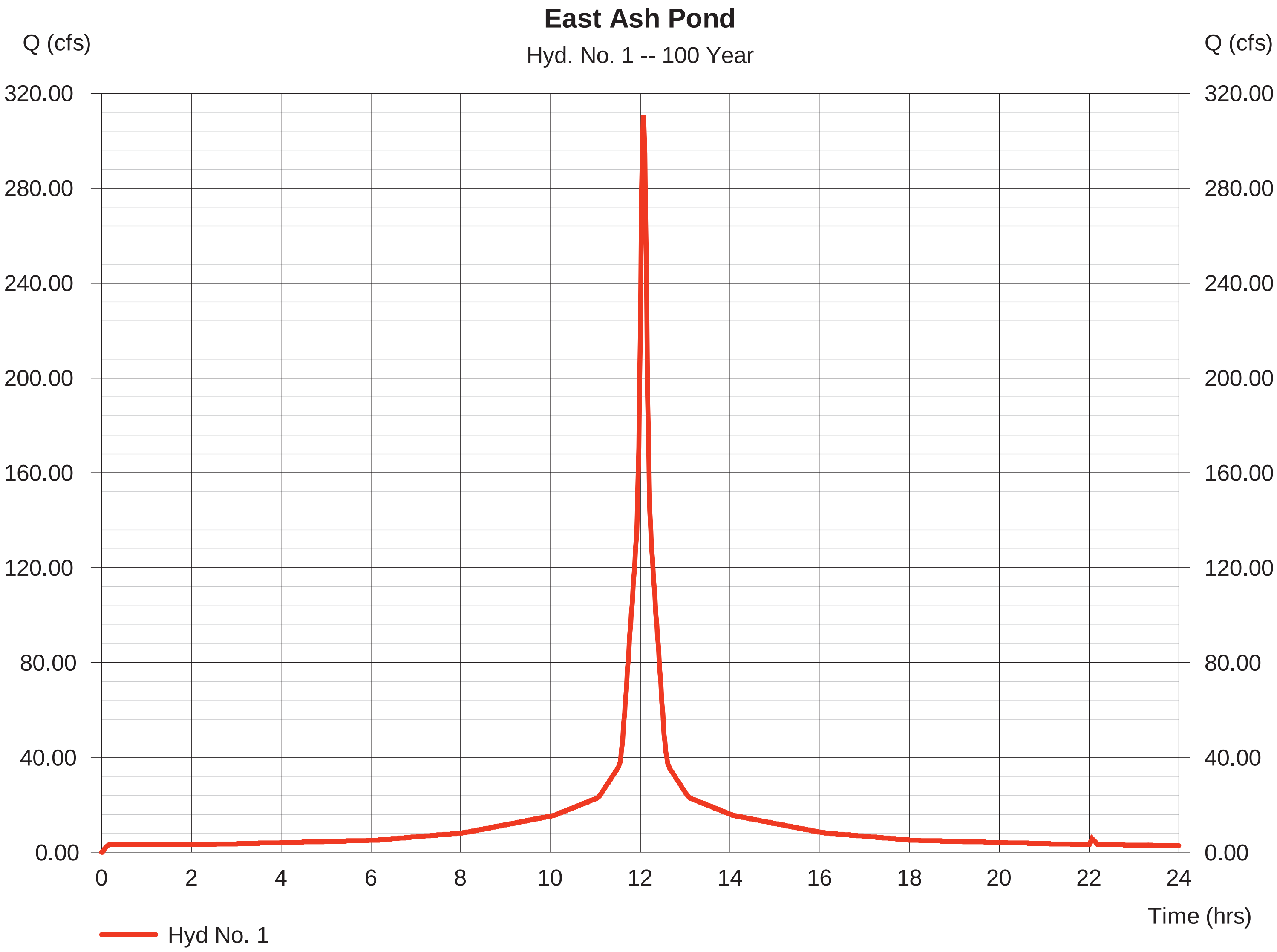

25-YEAR 24-HOUR RAINFALL (INCHES)
PACIFIC OCEAN
ATLANTIC OCEAN
GULF OF MEXICO
LAKE SUPERIOR
LAKE MICHIGAN
LAKE HURON
LAKE ERIE
LAKE ONTARIO
125°
120°
115°
110°
105°
100°
95°
90°
85°
80°
75°
70°
65°
45°
40°
35°
30°
25°
0 50 100 200 300 400 500
ALBERS EQUAL AREA PROJECTION
STANDARD PARALLELS 29° AND 45°

Hydrograph Report

Hyd. No. 1

East Ash Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 310.73 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 1 min	Hyd. volume	= 1,142,455 cuft
Drainage area	= 29.630 ac	Curve number	= 100
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 10.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



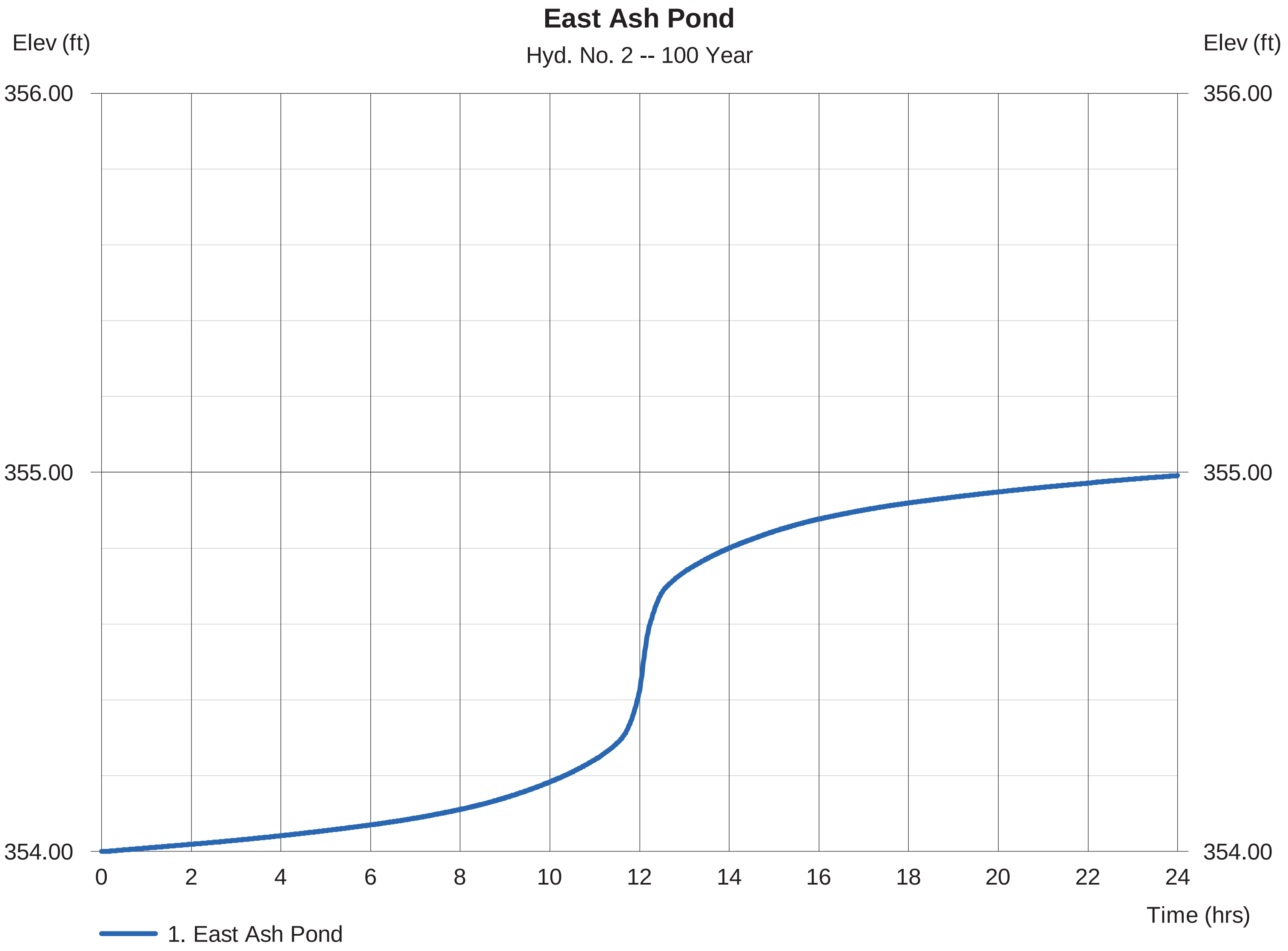
Hydrograph Report

Hyd. No. 2

East Ash Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 100 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - East Ash Pond	Max. Elevation	= 354.99 ft
Reservoir name	= East Ash Pond		

Storage Indication method used. Wet pond routing start elevation = 354.00 ft.

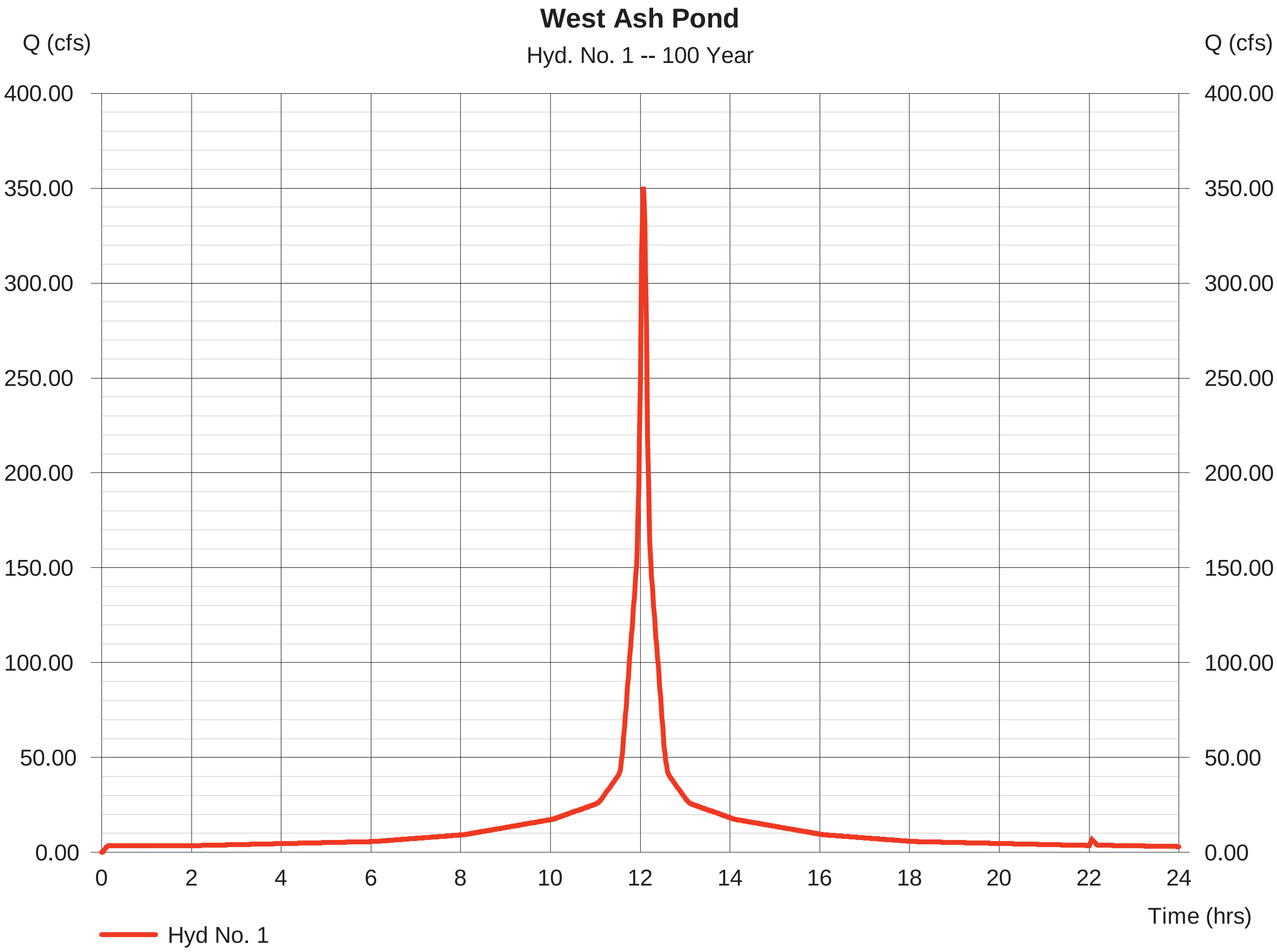


Hydrograph Report

Hyd. No. 1

West Ash Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 350.69 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.07 hrs
Time interval	= 1 min	Hyd. volume	= 1,289,360 cuft
Drainage area	= 33.440 ac	Curve number	= 100
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 10.30 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



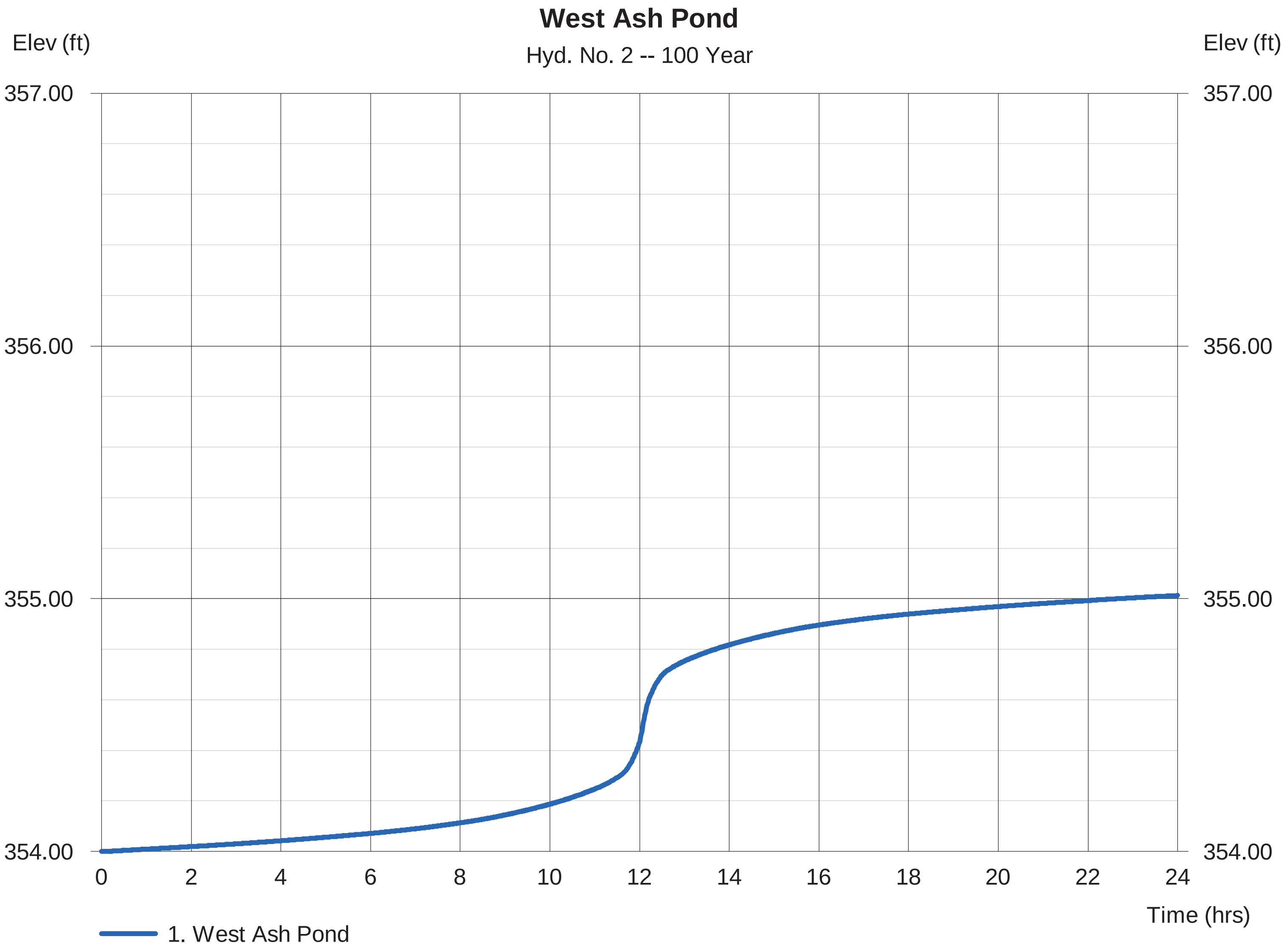
Hydrograph Report

Hyd. No. 2

West Ash Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 100 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - West Ash Pond	Max. Elevation	= 355.01 ft
Reservoir name	= West Ash Pond		

Storage Indication method used. Wet pond routing start elevation = 354.00 ft.



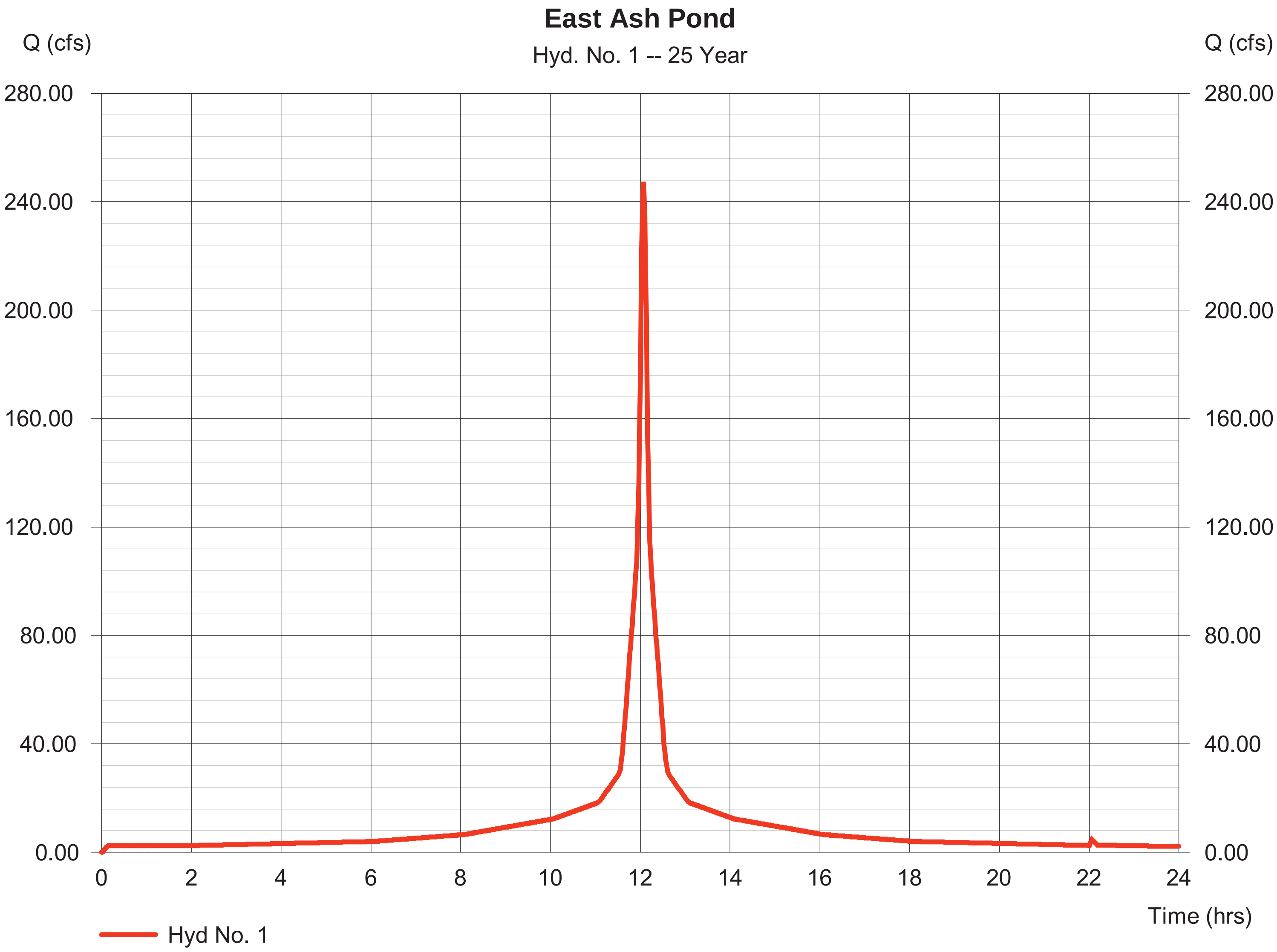
Hydrograph Report

Hyd. No. 1

East Ash Pond

Hydrograph type = SCS Runoff
Storm frequency = 25 yrs
Time interval = 1 min
Drainage area = 29.630 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 8.20 in
Storm duration = 24 hrs

Peak discharge = 247.38 cfs
Time to peak = 12.07 hrs
Hyd. volume = 909,528 cuft
Curve number = 100
Hydraulic length = 0 ft
Time of conc. (Tc) = 5.00 min
Distribution = Type III
Shape factor = 484



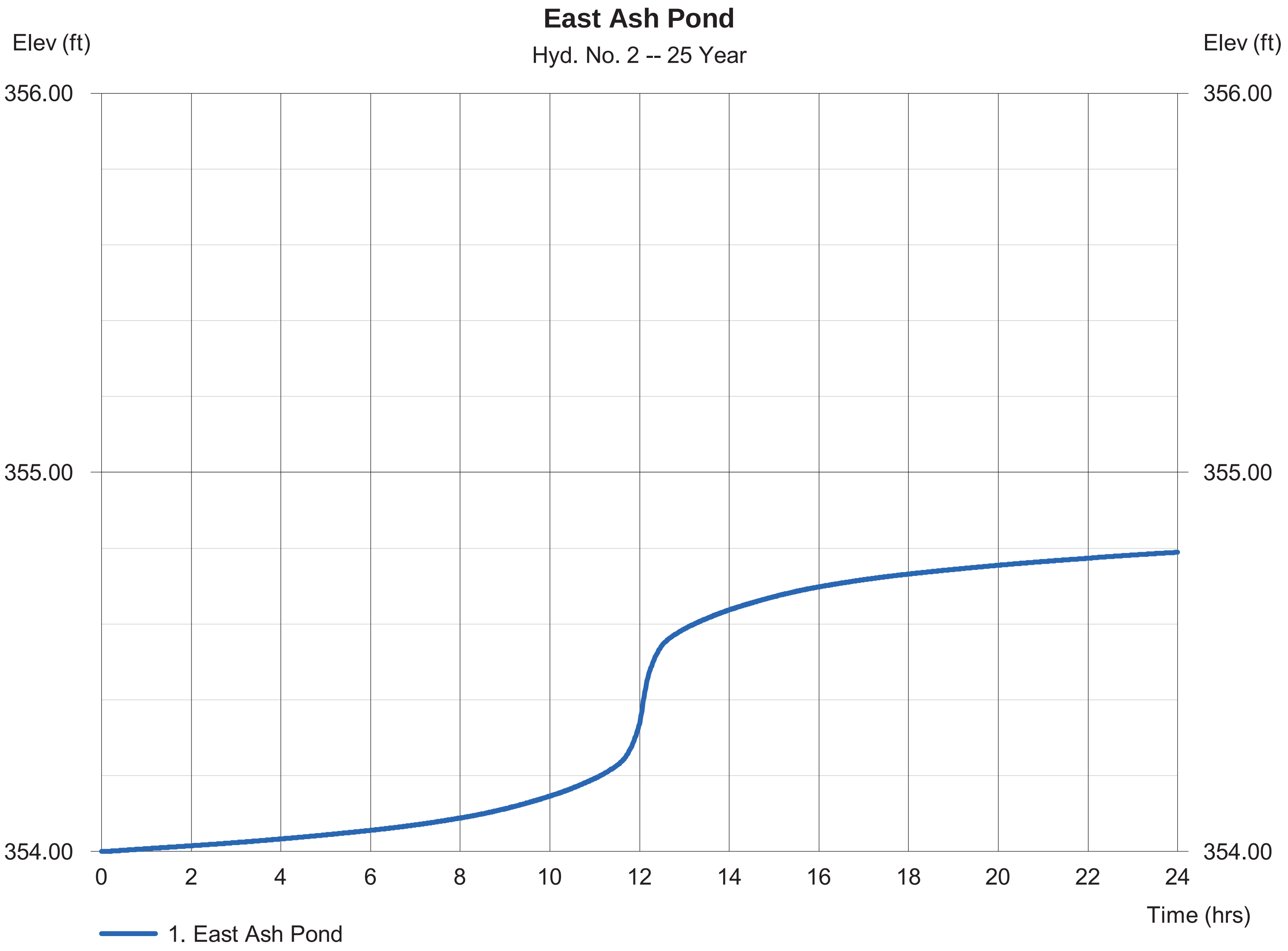
Hydrograph Report

Hyd. No. 2

East Ash Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 25 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - East Ash Pond	Max. Elevatioo	= 354.79 ft
Reservoir name	= East Ash Pond		

Storage Indication method used. Wet pond routing start elevation = 354.00 ft.

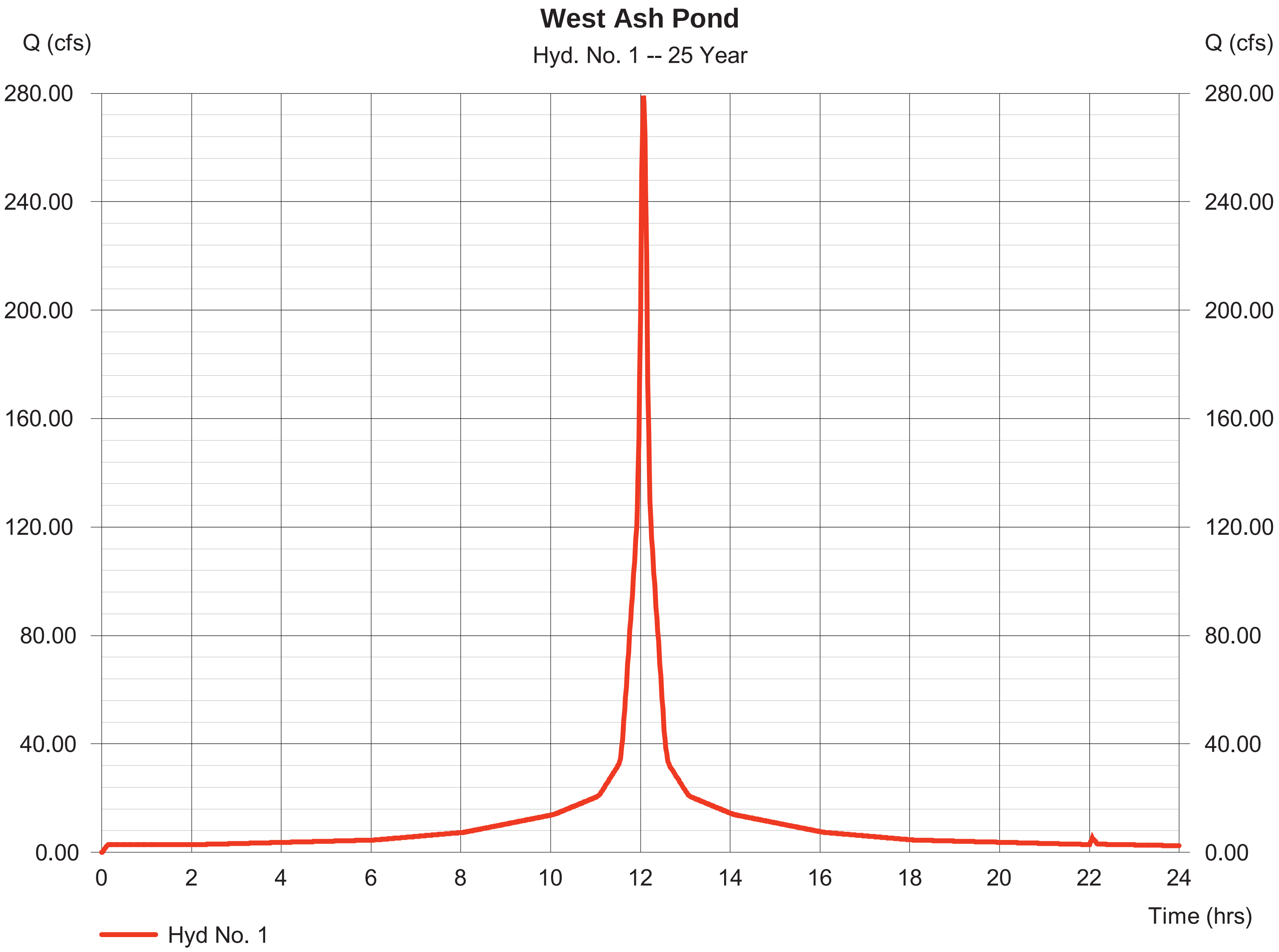


Hydrograph Report

Hyd. No. 1

West Ash Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 279.19 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 1 min	Hyd. volume	= 1,026,480 cuft
Drainage area	= 33.440 ac	Curve number	= 100
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 8.20 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



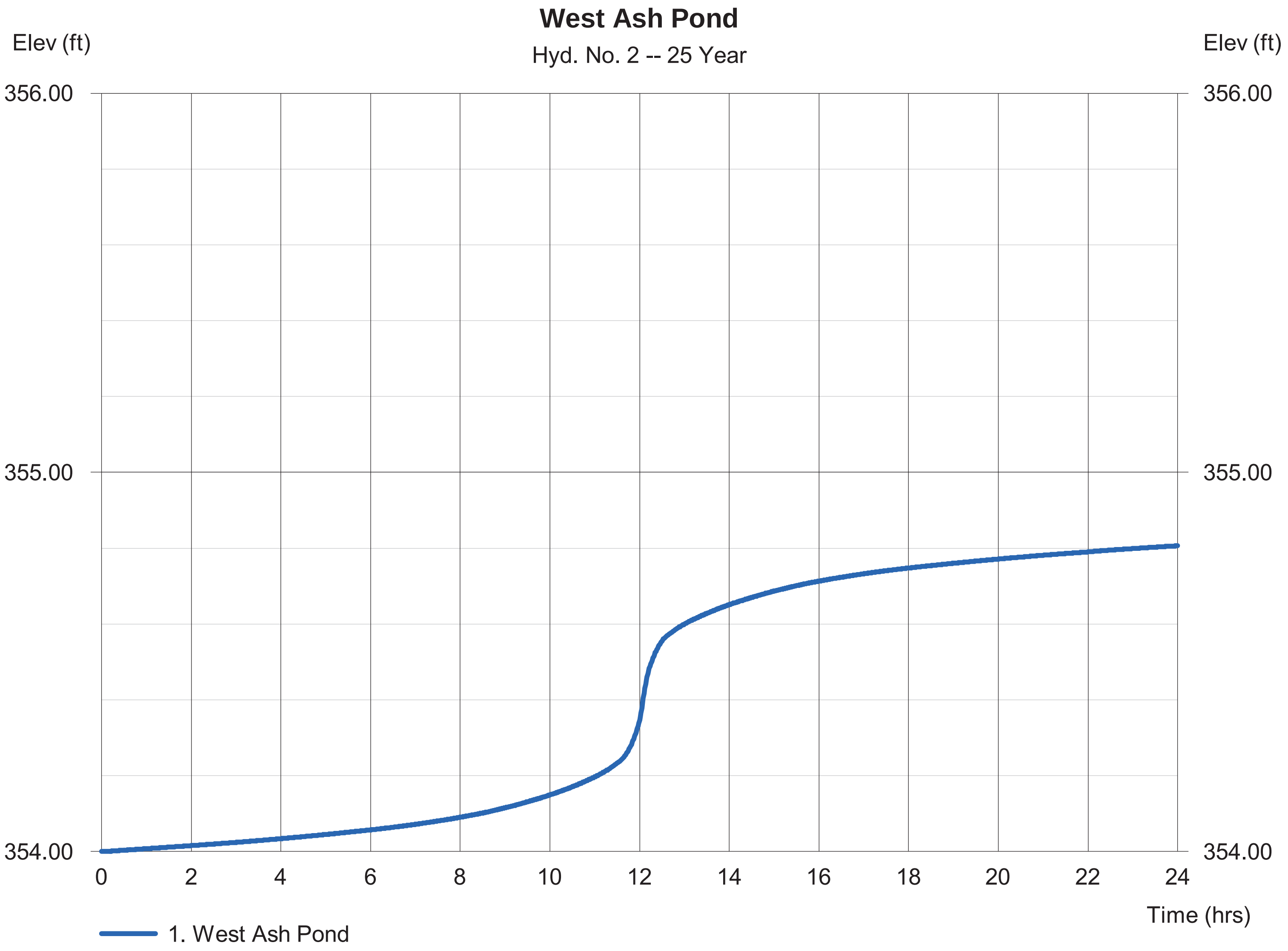
Hydrograph Report

Hyd. No. 2

West Ash Pond

Hydrograph type	= Reservoir	Peak discharge	= 0.000 cfs
Storm frequency	= 25 yrs	Time to peak	= n/a
Time interval	= 1 min	Hyd. volume	= 0 cuft
Inflow hyd. No.	= 1 - West Ash Pond	Max. Elevation	= 354.81 ft
Reservoir name	= West Ash Pond		

Storage Indication method used. Wet pond routing start elevation = 354.00 ft.



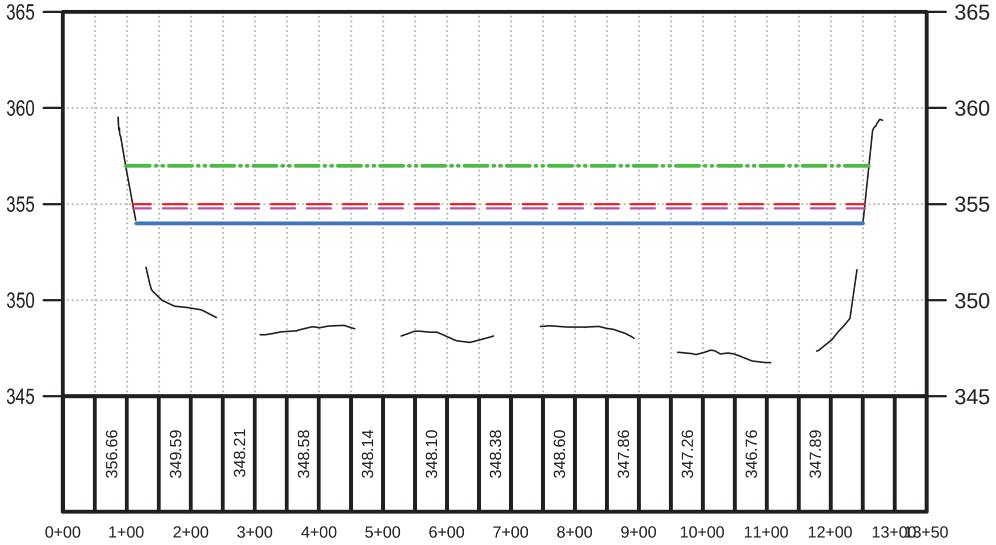
PLAN VIEW
SCALE: 1"=200'

0 300' 600'
1"=300'

N

LEGEND

▬ ▬ ▬ WATERSHED BOUNDARY



SECTION A-A
HORIZ. SCALE: 1"=300'
VERT. SCALE: 1"=30'

LEGEND

—··—··—	TOP OF EMBANKMENT ELEV.= 357.00
— — —	100 YEAR 24 HOUR WSEL ELEV.= 354.99
— — —	25 YEAR 24 HOUR WSEL ELEV.= 354.79
———	NORMAL OPERATING LEVEL= 354.00

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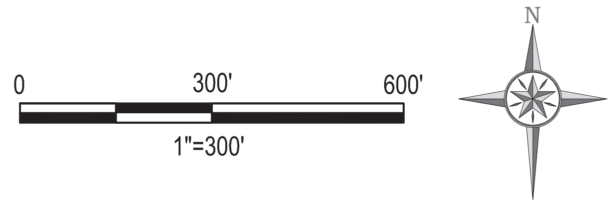
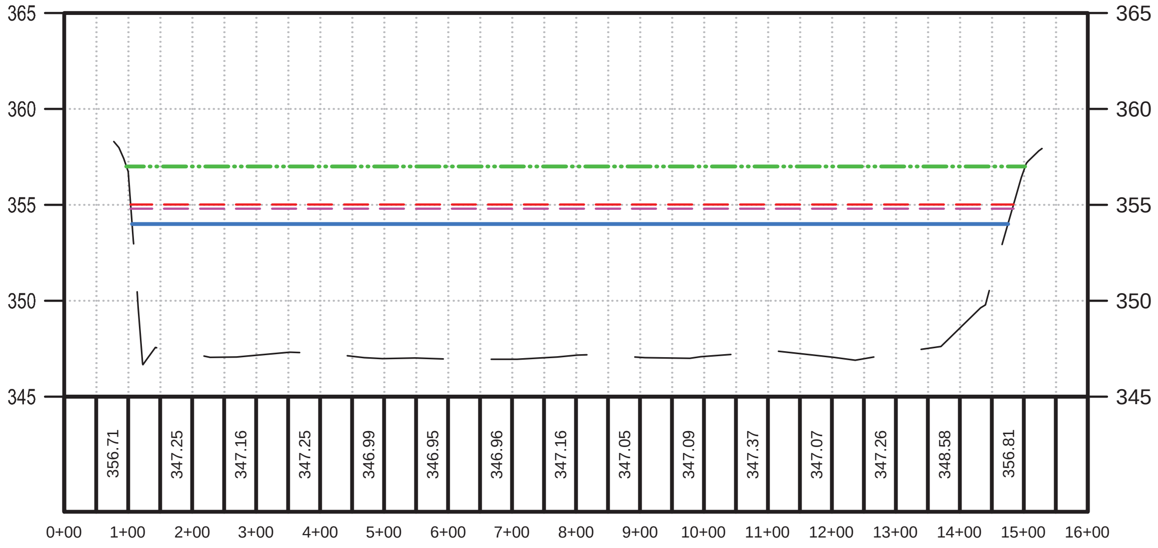
EAST ASH POND WATER SURFACE EXHIBIT



LEGEND

▬ ▬ ▬ WATERSHED BOUNDARY

PLAN VIEW
SCALE: 1"=300'



SECTION B-B
HORIZ. SCALE: 1"=300'
VERT. SCALE: 1"=30'

LEGEND

-··-··- TOP OF EMBANKMENT ELEV.= 357.00

— — — 100 YEAR 24 HOUR WSEL ELEV.= 355.01

— — — 25 YEAR 24 HOUR WSEL ELEV.= 354.81

——— NORMAL OPERATING LEVEL= 354.00

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WEST ASH POND WATER SURFACE EXHIBIT

3.6 – 2019 Annual Dam and Dike Inspection Report, Bottom Ash Ponds, November 2019

2019 ANNUAL DAM AND DIKE INSPECTION REPORT

BOTTOM ASH PONDS

PIRKEY POWER PLANT
HALLSVILLE, TEXAS

November 2019

Prepared by: American Electric Power Service Corporation
1 Riverside Plaza
Columbus, OH 43215

GERS-19-040

Dam & Dike Inspection Report
ASH Ponds

GERS-19-040
Revision 0

PIRKEY POWER PLANT
HALLSVILLE, TEXAS

INSPECTION DATE **October 22, 2019**

PREPARED BY Brett A. Dreger **DATE** 11/19/2019
Brett A. Dreger, P.E.

REVIEWED BY **DATE** 11/20/2019
Pedro J. Amaya, P.E. /For

APPROVED BY Gary F. Zych **DATE** 11/22/2019
Gary F. Zych, P.E.
Manager - Geotechnical Engineering

Gary F. Zych
GARY F. ZYCH
127152
11/22/2019

PROFESSIONAL ENGINEER
SEAL & SIGNATURE

I certify to the best of my knowledge, information and belief the information contained in this report meets the requirements of 40 CFR § 257.83(b).

TABLE OF CONTENTS

LIST OF TABLES

ATTACHMENTS

1.0 INTRODUCTION

This report was prepared by AEP- Geotechnical Engineering Services (GES) section, in part, to fulfill requirements of 40 CFR 257.83 and to provide South Western Electric Power Company (SWEPCO) and Pirkey Power Plant with an evaluation of the facility.

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas.

American Electric Power Service Corporation's Civil Engineering Division administers the Pirkey Power Plant's Dam Inspection and Maintenance Program (DIMP). As part of the DIMP, staff from the Geotechnical Engineering Services Section annually conducts dam and dike inspections. This report contains the inspection findings, observations, photographic descriptions, conclusions, and maintenance recommendations. This inspection report addresses the Bottom Ash Ponds at the Pirkey Power plant.

Mr. Brett Dreger, PE, a staff from the Geotechnical Engineering Services Section, conducted the Ash Ponds Inspection. Mr. William G. Carter, P.E. of AEP Plant Engineering Region 5, was the facility contact for the inspection and accompanied Mr. Brett Dreger during the inspection. The inspection was performed on October 22, 2019. Weather conditions were mostly sunny, with temperatures ranging from 50° F in the morning to 70° F in the afternoon. There was 2.5 inches of rainfall over the seven days prior to the inspection.

This report has been prepared by Mr. Brett Dreger, PE, under the direct supervision of Mr. Gary Zych, PE, AEP's Geotechnical section manager. The report presents: (i) Description of the impoundments, (i) Summary of Visual Observations; (ii) Conclusions; and (iii) Recommendations. Photographs identifying typical conditions, problem areas, items that need correction or requiring additional monitoring, have been selected from the inspection field photographic file and provided in the Attachments A and B, to this report.

2.0 DESCRIPTION OF IMPOUNDMENTS

2.1 EAST BOTTOM ASH POND

The East BAP CCR unit is located at the north end of the Plant and approximately 2,000 feet north-northwest of Brandy Branch Reservoir. The East BAP is partially incised below the existing natural ground surface with an embankment height of approximately 4 feet. The East BAP embankments are constructed of compacted clay on a 3:1 slope (3 feet horizontal, 1 foot vertical). The elevation of the top of the embankment around the perimeter of the East BAP is approximately 357 feet above msl, and the normal operating level is approximately 354 feet above msl. At the time of inspection, the EBAP was in service and the pool level was at 354.5 feet above msl. The interior bottom elevation of the East BAP is approximately 347.0 feet above msl.

Surface water elevation in the East BAP is controlled by a stop log regulated window cut into a concrete riser and a manually operated gate valve on a 36-inch-diameter discharge pipe at the southwest corner of the pond. Clear water overflow from the East BAP discharges through the 36-inch-diameter corrugated metal pipe into the 2.7- acre Secondary Bottom Ash Pond located directly south of the East BAP. Water in the Secondary Bottom Ash Pond is either pumped (recirculated) back into the boiler ash hopper, or gravity discharged through a pipe at the southwest corner of the Secondary Bottom Ash Pond into an unnamed intermittent tributary of Hatley Creek via Outfall 006 in accordance with Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0002496000.

2.2 WEST BOTTOM ASH POND

The West BAP CCR unit is located at the north end of the Plant and approximately 3,000 feet northwest of Brandy Branch Reservoir. The West BAP embankments have a maximum height of approximately 25 feet and are constructed of compacted clay on a slope ranging from 2.5:1 (2.5 feet horizontal, 1 foot vertical) to 3:1. The elevation at the top of the embankment around the perimeter of the West BAP is approximately 357 feet above msl, and the normal operating level is approximately 354 feet above msl. At the time of inspection, the WBAP was out of service and the pool level was at 348.5 feet above msl. The interior bottom elevation of the East BAP is approximately 347 feet above msl.

Surface water elevation in the West BAP is controlled by a stop log regulated window cut into a concrete riser and a manually operated gate valve on a 36-inch-diameter discharge pipe at the southeast corner of the pond. Clear water overflow from the West BAP discharges through the 36-inch-diameter corrugated metal pipe into the 2.7- acre Secondary Bottom Ash Pond located southeast of the West BAP. Water in the Secondary Bottom Ash Pond is either pumped (recirculated) back into the boiler ash hopper, or gravity discharged through a pipe at the southwest corner of the Secondary Bottom Ash Pond into an unnamed intermittent tributary of Hatley Creek via Outfall 006 in accordance with Texas Pollutant Discharge Elimination System (TPDES) Permit No. WQ0002496000.

3.0 REVIEW OF AVAILABLE INFORMATION (257.83(b)(1)(i))

A review of available information regarding the status and condition of the CCR Ponds, which include files available in the CCR operating record, such as design and construction information, periodic structural stability assessments, previous 7 day inspection reports, 30-day instrumentation data, and previous annual inspections has been conducted. Based on the review of the data there were no signs of actual or potential structural weakness or adverse conditions.

4.0 CHANGES IN GEOMETRY SINCE LAST INSPECTION (257.83(b)(2)(i))

No modifications have been made to the geometry of the East and West Bottom Ash Ponds since the 2018 annual inspection. The geometry of the impoundment has remained essentially unchanged.

5.0 CHANGES THAT EFFECT STABILITY OR OPERATION (257.83(b)(2)(vii))

Based on interviews with plant personnel and field observations there were no changes to the East and West Bottom Ash Ponds since the last annual inspection that would affect the stability or operation of the impounding structure.

6.0 IMPOUNDMENT CHARACTERISTICS (257.83(b)(2)(iii, iv, v))

6.1 EAST BOTTOM ASH POND

Table 1 is a summary of the minimum, maximum, and present depth and elevation of the impounded water and CCR material since the previous annual inspection; the storage capacity of the impounding structure at the time of the inspection; and the approximate volume of the impounded water at the time of the inspection.

Table 1 Summary of Relevant Storage Information for East bottom Ash Pond

	Primary Ash Pond
Approximate **Minimum** depth of impounded water since last annual inspection	0.5ft (347.5)
Approximate **Maximum** depth of impounded water since last annual inspection	7.5ft (354.5)
Approximate **Present** depth of impounded water at the time of the inspection	7.5 ft (354.5)
Approximate **Minimum** depth of CCR since last annual inspection	0.5ft (347.5)
Approximate **Maximum** depth of CCR since last annual inspection	7.5ft (354.5)
Approximate **Present** depth of CCR at the time of the inspection	2.0ft (349.0)
Storage Capacity of impounding structure at the time of the inspection	188 acre-ft
Approximate volume of impounded water at the time of the inspection	40 Million Gallons at El. 354.5
Approximate volume of CCR at the time of the inspection	60,000 c.y.

6.2 WEST BOTTOM ASH POND

Table 2 is a summary of the minimum, maximum, and present depth and elevation of the impounded water and CCR material since the previous annual inspection; the storage capacity of the impounding structure at the time of the inspection; and the approximate volume of the impounded water at the time of the inspection.

Table 2 Summary of Relevant Storage Information for West Bottom Ash Pond

	Bottom Ash Storage Pond
Approximate **Minimum** depth of impounded water since last annual inspection	0.5ft (347.5)
Approximate **Maximum** depth of impounded water since last annual inspection	7.5ft (354.5)
Approximate **Present** depth of impounded water at the time of the inspection	1.5ft (348.5)
Approximate **Minimum** depth of CCR since last annual inspection	0.5ft (347.5)
Approximate **Maximum** depth of CCR since last annual inspection	7.5ft (354.5)
Approximate **Present** depth of CCR at the time of the inspection	1.0ft (348.0)

Storage Capacity of impounding structure at the time of the inspection	188 acre-ft
Approximate volume of impounded water at the time of the inspection	5 Million Gallons at El. 348.5
Approximate volume of CCR at the time of the inspection	15,000 c.y.

7.0 INSPECTION (257.83(b)(1)(ii))

7.1 GENERAL

The summary of the visual observations uses terms to describe the general appearance or condition of an observed item, activity or structure. Their meaning is understood as follows:

Good:	A condition or activity that is generally better or slightly better than what is minimally expected or anticipated from a design or maintenance point of view.
Fair or Satisfactory:	A condition or activity that generally meets what is minimally expected or anticipated from a design or maintenance point of view.
Poor:	A condition or activity that is generally below what is minimally expected or anticipated from a design or maintenance point of view.
Minor:	A reference to an observed item (e.g., erosion, seepage, vegetation, etc.) where the current maintenance condition is below what is normal or desired, but which is not currently causing concern from a structure safety or stability point of view.
Significant:	A reference to an observed item (e.g. erosion, seepage, vegetation, etc.) where the current maintenance program has neglected to improve the condition. Usually, conditions that have been previously identified in the previous inspections, but have not yet been corrected.
Excessive:	A reference to an observed item (e.g., erosion, seepage, vegetation, etc.) where the current maintenance condition is below or worse than what is normal or desired, and which may have affected the ability of the observer to properly evaluate the structure or particular area being observed or which may be a concern from a structure safety or stability point of view.

In addition, a "deficiency" is some evidence that a dam has developed a problem that could impact the structural integrity of the dam. There are four general categories of deficiencies. These four categories are described below:

1. Uncontrolled Seepage

Uncontrolled seepage is seepage that is not behaving as the design engineer has intended. An example of uncontrolled seepage is seepage that comes through or around the embankment and is not picked up and safely carried off by a drain. Seepage that is collected by a drain can still be uncontrolled if it is not safely collected and transported, such as seepage that is not clear. Seepage that is unable to be measured and/or observe it is considered uncontrolled seepage. [Wet or soft areas are not considered as uncontrolled seepage, but can lead to this type of deficiency. These areas should be monitored frequently.]

2. Displacement:

   Displacement of the embankment is large scale movement of part of the dam. Common signs of displacement are cracks, scraps, bulges, depressions, sinkholes and slides.

3. Blockage of Control Features:

   Blockage of Control Features is the restriction of flow at spillways, decant or pipe spillways, or drains.

4. Erosion:

   Erosion is the gradual movement of surface material by water, wind or ice. Erosion is considered a deficiency when it is more than a minor routine maintenance item.

7.2 VISUAL INSPECTION (257.83(b)(2)(i))

A visual inspection of the CCR Ponds Complex was conducted to identify any signs of distress or malfunction of the impoundment and appurtenant structures. Specific items inspected included all structural elements of the dam such as upstream and downstream slopes, crest, and toe.

EAST BOTTOM ASH POND

In general, the crest, interior and exterior slopes of the dike appear to be in satisfactory and stable condition. No significant change to the exterior slope was noted from the previous inspection. No significant settlement or misalignment was observed. Seeps were not observed during the inspection. No animal burrows were observed during the inspection.

1. Photographs No. 1 illustrates the crest area and interior slopes of the eastern side of the east bottom ash pond. The crest has signs of rutting form truck traffic and the vegetation on the interior slopes is overgrown. There were no other signs of settlement, misalignment and cracking observed.

2. Photographs No. 2 illustrates the condition of the perimeter ditch on the east side of the pond. The perimeter ditch shows signs of a washout from a recent rain event. The sediment and vegetation buildup from the washout is causing standing water in the bottom of the ditch.

3. Photograph No. 3 shows the general condition of the interior area of the East Bottom Ash Pond. The east bottom ash pond was in service at the time of inspection.

4. Photograph No. 4 illustrates the typical condition of the crest area on the north side of the pond. In general, the crest area appeared to be in satisfactory condition with no signs of rutting, cracks or misalignment.

5. Photographs No. 5 shows the general condition of the interior slopes of the east bottom ash pond. The slope appeared in satisfactory and stable condition. There were no signs of settlement, misalignment, sloughing or erosion.

6. The overflow discharge structure walkway, railings, metal decking, and visible concrete were found to be in satisfactory, functional condition. However, there was overgrown vegetation adjacent to the access platform. Photographs No. 6 illustrate the access stairs, metal walkway, metal deck, and concrete structure of the overflow discharge structure.

Overall the facility is in satisfactory condition. The impoundment is functioning as intended with no signs of potential structural weakness or conditions which may be disrupting to the safe operation of the impoundment.

WEST BOTTOM ASH POND

In general, the crest, interior and exterior slopes of the dike appear to be in satisfactory and stable condition. No significant change to the exterior slope was noted from the previous inspection. No significant settlement or misalignment was observed. Seeps were not observed during the inspection. No animal burrows were observed during the inspection.

7. Photographs No. 7 and 8 illustrate a typical overview of the dike crest. The crest appears to be in good and stable condition. There were no other signs of settlement, misalignment and cracking observed.

8. Photographs No. 9 and 10 illustrate the condition of the interior slopes and vegetation management of the west bottom ash pond. The interior slopes and vegetation of the interior dikes appeared to be in satisfactory and stable condition.

9. Photograph No. 11 show the general condition of the interior area of the west bottom ash pond. There is some overgrown vegetation surrounding the sluicing pipe platform that extends out into center of the pond. The west bottom ash pond was out of service at the time of inspection.

10. The overflow discharge structure walkway, railings, metal decking, and visible concrete were found to be in satisfactory, functional condition. However, there was some overgrown vegetation adjacent to the access stairs. Photographs No. 12 illustrates the overgrown vegetation around the access metal walkway, metal deck, and concrete structure of the overflow discharge structure.

11. Photographs No. 13, 14 and 16 shows the general condition of the exterior slope and toe areas of the west bottom ash pond. The slopes appeared in satisfactory and stable condition. There were no signs of wet areas, settlement, misalignment, sloughing or erosion. The north and west exterior slopes had overgrown vegetation.

12. Photograph No. 15 shows a significant tire rut on the upper south exterior slope near the crest. The tire rut is likely caused from recent mowing activities.

13. Photograph No. 17 shows the development erosion formed along the edge of an access ramp on the southeast side of pond. There also are some minor erosion formed on another access ramp at the southwestern corner of the embankment. The erosion is taking place in

areas along these access ramps to the crest, but does not appear to be a detrimental condition to the integrity of the structure.

Overall the facility is in satisfactory condition. The impoundment is functioning as intended with no signs of potential structural weakness or conditions which maybe disrupting to the safe operation of the impoundment.

7.3 INSTRUMENTATION (257.83(b)(2)(ii))

The monitoring instrumentation for the West Bottom Ash Pond include open pipe type piezometers. The piezometers are located in the crest areas and are flush mount design. There is no monitoring instrumentation for the East Bottom Ash Pond.

Monitoring instrumentation data is reviewed as part of the annual inspection program for the Pirkey Bottom Ash Ponds. The maximum levels measured since the last inspection of the West Bottom Ash Pond are reported below:

Pond Name	Crest Elevation msl	Boring/Piezometer	Min/Max/Present WSEL msl
West Bottom Ash	357.0	W-1	323.80/338.31/323.80
West Bottom Ash	357.0	W-3	319.27/328.85/319.27

Piezometers W-1 and W-3 are in service and water level readings are measured on a monthly basis. The readings of the piezometers are in good agreement with the operating levels of the pond and are within the tolerance that would provide for a greater than minimum required stability for a facility of this type.

8.0 SUMMARY OF FINDINGS

Based on the visual observations during the inspection, the dam and appurtenances are generally in good condition. Specific conclusions related to this inspection include:

- There is no evidence of distress that would indicate the possibility of immediate sliding, slope instability, settlement, misalignment or cracking of the bottom ash pond embankments. As such it is concluded that the dam and dikes are performing as designed.
- Overall, the slope conditions of the dam and levees are generally fair with the exception of some tire ruts caused from truck traffic and mowing activities. These areas overtime can lead to significant erosion and stability problems.
- Vegetation management for the facilities is considered satisfactory. However, some areas are overgrown and the vegetation should be maintained at least 25 feet from the toe of the embankment.

9.0 RECOMMENDATIONS

A summary of our recommendations for general maintenance and continued monitoring, as well as any recommendations for remedial activities, is provided as follows:

9.1 MAINTENANCE ITEMS

The following maintenance items were identified during the visual inspection:

- Overall, the slope conditions of the dam and levees are generally fair with the exception of some tire ruts caused from truck traffic and mowing activities. These areas overtime can lead to significant erosion and stability problems.
- Vegetation management for the facilities is considered satisfactory. However, some areas are overgrown and the vegetation needs to be maintained at least 25 feet from the toe of the embankments.

9.2 ITEMS TO MONITOR

- No Items to monitor

9.3 DEFICIENCIES (257.83(b)(2)(vi))

There were no deficiencies or signs of structural weakness or disruptive conditions that were observed at the time of the inspection that would require additional investigation or remedial action. There were no deficiencies noted during any of the quarterly inspections. If any of these conditions occur before the next annual inspection contact AEP Geotechnical Engineering immediately.

If you have any questions with regard to this report, please contact Brett Dreger at Audinet: 200-2258 or Gary Zych at Audinet: 200-2917.

APPENDIX A:

Inspection Photographs – CCR Ponds Complex

Photo # 1

View of the East Bottom Ash Pond Crest Area. Crest Area has Minor Tire Ruts.

Photo # 2

View of the East Bottom Ash Pond Perimeter Ditch. Perimeter Ditch has a Washout From Previous Rain Event.

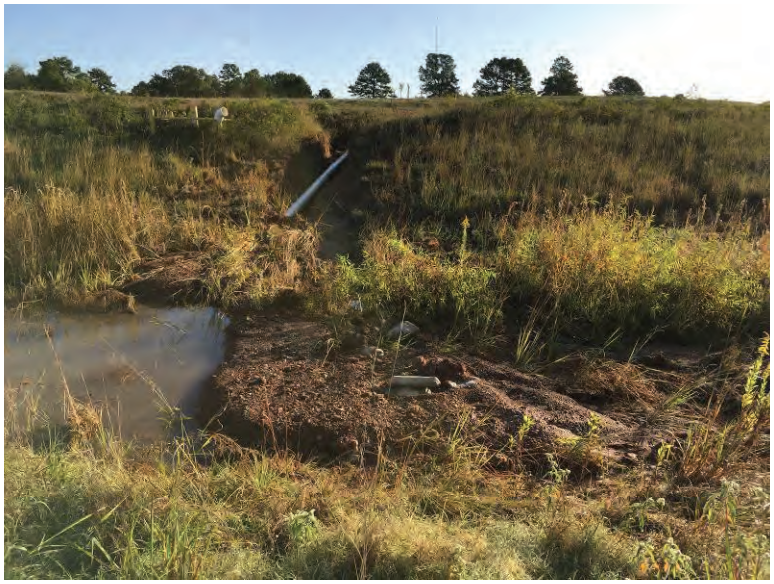

Photo # 3

View of the East Bottom Ash Pond Interior Area. East Bottom Ash Pond is Currently In Service.

Photo # 4	
View of the East Bottom Ash Pond Crest Area. Crest Conditions area Satisfactory.	
Photo # 5	
View of the East Bottom Ash Pond Interior Area and Slope Conditions. East Bottom Ash Pond is Currently In Service.	
Photo # 6	
View of the Discharge Structure at the East Bottom Ash Pond.	

Photo # 7	
View of the West Bottom Ash Pond Crest Area. Crest Conditions are Satisfactory.	
Photo # 8	
View of the West Bottom Ash Pond Crest Area. Crest Conditions are Satisfactory.	
Photo # 9	
View of the Interior Slope Conditions of the West Bottom Ash Pond.	

Photo # 10

View of the Interior Slope Conditions of the West Bottom Ash Pond. West Bottom Ash Pond is Currently Out of Service.

Photo # 11

View of the Sluicing Pipe Structure of the West Bottom Ash Pond.

Photo # 12

View of the Discharge Structure of the West Bottom Ash Pond.

Photo # 13 View of the North Exterior Slope of the West Bottom Ash Pond. Vegetation is overgrown.	
Photo # 14 View of the West Exterior Slope of the West Bottom Ash Pond. Vegetation is overgrown.	
Photo # 15 View of the South Exterior Slope of the West Bottom Ash Pond. Upper Section Slope has Significant Tire Rut.	

Photo # 16	
View of the South Exterior Slope the West Bottom Ash Pond.	
Photo # 17	
View of the Erosion Rills on the Access Ramp to the Crest Area on the Southeast corner of West Bottom Ash Pond.	

APPENDIX B:

Site Map – CCR Ponds Complex

Esri, HERE, Garmin, © OpenStreetMap contributors, Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix B:Pirkey Bottom Ash Ponds
Drawn By: Dan Murphy

N

0 350 700 Feet

3.7 – 2020 Annual Landfill Inspection Report, Landfill, December 29, 2020

2020 Annual Landfill Inspection Report

Landfill

H.W. Pirkey Power Plant
American Electric Power Service Company
(SWEPCO)
Hallsville, Texas

December 29, 2020

Prepared for:

AMERICAN ELECTRIC POWER

BOUNDLESS ENERGY

Prepared by:

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Document ID: GEVR-20-023

2020 Annual Landfill Inspection Report
(CCR Landfill)

H.W. Pirkey Power Plant, Hallsville, Texas

Document Number: GEVR-20-023

Date of Inspection: November 5, 2020

PREPARED BY ______________________ DATE 12-28-2020

Lane Roberts, P.E.

REVIEWED BY Cole Allen DATE 12-28-2020

Landon Cole Allen, P.E.

APPROVED BY ______________________ DATE 12-29-2020

Lane Roberts, P.E.

LANE D. ROBERTS
105135

12-29-2020

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I certify to the best of my knowledge, information and belief that the information contained in this report meets the requirements of 40 CFR § 257.84(b).

2020 Annual Landfill Inspection Report
H.W. Pirkey Power Plant
Hallsville, Texas

Table of Contents

Attachments

Attachment A

Figure 1 – Vicinity Map
Figure 2 – Landfill Site Map

Attachment B

Figure 3 – Inspection Photograph Location Map
Inspection Photographs

1.0 INTRODUCTION

This report was prepared by Akron Consulting, LLC for the AEP - Geotechnical Engineering Services (GES) section, in part, to fulfill requirements of 40 CFR 257.84 and to provide the H.W. Pirkey Power Plant an evaluation of the facility.

Mr. Lane Roberts, P.E. performed the 2020 inspection of the landfill at the H.W. Pirkey Plant. This report is a summary of the inspection and an assessment of the general condition of the facility. Mr. Ron Franklin of the plant was the facility contact for this inspection, which was performed on November 5, 2020. Weather conditions were partly cloudy with light winds, and the average temperature was in the low 70's (°F). Portions of the landfill had been recently mowed.

2.0 DESCRIPTION OF LANDFILL

The H.W. Pirkey Power Plant is located in southern Harrison County, approximately 6 miles southeast of Hallsville, Texas, as shown in Figure 1 – Vicinity Map in Attachment A. The CCR Landfill is located southwest of the main plant, between the Sabine Mine coal pile to the north and the Landfill Run-off Pond to the South. The overall features of the landfill were categorized into the following components as a means of organizing the inspection and reporting:

- Closed Landfill Area (1984, 1987, 1993, 1995, 1997, 1999, and 2005 Cells)
- Inactive Landfill Areas (2012, 1985 Pond Cell and 1993 Cell)
- Active Landfill Disposal Areas (2015 Cell)
- Landfill Construction Area for 2018 Cell
- Storm Water Drainage Ditches

These features, including the approximate limits of each area, are shown on Figure 2 – Site Map in Attachment A. Selected photographs taken during the inspection and used to illustrate the visual observations presented in the report are presented in Attachment B. Additional inspection photos not included in the report can be made available to the plant upon request.

In general, the southwestern area of the landfill is active. The remainder of the landfill area is considered closed and has a grass or turf cover present or is considered inactive. The landfill was developed around an existing oil/gas well known as the Mohan well which is located near the eastern edge of the landfill. Perimeter ditches carry non-contact water to the surrounding natural drainage courses. Multiple catch basins collect and convey non-contact water via "let-down" piping systems. All contact water is directed towards the Landfill Run-off Pond. The four leachate collection discharge pipes outlet on the southern end of the landfill, and all leachate water is conveyed to the Landfill Runoff Pond to the south. There are two parallel ditches on the western boundary of the landfill area, one ditch for contact water and one ditch for non-contact water.

Material to be placed in the active portions of the landfill is hauled via dump trucks on a haul road, which runs along the north and western edge of the landfill area. The active portion of landfill area has vertical chimney drains, which connect to the leachate collection system. Surface water runoff from the active landfill areas is collected and routed to the Landfill Runoff Pond via the chimney drains.

3.0 REVIEW OF AVAILABLE INFORMATION (257.84(b) (1)(i))

A review of available information regarding the status and condition of the landfill, which includes files available in the operating record, such as design, and construction information, previous 7-day inspection reports, and previous annual inspections have been conducted. Based on the review of the data, there were no signs of actual or potential structural weakness or adverse conditions.

4.0 INSPECTION (257.84(b)(1)(ii))

4.1 CHANGES IN GEOMETRY SINCE LAST INSPECTION (257.84(b)(2)(i))

No modifications occurred to the geometry of the landfill since the 2019 annual inspection. The only construction that has occurred since the 2019 annual inspection is the installation of a new 2019 Cap and Cover Area with ClosureTurf, along with the installation of additional rain flap, but neither of these activities changed the overall geometry of the landfill.

4.2 VOLUME (257.84(b)(2)(ii))

The total volume of ash disposed at the landfill as of November 2020 was estimated to be approximately 15.5 million cubic yards.

4.3 DEFINITIONS OF VISUAL OBSERVATIONS AND DEFICIENCIES

This summary of the visual observations uses terms to describe the general appearance or condition of an observed item, activity or structure. The meaning of these terms is as follows:

Good:	A condition or activity that is generally better or slightly better than what is minimally expected or anticipated from a design or maintenance point of view.
Fair/Satisfactory:	A condition or activity that generally meets what is minimally expected or anticipated from a design or maintenance point of view.
Poor:	A condition or activity that is generally below what is minimally expected or anticipated from a design or maintenance point of view.
Minor:	A reference to an observed item (e.g., erosion, seepage, vegetation, etc.) where the current maintenance condition is below what is normal or desired, but which is not currently causing concern from a structure safety or stability point of view.
Significant:	A reference to an observed item (e.g. erosion, seepage, vegetation, etc.) where the current maintenance program has neglected to improve the condition. Usually, these are conditions that have been identified in the previous inspections, but have not been corrected.
Excessive:	A reference to an observed item (e.g., erosion, seepage, vegetation, etc.) where the current maintenance condition is above or worse than what is normal or desired, and which may have affected the ability of the observer to properly evaluate the structure or particular area being observed or which may be a concern from a structure safety or stability point of view.

This document also uses the definition of a “deficiency” as referenced in the CCR rule section §257.84(b)(5) Inspection Requirements for CCR Landfills. This definition has been assembled using the CCR rule preamble as well as guidance from MSHA, “Qualifications for Impoundment Inspection” CI-31, 2004. These guidance documents further elaborate on the definition of deficiency. Items not defined by deficiency are considered maintenance or items to be monitored.

A “deficiency” is some evidence that a landfill has developed a problem that could impact the structural integrity of the landfill. There are four general categories of deficiencies. These four categories are described below:

1. Uncontrolled Seepage (Leachate Outbreak)
   Leachate outbreak is the uncontrolled release of leachate from the landfill.
2. Displacement of the Embankment
   Displacement of the embankment is large scale movement of part of the landfill. Common signs of displacement are cracks, scraps, bulges, depressions, sinkholes and slides.
3. Blockage of Control Features
   Blockage of Control Features is the restriction of flow at spillways, decant or pipe spillways, or drains.
4. Erosion
   Erosion is the gradual movement of surface material by water, wind or ice. Erosion is considered a deficiency when it is more than a minor routine maintenance item.

4.4 VISUAL INSPECTION (257.84(b)(1)(ii))

A visual inspection of the landfill was conducted to identify any signs of distress or malfunction of the landfill and appurtenant structures. Specific items inspected included all structural elements of the landfill perimeter berms, temporary and final covers, drainage features, open cells, and appurtenances such as chimney drains etc.

Overall, the facility is in good condition. The landfill is functioning as intended with no signs of potential structural weakness or conditions which are disruptive to the safe operation of the landfill. Inspection photos are included in Attachment B. Additional pictures taken during the inspection can be made available upon request. A site map presenting locations of the inspection observations is included as Figure 2 in Attachment A.

Closed Landfill Areas (1984, 1987, 1993, 1995, 1997, 1999, and 2005 Cells)

1. In general, surface water runoff from the cap was draining as designed. There were no signs of erosion, undermining, scarps or sloughs in the surface vegetation covering the top and side slope areas. Only minor hog rutting damage was found on the north slope of the 2005 Cell.
2. The closed landfill areas were observed to have a thick stand of grass cover over the majority of the capped area. The landfill cover of cells 1984, 1987, 1993, 1995, 1999 and 2005 were well vegetative. Areas with less vegetation had recently been re-seeded and hay mulched.
3. There were no signs of settlement, movement or distress of the landfill area. Access roads on top and adjacent to the landfill area were in good condition.
4. There is ponded water in the perimeter ditch on the north side of the landfill. However, a pump and pump house had recently been installed to pump this water around the landfill.

Inactive Landfill Disposal Areas (2012, 1985 Pond Cell and 1993 Cell)

5. The 36-inch-diameter and 18-inch-diameter leachate collection discharge pipe outlets near the south end of the 2012 Cell were unobstructed and free-flowing.
6. A temporary soil cover consisting of a red sandy-clay material has been placed for an erosion protection measure on the south slope. The vegetation on this area was in good condition. In addition to the soils cover, the lower adjacent area has been recently covered with a geo-membrane rain flap material for erosion protection. All disturbed soil areas were re-seeded and hay mulched as part of this installation.
7. The western-most top portion of the 2012 Cell area was covered with 18-inches of topsoil to complete the 2018 cap system at the end of 2019, and the vegetation is in good condition. As noted previously, a second area to the west was also capped and covered with ClosureTurf at the end of 2019.
8. The 1993 Cell was still covered with a geo-membrane rain flap material that appeared to be in good condition.
9. There is standing water at the surface near the groundwater interceptor drain manhole on the southern side of the landfill. Groundwater is also pushing up on the liner system in the perimeter ditch near the groundwater interceptor drain manhole. According to plant personnel, the groundwater in this area will be lowered once the Landfill Runoff Pond is lowered.

Active Landfill Disposal Areas (2015 Cell)

10. During the inspection, the lower portion of the active area was being re-graded so that a geo-membrane rain flap could be installed. The chimney drains were functioning as designed and there was no evidence of pooling water around the drains. In general, the chimney drain consists of bottom ash placed by filling in a 10-foot-diameter circle with a perforated drainpipe wrapped in filter fabric placed in the center that is connected to the leachate discharge pipes.
11. The CCR materials are being placed and graded in such a manner that any runoff from the active landfill area is collected, contained and drained through the chimney drain system.
12. The lower slopes of the 2015 active cell have been covered with a 20-mil geomembrane rain flap material for erosion protection and to minimize contact water in the perimeter ditches. This will be replaced with ClosureTurf in the near future.

2018 Landfill Cell Construction

13. The 2018 Landfill Cell bottom liner system has not been modified since the 2019 inspection. Once the leachate collection system is installed and a protective cover layer is in place, the cell will be ready for accepting CCR waste.
14. Based on the current conditions, storm water runoff from the liner area and perimeter ditches is considered non-contact water and is diverted around the Landfill Runoff Pond.

Storm Water Drainage Ditches

15. Concrete slope protection installed on the inlet side of two, 36-inch-diameter culverts, which discharge leachate and contact water into the Landfill Runoff Pond was observed to be broken and distressed. The geomembrane landfill liner extends underneath the entire length of the culverts and does not appear to be damaged. An access road is present over the top of the culverts. According to plant personnel, this will be repaired as part of the 2021 cap and cover project.

16. A non-contact water ditch runs along the eastern edge of the landfill area. The vegetation along this ditch was in good condition, with some isolated areas that had recently been re-seeded and hay mulched. There was no evidence of erosion, obstructions or poor drainage conditions.
17. A contact water ditch runs along the western edge of the landfill area and is lined with a geomembrane. The ditch was observed to be clear of any obstructions and will be reclaimed as part of the 2020 cap and cover project.
18. A non-contact storm water ditch which is located along the western edge of the landfill is lined with a geomembrane material. Runoff from the 2005 Cell is collected into a 36-inch-diameter conduit and this conduit discharges into the non-contact water ditch. An earthen berm armored with riprap material has been placed at the end of the non-contact water ditch to divert flow away from the toe area of the Landfill Runoff Pond Dam. Small holes about 2 inches in diameter have been cut into the geomembrane to allow any trapped groundwater under the geomembrane to drain and prevent floating of the geomembrane liner.
19. A non-contact storm water ditch runs along the western edge and southern edge of the landfill that is covered with a rain flap material. Runoff from the lower outside slope of the 2015 Cell is collected into a lined ditch and then discharges into the non-contact water ditch on the western side of the landfill.

4.5 CHANGES THAT EFFECT STABILITY OR OPERATION (257.84(b)(2)(iv))

Based on interviews with plant personnel and field observations, there were no changes to the landfill since the last annual inspection that would affect the stability of the landfill.

5.0 SUMMARY OF FINDINGS

5.1 GENERAL OBSERVATIONS

The following general observations were identified during the visual inspection:

1) In general, the landfill is functioning as intended and the active cell, inactive cells, closed areas, and storm water ditches are in good condition. The Plant is performing regular maintenance and inspections as required. Several maintenance items have been noted and are described in Section 5.2.

5.2 MAINTENANCE ITEMS

The following maintenance items were identified during the visual inspection, see site map for locations. Contact GES for specific recommendations regarding repairs:

1) Remove the broken and distressed concrete slab slope protection at the inlet of the two, 36-inch-diameter culverts. After removing the concrete slab, inspect this area for any damages. After inspection, replace the inlet of the culverts.

2) Drain the ground water pipes at the south end of the landfill into the Landfill Runoff Pond.

3) The hog rutting damage on the north slope of the 2005 Cell should be repaired. Any bare areas should be re-seeded. The ponded water in the north perimeter ditch should be pumped around the landfill with the recently installed pump.

5.3 ITEMS TO MONITOR

The following items were identified during the visual inspection as items to be monitored:

- None identified as part of this inspection.

5.4 DEFICIENCIES (257.84(b)(2)(iii))

There were no signs of structural weakness or disruptive conditions observed at the time of the inspection that would require additional investigation or remedial action. There were no deficiencies noted during this inspection or during any of the periodic 7-day inspections.

A deficiency is defined as either:

1) Uncontrolled seepage (leachate outbreak),
2) Displacement of the embankment,
3) Blockage of control features, or
4) Erosion, more than minor maintenance.

If any of these conditions occur before the next annual inspection, contact the Geotechnical Engineering Services (GES) section immediately.

ATTACHMENT A

Figure 1 – Vicinity Map
Figure 2 – Landfill Site Map

FIGURE 1 - VICINITY MAP

CCR LANDFILL, H.W. PIRKEY POWER PLANT, HALLSVILLE, TX

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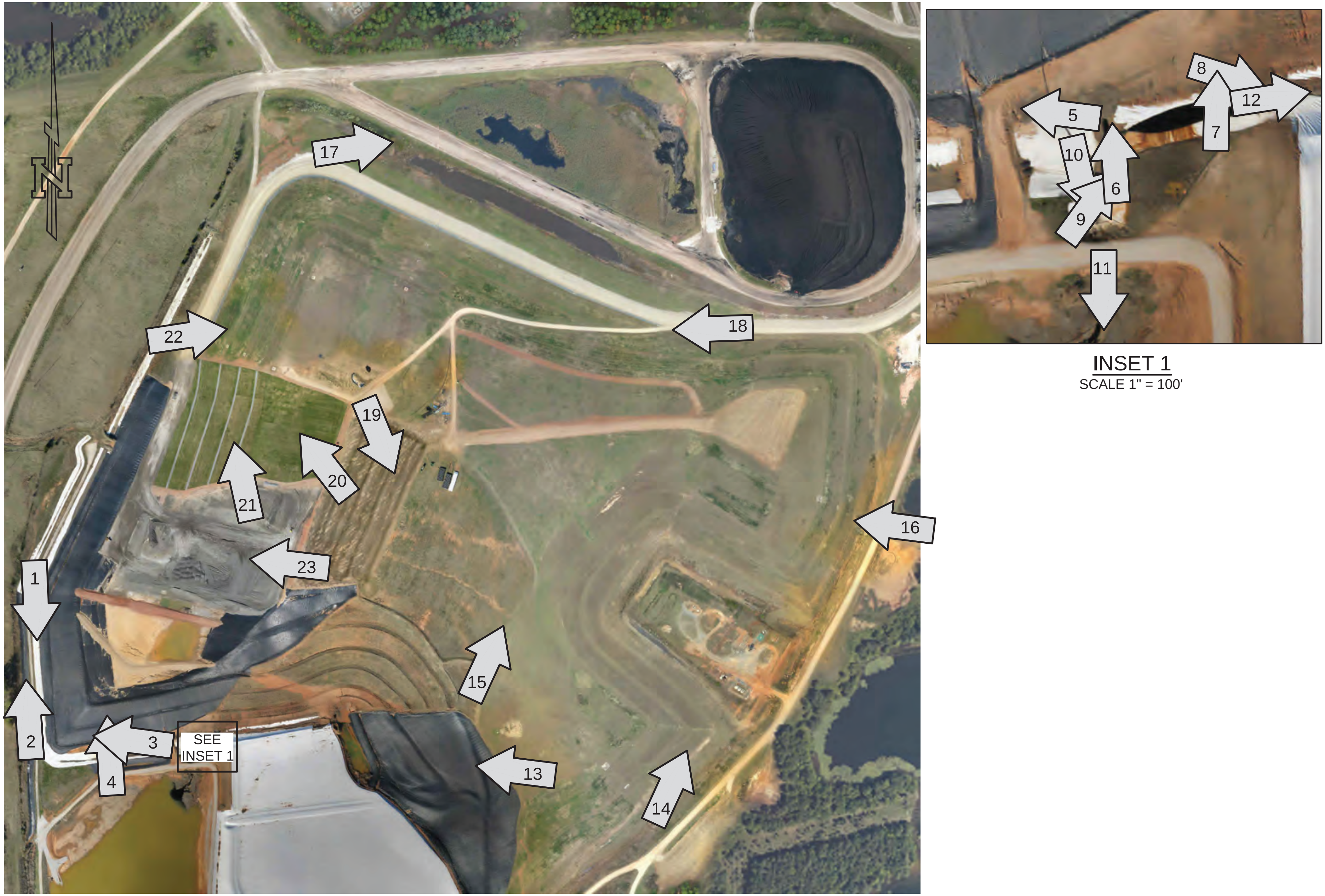
FIGURE 2
PIRKEY LANDFILL
SITE MAP

ATTACHMENT B

Figure 3 – Inspection Photograph Location Map
Inspection Photographs

FIGURE 3 - INSPECTION PHOTOGRAPH LOCATION MAP

CCR LANDFILL, H.W. PIRKEY POWER PLANT, HALLSVILLE, TX



INSET 1

SCALE 1" = 100'

PHOTO #1
View of the contact water ditch along the west side of the 2015 Cell

PHOTO #2
View of the non-contact water ditch along the west side of the 2015 Cell

PHOTO #3
View of the non-contact water rain flap ditch along the south side of the 2015 Cell

PHOTO #4 View of the 18" Leachate Pipe Outlet from the 2015 Cell	
PHOTO #5 View of the 6" Leachate Pipe Outlet from the 2015 Cell	
PHOTO #6 View of the 18" Leachate Pipe Outlet from the 2012/2015 Cell	

PHOTO #7
View of the 36" Leachate Pipe Outlet from the 2012 Cell

PHOTO #8
View of the 18" Leachate Pipe Outlet from the 2012/2018 Cell

PHOTO #9
View of the high groundwater under the perimeter ditch liner

PHOTO #10
View of the broken concrete near the inlet of the dual 36" culverts that drain into the Landfill Runoff Pond

PHOTO #11
View of the downstream end of the dual 36" culverts that drain into the Landfill Runoff Pond

PHOTO #12
View of the recently installed rain flap below the southern slopes

PHOTO #13
View of the rain flap in the 1993 and 2012 Cells, alongside the 2018 Cell

PHOTO #14
View of the eastern slopes

PHOTO #15
View of the southern top of the landfill (typical condition)

PHOTO #16
View of the energy dissipater of the letdown in the northeast corner with maintained vegetation

PHOTO #17
View of the recently installed pump house to pump water from the north side of the landfill around the landfill

PHOTO #18
View of the north slope and access road

PHOTO #19 View of the 2018 cap and cover area with topsoil and vegetation in good condition	
PHOTO #20 View of the top of the 2019 cap and cover area with ClosureTurf	
PHOTO #21 View of the slopes of the 2019 cap and cover area with ClosureTurf	

PHOTO #22
View of west slopes

PHOTO #23
View of active area

3.8 – 2020 Annual Landfill Inspection Report, FGD Stackout Area, December 24, 2020

2020 Annual Landfill Inspection Report

FGD Stackout Area

H.W. Pirkey Power Plant
American Electric Power Service Company
(SWEPCO)
Hallsville, Texas

December 24, 2020

Prepared for:

AMERICAN ELECTRIC POWER
BOUNDLESS ENERGY

Prepared by:

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Document ID: GEVR-20-024

2020 Annual Landfill Inspection Report

(FGD Stackout Area)

H.W. Pirkey Power Plant, Hallsville, Texas

Document Number: GEVR-20-024

Date of Inspection: November 5, 2020

PREPARED BY ____________ DATE 12-23-2020

Lane Roberts, P.E.

REVIEWED BY Cole Allen DATE 12-23-2020

Landon Cole Allen, P.E.

APPROVED BY ____________ DATE 12-24-2020

Lane Roberts, P.E.

LANE D. ROBERTS
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12-24-2020

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I certify to the best of my knowledge, information and belief that the information contained in this report meets the requirements of 40 CFR § 257.84(b).

2020 Annual Landfill Inspection Report (FGD Stackout Area)

H.W. Pirkey Power Plant
Hallsville, Texas

Table of Contents

Attachments

1.0 INTRODUCTION

This report was prepared by Akron Consulting, LLC for the AEP - Geotechnical Engineering Services (GES) section, in part, to fulfill requirements of 40 CFR 257.84 and to provide the H.W. Pirkey Power Plant an evaluation of the facility.

Mr. Lane Roberts, P.E. performed the 2020 inspection of the FGD Stackout Area at the H.W. Pirkey Plant. This report is a summary of the inspection and an assessment of the general condition of the facility. Mr. Ron Franklin of the plant was the facility contact for this inspection, which was performed on November 5, 2020. Weather conditions were partly cloudy with light winds, and the average temperature was in the low 70's (°F).

2.0 DESCRIPTION OF LANDFILL

The H.W. Pirkey Power Plant is located in southern Harrison County, approximately 6 miles southeast of Hallsville, Texas, as shown in Figure 1 – Vicinity Map in Attachment A. The FGD Stackout Area is located due west of the main plant. The FGD Stackout Area is a designated CCR Unit that is subject to 40 CFR 257.84 Inspection Requirements for CCR Landfills. The FGD Stackout Area is designed to temporarily hold a stockpile of Coal Combustion Residuals (CCR) material until it is hauled off by dump trucks for permanent disposal in a separate landfill. A radial arm stacker deposits the CCR material on the ground surface within the footprint of the FGD Stackout Area. A stone berm with a geomembrane cover exists around the perimeter of the FGD Stackout Area to contain any contact water. All contact water drains by gravity to the lower Surge Pond or the Auxiliary Surge Pond for circulation back to the plant. There is a concrete pad used for washing the tires of dump trucks that drive into the FGD Stackout Area.

These features, including the approximate limits of each area, are included in Figure 2 – Site Map in Attachment A. Selected photographs taken during the inspection and used to illustrate the visual observations presented in the report are presented in Attachment B. Additional inspection photos can be made available to the Plant upon request.

3.0 REVIEW OF AVAILABLE INFORMATION (257.84(b)(1)(i))

A review of available information regarding the status and condition of the FGD Stackout Area which includes files available in the operating record, such as design and construction information, previous periodic structural stability assessments, previous 7 day inspection reports, and previous annual inspections has been conducted. Based on the review of the data, there were no signs of actual or potential structural weakness or adverse conditions.

4.0 INSPECTION (257.84(b)(1)(ii))

4.1 CHANGES IN GEOMETRY SINCE LAST INSPECTION (257.84(b)(2)(i))

No modifications have been made to the geometry of the FGD Stackout Area since the 2019 annual inspection. However, in order to minimize erosion and contact storm water, the plant has recently installed a geomembrane rain flap on the western side of the area to direct non-contact storm water around the Surge Pond, but this did not change the overall geometry of the FGD Stackout Area.

4.2 VOLUME (257.84(b)(2)(ii))

The total volume of ash that has passed through the FGD Stackout Area since the 2019 inspection was estimated at approximately 175,000 cubic yards. At the time of the inspection, it was estimated that about 200 cubic yards were stockpiled at the FGD Stackout Area.

4.3 DEFINITIONS OF VISUAL OBSERVATIONS AND DEFICIENCIES

This summary of the visual observations uses terms to describe the general appearance or condition of an observed item, activity or structure. The meaning of these terms is as follows:

Good:	A condition or activity that is generally better or slightly better than what is minimally expected or anticipated from a design or maintenance point of view.
Fair/Satisfactory:	A condition or activity that generally meets what is minimally expected or anticipated from a design or maintenance point of view.
Poor:	A condition or activity that is generally below what is minimally expected or anticipated from a design or maintenance point of view.
Minor:	A reference to an observed item (e.g., erosion, seepage, vegetation, etc.) where the current maintenance condition is below what is normal or desired, but which is not currently causing concern from a structure safety or stability point of view.
Significant:	A reference to an observed item (e.g. erosion, seepage, vegetation, etc.) where the current maintenance program has neglected to improve the condition. Usually, these are conditions that have been identified in the previous inspections, but have not been corrected.
Excessive:	A reference to an observed item (e.g., erosion, seepage, vegetation, etc.) where the current maintenance condition is above or worse than what is normal or desired, and which may have affected the ability of the observer to properly evaluate the structure or particular area being observed or which may be a concern from a structure safety or stability point of view.

This document also uses the definition of a "deficiency" as referenced in the CCR rule section §257.84(b)(5) Inspection Requirements for CCR Landfills. This definition has been assembled using the CCR rule preamble as well as guidance from MSHA, "Qualifications for Impoundment Inspection" CI-31, 2004. These guidance documents further elaborate on the definition of deficiency. Items not defined by deficiency are considered maintenance or items to be monitored.

A "deficiency" is some evidence that a landfill has developed a problem that could impact the structural integrity of the landfill. There are four general categories of deficiencies. These four categories are described below:

1. Uncontrolled Seepage (Leachate Outbreak)

   Leachate outbreak is the uncontrolled release of leachate from the Landfill.

2. Displacement of the Embankment

   Displacement of the embankment is large scale movement of part of the landfill. Common signs of displacement are cracks, scarps, bulges, depressions, sinkholes and slides.
3. Blockage of Control Features

   Blockage of Control Features is the restriction of flow at spillways, decant or pipe spillways, or drains.
4. Erosion

   Erosion is the gradual movement of surface material by water, wind or ice. Erosion is considered a deficiency when it is more than a minor routine maintenance item.

4.4 VISUAL INSPECTION (257.84(b)(1)(ii))

A visual inspection of the FGD Stackout Area was conducted to identify any signs of distress or malfunction of the landfill and appurtenant structures. Specific items inspected included all structural elements of the landfill perimeter berms, ditches and drainage patterns.

Overall the facility is in good condition. The FGD Stackout Area is functioning as intended with no signs of potential structural weakness or conditions, which are disruptive to the safe operation of the landfill. Inspection photos are included in Attachment B. Additional pictures taken during the inspection can be made available upon request. A site map presenting locations of the inspection observations is included as Figure 2 in Attachment A.

1. The gravel berm with a geomembrane cover appeared to be in good condition. There was no evidence of holes, air/water pockets, or other signs of distress noted on the geomembrane.

2. Surface water runoff from along the eastern gravel berm with a geomembrane cover is conveyed underneath an access road via a steel pipe culvert. Storm water from this culvert outlets onto a concrete slab with curb walls underneath the supports for the conveyor belt that supplies the radial arm stacker. A section of these curb walls has been notched to allow surface water runoff to drain to the Auxiliary Surge Pond. The steel culvert was not obstructed, but the area upstream of the culvert should be re-graded to maintain positive drainage to the culvert.

3. There is no vegetal cover on the FGD Stackout Area due to material constantly being stockpiled and removed.

4. The geomembrane rain flap that was recently installed is functioning in good condition. All contact water adjacent to the rain flap is directed away from it to the Surge Pond.

5. Vehicle traffic enters the site from the south end via a gravel access ramp, which is also functioning in good condition. This ramp also serves as a berm to ensure the contact water in the FGD Stackout Area is contained and directed to the Surge Pond.

6. A minor obstruction was observed in the concrete ditch on the north end, which should be removed. Minor erosion was also observed where the FGD Stackout Pad surface drains into the Auxiliary Surge Pond, which should be repaired.

4.5 CHANGES THAT EFFECT STABILITY OR OPERATION (257.84(b)(2)(iv))

Based on interviews with plant personnel and field observations, there were no changes to the FGD Stackout Area since the last annual inspection that would affect the stability of the facility.

5.0 SUMMARY OF FINDINGS

5.1 GENERAL OBSERVATIONS

The following general observations were identified during the visual inspection:

1) In general, the FGD Stackout Area is functioning as intended and is in good condition. The Plant is performing regular maintenance and inspections as required. A few minor maintenance items have been noted and described in Section 5.2.

5.2 MAINTENANCE ITEMS

The following maintenance items were identified during the visual inspection (see site map for locations). Contact GES for specific recommendations regarding repairs:

1) The area upstream of the culvert that drains the eastern perimeter ditch should be re-graded to maintain positive drainage to the culvert.
2) The minor obstruction in the concrete ditch on the north end should be removed.
3) Repair the erosion rills that have formed from the stackout pad to the Auxiliary Surge Pond. This area shall be backfilled properly due to the presence of shallow pipelines in this area. This erosion is considered a minor maintenance item.

5.3 ITEMS TO MONITOR

There are no items to monitor as a result of observations made during this visual inspection.

5.4 DEFICIENCIES (257.84(b)(2)(iii))

There were no signs of structural weakness or disruptive conditions observed at the time of the inspection that would require additional investigation or remedial action. There were no deficiencies noted during this inspection or during any of the periodic 7-day inspections. A deficiency is defined as either:

1) Uncontrolled seepage (leachate outbreak),
2) Displacement of the embankment,
3) Blockage of control features, or
4) Erosion, more than minor maintenance.

If any of these conditions occur before the next annual inspection, contact the Geotechnical Engineering Services (GES) section immediately.

<u>ATTACHMENT A</u>

Figure 1 – Vicinity Map
Figure 2 – Site Map

FIGURE 1 - VICINITY MAP

CCR LANDFILL, H.W. PIRKEY POWER PLANT, HALLSVILLE, TX

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0 100' 200'
1"=100'

N

FIGURE 2
FGD STACKOUT AREA SITE MAP

ATTACHMENT B

Figure 3 – Inspection Photograph Location Map
Inspection Photographs

FIGURE 3 - INSPECTION PHOTOGRAPH LOCATION MAP

FGD STACKOUT AREA, H.W. PIRKEY POWER PLANT, HALLSVILLE, TX

PHOTO #1 View of the upstream end of the eastern steel culvert	
PHOTO #2 View of the downstream end of the eastern steel culvert	
PHOTO #3 View of the eastern perimeter berm / ditch with minor ponding	

PHOTO #4 View of the western perimeter berm / ditch with rain flap	
PHOTO #5 View of the northern perimeter berm / ditch	
PHOTO #6 View of the eastern side of the rain flap	

PHOTO #7
View of the conveyor, the radial arm stacker, and the active stackout area

PHOTO #8
View of the radial arm stacker and the active stackout area with the limestone pile in the distance (outside of FGD Stackout Area)

PHOTO #9
View of concrete ditch on the north end with minor obstruction

PHOTO #10
View of erosion between the stackout area and the Auxiliary Surge Pond

PHOTO #11
View of exposed shallow pipelines in one of the erosion rills

Volume 2

- **Attachment 4 – Groundwater Monitoring and Corrective Action**
- **Attachment 4, Subsection 4.13 – Statistical Analysis Summary, West Bottom Ash Pond, H.W. Pirkey Power Plant, Hallsville, Texas**

ATTACHMENT 4

Groundwater Monitoring and Corrective Action

30 TAC §352.281 – Groundwater Monitoring and Corrective Action Application Submission.
Submit documentation demonstrating compliance with Subchapter H: Groundwater Monitoring and Corrective Action.

- Submit Groundwater Monitoring Well Network Evaluation Reports
- Submit a description of the groundwater sampling and analysis program that demonstrates compliance with the requirements of 30 TAC §352.931/40 CFR §257.93.

Detection Monitoring

- Submit most recent Groundwater Monitoring and Corrective Action Annual Report
- Submit a description of the groundwater monitoring well system that demonstrates compliance with the requirements of 30 TAC §352.911/40 CFR §257.91.
- Submit sufficient information, supporting data, analyses and most recent alternative source demonstrations to support a detection monitoring program meeting the requirements of 30 TAC §352.941/40 CFR §257.94. **See Annual Groundwater Monitoring and Corrective Action Report.**

CCR Unit(s) in a Detection Monitoring Program

Landfill

Assessment Monitoring

- Submit sufficient information, supporting data, analyses and most recent alternative source demonstrations to support a detection monitoring program meeting the requirements of 30 TAC §352.941/40 CFR §257.94. **See Annual Groundwater Monitoring and Corrective Action Report.**
- Submit most recent Groundwater Monitoring and Corrective Action Annual Reports
- Submit a description of the groundwater monitoring well system that demonstrates compliance with the requirements of 30 TAC §352.911/40 CFR §257.91.

CCR Unit(s) in an Assessment Monitoring Program

EBAP, WBAP, FGDSA

4.1 – East Bottom Ash Pond – CCR Groundwater Monitoring Well Network Evaluation, May 25, 2016

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East Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

May 25, 2016

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Kenneth J. Brandner
Geology
1737
LICENSED
PROFESSIONAL GEOSCIENTIST

East Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

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Tables

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Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91, for the East Bottom Ash Pond (BAP) CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above and isolated from the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zone, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the East BAP (Site). The evaluation of the location restriction criteria is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the East BAP CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant East BAP.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The East BAP CCR unit is located at the north end of the Plant and approximately 2,000 feet north-northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of East BAP CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the East BAP.

2.2.1 Embankment Configuration

The East BAP is partially incised into native soils with an embankment height of approximately 4 feet (AMEC, 2011). The East BAP embankments are constructed of compacted clay on a 3:1 slope (3 feet horizontal, 1 foot vertical) (Sargent & Lundy, 1983). The elevation of the top of the embankment around the perimeter of the East BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, May 2011). The interior bottom elevation of the East BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Johnson & Pace, June 2011).

2.2.2 Area/Volume

The East BAP is approximately 31.5 acres in size. The design maximum ash storage capacity of the East BAP is 188 acre feet (Sargent & Lundy, 1983). Johnson & Pace calculated the East BAP ash storage capacity in 2011 at 161 acre feet at an elevation of 355 feet amsl (maximum operating level) (Johnson & Pace, June 2011).

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, flue gas desulfurization sludge) have been generated. The East BAP, which was placed into operation in 1985, receives bottom ash and economizer ash sluiced from the power plant boiler (**Figure 3**). Clear water overflow from the East BAP discharges into the Clearwater Pond located directly south of the East BAP. Bottom ash and economizer ash are periodically excavated from the East BAP and hauled by truck to either the on-site landfill for disposal, or sold for offsite beneficial re-use.

The base of the East BAP was constructed in 1983 with a compacted clay liner (Sargent & Lundy, 1983). Following installation of the compacted clay liner, soil borings S-4 through S-7 were advanced below the base of the East BAP to total depths of six feet in September 1983 (Southwestern Laboratories, 1984). The lithologic data from soil borings S-4 through S-7 confirm at least six feet of clay is present below the base of the East BAP (Sargent & Lundy, 1984).

2.2.4 Surface Water Control

Surface water elevation in the East BAP is controlled by a weir box and a manually operated gate valve on a 36-inch-diameter discharge pipe at the southwest corner of the pond. Clear water overflow from the East BAP discharges through the 36-inch-diameter pipe into the 2.7- acre Clearwater Pond located directly south of the East BAP (**Figure 3**). Water in the Clearwater Pond is pumped (re-circulated) back into the boiler ash hopper.

2.3 Previous Investigations

The initial soils investigation and design of the East BAP was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, and design of the East BAP. As discussed above in Section 2.2.3, the design included installation of a clay liner below the East BAP.

In September-October 1983, Southwestern Laboratories conducted a soil investigation at the Plant, including advancement of four soil borings (S-4 through S-7) below the East BAP (Southwestern Laboratories, 1984).

In 1984, Sargent & Lundy conducted an evaluation of the East BAP. This report included evaluation of soil sample geotechnical data, and concluded a low-permeability clay liner was present below the East BAP (Sargent & Lundy, 1984).

In 2009, ETTL Engineers & Consultants (ETTL) conducted a geotechnical investigation of the East BAP earthen embankment. The investigation included installation of two soil borings through the embankment (E1, E2), completion of the soil borings as piezometers PE-1 and PE-2, respectively, and collection of soil samples for geotechnical analyses. The report concluded the embankment was stable and the existing embankment slopes were acceptable if conditions are maintained (ETTL, 2010). The conditions to be maintained included embankment protection from erosion (vegetative cover), removal of brush and trees two feet or more in height, and control of animal burrowing.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed a hydraulic analysis of the East BAP for a 10-year, 24-hour rainfall event in accordance with the TCEQ TPDES permit design criteria. The report concluded the storage capacity of the East BAP is hydraulically adequate (Johnson & Pace, May 2011).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the East BAP area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the East BAP, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow groundwater flow direction in the area of the East BAP is west-southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The East BAP is located approximately 2,000 feet north-northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the area of the East BAP does not discharge into Brandy Branch Reservoir.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 500 feet south (side gradient) of the East BAP in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile southwest (downgradient) of the East BAP for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (up gradient) of the Pirkey Power Plant.

3. Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be placed down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the area of the East BAP is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 15 feet that is located between an elevation of approximately 325 and 340 feet amsl (**Appendix A**). The base of the East BAP is at an elevation of 347 feet amsl. Therefore the separation distance between the uppermost aquifer and the base of the East BAP is approximately seven feet. This separation distance is further illustrated on cross section A-A' (**Figure 4)** and cross section E-E' (**Figure 8)**.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness (approximately 15 feet), the yield of the uppermost aqufier is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Available groundwater elevations are summarized on **Table 1** for 2011 through 2016. The most recent comprehensive groundwater data set from January 20, 2016 is depicted on **Figure 9**. The groundwater flow is west-southwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

Per 40 CFR 257.60(a), new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five ft) above the upper limit of the uppermost aquifer, or must demonstrate there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high conditions).

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers, that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the area of the East BAP is the clayey and silty sand stratum that is located between an elevation of approximately 325 and 340 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 19, 2015 to review existing well network conditions and locations. A well construction table that summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as

Table 2. Photo documentation of the located wells during the August 19, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-2, AD-3, AD-4, AD-12, and AD-18 were previously installed at the Site to monitor the uppermost aquifer (clayey and silty sand stratum) associated with the East BAP. As discussed above in Section 3.1.1, the uppermost aquifer below the East BAP is approximately 15 feet thick and is located between an elevation of approximately 325 and 340 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on Geologic Cross Section A-A' (**Figure 4**), existing monitoring well AD-4 is screened in the uppermost aquifer upgradient (east) of the East BAP, and existing monitoring well AD-3 is screened in the uppermost aquifer sidegradient (northwest) of the East BAP. Existing monitoring wells AD-4, AD-12 and AD-18 (also located east of the East BAP) will be utilized as upgradient monitoring wells for the East BAP. Existing monitoring well AD-2, located west-southwest of the East BAP, will be utilized as a downgradient monitoring well for the East BAP.

As shown on **Figure 9**, shallow groundwater flow direction in the area of the East BAP is west-southwesterly. One existing monitoring well (AD-2) was located hydraulically downgradient of the East BAP during the August 19, 2015 site visit, and three downgradient monitoring wells are required to monitor groundwater quality downgradient of a CCR unit. This data gap was addressed by installation of new downgradient monitoring wells AD-31 and AD-32 during December 2015 as shown on **Figure 9** and **10**. With the addition of monitoring wells AD-31 on the west side of the East BAP and AD-32 on the south central side of the East BAP, there are no gaps remaining in the groundwater monitoring network for the East BAP.

4. Recommended Monitoring Network and PE Certification

The recommended existing groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the East BAP (up gradient or down gradient), well depth, and well construction. The recommended network would provide an improved understanding of groundwater quality, hydraulics, and groundwater flow at the East BAP.

4.1 Recommended Monitoring Well Network Distribution

Three up gradient well locations (existing monitoring wells AD-4, AD-12, and AD-18) and three down gradient well locations (existing monitoring wells AD-2, AD-31, and AD-32) are recommended to establish a groundwater quality monitoring well network for the East BAP. In addition, existing sidegradient monitoring well AD-3 may be utilized as a piezometer to obtain additional groundwater flow direction and gradient data for the East BAP.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the East BAP is summarized on **Table 3** and illustrated on **Figure 10.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 325 and 340 feet amsl as shown on Geologic Cross Sections A-A' (**Figure 4**) and E-E' (**Figure 8**). The screen elevations are presented in **Table 3**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the East BAP was addressed by installation of monitoring wells AD-31 and AD-32 during December 2015. Monitoring wells AD-31 and AD-32 were installed by a Texas Department of Licensing and Regulation (TDLR)-licensed water well driller. Well construction data for the monitoring well network are summarized on **Tables 2** and **3**, and the monitoring well completion diagrams are provided in **Appendix A**.

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system will be adequate to meet the requirements of 40 CFR Part 257.91.

Kenneth J. Brandner
Printed Name of Registered Professional Engineer

Kenneth J Brandner
Signature

KENNETH J. BRANDNER
69586

69586
Registration No.

Texas
Registration State

5-25-16
Date

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Tables

Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen(b)		Bottom of Screen(b)		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers(c)																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
NM - Not Measured

Table 2
Well Construction Details
AEP Pirkey Power Plant - CCR Units
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen[b]		Bottom of Screen[b]	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18	341	40	319	20	339.48	40	319.48
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29	350	51	328	31	347.84	51	327.84
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.48	40.5	321.48
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13	344	35	322	15.0	341.81	35.0	321.81
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8	335	30	313	10.0	332.65	30.0	312.65
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13	347	25	335	15.0	345.48	25.0	335.48
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8	352	30	330	10.0	349.50	30.0	329.50
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13	339	35	317	15.0	337.30	35.0	317.30
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8	339	30	317	10.0	337.23	30.0	317.23
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8	348	30	326	10.0	345.57	30.0	325.57
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13	334	35	312	15.0	331.72	35.0	311.72
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3	285	20	268	5.0	282.68	20.0	267.68
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8	326	30	304	10.0	324.15	30.0	304.15
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8	334	40	302	10.0	332.41	40.0	302.41
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.33	37.5	312.33
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13	323	35	301	15.0	320.92	35.0	300.92
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8	342	30	320	10.0	340.21	30.0	320.21
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8	331	25	314	10.0	329.04	25.0	314.04
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18	340	35	323	20.0	337.75	35.0	322.75
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11	346	33	324	13.0	344.23	33.0	324.23
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12	347	30	329	15.0	344.30	30.0	329.30
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8	297	25	280	10.0	294.64	25.0	279.64
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20	296	3.0	313.01	18.0	298.01
Piezometers[c]																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26	330	38	318	28.0	328.30	38.0	318.30

General Note:
Elevations in feet above mean sea level.

Footnotes:
(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.
(c) Souce: EETL (October 2010).
(d) Source: Aukland Consulting LLC (January 26, 2016).

Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

Table 3
Proposed Well Network
AEP Pirkey Power Plant - East Bottom Ash Pond
Hallsville, Harrison County, Texas

Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Target Elevation[a] (ft amsl)	Screen Bottom Target Elevation[a] (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-4	Exisiting	Uppermost Water-Bearing Unit	East of East Bottom Ash Pond	Upgradient	337.7	317.7	20	Existing well installed in 1983; well will be utilitzed to establish backgroud water quality
AD-12	Exisiting	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-18	Exisiting	Uppermost Water-Bearing Unit	East of East Bottom Ash Pond	Upgradient	345.5	335.5	10	Existing well installed in 2011; well will be utilitzed to establish backgroud water quality
Downgradient								
AD-2	Existing	Uppermost Water-Bearing Unit	West-Southwest of East Bottom Ash Pond	Down gradient	321.3	301.3	20	Existing well installed in 1983; uppermost shallow aquifer adjacent to the East Bottom Ash Pond - downgradient
AD-31	Existing	Uppermost Water-Bearing Unit	West of East Bottom Ash Pond	Down gradient	337.8	322.8	15	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to the East Bottom Ash Pond - downgradient
AD-32	Existing	Uppermost Water-Bearing Unit	South of East Bottom Ash Pond	Down gradient	344.2	324.2	20	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to the East Bottom Ash Pond - downgradient
Piezometers								
AD-3	Exisiting	Uppermost Water-Bearing Unit	Northwest of East Bottom Ash Pond	Side gradient	335.8	315.8	20	Existing well installed in 2011; and utilitzed to obtain water level data for uppermost water-bearing unit

Footnotes:

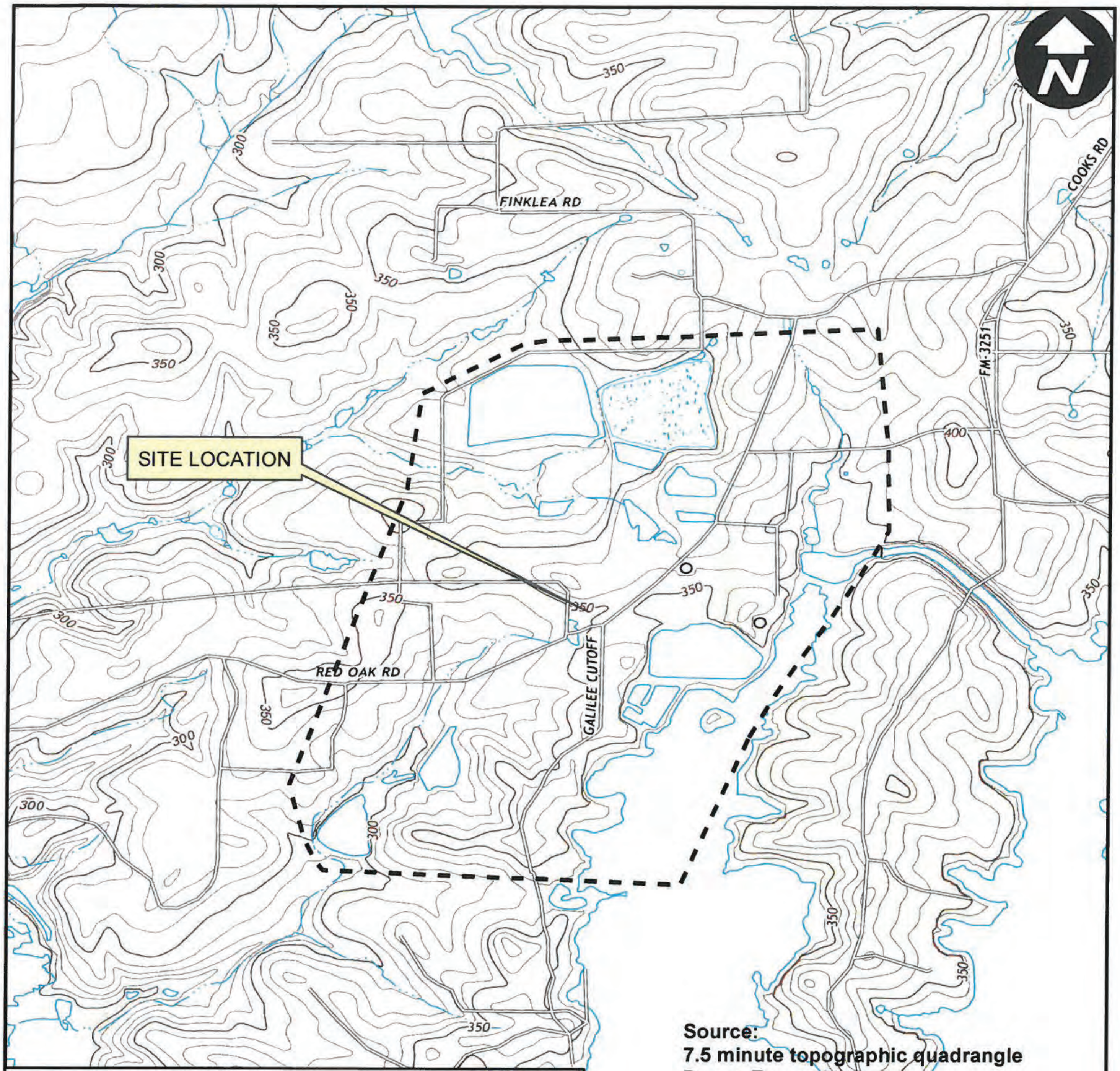
a. Target elevations are an estimated range.

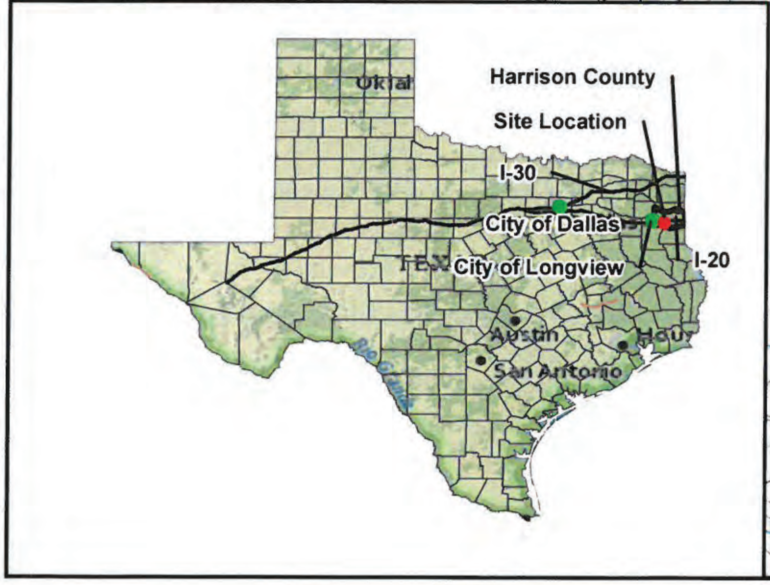
Acronyms and Abbreviations:

U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

ARCADIS

Figures





Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

0 2,000 4,000
SCALE IN FEET

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

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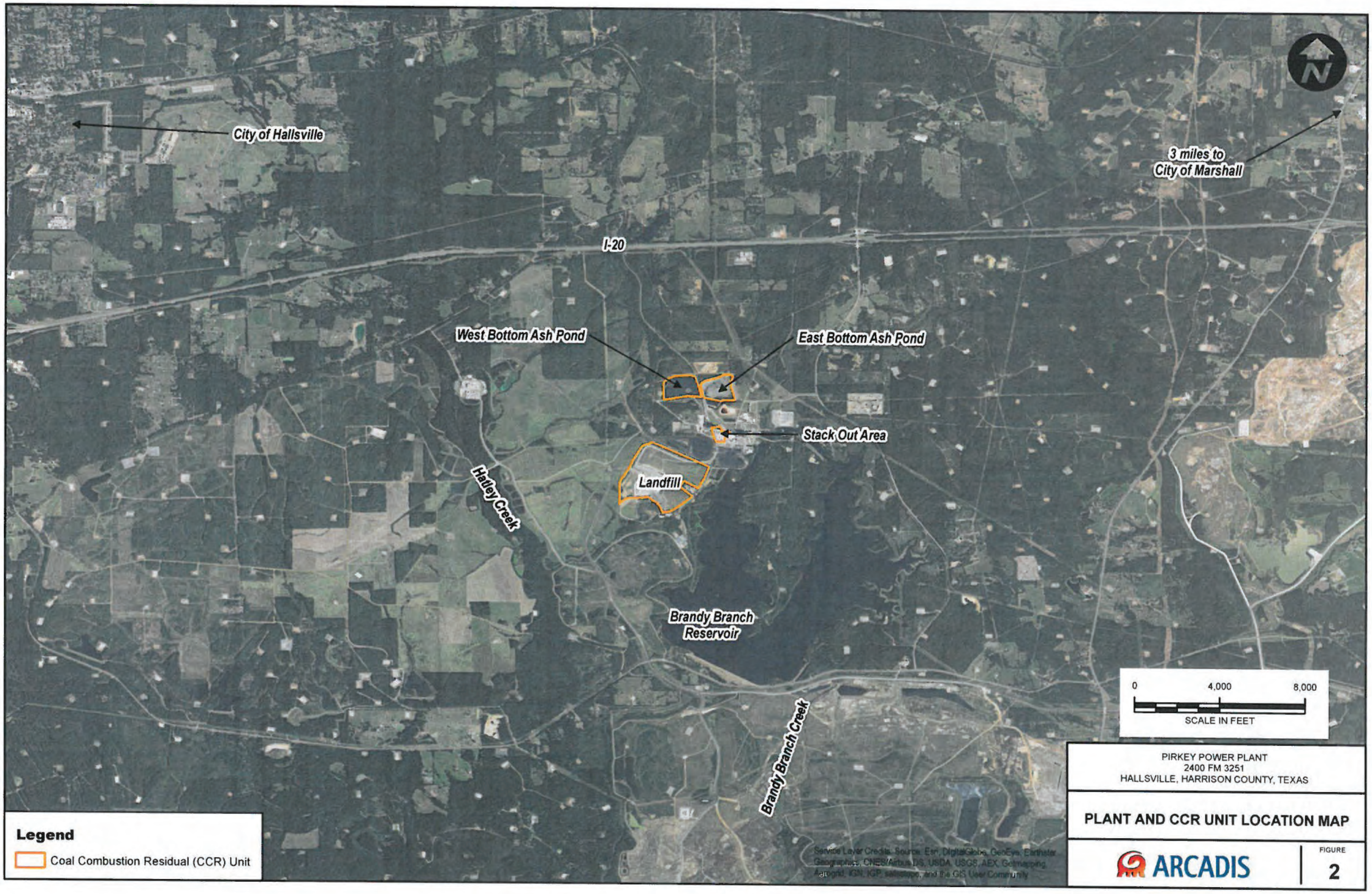


Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

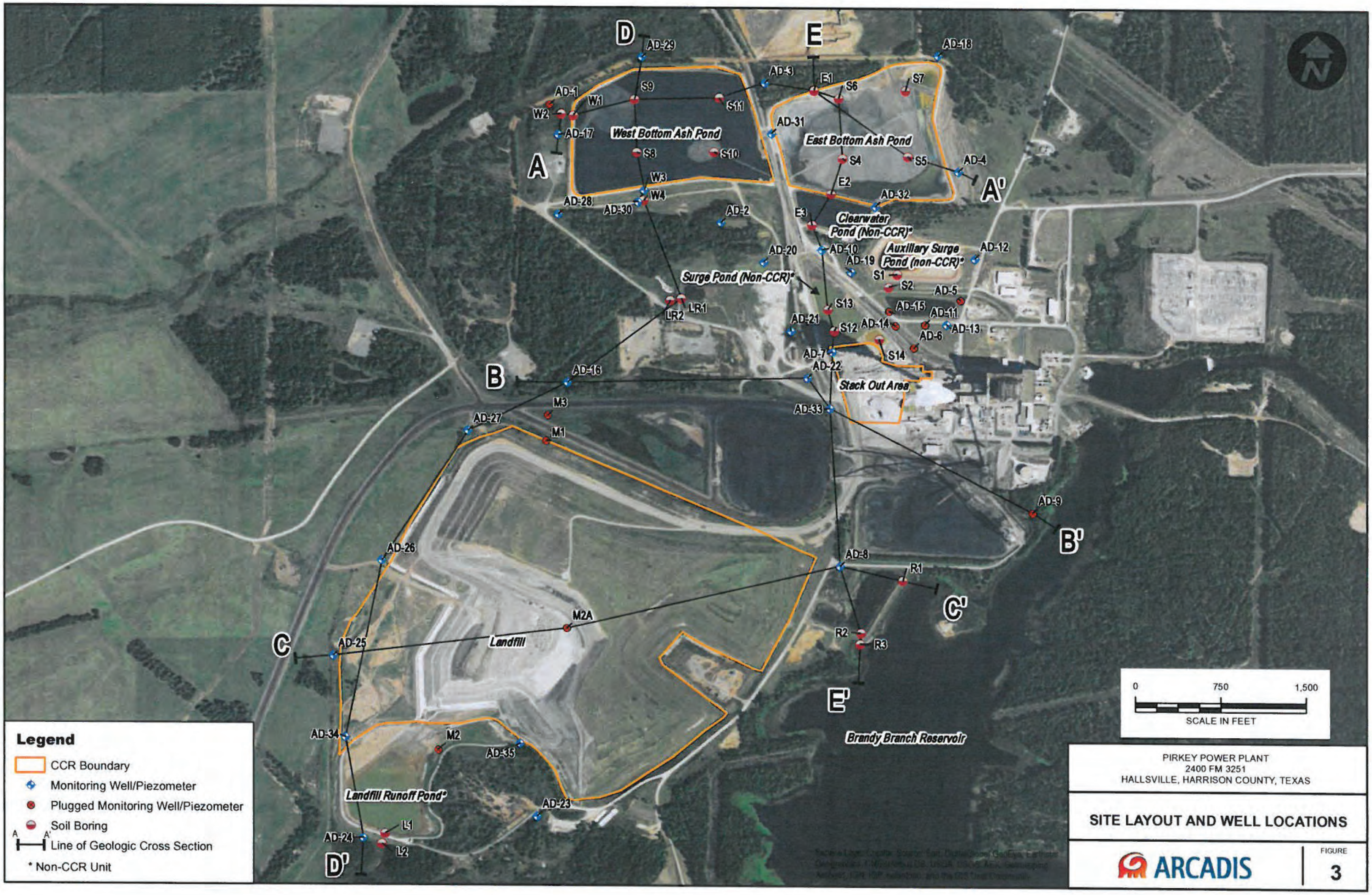
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



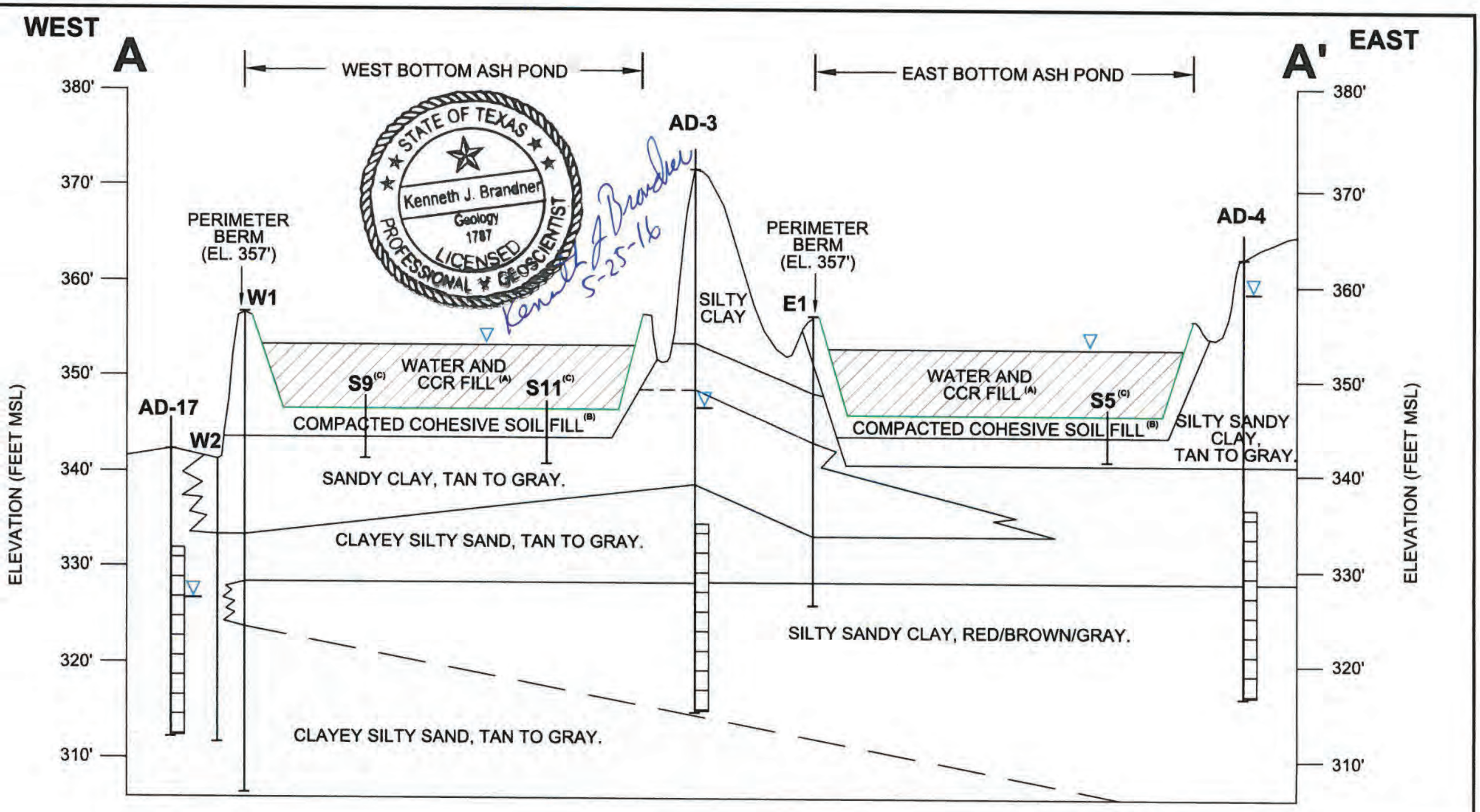
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE
3

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



Kenneth J. Brandner
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1787

Kenneth J Brandner
5-25-16

0 300'
HORIZONTAL SCALE

LEGEND

- ☐ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357'. OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).

C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
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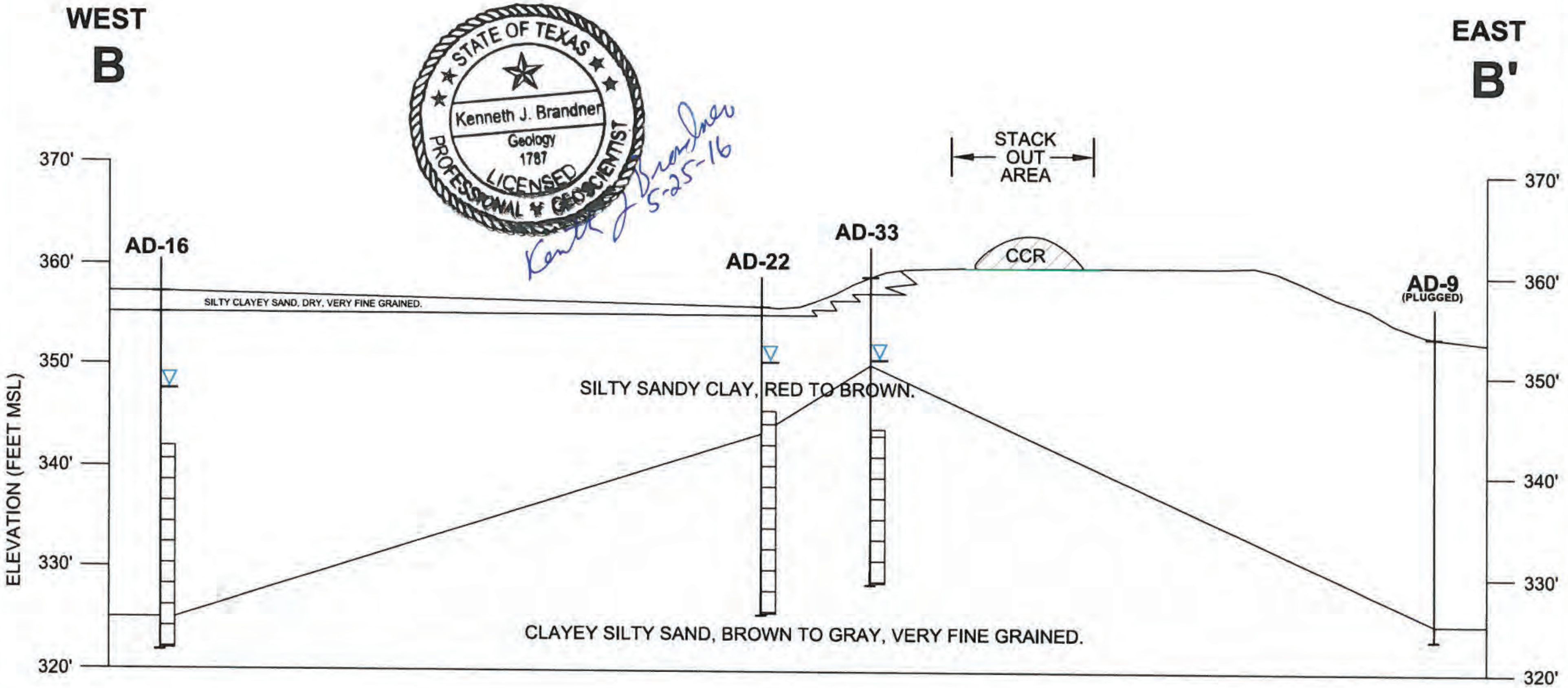

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5-25-16

0 300'
HORIZONTAL SCALE

LEGEND

- ⊟ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

NOTES:

A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE, ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.

B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 5 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 2/16/2016 1:49 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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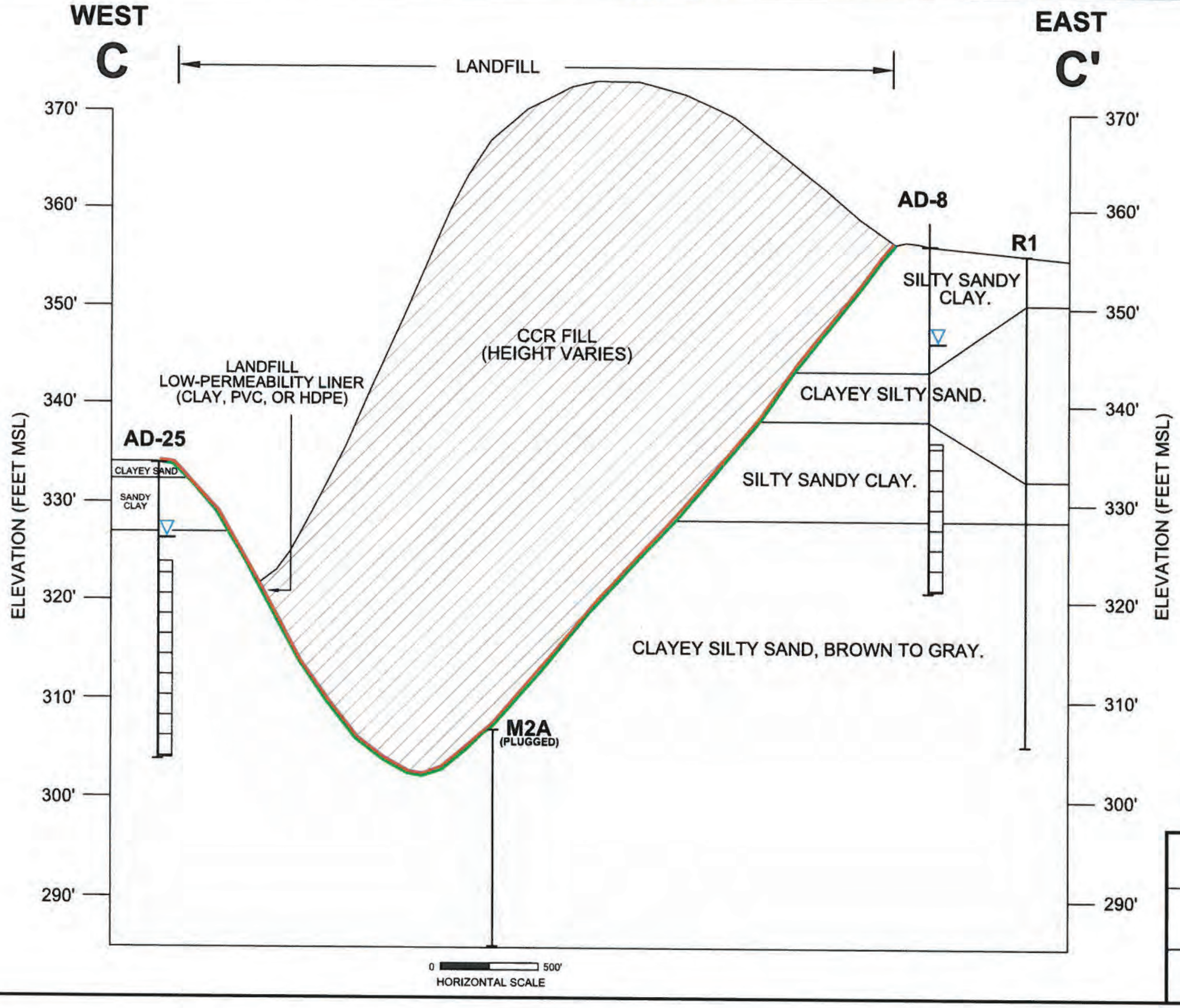

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5-25-16

LEGEND

⊟ MONITORING WELL SCREENED INTERVAL

▽ WATER LEVEL IN MONITORING WELL (1/20/16)

— BASE OF CCR UNIT

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 6 Cross Section C-C.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:25 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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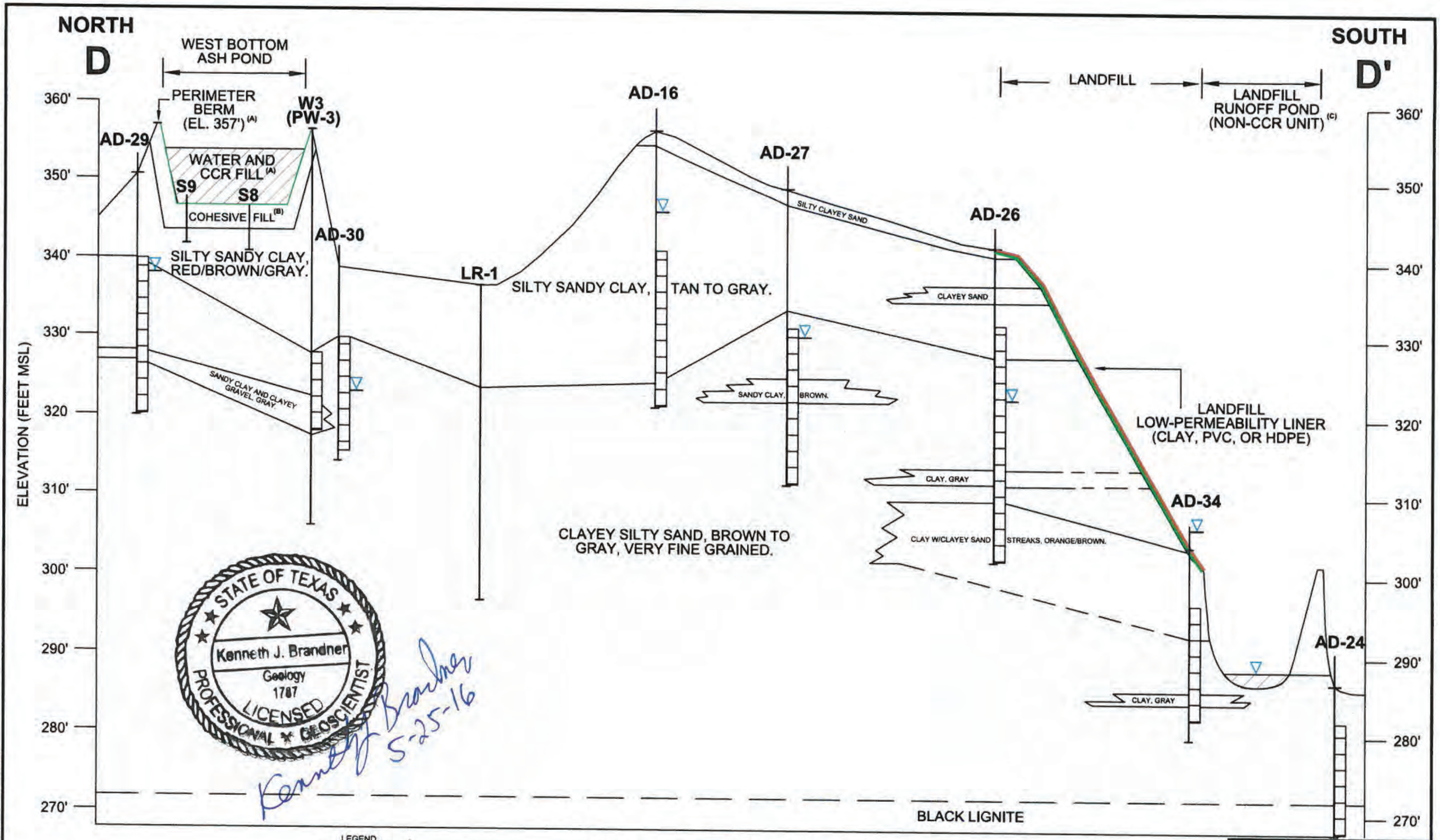

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5-25-16

LEGEND

⊟ MONITORING WELL SCREENED INTERVAL

▽ WATER LEVEL IN MONITORING WELL (1/20/16)

— BASE OF CCR UNIT

0 600'
HORIZONTAL SCALE

NOTES:

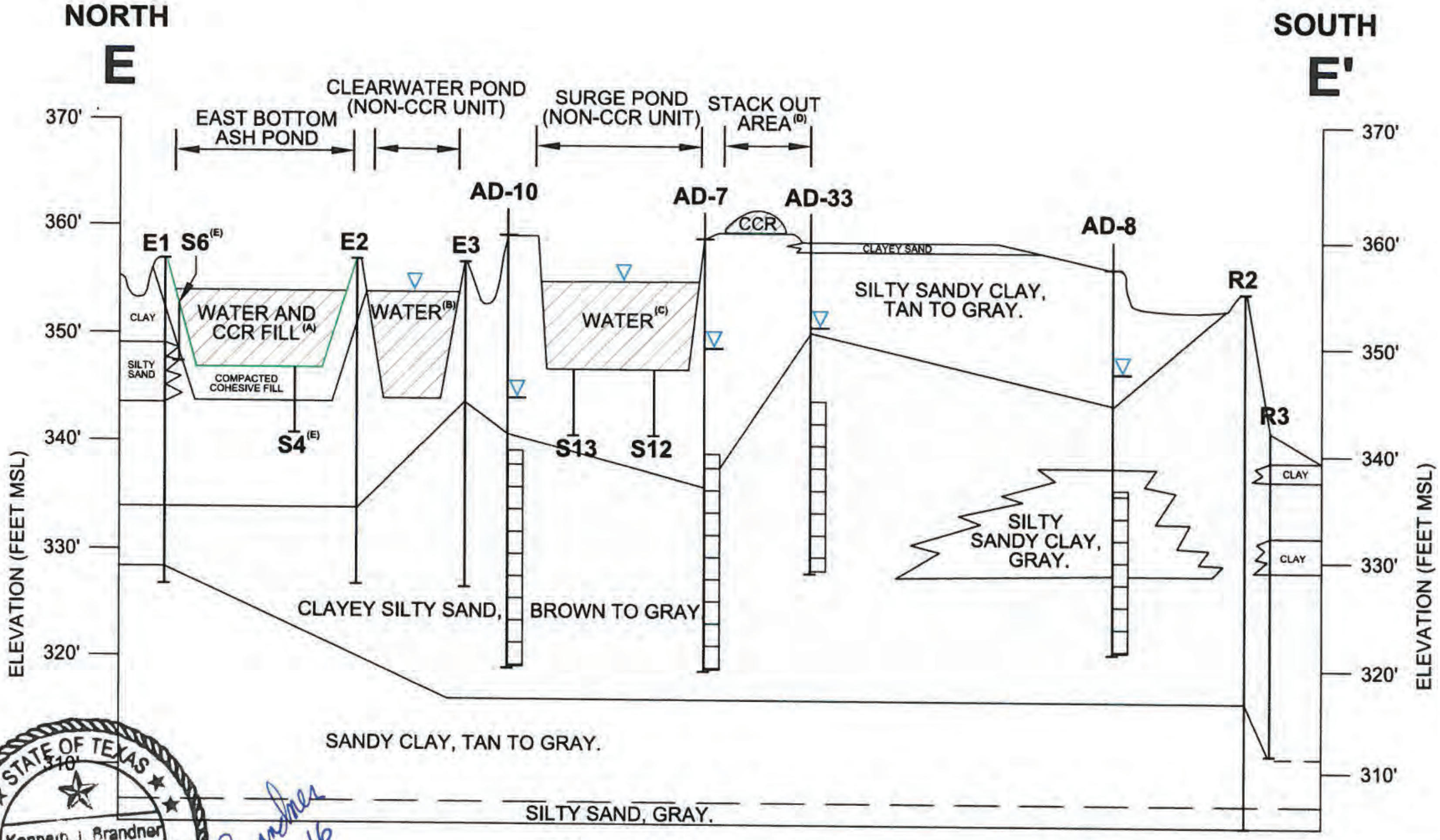
A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS

FIGURE
7



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5-25-16

0 500'
HORIZONTAL SCALE

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

NOTES:

A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).

C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".

D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.

E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

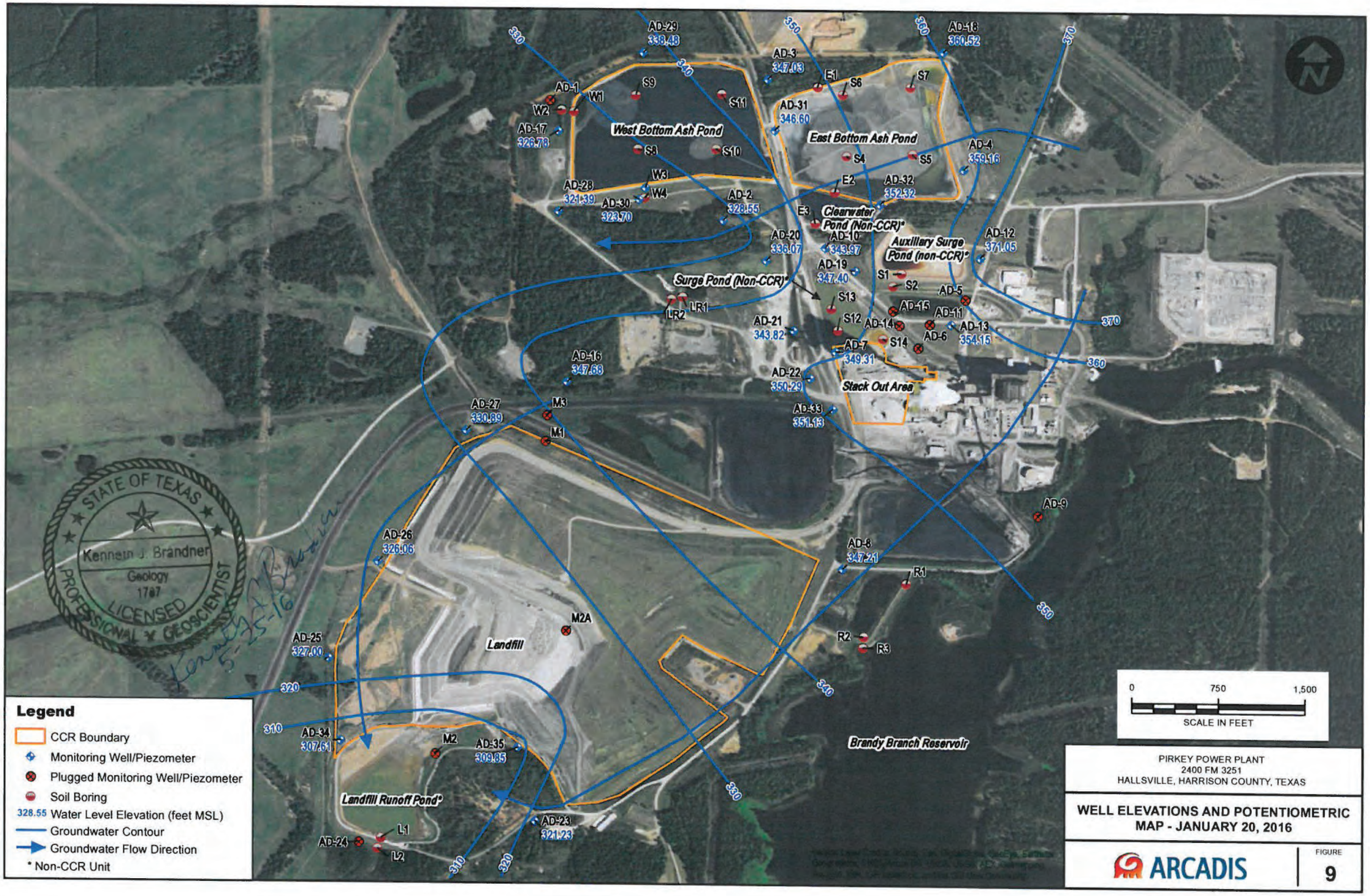
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF* G:\Active Projects\AEP\OH015978 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 8 Cross Section E-E'.dwg LAYOUT: MODEL SAVED: 2/22/2016 11:26 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE: —
PLOTTED: 2/22/2016 11:27 AM BY: LEASE, DIANA



Legend

- ▭ CCR Boundary
- ◆ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ● Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- — Groundwater Contour
- → Groundwater Flow Direction
- * Non-CCR Unit

STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL ★ GEOSCIENTIST

Kenneth J Brandner
5-25-16

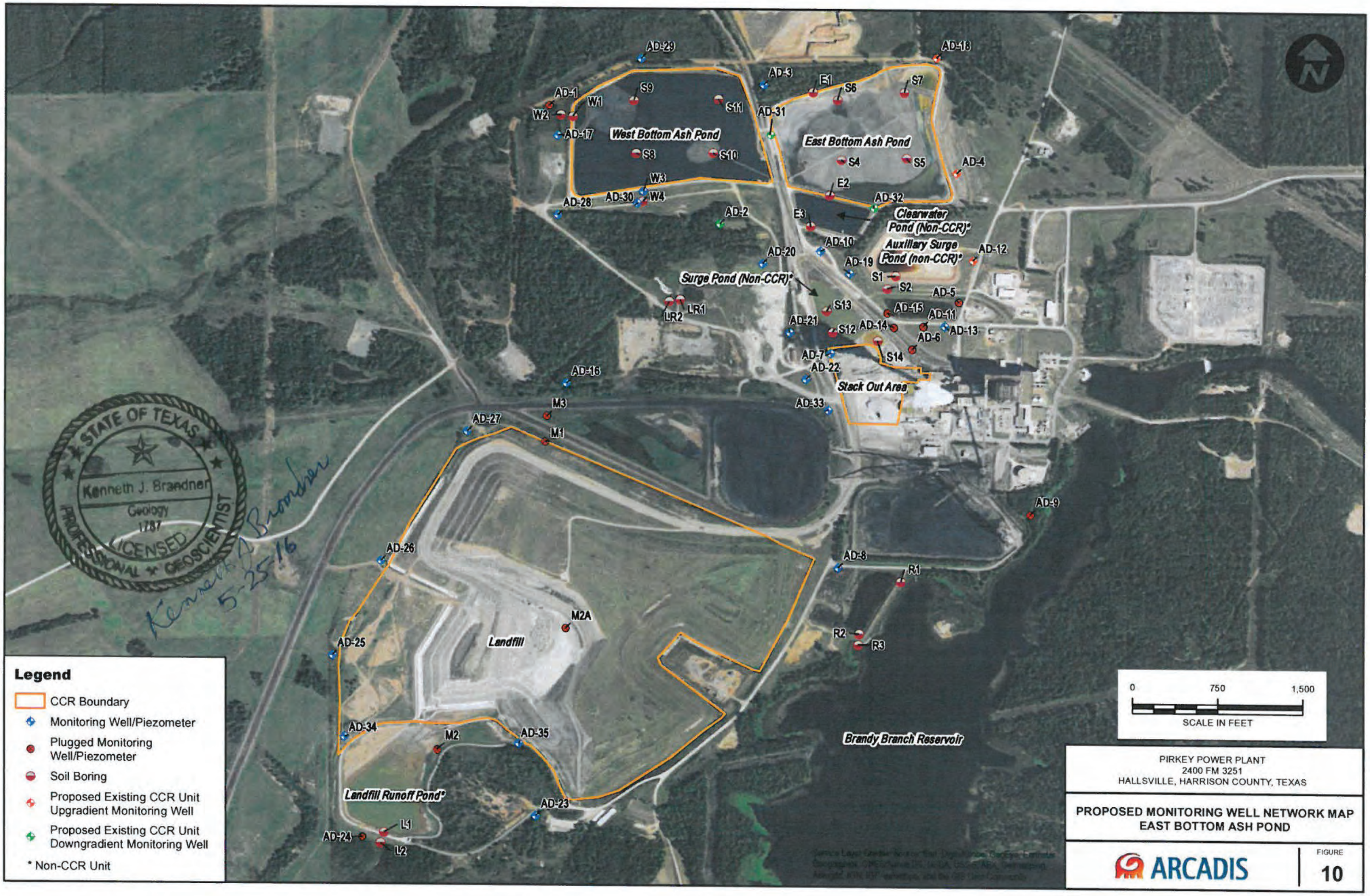
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

ARCADIS

FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Legend

- ▭ CCR Boundary
- ◆ Monitoring Well/Piezometer
- ● Plugged Monitoring Well/Piezometer
- ◐ Soil Boring
- ◆ Proposed Existing CCR Unit Upgradient Monitoring Well
- ◆ Proposed Existing CCR Unit Downgradient Monitoring Well

* Non-CCR Unit

Kenneth J. Braendner
Geology
1787

Kenneth J Braendner
5-25-16

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP
EAST BOTTOM ASH POND

ARCADIS

FIGURE
10

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 10 - Proposed Well Network - East Bottom Ash Pond.mxd

ARCADIS

Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

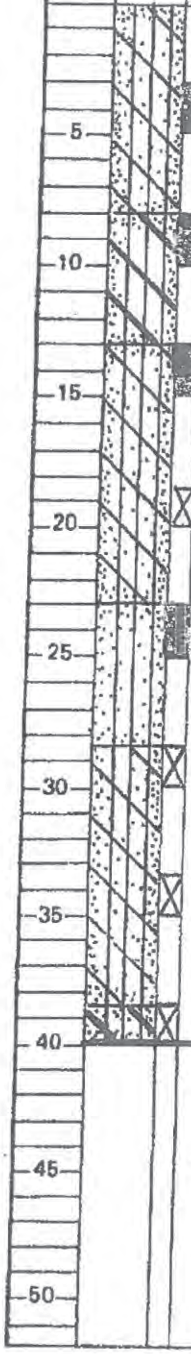
BORING NO.: MW-2
LOCATION: Hallsville

Date: 10-7-83 Type: Auger Ground Elevation:

Legend:

■ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Firm tan clayey silty sand

Medium tan and grey very sandy silty clay

Dense tan and grey clayey silty sand

Dense tan clayey silty sand 10-15-16 31 B/F

Dense tan silty sand

Very dense grey clayey silty sand 15-35=12" 50 B/F

Very dense grey clayey silty sand 21-29=9" 50 B/9"

Hard grey sandy silty clay 20-30=12" 50 B/F

Bottom of boring at 40 feet.

Water encountered at 25 feet.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

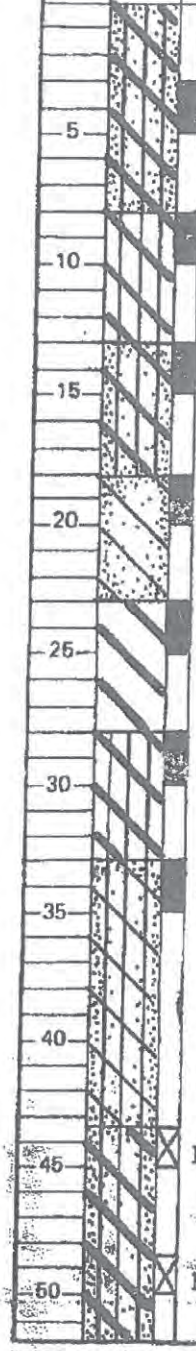
BORING NO.: MW-3
LOCATION: Hallsville, TX

Date: 11-4-83
Type: Auger
Ground Elevation:

Legend:

■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff red, brown and grey sandy silty clay

Stiff red, tan and grey silty clay lenses w/iron ore

Stiff brown and grey sandy silty clay

Firm brown and grey sand w/clay lenses

Stiff brown and grey clay

Stiff brown and grey clay w/silt lenses

Firm grey clayey silty sand

Hard grey clay w/silty sand lenses 43-7=6" 50 B/6"

Hard brown and grey silty sandy clay 21-29=12" 50 B/F

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

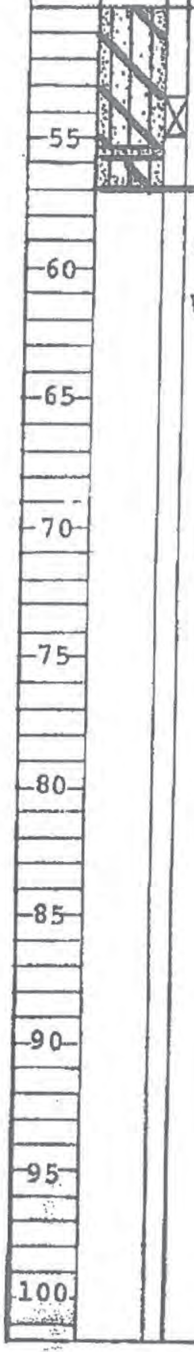
BORING NO.: MW-3
LOCATION: Hallsville, TX

Date: 11-4-83
Type: Auger
Ground Elevation:

Legend:

■ Sample
× Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Hard grey silty sandy clay 28-22=10" 50 B/10"

Bottom of boring at 57 feet.

Water encountered at 42 feet.

832964

LOG OF BORING

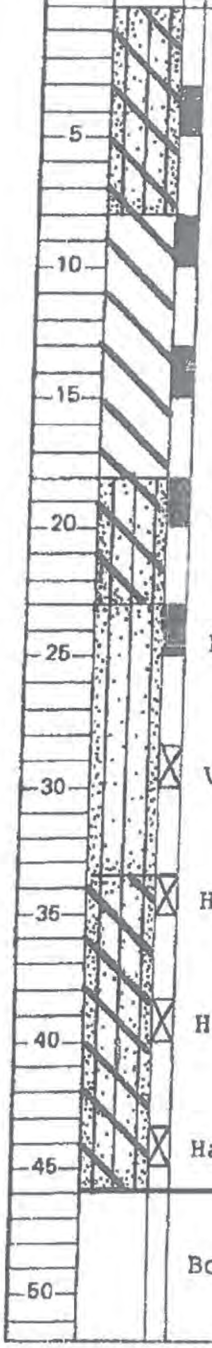
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-4
LOCATION: Hallsville

Date: 10-10-83
Type: Auger
Ground Elevation:

Legend:
▨ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff tan and grey silty sandy clay w/iron ore

Very stiff tan and grey clay

Very stiff tan and grey clay w/iron ore seam

Stiff tan and grey silty sandy clay lenses

Firm grey silty sand

Very dense grey silty sand 30-20=12" 50 B/F

Hard grey silty sandy clay 30-20=8" 50 B/8"

Hard grey silty sandy clay 25-25=8" 50 B/8"

Hard grey silty sandy clay 25-25=10½" 50 B/10½"

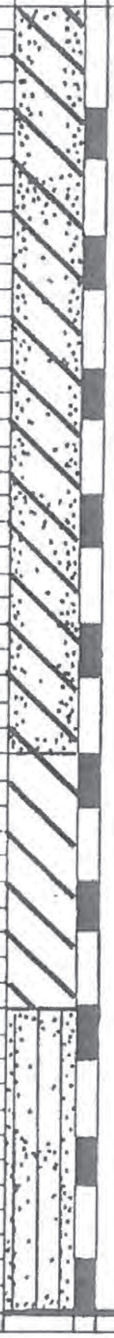
Bottom of boring at 46 feet.

832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond BORING NO.: MW-12
CLIENT: Southwestern Electric Power Company LOCATION: Hallsville, TX
N 6+13.25; W-6+90.36
Date: 1/30/86 Type: Rotary Ground Elevation: 378.41

Legend:
■ Sample X Penetration ▼ Water



Depth, Feet	Description of Stratum
5	Brown and tan sandy clay
10	Brown, tan and gray sandy clay
15	Tan and gray sandy clay
20	Brown and tan sandy clay
25	Gray and tan sandy clay
30	Brown and gray clay
35	Brown and gray clay
40	Gray silty sand
45	Gray silty sand
50	Gray silty sand

Water encountered at 27.5 feet.
Bottom of Boring at 51 feet.

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ______ ■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-18

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

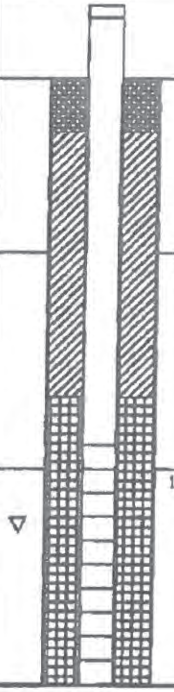
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 1/3/2011

PREPARED BY: Jeff Sammons **LOGGED BY:** Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.154' Datum: WGS-84 **WELL LOCATION:** Northeast of Bottom Ash Pond #1
LONGITUDE: W94°29.108'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
							
1 2 3 4 5 6 7			0-7	SM	Sandy Silt, some clay, very fine grained, gray, light brown, light brownish red, yellowish brown	None	Dry
8 9 10 11 12 13			7-16	CL	Clay, some sand, light gray, reddish gray, stiff, yellowish brown -iron oxide fracture at 9.5'	None	Dry
14 15 16					-increasing sand content at 14', thin lenses of iron-oxide cemented sand at 14.5', 15', 15.5', stiff		Moist
17 18 19			16-25	SM	Silty sand, some clay, gray, yellowish brown, dense, abundant gypsum crystals, abundant iron oxide cemented sandstone gravel in layers, saturated 19-21'	None None	Moist to V. Moist Saturated
20 21					-dark gray at 21'	None	
22					-clayey at 21-23'		
23 24					-greenish gray, trace clay, at 23'	None	
25					-clay lense, hard, dry, (shale), at 24.5-25'	None	Dry
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40					Boring Terminated at 25'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex
geoscience inc.

Total Depth: 25 feet **Riser Interval:** +3 (ags)-15'
Filter Sand (Size/Interval): 13-25' Screen Interval: 15-25'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13' Water level:
Surface Completion ☐ Flush ■ Above Ground 3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-31**

STATE OF TEXAS
JDS 1-21-16
JEFFREY D. SAMMONS
GEOLOGY
#10070
LICENSED
PROFESSIONAL GEOSCIENTIST

PROJECT INFORMATION

PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1021
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/08/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

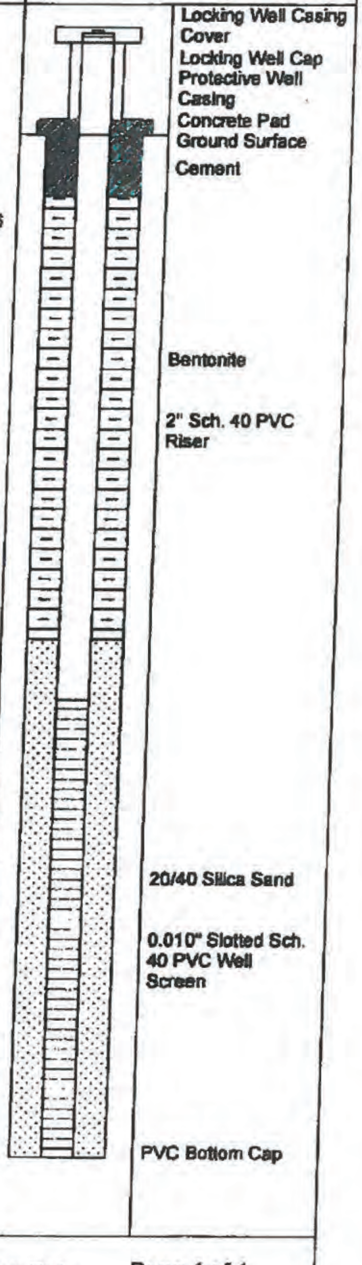
DRILLING INFORMATION

DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	50089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	360.75 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 28' 2.48"
LONGITUDE	94 29' 20.90"

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample **TBPG No. 50027**

DESCRIPTION	USCS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
		-4 to 0							
SANDY CLAY AND GRAVEL: dark reddish brown, moist	CH	0							
FAT CLAY WITH SAND: some laminations of very fine to fine sand, reddish brown and light gray	CH	3		■	22	81	51	15	36
FAT CLAY: some silt with trace very fine to fine sand laminations, reddish brown, yellowish brown and light gray	CH	6							
- light gray with laminations of light reddish brown silt and very fine sand at 11'		12	▼	■	28	95	68	31	37
CLAYEY SAND: very fine to fine sand, light reddish brown and light gray, very moist to saturated	SC	18	▽						
		21		■	26	44	36	21	15
- dark gray and gray clay with thin seams of light reddish brown very fine sand at 22' to 23'		22							
SILTY SAND: fine to very fine sand, some clay lenses and thin layers of partially cemented sandstone, gray and dark gray with light reddish brown, very moist to saturated - dark gray and reddiswh brown at 29', saturated - trace clay, light brown at 30'	SM	28							
		32		■	24	5	24	NP	
CLAYEY SAND: very fine sand, dark gray, very moist to saturated	SC	34							

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-32**

JEFFREY D. SAMMONS
GEOLOGY #10070
JDS 1-21-16

PROJECT INFORMATION

PROJECT: **Pirkey Power Plant**
PROJECT NO.: **I-04-1021**
LOGGED BY: **Jeffrey D. Sammons, P.G.**
SUPERVISING PG: **Jeffrey D. Sammons, P.G.**
COMPLETION: **12/11/2015**
DEVELOPMENT: **12/16/2015**
SITE LOCATION: **2400 FM 3251, Hallsville, Texas**
WELL OWNER: **AEP**

DRILLING INFORMATION

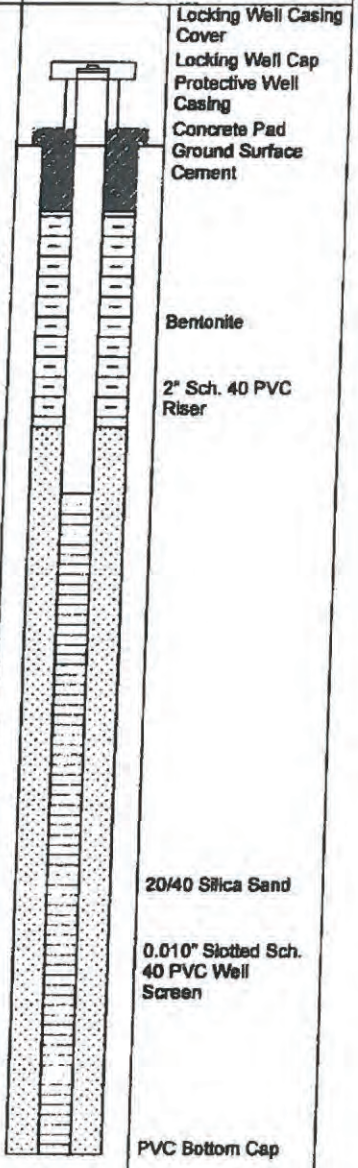
DRILLER: **Buford Collier**
DRILLER'S LICENSE NO.: **50089**
RIG TYPE: **Geoprobe 3230DT**
METHOD OF DRILLING: **Hollow Stem Auger**
SAMPLING METHODS: **Split Core**
SURFACE ELEVATION: **359.18 (Top of Casing)**
HOLE DIAMETER: **8.25"**
LATITUDE **32 27' 56.20"** LONGITUDE **94 29' 11.86"**

▼ Water Level Upon Installation (approx. 4.5') ▽ Water Level at Time of Drilling (approx. 12.5') ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	DEPTH	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, dark reddish brown, moist - interbeds of sand and clay, yellowish brown and light gray at 1' - reddish brown and light gray at 2' - light gray and yellowish brown at 4', - grayish brown and light gray at 6' - grayish brown, light gray, and reddish brown at 7'	SC	0						
		3	■	25	46	35	22	13
		7	■	26	44	37	20	17
SANDY LEAN CLAY: some gravel seams and thin interbeds of cemented sand, light yellowish brown and light gray, moist to saturated within gravel seams - some iron ore gravel at 16', very moist to saturated	CL	12.5						
		16	■	26	54	37	22	15
SILTY SAND: very fine to fine sand, trace clay, brownish gray and dark brownish gray, saturated - reddish brown and brown at 20'	SM	17.5						
SANDY LEAN CLAY: gray and dark gray, very moist	CL	20.5						
		21	■	26	51	37	24	13
CLAYEY SAND: fine to very fine sand, gray and dark gray, very moist to saturated	SC	25.5						
		26	■	26	47	41	22	19
SANDY LEAN CLAY: gray and dark gray, very moist	CL	30.5						
		31	■	26	59	35	21	14

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING E-1

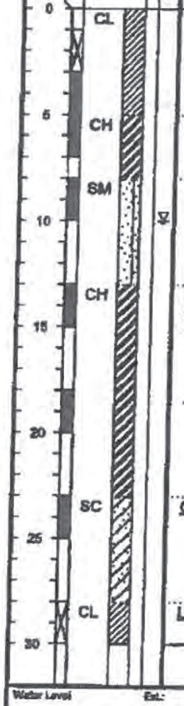
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; yellow and gray	N=9						
	–very stiff; yellow and white	P=2.75	24	42	22	20	68	+40 Sieve=5%, +4 Sieve=0%
CH	SANDY FAT CLAY(CH) very stiff; yellow and tan; with ferric joints	P=2.75	25	53	22	31	63	+40Sieve=13%, +4 Sieve=1%
SM	SILTY SAND(SM) yellow	SF	27				41	+40 Sieve=3%, +4 Sieve=1%
CH	FAT CLAY WITH SAND(CH) hard; brown and yellow; with ferric joints; with iron oxide cemented sandstone	P=4.5+	24	62	24	38	74	+40Sieve=19%, +4 Sieve=8%
	–very stiff; brownish yellow; with ferric joints	P=3.75						
SC	CLAYEY SAND(SC) medium dense; gray	N=26						
CL	LEAN CLAY(CL) hard; grey	N=43						

Bottom of Boring @ 30'

DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 10' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING E-2

PROJECT: Pirkey Power Plant
Hallsville, Texas

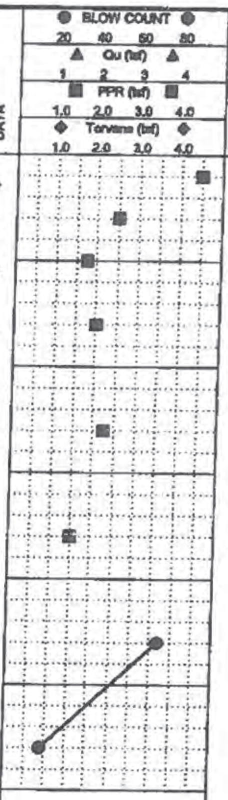
PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/08

SURFACE ELEVATION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY(CL) hard; gray and red; with gravel	P=4.5+										
	--very stiff; tan and red	P=2.5					18	47	17	30	69	+40Sieve=14%, +4 Sieve=5%
CH	SANDY FAT CLAY(CH) stiff; red and tan	P=1.75					21	50	18	34	69	+40 Sieve=8%, +4 Sieve=1%
	--red and gray	P=2.0										
	--very stiff; red, gray, and tan	P=2.25					23	57	18	38	71	+40 Sieve=6%, +4 Sieve=0%
CL	LEAN CLAY(CL) stiff; red and gray	P=1.5										
SM	SILTY SAND(SM) very dense; gray, red, and tan; saturated	N=74										
SC	CLAYEY SAND(SC) medium dense; greenish gray	N=18										
	Bottom of Boring @ 30'											



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 8' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-4
LOCATION: Hallsville,TX

Date: 9-14-83
Type:
Ground Elevation: 347.3

Legend:
▆ Sample
X Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
5		▆	Red and grey sandy silty clay Red and grey sandy silty clay Red and grey sandy silty clay w/iron ore
10 15 20 25 30 35 40 45 50			Bottom of boring at 6 feet. No water encountered.

SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-5
LOCATION: Hallsville, TX

Date: 9-14-83
Type:
Ground Elevation: 347.1

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
			Red and grey silty sandy clay w/iron ore
			Red and grey silty sandy clay w/iron ore
5			Red and grey silty sandy clay 7-13-15 28 B/F

Bottom of boring at 6 feet.

No water encountered.

10
15
20
25
30
35
40
45
50

SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO
BORING NO.: S-6
LOCATION: Hallsville, TX
Date: 9-14-83
Type:
Ground Elevation: 353.6

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum

Red and grey silty clay lenses w/iron ore

Red and grey silty sandy clay w/iron ore

Red and grey silty clay

Bottom of boring at 6 feet.

No water encountered.

5
10
15
20
25
30
35
40
45
50

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-7
LOCATION: Hallsville, TX

Date: 9-14-83
Type:
Ground Elevation: 346.9

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum

Red, brown and grey silty clay

Red, brown and grey silty clay w/silt lenses and iron ore

Red, brown and grey silty sandy clay

Bottom of boring at 6 feet.

No water encountered.

-5- -10- -15- -20- -25- -30- -35- -40- -45- -50-

ARCADIS

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 1 **Date:** 8/19/2015

Direction Photo Taken:

South

Description:

P8190374
Vegetative strip adjacent to East Ash Pond. Under new rule this potential wetland is likely non-jurisdictional.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 2 **Date:** 8/19/2015

Direction Photo Taken:

Description:

P8190372
AD- 4 Ground water monitoring well. East Bottom Ash Pond embankment in background.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 3

Date: 8/19/2015

Direction Photo Taken:

South

Description:

P8190378
View across East and West Botton Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 4

Date: 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190379
Road side ditch, not considered a wetland, due to lack of hydric vegetation and connectivity.

ARCADIS **PHOTOGRAPHIC LOG**

Project Name: AEP – Pirkey Power Plant

Location: Hallsville, Harrison County, Texas

Project No. OH015976.0001

Photo No. 5

Date: 8/19/2015

Direction Photo Taken:

North

Description:

P8190380
AD-18 Ground water monitoring well.

ARCADIS **PHOTOGRAPHIC LOG**

Project Name: AEP – Pirkey Power Plant

Location: Hallsville, Harrison County, Texas

Project No. OH015976.0001

Photo No. 6

Date: 8/19/2015

Direction Photo Taken:

North

Description:

P8190381
AD-18 Ground water monitoring well.

4.2 – West Bottom Ash Pond – CCR Groundwater Monitoring Well Network Evaluation, May 25, 2016

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West Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

May 25, 2016

ARCADIS

STATE OF TEXAS
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Geology
1787
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Professional Engineer

West Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
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Date:
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Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91, for the West Bottom Ash Pond (BAP) CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above and isolated from the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zone, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the West BAP (Site). The evaluation of the location restriction criteria is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the West BAP CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant West BAP.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The West BAP CCR unit is located at the north end of the Plant and approximately 3,000 feet northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of West BAP CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the West BAP.

2.2.1 Embankment Configuration

The West BAP embankments have a maximum height of approximately 25 feet and are constructed of compacted clay on a slope ranging from 2.5:1 (2.5 feet horizontal, 1 foot vertical) to 3:1 (Sargent & Lundy, 1983). The elevation at the top of the embankment around the perimeter of the West BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, 2011). The interior bottom elevation of the West BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Akron Consulting, 2012).

2.2.2 Area/Volume

The West BAP is approximately 30.9 acres in size. The design maximum ash storage capacity of the West BAP is 188 acre feet at an elevation of 354 feet amsl (normal operating level) and 216.5 acre feet at an elevation of 355 feet amsl (maximum operating level) (Sargent & Lundy, 1983; Akron Consulting, 2012).

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, flue gas desulfurization sludge) have been generated. The West BAP, which was placed into operation in 1985, receives bottom ash and economizer ash sluiced from the power plant boiler (**Figure 3**). Clear water overflow from the West BAP discharges into the Clearwater Pond located southeast of the West BAP. Bottom ash and economizer ash are periodically excavated from the West BAP and hauled by truck to either the on-site landfill for disposal, or sold for offsite beneficial re-use.

The base of the West BAP was constructed in 1983 with a compacted clay liner (Sargent & Lundy, 1983). Following installation of the compacted clay liner, soil borings S-8 through S-11 were advanced below the base of the West BAP to total depths of six feet in September 1983 (Southwestern Laboratories, 1984). The lithologic data from soil borings S-8 through S-11 confirm at least six feet of clay is present below the base of the West BAP (Sargent & Lundy, 1984).

2.2.4 Surface Water Control

Surface water elevation in the West BAP is controlled by a weir box and a manually operated gate valve on a 36-inch-diameter discharge pipe at the southeast corner of the pond. Clear water overflow from the West BAP discharges through the 36-inch-diameter pipe into the 2.7-acre Clearwater Pond located southeast of the West BAP (Figure 3). Water in the Clearwater Pond is pumped (re-circulated) back into the boiler ash hopper.

2.3 Previous Investigations

The initial soils investigation and design of the West BAP was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, and design of the West BAP. As discussed above in Section 2.2.3, the design included installation of a clay liner below the West BAP.

In September-October 1983, Southwestern Laboratories conducted a soil investigation at the Plant, including advancement of four soil borings (S-8 through S-11) below the West BAP (Southwestern Laboratories, 1984).

In 1984, Sargent & Lundy conducted an evaluation of the West BAP. This report included evaluation of soil sample geotechnical data, and concluded a low-permeability clay liner was present below the West BAP (Sargent & Lundy, 1984).

In 2009, ETTL Engineers & Consultants (ETTL) conducted a geotechnical investigation of the West BAP earthen embankment. The investigation included installation of two soil borings through the embankment (W1, W3) and two soil borings along the outer toe of the embankment (W2, W4), completion of soil borings W1 and W3 as piezometers PW-1 and PW-3, respectively, and collection of soil samples for geotechnical analyses. The report concluded the embankment was stable and the existing embankment slopes were acceptable if conditions are maintained (ETTL, 2010). The conditions to be maintained included embankment protection from erosion (vegetative cover), removal of brush and trees two feet or more in height, and control of animal burrowing.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed a hydraulic analysis of the West BAP for a 10-year, 24-hour rainfall event in accordance with the TCEQ TPDES permit design criteria. The report concluded the storage capacity of the West BAP is hydraulically adequate (Johnson & Pace, 2011).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the West BAP area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the West BAP, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow groundwater flow direction in the area of the West BAP is west-southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The West BAP is located approximately 3,000 feet northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the area of the West BAP does not discharge into Brandy Branch Reservoir.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 500 feet southeast (side gradient) of the West BAP in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile south (side gradient) of the West BAP for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (up gradient) of the Pirkey Power Plant.

3. Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be located down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the area of the West BAP is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 15 feet that is located between an elevation of approximately 325 and 340 feet amsl (**Appendix A**). The base of the West BAP is at an elevation of 347 feet amsl. Therefore the separation distance between the uppermost aquifer and the base of the West BAP is approximately seven feet. This separation distance is further illustrated on cross section A-A' (**Figure 4)** and cross section D-D' (**Figure 7)**.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness (approximately 15 feet), the yield of the uppermost aquifer is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Available groundwater elevations are summarized on **Table 1** for 2011 through 2016. The most recent comprehensive groundwater data set from January 20, 2016 is depicted on **Figure 9**. The groundwater flow is west-southwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

Per 40 CFR 257.60(a), new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five ft) above the upper limit of the uppermost aquifer, or must demonstrate there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high conditions).

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers, that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the area of the West BAP is the clayey and silty sand stratum that is located between an elevation of approximately 325 and 340 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 19, 2015 to review existing well network conditions and locations. A well construction table that summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as **Table 2**. Photo documentation of the located wells during the August 19, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-3, AD-12, AD-17, AD-18, AD-28, and AD-29 were previously installed at the Site to monitor the uppermost aquifer (clayey and silty sand stratum) associated with the West BAP. As discussed above in Section 3.1.1, the uppermost aquifer below the West BAP is approximately 15 feet thick and is located between an elevation of approximately 325 and 340 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on Geologic Cross Section A-A' (**Figure 4**), existing monitoring well AD-3 is screened in the uppermost aquifer upgradient (east) of the West BAP, and existing monitoring well AD-17 is screened in the uppermost aquifer downgradient (west) of the West BAP. Existing monitoring wells AD-3, AD-12 and AD-18 (also located east of the West BAP) will be utilized as upgradient monitoring wells for the West BAP. Existing monitoring wells AD-17 and AD-28 (also located west of the West BAP) will be utilized as downgradient monitoring wells for the West BAP.

As shown on **Figure 9**, shallow groundwater flow direction in the area of the West BAP is west-southwesterly. Two existing monitoring wells (AD-17, AD-28) were located hydraulically downgradient of the West BAP during the August 19, 2015 site visit, and three downgradient monitoring wells are required to monitor groundwater quality downgradient of a CCR unit. This data gap was addressed by installation of new downgradient monitoring well AD-30 along the south central side of the West BAP during December 2015 as shown on **Figure 9** and **10**. With the addition of monitoring well AD-30, there are no gaps remaining in the groundwater monitoring network for the West BAP.

4. Recommended Monitoring Network and PE Certification

The recommended existing groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the West BAP (up gradient or down gradient), well depth, and well construction. The recommended network would provide an improved understanding of groundwater quality, hydraulics, and groundwater flow at the West BAP.

4.1 Recommended Monitoring Well Network Distribution

Three up gradient well locations (existing monitoring wells AD-3, AD-12, and AD-18) and three down gradient well locations (existing monitoring wells AD-17, AD-28, and AD-30) are recommended to establish a groundwater quality monitoring well network for the West BAP. In addition, existing side gradient monitoring well AD-29 may be utilized as a piezometer to obtain additional groundwater flow direction and gradient data for the West BAP.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the West BAP is summarized on **Table 3** and illustrated on **Figure 10.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring well network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 325 and 340 feet amsl as shown on Geologic Cross Sections A-A' (**Figure 4**) and D-D' (**Figure 7**). The screen elevations are presented in **Table 3**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the West BAP was addressed by installation of monitoring well AD-30 during December 2015. Monitoring well AD-30 was installed by a Texas Department of Licensing and Regulation (TDLR)-licensed water well driller. Well construction data for the monitoring well network are summarized on **Tables 2** and **3**, and the monitoring well completion diagrams are provided in **Appendix A**.

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system will be adequate to meet the requirements of 40 CFR Part 257.91.

Kenneth J. Brandner

Printed Name of Registered Professional Engineer

Kenneth J Brandner

Signature

KENNETH J. BRANDNER
69586

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Registration No.

Texas

Registration State

5-25-16

Date

5. References

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Tables

Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation$^{(a)}$	Top of Casing Elevation$^{(a)}$	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen$^{(b)}$		Bottom of Screen$^{(b)}$		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30$^{(d)}$	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31$^{(d)}$	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32$^{(d)}$	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33$^{(d)}$	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34$^{(d)}$	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35$^{(d)}$	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers$^{(c)}$																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
NM - Not Measured

Table 2
Well Construction Details
AEP Pirkey Power Plant - CCR Units
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen(b)		Bottom of Screen(b)	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18	341	40	319	20	339.48	40	319.48
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29	350	51	328	31	347.84	51	327.84
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.48	40.5	321.48
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13	344	35	322	15.0	341.81	35.0	321.81
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8	335	30	313	10.0	332.65	30.0	312.65
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13	347	25	335	15.0	345.48	25.0	335.48
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8	352	30	330	10.0	349.50	30.0	329.50
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13	339	35	317	15.0	337.30	35.0	317.30
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8	339	30	317	10.0	337.23	30.0	317.23
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8	348	30	326	10.0	345.57	30.0	325.57
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13	334	35	312	15.0	331.72	35.0	311.72
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3	285	20	268	5.0	282.68	20.0	267.68
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8	326	30	304	10.0	324.15	30.0	304.15
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8	334	40	302	10.0	332.41	40.0	302.41
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.33	37.5	312.33
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13	323	35	301	15.0	320.92	35.0	300.92
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8	342	30	320	10.0	340.21	30.0	320.21
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8	331	25	314	10.0	329.04	25.0	314.04
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18	340	35	323	20.0	337.75	35.0	322.75
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11	346	33	324	13.0	344.23	33.0	324.23
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12	347	30	329	15.0	344.30	30.0	329.30
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8	297	25	280	10.0	294.64	25.0	279.64
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20	296	3.0	313.01	18.0	298.01
Piezometers(c)																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26	330	38	318	28.0	328.30	38.0	318.30

General Note:
Elevations in feet above mean sea level.

Footnotes:
(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.
(c) Souce: EETL (October 2010).
(d) Source: Aukland Consulting LLC (January 26, 2016).

Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

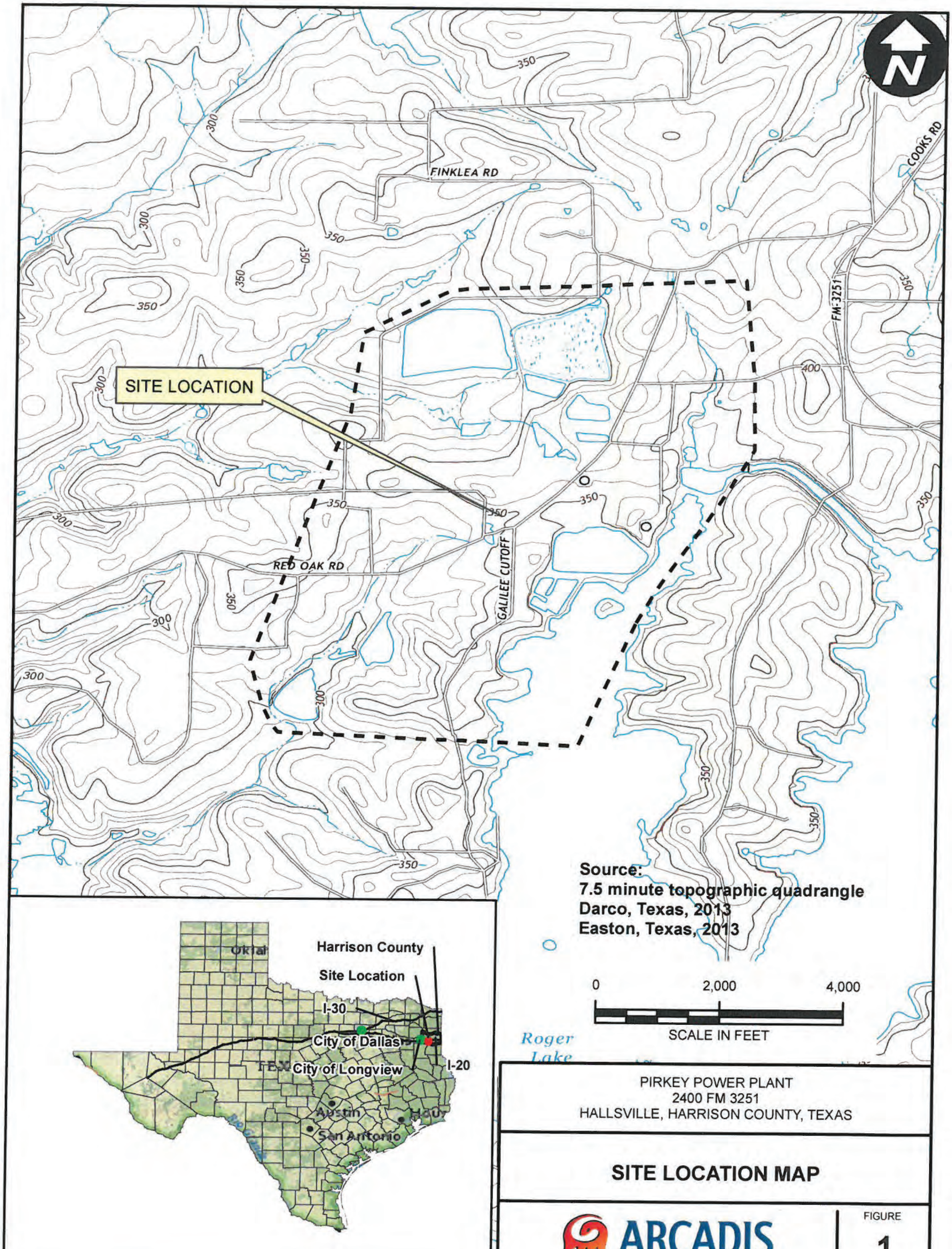
Table 3
Proposed Well Network
AEP Pirkey Power Plant - West Bottom Ash Pond
Hallsville, Harrison County, Texas

Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Target Elevation[a] (ft amsl)	Screen Bottom Target Elevation[a] (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-3	Exisiting	Uppermost Water-Bearing Unit	East of West Bottom Ash Pond	Upgradient	335.8	315.8	20	Existing well installed in 1983; well will be utilitzed to establish backgroud water quality
AD-12	Exisiting	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-18	Exisiting	Uppermost Water-Bearing Unit	East of West Bottom Ash Pond	Upgradient	345.5	335.5	10	Existing well installed in 2011; well will be utilitzed to establish backgroud water quality
Downgradient								
AD-17	Existing	Uppermost Water-Bearing Unit	West of West Bottom Ash Pond	Down gradient	332.7	312.7	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to the West Bottom Ash Pond - downgradient
AD-28	Existing	Uppermost Water-Bearing Unit	Southwest of West Bottom Ash Pond	Down gradient	320.9	300.9	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to the West Bottom Ash Pond - downgradient
AD-30	Existing	Uppermost Water-Bearing Unit	South of West Bottom Ash Pond	Down gradient	329.0	314.0	15	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to the West Bottom Ash Pond - downgradient
Piezometers								
AD-29	Exisiting	Uppermost Water-Bearing Unit	North of West Bottom Ash Pond	Side gradient	340.2	320.2	20	Existing well installed in 2011; and utilitzed to obtain water level data for uppermost water-bearing unit

Footnotes:
a. Target elevations are an estimated range.

Acronyms and Abbreviations:
U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

Figures



Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

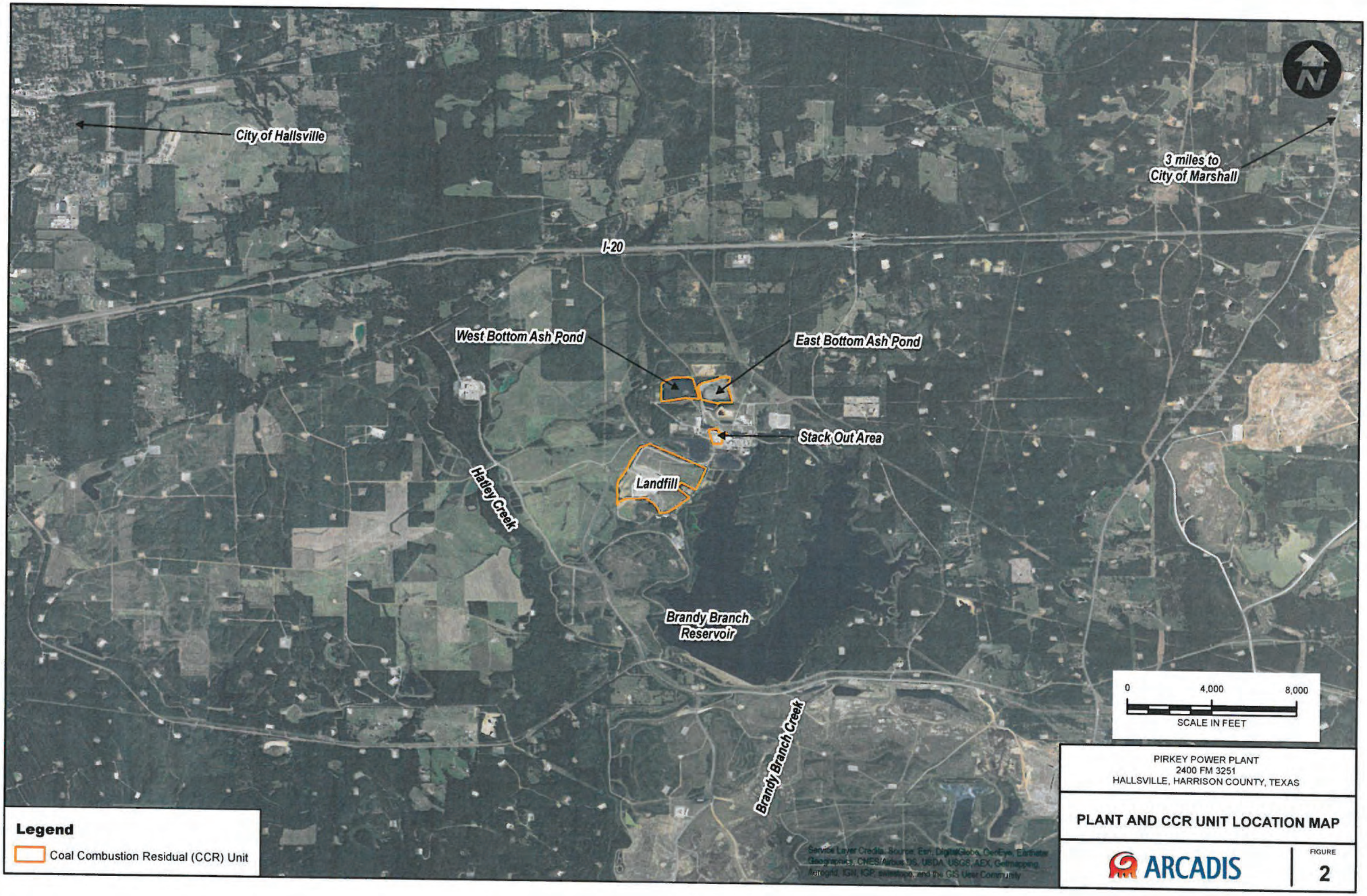
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

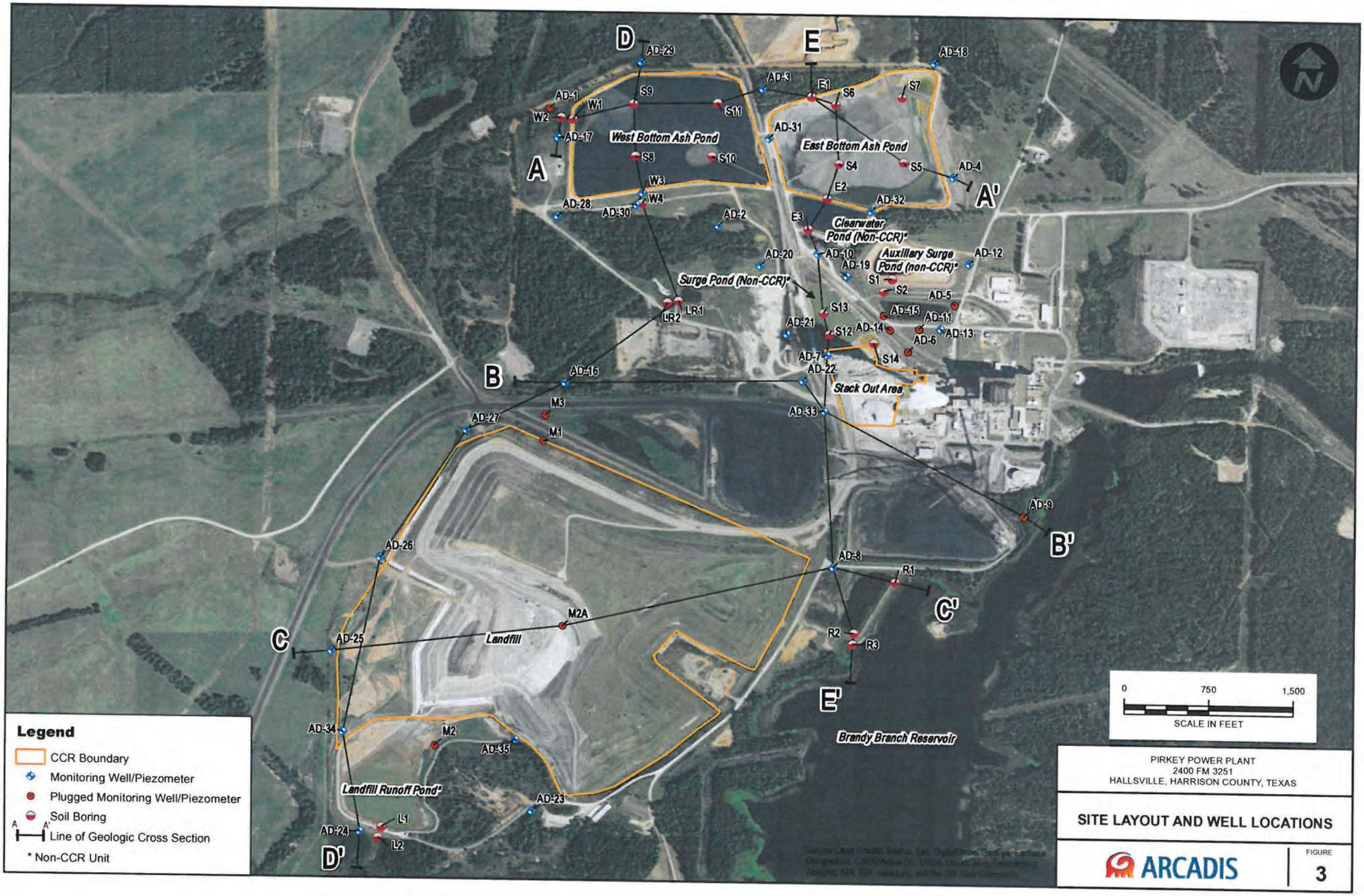
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



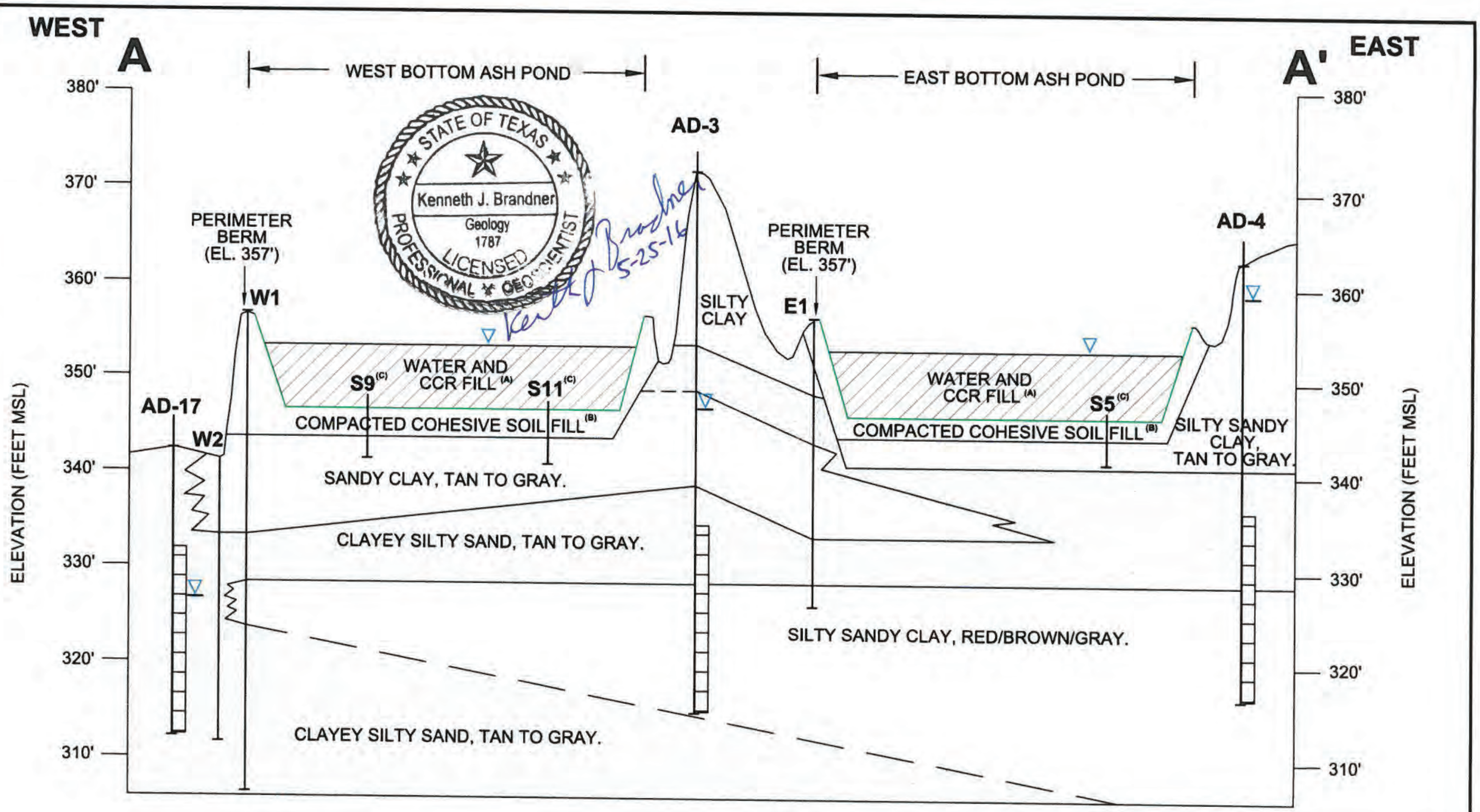
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE
3

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



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5-25-16

LEGEND

▤ MONITORING WELL SCREENED INTERVAL

▽ WATER LEVEL IN MONITORING WELL (1/20/16)

— BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).

C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:18 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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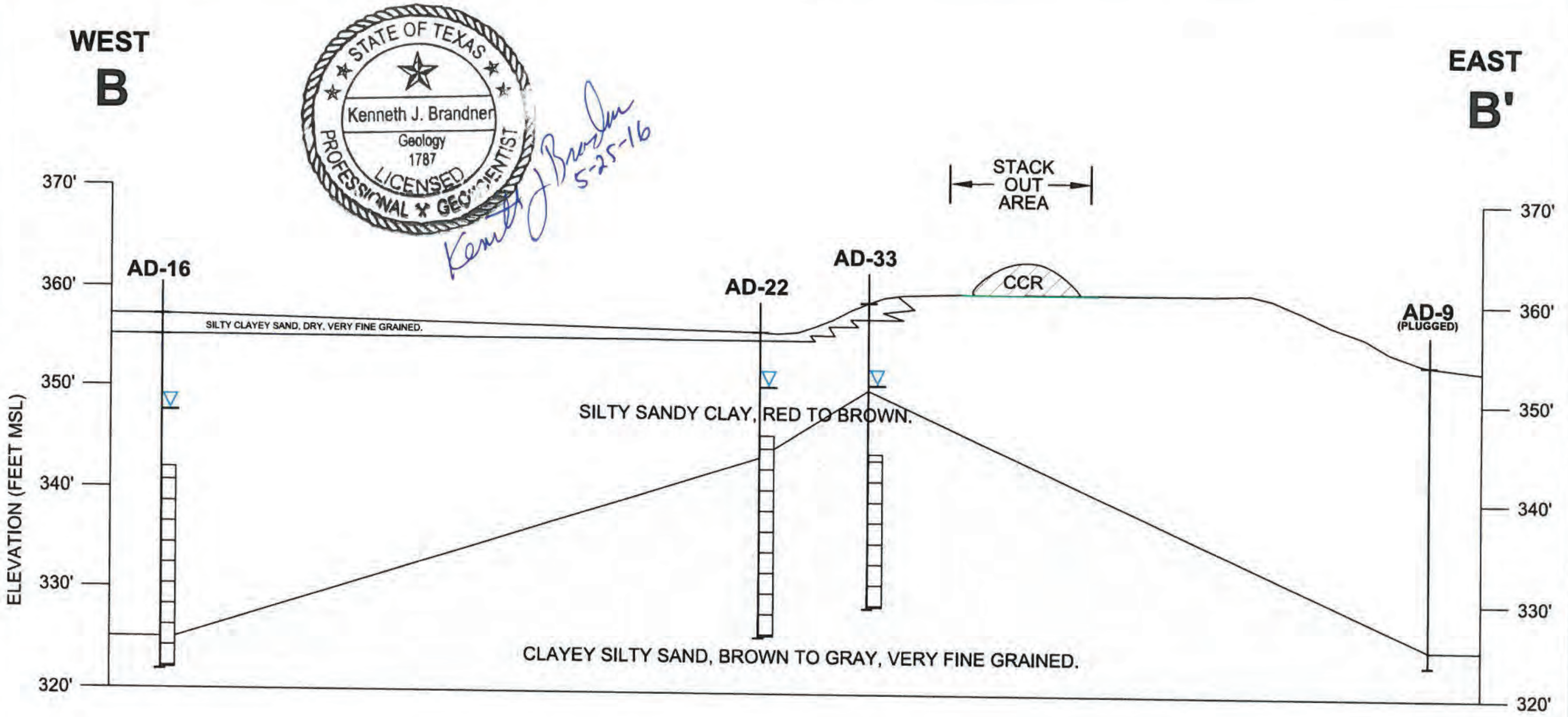

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0 300'
HORIZONTAL SCALE

LEGEND

- ▤ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

NOTES:

A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 5 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 2/16/2016 1:49 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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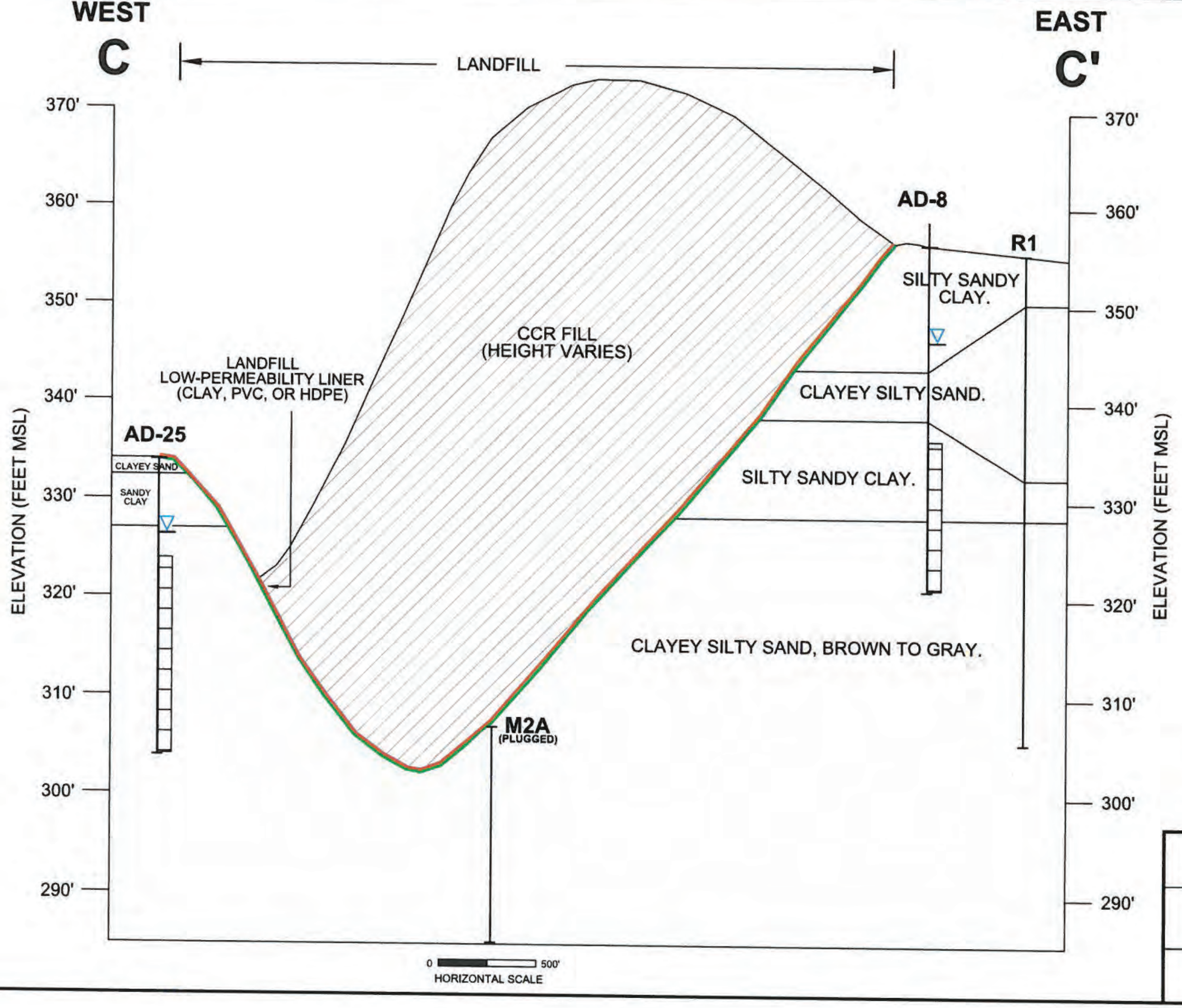

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LEGEND

- ⌸ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:25 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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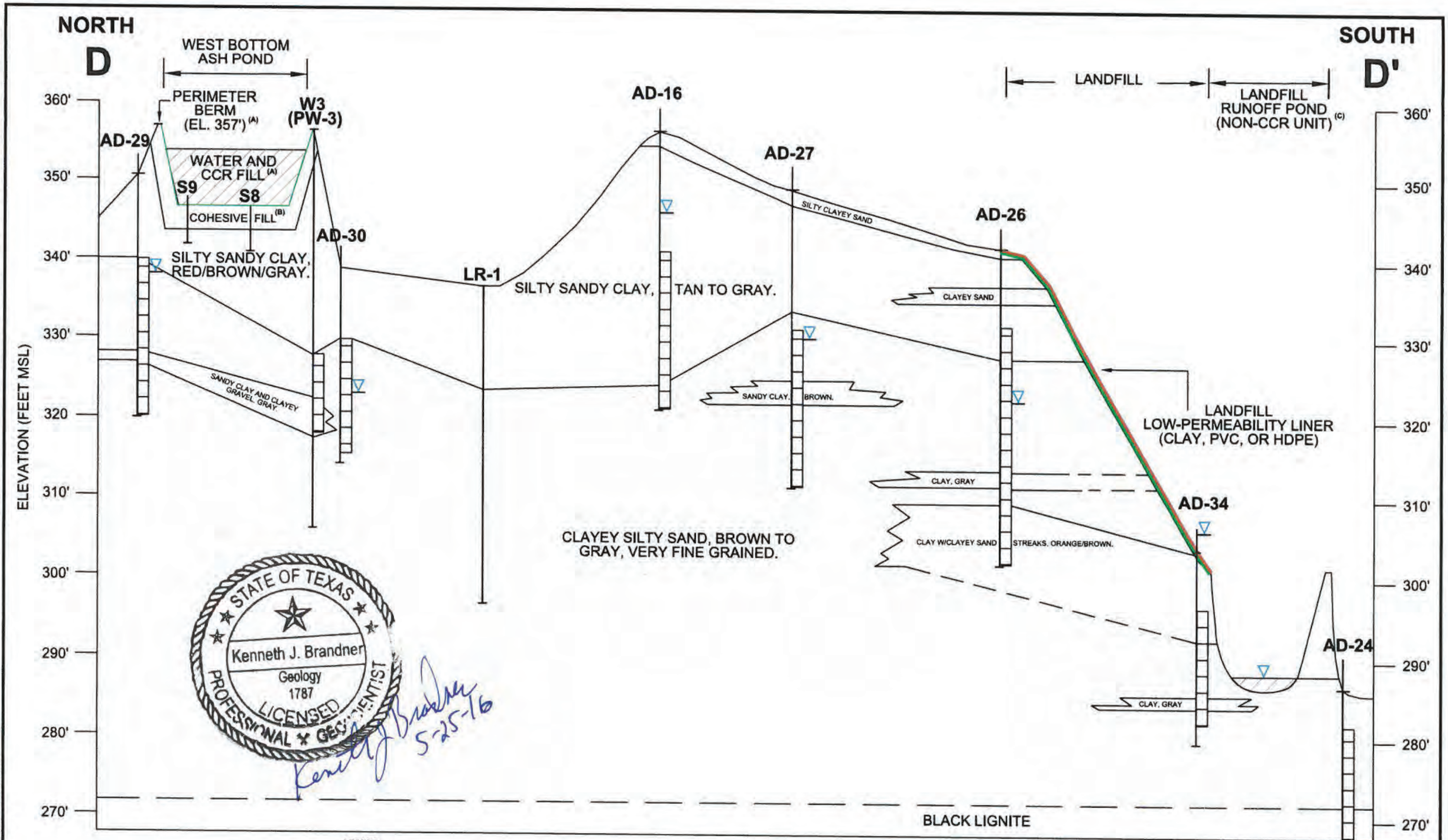

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5-25-16

0 600'
HORIZONTAL SCALE

LEGEND

- ⊟ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).

C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS

FIGURE
7

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 7 Cross Section D-D'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:30 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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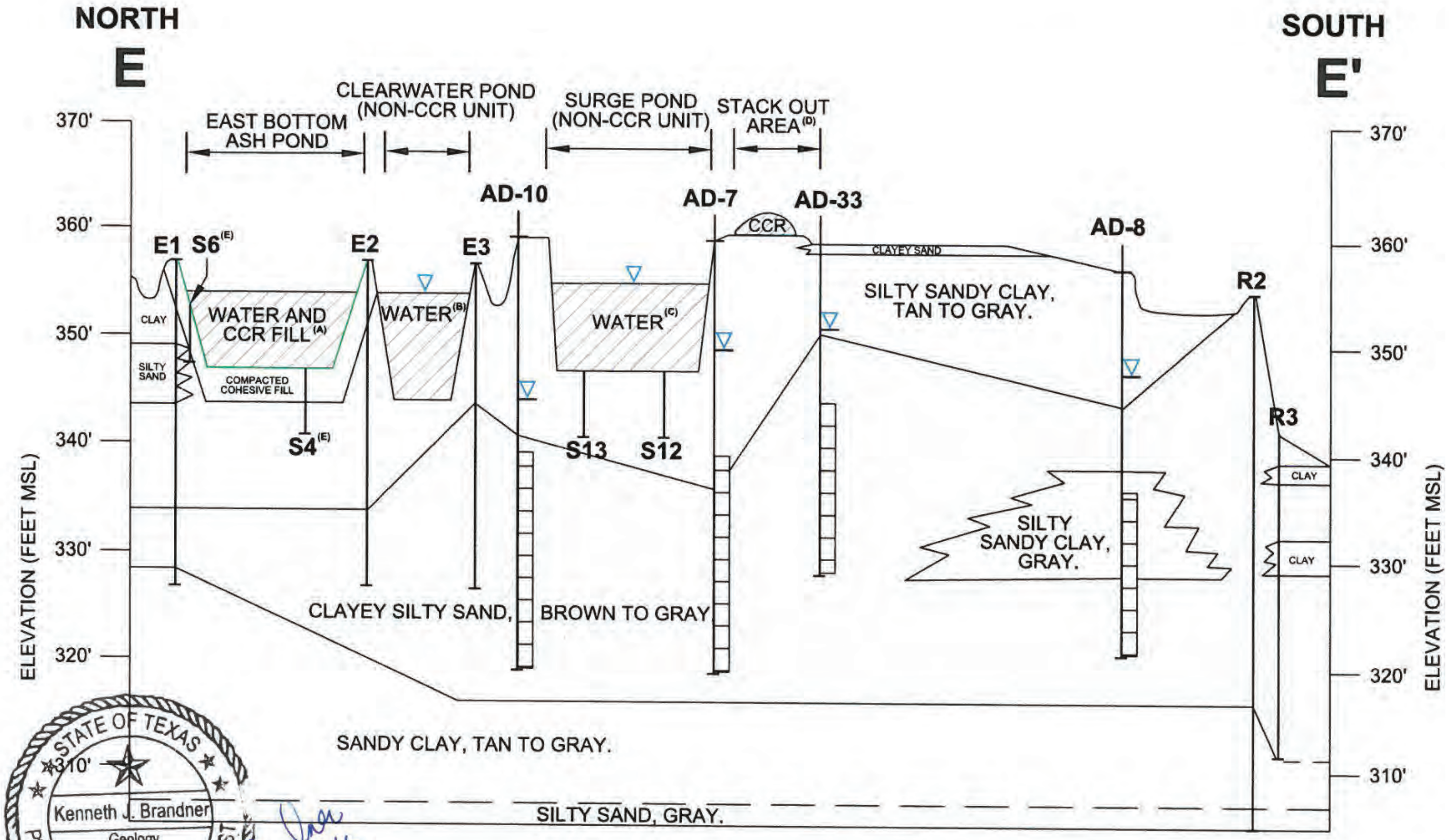

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5-25-16

0 500'
HORIZONTAL SCALE

LEGEND

▤	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

NOTES:
- A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357'. OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
- B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).
- C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".
- D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
- E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

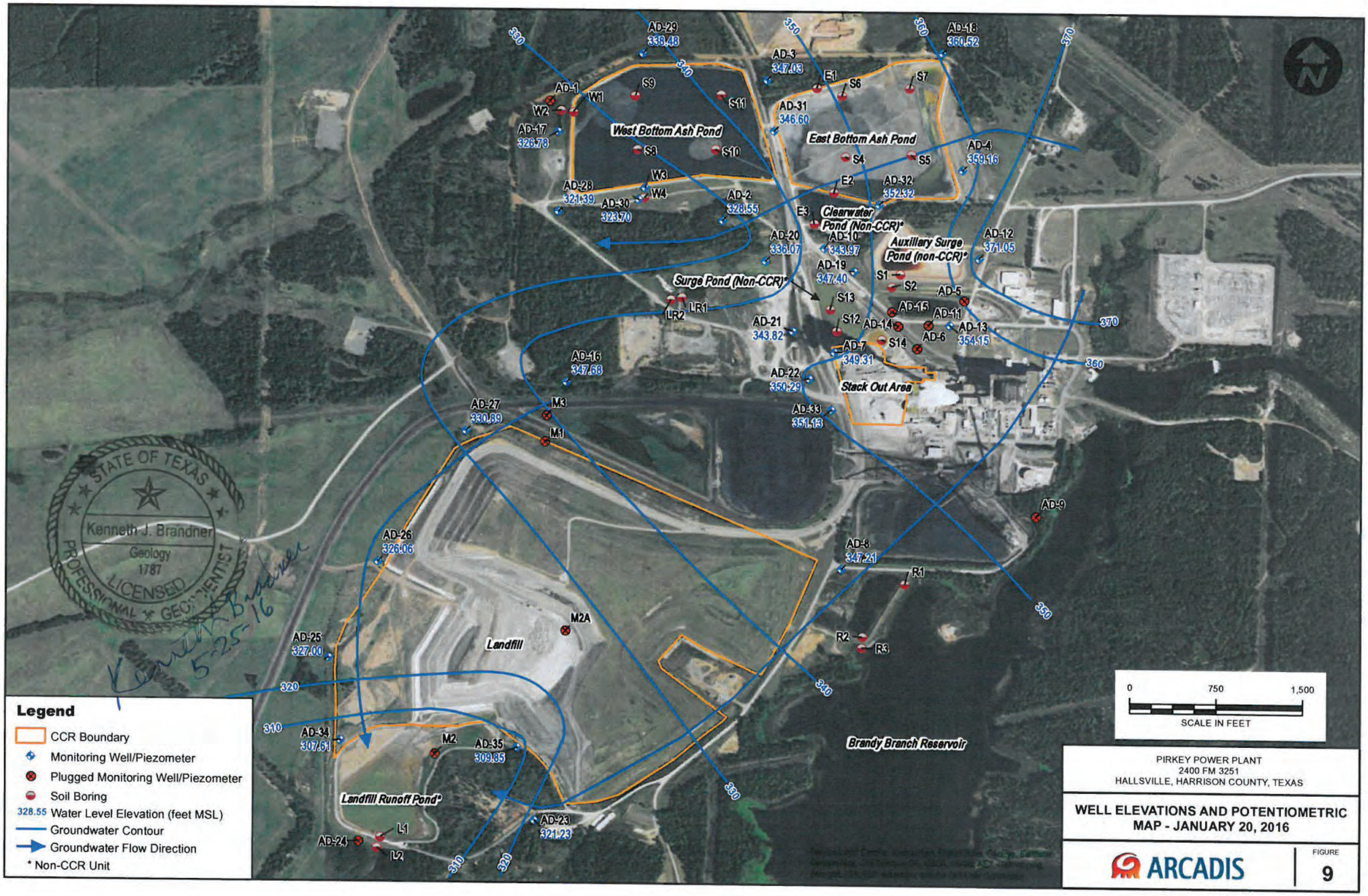
CROSS SECTION
E - E'

ARCADIS

FIGURE
8

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 8 Cross Section E-E'.dwg LAYOUT: MODEL SAVED: 2/22/2016 11:26 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
— PLOTTED: 2/22/2016 11:37 AM BY: LEASE, DIANA

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST

Kenneth Brandner
5-25-16

Legend

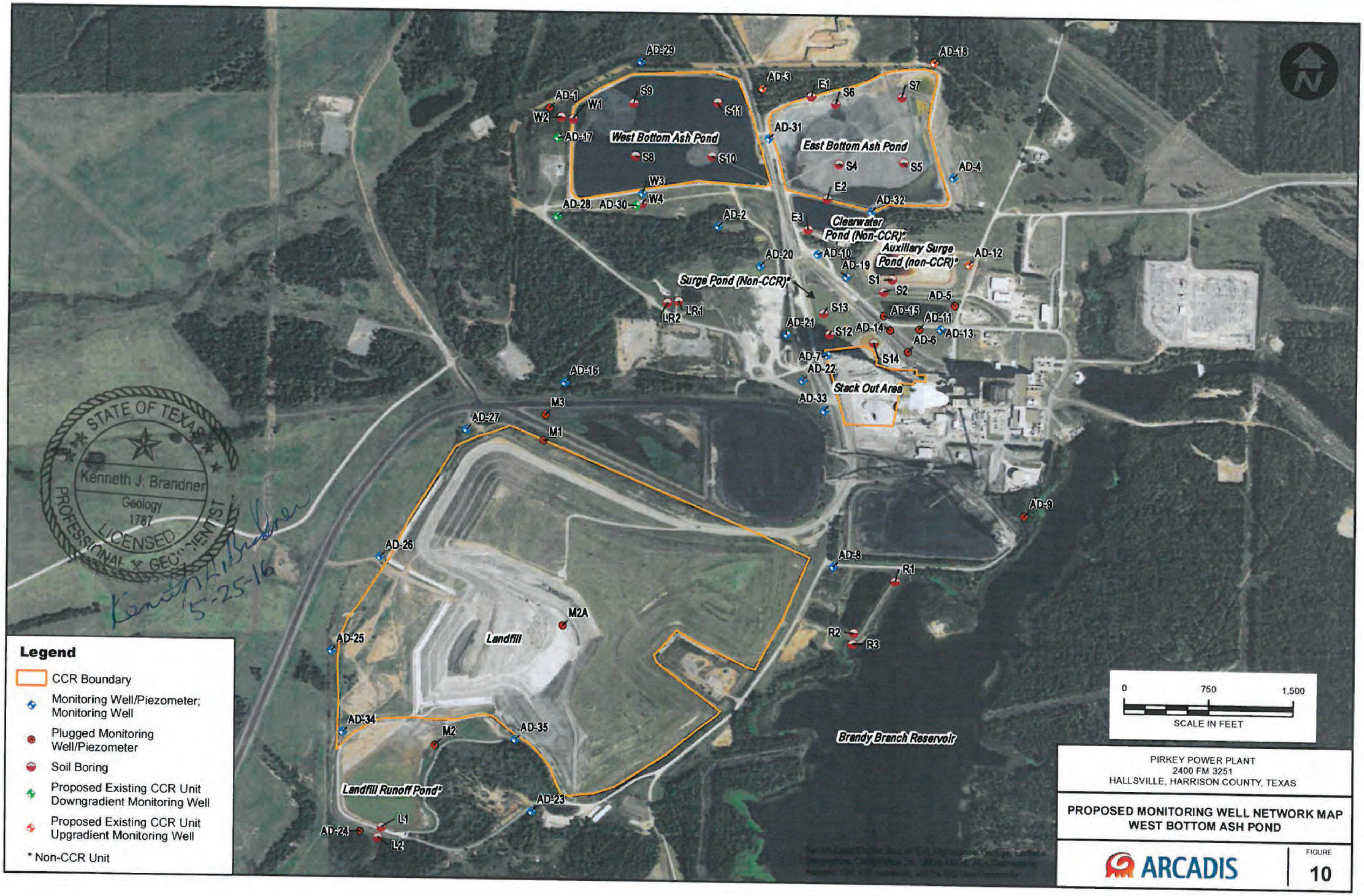
- ▭ CCR Boundary
- ◆ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ● Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- — Groundwater Contour
- → Groundwater Flow Direction
- * Non-CCR Unit

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

ARCADIS

FIGURE
9



Kenneth J. Brandner
Geology
1787

Kenneth J. Brandner 5-25-16

Legend

- ▭ CCR Boundary
- ◆ Monitoring Well/Piezometer; Monitoring Well
- ● Plugged Monitoring Well/Piezometer
- ◓ Soil Boring
- ◆ Proposed Existing CCR Unit Downgradient Monitoring Well
- ◆ Proposed Existing CCR Unit Upgradient Monitoring Well

* Non-CCR Unit

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP
WEST BOTTOM ASH POND

ARCADIS

FIGURE
10

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 10 - Proposed Well Network - West Bottom Ash Pond.mxd

ARCADIS

Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-1
LOCATION: Hallsville

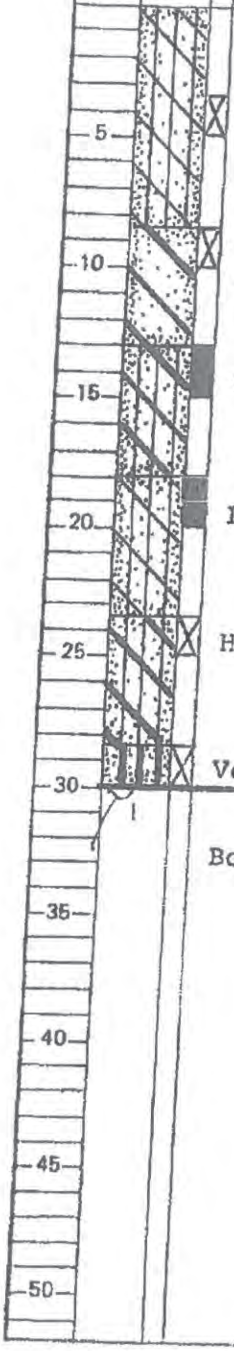
Date: 10-6-83 Type: Auger Ground Elevation:

Depth, Feet | Symbol | Sample

Legend:

■ Sample X Penetration ▼ Water

Description of Stratum



Very dense brown and grey clayey silty sand w/clay seam
33-17=7" 50 B/7"

Very stiff tan and grey very sandy clay w/iron ore
6-9-21 30 B/F

Stiff grey silty sandy clay

Loose grey clayey silty sand

Hard grey silty sandy clay lenses 30-20=11" 50 B/11"

Very dense grey clayey sandy silt 19-31=11½" 50 B/11½"

Bottom of boring at 30 feet.

832964

LOG OF BORING

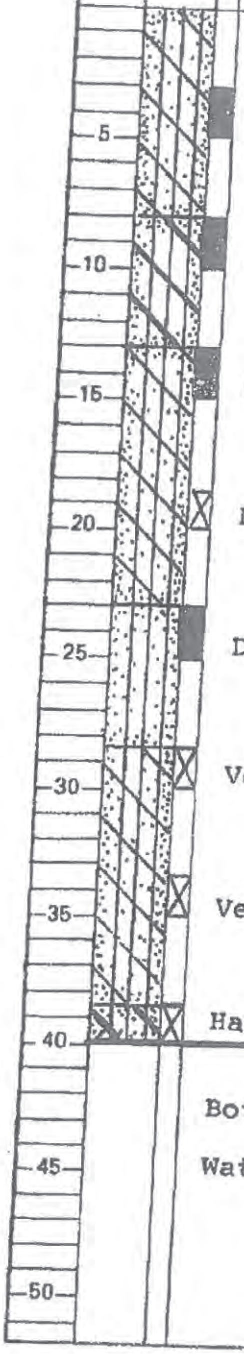
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-2
LOCATION: Hallsville

Date: 10-7-83 Type: Auger Ground Elevation:

Legend:
■ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Firm tan clayey silty sand

Medium tan and grey very sandy silty clay

Dense tan and grey clayey silty sand

Dense tan clayey silty sand 10-15-16 31 B/F

Dense tan silty sand

Very dense grey clayey silty sand 15-35=12" 50 B/F

Very dense grey clayey silty sand 21-29=9" 50 B/9"

Hard grey sandy silty clay 20-30=12" 50 B/F

Bottom of boring at 40 feet.

Water encountered at 25 feet.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

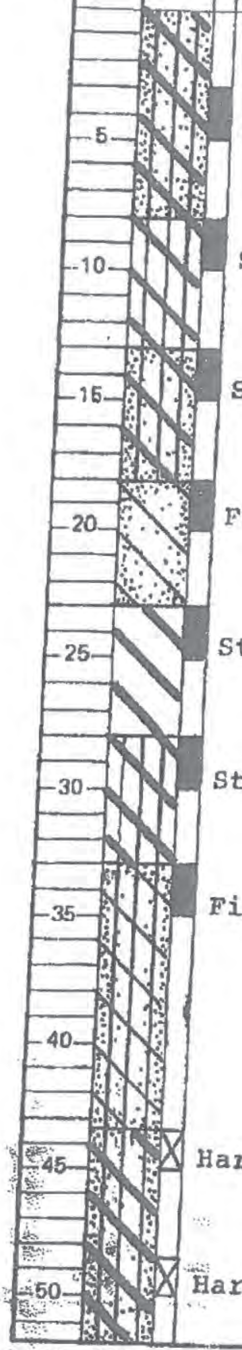
BORING NO.: MW-3
LOCATION: Hallsville,TX

Date: 11-4-83
Type: Auger
Ground Elevation:

Depth, Feet | Symbol | Sample

Legend:
■ Sample
X Penetration
▼ Water

Description of Stratum



Stiff red, brown and grey sandy silty clay

Stiff red, tan and grey silty clay lenses w/iron ore

Stiff brown and grey sandy silty clay

Firm brown and grey sand w/clay lenses

Stiff brown and grey clay

Stiff brown and grey clay w/silt lenses

Firm grey clayey silty sand

Hard grey clay w/silty sand lenses 43-7=6" 50 B/6"

Hard brown and grey silty sandy clay 21-29=12" 50 B/F

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-3
LOCATION: Hallsville,TX

Date: 11-4-83 Type: Auger Ground Elevation:

Legend:
■ Sample × Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
55	▨	☒	Hard grey silty sandy clay 28-22=10" 50 B/10"
60			Bottom of boring at 57 feet.
			Water encountered at 42 feet.
65			
70			
75			
80			
85			
90			
95			
100			

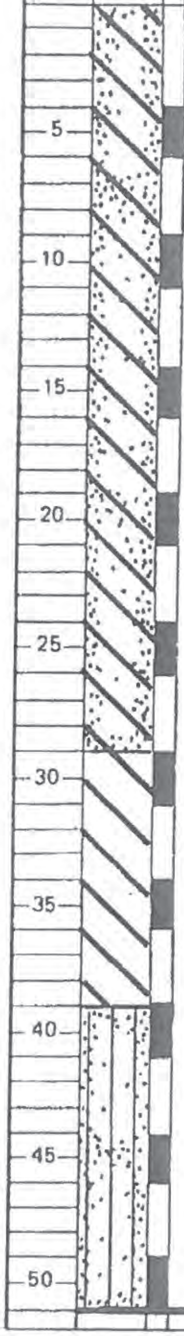
832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond BORING NO.: MW-12
CLIENT: Southwestern Electric Power Company LOCATION: Hallsville, TX
N 6+13.25; W-6+90.36
Date: 1/30/86 Type: Rotary Ground Elevation: 378.41

Legend:

■ Sample X Penetration ▼ Water



Depth, Feet	Description of Stratum
5	Brown and tan sandy clay
10	Brown, tan and gray sandy clay
15	Tan and gray sandy clay
20	Brown and tan sandy clay
25	Gray and tan sandy clay
30	Brown and gray clay
35	Brown and gray clay
40	Gray silty sand
45	Gray silty sand
50	Gray silty sand

Water encountered at 27.5 feet.
Bottom of Boring at 51 feet.

SOUTHWESTERN LABORATORIES

APEX PROJECT NO.: 110-089

☐ **BORING**
BORING NUMBER:

■ **MONITOR WELL**
MONITOR WELL NUMBER: AD-17

FACILITY NAME: AEP- Pirkey Power Plant

FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.

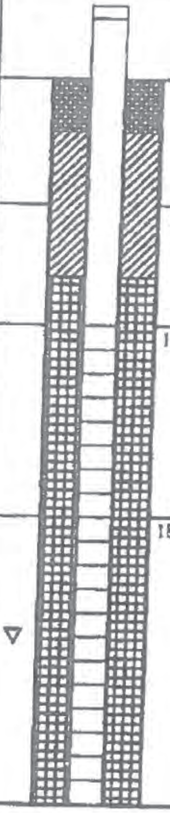
COMPLETION DATE: 12/30/2010

PREPARED BY: Jeff Sammons

LOGGED BY: Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.039
LONGITUDE: W94°29.659'
Datum: WGS-84

WELL LOCATION: West of Bottom Ash Pond #2



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1 2 3 4 5			0-5.5	SM	Silty sand, trace clay, reddish brown, brown, light gray, loose to dense -clayey at 0.5-1.5'	None	Moist
6 7 8 9 10			5.5-10	SC	Clayey sand, reddish brown, yellowish brown, laminated iron ore, iron ore concretions	None	Moist
11 12 13 14 15 16 17 18			10-18.5	SM	Silty sand, light reddish brown, yellowish brown, dense, some clay -trace clay, yellowish brown, 15-16' -iron ore concretions at 16' -light yellowish brown, light gray at 17' -laminated iron ore at 18.5'	None	V. Moist
19 20 21 22 23 24 25 26 27 28 29 30			▽ 18.5-30	SC	Clayey sand, yellowish brown, light gray, saturated sand lenses -gravelly at 21' -laminated ironstone at 22.5' -very dense, gray, light gray at 25' -some clay at 27.5, greenish gray, gray, to boring termination	None	Saturated Dry to Moist
31 32 33 34 35 36 37 38 39 40					Boring Terminated at 30'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2', Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 23.26
Above Ground 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ____ ■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-18

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

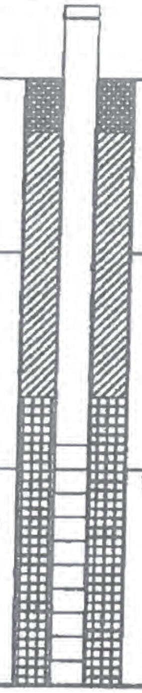
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 1/3/2011

PREPARED BY: Jeff Sammons **LOGGED BY:** Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.154' Datum: WGS-84 **WELL LOCATION:** Northeast of Bottom Ash Pond #1
LONGITUDE: W94°29.108'



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-7	SM	Sandy Silt, some clay, very fine grained, gray, light brown,	None	Dry
2					light brownish red, yellowish brown		
3							
4							
5							
6							
7							
8			7-16	CL	Clay, some sand, light gray, reddish grey, stiff, yellowish brown	None	Dry
9					-iron oxide fracture at 9.5'		
10							
11							
12							
13							
14					-increasing sand content at 14', thin lenses of iron-oxide		Moist
15					cemented sand at 14.5', 15', 15.5', stiff		
16							
17			16-25	SM	Silty sand, some clay, gray, yellowish brown, dense, abundant	None	Moist to
18					gypsum crystals, abundant iron oxide cemented sandstone		V. Moist
19			▽		gravel in layers, saturated 19-21'		Saturated
20						None	
21					-dark gray at 21'	None	
22					-clayey at 21-23'		
23					-greenish gray, trace clay, at 23'	None	
24							
25					-clay lense, hard, dry, (shale), at 24.5-25'	None	Dry
26							
27					Boring Terminated at 25'		
28							
29							
30							
31							
32							
33							
34							
35							
36							
37							
38							
39							
40							

▨ Cement ▧ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 25 feet
Filter Sand (Size/Interval): 13-25'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-15'
Screen Interval: 15-25'
Water level:
Above Ground 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089
☐ **BORING** **BORING NUMBER:** ______
■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-28

FACILITY NAME: AEP- Pirkey Power Plant
FACILITY ID NO.: N/A

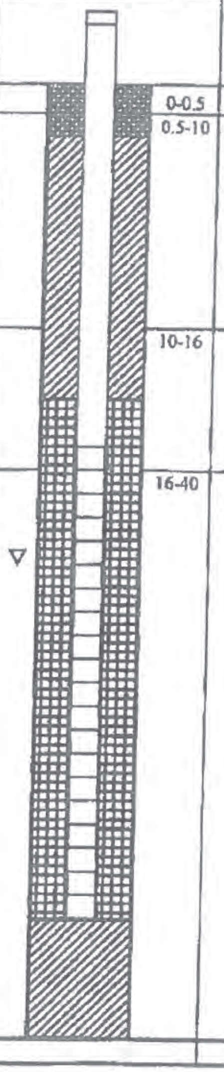
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.
COMPLETION DATE: 12/28/2010

PREPARED BY: Jeff Sammons
LOGGED BY: Jeff Sammons

LATTITUDE: N 32°27.926'
LONGITUDE: W94°29.658'
Datum: WGS-84
WELL LOCATION: Southwest of Primary Bottom Ash Pond #2



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SM	Silty sand, light brown, very fine grained, loost	None	Moist
2			0.5-10	CL	Sandy clay, reddish brown, yellowish brown, stiff, hard, some iron ore gravel at .5-1.5'	None	Dry
3							
4							
5					-light gray, dark reddish brown at 5'		
6					-iron oxide cemented stone at 6.5'		
7							
8							
9							
10							
11			10-16	SM	Silty sand, very fine grained, some clay, light yellowish brown, light gray, medium dense	None	Moist to V. Moist
12							
13					-light yellowish brown at 11.5'		
14							
15							
16							
17			16-40	SC	Clayey sand, dark gray, medium dense	None	Moist
18							
19							
20			▽		-dark gray at 20'		
21					-cemented sandstone at 21'		
22					-no recovery from 22' to 35'		
23							
24							V. Moist to Saturated
25							
26							
27							
28							
29							
30							
31							
32							
33							
34							
35					-1.5" layer of cemented sandstone at 35'		
36							
37							Dry to Moist
38							
39							
40							
					Boring Terminated at 40'		

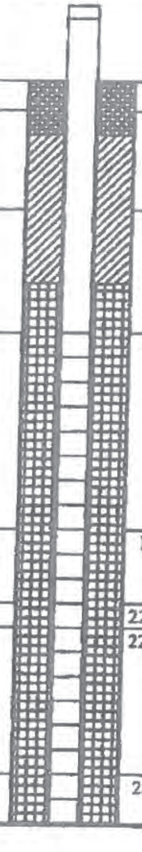
▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet
Filter Sand (Size/Interval): 13-35'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13'
Surface Completion ☐ Flush ■ Above Ground
Riser Interval: +3 (ags)-15'
Screen Interval: 15-35'
Water level: 19.98'
Above Ground 3.5'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089
☐ **BORING** **BORING NUMBER:**
☒ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-29
FACILITY NAME: AEP- Pirkey Power Plant
FACILITY ID NO.: N/A
FACILITY ADDRESS: Hallsville, Texas
DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig
DRILLER: Ed Wilson, Apex Geoscience Inc.
COMPLETION DATE: 1/3/2011
PREPARED BY: Jeff Sammons
LOGGED BY: Jeff Sammons
LATTITUDE: N 32°28.139'
LONGITUDE: W94°29.534
Datum: WGS-84
WELL LOCATION: North of Bottom Ash Pond #2



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SM	Silty sand, brown, light brown, very fine grained	None	Moist
2 3 4 5			0.5-5	CL	Clay, some sand, red, reddish brown, light gray, stiff	None	Dry
6 7 8 9 10			5-10	CL	Sandy clay, light gray, light red -abundant iron ore, yellowish brown, yellow, dry	None	Dry
11 12 13 14 15 16 17 18			10-18	SC	Clayey sand, yellowish brow, reddish brown, light gray, medium dense -light gray, yellow, at 11' -4" saturated sand seam, trace clay at 13' -purple, yellowish brown, reddish brown, medium dense to loose	None	Moist
19 20 21			▽ 18-22	SM	Silty sand, reddish brown to red -some iron ore gravel, some clay, saturated, gypsum crystals, at 20'	None	V. Moist
22			22-22.5	CL	Sandy clay, dark gray, stiff	None	Dry
23 24 25 26 27 28			22.5-28	SM	Silty sand, saturated, greenish gray, loose	None	Dry to Moist
29 30			28-30	SC	Clayey sand, greenish gray, dark gray, dark brown, dry, very dense, slightly cemented	None	Dry to Moist
31 32 33 34 39 40					Boring Terminated at 30'		

▒ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ☒ Above Ground
Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level:
3'

Note: This log is not to be used separate from this report.

Boring Logs_110-089, AD-29

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-30**

JDS 1-21-16
JEFFREY D. SAMMONS
GEOLOGY
#10070
LICENSED

PROJECT INFORMATION

PROJECT: **Pirkey Power Plant**
PROJECT NO.: **I-04-1021**
LOGGED BY: **Jeffrey D. Sammons, P.G.**
SUPERVISING PG: **Jeffrey D. Sammons, P.G.**
COMPLETION: **12/08/2015**
DEVELOPMENT: **12/16/2015**
SITE LOCATION: **2400 FM 3251, Hallsville, Texas**
WELL OWNER: **AEP**

DRILLING INFORMATION

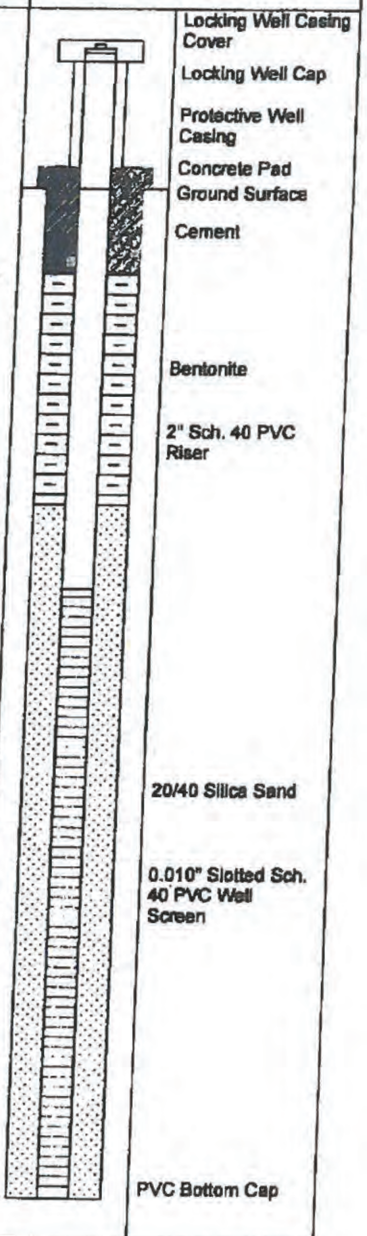
DRILLER: **Buford Collier**
DRILLER'S LICENSE NO.: **50089**
RIG TYPE: **Geoprobe 3230DT**
METHOD OF DRILLING: **Hollow Stem Auger**
SAMPLING METHODS: **Split Core**
SURFACE ELEVATION: **342.02 (Top of Casing)**
HOLE DIAMETER: **8.25"**
LATITUDE **32 27' 58.49"** LONGITUDE **94 29' 32.53"**

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	SOIL SYMBOLS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
			-4 -3 -2 -1							
SANDY LEAN CLAY: light reddish brown and light gray	CL		0 1 2		■	17	64	24	17	7
- trace sand and silt at 3.0' to 3.5', light reddish brown			3 4 5 6							
- some iron ore gravel at 7', light gray, reddish brown, light reddish brown, increasing sand content with depth			7 8		■	14	53	38	24	14
CLAYEY SILTY SAND: very fine to fine sand, reddish brown, light brown, and light gray	SM-SC		9 10							
SILTY SAND: very fine to fine sand, some lenses of clay and partially cemented sand, reddish brown and light gray, moist	SM		11 12 13		■	10	13	28	NP	-
CLAYEY SAND: very fine to fine sand with some fine to coarse iron ore gravel and partially cemented sand, reddish brown and light gray, moist	SC		14 15 16	▼	■	20	26	34	24	10
SILTY SAND: very fine to fine sand, some clay, light gray and reddish brown, saturated	SM		17 18	▽						
- some iron ore gravel at 19', gray and reddish brown, increasing clay content with depth, very moist			19 20 21							
SILTY CLAYEY SAND: fine to very fine sand, some clay lenses, gray and dark gray, moist	SM-SC		22 23 24 25		■	20	49	30	22	8

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

Page 1 of 1

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING LR-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

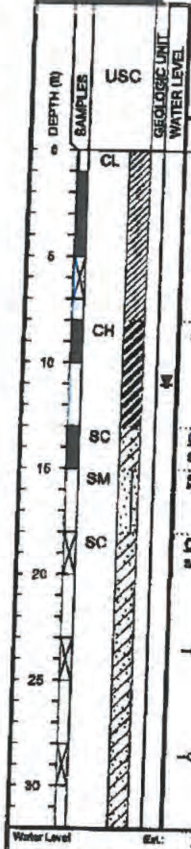
PROJECT NO.: G3241-095

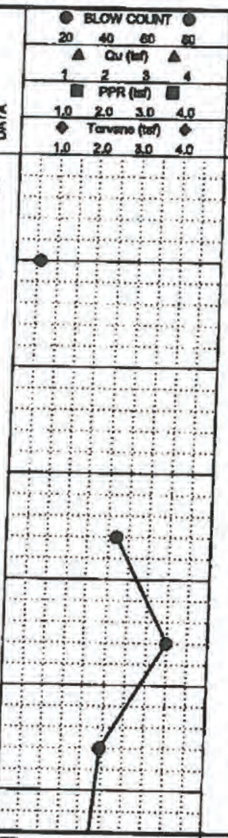
BORING TYPE: Flight Auger

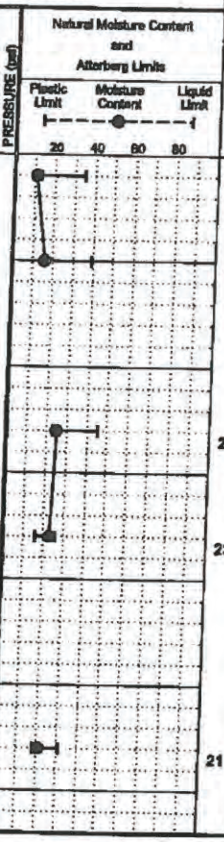
DATE 10/20/09

SURFACE ELEVATION 337.2

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. 6)
CL	LEAN CLAY WITH SAND(CL) very stiff; tan	P=3.5					11	35	13	22	70	+40 Sieve=3%, +4 Sieve=1%
	--tan and orange											
	--stiff; red and tan	N=12					16	39	16	23	68	+40 Sieve= 4%, +4 Sieve=2%
CH	SANDY FAT CLAY(CH) tan and orange											
SC	CLAYEY SAND(SC) gray; with clay and sand seams	SF					25	45	23	22	44	+40Sieve=13%, +4 Sieve=5%
SM	SILTY SAND(SM) dark gray											
SC	CLAYEY SAND(SC) very dense; gray; with small clay seams	N=54					23	26	16	10	20	+40 Sieve=2%, +4 Sieve=0%
	--dark gray	N=80										
	--dense; gray and brown	N=49					21	31	18	13	29	+40 Sieve=1%, +4 Sieve=0%







Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling. Water level @ 11' and open to 38' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.804', W 94°29.482'

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING LR-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 337.2

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	● BLOW COUNT ● 20 40 60 80 ▲ Qu (tsf) ▲ 1 2 3 4 ■ PPR (tsf) ■ 1.0 2.0 3.0 4.0 ◆ Torvane (tsf) ◆ 1.0 2.0 3.0 4.0	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits Plastic Limit ├ - - - Moisture Content ● - - - ┤ Liquid Limit 20 40 60 80	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	☒				—gray	N=44												
35																		
	☒					N=48												
40					Bottom of Boring @ 40'													

Water Level: Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 13' while drilling. Water level @ 11' and open to 38' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.804', W 94°29.482'

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING LR-2

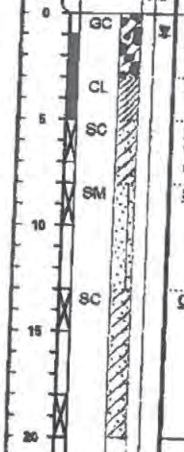
PROJECT: Pirkey Power Plant
Hallsville, Texas

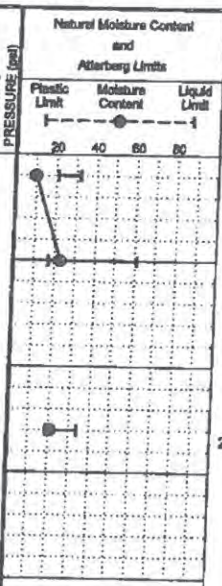
PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/08

SURFACE ELEVATION 328.0





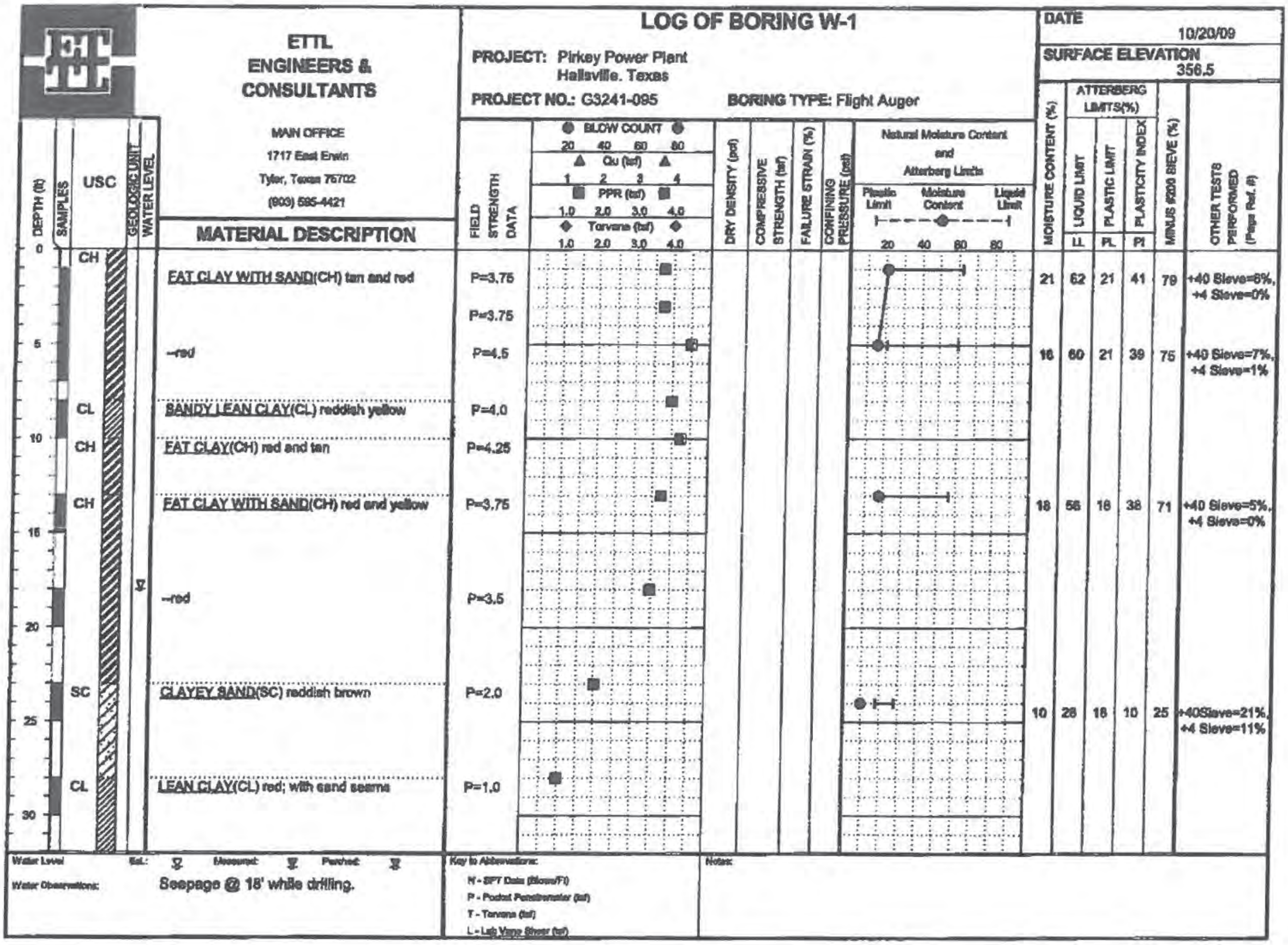
DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	GC	CLAYEY GRAVEL(GC) medium dense; tan, gray, and red; with ferric seams	P=4.5+					10	32	21	11	6	+40Sieve=84%, +4 Sieve=77%
	CL	SANDY LEAN CLAY(CL) stiff; tan and gray	P=1.75										
5	SC	CLAYEY SAND(SC) very stiff; tan and gray; with ferric seams; with iron oxide cemented sandstone	P=2.25					23	61	17	44	41	+40Sieve=6%, +4 Sieve=0%
	SM	SILTY SAND(SM) dense; gray	N=46										
10													
	SC	CLAYEY SAND(SC) dense; gray	N=35					21	34	19	15	31	+40Sieve=2%, +4 Sieve=0%
15													
			N=49										
20		Bottom of Boring @ 20'											

Water Level: Est.: ∇ Measured: ∇ Perched: ∇

Water Observations: Seepage @ 3' while drilling. Water level @ 1' and open to 18' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.801', W 94°29.491'



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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-1

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.5

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH	FAT CLAY WITH SAND(CH) tan and red	P=3.75	21	62	21	41	79	+40 Sieve=6%, +4 Sieve=0%
		P=3.75						
	--red	P=4.5	16	60	21	39	75	+40 Sieve=7%, +4 Sieve=1%
CL	SANDY LEAN CLAY(CL) reddish yellow	P=4.0						
CH	FAT CLAY(CH) red and tan	P=4.25						
CH	FAT CLAY WITH SAND(CH) red and yellow	P=3.75	18	56	18	38	71	+40 Sieve=5%, +4 Sieve=0%
	--red	P=3.5						
SC	CLAYEY SAND(SC) reddish brown	P=2.0	10	28	18	10	25	+40Sieve=21%, +4 Sieve=11%
CL	LEAN CLAY(CL) red; with sand seams	P=1.0						

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 18' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

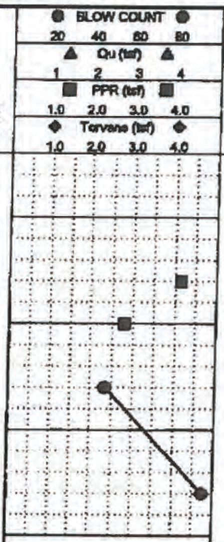
PROJECT NO.: G3241-095

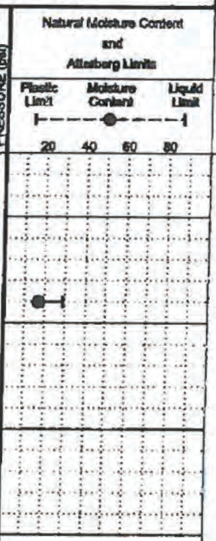
BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.5

DEPTH (ft)	SAMPLES	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	☒	SC	CLAYEY SAND(SC) grayish brown	N=32										
35														
	■		–tannish gray	P=4.15					17	29	19	10	25	+40 Sieve=1%, +4 Sieve=0%
40				P=2.8										
	☒		–gray	N=47										
45														
	☒	SM SC	SILTY CLAYEY SAND(SM-SC) gray	N=50/6"										
50			Bottom of Boring @ 50'											





Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-2

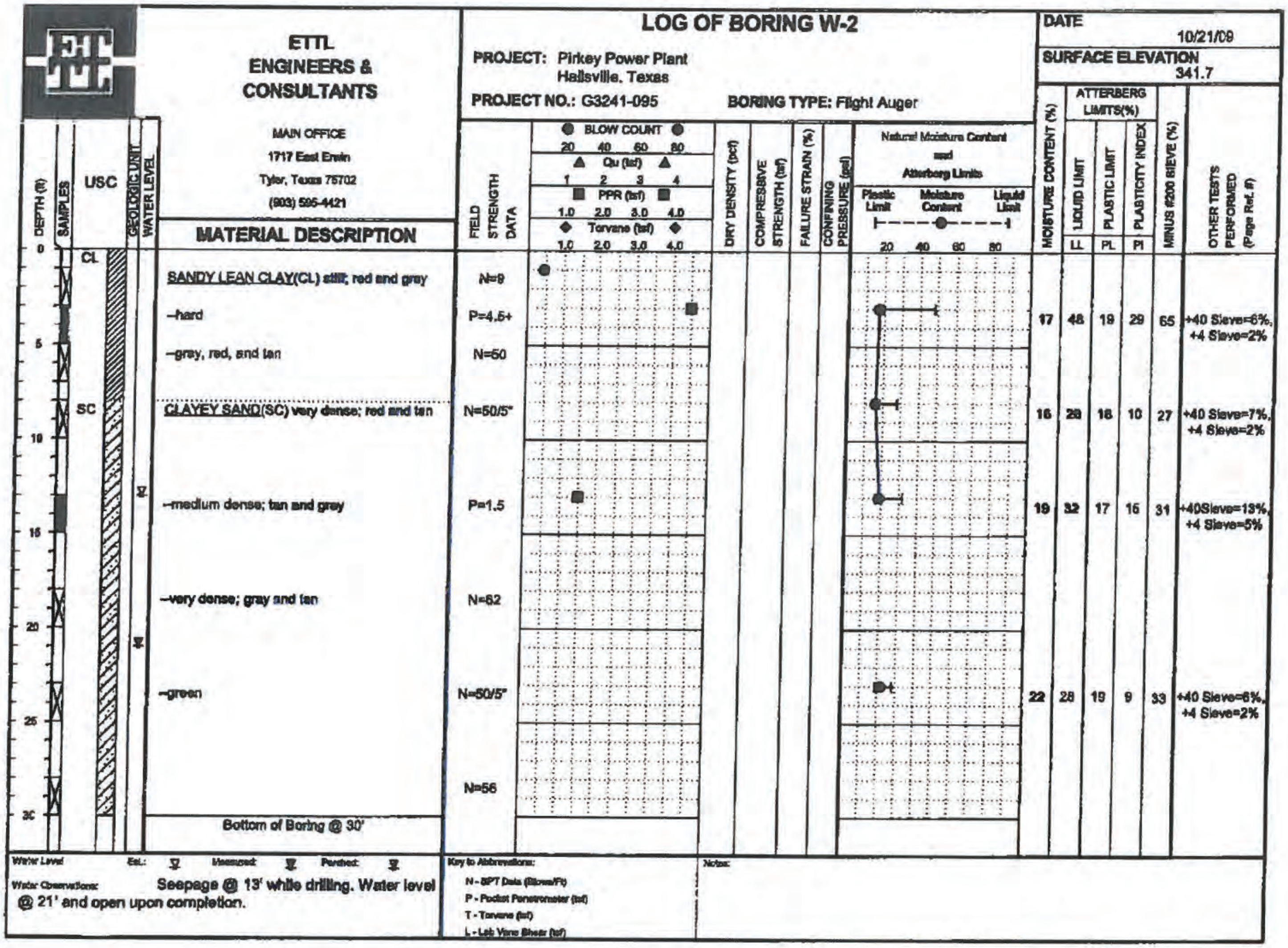
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/21/09

SURFACE ELEVATION 341.7



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; red and grey	N=9						
	--hard	P=4.5+	17	48	19	29	65	+40 Sieve=6%, +4 Sieve=2%
	--gray, red, and tan	N=50						
SC	CLAYEY SAND(SC) very dense; red and tan	N=50/5"	16	26	16	10	27	+40 Sieve=7%, +4 Sieve=2%
	--medium dense; tan and grey	P=1.5	19	32	17	15	31	+40Sieve=13%, +4 Sieve=5%
	--very dense; gray and tan	N=62						
	--green	N=50/5"	22	28	19	9	33	+40 Sieve=6%, +4 Sieve=2%
		N=56						

Bottom of Boring @ 30'

Water Level Est.: ∇ Measured: ▼ Perched: ∇

Water Observations: Seepage @ 13' while drilling. Water level @ 21' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-3

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

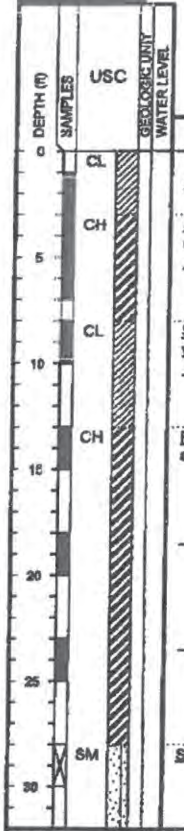
BORING TYPE: Flight Auger

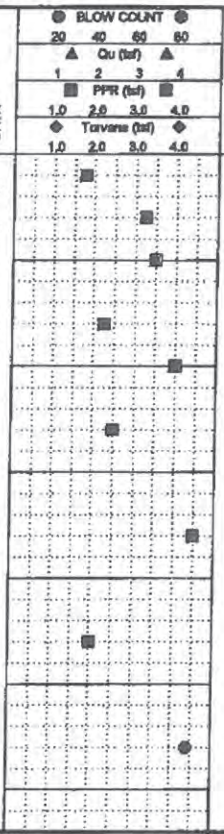
DATE 10/20/09

SURFACE ELEVATION 356.3

MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; white and tan	P=1.75	18	46	17	29	61	+40 Sieve=7%, +4 Sieve=2%
CH	SANDY FAT CLAY(CH) very stiff; red, tan, and white	P=3.25						
	--white, tan, and red	P=3.5	17	55	18	37	68	+40 Sieve=5%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) very stiff; red and yellow	P=2.25						
	--hard; red and yellow	P=4.0						
CH	FAT CLAY WITH SAND(CH) very stiff; red and yellow	P=2.5	24	68	22	46	60	+40 Sieve=6%, +4 Sieve=0%
	--hard	P=4.5+						
	--stiff	P=2.0	24	52	18	34	69	+40 Sieve=4%, +4 Sieve=0%
SM	SILTY SAND(SM) very dense; yellow and red	N=88						





DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 34' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
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L - Lab Vane Shear (tsf)

Notes:

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-3

PROJECT: Pirkey Power Plant
Hallsville, Texas

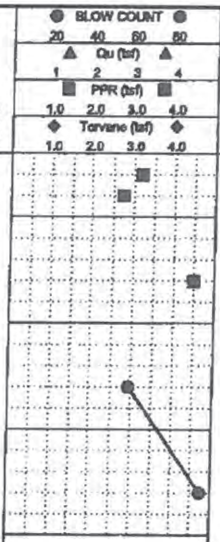
PROJECT NO.: G3241-095

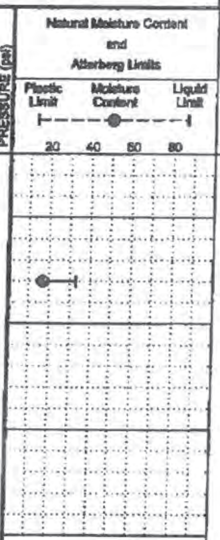
BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.3

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35		CL		▽	**SANDY LEAN CLAY**(CL) very stiff; gray; with iron oxide cemented sandstone gravel	P=3.25										
40		SC			**CLAYEY SAND**(SC) very dense; dark gray	P=4.5+					17	33	17	16	38	+40 Sieve=1%, +4 Sieve=0%
45		SM SC			**SILTY CLAYEY SAND**(SM-SC) very dense; gray; saturated	N=59										
50		SC			**CLAYEY SAND**(SC) very dense; dark gray	N=50/4"										
					Bottom of Boring @ 50'											





Water Level Est.: ▽ Measured: ▽ Perched: ▽

Water Observations: Seepage @ 34' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

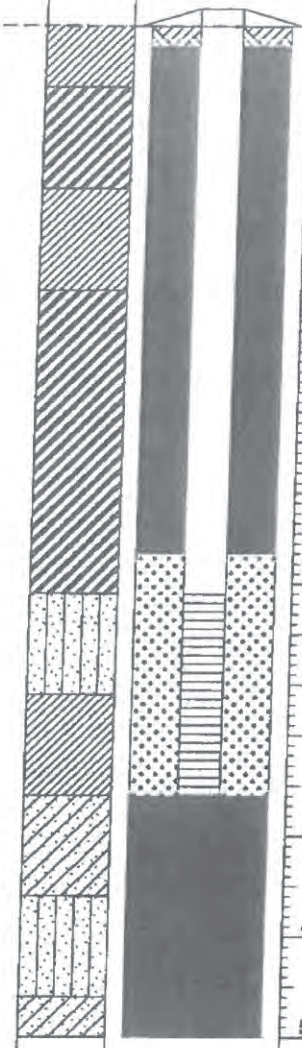
Notes:

ENVIRONMENTAL LOG

Client: Pirkey Power Plant
Project No: G3241-095 **Phase** **Task**

Well No. PW-3 (W3)
Location Hallsville, Texas
Surface Elev.
Page 1 **of** 1

Depth Feet	Sampler	Overburden/Lithologic Description	FID (ppm)	Graphic Log	Well Construction Graphics	Depth Feet	Well Construction Details
							T.O.C. Elev. .
0		Ground Surface				0	
		SANDY LEAN CLAY(CL) stiff; white and tan					
		SANDY FAT CLAY(CH) very stiff; red, tan, and white					
5		—white, tan, and red				5	
		SANDY LEAN CLAY(CL) very stiff; red and yellow					
10		—hard; red and yellow				10	
15		FAT CLAY WITH SAND(CH) very stiff; red and yellow				15	
20						20	
25						25	
30		SILTY SAND(SM) very dense; yellow and red				30	
35		SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel				35	
40		CLAYEY SAND(SC) very dense; dark gray				40	
45		SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated				45	
50		CLAYEY SAND(SC) very dense; dark gray				50	
		Bottom of Boring @ 50'					



Driller Doug Hinds	**Drilling Method** Flight Augers	**Bentonite Seal** 1-26' & 38-50'
Logged By Blake Hobbs	**Borehole Diameter** 6.5"	**Filter Pack Qty.** 26-38'
Drilling Started 10/20/09	**Well Casing** 2.0" **Dia.** 0.0' **to** 28.0'	**Filter Pack Type** 20/40 Sand
Drilling Completed	**Casing Type** PVC	**Static Water Level**
Construction Completed	**Well Screen** 2.0" **Dia.** 28.0' **to** 38.0'	
Development Completed	**Screen Type** Slotted	**Notes:**
Type of Well	**Slot Size** 0.010"	
	Grout Type Bentonite	

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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-4

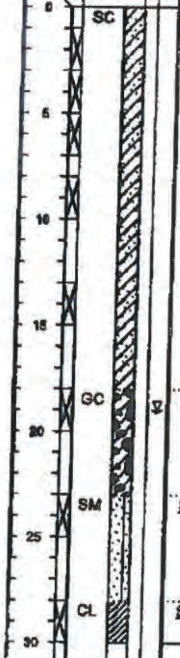
PROJECT: Pirkey Power Plant
Hallsville, Texas

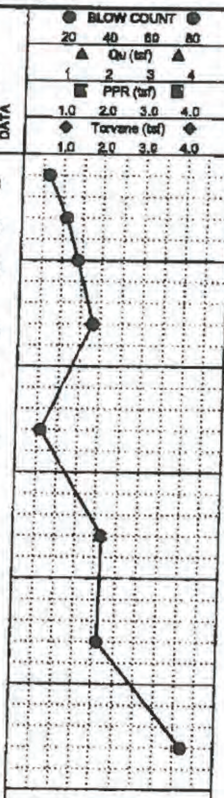
PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 338.0





USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) stiff; brown, red, and yellow	N=13										
	–with gravel	N=22					12	31	17	14	35	+40Sieve=31%, +4 Sieve=16%
	–red and tan; with iron oxide cemented sandstone	N=28										
	–dense; red and white; with clay seams	N=36					15	60	16	44	39	+40Sieve=11%, +4 Sieve=4%
	–medium dense; orangish gray; with gravel	N=12					17	30	14	16	22	+40Sieve=28%, +4 Sieve=17%
GC	CLAYEY GRAVEL(GC) dense; dark grey	N=43					20	31	16	15	7	+40Sieve=68%, +4 Sieve=62%
SM	SILTY SAND(SM) dense; dark gray	N=42										
CL	SANDY LEAN CLAY(CL) very dense; gray	N=84										
	Bottom of Boring @ 30'											

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 19' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-8
LOCATION: Hallsville,TX

Date: 9-15-83 Type:

Ground Elevation: 347.1

Legend:

■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
		■	Red and brown slightly sandy silty clay
		■	Red and brown silty clay with silt lenses
5		■	Red and brown silty sandy clay

Bottom of boring at 6 feet.

No water encountered.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-9
LOCATION: Hallsville,TX

Date: 9-15-83
Type:
Ground Elevation: 348.1

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum

Red and grey silty clay with silty sand

Red and grey silty sandy clay

Red and grey silty sandy clay

Bottom of boring at 6 feet.

No water encountered.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

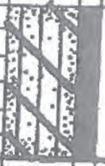
BORING NO.: S-10
LOCATION: Hallsville

Date: 10-6-83
Type: Auger
Ground Elevation: 347.4

Legend:

▇ Sample
X Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
			Very stiff tan and brown sandy silty clay
			Very stiff tan and grey sandy silty clay
5			Stiff tan and grey sandy silty clay



Bottom of boring at 6 feet.

No water encountered.

10
15
20
25
30
35
40
45
50

SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-11
LOCATION: Hallsville

Date: 10-6-83
Type: Auger
Ground Elevation: 347.0

Legend:

▨ Sample
X Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
	▨	▨	Very stiff tan and grey sandy silty clay lenses
	▨	▨	Very stiff tan and grey silty clay lenses
5	▨	▨	Very stiff tan and grey silty clay lenses
10			Bottom of boring at 6 feet. No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			

ARCADIS

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – Pirkey Power Plant

Location:
Hallsville, Harrison County, Texas

Project No.
OH015976.0001

Photo No. 1
Date: 8/19/2015

Direction Photo Taken:
South

Description:
P8190378
View across East and West Botton Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – Pirkey Power Plant

Location:
Hallsville, Harrison County, Texas

Project No.
OH015976.0001

Photo No. 2
Date: 8/19/2015

Direction Photo Taken:
Southeast

Description:
P8190379
Road side ditch, not considered a wetland, due to lack of hydric vegetation and connectivity.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 3

Date: 8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190383
Upland forest bordering north of West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 4

Date: 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190385
Pizometer along West Bottom Ash Pond perimeter embankment road.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 5 **Date:** 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190386
Pizometer along West Bottom Ash Pond perimeter embankment road.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 6 **Date:** 8/19/2015

Direction Photo Taken:

North

Description:

P8190387

AD-3 in the wooded area east of West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No. 7 **Date:** 8/19/2015

Direction Photo Taken:

Description:

P8190390
Dry (non-wetland) ditch adjacent to railroad and West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No. 8 **Date:** 8/19/2015

Direction Photo Taken:

West Northwest

Description:

P8190392
West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – Pirkey Power Plant

Location:
Hallsville, Harrison County, Texas

Project No.
OH015976.0001

Photo No. 9
Date: 8/19/2015

Direction Photo Taken:

East Southeast

Description:

P8190396
West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name:
AEP – Pirkey Power Plant

Location:
Hallsville, Harrison County, Texas

Project No.
OH015976.0001

Photo No. 10
Date: 8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190399
Upland drainage at the toe of the West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
11	8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190403
Vegetated strip around culvert that drains East and West BAPs. This potential wetland may be jurisdictional and is associated with an intermittent stream.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
12	8/19/2015

Direction Photo Taken:

Southwest

Description:

P8190411
Small vegetated strip adjacent to access road south of southeast corner of West Botton Ash Pond.

ARCADIS **PHOTOGRAPHIC LOG**

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 13 **Date:** 8/19/2015

Direction Photo Taken:

West Northwest

Description:

P8190414
Looking across West Bottom Ash Pond

ARCADIS **PHOTOGRAPHIC LOG**

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 14 **Date:** 8/19/2015

Direction Photo Taken:

South Southeast

Description:

P8190417
West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 15

Date: 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190419
Small vegetated strip in outside corner of access road south of southeast corner of West Botton Ash Pond.

4.3 – Landfill – CCR Groundwater Monitoring Well Network Evaluation Update, January 20, 2022

American Electric Power Service Corporation

Landfill - CCR Groundwater Monitoring Well Network Evaluation Update

H.W. Pirkey Power Plant

2400 FM 3251

Harrison County

Hallsville, Texas

January 20, 2022

Landfill - CCR Groundwater Monitoring Well Network Evaluation Update

H.W. Pirkey Power Plant

2400 FM 3251

Harrison County

Hallsville, Texas

January 20, 2022

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Acronyms and Abbreviations

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

1 Objective

This update report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to provide an updated assessment the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91 and Texas Administrative Code (TAC) 30 TAC 352.911, for the Landfill CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The Landfill CCR Unit at the Plant was 130 acres and when fully expanded will cover approximately 145 acres in size. As shown on **Figure 2**, the Landfill was expanded laterally to the south beginning in 2018 (2018 Lateral Expansion). The 2018 Lateral Expansion will be approximately 15 acres in size. Currently approximately 3.5 acres of the 2018 landfill expansion has been constructed, in the northern portion of the expansion area, including the basal liners and leachate drainage system. The remaining area of the 2018 landfill expansion has not yet been fully constructed**.** During Lateral Expansion construction activities one of the existing downgradient monitoring wells (monitoring well AD-35) was plugged and replaced with new monitoring well AD-36. Monitoring well AD-35 was plugged because it was located within the footprint of the 2018 Lateral Expansion, and newly installed monitoring well AD-36 is located hydraulically downgradient of the 2018 Lateral Expansion.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report provides an updated evaluation of the groundwater monitoring well network in the uppermost aquifer at the Landfill, including the 2018 Lateral Expansion. The updated evaluation of the location restriction criteria for the Landfill 2018 Lateral Expansion is not included in this report and was completed previously under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the Landfill CCR unit, including the 2018 Lateral Expansion area, as well as publicly-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

2 Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant Landfill.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The existing Landfill CCR unit is located in the southern portion of the Plant. The existing Landfill CCR unit is currently approximately 133.5 acres in size, including 3.5 acres associated with the 2018 Landfill Lateral Expansion. When completed, the 2018 Landfill Lateral Expansion will cover in approximately 15 acres directly south of the existing Landfill (**Figures 2** and **3**).

2.2 Description of Landfill CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the Landfill.

2.2.1 Embankment Configuration

The Landfill was constructed in the southwestern portion of the Plant, and as shown on the U.S. Geological Survey 1983 topographic map (**Figure 1**), the southwestern portion of the Plant contained an unnamed intermittent tributary of Hatley Creek prior to Landfill construction in 1984. The Landfill was constructed within the unnamed tributary creek which had a bottom elevation ranging from approximately 290 feet amsl on the south side of the Landfill to 300 feet amsl on the north side of the Landfill. The native soil sidewalls of the tributary creek at the Landfill location have a maximum elevation of approximately 355 feet amsl. Therefore, as shown on Geologic Cross Section C-C’ (**Figure 6**), the Landfill is partially incised within the tributary creek, and the tributary creek native soil sidewalls serve as a natural embankment for the lower portion of the Landfill.

The original Landfill design included emplacement of CCR materials in the Landfill with 3:1 slopes (3 feet horizontal, 1 foot vertical) with an approximate 10 foot wide bench for every 20 foot vertical rise of CCR material (VFL Technology Corporation, 1984). In addition to the Landfill CCR material embankments, earthen embankments are present around portions of the Landfill to control storm water flow.

The 2018 Landfill Lateral Expansion will cover approximately 15 acres directly south of the existing Landfill. Currently approximately 3.5 acres of the 2018 landfill expansion has been constructed, in the northern portion of the expansion area, including the basal liners and leachate drainage system. The remaining area of the 2018 landfill expansion has not yet been constructed**.** In 2016, Auckland Consulting conducted a stability assessment of the 2018 Lateral Expansion area and concluded the embankments would be stable on slopes no steeper than 3:1 (Auckland, November 2016). The 2016 Auckland Consulting report stated the northern and eastern extents of the 2018 Lateral Expansion will be constructed contiguous to the existing Landfill disposal area, and ash disposal will be completed in multiple lifts, each with an approximate height of 20 feet, integrated with safety benches, and maximum side slopes of 3:1 to a maximum waste height of 120 feet.

2.2.2 Area/Volume

Prior to expansion, the landfill was approximately 130 acres in size and was designed to receive 12,207,000 cubic yards (7,566 acre feet) of CCR materials including fly ash, bottom ash, economizer ash, and stabilized FGD sludge (VFL Technology Corporation, 1984). The design capacity of the CCR materials to be placed within the 2018 Lateral Expansion is approximately 2,200,000 cubic yards.

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, stabilized FGD sludge) have been generated. The CCR materials that are not taken offsite for beneficial reuse are disposed of in the Landfill. The Landfill was constructed in several phases beginning with the northeast portion (Phase 1) in 1984. The Landfill was expanded (east-central portion) in 1985 and 1987. The Landfill was subsequently expanded to the west and south during the 1990’s, including construction of the Landfill Stormwater Runoff Pond (non-CCR unit) directly south of the Landfill in 1993 and 1994.

In 2005, ETTL conducted a geotechnical evaluation of the Landfill and Landfill Stormwater Runoff Pond, including installation 30 soil borings, ten cone penetration test (CPT) borings, and geotechnical testing of soil samples. The Landfill was further expanded to the west between 2005 and 2015 to its previous size of approximately 130 acres as shown on **Figure 3**.

The 2018 Landfill Lateral Expansion design included emplacement of up to 120 feet of CCR materials with maximum side slopes of 3:1 above the Landfill liner system which consisted of a 60-mil HDPE top liner underlain by a 2-foot-thick compacted clay bottom liner. Prior to installation of the liner system, approximately 10 to 15 feet of cut into the existing soils will occur along the topographically higher southern portion of the Lateral Expansion, and emplacement of these soils (clayey sands, silty clayey sand and/or lean clays) as fill materials below the liner system in the topographically lower central and northern portions of the Lateral Expansion. As detailed below in Section 3.3.2, during Lateral Expansion construction activities, existing downgradient monitoring well AD-35, located within the Lateral Expansion construction zone, was plugged and replaced with new monitoring well (AD-36) located directly downgradient to the west of the Lateral Expansion area.

2.2.4 Surface Water Control

Surface water in the area of the existing Landfill flows in a general southerly direction to the Landfill Stormwater Runoff Pond located directly southwest of the existing Landfill. Surface water in the area of the 2018 Landfill Lateral Expansion flows in a general westerly direction to the Landfill Stormwater Runoff Pond. The Landfill Stormwater Runoff Pond, which is approximately 16 acres in size, also receives (1) Landfill leachate that is gravity drained from the existing Landfill via underground lateral perforated pipes and permeable bottom ash materials that were installed above portions of the existing Landfill liner, (2) Landfill leachate that will gravity drain via underground lateral perforated pipes that were installed above the 2018 Landfill Lateral Expansion liner system, and (3) shallow groundwater that will gravity drain via underground lateral perforated HDPE underdrain pipes that were installed in permeable bottom ash materials approximately seven feet below the 60-mil HDPE liner of the 2018 Landfill Lateral Expansion.

2.3 Previous Investigations

The initial soils investigation and design of the Plant was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, including the Landfill Area.

A soils investigation of the Landfill was conducted by Southwestern Laboratories in 1984. The investigation included installation of 45 soil borings and geotechnical analyses of soil samples. The report recommended installation of three feet of compacted clay as the bottom liner for the Landfill (Southwestern Laboratories, July 1984).

An engineering design report for the Landfill was prepared by VFL Technology Corporation in 1984. The Landfill design included a bottom compacted clay liner three feet in thickness, and Landfill side slopes of 3:1 (VFL Technology Corporation, 1984).

In 1985, Southwestern Laboratories conducted a geotechnical evaluation of the clay liner that was installed at the base of the Landfill, including installation of four soil borings and permeability testing of soil samples. The report concluded the clay liner was three feet thick with a permeability less than 1×10^{-7} centimeters per second (cm/sec) (Southwestern Laboratories, 1985).

In 1993, Alliance Inc. conducted a geotechnical investigation of the clay liner installed at the base of the Landfill following a Landfill expansion phase in 1993. The report concluded the clay liner was three feet or more in thickness, and the clay liner met the permeability specifications of $<1 \times 10^{-7}$ cm/sec (Alliance Inc., 1993).

In 1995, Central and South West Services prepared design specifications for Landfill expansion to the west and south. The design specifications included a geosynthetic clay liner overlain by a 0.060-inch (60 mil) HDPE liner (Central and South West Services, 1995).

In 2005, ETTL conducted a geotechnical evaluation of the Landfill and Landfill Stormwater Runoff Pond, including installation 30 soil borings, ten CPT borings, and geotechnical testing of soil samples. The geotechnical data was obtained to design Landfill expansions in 2005 through 2007.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, March 2011).

In 2012, Apex Geoscience conducted a geotechnical investigation for Landfill expansion activities planned at the western portion of the Landfill where surface lignite mining operations had previously been conducted to a depth of 50 to 100 feet using a dragline, and the spoils (reclaimed soil) were returned to the excavation. The report concluded the Landfill embankments would be stable with side slopes of 3:1 (Apex Geoscience, 2013).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

In 2016, Auckland Consulting conducted a geotechnical evaluation of the 2018 Landfill Lateral Expansion area, including installation of eight soil borings (B1 through B8) with total depths ranging from 40 to 62 feet below ground surface (bgl). Soil boring locations are shown on **Figure 11**, and copies of the soil boring logs are provided in **Appendix A.** Based on the results of the 2016 geotechnical evaluation, including slope stability modeling and settlement analysis, Auckland Consulting concluded the 2018 Landfill Lateral Expansion will be structurally stable with maximum side slopes of 3:1 to a maximum disposal height of 120 feet (Auckland, November 2016).

In 2018, Auckland Consulting installed seven piezometers (PZ-1 through PZ-7) within the 2018 Landfill Lateral Expansion area to obtain detailed depth to groundwater and groundwater flow direction data prior to construction of the Lateral Expansion. The piezometers were completed in the uppermost water-bearing unit with total depths ranging from 14 to 20 feet bgl. Piezometer locations are shown on **Figure 11**, and piezometer completion data is provided in **Appendix A.**

In November 2018, AD-35 was decommissioned due to landfill expansion activities. AD-36 was installed in April 2019 as replacement of AD-35 as a new downgradient monitoring well in the CCR well network. Eight background samples were collected from August 2019 to July 2020 to establish Appendix III background values at AD-36 to incorporate AD-36 into the CCR well network (AEP, 2021). AD-36 has been included in the subsequent semi-annual sampling events completed in November 2020, May 2021, and November 2021. The well construction log and well construction report for AD-36 are included in **Appendix B**.

2.4 Hydrogeologic Setting

2.4.1 General

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Site in the area of the Landfill Stormwater Runoff Pond. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of up to approximately 100 feet in Harrison county, Texas (Broom, 1966). As shown on Geologic Cross Sections C-C’ (**Figure 6**) and D-D’ (**Figure 7**), a thick sand stratum is located below and adjacent to the Landfill between an elevation of approximately 270 feet and 330 feet amsl. This sand stratum likely corresponds to the Carrizo Sand based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

The Carrizo Sand is underlain by the Eocene-age Wilcox Formation, which outcrops in topographically low areas near the Sabine River to the south and southeast of the Plant (Flawn, 1965). The Wilcox Formation consists of interbedded sand and clay with seams of lignite, and attains a thickness of approximately 700 feet (Broom, 1966). As shown on Geologic Cross Section D-D’ (**Figure 7**), a lignite seam was encountered below an elevation of approximately 270 feet amsl during drilling of monitoring well AD-24 at the south end of the Site. This lignite seam likely corresponds to the top of the Wilcox Formation based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

These features are further illustrated on five lines of cross section that were prepared through the existing Landfill Area, with three lines trending from west to east (A-A’; B-B’; C-C’), and the other two lines trending from north to south (D-D’; E-E’). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A’) through **Figure 8** (E-E’).

2.4.2 2018 Landfill Lateral Expansion Area

Based on the hydrogeologic data obtained from soil borings, monitoring wells, and piezometers installed in the 2018 Landfill Lateral Expansion area, four lines of cross section were prepared through the 2018 Landfill Lateral Expansion area. The cross section location map is included as **Figure 11** and the lines of cross section are included as **Figure 12** (F-F’), **Figure 13** (G-G’), **Figure 14** (H-H’), and **Figure 15** (I-I’).

As shown on **Figures 12** through **15**, a reddish-brown to gray clayey and silty sand stratum is located below the Lateral Expansion area between an elevation of approximately 280 feet and 330 feet amsl. This sand stratum likely corresponds to the Carrizo Sand based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

As shown on **Figures 12** through **15**, a clay stratum with an average thickness of approximately 10 feet is located below the sand stratum, and a lignite seam is present below the clay stratum at an elevation of approximately 270 feet amsl. As discussed above in Section 2.4.1, this lignite seam likely corresponds to the top of the Wilcox Formation based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

2.4.3 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1˚ Fahrenheit (F) in January to 83.8˚F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.4 Regional and Local Geologic Setting

The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant where the existing Landfill, 2018 Landfill Lateral Expansion, and Landfill Stormwater Runoff Pond are located (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 “*Ground-Water Resources of Harrison County, Texas*” (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology “*Geologic Atlas of Texas – Tyler Sheet*” (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K “*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*” (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled “*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*” (ETTL, 2010).

2.4.5 Surface Water and Surface Water Groundwater Interactions

Figures 9 and **10** are potentiometric surface maps based on January 2016 and August 2017 water level data, respectively, for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1** and has been updated to include data through 2021. As shown on **Figures 9** and **10**, shallow groundwater flow direction in the Landfill area is southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The Landfill is located approximately 400 feet west of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980’s. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figures 9** and **10**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore, shallow groundwater in the Landfill area does not discharge into Brandy Branch Reservoir. Brandy Branch Reservoir likely recharges the uppermost water bearing unit in the southern portion of the Site, where the pool level in the Reservoir (340 feet amsl) is higher than water level elevations in monitoring wells located southwest (downslope) of the Reservoir.

Figure 16 is a June 2018 potentiometric surface map for the uppermost water-bearing unit in the 2018 Landfill Lateral Expansion area, and water level elevations for the 2018 Landfill Lateral Expansion area piezometers are summarized on **Table 2**. As shown on **Figure 16** and potentiometric figures for the semi-annual sampling from 2019 to 2021 included in **Appendix C**, shallow groundwater flow direction in the 2018 Landfill Lateral Expansion area is westerly toward the Landfill Stormwater Runoff Pond at a hydraulic gradient of approximately 0.02 foot per foot. Water level elevations in the 2018 Landfill Lateral Expansion area piezometers were higher than the surface water elevation of the Landfill Stormwater Runoff Pond (approximately 298 feet amsl), which indicated shallow groundwater in the 2018 Landfill Lateral Expansion area discharges into the Landfill Stormwater Runoff Pond.

2.4.6 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled directly east of the Landfill in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 330 to 426 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled directly south of the Landfill by Amoco Production Company in 1991 for use as an oil field rig supply well. The water well was screened from 163 to 243 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The third closest water well was reportedly drilled approximately 200 feet southwest of the Landfill by Matador Operating in 2000 for use as an industrial well. The water well was screened from 340 to 420 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth and is located approximately ¼-mile east (upgradient) of the Pirkey Power Plant.

3 Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 and 30 TAC 352.911 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be placed down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the existing Landfill Area is a very fine to fine grained clayey and silty sand stratum located below and adjacent to the existing Landfill between an elevation of approximately 270 feet and 330 feet amsl (**Appendix B**). The location of the uppermost water bearing unit relative to the existing Landfill is shown on cross section C-C' (**Figure 6)** and cross section D-D' (**Figure 7)**.

The location of the uppermost water bearing unit relative to the 2018 Landfill Lateral Expansion is shown on cross section F-F' (**Figure 12**), cross section G-G' (**Figure 13**), H-H' (**Figure 14**), and cross section I-I' (**Figure 15**). As shown on these geologic cross sections, the uppermost aquifer in the Landfill Lateral Expansion area is a clayey and silty sand stratum located between an elevation of approximately 280 feet and 330 feet amsl. Clay interbeds are present within the sand stratum, but the clay interbeds are discontinuous, indicating the entire saturated thickness of the sand stratum between approximately 280 feet and 330 feet amsl in the Lateral Expansion area is in hydraulic communication and represents the uppermost aquifer.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness in the Landfill area (up to 60 feet), the yield of the uppermost aquifer is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Groundwater elevations from the plant monitoring wells are summarized on **Table 1** and piezometer data is summarized on **Table 2**. The plant-wide comprehensive groundwater elevation data set from August 24, 2017 is depicted on **Figure 10**. Sitewide potentiometric surface maps from 2019 to 2021 are also included in **Appendix C**. The groundwater flow direction in the Landfill area is south to southwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

Current groundwater elevations in the Landfill 2018 Lateral Expansion area are summarized on **Table 1-**, and a June 22, 2018 piezometric surface map is depicted on **Figure 16,** and potentiometric surface maps for sampling events completed from 2019 to 2021 are included in **Appendix C**. As shown on these figures, shallow groundwater flow direction in the 2018 Landfill Lateral Expansion area is westerly toward the Landfill Stormwater Runoff Pond at a hydraulic gradient of approximately 0.02 foot per foot. Water level elevations in the 2018 Landfill Lateral Expansion area piezometers are higher than the surface water elevation of the Landfill Stormwater Runoff Pond (approximately 298 feet amsl), which indicates shallow groundwater in the 2018 Landfill Lateral Expansion area discharges into the Landfill Stormwater Runoff Pond.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 and 30 TAC 352.3 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers, that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the Landfill area is the clayey and silty sand stratum that is located between an elevation of approximately 270 and 330 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

A well construction table that summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as **Table 3**.

Monitoring wells AD-8, AD-12, AD-16, AD-23, AD-24, AD-25, AD-26, AD-27, AD-34, and AD-35 were previously installed at the Site to monitor the uppermost aquifer (clayey and silty sand stratum) associated with the Landfill. AD-35 was decommissioned in 2018 and AD-36 was installed as a replacement in 2019. As discussed above in Section 3.1.1, the uppermost aquifer below and adjacent to the existing Landfill is up to 60 feet thick and is located between an elevation of approximately 270 and 330 feet amsl. The uppermost aquifer below the Landfill Lateral Expansion area is located between an elevation of approximately 280 and 330 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on **Figure 10** and subsequent potentiometric maps in **Appendix C** shallow groundwater flow direction in the existing Landfill area is south to southwesterly. Four existing monitoring wells (AD-8, AD-12, AD-16, and AD-27) are located up gradient north and northeast of the Landfill and will be utilized as up gradient monitoring wells for the Landfill.

As shown on **Figure 10** and subsequent potentiometric maps in **Appendix C**, three existing monitoring wells (AD-23, AD-34, and AD-36) are located downgradient (south) of the Landfill and are currently utilized to monitor groundwater quality downgradient of the Landfill CCR unit. Monitoring well MW-35 was located within the footprint of the proposed 2018 Landfill Lateral Expansion and was plugged by a Texas Department of Licensing and Regulation (TDLR) licensed water well driller. This data gap was addressed by installation of new downgradient monitoring well AD-36. As shown on potentiometric surface maps included in **Appendix C**, monitoring well AD-36 is located on the west (downgradient) side of the 2018 Landfill Lateral Expansion. With the addition of monitoring well AD-36 as a replacement for monitoring well AD-35, there are no gaps in the groundwater monitoring network for the Landfill.

4 Monitoring Well Network and PE Certification

The groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91 and 30 TAC 352.911. These wells are further discussed below with respect to location to the Landfill (up gradient or down gradient), well depth, and well construction. The monitoring well network provides an adequate understanding of groundwater quality, hydraulics, and groundwater flow at the Landfill.

4.1 Monitoring Well Network Distribution

Four up gradient well locations (existing monitoring wells AD-8, AD-12, AD-16, and AD-27) and three downgradient well locations (existing monitoring wells AD-23, AD-34, and AD-36) are currently utilized as the groundwater quality monitoring well network for the Landfill. During the 2018 Landfill Lateral Expansion construction activities, monitoring well AD-35 was plugged and replaced with a new monitoring well (AD-36) installed directly west (downgradient) of the Lateral Expansion. In addition, existing side gradient monitoring wells AD-25 and AD-26 may be utilized as piezometers to obtain additional groundwater flow direction and gradient data for the Landfill.

4.1.1 Location

The monitoring well network for groundwater quality of the uppermost aquifer at the Landfill is summarized on **Table 4** and illustrated on **Figure 17.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 270 and 330 feet amsl in the existing Landfill area, and between an elevation of approximately 280 and 330 feet amsl in the Landfill Lateral Expansion area, as shown on Geologic Cross Sections C-C’ (**Figure 6**), D-D’ (**Figure 7**), F-F’ (**Figure 12**), G-G’ (**Figure 13**), H-H’ (**Figure 14**), and I-I’ (**Figure 15**). The screen elevations are presented in **Table 4**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the Landfill due to the expansion activities has been previously addressed by plugging of monitoring well AD-35 in 2018 and installation of new monitoring well AD-36 in 2019. Well construction data for the monitoring well network are summarized on **Tables 3** and **4**, and the monitoring well completion diagrams for the existing monitoring wells are provided in **Appendix B**.

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system for the Landfill CCR unit is adequate to meet the requirements of 40 CFR Part 257.91 and 30 TAC 352.911.

Kenneth J. Brandner
Printed Name of Registered Professional Engineer

Kenneth J Brandner
Signature

KENNETH J. BRANDNER
69586

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Texas Board of Professional Engineers firm registration #F-533

Firm Information

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Tables

Table 1
Water Level Data
AEP Pirkey Power Plant-Landfill CCR
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole Depth ft. bls	Date Installed	Screen Material	Well Diameter inches	Top of Screen(b)		Bottom of Screen(b)		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016	1/12/2017	3/1/2017	4/11/2017
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																								
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20.0	321.3	40.0	301.3	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55	327.65	327.96	329.09
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37.0	335.8	57.0	315.8	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03	344.19	345.53	345.53
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26.0	337.7	46.0	317.7	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16	353.27	355.38	356.62
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20.0	339.6	40.0	319.6	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31	347.04	347.96	347.87
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20.0	336.9	35.0	321.9	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21	345.74	346.00	345.81
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20.0	339.5	40.0	319.5	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97	---	---	---
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31.0	347.8	51.0	327.8	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05	365.11	368.79	372.97
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.5	40.5	321.5	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15	352.01	352.81	352.68
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.8	35.0	321.8	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68	343.09	344.54	344.69
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.7	30.0	312.7	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78	324.70	326.27	326.27
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.5	25.0	335.5	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52	357.06	359.21	358.63
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.5	30.0	329.5	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40	---	---	---
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.3	35.0	317.3	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07	---	---	---
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.2	30.0	317.2	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82	---	---	---
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.6	30.0	325.6	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29	347.20	348.52	348.45
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.7	35.0	311.7	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23	320.99	321.00	320.85
AD-24(e)	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.7	20.0	267.7	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56				
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.2	30.0	304.2	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00	---	---	---
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.4	40.0	302.4	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06	---	---	---
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.3	37.5	312.3	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89	330.04	331.59	331.24
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.9	35.0	300.9	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39	320.27	320.51	320.69
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.2	30.0	320.2	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48	---	---	---
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.0	25.0	314.0	---	---	---	---	---	---	---	---	323.70	322.23	322.85	322.88
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.8	35.0	322.8	---	---	---	---	---	---	---	---	346.60	343.78	344.53	344.58
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.2	33.0	324.2	---	---	---	---	---	---	---	---	352.32	347.44	348.44	349.09
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.3	30.0	329.3	---	---	---	---	---	---	---	---	351.13	348.56	349.32	349.25
AD-34(d,f)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.6	25.0	279.6	---	---	---	---	---	---	---	---	307.61	307.61	307.61	307.61
AD-35(d,g)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.0	18.0	298.0	---	---	---	---	---	---	---	---	309.85	310.42	310.82	311.27
AD-36(d)	32° 27' 05.39"	94° 29' 50.99"	306.50	309.20	15	4/24/19	Sch. 40 PVC	2	5.0	301.5	15.0	291.5	---	---	---	---	---	---	---	---	---	---	---	---
Piezometers(c)																								
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.3	38.0	318.3	---	---	---	---	---	---	---	---	---	---	---	---

NOTES:

(a) Source: Apex Geoscience Inc. (March 23, 2011) and Akron Consulting, LLC (2019).

(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).

(c) Souce: EETL (October 2010).

(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015. AD-36 installed April 2019.

(e) AD-24 was abandoned on January 26, 2016

(f) AD-34 water level observations are often flowing artesian (water upwelling out of the well casing with an entered 0.00 depth to water) and the actual water level is greater.

(g) AD-35 was abandoned on November 13, 2018

Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through November 2021.

--- = Not Measured

ft = Feet

bls = Below land surface

msl = mean sea level

Elev. = Elevation in feet above mean sea level

Table 1
Water Level Data
AEP Pirkey Power Plant-Landfill CCR
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole Depth ft. bls	Date Installed	Screen Material	Well Diameter inches	Top of Screen(b)		Bottom of Screen(b)		8/24/2017	3/22/2018	8/21/2018	2/28/2019	5/23/2019	8/12/2019	1/27/2020	3/11/2020	4/15/2020	6/3/2020	6/16/2020
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																							
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20.0	321.3	40.0	301.3	327.63	328.36	326.99	329.21	328.91	327.60	---	329.23	---	328.06	---
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37.0	335.8	57.0	315.8	343.49	344.56	343.28	348.36	349.37	346.08	---	347.22	---	347.76	---
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26.0	337.7	46.0	317.7	353.58	359.04	350.39	360.40	361.18	354.10	---	360.56	---	360.25	---
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20.0	339.6	40.0	319.6	347.40	348.46	344.57	350.21	350.82	346.85	---	350.64	---	350.25	---
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20.0	336.9	35.0	321.9	346.31	346.11	345.24	348.05	348.60	347.33	---	---	---	348.61	---
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20.0	339.5	40.0	319.5	---	---	---	---	---	343.07	---	---	---	---	---
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31.0	347.8	51.0	327.8	367.68	370.57	357.99	372.43	373.12	361.90	---	373.10	---	371.68	---
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.5	40.5	321.5	352.62	353.25	349.14	355.63	355.87	350.87	---	355.71	---	355.17	---
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.8	35.0	321.8	342.71	344.63	340.03	351.21	351.92	343.92	---	---	---	349.39	---
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.7	30.0	312.7	324.18	327.13	324.12	331.11	331.66	326.45	---	330.07	---	328.04	---
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.5	25.0	335.5	358.23	360.00	361.99	354.61	360.74	357.09	---	360.58	---	359.98	---
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.5	30.0	329.5	---	---	---	---	---	345.31	---	---	---	---	---
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.3	35.0	317.3	---	---	---	---	---	335.36	---	---	---	---	---
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.2	30.0	317.2	---	---	---	---	---	341.78	---	---	---	---	---
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.6	30.0	325.6	347.37	349.62	344.11	350.90	351.99	346.70	---	351.80	---	350.95	---
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.7	35.0	311.7	320.77	320.17	320.31	320.88	320.99	321.29	320.46	---	---	320.79	---
AD-24(e)	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.7	20.0	267.7											
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.2	30.0	304.2	---	---	---	329.55	330.57	327.80	---	---	---	---	---
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.4	40.0	302.4	---	---	---	329.50	331.10	331.03	---	---	---	---	---
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.3	37.5	312.3	330.05	332.49	328.61	335.04	336.53	330.71	---	---	---	335.75	---
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.9	35.0	300.9	320.07	321.73	319.93	321.86	322.61	320.40	---	321.98	---	321.28	---
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.2	30.0	320.2	---	---	---	---	---	337.47	---	---	---	---	---
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.0	25.0	314.0	322.04	323.29	321.70	324.54	325.21	322.63	---	323.94	---	323.40	---
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.8	35.0	322.8	343.57	344.10	342.73	348.31	349.68	346.63	---	346.95	---	347.95	---
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.2	33.0	324.2	349.73	351.42	347.58	352.86	354.14	353.12	---	352.55	---	352.87	---
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.3	30.0	329.3	349.31	350.10	347.23	351.99	352.95	349.96	---	352.68	---	352.54	---
AD-34(d,f)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.6	25.0	279.6	307.61	307.61	306.66	307.61	307.61	---	307.61	307.61	---	307.61	---
AD-35(d,g)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.0	18.0	298.0	310.28	311.17	297.95								
AD-36(d)	32° 27' 05.39"	94° 29' 50.99"	306.50	309.20	15	4/24/19	Sch. 40 PVC	2	5.0	301.5	15.0	291.5	---	---	---	---	---	302.94	302.63	303.21	302.74	303.78	303.74
Piezometers(c)																							
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.3	38.0	318.3	---	---	---	---	---	---	---	---	---	---	---

NOTES:

(a) Source: Apex Geoscience Inc. (March 23, 2011) and Akron Consulting, LLC (2019).

(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).

(c) Souce: EETL (October 2010).

(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015. AD-36 installed April 2019.

(e) AD-24 was abandoned on January 26, 2016

(f) AD-34 water level observations are often flowing artesian (water upwelling out of the well casing with an entered 0.00 depth to water) and the actual water level is greater.

(g) AD-35 was abandoned on November 13, 2018

Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through November 2021.

--- = Not Measured

ft = Feet

bls = Below land surface

msl = mean sea level

Elev. = Elevation in feet above mean sea level

Table 1
Water Level Data
AEP Pirkey Power Plant-Landfill CCR
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole Depth ft. bls	Date Installed	Screen Material	Well Diameter inches	Top of Screen(b)		Bottom of Screen(b)		7/1/2020	11/4/2020	3/8/2021	5/25/2021	7/27/2021	11/17/2021
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																		
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20.0	321.3	40.0	301.3	---	327.57	329.00	329.57	---	327.36
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37.0	335.8	57.0	315.8	---	342.89	346.58	347.46	---	342.60
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26.0	337.7	46.0	317.7	---	349.70	359.14	360.45	---	351.40
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20.0	339.6	40.0	319.6	---	346.45	350.13	350.97	---	345.08
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20.0	336.9	35.0	321.9	---	346.63	---	348.58	---	346.48
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20.0	339.5	40.0	319.5	---	---	---	---	---	---
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31.0	347.8	51.0	327.8	---	361.86	373.52	375.56	---	358.32
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.5	40.5	321.5	---	350.93	355.22	356.42	---	349.43
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.8	35.0	321.8	---	343.07	---	350.52	---	341.99
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.7	30.0	312.7	---	324.36	329.37	329.03	---	323.77
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.5	25.0	335.5	---	354.98	359.99	360.46	---	355.55
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.5	30.0	329.5	---	---	---	---	---	---
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.3	35.0	317.3	---	---	---	---	---	---
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.2	30.0	317.2	---	---	---	---	---	---
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.6	30.0	325.6	---	346.12	351.33	352.31	---	345.25
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.7	35.0	311.7	---	320.83	---	320.32	---	320.49
AD-24(e)	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.7	20.0	267.7						
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.2	30.0	304.2	---	326.73	---	330.48	---	327.37
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.4	40.0	302.4	---	330.32	---	331.02	---	330.64
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.3	37.5	312.3	---	329.77	---	337.25	---	329.69
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.9	35.0	300.9	---	319.99	322.06	323.10	---	319.98
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.2	30.0	320.2	---	---	---	---	---	---
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.0	25.0	314.0	---	321.90	324.19	324.94	---	321.80
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.8	35.0	322.8	---	342.84	346.24	347.27	---	342.79
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.2	33.0	324.2	---	346.13	350.30	351.28	---	348.72
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.3	30.0	329.3	---	348.71	351.84	352.95	---	348.40
AD-34(d,f)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.6	25.0	279.6	---	307.00	---	307.61	307.61	307.20
AD-35(d,g)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.0	18.0	298.0						
AD-36(d)	32° 27' 05.39"	94° 29' 50.99"	306.50	309.20	15	4/24/19	Sch. 40 PVC	2	5.0	301.5	15.0	291.5	303.86	302.88	---	302.22	302.42	301.66
Piezometers(c)																		
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.3	38.0	318.3	---	---	---	---	---	---

NOTES:

(a) Source: Apex Geoscience Inc. (March 23, 2011) and Akron Consulting, LLC (2019).

(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).

(c) Souce: EETL (October 2010).

(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015. AD-36 installed April 2019.

(e) AD-24 was abandoned on January 26, 2016

(f) AD-34 water level observations are often flowing artesian (water upwelling out of the well casing with an entered 0.00 depth to water) and the actual water level is greater.

(g) AD-35 was abandoned on November 13, 2018

Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through November 2021.

--- = Not Measured

ft = Feet

bls = Below land surface

msl = mean sea level

Elev. = Elevation in feet above mean sea level

Table 2
Piezometer Water Level Data - 2018 Landfill Lateral Expansion Area
AEP Pirkey Power Plant-Landfill CCR
Hallsville, Harrision County, Texas

Piezometer Completion Information									
Piezometer ID:	**PZ1**	**PZ2**	**PZ3**	**PZ4**	**PZ5**	**PZ6**	**PZ7**	**AD-23**	**AD-35**
Northing	6871372.73	6871442.96	6871218.9	6871018.52	6870962.73	6870939.86	6871250.41		
Easting	3203056.63	3203345.4	3203322.02	3203009.98	3203281.7	3203544.92	3202996.36		
Screen length	10	10	10	10	10	10	10	20	15
TD (from GS)	14	14	14	14	20	20	14	37.44	18
Sand pack, top (from GS)	3	3	3	3	8	8	3		
Elev, GS								346.72	334.15
Elev, TOC	308.85	312.74	307.35	311.53	328.3	328.78	303.73	350.1	318.95

Piezometer Depth to Water Measurements (feet) below TOC									
Date	**PZ1**	**PZ2**	**PZ3**	**PZ4**	**PZ5**	**PZ6**	**PZ7**	**AD-23**	**AD-35**
6/20/2018	9.98	9.99	4.29	8.66	20.47	13.23	2.84		
6/21/2018	9.99	9.95	4.07	8.37	20.47	13.24	2.75	29.4	7.95
6/22/2018	9.99	9.91	3.98	8.31	20.47	13.25	2.76	29.42	7.92
6/29/2018	10.01	10.1	4.34	8.85	20.63	13.4	2.98	29.39	8.14
7/6/2018	10.02	10.23	4.45	8.92	20.75	13.52	3.21	29.43	8.23

Piezometer Potentiometric Surface (Water Table) Elevations (feet AMSL)									
Date	**PZ1**	**PZ2**	**PZ3**	**PZ4**	**PZ5**	**PZ6**	**PZ7**	**AD-23**	**AD-35**
6/20/2018	298.87	302.75	303.06	302.87	307.83	315.55	300.89		
6/21/2018	298.86	302.79	303.28	303.16	307.83	315.54	300.98	320.70	311.00
6/22/2018	298.86	302.83	303.37	303.22	307.83	315.53	300.97	320.68	311.03
6/29/2018	298.84	302.64	303.01	302.68	307.67	315.38	300.75	320.71	310.81
7/6/2018	298.83	302.51	302.9	302.61	307.55	315.26	300.52	320.67	310.72

NOTES:

GS = Ground surface

TD = Total depth

TOC = Top of piezometer casing

AMSL = Above mean sea level

Table 3
Well Construction Details
AEP Pirkey Power Plant-Landfill CCR
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen(b)		Bottom of Screen(b)	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18.0	341.5	40.0	319.5	20.0	339.5	40.0	319.5
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29.0	349.8	51.0	327.8	31.0	347.8	51.0	327.8
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.5	40.5	321.5
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13.0	343.8	35.0	321.8	15.0	341.8	35.0	321.8
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8.0	334.7	30.0	312.7	10.0	332.7	30.0	312.7
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13.0	347.5	25.0	335.5	15.0	345.5	25.0	335.5
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8.0	351.5	30.0	329.5	10.0	349.5	30.0	329.5
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13.0	339.3	35.0	317.3	15.0	337.3	35.0	317.3
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8.0	339.2	30.0	317.2	10.0	337.2	30.0	317.2
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8.0	347.6	30.0	325.6	10.0	345.6	30.0	325.6
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13.0	333.7	35.0	311.7	15.0	331.7	35.0	311.7
AD-24(e)	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3.0	284.7	20.0	267.7	5.0	282.7	20.0	267.7
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8.0	326.2	30.0	304.2	10.0	324.2	30.0	304.2
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8.0	334.4	40.0	302.4	10.0	332.4	40.0	302.4
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.3	37.5	312.3
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13.0	322.9	35.0	300.9	15.0	320.9	35.0	300.9
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8.0	342.2	30.0	320.2	10.0	340.2	30.0	320.2
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8.0	331.0	25.0	314.0	10.0	329.0	25.0	314.0
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18.0	339.8	35.0	322.8	20.0	337.8	35.0	322.8
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11.0	346.2	33.0	324.2	13.0	344.2	33.0	324.2
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12.0	347.3	30.0	329.3	15.0	344.3	30.0	329.3
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8.0	296.6	25.0	279.6	10.0	294.6	25.0	279.6
AD-35(d,f)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20.0	296.0	3.0	313.0	18.0	298.0
AD-36(d)	32° 27' 05.39"	94° 29' 50.99"	306.50	309.20	15	4/24/19	Sch. 40 PVC	2	4.0	302.5	15.0	291.5	5.0	301.5	15.0	291.5
Piezometers(c)																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26.0	330.3	38.0	318.3	28.0	328.3	38.0	318.3

NOTES:

Elevations in feet above mean sea level.

(a) Source: Apex Geoscience Inc. (March 23, 2011) and Akron Consulting, LLC (2019).

(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.

(c) Souce: EETL (October 2010).

(d) Source: Aukland Consulting LLC (January 26, 2016 and April 2019).

(e) AD-24 was abandoned on January 26, 2016

(f) AD-35 was abandoned on November 13, 2018

NA = Data not available

ft = feet

bls = below land surface

msl = mean sea level

Table 4
Monitoring Well Network
AEP Pirkey Power Plant-Landfill CCR
Hallsville, Harrison County, Texas

Well ID	Hydrostratigraphic Unit Target	Location Description		Screen Top Elevation (ft amsl)	Screen Bottom Elevation (ft amsl)	Screen Length (ft)	Comments
<u>Upgradient</u>							
AD-8	Uppermost Water-Bearing Unit	Northeast of Landfill	Upgradient	336.9	321.9	15	Existing well installed in 1983; well will be utilitzed to establish backgroud water quality
AD-12	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-16	Uppermost Water-Bearing Unit	North of Landfill	Upgradient	341.8	321.8	20	Existing well installed in 2010; well will be utilitzed to establish backgroud water quality
AD-27	Uppermost Water-Bearing Unit	Northwest of Landfill	Upgradient	332.3	312.3	20	Existing well installed in 2010; well will be utilitzed to establish backgroud water quality
<u>Downgradient</u>							
AD-23	Uppermost Water-Bearing Unit	South of Landfill	Down gradient	331.7	311.7	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to Landfill - downgradient
AD-34	Uppermost Water-Bearing Unit	Southwest of Landfill	Down gradient	294.6	279.6	15	Existing monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to Landfill - downgradient.
AD-35[(a)]	Uppermost Water-Bearing Unit	South of Landfill	Down gradient	313.0	298.0	15	Monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to Landfill - downgradient. Was plugged during 2018 Landfill Cell construction on November 13, 2018 and replaced with AD-36.
AD-36	Uppermost Water-Bearing Unit	South of Landfill, West of 2018 Landfill Cell	Down gradient	301.5	291.5	10.0	New well installed on April 24, 2019 in uppermost shallow aquifer adjacent to Landfill - downgradient.
<u>Piezometers</u>							
AD-25	Uppermost Water-Bearing Unit	West of Landfill	Side gradient	324.2	304.2	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to Landfill - side gradient
AD-26	Uppermost Water-Bearing Unit	West of Landfill	Side gradient	332.4	302.4	30	Existing well installed in 2010; uppermost shallow aquifer adjacent to Landfill - side gradient

NOTES:

(a) AD-35 was abandoned on November 13, 2018.

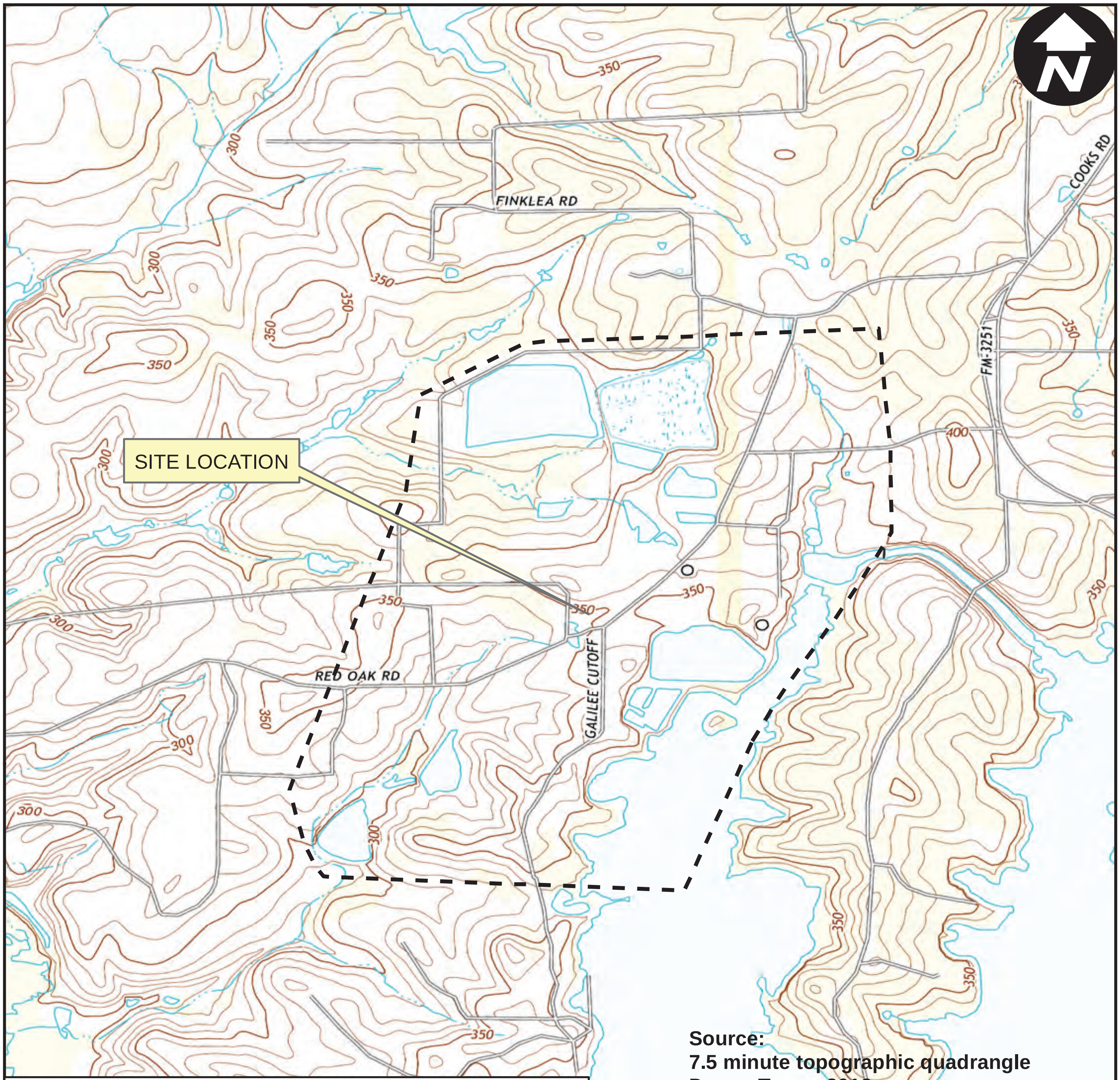
U = Upgradient

D = Downgradient

ft = feet

amsl = above mean sea level

Figures



Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

0 2,000 4,000
SCALE IN FEET

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

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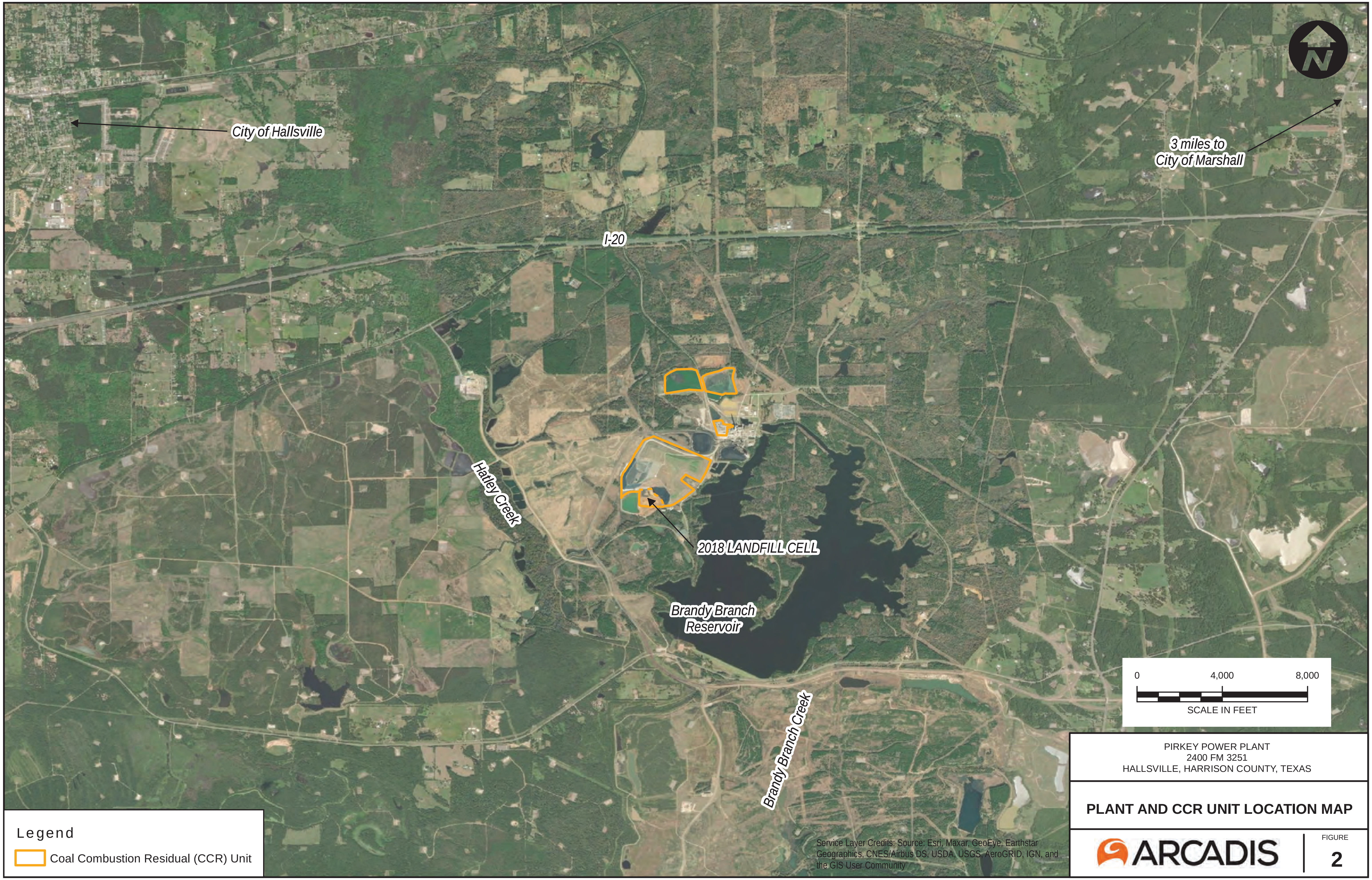
FIGURE
1

Document Path: T:_ENV\AEP\Pirkey Plant\MXD\Updated\Figure 1 - Site Location Map.mxd



PIRKEY POWER PLANT
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PLANT AND CCR UNIT LOCATION MAP

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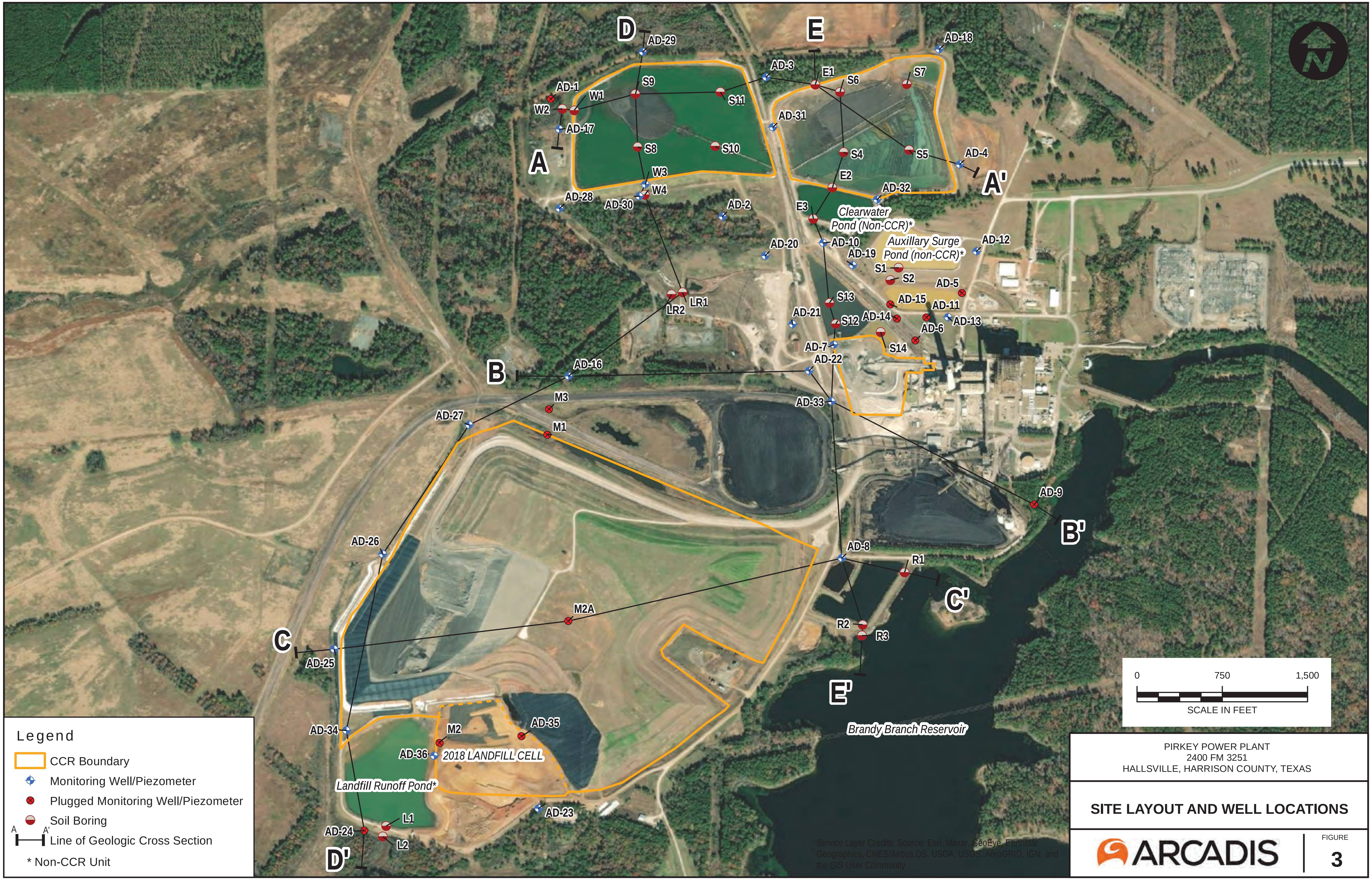
FIGURE
2

Document Path: T:_ENV\AEP\Pirkey Plant\MXD\Updated\Figure 2 - Plant and CCR Unit Location Map.mxd



Legend

- ▭ CCR Boundary
- ⊕ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ◐ Soil Boring
- A├─┤A' Line of Geologic Cross Section

* Non-CCR Unit

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SITE LAYOUT AND WELL LOCATIONS

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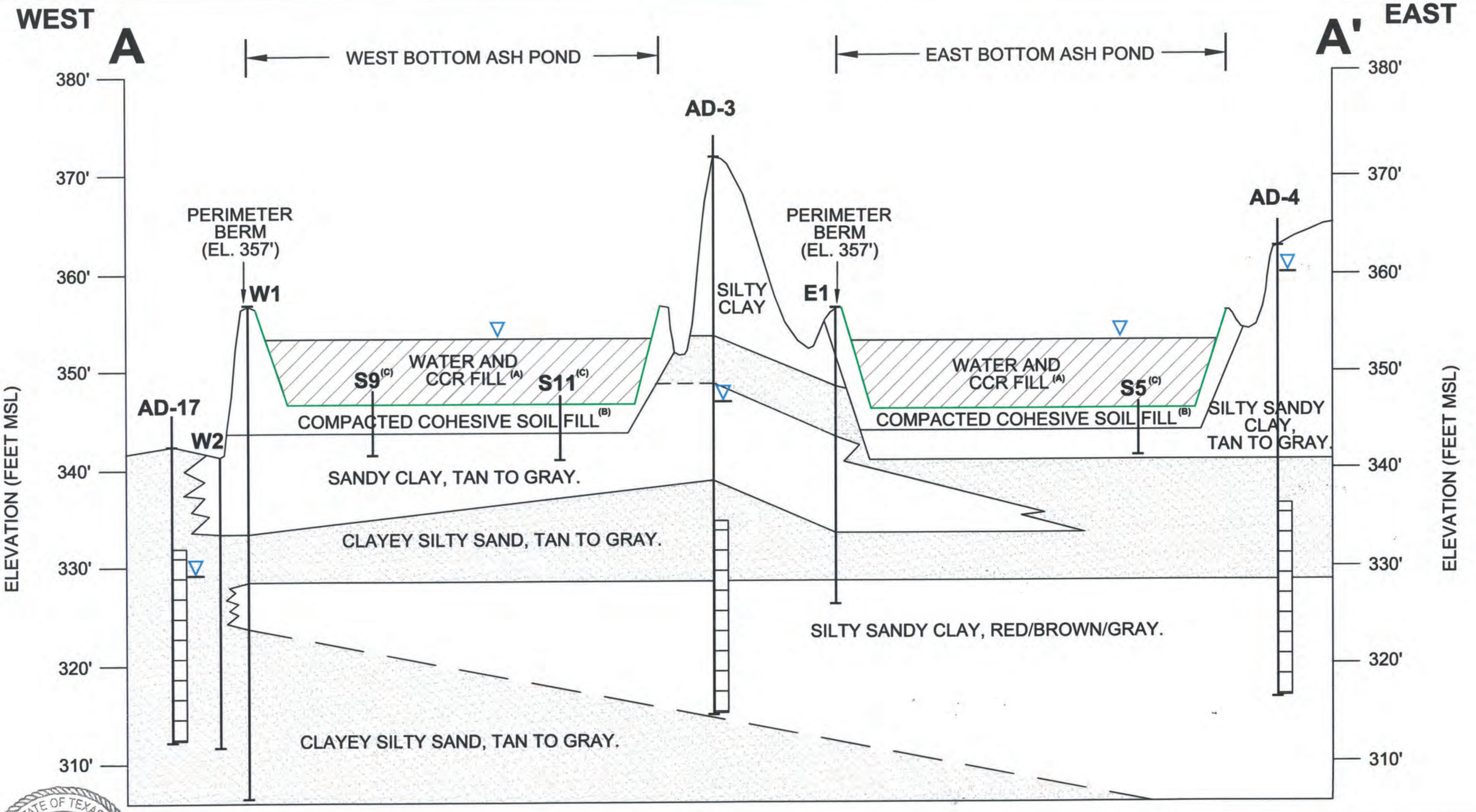
FIGURE
3

Document Path: T:_ENV\AEP\Pirkey Plant\MXD\Updated\Figure 3 - Site Layout and Well Locations.mxd



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0 300'
HORIZONTAL SCALE

LEGEND

⌸	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (MAY 2021)
—	BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).

C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

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CROSS SECTION A - A'

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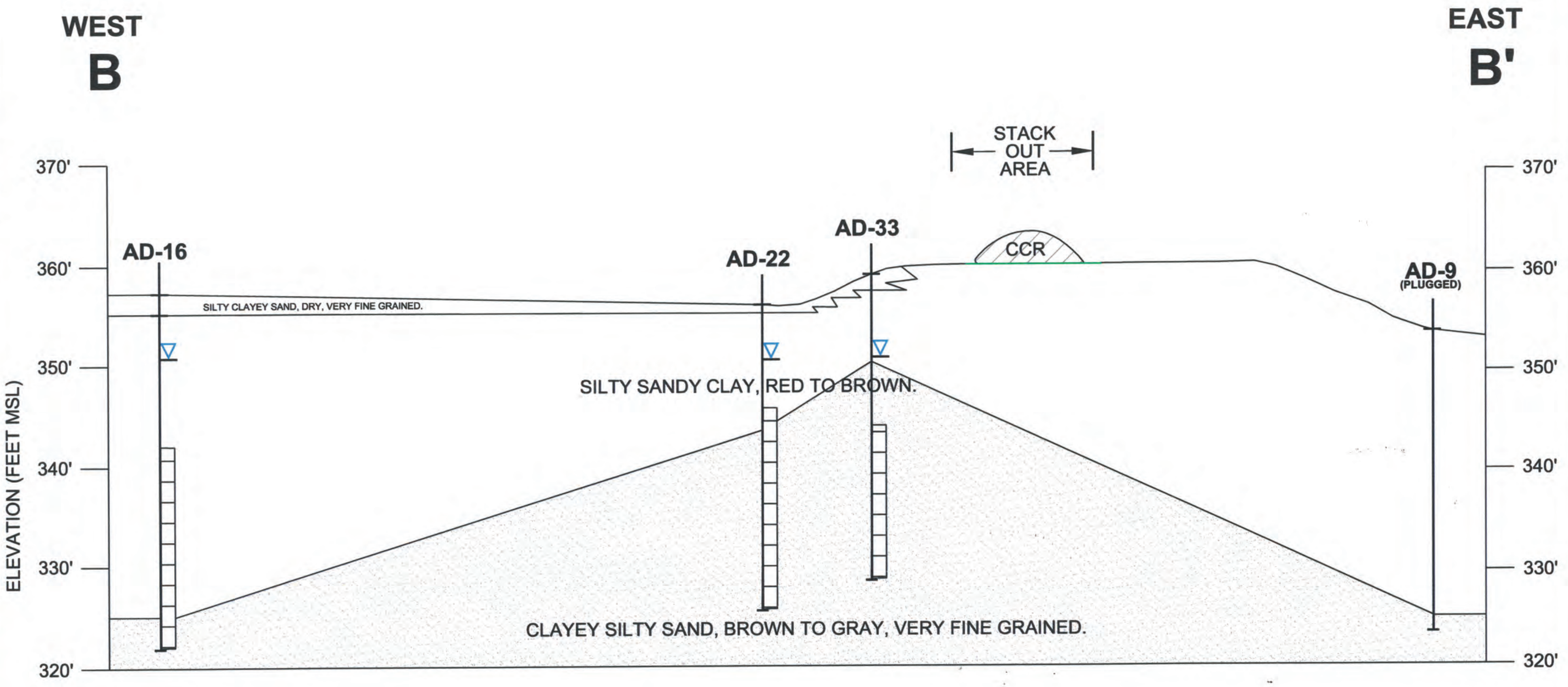
FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\30117944 - Pirkey 2022\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 2/22/2016 11:17 AM ACADVER: 24.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 1/13/2022 10:21 AM BY: LEASE, DIANA



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0 300'
HORIZONTAL SCALE

LEGEND

- ☐ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (MAY 2021)
- — BASE OF CCR UNIT

NOTES:
A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE, ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

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CROSS SECTION B - B'

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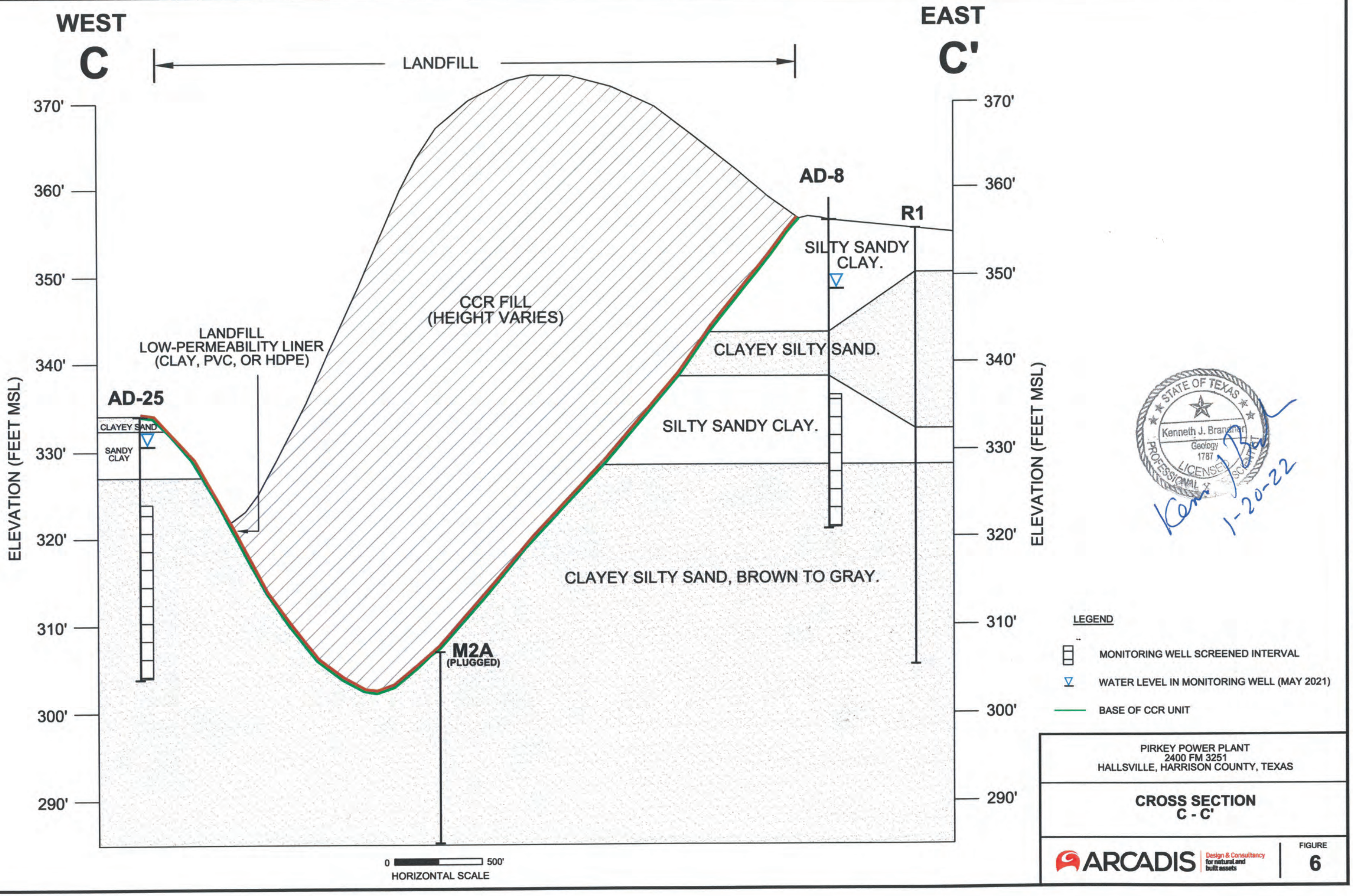
FIGURE
5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\30117944 - Pirkey 2022\Figures-Maps\Figure 5 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:22 PM ACADVER: 24.0S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 1/13/2022 10:56 AM BY: LEASE, DIANA



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CROSS SECTION
C - C'

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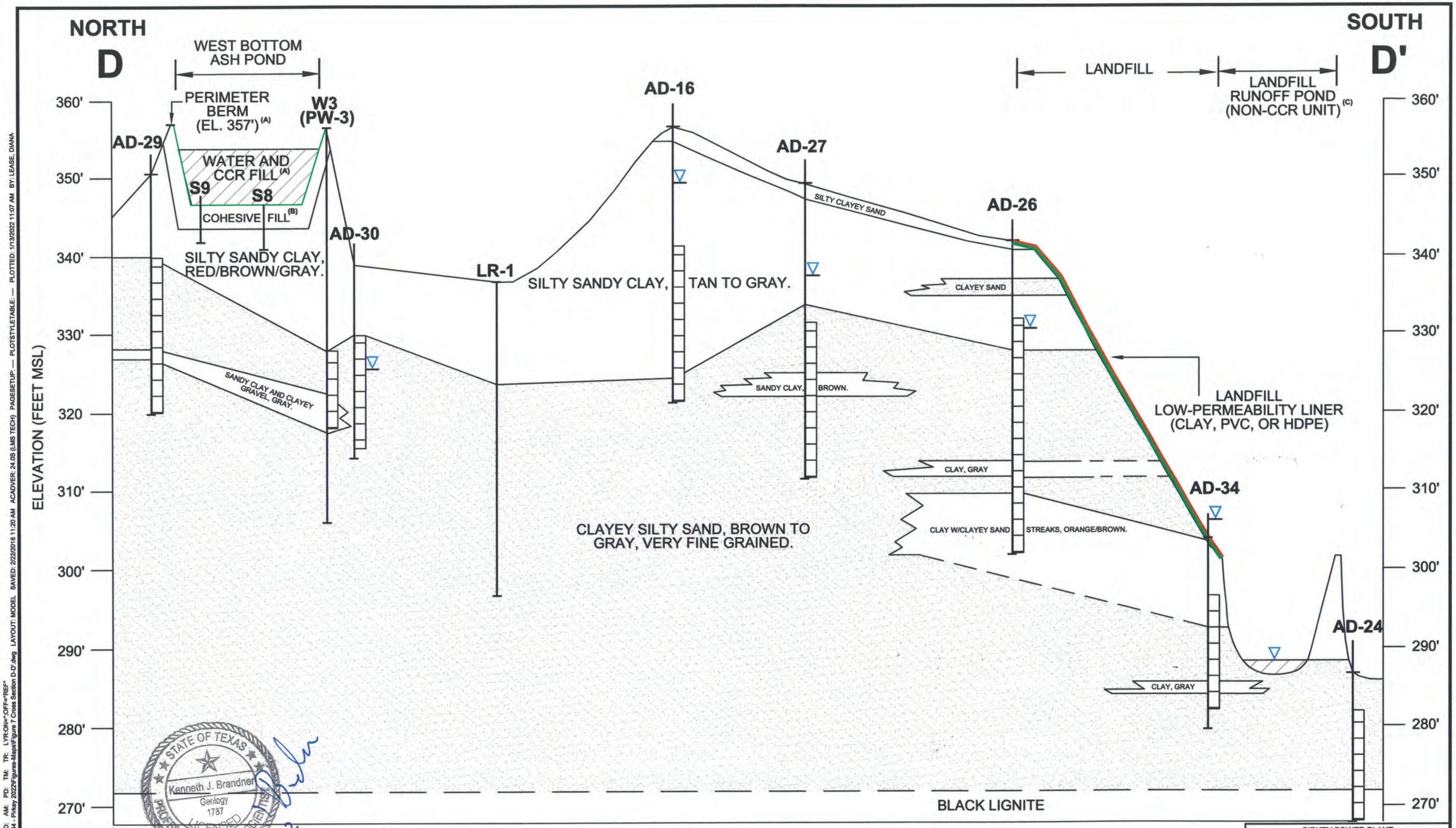
FIGURE
6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\30117944 - Pirkey 2022\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 2/22/2016 11:19 AM ACADVER: 24.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 1/13/2022 11:01 AM BY: LEASE, DIANA



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0 600'
HORIZONTAL SCALE

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (MAY 2021)
🟩	BASE OF CCR UNIT

NOTES:
A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

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**CROSS SECTION
D - D'**

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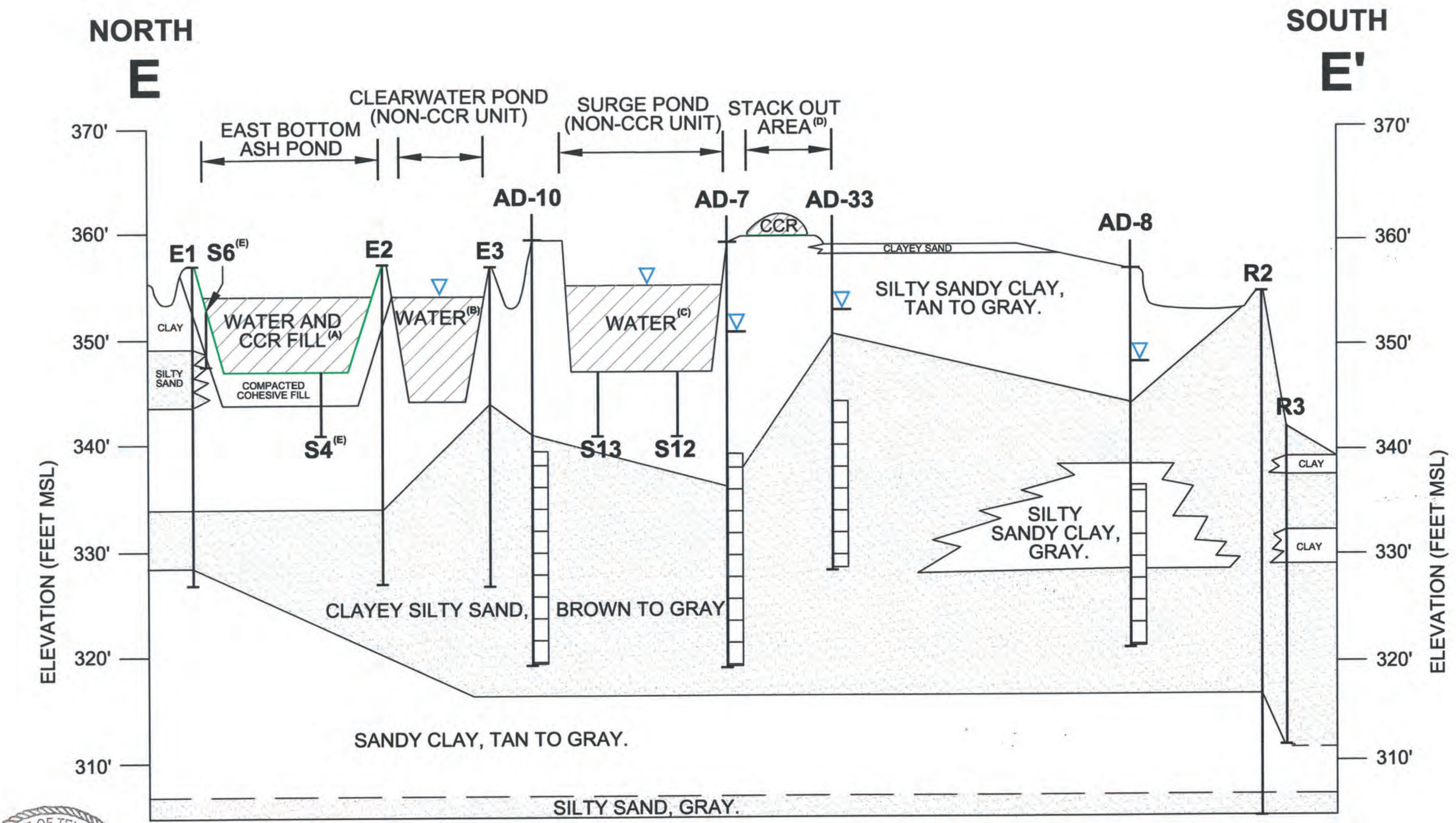
FIGURE
7

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\30117944 - Pirkey 2022\Figures-Maps\Figure 7 Cross Section D-D'.dwg LAYOUT: MODEL SAVED: 2/22/2016 11:20 AM ACADVER: 24.0S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 1/13/2022 11:07 AM BY: LEASE, DIANA



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0 500'
HORIZONTAL SCALE

LEGEND

- ▯ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (MAY 2021)
- — BASE OF CCR UNIT

NOTES:

A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).

C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".

D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.

E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

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CROSS SECTION E - E'

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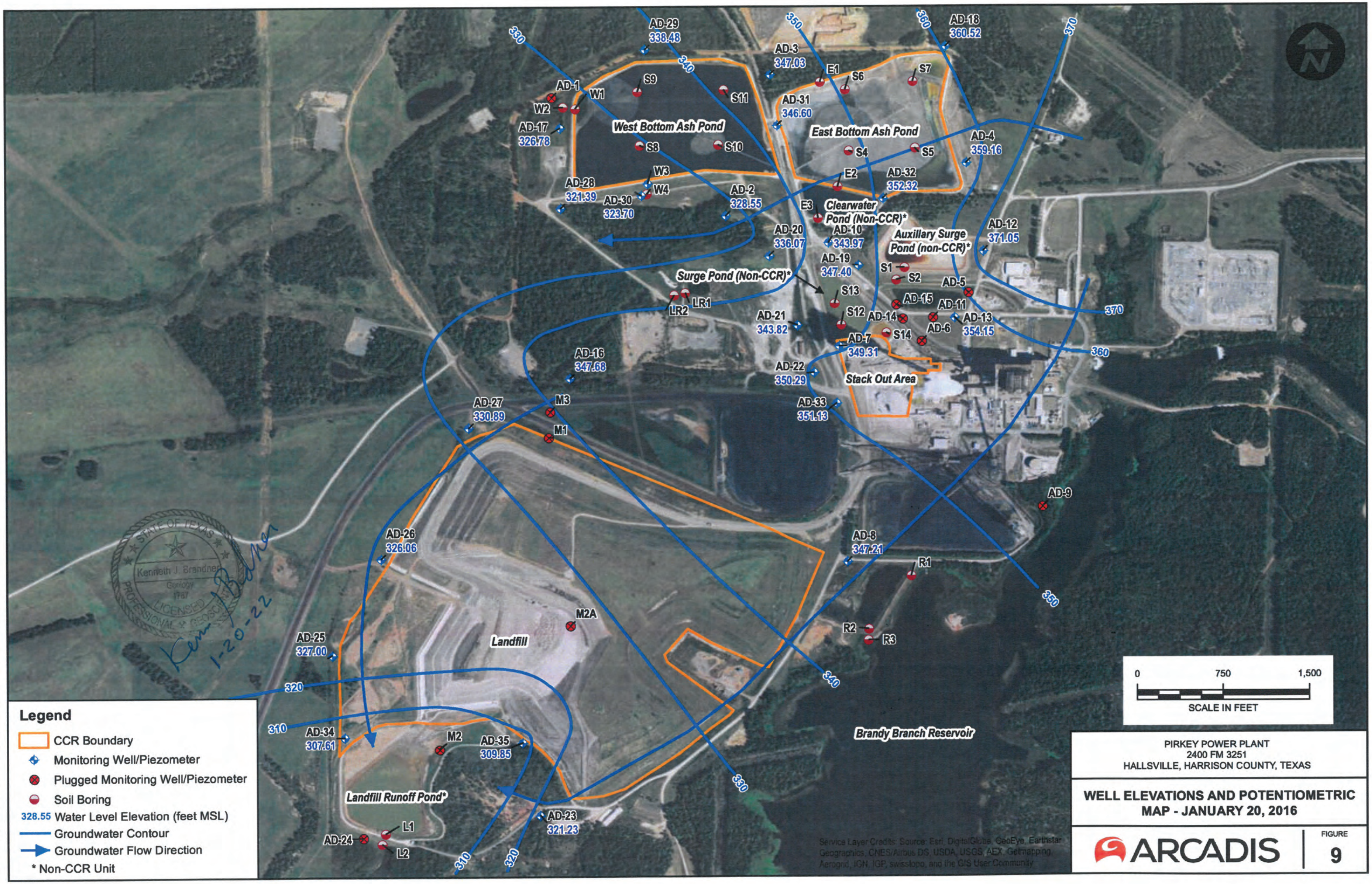
FIGURE
8

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF* G:\Active Projects\AEP\30117944 - Pirkey 2022\Figures-Maps\Figure 8 Cross Section E-E'.dwg LAYOUT: MODEL SAVED: 2/22/2016 11:37 AM ACADVER: 24.0S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: --- PLOTTED: 1/13/2022 11:11 AM BY: LEASE, DIANA



Legend

- 🟧 CCR Boundary
- ◆ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ● Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- — Groundwater Contour
- → Groundwater Flow Direction
- * Non-CCR Unit

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PIRKEY POWER PLANT
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HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

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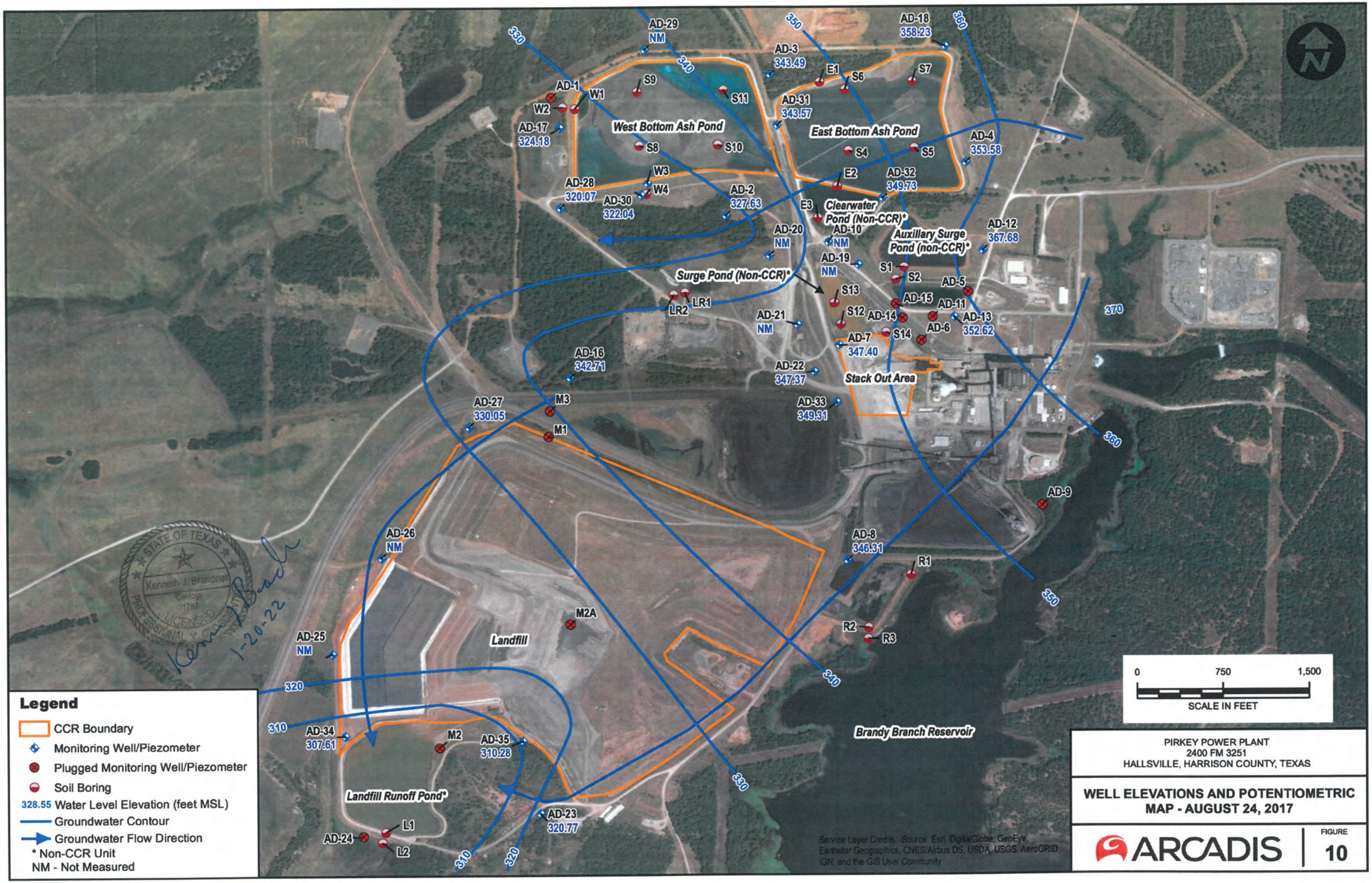
FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



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Legend

- 🟧 CCR Boundary
- ◆ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ● Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- — Groundwater Contour
- → Groundwater Flow Direction

* Non-CCR Unit
NM - Not Measured

PIRKEY POWER PLANT
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WELL ELEVATIONS AND POTENTIOMETRIC MAP - AUGUST 24, 2017

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FIGURE
10

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 10 - Well Elevations and Potentiometric Map - August 24, 2017.mxd

Legend

- 🟧 CCR Boundary
- ⊕ Monitoring Well
- ⊗ Plugged Monitoring Well/Piezometer
- ● Soil Boring
- A├─┤A' Line of Geologic Cross Section
- * Non-CCR Unit

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

PIRKEY POWER PLANT
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2018 LANDFILL CELL AREA

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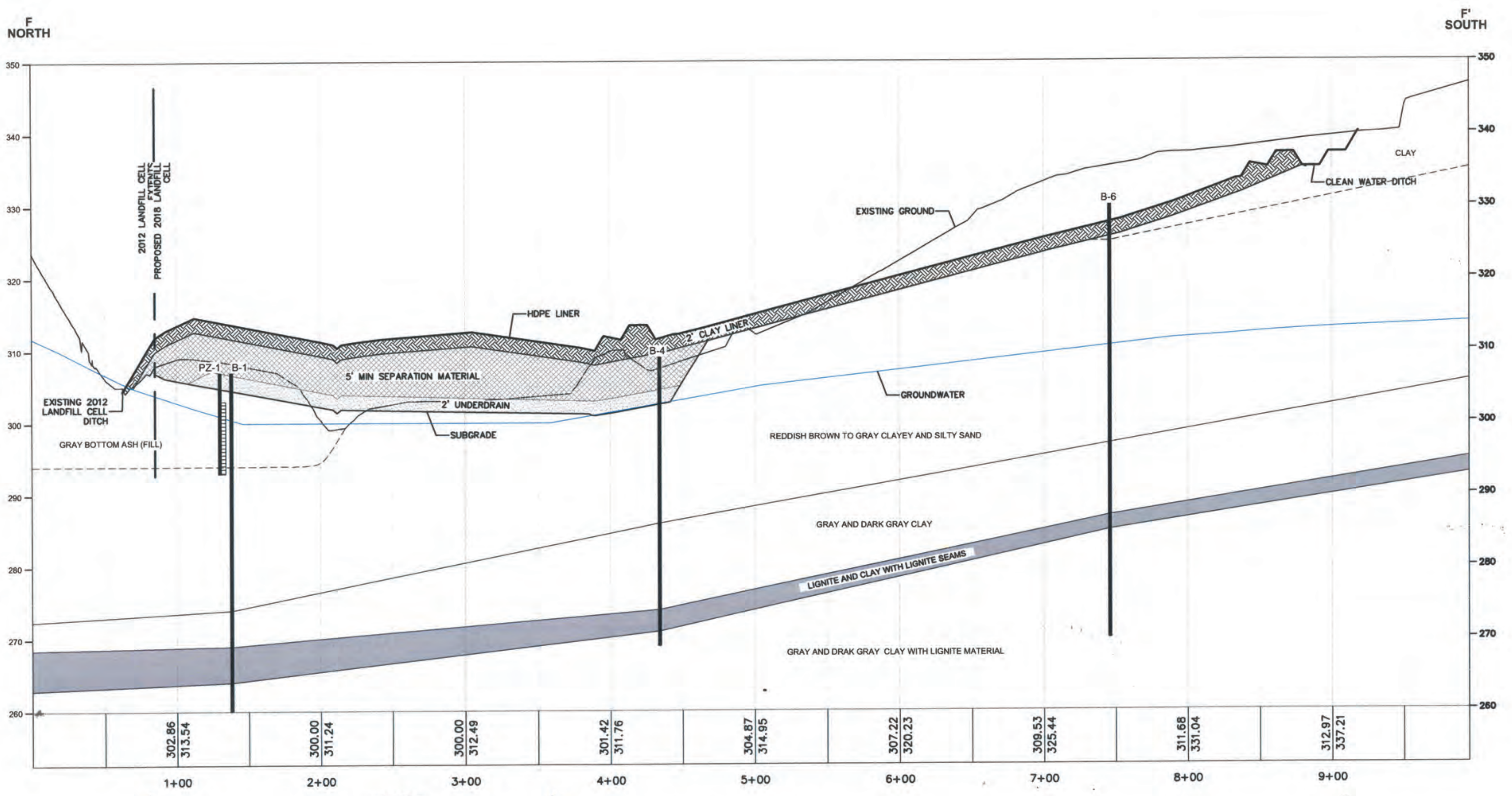
FIGURE
11

Document Path: T:_ENV\AEP\Pirkey Plant\MXD\Updated\Figure 11 - Landfill - 2018 Cell Expansion.mxd



HORIZONTAL SCALE 1" = 80'
VERTICAL SCALE 1" = 8'

0 80' 80'
GRAPHIC SCALE

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NOTES:
1. MODIFIED FROM AKRON CONSULTING, LLC FIGURE TITLED "2018 LF EXPANSION CROSS SECTIONS A & B, DRAWING NO. 1-3494".
2. MONITORING WELLS, SOIL BORINGS, AND GEOLOGIC DESCRIPTIONS WERE ADDED BY ARCADIS TO ORIGINAL SOURCE FILE. THEY ARE PROJECTED ONTO THE SECTION LINE. THEREFORE, STRATIGRAPHIC INTERPRETATIONS ARE CONSIDERED APPROXIMATE.
3. THE GROUNDWATER ELEVATION PROFILE IS CONSISTENT WITH GROUNDWATER MEASUREMENTS COLLECTED BETWEEN 6/20/2018 AND 7/6/2018.

LEGEND

PZ-1 — SAMPLE IDENTIFICATION
— BORING/WELL
— WELL SCREEN

MATERIAL LEGEND

░	BOTTOM ASH
▩	CLAY LINER
▇	FGD SLUDGE PROTECTIVE CAP
▒	SEPARATION MATERIAL

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION F-F'

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FIGURE
12

C:\Users\bsmith\OneDrive - ARCADIS\BIM360 - OneDrive Sync Location\AUS-AEP-PIRKEY POWER PLANT-HALLSVILLE Texas\2022\01-In Progress\01-DWG\PIRKEY TX CS FIGURES.dwg LAYOUT: FF SAVED: 1/19/2022 5:30 PM ACADVER: 23.1S (LMS TECH) PAGESETUP: --- PLOTSTYLETABLE: PLTHALF.CTB PLOTTED: 1/20/2022 7:10 AM BY: SMITH, BOB
XREFS: IMAGES: PROJECTNAME: ---

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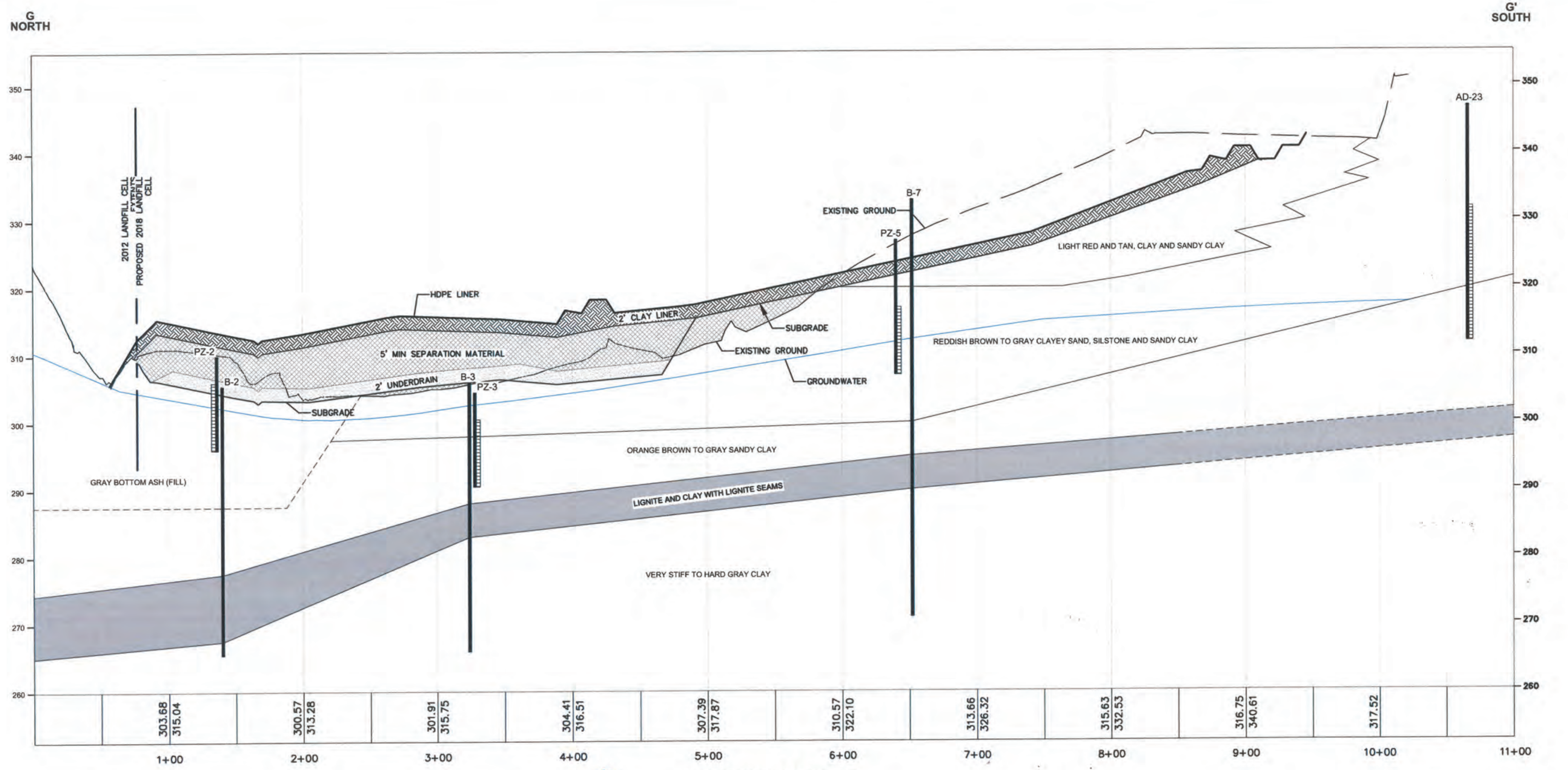
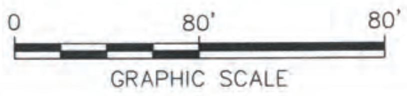
XREFS: IMAGES: PROJECTNAME: ---



HORIZONTAL SCALE 1" = 80'
VERTICAL SCALE 1" = 8'



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NOTES:

1. MODIFIED FROM AKRON CONSULTING, LLC FIGURE TITLED "2018 LF EXPANSION CROSS SECTIONS A & B, DRAWING NO. 1-3494".
2. MONITORING WELLS, SOIL BORINGS, AND GEOLOGIC DESCRIPTIONS WERE ADDED BY ARCADIS TO ORIGINAL SOURCE FILE. THEY ARE PROJECTED ONTO THE SECTION LINE. THEREFORE, STRATIGRAPHIC INTERPRETATIONS ARE CONSIDERED APPROXIMATE.
3. THE GROUNDWATER ELEVATION PROFILE IS CONSISTENT WITH GROUNDWATER MEASUREMENTS COLLECTED BETWEEN 6/20/2018 AND 7/6/2018.

LEGEND

PZ-3 — SAMPLE IDENTIFICATION
BORING/WELL
WELL SCREEN

MATERIAL LEGEND

▨	BOTTOM ASH
▨	CLAY LINER
▨	FGD SLUDGE PROTECTIVE CAP
▨	SEPARATION MATERIAL

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION G-G'

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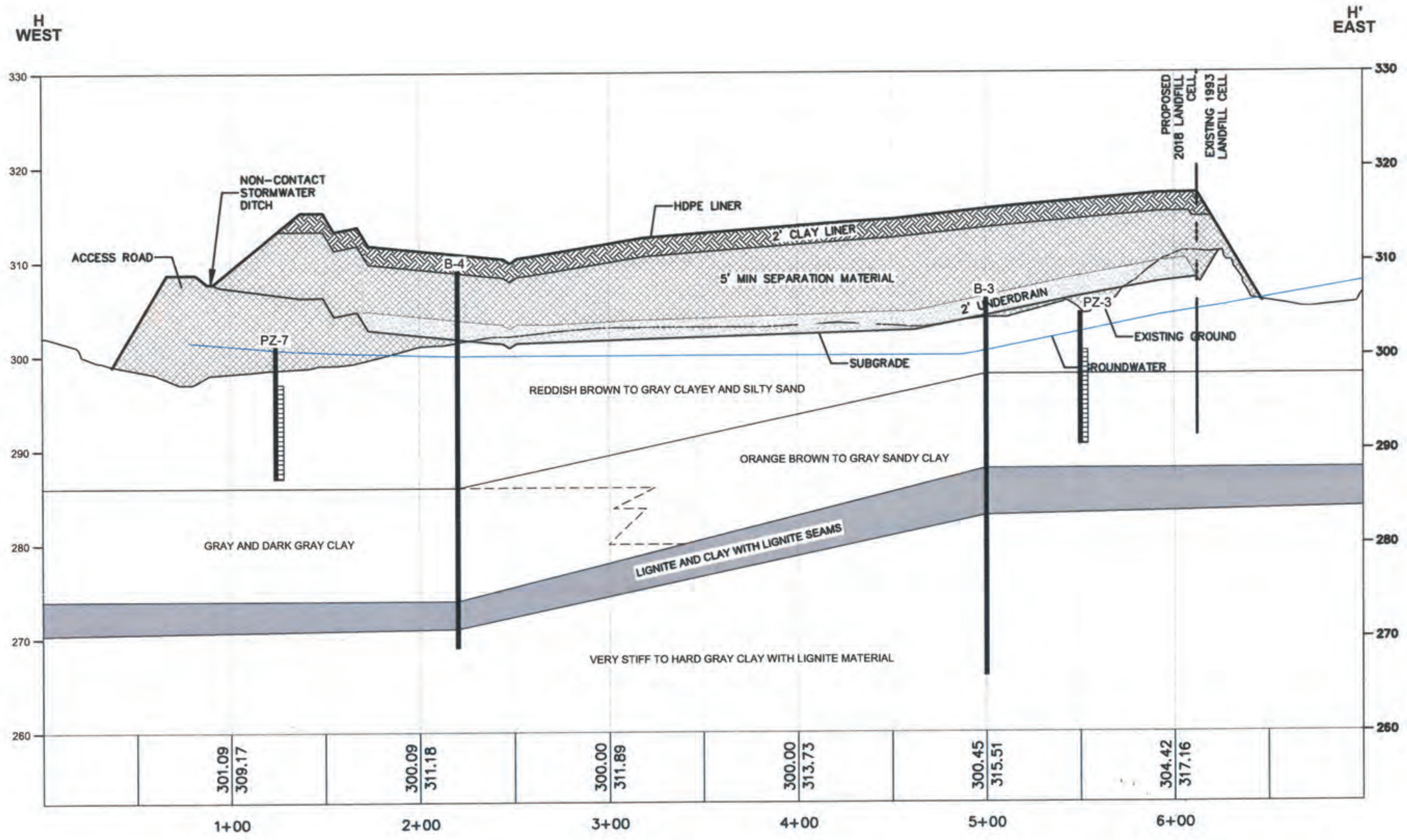
FIGURE
13



HORIZONTAL SCALE 1" = 80'
VERTICAL SCALE 1" = 8'

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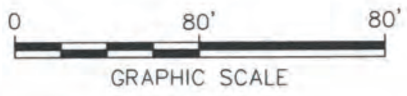

NOTES:
1. MODIFIED FROM AKRON CONSULTING, LLC FIGURE TITLED "2018 LF EXPANSION CROSS SECTIONS C & D, DRAWING NO. 1-3494".
2. MONITORING WELLS, SOIL BORINGS, AND GEOLOGIC DESCRIPTIONS WERE ADDED BY ARCADIS TO ORIGINAL SOURCE FILE. THEY ARE PROJECTED ONTO THE SECTION LINE. THEREFORE, STRATIGRAPHIC INTERPRETATIONS ARE CONSIDERED APPROXIMATE.
3. THE GROUNDWATER ELEVATION PROFILE IS CONSISTENT WITH GROUNDWATER MEASUREMENTS COLLECTED BETWEEN 6/20/2018 AND 7/6/2018.

LEGEND

PZ-7 — SAMPLE IDENTIFICATION
BORING/WELL
WELL SCREEN

MATERIAL LEGEND

░	BOTTOM ASH
▩	CLAY LINER
▬	FGD SLUDGE PROTECTIVE CAP
▨	SEPARATION MATERIAL

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HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION H-H'

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FIGURE
14

C:\Users\bsmith\OneDrive - ARCADIS\BIM360 - OneDrive Sync Location\AUS-AEP-PIRKEY POWER PLANT-HALLSVILLE Texas\2022\01-In Progress\01-DWG\PIRKEY TX CS FIGURES.dwg LAYOUT: HH SAVED: 1/19/2022 5:30 PM ACADVER: 23.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTHALF.CTB PLOTTED: 1/20/2022 7:11 AM BY: SMITH, BOB
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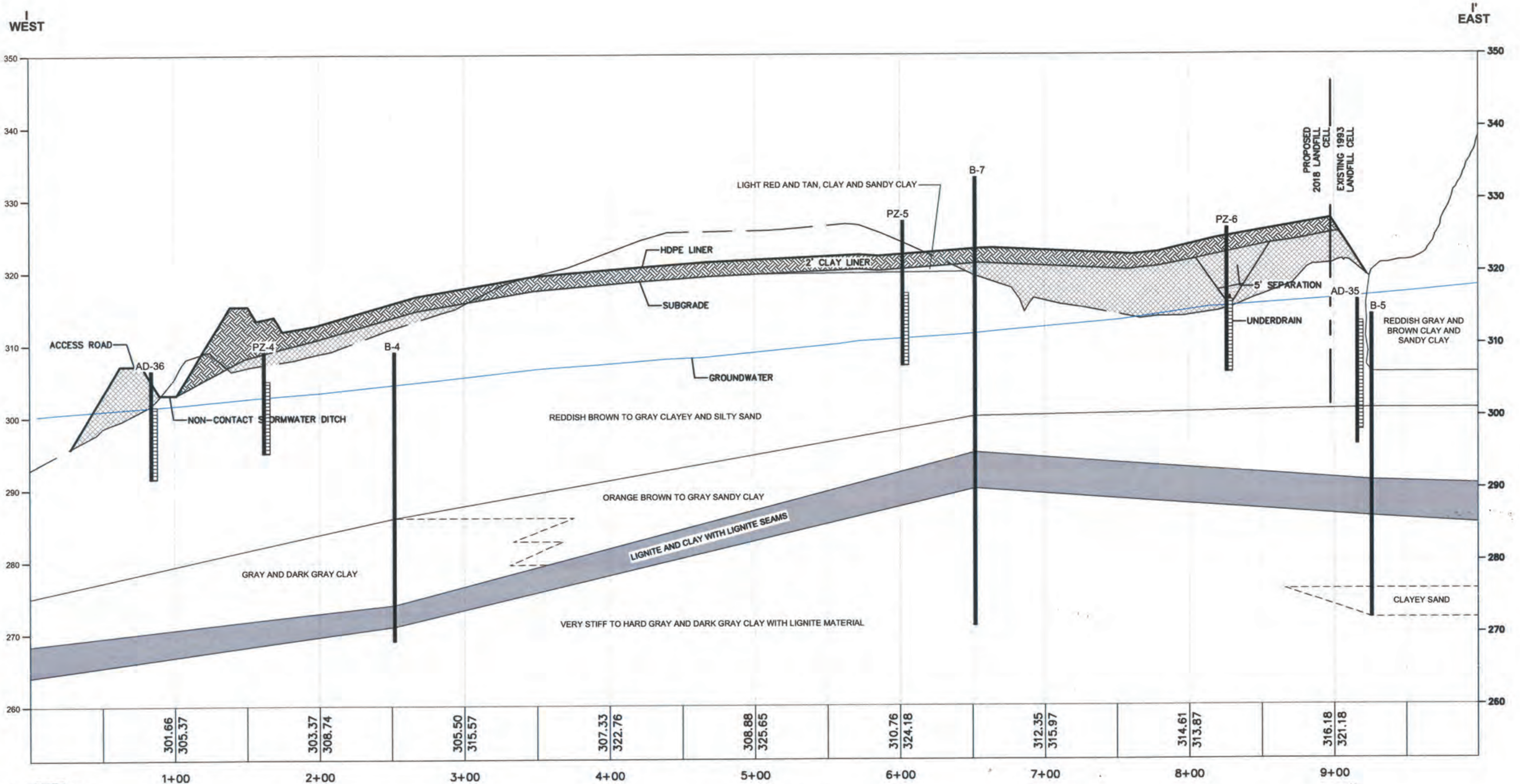

HORIZONTAL SCALE 1" = 80'
VERTICAL SCALE 1" = 8'

0 80' 80'
GRAPHIC SCALE

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1-20-22

NOTES:

1. MODIFIED FROM AKRON CONSULTING, LLC FIGURE TITLED "2018 LF EXPANSION CROSS SECTIONS C & D, DRAWING NO. 1-3494".
2. MONITORING WELLS, SOIL BORINGS, AND GEOLOGIC DESCRIPTIONS WERE ADDED BY ARCADIS TO ORIGINAL SOURCE FILE. THEY ARE PROJECTED ONTO THE SECTION LINE. THEREFORE, STRATIGRAPHIC INTERPRETATIONS ARE CONSIDERED APPROXIMATE.
3. THE GROUNDWATER ELEVATION PROFILE IS CONSISTENT WITH GROUNDWATER MEASUREMENTS COLLECTED BETWEEN 6/20/2018 AND 7/6/2018.

LEGEND

PZ-4 — SAMPLE IDENTIFICATION
— BORING/WELL
— WELL SCREEN

MATERIAL LEGEND

░	BOTTOM ASH
▩	CLAY LINER
▆	FGD SLUDGE PROTECTIVE CAP
▒	SEPARATION MATERIAL

PIRKEY POWER PLANT
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HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION I-I'

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FIGURE
15

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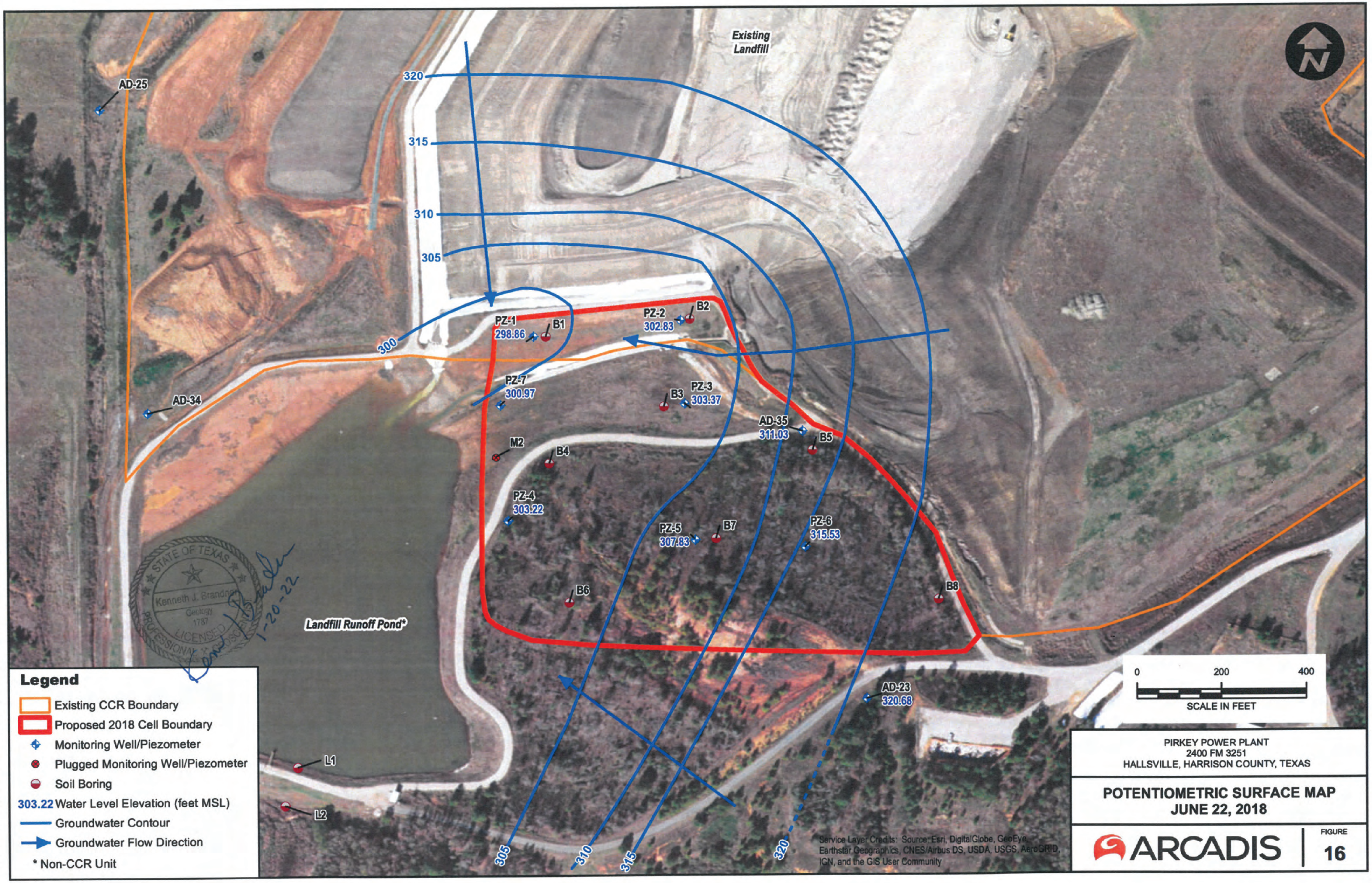

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1-20-22

Legend

🟧 Existing CCR Boundary

🟥 Proposed 2018 Cell Boundary

◆ Monitoring Well/Piezometer

⊗ Plugged Monitoring Well/Piezometer

● Soil Boring

303.22 Water Level Elevation (feet MSL)

— Groundwater Contour

→ Groundwater Flow Direction

* Non-CCR Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

POTENTIOMETRIC SURFACE MAP
JUNE 22, 2018

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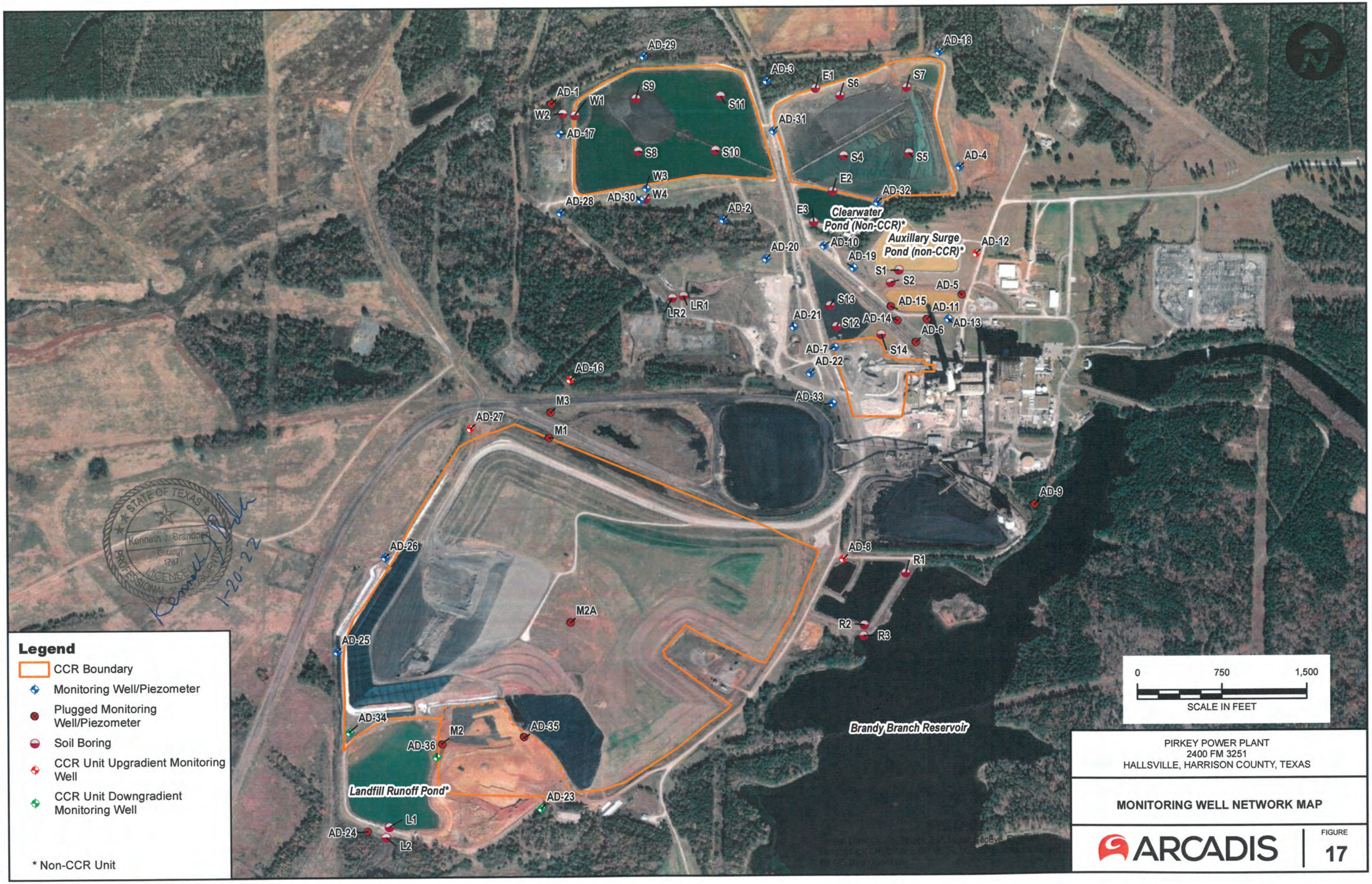
FIGURE
16

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 15 - Potentiometric Surface Map June 22_2018.mxd



Legend

▭ CCR Boundary
◆ Monitoring Well/Piezometer
⊗ Plugged Monitoring Well/Piezometer
● Soil Boring
◆ CCR Unit Upgradient Monitoring Well
◆ CCR Unit Downgradient Monitoring Well

* Non-CCR Unit

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MONITORING WELL NETWORK MAP

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FIGURE
17

Document Path: T:_ENV\AEP\Pirkey Plant\MXD\Updated\Figure 17 - Proposed Well Network - Landfill.mxd

Appendix A

Soil Boring Logs and Piezometers - 2018 Landfill Lateral Expansion Area

Auckland Consulting LLC

LOG OF BORING B1

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/07/2016

GPS Coordinates: N32° 27' 12.0" W94° 29' 48.6"
Surface Elevation: N/A
Drilling Method: HSA

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0	☒	🟩	Medium Stiff, red, brown and gray, Sandy Lean Clay (CL), mottled, few gravel	8			52	16	39	13	26	
	5	■	🟥	Gray, Bottom Ash		N/A			15				64
		☒	🟥		13								
▼	10	☒	🟥		6								
	15	☒	🟨	Very Loose, brown, gray and red, Silty Clayey Sand (SC-SM), mottled, with organics (roots)	3			49	24	22	16	6	
	20	☒	🟨	- red, tan and gray at 18 ft	1								
	25	☒	🟨	Very Loose, light gray, red and tan, Silty Sand (SM), mottled	1			36	19	NP	NP	NP	
		■	🟨			N/A							
	30	☒	🟨	- loose, few clay below 28 ft	10			31	19				
	35	☒	🟩	Very Stiff, dark gray and gray, Sandy Lean Clay (CL)	24			55	21	29	13	16	
	40	☒	⬛	Black, Lignite	50/2								
	45	☒	🟩	Hard, dark gray and gray, Lean Clay (CL), laminated, few lignitic material	61								
		■	🟩			4.5		97	20	38	20	18	105
	50			Boring terminated at 47 feet.									

Additional Information/Comments:

Logger: D. Diduch

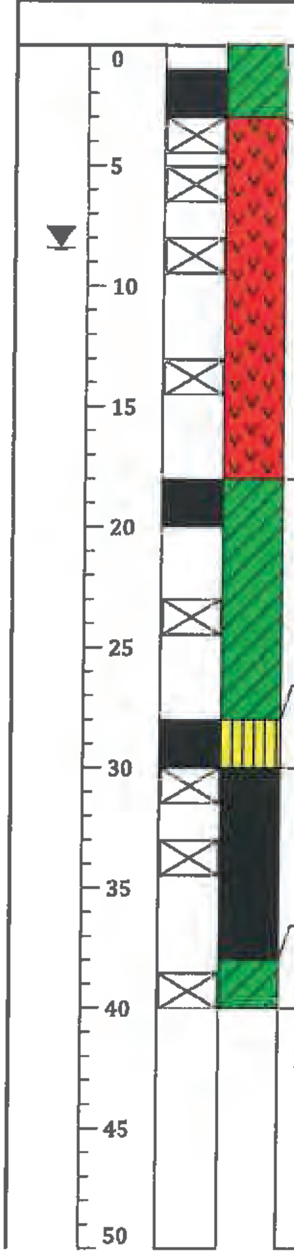
Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 8 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B2

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/06/2016

GPS Coordinates: N32° 27' 12.3" W94° 29' 45.3"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Very Stiff, red and brown, Sandy Lean Clay (CL), mottled, few gravel		2.5		57	18	30	12	18	
Gray, Bottom Ash	4								
	3								
	1								
	2								
Soft, dark gray, Sandy Lean Clay (CL)		0.5		62	20	34	13	21	91
- very soft below 23 ft	1								
Very Stiff, dark gray and gray, Sandy Silty Clay (CL-ML), with lignitic material		3.0		50	15	20	16	4	117
Black, Lignite	50/3								
	50/3								
Hard, gray and dark gray, Lean Clay (CL), laminated, trace gypsum	44			95	22	38	17	21	
Boring terminated at 40 feet.									

Additional Information/Comments:

Logger: D. Diduch
Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 8 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

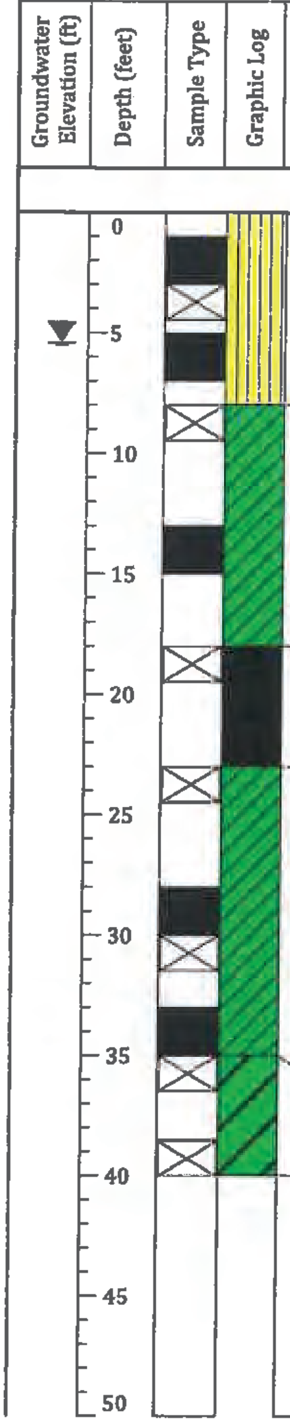
LOG OF BORING B3

Project Name:	Pirkey - 2019 Landfill Expansion		
Project Location:	Hallsville, Texas	Project No.:	2016-011
Drilling Contractor:	C&S Lease	Drill Date(s):	09/08/2016

GPS Coordinates: N32° 27' 10.3" W94° 29' 45.9"

Surface Elevation: N/A

Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Soft, brown, tan and red, Sandy Silty Clay (CL-ML), mottled, with few organics		N/A							
	4			53	19	20	15	5	
		N/A							
Very Stiff, brown and gray, Lean Clay with Sand (CL), mottled, laminated	24			77	19	29	17	12	
- stiff below 13 ft		1.5		75	22	31	17	14	103
Black, Lignite	50/3.75								
Hard, gray, Lean Clay (CL), mottled, laminated, few lignitic material	55								
- very stiff between 28 ft and 30 ft		2.5		99	17	38	18	20	117
- hard below 30 ft	33								
- attempted, no recovery		N/A							
Very Stiff, gray, Fat Clay (CH), mottled, laminated, trace gypsum	27			97	23	51	17	34	
	26								
Boring terminated at 40 feet.									

Additional Information/Comments:

Logger: D. Diduch

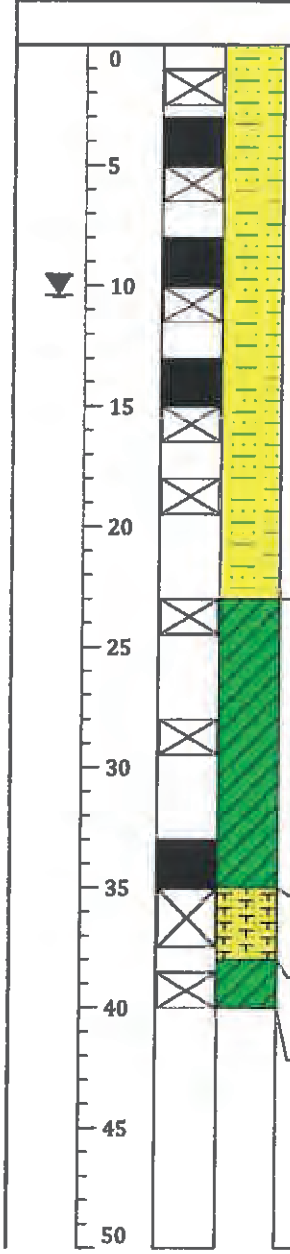
Notes/Comments: Seepage encountered at 5 ft during drilling. Water level at 5 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B4

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/12/2016

GPS Coordinates: N32° 27' 9.0" W94° 29' 48.6"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Very Loose, reddish brown, Clayey Sand (SC), mottled	2								
		3.5		27	14	23	14	9	
- medium dense between 3 ft and 10 ft									
- few gravel below 5 ft	15								
		2.5		49	18	28	13	15	115
- loose between 10 ft and 15 ft	5								
		0.5		49	20	29	15	14	
- medium dense between 15 ft and 18 ft	27								
- very dense below 18 ft	60								
Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	32								
- very stiff at 28 ft	17			88	22	45	16	29	
- attempted, no recovery		N/A							
Very Dense, gray and tan, Silty Sand (SM), with lignitic material	50/2								
Hard, gray, dark gray and black, Lean Clay (CL), mottled, with lignitic material	95/11								
Boring terminated at 40 feet.									

Additional Information/Comments:

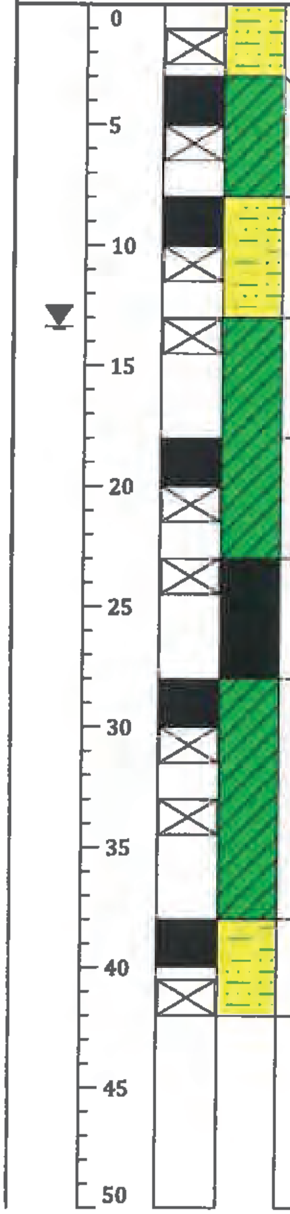
Logger: D. Diduch
Notes/Comments: Seepage encountered at 10 ft during drilling. Water level at 10 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B5

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/09/2016

GPS Coordinates: N32° 27' 9.2" W94° 29' 42.4"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Loose, reddish brown, Clayey Sand (SC), mottled	8								
Very Stiff, red and brown, Sandy Lean Clay (CL), mottled, few gravel	19	4.0	6.6	51	16	34	14	20	116
Dense, red, tan and brown, Clayey Sand (SC), mottled	34	4.0		40	20				
Very Stiff, gray and tan, Lean Clay (CL), mottled, laminated	17			96	21	41	16	25	
Very Stiff, gray and dark gray, Lean Clay with Sand (CL), mottled	38	3.0		55	18	29	17	12	
Black, Lignite	50/6								
Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	39	4.0		99	21				
- very stiff at 33 ft	24								
Medium Dense, gray and dark gray, Clayey Sand (SC)	27	2.5		45	27	36	16	20	
Boring terminated at 42 feet.									

Additional Information/Comments:

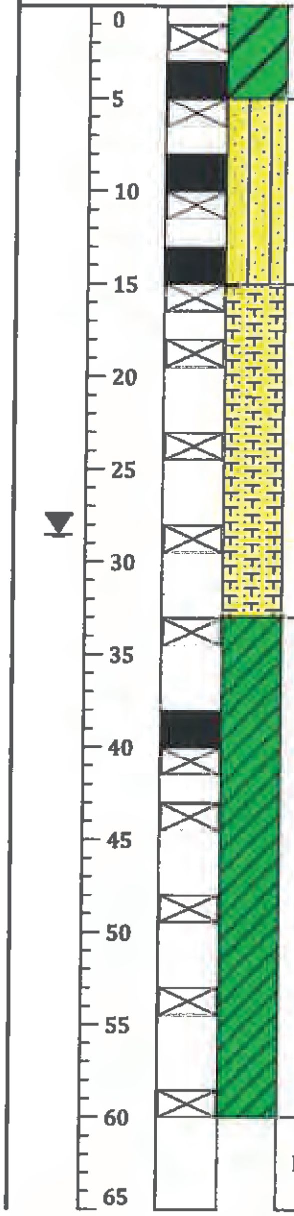
Logger: D. Diduch
Notes/Comments: Seepage encountered at 13 ft during drilling. Water level at 13 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B6

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/16/2016

GPS Coordinates: N32° 27' 5.7" W94° 29' 48.0"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Very Stiff, red and brown, Sandy Fat Clay (CH), mottled	17	4.5		55	19	61	25	36	
Medium Dense, light red, tan and brown, Silty Clayey Sand (SC-SM), mottled	28	3.5		48	11				
- tan, light red and gray below 8 ft, with few gravel between 8 ft and 10 ft	19	2.5		33	12	19	15	4	
Very Dense, tan, light red and gray, Silty Sand (SM), mottled	88/10								
- dense between 18 ft and 23 ft	42								
- medium dense between 23 ft and 28 ft	28								
- very dense below 28 ft	85/11			17	22	NP	NP	NP	
Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	72								
- little recovery, few sand between 38 ft and 40 ft	48	N/A		97	22	42	17	25	
- gray, dark gray and black, with lignitic material, laminated between 43 ft and 45 ft	50/3								
	40								
	60								
	40			98	19	42	17	25	
Boring terminated at 60 feet.									

Additional Information/Comments:

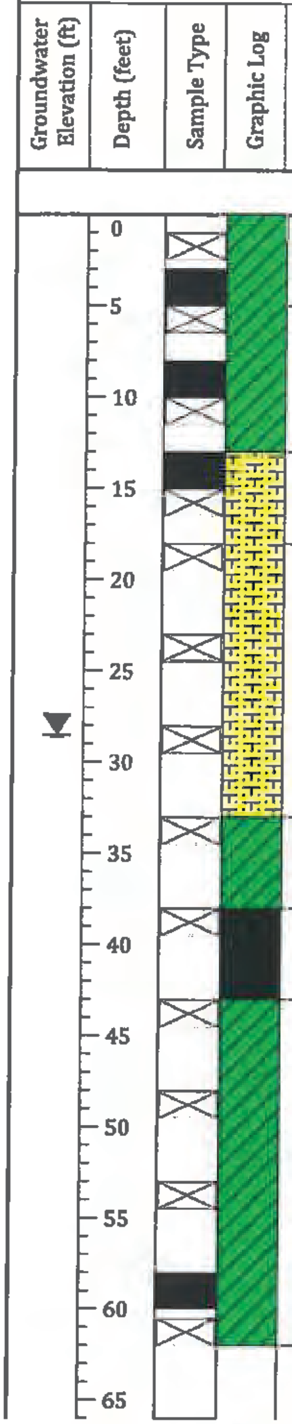
Logger: D. Diduch
Notes/Comments: Seepage encountered at 28 ft during drilling. Water level at 28 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B7

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/14/2016

GPS Coordinates: N32° 27' 7.1" W94° 29' 44.6"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Stiff, light red and tan, Sandy Lean Clay (CL), mottled	13			51	19				
		N/A							
Very Stiff, light tan, red and brown, Lean Clay (CL), mottled	20			85	17	29	14	15	
		N/A							
	21								
Very Dense, light gray, Silty Sand (SM)		N/A							
	87/10			45	10	NP	NP	NP	
Very Dense, red, brown and gray, Silty Sand (SM)	60								
	84/11			18	21				
	50/2								
Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	40								
Black, Lignite	50/5								
Hard, dark gray, Lean Clay (CL), mottled, laminated, trace gypsum	81								
	64								
	35			95	18	43	17	26	
- attempted, no recovery		N/A							
	77								
Boring terminated at 62 feet.									

Additional Information/Comments:

Logger: D. Diduch

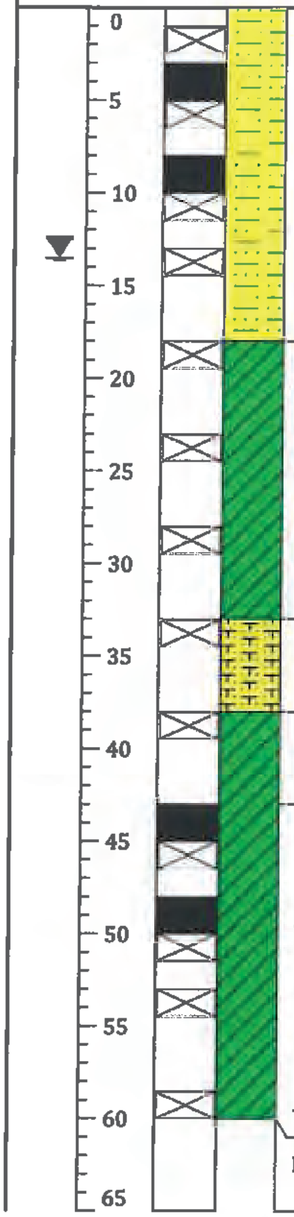
Notes/Comments: Seepage encountered at 28 ft during drilling. Water level at 28 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B8

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/13/2016

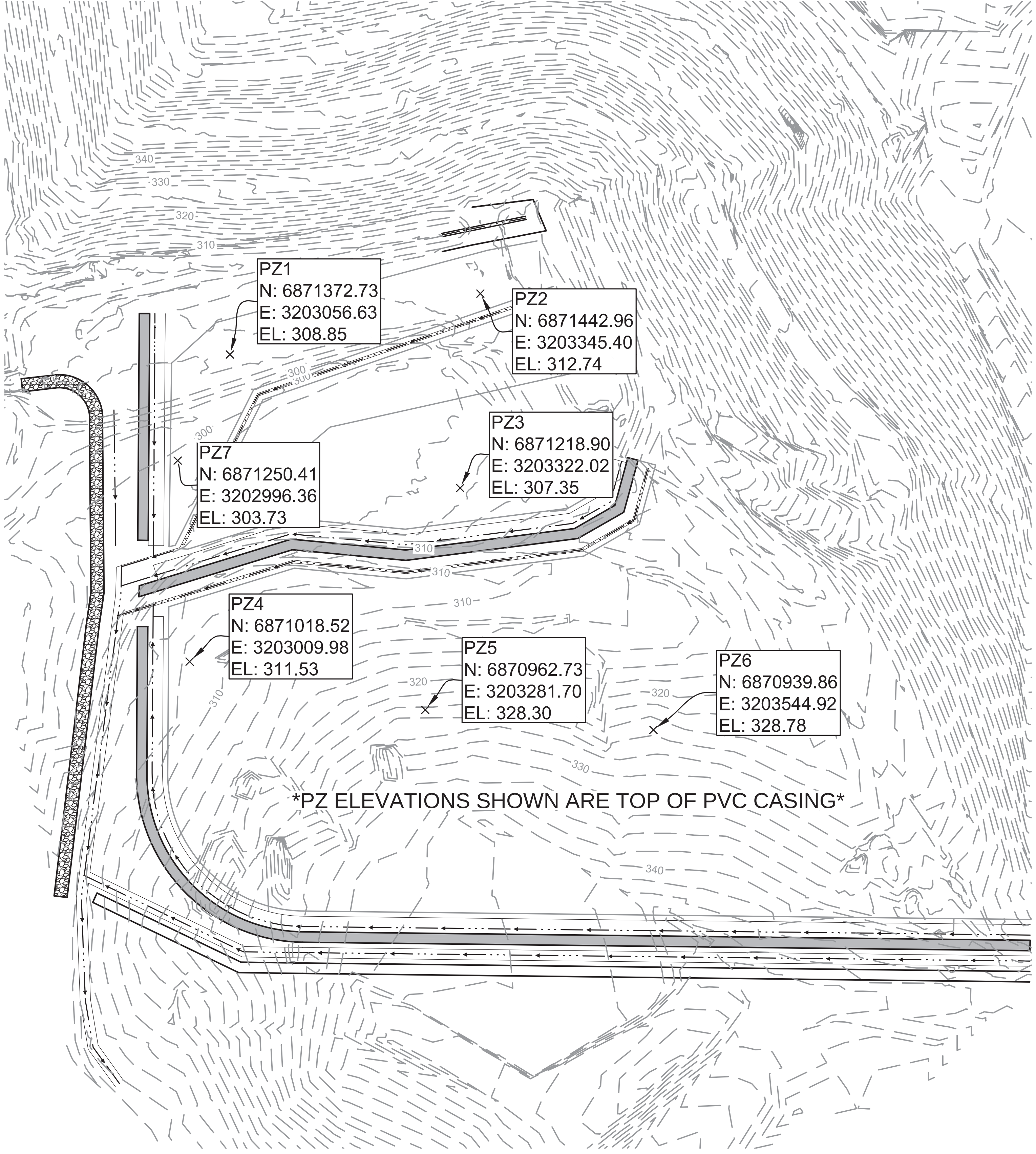
GPS Coordinates: N32° 27' 5.7" W94° 29' 39.6"
Surface Elevation: N/A
Drilling Method: HSA



Groundwater Elevation (ft)	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	Loose, red, tan, and brown, Clayey Sand (SC)	6								
			2.0		39	13	19	12	7	
		7								
	- medium dense, light gray, red and tan below 8 ft		N/A							
		18			37	23				
▼		15								
	Very Stiff, gray and brown, Lean Clay (CL), mottled, laminated	22			91	25	42	16	26	
	- hard below 23 ft	79								
		79/11								
	Very Dense, dark gray, Silty Sand (SM)	76/11			43	30	NP	NP	NP	
	Very Stiff, gray and dark gray, Lean Clay (CL), mottled, laminated	21			97	23				
	Stiff, gray and dark gray, Sandy Lean Clay (CL), mottled, with occasional lignitic seams		1.5		59	25	33	18	15	93
		22								
	- attempted, no recovery		N/A							
		16			48	30				
		22								
	- laminated at 58 ft	29			62	25	44	21	23	
	Boring terminated at 60 feet.									

Additional Information/Comments:

Logger: D. Diduch
Notes/Comments: Seepage encountered at 13 ft during drilling. Water level at 13 feet upon completion.
N/A: Not Attempted



PZ1
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E: 3203056.63
EL: 308.85

PZ2
N: 6871442.96
E: 3203345.40
EL: 312.74

PZ3
N: 6871218.90
E: 3203322.02
EL: 307.35

PZ7
N: 6871250.41
E: 3202996.36
EL: 303.73

PZ4
N: 6871018.52
E: 3203009.98
EL: 311.53

PZ5
N: 6870962.73
E: 3203281.70
EL: 328.30

PZ6
N: 6870939.86
E: 3203544.92
EL: 328.78

PZ ELEVATIONS SHOWN ARE TOP OF PVC CASING

AKRON CONSULTING, LLC.
431 N. CENTER ST.
LONGVIEW, TX 75601
TBPE Firm Reg. # 14014
(O) 903-236-9744
(F) 903-236-9745
www.akron-consulting.com

0 150' 300'
1"=150'

N

PZ WELL
AS-BUILT
LOCATIONS

STATE OF TEXAS WELL REPORT for Tracking #482280

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-1**
Address:	**502 N. Allen Strreet** **Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road** **Hallsville, TX 75650**	Latitude:	**32° 27' 11.79" N**
		Longitude:	**094° 29' 48.1" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/14/2018**

Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482283

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-2**
Address:	**502 N. Allen Strreet** **Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road** **Hallsville, TX 75650**	Latitude:	**32° 27' 12.36" N**
		Longitude:	**094° 29' 44.64" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/14/2018** Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482286

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-3**
Address:	**502 N. Allen Strrreet Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 10.18" N**
		Longitude:	**094° 29' 45.15" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/14/2018** Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482290

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-4**
Address:	**502 N. Allen Strreet** **Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road** **Hallsville, TX 75650**	Latitude:	**32° 27' 08.3" N**
		Longitude:	**094° 29' 48.73" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/15/2018** Drilling End Date: **6/15/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **Michael Aaron Dodson**

Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**4**	**14**

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Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482295

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-5**
Address:	**502 N. Allen Strrreet** **Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road** **Hallsville, TX 75650**	Latitude:	**32° 27' 07.7" N**
		Longitude:	**094° 29' 45.72" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/15/2018**

Drilling End Date: **6/15/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**20**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**20**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**8**	**Bentonite 4 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Sandy Clay**
5	**10**	**Very Soft Red/Brown Clay**
10	**15**	**Very Soft Red/Tan Sandy Clay**
15	**20**	**Tan/Red Silty Sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**10**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**10**	**20**

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STATE OF TEXAS WELL REPORT for Tracking #482297

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-6**
Address:	**502 N. Allen Strrreet Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 07.69" N**
		Longitude:	**094° 29' 42.56" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/15/2018** Drilling End Date: **6/15/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**20**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**20**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**8**	**Bentonite 4 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **Michael Aaron Dodson**

Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**5**	**Red Soft Sandy Clay**
5	**10**	**Very Soft Red/Brown Clay**
10	**15**	**Very Soft Red/Tan Sandy Clay**
15	**20**	**Tan/Red Silty Sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**10**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**10**	**20**

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STATE OF TEXAS WELL REPORT for Tracking #482288

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-7**
Address:	**502 N. Allen Strrreet Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 10.81" N**
		Longitude:	**094° 29' 48.7" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/14/2018**

Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**4**	**14**

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Appendix B

Boring/Well Construction Logs

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

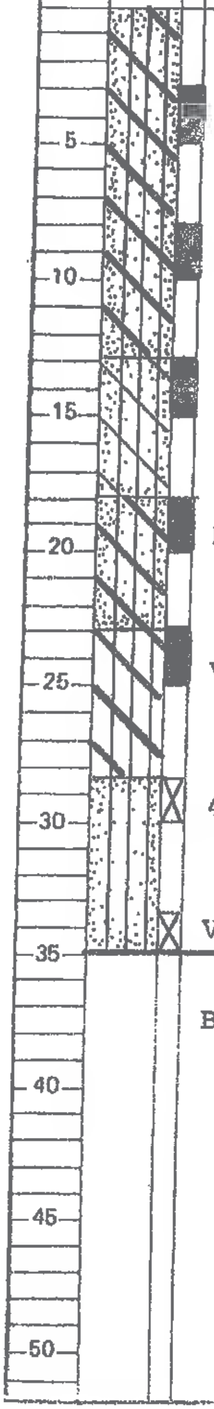
BORING NO.: MW-8
LOCATION: Hallsville

Date: 10-4-83
Type: Auger
Ground Elevation:

Legend:

■ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff tan silty sandy clay w/iron ore

Stiff tan and grey silty sandy clay w/iron ore

Firm tan and grey clayey silty sand

Medium tan and grey very silty sandy clay w/iron ore

Very stiff grey silty clay lenses

43-7=5½" 50 B/5½"

Very dense tan and grey silty sand 50 B/5½"

Bottom of boring at 35 feet.

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ______ ■ MONITOR WELL MONITOR WELL NUMBER: AD-16

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/30/2010

PREPARED BY: Jeff Sammons LOGGED BY: Matt Lyon/Jeff Sammons

LATTITUDE: N 32°27.680' Datum: WGS-84 WELL LOCATION: North of Mine Haul Road
LONGITUDE: W94°29.642'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS		USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
								
1 2				0-2	SM	Silty sand, very fine grained, light brown	None	Dry
3 4 5 6 7 8				2-8	CL	Sandy clay, yellowish brown, reddish brown -some iron oxide concretions at 2.5' -light gray at 5'	None	Dry
9 10				8-10	CL	Clay, red, light yellowish brown, gray, fat, hard, some very fine laminated sand seams	None	Dry
11				10-11	CL	Sandy clay, red, light gray, yellowish brown, stiff to hard	None	Dry
12 13 14				11-14.25	CL	Clay, yellowish brown, some sand, reddish brown, light gray, hard -clayey sand seam at 14-14.25', yellowish brown, light gray	None	Dry Moist
15 16 17 18				14.25-18	CL	Sandy clay, red, light gray, gray, very thin sand lenses interbedded in clay	None	Moist to V. Moist
19 20 21 22 23 24 25 26 27 28 29 30 31 32			▽	18-29.5	CL	Clay, reddish gray, light gray, yellowish brown, hard, gray -2" reddish brown iron oxide cemented sand laminations at 19.75' -very moist, 1" gravelly sand lense, very fine gypsum crystals at 21' -sandy 22', 22.5', 24' -gray, yellowish brown at 24-24.5' - dark gray, very fine gypsum crystals, trace sand, hard, dry, at 25'	None	Moist V. Moist Dry
33 34 35				32-35	SC	Clayey sand, greenish gray, light gray, some very fine gypsum crystals, dense	None	Moist
36 37 38 39 40						Boring Terminated at 35'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 35 feet
Filter Sand (Size/Interval): 13-35'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-15'
Screen Interval: 15-35'
Water level: 23.37'
Above Ground 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-23

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

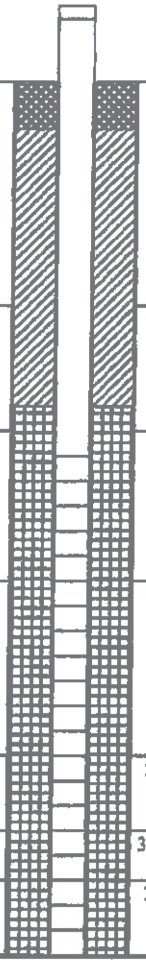
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/15/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 **WELL LOCATION:**
LONGITUDE: W94°29'41.3"



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1 2 3 4 5 6 7 8 9			0-9	SC	Clayey sand, brown, with yellowish brown and orangish brown laminations, very fine grained, very silty, few light gray clay streaks	None	Moist
10 11 12 13 14			9-14	ML	Siltstone with light gray clay streaks, light gray with orangish brown streaks, few small iron ore pebbles	None	Moist
15 16 17 18 19 20			14-20	SM	Sand, light gray with orangish brown streaks, very silty, very fine grained, few clay laminations	None	Slightly Moist
21 22 23 24 25 26 27			20-27	ML	Siltstone, light gray with orangish brown streaks	None None	Very Moist V. Moist
28 29 30			27-30.5	SM	Sand, light brown mottled with orangish brown, very fine grained, very silty	None	Wet
31 32			▽ 30.5-31.5	SC	Slightly sandy clay, orangish brown mottle with orangish brown, silty, very fine grained (30-31.5')	None	Moist
33 34 35			31.5-35	CL	Lean clay, dense, small sandy streaks, dark gray, very fine grained (31.5-35')	None	Moist
36 37 38 39 40					Boring Terminated at 35'		

▩ Cement ▨ Bentonite ▦ Filter Sand Water Level

Apex geoscience inc.

Total Depth: 35 feet Riser Interval: +3 (ags)-15'
Filter Sand (Size/Interval): 13-35' Screen Interval: 15-35'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13' Water level: 30.83
Surface Completion Flush ■ Above Ground 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089
☐ **BORING** **BORING NUMBER:**
■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-24

FACILITY NAME: AEP- Pirkey Power Plant
FACILITY ID NO.: N/A

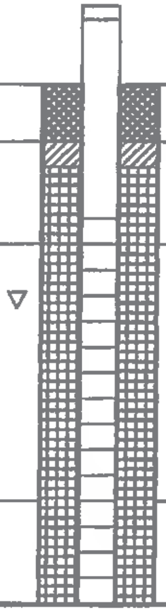
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.
COMPLETION DATE: 12/27/2010

PREPARED BY: Jeff Sammons
LOGGED BY: Jeff Sammons

LATTITUDE: N 32°27.024' Datum: WGS-84
LONGITUDE: W94°29.940'
WELL LOCATION: South of LF pond dam



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-1.5	SM	Silty sand, very fine grained, some clay, brown and reddish	None	Moist
2					brown, medium dense		
3			1.5-6.5	SC	Clayey sand, silty, gray, yellowish brown, reddish brown,	None	Dry
4					very fine grained, dense		
5					-some iron oxide concretions and gravel at 5-6', trace organic		Moist
6					matter at 6', gray, dark gray, reddish brown, loose to med. dense		
7			6.5-16	SM	Silty sand, very fine grained, red, loose, trace clay	None	Saturated
8							
9			▽				
10					-some gravel at 10'		
11					-hard cemented sandstone with iron oxide at 11'		
12							
13							
14							
15					- some clay at 15-16', medium dense, gray, dark gray		Moist
16							
17			16-20	Lignite	Lignite, black, loose, saturated at 16-17'	None	Saturated
18					- medium dense, moist at 17-20'		
19							
20							
21							
22					Boring Terminated @ 20'		
23							
24							
25							
26							
27							
28							
29							
30							

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex
geoscience inc.

Total Depth: 20 feet
Filter Sand (Size/Interval): 3-20'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-3'
Surface Completion ☐ Flush ■ Above Ground 3'

Riser Interval: +3 (ags)-5'
Screen Interval: 5-20'
Water level: 8.4

Note: This log is not to be used separate from this report.

Boring Logs_110-089, AD-24

APEX PROJECT NO.: 110-089

☐ **BORING** **BORING NUMBER:**

■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-25

FACILITY NAME: AEP- Pirkey Power Plant

FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.

COMPLETION DATE: 12/14/2010

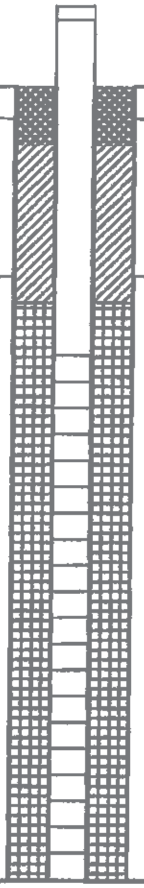
PREPARED BY: David Bedford

LOGGED BY: David Bedford

LATTITUDE: N 32°27'17.2" Datum: WGS-84

LONGITUDE: W94°29'59.1"

WELL LOCATION: S. of Diesel ASTs



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-1.5	SC	Clayey sand, brown, silty, very fine grained, moist	None	Moist
2			1.5-7	CH	Fat sandy clay, orangish brown, very fine grained, moist	None	Moist
3							
4							
5							
6							
7							
8			7-30	SC	Clayey sand, orangish brown mottled with dark gray,	None	Moist
9					very fine grained, few light gray clay inclusions		
10							
11							
12							
13							
14			▽		Wet @ 14'		Wet
15							
16					15-20' - few pieces of dark gray cystalline rock		
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
31							
32					Boring Terminated at 30'		
33							
34							
35							

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex
geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground 3'

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 12.69'

Note: This log is not to be used separate from this report.

Boring Logs_110-089, AD-25

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ☒ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-26

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

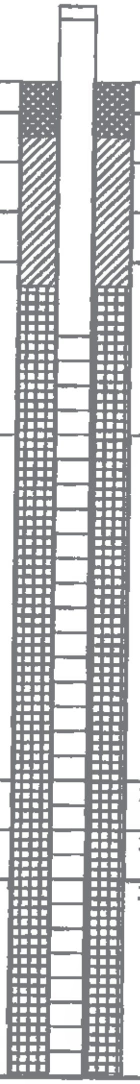
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/14/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'25.3" Datum: WGS-84 **WELL LOCATION:** By silt fence and plastic lined trench
LONGITUDE: W94°29'54.8"



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-1	SC	Slightly clayey sand, light brown, very fine grained, silty	None	Moist
2			1-3	CL	Sandy clay, lean, very fine grained, reddish brown	None	Moist
3							
4			3-5	CL	Lean, slightly sandy clay with clayey sand streaks, orangish	None	Moist
5					brown, small coal pieces, very fine grained		
6			5-7	SC	Clayey sand, orangish brown, very fine grained, brown clay	None	Moist
7					inclusions		
8			7-14	CL	Lean clay, orangish brown mottled with brown/light gray clayey	None	Moist
9					sand streaks, very fine grained, few coal pieces		
10							
11							
12							
13							
14							
15			14-28	SC	Clayey sand, dark brown with orangish brown streaks,	None	Slightly Wet
16					very fine grained, coal pieces		
17							
18							
19							
20			▽				Wet
21					20-22' - Large clay inclusions, brown		
22							Very Moist
23							
24							
25							
26					Wet from 25-26'		
27							
28							
29			28-30	CL	Lean clay, light gray with orangish brown streaks, few small	None	V. Moist
30					sandy streaks, very fine grained		
31			30-32	SC	Clayey sand, light black, very fine grained, small pieces mica	None	Wet
32					Wet from 30-30.5'		Moist
33			32-40	CL	Lean clay, orangish brown, small clayey sand streaks, very	None	Moist
34					fine grained, brown streaks		
35							Slightly Wet
36							
37							
38							
39							
40							
					Boring Terminated at 40'		

▨ Cement ▧ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet
Filter Sand (Size/Interval): 8-40'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ☒ Above Ground 3'

Riser Interval: +3 (ags)-10'
Screen Interval: 10-40'
Water level: 19.45'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089
☐ **BORING** **BORING NUMBER:**
■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-27

FACILITY NAME: AEP- Pirkey Power Plant
FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.
COMPLETION DATE: 12/15/2010

PREPARED BY: David Bedford
LOGGED BY: David Bedford

LATTITUDE: N 32°27'36.8" Datum: WGS-84
LONGITUDE: W94°29'47.3"
WELL LOCATION: By corner lined ditch

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1 2			0-2	SC	Clayey sand, orangish brown with dark gray laminations, very fine grained	None	Slightly Moist
3 4 5 6 7 8 9 10 11 12 13 14 15			2-15.5	CL	Lean clay, dense, few thin sandy streaks, reddish orange, very fine grained, mottled with light brownish gray Orange to brown with orangish brown streaks, at 10' becomes brittle	None	Slightly Moist
16 17 18 19 20 21 22 23			15.5-23	SC	Clayey sand, greenish brown with orangish brown streaks, few thin tan clay streaks, very fine grained	None	Moist
24			23-24	SM	Sand, orangish brown, silty, very fine grained	None	Wet
25 26 27			▽ 24-27	CH	Fat clay, brown with orangish brown streaks, many sandy streaks, very fine grained	None	Very Moist
28 29 30			27-30	SM	Sand, greenish gray with orangish brown streaks, very fine to fine grained, wet	None	Wet
31 32 33 34 35 36 37			30-37.5	SC	Clayey sand with clay streaks, light greenish black, very fine grained Wet red brittle shale from 35-35.2	None	Slightly Wet
38 39 40					Boring Terminated at 37.5'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet
Filter Sand (Size/Interval): 15.5-37.5'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-15.5'
Surface Completion ☐ Flush ■ Above Ground 3'
Riser Interval: +3 (ags)-17.5'
Screen Interval: 17.5-37.5'
Water level: 26.73'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-34**

STATE OF TEXAS
JDS 1-21-16
JEFFREY D. SAMMONS
GEOLOGY
#10070
LICENSED
PROFESSIONAL GEOSCIENTIST

PROJECT INFORMATION

PROJECT: **Pirkey Power Plant**
PROJECT NO.: **I-04-1021**
LOGGED BY: **Jeffrey D. Sammons, P.G.**
SUPERVISING PG: **Jeffrey D. Sammons, P.G.**
COMPLETION: **12/11/2015**
DEVELOPMENT: **12/16/2015**
SITE LOCATION: **2400 FM 3251, Hallsville, Texas**
WELL OWNER: **AEP**

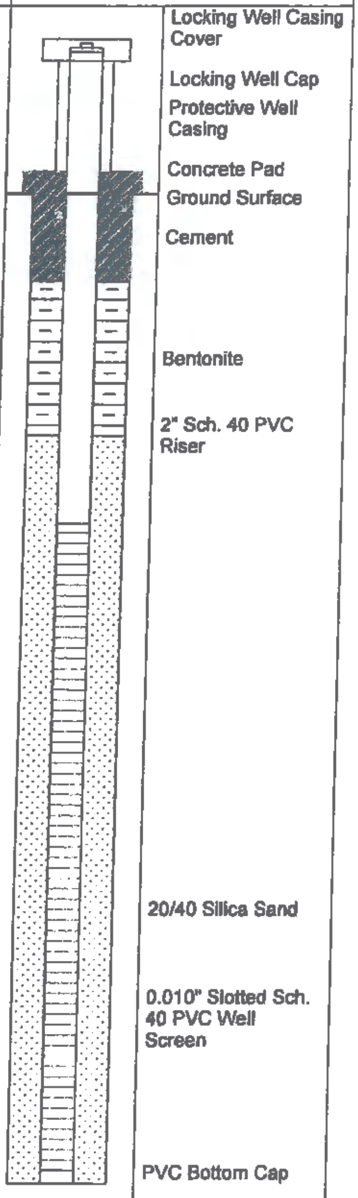
DRILLING INFORMATION

DRILLER: **Buford Collier**
DRILLER'S LICENSE NO.: **50089**
RIG TYPE: **Geoprobe 3230DT**
METHOD OF DRILLING: **Hollow Stem Auger**
SAMPLING METHODS: **Split Core**
SURFACE ELEVATION: **307.61 (Top of Casing)**
HOLE DIAMETER: **8.25"**
LATITUDE **32 27' 10.13"** LONGITUDE **94 29' 57.93"**

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample TBPG No. 50027

DESCRIPTION	USCS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
		-4 to 0	▼ (-3)						
CLAYEY SAND: very fine to fine sand, some silt, reddish brownish, light reddish brown, light gray, moist	SC	0 to 2							
FAT CLAY: trace sand and silt, some iron oxide concretions, dark reddish brown, reddish brown, and and light gray, moist - some silt and very fine to fine sand at 5', light gray, light reddish brown, and light yellowish brown, moist to very moist	CH	2 to 6		■ (3)	31	89	63	23	40
SANDY LEAN CLAY: some very fine to fine sand, dark gray, moist - reddish brown, dark reddish brown, dark gray, light gray at 10' to 12.5'	CL	6 to 12.5	▽ (12.5)	■ (12)	23	64	26	18	8
SILTY SAND: very fine to fine sand, some clay, gray and dark gray, saturated - increasing clay content with depth	SM	12.5 to 19		■ (16)	22	29	25	NP	-
FAT CLAY: trace sand and silt, gray, moist	CH	19 to 21		■ (21)	23	90	55	27	28
CLAYEY SAND: fine to very fine sand, dark gray, moist to very moist	SC	21 to 25							

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-35**

JDS 1-21-16

JEFFREY D. SAMMONS
GEOLOGY
#10070

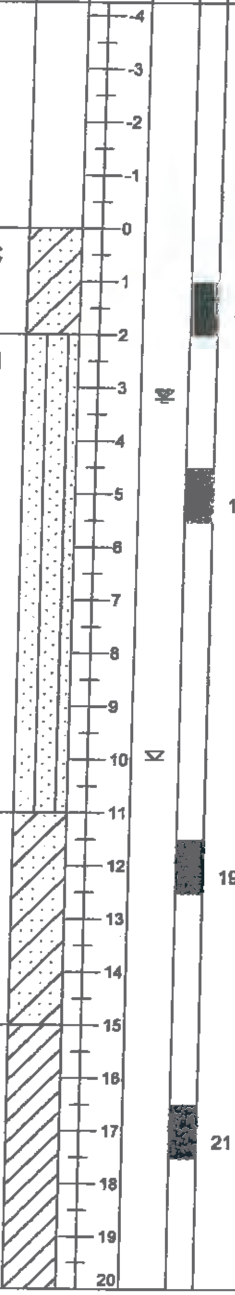
PROJECT INFORMATION

PROJECT: **Pirkey Power Plant**
PROJECT NO.: **I-04-1021**
LOGGED BY: **Jeffrey D. Sammons, P.G.**
SUPERVISING PG: **Jeffrey D. Sammons, P.G.**
COMPLETION: **12/11/2015**
DEVELOPMENT: **12/16/2015**
SITE LOCATION: **2400 FM 3251, Hallsville, Texas**
WELL OWNER: **AEP**

DRILLING INFORMATION

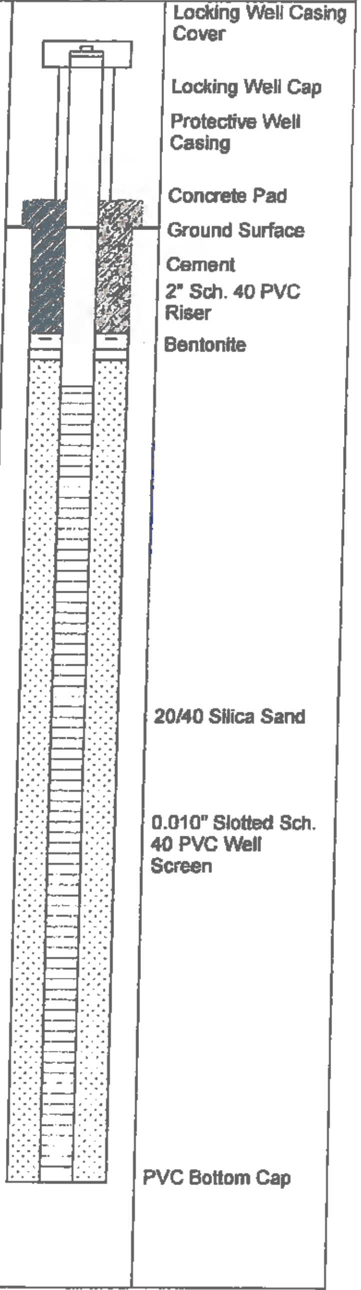
DRILLER: **Buford Collier**
DRILLER'S LICENSE NO.: **50089**
RIG TYPE: **Geoprobe 3230DT**
METHOD OF DRILLING: **Hollow Stem Auger**
SAMPLING METHODS: **Split Core**
SURFACE ELEVATION: **318.95 (Top of Casing)**
HOLE DIAMETER: **8.25"**
LATITUDE **32 27' 9.64"** LONGITUDE **94 29' 42.74"**

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ▨ Geotechnical Lab Sample **TBPG No. 50027**



DESCRIPTION	USCS	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, some iron ore gravel, reddish brownish, dark reddish brown, yellowish brown, gray, moist	SC	13	46	32	15	17
SILTY SAND: very fine to fine sand, trace clay, trace iron ore gravel, light reddish brown, moist, increasing moisture content with depth - saturated at 10' to 11'	SM	12	26	16	NP	
CLAYEY SAND: very fine to fine sand, trace iron ore gravel, light reddish brown, very moist - thin seams of saturated very fine sand with trace of clay at 12.25' to 12.5' - light reddish brown and light gray, moist to very moist at 12.5' to 15'	SC	19	33	31	18	13
LEAN CLAY: intebedded clays and silts with laminations of very fine sand, light gray, gray and light reddish brown, moist to very moist - thin lenses of very moist very fine sand and partially cemented very fine sand at 17.5' and 18', reddish brown	CL	21	93	34	20	14

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

SOIL/WELL BORING LOG

Auckland Consulting LLC

TBPE Firm No. F16721

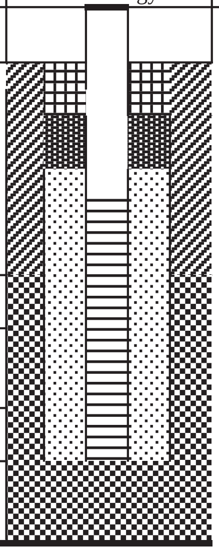
Project:	AEP - Pirkey Power Station Harrison County
Drilling Co.:	C&S Lease
Driller:	Buford E. Collier
Drilling Method:	Hollow Stem Auger

STATE OF TEXAS
JOHN J. TAYNTOR
99202
LICENSED
PROFESSIONAL ENGINEER

04/30/2019

Well/Boring #:	AD-36	Date Drilled:	4/24/19
Depth of Boring/well:	15 feet	Diameter of Boring:	8.25 inches
Length of Screen:	10 feet	Diameter of Screen:	2 inches
Length of Casing:	5 feet	Diameter of Casing:	2 inches
Filter Pack:	20/40	Slot Size:	0.010 inches
Logged By:	John J. Tayntor	Screen Material:	Sch 40 PVC

▦ - Concrete/cement
▨ - Clay
░ - Silty Sand
▩ - Bentonite
▒ - Silty Clay
▩ - Sandy Clay
☰ - Well Screen
⁘ - Sand
▩ - Lignite
‖ - Gravel
▽ - Initial Water Level

Depth Feet	GEOLOGIC DESCRIPTION	Lithology Classification	PID ppm	Depth Feet	Well Completion and Lithology	Remarks
0.0						
5.0	Fill - Reddish Brown, Sandy Lean Clay (CL) with gravel	CL/Fill		0-9		
10.0	Reddish Brown and Tan, Clayey Sand (SC), with gravel	SC		9-11		
	Reddish brown, Sandy Lean Clay (CL), few gravel	CL		11-14		
15.0	Reddish brown, Clayey Sand (SC), with gravel	SC		14-15		
	Well TD = 15 feet.					

*Soil descriptions based on visual observations and intervals are approximate.
MW Location Coordinates: N6871017.4, E3202874.4

STATE OF TEXAS WELL REPORT for Tracking #511623

Owner:	**American Electric Power Company**	Owner Well #:	**AD-36**
Address:	**502 N. Allen Street Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 05.39" N**
		Longitude:	**094° 29' 50.99" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **4/24/2019** Drilling End Date: **4/24/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**15**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
4	**15**	**Sand**	**20/40**

Annular Seal Data: **No Data**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C & S Lease Service**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **David Diduch**

Apprentice Number: **60297**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**9**	**Sandy clay with gravel, mainly fill**
9	**11**	**Clayey sand, mainly Iron ore**
11	**14**	**Sandy clay**
14	**15**	**clayey sand with iron ore**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

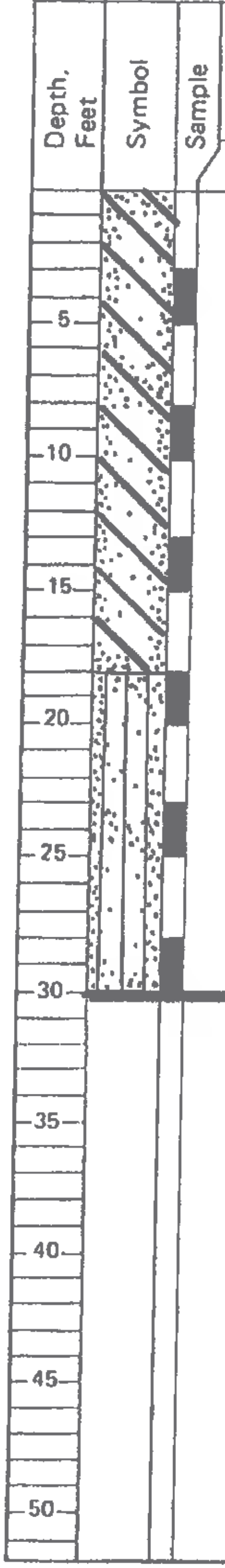
Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

LOG OF BORING

852164
PROJECT: Monitoring Well Instllation
CLIENT: Southwestern Electric Power Company
BORING NO.: M-1
LOCATION: Hallsville, TX
S 12+32.79; W 35+34.55
Date: 1/29/86
Type: Rotary
Ground Elevation: 337.67

Legend:
■ Sample
X Penetration
▼ Water



Description of Stratum

Brown and tan sandy clay

Brown and tan sandy clay w/iron ore

Brown and tan sandy clay w/iron ore

Gray silty sand

Gray silty sand

Gray silty sand

Bottom of Boring at 30 feet.
Water encountered at 10 feet.

LOG OF BORING

852164

PROJECT: Monitoring Well Installation
CLIENT: Southwestern Electric Power Company
BORING NO.: MW-2
LOCATION: Hallsville, TX
S 38+86.22; W 45+76.41
Date: 1/29/86
Type: Rotary
Ground Elevation: 302.19

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet	Description of Stratum
5	Brown silty sand w/iron ore
10	Brown silty sand w/iron ore
15	Brown and gray silty sand
20	Gray silty sand
25	Gray silty sand
30	Bottom of Boring at 27 feet. Water encountered at 11 feet.
35	
40	
45	
50	

SOUTHWESTERN LABORATORIES

LOG OF BORING

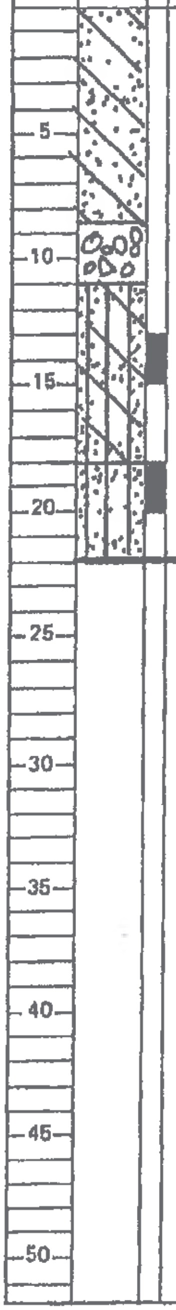
852164
PROJECT: Sludge Disposal Area
CLIENT: Southwestern Electric Power Company
BORING NO.: M. 2A
LOCATION: Hallsville, TX

Date: 6/20/85
Type: Auger
Ground Elevation: 308.40

Legend:
■ Sample
X Penetration
▼ Water

Plant Site Coordinates: South S 27+55.45
West W 36+47.44

Depth, Feet | Symbol | Sample | Description of Stratum



Red-brown clayey sand

Gravel

Gray clayey silty sand

Gray silty sand

Bottom of Boring at 22 feet.
Water encountered at 12 feet.

Bottom of Casing at 22 feet.
Screen length 15 feet.

Log of Boring

Number
M-3

Location
Harrison Co., miles SW Marshall City Ha

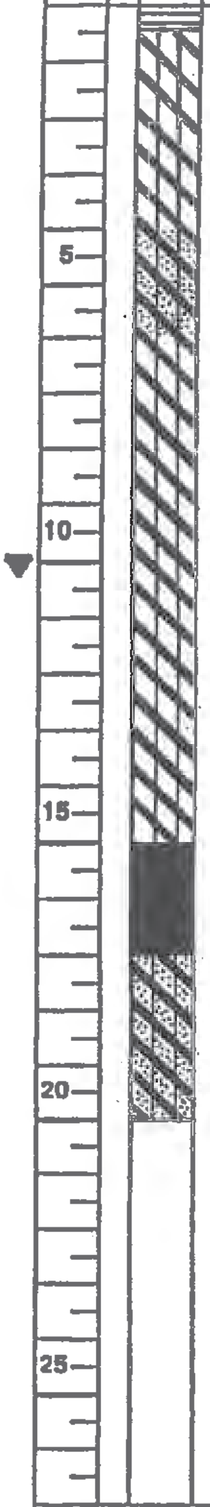
Project
New Monitor Well Installation, H.W. Pirkey Power Plant

Type
Groundwater Monitor Well

Surface Elevation
275.0'

Depth Feet | Samples | Hand Penetrometer (Tons/Sq. Ft.) | Standard Penetration (Blows/Foot)

STRATUM DESCRIPTION



Sod

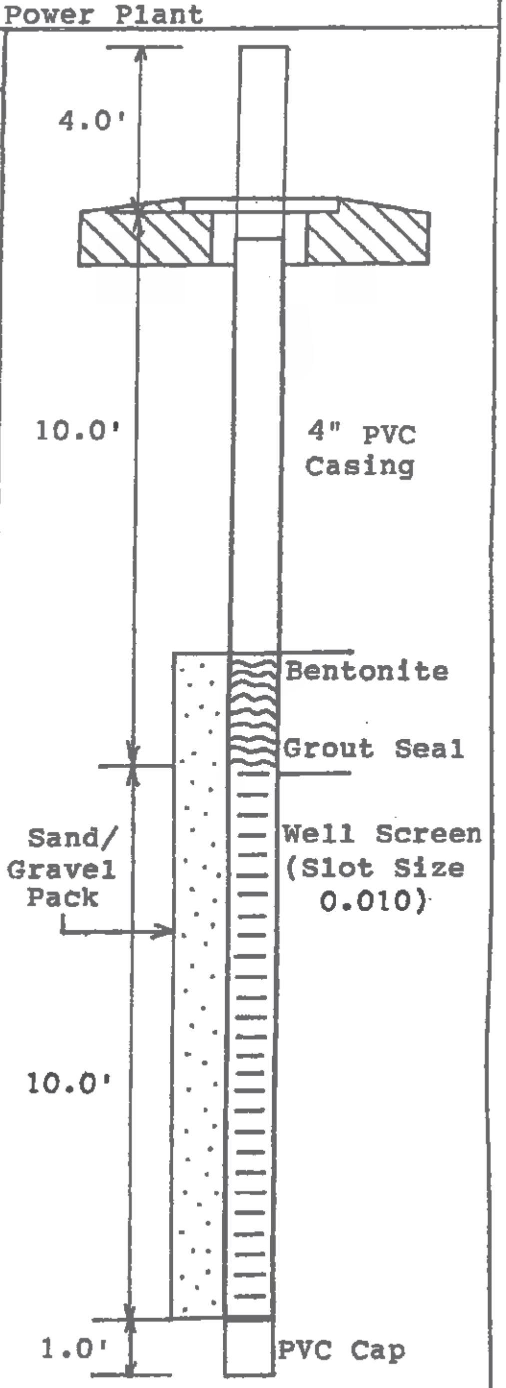
Brown Silty Clay

Brown Silty Sandy Clay

Red & Gray Silty Clay

Lignite

Tan Silty Sandy Clay



Completion Depth
20'

Date
7-1-93

Water Observations
Water Encountered at 10.0'

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

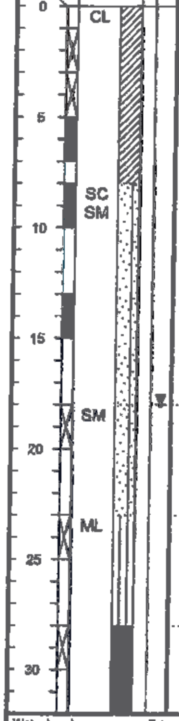
LOG OF BORING L-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

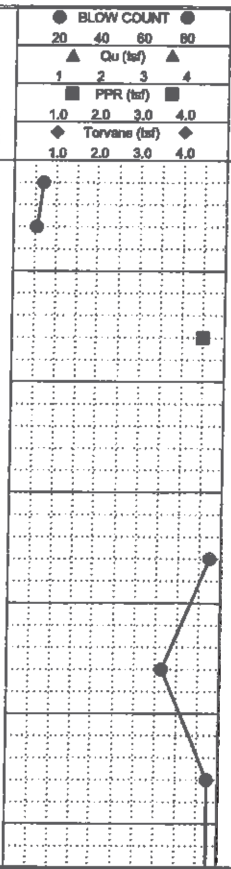
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

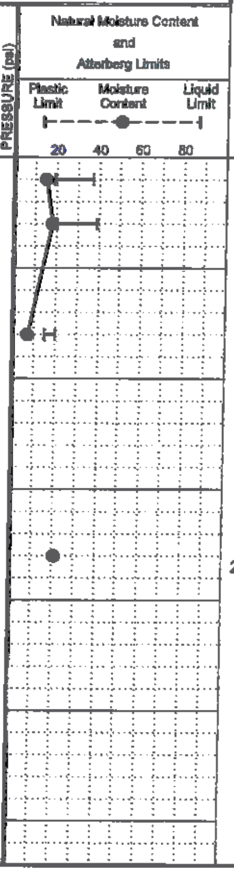
SURFACE ELEVATION 296.0



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; orangish gray	N=14	15	37	19	18	74	+40 Sieve=7%, +4 Sieve=2%
	--reddish brown	N=11	18	39	20	19	74	+40 Sieve=11%, +4 Sieve=3%
SC SM	SILTY CLAYEY SAND(SC-SM) reddish brown; with gravel	P=4.5+	7	20	15	5	32	+40 Sieve=61%, +4 Sieve=33%
	--reddish tan; with iron oxide cemented sandstone	SF						
SM	SILTY SAND(SM) very dense; dark gray; laminated; saturated	N=50/3"	21				30	+40 Sieve=0%, +4 Sieve=0%
ML	SANDY SILT(ML) very dense; dark gray; with lignite @ 24'	N=73						
	LIGNITE very dense; black	N=50/0.5"						



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 17' while drilling. Water level @ 18' and open upon completion.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING L-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

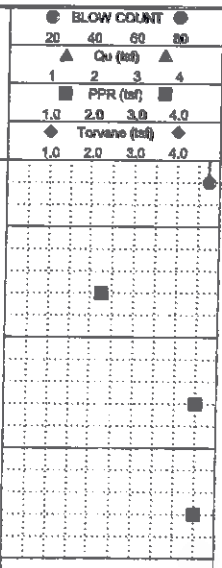
BORING TYPE: Flight Auger

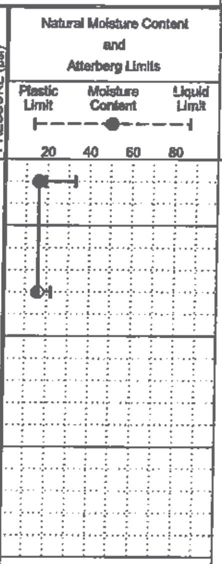
DATE 10/19/08

SURFACE ELEVATION 296.0

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	CL	LEAN CLAY(CL) hard; light gray; with vertical black silty seam	N=50/3"					16	33	19	14	97	+40 Sieve=0%, +4 Sieve=0%
40	CL ML	SANDY SILT CLAY(CL-ML) hard; gray	P=2.25 P=4.5+					16	22	16	6	51	+40 Sieve=0%, +4 Sieve=0%
45	CL	LEAN CLAY(CL) hard; dark brown laminated	P=4.5+										
50			P=4.5+										

Bottom of Boring @ 50'





Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 17' while drilling. Water level @ 18' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING L-2

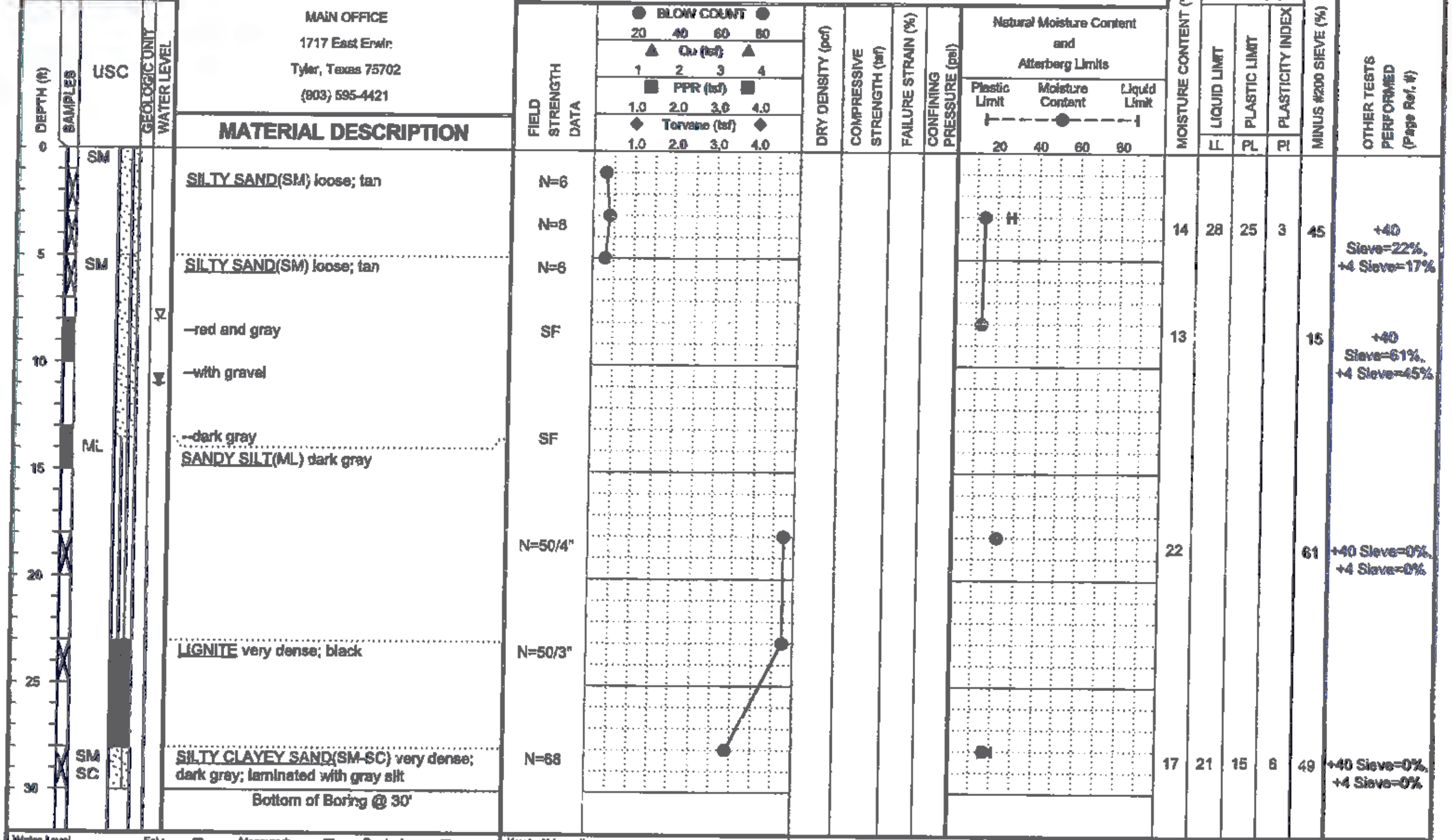
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/19/09

SURFACE ELEVATION 291.4



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SM	SILTY SAND(SM) loose; tan	N=6						
		N=8	14	28	25	3	45	+40 Sieve=22%, +4 Sieve=17%
SM	SILTY SAND(SM) loose; tan	N=6						
	--red and gray	SF	13				15	+40 Sieve=61%, +4 Sieve=45%
	--with gravel							
ML	--dark gray SANDY SILT(ML) dark gray	SF						
		N=50/4"	22				61	+40 Sieve=0%, +4 Sieve=0%
	LIGNITE very dense; black	N=50/3"						
SM SC	SILTY CLAYEY SAND(SM-SC) very dense; dark gray; laminated with gray silt	N=68	17	21	15	6	49	+40 Sieve=0%, +4 Sieve=0%
	Bottom of Boring @ 30'							

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 8' while drilling. Water level @ 26' and open to 26' upon completion. Water level @ 11' and open to 28' after

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.034', W 94°29.952'

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MAIN OFFICE
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Tyler, Texas 75702
(903) 595-4421

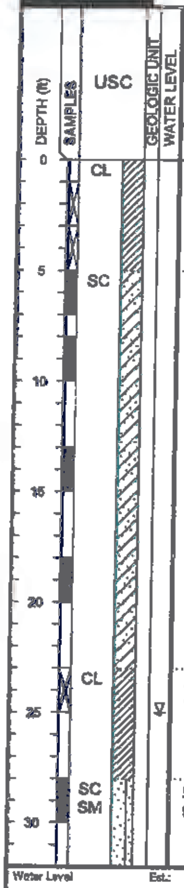
LOG OF BORING R-1

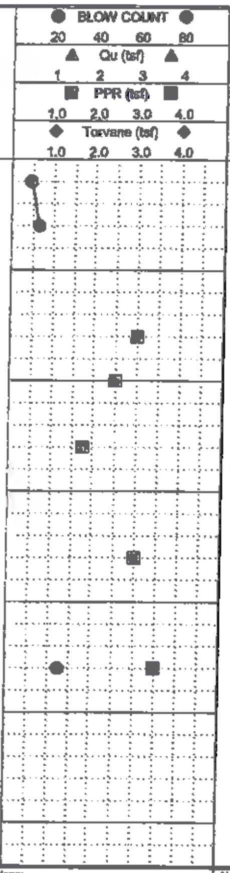
PROJECT: Pirkey Power Plant
Hallsville. Texas

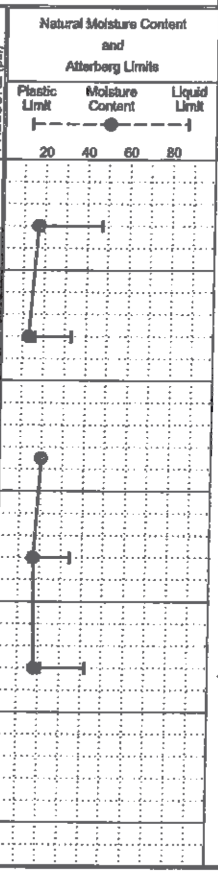
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 356.3







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) medium stiff; red and brown; with gravel	N=9										
	--stiff; clay content increasing	N=13					17	47	19	28	52	+40Sieve=4%, +4 Sieve=1%
SC	CLAYEY SAND(SC) medium dense; reddish brown; with ferric seams	P=2.75										
		P=3.0					13	33	16	17	22	+40Sieve=36%, +4 Sieve=30%
		P=2.5										
	--with clay nodules	P=1.75 SF	106	1.10	4	9	20					
		P=3.0					17	34	15	19	39	+40Sieve=8%, +4 Sieve=1%
CL	SANDY LEAN CLAY(CL) very stiff; orange and tan; saturated	N=25 P=3.5					18	42	21	21	57	+40Sieve=9%, +4 Sieve=6%
SC SM	CLAYEY SILTY SAND(SC-SM) orange and gray	SF										

Water Level Est.: ∇ Measured: ∇ Perched: ∇

Water Observations: Seepage @ 25' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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1717 East Erwin
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LOG OF BORING R-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

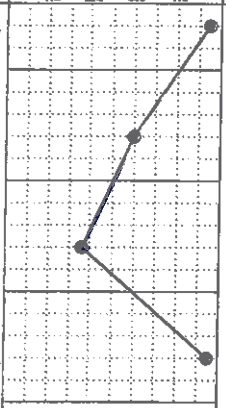
DATE 10/19/09

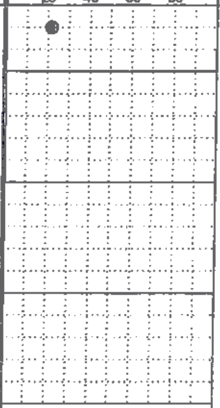
SURFACE ELEVATION 356.3

● BLOW COUNT ● 20 40 60 80
▲ Qu (tsf) ▲ 1 2 3 4
■ PPR (tsf) ■ 1.0 2.0 3.0 4.0
◆ Torvane (tsf) ◆ 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits
Plastic Limit ⊢ - - - ● - - - ⊣ Liquid Limit
Moisture Content
20 40 60 80

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	☒	SM			SILTY SAND(SM) very dense; gray; with gravel	N=50/5.5"					22				16	+40Sieve=2%, +4 Sieve=1%
35																
	☒				--orange and gray	N=60										
40																
	☒				--brown	N=36										
45																
	☒				--brown and gray	N=50/5.75"										
50					Bottom of Boring @ 50'											





Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 25' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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1717 East Erwin
Tyler, Texas 75702
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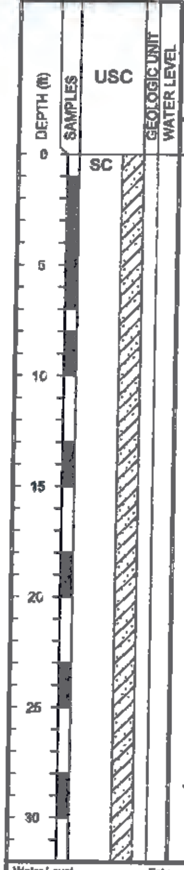
LOG OF BORING R-2

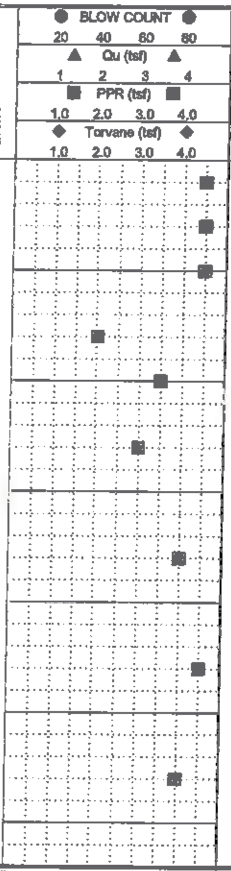
PROJECT: Pirkey Power Plant
Hallsville, Texas

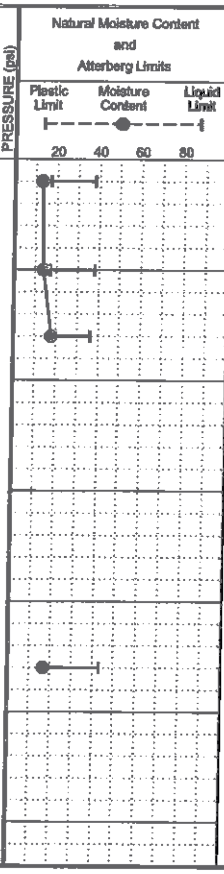
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 355.1







MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CLAYEY SAND(SC) medium dense; reddish tan; with gravel	P=4.5+					13	38	17	21	44	+40Sieve=6%, +4 Sieve=2%
	P=4.5+										
–red and orangish gray; with clay lenses	P=4.5					14	38	17	21	41	+40Sieve=9%, +4 Sieve=3%
–gravelly and ferric seams	P=2.0					18	36	18	18	44	+40Sieve=12%, +4 Sieve=5%
	P=3.5										
–orange and red	P=3.0										
	P=4.0										
–red and tan	P=4.5+					17	43	18	25	42	+40Sieve=6%, +4 Sieve=0%
–red and orange	P=4.0										

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 38' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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(903) 595-4421

LOG OF BORING R-2

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 355.1

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	▮					P=4.5					22	34	15	19	39	+40Sieve=7%, +4 Sieve=3%
40	▮	CL		▽	SANDY LEAN CLAY(CL) soft; tan and gray	P=0.2										
45	▮				--stiff; gray and tan	P=1.3										
50	▮	SM			SILTY SAND(SM) gray	SF										
					Bottom of Boring @ 50'											

Field strength scales: ● BLOW COUNT ● 20 40 60 80; ▲ Qu (tsf) ▲ 1 2 3 4; ■ PPR (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (tsf) ◆ 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit ⊢ - - - ● - - - ⊣ 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 38' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING R-3

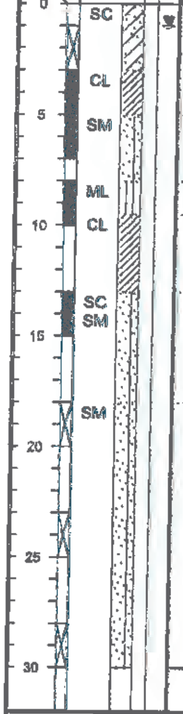
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

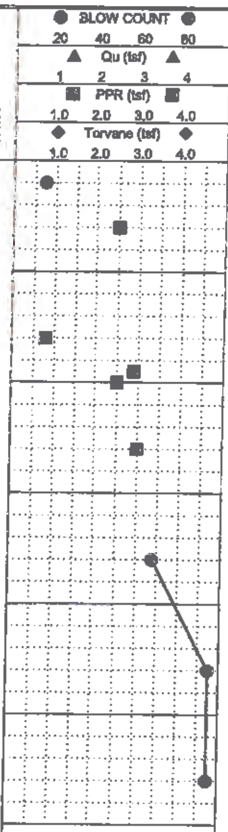
BORING TYPE: Flight Auger

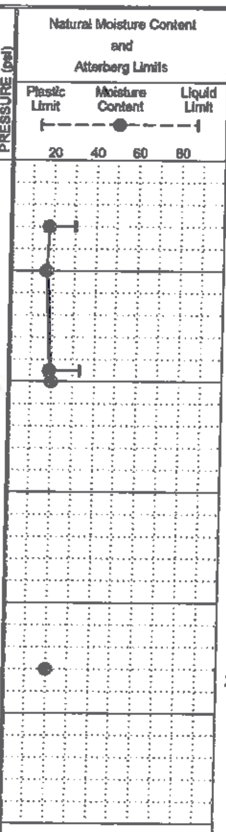
DATE 10/19/09

SURFACE ELEVATION 342.5



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) medium dense; tan	N=15										
CL	LEAN CLAY(CL) very stiff; tan and gray; laminated	P=2.5					18	30	16	14	88	+40Sieve=5%, +4 Sieve=1%
SM	SILTY SAND(SM) tan; with gravel	SF					17				30	+40Sieve=16%, +4 Sieve=9%
ML	SANDY SILT(ML) very loose; tan	P=0.8										
CL	LEAN CLAY(CL) very stiff; tan	P=2.5 P=2.9	108	1.60	7	7	19 20	33	17	16	86	+40Sieve=1%, +4 Sieve=0%
SC SM	SILTY CLAYEY SAND(SC-SM) medium dense; tan and gray	P=3.0										
SM	SILTY SAND(SM) very dense; tan and gray	N=68										
		N=50/6"					20				21	+40Sieve=1%, +4 Sieve=0%
		N=50/4"										
	Bottom of Boring @ 30'											





Water Level Est.: ▽ Measured: ▼ Perched: ▽

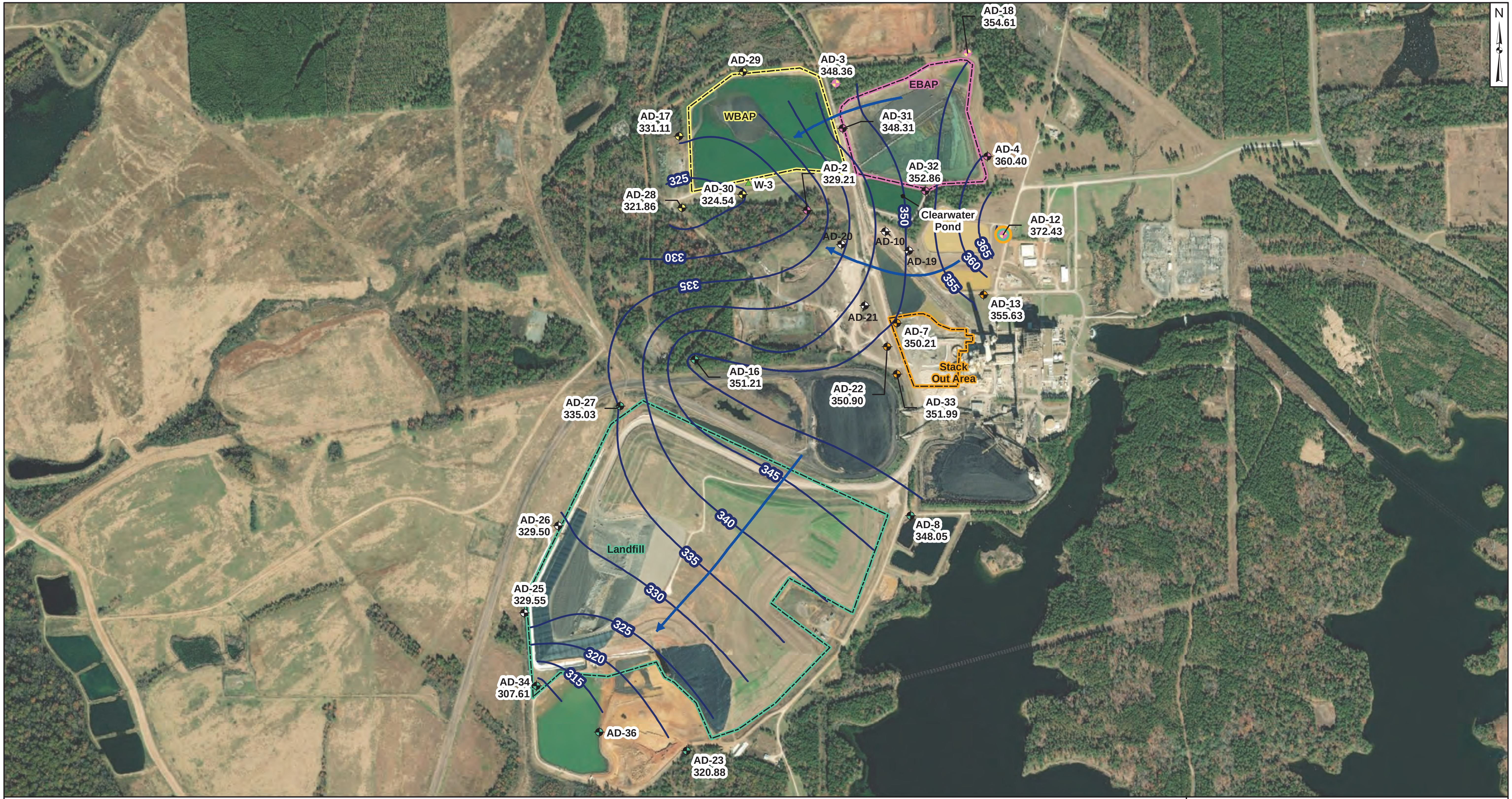
Water Observations: Seepage @ 6' while drilling. Water level @ 1' and open to 28' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.313', W 94°29.240'

Appendix C

Potentiometric Surface Maps, 2019-2021



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

Potentiometric Contours - Uppermost Aquifer
February 2019

AEP Pirkey Power Plant
Hallsville, Texas

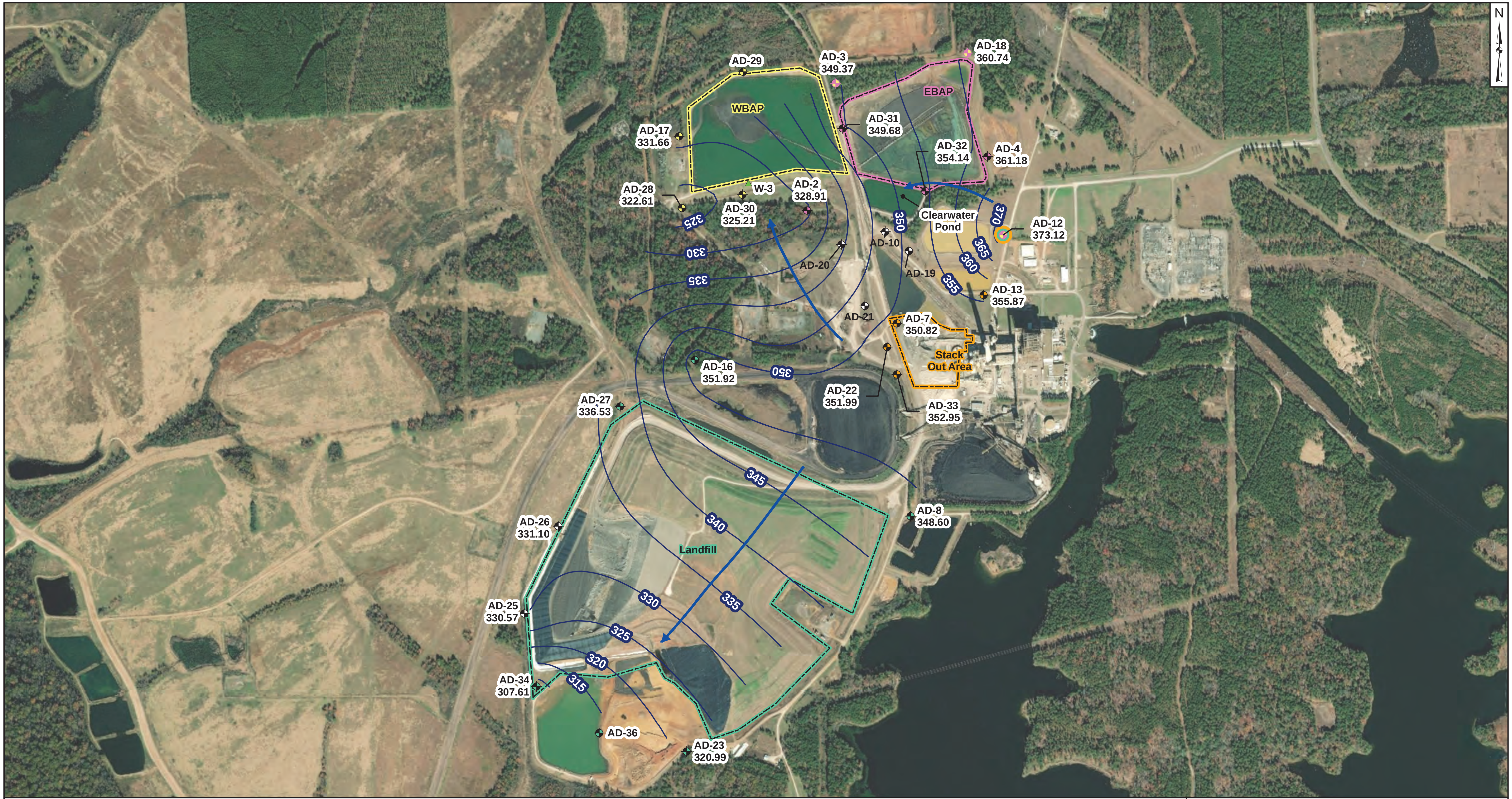
Geosyntec
consultants

Columbus, Ohio

2020/01/16

Figure
1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
May 2019

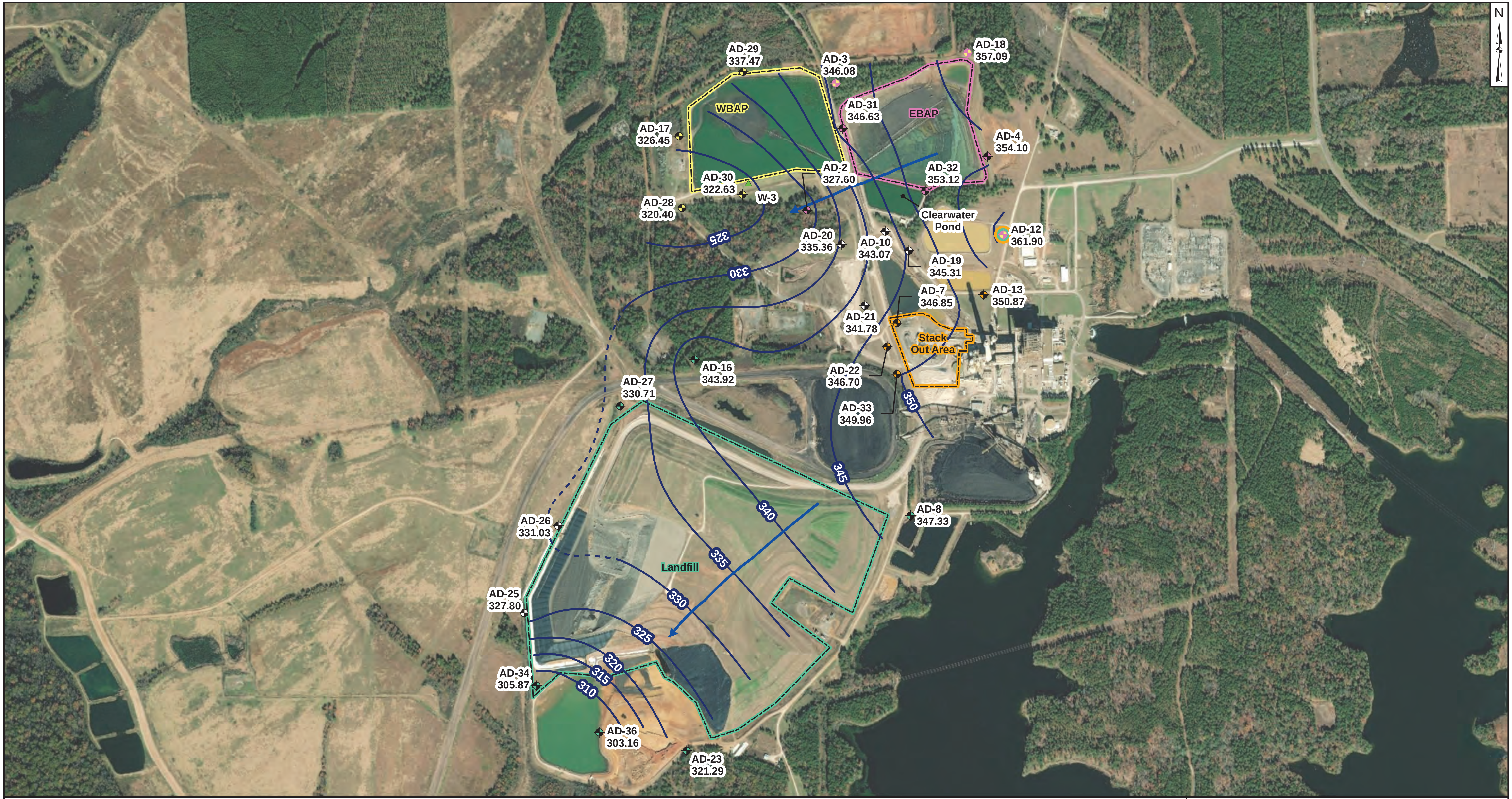
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
2

Columbus, Ohio
2020/01/16

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201905-May.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
August 2019

AEP Pirkey Power Plant
Hallsville, Texas

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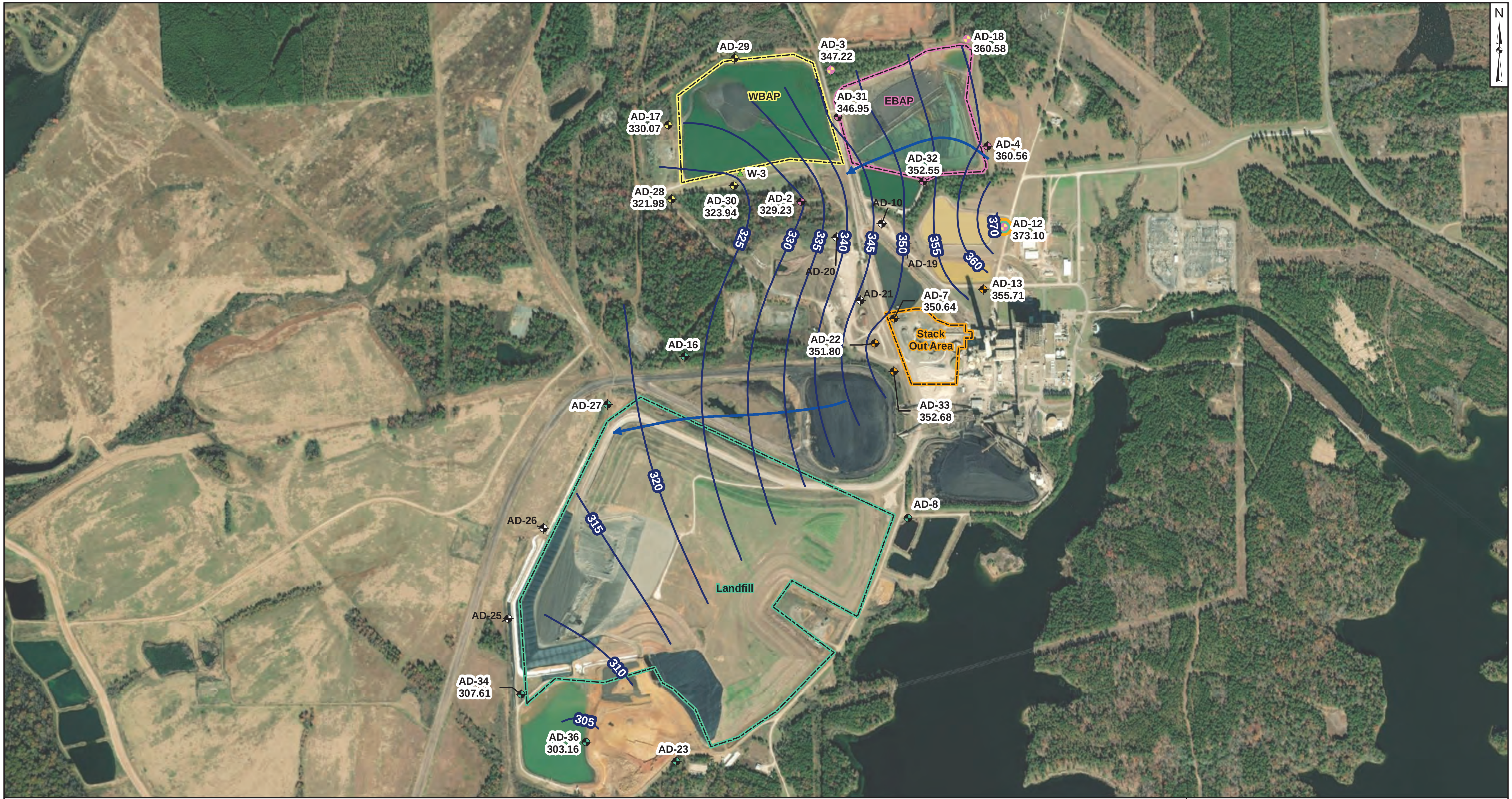
consultants

Figure
3

Columbus, Ohio
2020/01/16

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201908-August.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ● All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on March 10-11, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-16, AD-27, and AD-29 were not gauged in March 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer March 2020

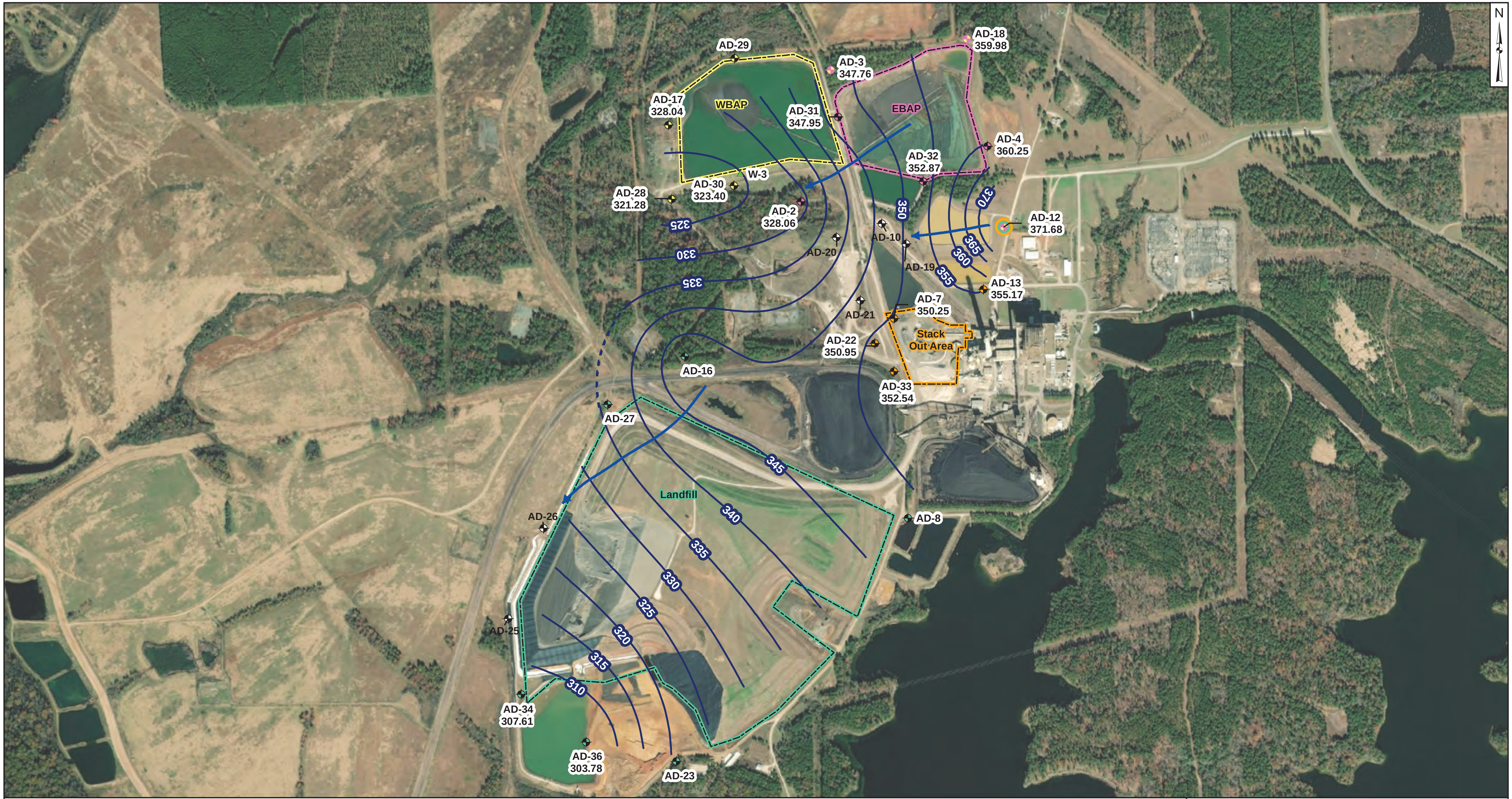
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Figure
1

Columbus, Ohio
2020/06/12

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2020\AEP-Pirkey_GW_2020-03March.mxd. ARevezzo. 6/12/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- ◆ Out of Network
- ◆ EBAP
- ◆ WBAP
- ◆ Landfill
- ◆ Stackout Area
- ◆ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on June 2 - 3, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-8, AD-16, AD-23, AD-27, and AD-29 were not gauged in June 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
June 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2020/11/13

Figure
2

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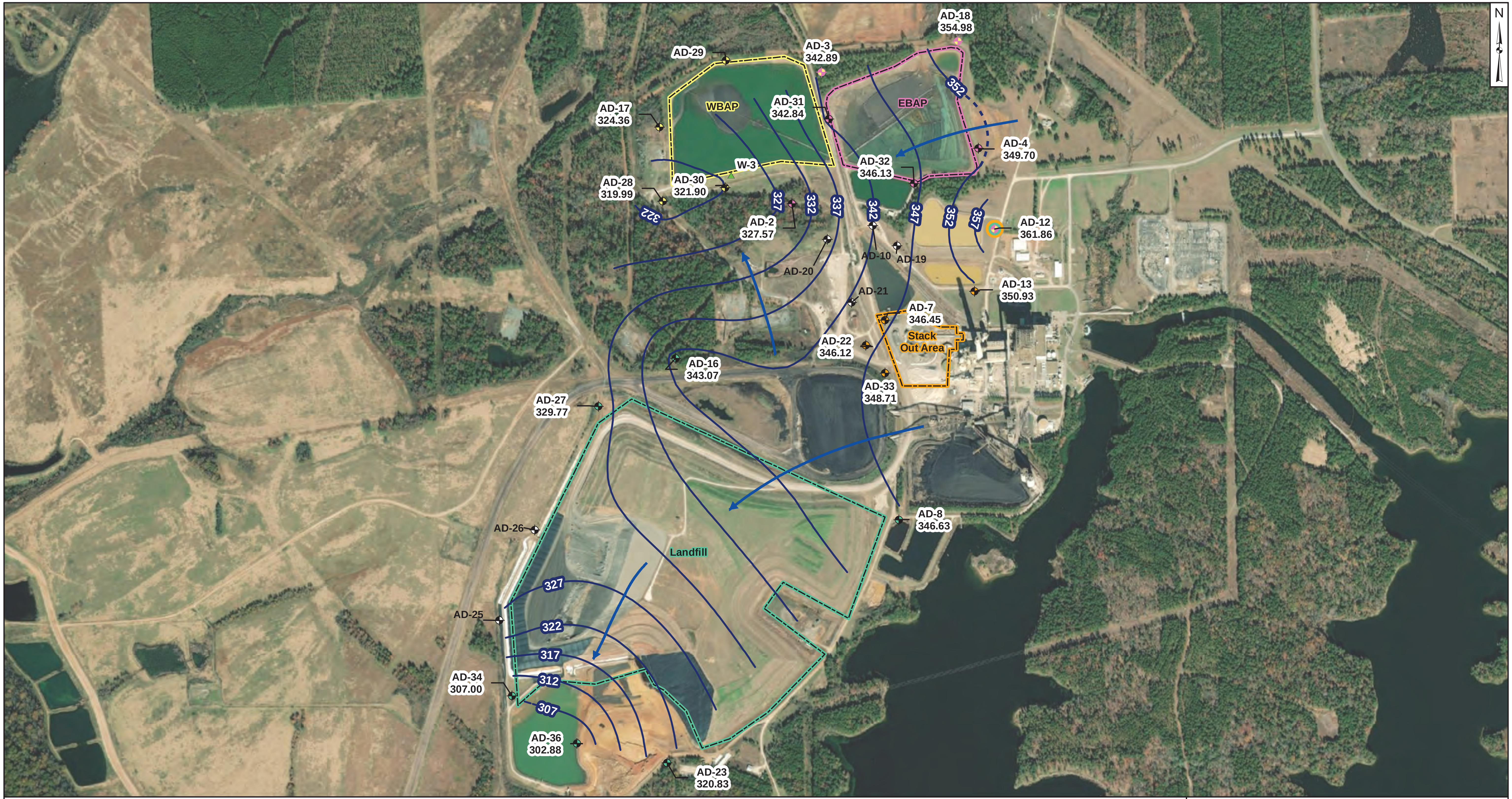

Legend

Groundwater Monitoring Wells

- ◆ Out of Network
- ◆ EBAP
- ◆ WBAP
- ◆ Landfill
- ◆ Stackout Area
- ◆ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on November 2-4, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 and AD-29 were not gauged in November 2020.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer
November 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio

2021/01/06

Figure

3

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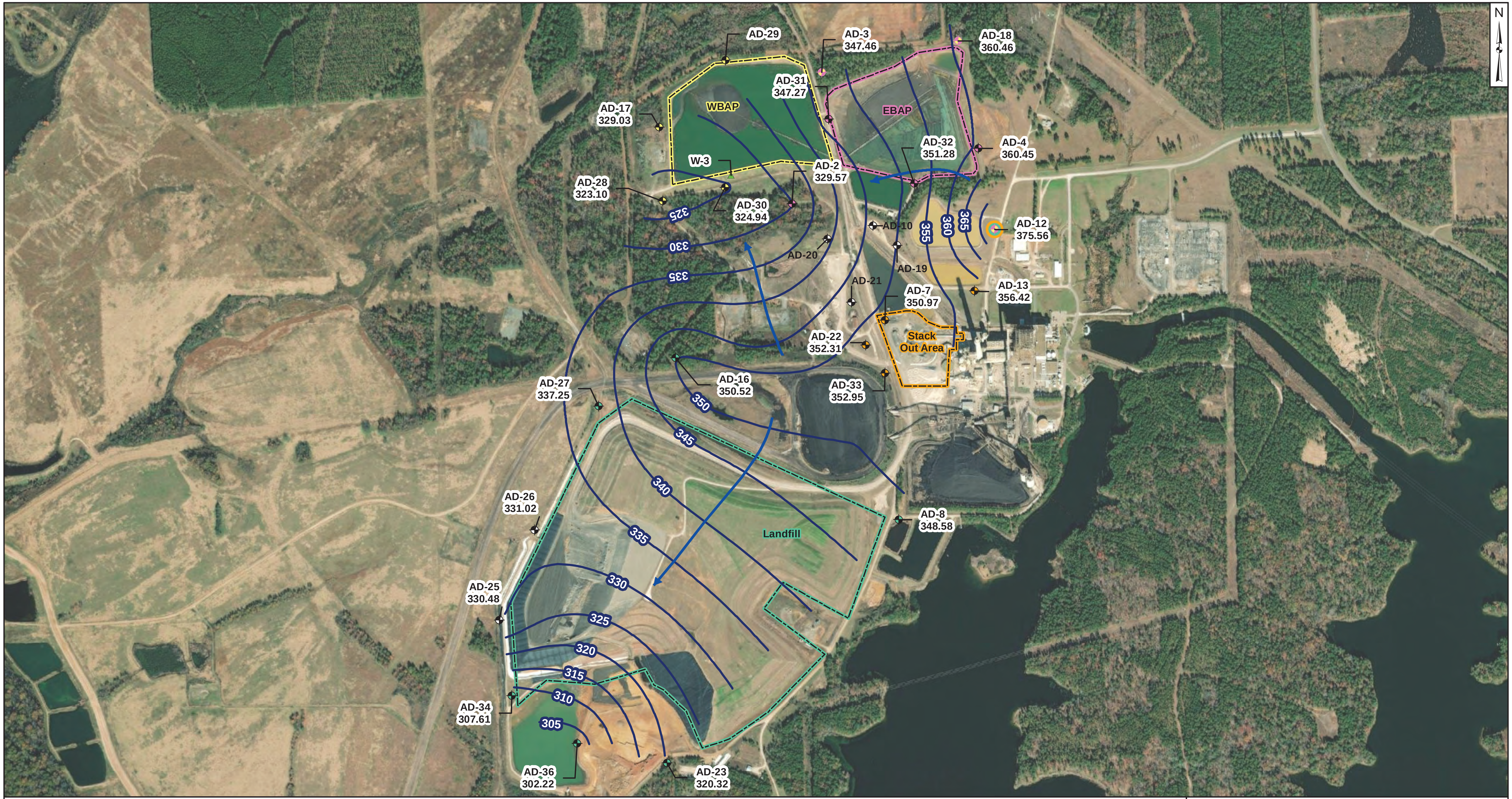

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour

Notes

- Monitoring well coordinates and water level data (collected on May 24-26, 2021) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- AD-10, AD-19, AD-20, AD-21, AD-29, AD-35, and W-3 were not gauged during the May 2021 event.

1,000 500 0 1,000
Feet

BETH ANN GROSS
79864

Beth Ann Gross
Oct 24, 2021

Geosyntec Consultants, Inc.
Texas Firm
Registration No. 1182

Potentiometric Contours - Uppermost Aquifer May 2021

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio | 2021/08/18

Figure
2

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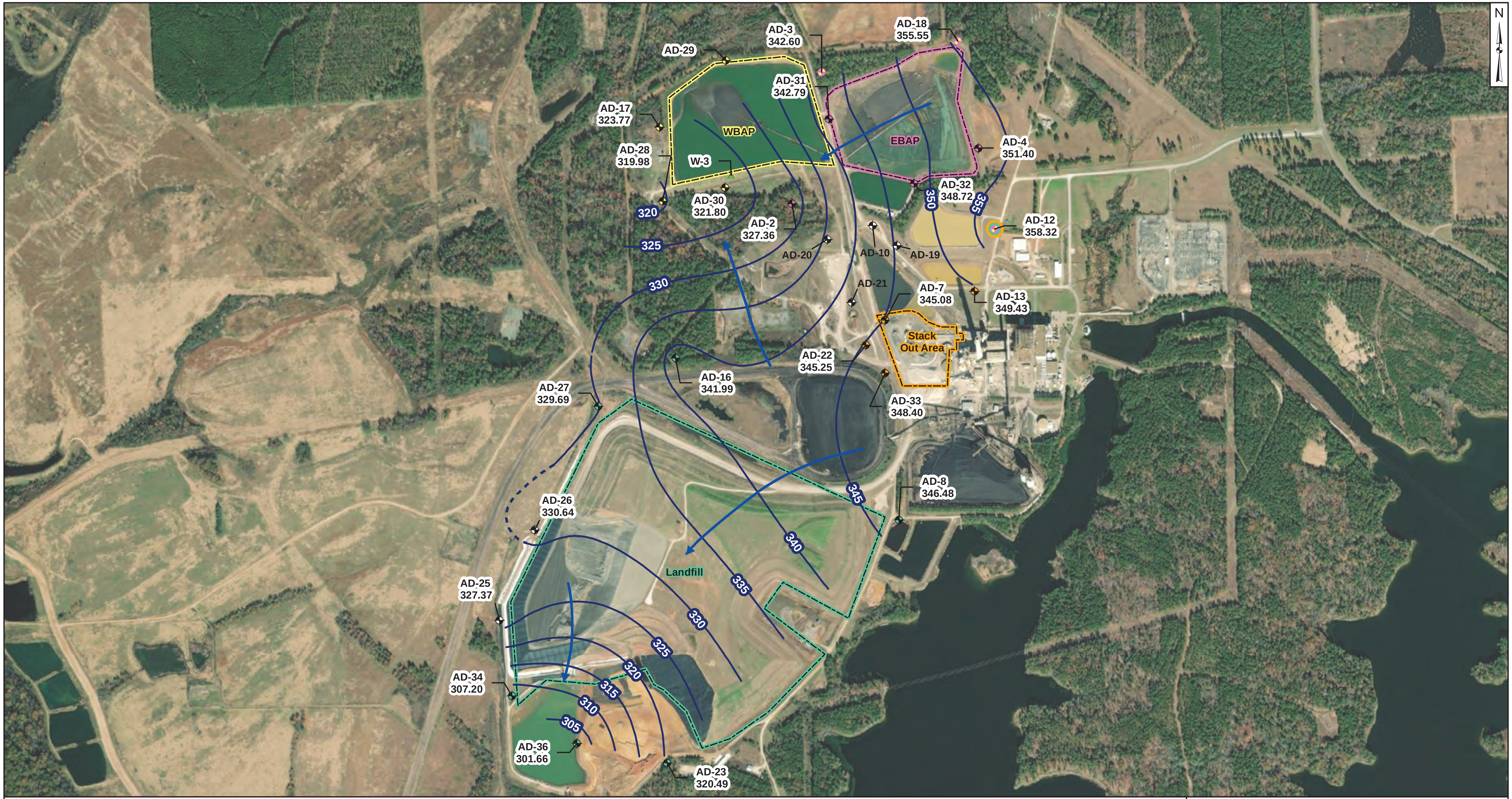

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contours (Inferred)
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on November 15 - 17, 2021) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluation (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- AD-10, AD-19, AD-20, AD-21, AD-29, AD-35, and W-3 were not gauged during the May 2021 event.

1,000 500 0 1,000
Feet

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Jan 14, 2022

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Texas Firm
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Potentiometric Contours - Uppermost Aquifer
November 2021

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
3

Columbus, Ohio
01/13/2022

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4.4 – Stack Out Area – CCR Groundwater Monitoring Well Network Evaluation, May 25, 2016

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American Electric Power Service Corporation

Stack Out Area - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

May 25, 2016

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STATE OF TEXAS
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Geology
1737
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Matthew J L

Matthew J. Lamb
Project Manager

John Holm, P.E.
Professional Engineer

Stack Out Area - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
AEP

Prepared by:
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Ohio 43235-1447
Tel 614 985 9100
Fax 614 985 9170

Our Ref.:
OH015976.0010

Date:
May 25, 2016

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91, for the Stack Out Area CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above and isolated from the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zone, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the Stack Out Area. The evaluation of the location restriction criteria is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the Stack Out Area CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant Stack Out Area.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The Stack Out Area CCR unit is located in the central portion of the Plant, and approximately 1,200 feet northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of Stack Out Area CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the Stack Out Area.

2.2.1 Stack Out Area Configuration

The Stack Out Area is an approximate 7-acre storage area for stabilized flue gas desulfurization (FGD) sludge. As shown on **Figure 3**, the Stack Out Area is located directly south of the Surge Pond, directly west of Thickener Tanks 1A and 1B, and directly east of a road that runs south to the on-site Landfill. The dimensions of the Stack Out Area are approximately 650 feet from north to south by 450 feet from east to west.

Stabilized FGD sludge is temporarily stockpiled directly above natural ground surface (native clay) in the Stack Out Area using a radial stacker. The maximum height of the stabilized FGD sludge piles are approximately 41 feet above ground surface. There are no solids retention structures in the Stack Out Area. The stabilized FGD sludge piles are located no closer than approximately 50 feet from the perimeter of the Stack Out Area, thereby preventing the stabilized FGD sludge from migrating beyond the boundaries of the Stack Out Area.

2.2.2 Area/Volume

The Stack Out Area is approximately 7 acres in size. However, as discussed above in Section 2.2.1, the CCR piles in the Stack Out Area are located no closer than approximately 50 feet from the perimeter of the Stack Out Area, therefore the effective storage area of the Stack Out Area is approximately 4.4 acres (550 feet by 350 feet), and the maximum CCR storage volume based on a maximum CCR pile height of 41 feet is 180 acre feet.

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, FGD sludge) have been generated. The Stack Out Area receives stabilized FGD sludge (**Figure 3**). Prior to storing the FGD sludge in the Stack Out Area, the FGD sludge is dewatered using belt presses, and the dewatering fluid is routed to the Surge Pond for reuse as FGD makeup water. The stabilized FGD sludge is then stockpiled in the Stack Out Area using a radial stacker with an approximate 3-foot-wide by 120-foot-long conveyor belt.

The stabilized FGD sludge is temporarily stored at the Stack Out Area. The stabilized FGD sludge is removed using front-end loaders or similar equipment, placed into trucks, and disposed of at the on-site Landfill CCR Unit located near the south end of the Plant.

Lithologic data from soil borings and monitoring wells confirm the native soils underling the Stack Out Area consist of low-permeability clay. As shown on Geologic Cross Sections B-B' (**Figure 5**) and E-E' (**Figure 8**), the native clay directly below the Stack Out Area extends from the surface to an average depth of approximately 20 feet. Therefore, as shown on **Figures 5** and **8**, the separation distance between the base of the Stack Out Area and uppermost aquifer exceeds 5 feet.

2.2.4 Surface Water Control

The Stack Out Area contains dewatered FGD sludge that is stockpiled using a radial stacker, therefore no sluice water is present in the Stack Out Area. Storm water in the Stack Out Area follows surface topography via gravity sheet flow. The ground surface elevation in the Stack Out Area ranges from approximately 360 to 365 feet amsl (Akron Consulting, 2015). Storm water flow in the Stack Out Area is in a general northerly direction to the Surge Pond, which is a below-grade (incised) non-CCR unit.

2.3 Previous Investigations

The initial soils investigation and design of the Plant was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, including the Stack Out Area.

In 2009, ETTL Engineers & Consultants (ETTL) conducted geotechnical investigations of earthen embankments associated with several ponds at the Plant. The Stack Out Area was not included in this evaluation because there are no earthen embankments in the Stack Out Area (ETTL, 2010).

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed hydraulic analysis of several ponds at the Plant. The Stack Out Area was not included in this evaluation because there is no impounded water in the Stack Out Area (Johnson & Pace, May 2011).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the Stack Out Area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the Stack Out Area, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost aquifer at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow groundwater flow direction in the Stack Out Area is northwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The Stack Out Area is located approximately 1,200 feet northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the Stack Out Area does not discharge into Brandy Branch Reservoir.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 1,000 feet north of the Stack Out Area in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile west (downgradient) of the Stack Out Area for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (upgradient) of the Pirkey Power Plant.

3. Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be placed down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the Stack Out Area is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 20 feet that is located between an elevation of approximately 320 and 340 feet amsl (**Appendix A**). The base of the Stack Out Area is at an elevation of 360 feet amsl. The separation distance between the uppermost aquifer and the base of the Stack Out Area ranges from approximately 10 to 20 feet. This separation distance is further illustrated on cross section B-B' (**Figure 5)** and cross section E-E' (**Figure 8)**.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer unit (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness in the Stack Out Area (approximately 20 feet), the yield of the uppermost aquifer is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Available groundwater elevations are summarized on **Table 1** for 2011 through 2016. The most recent comprehensive groundwater data set from January 20, 2016 is depicted on **Figure 9**. The groundwater flow direction in the Stack Out Area is northwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

Per 40 CFR 257.60(a), new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five ft) above the upper limit of the uppermost aquifer, or must demonstrate there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high conditions).

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers, that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the Stack Out Area is the clayey and silty sand stratum that is located between an elevation of approximately 320 and 340 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 19, 2015 to review existing well network conditions and locations. A well construction table that summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as

Table 2. Photo documentation of the located wells during the August 19, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-7, AD-12, AD-13, and AD-22 were previously installed at the Site to monitor the uppermost water-bearing unit (clayey and silty sand stratum) associated with the Stack Out Area. As discussed above in Section 3.1.1, the uppermost water-bearing unit below the Stack Out Area is approximately 20 feet thick and is located between an elevation of approximately 320 and 340 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on Geologic Cross Sections B-B' (**Figure 5**) and E-E' (**Figure 8**), existing monitoring wells AD-7 and AD-22 are screened in the uppermost water-bearing unit downgradient (northwest) of the Stack Out Area, and will be utilized as downgradient monitoring wells for the Stack Out Area. Existing monitoring wells AD-12 and AD-13 are screened in the uppermost water-bearing unit up gradient (east) of the Stack Out Area, and will be utilized as up gradient monitoring wells for the Stack Out Area.

As shown on **Figure 9**, shallow groundwater flow direction in the Stack Out Area is northwesterly. Two existing monitoring wells (AD-7 and AD-22) were located hydraulically downgradient of the Stack Out Area during the August 19, 2015 site visit, and three downgradient monitoring wells are required to monitor groundwater quality downgradient of a CCR unit. This data gap was addressed by installation of new downgradient monitoring well AD-33 during December 2015 as shown on **Figure 9** and **Figure 10**. With the addition of monitoring well AD-33 on the west side of the Stack Out Area, there are no gaps remaining in the groundwater monitoring network for the Stack Out Area.

4. Recommended Monitoring Network and PE Certification

The recommended existing groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the Stack Out Area (up gradient or down gradient), well depth, and well construction. The recommended network would provide an improved understanding of groundwater quality, hydraulics, and groundwater flow at the Stack Out Area.

4.1 Recommended Monitoring Well Network Distribution

Two up gradient well locations (existing monitoring wells AD-12 and AD-13) and three down gradient well locations (existing monitoring wells AD-7, AD-22, and AD-33) are recommended to establish a groundwater quality monitoring well network for the Stack Out Area.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the Stack Out Area is summarized on **Table 3** and illustrated on **Figure 10.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 320 and 340 feet amsl as shown on Geologic Cross Sections B-B' (**Figure 5**) and E-E' (**Figure 8**). The screen elevations are presented in **Table 3**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the Stack Out Area was addressed by installation of monitoring well AD-33 during December 2015. Monitoring well AD-33 was installed by a Texas Department of Licensing and Regulation (TDLR)-licensed water well driller. Well construction data for the monitoring well network are summarized on **Tables 2** and **3**, and the monitoring well completion diagrams are provided in **Appendix A.**

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system will be adequate to meet the requirements of 40 CFR Part 257.91.

Kenneth J. Brandner

Printed Name of Registered Professional Engineer

Kenneth J Brandner

Signature

KENNETH J. BRANDNER
69586

69586	Texas	5-25-16
Registration No.	Registration State	Date

5. References

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Tables

Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen(b)		Bottom of Screen(b)		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers(c)																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
NM - Not Measured

Table 2
Well Construction Details
AEP Pirkey Power Plant - CCR Units
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[(a)]	Top of Casing Elevation[(a)]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen[(b)]		Bottom of Screen[(b)]	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18	341	40	319	20	339.48	40	319.48
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29	350	51	328	31	347.84	51	327.84
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.48	40.5	321.48
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13	344	35	322	15.0	341.81	35.0	321.81
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8	335	30	313	10.0	332.65	30.0	312.65
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13	347	25	335	15.0	345.48	25.0	335.48
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8	352	30	330	10.0	349.50	30.0	329.50
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13	339	35	317	15.0	337.30	35.0	317.30
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8	339	30	317	10.0	337.23	30.0	317.23
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8	348	30	326	10.0	345.57	30.0	325.57
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13	334	35	312	15.0	331.72	35.0	311.72
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3	285	20	268	5.0	282.68	20.0	267.68
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8	326	30	304	10.0	324.15	30.0	304.15
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8	334	40	302	10.0	332.41	40.0	302.41
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.33	37.5	312.33
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13	323	35	301	15.0	320.92	35.0	300.92
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8	342	30	320	10.0	340.21	30.0	320.21
AD-30[(d)]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8	331	25	314	10.0	329.04	25.0	314.04
AD-31[(d)]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18	340	35	323	20.0	337.75	35.0	322.75
AD-32[(d)]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11	346	33	324	13.0	344.23	33.0	324.23
AD-33[(d)]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12	347	30	329	15.0	344.30	30.0	329.30
AD-34[(d)]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8	297	25	280	10.0	294.64	25.0	279.64
AD-35[(d)]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20	296	3.0	313.01	18.0	298.01
Piezometers[(c)]																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26	330	38	318	28.0	328.30	38.0	318.30

General Note:
Elevations in feet above mean sea level.

Footnotes:
(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.
(c) Souce: EETL (October 2010).
(d) Source: Aukland Consulting LLC (January 26, 2016).

Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

Table 3
Proposed Well Network
AEP Pirkey Power Plant - Stack Out Area
Hallsville, Harrison County, Texas

Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Target Elevation[a] (ft amsl)	Screen Bottom Target Elevation[a] (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-12	Exisiting	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-13	Exisiting	Uppermost Water-Bearing Unit	East of Stack Out Area	Upgradient	331.5	321.5	10	Existing well installed in 1988; well will be utilitzed to establish backgroud water quality
Downgradient								
AD-7	Existing	Uppermost Water-Bearing Unit	Northwest of Stack Out Area	Down gradient	339.6	319.6	20	Existing well installed in 1983; uppermost shallow aquifer adjacent to Stack Out Area - downgradient
AD-22	Existing	Uppermost Water-Bearing Unit	West of Stack Out Area	Down gradient	345.6	325.6	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to Stack Out Area - downgradient
AD-33	Existing	Uppermost Water-Bearing Unit	West of Stack Out Area	Down gradient	344.3	329.3	15	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to Stack Out Area - downgradient

Footnotes:

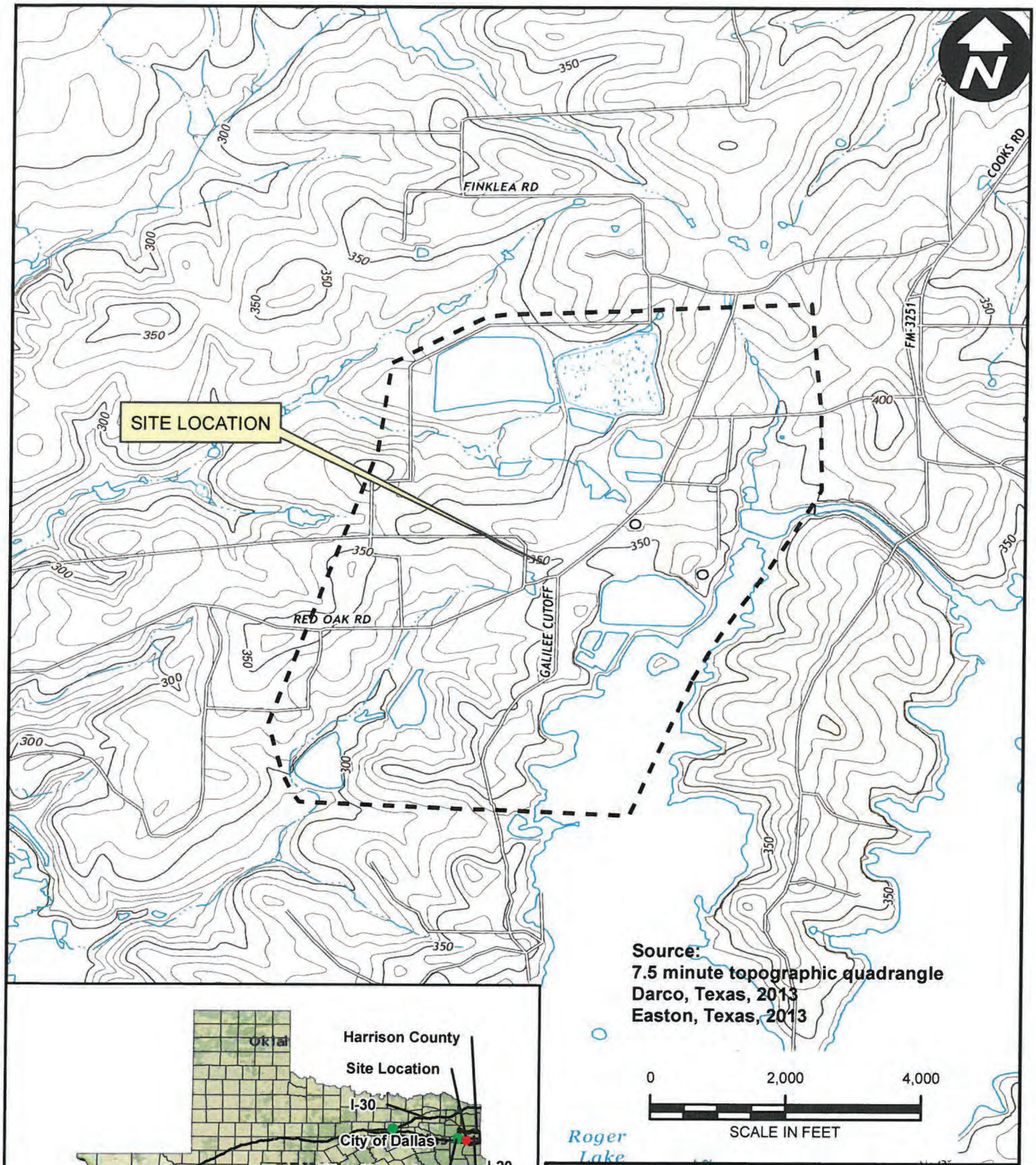
a. Target elevations are an estimated range.

Acronyms and Abbreviations:

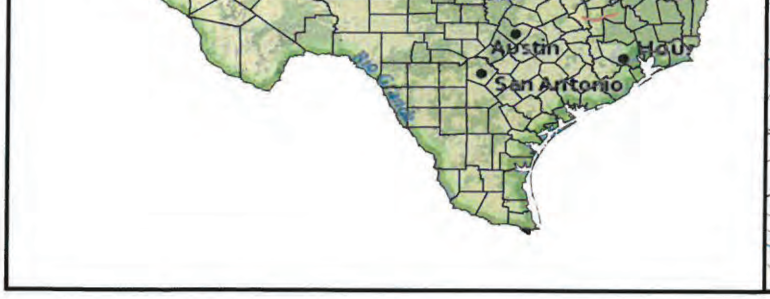
U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

ARCADIS

Figures



Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013



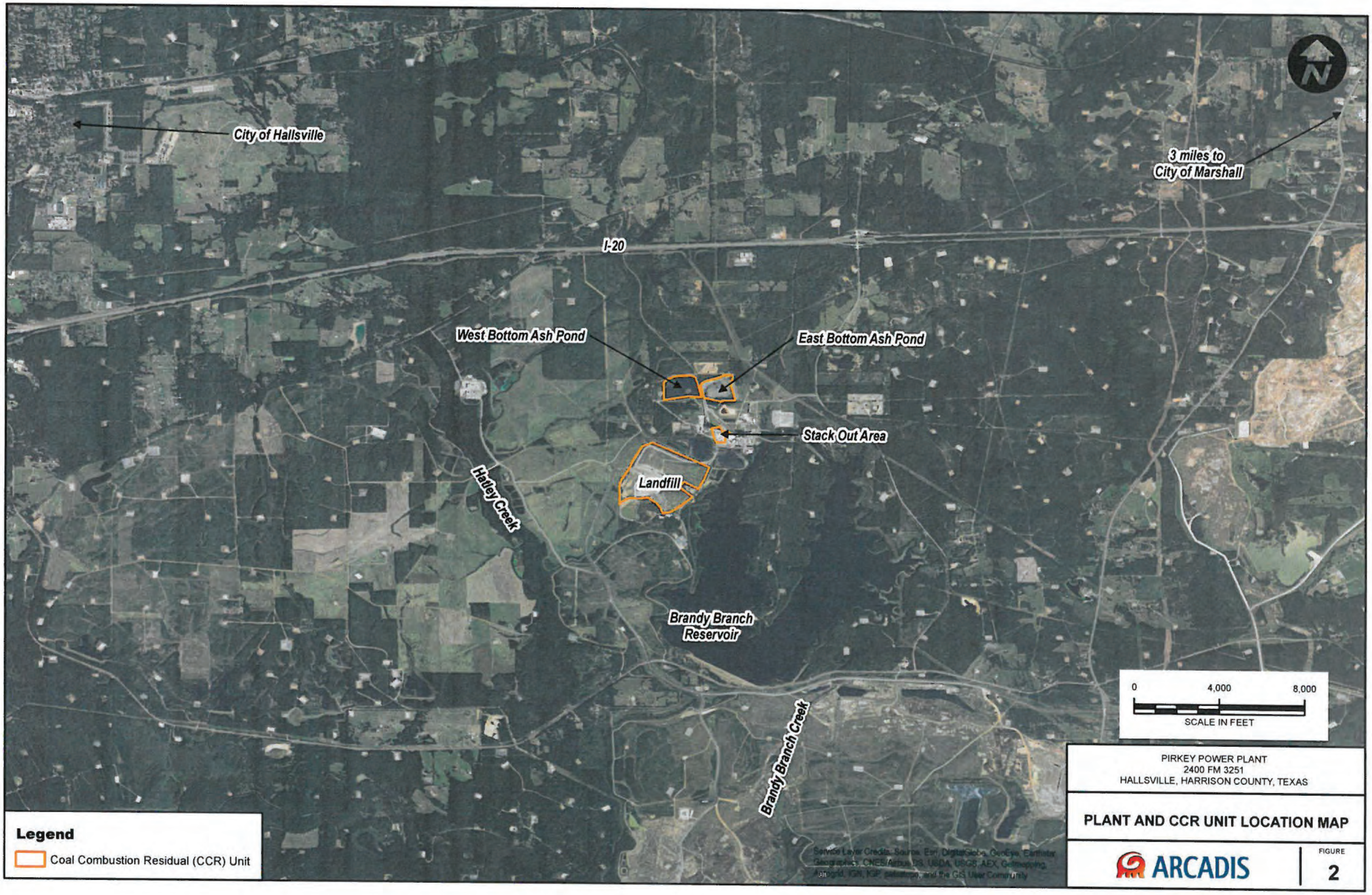
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd



Legend

🟧 Coal Combustion Residual (CCR) Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

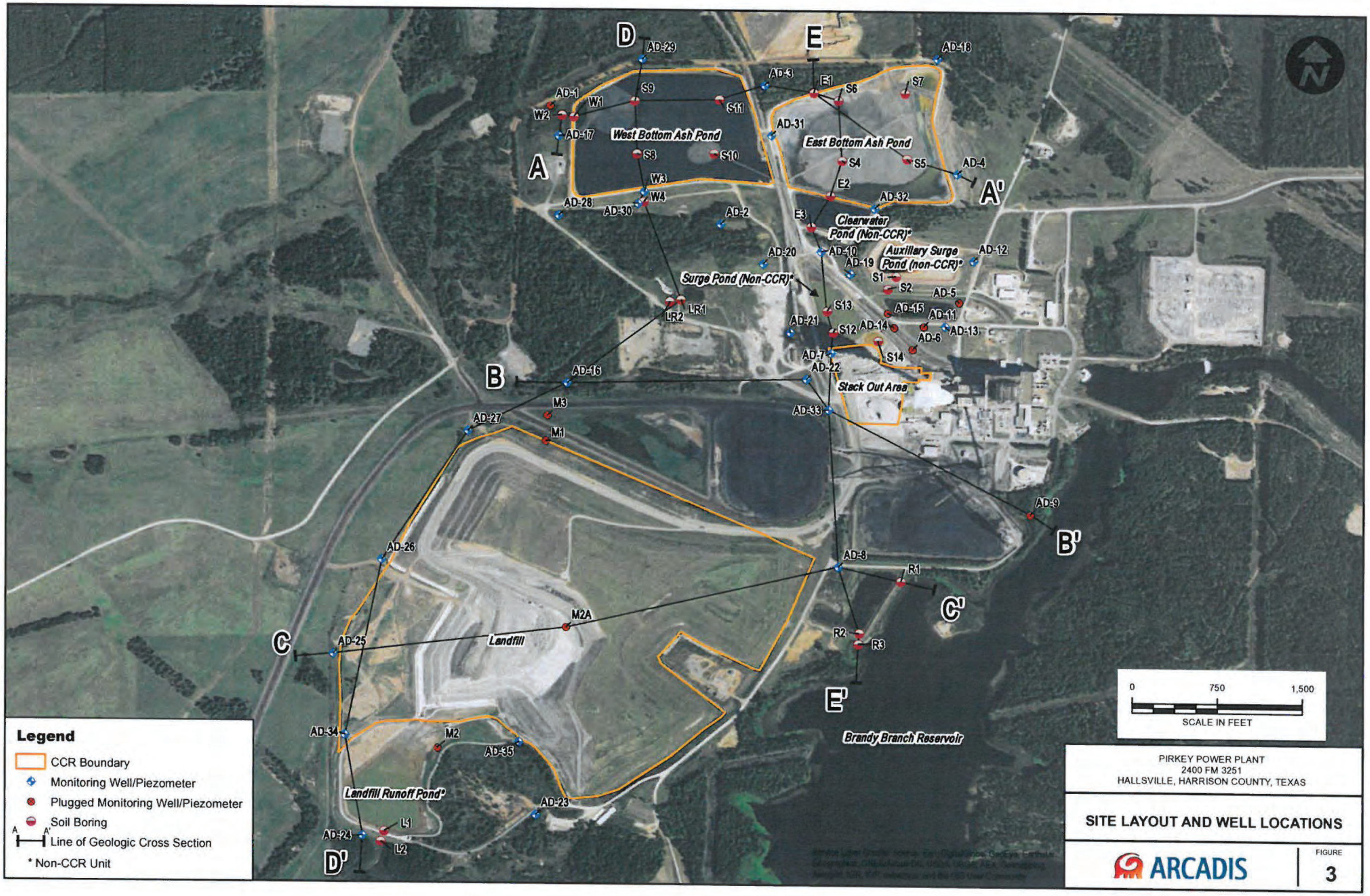
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



Legend

- ▭ CCR Boundary
- ◆ Monitoring Well/Piezometer
- ● Plugged Monitoring Well/Piezometer
- ◓ Soil Boring
- A ⊢⊣ A' Line of Geologic Cross Section
- * Non-CCR Unit

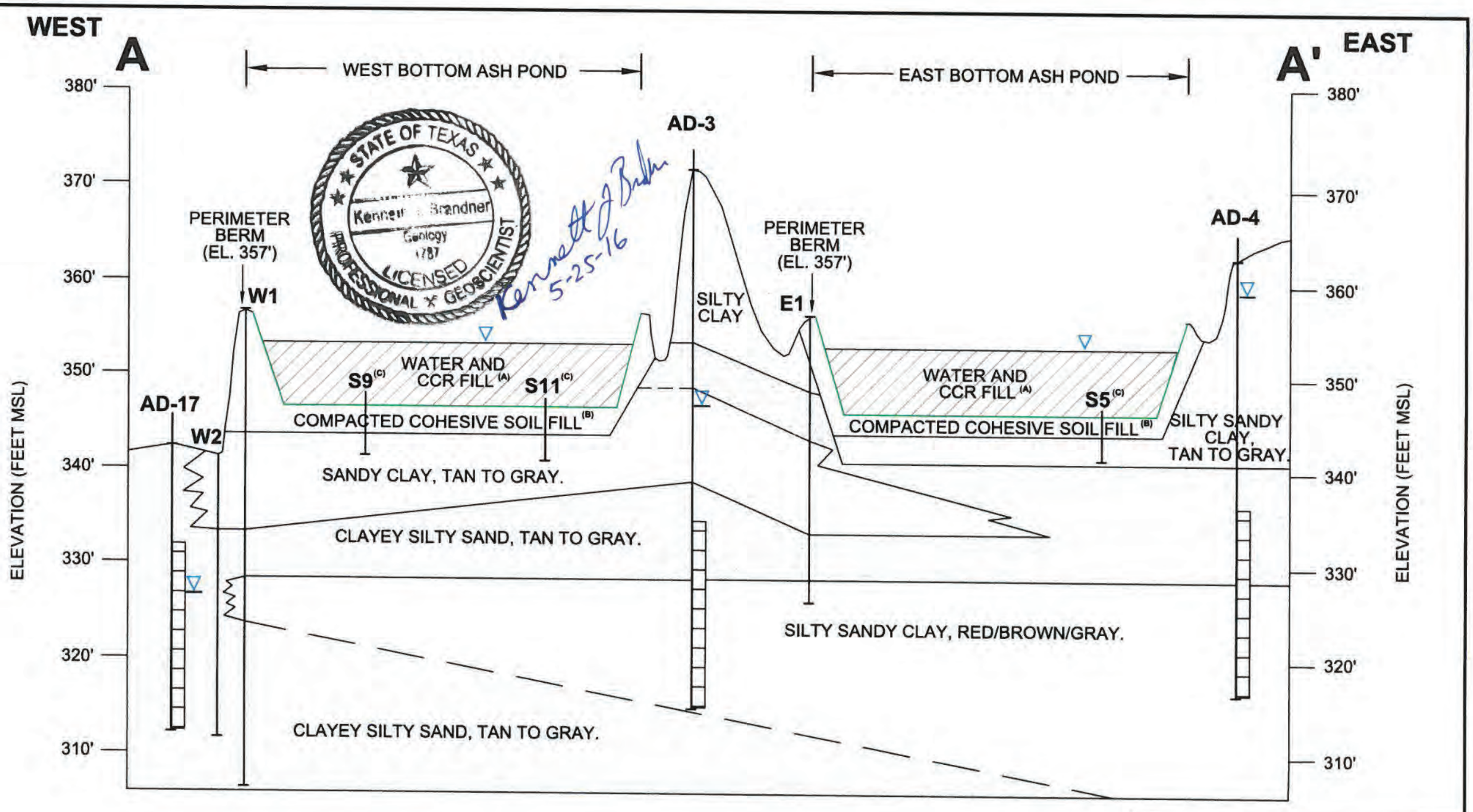
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE
3

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



Kenneth J. Brandner
1787
5-25-16

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).
C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:18 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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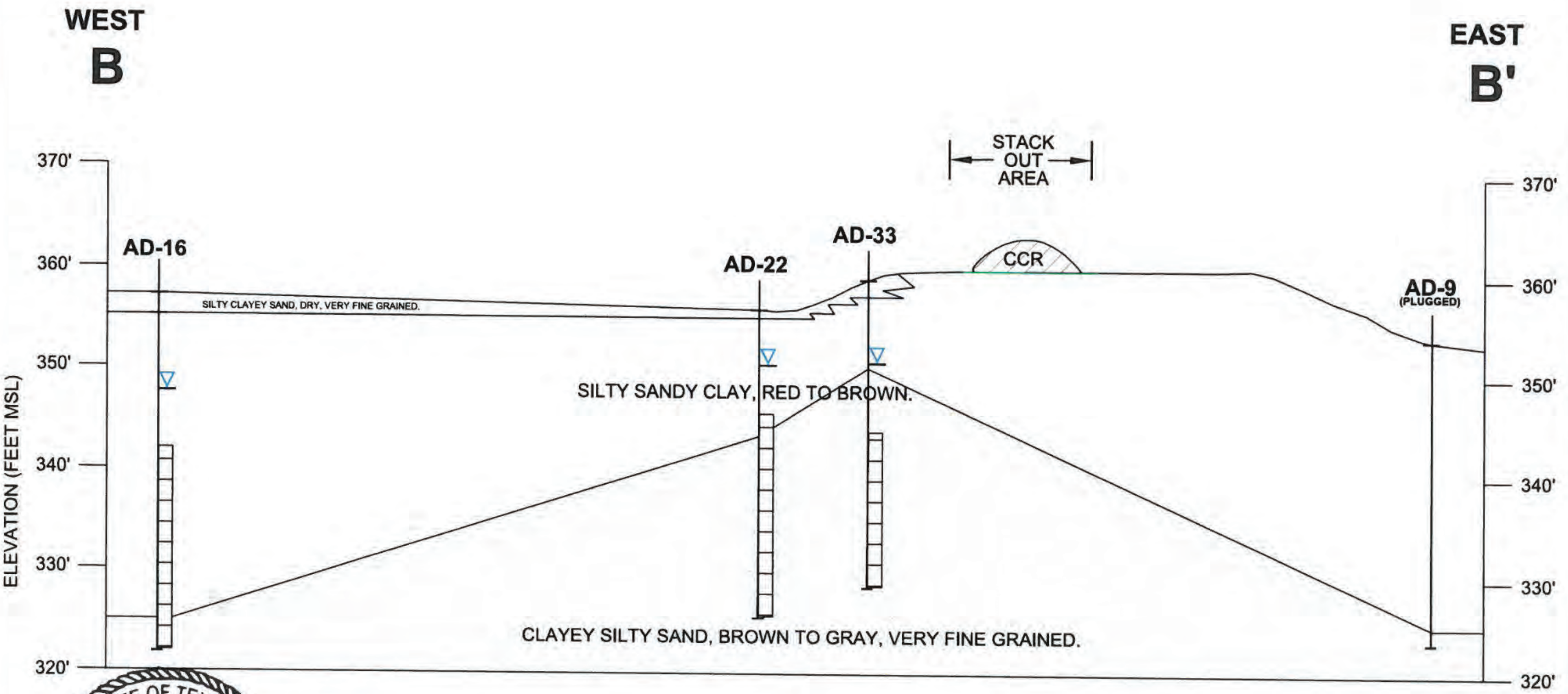

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LEGEND

- ⊟ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

NOTES:

A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 5 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 2/16/2016 1:49 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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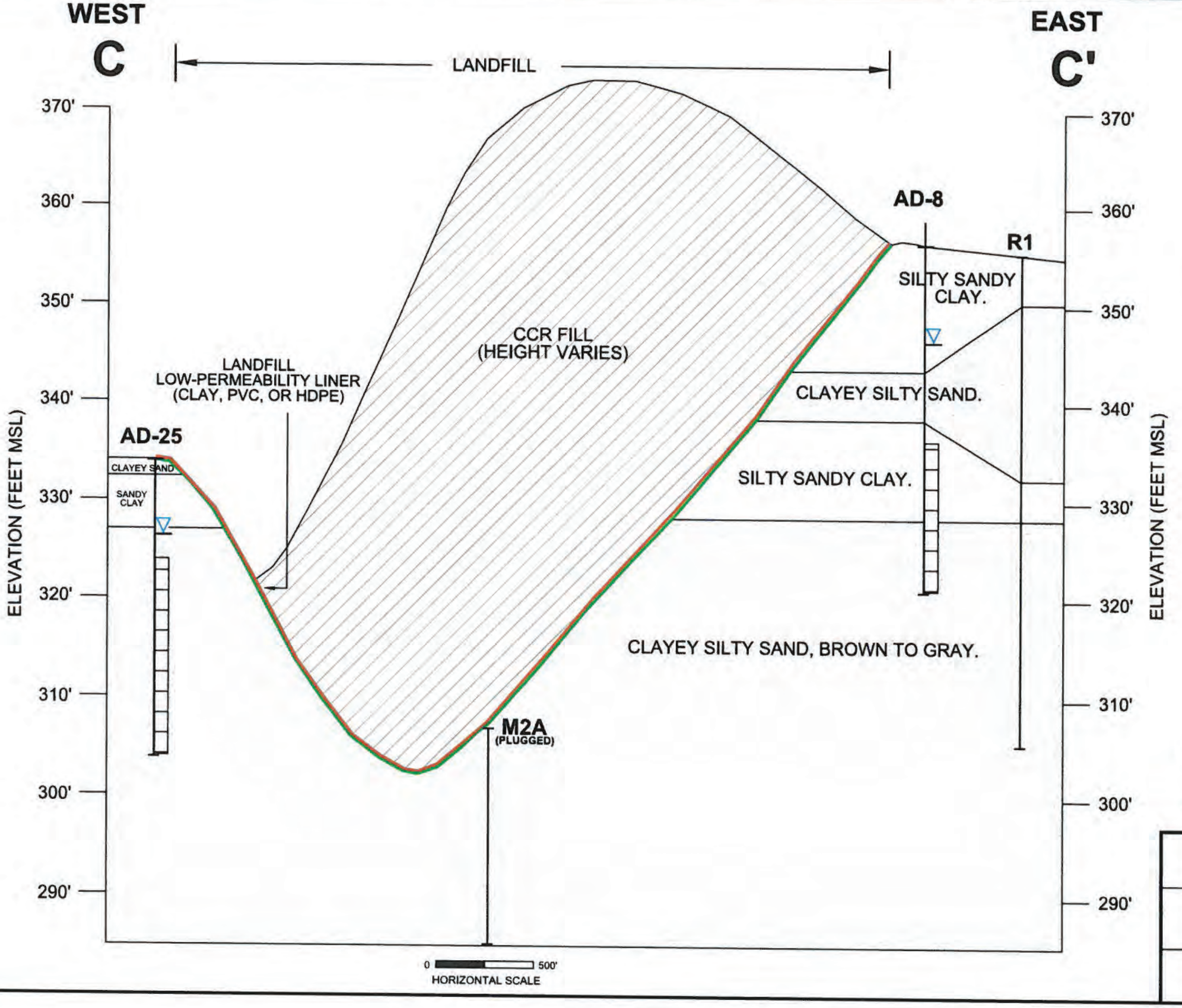

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5-25-16

LEGEND

- ⊟ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:25 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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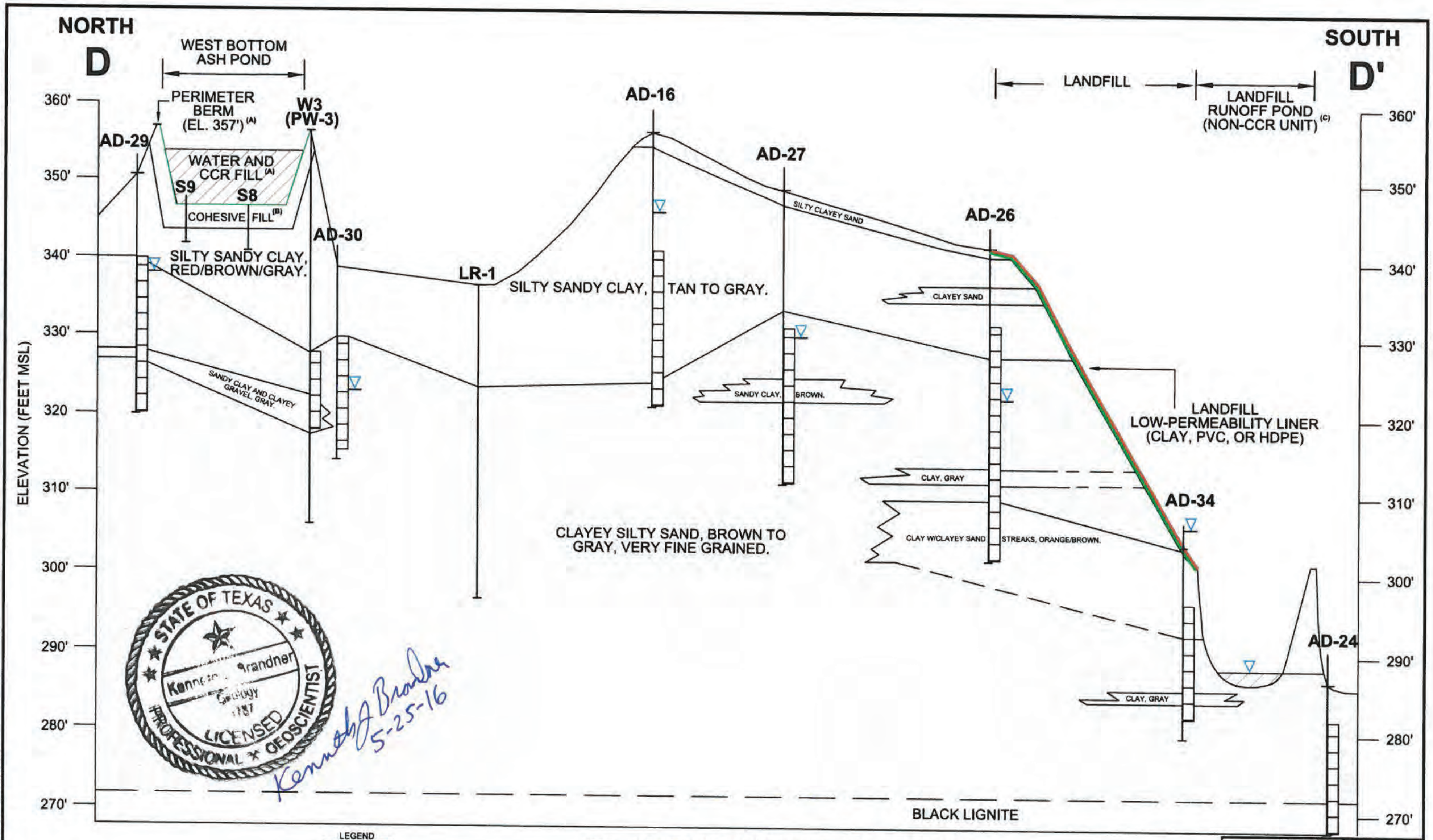

Kenneth J Brandner
5-25-16

0 600'
HORIZONTAL SCALE

LEGEND

▤	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).

C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION D - D'

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FIGURE
7

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 7 Cross Section D-D'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:30 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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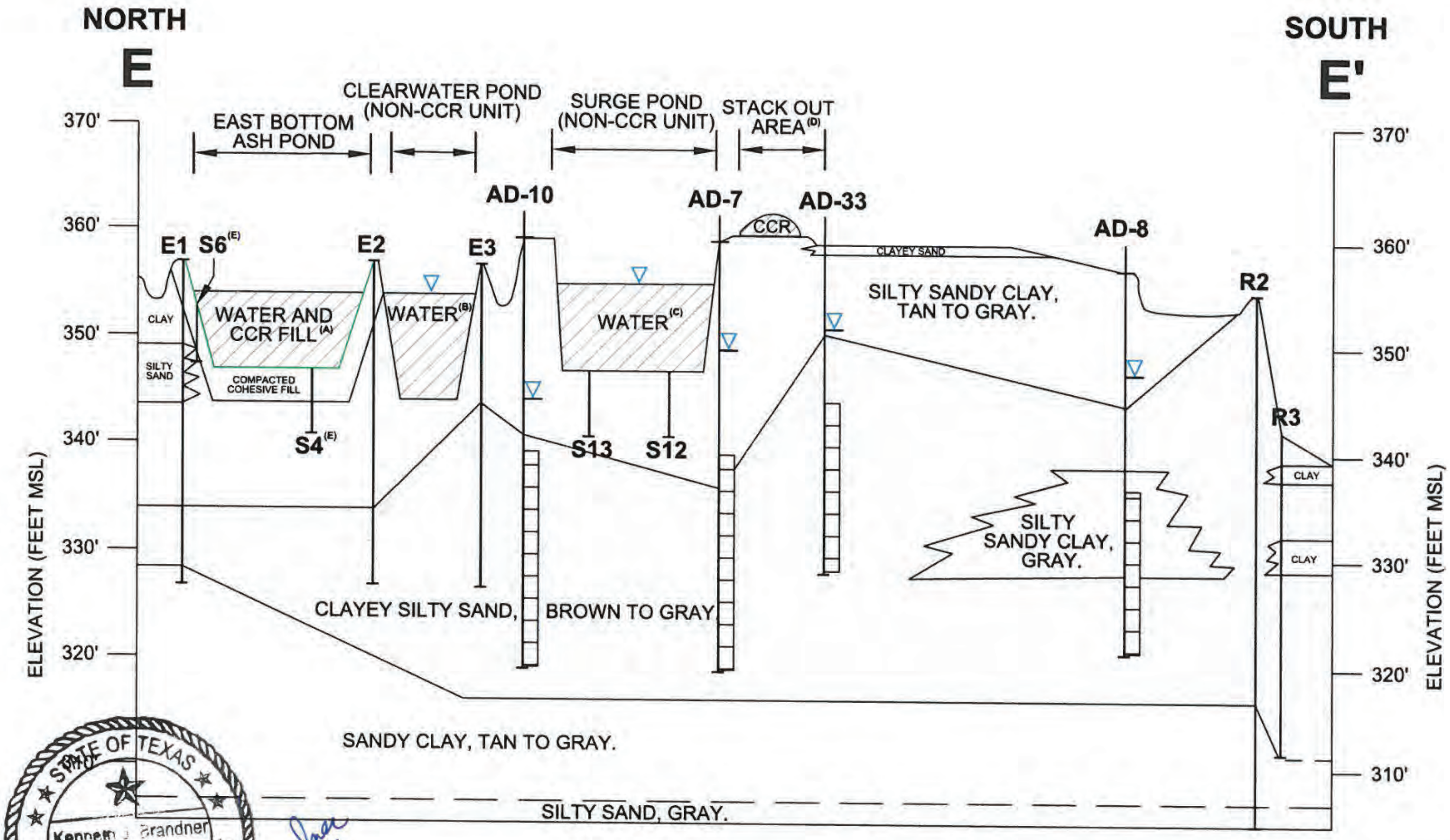

STATE OF TEXAS
Kenneth J. Brandner
Geology
1737
LICENSED
PROFESSIONAL GEOSCIENTIST

Kenneth J. Brandner 5-25-16

0 500'
HORIZONTAL SCALE

LEGEND

▤ MONITORING WELL SCREENED INTERVAL

▽ WATER LEVEL IN MONITORING WELL (1/20/16)

— BASE OF CCR UNIT

NOTES:

A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).

C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".

D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.

E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

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FIGURE
8

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 8 Cross Section E-E'.dwg LAYOUT: MODEL SAVED: 2/22/2016 11:26 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE: —
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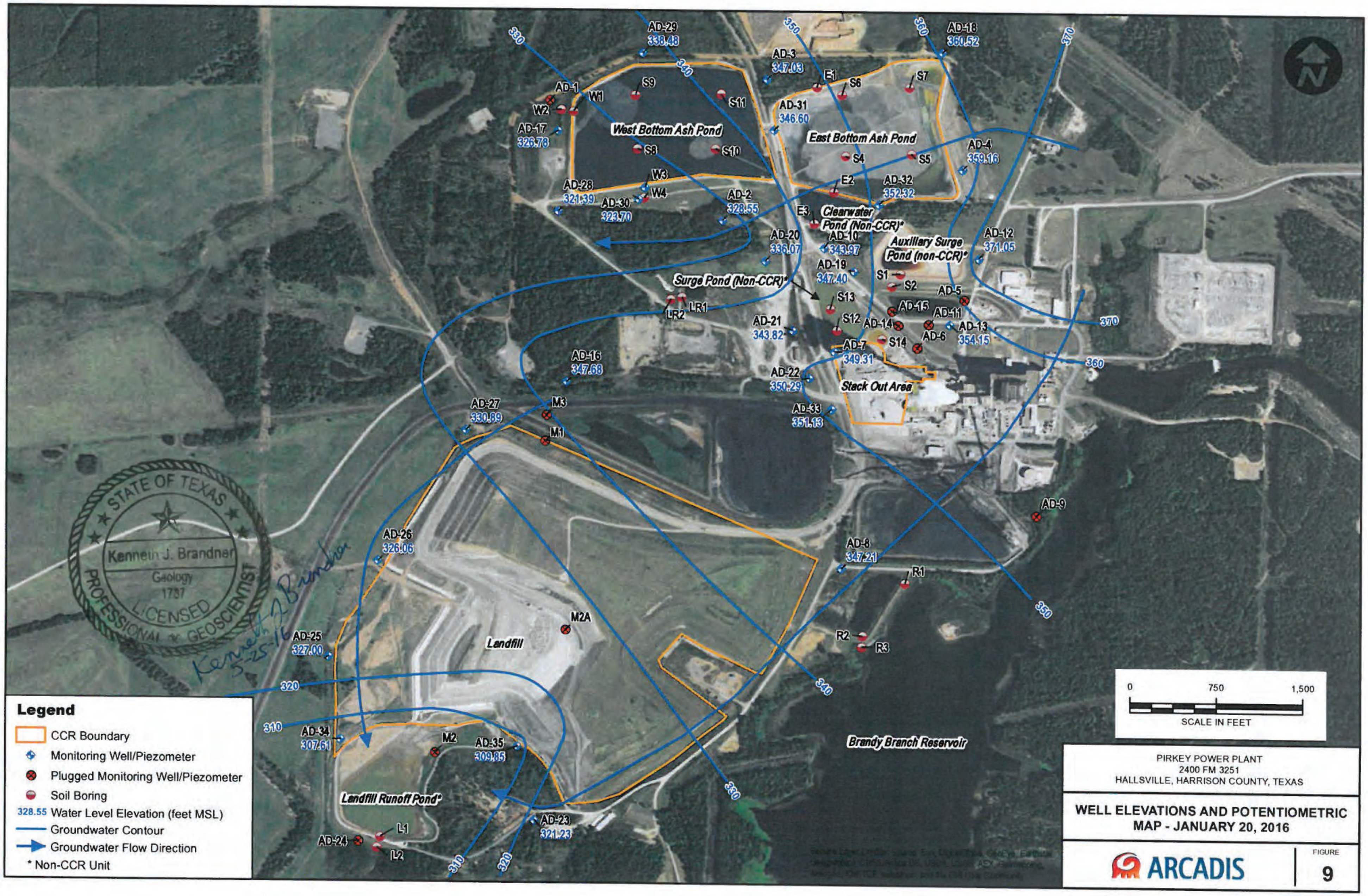

Legend

- ▭ CCR Boundary
- ◆ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ● Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- — Groundwater Contour
- → Groundwater Flow Direction
- * Non-CCR Unit

Kenneth J. Brandner
Geology
1737

Kenneth J Brandner
5-25-16

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

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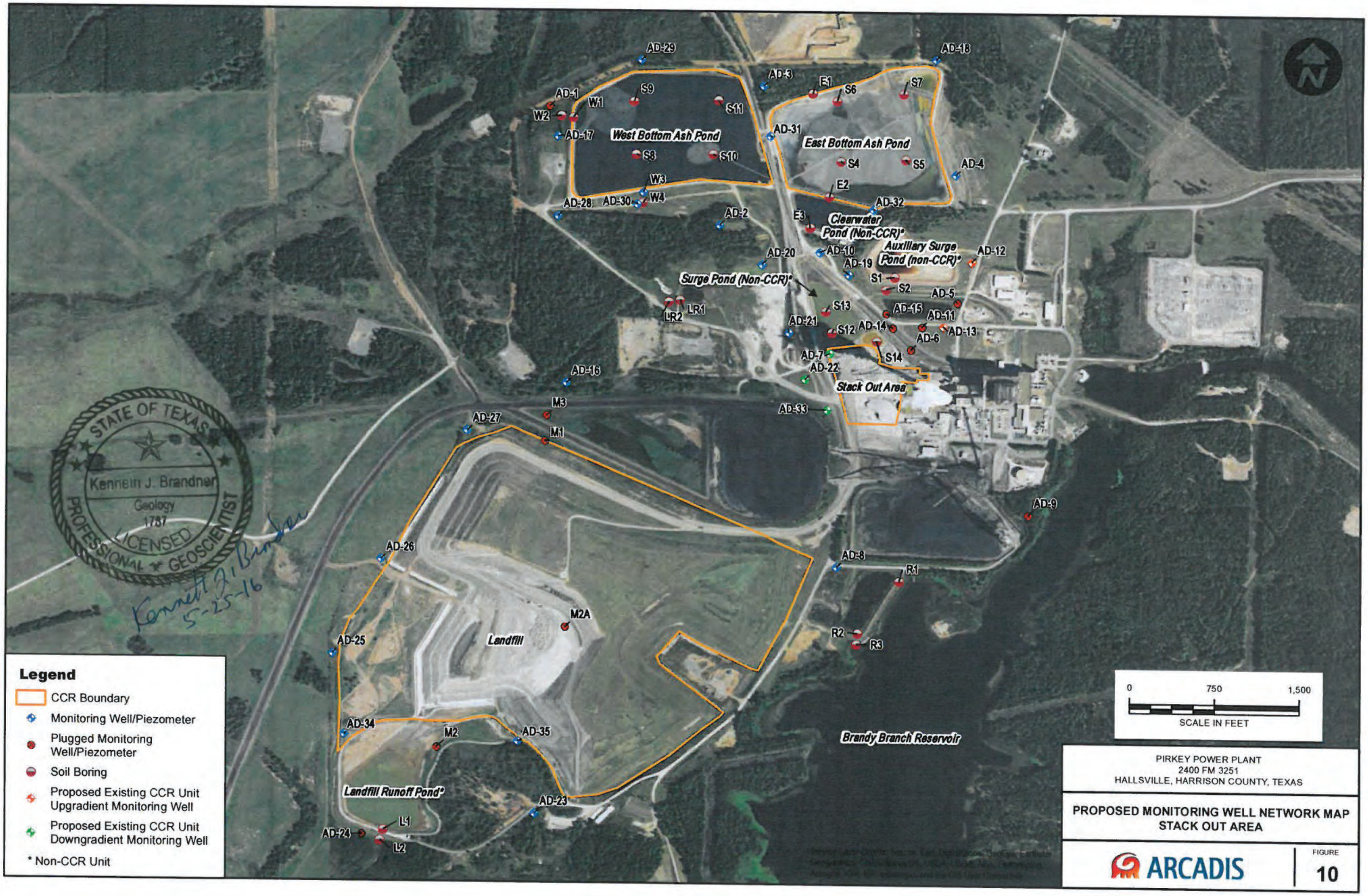
FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



Legend

- CCR Boundary
- Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- Proposed Existing CCR Unit Upgradient Monitoring Well
- Proposed Existing CCR Unit Downgradient Monitoring Well

* Non-CCR Unit

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1787

Kenneth J. Brandner
5-25-16

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP
STACK OUT AREA

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FIGURE
10

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 10 - Proposed Well Network - Stack Out Area.mxd

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Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

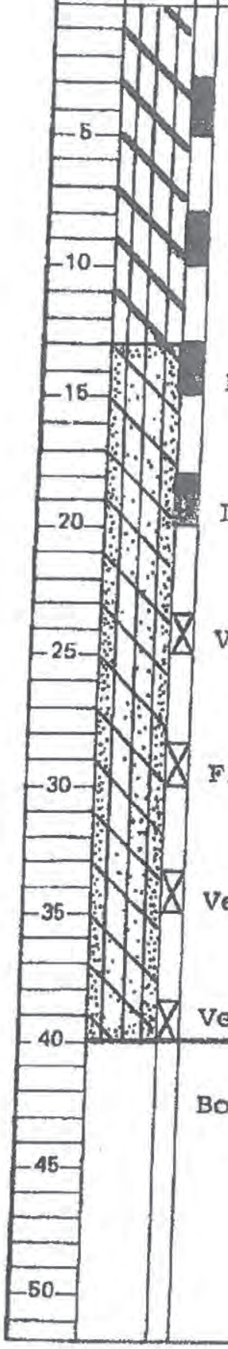
BORING NO.: MW-6
LOCATION: Hallsville

Date: 10-3-83 Type: Auger Ground Elevation:

Legend:

▨ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff tan and grey clay w/silt lenses and iron ore

Very stiff tan and grey clay w/silt lenses and iron ore

Firm tan and grey clayey silty sand

Loose brown and grey clayey silty sand

Very dense grey clayey silty sand 25-25=11½" 50 B/11½"

Firm grey clayey silty sand 7-7-17 24 B/F

Very dense grey clayey silty sand 25-25=9" 50 B/9"

Very dense grey clayey silty sand 18-32=10½" 50 B/10½"

Bottom of boring at 40 feet.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

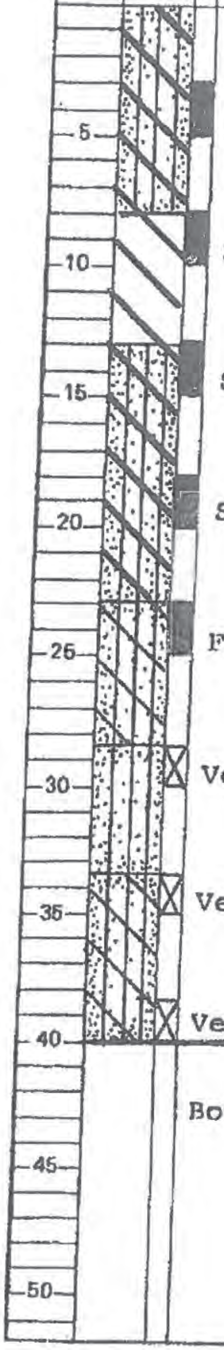
BORING NO.: MW-7
LOCATION: Hallsville

Date: 10-3-83 Type: Auger Ground Elevation:

Legend:

▇ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff red, tan and grey sandy silty clay w/iron ore

Stiff tan and grey clay w/iron ore

Stiff tan and grey silty sandy clay lenses w/iron ore

Stiff tan and grey very sandy silty clay

Firm tan and grey clayey silty sand

Very dense grey silty sand 23-27=12" 50 B/F

Very dense grey clayey silty sand 17-35=12" 50 B/F

Very dense grey clayey silty sand 25-25=10½" 50 B/10½"

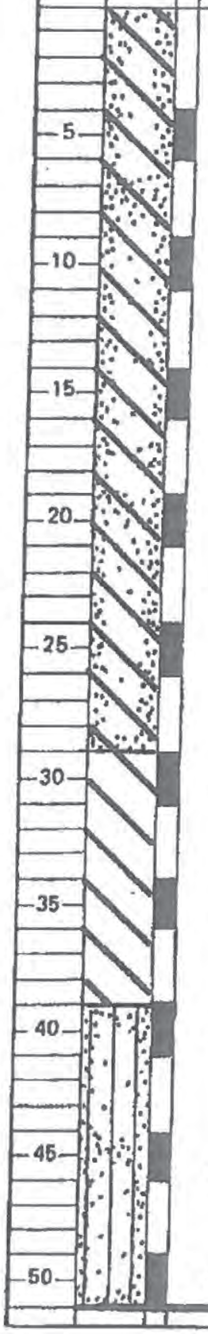
Bottom of boring at 40 feet.

832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond BORING NO.: MW-12
CLIENT: Southwestern Electric Power Company LOCATION: Hallsville, TX
N 6+13.25; W-6+90.36
Date: 1/30/86 Type: Rotary Ground Elevation: 378.41

Legend:
▆ Sample X Penetration ▼ Water



Depth, Feet	Description of Stratum
5	Brown and tan sandy clay
10	Brown, tan and gray sandy clay
15	Tan and gray sandy clay
20	Brown and tan sandy clay
25	Gray and tan sandy clay
30	Brown and gray clay
35	Brown and gray clay
40	Gray silty sand
45	Gray silty sand
50	Gray silty sand

Water encountered at 27.5 feet.
Bottom of Boring at 51 feet.

Observation Well Installation Report

Location Pirkey Power Plant	Date 2-23-88	Station # Elev. 361.85 0+33.3N, 8+84.7 W	City Hallsville, Texas
Project 880284	Observation Well Number MW-13	Location	
Type of Rig CME 55	Installed By DS, DY, LM	Date 2-23-88	Time

Method of Installation Hollow-stem auger

Log of Boring and Observation Well

Boring

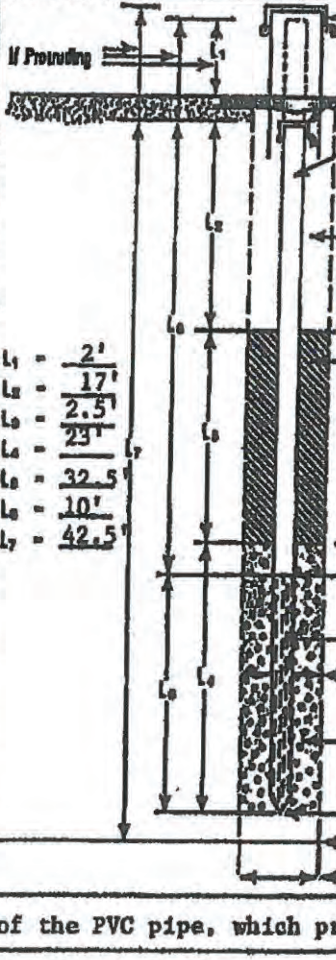
Depth in ft.	Cored Interval	Description

Observation Well

Type of Observation Well: ☐ Flush ☒ Protruding ☒ Locking Cap ☐ Manhole

Ground Elev. ______

Top of Riser Elev. ______



Protective Casing or Cap

I.D. Of Riser Pipe 4

Type of Pipe PVC Threaded

Type of Backfill Around Riser Bentonite & Portland Cement Grout

Top of Seal Elev ______

Type of Seal Material Bentonite Pellets 1/4"

L1 = 2'
L2 = 17'
L3 = 2.5'
L4 = 23'
L5 = 32.5'
L6 = 10'
L7 = 42.5'

Top of Filter Elev. ______

Elev. of Perforations ______

Size of Openings .010"

Diameter of Casing 4"

Tip ______

Type of Filter Material Tex Blast Blasting Sand

Bottom of Csg. Elev. ______

Bottom of Boring Elev. ______

Diameter of Boring 11"

Remarks L2, L5, L7 are measured from the top of the PVC pipe, which protrudes 2' above the ground surface.

Inspected By

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ______ ■ MONITOR WELL MONITOR WELL NUMBER: AD-22

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

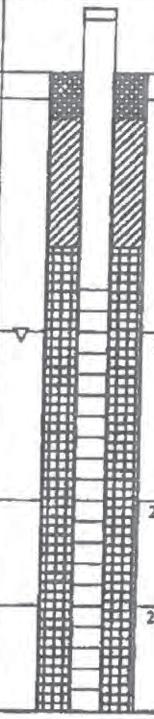
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/16/2010

PREPARED BY: David Bedford LOGGED BY: David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 WELL LOCATION: Triangle- South side Quansit Hut
LONGITUDE: W94°29'41.3"



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SC	Clayey sand, light brown, very fine grained	None	Moist
2 3 4 5 6 7 8 9 10 11 12			0.5-12	CL	Lean clay, light brown mottled with light gray Few iron ore (small) pebbles in clayey sandy streaks	None	Slightly Moist
13 14 15 16 17 18 19 20			▽ 12-20	SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained Slightly wet @ 12.5' from seepage Large amount of iron ore 15-17' Very firm 18-18.5'	None	Slightly Wet
21 22 23 24 25			20-25	SC	(Dense crystalline rock 21-21.1'), light brown clayey sand, greenish black, mica, black clay streaks, very fine grained, wet @ 20'	None	Wet
26 27 28 29 30			25-30	SM	Sand, greenish brown (1') grading to orangish brown, silty, very fine grained	None	Wet
31 32 33 34 35 36 37 38 39 40					Boring Terminated at 30'		

▦ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 12.5'
Above Ground 3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-33**

JEFFREY D. SAMMONS
GEOLOGY
#10070
1.21.16

PROJECT INFORMATION

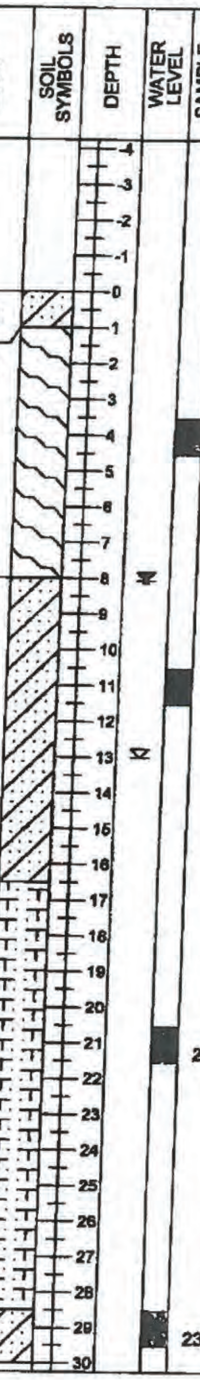
PROJECT: **Pirkey Power Plant**
PROJECT NO.: **I-04-1021**
LOGGED BY: **Jeffrey D. Sammons, P.G.**
SUPERVISING PG: **Jeffrey D. Sammons, P.G.**
COMPLETION: **12/11/2015**
DEVELOPMENT: **12/16/2015**
SITE LOCATION: **2400 FM 3251, Hallsville, Texas**
WELL OWNER: **AEP**

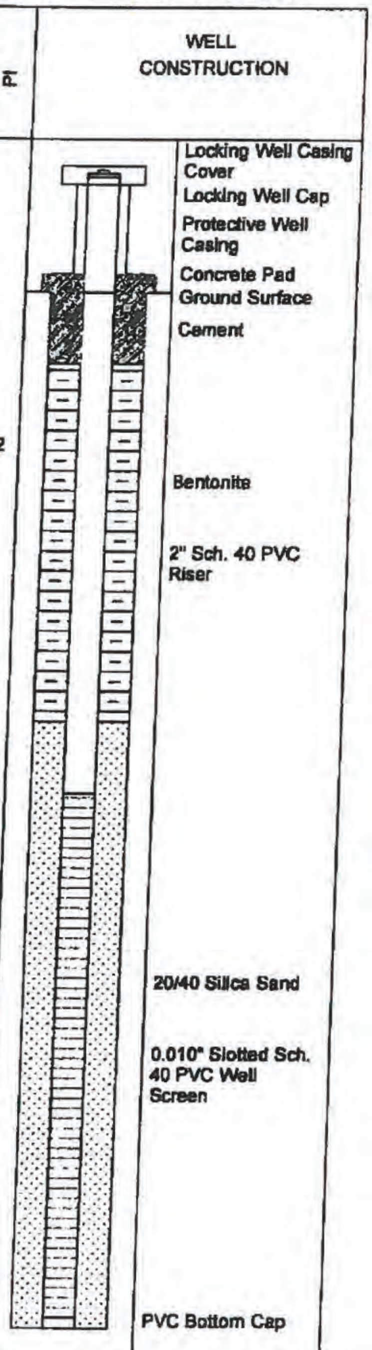
DRILLING INFORMATION

DRILLER: **Buford Collier**
DRILLER'S LICENSE NO.: **60089**
RIG TYPE: **Geoprobe 3230DT**
METHOD OF DRILLING: **Hollow Stem Auger**
SAMPLING METHODS: **Split Core**
SURFACE ELEVATION: **382.37 (Top of Casing)**
HOLE DIAMETER: **8.25"**
LATITUDE **32 27' 38.70"** LONGITUDE **94 28' 15.82"**

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample **TBPG No. 50027**

DESCRIPTION	USCS	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, some silt, dark brownish black and brown, very moist	SC					
FAT CLAY: trace sand and silt, reddish brown and light gray - some iron ore gravel at 2.0' - some silt and ironstone in thin seams at 2.5', light gray, yellowish brown, and reddish brown,	CH	29	93	74	32	42
CLAYEY SAND: interbedded clays and fine to very fine sand and silt, some iron ore gravel, light reddish brown and light gray	SC					
- some clay and trace of iron ore gravel at 11', light gray and reddish brown, moist		21	35	35	23	12
- trace clay at 13', thin saturated ironstone and gravel seams at 13' to 16', reddish brown, light reddish brown, and light gray - dark reddish brown at 15' - clay lense at 15.5' to 16.5', light reddish brown and light gray						
SILTY CLAYEY SAND: very fine to fine sand, reddish brown, very moist to saturated	SM-SC					
- some clay lenses and iron ore gravel at 20' - clayey at 20.5' to 21' - trace clay at 21', light gray, saturated		23	19	27	18	9
- some iron ore gravel at 28', reddish brown, very moist						
CLAYEY SAND: very fine to fine sand, dark gray and gray, moist	SC	23	30	25	18	7





NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

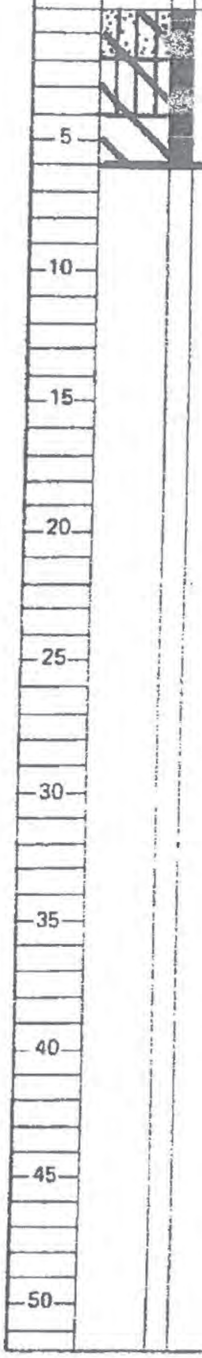
BORING NO.: S-12
LOCATION: Hallsville, TX

Date: 9-15-83
Type:
Ground Elevation: 348.3

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample

Description of Stratum



Red and grey sandy silty clay

Red and grey clay w/silt lenses

Red and grey clay

Bottom of boring at 6 feet.

No water encountered.

832964

LOG OF BORING

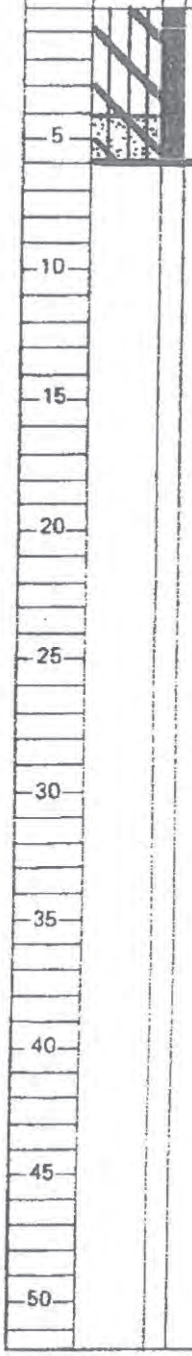
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-14
LOCATION: Hallsville, TX

Date: 9-15-83
Type:
Ground Elevation: 352.9

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Brown and red clay w/silt lenses

Brown and red slightly silty clay

Brown and red sandy silty clay

Bottom of boring at 6 feet.

No water encountered.

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Appendix B

Photographic Log

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PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
1	8/19/2015

Direction Photo Taken:

East Southeast

Description:

P8190405
AD-21 Ground water monitoring well northeast of Stack Out Area.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
2	8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190438
Stack Out Area

4.5 – A Groundwater Sampling and Analysis Plan for Pirkey Power Plant, CCR Units – Landfill, FGD Stackout Area, East Bottom Ash Pond, and West Bottom Ash Pond, December 2021 – Revision 1

A Groundwater Sampling and Analysis Plan for Pirkey Power Plant

CCR Units- Landfill, FGD Stackout Area, East Bottom Ash Pond, and West Bottom Ash Pond

Coal Combustion Residuals Rule Compliance

Prepared by: Environmental Services

Date: April 27, 2016

December 2021- Rev 1

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BOUNDLESS ENERGY™

Table of Contents

1. Introduction

The following sections address the Texas Commission on Environmental Quality (TCEQ) Coal Combustion Residual (CCR) rule (30 TAC 352) and includes protocols and considerations for gathering groundwater samples, preserving them, proper documentation and shipping them to the analytical lab.

The TCEQ's CCR Rule requires that a monitoring program include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of groundwater quality at the background and down gradient wells and that a sampling and analysis program be developed that includes procedures and techniques for:

- Sample collection
- Sample preservation and shipment
- Analytical procedures
- Chain of custody control
- Quality assurance and quality control
- Statistical analysis procedures

The purpose of this groundwater sampling and analysis plan (GW-SAP) is to lay out these details and is aimed at satisfying the monitoring of the PE-certified groundwater monitoring network according to the requirements of TCEQ's CCR Rule.

2. Sampling and Analysis Plan

This GW-SAP includes consistent sampling and analysis procedures that are protective of human health, safety, and the environment, and that are designed to ensure monitoring results that provide an accurate representation of groundwater quality.

The TCEQ's CCR Rule has a performance standard that calls for establishment of consistent sampling, laboratory analysis, and quality assurance/quality control procedures. The development of a GW-SAP in advance of performing the sampling provides an added benefit that analytical results will be less subject to variability over time. This is important because a change in sampling methods, laboratory analytical methods, or even analytical laboratories, can cause shifts in data that can complicate statistical analyses and potentially trigger a false SSI or SSL.

The TCEQ's CCR Rule requires analysis of total recoverable metals (i.e., no field filtering) in measuring groundwater quality. As a result, groundwater samples from some monitoring wells may exhibit variable levels of turbidity that can potentially trigger false SSIs or SSLs. Therefore, this sampling and analysis plan calls for the use of low-flow sampling techniques, which are designed to minimize turbidity at the time of sample collection. However, other sampling techniques may be used if low-flow sampling cannot be supported by the aquifer. This GW-SAP also includes a specification to collect an optional, filtered sample whenever turbidity is higher than a threshold of 10 NTU. If the optional field filtered samples are to be collected for a sampling event then there will be a specific instruction to collect the field filtered samples. If no specific instruction is given then field filtered samples will not be collected.

The TCEQ's CCR Rule calls for analysis of total recoverable metals, and has a performance standard that analytical methods be appropriate and accurate for groundwater analysis. There are a variety of laboratory analytical methods that meet these criteria, and selection of appropriate methods can be based on desired reporting limits, accuracy, precision, potential for interferences, and cost. A list of appropriate analytical methods is included in **Appendix C**.

Appendix B contains Instruction to sampler for sampling event. This form should be customized for a specific sampling event. This document will communicate to the sampler the scheduled date for sampling; the wells to be sampled; which parameters to the sampled; whether state parameters should be sampled. Other information pertinent to the specific sampling event may be included on this instruction sheet.

2.1 Measurement of Groundwater Level

As reference, a site map showing locations and ID of the monitoring wells is included in **Appendix A**. **Appendix B** contains monitoring well construction information and sample groundwater sampling data form. Prior to well purging and sampling, static water level in each well and piezometer are to be measured and recorded to the nearest hundredth of a foot. Static water levels for all wells and piezometers are to be taken within a 24-hour period. To measure the static water level, an electronic probe on a measuring tape is lowered into the groundwater well riser pipe. When the probe contacts the water a visual and audible alarm are activated. The static water level is established by reading the measurement on the tape to a hundredth of a foot (0.01-foot) at the top of the riser pipe, i.e., top of casing (TOC). Results are immediately recorded on the groundwater sampling data form along with the date, time, monitoring well number, and the name of the person recording the data. The probe is rinsed with deionized water before using in the first well and then after each use.

2.2 Collection and Handling of Groundwater Samples

Low flow sampling is the preferred method for collecting the groundwater samples. Therefore, the sample collector needs to be well versed in the intricacies of low flow sampling.

Low flow purging and sampling

Equipment needed

Low flow pump. The pump will have the ability to regulate flow in the range of 0.1 liters per minute to 0.5 liters per minute or a greater range.

Field parameter measurement instruments. The instruments should include instruments for measuring:

depth to water

pH

specific conductivity

turbidity

temperature

dissolved oxygen (if requested by AEP)

oxidation reduction potential (if requested by AEP)

Groundwater sampling data forms

See **Appendix B** for a check list of equipment to be considered for use.

Procedures to follow at the beginning of the sampling event.

Before beginning sampling all field instruments should be calibrated. Additional calibrations may be needed during the sampling procedure.

The instruments used to make the measurements will be instruments designed by the manufacturer to perform such measurements. The instruments will be calibrated in accordance with the manufacturer's instructions and decontaminated between each well by rinsing with deionized water or as recommended by the manufacturer. A record of the calibration procedures used and information on the specific standards used should be recorded on the Calibration Record Form (see **Appendix B** for example) or a similar form. At a minimum, a notation will be made stating that each instrument is in calibration or not in calibration.

Duplicate samples will be needed. Select suitable sampling locations for duplicates.

Blanks will be needed. Select suitable times and locations to collect blanks.

Purging and sampling procedures for each sampling location.

Decontaminate equipment

Reusable sampling equipment, including pumps, tubing, and instrumentation is decontaminated using deionized water, soap solution, or other appropriate methods after each use. The disposable equipment should be purchased in a clean state and maintained clean until used for sampling.

Measure groundwater level

If not previously measured as state in paragraph 2.1, prior to well purging or sampling, the depth to water in each well is measured and recorded. The depth to water is measured to the nearest 0.01 foot increment with a calibrated water level indicator. The probe is lowered into each well until the audible indicator sounds indicating that contact of the probe with the water surface has occurred. The depth of water is measured from the top of the casing. The top of casing has already been surveyed and its elevation is known. The data are recorded on the field log or similar form with date, time, monitoring well number, depth to water, and the name of the person recording the data. The probe is rinsed with deionized water before and after each use.

Install pump

Install the intake for the pump near the mid-point of the screened interval of the monitoring well. Minimize disturbances in the groundwater. Agitation of the groundwater will result in suspension of any particulates in the well and may result in chemistry changes in the groundwater due to aeration of the groundwater. Such conditions are to be avoided.

Measure groundwater level

The amount of groundwater drawdown needs to be checked. Ideally, only a small amount (less than one foot) of drawdown should occur as the result of purging the well. This measurement may be taken with a groundwater tape or an electronic pressure transducer or other suitable measuring instrument. This measurement may not have the same reference elevation as the depth to groundwater measurement and the measurement may not be the same value as the original depth to groundwater measurement.

Record the measurement.

Purge monitoring well

Set flow rate of pump

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. The water level should not be lowered so that the water level is brought down to within the screened interval. That is, the pump should be operated so that the water elevation is above the screened interval. However, the groundwater level may be within the screened interval before pumping begins. In that case the water level during pumping may be within the screened interval. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the minimal drawdown that can be achieved exceeds 1 foot, but remains stable, continue purging.

Monitor and record the water level and pumping rate on the groundwater sampling data form every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time.

If the water level continues to drop at the lowest practical pumping rate then an alternate purging and sampling procedure will apply. The well will be purged of water and allowed to recharge. Sampling will occur when enough water is in the well to obtain groundwater samples. Pumping rates for sampling will be low in order to minimize entrainment of solid particles.

Monitor parameters

In order to determine if the pumped groundwater has chemically stabilized to the point where a representative sample may be taken, certain field parameters are monitored.

Field parameters will include at least pH, specific conductivity, and turbidity. Other parameters that may be included are dissolved oxygen, oxidation reduction potential, and temperature.

Field parameters stabilize

Field parameter stabilization is considered to be achieved when two consecutive readings are within the following limits:

pH (± 0.1 unit),

Specific Conductance (3%),

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),

Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),

Oxidation/Reduction Potential (± 10 millivolts),

Temperature (± 3%).

Collect samples

Adequate sample volume is collected to meet the analysis requirements. Care is taken to collect an undisturbed sample to the extent practicable. The low flow pumping rate used during purging is also used for sample collection. Appropriate sample preservatives will be used for each sample collected. The preservatives may be put into the sample bottle before or immediately after the sample is collected. See Appendix C for types of sample containers needed and preservative needed.

Complete paperwork for this sample location

The groundwater sampling data form, sample labels, and chain of custody are to be complete for this sample location.

Decontaminate equipment, dispose of consumables

Any equipment that will be used on another sample location will have to be decontaminated before reuse. Any used consumable supplies needs to be collected for disposal or other disposition.

Clean up sample location and move to next sample location

The sample site should be cleaned up. Close and lock the monitoring well.

Equipment Decontamination Procedures

Reusable sampling equipment, including pumps, tubing, and instrumentation is decontaminated using deionized water, soap solution, or other appropriate methods after each use. This includes all non-dedicated equipment that is submerged in a monitoring well or otherwise contacts a groundwater sample.

Analytical Parameters

Parameters to be analyzed for the eight sample sets establishing background concentrations are shown in the table below. Both the Appendix III and Appendix IV list of parameters are used for the establishment of background concentrations. After collection of that initial set of data from eight discrete samples, the Appendix III detection monitoring parameters will continue on a semi-annual basis.

Field Filtered Samples

If directed by AEP the sampler will collect a field filtered metals sample. Field filtered metals samples will only be collected if the unfiltered groundwater has a turbidity of greater than 10 NTU. If the turbidity of the groundwater is less than 10 NTU then a sample will not be taken for the particular sampling location.

Field filtered samples are collected by placing a 0.45 micron filter on the end of the groundwater discharge tube. If single use (disposable) 0.45 micron filters are used then a new filter will be used for each sample. The filtered groundwater flowing out of the filter will be collected in a separate sample bottle and marked as a field filtered metals sample. See Appendix C for the type of sample bottle and the preservation method.

Appendix III parameters **Parameters for detection monitoring**	**Appendix IV parameters** **Parameters for assessment monitoring**
Boron (B)	Antimony (Sb)
Calcium (Ca)	Arsenic (As)
Chloride (Cl-)	Barium (Ba)
Fluoride (F-)	Beryllium (Be)
pH	Cadmium (Cd)
Sulfate (SO4-)	Chromium(Cr)
Total Dissolved Solids	Cobalt(Co)
	Fluoride (F-)
	Lead (Pb)
	Lithium(Li)
	Mercury (Hg)
	Molybdenum (Mo)
	Selenium (Se)
	Thallium (Tl)
	Radium 226 and 228 combined (Ra)

Sample Preservation and Handling

The proper containers for the parameters to be analyzed will be pre-cleaned and supplied by the contractor performing the sampling effort. Care will be taken during sampling not to overfill the sample bottles that contain preservatives. In addition to the sample bottles, one or more sample containers may be used in lieu of an in-line monitor for the field determination of parameters. The containers must be rinsed with distilled water and dried after each use or new clean sample containers utilized.

Upon completion of sampling of each monitoring well, all relevant sampling information should be recorded on the appropriate groundwater sampling data form, and the sample bottles placed in a cooler or ice chest at 40F (4C), as necessary, for storage until analyzed. If ice is the coolant then the sample bottles must be enclosed in sealed plastic bags. Once the final sample is collected at the site, the chain of custody form mentioned below must be completed. These procedures are necessary to insure that the maximum allowable holding time or maximum allowable shipping temperature for any of the parameters is not exceeded.

Sample Identification

Samples must be properly labeled. Information that should be transmitted to the laboratory includes:

- Plant name
- Sample/well identification number
- Analyses to be performed
- Date and time of collection
- Initials of field sampling personnel

A self-sticking, adhesive backed identification label will be attached to each sample container. The identification labels will be completed and attached to the appropriate container. The date and time of sampling will then be added at the time of collection.

Chain of Custody

To establish the documentation necessary to trace sample possession from the time of collection through analyses and final disposition, a chain of custody form will be filled out and must accompany each sample shipment. This record is required for legal verification of sample integrity. It also provides useful control over the routing of samples.

When transferring possession of the samples each individual relinquishing and receiving possession will sign, date and note the time on the form. Relevant information regarding the samples should be entered on the form.

The original chain of custody record must accompany the sample shipment. A chain of custody form, properly filled out, will accompany each shipment. Upon arrival at the Lab the chain of custody will serve to identify the shipment of samples.

An example of a chain of custody that fits the need and that has been used in the past at AEP is appended as **Appendix B**, as well as a sample container list to be used and preservation methods/protocols.

2.3 Laboratory Analyses

The analytical methods used by the laboratory must be appropriate for groundwater and accurately measure constituent concentrations in the water samples [40 CFR 257.93(b)]. Some state agencies require EPA sanctioned analytical methods. **Appendix C** lists many of the laboratory analytical methods used at our laboratories. Also listed is the type of sample container needed, the preservative, the holding time, and the name of the method.

The laboratory reports will be prepared in accordance with the laboratory's quality assurance procedures. The laboratories accreditation organization, e.g., NELAC, and the analytical method may also have reporting requirements.

2.4 Quality Assurance and Quality Control

Field quality assurance

Field quality control measures are proven procedures for collecting representative samples, calibrating field testing equipment, preserving samples for analysis, and documenting chain of custody. These measures contribute to producing monitoring results that are reliable indications of groundwater quality.

Calibration of field instruments

The instruments will be calibrated in accordance with the manufacturer's instructions. A record of the calibration procedures used and information on the specific standards used should be recorded on the Calibration Record Form or a similar form. At a minimum, a notation will be made stating that each instrument is in calibration or not in calibration.

Quality control samples collected in the field

ACID BLANK OR PRESERVATIVE BLANK: The laboratory prepares an acid or preservative blank by filling a sample container with deionized water. The sampling technician adds the same preservative used for the groundwater sample to the blank sample container. Typically, nitric acid is the only preservative used. However, if another preservative is needed for a sample then a blank for that preservative will be prepared and used. One preservative blank is taken per sampling event per source container of preservative used. The laboratory analyzes the blank for the same constituents as the samples. This will demonstrate that the acid contains no contaminants or that it is contaminated with some of the constituents for which the sample is being analyzed.

If the laboratory provides the sample bottles with preservative already in them then a preservative blank sample will not be obtained.

FIELD DUPLICATE: A second sample collected as close as possible in space and time to an original sample. The original and duplicate samples are assigned different laboratory identification numbers and analyzed independently. The duplicate is typically identified with a code that does not enable the laboratory to correlate it to the original sample. The code and sample location are recorded on the groundwater sampling data form so that the analytical results from the duplicate can be compared to the original sample after laboratory analysis is complete. Duplicates are useful in documenting the precision of the sampling process. In groundwater monitoring, one field duplicate is commonly collected each day.

EQUIPMENT RINSATE: A sample of analyte-free media which has been used to rinse the reusable sampling equipment. It is collected after completion of decontamination and prior to sampling. This blank is useful in documenting adequate decontamination of sampling equipment. One equipment rinsate is typically collected per day, although additional rinsate samples may be collected if the sampler deems appropriate.

FIELD BLANK: In the field, analyte-free water is collected into a sample container with the same preservatives as used for the groundwater samples. The sample containers are the same lot as used for the groundwater samples. These samples are used to evaluate contamination introduced from the sample container(s) with applicable preservatives.

TRIP BLANK: A sample of analyte-free media taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures.

Laboratory quality assurance

The laboratory's quality assurance procedures are documented in the laboratory's quality assurance manual. The requirements of the quality assurance manual will be followed by the laboratory.

3. Well Development

Well development is not part of sampling and analysis. However, well development may take place during a sampling event. If well development is indicated as part of the sampling event, well development will take place after groundwater sampling for the particular well has been completed.

Well development is intended to remove fine particulate matter (turbidity), commonly clay and silt, from the geologic formation near the well intake. The groundwater is disturbed, suspending particulates into the groundwater, and the removing the groundwater with suspended particulates.

Two methods of well development will be used: surging and pumping.

Surging is performed with a surge block or device. The movement of the surge block causes the water to move in a turbulent manner inside the well. This water movement causes particulates to be suspended in the groundwater. The surge block should be of sufficient weight and density that when lowered it will force water out of the well and into the formation. The surge block should lifted quickly in order to cause turbulent flow into the well. After the groundwater has been agitated with the surging activity the monitoring well will be pumped to remove the turbid water. Repeated cycles of surging and pumping may occur if there is an adequate supply of groundwater and the activity results in the removal of particulates (turbidity).

Well development will be documented on the Well Development Record form.

References

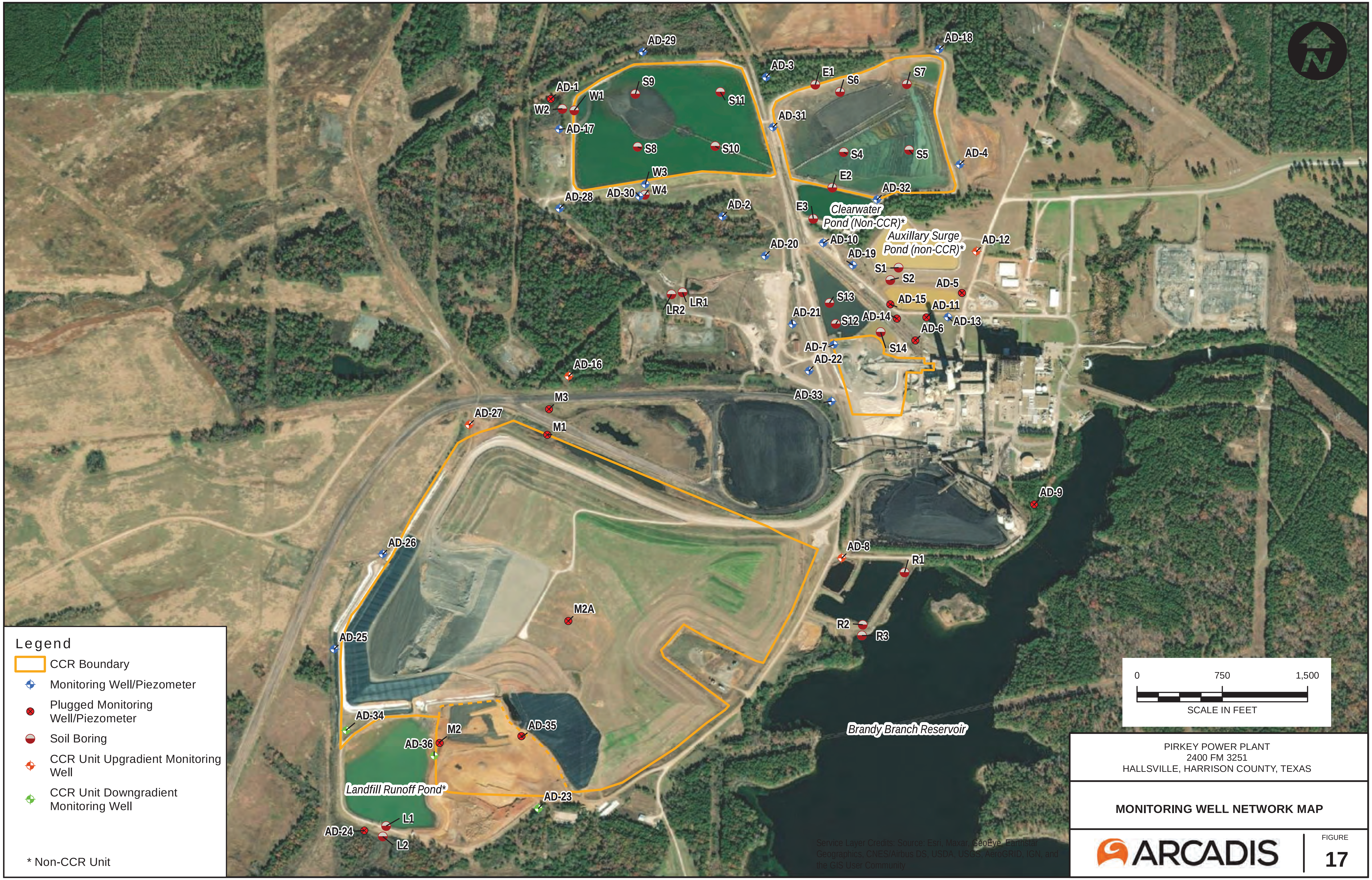
USEPA. *Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells.* EPA 600-4-89-034. U.S. Environmental Protection Agency, March 1991.

USEPA. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance*. EPA 530-R-09-007. U.S. Environmental Protection Agency, March 2009.

USEPA. *Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells. EQASOP-GW 001.* U.S. Environmental Protection Agency Region 1, January 2010.

APPENDIX A

Site Map with Groundwater Monitoring Wells



Legend

- ▭ CCR Boundary
- ⊕ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ◓ Soil Boring
- ⊕ CCR Unit Upgradient Monitoring Well
- ⊕ CCR Unit Downgradient Monitoring Well

* Non-CCR Unit

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

MONITORING WELL NETWORK MAP

ARCADIS

FIGURE
17

Document Path: T:_ENV\AEP\Pirkey Plant\MXD\Updated\Figure 17 - Proposed Well Network - Landfill.mxd

APPENDIX B

Forms

Instructions to sampler for sampling event

Monitoring Well Construction Data

Groundwater Sampling Data Form

Calibration Record Form

Monitor Well Development Record

Well Inspection Form

Chain of Custody Form

Instructions to sampler for sampling event.

Location	Pirkey
Event	
Scheduled sample date	
Contact information	Control Room 903-927-5883 Samantha McDonald 903-927-5853 John Burgess 903-927-5887 Leslie Fuerschbach 318-673-2744; cell 318-464-3123
Number of wells to sample (CCR)	20
Number of duplicate samples needed including blanks (CCR)	1 -metal; 1 - WQ; 2 - Ra-226; 2 - Ra-228*
Number of wells to sample (State)	None. State samples are never taken at Pirkey.
Number of duplicate samples needed including blanks (State)	None
Parameters to sample (see lists of parameters below)	Appendix III and Appendix IV

CCR samples						
Well	Metals	WQ	Ra-226	Ra-228	Field parameters	Depth gauge
see list below	x	x	x	x	x	x
see list below						x
duplicates	1 per sampling day	1 per sampling day				
Ra duplicates - see below			x	x		
Equipment blank	1	1				

Monitoring wells

Monitoring wells to sample (CCR):AD-2, 3, 4, 7, 8, 12, 13, 16, 17, 18, 22, 23, 27, 28, 30, 31, 32, 33, 34, 36 (20 wells total)

Monitoring wells to gauge depth to water only: AD-10, 19, 20, 21, 25, 26, 29 (7 wells total)

Chain of Custody

There will be one chain of custody for CCR metals and water quality.
There will be one chain of custody for CCR radium samples.

Duplicate Samples

Duplicate samples for Ra-226 and Ra-228.

The Ra-226 and Ra-228 samples are two separate samples.
The TCEQ's CCR Rule requires the results of the two analyses (Ra-226 and Ra-228) to be combined mathematically and the combined result reported.

For the radium duplicates mark the well name on the sample label and mark it 'Laboratory QC duplicate'.

For the radium duplicates mark the well name on the sample label and mark it 'Laboratory QC duplicate'.
The sample and duplicate for Ra-226 may come from a different well than the sample and duplicate for Ra-228.

The sample for Ra-226 will be one 1 liter bottle. The sample for Ra-228 will be one 1 liter bottle.
For every 10 wells or less obtain 1 duplicate for Ra-226.
*For every 10 wells or less obtain 1 duplicate for Ra-228 - however the duplicate will require 2 - 1 liter bottles.

Other duplicates.

Sample Bottles

Sample bottles and preservatives needed for each well:

CCR:
If Appendix III only is being sampled then one - 500 mL plastic for metals (nitric acid preservative) and one - 1 Liter plastic for water quality (ice sample to preserve).

If Appendix IV only is being sampled then one - 500 mL plastic for metals (nitric acid), one 1 Liter plastic for Ra-226 (nitric acid), one - 1 Liter plastic for Ra-228 (nitric acid), and one - 1 Liter plastic for water quality (ice).

If both Appendix III and Appendix IV are being sampled then one - 500 mL plastic for metals (nitric acid), one - 1 Liter plastic for Ra-226 (nitric acid), one - 1 Liter plastic for Ra-228 (nitric acid), and one - 1 Liter plastic for water quality (ice).

NOTE:
The metals sample bottle will provide groundwater for: Sb, As, B, Ba, Be, Ca, Cd, Cr, Co, Pb, Li, Hg, Mo, Se, Tl.
The water quality sample bottle will provide groundwater for: chloride, fluoride, sulfate, TDS.

Parameters

Appendix III parameters
Boron (B)
Calcium (Ca)
Chloride (Cl-)
Fluoride (F-)
pH
Sulfate (SO4-)
Total Dissolved Solids

Appendix IV parameters
Antimony (Sb)
Arsenic (As)
Barium (Ba)
Beryllium (Be)
Cadmium (Cd)
Chromium(Cr)
Cobalt(Co)
Fluoride (F-)
Lead (Pb)
Lithium(Li)
Mercury (Hg)
Molybdenum (Mo)
Selenium (Se)
Thallium (Tl)
Radium 226 and 228 combined (Ra)

NOTE: pH is measured in the field. A lab sample for pH is not obtained.

Monitoring Well Construction Data

Pirkey Power Plant

Well name	TOC	TD (TOC)	Screen, top (ft below TOC)	Screen, middle (ft below TOC)	Screen, bottom (ft below TOC)	
AD02	344.04	40.50	20.50	30.50	40.50	
AD03	375.30	58.40	38.40	48.40	58.40	
AD04	363.69	47.42	27.42	37.42	47.42	
AD07	362.79	41.98	21.98	31.98	41.98	
AD08	356.92	31.24	16.24	23.74	31.24	
AD10	359.48	43.35	23.35	33.35	43.35	depth gauge only
AD12	381.99	52.15	32.15	42.15	52.15	
AD13	364.76	40.87	25.87	33.37	40.87	
AD16	360.05	38.30	18.30	28.30	38.30	
AD17	346.09	32.60	12.60	22.60	32.60	
AD18	363.42	28.53	18.53	23.53	28.53	
AD19	362.82	33.13	12.13	22.63	33.13	depth gauge only
AD20	355.78	38.20	18.20	28.20	38.20	depth gauge only
AD21	350.72	32.30	12.30	22.30	32.30	depth gauge only
AD22	358.31	33.16	13.16	23.16	33.16	
AD23	350.10	37.44	17.44	27.44	37.44	
AD25	337.09	32.30	12.30	22.30	32.30	depth gauge only
AD26	345.25	42.77	12.77	27.77	42.77	depth gauge only
AD27	352.62	39.60	19.80	29.80	39.80	
AD28	339.40	38.68	18.68	28.64	38.60	
AD29	353.37	32.75	12.75	22.75	32.75	depth gauge only
AD30	342.02	27.04	12.04	19.54	27.04	
AD31	360.75	36.89	21.89	29.39	36.89	
AD32	359.18	34.38	14.38	24.38	34.38	
AD33	362.37	32.00	17.00	24.50	32.00	
AD34	307.61	26.65	11.65	19.15	26.65	
AD36	309.20	17.70	7.70	12.70	17.70	

Facility Name

Sampled by

Sample Location ID

Depth to water, feet(TOC)

Measured Total Depth, feet(TOC)

Depth to water Date

Purge Stabilization Data

Time	Water Depth	Flow Rate	pH	Spec Cond	Turbidity	D.O.	ORP	Temp, deg C		

Total volume purged

Sample appearance

Sample time

Sample date

CALIBRATION RECORD FORM

Name: ___________________________________ Date: ___________________________________

pH Meter
Manufacturer____
Model ____
Serial Number ____
Calibration method ____
Calibration standard: Part no.: ______________________ Lot no.: ______________________________
Expiration Date:____
Calibration standard: Part no.: ______________________ Lot no.: ______________________________
Expiration Date:____
Manufacturer's recommended calibration procedure was followed: YES / NO
Specific Conductivity Meter
Manufacturer____
Model ____
Serial Number ____
Calibration method ____
Calibration standard: Part no.: ______________________ Lot no.: ______________________________
Expiration Date:____
Calibration standard: Part no.: ______________________ Lot no.: ______________________________
Expiration Date:____
Manufacturer's recommended calibration procedure was followed: YES / NO
Turbidity Meter
Manufacturer____
Model ____
Serial Number ____
Calibration method ____
Calibration standard: Part no.: ______________________ Lot no./Serial no.:______________________
Expiration Date:____
Calibration standard: Part no.: ______________________ Lot no. /Serial no.:_____________________
Expiration Date:____
Manufacturer's recommended calibration procedure was followed: YES / NO
Other
Manufacturer____
Model ____
Serial Number ____
Calibration method ____
Calibration standard: Part no.: ______________________ Lot no. /Serial no.:_____________________
Expiration Date:____
Calibration standard: Part no.: ______________________ Lot no. /Serial no.:______________________
Expiration Date:____
Manufacturer's recommended calibration procedure was followed: YES / NO

Monitoring Well Development Record

Site: ____

Well: ____

Date: ____

Developer’s Name: ___________________________________

Comments: ____

____

____

Time	Activity, surging / pumping	pump rate	volume removed	Turbidity, NTU	Notes

Well Inspection Log

Facility: Pirkey PP Sampling Period: ____

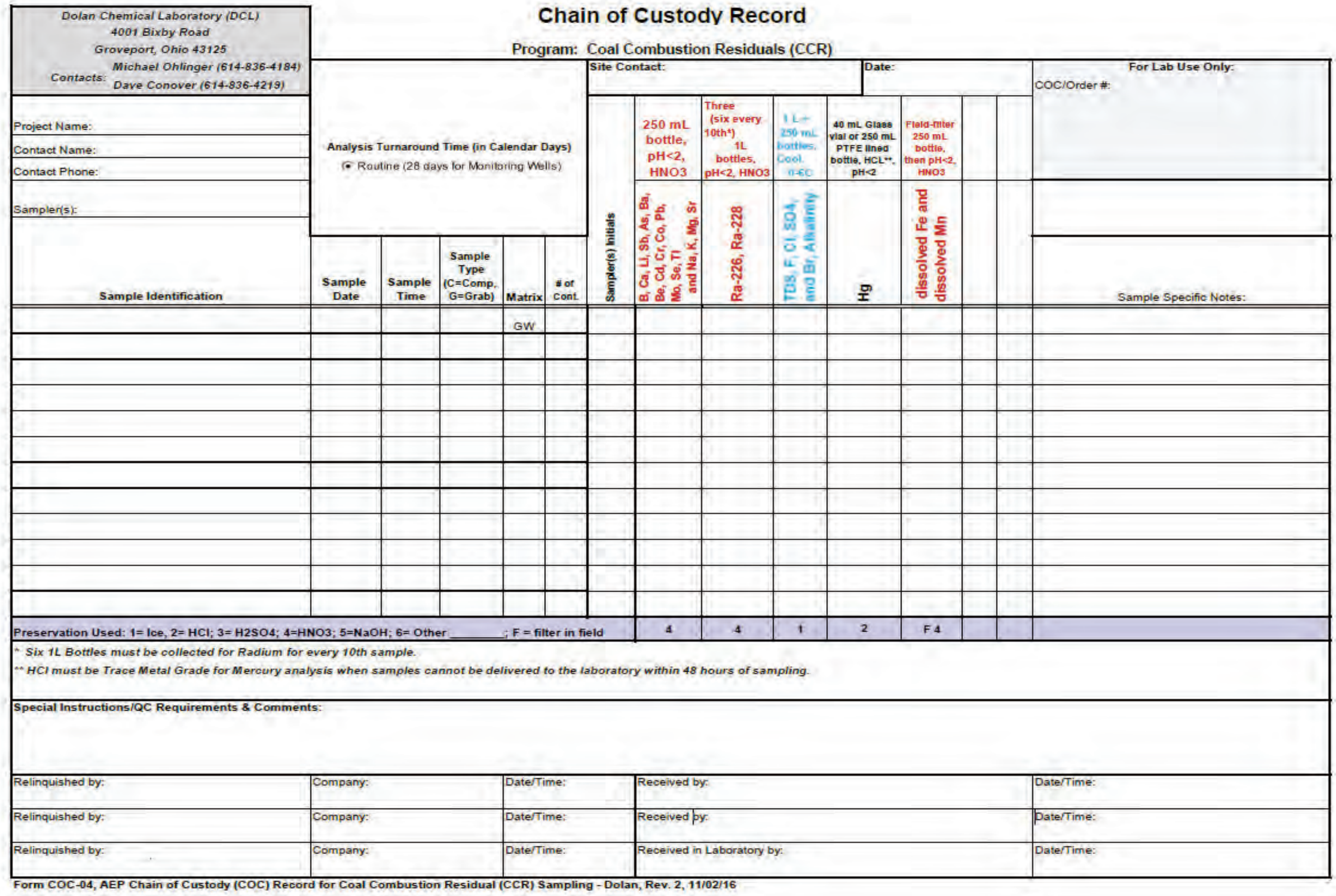
Sampling Contractor: ____ Signature: ____

Well No.	Well Locked	Lock Functioning	Well Locked After Sampling	Access to Well Maintained	Well Housing and Pad in Good Shape	Well Properly Labeled	Comments

Instructions: Complete form and submit to AEP Environmental Services with Field Data Log. Place check mark for items that are satisfactory. Unsatisfactory items should be left blank with a note in the comments section on what needs to be remedied.

Chain of Custody

It is preferred that one chain of custody be used for each CCR unit and one for background wells. (a total of 4 COCs)



Dolan Chemical Laboratory (DCL)
4001 Bixby Road
Groveport, Ohio 43125
Contacts: *Michael Ohlinger (614-836-4184)*
Dave Conover (614-836-4219)

Chain of Custody Record

Program: Coal Combustion Residuals (CCR)

Site Contact:

Date:

For Lab Use Only:
COC/Order #:

Project Name:
Contact Name:
Contact Phone:
Sampler(s):

Analysis Turnaround Time (in Calendar Days)
● Routine (28 days for Monitoring Wells)

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Sampler(s) Initials	250 mL bottle, pH<2, HNO3 B, Ca, Li, Sb, As, Ba, Be, Cd, Cr, Co, Pb, Mo, Se, Tl and Na, K, Mg, Sr	Three (six every 10th*) 1L bottles, pH<2, HNO3 Ra-226, Ra-228	1 L + 250 mL bottles, Cool, 0-6C TDS, F, Cl, SO4, and Br, Alkalinity	40 mL Glass vial or 250 mL PTFE lined bottle, HCL**, pH<2 Hg	Field-filter 250 mL bottle, then pH<2, HNO3 dissolved Fe and dissolved Mn			Sample Specific Notes:
				GW										
Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other_______; F = filter in field							4	4	1	2	F 4			

** Six 1L Bottles must be collected for Radium for every 10th sample.*
*** HCl must be Trace Metal Grade for Mercury analysis when samples cannot be delivered to the laboratory within 48 hours of sampling.*

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Date/Time:

Form COC-04, AEP Chain of Custody (COC) Record for Coal Combustion Residual (CCR) Sampling - Dolan, Rev. 2, 11/02/16

APPENDIX C

Laboratory Analysis Methods, Sample Containers, and Preservation Protocols

Cooling is not prohibited unless specifically noted. Cooling is required if specified for the analyte.

Analyte	**Metals -** aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, molybdenum, nickel, selenium, silver, strontium, thallium, tin, vanadium, zinc	
Method	EPA 200.7	Method 6010B
Container	plastic; glass (not acceptable for boron); perfluoropolymer	
Preservation	HNO_3 to pH<2	
Hold time	180 days	

Analyte	**Mercury**	
Method	EPA 7470A	EPA 245.1
Container	plastic; glass; perfluoropolymer	
Preservation	Hydrochloric to pH<2 (EPA 245.7); HNO_3 to pH<2 (EPA 7470)	
Hold time	28 days	

Analyte	**Chloride**
Method	EPA 300.0
Container	plastic; glass; perfluoropolymer
Preservation	None required
Hold time	28 days

Analyte	**Fluoride**
Method	EPA 300.0
Container	plastic; glass; perfluoropolymer
Preservation	None required
Hold time	28 days

Analyte	**Sulfate**
Method	EPA 300.0
Container	plastic; glass; perfluoropolymer
Preservation	cool, ≤ 6^{o}C
Hold time	28 days

Analyte	**Solids, total dissolved (TDS)**
Method	SM 2540 C
Container	plastic; glass; perfluoropolymer
Preservation	cool, ≤ 6^{o}C
Hold time	7 days

Analyte	**Radium 226**
Method	Method 9315
Container	plastic; glass; perfluoropolymer
Preservation	HNO_3 to pH<2
Hold time	180 days

Analyte	**Radium 228**
Method	Method 9320
Container	plastic; glass; perfluoropolymer
Preservation	HNO_3 to pH<2
Hold time	180 days

Analyte	**Ra-226 and Ra-228 combined**
Method	The TCEQ's CCR Rule in Appendix IV refers to 'Radium 226 and 228 combined'. The drinking water MCL is 5 pCi/L for Radium 226 and 228 combined. However, for laboratory analysis, there are two separate tests. The laboratory performs two analysis - one for Ra-226 and another for Ra-228. The value for Radium 226 and 228 combined is the arithmetic sum of the results for these two tests.

4.6 – Statistical Analysis Plan, H.W. Pirkey Power Plant, Hallsville, Texas, December 2021 Revision 2

STATISTICAL ANALYSIS PLAN
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants
engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

In collaboration with

Kristina Rayner
Groundwater Stats Consulting

and

Kirk M. Cameron, Ph.D.
MacStat Consulting, Ltd.

CHA8500
December 2021
Revision 2

TABLE OF CONTENTS

LIST OF TABLES

LIST OF APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

Annual Report	Annual Groundwater Monitoring and Corrective Action Report
ANOVA	analysis of variance
CCR	coal combustion residuals
CFR	Code of Federal Regulations
GWPS	groundwater protection standard
LCL	lower confidence limit
MCL	maximum contaminant level
OLS	ordinary least-squares
ORP	oxidation-reduction potential
PQL	practical quantitation limit
QC	quality control
RCRA	Resource Conservation and Recovery Act
RL	reporting limit
ROS	regression on order statistics
SAP	Statistical Analysis Plan
SSI	statistically significant increase
SSL	statistically significant level
SWFPR	site-wide false positive rate
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
UCL	upper confidence limit
Unified Guidance	*Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* (USEPA, 2009)
UPL	upper prediction limit
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit

SECTION 1

INTRODUCTION

In June 2021, the Texas Commission on Environmental Quality (TCEQ) issued new regulations regarding the disposal of coal combustion residuals (CCR) in certain landfills and impoundments under Title 30, Chapter 352, "Coal Combustion Residuals Waste Management." This Chapter is referred to herein as the "CCR rules." Facilities regulated under the CCR rules are required to develop and sample a groundwater monitoring well network to evaluate if landfilled CCR materials are impacting downgradient groundwater quality. As part of the evaluation, the analytical data collected during the sampling events must undergo statistical analysis to identify statistically significant increases (SSIs) in analyte concentrations above background levels. A description of acceptable statistical programs is provided in USEPA's document *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities*, *Unified Guidance* (USEPA, 2009), which is commonly referred to as the "Unified Guidance."

The CCR rules are not prescriptive regarding what statistical analyses should be selected so that groundwater data are interpreted in a consistent manner and the results meet certification requirements. Geosyntec Consultants, Inc. (Geosyntec) prepared this Statistical Analysis Plan (SAP) on behalf of American Electric Power (AEP) to develop a logic process regarding the appropriate statistical analysis of groundwater data collected in compliance with the CCR rules. The SAP will provide a narrative description of the statistical approach and methods used in accordance with the CCR rule reporting requirements [30 TAC 352.931].

This SAP describes statistical procedures to be used to establish background conditions, implement detection monitoring, implement assessment monitoring (as needed), and implement corrective action monitoring (as needed) for the H.W. Pirkey Power Plant East Bottom Ash Pond (EBAP), West Bottom Ash Pond (WBAP), Flue Gas Desulfurization (FGD) Stackout Area, and Landfill, all of which are located in Hallsville, Texas.

Procedures for collecting, preserving, and shipping groundwater samples are not included in this SAP. It is assumed that samples are collected and handled in accordance with AEP's statistical analysis plan and the requirements of 30 TAC 352.901 *et seq*.

SECTION 2

ANALYSES FOR REVIEWING AND PREPARING DATA

2.1 Physical Independence

Most statistical analyses require separate sampling events to be statistically independent. Statistical independence of groundwater samples is most likely to be realized when the samples are collected at time intervals that are sufficiently far apart that the samples are not from the same volume of groundwater. In such cases, the samples of groundwater are considered physically independent. To ensure physical independence, the minimum time between sampling events must be longer than the residence time of groundwater that would be collected in the monitoring well. The minimum time interval between sampling events (t_{min}) can be determined by calculating the groundwater velocity, as follows:

$$v = \frac{Ki}{n} \quad (1)$$

$$t_{min} = \frac{v}{D} \quad (2)$$

where:

$v =$ groundwater velocity
$K =$ hydraulic conductivity
$i =$ hydraulic gradient
$n =$ effective porosity
$t_{min} =$ minimum time interval between sampling events
$D =$ well bore volume (i.e., diameter of well and surrounding filter pack)

2.2 Testing for Normality

Many statistical analyses assume that the sample data are normally distributed. If such an analysis is used, the assumption of normality can be tested using the Shapiro-Wilk test (for sample sizes up to 50) or the Shapiro-Francía test (for sample sizes greater than 50). Normality can also be tested by less computationally intensive means such as graphing data on a probability plot. If the data appear not to be normally distributed (e.g., they are skewed in some fashion), then data may be transformed mathematically such that the transformed data do follow a normal distribution (e.g., lognormal distributions, Box-Cox transformations). Alternatively, a non-parametric test (i.e., a test that does not assume a particular distribution of the data) may be used. However, since non-parametric tests generally require large datasets to maintain an adequately low site-wide false positive rate (SWFPR), transforming the data is preferred.

2.3 Testing for Outliers

Outliers are extreme data points that may represent an anomaly or error. Datasets should be visually inspected for outliers using time series and/or box-and-whisker plots. While they are valuable as screening tools, visual methods are not foolproof. For example, if data are skewed according to a lognormal distribution, the boxplot screening may identify more outliers than actually exist. Typically, goodness-of-fit testing must be done on the non-outlier portion of the data to determine at what scale to test the possible outliers.

Potential outliers should be evaluated for potential sources of error (e.g., in transcription or calculation) or evidence that the data point is not representative (e.g., by examining quality control [QC] data, groundwater geochemistry, sampling procedures, etc.). Errors should be corrected prior to further statistical analysis, and data points that are flagged as non-representative should not be used in the statistical analysis. In addition, data points can be considered extreme outliers if they meet one of the following criteria:

$$x_i < \tilde{x}_{0.25} - 3 \times IQR \quad (3)$$

or

$$x_i > \tilde{x}_{0.75} + 3 \times IQR \quad (4)$$

where:

$x_i =$ individual data point
$\tilde{x}_{0.25} =$ first quartile
$\tilde{x}_{0.75} =$ third quartile
$IQR =$ the interquartile range $= \tilde{x}_{0.75} - \tilde{x}_{0.25}$

Extreme outliers may be excluded from the statistical analysis based on professional judgment. Goodness-of-fit testing may be needed to corroborate the classification of data points as extreme outliers. Flagged data and extreme outliers should still be maintained in the database and should be reevaluated as new data are collected.

2.4 Handling Duplicate or Replicate Data

Duplicate or replicate samples are often collected for QC purposes. Averaging the parent sample and duplicate sample results may give a more accurate representation of the constituent concentration at the time, but doing so would reduce the sample variability. Since many statistical tests assume that data are homoscedastic (i.e., the population variance does not change across samples), this technique is not recommended. Unless there is reason to suspect that either the parent sample or the duplicate sample is more representative of site groundwater, one of the samples should be selected at random and that value should be used in the subsequent statistical analysis. However, it should be reported when parent sample and duplicate sample results are different from a decision-making perspective, e.g., when the duplicate sample exceeds the groundwater protection standard (GWPS) but the parent sample does not.

2.5 Handling Non-Detect Data

If non-detect data are infrequent (less than 15%), half of the reporting limit (RL) can be used in place of these data without significantly altering the results of a statistical test. The RL may be either the laboratory practical quantification limit (PQL) or an established project limit which is less than the maximum contaminant level (MCL). If non-detect data are more frequent, parametric methods that explicitly consider non-detects or non-parametric methods insensitive to the presence of non-detect data should be used. Where available, estimated results less than the RL (i.e., “J-flagged” data) should be used, and these data should be considered detections for the purposes of statistical analysis.

2.6 Deseasonalizing Data

Most statistical tests assume that data are independent and identically distributed. Datasets with seasonal or cyclic patterns violate this assumption. If seasonal trends are not corrected, the variance of the data will be overestimated, lessening the statistical power of the test. False positives may also be identified for elevated results that are caused by seasonal variation instead of a release.

At the same time, deseasonalizing data inherently assumes that the seasonal pattern will continue into the future, so care should be taken when correcting for seasonality. There should be a physical explanation for the seasonal pattern, and the seasonal pattern should be observed for at least three cycles before deseasonalizing data.

To evaluate whether a seasonal pattern exists, data should first be visually inspected on a time series plot. Observing parallel or antiparallel patterns for the same constituent across multiple wells or for multiple constituents within a single well provides greater assurance of a seasonal pattern and may be used to infer a physical explanation.

If a seasonal pattern is observed, the dataset should undergo a statistical test for seasonality before deseasonalizing the data. First, results are categorized into seasons based on the observed seasonal pattern and the frequency of sampling (e.g., summer or winter; dry season or wet season; first, second, third, or fourth quarter; etc.). Then, the Kruskal-Wallis test can be applied to the various seasonal datasets to test whether the different seasons are statistically significantly different from one another.

To deseasonalize the data, a seasonal mean should be calculated for each season based on the categorization for the dataset, and a grand mean (i.e., the overall mean of all data) should be calculated. Each result should then be corrected based on the difference between the grand mean and the seasonal mean for that result’s season. Similar to transforming apparently non-normal data, statistics should be calculated based on the deseasonalized data.

SECTION 3

DETECTION MONITORING

3.1 Establishing Background

By October 17, 2017, eight independent background samples should be collected from each monitoring well in the CCR unit groundwater monitoring system as part of the initial monitoring period [30 TAC 352.941(a)]. Background wells do not necessarily need to be hydraulically upgradient of the CCR unit, but they must not be affected by a release from the CCR unit [30 TAC 352.911(a)]. The sampling frequency should be such that samples are physically independent, as described in **Section 2.1**. Samples should be analyzed for the Appendix III and Appendix IV constituents listed in **Table 1**.

Once analytical data are received, summary statistics (e.g., mean and variance) should be calculated for the background datasets. Initially, analysis should be done independently for each constituent at each well. As part of our protocol in such situations, time series plots and box plots will be prepared along with the summary statistics. The Kaplan-Meier method or robust regression on order statistics (ROS) can be used to compute summary statistics when there are large fractions (i.e., 15% to 50%) of non-detects; these methods are discussed below. If more than 50% of the data are non-detect, then summary statistics cannot be reliably calculated. Procedures for evaluating future data against these background datasets are described in **Section 3.2.1** (for detection monitoring) and **Section 4.1.1** (for assessment monitoring and corrective action monitoring).

Background data will be evaluated for statistically significant temporal trends using (a) ordinary least-squares (OLS) linear regression with a *t*-test ($\alpha = 0.01$) on the slope and/or (b) the non-parametric Theil-Sen slope estimator with Mann-Kendall trend test ($\alpha = 0.05$, or 0.01 for larger datasets). Non-detect data are replaced with half the RL for these analyses. The OLS linear regression or Theil-Sen slope estimator will be used to estimate the rate of change (increasing, no change, or decreasing) over time for each constituent at each well. The *t*-test or Mann-Kendall statistic will be used to determine whether a trend is statistically significant. OLS linear regression should only be used when at most 15% of the data are non-detect, when regression residuals are normally distributed, and when the variance from the regression line does not change over time. The Theil-Sen/Mann-Kendall analysis requires at least five observations for meaningful results; at least eight observations are recommended. Note that a statistically significant increasing trend in background data (or a statistically significant decreasing trend in pH) could indicate an existing release from the CCR unit or another source, and further investigation may be needed to determine the source of this trend.

Background data will also be evaluated for statistically significant seasonal patterns and, if present, will be deseasonalized using the procedure described in **Section 2.6**.

If the trend analysis does not indicate a statistically significant trend, the proposed background data will be tested for normality using one of the methods outlined in **Section 2.2**. When data follow a normal or transformed-normal distribution (e.g. lognormal or other Box-Cox transformation), parametric methods are applied. If fewer than 15% of the data are non-detect, non-detect data may be replaced with half the RL and the mean and variance can be calculated normally. If 15% to 50% of the data are non-detect, two methods – the Kaplan-Meier or Robust ROS method – can be used to determine the sample mean and variance. Kaplan-Meier should not be used if all non-detect data have the same RL or if the maximum detected value is less than the highest RL of the non-detect data. When data do not follow a normal or transformed-normal distribution, or when more than 50% of the data are non-detect, nonparametric methods may be used.

Once the sample mean and variance are calculated for each constituent at each well (assuming no significant trends over time), the data from background wells should be compared for each constituent. The purpose of this exercise is to test for significant spatial variation and to decide between interwell and intrawell approaches. First, the equality of variance across background wells should be tested visually using box-and-whisker plots and/or analytically using Levene's test ($\alpha = 0.01$). If the variances appear equal, then one-way, parametric analysis of variance (ANOVA) should be conducted across background wells ($\alpha = 0.05$). If there are no statistically significant differences among the background wells, then interwell comparisons may be appropriate to evaluate SSIs.

If ANOVA indicates statistically significant differences among background wells, then spatial variability can be concluded. As with temporal trends, the existence of spatial variability could indicate an existing release from the CCR unit or another source, and further investigation may be needed to determine the source of this variability. If the spatial variability is not caused by a release from the CCR unit, then intrawell comparisons would be appropriate to evaluate SSIs.

3.2 Evaluating Statistically Significant Increases (SSIs)

After the initial eight rounds of background sampling, groundwater sampling and analysis should be conducted on a semiannual basis. The statistical evaluation of each groundwater monitoring event must be completed within 90 days of receiving the analytical results from the laboratory [30 TAC 352.931(a)].

The CCR rules only require analysis of the Appendix III constituents; however, analyzing additional constituents should be considered. Turbidity, dissolved oxygen, and oxidation-reduction potential (ORP), should be measured in the field in addition to pH. Other geochemical parameters, such as alkalinity, magnesium, potassium, sodium, iron, and manganese, should also be analyzed in the laboratory periodically (e.g., once every one to four years). Both the field and laboratory geochemical parameters can help identify the cause of any apparent change in groundwater quality. Additionally, analyzing for the Appendix IV constituents periodically should be considered to ensure the background dataset for these constituents is complete and current should assessment monitoring be needed. Statistical analyses should still be limited to the Appendix III constituents to help meet the dual goals of a SWFPR less than 10% per year and an adequate statistical power.

The CCR rules specifically list four methods acceptable for statistical analysis: ANOVA, tolerance intervals, prediction intervals, and control charts [30 TAC 352.931(a)]. Of these, the Unified Guidance recommends prediction limits combined with retesting for maintaining a low SWFPR while providing high statistical power (USEPA, 2009). Control charts are also acceptable as long as parametric methods can be used (i.e., the data or transformed data are normally distributed and the frequency of non-detects is at most 50%), as there is no nonparametric counterpart to the control chart. ANOVA is not recommended as the CCR rules mandate a minimum Type I error (α) of 0.05, at which it would be difficult to maintain an annual SWFPR less than 10%.

Prediction intervals and control charts can be used for both interwell and intrawell comparisons. For interwell comparisons, the pooled data from background monitoring wells should be used for the background dataset; for intrawell comparisons, the background dataset should be a subset of historical data at each monitoring well. (See **Section 3.4** below for procedures for updating background datasets.) Interwell comparisons are preferable, but they should only be used when there are no trends and no statistically significant population differences among background wells; otherwise, a significant test result may only indicate natural spatial variability instead of an SSI.

For prediction intervals, the upper prediction limit (UPL) is calculated according to the following formula:

$$\mathrm{UPL} = \bar{x} + ks \quad (5)$$

where:

$\bar{x} =$ mean concentration of the background dataset
$s =$ standard deviation of the background dataset
$k =$ multiplier based on the characteristics of the site and the statistical test

Values for k are chosen to maintain an SWFPR less than 10% and depend on the following: (1) number of wells, (2) number of constituents being evaluated, (3) size of the background dataset, (4) retesting regime, and (5) whether intrawell or interwell comparisons are being used. Values for k are listed in Tables 19-1, 19-2, 19-10, and 19-11 in Appendix D of the Unified Guidance (USEPA, 2009). If the k value that precisely matches site conditions does not appear in these tables, it can be estimated using the provided values by linear interpolation.

A one-of-two or one-of-three testing regime should be employed; i.e., if at least one sample in a series of two or three (respectively) does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, if the initial result does not exceed the UPL, then no resampling is needed. If the initial result does exceed the UPL, then a resample should be collected prior to the next regularly scheduled sampling event at the monitoring well(s) and for the constituent(s) exceeding the UPL. Additional geochemical parameters, such as alkalinity, magnesium, potassium, sodium, iron, and manganese, should also be analyzed during resampling to help identify the source of the apparent increase. Enough time should elapse between the initial sample and each resample so that the samples are physically independent (**Section 2.1**). If both the initial result and the subsequent resample(s) exceed the UPL, then an SSI can be concluded.

Choosing between a one-of-two and a one-of-three testing regime should be done before conducting the statistical analysis, as the UPL calculation depends on the resampling regime selected. The choice should depend on site conditions and the size of the background dataset. First, if three physically independent samples cannot be collected in a six-month period, then a one-of-two testing regime should be used. A one-of-two testing regime may also be considered (a) if the background dataset has at least 16 data points or (b) if the CCR unit's monitoring well network has nine or fewer downgradient monitoring wells and a background dataset of at least 8 data points. Otherwise, a one-of-three testing regime should be employed to achieve an acceptably high statistical power and an acceptably low SWFPR.

If two physically independent samples cannot be collected in a six-month period, then a reduced monitoring frequency may be warranted. In this case, a demonstration must be made documenting the need for – and effectiveness of – a reduced monitoring frequency. This demonstration must be certified by a qualified professional engineer, and monitoring must still be done on at least an annual basis [30 TAC 352.941(a)].

The above procedure can be used wherever a mean and variance can be calculated for background data, including datasets that are transformed-normal and datasets where the mean and variance are calculated using the Kaplan-Meier or Robust ROS method. (Note that if data are transformed-normal, prediction intervals or control limits should first be calculated for the transformed data and then be transformed back into concentration terms.) Methods for determining prediction intervals where more than half of the background data are non-detect, where background data are neither normal nor transformed-normal, or where statistically significant trends or seasonal patterns exist are described below.

Different analyses can and should be used for different constituents and different monitoring wells within a CCR unit depending on the background data. For instance, if background wells have similar chloride data but different pH data, then interwell comparisons may be considered for chloride analysis and intrawell comparisons may be considered for pH analysis. If boron data are stable above the RL at MW-1 and mostly non-detect at MW-2, then it would be appropriate to use parametric prediction limits at MW-1 and non-parametric prediction limits at MW-2.

3.2.1 Most Background Data Are Non-Detect

If at least half of the data are non-detect, non-parametric prediction intervals with retesting should be used. In this method, the UPL is set either at the highest or at the second-highest concentration observed in the background dataset. A sufficiently large background dataset is paramount for this procedure to achieve an acceptably low SWFPR. To this end, the Kruskal-Wallis test should be performed on all background monitoring wells where at least 50% of the data for the constituent are non-detect to evaluate spatial variability. If the Kruskal-Wallis test indicates that there is no significant spatial variability among background wells, then the data from the background wells should be pooled to form a larger background dataset and thus to run an interwell test.

The choice between a one-of-two and a one-of-three testing regime should be based on the same criteria used for parametric testing, as described in **Section 3.2**. Choosing between using the highest or second-highest observed concentration as the UPL should depend in part on the size of the background dataset and the number of monitoring wells around the CCR unit. Assuming a one-of-three testing regime is used, the highest observed concentration should be used when the background dataset has fewer than 32 data points and the monitoring network has twelve or fewer wells. If there are at least thirteen wells, the highest observed concentration should be used when the background dataset has fewer than 48 data points. The second-highest observed concentration may be used for larger datasets.

If a one-of-two testing regime must be used due to aquifer conditions, then the highest observed concentration should be used (a) when the background dataset has fewer than 64 data points if there are fifteen or fewer wells or (b) when the background dataset has fewer than 88 data points if there are at least sixteen wells. The second-highest observed concentration may be used for larger datasets.

3.2.2 All Background Data Are Non-Detect

If all of the background data are non-detect, then the Double Quantification Rule should be used. According to this rule, if a sample and verification resample both exceed the PQL, then an SSI can be concluded. This can be thought of as setting the UPL at the PQL with a one-of-two testing regime. The possibility of false positives from this rule does not count against the calculated SWFPR because the false positive risk is small when all previous background data have been non-detect.

3.2.3 Background Data Are neither Normal nor Transformed-Normal

If background data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, then non-parametric prediction intervals with retesting should be used. In this method, the UPL is set either at the highest or at the second-highest concentration observed in the background dataset. A sufficiently large background dataset is paramount for this procedure to achieve an acceptably low SWFPR. To this end, the Kruskal-Wallis test should be performed on all background monitoring wells where at least 50% of the data for the constituent are non-detect to evaluate spatial variability. If the Kruskal-Wallis test indicates that there is no significant spatial variability among background wells, then the data from the background wells should be pooled to form a larger background dataset and thus to run an interwell test.

The choice between a one-of-two and a one-of-three testing regime should be based on the same criteria used for parametric testing, as described in **Section 3.2**. The choice between using the highest or second-highest observed concentration as the UPL should be based on the same considerations described in **Section 3.2.1**.

3.2.4 A Significant Temporal Trend Exists

True temporal trends in background data (i.e., absent a release from the facility or another source) are considered unlikely. Thus, a truncated dataset that does not exhibit a statistically significant trend may be used. In these cases, UPLs would be calculated as described in the previous sections.

Alternatively, if there is a significant temporal trend in the background data that is not attributable to a release, prediction limits can be constructed around a trend line. A trend line can be constructed parametrically using OLS linear regression. OLS linear regression should only be used when at most 15% of the data are non-detect, when regression residuals are normally distributed, and when the variance from the regression line does not change over time. If OLS linear regression is used, the UPL can be calculated according to the following equation:

$$\text{UPL} = \widehat{x_0} + t_{1-\alpha,n-2} * s_e * \sqrt{1 + \frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1)s_t^2}} \quad (6)$$

where:

$\widehat{x_0} =$ regression-line estimate of the mean concentration at time t_0
$t_{1-\alpha,n-2} =$ one-tailed *t*-value at a confidence of 1 – α and n – 2 degrees of freedom
$s_e =$ standard error of the regression line
$n =$ number of samples in the background dataset
$t_0 =$ date the groundwater sample being compared to the UPL was collected
$\bar{t} =$ mean of the sampling dates in the background dataset
$s_t =$ standard deviation of the sampling dates in the background dataset

The choice between a one-of-two and a one-of-three testing regime should be based on the same criteria used when there is no significant trend, as described in **Section 3.2**. The choice of α depends on the retesting regime and the number of wells within the monitoring network. If a one-of-two testing regime is employed, an α = 0.02 is recommended if there are eighteen or fewer wells and an α = 0.01 is recommended if there are at least nineteen wells within the monitoring network. If a one-of-three testing regime is employed, an α = 0.05 should be used.

3.2.5 A Significant Seasonal Pattern Exists

If a statistically significant seasonal pattern exists and if there is a physical explanation for the seasonality, the background data should be deseasonalized using the procedure described in **Section 2.6**. The background UPL should be calculated based on the deseasonalized data. Results should then be deseasonalized by subtracting the difference between the seasonal mean and the grand mean before comparing results to the UPL.

3.3 Responding to an Identified SSI

If the statistical evaluation indicates that an SSI is present, TCEQ and any local pollution agencies with jurisdiction that had requested to be notified should be notified in writing within 14 days of the SSI determination [30 TAC 352.941(b)] and intention to make an alternative source demonstration [30 TAC 352.941(c)(1)]. The data should be evaluated to assess whether the SSI is caused by a release from the CCR unit. If it can be shown that the SSI resulted from a release from another source, from an error in sampling or analysis, or from natural variability, then a demonstration of this must be made in writing and certified by a qualified professional engineer within 90 days of completing the statistical evaluation [30 TAC 352.941(c)(2)]. (The statistical evaluation itself must be completed within 90 days of receiving the analytical data from the laboratory.) If this demonstration is not made within 90 days of completing the statistical evaluation or was not satisfactory to TCEQ, then the site must begin assessment monitoring [30 TAC 352.941(d)].

3.4 Updating Background

As recommended in the Unified Guidance, background values should be updated every four to eight measurements, assuming no confirmed SSI is identified (USEPA, 2009). (See **Section 4.4** for procedures for updating background if an SSI has been identified.) A Student's *t*-test or the nonparametric Mann-Whitney test (also known as the Wilcoxon rank-sum test) should be conducted to compare the set of new data points against the existing background dataset, as appropriate. An $\alpha = 0.05$ is recommended given the relatively small size of the datasets, particularly if background is updated every four measurements and particularly if the nonparametric Mann-Whitney test is used. However, an α as low as 0.01 may be used if the existing background dataset is sufficiently large (i.e., contains at least five data points) or if Student's *t*-test is used.

If the *t*-test or Mann-Whitney test does not indicate significant differences, the new data should be combined with the existing background data to calculate an updated UPL. Increasing the size of the background dataset will increase the power of subsequent statistical tests.

If the *t*-test or Mann-Whitney test indicates a statistically significant difference between the two populations, then the data should not be combined with the existing background data until further review determines the cause of the difference. If the differences appear to be caused by a release, then the previous background dataset should continue to be used. Absent evidence of a release, the new dataset should be considered more representative of present-day groundwater conditions and used for background. Note that the *t*-test or Mann-Whitney test is used to compare new data to the existing background dataset for the purposes of updating background. The tests are not used to determine whether an SSI is present or whether a release has occurred.

Periodically, spatial variability among background wells may be re-assessed to determine whether using an interwell or intrawell comparison is appropriate on a constituent-by-constituent basis, as outlined in **Section 3.1**.

SECTION 4

ASSESSMENT MONITORING

A CCR unit must begin assessment monitoring if an SSI is identified and is not attributed to some cause besides a release from the CCR unit. Assessment monitoring must begin within 90 days of identifying the SSI. During this 90-day period, the monitoring well network must be sampled for all Appendix IV constituents [30 TAC 352.951(a)]. Within 90 days of obtaining the results from this sampling event, all of the CCR unit wells must be sampled for all Appendix III constituents and those Appendix IV constituents that were detected during the initial assessment monitoring event [30 TAC 352.951(a)].

After these initial assessment monitoring events, the CCR unit wells must be sampled for all Appendix III constituents and previously detected Appendix IV constituents on a semiannual basis [30 TAC 352.951(a)]. Additionally, the CCR unit wells must be sampled for all Appendix IV constituents on an annual basis [30 TAC 352.951(a)].

As with detection monitoring, if physically independent samples cannot be collected on a semiannual basis, then a reduced monitoring frequency may be warranted. A demonstration must be made documenting the need for – and effectiveness of – a reduced monitoring frequency. This demonstration must be certified by a qualified professional engineer, and monitoring must still be done on at least an annual basis [30 TAC 352.951(a)].

GWPSs must be established for each detected Appendix IV constituent. The GWPS shall be the greater of the background concentration and the MCL established by the USEPA for that constituent [30 TAC 352.951(b)]. If no MCL exists for that constituent, then the background concentration shall be the GWPS for that constituent [30 TAC 352.951(b)(2)]. An upper tolerance limit (UTL) with 95% confidence and 95% coverage is often used as the representative background concentration.

A single site-wide GWPS would be recommended for each constituent based on pooled background data, even if natural spatial variability exists. If background data are not pooled, background concentrations and consequently GWPSs would vary from well to well. One difficulty with this approach is that concentrations at one monitoring well may exceed the location-specific GWPS and still be below levels considered as natural background at other locations within the site. The pooled background is often more interpretable and less cumbersome for developing a single background-based GWPS per constituent.

To determine whether a move to corrective action is warranted, a confidence interval constructed on recent data at each compliance monitoring well should be compared to the site-wide GWPS. When the lower confidence limit (LCL) of this interval exceeds the GWPS, an assessment of corrective measures may be justified.

When corrective action is not warranted, to return from assessment monitoring to detection monitoring, the CCR rules specify that all Appendix III and IV constituents must be at or below background levels for two consecutive sampling events and after written approval from TCEQ [30 TAC 352.951(c)]. Procedures for comparing results to background are described in **Section 4.2**.

4.1 Comparing Data to the GWPS

As stated in **Section 4**, the GWPS is set at the MCL or (if an MCL does not exist for that constituent or if background data are higher than the MCL) a value based on background data, whichever is greater. The UTL calculated from the background dataset is often used as the background value.

Tolerance intervals are similar to prediction intervals. However, whereas prediction intervals represent a range where a future result is expected to lie, tolerance intervals represent a range where a proportion of the population is expected to lie. Tolerance intervals have both an associated coverage (i.e., the proportion of the population covered by the tolerance interval) and an associated confidence. A coverage of 95% ($\gamma = 0.95$) and a confidence of 95% ($\alpha = 0.05$) are typically used.

The UTL is calculated similarly to the UPL:

$$\mathrm{UTL} = \bar{x} + \tau s \quad (7)$$

Similar to the UPL calculation, $\bar{x}$ is the mean concentration and s is the standard deviation of the background dataset. However, in this case the multiplier τ is different from that of the UPL calculation and is a function of the chosen coverage and confidence and the size of the background dataset. Values of τ are tabulated in Table 17-3 in Appendix D of the Unified Guidance (USEPA, 2009). As with prediction limits, if the τ value that precisely matches site conditions does not appear in these tables, it can be estimated using the provided values by linear interpolation.

Once a GWPS is established, new data must be evaluated to determine whether they are statistically significantly higher than the GWPS. The statistical analyses listed in 40 CFR 257.93(f), as included by reference in 30 TAC 352.931(a), are appropriate for comparing new data to a background dataset but are not appropriate for comparing new data to a fixed standard. For these cases, the Unified Guidance recommends using confidence intervals around the mean or median (USEPA, 2009).

Evaluations should be done for each detected Appendix IV constituent at each well. Data from different wells should not be pooled. When selecting which data to include in the recent dataset, time series plots of concentration data at each well should be created and visually inspected. Only data that exhibit the same behavior as recent data should be included. For instance, if the last eight arsenic results cluster around 9 μg/L and the previous eight results cluster around 4 μg/L, then only the eight most recent results should be used in the statistical analysis. Similarly, if chromium concentrations steadily increased over the last ten samples and were stable previously, then the statistical analysis should only use the ten most recent results and (since they are steadily increasing) should involve constructing a confidence interval around a trend line.

At the same time, datasets should also be sufficiently large to maintain statistical power. As many data points that exhibit the same behavior as recent data as possible should be included, including data collected prior to assessment monitoring (e.g., during the initial eight monitoring events). Ideally, datasets should have at least eight data points; in no case should a dataset have fewer than four data points.

If at least 50% of the recent dataset is non-detect, then a parametric confidence interval should not be used, and the procedure in **Section 4.1.1** should be followed.

New data will be evaluated for statistically significant temporal trends using (1) OLS linear regression with a *t*-test ($\alpha = 0.01$) on the slope and/or (2) the non-parametric Theil-Sen slope estimator with Mann-Kendall trend test ($\alpha = 0.05$, or 0.01 for larger datasets). Non-detect data are replaced with half the RL for these analyses. The OLS linear regression or Theil-Sen slope estimator will be used to estimate the rate of change (increasing, no change, or decreasing) over time for each constituent at each well. The *t*-test or Mann-Kendall statistic will be used to determine whether a trend is statistically significant. OLS linear regression should only be used when at most 15% of the data are non-detect, when regression residuals are normally distributed, and when the variance from the regression line does not change over time. The Theil-Sen/Mann-Kendall analysis requires at least five observations for meaningful results; at least eight observations are recommended. If a significant temporal trend exists, then a confidence interval around the trend line should be constructed as outlined in **Section 4.1.3**.

If the trend analysis does not indicate a statistically significant trend, then the mean and variance should be calculated. If fewer than 15% of the data are non-detect, then the non-detect data can be replaced with half the RL and the mean and variance can be calculated normally. Tolerance intervals are sensitive to the choice of population distribution. Normality should be confirmed using the Shapiro-Wilk (or Shapiro-Francía) test and/or probability plots, as described in **Section 2.2**. If data appear not to be normally distributed, data should be transformed so that the transformed data are normally distributed.

Two methods – the Kaplan-Meier or Robust ROS method – can be used to determine the sample mean and variance when 15% to 50% of the data are non-detect. Kaplan-Meier should not be used if all non-detect data have the same RL or if the maximum detected value is less than the highest RL of the non-detect data.

When most of the data are detections, data are normally distributed, and there is no significant temporal trend, the LCL is calculated according to the following equation:

$$\mathrm{LCL} = \bar{x} - t_{1-\alpha,n-1} * \frac{s}{\sqrt{n}} \quad (8)$$

where:

$\bar{x} =$ mean concentration of the recent dataset
$t_{1-\alpha,n-1} =$ one-tailed t-value at a confidence of 1 – α and at n – 1 degrees of freedom
$s =$ standard deviation of the recent dataset
$n =$ number of samples in the recent dataset

The *t* value must be chosen in such a way to balance the competing goals of a low false-positive rate and a high statistical power. The Unified Guidance recommends that the statistical test have at least 80% power ($1 - \beta = 0.8$) when the underlying mean concentration is twice the MCL (USEPA, 2009). Values of the minimum α (from which *t* values can be determined) are tabulated for this criterion for various values of *n* in Table 22-2 in Appendix D of the Unified Guidance (USEPA, 2009). The selected α should be the maximum of the value in Table 22-2 and 0.01.

If data are transformed normal, the LCL should first be calculated for the transformed data and then be transformed back into concentration terms. Correction factors are available but are not expected to be required. Alternatively, a non-parametric LCL can be used, as described in **Section 4.1.2**.

If data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, then a non-parametric LCL should be used, as described in **Section 4.1.2**.

If the LCL exceeds the GWPS, then a statistically significant exceedance can be concluded. If this occurs, the owner/operator is required to take several actions, including potentially moving the facility to corrective action, as described in **Section 4.3**.

4.1.1 Most Data Are Non-Detect

If background data are mostly non-detect, non-parametric tolerance intervals should be used. In these cases, the UTL is set at either the highest or second-highest concentration observed in the background dataset. If all background data are non-detect, then the UTL would default to the RL. The highest or second-highest observed concentration (or RL) effectively becomes the GWPS when this value is greater than the MCL or if an MCL does not exist for the constituent. However, if most background data are non-detect, then detected concentrations are likely less than the MCL (if the MCL exists), and the GWPS will be set at the MCL.

If recent data are mostly non-detect, non-parametric confidence intervals can be constructed around the median by ranking the data from least to greatest and setting the LCL equal to one of the lower values of data. The confidence can be calculated based on the rank of the data point used and the sample size. Confidence values are tabulated in Table 21-11 in Appendix D of the Unified Guidance for sample sizes up to 20 (USEPA, 2009).

However, if most of the recent data are non-detect, then the data point selected for the LCL will also be non-detect. If the RL is less than the GWPS, then no statistically significant exceedance has occurred.

GWPSs should only be determined for detected Appendix IV constituents [30 TAC 352.951(b)]. If all the data for a constituent are non-detect, no statistical evaluation need be performed.

4.1.2 Data Are neither Normal nor Transformed-Normal

If background data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, then non-parametric tolerance intervals should be used. In these cases, the UTL is set at either the highest or second-highest concentration observed in the background dataset.

If recent data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, non-parametric confidence intervals can be constructed around the median by ranking the data from least to greatest and setting the LCL equal to one of the lower values of data. The confidence can be calculated based on the rank of the data point used and the sample size. Confidence values are tabulated in Table 21-11 in Appendix D of the Unified Guidance for sample sizes up to 20 (USEPA, 2009).

4.1.3 A Significant Temporal Trend Exists

If recent data show a significant temporal trend, then an LCL below the trend line can be calculated according to the following equation:

$$\mathrm{LCL} = \widehat{x_0} - \sqrt{2s_e^2 * F_{1-2\alpha,2,n-2} * \left(\frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1)s_t^2}\right)} \quad (9)$$

where:

$\widehat{x_0} =$ regression-line estimate of the mean concentration at time t_0
$s_e =$ standard error of the regression line
$F_{1-2\alpha,2,n-2} =$ upper (1 - 2α)th percentage point from an F-distribution with 2 and n – 2 degrees of freedom
$n =$ number of samples in the recent dataset
$t_0 =$ date of the most recent groundwater sample
$\bar{t} =$ mean of the sampling dates in the recent dataset
$s_t =$ standard deviation of the sampling dates in the recent dataset

Note that the LCL is a function of time; to assess current compliance, the date of the most recent sample should be used for t_0. If and only if the LCL is greater than the GWPS at this time, then a statistically significant exceedance can be concluded. This equation can also be used to assess when the LCL will exceed the GWPS (assuming the current trend continues).

The same α that would have been selected if there were no significant trend (as described in **Section 4.1**) should be used here to determine the proper F value.

If the Theil-Sen method is used to determine the trend line, a computationally intensive technique known as bootstrapping can be used to determine the LCL. This procedure is described in Section 21.3.2 of the Unified Guidance (USEPA, 2009).

4.1.4 A Significant Seasonal Pattern Exists

If a statistically significant seasonal pattern exists in the background data and if there is a physical explanation for the seasonality, the background data should be deseasonalized using the procedure described in **Section 2.6**. The background-based UTL should be calculated based on the deseasonalized data, and the GWPS should be set at the MCL or (if an MCL does not exist for that constituent or if background data are higher than the MCL) the background-based UTL, whichever is greater.

Similarly, if a statistically significant seasonal pattern exists in compliance well data and if there is a physical explanation for the seasonality, the compliance well data should be deseasonalized using the procedure described in **Section 2.6**. The LCL to be compared to the GWPS should be calculated based on the deseasonalized compliance well data.

4.2 Comparing Data to Background

Assessment monitoring data must be compared to the GWPS to assess whether corrective action is warranted at the CCR unit (i.e. the LCL exceeds the GWPS). Additionally, assessment monitoring data may be compared to background data to assess whether the CCR unit can move from assessment monitoring back to detection monitoring.

To return from assessment monitoring to detection monitoring, the CCR rules specify that all Appendix III and IV constituents must be at or below background levels for two consecutive sampling events and written approval needs to be received from TCEQ [30 TAC 352.951(c)]. However, the analysis of all Appendix III and IV constituents is not required for every monitoring event. Therefore, all Appendix III and IV constituents should be collected during two consecutive sampling events on a periodic basis (e.g., every two to four years) and/or when statistical evaluation of assessment monitoring data suggests groundwater concentrations are at or below background levels.

A UTL can be used to represent “a reasonable maximum on likely background concentrations” for Appendix III and IV constituents (USEPA, 2009). As described previously, UTLs can be determined parametrically or non-parametrically. For the parametric intervals, the UTL is calculated according to Equation 7. Non-parametric UTLs can be determined by setting the UTL to the highest or second-highest measured background value. If all background data are non-detect, then non-detect results in compliance wells can be considered statistically similar to background. If a temporal trend in background data exists and is not attributable to a release, background data can be truncated so that no significant temporal trend is evident.

To determine whether Appendix III and IV constituents are at or below background levels, a confidence interval constructed on recent data at each compliance monitoring well should be compared to the background UTL for each constituent. When the upper confidence limit (UCL) is below the background UTL, then it can be concluded that concentrations are at or below background. If UCLs are less than background UTLs for every constituent at every monitoring well for two consecutive events, then the CCR unit may return to detection monitoring.

When most of the data are detections, data are normally distributed, and there is no significant temporal trend, the UCL is calculated according to the following equation:

$$\mathrm{UCL} = \bar{x} + t_{1-\alpha,n-1} * \frac{s}{\sqrt{n}} \quad (10)$$

where:

$\bar{x} =$ mean concentration of the recent dataset
$t_{1-\alpha,n-1} =$ one-tailed *t*-value at a confidence of 1 – α and at n – 1 degrees of freedom
$s =$ standard deviation of the recent dataset
$n =$ number of samples in the recent dataset

If recent data are mostly non-detect or are non-normal and cannot be transformed such that the transformed data follow a normal distribution, non-parametric confidence intervals can be constructed around the median by ranking the data from least to greatest and setting the UCL equal to one of the higher values of data. The confidence can be calculated based on the rank of the data point used and the sample size. Confidence values are tabulated in Table 21-11 in Appendix D of the Unified Guidance for sample sizes up to 20 (USEPA, 2009).

If recent data show a significant temporal trend, then a UCL above the trend line can be calculated according to the following equation:

$$\mathrm{UCL} = \widehat{x_0} + \sqrt{2s_e^2 * F_{1-2\alpha,2,n-2} * \left(\frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1)s_t^2}\right)} \quad (11)$$

where:

$\widehat{x_0} =$ regression-line estimate of the mean concentration at time t_0
$s_e =$ standard error of the regression line
$F_{1-2\alpha,2,n-2} =$ upper (1 - 2α)th percentage point from an F-distribution with 2 and n – 2 degrees of freedom
$n =$ number of samples in the recent dataset
$t_0 =$ date of the most recent groundwater sample
$\bar{t} =$ mean of the sampling dates in the recent dataset
$s_t =$ standard deviation of the sampling dates in the recent dataset

In all cases, the choice of τ and α (for parametric UTLs and UCLs, respectively), the choice of the highest or second-highest data point (for non-parametric UTLs and UCLs), etc. should be made based on sound statistical judgment and site characteristics (e.g., size of datasets, number of monitoring wells, etc.).

4.3 Required Responses to the Results of the Statistical Evaluation

If the statistical evaluation demonstrates that the concentrations of all Appendix III and Appendix IV constituents are at or below background levels for two consecutive sampling events, then the CCR unit may return to detection monitoring with written approval from TCEQ [30 TAC 352.951(c)]. A notification that the CCR unit is returning to detection monitoring must be placed in the facility's operating record.

If the statistical evaluation demonstrates that some Appendix III or Appendix IV constituents are at concentrations above background levels but there are no statistically significant exceedances of GWPSs, then the CCR unit must remain in assessment monitoring [30 TAC 352.951(a)].

If the statistical evaluation demonstrates that an Appendix IV constituent is present at a statistically significant level (SSL) above its GWPS (i.e., if the LCL exceeds the GWPS), then the owner/operator must:

- Provide a written notification to TCEQ and any local pollution agencies with jurisdiction that had requested to be notified within 14 days of the determination [30 TAC 352.951(d)];

- Include a notification in the facility's operating record that identifies the constituents exceeding GWPSs [30 TAC 352.951(a)];

- Characterize the nature and extent of the release, including installing monitoring wells needed to delineate the plume, installing a monitoring well at the downgradient property boundary, quantifying the nature and the amount of the release, and sampling all wells for Appendix III and detected Appendix IV constituents [30 TAC 352.951(a)];

- If the plume has migrated off-site, notify property owners overlying the plume [30 TAC 352.951(a)]; and

- Either begin an assessment of corrective measures or demonstrate that the SSL is not due to a release from the CCR unit within 90 days of completing the statistical evaluation [30 TAC 352.951(e)]. This demonstration must be made in writing, certified by a qualified professional engineer, and submitted to TCEQ and any local pollution agency with jurisdiction that had requested to be notified [30 TAC 352.951(e)]. The CCR rules require the previous four actions to be taken even if it can be demonstrated that the SSL is not due to a release from the CCR unit.

Reporting requirements for assessment monitoring are summarized in **Section 6.2**.

4.4 Updating Background

Care should be taken when updating background during assessment monitoring since, by definition, an SSI over background has already occurred. Data that appear to be affected by a release from the CCR unit should not be included in updated background datasets. However, it may be possible to update some background datasets (e.g., constituents not associated with a release, wells upgradient of the CCR unit, etc.). Formal updating of Appendix III and Appendix IV constituents may be considered when there are at least four new points.

Data should be reviewed every four to eight measurements to assess the possibility of updating background datasets. Professional judgment should first be applied; any data that appear to be affected by a release should be excluded from the background update, even if there is no statistically significant difference between the new data and the existing background data.

For data that appear not to be affected by a release, a Student's *t*-test or Mann-Whitney test should be conducted to compare the set of new data points against the existing background dataset. If the *t*-test or Mann-Whitney test corroborates that there are no significant differences, the new data should be combined with the existing background data to create an updated and expanded background dataset. Increasing the size of the background dataset will increase the power of subsequent statistical tests.

If the *t*-test or Mann-Whitney test indicates a statistically significant difference between the two datasets, then it should be considered that the difference results from a release and the existing background dataset should continue to be used. If and only if there is evidence to suggest that the difference is not related to a release from the CCR unit, then the newer set of measurements should be used for background so that resulting statistical limits are representative of present-day groundwater quality conditions.

Periodically, spatial variability among background wells may be re-assessed to determine whether using an interwell or intrawell comparison is appropriate on a constituent-by-constituent basis, as outlined in **Section 3.1**.

SECTION 5

CORRECTIVE ACTION MONITORING

A CCR unit must begin an assessment of corrective measures if an SSL is identified and is not attributed to some cause other than a release from the CCR unit. The assessment of corrective measures must begin within 90 days of identifying the SSL [30 TAC 352.951(f)]. Based on the results of the corrective measures assessment, a remedy must be selected as soon as feasible [30 TAC 352.971(a)]. A schedule for implementing and completing the remedial activities must be included in the remedy selection [30 TAC 352.971(a)]. The owner/operator must begin remedial activities within 90 days of selecting a remedy, and a corrective action groundwater monitoring program must be implemented based on the schedule established as part of the remedy selection [30 TAC 352.981(a)].

The corrective action monitoring program must [30 TAC 352.981(a)]:

- Meet the requirements of an assessment monitoring program;
- Document the effectiveness of the remedy; and
- Demonstrate compliance with the GWPS.

The statistical methods used in corrective action monitoring are similar to those used in assessment monitoring. For each detected Appendix IV constituent, a GWPS is set at the MCL or (if an MCL does not exist for that constituent or if background data are higher than the MCL) a value based on background data, whichever is greater. A confidence interval is constructed based on recent data at each compliance well, and the confidence interval is compared to the site-wide GWPS. However, in assessment monitoring, the presumption is that a release has not occurred, and a release is concluded when average concentrations are higher than the GWPS (i.e., when the *lower* confidence limit [LCL] is *greater* than the GWPS). If a CCR unit is in corrective action monitoring, then evidence of a release has already been identified. Therefore, in corrective action monitoring, the presumption is that a release has occurred, and the conclusion that the remedy has successfully decreased concentrations below the GWPS is made when average concentrations are less than the GWPS (i.e., when the *upper* confidence limit [UCL] is *less* than the GWPS). (Note that this presumption only applies to well-constituent pairs where an SSL has previously been identified. Well-constituent pairs in assessment monitoring where an SSL has not been identified effectively remain in assessment monitoring until the entire unit returns to detection monitoring.)

A remedy is considered complete when, among other things, confidence intervals constructed for Appendix IV constituents for wells identified with SSLs have not exceeded the GWPS for three consecutive years [30 TAC 352.981(a)]. In this instance, a return to assessment monitoring would be warranted.

Upon completion of the remedy, the owner/operator must prepare a notification stating that the remedy is complete. The notification must be certified by a qualified professional engineer and submitted to TCEQ for approval before placement in the operating record [30 TAC 352.981(a)].

Prior to returning to assessment monitoring, documentation must be submitted to TCEQ that includes:

- Analytical data prepared and presented in accordance with 30 TAC 352.931 [30 TAC 352.981(b)(1)];
- A narrative discussing how the requirements of this section have been fulfilled for the impacted property [30 TAC 352.981(b)(2)]; and
- A description of the volume and final disposal location, and copies of waste manifests or documentation of disposal for waste or environmental media that had been removed from the impacted property [30 TAC 352.981(b)(3)].

The return to assessment monitoring must be approved by TCEQ in writing.

Otherwise, the owner/operator should follow the reporting requirements for assessment monitoring, as summarized in **Section 6.2**.

5.1 Comparing Data to the GWPS

As stated in **Section 5**, the GWPS is set at the MCL or (if an MCL does not exist for that constituent or if background data are higher than the MCL) a value based on background data, whichever is greater. The UTL calculated from the background dataset is often used as the background value. The UTL is calculated as described in **Section 4.1**. Methods for updating background are described in **Section 4.4**.

For well-constituent pairs in corrective action monitoring, new data must be evaluated to determine whether they are statistically significantly lower than the GWPS. The statistical analyses listed in 40 CFR 257.93(f), as included by reference in 30 TAC 352.931(a) are appropriate for comparing new data to a background dataset but are not appropriate for comparing new data to a fixed standard. For these cases, the Unified Guidance recommends using confidence intervals around the mean or median (USEPA, 2009).

When selecting which data to include in the recent dataset, time series plots of concentration data at each well should be created and visually inspected. Only data that exhibit the same behavior as recent data should be included. For instance, if the last eight arsenic results cluster around 9 µg/L and the previous eight results cluster around 4 µg/L, then only the eight most recent results should be used in the statistical analysis. Similarly, if chromium concentrations steadily increased over the last ten samples and were stable previously, then the statistical analysis should only use the ten most recent results and (since they are steadily increasing) should involve constructing a confidence interval around a trend line.

At the same time, datasets should also be sufficiently large to maintain statistical power. As many data points that exhibit the same behavior as recent data as possible should be included, including data collected prior to assessment monitoring (e.g., during the initial eight monitoring events). Ideally, datasets should have at least eight data points; in no case should a dataset have fewer than four data points.

If at least 50% of the recent dataset is non-detect, then a parametric confidence interval should not be used, and the procedure in **Section 5.1.1** should be followed.

New data will be evaluated for statistically significant temporal trends using (1) OLS linear regression with a *t*-test ($\alpha = 0.01$) on the slope and/or (2) the non-parametric Theil-Sen slope estimator with Mann-Kendall trend test ($\alpha = 0.05$, or 0.01 for larger datasets). Non-detect data are replaced with half the RL for these analyses. The OLS linear regression or Theil-Sen slope estimator will be used to estimate the rate of change (increasing, no change, or decreasing) over time for each constituent at each well. The *t*-test or Mann-Kendall statistic will be used to determine whether a trend is statistically significant. OLS linear regression should only be used when at most 15% of the data are non-detect, when regression residuals are normally distributed, and when the variance from the regression line does not change over time. The Theil-Sen/Mann-Kendall analysis requires at least five observations for meaningful results; at least eight observations are recommended. If a significant temporal trend exists, then a confidence interval around the trend line should be constructed as outlined in **Section 5.1.3**.

If the trend analysis does not indicate a statistically significant trend, then the mean and variance should be calculated. If fewer than 15% of the data are non-detect, then the non-detect data can be replaced with half the RL and the mean and variance can be calculated normally. Tolerance intervals are sensitive to the choice of population distribution. Normality should be confirmed using the Shapiro-Wilk (or Shapiro-Francía) test and/or probability plots, as described in **Section 2.2**. If data appear not to be normally distributed, data should be transformed so that the transformed data are normally distributed.

Two methods – the Kaplan-Meier or Robust ROS method – can be used to determine the sample mean and variance when 15% to 50% of the data are non-detect. Kaplan-Meier should not be used if all non-detect data have the same RL or if the maximum detected value is less than the highest RL of the non-detect data.

When most of the data are detections, data are normally distributed, and there is no significant temporal trend, the UCL is calculated according to the following equation:

$$\mathrm{UCL} = \bar{x} + t_{1-\alpha,n-1} * \frac{s}{\sqrt{n}} \quad (10)$$

where:

$\bar{x} =$ mean concentration of the recent dataset
$t_{1-\alpha,n-1} =$ one-tailed *t*-value at a confidence of 1 – α and at n – 1 degrees of freedom
$s =$ standard deviation of the recent dataset
$n =$ number of samples in the recent dataset

The *t* value must be chosen in such a way to balance the competing goals of a low false-positive rate and a high statistical power. The Unified Guidance recommends that the statistical test have at least 80% power ($1 - \beta = 0.8$) when the underlying mean concentration is twice the MCL (USEPA, 2009). Values of the minimum α (from which *t* values can be determined) are tabulated for this criterion for various values of *n* in Table 22-2 in Appendix D of the Unified Guidance (USEPA, 2009). The selected α should be the maximum of the value in Table 22-2 and 0.01.

If data are transformed normal, the UCL should first be calculated for the transformed data and then be transformed back into concentration terms. Correction factors are available but are not expected to be required. Alternatively, a non-parametric UCL can be used, as described in **Section 5.1.2**.

If data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, then a non-parametric UCL should be used, as described in **Section 5.1.2**.

5.1.1 Most Data Are Non-Detect

If recent data are mostly non-detect, non-parametric confidence intervals can be constructed around the median by ranking the data from least to greatest and setting the UCL equal to one of the higher values of data. The confidence can be calculated based on the rank of the data point used and the sample size. Confidence values are tabulated in Table 21-11 in Appendix D of the Unified Guidance for sample sizes up to 20 (USEPA, 2009).

5.1.2 Data Are neither Normal nor Transformed-Normal

If recent data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution, non-parametric confidence intervals can be constructed around the median by ranking the data from least to greatest and setting the UCL equal to one of the higher values of data. The confidence can be calculated based on the rank of the data point used and the sample size. Confidence values are tabulated in Table 21-11 in Appendix D of the Unified Guidance for sample sizes up to 20 (USEPA, 2009).

5.1.3 A Significant Temporal Trend Exists

If recent data show a significant temporal trend, then a UCL above the trend line can be calculated according to the following equation:

$$\mathrm{UCL} = \widehat{x_0} + \sqrt{2s_e^2 * F_{1-2\alpha,2,n-2} * \left(\frac{1}{n} + \frac{(t_0 - \bar{t})^2}{(n-1)s_t^2}\right)} \quad (11)$$

where:

$\widehat{x_0} =$ regression-line estimate of the mean concentration at time t_0
$s_e =$ standard error of the regression line
$F_{1-2\alpha,2,n-2} =$ upper (1 - 2α)th percentage point from an F-distribution with 2 and n – 2 degrees of freedom
$n =$ number of samples in the recent dataset
$t_0 =$ date of the most recent groundwater sample
$\bar{t} =$ mean of the sampling dates in the recent dataset
$s_t =$ standard deviation of the sampling dates in the recent dataset

Note that the UCL is a function of time; to assess current compliance, the date of the most recent sample should be used for t_0. If and only if the UCL is less than the GWPS at this time, then it can be concluded that the remedy has successfully decreased concentrations below the GWPS. This equation can also be used to assess when the UCL will decrease below the GWPS (assuming the current trend continues).

The same α that would have been selected if there were no significant trend (as described in **Section 5.1**) should be used here to determine the proper *F* value.

If the Theil-Sen method is used to determine the trend line, a computationally intensive technique known as bootstrapping can be used to determine the UCL. This procedure is described in Section 21.3.2 of the Unified Guidance (USEPA, 2009).

5.1.4 A Significant Seasonal Pattern Exists

If a statistically significant seasonal pattern exists in compliance well data and if there is a physical explanation for the seasonality, the compliance well data should be deseasonalized using the procedure described in **Section 2.6**. The UCL to be compared to the GWPS should be calculated based on the deseasonalized compliance well data.

SECTION 6

REPORTING REQUIREMENTS

The CCR rule specifies reporting requirements throughout the monitoring process. Throughout the process, the required documentation is required to be posted both to the site's operating record and to a public internet set for review. As required by 30 TAC 352.931(a), the chosen statistical methods described within this SAP are certified by a qualified professional engineer as appropriate for groundwater evaluation (**Section 7**).

6.1 Annual Groundwater Monitoring and Corrective Action Report

By January 31 of each year, all existing facilities must submit an Annual Groundwater Monitoring and Corrective Action Report (Annual Report) [30 TAC 352.901(a)]. The Annual Report should be prepared and posted to both the site operating record and the public internet site. The Annual Report must also be submitted to TCEQ for approval no later than 30 days after the report has been placed on the facility's operating record [30 TAC 352.902].

The Annual Report should document site status, summarize key actions taken, describe problems encountered and their resolutions, and project key actions to be taken for the following year. The Annual Report should also include [30 TAC 352.901(a)]:

- A figure showing the CCR unit and the monitoring well network;
- An identification of monitoring wells installed or abandoned during the preceding year and the rationale for doing so;
- A summary of groundwater samples collected, which wells were sampled, what dates the samples were collected, and whether the samples were collected for detection monitoring or assessment monitoring; and
- A discussion of any transition between monitoring programs (i.e., detection monitoring vs. assessment monitoring vs. corrective action monitoring.

If appropriate, the Annual Report should detail a demonstration for an alternative groundwater sampling frequency. If no SSIs are identified during each sampling event, an updated Annual Report should be submitted yearly.

6.2 Detection Monitoring

If SSIs are identified, TCEQ and any local pollution agencies with jurisdiction that had requested to be notified should be notified in writing within 14 days of the SSI determination [30 TAC 352.941(b)] and intention to make an alternative source demonstration [30 TAC 352.941(c)(1)]. The facility should demonstrate within 90 days of the detection, where possible, that SSIs over background are not due to a release from the facility, along with a certification by a qualified professional engineer that the information is accurate. The report documenting this demonstration must be submitted to TCEQ for approval and to any local pollution agencies with jurisdiction that had requested to be notified [30 TAC 352.941(c)(2)]. Additionally, the report should be included in the Annual Report. If the SSIs over background are attributed to a release from the facility, the facility should prepare and place in the operating record within 90 days a notification stating that an assessment monitoring program has been established [30 TAC 352.941(a)]. Additionally, the assessment monitoring program must be approved by TCEQ [30 TAC 352.941(d)].

6.3 Assessment Monitoring

If an assessment monitoring program is in place, the Annual Report must also include [30 TAC 352.951(a)]:

- Analytical results for Appendix III and detected Appendix IV constituents,
- Background concentrations for all Appendix III and Appendix IV constituents, and
- GWPSs established for detected Appendix IV constituents.

The semiannual analytical results for Appendix III and detected Appendix IV constituents must also be posted to the facility's operating record within 90 days of receipt [30 TAC 352.951(a)]. If a constituent is detected at an SSL above its GWPS, a notification must be reported to the site's operating record [30 TAC 352.951(a)]. The owner or operator must also submit a written notification to TCEQ and any local pollution agencies with jurisdiction that had requested to be notified within 14 days identifying the SSLs and specifying a plan and schedule for analyzing the release and for developing appropriate corrective action [30 TAC 352.951(d)].

Additionally, the facility must notify any person who owns or resides on land that directly overlies any part of an off-site contaminant plume and record the notifications in the facility's operating record. Within 90 days, the facility must either initiate an assessment of corrective measures or demonstrate that the SSL is not due to a release from the CCR unit. The demonstration must be supported by a report certified by a qualified professional engineer and submitted to TCEQ for approval [30 TAC 352.951(e)].

If the facility determines it may return to detection monitoring and received approval from TCEQ, the facility should issue a notification to the operating record and public site within 30 days [30 TAC 352.1301(a)].

6.4 Corrective Action Monitoring

If a corrective action monitoring program is in place, it must meet the requirements of an assessment monitoring program [30 TAC 352.981(a)]. Thus, the reporting requirements for corrective action monitoring will be similar to assessment monitoring, as described in **Section 6.3**. Upon completion of the remedy, the facility must prepare a notification that the remedy has been completed [30 TAC 352.981(b)]. The notification must be certified by a qualified professional engineer, approved by TCEQ, and placed in the operating record [30 TAC 352.981(a) and 30 TAC 352.981(c)].

SECTION 7

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

By means of this certification, I certify that I am a qualified professional engineer as defined in 30 TAC 352.3(a), that I have reviewed this SAP, and that the statistical methods described therein are appropriate and meet the requirements of 30 TAC 352.931.

DAVID ANTHONY MILLER

Printed Name of Qualified Professional Engineer

DAVID ANTHONY MILLER
112498

David Anthony Miller

Signature

112498

Registration No.

TEXAS

Registration State

12.09.21

Date

SECTION 8

REFERENCES

Electric Power Research Institute. 2015. Groundwater Monitoring Guidance for the Coal Combustion Residuals Rule. Palo Alto, CA. 3002006287.

Environmental Protection Agency. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance. EPA 530/R-09-007.

Texas Administrative Code. Coal Combustion Residuals Waste Management. Title 30, Part 1, Chapter 352. (2021).

TABLES

Table 1: Monitored Constituents under the CCR Rule

Appendix III Constituents	Appendix IV Constituents
Boron	Antimony
Calcium	Arsenic
Chloride	Barium
Fluoride	Beryllium
pH	Cadmium
Sulfate	Chromium
Total Dissolved Solids (TDS)	Cobalt
	Fluoride
	Lead
	Lithium
	Mercury
	Molybdenum
	Radium 226+228
	Selenium
	Thallium

ATTACHMENT A

Record of Revisions

ATTACHMENT A

RECORD OF REVISIONS

Revision 1 (October 2020)

- Added statistical procedures used to implement corrective action monitoring (Section 5) and reporting requirements for corrective action monitoring (Section 6.5).
- Added references to CCR rule-specified screening levels for constituents that do not have an MCL (i.e., cobalt, lead, lithium, and molybdenum) in Sections 2.5, 4, 4.1, and 5.1.
- Added statistical procedures used to evaluate whether a seasonal pattern exists and to deseasonalize data (Sections 2.6, 3.2.5, 4.1.4, and 5.1.4).
- Specified that the Mann-Kendall trend test can use an α of 0.01 for sufficiently large datasets (Sections 3.1, 4.1, and 5.1).
- Removed references to control limits in Section 3.2 because prediction limits are generally being used to conduct detection monitoring.
- Removed references to using trend tests to evaluate SSIs at the end of Section 3.2 because prediction limits are generally being used to conduct detection monitoring.
- Clarified that non-parametric limits should be used when data are non-normal and cannot be transformed such that the transformed data do follow a normal distribution (Sections 3.2.3, 4.1.2, and 5.1.2).
- Referred to the Wilcoxon rank-sum/Mann-Whitney test as the Mann-Whitney test to match the statistical output from Sanitas (Sections 3.4 and 4.4).
- Clarified that a background dataset that contains at least five data points is sufficiently large to use an α as low as 0.01 to conduct the Mann-Whitney test as part of a background update, in line with recommendations in the Unified Guidance (Section 3.4).
- Clarified the procedure to be used if the Mann-Whitney test indicates a statistically significant difference between existing background data and newer data (Sections 3.4 and 4.4).
- Clarified that spatial variability among background wells may be assessed periodically as part of a background update because spatial variability is evaluated when background values are initially established (Sections 3.4 and 4.4).

- Added statistical procedures to determine when Appendix III and Appendix IV concentrations are at or below background to evaluate whether units in assessment monitoring may return to detection monitoring (Section 4.2).

- Generally replaced “parameter” with “constituent”.

- Added references to the Unified Guidance and the CCR rule throughout the document.

- Made minor grammatical and stylistic changes throughout the document.

Revision 2 (November 2021)

- Removed references to screening levels for constituents that do not have an MCL.

- Updated references from the Code of Federal Regulations to Texas Administrative Code.

4.7 – Statistical Analysis Summary, Landfill, H.W. Pirkey Power Plant, Hallsville, Texas, January 3, 2018

Purpose of Statistical Analysis Summary Report

During the initial phase of ground water monitoring, the CCR rule requires AEP to collect at least eight independent samples from at least one up-gradient and three downgradient wells for 21 substances listed in the CCR rule. The CCR rule also requires us to select a statistical method that will be used to evaluate the samples in the later phases of the ground water monitoring program. The Statistical Plan, which has been posted to AEP's CCR website, describes the methods selected by AEP. *See* AEP's Statistical Analysis Plans.

Each **Statistical Analysis Summary Report** is based on the results of the 8 independent samples that were collected by October 17, 2017, and reported in the Annual Groundwater Monitoring Report. Using the statistical methods chosen by AEP, the samples were evaluated to eliminate outliers, determine variability and general trends in the data, and establish background values for: boron, calcium chloride, fluoride, pH, sulfate, and total dissolved solids. Appendix IV substances were evaluated for purposes of identifying outliers and understanding data trends.

A subsequent sample taken during the first detection monitoring sampling event was also compared using the proper statistical methods to the background values that were established for these seven substances from the eight independent samples. A second or third re-sampling event occurred, and the results compared using the same methods. This work is reported in the memorandum included in attachment A. If confirmed, AEP will be required to enter the next phase of monitoring. The results of future sampling will be further analyzed to target any specific substances for which ongoing monitoring or potential corrective action is required.

STATISTICAL ANALYSIS SUMMARY
LANDFILL
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

150 East Wilson Bridge Road
Suite 232
Worthington, Ohio 43085

January 3, 2018

CHA8423

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LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ANOVA	Analysis of Variance
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Value
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
LFB	Laboratory Fortified Blanks
LPL	Lower Prediction Limit
LRB	Laboratory Reagent Blanks
NELAP	National Environmental Laboratory Accreditation Program
PQL	Practical Quantitation Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SWFPR	Site-Wide False-Positive Rate
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the landfill, an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Eight monitoring events were completed prior to October 17, 2017 to establish background concentrations for Appendix III and Appendix IV parameters under the CCR rule. Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. The background data were reviewed for outliers, which were removed (when appropriate) prior to calculating upper prediction limits (UPLs) for each Appendix III parameter to represent background values. Oversight on the use of statistical calculations was provided by Dr. Kirk Cameron of MacStat Consulting, Ltd.

A groundwater sampling event occurred on August 23 and 24, 2017 at the landfill. This sampling event obtained the first sample for the 1-of-2 prediction interval statistical test used for detection monitoring. The results of this sampling event are included in this report.

SECTION 2

LANDFILL EVALUATION

2.1 Data Validation & QA/QC

During the background monitoring program, eight sets of samples were collected for analysis from each upgradient and downgradient well. A summary of data collected during background and detection monitoring sampling may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.5.32 statistics software. The export was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

The background data used to conduct the statistical analyses are summarized in Table 1. Statistical analyses for the landfill were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Results for all completed statistical tests are provided in Attachment A.

Time series plots of Appendix III and IV parameters are included in Attachment A. Mann-Kendall analyses ($\alpha = 0.01$) were conducted to evaluate trends in the background data. Mercury was found to be significantly decreasing at downgradient well AD-34. No other significant increasing or decreasing trends were observed for other parameters or at other monitoring wells.

2.2.1 Background Outlier Evaluation

Potential outliers were identified using Tukey's outlier test; i.e., data points were considered potential outliers if they met one of the following criteria:

$$x_i < \tilde{x}_{0.25} - 3 \times IQR \quad (1)$$

or

$$x_i > \tilde{x}_{0.75} + 3 \times IQR \quad (2)$$

where:

$x_i =$ individual data point
$\tilde{x}_{0.25} =$ first quartile
$\tilde{x}_{0.75} =$ third quartile
$IQR =$ the interquartile range $= \tilde{x}_{0.75} - \tilde{x}_{0.25}$

Data that were evaluated as potential outliers are summarized in Attachment A. Tukey's outlier test indicated 17 potential outliers, which are summarized in Table 2. Next, the data were reviewed to identify possible sources of errors or discrepancies, including data recording errors, unusual sampling conditions, laboratory quality indicators, or inconsistent sample turbidity. The findings of this data review are summarized below.

The primary sample result for fluoride collected on October 12, 2016 at upgradient well AD-12 (4.717 mg/L) was replaced with the duplicate sample result. Fluoride was not detected in the duplicate sample at a reporting limit of 1.0 mg/L. The duplicate sample was considered more representative based on the reported concentrations from the other background sampling events. The reported fluoride concentration of 0.2565 mg/L at AD-12 on April 11, 2017 was also identified as an outlier. However, it was an estimated (J-flagged) value and was not removed from the database.

Thirteen of the potential outliers were associated with mercury in upgradient wells. Several of the mercury samples were not detected and were reported as the reporting limit. Thus, samples which did have detectable concentrations of mercury were often identified as high potential outliers. These values were retained in the database, as they are likely reflective of aquifer conditions. Likewise, several estimated (J-flagged) mercury concentrations were identified as potential low outliers and were retained in the database.

The reported lithium concentration of 0.0001358 mg/L at AD-23 on May 10, 2016 was an estimated (J-flagged) value and was retained within the dataset. The reported lithium concentration of 1.01 mg/L at AD-23 on October 12, 2016 was also identified as a potential outlier. The sample was removed from the dataset because high turbidity was reported during sample collection, suggesting possible sampling error. The removed lithium value was associated with a downgradient monitoring well; therefore, its removal did not affect the calculation of background levels presented below.

2.2.2 Establishment of Background Levels

Analysis of variance (ANOVA) was conducted to determine whether spatial variation was present among the four upgradient wells (Attachment A). ANOVA indicated no significant variation among the four upgradient wells for pH. Consequently, interwell tests were used for pH. Significant variation was observed for boron, calcium, chloride, fluoride, sulfate, and total dissolved solids (TDS). Therefore, the appropriateness of using intrawell tests was evaluated for all Appendix III parameters at the Pirkey Plant Landfill.

Intrawell tests presume that the groundwater quality in the downgradient wells was not initially impacted by the CCR unit. To test this presumption, the data from the upgradient wells were pooled and the data from each downgradient well were compared to a pooled background value. Tolerance limits were calculated using the pooled background data for boron, calcium, chloride, fluoride, sulfate, and TDS. Parametric tolerance limits with 99% confidence and 95% coverage were calculated for calcium, chloride, and TDS. Non-parametric tolerance limits were calculated for boron, fluoride, and sulfate, due to non-normality, high frequency (more than 50%) of non-detects, and especially high observed spatial variability, respectively. Confidence intervals were calculated for each of these six parameters for each downgradient monitoring well. If the lower confidence limit from a downgradient well exceeded the upper tolerance limit for the pooled background data, it was concluded that downgradient groundwater concentrations were above background concentrations. In these instances, intrawell tests would not be appropriate. However, these analyses indicated no significant exceedances for boron, calcium, chloride, and fluoride; elevated concentrations of sulfate and TDS were observed. (Non-parametric analyses also indicated elevated TDS concentrations in downgradient wells and no significant exceedances for calcium. A non-parametric analysis for chloride indicated elevated chloride concentrations at downgradient well AD-35.) Therefore, intrawell tests were used to evaluate potential SSIs for boron, calcium, chloride, and fluoride. Parametric interwell tests were used to evaluate potential SSIs for pH, sulfate, and TDS.

After equality of variance was tested and identified outliers were removed (where appropriate), a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., “J-flagged” data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment A.

Upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. To conduct the intrawell tests for boron, calcium, chloride, and fluoride, a separate UPL was calculated for each downgradient well for each of these parameters. To conduct the interwell tests for pH, sulfate, and TDS, a single prediction interval was calculated for each of these parameters using pooled data from the four upgradient wells. The background data used for the UPL calculations are summarized in Table 1; the calculated UPLs are summarized in Table 3.

UPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where initial results did not exceed the UPL, a second sample was not collected. The one-of-two retesting procedure allowed achieving an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less. Power curves were constructed for the interwell and intrawell parametric tests and are compared with the EPA Reference Power Curve in Appendix A. The power curves associated with the statistical tests for the Pirkey Plant Landfill exceed the EPA Reference Power Curve at 3 and 4 standard deviations; this is considered a "good" level of statistical power according to EPA's *Unified Guidance* (USEPA, 2009).

2.2.3 Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey Landfill CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

DAVID ANTHONY MILLER
112498

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

01.03.18
Date

2.3 Conclusions

Eight background monitoring and one detection monitoring event were completed in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified seventeen potential outliers, with one value removed from the dataset without replacement. Prediction intervals were constructed based on the remaining background data and a one-of-two retesting procedure. Interwell tests were selected for pH, sulfate, and TDS, whereas intrawell tests were selected for boron, calcium, chloride, and fluoride.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H. W. Pirkey Power Plant. January 2017.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March 2009.

TABLES

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-8								
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.005U	0.00117J	0.005U	0.00147J	0.005U	0.00153J	0.00169J	0.005U	-
Barium	mg/L	0.038	0.061	0.048	0.061	0.052	0.06	0.052	0.051	-
Beryllium	mg/L	0.001	0.007	0.002	0.006	0.006	0.006	0.006	0.006	-
Boron	mg/L	1.58	0.775	1.04	0.793	0.769	0.734	0.777	0.779	0.411
Cadmium	mg/L	0.001U	0.00018J	0.001U	0.001U	0.00012J	0.00011J	0.00014J	0.00013J	-
Calcium	mg/L	109	20.7	50.7	20.8	17.2	18.6	18.1	17.1	19.4
Chloride	mg/L	9	13	12	13	13	13	10	12	9
Chromium	mg/L	0.001	0.001	0.00084J	0.00074J	0.00081J	0.002	0.00063J	0.00089J	-
Cobalt	mg/L	0.0018J	0.02	0.009	0.018	0.018	0.018	0.018	0.019	-
Combined Radium	pCi/L	0.9155	6.75	1.658	6.72	6.14	6.29	7.64	5.56	-
Fluoride	mg/L	1U	2	2	2	3	3	2	3	0.587J
Lead	mg/L	0.00103J	0.00147J	0.005U	0.00231J	0.00286J	0.003J	0.00327J	0.00244J	-
Lithium	mg/L	0.001U	0.032	0.018	0.032	0.03	0.032	0.031	0.031	-
Mercury	mg/L	0.00003	0.00021	0.00005	0.00011	0.00016	0.00016	0.00015	0.00001J	-
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.015	0.005U	0.00385J	0.00251J	0.005U	0.00141J	0.00179J	0.005U	-
Total Dissolved Solids	mg/L	432	280	285	276	296	280	250	284	110
Sulfate	mg/L	181	131	121	184	208	228	157	168	56
Thallium	mg/L	0.0012J	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	6.14	6.18	5.14	3.73	3.67	3.57	3.68	3.87	-

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-12								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Barium	mg/L	0.026	0.023	0.03	0.027	0.028	0.023	0.026	0.024	-
Beryllium	mg/L	0.00022J	0.00019J	0.00023J	0.00015J	0.00015J	0.00013J	0.00015J	0.00016J	-
Boron	mg/L	0.03	0.03	0.04	0.03	0.04	0.03	0.04	0.05	0.0495
Cadmium	mg/L	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	0.362	0.26	0.343	0.271	0.331	0.315	0.434	0.299	0.245
Chloride	mg/L	5	6	6	7	8	7	5	6	6
Chromium	mg/L	0.00071J	0.00069J	0.00035J	0.00053J	0.00033J	0.00065J	0.00033J	0.00042J	-
Cobalt	mg/L	0.00158J	0.00129J	0.00167J	0.00157J	0.00147J	0.00109J	0.0013J	0.00133J	-
Combined Radium	pCi/L	0.2073	2.909	0.881	0.257	0.767	1.536	0.416	0.3895	-
Fluoride	mg/L	1U	1U	1U	1	1U	1U	1U	0.2565J	0.213J
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.001U	0.008	0.01	0.012	0.013	0.01	0.009	0.008	-
Mercury	mg/L	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00001J	-
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00174J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	94	75	63	92	80	76	50	72	52
Sulfate	mg/L	4	4	7	8	6	6	4	7	6
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.00099J	0.002U	-
pH	SU	4.44	3.11	3.89	3.37	2.58	4.76	3.63	4.74	4.84

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-16								
		5/10/2016	7/14/2016	9/8/2016	10/13/2016	11/14/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.008	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.00183J	0.005U	0.005U	0.00152J	0.005U	0.005U	0.00151J	0.005U	-
Barium	mg/L	0.061	0.064	0.07	0.056	0.055	0.058	0.076	0.077	-
Beryllium	mg/L	0.00045J	0.00057J	0.00081J	0.00025J	0.00038J	0.00071J	0.00049J	0.00044J	-
Boron	mg/L	0.02	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.0365
Cadmium	mg/L	0.00008J	0.001U	0.00009J	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	1.21	2	1.83	1.15	1.58	1.76	1.29	1.21	0.945
Chloride	mg/L	8	9	9	9	9	10	9	11	12
Chromium	mg/L	0.001	0.001	0.002	0.001	0.00056J	0.00041J	0.00056J	0.00082J	-
Cobalt	mg/L	0.00424J	0.006	0.008	0.00334J	0.00434J	0.008	0.005	0.005	-
Combined Radium	pCi/L	1.294	1.438	1.931	1.843	2.123	2.629	1.417	0.932	-
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.006	0.036	0.032	0.033	0.028	0.031	0.021	0.019	-
Mercury	mg/L	0.00002J	0.00002J	0.00001J	0.00002U	0.00002U	0.00001J	0.00002U	0.00001J	-
Molybdenum	mg/L	0.005U	0.00112J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00226J	0.005U	0.005U	0.0017J	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	116	148	133	124	124	112	108	106	96
Sulfate	mg/L	16	45	33	16	23	43	22	24	14
Thallium	mg/L	0.00137J	0.002U	0.00175J	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	3.89	3.81	3.9	3.86	4.35	3.69	3.15	3.38	4.29

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-23								
		5/10/2016	**7/13/2016**	**9/8/2016**	**10/12/2016**	**11/15/2016**	**1/11/2017**	**2/28/2017**	**4/11/2017**	**8/23/2017**
		Background								**Detection**
Antimony	mg/L	0.00289J	0.0038J	0.005U	0.0013J	0.005U	0.005U	0.00166J	0.005U	-
Arsenic	mg/L	0.00165J	0.005U	0.005U	0.007	0.005U	0.00204J	0.005U	0.00397J	-
Barium	mg/L	0.048	0.048	0.053	0.12	0.05	0.073	0.041	0.086	-
Beryllium	mg/L	0.00019J	0.00019J	0.0002J	0.00046J	0.00013J	0.00016J	0.00012J	0.00032J	-
Boron	mg/L	0.01	0.03	0.02	0.03	0.03	0.02	0.03	0.03	0.0402
Cadmium	mg/L	0.00007J	0.00009J	0.001U	0.00014J	0.001U	0.001U	0.001U	0.00011J	-
Calcium	mg/L	0.535	0.317	0.26	0.321	0.249	0.319	0.217	0.543	0.276
Chloride	mg/L	4	4	5	6	5	6	4	7	6
Chromium	mg/L	0.002	0.002	0.005	0.041	0.006	0.015	0.0003J	0.022	-
Cobalt	mg/L	0.0023J	0.00273J	0.00201J	0.00391J	0.00167J	0.00226J	0.00105J	0.00261J	-
Combined Radium	pCi/L	6.86	5.69	6.68	12.89	7.54	8.06	5.74	10.31	-
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	0.2688J	0.198J
Lead	mg/L	0.005U	0.005U	0.00224J	0.031	0.00321J	0.011	0.005U	0.015	-
Lithium	mg/L	0.00014J	0.006	0.006	1.01	0.006	0.009	0.005	0.01	-
Mercury	mg/L	0.00001J	0.00002J	0.00002U	0.0001	0.00002J	0.00009	0.00002U	0.00012	-
Molybdenum	mg/L	0.005U	0.00135J	0.005U	0.00056J	0.0004J	0.005U	0.005U	0.00032J	-
Selenium	mg/L	0.00192J	0.002J	0.005U	0.00211J	0.00135J	0.005U	0.00131J	0.005U	-
Total Dissolved Solids	mg/L	72	59	64	68	100	60	48	76	64
Sulfate	mg/L	10	11	12	13	14	13	9	11	11
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	3.99	2.72	3.46	3.68	3.46	3.66	4.04	4.17	4.11

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-27								
		5/11/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.00121J	0.00096J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.00215J	0.00128J	0.005U	0.00214J	0.005U	0.00157J	0.005U	0.005U	-
Barium	mg/L	0.043	0.045	0.047	0.046	0.041	0.046	0.043	0.045	-
Beryllium	mg/L	0.005	0.005	0.006	0.005	0.005	0.005	0.005	0.005	-
Boron	mg/L	0.02	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.0358
Cadmium	mg/L	0.00043J	0.00043J	0.0004J	0.00042J	0.00042J	0.0003J	0.00029J	0.00041J	-
Calcium	mg/L	4.41	4.43	4.17	4.09	4.52	3.74	4.31	4.01	3.58
Chloride	mg/L	8	8	8	8	8	9	8	9	9
Chromium	mg/L	0.00087J	0.002	0.002	0.002	0.002	0.001	0.002	0.00095J	-
Cobalt	mg/L	0.02	0.021	0.02	0.02	0.022	0.018	0.021	0.021	-
Combined Radium	pCi/L	2.031	2.406	2.71	4.43	3.69	2.62	3.48	2.58	-
Fluoride	mg/L	0.6176J	1U	1U	1U	1U	1U	1U	1U	0.197J
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.066	0.097	0.095	0.096	0.095	0.1	0.1	0.104	-
Mercury	mg/L	0.00002U	0.00002J	0.00002U	0.00002U	0.00002U	0.00001J	0.00002U	0.00002U	-
Molybdenum	mg/L	0.005U	0.00043J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00111J	0.005U	0.005U	0.00136J	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	198	192	196	216	216	180	216	180	168
Sulfate	mg/L	51	54	52	58	92	58	56	54	52
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	3.88	2.7	2.89	3.02	3.46	4.07	2.81	3.3	3.71

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-34								
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/10/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.012	0.025	0.009	0.01	0.007	0.006	0.007	0.0045J	-
Barium	mg/L	0.072	0.177	0.031	0.039	0.023	0.029	0.011	0.023	-
Beryllium	mg/L	0.003	0.004	0.003	0.003	0.002	0.002	0.002	0.002	-
Boron	mg/L	0.08	0.111	0.09	0.09	0.1	0.07	0.08	0.09	0.107
Cadmium	mg/L	0.006	0.006	0.008	0.005	0.008	0.007	0.006	0.011	-
Calcium	mg/L	37.8	33.2	39.5	35.8	36.3	39.9	37	38.2	36.2
Chloride	mg/L	7	8	8	7	7	8	6	8	7
Chromium	mg/L	0.034	0.081	0.012	0.015	0.006	0.008	0.001U	0.007	-
Cobalt	mg/L	0.301	0.296	0.306	0.297	0.292	0.284	0.294	0.299	-
Combined Radium	pCi/L	9.64	7.75	7.91	10.12	13.21	11.9	9.87	2.407	-
Fluoride	mg/L	1U	1U	1U	0.6272J	0.9978J	1U	1U	0.5241J	0.619J
Lead	mg/L	0.012	0.039	0.00102J	0.0037J	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.176	0.183	0.158	0.174	0.154	0.164	0.158	0.167	-
Mercury	mg/L	0.0001	0.00031	0.00006	0.00004	0.00002	0.00003	0.00002U	0.00002J	-
Molybdenum	mg/L	0.00069J	0.00211J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.005U	0.007	0.005U	0.005U	0.00451J	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	1516	1396	1520	1464	1428	1378	1402	1490	1128
Sulfate	mg/L	974	837	870	1084	1006	1334	993	1016	1231
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	3.99	3.56	3.34	3.57	3.71	3.23	3.72	3	3.72

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-35								
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.011	0.009	0.00113J	0.00407J	0.012	0.00215J	0.00404J	0.0014J	-
Barium	mg/L	0.124	0.185	0.116	0.11	0.143	0.115	0.094	0.092	-
Beryllium	mg/L	0.00033J	0.00039J	0.00019J	0.00014J	0.0003J	0.00009J	0.00009J	0.00007J	-
Boron	mg/L	0.109	0.07	0.04	0.05	0.06	0.06	0.123	0.07	0.0413
Cadmium	mg/L	0.00011J	0.001U	0.001U	0.001U	0.00024J	0.00009J	0.001U	0.00033J	-
Calcium	mg/L	17.4	5.35	3.42	2.43	2	10.4	22.5	10.8	4.33
Chloride	mg/L	17	18	14	14	14	18	19	25	16
Chromium	mg/L	0.021	0.019	0.005	0.006	0.03	0.005	0.003	0.001	-
Cobalt	mg/L	0.01	0.006	0.00344J	0.00299J	0.007	0.00406J	0.00475J	0.006	-
Combined Radium	pCi/L	2.465	4.21	2.065	6.01	4.83	3.65	2.02	2.707	-
Fluoride	mg/L	1U	1U	1U	0.3552J	1U	1U	1U	1U	1U
Lead	mg/L	0.007	0.00437J	0.005U	0.00153J	0.007	0.005U	0.00124J	0.005U	-
Lithium	mg/L	0.001U	0.013	0.011	0.012	0.019	0.01	0.008	0.007	-
Mercury	mg/L	0.00006	0.00011	0.00002U	0.00001J	0.00007	0.00002J	0.00002J	0.00002U	-
Molybdenum	mg/L	0.00044J	0.005U	0.005U	0.005U	0.00058J	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	162	114	104	116	142	128	140	160	92
Sulfate	mg/L	50	28	21	23	29	62	84	75	35
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	4.68	4.62	4.02	3.58	4.32	4.72	3.54	4.81	4.86

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 2: Outlier Analysis Summary
Pirkey Landfill

Location	Well ID	Sample Date	Parameter	Reported Value	Units	Conclusions
Upgradient	AD-12	10/12/2016	Fluoride	4.717	mg/L	This value was replaced with 1.0 mg/ L (ND) - reporting limit for a non-detect concentration for the duplicate sample.
Upgradient	AD-12	4/11/2017	Fluoride	0.2565 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-8	7/13/2016	Mercury	0.000211	mg/L	The pooled upgradient data for mercury had several non-detect values which were reported as the reporting limit. This detected value represents likely aquifer conditions and was not removed from the dataset.
Upgradient	AD-16	5/10/2016	Mercury	0.00001506 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-16	9/8/2016	Mercury	0.00000753 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-8	9/8/2016	Mercury	0.000048	mg/L	The pooled upgradient data for mercury had several non-detect values which were reported as the reporting limit. This detected value represents likely aquifer conditions and was not removed from the dataset.
Upgradient	AD-8	10/12/2016	Mercury	0.000112	mg/L	The pooled upgradient data for mercury had several non-detect values which were reported as the reporting limit. This detected value represents likely aquifer conditions and was not removed from the dataset.
Upgradient	AD-8	11/15/2016	Mercury	0.00016	mg/L	The pooled upgradient data for mercury had several non-detect values which were reported as the reporting limit. This detected value represents likely aquifer conditions and was not removed from the dataset.
Upgradient	AD-8	1/11/2017	Mercury	0.000157	mg/L	The pooled upgradient data for mercury had several non-detect values which were reported as the reporting limit. This detected value represents likely aquifer conditions and was not removed from the dataset.
Upgradient	AD-16	1/11/2017	Mercury	0.00001045 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-27	1/11/2017	Mercury	0.00000659 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-8	2/28/2017	Mercury	0.000153	mg/L	The pooled upgradient data for mercury had several non-detect values which were reported as the reporting limit. This detected value represents likely aquifer conditions and was not removed from the dataset.
Upgradient	AD-12	4/11/2017	Mercury	0.00001364 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-16	4/10/2017	Mercury	0.00000733 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-8	4/11/2017	Mercury	0.00001068 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Downgradient	AD-23	5/10/2016	Lithium	0.0001358 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Downgradient	AD-23	10/12/2016	Lithium	1.01	mg/L	The value was removed from the dataset as an outlier. The sample had high turbidity during collection, suggesting possible sampling error.

Table 3: Background Level Summary
Pirkey Plant - Landfill

Parameter	Units	Description	AD-23	AD-34	AD-35
Boron	mg/L	Intrawell Background Value (UPL)	0.03	0.1201	0.1433
Calcium	mg/L	Intrawell Background Value (UPL)	0.6535	42.53	27.73
Chloride	mg/L	Intrawell Background Value (UPL)	7.893	9.204	26.47
Fluoride	mg/L	Intrawell Background Value (UPL)	1	1	1
pH	SU	Interwell Background Value (UPL)	5.375		
	SU	Interwell Background Value (LPL)	2.483		
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	335		
Sulfate	mg/L	Interwell Background Value (UPL)	207		

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

ATTACHMENT A

Evaluation of Detection Monitoring Data

Geosyntec
consultants

150 E.Wilson Bridge Road, Suite 232
Columbus, Ohio 43085
PH 614.468.0415
FAX 614.468.0416
www.geosyntec.com

Memorandum

Date:	February 27, 2018
To:	David Miller (AEP)
Copies to:	Terence Wehling (AEP)
From:	Allison Kreinberg and Bruce Sass, Ph.D. (Geosyntec)
Subject:	Evaluation of Detection Monitoring Data at H.W. Pirkey Plant's Landfill (LF)

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), detection monitoring events were completed on August 23, 2017 and December 21, 2017 at the Landfill (LF), an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Eight background monitoring events were conducted at the Pirkey LF prior to these detection monitoring events, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated January 3, 2018.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is only concluded if both samples in a series of two exceeds the UPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are summarized in Table 1b.

- Boron concentrations exceeded the intrawell UPL of 0.03 mg/L in both the initial (0.0402 mg/L) and second (0.0450 mg/L) samples collected at AD-23. Therefore, an SSI over background is concluded for boron at AD-23.

- Total dissolved solids (TDS) concentrations exceeded the interwell UPL of 335 mg/L in both the initial (1128 mg/L) and second (1260 mg/L) samples collected at AD-34. Therefore, an SSI over background is concluded for TDS at AD-34.

- Sulfate concentrations exceeded the interwell UPL of 207 mg/L in both the initial (1231 mg/L) and second (1020 mg/L) samples collected at AD-34. Therefore, an SSI over background is concluded for sulfate at AD-34.

As a result, the Pirkey LF CCR unit will conduct an alternate source demonstration.

No other exceedances of UPLs were observed during these detection monitoring events.

The following modifications to Geosyntec’s *Statistical Analysis Summary* report were incorporated after the certification date of January 3, 2018:

- Table 1 (“Groundwater Data Summary”) was revised to reflect appropriate significant digits for estimated (J-flagged) values; and,

- Figure E (“Analysis of Variance”) of Attachment A (“Statistical Analysis Output”) was revised to correct a formatting error.

* * * * *

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected statistical method, described above and in the January 3, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Pirkey LF CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

DAVID ANTHONY MILLER
112498

112498
License Number

TEXAS
Licensing State

02.27.18
Date

Table 1b: Detection Monitoring Data Evaluation
Pirkey Plant - Landfill

Parameter	Unit	Description	AD-23		AD-34		AD-35	
			8/23/2017	12/21/2017	8/23/2017	12/21/2017	8/23/2017	12/21/2017
Boron	mg/L	Intrawell Background Value (UPL)	0.03		0.120		0.143	
	mg/L	Detection Monitoring Result	**0.0402**	**0.0450**	0.107	-	0.0413	-
Calcium	mg/L	Intrawell Background Value (UPL)	0.654		42.5		27.7	
	mg/L	Detection Monitoring Result	0.276	0.469	36.2	-	4.33	-
Chloride	mg/L	Intrawell Background Value (UPL)	7.89		9.20		26.5	
	mg/L	Detection Monitoring Result	6	-	7	8	16	-
Fluoride	mg/L	Intrawell Background Value (UPL)	1		1		1	
	mg/L	Detection Monitoring Result	0.198	-	0.619	0.667	<0.083	-
pH	SU	Interwell Background Value (UPL)	5.38					
	SU	Interwell Background Value (LPL)	2.48					
	SU	Detection Monitoring Result	4.11	-	3.72		4.86	-
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	335					
	mg/L	Detection Monitoring Result	64	-	**1128**	**1260**	92	-
Sulfate	mg/L	Interwell Background Value (UPL)	207					
	mg/L	Detection Monitoring Result	11	-	**1231**	**1020**	35	-

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
-: Not Sampled
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

November 4, 2017

Geosyntec Consultants
Attn: Mr. Bruce Sass
150 E. Wilson Bridge Rd., #232
Worthington, OH 43085

Dear Mr. Sass,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the screening and statistical analysis of background groundwater data for American Electric Power's Pirkey Landfill. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at Pirkey Landfill for the CCR program in 2016, and 8 background samples have been collected at each of the groundwater monitoring wells. The monitoring well network, as provided by Geosyntec Consultants, consists of the following: upgradient AD-8, AD-12, AD-16, and AD-27; and downgradient wells AD-23, AD-34, and AD-35.

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis was reviewed by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to Groundwater Stats Consulting.

The following constituents were evaluated: Appendix III parameters – boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and Appendix IV parameters - antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 & 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters at all wells are provided for the purpose of screening data at these wells (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B). The time series plots are used to initially screen for suspected outliers and trends, while the box plots provide visual representation of variation within individual wells and between all wells.

Data at all wells were evaluated for the following: 1) outliers; 2) trends; 3) most appropriate statistical method for Appendix III parameters based on site characteristics of groundwater data upgradient of the facility; and 4) eligibility of downgradient wells when intrawell statistical methods are recommended. Power curves are provided to demonstrate that the selected statistical methods for Appendix III parameters comply with the USEPA Unified Guidance recommendations as discussed below.

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for boron, calcium, chloride, and fluoride;
2) Interwell prediction limits combined with a 1-of-2 resample plan for pH, sulfate, and TDS.

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, simple substitution of one-half the reporting limit is utilized in the statistical analysis. The reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Background Screening

Outlier Evaluation

Time series plots are used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III and Appendix IV parameters were formally tested using Tukey's box plot method and, when identified, flagged in the computer database with "o" and deselected prior to construction of statistical limits (Figure C).

Tukey's outlier test noted a couple outliers as may be seen on the Outlier Summary Table and accompanying graphs. Any values identified as outliers are plotted in a lighter font on the time series graph. While the test identified a few outliers for mercury in upgradient wells, no values were flagged at this time as all results are very low level concentrations. No values were flagged as outliers for pH in upgradient wells, as all concentrations appear to represent natural variation in groundwater upgradient of the facility. For fluoride in upgradient well AD-12 and lithium in downgradient well AD-23, only the identified high outliers were flagged at this time as the low outliers are trace (or estimated) values reported between the method detection limit (MDL) and the reporting limit (RL). A substitution of the most recent reporting limit was applied when varying detection limits existed in data.

No true seasonal patterns were observed on the time series plots for any of the detected data; therefore, no deseasonalizing adjustments were made to the data. When seasonal patterns are observed, data may be deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release.

While trends may be visual, a quantification of the trend and its significance is needed. The Sen's Slope/Mann Kendall trend test was used to evaluate all data at each well to identify statistically significant increasing or decreasing trends (Figure D). In the absence of suspected contamination, significant trending data are typically not included as part of the background data used for construction of prediction limits. This step serves to eliminate the trend and, thus, reduce variation in background. When statistically significant decreasing trends are present, earlier data are evaluated to determine whether earlier concentration levels are significantly different than current reported concentrations and will be deselected as necessary. When the historical records of data are truncated for the reasons above, a summary report will be provided to show the date ranges used in construction of the statistical limits.

The results of the trend analyses showed one statistically significant decreasing trend for mercury as may be seen on the Trend Test Summary Table that accompanies the trend tests. This trend is relatively low in magnitude when compared to average concentrations; therefore, no adjustments were made to the data sets.

Appendix III – Determination of Spatial Variation

The Analysis of Variance (ANOVA) was used to statistically evaluate differences in average concentrations among upgradient wells, which assists in identifying the most appropriate statistical approach (Figure E). Interwell tests, which compare downgradient well data to statistical limits constructed from pooled upgradient well data, are appropriate when average concentrations are similar across upgradient wells. Intrawell tests, which compare compliance data from a single well to screened historical data within the same well, are appropriate when upgradient wells exhibit spatial variation; when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective; and when downgradient water quality is unimpacted compared to upgradient water quality for the same parameter.

The ANOVA identified variation among upgradient well data for all of the Appendix III parameters except pH, making this parameter eligible for interwell prediction limits. All other Appendix III data were further evaluated as described below for the appropriateness of intrawell testing to accommodate the groundwater quality. A summary table of the ANOVA results is included with the reports.

Appendix III - Statistical Limits

Intrawell limits constructed from carefully screened background data from within each well serve to provide statistical limits that are conservative (i.e. lower) from a regulatory perspective, and that will rapidly identify a change in more recent compliance data from within a given well. This statistical method removes the element of variation from across wells and eliminates the chance of mistaking natural spatial variation for a release from the facility. Prior to performing intrawell prediction limits, several steps are required to reasonably demonstrate downgradient water quality does not have existing impacts from the practices of the facility.

Exploratory data analysis was used as a general comparison of concentrations in downgradient wells for all Appendix III parameters recommended for intrawell analyses to concentrations reported in upgradient wells. Upper tolerance limits are used in conjunction with confidence intervals to determine whether the estimated averages in downgradient wells are higher than observed levels upgradient of the facility. The upper tolerance limits were constructed to represent the extreme upper range of possible background levels at the site.

In cases where downgradient average concentrations are higher than observed concentrations upgradient for a given constituent, an independent study and hydrogeological investigation would be required to identify local geochemical conditions and expected groundwater quality for the region to justify an intrawell approach. Such an assessment is beyond the scope of services provided by Groundwater Stats Consulting. When there is not an obvious explanation for observed concentration differences in downgradient wells relative to reported concentrations in upgradient wells, interwell prediction limits will initially be selected for the statistical method until further evidence shows that concentrations are due to natural variation rather than a result of the facility.

Parametric tolerance limits were constructed with a target of 99% confidence and 95% coverage using pooled upgradient well data for each of the Appendix III parameters recommended for intrawell analyses (Figure F). The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. As more data are collected, the background population is better represented and the confidence and coverage levels increase.

Confidence intervals were constructed on downgradient wells for each of the Appendix III parameters using the tolerance limits discussed above, to determine intrawell eligibility for parameters with spatial variation among upgradient wells (Figure G). When the entire confidence interval is above a background standard for a given parameter, interwell methods are initially recommended as the statistical method. Therefore, only parameters with confidence intervals which did not exceed background standards are eligible for intrawell prediction limits.

Confidence intervals for the above parameters were found to be within their respective background limit for boron, calcium, chloride, and fluoride; while the confidence intervals for sulfate and TDS were above the background standards. Therefore, intrawell methods are recommended for boron, calcium, chloride, and fluoride. Interwell methods are initially recommended for sulfate and TDS, and pH which was determined to have no variation among upgradient well data. As mentioned earlier, if a demonstration supports natural variation in groundwater, intrawell methods will be considered for all parameters.

All available data through April 2017 for calcium at each well were used to establish intrawell background limits based on a 1-of-2 resample plan that will be used for future comparisons (Figure H). Interwell prediction limits, combined with a 1-of-2 resample plan, were constructed from upgradient wells for parameters discussed above (Figure I). Downgradient measurements will be compared to these background limits during each subsequent semi-annual sampling event.

Natural systems continuously evolve due to physical changes made to the environment. Examples include capping a landfill, paving areas near a well, or lining a drainage channel to prevent erosion. Periodic updating of background statistical limits will be necessary to accommodate these types of changes In the interwell case, newer data will be included in background when a minimum of 2 new samples per well are available. In the intrawell case, data for all wells and constituents are re-evaluated when a minimum of 4 new data points are available to determine whether earlier concentrations are representative of present-day groundwater quality. In some cases, the earlier portion of data are deselected prior to construction of limits in order to provide sensitive limits that will rapidly detect changes in groundwater quality. Even though the data are excluded from the calculation, the values will continue to be reported and shown in tables and graphs.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of an additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered to be a false positive result and, therefore, no further action is necessary. A summary table of the background prediction limits follows this letter.

Appendix IV – Assessment Monitoring Program

During an Assessment Monitoring program confidence intervals are constructed at all wells for detected Appendix IV parameters. A minimum of 4 samples is required to construct confidence intervals; however, 8 samples are generally recommended for better representation of the true average population. Established Maximum Contaminant Levels (MCLs) are used as the GWPS comparisons, unless background limits are higher as discussed below. Parametric confidence intervals are constructed with 99% confidence when data follow a normal or transformed-normal distribution. For all other cases, nonparametric confidence intervals are constructed, with the confidence level based on the number of samples available. The GWPS is exceeded only when the entire confidence interval exceeds its respective GWPS.

Background limits are established for the Appendix IV parameters using upper tolerance limits constructed with 95% confidence/95% coverage using pooled upgradient well data, for comparison against established MCLs. When background limits, or Alternate Contaminant Levels (ACLs), are higher than established MCLs, the CCR Rule recommends using these ACLs as the GWPS for the confidence interval comparisons. Additionally, tolerance limits are also recommended to establish ACLs for Appendix IV parameters, cobalt, lithium, and molybdenum, which do not have established MCLs. Since the scope of this project included screening and development of background limits for Appendix III Detection Monitoring statistics, comparison of the Appendix IV parameters with confidence intervals was not included in this report.

Recommendations

In summary, as a result of the background screening described in this letter, intrawell prediction limits combined with a 1-of-2 resample plan are recommended for boron, calcium, chloride, and fluoride. Interwell prediction limits combined with a 1-of-2 resample plan are recommended for pH, sulfate, and TDS. The statistical analyses will be constructed according to the USEPA Unified Guidance, based on 7 Appendix III parameters and 3 downgradient wells.

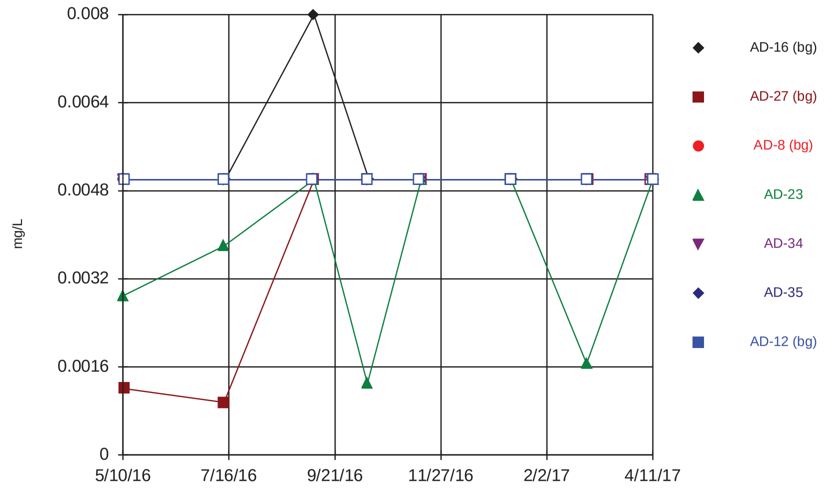
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Landfill. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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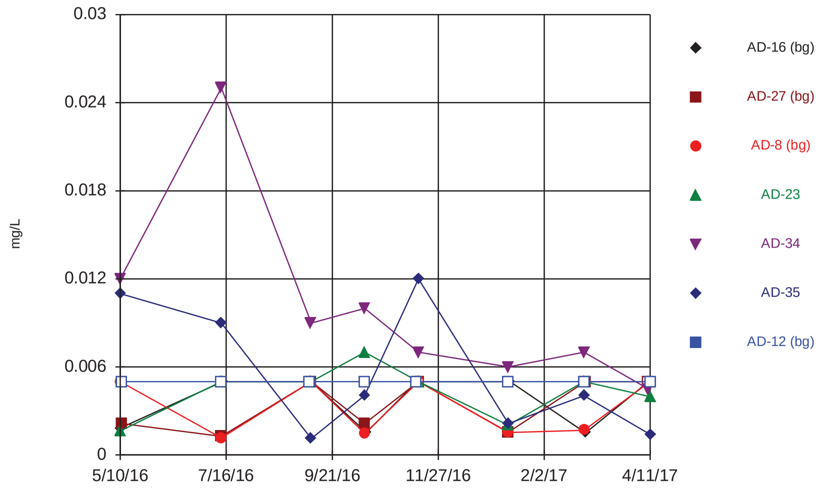
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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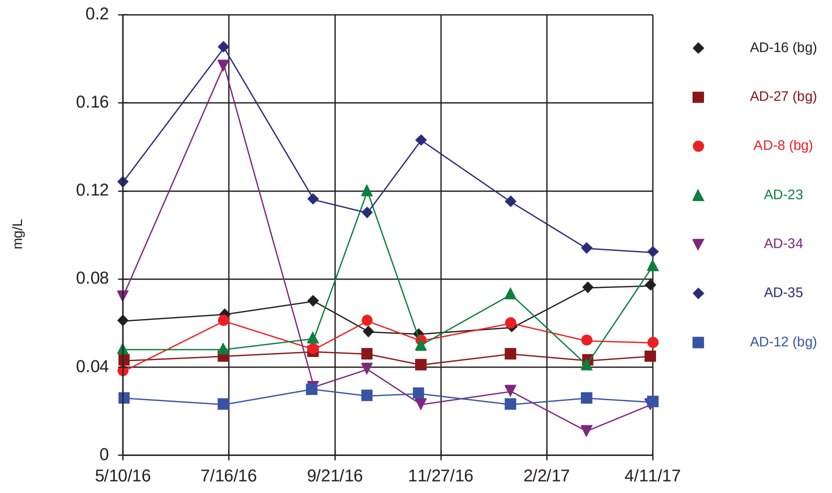
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Time Series



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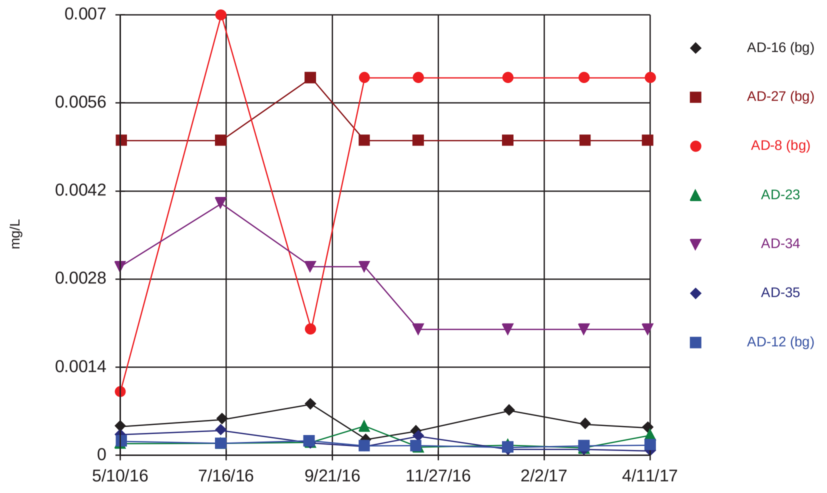
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Time Series



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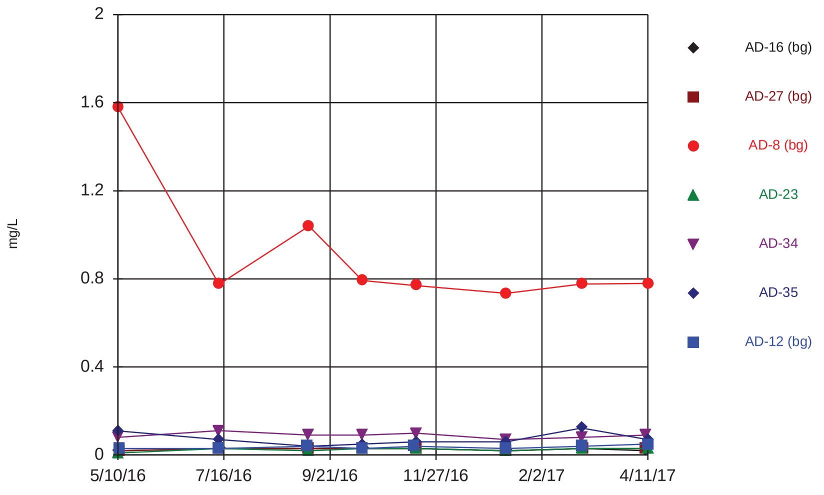
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Time Series



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Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
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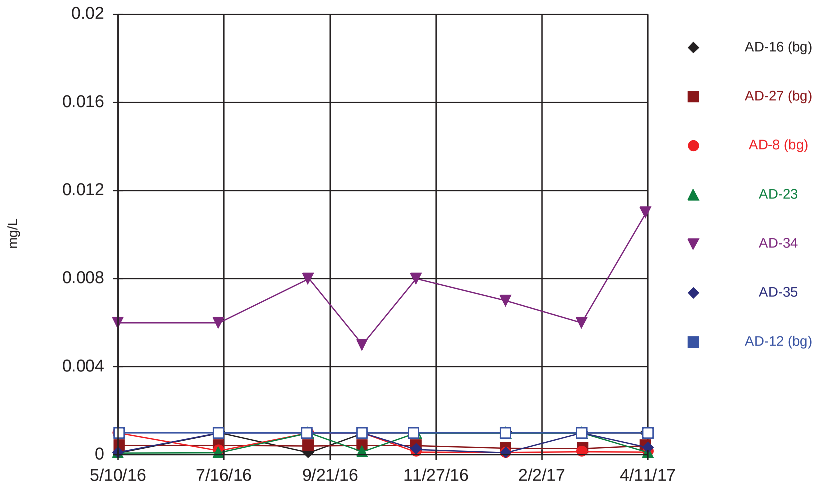

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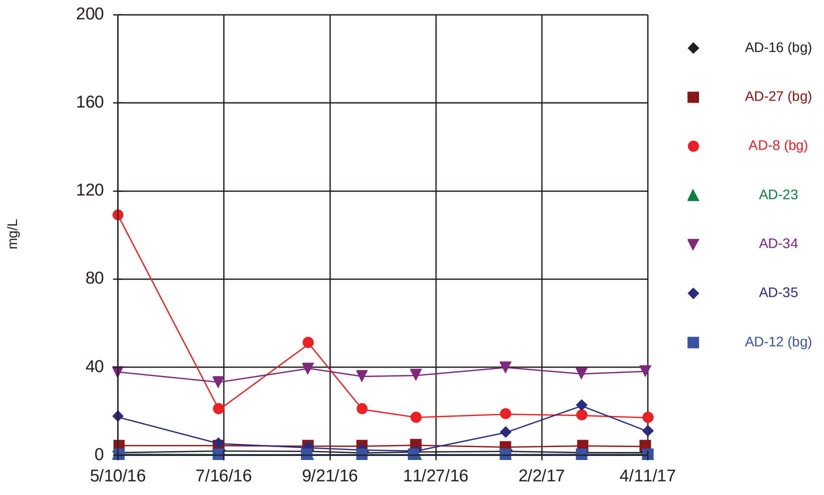

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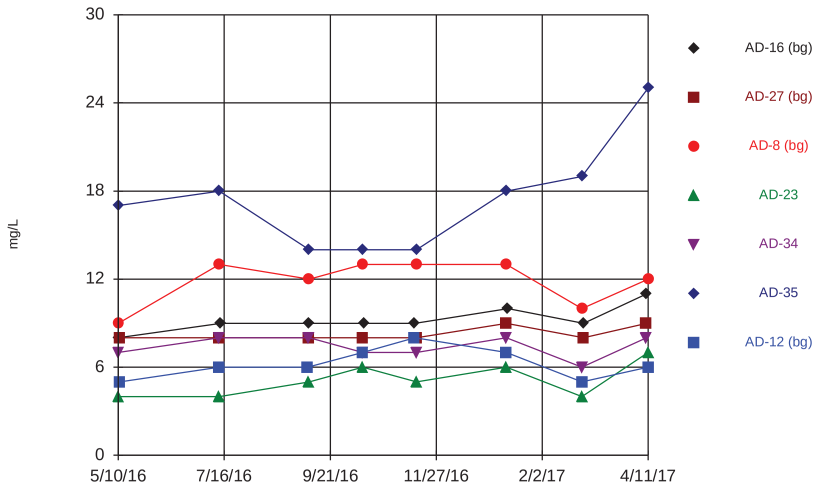

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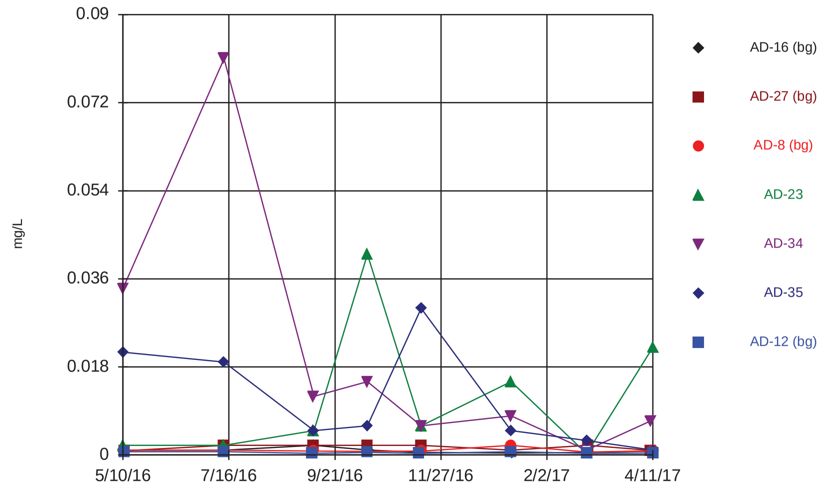

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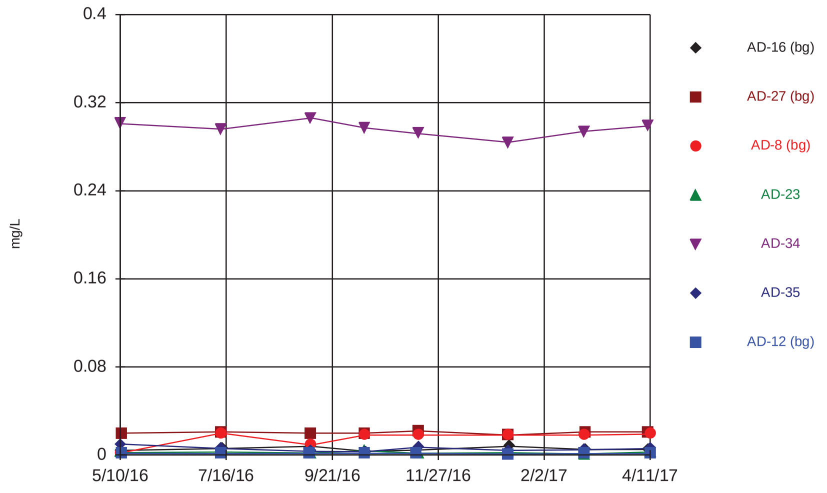
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Time Series



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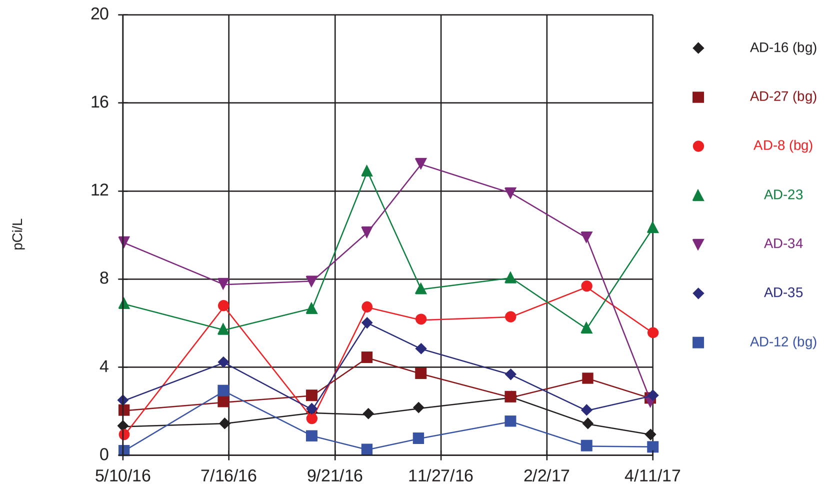
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 12/13/2017 6:01 AM View: Time Series
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Hollow symbols indicate censored values.

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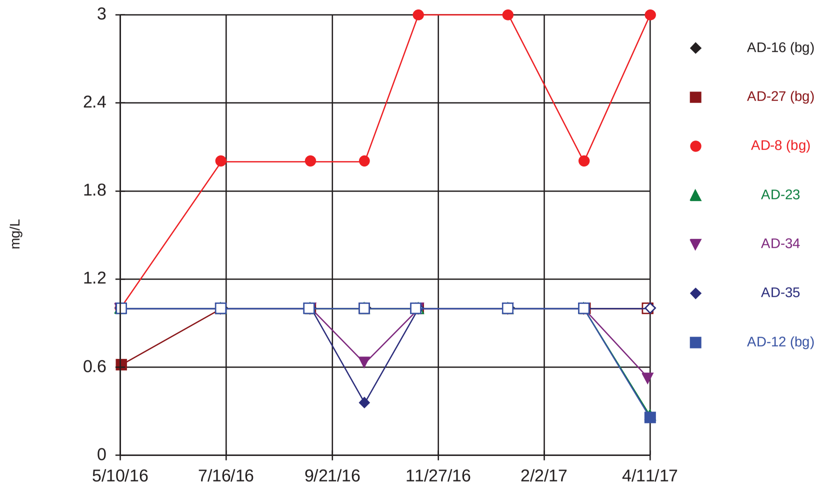

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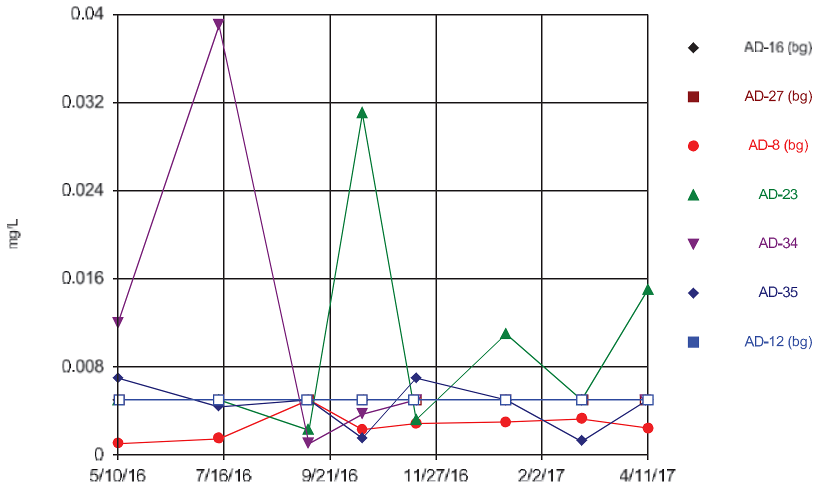

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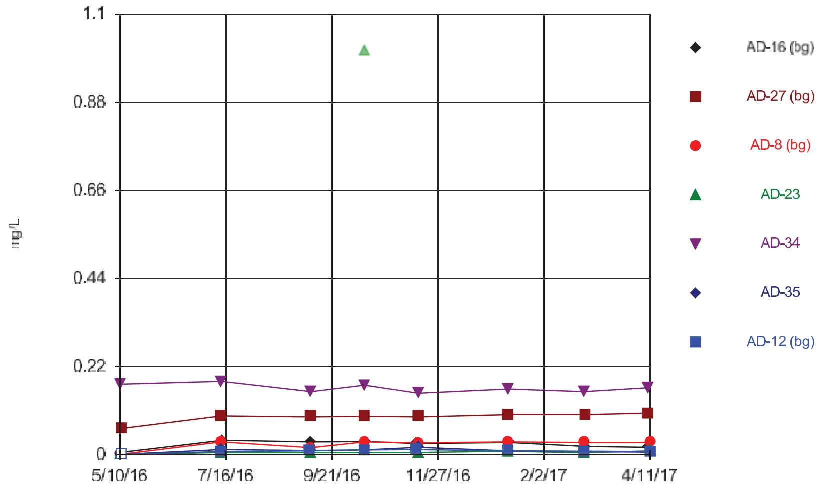

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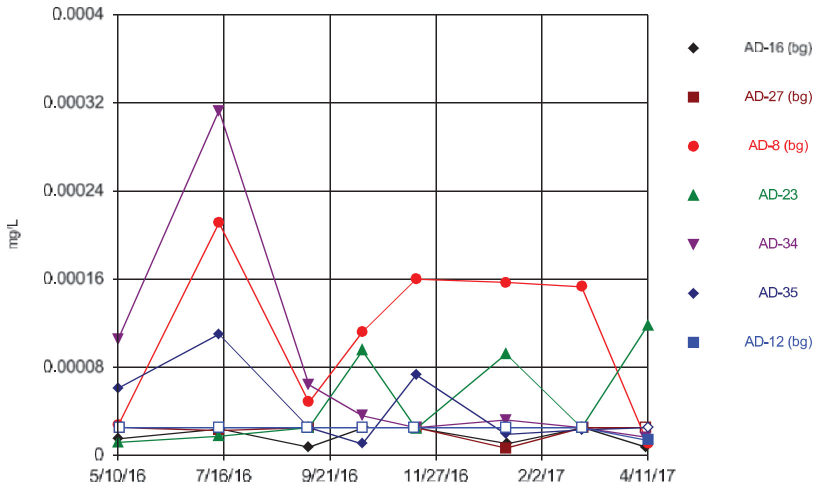

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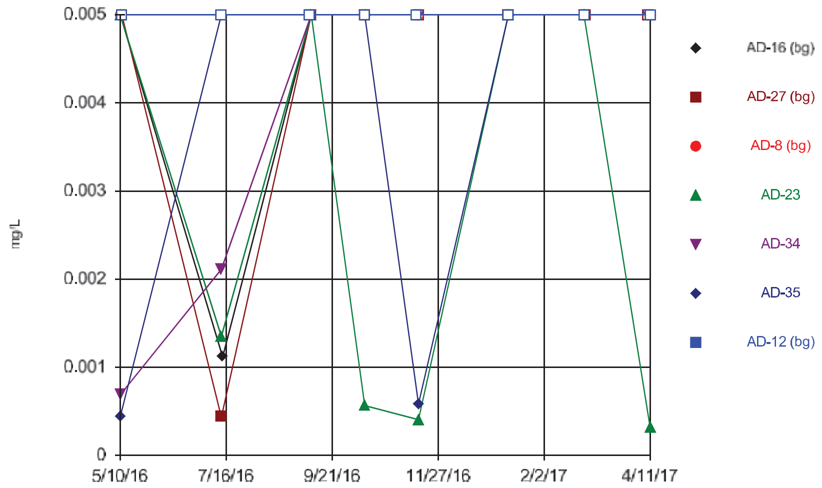
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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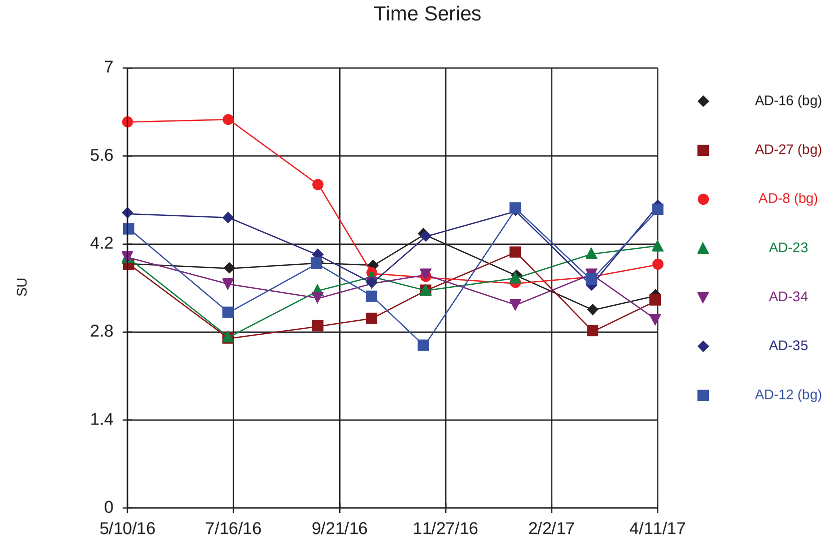
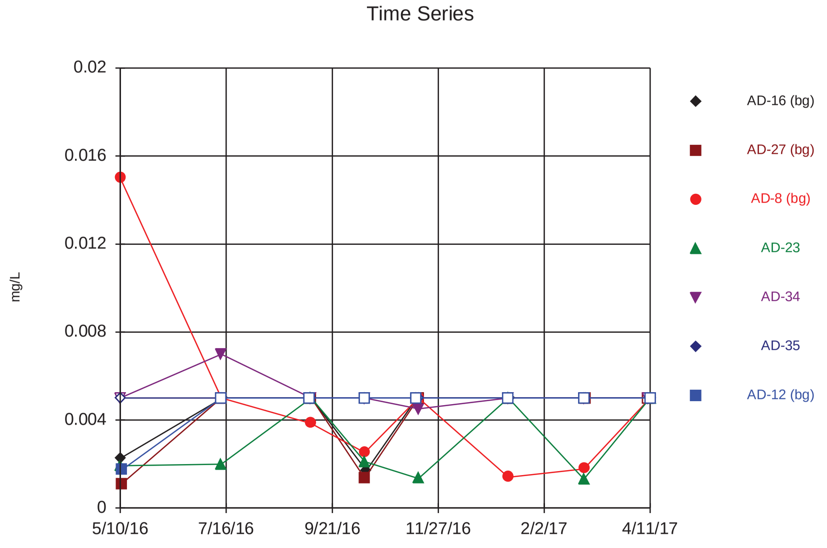
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



Constituent: pH, field Analysis Run 12/13/2017 6:01 AM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



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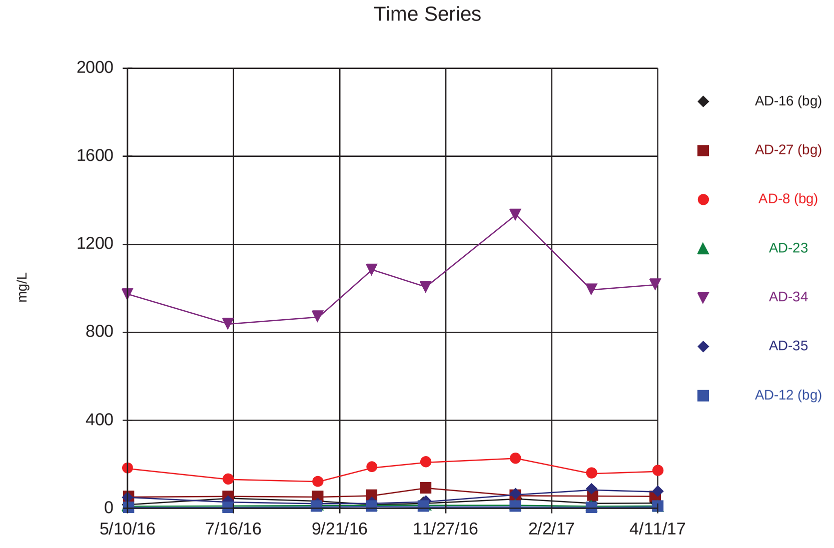

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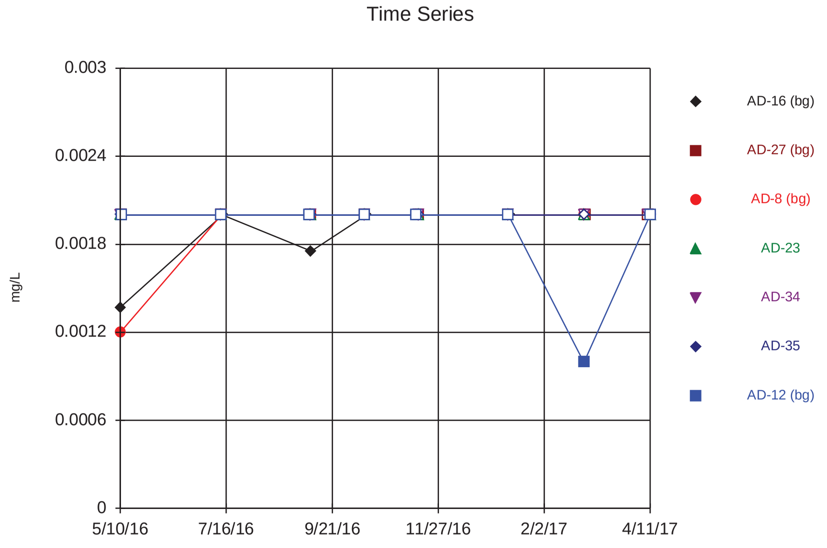

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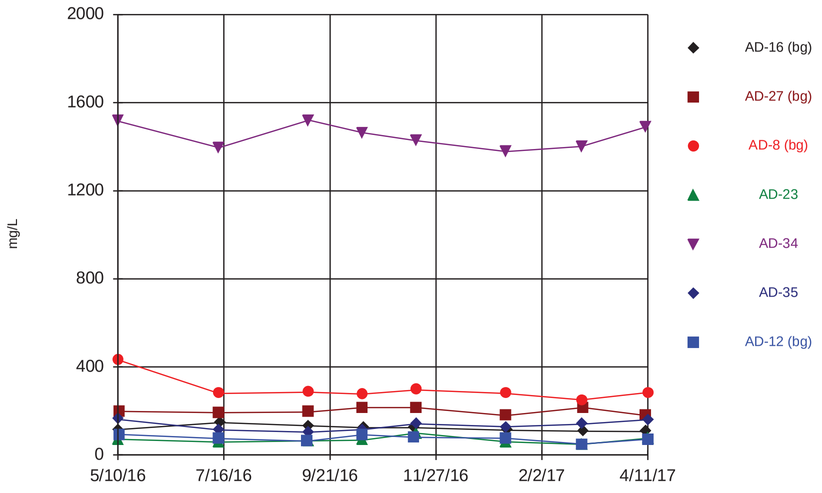
Time Series



Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/13/2017 6:01 AM   View: Time Series
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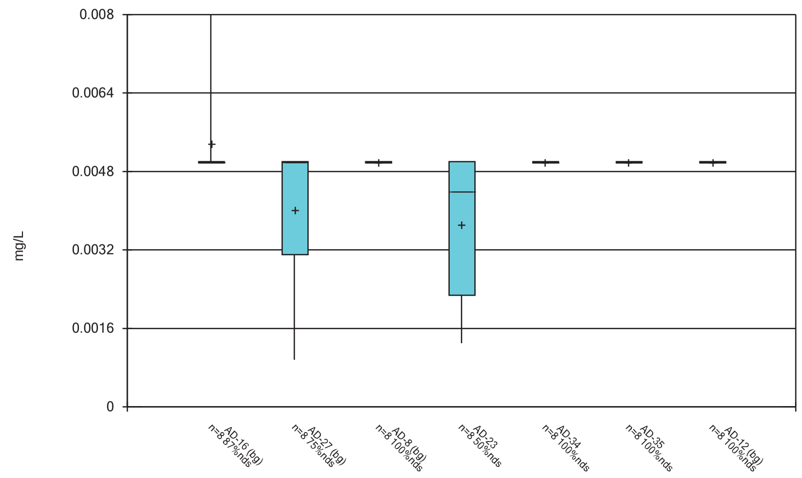
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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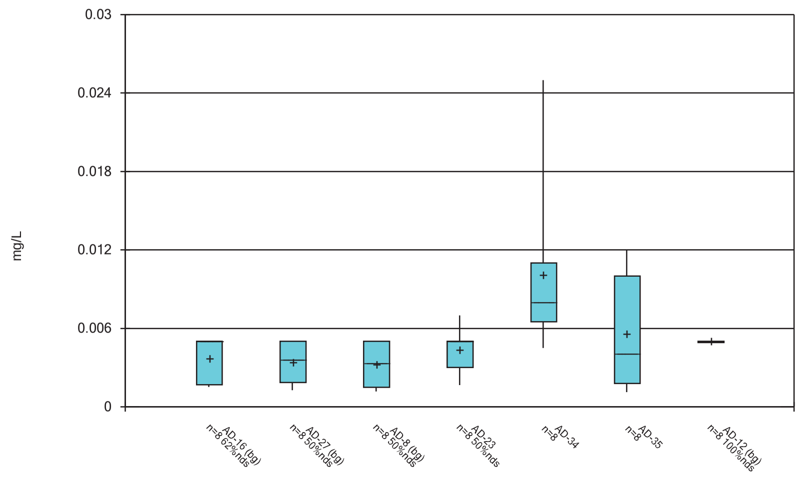
Box & Whiskers Plot



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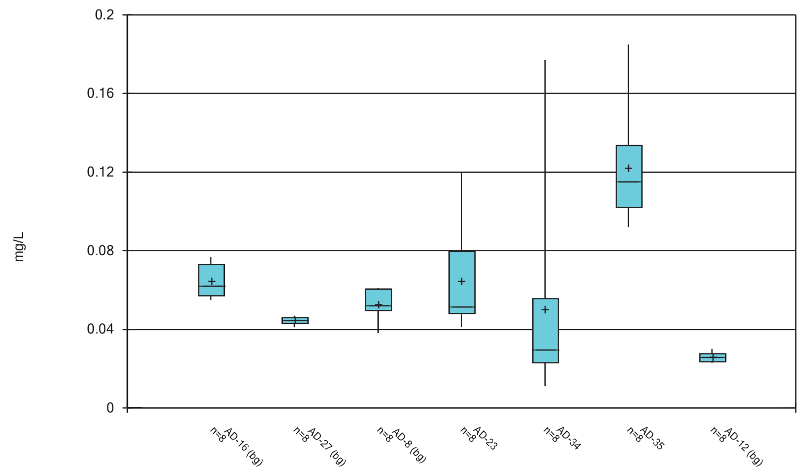
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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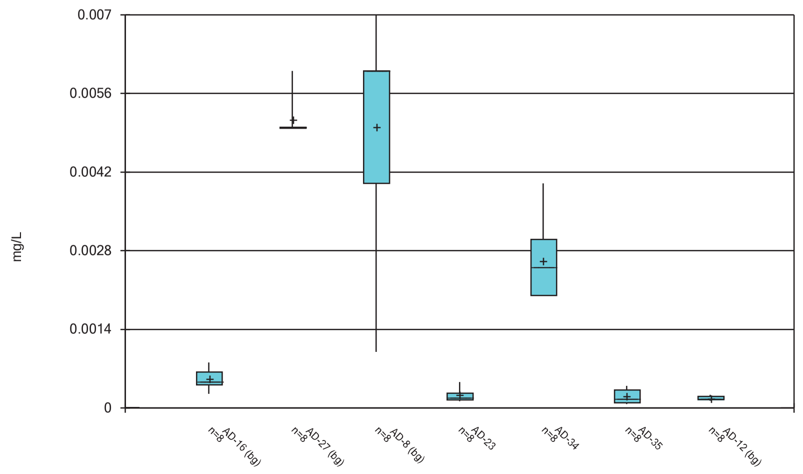
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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Pirkey LF Client: Geosyntec Data: Pirkey Landfill

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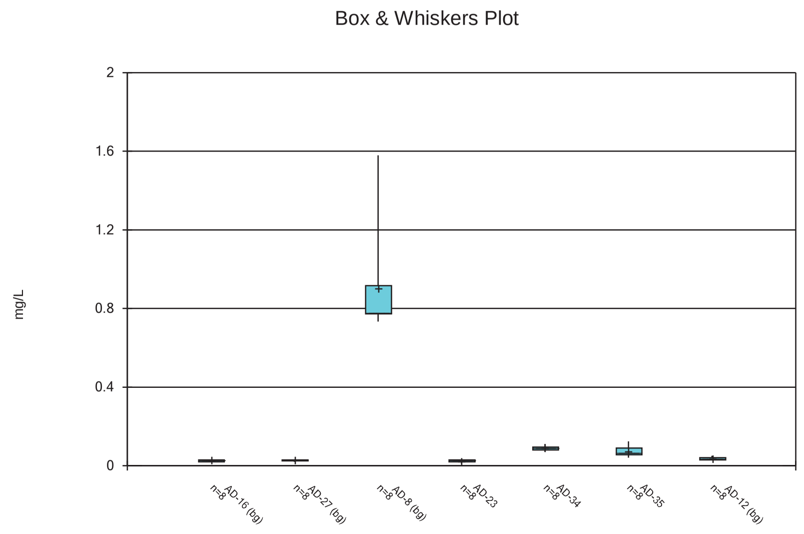

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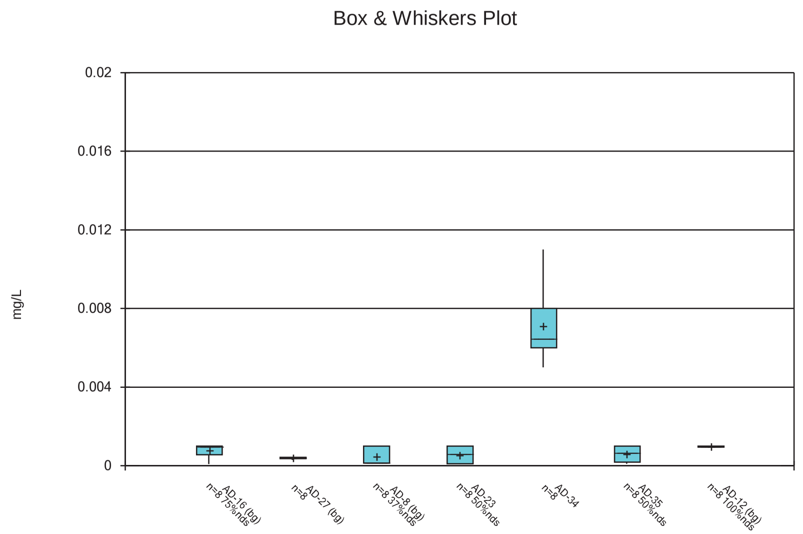

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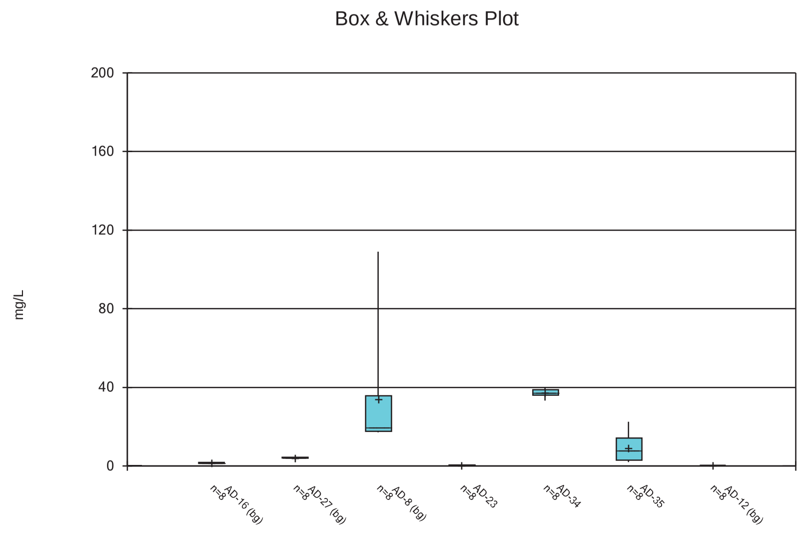
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



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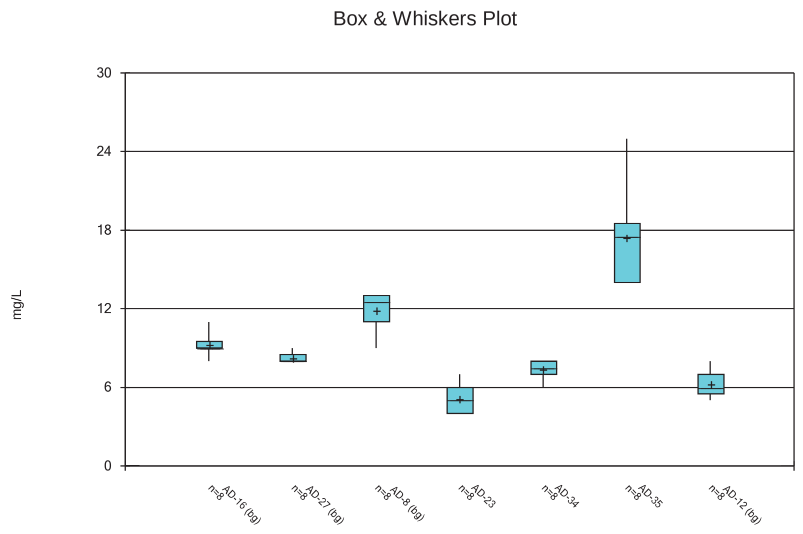
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

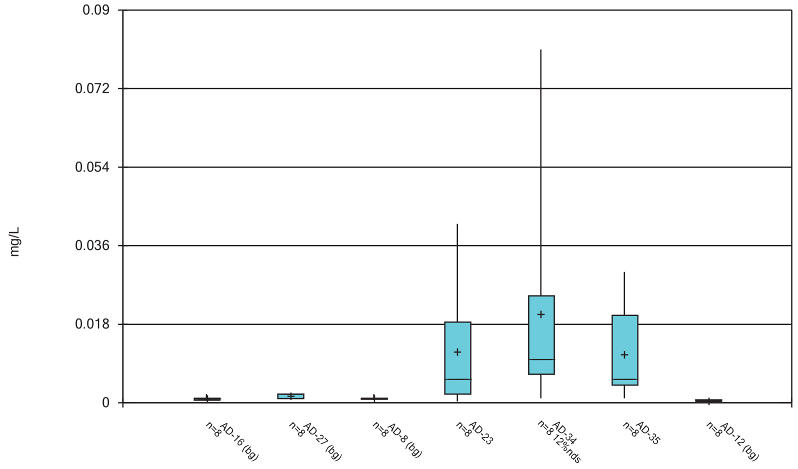
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



Constituent: Chloride, total Analysis Run 12/13/2017 6:02 AM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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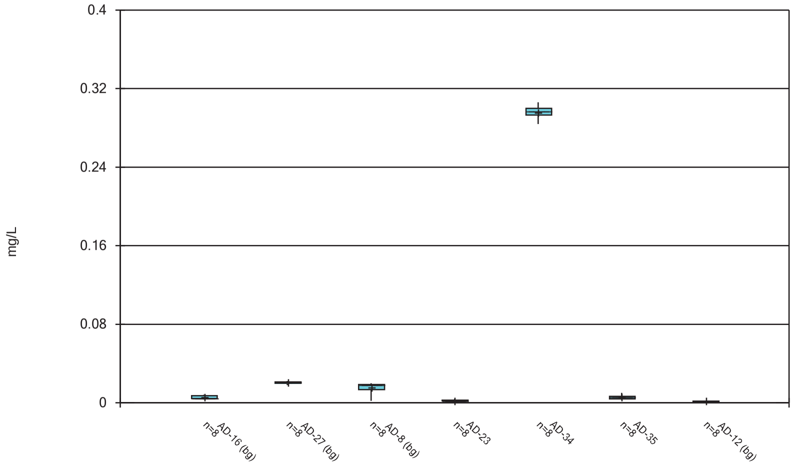
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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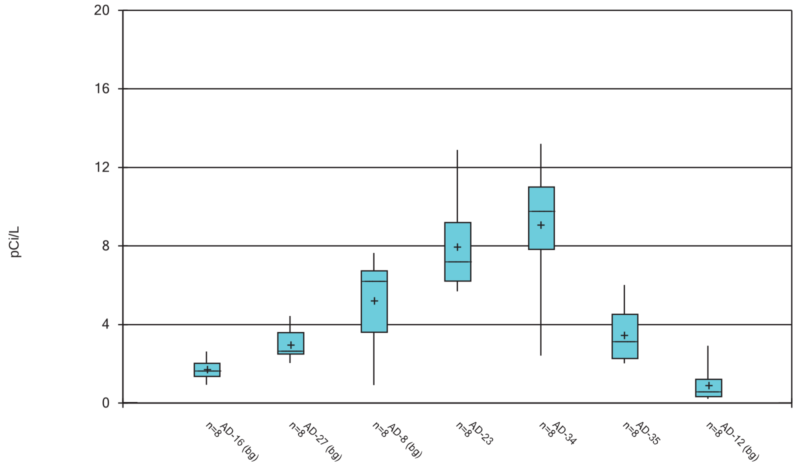
Box & Whiskers Plot



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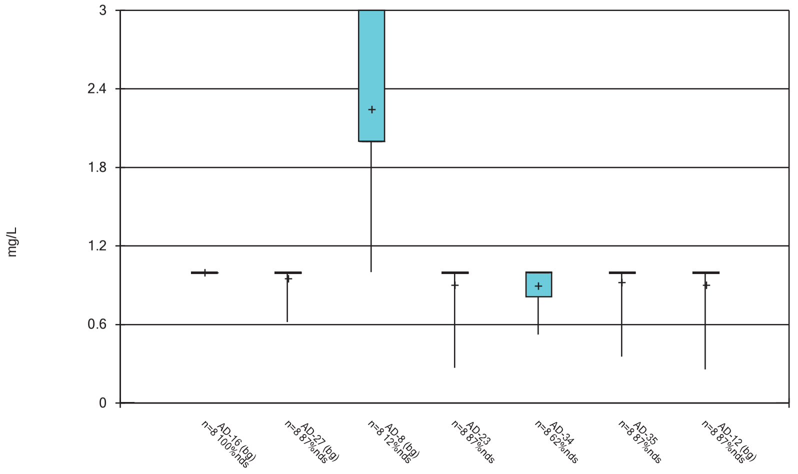
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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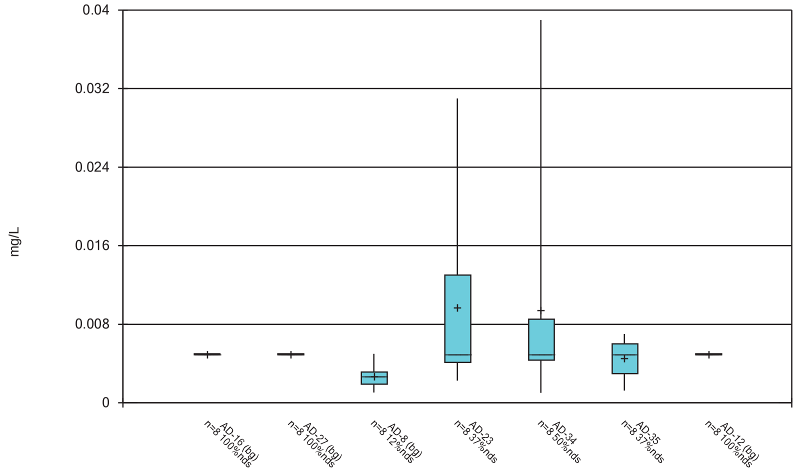
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

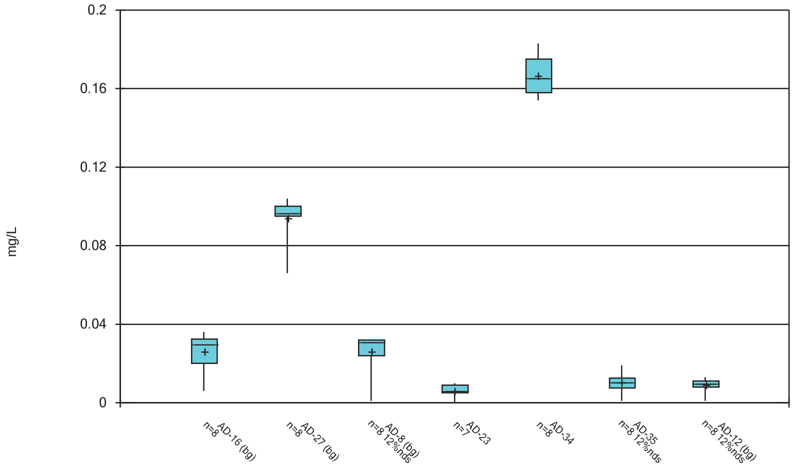
Box & Whiskers Plot



Constituent: Lead, total   Analysis Run 12/13/2017 6:02 AM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

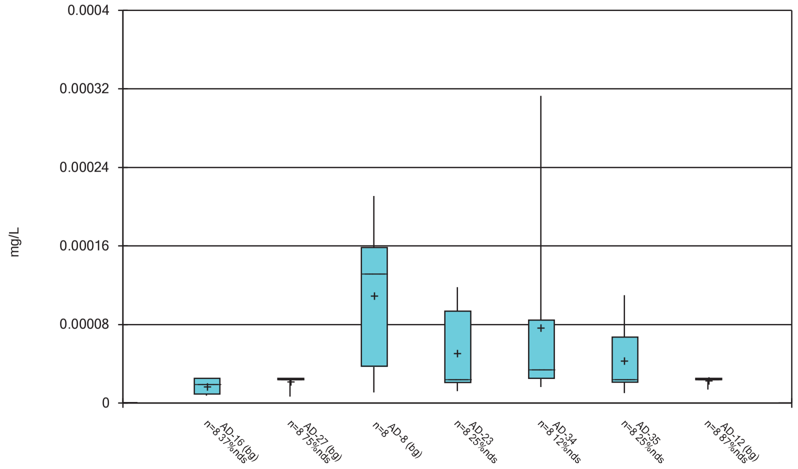
Box & Whiskers Plot



Constituent: Lithium, total   Analysis Run 12/13/2017 6:02 AM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

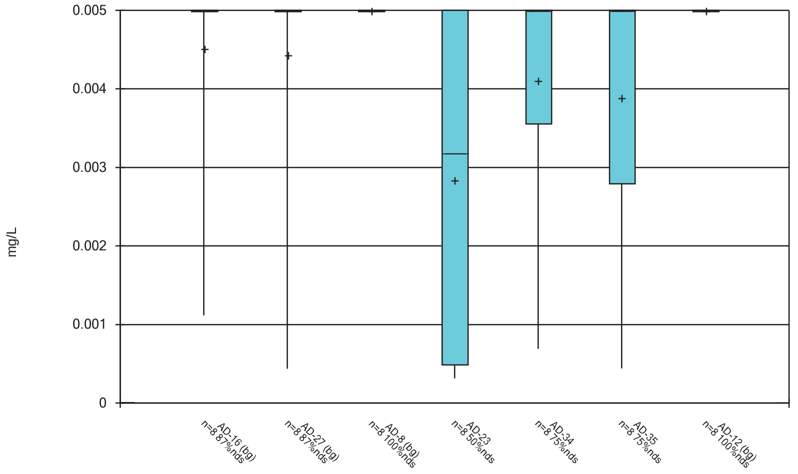
Box & Whiskers Plot



Constituent: Mercury, total   Analysis Run 12/13/2017 6:02 AM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

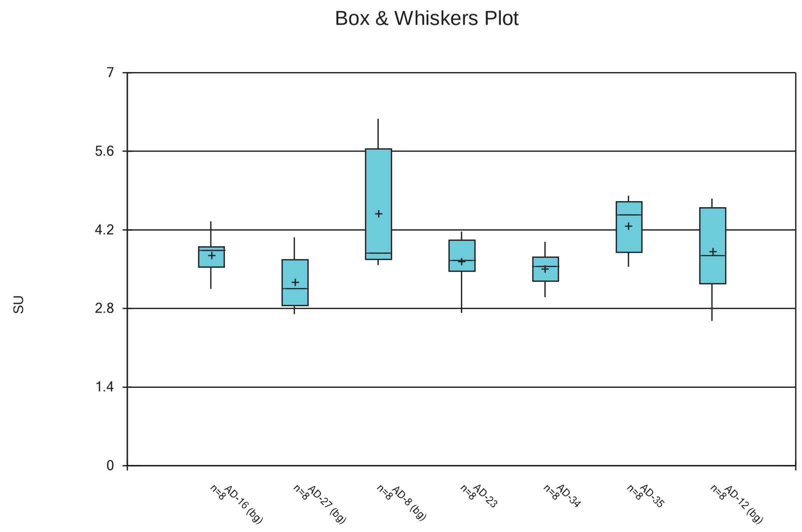
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



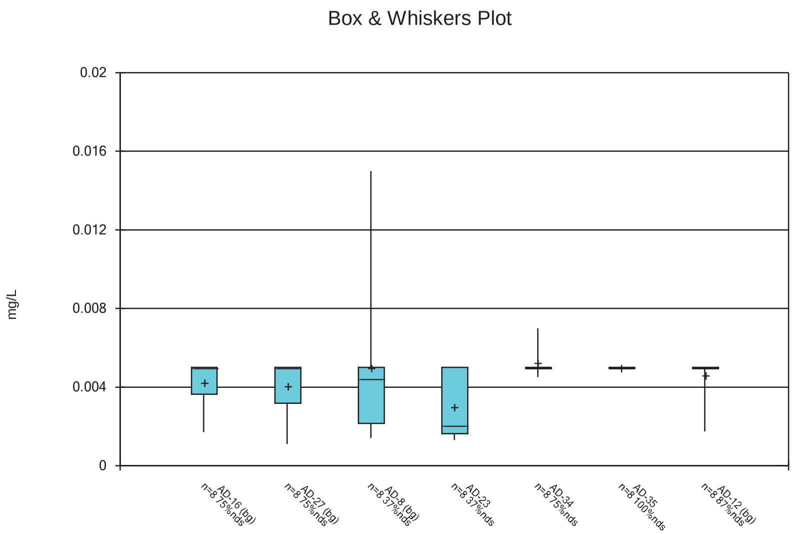
Constituent: Molybdenum, total   Analysis Run 12/13/2017 6:02 AM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



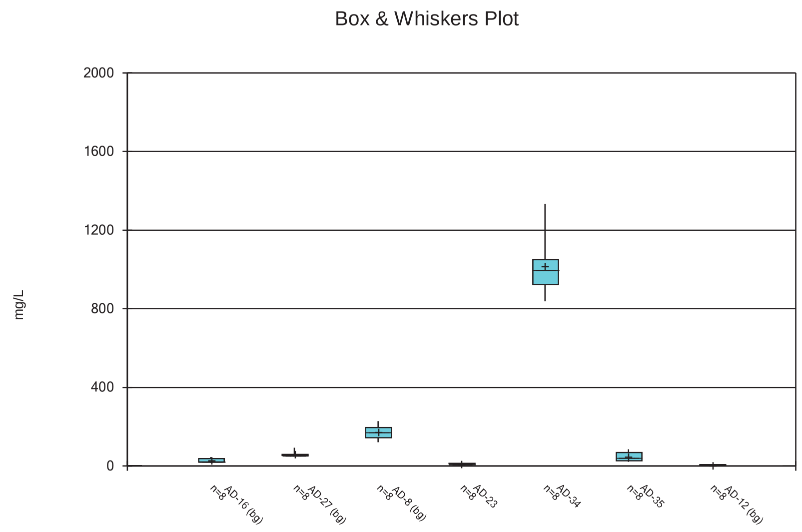
Constituent: pH, field   Analysis Run 12/13/2017 6:02 AM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



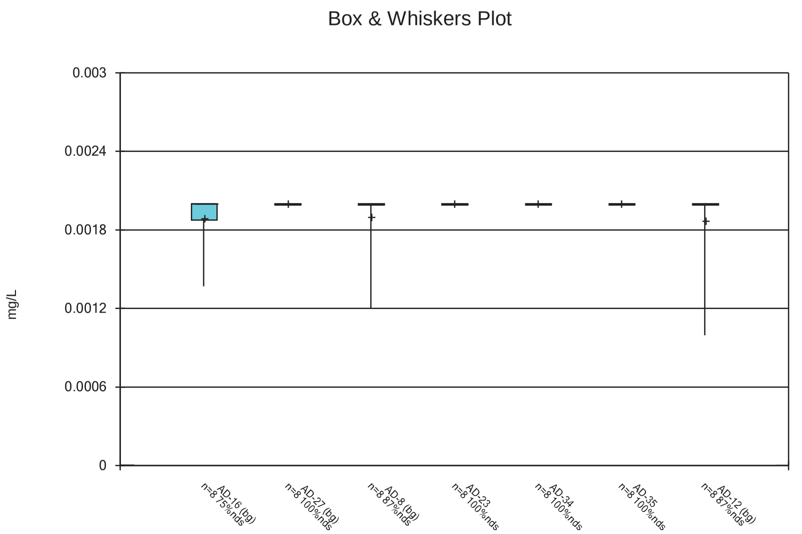
Constituent: Selenium, total   Analysis Run 12/13/2017 6:02 AM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



Constituent: Sulfate, total   Analysis Run 12/13/2017 6:02 AM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

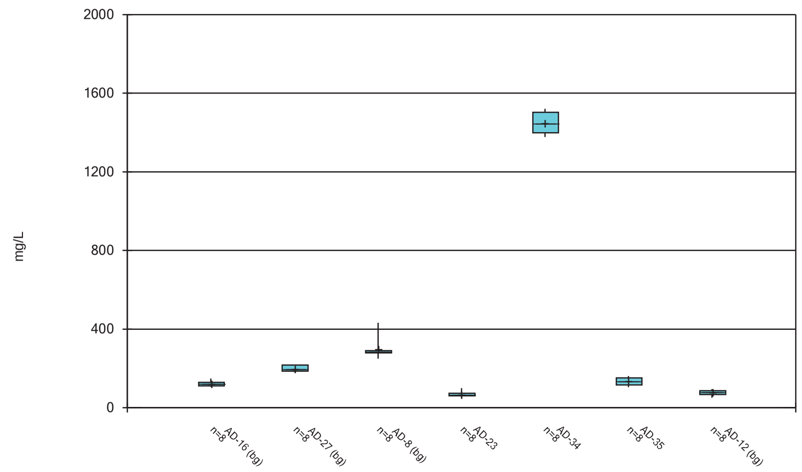
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



Constituent: Thallium, total   Analysis Run 12/13/2017 6:02 AM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/13/2017 6:02 AM   View: Time Series

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Outlier Summary

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 12/13/2017, 6:41 AM

	AD-23 Lithium, total (mg/L)
10/12/2016	1.01 (o)

Outlier Analysis - Upgradient Wells

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 12/13/2017, 6:05 AM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.004849	0.001122	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.003839	0.001639	unknown	ShapiroWilk
Barium, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP	32	0.04697	0.01547	normal	ShapiroWilk
Beryllium, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.002702	0.002627	unknown	ShapiroWilk
Boron, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.249	0.4091	unknown	ShapiroWilk
Cadmium, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.0006549	0.000386	unknown	ShapiroWilk
Calcium, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP	32	10.02	20.89	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP	32	8.906	2.291	x^(1/3)	ShapiroWilk
Chromium, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.001003	0.0005752	unknown	ShapiroWilk
Cobalt, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.01063	0.008303	unknown	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-16,AD-27,AD-8,...	No	n/a	NP	32	2.706	2.129	x^(1/3)	ShapiroWilk
Fluoride, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	1.277	0.6777	unknown	ShapiroWilk
Lead, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.004418	0.001175	unknown	ShapiroWilk
Lithium, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.03866	0.03453	unknown	ShapiroWilk
Mercury, total (mg/L)	**AD-16,AD-27,AD-8,...**	**Yes**	**0.00001506,0.00000753,0.00001045,0.00000733,0.000**	**NP (nrm)**	**32**	**0.0000433**	**0.00005255**	**unknown**	**ShapiroWilk**
Molybdenum, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.004736	0.001042	unknown	ShapiroWilk
pH, field (SU)	AD-16,AD-27,AD-8,...	No	n/a	NP	32	3.833	0.8501	ln(x)	ShapiroWilk
Selenium, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.00446	0.002402	unknown	ShapiroWilk
Sulfate, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	66.28	67.86	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP (nrm)	32	0.001916	0.0002466	unknown	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-16,AD-27,AD-8,...	No	n/a	NP	32	173.4	90.57	ln(x)	ShapiroWilk

Outlier Analysis - Significant Downgradient Wells

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 11/4/2017, 3:18 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Lithium, total (mg/L)	**AD-23**	**Yes**	**0.0001358,1.01**	**NP (nrm)**	**8**	**0.1315**	**0.355**	**unknown**	**ShapiroWilk**

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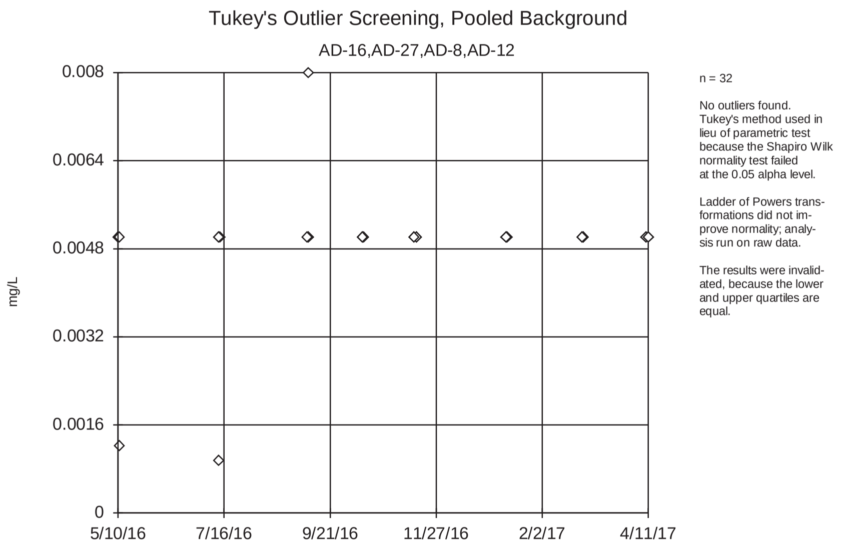
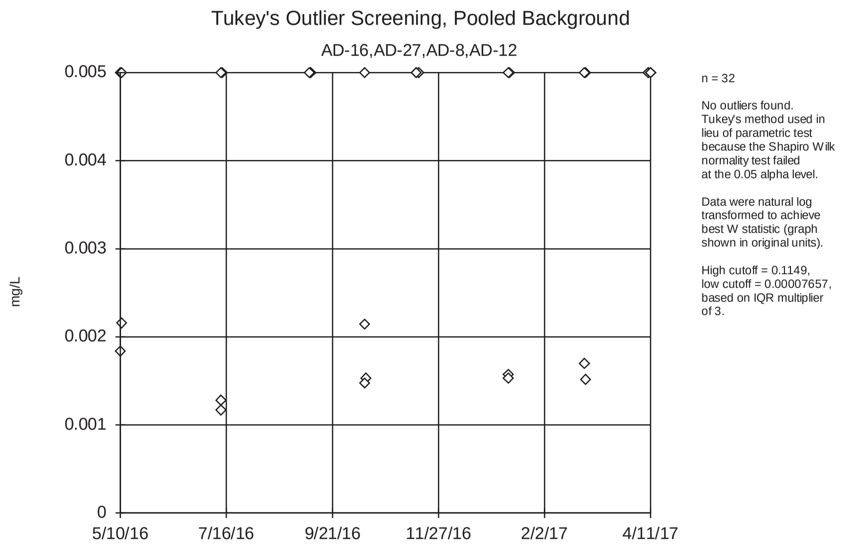


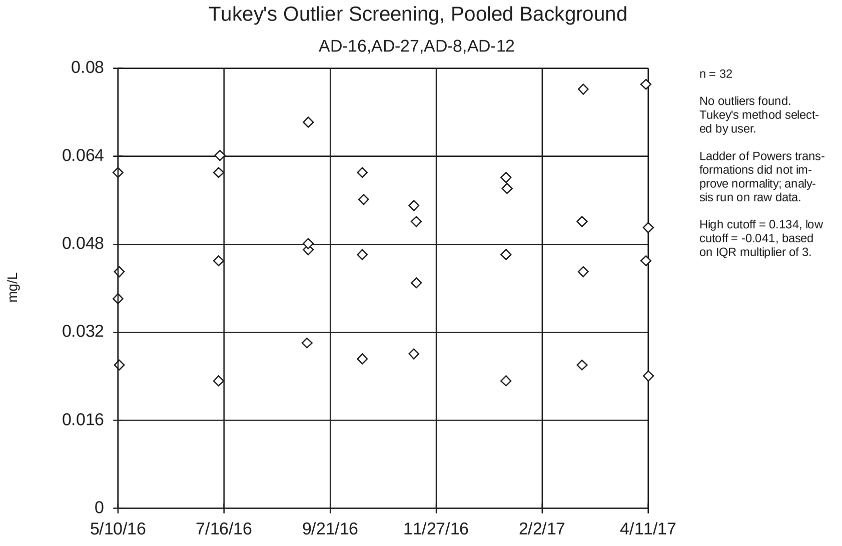
Constituent: Antimony, total   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



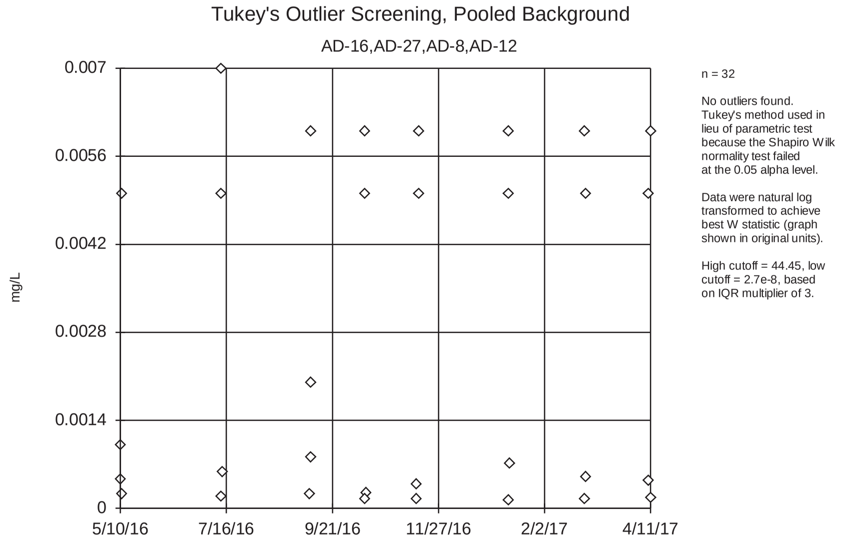
Constituent: Arsenic, total   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



Constituent: Barium, total   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

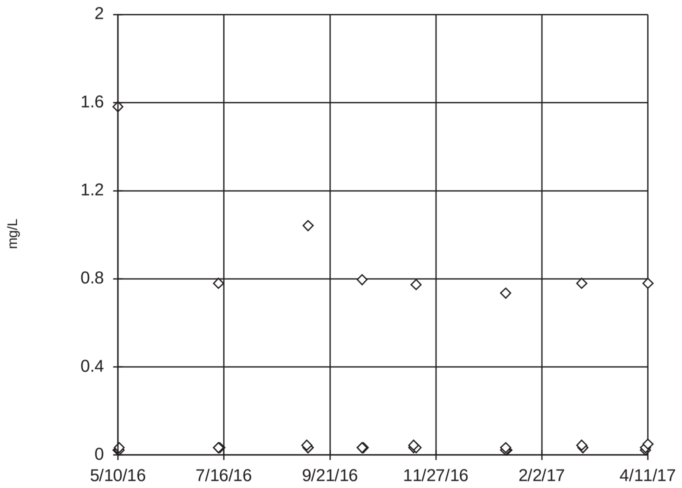


Constituent: Beryllium, total   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

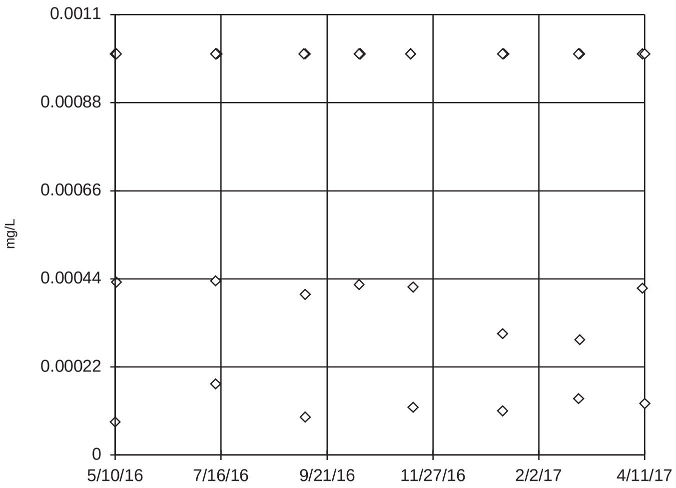
High cutoff = 49.88, low cutoff = 0.0001152, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 12/13/2017 6:04 AM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

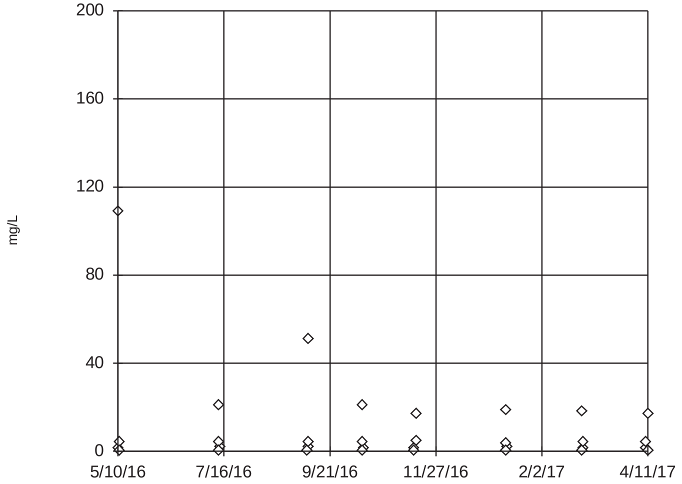
High cutoff = 0.03922, low cutoff = 0.000007506, based on IQR multiplier of 3.

Constituent: Cadmium, total Analysis Run 12/13/2017 6:04 AM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

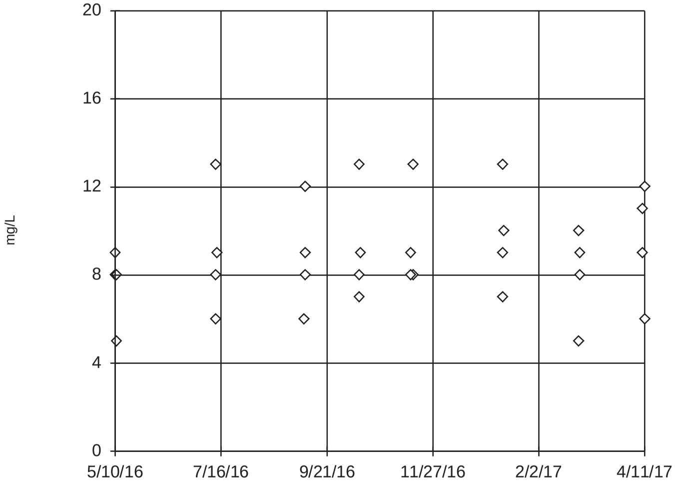
High cutoff = 16943, low cutoff = 0.0003666, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 12/13/2017 6:04 AM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

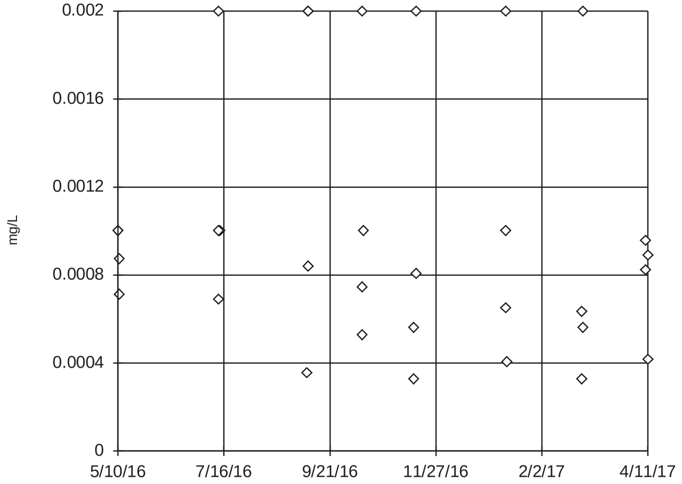
High cutoff = 17.94, low cutoff = 3.629, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 12/13/2017 6:04 AM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

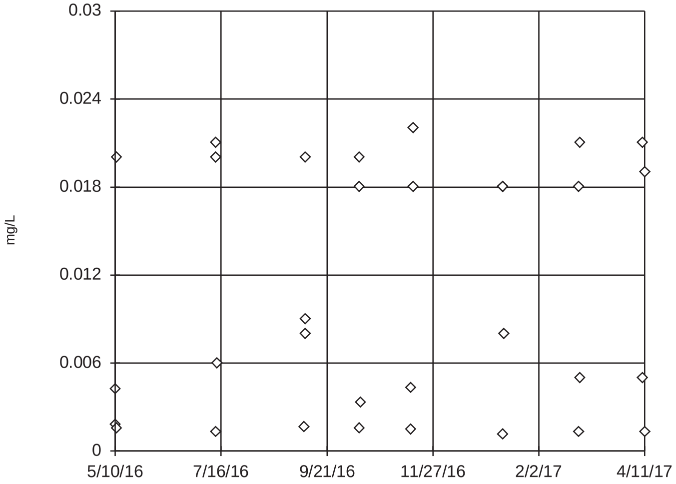
High cutoff = 0.004719, low cutoff = 0.0001263, based on IQR multiplier of 3.

Constituent: Chromium, total   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 27.74, low cutoff = 0.000001218, based on IQR multiplier of 3.

Constituent: Cobalt, total   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

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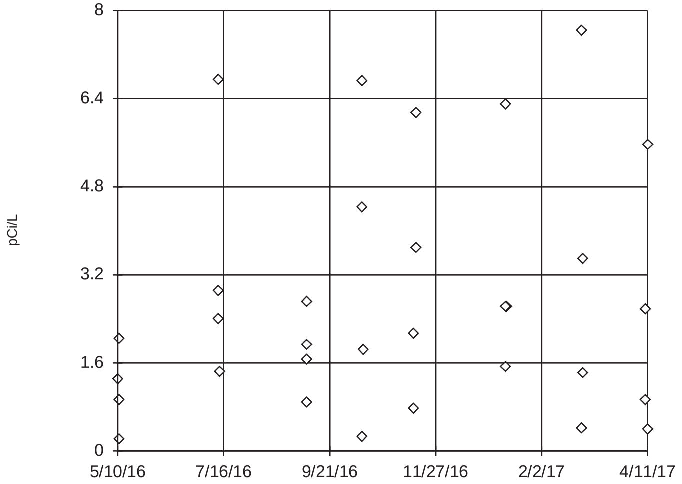
Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

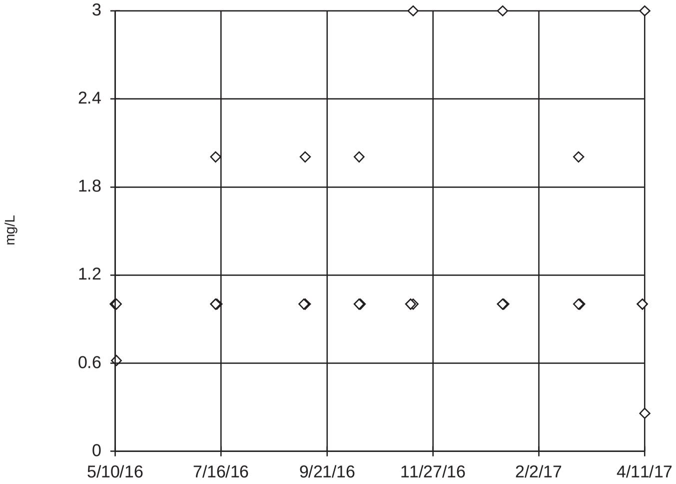
High cutoff = 27.59, low cutoff = -0.09607, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

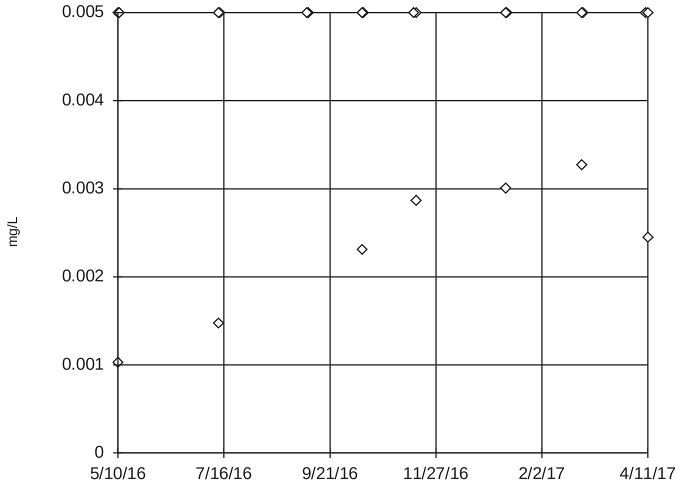
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Fluoride, total   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

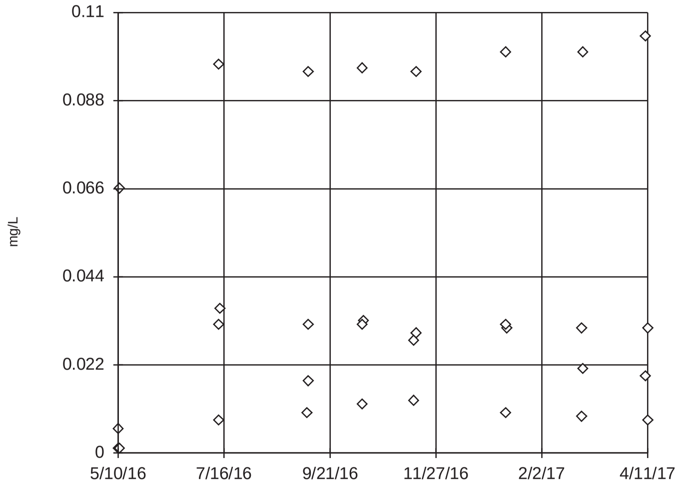
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Lead, total   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

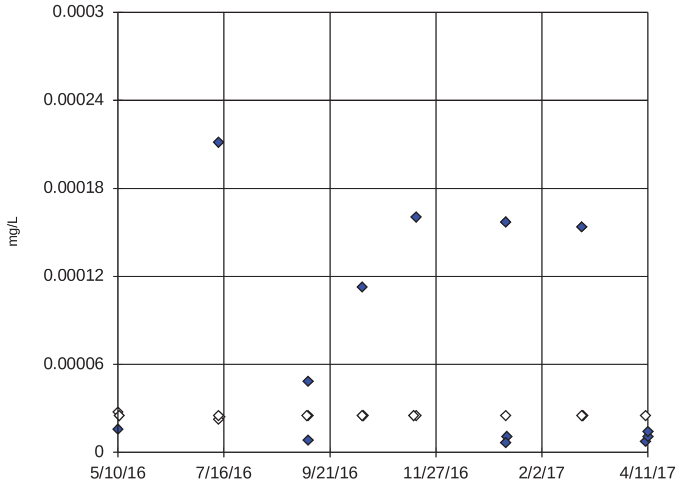
High cutoff = 0.516, low cutoff = -0.009623, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

Outliers are drawn as solid.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

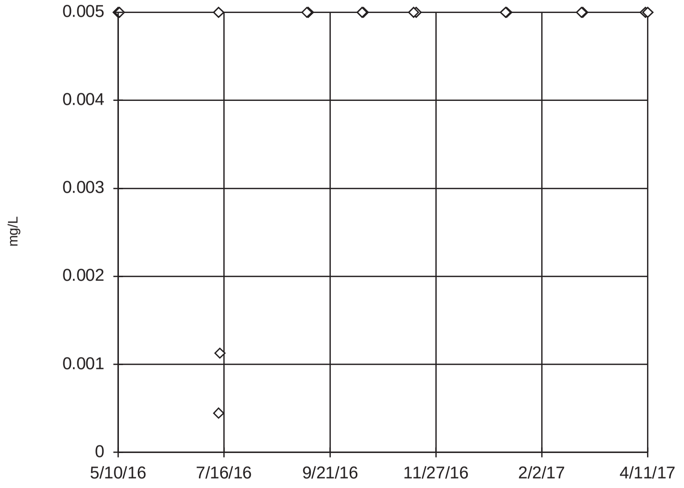
High cutoff = 0.00003142, low cutoff = 0.00001844, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

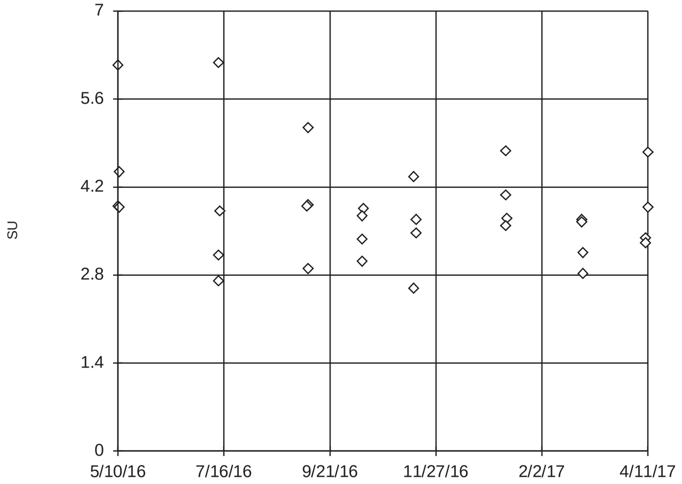
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Molybdenum, total   Analysis Run 12/13/2017 6:04 AM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

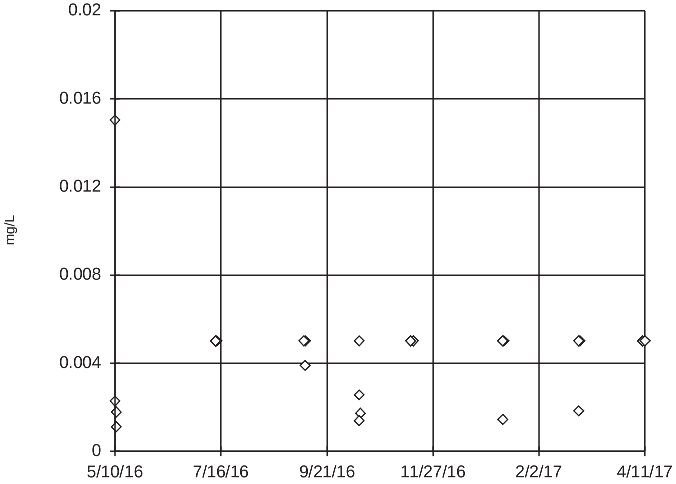
High cutoff = 6.794, low cutoff = 1.956, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 12/13/2017 6:04 AM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

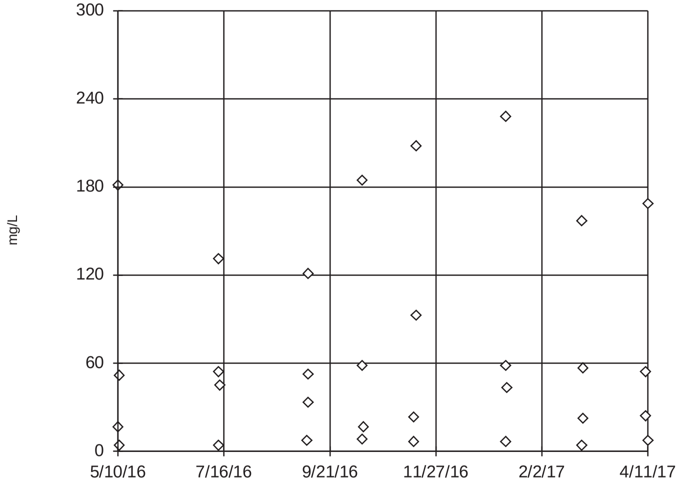
High cutoff = 0.02078, low cutoff = 0.0007481, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 12/13/2017 6:04 AM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

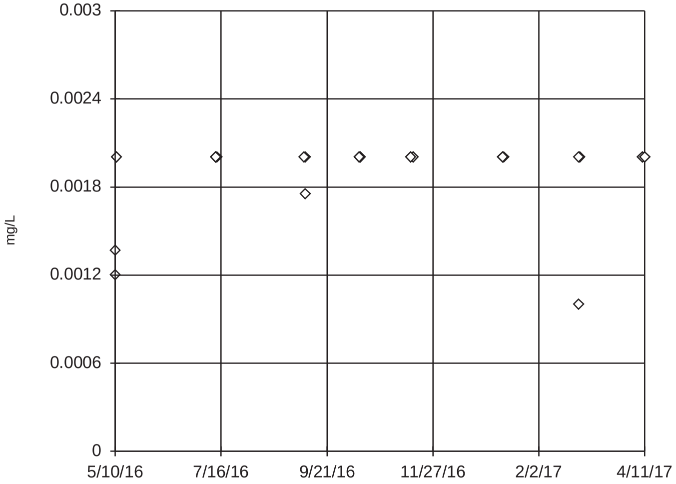
High cutoff = 1790, low cutoff = -136.7, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 12/13/2017 6:04 AM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

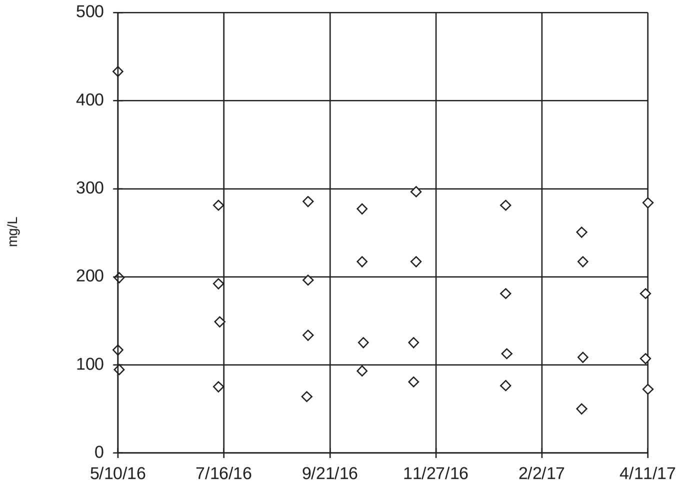
Data were x^6 transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium, total Analysis Run 12/13/2017 6:04 AM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Tukey's Outlier Screening, Pooled Background

AD-16,AD-27,AD-8,AD-12



n = 32

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2932, low cutoff = 7.912, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/13/2017 6:04 AM   View: Tukey's

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Outlier Analysis - All Downgradient Wells

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 11/4/2017, 3:18 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-23	No	n/a	NP (nrm)	8	0.003705	0.001575	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-34	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-35	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-23	No	n/a	NP	8	0.004332	0.001752	normal	ShapiroWilk
Arsenic, total (mg/L)	AD-34	No	n/a	NP	8	0.01006	0.006483	ln(x)	ShapiroWilk
Arsenic, total (mg/L)	AD-35	No	n/a	NP	8	0.005598	0.004408	ln(x)	ShapiroWilk
Barium, total (mg/L)	AD-23	No	n/a	NP	8	0.06488	0.02687	ln(x)	ShapiroWilk
Barium, total (mg/L)	AD-34	No	n/a	NP	8	0.05063	0.05413	ln(x)	ShapiroWilk
Barium, total (mg/L)	AD-35	No	n/a	NP	8	0.1224	0.03006	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-23	No	n/a	NP	8	0.0002214	0.0001158	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-34	No	n/a	NP (nrm)	8	0.002625	0.000744	unknown	ShapiroWilk
Beryllium, total (mg/L)	AD-35	No	n/a	NP	8	0.0002022	0.0001243	ln(x)	ShapiroWilk
Boron, total (mg/L)	AD-23	No	n/a	NP (nrm)	8	0.025	0.007559	unknown	ShapiroWilk
Boron, total (mg/L)	AD-34	No	n/a	NP	8	0.08888	0.01271	ln(x)	ShapiroWilk
Boron, total (mg/L)	AD-35	No	n/a	NP	8	0.07275	0.02871	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-23	No	n/a	NP (nrm)	8	0.0005514	0.0004799	unknown	ShapiroWilk
Cadmium, total (mg/L)	AD-34	No	n/a	NP	8	0.007125	0.001885	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-35	No	n/a	NP (nrm)	8	0.0005964	0.0004377	unknown	ShapiroWilk
Calcium, total (mg/L)	AD-23	No	n/a	NP	8	0.3451	0.1255	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-34	No	n/a	NP	8	37.21	2.163	x^6	ShapiroWilk
Calcium, total (mg/L)	AD-35	No	n/a	NP	8	9.288	7.502	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-23	No	n/a	NP	8	5.125	1.126	normal	ShapiroWilk
Chloride, total (mg/L)	AD-34	No	n/a	NP (nrm)	8	7.375	0.744	unknown	ShapiroWilk
Chloride, total (mg/L)	AD-35	No	n/a	NP	8	17.38	3.701	ln(x)	ShapiroWilk
Chromium, total (mg/L)	AD-23	No	n/a	NP	8	0.01166	0.014	x^(1/3)	ShapiroWilk
Chromium, total (mg/L)	AD-34	No	n/a	NP	8	0.0205	0.02639	ln(x)	ShapiroWilk
Chromium, total (mg/L)	AD-35	No	n/a	NP	8	0.01125	0.01059	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-23	No	n/a	NP	8	0.002317	0.0008382	sqrt(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-34	No	n/a	NP	8	0.2961	0.006534	x^6	ShapiroWilk
Cobalt, total (mg/L)	AD-35	No	n/a	NP	8	0.00553	0.002273	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-23	No	n/a	NP	8	7.971	2.477	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-34	No	n/a	NP	8	9.101	3.267	x^2	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-35	No	n/a	NP	8	3.495	1.441	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-23	No	n/a	NP (nrm)	8	0.9086	0.2585	unknown	ShapiroWilk
Fluoride, total (mg/L)	AD-34	No	n/a	NP (nrm)	8	0.8936	0.1982	unknown	ShapiroWilk
Fluoride, total (mg/L)	AD-35	No	n/a	NP (nrm)	8	0.9194	0.228	unknown	ShapiroWilk
Lead, total (mg/L)	AD-23	No	n/a	NP	8	0.009681	0.009618	ln(x)	ShapiroWilk
Lead, total (mg/L)	AD-34	No	n/a	NP	8	0.009464	0.01232	ln(x)	ShapiroWilk
Lead, total (mg/L)	AD-35	No	n/a	NP	8	0.004518	0.002162	x^2	ShapiroWilk
Lithium, total (mg/L)	**AD-23**	**Yes**	**0.0001358,1.01**	**NP (nrm)**	**8**	**0.1315**	**0.355**	**unknown**	**ShapiroWilk**
Lithium, total (mg/L)	AD-34	No	n/a	NP	8	0.1668	0.01018	ln(x)	ShapiroWilk
Lithium, total (mg/L)	AD-35	No	n/a	NP	8	0.01013	0.005194	normal	ShapiroWilk
Mercury, total (mg/L)	AD-23	No	n/a	NP	8	0.00005106	0.00004283	ln(x)	ShapiroWilk
Mercury, total (mg/L)	AD-34	No	n/a	NP	8	0.00007705	0.0000996	ln(x)	ShapiroWilk
Mercury, total (mg/L)	AD-35	No	n/a	NP	8	0.00004329	0.00003465	ln(x)	ShapiroWilk
Molybdenum, total (mg/L)	AD-23	No	n/a	NP (nrm)	8	0.002829	0.002341	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-34	No	n/a	NP (nrm)	8	0.0041	0.00171	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-35	No	n/a	NP (nrm)	8	0.003878	0.002078	unknown	ShapiroWilk
pH, field (SU)	AD-23	No	n/a	NP	8	3.648	0.4592	x^5	ShapiroWilk
pH, field (SU)	AD-34	No	n/a	NP	8	3.515	0.3135	x^2	ShapiroWilk
pH, field (SU)	AD-35	No	n/a	NP	8	4.286	0.515	x^6	ShapiroWilk
Selenium, total (mg/L)	AD-23	No	n/a	NP (nrm)	8	0.002961	0.001713	unknown	ShapiroWilk
Selenium, total (mg/L)	AD-34	No	n/a	NP (nrm)	8	0.005189	0.0007519	unknown	ShapiroWilk
Selenium, total (mg/L)	AD-35	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Sulfate, total (mg/L)	AD-23	No	n/a	NP	8	11.63	1.685	normal	ShapiroWilk

Outlier Analysis - All Downgradient Wells

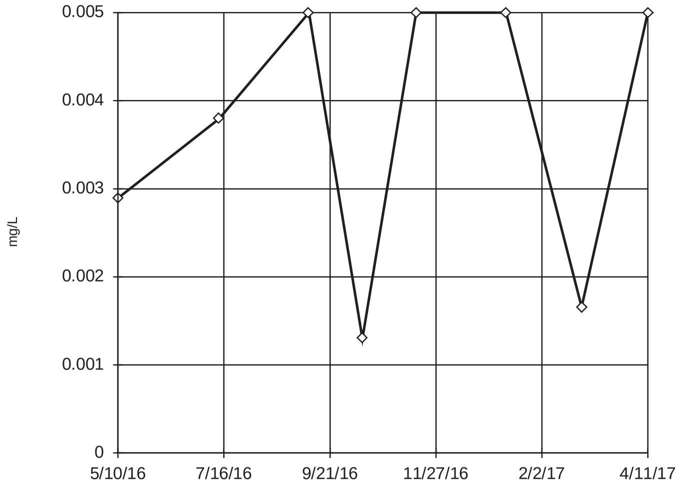
Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 11/4/2017, 3:18 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Sulfate, total (mg/L)	AD-34	No	n/a	NP	8	1014	151.9	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-35	No	n/a	NP	8	46.5	24.85	ln(x)	ShapiroWilk
Thallium, total (mg/L)	AD-23	No	n/a	NP (nrm)	8	0.002	0	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-34	No	n/a	NP (nrm)	8	0.002	0	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-35	No	n/a	NP (nrm)	8	0.002	0	unknown	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-23	No	n/a	NP	8	68.38	15.42	ln(x)	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-34	No	n/a	NP	8	1449	55.98	ln(x)	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-35	No	n/a	NP	8	133.3	21.43	ln(x)	ShapiroWilk

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

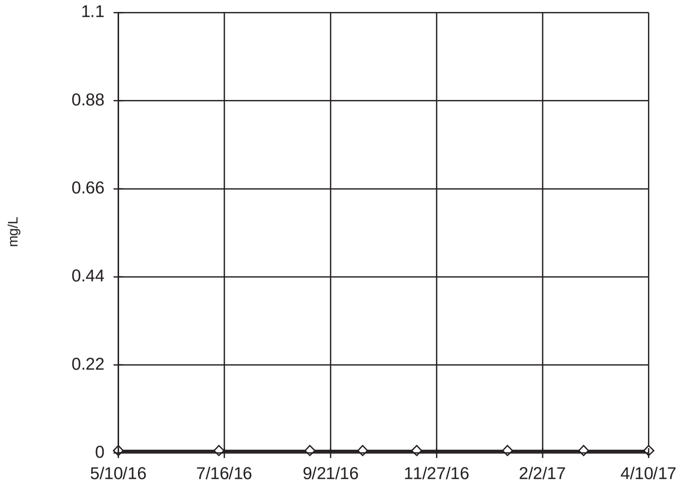
High cutoff = 0.01318, low cutoff = -0.005903, based on IQR multiplier of 3.

Constituent: Antimony, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

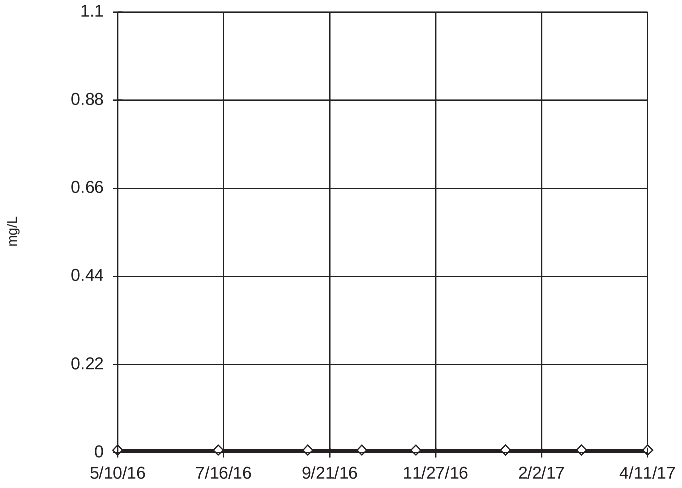
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Antimony, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

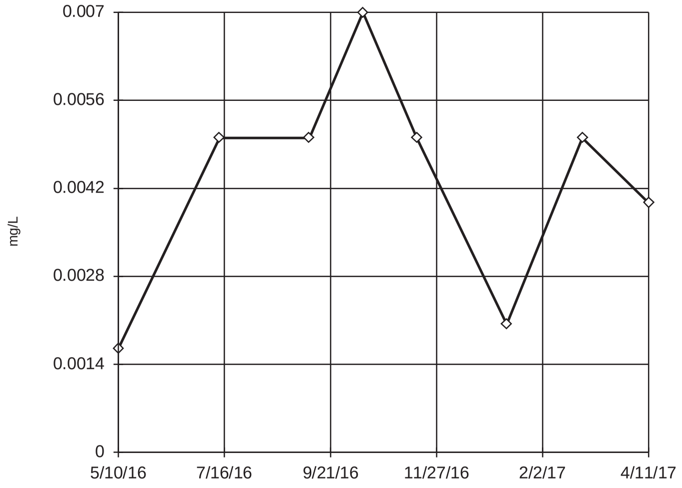
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Antimony, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

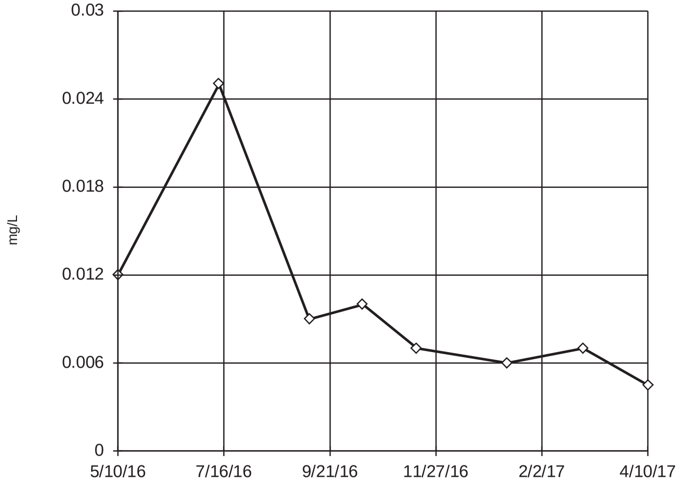
High cutoff = 0.01099, low cutoff = -0.002992, based on IQR multiplier of 3.

Constituent: Arsenic, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

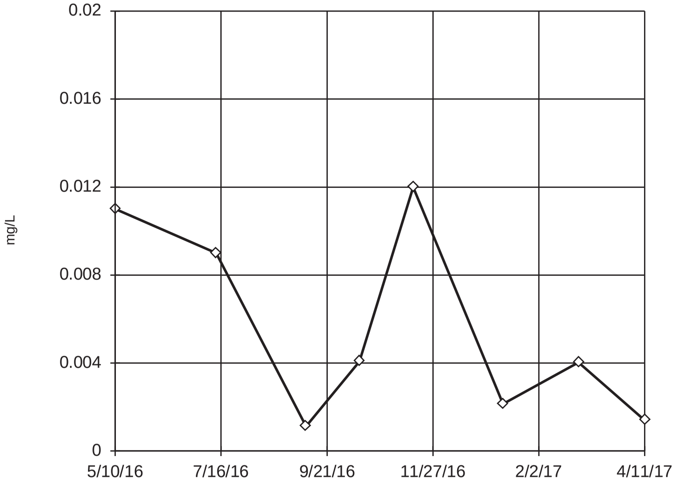
High cutoff = 0.0529, low cutoff = 0.001342, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

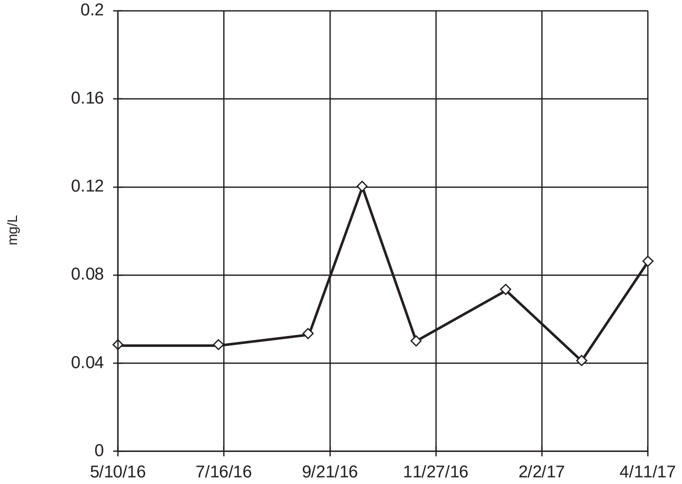
High cutoff = 1.884, low cutoff = 0.00000915, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

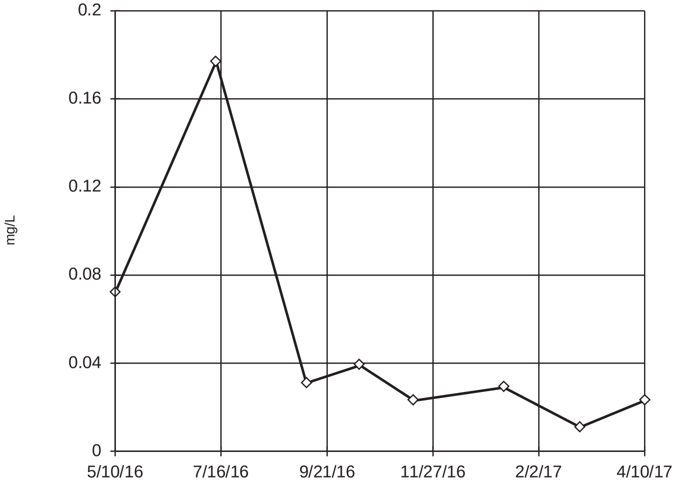
High cutoff = 0.3564, low cutoff = 0.01067, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

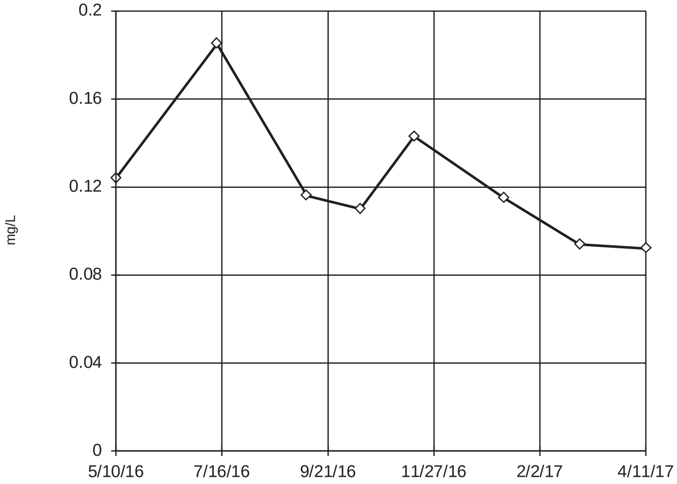
High cutoff = 0.6481, low cutoff = 0.001881, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

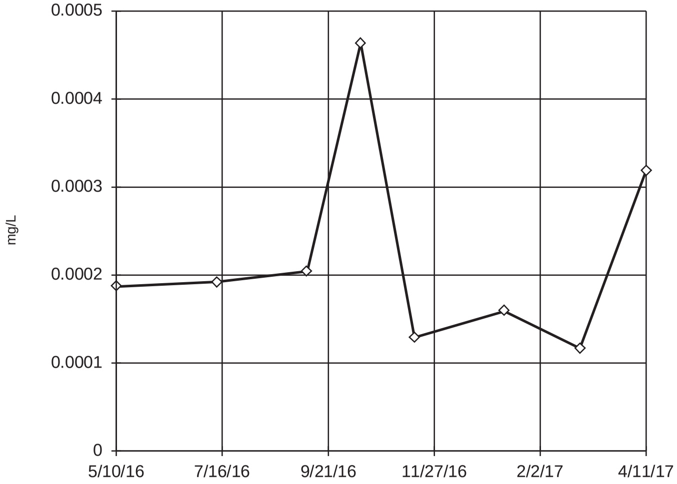
High cutoff = 0.299, low cutoff = 0.04528, based on IQR multiplier of 3.

Constituent: Barium, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

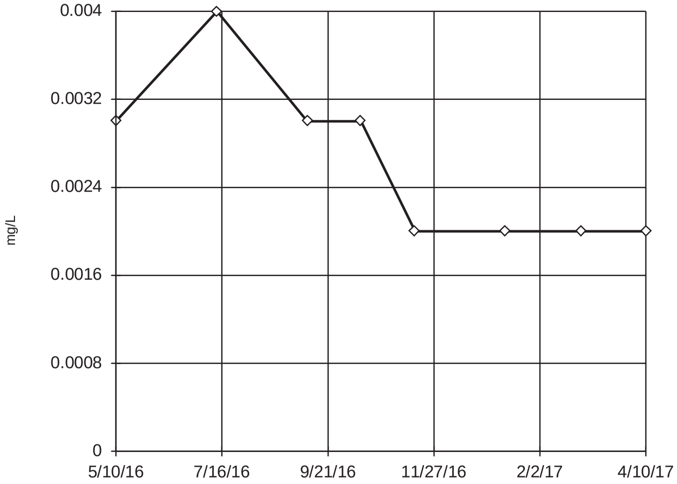
High cutoff = 0.001441, low cutoff = 0.0000254, based on IQR multiplier of 3.

Constituent: Beryllium, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

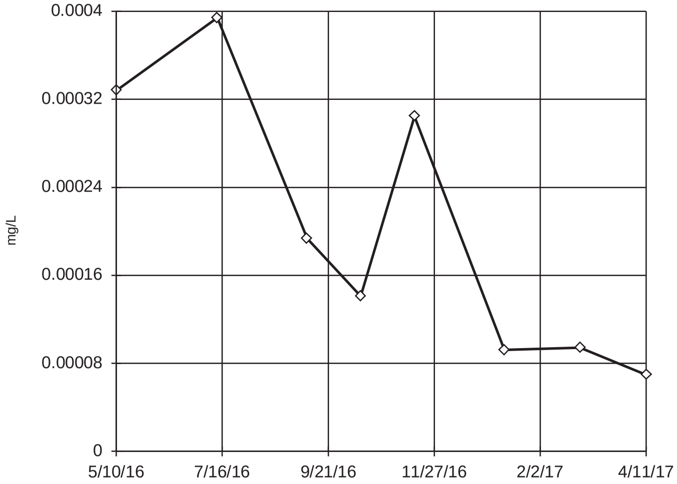
High cutoff = 0.007212, low cutoff = 0.0002122, based on IQR multiplier of 3.

Constituent: Beryllium, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

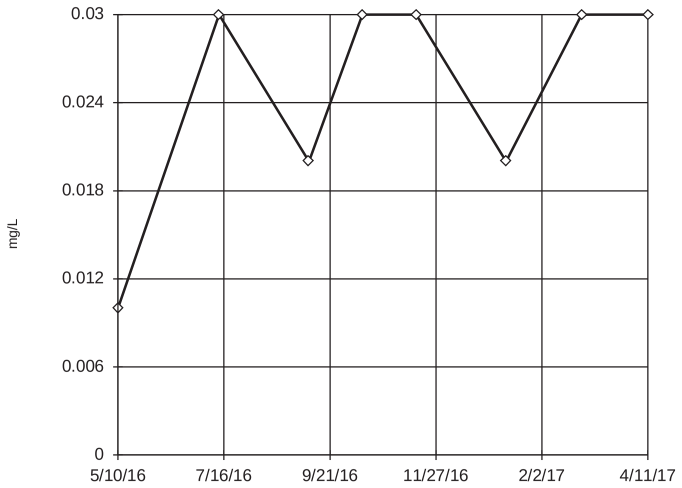
High cutoff = 0.01226, low cutoff = 0.000002406, based on IQR multiplier of 3.

Constituent: Beryllium, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

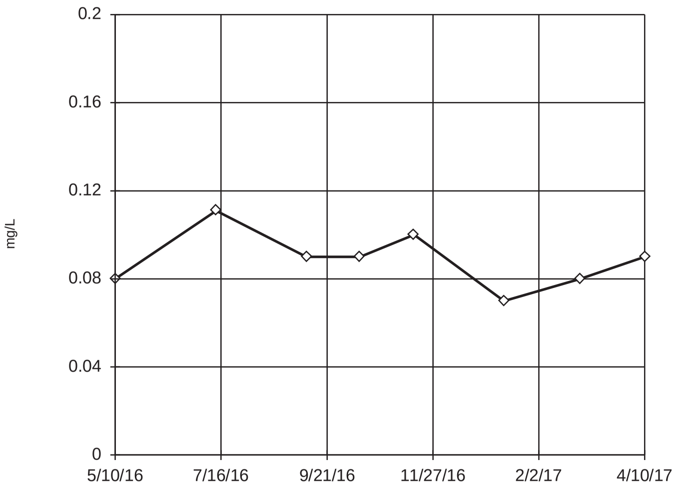
High cutoff = 0.04899, low cutoff = -0.03317, based on IQR multiplier of 3.

Constituent: Boron, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

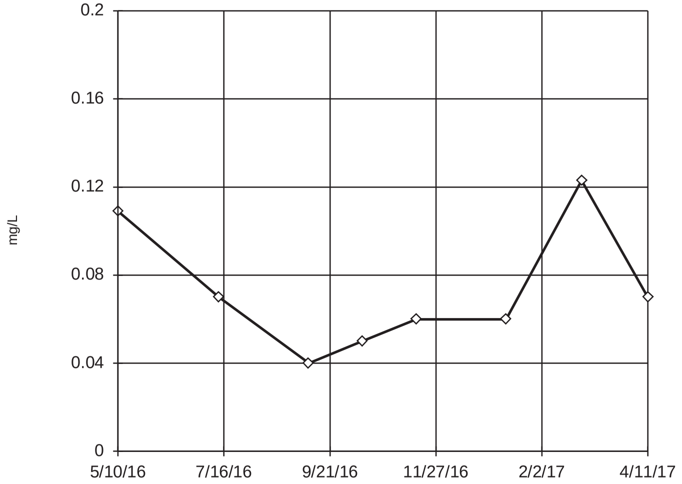
High cutoff = 0.1582, low cutoff = 0.04797, based on IQR multiplier of 3.

Constituent: Boron, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

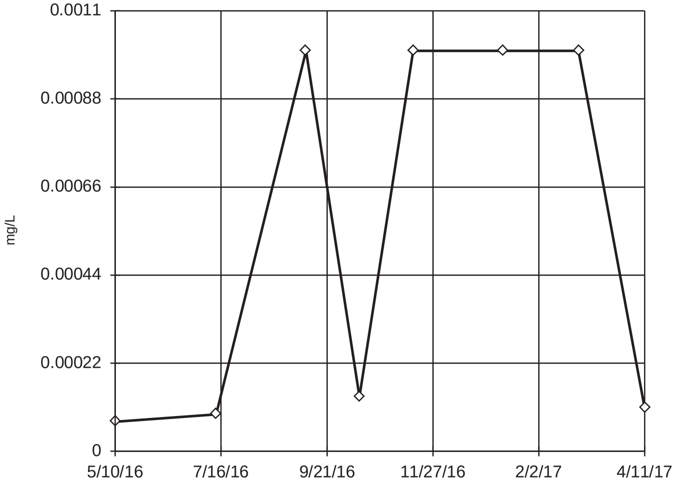
High cutoff = 0.3543, low cutoff = 0.0135, based on IQR multiplier of 3.

Constituent: Boron, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

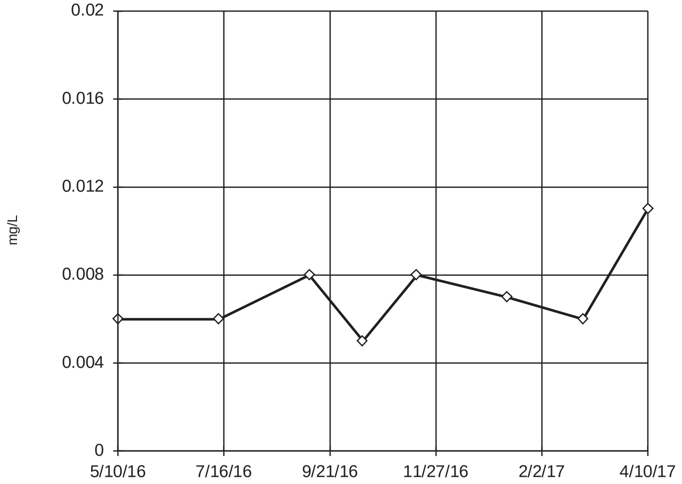
High cutoff = 1.002, low cutoff = 1.0e-7, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

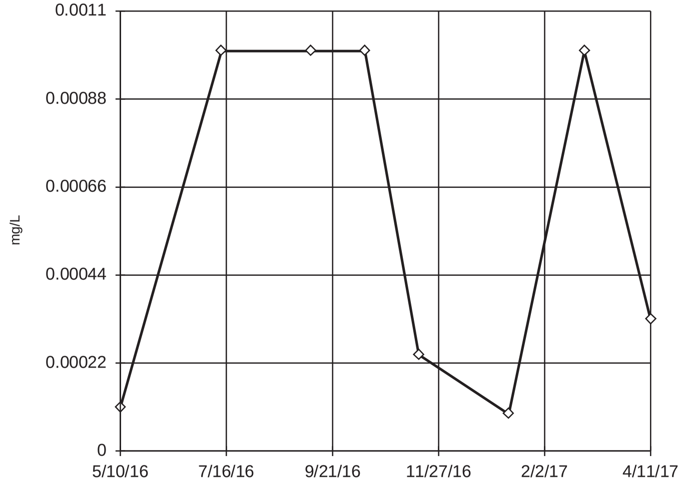
High cutoff = 0.01896, low cutoff = 0.002531, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

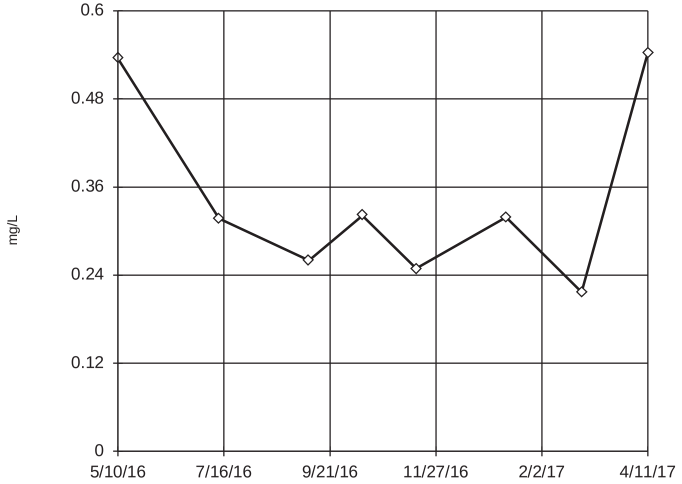
High cutoff = 0.2344, low cutoff = 6.9e-7, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

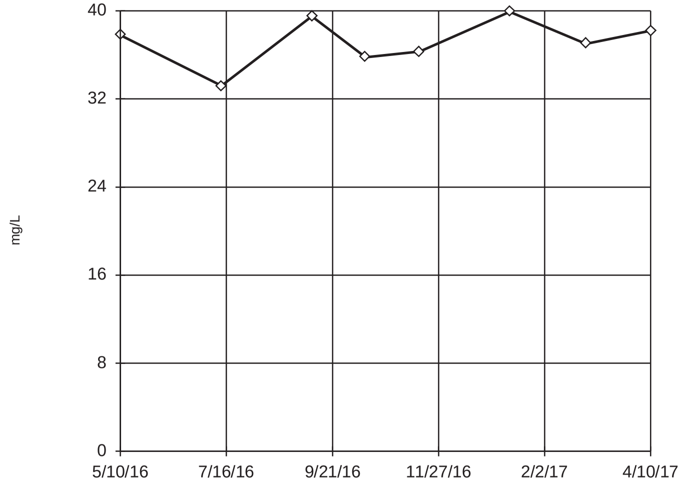
High cutoff = 1.79, low cutoff = 0.05889, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

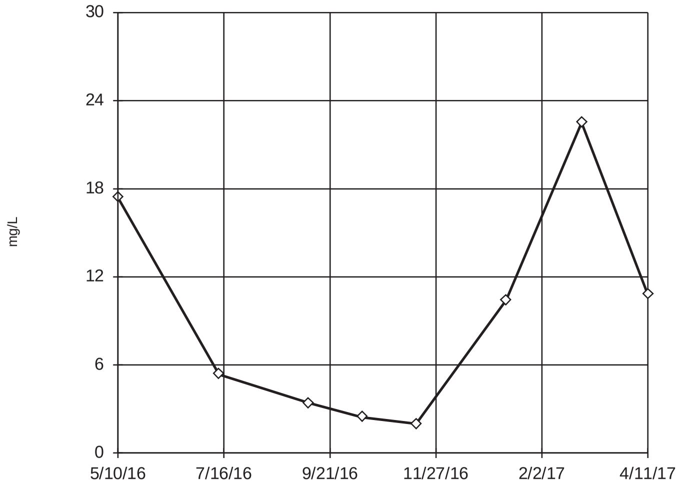
High cutoff = 43.96, low cutoff = -34.1, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

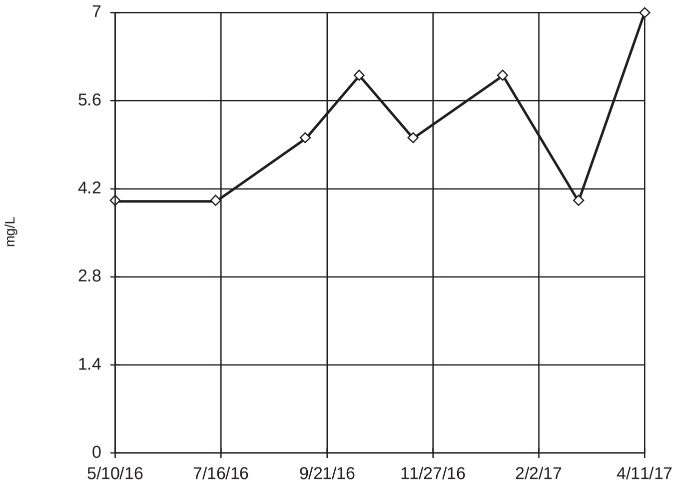
High cutoff = 1474, low cutoff = 0.02681, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

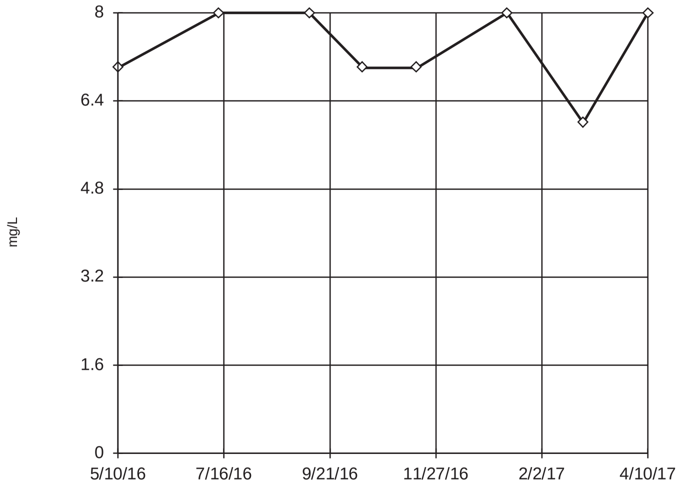
High cutoff = 12, low cutoff = -2, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

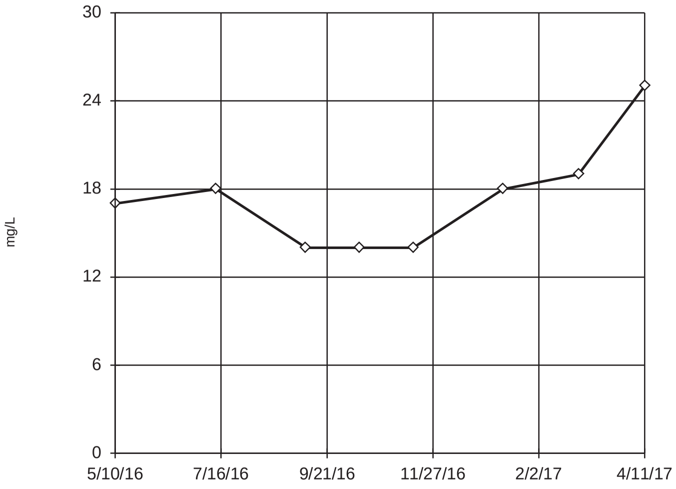
High cutoff = 10.44, low cutoff = 2, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

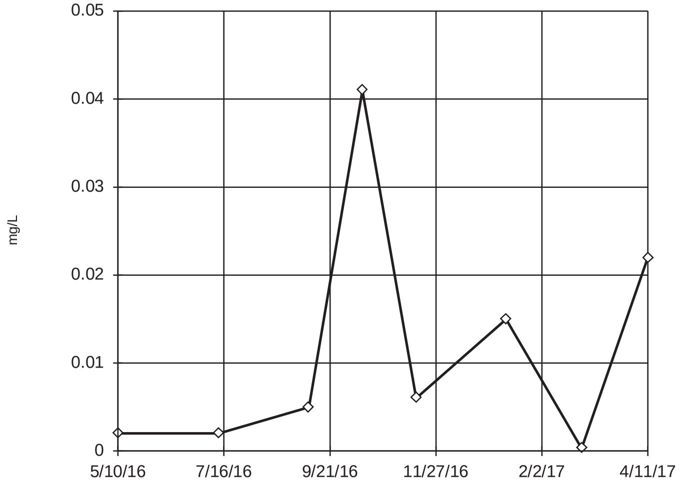
High cutoff = 42.63, low cutoff = 6.074, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

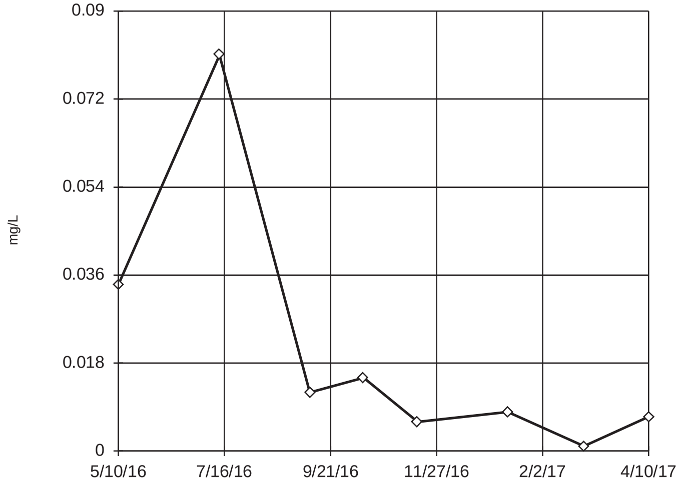
High cutoff = 0.3085, low cutoff = -0.02346, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

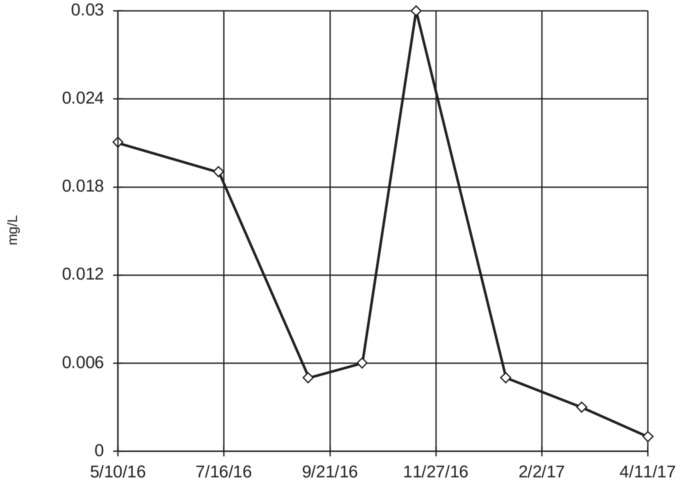
High cutoff = 0.9556, low cutoff = 0.0001532, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

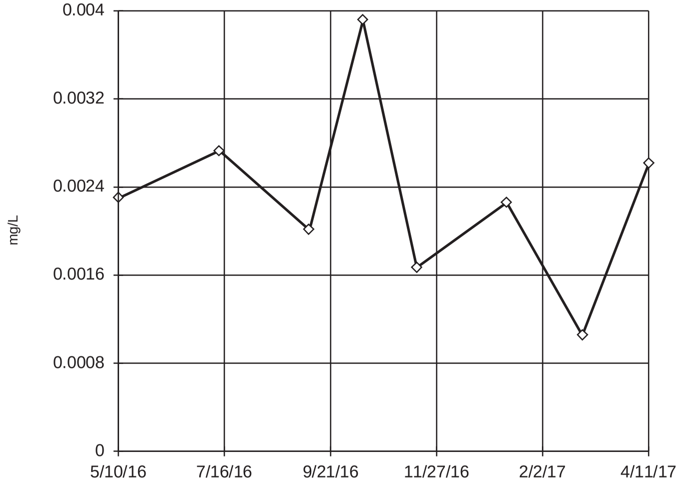
High cutoff = 2.74, low cutoff = 0.00002823, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

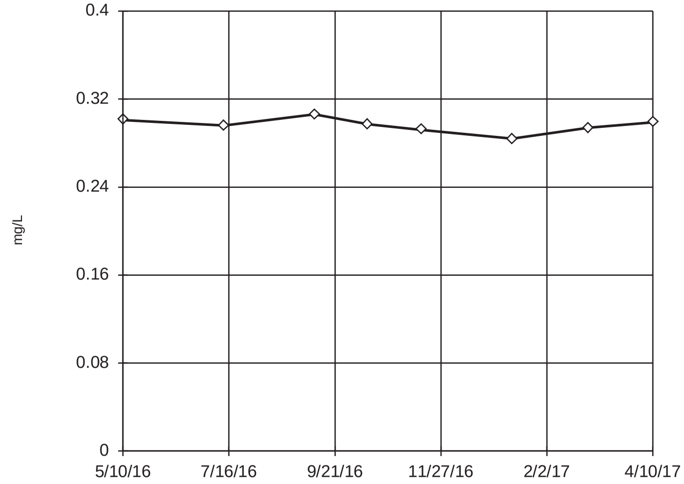
High cutoff = 0.006097, low cutoff = 0.0002696, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

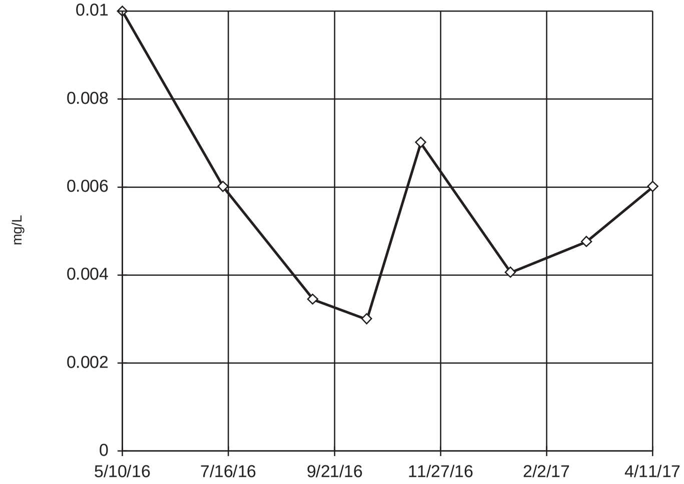
High cutoff = 0.3172, low cutoff = 0.2647, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

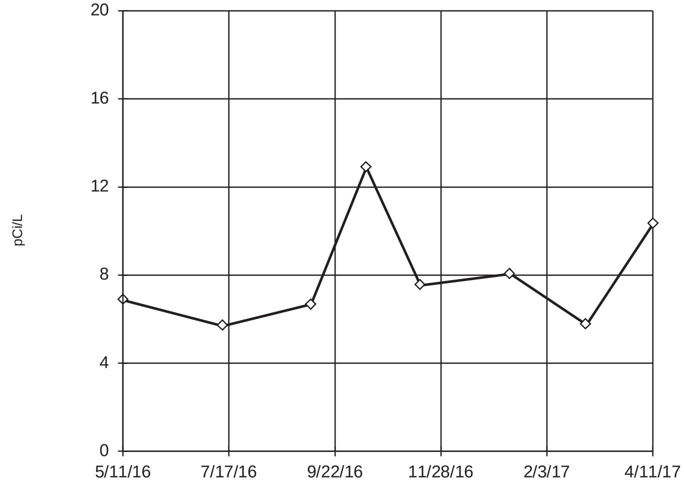
High cutoff = 0.03381, low cutoff = 0.0007163, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

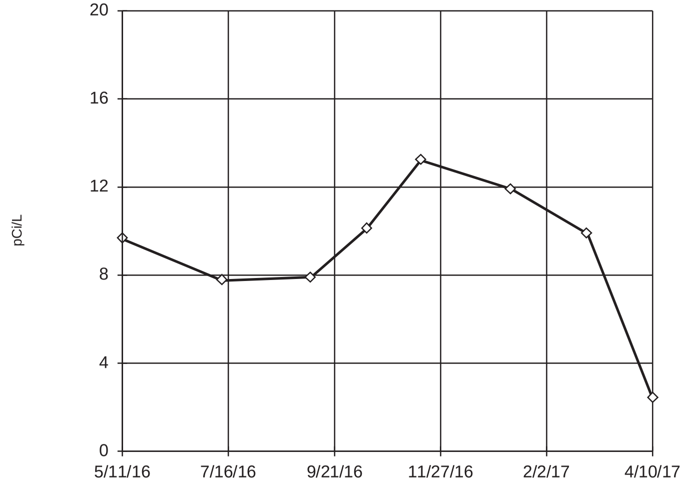
High cutoff = 29.08, low cutoff = 1.941, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

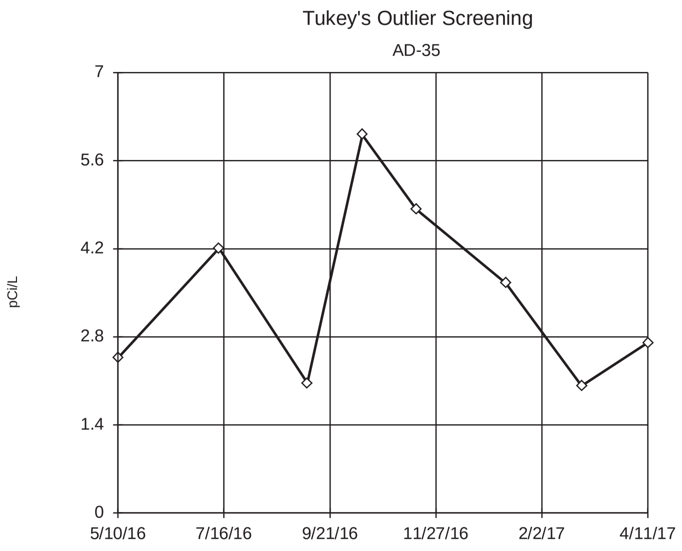
No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 17.44, low cutoff = -10.99, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/4/2017 3:06 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA



n = 8

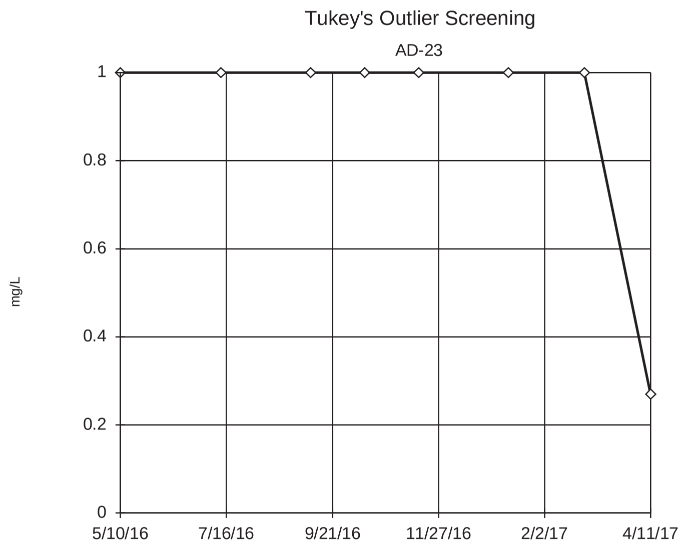
No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 36, low cutoff = 0.2826, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA



n = 8

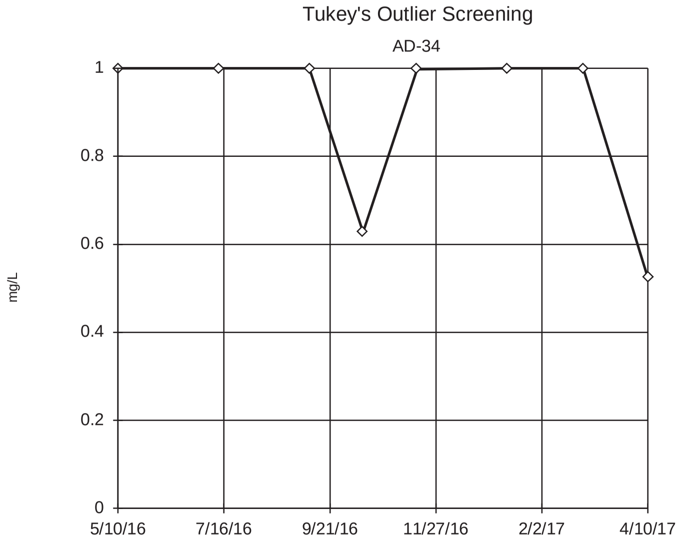
No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Fluoride, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA



n = 8

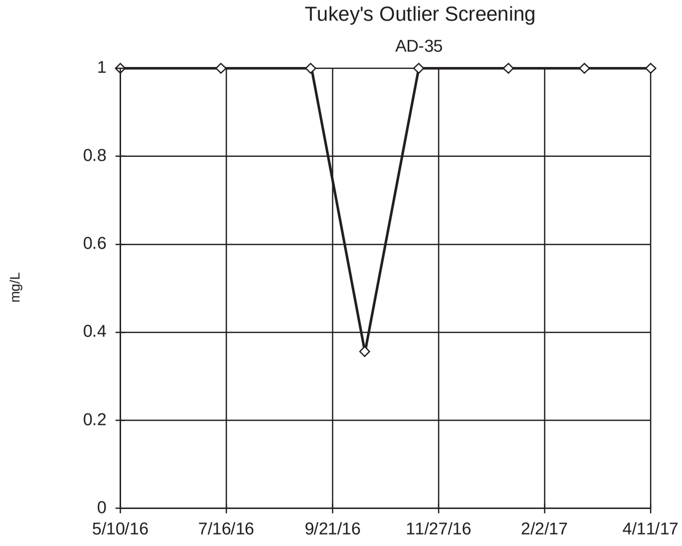
No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.02, low cutoff = 0.3917, based on IQR multiplier of 3.

Constituent: Fluoride, total   Analysis Run 11/4/2017 3:06 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

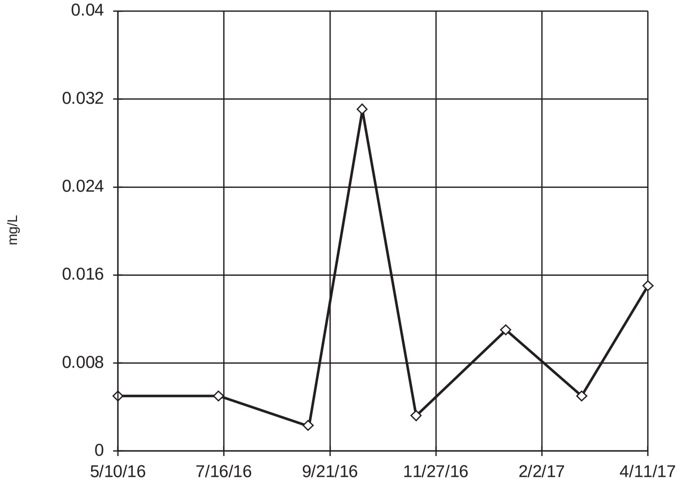
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Fluoride, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

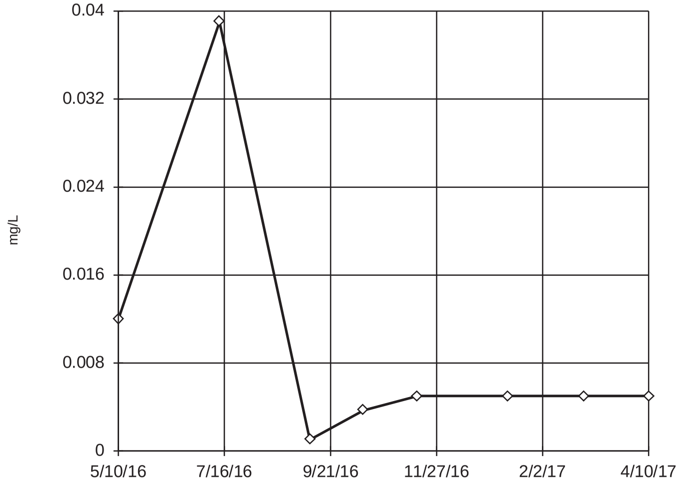
High cutoff = 0.4229, low cutoff = 0.0001217, based on IQR multiplier of 3.

Constituent: Lead, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

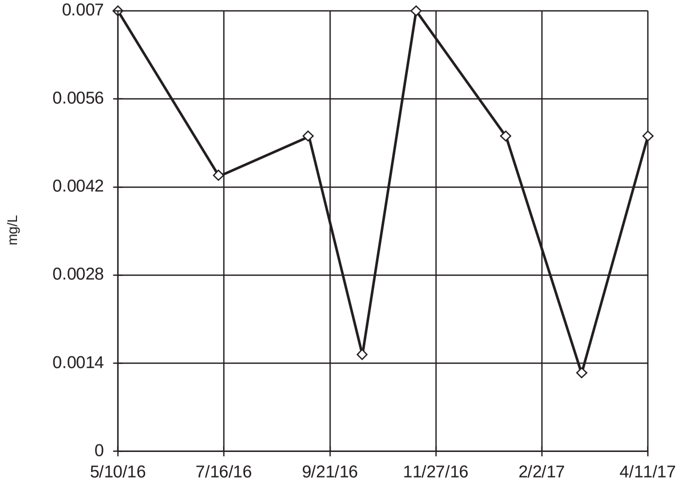
High cutoff = 0.04531, low cutoff = 0.0007349, based on IQR multiplier of 3.

Constituent: Lead, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found.
Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

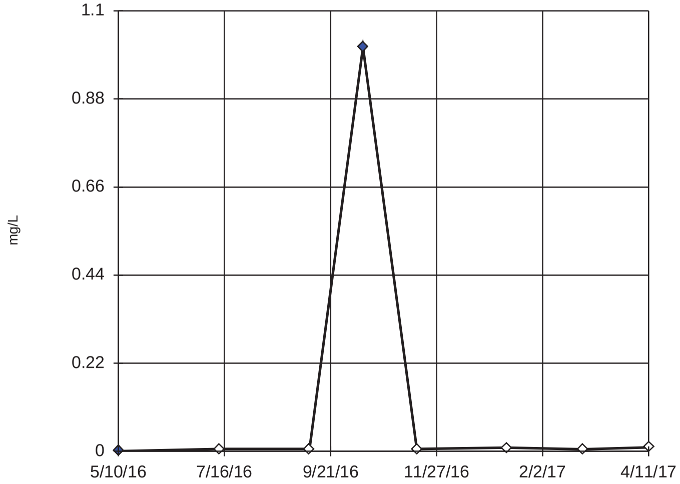
High cutoff = 0.01076, low cutoff = -0.00825, based on IQR multiplier of 3.

Constituent: Lead, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

Outliers are drawn as solid.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

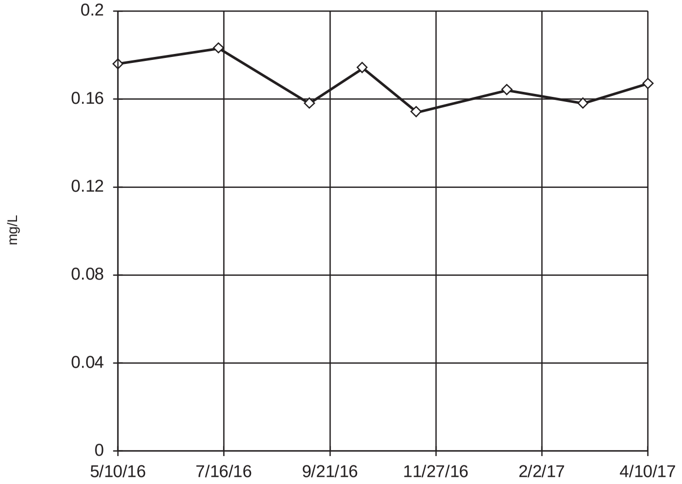
High cutoff = 0.0493, low cutoff = 0.001054, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

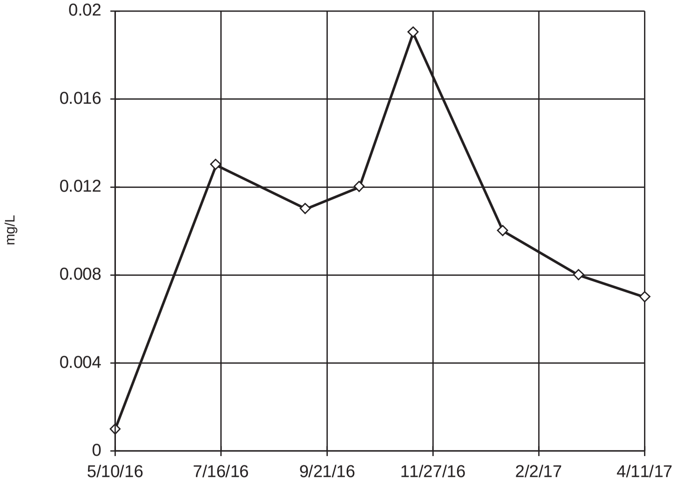
High cutoff = 0.2378, low cutoff = 0.1163, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

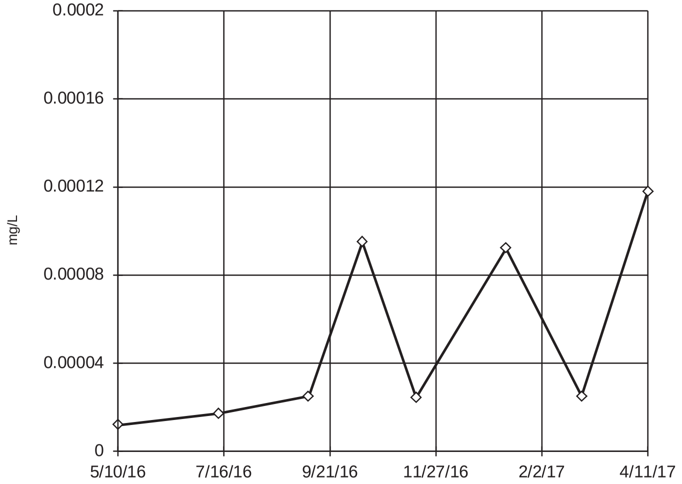
High cutoff = 0.0275, low cutoff = -0.0075, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

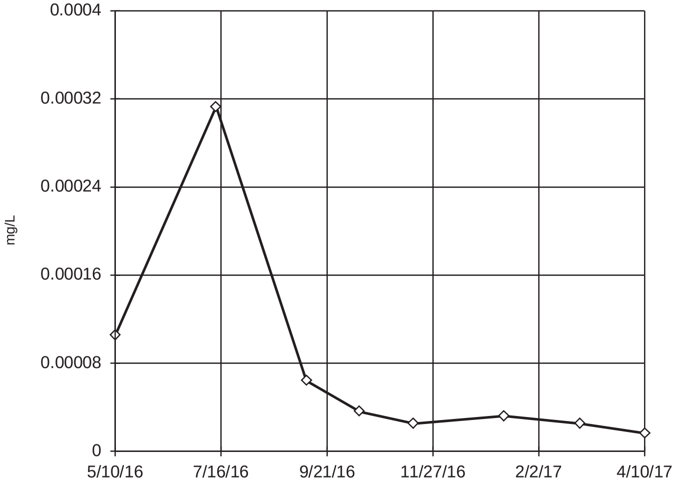
High cutoff = 0.008888, low cutoff = 2.2e-7, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

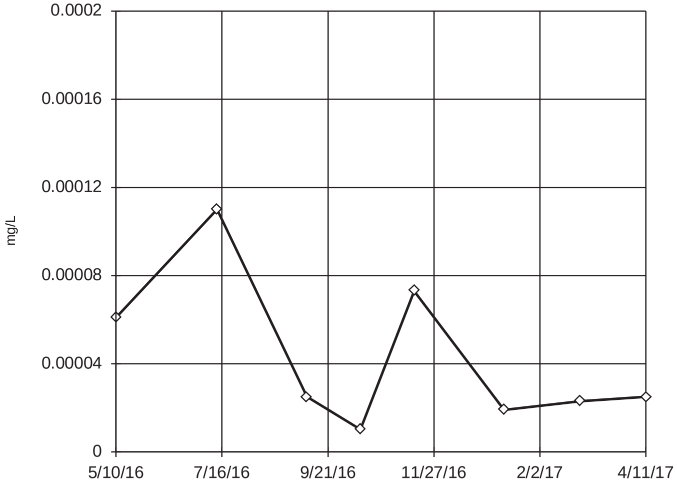
High cutoff = 0.00289, low cutoff = 7.1e-7, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

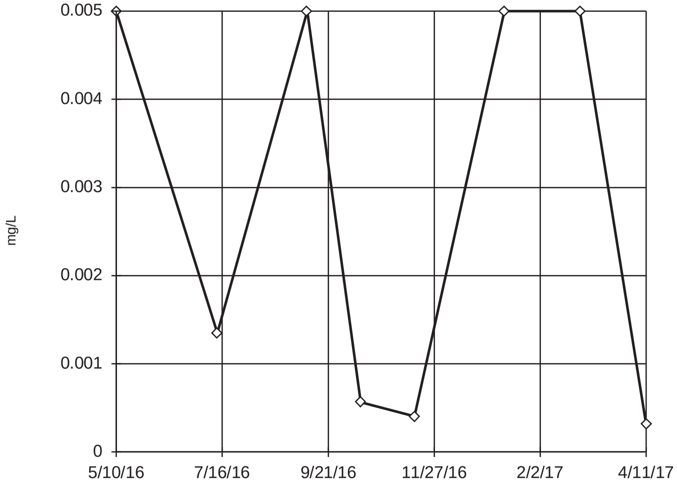
High cutoff = 0.002152, low cutoff = 6.5e-7, based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

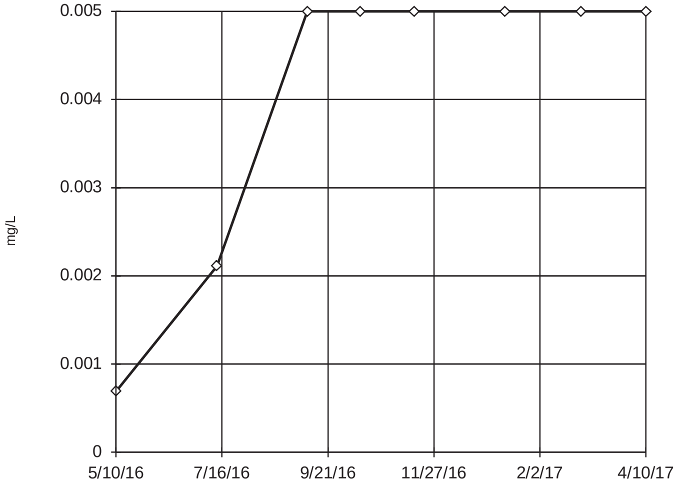
High cutoff = 5.756, low cutoff = 4.1e-7, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

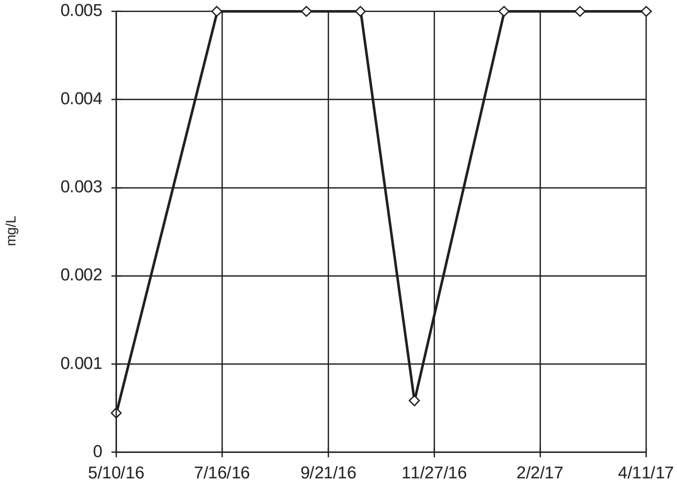
High cutoff = 0.009334, low cutoff = -0.0007791, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

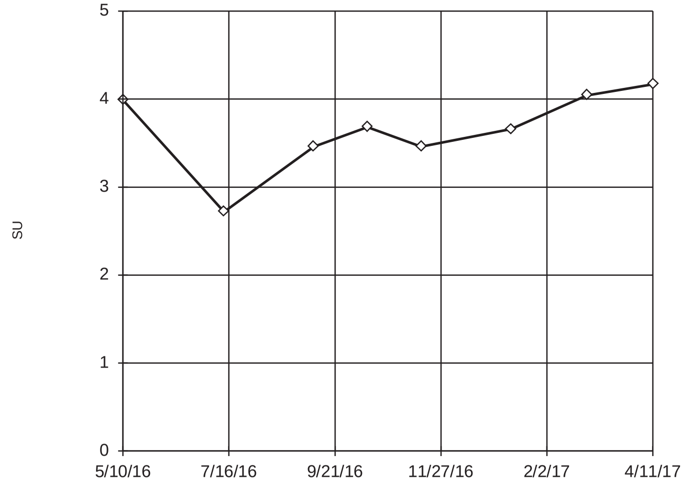
High cutoff = 0.1254, low cutoff = 0.00006808, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found. Tukey's method selected by user.

Data were x^5 transformed to achieve best W statistic (graph shown in original units).

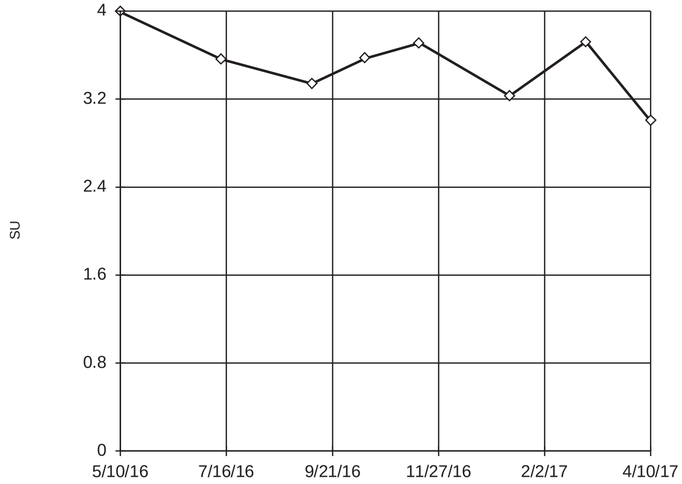
High cutoff = 4.851, low cutoff = -4.092, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

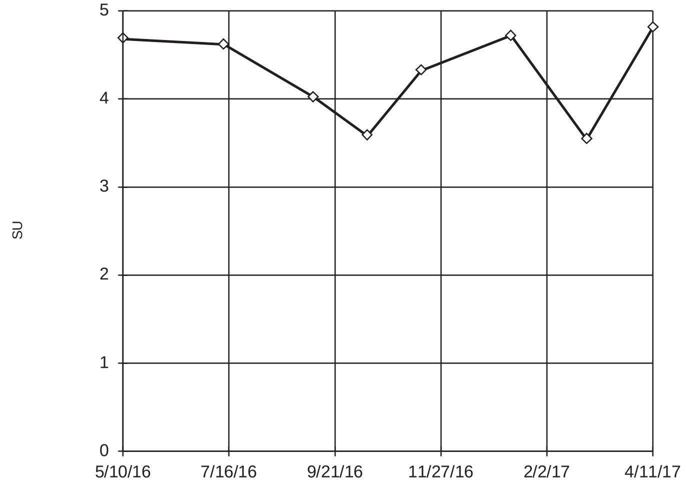
High cutoff = 4.777, low cutoff = 1.332, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

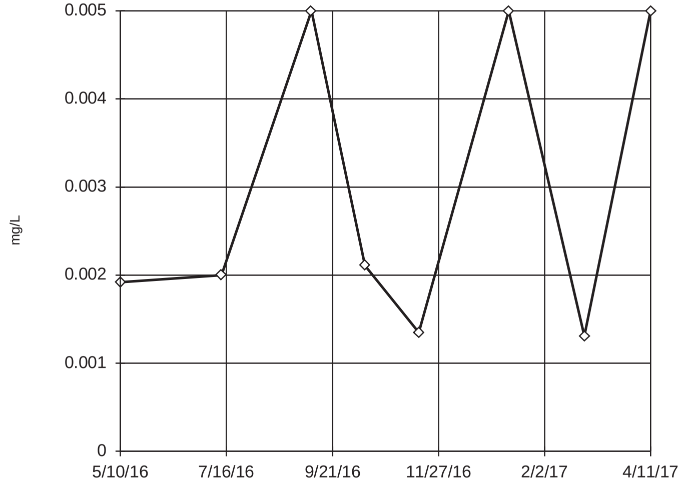
High cutoff = 5.682, low cutoff = -5.197, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

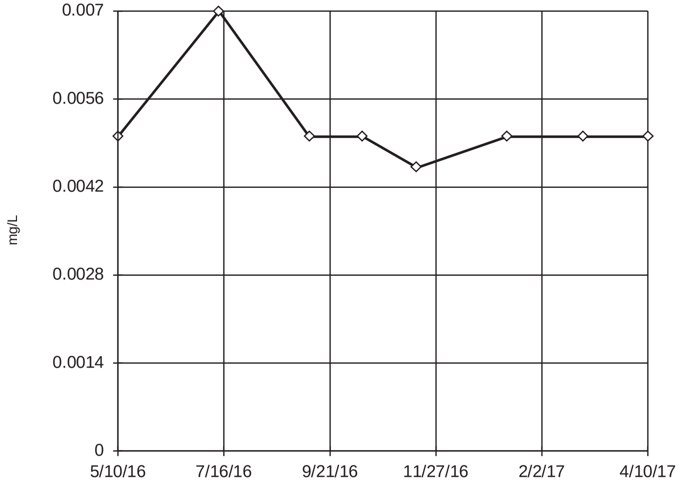
High cutoff = 0.1502, low cutoff = 0.00005355, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

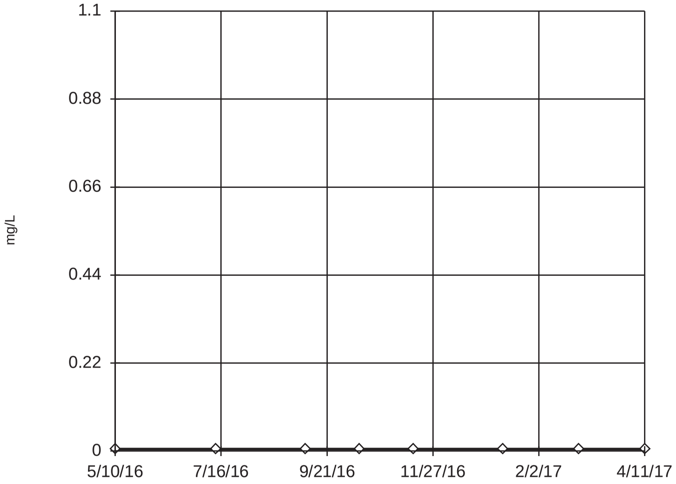
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Selenium, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

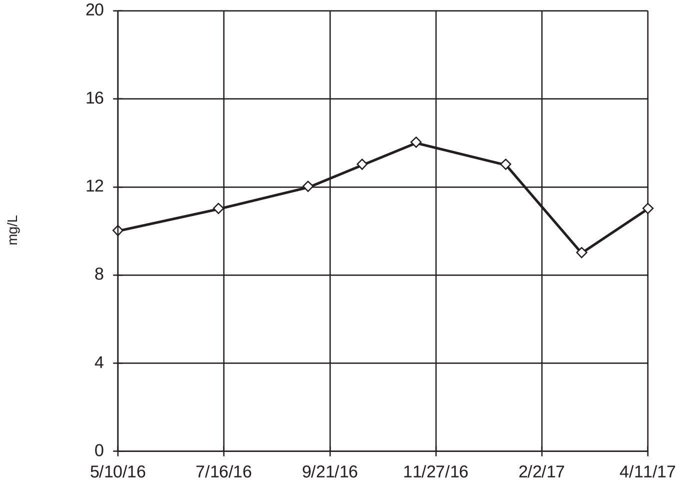
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Selenium, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

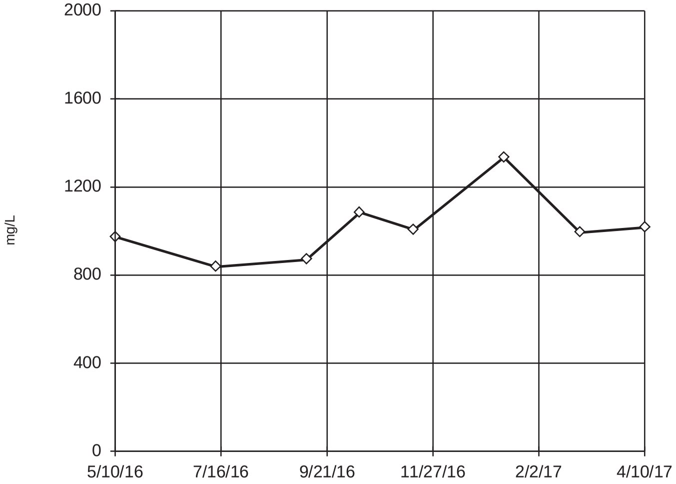
High cutoff = 20.5, low cutoff = 3, based on IQR multiplier of 3.

Constituent: Sulfate, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

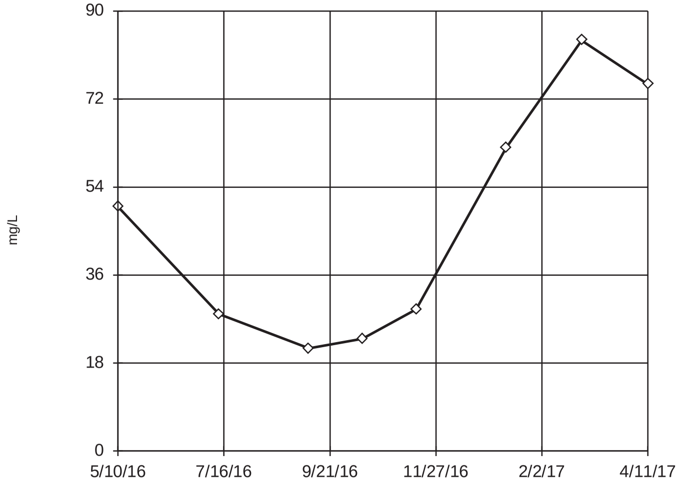
High cutoff = 1555, low cutoff = 621.3, based on IQR multiplier of 3.

Constituent: Sulfate, total   Analysis Run 11/4/2017 3:07 PM   View: Tukey's
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

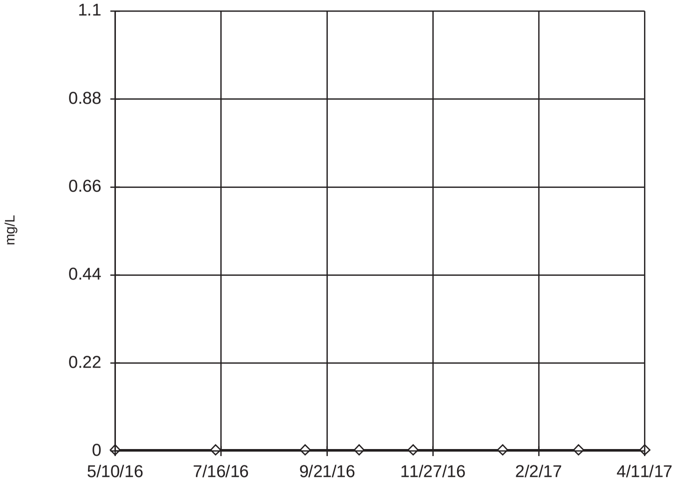
High cutoff = 1323, low cutoff = 1.308, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

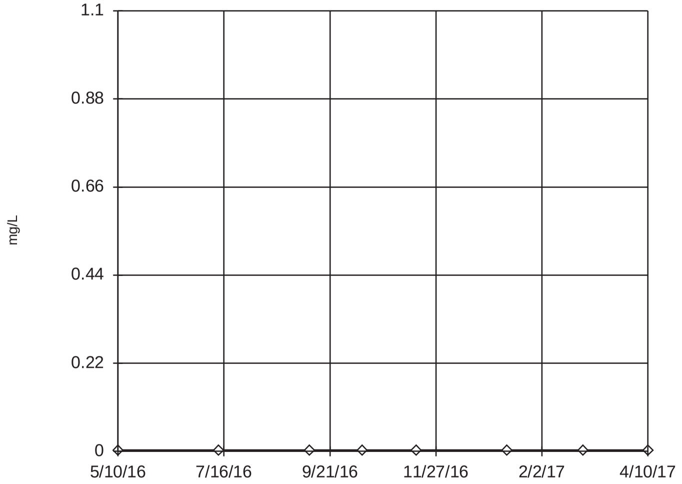
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium, total Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

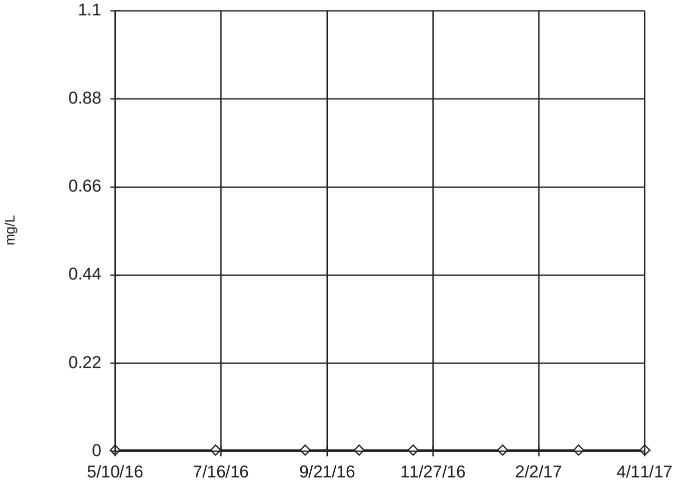
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium, total Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

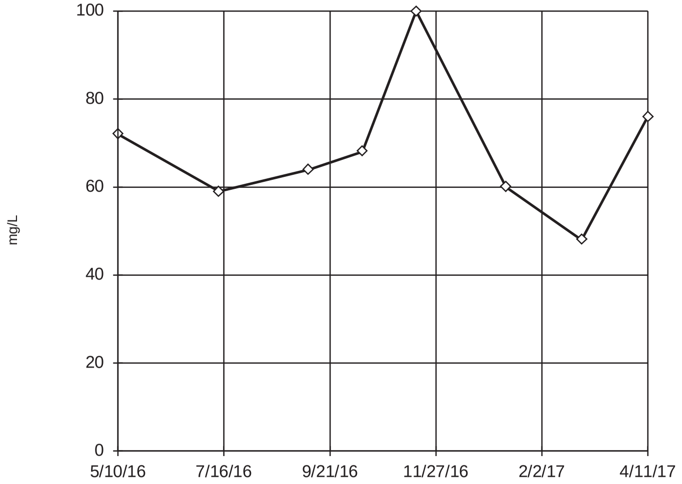
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium, total Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-23



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

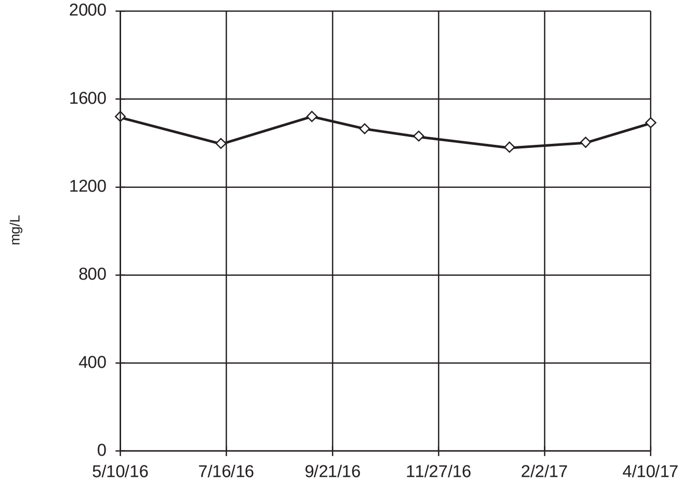
High cutoff = 142.2, low cutoff = 30.96, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-34



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

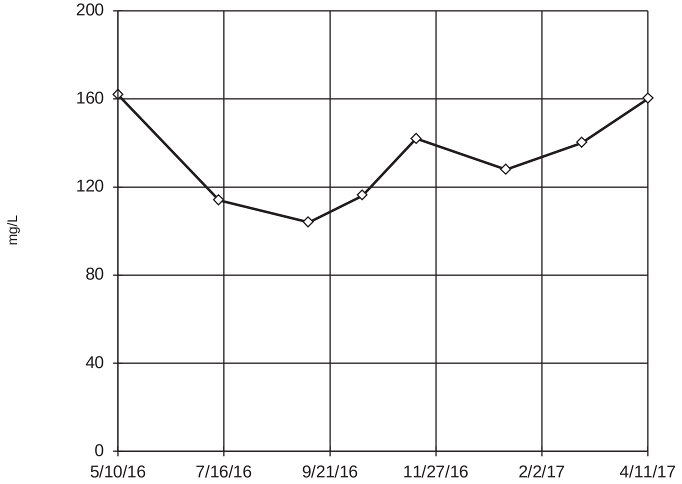
High cutoff = 1863, low cutoff = 1128, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. EPA

Tukey's Outlier Screening

AD-35



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 339.4, low cutoff = 51.06, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/4/2017 3:07 PM View: Tukey's
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Trend Tests Summary Table - Significant Results

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 10/26/2017, 9:09 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Mercury, total (mg/L)	**AD-34**	**-0.00009793**	**-23**	**-21**	**Yes**	**8**	**12.5**	**n/a**	**n/a**	**0.01**	**NP**

Trend Tests Summary Table - All Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 10/26/2017, 9:09 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Antimony, total (mg/L)	AD-16 (bg)	0	-3	-21	No	8	87.5	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-27 (bg)	0	11	21	No	8	75	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-8 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-23	0.0004706	6	21	No	8	50	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-34	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-35	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-16 (bg)	0	0	21	No	8	62.5	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-27 (bg)	0.001845	8	21	No	8	50	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-8 (bg)	0	4	21	No	8	50	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-23	0	0	21	No	8	50	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-34	-0.008831	-21	-21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-35	-0.008262	-10	-21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-16 (bg)	0.01472	8	21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-27 (bg)	0	-1	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-8 (bg)	0	0	21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-23	0.02355	7	21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-34	-0.05859	-19	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-35	-0.04138	-18	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-12 (bg)	-0.002403	-4	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-16 (bg)	-0.00007155	-2	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-27 (bg)	0	-3	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-8 (bg)	0	6	21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-23	-0.00004231	-2	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-34	-0.001818	-17	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-35	-0.0002852	-20	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-12 (bg)	-0.00008978	-12	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-16 (bg)	0	-3	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-27 (bg)	0	4	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-8 (bg)	-0.2304	-10	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-23	0	9	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-34	-0.007419	-4	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-35	0.02111	4	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0.01638	13	21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-16 (bg)	0	11	21	No	8	75	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-27 (bg)	-0.00005366	-16	-21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-8 (bg)	-0.0001511	-13	-21	No	8	37.5	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-23	0.00007121	10	21	No	8	50	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-34	0.002316	8	21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-35	0	-2	-21	No	8	50	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-16 (bg)	-0.6057	-7	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-27 (bg)	-0.5014	-10	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-8 (bg)	-9.522	-20	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-23	-0.07488	-4	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-34	3.133	8	21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-35	3.977	2	21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-12 (bg)	-0.007078	0	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-16 (bg)	2.173	16	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-27 (bg)	0	10	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-8 (bg)	0	1	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-23	2.944	13	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-34	0	-1	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-35	6.654	12	21	No	8	0	n/a	n/a	0.01	NP

Trend Tests Summary Table - All Results

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 10/26/2017, 9:09 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Chloride, total (mg/L)	AD-12 (bg)	0.5448	5	21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-16 (bg)	-0.0006231	-13	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-27 (bg)	0	-2	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-8 (bg)	-0.000225	-7	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-23	0.01545	9	21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-34	-0.03448	-18	-21	No	8	12.5	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-35	-0.0168	-17	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-12 (bg)	-0.0002747	-14	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-16 (bg)	0.0005181	4	21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-27 (bg)	0	4	21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-8 (bg)	0.003269	10	21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-23	-0.0009025	-6	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-34	-0.009055	-8	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-35	-0.002231	-3	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-12 (bg)	-0.0003758	-10	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-16 (bg)	0.4804	2	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-27 (bg)	0.7387	6	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-8 (bg)	2.347	6	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-23	3.544	8	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-34	0.6647	2	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-35	-0.8378	-4	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-12 (bg)	-0.4211	-2	-21	No	8	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-16 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-27 (bg)	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-8 (bg)	1.852	15	21	No	8	12.5	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-23	0	-7	-21	No	8	87.5	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-34	0	-8	-21	No	8	62.5	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-35	0	1	21	No	8	87.5	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-12 (bg)	0	-7	-21	No	8	75	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-16 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-27 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-8 (bg)	0.002299	12	21	No	8	12.5	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-23	0.006021	7	21	No	8	37.5	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-34	0	-2	-21	No	8	50	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-35	-0.001476	-6	-21	No	8	37.5	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-16 (bg)	-0.02002	-10	-21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-27 (bg)	0.0157	18	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-8 (bg)	0.00298	6	21	No	8	12.5	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-23	0.006028	9	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-34	-0.01964	-9	-21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-35	-0.006173	-6	-21	No	8	12.5	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-12 (bg)	0.002799	4	21	No	8	12.5	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-16 (bg)	0	-1	-21	No	8	37.5	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-27 (bg)	0	1	21	No	8	75	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-8 (bg)	-0.00001847	-2	-21	No	8	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-23	0.00004813	17	21	No	8	25	n/a	n/a	0.01	NP
Mercury, total (mg/L)	**AD-34**	**-0.00009793**	**-23**	**-21**	**Yes**	**8**	**12.5**	**n/a**	**n/a**	**0.01**	**NP**
Mercury, total (mg/L)	AD-35	-0.00004311	-7	-21	No	8	25	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-12 (bg)	0	-7	-21	No	8	87.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-16 (bg)	0	5	21	No	8	87.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-27 (bg)	0	5	21	No	8	87.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-8 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-23	-0.0003606	-8	-21	No	8	50	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-34	0	13	21	No	8	75	n/a	n/a	0.01	NP

Trend Tests Summary Table - All Results

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 10/26/2017, 9:09 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Molybdenum, total (mg/L)	AD-35	0	7	21	No	8	75	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
pH, field (SU)	AD-16 (bg)	-0.5685	-12	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-27 (bg)	0.4254	4	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-8 (bg)	-3.035	-14	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-23	1.168	13	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-34	-0.6209	-8	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-35	-0.02284	0	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-12 (bg)	0.5797	4	21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-16 (bg)	0	7	21	No	8	75	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-27 (bg)	0	9	21	No	8	75	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-8 (bg)	-0.006109	-11	-21	No	8	37.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-23	0.0002183	3	21	No	8	37.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-34	0	-5	-21	No	8	75	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-35	0	0	21	No	8	100	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-12 (bg)	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-16 (bg)	1.241	1	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-27 (bg)	3.345	8	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-8 (bg)	50.9	6	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-23	2.003	4	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-34	226.2	12	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-35	57.9	14	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	1.233	5	21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-16 (bg)	0	11	21	No	8	75	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-27 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-8 (bg)	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-23	0	0	21	No	8	100	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-34	0	0	21	No	8	100	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-35	0	0	21	No	8	100	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-12 (bg)	0	-5	-21	No	8	87.5	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-16 (bg)	-45.37	-19	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-27 (bg)	0	-2	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-8 (bg)	-38.7	-9	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-23	-3.707	0	21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-34	-70.77	-6	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-35	46.41	8	21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-25.99	-12	-21	No	8	0	n/a	n/a	0.01	NP

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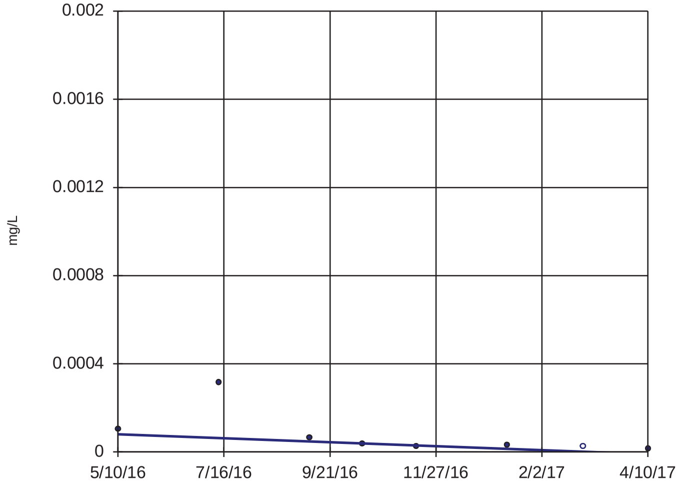
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-34



n = 8

Slope = -0.00009793
units per year.

Mann-Kendall
statistic = -23
critical = -21

Decreasing trend
significant at 99%
confidence level
(= 0.005 per
tail).

Constituent: Mercury, total Analysis Run 10/26/2017 9:07 AM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Analysis of Variance

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 1/15/2018, 6:44 PM

Constituent	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Calc.	Alpha	Method
Boron, total (mg/L)	n/a	n/a	n/a	No	Yes	23.84	0.05	NP (normality)
Calcium, total (mg/L)	n/a	n/a	n/a	No	Yes	29.1	0.05	NP (normality)
Chloride, total (mg/L)	n/a	n/a	n/a	No	Yes	26.19	0.05	NP (normality)
Fluoride, total (mg/L)	n/a	n/a	n/a	No	Yes	22.08	0.05	NP (normality)
pH, field (SU)	n/a	n/a	n/a	No	No	6.326	0.05	NP (eq. var.)
Sulfate, total (mg/L)	n/a	n/a	n/a	x^(1/3)	Yes	193.4	0.05	Param.
Total Dissolved Solids [TDS] (mg/L)	n/a	n/a	n/a	ln(x)	Yes	132.6	0.05	Param.

Non-Parametric ANOVA

Constituent: Boron, total Analysis Run 1/15/2018 6:43 PM View: ANOVA
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

For observations made between 5/10/2016 and 4/11/2017, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 23.84

Tabulated Chi-Squared value = 7.815 with 3 degrees of freedom at the 5% significance level.

There were 3 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 21.28
Adjusted Kruskal-Wallis statistic (H') = 23.84

Non-Parametric ANOVA

Constituent: Calcium, total Analysis Run 1/15/2018 6:43 PM View: ANOVA
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

For observations made between 5/10/2016 and 4/11/2017, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 29.1

Tabulated Chi-Squared value = 7.815 with 3 degrees of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 29.09
Adjusted Kruskal-Wallis statistic (H') = 29.1

Non-Parametric ANOVA

Constituent: Chloride, total Analysis Run 1/15/2018 6:43 PM View: ANOVA
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

For observations made between 5/10/2016 and 4/11/2017, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 26.19

Tabulated Chi-Squared value = 7.815 with 3 degrees of freedom at the 5% significance level.

There were 8 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 25.3
Adjusted Kruskal-Wallis statistic (H') = 26.19

Non-Parametric ANOVA

Constituent: Fluoride, total   Analysis Run 1/15/2018 6:44 PM   View: ANOVA
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

For observations made between 5/10/2016 and 4/11/2017, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 22.08

Tabulated Chi-Squared value = 7.815 with 3 degrees of freedom at the 5% significance level.

There were 3 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 13.83
Adjusted Kruskal-Wallis statistic (H') = 22.08

Non-Parametric ANOVA

Constituent: pH, field   Analysis Run 1/15/2018 6:44 PM   View: ANOVA
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

For observations made between 5/10/2016 and 4/11/2017, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 6.326

Tabulated Chi-Squared value = 7.815 with 3 degrees of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 6.325
Adjusted Kruskal-Wallis statistic (H') = 6.326

Parametric ANOVA

Constituent: Sulfate, total   Analysis Run 1/15/2018 6:44 PM   View: ANOVA
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test (after cube root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 193.4

Tabulated F statistic = 2.95 with 3 and 28 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	60.29	3	20.1	193.4
Error Within Groups	2.91	28	0.1039	
Total	63.2	31		

The Shapiro Wilk normality test on the residuals passed after cube root transformation. Alpha = 0.05, calculated = 0.9461, critical = 0.93. Levene's Equality of Variance test passed. Calculated = 2.341, tabulated = 2.95.

Parametric ANOVA

Constituent: Total Dissolved Solids [TDS] Analysis Run 1/15/2018 6:44 PM View: ANOVA
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 132.6

Tabulated F statistic = 2.95 with 3 and 28 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	8.638	3	2.879	132.6
Error Within Groups	0.608	28	0.02171	
Total	9.246	31		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.05, calculated = 0.9477, critical = 0.93. Levene's Equality of Variance test passed. Calculated = 0.9721, tabulated = 2.95.

Tolerance Limits - Appendix III

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 12/13/2017, 6:09 AM

Constituent	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	1.58	n/a	32	n/a	n/a	0	n/a	n/a	0.1937	NP Inter(normality)
Calcium, total (mg/L)	167.9	n/a	32	0.9914	1.665	0	None	ln(x)	0.01	Inter
Chloride, total (mg/L)	14.59	n/a	32	8.906	2.291	0	None	No	0.01	Inter
Fluoride, total (mg/L)	3	n/a	32	n/a	n/a	71.88	n/a	n/a	0.1937	NP Inter(normality)
pH, field (SU)	6.401	1.861	32	1.947	0.2081	0	None	sqrt(x)	0.01	Inter
Sulfate, total (mg/L)	297.5	n/a	32	7.07	4.101	0	None	sqrt(x)	0.01	Inter
Total Dissolved Solids [TDS] (mg/L)	398.2	n/a	32	173.4	90.57	0	None	No	0.01	Inter

Confidence Interval Summary Table - Significant Appendix III

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 12/13/2017, 6:11 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Sulfate, total (mg/L)	**AD-34**	**1175**	**853.3**	**228**	**Yes**	**8**	**1014**	**151.9**	**0**	**None**	**No**	**0.01**	**Param.**
Total Dissolved Solids [TDS] (mg/L)	**AD-34**	**1509**	**1390**	**448.6**	**Yes**	**8**	**1449**	**55.98**	**0**	**None**	**No**	**0.01**	**Param.**

Confidence Interval Summary Table - All Appendix III

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 12/13/2017, 6:11 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-23	0.03	0.01	1.58	No	8	0.025	0.007559	0	None	No	0.004	NP (normality)
Boron, total (mg/L)	AD-34	0.1023	0.0754	1.58	No	8	0.08888	0.01271	0	None	No	0.01	Param.
Boron, total (mg/L)	AD-35	0.1032	0.04232	1.58	No	8	0.07275	0.02871	0	None	No	0.01	Param.
Calcium, total (mg/L)	AD-23	0.4714	0.225	167.9	No	8	0.3451	0.1255	0	None	x^(1/3)	0.01	Param.
Calcium, total (mg/L)	AD-34	39.51	34.92	167.9	No	8	37.21	2.163	0	None	No	0.01	Param.
Calcium, total (mg/L)	AD-35	17.24	1.336	167.9	No	8	9.288	7.502	0	None	No	0.01	Param.
Chloride, total (mg/L)	AD-23	6.318	3.932	15.31	No	8	5.125	1.126	0	None	No	0.01	Param.
Chloride, total (mg/L)	AD-34	8	6	15.31	No	8	7.375	0.744	0	None	No	0.004	NP (normality)
Chloride, total (mg/L)	AD-35	21.19	13.65	15.31	No	8	17.38	3.701	0	None	sqrt(x)	0.01	Param.
Fluoride, total (mg/L)	AD-23	1	0.2688	3	No	8	0.9086	0.2585	87.5	None	No	0.004	NP (NDs)
Fluoride, total (mg/L)	AD-34	1	0.5241	3	No	8	0.8936	0.1982	62.5	None	No	0.004	NP (normality)
Fluoride, total (mg/L)	AD-35	1	0.3552	3	No	8	0.9194	0.228	87.5	None	No	0.004	NP (NDs)
pH, field (SU)	AD-23	4.216	3.079	6.49	No	8	3.648	0.4592	0	None	No	0.005	Param.
pH, field (SU)	AD-34	3.903	3.127	6.49	No	8	3.515	0.3135	0	None	No	0.005	Param.
pH, field (SU)	AD-35	4.923	3.649	6.49	No	8	4.286	0.515	0	None	No	0.005	Param.
Sulfate, total (mg/L)	AD-23	13.41	9.839	228	No	8	11.63	1.685	0	None	No	0.01	Param.
Sulfate, total (mg/L)	**AD-34**	**1175**	**853.3**	**228**	**Yes**	**8**	**1014**	**151.9**	**0**	**None**	**No**	**0.01**	**Param.**
Sulfate, total (mg/L)	AD-35	72.84	20.16	228	No	8	46.5	24.85	0	None	No	0.01	Param.
Total Dissolved Solids [TDS] (mg/L)	AD-23	84.72	52.03	448.6	No	8	68.38	15.42	0	None	No	0.01	Param.
Total Dissolved Solids [TDS] (mg/L)	**AD-34**	**1509**	**1390**	**448.6**	**Yes**	**8**	**1449**	**55.98**	**0**	**None**	**No**	**0.01**	**Param.**
Total Dissolved Solids [TDS] (mg/L)	AD-35	156	110.5	448.6	No	8	133.3	21.43	0	None	No	0.01	Param.

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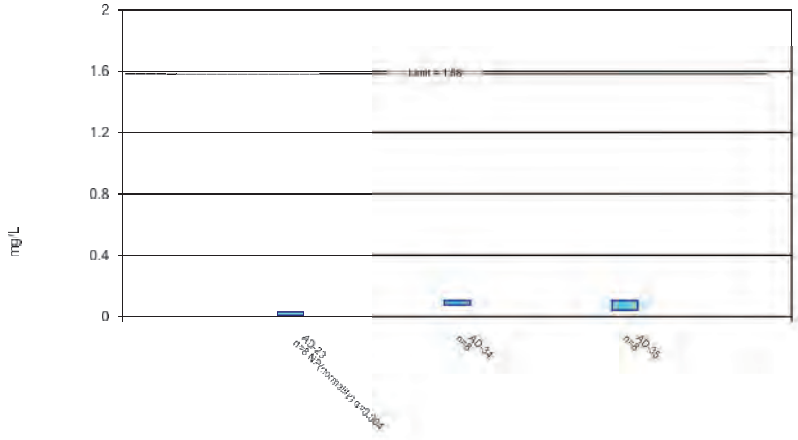
Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Boron, total   Analysis Run 12/13/2017 6:10 AM   View: Confidence Intervals - App III
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

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Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

Constituent: Calcium, total   Analysis Run 12/13/2017 6:10 AM   View: Confidence Intervals - App III
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

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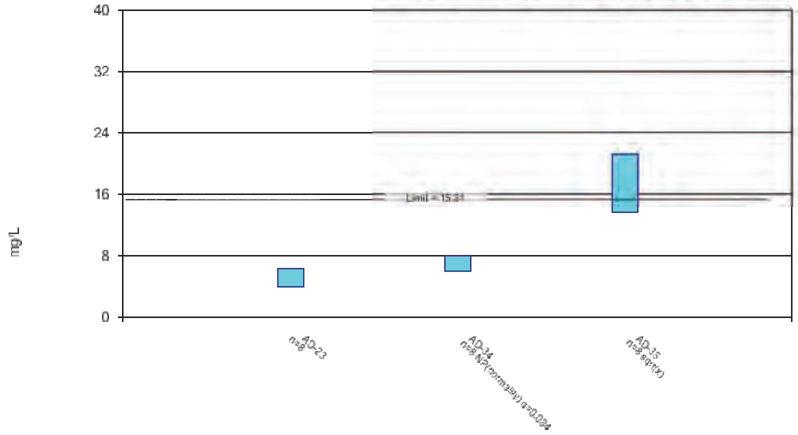
Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

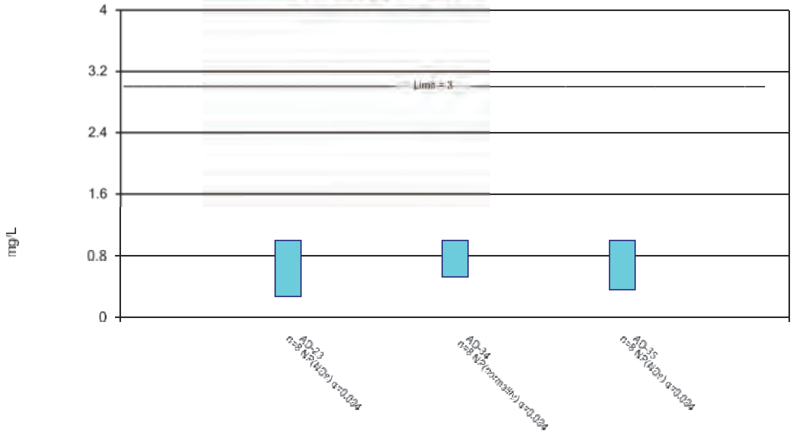


Constituent: Chloride, total   Analysis Run 12/13/2017 6:10 AM   View: Confidence Intervals - App III
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



Constituent: Fluoride, total   Analysis Run 12/13/2017 6:10 AM   View: Confidence Intervals - App III
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

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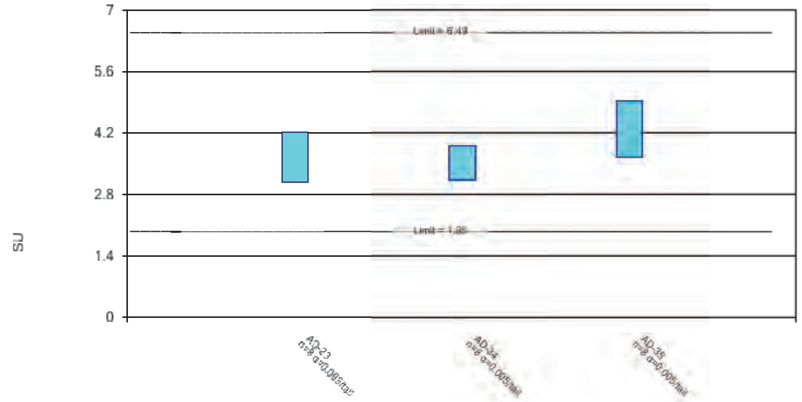
Parametric Confidence Interval

Compliance Limit is not exceeded. Normality Test: Shapiro Wilk, alpha based on n.

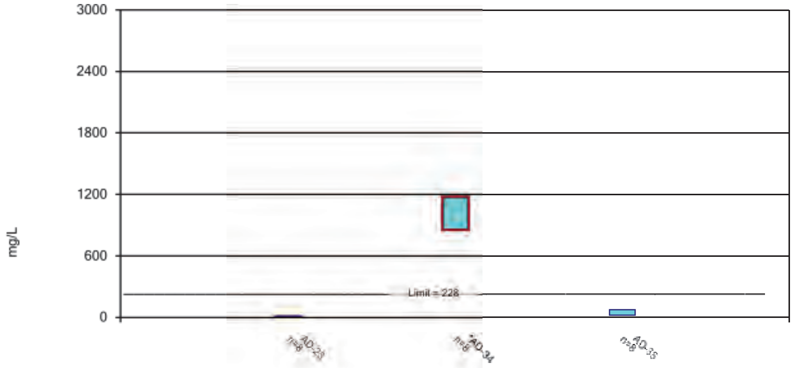


Constituent: pH, field Analysis Run 12/13/2017 6:10 AM View: Confidence Intervals - App III
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

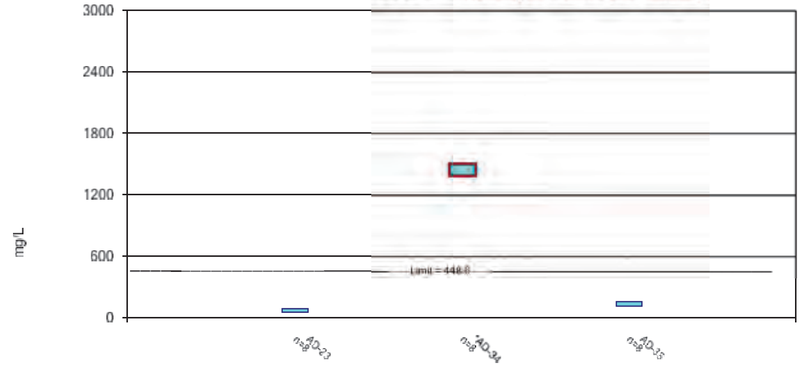


Constituent: Sulfate, total Analysis Run 12/13/2017 6:10 AM View: Confidence Intervals - App III
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



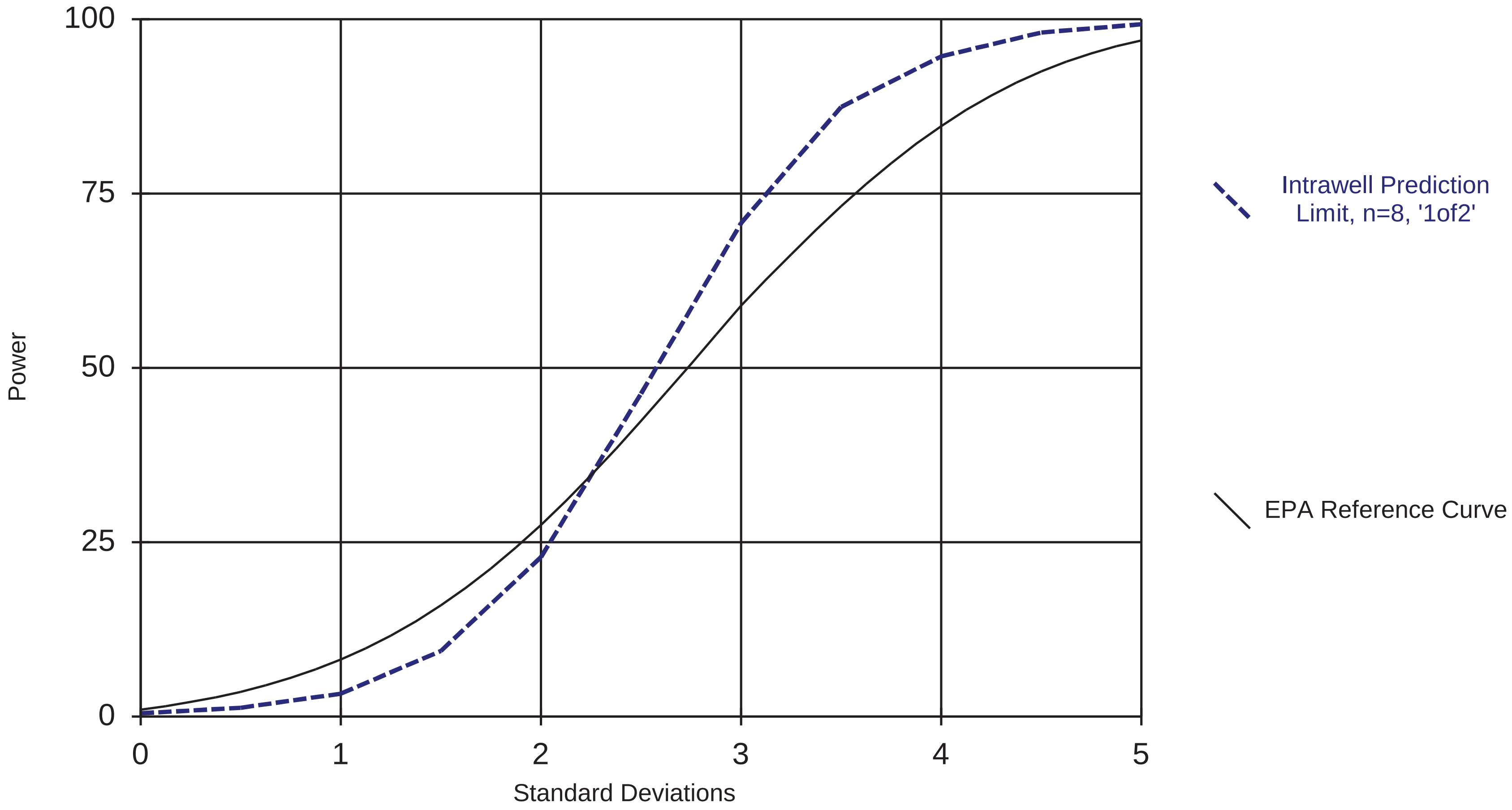
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/13/2017 6:10 AM View: Confidence Intervals -
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Intrawell Prediction Limit Summary Table

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 12/13/2017, 6:47 AM

Constituent	Well	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-16	0.03	n/a	8	n/a	n/a	0	n/a	n/a	0.02144	NP (normality) 1 of 2
Boron, total (mg/L)	AD-27	0.03	n/a	8	n/a	n/a	0	n/a	n/a	0.02144	NP (normality) 1 of 2
Boron, total (mg/L)	AD-8	1.58	n/a	8	n/a	n/a	0	n/a	n/a	0.02144	NP (normality) 1 of 2
Boron, total (mg/L)	AD-23	0.03	n/a	8	n/a	n/a	0	n/a	n/a	0.02144	NP (normality) 1 of 2
Boron, total (mg/L)	AD-34	0.1201	n/a	8	0.08888	0.01271	0	None	No	0.002505	Param 1 of 2
Boron, total (mg/L)	AD-35	0.1433	n/a	8	0.07275	0.02871	0	None	No	0.002505	Param 1 of 2
Boron, total (mg/L)	AD-12	0.05454	n/a	8	0.03625	0.00744	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-16	2.318	n/a	8	1.504	0.3311	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-27	4.848	n/a	8	4.21	0.2595	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-8	109	n/a	8	n/a	n/a	0	n/a	n/a	0.02144	NP (normality) 1 of 2
Calcium, total (mg/L)	AD-23	0.6535	n/a	8	0.3451	0.1255	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-34	42.53	n/a	8	37.21	2.163	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-35	27.73	n/a	8	9.288	7.502	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-12	0.4631	n/a	8	0.3269	0.05542	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-16	11.43	n/a	8	9.25	0.8864	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-27	9	n/a	8	n/a	n/a	0	n/a	n/a	0.02144	NP (normality) 1 of 2
Chloride, total (mg/L)	AD-8	15.69	n/a	8	11.88	1.553	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-23	7.893	n/a	8	5.125	1.126	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-34	9.204	n/a	8	7.375	0.744	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-35	26.47	n/a	8	17.38	3.701	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	AD-12	8.794	n/a	8	6.25	1.035	0	None	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	AD-16	1	n/a	8	n/a	n/a	100	n/a	n/a	0.02144	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-27	1	n/a	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-8	3.988	n/a	8	2.25	0.7071	12.5	None	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	AD-23	1	n/a	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-34	1	n/a	8	n/a	n/a	62.5	n/a	n/a	0.02144	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-35	1	n/a	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP (NDs) 1 of 2
Fluoride, total (mg/L)	AD-12	1	n/a	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP (NDs) 1 of 2

Power Curve



Kappa = 2.458, based on 3 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

Analysis Run 10/26/2017 9:43 AM View: Time Series

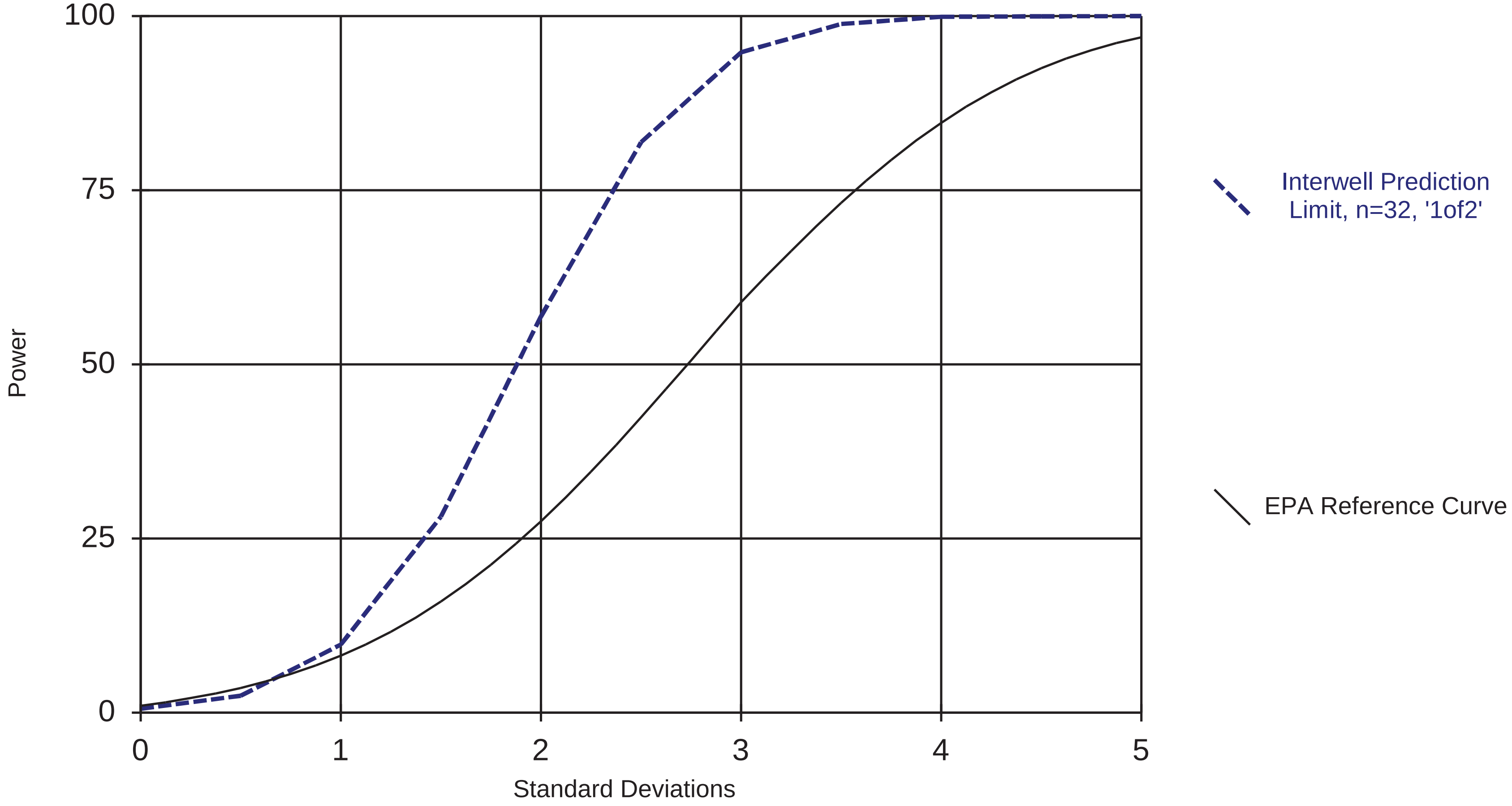
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Interwell Prediction Limit Summary Table

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 11/4/2017, 3:40 PM

Constituent	Well	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH, field (SU)	n/a	5.375	2.483	32	1.947	0.2081	0	None	sqrt(x)	0.001253	Param 1 of 2
Sulfate, total (mg/L)	n/a	207	n/a	32	7.07	4.101	0	None	sqrt(x)	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	n/a	335	n/a	32	173.4	90.57	0	None	No	0.002505	Param 1 of 2

Power Curve



Kappa = 1.784, based on 3 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

Analysis Run 10/26/2017 9:44 AM View: Time Series

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

4.8 – Annual Groundwater Monitoring Report, H.W. Pirkey Power Plant, Landfill CCR Management Unit, Hallsville, Texas, January 2018

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
Landfill CCR Management Unit
Hallsville, Texas

January 2018

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

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Table of Contents

Appendix I

I. <u>Overview</u>

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2018.

In general, the following activities were completed:

- Monitoring wells were installed and developed to establish a certified groundwater monitoring system around each CCR unit, in accordance with the requirements of 40 CFR 257.91 pursuant AEP's *Groundwater Monitoring Network Design Report (3/9/2017)*;
- Groundwater samples were collected and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 *et seq*. and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Background groundwater quality data was collected for each Appendix III and Appendix IV constituent;
- Detection Monitoring sampling was initiated;
- A statistical process in accordance with 40 CFR 257.93 to evaluate groundwater data was prepared, certified, and posted to AEP's CCR website in April 2017. AEP's *Statistical Analysis Plan (*AEP 2017). The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009). Data evaluation is underway.

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;

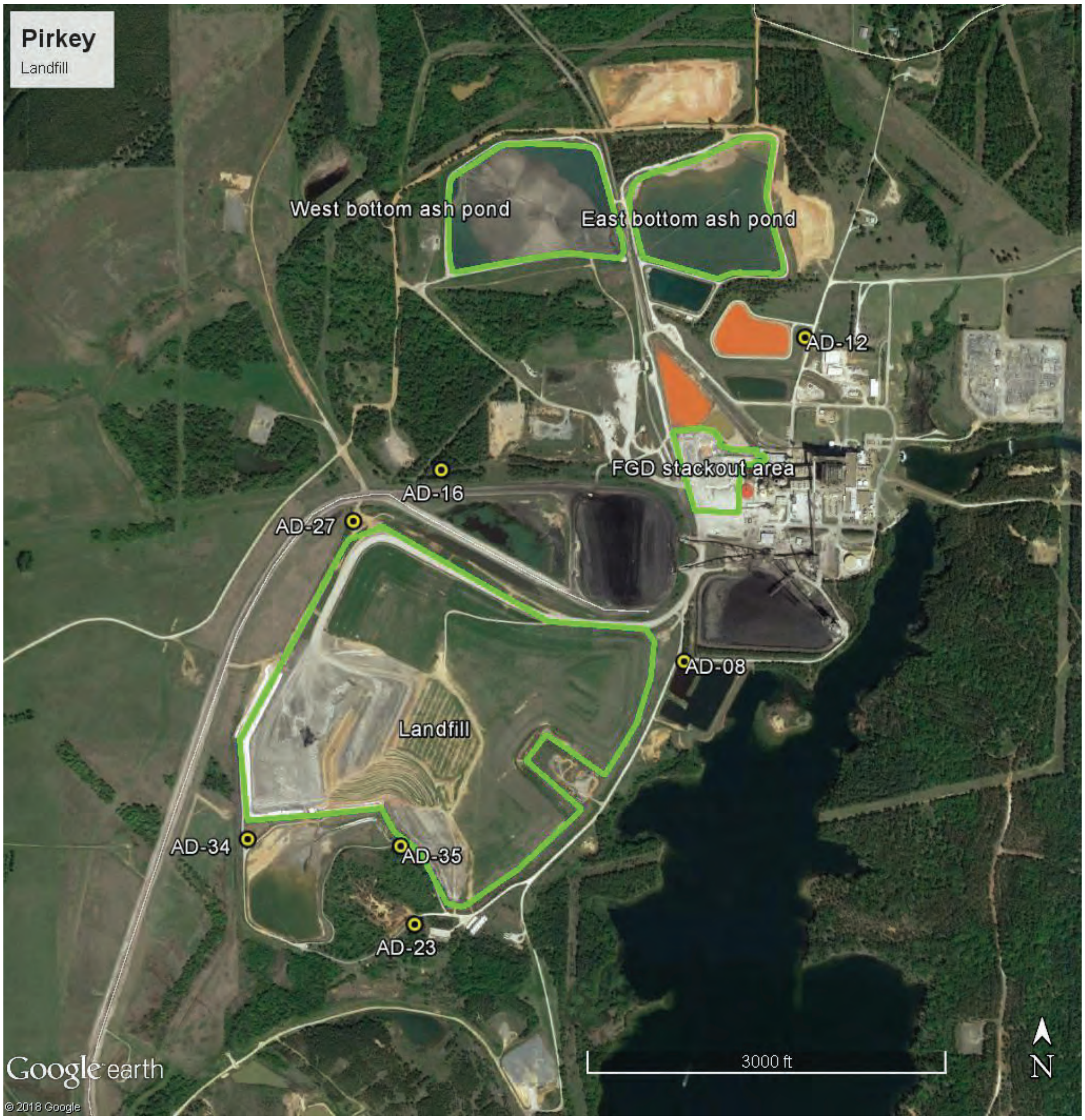
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations;
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

Landfill Monitoring Wells	
Up Gradient	Down Gradient
AD-8	AD-23
AD-12	AD-34
AD-16	AD-35
AD-27	



III. Monitoring Wells Installed or Decommissioned

There were no monitoring wells installed or decommissioned in 2017. The network design, as summarized in the *Groundwater Monitoring Network Design Report* (3/9/2017) and as posted at the CCR web site for Pirkey Power Plant, did not change. That design report, viewable on the AEP CCR web site, discusses the facility location, the hydrogeological setting, the hydrostratigraphic units, the uppermost aquifer, downgradient monitoring well locations and the upgradient monitoring well locations.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality data collected during the establishment of background quality. Static water elevation data from each monitoring event also are shown in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

V. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

As of this first annual groundwater report date there has been no transition between detection monitoring and assessment monitoring. Detection monitoring will continue in 2018. The sampling frequency of twice per year will be maintained for the Appendix III parameters (boron, calcium, chloride, fluoride, pH, sulfate and total dissolved solids).

Regarding defining an alternate monitoring frequency, the groundwater velocity and monitoring well production is high enough at this facility that no modification of the twice-per-year detection monitoring effort is needed.

VI. Other Information Required

At the appropriate time the geochemical analyses, coupled with the statistical analyses of the groundwater quality data, will determine whether an alternate source or alternate sources are affecting groundwater chemistry. In those cases where an alternate source demonstration is made, those analyses and supporting information will be presented as well.

VII. Description of Any Problems Encountered in 2017 and Actions Taken

No significant problems were encountered. The low flow sampling effort went smoothly and the schedule was met to support this first annual groundwater report preparation.

VIII. A Projection of Key Activities for the Upcoming Year

Key activities for 2018 include:

- Detection monitoring on a twice per year schedule;
- Evaluation of the first detection monitoring results from a statistical analysis viewpoint, looking for any statistically significant increases, or decreases when pH is considered;
- Responding to any new data received in light of what the CCR rule requires;
- Preparation of the second annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-8								
		5/10/2016	**7/13/2016**	**9/8/2016**	**10/12/2016**	**11/15/2016**	**1/11/2017**	**2/28/2017**	**4/11/2017**	**8/23/2017**
		Background								**Detection**
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	<0.00105 U	0.00117 J	<0.00105 U	0.00147 J	<0.00105 U	0.00153 J	0.00169 J	<0.00105 U	-
Barium	mg/L	0.0380	0.0610	0.0480	0.0610	0.0520	0.0600	0.0520	0.0510	-
Beryllium	mg/L	0.00100	0.00700	0.00200	0.00600	0.00600	0.00600	0.00600	0.00600	-
Boron	mg/L	1.58	0.775	1.04	0.793	0.769	0.734	0.777	0.779	0.411
Cadmium	mg/L	<0.00007 U	0.000176 J	<0.00007 U	<0.00007 U	0.000119 J	0.000109 J	0.000139 J	0.000128 J	-
Calcium	mg/L	109	20.7	50.7	20.8	17.2	18.6	18.1	17.1	19.4
Chloride	mg/L	9.00	13.0	12.0	13.0	13.0	13.0	10.0	12.0	9.00
Chromium	mg/L	0.00100	0.00100	0.000836 J	0.000742 J	0.000805 J	0.00200	0.000633 J	0.000888 J	-
Cobalt	mg/L	0.00180 J	0.0200	0.00900	0.0180	0.0180	0.0180	0.0180	0.0190	-
Combined Radium	pCi/L	0.916	6.75	1.66	6.72	6.14	6.29	7.64	5.56	-
Fluoride	mg/L	<0.083 U	2.00	2.00	2.00	3.00	3.00	2.00	3.00	0.587 J
Lead	mg/L	0.00103 J	0.00147 J	<0.00068 U	0.00231 J	0.00286 J	0.00300 J	0.00327 J	0.00244 J	-
Lithium	mg/L	<0.00013 U	0.0320	0.0180	0.0320	0.0300	0.0320	0.0310	0.0310	-
Mercury	mg/L	0.0000270	0.000211	0.0000480	0.000112	0.000160	0.000157	0.000153	0.0000107 J	-
Molybdenum	mg/L	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.0150	<0.00099 U	0.00385 J	0.00251 J	<0.00099 U	0.00141 J	0.00179 J	<0.00099 U	-
Total Dissolved Solids	mg/L	432	280	285	276	296	280	250	284	110
Sulfate	mg/L	181	131	121	184	208	228	157	168	56.0
Thallium	mg/L	0.00120 J	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	6.14	6.18	5.14	3.73	3.67	3.57	3.68	3.87	-

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-12								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.0260	0.0230	0.0300	0.0270	0.0280	0.0230	0.0260	0.0240	-
Beryllium	mg/L	0.000220 J	0.000190 J	0.000232 J	0.000150 J	0.000152 J	0.000127 J	0.000149 J	0.000159 J	-
Boron	mg/L	0.0300	0.0300	0.0400	0.0300	0.0400	0.0300	0.0400	0.0500	0.0495
Cadmium	mg/L	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	0.362	0.260	0.343	0.271	0.331	0.315	0.434	0.299	0.245
Chloride	mg/L	5.00	6.00	6.00	7.00	8.00	7.00	5.00	6.00	6.00
Chromium	mg/L	0.000711 J	0.000688 J	0.000354 J	0.000529 J	0.000328 J	0.000650 J	0.000326 J	0.000416 J	-
Cobalt	mg/L	0.00158 J	0.00129 J	0.00167 J	0.00157 J	0.00147 J	0.00109 J	0.00130 J	0.00133 J	-
Combined Radium	pCi/L	0.207	2.91	0.881	0.257	0.767	1.54	0.416	0.390	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	1.00	<0.083 U	<0.083 U	<0.083 U	0.257 J	0.213 J
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	<0.00013 U	0.00800	0.0100	0.0120	0.0130	0.0100	0.00900	0.00800	-
Mercury	mg/L	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	0.0000136 J	-
Molybdenum	mg/L	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00174 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	94.0	75.0	63.0	92.0	80.0	76.0	50.0	72.0	52.0
Sulfate	mg/L	4.00	4.00	7.00	8.00	6.00	6.00	4.00	7.00	6.00
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	0.000995 J	<0.00086 U	-
pH	SU	4.44	3.11	3.89	3.37	2.58	4.76	3.63	4.74	4.84

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).

J: Estimated value. Parameter was detected in concentrations below the reporting limit

-: Not sampled

For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-16								
		5/10/2016	7/14/2016	9/8/2016	10/13/2016	11/14/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	0.00800	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.00183 J	<0.00105 U	<0.00105 U	0.00152 J	<0.00105 U	<0.00105 U	0.00151 J	<0.00105 U	-
Barium	mg/L	0.0610	0.0640	0.0700	0.0560	0.0550	0.0580	0.0760	0.0770	-
Beryllium	mg/L	0.000454 J	0.000566 J	0.000811 J	0.000251 J	0.000385 J	0.000709 J	0.000488 J	0.000436 J	-
Boron	mg/L	0.0200	0.0300	0.0300	0.0300	0.0300	0.0200	0.0300	0.0200	0.0365
Cadmium	mg/L	0.0000818 J	<0.00007 U	0.0000926 J	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	1.21	2.00	1.83	1.15	1.58	1.76	1.29	1.21	0.945
Chloride	mg/L	8.00	9.00	9.00	9.00	9.00	10.0	9.00	11.0	12.0
Chromium	mg/L	0.00100	0.00100	0.00200	0.00100	0.000561 J	0.000406 J	0.000559 J	0.000822 J	-
Cobalt	mg/L	0.00424 J	0.00600	0.00800	0.00334 J	0.00434 J	0.00800	0.00500	0.00500	-
Combined Radium	pCi/L	1.29	1.44	1.93	1.84	2.12	2.63	1.42	0.932	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.00600	0.0360	0.0320	0.0330	0.0280	0.0310	0.0210	0.0190	-
Mercury	mg/L	0.0000151 J	0.0000240 J	0.00000753 J	<0.000005 U	<0.000005 U	0.0000105 J	<0.000005 U	0.00000733 J	-
Molybdenum	mg/L	<0.00029 U	0.00112 J	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00226 J	<0.00099 U	<0.00099 U	0.00170 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	116	148	133	124	124	112	108	106	96.0
Sulfate	mg/L	16.0	45.0	33.0	16.0	23.0	43.0	22.0	24.0	14.0
Thallium	mg/L	0.00137 J	<0.00086 U	0.00175 J	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	3.89	3.81	3.90	3.86	4.35	3.69	3.15	3.38	4.29

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-23								
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.00289 J	0.00380 J	<0.00093 U	0.00130 J	<0.00093 U	<0.00093 U	0.00166 J	<0.00093 U	-
Arsenic	mg/L	0.00165 J	<0.00105 U	<0.00105 U	0.00700	<0.00105 U	0.00204 J	<0.00105 U	0.00397 J	-
Barium	mg/L	0.0480	0.0480	0.0530	0.120	0.0500	0.0730	0.0410	0.0860	-
Beryllium	mg/L	0.000187 J	0.000192 J	0.000204 J	0.000464 J	0.000129 J	0.000159 J	0.000117 J	0.000319 J	-
Boron	mg/L	0.0100	0.0300	0.0200	0.0300	0.0300	0.0200	0.0300	0.0300	0.0402
Cadmium	mg/L	0.0000740 J	0.0000925 J	<0.00007 U	0.000136 J	<0.00007 U	<0.00007 U	<0.00007 U	0.000108 J	-
Calcium	mg/L	0.535	0.317	0.260	0.321	0.249	0.319	0.217	0.543	0.276
Chloride	mg/L	4.00	4.00	5.00	6.00	5.00	6.00	4.00	7.00	6.00
Chromium	mg/L	0.00200	0.00200	0.00500	0.0410	0.00600	0.0150	0.000296 J	0.0220	-
Cobalt	mg/L	0.00230 J	0.00273 J	0.00201 J	0.00391 J	0.00167 J	0.00226 J	0.00105 J	0.00261 J	-
Combined Radium	pCi/L	6.86	5.69	6.68	12.9	7.54	8.06	5.74	10.3	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	0.269 J	0.198 J
Lead	mg/L	<0.00068 U	<0.00068 U	0.00224 J	0.0310	0.00321 J	0.0110	<0.00068 U	0.0150	-
Lithium	mg/L	0.000136 J	0.00600	0.00600	1.01	0.00600	0.00900	0.00500	0.0100	-
Mercury	mg/L	0.0000119 J	0.0000172 J	<0.000005 U	0.0000950	0.0000244 J	0.0000920	<0.000005 U	0.000118	-
Molybdenum	mg/L	<0.00029 U	0.00135 J	<0.00029 U	0.000564 J	0.000404 J	<0.00029 U	<0.00029 U	0.000315 J	-
Selenium	mg/L	0.00192 J	0.00200 J	<0.00099 U	0.00211 J	0.00135 J	<0.00099 U	0.00131 J	<0.00099 U	-
Total Dissolved Solids	mg/L	72.0	59.0	64.0	68.0	100	60.0	48.0	76.0	64.0
Sulfate	mg/L	10.0	11.0	12.0	13.0	14.0	13.0	9.00	11.0	11.0
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	3.99	2.72	3.46	3.68	3.46	3.66	4.04	4.17	4.11

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-27								
		5/11/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.00121 J	0.000956 J	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.00215 J	0.00128 J	<0.00105 U	0.00214 J	<0.00105 U	0.00157 J	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.0430	0.0450	0.0470	0.0460	0.0410	0.0460	0.0430	0.0450	-
Beryllium	mg/L	0.00500	0.00500	0.00600	0.00500	0.00500	0.00500	0.00500	0.00500	-
Boron	mg/L	0.0200	0.0300	0.0300	0.0300	0.0300	0.0200	0.0300	0.0300	0.0358
Cadmium	mg/L	0.000431 J	0.000435 J	0.000398 J	0.000425 J	0.000419 J	0.000302 J	0.000287 J	0.000415 J	-
Calcium	mg/L	4.41	4.43	4.17	4.09	4.52	3.74	4.31	4.01	3.58
Chloride	mg/L	8.00	8.00	8.00	8.00	8.00	9.00	8.00	9.00	9.00
Chromium	mg/L	0.000871 J	0.00200	0.00200	0.00200	0.00200	0.00100	0.00200	0.000955 J	-
Cobalt	mg/L	0.0200	0.0210	0.0200	0.0200	0.0220	0.0180	0.0210	0.0210	-
Combined Radium	pCi/L	2.03	2.41	2.71	4.43	3.69	2.62	3.48	2.58	-
Fluoride	mg/L	0.618 J	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	0.197 J
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.0660	0.0970	0.0950	0.0960	0.0950	0.100	0.100	0.104	-
Mercury	mg/L	<0.000005 U	0.0000224 J	<0.000005 U	<0.000005 U	<0.000005 U	0.00000659 J	<0.000005 U	<0.000005 U	-
Molybdenum	mg/L	<0.00029 U	0.000435 J	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00111 J	<0.00099 U	<0.00099 U	0.00136 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	198	192	196	216	216	180	216	180	168
Sulfate	mg/L	51.0	54.0	52.0	58.0	92.0	58.0	56.0	54.0	52.0
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	3.88	2.70	2.89	3.02	3.46	4.07	2.81	3.30	3.71

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).

J: Estimated value. Parameter was detected in concentrations below the reporting limit

-: Not sampled

For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-34								
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/10/2017	8/23/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.0120	0.0250	0.00900	0.0100	0.00700	0.00600	0.00700	0.00450 J	-
Barium	mg/L	0.0720	0.177	0.0310	0.0390	0.0230	0.0290	0.0110	0.0230	-
Beryllium	mg/L	0.00300	0.00400	0.00300	0.00300	0.00200	0.00200	0.00200	0.00200	-
Boron	mg/L	0.0800	0.111	0.0900	0.0900	0.100	0.0700	0.0800	0.0900	0.107
Cadmium	mg/L	0.00600	0.00600	0.00800	0.00500	0.00800	0.00700	0.00600	0.0110	-
Calcium	mg/L	37.8	33.2	39.5	35.8	36.3	39.9	37.0	38.2	36.2
Chloride	mg/L	7.00	8.00	8.00	7.00	7.00	8.00	6.00	8.00	7.00
Chromium	mg/L	0.0340	0.0810	0.0120	0.0150	0.00600	0.00800	<0.00023 U	0.00700	-
Cobalt	mg/L	0.301	0.296	0.306	0.297	0.292	0.284	0.294	0.299	-
Combined Radium	pCi/L	9.64	7.75	7.91	10.1	13.2	11.9	9.87	2.41	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	0.627 J	0.998 J	<0.083 U	<0.083 U	0.524 J	0.619 J
Lead	mg/L	0.0120	0.0390	0.00102 J	0.00370 J	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.176	0.183	0.158	0.174	0.154	0.164	0.158	0.167	-
Mercury	mg/L	0.000105	0.000313	0.0000640	0.0000360	0.0000250	0.0000320	<0.000005 U	0.0000164 J	-
Molybdenum	mg/L	0.000688 J	0.00211 J	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	<0.00099 U	0.00700	<0.00099 U	<0.00099 U	0.00451 J	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	1520	1400	1520	1460	1430	1380	1400	1490	1130
Sulfate	mg/L	974	837	870	1080	1010	1330	993	1020	1230
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	3.99	3.56	3.34	3.57	3.71	3.23	3.72	3.00	3.72

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - Landfill

Parameter	Unit	AD-35								
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.0110	0.00900	0.00113 J	0.00407 J	0.0120	0.00215 J	0.00404 J	0.00140 J	-
Barium	mg/L	0.124	0.185	0.116	0.110	0.143	0.115	0.0940	0.0920	-
Beryllium	mg/L	0.000328 J	0.000394 J	0.000193 J	0.000141 J	0.000305 J	0.0000923 J	0.0000944 J	0.0000696 J	-
Boron	mg/L	0.109	0.0700	0.0400	0.0500	0.0600	0.0600	0.123	0.0700	0.0413
Cadmium	mg/L	0.000109 J	<0.00007 U	<0.00007 U	<0.00007 U	0.000241 J	0.0000922 J	<0.00007 U	0.000329 J	-
Calcium	mg/L	17.4	5.35	3.42	2.43	2.00	10.4	22.5	10.8	4.33
Chloride	mg/L	17.0	18.0	14.0	14.0	14.0	18.0	19.0	25.0	16.0
Chromium	mg/L	0.0210	0.0190	0.00500	0.00600	0.0300	0.00500	0.00300	0.00100	-
Cobalt	mg/L	0.0100	0.00600	0.00344 J	0.00299 J	0.00700	0.00406 J	0.00475 J	0.00600	-
Combined Radium	pCi/L	2.47	4.21	2.07	6.01	4.83	3.65	2.02	2.71	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	0.355 J	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U
Lead	mg/L	0.00700	0.00437 J	<0.00068 U	0.00153 J	0.00700	<0.00068 U	0.00124 J	<0.00068 U	-
Lithium	mg/L	<0.00013 U	0.0130	0.0110	0.0120	0.0190	0.0100	0.00800	0.00700	-
Mercury	mg/L	0.0000610	0.000110	<0.000005 U	0.0000102 J	0.0000730	0.0000191 J	0.0000231 J	<0.000005 U	-
Molybdenum	mg/L	0.000439 J	<0.00029 U	<0.00029 U	<0.00029 U	0.000583 J	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	162	114	104	116	142	128	140	160	92.0
Sulfate	mg/L	50.0	28.0	21.0	23.0	29.0	62.0	84.0	75.0	35.0
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	4.68	4.62	4.02	3.58	4.32	4.72	3.54	4.81	4.86

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

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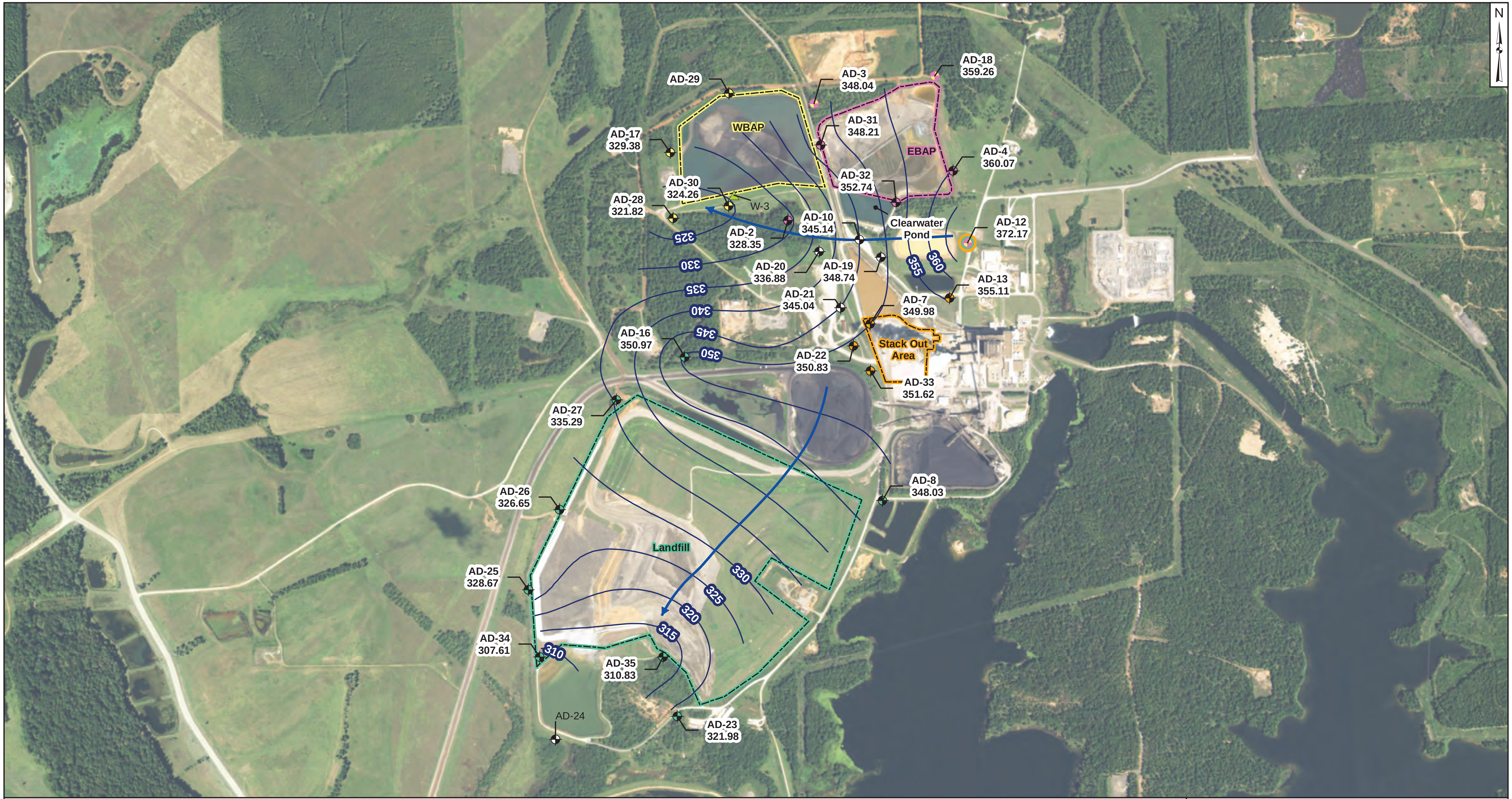
J: Estimated value. Parameter was detected in concentrations below the reporting limit

-: Not sampled

For statistical analysis, parameters which were not detected were replaced with the reporting limit.



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- ─ Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 11, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer
May 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Figure

1

Columbus, Ohio

2017/12/13

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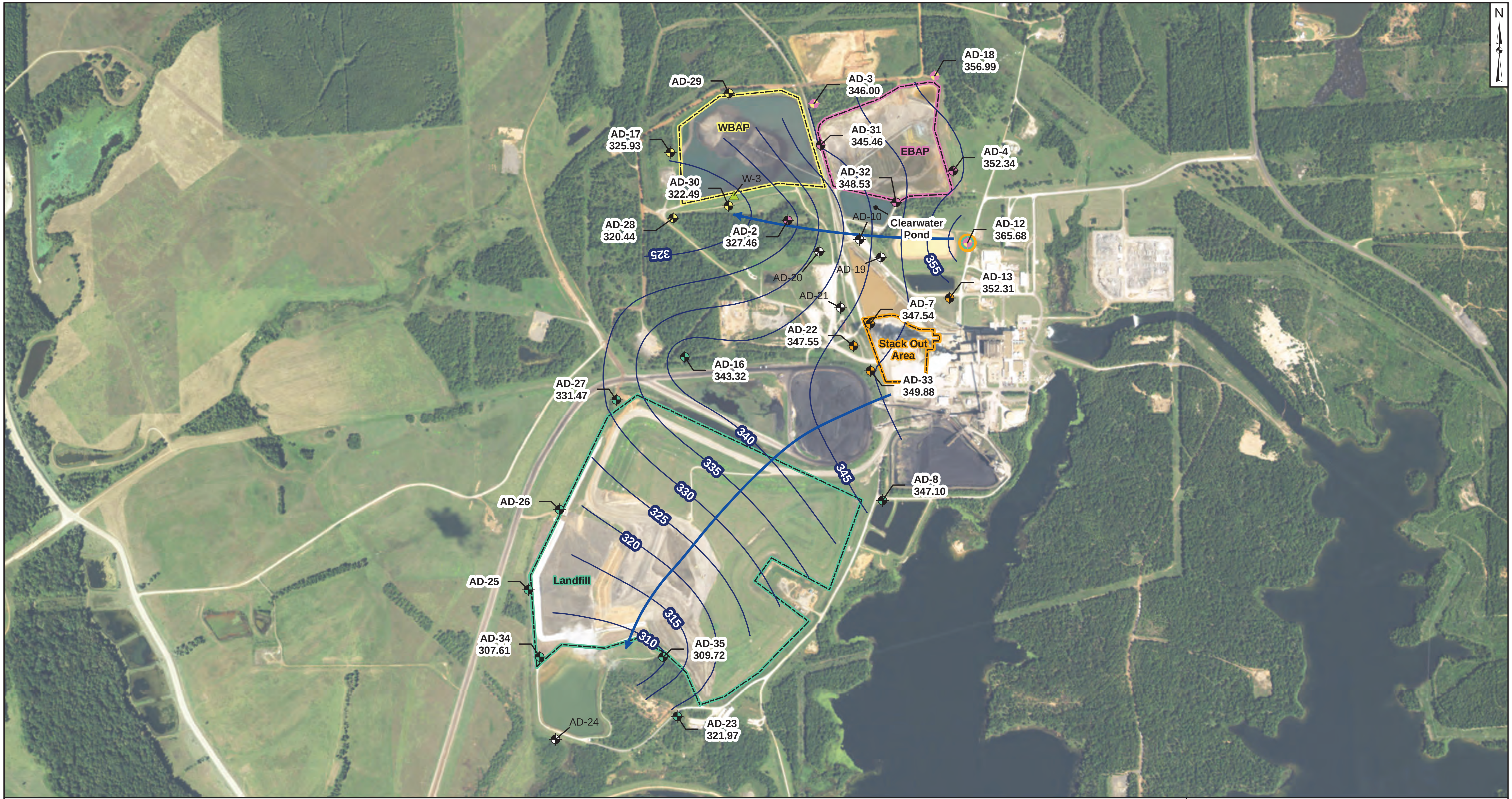

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on July 14, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
July 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2017/12/13

Figure
2

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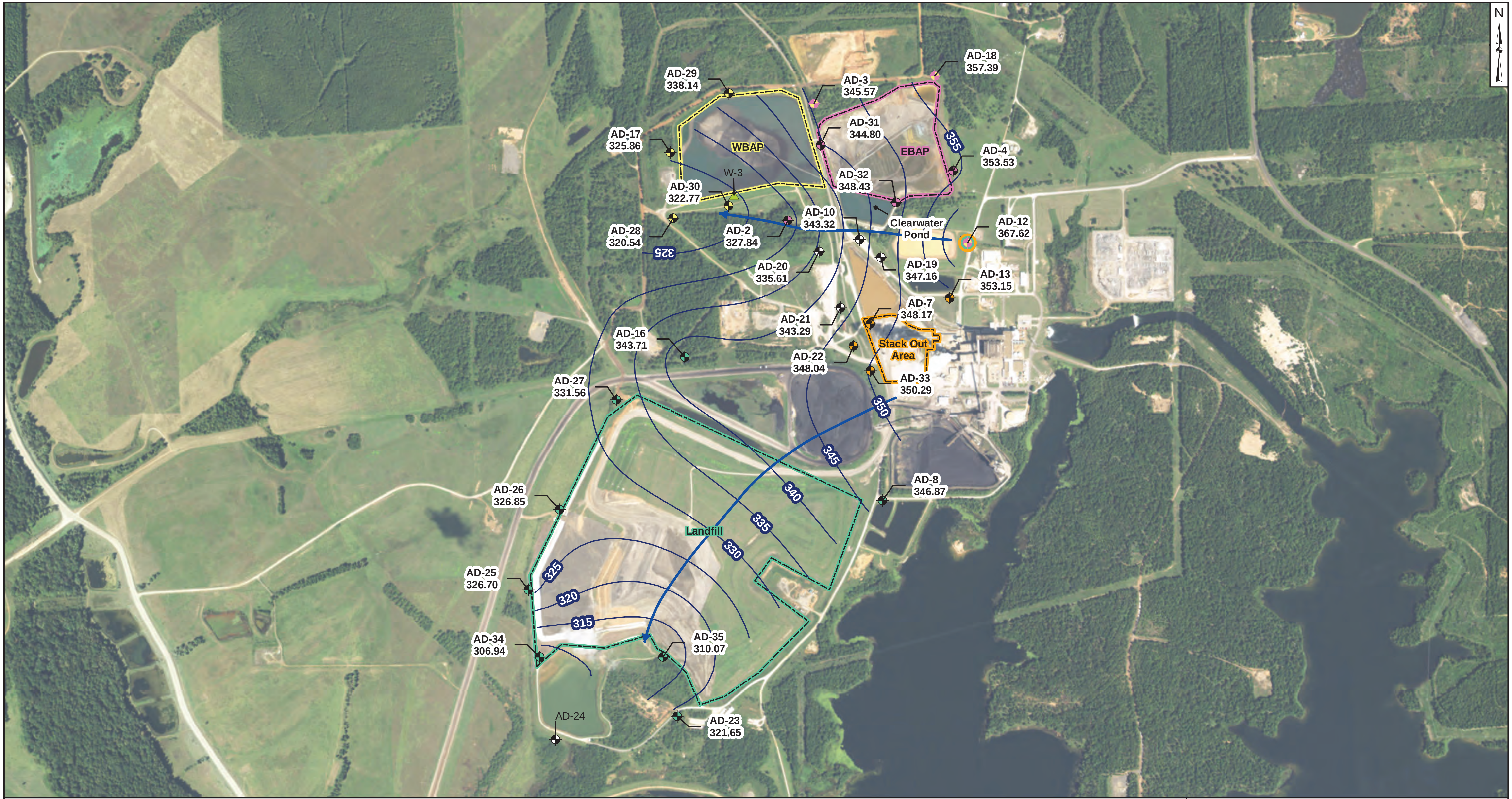

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on September 8, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer September 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio

2017/12/14

Figure

3

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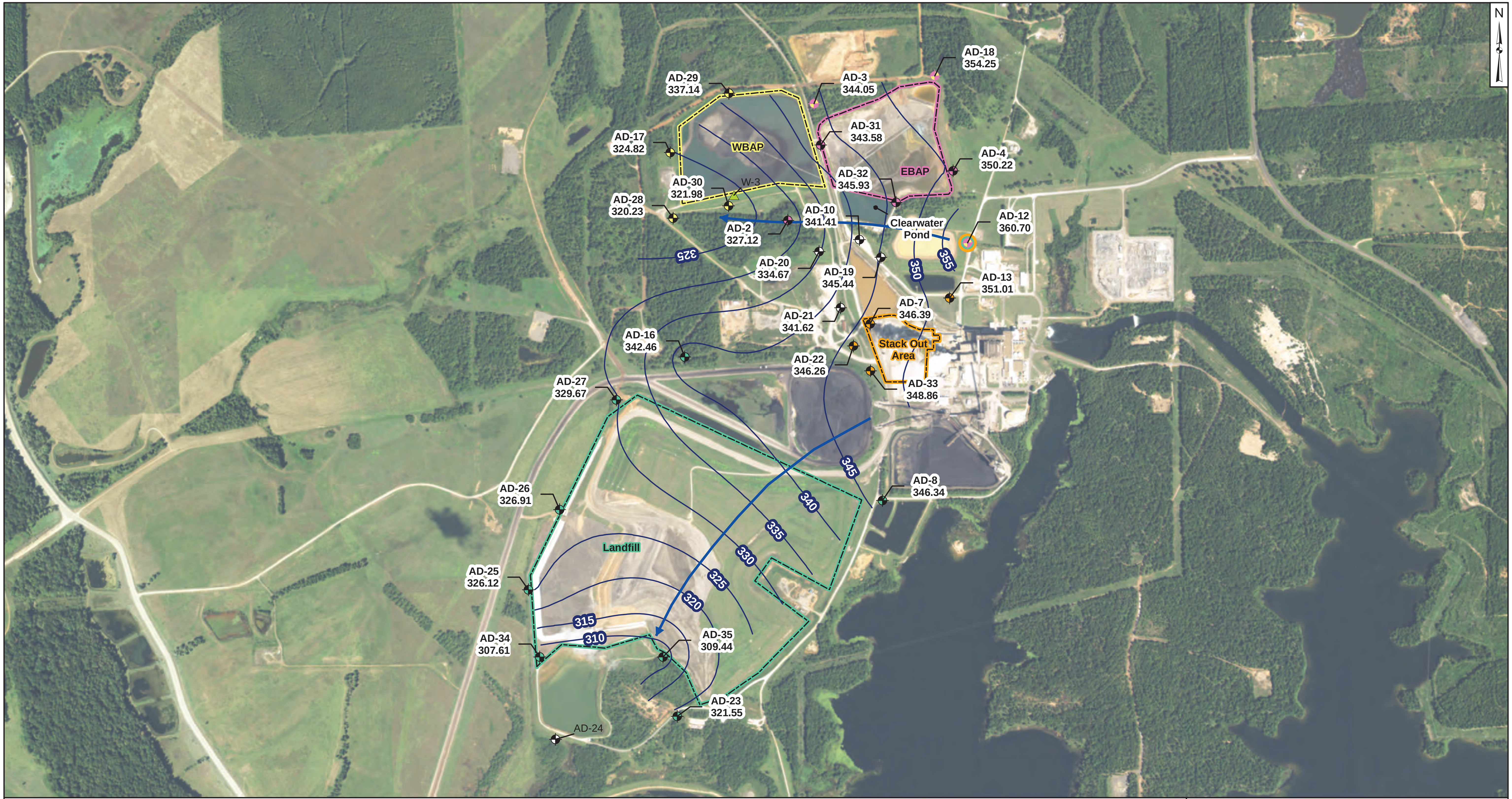

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stack Out Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on October 13, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer October 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
4

Columbus, Ohio

2017/12/13

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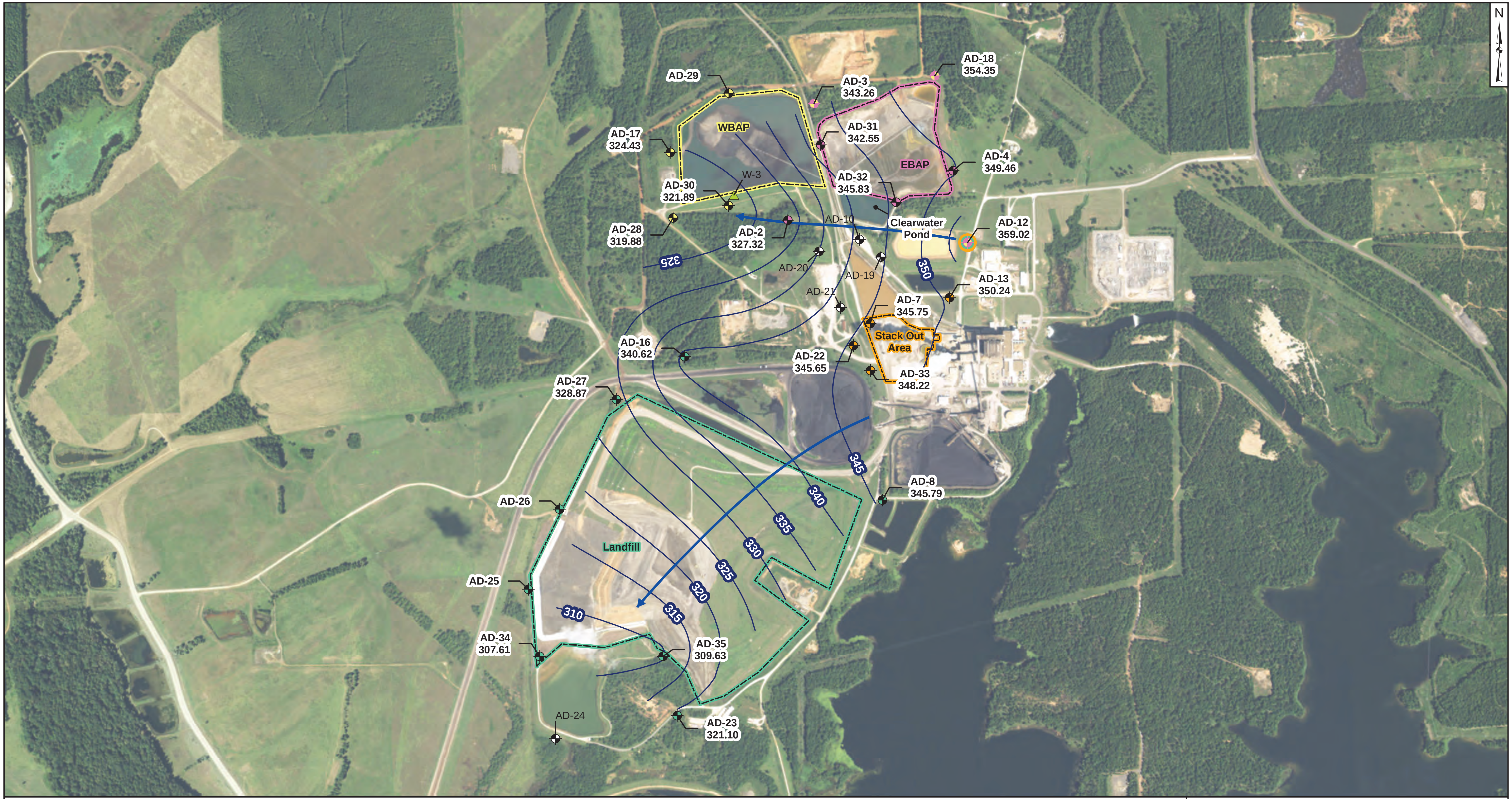

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected November 14 - 15, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer November 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
5

Columbus, Ohio
2017/12/13

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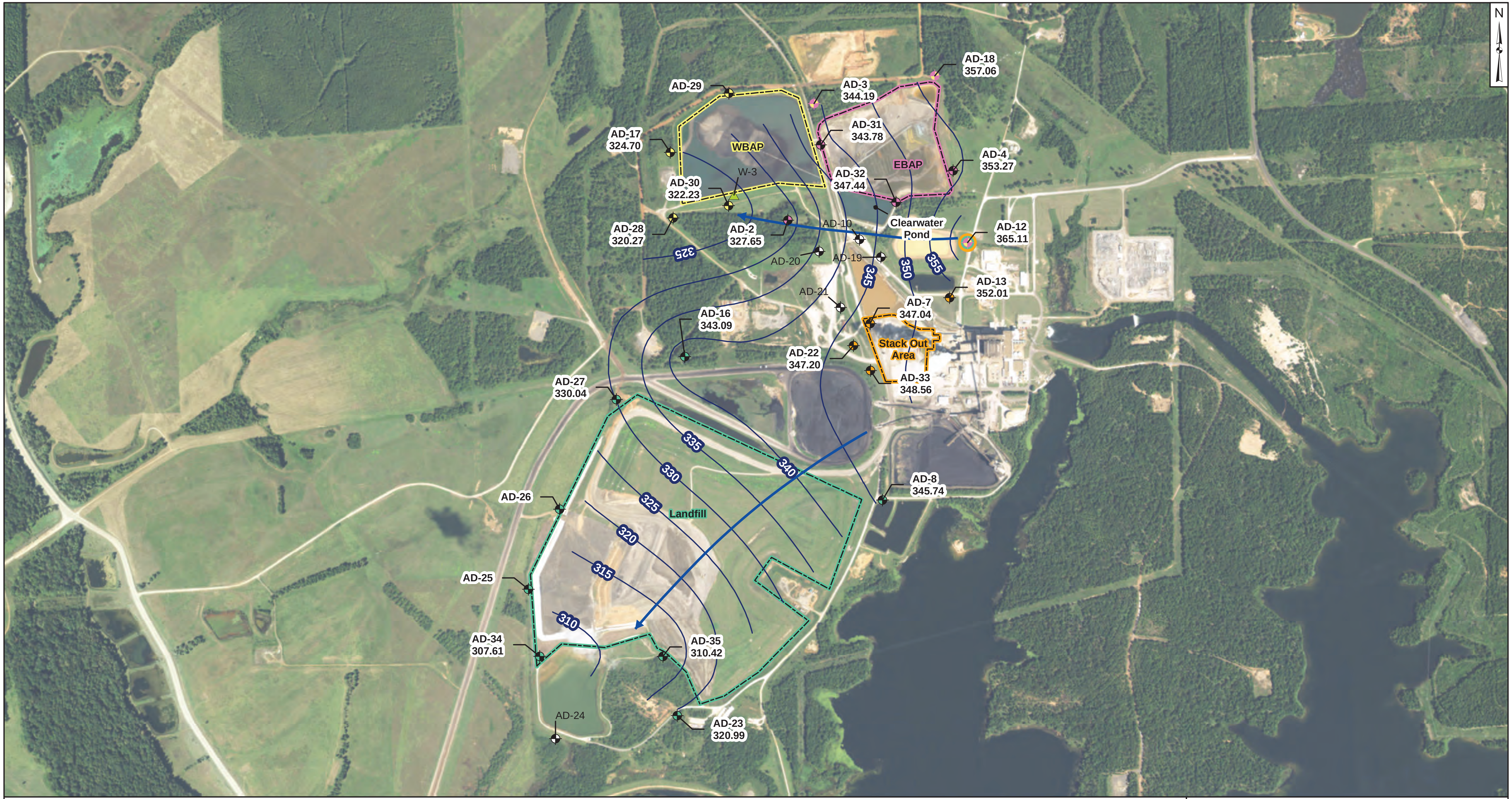

Legend

Groundwater Monitoring Wells
- Out of Network
- EBAP
- WBAP
- Landfill
- Stack Out Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes
- Monitoring well coordinates and water level data (collected on January 11 - 12, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer January 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2017/12/19

Figure

6

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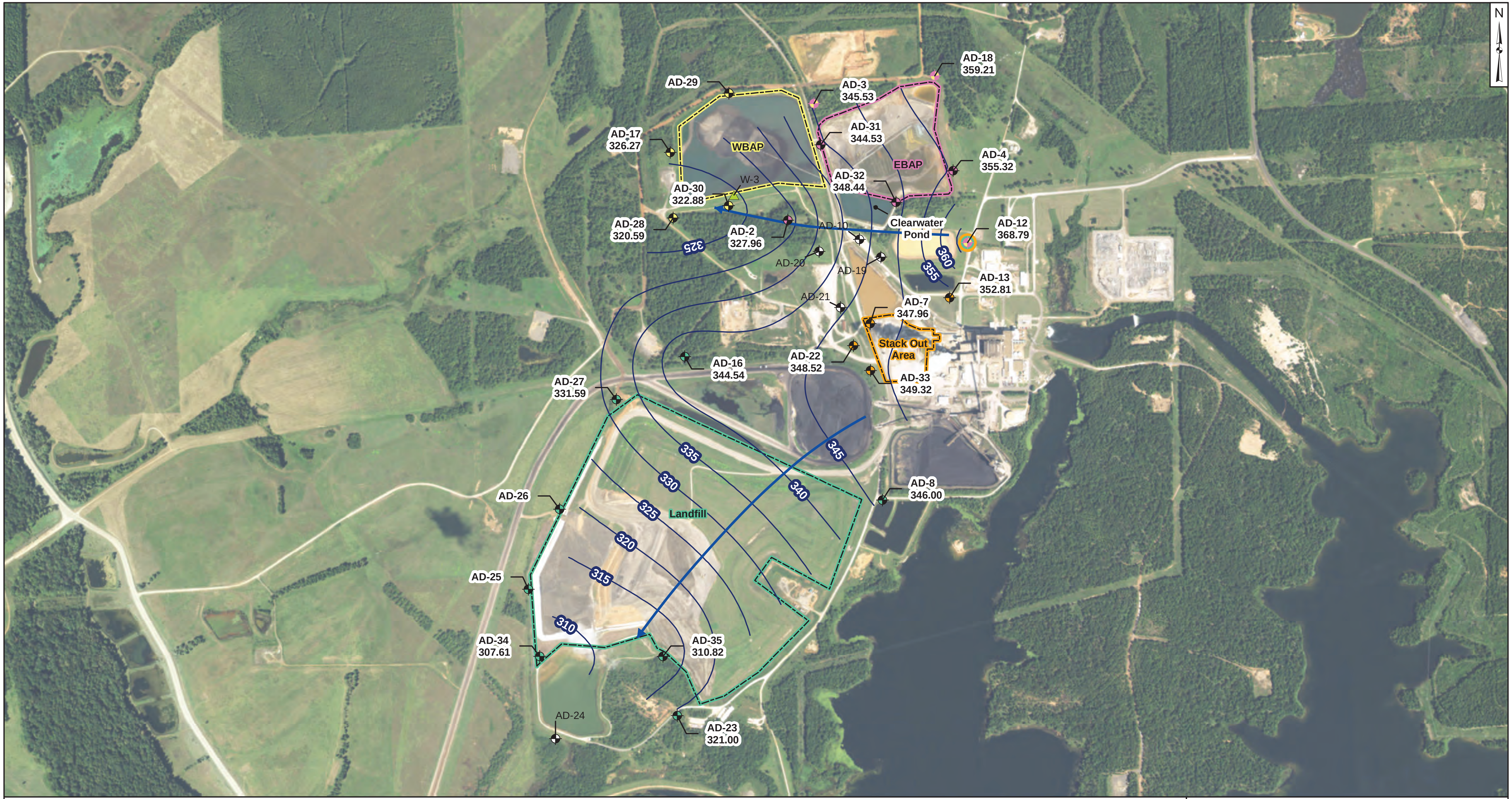

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP

- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on February 28 - March 1, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer February 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2017/12/14

Figure
7

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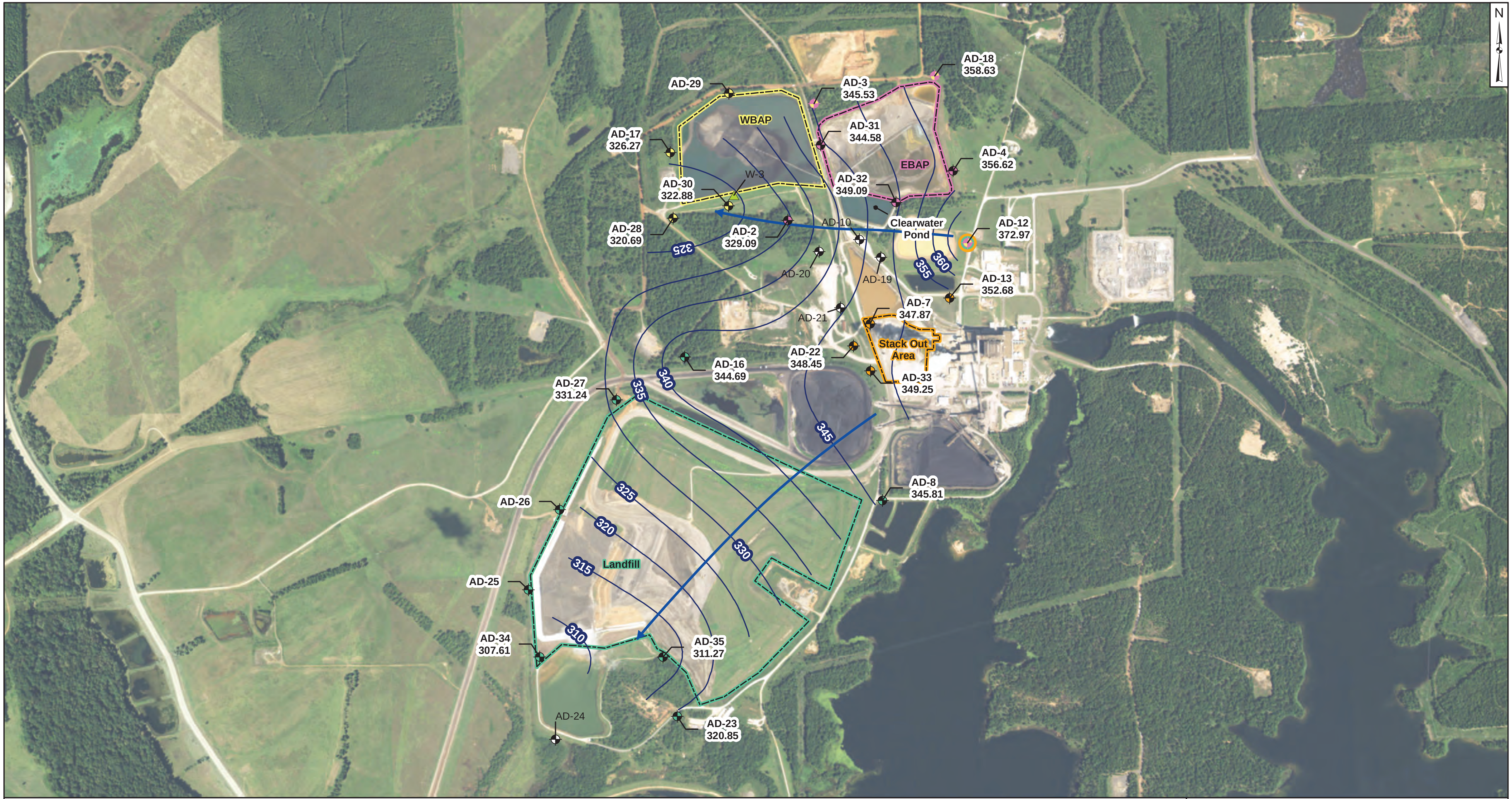

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ⊙ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on April 10 - 11, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
April 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
8

Columbus, Ohio
2017/12/14

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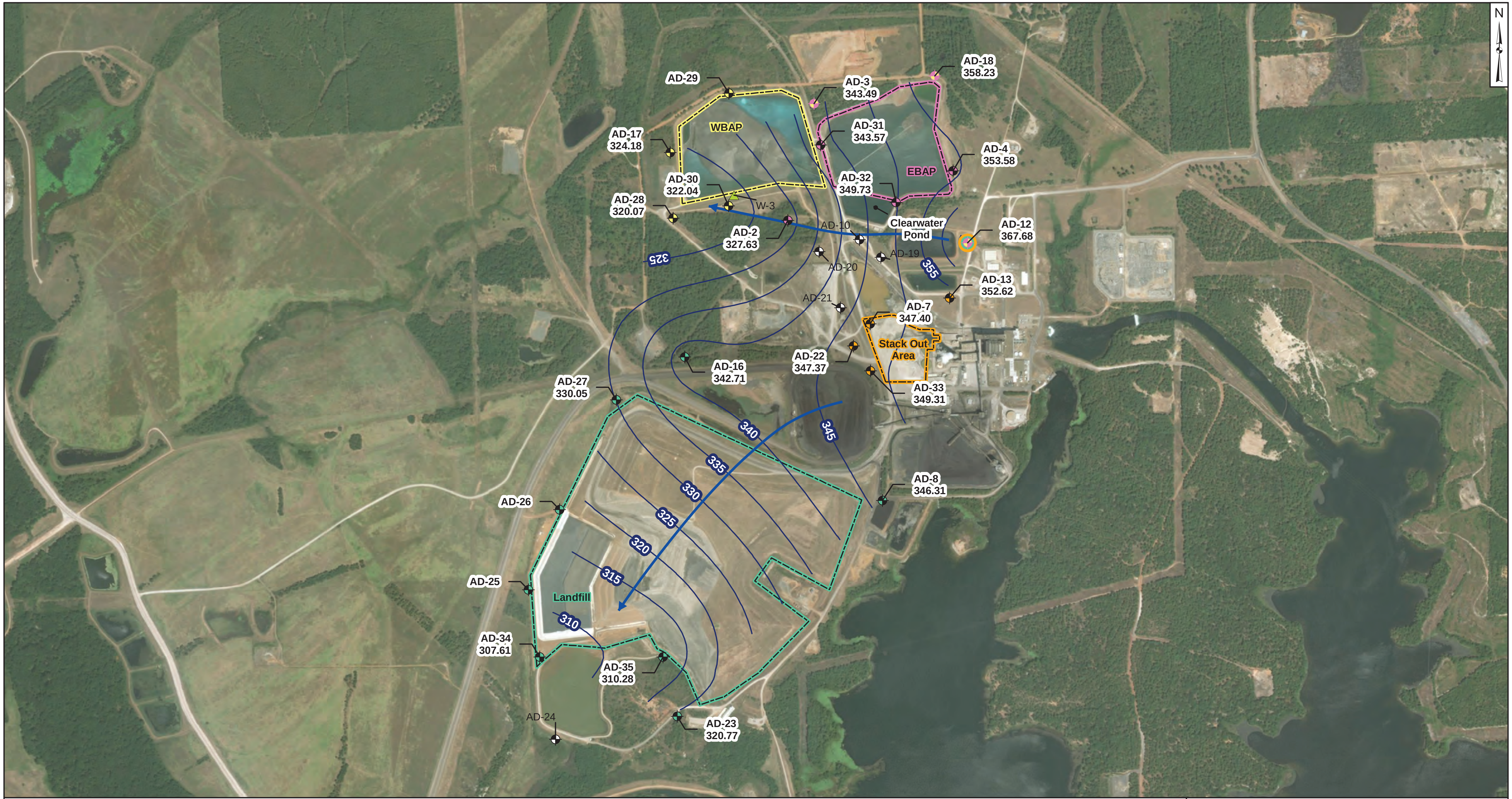

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
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- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on August 23 - 24, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
-East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
August 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2018/01/28

Figure

9

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USE data row --> **75** **8/24/2017**

Landfill

Distance between wells in feet

	AD8	AD12	AD16	AD23	AD27	AD34	AD35
AD8	-	2869	2582	3147	3008	3999	2872
AD12		-	3224	5870	4067	6305	5447
AD16			-	3795	853	3537	3196
AD23				-	3402	1621	734
AD27					-	2854	2780
AD34						-	1302
AD35							-

Landfill displaying data for date: **8/24/2017**

Hydraulic gradient in ft/ft

	AD8	AD12	AD16	AD23	AD27	AD34	AD35		
								max grad	
AD8	-	0.007449	0.001394	0.008116	0.005406	0.009677	0.012545	0.014842	
AD12		-	0.007745	0.007991	0.009253	0.009527	0.010538	hydraulic concuctivity	
AD16			-	0.005781	0.014842	0.009924	0.010147	0.0001	cm/sec
AD23				-	0.002728	0.008118	0.014292	porosity	
AD27					-	0.007863	0.007112	0.25	
AD34						-	0.002051	seepage rate, ft/yr	
AD35							-	6.14	

FGD stackout area

Distance between wells in feet

	AD7	AD12	AD13	AD22	AD33
AD7	-	1339	954	295	615
AD12		-	723	1627	1742
AD13			-	1191	1138
AD22				-	175
AD33					-

FGD stackout area displaying data for date: **8/24/2017**

Hydraulic gradient in ft/ft

	AD7	AD12	AD13	AD22	AD33		
						max grad	
AD7	-	0.015146	0.005472	0.000102	0.003106	0.02083	
AD12		-	0.02083	0.012483	0.010545	hydraulic concuctivity	
AD13			-	0.004408	0.002909	0.0001	cm/sec
AD22				-	0.011086	porosity	
AD33					-	0.25	

seepage rate, ft/yr

8.62

as of Mar 2011	Well ID	AD-02	AD-03	AD-04	AD-07	AD-08	AD-10	AD-12	AD-13	AD-16	AD-17	AD-18
	TOC, ft	344.04	375.30	366.79	362.79	359.84	362.21	381.99	364.76	360.05	346.09	363.42
	Measured depth to water											
	Date											
	4/13/2011	17.14	32.35	15.34	18.45	18.19	20.18	23.04	15.30	21.97	23.43	7.89
	12/15/2011	16.92	33.71	15.55	19.04	19.55	20.31	24.00	15.85	24.55	23.80	11.88
	6/20/2012	16.87	31.60	14.35	18.64	18.19	20.02	22.66	15.24	22.47	22.78	6.21
	1/23/2013	16.78	34.20	12.37	17.89	19.12	20.80	13.92	13.95	24.62	22.58	7.95
	7/7/2013	17.42	32.03	17.57	19.44	18.59	22.36	24.58	16.15	23.38	23.03	6.19
	1/22/2014	16.34	33.88	11.21	16.18	18.17	19.94	12.02	12.79	20.52	20.90	3.39
	7/9/2014	16.85	31.34	13.46	16.56	16.48	19.99	14.95	13.47	19.21	21.94	5.36
	1/28/2015	15.42	30.29	7.79	13.62	15.81	17.82	9.24	10.29	16.71	17.67	3.54
	1/20/2016	15.49	28.27	7.63	13.48	12.63		10.94	10.61	12.37		2.9
	3/7/2016	15.73	28.09	8.66	14.01	12.62	17.94	13.28	11.15	11.36	18.08	3.08
	5/11/2016	15.69	27.26	6.72	12.81	11.81	17.07	9.82	9.65	9.08	16.71	4.16
	7/14/2016	16.58	29.30	14.45	15.25	12.74		16.31	12.45	16.73	20.16	6.43
	9/8/2016	16.20	29.73	13.26	14.62	12.97	18.89	14.37	11.61	16.34	20.23	6.03
	10/13/2016	16.92	31.25	16.57	16.40	13.50	20.80	21.29	13.75	17.59	21.27	9.17
	11/15/2016	16.72	32.04	17.33	17.04	14.05		22.97	14.52	19.43	21.60	9.07
	1/12/2017	16.39	31.11	13.52	15.75	14.10		16.88	12.75	16.96	21.39	6.36
	3/1/2017	16.08	29.77	11.41	14.83	13.84		13.20	11.95	15.51	19.82	4.21
	4/11/2017	14.95	29.77	10.17	14.92	14.03		9.02	12.08	15.36	19.82	4.79
	8/24/2017	16.41	31.81	13.22	15.39	13.53		14.31	12.14	17.34	21.91	5.19

Well ID	AD-19	AD-20	AD-21	AD-22	AD-23	AD-24	AD-25	AD-26	AD-27	AD-28	AD-29	AD-30	AD-31	AD-32	AD-33	AD-34	AD-35
TOC, ft	362.82	355.79	350.72	358.51	350.10	291.14	337.09	345.25	352.62	339.40	353.37	342.02	360.75	359.18	362.37	307.61	318.95
						plugged 1-26-16											
Measured depth to water																	
Date																	
4/13/2011	18.75	21.29	10.29	14.87	30.45	8.22	12.58	20.72	26.80	19.73	18.69						
12/15/2011	19.24	21.16	10.70	15.35	31.16	6.85	15.19	21.48	28.08	20.24	20.00						
6/20/2012	18.53	21.10	10.50	14.77	30.81	6.04	13.95	21.63	26.49	19.48	18.63						
1/23/2013	18.20	21.01	9.15	13.68	31.44	5.51	15.15	22.93	27.23	19.19	15.90						
7/7/2013	20.22	22.41	11.56	15.61	31.23	6.08	14.94	23.16	27.27	19.71	16.53						
1/22/2014	17.71	20.41	8.36	12.02	30.30	2.84	14.53	22.01	26.23	18.75	14.82						
7/9/2014	17.06	20.92	9.05	12.74	30.31	4.04	12.85	22.74	24.71	19.18	17.52						
1/28/2015	14.90	18.91	5.27	8.27	30.26	2.58	10.67	22.21	22.93	17.24	12.80						
1/20/2016				8.22	28.87					18.01		18.32	14.15	6.86	11.24	0	9.1
3/7/2016	15.09	19.34	6.46	5.96	28.59	plugged	9.11	18.97	21.42	18.57	13.67	18.89	14.08	7.53	11.67	0.00	8.04
5/11/2016	14.08	18.91	5.68	7.68	28.12		8.42	18.60	17.33	17.58		17.76	12.54	6.44	10.75	0.00	8.12
7/14/2016				10.96	28.13				21.15	18.96		19.53	15.29	10.65	12.49	0.00	9.23
9/8/2016	15.66	20.18	7.43	10.47	28.45		10.39	18.40	21.06	18.86	15.23	19.25	15.95	10.75	12.08	0.67	8.88
10/13/2016	17.38	21.12	9.10	12.25	28.55		10.97	18.34	22.95	19.17	16.23	20.04	17.17	13.25	13.51	0.00	9.51
11/15/2016				12.86	29.00				23.75	19.52		20.13	18.20	13.35	14.15	0.00	9.32
1/12/2017				11.31	29.11				22.58	19.13		19.79	16.97	11.74	13.81	0.00	8.53
3/1/2017				9.99	29.10				21.03	18.89		19.17	16.22	10.74	13.05	0.00	8.13
4/11/2017				10.06	29.25				21.38	18.71		15.14	16.17	10.09	13.12	0.00	7.68
8/24/2017				11.14	29.33				22.57	19.33		19.98	17.18	9.45	13.06	0.00	8.67

WBAP
Distance between wells in feet

	AD3	AD12	AD17	AD18	AD28	AD30
AD3	-	2187	1604	1280	1955	1458
AD12		-	3132	1794	3123	2584
AD17			-	2911	695	904
AD18				-	3149	2603
AD28					-	689
AD30						-

WBAP displaying data for date: **8/24/2017**
Hydraulic gradient in ft/ft

	AD3	AD12	AD17	AD18	AD28	AD30	max grad
AD3	-	0.011061	0.012039	0.011516	0.01198	0.014712	0.032569
AD12		-	0.013889	0.005268	0.015245	0.017663	hydraulic concuctivity
AD17			-	0.011697	0.005914	0.002367	0.0001 cm/sec
AD18				-	0.001305	0.000822	porosity
AD28					-	0.032569	0.25
AD30						-	seepage rate, ft/yr

13.48

EBAP
Distance between wells in feet

	AD2	AD4	AD12	AD18	AD31	AD32
AD2	-	1822	1914	1569	932	1209
AD4		-	773	1022	1473	779
AD12			-	1794	1903	948
AD18				-	1459	1443
AD31					-	1001
AD32						-

EBAP displaying data for date: **8/24/2017**
Hydraulic gradient in ft/ft

	AD2	AD4	AD12	AD18	AD31	AD32	max grad
AD2	-	0.014237	0.020925	0.019503	0.017103	0.01828	0.020925
AD4		-	0.018254	0.00456	0.006789	0.004929	hydraulic concuctivity
AD12			-	0.005268	0.012669	0.018935	0.0001 cm/sec
AD18				-	0.010048	0.005891	porosity
AD31					-	0.006154	0.25
AD32						-	seepage rate, ft/yr

8.66

	Well ID	AD-02	AD-03	AD-04	AD-07	AD-08	AD-10	AD-12	AD-13	AD-16	AD-17	AD-18	AD-19	AD-20	AD-21
	TOC, ft	344.04	375.30	366.79	362.79	359.84	362.21	381.99	364.76	360.05	346.09	363.42	362.82	355.79	350.72
337.70	4/13/2011	326.90	342.95	351.45	344.34	341.65	342.03	358.95	349.46	338.08	322.66	355.53	344.07	334.50	340.43
335.90	12/15/2011	327.12	341.59	351.24	343.75	340.29	341.90	357.99	348.91	335.50	322.29	351.54	343.58	334.63	340.02
338.40	6/20/2012	327.17	343.70	352.44	344.15	341.65	342.19	359.33	349.52	337.58	323.31	357.21	344.29	334.69	340.22
339.40	1/23/2013	327.26	341.10	354.42	344.90	340.72	341.41	368.07	350.81	335.43	323.51	355.47	344.62	334.78	341.57
339.40	7/7/2013	326.62	343.27	349.22	343.35	341.25	339.85	357.41	348.61	336.67	323.06	357.23	342.60	333.38	339.16
338.70	1/22/2014	327.70	341.42	355.58	346.61	341.67	342.27	369.97	351.97	339.53	325.19	360.03	345.11	335.38	342.36
339.40	7/9/2014	327.19	343.96	353.33	346.23	343.36	342.22	367.04	351.29	340.84	324.15	358.06	345.76	334.87	341.67
339.40	1/28/2015	328.62	345.01	359.00	349.17	344.03	344.39	372.75	354.47	343.34	328.42	359.88	347.92	336.88	345.45
	1/20/2016	328.55	347.03	359.16	349.31	347.21		371.05	354.15	347.68		360.52			
	3/7/2016	328.31	347.21	358.13	348.78	347.22	344.27	368.71	353.61	348.69	328.01	360.34	347.73	336.45	344.26
	5/11/2016	328.35	348.04	360.07	349.98	348.03	345.14	372.17	355.11	350.97	329.38	359.26	348.74	336.88	345.04
	7/14/2016	327.46	346.00	352.34	347.54	347.10		365.68	352.31	343.32	325.93	356.99			
	9/8/2016	327.84	345.57	353.53	348.17	346.87	343.32	367.62	353.15	343.71	325.86	357.39	347.16	335.61	343.29
	10/13/2016	327.12	344.05	350.22	346.39	346.34	341.41	360.70	351.01	342.46	324.82	354.25	345.44	334.67	341.62
	11/15/2016	327.32	343.26	349.46	345.75	345.79		359.02	350.24	340.62	324.49	354.35			
	1/12/2017	327.65	344.19	353.27	347.04	345.74		365.11	352.01	343.09	324.70	357.06			
	3/1/2017	327.96	345.53	355.38	347.96	346.00		368.79	352.81	344.54	326.27	359.21			
	4/11/2017	329.09	345.53	356.62	347.87	345.81		372.97	352.68	344.69	326.27	358.63			
		327.63	343.49	353.57	347.40	346.31		367.68	352.62	342.71	324.18	358.23			

	Well ID	AD-22	AD-23	AD-24	AD-25	AD-26	AD-27	AD-28	AD-29	AD-30	AD-31	AD-32	AD-33	AD-34	AD-35
	TOC, ft	358.51	350.10	291.14	337.09	345.25	352.62	339.40	353.37	342.02	360.75	359.18	362.37	307.61	318.95
337.70	4/13/2011	343.64	319.65	282.92	324.51	324.53	325.82	319.67	334.68						
335.90	12/15/2011	343.16	318.94	284.29	321.90	323.77	324.54	319.16	333.37						
338.40	6/20/2012	343.74	319.29	285.10	323.14	323.62	326.13	319.92	334.74						
339.40	1/23/2013	344.83	318.66	285.63	321.94	322.32	325.39	320.21	337.47						
339.40	7/7/2013	342.90	318.87	285.06	322.15	322.09	325.35	319.69	336.84						
338.70	1/22/2014	346.49	319.80	288.30	322.56	323.24	326.39	320.65	338.55						
339.40	7/9/2014	345.77	319.79	287.10	324.24	322.51	327.91	320.22	335.85						
339.40	1/28/2015	350.24	319.84	288.56	326.42	323.04	329.69	322.16	340.57						
	1/20/2016	350.29	321.23					321.39		323.70	346.60	352.32	351.13	307.61	309.85
	3/7/2016	352.55	321.51	#VALUE!	327.98	326.28	331.20	320.83	339.70	323.13	346.67	351.65	350.70	307.61	310.91
	5/11/2016	350.83	321.98		328.67	326.65	335.29	321.82		324.26	348.21	352.74	351.62	307.61	310.83
	7/14/2016	347.55	321.97				331.47	320.44		322.49	345.46	348.53	349.88	307.61	309.72
	9/8/2016	348.04	321.65		326.70	326.85	331.56	320.54	338.14	322.77	344.80	348.43	350.29	306.94	310.07
	10/13/2016	346.26	321.55		326.12	326.91	329.67	320.23	337.14	321.98	343.58	345.93	348.86	307.61	309.44
	11/15/2016	345.65	321.10				328.87	319.88		321.89	342.55	345.83	348.22	307.61	309.63
	1/12/2017	347.20	320.99				330.04	320.27		322.23	343.78	347.44	348.56	307.61	310.42
	3/1/2017	348.52	321.00				331.59	320.51		322.85	344.53	348.44	349.32	307.61	310.82
	4/11/2017	348.45	320.85				331.24	320.69		326.88	344.58	349.09	349.25	307.61	311.27
		347.37	320.77				330.05	320.07		322.04	343.57	349.73	349.31	307.61	310.28

Seepage rate summary
in feet per year

	Landfill	**Stackout**	**WBAP**	**EBAP**	
3/7/2016	8.49	8.64	14.17	8.74	3/7/2016
5/11/2016	7.61	9.77	16.63	9.48	5/11/2016
7/14/2016	6.91	7.65	14.33	8.26	7/14/2016
9/8/2016	6.53	8.28	14.79	8.60	9/8/2016
10/13/2016	6.83	6.15	13.25	7.31	10/13/2016
11/15/2016	6.47	6.08	12.77	7.13	11/15/2016
1/12/2017	6.33	7.50	13.47	8.10	1/12/2017
3/1/2017	6.28	9.15	14.40	8.88	3/1/2017
4/11/2017	6.53	11.61	14.19	10.43	4/11/2017
8/24/2017	6.14	8.62	13.48	8.66	8/24/2017

4.9 – Annual Groundwater Monitoring Report, H.W. Pirkey Power Plant, Landfill CCR Management Unit, Hallsville, Texas, January 2021

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
Landfill CCR Management Unit
Hallsville, Texas

January 2021

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY
An AEP Company
BOUNDLESS ENERGY

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Appendix I- Groundwater Data Tables and Figures

Appendix II-Statistical Analyses

Appendix III- Alternate Source Demonstration

Appendix IV- Well Installation

I. Summary

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2021.

In general, the following activities were completed:

- Groundwater samples were collected for the wells the landfill groundwater monitoring network in June and November 2020 and analyzed for Appendix III, as specified in 40 CFR 257.94 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- An alternate source for the statistically significant increases (SSIs) over background that caused this unit to transition to assessment monitoring was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on January 7, 2020. As a result, the unit returned to detection monitoring and was in detection monitoring at the beginning of 2020;
- The unit was in detection monitoring at the end of 2020;
- There were no SSIs determined for the 2nd half 2019 groundwater sampling and analysis event;
- SSI over background was determined for fluoride at well AD-34 on October 2, 2020. An alternate source for fluoride exceedance was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on December 31, 2020;
- The November sampling event is undergoing statistical analysis;
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;

- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in **Appendix I**;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations, if applicable.
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

Landfill Monitoring Wells	
Up Gradient	Down Gradient
AD-8	AD-23
AD-12	AD-34
AD-16	AD-35 (decommissioned 2018)
AD-27	AD-36 (installed 2019)

III. Monitoring Wells Installed or Decommissioned

One monitoring well (AD-7R) was installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry. The well installation report can be found in **Appendix IV**.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event also are shown in **Appendix I**, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the detection monitoring rules, 40 CFR 257.94 et seq., two rounds of sampling were conducted in June and November including all Appendix III parameters.

The verification sample after the 2nd half 2019 groundwater sampling event appeared to be consistent with groundwater flow that is normally seen near the landfill (toward the south).

The verification sample after the 1st half 2020 groundwater sampling event appeared to be consistent with groundwater flow that is normally seen near the landfill (toward the south).

Detection monitoring will continue in 2021.

V. Statistical Evaluation of 2020 Events

The three statistical analysis reports available for this reporting period are included in **Appendix II**.

There were no SSIs determined for the 2nd half 2019 groundwater sampling and analysis event.

SSI over background was determined for fluoride at well AD-34 on October 2, 2020.

Data from the events conducted between August 2017 and June 2020, including both initial and verification results, were evaluated for inclusion in the background dataset. Additionally, data from eight background monitoring events at AD-36, which was installed to replace well AD-35 following its decommissioning, were evaluated to establish background concentrations for Appendix III constituent. Documentation for this information can be found in a report dated January 27, 2021 (*STATISTICAL ANALYSIS SUMMARY-Background Update Calculations H.W. Pirkey Power Plant Landfill*).

The November sampling event is undergoing statistical analysis.

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the landfill's SSIs over background. An alternate source for the SSIs over background that caused to unit to transition to assessment monitoring was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on January 7, 2020. As a result, the unit returned to detection monitoring.

SSI over background was determined for fluoride on October 2, 2020. An alternate source demonstration was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on December 31, 2020.

Documentation supporting these findings are found in **Appendix III**.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

On April 3, 2018, no alternate source was found for SSIs over background, so the unit transitioned to assessment monitoring. On December 26, 2019, SSLs above GWPS were identified. On March 26, 2019, no alternate sources were identified for the unit, so it transitioned into assessment of corrective measures. On April 22, 2019, an alternate source was identified for the SSLs, so the unit did not continue assessment of corrective measures work and remained in assessment monitoring.

On January 7, 2020, an alternate source was found for the SSIs determined for boron, total dissolved solids (TDS), and sulfate as summarized in *Groundwater Monitoring Statistical Evaluation Report* (1/3/2018), so the unit returned to detection monitoring. The unit remained in detection monitoring during 2020.

Detection monitoring will continue in 2021.

Regarding defining an alternate monitoring frequency, no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

No other information applies at this time.

IX. Description of Any Problems Encountered in 2020 and Actions Taken

No problems were encountered this year.

X. A Projection of Key Activities for the Upcoming Year

Key activities for the next year include:

- Detection monitoring sampling will be conducted;

- Evaluation of the detection monitoring results from a statistical analysis viewpoint, looking for any SSIs over background;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the next annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Table 1 - Groundwater Data Summary: AD-8
Pirkey - LF
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	1.58	109	9	< 0.083 U	6.1	181	432
7/13/2016	Background	0.775	20.7	13	2	6.2	131	280
9/8/2016	Background	1.04	50.7	12	2	5.1	121	285
10/12/2016	Background	0.793	20.8	13	2	3.7	184	276
11/15/2016	Background	0.769	17.2	13	3	3.7	208	296
1/11/2017	Background	0.734	18.6	13	3	3.6	228	280
2/28/2017	Background	0.777	18.1	10	2	3.7	157	250
4/11/2017	Background	0.779	17.1	12	3	3.9	168	284
8/23/2017	Detection	0.411	19.4	9	0.587 J	3.9	56	110
3/21/2018	Assessment	1.03	56.1	8	1.1987	5.7	140	278
8/20/2018	Assessment	0.714	14.5	18	5.1991	3.7	168	300
2/28/2019	Assessment	1.05	103	6.83	0.40	5.7	175	462
5/21/2019	Assessment	1.11	85.5	4.48	0.33	5.9	127	296
8/13/2019	Detection	0.818	27.6	12.7	3.39	4.6	128	260
6/3/2020	Detection	0.783	74.4	11.5	2.45	5.8	196	396
11/3/2020	Detection	0.822	18.5	15.8	2.50	4.1	119	237

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-8
Pirkey - LF
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	< 0.93 U	< 1.05 U	38	1	< 0.07 U	1	1.80288 J	0.9155	< 0.083 U	1.02541 J	< 0.00013 U	0.027	< 0.29 U	15	1.19926 J
7/13/2016	Background	< 0.93 U	1.16508 J	61	7	0.175996 J	1	20	6.75	2	1.46729 J	0.032	0.211	< 0.29 U	< 0.99 U	< 0.86 U
9/8/2016	Background	< 0.93 U	< 1.05 U	48	2	< 0.07 U	0.835837 J	9	1.658	2	< 0.68 U	0.018	0.048	< 0.29 U	3.84567 J	< 0.86 U
10/12/2016	Background	< 0.93 U	1.46586 J	61	6	< 0.07 U	0.74214 J	18	6.72	2	2.30733 J	0.032	0.112	< 0.29 U	2.51464 J	< 0.86 U
11/15/2016	Background	< 0.93 U	< 1.05 U	52	6	0.118693 J	0.805286 J	18	6.14	3	2.85553 J	0.03	0.16	< 0.29 U	< 0.99 U	< 0.86 U
1/11/2017	Background	< 0.93 U	1.53134 J	60	6	0.108717 J	2	18	6.29	3	2.99592 J	0.032	0.157	< 0.29 U	1.4083 J	< 0.86 U
2/28/2017	Background	< 0.93 U	1.68597 J	52	6	0.13889 J	0.633257 J	18	7.64	2	3.26919 J	0.031	0.153	< 0.29 U	1.78549 J	< 0.86 U
4/11/2017	Background	< 0.93 U	< 1.05 U	51	6	0.128137 J	0.887504 J	19	5.56	3	2.44168 J	0.031	0.01068 J	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	< 1.05 U	37.9	2.57	< 0.07 U	< 0.23 U	9.38	2.499	1.1987	0.95 J	0.01503	0.049	< 0.29 U	27.68	< 0.86 U
8/20/2018	Assessment	0.02 J	4.05	33.4	4.55	0.18	0.759	15.9	0.145	5.1991	4.46	0.0221	0.105	0.02 J	9.8	0.083
2/28/2019	Assessment	< 0.4 U	< 0.6 U	46.8	< 0.4 U	< 0.2 U	< 0.8 U	0.8 J	1.066	0.40	< 0.4 U	0.002 J	< 0.005 U	< 8 U	30.8	< 2 U
5/21/2019	Assessment	< 0.4 U	1 J	42.8	1 J	< 0.2 U	< 0.8 U	< 0.4 U	1.786	0.33	< 0.4 U	0.0003 J	0.009 J	< 8 U	23.9	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - LF
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	< 0.083 U	4.4	4	94
7/13/2016	Background	0.03	0.26	6	< 0.083 U	3.1	4	75
9/7/2016	Background	0.04	0.343	6	< 0.083 U	3.9	7	63
10/12/2016	Background	0.03	0.271	7	1	3.4	8	92
11/14/2016	Background	0.04	0.331	8	< 0.083 U	2.6	6	80
1/11/2017	Background	0.03	0.315	7	< 0.083 U	4.8	6	76
2/28/2017	Background	0.04	0.434	5	< 0.083 U	3.6	4	50
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	7	72
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	6	52
3/21/2018	Assessment	0.01397	0.269	5	< 0.083 U	4.2	3	< 2 U
8/20/2018	Assessment	0.017	0.338	10	< 0.083 U	4.4	4	94
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	3.6	36
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	4.0	80
8/12/2019	Detection	< 0.02 U	0.278	7.24	0.06 J	4.9	2.6	90
3/10/2020	Detection	0.02 J	0.3 J	6.08	0.10	4.9	3.7	62
6/2/2020	Detection	< 0.02 U	0.2 J	5.63	0.10	4.0	3.9	91
11/2/2020	Detection	0.03 J	0.3 J	4.65	0.08	4.3	3.3	74

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - LF
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	< 1.05 U	26	0.219521 J	< 0.07 U	0.710981 J	1.58207 J	0.2073	< 0.083 U	< 0.68 U	< 0.00013 U	< 0.005 U	< 0.29 U	1.73953 J	< 0.86 U
7/13/2016	Background	< 0.93 U	< 1.05 U	23	0.190337 J	< 0.07 U	0.68835 J	1.29444 J	2.909	< 0.083 U	< 0.68 U	0.008	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	30	0.232192 J	< 0.07 U	0.353544 J	1.66591 J	0.881	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
10/12/2016	Background	< 0.93 U	< 1.05 U	27	0.149553 J	< 0.07 U	0.529033 J	1.56632 J	0.257	1	< 0.68 U	0.012	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
11/14/2016	Background	< 0.93 U	< 1.05 U	28	0.152375 J	< 0.07 U	0.32826 J	1.47282 J	0.767	< 0.083 U	< 0.68 U	0.013	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
1/11/2017	Background	< 0.93 U	< 1.05 U	23	0.126621 J	< 0.07 U	0.650158 J	1.09495 J	1.536	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
2/28/2017	Background	< 0.93 U	< 1.05 U	26	0.149219 J	< 0.07 U	0.325811 J	1.29984 J	0.416	< 0.083 U	< 0.68 U	0.009	< 0.005 U	< 0.29 U	< 0.99 U	0.994913 J
4/11/2017	Background	< 0.93 U	< 1.05 U	24	0.159412 J	< 0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	< 0.68 U	0.008	0.01364 J	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	< 1.05 U	25.82	0.16 J	< 0.07 U	1.05	1.49 J	0.784	< 0.083 U	< 0.68 U	0.00722	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
8/20/2018	Assessment	< 0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	< 0.083 U	0.089	0.0143	< 0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	< 0.4 U	< 0.6 U	22.5	< 0.4 U	< 0.2 U	< 0.8 U	1.37	0.225	0.09	< 0.4 U	0.00688	< 0.005 U	< 8 U	< 0.6 U	< 2 U
5/21/2019	Assessment	< 0.4 U	< 0.6 U	21.7	< 0.4 U	< 0.2 U	< 0.8 U	1.15	0.201	0.09	< 0.4 U	0.00576	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-16
Pirkey - LF
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.02	1.21	8	< 0.083 U	3.9	16	116
7/14/2016	Background	0.03	2	9	< 0.083 U	3.8	45	148
9/8/2016	Background	0.03	1.83	9	< 0.083 U	3.9	33	133
10/13/2016	Background	0.03	1.15	9	< 0.083 U	3.9	16	124
11/14/2016	Background	0.03	1.58	9	< 0.083 U	4.4	23	124
1/12/2017	Background	0.02	1.76	10	< 0.083 U	3.7	43	112
3/1/2017	Background	0.03	1.29	9	< 0.083 U	3.2	22	108
4/10/2017	Background	0.02	1.21	11	< 0.083 U	3.4	24	106
8/24/2017	Detection	0.03648	0.945	12	< 0.083 U	4.3	14	96
3/22/2018	Assessment	0.0171	1.03	14	< 0.083 U	4.0	13	96
8/21/2018	Assessment	0.020	1.17	17	< 0.083 U	4.0	15	128
2/27/2019	Assessment	0.03 J	0.704	20.3	0.07 J	4.1	17.7	76
5/23/2019	Assessment	0.022	1.06	20.8	0.06 J	4.6	26.9	128
8/15/2019	Detection	< 0.02 U	0.874	20.0	0.06 J	5.1	15.4	110
6/3/2020	Detection	< 0.02 U	0.872	21.7	0.11	4.7	13.3	122
11/3/2020	Detection	< 0.02 U	0.817	19.9	0.07	4.4	11.0	105

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-16
Pirkey - LF
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	< 0.93 U	1.83497 J	61	0.453643 J	0.0817904 J	1	4.23727 J	1.294	< 0.083 U	< 0.68 U	0.006	0.01506 J	< 0.29 U	2.26113 J	1.3697 J
7/14/2016	Background	< 0.93 U	< 1.05 U	64	0.565692 J	< 0.07 U	1	6	1.438	< 0.083 U	< 0.68 U	0.036	0.02395 J	1.1177 J	< 0.99 U	< 0.86 U
9/8/2016	Background	8	< 1.05 U	70	0.810547 J	0.0926258 J	2	8	1.931	< 0.083 U	< 0.68 U	0.032	0.00753 J	< 0.29 U	< 0.99 U	1.75243 J
10/13/2016	Background	< 0.93 U	1.52475 J	56	0.250902 J	< 0.07 U	1	3.33761 J	1.843	< 0.083 U	< 0.68 U	0.033	< 0.005 U	< 0.29 U	1.70284 J	< 0.86 U
11/14/2016	Background	< 0.93 U	< 1.05 U	55	0.38481 J	< 0.07 U	0.561291 J	4.34297 J	2.123	< 0.083 U	< 0.68 U	0.028	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	58	0.70928 J	< 0.07 U	0.406161 J	8	2.629	< 0.083 U	< 0.68 U	0.031	0.01045 J	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	1.50766 J	76	0.487946 J	< 0.07 U	0.558767 J	5	1.417	< 0.083 U	< 0.68 U	0.021	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	77	0.435552 J	< 0.07 U	0.822329 J	5	0.932	< 0.083 U	< 0.68 U	0.019	0.00733 J	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	83.66	0.27 J	< 0.07 U	1.59	3.6 J	2.11	< 0.083 U	< 0.68 U	0.02224	0.018 J	< 0.29 U	< 0.99 U	< 0.86 U
8/21/2018	Assessment	0.03 J	0.42	69.0	0.213	0.03	0.211	3.78	1.92	< 0.083 U	0.082	0.0347	0.014 J	< 0.02 U	0.1	0.051
2/27/2019	Assessment	< 0.4 U	7.74	56.2	< 0.4 U	< 0.2 U	< 0.8 U	3.21	0.848	0.07 J	< 0.4 U	0.0154	0.011 J	< 8 U	< 0.6 U	< 2 U
5/23/2019	Assessment	< 0.4 U	5.80	83.4	< 0.4 U	< 0.2 U	< 0.8 U	3.16	1.957	0.06 J	< 0.4 U	0.0227	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-23
Pirkey - LF
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.01	0.535	4	< 0.083 U	4.0	10	72
7/13/2016	Background	0.03	0.317	4	< 0.083 U	2.7	11	59
9/8/2016	Background	0.02	0.26	5	< 0.083 U	3.5	12	64
10/12/2016	Background	0.03	0.321	6	< 0.083 U	3.7	13	68
11/15/2016	Background	0.03	0.249	5	< 0.083 U	3.5	14	100
1/11/2017	Background	0.02	0.319	6	< 0.083 U	3.7	13	60
2/28/2017	Background	0.03	0.217	4	< 0.083 U	4.0	9	48
4/11/2017	Background	0.03	0.543	7	0.2688 J	4.2	11	76
8/23/2017	Detection	0.04021	0.276	6	0.198 J	4.1	11	64
12/21/2017	Detection	0.04498	0.469	--	--	--	--	--
3/21/2018	Assessment	0.01762	0.227	4	< 0.083 U	3.9	10	72
8/20/2018	Assessment	0.017	0.247	9	< 0.083 U	3.8	11	92
2/28/2019	Assessment	0.02 J	0.3 J	6.94	0.04 J	5.1	7.2	70
5/23/2019	Assessment	0.017	0.3 J	6.82	0.04 J	4.8	9.1	54
8/13/2019	Detection	< 0.02 U	0.325	7.12	0.03 J	5.0	7.4	126
1/27/2020	Detection	--	--	--	--	4.3	--	70 J
6/3/2020	Detection	< 0.02 U	0.2 J	7.08	0.07	4.3	8.5	65
11/4/2020	Detection	< 0.02 U	0.2 J	6.97	0.05 J	3.9	7.9	71

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-23
Pirkey - LF
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	2.89148 J	1.65098 J	48	0.186855 J	0.0739811 J	2	2.29646 J	6.86	< 0.083 U	< 0.68 U	0.000135818 J	0.01188 J	< 0.29 U	1.91991 J	< 0.86 U
7/13/2016	Background	3.79558 J	< 1.05 U	48	0.192156 J	0.0925427 J	2	2.72879 J	5.69	< 0.083 U	< 0.68 U	0.006	0.01721 J	1.34973 J	2.00038 J	< 0.86 U
9/8/2016	Background	< 0.93 U	< 1.05 U	53	0.20435 J	< 0.07 U	5	2.01019 J	6.68	< 0.083 U	2.23756 J	0.006	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
10/12/2016	Background	1.29835 J	7	120	0.463688 J	0.13648 J	41	3.91303 J	12.89	< 0.083 U	31	1.01	0.095	0.563586 J	2.10924 J	< 0.86 U
11/15/2016	Background	< 0.93 U	< 1.05 U	50	0.129296 J	< 0.07 U	6	1.66943 J	7.54	< 0.083 U	3.21271 J	0.006	0.02438 J	0.403857 J	1.34763 J	< 0.86 U
1/11/2017	Background	< 0.93 U	2.03681 J	73	0.159 J	< 0.07 U	15	2.25934 J	8.06	< 0.083 U	11	0.009	0.092	< 0.29 U	< 0.99 U	< 0.86 U
2/28/2017	Background	1.65681 J	< 1.05 U	41	0.116844 J	< 0.07 U	0.295768 J	1.05228 J	5.74	< 0.083 U	< 0.68 U	0.005	< 0.005 U	< 0.29 U	1.3076 J	< 0.86 U
4/11/2017	Background	< 0.93 U	3.9673 J	86	0.318917 J	0.107977 J	22	2.60853 J	10.31	0.2688 J	15	0.01	0.118	0.31517 J	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	< 1.05 U	56.1	0.17 J	< 0.07 U	5.7	1.09 J	7.55	< 0.083 U	3.52 J	0.00709	0.02 J	< 0.29 U	< 0.99 U	< 0.86 U
8/20/2018	Assessment	0.03 J	0.87	53.5	0.147	0.01 J	1.77	0.803	11	< 0.083 U	4.79	0.00634	0.025	0.07 J	1.0	0.176
2/28/2019	Assessment	< 0.4 U	1 J	46.9	< 0.4 U	< 0.2 U	4.16	1 J	6.14	0.04 J	3.46	0.00646	0.035	< 8 U	1 J	< 2 U
5/23/2019	Assessment	< 0.4 U	0.7 J	56.4	< 0.4 U	< 0.2 U	3 J	0.7 J	9.66	0.04 J	8.99	0.00537	0.058 J	< 8 U	< 0.6 U	0.2 J

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-27
Pirkey - LF
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.02	4.41	8	0.6176 J	3.9	51	198
7/13/2016	Background	0.03	4.43	8	< 0.083 U	2.7	54	192
9/8/2016	Background	0.03	4.17	8	< 0.083 U	2.9	52	196
10/12/2016	Background	0.03	4.09	8	< 0.083 U	3.0	58	216
11/15/2016	Background	0.03	4.52	8	< 0.083 U	3.5	92	216
1/11/2017	Background	0.02	3.74	9	< 0.083 U	4.1	58	180
3/1/2017	Background	0.03	4.31	8	< 0.083 U	2.8	56	216
4/10/2017	Background	0.03	4.01	9	< 0.083 U	3.3	54	180
8/24/2017	Detection	0.0358	3.58	9	0.197 J	3.7	52	168
3/22/2018	Assessment	0.03901	5.58	11	< 0.083 U	3.9	78	192
8/21/2018	Assessment	0.024	4.58	10	< 0.083 U	3.5	65	196
2/28/2019	Assessment	0.07 J	4.02	11.7	0.20	4.7	52.8	42
5/23/2019	Assessment	0.023	3.89	11.4	0.20	4.4	55.2	204
8/16/2019	Detection	0.02 J	3.94	10.5	0.18	3.9	53.2	198
6/3/2020	Detection	0.03 J	3.55	12.8	0.25	4.2	54.6	219
11/3/2020	Detection	0.03 J	3.45	10.8	0.19	3.6	53.1	196

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-27
Pirkey - LF
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	1.20808 J	2.15232 J	43	5	0.431235 J	0.87101 J	20	2.031	0.6176 J	< 0.68 U	0.066	< 0.005 U	< 0.29 U	1.10872 J	< 0.86 U
7/13/2016	Background	0.956365 J	1.27952 J	45	5	0.434627 J	2	21	2.406	< 0.083 U	< 0.68 U	0.097	0.02241 J	0.434679 J	< 0.99 U	< 0.86 U
9/8/2016	Background	< 0.93 U	< 1.05 U	47	6	0.398469 J	2	20	2.71	< 0.083 U	< 0.68 U	0.095	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
10/12/2016	Background	< 0.93 U	2.14429 J	46	5	0.424977 J	2	20	4.43	< 0.083 U	< 0.68 U	0.096	< 0.005 U	< 0.29 U	1.35863 J	< 0.86 U
11/15/2016	Background	< 0.93 U	< 1.05 U	41	5	0.419182 J	2	22	3.69	< 0.083 U	< 0.68 U	0.095	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
1/11/2017	Background	< 0.93 U	1.56781 J	46	5	0.30207 J	1	18	2.62	< 0.083 U	< 0.68 U	0.1	0.00659 J	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	43	5	0.286804 J	2	21	3.48	< 0.083 U	< 0.68 U	0.1	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	45	5	0.414787 J	0.954802 J	21	2.58	< 0.083 U	< 0.68 U	0.104	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	40.53	5.29	0.48 J	3.09	25.63	2.808	< 0.083 U	< 0.68 U	0.108	0.012 J	< 0.29 U	< 0.99 U	< 0.86 U
8/21/2018	Assessment	0.02 J	1.71	39.5	4.90	0.46	1.14	24.6	2.619	< 0.083 U	0.296	0.0921	0.006 J	0.07 J	3.7	0.137
2/28/2019	Assessment	< 0.4 U	1 J	39.5	5.32	0.5 J	< 0.8 U	18.9	2.95	0.20	< 0.4 U	0.0892	< 0.005 U	< 8 U	2 J	< 2 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	41.0	5.22	0.3 J	< 0.8 U	19.9	3.93	0.20	< 0.4 U	0.0885	< 0.005 U	< 8 U	0.6 J	0.2 J

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-34
Pirkey - LF
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.08	37.8	7	< 0.083 U	4.0	974	1,516
7/13/2016	Background	0.111	33.2	8	< 0.083 U	3.6	837	1,396
9/8/2016	Background	0.09	39.5	8	< 0.083 U	3.3	870	1,520
10/12/2016	Background	0.09	35.8	7	0.6272 J	3.6	1,084	1,464
11/15/2016	Background	0.1	36.3	7	0.9978 J	3.7	1,006	1,428
1/11/2017	Background	0.07	39.9	8	< 0.083 U	3.2	1,334	1,378
2/28/2017	Background	0.08	37	6	< 0.083 U	3.7	993	1,402
4/10/2017	Background	0.09	38.2	8	0.5241 J	3.0	1,016	1,490
8/23/2017	Detection	0.107	36.2	7	0.619 J	3.7	1,231	1,128
12/21/2017	Detection	--	--	8	0.6669 J	--	1,020	1,260
3/21/2018	Assessment	0.171	40.1	6	< 0.083 U	3.7	956	1,424
8/20/2018	Assessment	0.067	37.0	10	< 0.083 U	3.7	1,064	1,462
2/27/2019	Assessment	0.08 J	39.9	7.64	0.86	2.9	970	1,470
5/21/2019	Assessment	0.060	42.0	7.34	0.69	3.3	1,080	1,154
8/13/2019	Detection	0.070	39.8	7.46	1.13	3.7	1,060	1,648
1/27/2020	Detection	--	--	--	0.9	3.6	--	1,550
3/11/2020	Detection	--	--	--	--	3.6	--	--
6/3/2020	Detection	0.058	40.1	7.68	1.22	3.4	1,150	1,620
7/15/2020	Detection	--	--	--	1.39	4.1	--	1,510
11/4/2020	Detection	0.060	39.5	7.10	0.82	3.4	1,090	1,670

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-34
Pirkey - LF
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	< 0.93 U	12	72	3	6	34	301	9.64	< 0.083 U	12	0.176	0.105	0.688222 J	< 0.99 U	< 0.86 U
7/13/2016	Background	< 0.93 U	25	177	4	6	81	296	7.75	< 0.083 U	39	0.183	0.313	2.11044 J	7	< 0.86 U
9/8/2016	Background	< 0.93 U	9	31	3	8	12	306	7.91	< 0.083 U	1.01746 J	0.158	0.064	< 0.29 U	< 0.99 U	< 0.86 U
10/12/2016	Background	< 0.93 U	10	39	3	5	15	297	10.12	0.6272 J	3.69632 J	0.174	0.036	< 0.29 U	< 0.99 U	< 0.86 U
11/15/2016	Background	< 0.93 U	7	23	2	8	6	292	13.21	0.9978 J	< 0.68 U	0.154	0.025	< 0.29 U	4.50827 J	< 0.86 U
1/11/2017	Background	< 0.93 U	6	29	2	7	8	284	11.9	< 0.083 U	< 0.68 U	0.164	0.032	< 0.29 U	< 0.99 U	< 0.86 U
2/28/2017	Background	< 0.93 U	7	11	2	6	< 0.23 U	294	9.87	< 0.083 U	< 0.68 U	0.158	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	4.49903 J	23	2	11	7	299	2.407	0.5241 J	< 0.68 U	0.167	0.0164 J	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	6.51	10.6	2.24	11.97	< 0.23 U	279	8.85	< 0.083 U	< 0.68 U	0.156	< 0.005 U	< 0.29 U	3.24 J	< 0.86 U
8/20/2018	Assessment	0.01 J	14.4	7.77	1.77	4.34	0.977	249	10.17	< 0.083 U	1.32	0.114	0.005 J	0.03 J	13.0	0.070
2/27/2019	Assessment	< 0.4 U	15.9	9.93	2.42	4.57	0.9 J	260	8.56	0.86	1 J	0.153	0.015 J	< 8 U	14.8	< 2 U
5/21/2019	Assessment	< 0.4 U	12.7	10.5	2.25	4.48	0.8 J	272	10.82	0.69	1 J	0.158	< 0.005 U	< 8 U	4.9	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-36
Pirkey - LF
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
8/13/2019	Background	0.065	0.240	9.46	0.05 J	4.7	2.2	92
1/27/2020	Background	0.056	0.304	8.65	0.05 J	4.7	3.5	40 J
3/11/2020	Background	0.05 J	0.2 J	8.44	0.06	5.0	3.7	60 J
4/15/2020	Background	0.054	0.2 J	8.40	0.05 J	3.6	3.7	40 J
5/13/2020	Background	0.055	0.2 J	8.56	0.05 J	4.1	3.4	40 J
6/3/2020	Background	0.052	0.2 J	8.52	0.07	4.6	3.3	65
6/16/2020	Background	0.064	0.2 J	8.39	0.05 J	4.6	3.6	50 J
7/1/2020	Background	0.059	0.3 J	--	--	4.9	--	52
7/15/2020	Background	--	--	8.09	0.08	5.0	3.7	--
11/4/2020	Detection	0.068	0.2 J	7.99	0.06 J	4.6	3.1	57

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-36
Pirkey - LF
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
8/13/2019	Background	< 0.02 U	0.15	10.8	0.234	< 0.01 U	0.203	0.901	1.298	0.05 J	< 0.05 U	0.0161	< 0.005 U	< 0.4 U	0.09 J	< 0.1 U
1/27/2020	Background	< 0.02 U	0.14	9.94	0.191	0.01 J	0.09 J	0.762	1.096	0.05 J	< 0.05 U	0.00277	< 0.2 U	< 0.4 U	0.07 J	< 0.1 U
3/11/2020	Background	< 0.02 U	0.09 J	10.2	0.184	< 0.01 U	< 0.04 U	0.760	4.056	0.06	< 0.05 U	0.00246	< 0.002 U	< 0.4 U	0.1 J	< 0.1 U
4/15/2020	Background	< 0.02 U	0.10	10.1	0.179	< 0.01 U	0.1 J	0.770	2.84	0.05 J	< 0.05 U	0.00210	0.003 J	0.8 J	0.09 J	< 0.1 U
5/13/2020	Background	< 0.02 U	0.15	10.2	0.194	< 0.01 U	0.247	0.750	2.346	0.05 J	< 0.05 U	0.00266	0.004 J	< 0.4 U	0.08 J	< 0.1 U
6/3/2020	Background	< 0.02 U	0.11	9.81	0.204	< 0.01 U	0.08 J	0.683	0.692	0.07	< 0.05 U	0.00262	0.005 J	< 0.4 U	0.09 J	< 0.1 U
6/16/2020	Background	< 0.02 U	0.11	9.75	0.173	< 0.01 U	0.214	0.723	0.885	0.05 J	0.08 J	0.00254	0.003 J	1 J	0.1 J	< 0.1 U
7/1/2020	Background	< 0.02 U	0.09 J	9.72	0.179	< 0.01 U	0.09 J	0.681	1.171	--	< 0.05 U	0.00268	0.004 J	< 0.4 U	0.06 J	< 0.1 U
7/15/2020	Background	--	--	--	--	--	--	--	--	0.08	--	--	--	--	--	--

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
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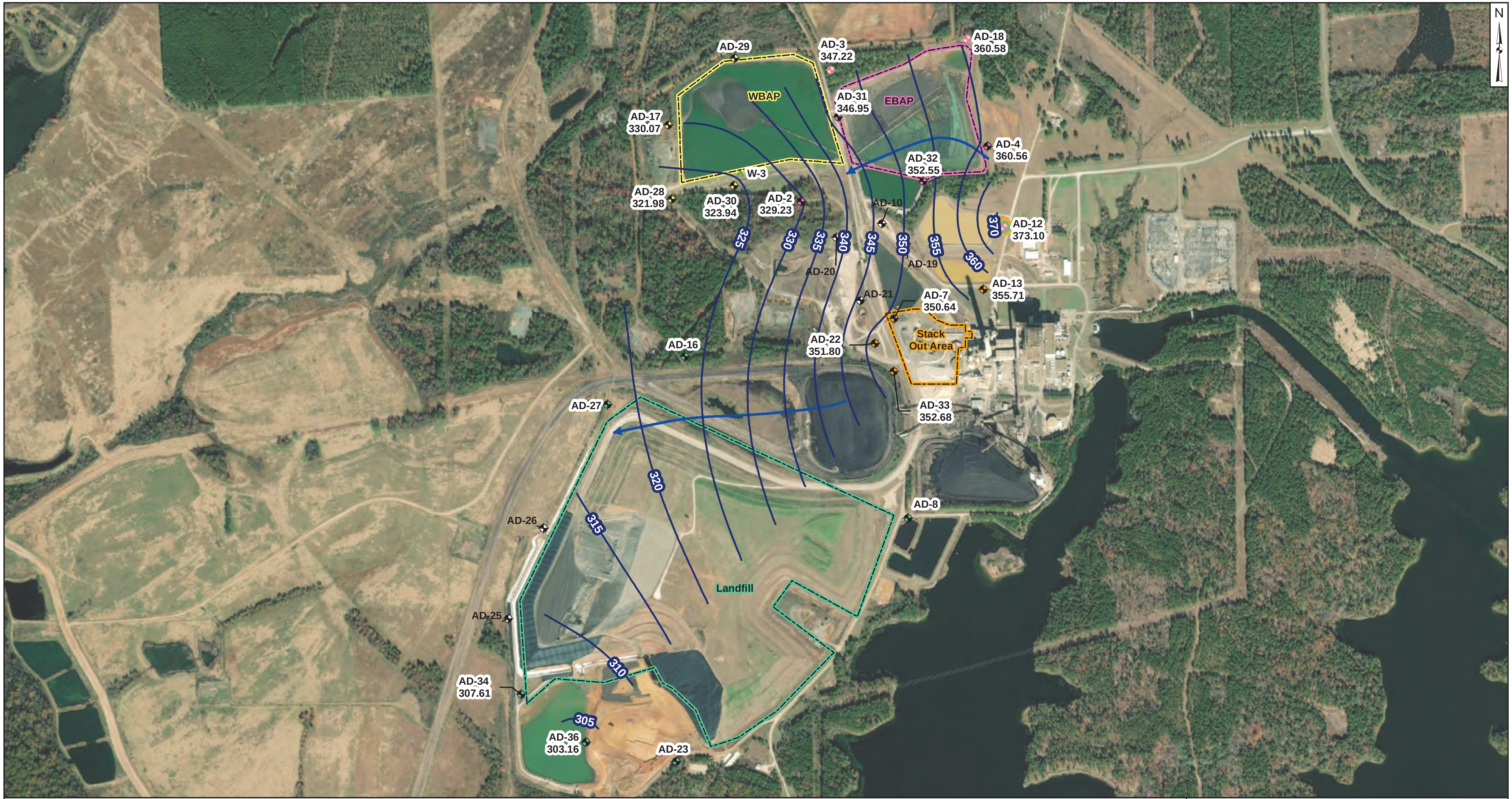
- -: Not analyzed
pCi/L: picocuries per liter

Table 1: Residence Time Calculation Summary
Pirkey Landfill

			2020-01[3]		2020-03		2020-06	
CCR Management Unit	Monitoring Well	Well Diameter (inches)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
Landfill	AD-8 [1]	4.0	NC	NC	NC	NC	6.4	19.0
	AD-12 [1]	4.0	NC	NC	35.1	3.5	20.1	6.0
	AD-16 [1]	2.0	NC	NC	NC	NC	24.7	2.5
	AD-23 [2]	2.0	21.3	2.9	NC	NC	17.9	3.4
	AD-27 [1]	2.0	NC	NC	NC	NC	9.8	6.2
	AD-34 [2]	2.0	NC	NC	3.3	18.7	NC	NC
	AD-36 [2]	2.0	21.3	2.9	11.7	5.2	22.6	2.7

			2020-07[3]		2020-11	
CCR Management Unit	Monitoring Well	Well Diameter (inches)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
Landfill	AD-8 [1]	4.0	NC	NC	7.0	17.4
	AD-12 [1]	4.0	NC	NC	26.9	4.5
	AD-16 [1]	2.0	NC	NC	21.6	2.8
	AD-23 [2]	2.0	NC	NC	14.2	4.3
	AD-27 [1]	2.0	NC	NC	16.6	3.7
	AD-34 [2]	2.0	10.1	6.0	27.3	2.2
	AD-36 [2]	2.0	22.1	2.8	26.0	2.3

Notes:
[1] - Background Well
[2] - Downgradient Well
[3] - Only select wells were gauged as part of two-of-two verification sampling
NC - Not Calculated



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP

- ⊕ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on March 10-11, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-16, AD-27, and AD-29 were not gauged in March 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer March 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio	2020/06/12	Figure 1

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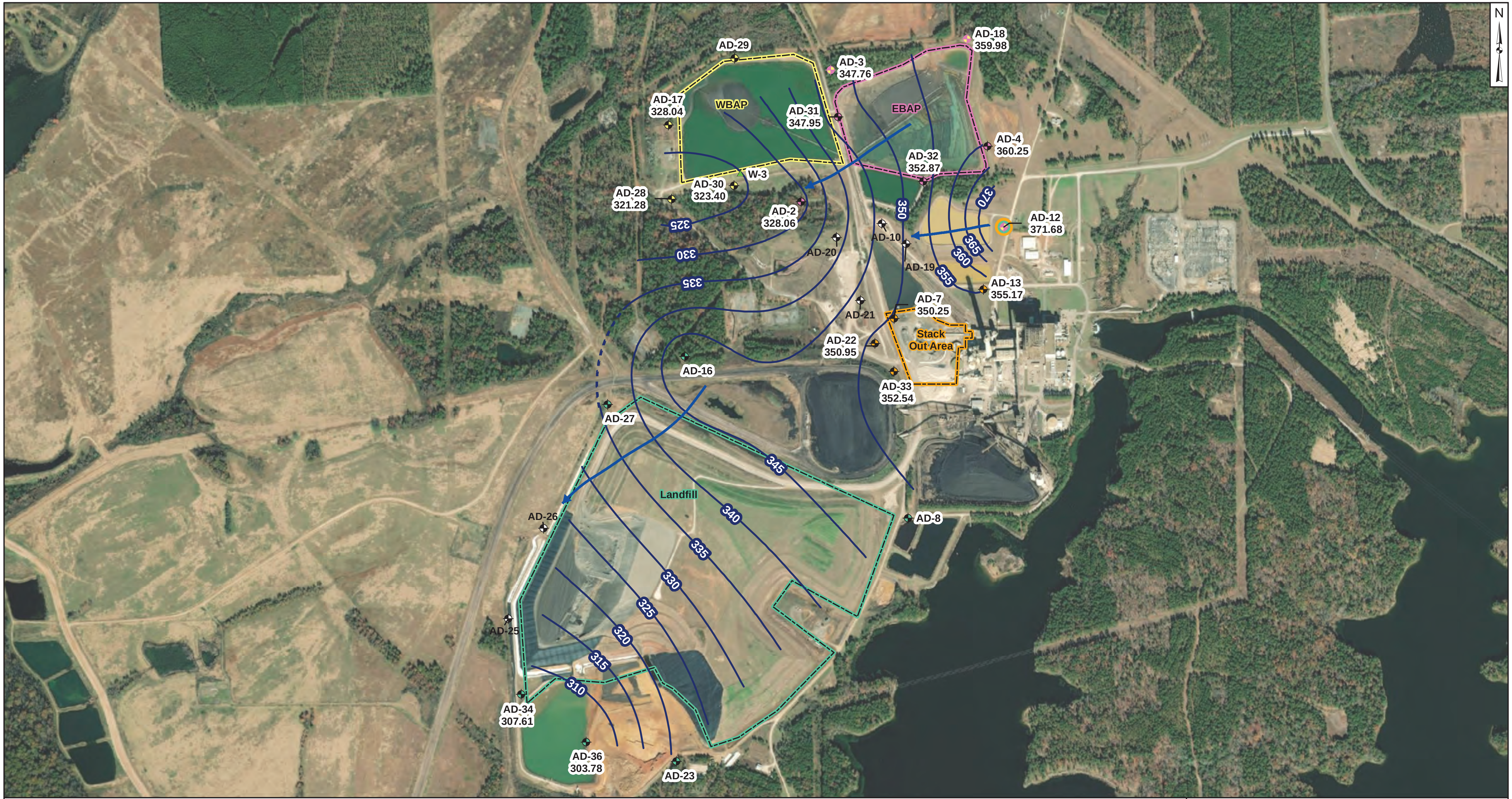


Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on June 2 - 3, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-8, AD-16, AD-23, AD-27, and AD-29 were not gauged in June 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
June 2020

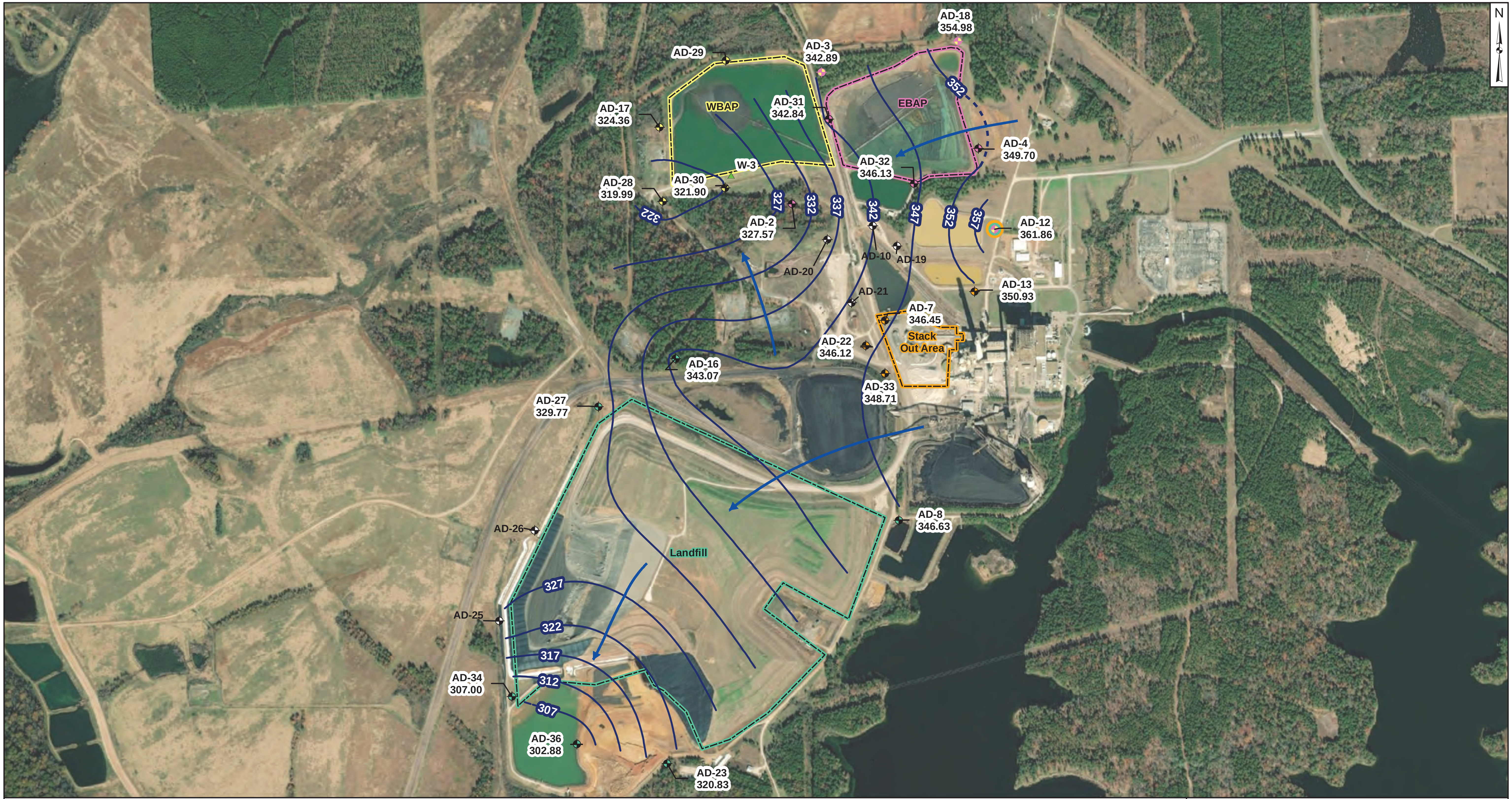
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2020/11/13

Figure
2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2020\AEP-Pirkey_GW_2020-06June.mxd. HDuff. 11/13/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- ⌖ Out of Network
- ⌖ EBAP
- ⌖ WBAP
- ⌖ Landfill
- ⌖ Stackout Area
- ⌖ EBAP and WBAP

- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on November 2-4, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 and AD-29 were not gauged in November 2020.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
November 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio | 2021/01/06

Figure
3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2020\AEP-Pirkey_GW_2020-11November_new.mxd. HDuff. 1/6/2021. Project/Phase/Task.

APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

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Memorandum

Date: February 7, 2020

To: David Miller (AEP)

Copies to: Leslie Fuerschbach (AEP)

From: Allison Kreinberg (Geosyntec)

Subject: Evaluation of Detection Monitoring Data at Pirkey Plant's Landfill

---

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257 Subpart D, "CCR rule"), the second semi-annual detection monitoring event of 2019 at the Landfill, an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas, was completed on August 13, 2019. Based on the results, a two-of-two verification sampling was completed on January 27, 2020.

Eight background monitoring events were conducted at the Pirkey LF prior to these detection monitoring events, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. Lower prediction limits (LPLs) were also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated January 3, 2018. An alternative source demonstration (ASD) was certified on January 7, 2020 which resulted in a revision from interwell tests to intrawell tests for the pH, sulfate, and TDS prediction limits.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is only concluded if both samples in a series of two exceeds the UPL (or are below the LPL for pH). In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are compared in Table 1. No SSIs were observed at the Pirkey Landfill CCR unit, and as a result the Pirkey Landfill will remain in detection monitoring.

The statistical analysis was conducted within 90 days of completion of sampling and analysis in accordance with 40 CFR 257.93(h)(2). A certification of these statistics by a qualified professional engineer is provided in Attachment A.

Table 1: Detection Monitoring Data Summary
Pirkey - Landfill

Parameter	Unit	Description	AD-23		AD-34	AD-34
			8/13/2019	1/27/2020	8/13/2019	1/27/2020
Boron	mg/L	Interwell Background Value (UPL)	0.0300		0.120	
		Detection Monitoring Result	0.0200	--	0.0700	--
Calcium	mg/L	Interwell Background Value (UPL)	0.654		42.5	
		Detection Monitoring Result	0.325	--	39.8	--
Chloride	mg/L	Interwell Background Value (UPL)	7.89		9.20	
		Detection Monitoring Result	7.12	--	7.46	--
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		1.00	
		Detection Monitoring Result	0.0300	--	**1.13**	0.90
pH	SU	Intrawell Background Value (UPL)	4.8		4.3	
		Intrawell Background Value (LPL)	2.5		2.7	
		Detection Monitoring Result	**5.0**	4.3	3.7	**--**
Sulfate	mg/L	Interwell Background Value (UPL)	15.8		1390	
		Detection Monitoring Result	7.40	--	1060	--
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	106		1590	
		Detection Monitoring Result	**126**	70	**1650**	1550

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected statistical method, described above and in the January 3, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Pirkey Landfill CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER

112498

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

02.07.2020
Date

Geosyntec consultants

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Memorandum

Date:	October 2, 2020
To:	David Miller (AEP)
Copies to:	Leslie Fuerschbach (AEP)
From:	Allison Kreinberg (Geosyntec)
Subject:	Evaluation of Detection Monitoring Data at Pirkey Plant's Landfill

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257 Subpart D, "CCR rule"), the first semi-annual detection monitoring event of 2020 at the Landfill, an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas, was completed on June 3, 2020. Based on the results, a two-of-two verification sampling was completed on July 15, 2020.

Eight background monitoring events were conducted at the Pirkey LF prior to these detection monitoring events, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. Lower prediction limits (LPLs) were also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated January 3, 2018. An alternative source demonstration (ASD) was certified on January 7, 2020 which resulted in a revision from interwell tests to intrawell tests for the pH, sulfate, and TDS prediction limits.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is only concluded if both samples in a series of two exceeds the UPL (or are below the LPL for pH). In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are compared in Table 1 and noted exceedances are described in the list below.

- Fluoride concentrations exceeded the intrawell UPL of 1.00 mg/L in both the initial (1.22 mg/L) and second (1.39 mg/L) samples collected at AD-34. Therefore, an SSI over background is concluded for fluoride at AD-34.

In response to the exceedances noted above, the Pirkey LF CCR unit will either transition to assessment monitoring or an alternative source demonstration (ASD) for fluoride will be conducted in accordance with 40 CFR 257.94(e)(2). If the ASD is successful, the Pirkey LF will remain in detection monitoring.

The statistical analysis was conducted within 90 days of completion of sampling and analysis in accordance with 40 CFR 257.93(h)(2). A certification of these statistics by a qualified professional engineer is provided in Attachment A.

Table 1: Detection Monitoring Data Summary
Pirkey Plant - Landfill

Analyte	Unit	Description	AD-23	AD-34	
			6/3/2020	6/3/2020	7/15/2020
Boron	mg/L	Intrawell Background Value (UPL)	0.030	0.120	
		Analytical Result	0.02	0.058	--
Calcium	mg/L	Intrawell Background Value (UPL)	0.65	42.5	
		Analytical Result	0.2	40.1	--
Chloride	mg/L	Intrawell Background Value (UPL)	7.89	9.20	
		Analytical Result	7.08	7.68	--
Fluoride	mg/L	Intrawell Background Value (UPL)	1.00	1.00	
		Analytical Result	0.07	**1.22**	**1.39**
pH	SU	Intrawell Background Value (UPL)	4.8	4.3	
		Intrawell Background Value (LPL)	2.5	2.7	
		Analytical Result	4.3	3.4	--
Sulfate	mg/L	Intrawell Background Value (UPL)	15.8	1,388	
		Analytical Result	8.5	1,150	--
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	106	1,587	
		Analytical Result	65	**1,620**	1,510

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

Background values are shaded gray.

ATTACHMENT A

Certification by a Qualified Professional Engineer

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected statistical method, described above and in the January 3, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Pirkey Landfill CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
112498

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

10.02.2020
Date

STATISTICAL ANALYSIS SUMMARY
Background Update Calculations
H.W. Pirkey Power Plant
Landfill
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec
consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

January 27, 2021

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LIST OF ACRONYMS AND ABBREVIATIONS

ANOVA	Analysis of Variance
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Value
CFR	Code of Federal Regulations
LF	Landfill
LFB	Laboratory Fortified Blanks
LPL	Lower Prediction Limit
LRB	Laboratory Reagent Blanks
NELAP	National Environmental Laboratory Accreditation Program
PQL	Practical Quantitation Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR Subpart D, "CCR rule"), groundwater monitoring has been conducted at the lined landfill (LF), an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Eight monitoring events were completed prior to May 2017 to establish background concentrations for Appendix III and Appendix IV constituents under the CCR rule. A detection monitoring event was conducted in August 2017 with verification samples collected in December 2017. During the August 2017 monitoring event, statistically significant increases (SSIs) for boron, sulfate, and total dissolved solids (TDS) were observed, and the unit transitioned to assessment monitoring. Semiannual assessment monitoring events were conducted between March 2018 and May 2019. An ASD was prepared in 2020 that indicated that:

- Former mining activities in the vicinity of the LF (shown as 'A Area' in Figure 1) were affecting groundwater quality at monitoring well AD-34;
- Interwell statistics were not appropriate for the Pirkey LF; and,
- The unit could return to detection monitoring (Geosyntec, 2020a).

Since returning to detection monitoring, two detection monitoring events have been completed ([1] August 2019 with verification samples collected in January 2020 and [2] June 2020).

Data from the events conducted between August 2017 and June 2020, including both initial and verification results, were evaluated for inclusion in the background dataset. Additionally, data from eight background monitoring events at AD-36, which was installed to replace well AD-35 following its decommissioning, were evaluated to establish background concentrations for Appendix III constituents. Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. The compliance data were reviewed for outliers, which were removed (when appropriate) prior to updating prediction limits for Appendix III constituents to represent background values at AD-23 and AD-34 and establishing background at AD-36. Oversight on the use of statistical calculations was provided by Dr. Jim Loftis, senior advisor at GSC. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

LANDFILL EVALUATION

2.1 Previous Background Calculations

Eight background monitoring events were completed from May 2016 through April 2017 to establish background concentrations for Appendix III and Appendix IV constituents under the CCR rule. The data were reviewed for outliers and trends prior to calculating UPLs for the Appendix III constituents. A lower prediction limit (LPL) was also established for pH. Interwell prediction limits were selected for pH, sulfate, and TDS, and intrawell prediction limits were selected for boron, calcium, chloride, and fluoride. Both the interwell and intrawell tests used a one-of-two resampling plan. The statistical analyses to establish background levels were previously documented in the February 2018 *Statistical Analysis Summary* report (Geosyntec, 2018).

The Pirkey LF transitioned to assessment monitoring following completion of the August 2017 detection monitoring event. Semiannual assessment monitoring events were completed between March 2018 and May 2019 in accordance with 40 CFR 257.95. Following the collection of additional data in the vicinity of the LF in 2019, the conceptual site model was updated. It was determined that former mining activities in the vicinity of the LF (shown as ‘A Area’ in Figure 1) were affecting groundwater quality at monitoring well AD-34 (Geosyntec, 2020a). Thus, interwell prediction limits are not appropriate for the detection monitoring. The unit returned to detection monitoring, and intrawell prediction limits were calculated to reflect the variability in the site conditions.

Monitoring well AD-35 was decommissioned in November 2018 due to landfill expansion activities. AD-35 was replaced by a new downgradient monitoring well, AD-36, which was installed in April 2019 and added to the monitoring network. Eight samples were collected between August 2019 and July 2020 to establish Appendix III background values at AD-36 in accordance with the CCR Rule.

2.2 Data Validation & QA/QC

After the last background monitoring event in 2017, three semiannual detection monitoring events and four semiannual assessment monitoring events were conducted at the LF. If the initial results from a detection monitoring event identified possible exceedances, verification sampling was completed on an individual well/constituent basis. Samples were analyzed for the Appendix III constituents during the semiannual assessment monitoring events; thus, a minimum of four samples were collected from each compliance well since the last background update. A summary of data collected at existing wells AD-23 and AD-34 during these detection and assessment monitoring events may be found in Table 1. A summary of the data collected at new well AD-36 during the eight background monitoring events may be found in Table 2.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.27 statistics software. The export was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.3 Statistical Analysis

The data used to conduct the statistical analyses described below are summarized in Table 1 and Table 2. Statistical analyses for the LF were conducted in accordance with the October 2020 *Statistical Analysis Plan* (Geosyntec, 2020b), except where noted below. The complete statistical analysis results are included in Attachment B.

Time series plots of Appendix III constituents are included in Attachment B and were used to evaluate concentrations over time and to provide an initial screening of suspected outliers and trends. Box plots were also compiled to provide visual representation of variations between wells and within individual wells (Attachment B).

2.3.1 Outlier Evaluation

Potential outliers were evaluated using Tukey’s outlier test; i.e., data points were considered potential outliers if they met one of the following criteria:

$$x_i < \tilde{x}_{0.25} - 3 \times IQR \quad (1)$$

or

$$x_i > \tilde{x}_{0.75} + 3 \times IQR \quad (2)$$

where:

$x_i =$ individual data point
$\tilde{x}_{0.25} =$ first quartile
$\tilde{x}_{0.75} =$ third quartile
$IQR =$ the interquartile range $= \tilde{x}_{0.75} - \tilde{x}_{0.25}$

Tukey’s outlier test indicated select values for boron and sulfate at upgradient well AD-27 and TDS at upgradient well AD-8 could be considered outliers. Additionally, the August 13, 2019 chloride value at AD-36 and TDS value at AD-23 could be considered outliers. However, these values were not removed from the dataset as they appeared to represent variation in natural groundwater concentrations (Attachment B).

2.3.2 AD-23 and AD-34 Prediction Limit Update

2.3.2.1 Establishment of Updated Background Dataset

Analysis of variance (ANOVA) was conducted during the initial background screening to assist in identifying if intrawell tests are the most appropriate statistical approach for assessing Appendix III constituents. Intrawell tests compare compliance data from a single well to background data within the same well and are most appropriate (1) when upgradient wells exhibit spatial variation; (2) when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective; or (3) when downgradient water quality is not impacted compared to upgradient water quality for the same constituent. Intrawell tests were used to evaluate potential SSIs for boron, calcium, chloride, and fluoride. Interwell tests were originally used to evaluate potential SSIs for pH, sulfate, and TDS. However, because former mining activities in the vicinity of the LF affect groundwater quality at monitoring well AD-34 (Geosyntec, 2020a), intrawell tests will be used to evaluate potential SSIs for all Appendix III constituents moving forward.

Periodic updating of background statistical limits is necessary as natural systems continuously change due to physical changes to the environment. For intrawell analyses, data for all wells and constituents are re-evaluated when a minimum of four new data points are available. These four (or more) new data points are used to compare against the existing background dataset.

Mann-Whitney (Wilcoxon rank-sum) tests were used to compare the medians of historical data (May 2016 – April 2017) to the new compliance samples (August 2017 – June 2020 [July 2020 for fluoride, TDS, and pH at AD-34]). Results were evaluated to determine if the medians of the two groups were similar at the 99% confidence level. Where no significant difference was found, the new compliance data were added to the background dataset. Where a statistically significant difference was found between the medians of the two groups, the data were reviewed to evaluate the cause of the difference and to determine if adding newer data to the background dataset, replacing the background dataset with the newer data, or continuing to use the existing background dataset was most appropriate. If the differences appeared to have been caused by a release, then the previous background dataset would have continued to be used.

The complete Mann-Whitney test results and a summary of the significant findings can be found in Attachment B. Statistically significant differences were found for calcium in upgradient well AD-16, chloride in upgradient wells AD-16 and AD-27, and pH at upgradient well AD-16. The more recent calcium values at AD-16 are lower than the initial background dataset, whereas the more recent chloride values at AD-16 and AD-27 are slightly higher than the initial background dataset. While the more recent chloride values at AD-16 and AD-27 are slightly higher than the initial background dataset, concentrations at both wells are still low and generally consistent with values at other wells in the network. Because AD-16 and AD-27 are upgradient wells and represent natural variability upgradient of the unit, the earlier sample results were deselected so that only the most recent eight data points will be used for calcium at AD-16 and chloride at AD-16 and AD-27. For pH at AD-16, the recent concentrations were only slightly higher than the initial dataset and all values were used in the prediction limit calculations. Because intrawell prediction limits are used for all Appendix III constituents, the selection of background datasets at upgradient wells will not affect the calculation of background prediction limits.

2.3.2.2 Updated Prediction Limits

After the revised background dataset was established, a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., “J-flagged” data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment B.

Intrawell UPLs were updated using all the historical data through June 2020 to represent background values for all Appendix III constituents at AD-23 and AD-24. The verification sample collected for fluoride, pH, and TDS at AD-34 in July 2020 was also included in the background update. Intrawell LPLs were also updated for pH. The updated prediction limits are summarized in Table 3.

The intrawell UPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where the initial result does not exceed the UPL, a second sample will not be collected. The retesting procedures allowed achieving an acceptably high statistical power to detect changes at downgradient wells for constituents evaluated using intrawell prediction limits.

2.3.3 AD-36 Prediction Limit Establishment

As eight groundwater sampling events have been completed at AD-36, which was recently added to the well network, prediction limits were established for Appendix III constituents using those eight events as the background dataset. The same approach outlined in Section 2.3.2.2 was used for the AD-36 dataset. Additionally, trend tests were completed to evaluate if significant trends were present at AD-36. No significant trends were identified for Appendix III constituents at AD-36 (Appendix A).

Intrawell UPLs were calculated using the complete background dataset to represent background values for all Appendix III constituents at AD-36. Intrawell LPLs were also updated for pH. The updated prediction limits are summarized in Table 3. The intrawell UPLs were calculated for a one-of-two retesting procedure. The retesting procedures allowed achieving an acceptably high statistical power to detect changes at downgradient wells for constituents evaluated using intrawell prediction limits.

2.4 Conclusions

Semiannual detection or assessment monitoring events have been completed at AD-23 and AD-34 in accordance with the CCR Rule since May 2017. Eight background events have been completed at AD-36 in accordance with the CCR Rule since August 2019. The laboratory and field data from these events were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. At AD-23 and AD-34, Mann-Whitney tests were completed to evaluate whether data from the detection monitoring events could be added to the existing background datasets. The background datasets were updated, and UPLs and LPLs were recalculated using intrawell prediction limits with a one-of-two retesting procedure for all Appendix III constituents. At AD-36, the background dataset was established, and UPLs and LPLs were calculated using intrawell prediction limits with a one-of-two retesting procedure for all Appendix III constituents.

SECTION 3

REFERENCES

Geosyntec Consultants, 2018. Statistical Analysis Summary. Landfill – H.W. Pirkey Plant. February.

Geosyntec Consultants, 2020a. Alternative Source Demonstration Report. Federal CCR Rule – H.W. Pirkey Power Plant Landfill. January.

Geosyntec Consultants, 2020b. Statistical Analysis Plan – Pirkey Plant. October.

TABLES

Table 1: Groundwater Data Summary
H.W. Pirkey Plant - Landfill

Parameter	Unit	AD-8							AD-12							
		8/23/2017	**3/21/2018**	**8/20/2018**	**2/28/2019**	**5/21/2019**	**8/13/2019**	**6/3/2020**	**8/23/2017**	**3/21/2018**	**8/20/2018**	**2/27/2019**	**5/21/2019**	**8/12/2019**	**3/10/2020**	**6/2/2020**
Boron	mg/L	0.411	1.03	0.714	1.05	1.11	0.818	0.783	0.0495	0.01397	0.0170	0.0300 J	0.0200	0.05 U	0.02 J	0.05 U
Calcium	mg/L	19.4	56.1	14.5	103	85.5	27.6	74.4	0.245	0.269	0.338	0.400 J	0.300 J	0.278	0.3 J	0.2 J
Chloride	mg/L	9.00	8.00	18.0	6.83	4.48	12.7	11.5	6.00	5.00	10.0	6.08	6.30	7.24	6.08	5.63
Fluoride	mg/L	0.587 J	1.1987	5.1991	0.400	0.330	3.39	2.45	0.213 J	1 U	1 U	0.0900	0.0900	0.0600 J	0.10	0.10
Sulfate	mg/L	56.0	140	168	175	127	128	196	6.00	3.00	4.00	3.60	4.00	2.60	3.7	3.9
Total Dissolved Solids	mg/L	110	278	300	462	296	260	396	52.0	5 U	94.0	36.0	80.0	90.0	62	91
pH	SU	3.9	5.7	3.7	5.7	5.9	4.6	5.8	4.8	4.2	4.4	5.2	4.1	4.9	4.9	4.0

Parameter	Unit	AD-16							AD-23								
		8/24/2017	**3/22/2018**	**8/21/2018**	**2/27/2019**	**5/23/2019**	**8/15/2019**	**6/3/2020**	**8/23/2017**	**12/21/2017**	**3/21/2018**	**8/20/2018**	**2/28/2019**	**5/23/2019**	**8/13/2019**	**1/27/2020**	**6/3/2020**
Boron	mg/L	0.03648	0.0171	0.0200	0.0300 J	0.0220	0.05 U	0.05 U	0.04021	0.04498	0.01762	0.0170	0.0200 J	0.0170	0.05 U	--	0.05 U
Calcium	mg/L	0.945	1.03	1.17	0.704	1.06	0.874	0.872	0.276	0.469	0.227	0.247	0.300 J	0.300 J	0.325	--	0.2 J
Chloride	mg/L	12.0	14.0	17.0	20.3	20.8	20.0	21.7	6.00	--	4.00	9.00	6.94	6.82	7.12	--	7.08
Fluoride	mg/L	1 U	1 U	1 U	0.0700 J	0.0600 J	0.0600 J	0.11	0.198 J	--	1 U	1 U	0.0400 J	0.0400 J	0.0300 J	--	0.07
Sulfate	mg/L	14.0	13.0	15.0	17.7	26.9	15.4	13.3	11.0	--	10.0	11.0	7.20	9.10	7.40	--	8.5
Total Dissolved Solids	mg/L	96.0	96.0	128	76.0	128	110	122	64.0	--	72.0	92.0	70.0	54.0	126	70.0 J	65
pH	SU	4.3	4.0	4.0	4.1	4.6	5.1	4.7	4.1	--	3.9	3.8	5.1	4.8	5.0	4.3	4.3

Parameter	Unit	AD-27							AD-34										
		8/24/2017	**3/22/2018**	**8/21/2018**	**2/28/2019**	**5/23/2019**	**8/16/2019**	**6/3/2020**	**8/23/2017**	**12/21/2017**	**3/21/2018**	**8/20/2018**	**2/27/2019**	**5/21/2019**	**8/13/2019**	**1/27/2020**	**3/11/2020**	**6/3/2020**	**7/15/2020**
Boron	mg/L	0.0358	0.03901	0.0240	0.0700 J	0.0230	0.0200 J	0.03 J	0.107	--	0.171	0.0670	0.0800 J	0.0600	0.0700	--	--	0.058	--
Calcium	mg/L	3.58	5.58	4.58	4.02	3.89	3.94	3.55	36.2	--	40.1	37.0	39.9	42.0	39.8	--	--	40.1	--
Chloride	mg/L	9.00	11.0	10.0	11.7	11.4	10.5	12.8	7.00	8.00	6.00	10.0	7.64	7.34	7.46	--	--	7.68	--
Fluoride	mg/L	0.197 J	1 U	1 U	0.200	0.200	0.180	0.25	0.619 J	0.6669 J	1 U	1 U	0.860	0.690	1.13	0.900	--	1.22	1.39
Sulfate	mg/L	52.0	78.0	65.0	52.8	55.2	53.2	54.6	1,231	1,020	956	1,064	970	1,080	1,060	--	--	1,150	--
Total Dissolved Solids	mg/L	168	192	196	42.0	204	198	219	1,128	1,260	1,424	1,462	1,470	1,154	1,648	1,550	--	1,620	1,510
pH	SU	3.7	3.9	3.5	4.7	4.4	3.9	4.3	3.7	--	3.7	3.7	2.9	3.3	3.7	3.6	3.6	3.4	4.1

Notes:
mg/L: milligrams per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
--: Not Measured

Table 2: AD-36 Background Groundwater Data Summary
H.W. Pirkey Plant - Landfill

Parameter	Unit	8/13/2019	1/27/2020	3/11/2020	4/15/2020	5/13/2020	6/3/2020	6/16/2020	7/1/2020	7/15/2020
Boron	mg/L	0.0650	0.056	0.05 J	0.054	0.055	0.052	0.064	0.059	--
Calcium	mg/L	0.240	0.304	0.2 J	0.2 J	0.2 J	0.2 J	0.2 J	0.3 J	--
Chloride	mg/L	9.46	8.65	8.44	8.40	8.56	8.52	8.39	--	8.09
Fluoride	mg/L	0.0500 J	0.05 J	0.06	0.05 J	0.05 J	0.07	0.05 J	--	0.08
Sulfate	mg/L	2.20	3.5	3.7	3.7	3.4	3.3	3.6	--	3.7
Total Dissolved Solids	mg/L	92.0	40 J	60 J	40 J	40 J	65	50 J	52	--
pH	SU	4.7	4.7	5.0	3.6	4.1	4.6	4.6	4.9	5.0

Notes:
mg/L: milligrams per liter
SU: standard unit
J: Estimated value. Parameter was detected in concentrations below the reporting limit.

Table 3: Revised Prediction Limit Summary
H.W. Pirkey Plant - Landfill

Parameter	Unit	Description	AD-23	AD-34	AD-36
Boron	mg/L	Intrawell Background Value (UPL)	0.0433	0.145	0.0702
Calcium	mg/L	Intrawell Background Value (UPL)	0.536	42.8	0.304
Chloride	mg/L	Intrawell Background Value (UPL)	8.88	9.35	9.54
Fluoride	mg/L	Intrawell Background Value (UPL)	1.00	1.29	0.0800
pH	SU	Intrawell Background Value (UPL)	5.2	4.2	5.7
		Intrawell Background Value (LPL)	2.8	2.9	3.5
Sulfate	mg/L	Intrawell Background Value (UPL)	14.5	1,280	4.20
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	111	1,700	98.5

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

FIGURES

Legend

- ⊕ Upgradient Well
- ⊕ Downgradient Well
- ⊕ Out of Network Well
- ⊕ Abandoned Well
- ▭ A Area
- ▭ Landfill

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- A Area is a former lignite (reclaimed) mine.
- AD-35 was abandoned in November 2018 and a new downgradient well, AD-36, was installed in April 2019.
- Aerial imagery provided by DigitalGlobe and dated 12/1/2018.

1,000 500 0 1,000
Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2020/01/06

Figure
1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Sitelayout_20191224.mxd. ARevezzo. 1/6/2020. Project/Phase/Task.

ATTACHMENT A

Certification by a Qualified Professional Engineer

Certification by a Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the H. W. Pirkey Plant Landfill CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

DAVID ANTHONY MILLER
112498

112498
License Number

TEXAS
Licensing State

01.27.2021
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

December 4, 2020

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey Landfill
Background Update – 2020

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the 2020 background update of groundwater data at American Electric Power Company's Pirkey Landfill. This site is in Detection Monitoring and the analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, is listed below. Note that downgradient well AD-35 was originally in the well network but has been abandoned and replaced with well AD-36.

- **Upgradient wells:** AD-8, AD-12, AD-16, and AD-27
- **Downgradient wells:** AD-23, AD-34, and AD-36

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC. During this analysis, proposed background data from replacement well AD-36 were screened, and data from all other wells were also screened for updating background statistical limits as described below.

The CCR program consists of the following Appendix III constituents:

- boron, calcium, chloride, fluoride, pH, sulfate, and TDS

Time series plots for these parameters at all wells are provided for the purpose of screening data at these wells (Figure A). Additionally, a separate section of box plots is included for all constituents at upgradient and downgradient wells (Figure B). The time series plots are used to initially screen for suspected outliers and trends, while the box plots provide visual representation of variation within individual wells and between all wells. When values in background have been flagged as outliers, they may be seen in a lighter font and as a disconnected symbol on the graphs.

In earlier analyses, data at all wells were evaluated for the following: 1) outliers; 2) trends; 3) most appropriate statistical method for Appendix III parameters based on site characteristics of groundwater data upgradient of the facility; and 4) eligibility of downgradient wells when intrawell statistical methods are recommended. Additionally, further studies conducted by Geosyntec Consultants since the original background screening support the use of intrawell methods due to the presence of mine spoils underlying well AD-34.

Power curves are provided to demonstrate that the selected statistical methods for Appendix III parameters comply with the USEPA Unified Guidance. The EPA suggests the selected statistical method should provide at least 55% power at 3 standard deviations or at least 80% power at 4 standard deviations.

Summary of Statistical Methods:

- Intrawell prediction limits, combined with a 1-of-2 resample plan for boron, calcium, chloride, fluoride, pH, sulfate, and TDS

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. While the false positive rate associated with the parametric limits is based on an annual 10% (5% per semi-annual event) as recommended by the EPA Unified Guidance (2009), the false positive rate associated with the nonparametric limits is dependent upon the available background sample size, number of future comparisons, and verification resample plan. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).

- When data contain <15% nondetects in background, simple substitution of one-half the reporting limit is utilized in the statistical analysis. The reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory.

- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.

- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Natural systems continuously evolve due to physical changes made to the environment. Examples include capping a landfill, paving areas near a well, or lining a drainage channel to prevent erosion. Periodic updating of background statistical limits is necessary to accommodate these types of changes. In the intrawell case, data for all wells and constituents may be re-evaluated when a minimum of 4 new data points are available to determine whether earlier concentrations are representative of present-day groundwater quality. In some cases, the earlier portion of data is deselected prior to construction of limits to provide sensitive limits that will rapidly detect changes in groundwater quality. Even though the data are excluded from the calculation, the values will continue to be reported and shown in tables and graphs.

Appendix III Background Update Summary – 2020

Prior to updating background data, samples were evaluated using Tukey's outlier test and visual screening through the July 2020 sample event. Tukey's outlier test only noted outliers for boron in upgradient well AD-27, chloride in well AD-36, sulfate in upgradient well AD-27, and TDS in well AD-23 and upgradient well AD-8 among the Appendix III parameters. However, none of the identified values were flagged as outliers since they appear to be representative of natural variation in groundwater quality. A summary of Tukey's test results follows this letter (Figure C).

The Sen's Slope/Mann Kendall trend test was used to evaluate all proposed background data at well AD-36 to identify statistically significant increasing or decreasing trends (Figure D). While trends may be visual, a quantification of the trend and its significance is needed. In the absence of suspected contamination, significant trending data are typically not included as part of the background data used for construction of prediction limits. The Sen's Slope/Mann Kendall trend test did not identify any statistically significant increasing or decreasing trends. A summary of those results follows this letter.

For all Appendix III parameters at all other wells besides AD-36, the Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through April 2017 to the new compliance samples at each well through July 2020 (Figure E). The test evaluates whether the groups are statistically different at the 99% confidence level. If no significant difference is found, background data may be updated with compliance data. The following well/constituent pairs had statistically significant higher medians in more recent data:

- Chloride: AD-16 (upgradient) and AD-27 (upgradient)
- ph: AD-16 (upgradient)

The following well/constituent pair had a statistically significant lower median in more recent data when compared to historical data:

- Calcium: AD-16 (upgradient)

Typically, when the test concludes that the medians of the two groups are significantly different, particularly in the downgradient wells, the background data are not updated to include the newer data but will be reconsidered in the future. However, since these differences occurred upgradient of the facility for each of the parameters above and represent natural variation in groundwater quality, the earlier portions of the records were deselected prior to construction of statistical limits so that limits are more representative of present-day water quality conditions. All records for these well/constituent pairs will utilize the most recent 8 measurements beginning from 4/10/2017. One exception is for pH where the most recent concentrations were only slightly higher than the earlier measurements. The test results are included with the Mann Whitney test section at the end of this report.

Intrawell prediction limits using all historical data through July 2020, except for the cases mentioned above which use truncated portions of the most recent data through July 2020, combined with a 1-of-2 resample plan, were constructed, and a summary of the updated limits follows this letter (Figure F).

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Landfill. If you have any questions or comments, please feel free to contact us.

For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Date Ranges

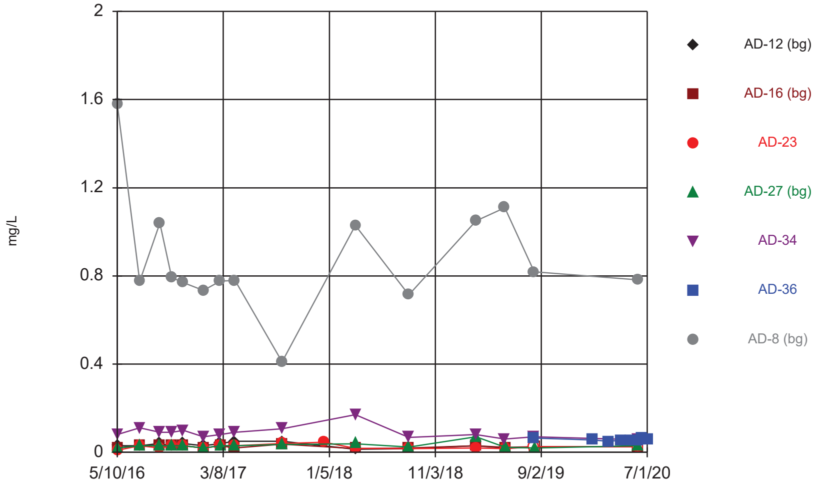
Date: 12/3/2020 12:32 PM

Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Calcium, total (mg/L)
  AD-16 background:4/10/2017-6/3/2020
Chloride, total (mg/L)
  AD-16 background:4/10/2017-6/3/2020
  AD-27 background:4/10/2017-6/3/2020

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

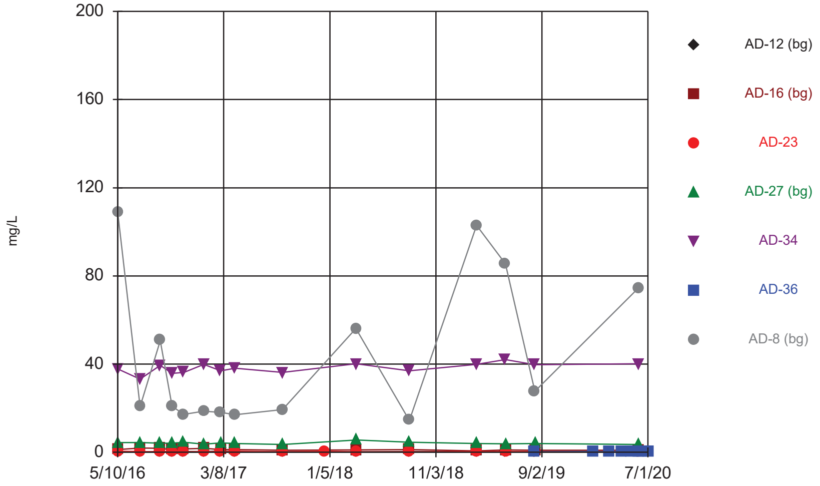
Time Series



Constituent: Boron, total Analysis Run 12/3/2020 12:36 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

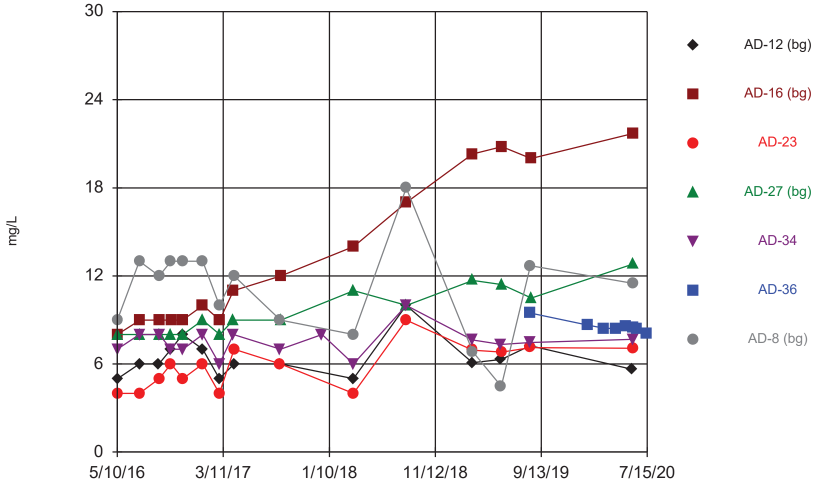
Time Series



Constituent: Calcium, total Analysis Run 12/3/2020 12:36 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

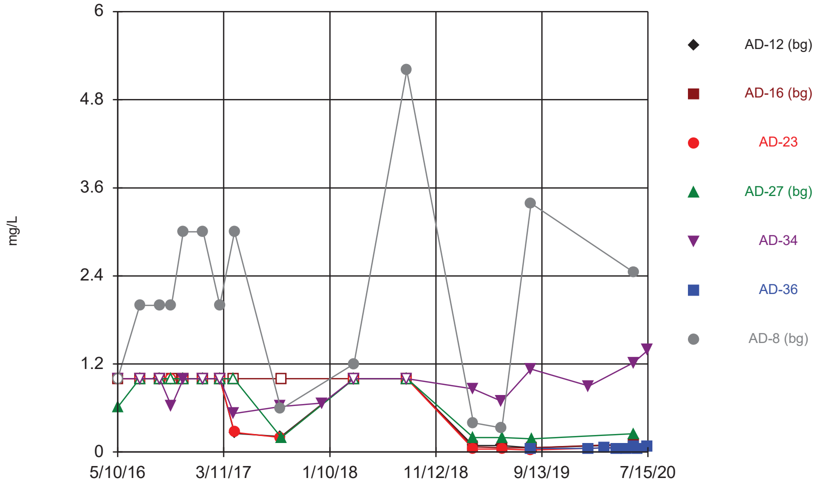
Time Series



Constituent: Chloride, total Analysis Run 12/3/2020 12:36 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

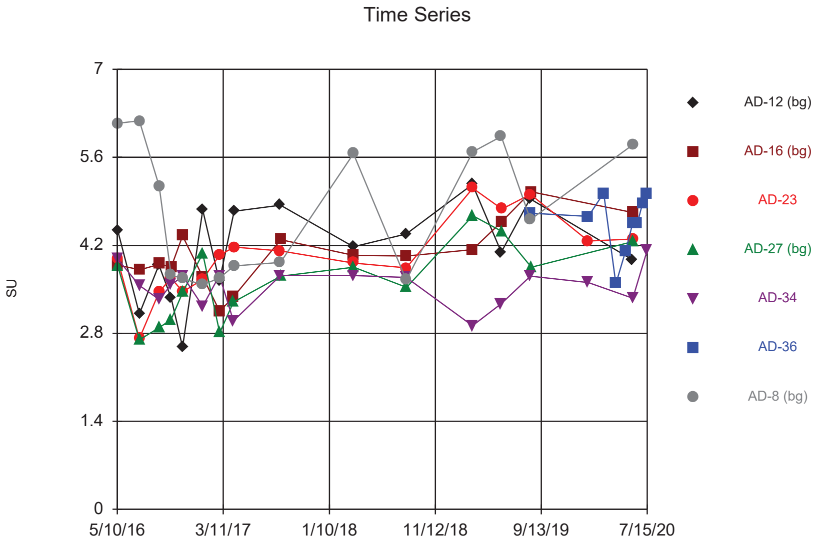
Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



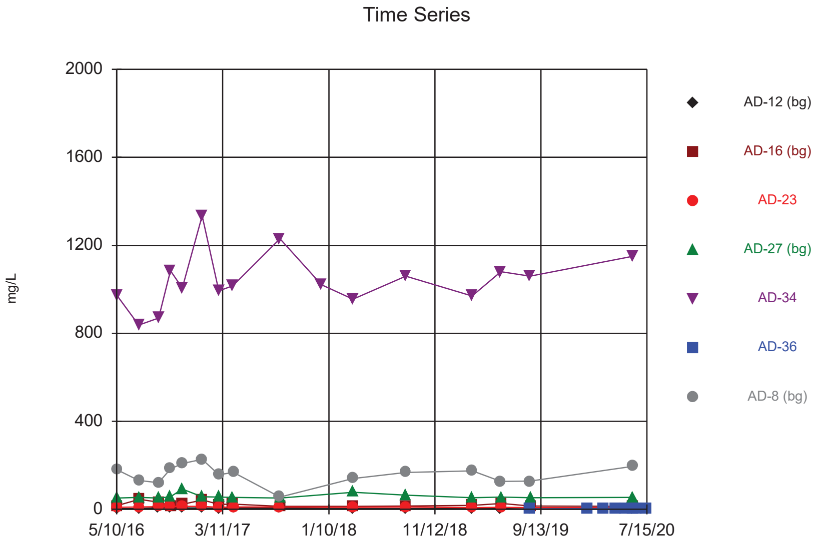
Constituent: Fluoride, total Analysis Run 12/3/2020 12:36 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



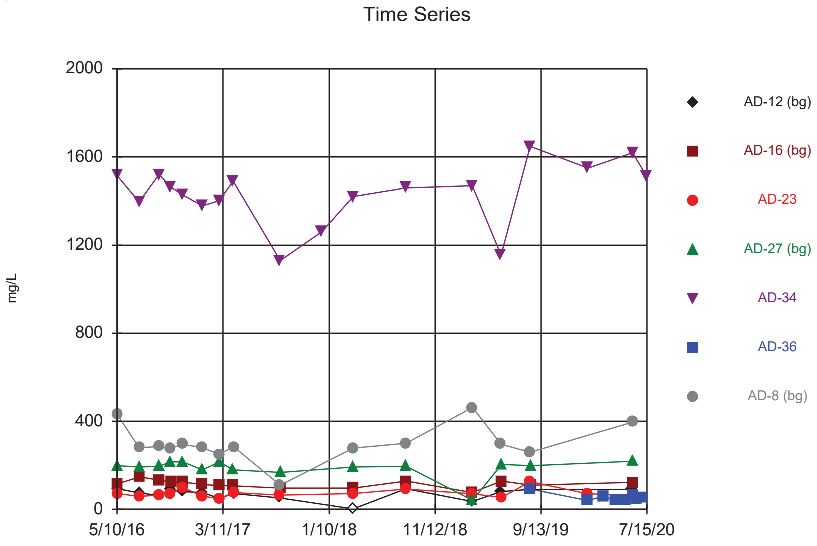
Constituent: pH, field Analysis Run 12/3/2020 12:36 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



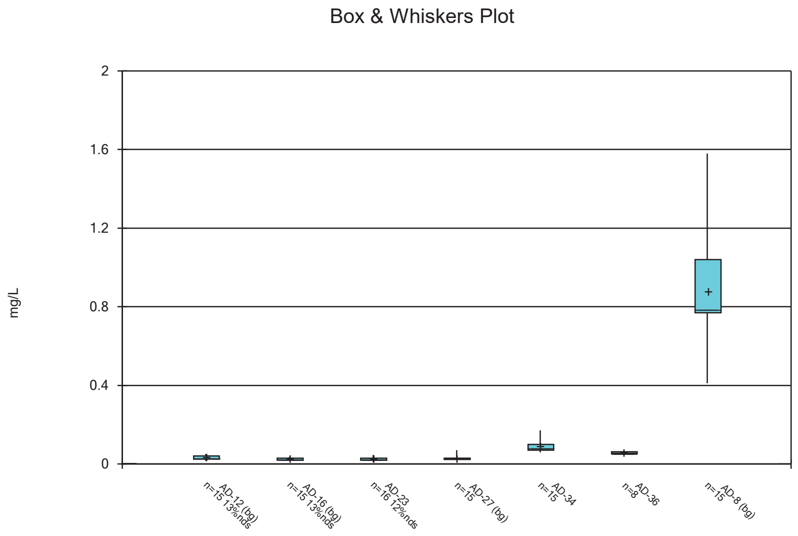
Constituent: Sulfate, total Analysis Run 12/3/2020 12:36 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



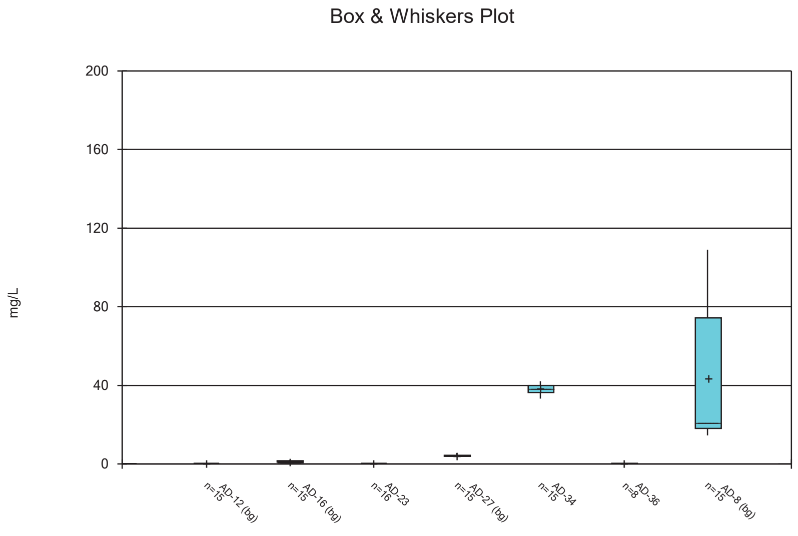
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/3/2020 12:36 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



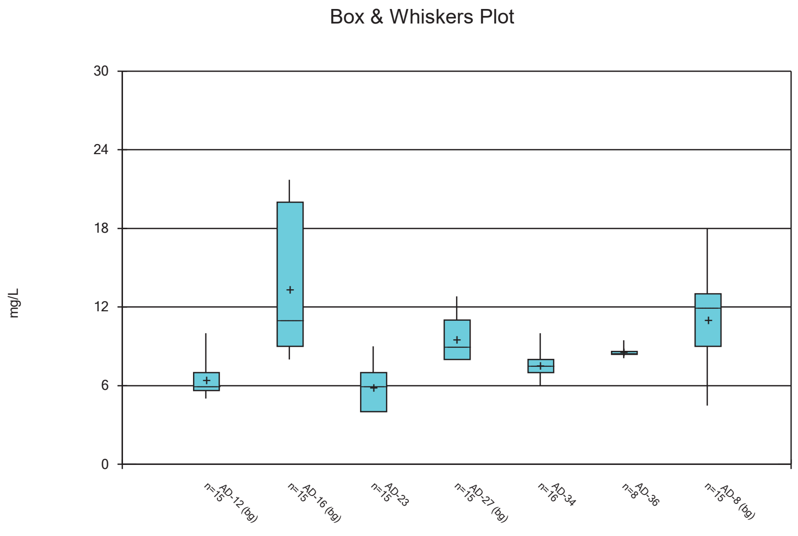
Constituent: Boron, total Analysis Run 12/3/2020 12:37 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



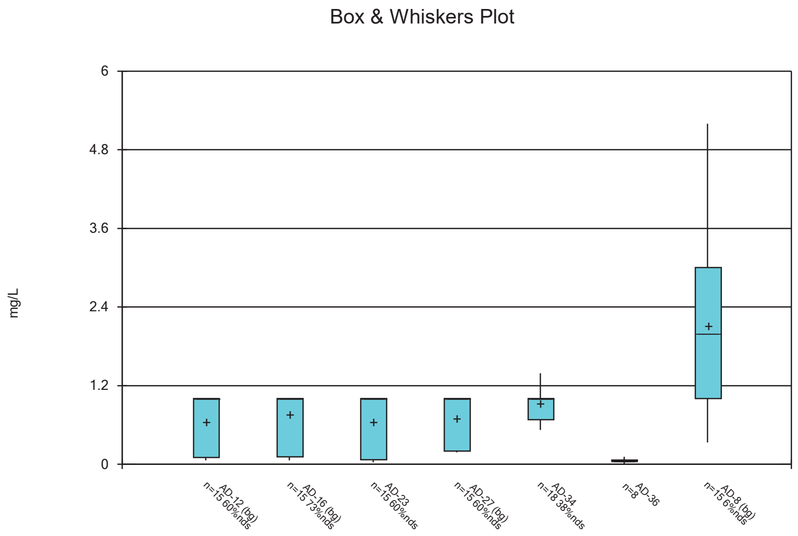
Constituent: Calcium, total Analysis Run 12/3/2020 12:37 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



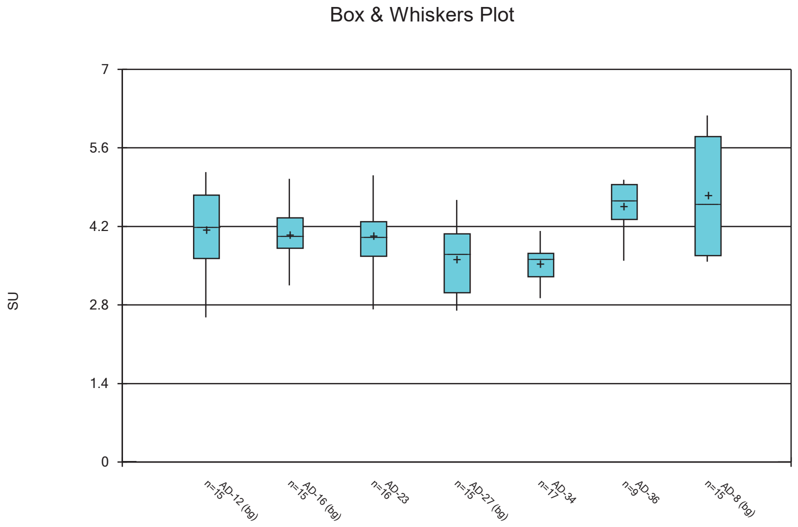
Constituent: Chloride, total Analysis Run 12/3/2020 12:37 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



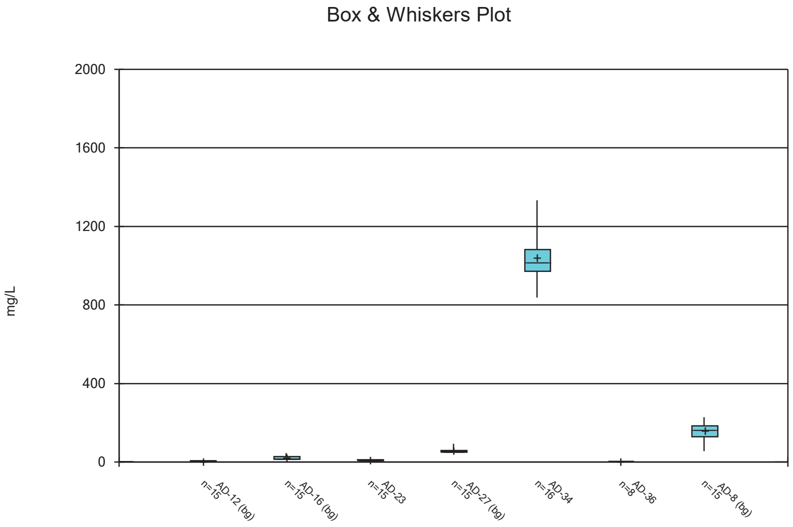
Constituent: Fluoride, total Analysis Run 12/3/2020 12:37 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



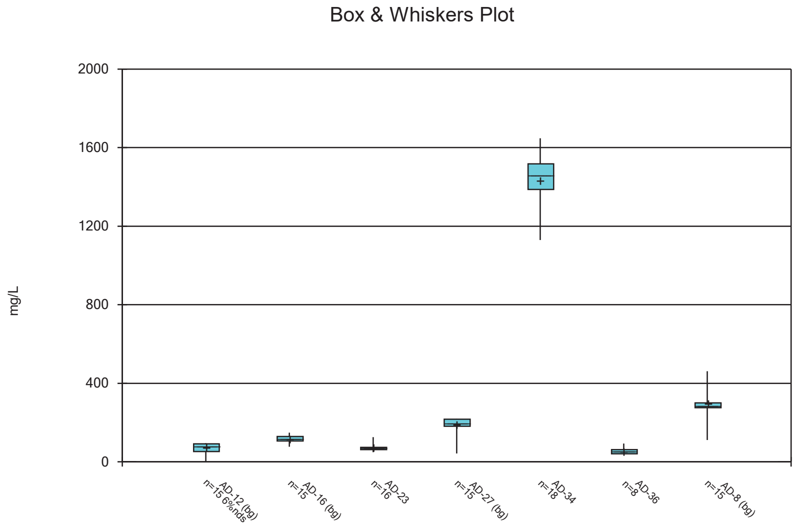
Constituent: pH, field Analysis Run 12/3/2020 12:37 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Sulfate, total Analysis Run 12/3/2020 12:37 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/3/2020 12:37 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Outlier Summary

Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill   Printed 12/2/2020, 4:48 PM

No values flagged as outliers.

Outlier Analysis - Significant Results

Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill Printed 12/2/2020, 4:59 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Boron, total (mg/L)	**AD-27 (bg)**	**Yes**	**0.07**	**NP**	**15**	**0.03079**	**0.01222**	**ln(x)**	**ShapiroWilk**
Chloride, total (mg/L)	**AD-36**	**Yes**	**9.46**	**NP**	**8**	**8.564**	**0.3981**	**ln(x)**	**ShapiroWilk**
Sulfate, total (mg/L)	**AD-27 (bg)**	**Yes**	**92,78**	**NP**	**15**	**59.05**	**11.39**	**ln(x)**	**ShapiroWilk**
Total Dissolved Solids [TDS] (mg/L)	**AD-23**	**Yes**	**126**	**NP**	**16**	**72.5**	**19.19**	**ln(x)**	**ShapiroWilk**
Total Dissolved Solids [TDS] (mg/L)	**AD-8 (bg)**	**Yes**	**432,110,462,396**	**NP**	**15**	**299**	**82.57**	**normal**	**ShapiroWilk**

Outlier Analysis - All Results

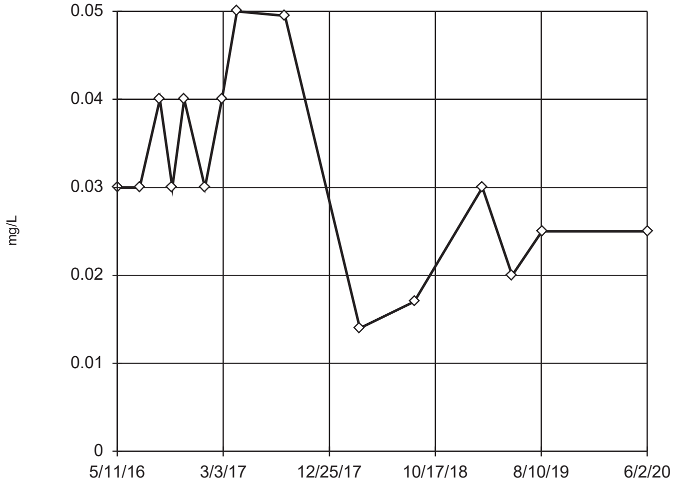
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill   Printed 12/2/2020, 4:59 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Boron, total (mg/L)	AD-12 (bg)	No	n/a	NP	15	0.03137	0.01078	sqrt(x)	ShapiroWilk
Boron, total (mg/L)	AD-16 (bg)	No	n/a	NP	15	0.02571	0.005645	x^(1/3)	ShapiroWilk
Boron, total (mg/L)	AD-23	No	n/a	NP	16	0.02542	0.009074	x^(1/3)	ShapiroWilk
Boron, total (mg/L)	**AD-27 (bg)**	**Yes**	**0.07**	**NP**	**15**	**0.03079**	**0.01222**	**ln(x)**	**ShapiroWilk**
Boron, total (mg/L)	AD-34	No	n/a	NP	15	0.08827	0.0279	ln(x)	ShapiroWilk
Boron, total (mg/L)	AD-36	No	n/a	NP	8	0.05688	0.00541	ln(x)	ShapiroWilk
Boron, total (mg/L)	AD-8 (bg)	No	n/a	NP	15	0.8775	0.261	x^(1/3)	ShapiroWilk
Calcium, total (mg/L)	AD-12 (bg)	No	n/a	NP	15	0.3097	0.06082	x^(1/3)	ShapiroWilk
Calcium, total (mg/L)	AD-16 (bg)	No	n/a	NP	15	1.246	0.3825	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-23	No	n/a	NP	16	0.3191	0.106	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-27 (bg)	No	n/a	NP	15	4.188	0.5016	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-34	No	n/a	NP	15	38.19	2.285	x^4	ShapiroWilk
Calcium, total (mg/L)	AD-36	No	n/a	NP	8	0.2305	0.04625	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-8 (bg)	No	n/a	NP	15	43.51	33.94	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-12 (bg)	No	n/a	NP	15	6.417	1.314	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-16 (bg)	No	n/a	NP	15	13.32	5.164	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-23	No	n/a	NP	15	5.864	1.505	normal	ShapiroWilk
Chloride, total (mg/L)	AD-27 (bg)	No	n/a	NP	15	9.493	1.628	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-34	No	n/a	NP	16	7.508	0.9337	ln(x)	ShapiroWilk
Chloride, total (mg/L)	**AD-36**	**Yes**	**9.46**	**NP**	**8**	**8.564**	**0.3981**	**ln(x)**	**ShapiroWilk**
Chloride, total (mg/L)	AD-8 (bg)	No	n/a	NP	15	11.03	3.252	normal	ShapiroWilk
Fluoride, total (mg/L)	AD-12 (bg)	No	n/a	NP	15	0.654	0.4413	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-16 (bg)	No	n/a	NP	15	0.7533	0.4236	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-23	No	n/a	NP	15	0.6431	0.4564	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-27 (bg)	No	n/a	NP	15	0.7096	0.3818	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-34	No	n/a	NP	18	0.9236	0.2249	normal	ShapiroWilk
Fluoride, total (mg/L)	AD-36	No	n/a	NP	8	0.0575	0.01165	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-8 (bg)	No	n/a	NP	15	2.104	1.315	sqrt(x)	ShapiroWilk
pH, field (SU)	AD-12 (bg)	No	n/a	NP	15	4.139	0.7332	x^3	ShapiroWilk
pH, field (SU)	AD-16 (bg)	No	n/a	NP	15	4.058	0.4938	sqrt(x)	ShapiroWilk
pH, field (SU)	AD-23	No	n/a	NP	16	4.033	0.6067	normal	ShapiroWilk
pH, field (SU)	AD-27 (bg)	No	n/a	NP	15	3.628	0.6016	normal	ShapiroWilk
pH, field (SU)	AD-34	No	n/a	NP	17	3.544	0.3201	x^2	ShapiroWilk
pH, field (SU)	AD-36	No	n/a	NP	9	4.566	0.4632	x^6	ShapiroWilk
pH, field (SU)	AD-8 (bg)	No	n/a	NP	15	4.75	1.061	x^2	ShapiroWilk
Sulfate, total (mg/L)	AD-12 (bg)	No	n/a	NP	15	4.873	1.641	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-16 (bg)	No	n/a	NP	15	22.49	10.42	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-23	No	n/a	NP	15	10.48	2.021	normal	ShapiroWilk
Sulfate, total (mg/L)	**AD-27 (bg)**	**Yes**	**92,78**	**NP**	**15**	**59.05**	**11.39**	**ln(x)**	**ShapiroWilk**
Sulfate, total (mg/L)	AD-34	No	n/a	NP	16	1040	123.8	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-36	No	n/a	NP	8	3.388	0.5027	x^6	ShapiroWilk
Sulfate, total (mg/L)	AD-8 (bg)	No	n/a	NP	15	157.9	42.45	x^2	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	No	n/a	NP	15	69.83	25.67	x^2	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-16 (bg)	No	n/a	NP	15	115.1	17.67	x^2	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	**AD-23**	**Yes**	**126**	**NP**	**16**	**72.5**	**19.19**	**ln(x)**	**ShapiroWilk**
Total Dissolved Solids [TDS] (mg/L)	AD-27 (bg)	No	n/a	NP	15	187.5	42.9	x^5	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-34	No	n/a	NP	18	1434	138.6	x^5	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-36	No	n/a	NP	8	54.88	17.74	ln(x)	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	**AD-8 (bg)**	**Yes**	**432,110,462,396**	**NP**	**15**	**299**	**82.57**	**normal**	**ShapiroWilk**

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-12 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1061, low cutoff = 0.001053, based on IQR multiplier of 3.

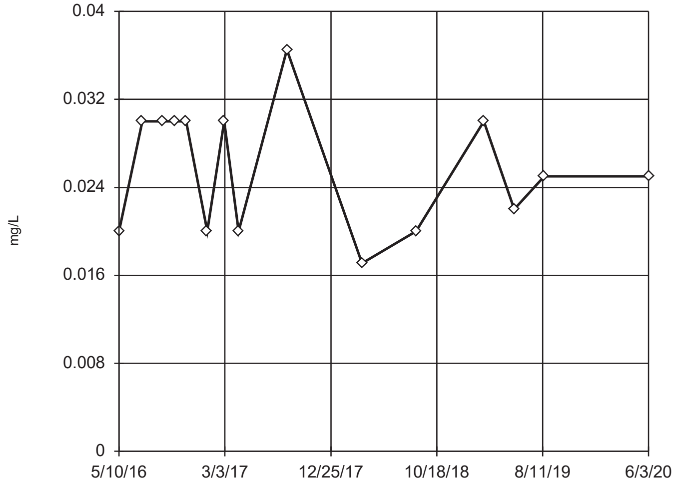
Constituent: Boron, total Analysis Run 12/2/2020 4:54 PM View: Descriptive

Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-16 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.07872, low cutoff = 0.003624, based on IQR multiplier of 3.

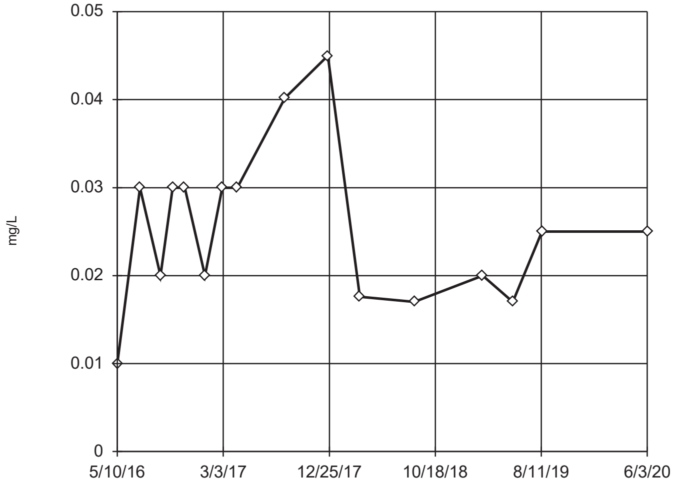
Constituent: Boron, total Analysis Run 12/2/2020 4:54 PM View: Descriptive

Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-23



n = 16

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.08845, low cutoff = 0.002246, based on IQR multiplier of 3.

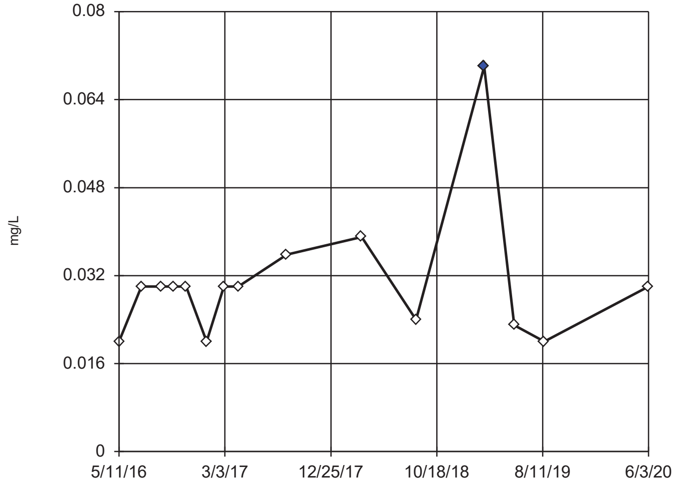
Constituent: Boron, total Analysis Run 12/2/2020 4:54 PM View: Descriptive

Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-27 (bg)



n = 15

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.06657, low cutoff = 0.01036, based on IQR multiplier of 3.

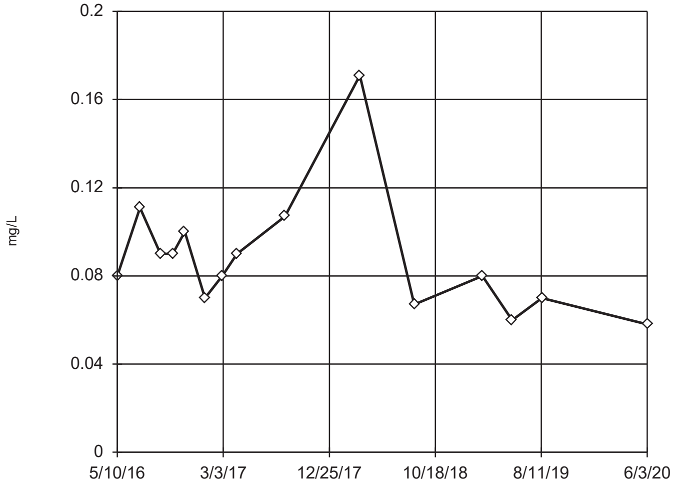
Constituent: Boron, total Analysis Run 12/2/2020 4:54 PM View: Descriptive

Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-34



n = 15

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

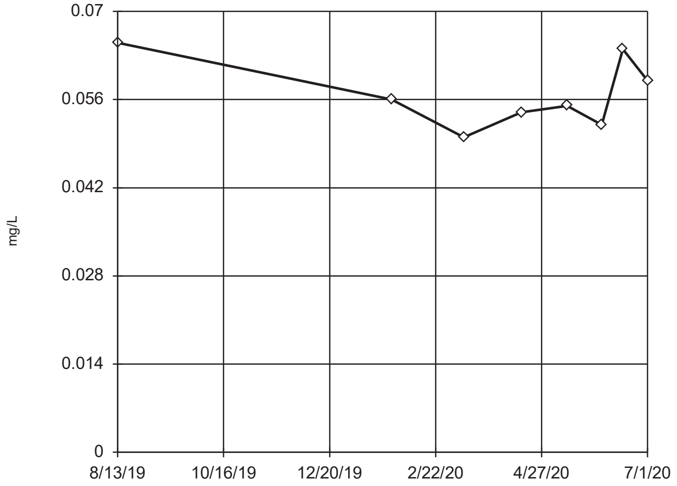
High cutoff = 0.2915, low cutoff = 0.02401, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 12/2/2020 4:54 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-36



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

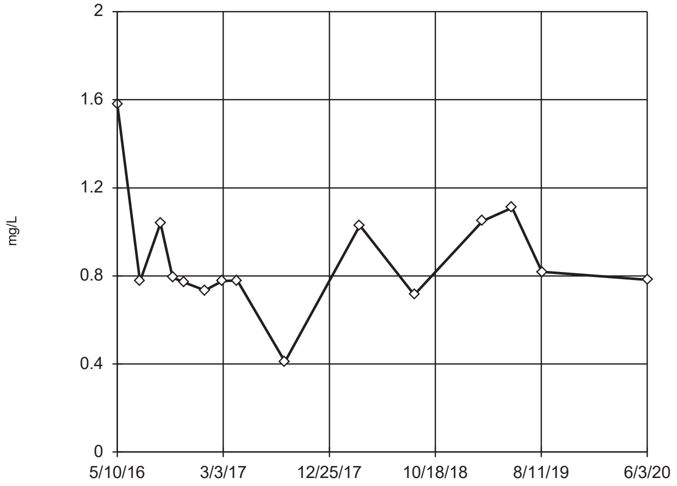
High cutoff = 0.09582, low cutoff = 0.03398, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 12/2/2020 4:54 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-8 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

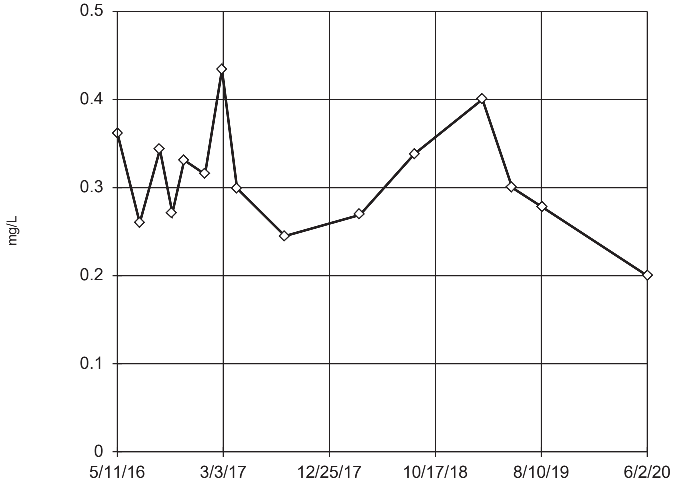
High cutoff = 2.218, low cutoff = 0.2444, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 12/2/2020 4:54 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-12 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

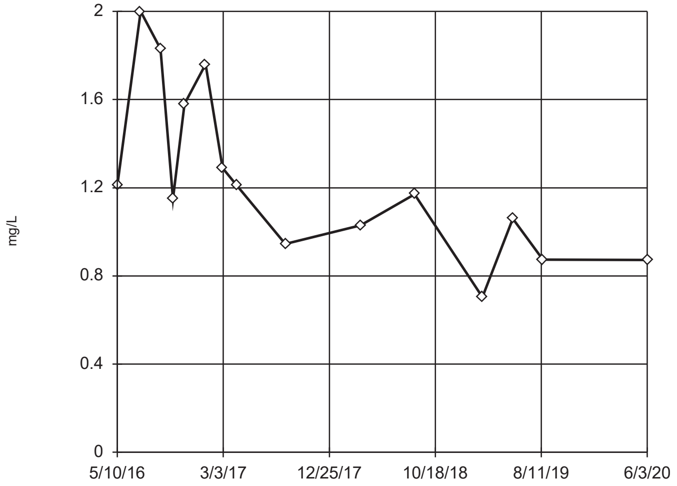
High cutoff = 0.6436, low cutoff = 0.1121, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 12/2/2020 4:54 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-16 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

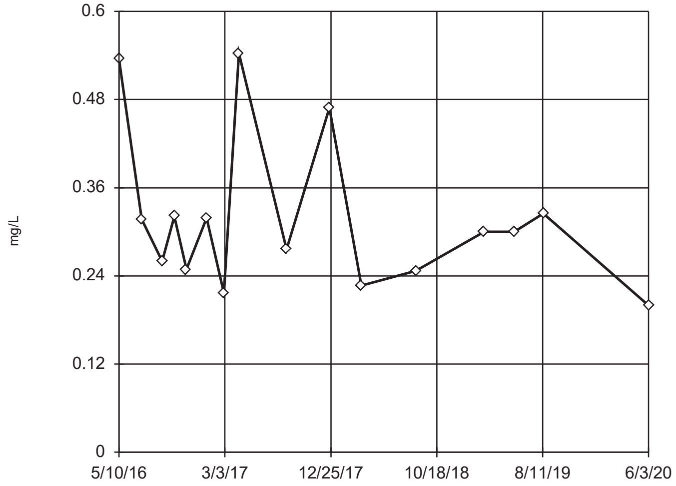
High cutoff = 7.385, low cutoff = 0.2022, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 12/2/2020 4:54 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-23



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

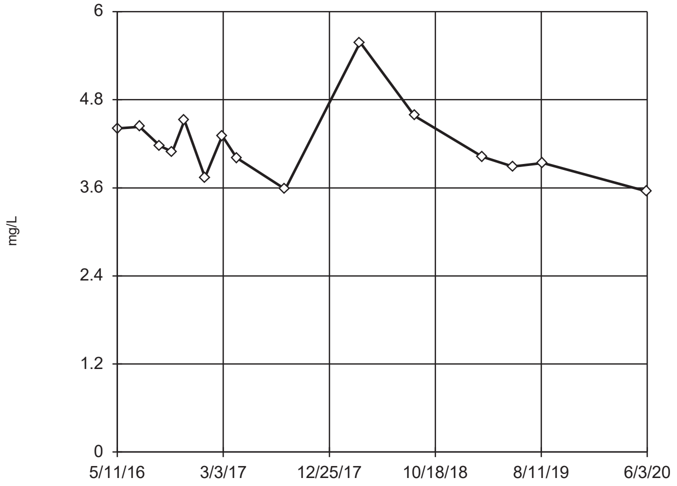
High cutoff = 0.7136, low cutoff = 0.1123, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 12/2/2020 4:54 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-27 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

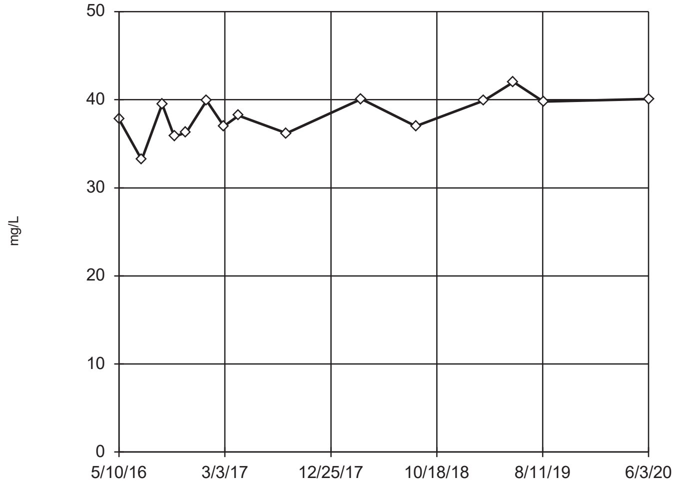
High cutoff = 6.543, low cutoff = 2.634, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 12/2/2020 4:54 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-34



n = 15

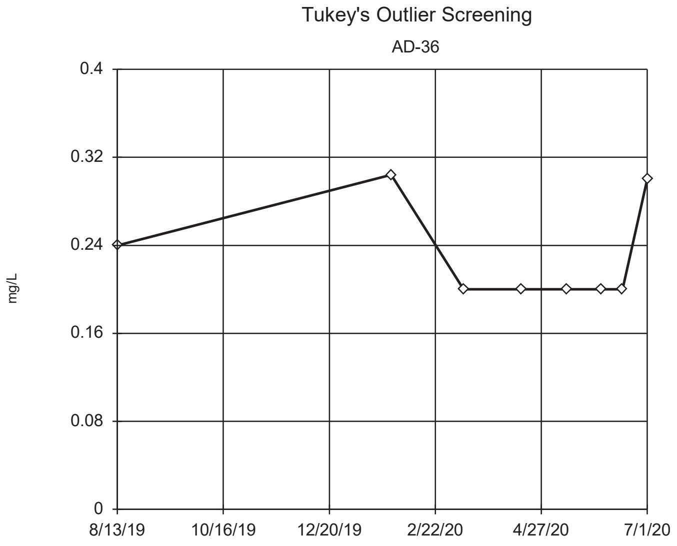
No outliers found. Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 47.12, low cutoff = -28.48, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 12/2/2020 4:54 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG


Tukey's Outlier Screening

AD-36

n = 8

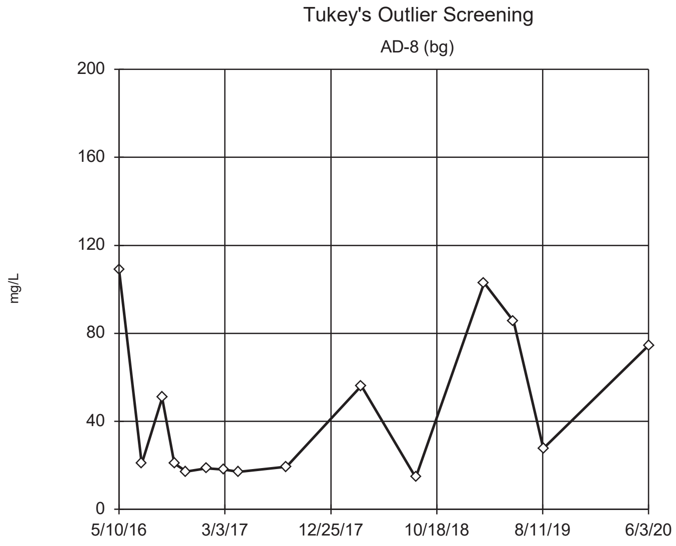
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.648, low cutoff = 0.08282, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG


Tukey's Outlier Screening

AD-8 (bg)

n = 15

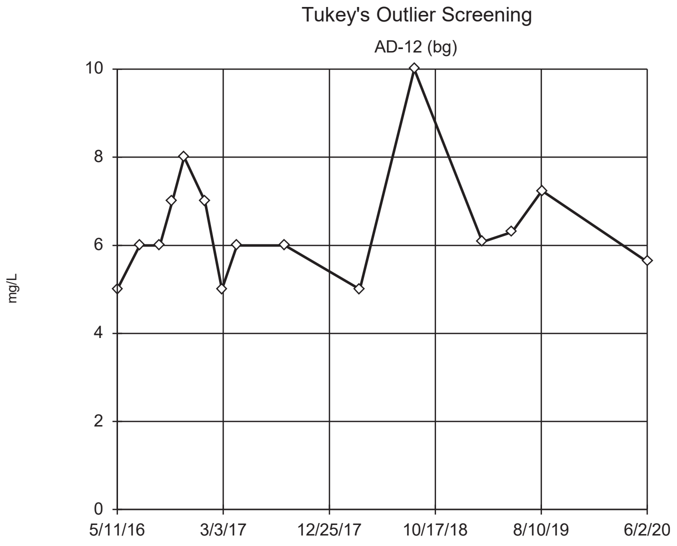
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5167, low cutoff = 0.2606, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG


Tukey's Outlier Screening

AD-12 (bg)

n = 15

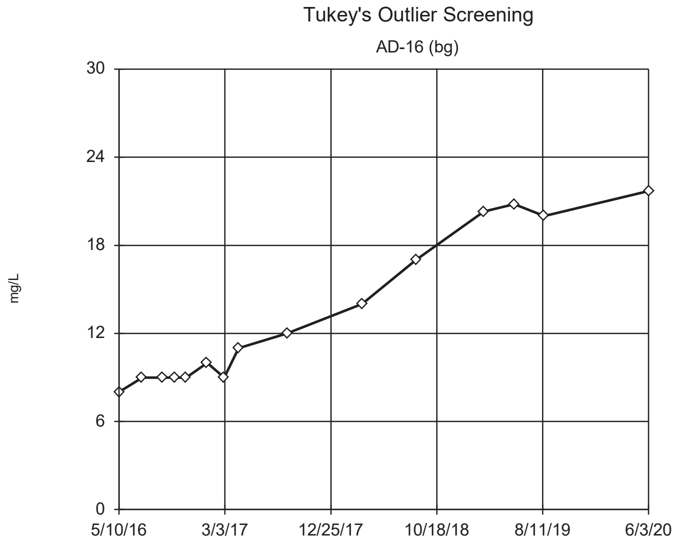
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 13.45, low cutoff = 2.929, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG


Tukey's Outlier Screening

AD-16 (bg)

n = 15

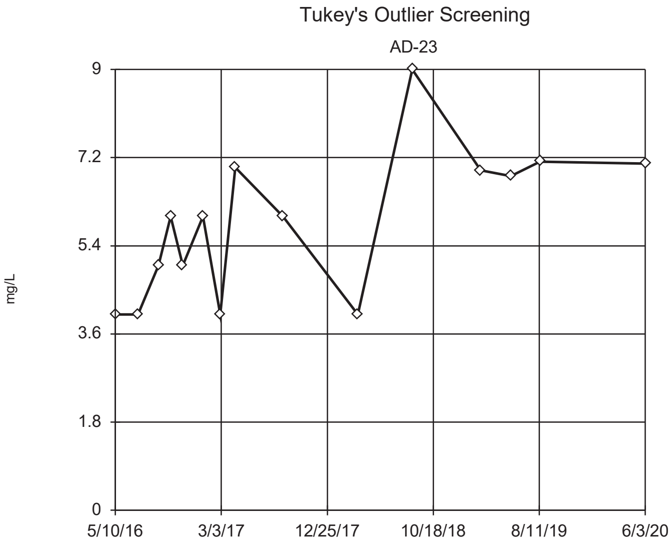
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 219.5, low cutoff = 0.8201, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 15

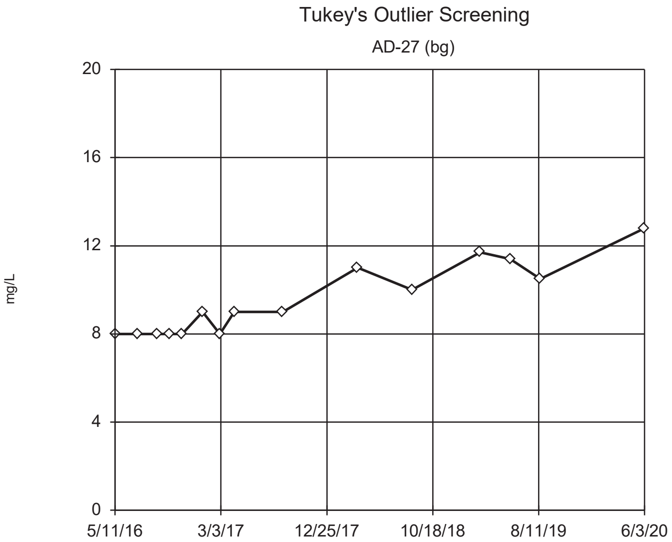
No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 16, low cutoff = -5, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 15

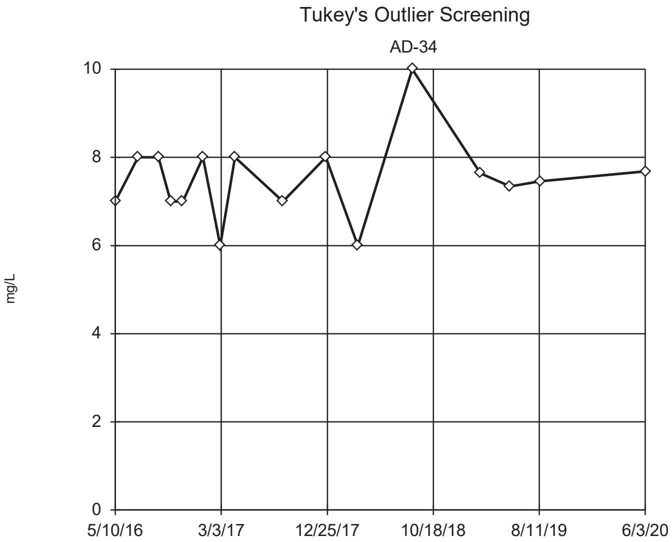
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 28.6, low cutoff = 3.077, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 16

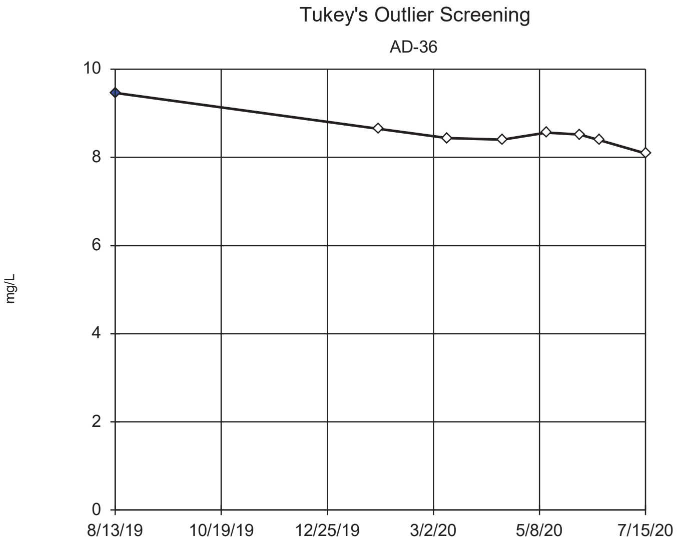
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 11.94, low cutoff = 4.689, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 8

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

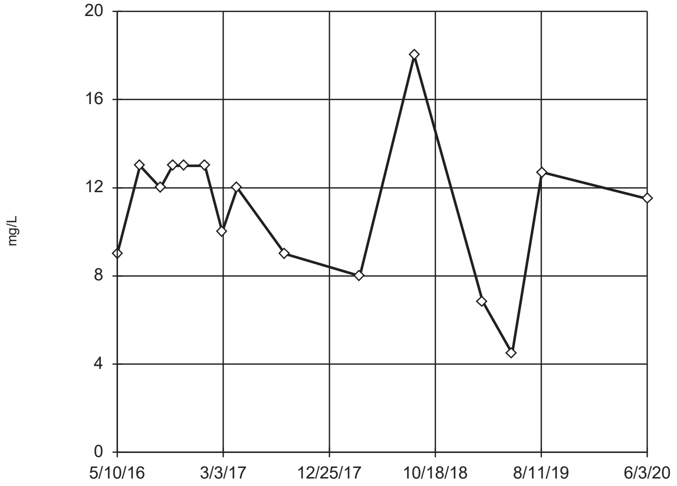
High cutoff = 9.267, low cutoff = 7.796, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-8 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

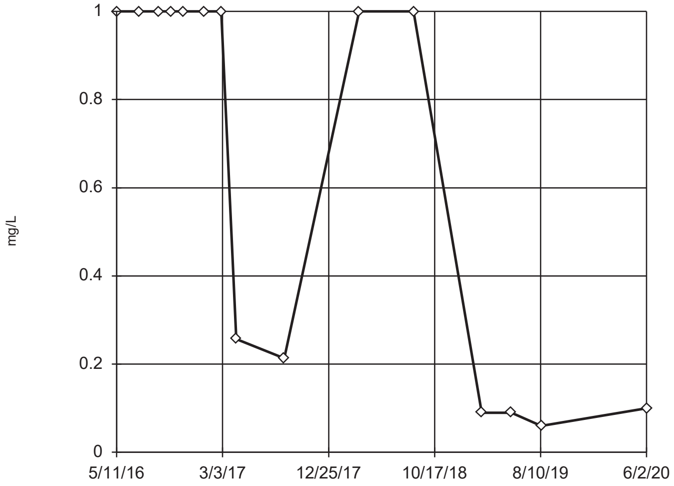
High cutoff = 25, low cutoff = -3, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-12 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

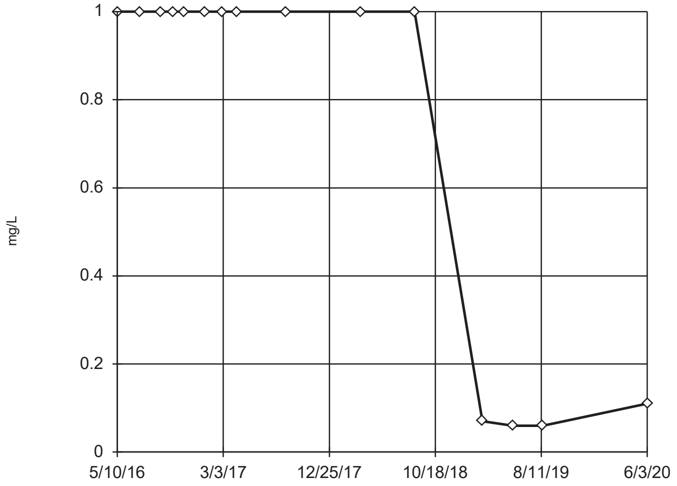
High cutoff = 1000, low cutoff = 0.0001, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-16 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

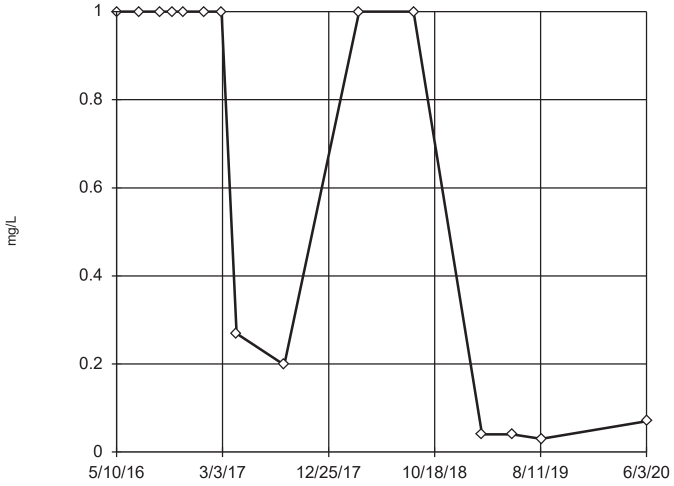
High cutoff = 751.3, low cutoff = 0.0001464, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-23



n = 15

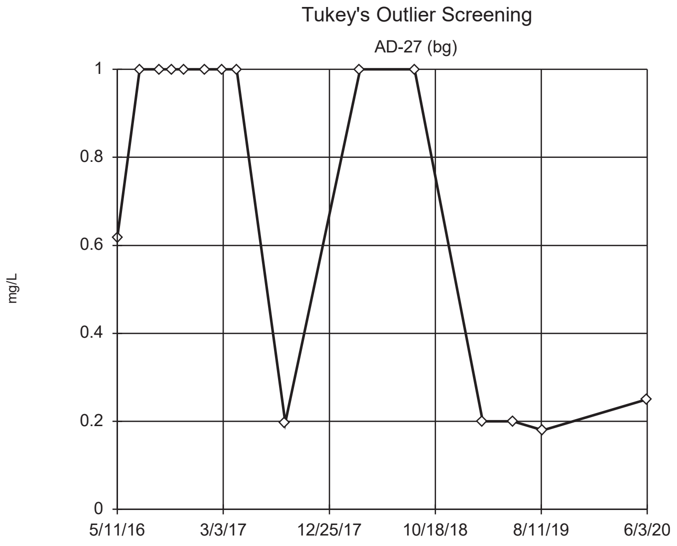
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2915, low cutoff = 0.00002401, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 15

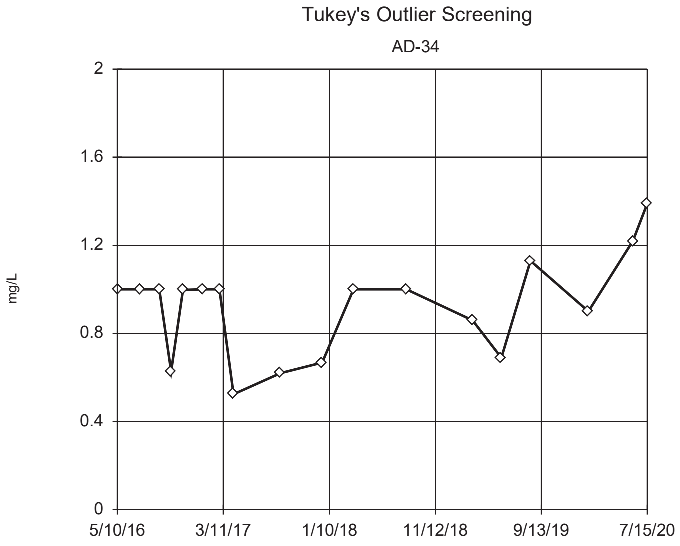
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 125, low cutoff = 0.0016, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 18

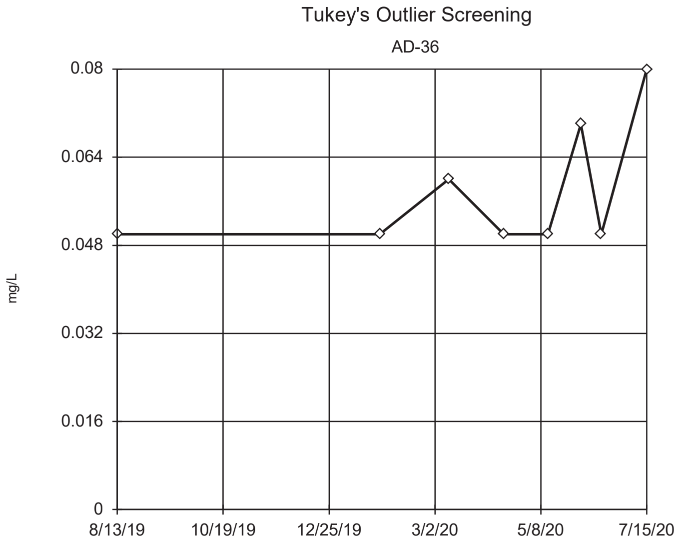
No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 1.965, low cutoff = -0.2862, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 8

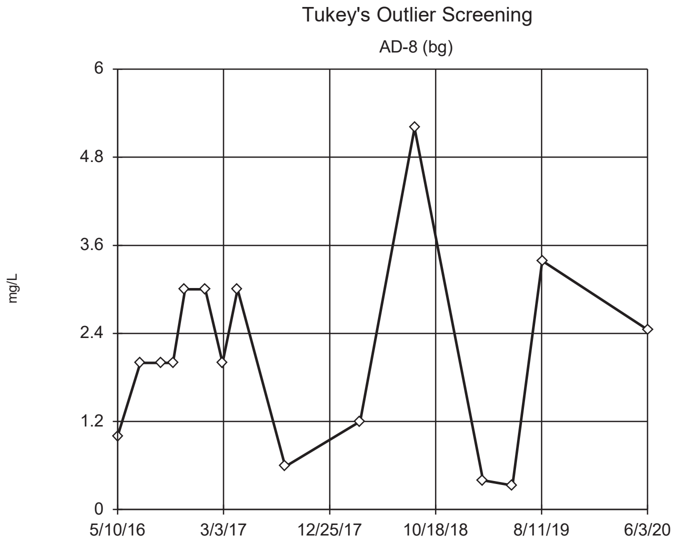
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1411, low cutoff = 0.02296, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 15

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

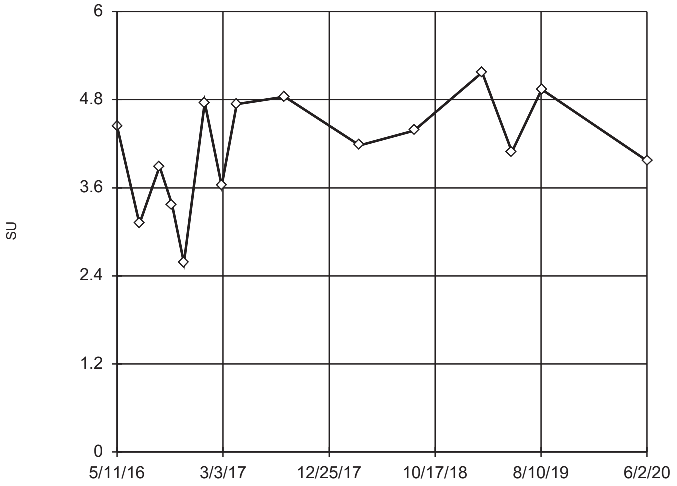
High cutoff = 15.43, low cutoff = -1.431, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-12 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

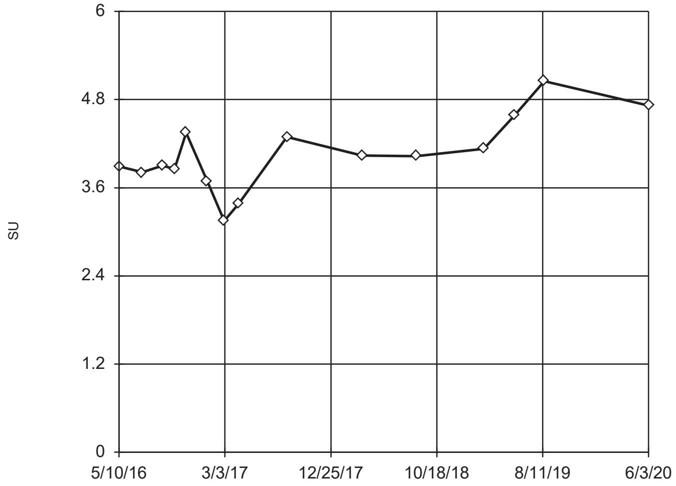
High cutoff = 6.603, low cutoff = -5.094, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-16 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

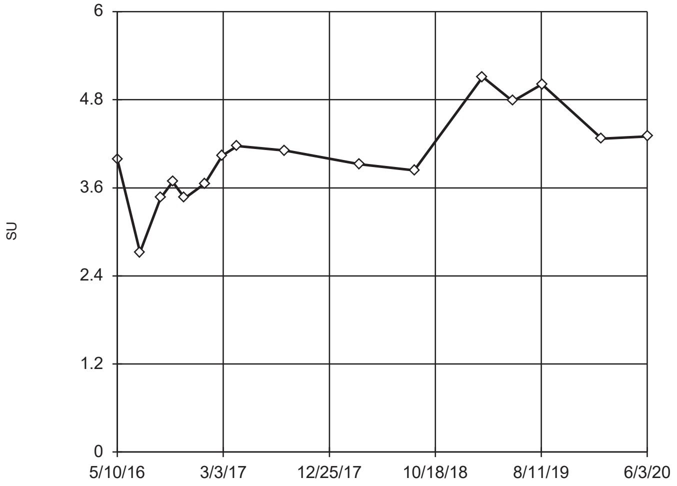
High cutoff = 6.185, low cutoff = 2.405, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-23



n = 16

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

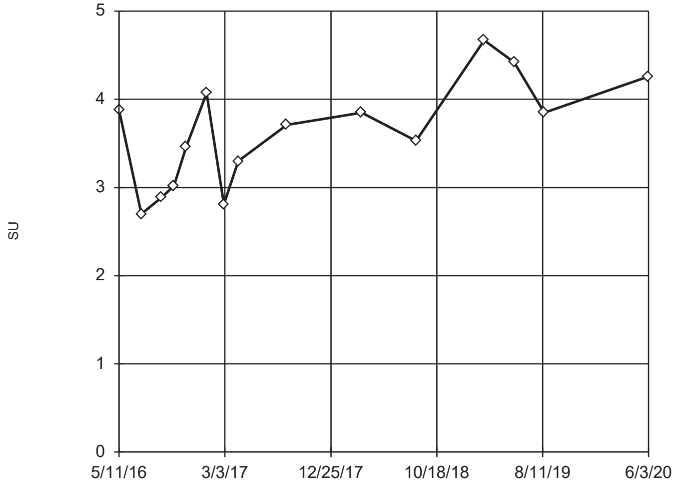
High cutoff = 6.13, low cutoff = 1.825, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-27 (bg)



n = 15

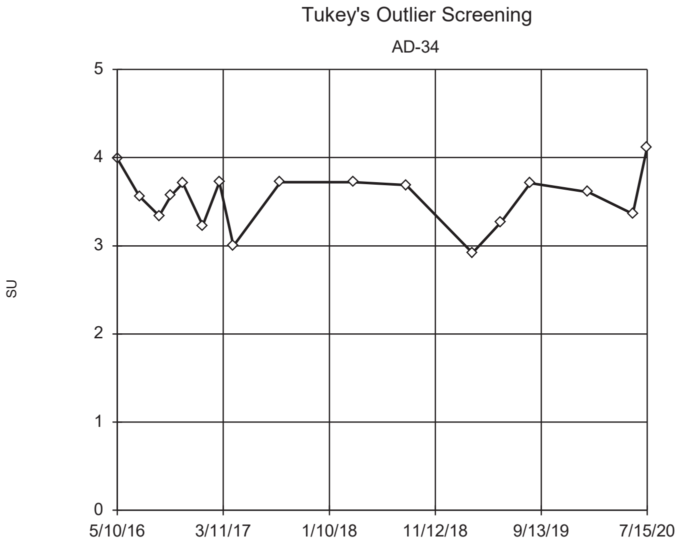
No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 7.22, low cutoff = -0.13, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 17

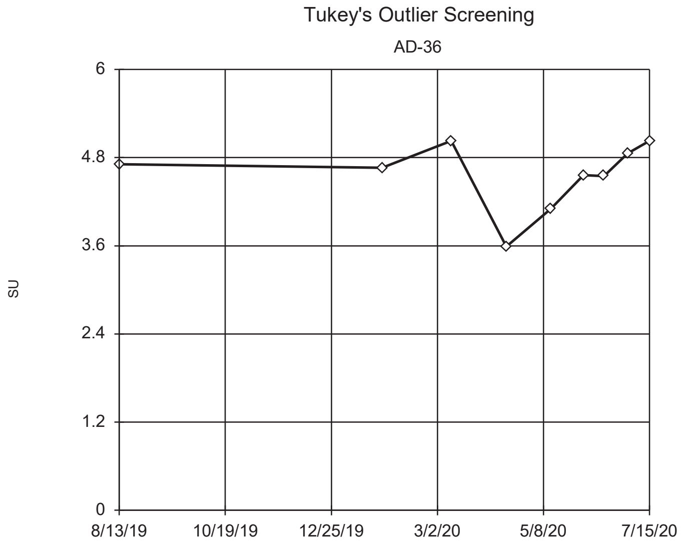
No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 4.752, low cutoff = 1.477, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 9

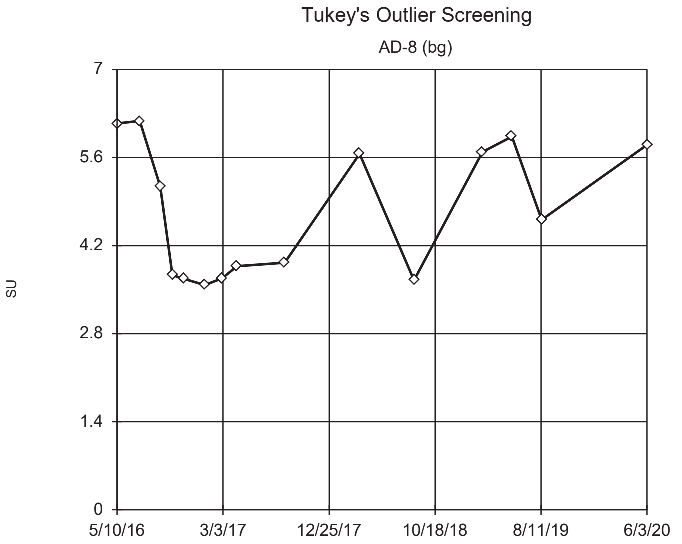
No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5.806, low cutoff = -5.061, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 15

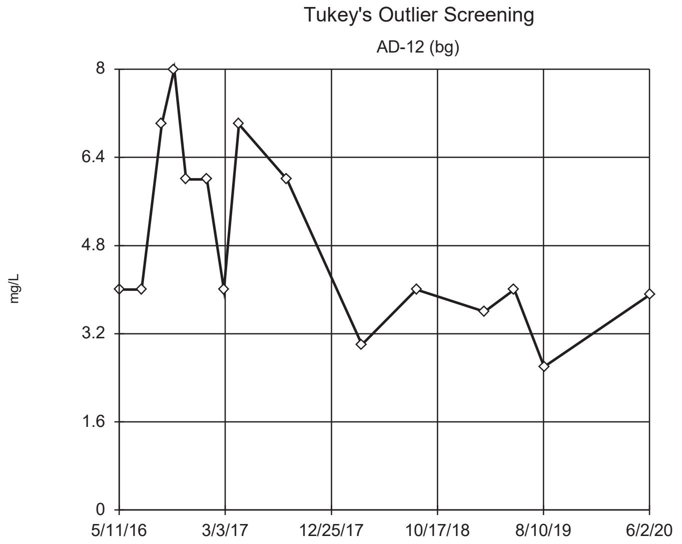
No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 9.692, low cutoff = -6.837, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 15

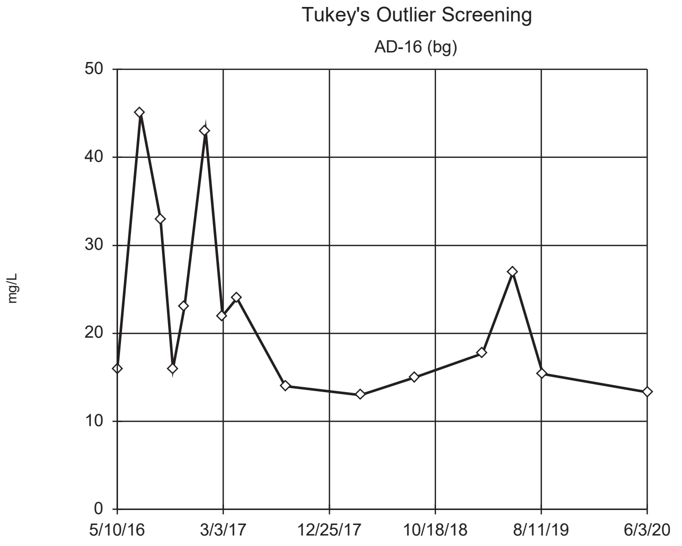
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 21.85, low cutoff = 1.071, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 15

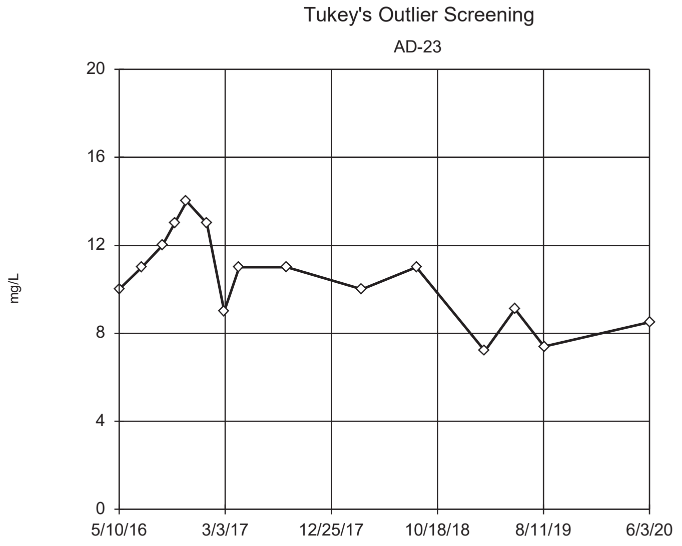
No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 155.1, low cutoff = 2.601, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 15

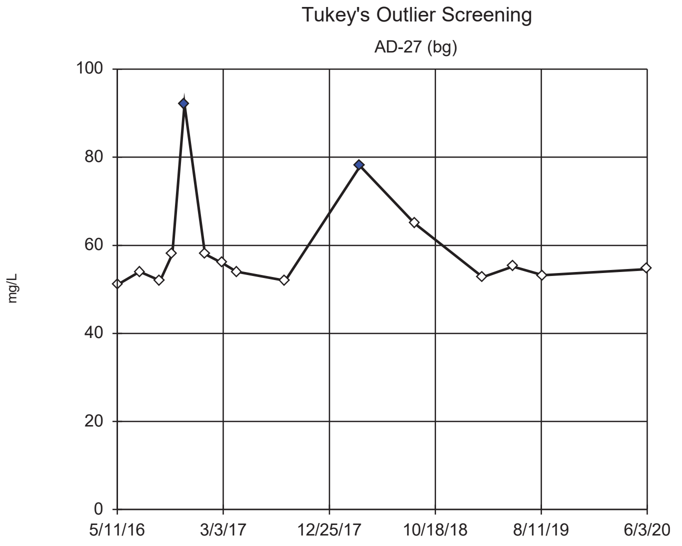
No outliers found.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 21, low cutoff = 0, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 15

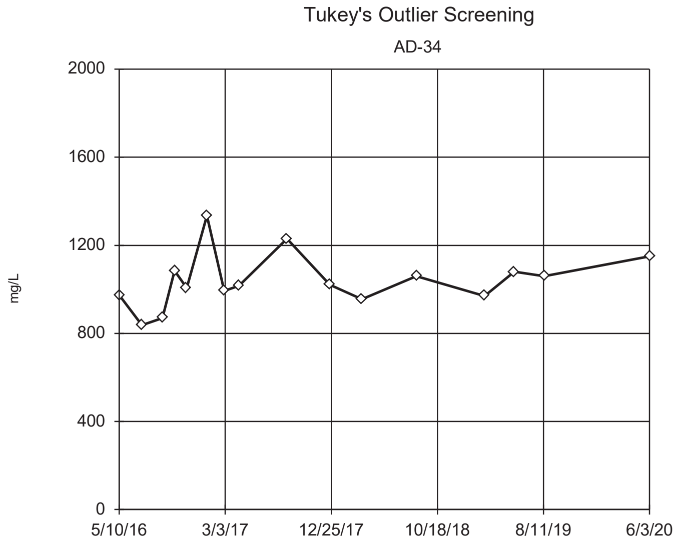
Outliers are drawn as solid.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 76.88, low cutoff = 39.83, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 16

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

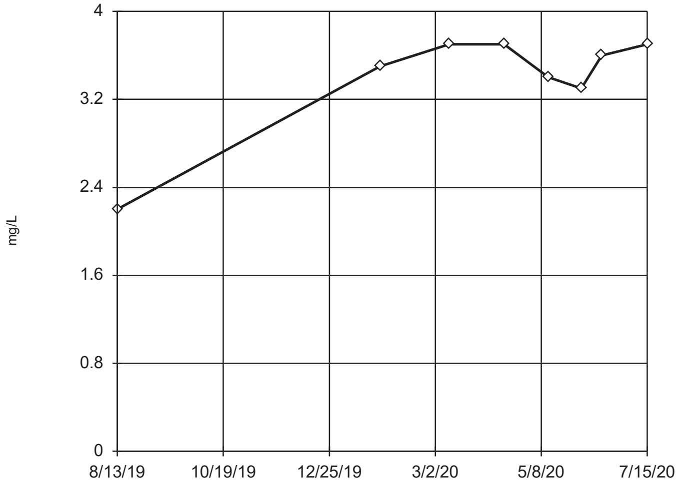
High cutoff = 1492, low cutoff = 704.7, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-36



n = 8

No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

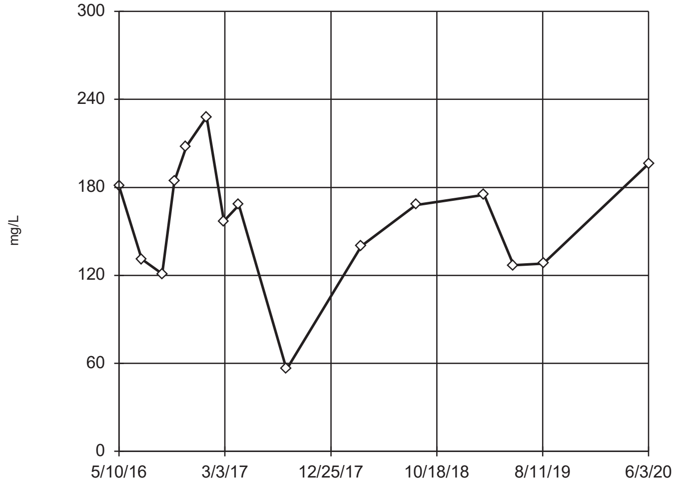
High cutoff = 4.264, low cutoff = -3.557, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-8 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

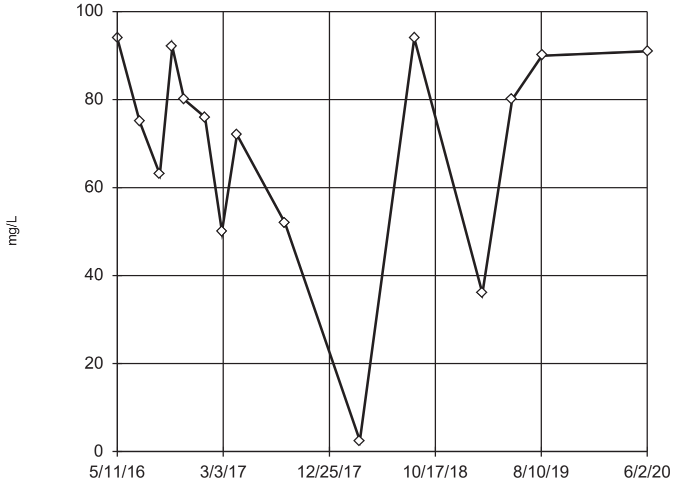
High cutoff = 293.7, low cutoff = -189.8, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-12 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

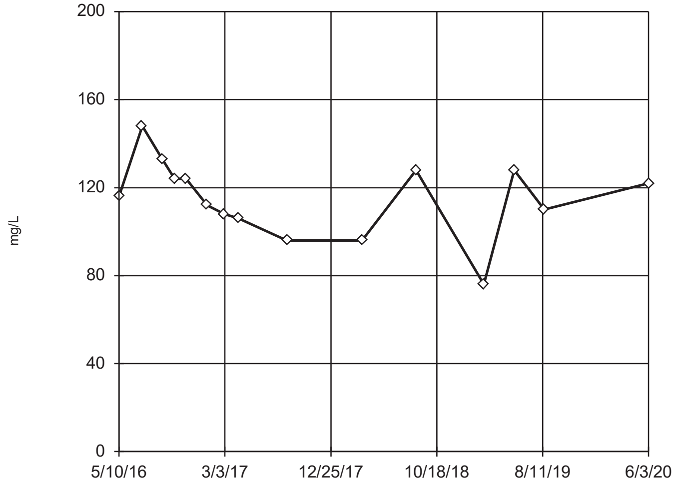
High cutoff = 158.2, low cutoff = -118.4, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-16 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

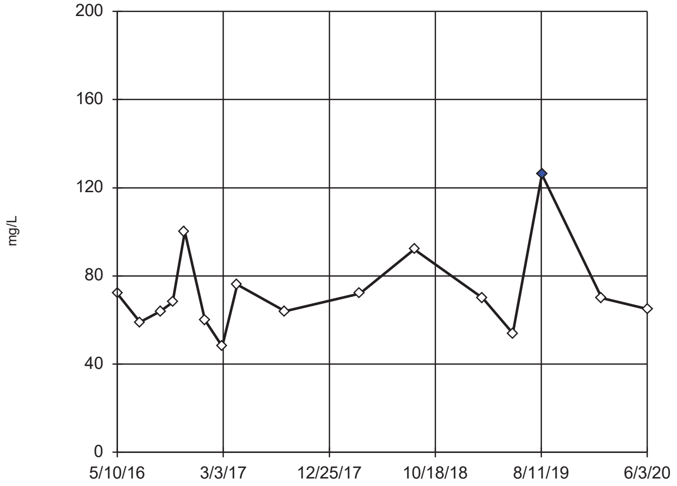
High cutoff = 178.4, low cutoff = -64.87, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/2/2020 4:55 PM View: Descriptive
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-23



n = 16

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

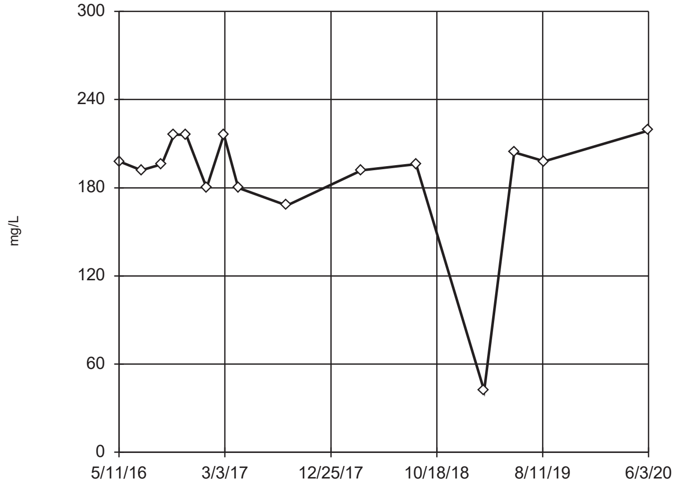
High cutoff = 125.8, low cutoff = 36.43, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/2/2020 4:55 PM   View: Descriptive
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-27 (bg)



n = 15

No outliers found. Tukey's method selected by user.

Data were x^5 transformed to achieve best W statistic (graph shown in original units).

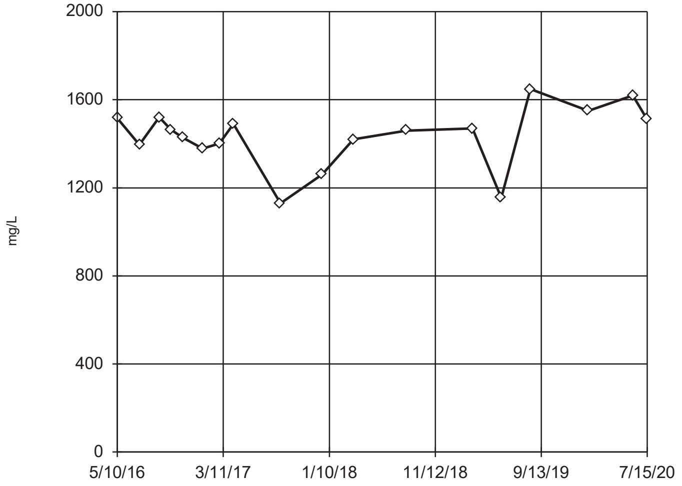
High cutoff = 265.3, low cutoff = -230.8, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/2/2020 4:55 PM   View: Descriptive
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-34



n = 18

No outliers found. Tukey's method selected by user.

Data were x^5 transformed to achieve best W statistic (graph shown in original units).

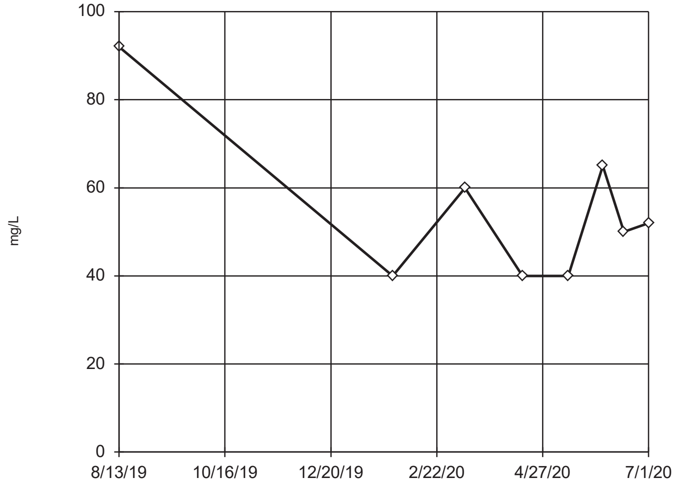
High cutoff = 1759, low cutoff = -1295, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/2/2020 4:55 PM   View: Descriptive
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-36



n = 8

No outliers found. Tukey's method selected by user.

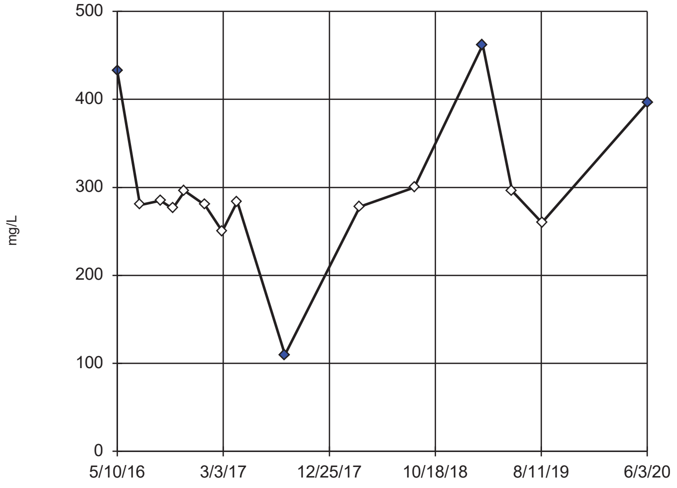
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 237.7, low cutoff = 10.51, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/2/2020 4:55 PM   View: Descriptive
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Tukey's Outlier Screening

AD-8 (bg)



n = 15

Outliers are drawn as solid.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 372, low cutoff = 204, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/2/2020 4:55 PM   View: Descriptive

Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Trend Test Summary - All Results (No Significant)

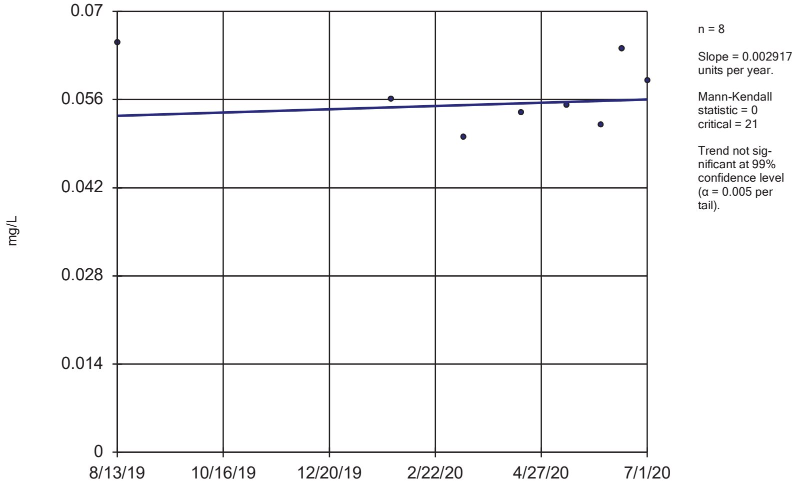
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill   Printed 12/2/2020, 4:32 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-36	0.002917	0	21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-36	0	-4	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-36	-1.181	-20	-21	No	8	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-36	0.008649	10	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-36	0.4073	5	25	No	9	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-36	0.6767	7	21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-36	0	-1	-21	No	8	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-36



n = 8

Slope = 0.002917 units per year.

Mann-Kendall statistic = 0 critical = 21

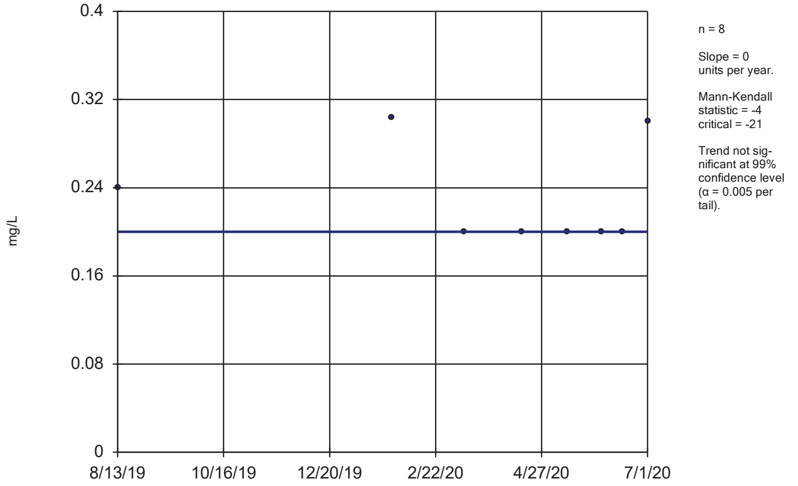
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/2/2020 4:31 PM View: AD-36
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-36



n = 8

Slope = 0 units per year.

Mann-Kendall statistic = -4 critical = -21

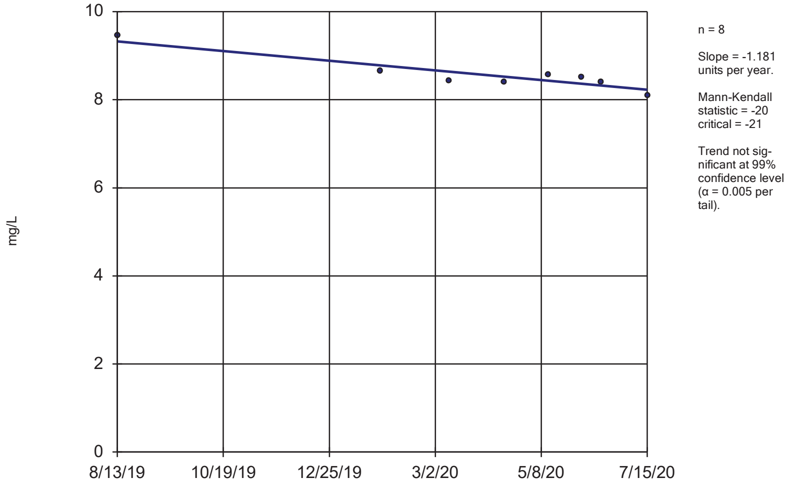
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Calcium, total Analysis Run 12/2/2020 4:31 PM View: AD-36
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-36



n = 8

Slope = -1.181 units per year.

Mann-Kendall statistic = -20 critical = -21

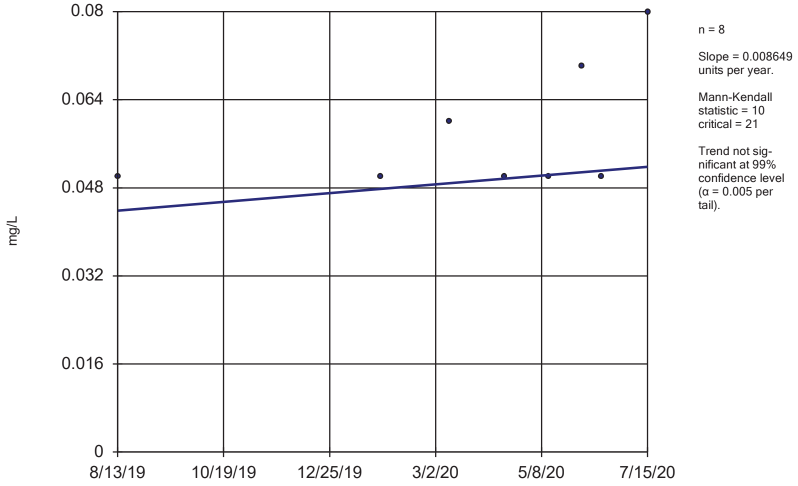
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 12/2/2020 4:31 PM View: AD-36
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-36



n = 8

Slope = 0.008649 units per year.

Mann-Kendall statistic = 10 critical = 21

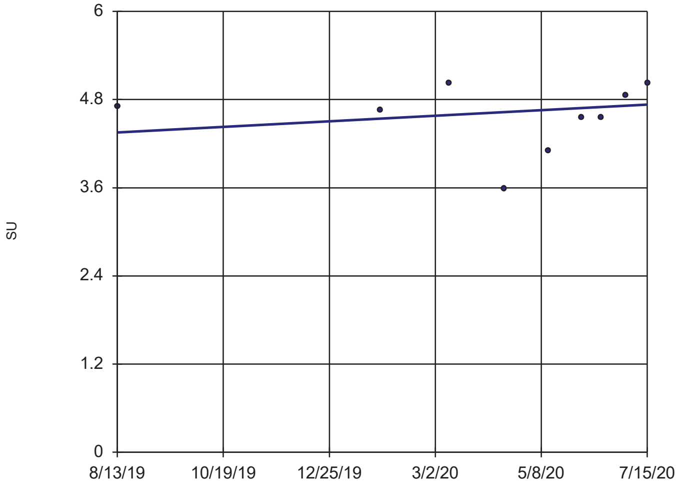
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 12/2/2020 4:31 PM View: AD-36
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-36



n = 9

Slope = 0.4073
units per year.

Mann-Kendall
statistic = 5
critical = 25

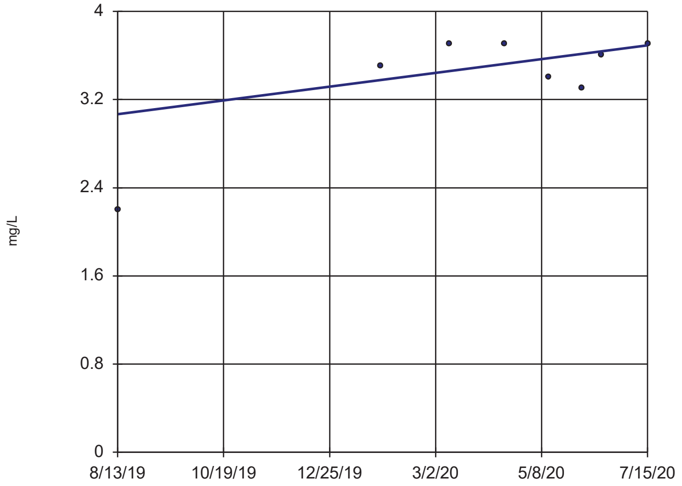
Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: pH, field   Analysis Run 12/2/2020 4:31 PM   View: AD-36
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-36



n = 8

Slope = 0.6767
units per year.

Mann-Kendall
statistic = 7
critical = 21

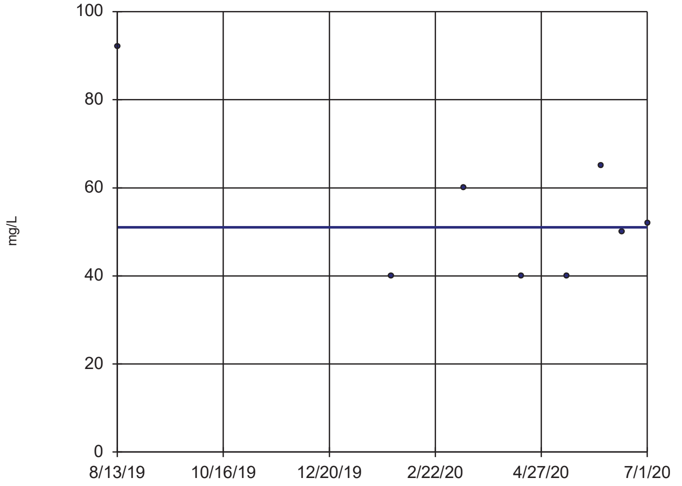
Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Sulfate, total   Analysis Run 12/2/2020 4:31 PM   View: AD-36
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-36



n = 8

Slope = 0
units per year.

Mann-Kendall
statistic = -1
critical = -21

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

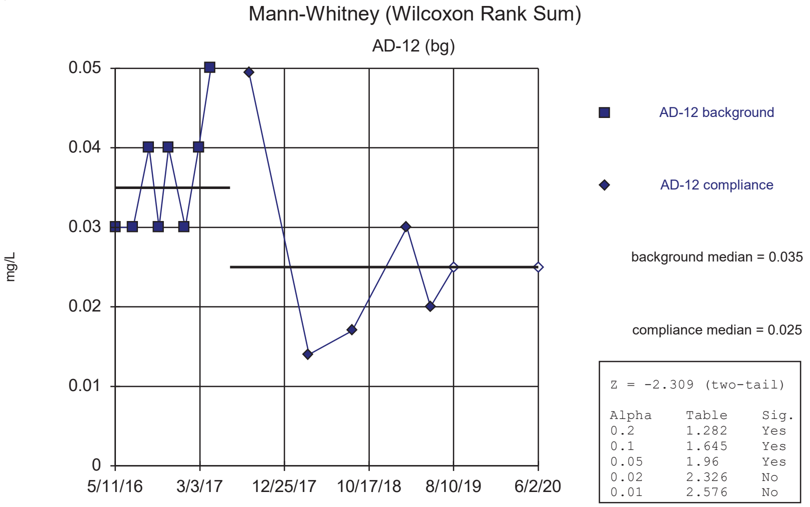
Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/2/2020 4:31 PM   View: AD-36
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Mann-Whitney Summary - Significant Results

Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill Printed 12/3/2020, 11:46 AM

Constituent	Well	Calc.	0.01	Sig.	Method
Calcium, total (mg/L)	**AD-16 (bg)**	**-3.185**	**Yes**	**Yes**	**Mann-W**
Chloride, total (mg/L)	**AD-16 (bg)**	**3.241**	**Yes**	**Yes**	**Mann-W**
Chloride, total (mg/L)	**AD-27 (bg)**	**3.179**	**Yes**	**Yes**	**Mann-W**
pH, field (SU)	**AD-16 (bg)**	**2.72**	**Yes**	**Yes**	**Mann-W**

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

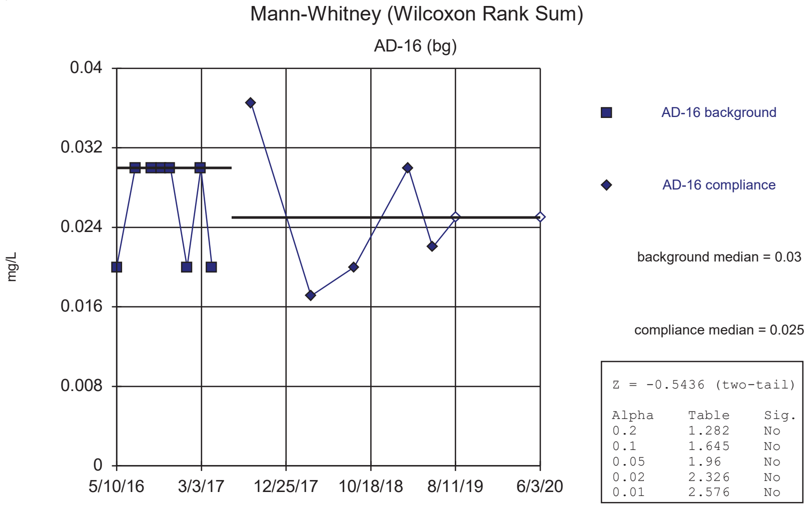


Z = -2.309 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	No
0.01	2.576	No

Constituent: Boron, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

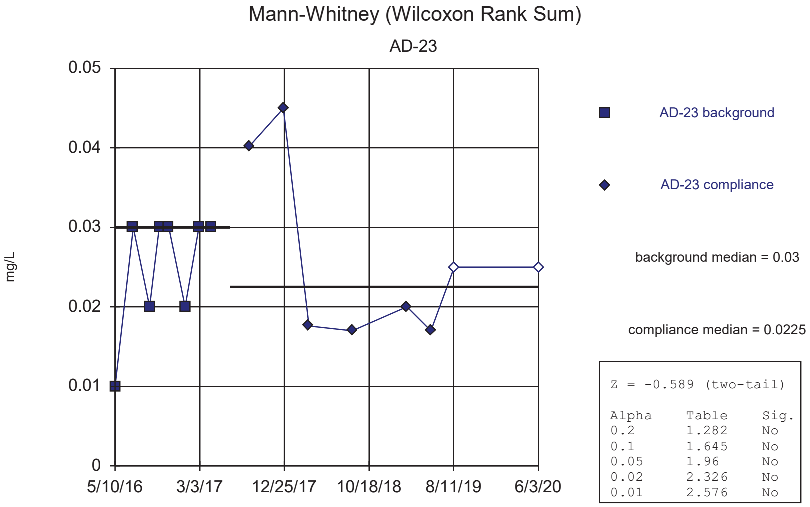


Z = -0.5436 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Boron, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

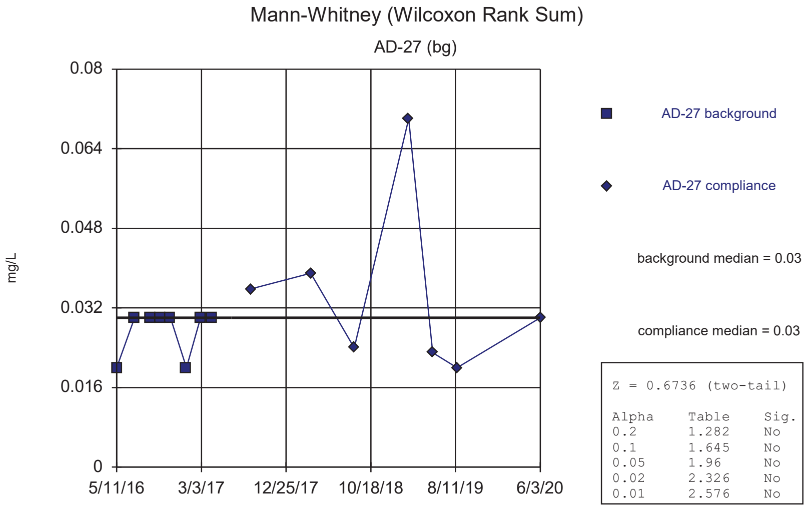


Z = -0.589 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Boron, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



Z = 0.6736 (two-tail)

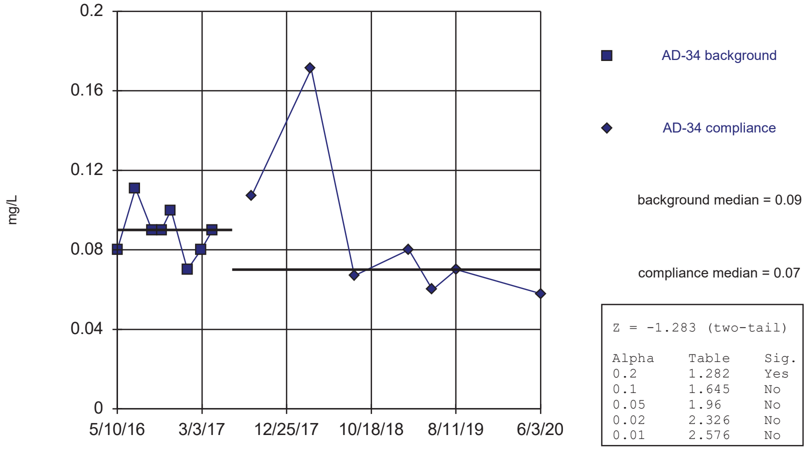
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Boron, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-34



background median = 0.09

compliance median = 0.07

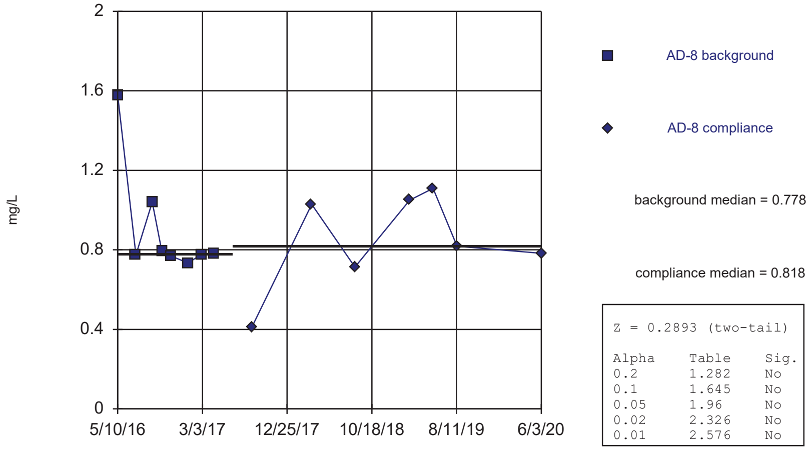
```
Z = -1.283 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Boron, total   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-8 (bg)



background median = 0.778

compliance median = 0.818

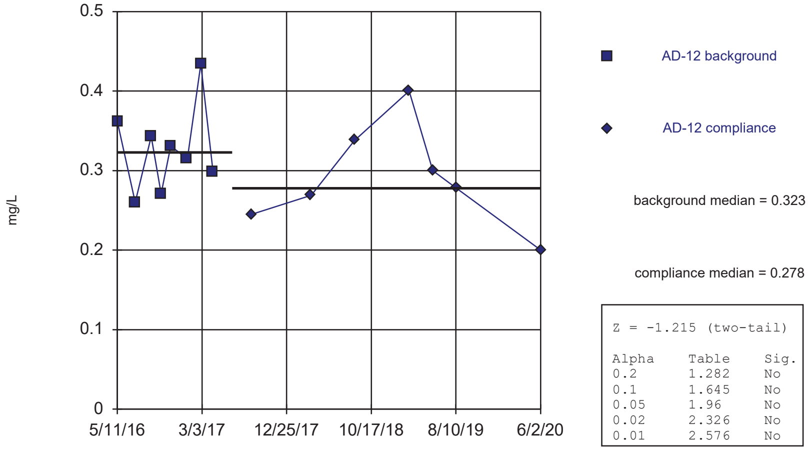
```
Z = 0.2893 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Boron, total   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



background median = 0.323

compliance median = 0.278

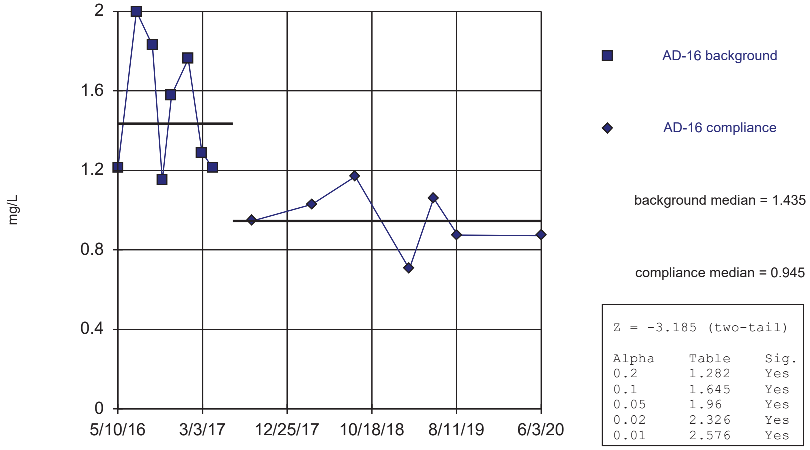
```
Z = -1.215 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Calcium, total   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-16 (bg)



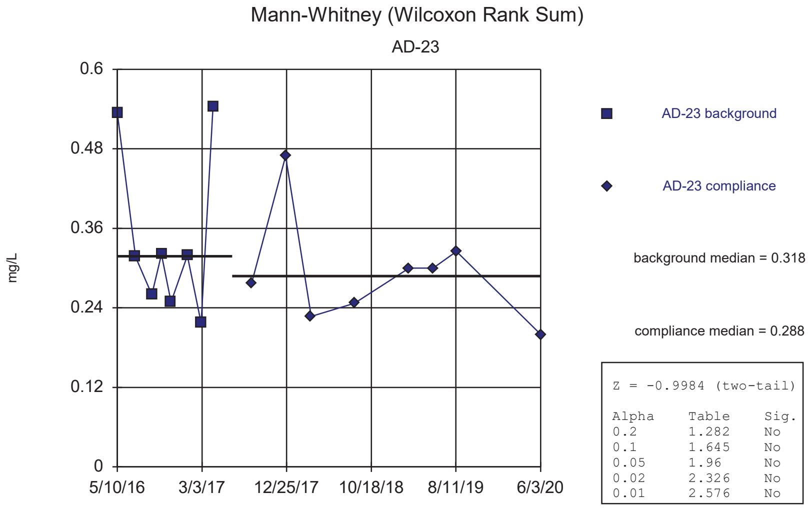
background median = 1.435

compliance median = 0.945

```
Z = -3.185 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      Yes
0.02      2.326     Yes
0.01      2.576     Yes
```

Constituent: Calcium, total   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



background median = 0.318

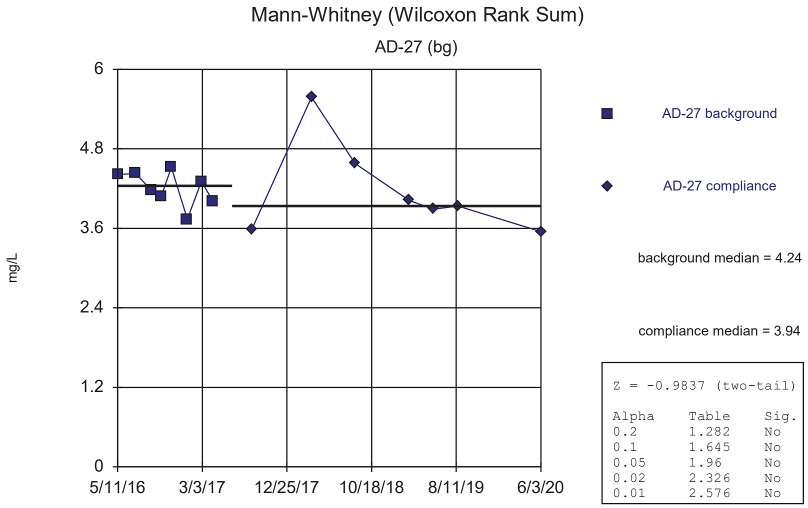
compliance median = 0.288

Z = -0.9984 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



background median = 4.24

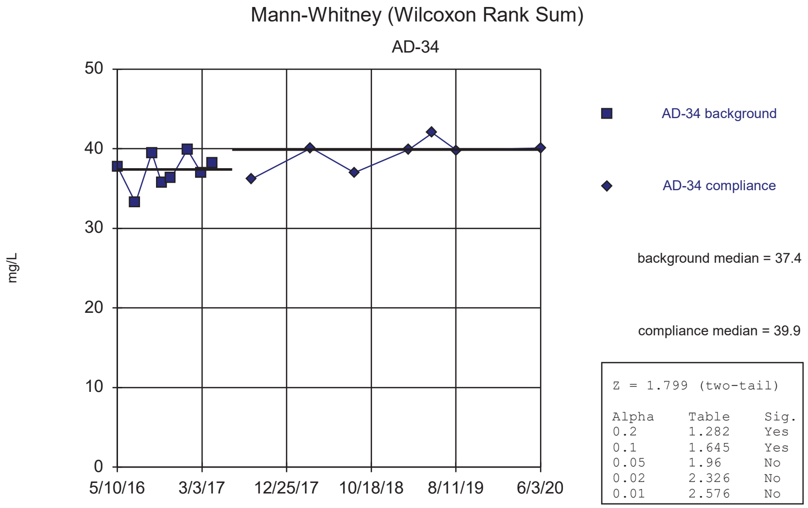
compliance median = 3.94

Z = -0.9837 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



background median = 37.4

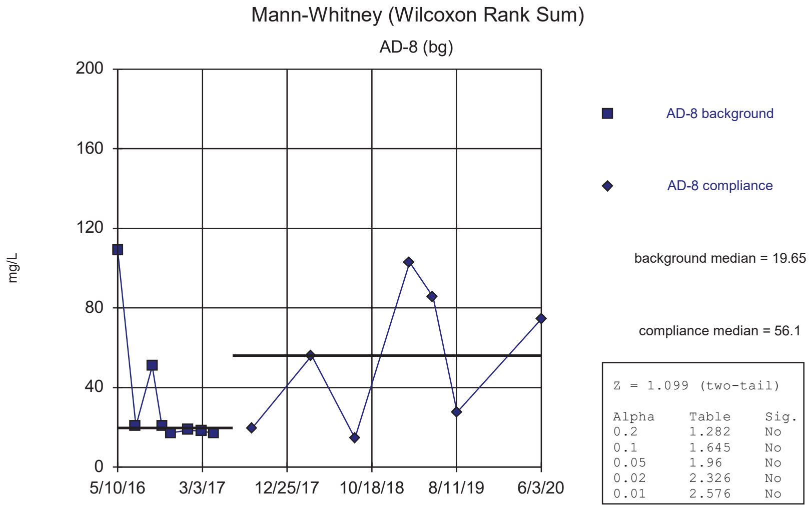
compliance median = 39.9

Z = 1.799 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



background median = 19.65

compliance median = 56.1

Z = 1.099 (two-tail)

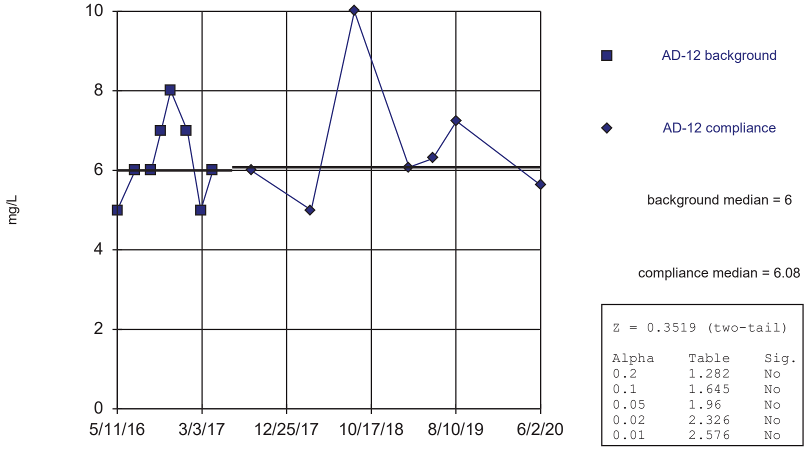
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



Z = 0.3519 (two-tail)

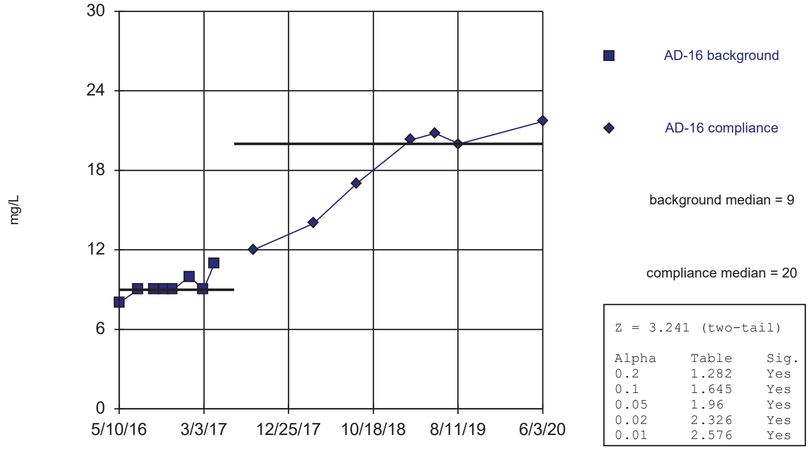
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Chloride, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-16 (bg)



Z = 3.241 (two-tail)

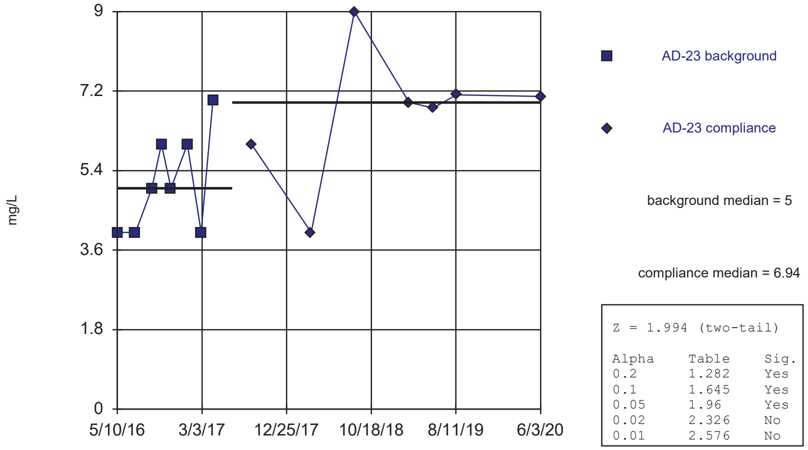
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	Yes
0.01	2.576	Yes

Constituent: Chloride, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-23



Z = 1.994 (two-tail)

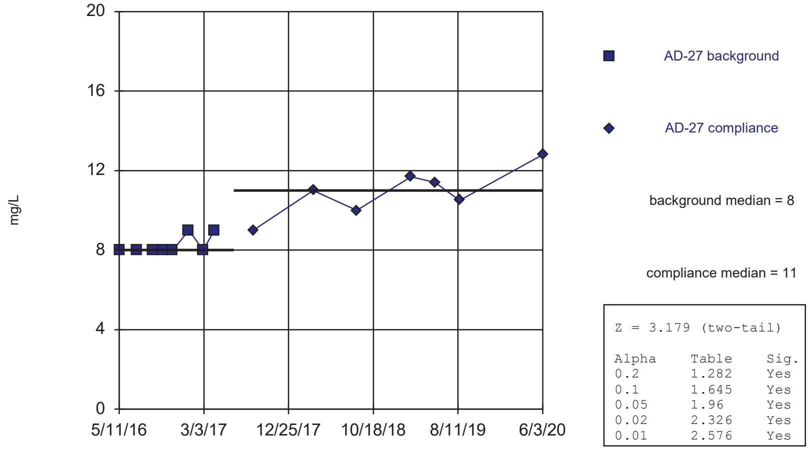
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	No
0.01	2.576	No

Constituent: Chloride, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-27 (bg)

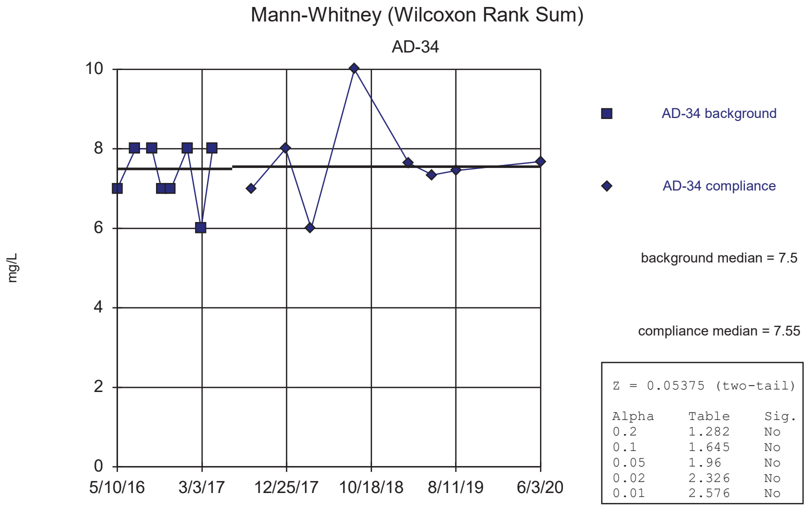


Z = 3.179 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	Yes
0.01	2.576	Yes

Constituent: Chloride, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

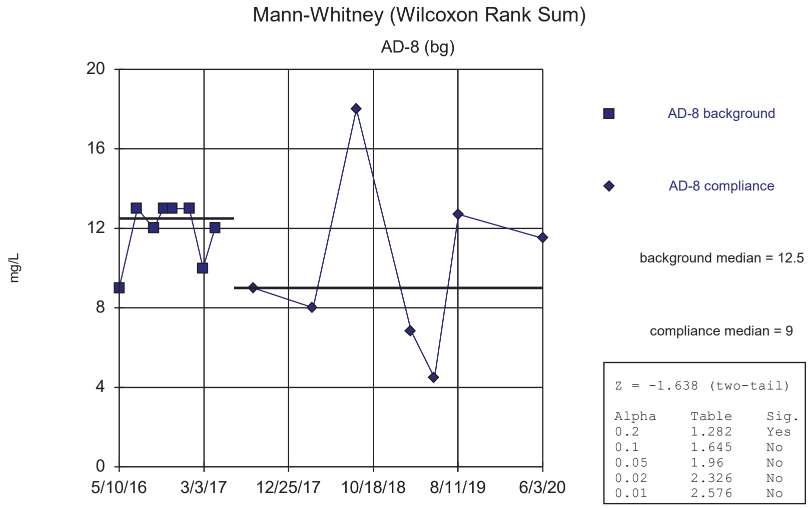


Z = 0.05375 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Chloride, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

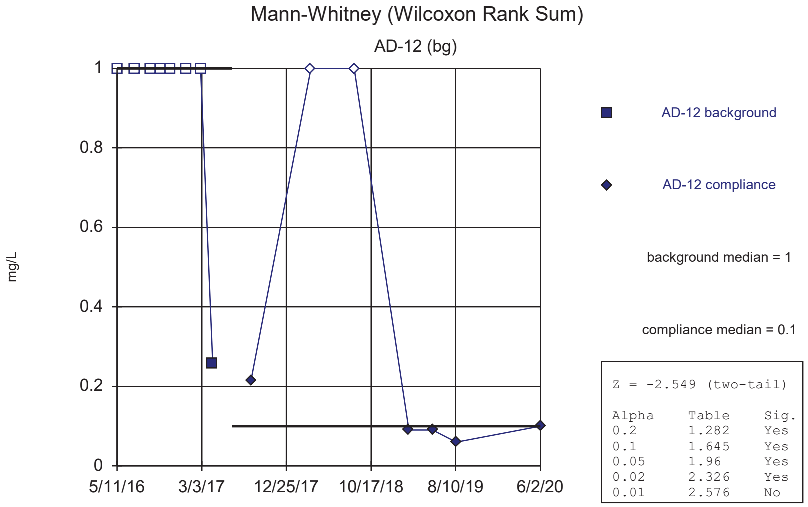


Z = -1.638 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Chloride, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

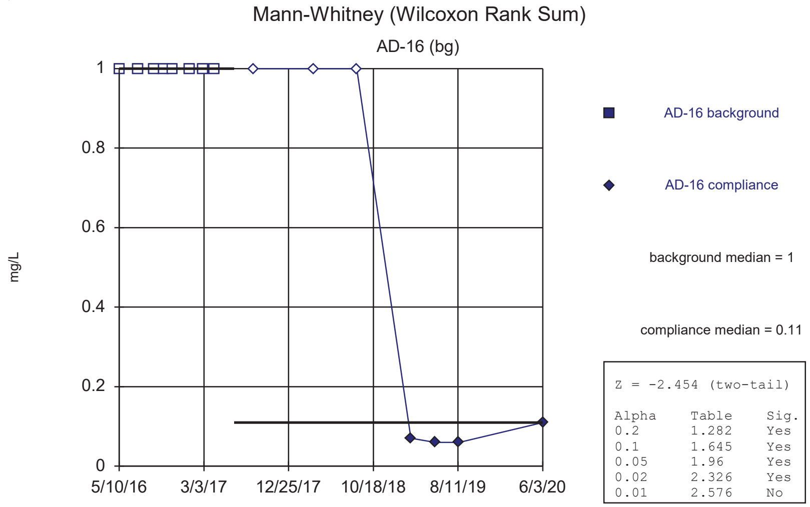


Z = -2.549 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	Yes
0.01	2.576	No

Constituent: Fluoride, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Z = -2.454 (two-tail)

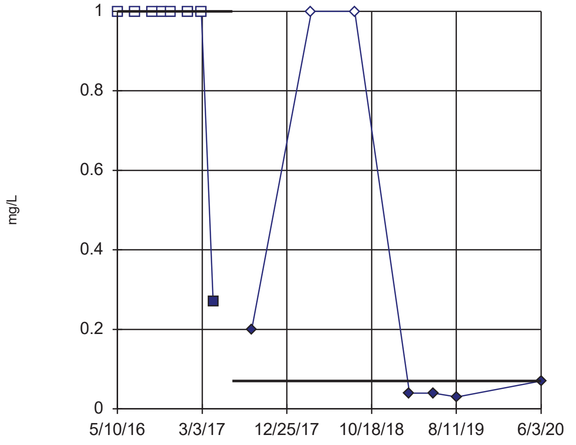
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	Yes
0.01	2.576	No

Constituent: Fluoride, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-23



■ AD-23 background

◆ AD-23 compliance

background median = 1

compliance median = 0.07

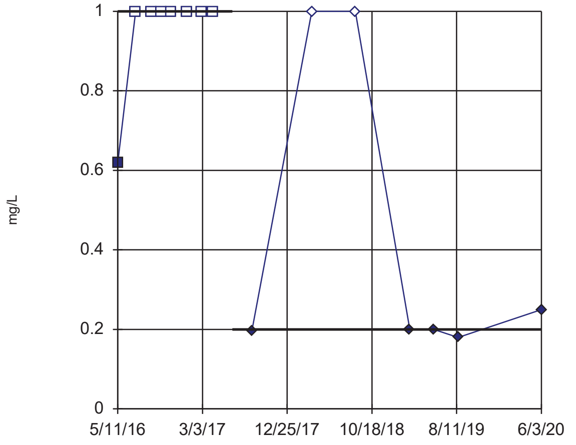
```
Z = -2.549 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      Yes
0.02      2.326     Yes
0.01      2.576     No
```

Constituent: Fluoride, total   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-27 (bg)



■ AD-27 background

◆ AD-27 compliance

background median = 1

compliance median = 0.2

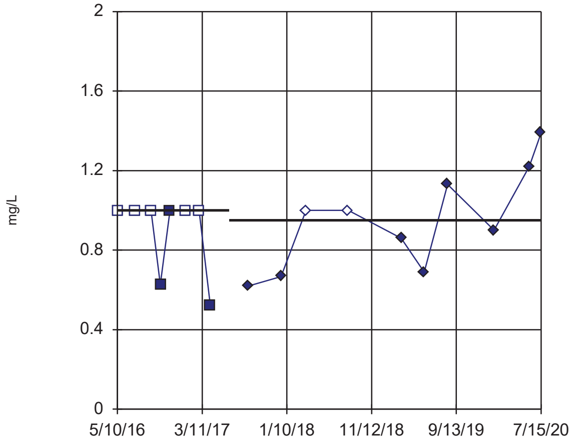
```
Z = -2.549 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      Yes
0.02      2.326     Yes
0.01      2.576     No
```

Constituent: Fluoride, total   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-34



■ AD-34 background

◆ AD-34 compliance

background median = 1

compliance median = 0.95

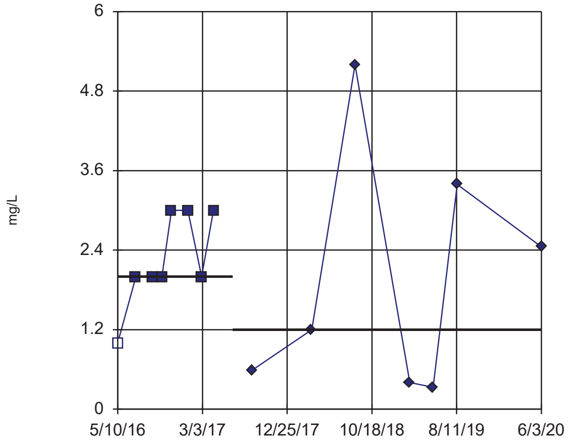
```
Z = 0.3204 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Fluoride, total   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-8 (bg)



■ AD-8 background

◆ AD-8 compliance

background median = 2

compliance median = 1.2

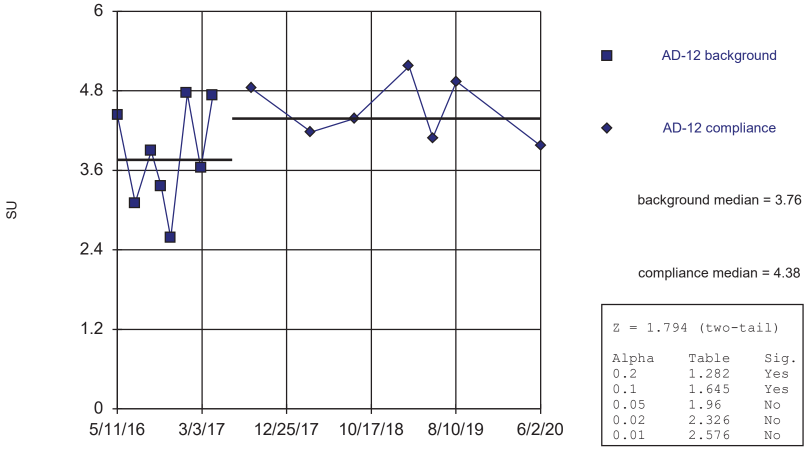
```
Z = -0.7618 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Fluoride, total   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



background median = 3.76

compliance median = 4.38

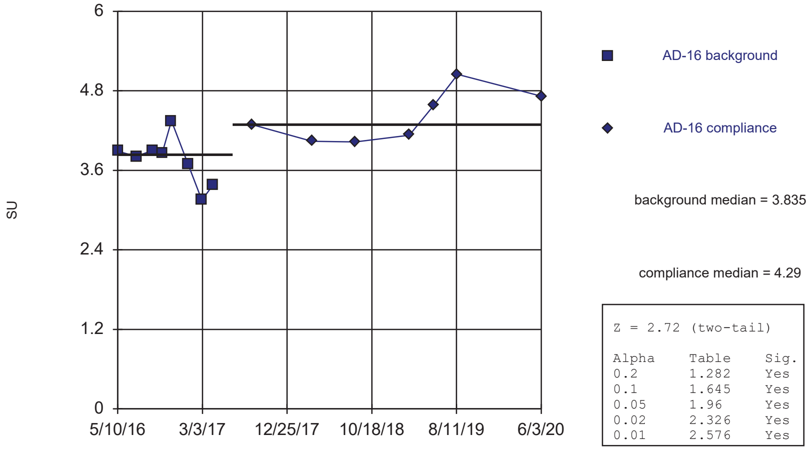
```
Z = 1.794 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: pH, field   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-16 (bg)



background median = 3.835

compliance median = 4.29

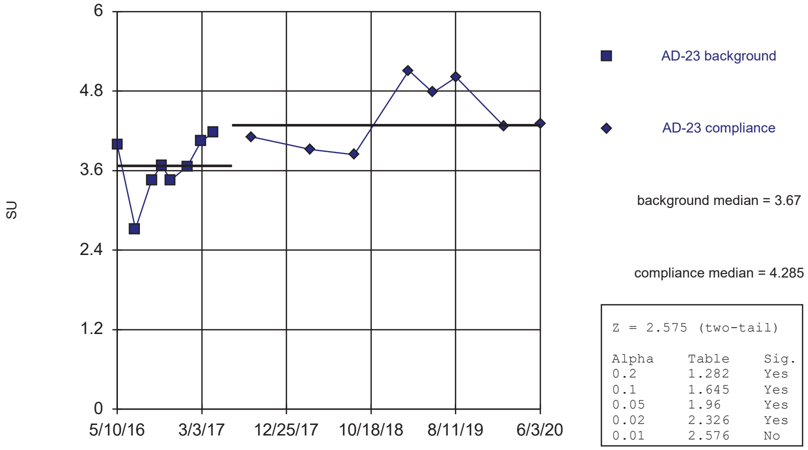
```
Z = 2.72 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      Yes
0.02      2.326     Yes
0.01      2.576     Yes
```

Constituent: pH, field   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-23



background median = 3.67

compliance median = 4.285

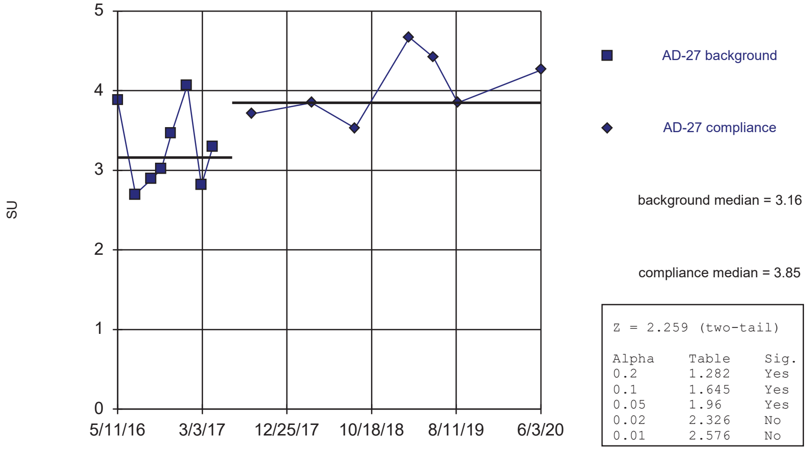
```
Z = 2.575 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      Yes
0.02      2.326     Yes
0.01      2.576     No
```

Constituent: pH, field   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-27 (bg)



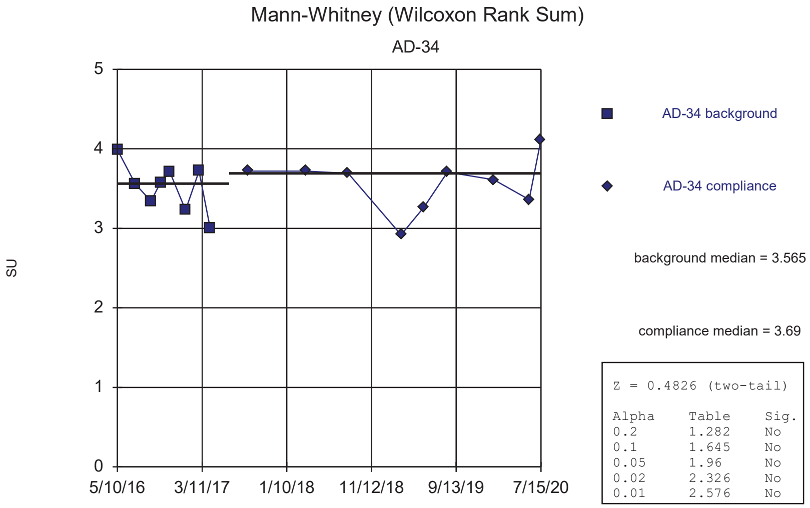
background median = 3.16

compliance median = 3.85

```
Z = 2.259 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      Yes
0.02      2.326     No
0.01      2.576     No
```

Constituent: pH, field   Analysis Run 12/3/2020 11:39 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

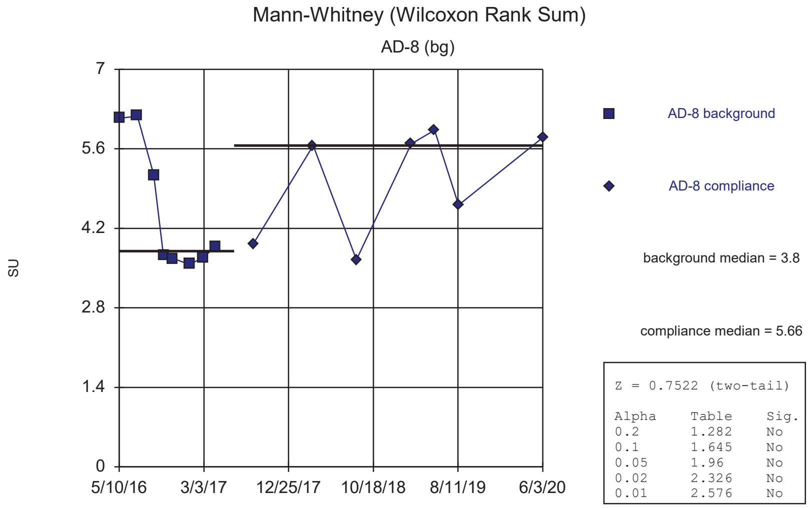
Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



```
Z = 0.4826 (two-tail)

Alpha    Table    Sig.
0.2      1.282    No
0.1      1.645    No
0.05     1.96     No
0.02     2.326    No
0.01     2.576    No
```

Constituent: pH, field Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

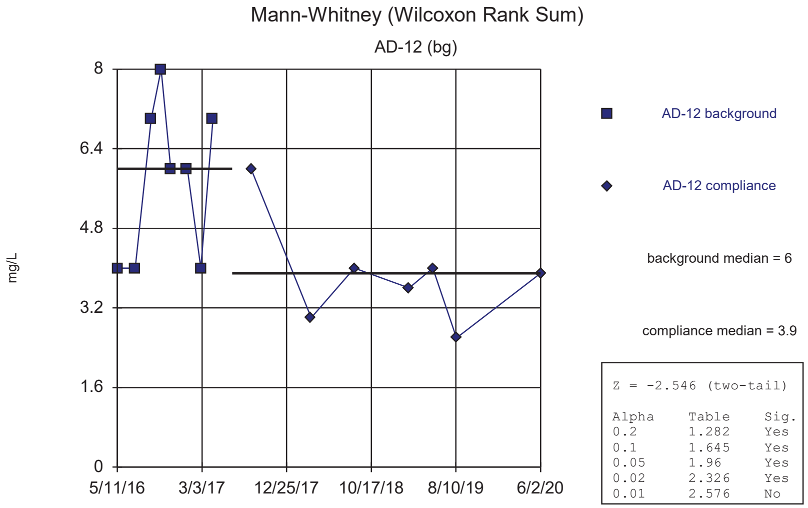
Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



```
Z = 0.7522 (two-tail)

Alpha    Table    Sig.
0.2      1.282    No
0.1      1.645    No
0.05     1.96     No
0.02     2.326    No
0.01     2.576    No
```

Constituent: pH, field Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

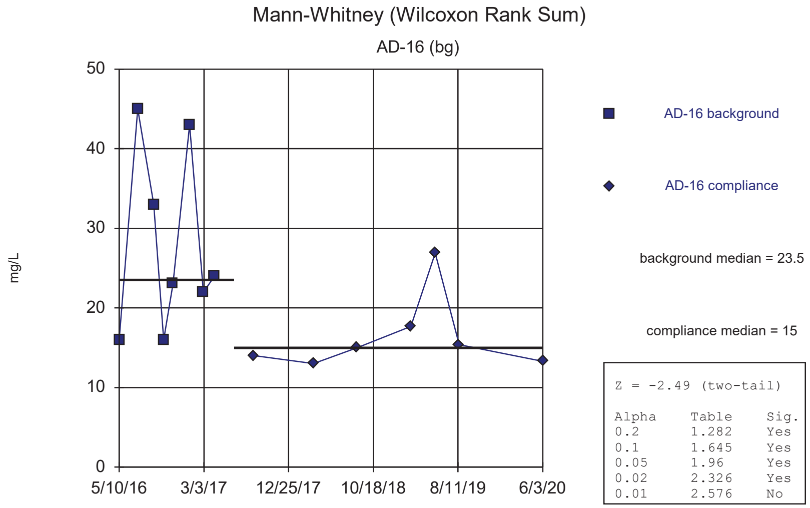
Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



```
Z = -2.546 (two-tail)

Alpha    Table    Sig.
0.2      1.282    Yes
0.1      1.645    Yes
0.05     1.96     Yes
0.02     2.326    Yes
0.01     2.576    No
```

Constituent: Sulfate, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



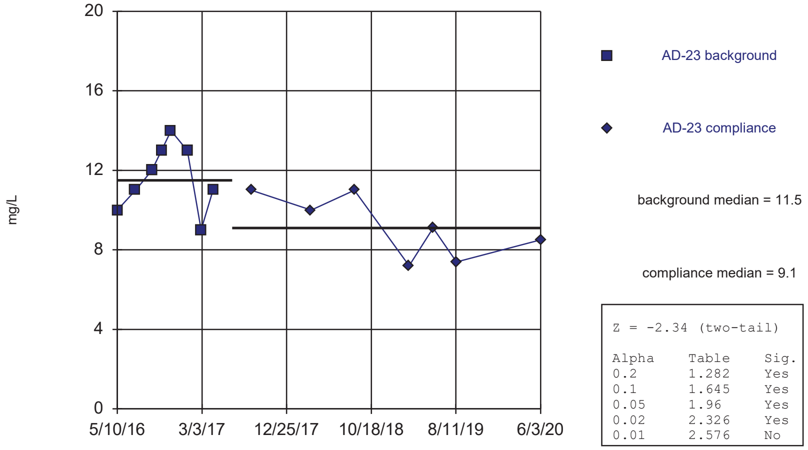
```
Z = -2.49 (two-tail)

Alpha    Table    Sig.
0.2      1.282    Yes
0.1      1.645    Yes
0.05     1.96     Yes
0.02     2.326    Yes
0.01     2.576    No
```

Constituent: Sulfate, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-23



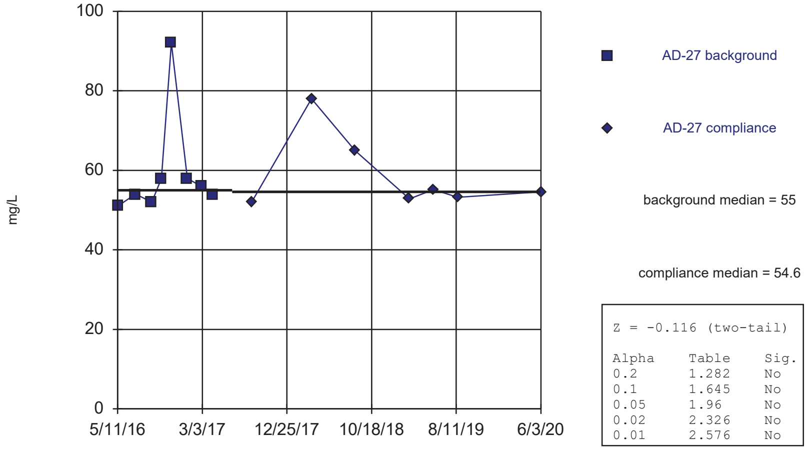
```
Z = -2.34 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      Yes
0.02      2.326     Yes
0.01      2.576     No
```

Constituent: Sulfate, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-27 (bg)



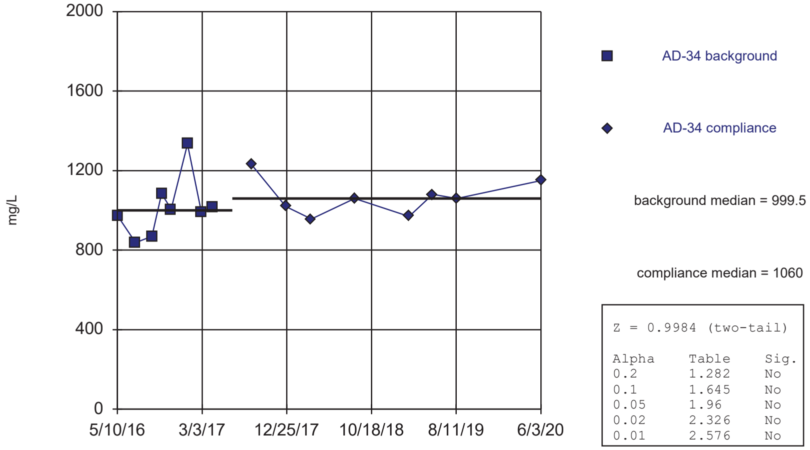
```
Z = -0.116 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Sulfate, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-34



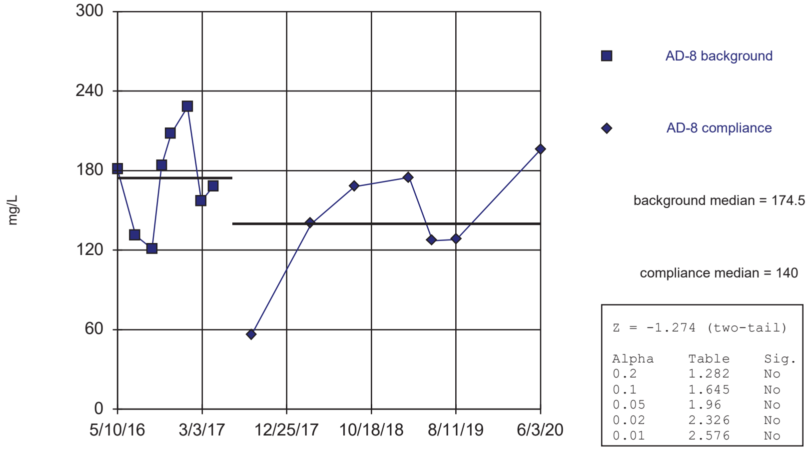
```
Z = 0.9984 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Sulfate, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

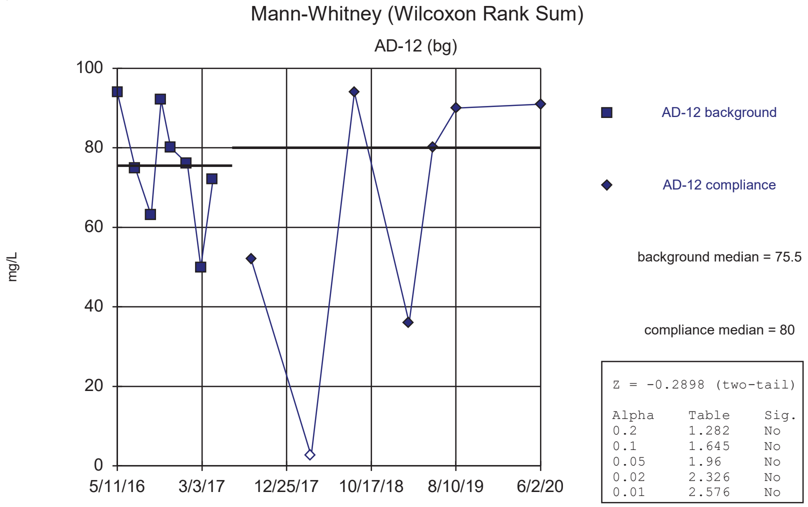
AD-8 (bg)



```
Z = -1.274 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Sulfate, total Analysis Run 12/3/2020 11:39 AM View: Mann Whitney
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

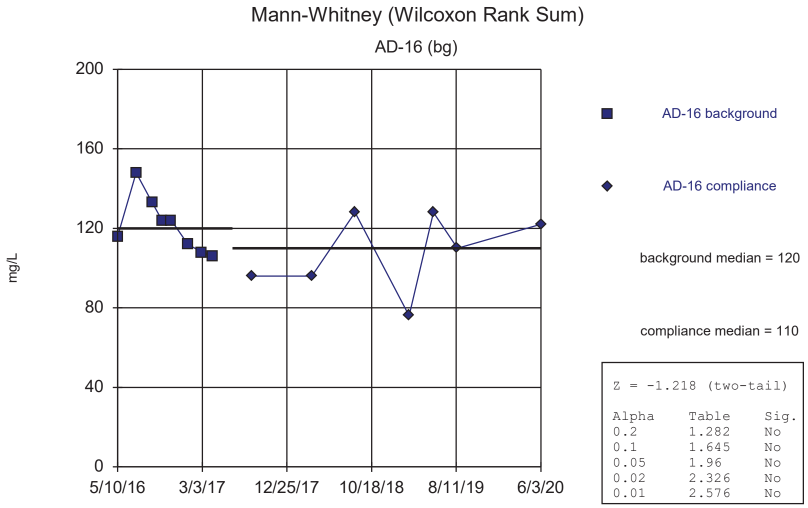
Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



```
Z = -0.2898 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/3/2020 11:40 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

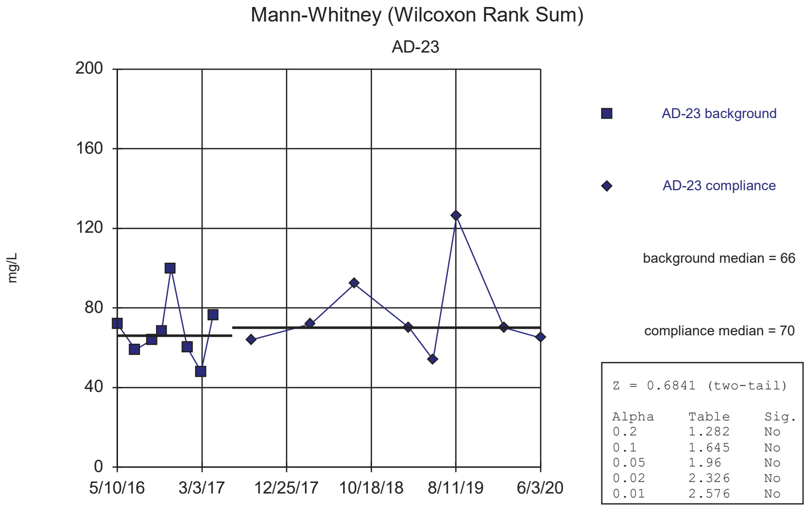
Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



```
Z = -1.218 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/3/2020 11:40 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

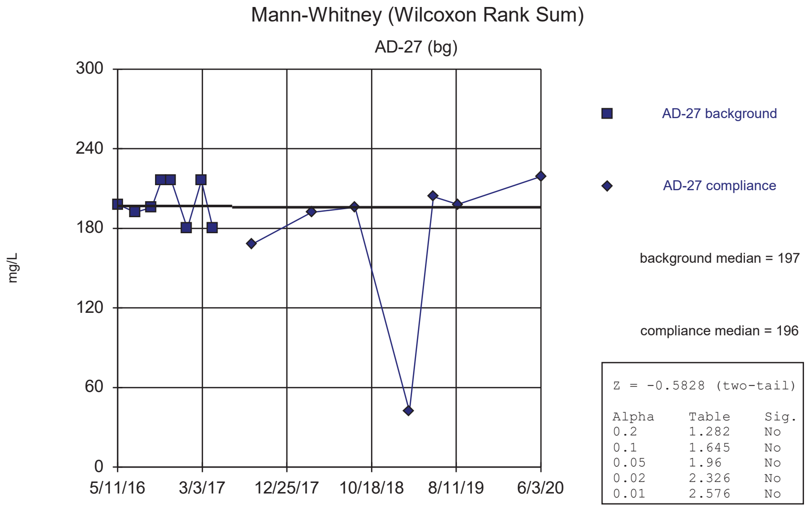
Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG



```
Z = 0.6841 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

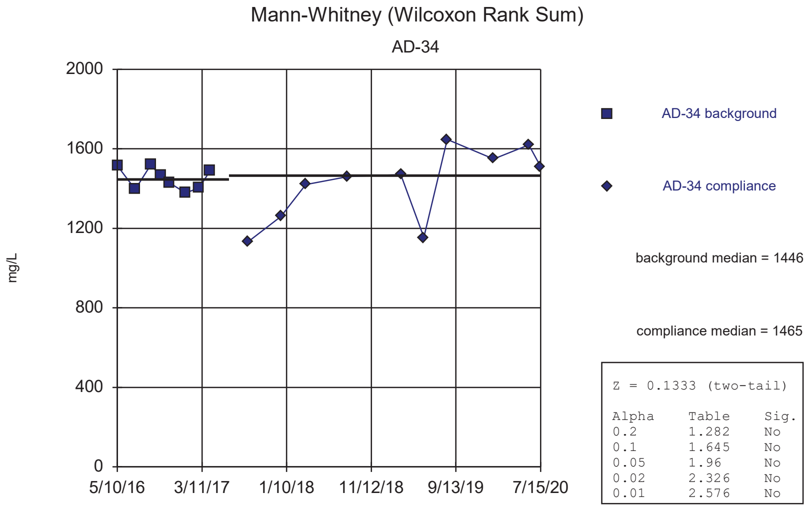
Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/3/2020 11:40 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

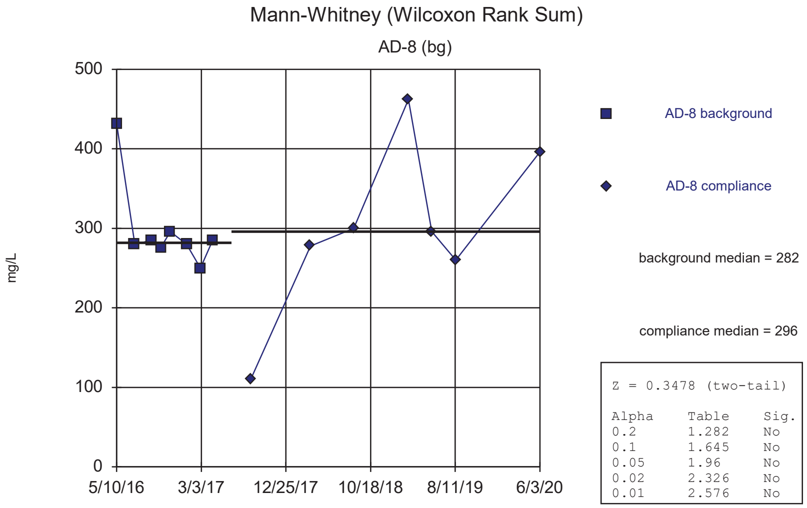


```
Z = -0.5828 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/3/2020 11:40 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill



Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/3/2020 11:40 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill



Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/3/2020 11:40 AM   View: Mann Whitney
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill

Intrawell Prediction Limit Summary - All Results

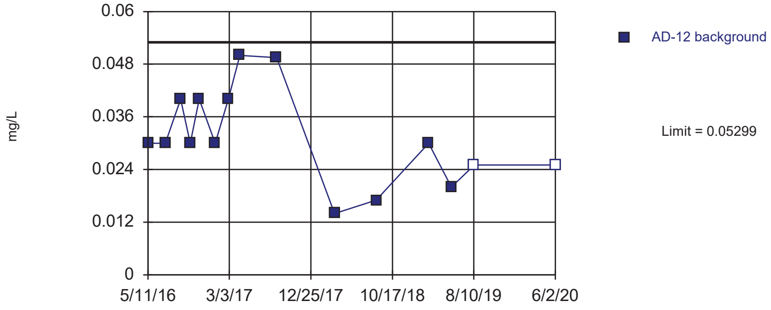
Pirkey Landfill   Client: Geosyntec   Data: Pirkey Landfill   Printed 12/3/2020, 12:34 PM

Constituent	Well	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-12	0.05299	n/a	15	0.03137	0.01078	13.33	None	No	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-16	0.03703	n/a	15	0.02571	0.005645	13.33	None	No	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-23	0.0433	n/a	16	0.02542	0.009074	12.5	None	No	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-27	0.05526	n/a	15	-3.534	0.3185	0	None	ln(x)	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-34	0.145	n/a	15	0.2942	0.04317	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-36	0.07017	n/a	8	0.05688	0.00541	0	None	No	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-8	1.401	n/a	15	0.8775	0.261	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-12	0.4316	n/a	15	0.3097	0.06082	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-16	1.397	n/a	8	0.9831	0.1682	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-23	0.536	n/a	16	0.5584	0.08819	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-27	5.194	n/a	15	4.188	0.5016	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-34	42.77	n/a	15	38.19	2.285	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-36	0.304	n/a	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Calcium, total (mg/L)	AD-8	147.5	n/a	15	3.504	0.7427	0	None	ln(x)	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-12	9.052	n/a	15	6.417	1.314	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-16	27.54	n/a	8	17.1	4.248	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-23	8.882	n/a	15	5.864	1.505	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-27	13.93	n/a	8	10.68	1.325	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-34	9.347	n/a	16	7.508	0.9337	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-36	9.542	n/a	8	8.564	0.3981	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-8	17.56	n/a	15	11.03	3.252	0	None	No	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-12	1	n/a	15	n/a	n/a	60	n/a	n/a	0.007533	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-16	1	n/a	15	n/a	n/a	73.33	n/a	n/a	0.007533	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-23	1	n/a	15	n/a	n/a	60	n/a	n/a	0.007533	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-27	1	n/a	15	n/a	n/a	60	n/a	n/a	0.007533	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-34	1.285	n/a	18	0.8208	0.2404	38.89	Kaplan-Meier	No	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-36	0.08	n/a	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Fluoride, total (mg/L)	AD-8	4.74	n/a	15	2.104	1.315	6.667	None	No	0.002505	Param Intra 1 of 2
pH, field (SU)	AD-12	5.61	2.669	15	4.139	0.7332	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-16	5.048	3.068	15	4.058	0.4938	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-23	5.228	2.837	16	4.033	0.6067	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-27	4.834	2.422	15	3.628	0.6016	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-34	4.168	2.919	17	3.544	0.3201	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-36	5.653	3.478	9	4.566	0.4632	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-8	6.18	3.57	15	n/a	n/a	0	n/a	n/a	0.01507	NP Intra (normality) 1 of 2
Sulfate, total (mg/L)	AD-12	8.164	n/a	15	4.873	1.641	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-16	44.65	n/a	15	4.639	1.019	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-23	14.53	n/a	15	10.48	2.021	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-27	92	n/a	15	n/a	n/a	0	n/a	n/a	0.007533	NP Intra (normality) 1 of 2
Sulfate, total (mg/L)	AD-34	1284	n/a	16	1040	123.8	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-36	4.198	n/a	8	40.92	13.44	0	None	x^3	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-8	243	n/a	15	157.9	42.45	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	121.3	n/a	15	69.83	25.67	6.667	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-16	150.6	n/a	15	115.1	17.67	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-23	110.9	n/a	16	8.453	1.055	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-27	233.2	n/a	15	7363038	2652026	0	None	x^3	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-34	1702	n/a	18	1434	138.6	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-36	98.48	n/a	8	54.88	17.74	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-8	464.6	n/a	15	299	82.57	0	None	No	0.002505	Param Intra 1 of 2

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-12 (bg)



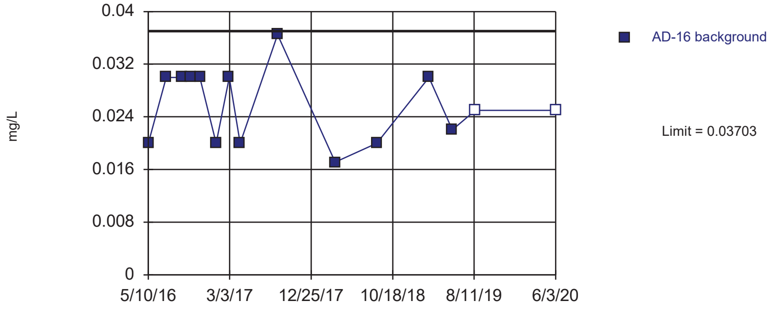
Background Data Summary: Mean=0.03137, Std. Dev.=0.01078, n=15, 13.33% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9405, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron, total Analysis Run 12/3/2020 12:32 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-16 (bg)



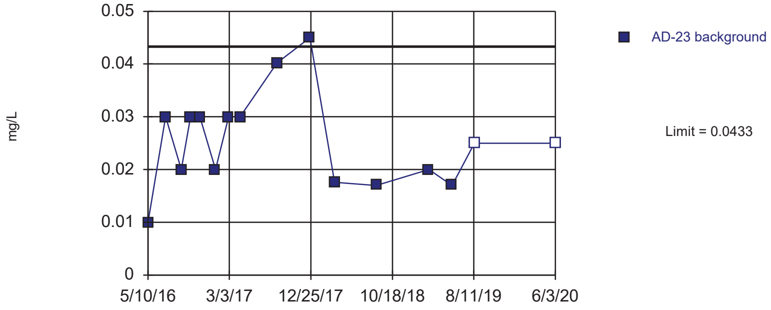
Background Data Summary: Mean=0.02571, Std. Dev.=0.005645, n=15, 13.33% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8915, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron, total Analysis Run 12/3/2020 12:32 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-23



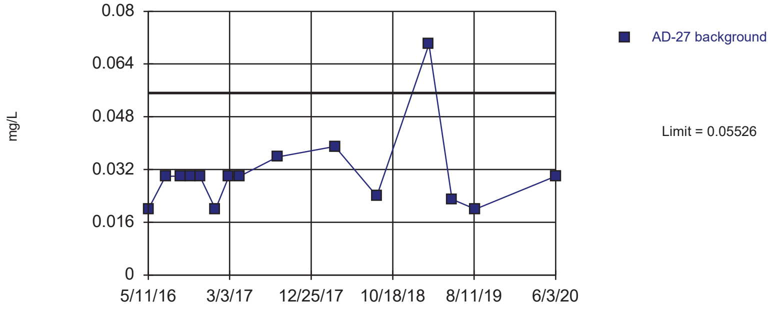
Background Data Summary: Mean=0.02542, Std. Dev.=0.009074, n=16, 12.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9384, critical = 0.844. Kappa = 1.97 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron, total Analysis Run 12/3/2020 12:32 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-27 (bg)



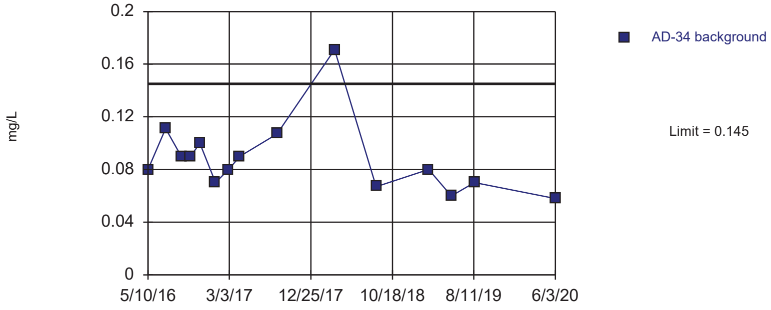
Background Data Summary (based on natural log transformation): Mean=-3.534, Std. Dev.=0.3185, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8388, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron, total Analysis Run 12/3/2020 12:32 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-34



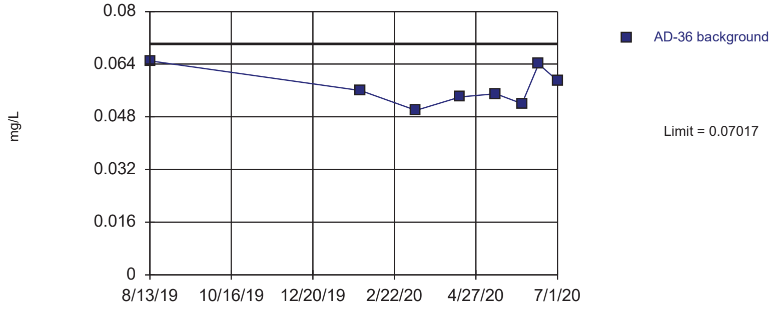
Background Data Summary (based on square root transformation): Mean=0.2942, Std. Dev.=0.04317, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8841, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-36



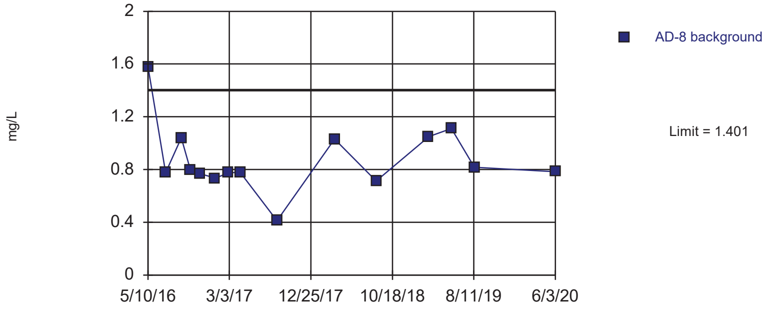
Background Data Summary: Mean=0.05688, Std. Dev.=0.00541, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9299, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-8 (bg)



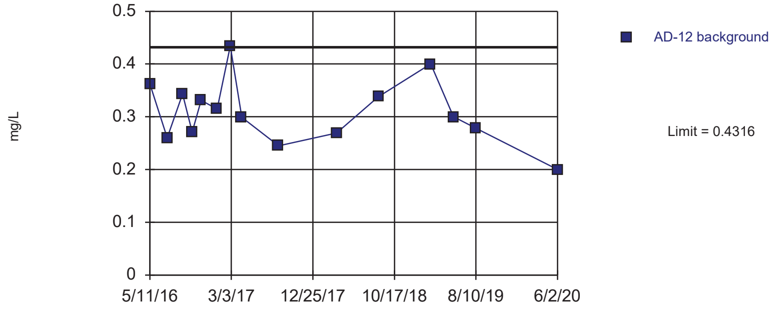
Background Data Summary: Mean=0.8775, Std. Dev.=0.261, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.852, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Boron, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-12 (bg)



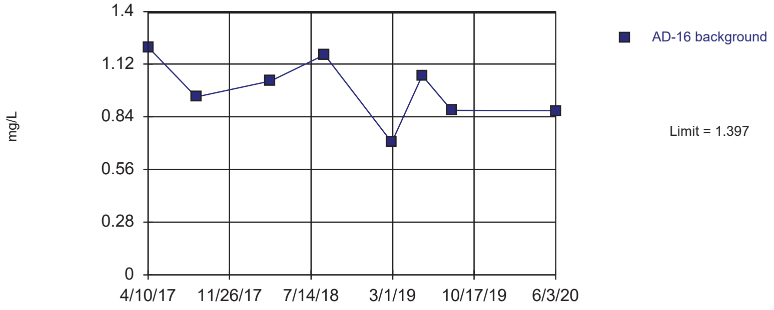
Background Data Summary: Mean=0.3097, Std. Dev.=0.06082, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9821, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16 (bg)



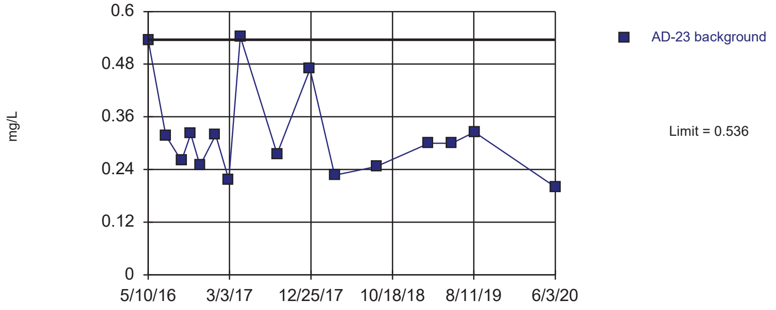
Background Data Summary: Mean=0.9831, Std. Dev.=0.1682, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.967, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-23



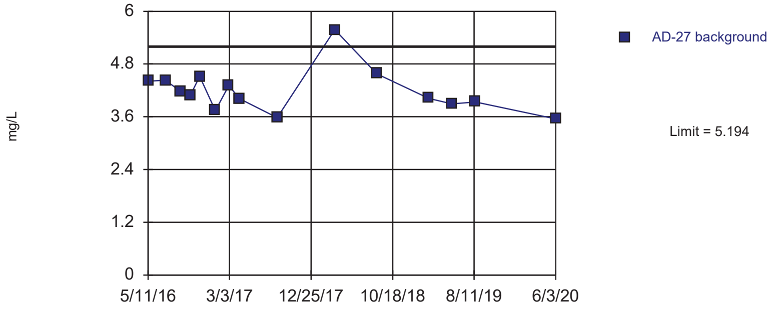
Background Data Summary (based on square root transformation): Mean=0.5584, Std. Dev.=0.08819, n=16. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8672, critical = 0.844. Kappa = 1.97 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-27 (bg)



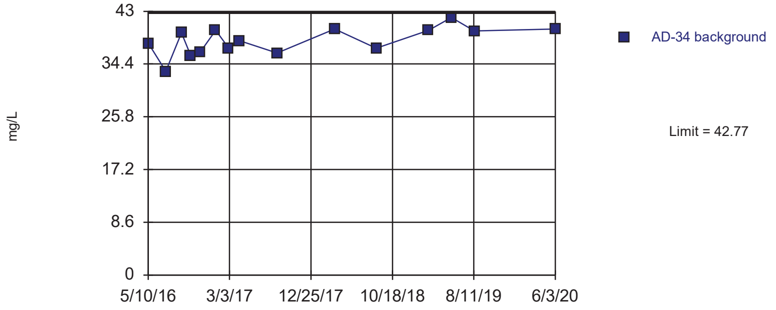
Background Data Summary: Mean=4.188, Std. Dev.=0.5016, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8881, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-34



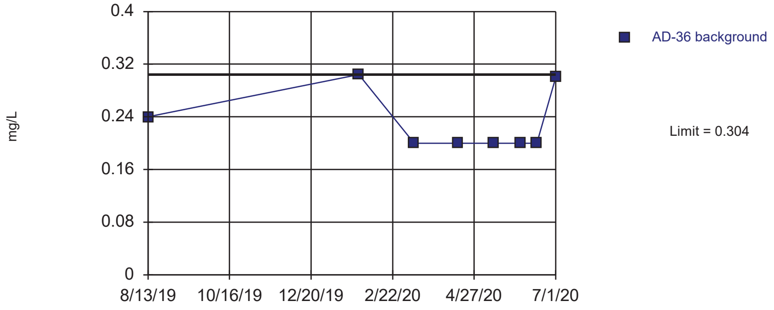
Background Data Summary: Mean=38.19, Std. Dev.=2.285, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9459, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-36



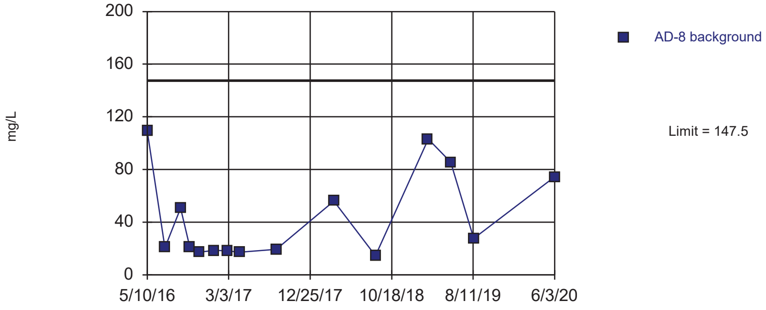
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2). Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-8 (bg)



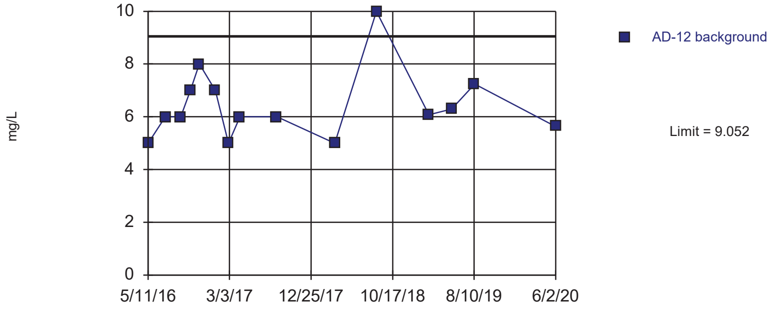
Background Data Summary (based on natural log transformation): Mean=3.504, Std. Dev.=0.7427, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8383, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-12 (bg)



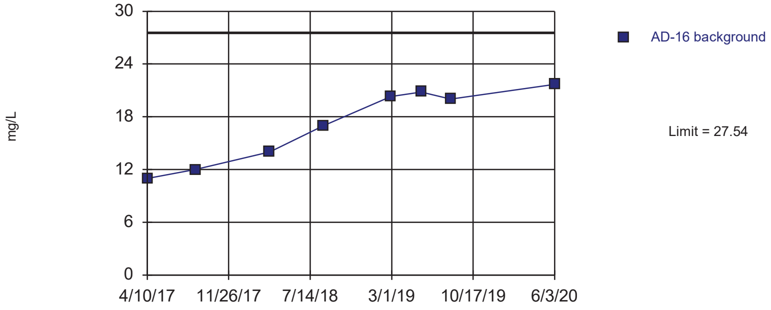
Background Data Summary: Mean=6.417, Std. Dev.=1.314, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8559, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16 (bg)



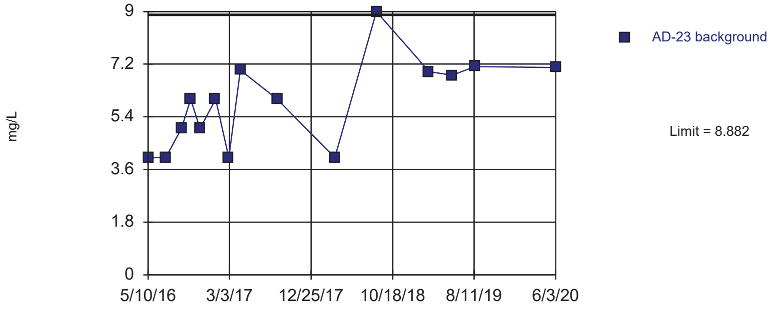
Background Data Summary: Mean=17.1, Std. Dev.=4.248, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.877, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-23



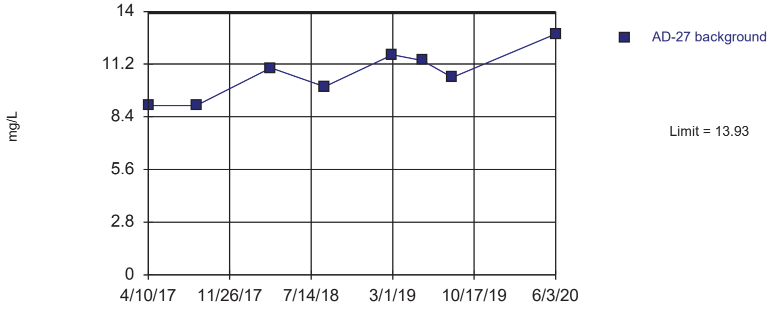
Background Data Summary: Mean=5.864, Std. Dev.=1.505, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9066, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-27 (bg)



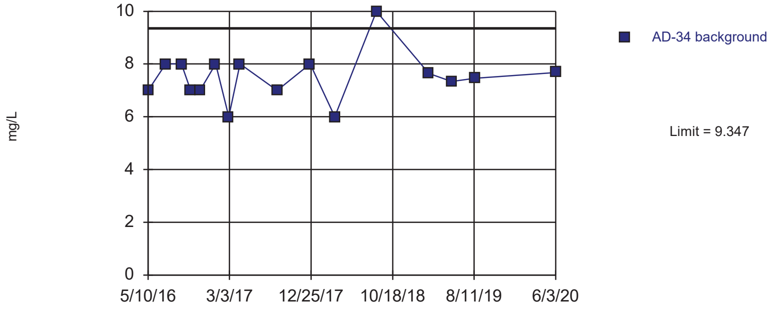
Background Data Summary: Mean=10.68, Std. Dev.=1.325, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9547, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-34



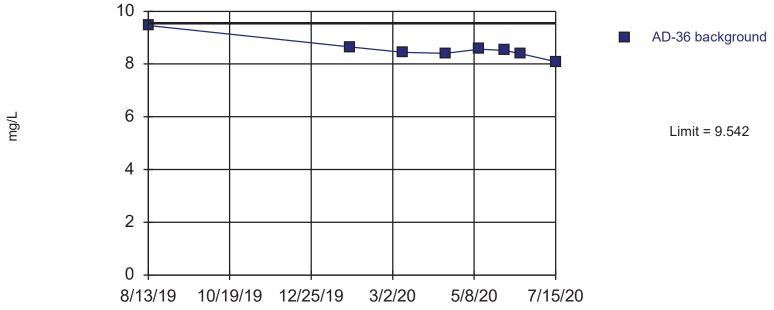
Background Data Summary: Mean=7.508, Std. Dev.=0.9337, n=16. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8815, critical = 0.844. Kappa = 1.97 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-36



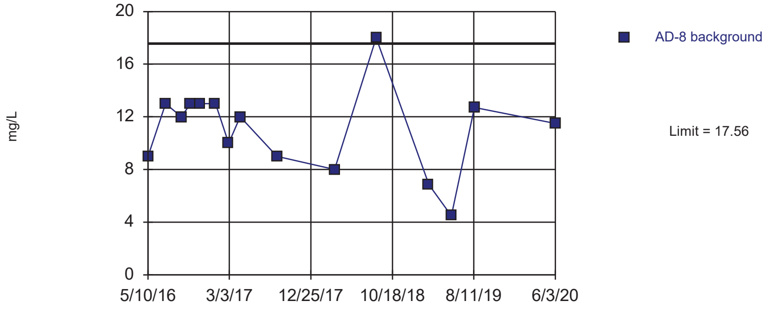
Background Data Summary: Mean=8.564, Std. Dev.=0.3981, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8029, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-8 (bg)



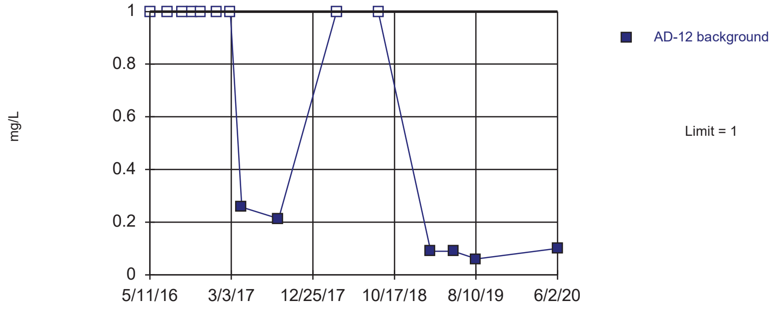
Background Data Summary: Mean=11.03, Std. Dev.=3.252, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.941, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Chloride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-12 (bg)



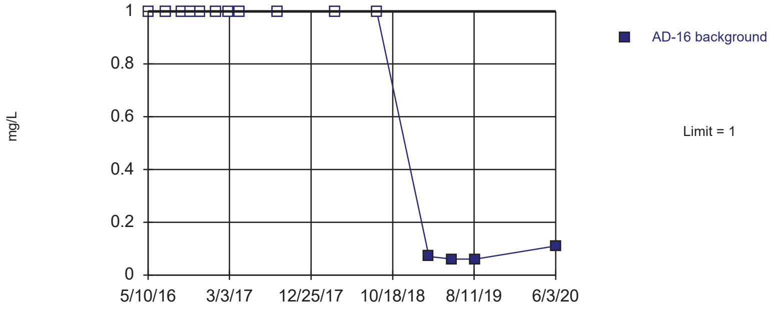
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 15 background values. 60% NDs. Well-constituent pair annual alpha = 0.01501. Individual comparison alpha = 0.007533 (1 of 2). Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-16 (bg)



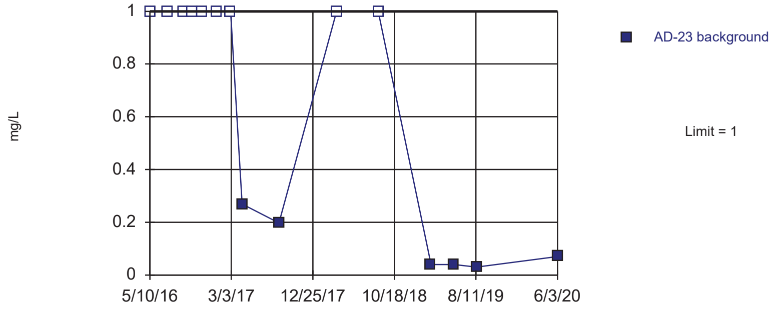
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 15 background values. 73.33% NDs. Well-constituent pair annual alpha = 0.01501. Individual comparison alpha = 0.007533 (1 of 2). Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-23



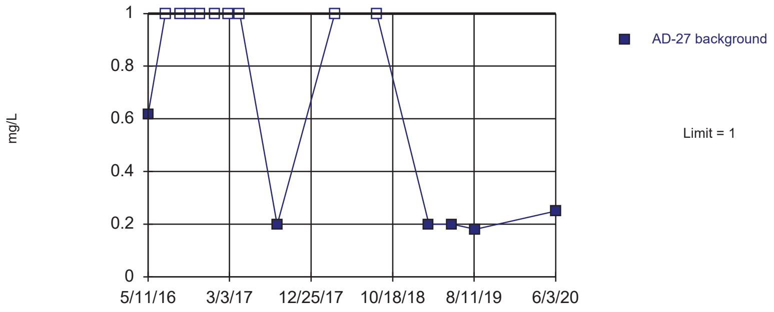
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 15 background values. 60% NDs. Well-constituent pair annual alpha = 0.01501. Individual comparison alpha = 0.007533 (1 of 2). Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Non-parametric, AD-27 (bg)



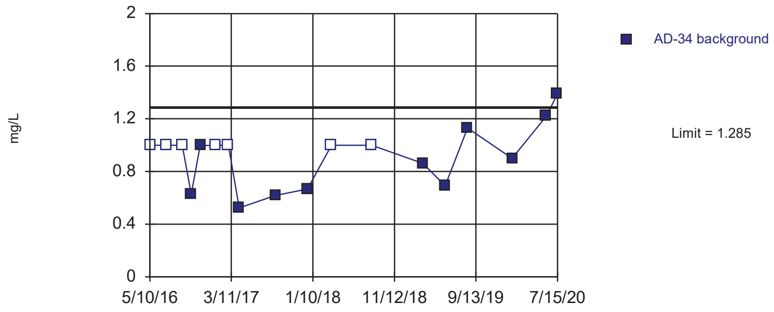
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 15 background values. 60% NDs. Well-constituent pair annual alpha = 0.01501. Individual comparison alpha = 0.007533 (1 of 2). Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-34



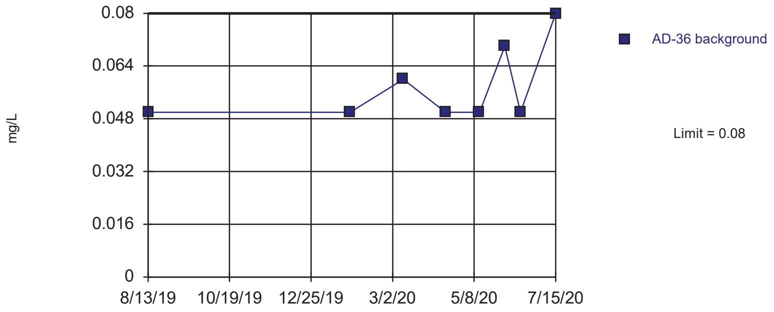
Background Data Summary (after Kaplan-Meier Adjustment): Mean=0.8208, Std. Dev.=0.2404, n=18, 38.89% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9192, critical = 0.858. Kappa = 1.931 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-36



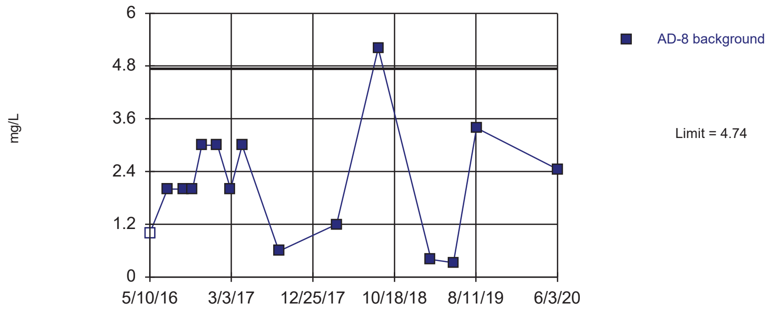
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2). Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-8 (bg)



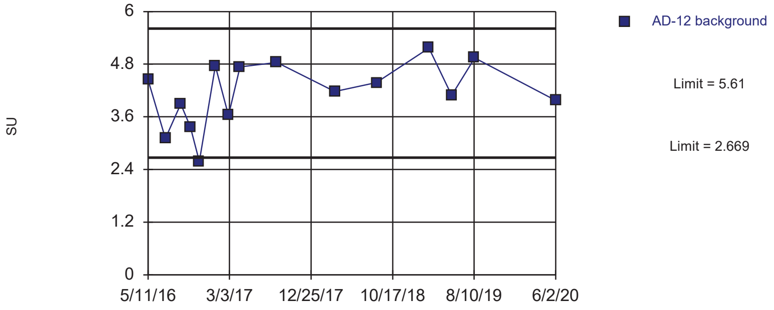
Background Data Summary: Mean=2.104, Std. Dev.=1.315, n=15, 6.667% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9353, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Fluoride, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-12 (bg)



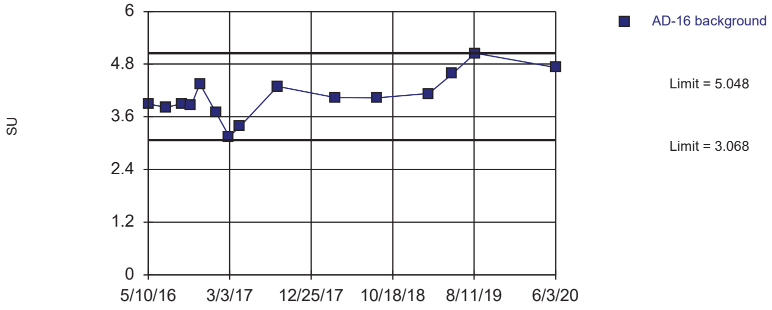
Background Data Summary: Mean=4.139, Std. Dev.=0.7332, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9592, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16 (bg)



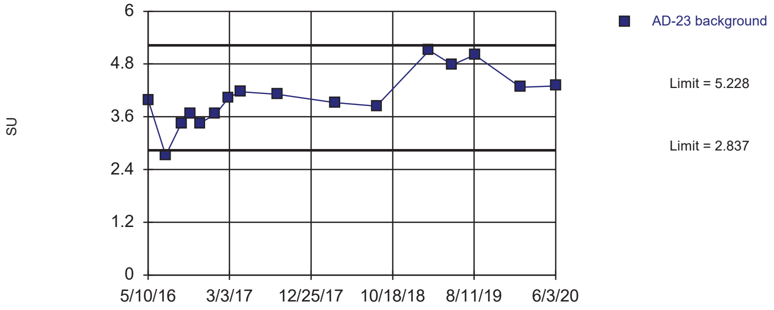
Background Data Summary: Mean=4.058, Std. Dev.=0.4938, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9814, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-23



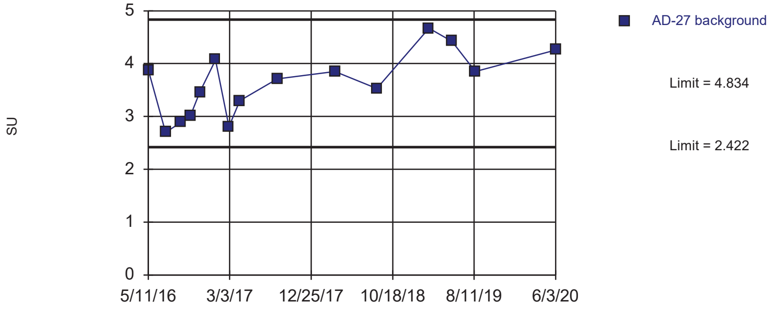
Background Data Summary: Mean=4.033, Std. Dev.=0.6067, n=16. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9632, critical = 0.844. Kappa = 1.97 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-27 (bg)



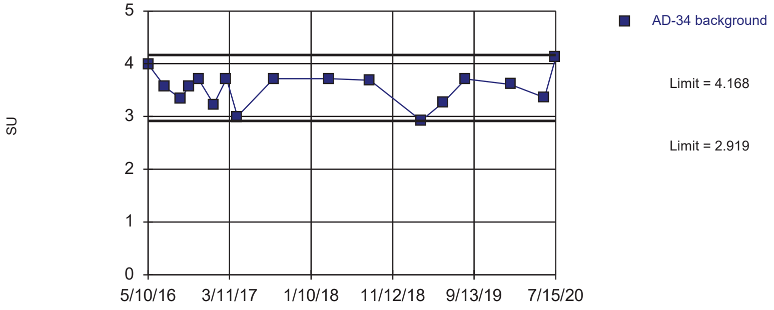
Background Data Summary: Mean=3.628, Std. Dev.=0.6016, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9661, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-34



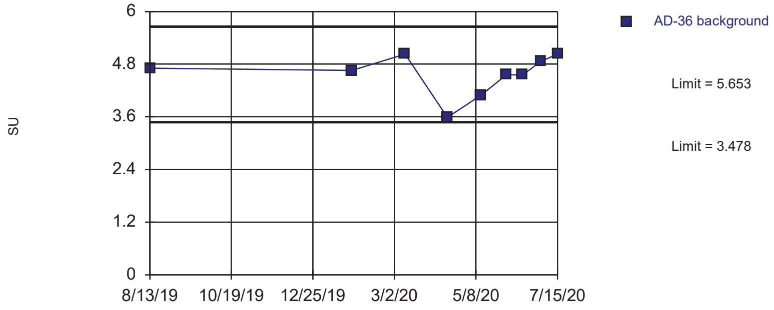
Background Data Summary: Mean=3.544, Std. Dev.=0.3201, n=17. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9468, critical = 0.851. Kappa = 1.951 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-36



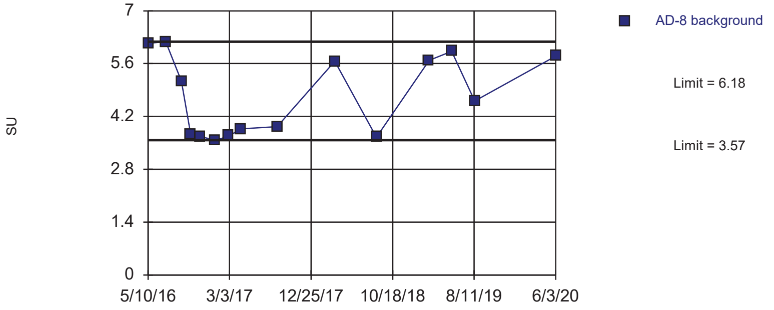
Background Data Summary: Mean=4.566, Std. Dev.=0.4632, n=9. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8742, critical = 0.764. Kappa = 2.348 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-8 (bg)



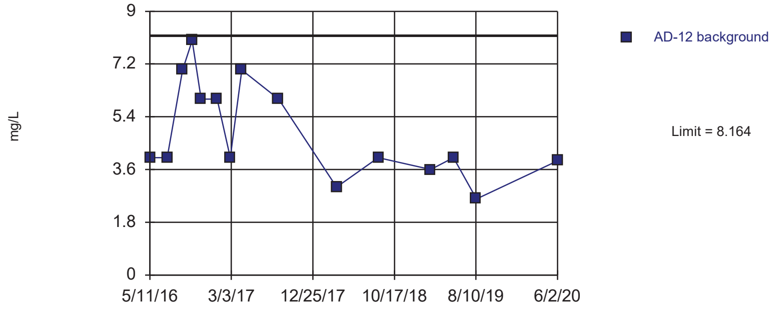
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limits are highest and lowest of 15 background values. Well-constituent pair annual alpha = 0.03002. Individual comparison alpha = 0.01507 (1 of 2). Assumes 1 future value.

Constituent: pH, field Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-12 (bg)



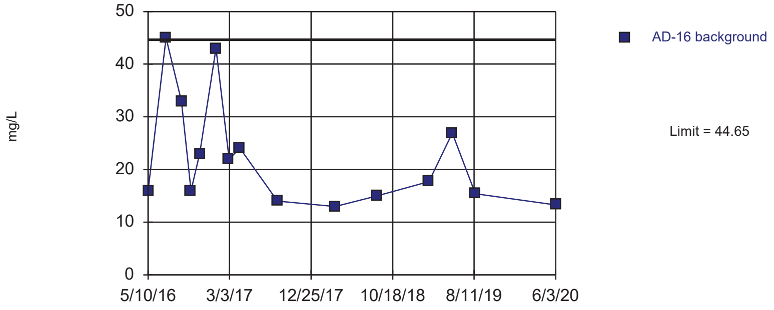
Background Data Summary: Mean=4.873, Std. Dev.=1.641, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8903, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16 (bg)



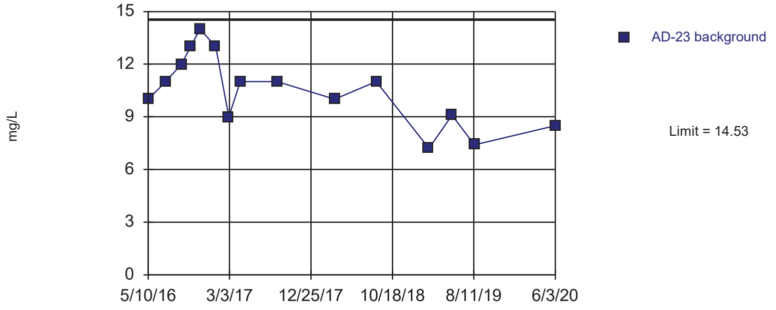
Background Data Summary (based on square root transformation): Mean=4.639, Std. Dev.=1.019, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8612, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-23



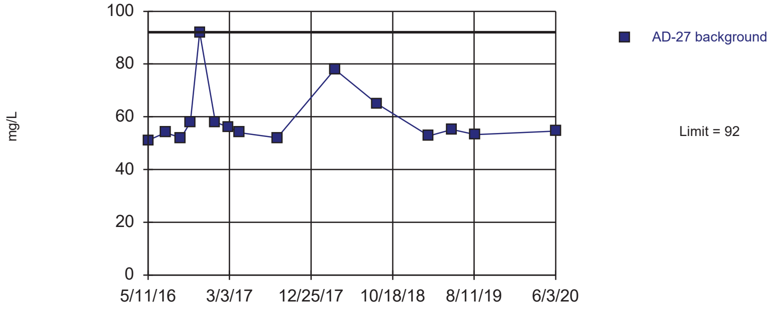
Background Data Summary: Mean=10.48, Std. Dev.=2.021, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9645, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Non-parametric, AD-27 (bg)



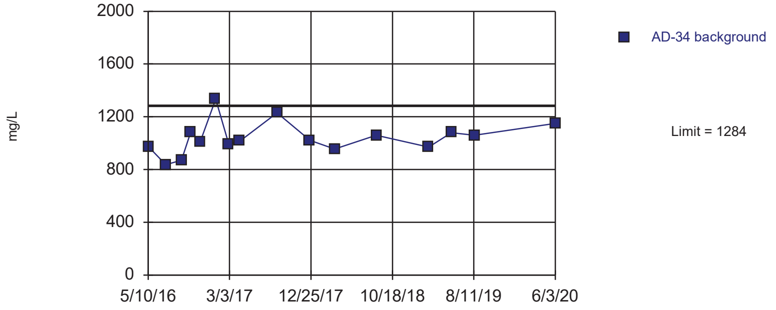
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 15 background values. Well-constituent pair annual alpha = 0.01501. Individual comparison alpha = 0.007533 (1 of 2). Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-34



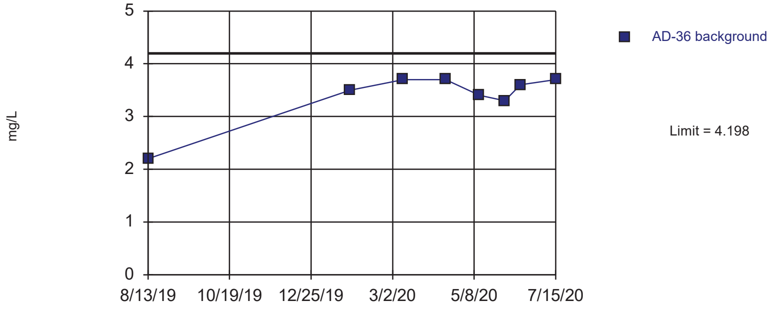
Background Data Summary: Mean=1040, Std. Dev.=123.8, n=16. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9456, critical = 0.844. Kappa = 1.97 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-36



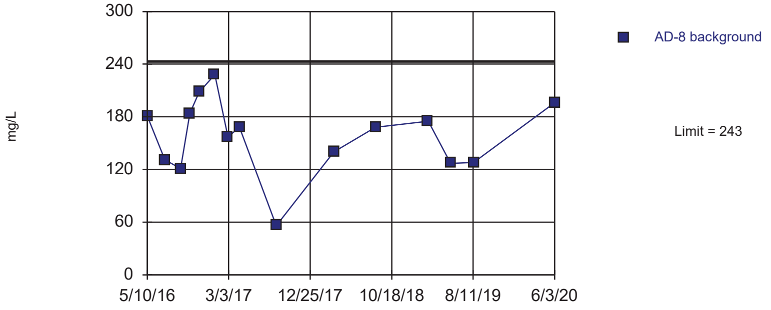
Background Data Summary (based on cube transformation): Mean=40.92, Std. Dev.=13.44, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7626, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/3/2020 12:33 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-8 (bg)



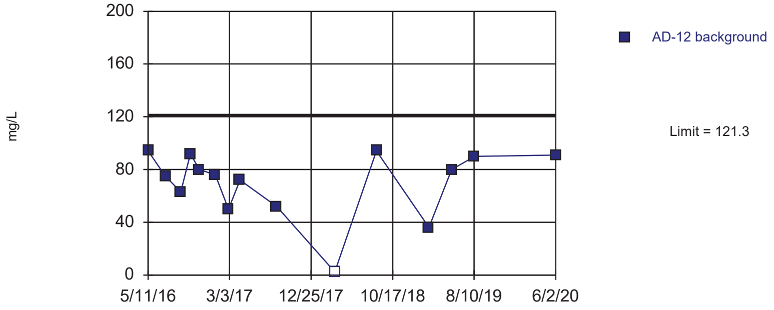
Background Data Summary: Mean=157.9, Std. Dev.=42.45, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9573, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/3/2020 12:34 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-12 (bg)



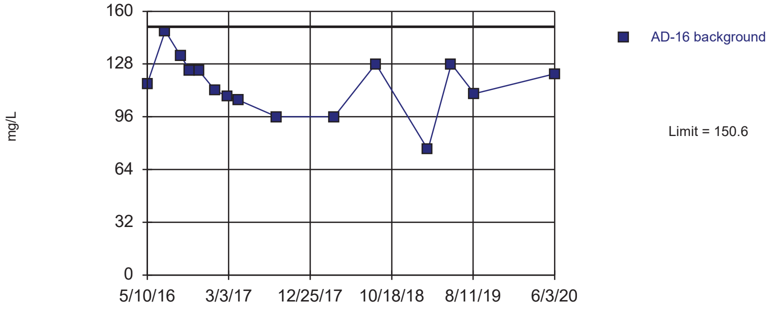
Background Data Summary: Mean=69.83, Std. Dev.=25.67, n=15, 6.667% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8522, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/3/2020 12:34 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-16 (bg)



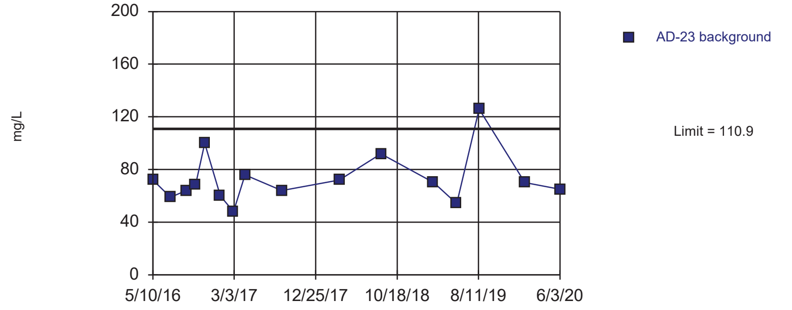
Background Data Summary: Mean=115.1, Std. Dev.=17.67, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9746, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/3/2020 12:34 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-23



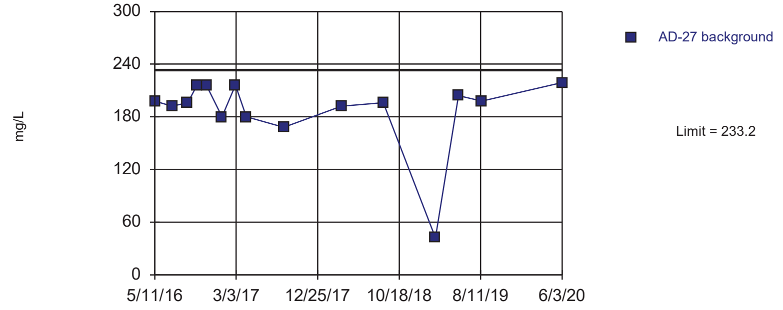
Background Data Summary (based on square root transformation): Mean=8.453, Std. Dev.=1.055, n=16. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8892, critical = 0.844. Kappa = 1.97 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/3/2020 12:34 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-27 (bg)



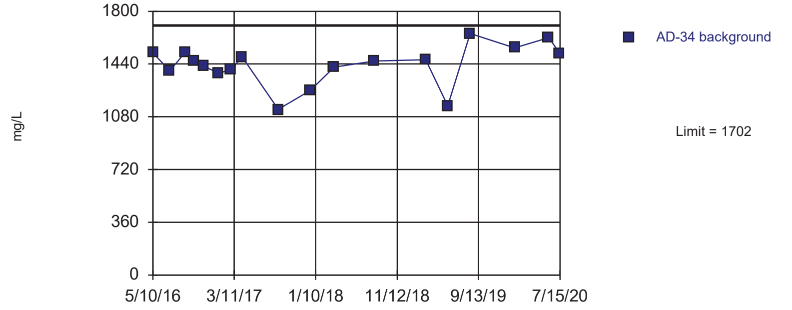
Background Data Summary (based on cube transformation): Mean=7363038, Std. Dev.=2652026, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8696, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/3/2020 12:34 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-34



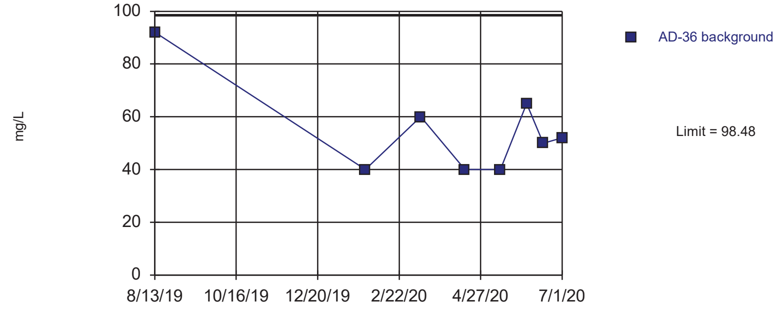
Background Data Summary: Mean=1434, Std. Dev.=138.6, n=18. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9175, critical = 0.858. Kappa = 1.931 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/3/2020 12:34 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.27 Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-36

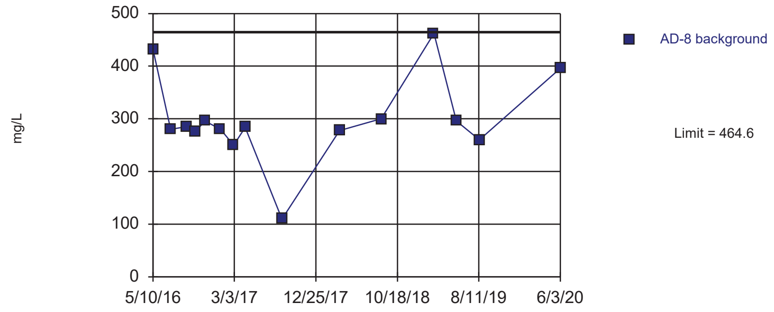


Background Data Summary: Mean=54.88, Std. Dev.=17.74, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8385, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/3/2020 12:34 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Prediction Limit

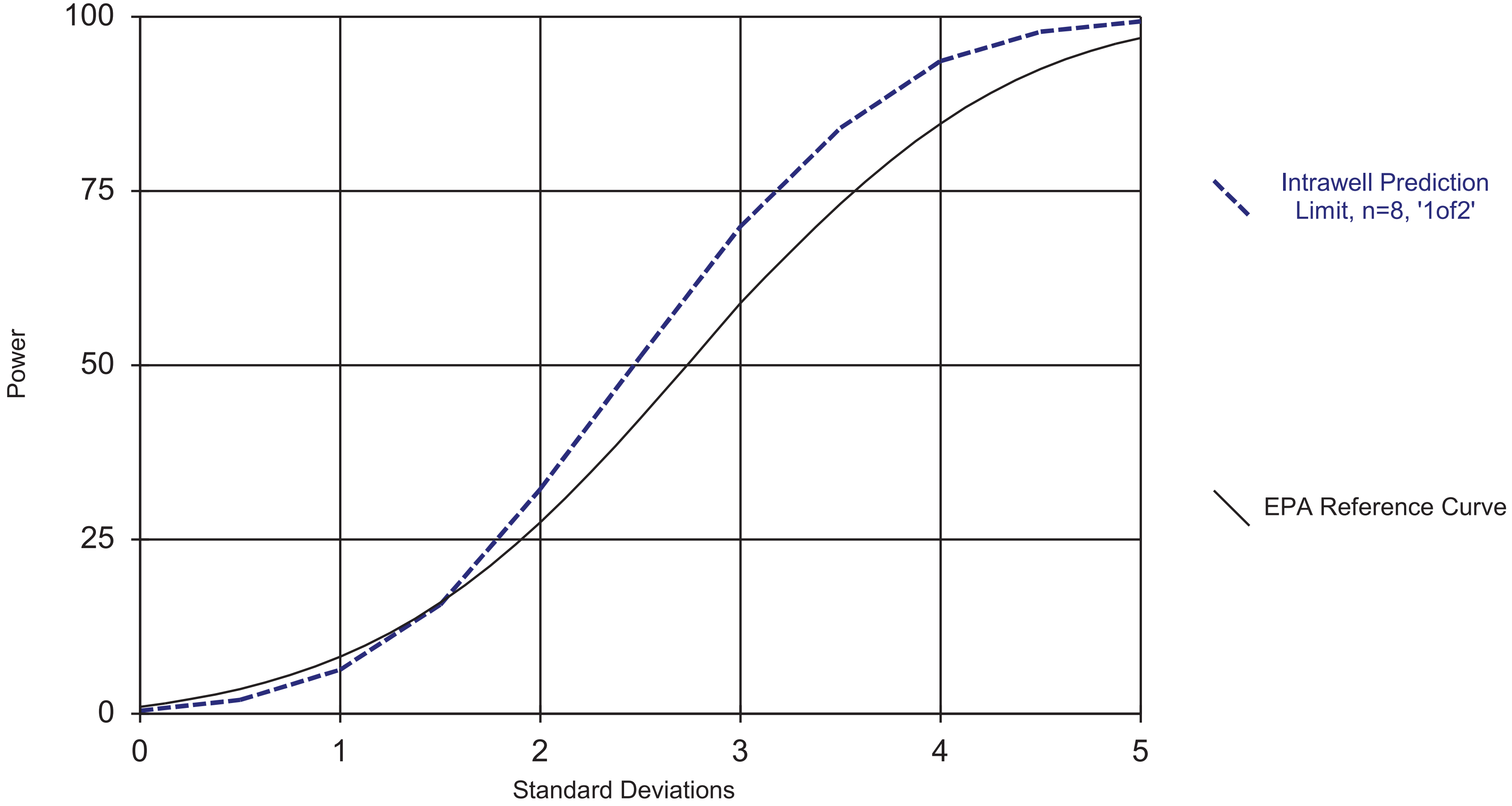
Intrawell Parametric, AD-8 (bg)



Background Data Summary: Mean=299, Std. Dev.=82.57, n=15. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8448, critical = 0.835. Kappa = 2.006 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/3/2020 12:34 PM View: PLs
Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

Power Curve



Kappa = 2.458, based on 3 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

Analysis Run 12/3/2020 12:41 PM View: Descriptive

Pirkey Landfill Client: Geosyntec Data: Pirkey Landfill

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
Landfill
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

December 2020

CHA8495

TABLE OF CONTENTS

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FIGURES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
LPL	Lower Prediction Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SU	Standard Unit
TCEQ	Texas Commission on Environmental Quality
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

This Alternative Source Demonstration (ASD) report has been prepared to address a statistically significant increase (SSI) for fluoride in the groundwater monitoring network at the H.W. Pirkey Power Plant's Landfill, located in Hallsville, Texas, following the first semiannual detection monitoring event of 2020. The Landfill is registered as an ash landfill under Texas Commission on Environmental Quality (TCEQ) Industrial and Hazardous Waste Solid Waste Registration No. 33240. The western side of the Landfill overlies a former lignite mining area, as shown in **Figure 1**.

Background groundwater concentrations for the Landfill were initially calculated in January 2018 with data from at least eight monitoring events (Geosyntec, 2018). Upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. Lower prediction limits (LPLs) were also calculated for pH. An alternative source demonstration (ASD) was certified on January 7, 2020 which resulted in a revision from interwell tests to intrawell tests for pH, sulfate, and TDS prediction limits due to the presence of lignite mine spoils within the screened interval at downgradient well AD-34 (Geosyntec, 2020). Prediction limits were calculated based on a one-of-two retesting procedure to maintain an appropriate site-wide false positive rate (SWFPR). With this procedure, an SSI is concluded only if both samples in a series of two exceed the UPL or, in the case of pH, are below the LPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

The first semi-annual detection monitoring event of 2020 was performed in June 2020 (initial sampling event), and the results were compared to the calculated prediction limits. Where initial exceedances were identified, verification resampling was completed in July 2020. Following verification resampling, an SSI for fluoride was identified at well AD-34 by intrawell analysis, A summary of the detection monitoring analytical results and the calculated prediction limits to which they were compared is provided in **Table 1**.

1.1 CCR Rule Requirements

USEPA regulations regarding assessment monitoring programs for CCR landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSI is identified (40 CFR 257.94(e)(2)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The owner or operator must complete the written demonstration within 90 days of detecting a statistically significant increase over background levels to include obtaining a*

> *certification from a qualified professional engineer… verifying the accuracy of the information in the report.*

Pursuant to 40 CFR 257.94(e)(2), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSI identified for fluoride at AD-34 is from a source other than the Landfill.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSI could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSI identified for fluoride at AD-34 was based on a Type IV cause and not by a release from the Pirkey Landfill.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSI to demonstrate that a source other than the CCR unit caused the SSI. The methodology used to evaluate the fluoride SSI and the proposed alternative source are described below.

2.1 Proposed Alternative Source – Natural Variation

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. Groundwater sampling, laboratory analysis, and statistical evaluations were generally completed in accordance with draft TCEQ guidance for groundwater monitoring (TCEQ, 2020). As described below, the SSI has been attributed to natural variation, which is a Type IV issue.

In February 2019, a Landfill leachate sample was collected for laboratory analysis to support an ASD for cobalt and cadmium (Burns & McDonnell, 2019). The results of this sample found that fluoride was detected at an estimated (J-flagged) concentration of 0.50 milligrams per liter (mg/L). The laboratory analytical report is provided as **Attachment A**. This concentration is below the intrawell UPL of 1.00 mg/L at AD-34, suggesting that the Landfill is not the likely source of the fluoride exceedance.

Fluoride concentrations at the site appear to be highly variable, including at background monitoring locations. Observed concentrations at background well AD-8 are consistently higher than those observed at AD-34 (**Figure 2**). The second semi-annual detection sampling event was conducted on November 4, 2020. The reported fluoride concentration for the sample from well AD-34 was 0.82 mg/L, which is below the calculated UPL (**Figure 3**). Based on recent results at AD-34, including the three samples collected during the 2020 groundwater monitoring events, a statistically significant positive trend is not demonstrated (**Figure 4**). Thus, the observed fluoride concentrations during the first semi-annual event are not considered indicative of a release from the LF and are instead likely due to natural variability in the aquifer.

A cause of the variability of dissolved fluoride concentrations may be associated with former mining activities that took place immediately underlying and downgradient of the Landfill. As has been noted in previous ASDs (Burns & McDonnell, 2019; Geosyntec, 2019; Geosyntec, 2020), AD-34 is screened within lignite mine spoils, which has significantly impacted its groundwater composition. An analysis of lignite in a well core advanced in the Wilcox formation, which is the material formerly mined in Area A, found that fluorine was present in the material at concentrations ranging from approximately 10 to 50 milligrams per kilogram of dry material (mg/kg dry lignite) (Chakrabouti et. al, 1984). It is feasible that fluorine could be mobilized from the mine spoils, resulting in variability in the aqueous fluoride concentrations at AD-34.

An additional line of evidence that the Landfill is likely not affecting groundwater at AD-34 is the lack of increasing concentrations for chloride. Chloride is a conservative constituent which is not significantly attenuated by chemical processes during advective flow. The concentration ratio between chloride and fluoride in groundwater varies between approximately 10:1 and 100:1 at both upgradient and downgradient locations (**Figure 5**). Chloride was detected in the Landfill leachate at 640 mg/L (**Attachment A**), which is approximately two orders of magnitude greater than the concentrations detected at AD-34. The concentration ratio between chloride and fluoride in the Landfill leachate is approximately 1200:1 (**Figure 5**), which suggests that dissolved chloride concentrations at AD-34 would be higher if this location were affected by leachate. As shown in **Figure 6**, the concentration of chloride is consistently around 7 mg/L, which is comparable to upgradient monitoring locations. A trend analysis found no significant increasing trend for chloride at AD-34 (**Figure 7**). Because chloride is a conservative constituent and concentrations are higher in the leachate, if the Landfill were affecting the groundwater composition, we would expect to observe an increasing trend of dissolved chloride at AD-34.

The lack of elevated fluoride in the Landfill leachate, the high concentration of fluoride at upgradient location AD-8, and the presence of fluorine in lignite mined within the footprint of the Landfill all indicate that the Landfill is not the likely source of elevated fluoride at AD-34.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified fluoride SSI is not due to a release from the Pirkey Landfill, the unit will remain in the detection monitoring program. Groundwater at the unit will continue to be sampled for Appendix III parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.94(e)(2) and supports the position that the fluoride SSI at AD-34 identified during the first semiannual detection monitoring event of 2020 was not due to a release from the Landfill. The identified SSI was, instead, attributed to natural variation in the aquifer associated with former mining activities. Therefore, no further action is warranted, and the Pirkey Landfill will remain in the detection monitoring program. Certification of this ASD by a qualified professional engineer is provided in **Attachment B**.

SECTION 4

REFERENCES

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Burns & McDonnell, 2019. Alternate Source Demonstration Evaluation Report. H.W. Pirkey Power Plant Landfill CCR Management Unit. April.

Chakraborti, D., Hillmann, D.C.J., Zingaro, R.A., and Irgolic, K.J. 1984. Ion-Chromatographic Determination of Fluorine in Texas Lignite. *Fresenius Z. Anal. Chem.*, 319: 556-559.

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TCEQ, 2020. Coal Combustion Residuals Groundwater Monitoring and Corrective Action Draft Technical Guideline No. 32. Topic: Coal Combustion Residuals (CCR) Groundwater Monitoring and Corrective Action. Waste Permits Division. May.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

TABLES

Table 1: Detection Monitoring Data Summary
Pirkey Plant - Landfill

Analyte	Unit	Description	AD-23	AD-34	
			6/3/2020	6/3/2020	7/15/2020
Boron	mg/L	Intrawell Background Value (UPL)	0.030	0.120	
		Analytical Result	0.02	0.058	--
Calcium	mg/L	Intrawell Background Value (UPL)	0.65	42.5	
		Analytical Result	0.2	40.1	--
Chloride	mg/L	Intrawell Background Value (UPL)	7.89	9.20	
		Analytical Result	7.08	7.68	--
Fluoride	mg/L	Intrawell Background Value (UPL)	1.00	1.00	
		Analytical Result	0.07	**1.22**	**1.39**
pH	SU	Intrawell Background Value (UPL)	4.8	4.3	
		Intrawell Background Value (LPL)	2.5	2.7	
		Analytical Result	4.3	3.4	--
Sulfate	mg/L	Intrawell Background Value (UPL)	15.8	1,388	
		Analytical Result	8.5	1,150	--
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	106	1,587	
		Analytical Result	65	**1,620**	1,510

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

Background values are shaded gray.

FIGURES

Legend

- ⊕ Upgradient Well
- ⊕ Downgradient Well
- ⊕ Out of Network Well
- ⊕ Abandoned Well
- 🟥 A Area
- ▭ Landfill

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- A Area is a former lignite (reclaimed) mine.
- AD-35 was abandoned in November 2018 and a new downgradient well, AD-36, was installed in April 2019.
- Aerial imagery provided by DigitalGlobe and dated 12/1/2018.

1,000 500 0 1,000
Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

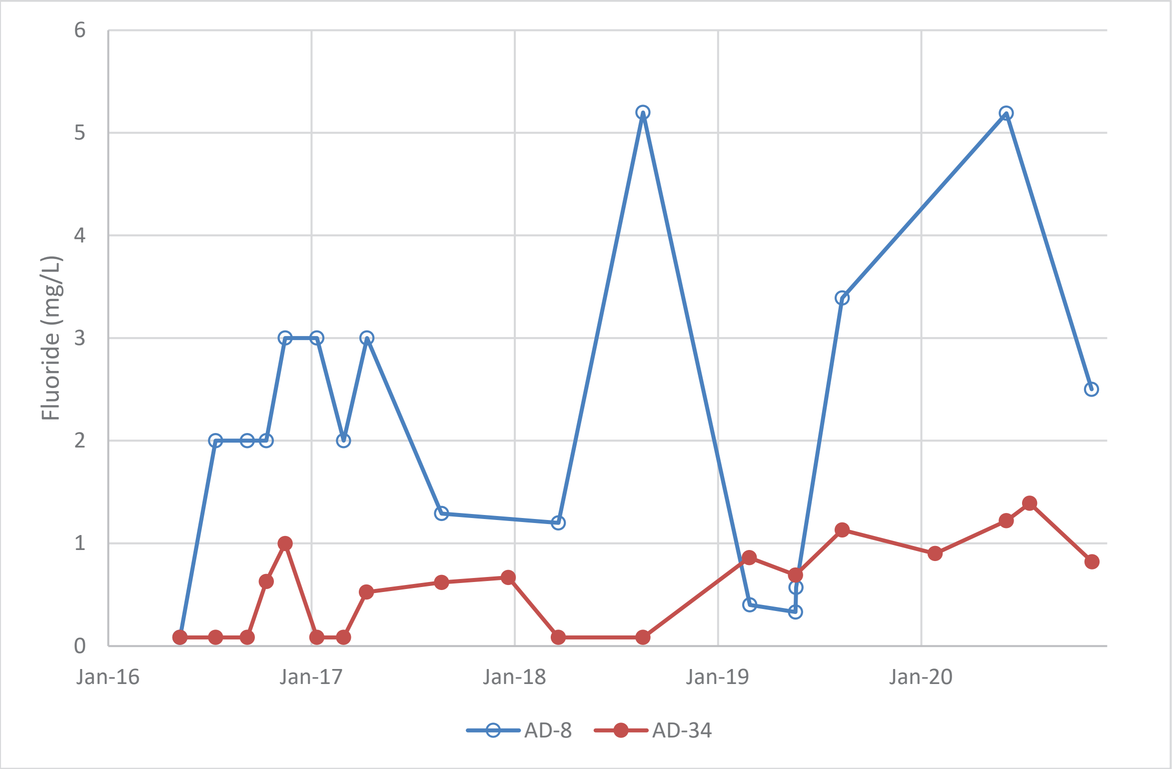
Figure

1

Columbus, Ohio

2020/01/06

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Sitelayout_20191224.mxd. ARevezzo. 1/6/2020. Project/Phase/Task.



Notes: Fluoride concentrations are shown in milligrams per liter (mg/L). AD-8 is shown with hollow symbols because it is an upgradient location.

AD-34 and AD-8 Fluoride Time Series Graph

Pirkey Landfill

Geosyntec consultants

AMERICAN ELECTRIC POWER

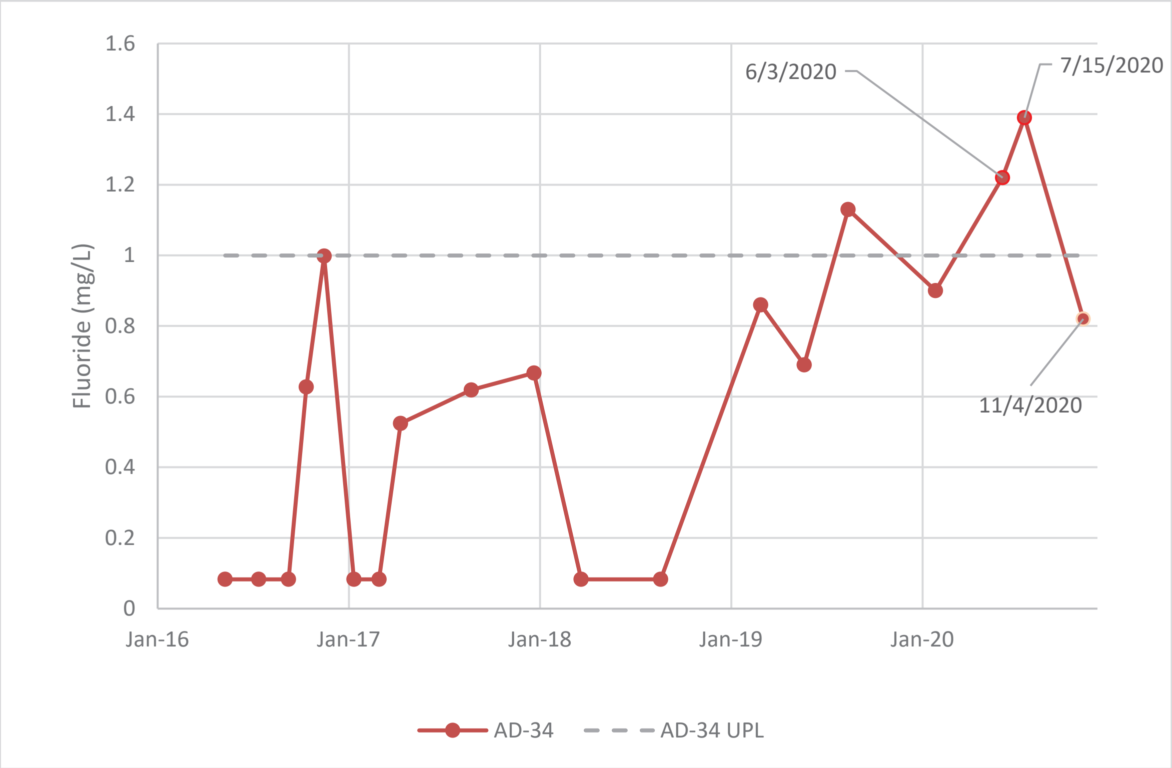
Figure

2

Columbus, Ohio

11-Dec-2020

internal info: path, date revised, author



Notes: Initial sampling for the first semi-annual detection monitoring event occurred on 6/3/2020. Verification resampling for the first semi-annual event occurred on 7/15/2020. Initial sampling for the second semi-annual event occurred on 11/4/2020. The upper prediction limit (UPL) was calculated using intrawell analyses.

AD-34 Fluoride Time Series Graph

Pirkey Landfill

Geosyntec consultants

AMERICAN ELECTRIC POWER

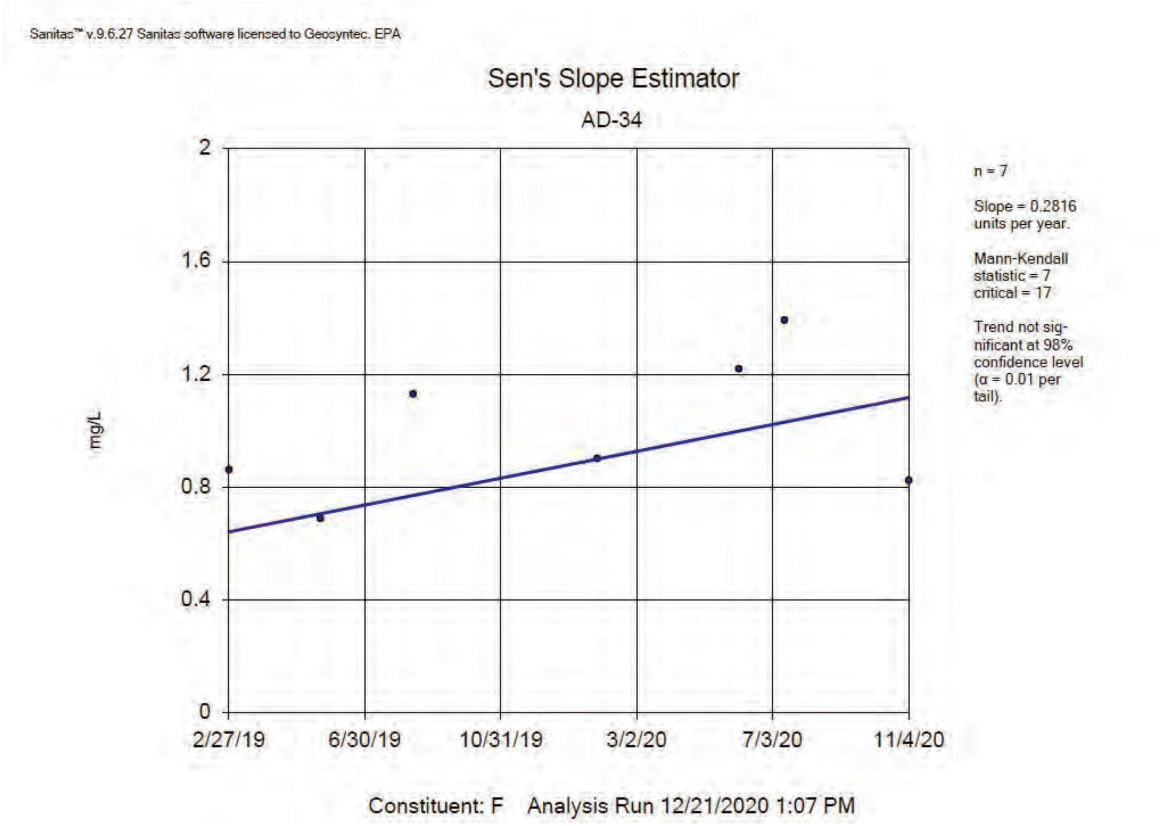
Columbus, Ohio

11-Dec-2020

Figure

3

internal info: path, date revised, author



Notes: Analysis of fluoride concentrations was completed using Sanitas™. No significant increasing trend was identified at 98% confidence level. As fluoride was not detected at AD-34 in 2018, all results collected after 2018 were used.

AD-34 Fluoride Trend Test

Pirkey Landfill

Geosyntec consultants

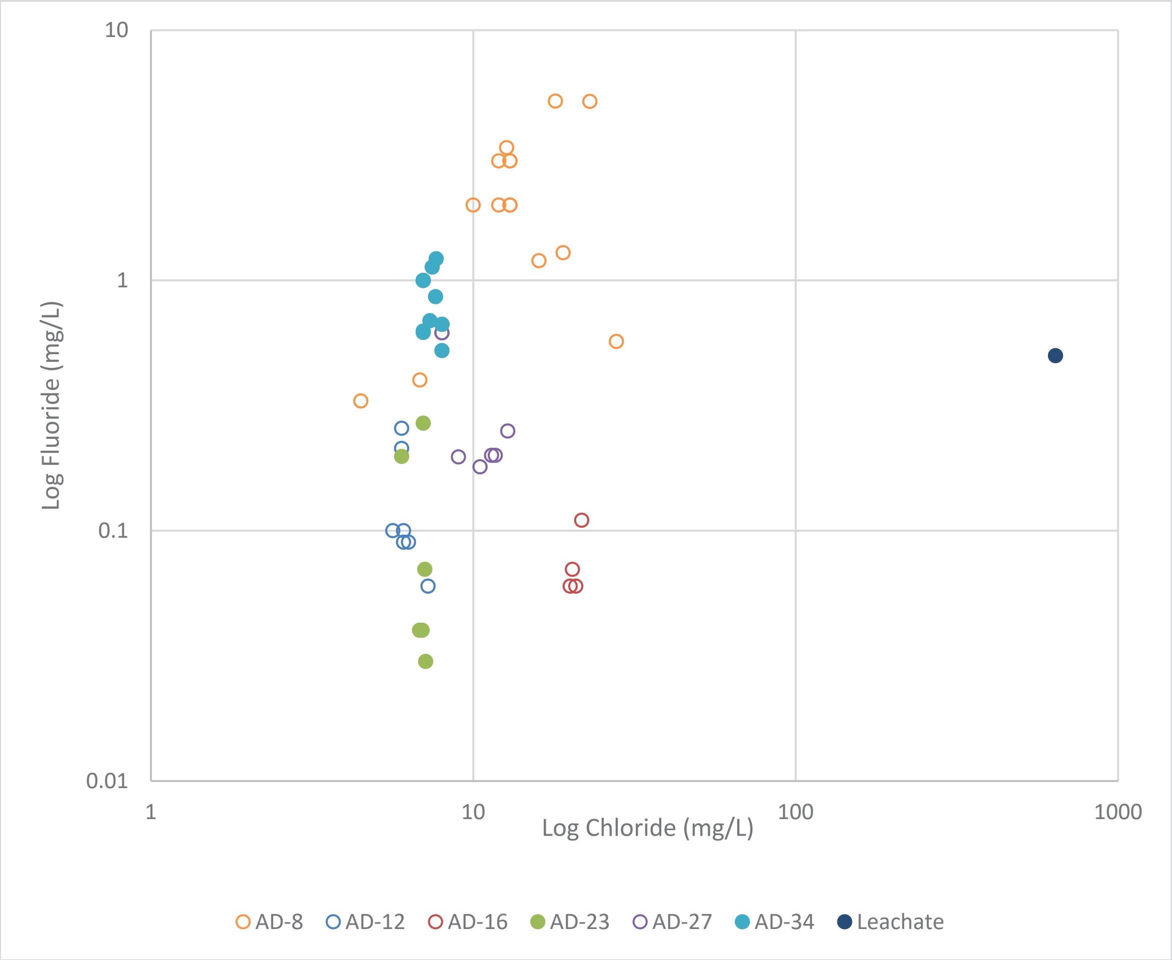
AMERICAN ELECTRIC POWER

Figure

4

Columbus, Ohio

28-Dec -2020



Notes: Chloride and fluoride concentrations are shown in milligrams per liter (mg/L). Upgradient wells are shown with hollow circles. ‘Leachate’ represents landfill leachate collected in February 2019.

Chloride and Fluoride Concentration Distribution

Pirkey Landfil

Geosyntec consultants

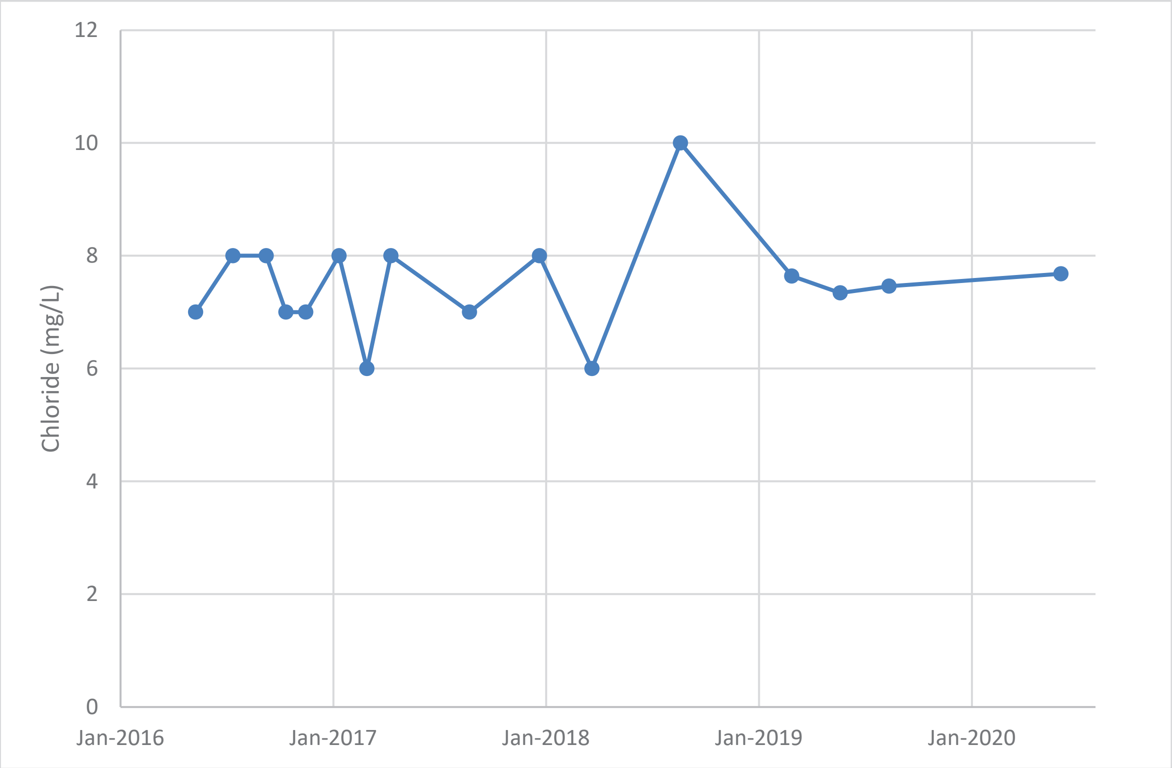
AMERICAN ELECTRIC POWER

Columbus, Ohio

28-Dec-2020

Figure

5



Notes: Chloride concentrations are shown in milligrams per liter (mg/L).

AD-34 Chloride Time Series Graph

Pirkey Landfill

Geosyntec consultants

AMERICAN ELECTRIC POWER

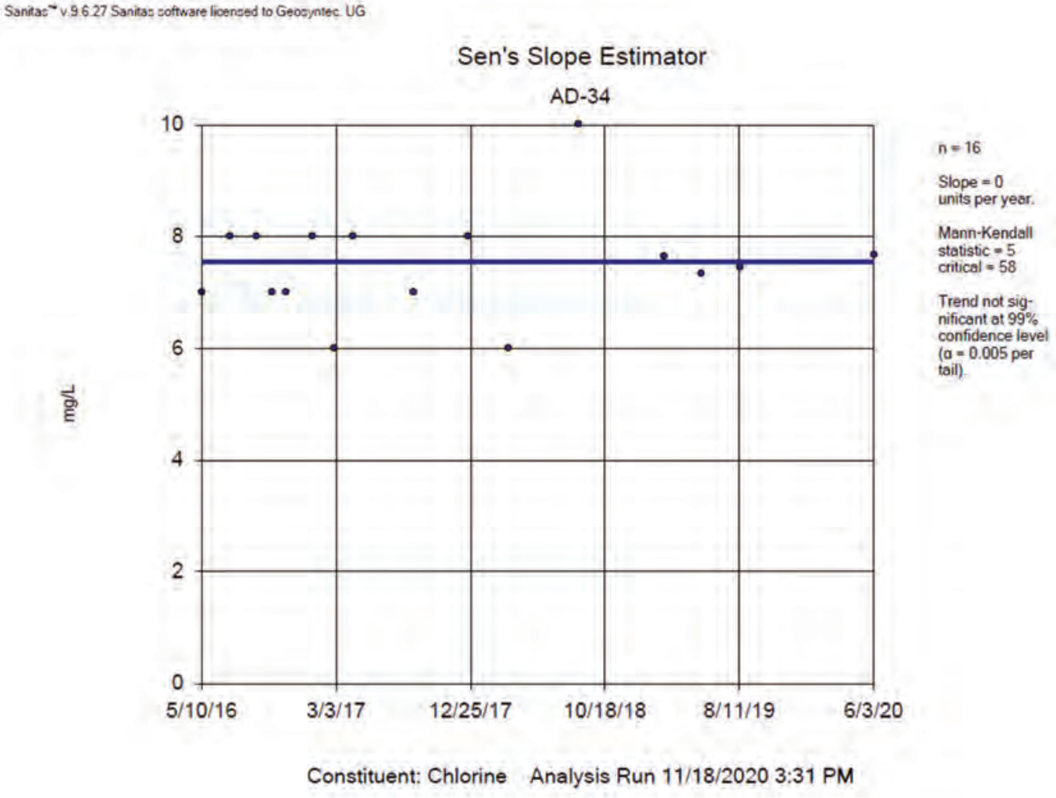
Columbus, Ohio

28-Dec-2020

Figure

6

internal info: path, date revised, author



Notes: Analysis of chloride concentrations was completed using Sanitas™. No significant increasing trend was identified at 99% confidence level.

AD-34 Chloride Trend Test

Pirkey Landfill

Geosyntec consultants

AMERICAN ELECTRIC POWER

Figure

7

Columbus, Ohio

28-Dec -2020

internal info: path, date revised, author

ATTACHMENT A

February 2019 Landfill Leachate
Laboratory Analytical Report

Client Sample Results

Client Sample ID: LANDFILL LEACHATE-1

Lab Sample ID: 490-168409-1

Date Collected: 02/11/19 15:45

Matrix: Water

Date Received: 02/13/19 09:40

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	**0.50**	**J**	1.0	0.010	mg/L			02/14/19 16:31	1
Sulfate	**2200**	**B**	500	3.0	mg/L			02/15/19 12:11	100
Chloride	**640**		150	10	mg/L			02/15/19 11:55	50

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	**0.0044**	**B**	0.0030	0.00080	mg/L		02/13/19 15:36	02/18/19 17:23	1
Arsenic	**0.045**		0.0050	0.00040	mg/L		02/13/19 15:36	02/15/19 17:49	1
Barium	**0.048**	**J**	0.20	0.00010	mg/L		02/13/19 15:36	02/15/19 17:49	1
Beryllium	**0.00011**	**J**	0.0040	0.00010	mg/L		02/13/19 15:36	02/15/19 17:49	1
Boron	5000	U	5000	180	mg/L		02/19/19 10:08	02/20/19 15:59	5000
Cadmium	**0.00030**	**J**	0.0050	0.00010	mg/L		02/13/19 15:36	02/15/19 17:49	1
Calcium	**590**		1.0	0.053	mg/L		02/13/19 15:36	02/15/19 17:49	1
Chromium	0.0050	U	0.0050	0.00050	mg/L		02/13/19 15:36	02/15/19 17:49	1
Cobalt	**0.00043**	**J**	0.0050	0.00010	mg/L		02/13/19 15:36	02/15/19 17:49	1
Lead	**0.00029**	**J B**	0.0050	0.00010	mg/L		02/13/19 15:36	02/15/19 17:49	1
Lithium	**0.042**		0.040	0.0030	mg/L		02/13/19 15:36	02/15/19 17:49	1
Molybdenum	**3.7**		0.010	0.0010	mg/L		02/13/19 15:36	02/15/19 17:49	1
Selenium	**0.13**		0.010	0.00030	mg/L		02/13/19 15:36	02/18/19 17:23	1
Thallium	0.0020	U	0.0020	0.00080	mg/L		02/13/19 15:36	02/15/19 17:49	1

Method: 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	**0.00050**		0.00020	0.00010	mg/L		02/15/19 10:11	02/18/19 12:51	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**5100**		1.0	0.28	mg/L			02/14/19 12:50	1

ATTACHMENT B

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey Landfill CCR management area and that the requirements of 40 CFR 257.94(e)(2) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Gross
Signature

BETH ANN GROSS
79864

Geosyntec Consultants
2039 Centre Pointe Blvd, Suite 103
Tallahassee, Florida 32308

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

12/31/2020
Date

APPENDIX IV

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #540556

Owner:	**American Electric Power Company**	Owner Well #:	**AD-7R**
Address:	**502 N. Allen Street** **Shreveport, LA 71101**	Grid #:	**35-37-1**
Well Location:	**2400 Farm Road 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 43.7" N**
		Longitude:	**094° 29' 18.3" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/3/2020** Drilling End Date: **3/3/2020**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**31.5**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
18	**31.5**	**Sand**	**20/40**

Annular Seal Data: **No Data**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **David Diduch**

Apprentice Number: **60297**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1.5**	**Top soil, vegetation, black silt, gravel, light gray/red/brown clayey silt**
1.5	**10**	**Red/light gray clay, low plasticity, high stiffness, iron ore present, trace silt,**
10	**15**	**Maroon/light gray clay, high stiffness, low plasticity, iron ore, wet**
15	**20**	**Black silty clay, low-moderate plasticity, wet, Maroon/orange clayey silt, wet, good cohesion, iron ore, gray/orange clayey silt, iron ore present, wet, good cohesion**
20	**24.6**	**Black clayey silt, Dark gray fine grained sand, trace clay, wet, black silty clay, low-moderate plasticity, moderate to low stiffness**
24.6	**31.5**	**Dark gray fine grained sand, wet, well sorted, orange fine grained sand, wet, well sorted, tan fine grained sand, wet, well sorted, iron present**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

4.10 – Statistical Analysis Summary, East Bottom Ash Pond, H.W. Pirkey Power Plant, Hallsville, Texas, January 3, 2018

Purpose of Statistical Analysis Summary Report

During the initial phase of ground water monitoring, the CCR rule requires AEP to collect at least eight independent samples from at least one up-gradient and three downgradient wells for 21 substances listed in the CCR rule. The CCR rule also requires us to select a statistical method that will be used to evaluate the samples in the later phases of the ground water monitoring program. The Statistical Plan, which has been posted to AEP's CCR website, describes the methods selected by AEP. *See* AEP's Statistical Analysis Plans.

Each **Statistical Analysis Summary Report** is based on the results of the 8 independent samples that were collected by October 17, 2017, and reported in the Annual Groundwater Monitoring Report. Using the statistical methods chosen by AEP, the samples were evaluated to eliminate outliers, determine variability and general trends in the data, and establish background values for: boron, calcium chloride, fluoride, pH, sulfate, and total dissolved solids. Appendix IV substances were evaluated for purposes of identifying outliers and understanding data trends.

A subsequent sample taken during the first detection monitoring sampling event was also compared using the proper statistical methods to the background values that were established for these seven substances from the eight independent samples. A second or third re-sampling event occurred, and the results compared using the same methods. This work is reported in the memorandum included in attachment A. If confirmed, AEP will be required to enter the next phase of monitoring. The results of future sampling will be further analyzed to target any specific substances for which ongoing monitoring or potential corrective action is required.

STATISTICAL ANALYSIS SUMMARY
EAST BOTTOM ASH POND
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants
engineers | scientists | innovators

150 East Wilson Bridge Road
Suite 232
Worthington, Ohio 43085

January 3, 2018

CHA8423

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LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ANOVA	Analysis of Variance
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Value
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EPA	Environmental Protection Agency
LFB	Laboratory Fortified Blanks
LPL	Lower Prediction Limit
LRB	Laboratory Reagent Blanks
NELAP	National Environmental Laboratory Accreditation Program
PQL	Practical Quantitation Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SWFPR	Site-Wide False-Positive Rate
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the East Bottom Ash Pond (EBAP), an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Eight monitoring events were completed prior to October 17, 2017 to establish background concentrations for Appendix III and Appendix IV parameters under the CCR rule. Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. The background data were reviewed for outliers, which were removed (when appropriate) prior to calculating upper prediction limits (UPLs) for each Appendix III parameter to represent background values. Oversight on the use of statistical calculations was provided by Dr. Kirk Cameron of MacStat Consulting, Ltd.

A groundwater sampling event occurred on August 23 and 24, 2017 at the EBAP. This sampling event obtained the first sample for the 1-of-2 prediction interval statistical test used for detection monitoring. The results of this sampling event are included in this report.

SECTION 2

EAST BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the background monitoring program, eight sets of samples were collected for analysis from each upgradient and compliance well. A summary of data collected during background and detection monitoring sampling may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.5.32 statistics software. The export was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

The background data used to conduct the statistical analyses and the detection monitoring data are summarized in Table 1. Statistical analyses for the EBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Results for all completed statistical tests are provided in Attachment A.

Time series plots of Appendix III and IV parameters are included in Attachment A. Mann-Kendall analyses ($\alpha = 0.01$) were conducted to evaluate trends in the background data. Beryllium was found to be significantly decreasing at upgradient well AD-18. Boron was found to be significantly increasing at compliance well AD-2. No other significant increasing or decreasing trends were observed for other parameters or at other monitoring wells.

2.2.1 Background Outlier Evaluation

Potential outliers were identified using Tukey's outlier test; i.e., data points were considered potential outliers if they met one of the following criteria:

$$x_i < \tilde{x}_{0.25} - 3 \times IQR \quad (1)$$

or

$$x_i > \tilde{x}_{0.75} + 3 \times IQR \quad (2)$$

where:

$x_i =$ individual data point
$\tilde{x}_{0.25} =$ first quartile
$\tilde{x}_{0.75} =$ third quartile
$IQR =$ the interquartile range $= \tilde{x}_{0.75} - \tilde{x}_{0.25}$

Data that were evaluated as potential outliers are summarized in Attachment A. Tukey's outlier test identified 14 potential outliers, which are summarized in Table 2. Next, the data were reviewed to identify possible sources of errors or discrepancies, including data recording errors, unusual sampling conditions, laboratory quality indicators, or inconsistent sample turbidity. The findings of this data review are summarized below.

While the reported fluoride concentration of 4.717 mg/L at upgradient well AD-12 on October 12, 2016 was not identified as an outlier by Tukey's method, the duplicate sample was more similar to other upgradient data and therefore considered more representative of background. This value was replaced with the reported fluoride concentration for the duplicate sample also collected at AD-12. The statistical analysis was rerun using the duplicate result's reporting limit of 1.0 mg/L, as fluoride was not detected in the duplicate. The duplicate sample was considered more representative based on the reported concentrations from the other background sampling events.

Seven parameters (arsenic, barium, calcium, chromium, cobalt, lead, and mercury) were identified as potential outliers during the May 11, 2016 sampling event at compliance well AD-31. These results suggest an issue with sample collection and the values were removed from the dataset. The reported lead value of 0.00154 mg/L at AD-31 during the October 12, 2016 sampling event was also identified as a potential outlier. Lead was generally not detected at a reporting limit of 0.005 mg/L at AD-31. As the potential outlier was an estimated value and likely reflects concentrations within the aquifer, this value was retained within the database.

The reported chloride concentration of 20 mg/L at compliance well AD-2 on September 7, 2016 and the reported lithium concentration of 0.016 mg/L at compliance well AD-32 on May 11, 2016 were both identified as potential outliers. Both of these values were kept in the dataset as they reflected concentrations in nearby compliance wells.

The remaining three potential outliers did not have an apparent reason for their elevated value and was removed as recommended by USEPA's *Unified Guidance* (USEPA, 2009). The three outliers that were removed were associated with compliance monitoring wells; therefore, their removal did not affect the calculation of background levels presented below. Additionally, two of the outliers were associated with Appendix IV parameters, for which background levels were not calculated.

2.2.2 Establishment of Background Levels

Analysis of variance (ANOVA) was conducted to determine whether spatial variation was present among the three upgradient wells (Attachment A). ANOVA indicated no significant variation among the three upgradient wells for fluoride. Consequently, interwell tests were used for fluoride. Significant variation was observed for boron, calcium, chloride, pH, sulfate, and total dissolved solids (TDS). Therefore, the appropriateness of using intrawell tests was evaluated for these parameters at the Pirkey EBAP.

Intrawell tests presume that the groundwater quality in the compliance wells was not initially impacted by the CCR unit. To test this presumption, the data from the upgradient wells were pooled and the data from each compliance well were compared to a pooled background value. Tolerance limits were calculated using the pooled background data for boron, calcium, chloride, pH, sulfate, and TDS. Parametric tolerance limits with 99% confidence and 95% coverage were calculated for boron, chloride, pH, and TDS; non-parametric tolerance limits were calculated for calcium and sulfate, given the greater spatial variability observed for these two parameters. Confidence intervals were calculated for each of these six parameters at each compliance monitoring well. If the lower confidence limit from a compliance well exceeded the upper tolerance limit for the pooled background data, it was concluded that groundwater concentrations at compliance wells were above background concentrations. In these instances, intrawell tests would not be appropriate. However, these analyses indicated no significant exceedances for pH; elevated concentrations of boron, calcium, chloride, sulfate, and TDS were observed. (Non-parametric analyses also indicated no significant exceedances for pH and elevated concentrations of boron, chloride, and TDS in compliance wells.) Therefore, intrawell tests were used to evaluate potential SSIs for pH. Interwell tests were used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS.

After equality of variance was tested and identified outliers were removed (where appropriate), a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., “J-flagged” data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) for each background dataset is shown in Attachment A.

Upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. To conduct the intrawell tests for pH, a separate UPL was calculated for each compliance well. To conduct the interwell tests for boron, calcium, chloride, fluoride, sulfate, and TDS, a single prediction interval was calculated for each of these parameters using pooled data from the three upgradient wells. The background data used for the UPL calculations are summarized in Table 1; the calculated UPLs are summarized in Table 3.

A significant increasing trend in boron concentrations was observed at compliance well AD-2. However, the rate of change in boron concentrations is low relative to absolute boron concentrations at AD-2. For this reason, the increasing trend in boron concentrations at AD-2 is not currently considered indicative of a release from the EBAP CCR unit.

UPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where initial results did not exceed the UPL, a second sample was not collected. The one-of-two retesting procedure allowed achieving an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less. Power curves were constructed for the interwell and intrawell parametric tests and are compared with the EPA Reference Power Curve in Attachment A. The power curves associated with the statistical tests for the Pirkey Plant EBAP exceed the EPA Reference Power Curve at 3 and 4 standard deviations; this is considered a "good" level of statistical power according to EPA's *Unified Guidance* (USEPA, 2009).

2.2.3 Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the H.W. Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

DAVID ANTHONY MILLER
112498

112498

License Number

TEXAS

Licensing State

01.03.18

Date

2.3 Conclusions

Eight background monitoring events and one detection monitoring event were completed in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified fourteen potential outliers, with ten values removed from the dataset without replacement. Prediction intervals were constructed based on the remaining background data and a one-of-two retesting procedure. Interwell tests were selected for boron, calcium, chloride, fluoride, sulfate, and TDS, whereas intrawell tests were selected for pH.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H. W. Pirkey Power Plant. January 2017.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March 2009.

TABLES

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-2								
		5/11/2016	7/14/2016	9/7/2016	10/13/2016	11/14/2016	1/12/2017	3/1/2017	4/11/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Barium	mg/L	0.038	0.038	0.039	0.039	0.034	0.037	0.037	0.037	-
Beryllium	mg/L	0.00051J	0.00047J	0.00044J	0.0004J	0.00037J	0.00038J	0.00041J	0.00044J	-
Boron	mg/L	1.27	1.34	1.3	1.48	1.36	1.48	1.62	1.65	1.46
Cadmium	mg/L	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	1.43	1.38	2.65	1.29	1.44	1.6	1.28	1.71	2.06
Chloride	mg/L	28	28	20	31	28	30	28	50	24
Chromium	mg/L	0.001U	0.0004J	0.00049J	0.00089J	0.001U	0.001U	0.001U	0.00024J	-
Cobalt	mg/L	0.01	0.011	0.01	0.011	0.01	0.01	0.01	0.011	-
Combined Radium	pCi/L	1.446	0.723	1.489	2.65	2.121	1.656	1.267	0.807	-
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.001U	0.051	0.048	0.052	0.048	0.052	0.051	0.052	-
Mercury	mg/L	0.0001	0.00007	0.00068	0.00005	0.00015	0.00009	0.00004	0.00003	-
Molybdenum	mg/L	0.005U	0.00086J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00208J	0.005U	0.005U	0.00138J	0.00123J	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	238	216	216	230	240	244	262	254	200
Sulfate	mg/L	68	71	49	67	72	94	80	88	64
Thallium	mg/L	0.002U	0.002U	0.00126J	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	4.37	4.2	4.18	3.56	3.89	3.93	4.12	3.98	4.27

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-4								
		5/11/2016	7/14/2016	9/8/2016	10/13/2016	11/15/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.00396J	0.008	0.005	0.011	0.005U	0.005U	0.005U	0.005U	-
Barium	mg/L	0.075	0.127	0.123	0.183	0.114	0.149	0.131	0.094	-
Beryllium	mg/L	0.001	0.001	0.001	0.00083J	0.00053J	0.00041J	0.00035J	0.00092J	-
Boron	mg/L	0.02	0.02	0.02	0.03	0.04	0.03	0.03	0.04	0.06229
Cadmium	mg/L	0.00013J	0.001U	0.00011J	0.001U	0.001U	0.001U	0.001U	0.00008J	-
Calcium	mg/L	1.63	2.32	2.37	2.87	2.71	2.94	2.86	1.91	2.04
Chloride	mg/L	4	4	5	6	5	5	4	5	5
Chromium	mg/L	0.0004J	0.003	0.002	0.007	0.00045J	0.00031J	0.001U	0.00024J	-
Cobalt	mg/L	0.008	0.009	0.008	0.007	0.006	0.00451J	0.00446J	0.008	-
Combined Radium	pCi/L	0.729	4.271	0.193	2.381	1.072	2.599	1.089	0.684	-
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.013	0.041	0.04	0.034	0.035	0.03	0.033	0.047	-
Mercury	mg/L	0.00001J	0.00004	0.00001J	0.00001J	0.00001J	0.00001J	0.00001J	0.00001J	-
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00179J	0.00174J	0.005U	0.0016J	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	148	157	136	164	152	148	148	140	94
Sulfate	mg/L	23	20	20	19	19	18	18	21	20
Thallium	mg/L	0.002U	0.00187J	0.002U	0.00087J	0.002U	0.002U	0.002U	0.002U	-
pH	SU	5.37	4.91	4.9	4.05	4.28	4.83	4.73	4.39	4.6

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-12								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Barium	mg/L	0.026	0.023	0.03	0.027	0.028	0.023	0.026	0.024	-
Beryllium	mg/L	0.00022J	0.00019J	0.00023J	0.00015J	0.00015J	0.00013J	0.00015J	0.00016J	-
Boron	mg/L	0.03	0.03	0.04	0.03	0.04	0.03	0.04	0.05	0.0495
Cadmium	mg/L	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	0.362	0.26	0.343	0.271	0.331	0.315	0.434	0.299	0.245
Chloride	mg/L	5	6	6	7	8	7	5	6	6
Chromium	mg/L	0.00071J	0.00069J	0.00035J	0.00053J	0.00033J	0.00065J	0.00033J	0.00042J	-
Cobalt	mg/L	0.00158J	0.00129J	0.00167J	0.00157J	0.00147J	0.00109J	0.0013J	0.00133J	-
Combined Radium	pCi/L	0.2073	2.909	0.881	0.257	0.767	1.536	0.416	0.3895	-
Fluoride	mg/L	1U	1U	1U	1	1U	1U	1U	0.2565J	0.213J
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.001U	0.008	0.01	0.012	0.013	0.01	0.009	0.008	-
Mercury	mg/L	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00001J	-
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00174J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	94	75	63	92	80	76	50	72	52
Sulfate	mg/L	4	4	7	8	6	6	4	7	6
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.00099J	0.002U	-
pH	SU	4.44	3.11	3.89	3.37	2.58	4.76	3.63	4.74	4.84

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-18								
		5/10/2016	7/14/2016	9/8/2016	10/13/2016	11/15/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.005U	0.00377J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Barium	mg/L	0.157	0.139	0.115	0.112	0.094	0.099	0.099	0.105	-
Beryllium	mg/L	0.00026J	0.00024J	0.00023J	0.00019J	0.00011J	0.00017J	0.00011J	0.00013J	-
Boron	mg/L	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.0278
Cadmium	mg/L	0.00011J	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	0.548	0.409	0.343	0.56	0.59	0.415	0.224	0.304	0.435
Chloride	mg/L	8	8	8	7	7	7	6	7	8
Chromium	mg/L	0.001	0.003	0.00078J	0.00063J	0.00072J	0.00041J	0.00057J	0.00097J	-
Cobalt	mg/L	0.00183J	0.00216J	0.0011J	0.00225J	0.00166J	0.00163J	0.00098J	0.00098J	-
Combined Radium	pCi/L	0.847	3.264	1.105	1.161	1.486	0.976	0.468	0.648	-
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.004	0.02	0.019	0.026	0.017	0.026	0.017	0.019	-
Mercury	mg/L	0.00002J	0.00006	0.00003	0.00001J	0.00003	0.00002J	0.00001J	0.00001J	-
Molybdenum	mg/L	0.005U	0.00041J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00171J	0.00245J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	108	116	110	124	134	128	108	102	68
Sulfate	mg/L	7	7	8	10	7	10	7	8	8
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	4.53	4.65	4.67	4.14	4.43	4.67	4.06	4.1	4.9

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-31								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.093	0.00342J	0.00434J	0.006	0.011	0.00392J	0.005U	0.00332J	-
Barium	mg/L	0.712	0.069	0.088	0.076	0.125	0.077	0.044	0.073	-
Beryllium	mg/L	0.01	0.001	0.002	0.001	0.002	0.001	0.001J	0.001	-
Boron	mg/L	0.08	0.03	0.03	0.04	0.04	0.03	0.04	0.04	0.01752
Cadmium	mg/L	0.00086J	0.001U	0.001U	0.001U	0.00017J	0.001U	0.001U	0.00009J	-
Calcium	mg/L	10.4	4.27	3.47	4.41	4.7	4.43	3.89	3.64	2.24
Chloride	mg/L	18	18	18	18	18	19	14	16	18
Chromium	mg/L	0.212	0.01	0.015	0.014	0.03	0.012	0.003	0.012	-
Cobalt	mg/L	0.05	0.011	0.011	0.011	0.014	0.01	0.009	0.011	-
Combined Radium	pCi/L	7.32	3.38	2.345	3.88	3.202	2.725	2.684	3.521	-
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.057	0.005U	0.005U	0.00154J	0.00393J	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.077	0.096	0.094	0.097	0.096	0.093	0.09	0.097	-
Mercury	mg/L	0.0018	0.00032	0.00028	0.00035	0.00052	0.00038	0.00014	0.00033	-
Molybdenum	mg/L	0.00089J	0.00032J	0.005U	0.005U	0.0004J	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00184J	0.00111J	0.005U	0.005U	0.00103J	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	286	245	260	276	266	252	212	252	228
Sulfate	mg/L	63	66	60	62	66	79	68	69	52
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.00102J	0.002U	0.002U	-
pH	SU	4.49	3.49	3.67	3.95	3.19	4.39	3.62	3.56	4.46

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-32								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.00377J	0.013	0.00326J	0.01	0.006	0.006	0.00456J	0.005U	-
Barium	mg/L	0.035	0.058	0.035	0.05	0.037	0.037	0.03	0.026	-
Beryllium	mg/L	0.003	0.008	0.008	0.007	0.009	0.007	0.005	0.004	-
Boron	mg/L	0.708	5.23	5.78	4.26	5.52	5.05	2.73	1.46	0.716
Cadmium	mg/L	0.00029J	0.00073J	0.0006J	0.00059J	0.00079J	0.0006J	0.00039J	0.00044J	-
Calcium	mg/L	7.41	33.9	37.4	27.1	35.9	40	18.4	11	7.15
Chloride	mg/L	12	32	35	29	34	35	19	15	14
Chromium	mg/L	0.005	0.018	0.006	0.015	0.008	0.009	0.005	0.003	-
Cobalt	mg/L	0.027	0.074	0.07	0.065	0.075	0.069	0.045	0.035	-
Combined Radium	pCi/L	2.501	6.41	4.846	17.32	3.731	4.342	4.001	4.32	-
Fluoride	mg/L	1U	0.67J	1U	0.8585J	0.7468J	1U	1U	0.4468J	1.962
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.016	0.119	0.111	0.972	0.114	0.115	0.095	0.095	-
Mercury	mg/L	0.00092	0.01392	0.00168	0.00728	0.00362	0.0072	0.00793	0.00276	-
Molybdenum	mg/L	0.005U	0.00076J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.005U	0.00389J	0.005U	0.00193J	0.005U	0.005U	0.00254J	0.005U	-
Total Dissolved Solids	mg/L	206	835	884	720	922	894	490	372	288
Sulfate	mg/L	124	461	479	430	621	683	285	200	115
Thallium	mg/L	0.002U	0.002U	0.00109J	0.002U	0.00108J	0.00099J	0.002U	0.002U	-
pH	SU	4.34	3.3	3.11	3.26	2.99	3.89	3.11	3.23	4.29

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 2: Outlier Analysis Summary
Pirkey East Bottom Ash Pond

Location	Well ID	Sample Date	Parameter	Reported Value	Units	Conclusions
Compliance	AD-31	5/11/2016	Arsenic	0.093	mg/L	A number of parameters were identified as outliers for this sample, suggesting sampling error. This value was removed from the dataset.
Compliance	AD-31	5/11/2016	Barium	0.712	mg/L	A number of parameters were identified as outliers for this sample, suggesting sampling error. This value was removed from the dataset.
Compliance	AD-31	5/11/2016	Calcium	10.4	mg/L	A number of parameters were identified as outliers for this sample, suggesting sampling error. This value was removed from the dataset.
Compliance	AD-2	9/7/2016	Chloride	20	mg/L	This value was not removed from the dataset, as it reflected concentrations similar to those in neighboring wells.
Compliance	AD-2	4/11/2017	Chloride	50	mg/L	This value was removed from the dataset as an outlier. Its removal did not affect the calculation of background values.
Compliance	AD-31	5/11/2016	Chromium	0.212	mg/L	A number of parameters were identified as outliers for this sample, suggesting sampling error. This value was removed from the dataset.
Compliance	AD-31	5/11/2016	Cobalt	0.05	mg/L	A number of parameters were identified as outliers for this sample, suggesting sampling error. This value was removed from the dataset.
Compliance	AD-32	10/12/2016	Combined Radium	17.32	pCi/L	This value was removed from the dataset as an outlier. Its removal did not affect the calculation of background values.
Compliance	AD-12	10/12/2016	Fluoride	4.717	mg/L	This value was replaced with 1.0 mg/L (ND) - the reporting limit for a non-detect concentration in the duplicate sample.
Compliance	AD-31	5/11/2016	Lead	0.057	mg/L	A number of parameters were identified as outliers for this sample, suggesting sampling error. This value was removed from the dataset.
Compliance	AD-31	10/12/2016	Lead	0.00154 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Compliance	AD-32	10/12/2016	Lithium	0.972	mg/L	This value was removed from the dataset as an outlier. Its removal did not affect the calculation of background values.
Compliance	AD-32	5/11/2016	Lithium	0.016	mg/L	This value was not removed from the dataset, as it reflected concentrations similar to those in neighboring wells.
Compliance	AD-31	5/11/2016	Mercury	0.001797	mg/L	A number of parameters were identified as outliers for this sample, suggesting sampling error. This value was removed from the dataset.

Table 3: Background Level Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Units	Description	AD-2	AD-31	AD-32
Boron	mg/L	Interwell Background Value (UPL)	0.04821		
Calcium	mg/L	Interwell Background Value (UPL)	2.94		
Chloride	mg/L	Interwell Background Value (UPL)	8.511		
Fluoride	mg/L	Interwell Background Value (UPL)	1		
pH	SU	Intrawell Background Value (UPL)	4.637	4.903	4.549
	SU	Intrawell Background Value (LPL)	3.421	2.687	2.259
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	174.1		
Sulfate	mg/L	Interwell Background Value (UPL)	23		

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

ATTACHMENT A

Evaluation of Detection Monitoring Data

Geosyntec
consultants

150 E.Wilson Bridge Road, Suite 232
Columbus, Ohio 43085
PH 614.468.0415
FAX 614.468.0416
www.geosyntec.com

Memorandum

Date:	February 27, 2018
To:	David Miller (AEP)
Copies to:	Terence Wehling (AEP)
From:	Allison Kreinberg and Bruce Sass, Ph.D. (Geosyntec)
Subject:	Evaluation of Detection Monitoring Data at Pirkey Plant's East Bottom Ash Pond (EBAP)

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), detection monitoring events were completed on August 23-24 and December 21, 2017 at the East Bottom Ash Pond (EBAP), an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Eight background monitoring events were conducted at the Pirkey EBAP prior to these detection monitoring events, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated January 3, 2018.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is only concluded if both samples in a series of two exceeds the UPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are summarized in Table 1b.

- Boron concentrations exceeded the interwell UPL of 0.0482 mg/L in both the initial (1.46 mg/L) and second (1.38 mg/L) samples collected at AD-2, and in both the initial (0.716 mg/L) and second (2.56 mg/L) samples collected at AD-32. Therefore, an SSI over background is concluded for boron at AD-2 and AD-32.

- Calcium concentrations exceeded the interwell UPL of 2.94 mg/L in both the initial (7.15 mg/L) and the second (17.1 mg/L) samples collected at AD-32. Therefore, an SSI over background is concluded for calcium at AD-32.

- Chloride concentrations exceeded the interwell UPL of 8.51 mg/L in both the initial (24 mg/L) and second (24 mg/L) samples collected at AD-2, in both the initial (18 mg/L) and second (20 mg/L) samples collected at AD-31, and in both the initial (14 mg/L) and second (22 mg/L) samples collected at AD-32. Therefore, an SSIs over background is concluded for chloride at AD-2, AD-31, and AD-32.

- Total dissolved solids (TDS) concentrations exceeded the interwell UPL of 174 mg/L in both the initial (200 mg/L) and second (206 mg/L) samples collected at AD-2, in both the initial (228 mg/L) and second (224 mg/L) samples collected at AD-31, and in both the initial (288 mg/L) and second (504 mg/L) samples collected at AD-32. Therefore, an SSI over the background is concluded for TDS at AD-2, AD-31, and AD-32.

- Sulfate concentrations exceeded the interwell UPL of 23 mg/L in both the initial (64 mg/L) and second (64 mg/L) samples collected at AD-2, in both the initial (52 mg/L) and second (58 mg/L) samples collected at AD-31, and in both the initial (115 mg/L) and second (324 mg/L) samples collected at AD-32. Therefore, an SSI over the background is concluded for sulfate at AD-2, AD-31, and AD-32.

As a result, the Pirkey EBAP CCR unit will conduct an alternate source demonstration. No other exceedances of UPLs were observed during these detection monitoring events.

The following modifications to Geosyntec's *Statistical Analysis Summary* report were incorporated after the certification date of January 3, 2018:

- Table 1 ("Groundwater Data Summary") was revised to reflect appropriate significant digits for estimated (J-flagged) values; and,

- Figure E ("Analysis of Variance") of Attachment A ("Statistical Analysis Output") was revised to correct a formatting error.

* * * * *

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected statistical method, described above and in the January 3, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Pirkey EBAP CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

DAVID ANTHONY MILLER
112498
LICENSED

112498
License Number

TEXAS
Licensing State

02.27.18
Date

Table 1b: Detection Monitoring Data Evaluation
Pirkey Plant - East Bottom Ash Pond

Parameter	Units	Description	AD-2		AD-31		AD-32	
			8/24/2017	12/21/2017	8/23/2017	12/21/2017	8/23/2017	12/21/2017
Boron	mg/L	Interwell Background Value (UPL)	0.0482					
	mg/L	Detection Monitring Results	**1.46**	**1.38**	0.0175	-	**0.716**	**2.56**
Calcium	mg/L	Interwell Background Value (UPL)	2.94					
	mg/L	Detection Monitring Results	2.06	2.92	2.24	-	**7.15**	**17.1**
Chloride	mg/L	Interwell Background Value (UPL)	8.51					
	mg/L	Detection Monitring Results	**24**	**24**	**18**	**20**	**14**	**22**
Fluoride	mg/L	Interwell Background Value (UPL)	1					
	mg/L	Detection Monitring Results	<0.083	<0.083	<0.083	<0.083	**1.962**	0.593
pH	SU	Intrawell Background Value (UPL)	4.64		4.90		4.55	
	SU	Intrawell Background Value (LPL)	3.42		2.69		2.26	
	SU	Detection Monitring Results	4.27	-	4.46	-	4.29	-
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	174					
	mg/L	Detection Monitring Results	**200**	**206**	**228**	**224**	**288**	**504**
Sulfate	mg/L	Interwell Background Value (UPL)	23					
	mg/L	Detection Monitring Results	**64**	**64**	**52**	**58**	**115**	**324**

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
-: Not Sampled
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

November 5, 2017

Geosyntec Consultants
Attn: Mr. Bruce Sass
150 E. Wilson Bridge Rd., #232
Worthington, OH 43085

Dear Mr. Sass,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the screening and statistical analysis of background groundwater data for American Electric Power's East Bottom Ash Pond. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at East Bottom Ash Pond for the CCR program in 2016, and 8 background samples have been collected at each of the groundwater monitoring wells. The monitoring well network, as provided by Geosyntec Consultants, consists of the following: upgradient wells AD-4, AD-12, and AD-18; and downgradient wells AD-2, AD-31, and AD-32A.

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis was reviewed by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to Groundwater Stats Consulting.

The following constituents were evaluated: Appendix III parameters – boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and Appendix IV parameters - antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 & 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters at all wells are provided for the purpose of screening data at these wells (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B). The time series plots are used to initially screen for suspected outliers and trends, while the box plots provide visual representation of variation within individual wells and between all wells.

Data at all wells were evaluated for the following: 1) outliers; 2) trends; 3) most appropriate statistical method for Appendix III parameters based on site characteristics of groundwater data upgradient of the facility; and 4) eligibility of downgradient wells when intrawell statistical methods are recommended. Power curves are provided to demonstrate that the selected statistical methods for Appendix III parameters comply with the USEPA Unified Guidance recommendations as discussed below.

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for pH;
2) Interwell prediction limits combined with a 1-of-2 resample plan for boron, calcium, chloride, fluoride, sulfate and TDS.

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, simple substitution of one-half the reporting limit is utilized in the statistical analysis. The reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Background Screening

Outlier Evaluation

Time series plots are used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III and Appendix IV parameters were formally tested using Tukey’s box plot method and, when identified, flagged in the computer database with “o” and deselected prior to construction of statistical limits (Figure C).

Tukey’s outlier test noted several outliers as may be seen on the Outlier Summary Table and accompanying graphs. Any values flagged as outliers are plotted in a lighter font on the time series graph. While the test identified a couple low outliers for chloride, lead and lithium in downgradient wells, these values were not flagged because they were similar in concentration to surrounding wells. It was noted that the first background sample in well AD-31 for several constituents was higher than all subsequent samples. This could be representative of well drilling processes, or an indication of sampling or analytical error. Therefore, these values were flagged as outliers since they do not appear to represent the population of groundwater at this well. In some cases, the test could not identify suspect outliers due to the upper and lower quartiles being equal. When extreme values were present in background, however, they were flagged as outliers, such as fluoride in upgradient well AD-12. A substitution of the most recent reporting limit was applied when varying detection limits existed in data.

No true seasonal patterns were observed on the time series plots for any of the detected data; therefore, no deseasonalizing adjustments were made to the data. When seasonal patterns are observed, data may be deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release.

While trends may be visual, a quantification of the trend and its significance is needed. The Sen's Slope/Mann Kendall trend test was used to evaluate all data at each well to identify statistically significant increasing or decreasing trends (Figure D). In the absence of suspected contamination, significant trending data are typically not included as part of the background data used for construction of prediction limits. This step serves to eliminate the trend and, thus, reduce variation in background. When statistically significant decreasing trends are present, earlier data are evaluated to determine whether earlier concentration levels are significantly different than current reported concentrations and will be deselected as necessary. When the historical records of data are truncated for the reasons above, a summary report will be provided to show the date ranges used in construction of the statistical limits.

The results of the trend analyses showed a couple statistically significant increasing and decreasing trends, as may be seen on the Trend Test Summary Table that accompanies the trend tests. These trends are relatively low in magnitude when compared to average concentrations; therefore, no adjustments were made to the data sets.

Appendix III – Determination of Spatial Variation

The Analysis of Variance (ANOVA) was used to statistically evaluate differences in average concentrations among upgradient wells, which assists in identifying the most appropriate statistical approach (Figure E). Interwell tests, which compare downgradient well data to statistical limits constructed from pooled upgradient well data, are appropriate when average concentrations are similar across upgradient wells. Intrawell tests, which compare compliance data from a single well to screened historical data within the same well, are appropriate when upgradient wells exhibit spatial variation; when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective; and when downgradient water quality is unimpacted compared to upgradient water quality for the same parameter.

The ANOVA identified no variation for fluoride, making this constituent suitable for interwell analyses. Variation was identified in groundwater upgradient of the site for all other Appendix III parameters. Therefore, these data were further evaluated as described for the appropriateness of intrawell testing to accommodate the groundwater quality. A summary table of the ANOVA results is included with the reports.

Appendix III - Statistical Limits

Intrawell limits constructed from carefully screened background data from within each well serve to provide statistical limits that are conservative (i.e. lower) from a regulatory perspective, and that will rapidly identify a change in more recent compliance data from within a given well. This statistical method removes the element of variation from across wells and eliminates the chance of mistaking natural spatial variation for a release from the facility. Prior to performing intrawell prediction limits, several steps are required to reasonably demonstrate downgradient water quality does not have existing impacts from the practices of the facility.

Exploratory data analysis was used as a general comparison of concentrations in downgradient wells for all Appendix III parameters recommended for intrawell analyses to concentrations reported in upgradient wells. Upper tolerance limits are used in conjunction with confidence intervals to determine whether the estimated averages in downgradient wells are higher than observed levels upgradient of the facility. The upper tolerance limits were constructed to represent the extreme upper range of possible background levels at the site.

In cases where downgradient average concentrations are higher than observed concentrations upgradient for a given constituent, an independent study and hydrogeological investigation would be required to identify local geochemical conditions and expected groundwater quality for the region to justify an intrawell approach. Such an assessment is beyond the scope of services provided by Groundwater Stats Consulting. When there is not an obvious explanation for observed concentration differences in downgradient wells relative to reported concentrations in upgradient wells, interwell prediction limits will initially be selected for the statistical method until further evidence shows that concentrations are due to natural variation rather than a result of the facility.

Parametric tolerance limits were constructed with a target of 99% confidence and 95% coverage using pooled upgradient well data for each of the Appendix III parameters recommended for intrawell analyses (Figure F). The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. As more data are collected, the background population is better represented and the confidence and coverage levels increase.

Confidence intervals were constructed on downgradient wells for each of the Appendix III parameters, using the tolerance limits discussed above, to determine intrawell eligibility for parameters exhibiting spatial variation (Figure G). When the entire confidence interval is above a background standard for a given parameter, interwell methods are initially recommended as the statistical method. Therefore, only parameters with confidence intervals which did not exceed background standards are eligible for intrawell prediction limits.

Confidence intervals for the above parameters were found to be within their respective background limit for pH, while the confidence intervals for all other Appendix III parameters evaluated were above the background standards for parameters exhibiting spatial variation. Therefore, intrawell methods are recommended for pH at this time, and interwell methods are recommended initially for all other Appendix III parameters. As mentioned earlier, if a demonstration supports natural variation in groundwater, intrawell methods will be considered for all parameters.

All available data through April 2017 at each well were used to establish intrawell background limits based on a 1-of-2 resample plan that will be used for future comparisons (Figure H). Interwell prediction limits, combined with a 1-of-2 resample plan, were constructed from upgradient wells for the Appendix III parameters discussed above (Figure I). Downgradient measurements will be compared to these background limits during each subsequent semi-annual sampling event.

Natural systems continuously evolve due to physical changes made to the environment. Examples include capping a landfill, paving areas near a well, or lining a drainage channel to prevent erosion. Periodic updating of background statistical limits will be necessary to accommodate these types of changes In the interwell case, newer data will be included in background when a minimum of 2 new samples from each upgradient well are available. In the intrawell case, data for all wells and constituents are re-evaluated when a minimum of 4 new data points from each well are available to determine whether earlier concentrations are representative of present-day groundwater quality. In some cases, the earlier portion of data are deselected prior to construction of limits in order to provide sensitive limits that will rapidly detect changes in groundwater quality. Even though the data are excluded from the calculation, the values will continue to be reported and shown in tables and graphs.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of an additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered to be a false positive result and, therefore, no further action is necessary. A summary table of the background prediction limits follows this letter.

Appendix IV – Assessment Monitoring Program

During an Assessment Monitoring program confidence intervals are constructed at all wells for detected Appendix IV parameters. A minimum of 4 samples is required to construct confidence intervals; however, 8 samples are generally recommended for better representation of the true average population. Established Maximum Contaminant Levels (MCLs) are used as the GWPS comparisons, unless background limits are higher as discussed below. Parametric confidence intervals are constructed with 99% confidence when data follow a normal or transformed-normal distribution. For all other cases, nonparametric confidence intervals are constructed, with the confidence level based on the number of samples available. The GWPS is exceeded only when the entire confidence interval exceeds its respective GWPS.

Background limits are established for the Appendix IV parameters using upper tolerance limits constructed with 95% confidence/95% coverage using pooled upgradient well data, for comparison against established MCLs. When background limits, or Alternate Contaminant Levels (ACLs), are higher than established MCLs, the CCR Rule recommends using these ACLs as the GWPS for the confidence interval comparisons. Additionally, tolerance limits are also recommended to establish ACLs for Appendix IV parameters, cobalt, lithium, and molybdenum, which do not have established MCLs. Since the scope of this project included screening and development of background limits for Appendix III Detection Monitoring statistics, comparison of the Appendix IV parameters with confidence intervals was not included in this report.

Recommendations

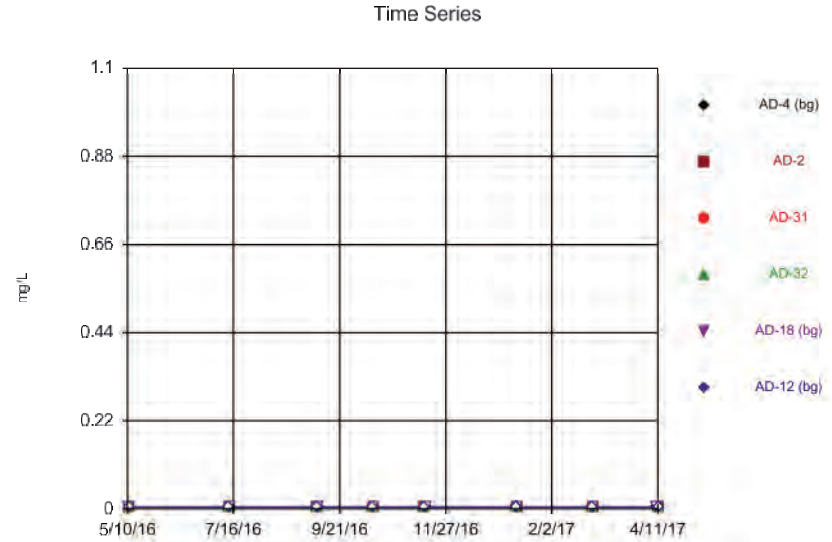
In summary, as a result of the background screening described in this letter, intrawell prediction limits combined with a 1-of-2 resample plan are recommended for pH. Interwell prediction limits combined with a 1-of-2 resample plan are recommended for boron, calcium, chloride, fluoride, sulfate, and TDS. The statistical analyses will be constructed according to the USEPA Unified Guidance, based on seven Appendix III parameters and three downgradient wells.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the East Bottom Ash Pond. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG
Hollow symbols indicate censored values.



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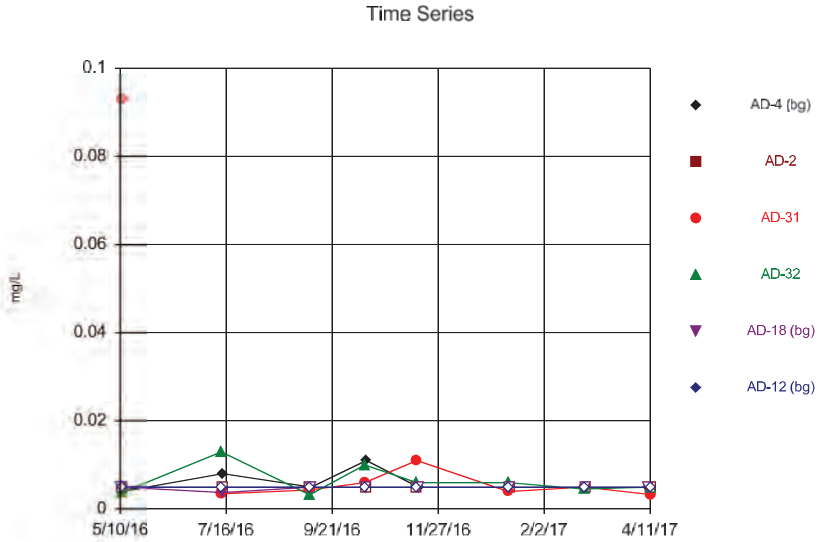

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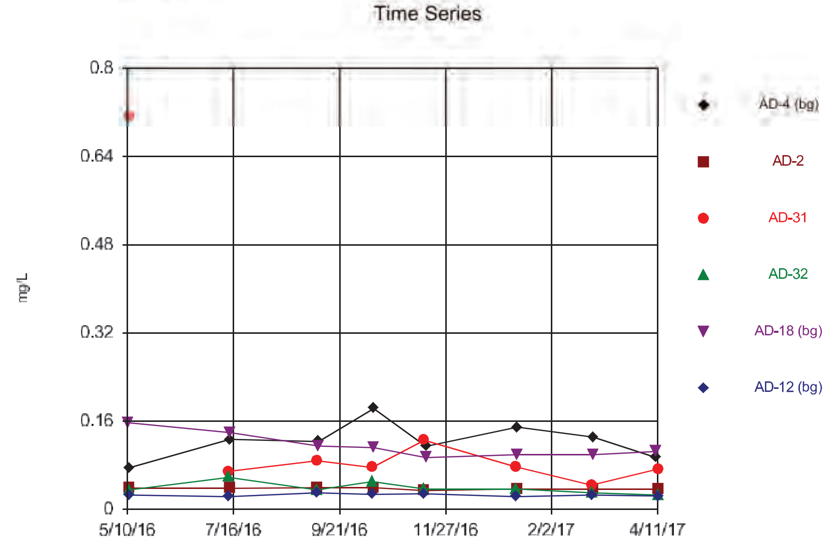

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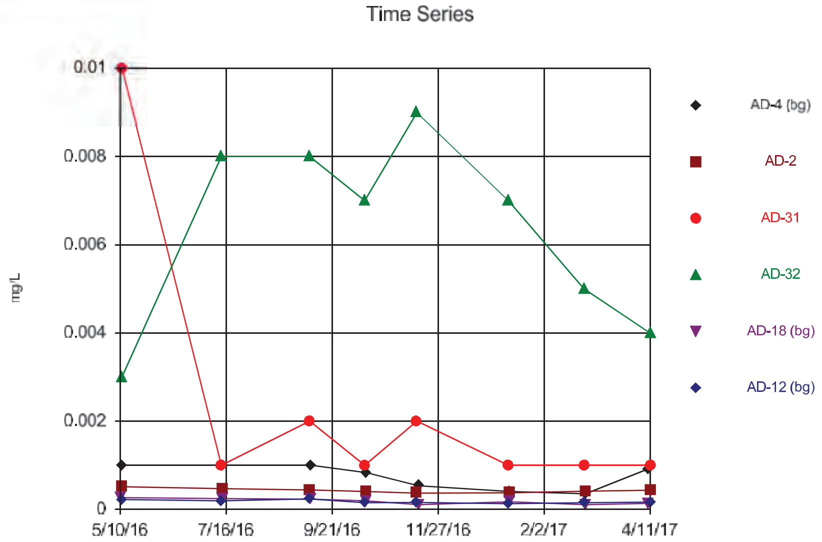
Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG



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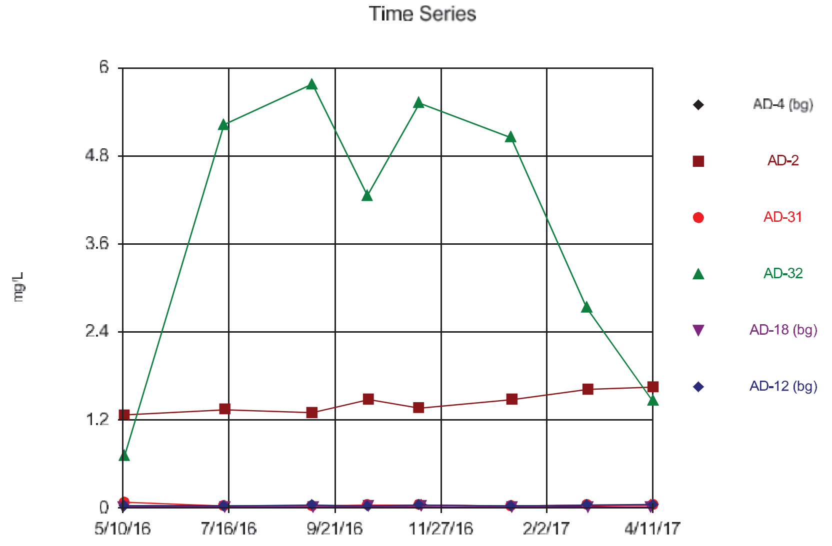

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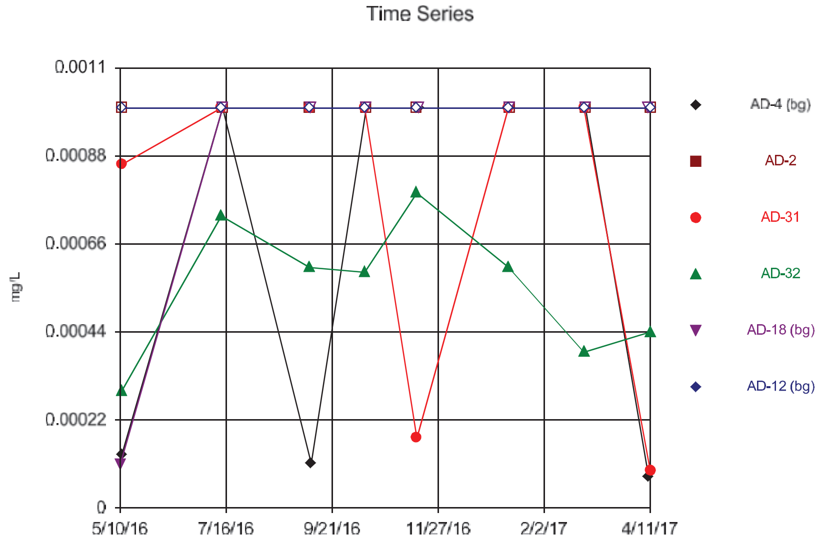

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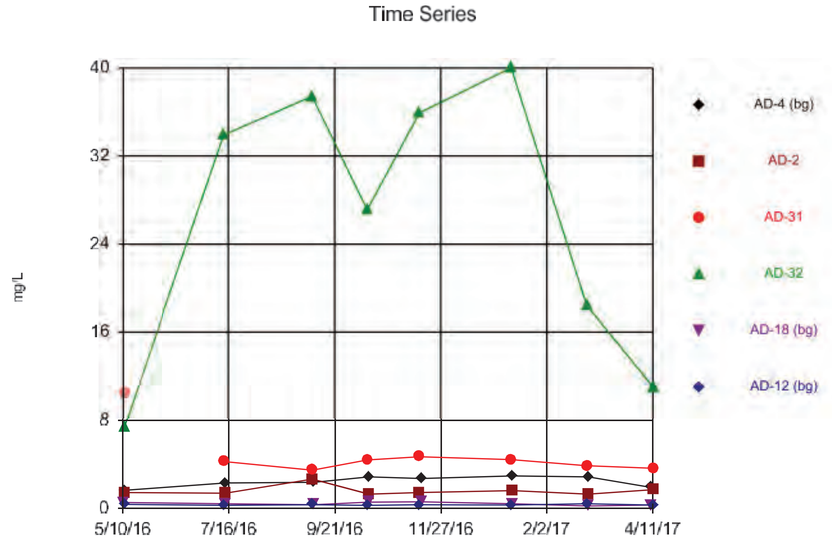

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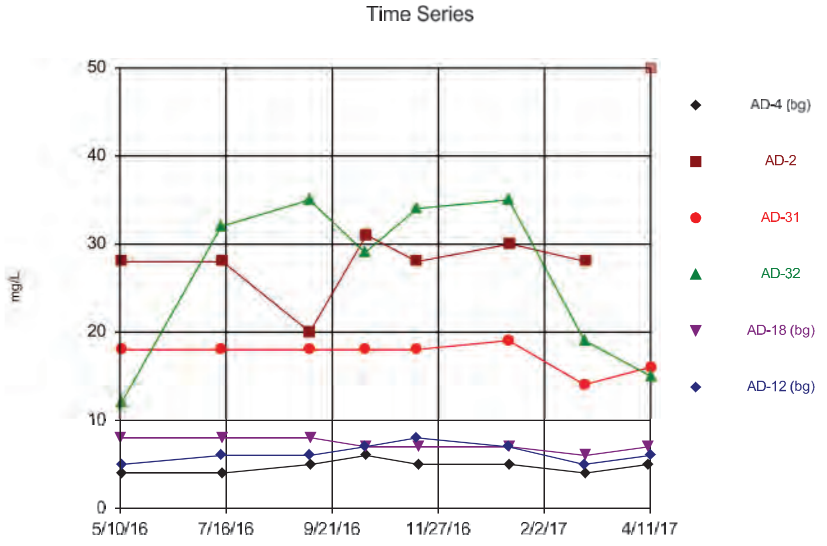

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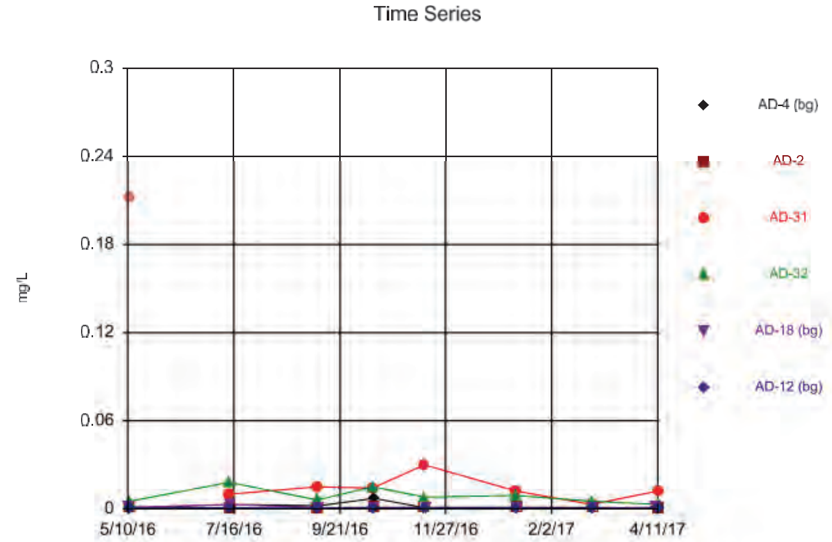

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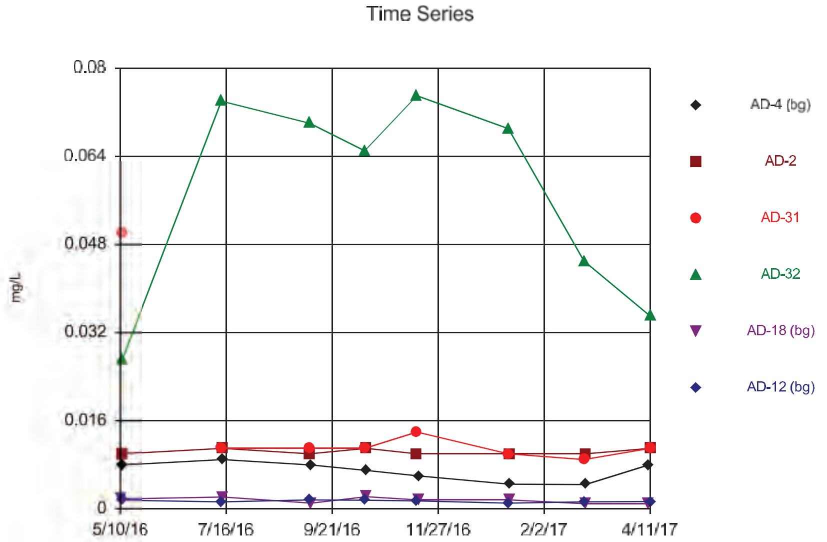
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



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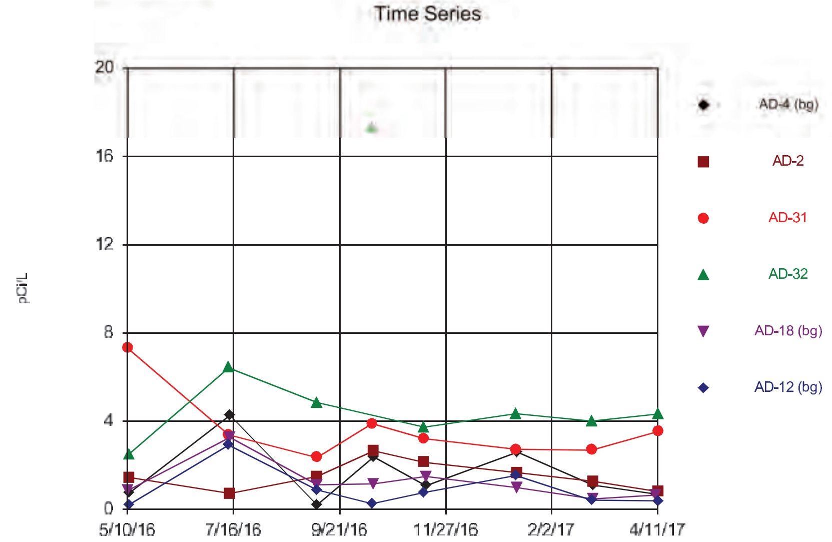

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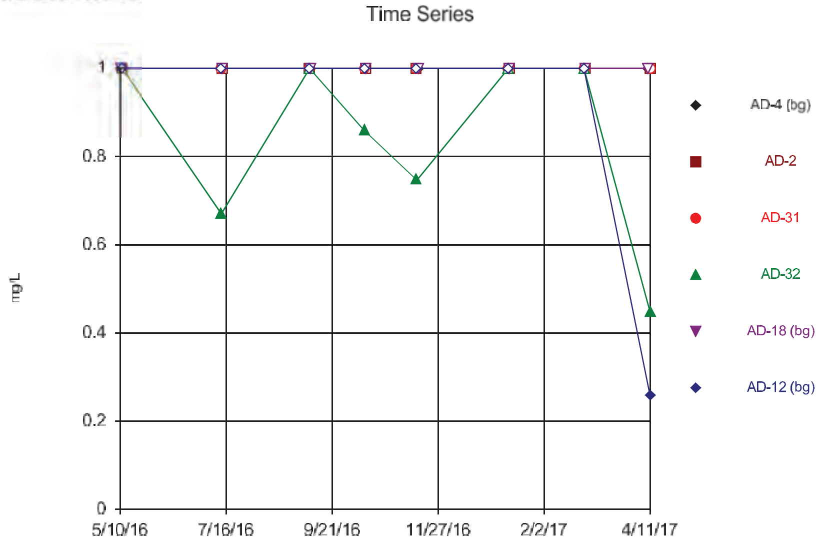

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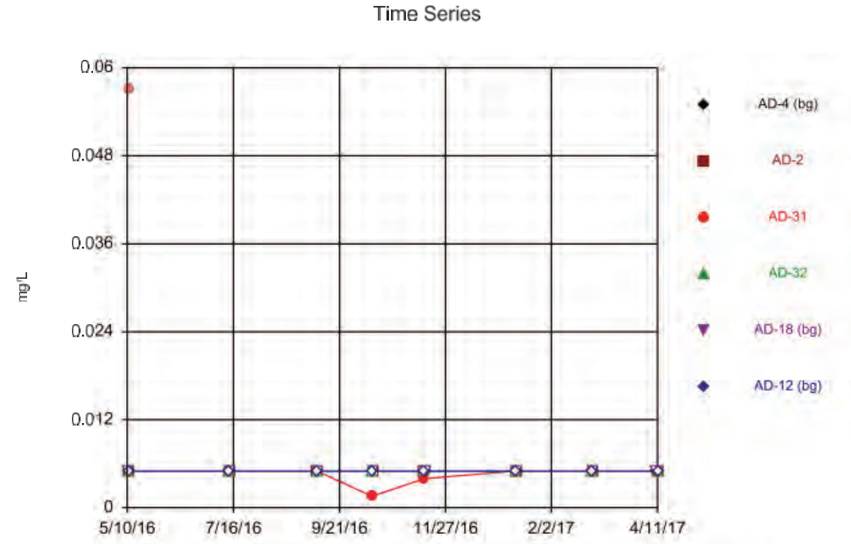

Constituent: Lead, total Analysis Run 12/14/2017 5:20 PM View: Time Series
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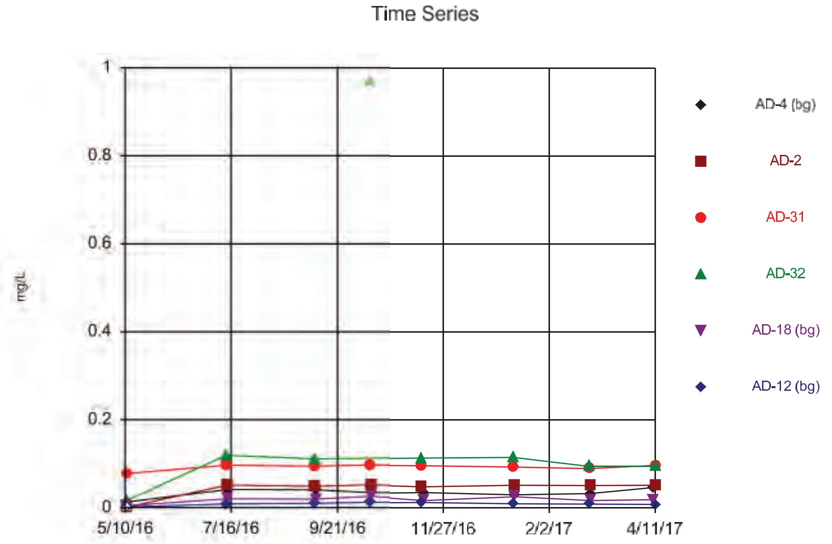

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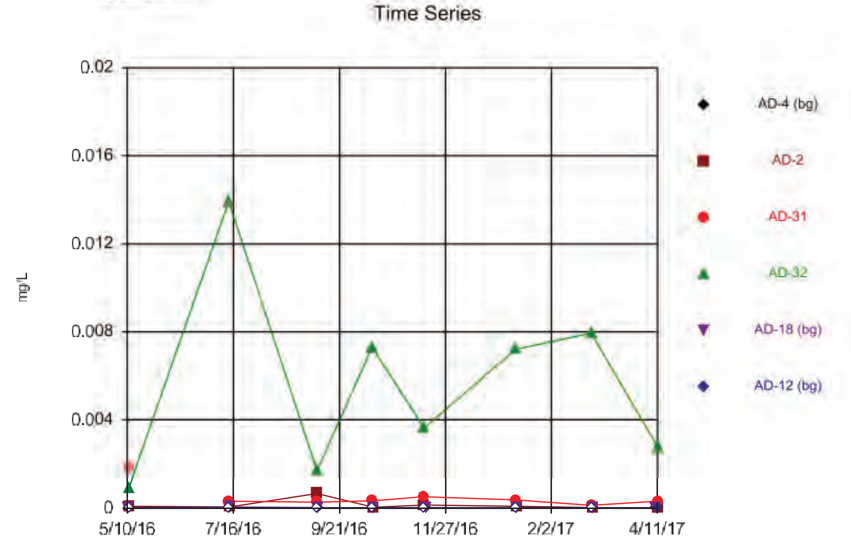

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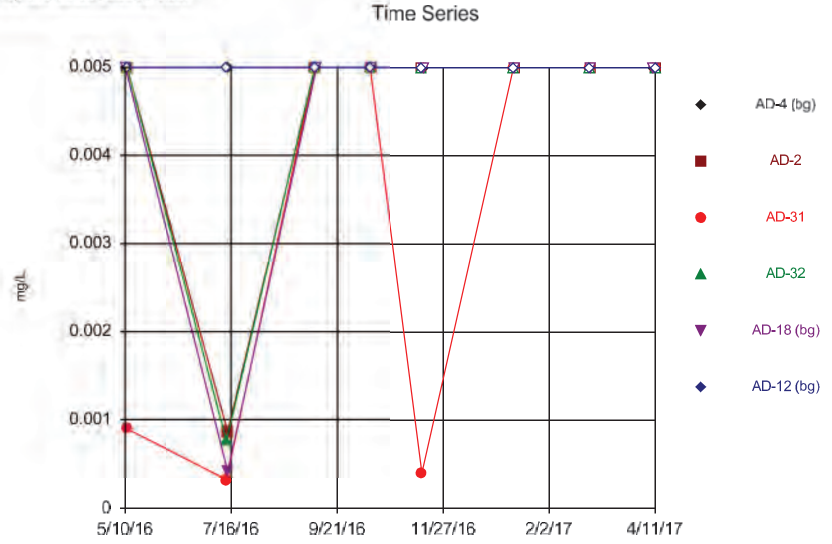
Hollow symbols indicate censored values.



Constituent: Molybdenum, total Analysis Run 12/14/2017 5:20 PM View: Time Series
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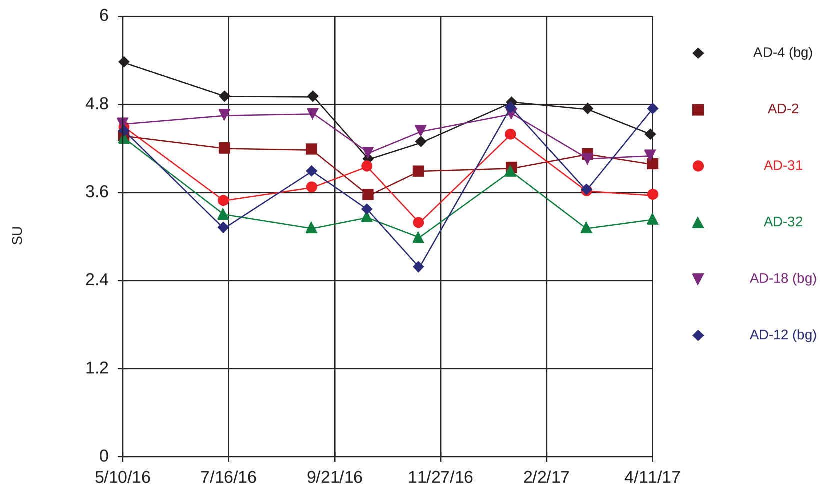
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Time Series



Constituent: pH, field Analysis Run 12/14/2017 5:20 PM View: Time Series
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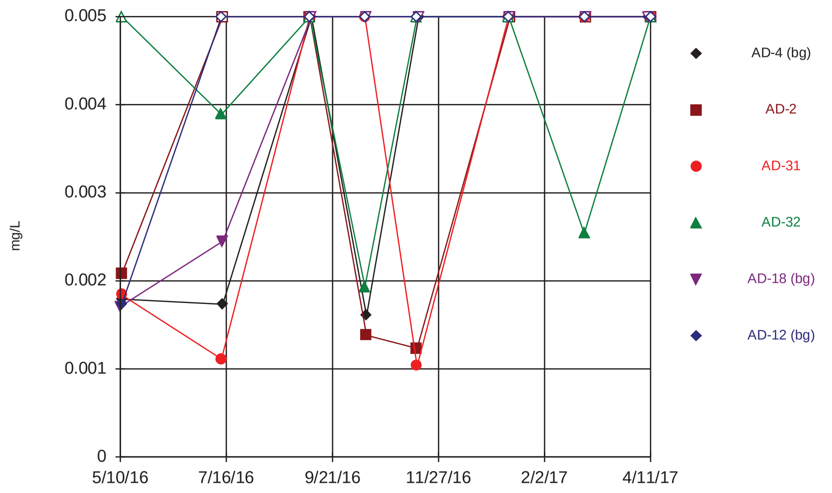
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Selenium, total Analysis Run 12/14/2017 5:20 PM View: Time Series
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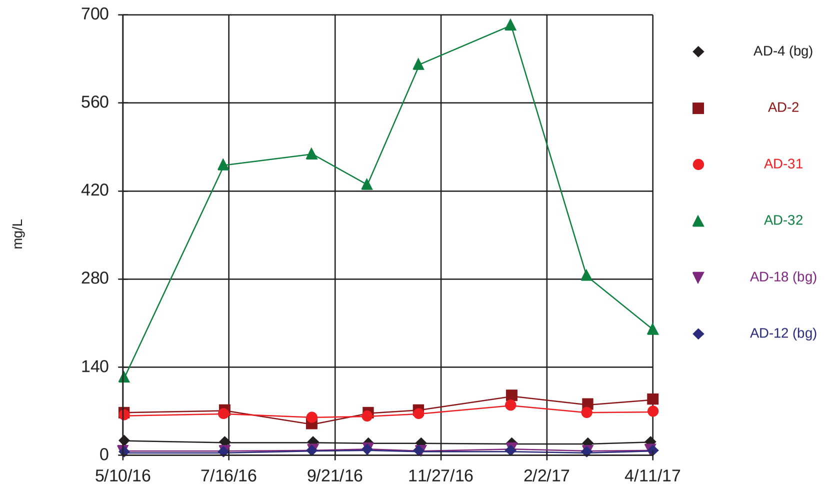
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Time Series



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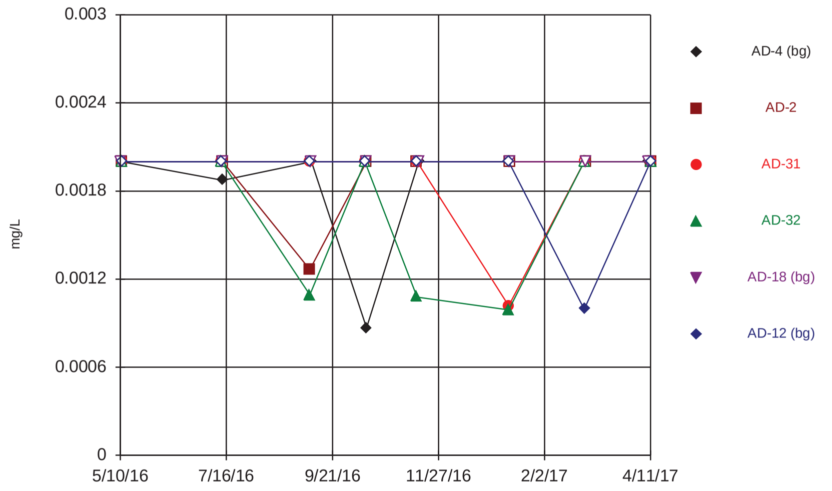
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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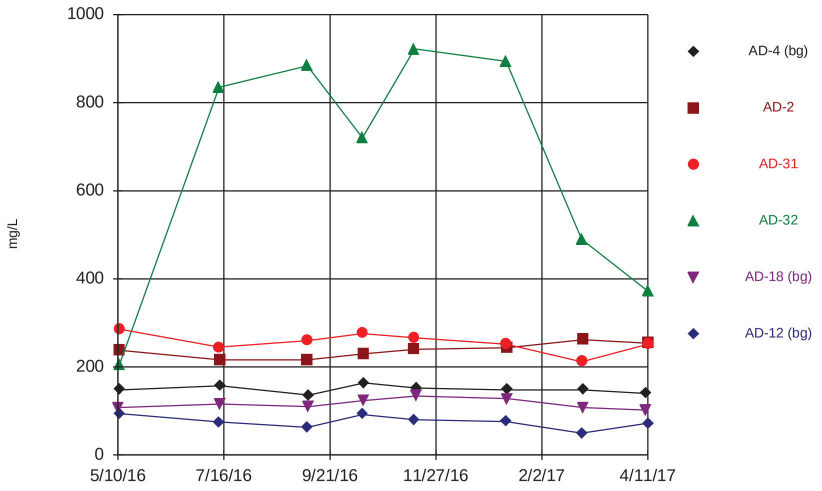
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Time Series



Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/14/2017 5:20 PM   View: Time Series
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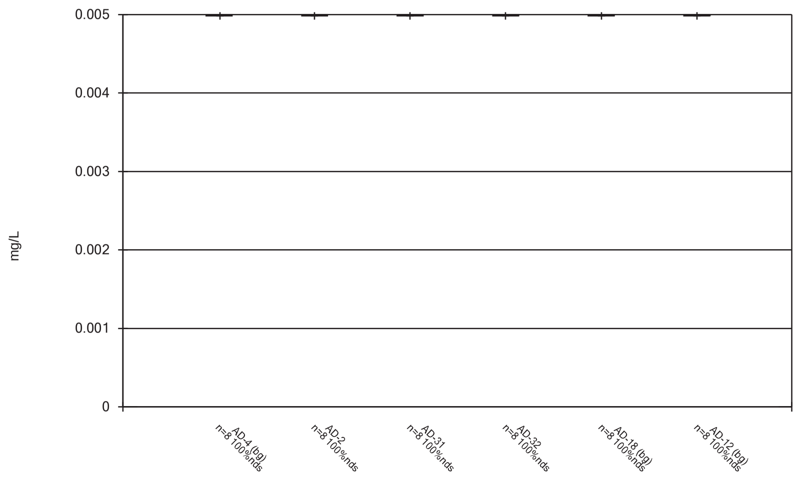
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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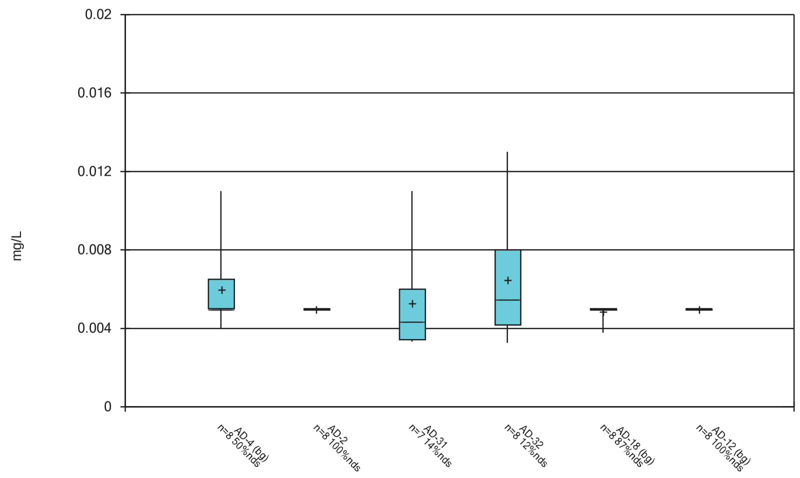
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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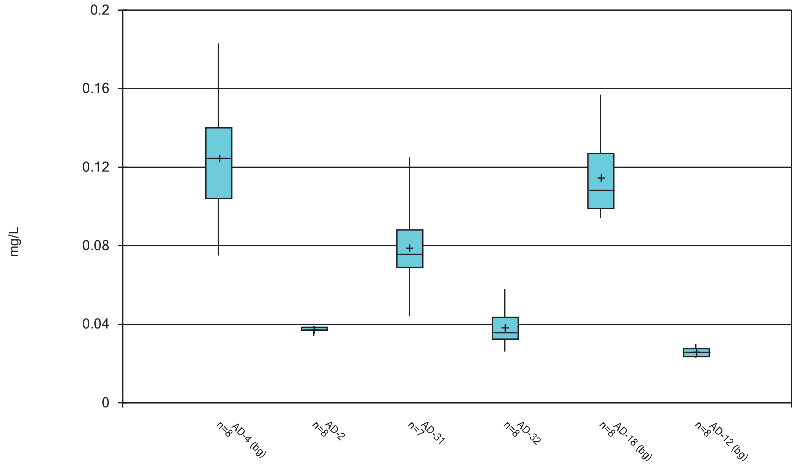
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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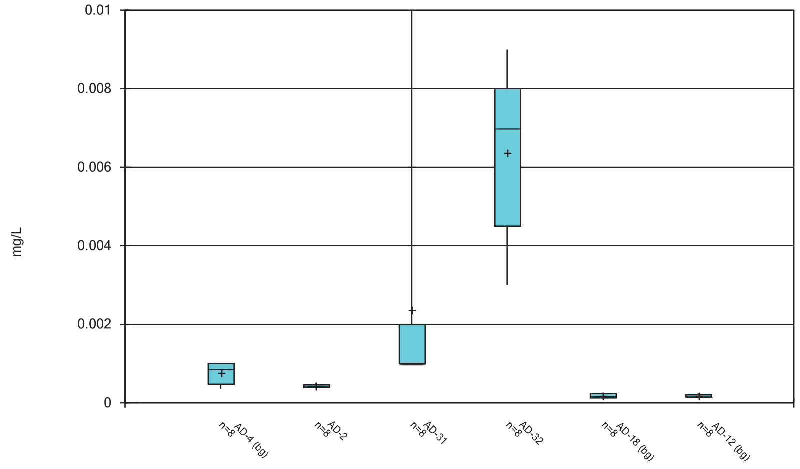
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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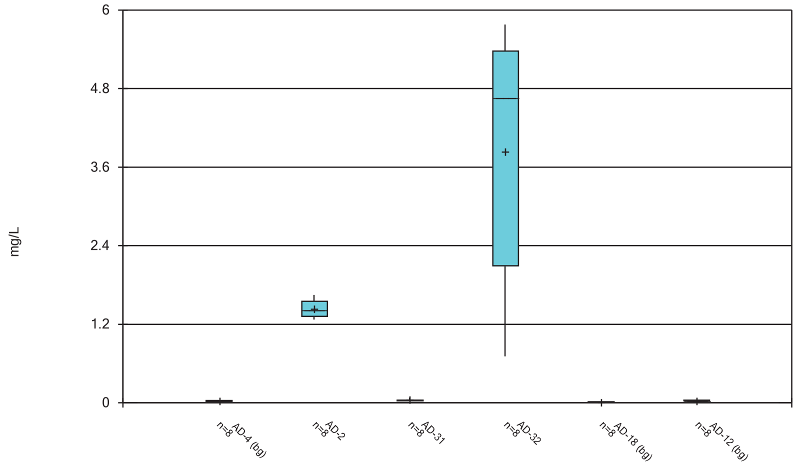
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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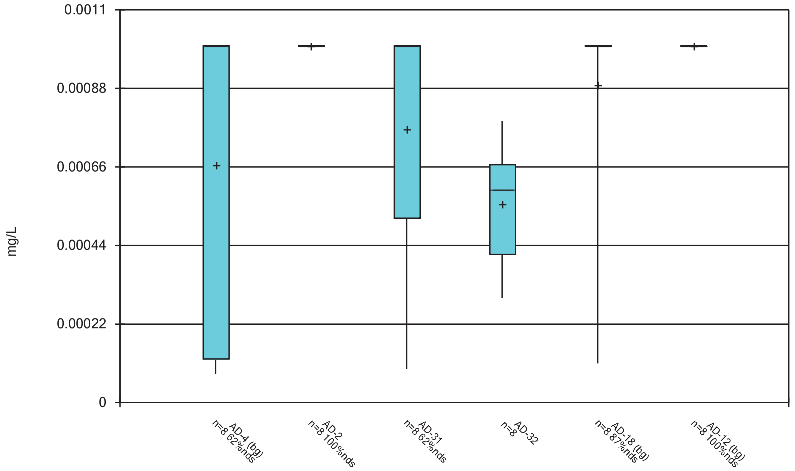
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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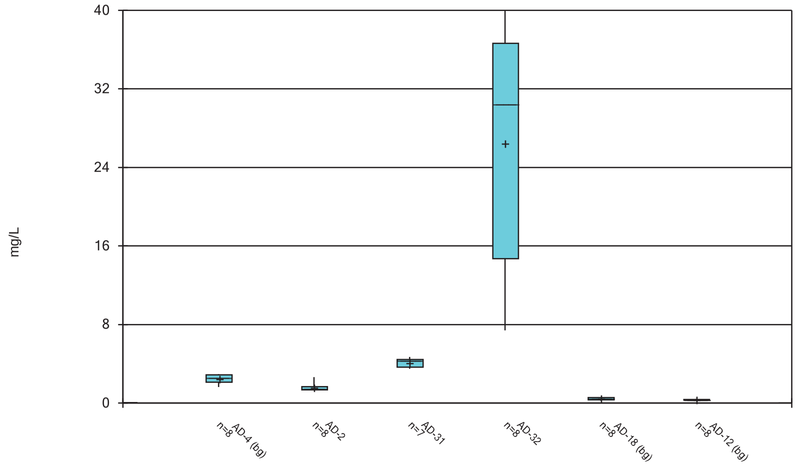
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

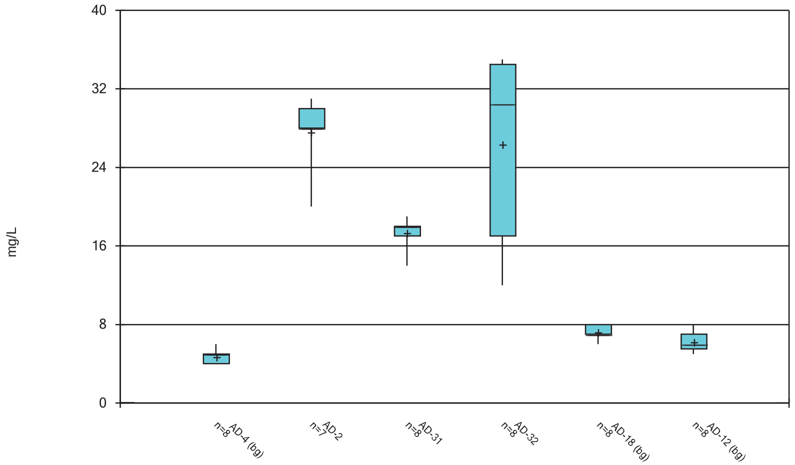
Box & Whiskers Plot



Constituent: Calcium, total Analysis Run 12/14/2017 5:21 PM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

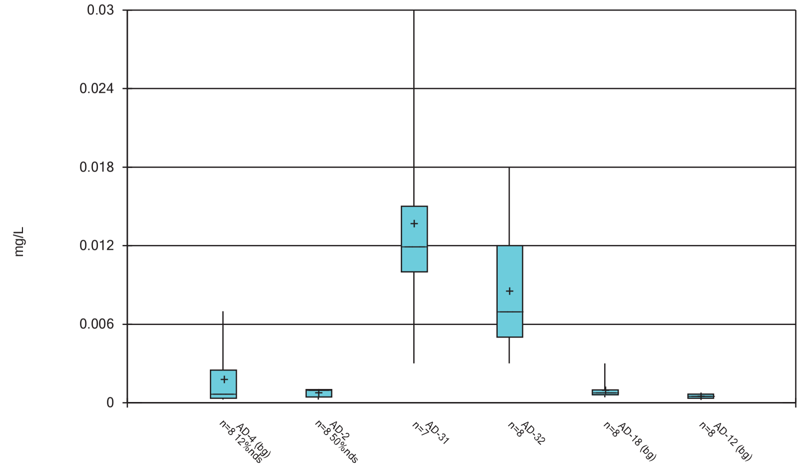
Box & Whiskers Plot



Constituent: Chloride, total Analysis Run 12/14/2017 5:21 PM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

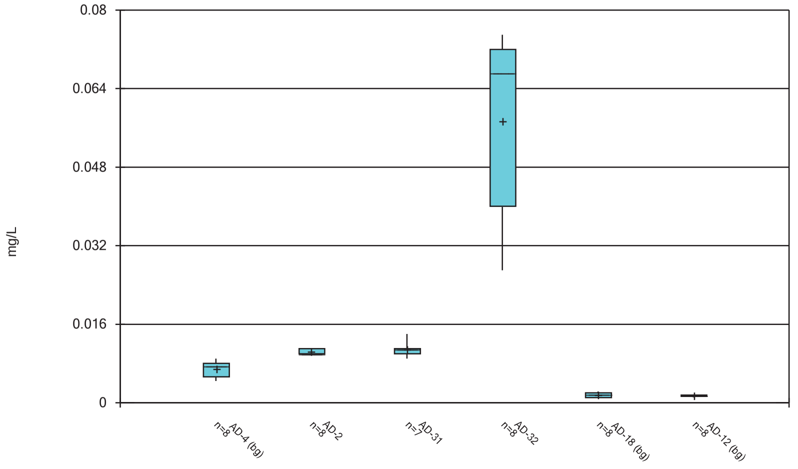
Box & Whiskers Plot



Constituent: Chromium, total Analysis Run 12/14/2017 5:21 PM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

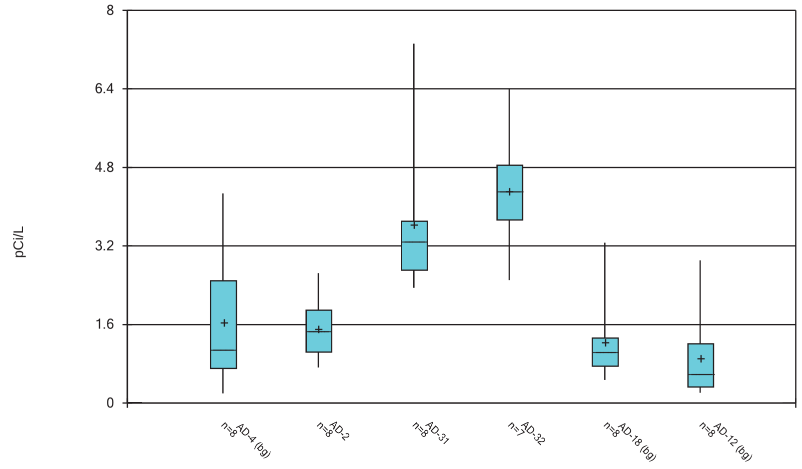
Box & Whiskers Plot



Constituent: Cobalt, total Analysis Run 12/14/2017 5:21 PM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Combined Radium 226 + 228 Analysis Run 12/14/2017 5:21 PM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

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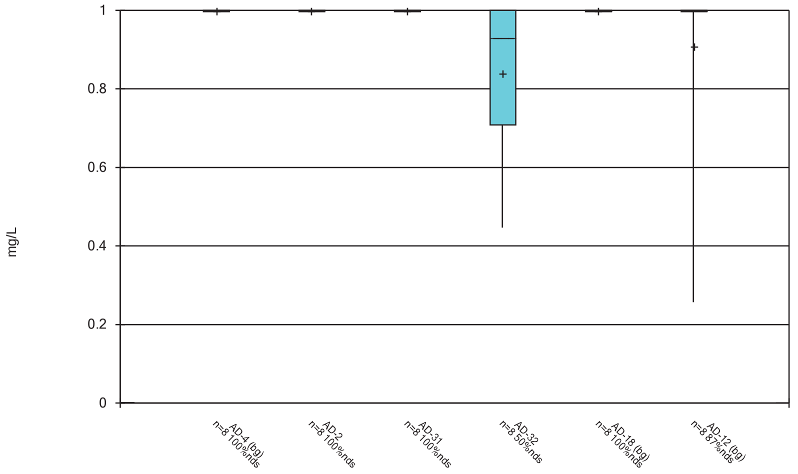
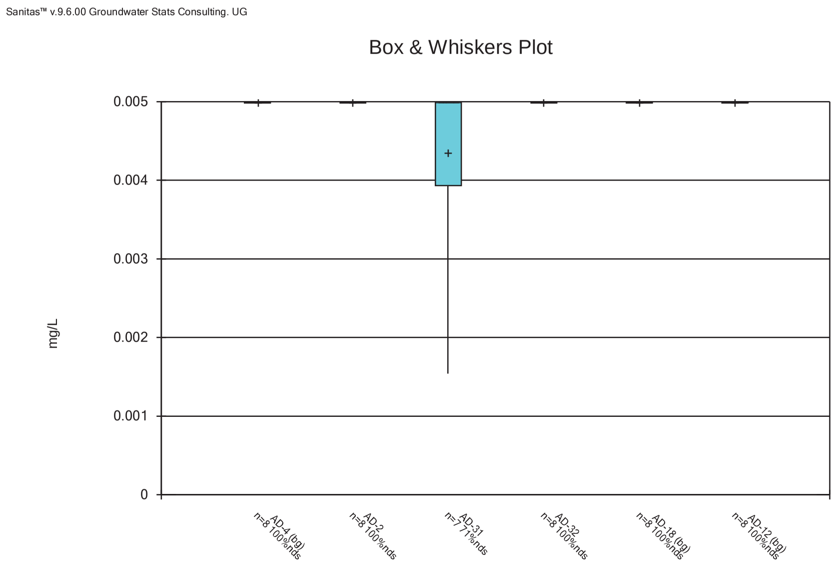
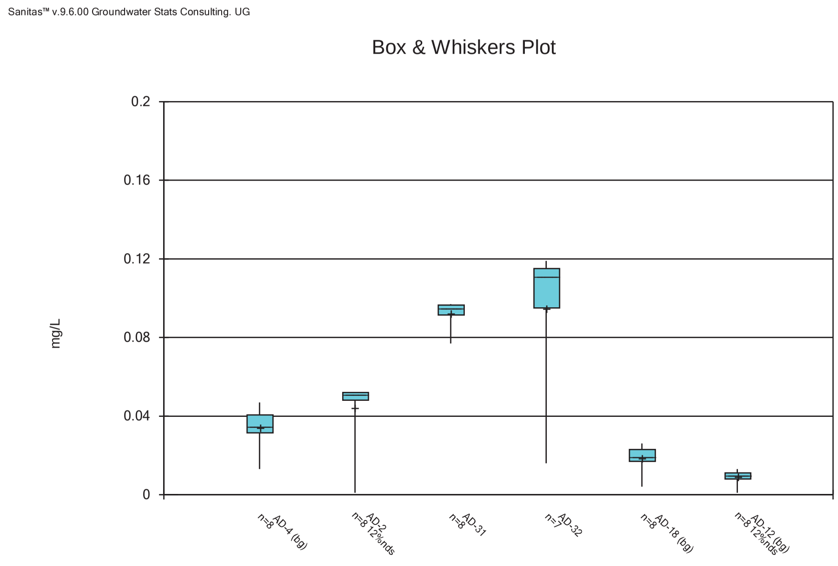
Box & Whiskers Plot



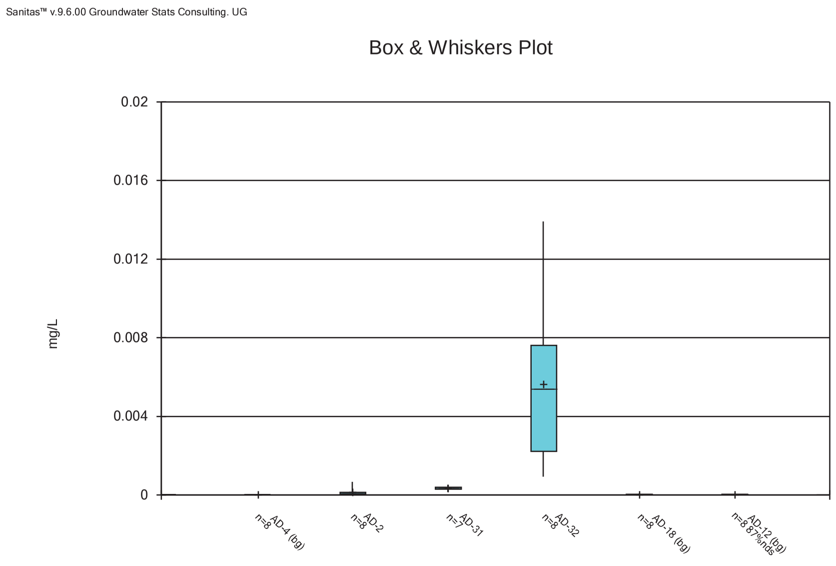
Constituent: Fluoride, total Analysis Run 12/14/2017 5:21 PM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP



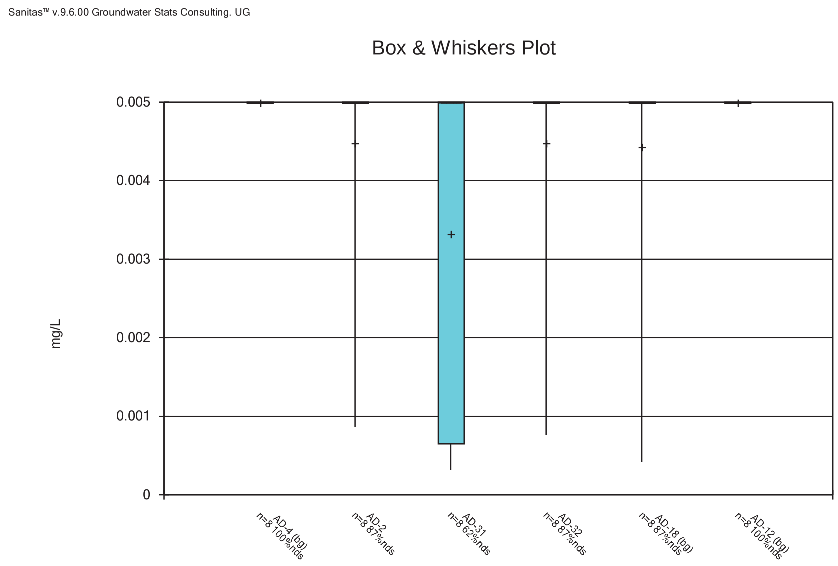
Constituent: Lead, total   Analysis Run 12/14/2017 5:21 PM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP



Constituent: Lithium, total   Analysis Run 12/14/2017 5:21 PM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP



Constituent: Mercury, total   Analysis Run 12/14/2017 5:21 PM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP



Constituent: Molybdenum, total   Analysis Run 12/14/2017 5:21 PM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

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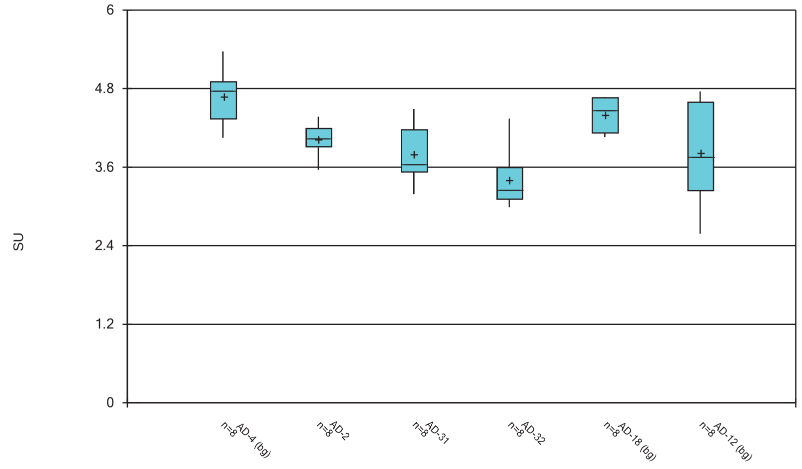
Box & Whiskers Plot



Constituent: pH, field   Analysis Run 12/14/2017 5:21 PM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

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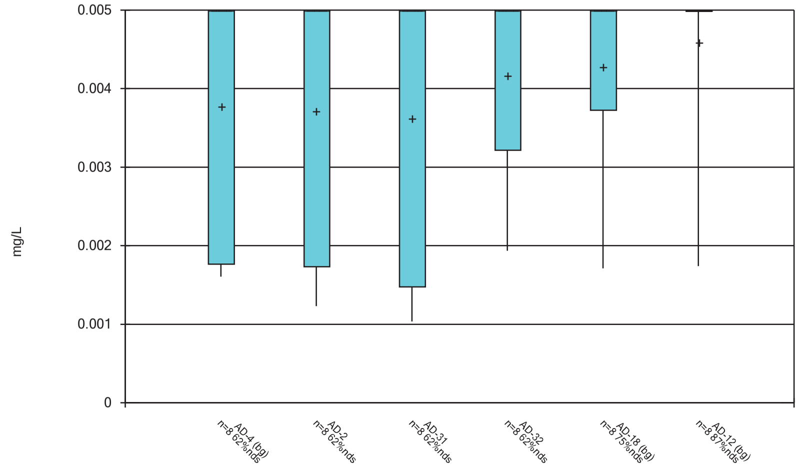
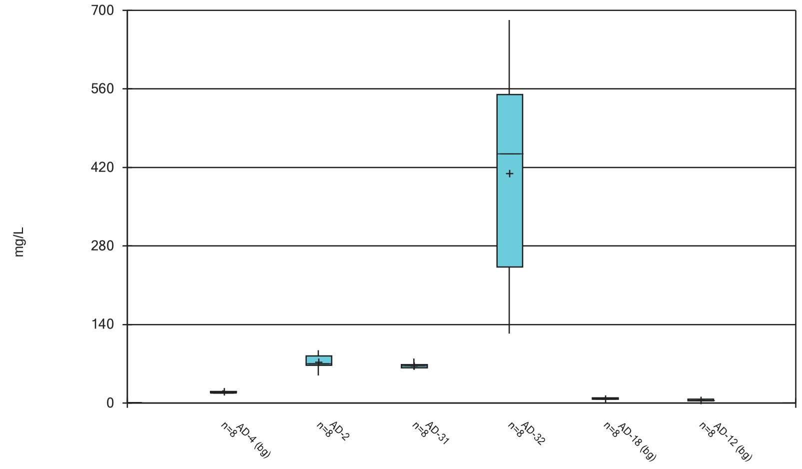
Box & Whiskers Plot



Constituent: Selenium, total   Analysis Run 12/14/2017 5:21 PM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

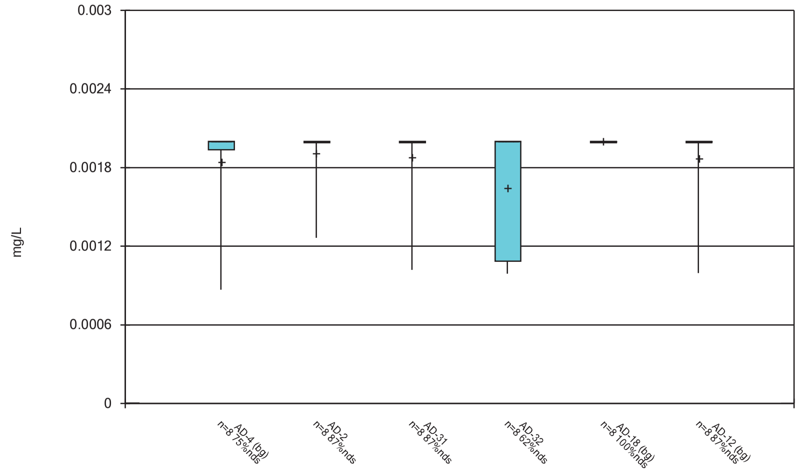
Box & Whiskers Plot



Constituent: Sulfate, total   Analysis Run 12/14/2017 5:21 PM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

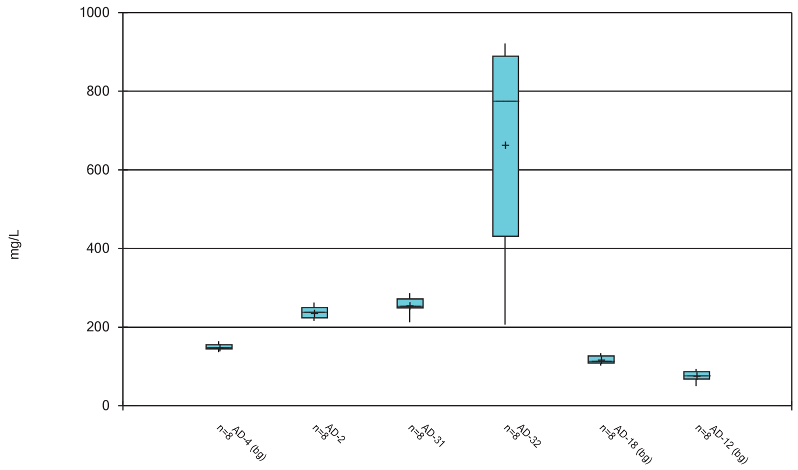
Box & Whiskers Plot



Constituent: Thallium, total   Analysis Run 12/14/2017 5:21 PM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/14/2017 5:21 PM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Outlier Summary

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/15/2017, 10:47 AM

	AD-31 Arsenic, total (mg/L)	AD-31 Barium, total (mg/L)	AD-31 Calcium, total (mg/L)	AD-2 Chloride, total (mg/L)	AD-31 Chromium, total (mg/L)	AD-31 Cobalt, total (mg/L)	AD-32 Combined Radium 226 + 228 (pCi/L)	AD-31 Lead, total (mg/L)	AD-32 Lithium, total (mg/L)	AD-31 Mercury, total (mg/L)
5/11/2016	0.093 (o)	0.712 (o)	10.4 (o)		0.212 (o)	0.05 (o)		0.057 (o)		0.001797 (o)
10/12/2016							17.32 (o)		0.972 (o)	
4/11/2017				50 (o)						

Outlier Analysis - All Upgradient Wells

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/5/2017, 8:41 AM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.005	0	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.00528	0.00141	unknown	ShapiroWilk
Barium, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.08846	0.05038	unknown	ShapiroWilk
Beryllium, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.0003689	0.0003208	unknown	ShapiroWilk
Boron, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.02583	0.01213	unknown	ShapiroWilk
Cadmium, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.0008514	0.0003395	unknown	ShapiroWilk
Calcium, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	1.067	1.038	unknown	ShapiroWilk
Chloride, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	6.083	1.316	unknown	ShapiroWilk
Chromium, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.001103	0.001466	unknown	ShapiroWilk
Cobalt, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.003286	0.002773	unknown	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-4,AD-18,AD-12	No	n/a	NP	24	1.264	1.064	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	1.124	0.7802	unknown	ShapiroWilk
Lead, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.005	0	unknown	ShapiroWilk
Lithium, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP	24	0.0205	0.01274	sqrt(x)	ShapiroWilk
Mercury, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP	24	0.00002041	0.00001243	ln(x)	ShapiroWilk
Molybdenum, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.004809	0.0009362	unknown	ShapiroWilk
pH, field (SU)	AD-4,AD-18,AD-12	No	n/a	NP	24	4.301	0.6353	x^3	ShapiroWilk
Selenium, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.00421	0.001406	unknown	ShapiroWilk
Sulfate, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	11.17	6.438	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP (nrm)	24	0.001906	0.0003017	unknown	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-4,AD-18,AD-12	No	n/a	NP	24	113.5	32.85	normal	ShapiroWilk

Outlier Analysis - Significant Downgradient Wells

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/14/2017, 5:32 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Arsenic, total (mg/L)	**AD-31**	**Yes**	**0.093**	**NP**	**8**	**0.01625**	**0.03111**	**ln(x)**	**ShapiroWilk**
Barium, total (mg/L)	**AD-31**	**Yes**	**0.712**	**NP**	**8**	**0.158**	**0.225**	**ln(x)**	**ShapiroWilk**
Calcium, total (mg/L)	**AD-31**	**Yes**	**10.4**	**NP**	**8**	**4.901**	**2.261**	**ln(x)**	**ShapiroWilk**
Chloride, total (mg/L)	**AD-2**	**Yes**	**20,50**	**NP (nrm)**	**8**	**30.38**	**8.585**	**unknown**	**ShapiroWilk**
Chromium, total (mg/L)	**AD-31**	**Yes**	**0.212**	**NP**	**8**	**0.0385**	**0.07051**	**ln(x)**	**ShapiroWilk**
Cobalt, total (mg/L)	**AD-31**	**Yes**	**0.05**	**NP**	**8**	**0.01588**	**0.01386**	**ln(x)**	**ShapiroWilk**
Combined Radium 226 + 228 (pCi/L)	**AD-32**	**Yes**	**17.32**	**NP**	**8**	**5.934**	**4.729**	**ln(x)**	**ShapiroWilk**
Lead, total (mg/L)	**AD-31**	**Yes**	**0.057,0.00154**	**NP (nrm)**	**8**	**0.01093**	**0.01865**	**unknown**	**ShapiroWilk**
Lithium, total (mg/L)	**AD-32**	**Yes**	**0.016,0.972**	**NP (nrm)**	**8**	**0.2046**	**0.3119**	**unknown**	**ShapiroWilk**
Mercury, total (mg/L)	**AD-31**	**Yes**	**0.001797**	**NP**	**8**	**0.0005158**	**0.0005286**	**ln(x)**	**ShapiroWilk**

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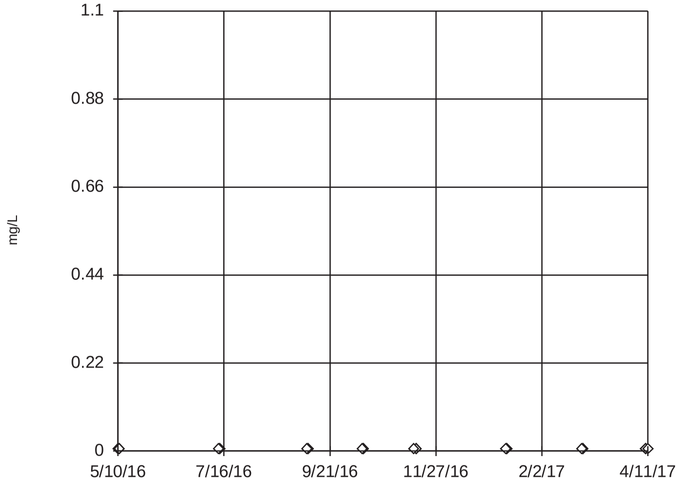
Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

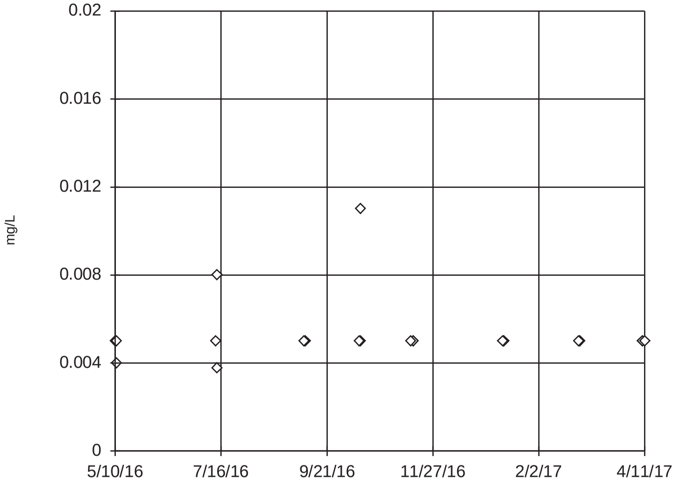
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Antimony, total   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

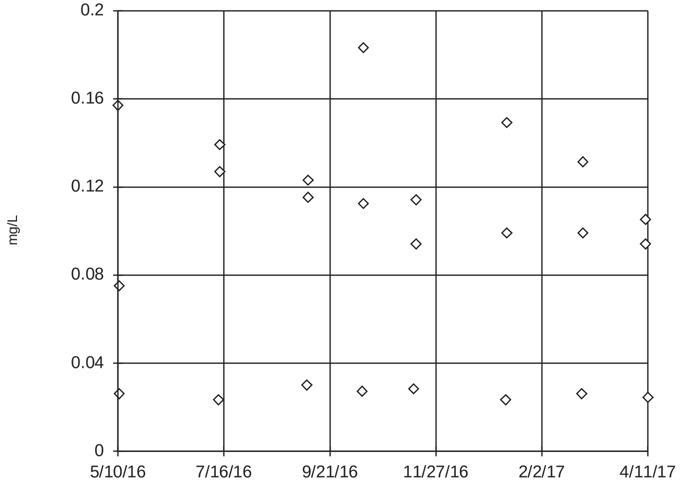
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Arsenic, total   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

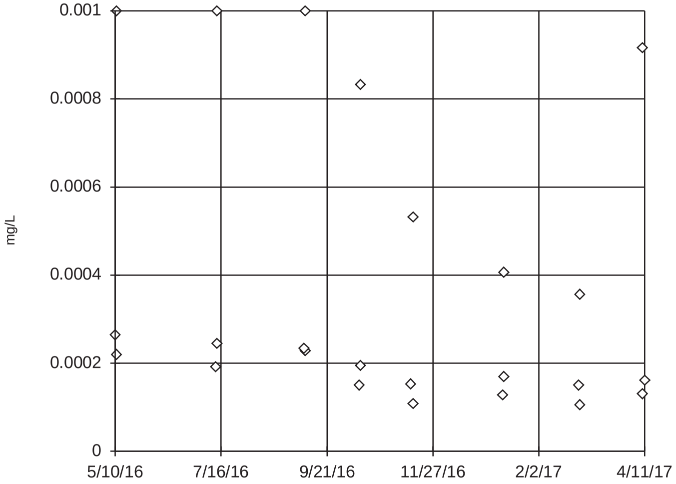
High cutoff = 0.2455, low cutoff = -0.2094, based on IQR multiplier of 3.

Constituent: Barium, total   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.01355, low cutoff = 0.000005177, based on IQR multiplier of 3.

Constituent: Beryllium, total   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

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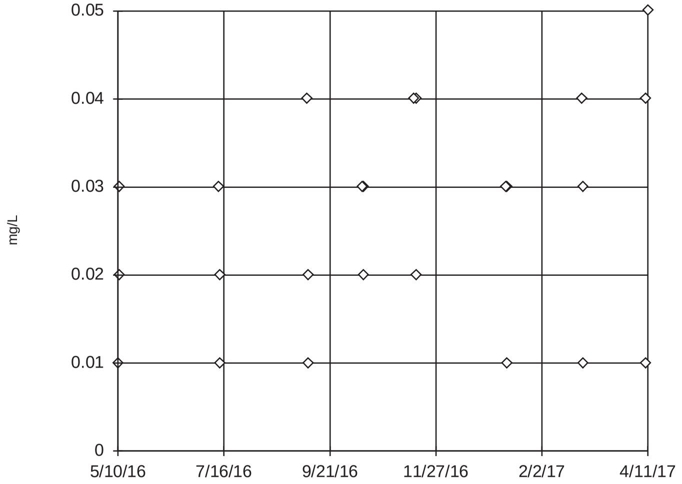
Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

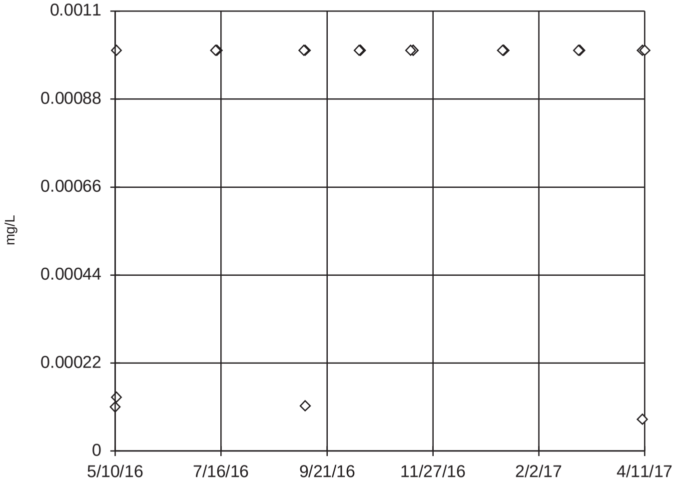
High cutoff = 0.095, low cutoff = -0.045, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/5/2017 8:38 AM View: Tukey's Outlier - Upgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Cadmium, total Analysis Run 11/5/2017 8:38 AM View: Tukey's Outlier - Upgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

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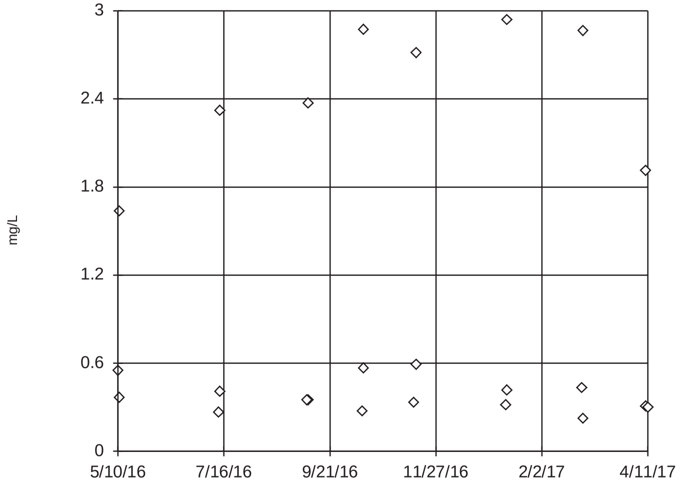
Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

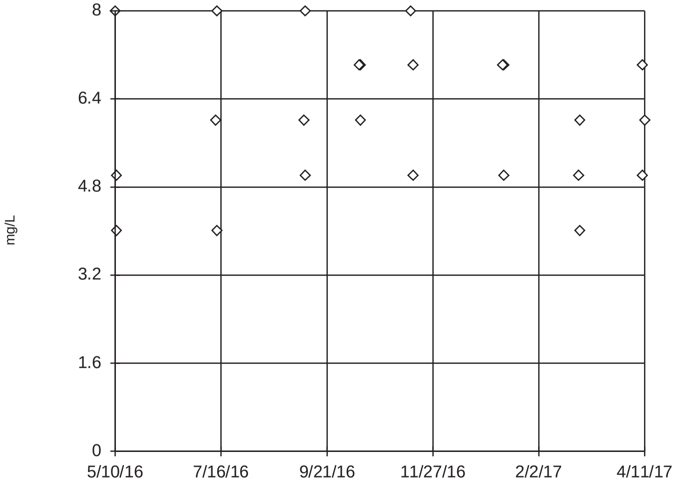
High cutoff = 583.2, low cutoff = 0.001165, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/5/2017 8:38 AM View: Tukey's Outlier - Upgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

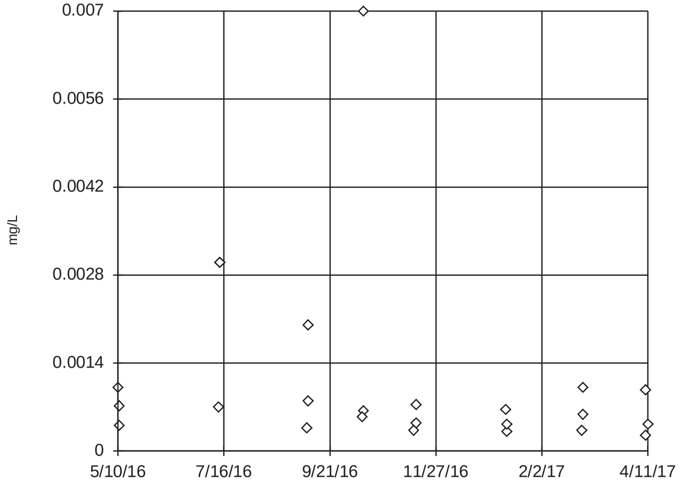
High cutoff = 13, low cutoff = -1, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/5/2017 8:38 AM View: Tukey's Outlier - Upgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

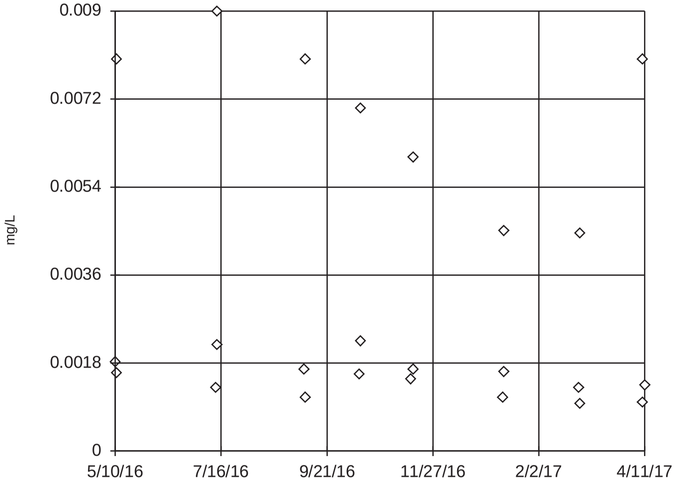
High cutoff = 0.0142, low cutoff = 0.000028, based on IQR multiplier of 3.

Constituent: Chromium, total   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

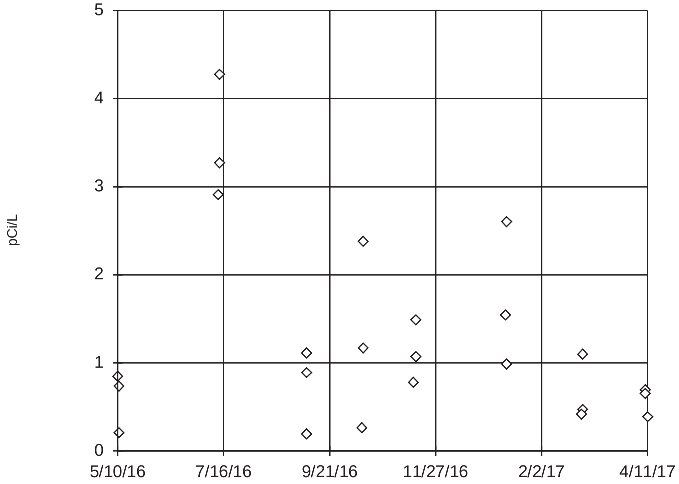
High cutoff = 0.3204, low cutoff = 0.00002137, based on IQR multiplier of 3.

Constituent: Cobalt, total   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

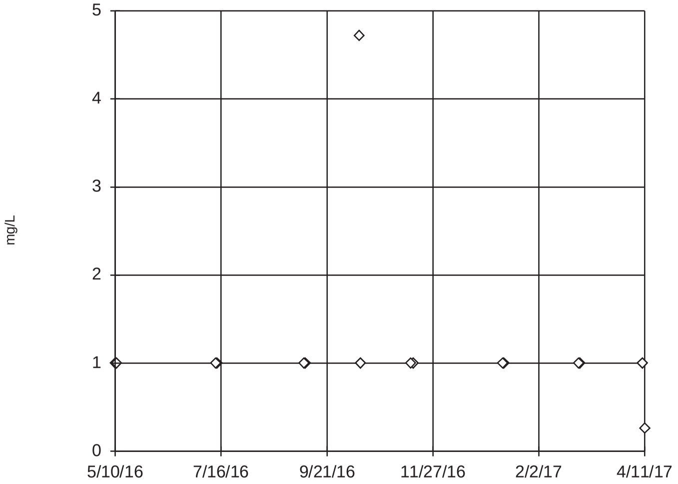
High cutoff = 31.2, low cutoff = 0.02667, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgra
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

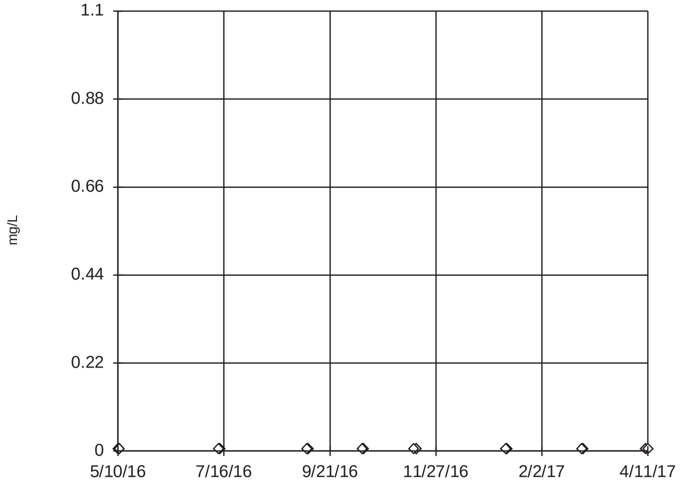
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Fluoride, total   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

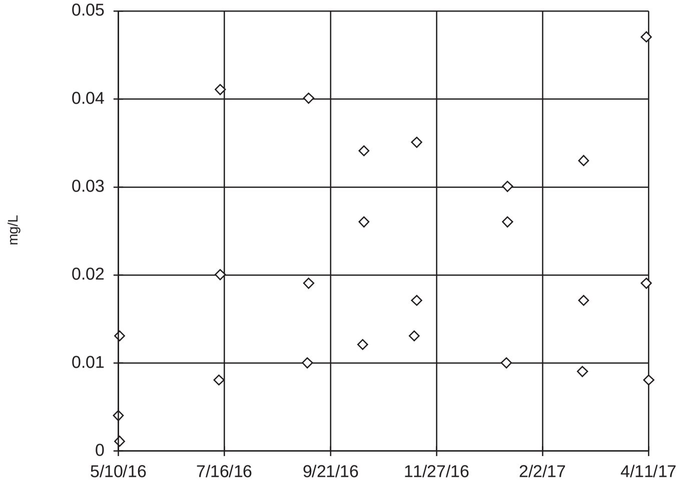
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Lead, total   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method selected by user.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

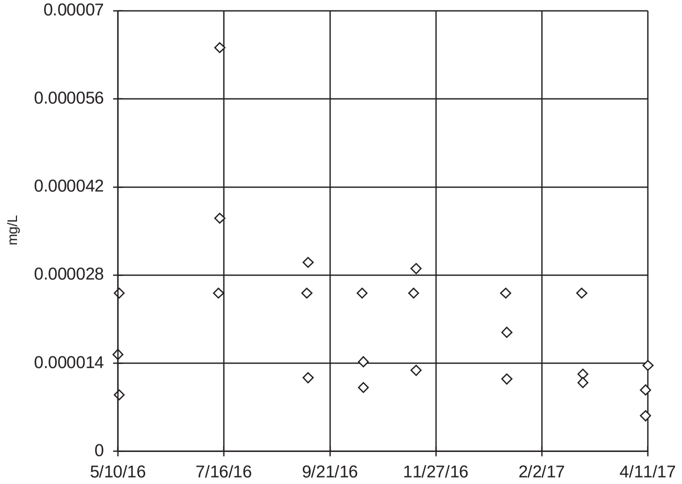
High cutoff = 0.1679,
low cutoff = -0.0175,
based on IQR multiplier
of 3.

Constituent: Lithium, total   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method selected by user.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

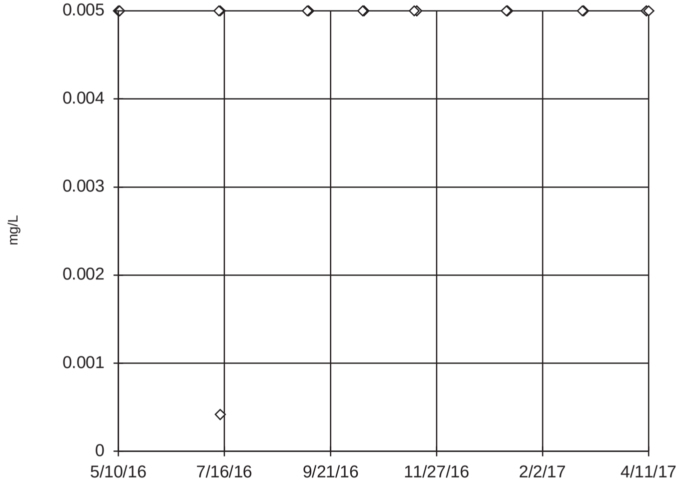
High cutoff = 0.0002579,
low cutoff = 0.000001114,
based on IQR multiplier
of 3.

Constituent: Mercury, total   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

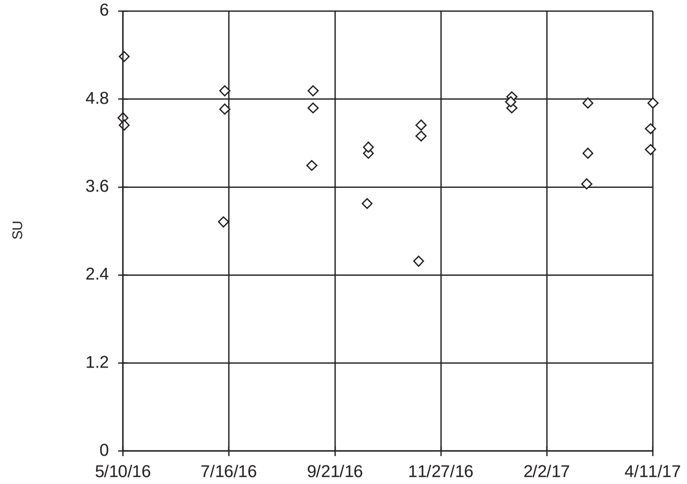
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Molybdenum, total   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

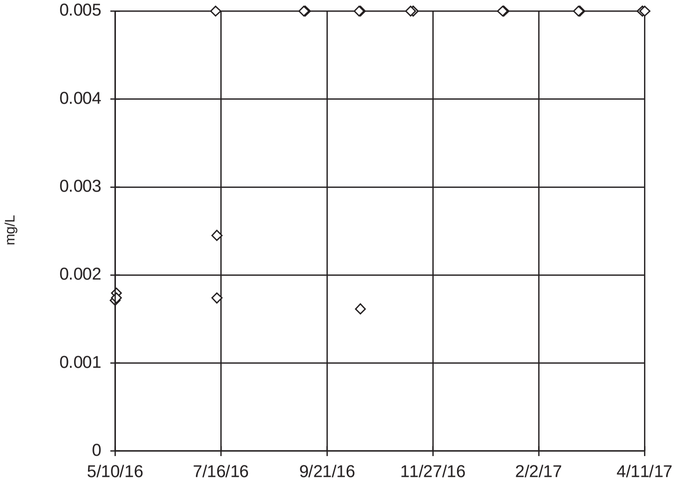
High cutoff = 6.079, low cutoff = -3.727, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/5/2017 8:38 AM View: Tukey's Outlier - Upgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

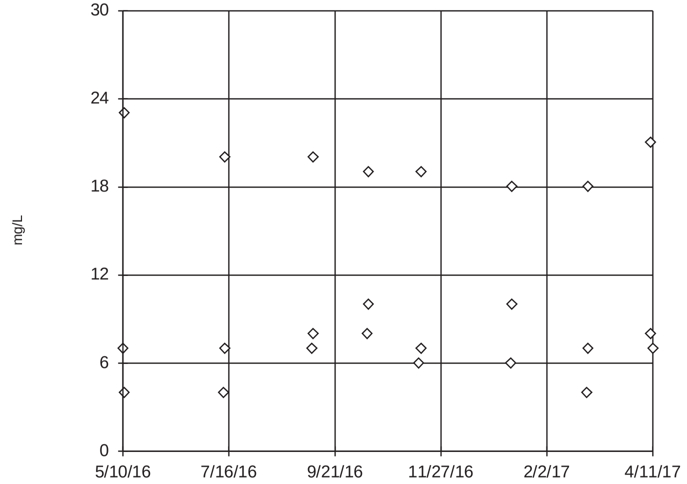
High cutoff = 0.01458, low cutoff = 0.001201, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/5/2017 8:38 AM View: Tukey's Outlier - Upgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

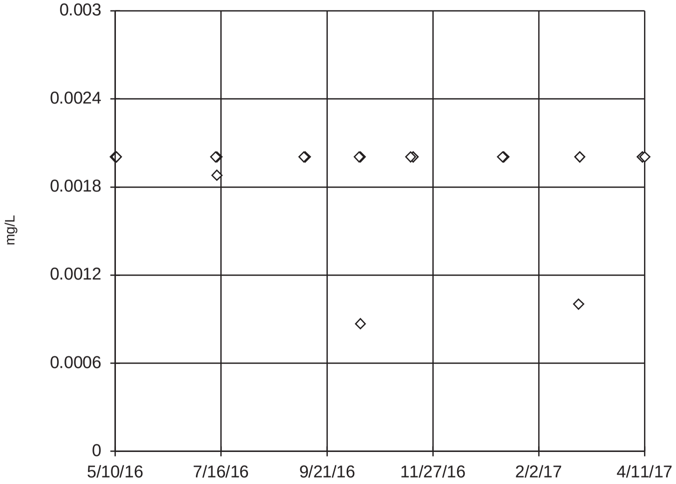
High cutoff = 341, low cutoff = 0.3796, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/5/2017 8:38 AM View: Tukey's Outlier - Upgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

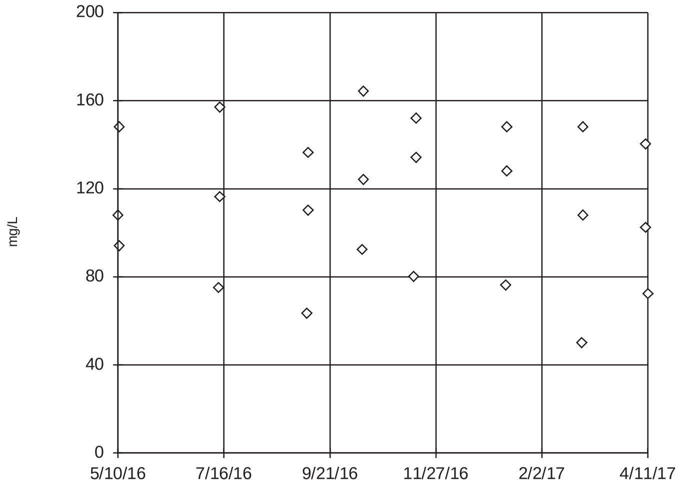
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium, total Analysis Run 11/5/2017 8:38 AM View: Tukey's Outlier - Upgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-4,AD-18,AD-12



n = 24

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 318, low cutoff = -88, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/5/2017 8:38 AM   View: Tukey's Outlier - Upgrad
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Outlier Analysis - All Downgradient Wells

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/14/2017, 5:32 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-2	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-31	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-32	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-2	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Arsenic, total (mg/L)	**AD-31**	**Yes**	**0.093**	**NP**	**8**	**0.01625**	**0.03111**	**ln(x)**	**ShapiroWilk**
Arsenic, total (mg/L)	AD-32	No	n/a	NP	8	0.006449	0.003358	ln(x)	ShapiroWilk
Barium, total (mg/L)	AD-2	No	n/a	NP	8	0.03738	0.001598	x^6	ShapiroWilk
Barium, total (mg/L)	**AD-31**	**Yes**	**0.712**	**NP**	**8**	**0.158**	**0.225**	**ln(x)**	**ShapiroWilk**
Barium, total (mg/L)	AD-32	No	n/a	NP	8	0.0385	0.01049	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-2	No	n/a	NP	8	0.0004267	0.00004829	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-31	No	n/a	NP (nrm)	8	0.002375	0.003114	unknown	ShapiroWilk
Beryllium, total (mg/L)	AD-32	No	n/a	NP	8	0.006375	0.002134	x^2	ShapiroWilk
Boron, total (mg/L)	AD-2	No	n/a	NP	8	1.438	0.1437	ln(x)	ShapiroWilk
Boron, total (mg/L)	AD-31	No	n/a	NP (nrm)	8	0.04125	0.01642	unknown	ShapiroWilk
Boron, total (mg/L)	AD-32	No	n/a	NP	8	3.842	1.959	x^4	ShapiroWilk
Cadmium, total (mg/L)	AD-2	No	n/a	NP (nrm)	8	0.001	0	unknown	ShapiroWilk
Cadmium, total (mg/L)	AD-31	No	n/a	NP (nrm)	8	0.000766	0.0003934	unknown	ShapiroWilk
Cadmium, total (mg/L)	AD-32	No	n/a	NP	8	0.0005541	0.0001688	normal	ShapiroWilk
Calcium, total (mg/L)	AD-2	No	n/a	NP	8	1.598	0.4498	ln(x)	ShapiroWilk
Calcium, total (mg/L)	**AD-31**	**Yes**	**10.4**	**NP**	**8**	**4.901**	**2.261**	**ln(x)**	**ShapiroWilk**
Calcium, total (mg/L)	AD-32	No	n/a	NP	8	26.39	12.62	x^2	ShapiroWilk
Chloride, total (mg/L)	**AD-2**	**Yes**	**20,50**	**NP (nrm)**	**8**	**30.38**	**8.585**	**unknown**	**ShapiroWilk**
Chloride, total (mg/L)	AD-31	No	n/a	NP (nrm)	8	17.38	1.598	unknown	ShapiroWilk
Chloride, total (mg/L)	AD-32	No	n/a	NP	8	26.38	9.531	x^5	ShapiroWilk
Chromium, total (mg/L)	AD-2	No	n/a	NP (nrm)	8	0.0007531	0.0003188	unknown	ShapiroWilk
Chromium, total (mg/L)	**AD-31**	**Yes**	**0.212**	**NP**	**8**	**0.0385**	**0.07051**	**ln(x)**	**ShapiroWilk**
Chromium, total (mg/L)	AD-32	No	n/a	NP	8	0.008625	0.005263	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-2	No	n/a	NP (nrm)	8	0.01038	0.0005175	unknown	ShapiroWilk
Cobalt, total (mg/L)	**AD-31**	**Yes**	**0.05**	**NP**	**8**	**0.01588**	**0.01386**	**ln(x)**	**ShapiroWilk**
Cobalt, total (mg/L)	AD-32	No	n/a	NP	8	0.0575	0.01896	x^6	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-2	No	n/a	NP	8	1.52	0.6404	sqrt(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-31	No	n/a	NP	8	3.632	1.572	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	**AD-32**	**Yes**	**17.32**	**NP**	**8**	**5.934**	**4.729**	**ln(x)**	**ShapiroWilk**
Fluoride, total (mg/L)	AD-2	No	n/a	NP (nrm)	8	1	0	unknown	ShapiroWilk
Fluoride, total (mg/L)	AD-31	No	n/a	NP (nrm)	8	1	0	unknown	ShapiroWilk
Fluoride, total (mg/L)	AD-32	No	n/a	NP (nrm)	8	0.8403	0.2053	unknown	ShapiroWilk
Lead, total (mg/L)	AD-2	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Lead, total (mg/L)	**AD-31**	**Yes**	**0.057,0.00154**	**NP (nrm)**	**8**	**0.01093**	**0.01865**	**unknown**	**ShapiroWilk**
Lead, total (mg/L)	AD-32	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Lithium, total (mg/L)	AD-2	No	n/a	NP (nrm)	8	0.04438	0.01761	unknown	ShapiroWilk
Lithium, total (mg/L)	AD-31	No	n/a	NP	8	0.0925	0.006698	x^6	ShapiroWilk
Lithium, total (mg/L)	**AD-32**	**Yes**	**0.016,0.972**	**NP (nrm)**	**8**	**0.2046**	**0.3119**	**unknown**	**ShapiroWilk**
Mercury, total (mg/L)	AD-2	No	n/a	NP	8	0.0001501	0.0002159	ln(x)	ShapiroWilk
Mercury, total (mg/L)	**AD-31**	**Yes**	**0.001797**	**NP**	**8**	**0.0005158**	**0.0005286**	**ln(x)**	**ShapiroWilk**
Mercury, total (mg/L)	AD-32	No	n/a	NP	8	0.005664	0.004296	x^(1/3)	ShapiroWilk
Molybdenum, total (mg/L)	AD-2	No	n/a	NP (nrm)	8	0.004483	0.001463	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-31	No	n/a	NP (nrm)	8	0.003326	0.002316	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-32	No	n/a	NP (nrm)	8	0.00447	0.001498	unknown	ShapiroWilk
pH, field (SU)	AD-2	No	n/a	NP	8	4.029	0.2473	x^6	ShapiroWilk
pH, field (SU)	AD-31	No	n/a	NP	8	3.795	0.4507	ln(x)	ShapiroWilk
pH, field (SU)	AD-32	No	n/a	NP	8	3.404	0.4657	ln(x)	ShapiroWilk
Selenium, total (mg/L)	AD-2	No	n/a	NP (nrm)	8	0.003712	0.001794	unknown	ShapiroWilk
Selenium, total (mg/L)	AD-31	No	n/a	NP (nrm)	8	0.003623	0.001915	unknown	ShapiroWilk
Selenium, total (mg/L)	AD-32	No	n/a	NP (nrm)	8	0.00417	0.001264	unknown	ShapiroWilk
Sulfate, total (mg/L)	AD-2	No	n/a	NP	8	73.63	13.91	x^2	ShapiroWilk

Outlier Analysis - All Downgradient Wells

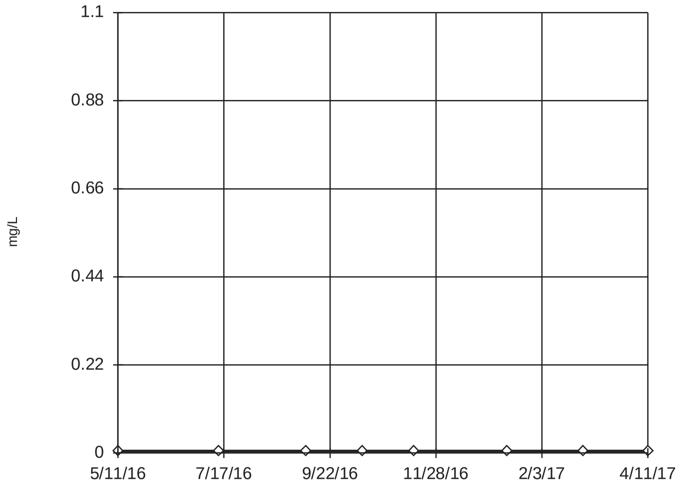
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/14/2017, 5:32 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Sulfate, total (mg/L)	AD-31	No	n/a	NP	8	66.63	5.854	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-32	No	n/a	NP	8	410.4	195.8	normal	ShapiroWilk
Thallium, total (mg/L)	AD-2	No	n/a	NP (nrm)	8	0.001908	0.0002601	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-31	No	n/a	NP (nrm)	8	0.001877	0.0003468	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-32	No	n/a	NP (nrm)	8	0.001645	0.0004905	unknown	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-2	No	n/a	NP	8	237.5	16.48	x^3	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-31	No	n/a	NP	8	256.1	22.38	x^5	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-32	No	n/a	NP	8	665.4	274	x^2	ShapiroWilk

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

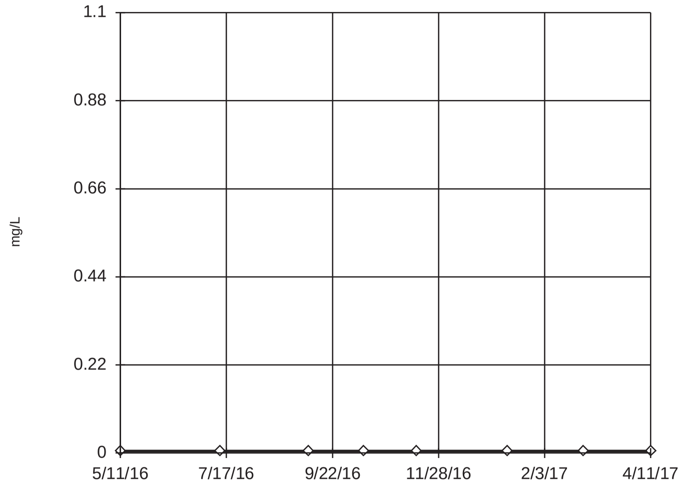
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Antimony, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

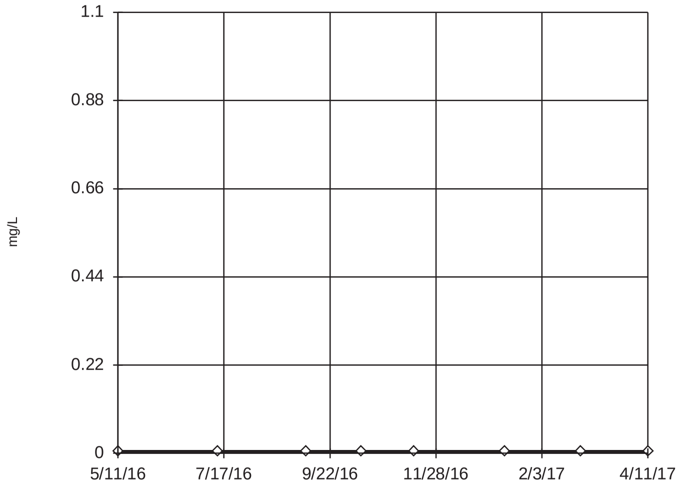
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Antimony, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

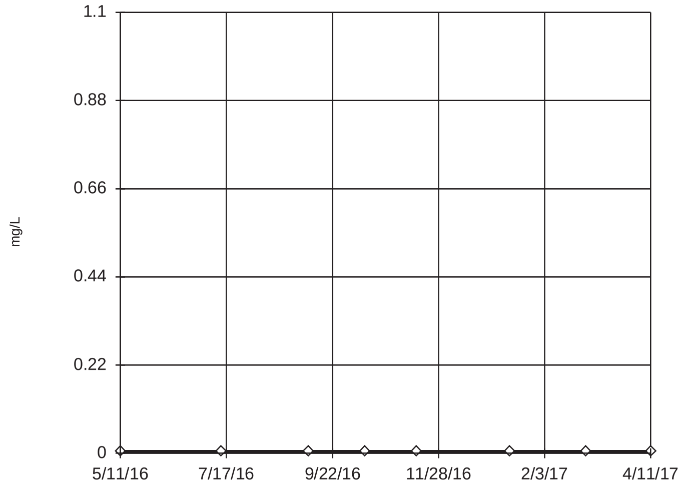
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Antimony, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

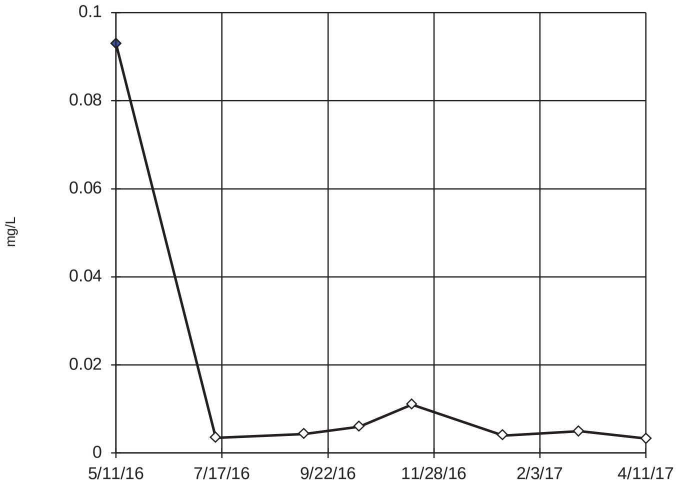
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Arsenic, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

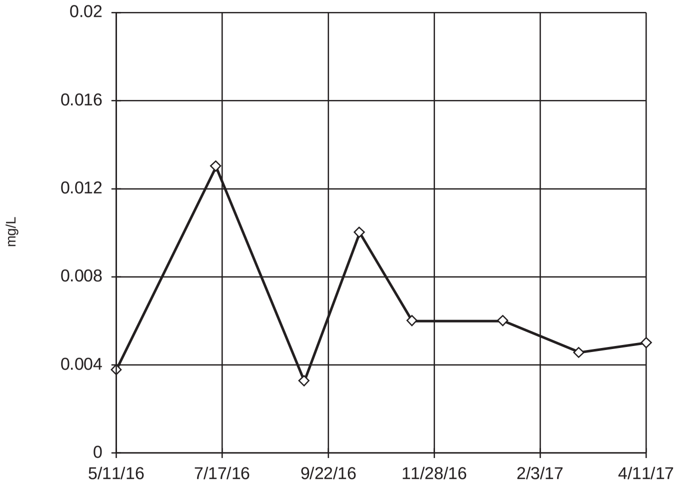
High cutoff = 0.08888, low cutoff = 0.0003345, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

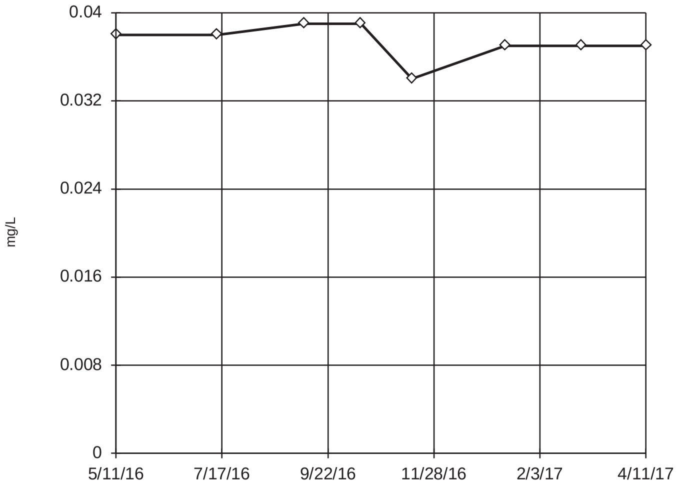
High cutoff = 0.05046, low cutoff = 0.0006367, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

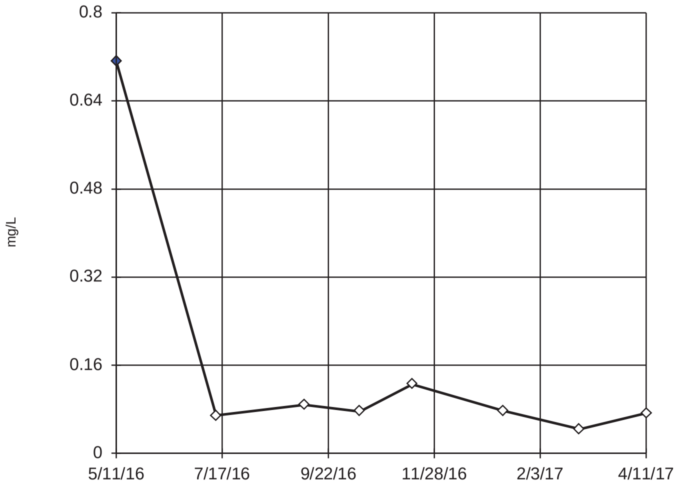
High cutoff = 0.04184, low cutoff = 0.02787, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

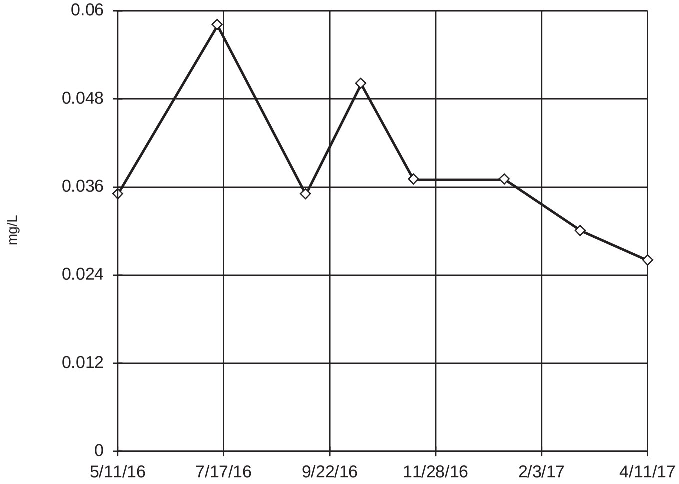
High cutoff = 0.3385, low cutoff = 0.02199, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

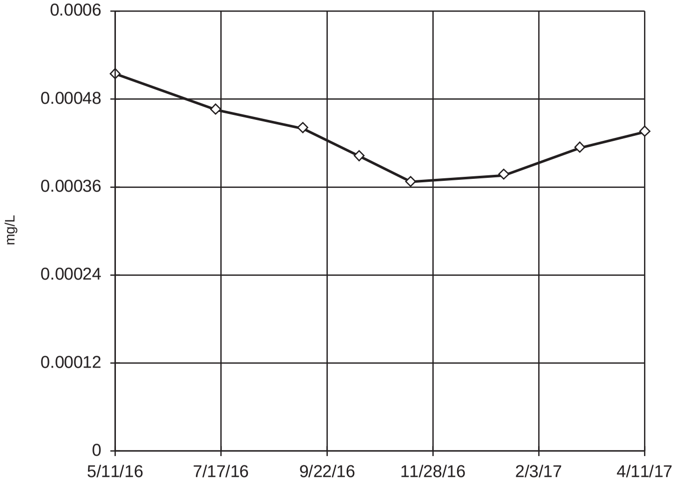
High cutoff = 0.1006, low cutoff = 0.01386, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

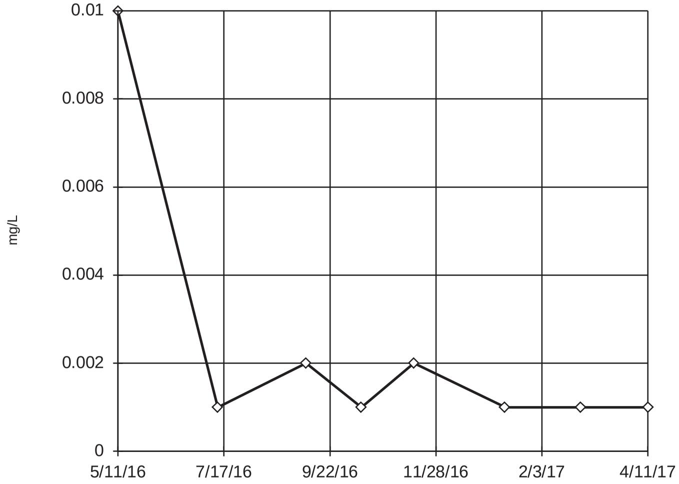
High cutoff = 0.0007123, low cutoff = 0.0002468, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

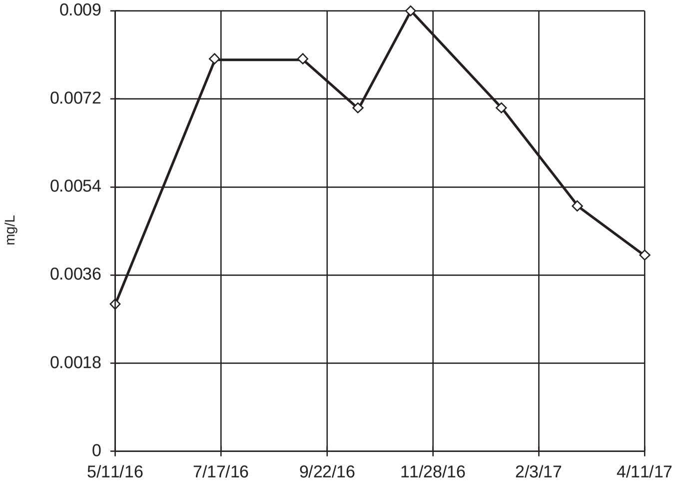
High cutoff = 0.016, low cutoff = 0.000125, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

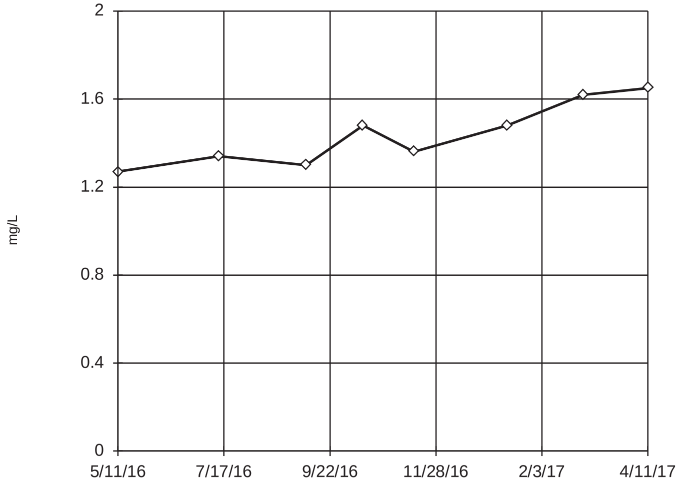
High cutoff = 0.01395, low cutoff = -0.01049, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

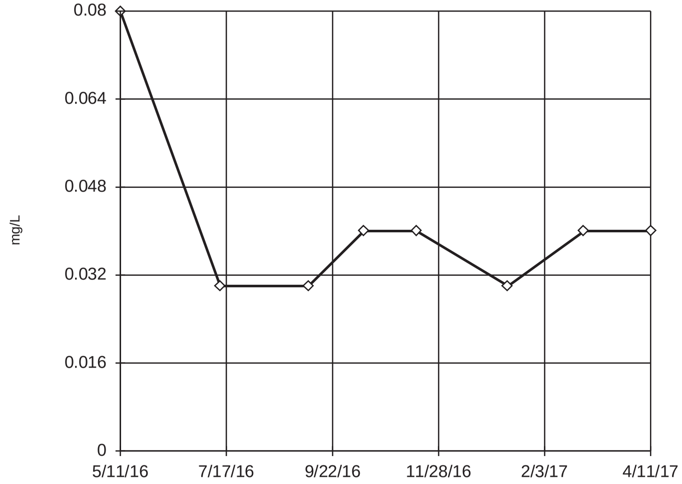
High cutoff = 2.5, low cutoff = 0.8174, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

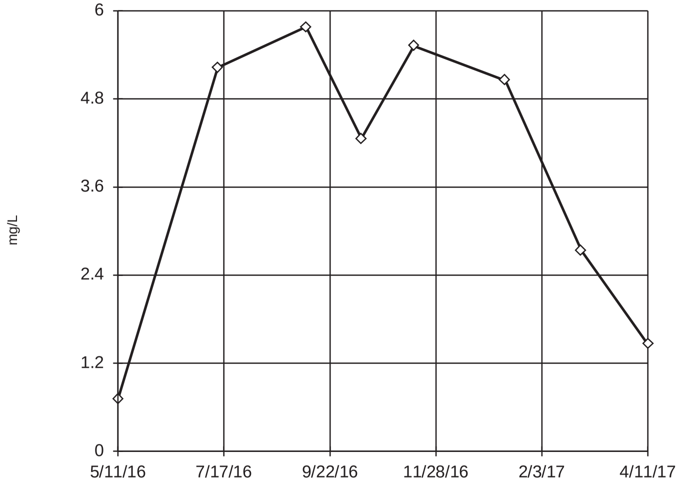
High cutoff = 0.09481, low cutoff = 0.01266, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

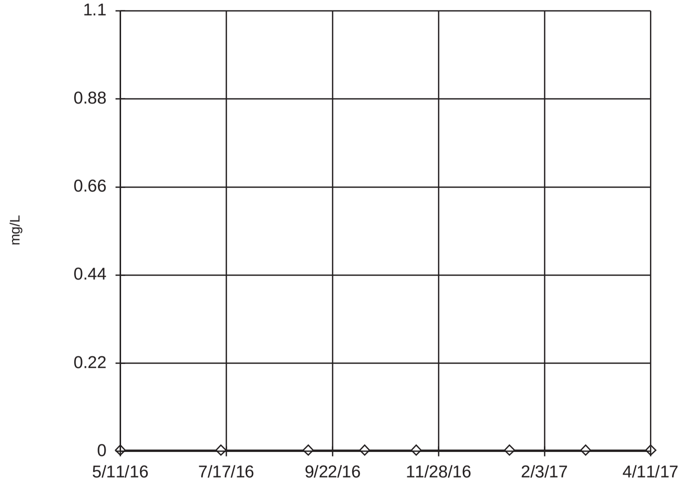
High cutoff = 7.558, low cutoff = -6.995, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

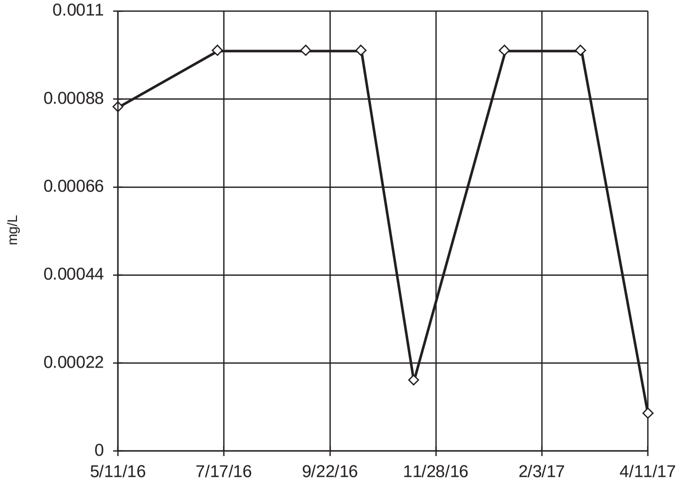
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Cadmium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

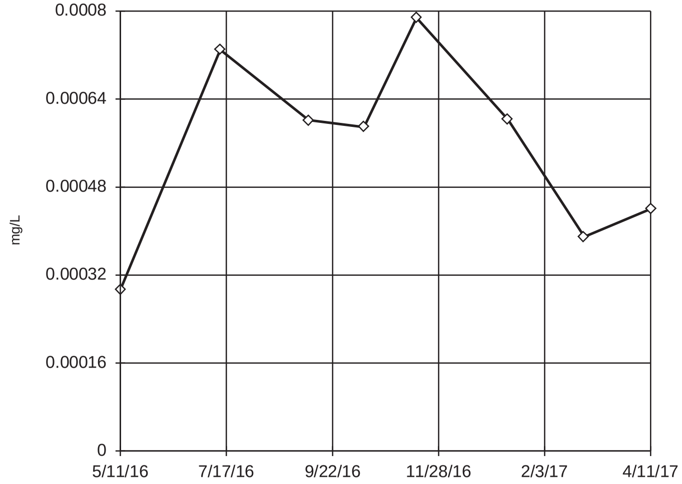
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Cadmium, total   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

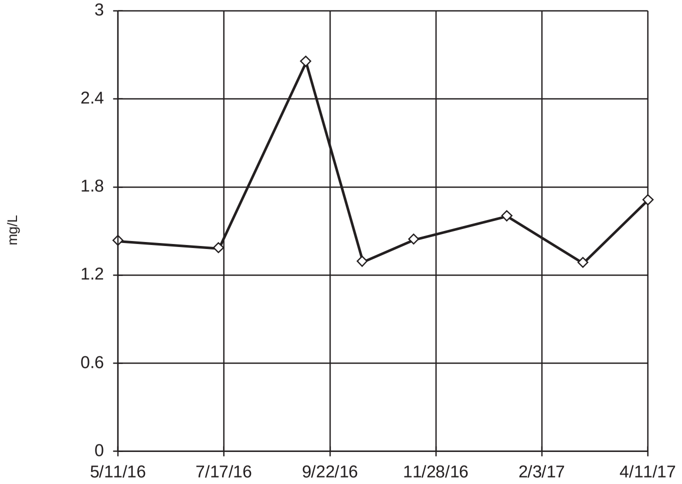
High cutoff = 0.001419, low cutoff = -0.0003382, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

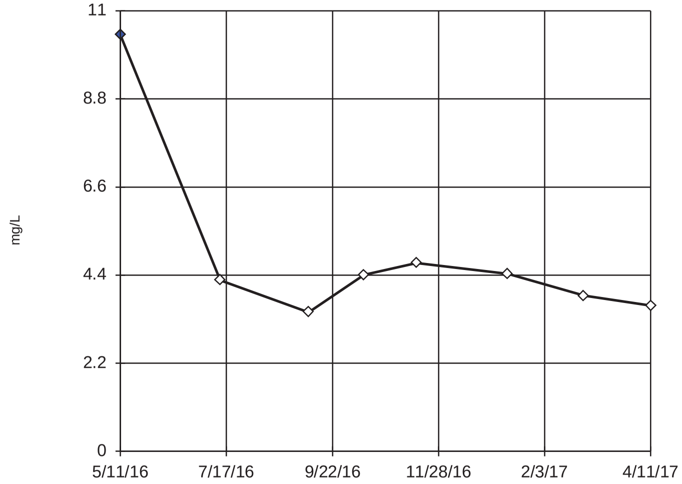
High cutoff = 3.152, low cutoff = 0.7003, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

Outlier is drawn as solid.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

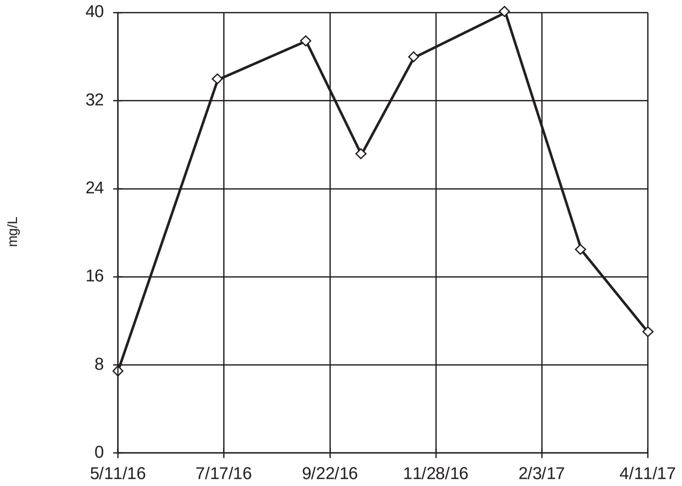
High cutoff = 8.136, low cutoff = 2.11, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

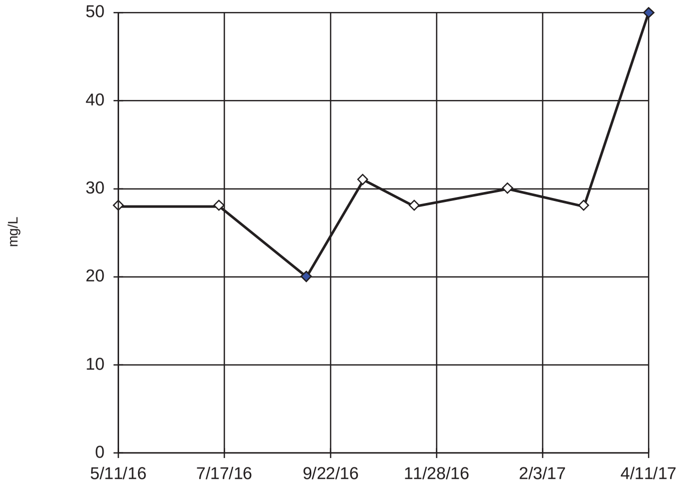
High cutoff = 68.45, low cutoff = -55.79, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

Outliers are drawn as solid.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

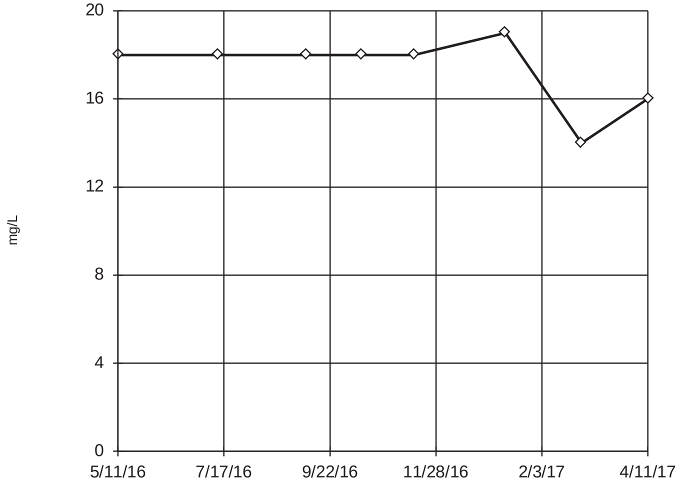
High cutoff = 39.4, low cutoff = 21.67, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

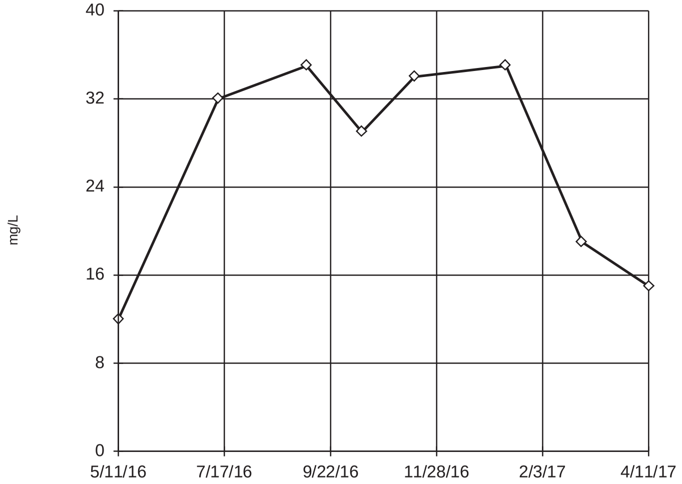
High cutoff = 19.78, low cutoff = -8.779, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method selected by user.

Data were x^5 transformed to achieve best W statistic (graph shown in original units).

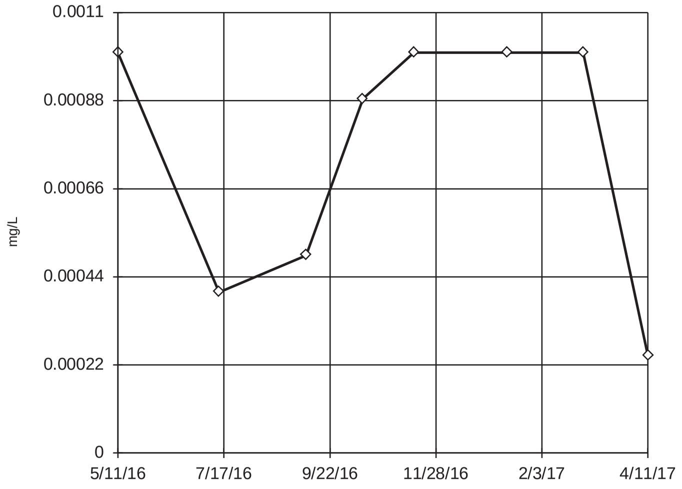
High cutoff = 45.31, low cutoff = -42.61, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

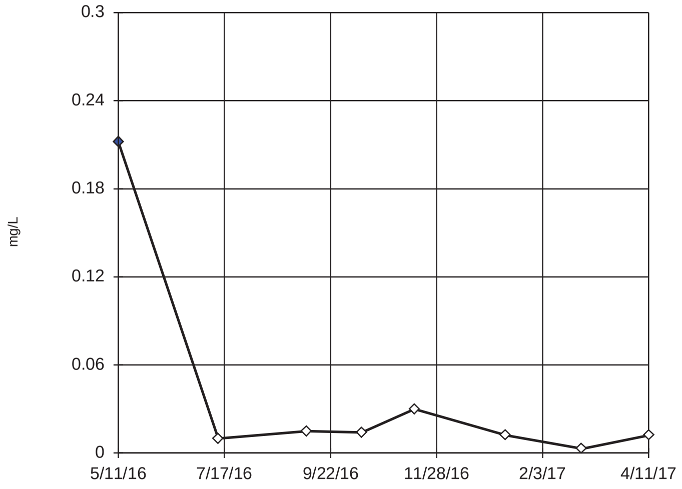
High cutoff = 0.003981, low cutoff = -0.0001069, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

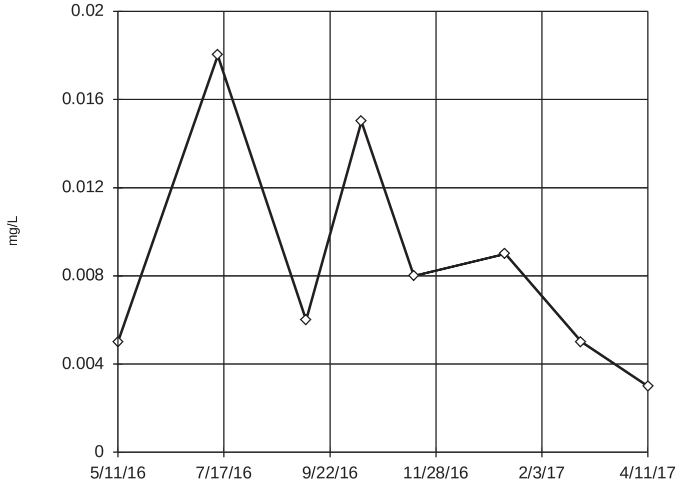
High cutoff = 0.154, low cutoff = 0.001508, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

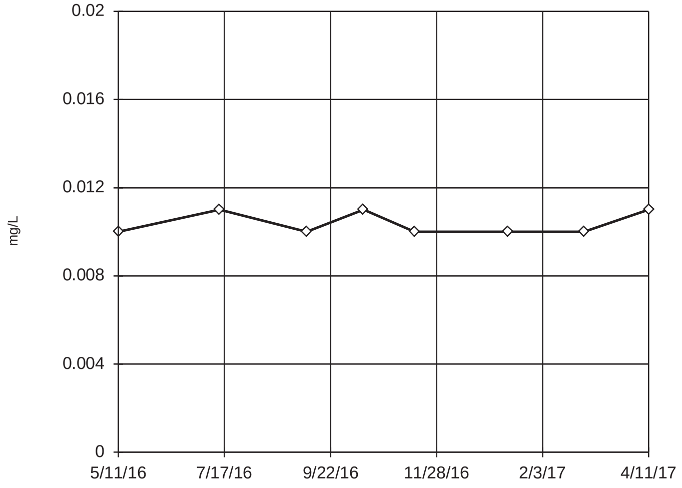
High cutoff = 0.1458, low cutoff = 0.0003985, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

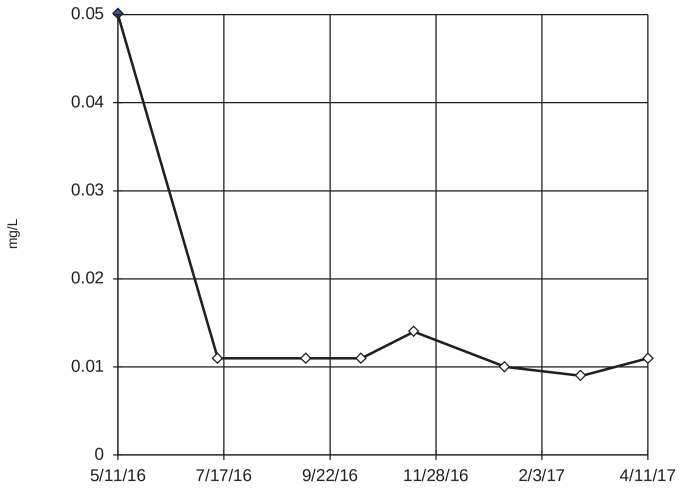
High cutoff = 0.014, low cutoff = 0.007, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

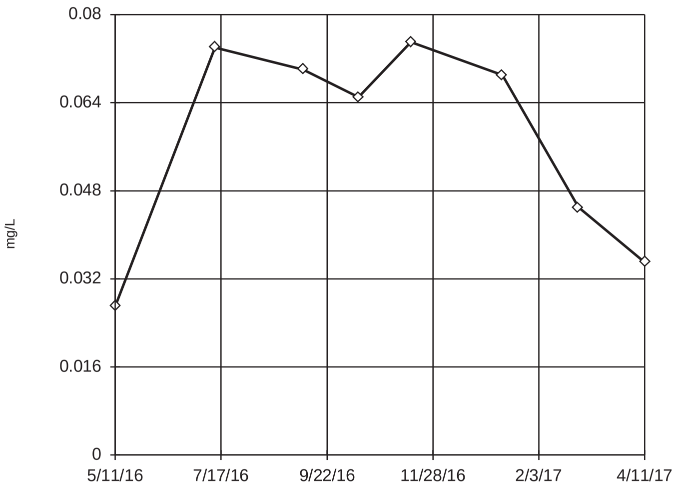
High cutoff = 0.02056, low cutoff = 0.006331, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

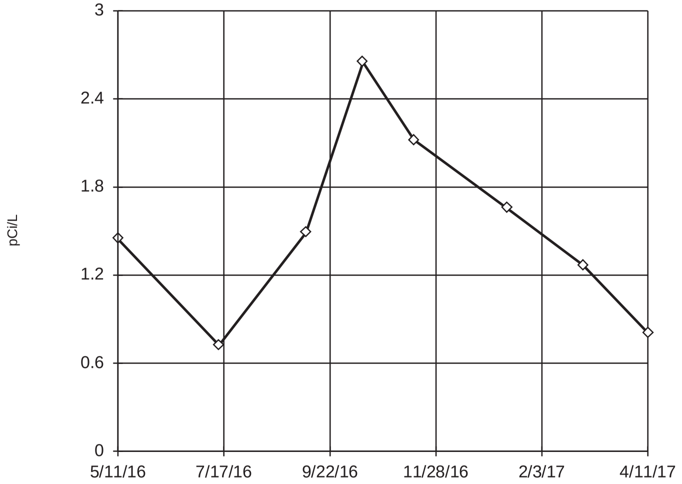
High cutoff = 0.09048, low cutoff = -0.08593, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

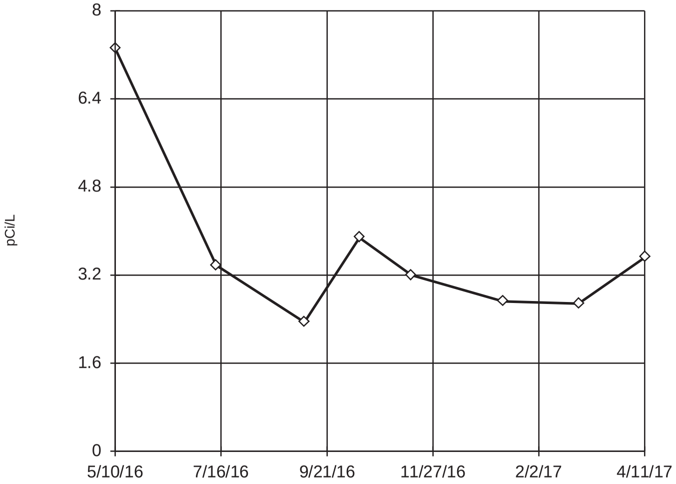
High cutoff = 6.005, low cutoff = -0.004482, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgr
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

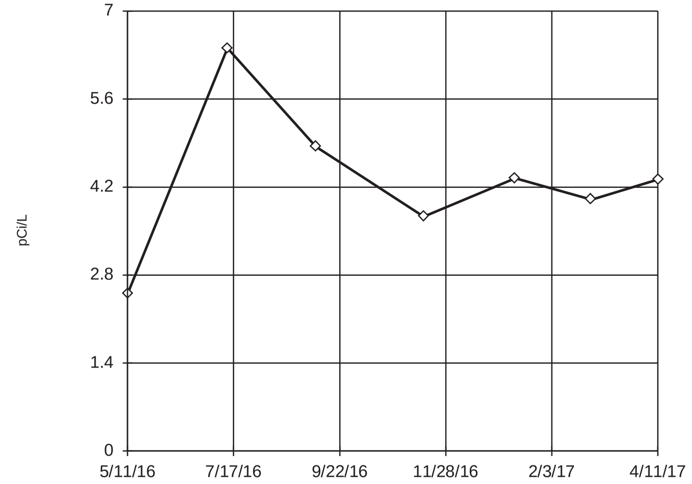
High cutoff = 9.436, low cutoff = 1.059, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgr
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 7

No outliers found.
Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

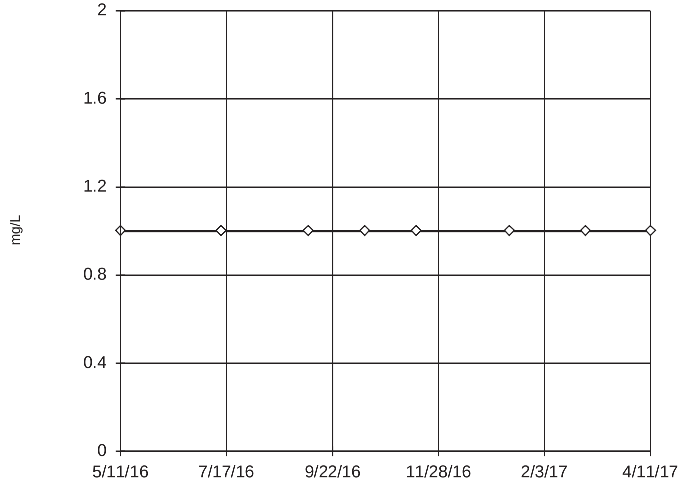
High cutoff = 9.064, low cutoff = 1.259, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 12/14/2017 5:26 PM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

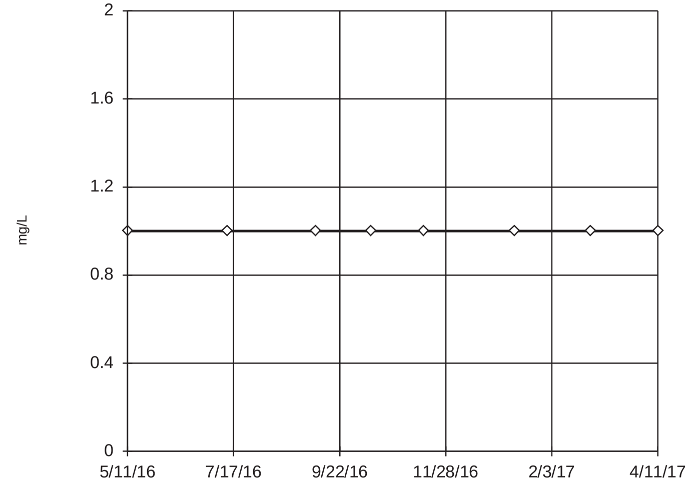
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Fluoride, total Analysis Run 12/14/2017 5:26 PM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

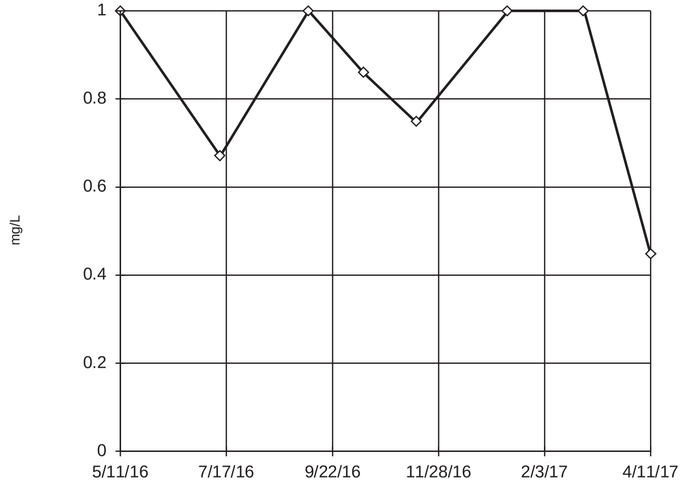
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Fluoride, total Analysis Run 12/14/2017 5:26 PM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

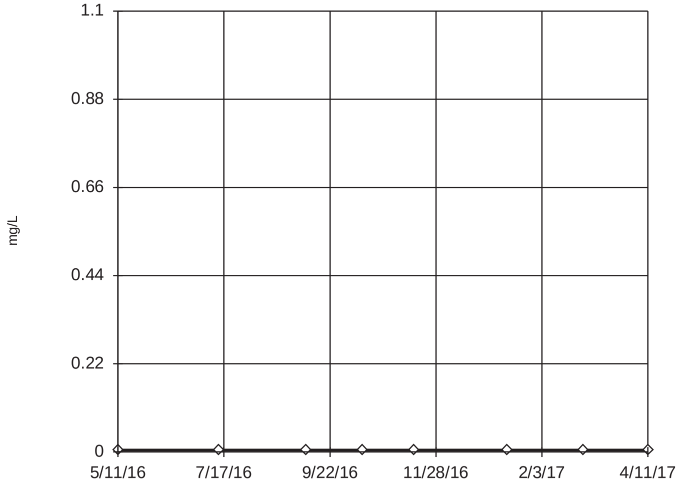
High cutoff = 1.578, low cutoff = -0.9934, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 12/14/2017 5:26 PM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

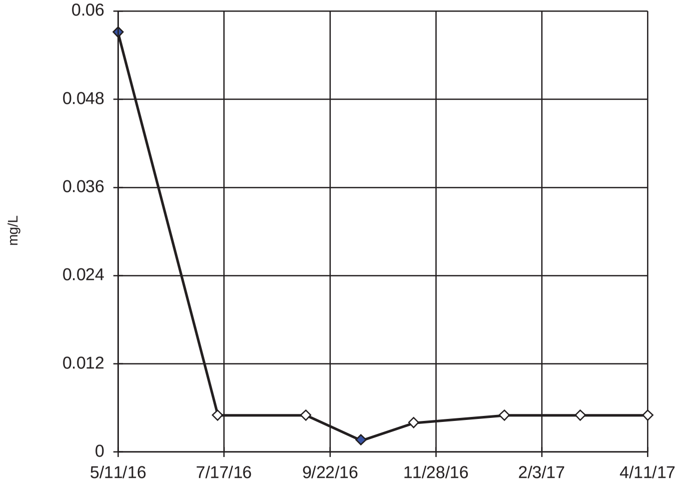
The results were invalid-
ated, because the lower
and upper quartiles are
equal.

Constituent: Lead, total   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

Outliers are drawn as
solid.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

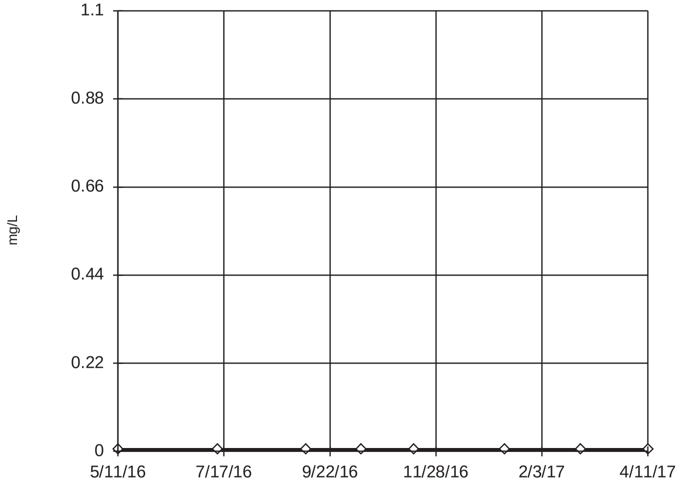
High cutoff = 0.007167,
low cutoff = 0.003094,
based on IQR multiplier
of 3.

Constituent: Lead, total   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

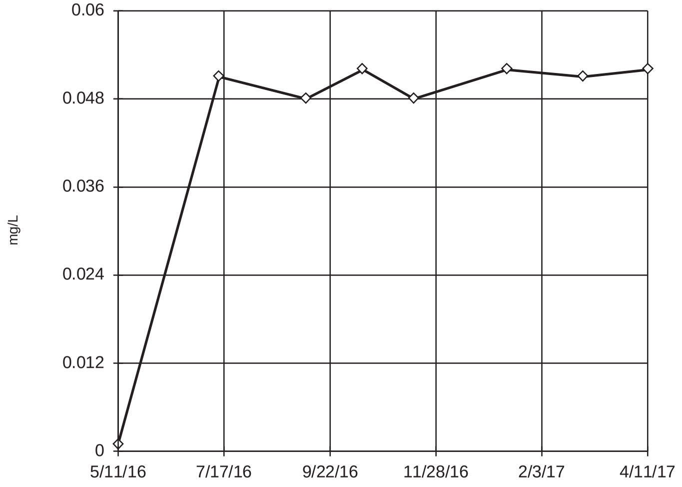
The results were invalid-
ated, because the lower
and upper quartiles are
equal.

Constituent: Lead, total   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were x^6 transform-
ed to achieve best W stat-
istic (graph shown in
original units).

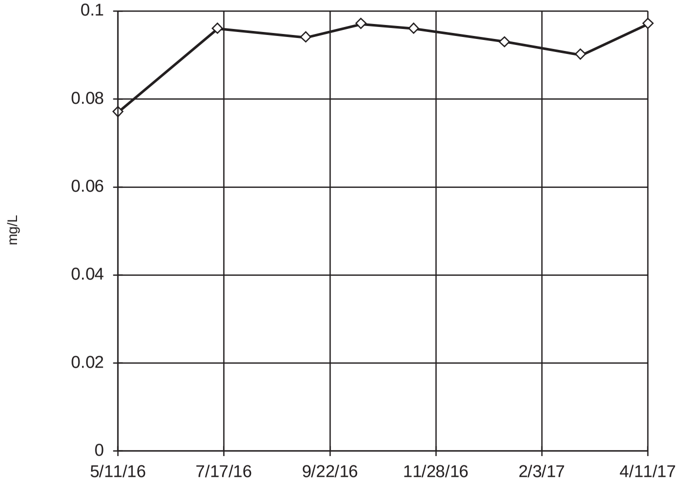
High cutoff = 0.05905,
low cutoff = -0.04671,
based on IQR multiplier
of 3.

Constituent: Lithium, total   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

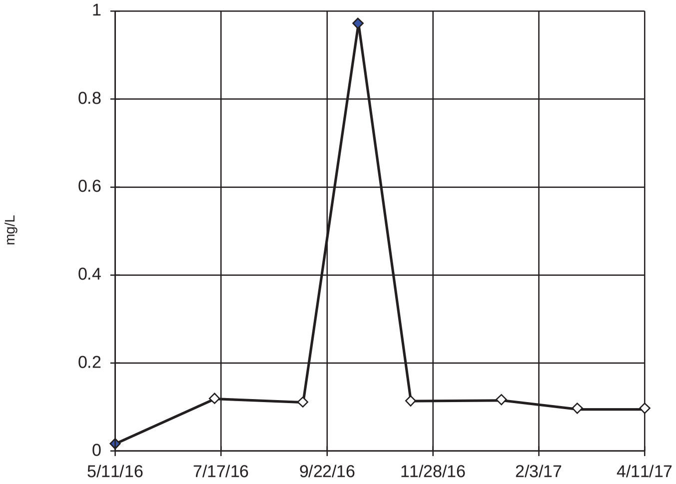
High cutoff = 0.1066,
low cutoff = -0.06369,
based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

Outliers are drawn as solid.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

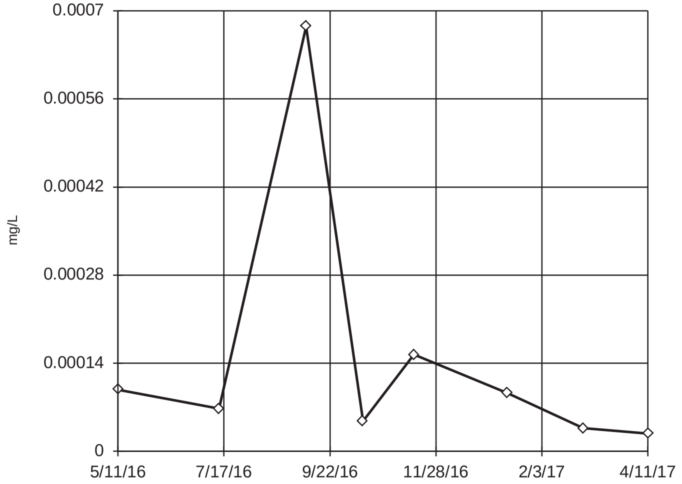
High cutoff = 0.2184,
low cutoff = 0.05088,
based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

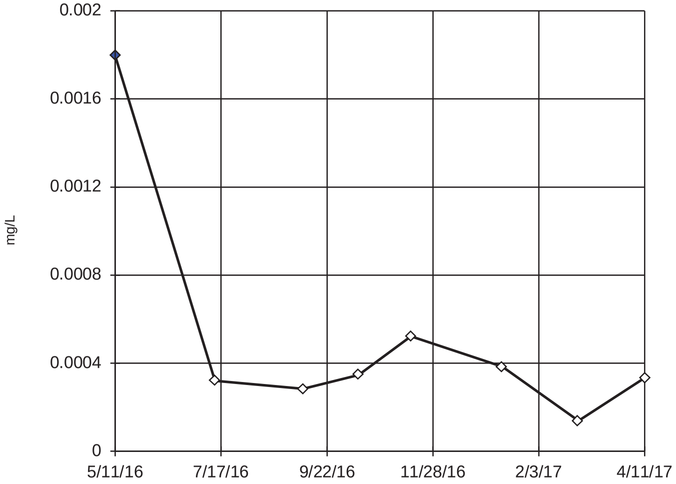
High cutoff = 0.003043,
low cutoff = 0.000001701,
based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

Outlier is drawn as solid.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

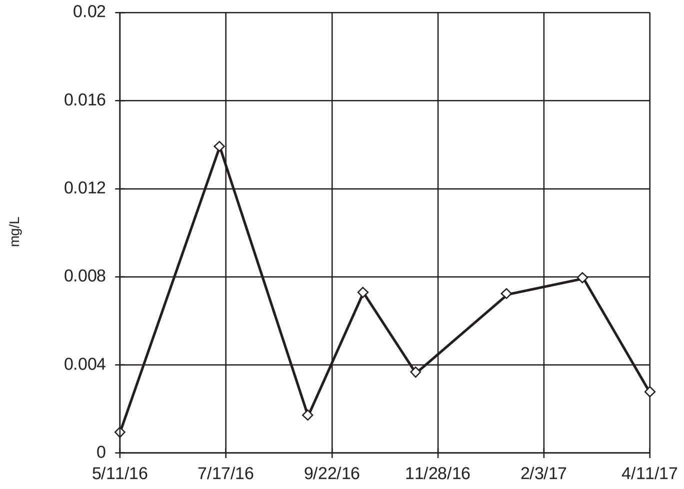
High cutoff = 0.001472,
low cutoff = 0.00009177,
based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

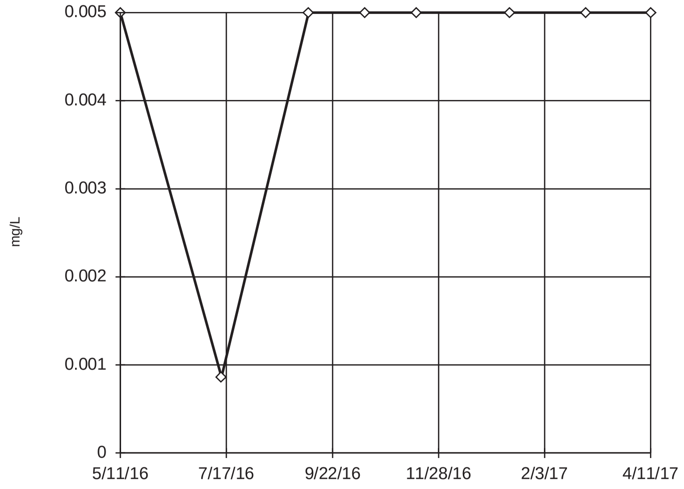
High cutoff = 0.06299, low cutoff = -0.0003692, based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

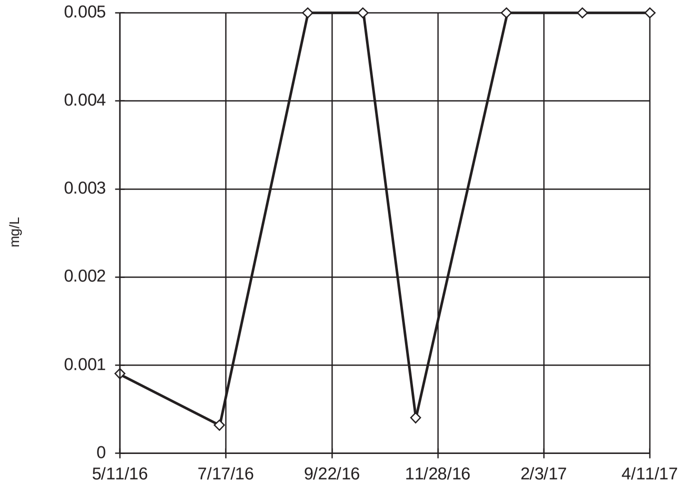
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Molybdenum, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

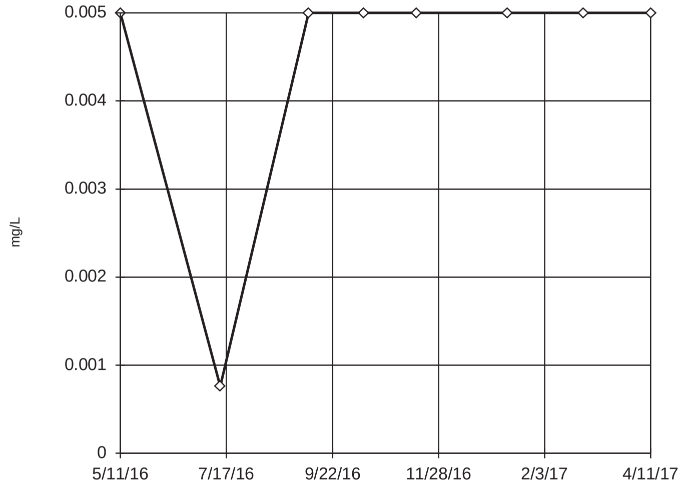
High cutoff = 2.906, low cutoff = 0.000001031, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

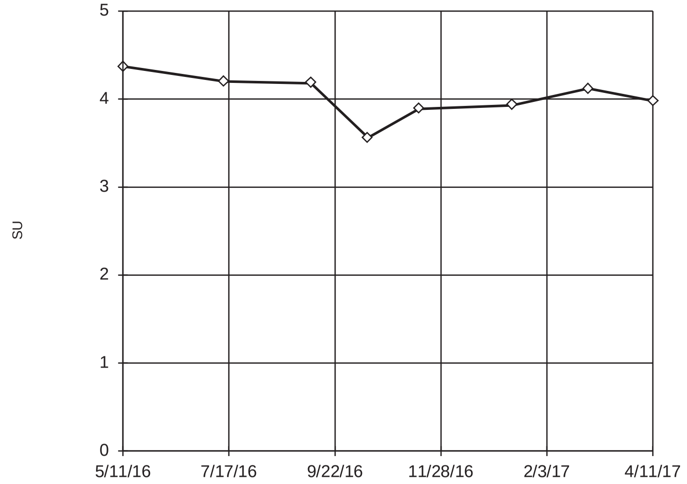
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Molybdenum, total Analysis Run 11/5/2017 8:53 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

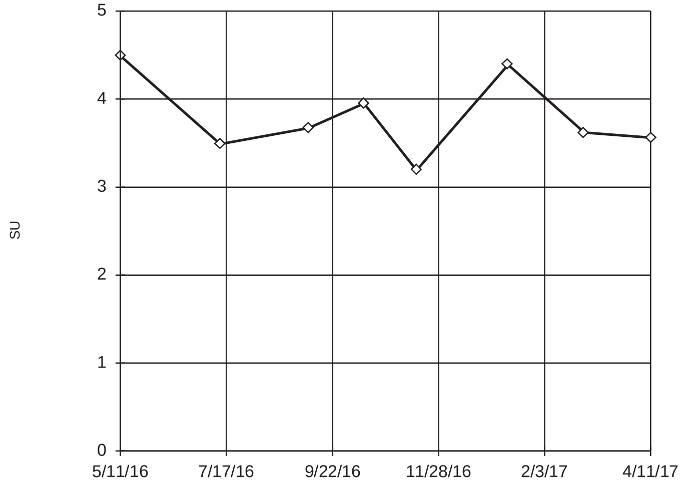
High cutoff = 4.71, low cutoff = -3.53, based on IQR multiplier of 3.

Constituent: pH, field   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

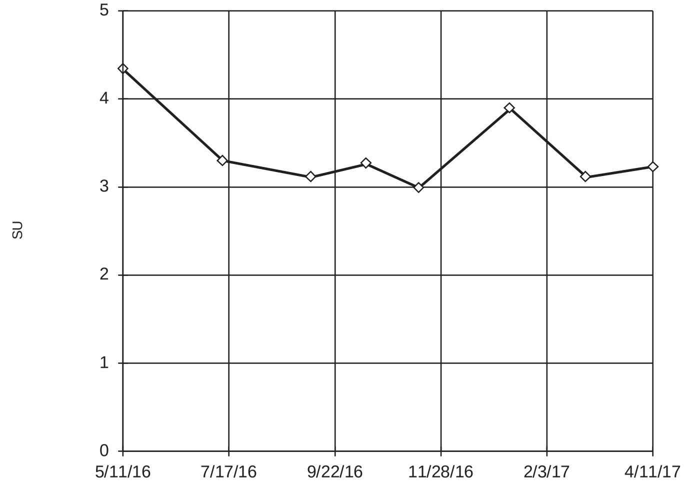
High cutoff = 6.866, low cutoff = 2.138, based on IQR multiplier of 3.

Constituent: pH, field   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

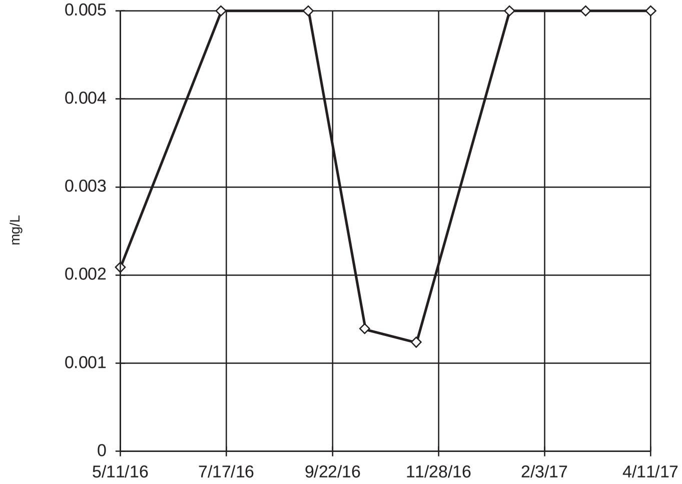
High cutoff = 5.478, low cutoff = 2.034, based on IQR multiplier of 3.

Constituent: pH, field   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

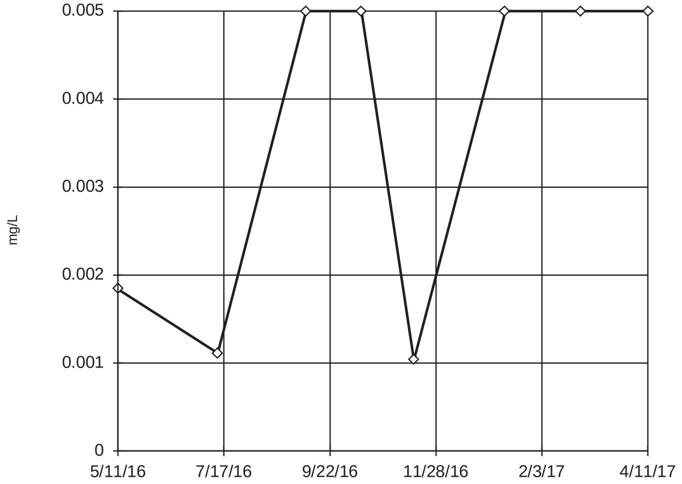
High cutoff = 0.1282, low cutoff = 0.00006614, based on IQR multiplier of 3.

Constituent: Selenium, total   Analysis Run 11/5/2017 8:53 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

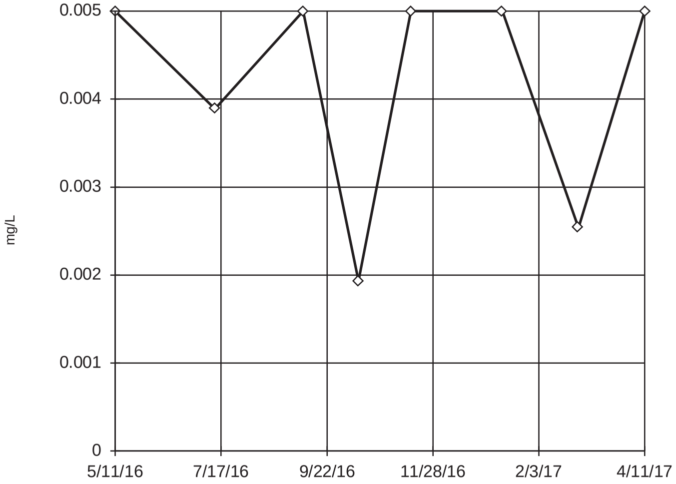
High cutoff = 0.2132, low cutoff = 0.00003357, based on IQR multiplier of 3.

Constituent: Selenium, total   Analysis Run 11/5/2017 8:54 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

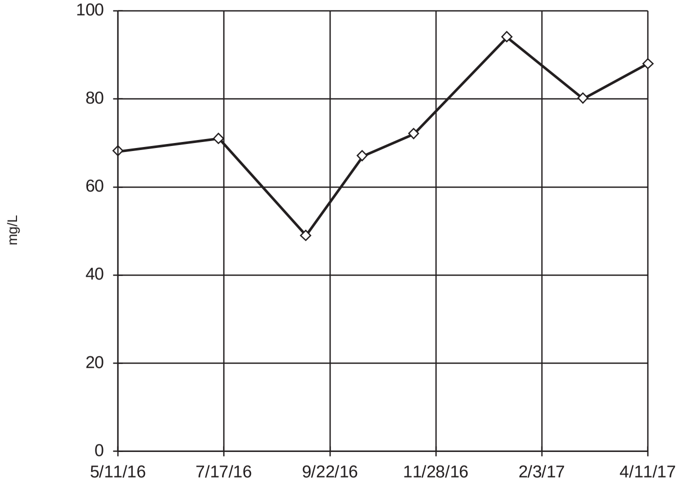
High cutoff = 0.008226, low cutoff = -0.005646, based on IQR multiplier of 3.

Constituent: Selenium, total   Analysis Run 11/5/2017 8:54 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

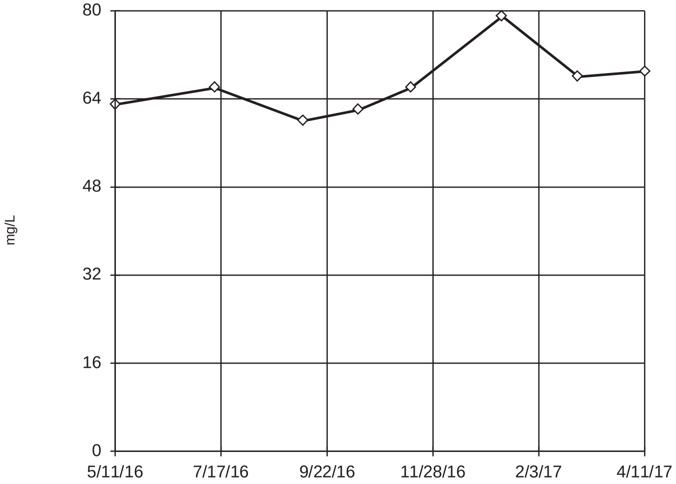
High cutoff = 120.9, low cutoff = -54.68, based on IQR multiplier of 3.

Constituent: Sulfate, total   Analysis Run 11/5/2017 8:54 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

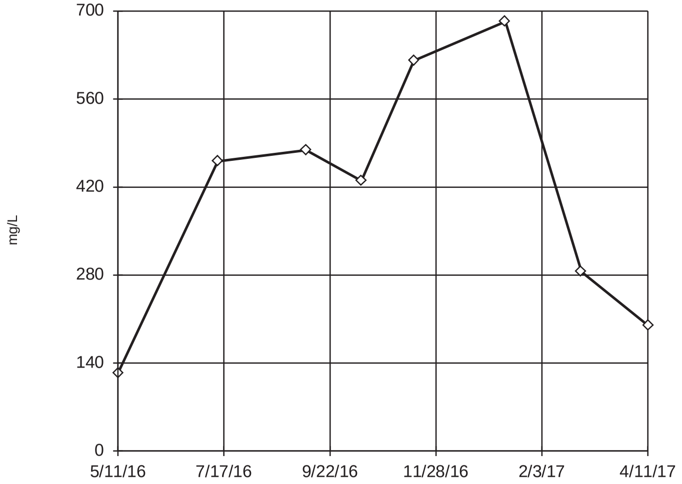
High cutoff = 90.18, low cutoff = 47.47, based on IQR multiplier of 3.

Constituent: Sulfate, total   Analysis Run 11/5/2017 8:54 AM   View: Tukey's Screen Downgradient
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

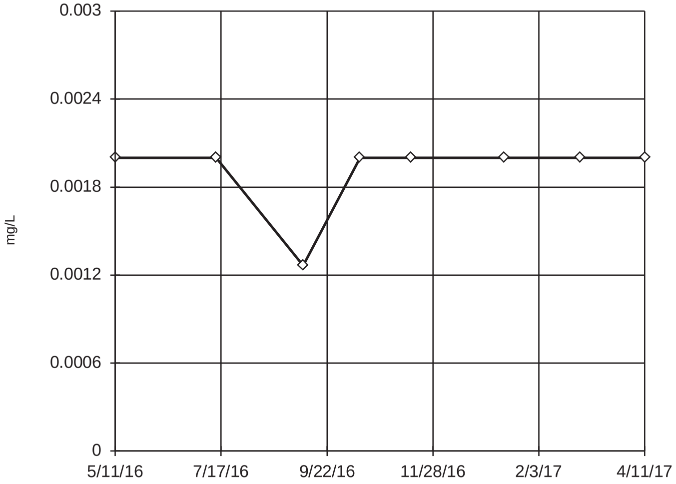
High cutoff = 1473, low cutoff = -680, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/5/2017 8:54 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

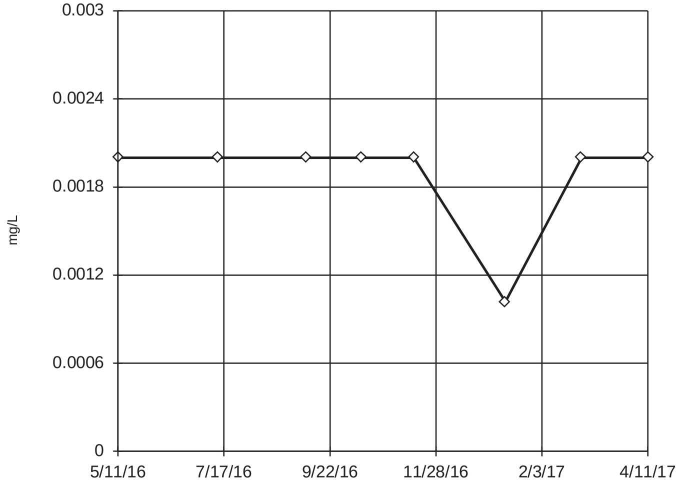
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium, total Analysis Run 11/5/2017 8:54 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

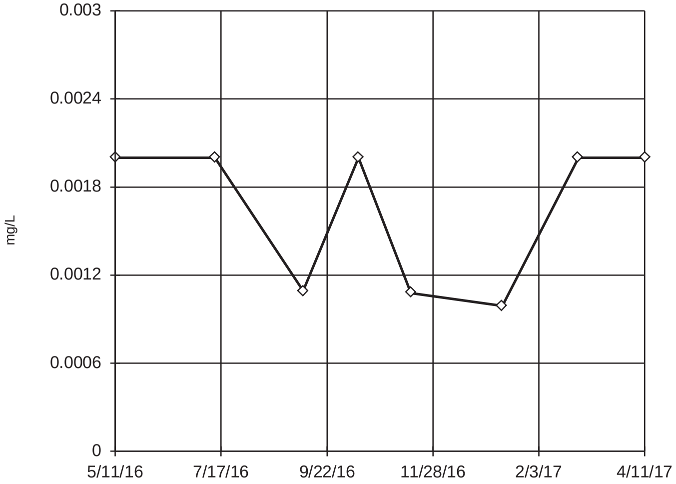
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium, total Analysis Run 11/5/2017 8:54 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

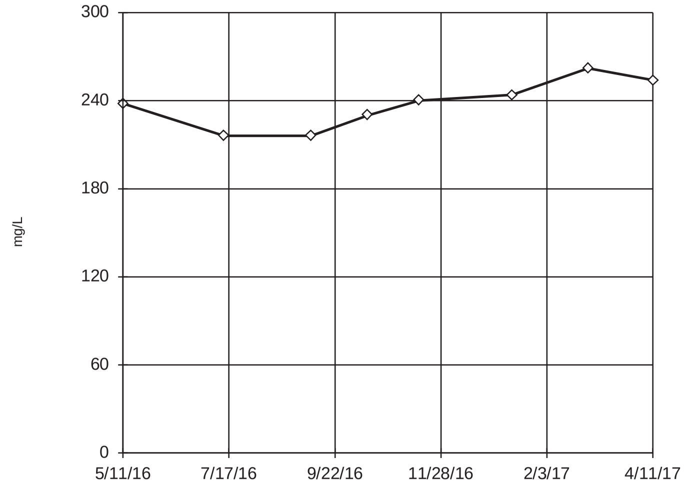
High cutoff = 0.01252, low cutoff = 0.0001734, based on IQR multiplier of 3.

Constituent: Thallium, total Analysis Run 11/5/2017 8:54 AM View: Tukey's Screen Downgradient
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-2



n = 8

No outliers found. Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

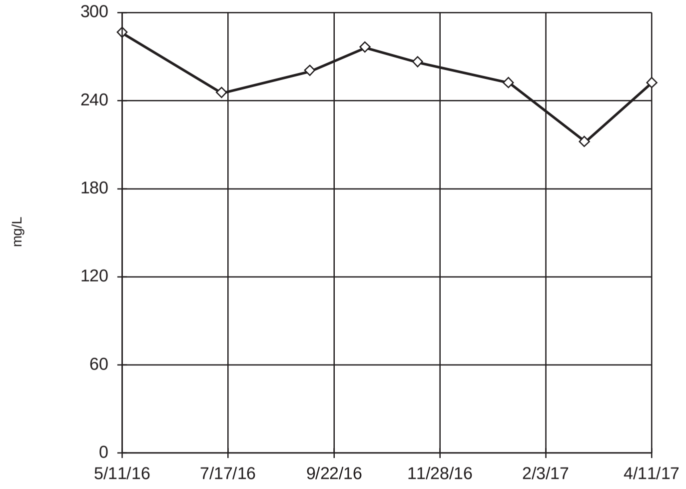
High cutoff = 305.3, low cutoff = -123.5, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/5/2017 8:54 AM   View: Tukey's Screen Downgr
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-31



n = 8

No outliers found. Tukey's method selected by user.

Data were x^5 transformed to achieve best W statistic (graph shown in original units).

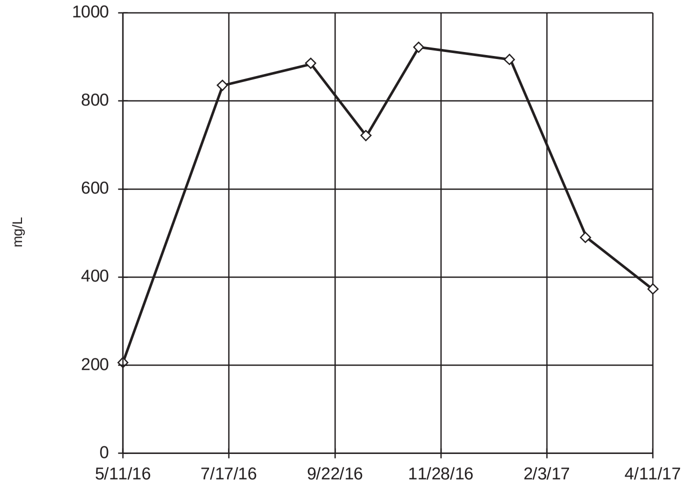
High cutoff = 313.3, low cutoff = -226.9, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/5/2017 8:54 AM   View: Tukey's Screen Downgr
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-32



n = 8

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1610, low cutoff = -1270, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/5/2017 8:54 AM   View: Tukey's Screen Downgr
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Trend Tests Summary Table - Significant Results

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP   Printed 10/26/2017, 5:42 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Beryllium, total (mg/L)	**AD-18 (bg)**	**-0.0001625**	**-22**	**-21**	**Yes**	**8**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Boron, total (mg/L)	**AD-2**	**0.4158**	**23**	**21**	**Yes**	**8**	**0**	**n/a**	**n/a**	**0.01**	**NP**

Trend Tests Summary Table - All Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 10/26/2017, 5:42 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Antimony, total (mg/L)	AD-4 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-2	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-31	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-32	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-18 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-4 (bg)	0	0	21	No	8	50	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-2	0	0	21	No	8	100	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-31	-0.0001317	-1	-18	No	7	14.29	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-32	-0.002017	-3	-21	No	8	12.5	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-18 (bg)	0	5	21	No	8	87.5	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-4 (bg)	0.01156	2	21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-2	-0.001294	-9	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-31	-0.01622	-3	-18	No	7	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-32	-0.02562	-12	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-18 (bg)	-0.0544	-17	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-12 (bg)	-0.002403	-4	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-4 (bg)	-0.0007338	-17	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-2	-0.0001138	-12	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-31	0	-6	-18	No	7	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-32	-0.003454	-6	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	**AD-18 (bg)**	**-0.0001625**	**-22**	**-21**	**Yes**	**8**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Beryllium, total (mg/L)	AD-12 (bg)	-0.00008978	-12	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-4 (bg)	0.02068	17	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	**AD-2**	**0.4158**	**23**	**21**	**Yes**	**8**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Boron, total (mg/L)	AD-31	0	1	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-32	-2.536	-6	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-18 (bg)	0	0	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0.01638	13	21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-4 (bg)	0	0	21	No	8	62.5	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-2	0	0	21	No	8	100	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-31	0	-4	-21	No	8	62.5	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-32	-0.0001931	-2	-21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-18 (bg)	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-4 (bg)	0.9424	10	21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-2	0.09878	2	21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-31	-1.626	-8	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-32	-2.07	0	21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-18 (bg)	-0.2577	-8	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-12 (bg)	-0.007078	0	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-4 (bg)	0	5	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-2	0	3	18	No	7	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-31	0	-6	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-32	-2.684	-1	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-18 (bg)	-1.818	-17	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.5448	5	21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-4 (bg)	-0.0008849	-9	-18	No	7	14.29	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-2	0	2	21	No	8	50	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-31	-0.005069	-4	-18	No	7	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-32	-0.01118	-9	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-18 (bg)	-0.0005302	-12	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-12 (bg)	-0.0002747	-14	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-4 (bg)	-0.005249	-15	-21	No	8	0	n/a	n/a	0.01	NP

Trend Tests Summary Table - All Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 10/26/2017, 5:42 AM

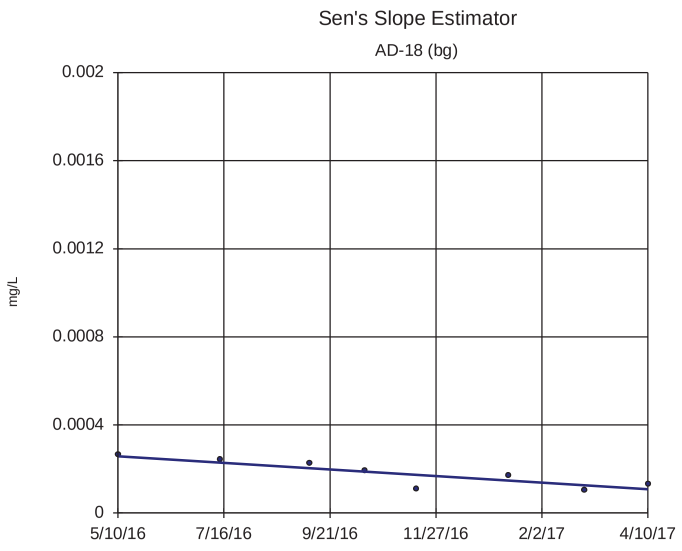
Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Cobalt, total (mg/L)	AD-2	0	1	21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-31	0	-5	-18	No	7	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-32	-0.03109	-6	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-18 (bg)	-0.00106	-14	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-12 (bg)	-0.0003758	-10	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-4 (bg)	-0.5096	-2	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-2	-0.3426	-2	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-31	-0.3118	-1	-18	No	7	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-32	-0.08922	-1	-18	No	7	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-18 (bg)	-0.9109	-10	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-12 (bg)	-0.4211	-2	-21	No	8	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-4 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-2	0	0	21	No	8	100	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-31	0	0	21	No	8	100	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-32	0	-4	-21	No	8	50	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-18 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-12 (bg)	0	-6	-18	No	7	85.71	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-4 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-2	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-31	0	3	18	No	7	71.43	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-32	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-18 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-4 (bg)	0.009586	2	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-2	0.006508	13	21	No	8	12.5	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-31	0.001904	4	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-32	-0.008022	-2	-18	No	7	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-18 (bg)	0.0025	3	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-12 (bg)	0.002799	4	21	No	8	12.5	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-4 (bg)	-0.000002599	-4	-21	No	8	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-2	-0.0000782	-14	-21	No	8	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-31	-0.0002617	-6	-21	No	8	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-32	0.001905	4	21	No	8	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-18 (bg)	-0.00003352	-16	-21	No	8	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-12 (bg)	0	-7	-21	No	8	87.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-4 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-2	0	5	21	No	8	87.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-31	0.0001258	10	21	No	8	62.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-32	0	5	21	No	8	87.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-18 (bg)	0	5	21	No	8	87.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
pH, field (SU)	AD-4 (bg)	-0.7775	-14	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-2	-0.3242	-10	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-31	-0.3537	-6	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-32	-0.3477	-9	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-18 (bg)	-0.525	-9	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-12 (bg)	0.5797	4	21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-4 (bg)	0.001753	10	21	No	8	62.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-2	0	4	21	No	8	62.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-31	0	8	21	No	8	62.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-32	0	0	21	No	8	62.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-18 (bg)	0	13	21	No	8	75	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-12 (bg)	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-4 (bg)	-3.727	-13	-21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-2	30.71	16	21	No	8	0	n/a	n/a	0.01	NP

Trend Tests Summary Table - All Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 10/26/2017, 5:42 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Sulfate, total (mg/L)	AD-31	8.045	15	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-32	100.1	2	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-18 (bg)	0	6	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	1.233	5	21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-4 (bg)	0	5	21	No	8	75	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-2	0	3	21	No	8	87.5	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-31	0	-3	-21	No	8	87.5	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-32	0	-4	-21	No	8	62.5	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-18 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-12 (bg)	0	-5	-21	No	8	87.5	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-4 (bg)	-14.03	-7	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-2	53.67	19	21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-31	-38.04	-11	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-32	-73.62	0	21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-18 (bg)	-2.098	-1	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-25.99	-12	-21	No	8	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



n = 8

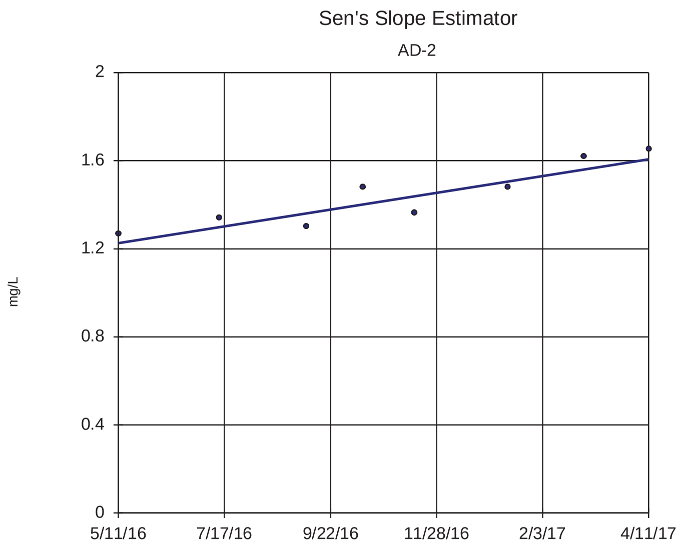
Slope = -0.0001625
units per year.

Mann-Kendall
statistic = -22
critical = -21

Decreasing trend
significant at 99%
confidence level
(= 0.005 per
tail).

Constituent: Beryllium, total Analysis Run 10/26/2017 5:37 AM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



n = 8

Slope = 0.4158
units per year.

Mann-Kendall
statistic = 23
critical = 21

Increasing trend
significant at 99%
confidence level
(= 0.005 per
tail).

Constituent: Boron, total Analysis Run 10/26/2017 5:37 AM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tolerance Limits - Appendix III

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/5/2017, 9:29 AM

Constituent	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	0.05813	n/a	24	0.02583	0.01213	0	None	No	0.01	Inter
Calcium, total (mg/L)	2.94	n/a	24	n/a	n/a	0	n/a	n/a	0.292	NP Inter(normality)
Chloride, total (mg/L)	9.588	n/a	24	6.083	1.316	0	None	No	0.01	Inter
Fluoride, total (mg/L)	1	n/a	23	n/a	n/a	95.65	n/a	n/a	0.3074	NP Inter(NDs)
pH, field (SU)	6.21	2.393	24	4.301	0.6353	0	None	No	0.01	Inter
Sulfate, total (mg/L)	23	n/a	24	n/a	n/a	0	n/a	n/a	0.292	NP Inter(normality)
Total Dissolved Solids [TDS] (mg/L)	201	n/a	24	113.5	32.85	0	None	No	0.01	Inter

Analysis of Variance

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP   Printed 1/15/2018, 6:41 PM

Constituent	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Calc.	Alpha	Method
Boron, total (mg/L)	n/a	n/a	n/a	No	Yes	24.16	0.05	Param.
Calcium, total (mg/L)	n/a	n/a	n/a	x^(1/3)	Yes	188.1	0.05	Param.
Chloride, total (mg/L)	n/a	n/a	n/a	No	Yes	18.34	0.05	Param.
Fluoride, total (mg/L)	n/a	n/a	n/a	No	No	2	0.05	NP (NDs)
pH, field (SU)	n/a	n/a	n/a	x^3	Yes	5.009	0.05	Param.
Sulfate, total (mg/L)	n/a	n/a	n/a	No	Yes	193.8	0.05	Param.
Total Dissolved Solids [TDS] (mg/L)	n/a	n/a	n/a	No	Yes	79.47	0.05	Param.

Parametric ANOVA

Constituent: Boron, total   Analysis Run 1/15/2018 5:57 PM   View: ANOVA
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 24.16

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.002358	2	0.001179	24.16
Error Within Groups	0.001025	21	0.00004881	
Total	0.003383	23		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9277, critical = 0.916. Levene's Equality of Variance test passed. Calculated = 1.563, tabulated = 3.47.

Parametric ANOVA

Constituent: Calcium, total   Analysis Run 1/15/2018 6:39 PM   View: ANOVA
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test (after cube root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 188.1

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	2.112	2	1.056	188.1
Error Within Groups	0.1179	21	0.005615	
Total	2.23	23		

The Shapiro Wilk normality test on the residuals passed after cube root transformation. Alpha = 0.05, calculated = 0.9364, critical = 0.916. Levene's Equality of Variance test passed. Calculated = 2.682, tabulated = 3.47.

Parametric ANOVA

Constituent: Chloride, total Analysis Run 1/15/2018 6:40 PM View: ANOVA
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 18.34

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	25.33	2	12.67	18.34
Error Within Groups	14.5	21	0.6905	
Total	39.83	23		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9484, critical = 0.916. Levene's Equality of Variance test passed. Calculated = 0.8421, tabulated = 3.47.

Non-Parametric ANOVA

Constituent: Fluoride, total Analysis Run 1/15/2018 6:40 PM View: ANOVA
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

For observations made between 5/10/2016 and 4/11/2017, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 2

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.24
Adjusted Kruskal-Wallis statistic (H') = 2

Parametric ANOVA

Constituent: pH, field   Analysis Run 1/15/2018 6:40 PM   View: ANOVA
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test (after cube transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 5.009

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	7477	2	3738	5.009
Error Within Groups	15674	21	746.4	
Total	23151	23		

The Shapiro Wilk normality test on the residuals passed after cube transformation. Alpha = 0.05, calculated = 0.9613, critical = 0.916. Levene's Equality of Variance test passed. Calculated = 2.791, tabulated = 3.47.

Parametric ANOVA

Constituent: Sulfate, total   Analysis Run 1/15/2018 6:40 PM   View: ANOVA
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 193.8

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	904.3	2	452.2	193.8
Error Within Groups	49	21	2.333	
Total	953.3	23		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9206, critical = 0.916. Levene's Equality of Variance test passed. Calculated = 0.3121, tabulated = 3.47.

Parametric ANOVA

Constituent: Total Dissolved Solids [TDS]   Analysis Run 1/15/2018 6:40 PM   View: ANOVA
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 79.47

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	21918	2	10959	79.47
Error Within Groups	2896	21	137.9	
Total	24814	23		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9713, critical = 0.916. Levene's Equality of Variance test passed. Calculated = 0.6531, tabulated = 3.47.

Confidence Interval Summary Table - Significant Results Appendix III

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/10/2017, 7:19 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-2**	**1.59**	**1.285**	**0.058**	**Yes**	**8**	**1.438**	**0.1437**	**0**	**None**	**No**	**0.01**	**Param.**
Boron, total (mg/L)	**AD-32**	**5.919**	**1.766**	**0.058**	**Yes**	**8**	**3.842**	**1.959**	**0**	**None**	**No**	**0.01**	**Param.**
Calcium, total (mg/L)	**AD-31**	**4.657**	**3.575**	**2.94**	**Yes**	**7**	**4.116**	**0.4555**	**0**	**None**	**No**	**0.01**	**Param.**
Calcium, total (mg/L)	**AD-32**	**39.76**	**13.01**	**2.94**	**Yes**	**8**	**26.39**	**12.62**	**0**	**None**	**No**	**0.01**	**Param.**
Chloride, total (mg/L)	**AD-2**	**30.84**	**24.13**	**9.59**	**Yes**	**7**	**27.57**	**3.552**	**0**	**None**	**x^4**	**0.01**	**Param.**
Chloride, total (mg/L)	**AD-31**	**19**	**14**	**9.59**	**Yes**	**8**	**17.38**	**1.598**	**0**	**None**	**No**	**0.004**	**NP (normality)**
Chloride, total (mg/L)	**AD-32**	**35**	**12**	**9.59**	**Yes**	**8**	**26.38**	**9.531**	**0**	**None**	**No**	**0.004**	**NP (normality)**
Sulfate, total (mg/L)	**AD-2**	**88.37**	**58.88**	**23**	**Yes**	**8**	**73.63**	**13.91**	**0**	**None**	**No**	**0.01**	**Param.**
Sulfate, total (mg/L)	**AD-31**	**72.83**	**60.42**	**23**	**Yes**	**8**	**66.63**	**5.854**	**0**	**None**	**No**	**0.01**	**Param.**
Sulfate, total (mg/L)	**AD-32**	**617.9**	**202.9**	**23**	**Yes**	**8**	**410.4**	**195.8**	**0**	**None**	**No**	**0.01**	**Param.**
Total Dissolved Solids [TDS] (mg/L)	**AD-2**	**255**	**220**	**201**	**Yes**	**8**	**237.5**	**16.48**	**0**	**None**	**No**	**0.01**	**Param.**
Total Dissolved Solids [TDS] (mg/L)	**AD-31**	**279.8**	**232.4**	**201**	**Yes**	**8**	**256.1**	**22.38**	**0**	**None**	**No**	**0.01**	**Param.**
Total Dissolved Solids [TDS] (mg/L)	**AD-32**	**955.8**	**375**	**201**	**Yes**	**8**	**665.4**	**274**	**0**	**None**	**No**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results Appendix III

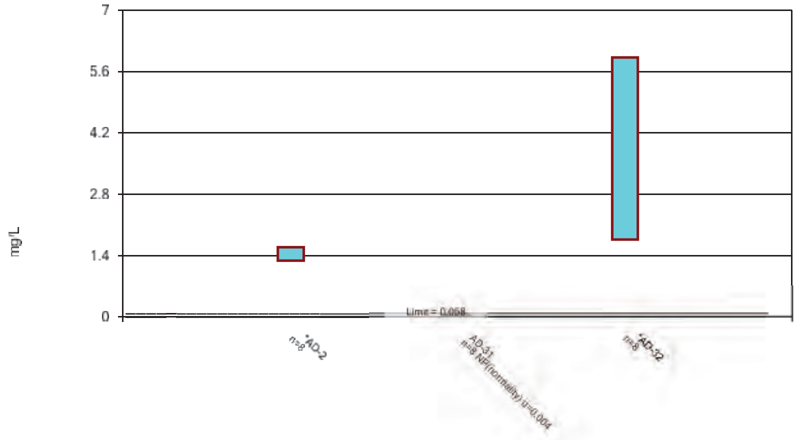
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/10/2017, 7:19 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-2**	**1.59**	**1.285**	**0.058**	**Yes**	**8**	**1.438**	**0.1437**	**0**	**None**	**No**	**0.01**	**Param.**
Boron, total (mg/L)	AD-31	0.08	0.03	0.058	No	8	0.04125	0.01642	0	None	No	0.004	NP (normality)
Boron, total (mg/L)	**AD-32**	**5.919**	**1.766**	**0.058**	**Yes**	**8**	**3.842**	**1.959**	**0**	**None**	**No**	**0.01**	**Param.**
Calcium, total (mg/L)	AD-2	2.65	1.28	2.94	No	8	1.598	0.4498	0	None	No	0.004	NP (normality)
Calcium, total (mg/L)	**AD-31**	**4.657**	**3.575**	**2.94**	**Yes**	**7**	**4.116**	**0.4555**	**0**	**None**	**No**	**0.01**	**Param.**
Calcium, total (mg/L)	**AD-32**	**39.76**	**13.01**	**2.94**	**Yes**	**8**	**26.39**	**12.62**	**0**	**None**	**No**	**0.01**	**Param.**
Chloride, total (mg/L)	**AD-2**	**30.84**	**24.13**	**9.59**	**Yes**	**7**	**27.57**	**3.552**	**0**	**None**	**x^4**	**0.01**	**Param.**
Chloride, total (mg/L)	**AD-31**	**19**	**14**	**9.59**	**Yes**	**8**	**17.38**	**1.598**	**0**	**None**	**No**	**0.004**	**NP (normality)**
Chloride, total (mg/L)	**AD-32**	**35**	**12**	**9.59**	**Yes**	**8**	**26.38**	**9.531**	**0**	**None**	**No**	**0.004**	**NP (normality)**
Fluoride, total (mg/L)	AD-2	1	1	4	No	8	1	0	100	None	No	0.004	NP (NDs)
Fluoride, total (mg/L)	AD-31	1	1	4	No	8	1	0	100	None	No	0.004	NP (NDs)
Fluoride, total (mg/L)	AD-32	1	0.4468	4	No	8	0.8403	0.2053	50	None	No	0.004	NP (normality)
pH, field (SU)	AD-2	4.335	3.723	6.21	No	8	4.029	0.2473	0	None	No	0.005	Param.
pH, field (SU)	AD-31	4.353	3.237	6.21	No	8	3.795	0.4507	0	None	No	0.005	Param.
pH, field (SU)	AD-32	4.34	2.99	6.21	No	8	3.404	0.4657	0	None	No	0.004	NP (normality)
Sulfate, total (mg/L)	**AD-2**	**88.37**	**58.88**	**23**	**Yes**	**8**	**73.63**	**13.91**	**0**	**None**	**No**	**0.01**	**Param.**
Sulfate, total (mg/L)	**AD-31**	**72.83**	**60.42**	**23**	**Yes**	**8**	**66.63**	**5.854**	**0**	**None**	**No**	**0.01**	**Param.**
Sulfate, total (mg/L)	**AD-32**	**617.9**	**202.9**	**23**	**Yes**	**8**	**410.4**	**195.8**	**0**	**None**	**No**	**0.01**	**Param.**
Total Dissolved Solids [TDS] (mg/L)	**AD-2**	**255**	**220**	**201**	**Yes**	**8**	**237.5**	**16.48**	**0**	**None**	**No**	**0.01**	**Param.**
Total Dissolved Solids [TDS] (mg/L)	**AD-31**	**279.8**	**232.4**	**201**	**Yes**	**8**	**256.1**	**22.38**	**0**	**None**	**No**	**0.01**	**Param.**
Total Dissolved Solids [TDS] (mg/L)	**AD-32**	**955.8**	**375**	**201**	**Yes**	**8**	**665.4**	**274**	**0**	**None**	**No**	**0.01**	**Param.**

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

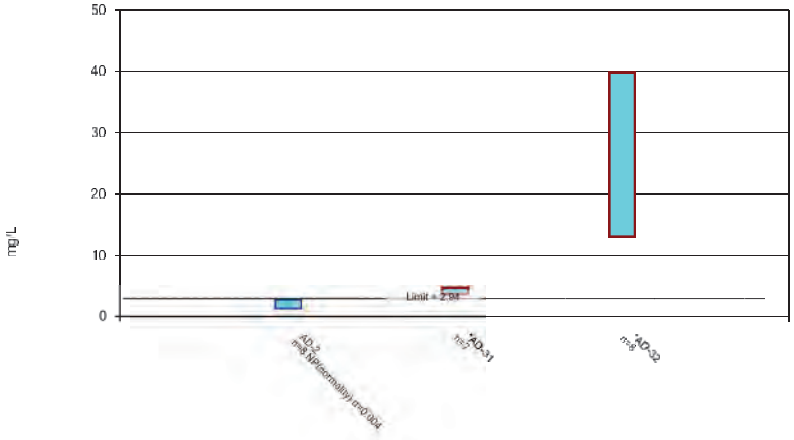


Constituent: Boron, total Analysis Run 12/10/2017 7:17 PM View: Confidence Intervals
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

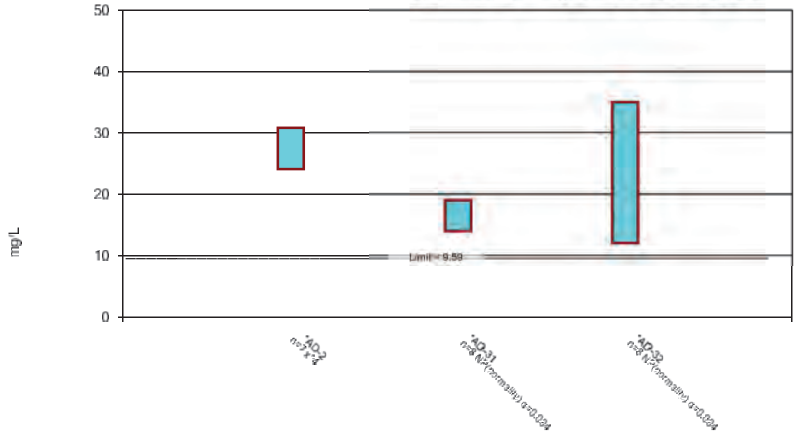


Constituent: Calcium, total Analysis Run 12/10/2017 7:17 PM View: Confidence Intervals
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

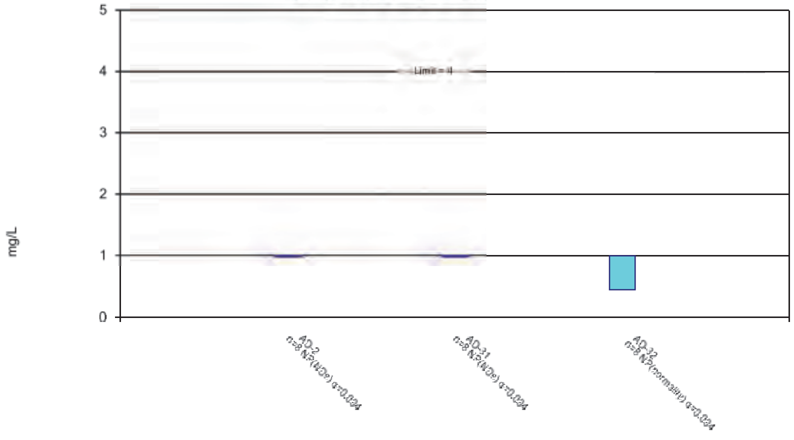


Constituent: Chloride, total Analysis Run 12/10/2017 7:17 PM View: Confidence Intervals
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG

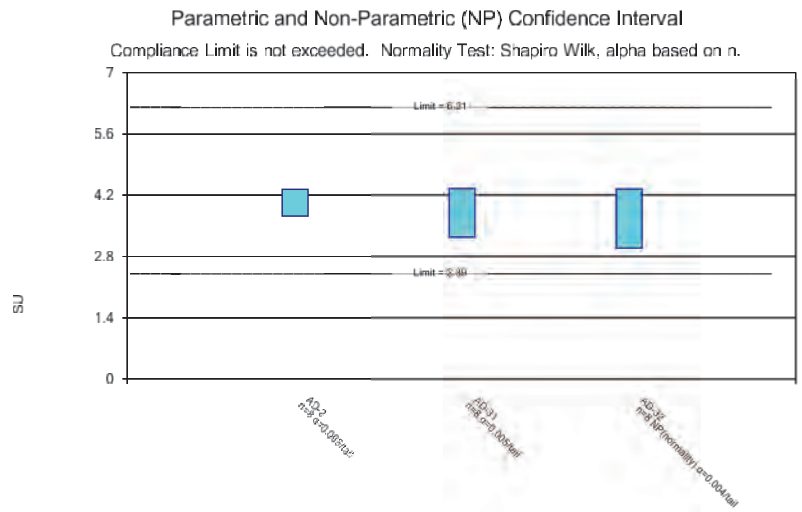
Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



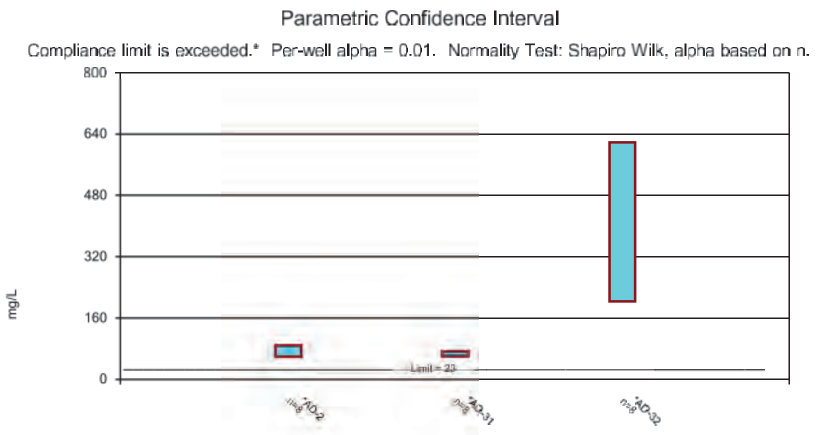
Constituent: Fluoride, total Analysis Run 12/10/2017 7:18 PM View: Confidence Intervals
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG



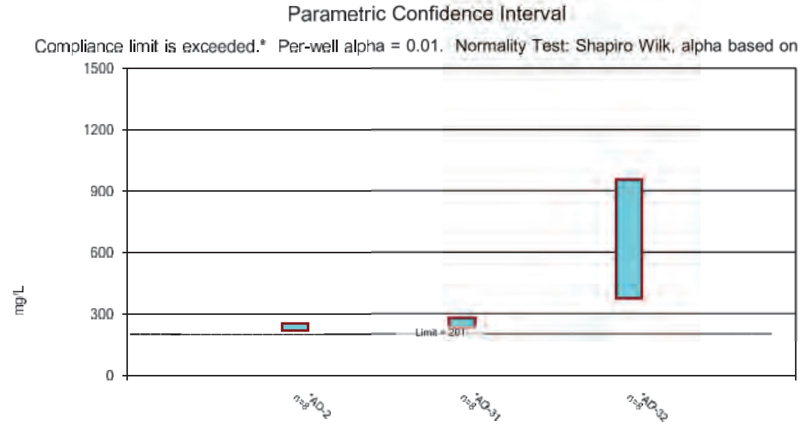
Constituent: pH, field   Analysis Run 12/10/2017 7:18 PM   View: Confidence Intervals
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG



Constituent: Sulfate, total   Analysis Run 12/10/2017 7:18 PM   View: Confidence Intervals
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG



Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/10/2017 7:18 PM   View: Confidence Intervals
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

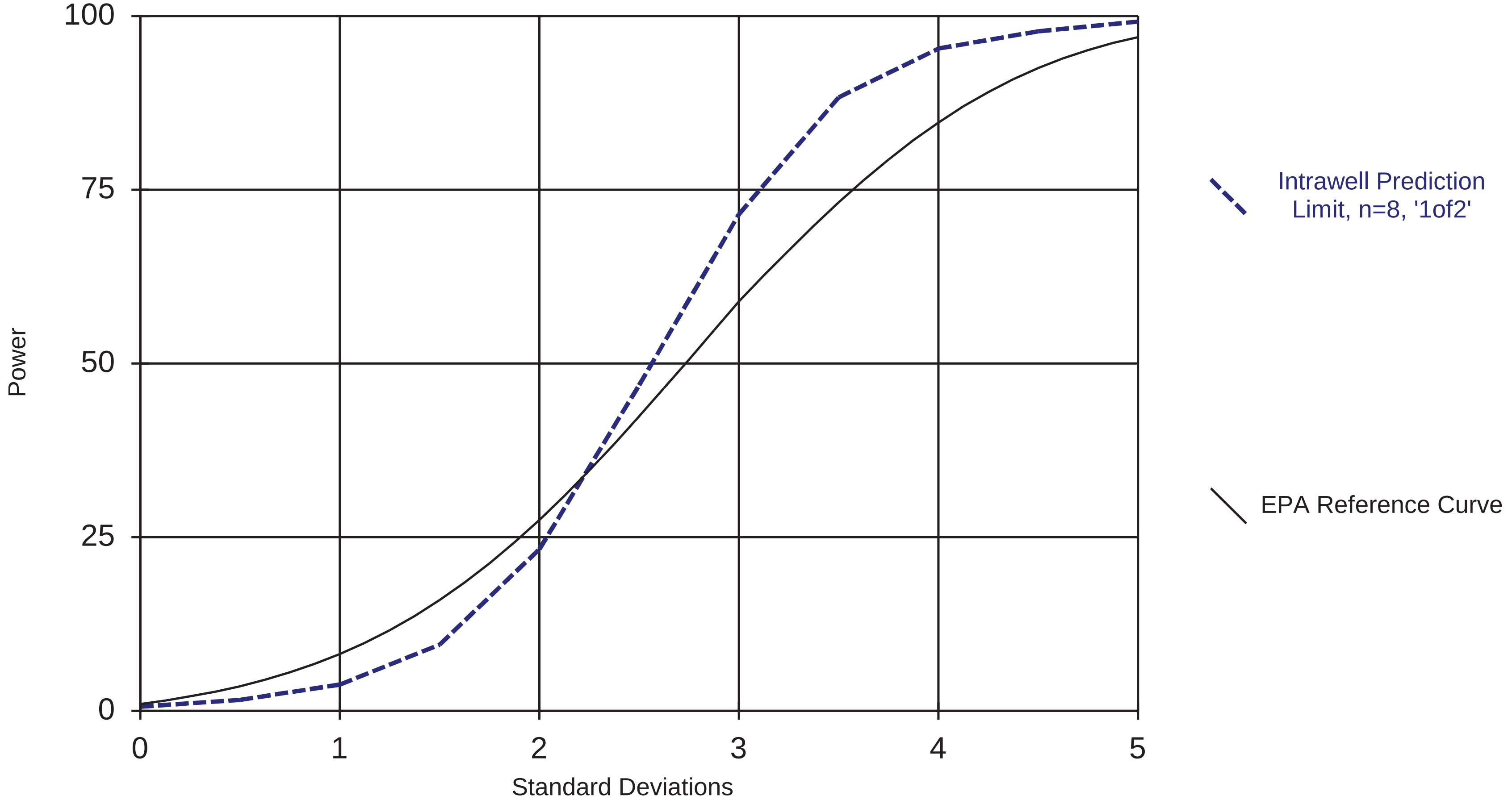
Intrawell Prediction Limit Summary Table

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 10/26/2017, 6:00 AM

Constituent	Well	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH, field (SU)	AD-4	5.718	3.647	8	4.683	0.4215	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-2	4.637	3.421	8	4.029	0.2473	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-31	4.903	2.687	8	3.795	0.4507	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-32	4.549	2.259	8	3.404	0.4657	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-18	5.063	3.75	8	4.406	0.267	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-12	5.764	1.866	8	3.815	0.7928	0	None	No	0.001253	Param Intra 1 of 2

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Power Curve



Kappa = 2.458, based on 3 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

Analysis Run 10/26/2017 5:58 AM   View: PL's Intrawell

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

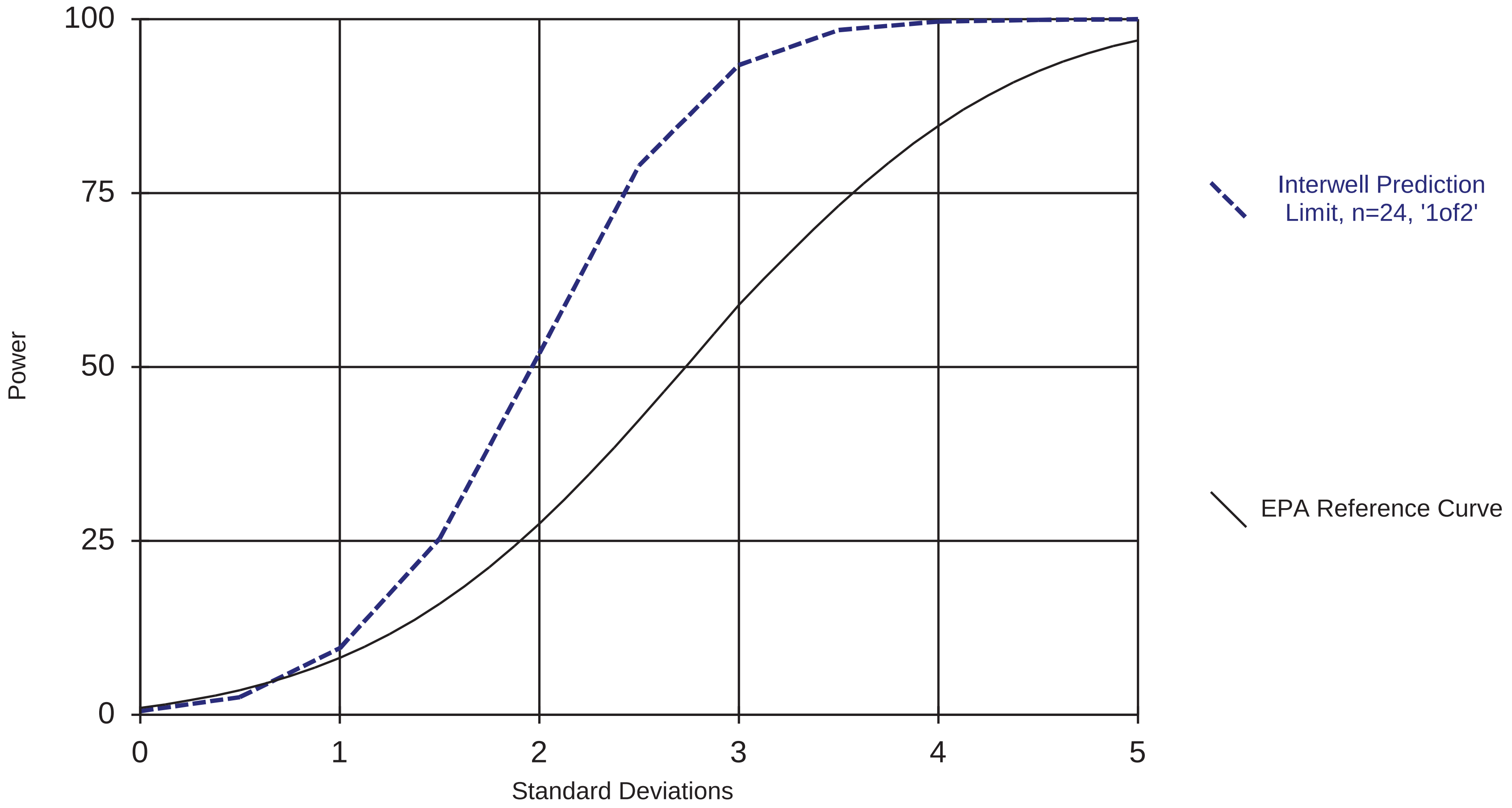
Interwell Prediction Limit Summary Table

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 10/26/2017, 6:01 AM

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	0.04821	24	0.02583	0.01213	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	2.94	24	n/a	n/a	0	n/a	n/a	0.003036	NP (normality) 1 of 2
Chloride, total (mg/L)	8.511	24	6.083	1.316	0	None	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	1	23	n/a	n/a	95.65	n/a	n/a	0.003311	NP (NDs) 1 of 2
Sulfate, total (mg/L)	23	24	n/a	n/a	0	n/a	n/a	0.003036	NP (normality) 1 of 2
Total Dissolved Solids [TDS] (mg/L)	174.1	24	113.5	32.85	0	None	No	0.002505	Param 1 of 2

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Power Curve



Kappa = 1.845, based on 3 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

Analysis Run 10/26/2017 5:58 AM View: PL's Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

4.11 – Annual Groundwater Monitoring Report, H.W. Pirkey Power Plant, East Bottom Ash Pond CCR Management Unit, Hallsville, Texas, January 2018

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
East Bottom Ash Pond CCR Management Unit
Hallsville, Texas

January 2018

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY℠
An AEP Company
BOUNDLESS ENERGY™

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Appendix I

I. Overview

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2018.

In general, the following activities were completed:

- Monitoring wells were installed and developed to establish a certified groundwater monitoring system around each CCR unit, in accordance with the requirements of 40 CFR 257.91 pursuant AEP's *Groundwater Monitoring Network Design Report (3/9/2017)*;
- Groundwater samples were collected and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Background groundwater quality data was collected for each Appendix III and Appendix IV constituent;
- Detection Monitoring sampling was initiated;
- A statistical process in accordance with 40 CFR 257.93 to evaluate groundwater data was prepared, certified, and posted to AEP's CCR website in April 2017. AEP's *Statistical Analysis Plan (*AEP 2017). The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009). Data evaluation is underway.

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;

- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations;
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

East Bottom Ash Pond Monitoring Wells	
Up Gradient	Down Gradient
AD-4	AD-2
AD-12	AD-31
AD-18	AD-32

III. Monitoring Wells Installed or Decommissioned

There were no monitoring wells installed or decommissioned in 2017. The network design, as summarized in the *Groundwater Monitoring Network Design Report* (3/9/2017) and as posted at the CCR web site for Pirkey Power Plant, did not change. That design report, viewable on the AEP CCR web site, discusses the facility location, the hydrogeological setting, the hydrostratigraphic units, the uppermost aquifer, downgradient monitoring well locations and the upgradient monitoring well locations.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality data collected during the establishment of background quality. Static water elevation data from each monitoring event also are shown in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

V. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

As of this first annual groundwater report date there has been no transition between detection monitoring and assessment monitoring. Detection monitoring will continue in 2018. The sampling frequency of twice per year will be maintained for the Appendix III parameters (boron, calcium, chloride, fluoride, pH, sulfate and total dissolved solids).

Regarding defining an alternate monitoring frequency, the groundwater velocity and monitoring well production is high enough at this facility that no modification of the twice-per-year detection monitoring effort is needed.

VI. Other Information Required

At the appropriate time the geochemical analyses, coupled with the statistical analyses of the groundwater quality data, will determine whether an alternate source or alternate sources are affecting groundwater chemistry. In those cases where an alternate source demonstration is made, those analyses and supporting information will be presented as well.

VII. Description of Any Problems Encountered in 2017 and Actions Taken

No significant problems were encountered. The low flow sampling effort went smoothly and the schedule was met to support this first annual groundwater report preparation.

VIII. A Projection of Key Activities for the Upcoming Year

Key activities for 2018 include:

- Detection monitoring on a twice per year schedule;
- Evaluation of the first detection monitoring results from a statistical analysis viewpoint, looking for any statistically significant increases, or decreases when pH is considered;
- Responding to any new data received in light of what the CCR rule requires;
- Preparation of the second annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-2								
		5/11/2016	7/14/2016	9/7/2016	10/13/2016	11/14/2016	1/12/2017	3/1/2017	4/11/2017	8/24/2017
		Background								Detection
Antimony	mg/L	F	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.0380	0.0380	0.0390	0.0390	0.0340	0.0370	0.0370	0.0370	-
Beryllium	mg/L	0.000515 J	0.000465 J	0.000440 J	0.000402 J	0.000367 J	0.000376 J	0.000414 J	0.000435 J	-
Boron	mg/L	1.27	1.34	1.30	1.48	1.36	1.48	1.62	1.65	1.46
Cadmium	mg/L	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	1.43	1.38	2.65	1.29	1.44	1.60	1.28	1.71	2.06
Chloride	mg/L	28.0	28.0	20.0	31.0	28.0	30.0	28.0	50.0	24.0
Chromium	mg/L	<0.00023 U	0.000402 J	0.000494 J	0.000885 J	<0.00023 U	<0.00023 U	<0.00023 U	0.000244 J	-
Cobalt	mg/L	0.0100	0.0110	0.0100	0.0110	0.0100	0.0100	0.0100	0.0110	-
Combined Radium	pCi/L	1.45	0.723	1.49	2.65	2.12	1.66	1.27	0.807	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	<0.00013 U	0.0510	0.0480	0.0520	0.0480	0.0520	0.0510	0.0520	-
Mercury	mg/L	0.0000980	0.0000680	0.000675	0.0000480	0.000154	0.0000930	0.0000370	0.0000280	-
Molybdenum	mg/L	<0.00029 U	0.000863 J	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00208 J	<0.00099 U	<0.00099 U	0.00138 J	0.00123 J	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	238	216	216	230	240	244	262	254	200
Sulfate	mg/L	68.0	71.0	49.0	67.0	72.0	94.0	80.0	88.0	64.0
Thallium	mg/L	<0.00086 U	<0.00086 U	0.00126 J	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	4.37	4.20	4.18	3.56	3.89	3.93	4.12	3.98	4.27

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-4								
		5/11/2016	7/14/2016	9/8/2016	10/13/2016	11/15/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.00396 J	0.00800	0.00500	0.0110	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.0750	0.127	0.123	0.183	0.114	0.149	0.131	0.0940	-
Beryllium	mg/L	0.00100	0.00100	0.00100	0.000831 J	0.000531 J	0.000406 J	0.000354 J	0.000915 J	-
Boron	mg/L	0.0200	0.0200	0.0200	0.0300	0.0400	0.0300	0.0300	0.0400	0.0623
Cadmium	mg/L	0.000133 J	<0.00007 U	0.000111 J	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	0.0000796 J	-
Calcium	mg/L	1.63	2.32	2.37	2.87	2.71	2.94	2.86	1.91	2.04
Chloride	mg/L	4.00	4.00	5.00	6.00	5.00	5.00	4.00	5.00	5.00
Chromium	mg/L	0.000397 J	0.00300	0.00200	0.00700	0.000446 J	0.000306 J	<0.00023 U	0.000241 J	-
Cobalt	mg/L	0.00800	0.00900	0.00800	0.00700	0.00600	0.00451 J	0.00446 J	0.00800	-
Combined Radium	pCi/L	0.729	4.27	0.193	2.38	1.07	2.60	1.09	0.684	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.0130	0.0410	0.0400	0.0340	0.0350	0.0300	0.0330	0.0470	-
Mercury	mg/L	0.00000891 J	0.0000370	0.0000115 J	0.0000101 J	0.0000127 J	0.0000115 J	0.0000122 J	0.00000554 J	-
Molybdenum	mg/L	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00179 J	0.00174 J	<0.00099 U	0.00160 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	148	157	136	164	152	148	148	140	94.0
Sulfate	mg/L	23.0	20.0	20.0	19.0	19.0	18.0	18.0	21.0	20.0
Thallium	mg/L	<0.00086 U	0.00187 J	<0.00086 U	0.000869 J	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	5.37	4.91	4.90	4.05	4.28	4.83	4.73	4.39	4.60

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-12								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.0260	0.0230	0.0300	0.0270	0.0280	0.0230	0.0260	0.0240	-
Beryllium	mg/L	0.000220 J	0.000190 J	0.000232 J	0.000150 J	0.000152 J	0.000127 J	0.000149 J	0.000159 J	-
Boron	mg/L	0.0300	0.0300	0.0400	0.0300	0.0400	0.0300	0.0400	0.0500	0.0495
Cadmium	mg/L	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	0.362	0.260	0.343	0.271	0.331	0.315	0.434	0.299	0.245
Chloride	mg/L	5.00	6.00	6.00	7.00	8.00	7.00	5.00	6.00	6.00
Chromium	mg/L	0.000711 J	0.000688 J	0.000354 J	0.000529 J	0.000328 J	0.000650 J	0.000326 J	0.000416 J	-
Cobalt	mg/L	0.00158 J	0.00129 J	0.00167 J	0.00157 J	0.00147 J	0.00109 J	0.00130 J	0.00133 J	-
Combined Radium	pCi/L	0.207	2.91	0.881	0.257	0.767	1.54	0.416	0.390	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	1.00	<0.083 U	<0.083 U	<0.083 U	0.257 J	0.213 J
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	<0.00013 U	0.00800	0.0100	0.0120	0.0130	0.0100	0.00900	0.00800	-
Mercury	mg/L	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	0.0000136 J	-
Molybdenum	mg/L	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00174 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	94.0	75.0	63.0	92.0	80.0	76.0	50.0	72.0	52.0
Sulfate	mg/L	4.00	4.00	7.00	8.00	6.00	6.00	4.00	7.00	6.00
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	0.000995 J	<0.00086 U	-
pH	SU	4.44	3.11	3.89	3.37	2.58	4.76	3.63	4.74	4.84

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).

J: Estimated value. Parameter was detected in concentrations below the reporting limit

-: Not sampled

For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-18								
		5/10/2016	7/14/2016	9/8/2016	10/13/2016	11/15/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	<0.00105 U	0.00377 J	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.157	0.139	0.115	0.112	0.0940	0.0990	0.0990	0.105	-
Beryllium	mg/L	0.000263 J	0.000243 J	0.000226 J	0.000193 J	0.000107 J	0.000169 J	0.000105 J	0.000130 J	-
Boron	mg/L	0.0100	0.0100	0.0100	0.0200	0.0200	0.0100	0.0100	0.0100	0.0278
Cadmium	mg/L	0.000109 J	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	0.548	0.409	0.343	0.560	0.590	0.415	0.224	0.304	0.435
Chloride	mg/L	8.00	8.00	8.00	7.00	7.00	7.00	6.00	7.00	8.00
Chromium	mg/L	0.00100	0.00300	0.000780 J	0.000631 J	0.000725 J	0.000411 J	0.000573 J	0.000968 J	-
Cobalt	mg/L	0.00183 J	0.00216 J	0.00110 J	0.00225 J	0.00166 J	0.00163 J	0.000977 J	0.000982 J	-
Combined Radium	pCi/L	0.847	3.26	1.11	1.16	1.49	0.976	0.468	0.648	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.00400	0.0200	0.0190	0.0260	0.0170	0.0260	0.0170	0.0190	-
Mercury	mg/L	0.0000154 J	0.0000640	0.0000300	0.0000142 J	0.0000290	0.0000189 J	0.0000109 J	0.00000960 J	-
Molybdenum	mg/L	<0.00029 U	0.000413 J	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00171 J	0.00245 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	108	116	110	124	134	128	108	102	68.0
Sulfate	mg/L	7.00	7.00	8.00	10.0	7.00	10.0	7.00	8.00	8.00
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	4.53	4.65	4.67	4.14	4.43	4.67	4.06	4.10	4.90

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-31								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.0930	0.00342 J	0.00434 J	0.00600	0.0110	0.00392 J	<0.00105 U	0.00332 J	-
Barium	mg/L	0.712	0.0690	0.0880	0.0760	0.125	0.0770	0.0440	0.0730	-
Beryllium	mg/L	0.0100	0.00100	0.00200	0.00100	0.00200	0.00100	0.000998 J	0.00100	-
Boron	mg/L	0.0800	0.0300	0.0300	0.0400	0.0400	0.0300	0.0400	0.0400	0.0175
Cadmium	mg/L	0.000859 J	<0.00007 U	<0.00007 U	<0.00007 U	0.000175 J	<0.00007 U	<0.00007 U	0.0000944 J	-
Calcium	mg/L	10.4	4.27	3.47	4.41	4.70	4.43	3.89	3.64	2.24
Chloride	mg/L	18.0	18.0	18.0	18.0	18.0	19.0	14.0	16.0	18.0
Chromium	mg/L	0.212	0.0100	0.0150	0.0140	0.0300	0.0120	0.00300	0.0120	-
Cobalt	mg/L	0.0500	0.0110	0.0110	0.0110	0.0140	0.0100	0.00900	0.0110	-
Combined Radium	pCi/L	7.32	3.38	2.35	3.88	3.20	2.73	2.68	3.52	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U
Lead	mg/L	0.0570	<0.00068 U	<0.00068 U	0.00154 J	0.00393 J	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.0770	0.0960	0.0940	0.0970	0.0960	0.0930	0.0900	0.0970	-
Mercury	mg/L	0.00180	0.000320	0.000284	0.000347	0.000523	0.000384	0.000138	0.000333	-
Molybdenum	mg/L	0.000894 J	0.000316 J	<0.00029 U	<0.00029 U	0.000402 J	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00184 J	0.00111 J	<0.00099 U	<0.00099 U	0.00103 J	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	286	245	260	276	266	252	212	252	228
Sulfate	mg/L	63.0	66.0	60.0	62.0	66.0	79.0	68.0	69.0	52.0
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	0.00102 J	<0.00086 U	<0.00086 U	-
pH	SU	4.49	3.49	3.67	3.95	3.19	4.39	3.62	3.56	4.46

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-32								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.00377 J	0.0130	0.00326 J	0.0100	0.00600	0.00600	0.00456 J	<0.00105 U	-
Barium	mg/L	0.0350	0.0580	0.0350	0.0500	0.0370	0.0370	0.0300	0.0260	-
Beryllium	mg/L	0.00300	0.00800	0.00800	0.00700	0.00900	0.00700	0.00500	0.00400	-
Boron	mg/L	0.708	5.23	5.78	4.26	5.52	5.05	2.73	1.46	0.716
Cadmium	mg/L	0.000293 J	0.000730 J	0.000602 J	0.000589 J	0.000788 J	0.000602 J	0.000389 J	0.000440 J	-
Calcium	mg/L	7.41	33.9	37.4	27.1	35.9	40.0	18.4	11.0	7.15
Chloride	mg/L	12.0	32.0	35.0	29.0	34.0	35.0	19.0	15.0	14.0
Chromium	mg/L	0.00500	0.0180	0.00600	0.0150	0.00800	0.00900	0.00500	0.00300	-
Cobalt	mg/L	0.0270	0.0740	0.0700	0.0650	0.0750	0.0690	0.0450	0.0350	-
Combined Radium	pCi/L	2.50	6.41	4.85	17.3	3.73	4.34	4.00	4.32	-
Fluoride	mg/L	<0.083 U	0.670 J	<0.083 U	0.859 J	0.747 J	<0.083 U	<0.083 U	0.447 J	1.96
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.0160	0.119	0.111	0.972	0.114	0.115	0.0950	0.0950	-
Mercury	mg/L	0.000925	0.0139	0.00168	0.00729	0.00362	0.00720	0.00793	0.00276	-
Molybdenum	mg/L	<0.00029 U	0.000762 J	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	<0.00099 U	0.00389 J	<0.00099 U	0.00193 J	<0.00099 U	<0.00099 U	0.00254 J	<0.00099 U	-
Total Dissolved Solids	mg/L	206	835	884	720	922	894	490	372	288
Sulfate	mg/L	124	461	479	430	621	683	285	200	115
Thallium	mg/L	<0.00086 U	<0.00086 U	0.00109 J	<0.00086 U	0.00108 J	0.000991 J	<0.00086 U	<0.00086 U	-
pH	SU	4.34	3.30	3.11	3.26	2.99	3.89	3.11	3.23	4.29

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

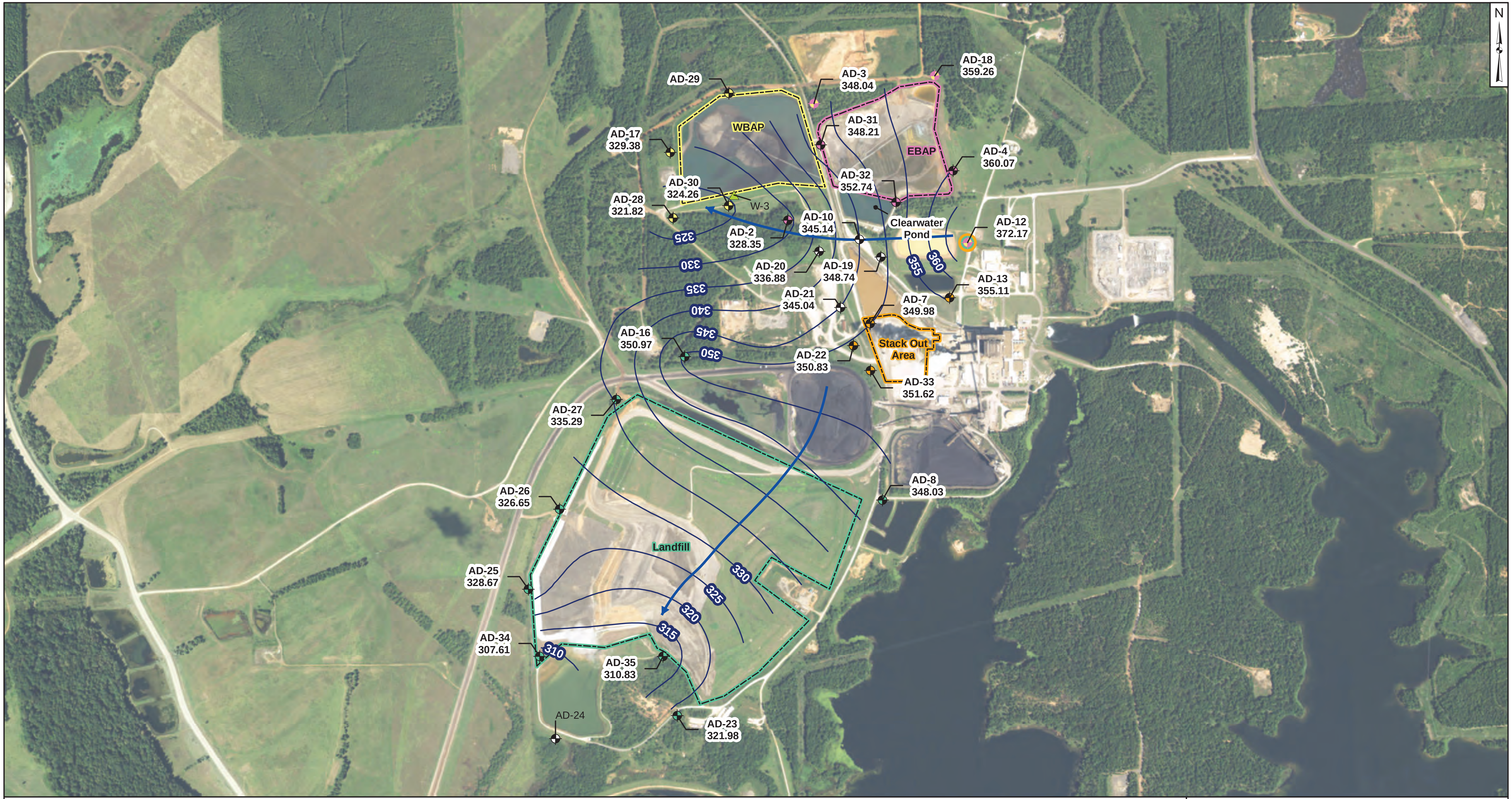
SU: standard unit

U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).

J: Estimated value. Parameter was detected in concentrations below the reporting limit

-: Not sampled

For statistical analysis, parameters which were not detected were replaced with the reporting limit.



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 11, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
May 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2017/12/13

Figure
1

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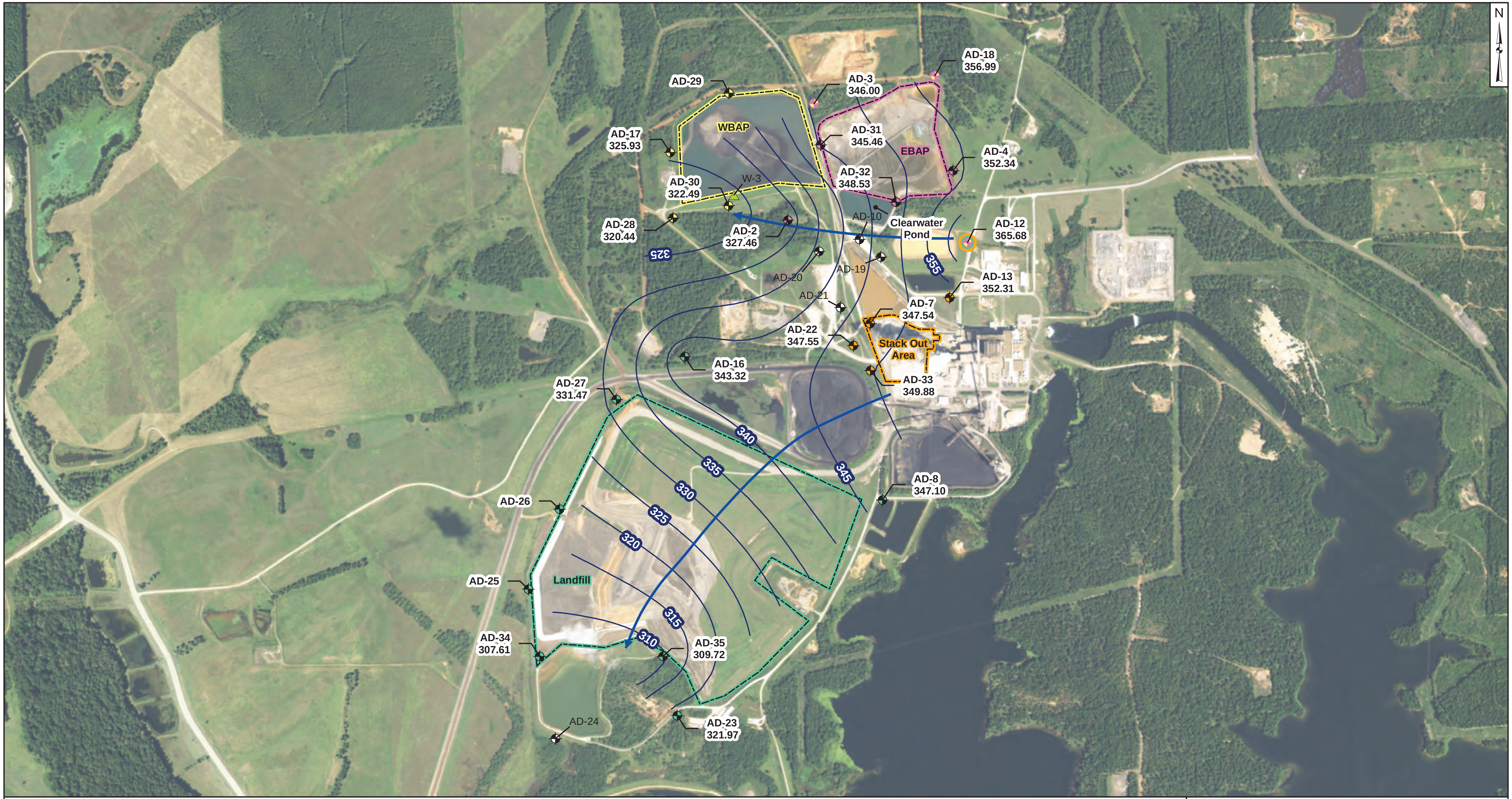

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on July 14, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer July 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2017/12/13

Figure

2

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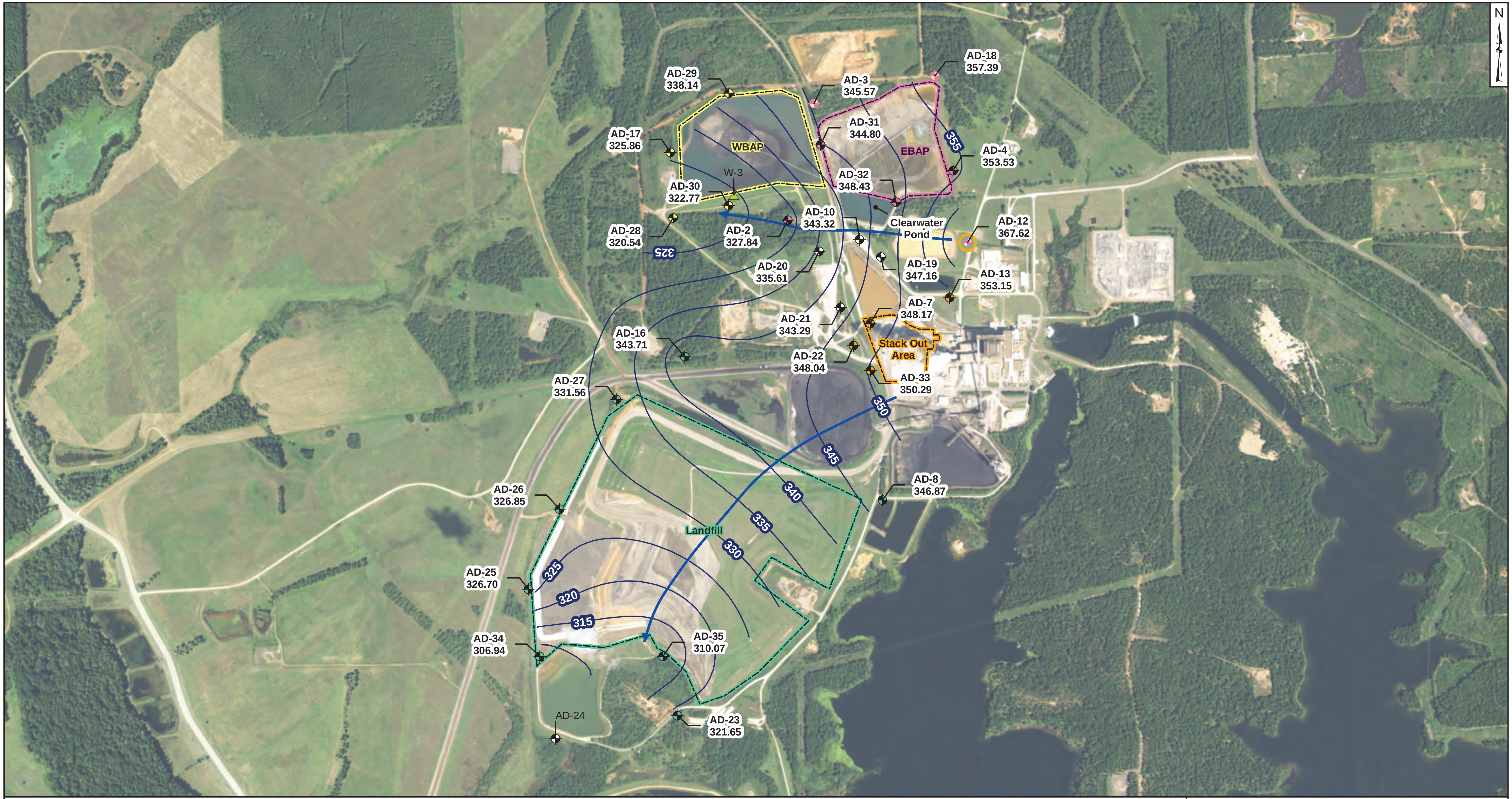

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stack Out Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on September 8, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer September 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2017/12/14

Figure
3

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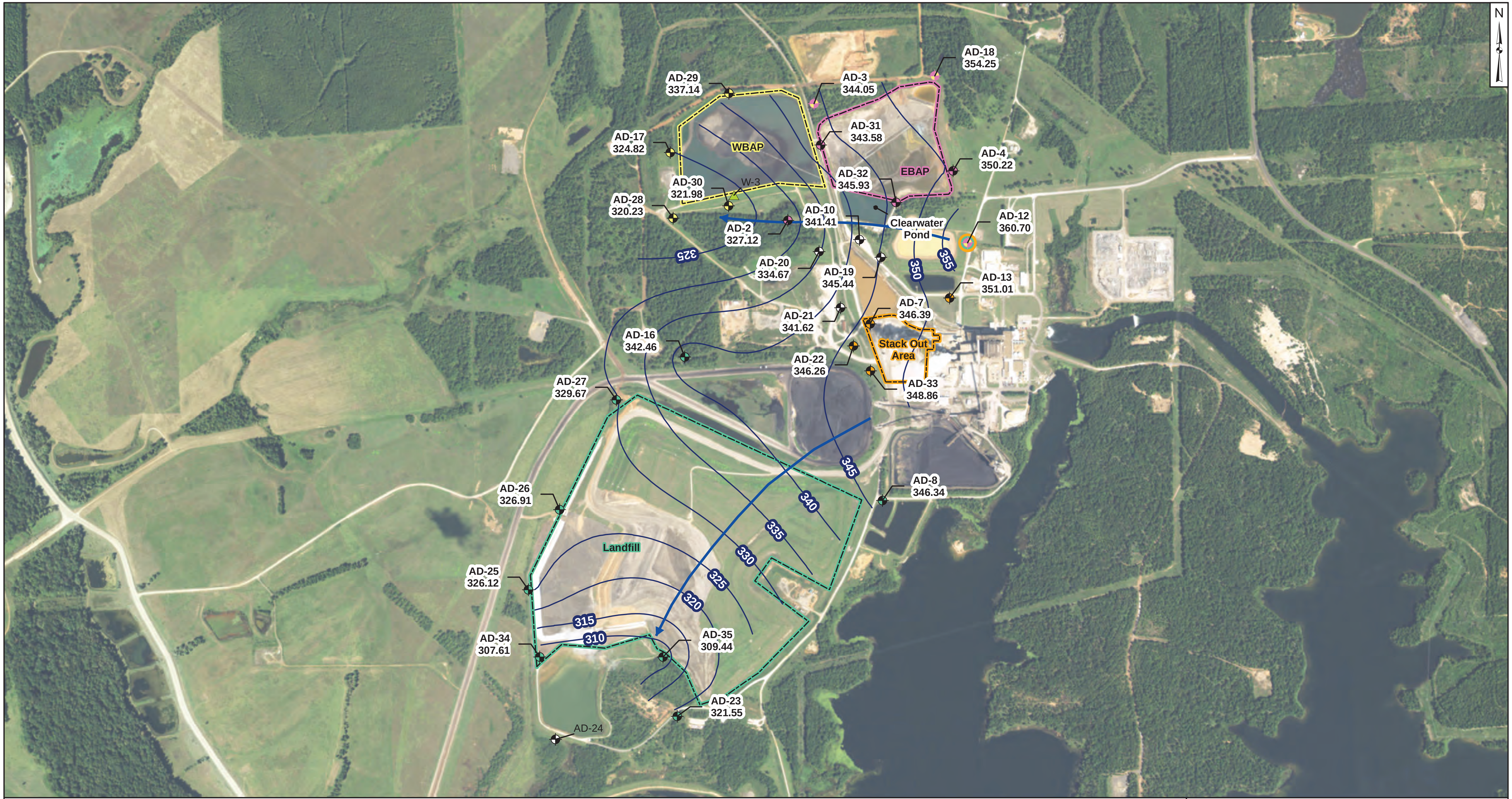

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on October 13, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer October 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2017/12/13

Figure

4

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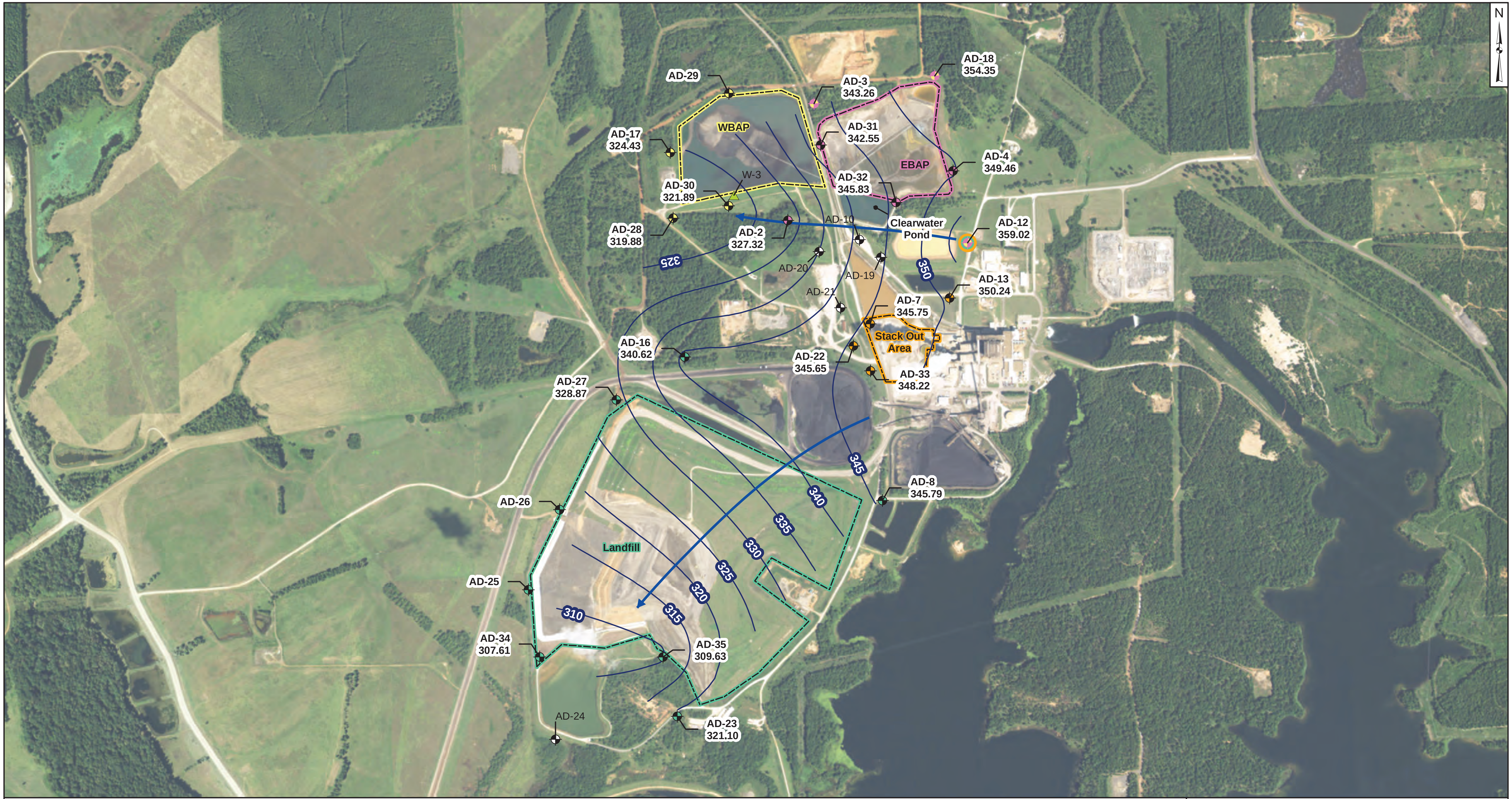

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected November 14 - 15, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer November 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2017/12/13

Figure
5

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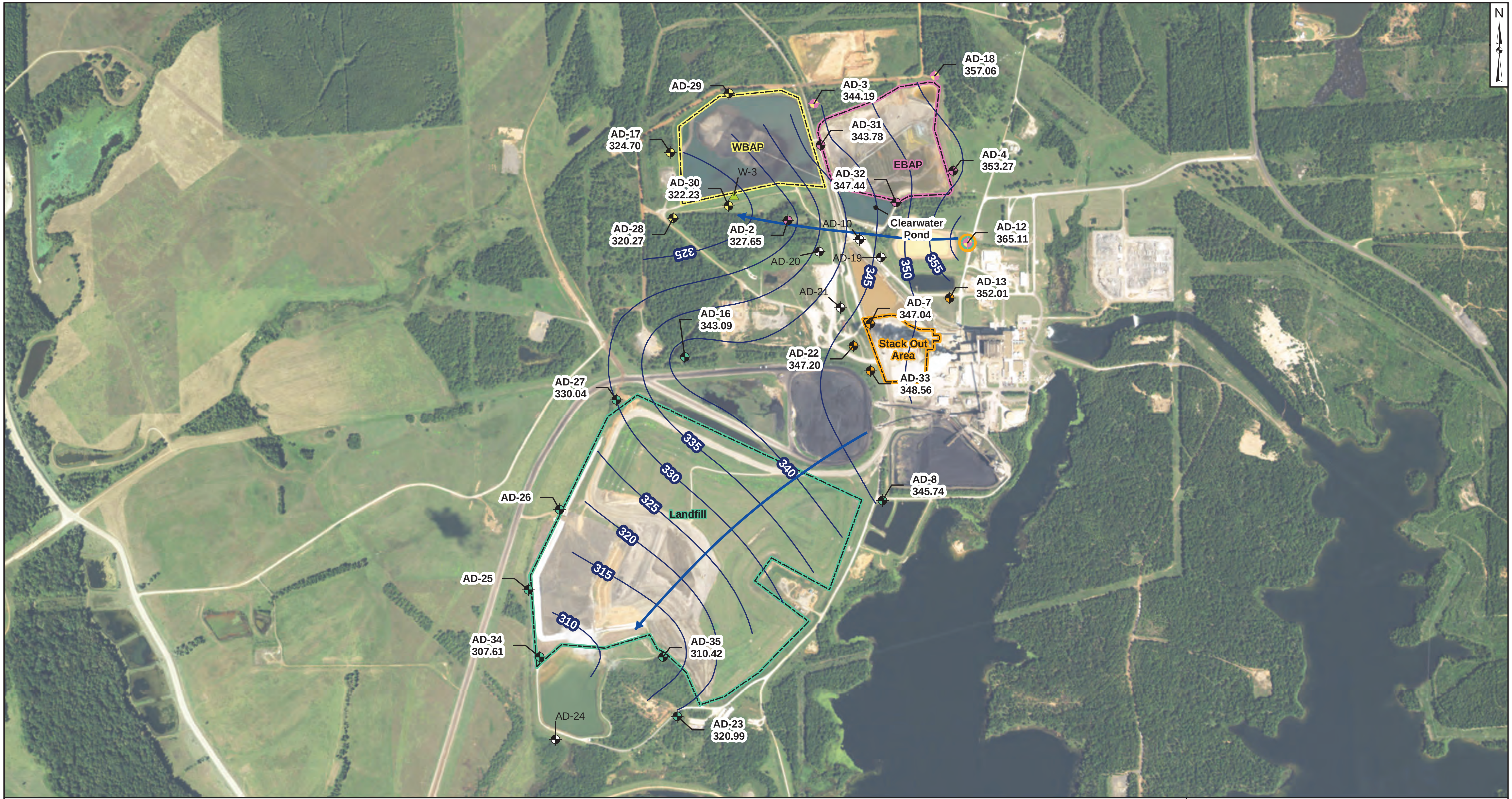

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stack Out Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on January 11 - 12, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer January 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2017/12/19

Figure
6

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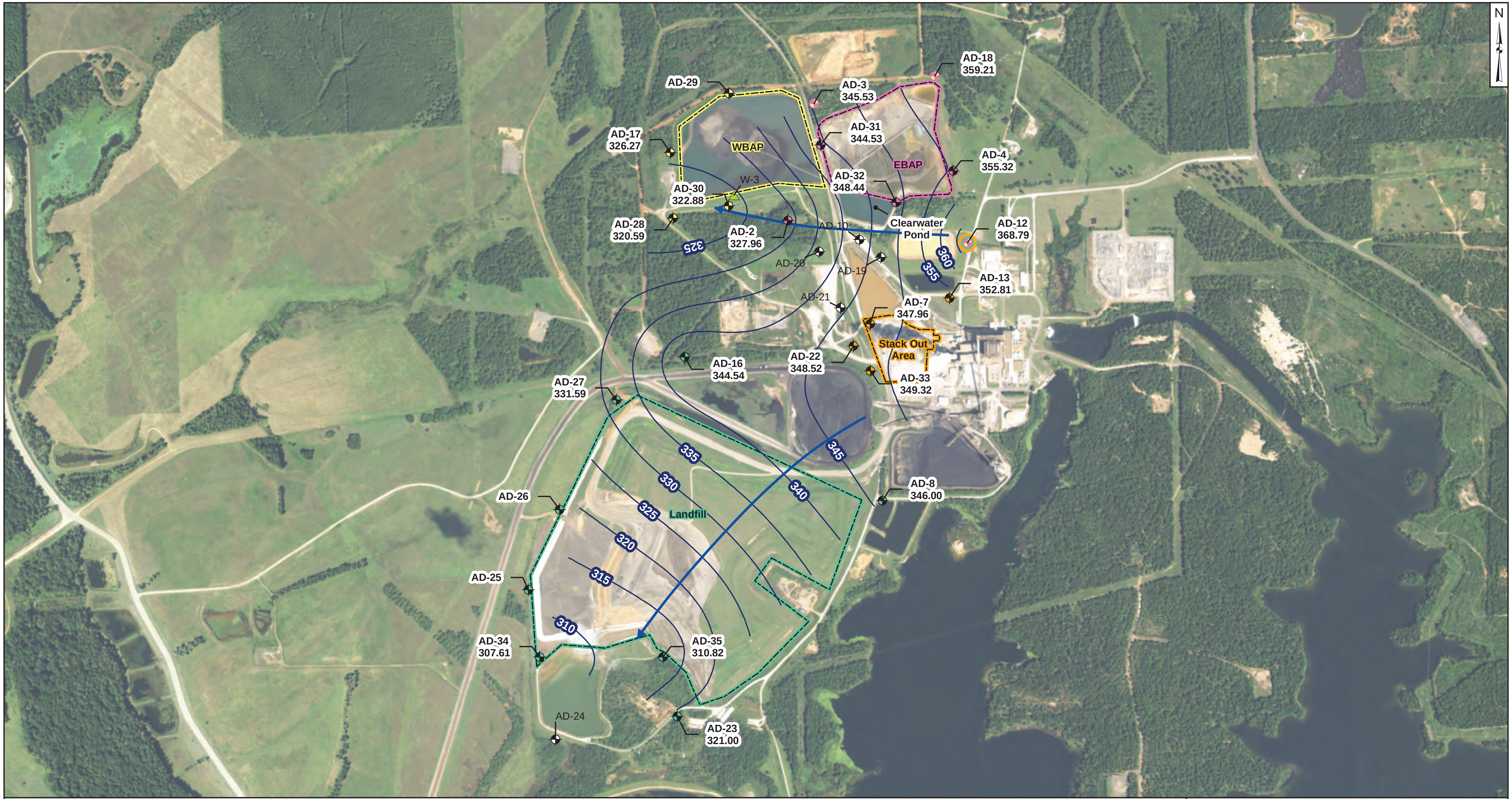

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP

- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on February 28 - March 1, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer February 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
7

Columbus, Ohio
2017/12/14

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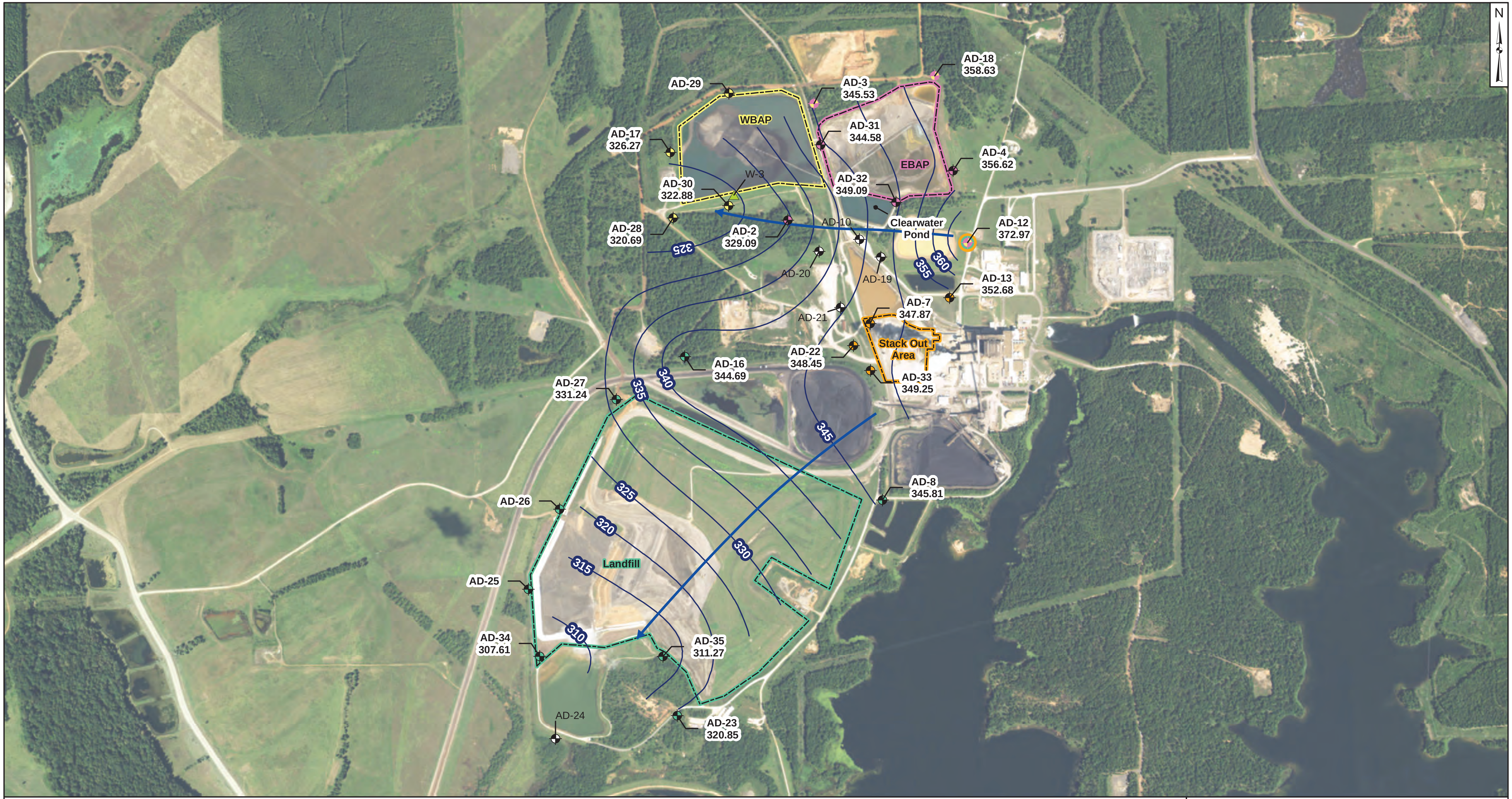

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stack Out Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on April 10 - 11, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

Potentiometric Contours - Uppermost Aquifer April 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2017/12/14

Figure
8

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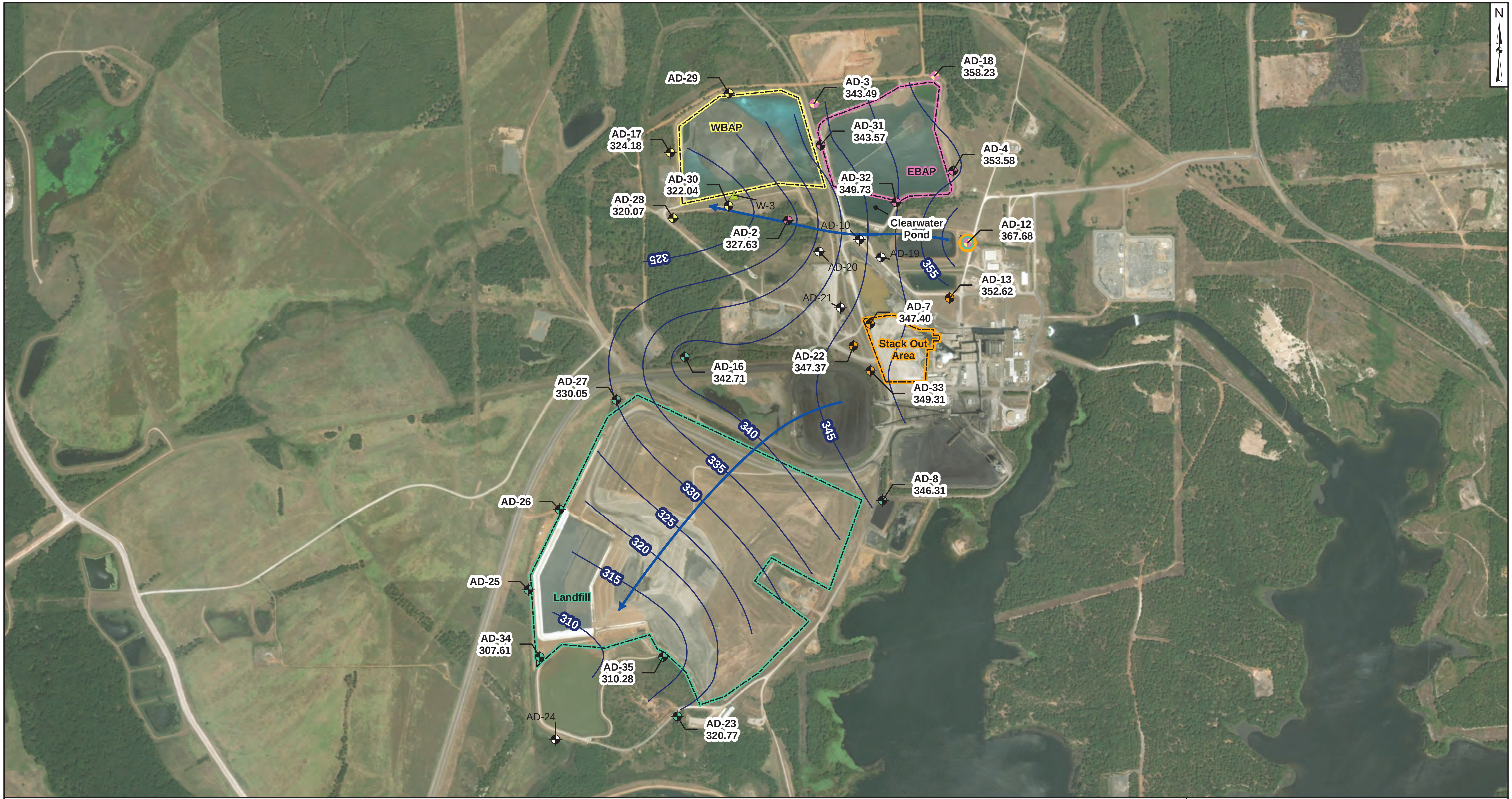

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stack Out Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on August 23 - 24, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
-East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer August 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio

2018/01/28

Figure
9

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USE data row --> **75** **8/24/2017**

Landfill

Distance between wells in feet

	AD8	AD12	AD16	AD23	AD27	AD34	AD35
AD8	-	2869	2582	3147	3008	3999	2872
AD12		-	3224	5870	4067	6305	5447
AD16			-	3795	853	3537	3196
AD23				-	3402	1621	734
AD27					-	2854	2780
AD34						-	1302
AD35							-

Landfill displaying data for date: **8/24/2017**

Hydraulic gradient in ft/ft

	AD8	AD12	AD16	AD23	AD27	AD34	AD35	max grad
AD8	-	0.007449	0.001394	0.008116	0.005406	0.009677	0.012545	0.014842
AD12		-	0.007745	0.007991	0.009253	0.009527	0.010538	hydraulic concuctivity
AD16			-	0.005781	0.014842	0.009924	0.010147	0.0001 cm/sec
AD23				-	0.002728	0.008118	0.014292	porosity
AD27					-	0.007863	0.007112	0.25
AD34						-	0.002051	seepage rate, ft/yr
AD35							-	6.14

FGD stackout area

Distance between wells in feet

	AD7	AD12	AD13	AD22	AD33
AD7	-	1339	954	295	615
AD12		-	723	1627	1742
AD13			-	1191	1138
AD22				-	175
AD33					-

FGD stackout area displaying data for date: **8/24/2017**

Hydraulic gradient in ft/ft

	AD7	AD12	AD13	AD22	AD33	max grad
AD7	-	0.015146	0.005472	0.000102	0.003106	0.02083
AD12		-	0.02083	0.012483	0.010545	hydraulic concuctivity
AD13			-	0.004408	0.002909	0.0001 cm/sec
AD22				-	0.011086	porosity
AD33					-	0.25
						seepage rate, ft/yr
						8.62

as of Mar 2011	Well ID	AD-02	AD-03	AD-04	AD-07	AD-08	AD-10	AD-12	AD-13	AD-16	AD-17	AD-18	AD-19	AD-20	AD-21
	TOC, ft	344.04	375.30	366.79	362.79	359.84	362.21	381.99	364.76	360.05	346.09	363.42	362.82	355.79	350.72
	Measured depth to water														
	Date														
	4/13/2011	17.14	32.35	15.34	18.45	18.19	20.18	23.04	15.30	21.97	23.43	7.89	18.75	21.29	10.29
	12/15/2011	16.92	33.71	15.55	19.04	19.55	20.31	24.00	15.85	24.55	23.80	11.88	19.24	21.16	10.70
	6/20/2012	16.87	31.60	14.35	18.64	18.19	20.02	22.66	15.24	22.47	22.78	6.21	18.53	21.10	10.50
	1/23/2013	16.78	34.20	12.37	17.89	19.12	20.80	13.92	13.95	24.62	22.58	7.95	18.20	21.01	9.15
	7/7/2013	17.42	32.03	17.57	19.44	18.59	22.36	24.58	16.15	23.38	23.03	6.19	20.22	22.41	11.56
	1/22/2014	16.34	33.88	11.21	16.18	18.17	19.94	12.02	12.79	20.52	20.90	3.39	17.71	20.41	8.36
	7/9/2014	16.85	31.34	13.46	16.56	16.48	19.99	14.95	13.47	19.21	21.94	5.36	17.06	20.92	9.05
	1/28/2015	15.42	30.29	7.79	13.62	15.81	17.82	9.24	10.29	16.71	17.67	3.54	14.90	18.91	5.27
	1/20/2016	15.49	28.27	7.63	13.48	12.63		10.94	10.61	12.37		2.9			
	3/7/2016	15.73	28.09	8.66	14.01	12.62	17.94	13.28	11.15	11.36	18.08	3.08	15.09	19.34	6.46
	5/11/2016	15.69	27.26	6.72	12.81	11.81	17.07	9.82	9.65	9.08	16.71	4.16	14.08	18.91	5.68
	7/14/2016	16.58	29.30	14.45	15.25	12.74		16.31	12.45	16.73	20.16	6.43			
	9/8/2016	16.20	29.73	13.26	14.62	12.97	18.89	14.37	11.61	16.34	20.23	6.03	15.66	20.18	7.43
	10/13/2016	16.92	31.25	16.57	16.40	13.50	20.80	21.29	13.75	17.59	21.27	9.17	17.38	21.12	9.10
	11/15/2016	16.72	32.04	17.33	17.04	14.05		22.97	14.52	19.43	21.60	9.07			
	1/12/2017	16.39	31.11	13.52	15.75	14.10		16.88	12.75	16.96	21.39	6.36			
	3/1/2017	16.08	29.77	11.41	14.83	13.84		13.20	11.95	15.51	19.82	4.21			
	4/11/2017	14.95	29.77	10.17	14.92	14.03		9.02	12.08	15.36	19.82	4.79			
	8/24/2017	16.41	31.81	13.22	15.39	13.53		14.31	12.14	17.34	21.91	5.19			

Well ID	AD-22	AD-23	AD-24	AD-25	AD-26	AD-27	AD-28	AD-29	AD-30	AD-31	AD-32	AD-33	AD-34	AD-35
TOC, ft	358.51	350.10	291.14	337.09	345.25	352.62	339.40	353.37	342.02	360.75	359.18	362.37	307.61	318.95
			plugged 1-26-16											
Date														
4/13/2011	14.87	30.45	8.22	12.58	20.72	26.80	19.73	18.69						
12/15/2011	15.35	31.16	6.85	15.19	21.48	28.08	20.24	20.00						
6/20/2012	14.77	30.81	6.04	13.95	21.63	26.49	19.48	18.63						
1/23/2013	13.68	31.44	5.51	15.15	22.93	27.23	19.19	15.90						
7/7/2013	15.61	31.23	6.08	14.94	23.16	27.27	19.71	16.53						
1/22/2014	12.02	30.30	2.84	14.53	22.01	26.23	18.75	14.82						
7/9/2014	12.74	30.31	4.04	12.85	22.74	24.71	19.18	17.52						
1/28/2015	8.27	30.26	2.58	10.67	22.21	22.93	17.24	12.80						
1/20/2016	8.22	28.87					18.01		18.32	14.15	6.86	11.24	0	9.1
3/7/2016	5.96	28.59	plugged	9.11	18.97	21.42	18.57	13.67	18.89	14.08	7.53	11.67	0.00	8.04
5/11/2016	7.68	28.12		8.42	18.60	17.33	17.58		17.76	12.54	6.44	10.75	0.00	8.12
7/14/2016	10.96	28.13				21.15	18.96		19.53	15.29	10.65	12.49	0.00	9.23
9/8/2016	10.47	28.45		10.39	18.40	21.06	18.86	15.23	19.25	15.95	10.75	12.08	0.67	8.88
10/13/2016	12.25	28.55		10.97	18.34	22.95	19.17	16.23	20.04	17.17	13.25	13.51	0.00	9.51
11/15/2016	12.86	29.00				23.75	19.52		20.13	18.20	13.35	14.15	0.00	9.32
1/12/2017	11.31	29.11				22.58	19.13		19.79	16.97	11.74	13.81	0.00	8.53
3/1/2017	9.99	29.10				21.03	18.89		19.17	16.22	10.74	13.05	0.00	8.13
4/11/2017	10.06	29.25				21.38	18.71		15.14	16.17	10.09	13.12	0.00	7.68
8/24/2017	11.14	29.33				22.57	19.33		19.98	17.18	9.45	13.06	0.00	8.67

WBAP

Distance between wells in feet

	AD3	AD12	AD17	AD18	AD28	AD30
AD3	-	2187	1604	1280	1955	1458
AD12		-	3132	1794	3123	2584
AD17			-	2911	695	904
AD18				-	3149	2603
AD28					-	689
AD30						-

WBAP displaying data for date: **8/24/2017**

Hydraulic gradient in ft/ft

	AD3	AD12	AD17	AD18	AD28	AD30	max grad
AD3	-	0.011061	0.012039	0.011516	0.01198	0.014712	0.032569
AD12		-	0.013889	0.005268	0.015245	0.017663	hydraulic concuctivity
AD17			-	0.011697	0.005914	0.002367	0.0001 cm/sec
AD18				-	0.001305	0.000822	porosity
AD28					-	0.032569	0.25
AD30						-	seepage rate, ft/yr

13.48

EBAP

Distance between wells in feet

	AD2	AD4	AD12	AD18	AD31	AD32
AD2	-	1822	1914	1569	932	1209
AD4		-	773	1022	1473	779
AD12			-	1794	1903	948
AD18				-	1459	1443
AD31					-	1001
AD32						-

EBAP displaying data for date: **8/24/2017**

Hydraulic gradient in ft/ft

	AD2	AD4	AD12	AD18	AD31	AD32	max grad
AD2	-	0.014237	0.020925	0.019503	0.017103	0.01828	0.020925
AD4		-	0.018254	0.00456	0.006789	0.004929	hydraulic concuctivity
AD12			-	0.005268	0.012669	0.018935	0.0001 cm/sec
AD18				-	0.010048	0.005891	porosity
AD31					-	0.006154	0.25
AD32						-	seepage rate, ft/yr

8.66

	Well ID	AD-02	AD-03	AD-04	AD-07	AD-08	AD-10	AD-12	AD-13	AD-16	AD-17	AD-18	AD-19	AD-20	AD-21	AD-22	AD-23	AD-24	AD-25	AD-26	AD-27	AD-28	AD-29	AD-30	AD-31	AD-32	AD-33	AD-34	AD-35
	TOC, ft	344.04	375.30	366.79	362.79	359.84	362.21	381.99	364.76	360.05	346.09	363.42	362.82	355.79	350.72	358.51	350.10	291.14	337.09	345.25	352.62	339.40	353.37	342.02	360.75	359.18	362.37	307.61	318.95
337.70	4/13/2011	326.90	342.95	351.45	344.34	341.65	342.03	358.95	349.46	338.08	322.66	355.53	344.07	334.50	340.43	343.64	319.65	282.92	324.51	324.53	325.82	319.67	334.68						
335.90	12/15/2011	327.12	341.59	351.24	343.75	340.29	341.90	357.99	348.91	335.50	322.29	351.54	343.58	334.63	340.02	343.16	318.94	284.29	321.90	323.77	324.54	319.16	333.37						
338.40	6/20/2012	327.17	343.70	352.44	344.15	341.65	342.19	359.33	349.52	337.58	323.31	357.21	344.29	334.69	340.22	343.74	319.29	285.10	323.14	323.62	326.13	319.92	334.74						
339.40	1/23/2013	327.26	341.10	354.42	344.90	340.72	341.41	368.07	350.81	335.43	323.51	355.47	344.62	334.78	341.57	344.83	318.66	285.63	321.94	322.32	325.39	320.21	337.47						
339.40	7/7/2013	326.62	343.27	349.22	343.35	341.25	339.85	357.41	348.61	336.67	323.06	357.23	342.60	333.38	339.16	342.90	318.87	285.06	322.15	322.09	325.35	319.69	336.84						
338.70	1/22/2014	327.70	341.42	355.58	346.61	341.67	342.27	369.97	351.97	339.53	325.19	360.03	345.11	335.38	342.36	346.49	319.80	288.30	322.56	323.24	326.39	320.65	338.55						
339.40	7/9/2014	327.19	343.96	353.33	346.23	343.36	342.22	367.04	351.29	340.84	324.15	358.06	345.76	334.87	341.67	345.77	319.79	287.10	324.24	322.51	327.91	320.22	335.85						
339.40	1/28/2015	328.62	345.01	359.00	349.17	344.03	344.39	372.75	354.47	343.34	328.42	359.88	347.92	336.88	345.45	350.24	319.84	288.56	326.42	323.04	329.69	322.16	340.57						
	1/20/2016	328.55	347.03	359.16	349.31	347.21		371.05	354.15	347.68		360.52				350.29	321.23					321.39		323.70	346.60	352.32	351.13	307.61	309.85
	3/7/2016	328.31	347.21	358.13	348.78	347.22	344.27	368.71	353.61	348.69	328.01	360.34	347.73	336.45	344.26	352.55	321.51	#VALUE!	327.98	326.28	331.20	320.83	339.70	323.13	346.67	351.65	350.70	307.61	310.91
	5/11/2016	328.35	348.04	360.07	349.98	348.03	345.14	372.17	355.11	350.97	329.38	359.26	348.74	336.88	345.04	350.83	321.98		328.67	326.65	335.29	321.82		324.26	348.21	352.74	351.62	307.61	310.83
	7/14/2016	327.46	346.00	352.34	347.54	347.10		365.68	352.31	343.32	325.93	356.99				347.55	321.97				331.47	320.44		322.49	345.46	348.53	349.88	307.61	309.72
	9/8/2016	327.84	345.57	353.53	348.17	346.87	343.32	367.62	353.15	343.71	325.86	357.39	347.16	335.61	343.29	348.04	321.65		326.70	326.85	331.56	320.54	338.14	322.77	344.80	348.43	350.29	306.94	310.07
	10/13/2016	327.12	344.05	350.22	346.39	346.34	341.41	360.70	351.01	342.46	324.82	354.25	345.44	334.67	341.62	346.26	321.55		326.12	326.91	329.67	320.23	337.14	321.98	343.58	345.93	348.86	307.61	309.44
	11/15/2016	327.32	343.26	349.46	345.75	345.79		359.02	350.24	340.62	324.49	354.35				345.65	321.10				328.87	319.88		321.89	342.55	345.83	348.22	307.61	309.63
	1/12/2017	327.65	344.19	353.27	347.04	345.74		365.11	352.01	343.09	324.70	357.06				347.20	320.99				330.04	320.27		322.23	343.78	347.44	348.56	307.61	310.42
	3/1/2017	327.96	345.53	355.38	347.96	346.00		368.79	352.81	344.54	326.27	359.21				348.52	321.00				331.59	320.51		322.85	344.53	348.44	349.32	307.61	310.82
	4/11/2017	329.09	345.53	356.62	347.87	345.81		372.97	352.68	344.69	326.27	358.63				348.45	320.85				331.24	320.69		326.88	344.58	349.09	349.25	307.61	311.27
		327.63	343.49	353.57	347.40	346.31		367.68	352.62	342.71	324.18	358.23				347.37	320.77				330.05	320.07		322.04	343.57	349.73	349.31	307.61	310.28

Seepage rate summary
in feet per year

	Landfill	**Stackout**	**WBAP**	**EBAP**	
3/7/2016	8.49	8.64	14.17	8.74	3/7/2016
5/11/2016	7.61	9.77	16.63	9.48	5/11/2016
7/14/2016	6.91	7.65	14.33	8.26	7/14/2016
9/8/2016	6.53	8.28	14.79	8.60	9/8/2016
10/13/2016	6.83	6.15	13.25	7.31	10/13/2016
11/15/2016	6.47	6.08	12.77	7.13	11/15/2016
1/12/2017	6.33	7.50	13.47	8.10	1/12/2017
3/1/2017	6.28	9.15	14.40	8.88	3/1/2017
4/11/2017	6.53	11.61	14.19	10.43	4/11/2017
8/24/2017	6.14	8.62	13.48	8.66	8/24/2017

4.12 – Annual Groundwater Monitoring Report, H.W. Pirkey Power Plant, East Bottom Ash Pond CCR Management Unit, Hallsville, Texas, January 2021

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
East Bottom Ash Pond CCR Management Unit
Hallsville, Texas

January 2021

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SOUTHWESTERN ELECTRIC POWER COMPANY
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I. Summary

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2021.

In general, the following activities were completed:

- Groundwater samples were collected for AD-2, AD-4, AD-12, AD-18, AD-31, and AD-32 in March, June, and November 2020 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in Assessment monitoring at the beginning and end of 2020;
- Statistical analysis report dated January 3, 2020 was included in last year's Annual Groundwater Monitoring Report. The following Appendix IV parameters exceeded established groundwater protection standards:
    - Lithium at AD-31 and AD-32
    - Cobalt at AD-2 and AD-32

  The following Appendix III parameters exceeded background:
    - Boron at AD-2 and AD-32
    - Calcium at AD-2, AD-31, and AD-32
    - Chloride at AD-2, AD-31 and AD-32
    - Sulfate at AD-2, AD-31, and AD-32
    - TDS concentrations at AD-2, AD-31, and AD-32
- An alternate source demonstration for the constituents above was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 2, 2020.
- Statistical analysis report dated October 2, 2020 is included in **Appendix II**. The following Appendix IV parameters exceeded established groundwater protection standards:
    - Lithium at AD-31 and AD-32
    - Cobalt at AD-2, AD-31, and AD-32

  - Mercury at AD-32

  The following Appendix III parameters exceeded background:

  - Boron at AD-2 and AD-32
  - Calcium at AD-32
  - Chloride at AD-2, AD-31, and AD-32
  - Sulfate at AD-2, AD-31, and AD-32
  - TDS concentrations at AD-2, AD-31, and AD-32

- An alternate source demonstration for the constituents above was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on December 31, 2020.
- The November 2020 data are still undergoing statistical analysis
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in **Appendix I**;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations.
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

East BAP Monitoring Wells	
Up Gradient	Down Gradient
AD-4	AD-2
AD-12	AD-31
AD-18	AD-32

III. Monitoring Wells Installed or Decommissioned

One monitoring well (AD-7R) was installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry. The well installation reports can be found in **Appendix IV**.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event are presented in **Appendix I**, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a March sampling event was conducted in accordance with 40 CFR 257.95(b). Two sampling events in June and November were conducted in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2021.

V. Statistical Evaluation of 2020 Events

Statistical analysis report dated January 3, 2020 was included in last year's Annual Groundwater Monitoring Report. The following Appendix IV parameters exceeded established groundwater protection standards:

- Lithium at AD-31 and AD-32
- Cobalt at AD-2 and AD-32

The following Appendix III parameters exceeded background:

- Boron at AD-2 and AD-32
- Calcium at AD-2, AD-31, and AD-32
- Chloride at AD-2, AD-31 and AD-32
- Sulfate at AD-2, AD-31, and AD-32
- TDS concentrations at AD-2, AD-31, and AD-32

Statistical analysis report dated October 2, 2020 is included in **Appendix II**. The following Appendix IV parameters exceeded established groundwater protection standards:

- Lithium at AD-31 and AD-32
- Cobalt at AD-2, AD-31, and AD-32
- Mercury at AD-32

The following Appendix III parameters exceeded background:

- Boron at AD-2 and AD-32
- Calcium at AD-32
- Chloride at AD-2, AD-31, and AD-32
- Sulfate at AD-2, AD-31, and AD-32
- TDS concentrations at AD-2, AD-31, and AD-32

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the east bottom ash pond SSLs above GWPSs.

SSLs above the GWPS were determined for cobalt and for lithium on January 3, 2020. An alternate source demonstration for the constituents above was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 2, 2020.

SSLs above the GWPS were determined for lithium, cobalt, and mercury on October 2, 2020. An alternate source demonstration for the constituents above was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on December 31, 2020.

The supporting information are found in **Appendix III**.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

Assessment monitoring will continue in 2021.

Regarding defining an alternate monitoring frequency, no modification to monitoring requirements is needed.

VIII. Other Information Required

On November 30, 2020, Pirkey Power Plant submitted a site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler by a date certain to US EPA. Pirkey Power Plant requested to allow the EBAP to continue to receive CCR and non-CR wastestreams after April 11, 2021.

Pirkey received TCEQ approval to extend the receipt of CCR waste and initiate closure activities April 11, 2021. Further extension can be obtained pending a successful demonstration to EPA under 40 CFR 257.103(f).

IX. Description of Any Problems Encountered in 2020 and Actions Taken

No problems were encountered this year.

X. A Projection of Key Activities for the Upcoming Year

Key activities for next year include:

- Assessment monitoring sampling will be conducted;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for any SSLs above GWPS;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the next annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Table 1 - Groundwater Data Summary: AD-2
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	1.27	1.43	28	< 0.083 U	4.4	68	238
7/14/2016	Background	1.34	1.38	28	< 0.083 U	4.2	71	216
9/7/2016	Background	1.3	2.65	20	< 0.083 U	4.2	49	216
10/13/2016	Background	1.48	1.29	31	< 0.083 U	3.6	67	230
11/14/2016	Background	1.36	1.44	28	< 0.083 U	3.9	72	240
1/12/2017	Background	1.48	1.6	30	< 0.083 U	3.9	94	244
3/1/2017	Background	1.62	1.28	28	< 0.083 U	4.1	80	262
4/11/2017	Background	1.65	1.71	50	< 0.083 U	4.0	88	254
8/24/2017	Detection	1.46	2.06	24	< 0.083 U	4.3	64	200
12/21/2017	Detection	1.38	2.92	24	< 0.083 U	--	64	206
3/22/2018	Assessment	1.99	1.97	30	< 0.083 U	4.2	105	220
8/21/2018	Assessment	2.14	1.65	46	< 0.083 U	4.7	130	312
2/28/2019	Assessment	2.25	1.96	31.8	0.1 J	3.5	129	384
5/22/2019	Assessment	2.17	2.19	29.6	0.1 J	4.0	137	316
8/12/2019	Assessment	2.16	3.30	28.4	0.1 J	4.6	128	306
3/11/2020	Assessment	2.78	2.50	29.7	0.14	4.0	178	374
6/3/2020	Assessment	2.44	2.44	29.3	0.15	4.6	174	387
11/2/2020	Assessment	2.62	1.99	29.2	0.11	3.9	158	347

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-2
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	< 1.05 U	38	0.514594 J	< 0.07 U	< 0.23 U	10	1.446	< 0.083 U	< 0.68 U	< 0.00013 U	0.098	< 0.29 U	2.08256 J	< 0.86 U
7/14/2016	Background	< 0.93 U	< 1.05 U	38	0.46511 J	< 0.07 U	0.401928 J	11	0.723	< 0.083 U	< 0.68 U	0.051	0.068	0.862706 J	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	39	0.439699 J	< 0.07 U	0.493592 J	10	1.489	< 0.083 U	< 0.68 U	0.048	0.675	< 0.29 U	< 0.99 U	1.26444 J
10/13/2016	Background	< 0.93 U	< 1.05 U	39	0.40165 J	< 0.07 U	0.885421 J	11	2.65	< 0.083 U	< 0.68 U	0.052	0.048	< 0.29 U	1.3807 J	< 0.86 U
11/14/2016	Background	< 0.93 U	< 1.05 U	34	0.367353 J	< 0.07 U	< 0.23 U	10	2.121	< 0.083 U	< 0.68 U	0.048	0.154	< 0.29 U	1.23147 J	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	37	0.376129 J	< 0.07 U	< 0.23 U	10	1.656	< 0.083 U	< 0.68 U	0.052	0.093	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	37	0.413652 J	< 0.07 U	< 0.23 U	10	1.267	< 0.083 U	< 0.68 U	0.051	0.037	< 0.29 U	< 0.99 U	< 0.86 U
4/11/2017	Background	< 0.93 U	< 1.05 U	37	0.435396 J	< 0.07 U	0.243798 J	11	0.807	< 0.083 U	< 0.68 U	0.052	0.028	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	33.28	0.45 J	< 0.07 U	< 0.23 U	12.43	1.053	< 0.083 U	< 0.68 U	0.05379	0.042	< 0.29 U	1.61 J	< 0.86 U
8/21/2018	Assessment	< 0.01 U	0.52	29.0	0.428	0.06	0.406	13.6	1.059	< 0.083 U	0.338	0.0479	0.02 J	0.06 J	1.1	0.096
2/28/2019	Assessment	0.02 J	0.53	26.1	0.5 J	0.06	0.1 J	13.9	1.261	0.1 J	0.355	0.0591	0.027	< 0.4 U	1.5	< 0.1 U
5/22/2019	Assessment	< 0.4 U	< 0.6 U	25.6	< 0.4 U	< 0.2 U	< 0.8 U	15.5	0.832	0.1 J	< 0.4 U	0.0542	0.063	< 8 U	0.9 J	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.35	22.8	0.402	0.06	0.292	13.0	1.812	0.1 J	0.288	0.0560	0.044	< 0.4 U	0.8	0.1 J
3/11/2020	Assessment	< 0.02 U	0.52	21.9	0.499	0.08	0.247	17.7	0.1882	0.14	0.600	0.0476	0.056	4.37	1.5	0.1 J
6/3/2020	Assessment	< 0.02 U	0.45	19.7	0.474	0.07	0.243	16.5	1.412	0.15	0.389	0.0464	0.085	< 0.4 U	1.5	0.1 J
11/2/2020	Assessment	< 0.02 U	0.41	21.5	0.463	0.07	0.254	16.9	0.961	0.11	0.435	0.0490	0.037	< 0.4 U	1.3	0.1 J

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-4
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.02	1.63	4	< 0.083 U	5.4	23	148
7/14/2016	Background	0.02	2.32	4	< 0.083 U	4.9	20	157
9/8/2016	Background	0.02	2.37	5	< 0.083 U	4.9	20	136
10/13/2016	Background	0.03	2.87	6	< 0.083 U	4.1	19	164
11/15/2016	Background	0.04	2.71	5	< 0.083 U	4.3	19	152
1/12/2017	Background	0.03	2.94	5	< 0.083 U	4.8	18	148
3/1/2017	Background	0.03	2.86	4	< 0.083 U	4.7	18	148
4/10/2017	Background	0.04	1.91	5	< 0.083 U	4.4	21	140
8/24/2017	Detection	0.06229	2.04	5	< 0.083 U	4.6	20	94
3/22/2018	Assessment	0.0331	1.41	3	< 0.083 U	4.8	23	132
8/21/2018	Assessment	0.018	2.38	7	< 0.083 U	4.8	21	158
2/28/2019	Assessment	0.021	1.57	3.56	0.11	4.9	22.9	192
5/23/2019	Assessment	0.021	1.71	3.31	0.15	5.0	24.6	150
8/14/2019	Assessment	< 0.02 U	1.97	6.22	0.12	5.5	21.7	146
3/11/2020	Assessment	< 0.02 U	1.46	3.42	0.13	5.4	24.2	166
6/3/2020	Assessment	0.02 J	1.72	3.65	0.14	5.4	24.7	168
11/4/2020	Assessment	0.02 J	2.33	3.66	0.05 J	4.9	18.7	162

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-4
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	3.95918 J	75	1	0.133362 J	0.396808 J	8	0.729	< 0.083 U	< 0.68 U	0.013	0.00891 J	< 0.29 U	1.79183 J	< 0.86 U
7/14/2016	Background	< 0.93 U	8	127	1	< 0.07 U	3	9	4.271	< 0.083 U	< 0.68 U	0.041	0.037	< 0.29 U	1.73546 J	1.87362 J
9/8/2016	Background	< 0.93 U	5	123	1	0.111076 J	2	8	0.193	< 0.083 U	< 0.68 U	0.04	0.01151 J	< 0.29 U	< 0.99 U	< 0.86 U
10/13/2016	Background	< 0.93 U	11	183	0.830588 J	< 0.07 U	7	7	2.381	< 0.083 U	< 0.68 U	0.034	0.01005 J	< 0.29 U	1.60451 J	0.868603 J
11/15/2016	Background	< 0.93 U	< 1.05 U	114	0.53145 J	< 0.07 U	0.446412 J	6	1.072	< 0.083 U	< 0.68 U	0.035	0.01268 J	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	149	0.406228 J	< 0.07 U	0.305795 J	4.5062 J	2.599	< 0.083 U	< 0.68 U	0.03	0.01146 J	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	131	0.354085 J	< 0.07 U	< 0.23 U	4.45689 J	1.089	< 0.083 U	< 0.68 U	0.033	0.01224 J	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	94	0.915299 J	0.0796 J	0.240917 J	8	0.684	< 0.083 U	< 0.68 U	0.047	0.00554 J	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	66.74	1.15	0.26 J	< 0.23 U	9.39	1.283	< 0.083 U	< 0.68 U	0.05374	< 0.005 U	< 0.29 U	1.99 J	< 0.86 U
8/21/2018	Assessment	< 0.01 U	1.30	121	0.400	0.02 J	0.198	4.43	1.331	< 0.083 U	0.098	0.0294	0.005 J	< 0.02 U	0.04 J	0.096
2/28/2019	Assessment	< 0.02 U	0.26	70.5	0.9 J	0.01 J	0.1 J	6.92	0.818	0.11	0.106	0.0513	< 0.005 U	< 0.4 U	0.03 J	< 0.1 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	61.7	0.5 J	< 0.2 U	1 J	7.86	0.5173	0.15	< 0.4 U	0.0516	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U
8/14/2019	Assessment	< 0.02 U	0.17	73.5	1.04	< 0.01 U	0.08 J	6.52	0.833	0.12	0.06 J	0.0484	< 0.005 U	< 0.4 U	0.04 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	1.16	69.0	0.965	< 0.01 U	0.1 J	7.89	0.2327	0.13	0.06 J	0.0415	< 0.002 U	< 0.4 U	< 0.03 U	< 0.1 U
6/3/2020	Assessment	< 0.02 U	0.52	67.9	0.527	< 0.01 U	0.2 J	7.15	0.87	0.14	0.06 J	0.0380	< 0.002 U	< 0.4 U	< 0.03 U	< 0.1 U
11/4/2020	Assessment	0.03 J	5.30	124	0.922	0.03 J	0.433	4.40	1.45	0.05 J	0.402	0.0274	0.008	< 0.4 U	0.1 J	0.1 J

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	< 0.083 U	4.4	4	94
7/13/2016	Background	0.03	0.26	6	< 0.083 U	3.1	4	75
9/7/2016	Background	0.04	0.343	6	< 0.083 U	3.9	7	63
10/12/2016	Background	0.03	0.271	7	1	3.4	8	92
11/14/2016	Background	0.04	0.331	8	< 0.083 U	2.6	6	80
1/11/2017	Background	0.03	0.315	7	< 0.083 U	4.8	6	76
2/28/2017	Background	0.04	0.434	5	< 0.083 U	3.6	4	50
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	7	72
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	6	52
3/21/2018	Assessment	0.01397	0.269	5	< 0.083 U	4.2	3	< 2 U
8/20/2018	Assessment	0.017	0.338	10	< 0.083 U	4.4	4	94
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	3.6	36
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	4.0	80
8/12/2019	Assessment	< 0.02 U	0.278	7.24	0.06 J	4.9	2.6	90
3/10/2020	Assessment	0.02 J	0.3 J	6.08	0.10	4.9	3.7	62
6/2/2020	Assessment	< 0.02 U	0.2 J	5.63	0.10	4.0	3.9	91
11/2/2020	Assessment	0.03 J	0.3 J	4.65	0.08	4.3	3.3	74

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	< 1.05 U	26	0.219521 J	< 0.07 U	0.710981 J	1.58207 J	0.2073	< 0.083 U	< 0.68 U	< 0.00013 U	< 0.005 U	< 0.29 U	1.73953 J	< 0.86 U
7/13/2016	Background	< 0.93 U	< 1.05 U	23	0.190337 J	< 0.07 U	0.68835 J	1.29444 J	2.909	< 0.083 U	< 0.68 U	0.008	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	30	0.232192 J	< 0.07 U	0.353544 J	1.66591 J	0.881	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
10/12/2016	Background	< 0.93 U	< 1.05 U	27	0.149553 J	< 0.07 U	0.529033 J	1.56632 J	0.257	1	< 0.68 U	0.012	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
11/14/2016	Background	< 0.93 U	< 1.05 U	28	0.152375 J	< 0.07 U	0.32826 J	1.47282 J	0.767	< 0.083 U	< 0.68 U	0.013	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
1/11/2017	Background	< 0.93 U	< 1.05 U	23	0.126621 J	< 0.07 U	0.650158 J	1.09495 J	1.536	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
2/28/2017	Background	< 0.93 U	< 1.05 U	26	0.149219 J	< 0.07 U	0.325811 J	1.29984 J	0.416	< 0.083 U	< 0.68 U	0.009	< 0.005 U	< 0.29 U	< 0.99 U	0.994913 J
4/11/2017	Background	< 0.93 U	< 1.05 U	24	0.159412 J	< 0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	< 0.68 U	0.008	0.01364 J	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	< 1.05 U	25.82	0.16 J	< 0.07 U	1.05	1.49 J	0.784	< 0.083 U	< 0.68 U	0.00722	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
8/20/2018	Assessment	< 0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	< 0.083 U	0.089	0.0143	< 0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	< 0.4 U	< 0.6 U	22.5	< 0.4 U	< 0.2 U	< 0.8 U	1.37	0.225	0.09	< 0.4 U	0.00688	< 0.005 U	< 8 U	< 0.6 U	< 2 U
5/21/2019	Assessment	< 0.4 U	< 0.6 U	21.7	< 0.4 U	< 0.2 U	< 0.8 U	1.15	0.201	0.09	< 0.4 U	0.00576	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.07 J	23.8	0.154	< 0.01 U	0.204	1.30	0.237	0.06 J	0.08 J	0.00829	< 0.005 U	< 0.4 U	0.2 J	< 0.1 U
3/10/2020	Assessment	< 0.02 U	0.09 J	21.7	0.139	0.01 J	0.2 J	1.21	3.0706	0.10	0.09 J	0.00547	< 0.002 U	< 0.4 U	0.2	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.09 J	19.0	0.132	< 0.01 U	0.208	1.02	0.799	0.10	0.09 J	0.00505	< 0.002 U	< 0.4 U	0.3	< 0.1 U
11/2/2020	Assessment	0.05 J	0.09 J	18.9	0.122	< 0.01 U	0.204	1.04	0.929	0.08	0.09 J	0.00510	< 0.002 U	< 0.4 U	0.3	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-18
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	**mg/L**	**mg/L**	**mg/L**	**SU**	**mg/L**	**mg/L**
5/10/2016	Background	0.01	0.548	8	< 0.083 U	4.5	7	108
7/14/2016	Background	0.01	0.409	8	< 0.083 U	4.7	7	116
9/8/2016	Background	0.01	0.343	8	< 0.083 U	4.7	8	110
10/13/2016	Background	0.02	0.56	7	< 0.083 U	4.1	10	124
11/15/2016	Background	0.02	0.59	7	< 0.083 U	4.4	7	134
1/12/2017	Background	0.01	0.415	7	< 0.083 U	4.7	10	128
3/1/2017	Background	0.01	0.224	6	< 0.083 U	4.1	7	108
4/10/2017	Background	0.01	0.304	7	< 0.083 U	4.1	8	102
8/24/2017	Detection	0.0278	0.435	8	< 0.083 U	4.9	8	68
3/22/2018	Assessment	0.01642	0.292	6	< 0.083 U	5.4	6	100
8/21/2018	Assessment	0.012	0.321	10	< 0.083 U	5.1	8	118
2/28/2019	Assessment	< 0.02 U	0.490	8.19	0.02 J	5.0	6.1	84
5/23/2019	Assessment	0.013	0.684	8.82	0.02 J	5.2	10.6	104
8/13/2019	Assessment	< 0.02 U	0.647	8.49	0.01 J	5.2	6.6	90
3/11/2020	Assessment	< 0.02 U	0.3 J	7.34	0.02 J	4.4	6.1	90 J
6/3/2020	Assessment	< 0.02 U	0.2 J	8.30	0.03 J	4.5	6.3	119
11/4/2020	Assessment	< 0.02 U	0.2 J	6.30	0.02 J	4.4	6.3	100

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-18
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	< 0.93 U	< 1.05 U	157	0.262755 J	0.109247 J	1	1.82932 J	0.847	< 0.083 U	< 0.68 U	0.004	0.01536 J	< 0.29 U	1.71074 J	< 0.86 U
7/14/2016	Background	< 0.93 U	3.77261 J	139	0.243326 J	< 0.07 U	3	2.16037 J	3.264	< 0.083 U	< 0.68 U	0.02	0.064	0.41347 J	2.45009 J	< 0.86 U
9/8/2016	Background	< 0.93 U	< 1.05 U	115	0.226343 J	< 0.07 U	0.779959 J	1.09947 J	1.105	< 0.083 U	< 0.68 U	0.019	0.03	< 0.29 U	< 0.99 U	< 0.86 U
10/13/2016	Background	< 0.93 U	< 1.05 U	112	0.192611 J	< 0.07 U	0.631027 J	2.24885 J	1.161	< 0.083 U	< 0.68 U	0.026	0.01416 J	< 0.29 U	< 0.99 U	< 0.86 U
11/15/2016	Background	< 0.93 U	< 1.05 U	94	0.107171 J	< 0.07 U	0.724569 J	1.66054 J	1.486	< 0.083 U	< 0.68 U	0.017	0.029	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	99	0.169196 J	< 0.07 U	0.411433 J	1.62881 J	0.976	< 0.083 U	< 0.68 U	0.026	0.01887 J	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	99	0.105337 J	< 0.07 U	0.572874 J	0.976724 J	0.468	< 0.083 U	< 0.68 U	0.017	0.01086 J	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	105	0.130316 J	< 0.07 U	0.967681 J	0.98157 J	0.648	< 0.083 U	< 0.68 U	0.019	0.0096 J	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	97.75	0.09 J	< 0.07 U	< 0.23 U	0.97 J	0.942	< 0.083 U	< 0.68 U	0.01647	0.006 J	< 0.29 U	1.53 J	< 0.86 U
8/21/2018	Assessment	0.02 J	1.01	99.8	0.129	0.02 J	0.809	1.18	1.108	< 0.083 U	0.280	0.0175	0.014 J	0.08 J	0.2	0.060
2/28/2019	Assessment	< 0.4 U	< 0.6 U	106	< 0.4 U	< 0.2 U	< 0.8 U	1.11	0.615	0.02 J	0.7 J	0.0177	0.009 J	< 8 U	< 0.6 U	< 2 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	131	< 0.4 U	< 0.2 U	< 0.8 U	1.47	0.492	0.02 J	< 0.4 U	0.0209	0.009 J	< 8 U	< 0.6 U	< 0.1 U
8/13/2019	Assessment	< 0.02 U	0.45	100	0.118	0.02 J	0.212	1.25	0.473	0.01 J	0.2 J	0.0183	0.023 J	< 0.4 U	0.09 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.09 J	97.1	0.09 J	0.01 J	0.1 J	0.948	4.813	0.02 J	< 0.05 U	0.0134	0.003 J	< 0.4 U	0.05 J	< 0.1 U
6/3/2020	Assessment	< 0.02 U	0.22	100	0.1 J	0.01 J	0.2 J	0.950	0.728	0.03 J	0.06 J	0.0132	0.007	< 0.4 U	0.09 J	< 0.1 U
11/4/2020	Assessment	< 0.02 U	0.29	89.3	0.08 J	0.01 J	0.1 J	0.917	1.169	0.02 J	0.06 J	0.0128	0.028	< 0.4 U	0.2 J	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-31
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.08	10.4	18	< 0.083 U	4.5	63	286
7/13/2016	Background	0.03	4.27	18	< 0.083 U	3.5	66	245
9/7/2016	Background	0.03	3.47	18	< 0.083 U	3.7	60	260
10/12/2016	Background	0.04	4.41	18	< 0.083 U	4.0	62	276
11/14/2016	Background	0.04	4.7	18	< 0.083 U	3.2	66	266
1/11/2017	Background	0.03	4.43	19	< 0.083 U	4.4	79	252
2/28/2017	Background	0.04	3.89	14	< 0.083 U	3.6	68	212
4/11/2017	Background	0.04	3.64	16	< 0.083 U	3.6	69	252
8/23/2017	Detection	0.01752	2.24	18	< 0.083 U	4.5	52	228
12/21/2017	Detection	--	--	20	< 0.083 U	--	58	224
3/22/2018	Assessment	0.04078	3.11	16	< 0.083 U	4.5	76	260
8/21/2018	Assessment	0.022	2.86	25	< 0.083 U	4.9	72	274
2/28/2019	Assessment	0.03 J	2.77	18.8	0.1 J	5.0	74.8	74
5/23/2019	Assessment	0.021	3.29	18.7	0.13	5.1	79.9	240
8/12/2019	Assessment	< 0.02 U	2.86	21.6	0.16	4.1	70.0	250
3/10/2020	Assessment	0.03 J	2.80	21.7	0.14	3.5	74.6	246
6/2/2020	Assessment	0.02 J	2.92	22.1	0.16	4.2	81.4	288
11/2/2020	Assessment	0.03 J	2.76	21.2	0.13	3.7	77.8	268

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-31
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	93	712	10	0.858875 J	212	50	7.32	< 0.083 U	57	0.077	1.797	0.893978 J	1.84045 J	< 0.86 U
7/13/2016	Background	< 0.93 U	3.41559 J	69	1	< 0.07 U	10	11	3.38	< 0.083 U	< 0.68 U	0.096	0.32	0.316083 J	1.11301 J	< 0.86 U
9/7/2016	Background	< 0.93 U	4.34007 J	88	2	< 0.07 U	15	11	2.345	< 0.083 U	< 0.68 U	0.094	0.284	< 0.29 U	< 0.99 U	< 0.86 U
10/12/2016	Background	< 0.93 U	6	76	1	< 0.07 U	14	11	3.88	< 0.083 U	1.54023 J	0.097	0.347	< 0.29 U	< 0.99 U	< 0.86 U
11/14/2016	Background	< 0.93 U	11	125	2	0.174662 J	30	14	3.202	< 0.083 U	3.93298 J	0.096	0.523	0.401556 J	1.03392 J	< 0.86 U
1/11/2017	Background	< 0.93 U	3.92088 J	77	1	< 0.07 U	12	10	2.725	< 0.083 U	< 0.68 U	0.093	0.384	< 0.29 U	< 0.99 U	1.01921 J
2/28/2017	Background	< 0.93 U	< 1.05 U	44	0.998308 J	< 0.07 U	3	9	2.684	< 0.083 U	< 0.68 U	0.09	0.138	< 0.29 U	< 0.99 U	< 0.86 U
4/11/2017	Background	< 0.93 U	3.31744 J	73	1	0.0944 J	12	11	3.521	< 0.083 U	< 0.68 U	0.097	0.333	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	3.32 J	70.83	1.24	0.12 J	9.62	11.12	2.955	< 0.083 U	< 0.68 U	0.09732	1.389	< 0.29 U	1.98 J	< 0.86 U
8/21/2018	Assessment	0.02 J	1.92	57.7	0.729	0.06	2.39	9.29	4.13	< 0.083 U	1.41	0.0556	1.112	0.24	2.5	0.113
2/28/2019	Assessment	< 0.4 U	< 0.6 U	33.1	1 J	< 0.2 U	< 0.8 U	9.38	3.156	0.1 J	< 0.4 U	0.0864	0.01 J	< 8 U	< 0.6 U	< 2 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	37.9	0.9 J	< 0.2 U	< 0.8 U	10.3	3.4	0.13	< 0.4 U	0.0928	0.057	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.53	35.0	0.850	0.06	0.365	8.69	2.196	0.16	0.325	0.0875	1.027	< 0.4 U	0.4	< 0.1 U
3/10/2020	Assessment	< 0.02 U	0.27	34.8	0.835	0.07	0.357	9.56	3.814	0.14	0.260	0.0669	0.183	< 0.4 U	0.4	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.21	32.7	0.868	0.06	0.292	9.62	2.656	0.16	0.2 J	0.0682	0.046	< 0.4 U	0.4	< 0.1 U
11/2/2020	Assessment	< 0.02 U	0.26	34.0	1.10	0.07	0.2 J	11.2	3.02	0.13	0.211	0.0895	0.144	< 0.4 U	0.3	0.1 J

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-32
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.708	7.41	12	< 0.083 U	4.3	124	206
7/13/2016	Background	5.23	33.9	32	0.67 J	3.3	461	835
9/7/2016	Background	5.78	37.4	35	< 0.083 U	3.1	479	884
10/12/2016	Background	4.26	27.1	29	0.8585 J	3.3	430	720
11/14/2016	Background	5.52	35.9	34	0.7468 J	3.0	621	922
1/11/2017	Background	5.05	40	35	< 0.083 U	3.9	683	894
2/28/2017	Background	2.73	18.4	19	< 0.083 U	3.1	285	490
4/11/2017	Background	1.46	11	15	0.4468 J	3.2	200	372
8/23/2017	Detection	0.716	7.15	14	1.962	4.3	115	288
12/21/2017	Detection	2.56	17.1	22	0.5932 J	--	324	504
3/21/2018	Assessment	0.628	6.32	15	< 0.083 U	4.1	113	288
8/21/2018	Assessment	2.45	17.8	28	< 0.083 U	3.9	321	548
2/28/2019	Assessment	0.679	6.62	17.5	0.40	3.2	121	222
5/21/2019	Assessment	0.555	5.35	18.6	0.31	3.2	105	292
8/16/2019	Assessment	1.92	14.6	26.1	0.83	4.0	273	522
3/10/2020	Assessment	0.656	6.84	20.5	0.39	3.7	117	286
6/2/2020	Assessment	0.557	5.75	24.1	0.41	3.9	93.6	327
11/2/2020	Assessment	4.04	34.3	36.2	1.40	3.4	690	1,070

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-32
Pirkey - EBAP
Appendix IV Constituents

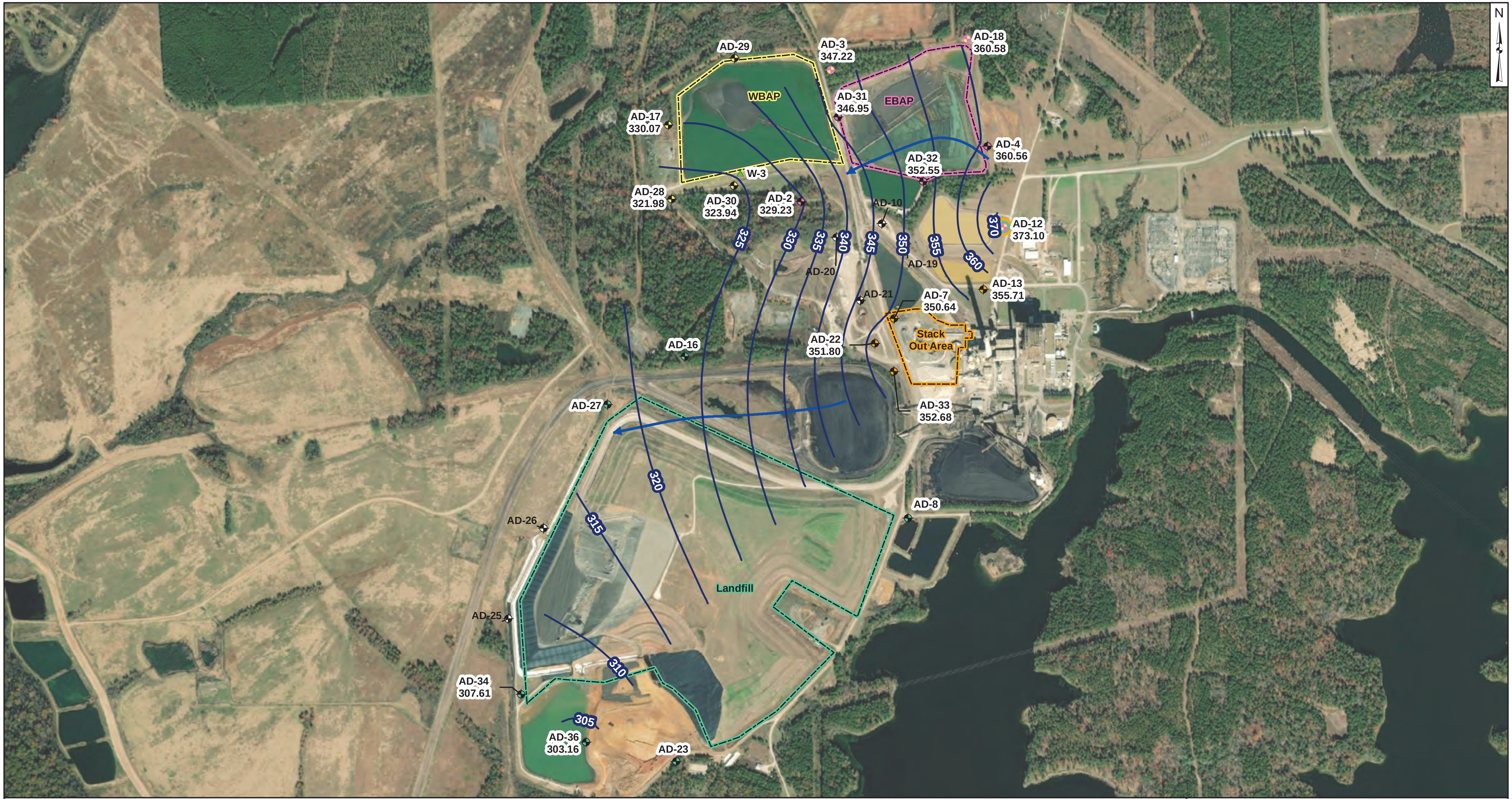
Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	3.77019 J	35	3	0.293016 J	5	27	2.501	< 0.083 U	< 0.68 U	0.016	0.925	< 0.29 U	< 0.99 U	< 0.86 U
7/13/2016	Background	< 0.93 U	13	58	8	0.729634 J	18	74	6.41	0.67 J	< 0.68 U	0.119	13.916	0.76212 J	3.88793 J	< 0.86 U
9/7/2016	Background	< 0.93 U	3.25886 J	35	8	0.601583 J	6	70	4.846	< 0.083 U	< 0.68 U	0.111	1.68	< 0.29 U	< 0.99 U	1.09263 J
10/12/2016	Background	< 0.93 U	10	50	7	0.589066 J	15	65	17.32	0.8585 J	< 0.68 U	0.972	7.285	< 0.29 U	1.93488 J	< 0.86 U
11/14/2016	Background	< 0.93 U	6	37	9	0.78793 J	8	75	3.731	0.7468 J	< 0.68 U	0.114	3.624	< 0.29 U	< 0.99 U	1.078 J
1/11/2017	Background	< 0.93 U	6	37	7	0.602157 J	9	69	4.342	< 0.083 U	< 0.68 U	0.115	7.202	< 0.29 U	< 0.99 U	0.991051 J
2/28/2017	Background	< 0.93 U	4.56273 J	30	5	0.389491 J	5	45	4.001	< 0.083 U	< 0.68 U	0.095	7.927	< 0.29 U	2.53854 J	< 0.86 U
4/11/2017	Background	< 0.93 U	< 1.05 U	26	4	0.440252 J	3	35	4.32	0.4468 J	< 0.68 U	0.095	2.755	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	3.05 J	41.25	3.17	0.55 J	5.38	25.8	4.922	< 0.083 U	< 0.68 U	0.103	6.4	< 0.29 U	2.18 J	< 0.86 U
8/21/2018	Assessment	0.01 J	4.81	17.2	3.70	0.47	0.646	43.5	6.01	< 0.083 U	0.714	0.0689	2.649	0.04 J	15.0	0.238
2/28/2019	Assessment	< 0.4 U	2 J	28.9	3.34	0.2 J	2 J	25.0	4.67	0.40	< 0.4 U	0.0919	1.135	< 8 U	3 J	< 2 U
5/21/2019	Assessment	< 0.4 U	0.8 J	35.6	2.77	0.3 J	1 J	23.5	5.37	0.31	0.4 J	0.0897	1.371	< 8 U	1 J	0.2 J
8/16/2019	Assessment	< 0.1 U	3.43	38.5	4.88	0.46	1.70	40.4	5.7	0.83	0.996	0.103	4.127	< 2 U	7.8	0.2 J
3/10/2020	Assessment	< 0.02 U	0.88	28.7	2.51	0.30	0.379	23.9	5.741	0.39	0.343	0.0711	1.70	< 0.4 U	2.6	0.2 J
6/2/2020	Assessment	< 0.02 U	0.98	31.9	2.35	0.25	0.675	20.8	4.445	0.41	0.405	0.0696	3.97	< 0.4 U	2.3	0.2 J
11/2/2020	Assessment	0.02 J	6.29	22.0	8.90	0.79	1.17	74.0	8.88	1.40	1.23	0.0987	1.40	< 0.4 U	25.3	0.4 J

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1: Residence Time Calculation Summary
Pirkey East Bottom Ash Pond

			2020-03		**2020-06**		**2020-11**	
CCR Management Unit	Monitoring Well	Well Diameter (inches)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
East Bottom Ash Pond	AD-2 [2]	4.0	32.0	3.8	26.9	4.5	24.6	5.0
	AD-4 [1]	4.0	7.2	16.9	10.4	11.7	4.9	24.8
	AD-12 [1]	4.0	35.1	3.5	20.1	6.0	26.9	4.5
	AD-18 [1]	2.0	9.2	6.6	10.1	6.0	10.8	5.6
	AD-31 [2]	2.0	24.3	2.5	26.6	2.3	23.5	2.6
	AD-32 [2]	2.0	21.7	2.8	21.0	2.9	13.8	4.4

Notes:
[1] - Background Well
[2] - Downgradient Well



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on March 10-11, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-16, AD-27, and AD-29 were not gauged in March 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

Potentiometric Contours - Uppermost Aquifer March 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure

1

Columbus, Ohio

2020/06/12

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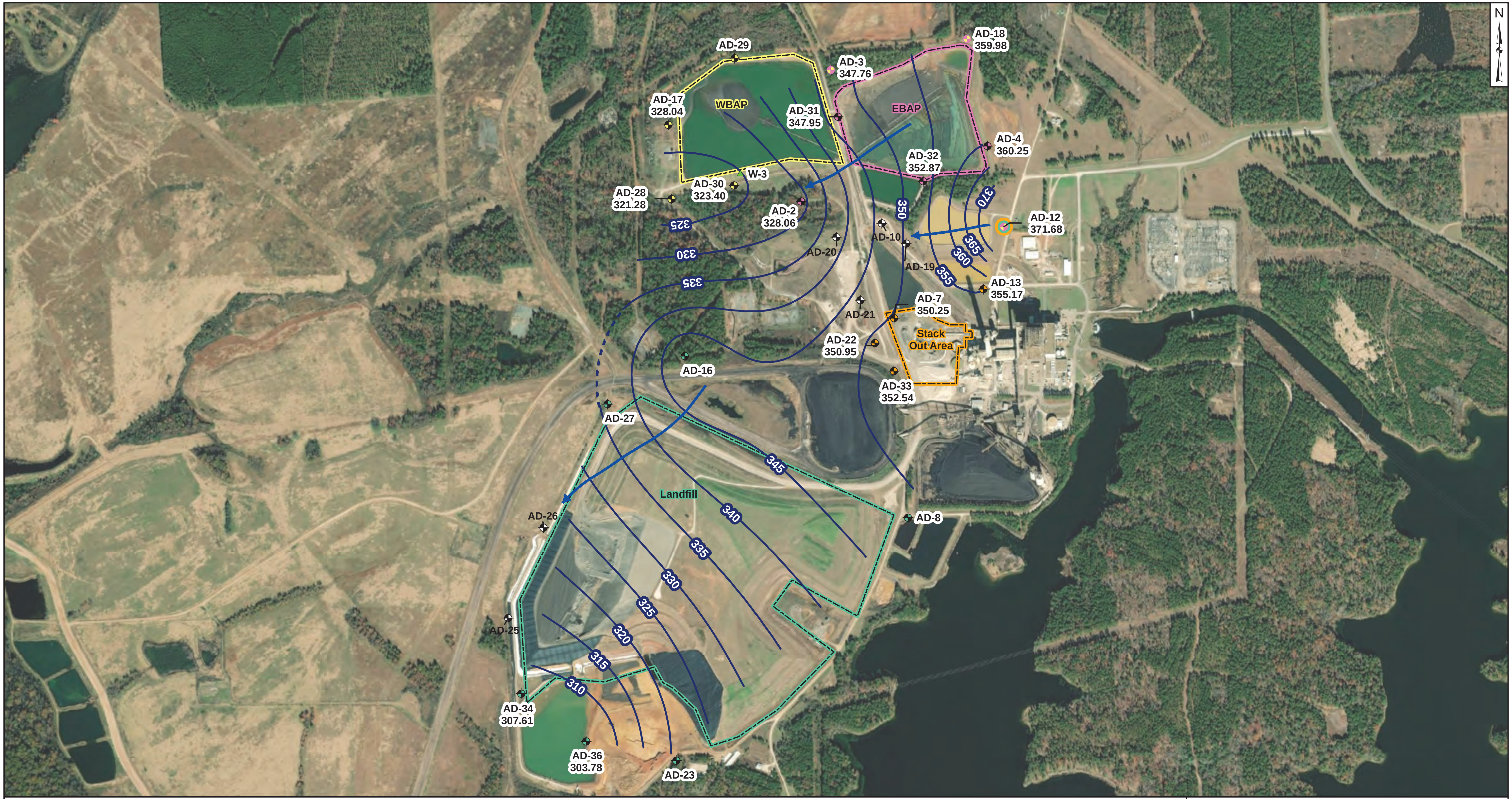

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on June 2 - 3, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-8, AD-16, AD-23, AD-27, and AD-29 were not gauged in June 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer June 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2020/11/13

Figure

2

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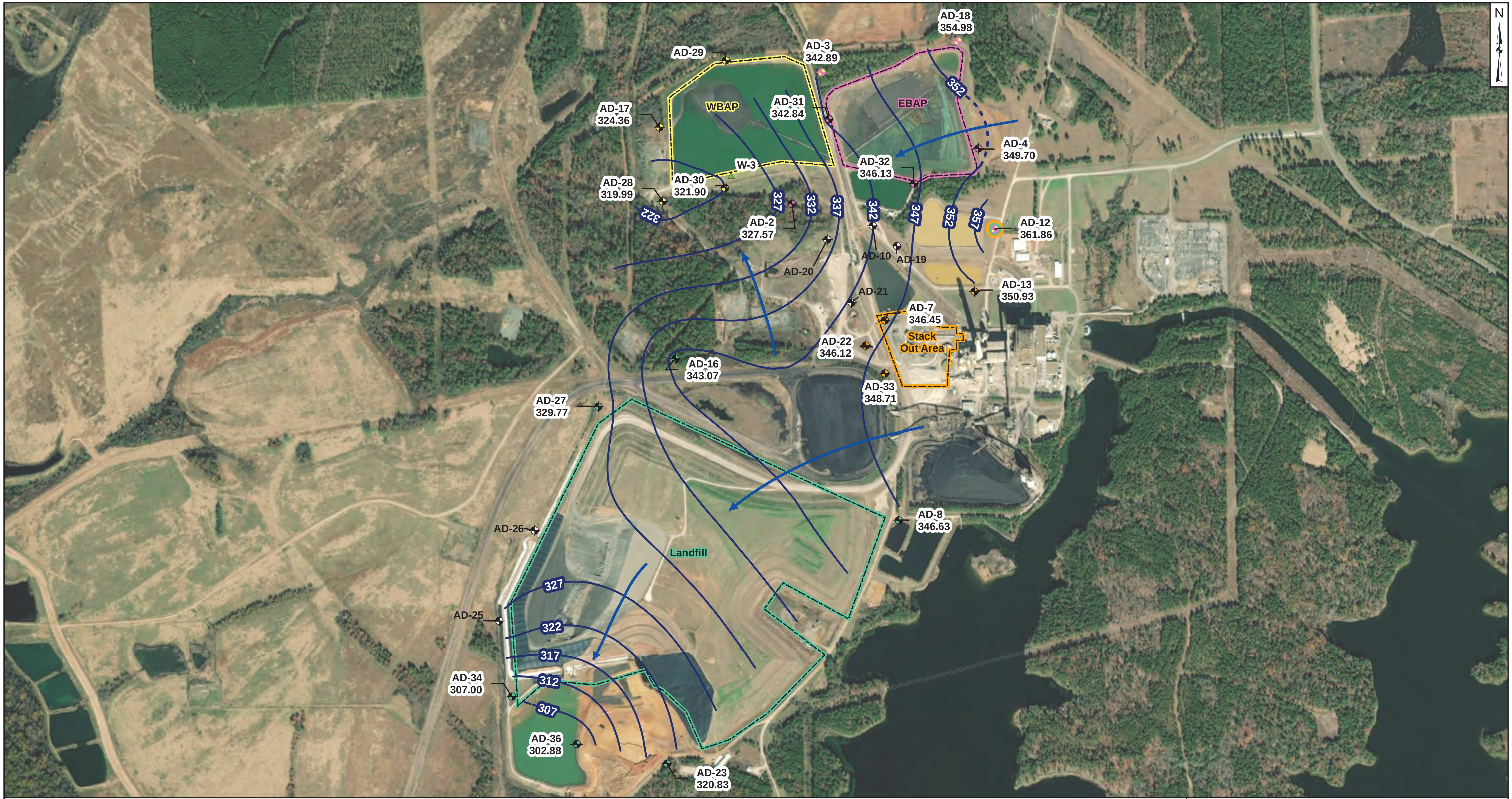

Legend

Groundwater Monitoring Wells

- ◈ Out of Network
- ◈ EBAP
- ◈ WBAP
- ◈ Landfill
- ◈ Stackout Area
- ◈ EBAP and WBAP

- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on November 2-4, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 and AD-29 were not gauged in November 2020.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
November 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio | 2021/01/06

Figure
3

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APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
EAST BOTTOM ASH POND
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

October 2, 2020

CHA8500

TABLE OF CONTENTS

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LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the East Bottom Ash Pond (EBAP), an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, calcium, chloride, total dissolved solids (TDS), and sulfate at the EBAP. An alternative source was not identified at the time, so the EBAP has been in assessment monitoring since. During the most recent assessment monitoring event, completed in August 2019, SSLs were identified for cobalt and lithium (Geosyntec, 2019). An alternative source demonstration (ASD) was successfully completed per 40 CFR 257.95(g)(3); therefore, the EBAP remained in assessment monitoring. Two assessment monitoring events were conducted at the EBAP in March and June 2020 in accordance with 40 CFR 257.95. The results of these assessment events are documented in this report.

Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact data usability.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. SSLs were identified for cobalt, lithium, and mercury. Thus, either the unit will move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

EAST BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (March 2020) and 257.95(d)(1) (June 2020). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events are presented in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.26 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the EBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained in March and June 2020 were screened for potential outliers. No outliers were identified for these events.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Tolerance limits were calculated parametrically with 95% coverage and 95% confidence for chromium, combined radium, and lithium. Non-parametric tolerance limits were calculated for barium, beryllium, cobalt, and mercury due to apparent non-normal distributions and for antimony, arsenic, cadmium, fluoride, lead, molybdenum, selenium, and thallium due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey EBAP:

- The LCL for cobalt exceeded the GWPS of 0.00939 mg/L at AD-2 (0.0100 mg/L), AD-31 (0.00942 mg/L), and AD-32 (0.0239 mg/L).
- The LCL for lithium exceeded the GWPS of 0.060 mg/L at AD-31 (0.0682 mg/L) and AD-32 (0.0770 mg/L).
- The LCL for mercury exceeded the GWPs of 0.00200 mg/L at AD-32 (0.00204 mg/L).

As a result, the Pirkey EBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the June 2020 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0510 mg/L at AD-2 (2.44 mg/L) and AD-32 (0.557 mg/L).
- Calcium concentrations exceeded the interwell UPL of 2.94 mg/L at AD-32 (5.75 mg/L).
- Chloride concentrations exceeded the interwell UPL of 9.16 mg/L at AD-2 (29.3 mg/L), AD-31 (22.1 mg/L) and AD-32 (24.1 mg/L).

- Sulfate concentrations exceeded the interwell UPL of 23.0 mg/L at AD-2 (174 mg/L), AD-31 (81.4 mg/L), and AD-32 (93.6 mg/L).

- TDS concentrations exceeded the interwell UPL of 176 mg/L at AD-2 (387 mg/L), AD-31 (288 mg/L), and AD-32 (327 mg/L).

While the prediction limits were calculated for a one-of-two retesting procedure, SSIs were conservatively assumed if the June 2020 sample was above the UPL or below the LPL. Based on these results, concentrations of Appendix III constituents appear to be above background concentrations.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the March and June 2020 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. SSLs were identified for cobalt, lithium, and mercury. Appendix III parameters were compared to calculated prediction limits, with exceedances identified for boron, calcium, chloride, sulfate, and TDS.

Based on this evaluation, the Pirkey EBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2019. Statistical Analysis Summary – East Bottom Ash Pond, H.W. Pirkey Plant. December.

TABLES

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-2		AD-4		AD-12		AD-18		AD-31		AD-32	
		3/11/2020	6/3/2020	3/11/2020	6/3/2020	3/10/2020	6/2/2020	3/11/2020	6/3/2020	3/10/2020	6/2/2020	3/10/2020	6/2/2020
Antimony	µg/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Arsenic	µg/L	0.52	0.45	1.16	0.52	0.09 J	0.09 J	0.09 J	0.22	0.27	0.21	0.88	0.98
Barium	µg/L	21.9	19.7	69.0	67.9	21.7	19.0	97.1	100	34.8	32.7	28.7	31.9
Beryllium	µg/L	0.499	0.474	0.965	0.527	0.139	0.132	0.09 J	0.1 J	0.835	0.868	2.51	2.35
Boron	mg/L	2.78	2.44	0.05 U	0.02 J	0.02 J	0.05 U	0.05 U	0.05 U	0.03 J	0.02 J	0.656	0.557
Cadmium	µg/L	0.08	0.07	0.05 U	0.05 U	0.01 J	0.05 U	0.01 J	0.01 J	0.07	0.06	0.30	0.25
Calcium	mg/L	2.50	2.44	1.46	1.72	0.3 J	0.2 J	0.3 J	0.2 J	2.80	2.92	6.84	5.75
Chloride	mg/L	29.7	29.3	3.42	3.65	6.08	5.63	7.34	8.30	21.7	22.1	20.5	24.1
Chromium	µg/L	0.247	0.243	0.1 J	0.2 J	0.2 J	0.208	0.1 J	0.2 J	0.357	0.292	0.379	0.675
Cobalt	µg/L	17.7	16.5	7.89	7.15	1.21	1.02	0.948	0.950	9.56	9.62	23.9	20.8
Combined Radium	pCi/L	0.1882	1.412	0.2327	0.87	3.0706	0.799	4.813	0.728	3.814	2.656	5.741	4.445
Fluoride	mg/L	0.14	0.15	0.13	0.14	0.10	0.10	0.02 J	0.03 J	0.14	0.16	0.39	0.41
Lead	µg/L	0.600	0.389	0.06 J	0.06 J	0.09 J	0.09 J	0.2 U	0.06 J	0.260	0.2 J	0.343	0.405
Lithium	mg/L	0.0476	0.0464	0.0415	0.0380	0.00547	0.00505	0.0134	0.0132	0.0669	0.0682	0.0711	0.0696
Mercury	µg/L	0.056	0.085	0.005 U	0.005 U	0.005 U	0.005 U	0.003 J	0.007	0.183	0.046	1.70	3.97
Molybdenum	µg/L	4.37	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Selenium	µg/L	1.5	1.5	0.2 U	0.2 U	0.2	0.3	0.05 J	0.09 J	0.4	0.4	2.6	2.3
Sulfate	mg/L	178	174	24.2	24.7	3.7	3.9	6.1	6.3	74.6	81.4	117	93.6
Thallium	µg/L	0.1 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	0.2 J
Total Dissolved Solids	mg/L	374	387	166	168	62	91	90 J	119	246	288	286	327
pH	SU	4.0	4.6	5.4	5.4	4.9	4.0	4.4	4.5	3.5	4.2	3.7	3.9

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.

Table 2: Groundwater Protection Standards
Pirkey Plant - East Bottom Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.0050
Arsenic, Total (mg/L)	0.01		0.011
Barium, Total (mg/L)	2		0.18
Beryllium, Total (mg/L)	0.004		0.0020
Cadmium, Total (mg/L)	0.005		0.0010
Chromium, Total (mg/L)	0.1		0.003
Cobalt, Total (mg/L)	n/a	0.006	0.0094
Combined Radium, Total (pCi/L)	5		4.60
Fluoride, Total (mg/L)	4		1.0
Lead, Total (mg/L)	0.015		0.0050
Lithium, Total (mg/L)	n/a	0.04	0.060
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.040
Selenium, Total (mg/L)	0.05		0.0050
Thallium, Total (mg/L)	0.002		0.0020

Notes:

Grey cell indicates calculated UTL is higher than MCL or CCR Rule-specified value.

MCL = Maximum Contaminant Level

Calculated UTL (Upper Tolerance Limit) represents site-specific background values.

The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3 - Appendix III Data Summary
Pirkey Plant - East Bottom Ash Pond

Analyte	Unit	Description	AD-2	AD-31	AD-32
			6/3/2020	6/2/2020	6/2/2020
Boron	mg/L	Interwell Background Value (UPL)	0.0510		
		Analytical Result	**2.44**	0.02	**0.557**
Calcium	mg/L	Interwell Background Value (UPL)	2.94		
		Analytical Result	2.44	2.92	**5.75**
Chloride	mg/L	Interwell Background Value (UPL)	9.16		
		Analytical Result	**29.3**	**22.1**	**24.1**
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
		Analytical Result	0.15	0.16	0.41
pH	SU	Intrawell Background Value (UPL)	4.8	5.4	4.6
		Intrawell Background Value (LPL)	3.3	2.8	2.5
		Analytical Result	4.6	4.2	3.9
Sulfate	mg/L	Interwell Background Value (UPL)	23.0		
		Analytical Result	**174**	**81.4**	**93.6**
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	176		
		Analytical Result	**387**	**288**	**327**

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

10.02.2020
Date

DAVID ANTHONY MILLER
112498

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

September 8, 2020

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey East Bottom Ash Pond
Assessment Monitoring Event – June 2020

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the evaluation of groundwater data from the Spring 2020 sample event for American Electric Power Company's Pirkey East Bottom Ash Pond (EBAP). The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling at each of the wells below began at Pirkey EBAP for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-4, AD-12, and AD-18
- **Downgradient wells:** AD-2, AD-31, and AD-32A

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC. The statistical analysis was reviewed Kristina Rayner, Groundwater Statistician and Founder of Groundwater Stats Consulting.

The CCR program consists of the following Assessment monitoring constituents:

- **Appendix IV –** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium

Time series plots and box plots for Appendix IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B).

Background Screening

Prior to constructing statistical limits, background data are screened through time series plots for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Values identified as outliers are flagged with (o) and displayed in a lighter font and disconnected symbol on the time series graphs. A summary of flagged outliers is included as Figure C.

For the current analysis, all data through June 2020 were screened, including data from downgradient wells. For the downgradient well data that are used to construct confidence intervals, a regulatory conservative approach is taken in that values that are marginally high relative to the rest of the data are retained unless there is particular justification for excluding them. Several outliers were flagged as a result of changes in reporting limits as follows.

A number of constituents in well AD-31 during the May 2016 event had higher reported concentrations compared to other reported values in this well for the same constituents, and therefore; these concentrations flagged as outliers. During the August 2019 event, a value of 0.015 mg/L was reported for selenium at well AD-32. That value was flagged as an outlier during this analysis since the reported value during the February 2019 event was significantly lower (0.003 mg/L) and similar to historical concentrations. The reporting limit during the February 2019 event for molybdenum at wells AD-12, AD-18, AD-31 and AD-32 was 0.04 mg/L, which is lower than the CCR Rule-Specified level of 0.1 mg/L. Therefore, these values were not considered outliers at this time. Wells AD-2 and AD-4 had a reporting limit of 0.002 mg/L during this event.

Summary of Statistical Methods

Assessment monitoring for Appendix IV parameters involves the comparison of a confidence interval for each parameter at each downgradient well against the corresponding Groundwater Protection Standard (GWPS). If, and only if, the entire confidence interval exceeds the GWPS, the well/constituent is considered to exceed its standard. The GWPS is determined for each parameter as the largest of the Maximum Contaminant Levels (MCLs), CCR Rule-Specified levels, or background limits determined from tolerance limits constructed from pooled upgradient well data.

Prior to computing tolerance limits on upgradient well data or confidence intervals on downgradient well data, the distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric tolerance limits and confidence intervals as appropriate, based on the following criteria.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, the reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory. There is no replacement of historical reporting limits with the most recent reporting limit. For several constituents, the most recent reporting limits are significantly lower than those reported historically. This is the most conservative approach for tolerance limits and confidence intervals at this site.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric tolerance limits are used on data containing greater than 50% nondetects.

Evaluation of Appendix IV Parameters

When data followed a normal or transformed-normal distribution, parametric tolerance limits were used to calculate background limits for Appendix IV parameters using pooled upgradient well data through June 2020 with a target of 95% confidence and 95% coverage (Figure D). Nonparametric tolerance limits are constructed when data do not follow a normal or transformed-normal distribution or when there are greater than 50% nondetects. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These background limits were then compared to the Maximum Contaminant Levels (MCLs) and CCR Rule-Specified levels to determine the highest limit for use as the GWPS in the confidence interval comparisons (Figure E).

Confidence intervals were then constructed on downgradient wells with data through June 2020 for each of the Appendix IV parameters using either parametric or nonparametric intervals depending on the data distribution and percentage of nondetects, similar to the logic used to construct tolerance limits as discussed above (Figure F). Each confidence interval was compared with the corresponding GWPS from Figure E. Only when the entire confidence interval is above the GWPS is the well/constituent pair considered to exceed its respective standard. Both a tabular summary and graphical presentation of the confidence interval results follow this letter. Exceedances were noted for the following well/constituent pairs:

- Cobalt: AD-2, AD-31, and AD-32
- Lithium: AD-31 and AD-32
- Mercury: AD-32

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey EBAP. If you have any questions or comments, please feel free to contact us.

For Groundwater Stats Consulting,

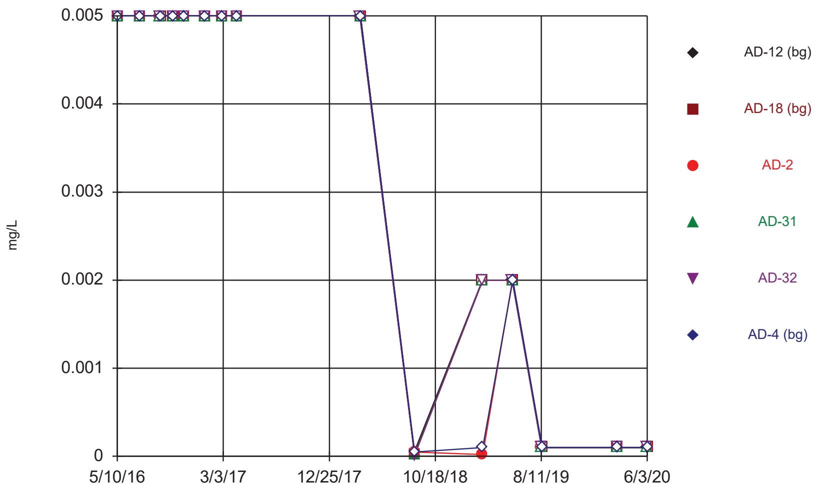
Kristina Rayner

Easton Rayner
Groundwater Analyst

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

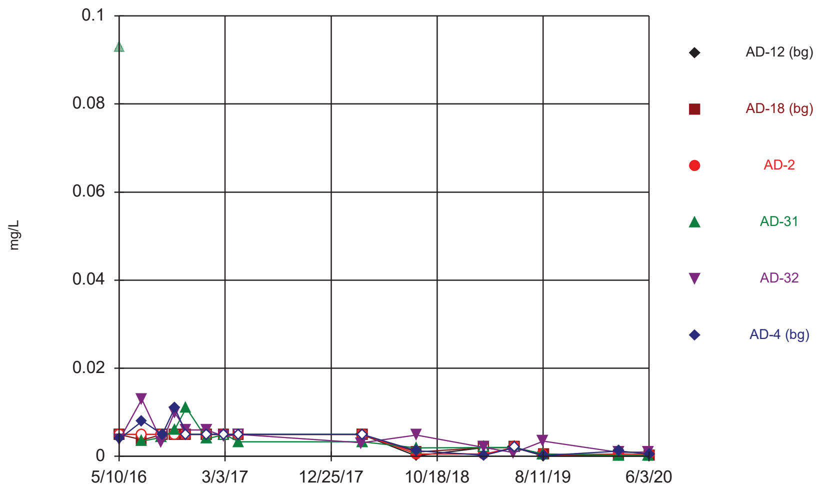
Time Series



Constituent: Antimony, total   Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

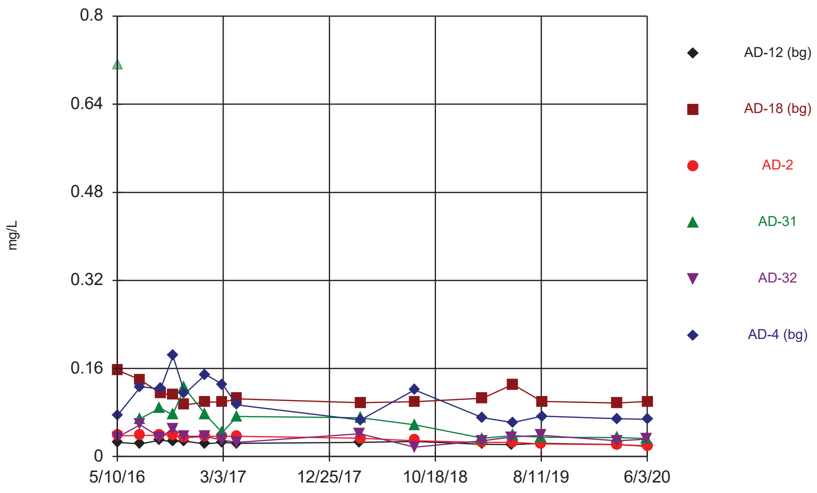
Time Series



Constituent: Arsenic, total   Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

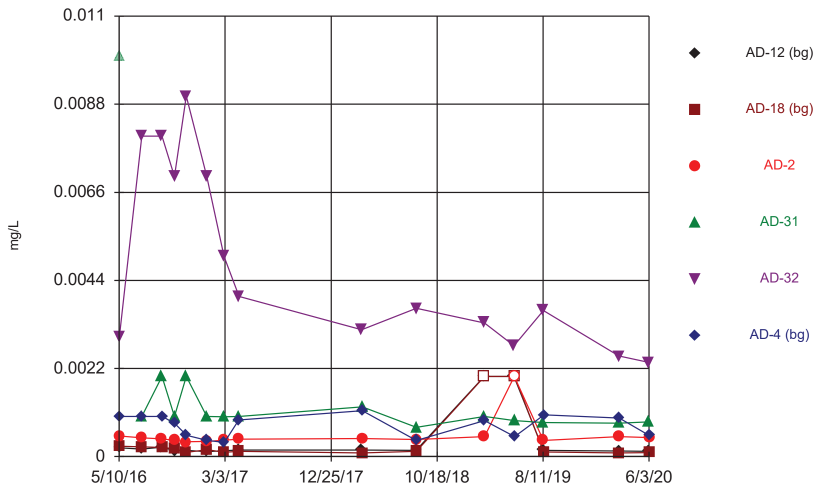
Time Series



Constituent: Barium, total   Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

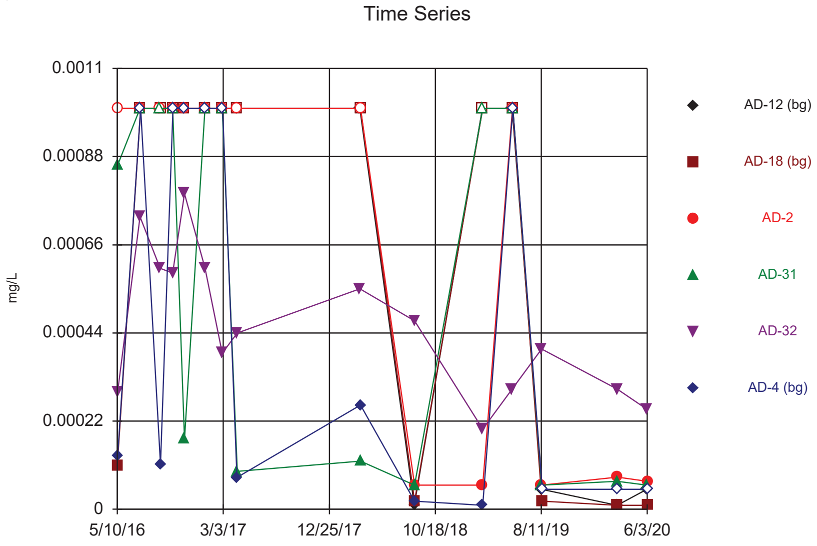
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



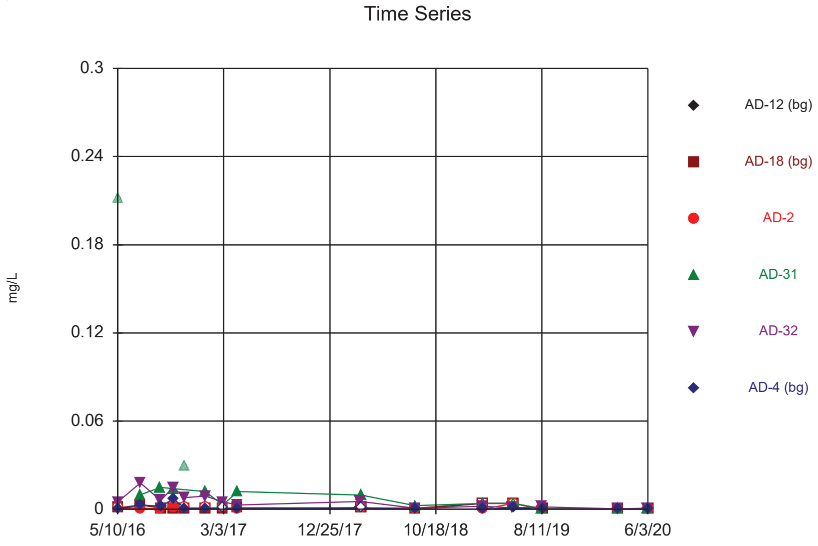
Constituent: Beryllium, total   Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



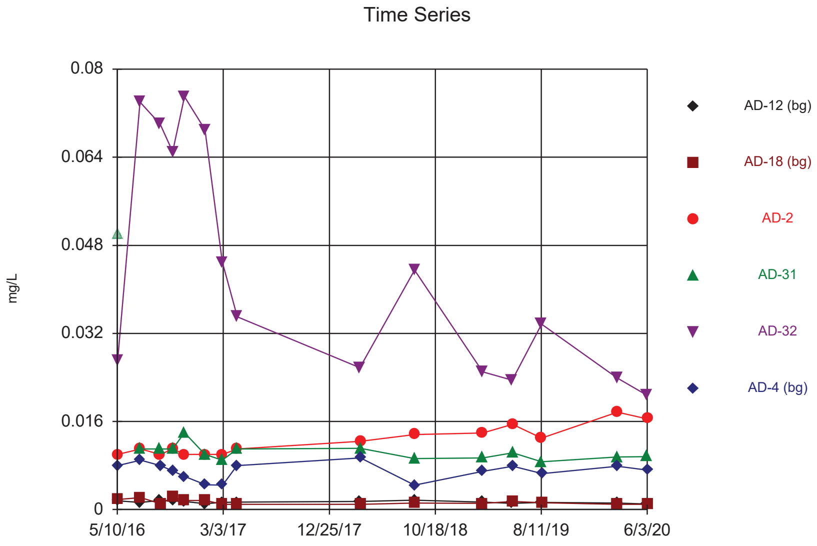
Constituent: Cadmium, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



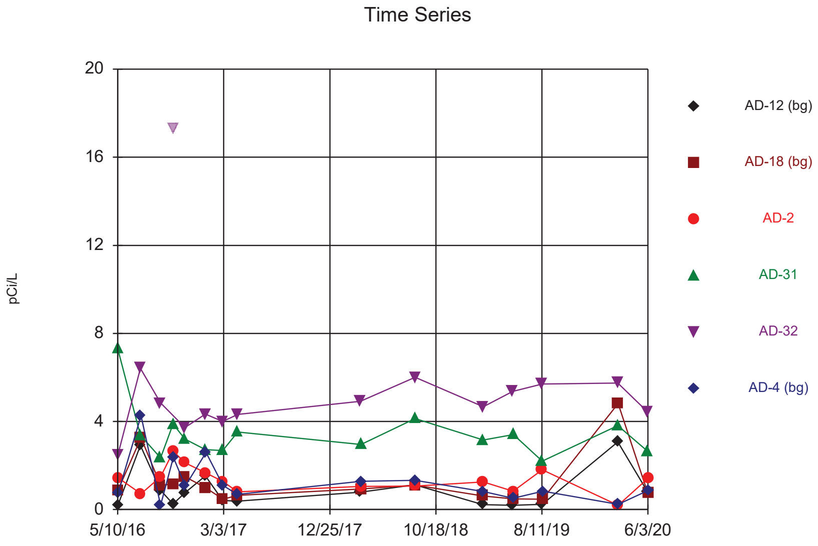
Constituent: Chromium, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG



Constituent: Cobalt, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

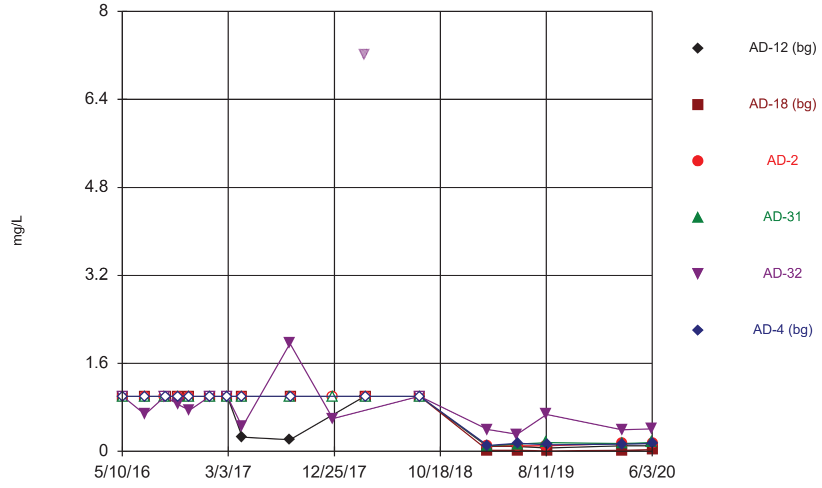
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG



Constituent: Combined Radium 226 + 228 Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

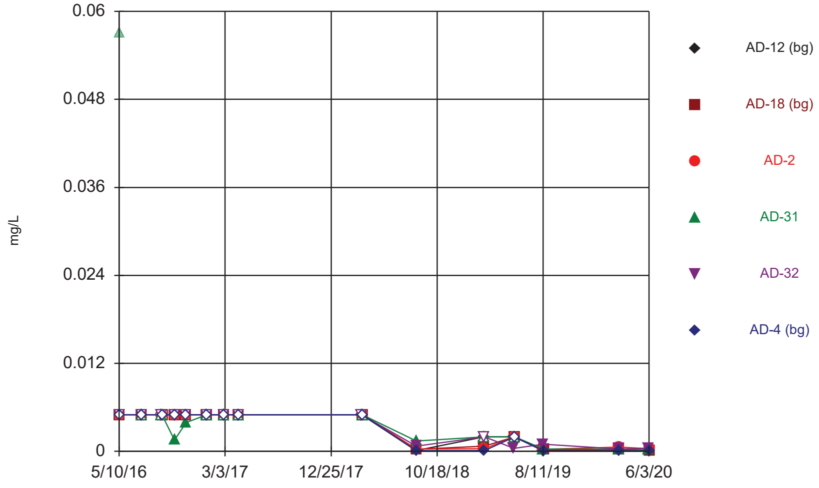
Time Series



Constituent: Fluoride, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

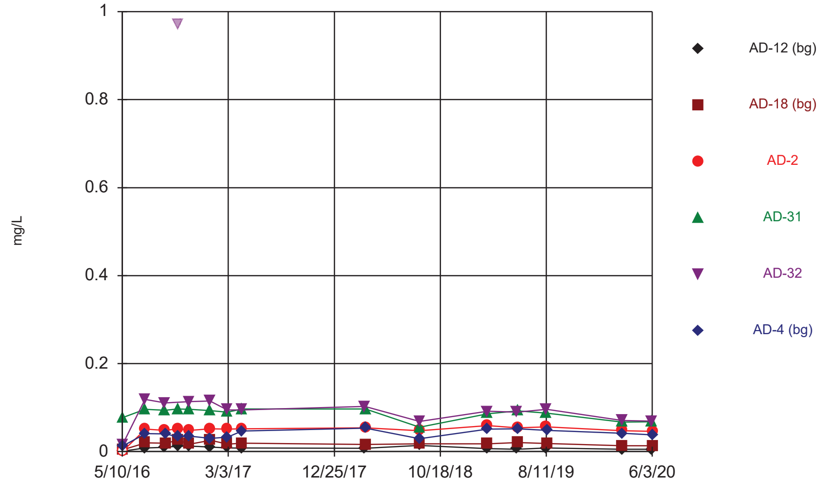
Time Series



Constituent: Lead, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

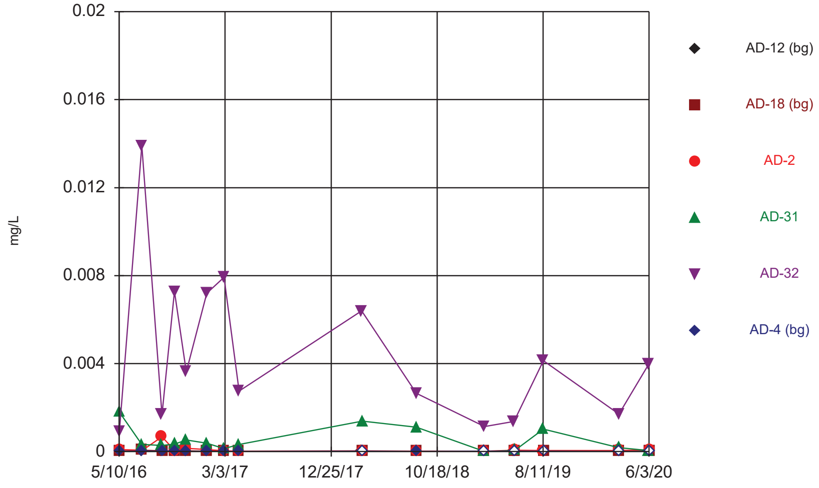
Time Series



Constituent: Lithium, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

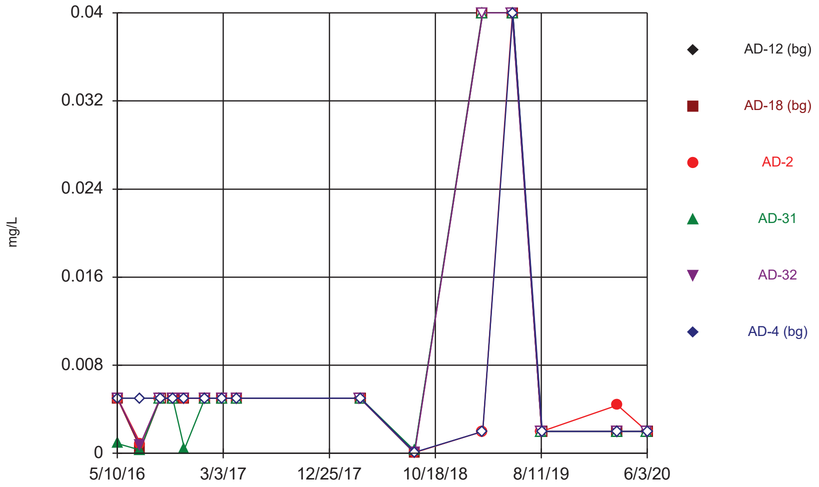
Time Series



Constituent: Mercury, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

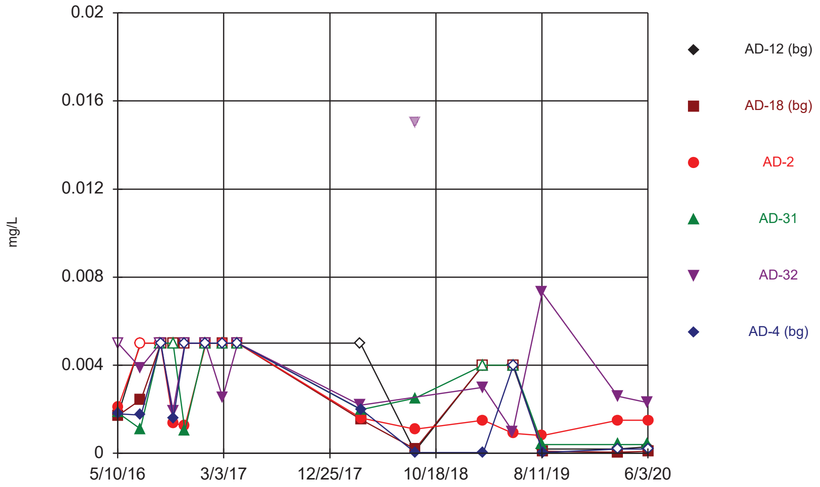
Time Series



Constituent: Molybdenum, total   Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

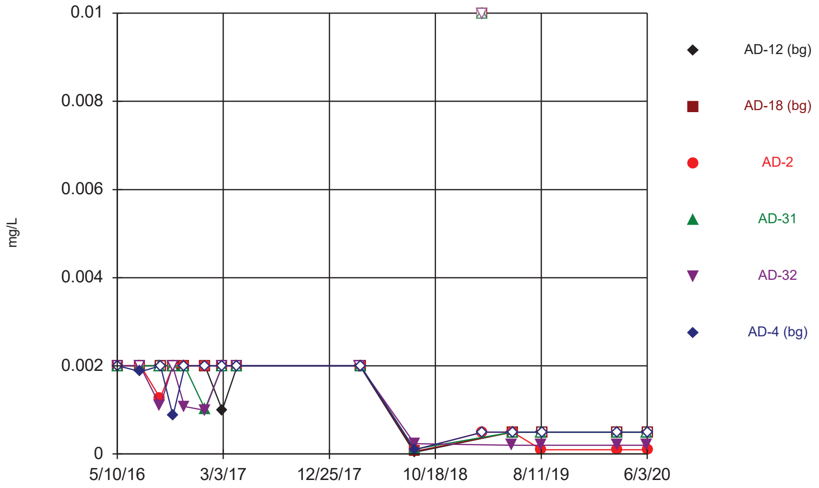
Time Series



Constituent: Selenium, total   Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Thallium, total   Analysis Run 9/8/2020 8:23 AM
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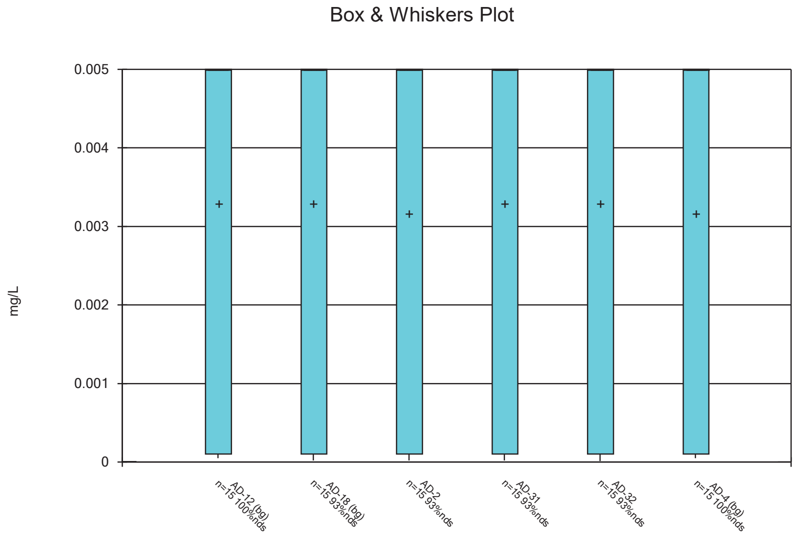
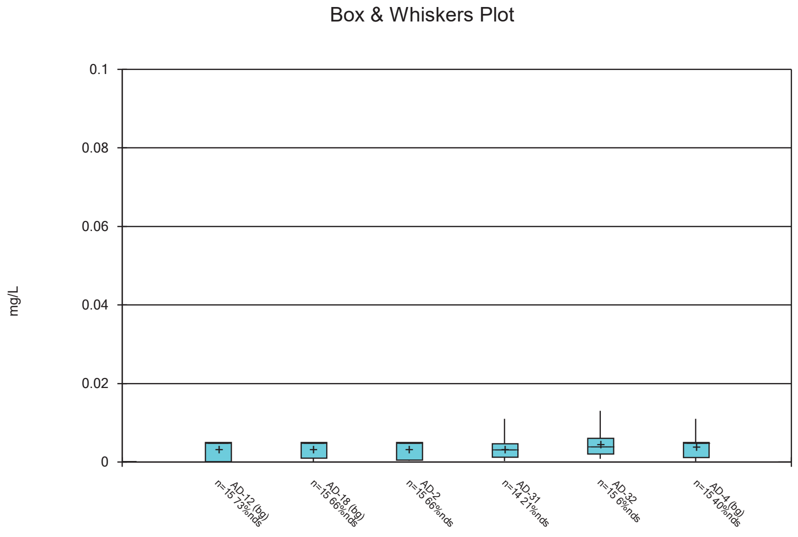
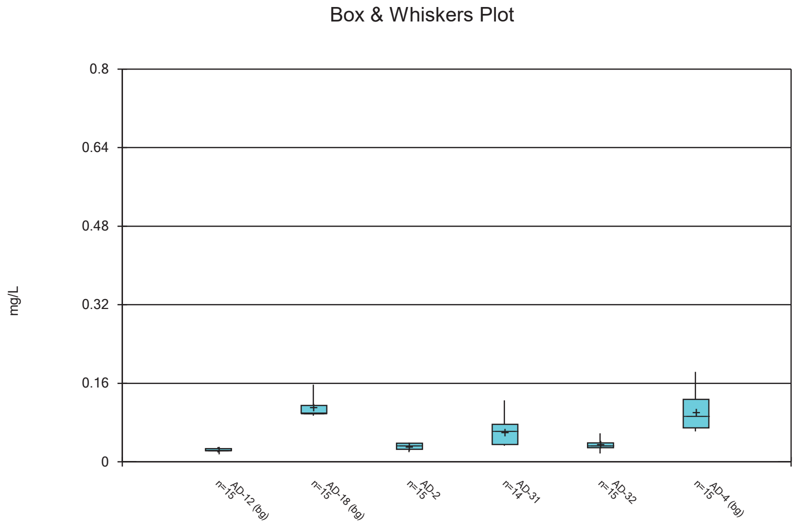


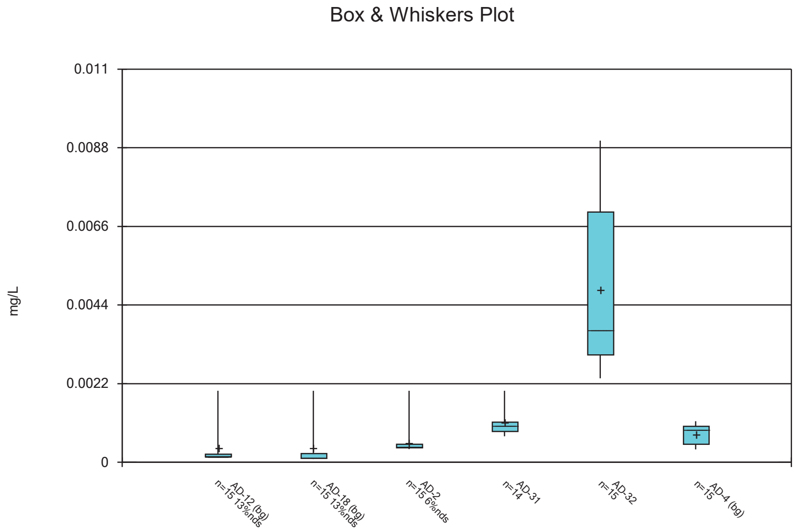
Constituent: Antimony, total   Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP



Constituent: Arsenic, total   Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

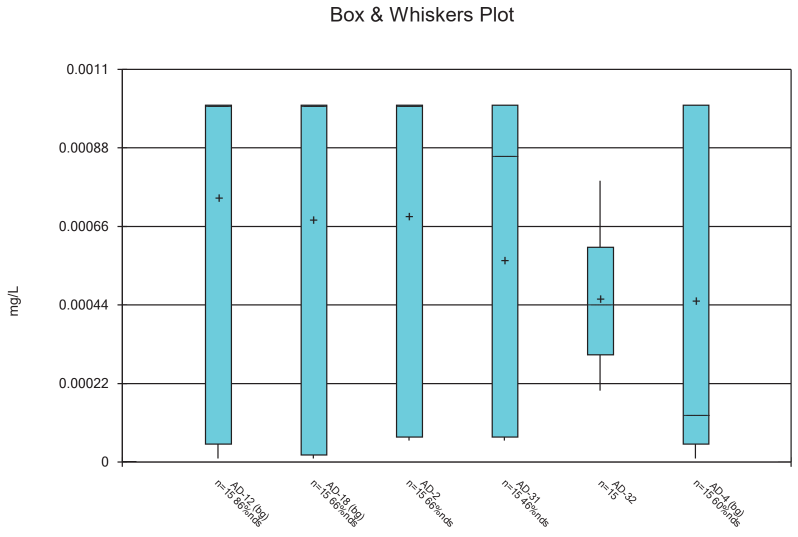


Constituent: Barium, total   Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP



Constituent: Beryllium, total   Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

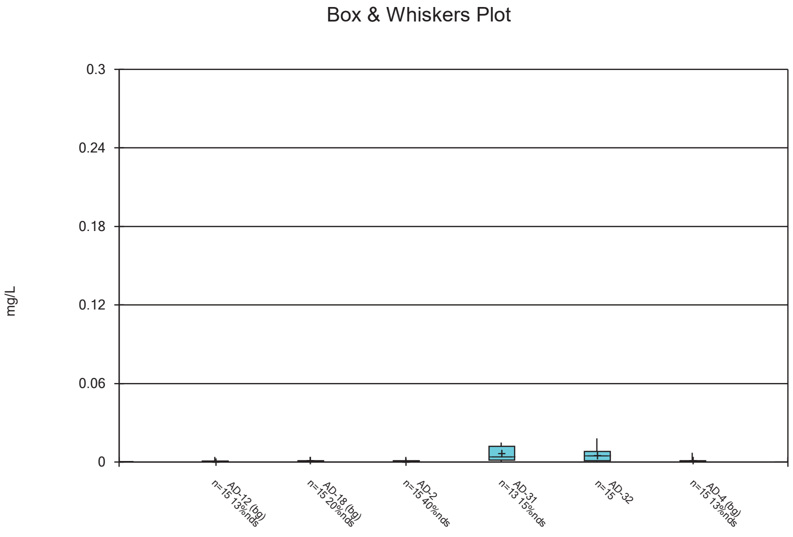
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG



Constituent: Cadmium, total   Analysis Run 9/8/2020 8:24 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG



Constituent: Chromium, total   Analysis Run 9/8/2020 8:24 AM

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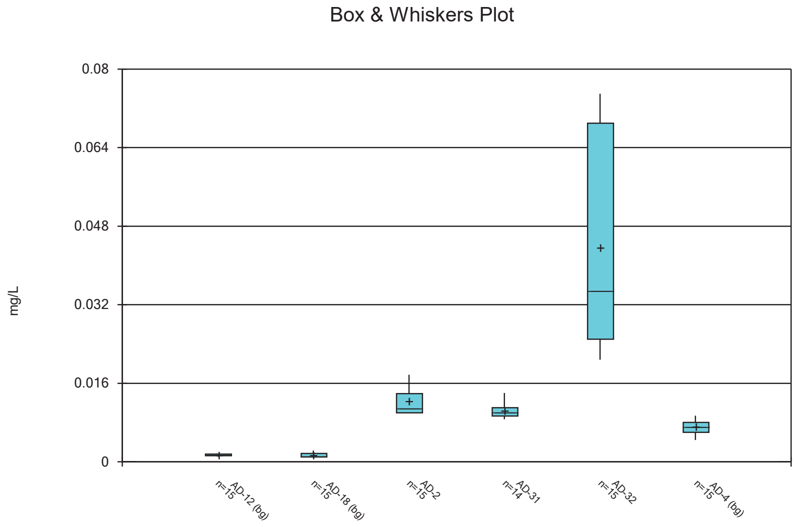
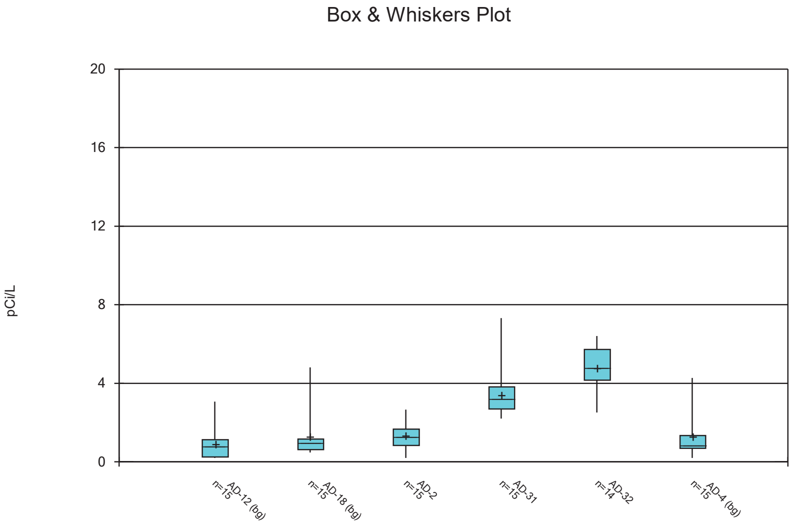


Constituent: Cobalt, total   Analysis Run 9/8/2020 8:24 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

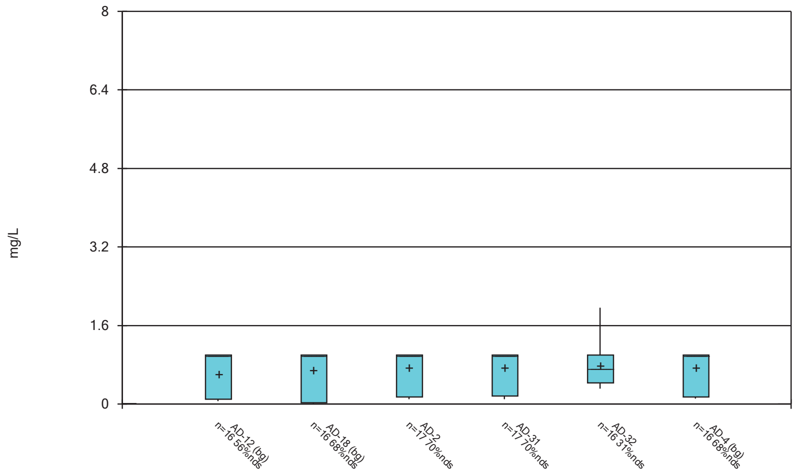


Constituent: Combined Radium 226 + 228   Analysis Run 9/8/2020 8:24 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot

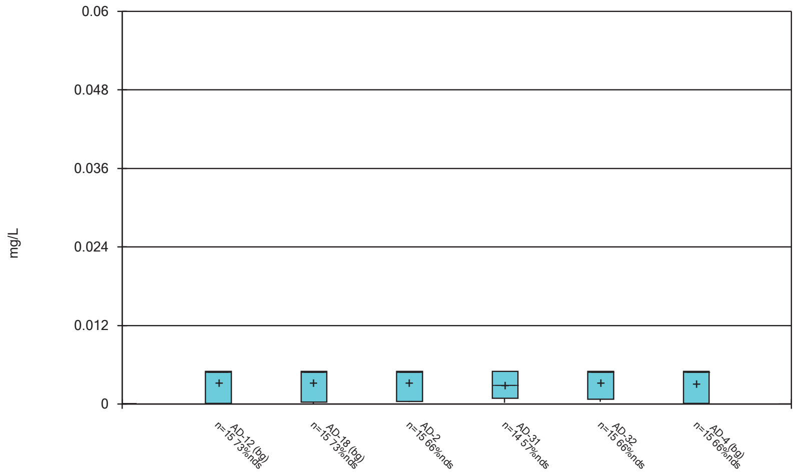


Constituent: Fluoride, total   Analysis Run 9/8/2020 8:24 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot

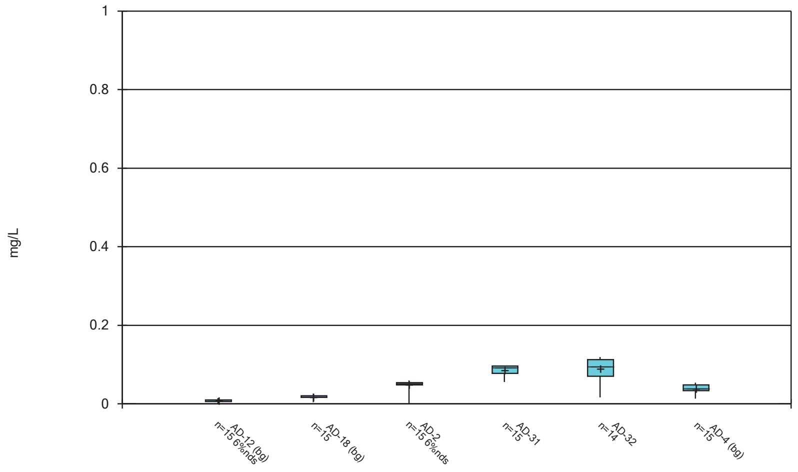


Constituent: Lead, total   Analysis Run 9/8/2020 8:24 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot

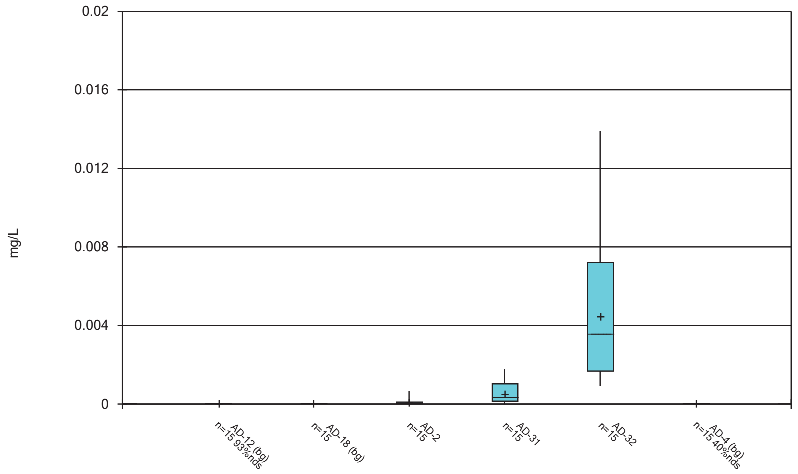


Constituent: Lithium, total   Analysis Run 9/8/2020 8:24 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot

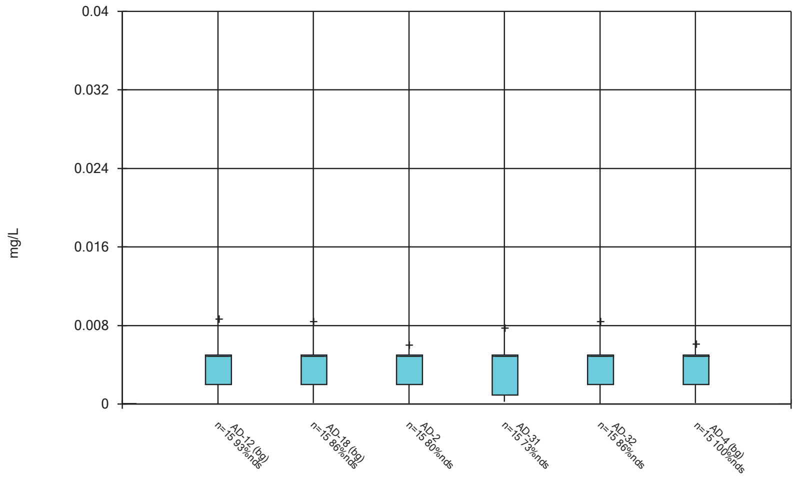


Constituent: Mercury, total   Analysis Run 9/8/2020 8:24 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot

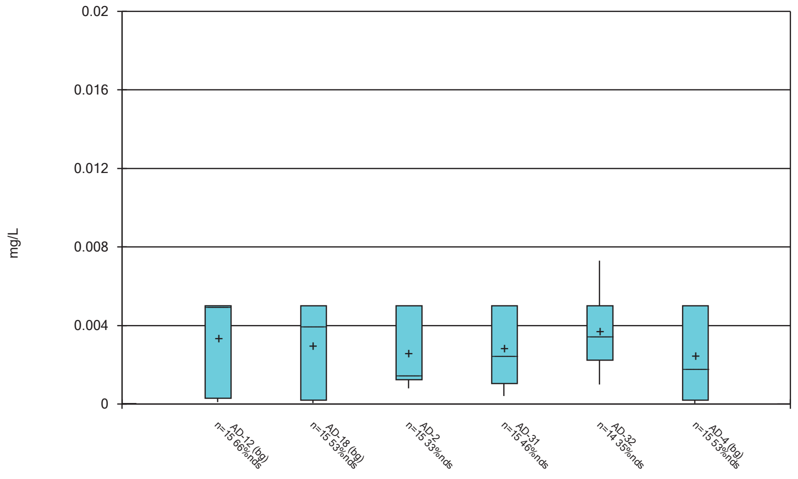


Constituent: Molybdenum, total Analysis Run 9/8/2020 8:24 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot

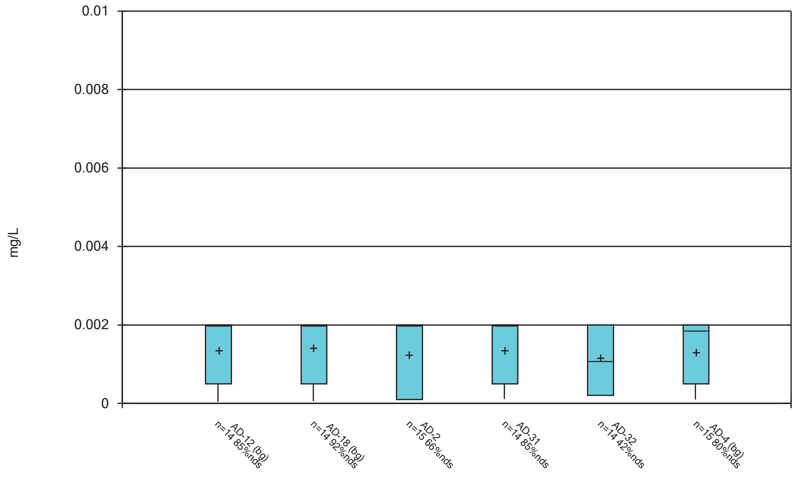


Constituent: Selenium, total Analysis Run 9/8/2020 8:24 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Thallium, total Analysis Run 9/8/2020 8:24 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Outlier Summary

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 9/4/2020, 3:47 PM

	AD-31 Arsenic, total (mg/L)	AD-31 Barium, total (mg/L)	AD-31 Beryllium, total (mg/L)	AD-31 Chromium, total (mg/L)	AD-31 Cobalt, total (mg/L)	AD-32 Combined Radium 226 + 228 (pCi/L)	AD-32 Fluoride, total (mg/L)	AD-31 Lead, total (mg/L)	AD-32 Lithium, total (mg/L)	AD-32 Selenium, total (mg/L)
5/11/2016	0.093 (o)	0.712 (o)	0.01 (o)	0.212 (o)	0.05 (o)			0.057 (o)		
10/12/2016						17.32 (o)			0.972 (o)	
11/14/2016				0.03 (o)						
3/21/2018							7.2 (o)			
8/21/2018										0.015 (o)
2/27/2019										
2/28/2019										

	AD-12 Thallium, total (mg/L)	AD-18 Thallium, total (mg/L)	AD-31 Thallium, total (mg/L)	AD-32 Thallium, total (mg/L)
5/11/2016				
10/12/2016				
11/14/2016				
3/21/2018				
8/21/2018				
2/27/2019	<0.01 (o)			
2/28/2019		<0.01 (o)	<0.01 (o)	<0.01 (o)

Tolerance Limit Summary Table

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP   Printed 9/8/2020, 8:48 AM

Constituent	Upper Lim.	Lower Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.0050	n/a	n/a	45	n/a	n/a	97.78	n/a	n/a	0.09944	NP Inter(NDs)
Arsenic, total (mg/L)	0.011	n/a	n/a	45	n/a	n/a	60	n/a	n/a	0.09944	NP Inter(NDs)
Barium, total (mg/L)	0.18	n/a	n/a	45	n/a	n/a	0	n/a	n/a	0.09944	NP Inter(normality)
Beryllium, total (mg/L)	0.0020	n/a	n/a	45	n/a	n/a	8.889	n/a	n/a	0.09944	NP Inter(normality)
Cadmium, total (mg/L)	0.0010	n/a	n/a	45	n/a	n/a	71.11	n/a	n/a	0.09944	NP Inter(NDs)
Chromium, total (mg/L)	0.003	n/a	n/a	45	-7.851	0.9761	15.56	Kaplan-Meier	ln(x)	0.05	Inter
Cobalt, total (mg/L)	0.0094	n/a	n/a	45	n/a	n/a	0	n/a	n/a	0.09944	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	4.6	n/a	n/a	45	-0.1917	0.8228	0	None	ln(x)	0.05	Inter
Fluoride, total (mg/L)	1.0	n/a	n/a	48	n/a	n/a	64.58	n/a	n/a	0.08526	NP Inter(NDs)
Lead, total (mg/L)	0.0050	n/a	n/a	45	n/a	n/a	71.11	n/a	n/a	0.09944	NP Inter(NDs)
Lithium, total (mg/L)	0.06	n/a	n/a	45	0.1385	0.05078	2.222	None	sqrt(x)	0.05	Inter
Mercury, total (mg/L)	0.000064	n/a	n/a	45	n/a	n/a	44.44	n/a	n/a	0.09944	NP Inter(normality)
Molybdenum, total (mg/L)	0.040	n/a	n/a	45	n/a	n/a	93.33	n/a	n/a	0.09944	NP Inter(NDs)
Selenium, total (mg/L)	0.0050	n/a	n/a	45	n/a	n/a	57.78	n/a	n/a	0.09944	NP Inter(NDs)
Thallium, total (mg/L)	0.0020	n/a	n/a	43	n/a	n/a	86.05	n/a	n/a	0.1102	NP Inter(NDs)

PIRKEY EBAP GWPS				
Constituent Name	**MCL**	**CCR Rule-Specified**	**Background Limit**	**GWPS**
Antimony, Total (mg/L)	0.006		0.005	0.006
Arsenic, Total (mg/L)	0.01		0.011	0.011
Barium, Total (mg/L)	2		0.18	2
Beryllium, Total (mg/L)	0.004		0.002	0.004
Cadmium, Total (mg/L)	0.005		0.001	0.005
Chromium, Total (mg/L)	0.1		0.003	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.0094	0.0094
Combined Radium, Total (pCi/L)	5		4.6	5
Fluoride, Total (mg/L)	4		1	4
Lead, Total (mg/L)	0.015		0.005	0.015
Lithium, Total (mg/L)	n/a	0.04	0.06	0.06
Mercury, Total (mg/L)	0.002		0.000064	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.04	0.1
Selenium, Total (mg/L)	0.05		0.005	0.05
Thallium, Total (mg/L)	0.002		0.002	0.002

**Grey cell indicates Background Limit is higher than MCL or CCR Rule -Specified Level*

**MCL = Maximum Contaminant Level*

**CCR = Coal Combustion Risidual*

**GWPS = Groundwater Protection Standard*

Confidence Intervals Summary Table - Significant Results

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP   Printed 9/8/2020, 8:52 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-2**	**0.0155**	**0.01**	**0.0094**	**Yes**	**15**	**0.01237**	**0.002581**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Cobalt, total (mg/L)	**AD-31**	**0.01126**	**0.009415**	**0.0094**	**Yes**	**14**	**0.01035**	**0.001344**	**0**	**None**	**sqrt(x)**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-32**	**0.07**	**0.0239**	**0.0094**	**Yes**	**15**	**0.04375**	**0.02093**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Lithium, total (mg/L)	**AD-31**	**0.097**	**0.0682**	**0.06**	**Yes**	**15**	**0.08631**	**0.01318**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Lithium, total (mg/L)	**AD-32**	**0.1073**	**0.07699**	**0.06**	**Yes**	**14**	**0.08969**	**0.02695**	**0**	**None**	**x^2**	**0.01**	**Param.**
Mercury, total (mg/L)	**AD-32**	**0.006254**	**0.002042**	**0.002**	**Yes**	**15**	**0.004445**	**0.003549**	**0**	**None**	**sqrt(x)**	**0.01**	**Param.**

Confidence Intervals Summary Table - All Results

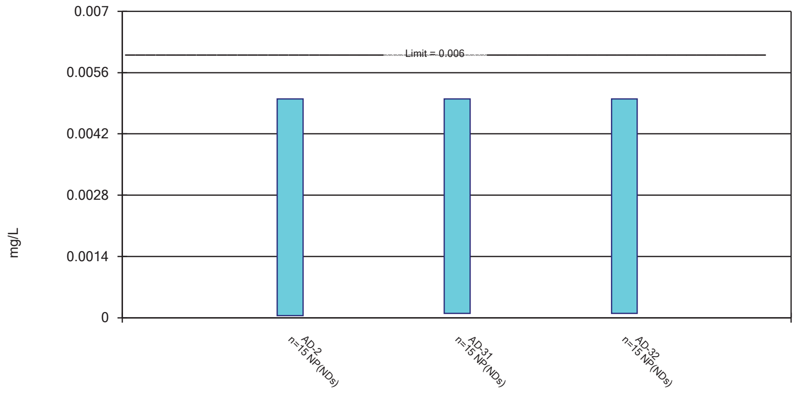
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 9/8/2020, 8:52 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	AD-2	0.005	0.00005	0.006	No	15	0.003158	0.002382	93.33	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-31	0.005	0.0001	0.006	No	15	0.003288	0.00225	93.33	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-32	0.005	0.0001	0.006	No	15	0.003287	0.002251	93.33	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-2	0.005	0.00052	0.011	No	15	0.003291	0.002198	66.67	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-31	0.004418	0.0008715	0.011	No	14	0.003375	0.002809	21.43	Kaplan-Meier	sqrt(x)	0.01	Param.
Arsenic, total (mg/L)	AD-32	0.006294	0.00215	0.011	No	15	0.004503	0.003361	6.667	None	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-2	0.038	0.0228	2	No	15	0.03183	0.006933	0	None	No	0.01	NP (normality)
Barium, total (mg/L)	AD-31	0.08003	0.04197	2	No	14	0.061	0.02687	0	None	No	0.01	Param.
Barium, total (mg/L)	AD-32	0.04192	0.02876	2	No	15	0.03534	0.009717	0	None	No	0.01	Param.
Beryllium, total (mg/L)	AD-2	0.0005	0.0004017	0.004	No	15	0.0005444	0.0004051	6.667	None	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-31	0.00124	0.00085	0.004	No	14	0.001101	0.0003985	0	None	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-32	0.006116	0.003218	0.004	No	15	0.004833	0.002305	0	None	x^(1/3)	0.01	Param.
Cadmium, total (mg/L)	AD-2	0.001	0.00006	0.005	No	15	0.0006887	0.0004558	66.67	None	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-31	0.001	0.00006	0.005	No	15	0.0005665	0.0004624	46.67	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-32	0.000581	0.0003394	0.005	No	15	0.0004602	0.0001783	0	None	No	0.01	Param.
Chromium, total (mg/L)	AD-2	0.0004629	0.0002143	0.1	No	15	0.0008208	0.0009457	40	Kaplan-Meier	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-31	0.009696	0.001498	0.1	No	13	0.006694	0.005523	15.38	Kaplan-Meier	No	0.01	Param.
Chromium, total (mg/L)	AD-32	0.007896	0.001708	0.1	No	15	0.005385	0.00529	0	None	sqrt(x)	0.01	Param.
Cobalt, total (mg/L)	**AD-2**	**0.0155**	**0.01**	**0.0094**	**Yes**	**15**	**0.01237**	**0.002581**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Cobalt, total (mg/L)	**AD-31**	**0.01126**	**0.009415**	**0.0094**	**Yes**	**14**	**0.01035**	**0.001344**	**0**	**None**	**sqrt(x)**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-32**	**0.07**	**0.0239**	**0.0094**	**Yes**	**15**	**0.04375**	**0.02093**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Combined Radium 226 + 228 (pCi/L)	AD-2	1.727	0.9091	5	No	15	1.318	0.6038	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-31	3.984	2.697	5	No	15	3.425	1.215	0	None	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-32	5.514	4.058	5	No	14	4.786	1.028	0	None	No	0.01	Param.
Fluoride, total (mg/L)	AD-2	1	0.14	4	No	17	0.7406	0.4144	70.59	None	No	0.01	NP (NDs)
Fluoride, total (mg/L)	AD-31	1	0.14	4	No	17	0.7465	0.405	70.59	None	No	0.01	NP (NDs)
Fluoride, total (mg/L)	AD-32	0.7898	0.3933	4	No	16	0.7786	0.4059	31.25	Kaplan-Meier	sqrt(x)	0.01	Param.
Lead, total (mg/L)	AD-2	0.005	0.000355	0.015	No	15	0.003265	0.002235	66.67	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-31	0.005	0.000325	0.015	No	14	0.002976	0.002039	57.14	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-32	0.005	0.000405	0.015	No	15	0.003324	0.002158	66.67	None	No	0.01	NP (NDs)
Lithium, total (mg/L)	AD-2	0.05405	0.04685	0.06	No	15	0.048	0.01346	6.667	None	x^4	0.01	Param.
Lithium, total (mg/L)	**AD-31**	**0.097**	**0.0682**	**0.06**	**Yes**	**15**	**0.08631**	**0.01318**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Lithium, total (mg/L)	**AD-32**	**0.1073**	**0.07699**	**0.06**	**Yes**	**14**	**0.08969**	**0.02695**	**0**	**None**	**x^2**	**0.01**	**Param.**
Mercury, total (mg/L)	AD-2	0.0001123	0.00003526	0.002	No	15	0.0001025	0.0001622	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-31	0.000782	0.000151	0.002	No	15	0.0005299	0.0005431	0	None	sqrt(x)	0.01	Param.
Mercury, total (mg/L)	**AD-32**	**0.006254**	**0.002042**	**0.002**	**Yes**	**15**	**0.004445**	**0.003549**	**0**	**None**	**sqrt(x)**	**0.01**	**Param.**
Molybdenum, total (mg/L)	AD-2	0.04	0.0008627	0.1	No	15	0.006086	0.009548	80	None	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-31	0.04	0.0004016	0.1	No	15	0.007857	0.01319	73.33	None	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-32	0.04	0.0007621	0.1	No	15	0.008453	0.01293	86.67	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-2	0.005	0.0011	0.05	No	15	0.002574	0.001801	33.33	None	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-31	0.005	0.0004	0.05	No	15	0.002844	0.001927	46.67	None	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-32	0.003814	0.001743	0.05	No	14	0.003696	0.001736	35.71	Kaplan-Meier	No	0.01	Param.
Thallium, total (mg/L)	AD-2	0.002	0.0001	0.002	No	15	0.001244	0.0008833	66.67	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-31	0.002	0.0005	0.002	No	14	0.001367	0.0007798	85.71	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-32	0.002	0.0002	0.002	No	14	0.001157	0.0008232	42.86	None	No	0.01	NP (normality)

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



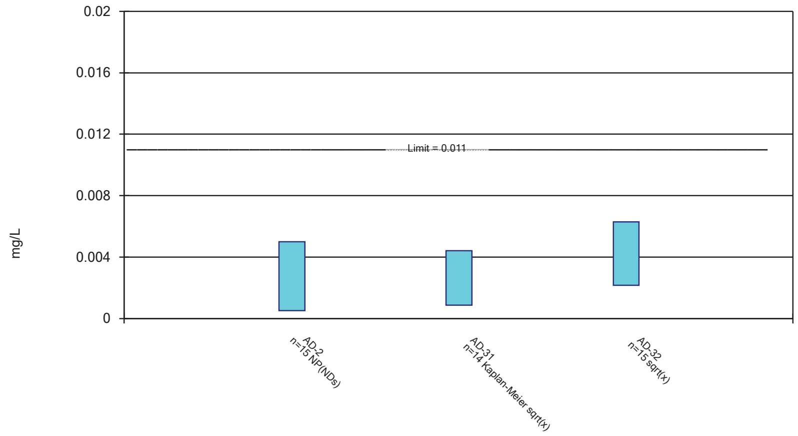
Constituent: Antimony, total   Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



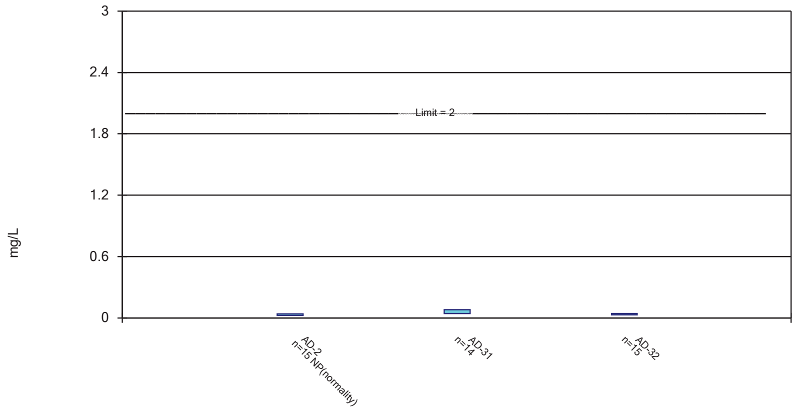
Constituent: Arsenic, total   Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



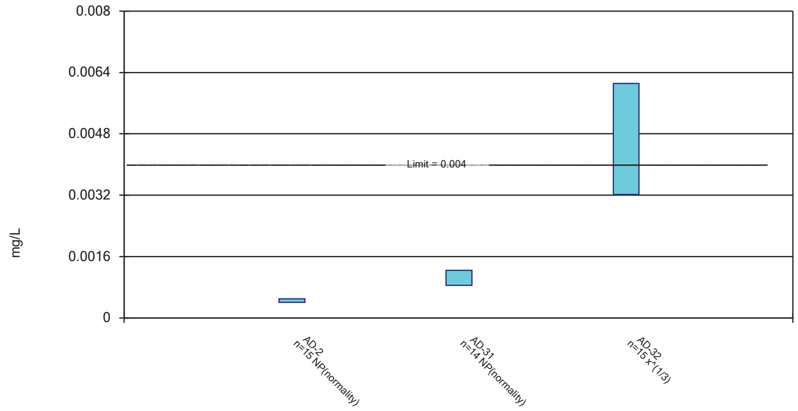
Constituent: Barium, total   Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



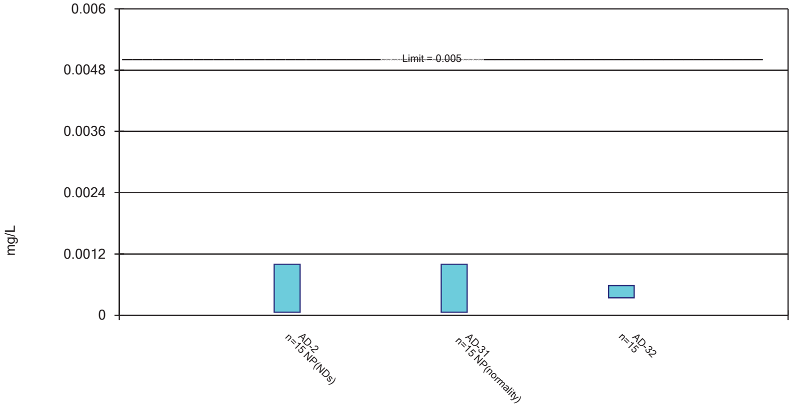
Constituent: Beryllium, total   Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



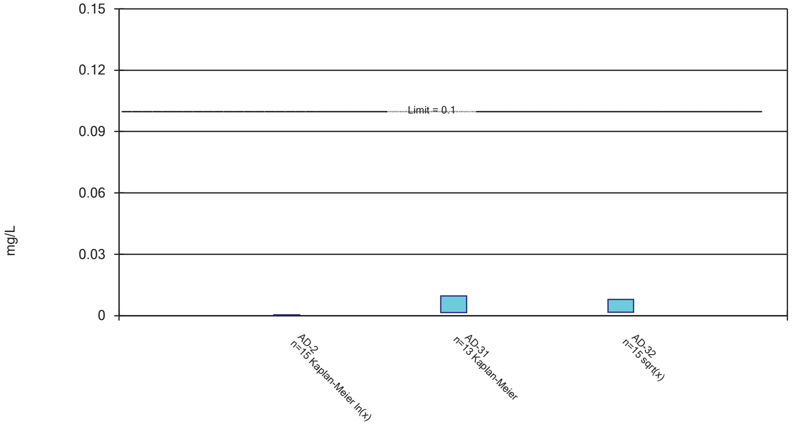
Constituent: Cadmium, total   Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



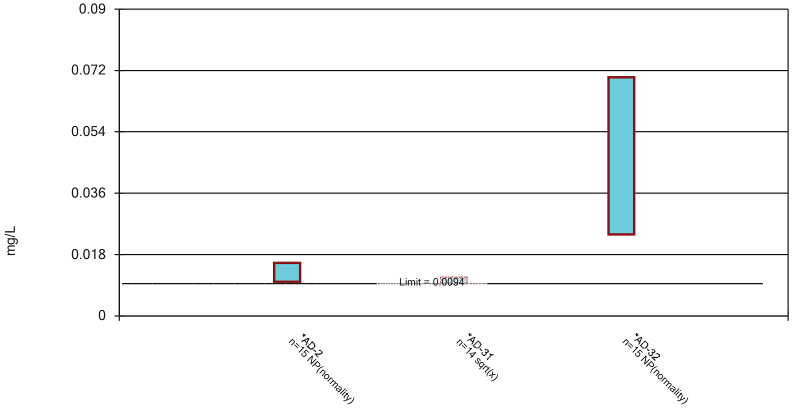
Constituent: Chromium, total   Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



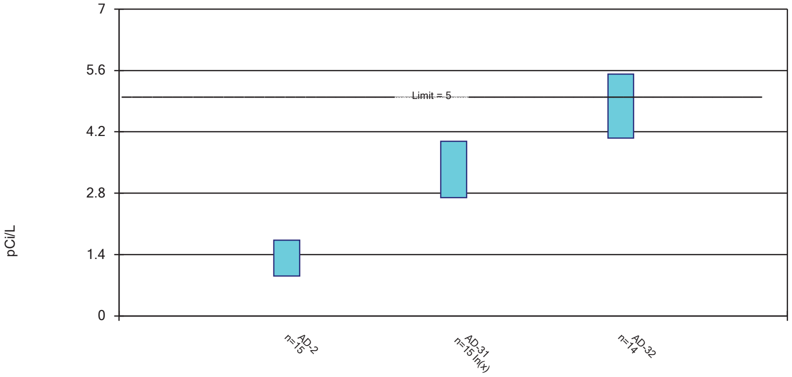
Constituent: Cobalt, total   Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



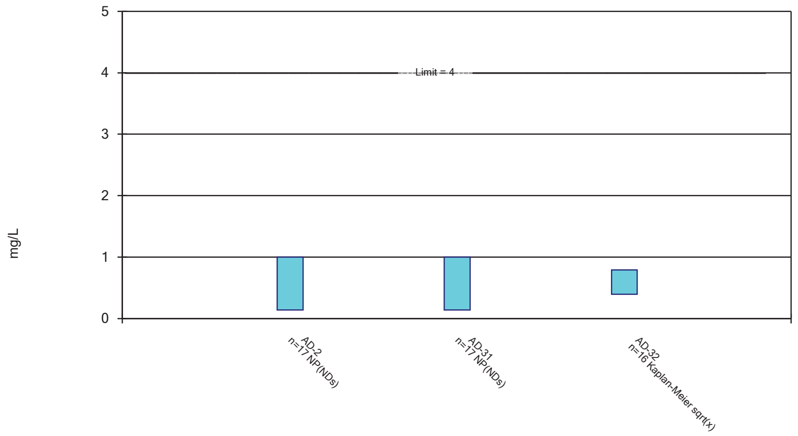
Constituent: Combined Radium 226 + 228   Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

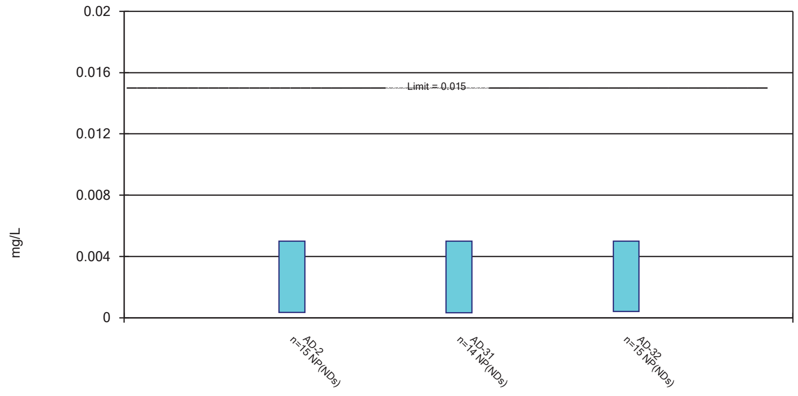


Constituent: Fluoride, total   Analysis Run 9/8/2020 8:50 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

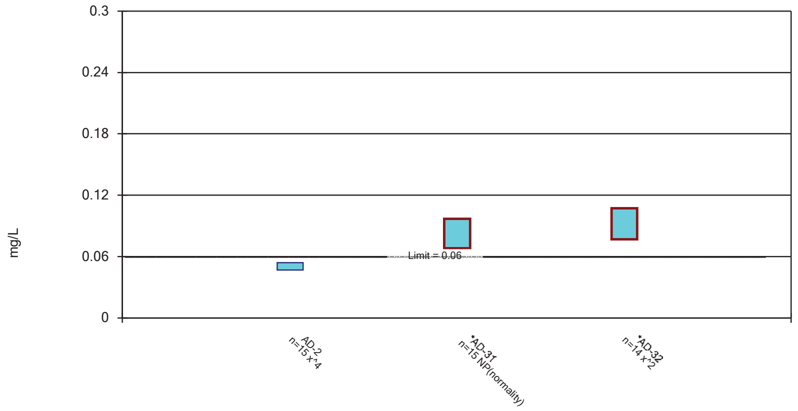


Constituent: Lead, total   Analysis Run 9/8/2020 8:50 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

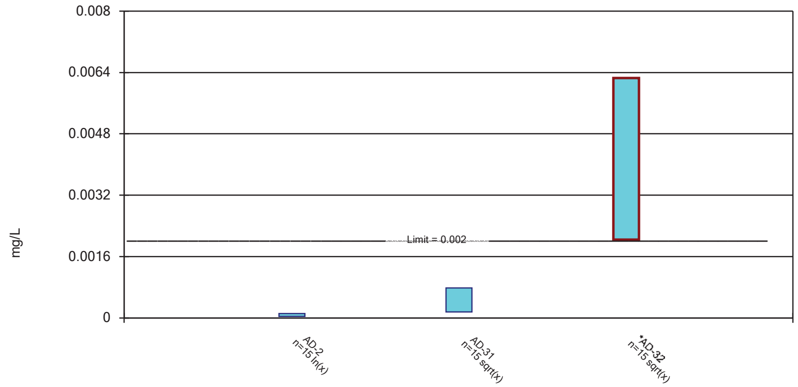


Constituent: Lithium, total   Analysis Run 9/8/2020 8:50 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

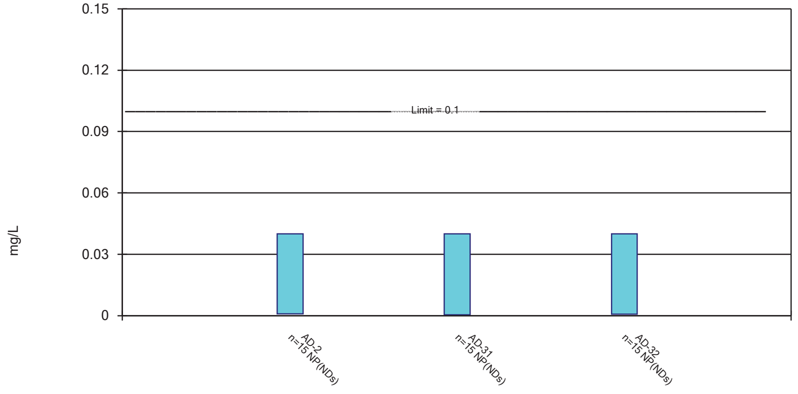


Constituent: Mercury, total   Analysis Run 9/8/2020 8:50 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

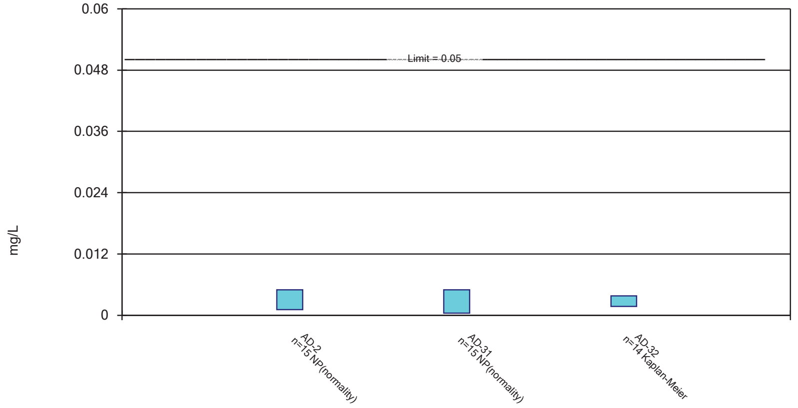


Constituent: Molybdenum, total   Analysis Run 9/8/2020 8:50 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

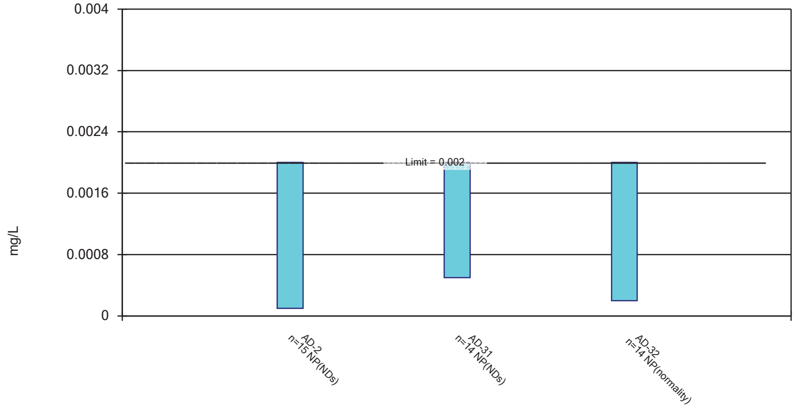


Constituent: Selenium, total   Analysis Run 9/8/2020 8:50 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Thallium, total   Analysis Run 9/8/2020 8:50 AM
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
East Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN
ELECTRIC
POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec
consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

April 2, 2020

CHA8495

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
VAP	Vertical Aquifer Profiling
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the East Bottom Ash Pond (EBAP, Figure 1). In August 2019, a semi-annual assessment monitoring event was conducted at the EBAP in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were re-established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or, for constituents without an MCL, the risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were re-calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey EBAP:

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.0100 mg/L), and AD-32 (0.0310 mg/L).
- LCLs for lithium exceeded the GWPS of 0.0616 mg/L at AD-31 (0.0859 mg/L) and AD-32 (0.0878 mg/L).

No other SSLs were identified (Geosyntec, 2020).

1.1 CCR Rule Requirements

USEPA regulations regarding assessment monitoring programs for CCR landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State*

> *Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSLs identified for cobalt and lithium are from a source other than the EBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for cobalt and lithium were based on a Type IV cause and not by a release from the Pirkey EBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for cobalt and lithium and the proposed alternative source are described below.

2.1 Proposed Alternative Sources

Initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify alternative sources due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSLs for cobalt and lithium have been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

2.1.1 Cobalt

In previous ASDs for cobalt at the EBAP, evidence was provided to show that the observed cobalt concentrations were due to natural variation (Geosyntec, 2019a; Geosyntec, 2019b; Geosyntec, 2019c). The previous ASDs discussed that the EBAP itself did not appear to be a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP leachate above the reporting limit of 0.01 mg/L. Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions. SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. Cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

Cobalt was detected at an estimated concentration of 0.0024 mg/L in a grab sample of the pond water. However, the reported concentration of cobalt in the pond water sample is significantly lower than the average concentration of cobalt observed at both wells where SSLs were identified (Table 1). Since the previous ASDs were prepared, there have been no notable changes in coal handling or sourcing at the plant that would have affected the composition of the ash or pond water.

Four additional permanent wells (B-2, B-3, AD-40, and AD-41) were installed upgradient of the EBAP in 2019. These upgradient locations were selected to represent conditions at the facility which are unimpacted by site operations. The most recent data available for select wells in the vicinity of the EBAP, as well as the upgradient locations, are shown in Figure 2. Groundwater cobalt concentrations at upgradient locations vary from 0.000799 mg/L to 0.0345 mg/L at AD-40 and B-3, respectively. This wide range in cobalt concentrations provides further evidence for the natural variation of cobalt at the Site, particularly as the concentration at B-3 exceeds the GWPS for the EBAP. Additionally, the cobalt concentration at B-3 is comparable to the most recent sample results at AD-32 (0.0337 mg/L) and higher than the most recent cobalt concentration reported at AD-2 (0.013 mg/L), which are the two wells with exceedances.

As noted in the previous two ASDs, soil samples collected across the site, including from locations near the EBAP, identified cobalt in the aquifer solids at varying concentrations. While no additional soil samples were collected in support of this ASD, soil sampling data from select upgradient and downgradient locations from previous site investigations are summarized in Table 2 and Figure 3. Cobalt was identified in the aquifer solids at varying concentrations, with the highest value of 23.5 milligrams per kilogram (mg/kg) reported at AD-41, which is upgradient of the EBAP (Figure 3). Other testing included collection of aquifer solids to evaluate for the presence of cobalt-containing minerals. X-ray diffraction evidence identified pyrite and marcasite (both iron sulfides) at select locations at concentrations up to 3% by weight (Table 2). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2017). While cobalt was identified in the aquifer solid samples collected from AD-32, soil analytical and mineralogical data are not available for AD-2. However, the wide distribution of cobalt and iron minerals across the site suggests that similar concentrations of cobalt are likely to be present in the aquifer solids at AD-2.

Groundwater samples were collected from upgradient location B-3 via vertical aquifer profiling (VAP), as described in an ASD previously generated for lithium exceedances at the EBAP (Geosyntec, 2019b). The VAP groundwater samples were centrifuged to separate solid and liquid phases, and the solid material was submitted for analysis of total metals and mineralogy by X-ray diffraction (XRD). The samples were also submitted for analysis of chemical composition and mineralogy by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Following installation of permanent monitoring wells at B-2 and B-3, groundwater samples were collected by purging groundwater through the filter pack using a submersible pump. An additional groundwater sample was collected at AD-32. These permanent well groundwater samples were filtered through a 1.5-micron filter and the solid material retained on the filter was submitted for analysis of total metals and by SEM/EDS.

Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from B-2 and B-3 (Table 2). Cobalt was detected in the AD-32 solid material at 5.4 mg/kg, which is comparable to the concentration observed in bulk soil collected at the same location at the screened interval (9.1 mg/kg). These results provide further evidence that cobalt concentrations reported during groundwater sampling are naturally occurring and associated with the solid phase in the aquifer.

According to XRD results of the centrifuged solid sample [VAP-B3-(40-45)], pyrite was present as approximately 3% of the solid phase (Table 3). Logging completed while the VAP boring was advanced identified lignite at several intervals, including 45 and 48 ft bgs (Figure 4). Furthermore, SEM/EDS of both centrifuged solid samples [VAP-B3-(40-45) and VAP-B3-(50-55)] identified pyrite in backscattered electron micrographs by the distinctive framboid pattern (Harris et al., 1981; Sawlowicz, 2000). Major peaks involving iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (Attachment A). While cobalt was not identified in the EDS spectrum, it would likely be present at concentrations below the detection limit. Pyrite was also identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site.

In addition to pyrite, hematite (an iron(III) oxide) was present at 2% of the centrifuged solid sample collected from upgradient location VAP-B3 (Table 3). Weathering of pyrite to hematite is a known phenomenon in east Texas soils (Dixon, et al., 1982); the adsorption of cobalt to hematite is a documented mechanism which provides an additional pathway for cobalt to enter groundwater from the soil system (McLaren et al., 1986; Borggaard, 1987).

The wide distribution of iron minerals across the site provides evidence that naturally occurring cobalt, which may substitute for iron in pyrite or adsorb to hematite, may also be present in the aquifer solids near the EBAP. The presence of lignite in the area is well-documented, including at upgradient and downgradient locations relative to the EBAP (Broom and Myers, 1966; ETTL, 2010). Additionally, the pond was not identified as the source of cobalt at wells downgradient of the EBAP in previous ASDs based on the documented low mobility of cobalt under the pond conditions and lack of detectable cobalt in the pond itself.

2.1.2 Lithium

Two ASDs were previously generated for lithium exceedances at the EBAP which attributed the observed concentrations to variations in naturally suspended matter that likely originates from lignite and is ubiquitous in the aquifer (Geosyntec, 2019b; Geosyntec, 2019c). Data gathered in support of the prior ASDs provides additional evidence that the observed lithium concentrations at AD-31 and AD-32 are due to natural variation in the aquifer.

During the August 2019 sampling event, groundwater samples were collected at B-2, B-3, AD-31, and AD-32 using low-flow sampling techniques. Total lithium concentrations in permanent upgradient wells B-2 and B-3 were measured at 0.055 mg/l and 0.090 mg/l, respectively, both of which are above the GWPS of 0.0616 mg/L (Figure 5). Lithium was detected at AD-31 at 0.0875 mg/L and AD-32 at 0.103 mg/L, which are comparable to the observed concentration at B-3. Because B-2 and B-3 were installed at locations upgradient to and unimpacted by Site activities, they suggest that lithium concentrations above the GWPS are naturally present in the vicinity of the EBAP.

As described in Section 2.1.1, groundwater samples were collected from B-2, B-3, and AD-32 and filtered to separate captured solid material. Both the solid material and the filtered groundwater were submitted for total metals analysis. Lithium was detected in the solid material at concentrations comparable to bulk soil at all locations, providing evidence that the particulates captured during groundwater sampling contain lithium (Table 4).

A previous ASD generated for lithium at the EBAP developed a proposed mechanism for lithium mobility in groundwater which pointed to desorption from clay minerals associated with naturally occurring lignite material as the source of lithium in both up and downgradient wells at the EBAP (Geosyntec, 2019b). Previously completed XRD analysis of the centrifuged solid material samples [VAP-B3-(40-45) and VAP-B3-(50-55)] found that clay minerals, including kaolinite, smectite, and illite/mica, made up at least 60% of the aquifer solid (Table 3). These clay minerals, particularly smectite and illite, are known to retain metals such as lithium via cation exchange processes. SEM/EDS analysis identified the presence of silicon, aluminum and oxygen, all of which are indicative of clay minerals (Attachment A). The backscattered electron micrographs of these samples also identified clay particles by morphology. The largest clay particles (> 5 µm) are likely kaolinite, while smectite and illite dominate the smaller size fraction.

Total metal concentrations in the solid materials separated from the groundwater samples during filtration and the filtered groundwater concentrations were used to calculated partition coefficients values (K_d) for lithium, potassium, and sodium. Details about the K_d calculation are provided in the previous ASD (Geosyntec, 2019c). K_d values for groundwater and particulate collected from wells B-2, B-3, and AD-32 were comparable to literature K_d values reported for organic-rich media such as bogs and peat beds (Sheppard et al., 2009; 2011), providing further evidence that lithium mobility in Site groundwater is similar to other sites with organic-rich soils (Table 5). Additionally, the calculated K_d values for Pirkey soils were consistent with the literature, with potassium being the largest (most sorbable) and sodium the smallest (least sorbable). Furthermore, the values are similar for groundwater from all three wells, suggesting a universal mechanism is controlling the mobilities of lithium, sodium, and potassium in groundwater.

These multiple lines of evidence show that elevated lithium concentrations at AD-31 and AD-32 are not due to a release from the EBAP, and instead can be attributed to natural variation. This variation appears related to the distribution of clay fractions associated with lignite materials in the soil aquifer material.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSLs are not due to a release from the Pirkey EBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and provides evidence that the SSLs for cobalt at AD-2 and AD-32 and for lithium at AD-31 and AD-32 identified during assessment monitoring in August 2019 were not due to a release from the EBAP. The identified SSLs were, instead, attributed to natural variation in the underlying geology. Therefore, no further action for cobalt or lithium is warranted, and the Pirkey EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

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TABLES

Table 1: Summary of Key Cobalt Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant

Sample	Unit	Cobalt Concentration
Bottom Ash (Solid Material)	mg/kg	6.1
SPLP Leachate of Bottom Ash	mg/L	<0.01
EBAP Pond Water	mg/L	0.0024 J
AD-2 - Average	mg/L	0.0113
AD-32 - Average	mg/L	0.0544

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

Average values were calculated using all cobalt data collected under 40 CFR 257 Subpart D, excluding any identified outliers.

Table 2: Soil Cobalt and Mineralogy Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Sample Depth (ft bgs)	Cobalt (mg/kg)	Pyrite/Marcasite (%)
Bulk Soil Samples			
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-41	15	< 1.0	--
	35	23.5	---
	95	1.90	---
B-2	10	2.36	---
	16	3.62	---
	71	10.30	---
	82	7.21	---
	87	3.11	---
B-3	10	1.30	---
	20	0.59	---
	97	1.11	---
Solid Material Retained After Filtration			
AD-32	13-33	5.4	--
B-2	38-48	4.3	--
B-3	29-34	12.0	--
	VAP 40-45	18.0	3

Notes:
'--' - analysis not completed
mg/kg- milligram per kilogram
ft bgs - feet below ground surface

For AD-XX locations, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-X locations were collected from cores removed from the borehole during well lithology logging.

Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

Table 3: X-Ray Diffraction Results
East Bottom Ash Pond - H. W. Pirkey Plant

Constituent	VAP-B3-(40-45)
Quartz	15
Plagioclase Feldspar	0.5
Orthoclase	ND
Calcite	ND
Dolomite	ND
Siderite	0.5
Goethite	ND
Hematite	2
Pyrite	3
Kaolinite	42
Chlorite	4
Illite/Mica	6
Smectite	12
Amorphous	15

Notes:

ND: Not detected

VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

Table 4: Soil Lithium Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Sample Depth (ft bgs)	Lithium (mg/kg)
Bulk Soil Samples		
AD-32	11	0.53
	20-25	1.60
B-2	10	5.30
	16	3.97
	71	7.42
	87	13.10
B-3	10	3.64
	20	2.59
	97	11.10
Lignite	N/A	2.9 J
Solid Material Retained After Filtration		
AD-32	13-33	9.8 J
B-2	38-48	6.5 J
B-3	29-34	7.8 J
	VAP 40-45	13.0

Notes:

J - estimated value

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

For AD-32, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-X locations were collected from cores removed from the borehole during well lithology logging.

Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

VAP - vertical aquifer profiling

Table 5: Calculated Site-Specific Partition Coefficients
East Bottom Ash Pond - H. W. Pirkey Plant

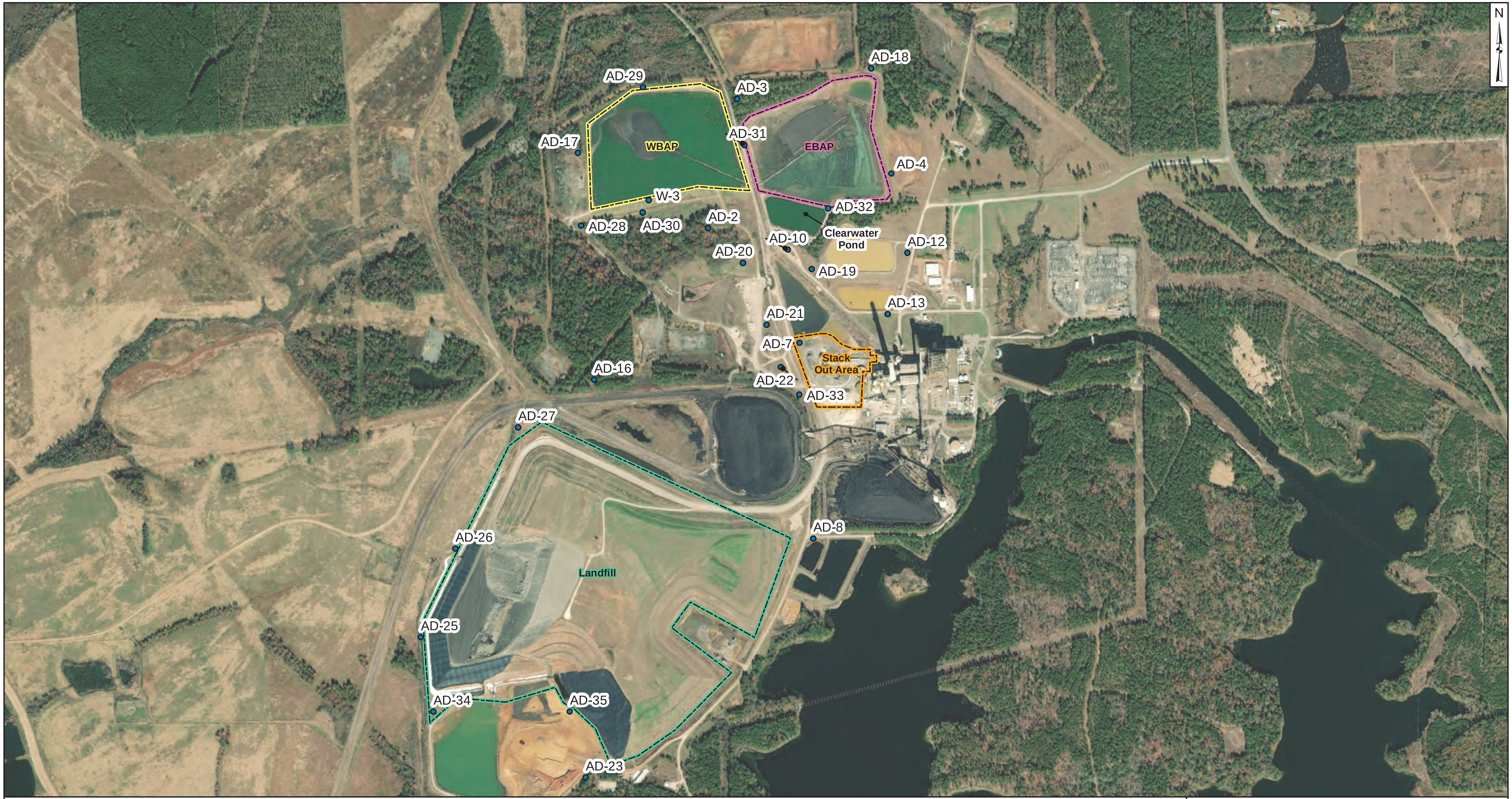
Source	B-2			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.081	6.5	80	43-370
K	2.6	1100	423	42-1200
Na	14	130	9	5.2-82

Source	B-3			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.097	7.8	80	43-370
K	2.9	1100	379	42-1200
Na	32	240	8	5.2-82

Source	AD-32			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.11	9.8	89	43-370
K	3.9	1800	462	42-1200
Na	57	220	4	5.2-82

Notes:
mg/L: milligrams per liter
mg/kg: milligrams per kilogram
L/kg: liters per kilogram
Kd: partition coefficient
Adsorbed values are total metals concentrations reported by USEPA Method 6010B.
Literature values represent maximum and minimum values for the parameter as reported in Sheppard et al, 2009 (Table 4-1, all sites) and Sheppard et al, 2011 (Table 3-3 cultivated peat and wetland peat only).

FIGURES



Legend

● Monitoring Wells
▭ EBAP
▭ Landfill
▭ Stack Out Area
▭ WBAP

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019

0 375 750 1,500 2,250 3,000
Feet

Site Layout

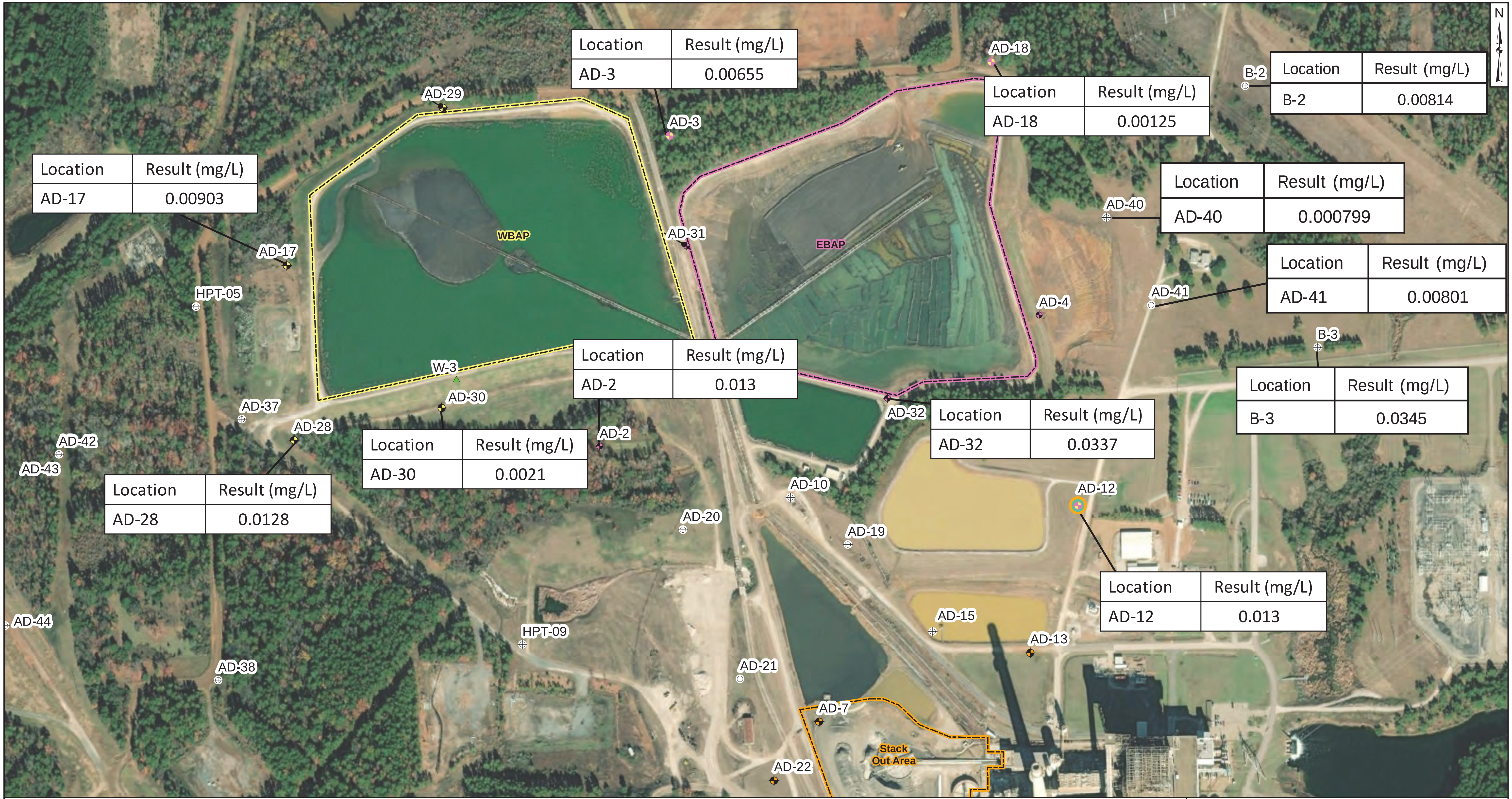
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio | 2020/03/24

Figure
1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_2020324.mxd. hduff. 3/24/2020. Project/Phase/Task.



Legend

- ⌖ Out of Network
- ◆ EBAP
- ◆ WBAP
- ◆ Landfill
- ◆ Stackout Area
- ◆ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- ▭ EBAP
- ▭ Stack Out Area
- ▭ WBAP

Notes

- Monitoring well coordinates, site features, and data provided by AEP
- AD-15 location is approximated
- Samples collected in August 2019
- AD-29 included in the well network for water level measurements only

400 200 0 400
Feet

Cobalt Distribution in Groundwater
August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio

2020/04/01

Figure
2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Pirkey_Cobalt_20200319.mxd. BAres. 4/1/2020. Project/Phase/Task.

Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	B-2				
Depth (ft bgs)	10	16	71	82	87
Cobalt (mg/kg)	2.36	3.62	10.30	7.21	3.11
Pyrite/Marcasite (%)	-	-	-	-	-

Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-41		
Depth (ft bgs)	15	35	95
Cobalt (mg/kg)	< 1.0	23.5	1.9
Pyrite/Marcasite (%)	-	-	-

Location	B-3		
Depth (ft bgs)	10	20	97
Cobalt (mg/kg)	1.30	0.59	1.11
Pyrite/Marcasite (%)	-	-	-

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Legend

⌖ Monitoring Wells

▭ EBAP

▭ WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.

300 150 0 300
Feet

Soil Chemical and Mineralogical Analysis Results

AEP Pirkey Power Plant
Hallsville, Texas

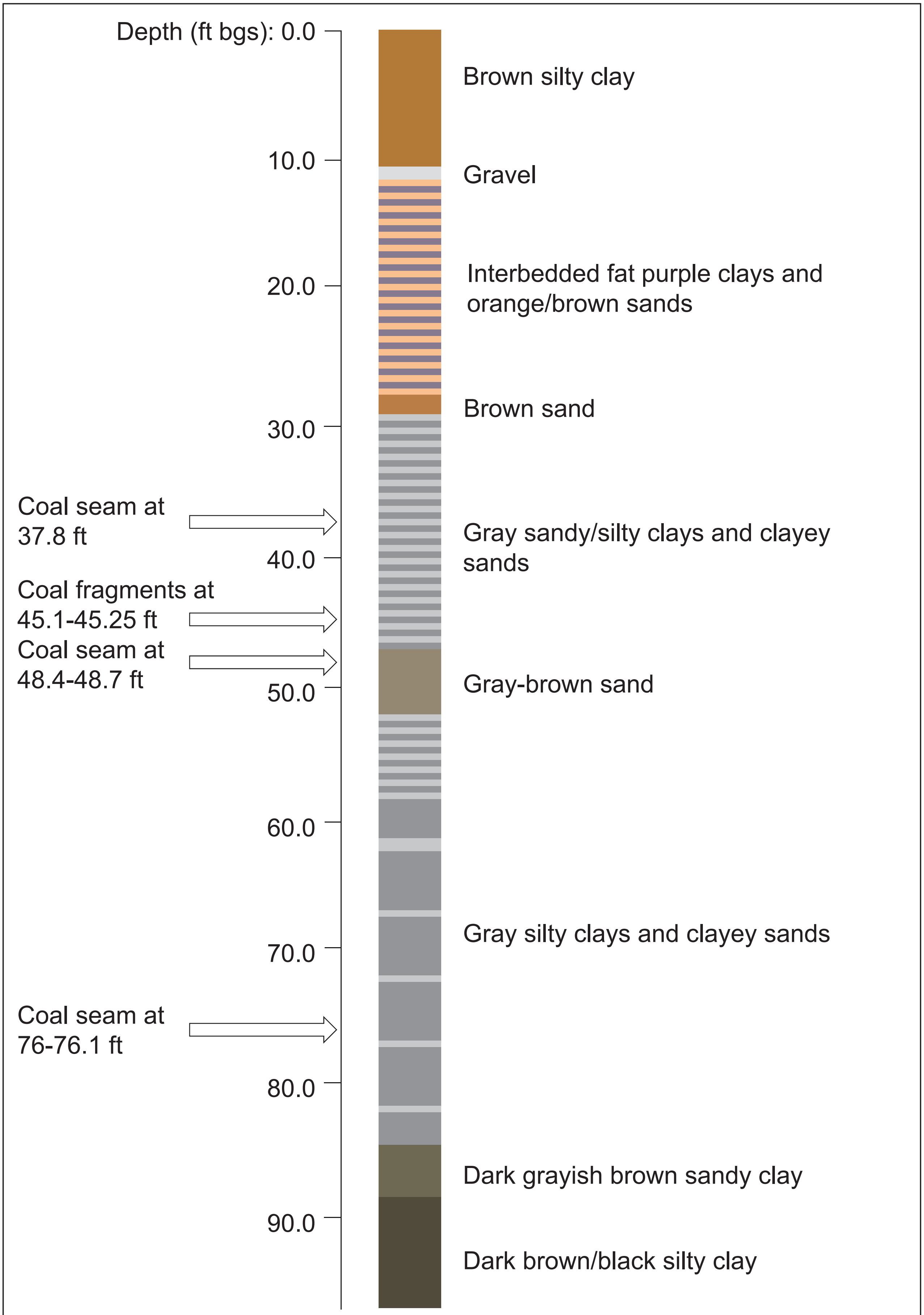
Geosyntec
consultants

Columbus, Ohio

2020/03/20

Figure
3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\Pirkey_SoilChem_minerals_March2019.mxd. hduff. 9/18/2019. Project/Phase/Task.



Notes:
- Ft = feet
- Bgs = below ground surface
- Boring completed May 2019
- Total depth of 97.5 ft bgs
- Well installed in offset boring screened at 29-34 ft bgs

B-3 Visual Boring Log

AEP Pirkey Powerplant
Hallsville, TX

Geosyntec
consultants

CHA8495
March 2020

Figure

4

Legend

● Borehole

⊕ Monitoring Well

Location Boundaries

▭ EBAP

▭ WBAP

Notes

- Lithium concentrations in micrograms per liter ug/L
- Monitoring well coordinates, site features, and data provided by AEP.
- Groundwater samples collected August 2019.

300 150 0 300

Feet

Lithium Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2020/03/20

Figure

5

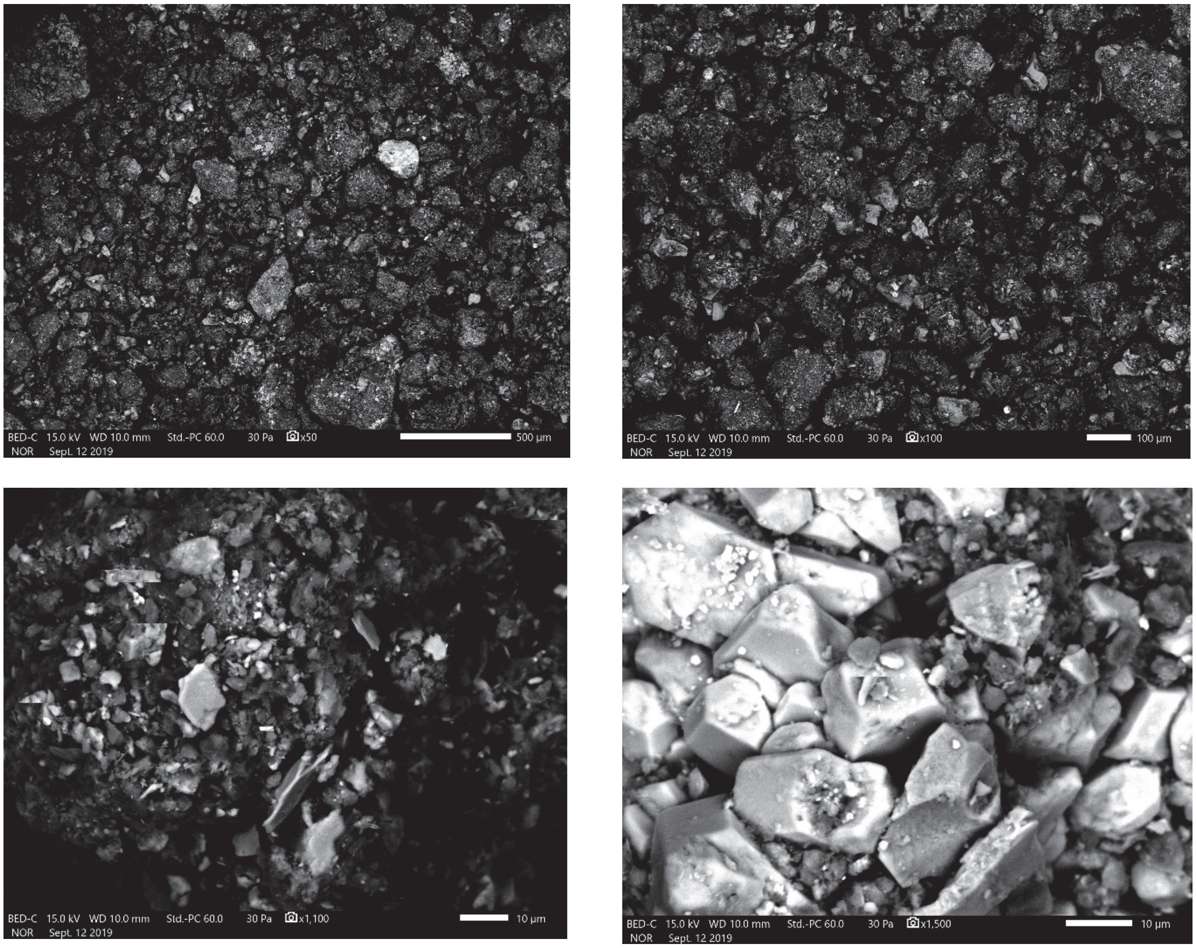
P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_Li_201909.mxd. hduff. 9/18/2019. CHA8462/12/02.

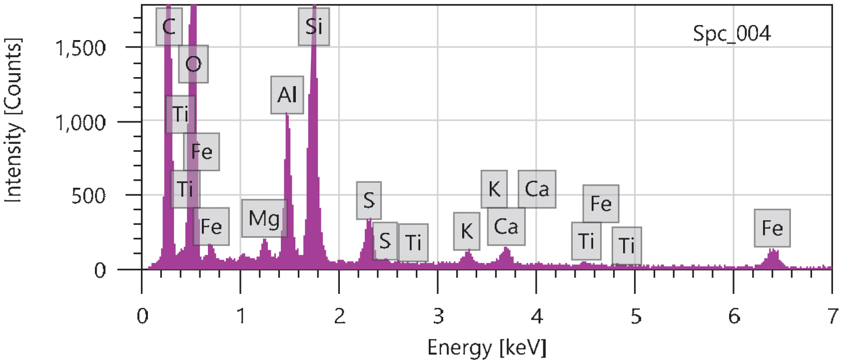
ATTACHMENT A

SEM/EDS Analysis

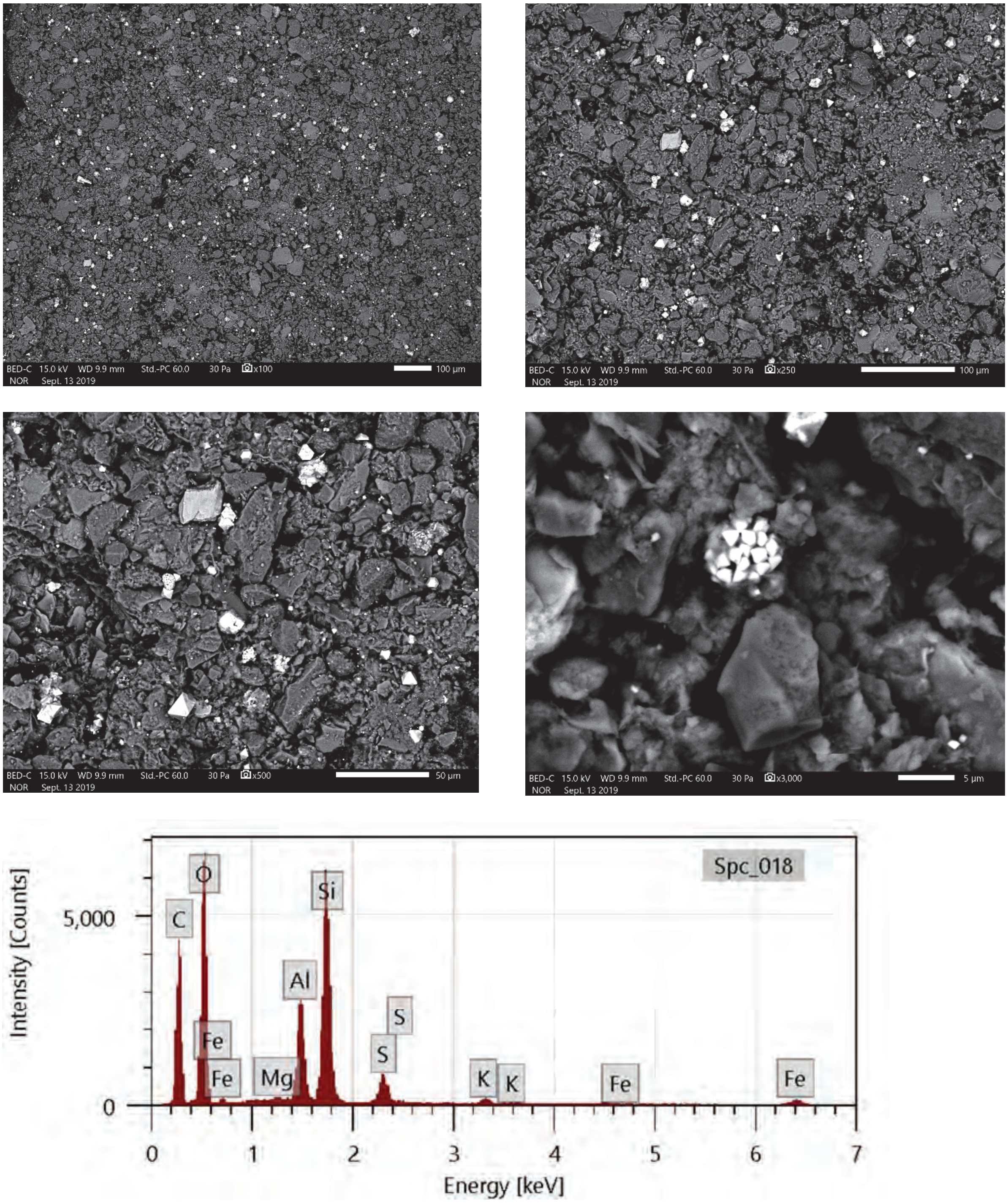
September 16, 2019

Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221
via Email: BSass@geosyntec.com

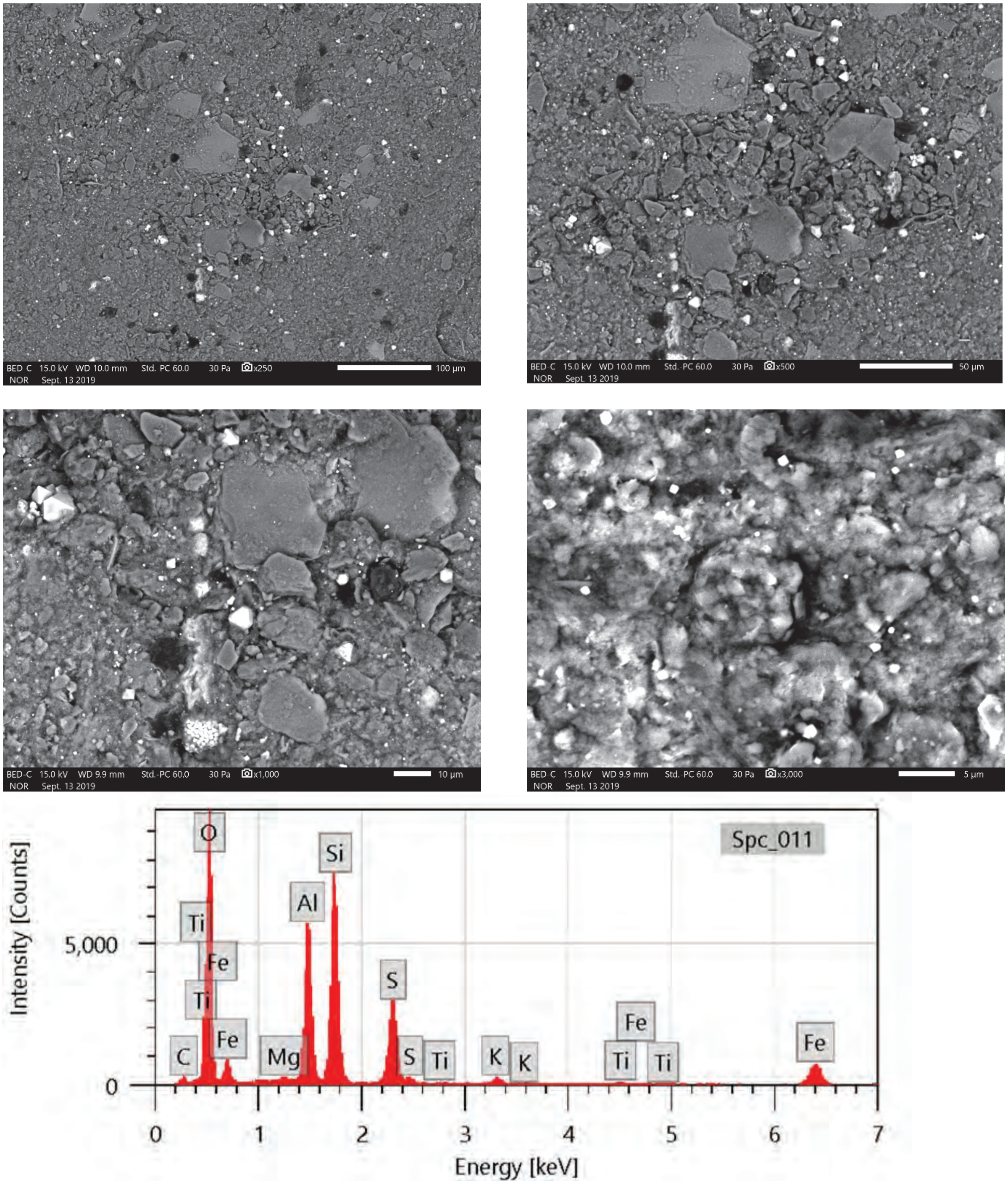




Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.



Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.



Sample VAP B3 50-55. Backscattered electron micrographs show the sample at 250X, 500X, 1000X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 3000X. Bright particles are mostly pyrite (framboid in bottom left micrograph); occasional particles of Fe-Ti oxide are detected. Major peaks for oxygen, silicon, and aluminum suggest clay. Large blocky particles are mostly quartz, feldspar, and clay.

ATTACHMENT B

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

BETH ANN GROSS
79864

Geosyntec Consultants
2039 Centre Point Blvd, Suite 103
Tallahassee, Florida 32308

Texas Registered Engineering Firm
No. F-1182

79864	Texas	4/2/2020
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
East Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

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LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Profile
SSL	Statistically Significant Level
TCEQ	Texas Commission on Environmental Quality
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
WBAP	West Bottom Ash Pond
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

This Alternative Source Demonstration (ASD) report has been prepared to address statistically significant levels (SSLs) for cobalt, lithium, and mercury in the groundwater monitoring network at the H.W. Pirkey Plant East Bottom Ash Pond (EBAP) following the first semiannual assessment monitoring event of 2020. The EBAP is registered as a surface impoundment under Texas Commission on Environmental Quality (TCEQ) Industrial and Hazardous Waste Solid Waste Registration No. 33240.

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the EBAP (**Figure 1**). In June 2020, a semi-annual assessment monitoring event was conducted at the EBAP in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the unit (AEP, 2017) and the United States Environmental Protection Agency's (USEPA's) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or, for parameters without an MCL, the risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were re-calculated for each Appendix IV parameter at the compliance wells to assess whether these parameter were present at a statistically significant level (SSL) above the GWPS. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey EBAP:

- The LCL for cobalt exceeded the GWPS of 0.00939 mg/L at AD-2 (0.0100 mg/L), AD-31 (0.00942 mg/L), and AD-32 (0.0239 mg/L);
- The LCL for lithium exceeded the GWPS of 0.060 mg/L at AD-31 (0.0682 mg/L) and AD-32 (0.0770 mg/L); and
- The LCL for mercury exceeded the GWPS of 0.00200 mg/L at AD-32 (0.00204 mg/L).

No other SSLs were identified (Geosyntec, 2020a).

1.1 CCR Rule Requirements

USEPA regulations regarding assessment monitoring programs for CCR landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section.*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this ASD report to document that the SSLs identified for cobalt, lithium, and mercury are from a source other than the EBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for cobalt, lithium, and mercury were based on a Type IV cause and not by a release from the Pirkey EBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for cobalt, lithium, and mercury and the proposed alternative sources are described below.

2.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. Groundwater sampling, laboratory analysis, and statistical evaluations were generally completed in accordance with the Federal CCR Rule and draft TCEQ guidance for groundwater monitoring (TCEQ, 2020). As described below, the SSLs have been attributed to natural variation associated with seasonal effects, which is a Type IV (natural variation) issue.

2.1.1 Cobalt

Previous ASDs for cobalt at the EBAP provided evidence that cobalt is present in the aquifer media at the site and that the observed cobalt concentrations were due to natural variation (Geosyntec, 2019a; Geosyntec, 2019b; Geosyntec, 2020b). The previous ASDs demonstrated that the EBAP is not a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-846 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP ash leachate above the reporting limit of 0.01 mg/L.

To support this ASD determination, a surface water sample was collected directly from the WBAP on November 4, 2020 as a surrogate for an EBAP sample. A sample could not be collected from the EBAP, as all ponded water had been removed at the time of sampling. However, the EBAP and WBAP receive the same process water, with the use of each pond dependent on available freeboard and cleaning schedule; thus, there is a basis for the equivalency between these two surface water samples. Cobalt was detected at a concentration of 0.000501 mg/L in the WBAP sample (**Table 1**). Cobalt was detected in a surface water sample previously collected (December 15, 2018) from the EBAP at an estimated concentration of 0.0024 mg/L (**Table 1**). These concentrations are lower than all reported groundwater cobalt concentrations for in-network wells from the most recent sampling event, and approximately two orders of magnitude lower than recent groundwater samples at the wells of interest (**Table 1; Figure 2**). Thus, the EBAP is not the likely source of cobalt at AD-2, AD-31, and AD-32.

Four additional permanent wells (B-2, B-3, AD-40, and AD-41) were installed upgradient of the EBAP in 2019. These upgradient locations were selected to represent conditions at the facility which are unimpacted by site operations. The most recent data available for select wells in the vicinity of the EBAP, as well as the upgradient locations, are shown on **Figure 2**. Groundwater cobalt concentrations at upgradient locations varied from 0.000799 mg/L (at AD-40) to 0.0108 mg/L (at B-3). This wide range in cobalt concentrations provides further evidence for the natural variation of cobalt at the Site, particularly as the concentration at upgradient location B-3 exceeds the GWPS for the EBAP.

As noted in the previous ASDs, soil samples collected across the site, including from locations near the EBAP, identified cobalt in the aquifer solids at varying concentrations. SB-2 was advanced in the vicinity of AD-2 in April 2020 to re-log the geology at AD-2 and collect samples for laboratory analysis of total metals and mineralogy. The SB-2 field boring log, which was generated by Auckland Consulting LLC, is provided as **Attachment A**. Cobalt was identified at SB-2 at concentrations of 9.45 milligrams per kilogram (mg/kg) at 25-27 feet below ground surface (bgs) and 19.2 mg/kg at 31-33 feet bgs (**Table 2**). These cobalt concentrations are greater than the concentration of cobalt present in the bottom ash (**Table 1**). Both samples correlate to the depth of the monitoring well screen of AD-2 (20-40 feet bgs), indicating that cobalt is present in aquifer solids within the AD-2 screened interval. Cobalt was also identified in the aquifer solids at varying concentrations at other locations throughout the site, with the highest value of 23.5 mg/kg reported at AD-41, which is upgradient of the EBAP (**Figure 3**).

In addition to total cobalt, soil samples were submitted for mineralogical analysis to evaluate the presence of cobalt-containing minerals. X-ray diffraction (XRD) analysis of soils from SB-2 identified pyrite (an iron sulfide) in samples collected at 25-27 feet bgs and 31-33 feet bgs at concentrations up to 7% by weight (**Figure 3**). Cobalt is known to undergo isomorphic substitution for iron in crystalline iron minerals such as pyrite due to their similar ionic radii of approximately 1.56 angstroms (Å) for iron vs. 1.52 Å for cobalt (Clementi and Raimondi, 1963; Krupka and Serne, 2002; Hitzman et al., 2017).

The aquifer solids at SB-2 are distinctly red in color at shallow depths, as illustrated in the photolog of soil cores provided in **Attachment B**. While shallow samples were not collected for mineralogical analysis, red color in soils is often associated with the presence of oxidized iron-bearing minerals such as hematite and goethite. The weathering of pyrite to goethite under oxidizing conditions is also a well-understood phenomenon, including in formations in east Texas (Senkayi et al., 1986; Dixon et al., 1982). It is likely that the pyrite weathering process is resulting in the release of isomorphically substituted cobalt from the pyrite crystal structure as it undergoes oxidative transformation to iron oxide minerals.

As described in a previous ASD, vertical aquifer profiling (VAP) was used to collect groundwater samples from upgradient locations B-2 and B-3 during the soil boring and sample collection process (Geosyntec, 2019b). A groundwater sample was also collected from AD-32, an existing well within the EBAP groundwater monitoring network. Solid phases within these groundwater samples were separated and submitted for analysis of chemical composition. For the VAP samples, separation was completed using a centrifuge due to the high abundance of solids. For the groundwater sample at AD-32, the sample was filtered using a 1.5-micron filter. Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient VAP location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from permanent monitoring wells B-2 and B-3 (**Table 2**). The concentrations of cobalt in the solid material retained after filtration were comparable to the bulk soil samples collected from the same locations.

The solid sample [VAP-B3-(40-45)] was submitted for mineralogical analysis via XRD and scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). The XRD results identified pyrite as approximately 3% of the solid phase (**Table 3**). Pyrite was identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site. Logging completed while the VAP boring was advanced identified coal at several intervals, including 45 and 48 feet bgs (**Figure 4**). Furthermore, SEM/EDS of both centrifuged solid samples [VAP-B3-(40-45) and VAP-B3-(50-55)] identified pyrite in backscattered electron micrographs by the distinctive framboidal morphology (Harris et al., 1981; Sawlowicz, 2000). Major peaks involving iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (**Attachment C**). While cobalt was not identified in the EDS spectrum, it is likely present at concentrations below the detection limit.

Naturally occurring cobalt is known to substitute for iron in pyrite, which is then known to weather to iron oxides. The presence of pyrite has been confirmed at AD-2 and across the Site. This suggests that pyrite may be providing a source for aqueous cobalt in groundwater. Additionally, the pond was not identified as the source of cobalt at wells in the EBAP network based on the low concentrations of cobalt in the pond itself.

2.1.2 Lithium

Previous ASDs for lithium at the EBAP attributed the observed lithium exceedances to variations in naturally suspended aquifer solids that likely originate from naturally occurring lignite and are ubiquitous in the aquifer based on the presence of lithium at upgradient locations and in the solid phase (Geosyntec, 2019b; Geosyntec, 2019c). Data gathered in support of the prior ASDs and recent results provide additional evidence that the observed lithium concentrations at AD-31 and AD-32 are due to natural variation in the aquifer.

As discussed in Section 2.1.1, a surface water sample was collected directly from the WBAP on November 4, 2020, as a surrogate for an EBAP sample. Lithium was detected in the WBAP sample at a concentration of 0.0274 mg/L, which is comparable to the estimated concentration of 0.023 mg/L reported at the EBAP in 2018 (**Table 4**). These concentrations are lower than the average lithium concentrations at AD-2 and AD-32 (**Table 4**). The mobile fraction identified by SPLP was even lower, with an estimated lithium concentration of 0.011 mg/L. Thus, the EBAP is not the likely source of lithium at AD-2 and AD-32.

Groundwater samples collected from upgradient wells B-2 and B-3 in November 2020 had total lithium concentrations of 0.063 mg/L and 0.103 mg/L, respectively, both of which were above the GWPS of 0.060 mg/L (**Figure 5**). Lithium was detected at AD-31 at 0.0682 mg/L, and AD-32 at 0.0696 mg/L, which were comparable to the observed concentration at B-2 and less than the observed concentration at B-3. Because B-2 and B-3 were installed at locations upgradient to and unimpacted by site activities, their lithium concentrations suggest that lithium is naturally present at concentrations above the GWPS in the vicinity of the EBAP.

As described in Section 2.1.1, groundwater samples were collected from B-2, B-3, and AD-32 and filtered to separate solids. Groundwater was also collected from a VAP boring (VAP-B3-(40-45)) and centrifuged to separate solids. Lithium was detected in the solid material separated from these groundwater samples at concentrations comparable to bulk soil at all locations, providing evidence that the particulates captured during groundwater sampling contain lithium (**Table 5**).

2.1.2.1 Calculated Partition Coefficients

A previous ASD for lithium at the EBAP developed a proposed lithium mobility in groundwater due to desorption from clay minerals associated with naturally occurring lignite material. This mechanism was posited as the source of lithium in both upgradient and downgradient wells at the EBAP (Geosyntec, 2019b). Previously completed XRD analysis of centrifuged solid material samples (VAP-B3-(40-45)) found that clay minerals, including kaolinite, smectite, and illite/mica, made up at least 60% of the aquifer solid (**Table 3**). These clay minerals, particularly smectite and illite, are known to retain positively charged ions such as lithium via cation exchange processes. SEM/EDS analysis identified the presence of silicon, aluminum and oxygen, all of which are indicative of clay minerals (**Attachment A**). The backscattered electron micrographs of these samples also identified clay particles by morphology. The largest clay particles (> 5 μm) are likely kaolinite, while smectite and illite dominate the smaller size fraction.

Total metal concentrations in the solid materials separated from the groundwater samples during filtration and the filtered groundwater concentrations were used to calculate partition coefficients values (K_d) for lithium, potassium, and sodium. Details about the K_d calculation are provided in the previous ASD (Geosyntec, 2019c). K_d values for groundwater and particulates collected from wells B-2, B-3, and AD-32 were comparable to literature K_d values reported for organic-rich media such as bogs and peat beds (Sheppard et al., 2009; Sheppard et al., 2011), providing further evidence that lithium mobility in site groundwater is similar to other sites with organic-rich soils (**Table 6**). Additionally, the calculated K_d values for Pirkey soils were consistent with the literature, with potassium having the highest K_d (greatest affinity for sorption) and sodium the lowest K_d (least affinity for sorption). Furthermore, the values are similar for groundwater from all three wells, suggesting a universal mechanism controlling lithium, sodium, and potassium mobility in groundwater.

These multiple lines of evidence show that elevated lithium concentrations at AD-31 and AD-32 are not due to a release from the EBAP, and instead can be attributed to natural variation. This variation appears related to the distribution of clay fractions associated with lignite materials in the soil aquifer material.

2.1.3 Mercury

As discussed in Section 2.1.1, a surface water sample was collected directly from the WBAP on November 4, 2020 as a surrogate for an EBAP sample. Mercury was not detected in the WBAP sample or a surface water sample previously collected from the EBAP (**Table 7**), with the reporting limits for these samples approximately one and three orders of magnitude lower than the average mercury concentration at AD-32 (**Table 7**). Thus, the EBAP is not the likely source of mercury at AD-32.

Dissolved concentrations of mercury at AD-32 are consistently lower than the reported total values (**Figure 6**), with no dissolved concentrations detected above the MCL of 0.002 mg/L. The recorded turbidity at the time of sampling was often elevated, with values ranging from approximately 45 to 450 nephelometric turbidity units (NTUs; **Figure 7**). The inclusion of suspended particles (including colloids) in samples with elevated turbidity is likely to result in an overestimation of metals due to the mobilization of metals from the colloidal or solid to aqueous phase following acid preservation during sample collection. Thus, the completion of low-flow purging of the well until field water quality parameters have stabilized is necessary to ensure the collected sample is representative of actual groundwater concentrations (USEPA, 1996). While low-flow purging was completed, a review of sample logs found multiple instances where turbidity did not stabilize within 10% for three consecutive readings, as recommended by TCEQ (TCEQ, 2020; **Attachment D**).

The difference between the total and dissolved mercury concentrations suggests that mercury is associated with the colloidal fraction that is captured in samples collected with elevated turbidity. Mercury is known to undergo isomorphic substitution for iron in crystalline iron minerals such as pyrite due to their similar ionic radii of approximately 1.56 angstroms (Å) for iron vs. 1.71 Å for mercury (Clementi and Raimondi, 1963; Manceau et. al, 2018). As documented in Section 2.1.1., pyrite was identified in aquifer solids in the vicinity of the EBAP, including from samples collected adjacent to AD-32 (**Figure 3**). Mercury was identified in the centrifuged solid material collected from upgradient VAP location B-3[VAP-B3-(40-45)] at 1.1 mg/kg (**Table 7**); pyrite was detected in this same sample at 3% (**Table 3**).

The abundance of pyrite across the site, including upgradient locations, and the likely association of mercury with pyrite suggests that the pond is not the likely source of mercury at AD-32. The currently calculated LCL of 0.00204 mg/L is negligibly above the MCL of 0.002.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSLs are not due to a release from the Pirkey EBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSLs for cobalt, lithium, and mercury during assessment monitoring in June 2020 were not due to a release from the EBAP. The identified SSLs were instead attributed to natural variation. Therefore, no further action is warranted, and the Pirkey EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in **Attachment E.**

SECTION 4

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TABLES

Table 1: Summary of Key Cobalt Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant

Sample	Sample Date	Unit	Cobalt Concentration
Bottom Ash (Solid Material)	2/11/2019	mg/kg	6.1
SPLP Leachate of Bottom Ash	2/11/2019	mg/L	<0.01
EBAP Pond Water	12/15/2018	mg/L	0.0024 J
WBAP Pond Water	11/4/2020	mg/L	0.000501
AD-2 - Average	May 2016 - June 2020	mg/L	0.0134
AD-31 - Average	May 2016 - June 2020	mg/L	0.0136
AD-32 - Average	May 2016 - June 2020	mg/L	0.0450

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

A sample was collected from the WBAP on 11/4/2020 as a surrogate for the EBAP, as the EBAP did not contain free water. The same process water is stored in both the WBAP or EBAP.

Average values were calculated using all cobalt data collected under 40 CFR 257 Subpart D, excluding any identified outliers.

Table 2: Soil Cobalt Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Location	Sample Depth (ft bgs)	Cobalt (mg/kg)
Bulk Soil Samples			
AD-2	EBAP Network	25-27	9.45
		31-33	19.2
AD-18	EBAP Network	8	3.60
		22	2.90
AD-31	EBAP Network	12	1.90
		26	0.83
AD-32	EBAP Network	11	1.70
		20-25	9.10
AD-41	Upgradient	15	< 1.0
		35	23.5
		95	1.90
B-2	Upgradient	10	2.36
		16	3.62
		71	10.30
		82	7.21
		87	3.11
B-3	Upgradient	10	1.30
		20	0.59
		97	1.11
Solid Material Retained After Filtration			
AD-32	EBAP Network	13-33	5.4
B-2	Upgradient	38-48	4.3
B-3	Upgradient	29-34	12.0
		VAP 40-45	18.0

Notes:

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

For AD-XX locations, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-2 and B-3 locations were collected from cores removed from the borehole during well lithology logging.

Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

Table 3: X-Ray Diffraction Results
East Bottom Ash Pond - H. W. Pirkey Plant

Constituent	**VAP-B3-(40-45)**
Quartz	15
Plagioclase Feldspar	0.5
Orthoclase	ND
Calcite	ND
Dolomite	ND
Siderite	0.5
Goethite	ND
Hematite	2
Pyrite	3
Kaolinite	42
Chlorite	4
Illite/Mica	6
Smectite	12
Amorphous	15

Notes:

ND: Not detected

VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

Table 4: Summary of Key Lithium Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant

Sample	Sample Date	Unit	Lithium Concentration
Bottom Ash (Solid Material)	2/11/2019	mg/kg	0.82 J
SPLP Leachate of Bottom Ash	2/11/2019	mg/L	0.011 J
EBAP Pond Water	12/15/2018	mg/L	0.023 J
WBAP Pond Water	11/4/2020	mg/L	0.0274
AD-2 - Average	May 2016 - June 2020	mg/L	0.0547
AD-32 - Average	May 2016 - June 2020	mg/L	0.150

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

A sample was collected from the WBAP on 11/4/2020 as a surrogate for the EBAP, as the EBAP did not contain free water. The same process water is stored in both the WBAP or EBAP.

Average values were calculated using all lithium data collected under 40 CFR 257 Subpart D, excluding any identified outliers.

Table 5: Soil Lithium Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Sample Depth (ft bgs)	Lithium (mg/kg)
Bulk Soil Samples		
AD-32	11	0.53
	20-25	1.60
B-2	10	5.30
	16	3.97
	71	7.42
	87	13.10
B-3	10	3.64
	20	2.59
	97	11.10
Lignite	N/A	2.9 J
Solid Material Retained After Filtration		
AD-32	13-33	9.8 J
B-2	38-48	6.5 J
B-3	29-34	7.8 J
	VAP 40-45	13.0

Notes:

J - estimated value

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

For AD-32, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-X locations were collected from cores removed from the borehole during well lithology logging.

Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

VAP - vertical aquifer profiling

Table 6: Calculated Site-Specific Partition Coefficients
East Bottom Ash Pond - H. W. Pirkey Plant

Source	B-2			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.081	6.5	80	43-370
K	2.6	1100	423	42-1200
Na	14	130	9	5.2-82

Source	B-3			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.097	7.8	80	43-370
K	2.9	1100	379	42-1200
Na	32	240	8	5.2-82

Source	AD-32			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.11	9.8	89	43-370
K	3.9	1800	462	42-1200
Na	57	220	4	5.2-82

Notes:
mg/L: milligrams per liter
mg/kg: milligrams per kilogram
L/kg: liters per kilogram
Kd: partition coefficient
Adsorbed values are total metals concentrations reported by USEPA Method 6010B.
Literature values represent maximum and minimum values for the parameter as reported in Sheppard et al, 2009 (Table 4-1, all sites) and Sheppard et al, 2011 (Table 3-3 cultivated peat and wetland peat only).

Table 7: Summary of Key Mercury Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant

Sample	Sample Date	Unit	Mercury Concentration
VAP-B3-(40-45)	6/19/2019	mg/kg	1.1
Bottom Ash (Solid Material)	2/11/2019	mg/kg	<0.13
SPLP Leachate of Bottom Ash	2/11/2019	µg/L	<0.20
EBAP Pond Water	12/15/2018	µg/L	<0.2
WBAP Pond Water	11/4/2020	µg/L	<0.002
AD-32 - Average	May 2016 - June 2020	µg/L	4.56

Notes:

mg/kg - milligram per kilogram

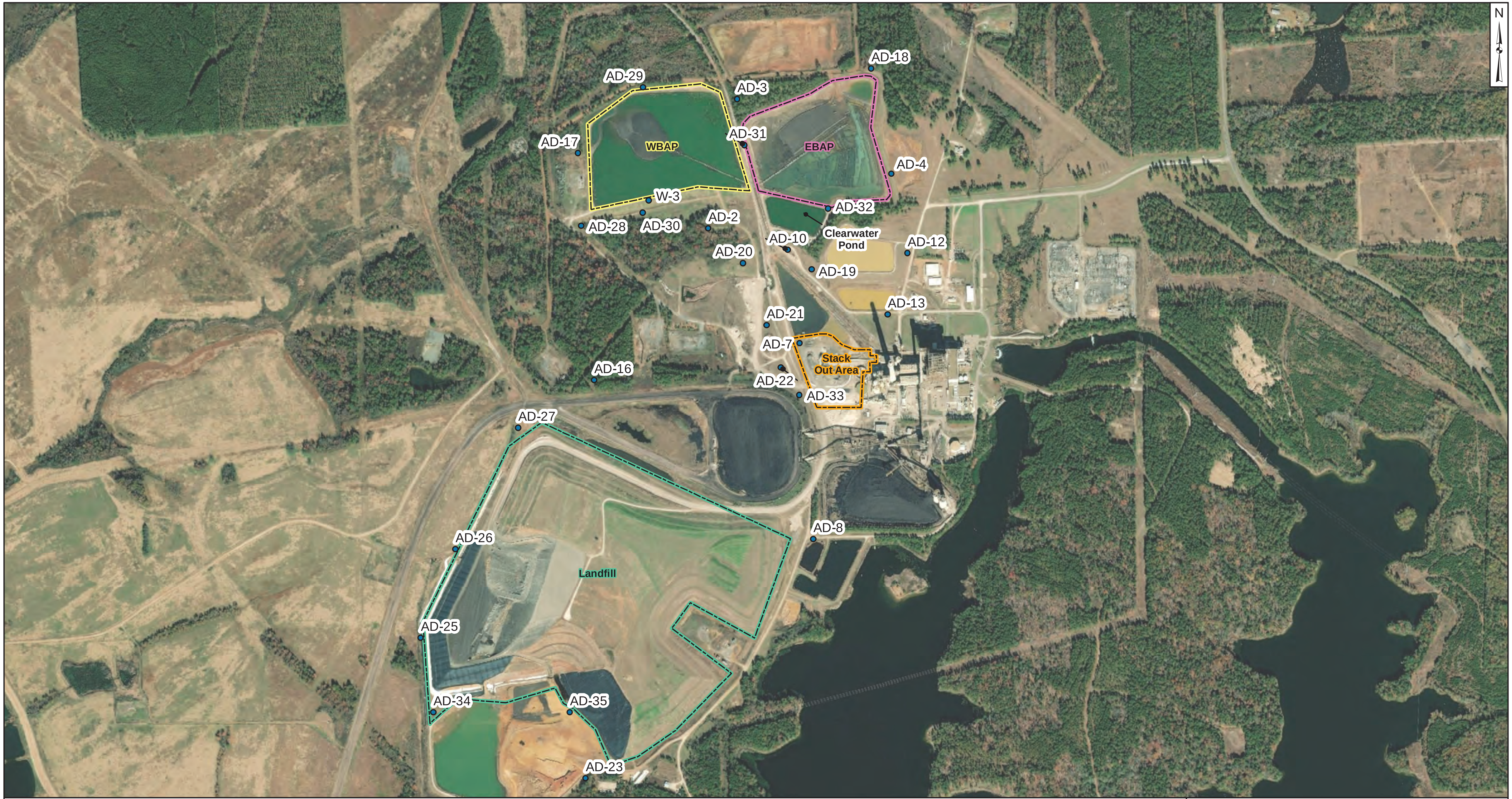
µg/L - microgram per liter

A sample was collected from the WBAP on 11/4/2020 as a surrogate for the EBAP, as the EBAP did not contain free water. The same process water is stored in both the WBAP or EBAP.

Average values were calculated using all mercury data collected under 40 CFR 257 Subpart D, excluding any identified outliers.

VAP-B3-(40-45) represents the solid phase that was separated via centrifugation from an aqueous sample at boring B-3.

FIGURES



Legend

- ● Monitoring Wells
- ▭ EBAP
- ▭ Landfill
- ▭ Stack Out Area
- ▭ WBAP

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019

0 375 750 1,500 2,250 3,000 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2020/03/24

Figure

1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_2020324.mxd. hduff. 3/24/2020. Project/Phase/Task.

Legend

- ⊕ Out of Network
- ◆ EBAP
- ◆ WBAP
- ◆ Landfill
- ◆ Stackout Area
- ◆ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- ▭ EBAP
- ▭ Stack Out Area
- ▭ WBAP

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- AD-15 location is approximated
- Samples collected in June 2020
- * - Well most recently sampled August 2019
- ** - Well most recently sampled November 2020
- AD-29 included in the well network for water level measurements only

400 200 0 400
Feet

Cobalt Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2020/12/22

Figure
2

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Pirkey_Cobalt_20201222.mxd. CChristenson. 12/22/2020. Project/Phase/Task.

Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	B-2				
Depth (ft bgs)	10	16	71	82	87
Cobalt (mg/kg)	2.36	3.62	10.30	7.21	3.11
Pyrite/Marcasite (%)	-	-	-	-	-

Location	AD-41		
Depth (ft bgs)	15	35	95
Cobalt (mg/kg)	< 1.0	23.5	1.9
Pyrite/Marcasite (%)	-	-	-

Location	AD-2	
Depth (ft bgs)	25-27	31-33
Cobalt (mg/kg)	9.45	19.2
Pyrite/Marcasite (%)	7	2

Location	B-3		
Depth (ft bgs)	10	20	97
Cobalt (mg/kg)	1.30	0.59	1.11
Pyrite/Marcasite (%)	-	-	-

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Legend

⌖	Monitoring Wells
🟪	EBAP
🟨	WBAP

Notes
- Monitoring well coordinates provided by AEP.
- AD-2 sample collected on April 20, 2020
- All other data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.

300 150 0 300
Feet

Cobalt Distribution in Soil

AEP Pirkey Power Plant
Hallsville, Texas

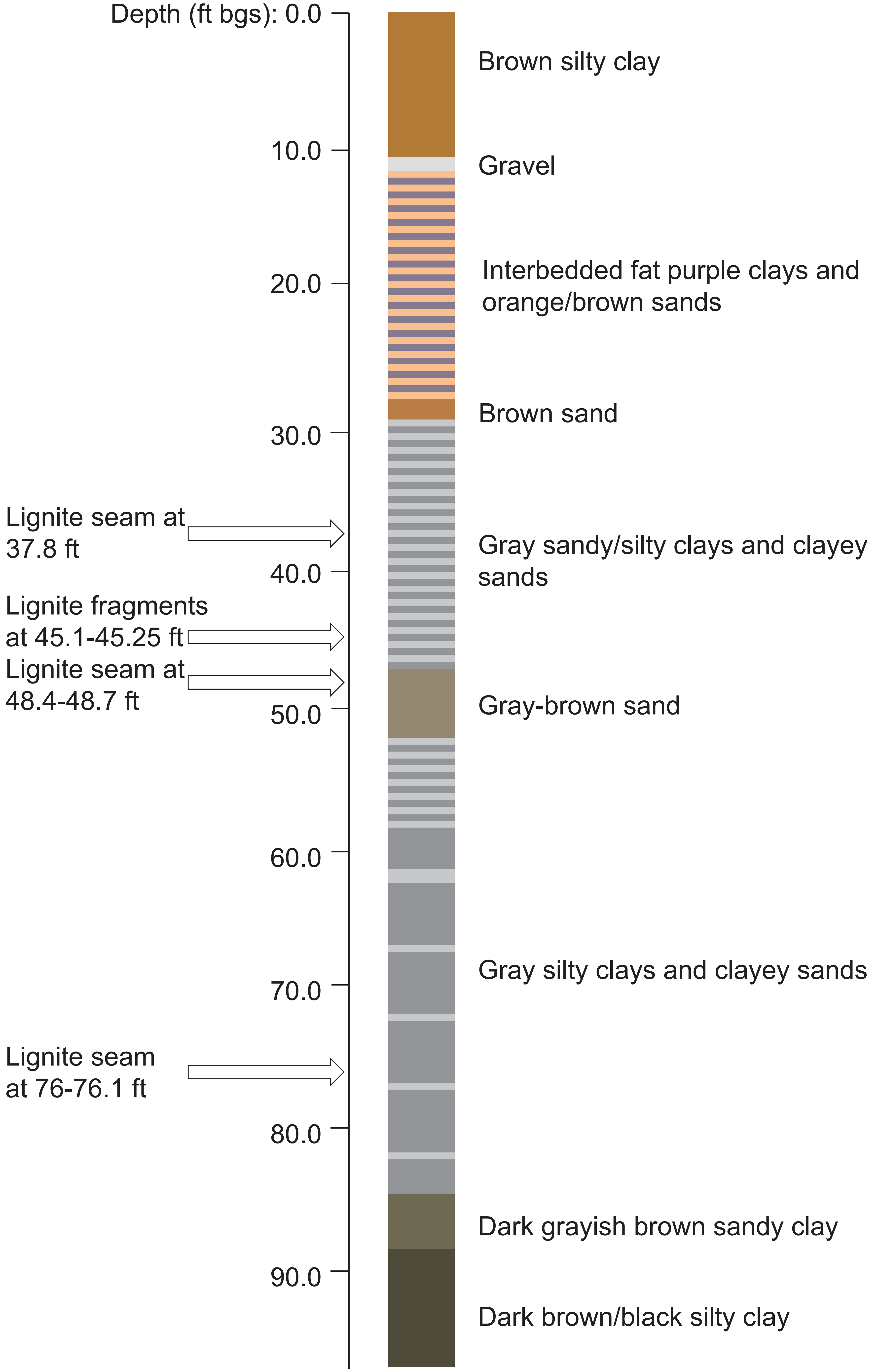
Geosyntec
consultants

Columbus, Ohio

2020/12/22

Figure
3

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\20201218 Pirkey_SoilChem_minerals_March2019_new.mxd. CChristenson. 12/22/2020. Project/Phase/Task.



Notes:
- Ft = feet
- Bgs = below ground surface
- Boring completed May 2019
- Total depth of 97.5 ft bgs
- Well installed in offset boring screened at 29-34 ft bgs

B-3 Visual Boring Log

AEP Pirkey Powerplant
Hallsville, TX

Geosyntec
consultants

CHA8462 | March 2020

Figure

4

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-05 Field Investigation\Field Forms\Compiled Boring Logs\Visual boring logs

B-2	Lithium (mg/L)
	0.0633

AD-31	Lithium (mg/L)
	0.0682

B-3	Lithium (mg/L)
	0.103

AD-32	Lithium (mg/L)
	0.0696

Legend

● Borehole

⊕ Monitoring Well

Location Boundaries

▭ EBAP

▭ WBAP

Notes

- Lithium concentrations in micrograms per liter ug/L
- Monitoring well coordinates, site features, and data provided by AEP.
- Groundwater samples were collected from AD-31 and AD-32 in June 2020
- Groundwater samples were collected from B-2 and B-3 in November 2020

300 150 0 300

Feet

Lithium Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

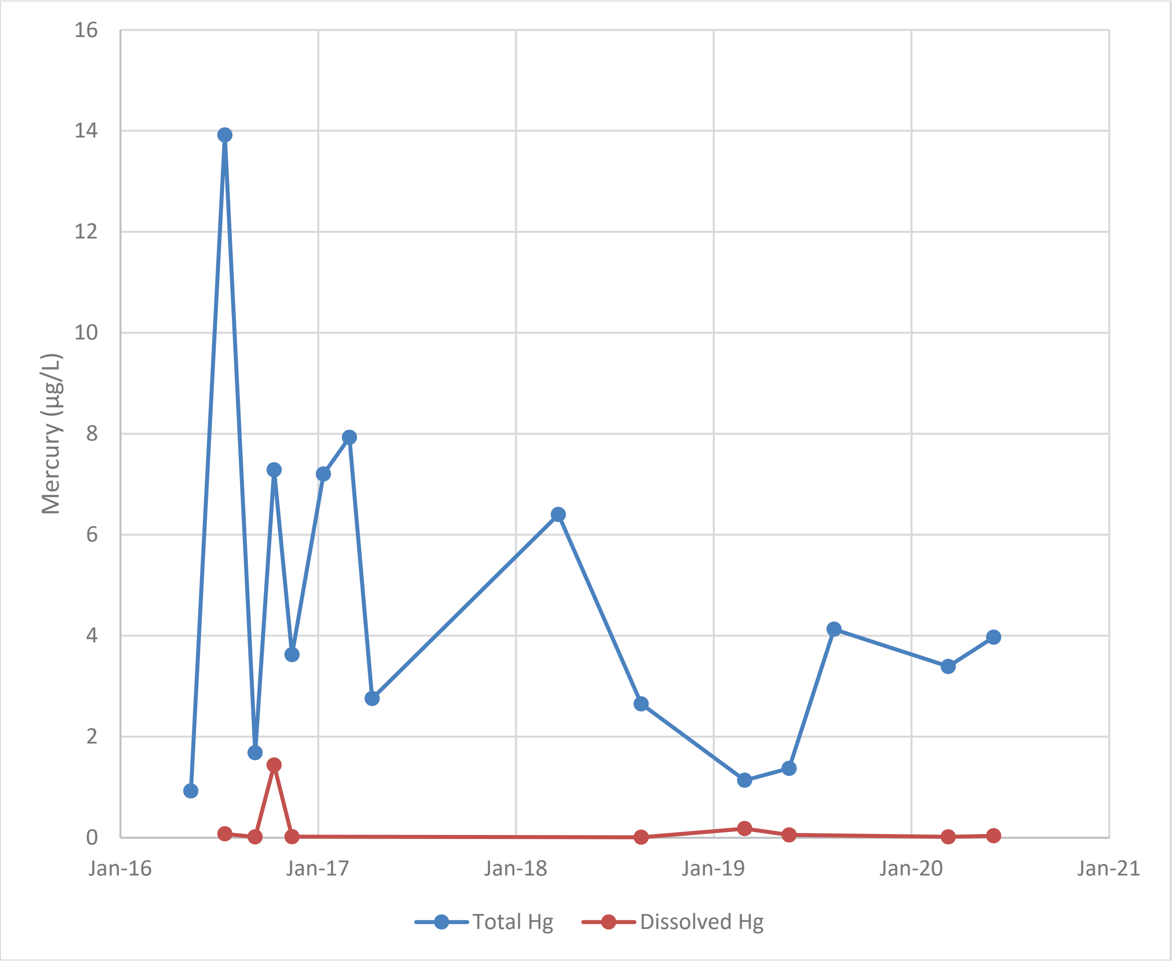
Columbus, Ohio

2020/12/22

Figure

5

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_Li_20201222.mxd. CChristenson. 12/22/2020. CHA8462/12/02.



Notes: Total and dissolved mercury results at AD-32 are shown. Concentrations are shown in micrograms per liter (µg/L).

Total and Dissolved Mercury Concentrations

East Bottom Ash Pond – H.W. Pirkey Plant

Geosyntec consultants

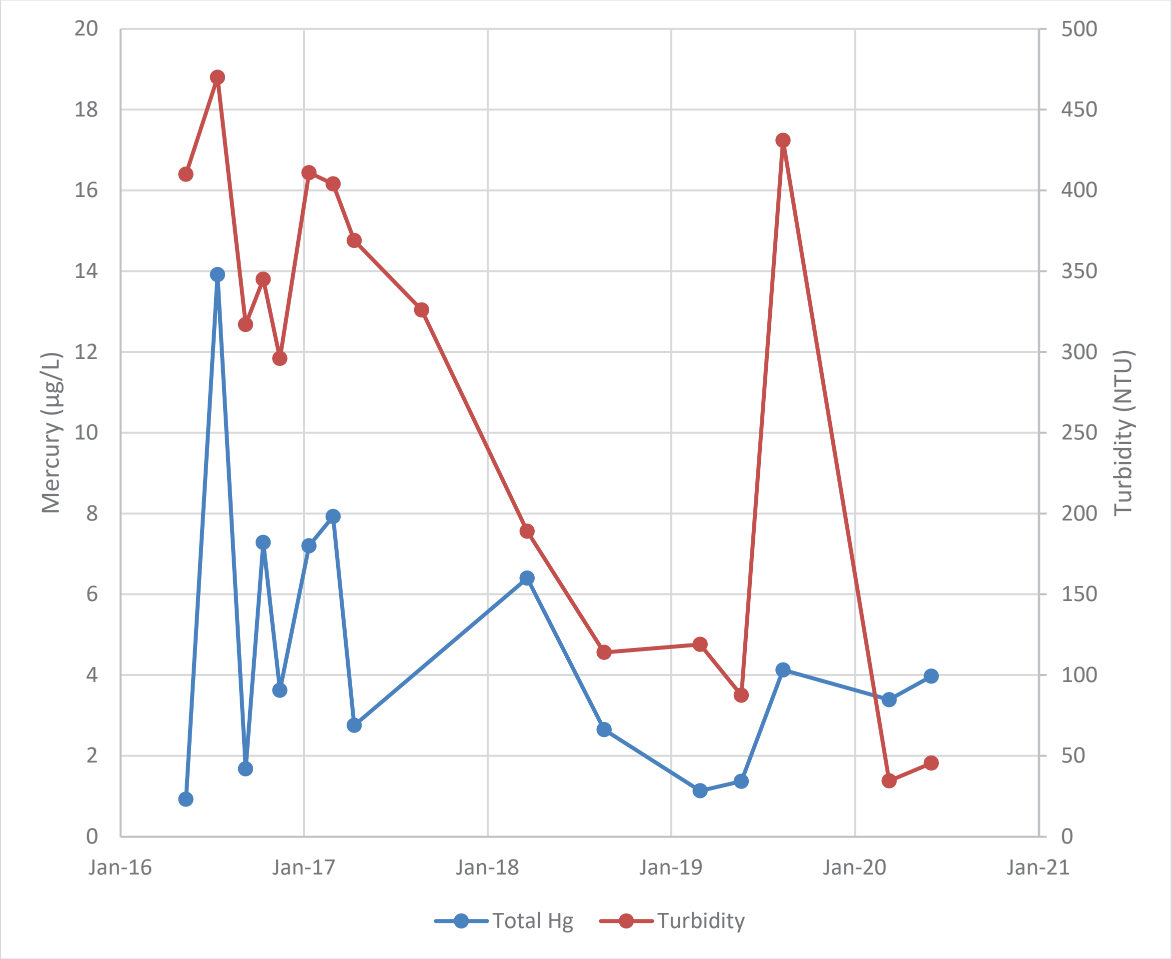
AMERICAN ELECTRIC POWER

Figure

6

Columbus, Ohio

22-December-2020



Notes: Total mercury results and field turbidity measurements at AD-32 are shown. Mercury concentrations are shown in micrograms per liter (µg/L). Turbidity is shown as as nephelometric turbidity units (NTU).

Mercury and Turbidity Time Series Graph

East Bottom Ash Pond – H.W. Pirkey Plant

Geosyntec consultants

AMERICAN ELECTRIC POWER

Figure

7

Columbus, Ohio

22-December-2020

internal info: path, date revised, author

ATTACHMENT A

SB-2 Boring Log

PROJECT NO. ____________ PROJ. ____________ BOR. NO. SB-2
LOCATION AD-2/MW-2 - Pirkey Power Plant ELEV. ____________ DATE 4/20/20

SILTS & SANDS		COHESIVE SOILS - CLAYS			COLORS	MATERIALS	SAND ADJ.	CHARACTERTICS
CONDITION		CONSISTENCY	PENETROMETER	N - VALUE				
VLo ...... Very Loose	0- 4	Vso.. Very Soft	0 - 0.25	<2	Li ..... Light .....Br ....Brown	Cl ..... Clay, Clayer	F.......Fine	Calc ..... Calcareous
Lo .... Loose	4-10	So.... Soft	0.25 - 0.5	2 - 4	Dk ... Dark .....Bk ....Black	Si ..... Silt, Silty	M ....Medium	Lig .... Lignite
MDe ..... Med. Dense	10-30	Mst.. Stiff	0.5 - 1.0	4 - 8	G ..... Grey ....Bl ....Blue	Sa ..... Sand, Sandy	Co....Coarse	Org .... Organic
De .... Dense	30-50	St..... Stiff	1.0 - 2.0	8 - 15	T ...... Tan ....Gr .....Grenn	Ls .... Limestone	Si.....Silty	Lam ...... Laminate
VDe ...... Very Dense	>50	VSt.. Very Stiff	2.0 - 4.0	15 - 30	R ...... Red ......Y ......Yellow	Gr .... Gravel		Sls .... Slickensided
		H..... Hard	> 4.0	>30	Rdish.Reddish. Wh ...White	SiS ... Siltstone		SL .... Slightly
						SS .... Sandstone		Sm(s) ... Seam (s)
						Sh..... Shale, Shaley		Nod ...... Nodules

	Sample Interval ~~TEST~~ ASSIGNMENT	~~SAMPLE NO.~~ Recovery	DEPTH FT.	SAMPLES	STRATUM DESCRIPTION: CONDITION OR CONSISTENCY	COLOR	MINOR MATERIALS OR ADJECTIVES	PREDOMINATE MATERIAL	CHARACTERISTICS OR MODIFICATIONS	STANDARD PENETROMETER: SEAT - 6"	1st - 6"	2nd - 6"	UNIFIED SOIL CLASSIFICATION	N - VALUE OR HAND PENETROMETER
	0-5	2' Rec	0		0-8'	Br, Lt. Rd Br	Si	Sa	Silty Sand - trace clay,					
SM									trace root hairs, moist.				moist	(0-5')
	5-10	2.5' Rec				Lt. Rd Br			- thin lenses (less than 1/4")				moist	(5-10')
8'									at 7.5', trace iron staining					
Cl	10-15	4' Rec	8		8-14.5	Lt. Rd Br, Rd	Sa, Si	Cl	Clay - some silty sand and silty				moist	(10-15')
						Br, Gray			clayey sand in interbedding					
									to 14.5', trace iron ore gravel					
14.5'									in sand seams @ 10.5, 12', 12.5'					
	15-20	2' Rec	14.5		14.5-	Rd Br, Ylw.	Si, Cl	Sa	silty clayey sand - some sandy clay;				v. moist to	
					39'	Br, Gray			thin cemented sand @ 16.5'				moist	(15-20
									and ironstone → (~1.5")					
	20-25'	* No Rec.						(?	- cemented sand seams in silty				v. moist	(20-25'?)
SC									sand @ 20-25'					
	25-30'	2.5' Rec				Gray - DkGray			- gravel & cemented sand seam @ 25' (6")				sat. @	25'-25.5'
						Dk. Br			- cemented and partially cemented					
						(25-39')			clayey silty sand @ 25.5				moist	25.5-27
									- dark gray silty sat sand seam (2")				sat.	@ 27.0' (2")
									@ 27'					
	30-35	3' Rec							- sat. silty sand seam @ 30.5' (1")				sat.	@ 30.5 (1")
									- sat. silty sand seam @ 32' (3")					32.0' (3")
39'									* some v.f. gypsum crystals in clayey sand					
									between sat. sand seams (25-40')				v. moist	(to 39')
ML	35-40	4' Rec	39		39-40	Lt. Gray, Gray (39-40')	Cl, Sa	Si	Clayey sandy silt,					
									- interbedded silt & clay @ 39' to 40'				moist	(39-40')
									B.T. @ 40'					
									* 25-27' collected @ 1015					
									* 31-33' collected @ 1035					

Type Boring HSA Dry Auger ☒ Rotary Wash ☐

SEEPAGE @ 25 FT. WHILE DRILLING, W.L. @ ___ FT. ON COMPL.
(OR) BAILED TO ___ FT. UPON COMPLETION.
W.L. @ ___ FT AND CAVED TO ___ FT. ON ________.

* GPS: 32.46522, -94.49032 (12' E, 3.5' N of AD-2/MW-2)

ATTACHMENT B

SB-2 Boring Photographic Log

GEOSYNTEC CONSULTANTS
Photographic Record

Client: AEP
Project Number: CHA8495

Site Name: Pirkey East Bottom Ash Pond
Site Location: Hallsville, Texas

Photograph 1

Date: 4/21/2020

Direction: N/A

Comments:
0-5 foot interval of SB-2.

Photograph 2

Date: 4/21/2020

Direction: N/A

Comments:
5-10 foot interval of SB-2.

GEOSYNTEC CONSULTANTS
Photographic Record

Client: AEP

Project Number: CHA8495

Site Name: Pirkey East Bottom Ash Pond

Site Location: Hallsville, Texas

Photograph 3

Date: 4/21/2020

Direction: N/A

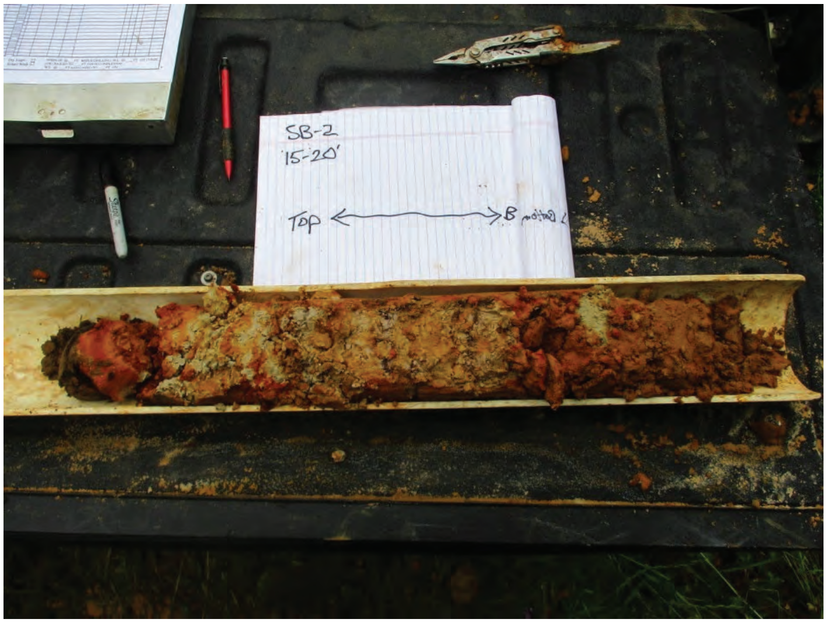
Comments:
10-15 foot interval of SB-2.

Photograph 4

Date: 4/21/2020

Direction: N/A

Comments:
15-20 foot interval of SB-2. Recovery of this interval was limited.



GEOSYNTEC CONSULTANTS
Photographic Record

Client: AEP	**Project Number:** CHA8495
Site Name: Pirkey East Bottom Ash Pond	**Site Location:** Hallsville, Texas

Photograph 5

Date: 4/21/2020

Direction: N/A

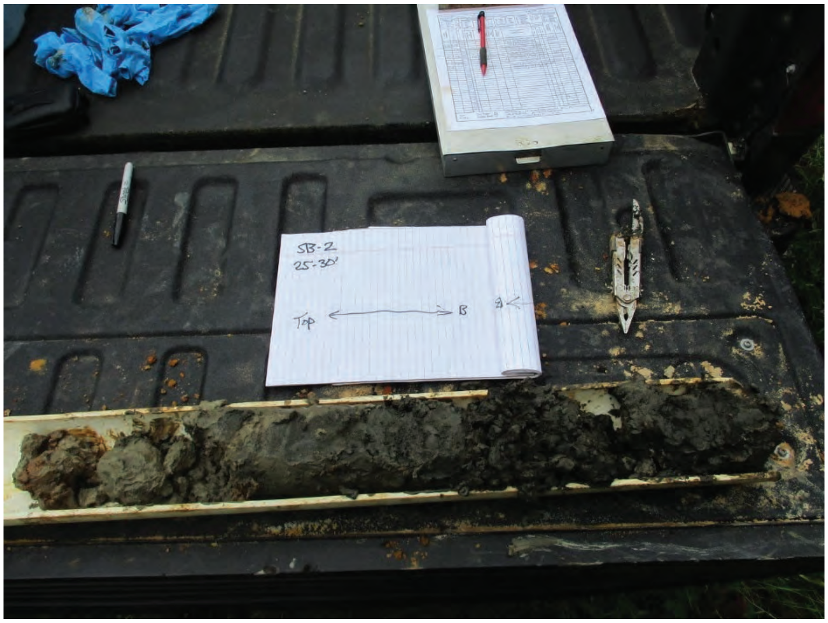
Comments:
20-25 foot interval of SB-2. Recovery of this interval was limited.

Photograph 6

Date: 4/21/2020

Direction: N/A

Comments:
25-30 foot interval of SB-2. Very little of this interval was recovered. A color change was observed from red to dark brown/black. A sample was collected from this interval.



Client: AEP	**Project Number:** CHA8495
Site Name: Pirkey East Bottom Ash Pond	**Site Location:** Hallsville, Texas

Photograph 9

Date: 4/21/2020

Direction: N/A

Comments:
30-35 foot interval of SB-2. Very little of this interval was recovered.. A sample was collected from this interval.

Photograph 10

Date: 4/21/2020

Direction: N/A

Comments:
35-40 foot interval of SB-2

ATTACHMENT C

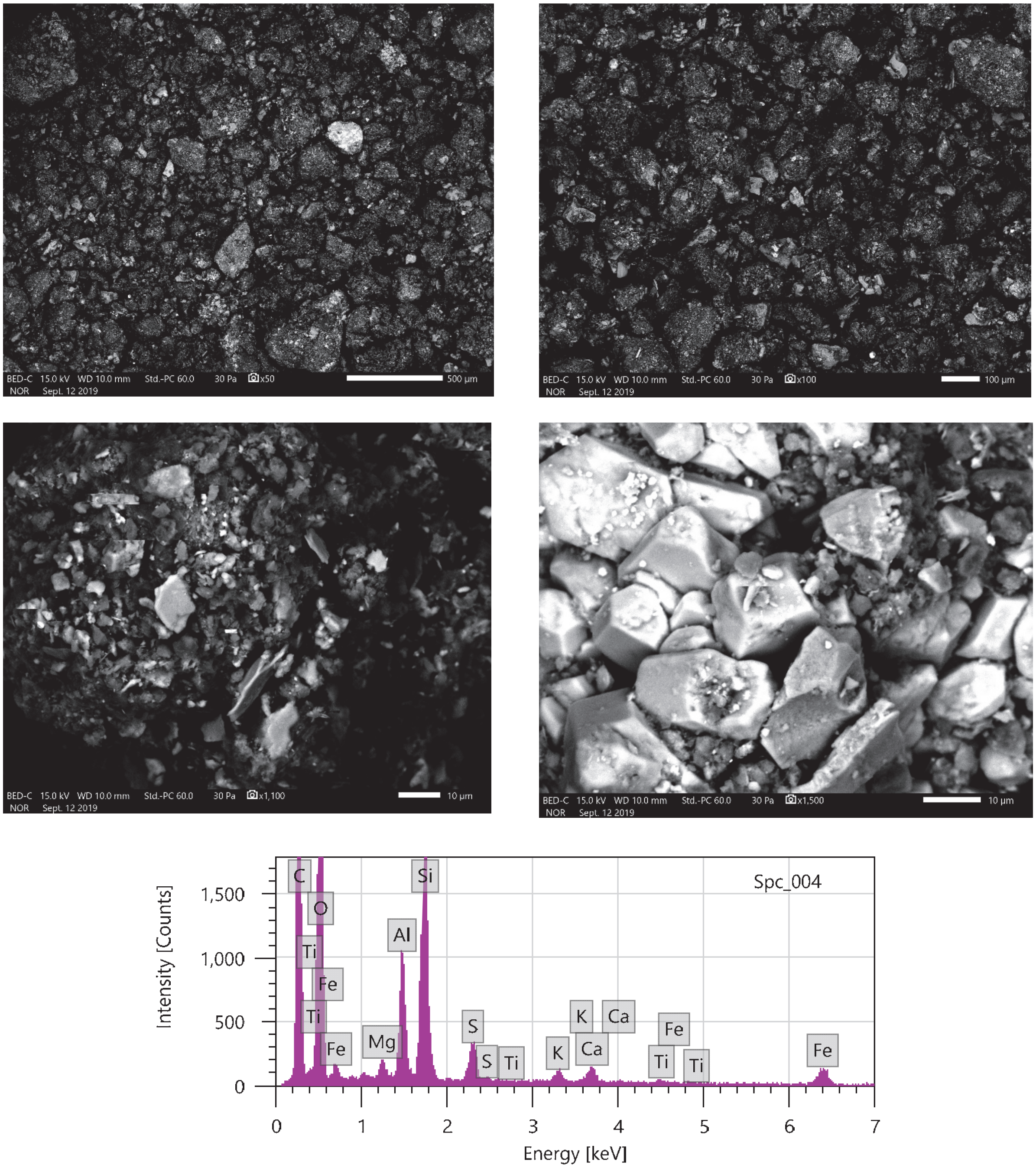
SEM/EDS Analysis

CTLGROUP

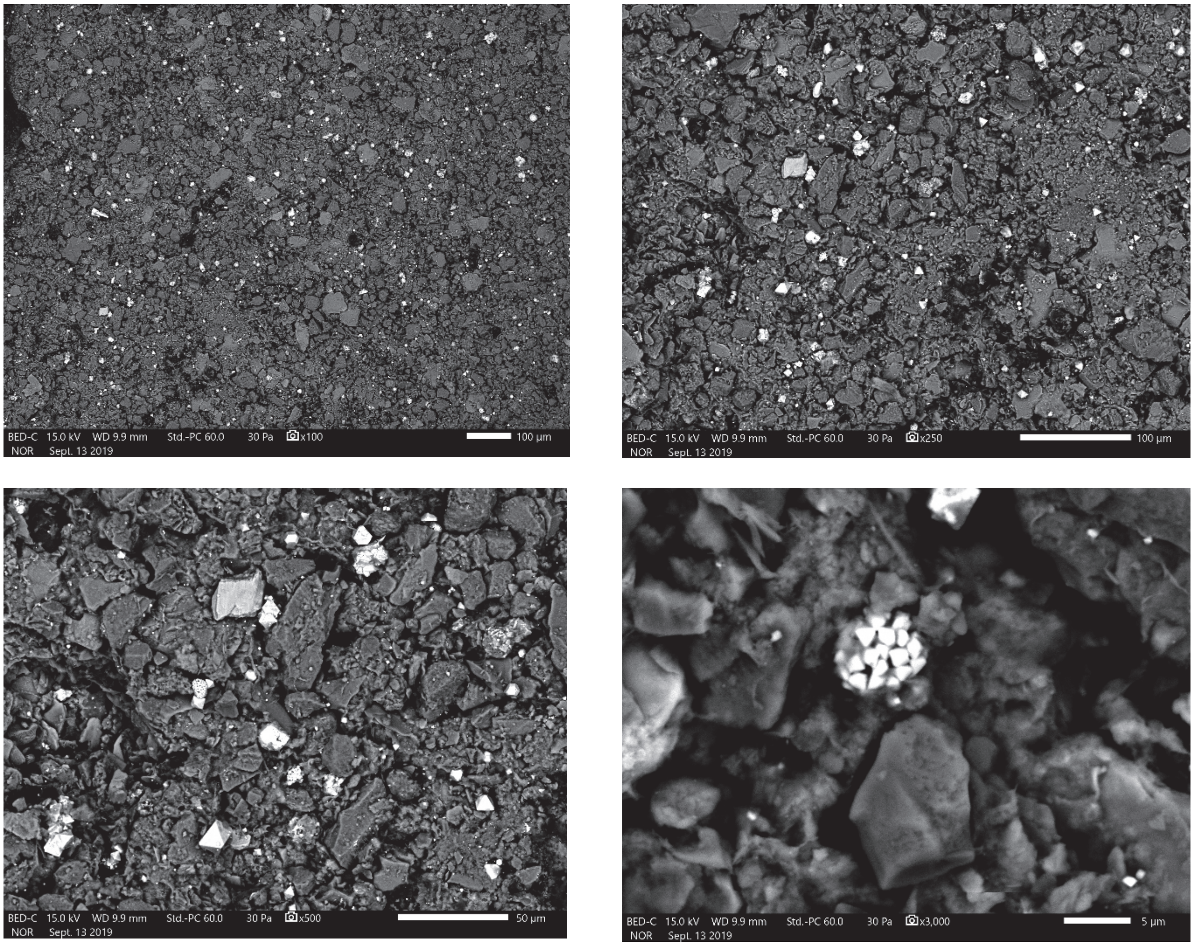
September 16, 2019

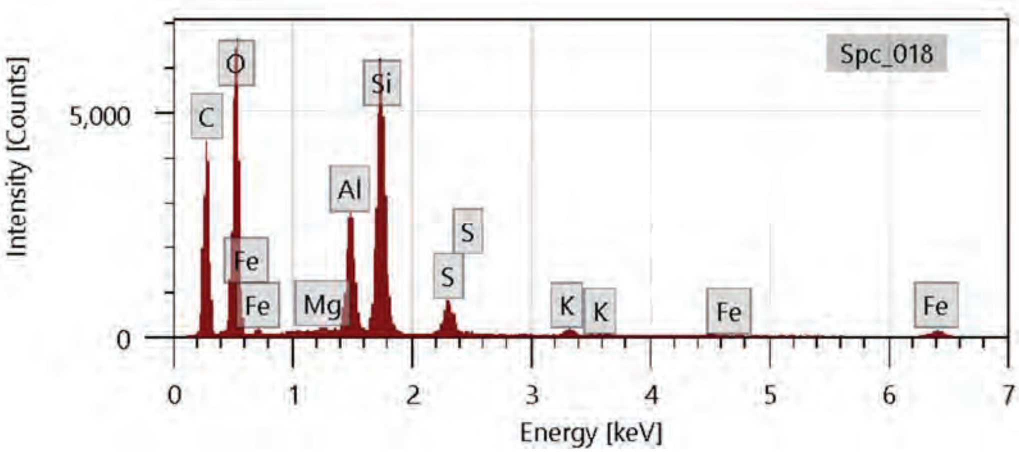
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221

via Email: BSass@geosyntec.com

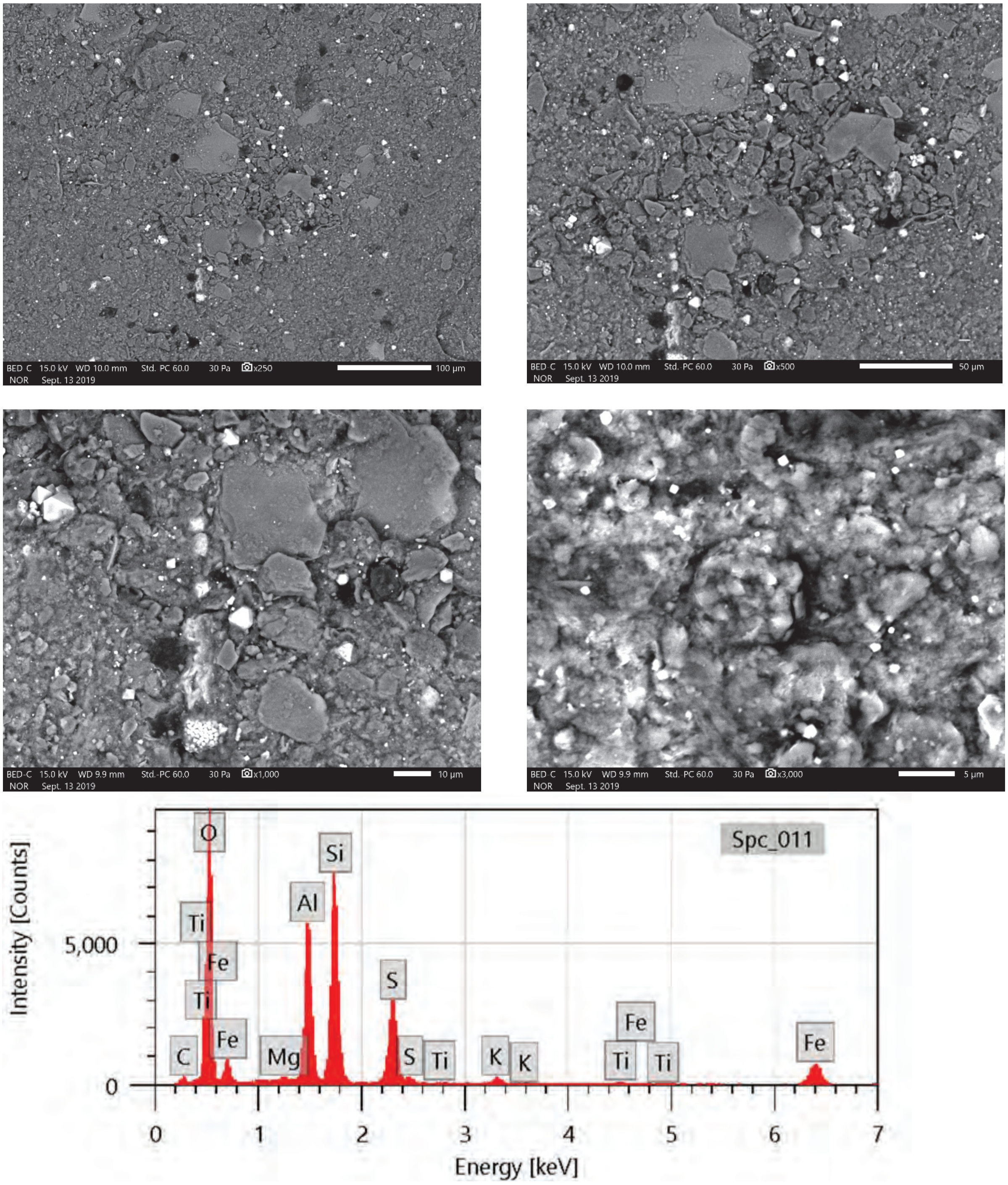


Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.



Sample VAP B3 50-55. Backscattered electron micrographs show the sample at 250X, 500X, 1000X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 3000X. Bright particles are mostly pyrite (framboid in bottom left micrograph); occasional particles of Fe-Ti oxide are detected. Major peaks for oxygen, silicon, and aluminum suggest clay. Large blocky particles are mostly quartz, feldspar, and clay.

ATTACHMENT D

AD-32 Low-Flow Purge Logs

Facility Name	Pickey
Sampled by	Matt Hamilton

Sample Location ID	AD-32

Depth to water, feet(TOC)	6.44
Measured Total Depth, feet(TOC)	34.69

Depth to water Date	

Purge Stabilization Data

Time	Water Depth	Flow Rate	pH	Spec Cond	Turbidity	D.O.	ORP	Temp, deg C		
905	6.33	380	4.69	302	468	3.42	258	22.49		
910	6.37	"	4.50	305	630	.98	243	22.24		
915	6.45	"	4.45	304	655	.71	238	22.21		
920	6.41	"	4.41	302	655	.95	235	22.15		
925	6.42	"	4.41	299	425	.81	234	22.17		
930	6.42	"	4.34	299	410	.80	242	22.17		

Total volume purged	2,280 mL
Sample appearance	Opaque
Sample time	932
Sample date	5/11/16

Facility Name	Pirkey
Sample by	Matt Hamilton

Sample Location ID	AD-32

Depth to water, feet (TOC)	7.76
Measured Total Depth, feet (TOC)	34.69

Depth to water date	3-21-18

Purge Stabilization Data

Time	Water Depth (from TOC)	Flow Rate (mL/min)	pH (S.U.)	Spec Cond (µS/cm)	Turbidity (N.T.U)	D.O. (mg/L)	ORP (mV)	Temperature (°C)		
1200	7.76	300	4.14	340	277	1.87	324	21.76		
1205	7.88	"	4.16	349	185	2.31	318	21.29		
1210	7.88	"	4.10	350	189	3.65	316	21.20		

Total volume purged	
Sample appearance	~~[illegible]~~ turbid / brown
Sample time	1212
Sample date	3-21-18

RA-Dup-1

Facility Name	AEP Pirkey PP
Sample by	Matt Hamilton

Sample Location ID	AD-32

Depth to water, feet (TOC)	5.04
Measured Total Depth, feet (TOC)	34.69

Depth to water date	5/21/2019

Purge Stabilization Data

Time	Water Depth (from TOC)	Flow Rate (mL/min)	pH (S.U.)	Spec Cond (µS/cm)	Turbidity (N.T.U)	D.O. (mg/L)	ORP (mV)	Temperature (°C)		
1245	5.01	240	3.38	292	200	5.25	370	30.27		
1250	5.06	240	3.21	316	101	1.08	388	26.36		
1255	5.07	240	3.21	315	84	0.85	386	25.43		
1300	5.08	240	3.21	315	87.5	0.70	386	25.65		

Total volume purged	
Sample appearance	Clear
Sample time	1302
Sample date	5/21/2019

Facility Name	Pirkey
Sample by	Mott/Hamilton

Depth to water, feet (TOC)	6.63
Measured Total Depth, feet (TOC)	34.65

Sample Location ID	AD-32
Depth to water date	3-10-20

Purge Stabilization Data

Time	Water Depth (from TOC)	Flow Rate (mL/min)	pH (S.U.)	Spec Cond (µS/cm)	Turbidity (N.T.U)	D.O. (mg/L)	ORP (mV)	Temperature (°C)		
1153	6.83	220	4.02	352	133	2.61	316	23.80		
1158	6.85	"	3.93	357	105	1.37	265	23.91		
1203	6.89	"	3.84	387	1.2	1.05	254	24.28		
1208	6.92	"	3.79	382	45	1.02	255	24.10		
1213	6.94	"	3.75	383	36.6	0.94	267	23.51		
1218	6.95	"	3.73	384	34.5	0.90	270	23.99		

Total volume purged	
Sample appearance	clear
Sample time	1220
Sample date	3-10-20

Dup-1

Facility Name	Pickens
Sample by	Matt Hamilton

Sample Location ID	AD-32

Depth to water, feet (TOC)	6.31
Measured Total Depth, feet (TOC)	34.69

Depth to water date	6-2-20

Purge Stabilization Data

Time	Water Depth (from TOC)	Flow Rate (mL/min)	pH (S.U.)	Spec Cond (µS/cm)	Turbidity (N.T.U)	D.O. (mg/L)	ORP (mV)	Temperature (°C)		
959	6.62	220	3.67	332	71.1	2.59	471	25.46		
1004	6.68	"	3.80	378	141	0.44	448	23.42		
1009	6.72	"	3.83	381	125	0.85	436	23.41		
1014	6.73	"	3.86	380	83.2	0.76	425	24.25		
1019	6.75	"	3.89	380	46.6	0.73	418	24.37		
1024	6.76	"	3.91	380	45.5	0.70	415	24.43		

Total volume purged	
Sample appearance	Cloud
Sample time	1026
Sample date	6-2-20

Facility Name	Pirkey
Sample by	Matt Hamilton

Sample Location ID	AD-32

Depth to water, feet (TOC)	13.05
Measured Total Depth, feet (TOC)	34.69

Depth to water date	11-2-20

Purge Stabilization Data

Time	Water Depth (from TOC)	Flow Rate (mL/min)	pH (S.U.)	Spec Cond (µS/cm)	Turbidity (N.T.U)	D.O. (mg/L)	ORP (mV)	Temperature (°C)		
954	13.39	220	3.47	1,430	47.6	50	458	19.71		
959	13.44	220	3.44	1,510	61.3	50	441	20.78		
1004	13.47	220	3.46	1,540	43.6	0.97	441	20.97		
1009	13.49	220	3.44	1,550	26.1	0.75	437	21.13		
1014	13.50	220	3.43	1,540	19.0	0.79	433	21.31		
1019	13.51	220	3.43	1,530	18.6	0.87	430	21.39		

Total volume purged	
Sample appearance	clear
Sample time	1021
Sample date	11-2-20

ATTACHMENT E

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

BETH ANN GROSS
79864

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Gross
Signature

Geosyntec Consultants
2039 Centre Pointe Blvd, Suite 103
Tallahassee, Florida 32308

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

12/31/2020
Date

APPENDIX IV

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #540556

Owner:	**American Electric Power Company**	Owner Well #:	**AD-7R**
Address:	**502 N. Allen Street Shreveport, LA 71101**	Grid #:	**35-37-1**
Well Location:	**2400 Farm Road 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 43.7" N**
		Longitude:	**094° 29' 18.3" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/3/2020**

Drilling End Date: **3/3/2020**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**31.5**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
18	**31.5**	**Sand**	**20/40**

Annular Seal Data: **No Data**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **David Diduch**

Apprentice Number: **60297**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1.5**	**Top soil, vegetation, black silt, gravel, light gray/red/brown clayey silt**
1.5	**10**	**Red/light gray clay, low plasticity, high stiffness, iron ore present, trace silt,**
10	**15**	**Maroon/light gray clay, high stiffness, low plasticity, iron ore, wet**
15	**20**	**Black silty clay, low-moderate plasticity, wet, Maroon/orange clayey silt, wet, good cohesion, iron ore, gray/orange clayey silt, iron ore present, wet, good cohesion**
20	**24.6**	**Black clayey silt, Dark gray fine grained sand, trace clay, wet, black silty clay, low-moderate plasticity, moderate to low stiffness**
24.6	**31.5**	**Dark gray fine grained sand, wet, well sorted, orange fine grained sand, wet, well sorted, tan fine grained sand, wet, well sorted, iron present**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Volume 3

- **Attachment 4, Subsection 4.14 – Annual Groundwater Monitoring Report, H.W. Pirkey Power Plant, West Bottom Ash Pond CCR Management Unit, Hallsville, Texas**
- **Attachment 5 – Closure Plans, Subsection 5.1 – Documentation of No Alternative Disposal Capacity and Risk Mitigation Plan for Permanent Cessation of Boiler(s) by a Date**

4.13 – Statistical Analysis Summary, West Bottom Ash Pond, H.W. Pirkey Power Plant, Hallsville, Texas, January 3, 2018

Purpose of Statistical Analysis Summary Report

During the initial phase of ground water monitoring, the CCR rule requires AEP to collect at least eight independent samples from at least one up-gradient and three downgradient wells for 21 substances listed in the CCR rule. The CCR rule also requires us to select a statistical method that will be used to evaluate the samples in the later phases of the ground water monitoring program. The Statistical Plan, which has been posted to AEP's CCR website, describes the methods selected by AEP. *See* AEP's Statistical Analysis Plans.

Each **Statistical Analysis Summary Report** is based on the results of the 8 independent samples that were collected by October 17, 2017, and reported in the Annual Groundwater Monitoring Report. Using the statistical methods chosen by AEP, the samples were evaluated to eliminate outliers, determine variability and general trends in the data, and establish background values for: boron, calcium chloride, fluoride, pH, sulfate, and total dissolved solids. Appendix IV substances were evaluated for purposes of identifying outliers and understanding data trends.

A subsequent sample taken during the first detection monitoring sampling event was also compared using the proper statistical methods to the background values that were established for these seven substances from the eight independent samples. A second or third re-sampling event occurred, and the results compared using the same methods. This work is reported in the memorandum included in attachment A. If confirmed, AEP will be required to enter the next phase of monitoring. The results of future sampling will be further analyzed to target any specific substances for which ongoing monitoring or potential corrective action is required.

STATISTICAL ANALYSIS SUMMARY
WEST BOTTOM ASH POND
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

150 East Wilson Bridge Road
Suite 232
Worthington, Ohio 43085

January 3, 2018

CHA8423

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LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ANOVA	Analysis of Variance
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Value
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
LFB	Laboratory Fortified Blanks
LPL	Lower Prediction Limit
LRB	Laboratory Reagent Blanks
NELAP	National Environmental Laboratory Accreditation Program
PQL	Practical Quantitation Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SWFPR	Site-Wide False-Positive Rate
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
WBAP	West Bottom Ash Pond

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the West Bottom Ash Pond (WBAP), an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Eight monitoring events were completed prior to October 17, 2017 to establish background concentrations for Appendix III and Appendix IV parameters under the CCR rule. Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. The background data were reviewed for outliers, which were removed (when appropriate) prior to calculating upper prediction limits (UPLs) for each Appendix III parameter to represent background values. Oversight on the use of statistical calculations was provided by Dr. Kirk Cameron of MacStat Consulting, Ltd.

A groundwater sampling event occurred on August 23 and 24, 2017 at the WBAP. The sampling event obtained the first sample for the 1-of-2 prediction interval statistical test used for detection monitoring. The results of this detection monitoring event are included in this report.

SECTION 2

WEST BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the background monitoring program, eight sets of samples were collected for analysis from each upgradient and downgradient well. A summary of data collected during background and detection monitoring sampling may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.5.32 statistics software. The export was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

The background data used to conduct the statistical analyses and the detection monitoring data are summarized in Table 1. Statistical analyses for the WBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Results for all completed statistical tests are provided in Attachment A.

Time series plots of Appendix III and IV parameters are included in Attachment A. Mann-Kendall analyses ($\alpha = 0.01$) were conducted to evaluate trends in the background data. Beryllium was found to be significantly decreasing at upgradient well AD-18. Boron and sulfate were found to be significantly increasing at downgradient well AD-30. No other significant increasing or decreasing trends were observed for other parameters or at other monitoring wells.

2.2.1 Background Outlier Evaluation

Potential outliers were identified using Tukey's outlier test; i.e., data points were considered potential outliers if they met one of the following criteria:

$$x_i < \tilde{x}_{0.25} - 3 \times IQR \quad (1)$$

or

$$x_i > \tilde{x}_{0.75} + 3 \times IQR \quad (2)$$

where:

$x_i =$ individual data point
$\tilde{x}_{0.25} =$ first quartile
$\tilde{x}_{0.75} =$ third quartile
$IQR =$ the interquartile range $= \tilde{x}_{0.75} - \tilde{x}_{0.25}$

Data that were evaluated as potential outliers are summarized in Attachment A. Tukey's outlier test identified three potential outliers, which are summarized in Table 2. Next, the data were reviewed to identify possible sources of errors or discrepancies, including data recording errors, unusual sampling conditions, laboratory quality indicators, or inconsistent sample turbidity. The findings of this data review are summarized below.

While the reported fluoride concentration of 4.717 mg/L at upgradient well AD-12 on October 12, 2016 was not identified as an outlier by Tukey's method, the duplicate sample was more similar to other upgradient data and therefore considered more representative of background. This value was replaced with the reported fluoride concentration for the duplicate sample also collected at AD-12. The statistical analysis was rerun using the duplicate result's reporting limit of 1.0 mg/L, as fluoride was not detected in the duplicate. The duplicate sample was considered more representative based on the reported concentrations from the other background sampling events.

While the reported lithium concentration of 0.991 mg/L at upgradient well AD-3 on October 13, 2016 was not identified as an outlier by Tukey's method, it appeared anomalously high and was removed from the dataset as recommended by USEPA's *Unified Guidance* (USEPA, 2009). The removal of this outlier resulted in the calculation of a more conservative background value.

The reported lithium value of 0.004 mg/L at AD-28 on May 11, 2016 was identified as a potential low outlier. However, this value was not removed from the dataset, as it reflected concentrations similar to those in neighboring downgradient wells.

The reported lithium and chromium values of 0.066 mg/L and 0.006 mg/L, respectively, for the October 13, 2016 sampling event were also identified as potential outliers. However, these values appeared anomalously high and were removed as recommended by USEPA's *Unified Guidance* (USEPA, 2009). The lithium and chromium outliers which were removed were associated with Appendix IV parameters at a downgradient monitoring well; thus, their removal did not affect the calculation of background levels presented below.

2.2.2 Establishment of Background Levels

Analysis of variance (ANOVA) was conducted to determine whether spatial variation was present among the three upgradient wells (Attachment A). ANOVA indicated no significant variation among the three upgradient wells for chloride and fluoride. Consequently, interwell tests were used for these parameters. Significant variation was observed for boron, calcium, pH, sulfate, and total dissolved solids (TDS). Therefore, the appropriateness of using intrawell tests was evaluated for these parameters at the Pirkey WBAP.

Intrawell tests presume that the groundwater quality in the downgradient wells was not initially impacted by the CCR unit. To test this presumption, the data from the upgradient wells were pooled and the data from each downgradient well were compared to a pooled background value. Tolerance limits were calculated using the pooled background data for boron, calcium, pH, sulfate, and TDS. Parametric tolerance limits with 99% confidence and 95% coverage were calculated for boron, pH, and TDS; non-parametric tolerance limits were calculated for calcium and sulfate, given the observed non-normality for these two parameters. Confidence intervals were calculated for each of these five parameters at each downgradient monitoring well. If the lower confidence limit from a downgradient well exceeded the upper tolerance limit for the pooled background data, it was concluded that downgradient groundwater concentrations were above background concentrations. In these instances, intrawell tests would not be appropriate. However, these analyses indicated no significant exceedances for calcium, pH, sulfate, and TDS; however elevated concentrations of boron were observed. (Non-parametric analysis also indicated elevated boron concentrations in downgradient wells and no significant exceedances for pH and TDS.) Therefore, intrawell tests were used to evaluate potential SSIs for calcium, pH, sulfate, and TDS. Interwell tests were used to evaluate potential SSIs for boron, chloride, and fluoride.

After equality of variance was tested and identified outliers were removed (where appropriate), a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., “J-flagged” data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment A.

Upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. To conduct the intrawell tests for calcium, pH, sulfate, and TDS, a separate UPL was calculated for each downgradient well for each of these parameters. To conduct the interwell tests for boron, chloride, and fluoride, a single prediction interval was calculated for each of these parameters using pooled data from the three upgradient wells. The background data used for the UPL calculations are summarized in Table 1; the calculated UPLs are summarized in Table 3.

Although a significant increasing trend in sulfate concentrations was observed at downgradient well AD-30, the UPL for sulfate was calculated as if no trend were present; i.e., the dataset was not limited to more recent data nor was the prediction interval constructed around a trendline. This was done because the rate of change in sulfate concentrations is low relative to absolute sulfate concentrations at AD-30. Sulfate concentrations at AD-30 are also similar to sulfate concentrations at upgradient well AD-3. For these reasons, the increasing trend in sulfate concentrations at AD-30 is not currently considered indicative of a release from the WBAP. The possibility of an ongoing increase and the need for truncating the background dataset for sulfate at AD-30 will be reevaluated after additional data are collected.

A significant increasing trend in boron concentrations was also observed at downgradient well AD-30. Interwell tests were conducted for boron, and the UPL was calculated using pooled upgradient data, so AD-30 data were not included in the calculation of the UPL for boron. Because the rate of change in boron concentrations is low relative to absolute boron concentrations at AD-30, the increasing trend in boron concentrations at AD-30 is not currently considered indicative of a release from the WBAP. If boron concentrations continue to increase at AD-30, and SSI will likely be concluded.

UPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where initial results did not exceed the UPL, a second sample was not collected. The one-of-two retesting procedure allowed achieving an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less. Power curves were constructed for the interwell and intrawell parametric tests and are compared with the EPA Reference Power Curve in Appendix A. The power curves associated with the statistical tests for the Pirkey Plant WBAP exceed the EPA Reference Power Curve at 3 and 4 standard deviations; this is considered a “good” level of statistical power according to EPA’s *Unified Guidance* (USEPA, 2009).

2.2.3 Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the H.W. Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
112498

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

01.03.18
Date

2.3 Conclusions

Eight background monitoring events and one detection monitoring events were completed in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified five potential outliers, with three values removed from the dataset without replacement. Prediction intervals were constructed based on the remaining background data and a one-of-two retesting procedure. Interwell tests were selected for boron, chloride, and fluoride, whereas intrawell tests were selected for calcium, pH, sulfate, and TDS.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H. W. Pirkey Power Plant. January 2017.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March 2009.

TABLES

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-3								
		5/11/2016	7/14/2016	9/8/2016	10/13/2016	11/14/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.005U	0.00211J	0.005U	0.00423J	0.00198J	0.005U	0.005U	0.005U	-
Barium	mg/L	0.059	0.07	0.07	0.082	0.064	0.062	0.062	0.061	-
Beryllium	mg/L	0.00041J	0.00058J	0.0005J	0.00059J	0.00031J	0.00028J	0.00028J	0.00028J	-
Boron	mg/L	0.04	0.06	0.06	0.05	0.07	0.05	0.05	0.06	0.0863
Cadmium	mg/L	0.00009J	0.001U	0.001U	0.00016J	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	2.9	4.67	4.28	4.93	4.61	3.81	2.55	2.6	2.37
Chloride	mg/L	6	6	7	8	7	7	5	10	6
Chromium	mg/L	0.00072J	0.001	0.00097J	0.002	0.00042J	0.00055J	0.001U	0.00025J	-
Cobalt	mg/L	0.00313J	0.007	0.007	0.009	0.008	0.00496J	0.00254J	0.0024J	-
Combined Radium	pCi/L	1.059	1.69	1.491	3.42	1.532	2.01	0.862	0.991	-
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.025	0.095	0.087	0.991	0.092	0.079	0.046	0.046	-
Mercury	mg/L	0.00001J	0.00002	0.00001J	0.00001J	0.00002U	0.00001J	0.00002U	0.00002U	-
Molybdenum	mg/L	0.00077J	0.00116J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.0033J	0.0025J	0.005U	0.00193J	0.005U	0.005U	0.00178J	0.005U	-
Total Dissolved Solids	mg/L	136	161	145	168	170	152	124	140	68
Sulfate	mg/L	18	30	28	31	29	27	16	19	17
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.00113J	0.002U	-
pH	SU	4.86	4.66	4.48	5.46	5.36	5.27	5.07	4.94	5.62

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-12								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Barium	mg/L	0.026	0.023	0.03	0.027	0.028	0.023	0.026	0.024	-
Beryllium	mg/L	0.00022J	0.00019J	0.00023J	0.00015J	0.00015J	0.00013J	0.00015J	0.00016J	-
Boron	mg/L	0.03	0.03	0.04	0.03	0.04	0.03	0.04	0.05	0.0495
Cadmium	mg/L	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	0.362	0.26	0.343	0.271	0.331	0.315	0.434	0.299	0.245
Chloride	mg/L	5	6	6	7	8	7	5	6	6
Chromium	mg/L	0.00071J	0.00069J	0.00035J	0.00053J	0.00033J	0.00065J	0.00033J	0.00042J	-
Cobalt	mg/L	0.00158J	0.00129J	0.00167J	0.00157J	0.00147J	0.00109J	0.0013J	0.00133J	-
Combined Radium	pCi/L	0.2073	2.909	0.881	0.257	0.767	1.536	0.416	0.3895	-
Fluoride	mg/L	1U	1U	1U	1	1U	1U	1U	0.2565J	0.213J
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.001U	0.008	0.01	0.012	0.013	0.01	0.009	0.008	-
Mercury	mg/L	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00001J	-
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00174J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	94	75	63	92	80	76	50	72	52
Sulfate	mg/L	4	4	7	8	6	6	4	7	6
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.00099J	0.002U	-
pH	SU	4.44	3.11	3.89	3.37	2.58	4.76	3.63	4.74	4.84

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-17								
		5/11/2016	7/14/2016	9/8/2016	10/13/2016	11/15/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.00121J	0.00131J	0.00177J	0.005U	0.005U	0.005U	0.005U	0.005U	-
Barium	mg/L	0.143	0.334	0.327	0.324	0.29	0.234	0.176	0.14	-
Beryllium	mg/L	0.00051J	0.00085J	0.00095J	0.00075J	0.00071J	0.00054J	0.0005J	0.00051J	-
Boron	mg/L	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.03	0.045
Cadmium	mg/L	0.00009J	0.00008J	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	0.648	1.28	1.19	1.34	1.3	1.08	0.57	0.395	1.06
Chloride	mg/L	12	34	29	32	30	26	19	20	25
Chromium	mg/L	0.001	0.002	0.005	0.00054J	0.00045J	0.00072J	0.00036J	0.00069J	-
Cobalt	mg/L	0.005	0.014	0.014	0.014	0.013	0.01	0.008	0.007	-
Combined Radium	pCi/L	2.082	3.12	4.473	6.64	7.94	9.6	2.31	3.67	-
Fluoride	mg/L	1U	1U	1U	0.393J	0.3446J	1U	1U	1U	0.245J
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.001U	0.027	0.028	0.026	0.026	0.023	0.019	0.016	-
Mercury	mg/L	0.00006	0.00014	0.00014	0.00005	0.00008	0.00006	0.00008	0.00007	-
Molybdenum	mg/L	0.005U	0.00049J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00255J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	68	96	88	96	88	90	80	88	98
Sulfate	mg/L	4	4	6	6	6	6	5	9	6
Thallium	mg/L	0.002U	0.002U	0.00108J	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	4.29	3.32	3.89	3.59	3.73	4.38	3.97	4.18	4.55

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-18								
		5/10/2016	**7/14/2016**	**9/8/2016**	**10/13/2016**	**11/15/2016**	**1/12/2017**	**3/1/2017**	**4/10/2017**	**8/24/2017**
		Background								**Detection**
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.005U	0.00377J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Barium	mg/L	0.157	0.139	0.115	0.112	0.094	0.099	0.099	0.105	-
Beryllium	mg/L	0.00026J	0.00024J	0.00023J	0.00019J	0.00011J	0.00017J	0.00011J	0.00013J	-
Boron	mg/L	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.0278
Cadmium	mg/L	0.00011J	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	0.548	0.409	0.343	0.56	0.59	0.415	0.224	0.304	0.435
Chloride	mg/L	8	8	8	7	7	7	6	7	8
Chromium	mg/L	0.001	0.003	0.00078J	0.00063J	0.00072J	0.00041J	0.00057J	0.00097J	-
Cobalt	mg/L	0.00183J	0.00216J	0.0011J	0.00225J	0.00166J	0.00163J	0.00098J	0.00098J	-
Combined Radium	pCi/L	0.847	3.264	1.105	1.161	1.486	0.976	0.468	0.648	-
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.004	0.02	0.019	0.026	0.017	0.026	0.017	0.019	-
Mercury	mg/L	0.00002J	0.00006	0.00003	0.00001J	0.00003	0.00002J	0.00001J	0.00001J	-
Molybdenum	mg/L	0.005U	0.00041J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00171J	0.00245J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	108	116	110	124	134	128	108	102	68
Sulfate	mg/L	7	7	8	10	7	10	7	8	8
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	4.53	4.65	4.67	4.14	4.43	4.67	4.06	4.1	4.9

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-28								
		5/11/2016	7/14/2016	9/7/2016	10/13/2016	11/15/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.00159J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.0025J	0.00153J	0.005U	0.006	0.00141J	0.005U	0.005U	0.005U	-
Barium	mg/L	0.223	0.17	0.168	0.152	0.148	0.154	0.163	0.162	-
Beryllium	mg/L	0.00097J	0.00066J	0.00073J	0.00042J	0.00052J	0.00048J	0.00058J	0.00065J	-
Boron	mg/L	0.277	0.301	0.332	0.23	0.32	0.285	0.293	0.293	0.281
Cadmium	mg/L	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	2.16	1.69	1.25	3.21	1.64	1.22	1.25	1.2	1.22
Chloride	mg/L	6	6	6	6	8	7	5	7	6
Chromium	mg/L	0.001	0.00098J	0.00061J	0.006	0.00064J	0.001U	0.00097J	0.00032J	-
Cobalt	mg/L	0.018	0.015	0.014	0.018	0.013	0.012	0.014	0.015	-
Combined Radium	pCi/L	1.212	2.29	1.44	2.547	3.35	2.67	2.082	2.331	-
Fluoride	mg/L	0.9005J	0.4478J	0.3966J	0.532J	0.9199J	0.7158J	1U	0.6732J	0.557J
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.004	0.034	0.03	0.066	0.032	0.031	0.031	0.03	-
Mercury	mg/L	0.00015	0.00016	0.00007	0.00008	0.00003	0.00002	0.00002	0.00003	-
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.00029J	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.0011J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	106	96	94	124	112	84	96	104	96
Sulfate	mg/L	18	17	19	19	16	17	18	20	18
Thallium	mg/L	0.002U	0.002U	0.00125J	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	4.71	5.14	4.07	5.28	4.15	4.1	3.37	4.1	5.1

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-30								
		5/11/2016	7/14/2016	9/7/2016	10/13/2016	11/15/2016	1/12/2017	3/1/2017	4/11/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.00171J	0.005U	0.005U	0.005U	0.005U	0.005U	0.001J	0.005U	-
Arsenic	mg/L	0.00193J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Barium	mg/L	0.054	0.054	0.052	0.056	0.052	0.051	0.055	0.055	-
Beryllium	mg/L	0.00016J	0.00013J	0.00015J	0.00006J	0.00006J	0.00006J	0.00006J	0.00006J	-
Boron	mg/L	0.258	0.384	0.515	0.625	0.701	0.697	0.824	0.837	1.39
Cadmium	mg/L	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	0.591	0.499	0.27	0.373	0.326	0.286	0.273	0.242	0.294
Chloride	mg/L	18	22	24	24	25	26	22	24	25
Chromium	mg/L	0.003	0.00099J	0.00077J	0.00054J	0.001U	0.0005J	0.00074J	0.00054J	-
Cobalt	mg/L	0.00221J	0.00214J	0.00183J	0.00226J	0.00192J	0.00176J	0.0017J	0.0018J	-
Combined Radium	pCi/L	1.057	4.701	0.312	2.27	4.07	0.355	0.354	1.861	-
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.001U	0.01	0.009	0.01	0.009	0.009	0.008	0.008	-
Mercury	mg/L	0.00028	0.00065	0.00021	0.00071	0.00058	0.00159	0.00259	0.00121	-
Molybdenum	mg/L	0.005U	0.00114J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.005U	0.005U	0.005U	0.005U	0.00121J	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	112	118	110	140	132	136	136	124	176
Sulfate	mg/L	14	14	15	18	19	22	25	27	46
Thallium	mg/L	0.002U	0.002U	0.00135J	0.002U	0.00096J	0.002U	0.002U	0.002U	-
pH	SU	4.65	4.78	4.35	4.24	4.29	5.15	4.83	4.21	5.15

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 2: Outlier Analysis Summary
Pirkey West Bottom Ash Pond

Location	Well ID	Sample Date	Parameter	Reported Value	Units	Conclusions
Upgradient	AD-12	10/12/2016	Fluoride	4.717	mg/L	While this value was not identified by Tukey's screening, it was replaced with the reported value of 1.0 mg/L U (non-detect) in the duplicate sample which was more similar to other reported values.
Upgradient	AD-3	10/13/2016	Lithium	0.991	mg/L	While this value was not identified by Tukey's screening, it appeared anomalously high and was removed from the dataset. Its removal resulted in a more conservative calculated background value.
Downgradient	AD-28	10/13/2016	Chromium	0.006	mg/L	This value was removed from the dataset as an outlier. Its removal did not affect calculation of background values.
Downgradient	AD-28	5/11/2016	Lithium	0.004	mg/L	This value was not removed from the dataset, as it reflected concentrations similar to those in neighboring wells.
Downgradient	AD-28	10/13/2016	Lithium	0.066	mg/L	This value was removed from the dataset as an outlier. Its removal did not affect calculation of background values.

Table 3: Background Level Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Units	Description	AD-12	AD-17	AD-28	AD-30
Boron	mg/L	Interwell Background Value (UPL)	0.06983			
Calcium	mg/L	Intrawell Background Value (UPL)	0.4631	1.903	3.411	0.6643
Chloride	mg/L	Interwell Background Value (UPL)	8.987			
Fluoride	mg/L	Interwell Background Value (UPL)	1			
pH	SU	Intrawell Background Value (UPL)	5.764	4.812	5.925	5.403
	SU	Intrawell Background Value (LPL)	1.866	3.025	2.805	3.722
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	110.7	109.2	132.3	154.7
Sulfate	mg/L	Intrawell Background Value (UPL)	9.636	9.636	21.22	31.56

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

ATTACHMENT A

Evaluation of Detection Monitoring Data

Geosyntec consultants

150 E.Wilson Bridge Road, Suite 232
Columbus, Ohio 43085
PH 614.468.0415
FAX 614.468.0416
www.geosyntec.com

Memorandum

Date: February 27, 2018

To: David Miller (AEP)

Copies to: Terence Wehling (AEP)

From: Allison Kreinberg and Bruce Sass, Ph.D. (Geosyntec)

Subject: Evaluation of Detection Monitoring Data at H.W. Pirkey Power Plant's West Bottom Ash Pond (WBAP)

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), detection monitoring events were completed on October 24, 2017 and December 21, 2017 at the West Bottom Ash Pond (WBAP), an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Eight background monitoring events were conducted at the Pirkey WBAP prior to these detection monitoring events, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated January 3, 2018.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is only concluded if both samples in a series of two exceeds the UPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are summarized in Table 1b.

- Boron concentrations exceeded the interwell UPL of 0.0698 mg/L in both the initial (0.281 mg/L) and second (0.277 mg/L) samples collected at AD-28, and in both the initial (1.39 mg/L) and second (1.27 mg/L) samples collected at AD-30. Therefore, an SSI over background is concluded for boron at AD-28 and AD-30.

- Chloride concentrations exceeded the interwell UPL of 8.99 mg/L in both the initial (25 mg/L) and second (26 mg/L) samples collected at AD-17, and in both the initial (25 mg/L) and second (26 mg/L) samples collected at AD-30. Therefore, an SSI over background is concluded for chloride at AD-17 and AD-30.

- Sulfate concentrations exceeded the intrawell UPL of 31.6 mg/L in both the initial (46 mg/L) and second (48 mg/L) samples collected at AD-30. Therefore, an SSI over background is concluded for sulfate at AD-30.

As a result, the Pirkey WBAP CCR unit will conduct an alternate source demonstration.

No other exceedances of UPLs were observed during these detection monitoring events.

The following modifications to Geosyntec's *Statistical Analysis Summary* report were incorporated after the certification date of January 3, 2018:

- Table 1 ("Groundwater Data Summary") was revised to reflect appropriate significant digits for estimated (J-flagged) values; and,

- Figure E ("Analysis of Variance") of Attachment A ("Statistical Analysis Output") was revised to correct a formatting error.

* * * * *

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected statistical method, described above and in the January 3, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Pirkey WBAP CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

DAVID ANTHONY MILLER
112498

112498
License Number

TEXAS
Licensing State

02.27.18
Date

Table 1b: Detection Monitoring Data Comparison
Pirkey - West Bottom Ash Pond

Parameter	Units	Description	AD-17		AD-28		AD-30	
			8/24/2017	12/21/2017	8/24/2017	12/21/2017	8/24/2017	12/21/2017
Boron	mg/L	Interwell Background Value (UPL)	0.0698					
	mg/L	Detection Monitoring Result	0.0450	-	**0.281**	**0.277**	**1.39**	**1.27**
Calcium	mg/L	Intrawell Background Value (UPL)	1.90		3.41		0.664	
	mg/L	Detection Monitoring Result	1.06	-	1.22	1.14	0.294	0.363
Chloride	mg/L	Interwell Background Value (UPL)	8.99					
	mg/L	Detection Monitoring Result	**25**	**26**	6	-	**25**	**26**
Fluoride	mg/L	Interwell Background Value (UPL)	1					
	mg/L	Detection Monitoring Result	0.245	<0.083	0.557	-	<0.083	<0.083
pH	SU	Intrawell Background Value (UPL)	4.81		5.93		5.40	
	SU	Intrawell Background Value (LPL)	3.03		2.81		3.72	
	SU	Detection Monitoring Result	4.55	-	5.10	-	5.15	-
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	109		132		155	
	mg/L	Detection Monitoring Result	98	76	96	-	**176**	152
Sulfate	mg/L	Intrawell Background Value (UPL)	9.64		21.2		31.6	
	mg/L	Detection Monitoring Result	6	8	18	-	**46**	**48**

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
-: Not Sampled
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

December 14, 2017

Geosyntec Consultants
Attn: Mr. Bruce Sass
150 E. Wilson Bridge Rd., #232
Worthington, OH 43085

Dear Mr. Sass,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the screening and statistical analysis of background groundwater data for American Electric Power's Pirkey West Bottom Ash Pond. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at Pirkey West Bottom Ash Pond for the CCR program in 2016, and 8 background samples have been collected at each of the groundwater monitoring wells. The monitoring well network, as provided by Geosyntec Consultants, consists of the following: upgradient wells AD-3, AD-12, and AD-18; and downgradient wells AD-17, AD-28, and AD-30.

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis was reviewed by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to Groundwater Stats Consulting.

The following constituents were evaluated: Appendix III parameters – boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and Appendix IV parameters - antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 & 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters at all wells are provided for the purpose of screening data at these wells (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B). The time series plots are used to initially screen for suspected outliers and trends, while the box plots provide visual representation of variation within individual wells and between all wells.

Data at all wells were evaluated for the following: 1) outliers; 2) trends; 3) most appropriate statistical method for Appendix III parameters based on site characteristics of groundwater data upgradient of the facility; and 4) eligibility of downgradient wells when intrawell statistical methods are recommended. Power curves are provided to demonstrate that the selected statistical methods for Appendix III parameters comply with the USEPA Unified Guidance recommendations as discussed below.

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for calcium, pH, sulfate, and TDS;
2) Interwell prediction limits combined with a 1-of-2 resample plan for boron, chloride, and fluoride.

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, simple substitution of one-half the reporting limit is utilized in the statistical analysis. The reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Background Screening

Outlier Evaluation

Time series plots are used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III and Appendix IV parameters were formally tested using Tukey's box plot method and, when identified, flagged in the computer database with "o" and deselected prior to construction of statistical limits (Figure C).

Tukey's outlier test noted a couple outliers as may be seen on the Outlier Summary Table and accompanying graphs. Any values flagged as outliers are plotted in a lighter font on the time series graph. The test did not identify an outlier for lithium in upgradient well AD-3; however, this value was flagged and deselected as it did not appear to represent the population. For the lithium outliers identified in downgradient well AD-28, only the high value was flagged at this time as outliers. A substitution of the most recent reporting limit was applied when varying detection limits existed in data.

No true seasonal patterns were observed on the time series plots for any of the detected data; therefore, no deseasonalizing adjustments were made to the data. When seasonal patterns are observed, data may be deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release.

While trends may be visual, a quantification of the trend and its significance is needed. The Sen's Slope/Mann Kendall trend test was used to evaluate all data at each well to identify statistically significant increasing or decreasing trends (Figure D). In the absence of suspected contamination, significant trending data are typically not included as part of the background data used for construction of prediction limits. This step serves to eliminate the trend and, thus, reduce variation in background. When statistically significant decreasing trends are present, earlier data are evaluated to determine whether earlier concentration levels are significantly different than current reported concentrations and will be deselected as necessary. When the historical records of data are truncated for the reasons above, a summary report will be provided to show the date ranges used in construction of the statistical limits.

The results of the trend analyses showed a couple statistically significant increasing and decreasing trends, as may be seen on the Trend Test Summary Table that accompanies the trend tests. The slope of the increasing trends noted for boron and sulfate in well AD-30 were similar to reported average concentrations. Because limited data are available, and further testing as discussed below indicated interwell testing for boron, and sulfate values were similar to reported values upgradient, no adjustments were made to the data sets.

Appendix III – Determination of Spatial Variation

The Analysis of Variance (ANOVA) was used to statistically evaluate differences in average concentrations among upgradient wells, which assists in identifying the most appropriate statistical approach (Figure E). Interwell tests, which compare downgradient well data to statistical limits constructed from pooled upgradient well data, are appropriate when average concentrations are similar across upgradient wells. Intrawell tests, which compare compliance data from a single well to screened historical data within the same well, are appropriate when upgradient wells exhibit spatial variation; when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective; and when downgradient water quality is unimpacted compared to upgradient water quality for the same parameter.

The ANOVA identified no variation for chloride and fluoride, making these constituents suitable for interwell analyses. Variation was identified in groundwater upgradient of the site for all other Appendix III parameters. Therefore, these data were further evaluated as described for the appropriateness of intrawell testing to accommodate the groundwater quality. A summary table of the ANOVA results is included with the reports.

Appendix III - Statistical Limits

Intrawell limits constructed from carefully screened background data from within each well serve to provide statistical limits that are conservative (i.e. lower) from a regulatory perspective, and that will rapidly identify a change in more recent compliance data from within a given well. This statistical method removes the element of variation from across wells and eliminates the chance of mistaking natural spatial variation for a release from the facility. Prior to performing intrawell prediction limits, several steps are required to reasonably demonstrate downgradient water quality does not have existing impacts from the practices of the facility.

Exploratory data analysis was used as a general comparison of concentrations in downgradient wells for all Appendix III parameters recommended for intrawell analyses to concentrations reported in upgradient wells. Upper tolerance limits are used in conjunction with confidence intervals to determine whether the estimated averages in downgradient wells are higher than observed levels upgradient of the facility. The upper tolerance limits were constructed to represent the extreme upper range of possible background levels at the site.

In cases where downgradient average concentrations are higher than observed concentrations upgradient for a given constituent, an independent study and hydrogeological investigation would be required to identify local geochemical conditions and expected groundwater quality for the region to justify an intrawell approach. Such an assessment is beyond the scope of services provided by Groundwater Stats Consulting. When there is not an obvious explanation for observed concentration differences in downgradient wells relative to reported concentrations in upgradient wells, interwell prediction limits will initially be selected for the statistical method until further evidence shows that concentrations are due to natural variation rather than a result of the facility.

Parametric tolerance limits were constructed with a target of 99% confidence and 95% coverage using pooled upgradient well data for each of the Appendix III parameters recommended for intrawell analyses (Figure F). The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. As more data are collected, the background population is better represented and the confidence and coverage levels increase.

Confidence intervals were constructed on downgradient wells for each of the Appendix III parameters exhibiting spatial variation, using the tolerance limits discussed above, to determine intrawell eligibility (Figure G). When the entire confidence interval is above a background standard for a given parameter, interwell methods are initially recommended as the statistical method. Therefore, only parameters with confidence intervals which did not exceed background standards are eligible for intrawell prediction limits.

Confidence intervals for the above parameters were found to be within their respective background limit for calcium, pH, sulfate and TDS while the confidence intervals for boron and chloride were above the background standards. Therefore, intrawell methods are recommended for calcium, pH, sulfate and TDS at this time, and interwell methods are recommended initially for all other Appendix III parameters. As mentioned earlier, if a demonstration supports natural variation in groundwater, intrawell methods will be considered for all parameters.

All available data through April 2017 at each well were used to establish intrawell background limits based on a 1-of-2 resample plan that will be used for future comparisons (Figure H). Interwell prediction limits, combined with a 1-of-2 resample plan, were constructed from upgradient wells for the Appendix III parameters discussed above (Figure I). Downgradient measurements will be compared to these background limits during each subsequent semi-annual sampling event.

Natural systems continuously evolve due to physical changes made to the environment. Examples include capping a landfill, paving areas near a well, or lining a drainage channel to prevent erosion. Periodic updating of background statistical limits will be necessary to accommodate these types of changes In the interwell case, newer data will be included in background when a minimum of 2 new samples for each upgradient well are available. In the intrawell case, data for all wells and constituents are re-evaluated when a minimum of 4 new data points for each well are available to determine whether earlier concentrations are representative of present-day groundwater quality. In some cases, the earlier portion of data are deselected prior to construction of limits in order to provide sensitive limits that will rapidly detect changes in groundwater quality. Even though the data are excluded from the calculation, the values will continue to be reported and shown in tables and graphs.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of an additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered to be a false positive result and, therefore, no further action is necessary. A summary table of the background prediction limits follows this letter.

Appendix IV – Assessment Monitoring Program

During an Assessment Monitoring program confidence intervals are constructed at all wells for detected Appendix IV parameters. A minimum of 4 samples is required to construct confidence intervals; however, 8 samples are generally recommended for better representation of the true average population. Established Maximum Contaminant Levels (MCLs) are used as the GWPS comparisons, unless background limits are higher as discussed below. Parametric confidence intervals are constructed with 99% confidence when data follow a normal or transformed-normal distribution. For all other cases, nonparametric confidence intervals are constructed, with the confidence level based on the number of samples available. The GWPS is exceeded only when the entire confidence interval exceeds its respective GWPS.

Background limits are established for the Appendix IV parameters using upper tolerance limits constructed with 95% confidence/95% coverage using pooled upgradient well data, for comparison against established MCLs. When background limits, or Alternate Contaminant Levels (ACLs), are higher than established MCLs, the CCR Rule recommends using these ACLs as the GWPS for the confidence interval comparisons. Additionally, tolerance limits are also recommended to establish ACLs for Appendix IV parameters, cobalt, lithium, and molybdenum, which do not have established MCLs. Since the scope of this project included screening and development of background limits for Appendix III Detection Monitoring statistics, comparison of the Appendix IV parameters with confidence intervals was not included in this report.

Recommendations

In summary, as a result of the background screening described in this letter, intrawell prediction limits combined with a 1-of-2 resample plan are recommended for calcium, pH, sulfate, and TDS. Interwell prediction limits combined with a 1-of-2 resample plan are recommended for boron, chloride and fluoride. The statistical analyses will be constructed according to the USEPA Unified Guidance, based on 7 Appendix III parameters and 3 downgradient wells.

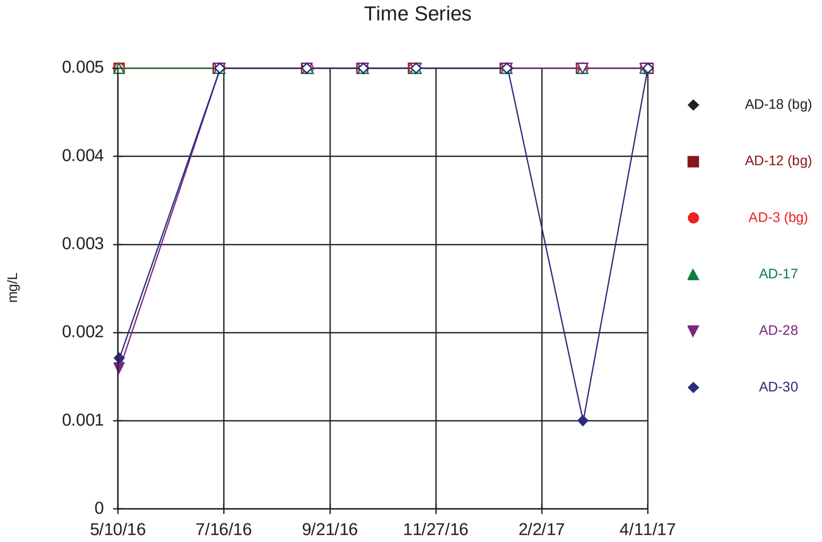
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey West Bottom Ash Pond. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



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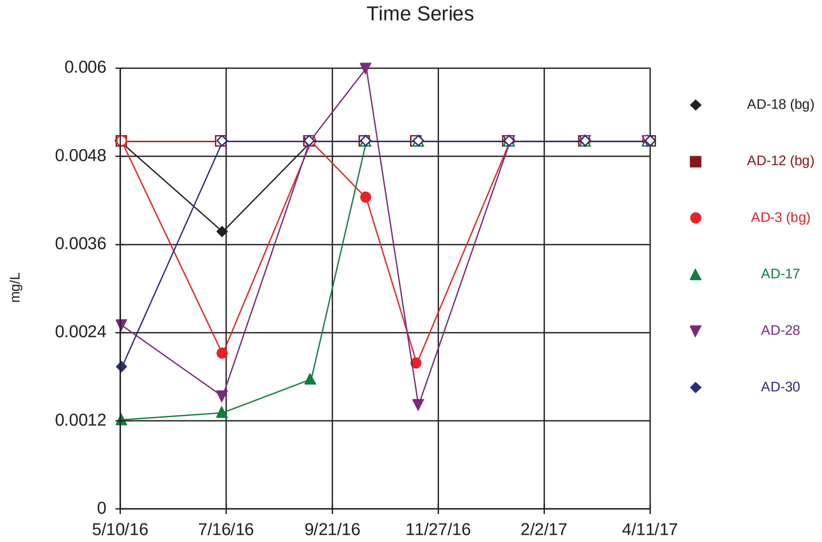
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



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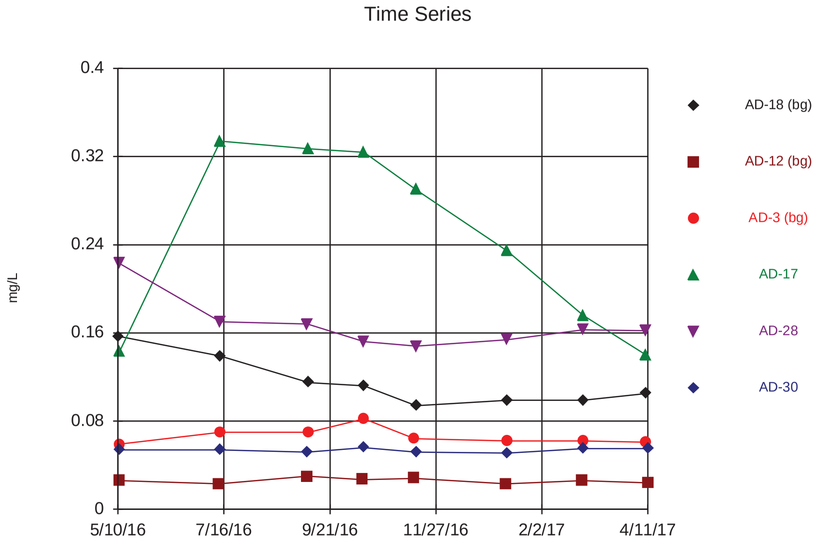

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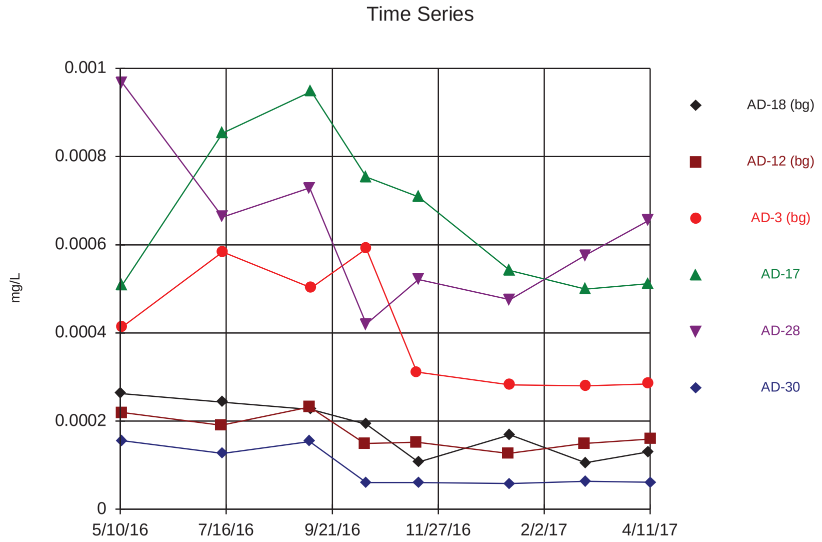

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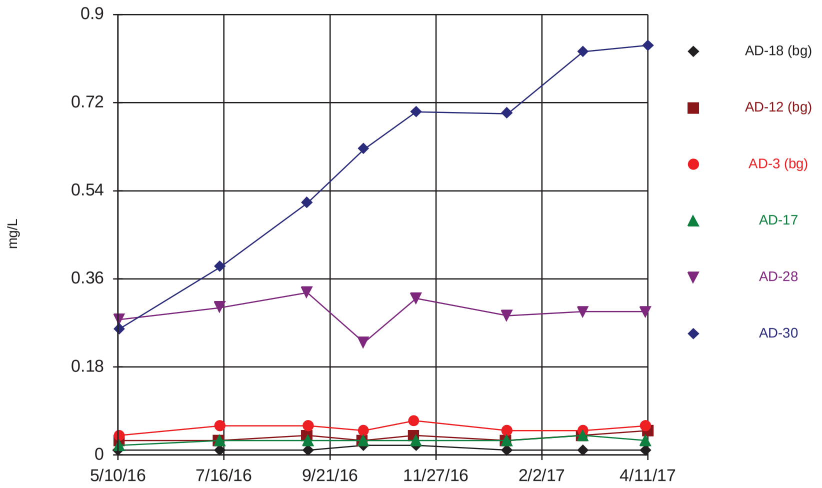
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Time Series



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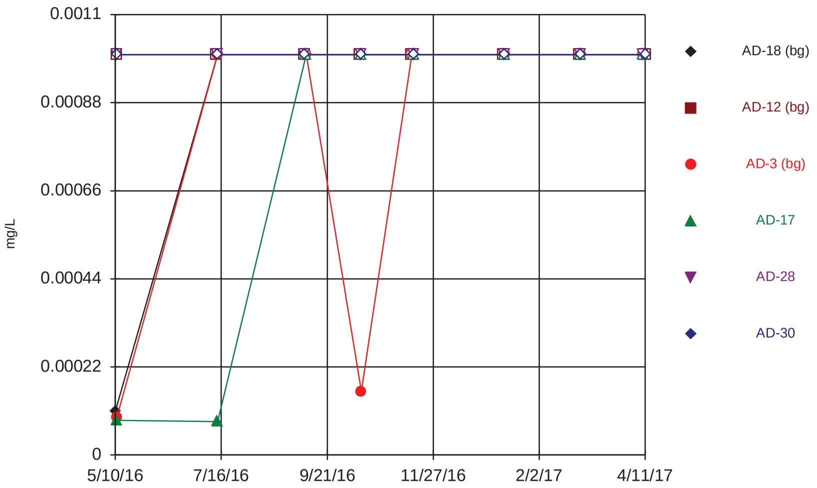
Time Series



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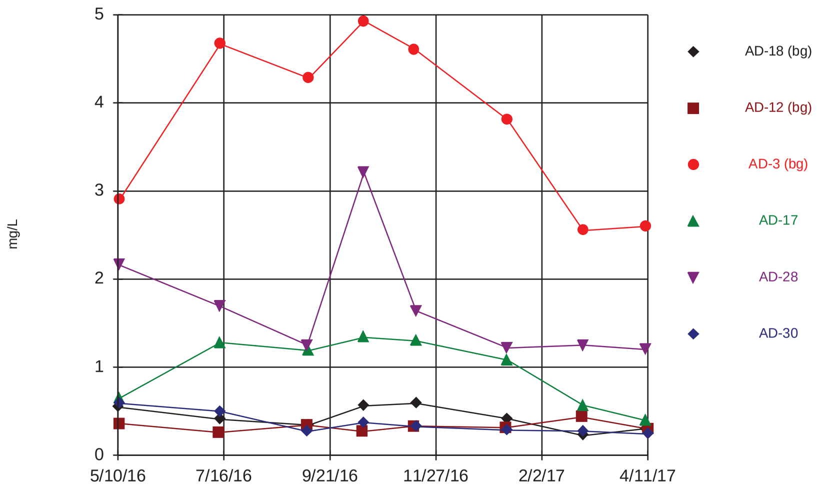
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Time Series



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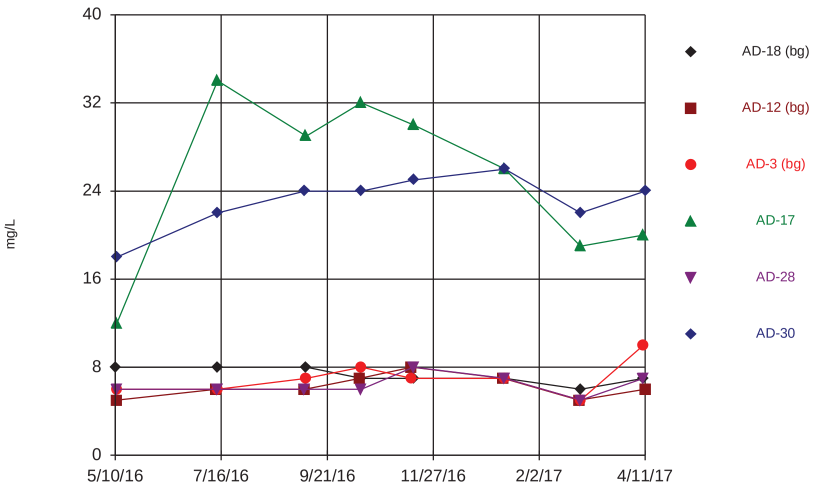
Time Series



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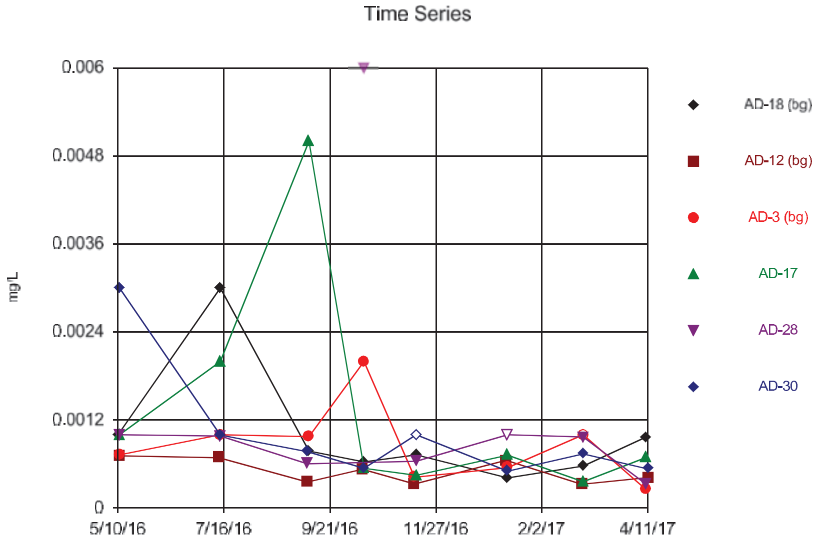

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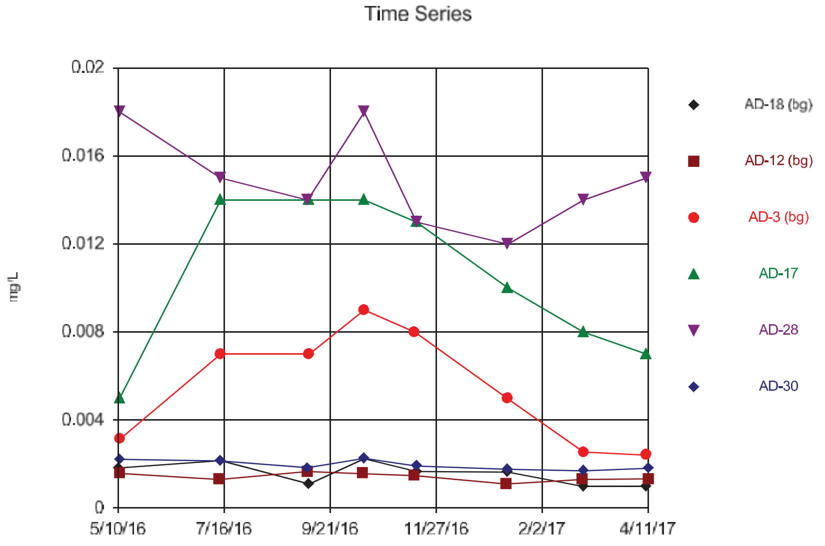
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



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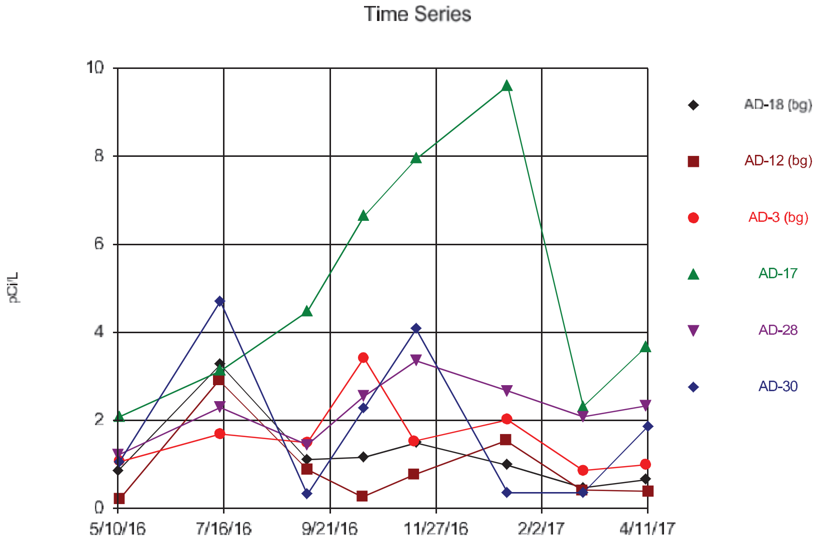
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



Constituent: Combined Radium 226 + 228 Analysis Run 12/14/2017 6:07 AM View: Time Series
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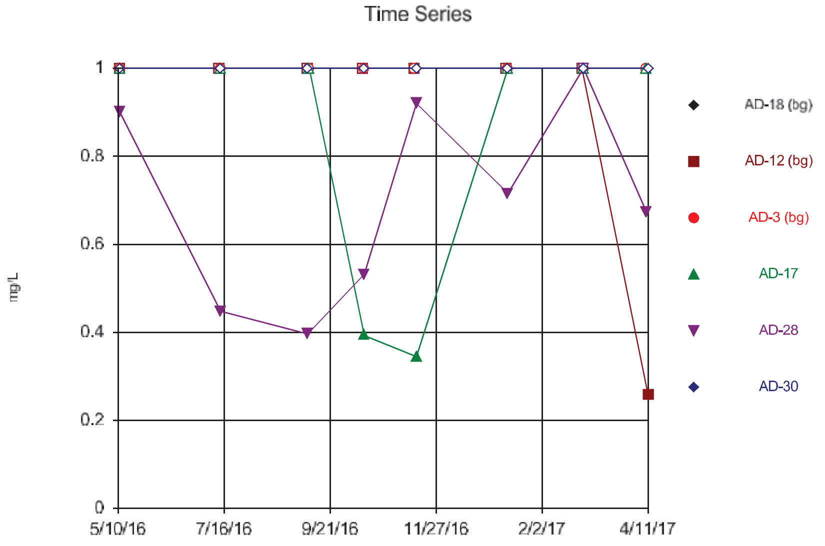
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



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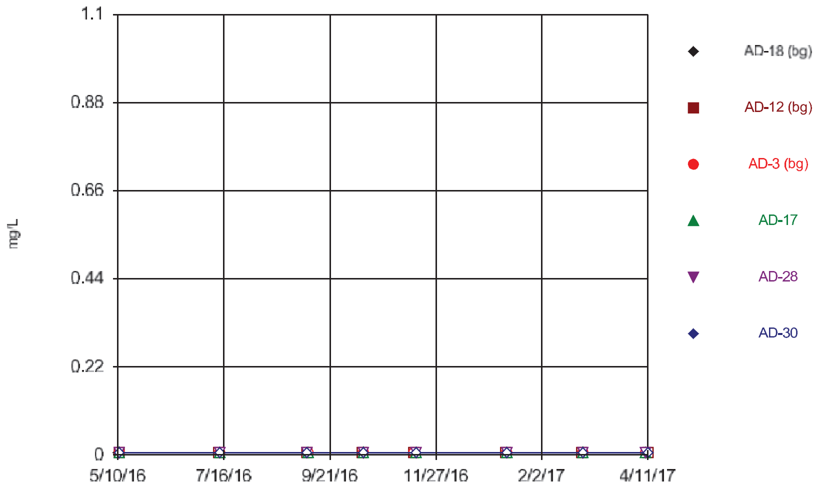
Hollow symbols indicate censored values.

Time Series



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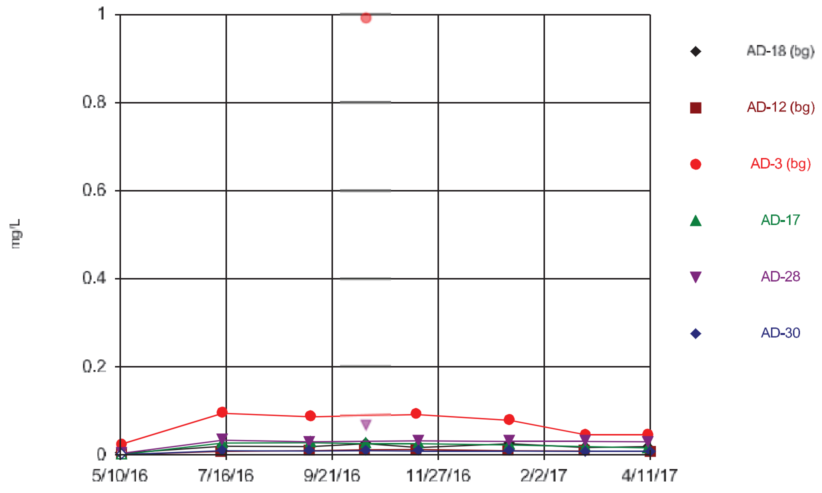

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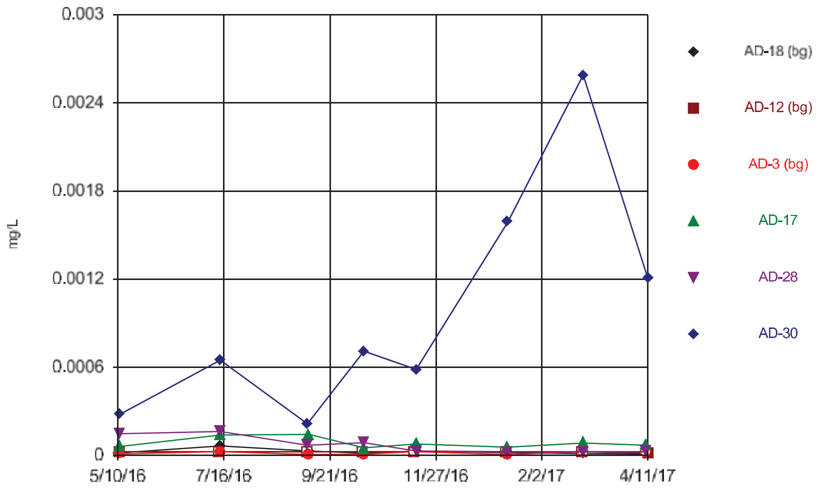

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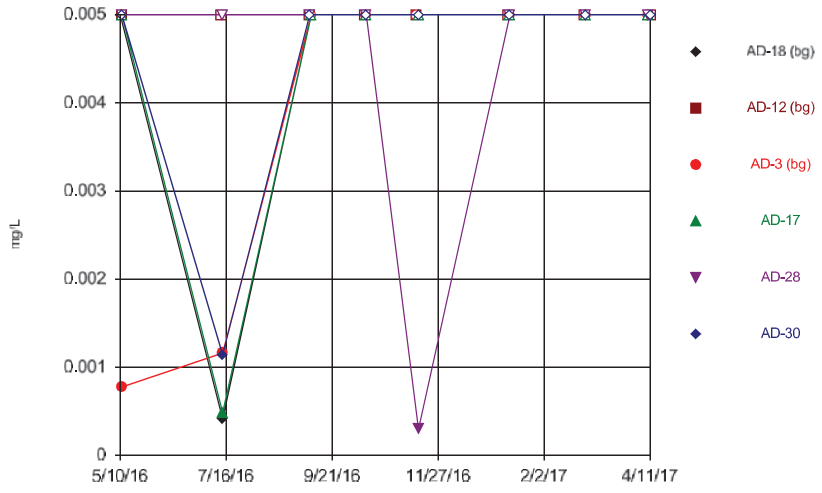
Hollow symbols indicate censored values.

Time Series



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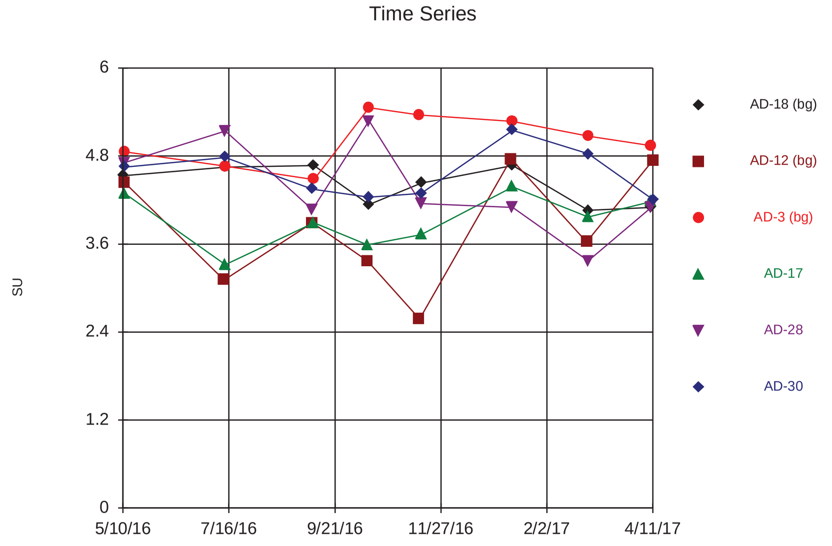

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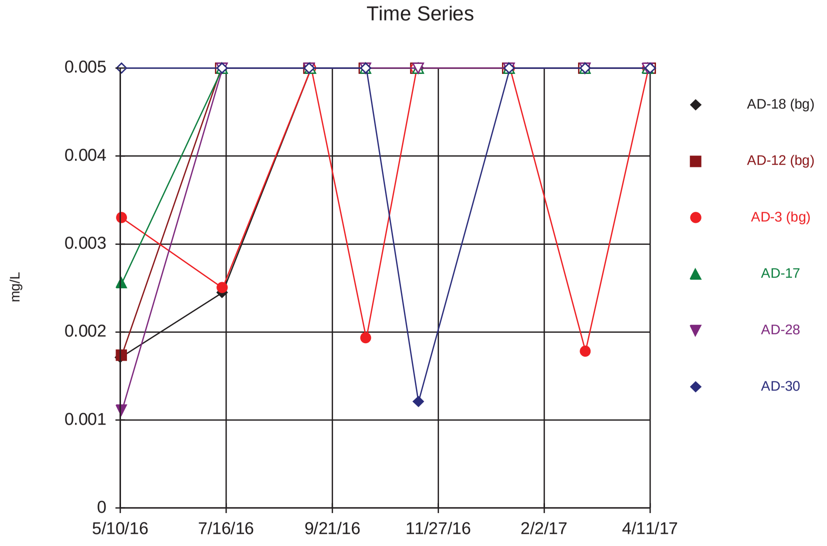

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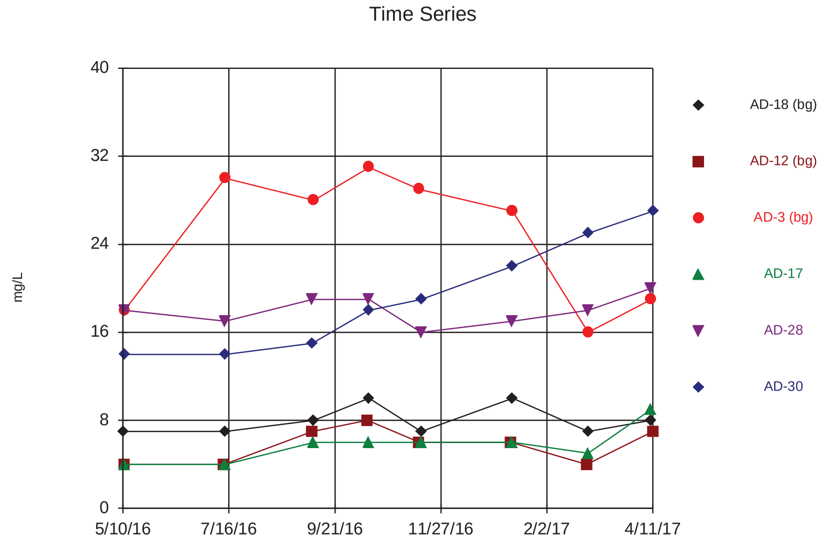
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



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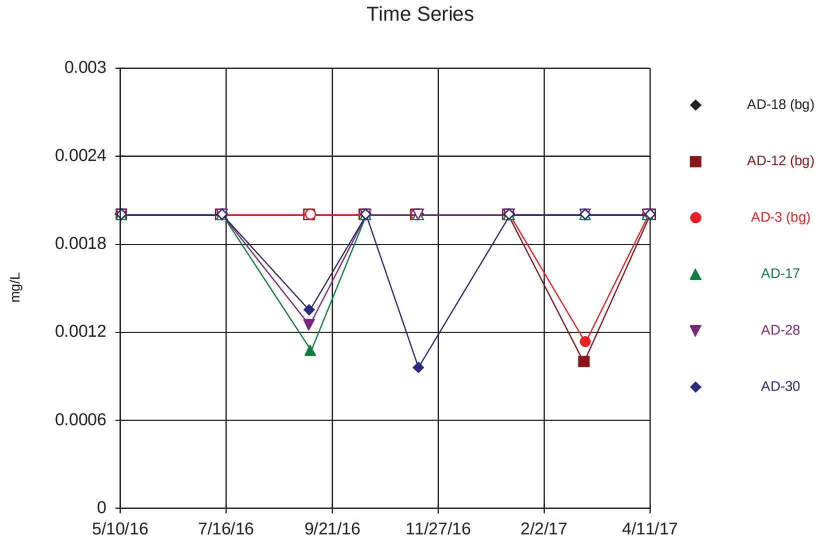

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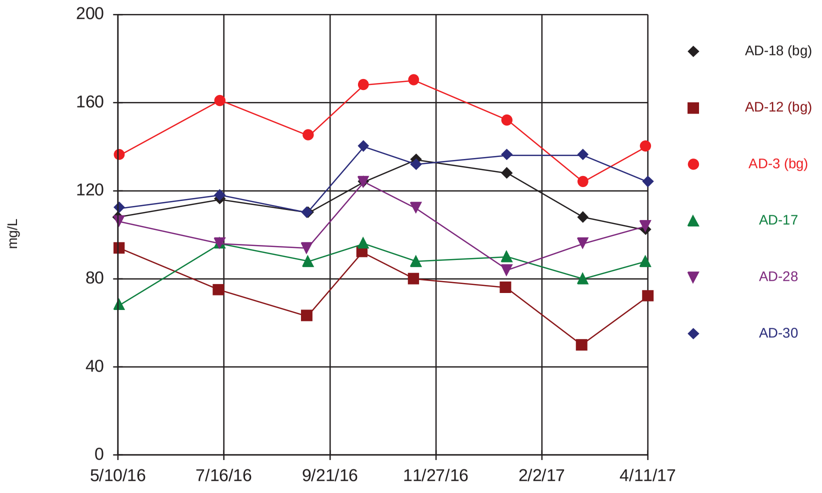
Time Series



Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/14/2017 6:08 AM   View: Time Series
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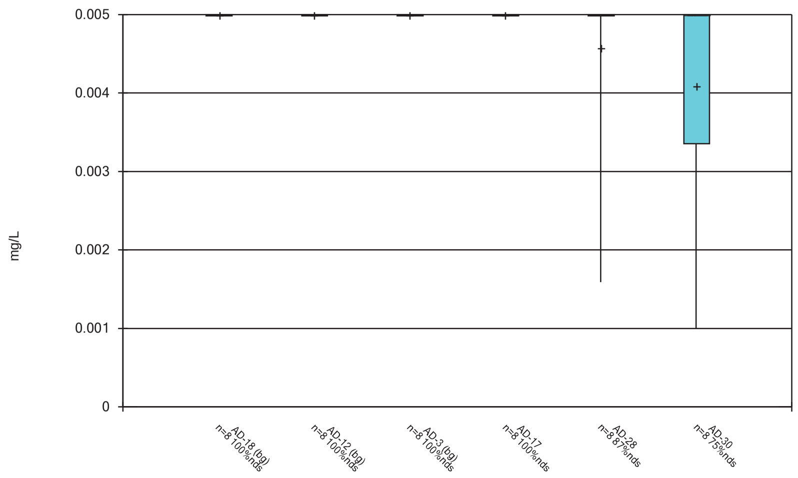
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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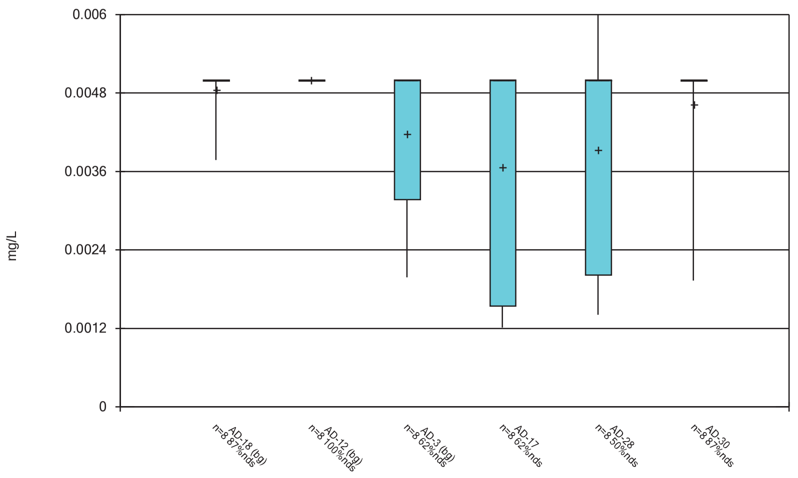
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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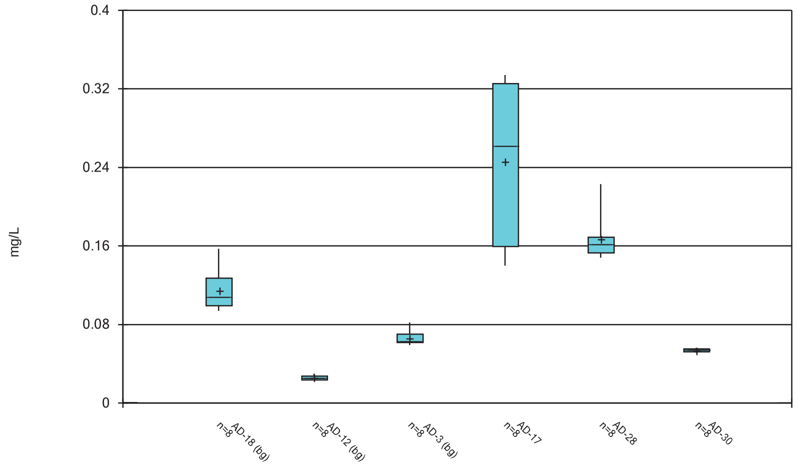
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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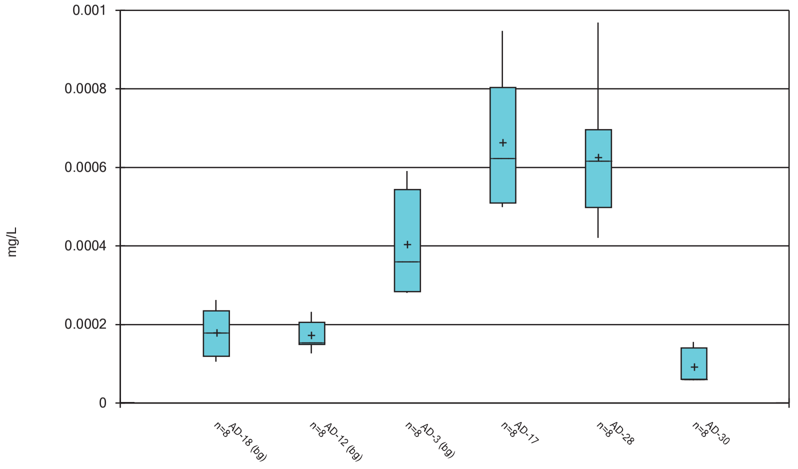
Box & Whiskers Plot



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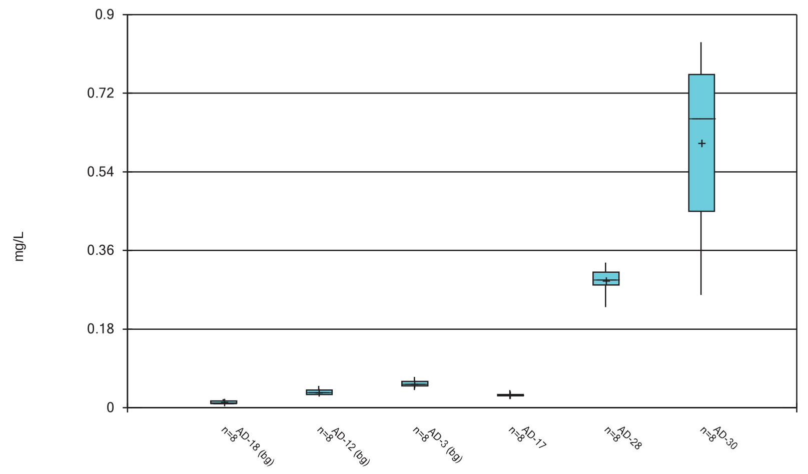
Box & Whiskers Plot



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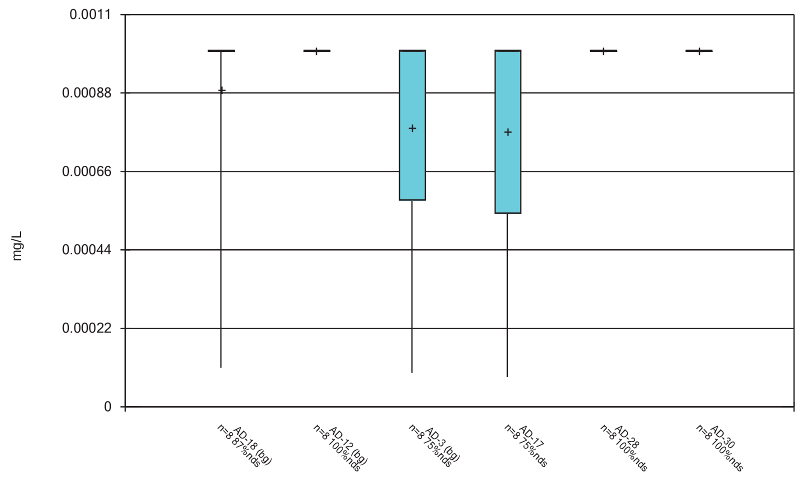
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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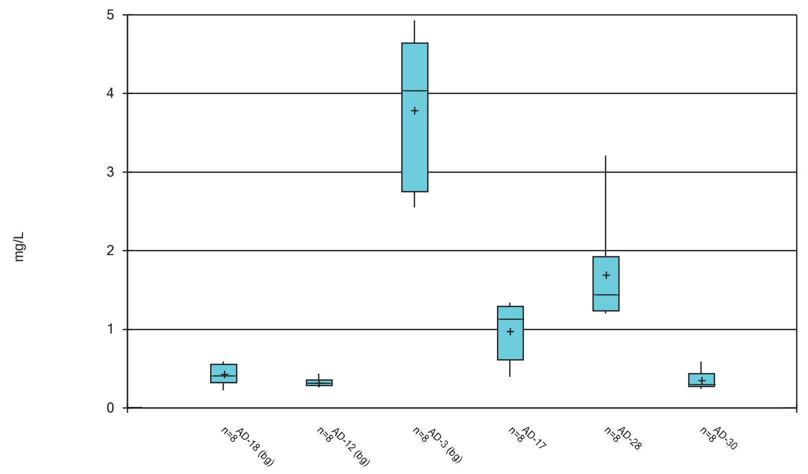
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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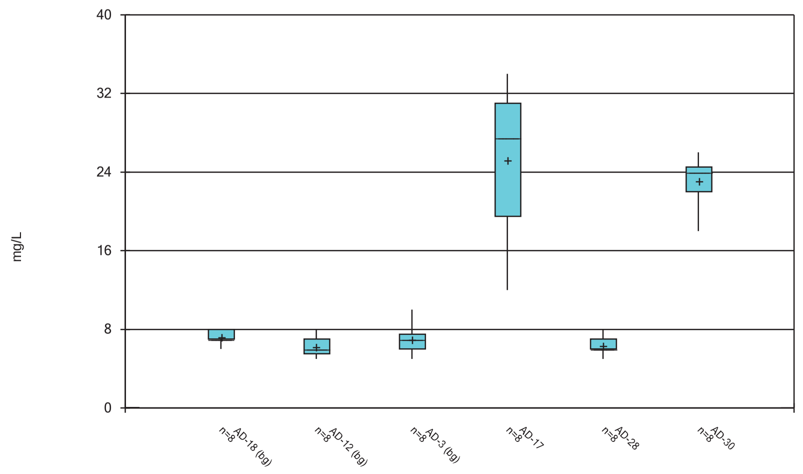
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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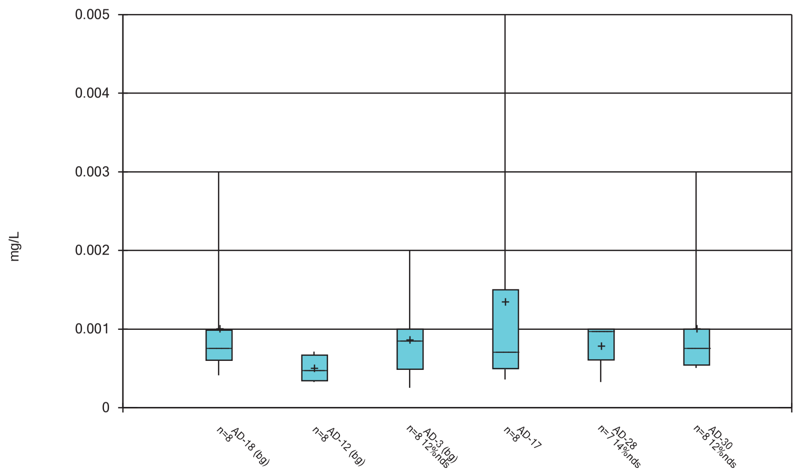
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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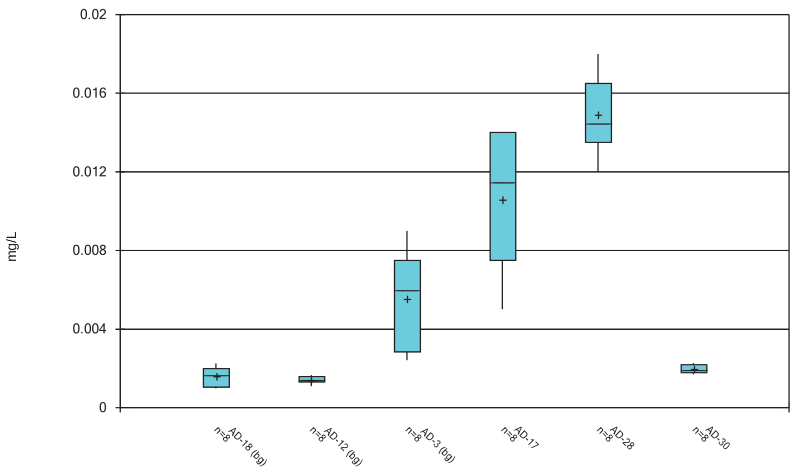
Box & Whiskers Plot



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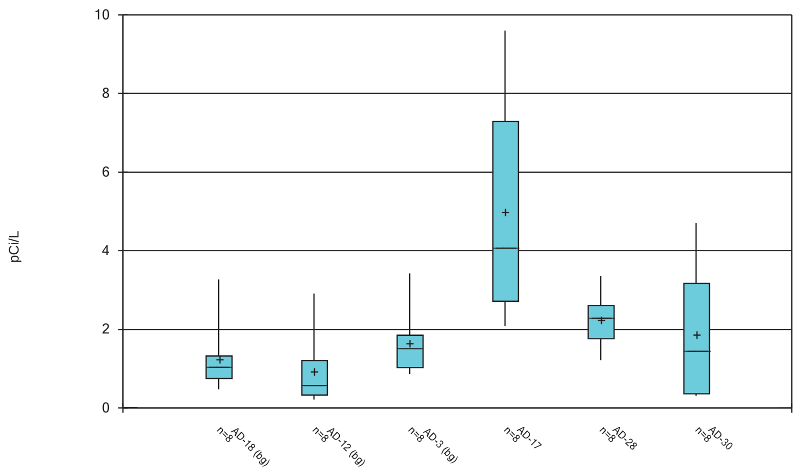
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Combined Radium 226 + 228 Analysis Run 12/14/2017 6:08 AM View: Time Series
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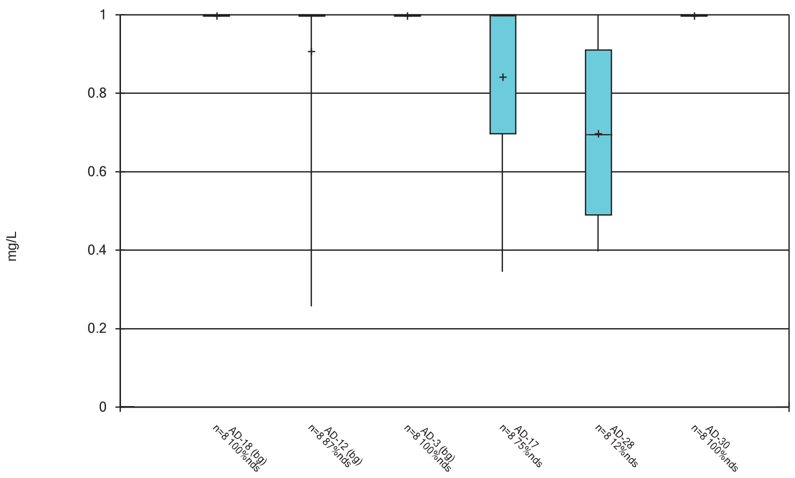
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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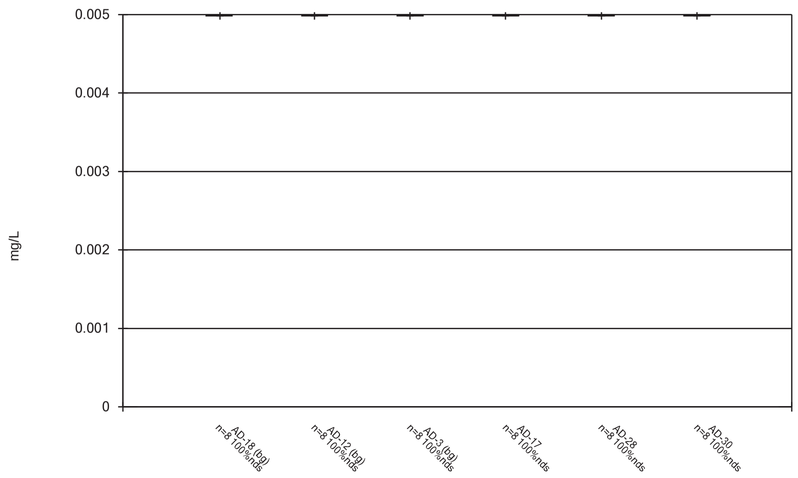
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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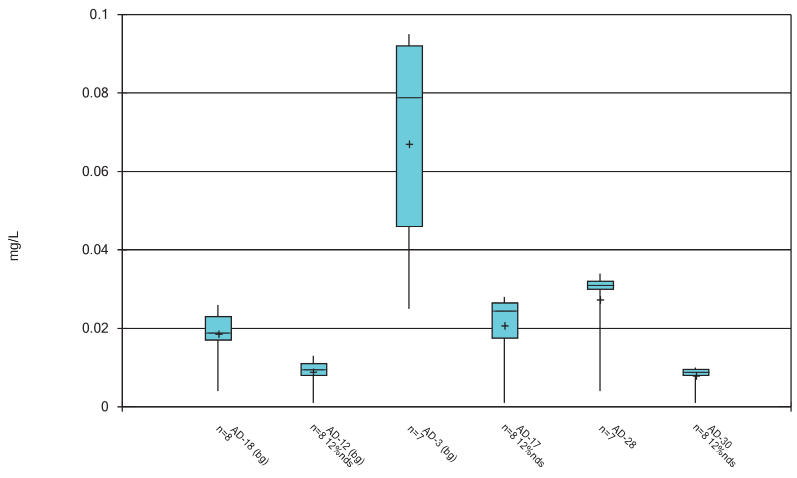
Box & Whiskers Plot



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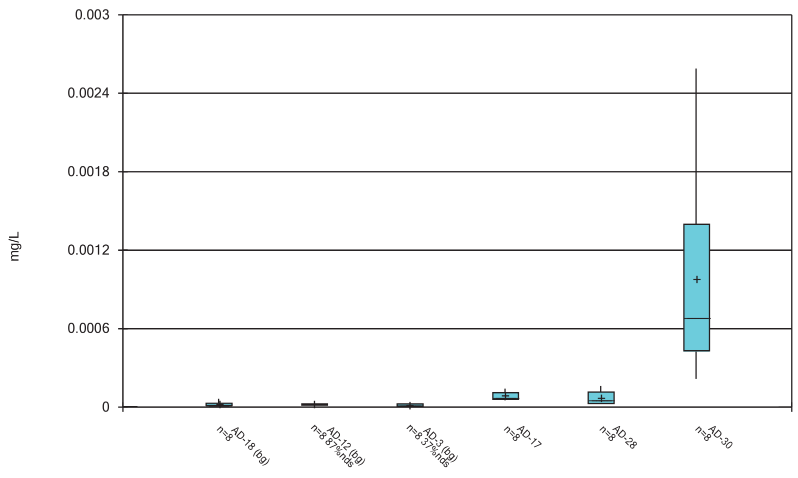
Box & Whiskers Plot



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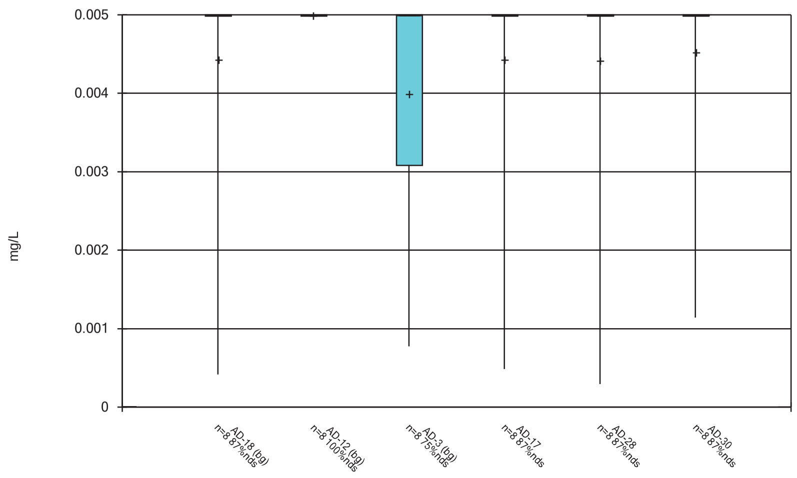
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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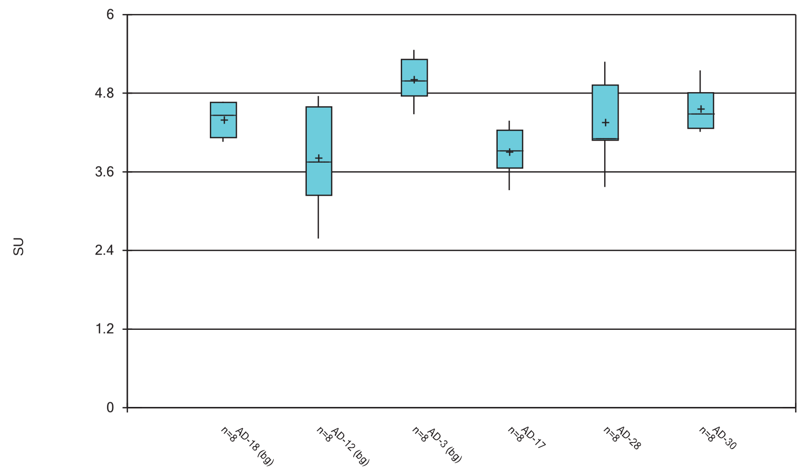
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: pH, field Analysis Run 12/14/2017 6:08 AM View: Time Series
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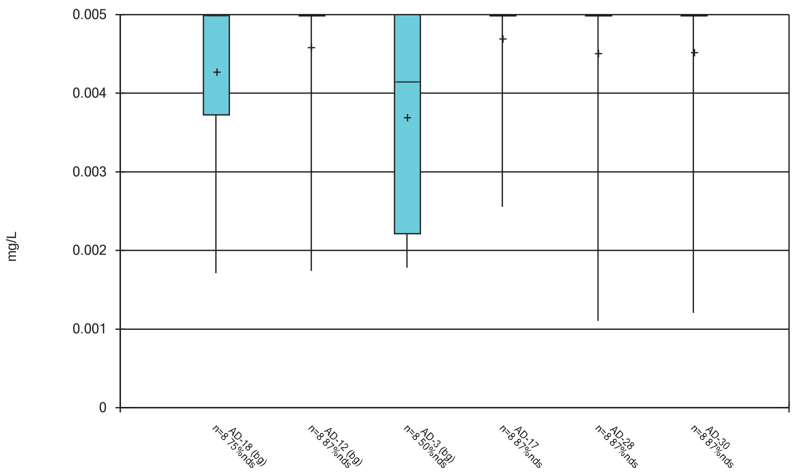
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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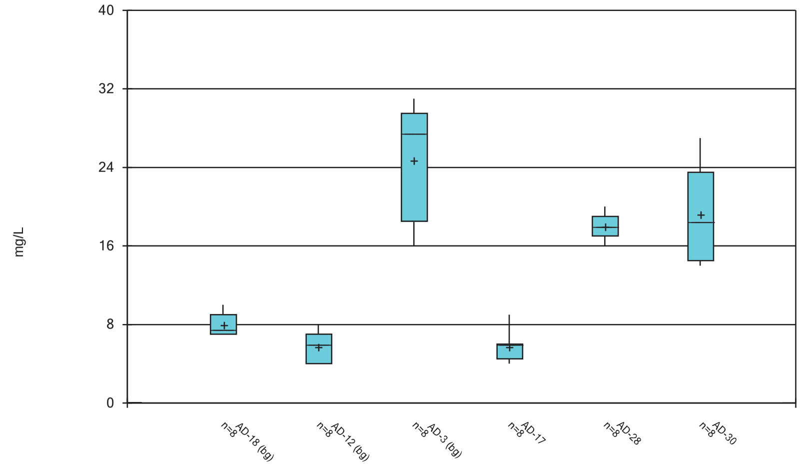
Box & Whiskers Plot



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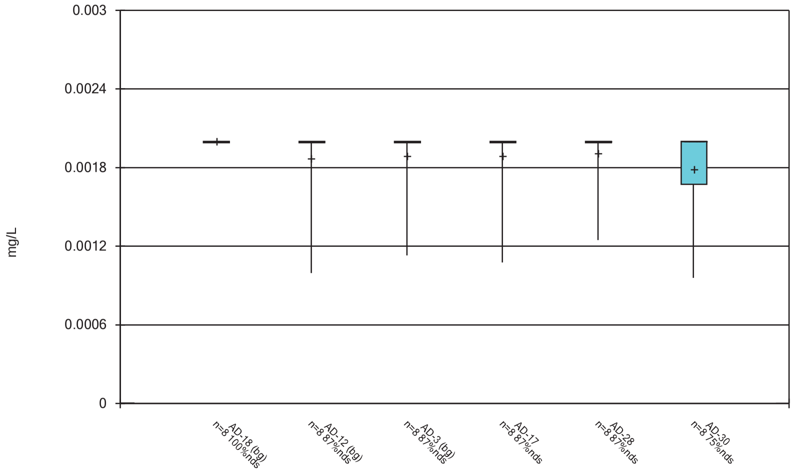
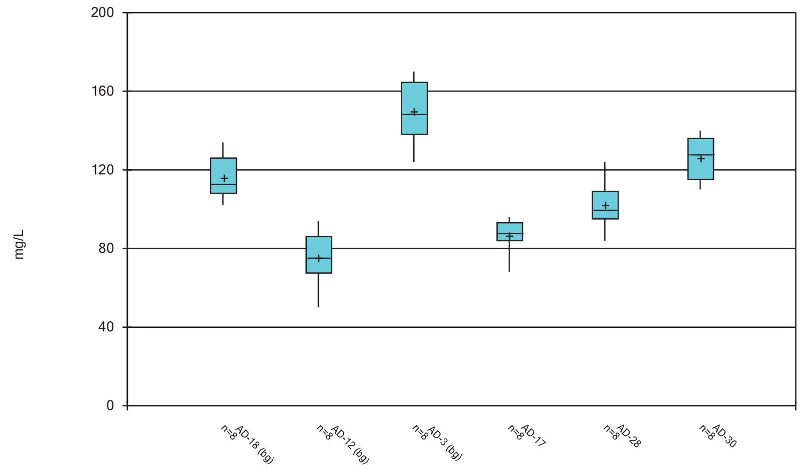
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Thallium, total Analysis Run 12/14/2017 6:08 AM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/14/2017 6:08 AM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Outlier Summary

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/14/2017, 6:06 AM

	AD-28 Chromium, total (mg/L)	AD-3 Lithium, total (mg/L)	AD-28 Lithium, total (mg/L)
10/13/2016	0.006 (o)	0.991 (o)	0.066 (o)

Outlier Analysis - Upgradient Wells

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 11/6/2017, 4:37 AM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	0.005	0	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	0.00467	0.0008589	unknown	ShapiroWilk
Barium, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	0.06904	0.0394	unknown	ShapiroWilk
Beryllium, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP	24	0.0002527	0.0001397	ln(x)	ShapiroWilk
Boron, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	0.03458	0.01911	unknown	ShapiroWilk
Cadmium, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	0.0008901	0.0002971	unknown	ShapiroWilk
Calcium, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	1.515	1.735	unknown	ShapiroWilk
Chloride, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP	24	6.833	1.167	x^(1/3)	ShapiroWilk
Chromium, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP	24	0.0007922	0.000594	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	0.002831	0.002425	unknown	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-18,AD-12,AD-3	No	n/a	NP	24	1.266	0.883	x^(1/3)	ShapiroWilk
Fluoride, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	1.124	0.7802	unknown	ShapiroWilk
Lead, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	0.005	0	unknown	ShapiroWilk
Lithium, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP	24	0.07	0.1983	ln(x)	ShapiroWilk
Mercury, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	0.00002123	0.00001198	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	0.004473	0.001429	unknown	ShapiroWilk
pH, field (SU)	AD-18,AD-12,AD-3	No	n/a	NP	24	4.411	0.7059	x^3	ShapiroWilk
Selenium, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	0.004184	0.001334	unknown	ShapiroWilk
Sulfate, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	12.83	9.347	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP (nrm)	24	0.001922	0.0002654	unknown	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-18,AD-12,AD-3	No	n/a	NP	24	113.7	33.83	normal	ShapiroWilk

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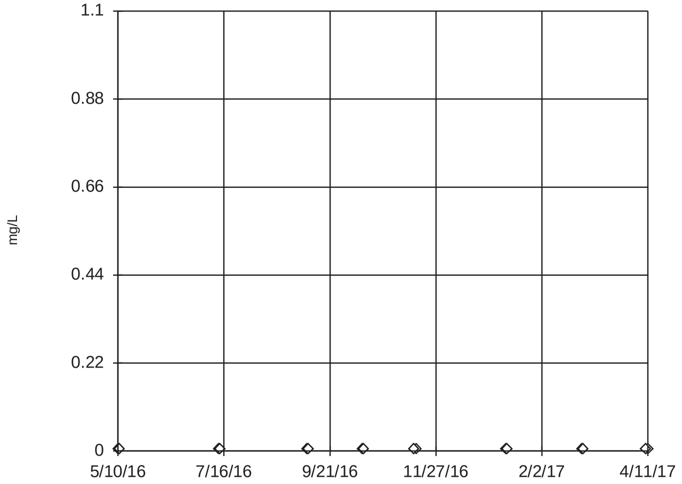
Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

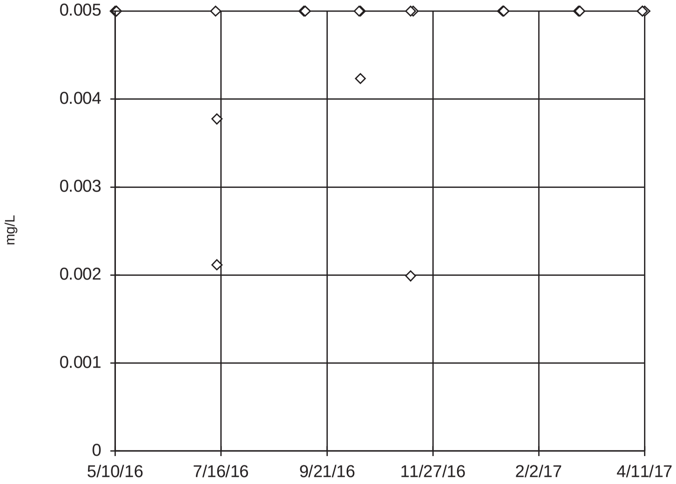
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Antimony, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were x^5 transformed to achieve best W statistic (graph shown in original units).

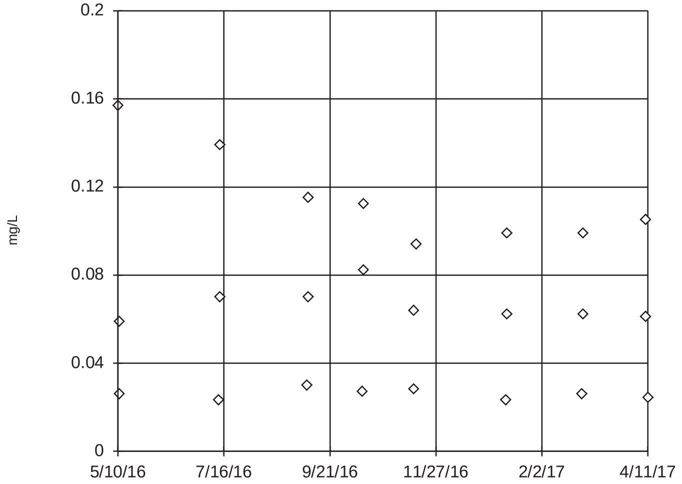
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Arsenic, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

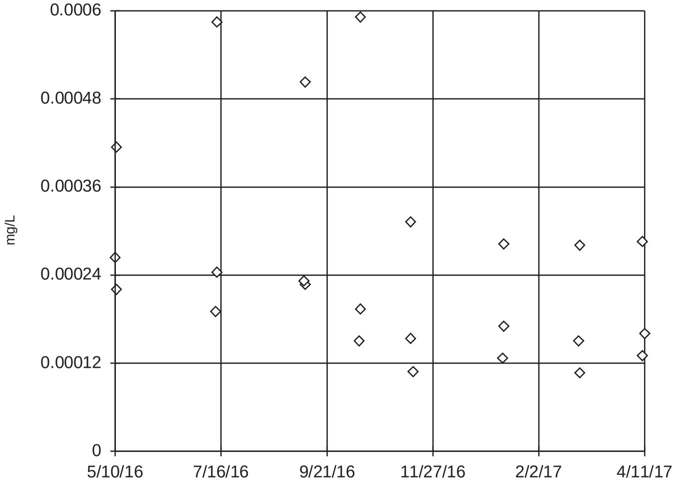
High cutoff = 0.5793, low cutoff = -0.07875, based on IQR multiplier of 3.

Constituent: Barium, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.001871, low cutoff = 0.00002285, based on IQR multiplier of 3.

Constituent: Beryllium, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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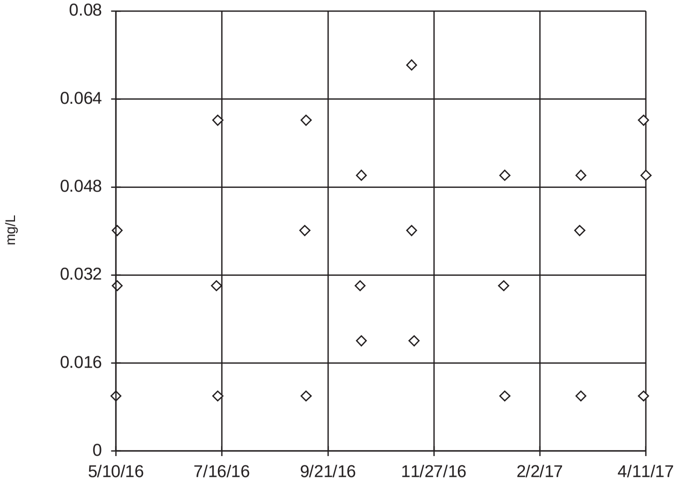
Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.155, low cutoff = -0.09, based on IQR multiplier of 3.

Constituent: Boron, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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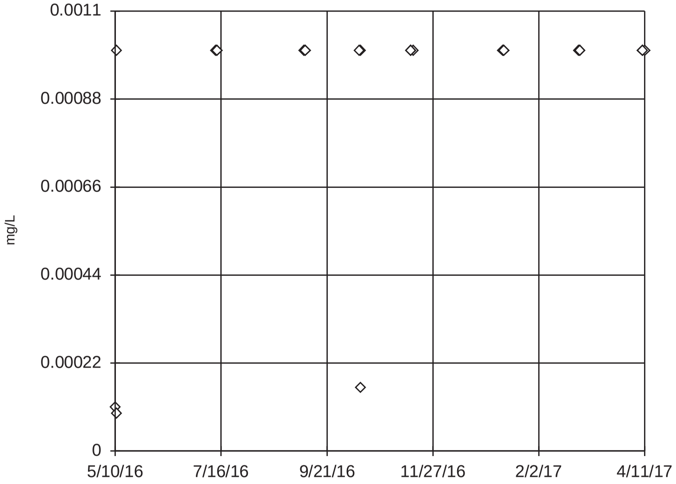
Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

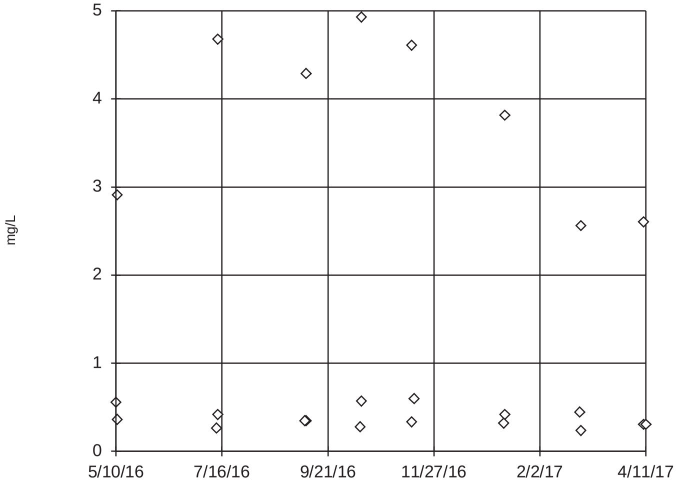
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Cadmium, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

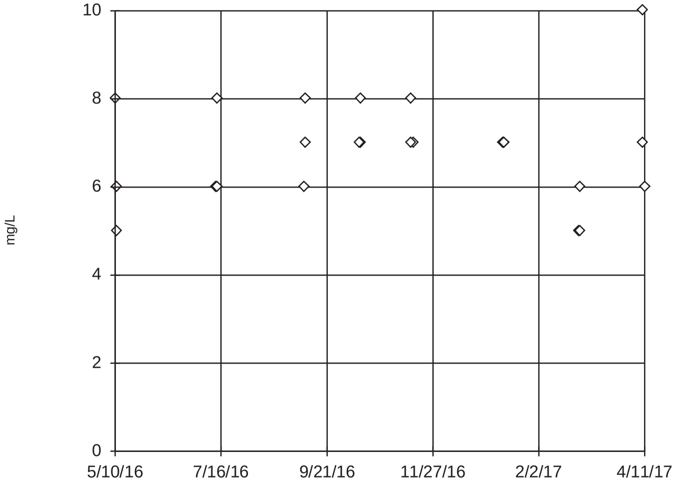
High cutoff = 1689, low cutoff = 0.0005251, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 13.39, low cutoff = 2.739, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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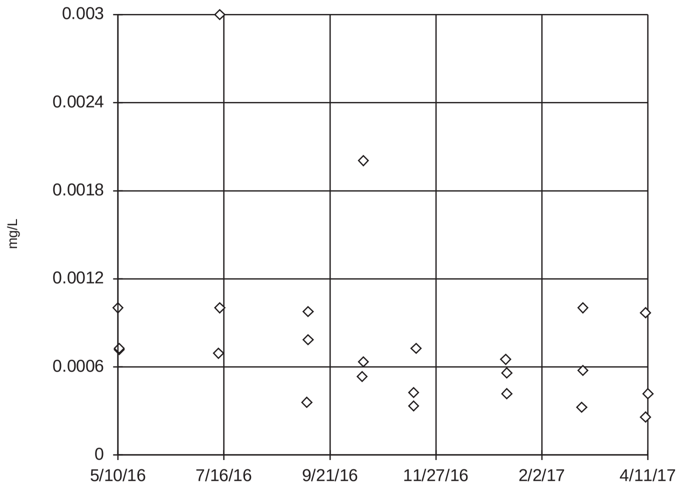
Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.01207, low cutoff = 0.00003373, based on IQR multiplier of 3.

Constituent: Chromium, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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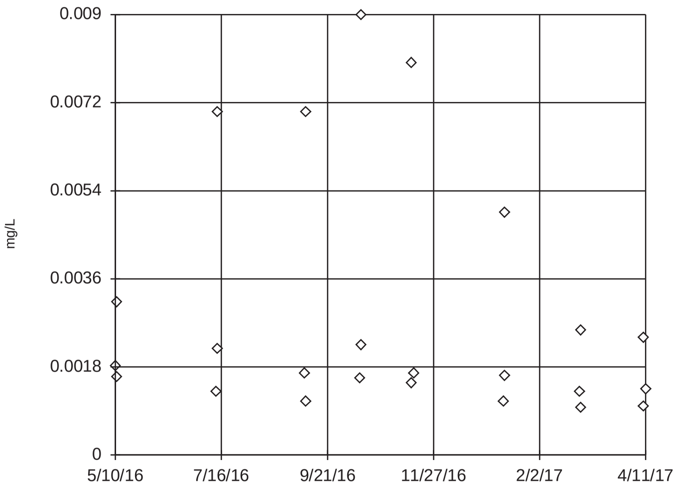
Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.02775, low cutoff = 0.0001338, based on IQR multiplier of 3.

Constituent: Cobalt, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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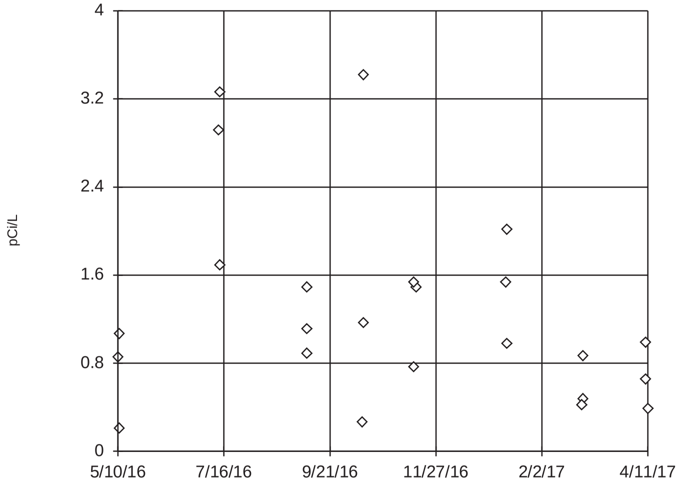
Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

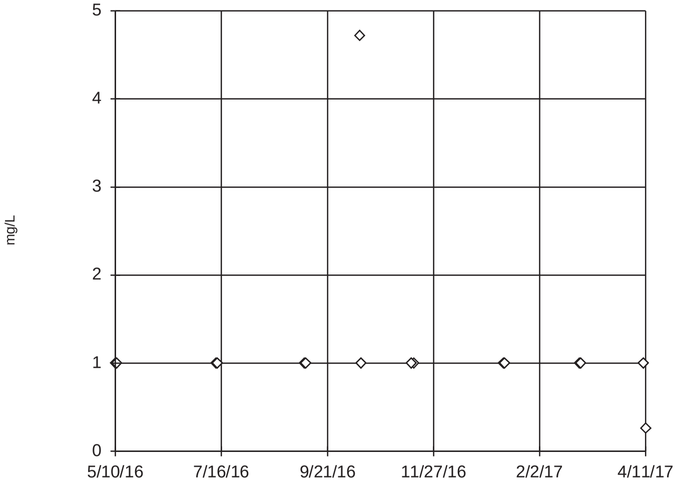
High cutoff = 7.325, low cutoff = 0.001047, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Fluoride, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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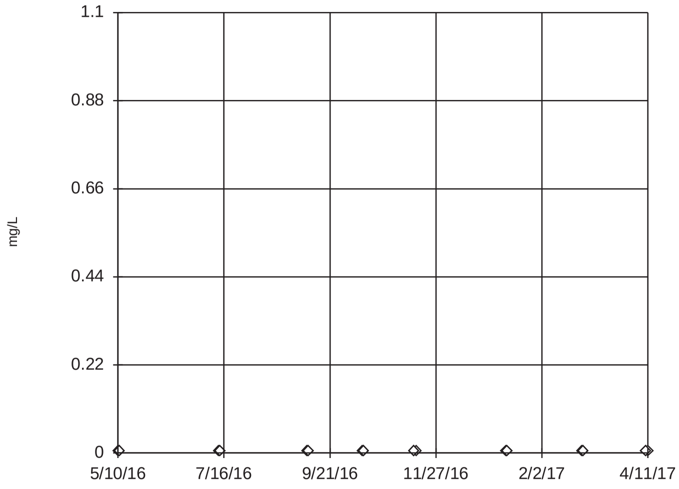
Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

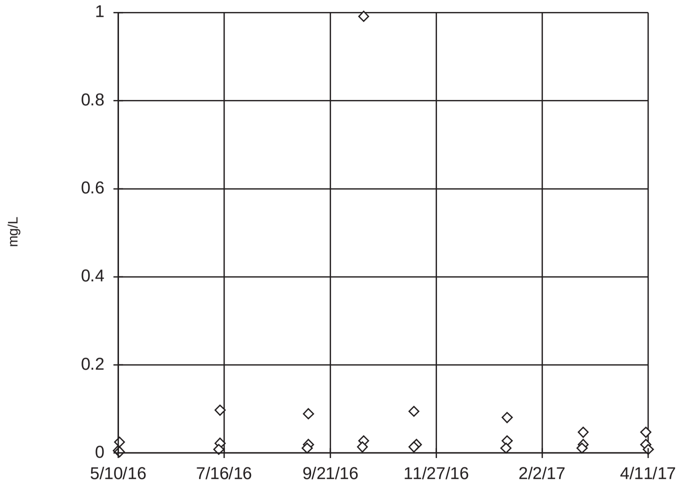
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Lead, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

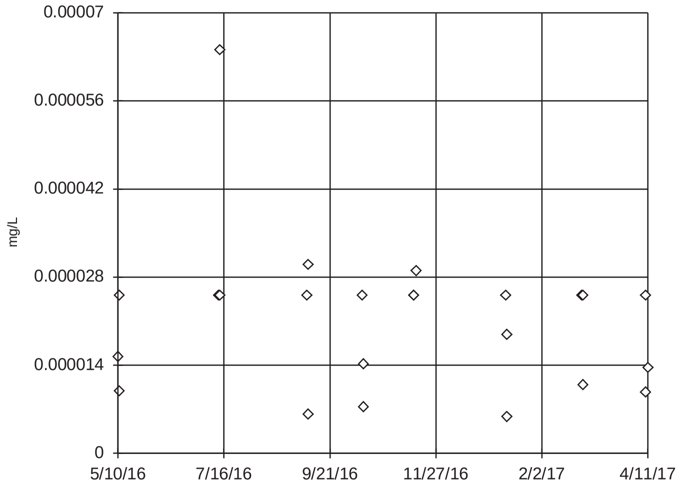
High cutoff = 4.477, low cutoff = 0.0001027, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

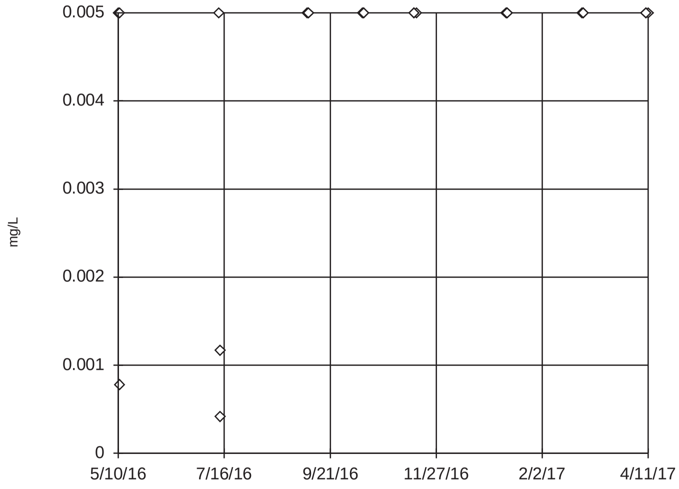
High cutoff = 0.0001099, low cutoff = 8.3e-8, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

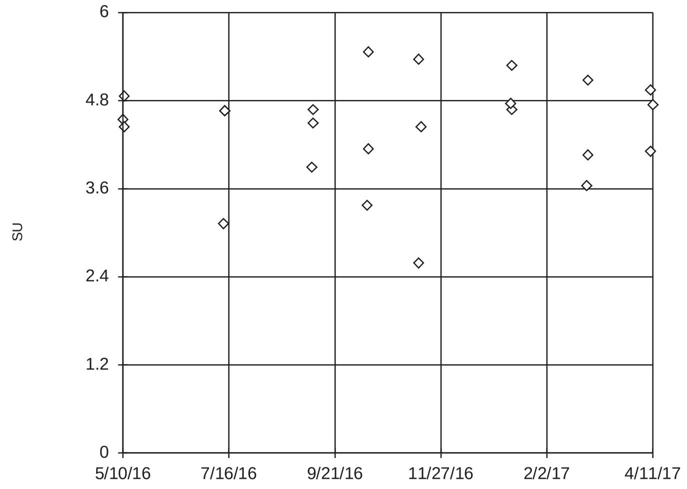
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Molybdenum, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

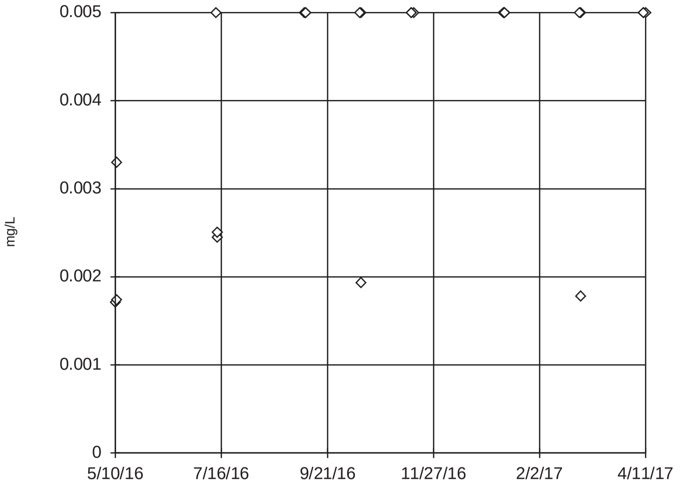
High cutoff = 6.228, low cutoff = -3.964, based on IQR multiplier of 3.

Constituent: pH, field   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

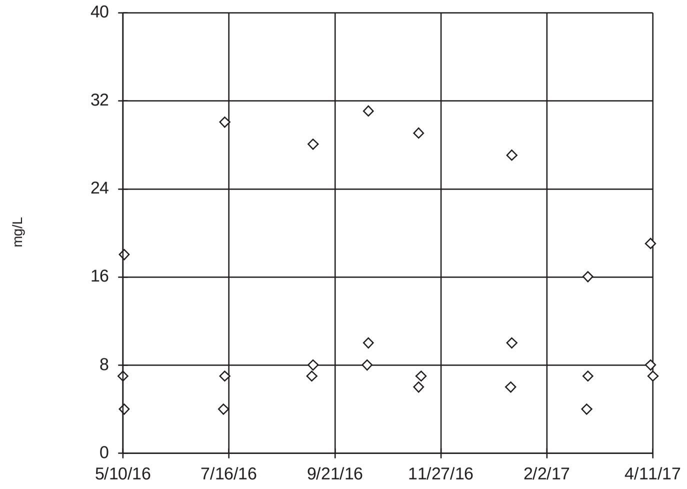
High cutoff = 0.02638, low cutoff = 0.0005444, based on IQR multiplier of 3.

Constituent: Selenium, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

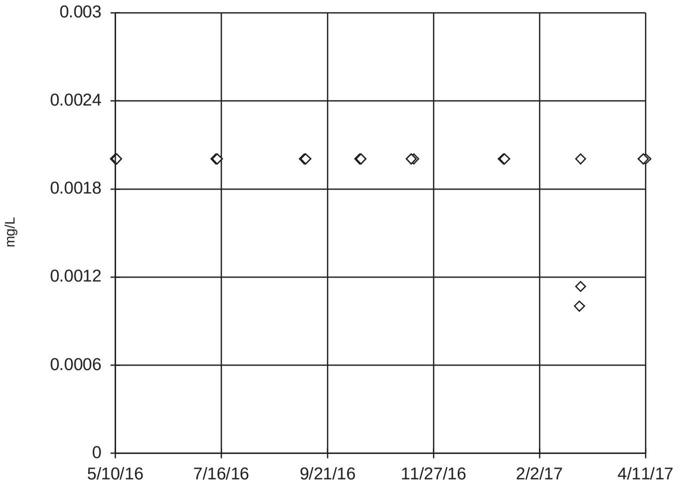
High cutoff = 341, low cutoff = 0.3796, based on IQR multiplier of 3.

Constituent: Sulfate, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

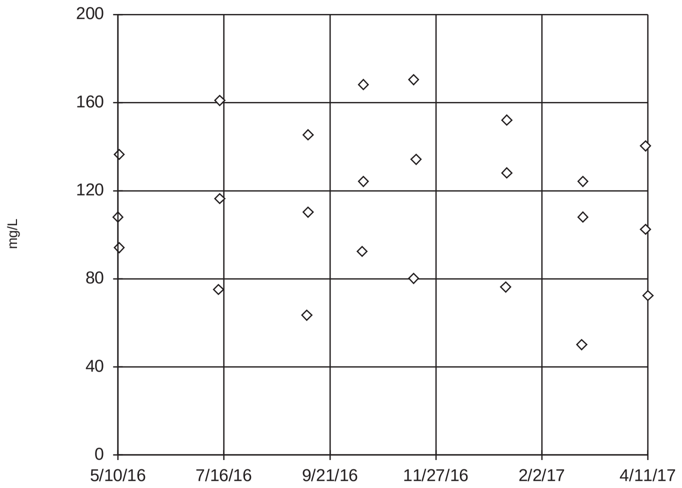
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium, total   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-18,AD-12,AD-3



n = 24

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 294, low cutoff = -70, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/6/2017 4:36 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Outlier Analysis - Downgradient Wells

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 11/6/2017, 4:40 AM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-17	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-28	No	n/a	NP (nrm)	8	0.004574	0.001206	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-30	No	n/a	NP (nrm)	8	0.004089	0.001698	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-17	No	n/a	NP (nrm)	8	0.003661	0.001854	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-28	No	n/a	NP (nrm)	8	0.00393	0.001814	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-30	No	n/a	NP (nrm)	8	0.004616	0.001086	unknown	ShapiroWilk
Barium, total (mg/L)	AD-17	No	n/a	NP	8	0.246	0.08385	x^2	ShapiroWilk
Barium, total (mg/L)	AD-28	No	n/a	NP	8	0.1675	0.02372	ln(x)	ShapiroWilk
Barium, total (mg/L)	AD-30	No	n/a	NP	8	0.05363	0.001768	x^6	ShapiroWilk
Beryllium, total (mg/L)	AD-17	No	n/a	NP	8	0.0006654	0.0001758	sqrt(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-28	No	n/a	NP	8	0.0006261	0.0001727	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-30	No	n/a	NP (nrm)	8	0.00009246	0.00004469	unknown	ShapiroWilk
Boron, total (mg/L)	AD-17	No	n/a	NP (nrm)	8	0.03	0.005345	unknown	ShapiroWilk
Boron, total (mg/L)	AD-28	No	n/a	NP	8	0.2914	0.03066	x^4	ShapiroWilk
Boron, total (mg/L)	AD-30	No	n/a	NP	8	0.6051	0.2061	x^2	ShapiroWilk
Cadmium, total (mg/L)	AD-17	No	n/a	NP (nrm)	8	0.0007713	0.0004235	unknown	ShapiroWilk
Cadmium, total (mg/L)	AD-28	No	n/a	NP (nrm)	8	0.001	0	unknown	ShapiroWilk
Cadmium, total (mg/L)	AD-30	No	n/a	NP (nrm)	8	0.001	0	unknown	ShapiroWilk
Calcium, total (mg/L)	AD-17	No	n/a	NP	8	0.9754	0.3773	x^6	ShapiroWilk
Calcium, total (mg/L)	AD-28	No	n/a	NP	8	1.703	0.695	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-30	No	n/a	NP	8	0.3575	0.1248	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-17	No	n/a	NP	8	25.25	7.573	x^2	ShapiroWilk
Chloride, total (mg/L)	AD-28	No	n/a	NP	8	6.375	0.9161	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-30	No	n/a	NP	8	23.13	2.475	x^6	ShapiroWilk
Chromium, total (mg/L)	AD-17	No	n/a	NP	8	0.001345	0.001565	ln(x)	ShapiroWilk
Chromium, total (mg/L)	**AD-28**	**Yes**	**0.006**	**NP (nrm)**	**8**	**0.00144**	**0.001859**	**unknown**	**ShapiroWilk**
Chromium, total (mg/L)	AD-30	No	n/a	NP	8	0.001011	0.0008271	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-17	No	n/a	NP	8	0.01063	0.003623	sqrt(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-28	No	n/a	NP	8	0.01488	0.002167	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-30	No	n/a	NP	8	0.001953	0.00022	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-17	No	n/a	NP	8	4.979	2.773	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-28	No	n/a	NP	8	2.24	0.6807	normal	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-30	No	n/a	NP	8	1.873	1.719	x^(1/3)	ShapiroWilk
Fluoride, total (mg/L)	AD-17	No	n/a	NP (nrm)	8	0.8422	0.2925	unknown	ShapiroWilk
Fluoride, total (mg/L)	AD-28	No	n/a	NP	8	0.6982	0.2278	normal	ShapiroWilk
Fluoride, total (mg/L)	AD-30	No	n/a	NP (nrm)	8	1	0	unknown	ShapiroWilk
Lead, total (mg/L)	AD-17	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Lead, total (mg/L)	AD-28	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Lead, total (mg/L)	AD-30	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Lithium, total (mg/L)	AD-17	No	n/a	NP	8	0.02075	0.009004	x^3	ShapiroWilk
Lithium, total (mg/L)	**AD-28**	**Yes**	**0.004,0.066**	**NP**	**8**	**0.03225**	**0.01671**	**normal**	**ShapiroWilk**
Lithium, total (mg/L)	AD-30	No	n/a	NP	8	0.008	0.002928	x^5	ShapiroWilk
Mercury, total (mg/L)	AD-17	No	n/a	NP	8	0.0000845	0.00003608	ln(x)	ShapiroWilk
Mercury, total (mg/L)	AD-28	No	n/a	NP	8	0.00007088	0.00005622	x^(1/3)	ShapiroWilk
Mercury, total (mg/L)	AD-30	No	n/a	NP	8	0.0009774	0.0007958	ln(x)	ShapiroWilk
Molybdenum, total (mg/L)	AD-17	No	n/a	NP (nrm)	8	0.004436	0.001596	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-28	No	n/a	NP (nrm)	8	0.004412	0.001664	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-30	No	n/a	NP (nrm)	8	0.004518	0.001364	unknown	ShapiroWilk
pH, field (SU)	AD-17	No	n/a	NP	8	3.919	0.3634	x^3	ShapiroWilk
pH, field (SU)	AD-28	No	n/a	NP	8	4.365	0.6348	x^(1/3)	ShapiroWilk
pH, field (SU)	AD-30	No	n/a	NP	8	4.563	0.3421	ln(x)	ShapiroWilk
Selenium, total (mg/L)	AD-17	No	n/a	NP (nrm)	8	0.004694	0.0008649	unknown	ShapiroWilk
Selenium, total (mg/L)	AD-28	No	n/a	NP (nrm)	8	0.004513	0.001378	unknown	ShapiroWilk
Selenium, total (mg/L)	AD-30	No	n/a	NP (nrm)	8	0.004526	0.001341	unknown	ShapiroWilk
Sulfate, total (mg/L)	AD-17	No	n/a	NP	8	5.75	1.581	ln(x)	ShapiroWilk

Outlier Analysis - Downgradient Wells

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 11/6/2017, 4:40 AM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Sulfate, total (mg/L)	AD-28	No	n/a	NP	8	18	1.309	normal	ShapiroWilk
Sulfate, total (mg/L)	AD-30	No	n/a	NP	8	19.25	5.007	ln(x)	ShapiroWilk
Thallium, total (mg/L)	AD-17	No	n/a	NP (nrm)	8	0.001884	0.0003269	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-28	No	n/a	NP (nrm)	8	0.001906	0.0002661	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-30	No	n/a	NP (nrm)	8	0.001788	0.0004056	unknown	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-17	No	n/a	NP	8	86.75	9.13	x^6	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-28	No	n/a	NP	8	102	12.33	ln(x)	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-30	No	n/a	NP	8	126	11.66	x^5	ShapiroWilk

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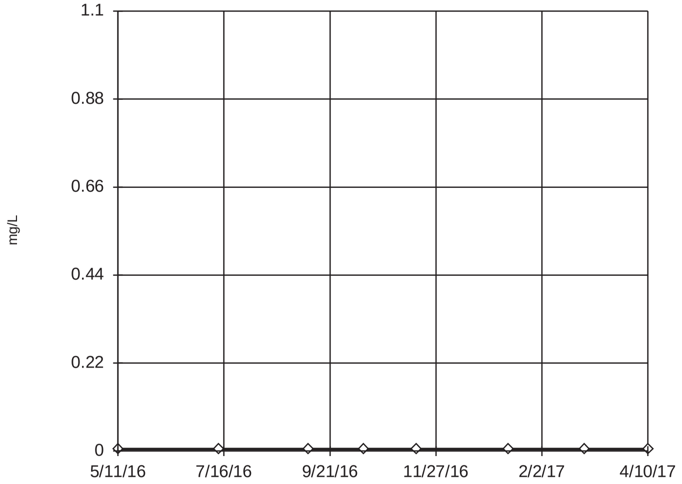

Tukey's Outlier Screening

AD-17

n = 8

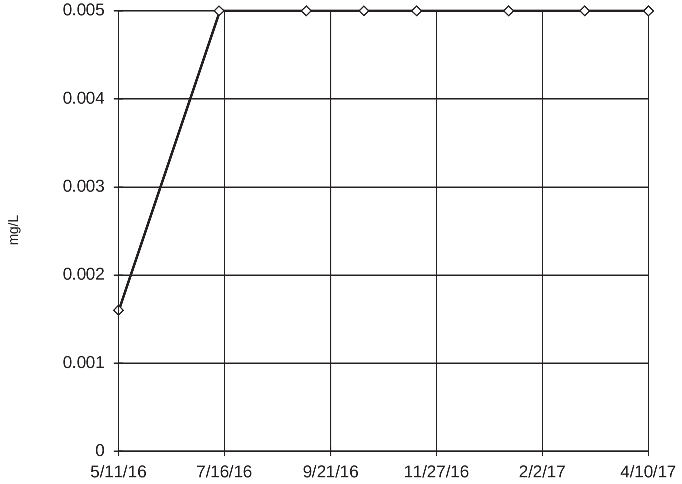
No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Antimony, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG


Tukey's Outlier Screening

AD-28

n = 8

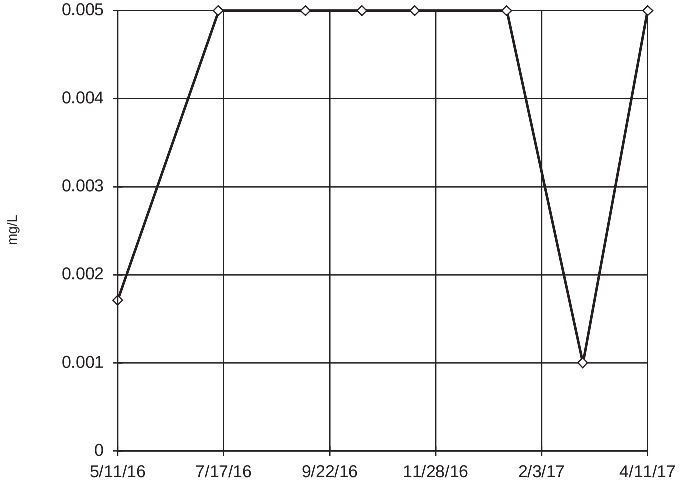
No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Antimony, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG


Tukey's Outlier Screening

AD-30

n = 8

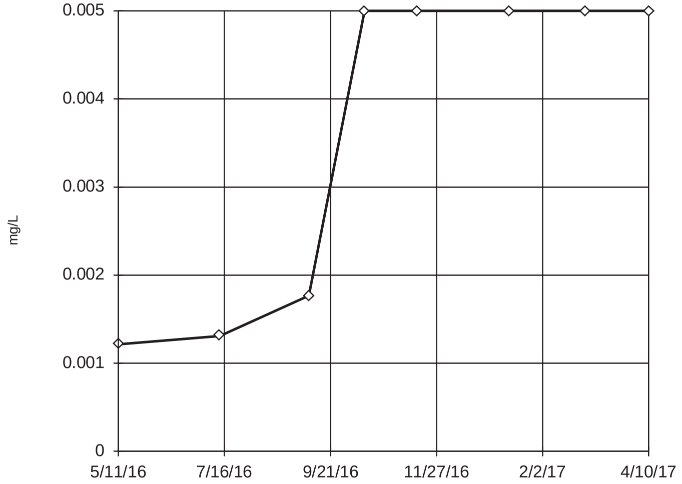
No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.02497, low cutoff = 0.0005858, based on IQR multiplier of 3.

Constituent: Antimony, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG


Tukey's Outlier Screening

AD-17

n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

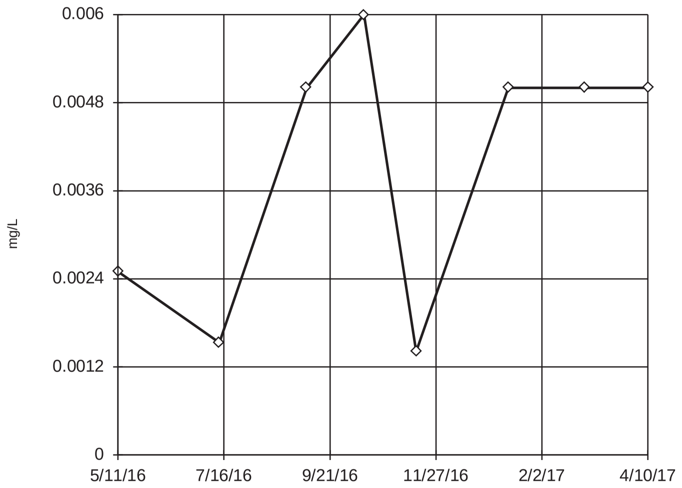
High cutoff = 0.1776, low cutoff = 0.00004283, based on IQR multiplier of 3.

Constituent: Arsenic, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.007782, low cutoff = -0.006956, based on IQR multiplier of 3.

Constituent: Arsenic, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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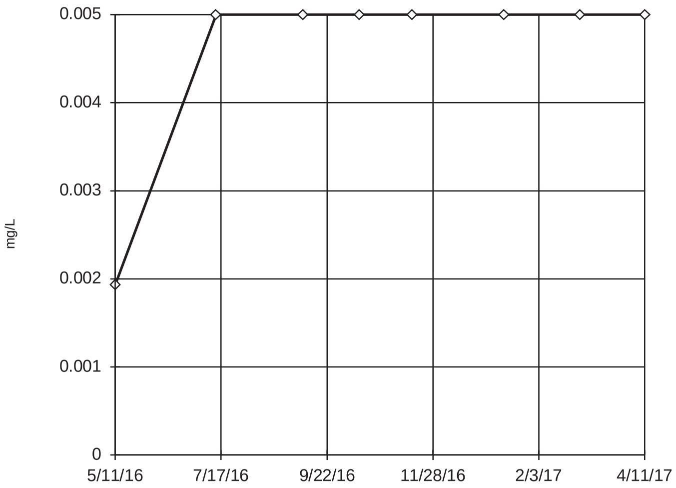
Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Arsenic, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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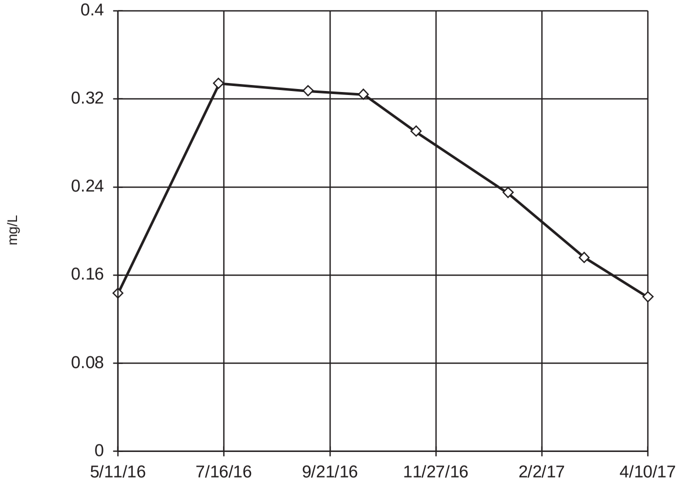
Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.5888, low cutoff = -0.4637, based on IQR multiplier of 3.

Constituent: Barium, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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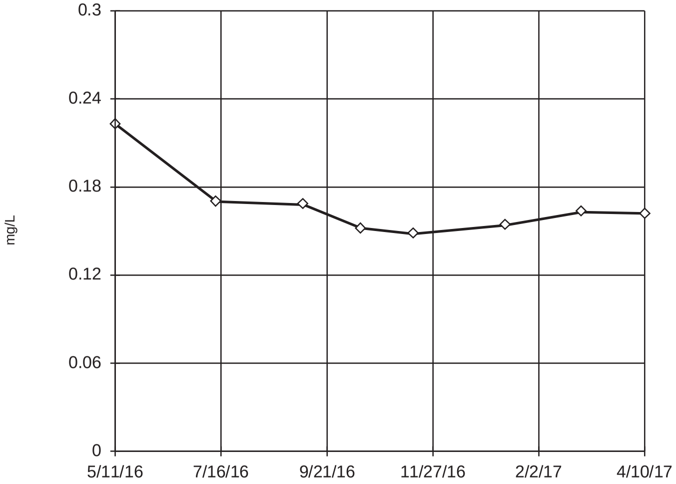
Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.2278, low cutoff = 0.1135, based on IQR multiplier of 3.

Constituent: Barium, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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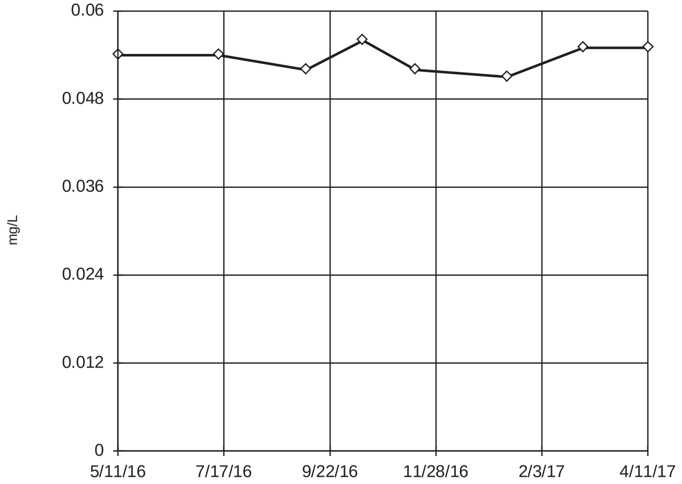
Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.06098,
low cutoff = -0.03977,
based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/6/2017 4:38 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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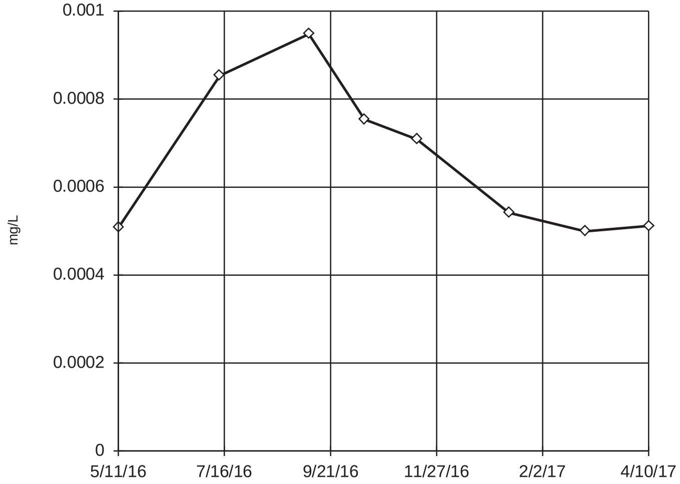
Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

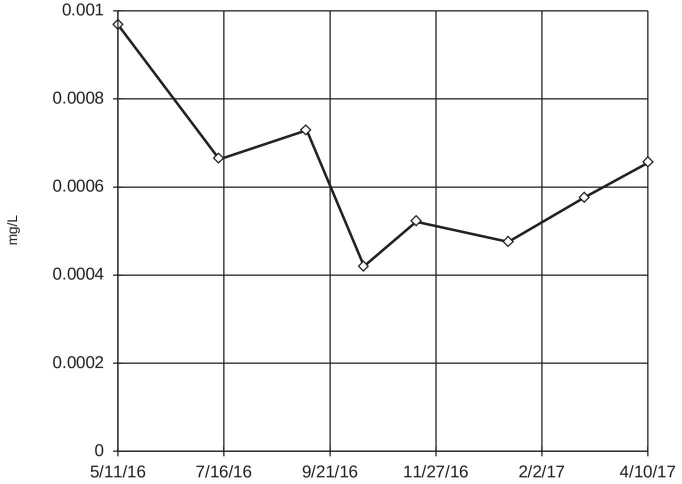
High cutoff = 0.00208,
low cutoff = 0.00002803,
based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/6/2017 4:38 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.001894,
low cutoff = 0.0001827,
based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/6/2017 4:38 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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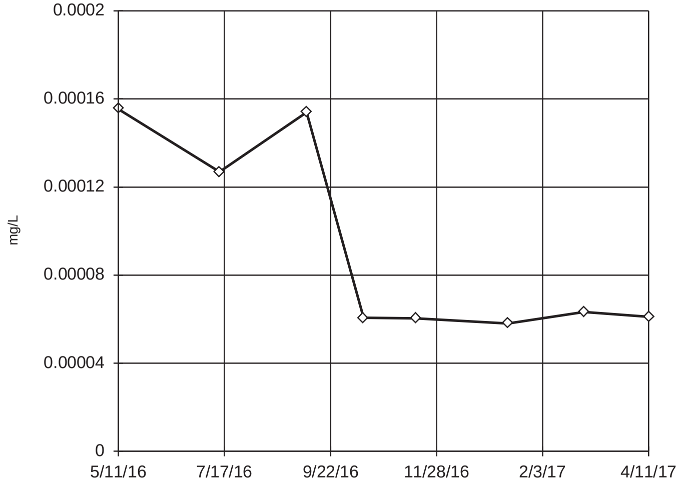
Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

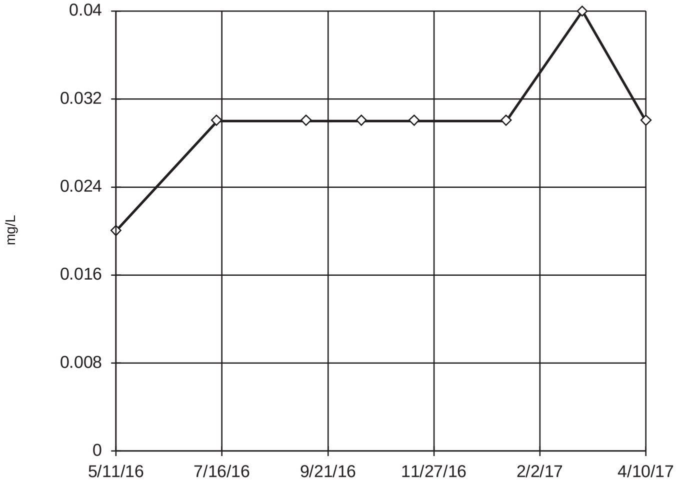
High cutoff = 0.001717,
low cutoff = 0.000004927,
based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/6/2017 4:38 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

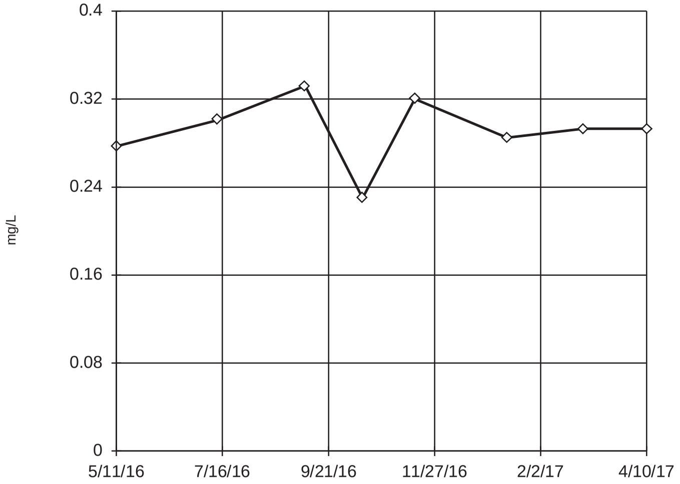
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Boron, total Analysis Run 11/6/2017 4:38 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found. Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.3696, low cutoff = -0.2354, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/6/2017 4:38 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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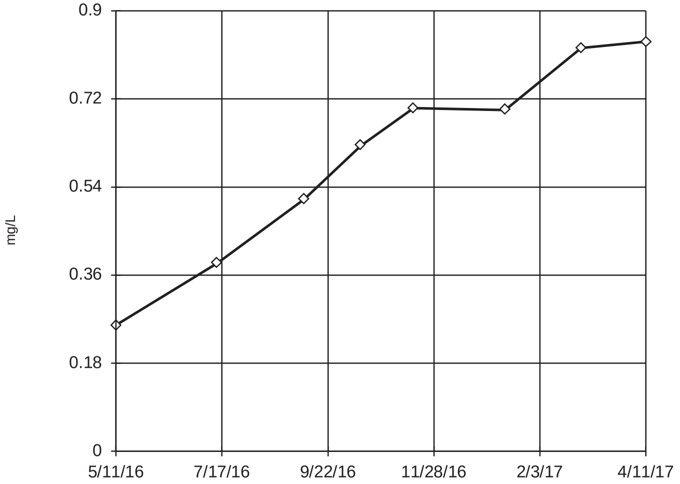
Tukey's Outlier Screening

AD-30



n = 8

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

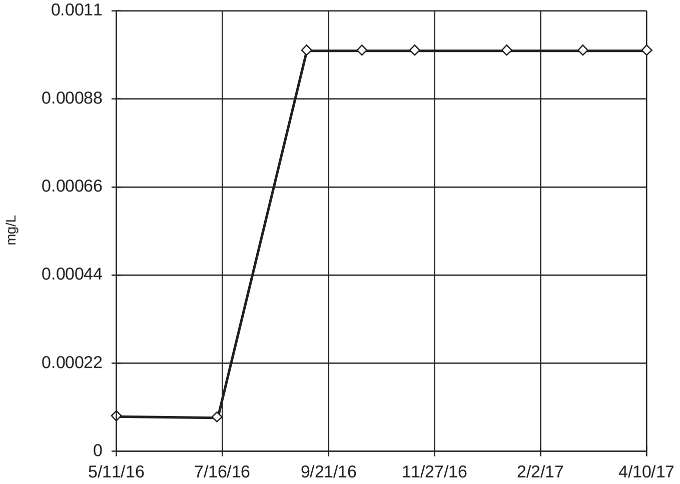
High cutoff = 1.312, low cutoff = -0.9645, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/6/2017 4:38 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

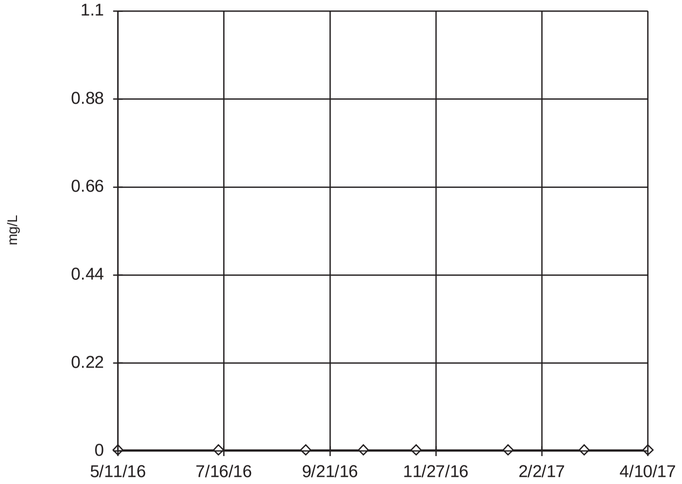
High cutoff = 0.0391, low cutoff = 0.000007534, based on IQR multiplier of 3.

Constituent: Cadmium, total Analysis Run 11/6/2017 4:38 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

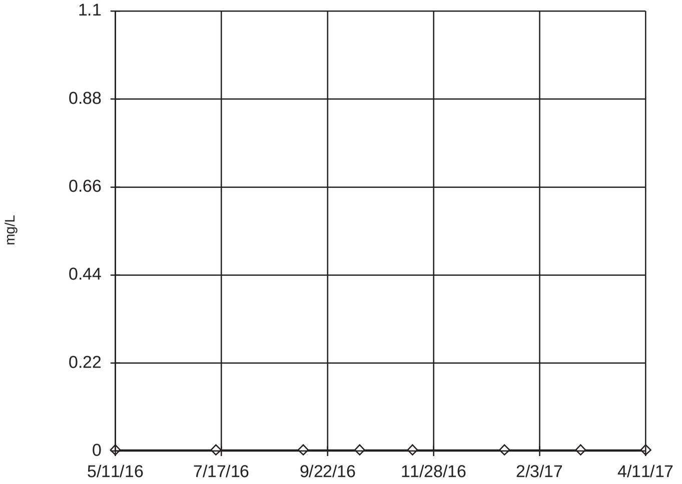
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Cadmium, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

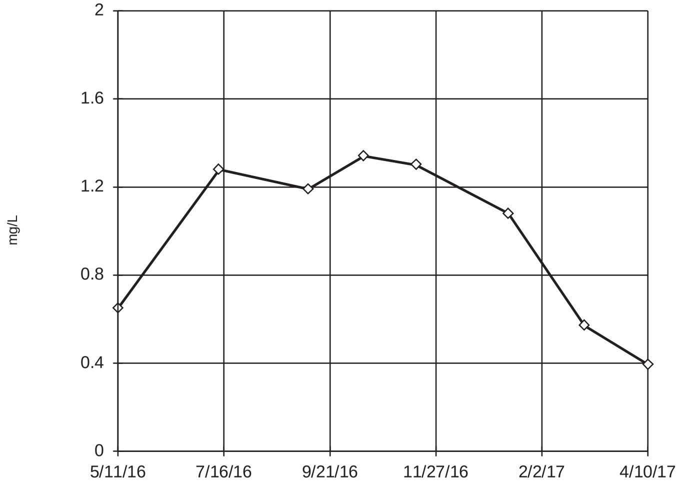
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Cadmium, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

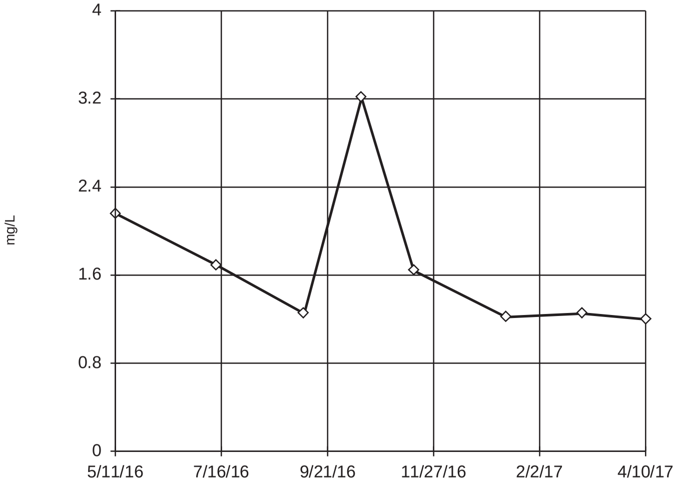
High cutoff = 1.623, low cutoff = -1.545, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

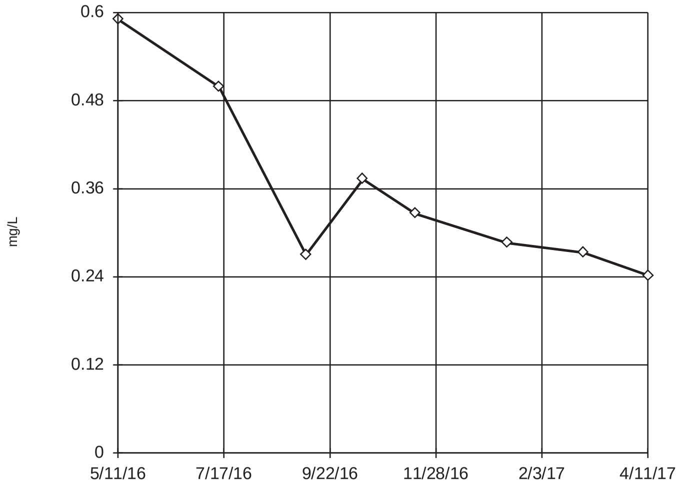
High cutoff = 7.076, low cutoff = 0.3334, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/6/2017 4:38 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

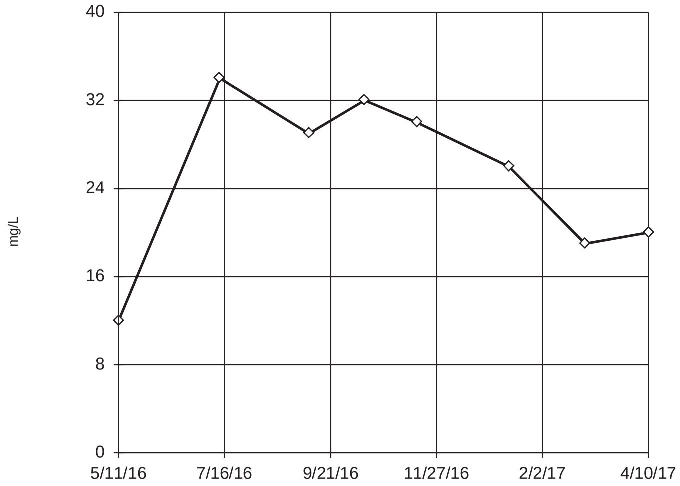
High cutoff = 1.731, low cutoff = 0.06766, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

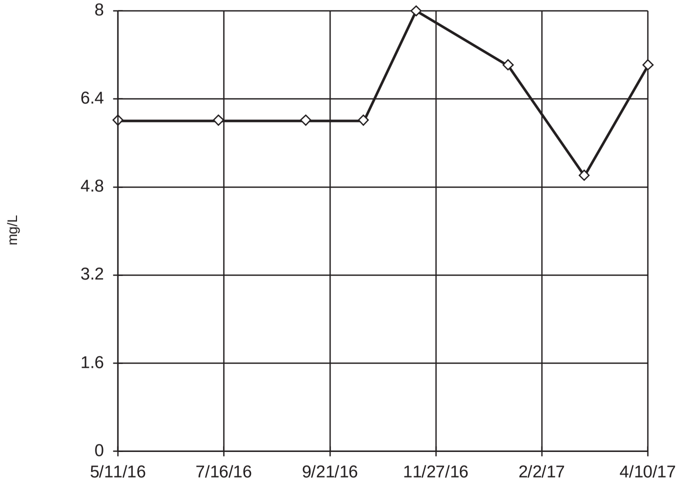
High cutoff = 52.02, low cutoff = -36.93, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

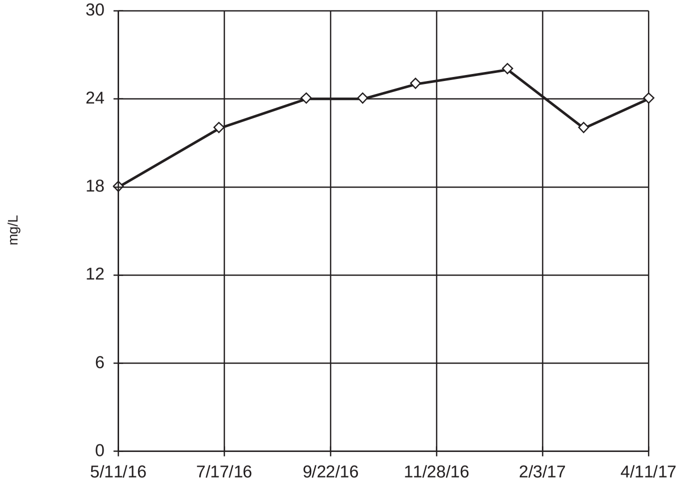
High cutoff = 11.12, low cutoff = 3.778, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

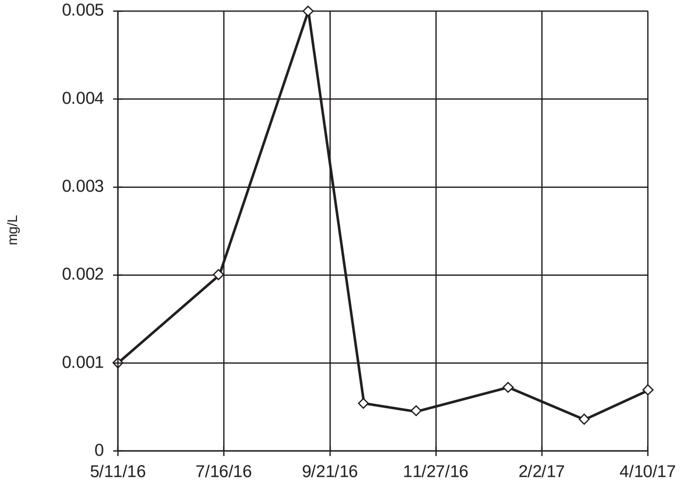
High cutoff = 28.45, low cutoff = -24.17, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

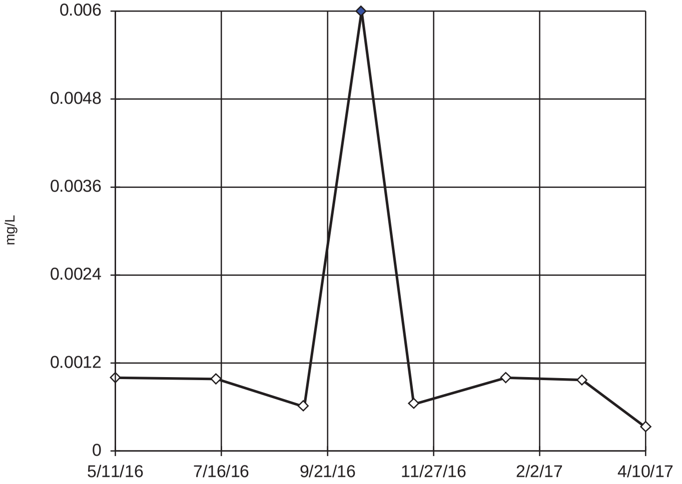
High cutoff = 0.0334, low cutoff = 0.00002087, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

Outlier is drawn as solid.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

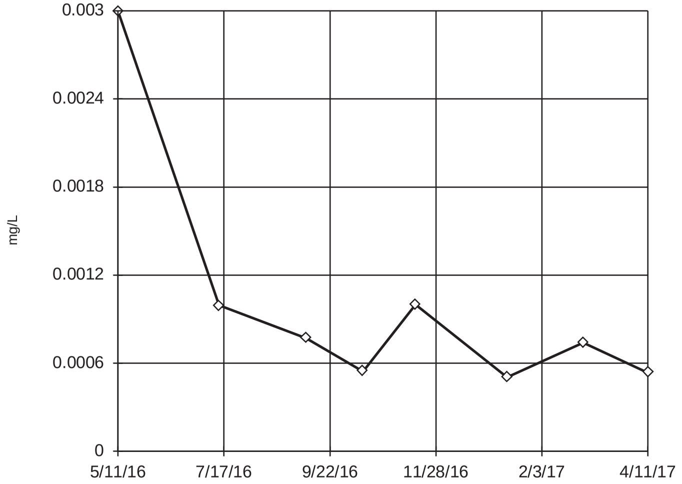
High cutoff = 0.004157, low cutoff = 0.0001496, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

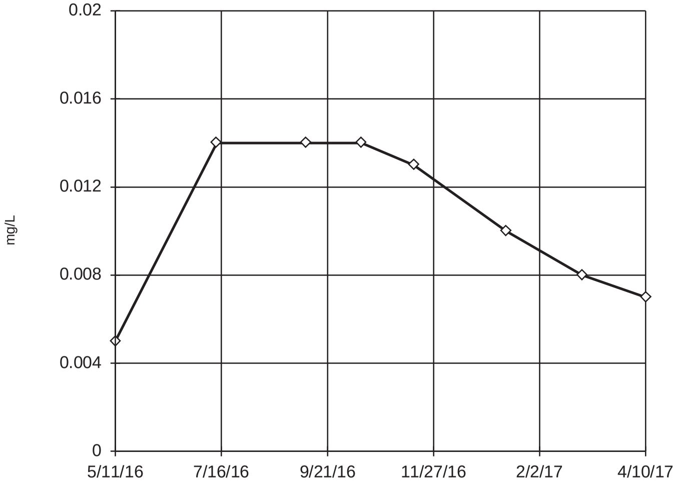
High cutoff = 0.006286, low cutoff = 0.00008562, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

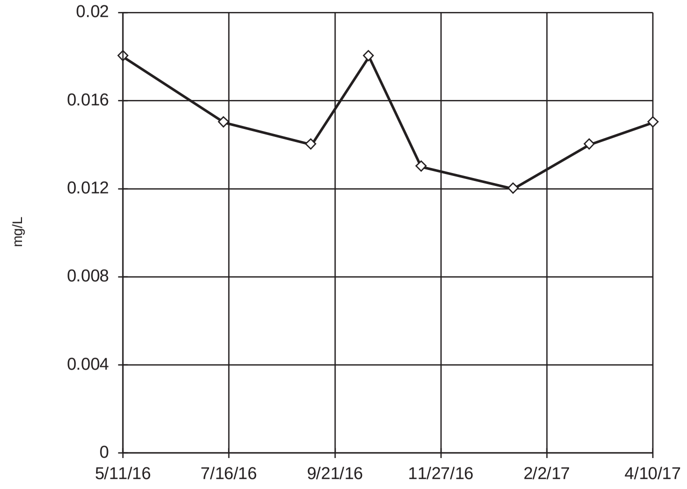
High cutoff = 0.04563, low cutoff = -0.00007652, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

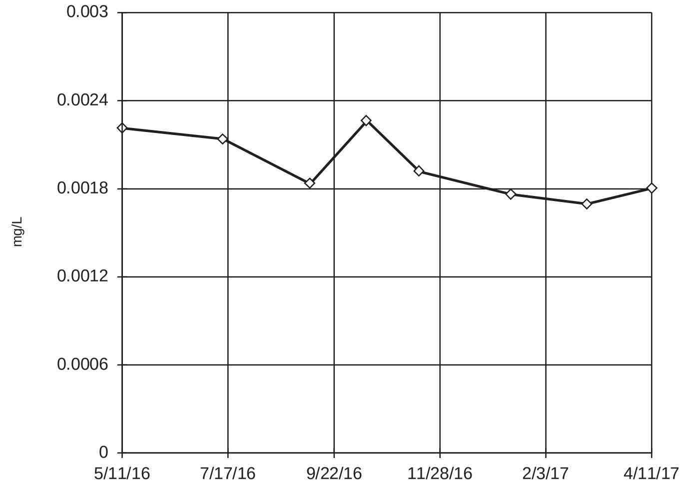
High cutoff = 0.02969, low cutoff = 0.007466, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

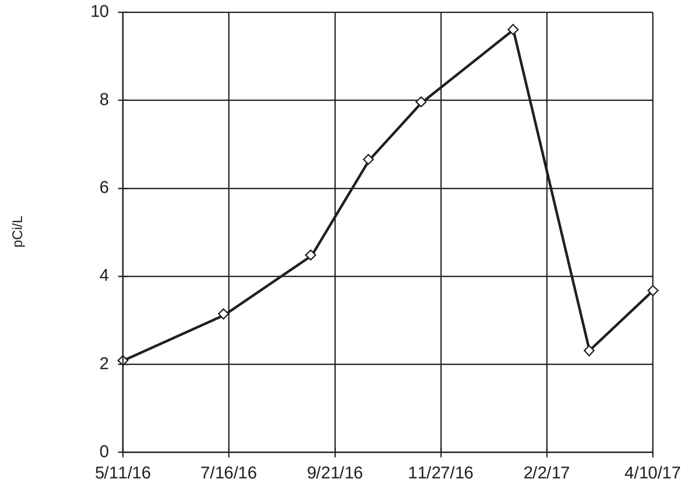
High cutoff = 0.003959, low cutoff = 0.0009797, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

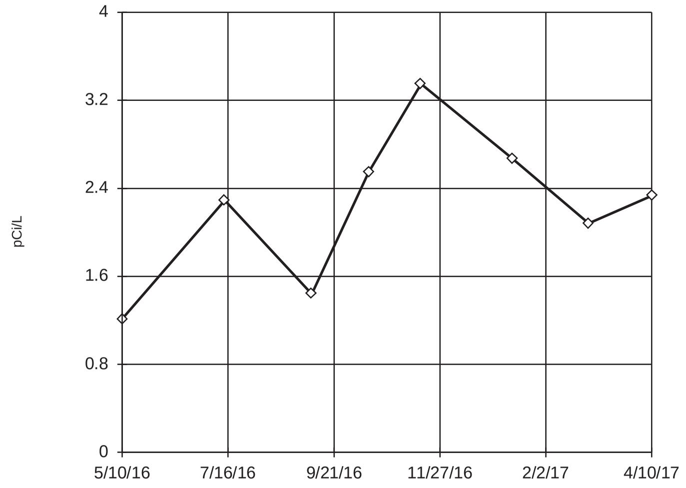
High cutoff = 143.7, low cutoff = 0.1357, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

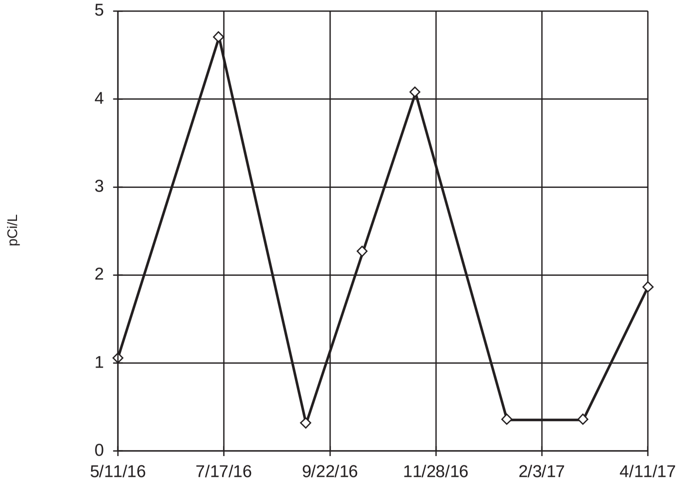
High cutoff = 5.151, low cutoff = -0.7815, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

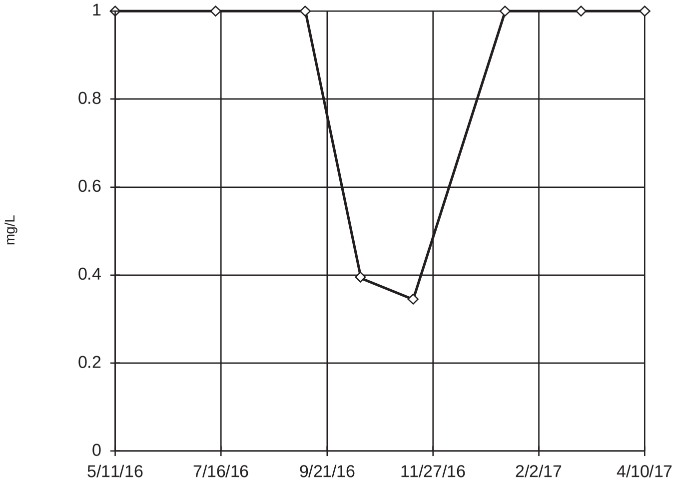
High cutoff = 50.59, low cutoff = -3.619, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

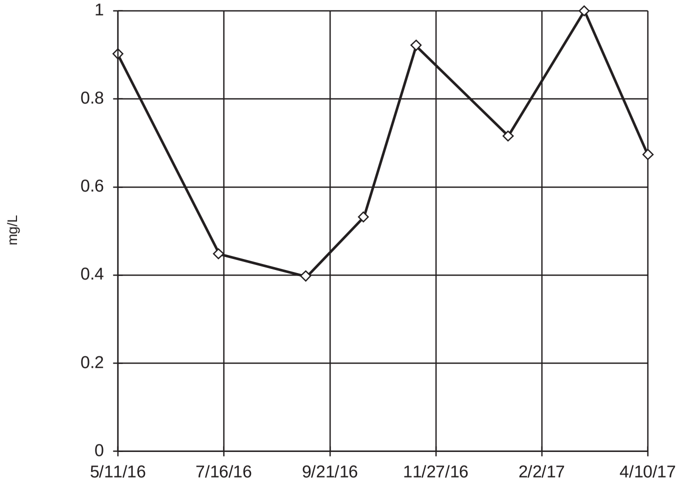
High cutoff = 4.059, low cutoff = 0.1544, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

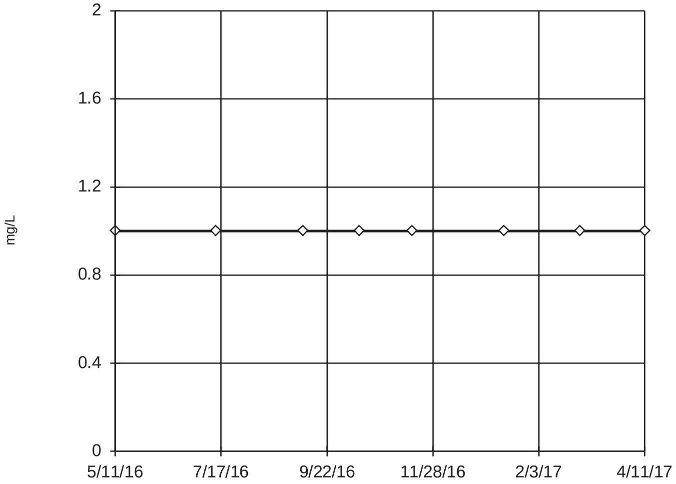
High cutoff = 2.171, low cutoff = -0.771, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

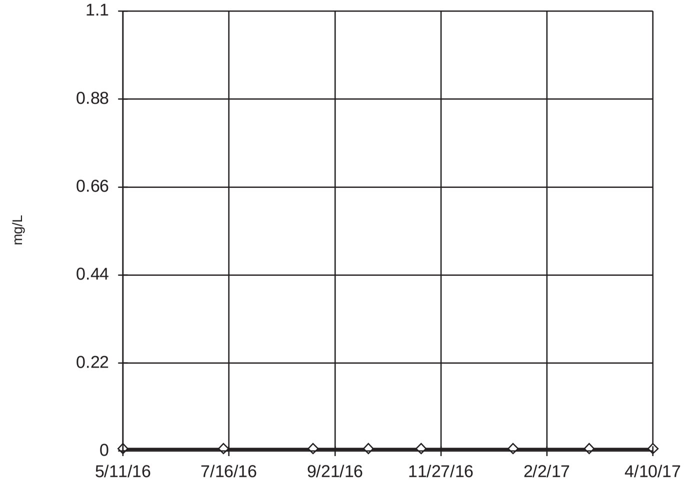
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Fluoride, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

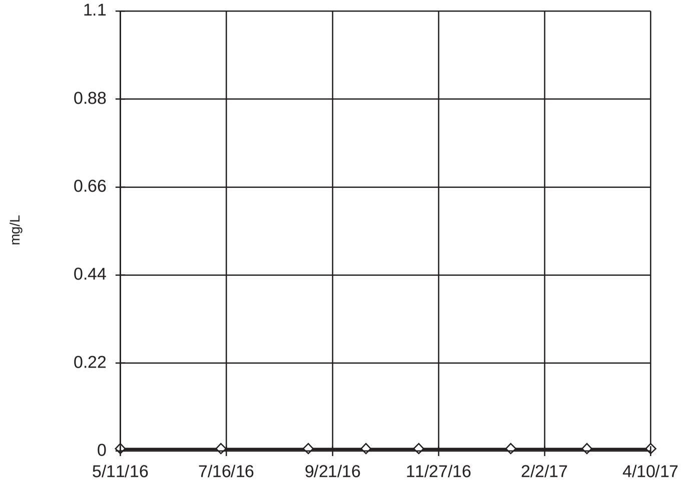
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Lead, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

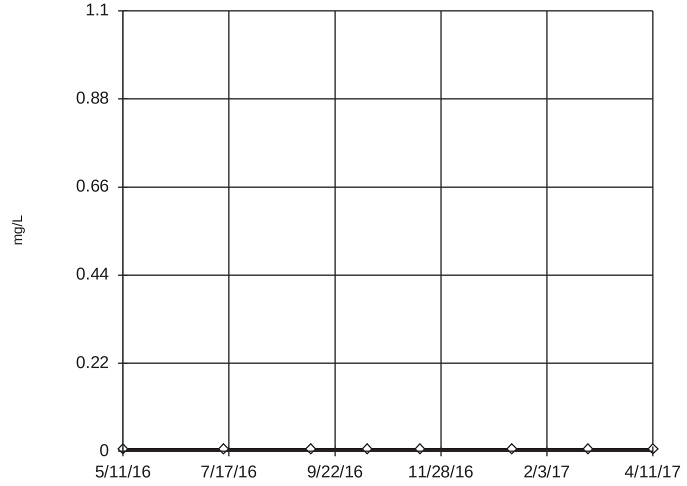
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Lead, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

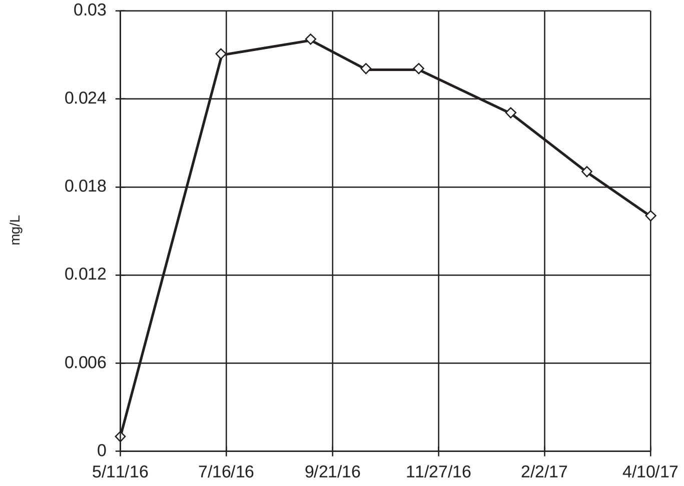
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Lead, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

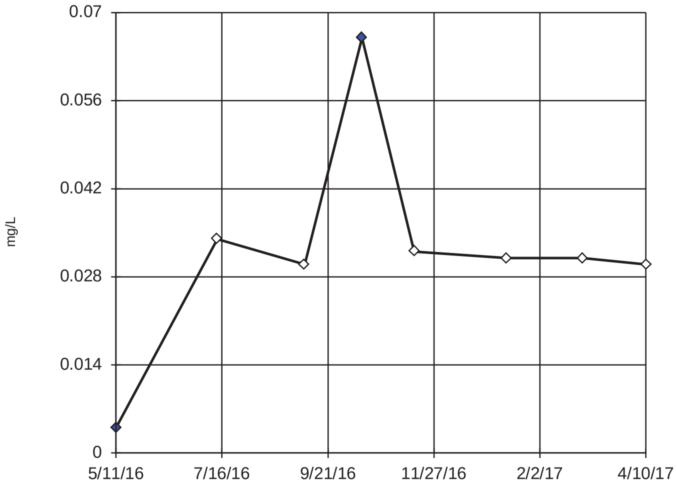
High cutoff = 0.03873, low cutoff = -0.03239, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

Outliers are drawn as solid.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

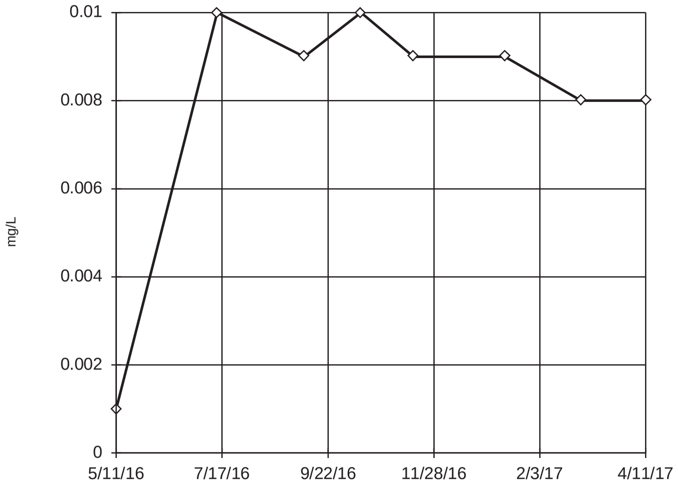
High cutoff = 0.042, low cutoff = 0.021, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method selected by user.

Data were x^5 transformed to achieve best W statistic (graph shown in original units).

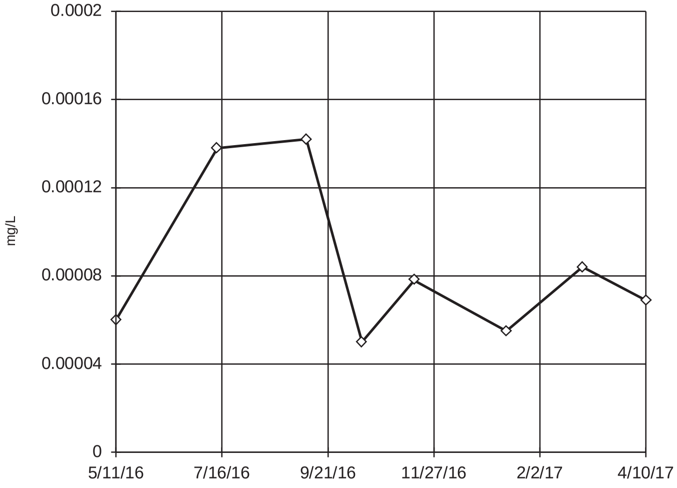
High cutoff = 0.01171, low cutoff = -0.01015, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

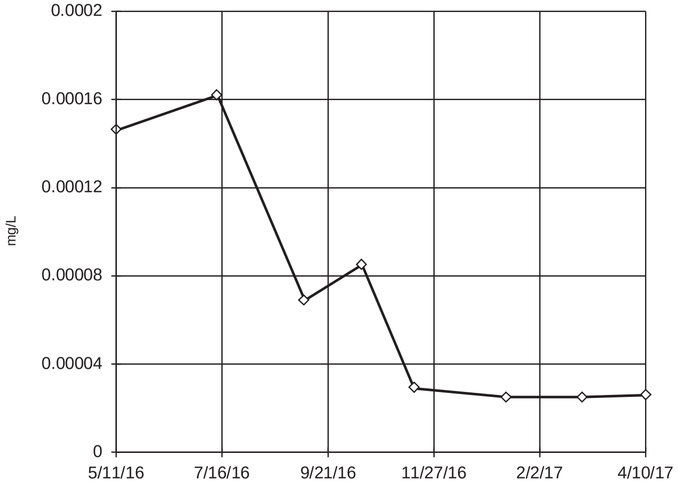
High cutoff = 0.0007088, low cutoff = 0.000008725, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

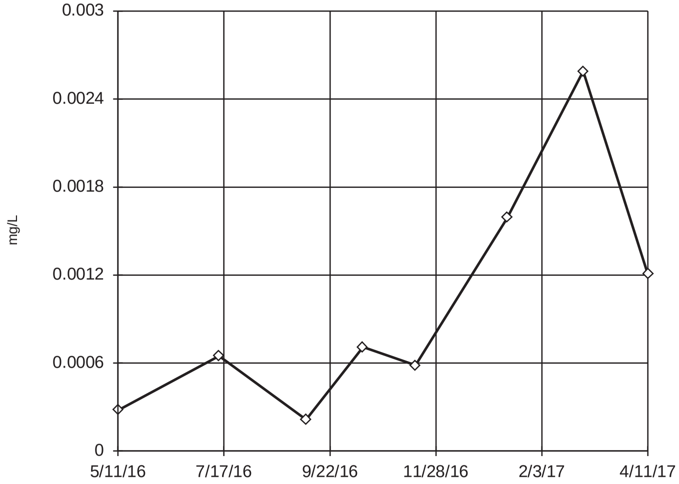
High cutoff = 0.001156, low cutoff = -0.00002014, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

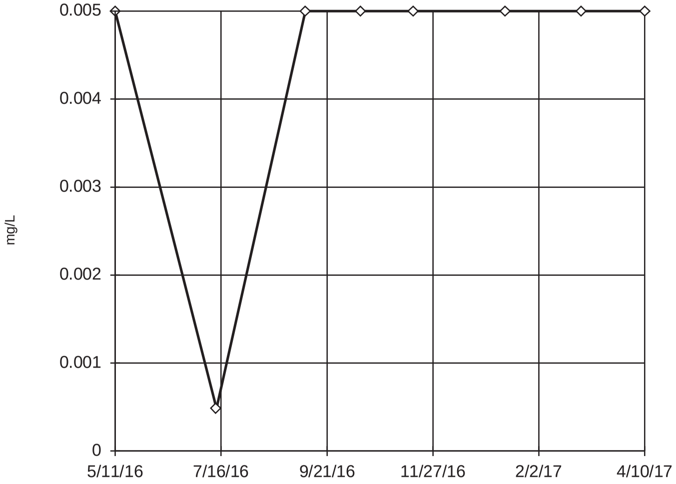
High cutoff = 0.05616, low cutoff = 0.000009933, based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were x^5 transformed to achieve best W statistic (graph shown in original units).

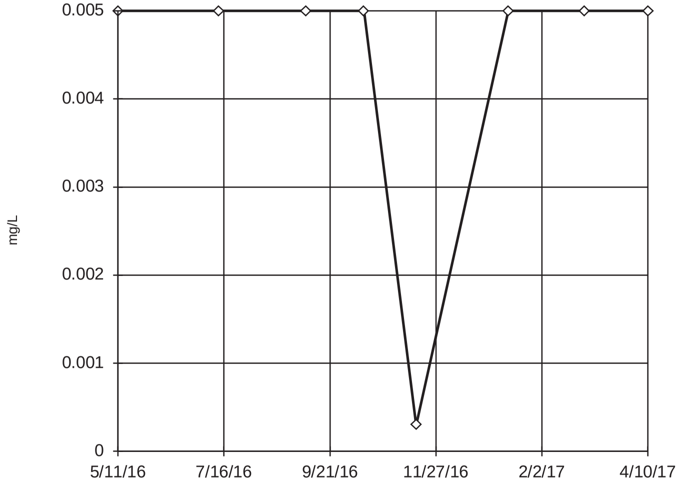
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Molybdenum, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

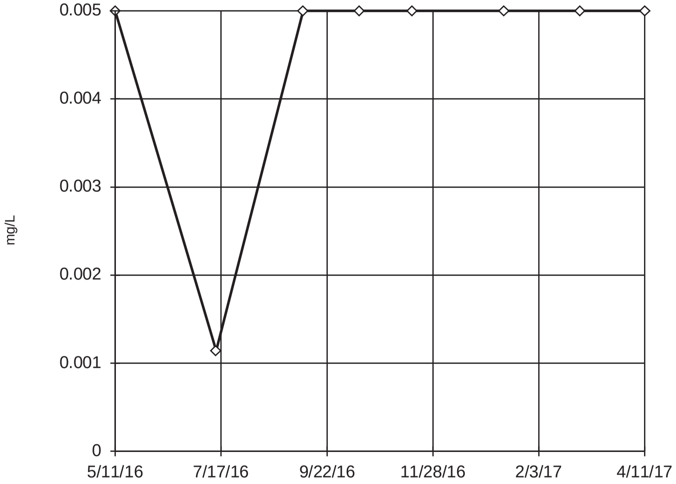
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Molybdenum, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

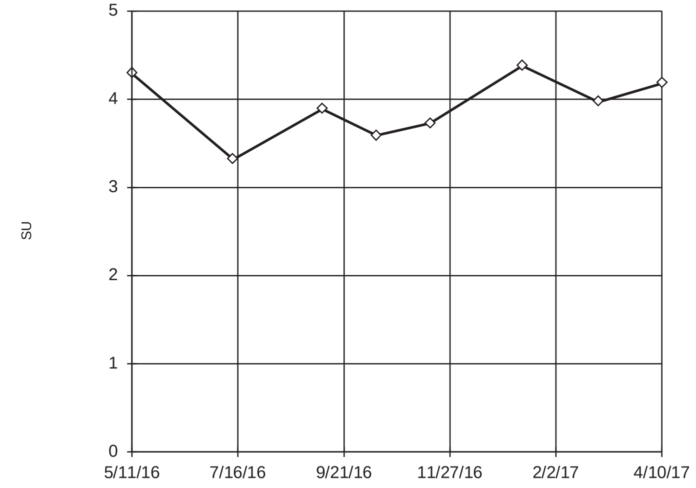
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Molybdenum, total Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

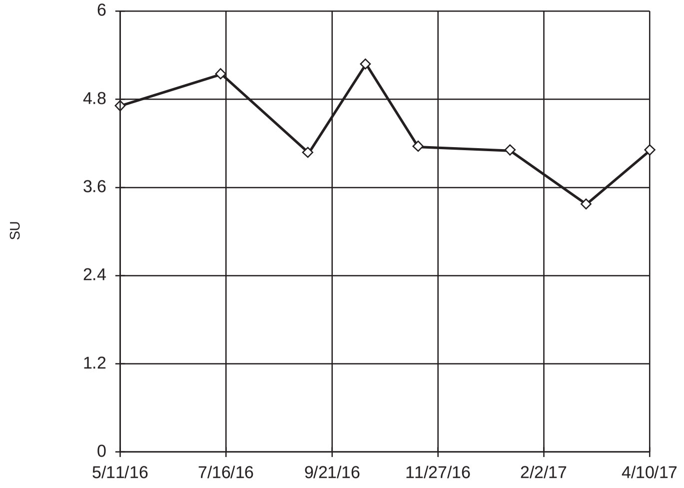
High cutoff = 5.392, low cutoff = -3.163, based on IQR multiplier of 3.

Constituent: pH, field   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

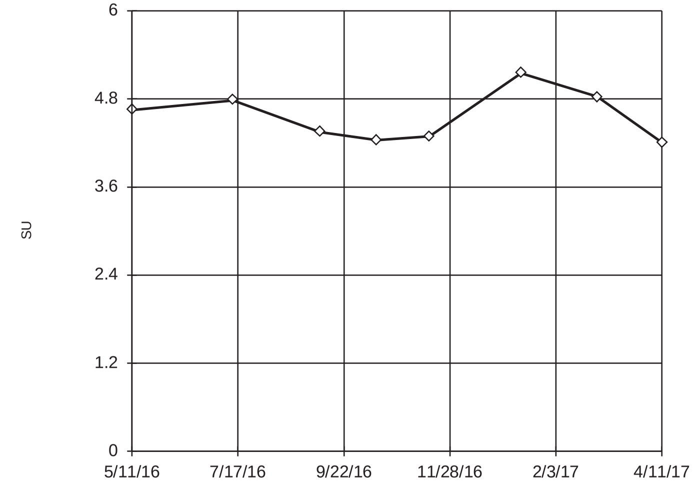
High cutoff = 8.101, low cutoff = 2.153, based on IQR multiplier of 3.

Constituent: pH, field   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

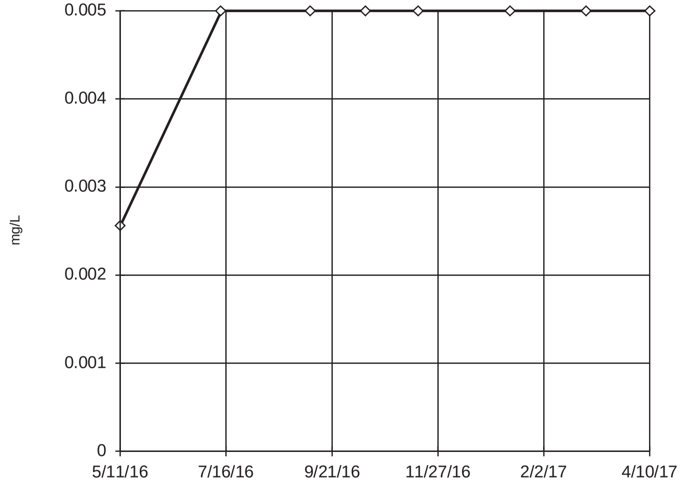
High cutoff = 6.871, low cutoff = 2.983, based on IQR multiplier of 3.

Constituent: pH, field   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

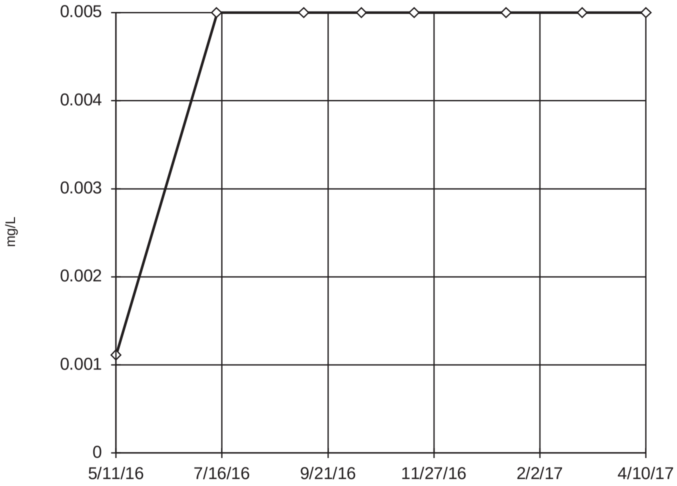
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Selenium, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

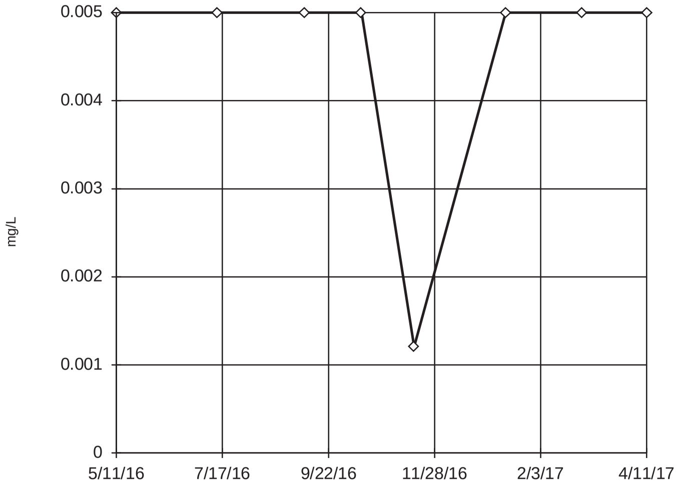
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Selenium, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

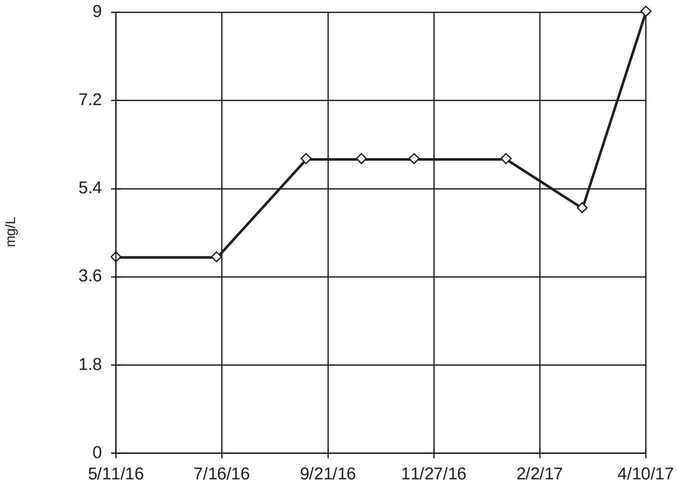
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Selenium, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

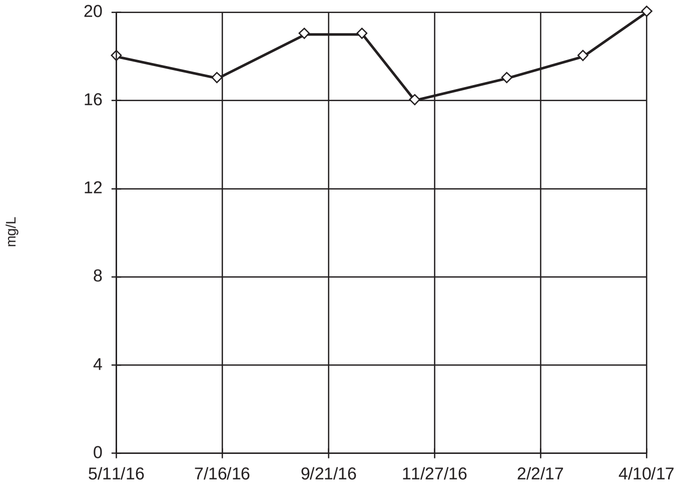
High cutoff = 14.49, low cutoff = 1.852, based on IQR multiplier of 3.

Constituent: Sulfate, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

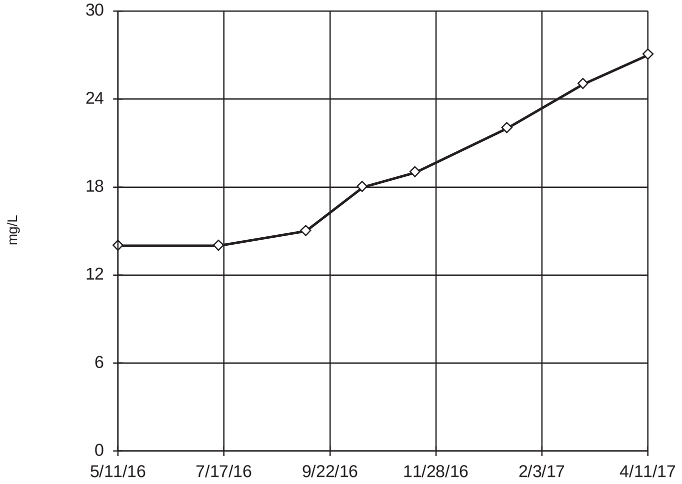
High cutoff = 25, low cutoff = 11, based on IQR multiplier of 3.

Constituent: Sulfate, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

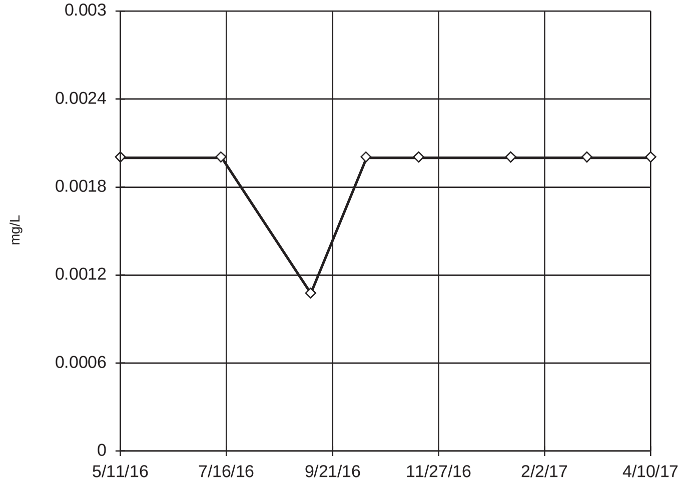
High cutoff = 99.4, low cutoff = 3.419, based on IQR multiplier of 3.

Constituent: Sulfate, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

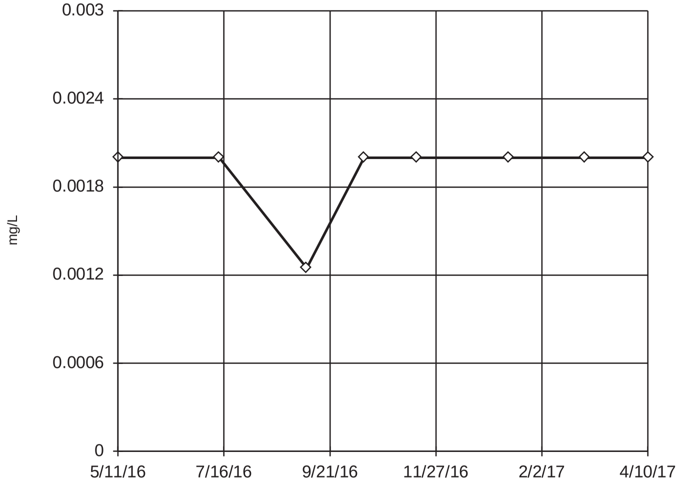
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

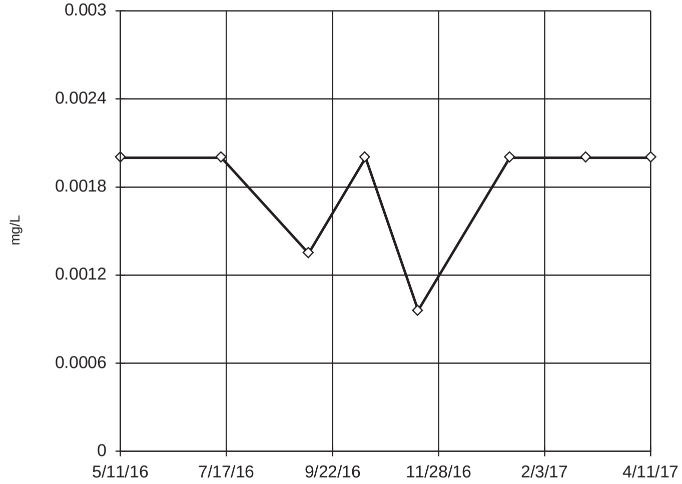
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

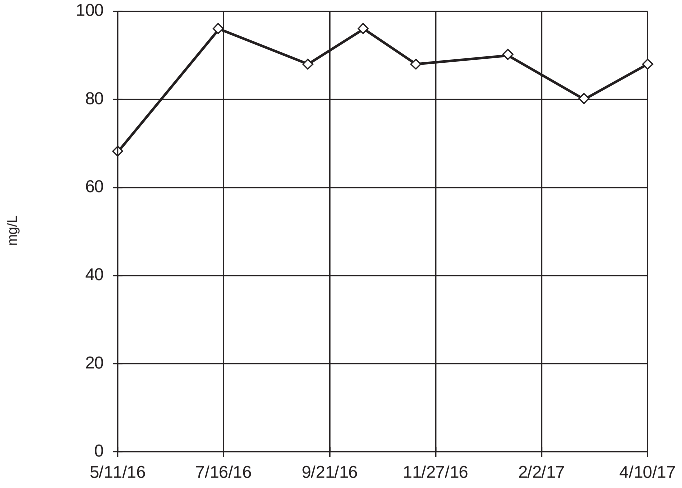
High cutoff = 0.00298, low cutoff = 0.0006939, based on IQR multiplier of 3.

Constituent: Thallium, total   Analysis Run 11/6/2017 4:39 AM   View: Tukey's
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-17



n = 8

No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

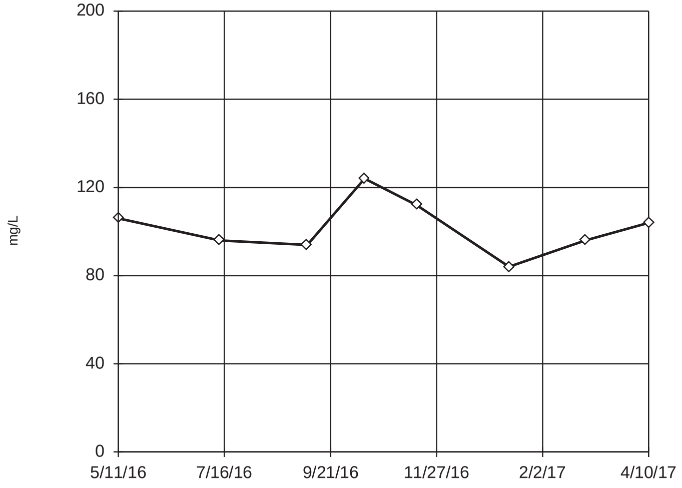
High cutoff = 107.4, low cutoff = -89.62, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-28



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

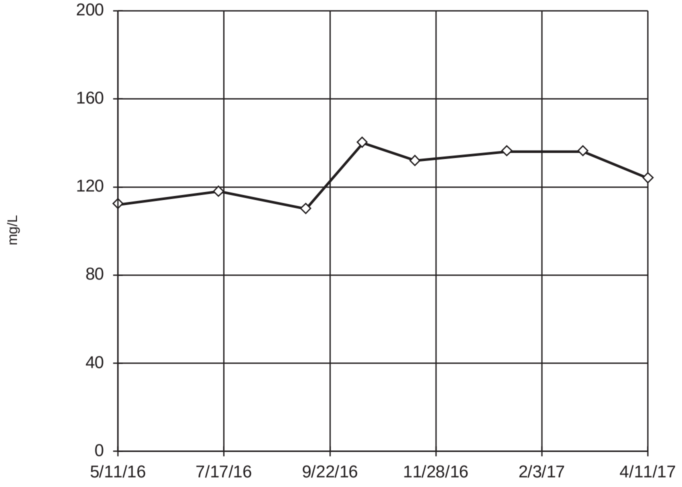
High cutoff = 164.4, low cutoff = 62.95, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-30



n = 8

No outliers found. Tukey's method selected by user.

Data were x^5 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 165.8, low cutoff = -142.4, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/6/2017 4:39 AM View: Tukey's
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Trend Tests Summary Table - Signifcant Results

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 10/28/2017, 12:35 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Beryllium, total (mg/L)	**AD-18 (bg)**	**-0.0001625**	**-22**	**-21**	**Yes**	**8**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Boron, total (mg/L)	**AD-30**	**0.6479**	**26**	**21**	**Yes**	**8**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Sulfate, total (mg/L)	**AD-30**	**17.48**	**27**	**21**	**Yes**	**8**	**0**	**n/a**	**n/a**	**0.01**	**NP**

Trend Tests Summary Table - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 10/28/2017, 12:35 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Antimony, total (mg/L)	AD-18 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-3 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-17	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-28	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-30	0	1	21	No	8	75	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-18 (bg)	0	5	21	No	8	87.5	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-3 (bg)	0	4	21	No	8	62.5	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-17	0.00442	18	21	No	8	62.5	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-28	0.001367	6	21	No	8	50	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-30	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-18 (bg)	-0.0544	-17	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-12 (bg)	-0.002403	-4	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-3 (bg)	-0.008287	-8	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-17	-0.2565	-16	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-28	-0.02268	-12	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-30	0	1	21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	**AD-18 (bg)**	**-0.0001625**	**-22**	**-21**	**Yes**	**8**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Beryllium, total (mg/L)	AD-12 (bg)	-0.00008978	-12	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-3 (bg)	-0.0001968	-14	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-17	-0.0004768	-12	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-28	-0.0003013	-8	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-30	-0.0001019	-14	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-18 (bg)	0	0	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0.01638	13	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-3 (bg)	0	4	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-17	0	11	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-28	0.005935	1	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	**AD-30**	**0.6479**	**26**	**21**	**Yes**	**8**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Cadmium, total (mg/L)	AD-18 (bg)	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-3 (bg)	0	9	21	No	8	75	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-17	0	11	21	No	8	75	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-28	0	0	21	No	8	100	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-30	0	0	21	No	8	100	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-18 (bg)	-0.2577	-8	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-12 (bg)	-0.007078	0	21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-3 (bg)	-2.133	-10	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-17	-0.5145	-10	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-28	-0.9761	-17	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-30	-0.3475	-20	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-18 (bg)	-1.818	-17	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.5448	5	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-3 (bg)	1.979	8	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-17	-15.7	-8	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-28	0	5	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-30	6.021	12	21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-18 (bg)	-0.0004344	-7	-18	No	7	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-12 (bg)	-0.0002747	-14	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-3 (bg)	-0.0004719	-7	-21	No	8	12.5	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-17	-0.0004806	-9	-18	No	7	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-28	-0.0003568	-9	-21	No	8	12.5	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-30	-0.0009388	-16	-21	No	8	12.5	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-18 (bg)	-0.00106	-14	-21	No	8	0	n/a	n/a	0.01	NP

Trend Tests Summary Table - All Results

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 10/28/2017, 12:35 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Cobalt, total (mg/L)	AD-12 (bg)	-0.0003758	-10	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-3 (bg)	-0.004997	-9	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-17	-0.009294	-11	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-28	-0.005128	-9	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-30	-0.0005358	-16	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-18 (bg)	-0.9109	-10	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-12 (bg)	-0.4211	-2	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-3 (bg)	-0.3567	-4	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-17	8.156	10	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-28	1.054	10	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-30	-0.8511	-4	-21	No	8	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-18 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-12 (bg)	0	-6	-18	No	7	85.71	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-3 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-17	0	-1	-21	No	8	75	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-28	0.2963	8	21	No	8	12.5	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-30	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-18 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-3 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-17	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-28	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-30	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-18 (bg)	0.0025	3	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-12 (bg)	0.002799	4	21	No	8	12.5	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-3 (bg)	-0.03209	-6	-18	No	7	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-17	-0.01236	-11	-21	No	8	12.5	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-28	0	-1	-18	No	7	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-30	-0.001848	-7	-21	No	8	12.5	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-18 (bg)	-0.000009298	-11	-18	No	7	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-12 (bg)	0	-7	-21	No	8	87.5	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-3 (bg)	0	4	21	No	8	37.5	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-17	-0.00001496	-2	-21	No	8	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-28	-0.0001469	-19	-21	No	8	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-30	0.001781	16	21	No	8	0	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-18 (bg)	0	5	21	No	8	87.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-3 (bg)	0	13	21	No	8	75	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-17	0	5	21	No	8	87.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-28	0	-1	-21	No	8	87.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-30	0	5	21	No	8	87.5	n/a	n/a	0.01	NP
pH, field (SU)	AD-18 (bg)	-0.525	-9	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-12 (bg)	0.5797	4	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-3 (bg)	0.1741	2	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-17	0.9086	8	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-28	-1.247	-11	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-30	-0.2176	-4	-21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-18 (bg)	0	13	21	No	8	75	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-12 (bg)	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-3 (bg)	0	2	21	No	8	50	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-17	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-28	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-30	0	-1	-21	No	8	87.5	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-18 (bg)	0	6	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	1.233	5	21	No	8	0	n/a	n/a	0.01	NP

Trend Tests Summary Table - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 10/28/2017, 12:35 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Sulfate, total (mg/L)	AD-3 (bg)	-9.195	-8	-21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-17	3.425	13	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-28	1.642	5	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	**AD-30**	**17.48**	**27**	**21**	**Yes**	**8**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Thallium, total (mg/L)	AD-18 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-12 (bg)	0	-5	-21	No	8	87.5	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-3 (bg)	0	-5	-21	No	8	87.5	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-17	0	3	21	No	8	87.5	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-28	0	3	21	No	8	87.5	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-30	0	1	21	No	8	75	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-18 (bg)	-2.098	-1	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-25.99	-12	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-3 (bg)	-11.71	-2	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-17	0	-2	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-28	-7.3	-3	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-30	24.41	9	21	No	8	0	n/a	n/a	0.01	NP

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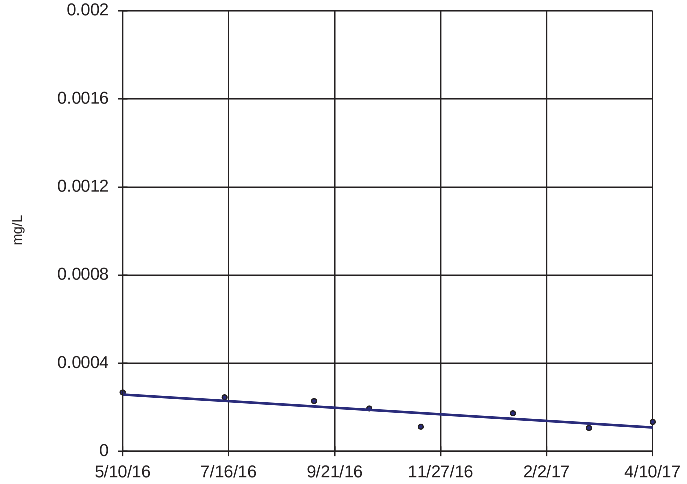
Sen's Slope Estimator

AD-18 (bg)



n = 8

Slope = -0.0001625 units per year.

Mann-Kendall statistic = -22 critical = -21

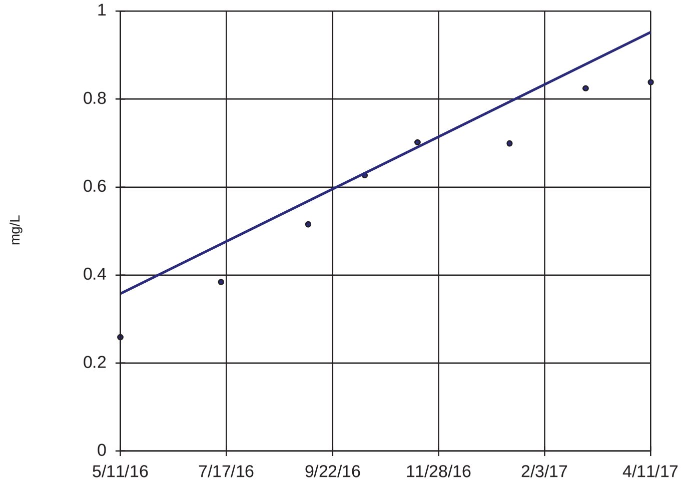
Decreasing trend significant at 99% confidence level (= 0.005 per tail).

Constituent: Beryllium, total   Analysis Run 10/28/2017 12:32 PM   View: Trends
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-30



n = 8

Slope = 0.6479 units per year.

Mann-Kendall statistic = 26 critical = 21

Increasing trend significant at 99% confidence level (= 0.005 per tail).

Constituent: Boron, total   Analysis Run 10/28/2017 12:33 PM   View: Trends
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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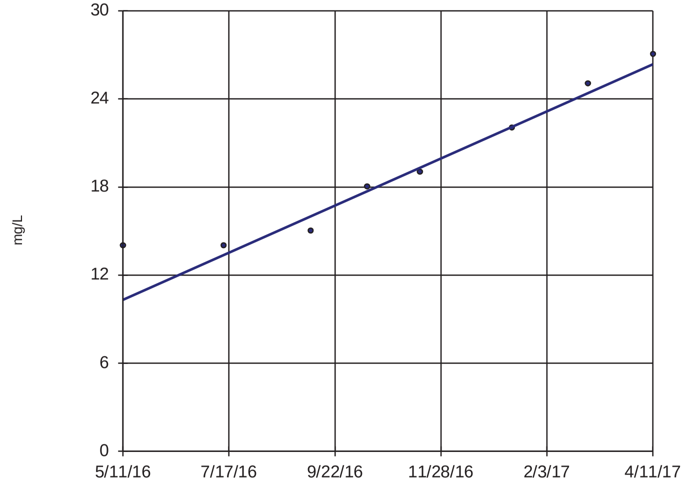
Sen's Slope Estimator

AD-30



n = 8

Slope = 17.48 units per year.

Mann-Kendall statistic = 27 critical = 21

Increasing trend significant at 99% confidence level (= 0.005 per tail).

Constituent: Sulfate, total   Analysis Run 10/28/2017 12:33 PM   View: Trends
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Analysis of Variance

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 1/15/2018, 7:00 PM

Constituent	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Calc.	Alpha	Method
Boron, total (mg/L)	n/a	n/a	n/a	No	Yes	67	0.05	Param.
Calcium, total (mg/L)	n/a	n/a	n/a	ln(x)	Yes	199.9	0.05	Param.
Chloride, total (mg/L)	n/a	n/a	n/a	No	No	1.685	0.05	Param.
Fluoride, total (mg/L)	n/a	n/a	n/a	No	No	2	0.05	NP (NDs)
pH, field (SU)	n/a	n/a	n/a	x^3	Yes	12.51	0.05	Param.
Sulfate, total (mg/L)	n/a	n/a	n/a	No	Yes	18.36	0.05	NP (eq. var.)
Total Dissolved Solids [TDS] (mg/L)	n/a	n/a	n/a	No	Yes	55.48	0.05	Param.

Parametric ANOVA

Constituent: Boron, total Analysis Run 1/15/2018 6:59 PM View: ANOVA
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 67

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.007258	2	0.003629	67
Error Within Groups	0.001138	21	0.00005417	
Total	0.008396	23		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.935, critical = 0.916. Levene's Equality of Variance test passed. Calculated = 2.333, tabulated = 3.47.

Parametric ANOVA

Constituent: Calcium, total   Analysis Run 1/15/2018 6:59 PM   View: ANOVA
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 199.9

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	28.89	2	14.44	199.9
Error Within Groups	1.517	21	0.07225	
Total	30.41	23		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.05, calculated = 0.959, critical = 0.916. Levene's Equality of Variance test passed. Calculated = 2.24, tabulated = 3.47.

Parametric ANOVA

Constituent: Chloride, total   Analysis Run 1/15/2018 6:59 PM   View: ANOVA
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test indicates NO VARIATION at the 5% significance level. Because the calculated F statistic is less than or equal to the tabulated F statistic, the hypothesis of a single homogeneous population is accepted.

Calculated F statistic = 1.685

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	4.333	2	2.167	1.685
Error Within Groups	27	21	1.286	
Total	31.33	23		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9353, critical = 0.916. Levene's Equality of Variance test passed. Calculated = 0.7235, tabulated = 3.47.

Non-Parametric ANOVA

Constituent: Fluoride, total Analysis Run 1/15/2018 6:59 PM View: ANOVA
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

For observations made between 5/10/2016 and 4/11/2017, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 2

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 0.24
Adjusted Kruskal-Wallis statistic (H') = 2

Parametric ANOVA

Constituent: pH, field   Analysis Run 1/15/2018 7:00 PM   View: ANOVA
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test (after cube transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 12.51

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	17643	2	8822	12.51
Error Within Groups	14803	21	704.9	
Total	32446	23		

The Shapiro Wilk normality test on the residuals passed after cube transformation. Alpha = 0.05, calculated = 0.974, critical = 0.916. Levene's Equality of Variance test passed. Calculated = 3.442, tabulated = 3.47.

Non-Parametric ANOVA

Constituent: Sulfate, total   Analysis Run 1/15/2018 7:00 PM   View: ANOVA
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

For observations made between 5/10/2016 and 4/11/2017, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 18.36

Tabulated Chi-Squared value = 5.991 with 2 degrees of freedom at the 5% significance level.

There were 5 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 18.01
Adjusted Kruskal-Wallis statistic (H') = 18.36

Parametric ANOVA

Constituent: Total Dissolved Solids [TDS] Analysis Run 1/15/2018 7:00 PM View: ANOVA
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

For observations made between 5/10/2016 and 4/11/2017 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 55.48

Tabulated F statistic = 3.47 with 2 and 21 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	22132	2	11066	55.48
Error Within Groups	4189	21	199.5	
Total	26321	23		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9541, critical = 0.916. Levene's Equality of Variance test passed. Calculated = 0.5685, tabulated = 3.47.

Tolerance Limits - Appendix III

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 11/6/2017, 4:55 AM

Constituent	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	0.08546	n/a	24	0.03458	0.01911	0	None	No	0.01	Inter
Calcium, total (mg/L)	4.93	n/a	24	n/a	n/a	0	n/a	n/a	0.292	NP Inter(normality)
Chloride, total (mg/L)	9.942	n/a	24	6.833	1.167	0	None	No	0.01	Inter
Fluoride, total (mg/L)	1	n/a	23	n/a	n/a	95.65	n/a	n/a	0.3074	NP Inter(NDs)
pH, field (SU)	6.532	2.291	24	4.411	0.7059	0	None	No	0.01	Inter
Sulfate, total (mg/L)	31	n/a	24	n/a	n/a	0	n/a	n/a	0.292	NP Inter(normality)
Total Dissolved Solids [TDS] (mg/L)	203.8	n/a	24	113.7	33.83	0	None	No	0.01	Inter

Confidence Interval Summary Table - Significant Results Appendix III

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 11/6/2017, 4:58 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-28**	**0.3239**	**0.2589**	**0.085**	**Yes**	**8**	**0.2914**	**0.03066**	**0**	**None**	**No**	**0.01**	**Param.**
Boron, total (mg/L)	**AD-30**	**0.8235**	**0.3867**	**0.085**	**Yes**	**8**	**0.6051**	**0.2061**	**0**	**None**	**No**	**0.01**	**Param.**
Chloride, total (mg/L)	**AD-17**	**33.28**	**17.22**	**9.94**	**Yes**	**8**	**25.25**	**7.573**	**0**	**None**	**No**	**0.01**	**Param.**
Chloride, total (mg/L)	**AD-30**	**25.75**	**20.5**	**9.94**	**Yes**	**8**	**23.13**	**2.475**	**0**	**None**	**No**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results Appendix III

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 11/6/2017, 4:58 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-17	0.04	0.02	0.085	No	8	0.03	0.005345	0	None	No	0.004	NP (normality)
Boron, total (mg/L)	**AD-28**	**0.3239**	**0.2589**	**0.085**	**Yes**	**8**	**0.2914**	**0.03066**	**0**	**None**	**No**	**0.01**	**Param.**
Boron, total (mg/L)	**AD-30**	**0.8235**	**0.3867**	**0.085**	**Yes**	**8**	**0.6051**	**0.2061**	**0**	**None**	**No**	**0.01**	**Param.**
Calcium, total (mg/L)	AD-17	1.338	0.6016	4.93	No	8	0.9754	0.3773	0	None	x^2	0.01	Param.
Calcium, total (mg/L)	AD-28	3.21	1.2	4.93	No	8	1.703	0.695	0	None	No	0.004	NP (normality)
Calcium, total (mg/L)	AD-30	0.4838	0.2361	4.93	No	8	0.3575	0.1248	0	None	sqrt(x)	0.01	Param.
Chloride, total (mg/L)	**AD-17**	**33.28**	**17.22**	**9.94**	**Yes**	**8**	**25.25**	**7.573**	**0**	**None**	**No**	**0.01**	**Param.**
Chloride, total (mg/L)	AD-28	7.346	5.404	9.94	No	8	6.375	0.9161	0	None	No	0.01	Param.
Chloride, total (mg/L)	**AD-30**	**25.75**	**20.5**	**9.94**	**Yes**	**8**	**23.13**	**2.475**	**0**	**None**	**No**	**0.01**	**Param.**
Fluoride, total (mg/L)	AD-17	1	0.3446	1	No	8	0.8422	0.2925	75	None	No	0.004	NP (normality)
Fluoride, total (mg/L)	AD-28	0.9397	0.4567	1	No	8	0.6982	0.2278	12.5	None	No	0.01	Param.
Fluoride, total (mg/L)	AD-30	1	1	1	No	8	1	0	100	None	No	0.004	NP (NDs)
pH, field (SU)	AD-17	4.368	3.469	6.53	No	8	3.919	0.3634	0	None	No	0.005	Param.
pH, field (SU)	AD-28	5.15	3.58	6.53	No	8	4.365	0.6348	0	None	No	0.005	Param.
pH, field (SU)	AD-30	4.986	4.139	6.53	No	8	4.563	0.3421	0	None	No	0.005	Param.
Sulfate, total (mg/L)	AD-17	7.385	4.165	31	No	8	5.75	1.581	0	None	sqrt(x)	0.01	Param.
Sulfate, total (mg/L)	AD-28	19.39	16.61	31	No	8	18	1.309	0	None	No	0.01	Param.
Sulfate, total (mg/L)	AD-30	24.56	13.94	31	No	8	19.25	5.007	0	None	No	0.01	Param.
Total Dissolved Solids [TDS] (mg/L)	AD-17	96.43	77.07	203.8	No	8	86.75	9.13	0	None	No	0.01	Param.
Total Dissolved Solids [TDS] (mg/L)	AD-28	115.1	88.93	203.8	No	8	102	12.33	0	None	No	0.01	Param.
Total Dissolved Solids [TDS] (mg/L)	AD-30	138.4	113.6	203.8	No	8	126	11.66	0	None	No	0.01	Param.

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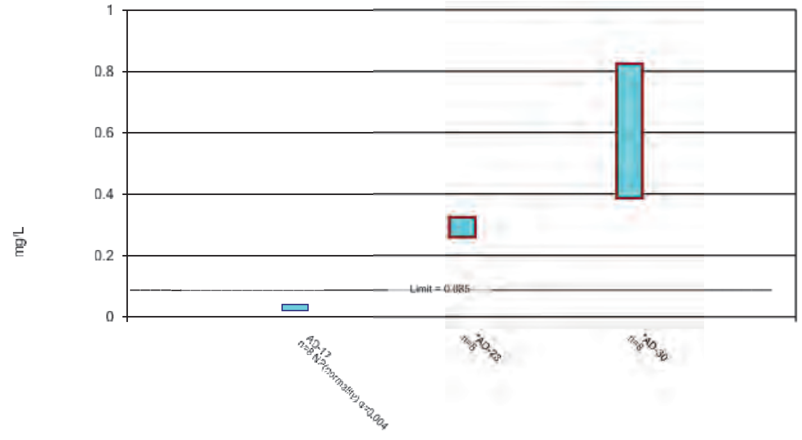
Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Boron, total Analysis Run 11/6/2017 4:57 AM View: Confidence Intervals
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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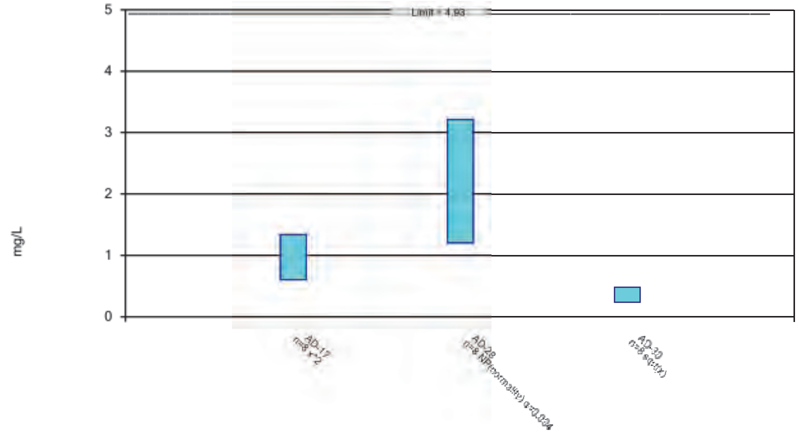
Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Calcium, total Analysis Run 11/6/2017 4:57 AM View: Confidence Intervals
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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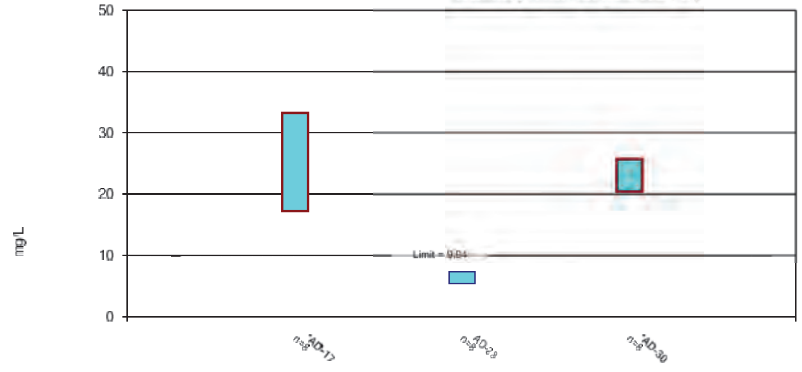
Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chloride, total Analysis Run 11/6/2017 4:57 AM View: Confidence Intervals
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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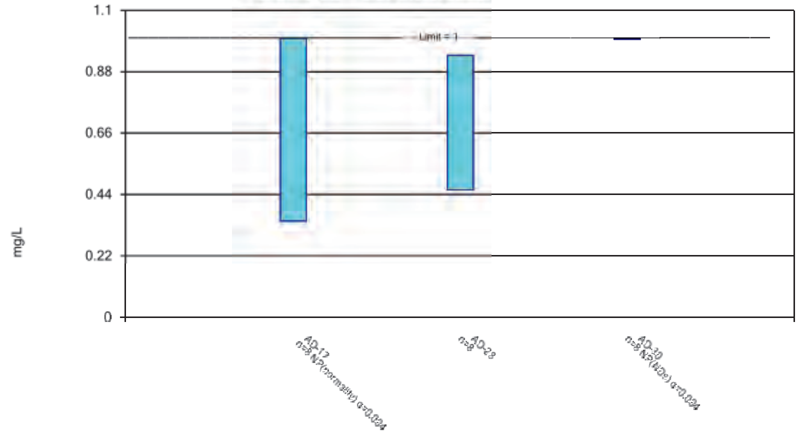
Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Fluoride, total Analysis Run 11/6/2017 4:57 AM View: Confidence Intervals
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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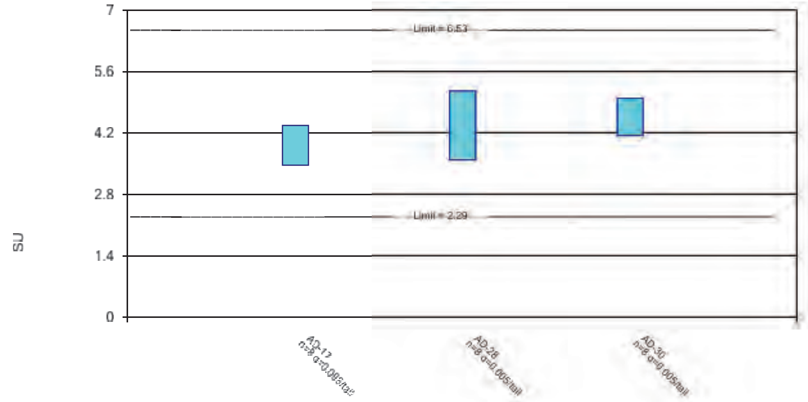
Parametric Confidence Interval

Compliance Limit is not exceeded. Normality Test: Shapiro Wilk, alpha based on n.

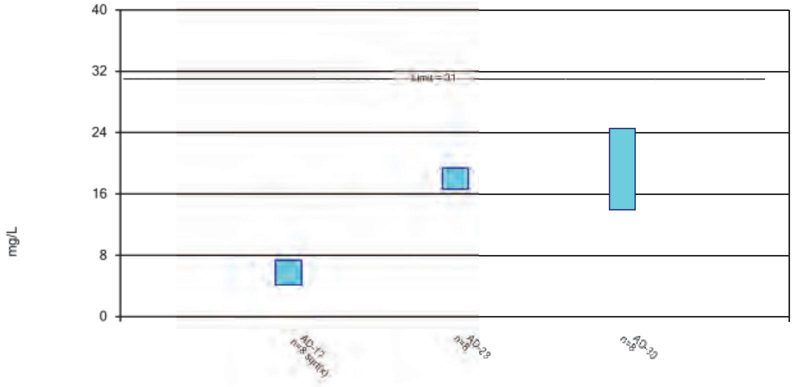


Constituent: pH, field Analysis Run 11/6/2017 4:57 AM View: Confidence Intervals
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

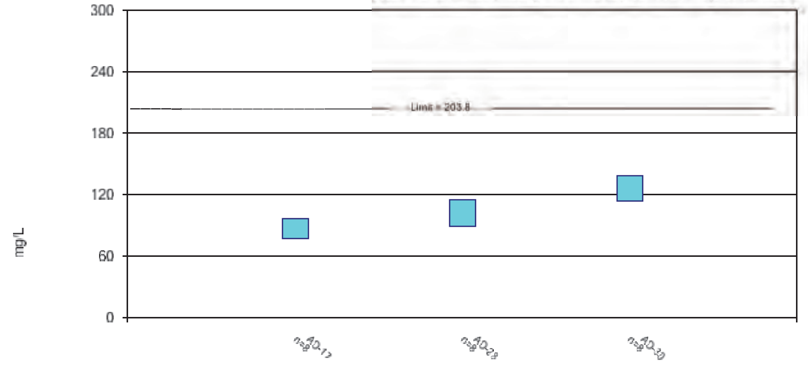


Constituent: Sulfate, total Analysis Run 11/6/2017 4:57 AM View: Confidence Intervals
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Total Dissolved Solids [TDS] Analysis Run 11/6/2017 4:57 AM View: Confidence Intervals
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Intrawell Prediction Limit Summary Table

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 10/28/2017, 12:50 PM

Constituent	Well	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-18	0.7495	n/a	8	0.4241	0.1324	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-12	0.4631	n/a	8	0.3269	0.05542	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-3	6.204	n/a	8	3.794	0.9807	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-17	1.903	n/a	8	0.9754	0.3773	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-28	3.411	n/a	8	1.703	0.695	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-30	0.6643	n/a	8	0.3575	0.1248	0	None	No	0.002505	Param 1 of 2
pH, field (SU)	AD-18	5.063	3.75	8	4.406	0.267	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-12	5.764	1.866	8	3.815	0.7928	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-3	5.857	4.168	8	5.013	0.3437	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-17	4.812	3.025	8	3.919	0.3634	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-28	5.925	2.805	8	4.365	0.6348	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-30	5.403	3.722	8	4.563	0.3421	0	None	No	0.001253	Param 1 of 2
Sulfate, total (mg/L)	AD-18	11.39	n/a	8	2.821	0.2255	0	None	sqrt(x)	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-12	9.636	n/a	8	5.75	1.581	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-3	39.6	n/a	8	24.75	6.042	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-17	9.636	n/a	8	5.75	1.581	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-28	21.22	n/a	8	18	1.309	0	None	No	0.002505	Param 1 of 2
Sulfate, total (mg/L)	AD-30	31.56	n/a	8	19.25	5.007	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-18	144	n/a	8	116.3	11.29	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	110.7	n/a	8	75.25	14.41	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-3	189.4	n/a	8	149.5	16.23	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-17	109.2	n/a	8	86.75	9.13	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-28	132.3	n/a	8	102	12.33	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-30	154.7	n/a	8	126	11.66	0	None	No	0.002505	Param 1 of 2

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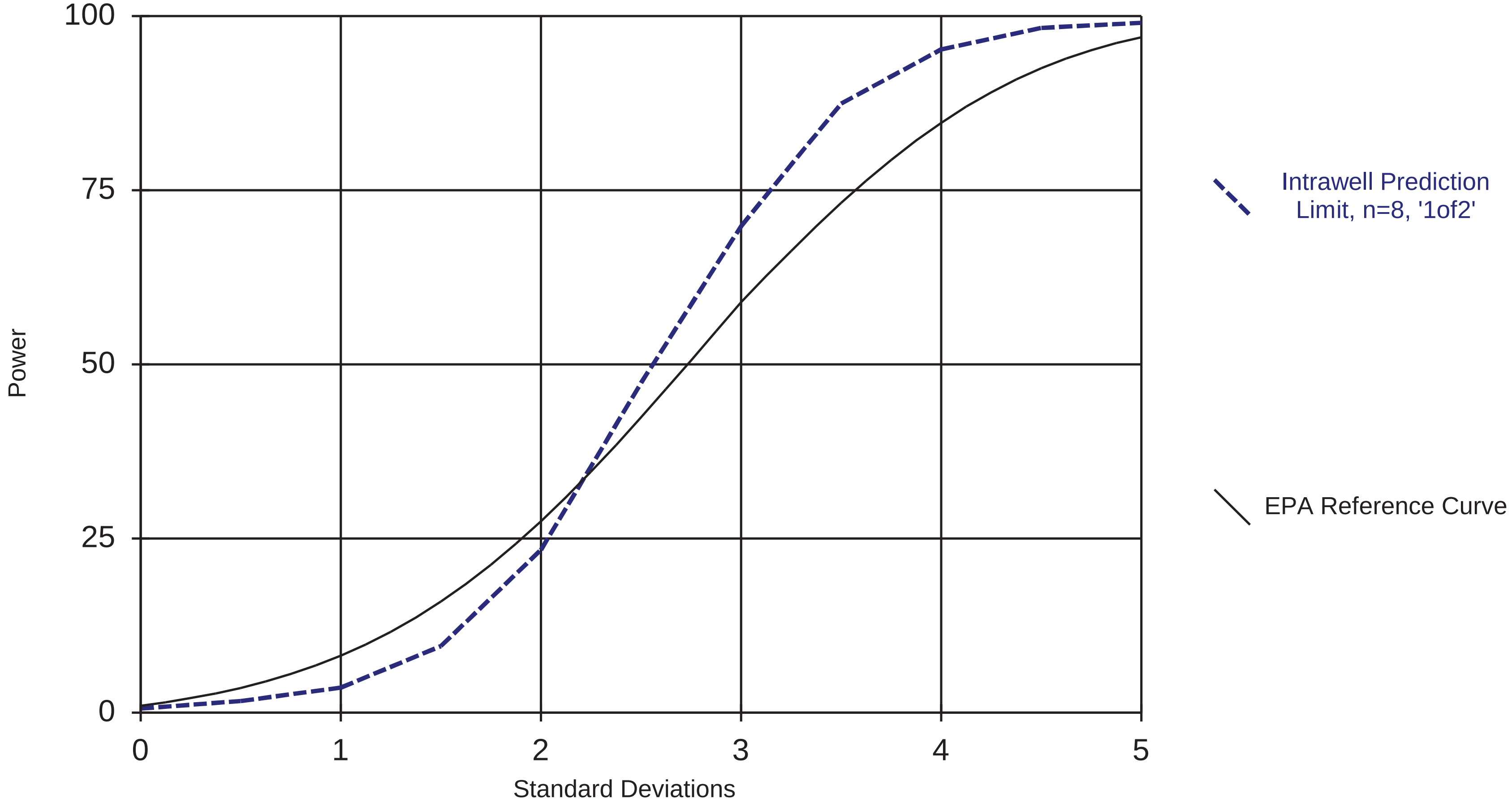
Power Curve



Kappa = 2.458, based on 3 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

Analysis Run 10/28/2017 12:43 PM View: Confidence Intervals

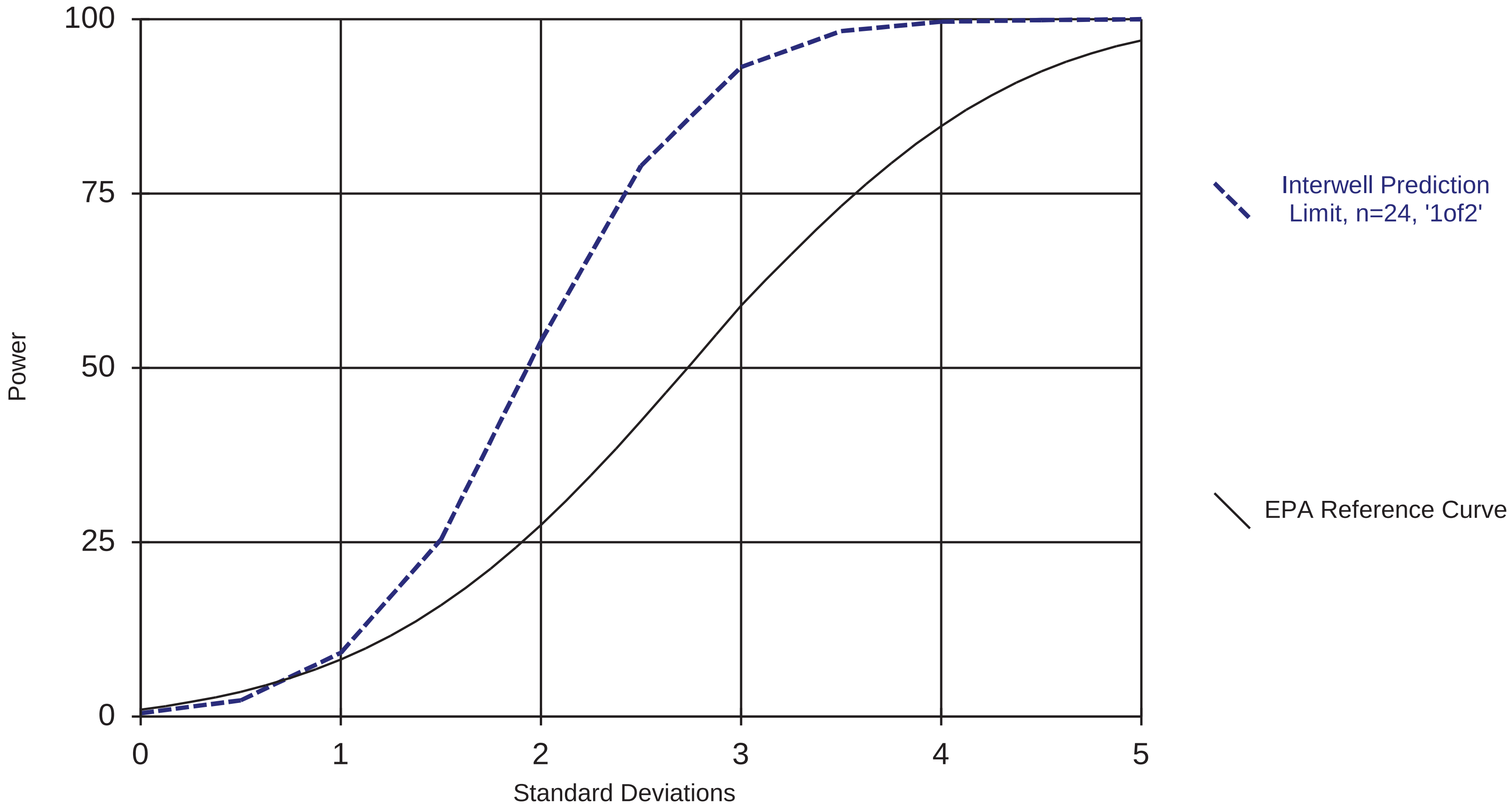
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Interwell Prediction Limit Summary Table

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 10/28/2017, 12:48 PM

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	0.06983	24	0.03458	0.01911	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	8.987	24	6.833	1.167	0	None	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	1	23	n/a	n/a	95.65	n/a	n/a	0.003311	NP (NDs) 1 of 2

Power Curve



Kappa = 1.845, based on 3 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

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Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Volume 3

- **Attachment 4, Subsection 4.14 – Annual Groundwater Monitoring Report, H.W. Pirkey Power Plant, West Bottom Ash Pond CCR Management Unit, Hallsville, Texas**
- **Attachment 5 – Closure Plans, Subsection 5.1 – Documentation of No Alternative Disposal Capacity and Risk Mitigation Plan for Permanent Cessation of Boiler(s) by a Date**

4.14 – Annual Groundwater Monitoring Report, H.W. Pirkey Power Plant, West Bottom Ash Pond CCR Management Unit, Hallsville, Texas, January 2018

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
West Bottom Ash Pond CCR Management Unit
Hallsville, Texas

January 2018

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY
An AEP Company
BOUNDLESS ENERGY

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Appendix I

I. Overview

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2018.

In general, the following activities were completed:

- Monitoring wells were installed and developed to establish a certified groundwater monitoring system around each CCR unit, in accordance with the requirements of 40 CFR 257.91 pursuant AEP's *Groundwater Monitoring Network Design Report (3/9/2017)*;
- Groundwater samples were collected and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Background groundwater quality data was collected for each Appendix III and Appendix IV constituent;
- Detection Monitoring sampling was initiated;
- A statistical process in accordance with 40 CFR 257.93 to evaluate groundwater data was prepared, certified, and posted to AEP's CCR website in April 2017. AEP's *Statistical Analysis Plan (*AEP 2017). The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009). Data evaluation is underway.

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;

- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations;
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

West Bottom Ash Pond Monitoring Wells	
Up Gradient	Down Gradient
AD-3	AD-17
AD-12	AD-28
AD-18	AD-30

III. Monitoring Wells Installed or Decommissioned

There were no monitoring wells installed or decommissioned in 2017. The network design, as summarized in the *Groundwater Monitoring Network Design Report* (3/9/2017) and as posted at the CCR web site for Pirkey Power Plant, did not change. That design report, viewable on the AEP CCR web site, discusses the facility location, the hydrogeological setting, the hydrostratigraphic units, the uppermost aquifer, downgradient monitoring well locations and the upgradient monitoring well locations.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality data collected during the establishment of background quality. Static water elevation data from each monitoring event also are shown in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

V. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

As of this first annual groundwater report date there has been no transition between detection monitoring and assessment monitoring. Detection monitoring will continue in 2018. The sampling frequency of twice per year will be maintained for the Appendix III parameters (boron, calcium, chloride, fluoride, pH, sulfate and total dissolved solids).

Regarding defining an alternate monitoring frequency, the groundwater velocity and monitoring well production is high enough at this facility that no modification of the twice-per-year detection monitoring effort is needed.

VI. Other Information Required

At the appropriate time the geochemical analyses, coupled with the statistical analyses of the groundwater quality data, will determine whether an alternate source or alternate sources are affecting groundwater chemistry. In those cases where an alternate source demonstration is made, those analyses and supporting information will be presented as well.

VII. Description of Any Problems Encountered in 2017 and Actions Taken

No significant problems were encountered. The low flow sampling effort went smoothly and the schedule was met to support this first annual groundwater report preparation.

VIII. <u>A Projection of Key Activities for the Upcoming Year</u>

Key activities for 2018 include:

- Detection monitoring on a twice per year schedule;
- Evaluation of the first detection monitoring results from a statistical analysis viewpoint, looking for any statistically significant increases, or decreases when pH is considered;
- Responding to any new data received in light of what the CCR rule requires;
- Preparation of the second annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-3								
		5/11/2016	7/14/2016	9/8/2016	10/13/2016	11/14/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	<0.00105 U	0.00211 J	<0.00105 U	0.00423 J	0.00198 J	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.0590	0.0700	0.0700	0.0820	0.0640	0.0620	0.0620	0.0610	-
Beryllium	mg/L	0.000413 J	0.000584 J	0.000502 J	0.000591 J	0.000311 J	0.000282 J	0.000280 J	0.000285 J	-
Boron	mg/L	0.0400	0.0600	0.0600	0.0500	0.0700	0.0500	0.0500	0.0600	0.0863
Cadmium	mg/L	0.0000947 J	<0.00007 U	<0.00007 U	0.000159 J	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	2.90	4.67	4.28	4.93	4.61	3.81	2.55	2.60	2.37
Chloride	mg/L	6.00	6.00	7.00	8.00	7.00	7.00	5.00	10.0	6.00
Chromium	mg/L	0.000725 J	0.00100	0.000974 J	0.00200	0.000422 J	0.000552 J	<0.00023 U	0.000251 J	-
Cobalt	mg/L	0.00313 J	0.00700	0.00700	0.00900	0.00800	0.00496 J	0.00254 J	0.00240 J	-
Combined Radium	pCi/L	1.06	1.69	1.49	3.42	1.53	2.01	0.862	0.991	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.0250	0.0950	0.0870	0.991	0.0920	0.0790	0.0460	0.0460	-
Mercury	mg/L	0.00000992 J	0.0000250	0.00000618 J	0.00000730 J	<0.000005 U	0.00000570 J	<0.000005 U	<0.000005 U	-
Molybdenum	mg/L	0.000775 J	0.00116 J	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00330 J	0.00250 J	<0.00099 U	0.00193 J	<0.00099 U	<0.00099 U	0.00178 J	<0.00099 U	-
Total Dissolved Solids	mg/L	136	161	145	168	170	152	124	140	68.0
Sulfate	mg/L	18.0	30.0	28.0	31.0	29.0	27.0	16.0	19.0	17.0
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	0.00113 J	<0.00086 U	-
pH	SU	4.86	4.66	4.48	5.46	5.36	5.27	5.07	4.94	5.62

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-12								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.0260	0.0230	0.0300	0.0270	0.0280	0.0230	0.0260	0.0240	-
Beryllium	mg/L	0.000220 J	0.000190 J	0.000232 J	0.000150 J	0.000152 J	0.000127 J	0.000149 J	0.000159 J	-
Boron	mg/L	0.0300	0.0300	0.0400	0.0300	0.0400	0.0300	0.0400	0.0500	0.0495
Cadmium	mg/L	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	0.362	0.260	0.343	0.271	0.331	0.315	0.434	0.299	0.245
Chloride	mg/L	5.00	6.00	6.00	7.00	8.00	7.00	5.00	6.00	6.00
Chromium	mg/L	0.000711 J	0.000688 J	0.000354 J	0.000529 J	0.000328 J	0.000650 J	0.000326 J	0.000416 J	-
Cobalt	mg/L	0.00158 J	0.00129 J	0.00167 J	0.00157 J	0.00147 J	0.00109 J	0.00130 J	0.00133 J	-
Combined Radium	pCi/L	0.207	2.91	0.881	0.257	0.767	1.54	0.416	0.390	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	1.00	<0.083 U	<0.083 U	<0.083 U	0.257 J	0.213 J
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	<0.00013 U	0.00800	0.0100	0.0120	0.0130	0.0100	0.00900	0.00800	-
Mercury	mg/L	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	0.0000136 J	-
Molybdenum	mg/L	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00174 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	94.0	75.0	63.0	92.0	80.0	76.0	50.0	72.0	52.0
Sulfate	mg/L	4.00	4.00	7.00	8.00	6.00	6.00	4.00	7.00	6.00
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	0.000995 J	<0.00086 U	-
pH	SU	4.44	3.11	3.89	3.37	2.58	4.76	3.63	4.74	4.84

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-17								
		5/11/2016	7/14/2016	9/8/2016	10/13/2016	11/15/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.00121 J	0.00131 J	0.00177 J	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.143	0.334	0.327	0.324	0.290	0.234	0.176	0.140	-
Beryllium	mg/L	0.000507 J	0.000853 J	0.000948 J	0.000754 J	0.000709 J	0.000541 J	0.000499 J	0.000512 J	-
Boron	mg/L	0.0200	0.0300	0.0300	0.0300	0.0300	0.0300	0.0400	0.0300	0.0450
Cadmium	mg/L	0.0000868 J	0.0000833 J	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	0.648	1.28	1.19	1.34	1.30	1.08	0.570	0.395	1.06
Chloride	mg/L	12.0	34.0	29.0	32.0	30.0	26.0	19.0	20.0	25.0
Chromium	mg/L	0.00100	0.00200	0.00500	0.000542 J	0.000448 J	0.000723 J	0.000359 J	0.000689 J	-
Cobalt	mg/L	0.00500	0.0140	0.0140	0.0140	0.0130	0.0100	0.00800	0.00700	-
Combined Radium	pCi/L	2.08	3.12	4.47	6.64	7.94	9.60	2.31	3.67	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	0.393 J	0.345 J	<0.083 U	<0.083 U	<0.083 U	0.245 J
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	<0.00013 U	0.0270	0.0280	0.0260	0.0260	0.0230	0.0190	0.0160	-
Mercury	mg/L	0.0000600	0.000138	0.000142	0.0000500	0.0000780	0.0000550	0.0000840	0.0000690	-
Molybdenum	mg/L	<0.00029 U	0.000486 J	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00255 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	68.0	96.0	88.0	96.0	88.0	90.0	80.0	88.0	98.0
Sulfate	mg/L	4.00	4.00	6.00	6.00	6.00	6.00	5.00	9.00	6.00
Thallium	mg/L	<0.00086 U	<0.00086 U	0.00108 J	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	4.29	3.32	3.89	3.59	3.73	4.38	3.97	4.18	4.55

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-18								
		5/10/2016	7/14/2016	9/8/2016	10/13/2016	11/15/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	<0.00105 U	0.00377 J	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.157	0.139	0.115	0.112	0.0940	0.0990	0.0990	0.105	-
Beryllium	mg/L	0.000263 J	0.000243 J	0.000226 J	0.000193 J	0.000107 J	0.000169 J	0.000105 J	0.000130 J	-
Boron	mg/L	0.0100	0.0100	0.0100	0.0200	0.0200	0.0100	0.0100	0.0100	0.0278
Cadmium	mg/L	0.000109 J	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	0.548	0.409	0.343	0.560	0.590	0.415	0.224	0.304	0.435
Chloride	mg/L	8.00	8.00	8.00	7.00	7.00	7.00	6.00	7.00	8.00
Chromium	mg/L	0.00100	0.00300	0.000780 J	0.000631 J	0.000725 J	0.000411 J	0.000573 J	0.000968 J	-
Cobalt	mg/L	0.00183 J	0.00216 J	0.00110 J	0.00225 J	0.00166 J	0.00163 J	0.000977 J	0.000982 J	-
Combined Radium	pCi/L	0.847	3.26	1.11	1.16	1.49	0.976	0.468	0.648	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.00400	0.0200	0.0190	0.0260	0.0170	0.0260	0.0170	0.0190	-
Mercury	mg/L	0.0000154 J	0.0000640	0.0000300	0.0000142 J	0.0000290	0.0000189 J	0.0000109 J	0.00000960 J	-
Molybdenum	mg/L	<0.00029 U	0.000413 J	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00171 J	0.00245 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	108	116	110	124	134	128	108	102	68.0
Sulfate	mg/L	7.00	7.00	8.00	10.0	7.00	10.0	7.00	8.00	8.00
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	4.53	4.65	4.67	4.14	4.43	4.67	4.06	4.10	4.90

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-28								
		5/11/2016	7/14/2016	9/7/2016	10/13/2016	11/15/2016	1/12/2017	3/1/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.00159 J	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.00250 J	0.00153 J	<0.00105 U	0.00600	0.00141 J	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.223	0.170	0.168	0.152	0.148	0.154	0.163	0.162	-
Beryllium	mg/L	0.000969 J	0.000663 J	0.000729 J	0.000420 J	0.000521 J	0.000476 J	0.000577 J	0.000655 J	-
Boron	mg/L	0.277	0.301	0.332	0.230	0.320	0.285	0.293	0.293	0.281
Cadmium	mg/L	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	2.16	1.69	1.25	3.21	1.64	1.22	1.25	1.20	1.22
Chloride	mg/L	6.00	6.00	6.00	6.00	8.00	7.00	5.00	7.00	6.00
Chromium	mg/L	0.00100	0.000983 J	0.000606 J	0.00600	0.000639 J	<0.00023 U	0.000969 J	0.000324 J	-
Cobalt	mg/L	0.0180	0.0150	0.0140	0.0180	0.0130	0.0120	0.0140	0.0150	-
Combined Radium	pCi/L	1.21	2.29	1.44	2.55	3.35	2.67	2.08	2.33	-
Fluoride	mg/L	0.901 J	0.448 J	0.397 J	0.532 J	0.920 J	0.716 J	<0.083 U	0.673 J	0.557 J
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.00400	0.0340	0.0300	0.0660	0.0320	0.0310	0.0310	0.0300	-
Mercury	mg/L	0.000146	0.000162	0.0000690	0.0000850	0.0000290	0.0000250	0.0000250	0.0000260	-
Molybdenum	mg/L	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	0.000294 J	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00110 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	106	96.0	94.0	124	112	84.0	96.0	104	96.0
Sulfate	mg/L	18.0	17.0	19.0	19.0	16.0	17.0	18.0	20.0	18.0
Thallium	mg/L	<0.00086 U	<0.00086 U	0.00125 J	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	4.71	5.14	4.07	5.28	4.15	4.10	3.37	4.10	5.10

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).

J: Estimated value. Parameter was detected in concentrations below the reporting limit.

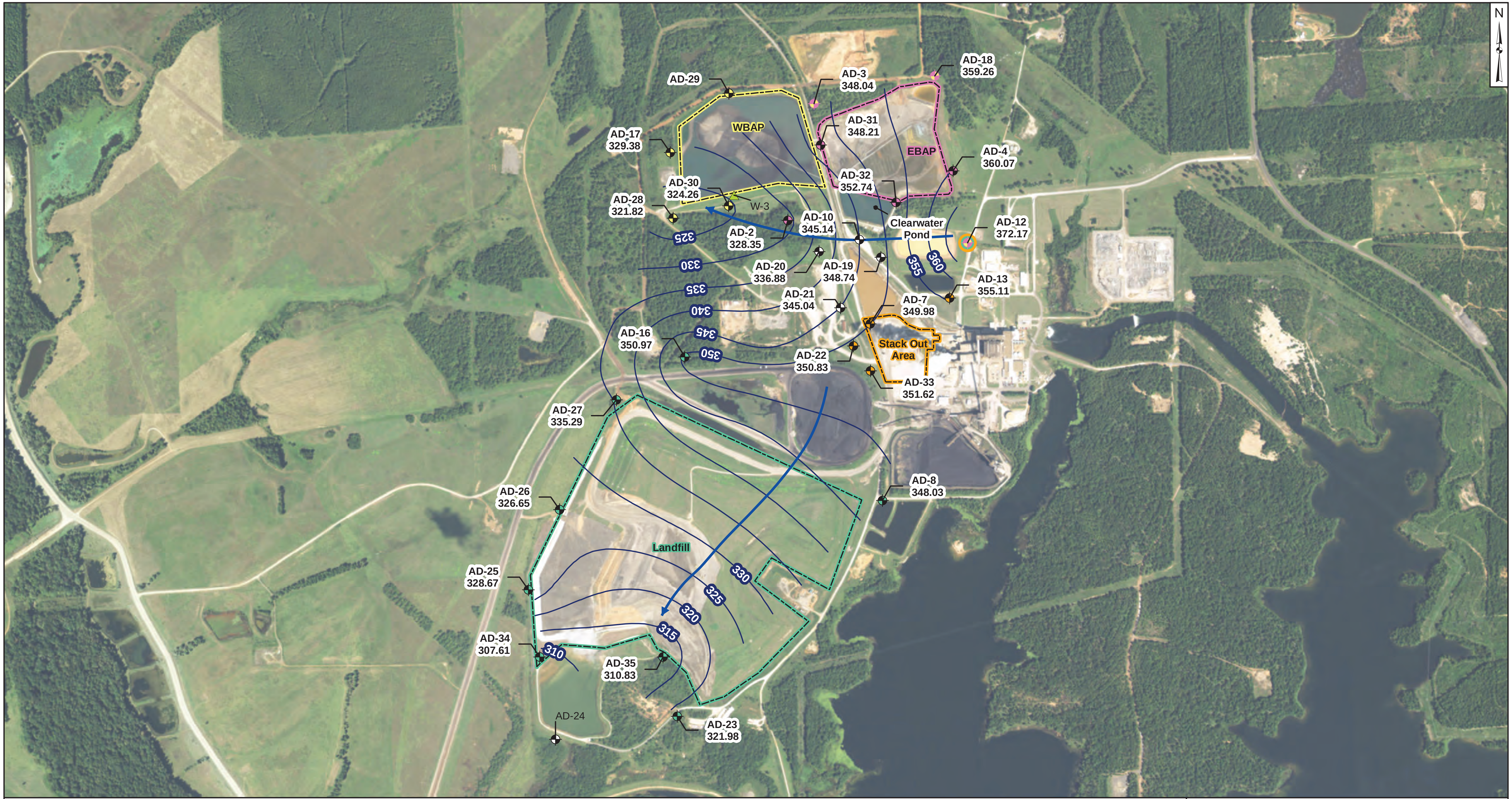
-: Not sampled

For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-30								
		5/11/2016	7/14/2016	9/7/2016	10/13/2016	11/15/2016	1/12/2017	3/1/2017	4/11/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.00171 J	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	0.000997 J	<0.00093 U	-
Arsenic	mg/L	0.00193 J	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.0540	0.0540	0.0520	0.0560	0.0520	0.0510	0.0550	0.0550	-
Beryllium	mg/L	0.000155 J	0.000127 J	0.000154 J	0.0000607 J	0.0000604 J	0.0000581 J	0.0000632 J	0.0000611 J	-
Boron	mg/L	0.258	0.384	0.515	0.625	0.701	0.697	0.824	0.837	1.39
Cadmium	mg/L	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	0.591	0.499	0.270	0.373	0.326	0.286	0.273	0.242	0.294
Chloride	mg/L	18.0	22.0	24.0	24.0	25.0	26.0	22.0	24.0	25.0
Chromium	mg/L	0.00300	0.000994 J	0.000770 J	0.000544 J	<0.00023 U	0.000504 J	0.000740 J	0.000536 J	-
Cobalt	mg/L	0.00221 J	0.00214 J	0.00183 J	0.00226 J	0.00192 J	0.00176 J	0.00170 J	0.00180 J	-
Combined Radium	pCi/L	1.06	4.70	0.312	2.27	4.07	0.355	0.354	1.86	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	<0.00013 U	0.0100	0.00900	0.0100	0.00900	0.00900	0.00800	0.00800	-
Mercury	mg/L	0.000278	0.000649	0.000214	0.000709	0.000584	0.00159	0.00259	0.00121	-
Molybdenum	mg/L	<0.00029 U	0.00114 J	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	0.00121 J	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	112	118	110	140	132	136	136	124	176
Sulfate	mg/L	14.0	14.0	15.0	18.0	19.0	22.0	25.0	27.0	46.0
Thallium	mg/L	<0.00086 U	<0.00086 U	0.00135 J	<0.00086 U	0.000959 J	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	4.65	4.78	4.35	4.24	4.29	5.15	4.83	4.21	5.15

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 11, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer May 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio
2017/12/13

Figure
1

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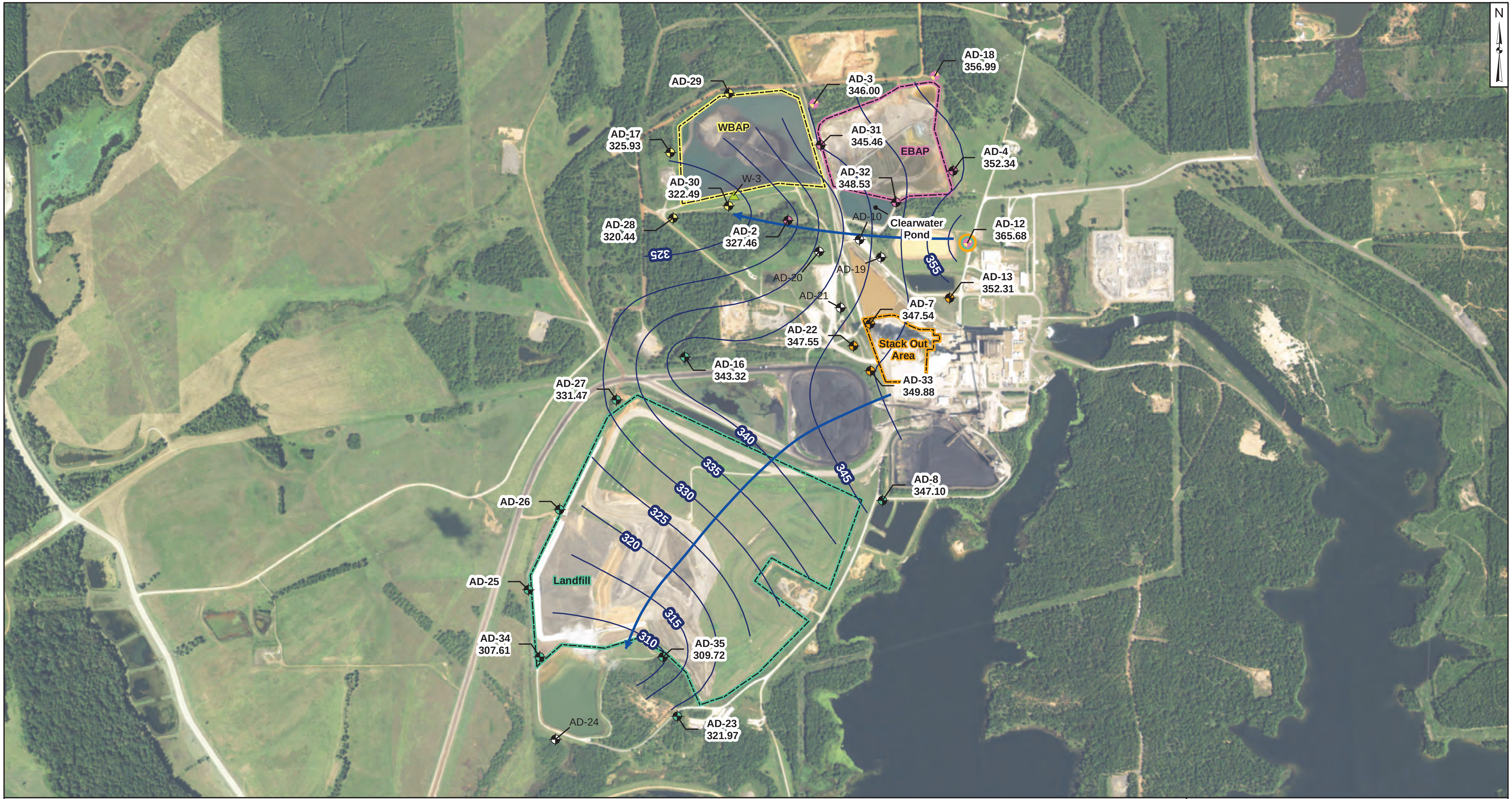

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stack Out Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on July 14, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

Potentiometric Contours - Uppermost Aquifer July 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Figure

2

Columbus, Ohio

2017/12/13

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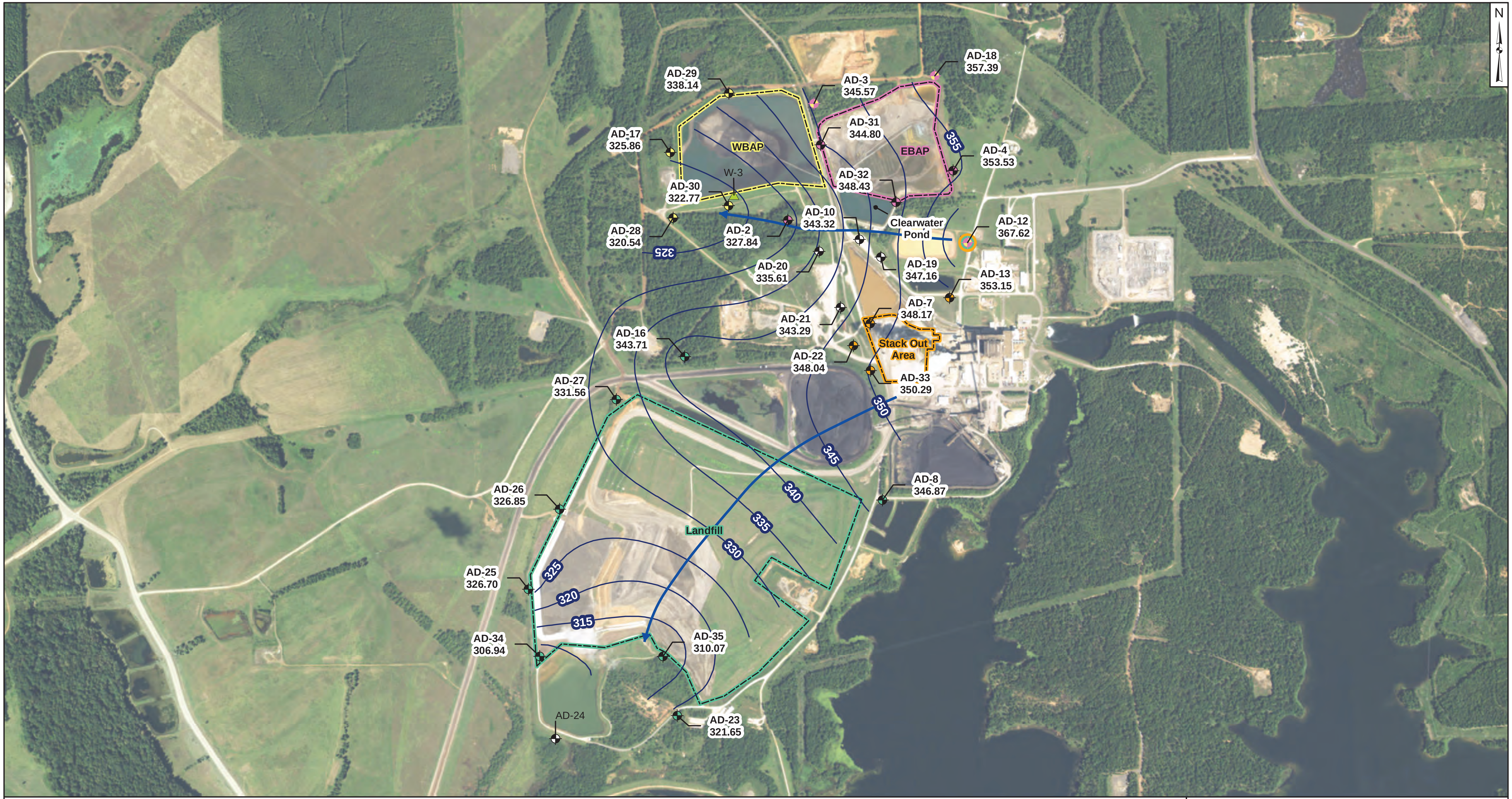

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- ― Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on September 8, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer September 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Figure
3

Columbus, Ohio
2017/12/14

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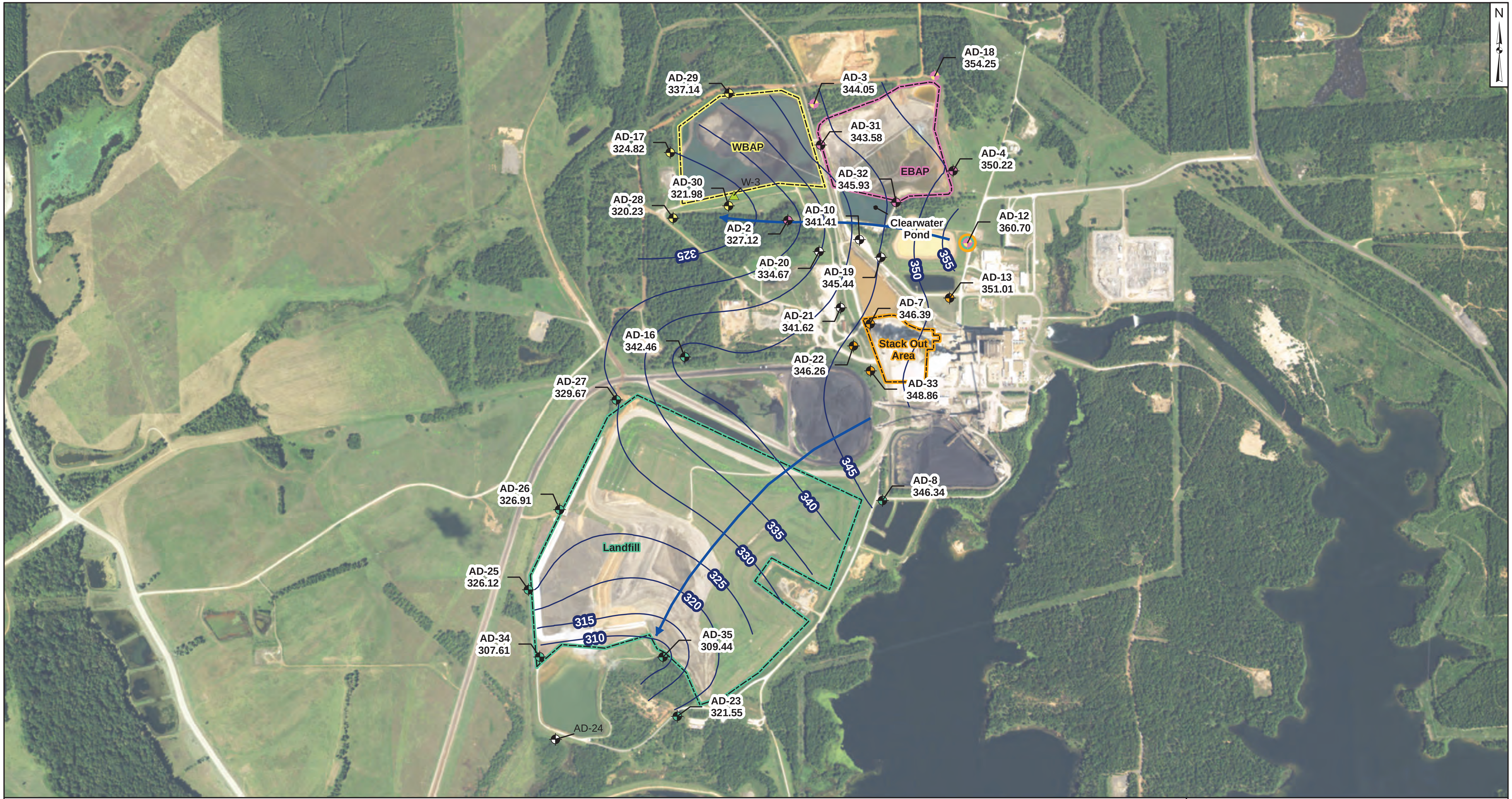

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stack Out Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on October 13, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer October 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2017/12/13

Figure
4

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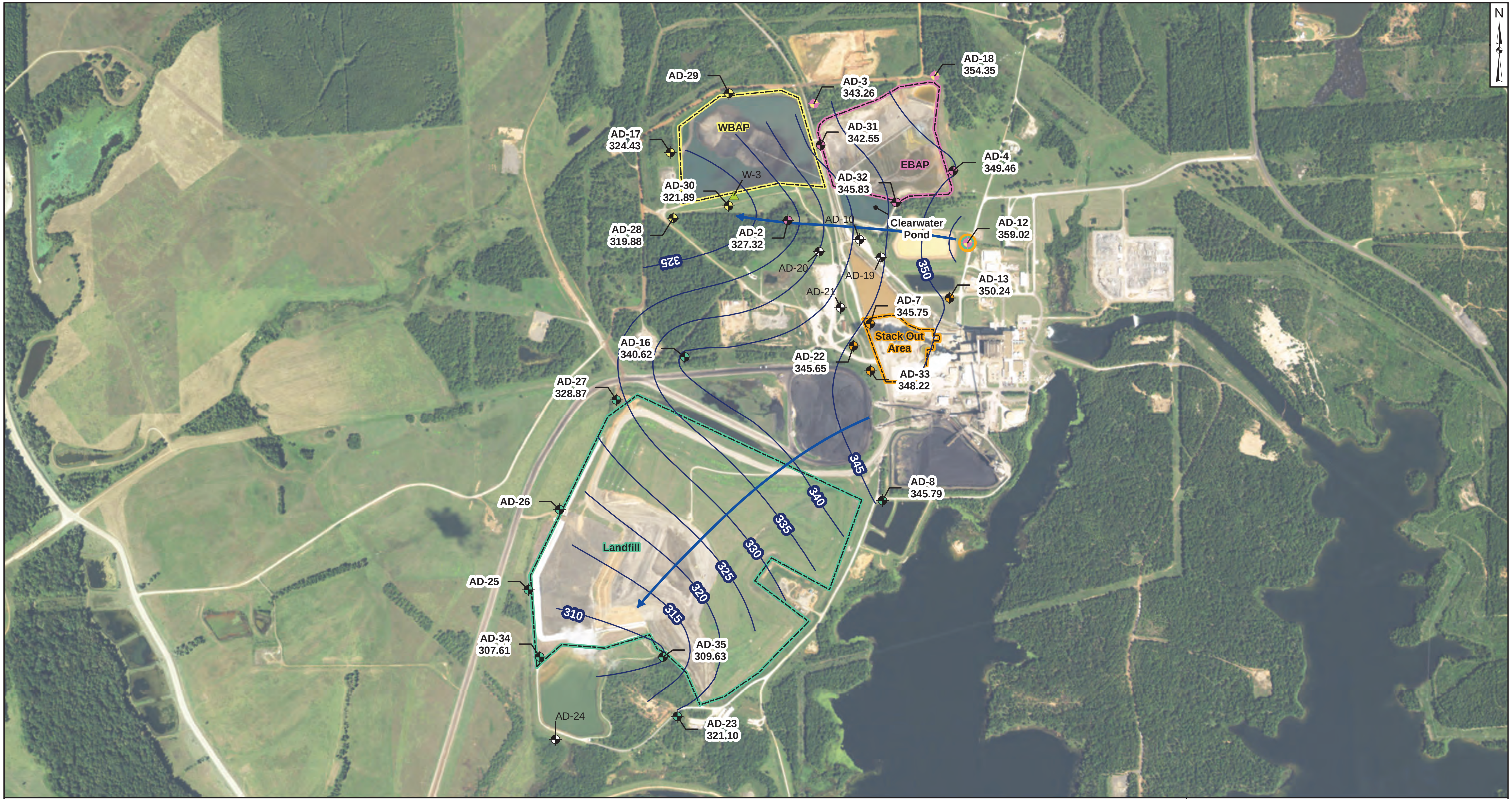

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP

◎ All CCR Unit Networks

▲ Piezometer

— Groundwater Elevation Contour

→ Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected November 14 - 15, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer
November 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio

2017/12/13

Figure

5

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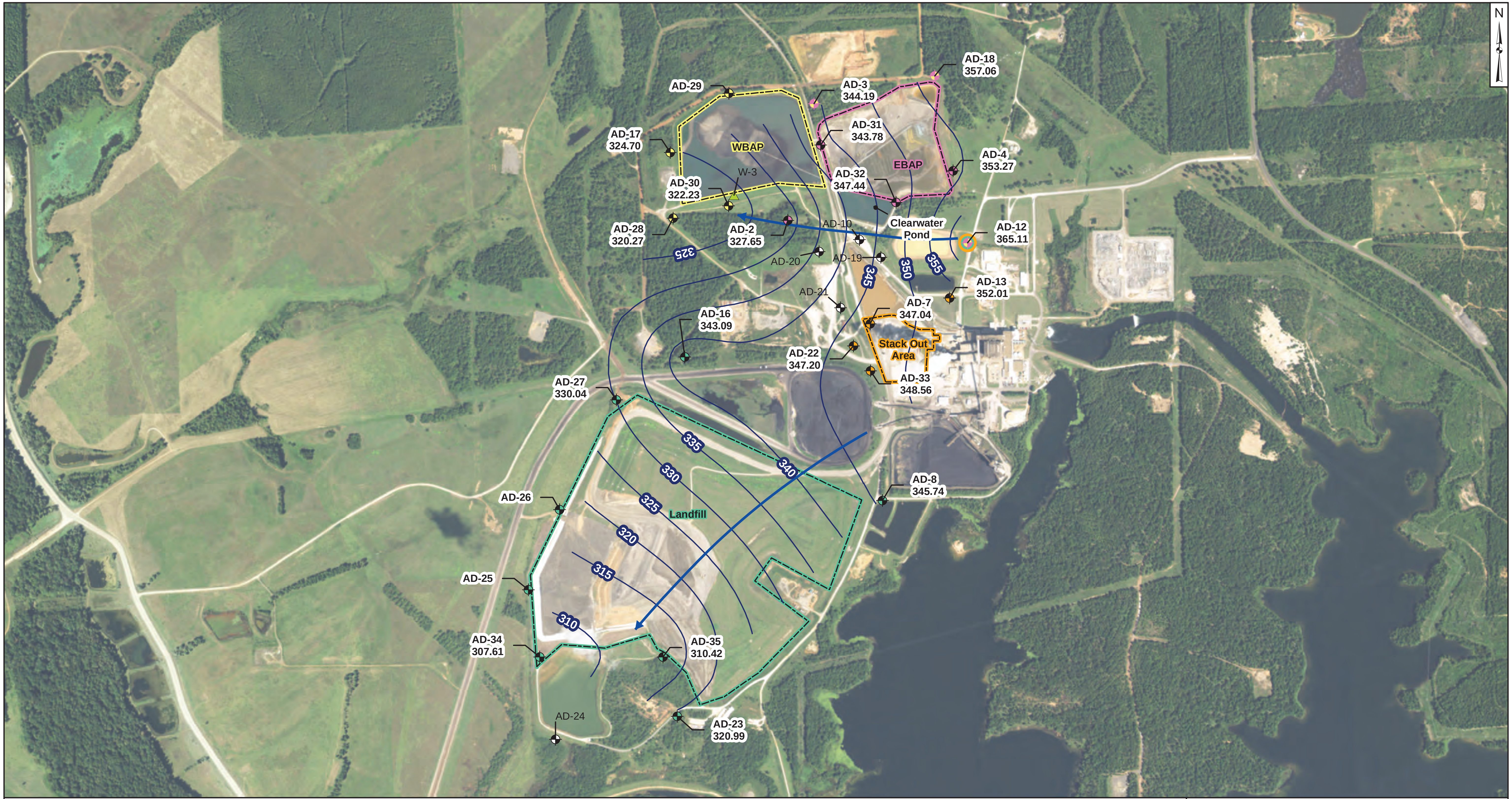

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP

- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on January 11 - 12, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
January 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
6

Columbus, Ohio
2017/12/19

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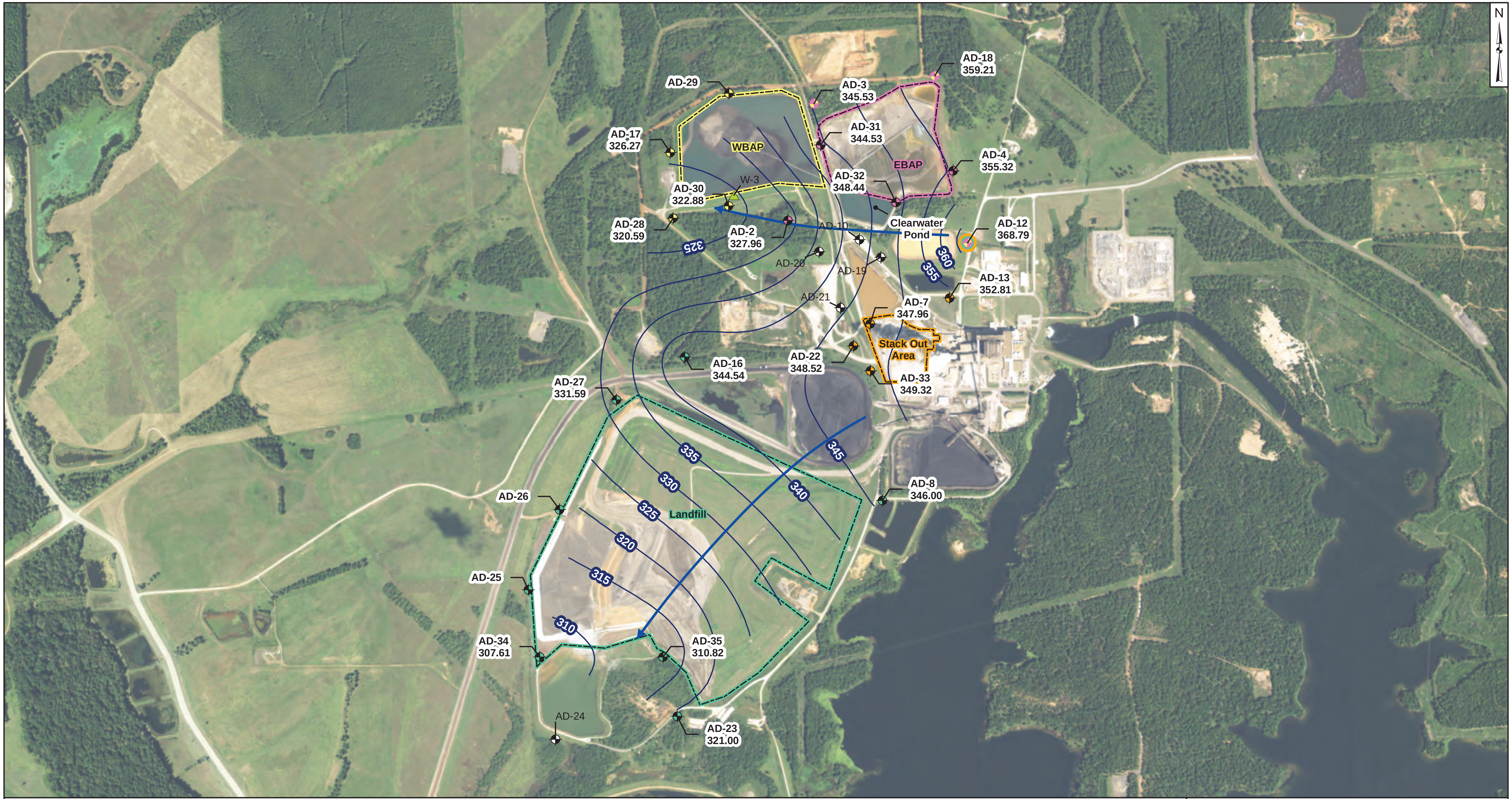

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on February 28 - March 1, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer February 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2017/12/14

Figure
7

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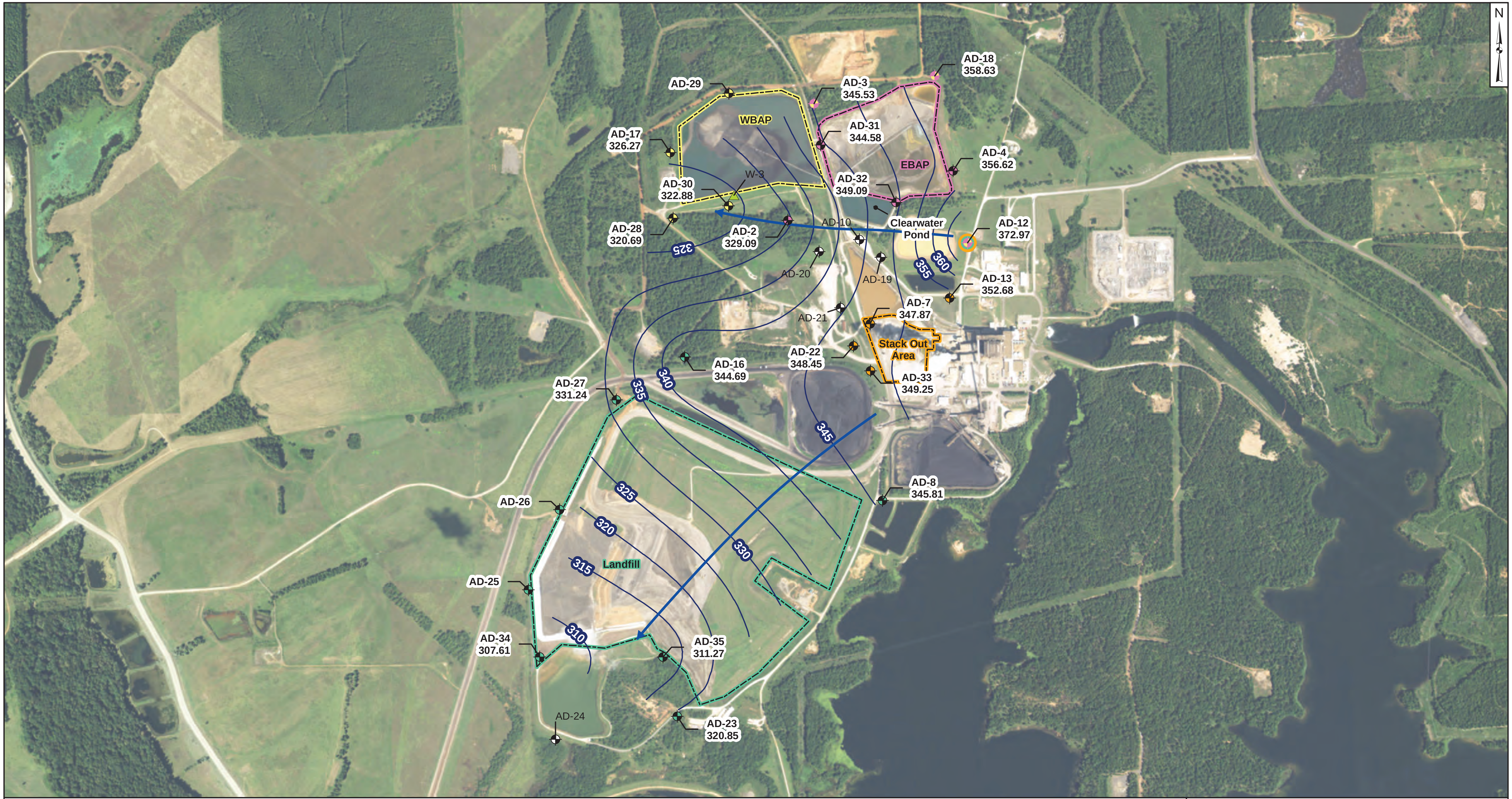

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on April 10 - 11, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
April 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
8

Columbus, Ohio	2017/12/14

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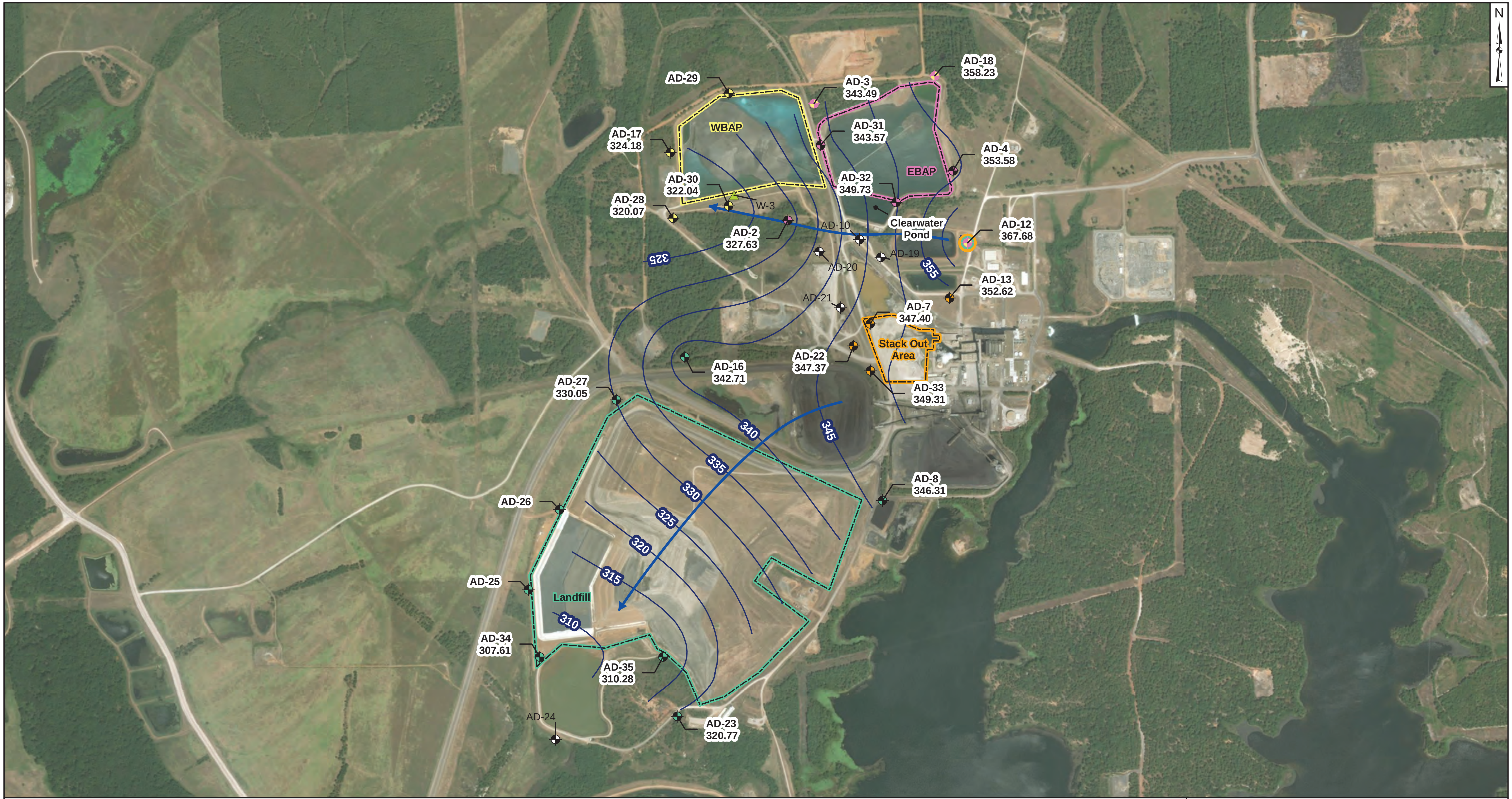

Legend

Groundwater Monitoring Wells

- ⌖ Out of Network
- ⌖ EBAP
- ⌖ WBAP
- ⌖ Landfill
- ⌖ Stack Out Area
- ⌖ EBAP and WBAP

- ◎ All CCR Unit Networks
- △ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on August 23 - 24, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
-East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
August 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
9

Columbus, Ohio
2018/01/28

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USE data row --> **75** **8/24/2017**

Landfill

Distance between wells in feet

	AD8	AD12	AD16	AD23	AD27	AD34	AD35
AD8	-	2869	2582	3147	3008	3999	2872
AD12		-	3224	5870	4067	6305	5447
AD16			-	3795	853	3537	3196
AD23				-	3402	1621	734
AD27					-	2854	2780
AD34						-	1302
AD35							-

Landfill displaying data for date: **8/24/2017**

Hydraulic gradient in ft/ft

	AD8	AD12	AD16	AD23	AD27	AD34	AD35	max grad
AD8	-	0.007449	0.001394	0.008116	0.005406	0.009677	0.012545	0.014842
AD12		-	0.007745	0.007991	0.009253	0.009527	0.010538	hydraulic concuctivity
AD16			-	0.005781	0.014842	0.009924	0.010147	0.0001 cm/sec
AD23				-	0.002728	0.008118	0.014292	porosity
AD27					-	0.007863	0.007112	0.25
AD34						-	0.002051	seepage rate, ft/yr
AD35							-	6.14

FGD stackout area

Distance between wells in feet

	AD7	AD12	AD13	AD22	AD33
AD7	-	1339	954	295	615
AD12		-	723	1627	1742
AD13			-	1191	1138
AD22				-	175
AD33					-

FGD stackout area displaying data for date: **8/24/2017**

Hydraulic gradient in ft/ft

	AD7	AD12	AD13	AD22	AD33	max grad
AD7	-	0.015146	0.005472	0.000102	0.003106	0.02083
AD12		-	0.02083	0.012483	0.010545	hydraulic concuctivity
AD13			-	0.004408	0.002909	0.0001 cm/sec
AD22				-	0.011086	porosity
AD33					-	0.25

seepage rate, ft/yr

8.62

as of Mar 2011

Well ID	AD-02	AD-03	AD-04	AD-07	AD-08	AD-10	AD-12	AD-13	AD-16	AD-17	AD-18	AD-19	AD-20	AD-21	AD-22	AD-23	AD-24	AD-25	AD-26	AD-27	AD-28	AD-29	AD-30	AD-31	AD-32	AD-33	AD-34	AD-35
TOC, ft	344.04	375.30	366.79	362.79	359.84	362.21	381.99	364.76	360.05	346.09	363.42	362.82	355.79	350.72	358.51	350.10	291.14	337.09	345.25	352.62	339.40	353.37	342.02	360.75	359.18	362.37	307.61	318.95
																	plugged 1-26-16											
Measured depth to water																												
Date																												
4/13/2011	17.14	32.35	15.34	18.45	18.19	20.18	23.04	15.30	21.97	23.43	7.89	18.75	21.29	10.29	14.87	30.45	8.22	12.58	20.72	26.80	19.73	18.69						
12/15/2011	16.92	33.71	15.55	19.04	19.55	20.31	24.00	15.85	24.55	23.80	11.88	19.24	21.16	10.70	15.35	31.16	6.85	15.19	21.48	28.08	20.24	20.00						
6/20/2012	16.87	31.60	14.35	18.64	18.19	20.02	22.66	15.24	22.47	22.78	6.21	18.53	21.10	10.50	14.77	30.81	6.04	13.95	21.63	26.49	19.48	18.63						
1/23/2013	16.78	34.20	12.37	17.89	19.12	20.80	13.92	13.95	24.62	22.58	7.95	18.20	21.01	9.15	13.68	31.44	5.51	15.15	22.93	27.23	19.19	15.90						
7/7/2013	17.42	32.03	17.57	19.44	18.59	22.36	24.58	16.15	23.38	23.03	6.19	20.22	22.41	11.56	15.61	31.23	6.08	14.94	23.16	27.27	19.71	16.53						
1/22/2014	16.34	33.88	11.21	16.18	18.17	19.94	12.02	12.79	20.52	20.90	3.39	17.71	20.41	8.36	12.02	30.30	2.84	14.53	22.01	26.23	18.75	14.82						
7/9/2014	16.85	31.34	13.46	16.56	16.48	19.99	14.95	13.47	19.21	21.94	5.36	17.06	20.92	9.05	12.74	30.31	4.04	12.85	22.74	24.71	19.18	17.52						
1/28/2015	15.42	30.29	7.79	13.62	15.81	17.82	9.24	10.29	16.71	17.67	3.54	14.90	18.91	5.27	8.27	30.26	2.58	10.67	22.21	22.93	17.24	12.80						
1/20/2016	15.49	28.27	7.63	13.48	12.63		10.94	10.61	12.37		2.9				8.22	28.87					18.01		18.32	14.15	6.86	11.24	0	9.1
3/7/2016	15.73	28.09	8.66	14.01	12.62	17.94	13.28	11.15	11.36	18.08	3.08	15.09	19.34	6.46	5.96	28.59	plugged	9.11	18.97	21.42	18.57	13.67	18.89	14.08	7.53	11.67	0.00	8.04
5/11/2016	15.69	27.26	6.72	12.81	11.81	17.07	9.82	9.65	9.08	16.71	4.16	14.08	18.91	5.68	7.68	28.12		8.42	18.60	17.33	17.58		17.76	12.54	6.44	10.75	0.00	8.12
7/14/2016	16.58	29.30	14.45	15.25	12.74		16.31	12.45	16.73	20.16	6.43				10.96	28.13				21.15	18.96		19.53	15.29	10.65	12.49	0.00	9.23
9/8/2016	16.20	29.73	13.26	14.62	12.97	18.89	14.37	11.61	16.34	20.23	6.03	15.66	20.18	7.43	10.47	28.45		10.39	18.40	21.06	18.86	15.23	19.25	15.95	10.75	12.08	0.67	8.88
10/13/2016	16.92	31.25	16.57	16.40	13.50	20.80	21.29	13.75	17.59	21.27	9.17	17.38	21.12	9.10	12.25	28.55		10.97	18.34	22.95	19.17	16.23	20.04	17.17	13.25	13.51	0.00	9.51
11/15/2016	16.72	32.04	17.33	17.04	14.05		22.97	14.52	19.43	21.60	9.07				12.86	29.00				23.75	19.52		20.13	18.20	13.35	14.15	0.00	9.32
1/12/2017	16.39	31.11	13.52	15.75	14.10		16.88	12.75	16.96	21.39	6.36				11.31	29.11				22.58	19.13		19.79	16.97	11.74	13.81	0.00	8.53
3/1/2017	16.08	29.77	11.41	14.83	13.84		13.20	11.95	15.51	19.82	4.21				9.99	29.10				21.03	18.89		19.17	16.22	10.74	13.05	0.00	8.13
4/11/2017	14.95	29.77	10.17	14.92	14.03		9.02	12.08	15.36	19.82	4.79				10.06	29.25				21.38	18.71		15.14	16.17	10.09	13.12	0.00	7.68
8/24/2017	16.41	31.81	13.22	15.39	13.53		14.31	12.14	17.34	21.91	5.19				11.14	29.33				22.57	19.33		19.98	17.18	9.45	13.06	0.00	8.67

WBAP
Distance between wells in feet

	AD3	AD12	AD17	AD18	AD28	AD30
AD3	-	2187	1604	1280	1955	1458
AD12		-	3132	1794	3123	2584
AD17			-	2911	695	904
AD18				-	3149	2603
AD28					-	689
AD30						-

WBAP displaying data for date: **8/24/2017**
Hydraulic gradient in ft/ft

	AD3	AD12	AD17	AD18	AD28	AD30
AD3	-	0.011061	0.012039	0.011516	0.01198	0.014712
AD12		-	0.013889	0.005268	0.015245	0.017663
AD17			-	0.011697	0.005914	0.002367
AD18				-	0.001305	0.000822
AD28					-	0.032569
AD30						-

max grad
0.032569
hydraulic concuctivity
0.0001 cm/sec
porosity
0.25
seepage rate, ft/yr
13.48

EBAP
Distance between wells in feet

	AD2	AD4	AD12	AD18	AD31	AD32
AD2	-	1822	1914	1569	932	1209
AD4		-	773	1022	1473	779
AD12			-	1794	1903	948
AD18				-	1459	1443
AD31					-	1001
AD32						-

EBAP displaying data for date: **8/24/2017**
Hydraulic gradient in ft/ft

	AD2	AD4	AD12	AD18	AD31	AD32
AD2	-	0.014237	0.020925	0.019503	0.017103	0.01828
AD4		-	0.018254	0.00456	0.006789	0.004929
AD12			-	0.005268	0.012669	0.018935
AD18				-	0.010048	0.005891
AD31					-	0.006154
AD32						-

max grad
0.020925
hydraulic concuctivity
0.0001 cm/sec
porosity
0.25
seepage rate, ft/yr
8.66

	Well ID	AD-02	AD-03	AD-04	AD-07	AD-08	AD-10	AD-12	AD-13	AD-16	AD-17	AD-18	AD-19	AD-20	AD-21
	TOC, ft	344.04	375.30	366.79	362.79	359.84	362.21	381.99	364.76	360.05	346.09	363.42	362.82	355.79	350.72
337.70	4/13/2011	326.90	342.95	351.45	344.34	341.65	342.03	358.95	349.46	338.08	322.66	355.53	344.07	334.50	340.43
335.90	12/15/2011	327.12	341.59	351.24	343.75	340.29	341.90	357.99	348.91	335.50	322.29	351.54	343.58	334.63	340.02
338.40	6/20/2012	327.17	343.70	352.44	344.15	341.65	342.19	359.33	349.52	337.58	323.31	357.21	344.29	334.69	340.22
339.40	1/23/2013	327.26	341.10	354.42	344.90	340.72	341.41	368.07	350.81	335.43	323.51	355.47	344.62	334.78	341.57
339.40	7/7/2013	326.62	343.27	349.22	343.35	341.25	339.85	357.41	348.61	336.67	323.06	357.23	342.60	333.38	339.16
338.70	1/22/2014	327.70	341.42	355.58	346.61	341.67	342.27	369.97	351.97	339.53	325.19	360.03	345.11	335.38	342.36
339.40	7/9/2014	327.19	343.96	353.33	346.23	343.36	342.22	367.04	351.29	340.84	324.15	358.06	345.76	334.87	341.67
339.40	1/28/2015	328.62	345.01	359.00	349.17	344.03	344.39	372.75	354.47	343.34	328.42	359.88	347.92	336.88	345.45
	1/20/2016	328.55	347.03	359.16	349.31	347.21		371.05	354.15	347.68		360.52			
	3/7/2016	328.31	347.21	358.13	348.78	347.22	344.27	368.71	353.61	348.69	328.01	360.34	347.73	336.45	344.26
	5/11/2016	328.35	348.04	360.07	349.98	348.03	345.14	372.17	355.11	350.97	329.38	359.26	348.74	336.88	345.04
	7/14/2016	327.46	346.00	352.34	347.54	347.10		365.68	352.31	343.32	325.93	356.99			
	9/8/2016	327.84	345.57	353.53	348.17	346.87	343.32	367.62	353.15	343.71	325.86	357.39	347.16	335.61	343.29
	10/13/2016	327.12	344.05	350.22	346.39	346.34	341.41	360.70	351.01	342.46	324.82	354.25	345.44	334.67	341.62
	11/15/2016	327.32	343.26	349.46	345.75	345.79		359.02	350.24	340.62	324.49	354.35			
	1/12/2017	327.65	344.19	353.27	347.04	345.74		365.11	352.01	343.09	324.70	357.06			
	3/1/2017	327.96	345.53	355.38	347.96	346.00		368.79	352.81	344.54	326.27	359.21			
	4/11/2017	329.09	345.53	356.62	347.87	345.81		372.97	352.68	344.69	326.27	358.63			
		327.63	343.49	353.57	347.40	346.31		367.68	352.62	342.71	324.18	358.23			

	Well ID	AD-22	AD-23	AD-24	AD-25	AD-26	AD-27	AD-28	AD-29	AD-30	AD-31	AD-32	AD-33	AD-34	AD-35
	TOC, ft	358.51	350.10	291.14	337.09	345.25	352.62	339.40	353.37	342.02	360.75	359.18	362.37	307.61	318.95
337.70	4/13/2011	343.64	319.65	282.92	324.51	324.53	325.82	319.67	334.68						
335.90	12/15/2011	343.16	318.94	284.29	321.90	323.77	324.54	319.16	333.37						
338.40	6/20/2012	343.74	319.29	285.10	323.14	323.62	326.13	319.92	334.74						
339.40	1/23/2013	344.83	318.66	285.63	321.94	322.32	325.39	320.21	337.47						
339.40	7/7/2013	342.90	318.87	285.06	322.15	322.09	325.35	319.69	336.84						
338.70	1/22/2014	346.49	319.80	288.30	322.56	323.24	326.39	320.65	338.55						
339.40	7/9/2014	345.77	319.79	287.10	324.24	322.51	327.91	320.22	335.85						
339.40	1/28/2015	350.24	319.84	288.56	326.42	323.04	329.69	322.16	340.57						
	1/20/2016	350.29	321.23					321.39		323.70	346.60	352.32	351.13	307.61	309.85
	3/7/2016	352.55	321.51	#VALUE!	327.98	326.28	331.20	320.83	339.70	323.13	346.67	351.65	350.70	307.61	310.91
	5/11/2016	350.83	321.98		328.67	326.65	335.29	321.82		324.26	348.21	352.74	351.62	307.61	310.83
	7/14/2016	347.55	321.97				331.47	320.44		322.49	345.46	348.53	349.88	307.61	309.72
	9/8/2016	348.04	321.65		326.70	326.85	331.56	320.54	338.14	322.77	344.80	348.43	350.29	306.94	310.07
	10/13/2016	346.26	321.55		326.12	326.91	329.67	320.23	337.14	321.98	343.58	345.93	348.86	307.61	309.44
	11/15/2016	345.65	321.10				328.87	319.88		321.89	342.55	345.83	348.22	307.61	309.63
	1/12/2017	347.20	320.99				330.04	320.27		322.23	343.78	347.44	348.56	307.61	310.42
	3/1/2017	348.52	321.00				331.59	320.51		322.85	344.53	348.44	349.32	307.61	310.82
	4/11/2017	348.45	320.85				331.24	320.69		326.88	344.58	349.09	349.25	307.61	311.27
		347.37	320.77				330.05	320.07		322.04	343.57	349.73	349.31	307.61	310.28

Seepage rate summary
in feet per year

	Landfill	**Stackout**	**WBAP**	**EBAP**	
3/7/2016	8.49	8.64	14.17	8.74	3/7/2016
5/11/2016	7.61	9.77	16.63	9.48	5/11/2016
7/14/2016	6.91	7.65	14.33	8.26	7/14/2016
9/8/2016	6.53	8.28	14.79	8.60	9/8/2016
10/13/2016	6.83	6.15	13.25	7.31	10/13/2016
11/15/2016	6.47	6.08	12.77	7.13	11/15/2016
1/12/2017	6.33	7.50	13.47	8.10	1/12/2017
3/1/2017	6.28	9.15	14.40	8.88	3/1/2017
4/11/2017	6.53	11.61	14.19	10.43	4/11/2017
8/24/2017	6.14	8.62	13.48	8.66	8/24/2017

4.15 – Annual Groundwater Monitoring Report, H.W. Pirkey Power Plant, West Bottom Ash Pond CCR Management Unit, Hallsville, Texas, January 2021

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
West Bottom Ash Pond CCR Management Unit
Hallsville, Texas

January 2021

Prepared by:
American Electric Power Service Corporation
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Table of Contents

I. Overview

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2021.

In general, the following activities were completed:

- Groundwater samples were collected for AD-3, AD-12, AD-17, AD-18, AD-28, and AD-30 in March, June, and November 2020 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in assessment monitoring and the beginning and the end of 2020.
- Statistical analysis report dated January 3, 2020 was included in last year's Annual Groundwater Monitoring Report. The following Appendix IV parameters exceeded established groundwater protection standards:
    - Cobalt at AD-28

  The following Appendix III parameters exceeded background:
    - Boron at AD-28 and AD-30
    - Chloride at AD-17 and AD-30
    - Sulfate at AD-30
- An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 2, 2020.
- Statistical analysis report dated October 2, 2020 is included in **Appendix II**. The following Appendix IV parameters exceeded established groundwater protection standards:
    - Cobalt at AD-28

  The following Appendix III parameters exceeded background:
    - Boron at AD-28 and AD-30
    - Chloride at AD-17 and AD-30
    - Sulfate at AD-28 and AD-30

  - TDS concentrations at AD-30

- An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on December 31, 2020.
- Statistical evaluation of the groundwater data collected during the Second 2020 semi-annual groundwater monitoring event is underway.
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in **Appendix I**;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations, if applicable.
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

West Bottom Ash Pond Monitoring Wells	
Up Gradient	Down Gradient
AD-3	AD-17
AD-12	AD-28
AD-18	AD-30

III. Monitoring Wells Installed or Decommissioned

One monitoring well (AD-7R) was installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry. The well installation reports can be found in **Appendix IV**.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event also are shown in **Appendix I**, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a one round of sampling in March in accordance with 40 CFR 257.95(b). A June sampling event was conducted in accordance with 40 CFR 257.95(d)(1) followed by a November round of sampling in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2021.

V. Statistical Evaluation of 2020 Events

Statistical analysis report dated January 3, 2020 was included in last year's Annual Groundwater Monitoring Report. The following Appendix IV parameters exceeded established groundwater protection standards:

- Cobalt at AD-28

The following Appendix III parameters exceeded background:

- Boron at AD-28 and AD-30
- Chloride at AD-17 and AD-30
- Sulfate at AD-30

Statistical analysis report dated October 2, 2020 is included in **Appendix II**. The following Appendix IV parameters exceeded established groundwater protection standards:

- Cobalt at AD-28

The following Appendix III parameters exceeded background:

- Boron at AD-28 and AD-30
- Chloride at AD-17 and AD-30
- Sulfate at AD-28 and AD-30
- TDS concentrations at AD-30

Statistics have not been completed for the November sampling event, so no SSLs have been determined yet.

VI. Alternate Source Demonstration

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on January 3, 2020. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 2, 2020.

SSLs above the GWPS were determined for cobalt at wells AD-28 on October 2, 2020. An alternate source was identified in a report *(Alternative Source Demonstration Report Federal CCR Rule)* on December 31, 2020.

The supporting information are found in **Appendix III**.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

The unit transitioned from detection monitoring to assessment monitoring transition on April 3, 2018.

Assessment monitoring will continue in 2021.

Regarding defining an alternate monitoring frequency, no modification to the monitoring requirements is needed.

VIII. Other Information Required

On November 30, 2020, Pirkey Power Plant submitted a site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler by a date certain to US EPA. Pirkey Power Plant requested to allow the WBAP to continue to receive CCR and non-CR wastestreams after April 11, 2021.

Pirkey received TCEQ approval to extend the receipt of CCR waste and initiate closure activities April 11, 2021. Further extension can be obtained pending a successful demonstration to EPA under 40 CFR 257.103(f).

IX. Description of Any Problems Encountered in 2020 and Actions Taken

No significant problems were encountered.

X. A Projection of Key Activities for the Upcoming Year

Key activities for next year will include:

- Assessment monitoring sampling will be conducted;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for any SSLs above GWPS;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the next annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Table 1 - Groundwater Data Summary: AD-3
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.04	2.9	6	< 0.083 U	4.9	18	136
7/14/2016	Background	0.06	4.67	6	< 0.083 U	4.7	30	161
9/8/2016	Background	0.06	4.28	7	< 0.083 U	4.5	28	145
10/13/2016	Background	0.05	4.93	8	< 0.083 U	5.5	31	168
11/14/2016	Background	0.07	4.61	7	< 0.083 U	5.4	29	170
1/12/2017	Background	0.05	3.81	7	< 0.083 U	5.3	27	152
3/1/2017	Background	0.05	2.55	5	< 0.083 U	5.1	16	124
4/10/2017	Background	0.06	2.6	10	< 0.083 U	4.9	19	140
8/24/2017	Detection	0.08625	2.37	6	< 0.083 U	5.6	17	68
3/22/2018	Assessment	0.05508	3.41	5	< 0.083 U	5.3	26	140
8/21/2018	Assessment	0.055	4.79	9	< 0.083 U	5.6	34	166
2/27/2019	Assessment	0.034	3.46	6.16	0.04 J	5.3	21.8	50
5/23/2019	Assessment	0.045	6.19	5.99	0.09	4.9	29.5	154
8/13/2019	Assessment	0.05 J	5.08	6.83	0.19	5.1	32.5	168
3/11/2020	Assessment	0.04 J	2.84	5.76	0.04 J	4.8	19.5	124
6/3/2020	Assessment	0.04 J	4.56	6.44	0.09	5.3	29.2	171
11/3/2020	Assessment	0.054	4.58	6.32	0.08	5.0	30.1	167

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-3
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**pCi/L**	**mg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
5/11/2016	Background	< 0.93 U	< 1.05 U	59	0.412956 J	0.0947139 J	0.724945 J	3.12937 J	1.059	< 0.083 U	< 0.68 U	0.025	0.00992 J	0.774997 J	3.29747 J	< 0.86 U
7/14/2016	Background	< 0.93 U	2.10876 J	70	0.583927 J	< 0.07 U	1	7	1.69	< 0.083 U	< 0.68 U	0.095	0.025	1.16077 J	2.50173 J	< 0.86 U
9/8/2016	Background	< 0.93 U	< 1.05 U	70	0.502486 J	< 0.07 U	0.974129 J	7	1.491	< 0.083 U	< 0.68 U	0.087	0.00618 J	< 0.29 U	< 0.99 U	< 0.86 U
10/13/2016	Background	< 0.93 U	4.22879 J	82	0.591063 J	0.159178 J	2	9	3.42	< 0.083 U	< 0.68 U	0.991	0.0073 J	< 0.29 U	1.92667 J	< 0.86 U
11/14/2016	Background	< 0.93 U	1.98138 J	64	0.310985 J	< 0.07 U	0.42234 J	8	1.532	< 0.083 U	< 0.68 U	0.092	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	62	0.281878 J	< 0.07 U	0.551806 J	4.96138 J	2.01	< 0.083 U	< 0.68 U	0.079	0.0057 J	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	62	0.279961 J	< 0.07 U	< 0.23 U	2.54266 J	0.862	< 0.083 U	< 0.68 U	0.046	< 0.005 U	< 0.29 U	1.78128 J	1.13014 J
4/10/2017	Background	< 0.93 U	< 1.05 U	61	0.284613 J	< 0.07 U	0.250858 J	2.40319 J	0.991	< 0.083 U	< 0.68 U	0.046	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	57.94	0.22 J	< 0.07 U	0.86 J	3.74 J	0.739	< 0.083 U	< 0.68 U	0.06189	< 0.005 U	< 0.29 U	1.13 J	< 0.86 U
8/21/2018	Assessment	< 0.01 U	1.01	63.3	0.240	0.02 J	0.496	7.18	1.837	< 0.083 U	0.355	0.0876	< 0.005 U	0.1 J	0.1	0.057
2/27/2019	Assessment	0.04 J	0.13	54.2	< 0.4 U	0.03 J	0.04 J	2.31	0.3144	0.04 J	0.05 J	0.0525	< 0.005 U	< 0.4 U	0.05 J	< 0.1 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	61.8	< 0.4 U	< 0.2 U	< 0.8 U	4.94	0.988	0.09	< 0.4 U	0.0734	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U
8/13/2019	Assessment	< 0.02 U	2.41	58.3	0.196	0.02 J	0.206	6.55	1.378	0.19	0.417	0.108	< 0.005 U	< 0.4 U	0.1 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.81	62.4	0.312	0.02 J	0.1 J	2.62	1.504	0.04 J	0.396	0.0353	0.003 J	< 0.4 U	0.09 J	< 0.1 U
6/3/2020	Assessment	< 0.02 U	0.66	57.4	0.228	0.09	0.226	4.36	1.352	0.09	0.372	0.0561	0.003 J	< 0.4 U	0.06 J	< 0.1 U
11/3/2020	Assessment	< 0.02 U	1.22	64.8	0.257	0.02 J	0.220	5.27	1.594	0.08	0.364	0.0714	< 0.002 U	< 0.4 U	0.08 J	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	< 0.083 U	4.4	4	94
7/13/2016	Background	0.03	0.26	6	< 0.083 U	3.1	4	75
9/7/2016	Background	0.04	0.343	6	< 0.083 U	3.9	7	63
10/12/2016	Background	0.03	0.271	7	1	3.4	8	92
11/14/2016	Background	0.04	0.331	8	< 0.083 U	2.6	6	80
1/11/2017	Background	0.03	0.315	7	< 0.083 U	4.8	6	76
2/28/2017	Background	0.04	0.434	5	< 0.083 U	3.6	4	50
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	7	72
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	6	52
3/21/2018	Assessment	0.01397	0.269	5	< 0.083 U	4.2	3	< 2 U
8/20/2018	Assessment	0.017	0.338	10	< 0.083 U	4.4	4	94
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	3.6	36
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	4.0	80
8/12/2019	Assessment	< 0.02 U	0.278	7.24	0.06 J	4.9	2.6	90
3/10/2020	Assessment	0.02 J	0.3 J	6.08	0.10	4.9	3.7	62
6/2/2020	Assessment	< 0.02 U	0.2 J	5.63	0.10	4.0	3.9	91
11/2/2020	Assessment	0.03 J	0.3 J	4.65	0.08	4.3	3.3	74

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	< 1.05 U	26	0.219521 J	< 0.07 U	0.710981 J	1.58207 J	0.2073	< 0.083 U	< 0.68 U	< 0.00013 U	< 0.005 U	< 0.29 U	1.73953 J	< 0.86 U
7/13/2016	Background	< 0.93 U	< 1.05 U	23	0.190337 J	< 0.07 U	0.68835 J	1.29444 J	2.909	< 0.083 U	< 0.68 U	0.008	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	30	0.232192 J	< 0.07 U	0.353544 J	1.66591 J	0.881	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
10/12/2016	Background	< 0.93 U	< 1.05 U	27	0.149553 J	< 0.07 U	0.529033 J	1.56632 J	0.257	1	< 0.68 U	0.012	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
11/14/2016	Background	< 0.93 U	< 1.05 U	28	0.152375 J	< 0.07 U	0.32826 J	1.47282 J	0.767	< 0.083 U	< 0.68 U	0.013	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
1/11/2017	Background	< 0.93 U	< 1.05 U	23	0.126621 J	< 0.07 U	0.650158 J	1.09495 J	1.536	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
2/28/2017	Background	< 0.93 U	< 1.05 U	26	0.149219 J	< 0.07 U	0.325811 J	1.29984 J	0.416	< 0.083 U	< 0.68 U	0.009	< 0.005 U	< 0.29 U	< 0.99 U	0.994913 J
4/11/2017	Background	< 0.93 U	< 1.05 U	24	0.159412 J	< 0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	< 0.68 U	0.008	0.01364 J	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	< 1.05 U	25.82	0.16 J	< 0.07 U	1.05	1.49 J	0.784	< 0.083 U	< 0.68 U	0.00722	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
8/20/2018	Assessment	< 0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	< 0.083 U	0.089	0.0143	< 0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	< 0.4 U	< 0.6 U	22.5	< 0.4 U	< 0.2 U	< 0.8 U	1.37	0.225	0.09	< 0.4 U	0.00688	< 0.005 U	< 8 U	< 0.6 U	< 2 U
5/21/2019	Assessment	< 0.4 U	< 0.6 U	21.7	< 0.4 U	< 0.2 U	< 0.8 U	1.15	0.201	0.09	< 0.4 U	0.00576	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.07 J	23.8	0.154	< 0.01 U	0.204	1.30	0.237	0.06 J	0.08 J	0.00829	< 0.005 U	< 0.4 U	0.2 J	< 0.1 U
3/10/2020	Assessment	< 0.02 U	0.09 J	21.7	0.139	0.01 J	0.2 J	1.21	3.0706	0.10	0.09 J	0.00547	< 0.002 U	< 0.4 U	0.2	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.09 J	19.0	0.132	< 0.01 U	0.208	1.02	0.799	0.10	0.09 J	0.00505	< 0.002 U	< 0.4 U	0.3	< 0.1 U
11/2/2020	Assessment	0.05 J	0.09 J	18.9	0.122	< 0.01 U	0.204	1.04	0.929	0.08	0.09 J	0.00510	< 0.002 U	< 0.4 U	0.3	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-17
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.02	0.648	12	< 0.083 U	4.3	4	68
7/14/2016	Background	0.03	1.28	34	< 0.083 U	3.3	4	96
9/8/2016	Background	0.03	1.19	29	< 0.083 U	3.9	6	88
10/13/2016	Background	0.03	1.34	32	0.393 J	3.6	6	96
11/15/2016	Background	0.03	1.3	30	0.3446 J	3.7	6	88
1/12/2017	Background	0.03	1.08	26	< 0.083 U	4.4	6	90
3/1/2017	Background	0.04	0.57	19	< 0.083 U	4.0	5	80
4/10/2017	Background	0.03	0.395	20	< 0.083 U	4.2	9	88
8/24/2017	Detection	0.04495	1.06	25	0.245 J	4.6	6	98
12/21/2017	Detection	--	--	26	< 0.083 U	--	8	76
3/22/2018	Assessment	0.03113	0.0981	13	< 0.083 U	4.4	5	44
8/21/2018	Assessment	0.044	0.997	35	< 0.083 U	3.9	7	98
2/28/2019	Assessment	0.03 J	0.2 J	10.2	0.12	3.7	2.4	68
5/23/2019	Assessment	0.019	0.2 J	10.3	0.13	4.0	2.4	58
8/13/2019	Assessment	0.03 J	0.777	26.3	0.24	4.8	1.8	88
3/11/2020	Assessment	< 0.02 U	0.1 J	10.1	0.13	4.4	2.4	60 J
6/3/2020	Assessment	0.02 J	0.312	22.7	0.26	4.2	2.7	77
11/3/2020	Assessment	0.03 J	1.06	32.4	0.24	3.7	1.8	86

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-17
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	1.21333 J	143	0.507354 J	0.0868344 J	1	5	2.082	< 0.083 U	< 0.68 U	< 0.00013 U	0.06	< 0.29 U	2.55378 J	< 0.86 U
7/14/2016	Background	< 0.93 U	1.3096 J	334	0.85295 J	0.0833036 J	2	14	3.12	< 0.083 U	< 0.68 U	0.027	0.138	0.485824 J	< 0.99 U	< 0.86 U
9/8/2016	Background	< 0.93 U	1.76675 J	327	0.948023 J	< 0.07 U	5	14	4.473	< 0.083 U	< 0.68 U	0.028	0.142	< 0.29 U	< 0.99 U	1.0754 J
10/13/2016	Background	< 0.93 U	< 1.05 U	324	0.753919 J	< 0.07 U	0.542006 J	14	6.64	0.393 J	< 0.68 U	0.026	0.05	< 0.29 U	< 0.99 U	< 0.86 U
11/15/2016	Background	< 0.93 U	< 1.05 U	290	0.708598 J	< 0.07 U	0.448238 J	13	7.94	0.3446 J	< 0.68 U	0.026	0.078	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	234	0.541302 J	< 0.07 U	0.723126 J	10	9.6	< 0.083 U	< 0.68 U	0.023	0.055	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	176	0.499114 J	< 0.07 U	0.359001 J	8	2.31	< 0.083 U	< 0.68 U	0.019	0.084	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	140	0.511666 J	< 0.07 U	0.689417 J	7	3.67	< 0.083 U	< 0.68 U	0.016	0.069	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	94.77	0.38 J	< 0.07 U	1.21	4.57 J	1.669	< 0.083 U	< 0.68 U	0.01186	0.125	< 0.29 U	< 0.99 U	< 0.86 U
8/21/2018	Assessment	< 0.01 U	0.41	223	0.588	0.04	0.367	10.9	2.505	< 0.083 U	0.181	0.0234	0.216	< 0.02 U	0.5	0.051
2/28/2019	Assessment	< 0.4 U	< 0.6 U	71.4	< 0.4 U	< 0.2 U	< 0.8 U	2.93	0.772	0.12	< 0.4 U	0.00912	0.107	< 8 U	< 0.6 U	< 2 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	82.9	< 0.4 U	< 0.2 U	0.9 J	3.15	1.62	0.13	< 0.4 U	0.00911	0.103	< 8 U	< 0.6 U	< 0.1 U
8/13/2019	Assessment	< 0.02 U	0.40	216	0.554	0.04 J	0.732	9.03	6.4	0.24	0.2 J	0.0193	0.447	< 0.4 U	0.3	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.46	73.5	0.285	0.02 J	0.700	3.04	3.986	0.13	0.2 J	0.00822	0.175	< 0.4 U	0.2 J	< 0.1 U
6/3/2020	Assessment	< 0.02 U	0.17	176	0.553	0.03 J	0.208	7.02	2.44	0.26	0.09 J	0.0147	0.346	< 0.4 U	0.4	< 0.1 U
11/3/2020	Assessment	< 0.02 U	0.44	263	0.610	0.05	0.518	12.1	8.21	0.24	0.209	0.0237	0.476	< 0.4 U	0.4	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-18
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.01	0.548	8	< 0.083 U	4.5	7	108
7/14/2016	Background	0.01	0.409	8	< 0.083 U	4.7	7	116
9/8/2016	Background	0.01	0.343	8	< 0.083 U	4.7	8	110
10/13/2016	Background	0.02	0.56	7	< 0.083 U	4.1	10	124
11/15/2016	Background	0.02	0.59	7	< 0.083 U	4.4	7	134
1/12/2017	Background	0.01	0.415	7	< 0.083 U	4.7	10	128
3/1/2017	Background	0.01	0.224	6	< 0.083 U	4.1	7	108
4/10/2017	Background	0.01	0.304	7	< 0.083 U	4.1	8	102
8/24/2017	Detection	0.0278	0.435	8	< 0.083 U	4.9	8	68
3/22/2018	Assessment	0.01642	0.292	6	< 0.083 U	5.4	6	100
8/21/2018	Assessment	0.012	0.321	10	< 0.083 U	5.1	8	118
2/28/2019	Assessment	< 0.02 U	0.490	8.19	0.02 J	5.0	6.1	84
5/23/2019	Assessment	0.013	0.684	8.82	0.02 J	5.2	10.6	104
8/13/2019	Assessment	< 0.02 U	0.647	8.49	0.01 J	5.2	6.6	90
3/11/2020	Assessment	< 0.02 U	0.3 J	7.34	0.02 J	4.4	6.1	90 J
6/3/2020	Assessment	< 0.02 U	0.2 J	8.30	0.03 J	4.5	6.3	119
11/4/2020	Assessment	< 0.02 U	0.2 J	6.30	0.02 J	4.4	6.3	100

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-18
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	< 0.93 U	< 1.05 U	157	0.262755 J	0.109247 J	1	1.82932 J	0.847	< 0.083 U	< 0.68 U	0.004	0.01536 J	< 0.29 U	1.71074 J	< 0.86 U
7/14/2016	Background	< 0.93 U	3.77261 J	139	0.243326 J	< 0.07 U	3	2.16037 J	3.264	< 0.083 U	< 0.68 U	0.02	0.064	0.41347 J	2.45009 J	< 0.86 U
9/8/2016	Background	< 0.93 U	< 1.05 U	115	0.226343 J	< 0.07 U	0.779959 J	1.09947 J	1.105	< 0.083 U	< 0.68 U	0.019	0.03	< 0.29 U	< 0.99 U	< 0.86 U
10/13/2016	Background	< 0.93 U	< 1.05 U	112	0.192611 J	< 0.07 U	0.631027 J	2.24885 J	1.161	< 0.083 U	< 0.68 U	0.026	0.01416 J	< 0.29 U	< 0.99 U	< 0.86 U
11/15/2016	Background	< 0.93 U	< 1.05 U	94	0.107171 J	< 0.07 U	0.724569 J	1.66054 J	1.486	< 0.083 U	< 0.68 U	0.017	0.029	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	99	0.169196 J	< 0.07 U	0.411433 J	1.62881 J	0.976	< 0.083 U	< 0.68 U	0.026	0.01887 J	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	99	0.105337 J	< 0.07 U	0.572874 J	0.976724 J	0.468	< 0.083 U	< 0.68 U	0.017	0.01086 J	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	105	0.130316 J	< 0.07 U	0.967681 J	0.98157 J	0.648	< 0.083 U	< 0.68 U	0.019	0.0096 J	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	97.75	0.09 J	< 0.07 U	< 0.23 U	0.97 J	0.942	< 0.083 U	< 0.68 U	0.01647	0.006 J	< 0.29 U	1.53 J	< 0.86 U
8/21/2018	Assessment	0.02 J	1.01	99.8	0.129	0.02 J	0.809	1.18	1.108	< 0.083 U	0.280	0.0175	0.014 J	0.08 J	0.2	0.060
2/28/2019	Assessment	< 0.4 U	< 0.6 U	106	< 0.4 U	< 0.2 U	< 0.8 U	1.11	0.615	0.02 J	0.7 J	0.0177	0.009 J	< 8 U	< 0.6 U	< 2 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	131	< 0.4 U	< 0.2 U	< 0.8 U	1.47	0.492	0.02 J	< 0.4 U	0.0209	0.009 J	< 8 U	< 0.6 U	< 0.1 U
8/13/2019	Assessment	< 0.02 U	0.45	100	0.118	0.02 J	0.212	1.25	0.473	0.01 J	0.2 J	0.0183	0.023 J	< 0.4 U	0.09 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.09 J	97.1	0.09 J	0.01 J	0.1 J	0.948	4.813	0.02 J	< 0.05 U	0.0134	0.003 J	< 0.4 U	0.05 J	< 0.1 U
6/3/2020	Assessment	< 0.02 U	0.22	100	0.1 J	0.01 J	0.2 J	0.950	0.728	0.03 J	0.06 J	0.0132	0.007	< 0.4 U	0.09 J	< 0.1 U
11/4/2020	Assessment	< 0.02 U	0.29	89.3	0.08 J	0.01 J	0.1 J	0.917	1.169	0.02 J	0.06 J	0.0128	0.028	< 0.4 U	0.2 J	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-28
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.277	2.16	6	0.9005 J	4.7	18	106
7/14/2016	Background	0.301	1.69	6	0.4478 J	5.1	17	96
9/7/2016	Background	0.332	1.25	6	0.3966 J	4.1	19	94
10/13/2016	Background	0.23	3.21	6	0.532 J	5.3	19	124
11/15/2016	Background	0.32	1.64	8	0.9199 J	4.2	16	112
1/12/2017	Background	0.285	1.22	7	0.7158 J	4.1	17	84
3/1/2017	Background	0.293	1.25	5	< 0.083 U	3.4	18	96
4/10/2017	Background	0.293	1.2	7	0.6732 J	4.1	20	104
8/24/2017	Detection	0.281	1.22	6	0.557 J	5.1	18	96
12/21/2017	Detection	0.277	1.14	--	--	--	--	--
3/22/2018	Assessment	0.254	1.4	5	0.6327 J	5.2	23	100
8/21/2018	Assessment	0.330	1.39	9	0.4982 J	5.0	22	96
2/27/2019	Assessment	0.458	1.65	6.29	0.81	5.0	19.6	32
5/22/2019	Assessment	0.313	1.24	4.48	0.69	4.6	20.1	100
8/12/2019	Assessment	0.366	1.72	6.04	0.65	4.7	22.5	128
3/11/2020	Assessment	0.370	1.14	5.48	1.04	4.2	29.1	112
6/2/2020	Assessment	0.351	1.18	5.33	0.87	4.5	26.2	125
11/2/2020	Assessment	0.395	1.38	5.51	0.55	4.4	21.9	104

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-28
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	1.58838 J	2.49885 J	223	0.968775 J	< 0.07 U	1	18	1.212	0.9005 J	< 0.68 U	0.004	0.146	< 0.29 U	1.10335 J	< 0.86 U
7/14/2016	Background	< 0.93 U	1.52986 J	170	0.663081 J	< 0.07 U	0.982579 J	15	2.29	0.4478 J	< 0.68 U	0.034	0.162	< 0.29 U	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	168	0.728735 J	< 0.07 U	0.605543 J	14	1.44	0.3966 J	< 0.68 U	0.03	0.069	< 0.29 U	< 0.99 U	1.24745 J
10/13/2016	Background	< 0.93 U	6	152	0.42032 J	< 0.07 U	6	18	2.547	0.532 J	< 0.68 U	0.066	0.085	< 0.29 U	< 0.99 U	< 0.86 U
11/15/2016	Background	< 0.93 U	1.40867 J	148	0.520895 J	< 0.07 U	0.638766 J	13	3.35	0.9199 J	< 0.68 U	0.032	0.029	0.294156 J	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	154	0.475597 J	< 0.07 U	< 0.23 U	12	2.67	0.7158 J	< 0.68 U	0.031	0.025	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	163	0.576508 J	< 0.07 U	0.968975 J	14	2.082	< 0.083 U	< 0.68 U	0.031	0.025	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	162	0.654819 J	< 0.07 U	0.324151 J	15	2.331	0.6732 J	< 0.68 U	0.03	0.026	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	166	0.95 J	< 0.07 U	< 0.23 U	14.36	1.288	0.6327 J	< 0.68 U	0.02561	0.046	< 0.29 U	< 0.99 U	< 0.86 U
8/21/2018	Assessment	0.03 J	0.64	143	0.598	0.05	0.688	14.4	2.028	0.4982 J	0.266	0.0307	0.028	0.05 J	0.3	0.03 J
2/27/2019	Assessment	< 0.4 U	< 0.6 U	154	0.9 J	< 0.2 U	< 0.8 U	14.3	2.318	0.81	< 0.4 U	0.0266	0.061	< 8 U	< 0.6 U	< 2 U
5/22/2019	Assessment	< 0.4 U	< 0.6 U	148	0.5 J	< 0.2 U	< 0.8 U	13.8	1.948	0.69	< 0.4 U	0.0227	0.028	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	0.02 J	0.64	113	0.473	0.04 J	0.416	12.8	2.381	0.65	0.1 J	0.0380	0.092	< 0.4 U	0.2 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.21	172	0.959	0.07	0.235	17.1	2.265	1.04	0.1 J	0.0226	0.028	< 0.4 U	0.4	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.16	146	0.801	0.05	0.230	13.6	1.667	0.87	0.06 J	0.0223	0.026	< 0.4 U	0.3	< 0.1 U
11/2/2020	Assessment	< 0.02 U	0.18	131	0.466	0.04 J	0.2 J	13.4	2.33	0.55	0.06 J	0.0279	0.064	< 0.4 U	0.2	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-30
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.258	0.591	18	< 0.083 U	4.7	14	112
7/14/2016	Background	0.384	0.499	22	< 0.083 U	4.8	14	118
9/7/2016	Background	0.515	0.27	24	< 0.083 U	4.4	15	110
10/13/2016	Background	0.625	0.373	24	< 0.083 U	4.2	18	140
11/15/2016	Background	0.701	0.326	25	< 0.083 U	4.3	19	132
1/12/2017	Background	0.697	0.286	26	< 0.083 U	5.2	22	136
3/1/2017	Background	0.824	0.273	22	< 0.083 U	4.8	25	136
4/11/2017	Background	0.837	0.242	24	< 0.083 U	4.2	27	124
8/24/2017	Detection	1.39	0.294	25	< 0.083 U	5.2	46	176
12/21/2017	Detection	1.27	0.363	26	< 0.083 U	--	48	152
3/22/2018	Assessment	0.937	0.345	17	< 0.083 U	5.2	44	140
8/21/2018	Assessment	1.57	0.716	29	< 0.083 U	4.8	66	188
2/28/2019	Assessment	0.491	0.3 J	14.6	< 0.04 U	4.2	31.5	--
4/3/2019	Assessment	--	--	--	--	--	--	135
5/23/2019	Assessment	0.520	1.74	18.8	0.04 J	4.9	29.2	112
8/12/2019	Assessment	1.25	0.302	28.1	0.03 J	4.9	39.8	160
3/11/2020	Assessment	1.63	0.351	22.8	0.05 J	4.6	76.4	188
6/2/2020	Assessment	1.58	0.341	23.2	0.05 J	4.9	77.2	219
11/2/2020	Assessment	2.55	0.523	30.6	0.05 J	4.4	109	252

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-30
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	1.71137 J	1.92931 J	54	0.155441 J	< 0.07 U	3	2.21375 J	1.057	< 0.083 U	< 0.68 U	< 0.00013 U	0.278	< 0.29 U	< 0.99 U	< 0.86 U
7/14/2016	Background	< 0.93 U	< 1.05 U	54	0.126875 J	< 0.07 U	0.994219 J	2.13856 J	4.701	< 0.083 U	< 0.68 U	0.01	0.649	1.14165 J	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	52	0.153878 J	< 0.07 U	0.769517 J	1.83325 J	0.312	< 0.083 U	< 0.68 U	0.009	0.214	< 0.29 U	< 0.99 U	1.34697 J
10/13/2016	Background	< 0.93 U	< 1.05 U	56	0.0606961 J	< 0.07 U	0.543859 J	2.26228 J	2.27	< 0.083 U	< 0.68 U	0.01	0.709	< 0.29 U	< 0.99 U	< 0.86 U
11/15/2016	Background	< 0.93 U	< 1.05 U	52	0.0603858 J	< 0.07 U	< 0.23 U	1.91681 J	4.07	< 0.083 U	< 0.68 U	0.009	0.584	< 0.29 U	1.2068 J	0.959001 J
1/12/2017	Background	< 0.93 U	< 1.05 U	51	0.0580655 J	< 0.07 U	0.504125 J	1.76108 J	0.355	< 0.083 U	< 0.68 U	0.009	1.588	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	0.997045 J	< 1.05 U	55	0.0632093 J	< 0.07 U	0.740184 J	1.69598 J	0.354	< 0.083 U	< 0.68 U	0.008	2.59	< 0.29 U	< 0.99 U	< 0.86 U
4/11/2017	Background	< 0.93 U	< 1.05 U	55	0.0611 J	< 0.07 U	0.535696 J	1.80383 J	1.861	< 0.083 U	< 0.68 U	0.008	1.207	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	56.42	0.09 J	< 0.07 U	1.47	2.6 J	1.108	< 0.083 U	< 0.68 U	0.00837	0.104	< 0.29 U	< 0.99 U	< 0.86 U
8/21/2018	Assessment	< 100 U	0.77	62.9	0.07 J	< 0.05 U	1.22	2.93	0.987	< 0.083 U	0.2 J	0.0118	1.123	< 200 U	0.4 J	0.1 J
2/28/2019	Assessment	< 0.4 U	< 0.6 U	43.3	< 0.4 U	< 0.2 U	4 J	1.67	1.144	< 0.04 U	< 0.4 U	0.00707	0.461	< 8 U	< 0.6 U	< 2 U
5/23/2019	Assessment	< 0.4 U	0.6 J	59.2	< 0.4 U	< 0.2 U	1 J	3.26	1.089	0.04 J	< 0.4 U	0.00841	0.165	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.21	58.0	0.07 J	< 0.01 U	0.374	2.10	1.217	0.03 J	0.06 J	0.00804	0.345	< 0.4 U	0.2 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.23	82.6	0.08 J	< 0.01 U	0.300	2.82	3.41	0.05 J	0.09 J	0.00788	0.010	0.8 J	0.2 J	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.19	77.3	0.08 J	< 0.01 U	0.531	2.64	0.983	0.05 J	0.09 J	0.00779	0.021	< 0.4 U	0.2	< 0.1 U
11/2/2020	Assessment	< 0.02 U	0.15	104	0.09 J	0.01 J	0.328	4.10	1.311	0.05 J	< 0.05 U	0.0104	0.085	< 0.4 U	0.2 J	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1: Residence Time Calculation Summary
Pirkey West Bottom Ash Pond

			2020-03		**2020-06**		**2020-11**	
CCR Management Unit	Monitoring Well	Well Diameter (inches)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
West Bottom Ash Pond	AD-3 [1]	4.0	16.5	7.4	16.3	7.5	26.3	4.6
	AD-12 [1]	4.0	35.1	3.5	20.1	6.0	26.9	4.5
	AD-17 [2]	2.0	13.1	4.6	12.0	5.1	7.9	7.7
	AD-18 [1]	2.0	9.2	6.6	10.1	6.0	10.8	5.6
	AD-28 [2]	2.0	10.7	5.7	15.4	3.9	11.6	5.2
	AD-30 [2]	2.0	14.9	4.1	13.1	4.6	13.4	4.5

Notes:
[1] - Background Well
[2] - Downgradient Well

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP

◎ All CCR Unit Networks

▲ Piezometer

— Groundwater Elevation Contour

→ Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on March 10-11, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-16, AD-27, and AD-29 were not gauged in March 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer March 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
1

Columbus, Ohio
2020/06/12

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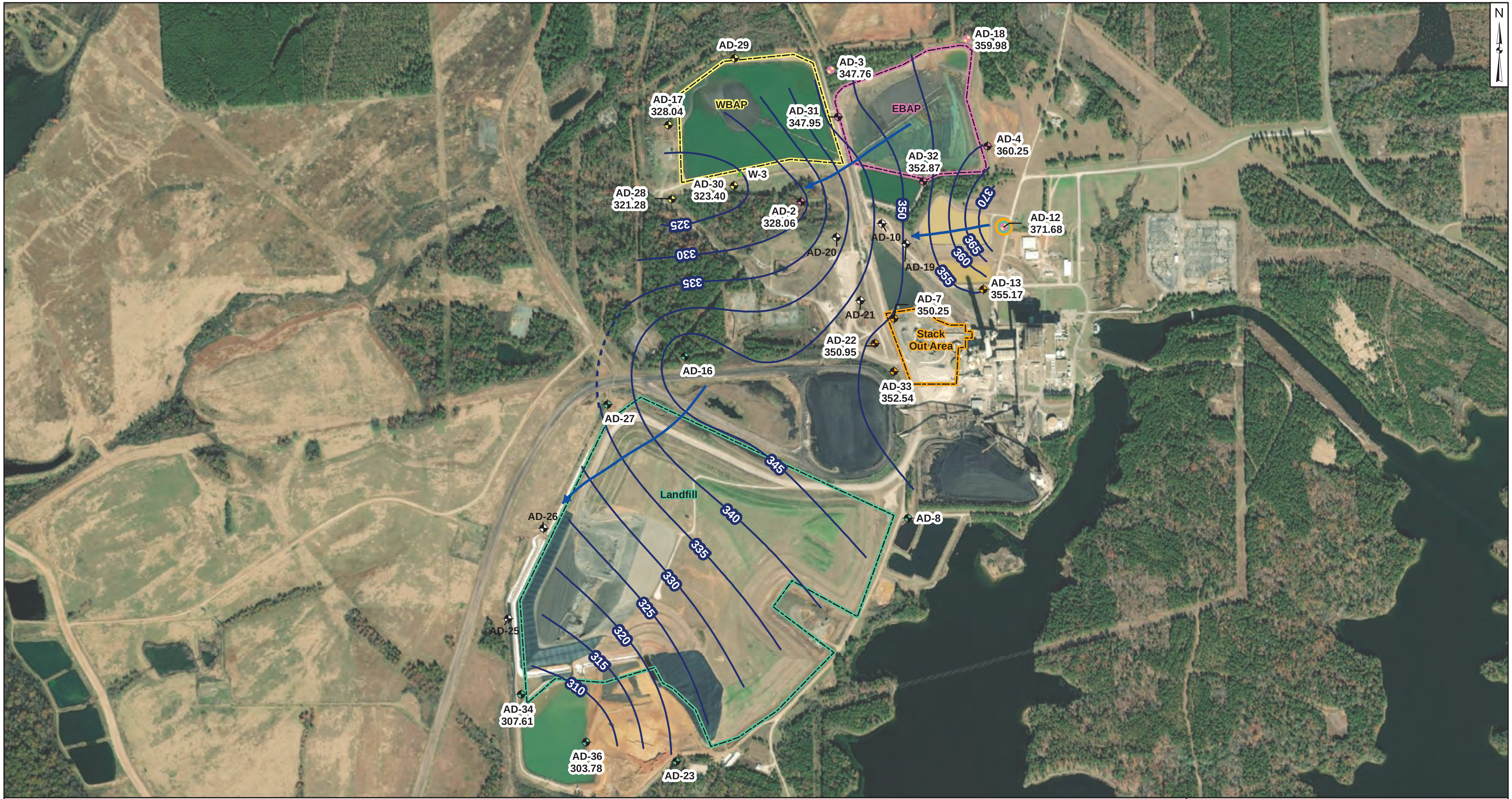

Legend

Groundwater Monitoring Wells

- ⌖ Out of Network
- ⌖ EBAP
- ⌖ WBAP
- ⌖ Landfill
- ⌖ Stackout Area
- ⌖ EBAP and WBAP

- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on June 2 - 3, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-8, AD-16, AD-23, AD-27, and AD-29 were not gauged in June 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
June 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2020/11/13

Figure
2

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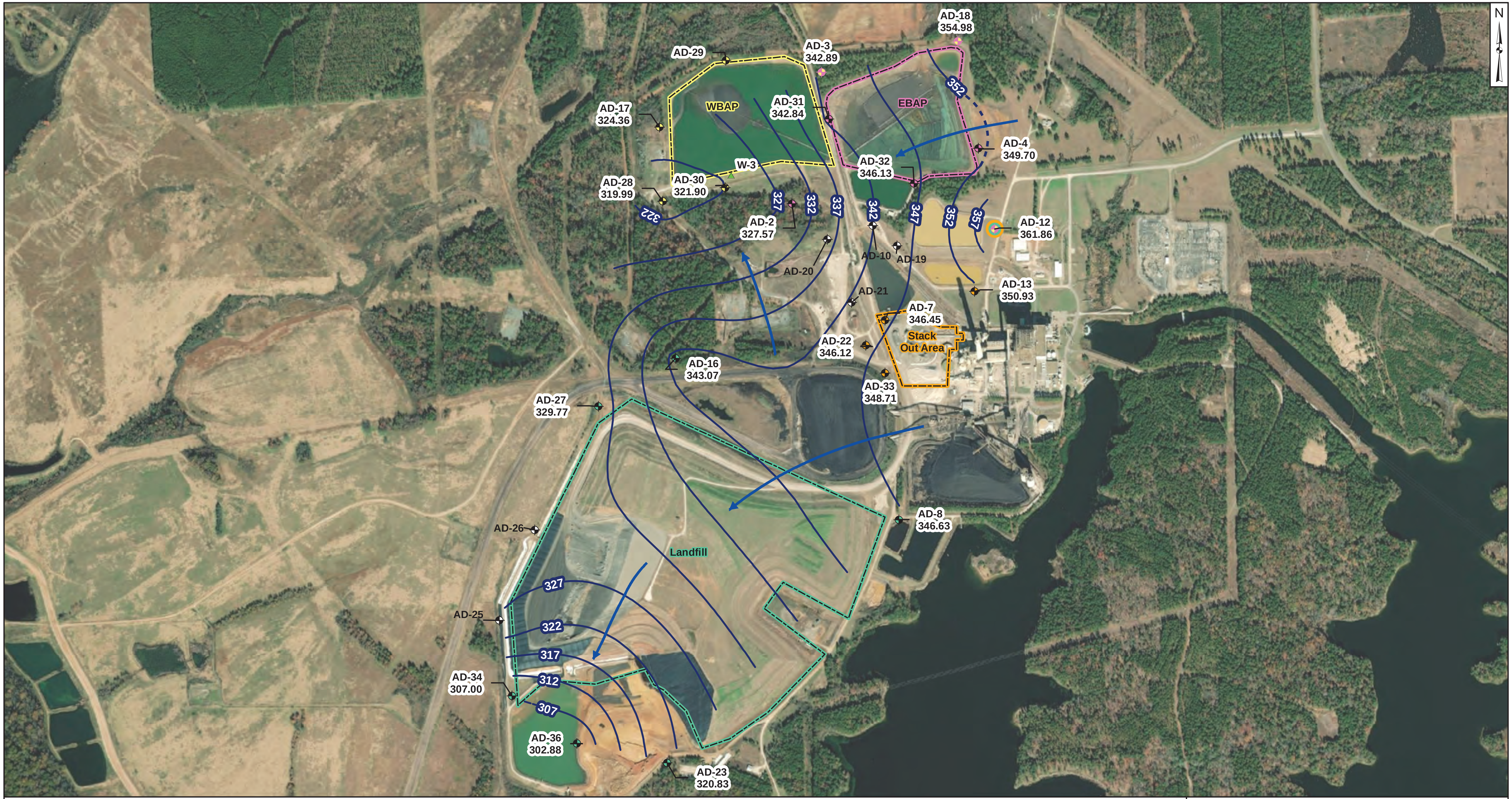

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on November 2-4, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 and AD-29 were not gauged in November 2020.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
November 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
3

Columbus, Ohio
2021/01/06

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APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
WEST BOTTOM ASH POND
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

October 2, 2020

CHA8500

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
WBAP	West Bottom Ash Pond

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the West Bottom Ash Pond (WBAP), an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron at the WBAP. An alternative source was not identified at the time, so the WBAP has been in assessment monitoring since. Groundwater protection standards (GWPS) were set in accordance with 40 CFR 257.95(d)(2) and a statistical evaluation of the assessment monitoring data was conducted. During the most recent assessment monitoring event, completed in August 2019, an SSL was identified for cobalt at well AD-28 (Geosyntec, 2019). A successful alternative source demonstration (ASD) was completed per 40 CFR 257.95(g)(3); therefore, the WBAP remained in assessment monitoring. Two assessment monitoring events were conducted at the WBAP in March and June 2020 in accordance with 40 CFR 257.95. The results of these assessment events are documented in this report.

Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact data usability.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. An SSL was identified for cobalt. Thus, either the unit will move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

WEST BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (March 2020) and 257.95(d)(1) (June 2020). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events are presented in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.26 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the WBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained in March and June 2020 were screened for potential outliers. No outliers were identified for these events.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Tolerance limits were calculated parametrically with 95% coverage and 95% confidence for chromium, combined radium, and lithium. Non-parametric tolerance limits were calculated for barium, beryllium, cobalt, and mercury due to apparent non-normal distributions and for antimony, arsenic, cadmium, fluoride, lead, molybdenum, selenium, and thallium due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSL was identified at the Pirkey WBAP:

- The LCL for cobalt exceeded the GWPS of 0.0090 mg/L at AD-28 (0.0134 mg/L).

As a result, the Pirkey WBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results was also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the June 2020 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0768 mg/L at AD-28 (0.351 mg/L) and AD-30 (1.58 mg/L).

- Chloride concentrations exceeded the interwell UPL of 9.50 mg/L at AD-17 (22.7 mg/L) and AD-30 (23.2 mg/L).

- Sulfate concentrations exceeded the intrawell UPL of 23.2 mg/L at AD-28 (26.2 mg/L) and the intrawell UPL of 31.6 mg/L at AD-30 (77.2 mg/L).

- Total dissolved solids (TDS) concentrations exceeded the intrawell UPL of 189 mg/L at AD-30 (219 mg/L).

While the prediction limits were calculated for a one-of-two retesting procedure, SSIs were conservatively assumed if the June 2020 sample was above the UPL or below the LPL. Based on these results, concentrations of Appendix III constituents appear to be above background concentrations.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the March and June 2020 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. An SSL was identified for cobalt. Appendix III parameters were compared to calculated prediction limits, with exceedances identified for boron, chloride, sulfate, and TDS.

Based on this evaluation, the Pirkey WBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2019. Statistical Analysis Summary – West Bottom Ash Pond, H.W. Pirkey Plant. December.

TABLES

Table 1 - Groundwater Data Summary
Pirkey Plant - West Bottom Ash Pond

Parameter	Unit	AD-3		AD-12		AD-17		AD-18		AD-28		AD-30	
		3/11/2020	6/3/2020	3/10/2020	6/2/2020	3/11/2020	6/3/2020	3/11/2020	6/3/2020	3/11/2020	6/2/2020	3/11/2020	6/2/2020
Antimony	µg/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Arsenic	µg/L	0.81	0.66	0.09 J	0.09 J	0.46	0.17	0.09 J	0.22	0.21	0.16	0.23	0.19
Barium	µg/L	62.4	57.4	21.7	19.0	73.5	176	97.1	100	172	146	82.6	77.3
Beryllium	µg/L	0.312	0.228	0.139	0.132	0.285	0.553	0.09 J	0.1 J	0.959	0.801	0.08 J	0.08 J
Boron	mg/L	0.04 J	0.04 J	0.02 J	0.05 U	0.05 U	0.02 J	0.05 U	0.05 U	0.370	0.351	1.63	1.58
Cadmium	µg/L	0.02 J	0.09	0.01 J	0.05 U	0.02 J	0.03 J	0.01 J	0.01 J	0.07	0.05	0.05 U	0.05 U
Calcium	mg/L	2.84	4.56	0.3 J	0.2 J	0.1 J	0.312	0.3 J	0.2 J	1.14	1.18	0.351	0.341
Chloride	mg/L	5.76	6.44	6.08	5.63	10.1	22.7	7.34	8.30	5.48	5.33	22.8	23.2
Chromium	µg/L	0.1 J	0.226	0.2 J	0.208	0.700	0.208	0.1 J	0.2 J	0.235	0.230	0.300	0.531
Cobalt	µg/L	2.62	4.36	1.21	1.02	3.04	7.02	0.948	0.950	17.1	13.6	2.82	2.64
Combined Radium	pCi/L	1.504	1.352	3.0706	0.799	3.986	2.44	4.813	0.728	2.265	1.667	3.41	0.983
Fluoride	mg/L	0.04 J	0.09	0.10	0.10	0.13	0.26	0.02 J	0.03 J	1.04	0.87	0.05 J	0.05 J
Lead	µg/L	0.396	0.372	0.09 J	0.09 J	0.2 J	0.09 J	0.2 U	0.06 J	0.1 J	0.06 J	0.09 J	0.09 J
Lithium	mg/L	0.0353	0.0561	0.00547	0.00505	0.00822	0.0147	0.0134	0.0132	0.0226	0.0223	0.00788	0.00779
Mercury	µg/L	0.003 J	0.003 J	0.005 U	0.005 U	0.175	0.346	0.003 J	0.007	0.028	0.026	0.010	0.021
Molybdenum	µg/L	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	0.8 J	2 U
Selenium	µg/L	0.09 J	0.06 J	0.2	0.3	0.2 J	0.4	0.05 J	0.09 J	0.4	0.3	0.2 J	0.2
Sulfate	mg/L	19.5	29.2	3.7	3.9	2.4	2.7	6.1	6.3	29.1	26.2	76.4	77.2
Thallium	µg/L	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
Total Dissolved Solids	mg/L	124	171	62	91	60 J	77	90 J	119	112	125	188	219
pH	SU	4.8	5.3	4.9	4.0	4.4	4.2	4.4	4.5	4.2	4.5	4.6	4.9

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.

Table 2: Groundwater Protection Standards
Pirkey Plant - West Bottom Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.0050
Barium, Total (mg/L)	2		0.16
Beryllium, Total (mg/L)	0.004		0.0020
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.0036
Cobalt, Total (mg/L)	n/a	0.006	0.009
Combined Radium, Total (pCi/L)	5		3.80
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.13
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.01
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.002

Notes:

Grey cell indicates calculated UTL is higher than MCL.

MCL = Maximum Contaminant Level

RSL = Regional Screening Level

Calculated UTL (Upper Tolerance Limit) represents site-specific background values.

The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3 - Appendix III Data Summary
Pirkey Plant - West Bottom Ash Pond

Analyte	Unit	Description	AD-17	AD-28	AD-30
			6/3/2020	6/2/2020	6/2/2020
Boron	mg/L	Interwell Background Value (UPL)	0.0768		
		Analytical Result	0.02	**0.351**	**1.58**
Calcium	mg/L	Intrawell Background Value (UPL)	1.79		
		Analytical Result	0.312	1.18	0.341
Chloride	mg/L	Interwell Background Value (UPL)	9.50		
		Analytical Result	**22.7**	5.33	**23.2**
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
		Analytical Result	0.26	0.87	0.05
pH	SU	Intrawell Background Value (UPL)	4.8	5.9	5.5
		Intrawell Background Value (LPL)	3.2	3.3	3.8
		Analytical Result	4.2	4.5	4.9
Sulfate	mg/L	Intrawell Background Value (UPL)	9.32	23.2	31.6
		Analytical Result	2.7	**26.2**	**77.2**
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	115	129	189
		Analytical Result	77	125	**219**

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

DAVID ANTHONY MILLER
112498

112498
License Number

TEXAS
Licensing State

10.02.2020
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

September 1, 2020

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey West Bottom Ash Pond
Assessment Monitoring Event – June 2020

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the Assessment Monitoring Event statistical analysis of groundwater data through June 2020 for American Electric Power Inc.'s Pirkey West Bottom Ash Pond. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-3, AD-12, and AD-18
- **Downgradient wells:** AD-17, AD-28, and AD-30

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis report was prepared according to the background screening conducted in December 2017 that was approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to Groundwater Stats Consulting. The analysis was reviewed by Dr. Jim Loftis, Civil & Environmental Engineering professor emeritus at Colorado State University and Senior Advisor to Groundwater Stats Consulting.

The CCR Assessment Monitoring program consists of the following constituents:

- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium

Time series plots and box plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B).

Background Screening:

Prior to constructing statistical limits, background data are screened through time series plots for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Values identified as outliers are flagged with (o) and displayed in a lighter font and disconnected symbol on the time series graphs. A summary of flagged outliers is included as Figure C.

For the current analysis, all data through June 2020 were screened, including data from downgradient wells. For the downgradient well data that are used to construct confidence intervals, a regulatory conservative approach is taken in that values that are marginally high relative to the rest of the data are retained unless there is particular justification for excluding them. Several outliers were flagged as a result of changes in reporting limits as follows.

The reporting limit for thallium for the February 2019 event was <0.01 mg/L, which is higher than both the historical reporting limit of <0.002 mg/L and the GWPS. Since the <0.01 mg/L values cannot help distinguish whether other observations exceed the GWPS, they are flagged as outliers. Similarly, the high nondetects for molybdenum of <0.04 mg/L for February and May of 2019 are flagged since they are censored at a much higher level than are the other nondetects. However, they are still lower than the GWPS of 0.1 mg/L.

Summary of Statistical Methods:

Assessment monitoring for Appendix IV parameters involves the comparison of a confidence interval for each parameter at each downgradient well against the corresponding Ground Water Protection Standard (GWPS). If, and only if, the entire confidence interval exceeds the GWPS, the well/constituent is considered to exceed its standard. The GWPS is determined for each parameter as the largest of the Maximum Contaminant Levels (MCLs), CCR Rule-Specified levels, or background limits determined from tolerance limits on pooled upgradient well data.

Prior to computing tolerance limits on upgradient well data or confidence intervals on downgradient well data, the distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric tolerance limits and confidence intervals as appropriate, based on the following criteria.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, the reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory. There is no replacement of historical reporting limits with the most recent reporting limit. For several constituents, the most recent reporting limits are significantly lower than those reported historically. This is the most conservative approach for tolerance limits and confidence intervals at this site.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric tolerance limits are used on data containing greater than 50% nondetects.

Evaluation of Appendix IV Parameters – June 2020:

When data followed a normal or transformed-normal distribution, parametric tolerance limits were used to calculate background limits for Appendix IV parameters using pooled upgradient well data through June 2020 with a target of 95% confidence and 95% coverage (Figure D). Nonparametric tolerance limits are constructed when data do not follow a normal or transformed-normal distribution or when there are greater than 50% nondetects. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These background limits were then compared to the Maximum Contaminant Levels (MCLs) and CCR Rule-Specified levels to determine the highest limit for use as the GWPS in the confidence interval comparisons (Figure E).

Confidence intervals were then constructed on downgradient wells with data through June 2020 for each of the Appendix IV parameters using either parametric or nonparametric intervals depending on the data distribution and percentage of nondetects, similar to the logic used to construct tolerance limits as discussed above (Figure F). Each confidence interval was compared with the corresponding GWPS from Figure E. Only when the entire confidence interval is above the GWPS is the well/constituent pair considered to exceed its respective standard. Both a tabular summary and graphical presentation of the confidence interval results follow this letter. An exceedance was noted for the following well/constituent pair:

- Cobalt: AD-28

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey West Bottom Ash Pond. If you have any questions or comments, please feel free to contact us.

For Groundwater Stats Consulting,

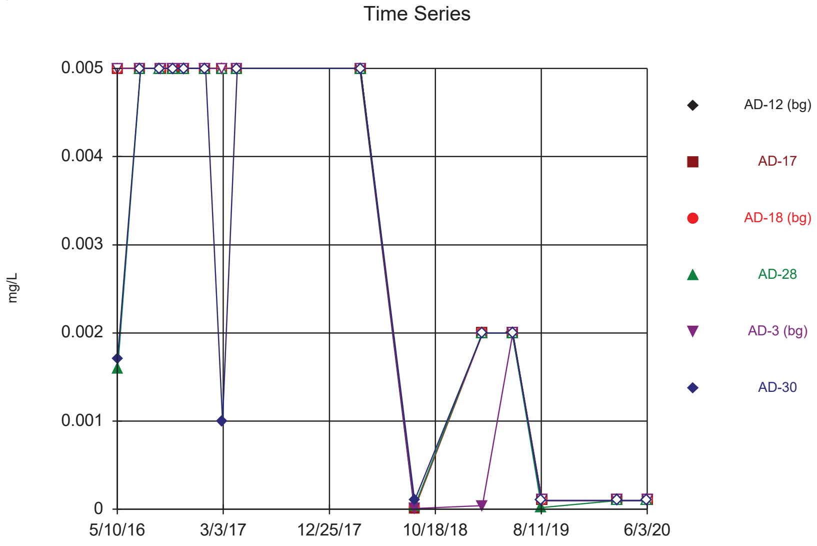
A Collins

Andrew T. Collins
Project Manager

Kristina Rayner

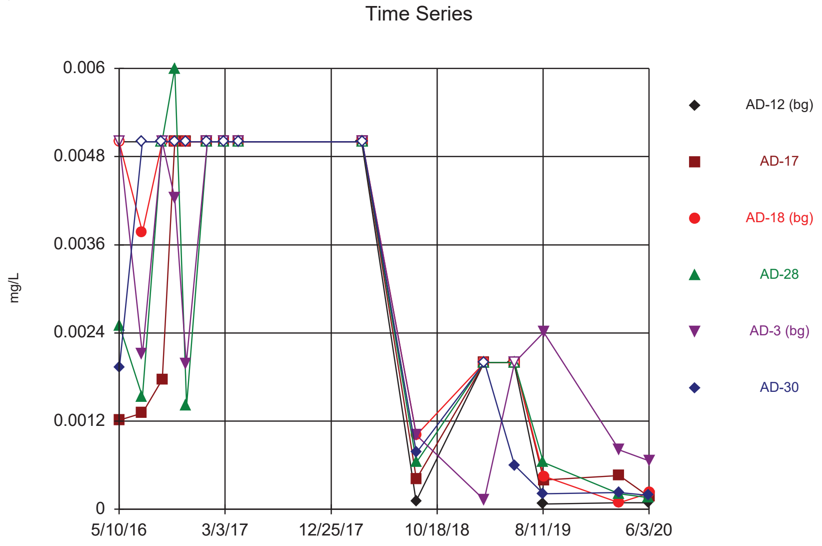
Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



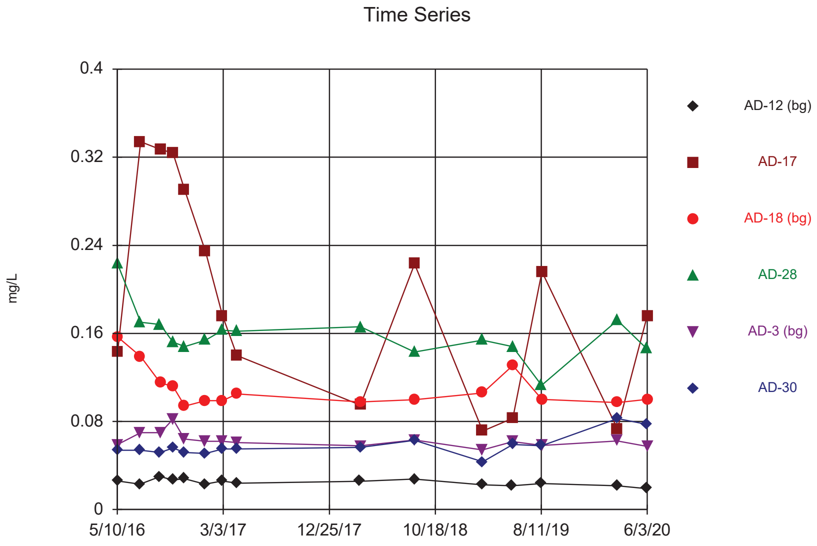
Constituent: Antimony, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



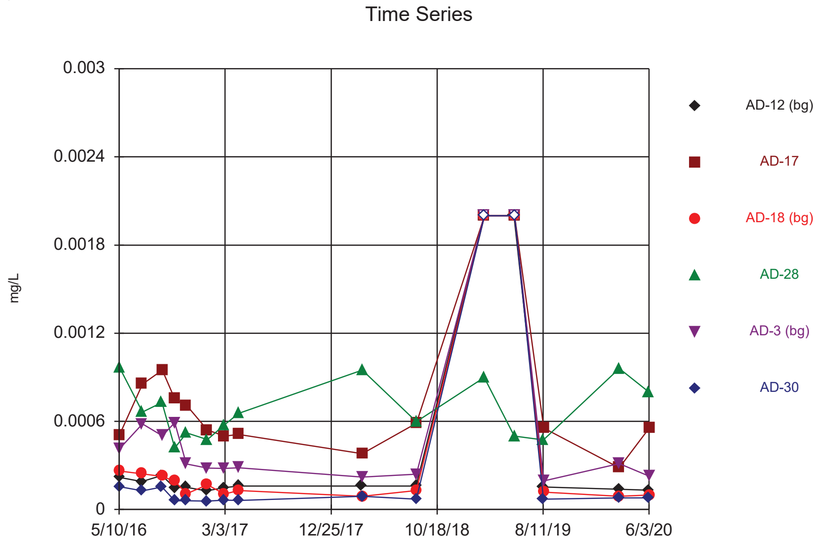
Constituent: Arsenic, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG



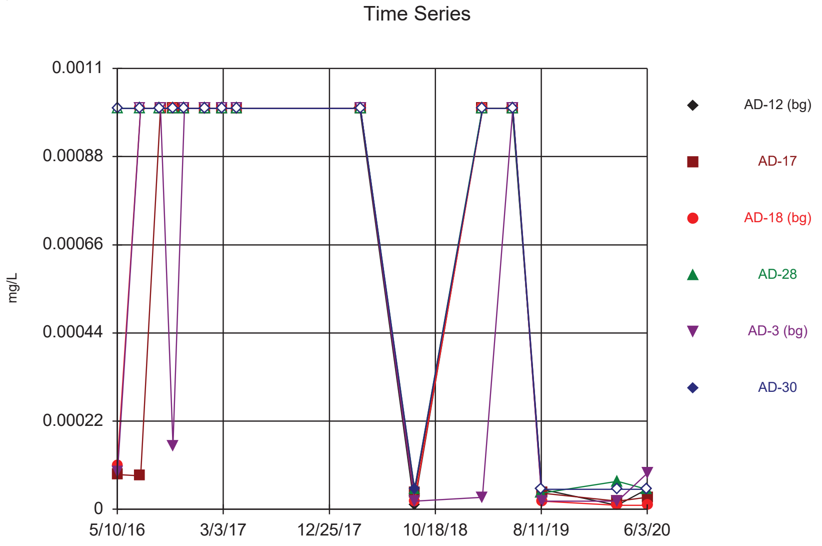
Constituent: Barium, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



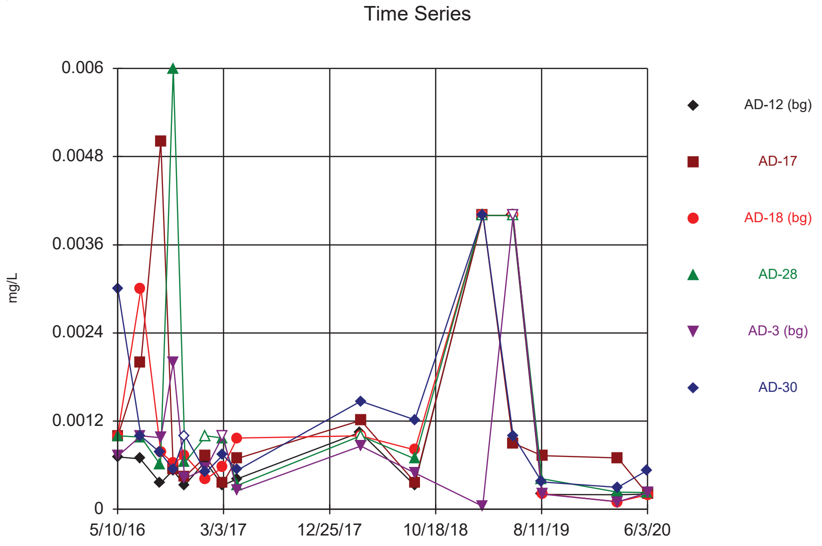
Constituent: Beryllium, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



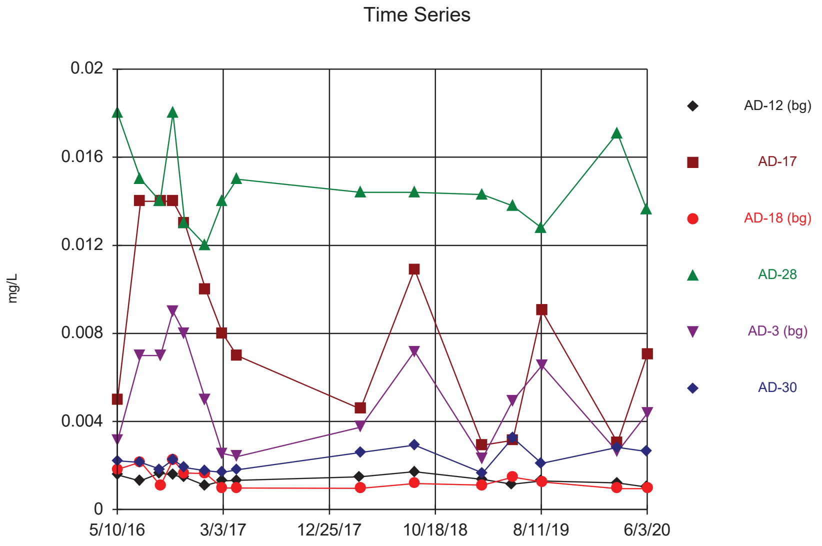
Constituent: Cadmium, total   Analysis Run 9/1/2020 1:39 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



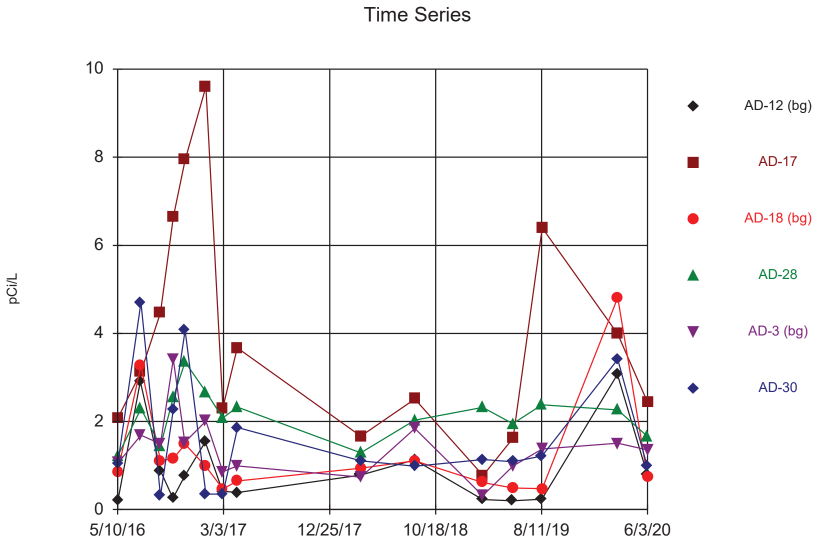
Constituent: Chromium, total   Analysis Run 9/1/2020 1:39 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG



Constituent: Cobalt, total   Analysis Run 9/1/2020 1:39 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

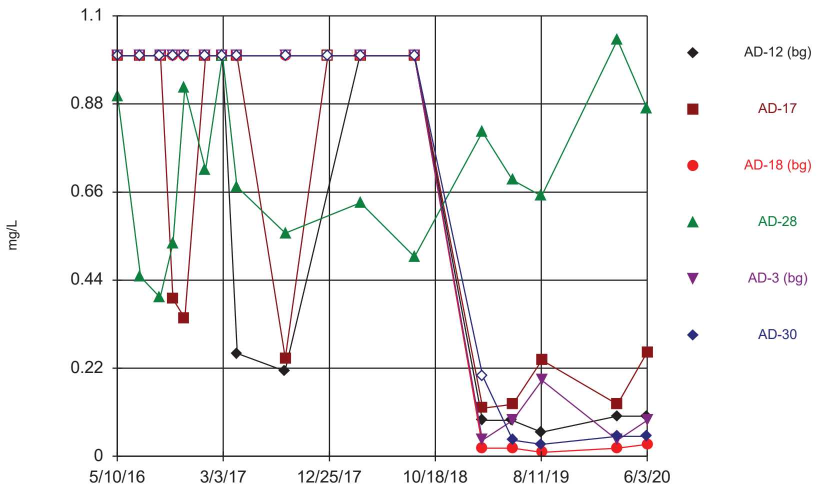
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG



Constituent: Combined Radium 226 + 228   Analysis Run 9/1/2020 1:39 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

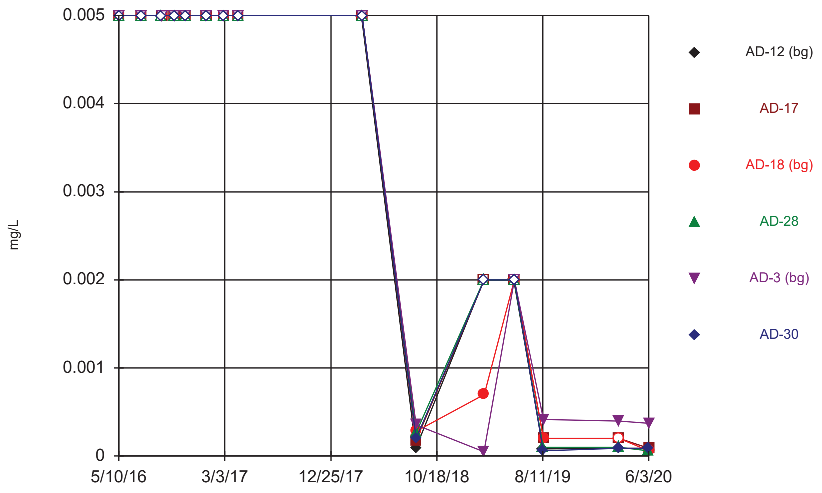
Time Series



Constituent: Fluoride, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

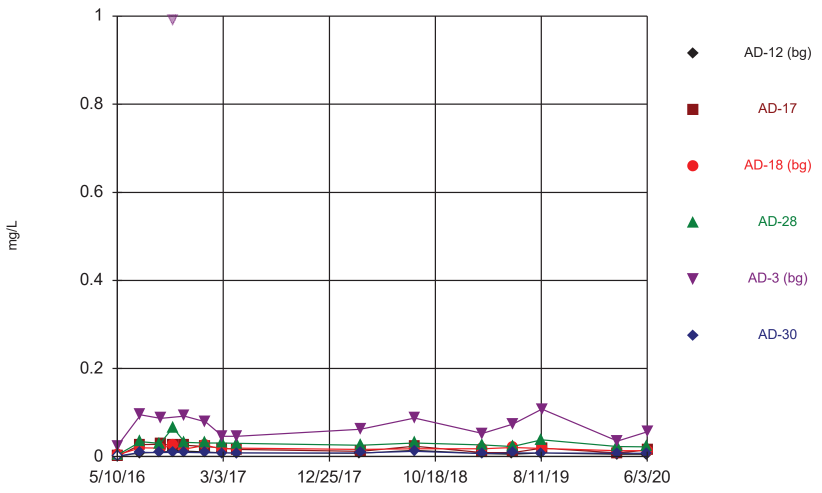
Time Series



Constituent: Lead, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

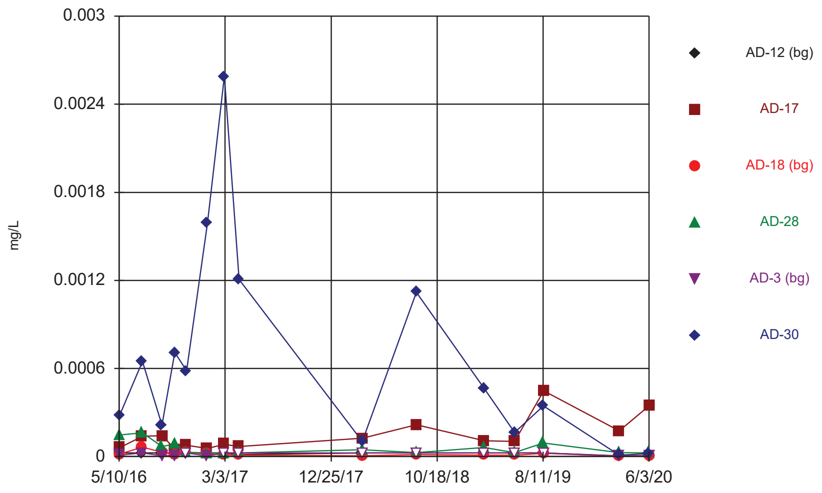
Time Series



Constituent: Lithium, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

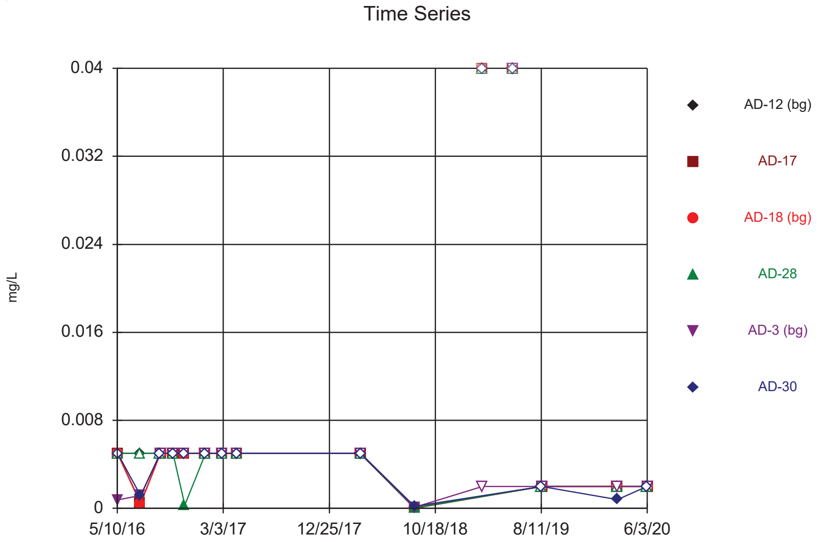
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



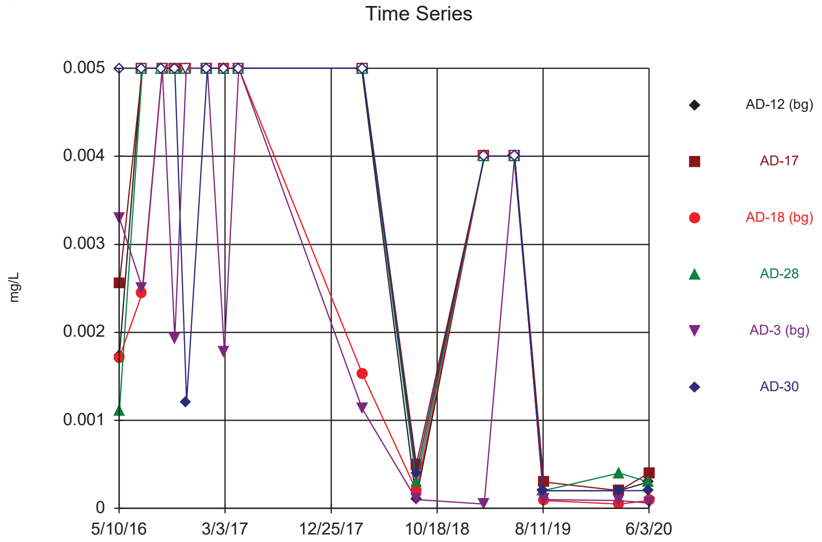
Constituent: Mercury, total Analysis Run 9/1/2020 1:39 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



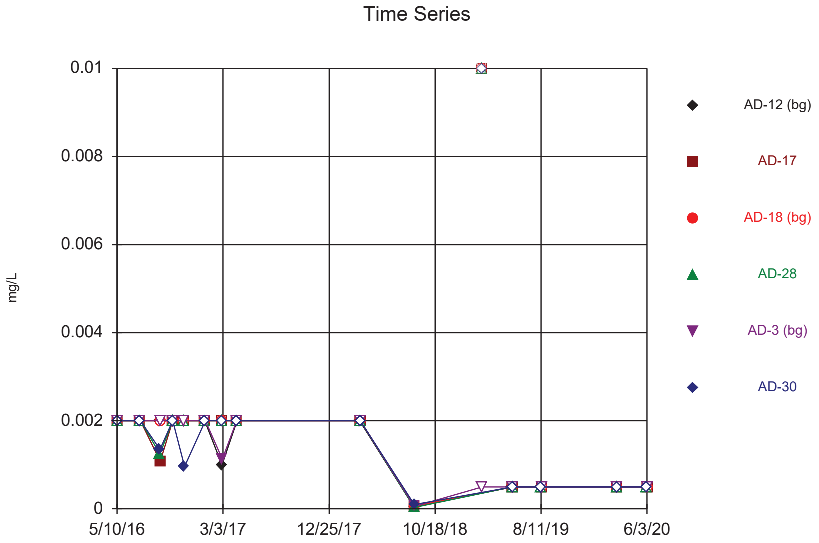
Constituent: Molybdenum, total   Analysis Run 9/1/2020 1:39 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



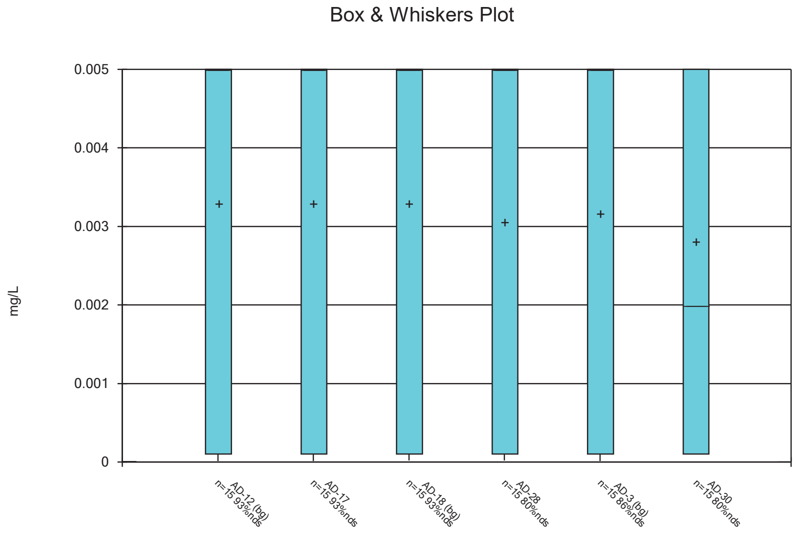
Constituent: Selenium, total   Analysis Run 9/1/2020 1:39 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



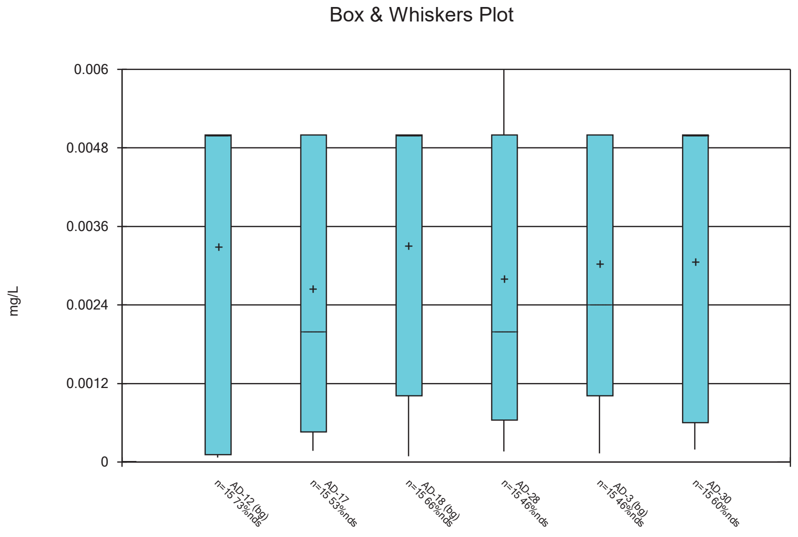
Constituent: Thallium, total   Analysis Run 9/1/2020 1:39 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG



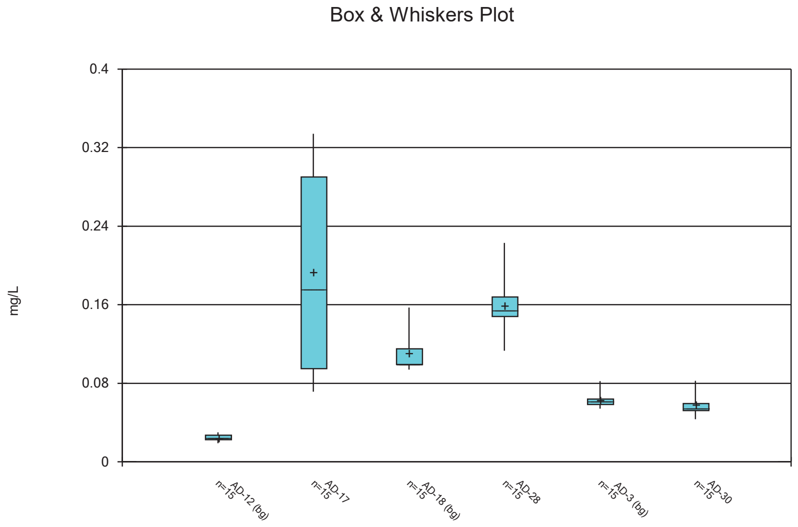
Constituent: Antimony, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG



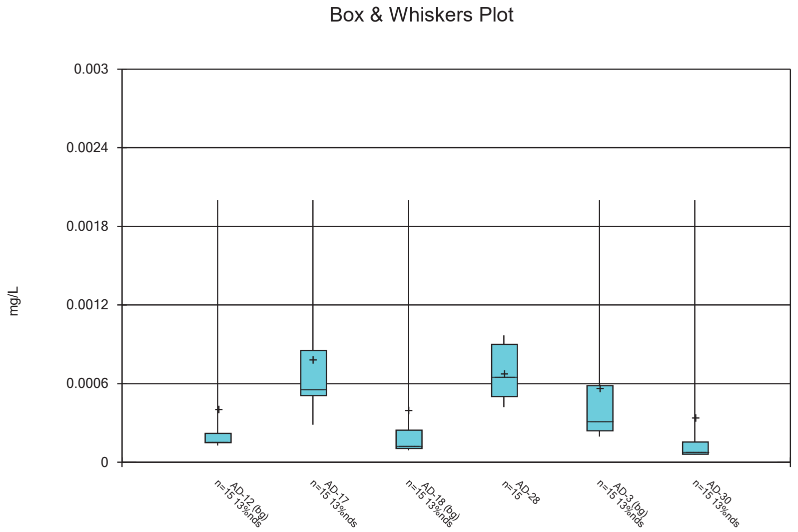
Constituent: Arsenic, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG



Constituent: Barium, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

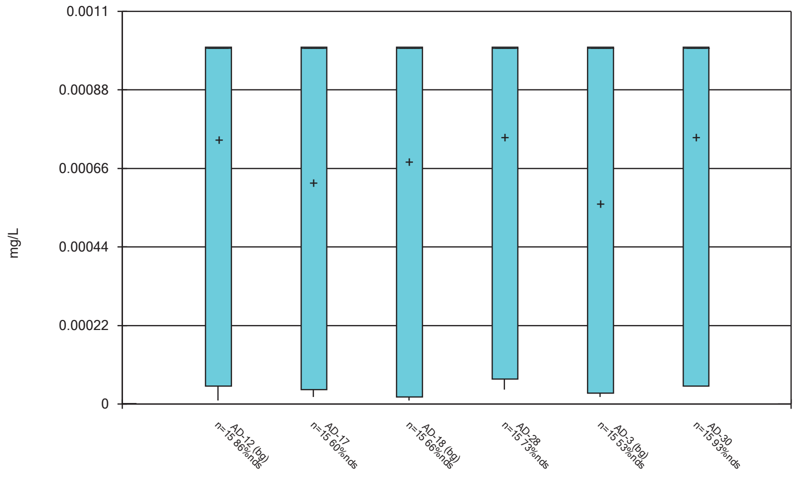
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG



Constituent: Beryllium, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

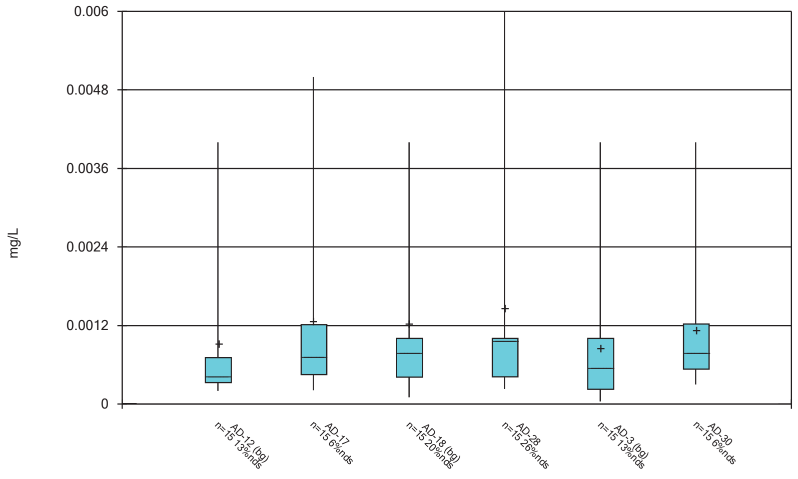
Box & Whiskers Plot



Constituent: Cadmium, total   Analysis Run 9/1/2020 1:42 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

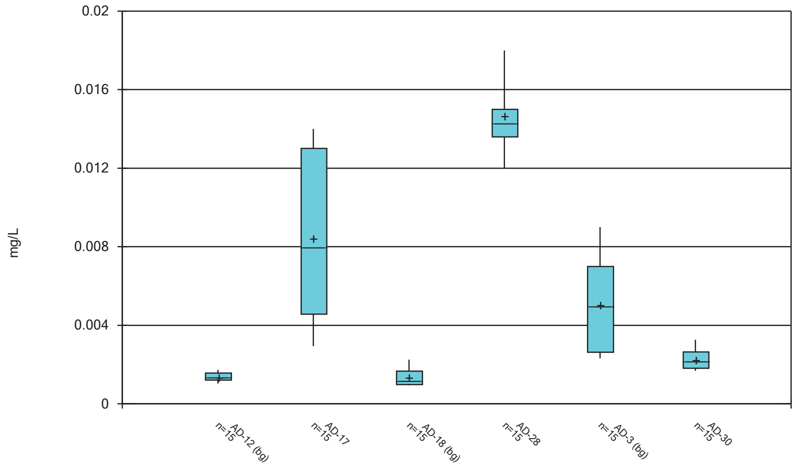
Box & Whiskers Plot



Constituent: Chromium, total   Analysis Run 9/1/2020 1:42 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

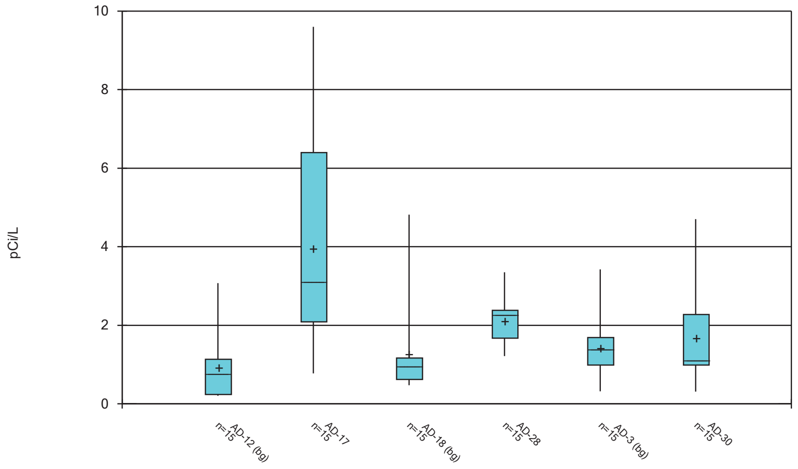
Box & Whiskers Plot



Constituent: Cobalt, total   Analysis Run 9/1/2020 1:42 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

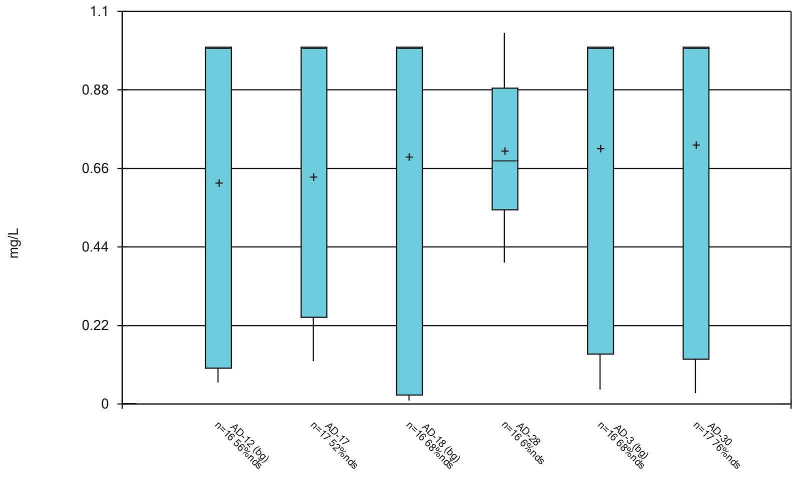
Box & Whiskers Plot



Constituent: Combined Radium 226 + 228   Analysis Run 9/1/2020 1:42 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

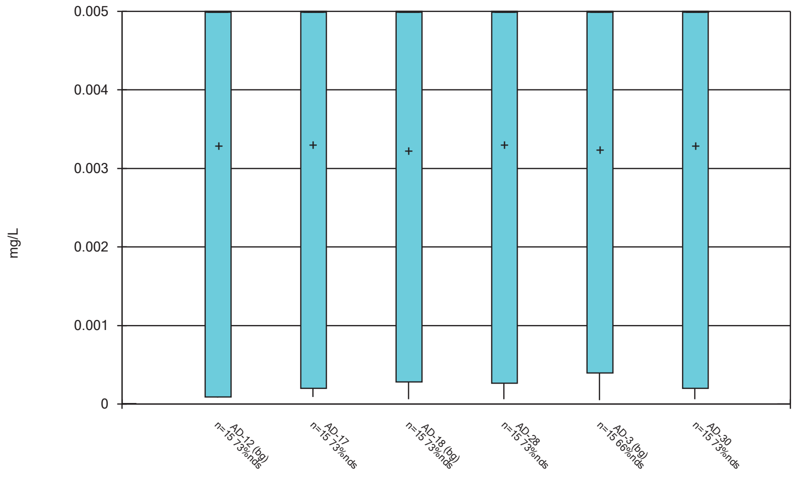
Box & Whiskers Plot



Constituent: Fluoride, total   Analysis Run 9/1/2020 1:42 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

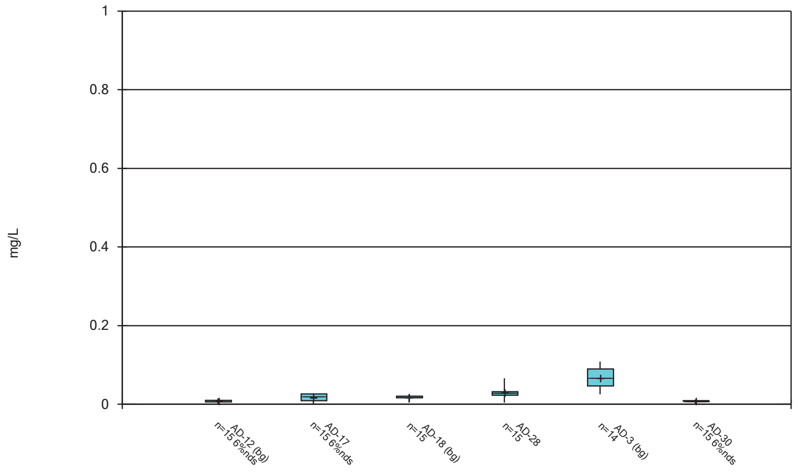
Box & Whiskers Plot



Constituent: Lead, total   Analysis Run 9/1/2020 1:42 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

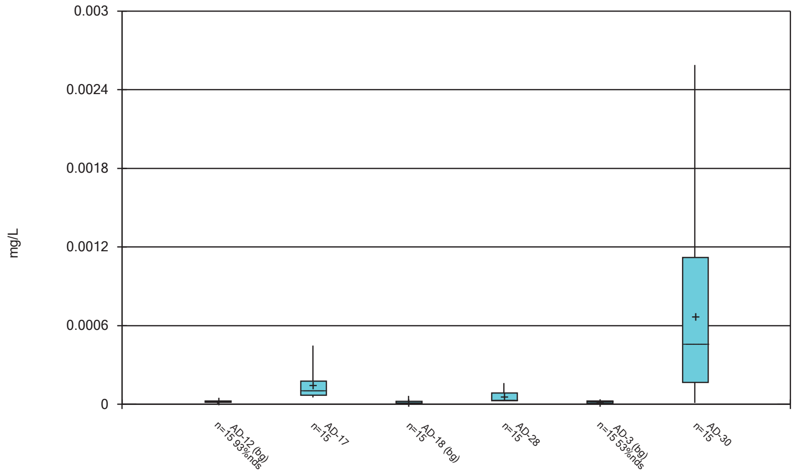
Box & Whiskers Plot



Constituent: Lithium, total   Analysis Run 9/1/2020 1:42 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

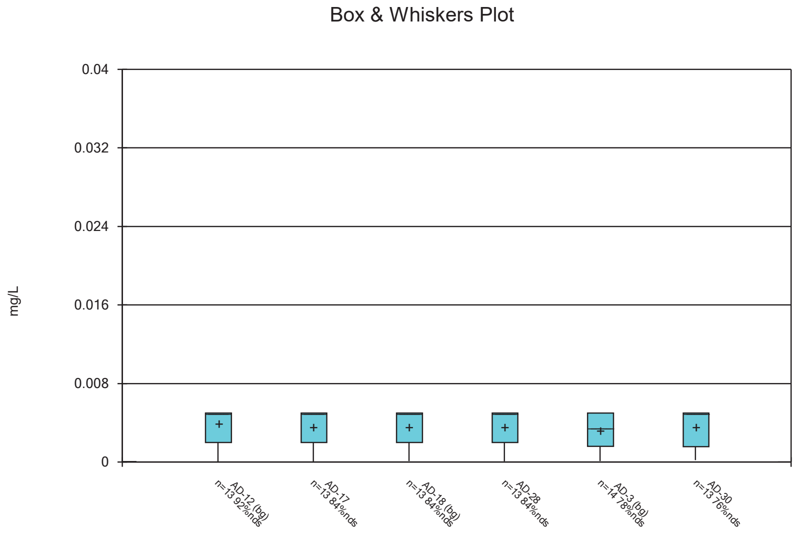
Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Box & Whiskers Plot



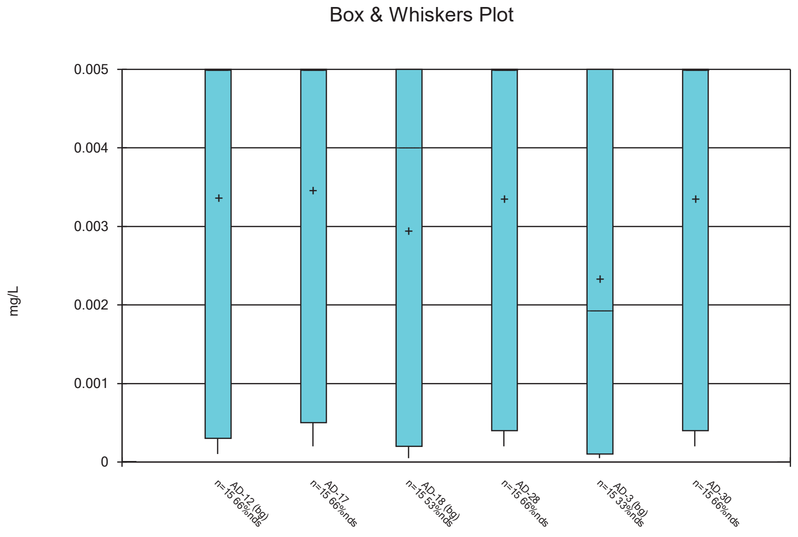
Constituent: Mercury, total   Analysis Run 9/1/2020 1:42 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG



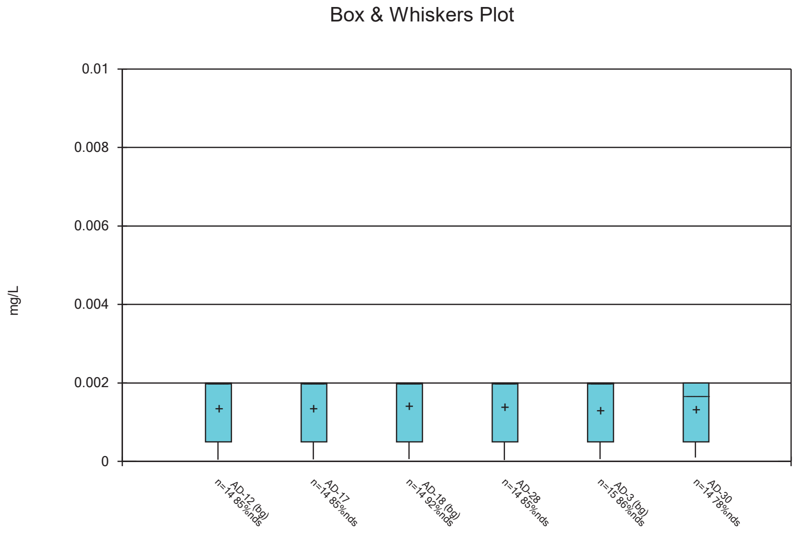
Constituent: Molybdenum, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG



Constituent: Selenium, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG



Constituent: Thallium, total Analysis Run 9/1/2020 1:42 PM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Outlier Summary

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 9/1/2020, 1:43 PM

	AD-3 Lithium, total (mg/L)	AD-12 Molybdenum, total (mg/L)	AD-17 Molybdenum, total (mg/L)	AD-18 Molybdenum, total (mg/L)	AD-28 Molybdenum, total (mg/L)	AD-3 Molybdenum, total (mg/L)	AD-30 Molybdenum, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-17 Thallium, total (mg/L)	AD-18 Thallium, total (mg/L)
10/13/2016	0.991 (o)									
2/27/2019		<0.04 (o)			<0.04 (o)			<0.01 (o)		
2/28/2019			<0.04 (o)	<0.04 (o)			<0.04 (o)		<0.01 (o)	<0.01 (o)
5/21/2019		<0.04 (o)								
5/22/2019					<0.04 (o)					
5/23/2019			<0.04 (o)	<0.04 (o)		<0.04 (o)	<0.04 (o)			

	AD-28 Thallium, total (mg/L)	AD-30 Thallium, total (mg/L)
10/13/2016		
2/27/2019	<0.01 (o)	
2/28/2019		<0.01 (o)
5/21/2019		
5/22/2019		
5/23/2019		

Tolerance Limit Summary Table

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 9/1/2020, 1:46 PM

Constituent	Upper Lim.	Lower Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.005	n/a	n/a	45	n/a	n/a	91.11	n/a	n/a	0.09944	NP Inter(NDs)
Arsenic, total (mg/L)	0.005	n/a	n/a	45	n/a	n/a	62.22	n/a	n/a	0.09944	NP Inter(NDs)
Barium, total (mg/L)	0.157	n/a	n/a	45	n/a	n/a	0	n/a	n/a	0.09944	NP Inter(normality)
Beryllium, total (mg/L)	0.002	n/a	n/a	45	n/a	n/a	13.33	n/a	n/a	0.09944	NP Inter(normality)
Cadmium, total (mg/L)	0.001	n/a	n/a	45	n/a	n/a	68.89	n/a	n/a	0.09944	NP Inter(NDs)
Chromium, total (mg/L)	0.003583	n/a	n/a	45	-7.811	0.942	15.56	Kaplan-Meier	ln(x)	0.01	Inter
Cobalt, total (mg/L)	0.009	n/a	n/a	45	n/a	n/a	0	n/a	n/a	0.09944	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	3.759	n/a	n/a	45	1.025	0.3952	0	None	sqrt(x)	0.01	Inter
Fluoride, total (mg/L)	1	n/a	n/a	48	n/a	n/a	64.58	n/a	n/a	0.08526	NP Inter(NDs)
Lead, total (mg/L)	0.005	n/a	n/a	45	n/a	n/a	71.11	n/a	n/a	0.09944	NP Inter(NDs)
Lithium, total (mg/L)	0.1261	n/a	n/a	44	0.2824	0.09431	2.273	None	x^(1/3)	0.01	Inter
Mercury, total (mg/L)	0.000064	n/a	n/a	45	n/a	n/a	48.89	n/a	n/a	0.09944	NP Inter(normality)
Molybdenum, total (mg/L)	0.005	n/a	n/a	40	n/a	n/a	85	n/a	n/a	0.1285	NP Inter(NDs)
Selenium, total (mg/L)	0.005	n/a	n/a	45	n/a	n/a	51.11	n/a	n/a	0.09944	NP Inter(NDs)
Thallium, total (mg/L)	0.002	n/a	n/a	43	n/a	n/a	88.37	n/a	n/a	0.1102	NP Inter(NDs)

PIRKEY WBAP GWPS				
Constituent Name	**MCL**	**CCR Rule-Specified**	**Background Limit**	**GWPS**
Antimony, Total (mg/L)	0.006		0.005	0.006
Arsenic, Total (mg/L)	0.01		0.005	0.01
Barium, Total (mg/L)	2		0.16	2
Beryllium, Total (mg/L)	0.004		0.002	0.004
Cadmium, Total (mg/L)	0.005		0.001	0.005
Chromium, Total (mg/L)	0.1		0.0036	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.009	0.009
Combined Radium, Total (pCi/L)	5		3.8	5
Fluoride, Total (mg/L)	4		1	4
Lead, Total (mg/L)	0.015		0.005	0.015
Lithium, Total (mg/L)	n/a	0.04	0.13	0.13
Mercury, Total (mg/L)	0.002		0.000064	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.005	0.1
Selenium, Total (mg/L)	0.05		0.005	0.05
Thallium, Total (mg/L)	0.002		0.002	0.002

**Grey cell indicates Background Limit is higher than MCL or CCR Rule-Specified Level*

**MCL = Maximum Contaminant Level*

**GWPS = Groundwater Protection Standard*

**CCR = Coal Combustion Resdiual*

Confidence Intervals Summary Table - Significant Results

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 9/1/2020, 1:47 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-28**	**0.01584**	**0.01341**	**0.009**	**Yes**	**15**	**0.01463**	**0.001788**	**0**	**None**	**No**	**0.01**	**Param.**

Confidence Intervals Summary Table - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 9/1/2020, 1:47 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	AD-17	0.005	0.0001	0.006	No	15	0.003287	0.002251	93.33	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-28	0.005	0.0001	0.006	No	15	0.003056	0.002244	80	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-30	0.005	0.0001	0.006	No	15	0.002807	0.002216	80	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-17	0.005	0.00041	0.01	No	15	0.002649	0.002064	53.33	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-28	0.00179	0.000318	0.01	No	15	0.002806	0.002111	46.67	Kaplan-Meier	sqrt(x)	0.01	Param.
Arsenic, total (mg/L)	AD-30	0.005	0.00023	0.01	No	15	0.003062	0.002207	60	Kaplan-Meier	No	0.01	NP (NDs)
Barium, total (mg/L)	AD-17	0.2575	0.1299	2	No	15	0.1937	0.0942	0	None	No	0.01	Param.
Barium, total (mg/L)	AD-28	0.1731	0.143	2	No	15	0.1588	0.02303	0	None	ln(x)	0.01	Param.
Barium, total (mg/L)	AD-30	0.0629	0.052	2	No	15	0.05791	0.009988	0	None	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-17	0.0009604	0.0004649	0.004	No	15	0.0007789	0.0005239	13.33	None	ln(x)	0.01	Param.
Beryllium, total (mg/L)	AD-28	0.0008109	0.0005478	0.004	No	15	0.0006793	0.0001941	0	None	No	0.01	Param.
Beryllium, total (mg/L)	AD-30	0.0001554	0.0000607	0.004	No	15	0.000342	0.0006739	13.33	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-17	0.001	0.00004	0.005	No	15	0.00062	0.000482	60	None	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-28	0.001	0.00005	0.005	No	15	0.0007473	0.0004337	73.33	None	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-30	0.001	0.00005	0.005	No	15	0.0007467	0.0004349	93.33	None	No	0.01	NP (NDs)
Chromium, total (mg/L)	AD-17	0.001516	0.0004663	0.1	No	15	0.001259	0.001397	6.667	None	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-28	0.001076	0.0003645	0.1	No	15	0.001473	0.001732	26.67	Kaplan-Meier	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-30	0.0014	0.00053	0.1	No	15	0.001132	0.001032	6.667	None	ln(x)	0.01	Param.
Cobalt, total (mg/L)	AD-17	0.01119	0.005565	0.009	No	15	0.008376	0.004148	0	None	No	0.01	Param.
Cobalt, total (mg/L)	**AD-28**	**0.01584**	**0.01341**	**0.009**	**Yes**	**15**	**0.01463**	**0.001788**	**0**	**None**	**No**	**0.01**	**Param.**
Cobalt, total (mg/L)	AD-30	0.002581	0.001905	0.009	No	15	0.002243	0.0004988	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-17	5.699	2.199	5	No	15	3.949	2.583	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-28	2.502	1.741	5	No	15	2.122	0.5619	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-30	2.351	0.7361	5	No	15	1.661	1.366	0	None	sqrt(x)	0.01	Param.
Fluoride, total (mg/L)	AD-17	1	0.24	4	No	17	0.639	0.4004	52.94	None	No	0.01	NP (NDs)
Fluoride, total (mg/L)	AD-28	0.8371	0.5796	4	No	16	0.7084	0.1979	6.25	None	No	0.01	Param.
Fluoride, total (mg/L)	AD-30	1	0.05	4	No	17	0.7276	0.4364	76.47	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-17	0.005	0.0002	0.015	No	15	0.003311	0.002214	73.33	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-28	0.005	0.0001	0.015	No	15	0.003302	0.002229	73.33	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-30	0.005	0.00009	0.015	No	15	0.003296	0.002238	73.33	None	No	0.01	NP (NDs)
Lithium, total (mg/L)	AD-17	0.02305	0.01185	0.13	No	15	0.01745	0.008263	6.667	None	No	0.01	Param.
Lithium, total (mg/L)	AD-28	0.034	0.0226	0.13	No	15	0.02977	0.01269	0	None	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-30	0.009627	0.007251	0.13	No	15	0.008224	0.002313	6.667	None	x^2	0.01	Param.
Mercury, total (mg/L)	AD-17	0.0001951	0.00007579	0.002	No	15	0.0001463	0.0001132	0	None	x^(1/3)	0.01	Param.
Mercury, total (mg/L)	AD-28	0.000092	0.000026	0.002	No	15	0.0000584	0.00004511	0	None	No	0.01	NP (normality)
Mercury, total (mg/L)	AD-30	0.0009903	0.0001826	0.002	No	15	0.0006697	0.0007057	0	None	sqrt(x)	0.01	Param.
Molybdenum, total (mg/L)	AD-17	0.005	0.0004858	0.1	No	13	0.003577	0.001955	84.62	None	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-28	0.005	0.0002942	0.1	No	13	0.003565	0.001976	84.62	None	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-30	0.005	0.0008	0.1	No	13	0.003549	0.001962	76.92	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-17	0.005	0.0004	0.05	No	15	0.003464	0.002055	66.67	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-28	0.005	0.0003	0.05	No	15	0.003354	0.002153	66.67	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-30	0.005	0.0002	0.05	No	15	0.003347	0.002166	66.67	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-17	0.002	0.0005	0.002	No	14	0.001366	0.0007859	85.71	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-28	0.002	0.0005	0.002	No	14	0.001377	0.0007851	85.71	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-30	0.002	0.0005	0.002	No	14	0.001315	0.0007619	78.57	None	No	0.01	NP (NDs)

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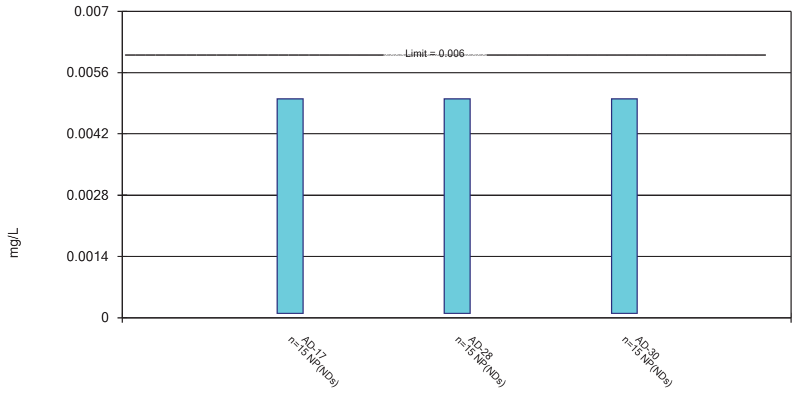
Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

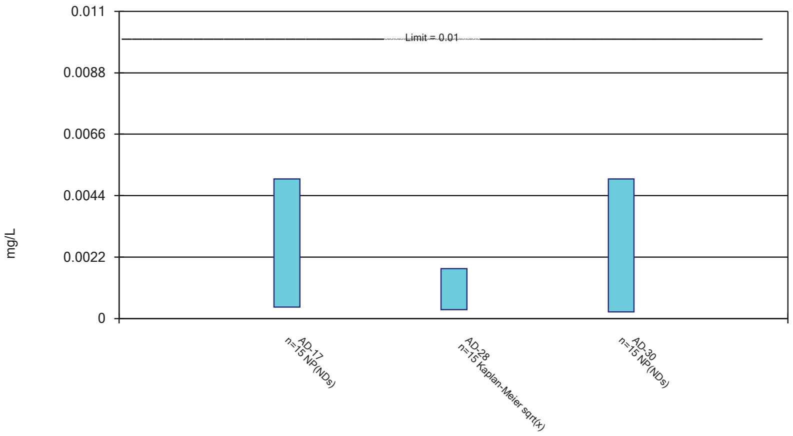


Constituent: Antimony, total   Analysis Run 9/1/2020 1:47 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

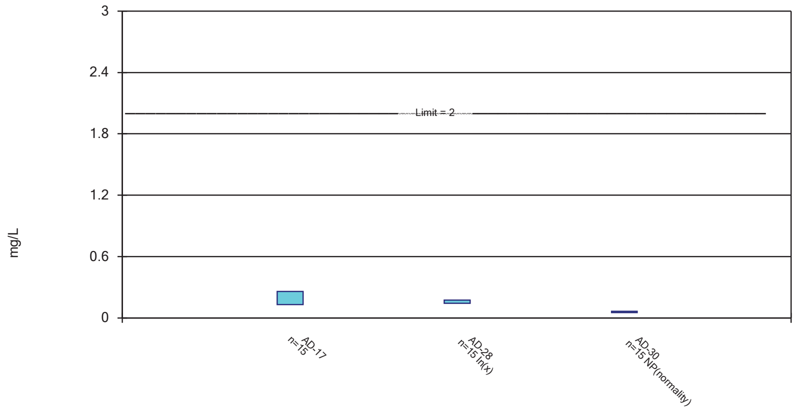


Constituent: Arsenic, total   Analysis Run 9/1/2020 1:47 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

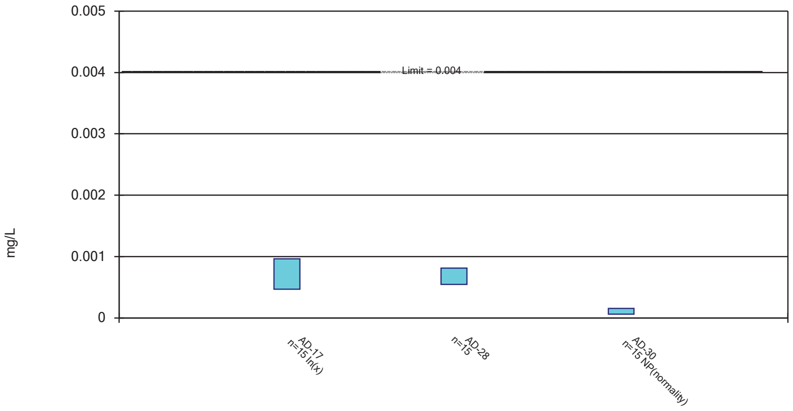


Constituent: Barium, total   Analysis Run 9/1/2020 1:47 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

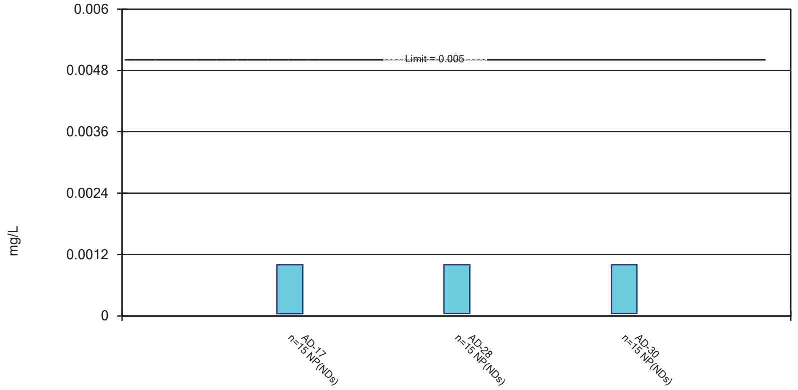


Constituent: Beryllium, total   Analysis Run 9/1/2020 1:47 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

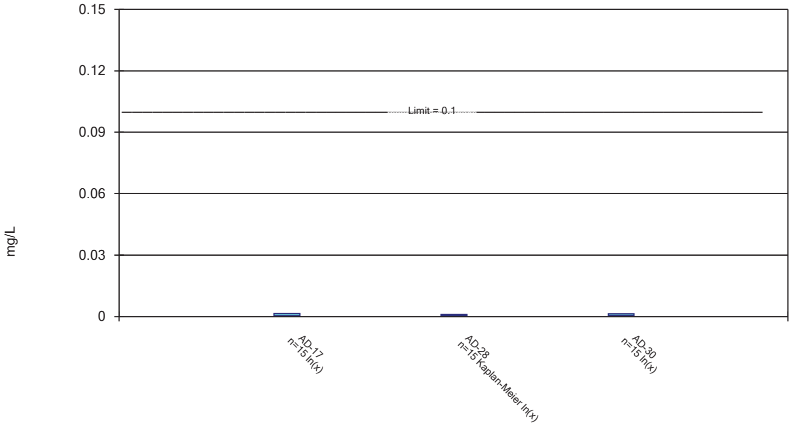


Constituent: Cadmium, total   Analysis Run 9/1/2020 1:47 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

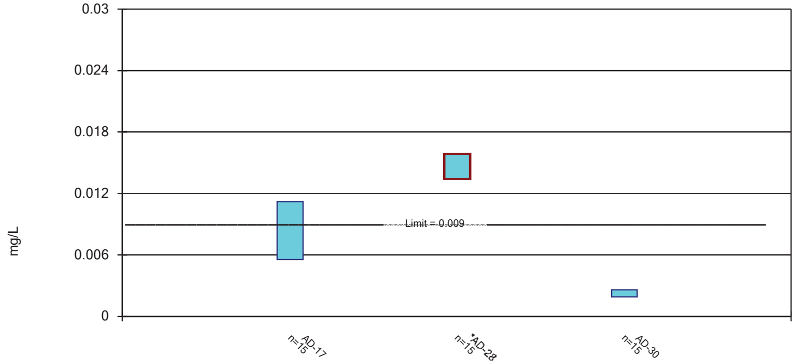


Constituent: Chromium, total   Analysis Run 9/1/2020 1:47 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

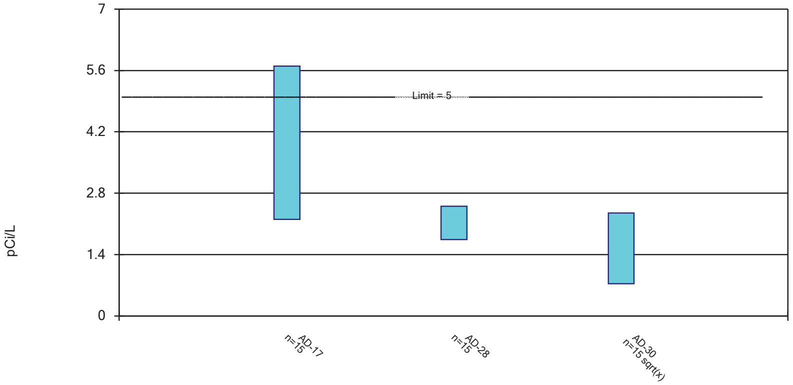


Constituent: Cobalt, total   Analysis Run 9/1/2020 1:47 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

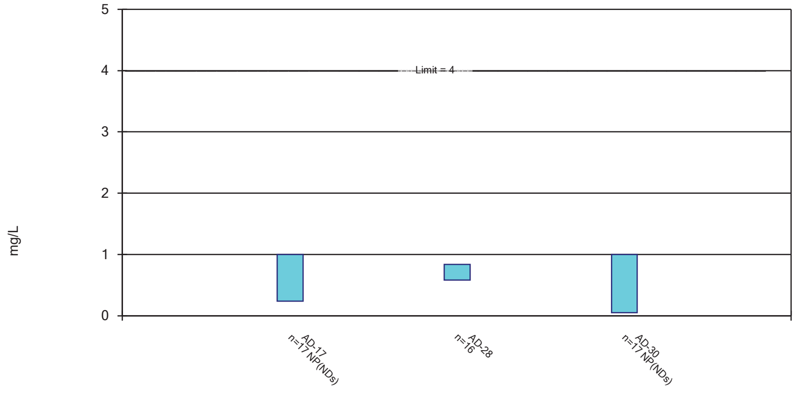


Constituent: Combined Radium 226 + 228   Analysis Run 9/1/2020 1:47 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



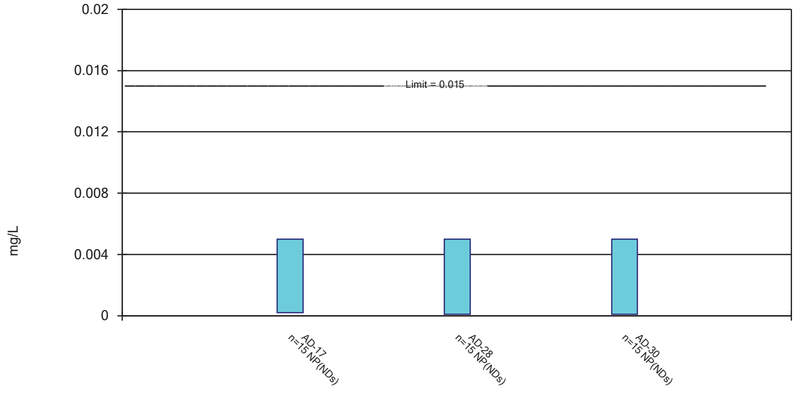
Constituent: Fluoride, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



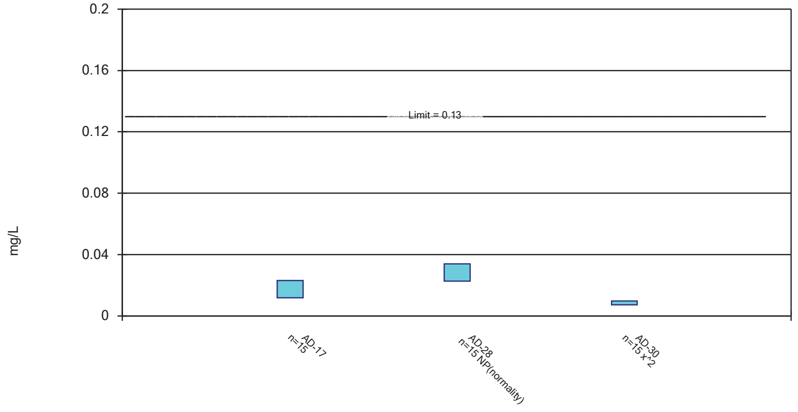
Constituent: Lead, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



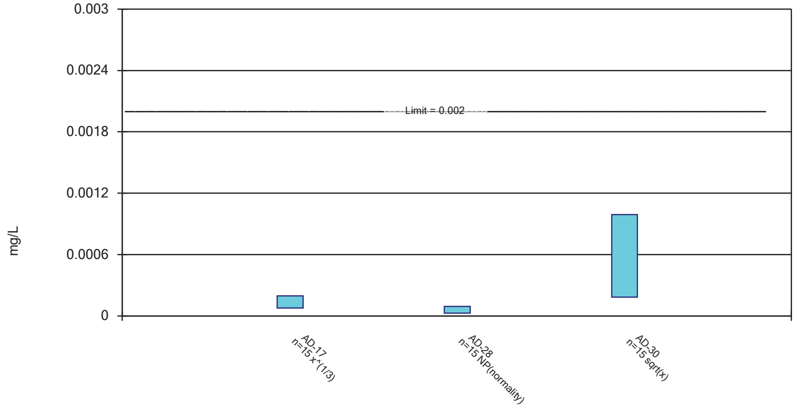
Constituent: Lithium, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



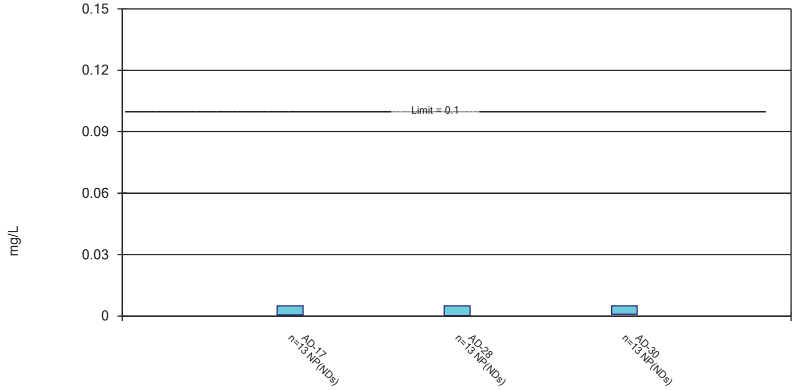
Constituent: Mercury, total Analysis Run 9/1/2020 1:47 PM View: Appendix IV

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

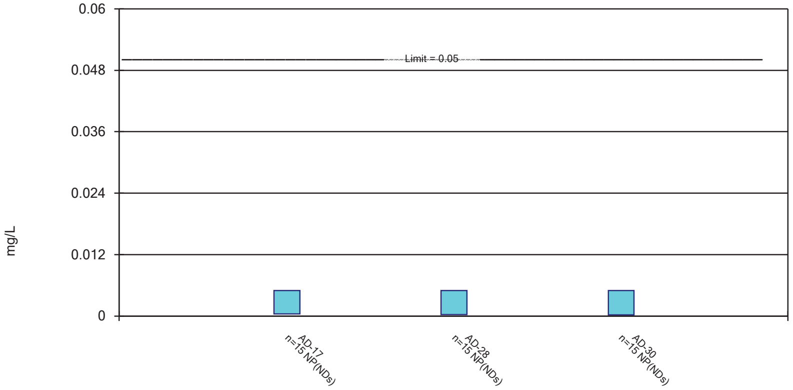


Constituent: Molybdenum, total   Analysis Run 9/1/2020 1:47 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

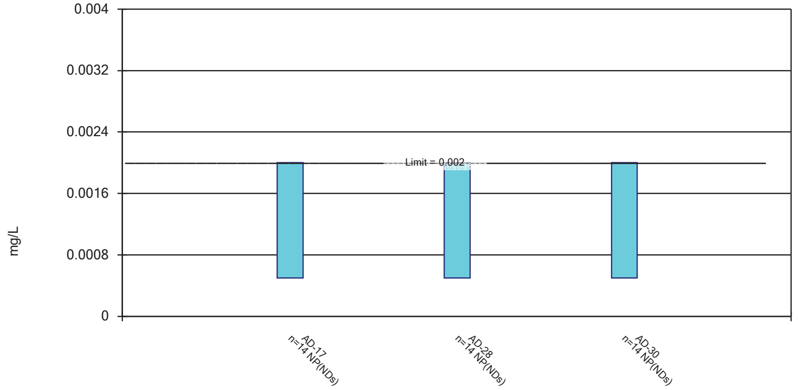


Constituent: Selenium, total   Analysis Run 9/1/2020 1:47 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Thallium, total   Analysis Run 9/1/2020 1:47 PM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT
FEDERAL CCR RULE

H.W. Pirkey Power Plant
West Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants
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941 Chatham Lane
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April 2, 2020

CHA8495

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ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopy
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
VAP	Vertical Aquifer Profiling
WBAP	West Bottom Ash Pond
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the West Bottom Ash Pond (WBAP, Figure 1). In August 2019, a semi-annual assessment monitoring event was conducted at the WBAP in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were re-established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or, for constituents without an MCL, the risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were re-calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). At the WBAP, an SSL was identified for cobalt at AD-28, where the LCL of 0.0132 milligrams per liter (mg/L) exceeded the calculated GWPS of 0.009 mg/L (Geosyntec, 2020). No other SSLs were identified.

1.1 CCR Rule Requirements

USEPA regulations regarding assessment monitoring programs for coal combustion residuals CCR landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for cobalt at AD-28 is from a source other than the WBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSL identified for cobalt at AD-28 was based on a Type IV cause and not by a release from the Pirkey WBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSL identified for cobalt and the proposed alternative source are described below.

2.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSL has been attributed to natural variation associated with the underlying geology, which is a Type IV (natural variation) issue.

Monitoring well AD-28 is located near the southwest corner of the WBAP, as shown in Figure 1. Two previous ASDs for cobalt at the WBAP provided evidence to show that cobalt is present in the aquifer media at the site and that the observed cobalt concentrations were due to natural variation (Geosyntec, 2019a; Geosyntec, 2019b). The previous ASDs discussed how the WBAP itself did not appear to be a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP leachate above the reporting limit of 0.01 mg/L. Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions. SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. Cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

Cobalt was also not detected above the reporting limit of 0.005 mg/L in a grab sample of the pond water. As shown in Table 1, the reporting limits for the SPLP ash leachate test and pond water analysis are both below the average concentration of cobalt for samples collected at AD-28 for compliance under the Federal CCR Rule (0.0145 mg/L). Since the previous ASD was prepared, there have been no notable changes in coal handling or sourcing at the plant that would have affected the composition of the ash or pond water.

Four additional permanent wells (B-2, B-3, AD-40, and AD-41) were installed upgradient of the WBAP in 2019. These upgradient locations were selected to represent conditions at the facility which are unimpacted by site operations. The most recent data available for select wells in the vicinity of the WBAP, as well as the upgradient locations, are shown in Figure 2. Groundwater cobalt concentrations at upgradient locations vary from 0.000799 mg/L to 0.0345 mg/L at AD-40 and B-3, respectively. This wide range in cobalt concentrations provides further evidence for the natural variation of cobalt at the Site, particularly as the concentrations at upgradient well B-3 exceed both the GWPS for the WBAP and the LCL calculated for cobalt at AD-28 (the well of interest).

As noted in the previous two ASDs, soil samples collected across the site, including from locations near the WBAP, identified cobalt in the aquifer solids at varying concentrations. While no additional soil samples were collected in support of this ASD, soil sampling data from select upgradient and downgradient locations from the previous investigations are summarized in Table 2 and Figure 3. Cobalt was identified in the aquifer solids at varying concentrations, with the highest value of 23.5 milligrams per kilogram (mg/kg) reported at AD-41, which is upgradient of the WBAP (Figure 3). Other testing included collection of aquifer solids to evaluate for the presence of cobalt-containing minerals. X-ray diffraction evidence identified pyrite and marcasite (both iron sulfides) at select locations at concentrations up to 3% by weight (Table 2). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2017).

Groundwater samples were collected from upgradient location B-3 via vertical aquifer profiling (VAP), as described in an ASD previously generated for the Pirkey Plant's East Bottom Ash Pond (EBAP; Geosyntec, 2019c). The VAP groundwater samples were centrifuged to separate solid and liquid phases, and the solid material was submitted for analysis of total metals and mineralogy by X-ray diffraction (XRD). The samples were also submitted for analysis of chemical composition and mineralogy by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Following installation of permanent monitoring wells at B-2 and B-3, groundwater samples were collected by purging groundwater through the filter pack using a submersible pump. An additional groundwater sample was collected at AD-30. These permanent well groundwater samples were filtered through a 1.5-micron filter, and the solid material retained on the filter was submitted for analysis of total metals and by SEM/EDS.

Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient VAP location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from permanent monitoring wells B-2 and B-3 (Table 2). Cobalt was detected in the solid material filtered out of groundwater at AD-30 at an estimated value of 9.3 mg/kg, which is comparable to the concentration observed in bulk soil collected at the same location at the screened interval (15 mg/kg). These results provide further evidence that cobalt concentrations reported during groundwater sampling are naturally occurring and associated with the solid phase in the aquifer.

According to XRD results of the centrifuged solid sample [VAP-B3-(40-45)], pyrite was present as approximately 3% of the solid phase (Table 3). Logging completed while the VAP boring was advanced identified coal at several intervals, including 45 and 48 ft bgs (Figure 4). Furthermore, SEM/EDS of both centrifuged solid samples [VAP-B3-(40-45) and VAP-B3-(50-55)] identified pyrite in backscattered electron micrographs by the distinctive framboid pattern (Harris et al., 1981; Sawlowicz, 2000). Major peaks involving iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (Attachment A). While cobalt was not identified in the EDS spectrum, it is likely present at concentrations below the detection limit.

Pyrite was also identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site.

In addition to pyrite, hematite (an iron(III) oxide) was present at 2% of the centrifuged solid sample (Table 3). Weathering of pyrite to hematite is a known phenomenon in east Texas soils (Dixon, et al., 1982); the adsorption of cobalt to hematite is a documented mechanism which provides an additional pathway for cobalt to enter groundwater from the soil system (McLaren et al., 1986; Borggaard, 1987).

While soil analytical and mineralogical data are not available for AD-28, the wide distribution of iron minerals across the site suggests that naturally occurring cobalt, which is known to substitute for iron in pyrite or adsorb to hematite, may also be present in the aquifer solids near AD-28. The presence of lignite in the area is well-documented, including at upgradient and downgradient locations relative to the WBAP (Broom and Myers, 1966; ETTL, 2010). Additionally, the pond was not identified as the source of cobalt at AD-28 in the previous two ASDs based on the documented low mobility of cobalt under the pond conditions and lack of detectable cobalt in the pond itself.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSL is not due to a release from the Pirkey WBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of cobalt for AD-28 identified during assessment monitoring in August 2019 was not due to a release from the WBAP. The identified SSL was, instead, attributed to natural variation in the underlying geology, including the presence of pyrite or marcasite and hematite in the solid aquifer material. Therefore, no further action is warranted, and the Pirkey WBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

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TABLES

Table 1: Summary of Key Analytical Data
West Bottom Ash Pond - H.W. Pirkey Plant

Sample	Unit	Cobalt Concentration
Bottom Ash	mg/kg	5.8
SPLP Leachate	mg/L	<0.01
WBAP Pond Water	mg/L	<0.005
AD-28 - Average	mg/L	0.0145

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

AD-28 - Average value was calculated using all cobalt data collected under 40 CFR 257 Subpart D.

Table 2: Soil Cobalt and Mineralogy Data
West Bottom Ash Pond - H.W. Pirkey Plant

Location ID	**Sample Depth (ft bgs)**	**Cobalt (mg/kg)**	**Pyrite/Marcasite (%)**
Bulk Soil Samples			
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-41	15	< 1.0	--
	35	23.5	---
	95	1.90	---
B-2	10	2.36	---
	16	3.62	---
	71	10.30	---
	82	7.21	---
	87	3.11	---
B-3	10	1.30	---
	20	0.59	---
	97	1.11	---
Solid Material Retained After Filtration			
AD-30	15-25	9.3 J	--
B-2	38-48	4.3 J	--
B-3	29-34	12.0	--
	VAP 40-45	18.0	3

Notes:

'--' - analysis not completed

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

J = estimated value

For AD-XX locations, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-X locations were collected from cores removed from the borehole during well lithology logging.

Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

Table 3: X-Ray Diffraction Results
West Bottom Ash Pond - H. W. Pirkey Plant

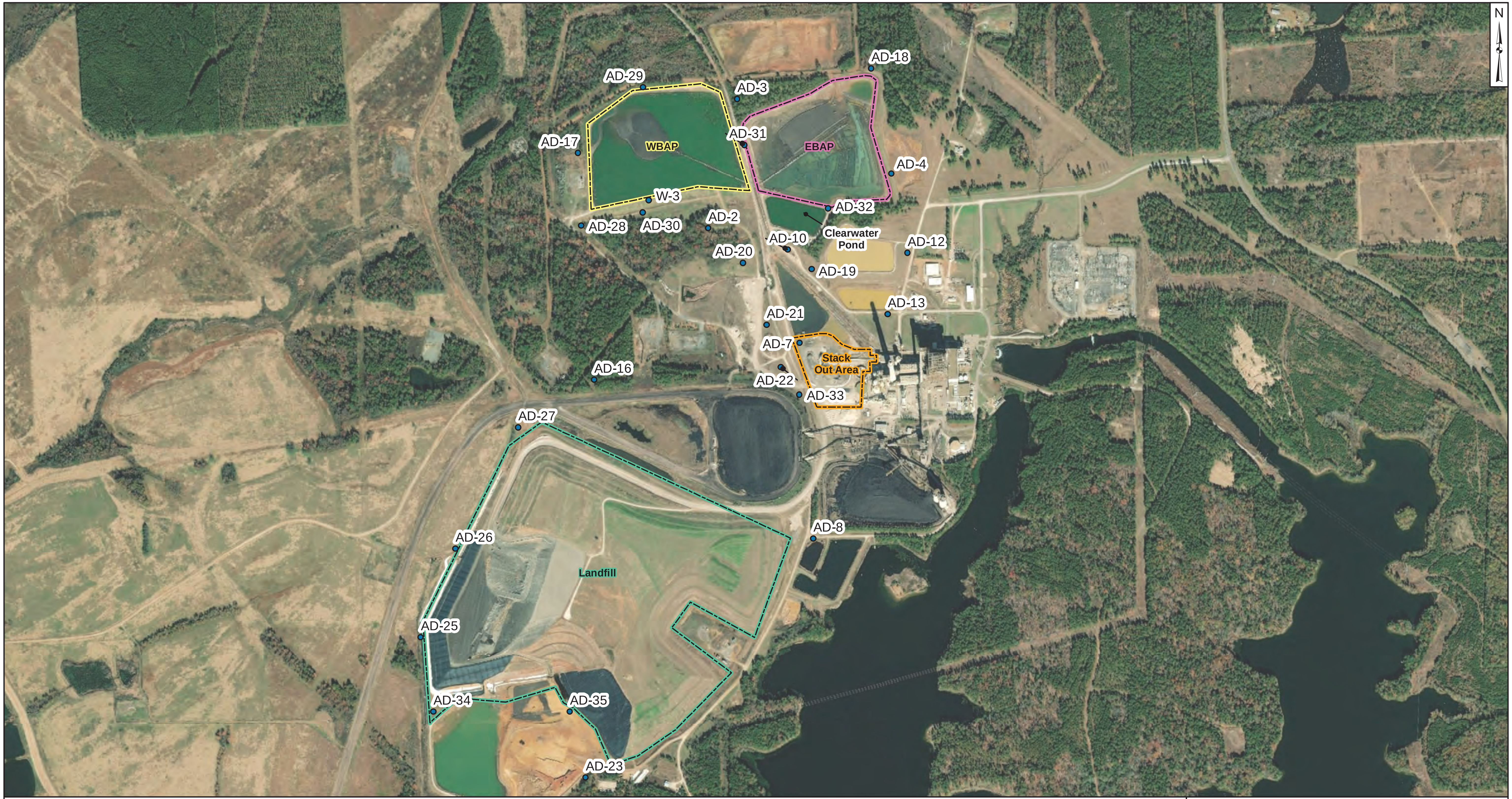
Constituent	**VAP-B3-(40-45)**
Quartz	15
Plagioclase Feldspar	0.5
Orthoclase	ND
Calcite	ND
Dolomite	ND
Siderite	0.5
Goethite	ND
Hematite	2
Pyrite	3
Kaolinte	42
Chlorite	4
Illite/Mica	6
Smectite	12
Amorphous	15

Notes:

ND: Not detected

VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

FIGURES



0 375 750 1,500 2,250 3,000
Feet

Legend

- ● Monitoring Wells
- ▭ EBAP
- ▭ Landfill
- ▭ Stack Out Area
- ▭ WBAP

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

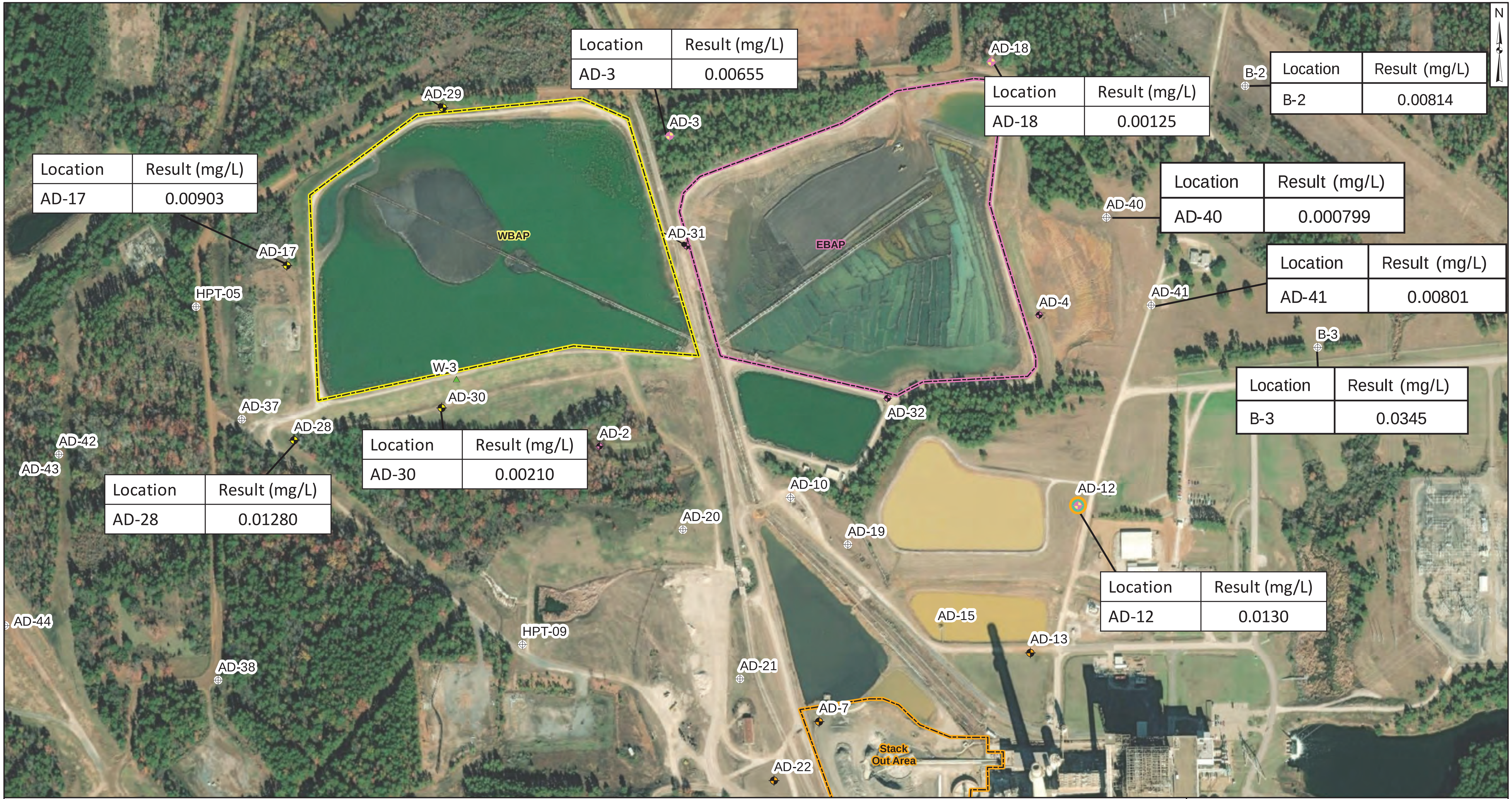
Columbus, Ohio

2020/03/24

Figure

1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_2020324.mxd. hduff. 3/24/2020. Project/Phase/Task.



Legend

- ⌖ Out of Network
- ◆ EBAP
- ◆ WBAP
- ◆ Landfill
- ◆ Stackout Area
- ◆ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- ▭ EBAP
- ▭ Stack Out Area
- ▭ WBAP

Notes

- Monitoring well coordinates, site features, and data provided by AEP

-AD-15 location is approximated

- Samples collected in August 2019

- AD-29 included in the well network for water level measurements only

400 200 0 400 Feet

Cobalt Distribution in Groundwater August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio

2020/03/30

Figure 2

C:\Users\BAres\Documents\AEP_Pirkey_Cobalt_20200319.mxd. BAres. 3/30/2020. Project/Phase/Task.

Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	B-2				
Depth (ft bgs)	10	16	71	82	87
Cobalt (mg/kg)	2.36	3.62	10.30	7.21	3.11
Pyrite/Marcasite (%)	-	-	-	-	-

Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-41		
Depth (ft bgs)	15	35	95
Cobalt (mg/kg)	< 1.0	23.5	1.9
Pyrite/Marcasite (%)	-	-	-

Location	B-3		
Depth (ft bgs)	10	20	97
Cobalt (mg/kg)	1.30	0.59	1.11
Pyrite/Marcasite (%)	-	-	-

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Legend

⌖	Monitoring Wells
▭	EBAP
▭	WBAP

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.

300 150 0 300
Feet

Soil Chemical and Mineralogical Analysis Results

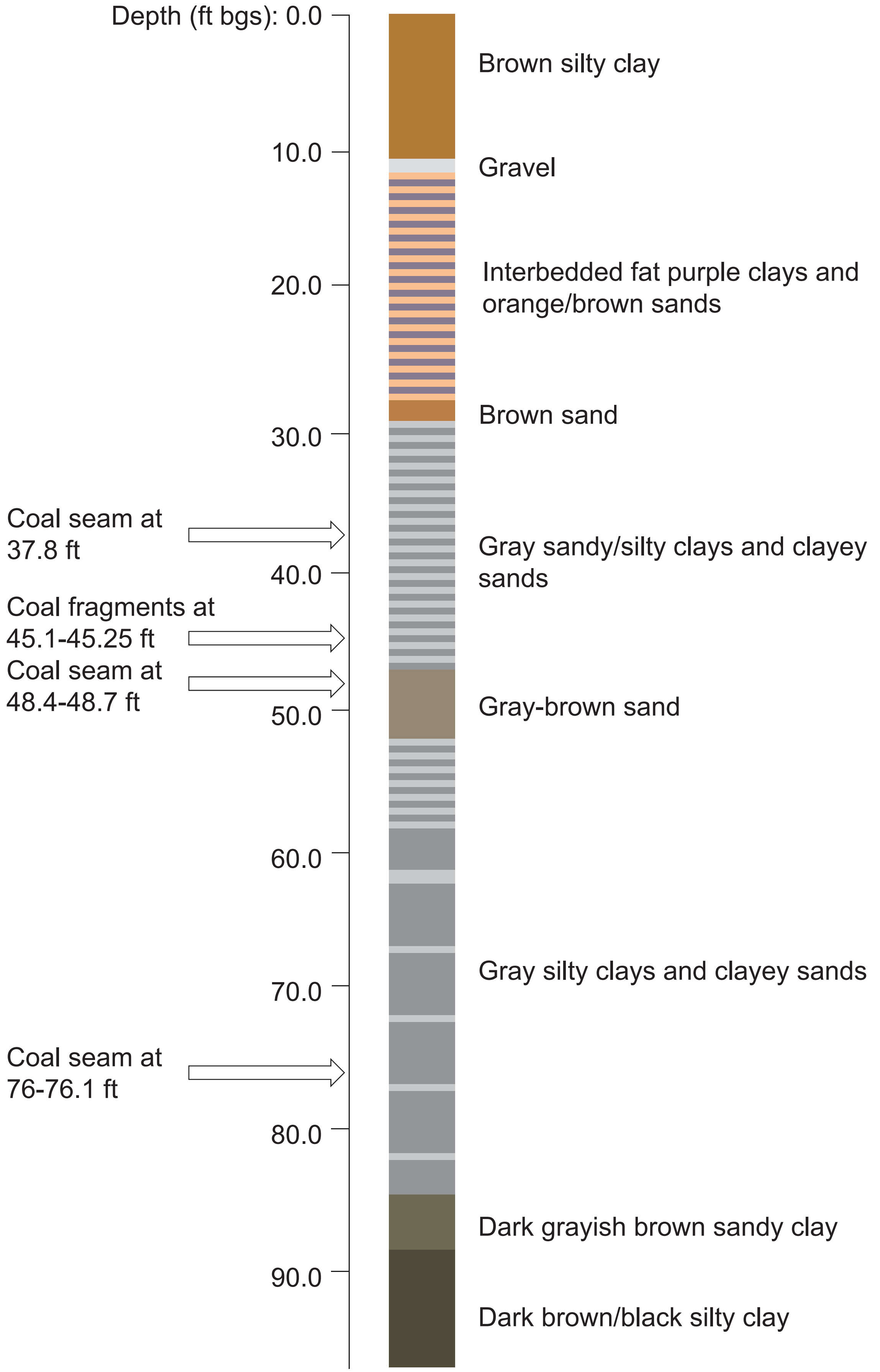
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2020/03/19

Figure
3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\Pirkey_SoilChem_minerals_March2019.mxd. hduff. 9/18/2019. Project/Phase/Task.



Notes:
- Ft = feet
- Bgs = below ground surface
- Boring completed May 2019
- Total depth of 97.5 ft bgs
- Well installed in offset boring screened at 29-34 ft bgs

B-3 Visual Boring Log

AEP Pirkey Powerplant
Hallsville, TX

Geosyntec
consultants

CHA8495 | March 2020

Figure

4

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-05 Field Investigation\Field Forms\Compiled Boring Logs\Visual boring logs

ATTACHMENT A

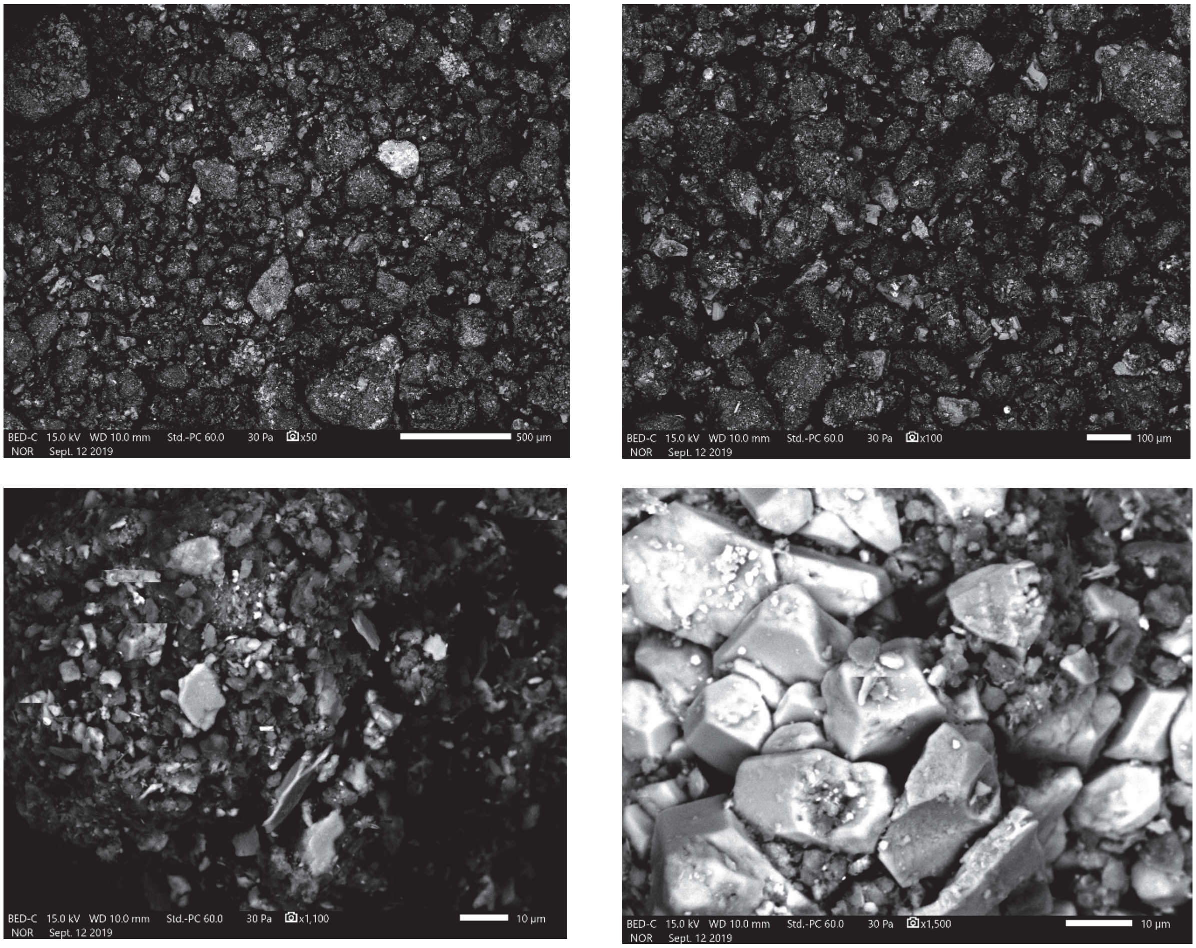
SEM/EDS Analysis

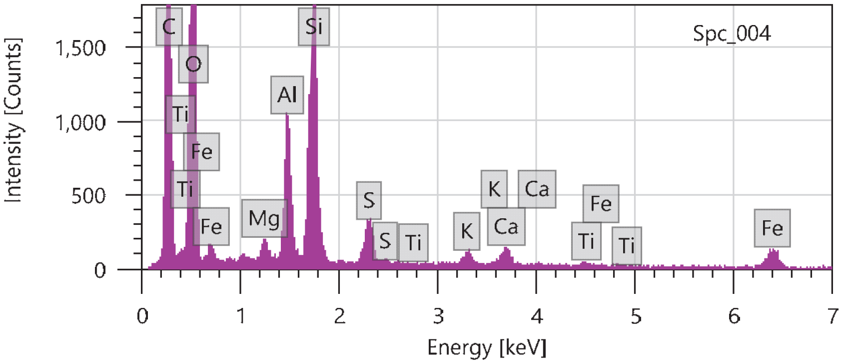
CTLGroup

September 16, 2019

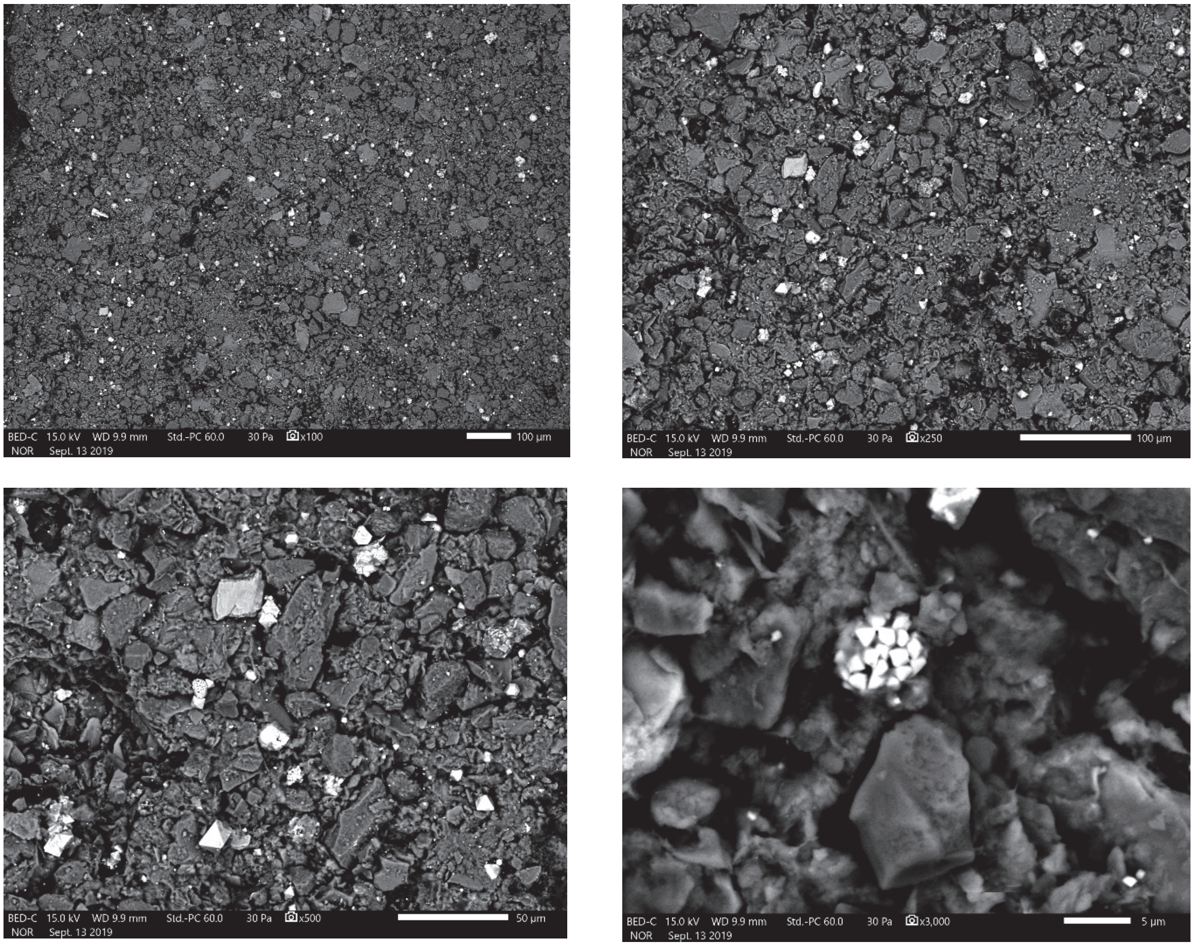
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221

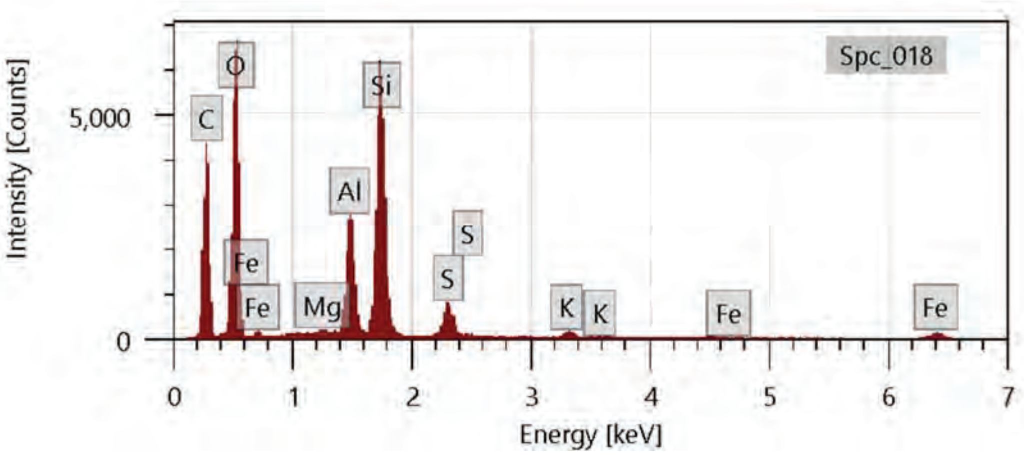
via Email: BSass@geosyntec.com



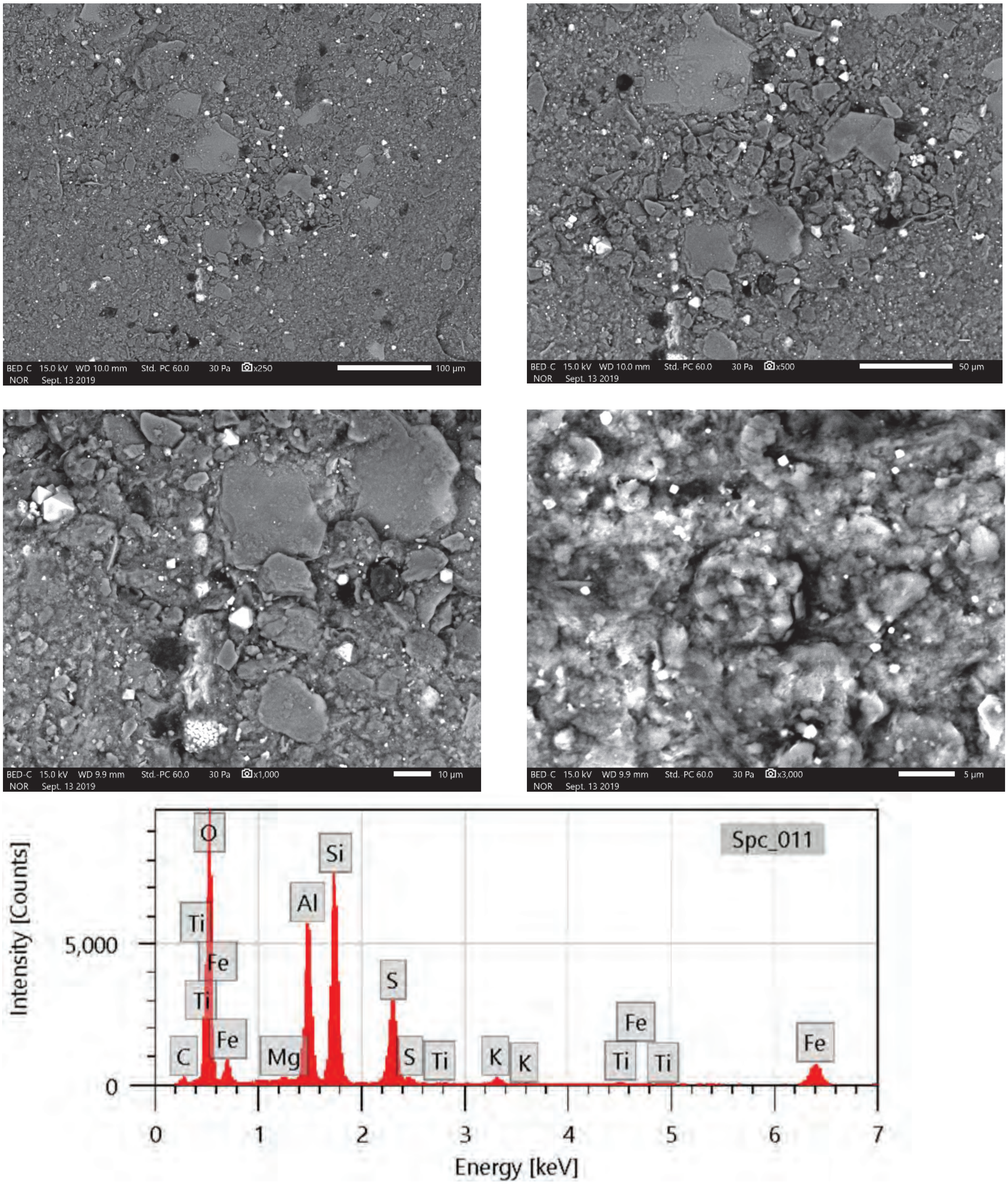


Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.



Sample VAP B3 50-55. Backscattered electron micrographs show the sample at 250X, 500X, 1000X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 3000X. Bright particles are mostly pyrite (framboid in bottom left micrograph); occasional particles of Fe-Ti oxide are detected. Major peaks for oxygen, silicon, and aluminum suggest clay. Large blocky particles are mostly quartz, feldspar, and clay.

ATTACHMENT B

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

BETH ANN GROSS
79864

Geosyntec Consultants
2039 Centre Pointe Blvd, Suite 103
Tallahassee, Florida 32308

Texas Registered Engineering Firm
No. F-1182

79864	Texas	4/2/2020
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
West Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants
engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

December 2020

CHA8495

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopy
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
TCEQ	Texas Commission on Environmental Quality
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
VAP	Vertical Aquifer Profiling
WBAP	West Bottom Ash Pond
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

This Alternative Source Demonstration (ASD) report has been prepared to address a statistically significant level (SSL) for cobalt in the groundwater monitoring network at the H.W. Pirkey Plant Western Bottom Ash Pond (WBAP) following the first semiannual detection monitoring event of 2020. The WBAP is registered as a surface impoundment under Texas Commission on Environmental Quality (TCEQ) Industrial and Hazardous Waste Solid Waste Registration No. 33240.

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the West Bottom Ash Pond (**Figure 1**). In June 2020, a semi-annual assessment monitoring event was conducted at the WBAP in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or, for constituents without an MCL, the risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were re-calculated for Appendix IV parameters at the compliance wells to assess whether these parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). An SSL was identified for cobalt at AD-28 at the WBAP, where the LCL of 0.0134 milligrams per liter (mg/L) exceeded the calculated GWPS of 0.009 mg/L (Geosyntec, 2020a). No other SSLs were identified.

1.1 CCR Rule Requirements

USEPA regulations regarding assessment monitoring programs for CCR landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a*

> *qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section.*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this ASD report to document that the SSL identified for cobalt at AD-28 is from a source other than the WBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSL identified for cobalt at AD-28 was based on a Type IV cause and not by a release from the Pirkey WBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSL identified for cobalt and the proposed alternative source are described below.

2.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. Groundwater sampling, laboratory analysis, and statistical evaluations were generally completed in accordance with the Federal CCR Rule and draft TCEQ guidance for groundwater monitoring (TCEQ, 2020). As described below, the SSL has been attributed to natural variation associated with the underlying geology, which is a Type IV (natural variation) issue.

Monitoring well AD-28 is located near the southwest corner of the WBAP, as shown in **Figure 1**. Previous ASDs for cobalt at the WBAP provided evidence to show that cobalt is present in the aquifer media at the site and that the observed cobalt concentrations were due to natural variation (Geosyntec, 2019a; Geosyntec, 2019b; Geosyntec, 2020b). The previous ASDs discussed how the WBAP itself did not appear to be a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP leachate above the reporting limit of 0.01 mg/L (**Table 1**).

To support this ASD determination, a grab sample of the pond water was collected from the WBAP on November 4, 2020. Cobalt was detected at a concentration of 0.000501 mg/L in the WBAP sample (**Table 1**). This concentration is lower than all reported cobalt concentrations for in network wells from the most recent sampling event, and over an order of magnitude lower than the average concentration observed at AD-28 (**Figure 2; Table 1**). Thus, the WBAP is not the likely source of cobalt at AD-28.

Groundwater cobalt concentrations at the Site vary considerably, even within upgradient monitoring wells. The most recent cobalt concentrations from upgradient wells vary from 0.000799 mg/L at AD-40 to 0.0108 mg/L at B-3 (**Figure 2**). The reported cobalt concentration at downgradient well AD-28, which was identified as an exceedance, was only slightly above the value reported at B-3. The range of cobalt concentrations provides evidence for natural variation of cobalt at the Site, particularly as the concentration at upgradient well B-3 exceeds the GWPS for the WBAP.

As noted in the previous ASDs, soil samples collected across the site, including from locations near the WBAP, identified cobalt in the aquifer solids at varying concentrations. SB-28 was advanced in the vicinity of AD-28 in April 2020 to re-log the geology at AD-28 and collect samples for laboratory analysis of total metals and mineralogy. The SB-28 field boring log, generated by Auckland Consulting LLC, is provided as **Attachment A**. Cobalt was identified at SB-28 at concentrations of 4.53 milligrams per kilogram (mg/kg) at 15.5-16 feet below ground surface (bgs) and 8.70 mg/kg at 40-41 feet bgs (**Table 2**). The 15.5-16 feet bgs interval at SB-28 correlates to the depth of the monitoring well screen of AD-28 (15-35 feet bgs), indicating that cobalt is present in aquifer solids within the AD-28 screened interval. Cobalt was also identified in the aquifer solids at varying concentrations at other locations throughout the site, with the highest value of 23.5 mg/kg reported at AD-41, which is upgradient of the WBAP (**Figure 3**).

In addition to total cobalt, soil samples were submitted for mineralogical analysis to evaluate the presence of cobalt-containing minerals. X-ray diffraction (XRD) analysis of soils from SB-28 identified pyrite (an iron sulfide) in samples collected at 25-30 feet bgs and 40-41 feet bgs at concentrations up to 3% by weight (**Table 2, Table 3**). Cobalt is known to undergo isomorphic substitution for iron in crystalline iron minerals such as pyrite due to their similar ionic radii of approximately 1.56 angstrom (Å) for iron vs. 1.52 Å for cobalt (Clementi and Raimondi, 1963; Krupka and Serne, 2002; Hitzman et al., 2017).

The aquifer solids at SB-28 are distinctly red in color at shallow depths, as illustrated in the photolog of soil cores provided in **Attachment B.** Red color in soils is often associated with the presence of oxidized iron-bearing minerals such as hematite and goethite. Goethite, an iron oxide mineral (FeOOH), was present at depths up to 16 ft bgs at SB-28 at up to 37% of the total aquifer solids (**Table 3**). The weathering of pyrite to goethite under oxidizing conditions is also a well-understood phenomenon, including in formations in east Texas (Senkayi et al., 1986; Dixon et al., 1982). It is likely that the pyrite weathering process is resulting in the release of isomorphically substituted cobalt from the pyrite crystal structure as it undergoes oxidative transformation to iron oxide minerals.

As described in an ASD previously generated for the Pirkey Plant's East Bottom Ash Pond, vertical aquifer profiling was used to collect groundwater samples from upgradient locations B-2 and B-3 during the soil boring and sample collection process (EBAP; Geosyntec, 2019c). A groundwater sample was also collected from AD-30, an existing well within the WBAP groundwater monitoring network. Solid phases within these groundwater samples were separated and submitted for analysis of chemical composition and mineralogy. For the VAP samples, separation was completed using a centrifuge. For the groundwater sample at AD-30, the sample was filtered using a 1.5-micron filter. Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient VAP location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from permanent monitoring wells B-2 and B-3 (**Table 2**). The concentrations of cobalt in the solid material retained after filtration were comparable to the bulk soil samples collected from the same locations.

The solid sample [VAP-B3-(40-45)] was submitted for mineralogical analysis via XRD and scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). The XRD results identified pyrite as approximately 3% of the solid phase (**Table 4**). Pyrite was identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site. Logging completed while the VAP boring was advanced identified coal at several intervals, including 45 and 48 ft bgs (**Figure 4**). Furthermore, SEM/EDS of both centrifuged solid samples [VAP-B3-(40-45) and VAP-B3-(50-55)] identified pyrite in backscattered electron micrographs by the distinctive framboidal morphology (Harris et al., 1981; Sawlowicz, 2000). Major peaks involving iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (**Attachment C**). While cobalt was not identified in the EDS spectrum, it is likely present at concentrations below the detection limit.

Naturally occurring cobalt is known to substitute for iron in pyrite, which is then known to weather to iron oxides. The presence of pyrite and iron oxides has been confirmed at AD-28 and across the Site. The presence of these aquifer minerals suggests that pyrite may be providing a source for aqueous cobalt in groundwater. Additionally, the pond was not identified as the source of cobalt at AD-28 based on the low concentrations of cobalt in the pond itself.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSL is not due to a release from the Pirkey WBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL for cobalt identified at AD-28 during assessment monitoring in June 2020 was not due to a release from the WBAP. The identified SSL was, instead, attributed to natural variation in the underlying geology, including the presence of pyrite and goethite in the solid aquifer material. Therefore, no further action is warranted, and the Pirkey WBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in **Attachment D**.

SECTION 4

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TABLES

Table 1: Summary of Key Analytical Data
West Bottom Ash Pond - H.W. Pirkey Plant

Sample	Sample Date	Unit	Cobalt Concentration
Bottom Ash	2/11/2019	mg/kg	5.8
SPLP Leachate	2/11/2019	mg/L	<0.01
WBAP Pond Water	11/4/2020	mg/L	0.000501
AD-28 - Average	May 2016 - June 2020	mg/L	0.0146

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

AD-28 - Average value was calculated using all cobalt data collected under 40 CFR 257 Subpart D.

Table 2: Soil Cobalt and Mineralogy Data
West Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Location	Sample Depth (ft bgs)	Cobalt (mg/kg)
Bulk Soil Samples			
AD-28	WBAP Network	6-6.5	< 2.38
		15.5-16	4.53
		25-30	< 2.50
		40-41	8.70
AD-30	WBAP Network	7	1.00
		23	15.0
B-2	Upgradient	10	2.36
		16	3.62
		71	10.30
		82	7.21
		87	3.11
B-3	Upgradient	10	1.30
		20	0.59
		97	1.11
Solid Material Retained After Filtration			
AD-30	WBAP Network	15-25	9.3 J
B-2	Upgradient	38-48	4.3 J
B-3	Upgradient	29-34	12.0
		VAP 40-45	18.0

Notes:
mg/kg- milligram per kilogram
ft bgs - feet below ground surface
J = estimated value

For AD-28 and AD_30, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples at B-2 and B-3 were collected from cores removed from the borehole during well lithology logging.

Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

Table 3 - AD-28 Mineralogy Results
West Bottom Ash Pond - H. W. Pirkey Plant

Boring ID	**SB-28 (AD-28)**			
Sample Depth Interval	6-6.5	15.5-16	25-30	40-41
Sample Location	Above Screened Interval	Within Screened Interval		Below Screened Interval
Color	Red-brown to yellow-brown	Light gray, light red-brown	Brown, light red-brown	Gray to dark gray
Mineralogy				
Quartz	58%	46%	73%	34%
Pyrite	--	--	3%	3%
K-Feldspar	--	1%	1%	1%
Siderite	--	--	2%	52%
Goethite	37%	15%	--	--
Anhydrite	--	--	--	2%
Clay/Mica	5%	38%	21%	8%

Notes:

Sample depths are shown in feet below ground surface (bgs)

Well AD-28 is screened from 15-35 ft. below ground surface.

Mineralogical components are shown in relative abundance.

Table 4: B-3 X-Ray Diffraction Results
West Bottom Ash Pond - H. W. Pirkey Plant

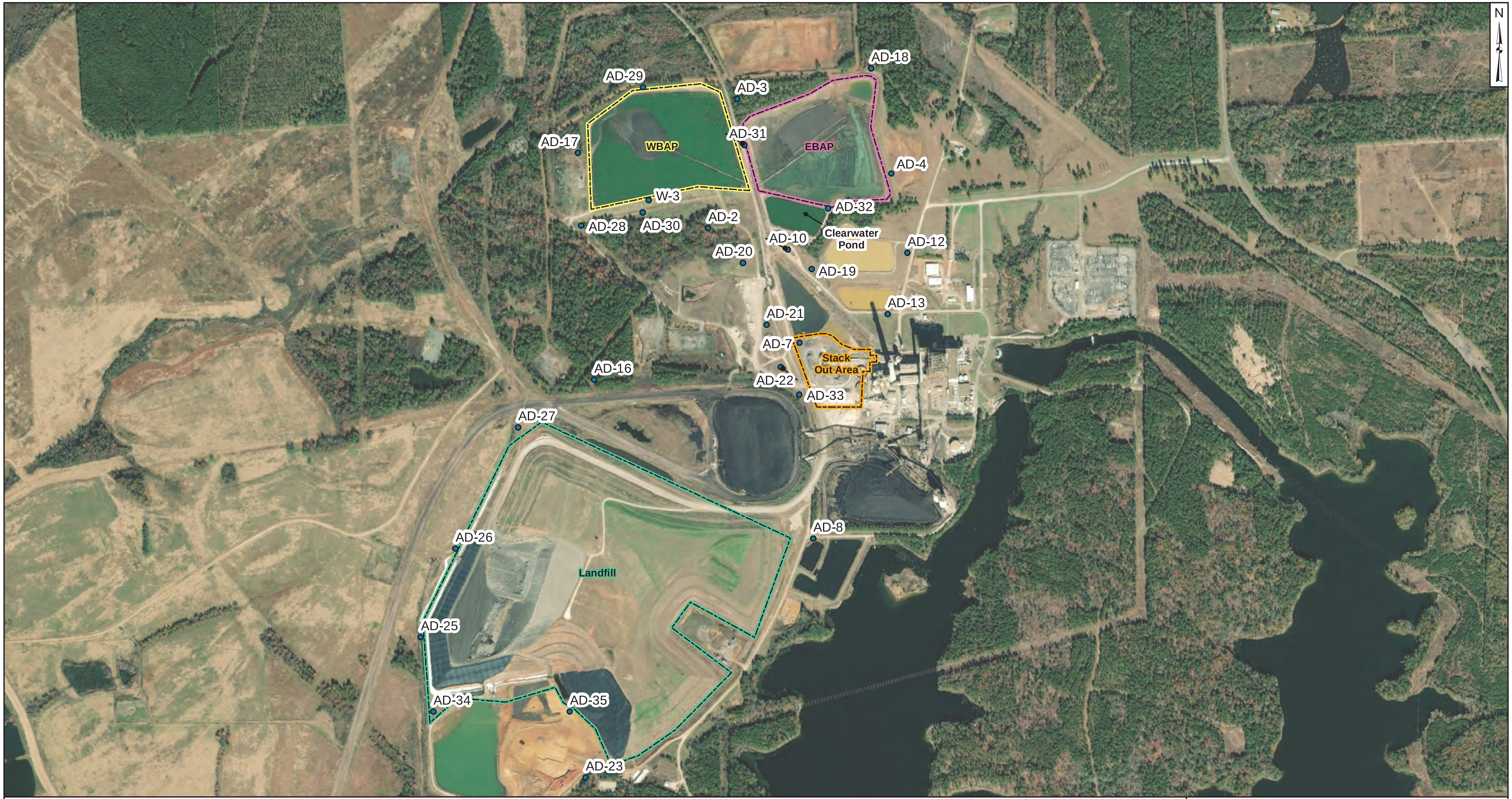
Constituent	**VAP-B3-(40-45)**
Quartz	15
Plagioclase Feldspar	0.5
Orthoclase	ND
Calcite	ND
Dolomite	ND
Siderite	0.5
Goethite	ND
Hematite	2
Pyrite	3
Kaolinte	42
Chlorite	4
Illite/Mica	6
Smectite	12
Amorphous	15

Notes:

ND: Not detected

VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

FIGURES



Legend

- ● Monitoring Wells
- ▭ EBAP
- ▭ Landfill
- ▭ Stack Out Area
- ▭ WBAP

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019

0 375 750 1,500 2,250 3,000 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2020/11/18

Figure
1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_2020324.mxd. hduff. 3/24/2020. Project/Phase/Task.

Well	Result (mg/L)
AD-3	0.00436
B-2**	0.00716
AD-18	0.00095
AD-17	0.00702
AD-40*	0.000799
AD-41*	0.00801
B-3**	0.0108
AD-30	0.00264
AD-28	0.0136
AD-12	0.0010

Legend

- ⊕ Out of Network
- ◆ EBAP
- ◆ WBAP
- ◆ Landfill
- ◆ Stackout Area
- ◆ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- ▭ EBAP
- ▭ Stack Out Area
- ▭ WBAP

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- AD-15 location is approximated
- Samples collected in June 2020
- * - Well most recently sampled August 2019
- ** - Well most recently sampled November 2020
- AD-29 included in the well network for water level measurements only

400 200 0 400
Feet

Cobalt Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/12/22

Figure
2

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Pirkey_Cobalt_20201222.mxd. CChristenson. 12/22/2020. Project/Phase/Task.

Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	B-2				
Depth (ft bgs)	10	16	71	82	87
Cobalt (mg/kg)	2.36	3.62	10.30	7.21	3.11
Pyrite/Marcasite (%)	-	-	-	-	-

Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-41		
Depth (ft bgs)	15	35	95
Cobalt (mg/kg)	< 1.0	23.5	1.9
Pyrite/Marcasite (%)	-	-	-

Location	AD-2	
Depth (ft bgs)	25-27	31-33
Cobalt (mg/kg)	9.45	19.2
Pyrite/Marcasite (%)	7	2

Location	B-3		
Depth (ft bgs)	10	20	97
Cobalt (mg/kg)	1.30	0.59	1.11
Pyrite/Marcasite (%)	-	-	-

Location	AD-28			
Depth (ft bgs)	6 – 6.5	15.5 - 16	25 - 30	40 - 41
Cobalt (mg/kg)	< 2.38	4.53	< 2.50	8.7
Pyrite/Marcasite (%)	0	0	3	3

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Legend

⊕	Monitoring Wells
▭	EBAP
▭	WBAP

Notes
- Monitoring well coordinates provided by AEP.
- AD-2 and AD-28 samples collected on April 20, 2020
- All other data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.

300 150 0 300
Feet

Cobalt Distribution in Soil

AEP Pirkey Power Plant
Hallsville, Texas

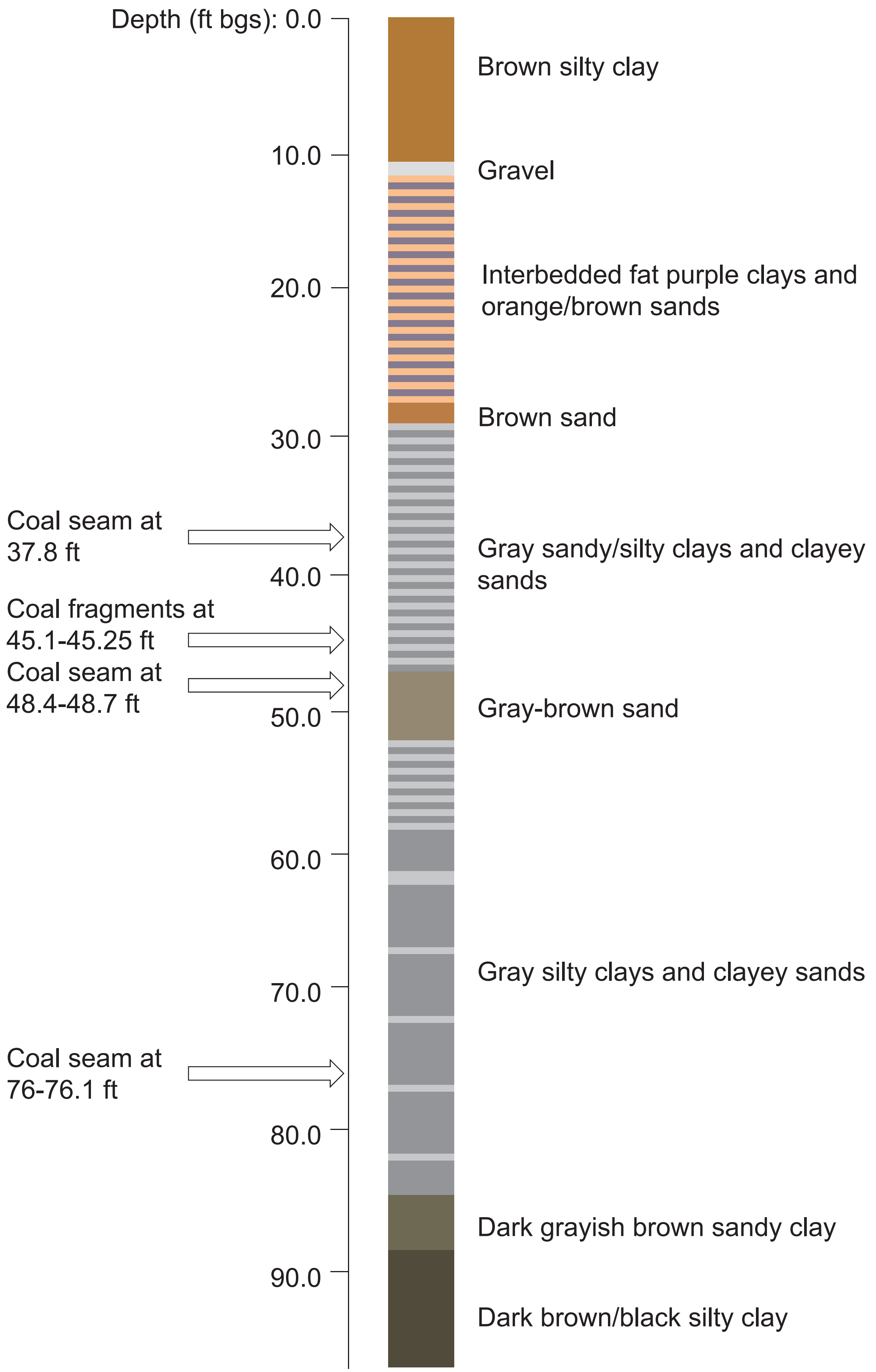
Geosyntec
consultants

Columbus, Ohio

2020/12/22

Figure
3

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\20201218 Pirkey_SoilChem_minerals_March2019_new.mxd. CChristenson. 12/22/2020. Project/Phase/Task.



Notes:
- Ft = feet
- Bgs = below ground surface
- Boring completed May 2019
- Total depth of 97.5 ft bgs
- Well installed in offset boring screened at 29-34 ft bgs

B-3 Visual Boring Log

AEP Pirkey Powerplant
Hallsville, TX

Geosyntec consultants

CHA8495

November 2020

Figure

4

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-05 Field Investigation\Field Forms\Compiled Boring Logs\Visual boring logs

ATTACHMENT A

SB-28 Boring Log

PROJECT NO. ________ **PROJ.** ________ **BOR. NO.** SB-28

LOCATION AD-28/MW-28 - Pirkey Power Plant **ELEV.** ________ **DATE** 4/20/20

SILTS & SANDS		COHESIVE SOILS - CLAYS			COLORS	MATERIALS	SAND ADJ.	CHARACTERTICS
CONDITION		CONSISTENCY	PENETROMETER	N - VALUE				
VLo ...... Very Loose	0 - 4	Vso.. Very Soft	0 - 0.25	<2	Li .... Light .....Br ....Brown	Cl ..... Clay, Clayer	F.......Fine	Calc ..... Calcareous
Lo .... Loose	4-10	So.... Soft	0.25 - 0.5	2 - 4	Dk ... Dark .....Bk ....Black	Si ..... Silt, Silty	M ....Medium	Lig .... Lignite
MDe ..... Med. Dense	10-30	Mst.. Stiff	0.5 - 1.0	4 - 8	G ..... Grey ....Bl ....Blue	Sa ..... Sand, Sandy	Co....Coarse	Org .... Organic
De .... Dense	30-50	St..... Stiff	1.0 - 2.0	8 - 15	T ...... Tan ....Gr .....Grenn	Ls .... Limestone	Si.....Silty	Lam ...... Laminate
VDe ...... Very Dense	>50	VSt.. Very Stiff	2.0 - 4.0	15 - 30	R ...... Red ......Y ......Yellow	Gr .... Gravel		Sls .... Slickensided
		H..... Hard	> 4.0	>30	Rdish.Reddish. Wh ...White	SiS ... Siltstone		SL .... Slightly
						SS .... Sandstone		Sm(s) ... Seam (s)
						Sh..... Shale, Shaley		Nod ...... Nodules

	Sample Interval ~~TEST ASSIGNMENT~~	~~SAMPLE NO.~~ Recovery	DEPTH FT.	SAMPLES	CONDITION OR CONSISTENCY	COLOR	MINOR MATERIALS OR ADJECTIVES	PREDOMINATE MATERIAL	CHARACTERISTICS OR MODIFICATIONS	SEAT - 6"	1st - 6"	2nd - 6"	UNIFIED SOIL CLASSIFICATION	N - VALUE OR HAND PENETROMETER
0 SM	0-5	4'	0		0-2	Br, Lt.Br	Si	Sa	Silty sand, trace clay, +				moist	(0-2)
			2			Lt.Rd Br			roots, trace fine iron ore					
2'									gravel,				moist	(2-5)
					2-10'	Rd Br, Yllw Br	Si, Gr	Cl	Clay - some silt, trace					
									v.f. sand, trace coarse iron					
									ore concretions,				moist	(5-10)
CL	5-10	1.5'							-some v.f. sand, ironstone					
									layer @ 6-6.5'					
10'									clayey vf to f					
	10-15	1'	10		10'-16-	Rd Br, Lt.Br	Si Cl	Sa	Silty Sand with clay in				v. moist	(10-15)
SC-SM									thin lences, trace cemented					
									clayey sand					
	15-20	1.5'				Lt.Br & Lt.Rd Br			- clay lense @ 15' (6")				v.moist	(15-16)
16'									- ironstone layer @ 15.5' &					
SM									cemented sand to 16'-					
	20-25	3"			16-40	Br, Lt.Rd Br	Si	Sa	Silty Sand - some ironstone				Saturated @ 16' to 40'	
						Gray			- gray @ 20'					
	25-30	3'							& some cemented clayey sand (only recovery @ 25-30')					
	30-35	NR												
	35-40	NR												
									B.T. @ 40'					
									* Split Spoon Driven					
40'									from 40-41'					
SC	40-41	1'			40-41	Gray, Dk Gray	Cl	Sa	clayey sand w/ lenses of					
									cemented sand @ 41.5-41.75				v. moist	40-41
									trace v.f. gypsum crystals @ 40-41'					
									* 6-6.5' collected @ 1140					
									* 15.5-16' collected @ 1215					
									* 25-30' collected @ 1230					
									* 40-41 collected @ 1300					

Type Boring HSA Dry Auger ☒ Rotary Wash ☐

SEEPAGE @ 16 FT. WHILE DRILLING, W.L. @ ___FT. ON COMPL.
(OR) BAILED TO ___FT. UPON COMPLETION.
W.L. @ ___FT AND CAVED TO ___FT. ON ________.

* GPS: 32.46544°, -94.49432 (18' W-NW of AD-28/MW-28)

ATTACHMENT B

SB-28 Boring Photographic Log

GEOSYNTEC CONSULTANTS
Photographic Record

Client: American Electric Power

Project Number: CHA8495/12A/02

Site Name: H.W. Pirkey Plant WBAP

Site Location: Hallsville, Texas

Photograph 1

Date: 4/21/2020

Direction: N/A

Comments:
Multiple sections of core from soil boring SB-28 advanced near downgradient monitoring well AD-28 within the Western Bottom Ash Pond (WBAP) CCR unit. 5-foot pushes were used. Note the reddish color indicating the presence of oxidized iron-bearing minerals.

Photograph 2

Date: 4/21/2020

Direction: N/A

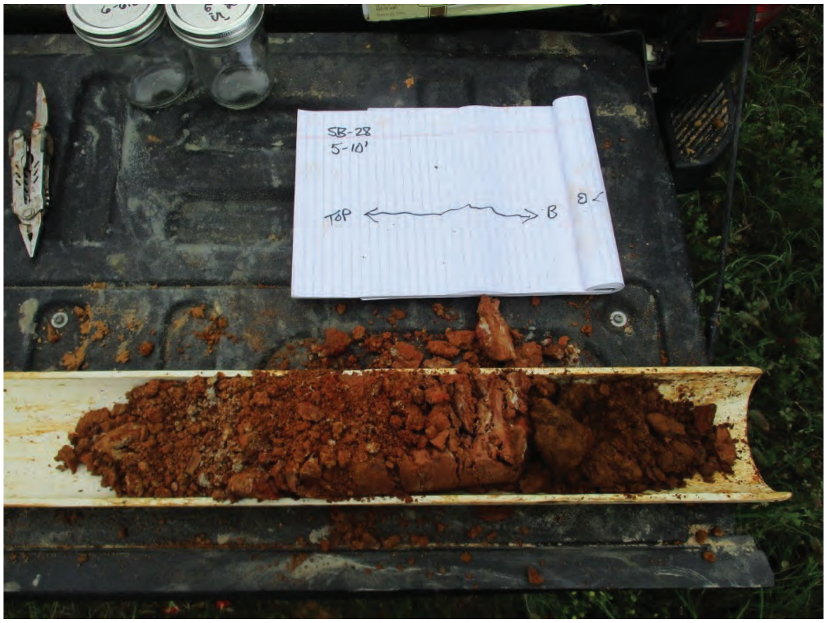
Comments:
0-5 foot interval of SB-28.

Photograph 3

Date: 4/21/2020

Direction: N/A

Comments:
5-10 foot interval of SB-28. Recovery of this interval was limited. A sample was collected from this interval from 6-6.5 ft. below ground surface (bgs).



Photograph 4

Date: 4/21/2020

Direction: N/A

Comments:
10-15 foot interval of SB-28. Recovery of this interval was limited.

Photograph 5

Date: 4/21/2020

Direction: N/A

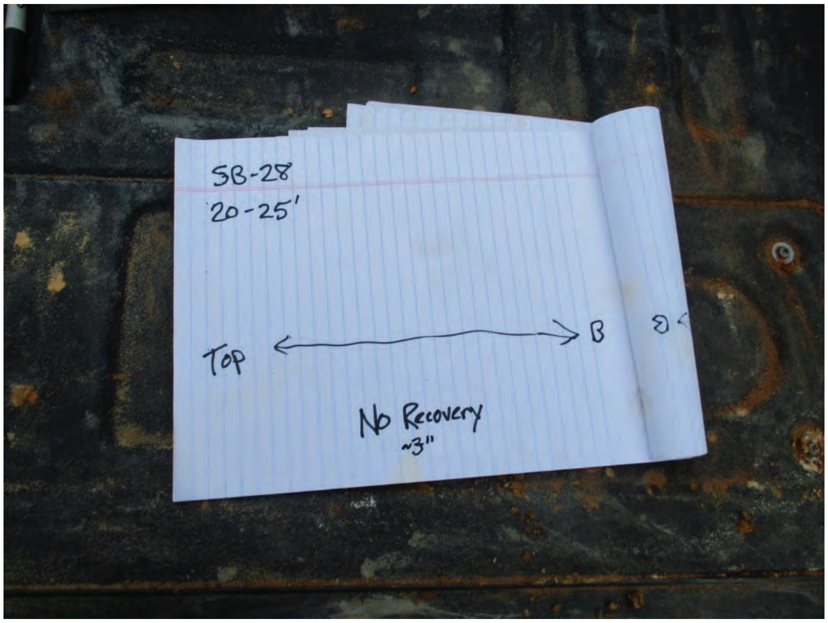
Comments:
15-20 foot interval of SB-28. Recovery of this interval was limited. A sample was collected from this interval from 15.5-16 ft. bgs.

Photograph 6

Date: 4/21/2020

Direction: N/A

Comments:
Field geologist’s note indicating that very little of the 20-25 foot interval of SB-28 was recovered.



Photograph 7 **Date: 4/21/2020** **Direction: N/A** **Comments:** 25-30 foot interval of SB-28. Very little of this interval was recovered. Note the color change of the soil from red to dark brown/black. A sample was collected from this interval.	
Photograph 8 **Date: 4/21/2020** **Direction: N/A** **Comments:** Bottom of SB-28. The boring log indicates no recovery of soil from the 30-40 foot interval. A sample was collected from this interval.	

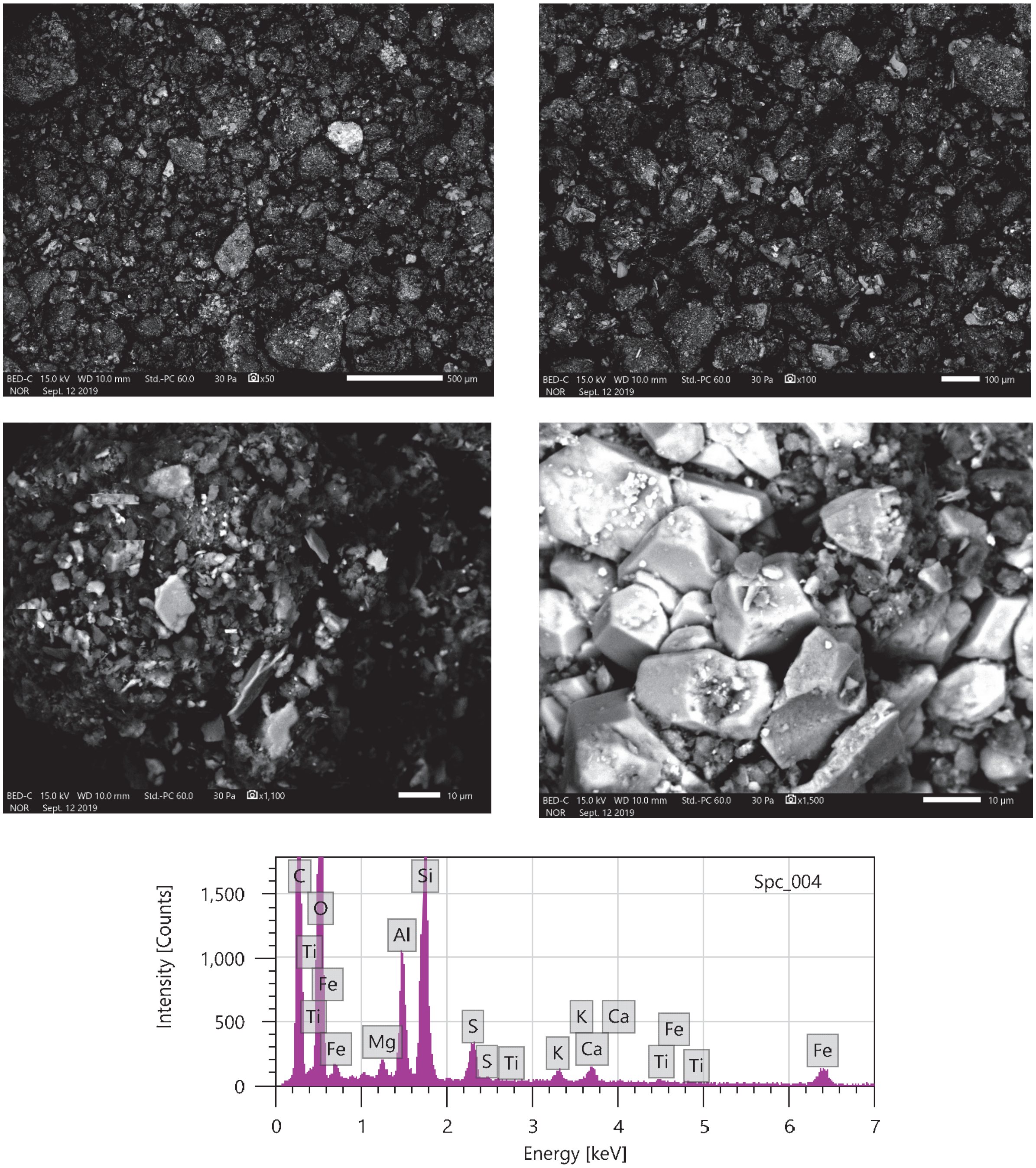
ATTACHMENT C

SEM/EDS Analysis

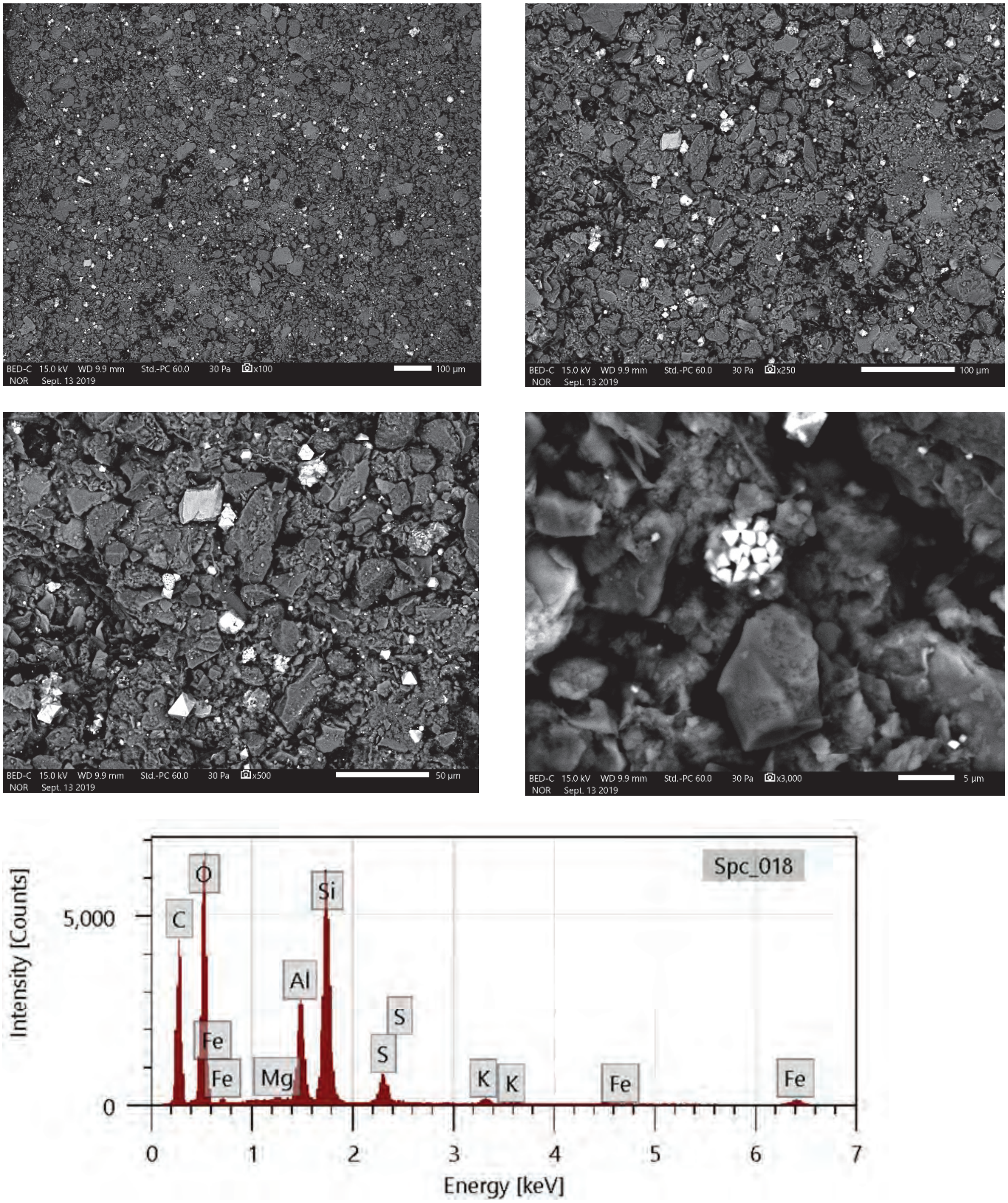
September 16, 2019

Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221

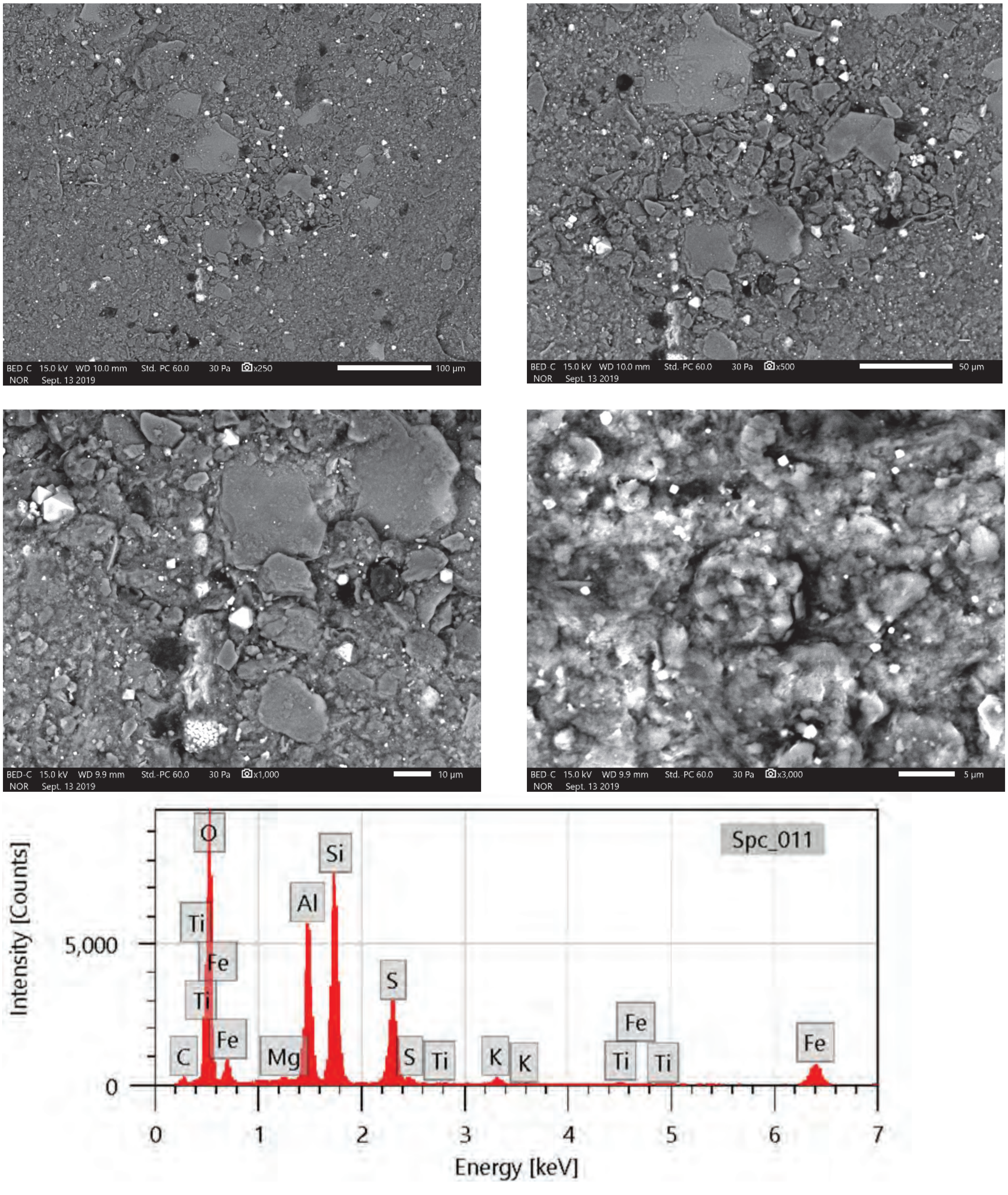
via Email: BSass@geosyntec.com



Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.



Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.



Sample VAP B3 50-55. Backscattered electron micrographs show the sample at 250X, 500X, 1000X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 3000X. Bright particles are mostly pyrite (framboid in bottom left micrograph); occasional particles of Fe-Ti oxide are detected. Major peaks for oxygen, silicon, and aluminum suggest clay. Large blocky particles are mostly quartz, feldspar, and clay.

ATTACHMENT D

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

BETH ANN GROSS
79864

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Gross
Signature

Geosyntec Consultants
2039 Centre Pointe Blvd, Suite 103
Tallahassee, Florida 32308

Texas Registered Engineering Firm
No. F-1182

79864	Texas	12/31/2020
License Number	Licensing State	Date

APPENDIX IV

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #540556

Owner:	**American Electric Power Company**	Owner Well #:	**AD-7R**
Address:	**502 N. Allen Street Shreveport, LA 71101**	Grid #:	**35-37-1**
Well Location:	**2400 Farm Road 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 43.7" N**
		Longitude:	**094° 29' 18.3" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/3/2020**

Drilling End Date: **3/3/2020**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**31.5**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
18	**31.5**	**Sand**	**20/40**

Annular Seal Data: **No Data**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **David Diduch**

Apprentice Number: **60297**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1.5**	**Top soil, vegetation, black silt, gravel, light gray/red/brown clayey silt**
1.5	**10**	**Red/light gray clay, low plasticity, high stiffness, iron ore present, trace silt,**
10	**15**	**Maroon/light gray clay, high stiffness, low plasticity, iron ore, wet**
15	**20**	**Black silty clay, low-moderate plasticity, wet, Maroon/orange clayey silt, wet, good cohesion, iron ore, gray/orange clayey silt, iron ore present, wet, good cohesion**
20	**24.6**	**Black clayey silt, Dark gray fine grained sand, trace clay, wet, black silty clay, low-moderate plasticity, moderate to low stiffness**
24.6	**31.5**	**Dark gray fine grained sand, wet, well sorted, orange fine grained sand, wet, well sorted, tan fine grained sand, wet, well sorted, iron present**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

4.16 – Statistical Analysis Summary, FGD Stackout Area, H.W. Pirkey Power Plant, Hallsville, Texas, January 3, 2018

Purpose of Statistical Analysis Summary Report

During the initial phase of ground water monitoring, the CCR rule requires AEP to collect at least eight independent samples from at least one up-gradient and three downgradient wells for 21 substances listed in the CCR rule. The CCR rule also requires us to select a statistical method that will be used to evaluate the samples in the later phases of the ground water monitoring program. The Statistical Plan, which has been posted to AEP's CCR website, describes the methods selected by AEP. *See* AEP's Statistical Analysis Plans.

Each **Statistical Analysis Summary Report** is based on the results of the 8 independent samples that were collected by October 17, 2017, and reported in the Annual Groundwater Monitoring Report. Using the statistical methods chosen by AEP, the samples were evaluated to eliminate outliers, determine variability and general trends in the data, and establish background values for: boron, calcium chloride, fluoride, pH, sulfate, and total dissolved solids. Appendix IV substances were evaluated for purposes of identifying outliers and understanding data trends.

A subsequent sample taken during the first detection monitoring sampling event was also compared using the proper statistical methods to the background values that were established for these seven substances from the eight independent samples. A second or third re-sampling event occurred, and the results compared using the same methods. This work is reported in the memorandum included in attachment A. If confirmed, AEP will be required to enter the next phase of monitoring. The results of future sampling will be further analyzed to target any specific substances for which ongoing monitoring or potential corrective action is required.

STATISTICAL ANALYSIS SUMMARY
FLUE GAS DESULFURIZATION (FGD) STACKOUT AREA
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants
engineers | scientists | innovators

150 East Wilson Bridge Road
Suite 232
Worthington, Ohio 43085

January 3, 2018

CHA8423

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ANOVA	Analysis of Variance
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Value
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
FGD	Flue Gas Desulfurization
LFB	Laboratory Fortified Blanks
LPL	Lower Prediction Limit
LRB	Laboratory Reagent Blanks
NELAP	National Environmental Laboratory Accreditation Program
PQL	Practical Quantitation Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SWFPR	Site-Wide False-Positive Rate
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the flue gas desulfurization (FGD) Stackout Pad, an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Eight monitoring events were completed prior to October 17, 2017 to establish background concentrations for Appendix III and Appendix IV parameters under the CCR rule. Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. The background data were reviewed for outliers, which were removed (when appropriate) prior to calculating upper prediction limits (UPLs) for each Appendix III parameter to represent background values. Oversight on the use of statistical calculations was provided by Dr. Kirk Cameron of MacStat Consulting, Ltd.

A groundwater sampling event occurred on August 23 and 24, 2017 at the FGD Stackout Pad. This sampling event obtained the first sample for the 1-of-3 prediction interval statistical test used for detection monitoring. The results of this sampling event are included in this report.

SECTION 2

FGD STACKOUT AREA EVALUATION

2.1 Data Validation & QA/QC

During the background monitoring program, eight sets of samples were collected for analysis from each upgradient and downgradient well. A summary of data collected during background and detection monitoring sampling may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.5.32 statistics software. The export was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

The background data used to conduct the statistical analyses and the detection monitoring data are summarized in Table 1. Statistical analyses for the FGD Stackout Area were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Results for all completed statistical tests are provided in Attachment A.

Time series plots of Appendix III and IV parameters are included in Attachment A. Mann-Kendall analyses ($\alpha = 0.01$) were conducted to evaluate trends in the background data. No statistically significant increasing or decreasing trend was observed for any Appendix III or IV parameter at any monitoring well.

2.2.1 Background Outlier Evaluation

Potential outliers were identified using Tukey's outlier test; i.e., data points were considered potential outliers if they met one of the following criteria:

$$x_i < \tilde{x}_{0.25} - 3 \times IQR \quad (1)$$

or

$$x_i > \tilde{x}_{0.75} + 3 \times IQR \quad (2)$$

where:

$x_i =$ individual data point
$\tilde{x}_{0.25} =$ first quartile
$\tilde{x}_{0.75} =$ third quartile
$IQR =$ the interquartile range $= \tilde{x}_{0.75} - \tilde{x}_{0.25}$

Data that were evaluated as potential outliers are summarized in Attachment A. Tukey's outlier test identified 14 potential outliers, which are summarized in Table 2. Next, the data were reviewed to identify possible sources of errors or discrepancies, including data recording errors, unusual sampling conditions, laboratory quality, or inconsistent sample turbidity. The findings of this data review are summarized below.

While the reported fluoride concentration of 4.717 mg/L at upgradient well AD-12 on October 12, 2016 was not identified as an outlier by Tukey's method, the duplicate sample was more similar to other upgradient data and therefore considered more representative of background. This value was replaced with the reported fluoride concentration for the duplicate sample also collected at AD-12. The statistical analysis was rerun using the duplicate result's reporting limit of 1.0 mg/L, as fluoride was not detected in the duplicate. The duplicate sample was considered more representative based on the reported concentrations from the other background sampling events.

Several estimated (J-flagged) values for arsenic, mercury, and thallium were identified as possible outliers at upgradient well locations AD-12 and AD-13. These values were not removed from the dataset, as they likely represent approximate trace concentrations in the aquifer and assist in the development of a representative background value.

The reported arsenic concentration of 0.009 mg/L at upgradient well AD-13 on July 13, 2016 was also identified as a potential high outlier. As there was no apparent reason for its elevated concentration, this value was removed from the dataset as an outlier. The removal of this outlier resulted in the generation of a more conservative background value.

Select lithium concentrations at downgradient wells AD-33 and AD-7 were identified as potential outliers. These values were similar to neighboring downgradient wells, with concentrations lower than those noted in the upgradient wells, and were not removed from the dataset.

The reported barium (0.163 mg/L) and cobalt (0.033 mg/L) values during the September 7, 2016 sampling event at downgradient well AD-33 were identified as potential outliers. These values were removed from the dataset, as the sample had high turbidity during sample collection, possibly artificially elevating these values due to sampling error or the presence of colloidal materials.

The reported total dissolved solids (TDS) concentration of 326 mg/L at AD-33 on May 11, 2016 was identified as a potential outlier. However, this outlier did not have an apparent reason for its elevated value and was removed as recommended by USEPA’s *Unified Guidance* (USEPA, 2009). Because intrawell tests were used to evaluate statistically significant increases (SSIs) for TDS, the removal of this high outlier resulted in the generation of a more conservative background concentration.

2.2.2 Establishment of Background Levels

Analysis of variance (ANOVA) was conducted to determine whether spatial variation was present between the two upgradient wells (Attachment A). ANOVA indicated no significant variation between the two upgradient wells for fluoride. Consequently, interwell tests were used for fluoride. Significant variation was observed for boron, calcium, chloride, pH, sulfate, and TDS. Therefore, the appropriateness of using intrawell tests was evaluated for these parameters at the Pirkey Plant Stackout Area.

Intrawell tests presume that the groundwater quality in the downgradient wells was not initially impacted by the CCR unit. To test this presumption, the data from the upgradient wells were pooled and the data from each downgradient well were compared to a pooled background value. Tolerance limits were calculated using the pooled background data for boron, calcium, chloride, pH, sulfate, and TDS. A parametric tolerance limit with 99% confidence and 95% coverage was calculated for boron, pH, and TDS; non-parametric tolerance limits were calculated for calcium, chloride, and sulfate, given the greater spatial variability observed for these three parameters. Confidence intervals were calculated for each of these six parameters at each downgradient monitoring well. If the lower confidence limit from a downgradient well exceeded the upper tolerance limit for the pooled background data, it was concluded that downgradient groundwater concentrations were above background concentrations. In these instances, intrawell tests would not be appropriate. However, these analyses indicated no significant exceedances for calcium, pH, and TDS; elevated concentrations of boron, chloride, and sulfate were observed. (Non-parametric analyses conducted for boron and pH also indicated elevated boron concentrations and no significant exceedances for pH in downgradient wells. A non-parametric analysis for TDS indicated elevated TDS concentrations at downgradient well AD-22.) Therefore, intrawell tests were used to evaluate potential SSIs for calcium, pH, and TDS. Interwell tests were used to evaluate potential SSIs for boron, chloride, fluoride, and sulfate.

After equality of variance was tested and identified outliers were removed (where appropriate), a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., “J-flagged” data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment A.

Upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. To conduct the intrawell tests for calcium, pH, and TDS, a separate UPL was calculated for each downgradient well for each of these parameters. To conduct the interwell tests for boron, chloride, fluoride, and sulfate, a single prediction interval was calculated for each of these parameters using pooled data from the two upgradient wells. The background data used for the UPL calculations are summarized in Table 1; the calculated UPLs are summarized in Table 3.

UPLs were calculated for a one-of-three retesting procedure; i.e., if at least one sample in a series of three does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where initial results did not exceed the UPL, a second or third sample was not collected. The one-of-three retesting procedure allowed achieving an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less. Power curves were constructed for the interwell and intrawell parametric tests and are compared with the EPA Reference Power Curve in Attachment A. The power curves associated with the statistical tests for the Pirkey Plant FGD Stackout Area exceed the EPA Reference Power Curve at 3 and 4 standard deviations; this is considered a "good" level of statistical power according to EPA's *Unified Guidance* (USEPA, 2009).

2.2.3 Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the H.W. Pirkey Power Plant FGD Stackout CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

DAVID ANTHONY MILLER
112498

David Anthony Miller

Signature

112498
License Number

TEXAS
Licensing State

01.03.18
Date

2.3 Conclusions

Eight background monitoring events and one detection monitoring event were completed in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified fifteen potential outliers, with four values removed from the data set without replacement. Prediction intervals were constructed based on the remaining background data and a one-of-three retesting procedure. Interwell tests were selected for boron, chloride, fluoride, and sulfate, whereas intrawell tests were selected for calcium, pH, and TDS.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. January 2017.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March 2009.

TABLES

Table 1 - Groundwater Data Summary
Pirkey Plant - Stackout

Parameter	Unit	AD-7								
		5/11/2016	7/13/2016	9/7/2016	10/13/2016	11/14/2016	1/11/2017	2/28/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.00138J	0.00118J	0.005U	0.00108J	0.005U	0.005U	0.005U	0.005U	-
Barium	mg/L	0.037	0.05	0.05	0.061	0.06	0.058	0.053	0.051	-
Beryllium	mg/L	0.008	0.003	0.004	0.004	0.004	0.005	0.005	0.007	-
Boron	mg/L	2.39	0.716	0.978	0.67	0.682	1.39	1.51	3.24	0.943
Cadmium	mg/L	0.00087J	0.00067J	0.00073J	0.00086J	0.001	0.00076J	0.00084J	0.00072J	-
Calcium	mg/L	6.58	2.97	3.15	2.81	2.63	3.92	4.78	5.06	2.99
Chloride	mg/L	28	16	18	17	16	19	20	28	18
Chromium	mg/L	0.00077J	0.001	0.00032J	0.001	0.001U	0.001U	0.001U	0.0003J	-
Cobalt	mg/L	0.052	0.024	0.027	0.023	0.022	0.031	0.034	0.044	-
Combined Radium	pCi/L	4.344	0.942	3.132	3.81	3.538	3.77	3.92	4.35	-
Fluoride	mg/L	0.6493J	1U	1U	1U	1U	1U	1U	0.4117J	2.994
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.044	0.099	0.099	0.101	0.099	0.101	0.101	0.111	-
Mercury	mg/L	0.00031	0.00026	0.00006	0.00015	0.00004	0.00002J	0.00018	0.00019	-
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00105J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	302	204	208	212	216	204	240	322	176
Sulfate	mg/L	92	40	42	38	38	46	46	65	51
Thallium	mg/L	0.002U	0.00103J	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	3.95	3.55	4.08	3.81	4.04	3.51	3.74	3.58	-

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - Stackout

Parameter	Unit	AD-12								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Barium	mg/L	0.026	0.023	0.03	0.027	0.028	0.023	0.026	0.024	-
Beryllium	mg/L	0.00022J	0.00019J	0.00023J	0.00015J	0.00015J	0.00013J	0.00015J	0.00016J	-
Boron	mg/L	0.03	0.03	0.04	0.03	0.04	0.03	0.04	0.05	0.0495
Cadmium	mg/L	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	0.362	0.26	0.343	0.271	0.331	0.315	0.434	0.299	0.245
Chloride	mg/L	5	6	6	7	8	7	5	6	6
Chromium	mg/L	0.00071J	0.00069J	0.00035J	0.00053J	0.00033J	0.00065J	0.00033J	0.00042J	-
Cobalt	mg/L	0.00158J	0.00129J	0.00167J	0.00157J	0.00147J	0.00109J	0.0013J	0.00133J	-
Combined Radium	pCi/L	0.2073	2.909	0.881	0.257	0.767	1.536	0.416	0.3895	-
Fluoride	mg/L	1U	1U	1U	1	1U	1U	1U	0.2565J	0.213J
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.001U	0.008	0.01	0.012	0.013	0.01	0.009	0.008	-
Mercury	mg/L	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00001J	-
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00174J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	94	75	63	92	80	76	50	72	52
Sulfate	mg/L	4	4	7	8	6	6	4	7	6
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.00099J	0.002U	-
pH	SU	4.44	3.11	3.89	3.37	2.58	4.76	3.63	4.74	4.84

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Component was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Component was detected in concentrations below the reporting limit
-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - Stackout

Parameter	**Unit**	**AD-13**								
		5/11/2016	**7/13/2016**	**9/7/2016**	**10/13/2016**	**11/14/2016**	**1/11/2017**	**2/28/2017**	**4/11/2017**	**8/23/2017**
		Background								**Detection**
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.00426J	0.009	0.005U	0.007	0.00207J	0.00274J	0.00164J	0.00443J	-
Barium	mg/L	0.038	0.044	0.047	0.043	0.039	0.039	0.034	0.045	-
Beryllium	mg/L	0.00059J	0.002	0.00063J	0.00096J	0.00072J	0.0003J	0.00029J	0.00074J	-
Boron	mg/L	0.06	0.06	0.05	0.06	0.06	0.04	0.07	0.08	0.0741
Cadmium	mg/L	0.00029J	0.00009J	0.00022J	0.001U	0.00031J	0.00011J	0.001U	0.002	-
Calcium	mg/L	8.77	9.08	8.48	7.53	7.21	6.14	7.88	9.11	9.5
Chloride	mg/L	28	32	23	26	26	22	28	32	21
Chromium	mg/L	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	-
Cobalt	mg/L	0.042	0.047	0.038	0.042	0.042	0.032	0.044	0.056	-
Combined Radium	pCi/L	0.989	2.332	1.219	2.422	1.723	1.844	1.728	1.309	-
Fluoride	mg/L	0.748J	0.3474J	1U	0.6297J	0.3114J	1U	1U	0.4278J	0.344J
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.081	0.158	0.139	0.142	0.136	0.133	0.153	0.156	-
Mercury	mg/L	0.00001J	0.00002J	0.00002U	0.00002U	0.00002U	0.00001J	0.00002U	0.00002U	-
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.005U	0.00364J	0.005U	0.0026J	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	236	192	228	236	250	188	172	200	160
Sulfate	mg/L	52	59	41	47	47	37	56	58	38
Thallium	mg/L	0.00111J	0.00093J	0.00144J	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	5.63	5.64	5.19	5.77	6.06	5.82	5.92	5.21	5.98

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - Stackout

Parameter	Unit	AD-22								
		5/11/2016	7/14/2016	9/7/2016	10/12/2016	11/14/2016	1/12/2017	3/1/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.023	0.012	0.023	0.01	0.0037J	0.006	0.00161J	0.011	-
Barium	mg/L	0.071	0.048	0.108	0.054	0.066	0.067	0.029	0.13	-
Beryllium	mg/L	0.013	0.006	0.005	0.004	0.004	0.004	0.01	0.006	-
Boron	mg/L	0.08	0.04	0.04	0.03	0.04	0.02	0.05	0.04	0.0508
Cadmium	mg/L	0.002	0.00067J	0.00083J	0.00033J	0.0006J	0.00039J	0.001	0.002	-
Calcium	mg/L	15.3	9.5	6.95	7.68	7.55	6.47	13.6	10.8	7.77
Chloride	mg/L	76	52	42	52	48	51	69	72	54
Chromium	mg/L	0.024	0.012	0.033	0.007	0.002	0.002	0.001U	0.005	-
Cobalt	mg/L	0.129	0.067	0.054	0.054	0.047	0.043	0.105	0.078	-
Combined Radium	pCi/L	6.994	2.325	3.412	3.39	3.63	3.173	4.385	3.045	-
Fluoride	mg/L	1.266	0.3891J	1U	0.473J	0.2834J	1U	1U	0.5041J	1.196
Lead	mg/L	0.00097J	0.005U	0.00273J	0.005U	0.005U	0.005U	0.005U	0.00189J	-
Lithium	mg/L	0.139	0.169	0.131	0.14	0.115	0.104	0.218	0.176	-
Mercury	mg/L	0.01341	0.017	0.01983	0.00798	0.00863	0.01332	0.00022	0.0072	-
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.00197J	0.005U	0.005U	0.005U	0.005U	0.0011J	0.005U	0.00187J	-
Total Dissolved Solids	mg/L	672	412	341	388	362	344	624	446	350
Sulfate	mg/L	284	162	114	148	177	137	266	215	121
Thallium	mg/L	0.00116J	0.0009J	0.00125J	0.002U	0.002U	0.002U	0.002U	0.002U	-
pH	SU	4.02	3.9	4.05	4.7	4.41	4.23	4.07	4.07	4.6

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 1 - Groundwater Data Summary
Pirkey Plant - Stackout

Parameter	Unit	AD-33								
		5/11/2016	7/14/2016	9/7/2016	10/12/2016	11/14/2016	1/12/2017	2/28/2017	4/10/2017	8/23/2017
		Background								Detection
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Arsenic	mg/L	0.00254J	0.00492J	0.067	0.00216J	0.00146J	0.00113J	0.00107J	0.005U	-
Barium	mg/L	0.06	0.064	0.163	0.059	0.052	0.056	0.055	0.055	-
Beryllium	mg/L	0.002	0.002	0.004	0.001	0.001	0.001	0.001	0.001	-
Boron	mg/L	0.126	0.173	0.152	0.162	0.182	0.144	0.14	0.114	0.0795
Cadmium	mg/L	0.001U	0.001U	0.00098J	0.001U	0.001U	0.001U	0.001U	0.001U	-
Calcium	mg/L	2.44	1.69	1.81	1.39	1.63	1.26	1.25	1.29	1.06
Chloride	mg/L	8	16	10	9	8	10	7	9	9
Chromium	mg/L	0.004	0.009	0.125	0.004	0.001	0.002	0.001U	0.003	-
Cobalt	mg/L	0.012	0.012	0.033	0.01	0.009	0.009	0.009	0.01	-
Combined Radium	pCi/L	1.303	4.28	3.461	2.208	1.953	2.596	0.942	9.024	-
Fluoride	mg/L	1U	1U	1U	0.357J	1U	1U	1U	1U	0.67J
Lead	mg/L	0.005U	0.005U	0.014	0.005U	0.005U	0.005U	0.005U	0.005U	-
Lithium	mg/L	0.001U	0.029	0.048	0.027	0.024	0.027	0.026	0.027	-
Mercury	mg/L	0.00029	0.00071	0.00183	0.00014	0.0002	0.00036	0.00041	0.00034	-
Molybdenum	mg/L	0.005U	0.005U	0.00074J	0.005U	0.005U	0.005U	0.005U	0.005U	-
Selenium	mg/L	0.005U	0.005U	0.00161J	0.005U	0.005U	0.005U	0.005U	0.005U	-
Total Dissolved Solids	mg/L	326	176	176	180	190	168	146	178	132
Sulfate	mg/L	56	108	64	46	54	58	51	49	40
Thallium	mg/L	0.002U	0.00119J	0.002U	0.00157J	0.002U	0.002U	0.002U	0.002U	-
pH	SU	4.11	3.14	3.61	3.44	3.13	4.31	3.89	3.4	4.39

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Component was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Component was detected in concentrations below the reporting limit

-: Not sampled

Table 2: Outlier Analysis Summary
Pirkey Stackout Pad

Location	Well ID	Sample Date	Parameter	Reported Value	Units	Conclusions
Upgradient	AD-13	7/13/2016	Arsenic	0.009	mg/L	This value was conservatively removed from the dataset per the *Unified Guidance* .
Upgradient	AD-12	11/14/2016	Arsenic	0.00207189 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-12	2/28/2017	Arsenic	0.00164435 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-12	10/12/2016	Fluoride	4.717	mg/L	This value was not identified as an outlier by Tukey's method. However, the duplicate value was more comparable to other sampling events. It was replaced with the reported value of 1.0 mg/L U (non-detect) in the duplicate sample.
Upgradient	AD-13	5/11/2016	Mercury	0.00000969 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-13	1/11/2017	Mercury	0.00000732 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-13	7/13/2016	Thallium	0.000928756 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	AD-12	2/28/2017	Thallium	0.000994913 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Downgradient	AD-33	9/7/2016	Barium	0.163	mg/L	This value was removed from the dataset per professional judgment. The sample had high turbidity during collection, suggesting possible sampling error.
Downgradient	AD-33	9/7/2016	Cobalt	0.033	mg/L	This value was removed from the dataset per professional judgment. The sample had high turbidity during collection, suggesting possible sampling error.
Downgradient	AD-33	5/11/2016	Lithium	0.001 U	mg/L	This value was not detected and was replaced with the reporting limit. The value was retained in the dataset.
Downgradient	AD-33	9/7/2016	Lithium	0.048	mg/L	This value was not removed from the dataset as it reflected concentrations similar to those in neighboring wells.
Downgradient	AD-7	5/11/2016	Lithium	0.044	mg/L	This value was not removed from the dataset as it reflected concentrations similar to those in neighboring wells.
Downgradient	AD-7	4/10/2017	Lithium	0.111	mg/L	This value was not removed from the dataset as it reflected concentrations similar to those in neighboring wells.
Downgradient	AD-33	5/11/2016	Total Dissolved Solids	326	mg/L	This value was conservatively removed from the dataset per the *Unified Guidance* .

Table 3: Background Level Summary
Pirkey Plant - Stackout Pad

Parameter	Units	Description	AD-7	AD-22	AD-33
Boron	mg/L	Interwell Background Value (UPL)	0.0672		
Calcium	mg/L	Intrawell Background Value (UPL)	7.092	17.03	2.497
Chloride	mg/L	Interwell Background Value (UPL)	32		
Fluoride	mg/L	Interwell Background Value (UPL)	1		
pH	SU	Intrawell Background Value (UPL)	4.286	4.762	4.608
	SU	Intrawell Background Value (LPL)	3.279	3.601	2.65
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	343.9	736.4	206.8
Sulfate	mg/L	Interwell Background Value (UPL)	59		

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

ATTACHMENT A

Evaluation of Detection Monitoring Data

Geosyntec consultants

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Memorandum

Date:	February 27, 2018
To:	David Miller (AEP)
Copies to:	Terence Wehling (AEP)
From:	Allison Kreinberg and Bruce Sass, Ph.D. (Geosyntec)
Subject:	Evaluation of Detection Monitoring Data at H.W. Pirkey Plant's Flue Gas Desulfurization (FGD) Stackout Pad

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), detection monitoring events were completed on August 23-24, 2017 and December 21, 2017 at the flue gas desulfurization (FGD) Stackout Pad, an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Eight background monitoring events were conducted at the Pirkey FGD Stackout Pad prior to these detection monitoring events, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated January 3, 2018.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-three retesting procedure. With this procedure, a statistically significant increase (SSI) is only concluded if both samples in a series of two exceeds the UPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are summarized in Table 1b.

- Boron concentrations exceeded the interwell UPL of 0.0672 mg/L in both the initial (0.943 mg/L) and second (0.718 mg/L) samples collected at AD-7, and in both the initial (0.0795 mg/L) and second (0.0999 mg/L) samples collected at AD-33. Therefore, an SSI over background is concluded for boron at AD-7 and AD-33.

- Chloride concentrations exceeded the interwell UPL of 32 mg/L in both the initial (54 mg/L) and second (61 mg/L) samples collected at AD-22. Therefore, an SSI over background is concluded for chloride at AD-22.

- Sulfate concentrations exceeded the interwell UPL of 59 mg/L in both the initial (121 mg/L) and second (120 mg/L) samples collected at AD-22. Therefore, an SSI over background is concluded for sulfate at AD-22.

As a result, the Pirkey FGD Stackout Pad CCR unit will conduct an alternate source demonstration.

No other exceedances of UPLs were observed during these detection monitoring events.

The following modifications to Geosyntec's *Statistical Analysis Summary* report were incorporated after the certification date of January 3, 2018:

- Table 1 ("Groundwater Data Summary") was revised to reflect appropriate significant digits for estimated (J-flagged) values; and,

- Figure E ("Analysis of Variance") of Attachment A ("Statistical Analysis Output") was revised to correct a formatting error.

* * * * *

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected statistical method, described above and in the January 3, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD Stackout Pad CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

DAVID ANTHONY MILLER
112498

112498
License Number

TEXAS
Licensing State

02.27.18
Date

Table 1b: Detection Monitoring Data Evaluation
Pirkey Plant - FGD Stackout Pad

Parameter	Unit	Description	AD-7		AD-22		AD-33	
			8/24/2017	12/21/2017	8/23/2017	12/21/2017	8/23/2017	12/21/2017
Boron	mg/L	Interwell Background Value (UPL)	0.0672					
	mg/L	Detection Monitoring Result	**0.943**	**0.718**	0.0508	0.0628	**0.0795**	**0.0999**
Calcium	mg/L	Intrawell Background Value (UPL)	7.09		17.03		2.50	
	mg/L	Detection Monitoring Result	2.99	3.26	7.77	7.29	1.06	0.946
Chloride	mg/L	Interwell Background Value (UPL)	32					
	mg/L	Detection Monitoring Result	18	19	**54**	**61**	9	-
Fluoride	mg/L	Interwell Background Value (UPL)	1					
	mg/L	Detection Monitoring Result	**2.994**	<0.083	**1.196**	<0.083	0.67	-
pH	SU	Intrawell Background Value (UPL)	4.29		4.76		4.61	
	SU	Intrawell Background Value (LPL)	3.28		3.60		2.65	
	SU	Detection Monitoring Result	3.70	-	4.60	-	4.39	-
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	344		736		207	
	mg/L	Detection Monitoring Result	176	176	350	344	132	-
Sulfate	mg/L	Interwell Background Value (UPL)	59					
	mg/L	Detection Monitoring Result	51	39	**121**	**120**	40	-

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

-: Not Sampled

Bold values exceed the background value.

Background values are shaded gray.

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

December 14, 2017

Geosyntec Consultants
Attn: Mr. Bruce Sass
150 E. Wilson Bridge Rd., #232
Worthington, OH 43085

Dear Mr. Sass,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the screening and statistical analysis of background groundwater data for American Electric Power's Pirkey Stackout. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at Pirkey Stackout for the CCR program in 2016, and 8 background samples have been collected at each of the groundwater monitoring wells. The monitoring well network, as provided by Geosyntec Consultants, consists of the following: upgradient wells AD-12 and AD-13; and downgradient wells AD-22, AD-33, and AD-7.

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis was reviewed by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to Groundwater Stats Consulting.

The following constituents were evaluated: Appendix III parameters – boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and Appendix IV parameters - antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 & 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters at all wells are provided for the purpose of screening data at these wells (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B). The time series plots are used to initially screen for suspected outliers and trends, while the box plots provide visual representation of variation within individual wells and between all wells.

Data at all wells were evaluated for the following: 1) outliers; 2) trends; 3) most appropriate statistical method for Appendix III parameters based on site characteristics of groundwater data upgradient of the facility; and 4) eligibility of downgradient wells when intrawell statistical methods are recommended. Power curves are provided to demonstrate that the selected statistical methods for Appendix III parameters comply with the USEPA Unified Guidance recommendations as discussed below.

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for calcium, pH, and TDS;
2) Interwell prediction limits combined with a 1-of-2 resample plan for boron, chloride, fluoride, and sulfate.

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, simple substitution of one-half the reporting limit is utilized in the statistical analysis. The reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Background Screening

Outlier Evaluation

Time series plots are used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III and Appendix IV parameters were formally tested using Tukey's box plot method and, when identified, flagged in the computer database with "o" and deselected prior to construction of statistical limits (Figure C).

Tukey's outlier test noted a few outliers as may be seen on the Outlier Summary Table and accompanying graphs. Any values flagged as outliers are plotted in a lighter font on the time series graph. The test identified a few low outliers for arsenic, mercury, and thallium. These values were trace values detected between the Method Detection Limit and Practical Quantitation Limit and, therefore, were not flagged. The lithium values identified as outliers by Tukey's in downgradient wells AD-33 and AD-7 were similar to neighboring wells, with concentrations lower than those noted in upgradient well AD-13, and, therefore, were not flagged in the database

In some cases, the test could not identify suspect outliers due to the upper and lower quartiles being equal. When extreme values were present in background, however, they were flagged as outliers. While the reported value of 4.717 mg/L for fluoride in upgradient well MW12 was not identified as an outlier using Tukey's method, this value was flagged as such because it is significantly different from other measurements in both upgradient wells. The resulting statistical limit for this Appendix III parameter is conservative from a regulatory perspective. A substitution of the most recent reporting limit was applied when varying detection limits existed in data.

No true seasonal patterns were observed on the time series plots for any of the detected data; therefore, no deseasonalizing adjustments were made to the data. When seasonal patterns are observed, data may be deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release.

While trends may be visual, a quantification of the trend and its significance is needed. The Sen's Slope/Mann Kendall trend test was used to evaluate all data at each well to identify statistically significant increasing or decreasing trends (Figure D). In the absence of suspected contamination, significant trending data are typically not included as part of the background data used for construction of prediction limits. This step serves to eliminate the trend and, thus, reduce variation in background. When statistically significant decreasing trends are present, earlier data are evaluated to determine whether earlier concentration levels are significantly different than current reported concentrations and will be deselected as necessary. When the historical records of data are truncated for the reasons above, a summary report will be provided to show the date ranges used in construction of the statistical limits.

The results of the trend analyses showed no statistically significant trends, as may be seen on the Trend Test Summary Table that accompanies the trend tests. Therefore, no adjustments were made to the data sets.

Appendix III – Determination of Spatial Variation

The Analysis of Variance (ANOVA) was used to statistically evaluate differences in average concentrations among upgradient wells, which assists in identifying the most appropriate statistical approach (Figure E). Interwell tests, which compare downgradient well data to statistical limits constructed from pooled upgradient well data, are appropriate when average concentrations are similar across upgradient wells. Intrawell tests, which compare compliance data from a single well to screened historical data within the same well, are appropriate when upgradient wells exhibit spatial variation; when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective; and when downgradient water quality is unimpacted compared to upgradient water quality for the same parameter.

The ANOVA identified no variation for fluoride, making this constituent suitable for interwell analyses. Variation was identified in groundwater upgradient of the site for all other Appendix III parameters. Therefore, these data were further evaluated as described for the appropriateness of intrawell testing to accommodate the groundwater quality. A summary table of the ANOVA results is included with the reports.

Appendix III - Statistical Limits

Intrawell limits constructed from carefully screened background data from within each well serve to provide statistical limits that are conservative (i.e. lower) from a regulatory perspective, and that will rapidly identify a change in more recent compliance data from within a given well. This statistical method removes the element of variation from across wells and eliminates the chance of mistaking natural spatial variation for a release from the facility. Prior to performing intrawell prediction limits, several steps are required to reasonably demonstrate downgradient water quality does not have existing impacts from the practices of the facility.

Exploratory data analysis was used as a general comparison of concentrations in downgradient wells for all Appendix III parameters recommended for intrawell analyses to concentrations reported in upgradient wells. Upper tolerance limits are used in conjunction with confidence intervals to determine whether the estimated averages in downgradient wells are higher than observed levels upgradient of the facility. The upper tolerance limits were constructed to represent the extreme upper range of possible background levels at the site.

In cases where downgradient average concentrations are higher than observed concentrations upgradient for a given constituent, an independent study and hydrogeological investigation would be required to identify local geochemical conditions and expected groundwater quality for the region to justify an intrawell approach. Such an assessment is beyond the scope of services provided by Groundwater Stats Consulting. When there is not an obvious explanation for observed concentration differences in downgradient wells relative to reported concentrations in upgradient wells, interwell prediction limits will initially be selected for the statistical method until further evidence shows that concentrations are due to natural variation rather than a result of the facility.

Parametric tolerance limits were constructed with a target of 99% confidence and 95% coverage using pooled upgradient well data for each of the Appendix III parameters recommended for intrawell analyses (Figure F). The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. As more data are collected, the background population is better represented and the confidence and coverage levels increase.

Confidence intervals were constructed on downgradient wells for each of the Appendix III parameters using the tolerance limits discussed above, to determine intrawell eligibility for parameters exhibiting spatial variation (Figure G). When the entire confidence interval is above a background standard for a given parameter, interwell methods are initially recommended as the statistical method. Therefore, only parameters with confidence intervals which did not exceed background standards are eligible for intrawell prediction limits.

Confidence intervals for the above parameters were found to be within their respective background limit for calcium, pH, and TDS; while the confidence intervals for all other Appendix III parameters evaluated were above the background standards. Therefore, intrawell methods are recommended for calcium, pH, and TDS at this time, and interwell methods are recommended initially for all other Appendix III parameters. As mentioned earlier, if a demonstration supports natural variation in groundwater, intrawell methods will be considered for all parameters.

All available data through April 2017 at each well were used to establish intrawell background limits based on a 1-of-2 resample plan that will be used for future comparisons (Figure H). Interwell prediction limits, combined with a 1-of-2 resample plan, were constructed from upgradient wells for the Appendix III parameters discussed above (Figure I). Downgradient measurements will be compared to these background limits during each subsequent semi-annual sampling event.

Natural systems continuously evolve due to physical changes made to the environment. Examples include capping a landfill, paving areas near a well, or lining a drainage channel to prevent erosion. Periodic updating of background statistical limits will be necessary to accommodate these types of changes In the interwell case, newer data will be included in background when a minimum of 2 new samples from each well are available. In the intrawell case, data for all wells and constituents are re-evaluated when a minimum of 4 new data points are available to determine whether earlier concentrations are representative of present-day groundwater quality. In some cases, the earlier portion of data are deselected prior to construction of limits in order to provide sensitive limits that will rapidly detect changes in groundwater quality. Even though the data are excluded from the calculation, the values will continue to be reported and shown in tables and graphs.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of an additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered to be a false positive result and, therefore, no further action is necessary. A summary table of the background prediction limits follows this letter.

Appendix IV – Assessment Monitoring Program

During an Assessment Monitoring program confidence intervals are constructed at all wells for detected Appendix IV parameters. A minimum of 4 samples is required to construct confidence intervals; however, 8 samples are generally recommended for better representation of the true average population. Established Maximum Contaminant Levels (MCLs) are used as the GWPS comparisons, unless background limits are higher as discussed below. Parametric confidence intervals are constructed with 99% confidence when data follow a normal or transformed-normal distribution. For all other cases, nonparametric confidence intervals are constructed, with the confidence level based on the number of samples available. The GWPS is exceeded only when the entire confidence interval exceeds its respective GWPS.

Background limits are established for the Appendix IV parameters using upper tolerance limits constructed with 95% confidence/95% coverage using pooled upgradient well data, for comparison against established MCLs. When background limits, or Alternate Contaminant Levels (ACLs), are higher than established MCLs, the CCR Rule recommends using these ACLs as the GWPS for the confidence interval comparisons. Additionally, tolerance limits are also recommended to establish ACLs for Appendix IV parameters, cobalt, lithium, and molybdenum, which do not have established MCLs. Since the scope of this project included screening and development of background limits for Appendix III Detection Monitoring statistics, comparison of the Appendix IV parameters with confidence intervals was not included in this report.

Recommendations

In summary, as a result of the background screening described in this letter, intrawell prediction limits combined with a 1-of-2 resample plan are recommended for calcium, pH, and TDS. Interwell prediction limits combined with a 1-of-2 resample plan are recommended for boron, chloride, fluoride, and sulfate.

The statistical analyses will be constructed according to the USEPA Unified Guidance, based on 7 Appendix III parameters and 2 downgradient wells.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Stackout. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG
Hollow symbols indicate censored values.

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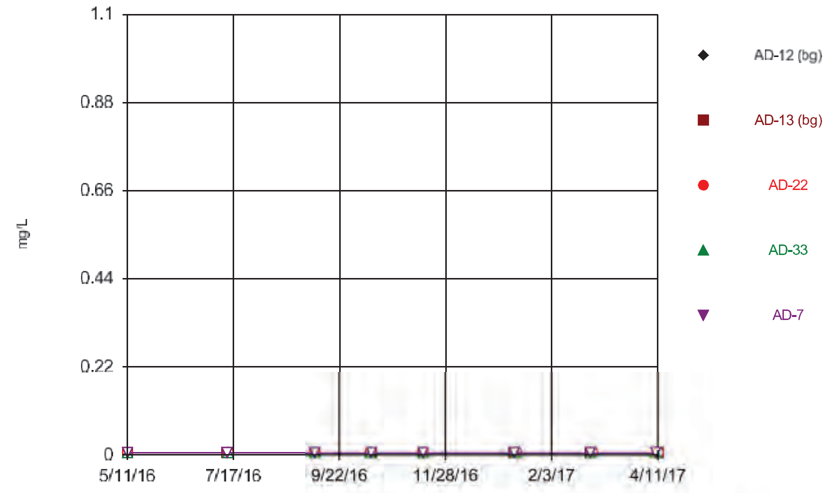

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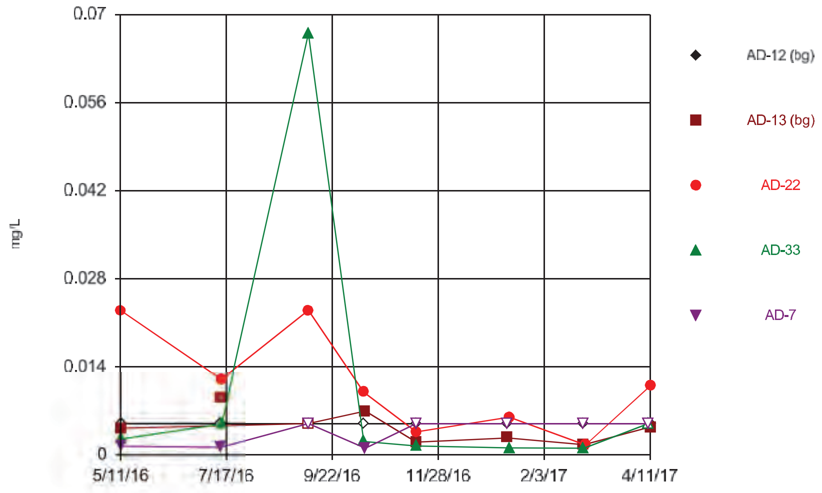

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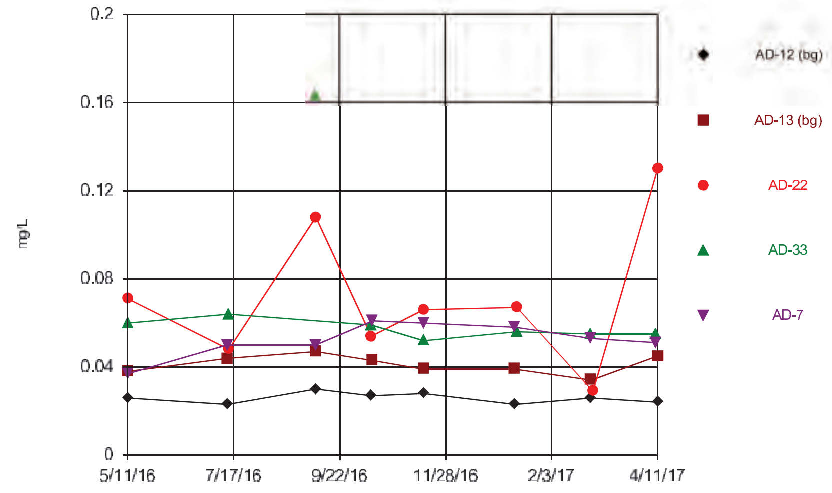

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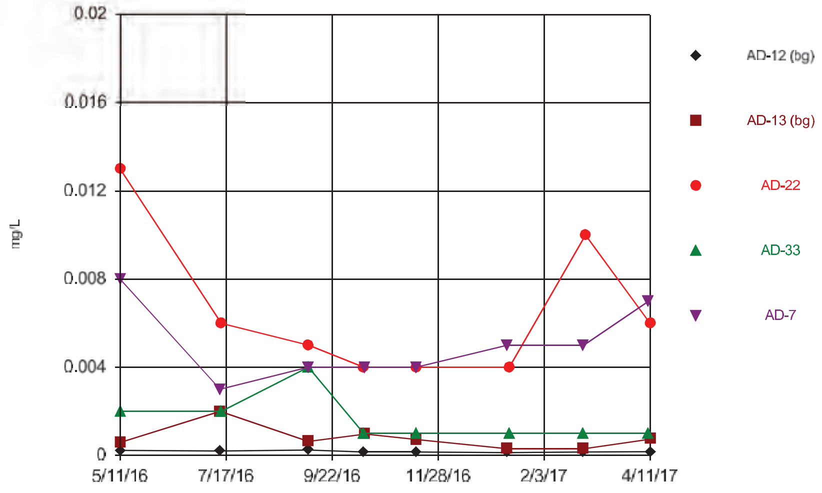

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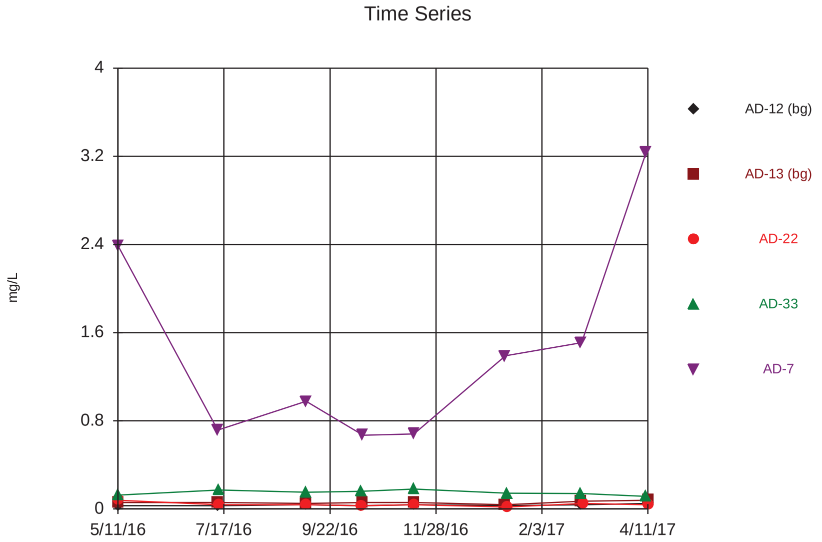

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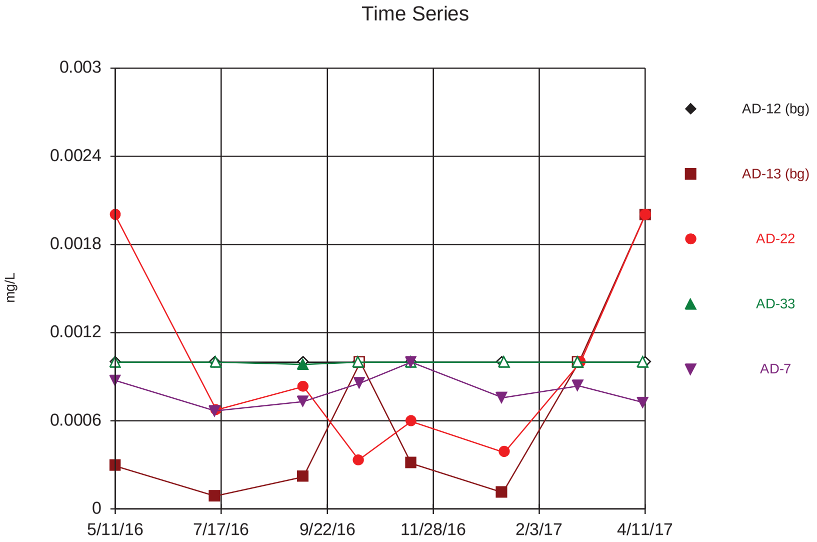

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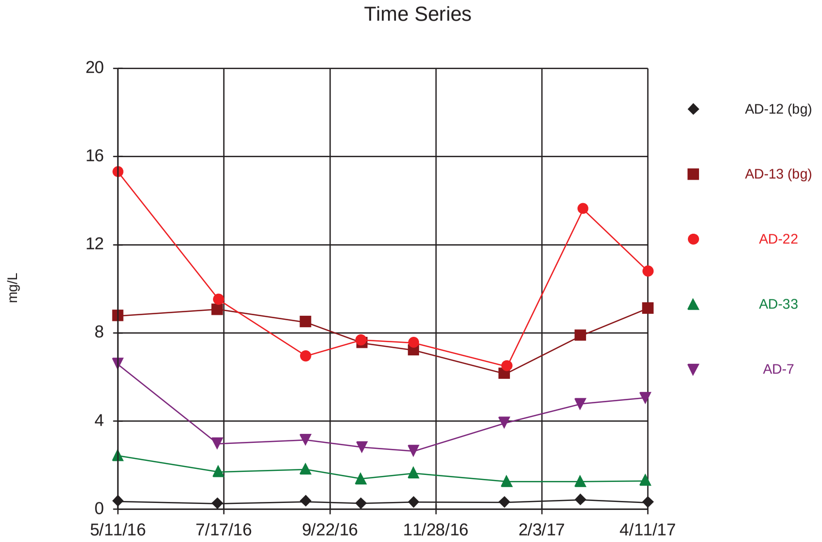

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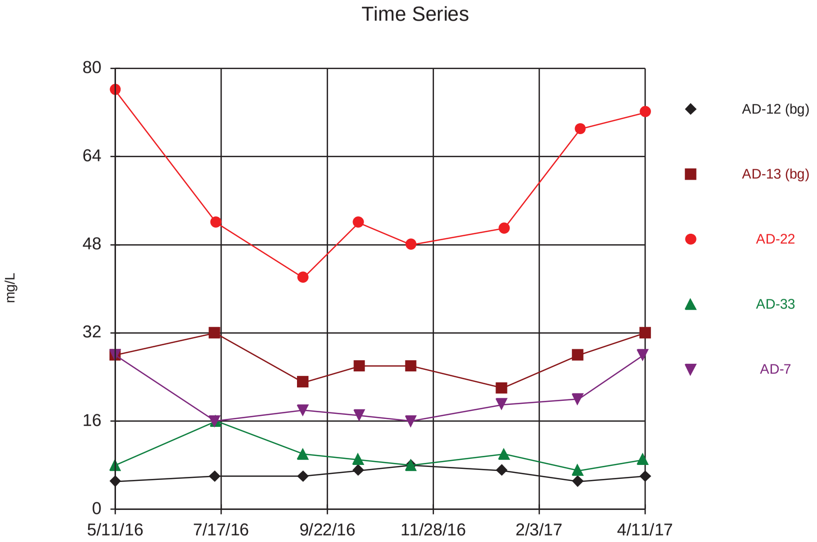

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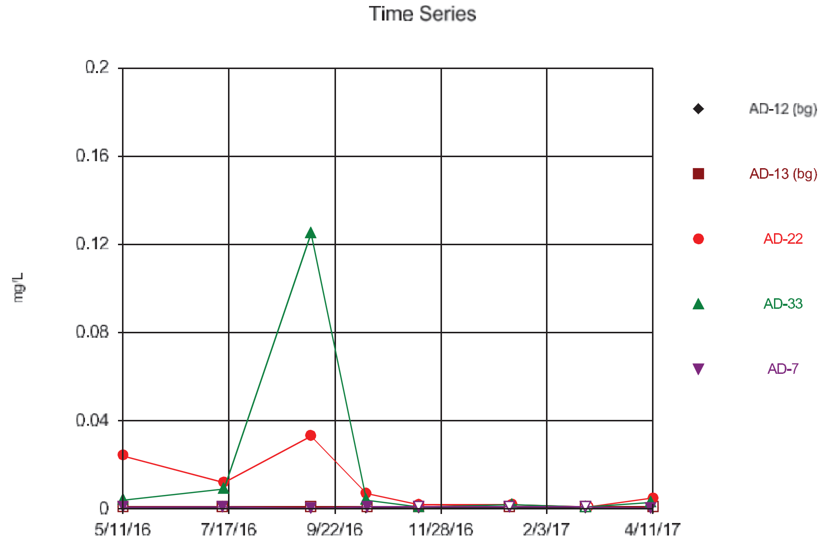

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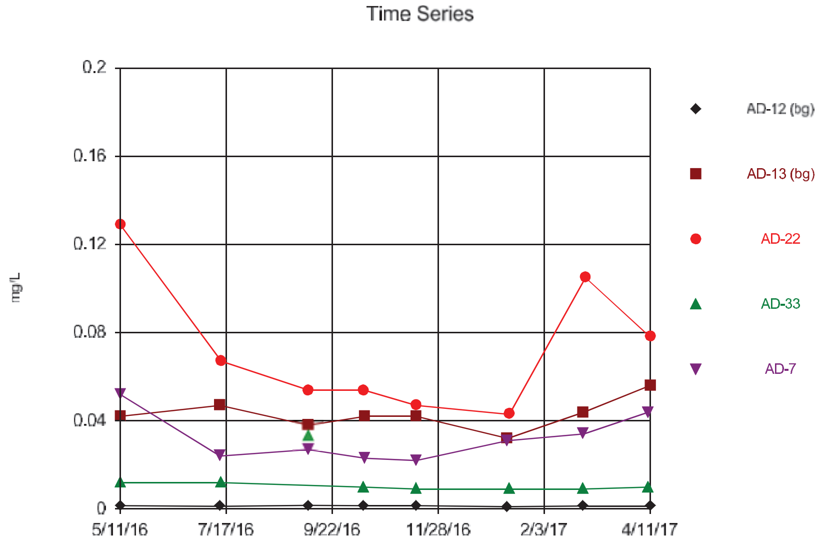

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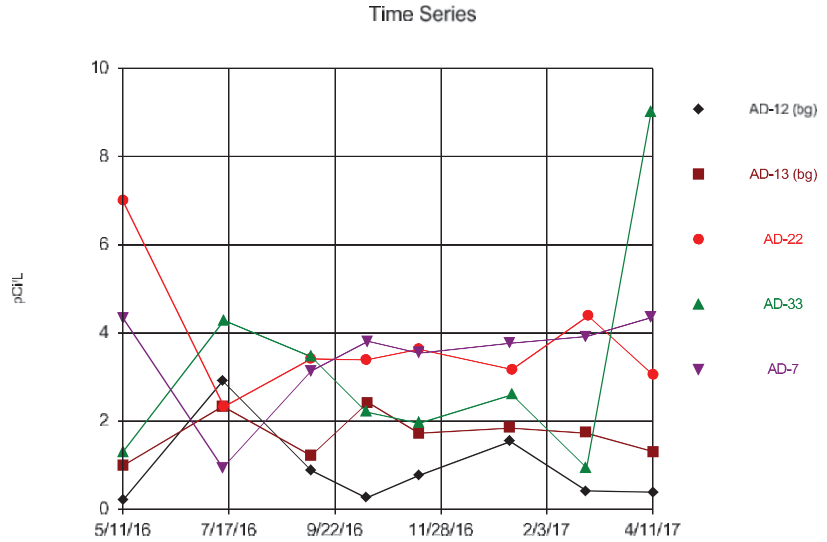

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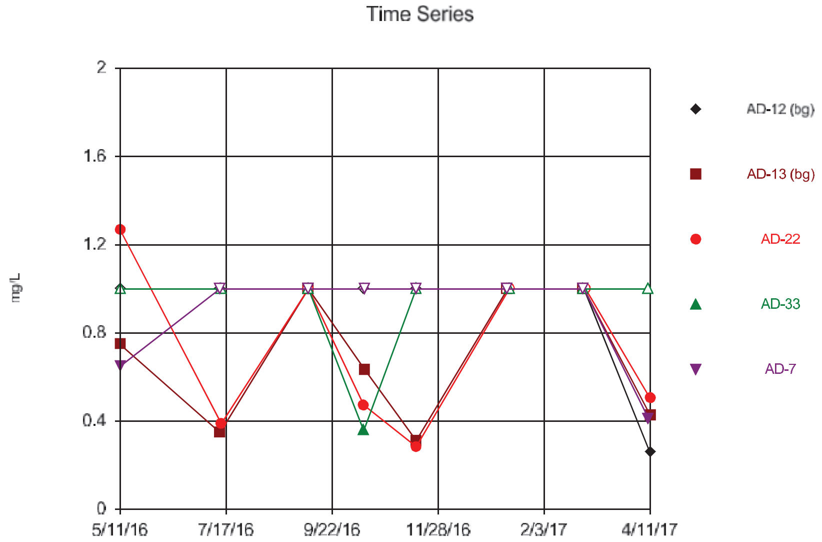

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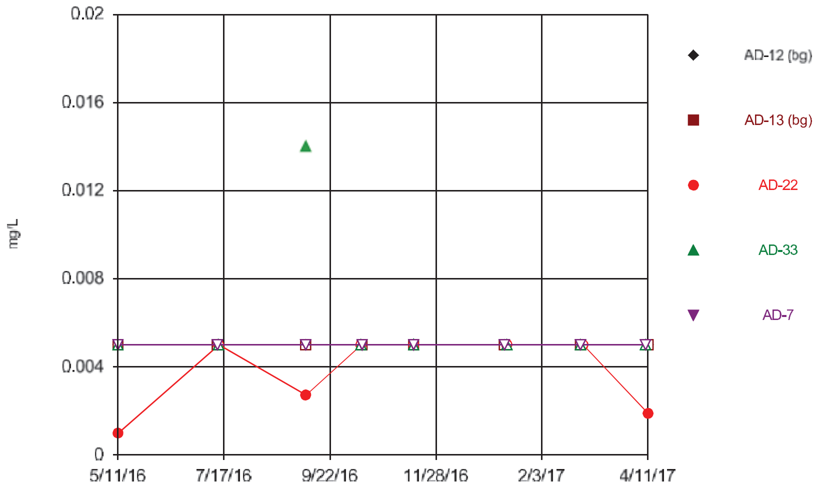

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Hollow symbols indicate censored values.

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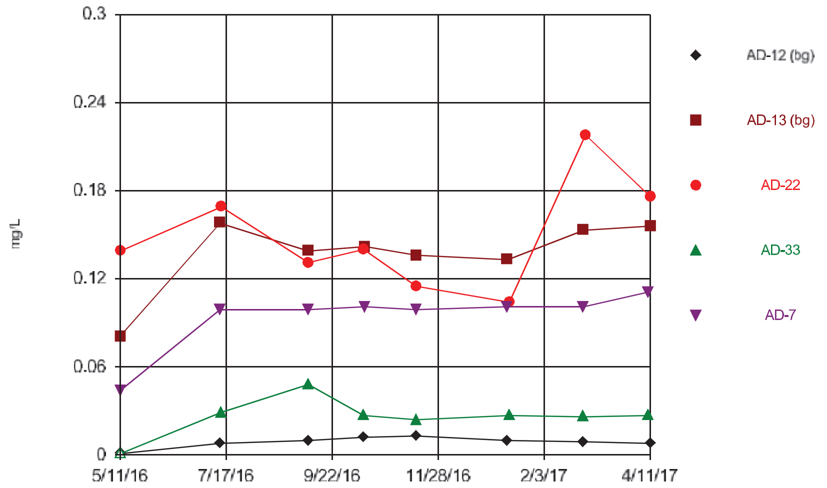

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Hollow symbols indicate censored values.

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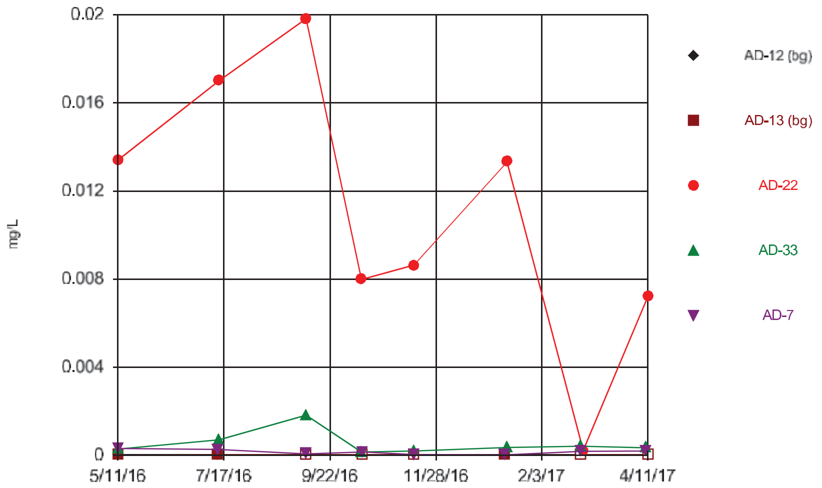

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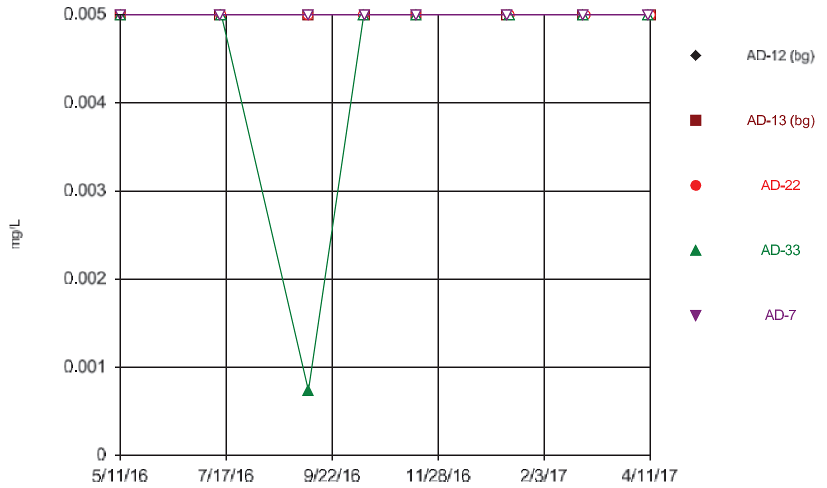
Hollow symbols indicate censored values.

Time Series



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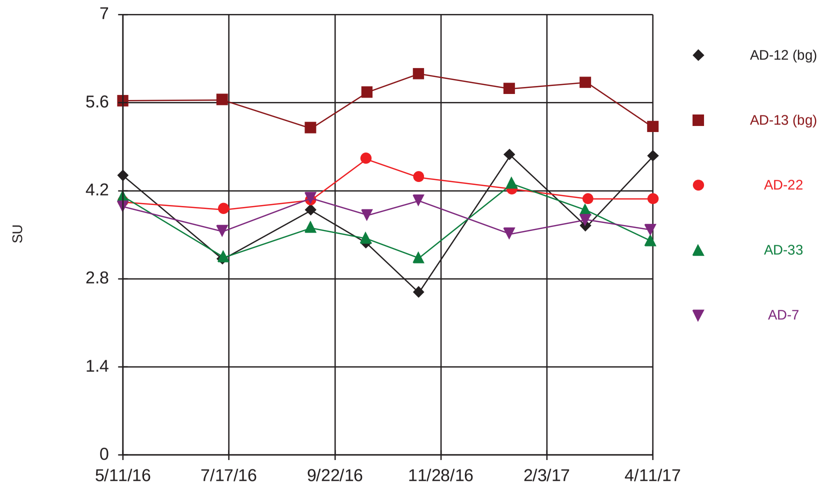
Time Series



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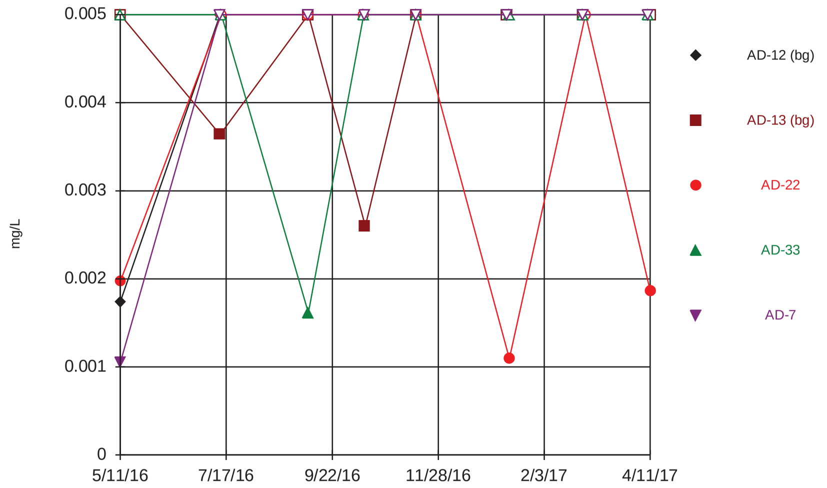
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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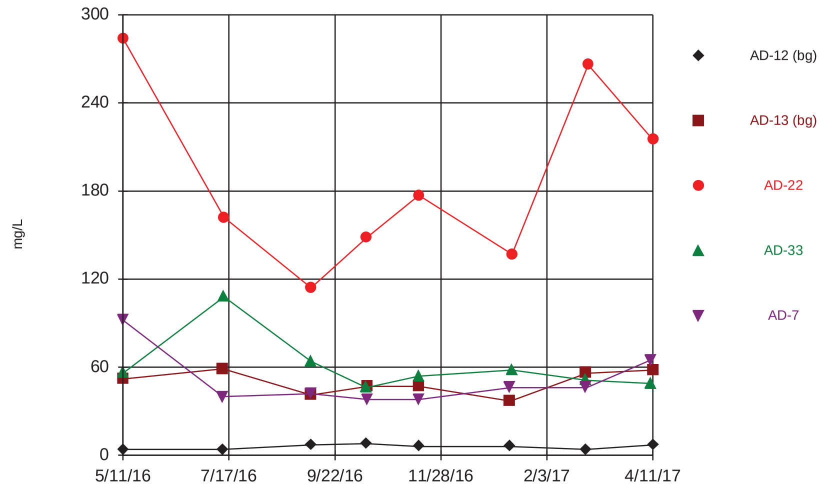
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Time Series



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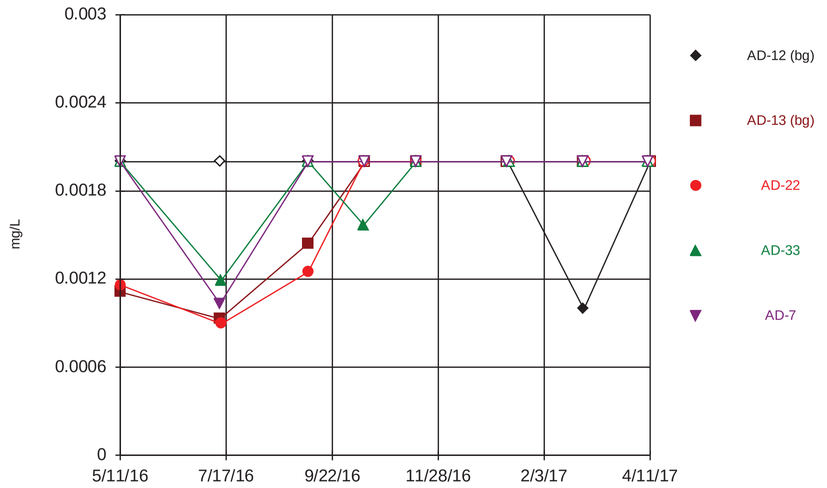
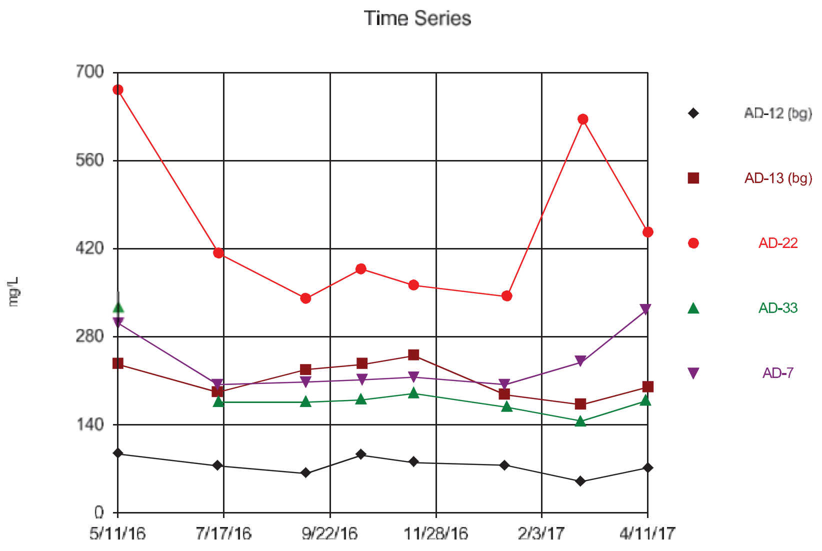
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

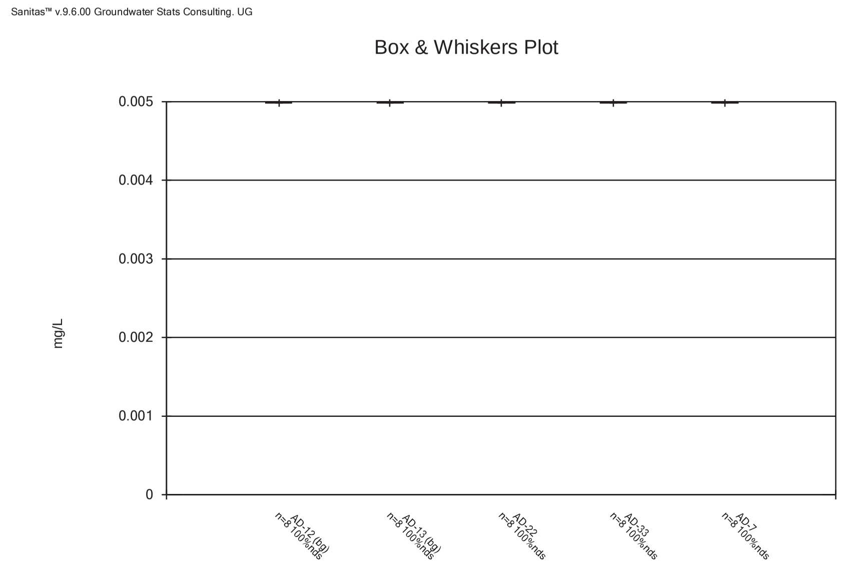
Time Series



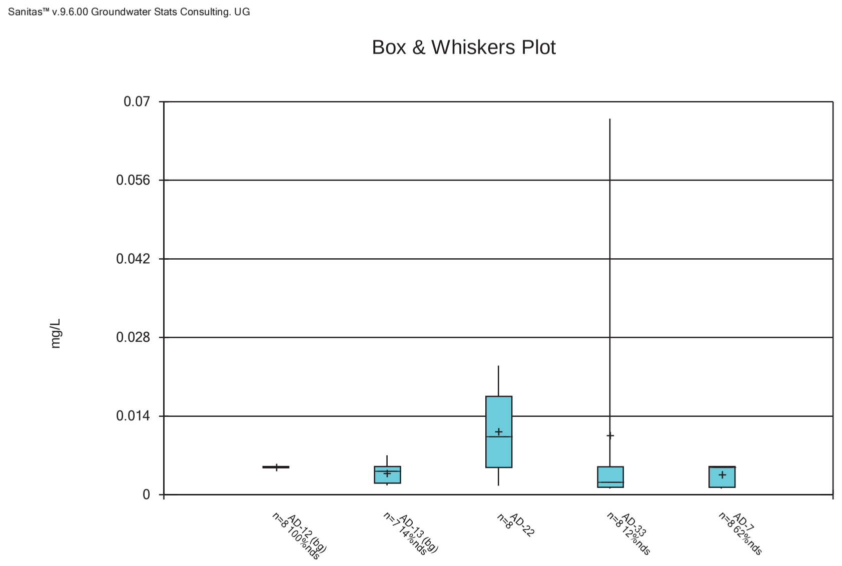
Constituent: Thallium, total   Analysis Run 12/14/2017 5:44 AM   View: Time Series
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout



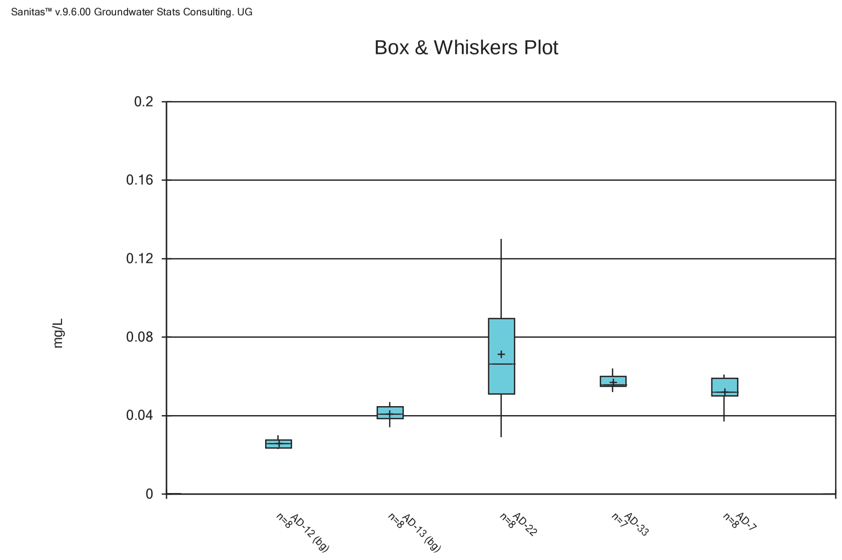
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/14/2017 5:44 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout



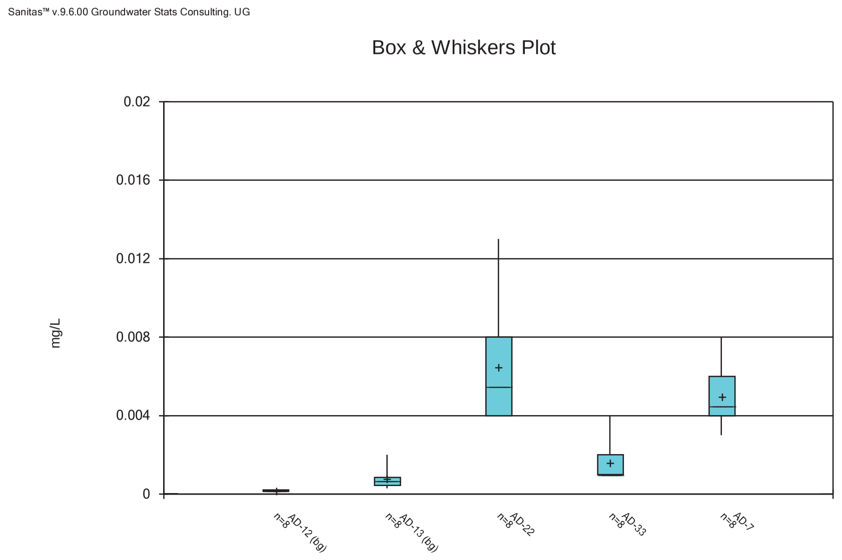
Constituent: Antimony, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout



Constituent: Arsenic, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout



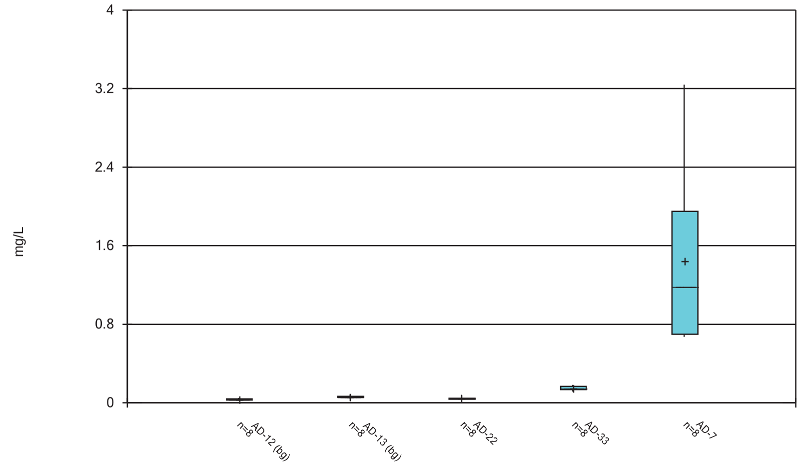
Constituent: Barium, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout



Constituent: Beryllium, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

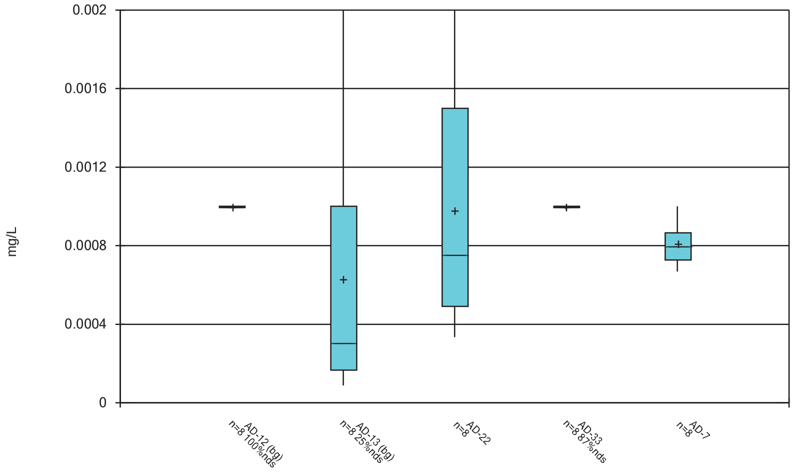
Box & Whiskers Plot



Constituent: Boron, total   Analysis Run 12/14/2017 5:46 AM   View: Time Series
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

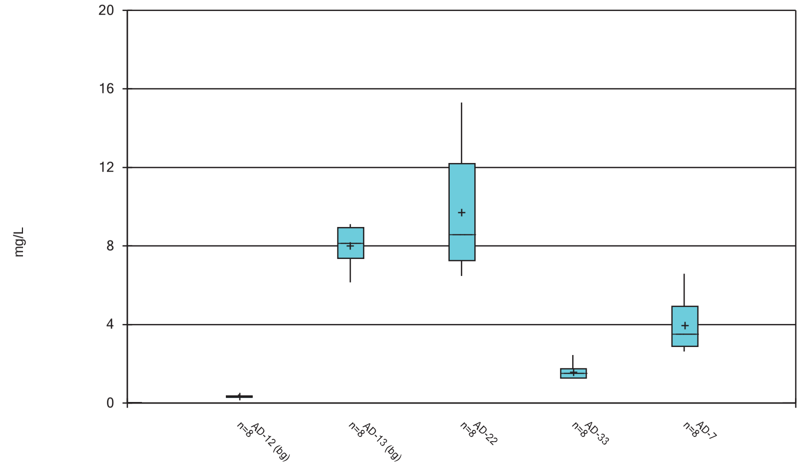
Box & Whiskers Plot



Constituent: Cadmium, total   Analysis Run 12/14/2017 5:46 AM   View: Time Series
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

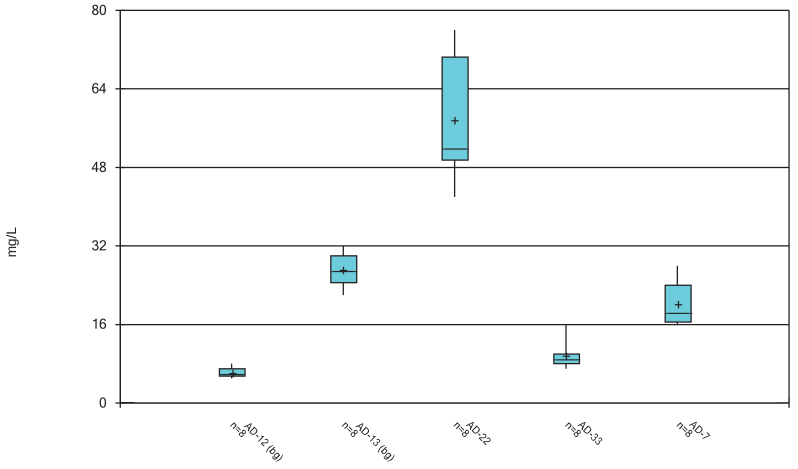
Box & Whiskers Plot



Constituent: Calcium, total   Analysis Run 12/14/2017 5:46 AM   View: Time Series
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

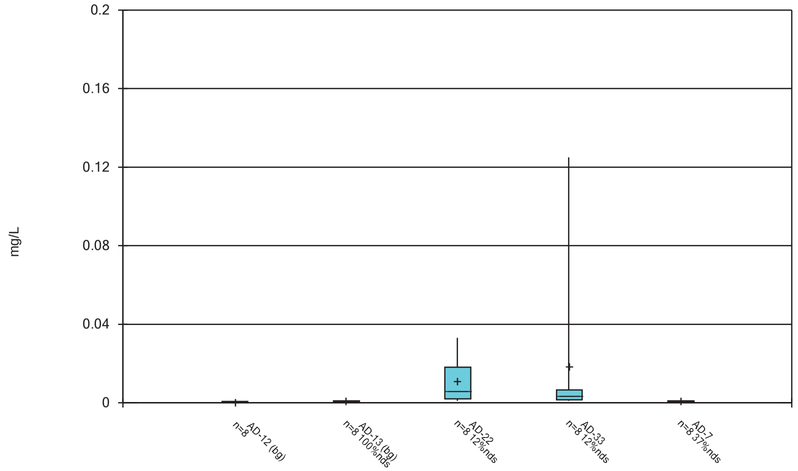
Box & Whiskers Plot



Constituent: Chloride, total   Analysis Run 12/14/2017 5:46 AM   View: Time Series
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

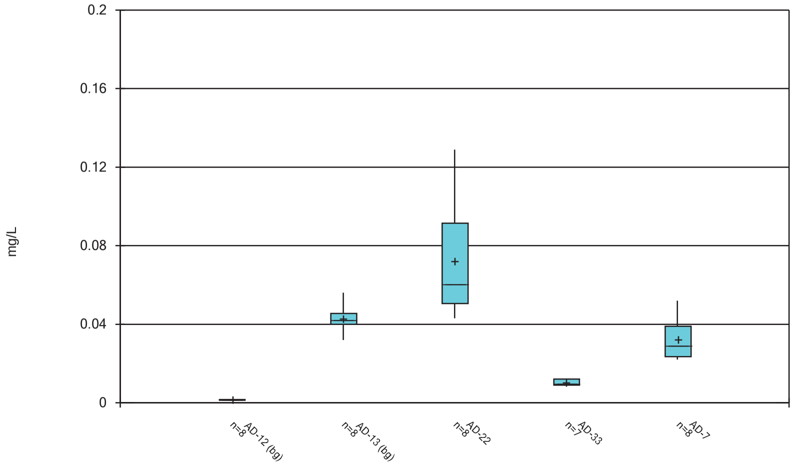
Box & Whiskers Plot



Constituent: Chromium, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

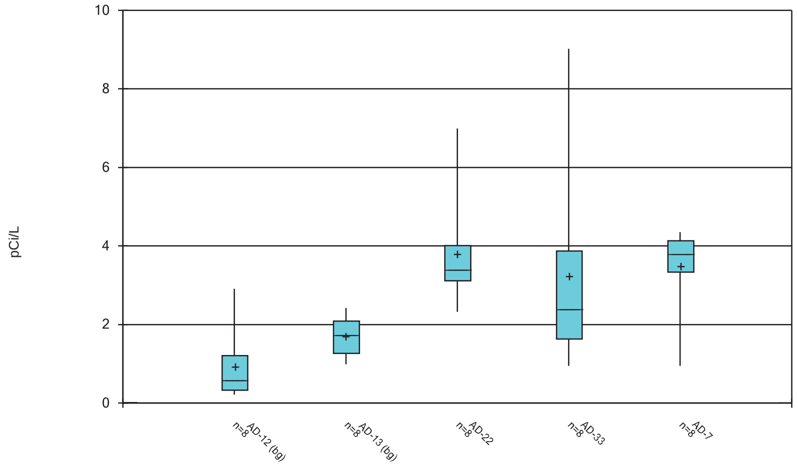
Box & Whiskers Plot



Constituent: Cobalt, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

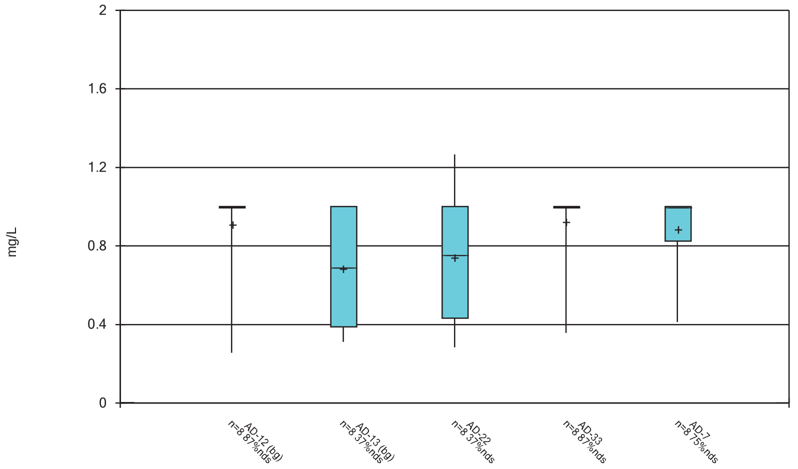
Box & Whiskers Plot



Constituent: Combined Radium 226 + 228 Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

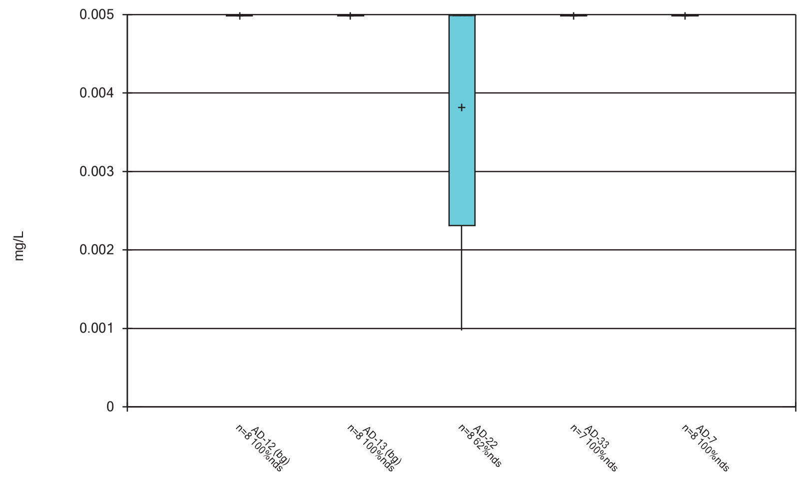
Box & Whiskers Plot



Constituent: Fluoride, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

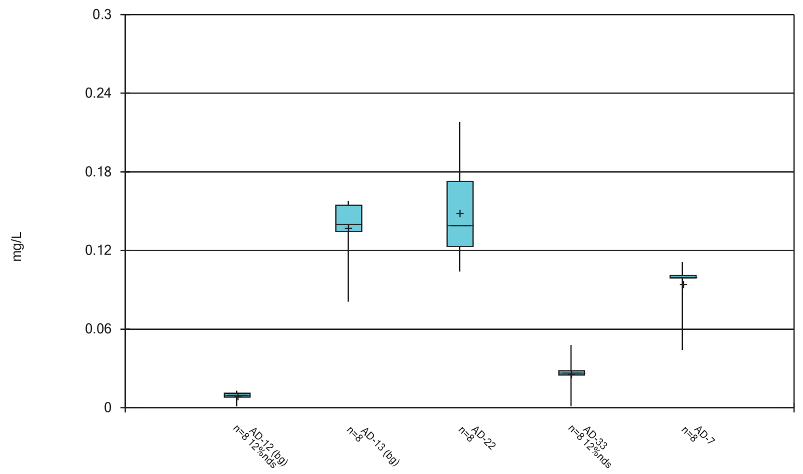
Box & Whiskers Plot



Constituent: Lead, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

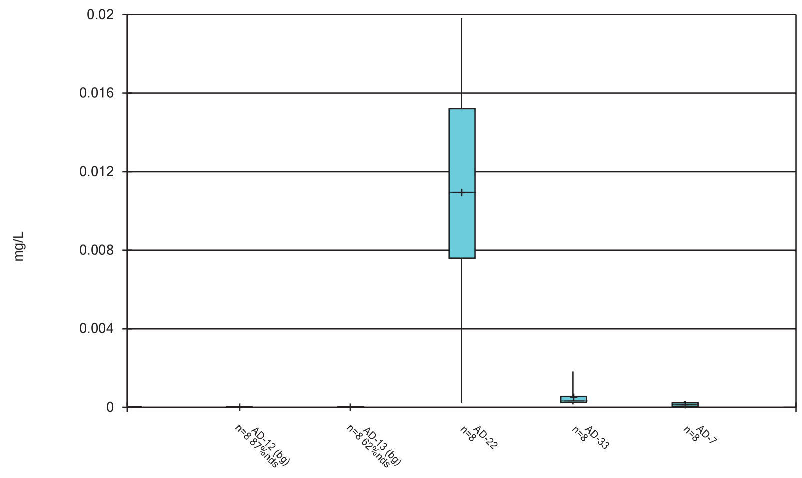
Box & Whiskers Plot



Constituent: Lithium, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

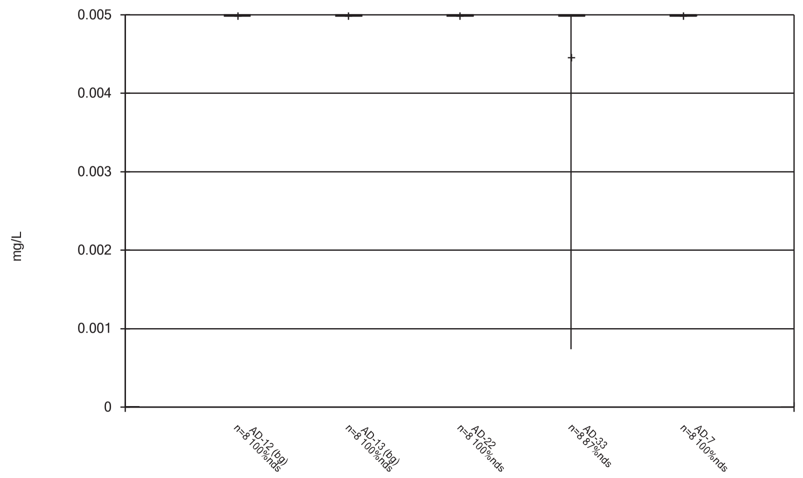
Box & Whiskers Plot



Constituent: Mercury, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

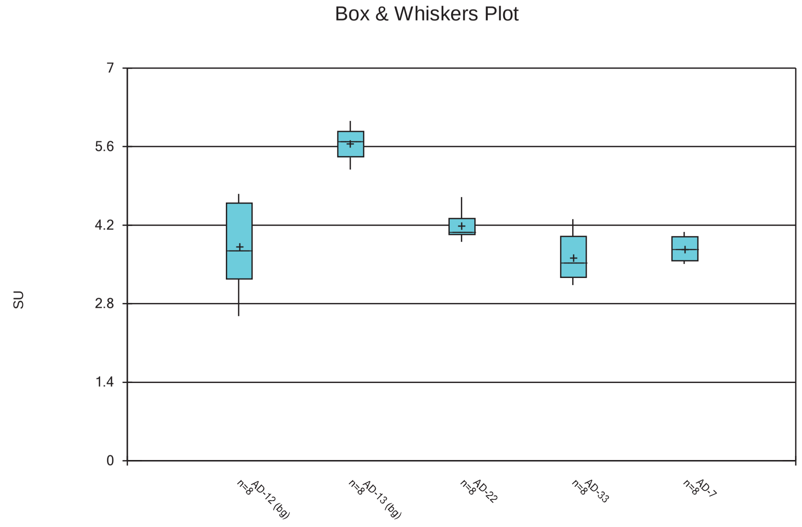
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



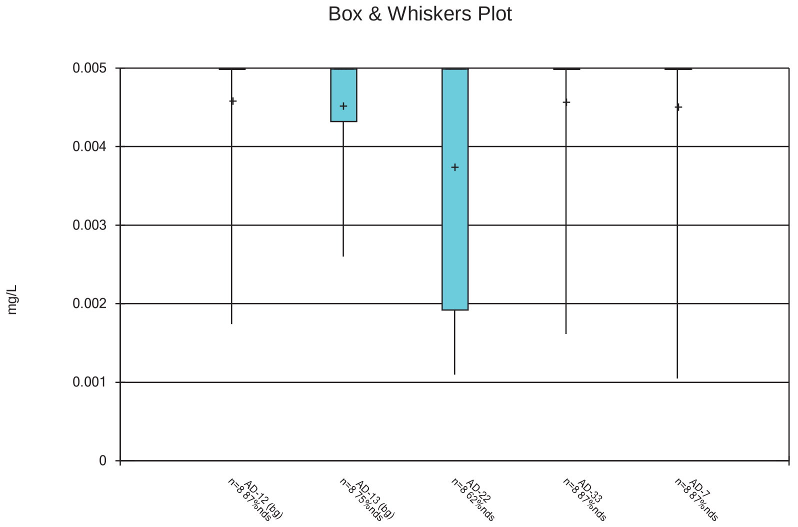
Constituent: Molybdenum, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



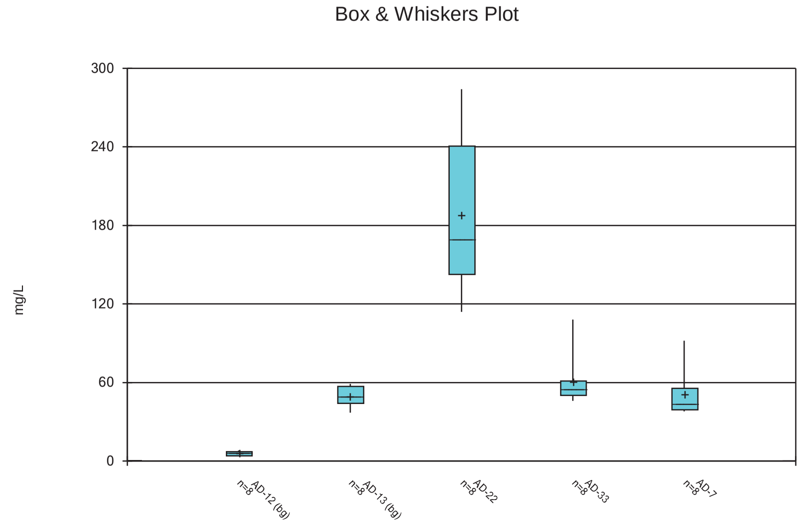
Constituent: pH, field Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



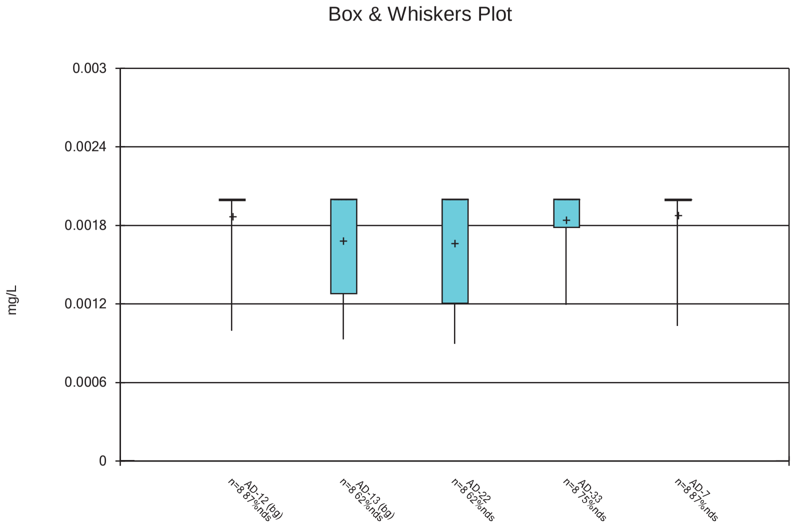
Constituent: Selenium, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



Constituent: Sulfate, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

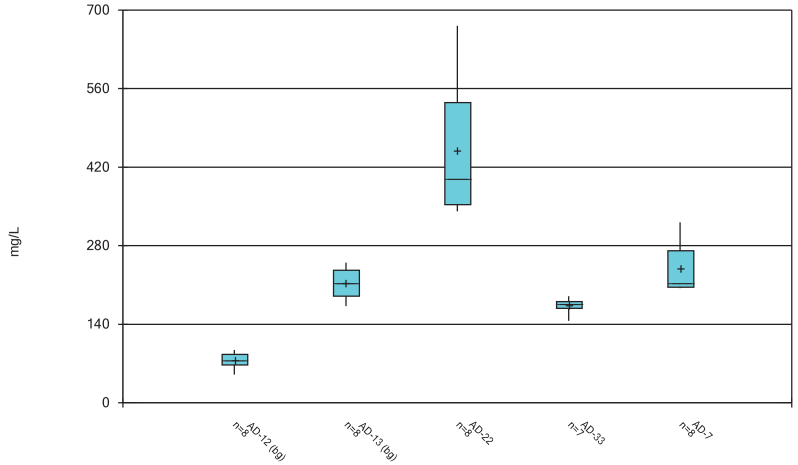
Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



Constituent: Thallium, total Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/14/2017 5:46 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Outlier Summary

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 12/14/2017, 5:41 AM

	AD-13 Arsenic, total (mg/L)	AD-33 Barium, total (mg/L)	AD-33 Cobalt, total (mg/L)	AD-33 Lead, total (mg/L)	AD-33 Total Dissolved Solids [TDS] (mg/L)
5/11/2016					326 (o)
7/13/2016	0.009 (o)				
9/7/2016		0.163 (o)	0.033 (o)	0.014 (o)	

Outlier Analysis - All Upgradient Wells

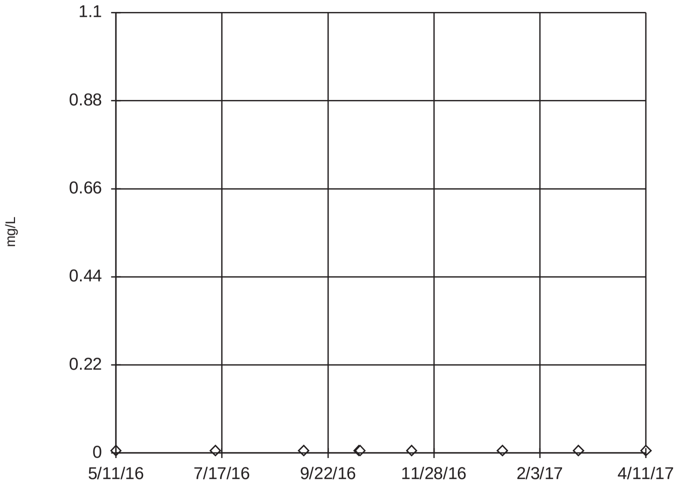
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 11/4/2017, 6:48 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	0.005	0	unknown	ShapiroWilk
Arsenic, total (mg/L)	**AD-12,AD-13**	**Yes**	**0.009,0.002072,0.001644**	**NP (nrm)**	**16**	**0.004759**	**0.00173**	**unknown**	**ShapiroWilk**
Barium, total (mg/L)	AD-12,AD-13	No	n/a	NP	16	0.0335	0.008579	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-12,AD-13	No	n/a	NP	16	0.0004755	0.0004854	ln(x)	ShapiroWilk
Boron, total (mg/L)	AD-12,AD-13	No	n/a	NP	16	0.04813	0.01559	sqrt(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	0.000814	0.0004933	unknown	ShapiroWilk
Calcium, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	4.176	4.038	unknown	ShapiroWilk
Chloride, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	16.69	11.09	unknown	ShapiroWilk
Chromium, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	0.0007501	0.0002817	unknown	ShapiroWilk
Cobalt, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	0.02214	0.02193	unknown	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-12,AD-13	No	n/a	NP	16	1.308	0.8198	sqrt(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	1.027	1.026	unknown	ShapiroWilk
Lead, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	0.005	0	unknown	ShapiroWilk
Lithium, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	0.07306	0.06844	unknown	ShapiroWilk
Mercury, total (mg/L)	**AD-12,AD-13**	**Yes**	**0.00000969,0.00000732**	**NP (nrm)**	**16**	**0.00002187**	**0.000006067**	**unknown**	**ShapiroWilk**
Molybdenum, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	0.005	0	unknown	ShapiroWilk
pH, field (SU)	AD-12,AD-13	No	n/a	NP	16	4.735	1.114	x^3	ShapiroWilk
Selenium, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	0.004561	0.001006	unknown	ShapiroWilk
Sulfate, total (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	27.69	23.34	unknown	ShapiroWilk
Thallium, total (mg/L)	**AD-12,AD-13**	**Yes**	**0.0009949,0.0009288**	**NP (nrm)**	**16**	**0.00178**	**0.0004066**	**unknown**	**ShapiroWilk**
Total Dissolved Solids [TDS] (mg/L)	AD-12,AD-13	No	n/a	NP (nrm)	16	144	74.23	unknown	ShapiroWilk

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

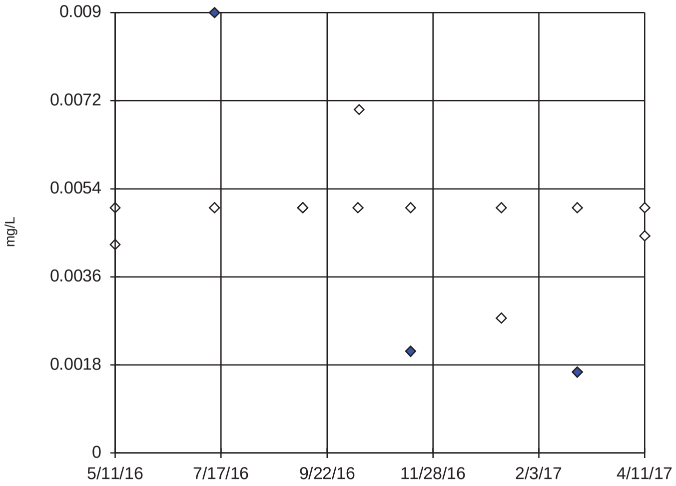
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Antimony, total Analysis Run 11/4/2017 6:44 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

Outliers are drawn as solid.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

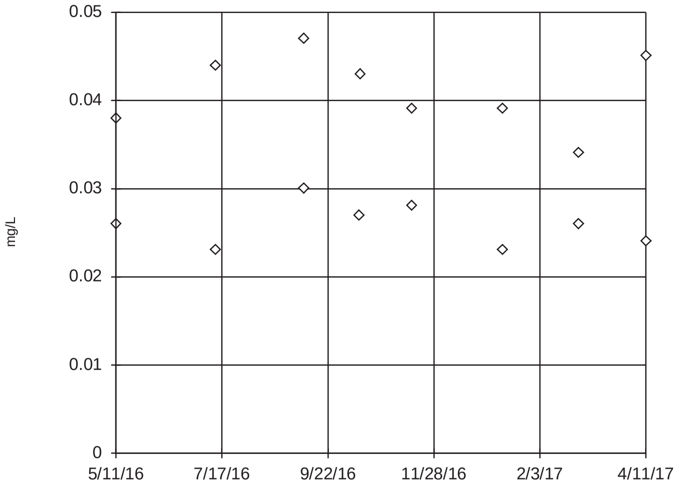
High cutoff = 0.007242, low cutoff = 0.002655, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/4/2017 6:44 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

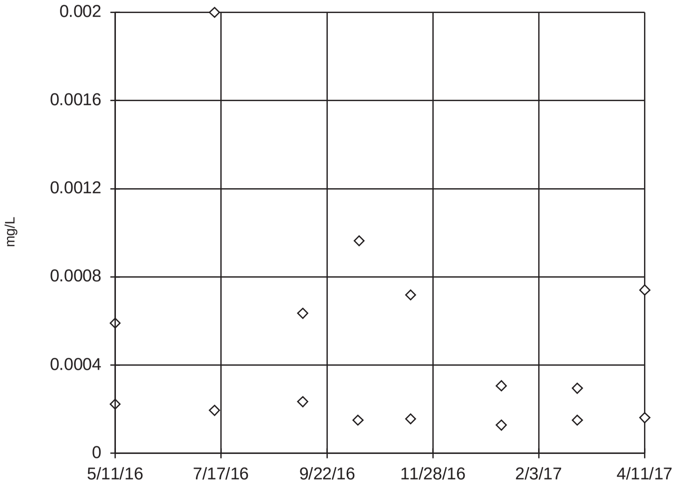
High cutoff = 0.16, low cutoff = 0.006654, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/4/2017 6:45 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

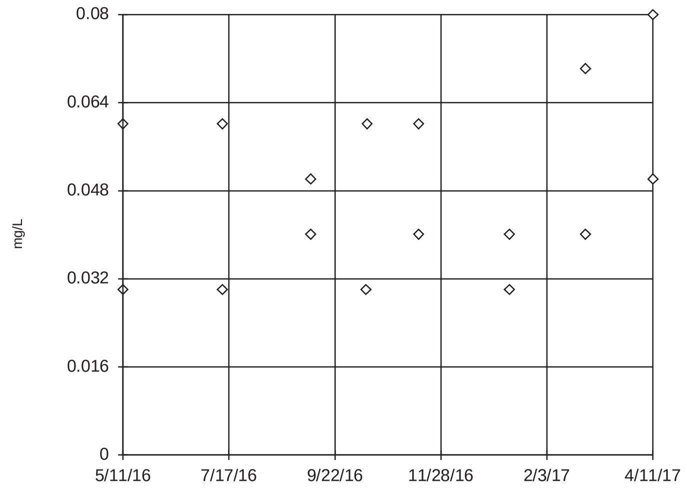
High cutoff = 0.05421, low cutoff = 0.000001935, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/4/2017 6:45 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1764, low cutoff = 0.0001337, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/4/2017 6:45 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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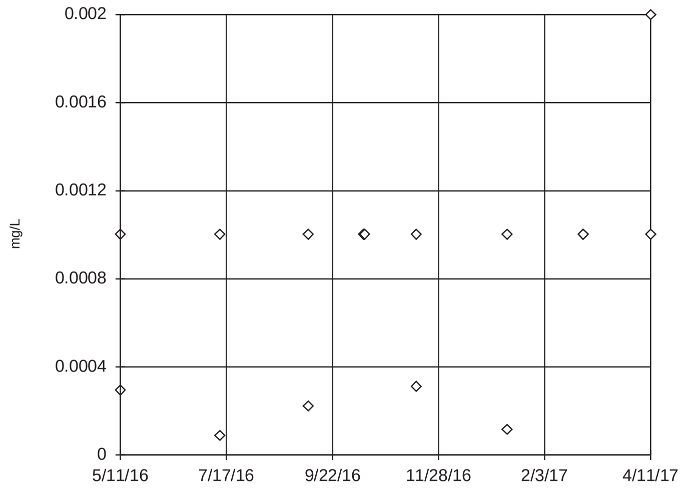
Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

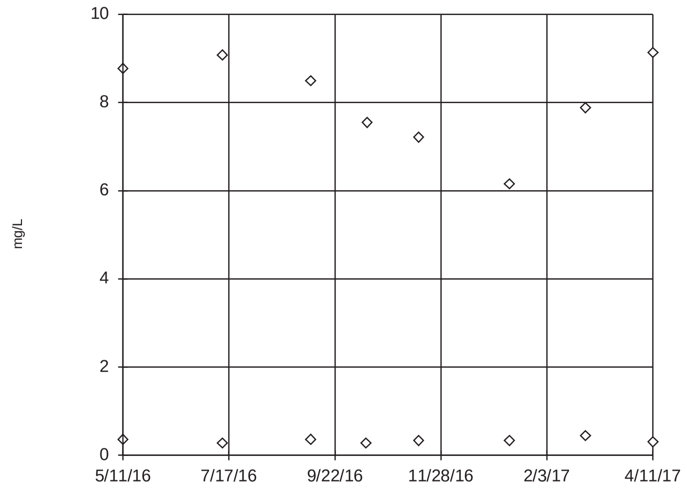
High cutoff = 0.005529, low cutoff = -0.000643, based on IQR multiplier of 3.

Constituent: Cadmium, total Analysis Run 11/4/2017 6:45 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube transformed to achieve best W statistic (graph shown in original units).

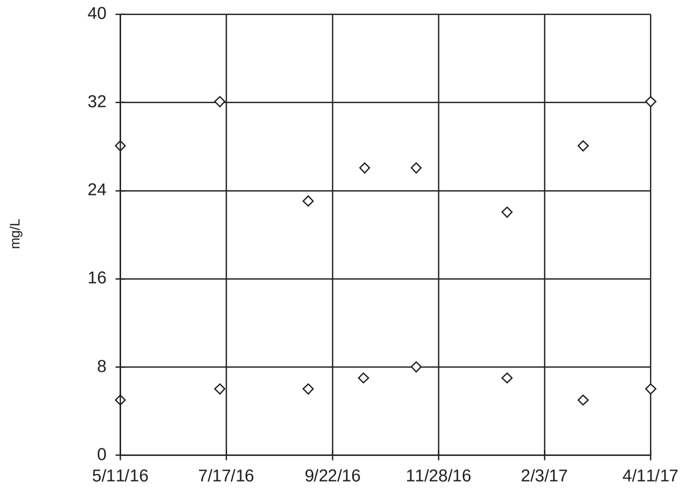
High cutoff = 13, low cutoff = -11.81, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/4/2017 6:45 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

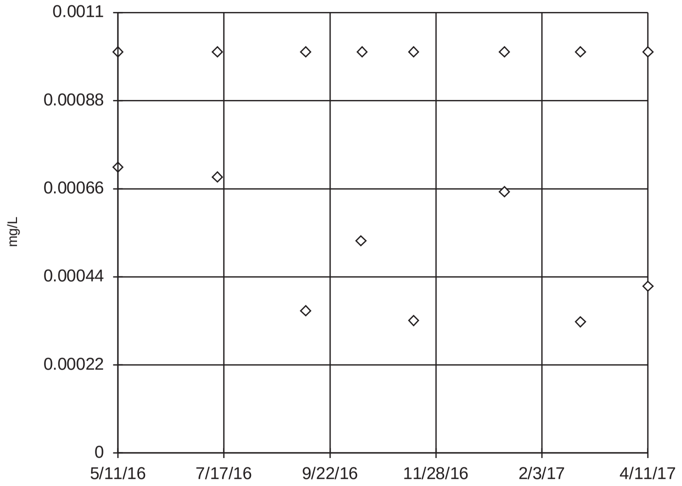
High cutoff = 53.03, low cutoff = -45.23, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/4/2017 6:45 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

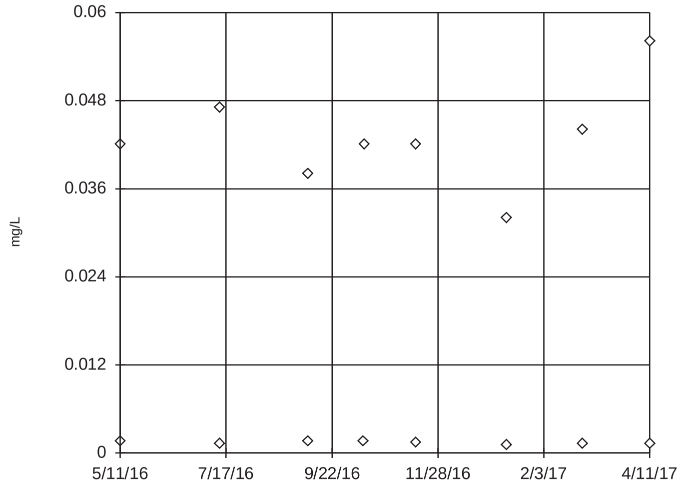
High cutoff = 0.003769, low cutoff = -0.0000652, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/4/2017 6:45 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

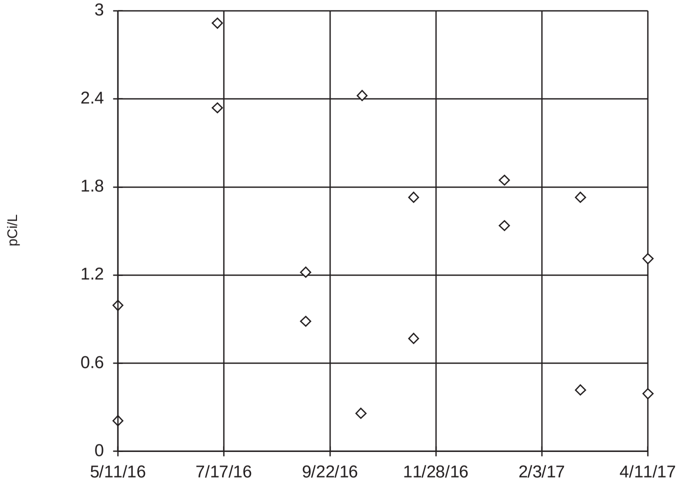
High cutoff = 0.08396, low cutoff = -0.07269, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/4/2017 6:45 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

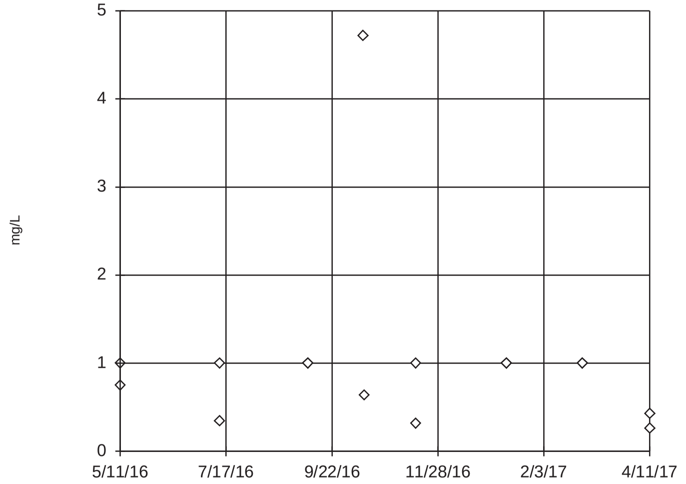
High cutoff = 9.387, low cutoff = -0.9354, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/4/2017 6:45 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

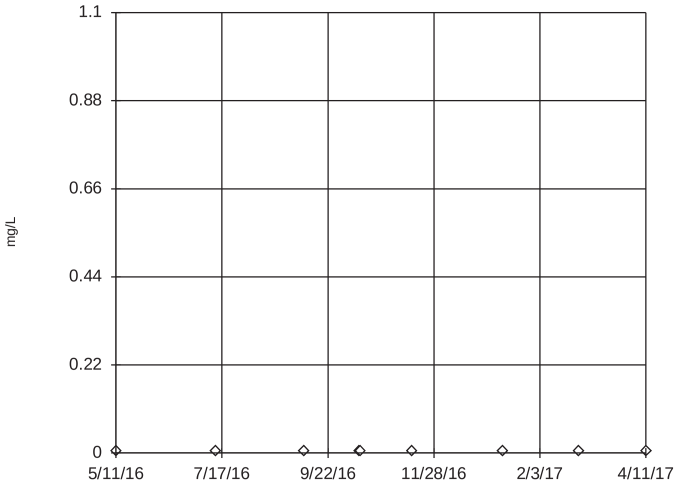
High cutoff = 7.152, low cutoff = 0.07257, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/4/2017 6:45 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

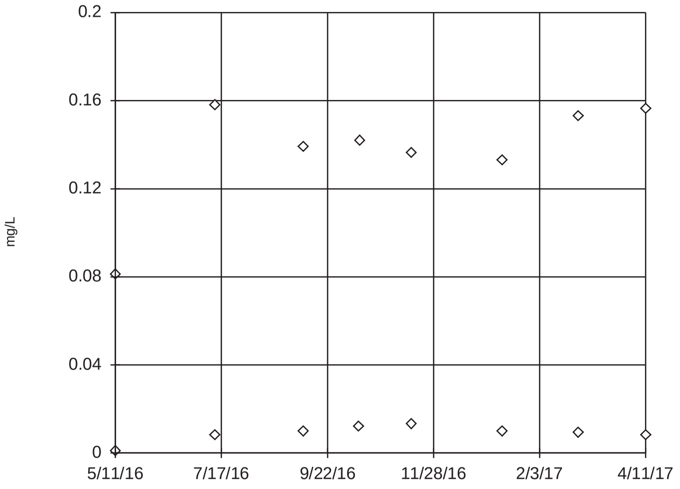
The results were invalid-
ated, because the lower
and upper quartiles are
equal.

Constituent: Lead, total   Analysis Run 11/4/2017 6:45 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

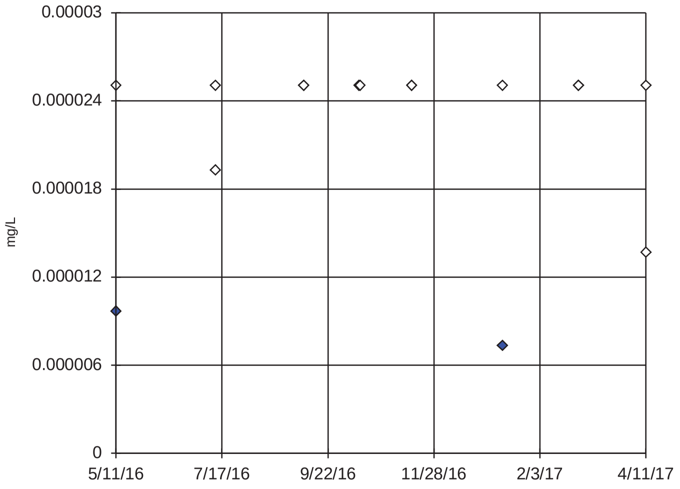
High cutoff = 456.3, low
cutoff = 0.000002921,
based on IQR multiplier
of 3.

Constituent: Lithium, total   Analysis Run 11/4/2017 6:45 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

Outliers are drawn as
solid.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square trans-
formed to achieve best
W statistic (graph shown
in original units).

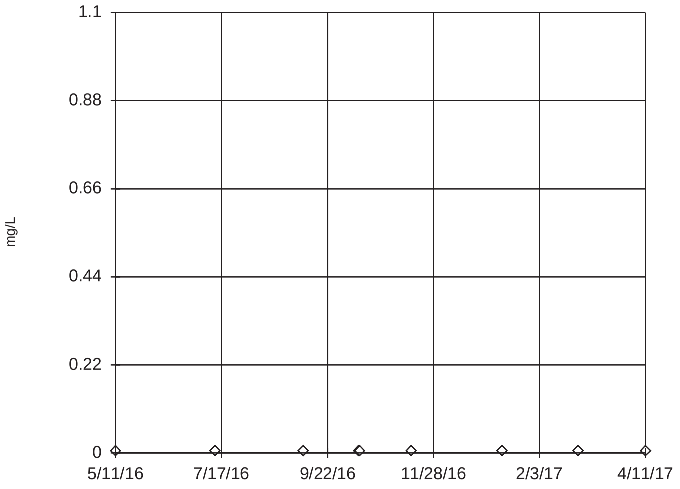
High cutoff = 0.0000317,
low cutoff = 0.00001088,
based on IQR multiplier
of 3.

Constituent: Mercury, total   Analysis Run 11/4/2017 6:45 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

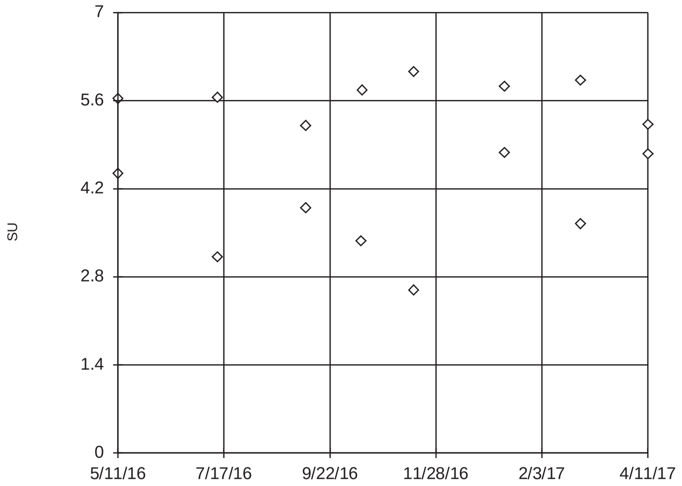
The results were invalid-
ated, because the lower
and upper quartiles are
equal.

Constituent: Molybdenum, total   Analysis Run 11/4/2017 6:45 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

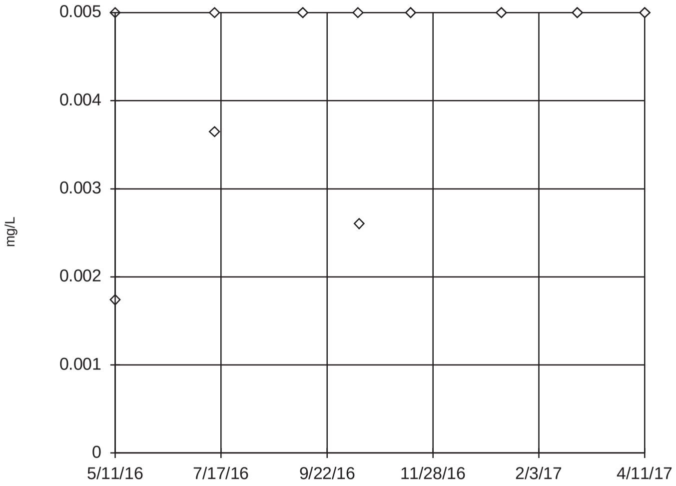
High cutoff = 8.354, low cutoff = -7.006, based on IQR multiplier of 3.

Constituent: pH, field   Analysis Run 11/4/2017 6:45 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

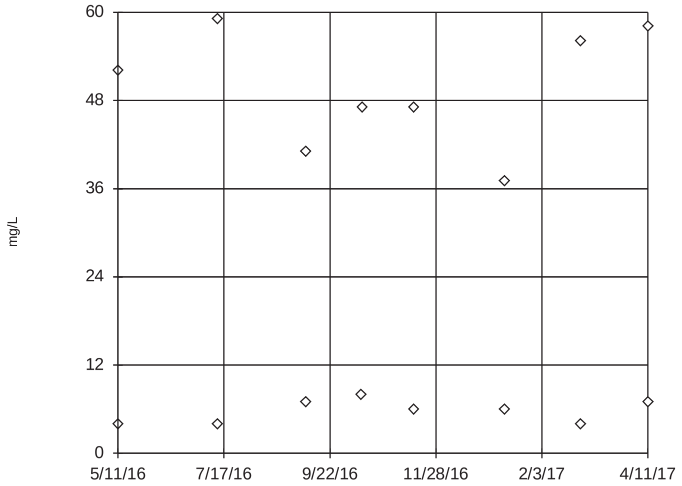
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Selenium, total   Analysis Run 11/4/2017 6:45 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

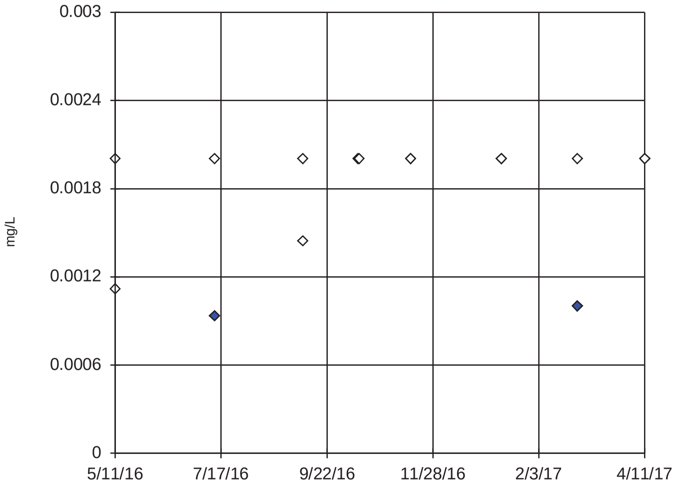
High cutoff = 98.58, low cutoff = -85, based on IQR multiplier of 3.

Constituent: Sulfate, total   Analysis Run 11/4/2017 6:45 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

Outliers are drawn as solid.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

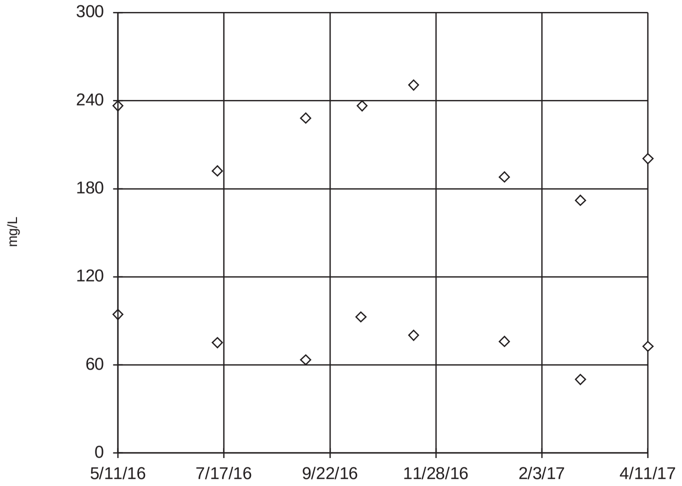
High cutoff = 0.003078, low cutoff = 0.001001, based on IQR multiplier of 3.

Constituent: Thallium, total   Analysis Run 11/4/2017 6:45 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-13



n = 16

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

High cutoff = 4832, low
cutoff = 3.337, based
on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/4/2017 6:45 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Outlier Analysis - All Downgradient Wells

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 11/4/2017, 6:51 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-22	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-33	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-7	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-22	No	n/a	NP	8	0.01129	0.008069	x^(1/3)	ShapiroWilk
Arsenic, total (mg/L)	AD-33	No	n/a	NP	8	0.01066	0.02282	ln(x)	ShapiroWilk
Arsenic, total (mg/L)	AD-7	No	n/a	NP (nrm)	8	0.003581	0.00196	unknown	ShapiroWilk
Barium, total (mg/L)	AD-22	No	n/a	NP	8	0.07163	0.03267	ln(x)	ShapiroWilk
Barium, total (mg/L)	**AD-33**	**Yes**	**0.163**	**NP**	**8**	**0.0705**	**0.03756**	**ln(x)**	**ShapiroWilk**
Barium, total (mg/L)	AD-7	No	n/a	NP	8	0.0525	0.00769	x^4	ShapiroWilk
Beryllium, total (mg/L)	AD-22	No	n/a	NP	8	0.0065	0.003295	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-33	No	n/a	NP (nrm)	8	0.001625	0.001061	unknown	ShapiroWilk
Beryllium, total (mg/L)	AD-7	No	n/a	NP	8	0.005	0.00169	ln(x)	ShapiroWilk
Boron, total (mg/L)	AD-22	No	n/a	NP	8	0.0425	0.01753	ln(x)	ShapiroWilk
Boron, total (mg/L)	AD-33	No	n/a	NP	8	0.1491	0.023	normal	ShapiroWilk
Boron, total (mg/L)	AD-7	No	n/a	NP	8	1.447	0.93	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-22	No	n/a	NP	8	0.0009779	0.000667	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-33	No	n/a	NP (nrm)	8	0.0009981	0.000005412	unknown	ShapiroWilk
Cadmium, total (mg/L)	AD-7	No	n/a	NP	8	0.0008063	0.0001069	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-22	No	n/a	NP	8	9.731	3.263	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-33	No	n/a	NP	8	1.595	0.403	ln(x)	ShapiroWilk
Calcium, total (mg/L)	AD-7	No	n/a	NP	8	3.988	1.387	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-22	No	n/a	NP	8	57.75	12.63	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-33	No	n/a	NP	8	9.625	2.774	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-7	No	n/a	NP	8	20.25	4.979	ln(x)	ShapiroWilk
Chromium, total (mg/L)	AD-22	No	n/a	NP	8	0.01075	0.01176	ln(x)	ShapiroWilk
Chromium, total (mg/L)	AD-33	No	n/a	NP	8	0.01863	0.04306	ln(x)	ShapiroWilk
Chromium, total (mg/L)	AD-7	No	n/a	NP (nrm)	8	0.0007972	0.000314	unknown	ShapiroWilk
Cobalt, total (mg/L)	AD-22	No	n/a	NP	8	0.07213	0.0305	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	**AD-33**	**Yes**	**0.033**	**NP (nrm)**	**8**	**0.013**	**0.008177**	**unknown**	**ShapiroWilk**
Cobalt, total (mg/L)	AD-7	No	n/a	NP	8	0.03213	0.01082	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-22	No	n/a	NP	8	3.794	1.416	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-33	No	n/a	NP	8	3.221	2.584	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-7	No	n/a	NP	8	3.476	1.099	x^4	ShapiroWilk
Fluoride, total (mg/L)	AD-22	No	n/a	NP	8	0.7395	0.3661	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-33	No	n/a	NP (nrm)	8	0.9196	0.2273	unknown	ShapiroWilk
Fluoride, total (mg/L)	AD-7	No	n/a	NP (nrm)	8	0.8826	0.2264	unknown	ShapiroWilk
Lead, total (mg/L)	AD-22	No	n/a	NP (nrm)	8	0.003825	0.001689	unknown	ShapiroWilk
Lead, total (mg/L)	AD-33	No	n/a	NP (nrm)	8	0.006125	0.003182	unknown	ShapiroWilk
Lead, total (mg/L)	AD-7	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Lithium, total (mg/L)	AD-22	No	n/a	NP	8	0.149	0.03699	ln(x)	ShapiroWilk
Lithium, total (mg/L)	**AD-33**	**Yes**	**0.001,0.048**	**NP**	**8**	**0.02613**	**0.01268**	**normal**	**ShapiroWilk**
Lithium, total (mg/L)	**AD-7**	**Yes**	**0.044,0.111**	**NP (nrm)**	**8**	**0.09438**	**0.02074**	**unknown**	**ShapiroWilk**
Mercury, total (mg/L)	AD-22	No	n/a	NP	8	0.01095	0.006216	normal	ShapiroWilk
Mercury, total (mg/L)	AD-33	No	n/a	NP	8	0.0005343	0.0005487	ln(x)	ShapiroWilk
Mercury, total (mg/L)	AD-7	No	n/a	NP	8	0.0001526	0.0001051	normal	ShapiroWilk
Molybdenum, total (mg/L)	AD-22	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-33	No	n/a	NP (nrm)	8	0.004467	0.001507	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-7	No	n/a	NP (nrm)	8	0.005	0	unknown	ShapiroWilk
pH, field (SU)	AD-22	No	n/a	NP	8	4.181	0.2594	ln(x)	ShapiroWilk
pH, field (SU)	AD-33	No	n/a	NP	8	3.629	0.4375	ln(x)	ShapiroWilk
pH, field (SU)	AD-7	No	n/a	NP	8	3.783	0.2251	ln(x)	ShapiroWilk
Selenium, total (mg/L)	AD-22	No	n/a	NP (nrm)	8	0.003742	0.001755	unknown	ShapiroWilk
Selenium, total (mg/L)	AD-33	No	n/a	NP (nrm)	8	0.004577	0.001197	unknown	ShapiroWilk
Selenium, total (mg/L)	AD-7	No	n/a	NP (nrm)	8	0.004506	0.001398	unknown	ShapiroWilk
Sulfate, total (mg/L)	AD-22	No	n/a	NP	8	187.9	61.53	ln(x)	ShapiroWilk

Outlier Analysis - All Downgradient Wells

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 11/4/2017, 6:51 PM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Sulfate, total (mg/L)	AD-33	No	n/a	NP	8	60.75	19.89	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-7	No	n/a	NP	8	50.88	18.77	ln(x)	ShapiroWilk
Thallium, total (mg/L)	AD-22	No	n/a	NP (nrm)	8	0.001663	0.000475	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-33	No	n/a	NP (nrm)	8	0.001845	0.0003042	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-7	No	n/a	NP (nrm)	8	0.001879	0.0003422	unknown	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	AD-22	No	n/a	NP	8	448.6	128.6	ln(x)	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	**AD-33**	**Yes**	**326**	**NP**	**8**	**192.5**	**55.42**	**ln(x)**	**ShapiroWilk**
Total Dissolved Solids [TDS] (mg/L)	AD-7	No	n/a	NP (nrm)	8	238.5	47.1	unknown	ShapiroWilk

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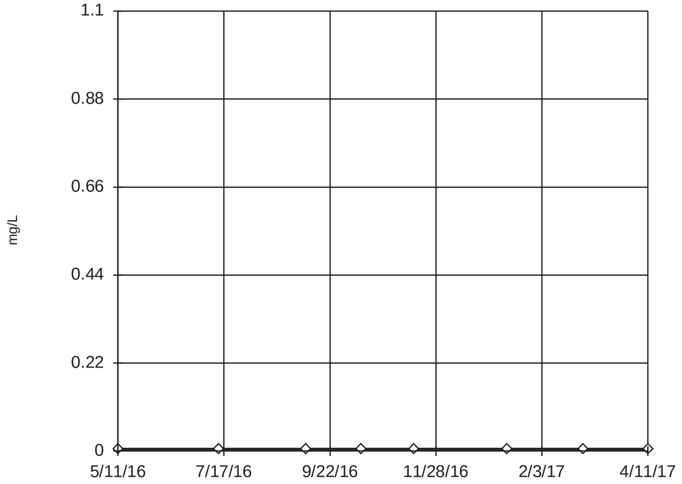
Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

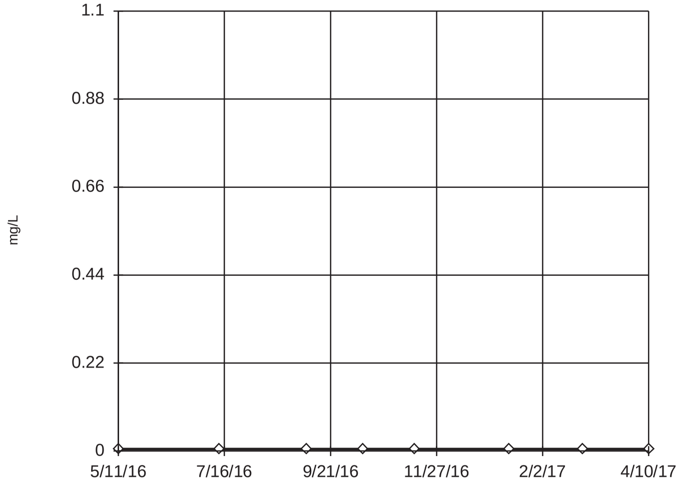
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Antimony, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

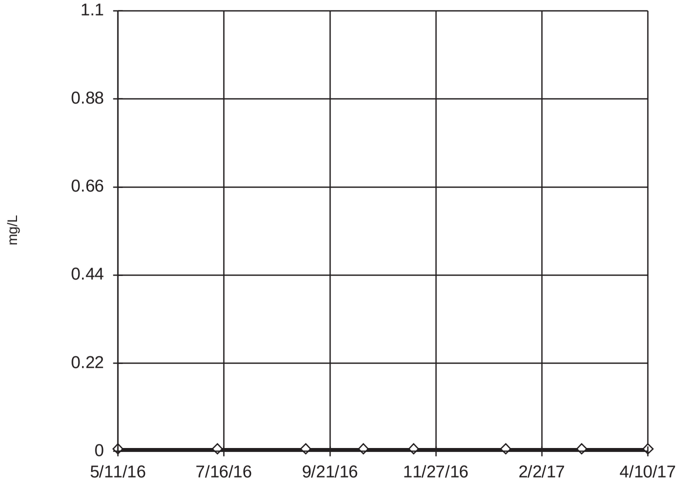
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Antimony, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

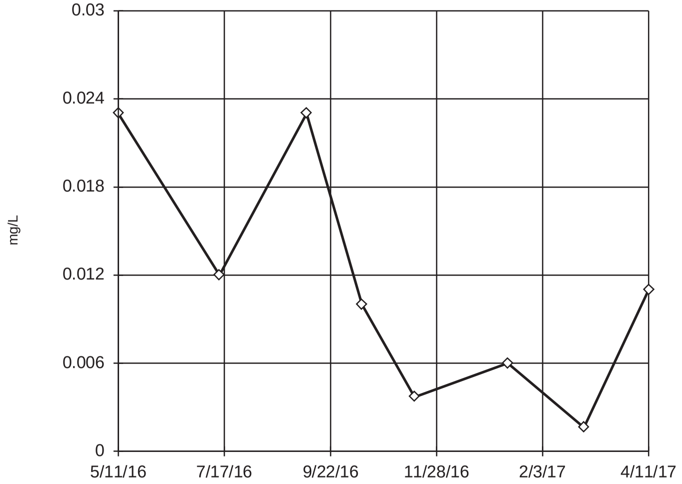
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Antimony, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

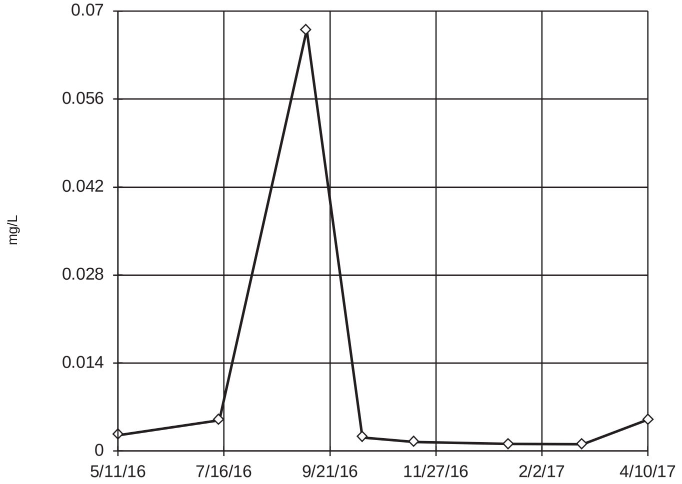
High cutoff = 0.1423, low cutoff = -0.0009207, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

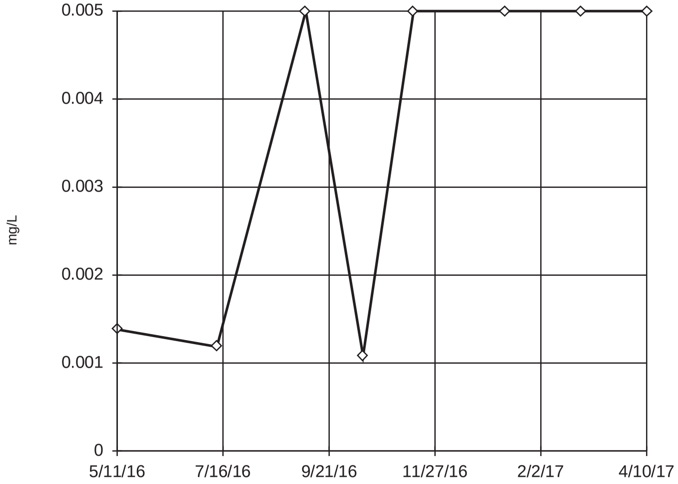
High cutoff = 0.2842,
low cutoff = 0.00002243,
based on IQR multiplier of 3.

Constituent: Arsenic, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

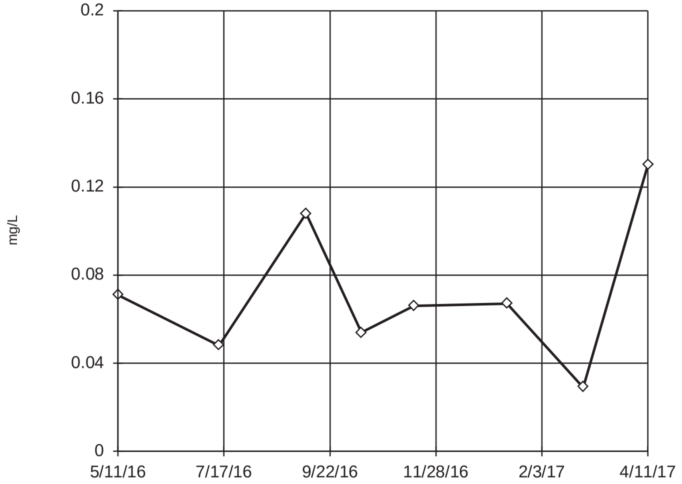
High cutoff = 0.2984,
low cutoff = 0.00002144,
based on IQR multiplier of 3.

Constituent: Arsenic, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

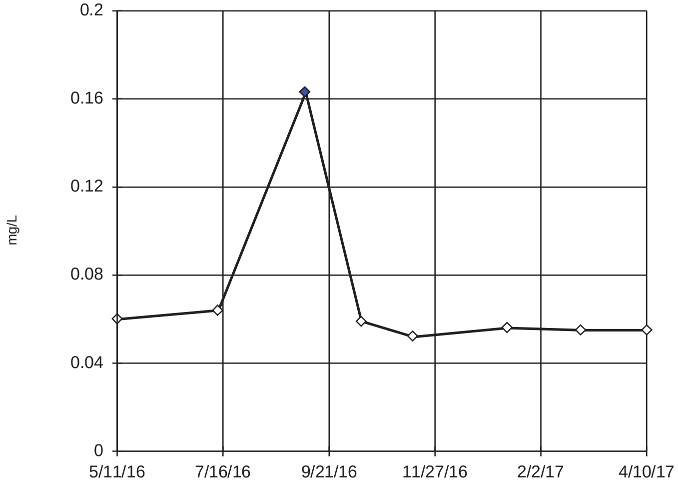
High cutoff = 0.4456,
low cutoff = 0.01001,
based on IQR multiplier of 3.

Constituent: Barium, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

Outlier is drawn as solid.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

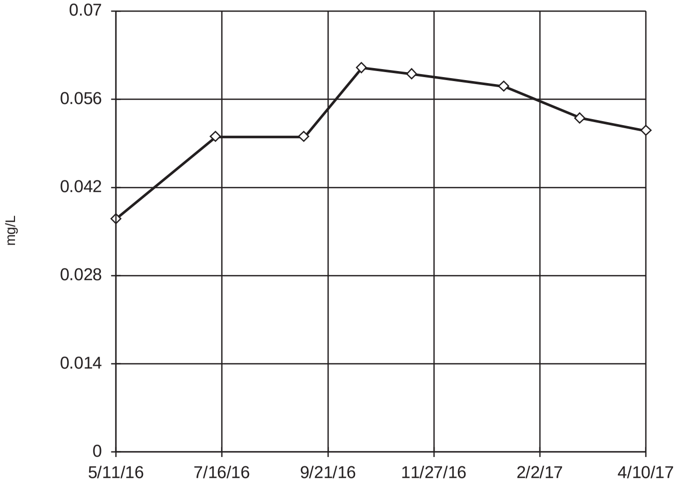
High cutoff = 0.08863,
low cutoff = 0.03846,
based on IQR multiplier of 3.

Constituent: Barium, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

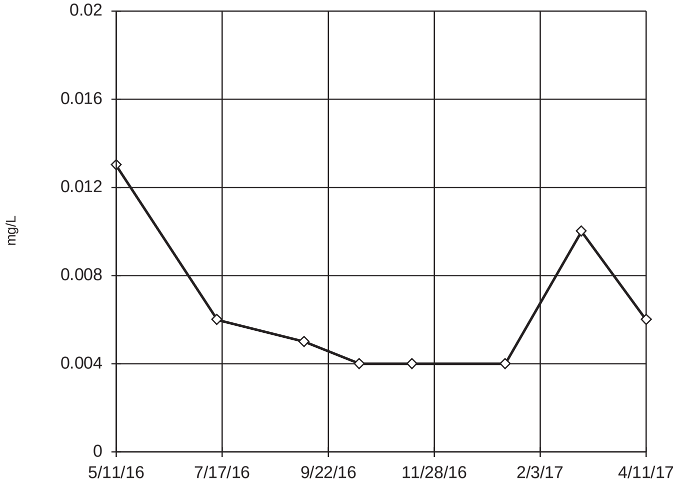
High cutoff = 0.07389, low cutoff = -0.05813, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

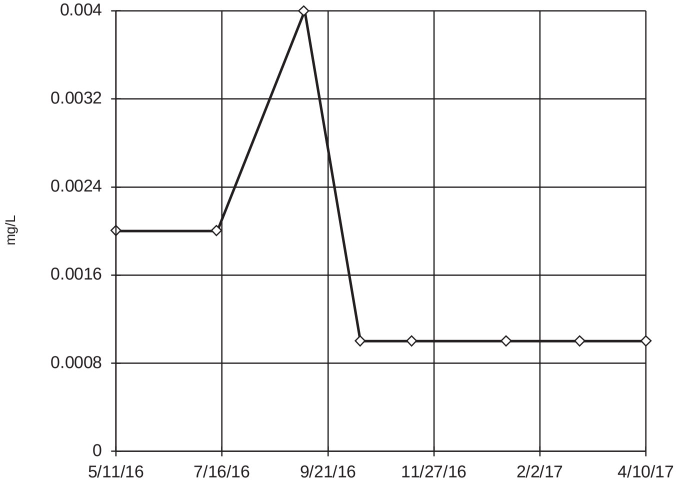
High cutoff = 0.05625, low cutoff = 0.0005508, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

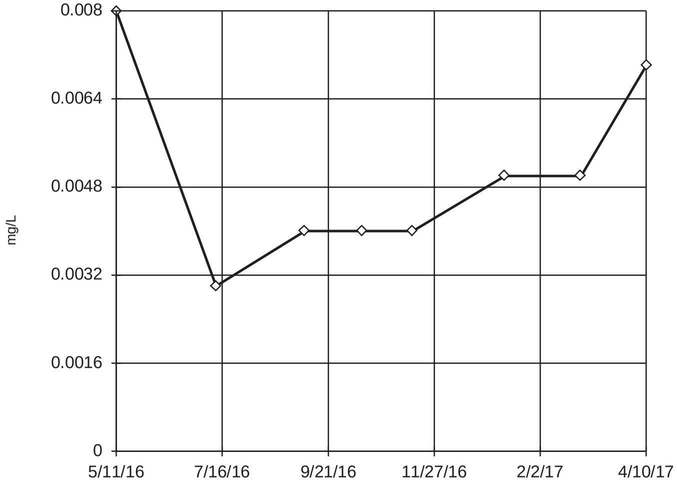
High cutoff = 0.016, low cutoff = 0.000125, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

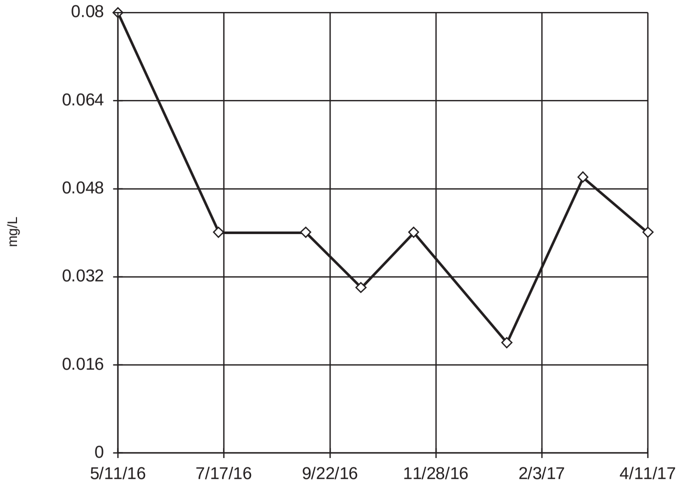
High cutoff = 0.01914, low cutoff = 0.001236, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

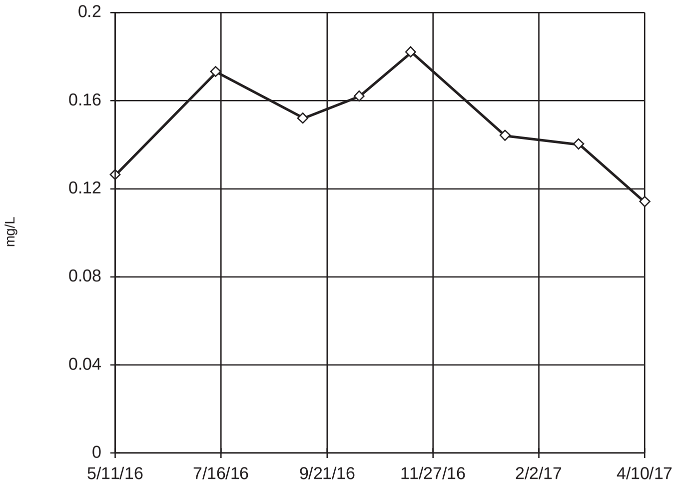
High cutoff = 0.09623, low cutoff = 0.0161, based on IQR multiplier of 3.

Constituent: Boron, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

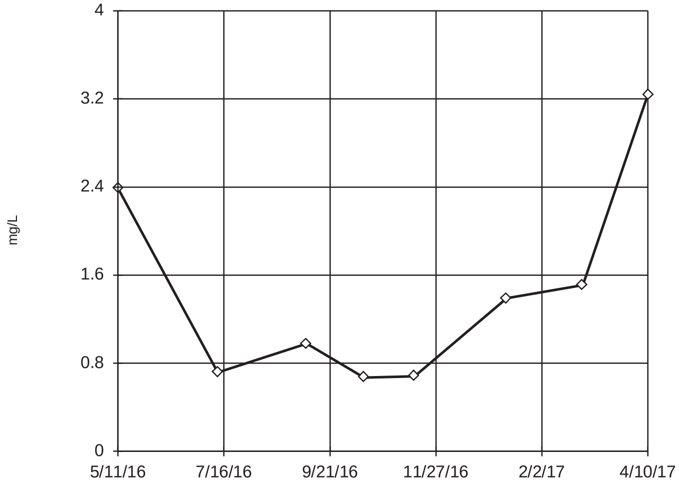
High cutoff = 0.271, low cutoff = 0.0295, based on IQR multiplier of 3.

Constituent: Boron, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

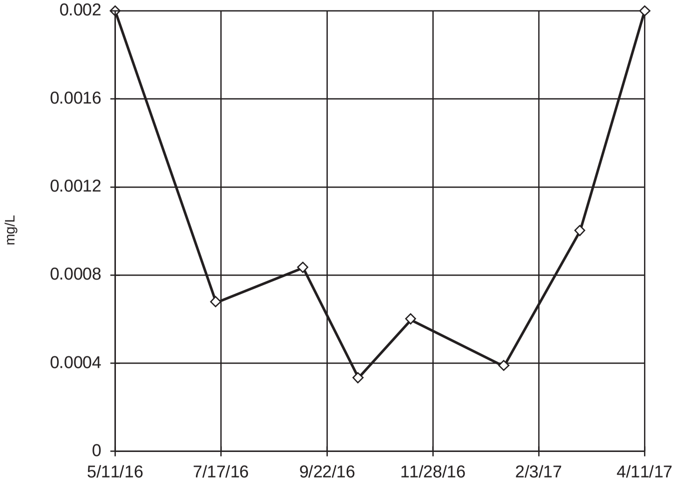
High cutoff = 38.17, low cutoff = 0.03478, based on IQR multiplier of 3.

Constituent: Boron, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

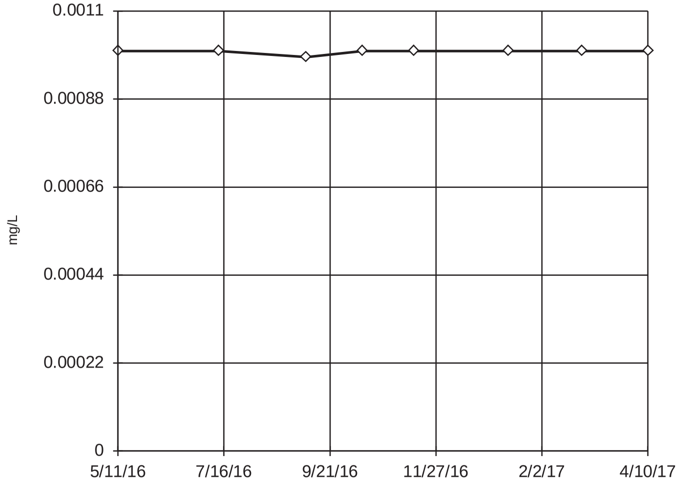
High cutoff = 0.03627, low cutoff = 0.0000187, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

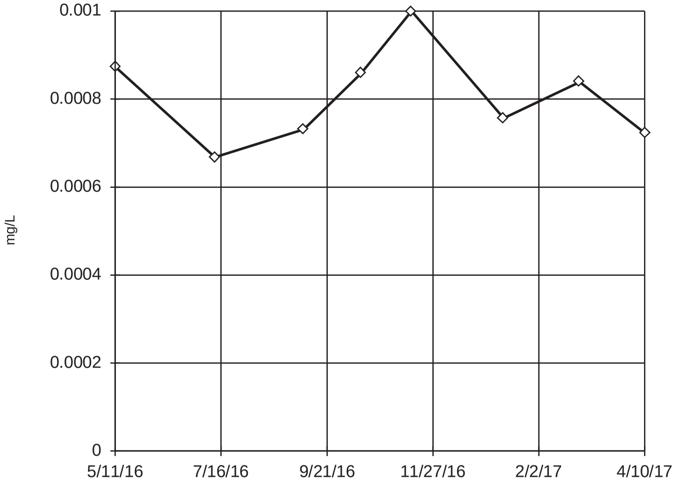
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Cadmium, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

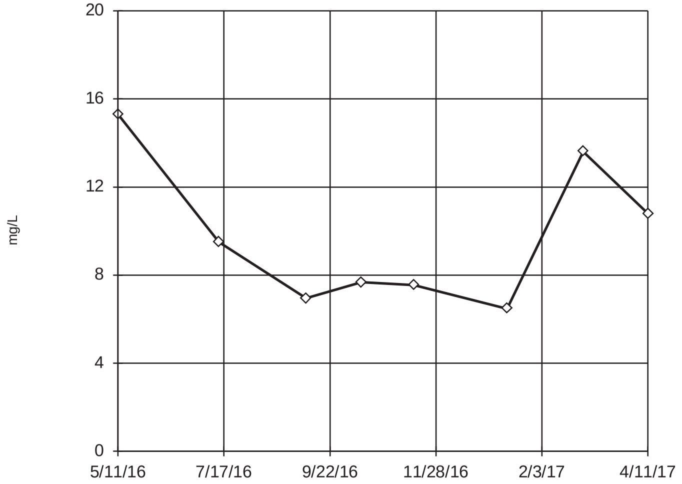
High cutoff = 0.001463, low cutoff = 0.0004304, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

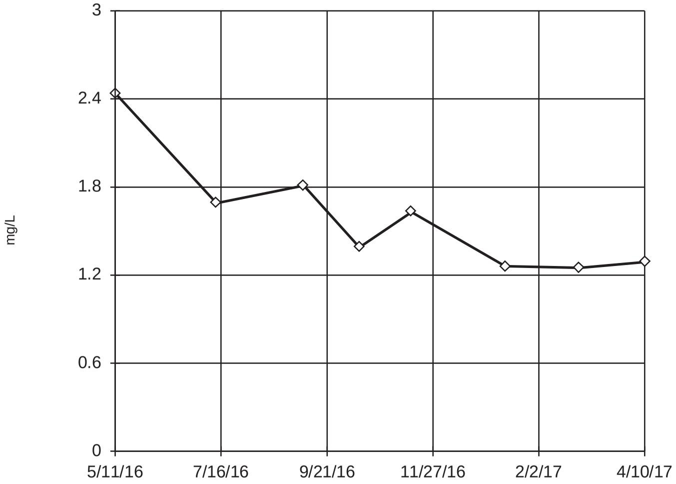
High cutoff = 56.76, low cutoff = 1.547, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

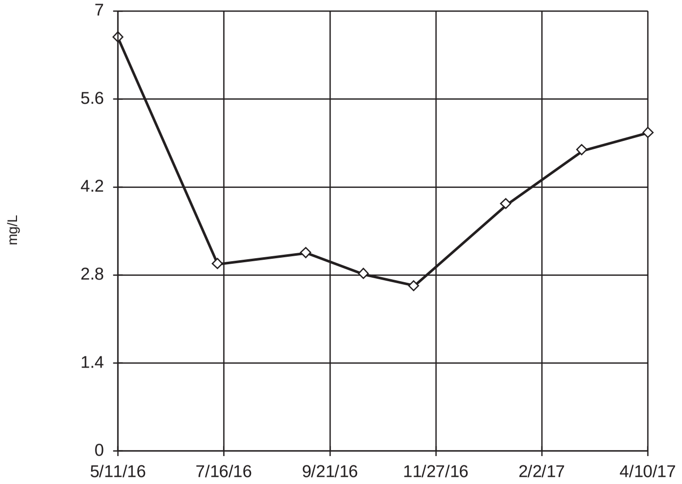
High cutoff = 4.515, low cutoff = 0.4938, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

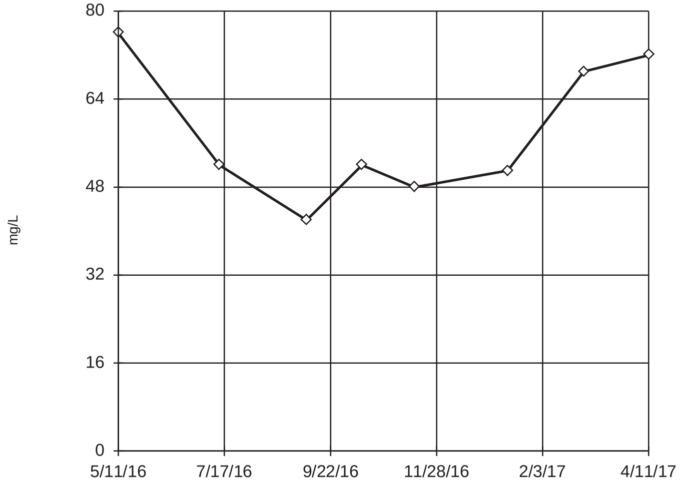
High cutoff = 24.26, low cutoff = 0.5855, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

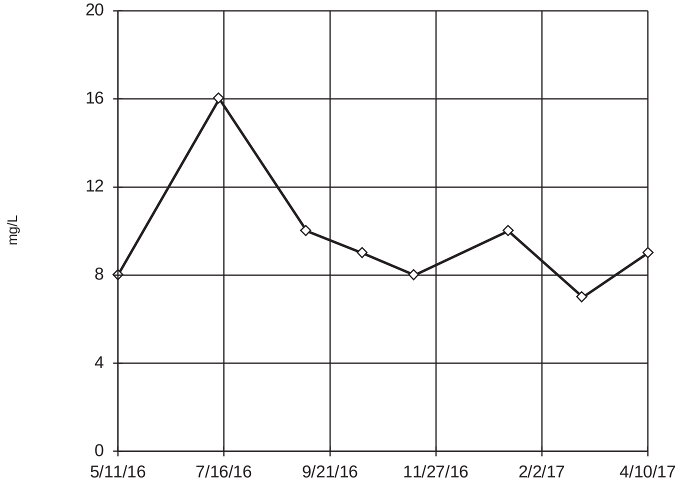
High cutoff = 203.8, low cutoff = 17.11, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

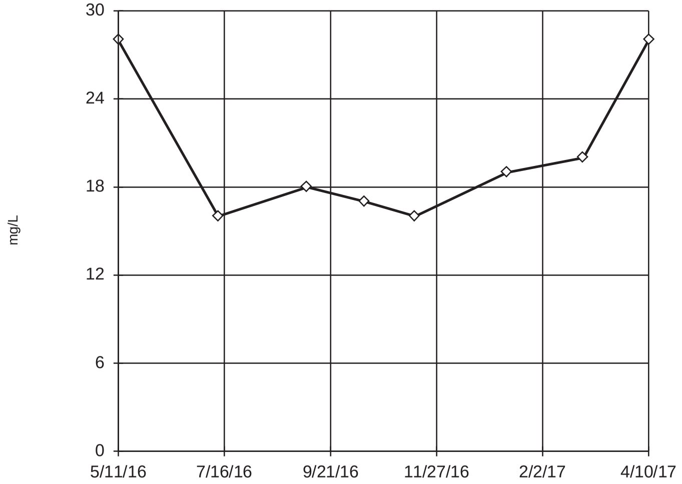
High cutoff = 19.53, low cutoff = 4.096, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

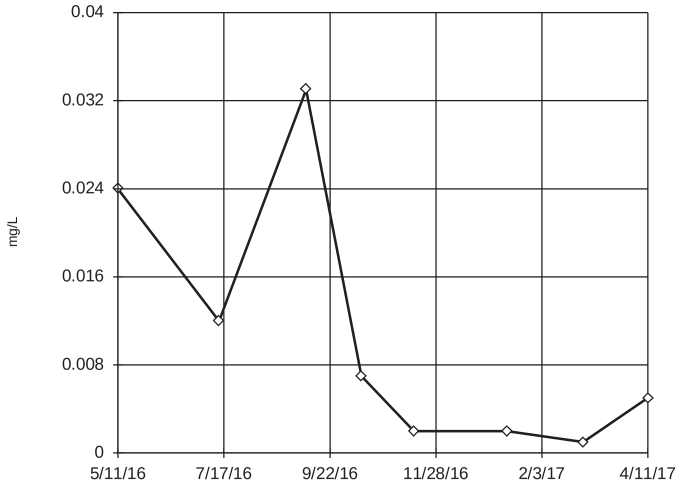
High cutoff = 69.91, low cutoff = 5.583, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

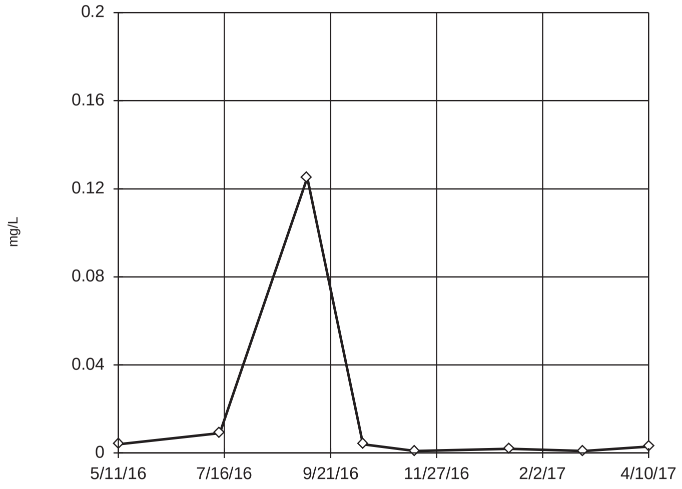
High cutoff = 10.37, low cutoff = 0.000003274, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

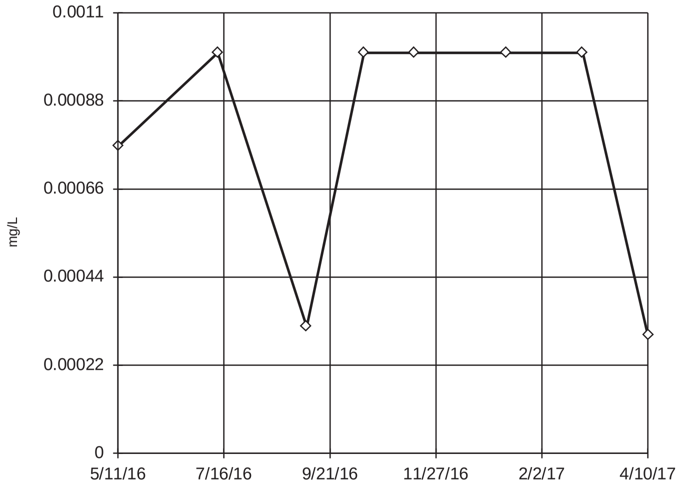
High cutoff = 0.4582, low cutoff = 0.00001852, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were cube transformed to achieve best W statistic (graph shown in original units).

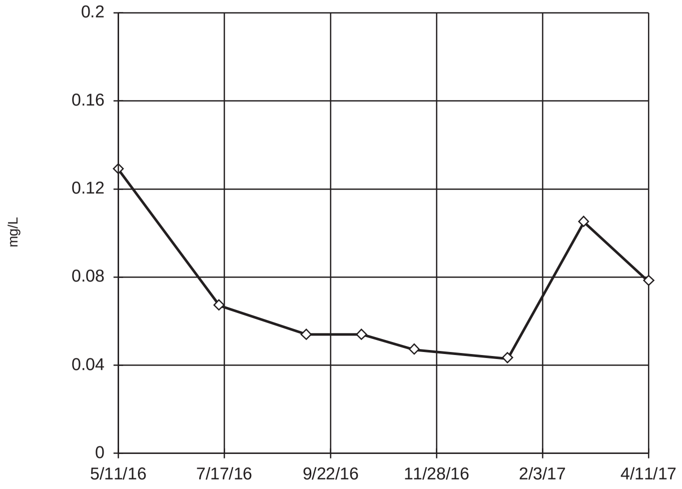
High cutoff = 0.001486, low cutoff = -0.001268, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

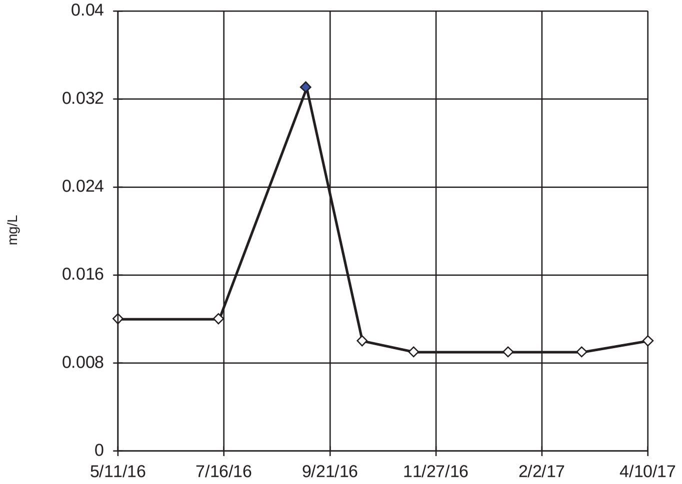
High cutoff = 0.5246, low cutoff = 0.008691, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

Outlier is drawn as solid. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

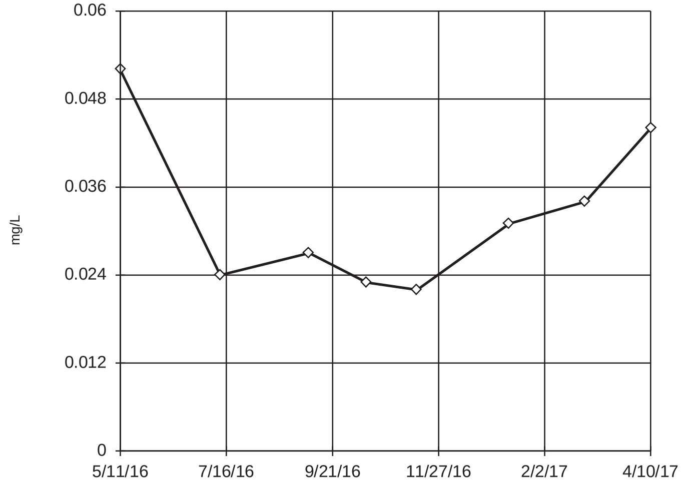
High cutoff = 0.02844, low cutoff = 0.003797, based on IQR multiplier of 3.

Constituent: Cobalt, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

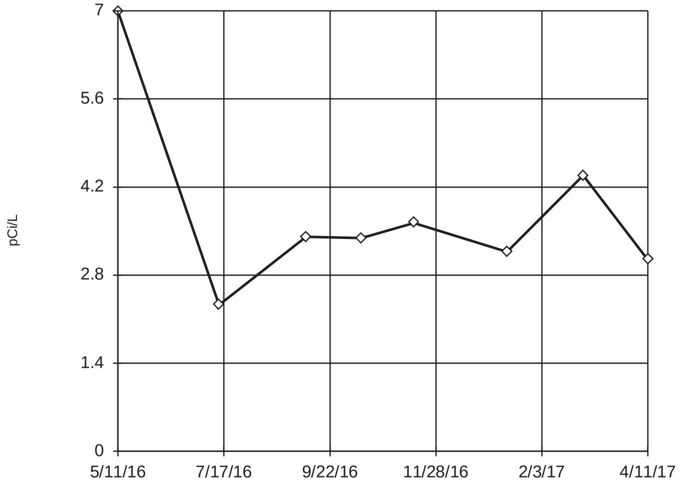
High cutoff = 0.1726, low cutoff = 0.005266, based on IQR multiplier of 3.

Constituent: Cobalt, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

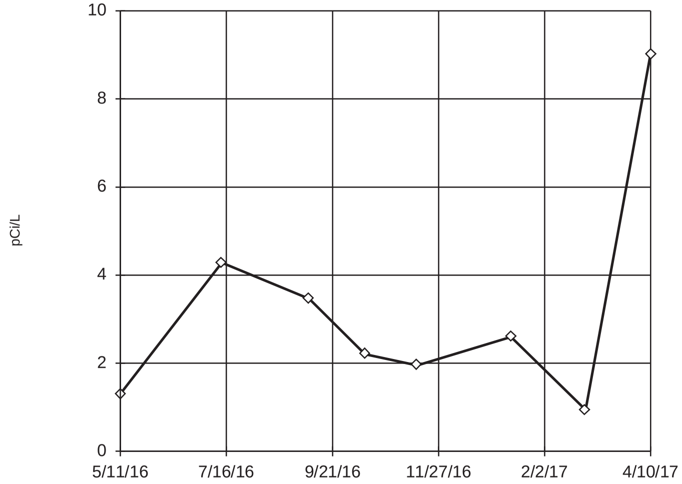
High cutoff = 8.437, low cutoff = 1.47, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

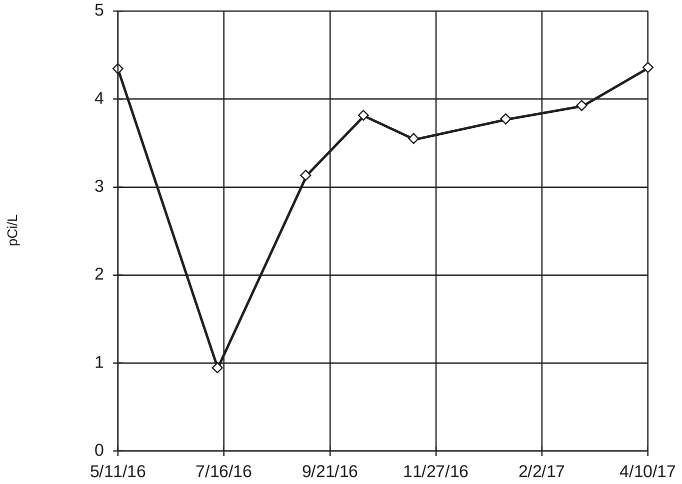
High cutoff = 54.05, low cutoff = 0.1136, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

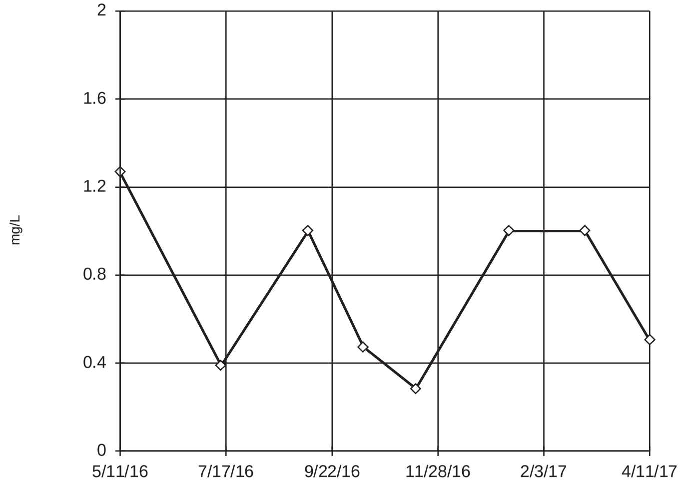
High cutoff = 5.327, low cutoff = -4.422, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

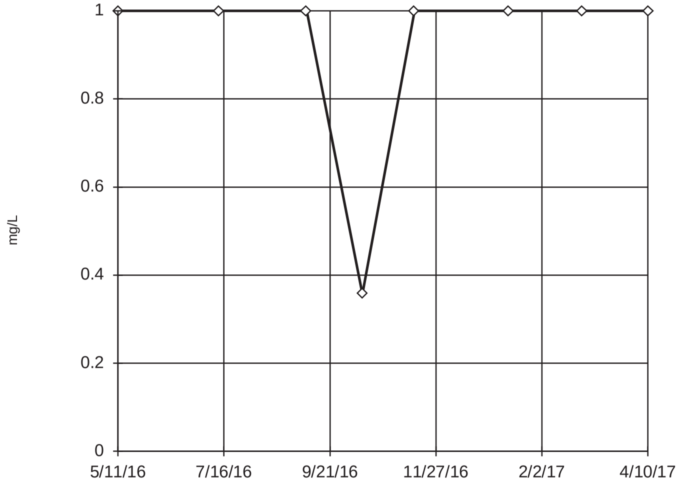
High cutoff = 12.67, low cutoff = 0.03387, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

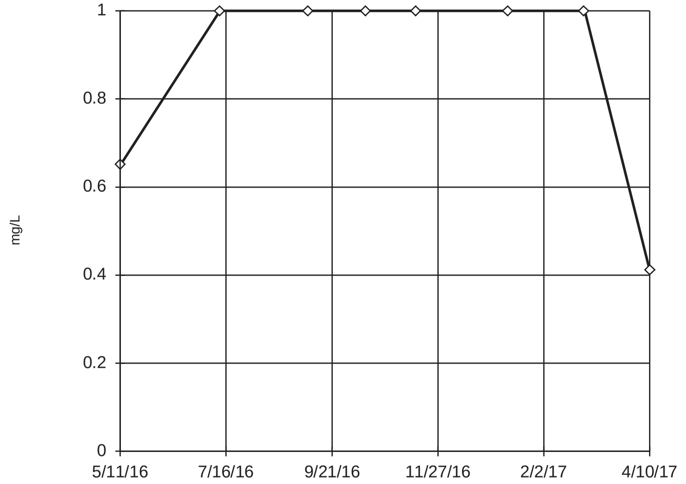
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Fluoride, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

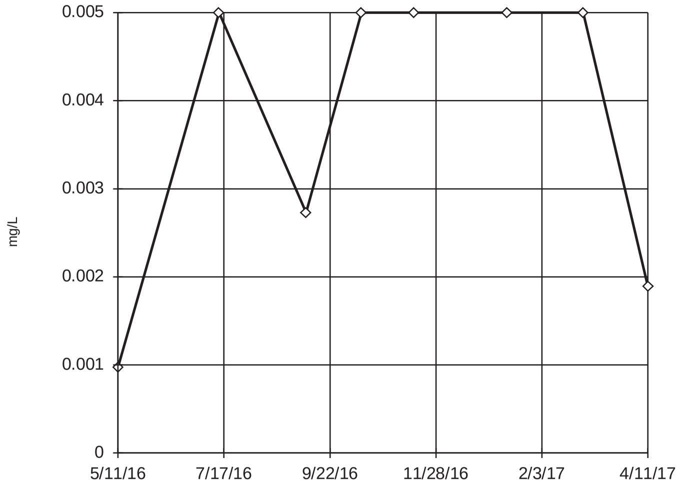
High cutoff = 1.526, low cutoff = 0.2986, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

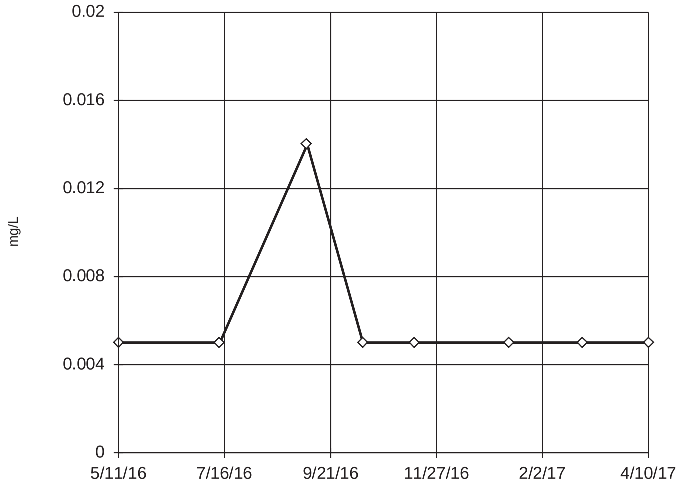
High cutoff = 0.01938,
low cutoff = -0.0004245,
based on IQR multiplier
of 3.

Constituent: Lead, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

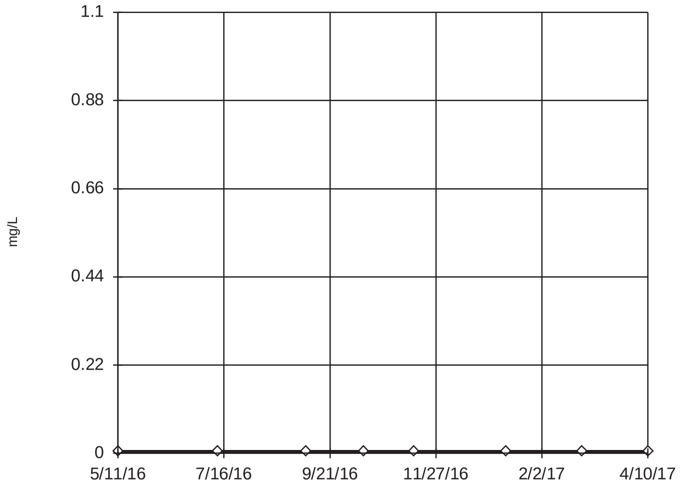
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Lead, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

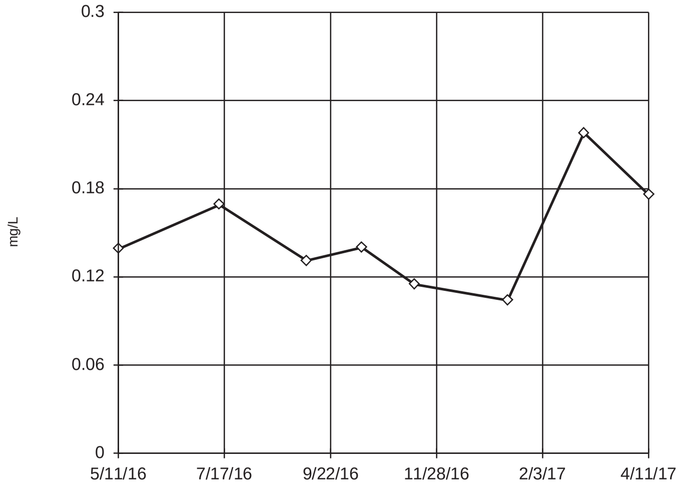
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Lead, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

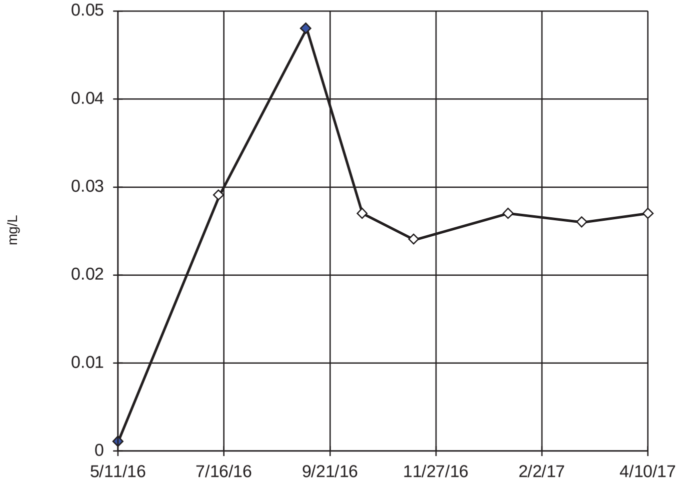
High cutoff = 0.4785,
low cutoff = 0.04424,
based on IQR multiplier
of 3.

Constituent: Lithium, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

Outliers are drawn as solid.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

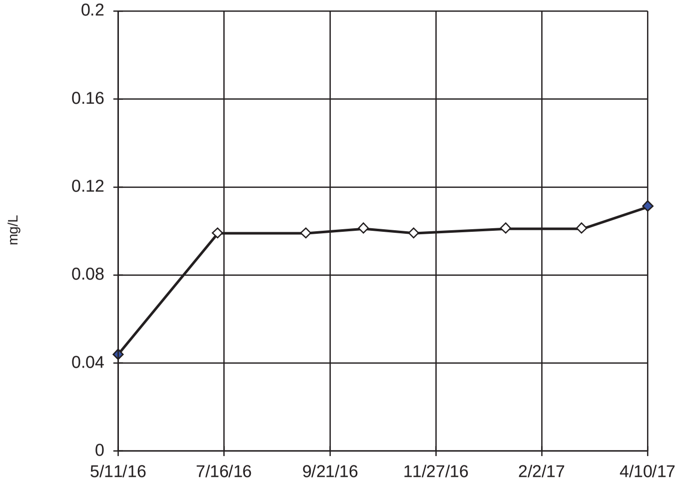
High cutoff = 0.037, low cutoff = 0.016, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

Outliers are drawn as solid.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

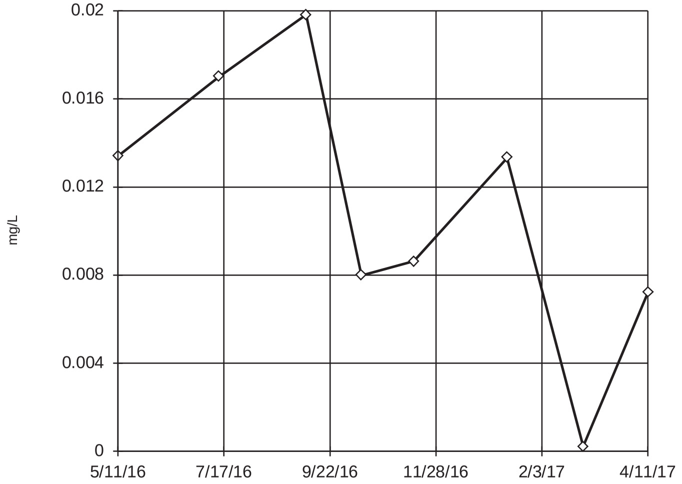
High cutoff = 0.106, low cutoff = 0.09136, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

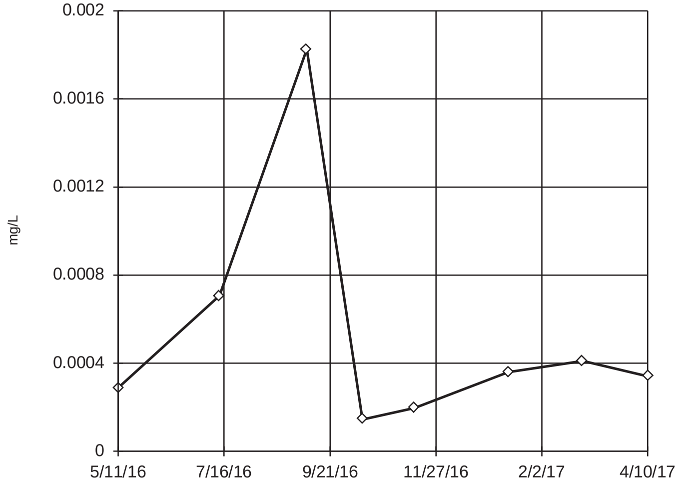
High cutoff = 0.03804, low cutoff = -0.01525, based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

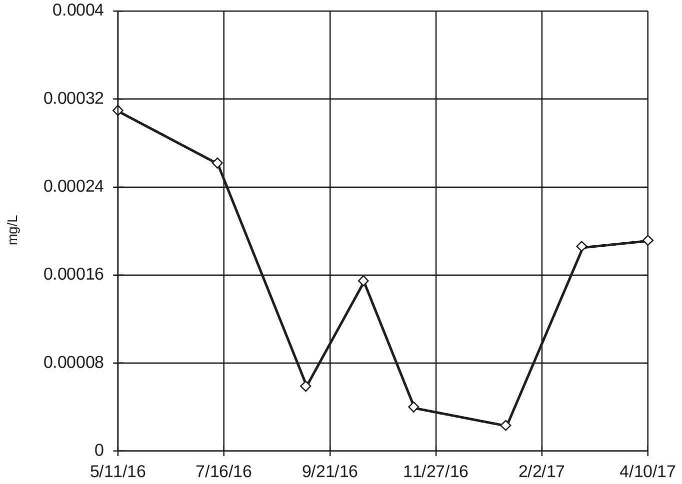
High cutoff = 0.006218, low cutoff = 0.00002063, based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

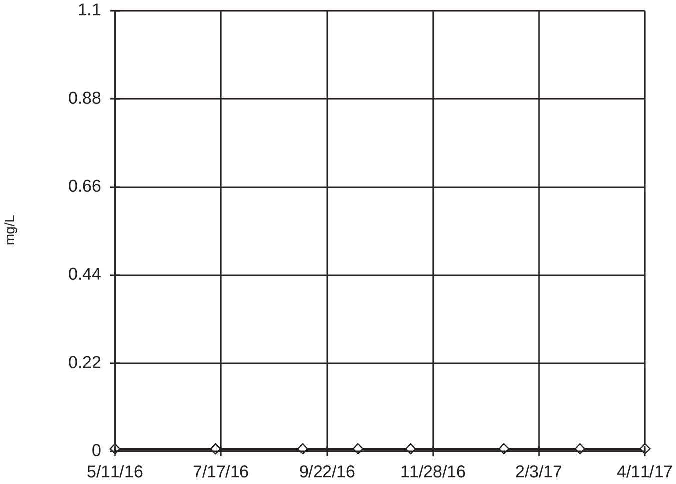
High cutoff = 0.000757,
low cutoff = -0.000482,
based on IQR multiplier
of 3.

Constituent: Mercury, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

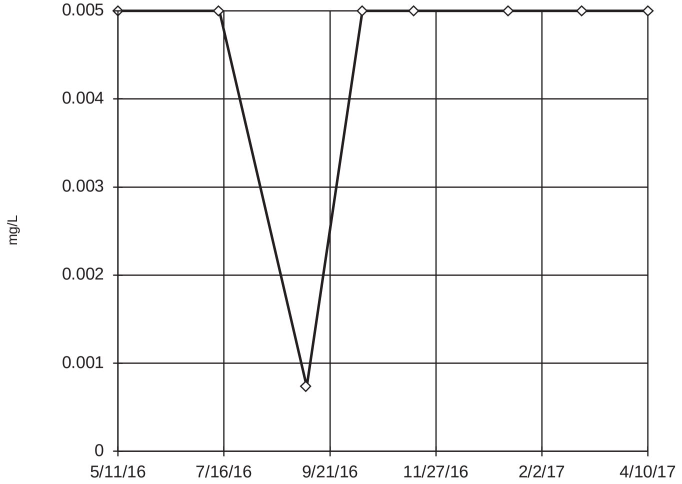
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Molybdenum, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

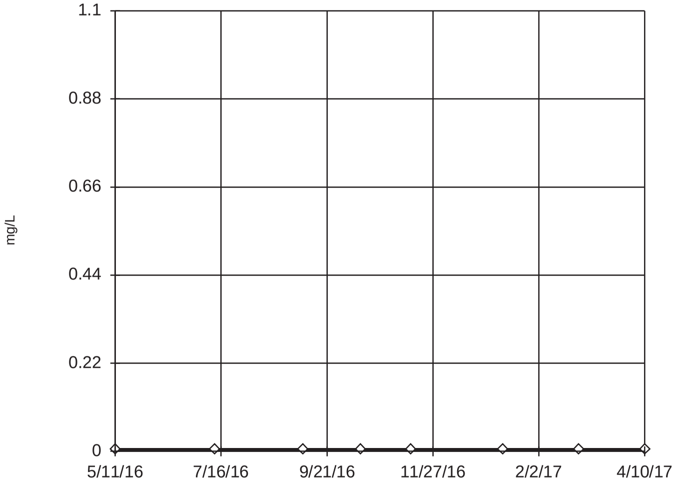
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Molybdenum, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

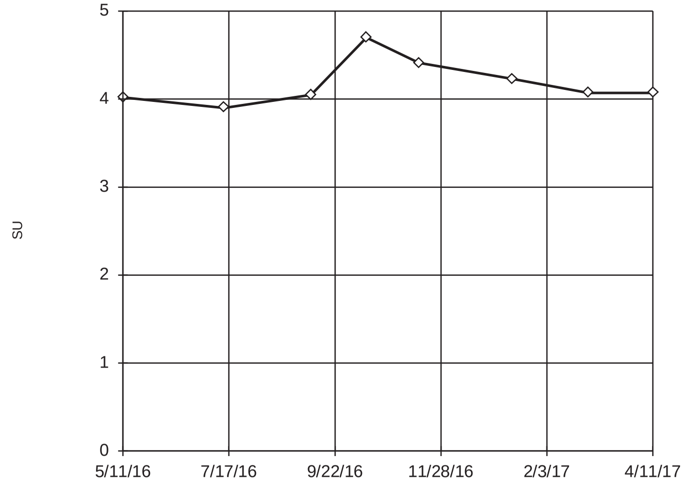
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Molybdenum, total   Analysis Run 11/4/2017 6:49 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5.297, low cutoff = 3.29, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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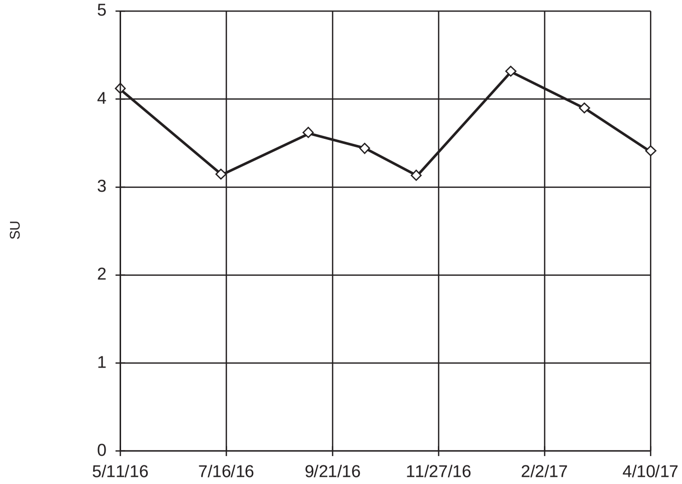
Tukey's Outlier Screening

AD-33



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

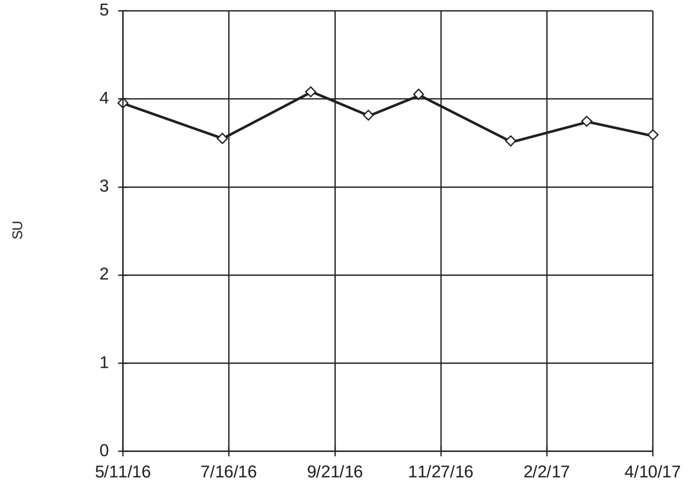
High cutoff = 7.328, low cutoff = 1.783, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/4/2017 6:49 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

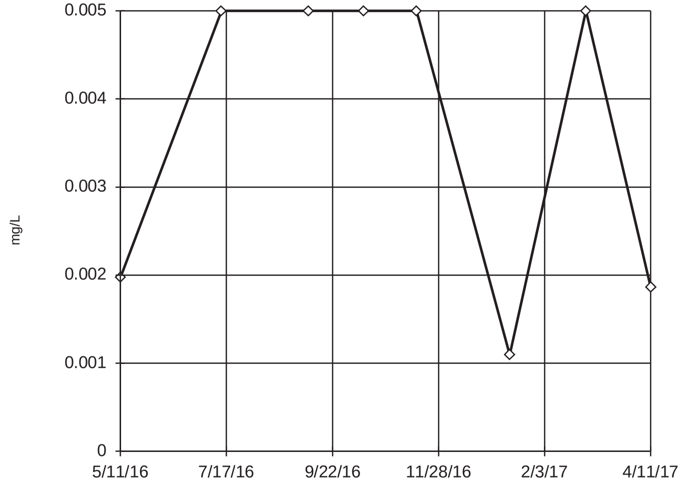
High cutoff = 5.621, low cutoff = 2.534, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/4/2017 6:50 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found. Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

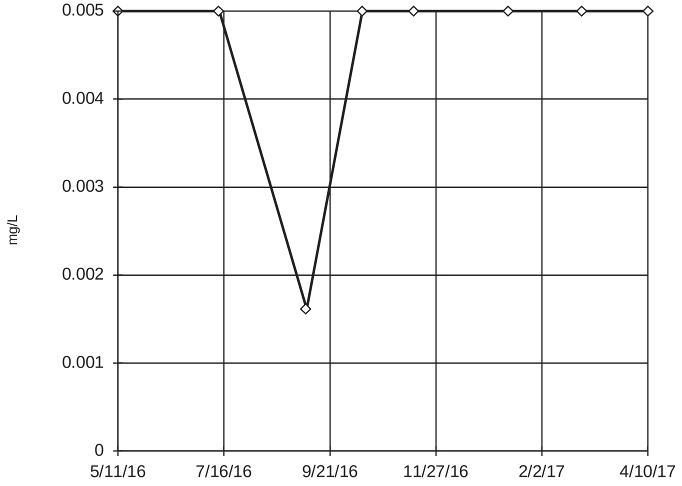
High cutoff = 0.08862, low cutoff = 0.0001082, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/4/2017 6:50 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were square root
transformed to achieve
best W statistic (graph
shown in original units).

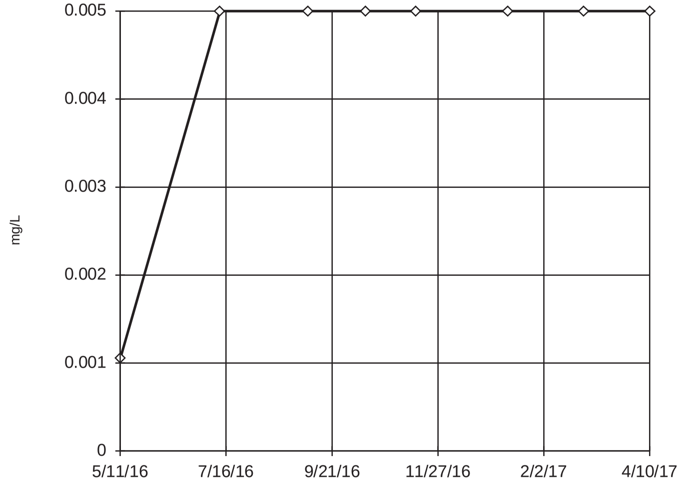
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Selenium, total   Analysis Run 11/4/2017 6:50 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method used in
lieu of parametric test
because the Shapiro Wilk
normality test failed
at the 0.05 alpha level.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

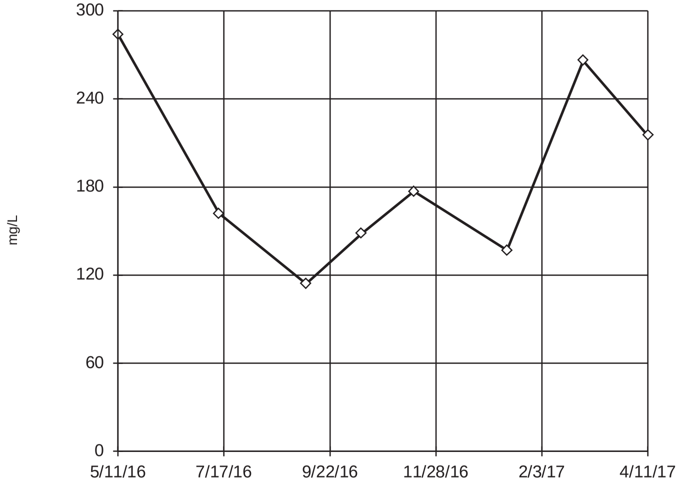
The results were invalidated, because the lower
and upper quartiles are
equal.

Constituent: Selenium, total   Analysis Run 11/4/2017 6:50 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

High cutoff = 1133, low
cutoff = 30.06, based
on IQR multiplier of 3.

Constituent: Sulfate, total   Analysis Run 11/4/2017 6:50 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

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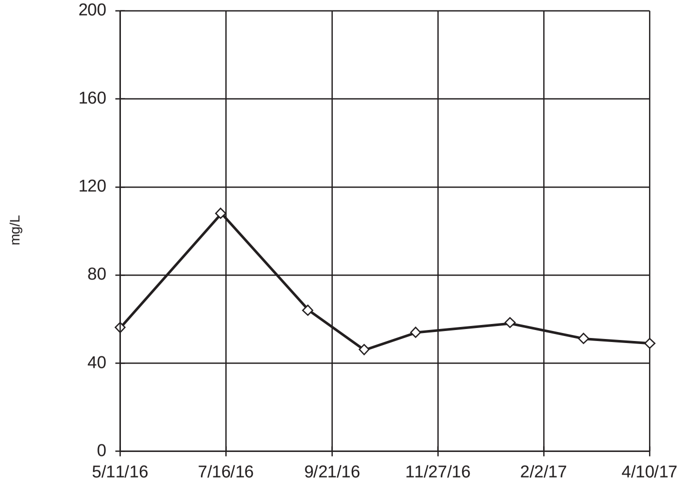
Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log
transformed to achieve
best W statistic (graph
shown in original units).

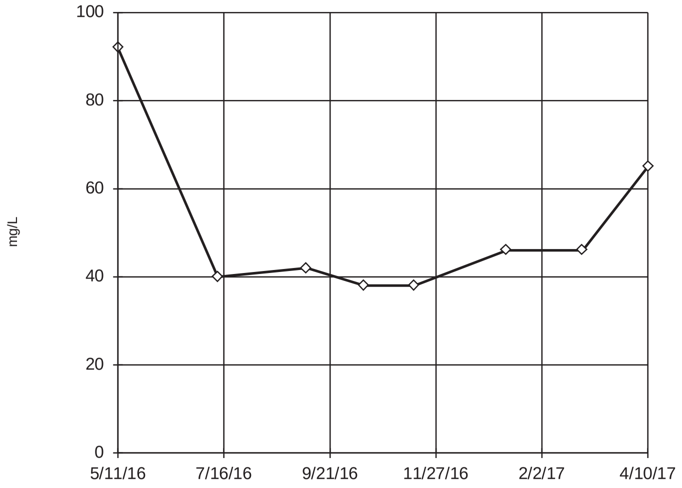
High cutoff = 110.3, low
cutoff = 27.61, based
on IQR multiplier of 3.

Constituent: Sulfate, total   Analysis Run 11/4/2017 6:50 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

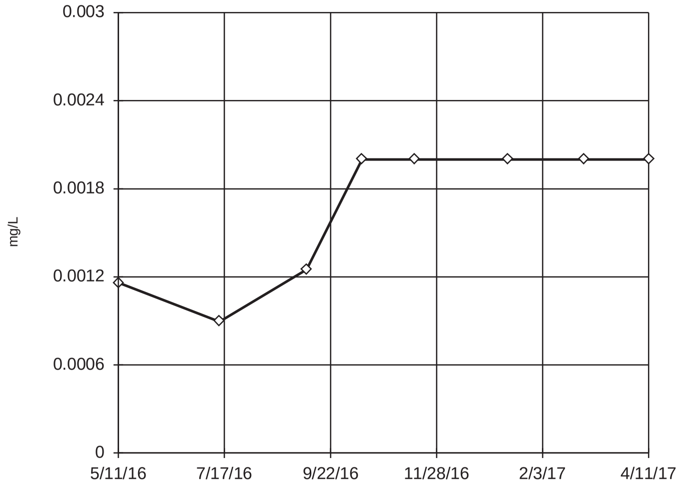
High cutoff = 150.9, low cutoff = 14.13, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/4/2017 6:50 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-22



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

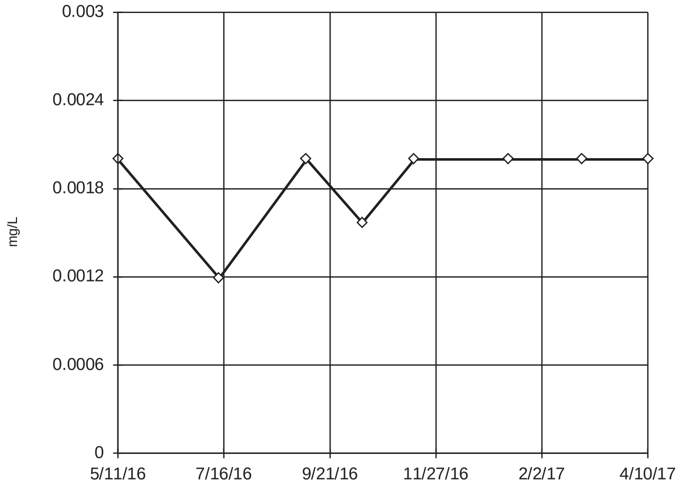
High cutoff = 0.009149, low cutoff = 0.0002634, based on IQR multiplier of 3.

Constituent: Thallium, total Analysis Run 11/4/2017 6:50 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-33



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square transformed to achieve best W statistic (graph shown in original units).

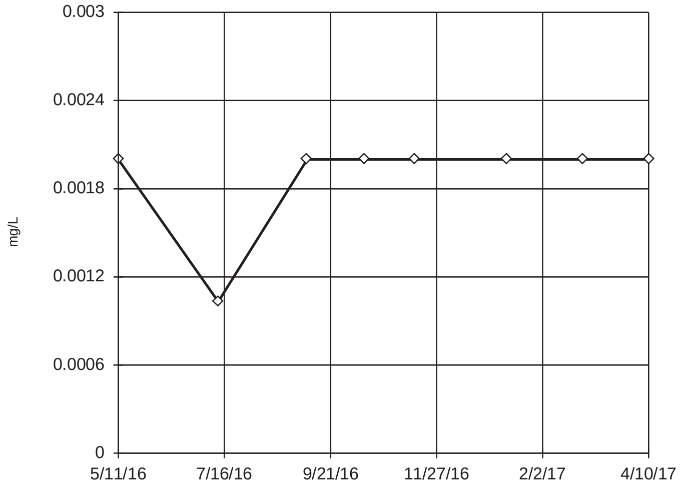
High cutoff = 0.002513, low cutoff = 0.0009557, based on IQR multiplier of 3.

Constituent: Thallium, total Analysis Run 11/4/2017 6:50 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

AD-7



n = 8

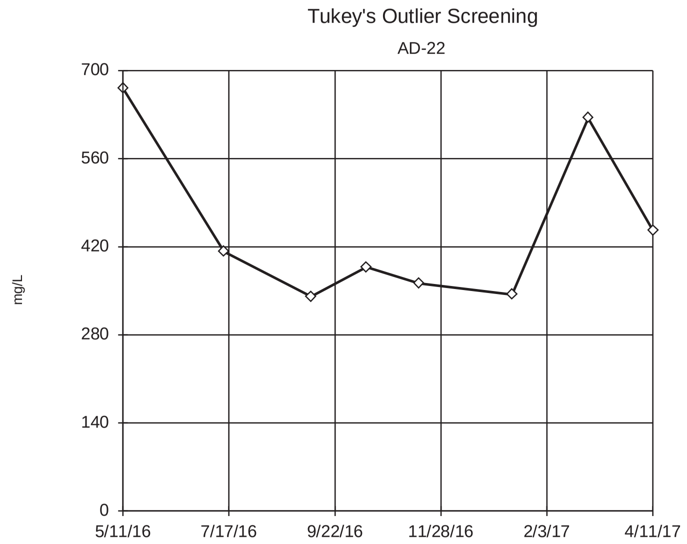
No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were square root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium, total Analysis Run 11/4/2017 6:50 PM View: Tukey's Test
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



n = 8

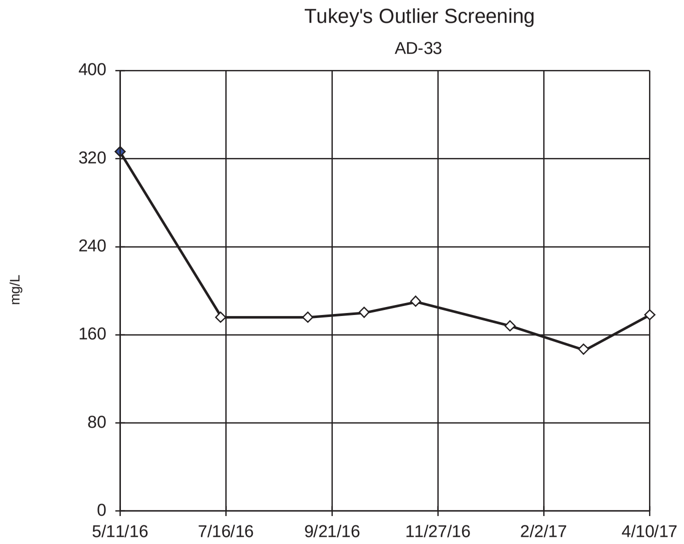
No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1763, low cutoff = 105.6, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/4/2017 6:50 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



n = 8

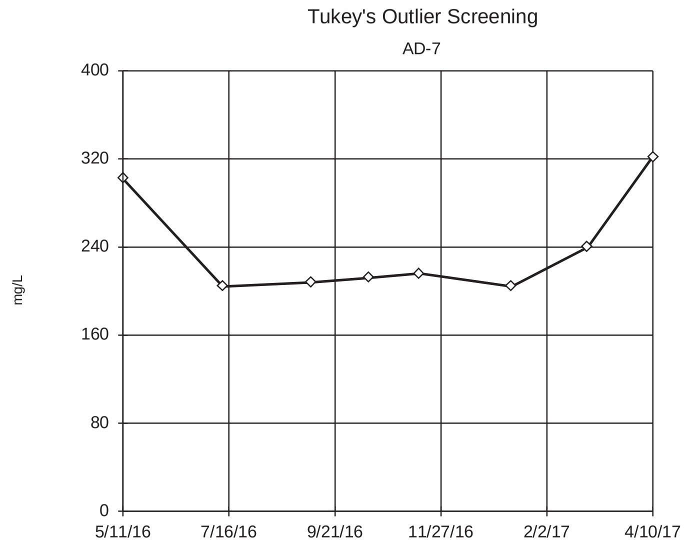
Outlier is drawn as solid.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 230, low cutoff = 138.2, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/4/2017 6:50 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 601, low cutoff = 92.27, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/4/2017 6:50 PM   View: Tukey's Test
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Trend Tests Summary Table - All Results

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 10/27/2017, 5:27 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Antimony, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-13 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-22	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-33	0	0	21	No	8	100	n/a	n/a	0.01	NP
Antimony, total (mg/L)	AD-7	0	0	21	No	8	100	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-13 (bg)	-0.002264	-5	-18	No	7	14.29	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-22	-0.01838	-15	-21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-33	-0.001828	-7	-18	No	7	14.29	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	AD-7	0.001977	10	21	No	8	62.5	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-12 (bg)	-0.002403	-4	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-13 (bg)	-0.003674	-3	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-22	0.01526	2	21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-33	-0.007766	-12	-18	No	7	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	AD-7	0.005527	7	21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-12 (bg)	-0.00008978	-12	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-13 (bg)	-0.0004414	-6	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-22	-0.003299	-6	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-33	-0.001169	-13	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	AD-7	0.00292	10	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0.01638	13	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-13 (bg)	0.01416	8	21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-22	-0.01862	-6	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-33	-0.03784	-8	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-7	1.155	8	21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-13 (bg)	0.001164	13	21	No	8	25	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-22	0.0001029	1	21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-33	0	3	21	No	8	87.5	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	AD-7	-0.00002448	-2	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-12 (bg)	-0.007078	0	21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-13 (bg)	-1.581	-6	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-22	-1.774	-4	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-33	-0.9245	-20	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-7	2.068	4	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.5448	5	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-13 (bg)	0	1	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-22	22.21	3	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-33	-2.571	-7	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-7	5.106	8	21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-12 (bg)	-0.0002747	-14	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-13 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-22	-0.02017	-17	-21	No	8	12.5	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-33	-0.003737	-9	-18	No	7	14.29	n/a	n/a	0.01	NP
Chromium, total (mg/L)	AD-7	8.5e-11	0	21	No	8	37.5	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-12 (bg)	-0.0003758	-10	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-13 (bg)	0.003891	5	21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-22	-0.03459	-7	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-33	-0.003852	-13	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	AD-7	0.01436	4	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-12 (bg)	-0.4211	-2	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-13 (bg)	0.08465	2	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-22	-0.5726	-4	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-33	0.4095	0	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	AD-7	1.556	12	21	No	8	0	n/a	n/a	0.01	NP

Trend Tests Summary Table - All Results

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 10/27/2017, 5:27 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Fluoride, total (mg/L)	AD-12 (bg)	0	-7	-21	No	8	75	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-13 (bg)	0	1	21	No	8	37.5	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-22	-0.1568	-3	-21	No	8	37.5	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-33	0	1	21	No	8	87.5	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-7	0	-1	-21	No	8	75	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-13 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-22	0	4	21	No	8	62.5	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-33	0	0	18	No	7	100	n/a	n/a	0.01	NP
Lead, total (mg/L)	AD-7	0	0	21	No	8	100	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-12 (bg)	0.002799	4	21	No	8	12.5	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-13 (bg)	0.02891	6	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-22	0.005899	2	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-33	0	-1	-21	No	8	12.5	n/a	n/a	0.01	NP
Lithium, total (mg/L)	AD-7	0.01437	20	21	No	8	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-12 (bg)	0	-7	-21	No	8	87.5	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-13 (bg)	0	8	21	No	8	62.5	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-22	-0.01303	-14	-21	No	8	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-33	-0.00001044	0	21	No	8	0	n/a	n/a	0.01	NP
Mercury, total (mg/L)	AD-7	-0.000114	-8	-21	No	8	0	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-12 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-13 (bg)	0	0	21	No	8	100	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-22	0	0	21	No	8	100	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-33	0	3	21	No	8	87.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	AD-7	0	0	21	No	8	100	n/a	n/a	0.01	NP
pH, field (SU)	AD-12 (bg)	0.5797	4	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-13 (bg)	0.3064	8	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-22	0.05828	7	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-33	-0.05539	-2	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-7	-0.2956	-8	-21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-12 (bg)	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-13 (bg)	0	5	21	No	8	75	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-22	0	-4	-21	No	8	62.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-33	0	3	21	No	8	87.5	n/a	n/a	0.01	NP
Selenium, total (mg/L)	AD-7	0	7	21	No	8	87.5	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	1.233	5	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-13 (bg)	2.491	1	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-22	55.31	2	21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-33	-17.52	-12	-21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-7	8.956	4	21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-12 (bg)	0	-5	-21	No	8	87.5	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-13 (bg)	0.00106	16	21	No	8	62.5	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-22	0.001143	16	21	No	8	62.5	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-33	0	7	21	No	8	75	n/a	n/a	0.01	NP
Thallium, total (mg/L)	AD-7	0	5	21	No	8	87.5	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-25.99	-12	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-13 (bg)	-35.48	-7	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-22	-78.46	-2	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-33	-38.7	-9	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-7	37.94	9	21	No	8	0	n/a	n/a	0.01	NP

Analysis of Variance

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 1/15/2018, 6:47 PM

Constituent	Crit.	Sig.	Alpha	Transform	ANOVA Sig.	Calc.	Alpha	Method
Boron, total (mg/L)	n/a	n/a	n/a	No	Yes	22.77	0.05	Param.
Calcium, total (mg/L)	n/a	n/a	n/a	ln(x)	Yes	1807	0.05	Param.
Chloride, total (mg/L)	n/a	n/a	n/a	sqrt(x)	Yes	348.9	0.05	Param.
Fluoride, total (mg/L)	n/a	n/a	n/a	x^3	No	3.944	0.05	Param.
pH, field (SU)	n/a	n/a	n/a	x^2	Yes	47.77	0.05	Param.
Sulfate, total (mg/L)	n/a	n/a	n/a	sqrt(x)	Yes	384.8	0.05	Param.
Total Dissolved Solids [TDS] (mg/L)	n/a	n/a	n/a	sqrt(x)	Yes	167.4	0.05	Param.

Parametric ANOVA

Constituent: Boron, total Analysis Run 1/15/2018 6:46 PM View: ANOVA
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

For observations made between 5/11/2016 and 4/11/2017 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 22.77

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.002256	1	0.002256	22.77
Error Within Groups	0.001388	14	0.00009911	
Total	0.003644	15		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9615, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 0.14, tabulated = 4.6.

Parametric ANOVA

Constituent: Calcium, total   Analysis Run 1/15/2018 6:46 PM   View: ANOVA
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

For observations made between 5/11/2016 and 4/11/2017 the parametric analysis of variance test (after natural log transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 1807

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	41.09	1	41.09	1807
Error Within Groups	0.3182	14	0.02273	
Total	41.41	15		

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.05, calculated = 0.9783, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 0.1573, tabulated = 4.6.

Parametric ANOVA

Constituent: Chloride, total   Analysis Run 1/15/2018 6:46 PM   View: ANOVA
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

For observations made between 5/11/2016 and 4/11/2017 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 348.9

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	29.27	1	29.27	348.9
Error Within Groups	1.174	14	0.08389	
Total	30.44	15		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.05, calculated = 0.965, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 2.114, tabulated = 4.6.

Parametric ANOVA

Constituent: Fluoride, total   Analysis Run 1/15/2018 6:46 PM   View: ANOVA
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

For observations made between 5/11/2016 and 4/11/2017 the parametric analysis of variance test (after cube transformation) indicates NO VARIATION at the 5% significance level. Because the calculated F statistic is less than or equal to the tabulated F statistic, the hypothesis of a single homogeneous population is accepted.

Calculated F statistic = 3.944

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.6393	1	0.6393	3.944
Error Within Groups	2.269	14	0.1621	
Total	2.909	15		

The Shapiro Wilk normality test on the residuals passed after cube transformation. Alpha = 0.05, calculated = 0.9011, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 2.617, tabulated = 4.6.

Parametric ANOVA

Constituent: pH, field   Analysis Run 1/15/2018 6:47 PM   View: ANOVA
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

For observations made between 5/11/2016 and 4/11/2017 the parametric analysis of variance test (after square transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 47.77

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	1151	1	1151	47.77
Error Within Groups	337.2	14	24.09	
Total	1488	15		

The Shapiro Wilk normality test on the residuals passed after square transformation. Alpha = 0.05, calculated = 0.9676, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 3.098, tabulated = 4.6.

Parametric ANOVA

Constituent: Sulfate, total Analysis Run 1/15/2018 6:47 PM View: ANOVA
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

For observations made between 5/11/2016 and 4/11/2017 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 384.8

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	86.35	1	86.35	384.8
Error Within Groups	3.141	14	0.2244	
Total	89.49	15		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.05, calculated = 0.9607, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 2.922, tabulated = 4.6.

Parametric ANOVA

Constituent: Total Dissolved Solids [TDS]   Analysis Run 1/15/2018 6:47 PM   View: ANOVA
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

For observations made between 5/11/2016 and 4/11/2017 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 167.4

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	140.2	1	140.2	167.4
Error Within Groups	11.72	14	0.8372	
Total	151.9	15		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.05, calculated = 0.95, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 1.135, tabulated = 4.6.

Tolerance Limits - Appendix III

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 11/5/2017, 6:44 AM

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	0.09532	16	0.04813	0.01559	0	None	No	0.01	Inter
Calcium, total (mg/L)	9.11	16	n/a	n/a	0	n/a	n/a	0.4401	NP Inter(normality)
Chloride, total (mg/L)	32	16	n/a	n/a	0	n/a	n/a	0.4401	NP Inter(normality)
Fluoride, total (mg/L)	1	15	n/a	n/a	60	n/a	n/a	0.4633	NP Inter(normality)
pH, field (SU)	8.548	16	4.735	1.114	0	None	No	0.01	Inter
Sulfate, total (mg/L)	59	16	n/a	n/a	0	n/a	n/a	0.4401	NP Inter(normality)
Total Dissolved Solids [TDS] (mg/L)	368.8	16	144	74.23	0	None	No	0.01	Inter

Confidence Interval Summary Table - Significant Results Appendix III

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 11/5/2017, 6:49 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-33**	**0.1735**	**0.1247**	**0.095**	**Yes**	**8**	**0.1491**	**0.023**	**0**	**None**	**No**	**0.01**	**Param.**
Boron, total (mg/L)	**AD-7**	**2.366**	**0.5929**	**0.095**	**Yes**	**8**	**1.447**	**0.93**	**0**	**None**	**sqrt(x)**	**0.01**	**Param.**
Chloride, total (mg/L)	**AD-22**	**71.14**	**44.36**	**32**	**Yes**	**8**	**57.75**	**12.63**	**0**	**None**	**No**	**0.01**	**Param.**
Sulfate, total (mg/L)	**AD-22**	**253.1**	**122.7**	**59**	**Yes**	**8**	**187.9**	**61.53**	**0**	**None**	**No**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results Appendix III

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 11/5/2017, 6:49 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-22	0.06033	0.02549	0.095	No	8	0.0425	0.01753	0	None	sqrt(x)	0.01	Param.
Boron, total (mg/L)	**AD-33**	**0.1735**	**0.1247**	**0.095**	**Yes**	**8**	**0.1491**	**0.023**	**0**	**None**	**No**	**0.01**	**Param.**
Boron, total (mg/L)	**AD-7**	**2.366**	**0.5929**	**0.095**	**Yes**	**8**	**1.447**	**0.93**	**0**	**None**	**sqrt(x)**	**0.01**	**Param.**
Calcium, total (mg/L)	AD-22	13.19	6.273	9.11	No	8	9.731	3.263	0	None	No	0.01	Param.
Calcium, total (mg/L)	AD-33	2.004	1.197	9.11	No	8	1.595	0.403	0	None	sqrt(x)	0.01	Param.
Calcium, total (mg/L)	AD-7	5.458	2.517	9.11	No	8	3.988	1.387	0	None	No	0.01	Param.
Chloride, total (mg/L)	**AD-22**	**71.14**	**44.36**	**32**	**Yes**	**8**	**57.75**	**12.63**	**0**	**None**	**No**	**0.01**	**Param.**
Chloride, total (mg/L)	AD-33	12.16	7.178	32	No	8	9.625	2.774	0	None	ln(x)	0.01	Param.
Chloride, total (mg/L)	AD-7	28	16	32	No	8	20.25	4.979	0	None	No	0.004	NP (normality)
Fluoride, total (mg/L)	AD-22	1.441	0.3239	1	No	8	0.7395	0.3661	37.5	Cohen`s	No	0.01	Param.
Fluoride, total (mg/L)	AD-33	1	0.357	1	No	8	0.9196	0.2273	87.5	Cohen`s	No	0.004	NP (NDs)
Fluoride, total (mg/L)	AD-7	1	0.4117	1	No	8	0.8826	0.2264	75	None	No	0.004	NP (normality)
pH, field (SU)	AD-22	4.502	3.86	8.55	No	8	4.181	0.2594	0	None	No	0.005	Param.
pH, field (SU)	AD-33	4.17	3.087	8.55	No	8	3.629	0.4375	0	None	No	0.005	Param.
pH, field (SU)	AD-7	4.061	3.504	8.55	No	8	3.783	0.2251	0	None	No	0.005	Param.
Sulfate, total (mg/L)	**AD-22**	**253.1**	**122.7**	**59**	**Yes**	**8**	**187.9**	**61.53**	**0**	**None**	**No**	**0.01**	**Param.**
Sulfate, total (mg/L)	AD-33	108	46	59	No	8	60.75	19.89	0	None	No	0.004	NP (normality)
Sulfate, total (mg/L)	AD-7	92	38	59	No	8	50.88	18.77	0	None	No	0.004	NP (normality)
Total Dissolved Solids [TDS] (mg/L)	AD-22	672	341	368.8	No	8	448.6	128.6	0	None	No	0.004	NP (normality)
Total Dissolved Solids [TDS] (mg/L)	AD-33	326	146	368.8	No	8	192.5	55.42	0	None	No	0.004	NP (normality)
Total Dissolved Solids [TDS] (mg/L)	AD-7	322	204	368.8	No	8	238.5	47.1	0	None	No	0.004	NP (normality)

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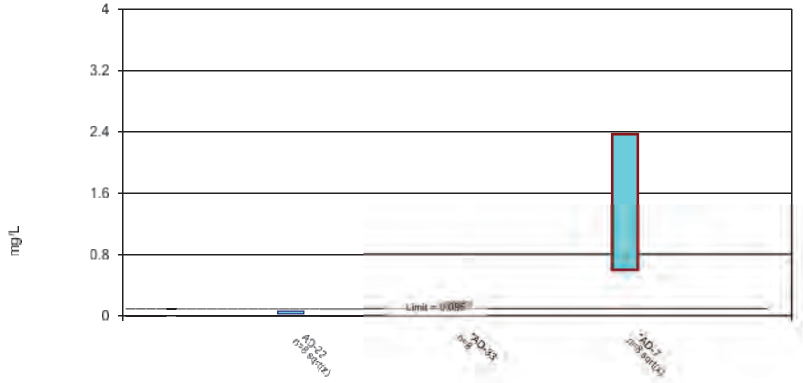
Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Boron, total Analysis Run 11/5/2017 6:48 AM View: Confidence Intervals - App III
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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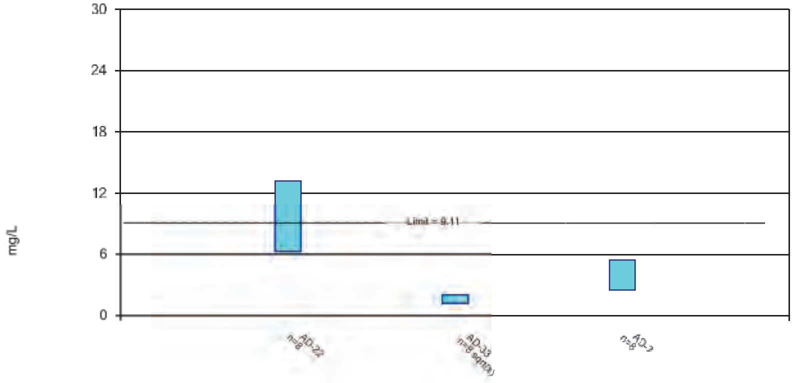
Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

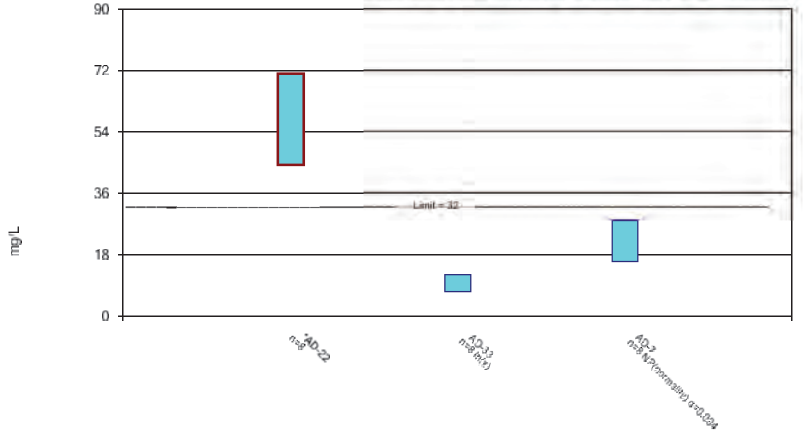


Constituent: Calcium, total Analysis Run 11/5/2017 6:48 AM View: Confidence Intervals - App III
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

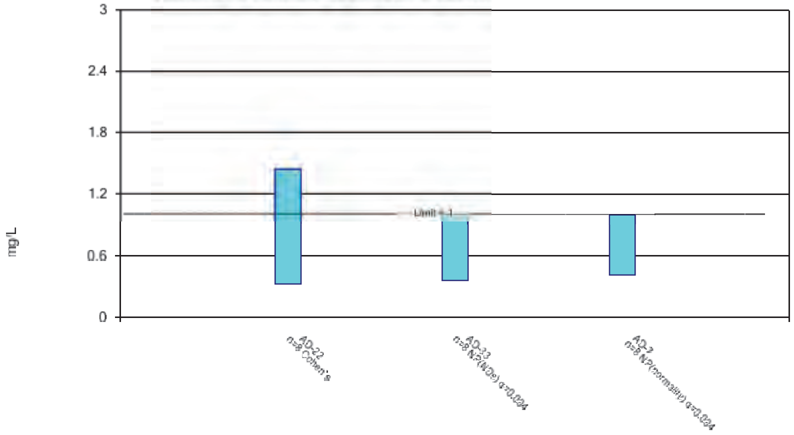


Constituent: Chloride, total Analysis Run 11/5/2017 6:48 AM View: Confidence Intervals - App III
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

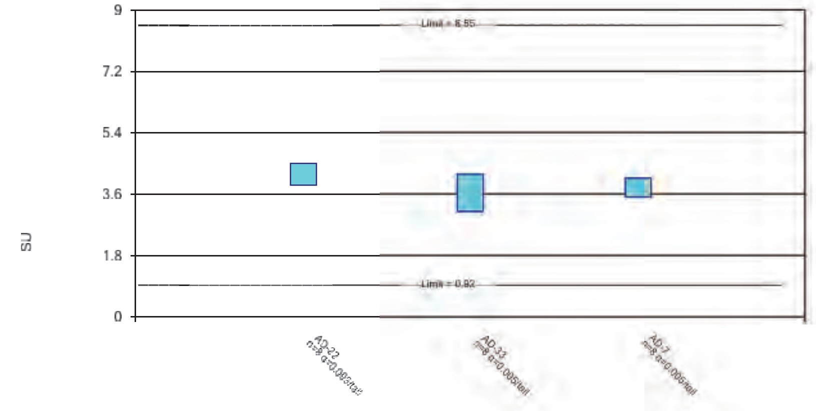


Constituent: Fluoride, total Analysis Run 11/5/2017 6:48 AM View: Confidence Intervals - App III
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Normality Test: Shapiro Wilk, alpha based on n.

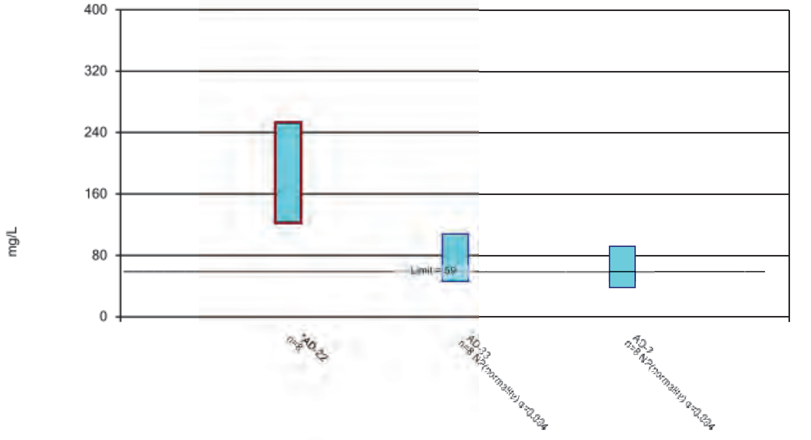


Constituent: pH, field   Analysis Run 11/5/2017 6:48 AM   View: Confidence Intervals - App III
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

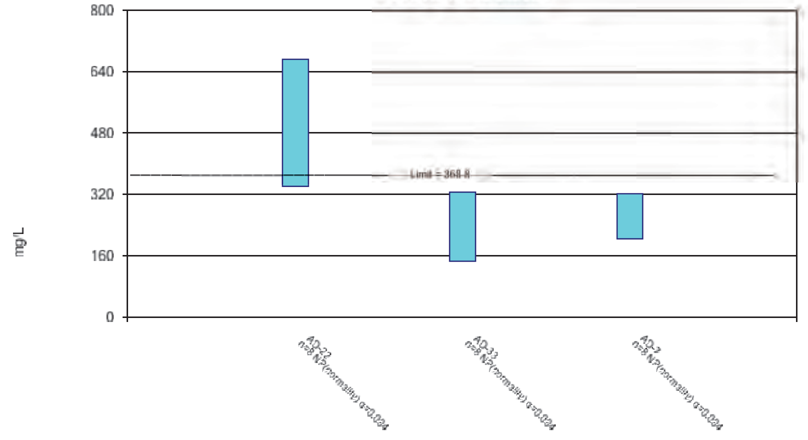


Constituent: Sulfate, total   Analysis Run 11/5/2017 6:48 AM   View: Confidence Intervals - App III
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.00 Groundwater Stats Consulting, UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



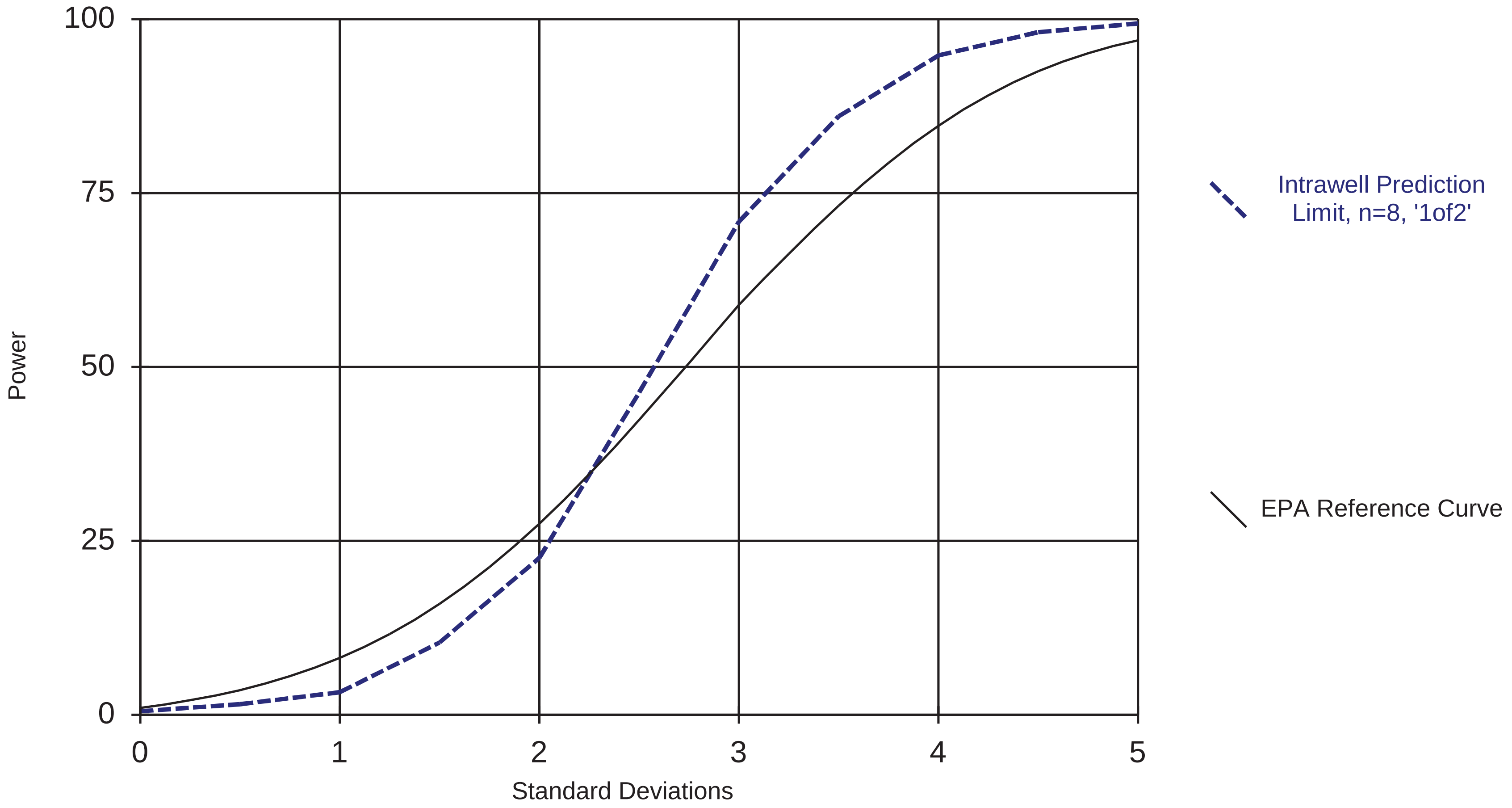
Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/5/2017 6:48 AM   View: Confidence Intervals - A
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Intrawell Prediction Limit Summary Table

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/14/2017, 5:50 AM

Constituent	Well	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-12	0.4509	n/a	8	0.3269	0.05542	0	None	No	0.003756	Param Intra 1 of 2
Calcium, total (mg/L)	AD-13	10.35	n/a	8	8.025	1.038	0	None	No	0.003756	Param Intra 1 of 2
Calcium, total (mg/L)	AD-22	17.03	n/a	8	9.731	3.263	0	None	No	0.003756	Param Intra 1 of 2
Calcium, total (mg/L)	AD-33	2.497	n/a	8	1.595	0.403	0	None	No	0.003756	Param Intra 1 of 2
Calcium, total (mg/L)	AD-7	7.092	n/a	8	3.988	1.387	0	None	No	0.003756	Param Intra 1 of 2
pH, field (SU)	AD-12	5.589	2.041	8	3.815	0.7928	0	None	No	0.001878	Param Intra 1 of 2
pH, field (SU)	AD-13	6.358	4.952	8	5.655	0.3139	0	None	No	0.001878	Param Intra 1 of 2
pH, field (SU)	AD-22	4.762	3.601	8	4.181	0.2594	0	None	No	0.001878	Param Intra 1 of 2
pH, field (SU)	AD-33	4.608	2.65	8	3.629	0.4375	0	None	No	0.001878	Param Intra 1 of 2
pH, field (SU)	AD-7	4.286	3.279	8	3.783	0.2251	0	None	No	0.001878	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	107.5	n/a	8	75.25	14.41	0	None	No	0.003756	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-13	275.9	n/a	8	212.8	28.2	0	None	No	0.003756	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-22	736.4	n/a	8	448.6	128.6	0	None	No	0.003756	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-33	206.8	n/a	7	173.4	13.75	0	None	No	0.003756	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-7	343.9	n/a	8	238.5	47.1	0	None	No	0.003756	Param Intra 1 of 2

Power Curve



Kappa = 2.458, based on 3 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

Analysis Run 11/5/2017 7:53 AM   View: Confidence Intervals - App IV

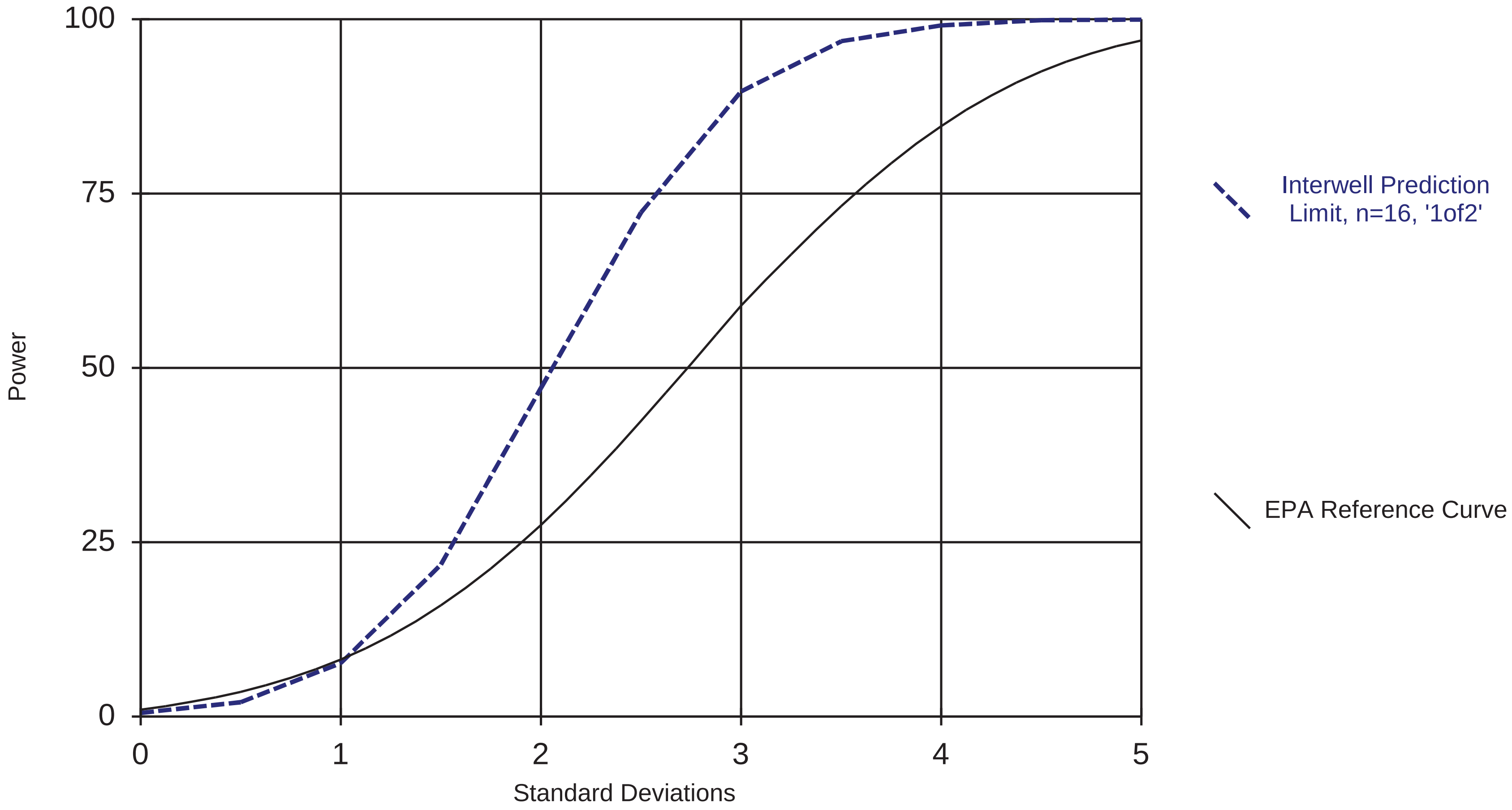
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Interwell Prediction Limit Summary Table

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 10/27/2017, 5:50 AM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	n/a	0.0672	16	0.04813	0.01559	0	None	No	0.003756	Param Inter 1 of 3
Chloride, total (mg/L)	n/a	32	16	n/a	n/a	0	n/a	n/a	0.001014	NP Inter (normality) 1 of 3
Fluoride, total (mg/L)	n/a	1	15	n/a	n/a	60	n/a	n/a	0.001292	NP Inter (NDs) 1 of 3
Sulfate, total (mg/L)	n/a	59	16	n/a	n/a	0	n/a	n/a	0.001014	NP Inter (normality) 1 of 3

Power Curve



Kappa = 1.96, based on 3 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

Analysis Run 11/5/2017 7:53 AM View: Confidence Intervals - App IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

4.17 – Annual Groundwater Monitoring Report, H.W. Pirkey Power Plant, FGD Stackout Area CCR Management Unit, Hallsville, Texas, January 2018

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
FGD Stackout Area CCR Management Unit
Hallsville, Texas

January 2018

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY
An AEP Company
BOUNDLESS ENERGY

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Table of Contents

Appendix I

I. Overview

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2018.

In general, the following activities were completed:

- Monitoring wells were installed and developed to establish a certified groundwater monitoring system around each CCR unit, in accordance with the requirements of 40 CFR 257.91 pursuant AEP's *Groundwater Monitoring Network Design Report (3/9/2017)*;
- Groundwater samples were collected and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 *et seq*. and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Background groundwater quality data was collected for each Appendix III and Appendix IV constituent;
- Detection Monitoring sampling was initiated;
- A statistical process in accordance with 40 CFR 257.93 to evaluate groundwater data was prepared, certified, and posted to AEP's CCR website in April 2017. AEP's *Statistical Analysis Plan (*AEP 2017). The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009). Data evaluation is underway.

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;

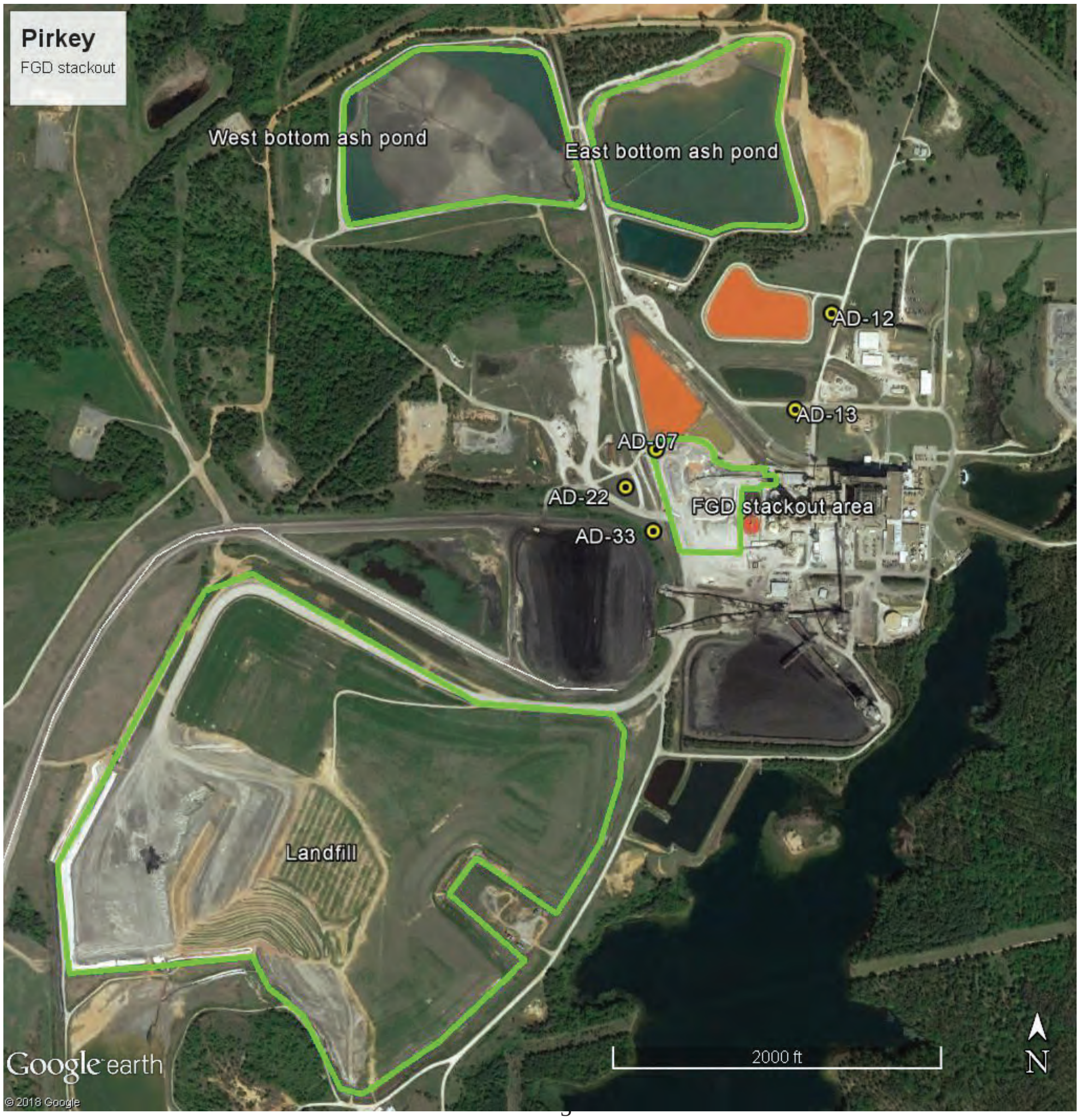
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations;
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

FGD Stackout Area Monitoring Wells	
Up Gradient	Down Gradient
AD-12	AD-7
AD-13	AD-22
	AD-33



III. Monitoring Wells Installed or Decommissioned

There were no monitoring wells installed or decommissioned in 2017. The network design, as summarized in the *Groundwater Monitoring Network Design Report* (3/9/2017) and as posted at the CCR web site for Pirkey Power Plant, did not change. That design report, viewable on the AEP CCR web site, discusses the facility location, the hydrogeological setting, the hydrostratigraphic units, the uppermost aquifer, downgradient monitoring well locations and the upgradient monitoring well locations.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality data collected during the establishment of background quality. Static water elevation data from each monitoring event also are shown in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

V. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

As of this first annual groundwater report date there has been no transition between detection monitoring and assessment monitoring. Detection monitoring will continue in 2018. The sampling frequency of twice per year will be maintained for the Appendix III parameters (boron, calcium, chloride, fluoride, pH, sulfate and total dissolved solids).

Regarding defining an alternate monitoring frequency, the groundwater velocity and monitoring well production is high enough at this facility that no modification of the twice-per-year detection monitoring effort is needed.

VI. Other Information Required

At the appropriate time the geochemical analyses, coupled with the statistical analyses of the groundwater quality data, will determine whether an alternate source or alternate sources are affecting groundwater chemistry. In those cases where an alternate source demonstration is made, those analyses and supporting information will be presented as well.

VII. Description of Any Problems Encountered in 2017 and Actions Taken

No significant problems were encountered. The low flow sampling effort went smoothly and the schedule was met to support this first annual groundwater report preparation.

VIII. A Projection of Key Activities for the Upcoming Year

Key activities for 2018 include:

- Detection monitoring on a twice per year schedule;
- Evaluation of the first detection monitoring results from a statistical analysis viewpoint, looking for any statistically significant increases, or decreases when pH is considered;
- Responding to any new data received in light of what the CCR rule requires;
- Preparation of the second annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Table 1 - Groundwater Data Summary
Pirkey Plant - Stackout Pad

Parameter	Unit	AD-7								
		5/11/2016	7/13/2016	9/7/2016	10/13/2016	11/14/2016	1/11/2017	2/28/2017	4/10/2017	8/24/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.00138 J	0.00118 J	<0.00105 U	0.00108 J	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.0370	0.0500	0.0500	0.0610	0.0600	0.0580	0.0530	0.0510	-
Beryllium	mg/L	0.00800	0.00300	0.00400	0.00400	0.00400	0.00500	0.00500	0.00700	-
Boron	mg/L	2.39	0.716	0.978	0.670	0.682	1.39	1.51	3.24	0.943
Cadmium	mg/L	0.000874 J	0.000668 J	0.000731 J	0.000858 J	0.00100	0.000757 J	0.000839 J	0.000724 J	-
Calcium	mg/L	6.58	2.97	3.15	2.81	2.63	3.92	4.78	5.06	2.99
Chloride	mg/L	28.0	16.0	18.0	17.0	16.0	19.0	20.0	28.0	18.0
Chromium	mg/L	0.000766 J	0.00100	0.000316 J	0.00100	<0.00023 U	<0.00023 U	<0.00023 U	0.000295 J	-
Cobalt	mg/L	0.0520	0.0240	0.0270	0.0230	0.0220	0.0310	0.0340	0.0440	-
Combined Radium	pCi/L	4.34	0.942	3.13	3.81	3.54	3.77	3.92	4.35	-
Fluoride	mg/L	0.649 J	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	<0.083 U	0.412 J	2.99
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.0440	0.0990	0.0990	0.101	0.0990	0.101	0.101	0.111	-
Mercury	mg/L	0.000309	0.000261	0.0000590	0.000154	0.0000390	0.0000228 J	0.000185	0.000191	-
Molybdenum	mg/L	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00105 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	302	204	208	212	216	204	240	322	176
Sulfate	mg/L	92.0	40.0	42.0	38.0	38.0	46.0	46.0	65.0	51.0
Thallium	mg/L	<0.00086 U	0.00103 J	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	3.95	3.55	4.08	3.81	4.04	3.51	3.74	3.58	-

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - Stackout Pad

Parameter	Unit	AD-12								
		5/11/2016	7/13/2016	9/7/2016	10/12/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	<0.00105 U	-
Barium	mg/L	0.0260	0.0230	0.0300	0.0270	0.0280	0.0230	0.0260	0.0240	-
Beryllium	mg/L	0.000220 J	0.000190 J	0.000232 J	0.000150 J	0.000152 J	0.000127 J	0.000149 J	0.000159 J	-
Boron	mg/L	0.0300	0.0300	0.0400	0.0300	0.0400	0.0300	0.0400	0.0500	0.0495
Cadmium	mg/L	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	0.362	0.260	0.343	0.271	0.331	0.315	0.434	0.299	0.245
Chloride	mg/L	5.00	6.00	6.00	7.00	8.00	7.00	5.00	6.00	6.00
Chromium	mg/L	0.000711 J	0.000688 J	0.000354 J	0.000529 J	0.000328 J	0.000650 J	0.000326 J	0.000416 J	-
Cobalt	mg/L	0.00158 J	0.00129 J	0.00167 J	0.00157 J	0.00147 J	0.00109 J	0.00130 J	0.00133 J	-
Combined Radium	pCi/L	0.207	2.91	0.881	0.257	0.767	1.54	0.416	0.390	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	1.00	<0.083 U	<0.083 U	<0.083 U	0.257 J	0.213 J
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	<0.00013 U	0.00800	0.0100	0.0120	0.0130	0.0100	0.00900	0.00800	-
Mercury	mg/L	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	<0.000005 U	0.0000136 J	-
Molybdenum	mg/L	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00174 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	94.0	75.0	63.0	92.0	80.0	76.0	50.0	72.0	52.0
Sulfate	mg/L	4.00	4.00	7.00	8.00	6.00	6.00	4.00	7.00	6.00
Thallium	mg/L	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	0.000995 J	<0.00086 U	-
pH	SU	4.44	3.11	3.89	3.37	2.58	4.76	3.63	4.74	4.84

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).

J: Estimated value. Parameter was detected in concentrations below the reporting limit.

-: Not sampled

For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - Stackout Pad

Parameter	Unit	AD-13								
		5/11/2016	7/13/2016	9/7/2016	10/13/2016	11/14/2016	1/11/2017	2/28/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.00426 J	0.00900	<0.00105 U	0.00700	0.00207 J	0.00274 J	0.00164 J	0.00443 J	-
Barium	mg/L	0.0380	0.0440	0.0470	0.0430	0.0390	0.0390	0.0340	0.0450	-
Beryllium	mg/L	0.000587 J	0.00200	0.000631 J	0.000963 J	0.000718 J	0.000303 J	0.000290 J	0.000737 J	-
Boron	mg/L	0.0600	0.0600	0.0500	0.0600	0.0600	0.0400	0.0700	0.0800	0.0741
Cadmium	mg/L	0.000294 J	0.0000875 J	0.000220 J	<0.00007 U	0.000310 J	0.000112 J	<0.00007 U	0.00200	-
Calcium	mg/L	8.77	9.08	8.48	7.53	7.21	6.14	7.88	9.11	9.50
Chloride	mg/L	28.0	32.0	23.0	26.0	26.0	22.0	28.0	32.0	21.0
Chromium	mg/L	<0.00023 U	<0.00023 U	<0.00023 U	<0.00023 U	<0.00023 U	<0.00023 U	<0.00023 U	<0.00023 U	-
Cobalt	mg/L	0.0420	0.0470	0.0380	0.0420	0.0420	0.0320	0.0440	0.0560	-
Combined Radium	pCi/L	0.989	2.33	1.22	2.42	1.72	1.84	1.73	1.31	-
Fluoride	mg/L	0.748 J	0.347 J	<0.083 U	0.630 J	0.311 J	<0.083 U	<0.083 U	0.428 J	0.344 J
Lead	mg/L	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	0.0810	0.158	0.139	0.142	0.136	0.133	0.153	0.156	-
Mercury	mg/L	0.00000969 J	0.0000193 J	<0.000005 U	<0.000005 U	<0.000005 U	0.00000732 J	<0.000005 U	<0.000005 U	-
Molybdenum	mg/L	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	<0.00099 U	0.00364 J	<0.00099 U	0.00260 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	236	192	228	236	250	188	172	200	160
Sulfate	mg/L	52.0	59.0	41.0	47.0	47.0	37.0	56.0	58.0	38.0
Thallium	mg/L	0.00111 J	0.000929 J	0.00144 J	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	5.63	5.64	5.19	5.77	6.06	5.82	5.92	5.21	5.98

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).

J: Estimated value. Parameter was detected in concentrations below the reporting limit.

-: Not sampled

For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - Stackout Pad

Parameter	Unit	AD-22								
		5/11/2016	7/14/2016	9/7/2016	10/12/2016	11/14/2016	1/12/2017	3/1/2017	4/11/2017	8/23/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.0230	0.0120	0.0230	0.0100	0.00370 J	0.00600	0.00161 J	0.0110	-
Barium	mg/L	0.0710	0.0480	0.108	0.0540	0.0660	0.0670	0.0290	0.130	-
Beryllium	mg/L	0.0130	0.00600	0.00500	0.00400	0.00400	0.00400	0.0100	0.00600	-
Boron	mg/L	0.0800	0.0400	0.0400	0.0300	0.0400	0.0200	0.0500	0.0400	0.0508
Cadmium	mg/L	0.00200	0.000674 J	0.000833 J	0.000334 J	0.000596 J	0.000386 J	0.00100	0.00200	-
Calcium	mg/L	15.3	9.50	6.95	7.68	7.55	6.47	13.6	10.8	7.77
Chloride	mg/L	76.0	52.0	42.0	52.0	48.0	51.0	69.0	72.0	54.0
Chromium	mg/L	0.0240	0.0120	0.0330	0.00700	0.00200	0.00200	<0.00023 U	0.00500	-
Cobalt	mg/L	0.129	0.0670	0.0540	0.0540	0.0470	0.0430	0.105	0.0780	-
Combined Radium	pCi/L	6.99	2.33	3.41	3.39	3.63	3.17	4.39	3.05	-
Fluoride	mg/L	1.27	0.389 J	<0.083 U	0.473 J	0.283 J	<0.083 U	<0.083 U	0.504 J	1.20
Lead	mg/L	0.000973 J	<0.00068 U	0.00273 J	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	0.00189 J	-
Lithium	mg/L	0.139	0.169	0.131	0.140	0.115	0.104	0.218	0.176	-
Mercury	mg/L	0.0134	0.0170	0.0198	0.00798	0.00863	0.0133	0.000220	0.00720	-
Molybdenum	mg/L	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	0.00197 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	0.00110 J	<0.00099 U	0.00187 J	-
Total Dissolved Solids	mg/L	672	412	341	388	362	344	624	446	350
Sulfate	mg/L	284	162	114	148	177	137	266	215	121
Thallium	mg/L	0.00116 J	0.000895 J	0.00125 J	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	4.02	3.90	4.05	4.70	4.41	4.23	4.07	4.07	4.60

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).

J: Estimated value. Parameter was detected in concentrations below the reporting limit.

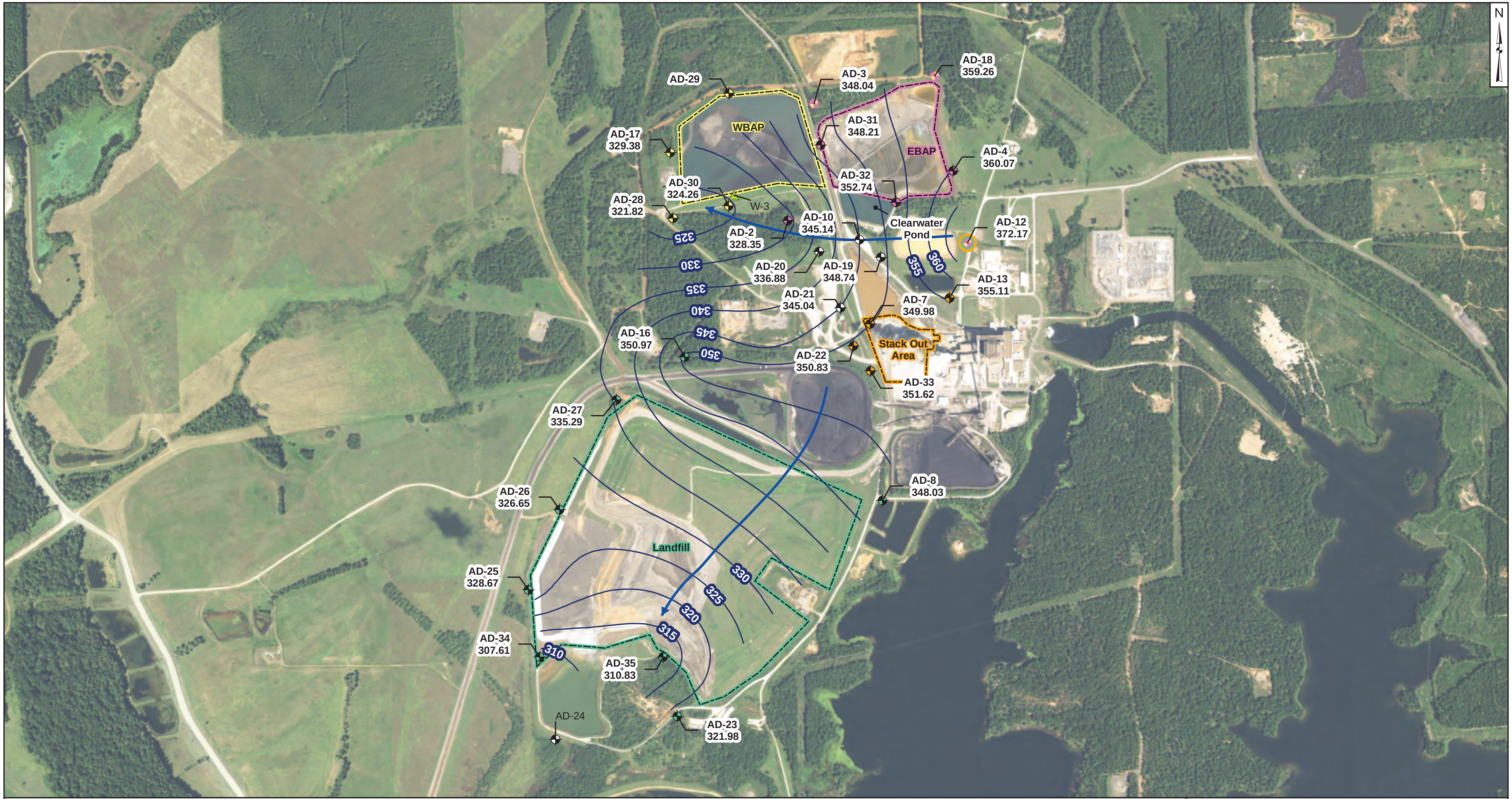
-: Not sampled

For statistical analysis, parameters which were not detected were replaced with the reporting limit.

Table 1 - Groundwater Data Summary
Pirkey Plant - Stackout Pad

Parameter	Unit	AD-33								
		5/11/2016	7/14/2016	9/7/2016	10/12/2016	11/14/2016	1/12/2017	2/28/2017	4/10/2017	8/23/2017
		Background								Detection
Antimony	mg/L	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	<0.00093 U	-
Arsenic	mg/L	0.00254 J	0.00492 J	0.0670	0.00216 J	0.00146 J	0.00113 J	0.00107 J	<0.00105 U	-
Barium	mg/L	0.0600	0.0640	0.163	0.0590	0.0520	0.0560	0.0550	0.0550	-
Beryllium	mg/L	0.00200	0.00200	0.00400	0.00100	0.00100	0.00100	0.00100	0.00100	-
Boron	mg/L	0.126	0.173	0.152	0.162	0.182	0.144	0.140	0.114	0.0795
Cadmium	mg/L	<0.00007 U	<0.00007 U	0.000985 J	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	<0.00007 U	-
Calcium	mg/L	2.44	1.69	1.81	1.39	1.63	1.26	1.25	1.29	1.06
Chloride	mg/L	8.00	16.0	10.0	9.00	8.00	10.0	7.00	9.00	9.00
Chromium	mg/L	0.00400	0.00900	0.125	0.00400	0.00100	0.00200	<0.00023 U	0.00300	-
Cobalt	mg/L	0.0120	0.0120	0.0330	0.0100	0.00900	0.00900	0.00900	0.0100	-
Combined Radium	pCi/L	1.30	4.28	3.46	2.21	1.95	2.60	0.942	9.02	-
Fluoride	mg/L	<0.083 U	<0.083 U	<0.083 U	0.357 J	<0.083 U	<0.083 U	<0.083 U	<0.083 U	0.670 J
Lead	mg/L	<0.00068 U	<0.00068 U	0.0140	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	<0.00068 U	-
Lithium	mg/L	<0.00013 U	0.0290	0.0480	0.0270	0.0240	0.0270	0.0260	0.0270	-
Mercury	mg/L	0.000288	0.000707	0.00183	0.000145	0.000197	0.000360	0.000410	0.000341	-
Molybdenum	mg/L	<0.00029 U	<0.00029 U	0.000737 J	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	<0.00029 U	-
Selenium	mg/L	<0.00099 U	<0.00099 U	0.00161 J	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	<0.00099 U	-
Total Dissolved Solids	mg/L	326	176	176	180	190	168	146	178	132
Sulfate	mg/L	56.0	108	64.0	46.0	54.0	58.0	51.0	49.0	40.0
Thallium	mg/L	<0.00086 U	0.00119 J	<0.00086 U	0.00157 J	<0.00086 U	<0.00086 U	<0.00086 U	<0.00086 U	-
pH	SU	4.11	3.14	3.61	3.44	3.13	4.31	3.89	3.40	4.39

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL).
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
-: Not sampled
For statistical analysis, parameters which were not detected were replaced with the reporting limit.



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 11, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
May 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2017/12/13

Figure
1

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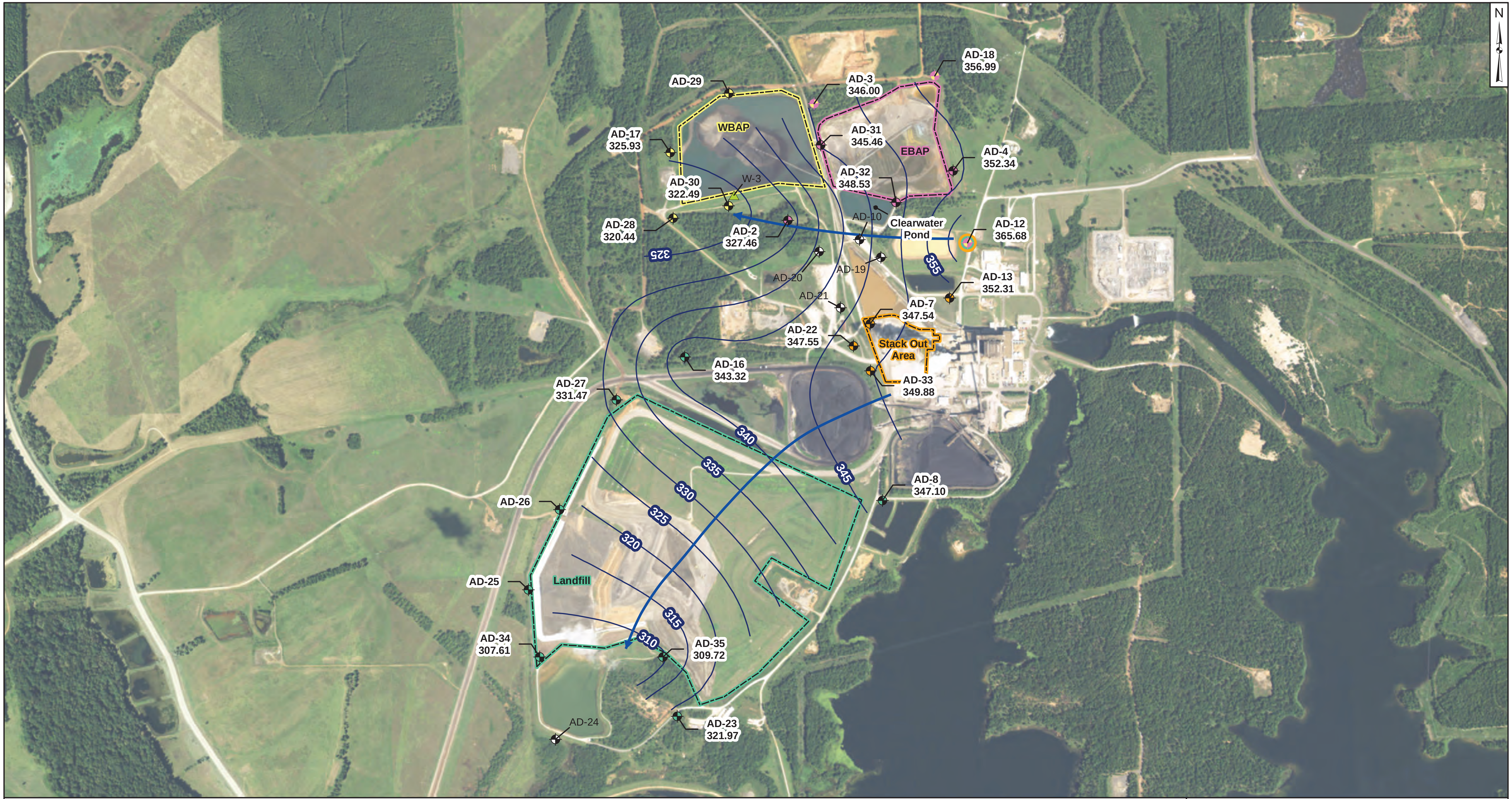

1,000 500 0 1,000
Feet

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on July 14, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

Potentiometric Contours - Uppermost Aquifer July 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2017/12/13

Figure
2

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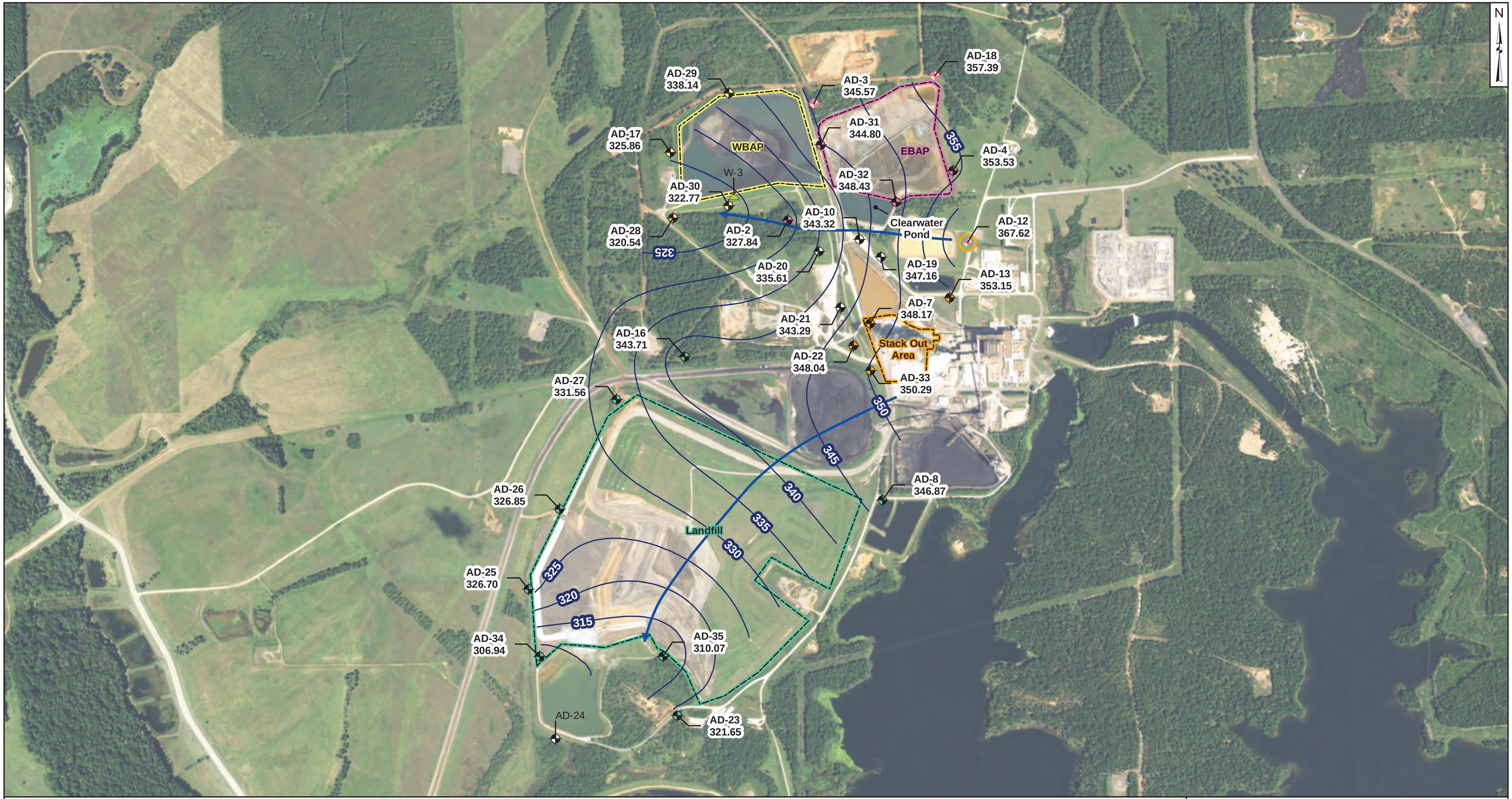

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on September 8, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
September 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2017/12/14

Figure
3

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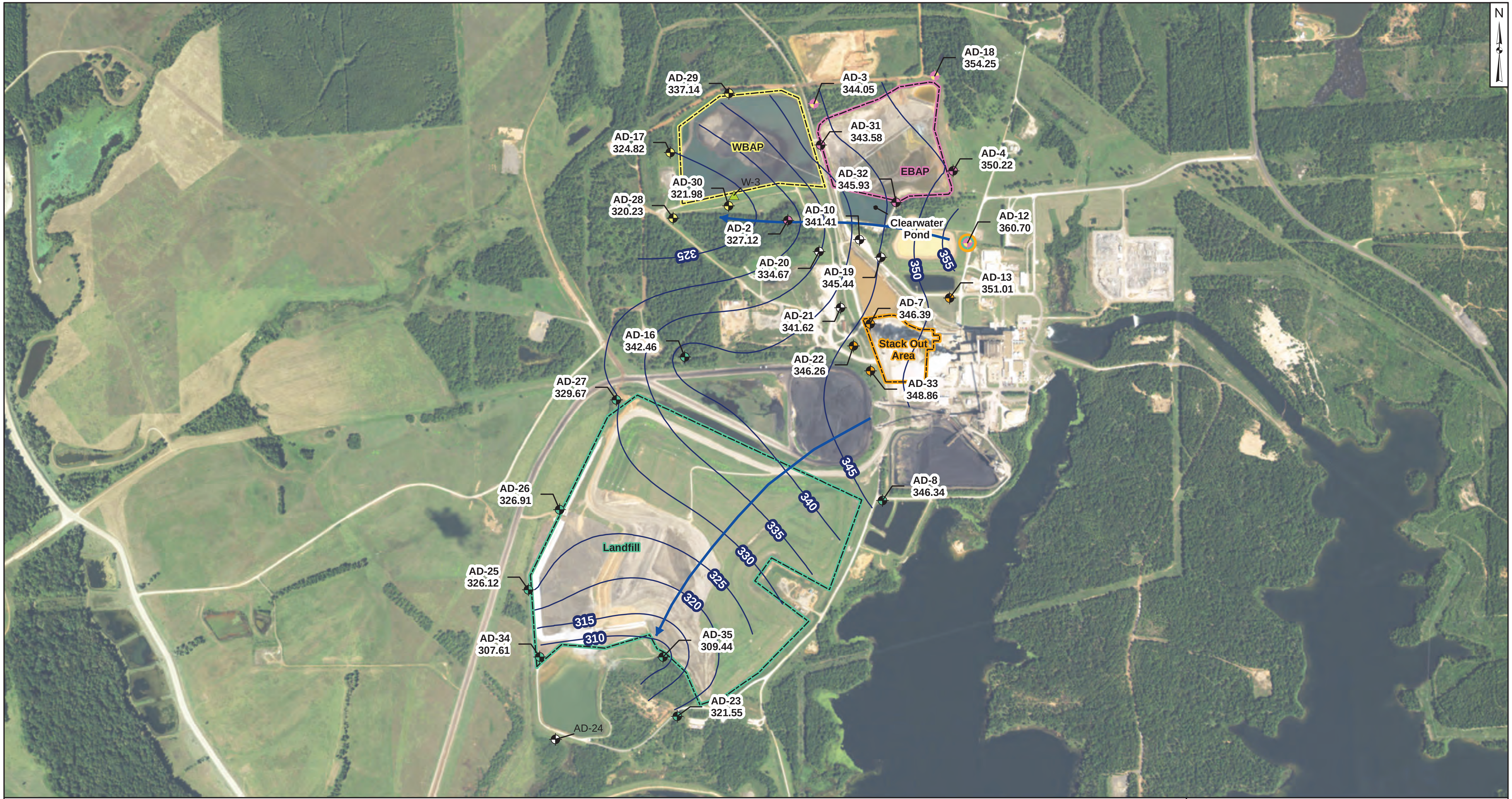

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- △ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on October 13, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
October 2016

AEP Pirkey Power Plant
Hallsville, Texas

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consultants

Columbus, Ohio	2017/12/13	Figure 4

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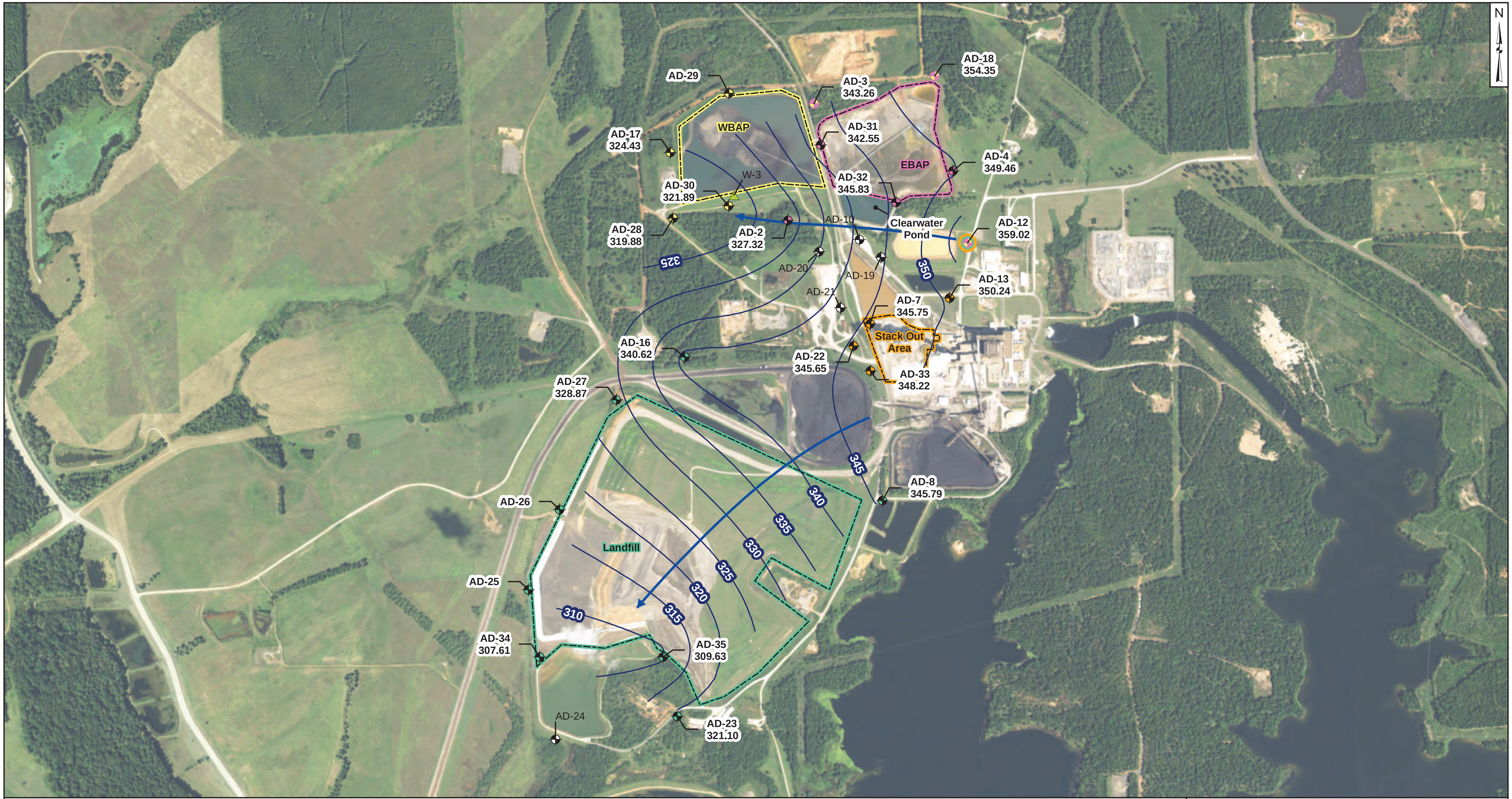

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected November 14 - 15, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer November 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
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Figure
5

Columbus, Ohio
2017/12/13

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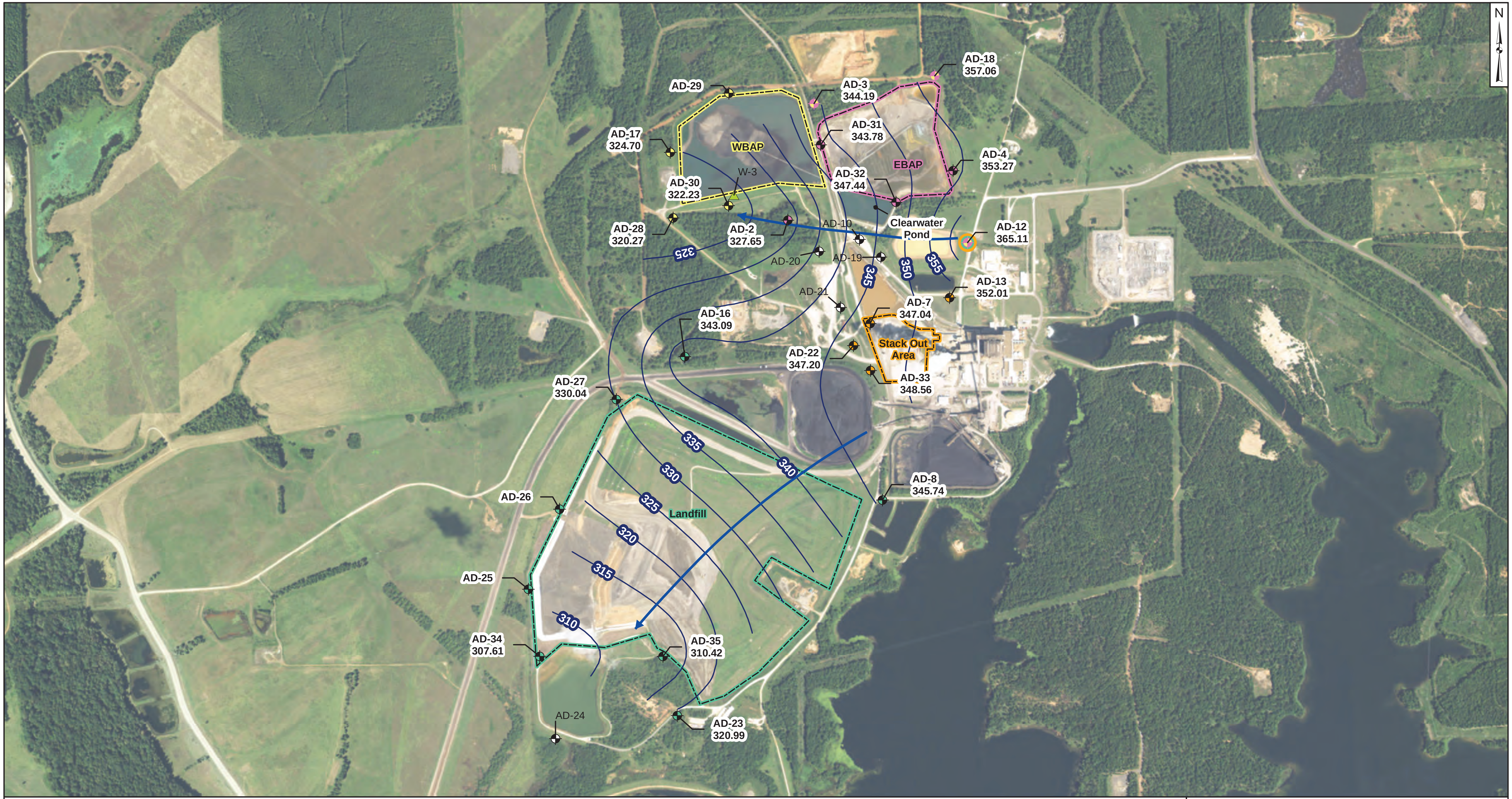

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stack Out Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on January 11 - 12, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

Potentiometric Contours - Uppermost Aquifer January 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2017/12/19

Figure

6

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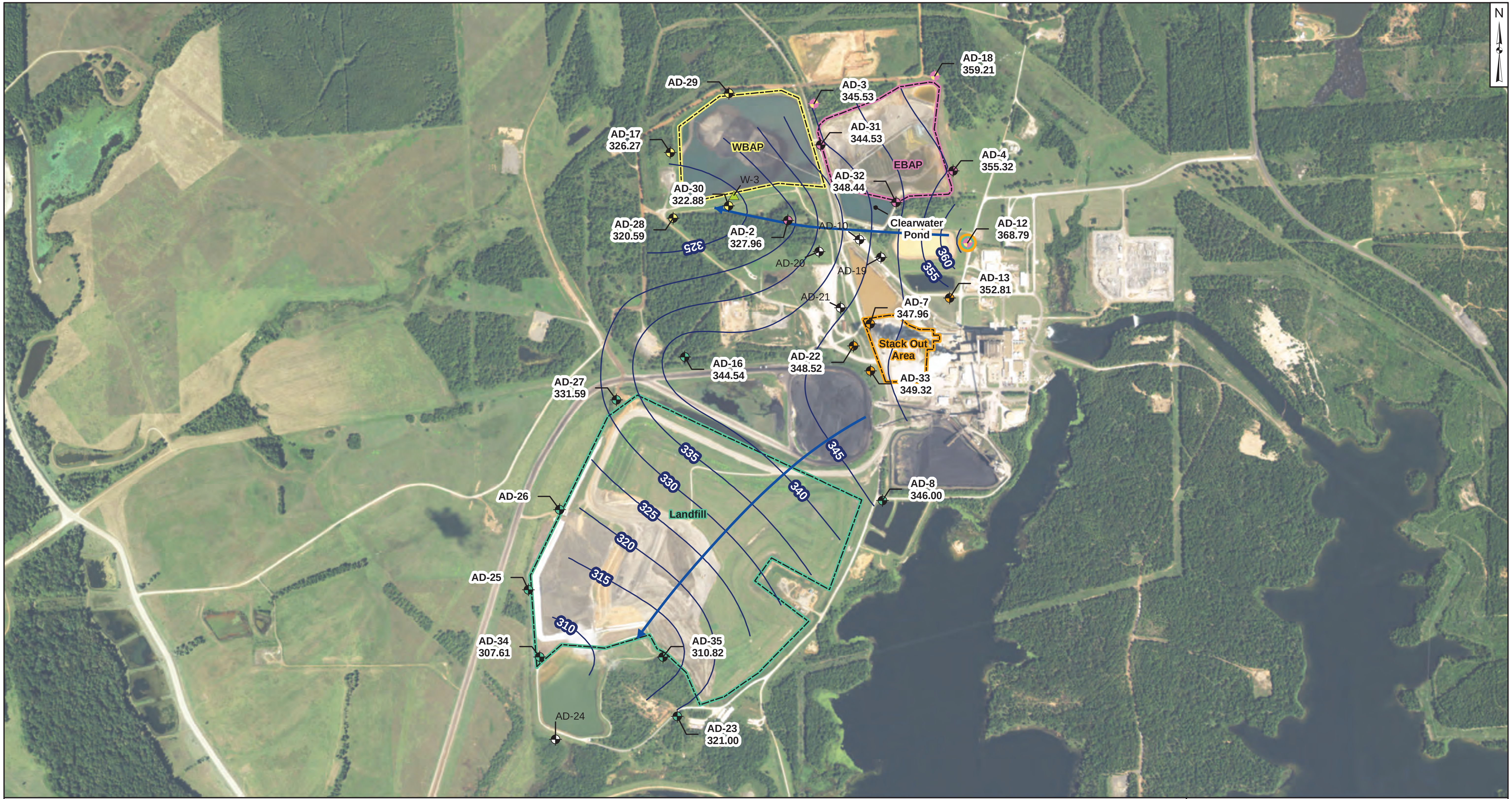

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on February 28 - March 1, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer February 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
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Columbus, Ohio

2017/12/14

Figure
7

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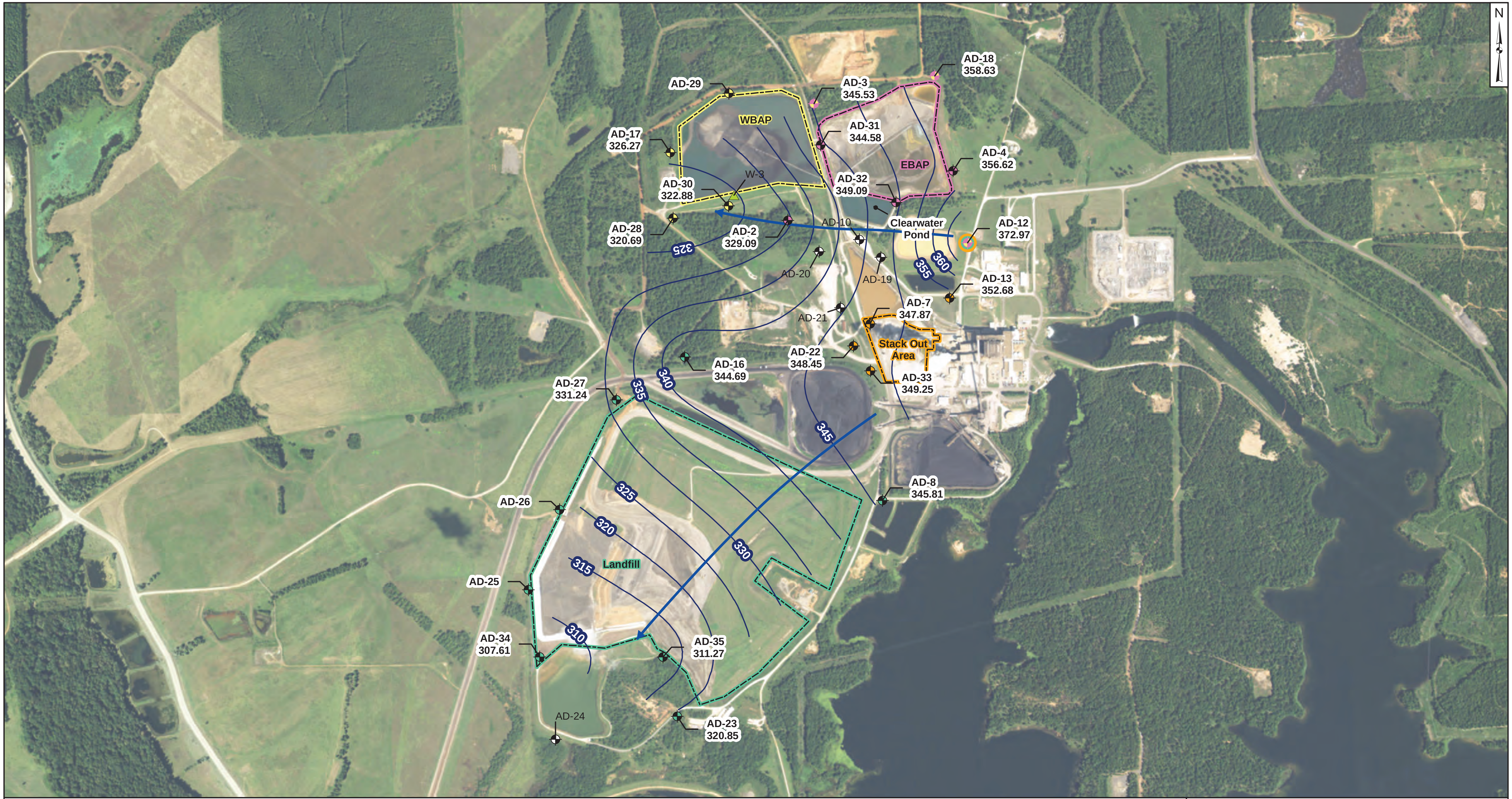

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on April 10 - 11, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer April 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure

8

Columbus, Ohio

2017/12/14

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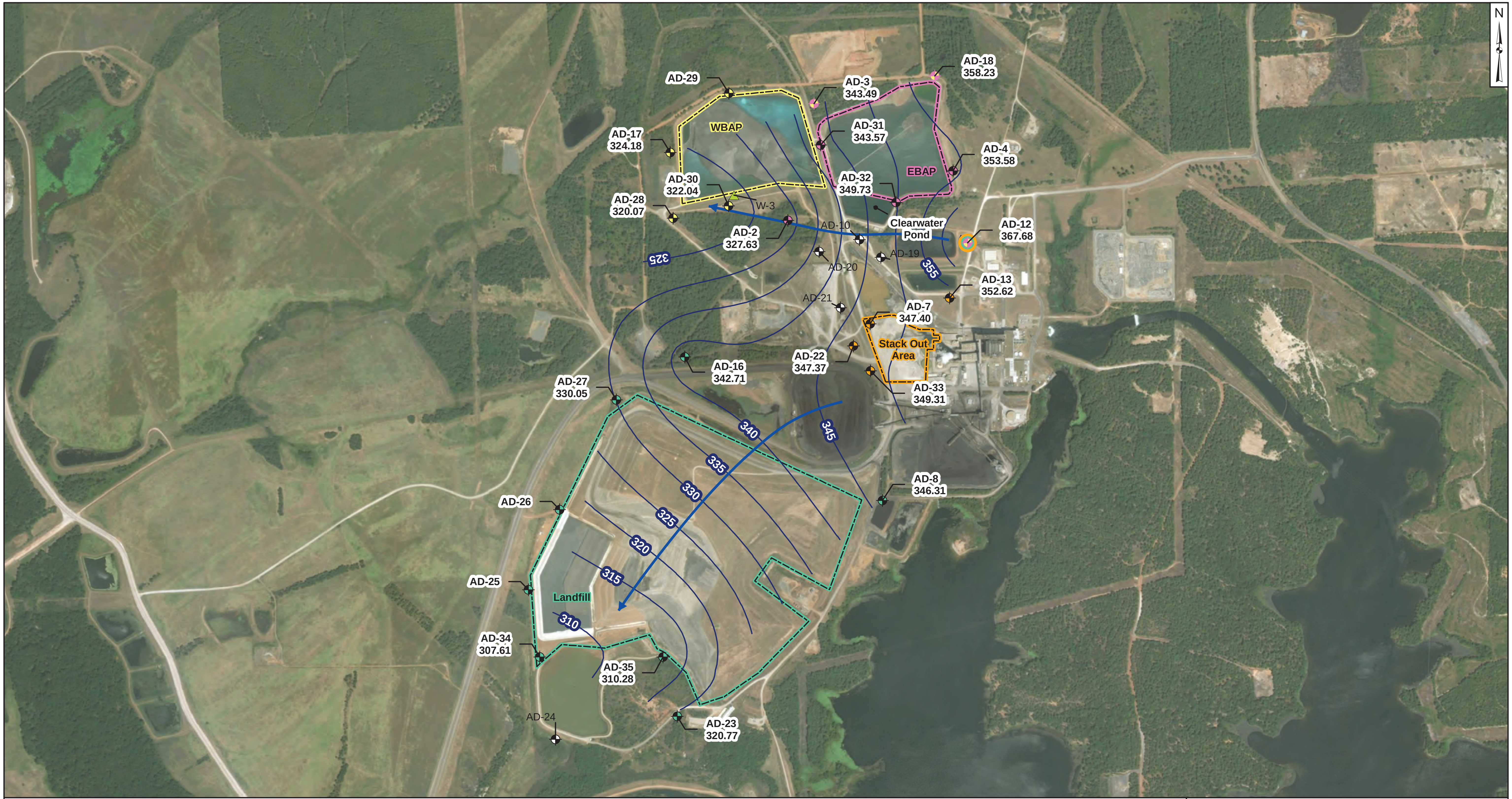

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP

- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on August 23 - 24, 2017) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer August 2017

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
9

Columbus, Ohio
2018/01/28

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USE data row --> **75** **8/24/2017**

Landfill

Distance between wells in feet

	AD8	AD12	AD16	AD23	AD27	AD34	AD35
AD8	-	2869	2582	3147	3008	3999	2872
AD12		-	3224	5870	4067	6305	5447
AD16			-	3795	853	3537	3196
AD23				-	3402	1621	734
AD27					-	2854	2780
AD34						-	1302
AD35							-

Landfill displaying data for date: **8/24/2017**

Hydraulic gradient in ft/ft

	AD8	AD12	AD16	AD23	AD27	AD34	AD35	max grad	
AD8	-	0.007449	0.001394	0.008116	0.005406	0.009677	0.012545	0.014842	
AD12		-	0.007745	0.007991	0.009253	0.009527	0.010538	hydraulic concuctivity	
AD16			-	0.005781	0.014842	0.009924	0.010147	0.0001	cm/sec
AD23				-	0.002728	0.008118	0.014292	porosity	
AD27					-	0.007863	0.007112	0.25	
AD34						-	0.002051	seepage rate, ft/yr	
AD35							-	6.14	

FGD stackout area

Distance between wells in feet

	AD7	AD12	AD13	AD22	AD33
AD7	-	1339	954	295	615
AD12		-	723	1627	1742
AD13			-	1191	1138
AD22				-	175
AD33					-

FGD stackout area displaying data for date: **8/24/2017**

Hydraulic gradient in ft/ft

	AD7	AD12	AD13	AD22	AD33	max grad	
AD7	-	0.015146	0.005472	0.000102	0.003106	0.02083	
AD12		-	0.02083	0.012483	0.010545	hydraulic concuctivity	
AD13			-	0.004408	0.002909	0.0001	cm/sec
AD22				-	0.011086	porosity	
AD33					-	0.25	

seepage rate, ft/yr
8.62

as of Mar 2011	Well ID	AD-02	AD-03	AD-04	AD-07	AD-08	AD-10	AD-12	AD-13	AD-16	AD-17	AD-18
	TOC, ft	344.04	375.30	366.79	362.79	359.84	362.21	381.99	364.76	360.05	346.09	363.42
	Measured depth to water											
	Date											
	4/13/2011	17.14	32.35	15.34	18.45	18.19	20.18	23.04	15.30	21.97	23.43	7.89
	12/15/2011	16.92	33.71	15.55	19.04	19.55	20.31	24.00	15.85	24.55	23.80	11.88
	6/20/2012	16.87	31.60	14.35	18.64	18.19	20.02	22.66	15.24	22.47	22.78	6.21
	1/23/2013	16.78	34.20	12.37	17.89	19.12	20.80	13.92	13.95	24.62	22.58	7.95
	7/7/2013	17.42	32.03	17.57	19.44	18.59	22.36	24.58	16.15	23.38	23.03	6.19
	1/22/2014	16.34	33.88	11.21	16.18	18.17	19.94	12.02	12.79	20.52	20.90	3.39
	7/9/2014	16.85	31.34	13.46	16.56	16.48	19.99	14.95	13.47	19.21	21.94	5.36
	1/28/2015	15.42	30.29	7.79	13.62	15.81	17.82	9.24	10.29	16.71	17.67	3.54
	1/20/2016	15.49	28.27	7.63	13.48	12.63		10.94	10.61	12.37		2.9
	3/7/2016	15.73	28.09	8.66	14.01	12.62	17.94	13.28	11.15	11.36	18.08	3.08
	5/11/2016	15.69	27.26	6.72	12.81	11.81	17.07	9.82	9.65	9.08	16.71	4.16
	7/14/2016	16.58	29.30	14.45	15.25	12.74		16.31	12.45	16.73	20.16	6.43
	9/8/2016	16.20	29.73	13.26	14.62	12.97	18.89	14.37	11.61	16.34	20.23	6.03
	10/13/2016	16.92	31.25	16.57	16.40	13.50	20.80	21.29	13.75	17.59	21.27	9.17
	11/15/2016	16.72	32.04	17.33	17.04	14.05		22.97	14.52	19.43	21.60	9.07
	1/12/2017	16.39	31.11	13.52	15.75	14.10		16.88	12.75	16.96	21.39	6.36
	3/1/2017	16.08	29.77	11.41	14.83	13.84		13.20	11.95	15.51	19.82	4.21
	4/11/2017	14.95	29.77	10.17	14.92	14.03		9.02	12.08	15.36	19.82	4.79
	8/24/2017	16.41	31.81	13.22	15.39	13.53		14.31	12.14	17.34	21.91	5.19

Well ID	AD-19	AD-20	AD-21	AD-22	AD-23	AD-24	AD-25	AD-26	AD-27	AD-28	AD-29	AD-30	AD-31	AD-32	AD-33	AD-34	AD-35
TOC, ft	362.82	355.79	350.72	358.51	350.10	291.14	337.09	345.25	352.62	339.40	353.37	342.02	360.75	359.18	362.37	307.61	318.95
						plugged 1-26-16											
Measured depth to water																	
Date																	
4/13/2011	18.75	21.29	10.29	14.87	30.45	8.22	12.58	20.72	26.80	19.73	18.69						
12/15/2011	19.24	21.16	10.70	15.35	31.16	6.85	15.19	21.48	28.08	20.24	20.00						
6/20/2012	18.53	21.10	10.50	14.77	30.81	6.04	13.95	21.63	26.49	19.48	18.63						
1/23/2013	18.20	21.01	9.15	13.68	31.44	5.51	15.15	22.93	27.23	19.19	15.90						
7/7/2013	20.22	22.41	11.56	15.61	31.23	6.08	14.94	23.16	27.27	19.71	16.53						
1/22/2014	17.71	20.41	8.36	12.02	30.30	2.84	14.53	22.01	26.23	18.75	14.82						
7/9/2014	17.06	20.92	9.05	12.74	30.31	4.04	12.85	22.74	24.71	19.18	17.52						
1/28/2015	14.90	18.91	5.27	8.27	30.26	2.58	10.67	22.21	22.93	17.24	12.80						
1/20/2016				8.22	28.87					18.01		18.32	14.15	6.86	11.24	0	9.1
3/7/2016	15.09	19.34	6.46	5.96	28.59	plugged	9.11	18.97	21.42	18.57	13.67	18.89	14.08	7.53	11.67	0.00	8.04
5/11/2016	14.08	18.91	5.68	7.68	28.12		8.42	18.60	17.33	17.58		17.76	12.54	6.44	10.75	0.00	8.12
7/14/2016				10.96	28.13				21.15	18.96		19.53	15.29	10.65	12.49	0.00	9.23
9/8/2016	15.66	20.18	7.43	10.47	28.45		10.39	18.40	21.06	18.86	15.23	19.25	15.95	10.75	12.08	0.67	8.88
10/13/2016	17.38	21.12	9.10	12.25	28.55		10.97	18.34	22.95	19.17	16.23	20.04	17.17	13.25	13.51	0.00	9.51
11/15/2016				12.86	29.00				23.75	19.52		20.13	18.20	13.35	14.15	0.00	9.32
1/12/2017				11.31	29.11				22.58	19.13		19.79	16.97	11.74	13.81	0.00	8.53
3/1/2017				9.99	29.10				21.03	18.89		19.17	16.22	10.74	13.05	0.00	8.13
4/11/2017				10.06	29.25				21.38	18.71		15.14	16.17	10.09	13.12	0.00	7.68
8/24/2017				11.14	29.33				22.57	19.33		19.98	17.18	9.45	13.06	0.00	8.67

WBAP
Distance between wells in feet

	AD3	AD12	AD17	AD18	AD28	AD30
AD3	-	2187	1604	1280	1955	1458
AD12		-	3132	1794	3123	2584
AD17			-	2911	695	904
AD18				-	3149	2603
AD28					-	689
AD30						-

WBAP displaying data for date: **8/24/2017**
Hydraulic gradient in ft/ft

	AD3	AD12	AD17	AD18	AD28	AD30	max grad
AD3	-	0.011061	0.012039	0.011516	0.01198	0.014712	0.032569
AD12		-	0.013889	0.005268	0.015245	0.017663	hydraulic concuctivity
AD17			-	0.011697	0.005914	0.002367	0.0001 cm/sec
AD18				-	0.001305	0.000822	porosity
AD28					-	0.032569	0.25
AD30						-	seepage rate, ft/yr

13.48

EBAP
Distance between wells in feet

	AD2	AD4	AD12	AD18	AD31	AD32
AD2	-	1822	1914	1569	932	1209
AD4		-	773	1022	1473	779
AD12			-	1794	1903	948
AD18				-	1459	1443
AD31					-	1001
AD32						-

EBAP displaying data for date: **8/24/2017**
Hydraulic gradient in ft/ft

	AD2	AD4	AD12	AD18	AD31	AD32	max grad
AD2	-	0.014237	0.020925	0.019503	0.017103	0.01828	0.020925
AD4		-	0.018254	0.00456	0.006789	0.004929	hydraulic concuctivity
AD12			-	0.005268	0.012669	0.018935	0.0001 cm/sec
AD18				-	0.010048	0.005891	porosity
AD31					-	0.006154	0.25
AD32						-	seepage rate, ft/yr

8.66

	Well ID	AD-02	AD-03	AD-04	AD-07	AD-08	AD-10	AD-12	AD-13	AD-16	AD-17	AD-18	AD-19	AD-20	AD-21	AD-22	AD-23	AD-24	AD-25	AD-26	AD-27	AD-28	AD-29	AD-30	AD-31	AD-32	AD-33	AD-34	AD-35
	TOC, ft	344.04	375.30	366.79	362.79	359.84	362.21	381.99	364.76	360.05	346.09	363.42	362.82	355.79	350.72	358.51	350.10	291.14	337.09	345.25	352.62	339.40	353.37	342.02	360.75	359.18	362.37	307.61	318.95
337.70	4/13/2011	326.90	342.95	351.45	344.34	341.65	342.03	358.95	349.46	338.08	322.66	355.53	344.07	334.50	340.43	343.64	319.65	282.92	324.51	324.53	325.82	319.67	334.68						
335.90	12/15/2011	327.12	341.59	351.24	343.75	340.29	341.90	357.99	348.91	335.50	322.29	351.54	343.58	334.63	340.02	343.16	318.94	284.29	321.90	323.77	324.54	319.16	333.37						
338.40	6/20/2012	327.17	343.70	352.44	344.15	341.65	342.19	359.33	349.52	337.58	323.31	357.21	344.29	334.69	340.22	343.74	319.29	285.10	323.14	323.62	326.13	319.92	334.74						
339.40	1/23/2013	327.26	341.10	354.42	344.90	340.72	341.41	368.07	350.81	335.43	323.51	355.47	344.62	334.78	341.57	344.83	318.66	285.63	321.94	322.32	325.39	320.21	337.47						
339.40	7/7/2013	326.62	343.27	349.22	343.35	341.25	339.85	357.41	348.61	336.67	323.06	357.23	342.60	333.38	339.16	342.90	318.87	285.06	322.15	322.09	325.35	319.69	336.84						
338.70	1/22/2014	327.70	341.42	355.58	346.61	341.67	342.27	369.97	351.97	339.53	325.19	360.03	345.11	335.38	342.36	346.49	319.80	288.30	322.56	323.24	326.39	320.65	338.55						
339.40	7/9/2014	327.19	343.96	353.33	346.23	343.36	342.22	367.04	351.29	340.84	324.15	358.06	345.76	334.87	341.67	345.77	319.79	287.10	324.24	322.51	327.91	320.22	335.85						
339.40	1/28/2015	328.62	345.01	359.00	349.17	344.03	344.39	372.75	354.47	343.34	328.42	359.88	347.92	336.88	345.45	350.24	319.84	288.56	326.42	323.04	329.69	322.16	340.57						
	1/20/2016	328.55	347.03	359.16	349.31	347.21		371.05	354.15	347.68		360.52				350.29	321.23					321.39		323.70	346.60	352.32	351.13	307.61	309.85
	3/7/2016	328.31	347.21	358.13	348.78	347.22	344.27	368.71	353.61	348.69	328.01	360.34	347.73	336.45	344.26	352.55	321.51	#VALUE!	327.98	326.28	331.20	320.83	339.70	323.13	346.67	351.65	350.70	307.61	310.91
	5/11/2016	328.35	348.04	360.07	349.98	348.03	345.14	372.17	355.11	350.97	329.38	359.26	348.74	336.88	345.04	350.83	321.98		328.67	326.65	335.29	321.82		324.26	348.21	352.74	351.62	307.61	310.83
	7/14/2016	327.46	346.00	352.34	347.54	347.10		365.68	352.31	343.32	325.93	356.99				347.55	321.97				331.47	320.44		322.49	345.46	348.53	349.88	307.61	309.72
	9/8/2016	327.84	345.57	353.53	348.17	346.87	343.32	367.62	353.15	343.71	325.86	357.39	347.16	335.61	343.29	348.04	321.65		326.70	326.85	331.56	320.54	338.14	322.77	344.80	348.43	350.29	306.94	310.07
	10/13/2016	327.12	344.05	350.22	346.39	346.34	341.41	360.70	351.01	342.46	324.82	354.25	345.44	334.67	341.62	346.26	321.55		326.12	326.91	329.67	320.23	337.14	321.98	343.58	345.93	348.86	307.61	309.44
	11/15/2016	327.32	343.26	349.46	345.75	345.79		359.02	350.24	340.62	324.49	354.35				345.65	321.10				328.87	319.88		321.89	342.55	345.83	348.22	307.61	309.63
	1/12/2017	327.65	344.19	353.27	347.04	345.74		365.11	352.01	343.09	324.70	357.06				347.20	320.99				330.04	320.27		322.23	343.78	347.44	348.56	307.61	310.42
	3/1/2017	327.96	345.53	355.38	347.96	346.00		368.79	352.81	344.54	326.27	359.21				348.52	321.00				331.59	320.51		322.85	344.53	348.44	349.32	307.61	310.82
	4/11/2017	329.09	345.53	356.62	347.87	345.81		372.97	352.68	344.69	326.27	358.63				348.45	320.85				331.24	320.69		326.88	344.58	349.09	349.25	307.61	311.27
		327.63	343.49	353.57	347.40	346.31		367.68	352.62	342.71	324.18	358.23				347.37	320.77				330.05	320.07		322.04	343.57	349.73	349.31	307.61	310.28

Seepage rate summary
in feet per year

	Landfill	Stackout	WBAP	EBAP	
3/7/2016	8.49	8.64	14.17	8.74	3/7/2016
5/11/2016	7.61	9.77	16.63	9.48	5/11/2016
7/14/2016	6.91	7.65	14.33	8.26	7/14/2016
9/8/2016	6.53	8.28	14.79	8.60	9/8/2016
10/13/2016	6.83	6.15	13.25	7.31	10/13/2016
11/15/2016	6.47	6.08	12.77	7.13	11/15/2016
1/12/2017	6.33	7.50	13.47	8.10	1/12/2017
3/1/2017	6.28	9.15	14.40	8.88	3/1/2017
4/11/2017	6.53	11.61	14.19	10.43	4/11/2017
8/24/2017	6.14	8.62	13.48	8.66	8/24/2017

4.18 – Annual Groundwater Monitoring Report, H.W. Pirkey Power Plant, FGD Stackout Area CCR Management Unit, Hallsville, Texas, January 2021

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
FGD Stackout Area CCR Management Unit
Hallsville, Texas

January 2021

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY℠
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Table of Contents

I. Summary

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2021.

In general, the following activities were completed:

- Groundwater samples were collected for AD-7, AD-12, AD-13, AD-22, and AD-33 in March, June, and November 2020 analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in Assessment monitoring at the beginning and the end of 2020;
- Statistical analysis report dated January 3, 2020 was included in last year's Annual Groundwater Monitoring Report. The following Appendix IV parameters exceeded established groundwater protection standards:
    - Beryllium at AD-7 and AD-22
    - Cobalt at AD-22

  The following Appendix III parameters exceeded background:
    - Boron at AD-33 and AD-7
    - Calcium at AD-22 and AD-7
    - Chloride at AD-22
    - Fluoride at AD-22
    - The May 2019 pH measurement at AD-22
    - Sulfate at AD-22 and AD-7
    - TDS concentrations at AD-33 and AD-7
- An alternate source for beryllium and cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 2, 2020.
- Statistical analysis report dated October 2, 2020 is included in **Appendix II**. The following Appendix IV parameters exceeded established groundwater protection standards:

  - Beryllium at AD-7 and AD-22
  - Cobalt at AD-22

  The following Appendix III parameters exceeded background:

  - Boron at AD-7 and AD-33
  - Chloride at AD-22
  - Fluoride at AD-22
  - Sulfate at AD-22
  - TDS concentrations at AD-7, AD-22, and AD-33

- An alternate source for beryllium and cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on December 31, 2020.
- The November 2020 data are still undergoing statistical analysis.
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

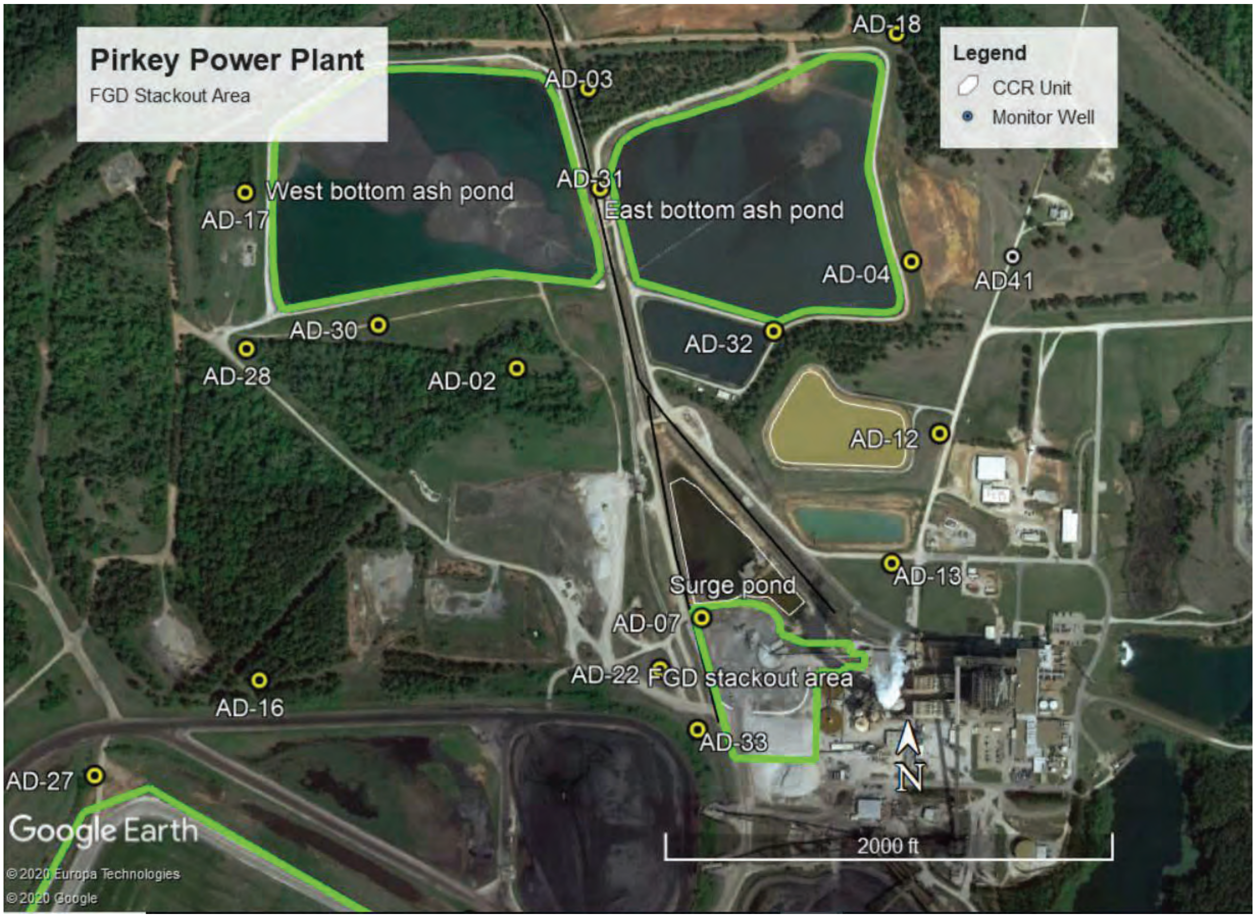
- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in **Appendix I**;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations.
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

FGD Stackout Area Monitoring Wells	
Up Gradient	Down Gradient
AD-12	AD-7
AD-13	AD-22
	AD-33



III. Monitoring Wells Installed or Decommissioned

One monitoring well (AD-7R) was installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry. The well installation reports can be found in **Appendix IV**.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event also are shown in **Appendix I**, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a March sampling event was conducted in accordance with 40 CFR 257.95(b). Two sampling events in June and November were conducted in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2021.

V. Statistical Evaluation of 2020 Events

Statistical analysis report dated January 3, 2020 was included in last year's Annual Groundwater Monitoring Report.

- The following Appendix IV parameters exceeded established groundwater protection standards:
    - Beryllium at AD-7 and AD-22
    - Cobalt at AD-22

  The following Appendix III parameters exceeded background:
    - Boron at AD-33 and AD-7
    - Calcium at AD-22 and AD-7
    - Chloride at AD-22
    - Fluoride at AD-22
    - The May 2019 pH measurement at AD-22
    - Sulfate at AD-22 and AD-7
    - TDS concentrations at AD-33 and AD-7

Statistical analysis report dated October 2, 2020 is included in **Appendix II**. The following Appendix IV parameters exceeded established groundwater protection standards:

- Beryllium at AD-7 and AD-22
- Cobalt at AD-22

The following Appendix III parameters exceeded background:

- Boron at AD-7 and AD-33
- Chloride at AD-22

- Fluoride at AD-22
- Sulfate at AD-22
- TDS concentrations at AD-7, AD-22, and AD-33

The second semi-annual groundwater monitoring data from November is still undergoing statistical analysis.

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the SSLs above GWPSs. SSLs above the GWPS were determined for beryllium at wells AD-7 and AD-22 and cobalt at well AD-22 on January 3, 2020. An alternate source for beryllium and cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 2, 2020.

SSLs above the groundwater protection standard GWPS were determined for beryllium at wells AD-7 and AD-22 and cobalt at AD-22 on October 2, 2020. An alternate source for beryllium and cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on December 31, 2020.

The supporting information are found in **Appendix III**.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

The unit transitioned from detection monitoring to assessment monitoring on April 3, 2018.

Assessment monitoring will continue in 2021.

Regarding defining an alternate monitoring frequency, no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

No other information applies at this time.

IX. Description of Any Problems Encountered in 2020 and Actions Taken

No significant problems were encountered.

X. A Projection of Key Activities for the Upcoming Year

Key activities for next year include:

- Assessment monitoring sampling will be conducted;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for any SSLs above GWPS;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the next annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Table 1 - Groundwater Data Summary: AD-7
Pirkey - Stackout
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	2.39	6.58	28	0.6493 J	4.0	92	302
7/13/2016	Background	0.716	2.97	16	< 0.083 U	3.6	40	204
9/7/2016	Background	0.978	3.15	18	< 0.083 U	4.1	42	208
10/13/2016	Background	0.67	2.81	17	< 0.083 U	3.8	38	212
11/14/2016	Background	0.682	2.63	16	< 0.083 U	4.0	38	216
1/11/2017	Background	1.39	3.92	19	< 0.083 U	3.5	46	204
2/28/2017	Background	1.51	4.78	20	< 0.083 U	3.7	46	240
4/10/2017	Background	3.24	5.06	28	0.4117 J	3.6	65	322
8/24/2017	Detection	0.943	2.99	18	2.994	3.7	51	176
12/21/2017	Detection	0.718	3.26	19	< 0.083 U	--	39	176
3/21/2018	Assessment	2.47	5.37	20	< 0.083 U	3.6	90	266
8/20/2018	Assessment	1.36	3.76	33	< 0.083 U	4.3	54	180
2/27/2019	Assessment	2.10	5.20	29.9	0.50	2.9	69.1	268
5/22/2019	Assessment	0.195	5.77	28.0	0.58	3.4	91.6	334
8/12/2019	Assessment	3.54	4.20	36.7	0.30	4.0	59.6	266
3/10/2020	Assessment	1.99	4.86	28.7	0.57	3.5	88.5	254
6/2/2020	Assessment	1.93	4.98	29.1	0.58	3.3	74.4	303
11/3/2020	Assessment	4.19	4.10	38.2	0.27	3.3	60.2	236

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-7
Pirkey - Stackout
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	1.38216 J	37	8	0.87394 J	0.766043 J	52	4.344	0.6493 J	< 0.68 U	0.044	0.309	< 0.29 U	1.04661 J	< 0.86 U
7/13/2016	Background	< 0.93 U	1.18444 J	50	3	0.66774 J	1	24	0.942	< 0.083 U	< 0.68 U	0.099	0.261	< 0.29 U	< 0.99 U	1.03212 J
9/7/2016	Background	< 0.93 U	< 1.05 U	50	4	0.730872 J	0.316008 J	27	3.132	< 0.083 U	< 0.68 U	0.099	0.059	< 0.29 U	< 0.99 U	< 0.86 U
10/13/2016	Background	< 0.93 U	1.08028 J	61	4	0.858417 J	1	23	3.81	< 0.083 U	< 0.68 U	0.101	0.154	< 0.29 U	< 0.99 U	< 0.86 U
11/14/2016	Background	< 0.93 U	< 1.05 U	60	4	1	< 0.23 U	22	3.538	< 0.083 U	< 0.68 U	0.099	0.039	< 0.29 U	< 0.99 U	< 0.86 U
1/11/2017	Background	< 0.93 U	< 1.05 U	58	5	0.756968 J	< 0.23 U	31	3.77	< 0.083 U	< 0.68 U	0.101	0.02275 J	< 0.29 U	< 0.99 U	< 0.86 U
2/28/2017	Background	< 0.93 U	< 1.05 U	53	5	0.838869 J	< 0.23 U	34	3.92	< 0.083 U	< 0.68 U	0.101	0.185	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	51	7	0.723565 J	0.295188 J	44	4.35	0.4117 J	< 0.68 U	0.111	0.191	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	< 1.05 U	40.31	6.81	0.82 J	< 0.23 U	45.34	3.99	< 0.083 U	< 0.68 U	0.108	0.117	< 0.29 U	< 0.99 U	< 0.86 U
8/20/2018	Assessment	0.01 J	0.47	51.6	2.07	0.68	0.075	25.6	0.787	< 0.083 U	0.362	0.0877	0.006 J	< 0.02 U	1.0	0.179
2/27/2019	Assessment	< 0.4 U	2.12	42.9	7.01	0.73	0.225	41.0	4.75	0.50	1 J	0.106	0.201	< 0.4 U	7.1	< 2 U
5/22/2019	Assessment	< 0.4 U	2 J	37.8	6.47	0.6 J	< 0.8 U	46.0	4.72	0.58	0.8 J	0.0975	0.26	< 8 U	3 J	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.64	41.9	3.24	0.75	0.1 J	29.7	3.278	0.30	0.529	0.102	0.09	< 0.4 U	1.7	0.2 J
3/10/2020	Assessment	< 0.02 U	1.54	31.0	5.29	0.72	0.212	42.1	5.283	0.57	0.943	0.0781	0.179	< 0.4 U	5.5	0.2 J
6/2/2020	Assessment	< 0.02 U	1.29	38.9	5.14	0.69	0.241	39.6	4.1	0.58	0.876	0.0720	0.349	< 0.4 U	5.0	0.2 J
11/3/2020	Assessment	< 0.02 U	0.61	47.9	2.97	0.78	0.236	31.5	2.957	0.27	0.783	0.0752	0.085	< 0.4 U	2.1	0.2 J

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - Stackout
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	< 0.083 U	4.4	4	94
7/13/2016	Background	0.03	0.26	6	< 0.083 U	3.1	4	75
9/7/2016	Background	0.04	0.343	6	< 0.083 U	3.9	7	63
10/12/2016	Background	0.03	0.271	7	1	3.4	8	92
11/14/2016	Background	0.04	0.331	8	< 0.083 U	2.6	6	80
1/11/2017	Background	0.03	0.315	7	< 0.083 U	4.8	6	76
2/28/2017	Background	0.04	0.434	5	< 0.083 U	3.6	4	50
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	7	72
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	6	52
3/21/2018	Assessment	0.01397	0.269	5	< 0.083 U	4.2	3	< 2 U
8/20/2018	Assessment	0.017	0.338	10	< 0.083 U	4.4	4	94
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	3.6	36
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	4.0	80
8/12/2019	Assessment	< 0.02 U	0.278	7.24	0.06 J	4.9	2.6	90
3/10/2020	Assessment	0.02 J	0.3 J	6.08	0.10	4.9	3.7	62
6/2/2020	Assessment	< 0.02 U	0.2 J	5.63	0.10	4.0	3.9	91
11/2/2020	Assessment	0.03 J	0.3 J	4.65	0.08	4.3	3.3	74

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - Stackout
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	< 1.05 U	26	0.219521 J	< 0.07 U	0.710981 J	1.58207 J	0.2073	< 0.083 U	< 0.68 U	< 0.00013 U	< 0.005 U	< 0.29 U	1.73953 J	< 0.86 U
7/13/2016	Background	< 0.93 U	< 1.05 U	23	0.190337 J	< 0.07 U	0.68835 J	1.29444 J	2.909	< 0.083 U	< 0.68 U	0.008	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	30	0.232192 J	< 0.07 U	0.353544 J	1.66591 J	0.881	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
10/12/2016	Background	< 0.93 U	< 1.05 U	27	0.149553 J	< 0.07 U	0.529033 J	1.56632 J	0.257	1	< 0.68 U	0.012	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
11/14/2016	Background	< 0.93 U	< 1.05 U	28	0.152375 J	< 0.07 U	0.32826 J	1.47282 J	0.767	< 0.083 U	< 0.68 U	0.013	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
1/11/2017	Background	< 0.93 U	< 1.05 U	23	0.126621 J	< 0.07 U	0.650158 J	1.09495 J	1.536	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
2/28/2017	Background	< 0.93 U	< 1.05 U	26	0.149219 J	< 0.07 U	0.325811 J	1.29984 J	0.416	< 0.083 U	< 0.68 U	0.009	< 0.005 U	< 0.29 U	< 0.99 U	0.994913 J
4/11/2017	Background	< 0.93 U	< 1.05 U	24	0.159412 J	< 0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	< 0.68 U	0.008	0.01364 J	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	< 1.05 U	25.82	0.16 J	< 0.07 U	1.05	1.49 J	0.784	< 0.083 U	< 0.68 U	0.00722	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
8/20/2018	Assessment	< 0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	< 0.083 U	0.089	0.0143	< 0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	< 0.4 U	< 0.6 U	22.5	< 0.4 U	< 0.2 U	< 0.8 U	1.37	0.225	0.09	< 0.4 U	0.00688	< 0.005 U	< 8 U	< 0.6 U	< 2 U
5/21/2019	Assessment	< 0.4 U	< 0.6 U	21.7	< 0.4 U	< 0.2 U	< 0.8 U	1.15	0.201	0.09	< 0.4 U	0.00576	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.07 J	23.8	0.154	< 0.01 U	0.204	1.30	0.237	0.06 J	0.08 J	0.00829	< 0.005 U	< 0.4 U	0.2 J	< 0.1 U
3/10/2020	Assessment	< 0.02 U	0.09 J	21.7	0.139	0.01 J	0.2 J	1.21	3.0706	0.10	0.09 J	0.00547	< 0.002 U	< 0.4 U	0.2	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.09 J	19.0	0.132	< 0.01 U	0.208	1.02	0.799	0.10	0.09 J	0.00505	< 0.002 U	< 0.4 U	0.3	< 0.1 U
11/2/2020	Assessment	0.05 J	0.09 J	18.9	0.122	< 0.01 U	0.204	1.04	0.929	0.08	0.09 J	0.00510	< 0.002 U	< 0.4 U	0.3	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-13
Pirkey - Stackout
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.06	8.77	28	0.748 J	5.6	52	236
7/13/2016	Background	0.06	9.08	32	0.3474 J	5.6	59	192
9/7/2016	Background	0.05	8.48	23	< 0.083 U	5.2	41	228
10/13/2016	Background	0.06	7.53	26	0.6297 J	5.8	47	236
11/14/2016	Background	0.06	7.21	26	0.3114 J	6.1	47	250
1/11/2017	Background	0.04	6.14	22	< 0.083 U	5.8	37	188
2/28/2017	Background	0.07	7.88	28	< 0.083 U	5.9	56	172
4/11/2017	Background	0.08	9.11	32	0.4278 J	5.2	58	200
8/23/2017	Detection	0.07408	9.5	21	0.344 J	6.0	38	160
3/21/2018	Assessment	0.07169	10.3	25	< 0.083 U	5.9	48	176
8/20/2018	Assessment	0.065	8.40	39	0.0845 J	5.9	66	210
2/27/2019	Assessment	0.08 J	11.0	40.8	0.25	5.2	80.8	176
5/21/2019	Assessment	0.061	10.1	34.8	0.40	5.3	69.5	190
8/12/2019	Assessment	0.064	8.68	42.3	0.39	5.9	73.6	310
3/10/2020	Assessment	0.067	10.7	41.1	0.32	6.4	82.7	216
6/2/2020	Assessment	0.065	10.9	41.4	0.45	6.4	83.4	322
11/2/2020	Assessment	0.052	5.90	22.6	0.38	6.4	39.1	204

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-13
Pirkey - Stackout
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	4.25914 J	38	0.586539 J	0.293832 J	< 0.23 U	42	0.989	0.748 J	< 0.68 U	0.081	0.00969 J	< 0.29 U	< 0.99 U	1.11268 J
7/13/2016	Background	< 0.93 U	9	44	2	0.0875208 J	< 0.23 U	47	2.332	0.3474 J	< 0.68 U	0.158	0.01928 J	< 0.29 U	3.63671 J	0.928756 J
9/7/2016	Background	< 0.93 U	< 1.05 U	47	0.631177 J	0.219799 J	< 0.23 U	38	1.219	< 0.083 U	< 0.68 U	0.139	< 0.005 U	< 0.29 U	< 0.99 U	1.44332 J
10/13/2016	Background	< 0.93 U	7	43	0.963478 J	< 0.07 U	< 0.23 U	42	2.422	0.6297 J	< 0.68 U	0.142	< 0.005 U	< 0.29 U	2.59885 J	< 0.86 U
11/14/2016	Background	< 0.93 U	2.07189 J	39	0.717704 J	0.310257 J	< 0.23 U	42	1.723	0.3114 J	< 0.68 U	0.136	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
1/11/2017	Background	< 0.93 U	2.73936 J	39	0.302907 J	0.11238 J	< 0.23 U	32	1.844	< 0.083 U	< 0.68 U	0.133	0.00732 J	< 0.29 U	< 0.99 U	< 0.86 U
2/28/2017	Background	< 0.93 U	1.64435 J	34	0.290018 J	< 0.07 U	< 0.23 U	44	1.728	< 0.083 U	< 0.68 U	0.153	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
4/11/2017	Background	< 0.93 U	4.43115 J	45	0.736525 J	2	< 0.23 U	56	1.309	0.4278 J	< 0.68 U	0.156	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	3.23 J	42.23	0.46 J	0.86 J	< 0.23 U	39.91	2.093	< 0.083 U	< 0.68 U	0.145	< 0.005 U	< 0.29 U	3.86 J	< 0.86 U
8/20/2018	Assessment	0.01 J	5.79	40.9	0.648	< 0.005 U	0.103	48.8	1.735	0.0845 J	0.01 J	0.146	< 0.005 U	< 0.02 U	0.2	0.03 J
2/27/2019	Assessment	< 0.4 U	2.17	38.5	< 0.4 U	< 0.2 U	< 0.8 U	48.7	0.909	0.25	< 0.4 U	0.165	< 0.005 U	< 8 U	< 0.6 U	< 2 U
5/21/2019	Assessment	< 0.4 U	2 J	35.0	< 0.4 U	< 0.2 U	< 0.8 U	44.7	0.875	0.40	< 0.4 U	0.153	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	< 0.02 U	1.64	35.0	0.235	< 0.01 U	0.06 J	44.5	1.642	0.39	< 0.05 U	0.139	< 0.005 U	< 0.4 U	< 0.03 U	< 0.1 U
3/10/2020	Assessment	< 0.02 U	1.58	38.4	0.327	< 0.01 U	0.06 J	44.7	1.382	0.32	< 0.05 U	0.145	< 0.002 U	< 0.4 U	< 0.03 U	< 0.1 U
6/2/2020	Assessment	< 0.02 U	1.39	35.6	0.222	< 0.01 U	0.07 J	43.7	1.116	0.45	< 0.05 U	0.140	< 0.002 U	< 0.4 U	0.04 J	< 0.1 U
11/2/2020	Assessment	< 0.02 U	3.40	34.5	0.270	< 0.01 U	0.2 J	35.4	1.729	0.38	< 0.05 U	0.109	< 0.002 U	< 0.4 U	0.07 J	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-22
Pirkey - Stackout
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.08	15.3	76	1.266	4.0	284	672
7/14/2016	Background	0.04	9.5	52	0.3891 J	3.9	162	412
9/7/2016	Background	0.04	6.95	42	< 0.083 U	4.1	114	341
10/12/2016	Background	0.03	7.68	52	0.473 J	4.7	148	388
11/14/2016	Background	0.04	7.55	48	0.2834 J	4.4	177	362
1/12/2017	Background	0.02	6.47	51	< 0.083 U	4.2	137	344
3/1/2017	Background	0.05	13.6	69	< 0.083 U	4.1	266	624
4/11/2017	Background	0.04	10.8	72	0.5041 J	4.1	215	446
8/23/2017	Detection	0.05075	7.77	54	1.196	4.6	121	350
12/21/2017	Detection	0.06278	7.29	61	< 0.083 U	--	120	344
3/21/2018	Assessment	0.0818	15.2	79	< 0.083 U	3.9	377	656
8/20/2018	Assessment	0.031	9.43	92	< 0.083 U	4.2	184	476
2/27/2019	Assessment	0.07 J	15.2	76.7	1.33	4.9	337	584
5/22/2019	Assessment	0.073	16.5	63.3	1.06	5.1	360	506
8/12/2019	Assessment	0.03 J	8.96	79.6	0.45	4.8	198	484
3/10/2020	Assessment	0.067	12.7	73.6	1.25	3.8	364	654
6/2/2020	Assessment	0.062	13.1	74.0	1.25	3.6	369	682
11/2/2020	Assessment	0.03 J	8.60	84.0	0.28	4.8	190	468

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-22
Pirkey - Stackout
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	23	71	13	2	24	129	6.994	1.266	0.97266 J	0.139	13.41	< 0.29 U	1.97127 J	1.16089 J
7/14/2016	Background	< 0.93 U	12	48	6	0.674427 J	12	67	2.325	0.3891 J	< 0.68 U	0.169	17	< 0.29 U	< 0.99 U	0.895409 J
9/7/2016	Background	< 0.93 U	23	108	5	0.833408 J	33	54	3.412	< 0.083 U	2.72959 J	0.131	19.829	< 0.29 U	< 0.99 U	1.25036 J
10/12/2016	Background	< 0.93 U	10	54	4	0.333745 J	7	54	3.39	0.473 J	< 0.68 U	0.14	7.984	< 0.29 U	< 0.99 U	< 0.86 U
11/14/2016	Background	< 0.93 U	3.69822 J	66	4	0.596378 J	2	47	3.63	0.2834 J	< 0.68 U	0.115	8.634	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	6	67	4	0.385609 J	2	43	3.173	< 0.083 U	< 0.68 U	0.104	13.32	< 0.29 U	1.09664 J	< 0.86 U
3/1/2017	Background	< 0.93 U	1.61319 J	29	10	1	< 0.23 U	105	4.385	< 0.083 U	< 0.68 U	0.218	0.22	< 0.29 U	< 0.99 U	< 0.86 U
4/11/2017	Background	< 0.93 U	11	130	6	2	5	78	3.045	0.5041 J	1.89388 J	0.176	7.201	< 0.29 U	1.86563 J	< 0.86 U
3/21/2018	Assessment	< 0.93 U	3.56 J	24.13	12.1	1.87	< 0.23 U	121	6.22	< 0.083 U	< 0.68 U	0.277	1.206	< 0.29 U	< 0.99 U	< 0.86 U
8/20/2018	Assessment	0.02 J	5.18	22.7	3.30	0.46	0.829	62.9	3.088	< 0.083 U	0.386	0.132	1.448	0.07 J	2.5	0.162
2/27/2019	Assessment	< 0.4 U	6.30	17.0	13.3	1.55	0.8 J	123	5.99	1.33	0.5 J	0.269	0.642	< 8 U	16.7	< 2 U
5/22/2019	Assessment	< 0.4 U	5.89	16.7	12.5	1.52	< 0.8 U	129	6.71	1.06	< 0.4 U	0.288	0.837	< 8 U	5.9	0.2 J
8/12/2019	Assessment	< 0.02 U	2.19	15.3	3.38	0.44	0.2 J	57.5	3.088	0.45	0.1 J	0.151	0.325	< 0.4 U	2.0	0.2 J
3/10/2020	Assessment	< 0.02 U	4.26	18.2	10.1	1.41	0.398	108	7.68	1.25	0.346	0.222	1.58	< 0.4 U	10.5	0.2 J
6/2/2020	Assessment	< 0.02 U	3.53	14.4	8.00	1.43	0.376	101	4.334	1.25	0.261	0.185	0.171	< 0.4 U	10.7	0.3 J
11/2/2020	Assessment	< 0.02 U	1.92	20.4	2.39	0.47	0.2 J	60.0	3.338	0.28	0.2 J	0.101	0.184	< 0.4 U	2.4	0.1 J

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-33
Pirkey - Stackout
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.126	2.44	8	< 0.083 U	4.1	56	326
7/14/2016	Background	0.173	1.69	16	< 0.083 U	3.1	108	176
9/7/2016	Background	0.152	1.81	10	< 0.083 U	3.6	64	176
10/12/2016	Background	0.162	1.39	9	0.357 J	3.4	46	180
11/14/2016	Background	0.182	1.63	8	< 0.083 U	3.1	54	190
1/12/2017	Background	0.144	1.26	10	< 0.083 U	4.3	58	168
2/28/2017	Background	0.14	1.25	7	< 0.083 U	3.9	51	146
4/10/2017	Background	0.114	1.29	9	< 0.083 U	3.4	49	178
8/23/2017	Detection	0.07952	1.06	9	0.67 J	4.4	40	132
12/21/2017	Detection	0.09993	0.946	--	--	--	--	--
3/21/2018	Assessment	0.115	1.42	7	< 0.083 U	4.4	58	160
8/21/2018	Assessment	0.098	1.09	12	< 0.083 U	3.6	48	156
2/27/2019	Assessment	0.134	1.73	8.89	0.25	3.3	62.8	146
5/22/2019	Assessment	0.111	1.65	8.57	0.23	4.1	60.4	204
8/12/2019	Assessment	0.097	1.03	8.85	0.19	4.2	44.3	156
3/10/2020	Assessment	0.132	1.61	8.81	0.25	4.0	64.5	172
6/2/2020	Assessment	0.112	1.49	8.89	0.28	3.9	63.1	206
11/2/2020	Assessment	0.115	0.980	8.49	0.16	3.9	44.8	162

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-33
Pirkey - Stackout
Appendix IV Constituents

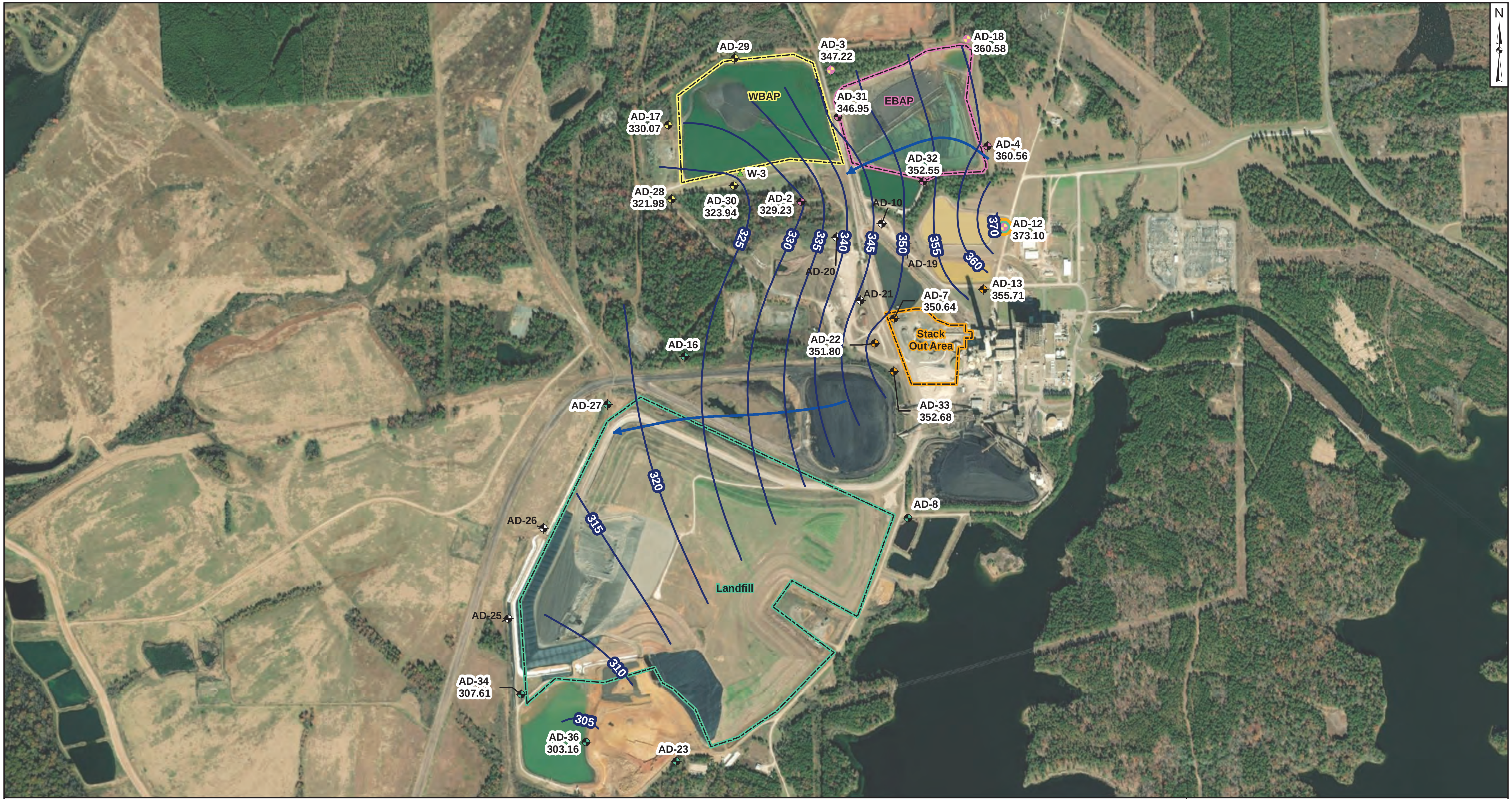
Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	2.53645 J	60	2	< 0.07 U	4	12	1.303	< 0.083 U	< 0.68 U	< 0.00013 U	0.288	< 0.29 U	< 0.99 U	< 0.86 U
7/14/2016	Background	< 0.93 U	4.91616 J	64	2	< 0.07 U	9	12	4.28	< 0.083 U	< 0.68 U	0.029	0.707	< 0.29 U	< 0.99 U	1.19199 J
9/7/2016	Background	< 0.93 U	67	163	4	0.984692 J	125	33	3.461	< 0.083 U	14	0.048	1.826	0.736517 J	1.61343 J	< 0.86 U
10/12/2016	Background	< 0.93 U	2.15866 J	59	1	< 0.07 U	4	10	2.208	0.357 J	< 0.68 U	0.027	0.145	< 0.29 U	< 0.99 U	1.56738 J
11/14/2016	Background	< 0.93 U	1.46353 J	52	1	< 0.07 U	1	9	1.953	< 0.083 U	< 0.68 U	0.024	0.197	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	1.12979 J	56	1	< 0.07 U	2	9	2.596	< 0.083 U	< 0.68 U	0.027	0.36	< 0.29 U	< 0.99 U	< 0.86 U
2/28/2017	Background	< 0.93 U	1.069 J	55	1	< 0.07 U	< 0.23 U	9	0.942	< 0.083 U	< 0.68 U	0.026	0.41	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	55	1	< 0.07 U	3	10	9.024	< 0.083 U	< 0.68 U	0.027	0.341	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	1.78 J	57.26	1.4	0.15 J	4.64	10.42	1.643	< 0.083 U	< 0.68 U	0.02669	0.825	< 0.29 U	< 0.99 U	< 0.86 U
8/21/2018	Assessment	0.01 J	0.65	43.8	0.905	0.04	0.147	7.72	6.32	< 0.083 U	0.151	0.0178	0.745	< 0.02 U	1.7	0.05 J
2/27/2019	Assessment	< 0.4 U	1 J	49.5	1 J	< 0.2 U	< 0.8 U	10.5	2.235	0.25	< 0.4 U	0.0262	0.464	< 8 U	3 J	< 2 U
5/22/2019	Assessment	< 0.4 U	< 0.6 U	52.4	1 J	< 0.2 U	< 0.8 U	10.5	1.178	0.23	< 0.4 U	0.0245	0.481	< 8 U	1 J	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.41	38.6	1.00	0.04 J	0.1 J	7.02	1.141	0.19	0.1 J	0.0233	0.564	< 0.4 U	1.1	< 0.1 U
3/10/2020	Assessment	< 0.02 U	0.63	45.3	1.18	0.06	0.1 J	9.67	2.479	0.25	0.208	0.0197	2.45	< 0.4 U	2.0	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.61	41.3	1.15	0.05 J	0.2 J	8.78	1.477	0.28	0.2 J	0.0188	2.52	< 0.4 U	2.1	< 0.1 U
11/2/2020	Assessment	< 0.02 U	0.39	45.1	0.858	0.04 J	0.1 J	7.86	1.443	0.16	0.2 J	0.0175	4.30	< 0.4 U	1.1	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1: Residence Time Calculation Summary
Pirkey Plant - Stackout Area

			2020-03		2020-06		2020-11	
CCR Management Unit	Monitoring Well	Well Diameter (inches)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
Stack Out Area	AD-7 [2]	4.0	8.7	13.9	12.1	10.0	9.0	13.6
	AD-12 [1]	4.0	35.1	3.5	20.1	6.0	26.9	4.5
	AD-13 [1]	4.0	32.3	3.8	41.3	2.9	19.0	6.4
	AD-22 [2]	2.0	24.2	2.5	13.3	4.6	9.5	6.4
	AD-33 [2]	2.0	14.2	4.3	8.2	7.4	9.6	6.3

Notes:
[1] - Background Well
[2] - Downgradient Well



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- ― Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on March 10-11, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-16, AD-27, and AD-29 were not gauged in March 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer March 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
1

Columbus, Ohio
2020/06/12

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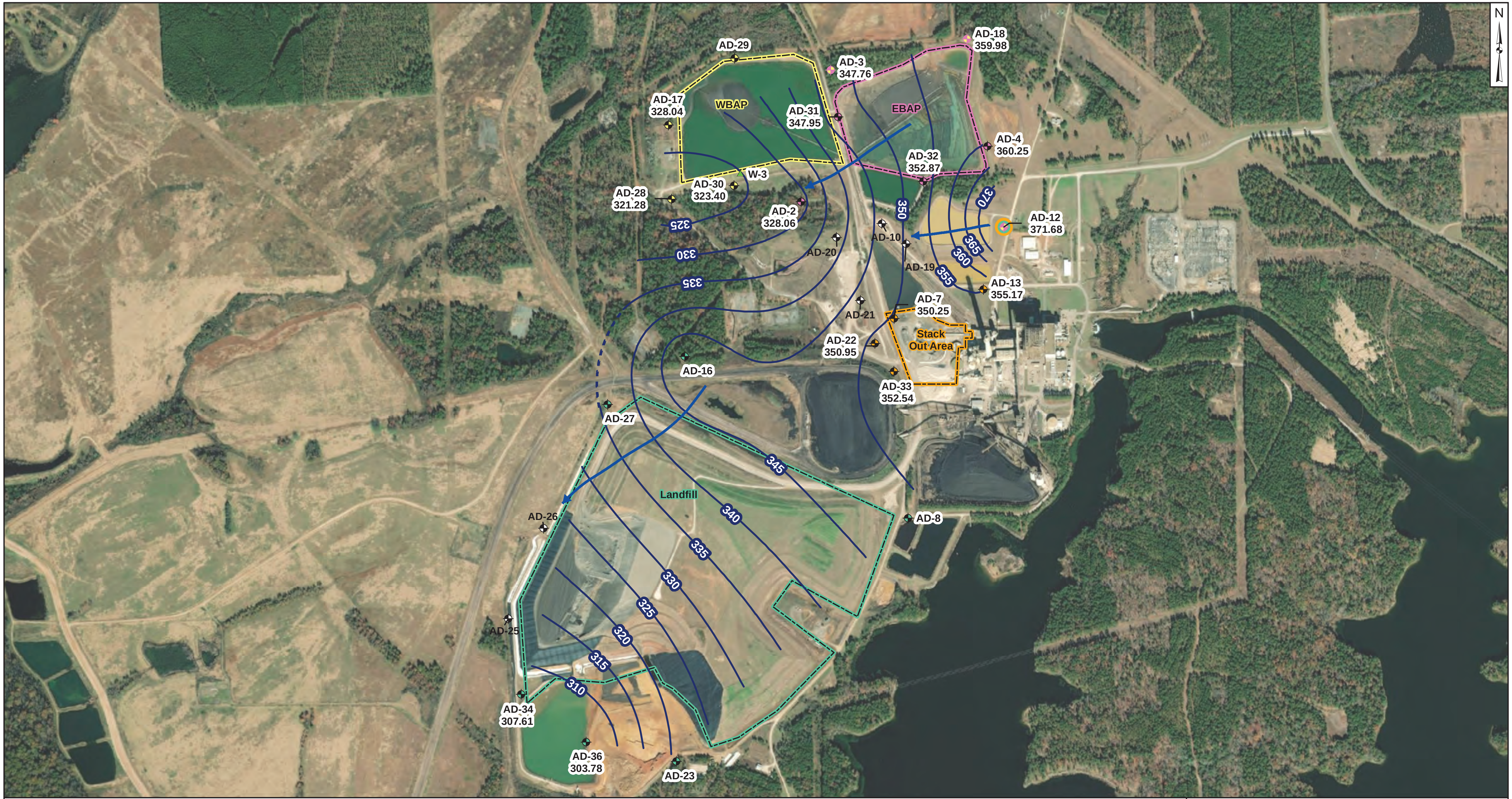

1,000 500 0 1,000
Feet

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP

- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on June 2 - 3, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-8, AD-16, AD-23, AD-27, and AD-29 were not gauged in June 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

Potentiometric Contours - Uppermost Aquifer
June 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio

2020/11/13

Figure

2

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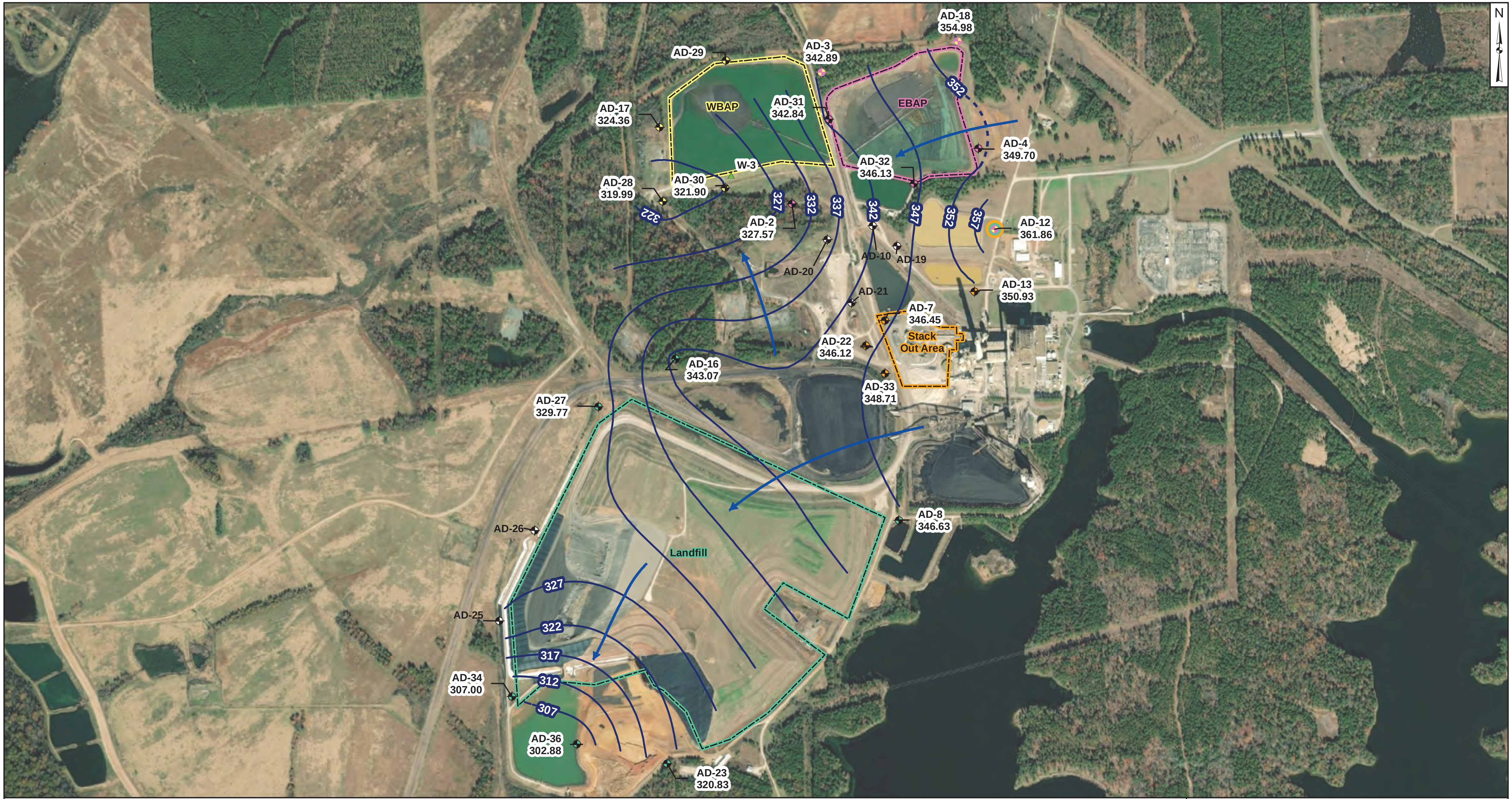

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on November 2-4, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 and AD-29 were not gauged in November 2020.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer November 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio

2021/01/06

Figure

3

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APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
FLUE GAS DESULFURIZATION (FGD) STACKOUT AREA
H.W. Pirkey Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

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October 2, 2020

CHA8500

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LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
FGD	Flue Gas Desulfurization
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the Flue Gas Desulfurization (FGD) Stackout Area, an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, and sulfate at the FGD Stackout Area. An alternative source was not identified at the time, so the FGD Stackout Area has been in assessment monitoring since. Groundwater protection standards (GWPS) were set in accordance with 40 CFR 257.95(d)(2) and a statistical evaluation of the assessment monitoring data was conducted. During the most recent assessment monitoring event, completed in August 2019, statistically significant levels (SSLs) for beryllium and cobalt were identified (Geosyntec, 2019). A successful alternative source demonstration (ASD) was prepared per 40 CFR 257.95(g)(3); therefore, the FGD Stackout Area remained in assessment monitoring. Two assessment monitoring events were conducted at the FGD Stackout Area in March and June 2020, in accordance with 40 CFR 257.95. The results of these assessment events are documented in this report.

Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact data usability.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. SSLs were identified for beryllium and cobalt. Thus, either the unit will move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

FGD STACKOUT AREA EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (March 2020) and 257.95(d)(1) (June 2020). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events are presented in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.26 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the FGD Stackout Area were conducted in accordance with the January 2017 Statistical Analysis Plan (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained in March and August 2020 were screened for potential outliers. No outliers were identified for these events.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Tolerance limits were calculated parametrically with 95% coverage and 95% confidence for arsenic, barium, chromium, and combined radium. Non-parametric tolerance limits were calculated for beryllium, cobalt, fluoride, and lithium due to apparent non-normal distributions and for antimony, cadmium, lead, mercury, molybdenum, selenium, and thallium due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). For mercury at AD-22, earlier values were higher than recent values and so the confidence interval was calculated using only the most recent eight samples to better reflect recent conditions.

Seasonal patterns were observed for beryllium, cobalt, and combined radium at AD-7 and for beryllium, cadmium, cobalt, combined radium, and lithium at AD-22. For these well/parameter pairs, Kruskal Wallis tests were performed to test whether differences between the results from different seasons were statistically significant. Statistically significant differences were found for all pairs identified above except lithium at AD-22. Where the Kruskal-Wallis test found significant seasonal effects, the data for these well/parameter pairs was deseasonalized so that the resulting confidence limits correctly account for seasonality as a predictable pattern rather than random variation or a release.

An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs was identified at the Pirkey FGD Stackout Area:

- The deseasonalized LCL for beryllium exceeded the GWPS of 0.00400 mg/L at AD-7 (0.00439 mg/L) and at AD-22 (0.00635 mg/L).

- The deseasonalized LCL for cobalt exceeded the GWPS of 0.056 mg/L at AD-22 (0.0727 mg/L).

As a result, the Pirkey FGD Stackout Area will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the June 2020 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0845 mg/L at AD-7 (1.93 mg/L) and AD-33 (0.112 mg/L).
- Chloride concentrations exceeded the interwell UPL of 40.8 mg/L at AD-22 (74.0 mg/L).
- Fluoride concentrations exceeded the interwell UPL of 1.00 mg/L at AD-22 (1.25 mg/L).
- Sulfate concentrations exceeded the interwell UPL of 80.8 mg/L at AD-22 (369 mg/L)
- Total dissolved solids (TDS) concentrations exceeded the intrawell UPL of 291 mg/L at AD-7 (303 mg/L), the intrawell UPL of 651 mg/L at AD-22 (682 mg/L), and the intrawell UPL of 203 mg/L at AD-33 (206 mg/L).

While the prediction limits were calculated for a one-of-two retesting procedure, SSIs were conservatively assumed if the June 2020 sample was above the UPL or below the LPL. Based on these results, concentrations of Appendix III constituents appear to be above background concentrations.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the March and June 2020 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. SSLs were identified for beryllium and cobalt. Appendix III parameters were compared to calculated prediction limits, with exceedances identified for boron, chloride, fluoride, sulfate, and TDS.

Based on this evaluation, the Pirkey FGD Stackout Area CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Plant. January 2017.

Geosyntec Consultants. 2019. Statistical Analysis Summary – Flue Gas Desulfurization (FGD) Stackout Area, H.W. Pirkey Plant, Hallsville, Texas. December 10, 2019.

TABLES

Table 1 - Groundwater Data Summary
Pirkey Plant - Stackout Pad

Parameter	Unit	AD-7		AD-12		AD-13		AD-22		AD-33	
		3/10/2020	6/2/2020	3/10/2020	6/2/2020	3/10/2020	6/2/2020	3/10/2020	6/2/2020	3/10/2020	6/2/2020
Antimony	µg/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Arsenic	µg/L	1.54	1.29	0.09 J	0.09 J	1.58	1.39	4.26	3.53	0.63	0.61
Barium	µg/L	31.0	38.9	21.7	19.0	38.4	35.6	18.2	14.4	45.3	41.3
Beryllium	µg/L	5.29	5.14	0.139	0.132	0.327	0.222	10.1	8.00	1.18	1.15
Boron	mg/L	1.99	1.93	0.02 J	0.05 U	0.067	0.065	0.067	0.062	0.132	0.112
Cadmium	µg/L	0.72	0.69	0.01 J	0.05 U	0.05 U	0.05 U	1.41	1.43	0.06	0.05 J
Calcium	mg/L	4.86	4.98	0.3 J	0.2 J	10.7	10.9	12.7	13.1	1.61	1.49
Chloride	mg/L	28.7	29.1	6.08	5.63	41.1	41.4	73.6	74.0	8.81	8.89
Chromium	µg/L	0.212	0.241	0.2 J	0.208	0.06 J	0.07 J	0.398	0.376	0.1 J	0.2 J
Cobalt	µg/L	42.1	39.6	1.21	1.02	44.7	43.7	108	101	9.67	8.78
Combined Radium	pCi/L	5.283	4.1	3.0706	0.799	1.382	1.116	7.68	4.334	2.479	1.477
Fluoride	mg/L	0.57	0.58	0.10	0.10	0.32	0.45	1.25	1.25	0.25	0.28
Lead	µg/L	0.943	0.876	0.09 J	0.09 J	0.2 U	0.2 U	0.346	0.261	0.208	0.2 J
Lithium	mg/L	0.0781	0.0720	0.00547	0.00505	0.145	0.140	0.222	0.185	0.0197	0.0188
Mercury	µg/L	0.179	0.349	0.005 U	0.005 U	0.005 U	0.005 U	1.58	0.171	2.45	2.52
Molybdenum	µg/L	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Selenium	µg/L	5.5	5.0	0.2	0.3	0.2 U	0.04 J	10.5	10.7	2.0	2.1
Sulfate	mg/L	88.5	74.4	3.7	3.9	82.7	83.4	364	369	64.5	63.1
Thallium	µg/L	0.2 J	0.2 J	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	0.3 J	0.5 U	0.5 U
Total Dissolved Solids	mg/L	254	303	62	91	216	322	654	682	172	206
pH	SU	3.5	3.3	4.9	4.0	6.4	6.4	3.8	3.6	4.0	3.9

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.

Table 2: Groundwater Protection Standards
Pirkey Plant - Stackout

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.007
Barium, Total (mg/L)	2		0.051
Beryllium, Total (mg/L)	0.004		0.002
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.002
Cobalt, Total (mg/L)	n/a	0.006	0.056
Combined Radium, Total (pCi/L)	5		3.00
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.17
Mercury, Total (mg/L)	0.002		0.000025
Molybdenum, Total (mg/L)	n/a	0.1	0.005
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.002

Notes:

Grey cell indicates calculated UTL is higher than MCL or CCR Rule-specified value.

MCL = Maximum Contaminant Level

Calculated UTL (Upper Tolerance Limit) represents site-specific background values.

The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3 - Appendix III Data Summary
Pirkey Plant - Stackout Pad

Analyte	Unit	Description	AD-7	AD-22	AD-33
			6/2/2020	6/2/2020	6/2/2020
Boron	mg/L	Interwell Background Value (UPL)	0.0845		
		Analytical Result	**1.93**	0.062	**0.112**
Calcium	mg/L	Intrawell Background Value (UPL)	5.32	15.2	2.29
		Analytical Result	4.98	13.1	1.49
Chloride	mg/L	Interwell Background Value (UPL)	40.8		
		Analytical Result	29.1	**74.0**	8.89
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
		Analytical Result	0.58	**1.25**	0.28
pH	SU	Intrawell Background Value (UPL)	4.5	4.9	4.7
		Intrawell Background Value (LPL)	3.0	3.6	2.7
		Analytical Result	3.3	3.6	3.9
Sulfate	mg/L	Interwell Background Value (UPL)	80.8		
		Analytical Result	74.4	**369**	63.1
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	291	651	203
		Analytical Result	**303**	**682**	**206**

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD Stackout Area CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

DAVID ANTHONY MILLER
112498

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

10.02.2020
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CON NG

September 17, 2020

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey Stackout
Assessment Monitoring Event – June 2020

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the Assessment Monitoring Event statistical analysis of groundwater data through June 2020 for American Electric Power Inc.'s Pirkey Stackout. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-12 and AD-13
- **Downgradient wells:** AD-22, AD-33, and AD-7

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC. The analysis was reviewed by Dr. Jim Loftis, Civil & Environmental Engineering professor emeritus at Colorado State University and Senior Advisor to Groundwater Stats Consulting.

The CCR Assessment Monitoring program consists of the following constituents:

- **Appendix IV** (Assessment Monitoring) – antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium

Time series plots and box plots for Appendix IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B).

Background Screening

Prior to constructing statistical limits, background data are screened through time series plots for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Values identified as outliers are flagged with (o) and displayed in a lighter font and disconnected symbol on the time series graphs. A summary of flagged outliers and excluded values is included as Figure C.

For the current analysis all data through June 2020 were screened, including data at downgradient wells. For the downgradient well data that are used to construct confidence intervals, a regulatory conservative approach is taken in that values that are marginally high relative to the rest of the data are retained unless there is particular justification for excluding them. In particular, for the 9/7/16 observations, the values were very high for several constituents at the same time, suggesting a likely systematic error. Therefore, those values were flagged. Additionally, reported mercury values in well AD-22 prior to April 2017 were unusually high compared to recently reported measurements and were, therefore, flagged with an "L" and deselected prior to constructing confidence intervals. The most recent 8 observations, which are consistently stable, are used to represent present-day groundwater quality conditions.

Several outliers were flagged as a result of changes in reporting limits. The reporting limit during the February and May 2019 events for molybdenum at all wells (except for well AD-7 in February) was 0.04 mg/L, compared to the previous reporting limit of 0.002 mg/L. The resulting nondetects reported at 0.04 mg/L are censored at much higher levels than the rest of the data and, therefore, are flagged as outliers. The reporting limit (practical quantitation limit) for the February 2019 event for thallium also increased from the historical reporting limit of 0.002 mg/L to 0.01 mg/L for all wells. However, since no detections were present above the method detection limit of 0.002 mg/L, the historical reporting limit of 0.002 mg/L was used for historic nondetects, and the nondetects with a reporting limit of 0.01 mg/L were flagged as outliers.

Summary of Statistical Methods

Assessment monitoring for Appendix IV parameters involves the comparison of a confidence interval for each parameter at each downgradient well against the corresponding Ground Water Protection Standard (GWPS). If, and only if, the entire confidence interval exceeds the GWPS, the well/constituent is considered to exceed its standard. The GWPS is determined for each parameter as the largest of the Maximum Contaminant Levels (MCLs), CCR Rule-Specified levels, or background limits determined from tolerance limits on pooled upgradient well data.

Prior to computing tolerance limits on upgradient well data or confidence intervals on downgradient well data, the distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric tolerance limits and confidence intervals as appropriate, based on the following criteria.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, the reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory. There is no replacement of historical reporting limits with the most recent reporting limit. For several constituents, the most recent reporting limits are significantly lower than those reported historically. This is the most conservative approach for tolerance limits and confidence intervals at this site.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric tolerance limits and confidence intervals are used on data containing greater than 50% nondetects.

Evaluation of Appendix IV Parameters – June 2020

When data followed a normal or transformed-normal distribution, parametric tolerance limits were used to calculate background limits for Appendix IV parameters using pooled upgradient well data through June 2020 with a target of 95% confidence and 95%

coverage (Figure D). Nonparametric tolerance limits are constructed when data do not follow a normal or transformed-normal distribution or when there are greater than 50% nondetects. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These background limits were then compared to the Maximum Contaminant Levels (MCLs) and CCR Rule-Specified levels to determine the highest limit for use as the GWPS in the confidence interval comparisons (Figure E).

Confidence intervals were then constructed on downgradient wells with data through June 2020 for each of the Appendix IV parameters using either parametric or nonparametric intervals depending on the data distribution and percentage of nondetects, similar to the logic used to construct tolerance limits as discussed above (Figure F). Each confidence interval was compared with the corresponding GWPS from Figure E. Only when the entire confidence interval is above the GWPS is the well/constituent pair considered to exceed its respective standard. Both a tabular summary and graphical presentation of the confidence interval results follow this letter. Exceedances were noted for the following well/constituent pairs:

- Beryllium: AD-22
- Cobalt: AD-22

Seasonal patterns were observed on the time series plots in well AD-22 for beryllium, cadmium, cobalt, combined radium 226 + 228, and lithium; and in well AD-7 for beryllium, cobalt, and combined radium 226 + 228. The Kruskal-Wallis test was used to evaluate seasonality for these well/constituent pairs and confirmed seasonality for all those listed above except for lithium in well AD-22 (Figure G). When seasonal patterns are observed, data are deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release. This procedure includes subtracting the seasonal mean from each value within a given season, and adding the overall mean to each observation. Confidence intervals were constructed with deseasonalized values, and the results follow this letter (Figure H). The GWPS was exceeded by the following well/constituent pairs:

- Beryllium: AD-22 and AD-7
- Cobalt: AD-22

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for Pirkey Stackout. If you have any questions or comments, please feel free to contact us.

For Groundwater Stats Consulting,

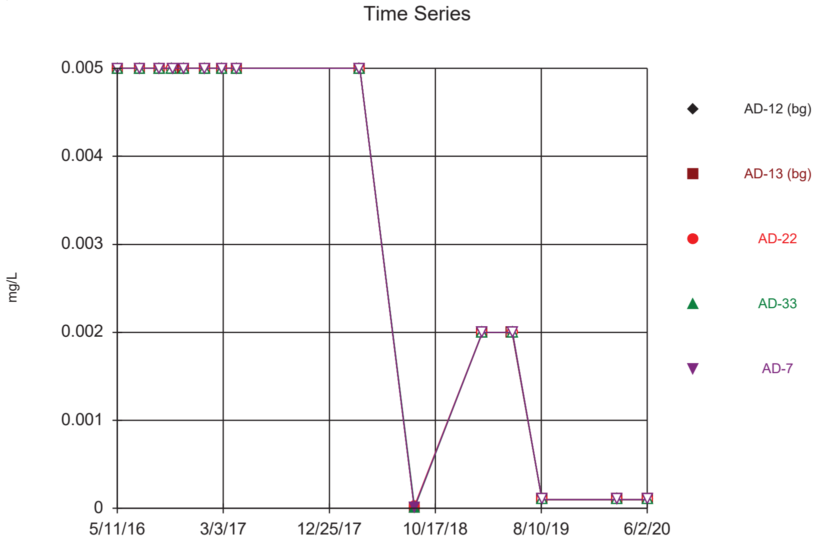
A Collins

Andrew T. Collins
Project Manager

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Antimony, total Analysis Run 9/17/2020 10:30 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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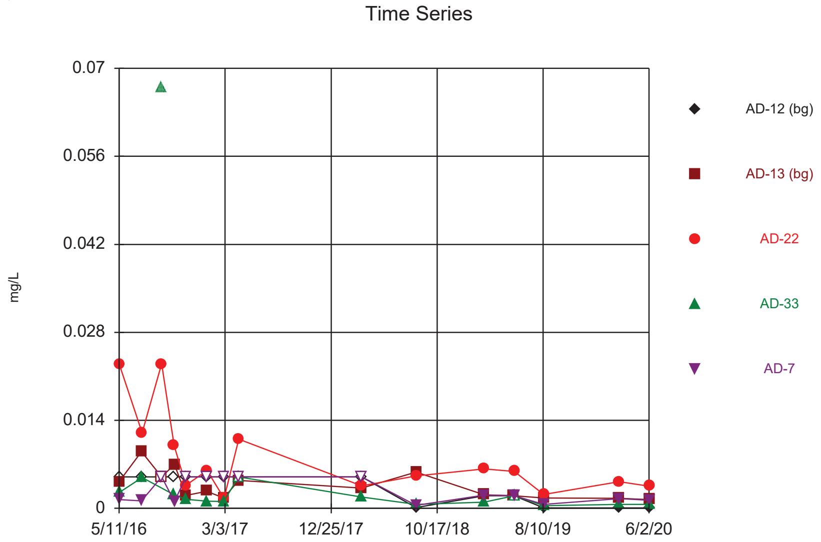
Hollow symbols indicate censored values.



Constituent: Arsenic, total Analysis Run 9/17/2020 10:30 AM View: Appendix IV
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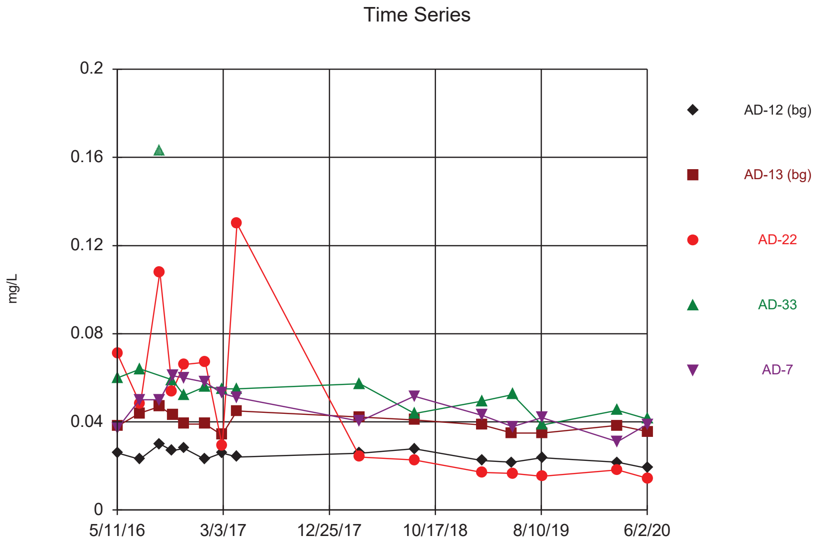

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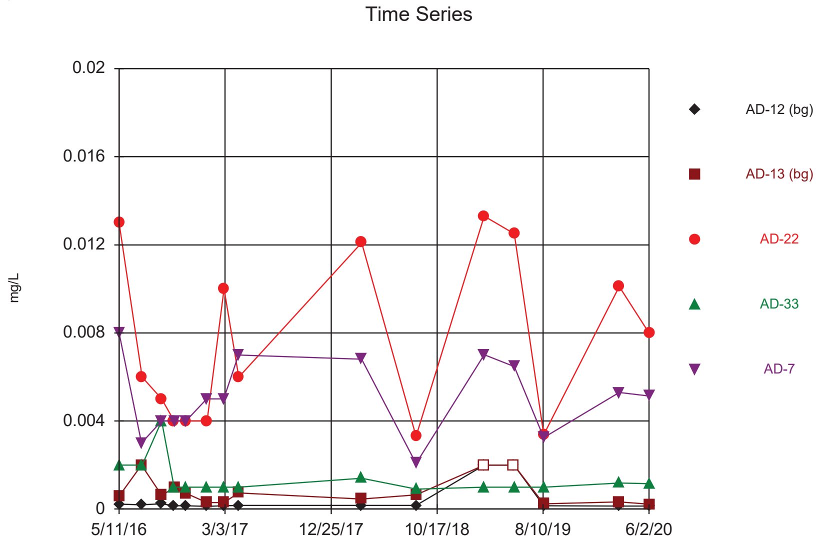

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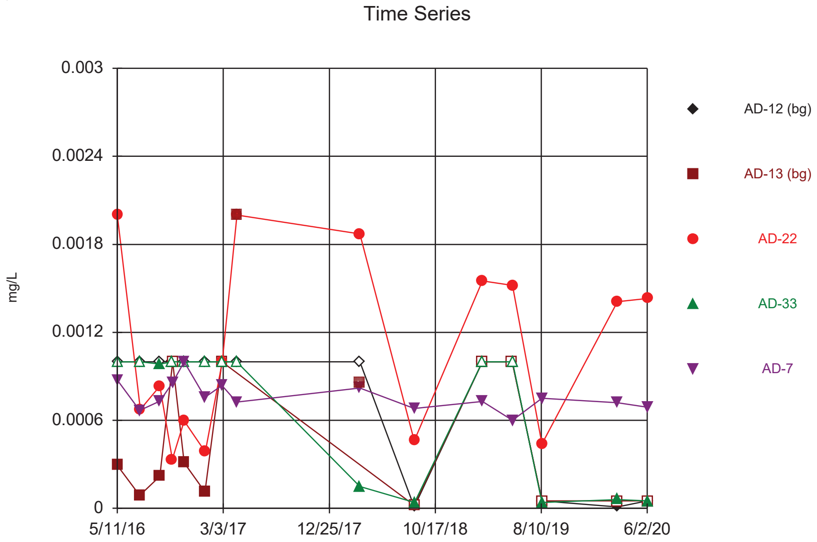

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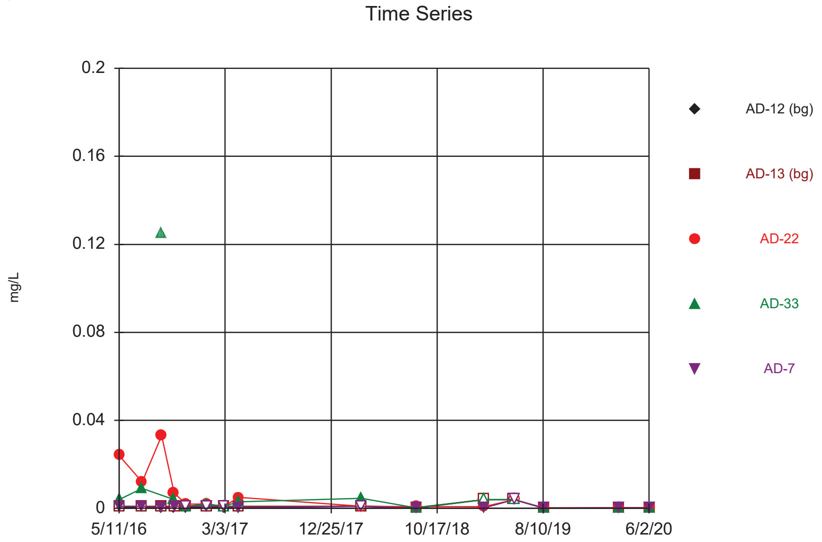

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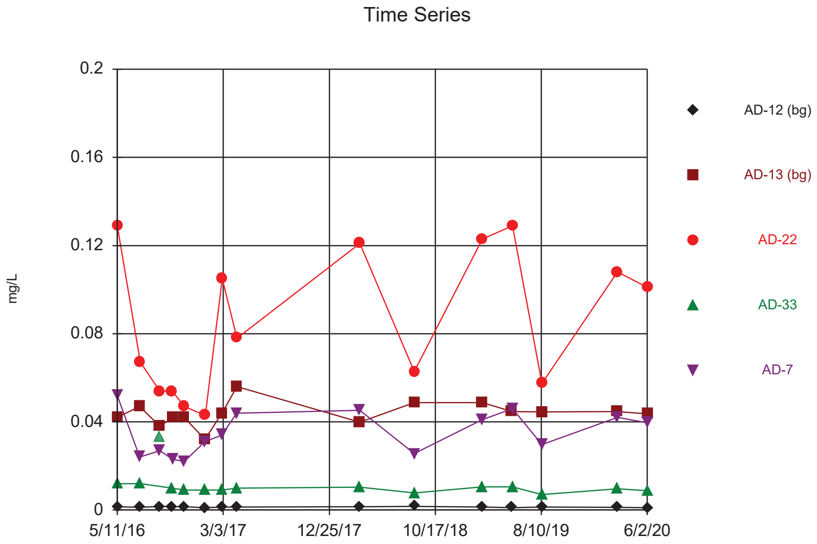
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG



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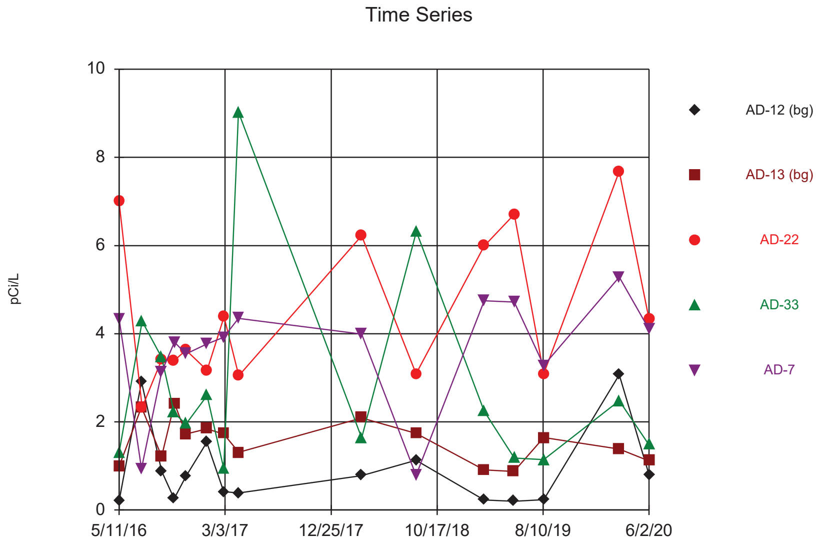

Constituent: Combined Radium 226 + 228 Analysis Run 9/17/2020 10:30 AM View: Appendix IV
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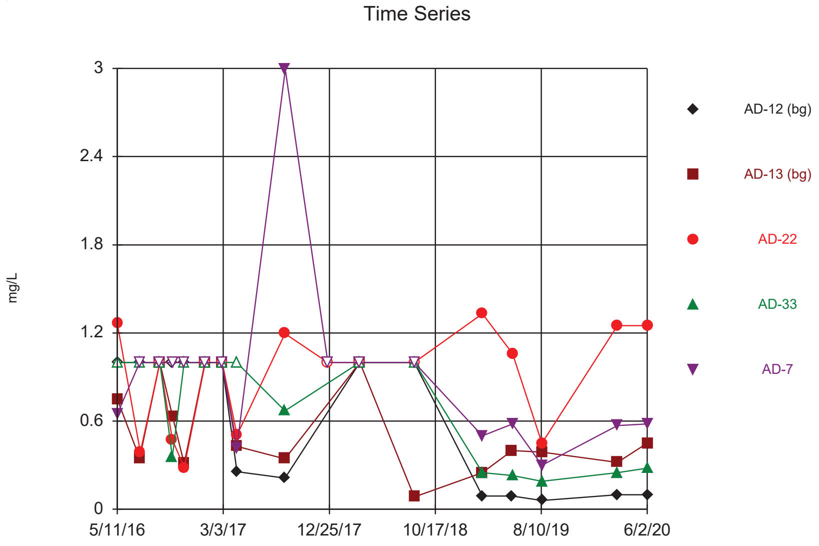
Hollow symbols indicate censored values.



Constituent: Fluoride, total Analysis Run 9/17/2020 10:30 AM View: Appendix IV
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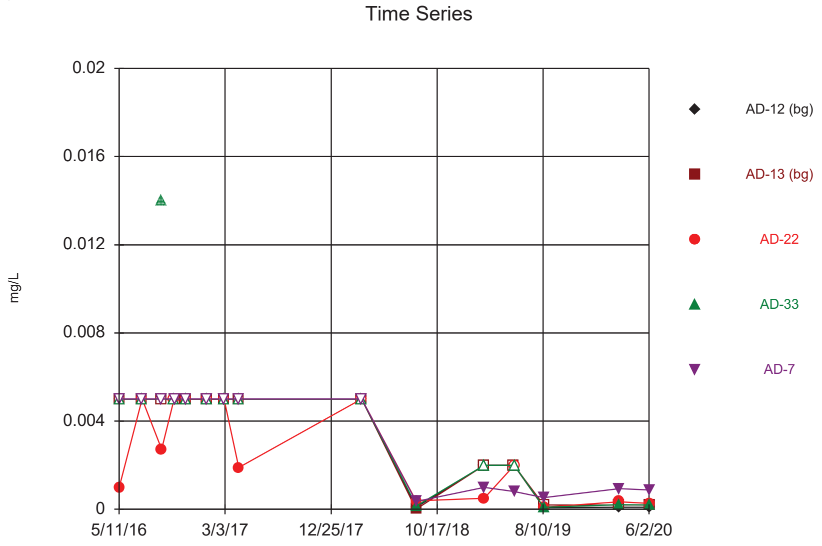
Hollow symbols indicate censored values.



Constituent: Lead, total Analysis Run 9/17/2020 10:30 AM View: Appendix IV
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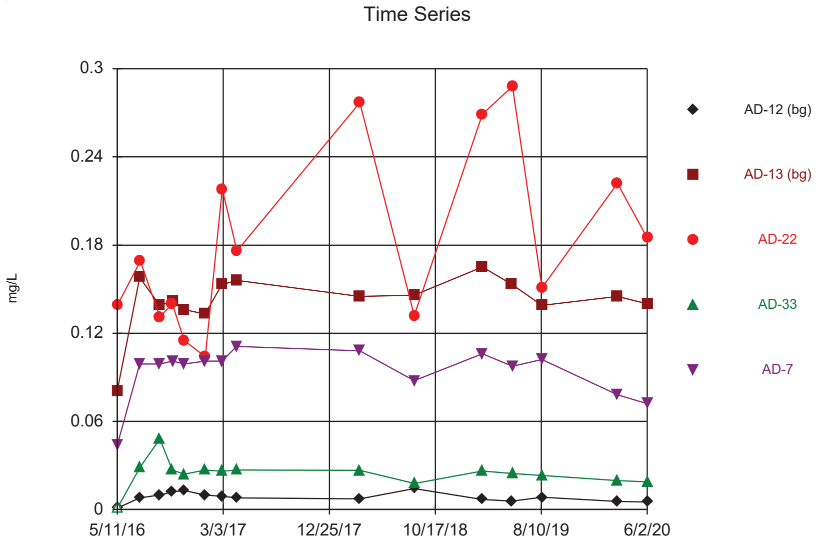
Hollow symbols indicate censored values.



Constituent: Lithium, total Analysis Run 9/17/2020 10:30 AM View: Appendix IV
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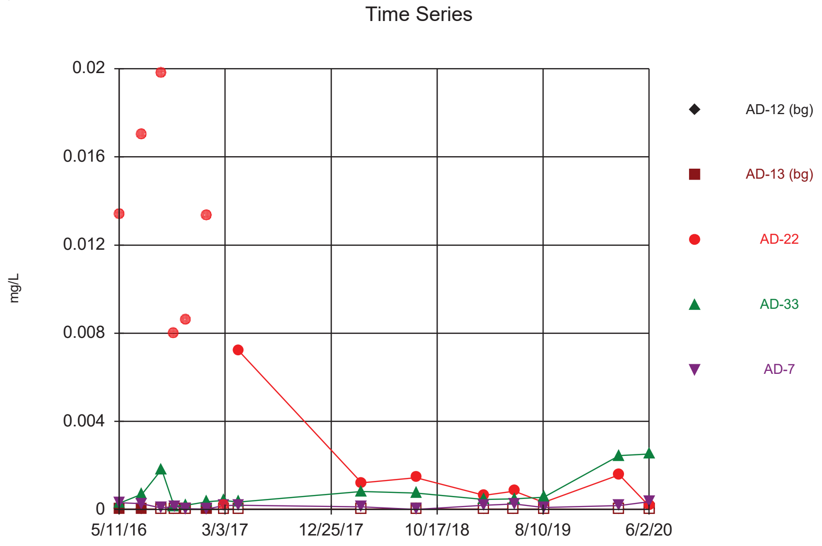

Constituent: Mercury, total Analysis Run 9/17/2020 10:30 AM View: Appendix IV
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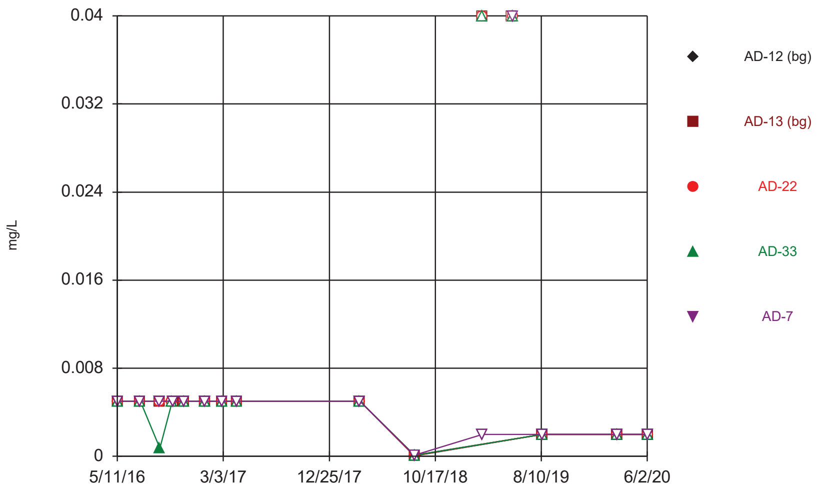
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Molybdenum, total Analysis Run 9/17/2020 10:30 AM View: Appendix IV
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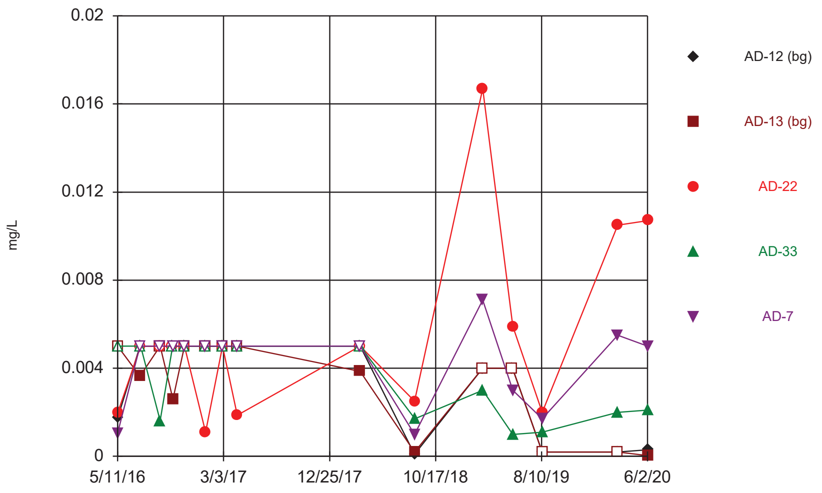
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Selenium, total Analysis Run 9/17/2020 10:30 AM View: Appendix IV
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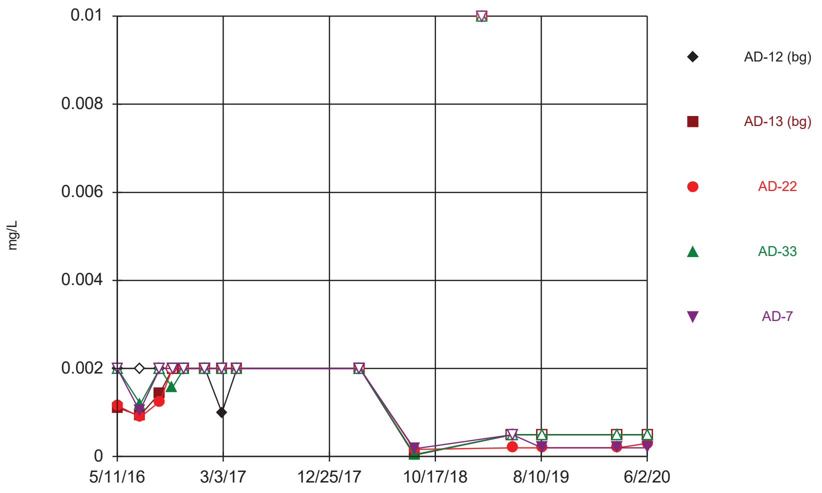
Hollow symbols indicate censored values.

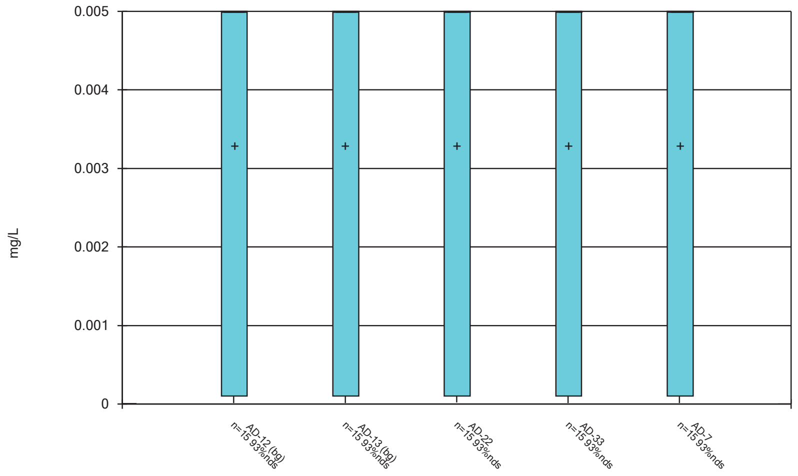
Time Series



Constituent: Thallium, total Analysis Run 9/17/2020 10:30 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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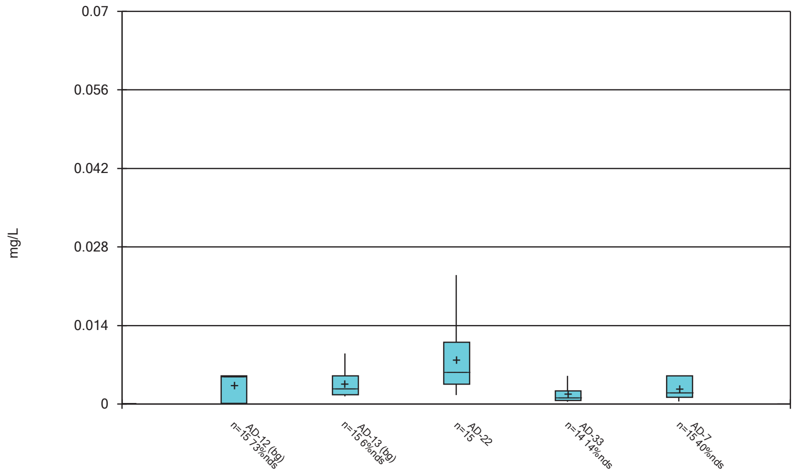
Box & Whiskers Plot



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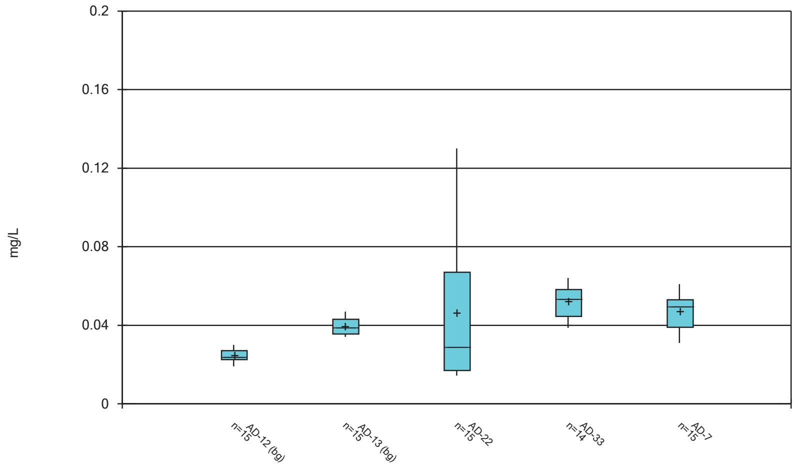
Box & Whiskers Plot



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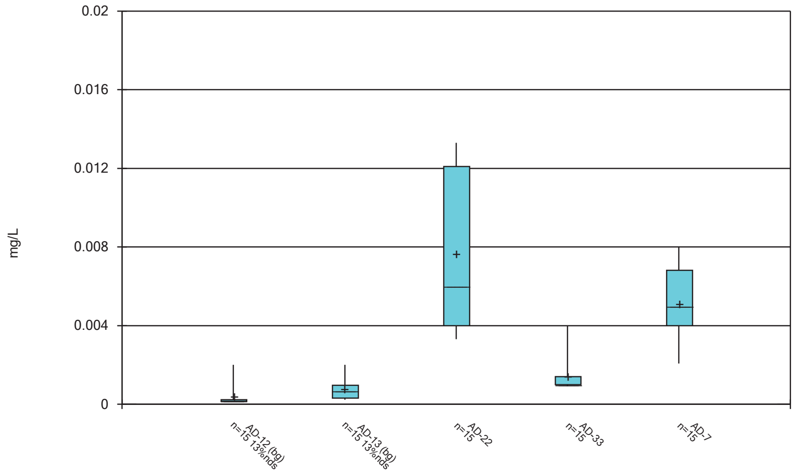
Box & Whiskers Plot



Constituent: Beryllium, total   Analysis Run 9/17/2020 10:15 AM   View: Appendix IV
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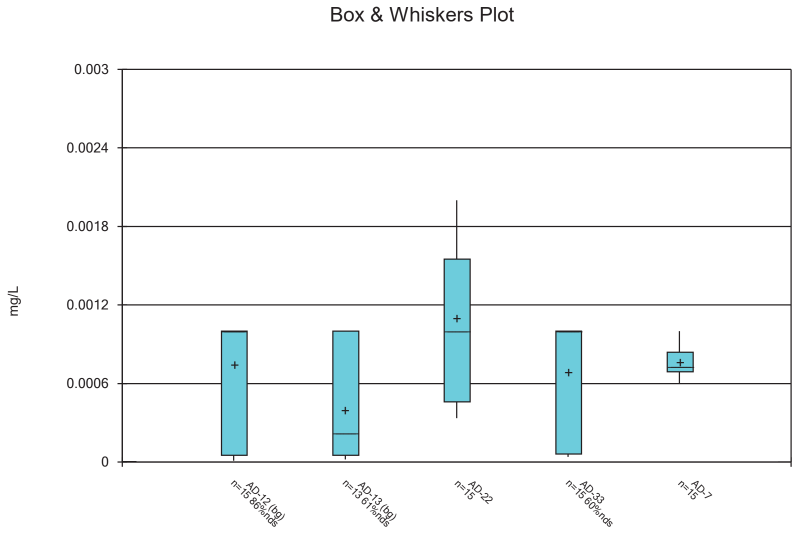

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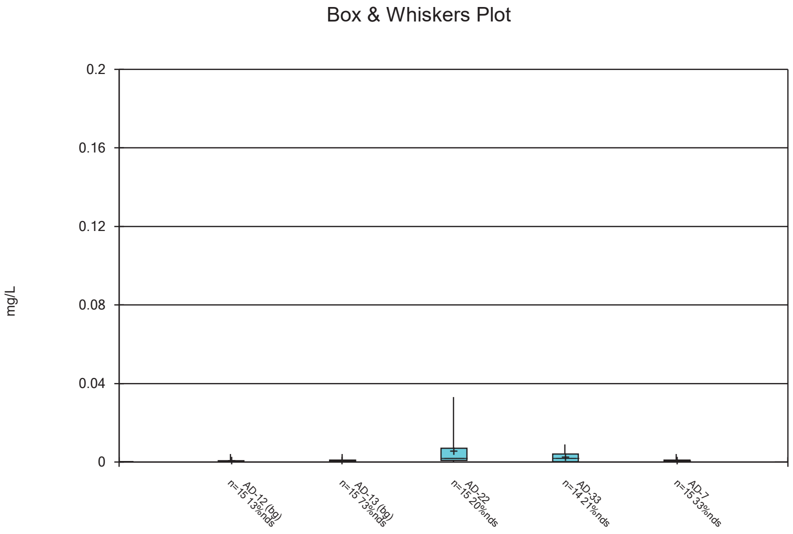

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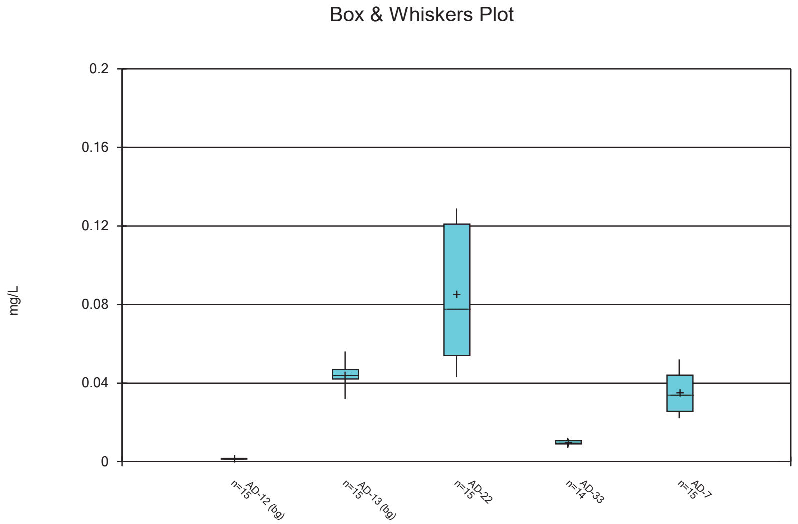

Constituent: Cobalt, total   Analysis Run 9/17/2020 10:15 AM   View: Appendix IV
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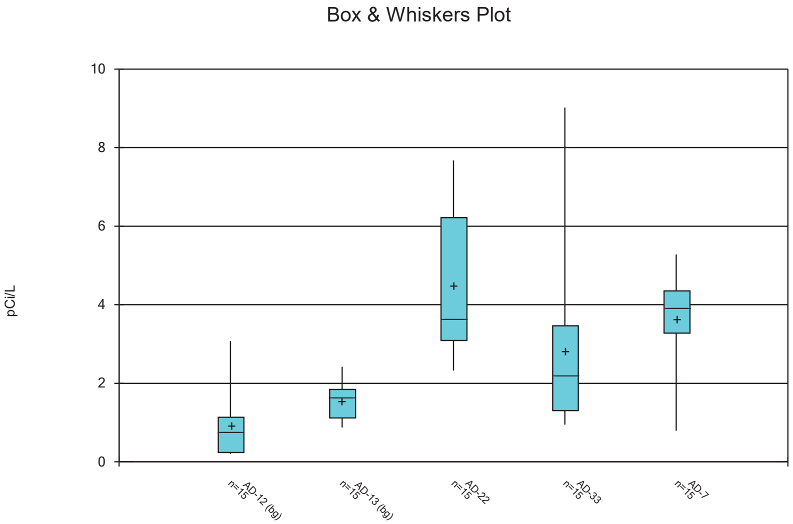

Constituent: Combined Radium 226 + 228   Analysis Run 9/17/2020 10:15 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

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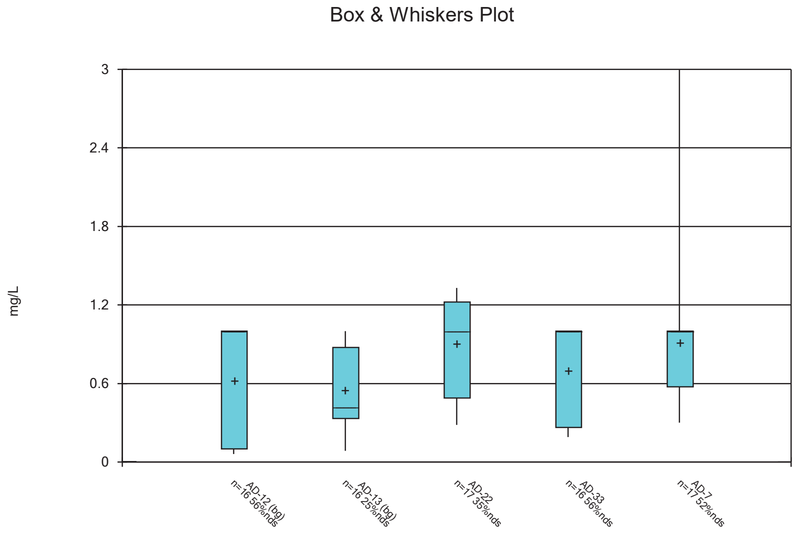
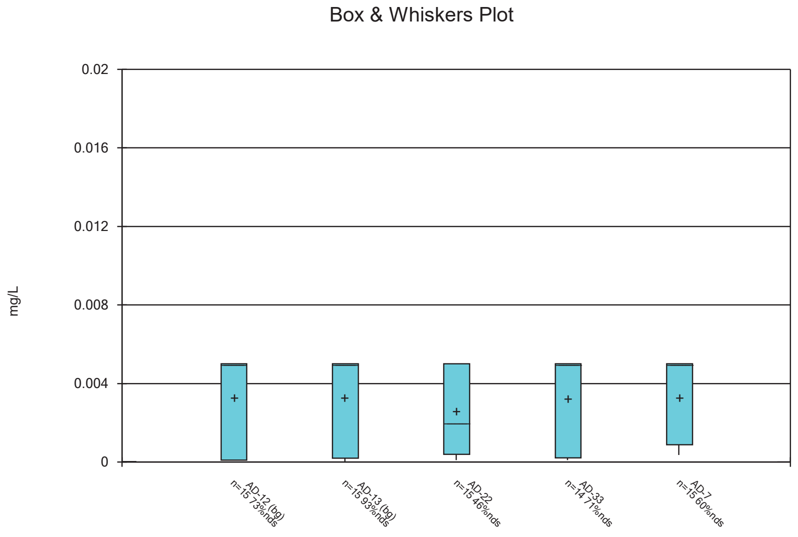


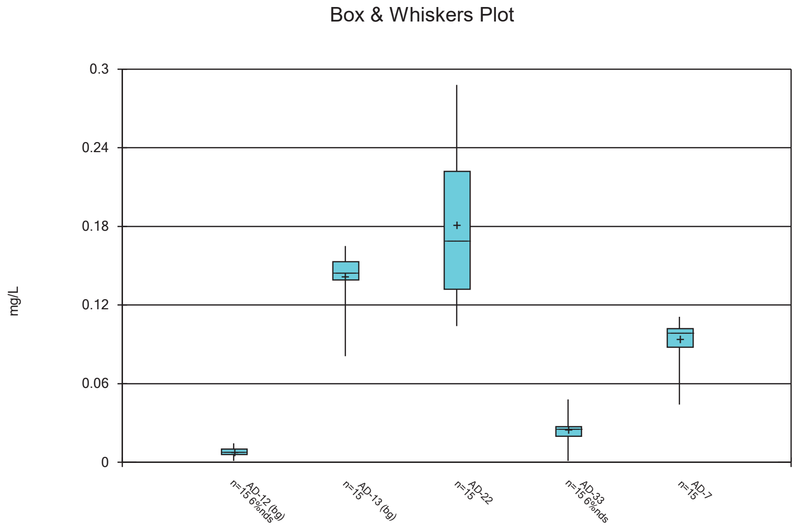
Constituent: Fluoride, total   Analysis Run 9/17/2020 10:15 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG



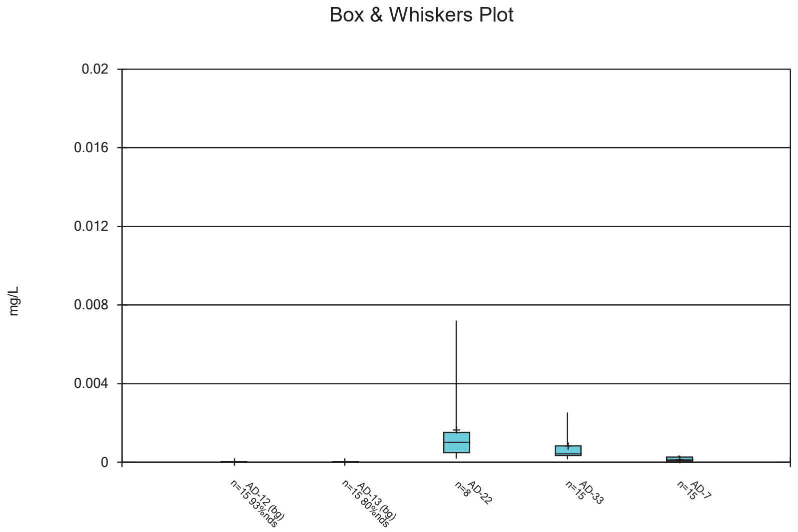
Constituent: Lead, total   Analysis Run 9/17/2020 10:15 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG



Constituent: Lithium, total   Analysis Run 9/17/2020 10:15 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

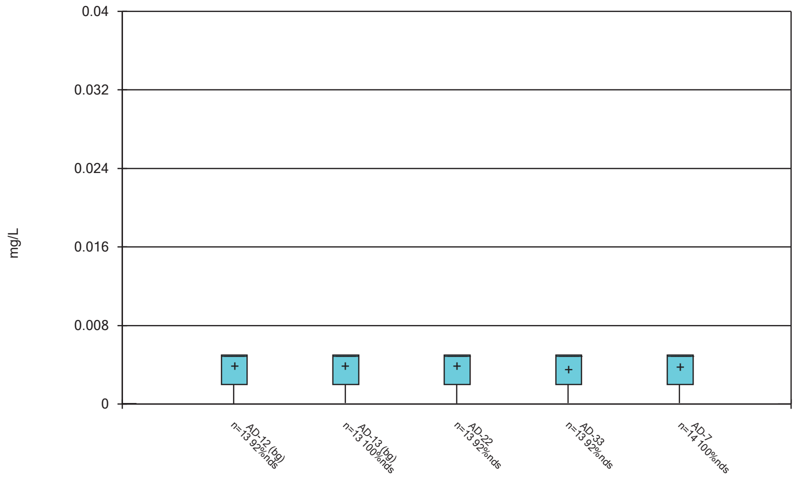
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG



Constituent: Mercury, total   Analysis Run 9/17/2020 10:15 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

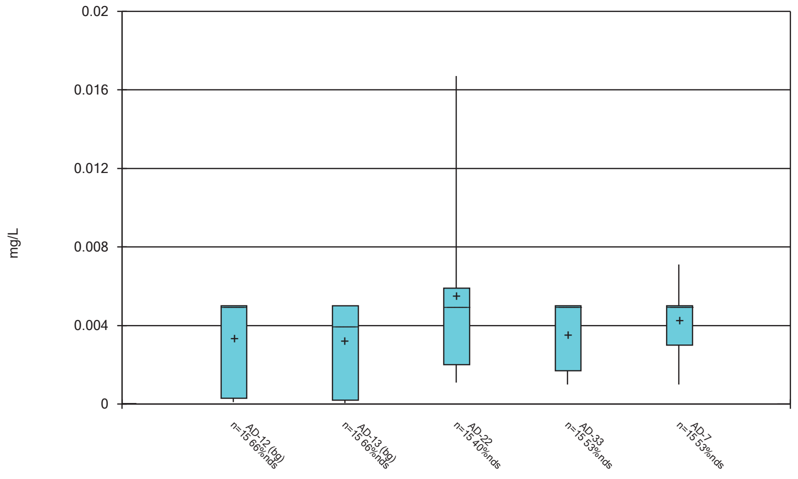
Box & Whiskers Plot



Constituent: Molybdenum, total Analysis Run 9/17/2020 10:15 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

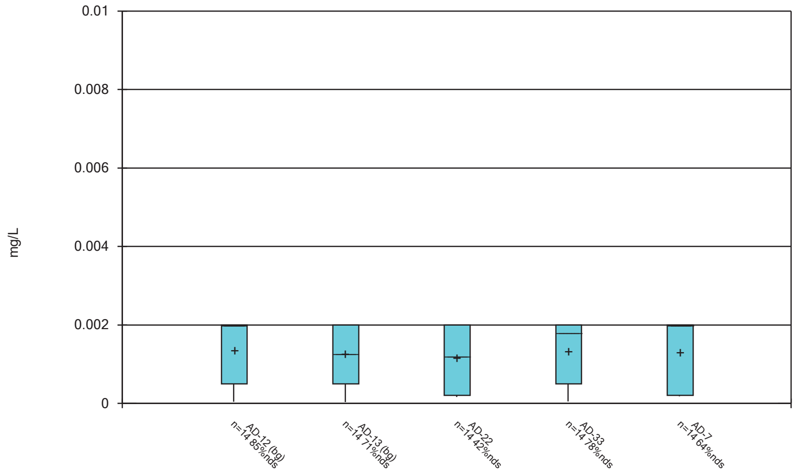
Box & Whiskers Plot



Constituent: Selenium, total Analysis Run 9/17/2020 10:15 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Thallium, total Analysis Run 9/17/2020 10:15 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Excluded Values Summary

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 9/17/2020, 10:24 AM

	AD-33 Arsenic, total (mg/L)	AD-33 Barium, total (mg/L)	AD-13 Cadmium, total (mg/L)	AD-33 Chromium, total (mg/L)	AD-33 Cobalt, total (mg/L)	AD-33 Lead, total (mg/L)	AD-22 Mercury, total (mg/L)	AD-12 Molybdenum, total (mg/L)	AD-13 Molybdenum, total (mg/L)	AD-22 Molybdenum, total (mg/L)
5/11/2016							0.01341 (L)			
7/14/2016							0.017 (L)			
9/7/2016	0.067 (o)	0.163 (o)		0.125 (o)	0.033 (o)	0.014 (o)	0.019829 (L)			
10/12/2016							0.007984 (L)			
11/14/2016							0.008634 (L)			
1/12/2017							0.01332 (L)			
3/1/2017							0.00022 (L)			
4/11/2017			0.002 (o)							
3/21/2018			0.00086 (J,o)							
2/27/2019								<0.04 (o)	<0.04 (o)	<0.04 (o)
5/21/2019								<0.04 (o)	<0.04 (o)	
5/22/2019										<0.04 (o)

	AD-33 Molybdenum, total (mg/L)	AD-7 Molybdenum, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-13 Thallium, total (mg/L)	AD-22 Thallium, total (mg/L)	AD-33 Thallium, total (mg/L)	AD-7 Thallium, total (mg/L)
5/11/2016							
7/14/2016							
9/7/2016							
10/12/2016							
11/14/2016							
1/12/2017							
3/1/2017							
4/11/2017							
3/21/2018							
2/27/2019	<0.04 (o)		<0.01 (o)	<0.01 (o)	<0.01 (o)	<0.01 (o)	<0.01 (o)
5/21/2019							
5/22/2019	<0.04 (o)	<0.04 (o)					

Tolerance Limit Summary Table

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 8/31/2020, 1:53 PM

Constituent	Upper Lim.	Lower Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.005	n/a	n/a	30	n/a	n/a	93.33	n/a	n/a	0.2146	NP Inter(NDs)
Arsenic, total (mg/L)	0.007024	n/a	n/a	30	0.002283	0.002136	40	Kaplan-Meier	No	0.05	Inter
Barium, total (mg/L)	0.05071	n/a	n/a	30	0.03213	0.00837	0	None	No	0.05	Inter
Beryllium, total (mg/L)	0.002	n/a	n/a	30	n/a	n/a	13.33	n/a	n/a	0.2146	NP Inter(normality)
Cadmium, total (mg/L)	0.001	n/a	n/a	28	n/a	n/a	75	n/a	n/a	0.2378	NP Inter(NDs)
Chromium, total (mg/L)	0.001732	n/a	n/a	30	-8.25	0.8522	43.33	Kaplan-Meier	ln(x)	0.05	Inter
Cobalt, total (mg/L)	0.056	n/a	n/a	30	n/a	n/a	0	n/a	n/a	0.2146	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	3.008	n/a	n/a	30	1.238	0.7976	0	None	No	0.05	Inter
Fluoride, total (mg/L)	1	n/a	n/a	32	n/a	n/a	40.63	n/a	n/a	0.1937	NP Inter(normality)
Lead, total (mg/L)	0.005	n/a	n/a	30	n/a	n/a	83.33	n/a	n/a	0.2146	NP Inter(NDs)
Lithium, total (mg/L)	0.165	n/a	n/a	30	n/a	n/a	3.333	n/a	n/a	0.2146	NP Inter(normality)
Mercury, total (mg/L)	0.000025	n/a	n/a	30	n/a	n/a	86.67	n/a	n/a	0.2146	NP Inter(NDs)
Molybdenum, total (mg/L)	0.005	n/a	n/a	26	n/a	n/a	96.15	n/a	n/a	0.2635	NP Inter(NDs)
Selenium, total (mg/L)	0.005	n/a	n/a	30	n/a	n/a	66.67	n/a	n/a	0.2146	NP Inter(NDs)
Thallium, total (mg/L)	0.002	n/a	n/a	28	n/a	n/a	78.57	n/a	n/a	0.2378	NP Inter(NDs)

PIRKEY STACKOUT GWPS				
Constituent Name	**MCL**	**CCR-Rule Specified**	**Background Limit**	**GWPS**
Antimony, Total (mg/L)	0.006		0.005	0.006
Arsenic, Total (mg/L)	0.01		0.007	0.01
Barium, Total (mg/L)	2		0.051	2
Beryllium, Total (mg/L)	0.004		0.002	0.004
Cadmium, Total (mg/L)	0.005		0.001	0.005
Chromium, Total (mg/L)	0.1		0.0017	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.056	0.056
Combined Radium, Total (pCi/L)	5		3	5
Fluoride, Total (mg/L)	4		1	4
Lead, Total (mg/L)	0.015		0.005	0.015
Lithium, Total (mg/L)	n/a	0.04	0.17	0.17
Mercury, Total (mg/L)	0.002		0.000025	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.005	0.1
Selenium, Total (mg/L)	0.05		0.005	0.05
Thallium, Total (mg/L)	0.002		0.002	0.002

**Grey cell indicates Background Limit is higher than MCL or CCR-Rule Specified Level*

**MCL = Maximum Contaminant Level*

**CCR = Coal Combustion Residual*

**GWPS = Groundwater Protection Standard*

Confidence Intervals Summary Table - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 9/17/2020, 10:27 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.009637**	**0.004719**	**0.004**	**Yes**	**15**	**0.007645**	**0.003828**	**0**	**None**	**ln(x)**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-22**	**0.1039**	**0.06069**	**0.056**	**Yes**	**15**	**0.08529**	**0.03223**	**0**	**None**	**ln(x)**	**0.01**	**Param.**

Confidence Intervals Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 9/17/2020, 10:27 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	AD-22	0.005	0.0001	0.006	No	15	0.003288	0.00225	93.33	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-33	0.005	0.0001	0.006	No	15	0.003287	0.002251	93.33	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-7	0.005	0.0001	0.006	No	15	0.003287	0.002251	93.33	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-22	0.01026	0.003594	0.01	No	15	0.008081	0.006787	0	None	ln(x)	0.01	Param.
Arsenic, total (mg/L)	AD-33	0.002362	0.0008009	0.01	No	14	0.001811	0.001479	14.29	None	ln(x)	0.01	Param.
Arsenic, total (mg/L)	AD-7	0.005	0.00108	0.01	No	15	0.00278	0.001921	40	None	No	0.01	NP (normality)
Barium, total (mg/L)	AD-22	0.05967	0.02152	2	No	15	0.04676	0.03601	0	None	ln(x)	0.01	Param.
Barium, total (mg/L)	AD-33	0.05764	0.0475	2	No	14	0.05209	0.007502	0	None	x^3	0.01	Param.
Barium, total (mg/L)	AD-7	0.05298	0.04051	2	No	15	0.04696	0.009146	0	None	sqrt(x)	0.01	Param.
Beryllium, total (mg/L)	**AD-22**	**0.009637**	**0.004719**	**0.004**	**Yes**	**15**	**0.007645**	**0.003828**	**0**	**None**	**ln(x)**	**0.01**	**Param.**
Beryllium, total (mg/L)	AD-33	0.002	0.000905	0.004	No	15	0.001376	0.0008065	0	None	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-7	0.006231	0.003906	0.004	No	15	0.005069	0.001715	0	None	No	0.01	Param.
Cadmium, total (mg/L)	AD-22	0.001456	0.000627	0.005	No	15	0.0011	0.0006127	0	None	x^(1/3)	0.01	Param.
Cadmium, total (mg/L)	AD-33	0.001	0.00005	0.005	No	15	0.0006883	0.0004547	60	None	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-7	0.0008252	0.0006941	0.005	No	15	0.0007627	0.0001001	0	None	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-22	0.004705	0.0005068	0.1	No	15	0.00624	0.009734	20	Kaplan-Meier	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-33	0.002969	0.0002839	0.1	No	14	0.002656	0.002524	21.43	Kaplan-Meier	sqrt(x)	0.01	Param.
Chromium, total (mg/L)	AD-7	0.0004389	0.0001532	0.1	No	15	0.0008153	0.0009626	33.33	Kaplan-Meier	ln(x)	0.01	Param.
Cobalt, total (mg/L)	**AD-22**	**0.1039**	**0.06069**	**0.056**	**Yes**	**15**	**0.08529**	**0.03223**	**0**	**None**	**ln(x)**	**0.01**	**Param.**
Cobalt, total (mg/L)	AD-33	0.01069	0.008684	0.056	No	14	0.009685	0.001413	0	None	No	0.01	Param.
Cobalt, total (mg/L)	AD-7	0.04137	0.02815	0.056	No	15	0.03509	0.009769	0	None	sqrt(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-22	5.422	3.266	5	No	15	4.498	1.736	0	None	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-33	3.509	1.46	5	No	15	2.816	2.227	0	None	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-7	4.468	3.296	5	No	15	3.648	1.264	0	None	x^3	0.01	Param.
Fluoride, total (mg/L)	AD-22	1.044	0.4482	4	No	17	0.9089	0.3463	35.29	Kaplan-Meier	x^3	0.01	Param.
Fluoride, total (mg/L)	AD-33	1	0.25	4	No	16	0.7017	0.3643	56.25	Kaplan-Meier	No	0.01	NP (NDs)
Fluoride, total (mg/L)	AD-7	1	0.57	4	No	17	0.9168	0.5919	52.94	Kaplan-Meier	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-22	0.005	0.000346	0.015	No	15	0.002613	0.002141	46.67	None	No	0.01	NP (normality)
Lead, total (mg/L)	AD-33	0.005	0.0002	0.015	No	14	0.00319	0.002247	71.43	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-7	0.005	0.0008	0.015	No	15	0.003301	0.00216	60	None	No	0.01	NP (NDs)
Lithium, total (mg/L)	AD-22	0.2147	0.1381	0.17	No	15	0.1811	0.06046	0	None	ln(x)	0.01	Param.
Lithium, total (mg/L)	AD-33	0.029	0.0188	0.17	No	15	0.0244	0.00947	6.667	None	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-7	0.104	0.09074	0.17	No	15	0.09375	0.01733	0	None	x^6	0.01	Param.
Mercury, total (mg/L)	AD-22	0.003088	0.0002845	0.002	No	8	0.001677	0.002289	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-33	0.001023	0.0003243	0.002	No	15	0.0008215	0.0007847	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-7	0.000233	0.00009001	0.002	No	15	0.0001615	0.0001055	0	None	No	0.01	Param.
Molybdenum, total (mg/L)	AD-22	0.005	0.002	0.1	No	13	0.003928	0.001741	92.31	None	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-33	0.005	0.0007365	0.1	No	13	0.003603	0.001911	92.31	None	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-7	0.005	0.002	0.1	No	14	0.003793	0.001746	100	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-22	0.005043	0.001657	0.05	No	15	0.005549	0.004187	40	Kaplan-Meier	ln(x)	0.01	Param.
Selenium, total (mg/L)	AD-33	0.005	0.001613	0.05	No	15	0.003501	0.001717	53.33	Kaplan-Meier	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-7	0.005	0.0017	0.05	No	15	0.00429	0.001765	53.33	Kaplan-Meier	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-22	0.002	0.0002	0.002	No	14	0.001169	0.0008233	42.86	None	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-33	0.002	0.0005	0.002	No	14	0.001344	0.0007651	78.57	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-7	0.002	0.0002	0.002	No	14	0.001308	0.0008556	64.29	None	No	0.01	NP (NDs)

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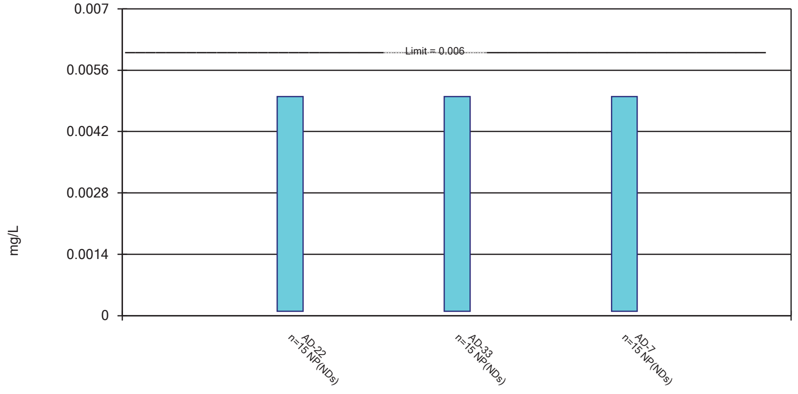
Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

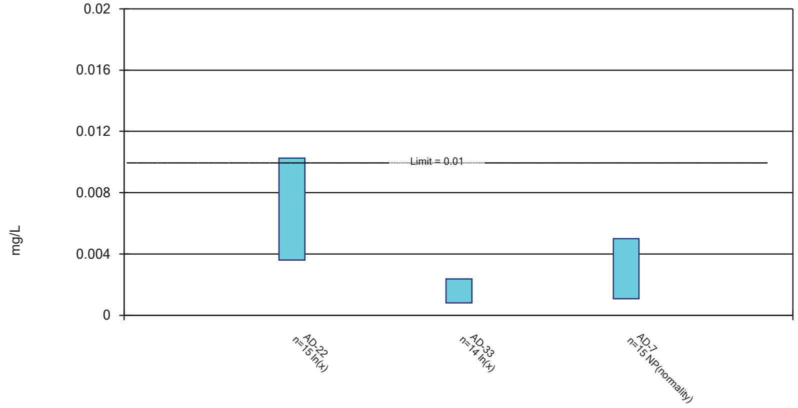


Constituent: Antimony, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

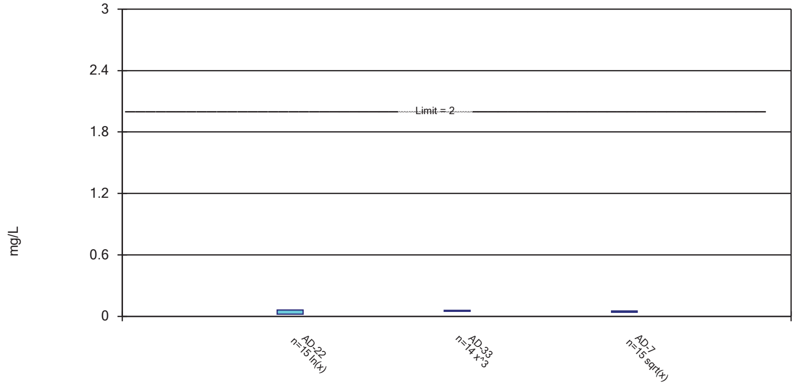


Constituent: Arsenic, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

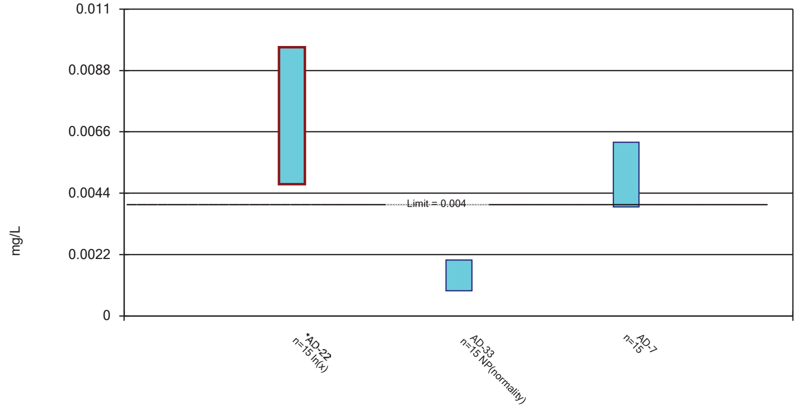


Constituent: Barium, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

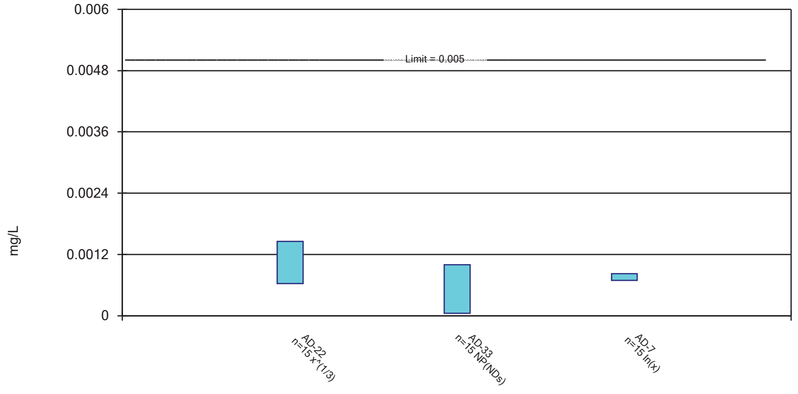


Constituent: Beryllium, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

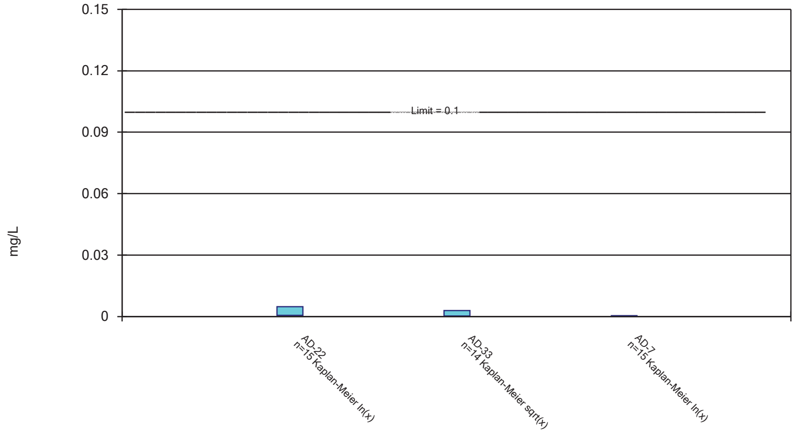


Constituent: Cadmium, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

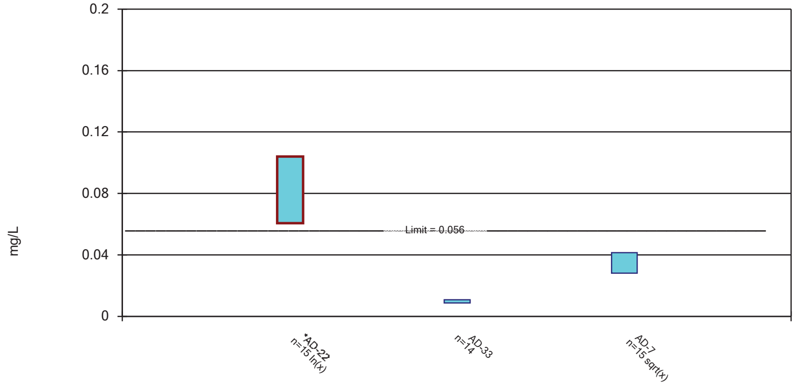


Constituent: Chromium, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

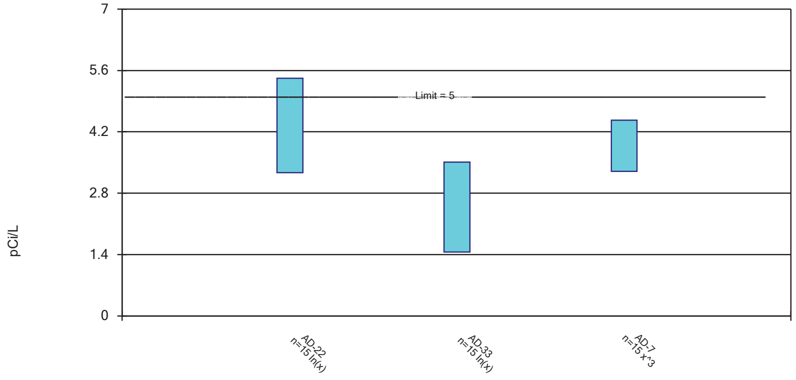


Constituent: Cobalt, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

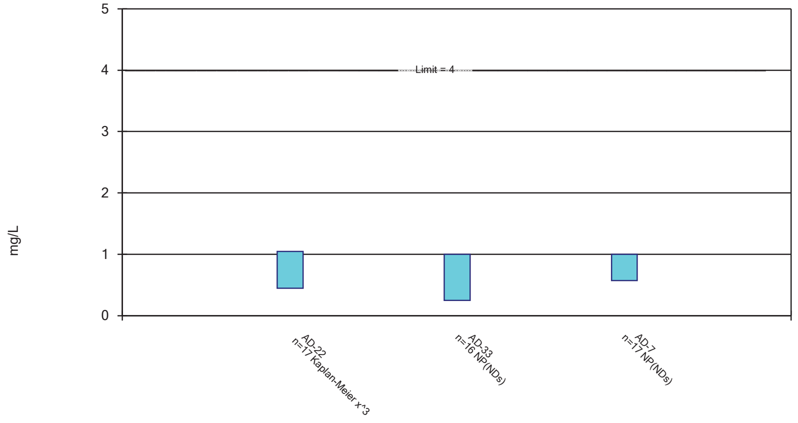


Constituent: Combined Radium 226 + 228   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

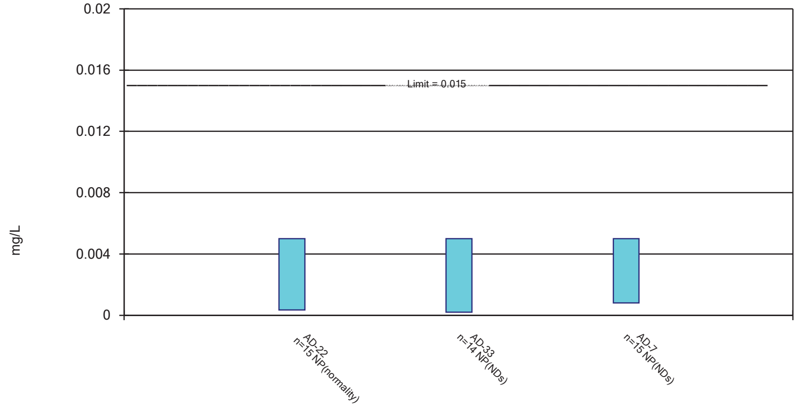


Constituent: Fluoride, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

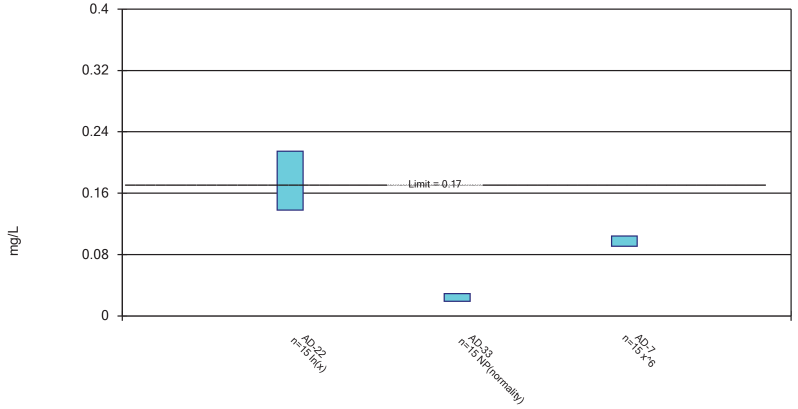


Constituent: Lead, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

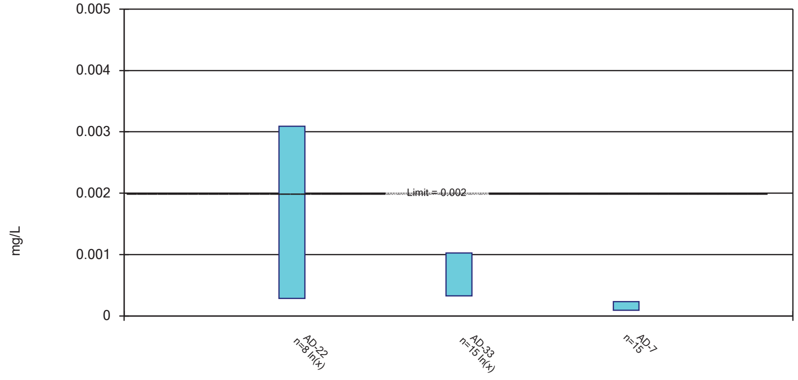


Constituent: Lithium, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

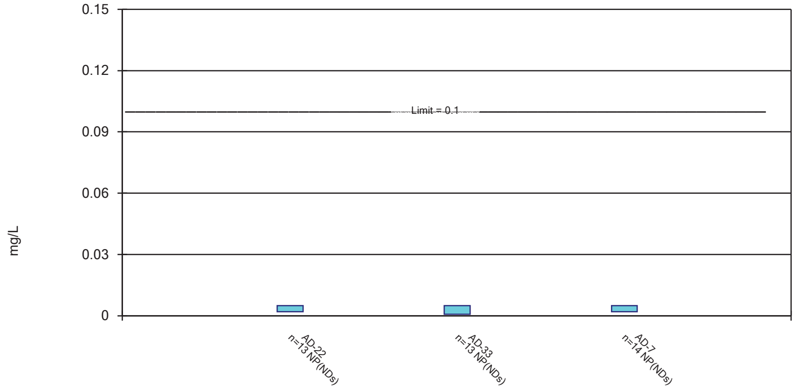


Constituent: Mercury, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

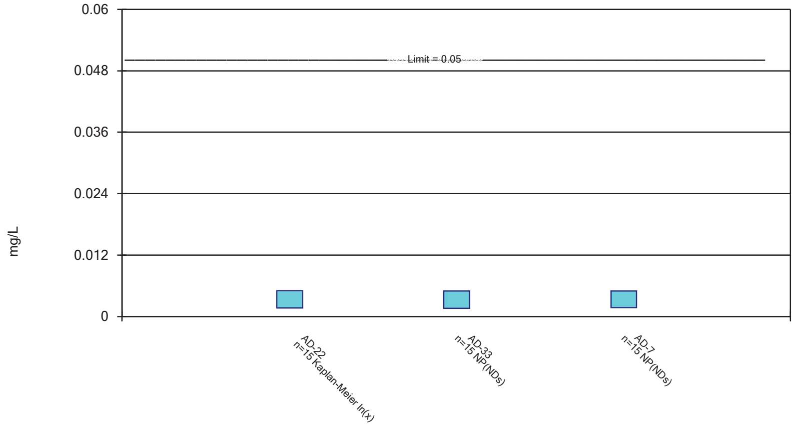


Constituent: Molybdenum, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

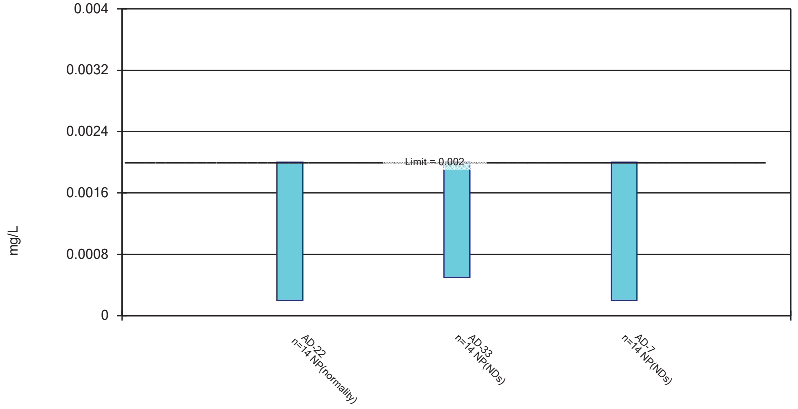


Constituent: Selenium, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Thallium, total   Analysis Run 9/17/2020 10:26 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Seasonality Summary Table - All Results

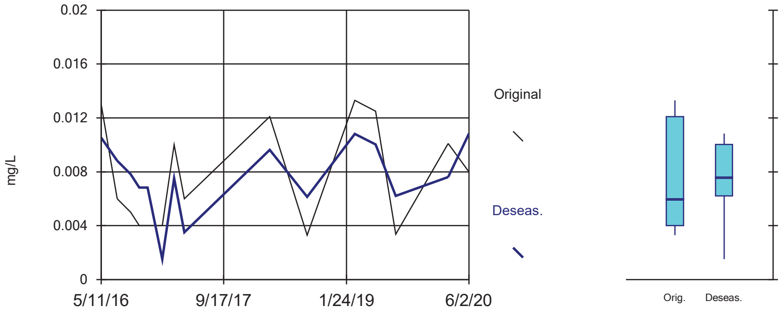
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 9/17/2020, 9:50 AM

Constituent	Well	Sig.	K.-W.	Chi-Sq.	df	N	Alpha
Beryllium, total (mg/L)	**AD-22**	**Yes**	**6.841**	**3.841**	**1**	**15**	**0.05**
Beryllium, total (mg/L)	**AD-7**	**Yes**	**9.135**	**3.841**	**1**	**15**	**0.05**
Calcium, total (mg/L)	**AD-22**	**Yes**	**5.794**	**3.841**	**1**	**17**	**0.05**
Cobalt, total (mg/L)	**AD-22**	**Yes**	**5.376**	**3.841**	**1**	**15**	**0.05**
Cobalt, total (mg/L)	**AD-7**	**Yes**	**9.054**	**3.841**	**1**	**15**	**0.05**
Combined Radium 226 + 228 (pCi/L)	**AD-22**	**Yes**	**4.339**	**3.841**	**1**	**15**	**0.05**
Combined Radium 226 + 228 (pCi/L)	**AD-7**	**Yes**	**7.714**	**3.841**	**1**	**15**	**0.05**
Lithium, total (mg/L)	AD-22	No	3.429	3.841	1	15	0.05

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Seasonality: AD-22

For the selected data, the Kruskal-Wallis test indicates SEASONALITYat the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one season has a significantly different median concentration of this constituent than any other season.
Calculated Kruskal-Wallis statistic = 6.841
Tabulated Chi-Squared value = 3.841 with 1 degrees of freedom at the 5% significance level.
There were 2 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 6.78
Adjusted Kruskal-Wallis statistic (H') = 6.841

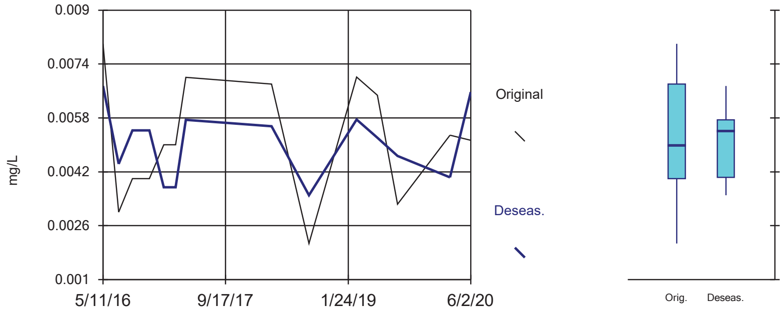


Constituent: Beryllium, total Analysis Run 9/17/2020 9:50 AM View: Seasonality
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Seasonality: AD-7

For the selected data, the Kruskal-Wallis test indicates SEASONALITYat the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one season has a significantly different median concentration of this constituent than any other season.
Calculated Kruskal-Wallis statistic = 9.135
Tabulated Chi-Squared value = 3.841 with 1 degrees of freedom at the 5% significance level.
There were 2 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 9.054
Adjusted Kruskal-Wallis statistic (H') = 9.135

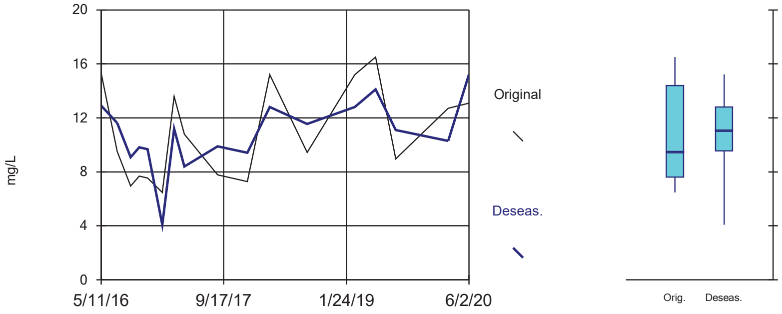


Constituent: Beryllium, total Analysis Run 9/17/2020 9:50 AM View: Seasonality
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Seasonality: AD-22

For the selected data, the Kruskal-Wallis test indicates SEASONALITYat the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one season has a significantly different median concentration of this constituent than any other season.
Calculated Kruskal-Wallis statistic = 5.794
Tabulated Chi-Squared value = 3.841 with 1 degrees of freedom at the 5% significance level.
There were 1 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 5.787
Adjusted Kruskal-Wallis statistic (H') = 5.794

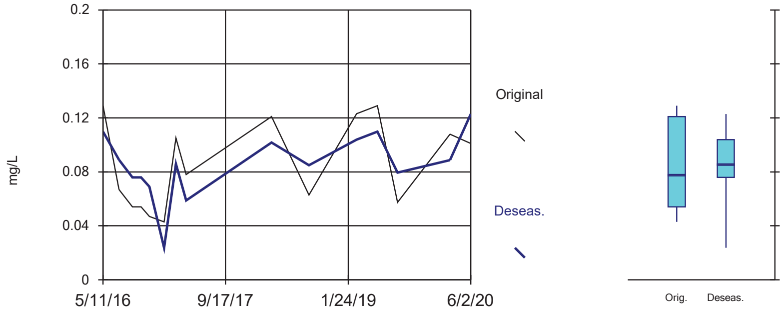


Constituent: Calcium, total Analysis Run 9/17/2020 9:50 AM View: Seasonality
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Seasonality: AD-22

For the selected data, the Kruskal-Wallis test indicates SEASONALITYat the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one season has a significantly different median concentration of this constituent than any other season.
Calculated Kruskal-Wallis statistic = 5.376
Tabulated Chi-Squared value = 3.841 with 1 degrees of freedom at the 5% significance level.
There were 2 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 5.357
Adjusted Kruskal-Wallis statistic (H') = 5.376

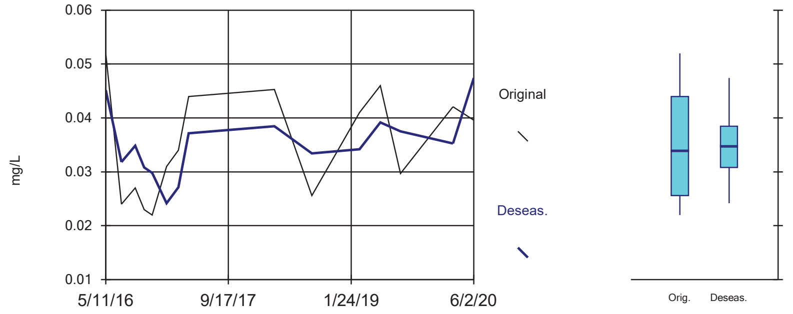


Constituent: Cobalt, total Analysis Run 9/17/2020 9:50 AM View: Seasonality
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Seasonality: AD-7

For the selected data, the Kruskal-Wallis test indicates SEASONALITYat the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one season has a significantly different median concentration of this constituent than any other season.
Calculated Kruskal-Wallis statistic = 9.054
Tabulated Chi-Squared value = 3.841 with 1 degrees of freedom at the 5% significance level.
There were 0 groups of ties in the data, so no adjustment to the Kruskal-Wallis statistic (H) was necessary.

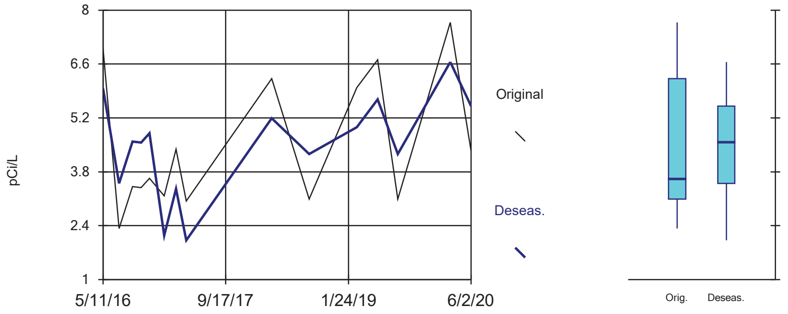


Constituent: Cobalt, total Analysis Run 9/17/2020 9:50 AM View: Seasonality
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Seasonality: AD-22

For the selected data, the Kruskal-Wallis test indicates SEASONALITYat the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one season has a significantly different median concentration of this constituent than any other season.
Calculated Kruskal-Wallis statistic = 4.339
Tabulated Chi-Squared value = 3.841 with 1 degrees of freedom at the 5% significance level.
There were 0 groups of ties in the data, so no adjustment to the Kruskal-Wallis statistic (H) was necessary.

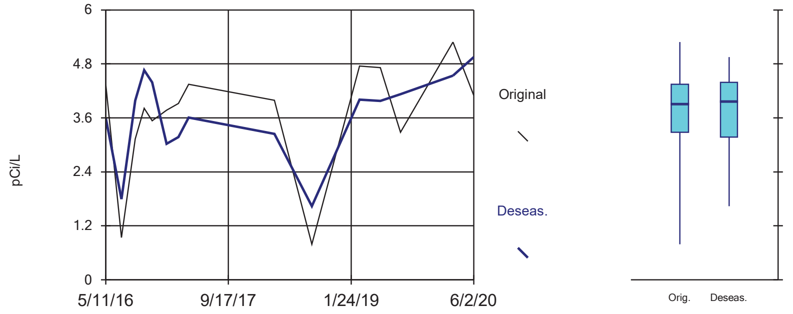


Constituent: Combined Radium 226 + 228 Analysis Run 9/17/2020 9:50 AM View: Seasonality
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Seasonality: AD-7

For the selected data, the Kruskal-Wallis test indicates SEASONALITYat the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one season has a significantly different median concentration of this constituent than any other season.
Calculated Kruskal-Wallis statistic = 7.714
Tabulated Chi-Squared value = 3.841 with 1 degrees of freedom at the 5% significance level.
There were 0 groups of ties in the data, so no adjustment to the Kruskal-Wallis statistic (H) was necessary.

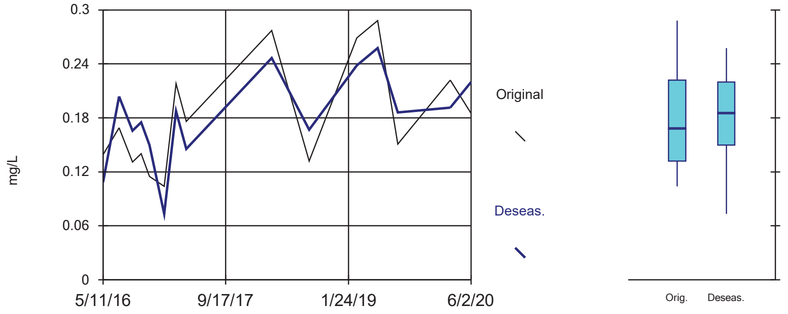


Constituent: Combined Radium 226 + 228 Analysis Run 9/17/2020 9:50 AM View: Seasonality
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Seasonality: AD-22

For the selected data, the Kruskal-Wallis test indicates NO SEASONALITYat the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no season has a significantly different median concentration of this constituent than any other season.
Calculated Kruskal-Wallis statistic = 3.429
Tabulated Chi-Squared value = 3.841 with 1 degrees of freedom at the 5% significance level.
There were 0 groups of ties in the data, so no adjustment to the Kruskal-Wallis statistic (H) was necessary.



Constituent: Lithium, total Analysis Run 9/17/2020 9:50 AM View: Seasonality
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Deseasonalized Confidence Intervals Summary Table - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 8/31/2020, 2:15 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.009479**	**0.006352**	**0.004**	**Yes**	**15**	**0.007645**	**0.002669**	**0**	**None**	**x^2**	**0.01**	**Param.**
Beryllium, total (mg/L)	**AD-7**	**0.005752**	**0.004385**	**0.004**	**Yes**	**15**	**0.005069**	**0.001009**	**0**	**None**	**No**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-22**	**0.1018**	**0.07269**	**0.056**	**Yes**	**15**	**0.08529**	**0.02423**	**0**	**None**	**x^2**	**0.01**	**Param.**

Deseasonalized Confidence Intervals Summary Table - All Results

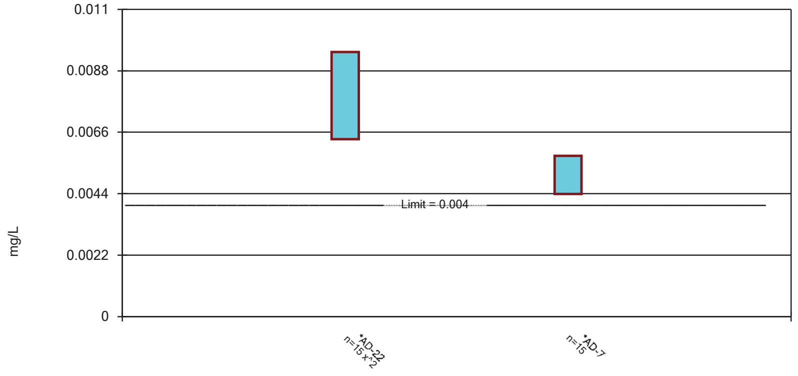
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 8/31/2020, 2:14 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.009479**	**0.006352**	**0.004**	**Yes**	**15**	**0.007645**	**0.002669**	**0**	**None**	**x^2**	**0.01**	**Param.**
Beryllium, total (mg/L)	**AD-7**	**0.005752**	**0.004385**	**0.004**	**Yes**	**15**	**0.005069**	**0.001009**	**0**	**None**	**No**	**0.01**	**Param.**
Cadmium, total (mg/L)	AD-22	0.001411	0.0007892	0.005	No	15	0.0011	0.000459	0	None	No	0.01	Param.
Cobalt, total (mg/L)	**AD-22**	**0.1018**	**0.07269**	**0.056**	**Yes**	**15**	**0.08529**	**0.02423**	**0**	**None**	**x^2**	**0.01**	**Param.**
Cobalt, total (mg/L)	AD-7	0.03908	0.03075	0.056	No	15	0.03509	0.006178	0	None	x^(1/3)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-22	5.424	3.775	5	No	15	4.498	1.313	0	None	x^2	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-7	4.313	3.249	5	No	15	3.648	0.96	0	None	x^3	0.01	Param.

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

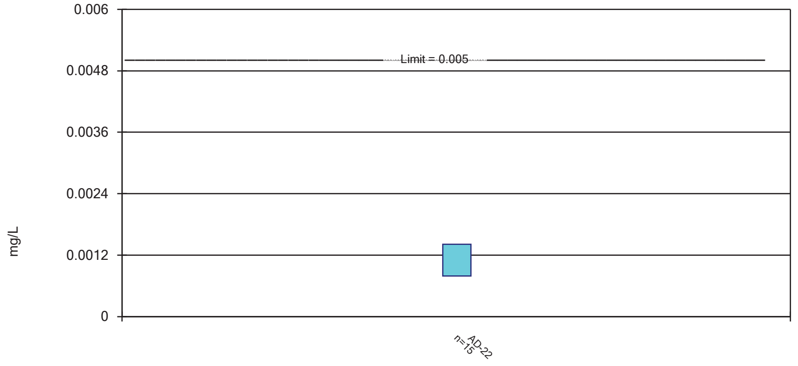


Constituent: Beryllium, total, Alt. Values Analysis Run 8/31/2020 2:12 PM View: Seasonality
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

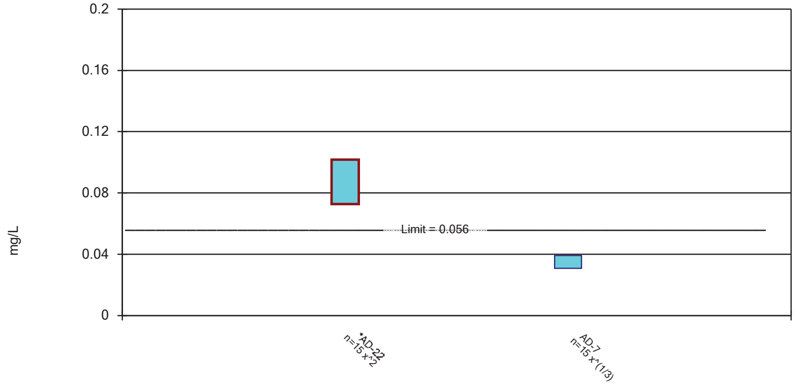


Constituent: Cadmium, total, Alt. Values Analysis Run 8/31/2020 2:12 PM View: Seasonality
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

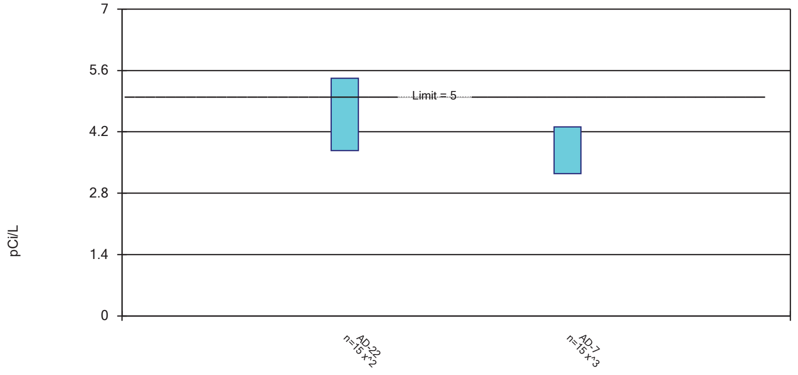


Constituent: Cobalt, total, Alt. Values Analysis Run 8/31/2020 2:13 PM View: Seasonality
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.26d Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228, Alt. Values Analysis Run 8/31/2020 2:13 PM View: Seasonalit
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants
engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

April 2, 2020

CHA8495

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EPRI	Electric Power Research Institute
FGD	Flue Gas Desulfurization
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SPLP	Synthetic Precipitation Leaching Profile
SSL	Statistically Significant Level
SU	Standard Unit
TCEQ	Texas Commission on Environmental Quality
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
WBAP	West Bottom Ash Pond
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the Flue Gas Desulfurization (FGD) Stackout Area (Figure 1). In August 2019, a semi-annual assessment monitoring event was conducted at the FGD Stackout Area in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were previously established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the unit (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or for constituents without an MCL, the risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether these parameters were present at a statistically significant level (SSL) above the GWPSs. Seasonal patterns were observed on the time series plots of beryllium and cobalt in wells AD-22 and AD-7 and for combined radium 226+228 in well AD-7 (Geosyntec, 2020). To correctly account for seasonality, confidence intervals for these wells and constituents were constructed using deseasonalized values. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey FGD Stackout Pad:

- The deseasaonalized LCL for beryllium exceeded the GWPS of 0.004 mg/L at AD-7 (0.00603 mg/L) and AD-22 (0.00447 mg/L); and,
- The deseasonalized LCL for cobalt exceeded the GWPS of 0.0560 mg/L at AD-22 (0.0727 mg/L).

No other SSLs were identified (Geosyntec, 2020).

1.1 CCR Rule Requirements

USEPA regulations regarding assessment monitoring programs for CCR landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling,*

> *analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSLs identified for beryllium and cobalt is from a source other than the WBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for beryllium and cobalt were based on a Type IV cause and not by a release from the Pirkey FGD Stackout Area.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for beryllium and cobalt and the proposed alternative sources are described below.

2.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSL has been attributed to natural variation associated with seasonal effects, which is a Type IV (natural variation) issue.

2.1.1 Beryllium

SSLs were identified for beryllium at AD-7 and AD-22 using deseasonalized statistics (Geosyntec, 2020). According to the Unified Guidance, "seasonal correction should be done both to minimize the chance of mistaking a seasonal effect for evidence of contaminated groundwater, and also to build more powerful background to compliance point tests. Problems can arise, for instance, from measurement variations associated with changing recharge rates during different seasons" (USEPA, 2009).

The seasonal effects observed in the statistical analysis occur in roughly annual cycles, with higher beryllium concentrations occurring in early spring and lower concentrations in early fall. For example, beryllium concentrations in 2019 at AD-22 were 0.0133 milligrams per liter (mg/L) in March 2019, in contrast to 0.00338 mg/L in September 2019. A previous ASD for the Stackout Pad showed that beryllium concentrations at AD-22 appear to correlate with groundwater elevations in the well (Geosyntec, 2019a). This relationship still holds true at AD-22 and also appears to be present at AD-7 (Figure 2). Beryllium concentrations at AD-7 and AD-22 are both correlated with seasonal changes in other constituents, including calcium (Figure 3) and lithium (Figure 4). The correlation between beryllium and both monovalent (lithium) and divalent (calcium) cations suggests that the increases in beryllium concentration are related to cation exchange behavior with clay minerals present in the native soil.

Five soil borings (SP-B1 through SP-B5) were advanced in the area of the Stackout Pad in March 2020 to investigate the distribution of clays in the subsurface geology. The soil boring locations are shown on Figure 1. Boring SP-B1 was advanced upgradient of the Stackout Pad to represent unimpacted conditions. SP-B2 and SP-B4 were advanced adjacent to AD-7 and AD-22, respectively, to re-log the geology at each well location. The boring logs are provided in Attachment A.

Generally, clay materials were identified in the seasonally saturated zones above the permanent water table. At AD-7, which was relogged by SP-B2, the depth to water fluctuated between approximately 9 and 15 feet below ground surface (ft bgs), with silty clay present from approximately 2.5-6.9 ft bgs before transitioning to clay until 18.8 ft bgs (Figure 5). At AD-22, which was relogged by SP-B4, the depth to water fluctuated between approximately 3 and 12 ft bgs. Clay was identified from approximately 1.5 ft bgs to 13.3 ft bgs, where it transitioned to a clayey silt (Figure 6).

Soil samples were collected from the seasonal water table and within the screened interval during the re-logging of AD-7 and AD-22 for analysis of mineralogy via X-ray diffraction (XRD). The XRD analysis confirmed the presence of clays within the seasonal water table and sand within the screened interval, as summarized in Table 1. The clay fraction of the uppermost samples collected from within the seasonal water table were further analyzed to identify the type of clays present. Smectite-type clays, which are 2:1-layer clays with significant cation exchange properties, make up the majority of the clay minerals present at those intervals.

Sorption and desorption of beryllium from smectite-type clays is well documented (Boschi and Willenbring, 2016a; You, et al., 1989). Desorption was found to be affected by pH, with 75% of beryllium desorbed from a smectite-type clay as pH changed from 6.0 standard units (SU) to 3.0 SU (Boschi and Willenbring, 2016b). The pH values recorded at AD-7 and AD-22 for samples collected under the Federal CCR Rule ranged from 2.9 to 4.1 SU and 3.9 to 5.1 SU, respectively, suggesting that conditions are favorable for beryllium desorption from smectite-type clays. The presence of these exchangeable clays provides further evidence that the exceedances of beryllium at AD-22 and AD-7 can be attributed to the effects of seasonal groundwater elevation changes, and the resulting cation exchange between groundwater and the exchangeable clay within the seasonal water table, on groundwater quality.

2.1.2 Cobalt

An SSL was identified for cobalt at AD-22 using deseasonalized statistics (Geosyntec, 2020). Similar to beryllium, the cobalt concentrations at AD-22 appear to correlate with seasonal changes in groundwater elevation (Figure 7). The cobalt concentrations are also well correlated with changes in other cations, including calcium and lithium (Figure 8). The concentration ratio between cobalt and calcium is consistent at both upgradient and downgradient locations (Figure 9), suggesting that the cobalt can be attributed to a natural mechanism which is consistent across the site.

While the seasonal increase in beryllium was attributed to desorption from smectite-type clay minerals, cobalt sorption to clay fractions is not favorable. However, cobalt is known to readily adsorb to iron oxides (Borggaard, 1987; McLaren, et al., 1986). Both the boring log for SP-B4, which was advanced to re-log AD-22 (Attachment A), and the original boring log for AD-22 (Attachment B) indicate the presence of iron ore material in the aquifer solids. Additionally, XRD analysis confirmed the presence of goethite, a pure iron oxide (FeOOH), present at low concentrations both within the seasonal water table and the screened interval at AD-22 (Table 1).

The presence of well-defined goethite suggests amorphous iron oxides are also likely present within these soils and provide reactive cation exchange sites with cobalt. These amorphous iron oxides, while likely present, are not easily identifiable with XRD, due to the non-crystalline nature of these iron phases. Seasonal increases in cobalt concentrations are likely associated with greater contact between groundwater and these iron oxides as the water table rises and saturates more of the aquifer solids.

While goethite was identified in the seasonally saturated zone, siderite and pyrite, both reduced iron-bearing minerals, were identified deeper, within the saturated screened interval at AD-22 (Table 1). The weathering of siderite and pyrite to goethite under oxidizing conditions is a well-understood phenomenon, including in formations in east Texas (Senkayi, et al., 1986; Dixon, et al., 1982). A review of geochemical conditions at AD-22 shows that pyrite and goethite are both able to form under different conditions, with recent conditions favoring goethite (Figure 10). Cobalt is known to substitute for iron in both siderite and pyrite due to their similar ionic radii (Gross, 1965; Hitzman, et al., 2017; Krupka and Serne, 2002). The proposed substitution of cobalt for iron in the crystal lattice of pyrite has been documented in other ASDs prepared for the Pirkey Plant's East Bottom Ash Pond (EBAP; Geosyntec, 2019b) and West Bottom Ash Pond (WBAP; Geosyntec, 2019c). The contribution of cobalt to groundwater via dissolution of siderite or pyrite is not likely to change seasonally, as they are present within the screened interval where the aquifer materials are continuously saturated.

As described above, the ratio between the observed calcium and concentrations is consistently on the order of 100:1 at all groundwater monitoring wells in the network (Figure 9). A sample was collected of the solid FGD sludge material which is accumulated on the Stackout Pad. The solid phase sample was leached using both USEPA's Synthetic Precipitation Leaching Profile (SPLP) testing procedure (SW-846 Test Method 1312) and Texas Commission on Environmental Quality's (TCEQ's) 7-Day Distilled Water Leachate Test Procedure (30 TAC Chapter 335 Subchapter R Appendix 4). While cobalt concentrations in both of the leached samples are consistent with those observed in the groundwater samples, the leached calcium concentrations are approximately two to three orders of magnitude higher. However, calcium concentrations in groundwater are generally consistent between AD-22 and upgradient well AD-13 (Figure 11). The different ratio between calcium and cobalt in the leached FGD sludge material (about 45,000:1) as compared to the ratio for groundwater partnered with the similarity between upgradient and downgradient calcium concentrations provide additional lines of evidence that the exceedances observed at the FGD Stackout Pad are not due to a release from the unit.

2.1.3 Conceptual Site Model

The seasonal fluctuations in beryllium concentrations at AD-7 and AD-22 and cobalt at AD-22 can be attributed to variations in the amount of the aquifer solids that are in contact with groundwater as the water table elevation changes. When the water table is higher, more clay material is in contact with groundwater, allowing greater desorption of cations (including beryllium) from the cation exchange sites on the clay. In the case of cobalt, more iron oxides are in contact with groundwater as the water table rises, allowing greater desorption from both amorphous and mineral phases. Thus, the observed SSLs were attributed to natural variation associated with seasonal desorption of beryllium and cobalt as the amount of aquifer solids that are saturated increases.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSLs are not due to a release from the Pirkey FGD Stackout Area, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSLs of beryllium at AD-7 and AD-22 and the SSL of cobalt at AD-22 identified during assessment monitoring in August 2019 were not due to a release from the FGD Stackout Area. The identified SSLs were, instead, attributed to natural variation related to seasonal desorption of beryllium and cobalt from the aquifer solids. Therefore, no further action is warranted, and the Pirkey FGD Stackout Area will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment C.

SECTION 4

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TABLES

Table 1: X-Ray Diffraction Results
FGD Stackout Pad - H. W. Pirkey Plant

Boring Location	**SP-B2**			**SP-B4**		
Associated Well	**AD-7**			**AD-22**		
Depth (ft bgs)	**10-12**	**16-18**	**27-29**	**6-8**	**18-20**	**22-24**
Sample Location	**Within Seasonal Water Table**	**Below Seasonal Water Table**	**Within Screened Interval**	**Within Seasonal Water Table**	**Below Seasonal Water Table**	**Within Screened Interval**
Quartz	39	37	79	28	47.5	95
Plagioclase Feldspar	-	1	-	<0.5	<0.5	1
K-Feldspar	<0.5	1	-	1	0.5	-
Goethite	1	2	0.5	1	-	2
Hematite	-	-	0.5	-	-	-
Chlorite	-	-	-	1	-	-
Siderite		-			10	-
Pyrite	-	-	-	-	2	-
Clays	*	59	20	*	40	2
Kaolinite	9			13		
Illite/Mica	1			2		
Smectite	50			43		
Mixed-Layered Illite/Smectite	-			11		

Notes:

-: not detected

Mineral constituents are reported in percentage.

Values shown as less than indicate the mineral constituent is present but below the quantification limit.

*The clay fraction at SP-B2-10-12 and SP-B4-6-8 were further analyzed to characterize the types of clays present, as listed below.

FIGURES

Legend

⊕ Downgradient Monitoring Well

⊕ Upgradient Monitoring Well

⊕ 2020 Soil Borings

▭ Stackout Pad

Notes

- Soil boring locations are approximate.
- Monitoring well locations are provided by AEP.

500 250 0 500
Feet

March 2020 Soil Borings

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

AMERICAN ELECTRIC POWER

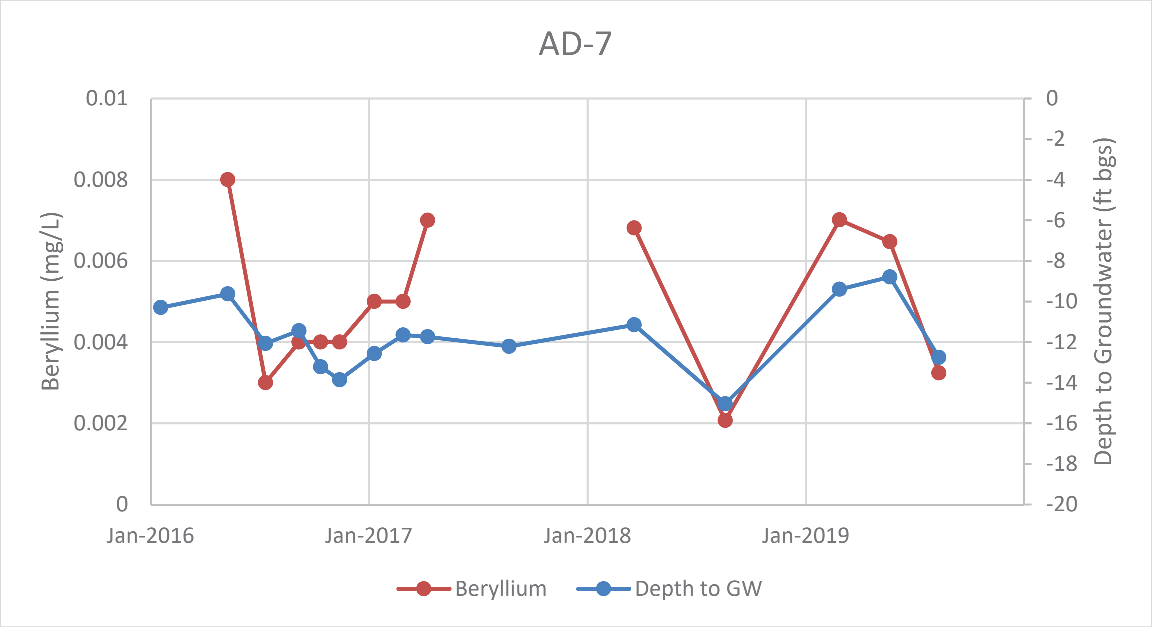
Figure

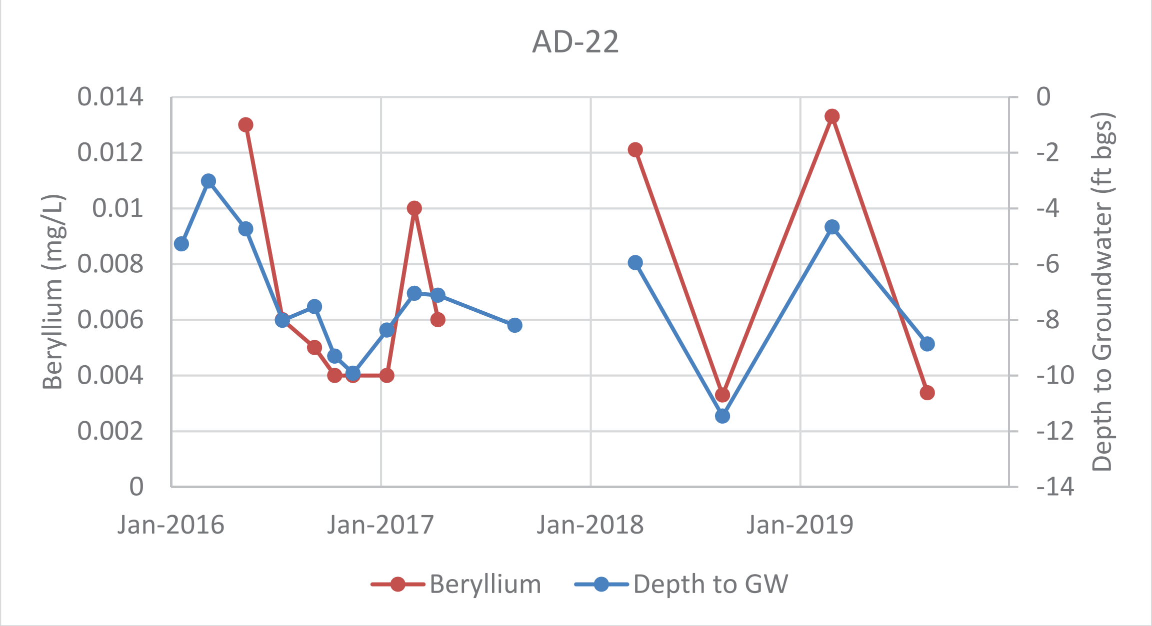
1

Columbus, Ohio

2020/03/27

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\Mike's GIS Files\Pirkey\MXDs\AEP-Pirkey_Stacker_Site_Layout.mxd. BAres. 3/27/2020. Project/Phase/Task.





Notes: Beryllium concentrations are shown in milligrams per liter (mg/L). Depth to water is shown as feet below ground surface (ft bgs). The gap in beryllium data represents the time period in which detection monitoring took place and samples were not analyzed for beryllium.

Beryllium v. Depth to Groundwater

Pirkey FGD Stackout Pad

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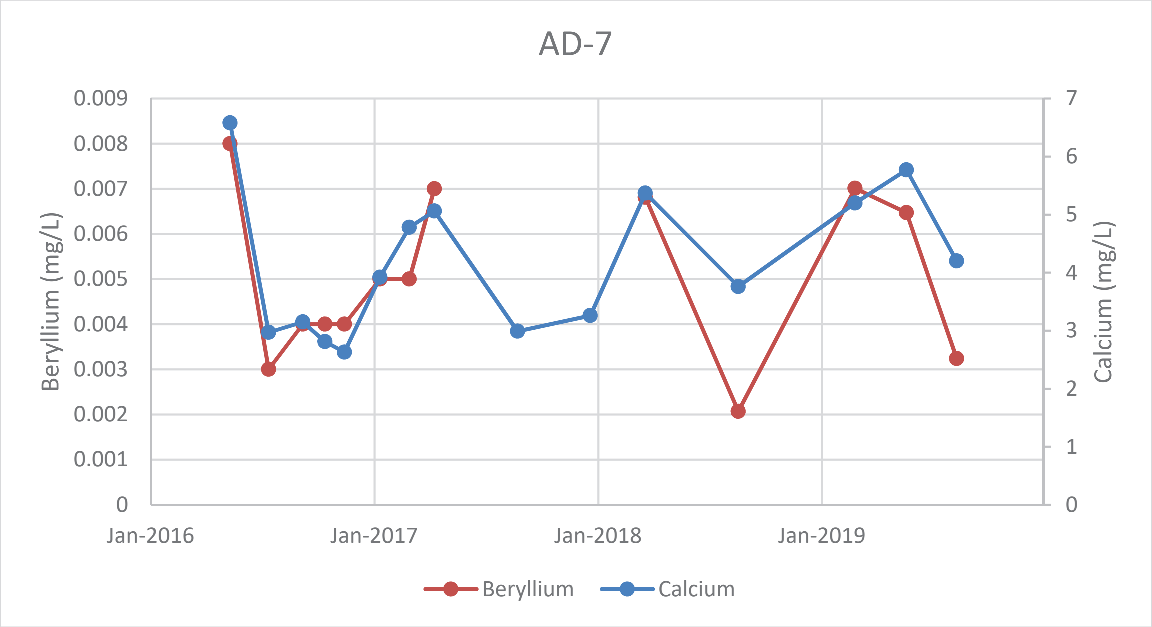
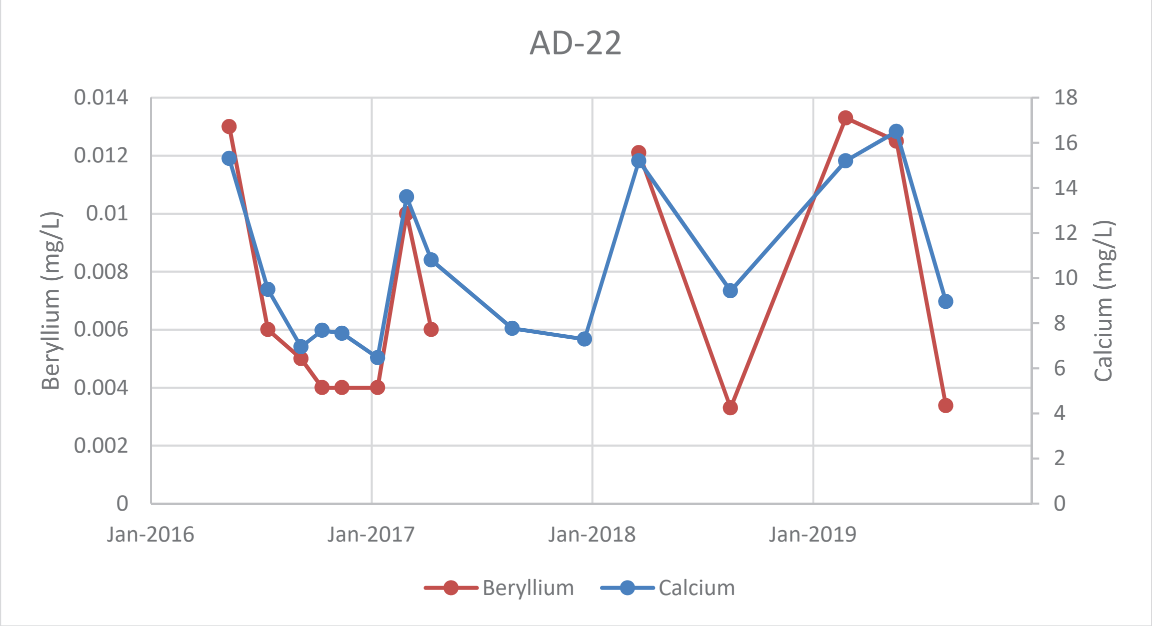
Figure

2

Columbus, Ohio

12-Mar-2020





Notes: Beryllium and calcium concentrations are shown in milligrams per liter (mg/L). The gaps in beryllium data represent the time period in which detection monitoring took place and samples were not analyzed for beryllium.

Beryllium v. Calcium Concentrations

Pirkey FGD Stackout Pad

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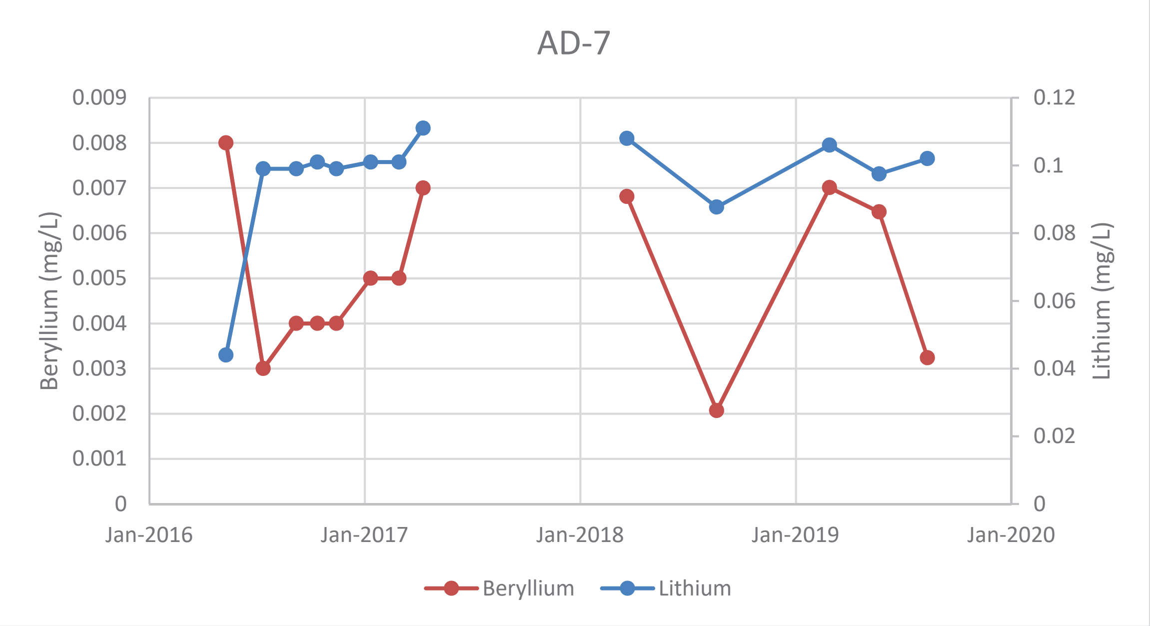
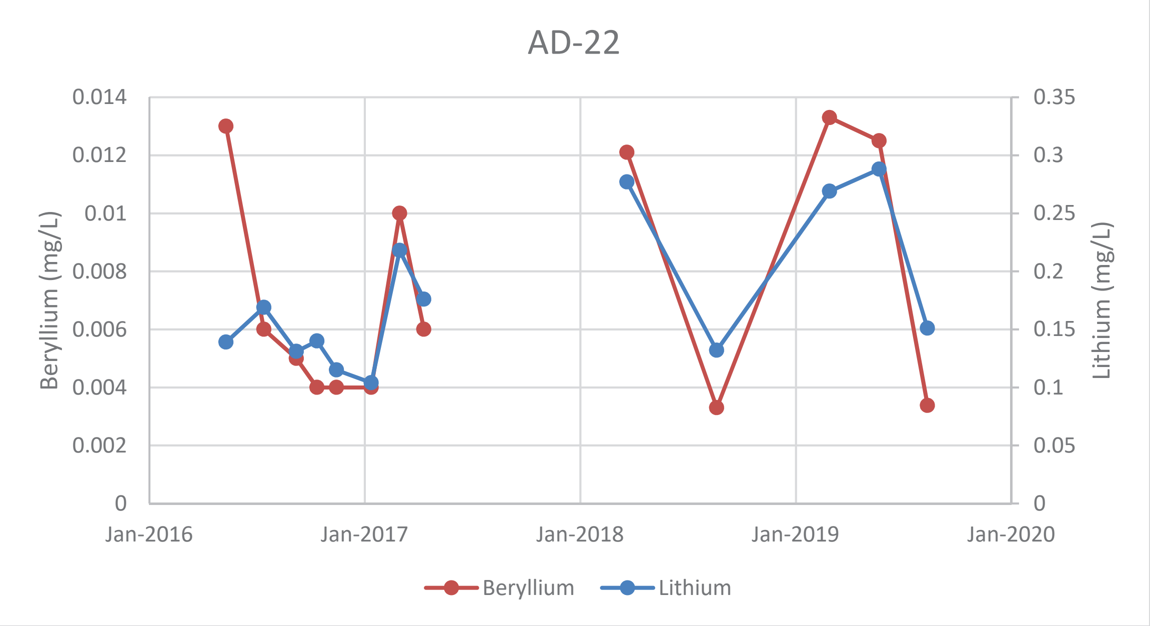
Columbus, Ohio

09-Mar-2020

Figure

3





Notes: Beryllium and lithium concentrations are shown in milligrams per liter (mg/L). The gaps in data represents the time period in which detection monitoring took place and samples were not analyzed for beryllium or lithium.

Beryllium v. Lithium Concentrations
Pirkey FGD Stackout Pad

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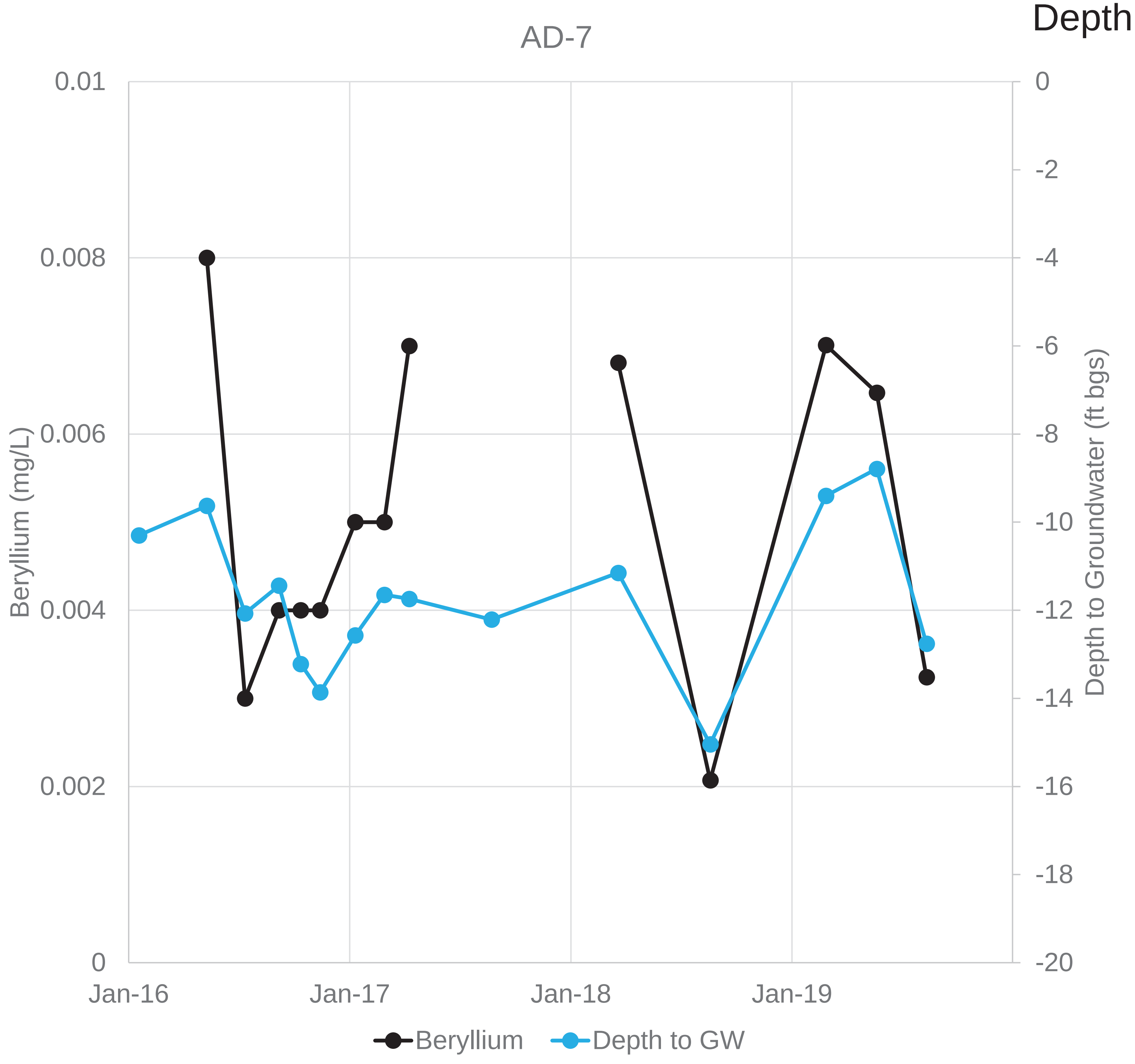
Columbus, Ohio

09-Mar-2020

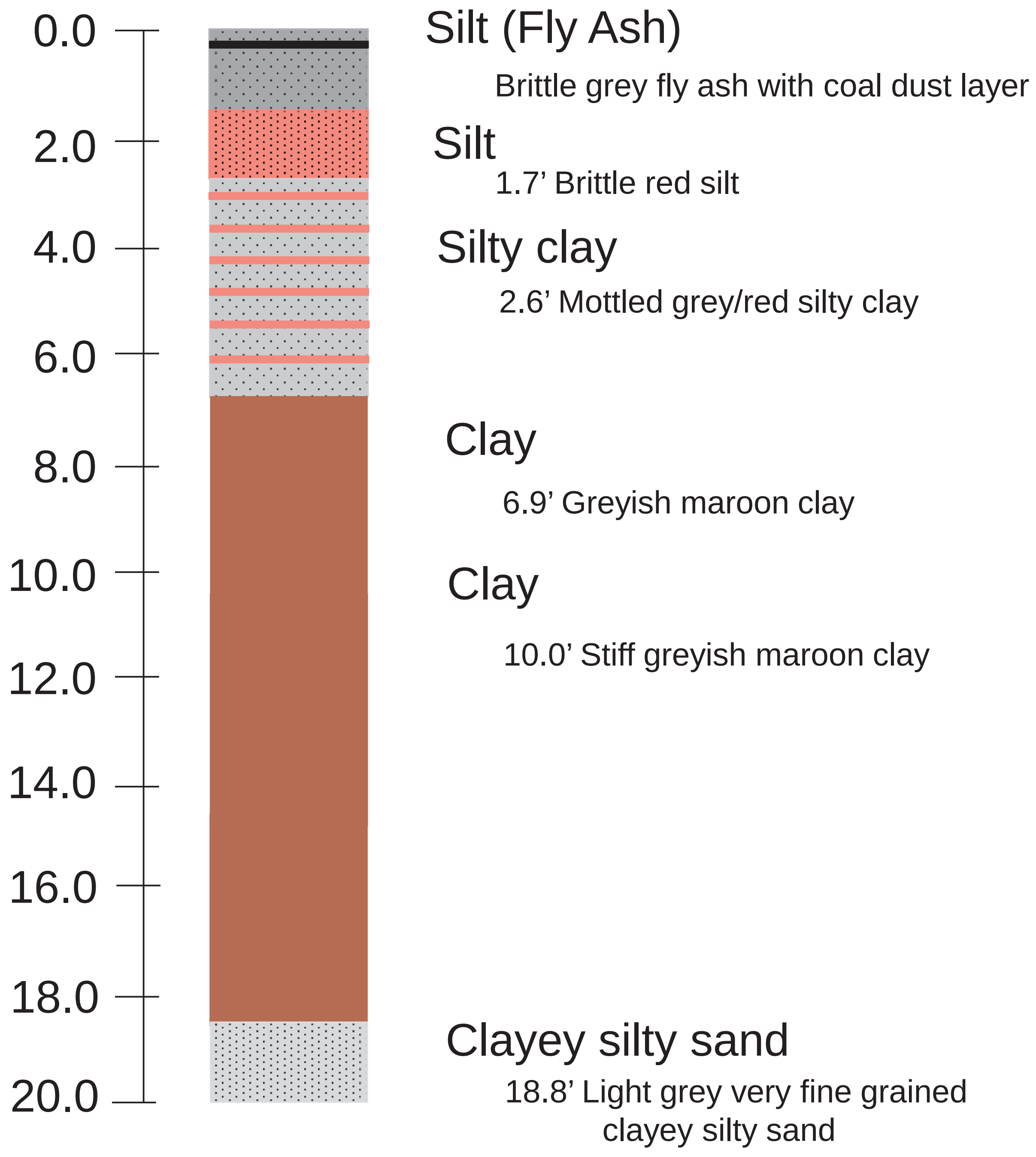
Figure

4

internal info: path, date revised, author



Depth (ft bgs)



Notes:
- AD-7 was re-logged with SP-B2
-A sample was collected for analysis of mineralogy from 10-12 ft bgs.
-The full boring log is available in Attachment A.

internal info: Path, date revised, author

AD-7 Seasonal Water Table Geology

Pirkey FGD Stackout Pad

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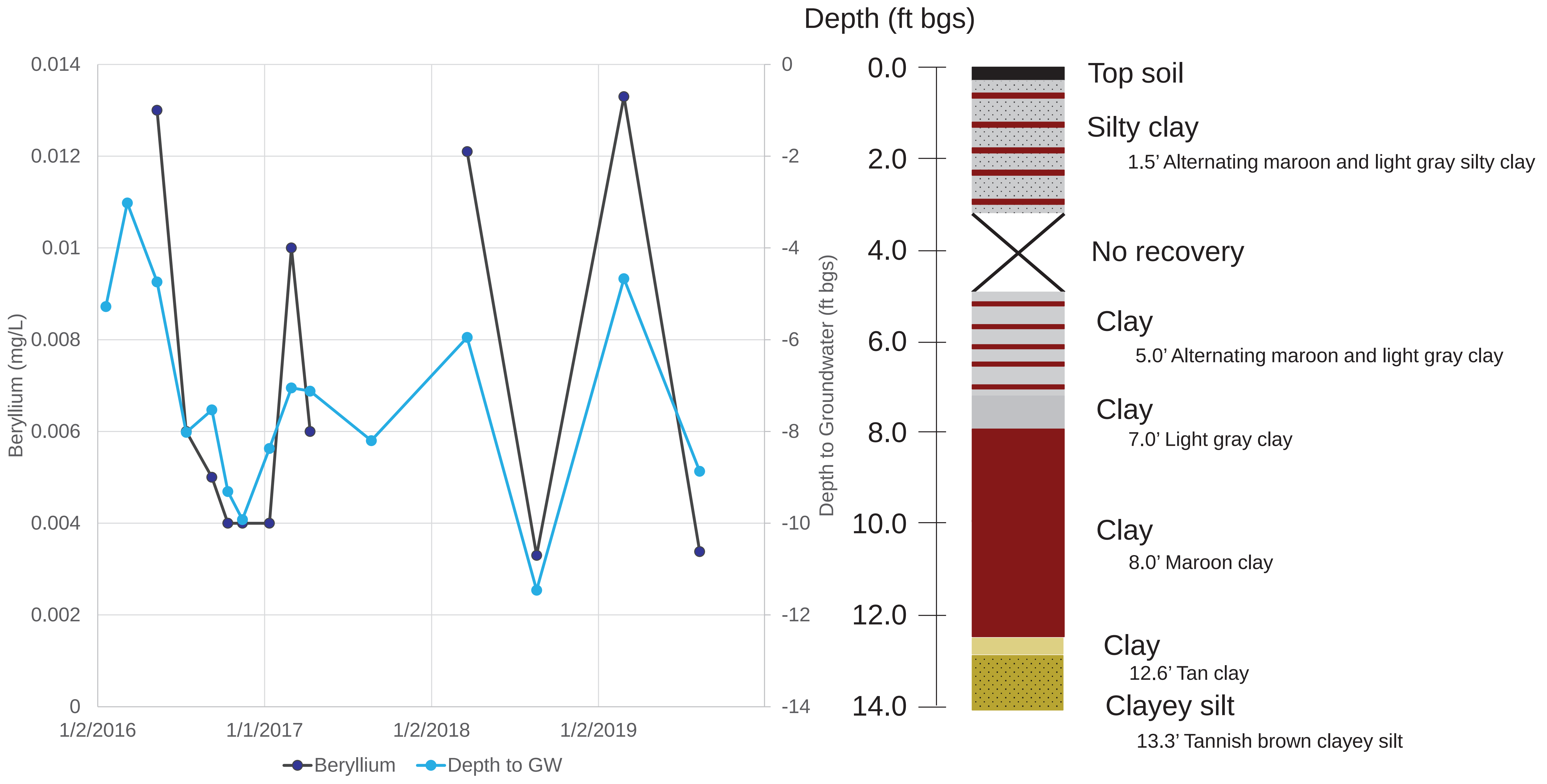
Figure

5

Columbus, OH

13-Mar-2020



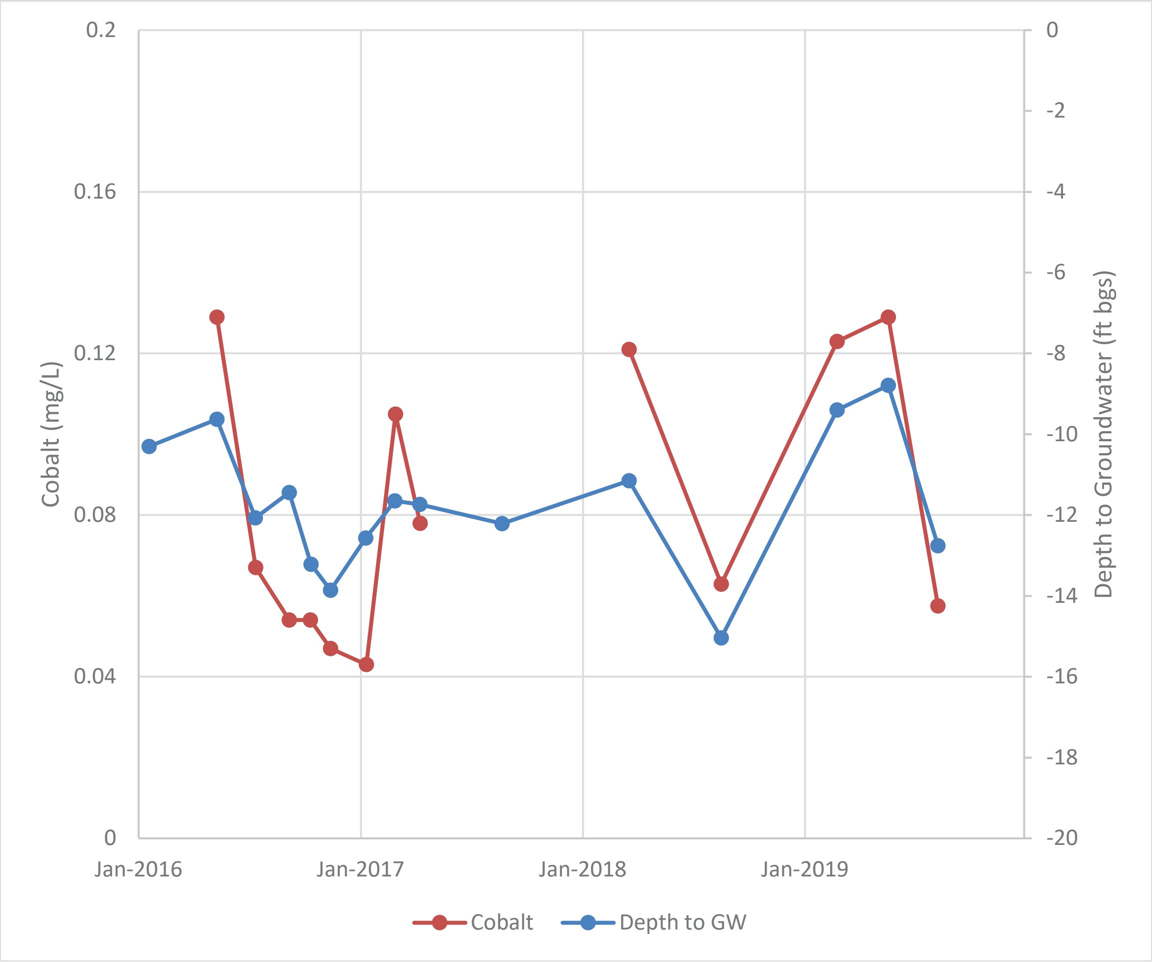
Notes:
-AD-22 was re-logged with SP-B4
-A sample was collected for analysis of mineralogy from 6-8 ft bgs.
-The full boring log is available in Attachment A.

internal info: Path, date revised, author

AD-22 Seasonal Water Table Geology

Pirkey FGD Stackout Pad

Geosyntec consultants	AMERICAN ELECTRIC POWER	Figure 6
Columbus, OH	13-Mar-2020	



Notes: Cobalt concentrations are shown in milligrams per liter (mg/L). Depth to water is shown as feet below ground surface (ft bgs). The gap in cobalt data represents the time period in which detection monitoring took place and samples were not analyzed for cobalt.

AD-22 Cobalt v. Depth to Groundwater

Pirkey FGD Stackout Pad

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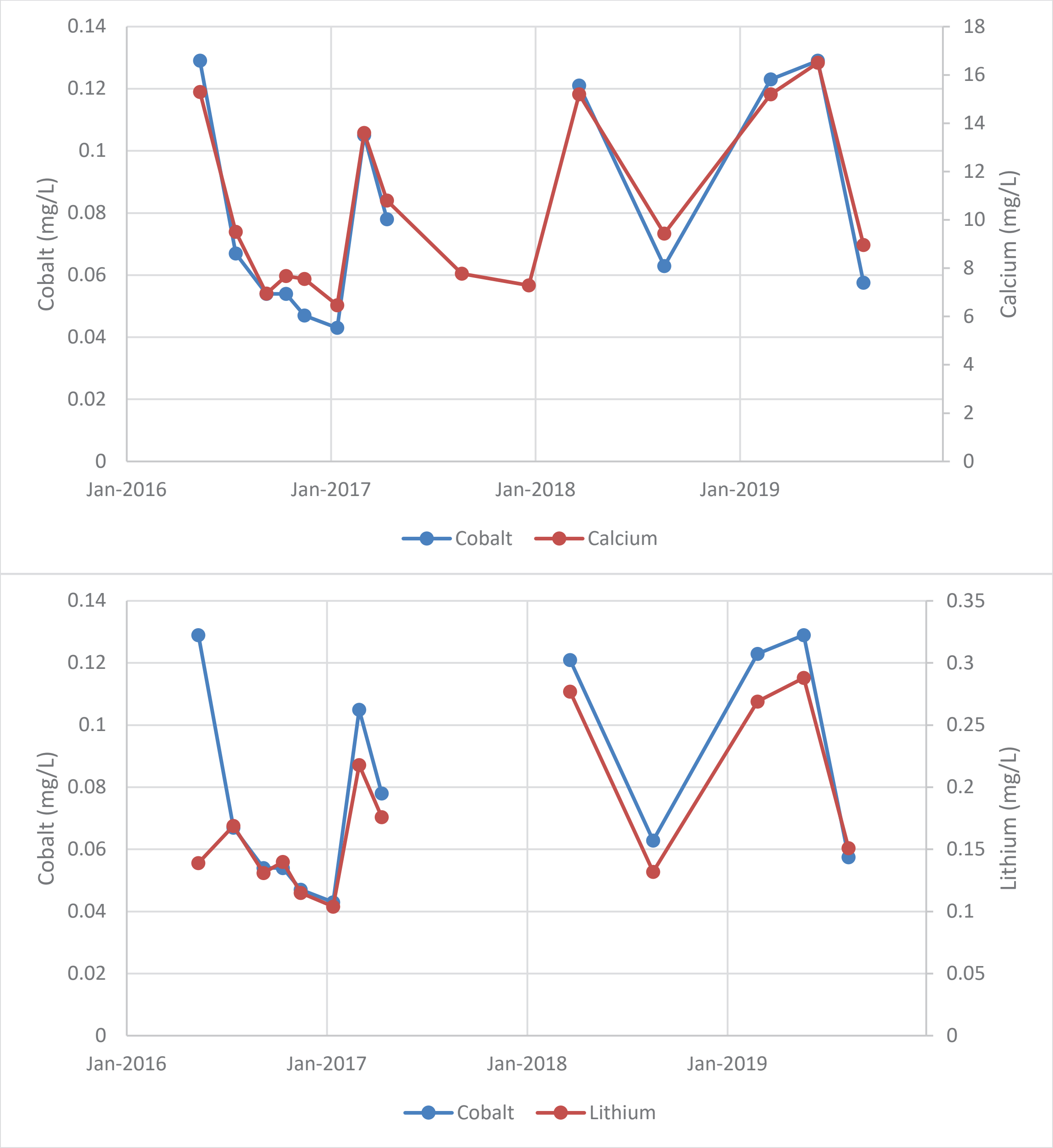
Figure

7

Columbus, Ohio

12-Mar-2020

internal info: path, date revised, author



Notes: Cobalt, calcium, and lithium concentrations are shown in milligrams per liter (mg/L). The gaps in cobalt and lithium data represent the time period during which detection monitoring took place and samples were not analyzed for cobalt and lithium.

AD-22 Cobalt v. Calcium and Lithium

Pirkey FGD Stackout Pad

Geosyntec consultants

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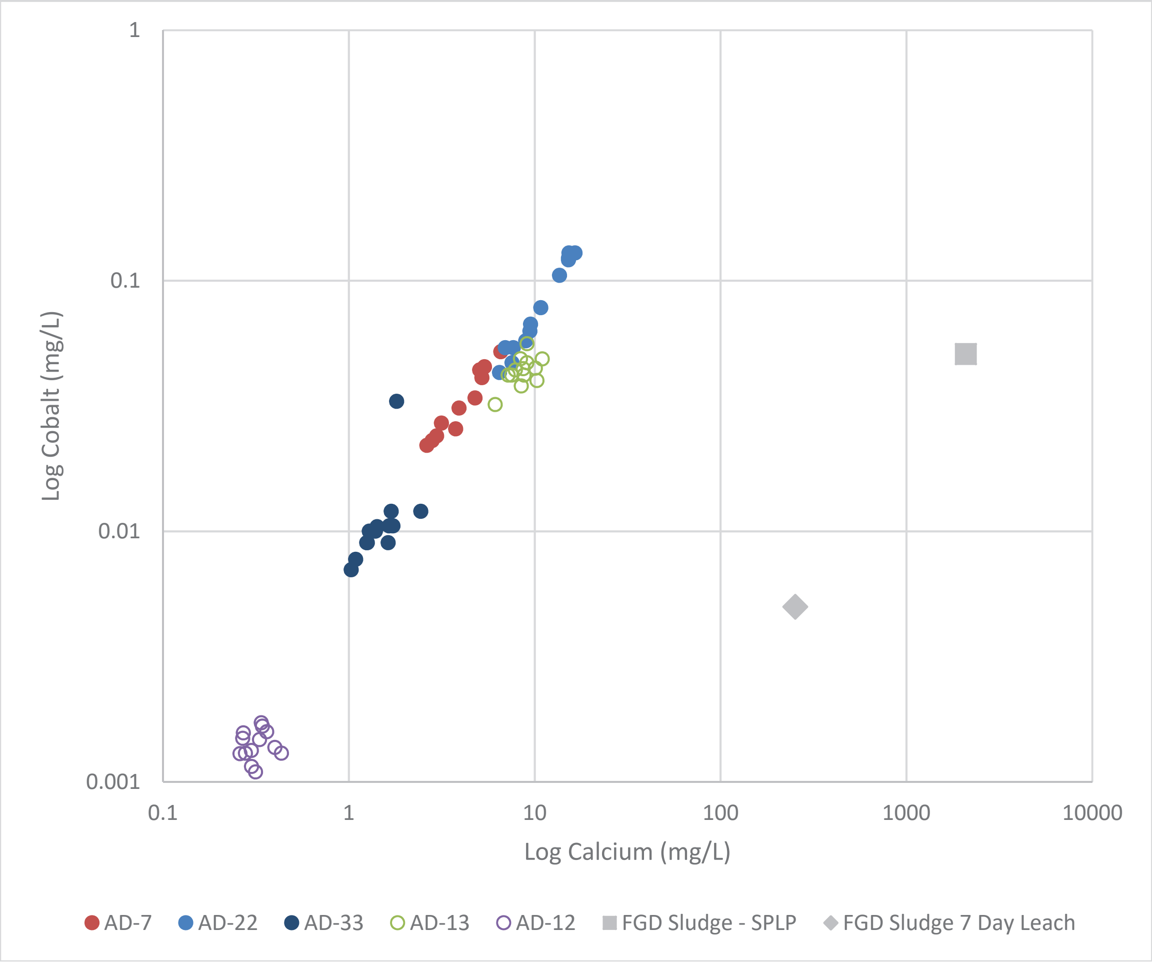
Figure

8

Columbus, Ohio

09-Mar-2020



Notes: Cobalt and calcium concentrations are shown in milligrams per liter (mg/L). Upgradient wells are shown with hollow circles. 'FGD Sludge-SPLP' and 'FGD Sludge 7 Day Leach' present the leached concentrations of cobalt and calcium using the Synthetic Precipitation Leaching Procedure (SW-846 Test Method 1312) and the 7-Day Distilled Water Leachate Test Procedure (30 TAC Chapter 335 R4), respectively.

Cobalt and Calcium Concentration Distribution

Pirkey FGD Stackout Pad

Geosyntec consultants

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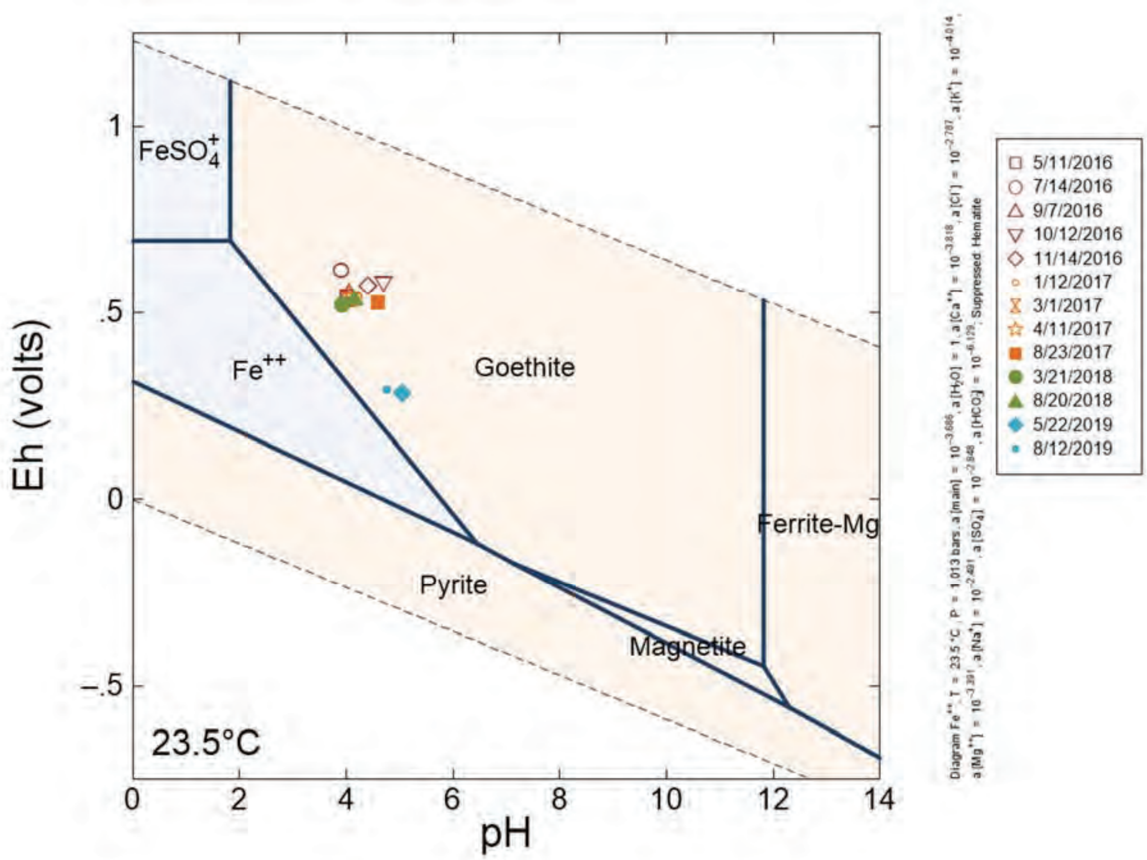
Figure

9

Columbus, Ohio

12-Mar-2020



Notes: Average groundwater concentrations of major cations and anions were used to establish baseline conditions for the diagram. Eh and pH values for sampling dates at AD-22 are shown on the diagram.

AD-22 Eh-pH Diagram

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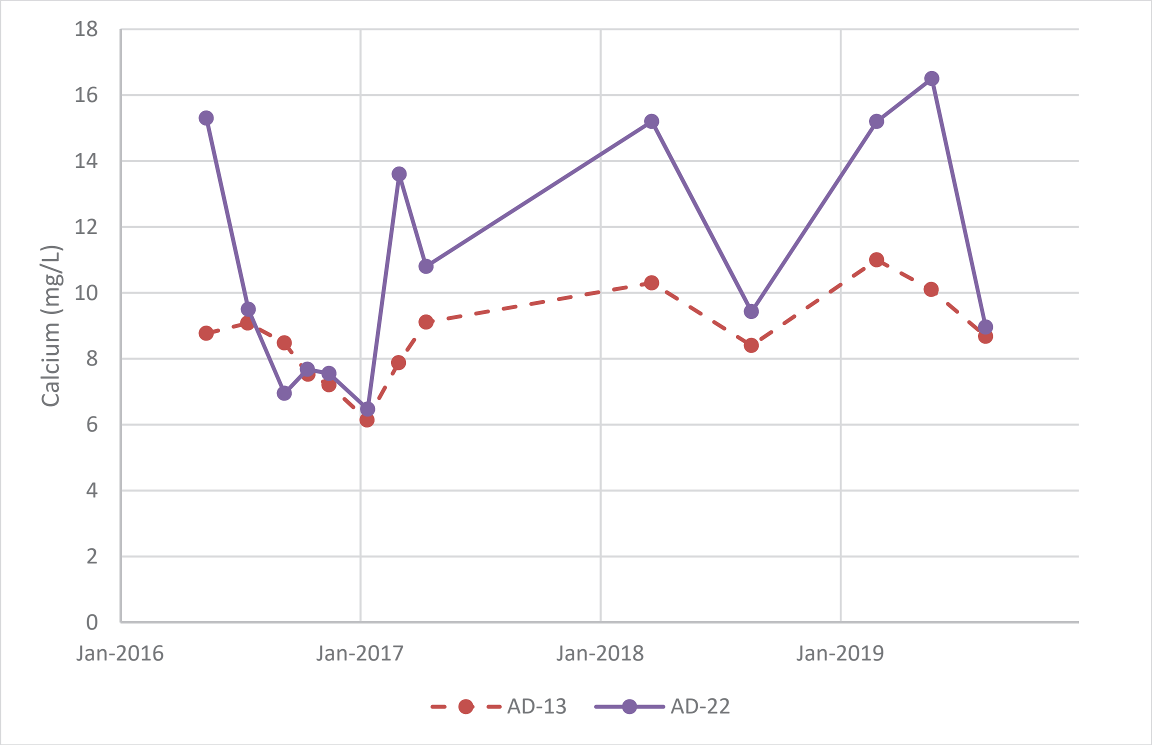
Figure

10

Columbus, Ohio

24-Mar-2020

internal info: path, date revised, author



Notes: Calcium concentrations are shown in milligrams per liter (mg/L). AD-13 is shown with a dashed line because it is an upgradient location.

Calcium Time Series Graph

Pirkey FGD Stackout Pad

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Columbus, Ohio

30-Mar-2020

Figure

11

ATTACHMENT A

March 2020 Boring Logs

Soil Boring Log

Project: AEP Pirkey
Boring/Well Name:______ SP-B1
Project Location:_____ Hallsville, TX
Boring Date:__ 3/2/2020

Soil Profile

Depth Scale Feet	Water Table	Description	PID*
		pp= pocket penetrometer	
0		0.0'-0.4': Top soil with vegetation, black silt	
		0.4'-2.1': Brown silt, fine grained, little cohesion, dry	
		2.1'-4.3': Light maroon and gray clay, low plasticity, moderate stiffness (pp. 3.5); light brown silt/iron ore	
		4.3'-10.0': Maroon clay, low plasticity, high stiffness (pp. 4.0-5.0), iron ore (brown/red silt pockets throughout), moist at 8.5'	
5			
10	▼	10.0'-15.0': Dark maroon clay, wet, moderate plasticity, moderate stiffness (pp. 2.5-3.0), red/brown silt pockets (iron ore)	
15		15.0'-15.5': Dark maroon and red/brown clayey silt; low cohesion; wet	
		15.5'-20.0': Light gray and red/brown clayey silt, wet, low cohesion, iron ore present	
20		20.0'-21.8': Dark maroon and red/brown clayey silt; good cohesion; wet	
		21.8'-24.0': Black silty clay, high stiffness (pp. >5.0), low plasticity	
		24.0'-24.5': Black silty clay, low stiffness (pp. 2.0), moderate plasticity	
25		24.5'-30.0': Dark gray/dark green fine grained sand, well sorted, trace silt; wet	
30		Samples collected at 10-12'; 16-18'; 27-29' TD at 30' bgs *PID readings not collected	
35			

Drill Rig Geoprobe 7822 DT
Drilling Contractor:___ Best Drilling
Driller:_ Ramon Gutierrez

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey

Boring/Well Name:______ SP-B2

Project Location:____ Hallsville, TX

Boring Date:__ 3/2/2020

Depth Scale Feet	Water Table	Soil Profile		PID*
		Description		
		pp= pocket penetrometer		
0		0.0'-0.2':	Gray silt, dry, brittle (fly ash)	
		0.2'-0.4':	Black, coal dust, strong odor	
		0.4'-1.7':	Gray silt, dry, brittle (fly ash)	
		1.7'-2.6':	red silt, brittle, dry	
		2.6'-6.5':	Gray and red silty clay, high stiffness (pp. 4.0-5.0), low plasticity, iron ore/mottling present	
5		6.5'-6.9':	Light gray, red and tan clay, low stiffness (pp. 1.5), moderate plasticity	
		6.9'-10.0':	Light gray and maroon clay, moderate stiffness (pp. 3.5), low plasticity, iron ore/mottling present; moist near 9'	
10	▼	10.0'-15.0':	Light gray and maroon clay, moderate/high stiffness (pp. 3.5-4.5), low plasticity, iron ore/mottling present; wet	
15		15.0'-18.5':	Maroon and light gray clay, moderate/high stiffness (pp. 3.0-4.0), low plasticity; wet	
		18.5'-18.8':	Red/brown silt, trace clay, good cohesion	
		18.8'-20.5':	Light gray clayey silty sand, very fine grained, moderate sorting, mottling present; wet	
20		20.5'-23.4':	Light gray and orange clayey silty sand, very fine grained; mottling present, moderate sorting; wet	
		23.4'-25.0':	Maroon and orange silty clay, low stiffness (pp. 0.5), high plasticity; wet	
25		25.0'-29.0':	Same as above; interchanging between silty clay and clayey silt throughout interval, iron ore/mottling present throughout	
		29.0'-29.5':	Black clay, moderate stiffness (pp.3.0), low plasticity	
		29.5'-30.0':	Gray fine grained sand, well sorted; wet	
30			Samples collected at 10-12'; 16-18'; 27-29'	
			TD at 30' bgs	
			*PID readings not collected	
35				

Drill Rig Geoprobe 3230 DT
Drilling Contractor:___ C&S
Driller:_ DJ Diduch

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey
Boring/Well Name:______ SP-B3
Project Location:_____ Hallsville, TX
Boring Date:__ 3/2/2020

Depth Scale Feet	Water Table	Soil Profile Description		PID*
		pp= pocket penetrometer		
0		0.0'-0.4':	Top soil, Black silt with vegetation	
		0.4'-0.7':	Brown silt, moist, low cohesion	
		0.7'-2.0':	Maroon and light gray silty clay, moderate stiffness (pp.2.5), moderate plasticity, iron ore/mottling present	
		2.0'-2.2':	Brown silt, dry, brittle	
		2.2'-5.6':	Maroon and ligh gray clay, high stiffness (pp. 4.0), low plasticity	
5		5.6'-6.0':	Orange silt, no cohesion, dry	
		6.0'-13.5':	Maroon clay, high stiffness (pp >4.5), low plasticity; moist at 9'; wet at 12'	
10				
	▽			
		13.5'-13.6':	Brown/orange silt (iron ore), no cohesion	
		13.6'-17.5':	Gray and orange clayey silt, good cohesion; iron ore present; wet	
15				
		17.5'-20.2':	Maroon and orange silty clay, low stiffness(pp. 0.5), moderate plasticity; iron ore present; wet	
20		20.2'-21.1':	Brown silt, no cohesion; wet	
		21.1'-22.7':	Brown fine grained sand, well sorted; wet	
		22.7'-25.0':	Maroon and orange silty clay, low stiffness (pp. 0.5), low plasticity; iron ore present; wet	
25				
30			Samples collected at 10-12'; 15-17'; 22-24' TD at 25' bgs; refusal *PID readings not collected	
35				

Drill Rig Geoprobe 3230 DT
Drilling Contractor:___ C&S
Driller:_ DJ Diduch

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey

Project Location:____ Hallsville, TX

Boring/Well Name:______ SP-B4

Boring Date:__ 3/3/2020

Soil Profile

pp= pocket penetrometer

Depth Scale Feet	Water Table	Interval	Description	PID*
0		0.0'-0.4':	Top soil, black silt, vegetation	
		0.4'-0.7':	Brown clayey silt, good cohesion	
		0.7'-1.5':	Red and light gray silty clay, moderate stiffness (pp. 2.5), high plasticity	
		1.5'-3.7':	Maroon and light gray clay, high stiffness (pp. 4.5-5.0), low plasticity; iron ore present 3.1'-3.7'	
		3.7'-5.0':	NO RECOVERY	
5		5.0'-7.0':	Maroon and light gray clay, high stiffness (pp. 4.5-5.0), low plasticity; iron ore present throughout	
		7.0'-8.0':	Light gray clay with iron ore, moderate stiffness (pp.2.5-3.0), moderate plasticity	
		8.0'-10.0':	Maroon clay, moderate stiffness (pp. 3.5), moderate plasticity; iron ore present; moist at 9'	
10		10.0'-12.6':	Maroon clay, moderate stiffness (pp. 3.5), moderate plasticity; iron ore present; wet at 12'	
	▼			
		12.6'-13.3':	Tan clay, low stiffness (pp.1.5), high plasticity; wet	
		13.3'-18.5':	Tan and brown clayey silt, moderate cohesion; iron ore present; wet	
15				
		18.5'-20.3':	Maroon silty clay, low stiffness (pp. 1.0), moderate plasticity; iron ore; wet	
20		20.3'-21.1':	Dark gray/black clay, trace silt, low stiffness (pp. 1.5), high plasticity; wet	
		21.1'-21.3':	Dark gray silt, good cohesion; wet	
		21.3'-21.9':	Dark gray silty clay, low stiffness (pp. 1.5), high plasticity; wet	
		21.9'-22.3':	Dark gray silt, moderate cohesion; wet	
		22.3'-22.7':	light brown silt; low cohesion; wet	
		22.7'-24.4':	Dark gray and dark green silty clay, moderate/high stiffness (pp.3.5), moderate plasticity; wet, glauconite present	
		24.4'-27.8':	Dark green/gray fine grained sand, well sorted; wet; glauconite present	
25		27.8'-30.0':	Red and orange fine grained sand, well sorted, with iron ore; wet	
30				
			Samples collected at 6-8'; 18-20'; 28-30' TD at 30' bgs; refusal *PID readings not collected	
35				

Drill Rig Geoprobe 3230 DT

Drilling Contractor:___ C&S

Driller:_ DJ Diduch

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey

Boring/Well Name:______ SP-B5

Project Location:_____ Hallsville, TX

Boring Date:__ 3/5/2020

Soil Profile

Depth Scale Feet	Water Table	Description		PID*
		pp= pocket penetrometer		
0		0.0'-0.6':	Top soil, black silt, vegetation	
		0.6'-0.9':	Brown clayey silt, good cohesion	
		0.9'-2.4':	Red and gray silty clay, moderate/high stiffness (pp. 3.5), high plasticity; iron ore present	
		2.4'-5.0':	NO RECOVERY	
5		5.0'-8.6':	Maroon and gray clay, moderate/high stiffness (pp. 3.5), low plasticity; iron ore present; moist	
	▼	8.6'-10.0':	Light gray and maroon clay, moderate/low stiffness (pp.2.0), high plasticity; iron ore present; wet	
10		10.0'-12.0':	Maroon and gray clay, high stiffness (pp. 4.0), moderate plasticity, iron ore present; wet	
		12.0'-12.9':	Iron ore with maroon clay, high stiffness (pp.4.0), moderate plasticity; wet	
		12.9'-15.0':	Maroon clay, high stiffness (pp.4.0), high plasticity; iron ore present; wet	
15		15.0'-18.4':	Light gray and orange clayey silt, good cohesion; iron ore present; wet	
		18.4'-18.6':	Dark maroon iron ore; wet	
		18.6'-20.0':	Orange and gray clayey silt, good cohesion; iron ore present; wet	
		20.0'-21.2':	Maroon and orange clayey silt, good cohesion; iron ore present; wet	
20		21.2'-22.3':	Black clay, trace silt, low stiffness (pp.1.0), high plasticity; wet	
		22.3'-22.6':	Black clay, high stiffness (pp.4.5), moderate plasticity	
		22.6'-22.9':	Black silt, no cohesion; wet	
		22.9'-23.4':	Black clay, trace silt, moderate stiffness (pp.2.5), high plasticity; wet	
		23.4'-25.0':	Dark gray and green fine grained sand; well sorted; wet; glauconite present	
25			Samples collected at 6-8'; 16-18'; 23-25' TD at 25' bgs; refusal *PID readings not collected	
30				
35				

Drill Rig Geoprobe 3230 DT

Drilling Contractor:___ C&S

Driller:_ DJ Diduch

Geosyntec Consultants

ATTACHMENT B

AD-22 Boring Log and Well Installation Diagram

☐ BORING ■ MONITOR WELL

APEX PROJECT NO.: 110-089 **BORING NUMBER:** ______ **MONITOR WELL NUMBER:** AD-22

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

FACILITY ADDRESS: Hallsville, Texas

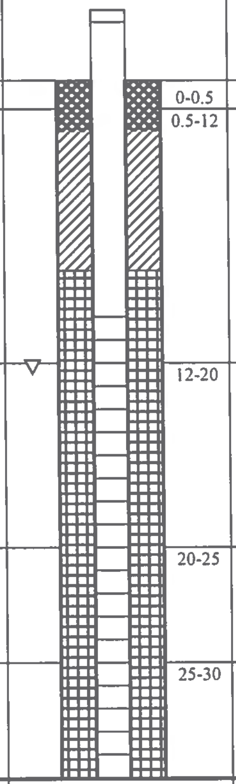
DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/16/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 **WELL LOCATION:** Triangle- South side Quansit Hut

LONGITUDE: W94°29'41.3"



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SC	Clayey sand, light brown, very fine grained	None	Moist
2 3 4 5 6 7 8 9 10 11 12			0.5-12	CL	Lean clay, light brown mottled with light gray Few iron ore (small) pebbles in clayey sandy streaks	None	Slightly Moist
13 14 15 16 17 18 19 20			▽ 12-20	SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained Slightly wet @ 12.5' from seepage Large amount of iron ore 15-17' Very firm 18-18.5'	None	Slightly Wet
21 22 23 24 25			20-25	SC	(Dense crystalline rock 21-21.1'), light brown clayey sand, greenish black, mica, black clay streaks, very fine grained, wet @ 20'	None	Wet
26 27 28 29 30			25-30	SM	Sand, greenish brown (1') grading to orangish brown, silty, very fine grained	None	Wet
31 32 33 34 35 36 37 38 39 40					Boring Terminated at 30'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet

Filter Sand (Size/Interval): 8-30'

Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'

Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'

Screen Interval: 10-30'

Water level: 12.5'

Above Ground 3'

Note: This log is not to be used separate from this report.

ATTACHMENT C

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD Stackout Area CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

BETH ANN GROSS
79864

Geosyntec Consultants
2039 Centre Pointe Blvd, Suite 103
Tallahassee, Florida 32308

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

4/2/2020
Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area Hallsville, Texas

Submitted to

AMERICAN
ELECTRIC
POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec
consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

December 2020

CHA8495

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LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EPRI	Electric Power Research Institute
FGD	Flue Gas Desulfurization
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SPLP	Synthetic Precipitation Leaching Profile
SSL	Statistically Significant Level
SU	Standard Unit
TCEQ	Texas Commission on Environmental Quality
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
WBAP	West Bottom Ash Pond
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

This Alternative Source Demonstration (ASD) report has been prepared to address statistically significant levels (SSLs) for beryllium and cobalt in the groundwater monitoring network at the H.W. Pirkey Plant Flue Gas Desulfurization (FGD) Stackout Area, located in Hallsville, Texas, following the first semiannual detection monitoring event of 2020. The FGD Stackout Pad is registered as a waste pile under Texas Commission on Environmental Quality (TCEQ) Industrial and Hazardous Waste Solid Waste Registration No. 33240.

The H.W. Pirkey Plant has four regulated coal combustion residuals (CCR) storage units, including the FGD Stackout Pad Area (**Figure 1**). In June 2020, a semi-annual assessment monitoring event was conducted at the FGD Stackout Area in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the unit (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or, for constituents without an MCL, the risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were re-calculated for Appendix IV parameters at the compliance wells to assess whether these parameters were present at a statistically significant level (SSL) above the GWPSs. Seasonal patterns were observed for beryllium, cobalt, and combined radium at AD-7 and for beryllium, cadmium, cobalt, combined radium, and lithium at AD-22 (Geosyntec, 2020a). To correctly account for seasonality, confidence intervals for these wells and constituents were constructed using deseasonalized values. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey FGD Stackout Pad:

- The deseasonalized LCL for beryllium exceeded the GWPS of 0.00400 mg/L at AD-7 (0.00439 mg/L) and AD-22 (0.00635 mg/L); and

- The deseasonalized LCL for cobalt exceeded the GWPS of 0.0560 mg/L at AD-22 (0.0727 mg/L).

No other SSLs were identified (Geosyntec, 2020a).

1.1 CCR Rule Requirements

USEPA regulations regarding assessment monitoring programs for CCR landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSLs identified for beryllium at AD-7 and AD-22 and cobalt at AD-22 are from a source other than the FGD Stackout Area.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for beryllium and cobalt were based on a Type IV cause and not by a release from the Pirkey FGD Stackout Area.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for beryllium and cobalt and the proposed alternative source are described below.

2.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. Groundwater sampling, laboratory analysis, and statistical evaluations were generally completed in accordance with draft TCEQ guidance for groundwater monitoring (TCEQ, 2020). As described below, the SSL has been attributed to natural variation associated with seasonal effects, which is a Type IV (natural variation) issue.

2.1.1 Beryllium

SSLs were identified for beryllium at AD-7 and AD-22 using deseasonalized statistics (Geosyntec, 2020a). According to the Unified Guidance, "seasonal correction should be done both to minimize the chance of mistaking a seasonal effect for evidence of contaminated groundwater, and also to build more powerful background to compliance point tests. Problems can arise, for instance, from measurement variations associated with changing recharge rates during different seasons" (USEPA, 2009).

The seasonal effects observed in the statistical analysis occur in roughly annual cycles, with somewhat higher beryllium concentrations occurring in early spring and lower concentrations in early fall. For example, beryllium concentrations in 2020 at AD-22 were 0.0101 milligrams per liter (mg/L) in March 2020, in contrast to 0.0080 mg/L in June 2020. Previous ASDs for the Stackout Pad showed that beryllium concentrations at AD-22 and AD-7 appear to correlate with groundwater elevations at the wells (Geosyntec, 2019; Geosyntec, 2020b). This relationship still holds true at both AD-22 and AD-7 (**Figure 2**). Beryllium concentrations at AD-7 and AD-22 are both correlated with seasonal changes in other constituents, including calcium (**Figure 3**) and lithium (**Figure 4**). The correlation between beryllium and both monovalent (lithium) and divalent (calcium) cations suggests that the variability in observed beryllium concentrations are related to cation exchange behavior with clay minerals present in the native soil.

Soil borings which were advanced in March 2020 found that clay materials were identified in the seasonally saturated zones above the permanent water table (Geosyntec, 2020b). At AD-7, which was relogged by SP-B2, the depth to water fluctuated between approximately 9 and 15 feet below ground surface (ft bgs). Silty clay was identified from approximately 2.5-6.9 ft bgs before transitioning to clay until 18.8 ft bgs (**Figure 5**). At AD-22, which was relogged by SP-B4, the depth to water fluctuated between approximately 3 and 12 ft bgs. Clay was identified from approximately 1.5 ft bgs to 13.3 ft bgs, where it transitioned to a clayey silt (**Figure 6**). Analysis by X-ray diffraction (XRD) confirmed the presence of clays within the seasonal water table and sand within the screened interval, as summarized in **Table 1**. The clay fraction of the uppermost samples collected from within the seasonal water table were further analyzed to identify the type of clays present. Smectite-type clays, which are 2:1-layer clays with characteristic cation exchange capacity, make up the majority of the clay minerals present at those intervals.

Sorption and desorption of beryllium from smectite-type clays is well documented (Boschi and Willenbring, 2016a; You, et al., 1989). Desorption was found to be affected by pH, with 75% of beryllium desorbed from a smectite-type clay as pH decreased from 6.0 standard units (SU) to 3.0 SU (Boschi and Willenbring, 2016b). The pH values recorded at AD-7 and AD-22 for samples collected under the Federal CCR Rule ranged from 2.9 to 4.1 SU and 3.9 to 5.1 SU, respectively, suggesting that conditions are favorable for beryllium desorption from smectite-type clays. The presence of these exchangeable clays provides further evidence that the exceedances of beryllium at AD-22 and AD-7 can be attributed to the effects of seasonal groundwater elevation changes, and the resulting cation exchange between groundwater and the exchangeable clay within the seasonal water table, on groundwater quality.

2.1.2 Cobalt

An SSL was identified for cobalt at AD-22 using deseasonalized statistics (Geosyntec, 2020a). As shown in a previous ASD (Geosyntec, 2020b), the cobalt concentrations at AD-22 also appear to correlate with seasonal changes in groundwater elevation (**Figure 7**). The cobalt concentrations are also well correlated with changes in other cations, including calcium and lithium (**Figure 8**), suggesting natural variability associated with interactions with the aquifer solids.

The concentration ratio between calcium and cobalt is consistently on the order of 1000:1 at both upgradient and downgradient locations (**Figure 9**). A sample was collected of the solid FGD sludge material which is accumulated on the Stackout Pad. The solid phase sample was leached using both USEPA's Synthetic Precipitation Leaching Profile (SPLP) testing procedure (SW-846 Test Method 1312) and TCEQ's 7-Day Distilled Water Leachate Test Procedure (30 TAC 335.521 Appendix 4). While cobalt concentrations in both of the leached samples are consistent with those observed in the groundwater samples, the leached calcium concentrations are approximately two to three orders of magnitude higher. However, calcium concentrations in groundwater are generally consistent between AD-22 and upgradient well AD-13 (**Figure 10**). The different ratio between calcium and cobalt in the leached FGD sludge material (about 45,000:1) as compared to the ratio for groundwater indicate that dissolved calcium concentrations at AD-22 would be significantly higher if the groundwater at this location were affected by leachate. The similarity between upgradient and downgradient calcium concentrations, provides an additional line of evidence that the exceedances observed at the FGD Stackout Pad are not due to a release from the unit.

Siderite and pyrite, both reduced iron-bearing minerals, were identified below the seasonal water table (within the saturated zone) at AD-22. Cobalt is known to undergo isomorphic substitution for iron in both siderite and pyrite (Gross, 1965; Hitzman, et al., 2017; Krupka and Serne, 2002). This is due to the similarity of their ionic radii (approximately 1.56 angstrom (Å) for iron vs. 1.52 Å for cobalt [Clementi and Raimondi, 1963). The proposed substitution of cobalt for iron in the crystal lattice of pyrite has been documented in other ASDs prepared for the Pirkey Plant's East Bottom Ash Pond (EBAP; Geosyntec, 2020c) and West Bottom Ash Pond (WBAP; Geosyntec, 2020d).

Goethite (an iron oxide) was identified within the seasonally saturated zone and the screened interval at AD-22 (**Table 1**). The weathering of siderite and pyrite to goethite under oxidizing conditions is a well-understood phenomenon, including in formations in east Texas (Senkayi, et al., 1986; Dixon, et al., 1982) and may have occurred within the seasonally saturated zone. A review of geochemical conditions at AD-22 shows that the conditions observed at AD-22 are favorable for goethite formation (**Figure 11**). During weathering from reduced to oxidized iron minerals, cobalt would be released from the mineral structure. The contribution of cobalt to groundwater via dissolution of siderite or pyrite within the saturated aquifer is not likely to change seasonally. However, the mobilization of cobalt which was released during weathering of siderite or pyrite to goethite in the seasonally saturated zone may explain the variability in aqueous cobalt concentrations and their correlation with the groundwater elevation.

2.1.3 Conceptual Site Model

The seasonal fluctuations in beryllium concentrations at AD-7 and AD-22 and cobalt at AD-22 can be attributed to variations in the amount of the aquifer solids that are in contact with groundwater as the water table elevation changes. When the water table is higher, more clay material is in contact with groundwater, allowing greater desorption of cations (including beryllium) from the cation exchange sites on the clay. In the case of cobalt, more iron oxides are in contact with groundwater as the water table rises, allowing for the release of cobalt from mineral phases where it has isomorphically substituted for iron. Thus, the observed SSLs were attributed to natural variation associated with seasonal desorption of beryllium and cobalt as the amount of aquifer solids that are saturated increases.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSLs are not due to a release from the Pirkey FGD Stackout Area, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of beryllium at AD-7 and cobalt at AD-22 identified during assessment monitoring in June 2020 were not due to a release from the FGD Stackout Area. The identified SSLs were, instead, attributed to natural variation related to seasonal desorption or dissolution of beryllium and cobalt from the aquifer solids. Therefore, no further action is warranted, and the Pirkey FGD Stackout Area will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in **Attachment C.**

SECTION 4

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TABLES

Table 1: X-Ray Diffraction Results
FGD Stackout Pad - H. W. Pirkey Plant

Boring Location	**SP-B2**			**SP-B4**		
Associated Well	**AD-7**			**AD-22**		
Depth (ft bgs)	**10-12**	**16-18**	**27-29**	**6-8**	**18-20**	**28-30**
Sample Location	**Within Seasonal Water Table**	**Below Seasonal Water Table**	**Within Screened Interval**	**Within Seasonal Water Table**	**Below Seasonal Water Table**	**Within Screened Interval**
Quartz	39	37	79	28	47.5	95
Plagioclase Feldspar	-	1	-	<0.5	<0.5	1
K-Feldspar	<0.5	1	-	1	0.5	-
Goethite	1	2	0.5	1	-	2
Hematite	-	-	0.5	-	-	-
Chlorite	-	-	-	1	-	-
Siderite		-			10	-
Pyrite	-	-	-	-	2	-
Clays	*	59	20	*	40	2
Kaolinite	9			13		
Illite/Mica	1			2		
Smectite	50			43		
Mixed-Layered Illite/Smectite	-			11		

Notes:

-: not detected

Mineral constituents are reported in percentage.

Values shown as less than indicate the mineral constituent is present but below the quantification limit.

*The clay fraction at SP-B2-10-12 and SP-B4-6-8 were further analyzed to characterize the types of clays present, as listed below.

FIGURES

Legend

⊕ Downgradient Monitoring Well

⊕ Upgradient Monitoring Well

⊕ 2020 Soil Borings

⬚ Stackout Pad

Notes

- Soil boring locations are approximate.
- Monitoring well locations are provided by AEP.

500 250 0 500
Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

AMERICAN
ELECTRIC
POWER

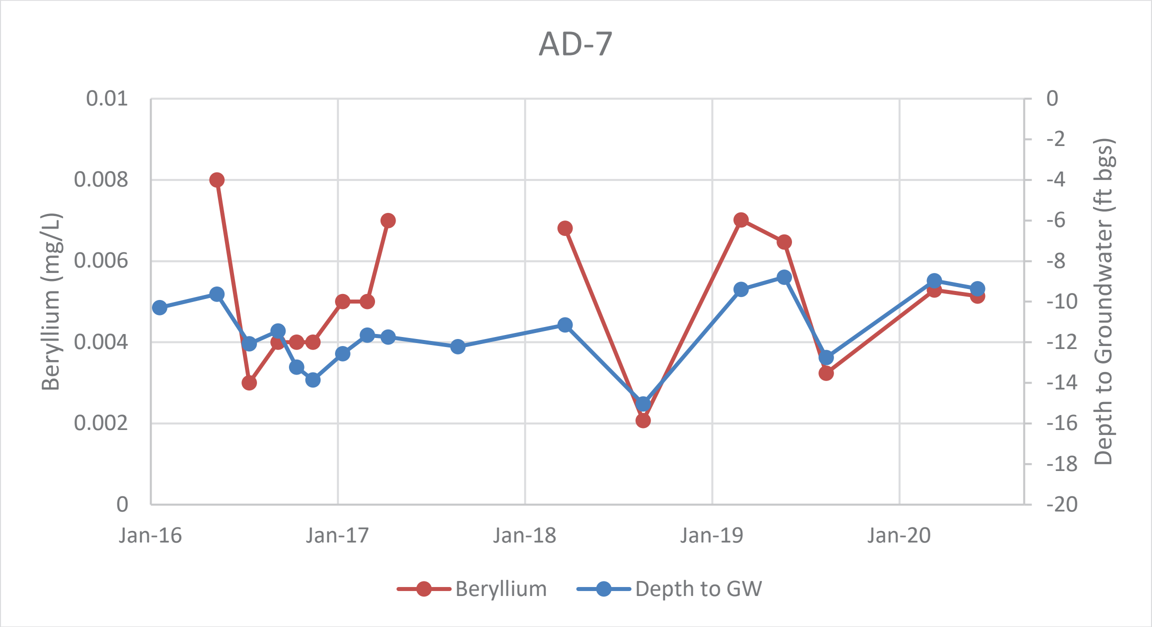
Figure

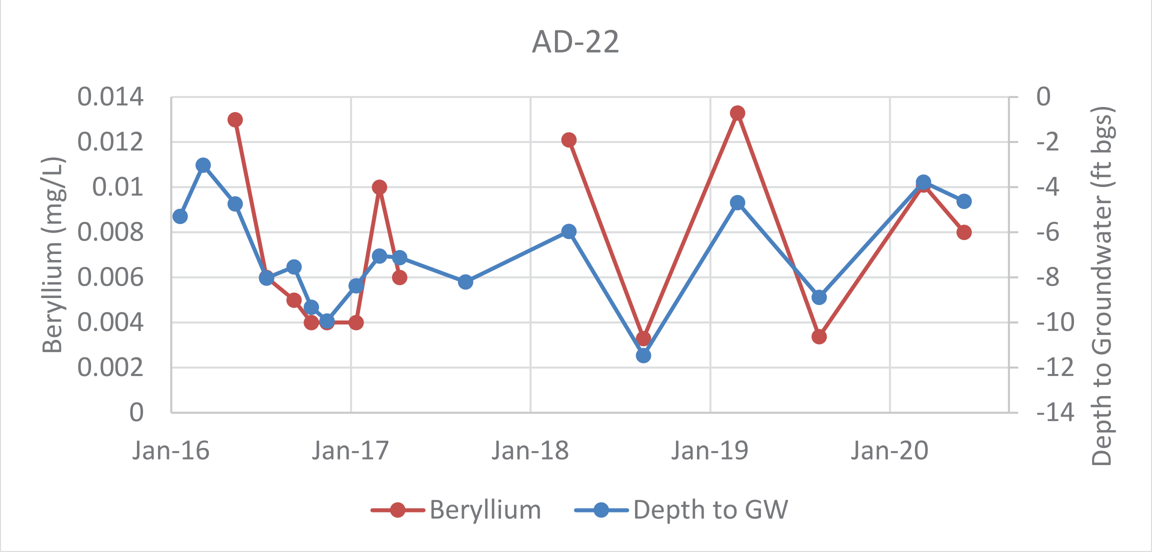
1

Columbus, Ohio

2020/03/27

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\Mike's GIS Files\Pirkey\MXDs\AEP-Pirkey_Stacker_Site_Layout.mxd. BAres. 3/27/2020. Project/Phase/Task.





Notes: Beryllium concentrations are shown in milligrams per liter (mg/L). Depth to water is shown as feet below ground surface (ft bgs). The gap in beryllium data represents the time period in which detection monitoring took place and samples were not analyzed for beryllium.

Beryllium v. Depth to Groundwater
Pirkey FGD Stackout Pad

Geosyntec consultants

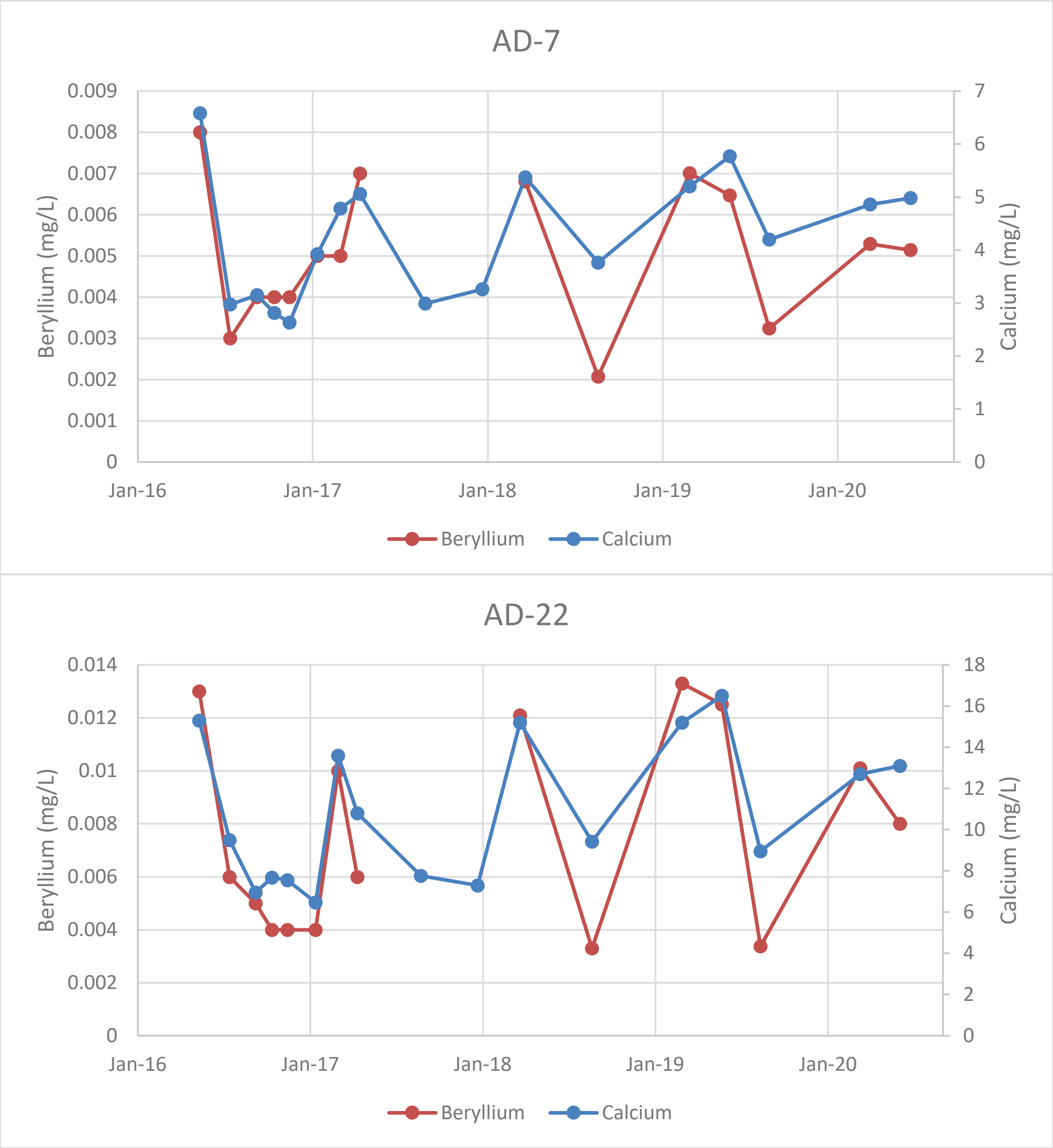
AMERICAN ELECTRIC POWER

Figure

2

Columbus, Ohio

2-Nov-2020



Notes: Beryllium and calcium concentrations are shown in milligrams per liter (mg/L). The gaps in beryllium data represent the time period in which detection monitoring took place and samples were not analyzed for beryllium.

Beryllium v. Calcium Concentrations

Pirkey FGD Stackout Pad

Geosyntec consultants

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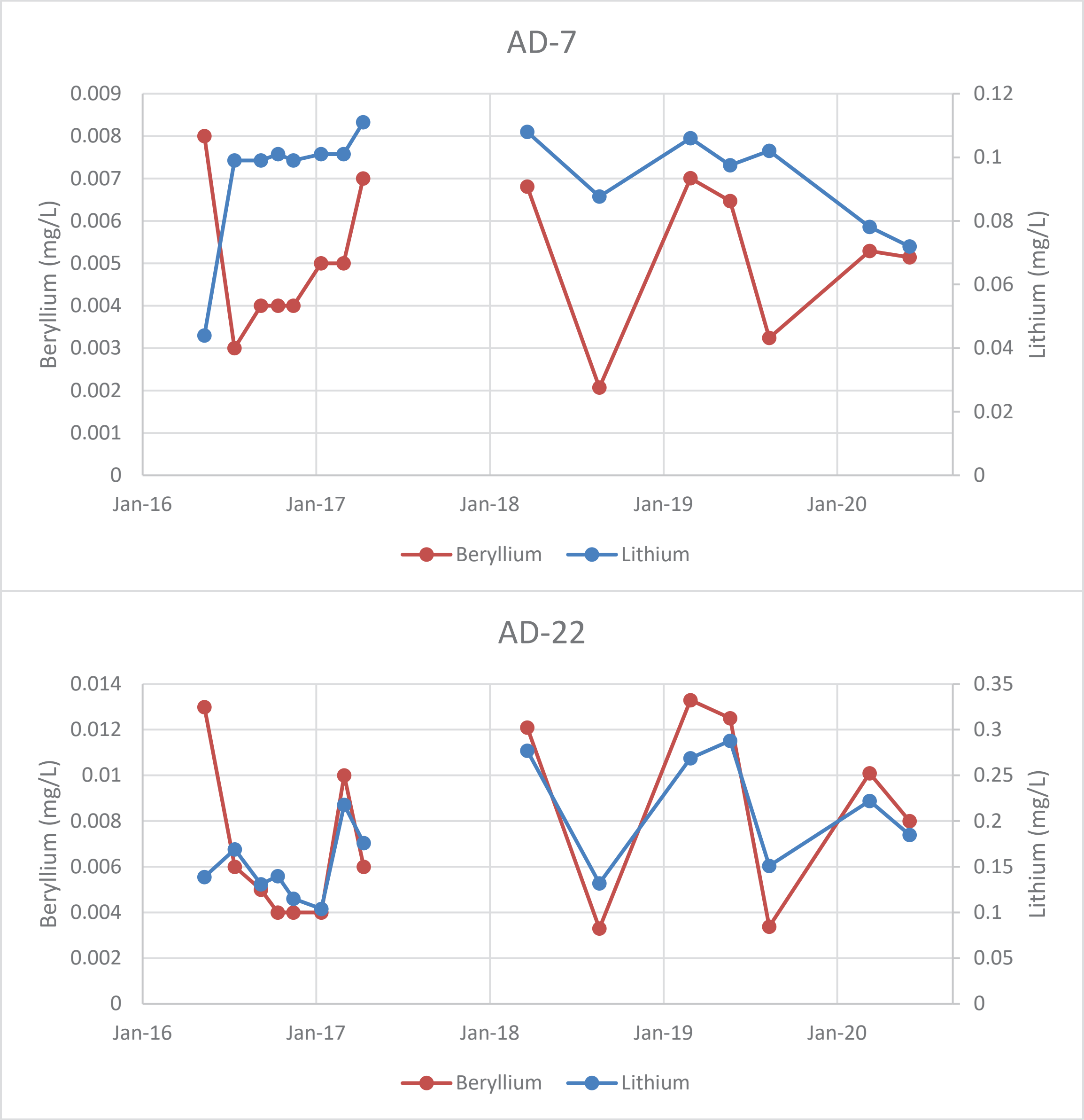
Figure

3

Columbus, Ohio

02-Nov-2020

internal info: path, date revised, author



Notes: Beryllium and lithium concentrations are shown in milligrams per liter (mg/L). The gaps in data represents the time period in which detection monitoring took place and samples were not analyzed for beryllium or lithium.

Beryllium v. Lithium Concentrations
Pirkey FGD Stackout Pad

Geosyntec consultants

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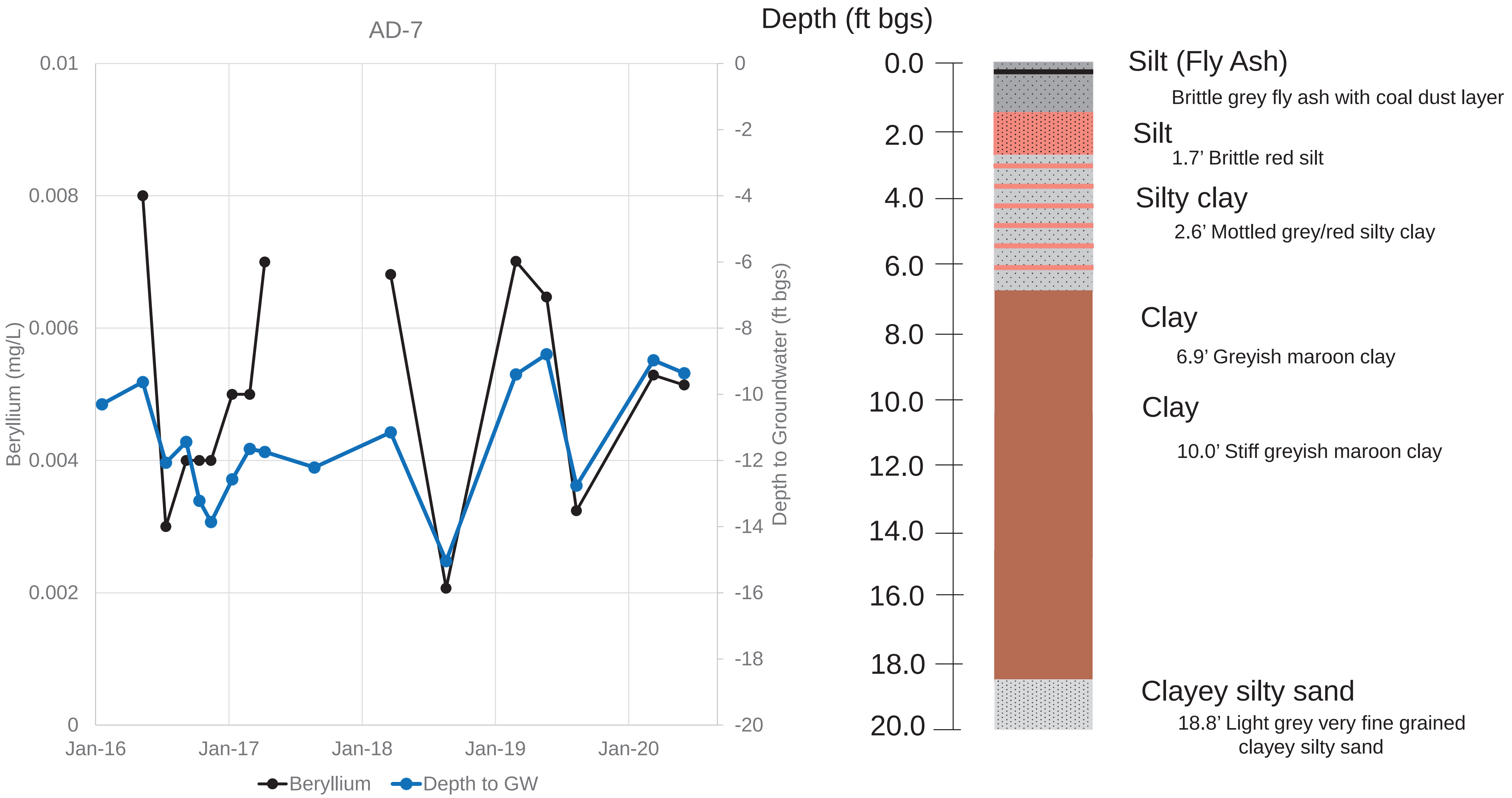
Figure

4

Columbus, Ohio

02-Nov-2020

internal info: path, date revised, author



Notes:
-A sample was collected for analysis of mineralogy from 10-12 ft bgs.
-The full boring log is available in Attachment A.

internal info: Path, date revised, author

AD-7 Seasonal Water Table Geology

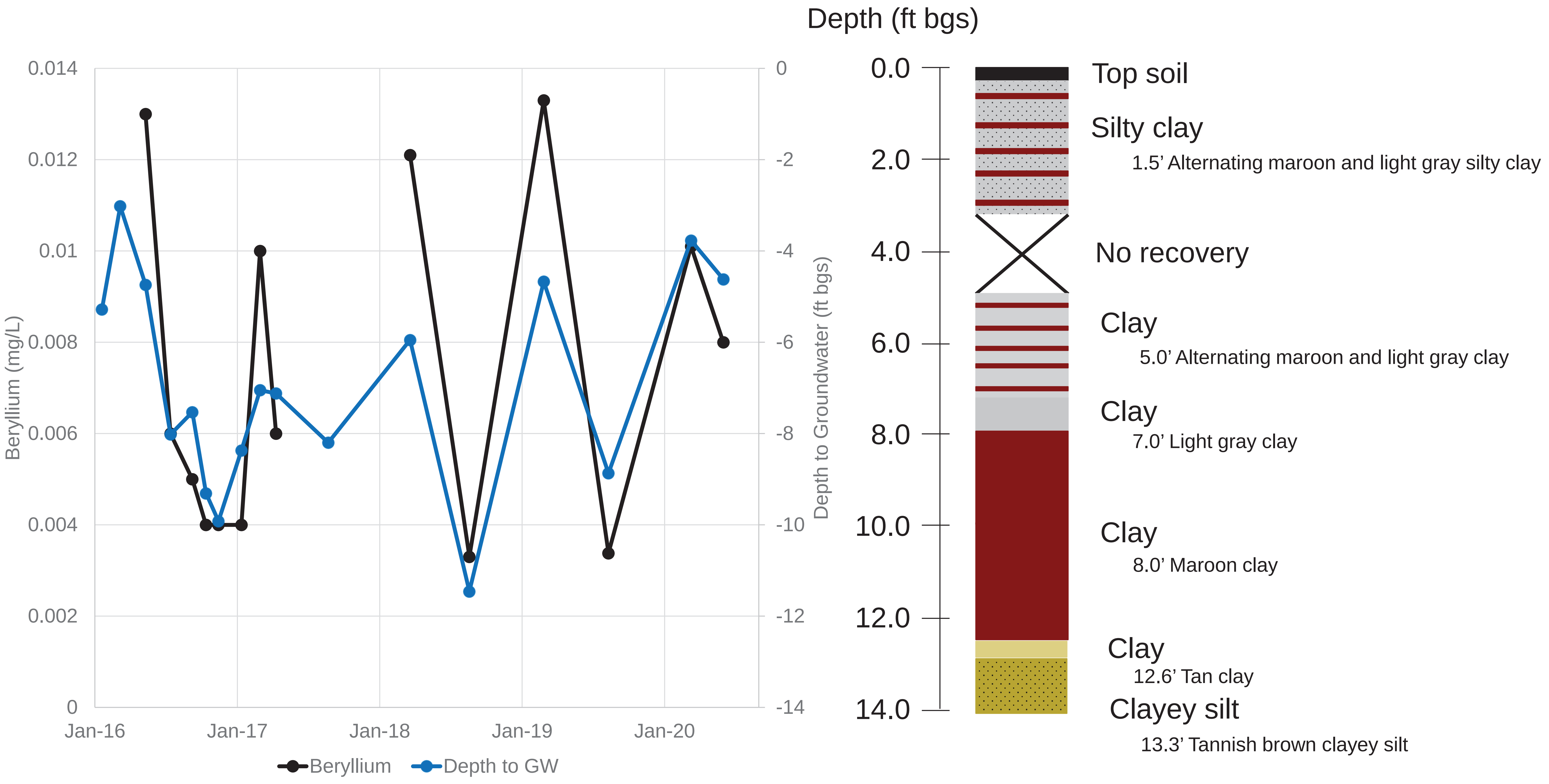
H.W. Pirkey Plant – FGD Stackout Pad

Geosyntec consultants

Figure 5

Columbus, OH

02-Nov-2020



Notes:
-A sample was collected for analysis of mineralogy from 6-8 ft bgs.
-The full boring log is available in Attachment A.

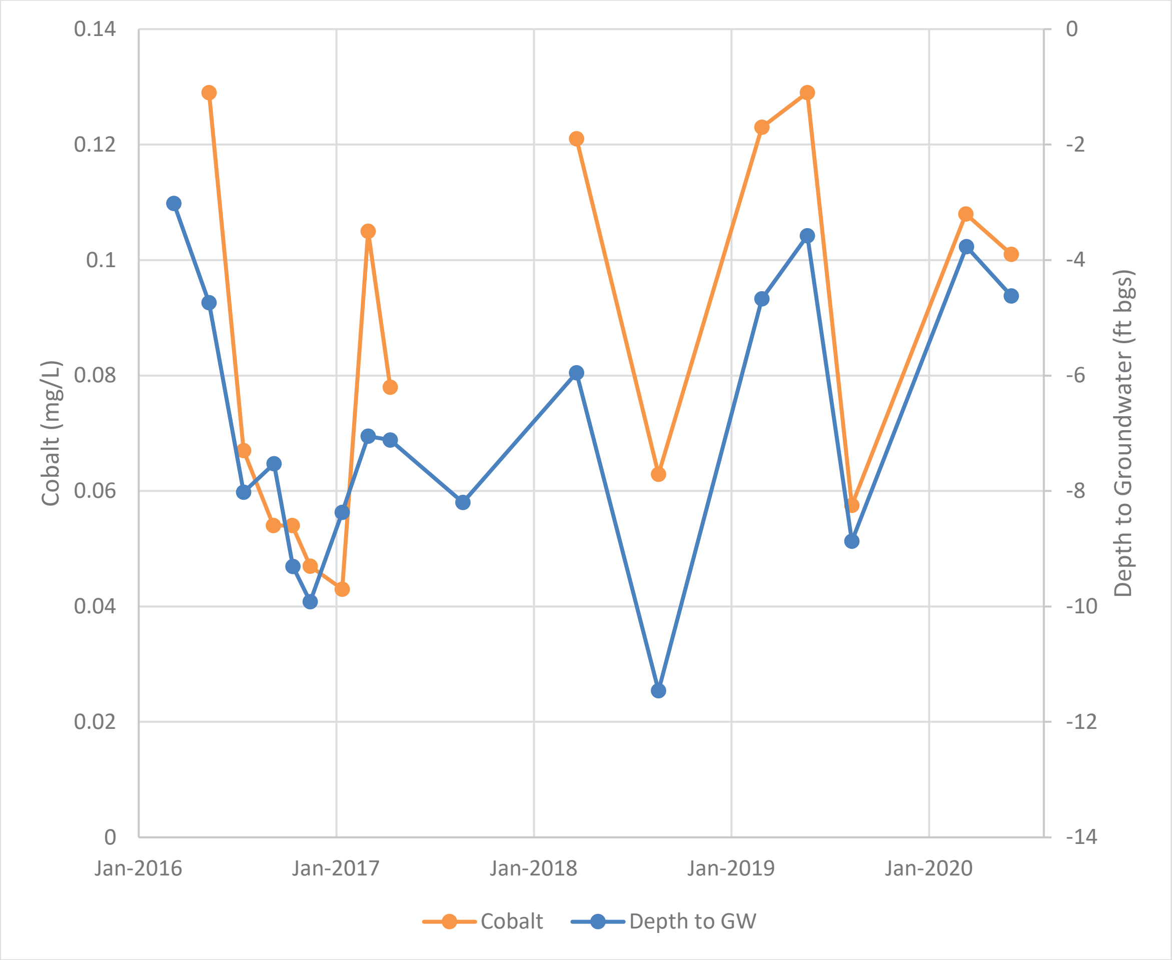
AD-22 Seasonal Water Table Geology
H. W. Pirkey Plant – FGD Stackout Pad

Geosyntec consultants

Figure
6

Columbus, OH
02-Nov-2020

internal info: Path, date revised, author



Notes: Cobalt concentrations are shown in milligrams per liter (mg/L). Depth to water is shown as feet below ground surface (ft bgs). The gap in cobalt data represents the time period in which detection monitoring took place and samples were not analyzed for cobalt.

AD-22 Cobalt v. Depth to Groundwater

Pirkey FGD Stackout Pad

Geosyntec consultants

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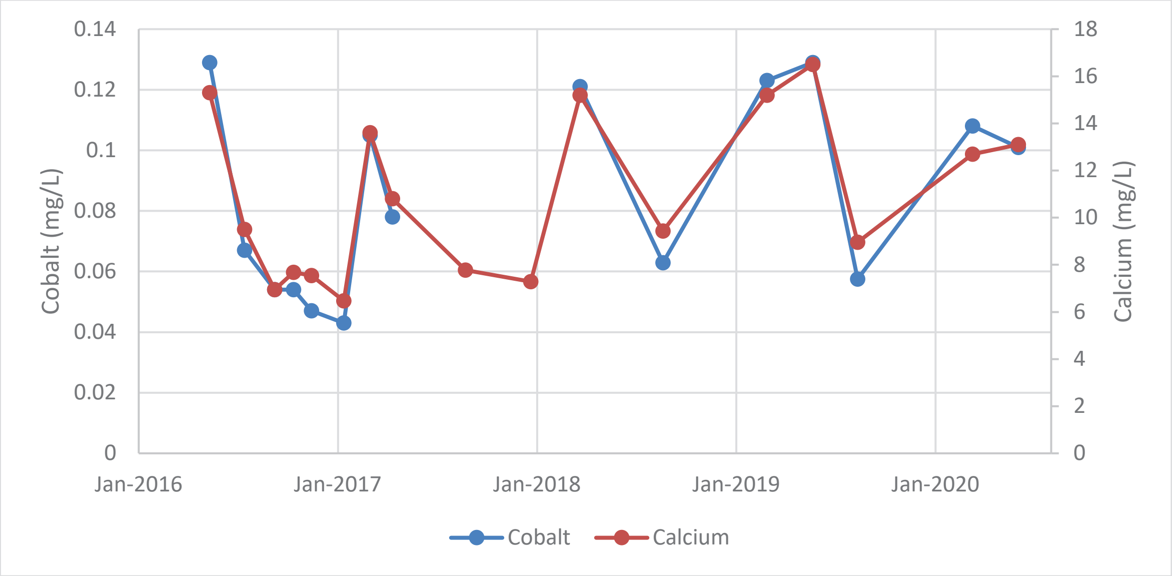
Figure

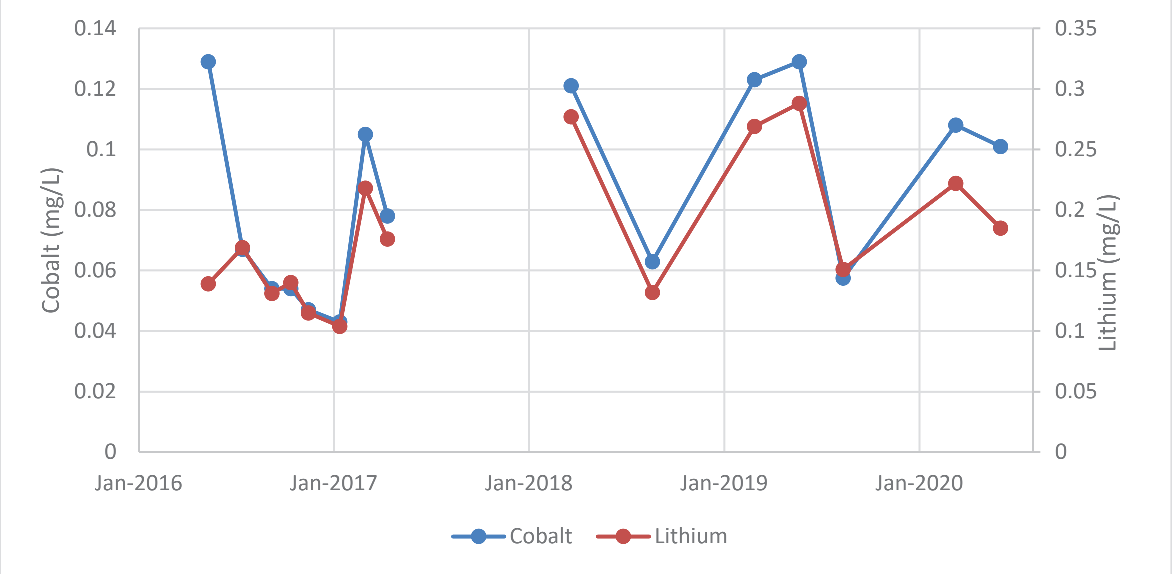
7

Columbus, Ohio

16-Nov-2020

internal info: path, date revised, author





Notes: Cobalt, calcium, and lithium concentrations are shown in milligrams per liter (mg/L). The gaps in cobalt and lithium data represent the time period during which detection monitoring took place and samples were not analyzed for cobalt and lithium.

AD-22 Cobalt v. Calcium and Lithium

Pirkey FGD Stackout Pad

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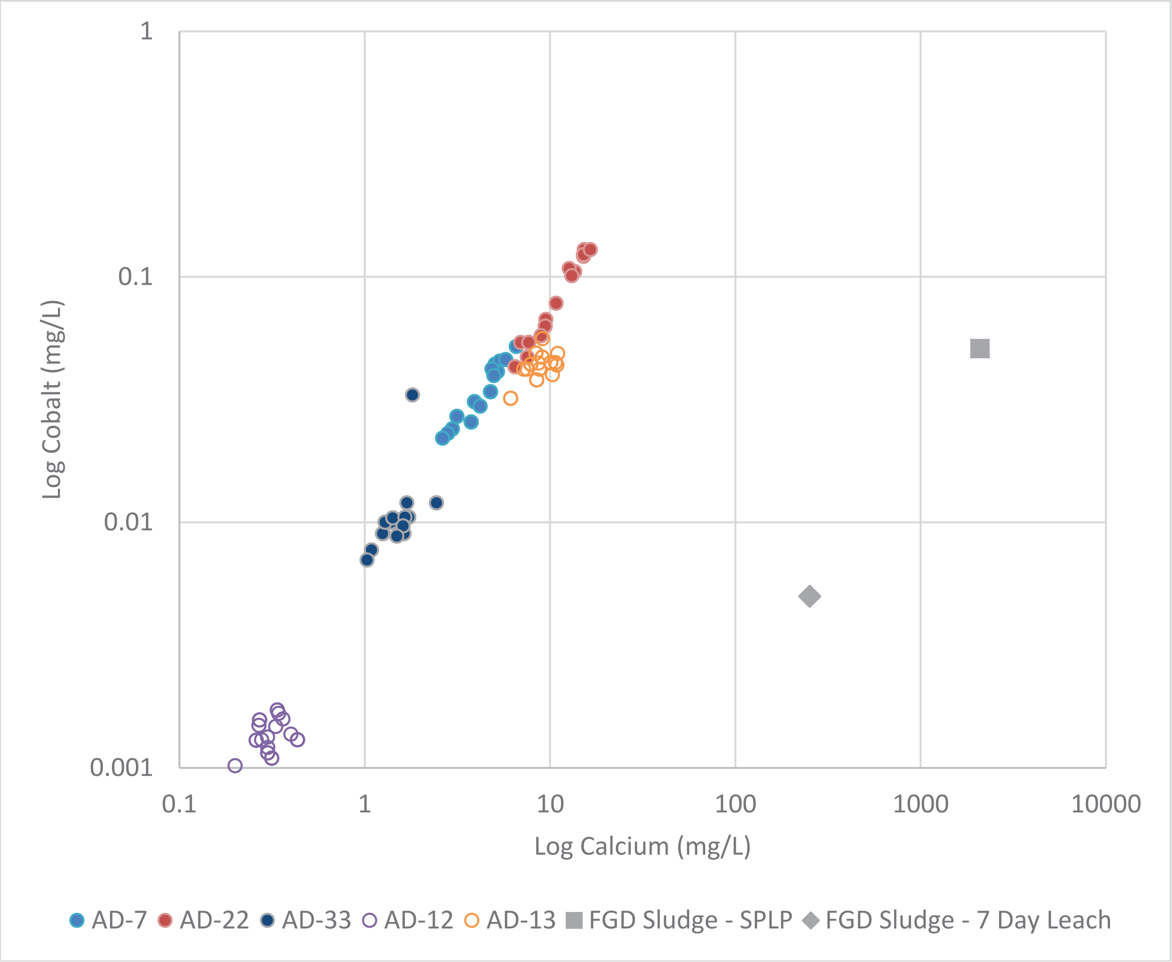
Columbus, Ohio

16-Nov-2020

Figure

8



Notes: Cobalt and calcium concentrations are shown in milligrams per liter (mg/L). Upgradient wells are shown with hollow circles. 'FGD Sludge-SPLP' and 'FGD Sludge 7 Day Leach' present the leached concentrations of cobalt and calcium using the Synthetic Precipitation Leaching Procedure (SW-846 Test Method 1312) and the 7-Day Distilled Water Leachate Test Procedure (30 TAC 335.521 Appendix 4), respectively.

Cobalt and Calcium Concentration Distribution

Pirkey FGD Stackout Pad

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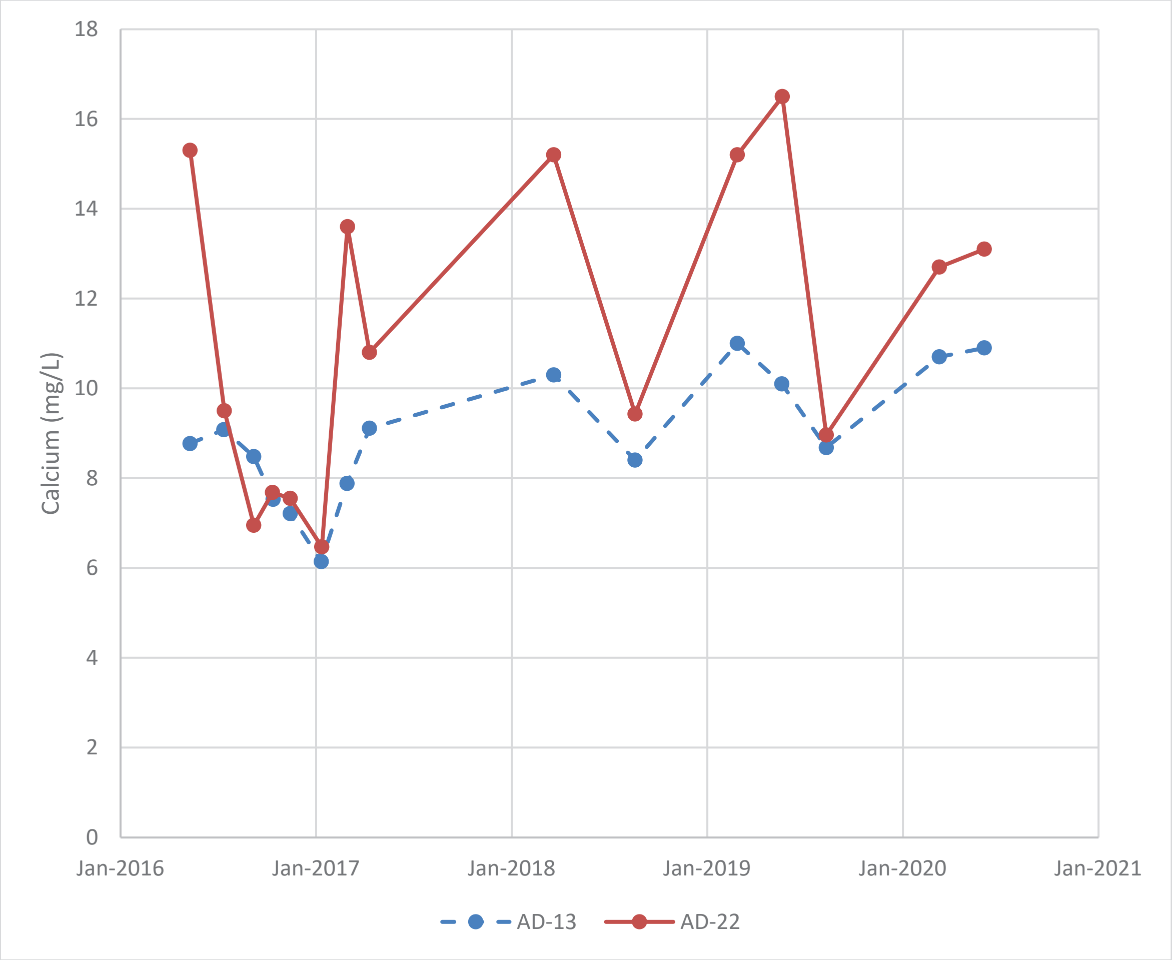
Columbus, Ohio

18-Dec-2020

Figure

9



Notes: Calcium concentrations are shown in milligrams per liter (mg/L). AD-13 is shown with a dashed line because it is an upgradient location.

Calcium Time Series Graph

Pirkey FGD Stackout Pad

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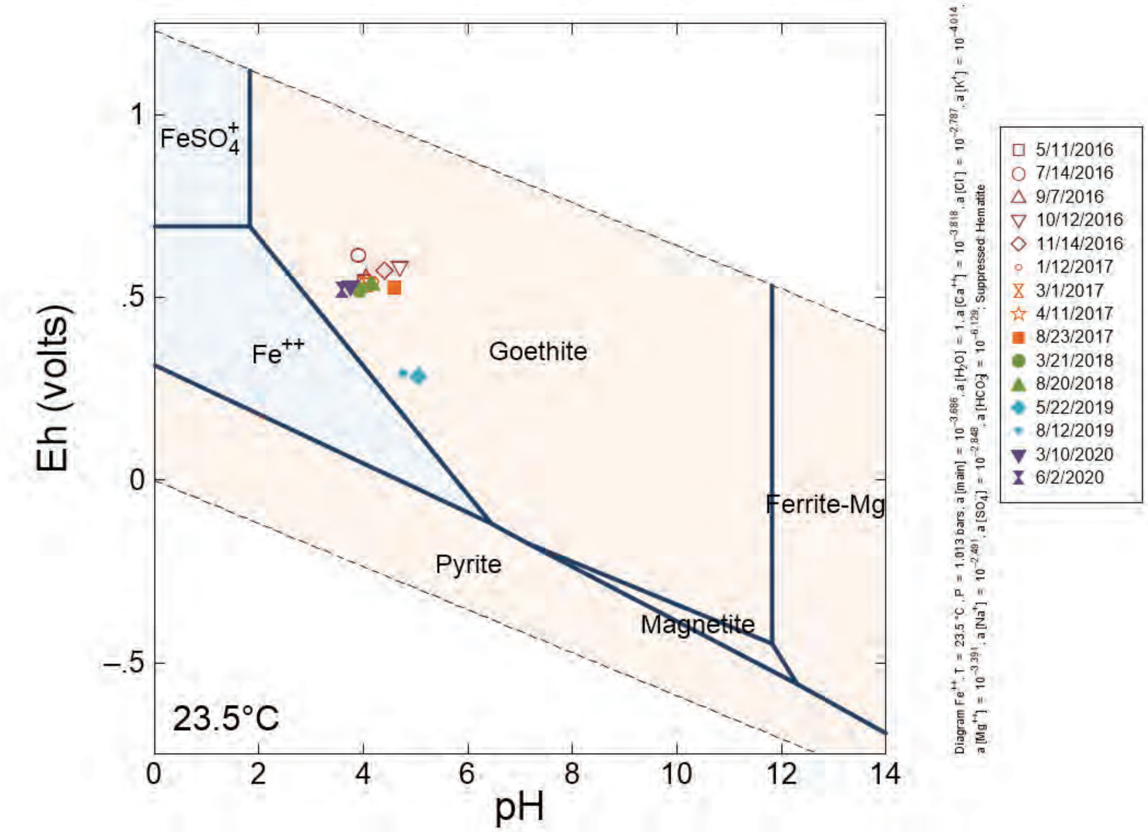
Columbus, Ohio

15-Dec-2020

Figure

10



Notes: Average groundwater concentrations of major cations and anions at AD-22 were used to establish baseline conditions for the diagram. Eh and pH values for sampling dates at AD-22 are shown on the diagram.

AD-22 Eh-pH Diagram

Pirkey FGD Stackout Pad

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Figure

11

Columbus, Ohio

15-Dec2020

internal info: path, date revised, author

ATTACHMENT A

March 2020 Boring Logs

Soil Boring Log

Project: AEP Pirkey

Project Location:____ Hallsville, TX

Boring/Well Name:______ SP-B1

Boring Date:__ 3/2/2020

Depth Scale Feet	Water Table	Soil Profile Description	PID*
		pp= pocket penetrometer	
0		0.0'-0.4': Top soil with vegetation, black silt 0.4'-2.1': Brown silt, fine grained, little cohesion, dry 2.1'-4.3': Light maroon and gray clay, low plasticity, moderate stiffness (pp. 3.5); light brown silt/iron ore 4.3'-10.0': Maroon clay, low plasticity, high stiffness (pp. 4.0-5.0), iron ore (brown/red silt pockets throughout), moist at 8.5'	
5			
10	▼	10.0'-15.0': Dark maroon clay, wet, moderate plasticity, moderate stiffness (pp. 2.5-3.0), red/brown silt pockets (iron ore)	
15		15.0'-15.5': Dark maroon and red/brown clayey silt; low cohesion; wet 15.5'-20.0': Light gray and red/brown clayey silt, wet, low cohesion, iron ore present	
20		20.0'-21.8': Dark maroon and red/brown clayey silt; good cohesion; wet 21.8'-24.0': Black silty clay, high stiffness (pp. >5.0), low plasticity 24.0'-24.5': Black silty clay, low stiffness (pp. 2.0), moderate plasticity	
25		24.5'-30.0': Dark gray/dark green fine grained sand, well sorted, trace silt; wet	
30		Samples collected at 10-12'; 16-18'; 27-29' TD at 30' bgs *PID readings not collected	
35			

Drill Rig Geoprobe 7822 DT

Drilling Contractor:___ Best Drilling

Driller:_ Ramon Gutierrez

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey

Boring/Well Name:______ SP-B2

Project Location:____ Hallsville, TX

Boring Date:__ 3/2/2020

Depth Scale Feet	Water Table	Soil Profile		PID*
		Description		
		pp= pocket penetrometer		
0		0.0'-0.2':	Gray silt, dry, brittle (fly ash)	
		0.2'-0.4':	Black, coal dust, strong odor	
		0.4'-1.7':	Gray silt, dry, brittle (fly ash)	
		1.7'-2.6':	red silt, brittle, dry	
		2.6'-6.5':	Gray and red silty clay, high stiffness (pp. 4.0-5.0), low plasticity, iron ore/mottling present	
5				
		6.5'-6.9':	Light gray, red and tan clay, low stiffness (pp. 1.5), moderate plasticity	
		6.9'-10.0':	Light gray and maroon clay, moderate stiffness (pp. 3.5), low plasticity, iron ore/mottling present; moist near 9'	
10	▼	10.0'-15.0':	Light gray and maroon clay, moderate/high stiffness (pp. 3.5-4.5), low plasticity, iron ore/mottling present; wet	
15		15.0'-18.5':	Maroon and light gray clay, moderate/high stiffness (pp. 3.0-4.0), low plasticity; wet	
		18.5'-18.8':	Red/brown silt, trace clay, good cohesion	
		18.8'-20.5':	Light gray clayey silty sand, very fine grained, moderate sorting, mottling present; wet	
20		20.5'-23.4':	Light gray and orange clayey silty sand, very fine grained; mottling present, moderate sorting; wet	
		23.4'-25.0':	Maroon and orange silty clay, low stiffness (pp. 0.5), high plasticity; wet	
25		25.0'-29.0':	Same as above; interchanging between silty clay and clayey silt throughout interval, iron ore/mottling present throughout	
		29.0'-29.5':	Black clay, moderate stiffness (pp.3.0), low plasticity	
		29.5'-30.0':	Gray fine grained sand, well sorted; wet	
30			Samples collected at 10-12'; 16-18'; 27-29'	
			TD at 30' bgs	
			*PID readings not collected	
35				

Drill Rig Geoprobe 3230 DT
Drilling Contractor:___ C&S
Driller:_ DJ Diduch

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey

Boring/Well Name:______ SP-B3

Project Location:_____ Hallsville, TX

Boring Date:__ 3/2/2020

Depth Scale Feet	Water Table	Soil Profile Description		PID*
		pp= pocket penetrometer		
0		0.0'-0.4':	Top soil, Black silt with vegetation	
		0.4'-0.7':	Brown silt, moist, low cohesion	
		0.7'-2.0':	Maroon and light gray silty clay, moderate stiffness (pp.2.5), moderate plasticity, iron ore/mottling present	
		2.0'-2.2':	Brown silt, dry, brittle	
		2.2'-5.6':	Maroon and ligh gray clay, high stiffness (pp. 4.0), low plasticity	
5		5.6'-6.0':	Orange silt, no cohesion, dry	
		6.0'-13.5':	Maroon clay, high stiffness (pp >4.5), low plasticity; moist at 9'; wet at 12'	
10	▼			
		13.5'-13.6':	Brown/orange silt (iron ore), no cohesion	
		13.6'-17.5':	Gray and orange clayey silt, good cohesion; iron ore present; wet	
15				
		17.5'-20.2':	Maroon and orange silty clay, low stiffness(pp. 0.5), moderate plasticity; iron ore present; wet	
20		20.2'-21.1':	Brown silt, no cohesion; wet	
		21.1'-22.7':	Brown fine grained sand, well sorted; wet	
		22.7'-25.0':	Maroon and orange silty clay, low stiffness (pp. 0.5), low plasticity; iron ore present; wet	
25				
30			Samples collected at 10-12'; 15-17'; 22-24'	
			TD at 25' bgs; refusal	
			*PID readings not collected	
35				

Drill Rig Geoprobe 3230 DT
Drilling Contractor:___ C&S
Driller:_ DJ Diduch

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey
Boring/Well Name:______ SP-B4
Project Location:____ Hallsville, TX
Boring Date:__ 3/3/2020

Soil Profile

Depth Scale Feet	Water Table		Description	PID*
		pp= pocket penetrometer		
0		0.0'-0.4':	Top soil, black silt, vegetation	
		0.4'-0.7':	Brown clayey silt, good cohesion	
		0.7'-1.5':	Red and light gray silty clay, moderate stiffness (pp. 2.5), high plasticity	
		1.5'-3.7':	Maroon and light gray clay, high stiffness (pp. 4.5-5.0), low plasticity; iron ore present 3.1'-3.7'	
		3.7'-5.0':	NO RECOVERY	
5		5.0'-7.0':	Maroon and light gray clay, high stiffness (pp. 4.5-5.0), low plasticity; iron ore present throughout	
		7.0'-8.0':	Light gray clay with iron ore, moderate stiffness (pp.2.5-3.0), moderate plasticity	
		8.0'-10.0':	Maroon clay, moderate stiffness (pp. 3.5), moderate plasticity; iron ore present; moist at 9'	
10		10.0'-12.6':	Maroon clay, moderate stiffness (pp. 3.5), moderate plasticity; iron ore present; wet at 12'	
	▽	12.6'-13.3':	Tan clay, low stiffness (pp.1.5), high plasticity; wet	
		13.3'-18.5':	Tan and brown clayey silt, moderate cohesion; iron ore present; wet	
15				
		18.5'-20.3':	Maroon silty clay, low stiffness (pp. 1.0), moderate plasticity; iron ore; wet	
20		20.3'-21.1':	Dark gray/black clay, trace silt, low stiffness (pp. 1.5), high plasticity; wet	
		21.1'-21.3':	Dark gray silt, good cohesion; wet	
		21.3'-21.9':	Dark gray silty clay, low stiffness (pp. 1.5), high plasticity; wet	
		21.9'-22.3':	Dark gray silt, moderate cohesion; wet	
		22.3'-22.7':	light brown silt; low cohesion; wet	
		22.7'-24.4':	Dark gray and dark green silty clay, moderate/high stiffness (pp.3.5), moderate plasticity; wet, glauconite present	
		24.4'-27.8':	Dark green/gray fine grained sand, well sorted; wet; glauconite present	
25		27.8'-30.0':	Red and orange fine grained sand, well sorted, with iron ore; wet	
30				
			Samples collected at 6-8'; 18-20'; 28-30' TD at 30' bgs; refusal *PID readings not collected	
35				

Drill Rig Geoprobe 3230 DT
Drilling Contractor:___ C&S
Driller:_ DJ Diduch

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey

Boring/Well Name:______ SP-B5

Project Location:_____ Hallsville, TX

Boring Date:__ 3/5/2020

Soil Profile

Depth Scale Feet	Water Table	Description		PID*
		pp= pocket penetrometer		
0		0.0'-0.6':	Top soil, black silt, vegetation	
		0.6'-0.9':	Brown clayey silt, good cohesion	
		0.9'-2.4':	Red and gray silty clay, moderate/high stiffness (pp. 3.5), high plasticity; iron ore present	
		2.4'-5.0':	NO RECOVERY	
5		5.0'-8.6':	Maroon and gray clay, moderate/high stiffness (pp. 3.5), low plasticity; iron ore present; moist	
	▼	8.6'-10.0':	Light gray and maroon clay, moderate/low stiffness (pp.2.0), high plasticity; iron ore present; wet	
10		10.0'-12.0':	Maroon and gray clay, high stiffness (pp. 4.0), moderate plasticity, iron ore present; wet	
		12.0'-12.9':	Iron ore with maroon clay, high stiffness (pp.4.0), moderate plasticity; wet	
		12.9'-15.0':	Maroon clay, high stiffness (pp.4.0), high plasticity; iron ore present; wet	
15		15.0'-18.4':	Light gray and orange clayey silt, good cohesion; iron ore present; wet	
		18.4'-18.6':	Dark maroon iron ore; wet	
		18.6'-20.0':	Orange and gray clayey silt, good cohesion; iron ore present; wet	
		20.0'-21.2':	Maroon and orange clayey silt, good cohesion; iron ore present; wet	
20		21.2'-22.3':	Black clay, trace silt, low stiffness (pp.1.0), high plasticity; wet	
		22.3'-22.6':	Black clay, high stiffness (pp.4.5), moderate plasticity	
		22.6'-22.9':	Black silt, no cohesion; wet	
		22.9'-23.4':	Black clay, trace silt, moderate stiffness (pp.2.5), high plasticity; wet	
		23.4'-25.0':	Dark gray and green fine grained sand; well sorted; wet; glauconite present	
25			Samples collected at 6-8'; 16-18'; 23-25' TD at 25' bgs; refusal *PID readings not collected	
30				
35				

Drill Rig Geoprobe 3230 DT
Drilling Contractor:___ C&S
Driller:_ DJ Diduch

Geosyntec Consultants

ATTACHMENT B

AD-22 Boring Log and Well Installation Diagram

☐ BORING ■ MONITOR WELL

APEX PROJECT NO.: 110-089 **BORING NUMBER:** ______ **MONITOR WELL NUMBER:** AD-22

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

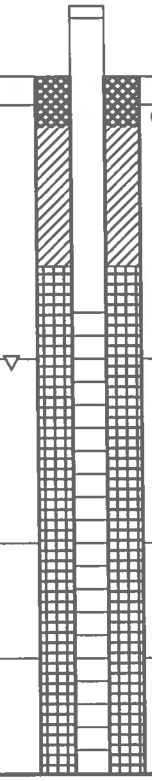
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/16/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 **WELL LOCATION:** Triangle- South side Quansit Hut
LONGITUDE: W94°29'41.3"

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
							
1			0-0.5	SC	Clayey sand, light brown, very fine grained	None	Moist
2 3 4 5 6 7 8 9 10 11 12			0.5-12	CL	Lean clay, light brown mottled with light gray Few iron ore (small) pebbles in clayey sandy streaks	None	Slightly Moist
13 14 15 16 17 18 19 20			▽ 12-20	SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained Slightly wet @ 12.5' from seepage Large amount of iron ore 15-17' Very firm 18-18.5'	None	Slightly Wet
21 22 23 24 25			20-25	SC	(Dense crystalline rock 21-21.1'), light brown clayey sand, greenish black, mica, black clay streaks, very fine grained, wet @ 20'	None	Wet
26 27 28 29 30			25-30	SM	Sand, greenish brown (1') grading to orangish brown, silty, very fine grained	None	Wet
31 32 33 34 35 36 37 38 39 40					Boring Terminated at 30'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 12.5'
Above Ground 3'

Note: This log is not to be used separate from this report.

ATTACHMENT C

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD Stackout Area CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

BETH ANN GROSS
79864

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Gross
Signature

Geosyntec Consultants
2039 Centre Pointe Blvd, Suite 103
Tallahassee, Florida 32308

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

12/31/2020
Date

APPENDIX IV

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #540556

Owner: **American Electric Power Company**

Address: **502 N. Allen Street**
Shreveport, LA 71101

Well Location: **2400 Farm Road 3251**
Hallsville, TX 75650

Well County: **Harrison**

Owner Well #: **AD-7R**

Grid #: **35-37-1**

Latitude: **32° 27' 43.7" N**

Longitude: **094° 29' 18.3" W**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/3/2020** Drilling End Date: **3/3/2020**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**31.5**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
18	**31.5**	**Sand**	**20/40**

Annular Seal Data: **No Data**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **David Diduch** Apprentice Number: **60297**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1.5**	**Top soil, vegetation, black silt, gravel, light gray/red/brown clayey silt**
1.5	**10**	**Red/light gray clay, low plasticity, high stiffness, iron ore present, trace silt,**
10	**15**	**Maroon/light gray clay, high stiffness, low plasticity, iron ore, wet**
15	**20**	**Black silty clay, low-moderate plasticity, wet, Maroon/orange clayey silt, wet, good cohesion, iron ore, gray/orange clayey silt, iron ore present, wet, good cohesion**
20	**24.6**	**Black clayey silt, Dark gray fine grained sand, trace clay, wet, black silty clay, low-moderate plasticity, moderate to low stiffness**
24.6	**31.5**	**Dark gray fine grained sand, wet, well sorted, orange fine grained sand, wet, well sorted, tan fine grained sand, wet, well sorted, iron present**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

ATTACHMENT 5
Closure Plans

30 TAC §352.301 – Closure and Post-Closure Care Application Submittal

Submit documentation demonstrating compliance with Subchapter J: Closure and Post Closure Care 30 TAC §352.1101(b), §352.1200, §352.1201, §352.1211, §352.1221, §352.1231, §352.1241.
(40 CFR §257.100 - §257.104)

EBAP – Closure Plan – Closure by Removal

- Extension Demonstration submitted to EPA
- TCEQ approval of extension request

WBAP – Closure Plan – Closure by Removal

- Extension Demonstration submitted to EPA
- TCEQ approval of extension request

FGDSA – Closure Plan – Closure by Removal

Landfill – Closure Plan – Closure in Place

5.1 – Documentation of No Alternative Disposal Capacity and Risk Mitigation Plan for Permanent Cessation of Boiler(s) by a Date Certain, CCR Units – East Bottom Ash Pond and West Bottom Ash Pond, November 2020

Henry W. Pirkey Power Plant

Notice of Intent to Comply With the Site-Specific Alternative to Initiation of Closure

CCR Units – East Bottom Ash Pond and West Bottom Ash Pond

As required by 40 CFR 257.103(f)(2)(viii), this is a notification that on November 30, 2020 Henry W. Pirkey Power Plant (Pirkey Plant) submitted a site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler by a date certain to US EPA. The submission has been placed in Pirkey Plant's operating record and posted to the CCR Rule Compliance Data and Information website.

AMERICAN
ELECTRIC
POWER
BOUNDLESS ENERGY

American Electric Power
1 Riverside Plaza
Columbus, OH 43215
aep.com

November 30, 2020

Submitted Electronically via Email

Mr. Andrew R. Wheeler, EPA Administrator
Environmental Protection Agency
1200 Pennsylvania Avenue, N.W.
Mail Code 5304-P
Washington, DC 20460

RE: Southwestern Electric Power Company
Henry W. Pirkey Power Plant Alternative Closure Demonstration

Dear Administrator Wheeler,

Southwestern Electric Power Company (SWEPCO) Henry W. Pirkey Power Plant (Pirkey Plant), hereby submits this request to the U.S. Environmental Protection Agency (EPA) for approval of a site-specific alternative deadline to initiate closure pursuant to 40 C.F.R. § 257.103(f)(2) for the East Bottom Ash Pond (EBAP) and West Bottom Ash Pond (WBAP) located at the Pirkey Plant near Hallsville, Texas. Pirkey Plant is requesting an extension pursuant to 40 C.F.R. § 257.103(f)(2) to allow the EBAP and WBAP to continue to receive CCR and non-CCR wastestreams after April 11, 2021. Enclosed is a demonstration prepared by American Electric Power and Burns & McDonnell that addresses all of the criteria in 40 C.F.R. § 257.103(f)(2)(i)-(iv) and contains the documentation required by 40 C.F.R. § 257.103(f)(2)(v). As allowed by the agency, in lieu of hard copies of these documents, electronic files were submitted to Kirsten Hillyer, Frank Behan, and Richard Huggins via email. If you have any questions regarding this submittal, please contact me at 614-716-2281 or damiller@aep.com.

Sincerely,

David A. Miller

David A. Miller, P.E.
Director, Land Environment & Remediation Services
Environmental Services Division

Attachments

cc: Kirsten Hillyer – USEPA
Frank Behan – USEPA
Richard Huggins – USEPA

Southwestern Electric Power Company

Henry W. Pirkey Power Plant

Documentation of No Alternative Disposal Capacity and Risk Mitigation Plan for Permanent Cessation of Boiler(s) by a Date Certain

Prepared by:

American Electric Power Service Corporation
1 Riverside Plaza
Columbus, OH 43215

and

Burns and McDonnell
9400 Ward Parkway
Kansas City, MO 64114

Submitted

11/30/2020

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Professional Engineer's Certification

I certify, as a Professional Engineer in the State of Texas, that the information in this document was assembled under my direct supervisory control and is accurate as of the date of my signature. This report is not intended or represented to be suitable for reuse without the specific verification or adaptation by the engineer.

DAVID ANTHONY MILLER

Printed Name of Registered Professional Engineer

DAVID ANTHONY MILLER
112498

David Anthony Miller

Signature

112498 TEXAS 11.30.2020

Registration No. **Registration State** **Date**

INTRODUCTION

American Electric Power Service Corporation (AEP) as agent for its affiliate Southwestern Electric Power Company (SWEPCO), an owner and operator of the Henry W. Pirkey Power Plant (Pirkey Power Plant) (2400 FM 3251 (Harrison County) in Hallsville, Texas) seeks Environmental Protection Agency (EPA) approval under 40 CFR 257.103(f)(2) - *"Permanent cessation of a coal-fired boiler(s) by a date certain"* for its Coal Combustion Residual (CCR) surface impoundments. As discussed herein, the coal-fired generating unit at Pirkey Plant will cease combusting coal in March 2023 and the CCR surface impoundments will be closed in order to comply with EPA's recently revised CCR regulations. Closure of the surface impoundments will be completed no later than October 17, 2023. This document will provide the required information to support the requested alternative closure deadline, including: (1) the options considered to obtain alternative disposal capacity both on and off site; (2) the risk mitigation plan developed to expedite any required corrective action; (3) required documentation and a certification of compliance with the applicable requirements of 40 CFR Part 257, Subpart D; and (4) a closure plan to demonstrate that the coal-fired units will cease combustion of coal and complete closure of the surface impoundments by the required deadlines.

On August 28, 2020, the EPA Administrator issued revisions to the CCR Rule (40 CFR Part 257, Subpart D) that require all unlined surface impoundments to initiate closure by April 11, 2021, unless an alternative deadline is requested and approved (40 C.F.R. § 257.101(a)(1) (85 Fed. Reg. 53,516)). Specifically, owners and operators of a CCR surface impoundment may continue to receive CCR and non-CCR wastestreams in an unlined CCR surface impoundment if the facility will cease operation of the coal-fired boiler(s) and complete closure of the impoundments within certain specified timeframes (40 C.F.R. § 257.103(f)(2)). To qualify for an alternative closure deadline, a facility must meet the following four criteria:

1. § 257.103(f)(2)(i) – No alternative disposal capacity is available on-site or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification.
2. § 257.103(f)(2)(ii) - Potential risks to human health and the environment from the continued operation of the CCR surface impoundment have been adequately mitigated;
3. § 257.103(f)(2)(iii) - The facility is in compliance with the CCR rule, including the requirement to conduct any necessary corrective action; and
4. § 257.103(f)(2)(iv) - The coal-fired boilers must cease operation and closure of the impoundment must be completed within the following timeframes:
    a. For a CCR surface impoundment that is 40 acres or smaller, the coal-fired boiler(s) must cease operation and the CCR surface impoundment must complete closure no later than October 17, 2023.
    b. For a CCR surface impoundment that is larger than 40 acres, the coal-fired boiler(s) must cease operation, and the CCR surface impoundment must complete closure no later than October 17, 2028.

40 CFR §257.103(f)(2)(v) details the documentation that must be provided to EPA to demonstrate that the four criteria set out above have been met. Therefore, this demonstration is organized based on the documentation requirements of 40 CFR§ 257.103(f)(2)(v)(A) – (D).

OVERVIEW OF PIRKEY POWER PLANT AND AFFECTED CCR UNITS

The Pirkey Power Plant began operations in 1985 as a coal-fired generating power plant. Throughout the life of the generating plant, CCR materials have been generated. To manage these CCR materials, Pirkey Power Plant operates four CCR units: a bottom ash pond complex of two CCR surface impoundments (East Bottom Ash Pond (EBAP) and West bottom Ash Pond (WBAP)), the Pirkey Landfill (LF), and a flue gas desulfurization (FGD) material Stack Out Area for FGD material staging prior to transport to the LF. The EBAP and WBAP were constructed in 1983 and 1984.

The Bottom Ash Complex is located at the north end of the Pirkey Power Plant property (Figure 1) and receives both CCR and non-CCR wastestreams. The EBAP and WBAP are 31.5 and 30.9 acres in size, respectively. Other ponds in the complex include the Clearwater Pond. The Clearwater Pond is not a CCR unit. The Bottom Ash Complex, including the Clearwater Pond, totals approximately 67 acres. For the CCR rule groundwater monitoring requirements, the EBAP and WBAP are monitored separately.

Pirkey Power Plant currently places CCR and non-CCR wastestreams into the pond complex alternating between the EBAP and WBAPs. Bottom ash generated at the plant is sluiced to one of the ponds (the active pond) until it is close to full. Bottom ash in the inactive pond is drained and dewatered, and then removed from the pond. Dry ash is loaded into trucks and transported to the LF. It typically takes approximately twelve months for the active pond to fill, at which time the second pond (which has been emptied of bottom ash) becomes the active pond, and the first pond is drained.

The EBAP has a surface area of 31.5 acres and a storage capacity of 188 acre-feet. The pond is almost entirely incised with a reported maximum embankment height of 4 feet. The embankments are constructed of compacted clay on a 3:1 slope. The elevation of the top of embankment around the perimeter of the EBAP is approximately 357 feet amsl and the normal operating level is approximately 354 feet amsl. The EBAP receives bottom ash and economizer ash sluiced from the unit. The EBAP meets the location restriction requirements including the minimum aquifer separation but does not meet the liner requirements of the CCR regulation and must close. A groundwater monitoring system was developed for the EBAP in 2017 and assessment monitoring was initiated in April of 2018 and continues today. Assessment monitoring identified an exceedance of the ground water protection standard for cobalt and lithium for the EBAP, but an alternate source demonstration was completed showing higher upgradient lithium concentrations and naturally occurring cobalt in the aquifer media, demonstrating that the EBAP was not the source of the cobalt and lithium detected.

The WBAP has a surface area of 30.9 acres and a storage capacity of 188 acre-feet. The maximum height of the embankment is 25 feet. The embankments are constructed of compacted clay on a slope ranging from 2.5:1 to 3:1. The elevation at the top of the embankment around the perimeter of the WBAP is approximately 357 feet amsl and the normal operating level is 354 feet amsl. The WBAP receives bottom ash and economizer ash sluiced from the unit. The WBAP meets the location restriction requirements including the minimum aquifer separation but does not meet the liner requirements of the CCR regulation and must close. A groundwater monitoring system was developed for the WBAP in 2017 and assessment monitoring was initiated in April of 2018 and continues today. Assessment monitoring identified an exceedance of the ground water protection standard for cobalt for the WBAP, but an alternate source demonstration was completed showing naturally occurring cobalt in the aquifer media, demonstrating that the WBAP was not the source of the cobalt detected.

Water overflow from the Bottom Ash Ponds discharges into the Clearwater Pond (a non-CCR unit) located directly south of EBAP. The water level is controlled by a weir box and a manually operated gate valve on a 36-inch diameter discharge pipe at the southwest corner of the pond. Water in the Clearwater pond is recirculated back to the plant for reuse.

The EBAP and WBAP are subject to the closure requirements in order to comply with EPA's recently revised CCR regulations. Therefore, the boiler associated with generating unit will be permanently shut down and closure of the EBAP and WBAP impoundments will be completed no later than October 17, 2023.

SATIFACTION OF THE CRITERIA IN 40 CFR §257.101(f)(2) FOR THE EBAP and WBAP

NO ALTERNATIVE DISPOSAL CAPACITY

From the regulatory text

> *257.103(f)(2)(i) No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification under this section.*
>
> *257.103(f)(2)(v)(A)To demonstrate that the criteria in paragraph (f)(2)(i) of this section have been met the owner or operator must submit a narrative that explains the options considered to obtain alternative capacity for CCR and/or non-CCR wastestreams both on and off-site.*

To demonstrate that the criteria in § 257.103(f)(2)(i) have been met, the following provides documentation that no alternative disposal capacity is currently available on-site or off-site for each CCR and non-CCR wastestream such that Pirkey Plant seeks to continue using the CCR surface impoundments after April 11, 2021. Consistent with the regulations, neither an increase in costs nor the inconvenience of existing capacity was used to support qualification under this criteria. Instead, as EPA explained in the preamble to the proposed Part A revisions, "it would be illogical to require facilities [ceasing power generation] to construct new capacity to manage CCR and non-CCR wastestreams." 84 Fed. Reg. 65,941, 65,956 (Dec. 2, 2019). EPA again reiterated in the preamble to the final revisions that "[i]n contrast to the provision under § 257.103(f)(1), the owner or operator does not need to develop alternative capacity because of the impending closure of the coal fired boiler. Since the coal-fired boiler will shortly cease power generation, it would be illogical to require these facilities to construct new capacity to manage CCR and non-CCR wastestreams." 85 Fed. Reg. at 53,547. Thus, new construction or the development of new alternative disposal capacity was not considered a viable option for any wastestream discussed below. Similarly, for the reasons documented below there is insufficient existing alternative disposal capacity available on or off-site for each CCR and non-CCR wastestream.

<u>CCR Wastestreams:</u>

The Bottom Ash Complex receives approximately 6.5 million gallons per day of sluiced water containing economizer and bottom ash. Pyrites, a non-CCR wastestream, are also managed with the CCR wastestreams.

AEP evaluated each CCR wastestream placed in the EBAP and WBAP at Pirkey Power Plant. For the reasons discussed below and in Table 1, the following CCR wastestreams must continue to be placed in the EBAP and WBAP due to lack of alternative capacity both on and off-site.

Table 1: Pirkey Power Plant CCR Wastestreams

CCR Wastestream	Average Flow (gpd)	Current Configuration	Alternative Capacity Currently Available? Yes/No	AEP Notes
Bottom Ash	6,500,000 (includes economizer ash and pyrites)	Bottom ash is currently alternately sluiced to the EBAP and WBAP. Ash from the pond not receiving sluice flows is cleaned with ash being transported to the onsite landfill.	No	There are currently no alternative CCR compliant ponds onsite and extensive modifications would be required to manage the bottom ash so that it could be disposed in the onsite landfill. These alternatives are not practicable for generating units that will retire in 2023.
Economizer Ash	Included with Bottom Ash flows	Sluiced to the existing EBAP and WBAP with bottom ash	No	There are currently no alternative CCR compliant ponds onsite and extensive modifications would be required to manage the economizer ash so that it could be disposed in the onsite landfill. These alternatives are not practicable for generating units that will retire in 2023.
Pyrites (non-CCR but handled with CCR wastestreams)	Included with Bottom Ash flows	Sluiced to the existing EBAP and WBAP using the existing bottom ash pumps and piping.	No	No alternate system is available for collection of pyrites which are comingled with bottom and economizer ash. Extensive modifications would be required to manage the pyrites so that it could be disposed in the onsite landfill. These alternatives are not practicable for generating units that will retire in 2023.

Pirkey Power Plant does not have an existing alternate impoundment on-site that meets the liner or aquifer separation requirements of EPA's CCR regulation, and considerable modifications to plant equipment, facilities, and processes will be necessary before Pirkey Power Plant can cease sluicing CCR and placing non-CCR wastestreams into the EBAP and WBAP. CCR sluicing flows are treated in the EBAP and WBAP to remove solids and then are recycled back to the plant for reuse. In order to meet the water quality requirements to support the plant operation and provide space for collection of solids, a new CCR compliant impoundment approximately 12 acres in size would be required. Since Pirkey Power Plant has elected to pursue the option to permanently cease combusting coal by a date certain, developing alternative disposal capacity is counterproductive to the work to retire the boilers and close the CCR surface impoundments. As EPA explained in the preamble of the 2015 rule, it is not possible for sites that sluice CCR material to an impoundment to eliminate the impoundment and dispose of the material offsite. See 80 Fed. Reg. 21,301, 21,423 (Apr. 17, 2015) ("[W]hile it is possible to transport dry ash off-site to [an] alternate disposal facility that is simply not feasible for wet-generated CCR. Nor can facilities immediately convert to dry handling systems."). A new CCR compliant impoundment would be required to treat the CCR flows as noted above.

If temporary frac tanks were used for treatment of the CCR sluice water and if 24 hours would provide sufficient residence time for the settling of the fine solids in the CCR wastestreams, approximately 650 frac tanks would be required to store and treat the bottom ash transport water. The number of tanks required was estimated by taking the total sluice flow (6.5 MGD) divided by the frac tank capacity (21,000 gallons) and doubling it to account for the 24 hours settling time requirement which resulted in 610 frac tanks. Because approximately 50 of these frac tanks would need to be rotated out of service each day for solids removal and disposal in the Pirkey landfill, an allowance, or emergency margin, of 50 frac tanks was added to this value, which resulted in a total of 660 tanks being required. These tanks would cover over 10 acres of the site. The tanks would require significant amounts of interconnecting piping which could create an unacceptable potential for significant leaks or spills.

For off-site disposal, 6.5 MGD on average would require approximately 866 trucks per day based on 7,500 gallons per truck to haul off and dispose of the water collected. This operation would need to take place 24 hours a day and 7 days a week and poses significant safety risks both on and off-site due to the truck traffic and is impossible to achieve.

The most likely facility type capable of managing industrial wastewaters are publicly-owned or private treatment works, underground injection wells, or publicly available waste management facilities capable of solidifying liquid wastes for disposal in a landfill. Given the volume and characteristics of the CCR wastestreams, increases in permitted capacity or other modifications to the permitted pretreatment programs of a public or private wastewater treatment facility would likely be required to manage this flow, if one were available. Off-site disposal is not an option for Pirkey Power Plant CCR material.

As a result, the conditions at Pirkey Power Plant satisfy the demonstration requirement in 40 CFR § 257.103(f)(2)(i) and in the interim period (prior to permanent cessation of the coal-fired boilers) Pirkey Power Plant must continue to use the EBAP and WBAP due to the absence of alternative disposal capacity both on and off-site of the facility.

Non-CCR Wastestreams:

Approximately 100,000 gallons per event of demineralizer regeneration waste.

AEP evaluated this non-CCR wastestream that is placed in the EBAP and WBAP at Pirkey Power Plant. For the reasons discussed below and in Table 2, this non-CCR wastestream must continue to be placed in the EBAP or WBAP due to lack of alternative capacity both on and off-site.

Table 2: Pirkey Power Plant non-CCR Wastestreams

Non-CCR Wastestream	Average Flow (gallons per event)	Current Configuration	AEP Notes
Demineralizer Regeneration Waste	100,000	Flows to the existing EBAP or WBAP	Regeneration of the existing anion and cation exchange resin beads occurs on a weekly basis as a batch treatment. The EBAP or WBAP provides treatment for this wastestream which allows it to be neutralized prior to returning to the plant. No alternative capacity exists for treatment.

Pirkey Power Plant does not have an existing alternate impoundment on-site that can be utilized for treatment of the non-CCR wastestream. As stated previously, since AEP has elected to pursue the option to permanently cease the use of the coal fired boilers by a certain date, developing alternative disposal capacity is “illogical,” to use EPA’s words, and also counterproductive to the work to retire the boilers and close the impoundments

There is currently no existing installed infrastructure at the plant to support reroute of these flows. Although this volume is significantly lower than the much larger volume of bottom ash transport water, rerouting this wastestream would require construction of additional treatment and storage capacity at the site, subject the facility to additional permitting obligations, and therefore is inconsistent with the work required to retire the unit and close the ponds.

Relative to the off-site disposal capacity for this non-CCR wastestream, the acidic nature of the wastestream makes it unacceptable at most off-site facilities without prior treatment. The most likely facility type capable of managing industrial wastewaters are publicly-owned or private treatment works, underground injection wells, or publicly available waste management facilities capable of solidifying liquid wastes for disposal in a landfill. Given the volume and characteristics of this non-CCR wastestream, increases in permitted capacity or other modifications to the permitted pretreatment programs of a public or private wastewater treatment facility would likely be required to manage this flow, if one were available.

There is neither on-site nor off-site capacity available to manage this non-CCR wastestream. Consequently, in order to continue to operate and generate electricity, Pirkey Power Plant must continue to use the Bottom Ash Complex to manage the non-CCR wastestream due to lack of alternative capacity both on and off-site.

Based on the evaluation of alternative disposal options, AEP selected the following options for compliance at Pirkey Power Plant:

- Cessation of the coal burning boilers
- Closure of the EBAP by CCR material removal.
- Closure of the WBAP by CCR material removal.

This strategy can be implemented in the least amount of time and accommodates the unique site features, quantity of wastestreams, and the lack of off-site disposal facilities.

Impact to Plant Operations if Alternative Capacity Not Obtained

If Pirkey Power Plant were required to immediately cease the placement of CCR and non-CCR wastestreams into the EBAP and WBAP, which is necessary for handling more than 6.5 MGD of CCR and non-CCR wastestreams, and initiate closure by April 11, 2021, AEP would have to temporarily or permanently cease power production at the Pirkey Power Plant. The EBAP and WBAP are integral in receiving and treating these flows as required to meet the plant's water balance. Therefore, the need for uninterrupted CCR and non-CCR waste stream capacity in the EBAP and WBAP will provide time to assess and mitigate any impacts of the retirement of this unit on SWEPCO's generating resources and the electric grid.

SWEPCO owns and operates three coal-fired generating facilities within northwest Arkansas and the eastern panhandle of Texas that are seeking additional time to provide alternative disposal capacity or cease combusting coal. Together, these facilities have a maximum generating capacity of over 2,000 MW. All of these facilities operate within the Southwest Power Pool Regional Transmission Organization (SPP). Because of their close geographic proximity, simultaneous immediate closure of a significant portion of this capacity would compromise SWEPCO's ability to meet electrical demand and capacity obligations of the SPP, would destabilize portions of the electricity grid and, therefore, would not be in the public interest. One facility will retire in 2023, one will be converted to satisfy both the ELG and CCR requirements, and the third will cease combusting coal in 2028. The requested extensions will allow for an orderly transition of generating resources, provide time to initiate transmission mitigation plans to avoid compromising the reliability of the grid, and maintain SWEPCO's ability to provide affordable electricity to customers.

RISK MITIGATION PLAN

257.103(f)(2)(v)(B) A risk mitigation plan describing the measures that will be taken to expedite any required corrective action, and that contains all of the following elements:

> *(1) A discussion of any physical or chemical measures a facility can take to limit any future releases to groundwater during operation.*

In order to demonstrate that the criteria in §257.103(f)(2)(ii) have been met, 40 CFR §257.103(f)(2)(v)(B) requires the applicant to describe the risk mitigation measures that will be taken to expedite any required corrective action at the plant. The following is a discussion of the physical and chemical measures the plant can take to limit any future releases to groundwater during operation to address the requirements in 40 CFR §257.103(f)(2)(v)(B)(1).

The plant could take the physical precautionary measure of minimizing the volume of CCR stored in the active surface impoundment. This will include periodic removal of the CCR throughout the course of the year. During any time of periodic removal of CCR, the plant will implement administrative controls to limit the depth of removal to ensure the original bottom of the pond is not disturbed, thereby eliminating any integrity issues with the current in-situ material.

Additionally, to prevent future groundwater contamination flowing towards the Hatley Creek, steps could be taken to lower the operational levels as low as possible to minimize the free liquids accompanied with diminishing the amount of CCR stored in the impoundment. This action can be initiated very quickly, but there is a limit on how low the pond can be lowered due to the physical configuration of the outlet structure from the pond complex.

Another potential physical measure that could be implemented, if necessary, is the installation of a hydraulic barrier.

These mitigation measures would promptly address any contaminate migrating towards Hatley Creek.

> *(2) A discussion of the surface impoundment's groundwater monitoring data and any found exceedances; the delineation of the plume (if necessary based on the groundwater monitoring data); identification of any nearby receptors that might be exposed to current or future groundwater contamination; and how such exposures could be promptly mitigated.*

Groundwater monitoring data

Groundwater monitoring at the EBAP and WBAP is accomplished using a PE-certified groundwater monitoring network composed of three upgradient monitoring wells and three downgradient monitoring wells per CCR unit. The certified Groundwater Monitoring Well Evaluation Report is included in Appendix C.

Groundwater at the EBAP and WBAP is monitored in accordance with an assessment monitoring program, following the requirements of 40 CFR 257.95 in the CCR rule. Assessment monitoring identified an exceedance of the ground water protection standard for cobalt and lithium for the EBAP and cobalt for the WBAP, but alternate source demonstration were completed showing higher upgradient lithium concentrations, and naturally occurring cobalt in the aquifer media, demonstrating that the EBAP and WBAP were not the source of the cobalt and lithium detected. Following the requirements of 40 CFR 257.95, groundwater samples from each monitoring well are analyzed for all parameters in appendix IV of the CCR rule during the first monitoring event of the annual monitoring cycle, then during the two subsequent events in the cycle, samples from each well are analyzed for all parameters in appendix III and those parameters in appendix IV that were detected during the first sampling event in the cycle. Analysis results for each constituent at each monitoring well are compared to corresponding groundwater protection standards according to statistical procedures and performance standards specified in 40 CFR 257.93(f) and 40 CFR 257.93(g). The BAP Complex is expected to remain in assessment monitoring until closure by removal is complete, but will transition to an assessment of corrective measures and selection of a remedy following requirements in 40 CFR 257.96 and 40 CFR 257.97, and a corrective action program following requirements in 40 CFR 257.98, if necessary. The concentrations of the Appendix III and IV constituents detected within the groundwater monitoring wells are presented in Table 1 of the Groundwater Monitoring and Corrective Action Reports in **Appendix F**.

Plume

The EBAP and WBAP are currently in assessment monitoring and have not exceeded a groundwater protection standard for any appendix IV parameter, therefore, no plume delineation has been necessary.

Nearby receptors and mitigation

Private wells:

There are approximately 12 private water wells located within a 0.5-mile radius of the plant. **Figure 2** shows 0.5-mile radius of the CCR units at Pirkey Power Plant. The groundwater production zones in most of these private wells are completed between 240 to 330 feet below ground surface. This production zone is at a different depth than the groundwater zone sampled by the monitor wells, which are completed at depths ranging from 18 to 57 feet below ground surface. The private water wells are used for non-potable water sources.

Hatley Creek:

To prevent future groundwater contamination from entering Hatley Creek, steps could be taken to lower the operational levels in the EBAP and WBAP as low as possible to minimize the free liquids accompanied with diminishing the amount of CCR stored in the impoundment and/or a hydraulic barrier could be constructed by the impoundments. These mitigation measures would promptly address any contaminate migrating toward the reservoir.

> (3) *A plan to expedite and maintain the containment of any contaminant plume that is either present or identified during continued operation of the unit*

AEP will establish contracts with consultants and drilling companies who are immediately available to prepare and execute a nature and extent report. Based on the results of the report, AEP will be able to readily implement a temporary containment plan until the proper Assessment of Corrective Action Report evaluates the appropriate potential methods for remediation.

As noted above in (1), a hydraulic barrier (cutoff wall) could be implemented in a relatively short timeframe after the identification of a release from the pond complex. Hydraulic barriers are commonly used to contain and/or isolate the migration of a plume and are incorporated into other Corrective Measures for groundwater remediation. This could be accomplished while the Assessment of Correct Action is being evaluated.

Cutoff walls act as barriers to migration of impacted groundwater and can isolate soils that have been impacted by CCR to prevent contact with unimpacted groundwater. Cutoff walls are often used in conjunction with an interior pumping system to establish a reverse gradient within the cutoff wall. The reverse gradient maintains an inward flow through the wall, keeping it from acting as a groundwater dam and controlling potential end-around or breakout flow of contaminated groundwater.

A commonly used cutoff wall construction technology is the slurry trench method, which consists of excavating a trench and backfilling it with a soil-bentonite mixture, often created with the soils excavated from the trench. The trench is temporarily supported with bentonite slurry that is pumped into the trench as it is excavated. Excavation for cutoff walls is conducted with conventional hydraulic excavators, hydraulic excavators equipped with specialized booms to extend their reach (i.e., long-stick excavators), or chisels and clamshells, depending upon the depth of the trench and the material to be excavated. For a cutoff wall to be technically feasible, there must be a low-permeability lower confining layer into which the barrier can be keyed, and it must be at a technically feasible depth.

A slurry wall, which is constructed with low permeable material such as bentonite, would be applicable to the Pirkey site since the uppermost aquifer is not deep below the surface. Slurry walls can be constructed up to depths of 60-80 feet. Sheet pile walls are limited to depths less than 60 feet. If the subsurface materials are very consolidated, the depths may even be less.

Another measure to contain the migration of the plume is extraction of the groundwater. This measure includes installation of a series of groundwater pumping wells or trenches to control and extract impacted groundwater. Groundwater extraction captures and contains impacted groundwater and can limit plume expansion.

Installation of a groundwater extraction system, whether wells or trenches, can be expedited with the assumption that there is a good conceptual site model (CSM) of the hydrogeological system around the CCR unit, groundwater flow and transport model, and aquifer test if a well system is the best option for intercepting the groundwater contaminant plume. Upon notification of an SSL exceedance of a GWPS for one or more Appendix IV parameters, an aquifer test will be conducted, and groundwater model developed for designing a groundwater extraction system for optimization of contaminant plume capture.

Based on site specific hydrogeology and future potential plume width and depth, a groundwater extraction system will typically consist of one to three extraction wells manifolded together with HDPE conveyance pipe to a common tank or lined collection vault prior to treatment at the on-site wastewater treatment plant and discharge via the NPDES permitted outfall.

NATTATIVE STRATEGY FOR COMPLIANCE WITH ALL REQUIREMENTS OF 40 CFR 257 SUBPART D

From the regulatory text

40 C.F.R. § 257.103(f)(2)(v)(C)(1) To demonstrate that the criteria in paragraph (f)(2)(iii) of this section have been met, the owner or operator must submit all of the following:

> *(1) A certification signed by the owner or operator that the facility is in compliance with all of the requirements of this subpart;*
>
> I hereby certify that, based on my inquiry of those persons who are immediately responsible for compliance with environmental regulations for the Pirkey Power Plant, the facility is in compliance with all of the requirements contained in 40 CFR §257 Subpart D – *Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments.*
>
> X David A. Miller
> David A. Miller P.E.

Director – Land Environmental and Remediation Services

The Pirkey Power Plant is maintaining compliance with all requirements of Standards for the Disposal of Coal Combustion Residuals in Landfills and Surface Impoundments. Reports documenting compliance with the rule's provisions, such as location restriction, design criteria, operating criteria, and groundwater monitoring are posted to the AEP public CCR Rule Compliance Data and Information Internet site at the following link: http://www.aep.com/about/codeofconduct/ccrrule/.

From the regulatory text

40 CFR §257.103(f)(2)(v)(C)(2) Visual representation of hydrogeologic information at and around the CCR unit(s) that supports the design, construction and installation of the groundwater monitoring system. This includes all of the following:

> *(i) Map(s) of groundwater monitoring well locations in relation to the CCR unit;*
> *(ii) Well construction diagrams and drilling logs for all groundwater monitoring wells; and*
> *(iii) Maps that characterize the direction of groundwater flow accounting for seasonal variations;*

Groundwater monitoring at the Pirkey Power Plant CCR units is accomplished using PE-certified groundwater monitoring networks. The EBAP and WBAP are composed of three upgradient monitoring wells and three downgradient monitoring wells each. The LF GWMN is composed of four upgradient and 3 downgradient monitoring wells. The FGD Stack Out Area GWMN is composed of two upgradient and three downgradient monitoring wells. The complete GWMN Reports are provided in **Appendix C** and include the following:

- A map showing the location of the monitoring wells relative to the CCR units is included in the GWMN report as **Figure 10**
- Boring logs and well construction diagrams are included in the GWMN Report in **Appendix C**.
- A typical groundwater flow direction map is included in the GWMN Report as **Figure 9**

40 CFR §257.103(f)(2)(v)(C)(3) Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;

The most recent Groundwater Monitoring and Corrective Action Reports summarize Appendix III and IV constituent concentrations at each groundwater monitoring well monitored during each sampling event as Table 1 (see **Appendix F**).

40 CFR §257.103(f)(2)(v)(C)(4) Description of site hydrogeology including stratigraphic cross-sections;

The central and northern part of Pirkey Plant is located within an outcrop of the Eocene age Recklaw Formation. The Recklaw formation consists predominantly of clay and fine grained sand with a maximum thickness of 100 feet. The Recklaw Formation is underlain by the Eocene age Carrizo Sand. The topographically low southern portion of the plant is located in outcrop of the Carrizo Sand. The Carrizo Sand consists of fine to medium grain sand interbedded with silt and clay with a thickness of approximately 100 feet. The Carrizo Sand is underlain by Upper Wilcox.

The monitor wells installed on-site have a depth to groundwater ranges from to 20 to 58 feet below ground surface. The complete GWMN Reports for each CCR unit at Pirkey Power Plant are provided in **Appendix C** and include a description of the site hydrogeology. Stratigraphic cross-sections are included in each of the GWMN Reports as **Figures 4 – 8**.

The Bottom Ash Pond Complex is located approximately 2,000 feet north-northwest of Brandy Branch Reservoir, which was dammed during plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. Shallow groundwater flow direction at the site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the site. Groundwater flow direction maps of the latest monitoring events completed in the spring and fall to show seasonal changes are provided in Figures 3 and 4.

40 CFR §257.103(f)(2)(v)(C)(5) Any corrective measures assessment required at § 257.96;

The Pirkey Power Plant CCR units have not entered Assessment of Corrective Measures, therefore, no corrective measures assessment reports have been required or prepared.

40 CFR §257.103(f)(2)(v)(C)(6) Any progress reports on remedy selection and design and the report of final remedy selection required at § 257.97(a);

The Pirkey Power Plant CCR units have not entered Assessment of Corrective Measures, therefore no progress reports on remedy selection and design and a report of final remedy selection have been required or prepared.

40 CFR §257.103(f)(2)(v)(C)(7) The most recent structural stability assessment required at § 257.73(d); and

The most recent structural stability assessments required at 40 CFR§ 257.73(d) for the EBAP and WBAP can be found in **Appendix D**. These reports will be updated every 5 years as required by the CCR rule.

40 CFR §257.103(f)(2)(v)(C)(8) The most recent safety factor assessment required at § 257.73(e).

The most recent safety factor assessments required at 40 CFR § 257.73(e) for the EBAP and WBAP can be found in Appendix E. These reports will be updated every 5 years as required by the CCR rule.

COAL-FIRED BOILERS CEASE OPERATION AND IMPOUNDMENT CLOSURE

From the regulatory text

(D) To demonstrate that the criteria in paragraph (f)(2)(iv) of this section have been met, the owner or operator must submit the closure plan required by § 257.102(b) and a narrative that specifies and justifies the date by which they intend to cease receipt of waste into the unit in order to meet the closure deadlines.

AEP will oversee detailed planning and design of the closure activities which includes: engineering and design; prepare and file all required permit applications; receive approval from the respective regulatory agencies; bid and award construction contract; development of a revised water balance diagram after the generating units cease operations; and sequencing construction activities.

The following are the planned activities that will be necessary to meet the closure date of October 17, 2023.

Engineering, Design and Permitting
The conceptual design of the pond closure has been completed. Detailed design of the final closure and repurposing activities will begin December 2020 and is planned to be completed by May 2021.

Contractor Selection
Construction bid packages for the EBAP and WBAP closure are planned to be issued to bidders in May 2021 with an award date of November 2021. Six months have been allowed for bidding, selection and award of construction contracts to the selected contractors in accordance with AEP's typical process.

Construction
The majority of the CCR material is currently being removed from the EBAP as part of the operational activities of the plant. Once the CCR material is removed, the EBAP will only be used to receive CCR or non-CCR flows during extreme rainfall events, such as hurricanes, as a means for emergency capacity for the WBAP. At the end of the hurricane season in 2022, the EBAP will no longer be needed as emergency capacity for the WBAP which will allow for the final closure of the EBAP to start. The removal of ash will be verified by comparing the excavated contours to the original design contours when the ponds were constructed. When the excavation has reached the original construction contours, an additional one foot of material will be removed to confirm removal of CCR. All CCR material excavated plus the one foot of over excavation will be hauled to the on-site landfill. An engineer will certify that the removal activities satisfy the specification and completion of closure by removal for the EBAP. The completion of the removal of the CCR from the EBAP is planned for January 2023.

Once CCR sluicing from the operating unit has ceased to the WBAP in March 2023, closure by removal will start. WBAP closure will begin with dewatering of the pond. Once dewatered, the ash will be removed (approx. 300,000 CY) and hauled to the onsite landfill. The planned duration of the dewatering and CCR removal work is 5 months based on previous cleaning efforts at the plant. The removal of ash will be verified by comparing the excavated contours to the original design contours when the ponds were constructed. When the excavation has reached the original construction contours, an additional one foot of material will be removed (approx. 49,000 CY) to confirm removal of CCR; this is estimated to require 2 months. All CCR material excavated plus the one foot of over excavation will be hauled to the on-site landfill. An engineer will certify that the removal activities satisfy the specification and completion of closure by removal for the WBAP. The completion of the removal of the CCR from the WBAP is planned for October 2023.

Table below summarizes the major tasks, durations and milestone dates associated with closing the EBAP and WBAP.

Closure Planning and Engineering	6 months
Spec, bid, and Award construction contracts	6 months
EBAP Dewatering	2 months
EBAP CCR Material Removal	3 months
EBAP Impacted Soil Removal	2 months
EBAP Closure Complete	January 2023
Cease Coal Combustion & Sluicing Wastestreams	March 2023
Commence WBAP Dewatering and CCR Removal	March 2023
WBAP Dewatering	2 months
WBAP CCR material removal	3 months
WBAP Impacted soil removal	2 months
WBAP Closure Complete	October 17, 2023

CONCLUSION

Based upon the information submitted in this demonstration, it has been shown that the Henry W. Pirkey Power Plant is unable to obtain alternative disposal capacity for the CCR and non-CCR wastestreams before April 11, 2021 and qualifies for the site specific alternate time frame for the initiation of closure as allowed by 40 CFR 257.103 – Alternate Closure Requirements and specifically 40 CFR 257.103(f)(2) – *Permanent cessation of a coal-fired boiler(s) by a date certain.*Therefore, it is requested that EPA approve this demonstration.

Figures

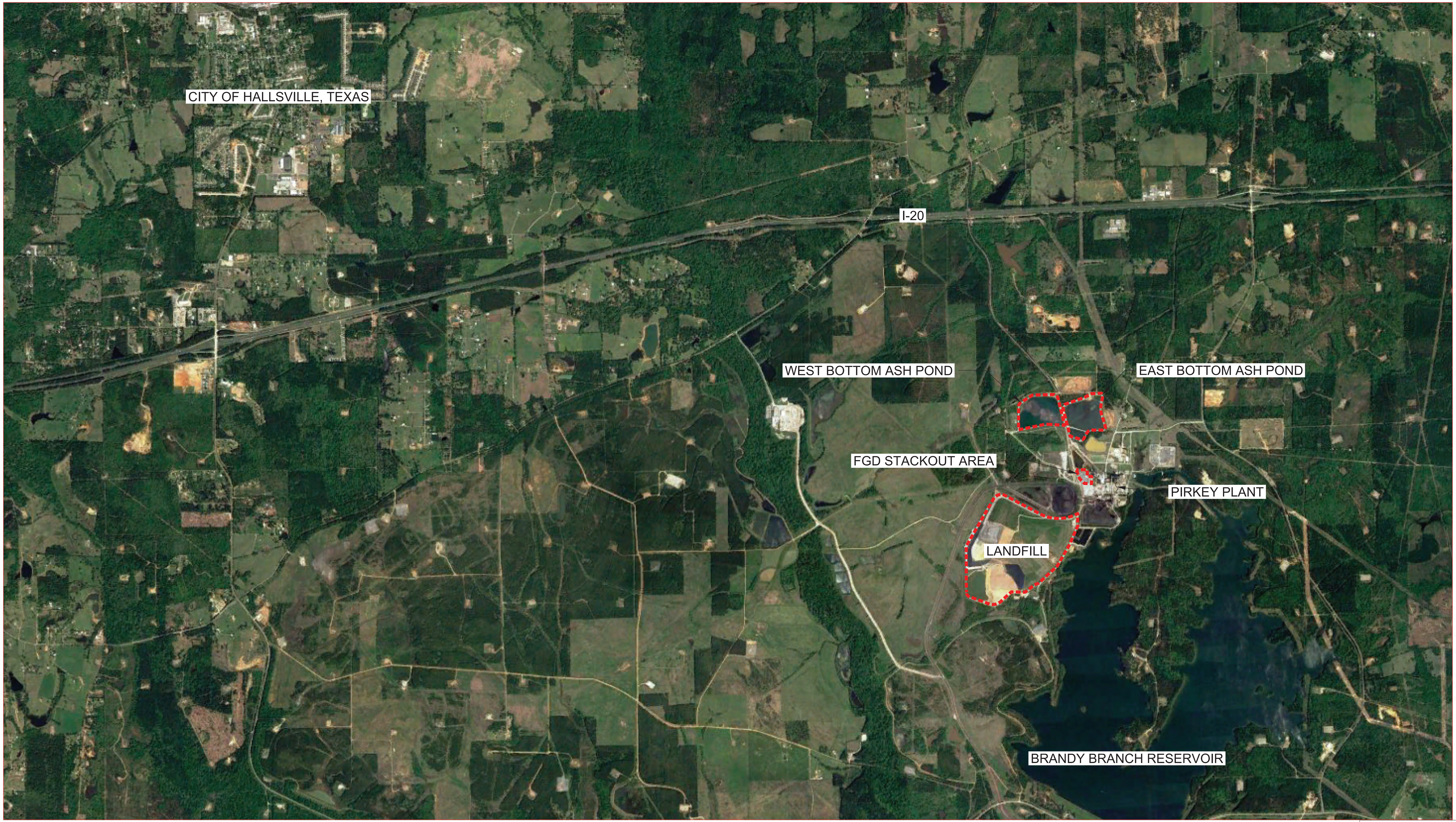


Figure 1

PRELIMINARY - NOT FOR CONSTRUCTION

🟥 LIMITS OF CCR UNIT

no.	date	by	ckd	description
A	06/22/20	KTM	MDB	ISSUED FOR EXTENSION REQUEST

no.	date	by	ckd	description

BURNS McDONNELL

9400 WARD PARKWAY
KANSAS CITY, MO 64114
816-333-9400
Burns & McDonnell Engineering Company, Inc.
Firm Reg. No. F-845

designed R. OWENS
detailed J. RIDDER

AMERICAN ELECTRIC POWER
BOUNDLESS ENERGY™

CCR / ELG COMPLIANCE PROJECT

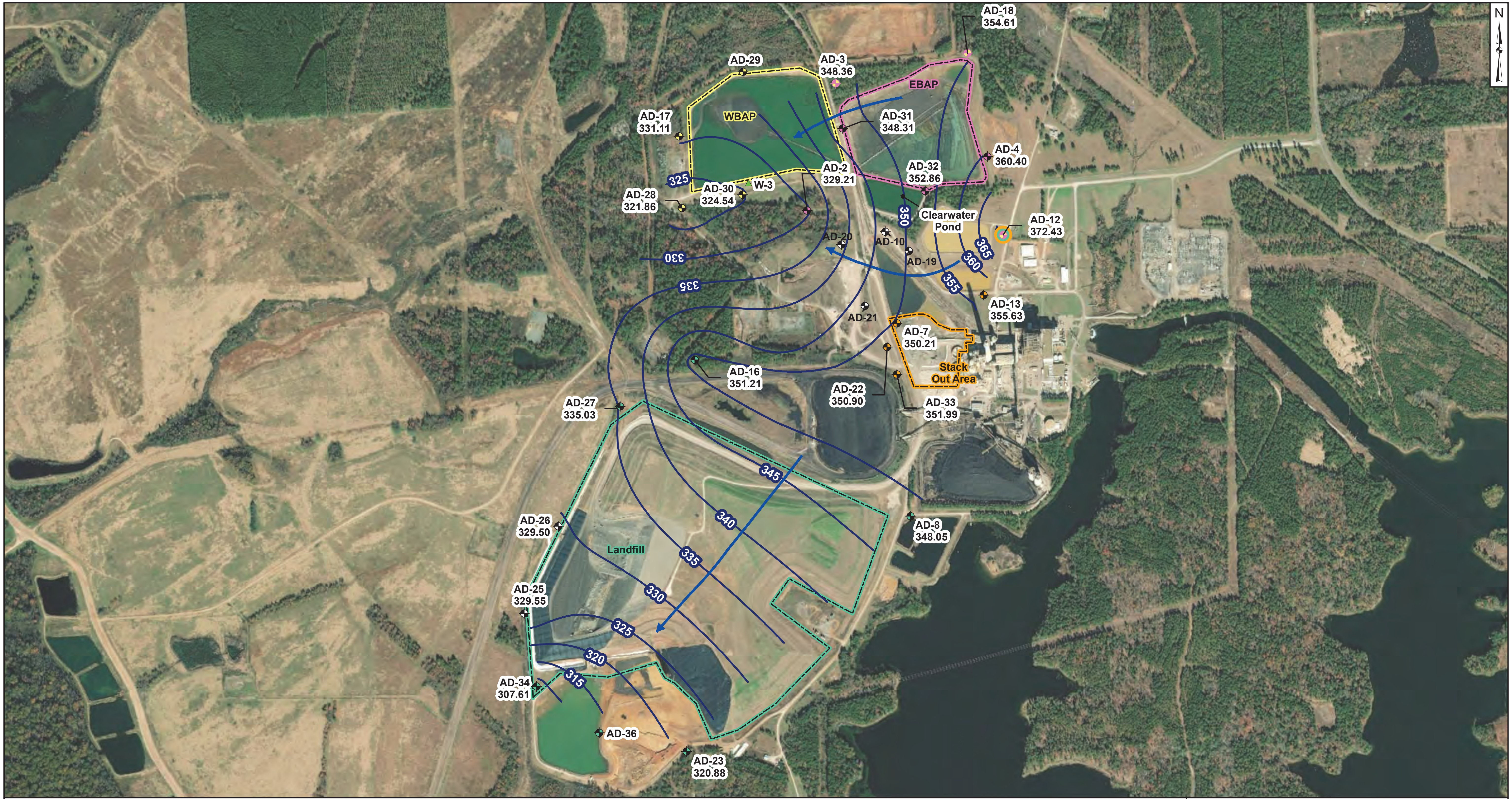
PIRKEY POWER PLANT
HARRISON COUNTY, TEXAS

CCR UNIT LOCATION MAP

project 120792
contract
drawing SK - C501
rev. A
sheet of sheets
file 120792SK-C501.DGN

Z:\Clients\ENR\AEPSvc\AEPCCRELG\120792_PirkeyCCRELG\Design\Civil\Dwgs\Sketches\120792SK-C501.dgn

6/22/2020



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
February 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
2

Columbus, Ohio
2020/01/16

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- ― Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
May 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2020/01/16

Figure
3

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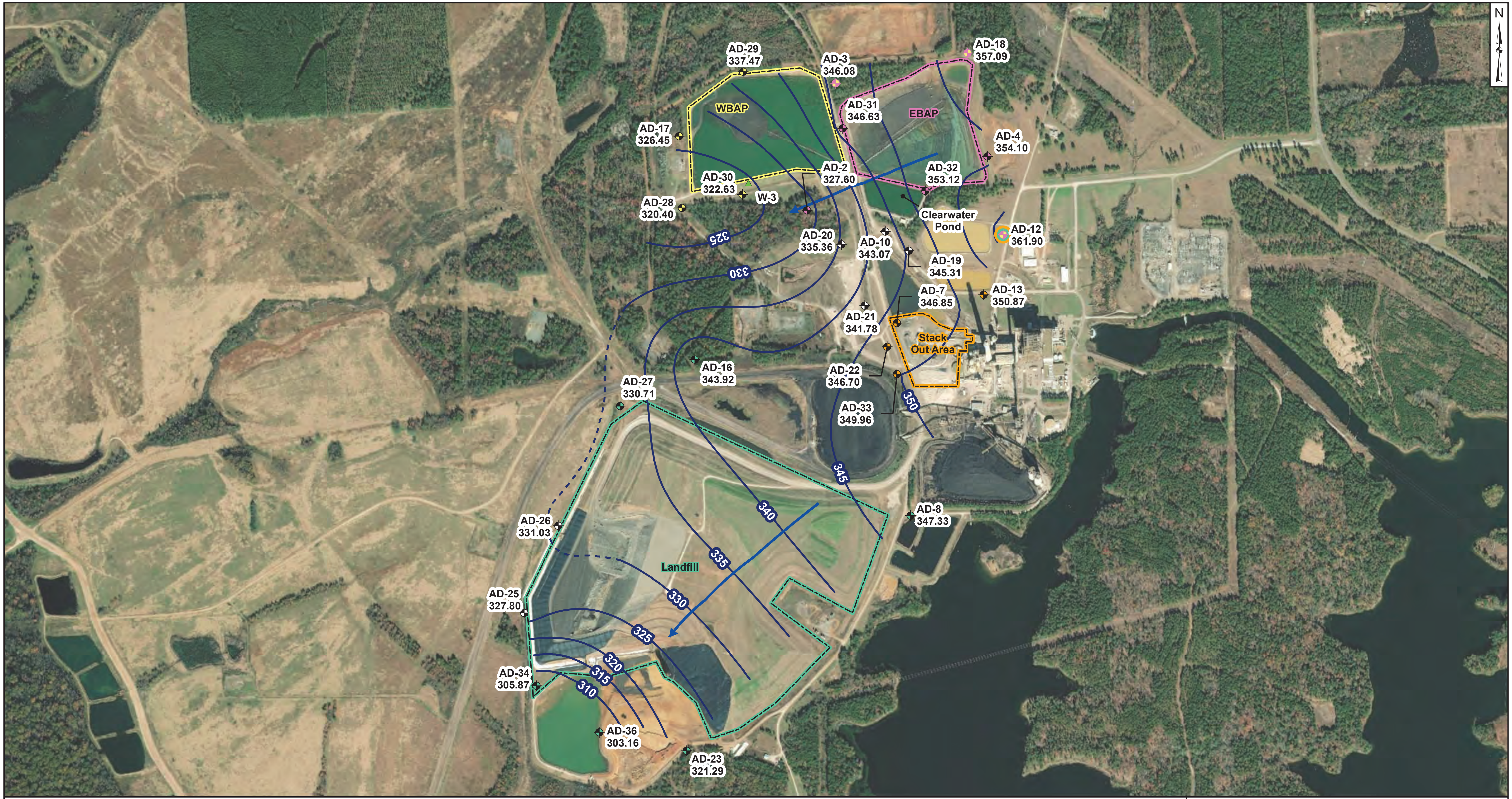


Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
August 2019

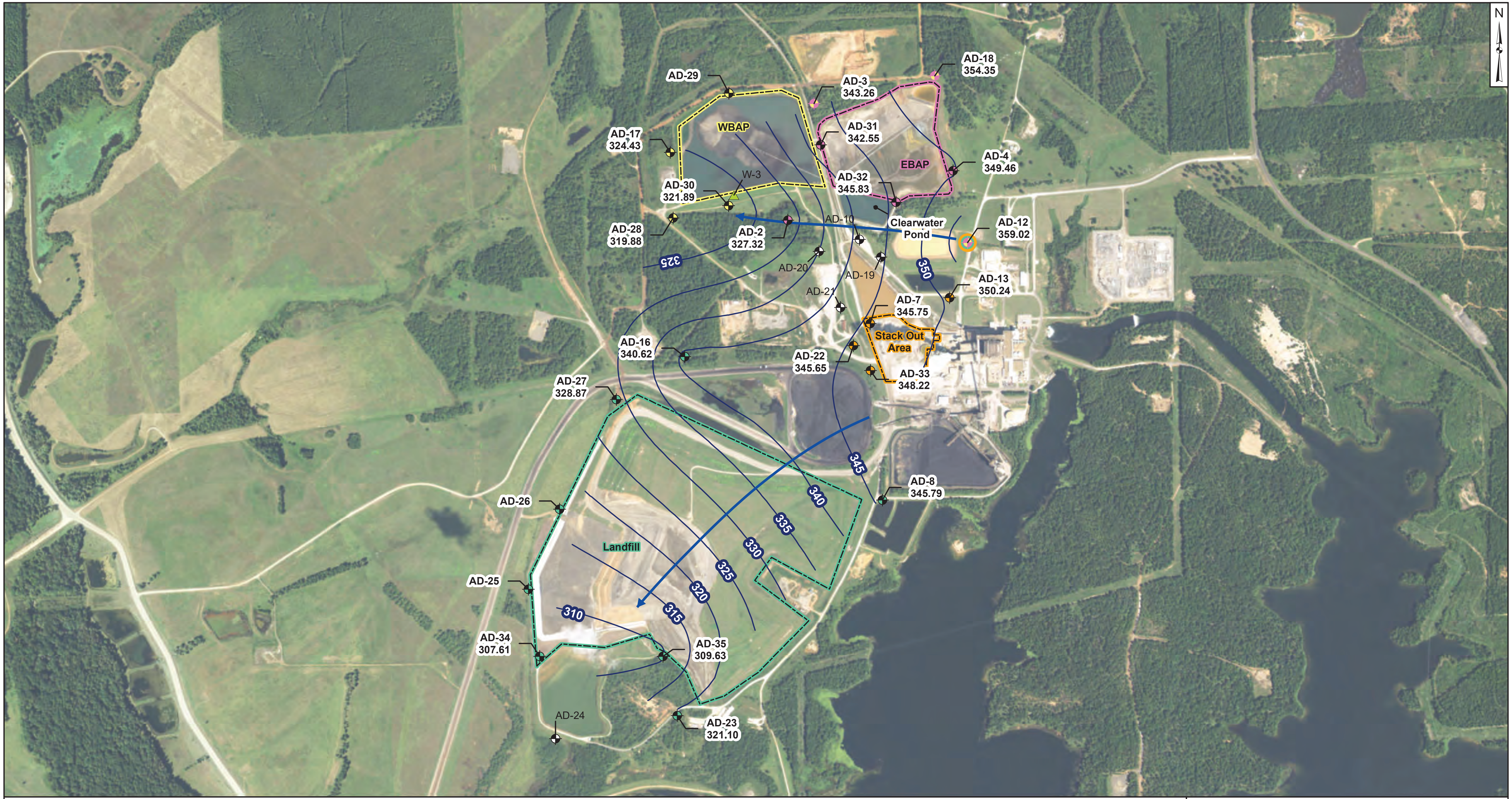
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2020/01/16

Figure
4

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201908-August.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stack Out Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- — Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected November 14 - 15, 2016) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).

Potentiometric Contours - Uppermost Aquifer November 2016

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2017/12/13

Figure

5

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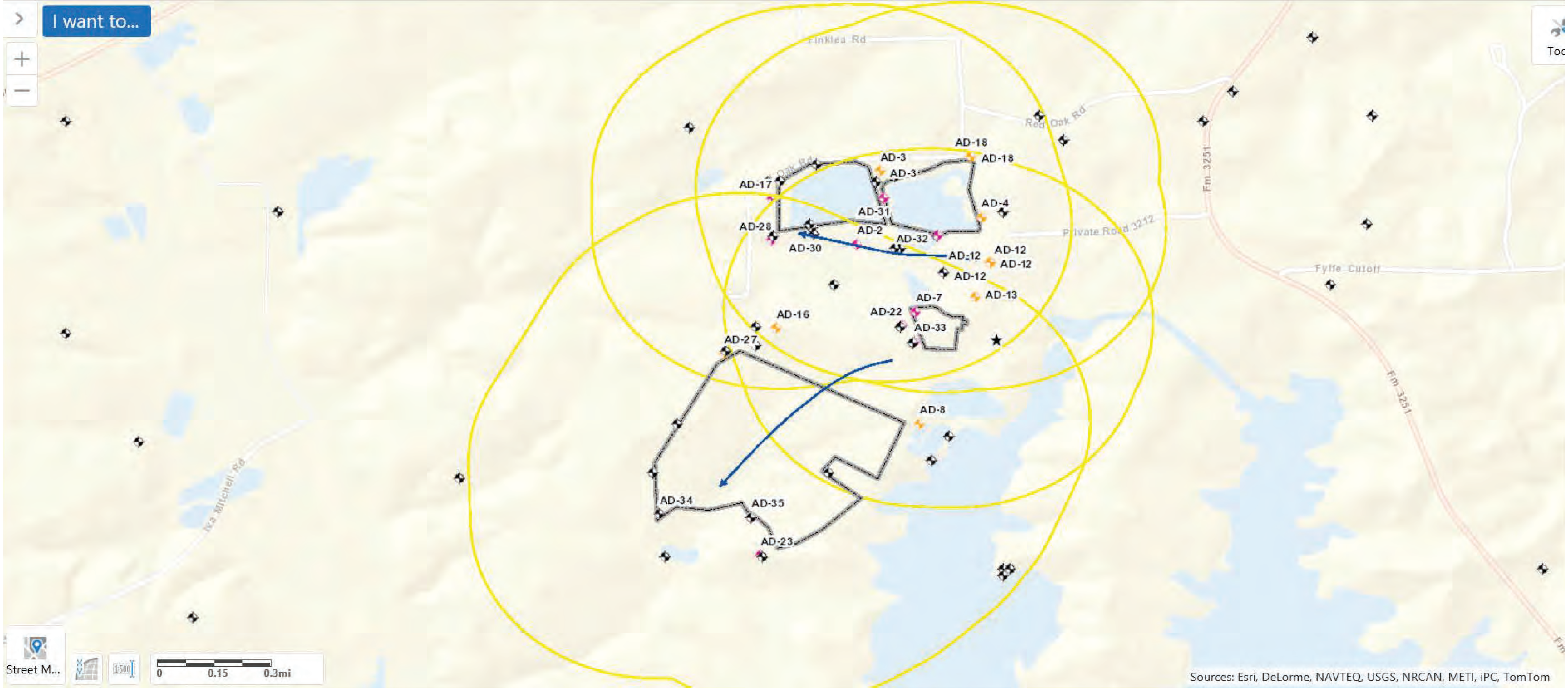
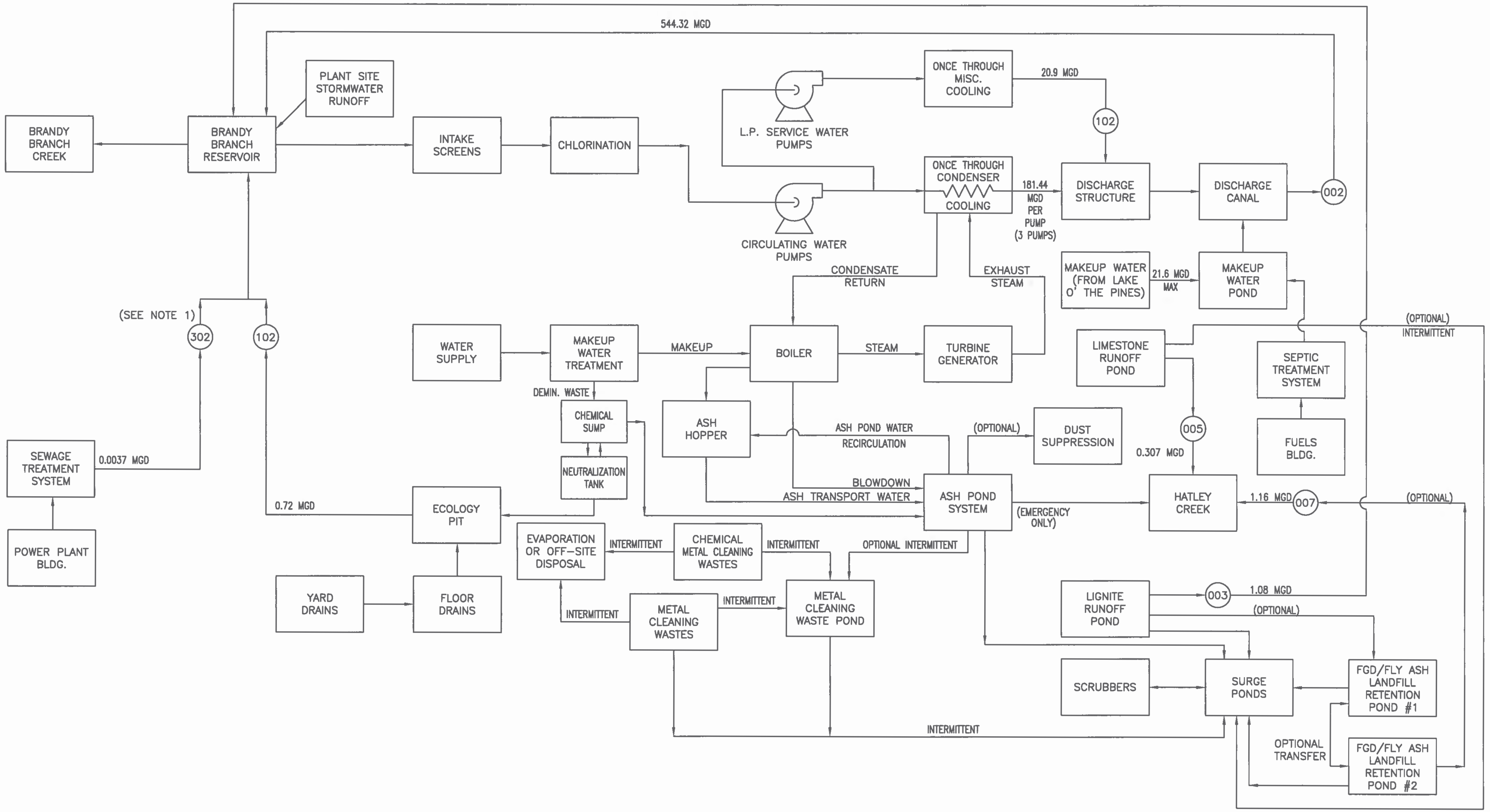

I want to...
Too
Finklea Rd
Red Oak Rd
Oak Rd
Private Road 3212
Fyffe Cutoff
Fm 3251
Fm 3251
Iva Mitchell Rd
AD-18
AD-18
AD-3
AD-3
AD-17
AD-4
AD-31
AD-28
AD-2
AD-32
AD-30
AD-12
AD-12
AD-12
AD-12
AD-13
AD-7
AD-22
AD-33
AD-16
AD-27
AD-8
AD-34
AD-35
AD-23
Street M...
0
0.15
0.3mi
Sources: Esri, DeLorme, NAVTEQ, USGS, NRCAN, METI, iPC, TomTom

Appendix A

Existing Water Balance



DATE	NO.	DESCRIPTION	APPD.
	4	ISSUED FOR REVISION	
		PRELIMINARY - REFERENCE ONLY	

REVISIONS

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SOUTHWESTERN ELECTRIC POWER COMPANY

HENRY W.PIRKEY PLANT

SOUTH HALLSVILLE TEXAS

ENVIRONMENTAL

SCHEMATIC OF WATER FLOW

UNIT: 1

DRAWING NUMBER: SWP07

REV: 4

CIVIL ENGINEERING

SCALE:
DR:
CH:
SUP:
ENG:
DATE: SEE REV 0

APPROVED BY

AMERICAN ELECTRIC POWER

AEP SERVICE CORP.
1 RIVERSIDE PLAZA
COLUMBUS, OH 43215

PLOT DATE: DD-MMM-YYYY
PLOT TIME: HOUR:MINUTE

Appendix B

Closure Plan required by §257.73(b)

CLOSURE PLAN

CFR 257.102(b)

East and West Bottom Ash Ponds

Pirkey Power Plant
Hallsville, Texas

October 2016
Revised November 2020

Prepared for : Southwest Electric Power Company - Pirkey Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

GERS – 20 –012

CLOSURE PLAN
CFR 257.102(b)
PIRKEY POWER PLANT
EAST AND WEST BOTTOM ASH PONDS

PREPARED BY Gary F. Zych DATE 11/20/2020
Gary F. Zych, P.E.

REVIEWED BY Arthur W. Rentzsch DATE 11/23/2020
Arthur W. Rentzsch

APPROVED BY Gary F. Zych DATE 11/23/2020
Gary F. Zych, P.E.
Department Manager – AEP Geotechnical Engineering

Gary F. Zych
STATE OF TEXAS
GARY F. ZYCH
127152
LICENSED
PROFESSIONAL ENGINEER
11/23/2020

I certify to the best of my knowledge, information, and belief that the information contained in this closure plan meets the requirements of 40 CFR § 257.102(b)

Table of CONTENTS

1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of CCR 257.102(b) for Closure Plans of Existing CCR Surface Impoundments.

2.0 DESCRIPTION OF THE CCR UNIT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for managing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP). These two ponds and a Clearwater Pond are collectively referenced at the Bottom Ash Complex. The Clearwater Pond is not a CCR surface impoundment.

The East BAP is located directly adjacent to and east of the West BAP. The East BAP receives sluiced bottom ash and has a surface area of 31.5 acres and a storage capacity of 188 acre-feet. The pond is almost entirely incised, with a reported maximum embankment height of 4 feet.

The West BAP, which also receives sluiced bottom ash, is located northwest of the main plant buildings and shares its eastern border with the western border of the East BAP. The West BAP receives sluiced bottom ash and has a surface area of 30.9 acres and a storage capacity of 188 acre-feet. The maximum embankment height is 25 feet. The main upstream embankment slopes are 3 feet horizontal to 1 foot vertical (3:1 H:V); while the main downstream slopes area 2.5:1 H:V.

The sluicing of CCR materials is alternated between the two CCR surface impoundments. CCR material is sluiced to one pond while the CCR material is dewatered and excavated from the other pond. The transport water from the sluicing operation is discharged into the Clearwater Pond. The plant recycles the water from the Clearwater Pond for plant operations.

3.0 DESCRIPTION OF CLOSURE PLAN 257.102(b)(1)(i)

[A narrative description of how the CCR unit will be closed in accordance with this section]

Closure of the Pirkey Power Plant East and West Bottom Ash Ponds will be completed by removal of all CCR material and sediments from each pond.

4.0 CLOSURE BY REMOVAL 257.102 (b)(1)(ii)

[If closure of the CCR unit will be accomplished through removal of CCR from the CCR unit, a description of the procedures to remove the CCR and decontaminate the CCR unit in accordance with paragraph (c) of this section.]

Closure by removal of the East and West bottom ash ponds will include removal of all CCR from the surface impoundments. The removal of all CCR and any sediments will be accomplished by dredging and/or mechanical means. The CCR material will be either placed in the onsite CCR landfill or hauled offsite for beneficial reuse. A visual evaluation of the pond bottom by a third party consultant will be the basis for declaring the CCR material has been removed. After all CCR material has been removed, an additional 12 inches of soil from the pond bottom will be removed. Following the removal of CCR and soil, the dikes forming the pond will be used as subgrade material to regrade the area. The disturbed area will be seeded at the completion.

4.1 CLOSURE PERFORMANCE STANDARDS 257.102 (c)

[An owner or operator may elect to close a CCR unit by removing and decontaminating all areas affected by releases from the CCR unit. CCR removal and decontamination of the CCR unit are complete when constituent concentrations throughout the CCR unit and any areas affected by releases from the CCR unit have been removed and groundwater monitoring concentrations do not exceed the groundwater protection standard established pursuant to §257.95(h) for constituents listed in appendix IV to this part.]

Closure of the CCR unit will be completed when all CCR materials in the unit, and any areas that may have been affected by releases from the CCR unit, have been removed and groundwater monitoring demonstrates that all concentrations of the assessment monitoring constituents listed in appendix IV to part 257 do not exceed either statistically equivalent background levels or MCLs for two consecutive sampling events using the statistical procedures in § 257.93(g).

5.0 ESTIMATE OF MAXIMUM CCR VOLUME 257.102 (b)(1)(iv)

[An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit.]

The estimated maximum CCR volume on-site is 188 Acre-Ft. or 303,307 cubic yards for the East Bottom Ash Pond and 188 Acre-Ft. or 303,307 cubic yards for the West Bottom Ash Pond.

6.0 ESTIMATE OF LARGEST AREA OF CCR REQUIRING COVER 257.102 (b)(1)(v)

[An estimate of the largest area of CCR unit ever requiring a final cover

This pond will be closed by removal of CCR materials as such this section is not applicable.

7.0 CLOSURE SCHEDULE 257.102(b)(1)(vi)

[A schedule for completing all activities necessary to satisfy the closure criteria in the section, including an estimate of the year in which all closure activities for the CCR unit will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR unit, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phases of the CCR surface impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of the CCR unit closure.

The generating units will cease operation in March 2023. During 2020, ash was removed from the East bottom ash pond as part of normal plant operations. The East pond will remain available to receive CCR or non-CCR material as a means for emergency capacity. The following schedule is related to the work necessary to complete final closure activities of both ponds.

Initiate engineering and design for closure	December 2020
Complete design and submit permit applications as necessary	May 2021
Remove CCR from East BAP	June 2020 –September 2020
Bid and award construction contract	May 2021 – November 2021
Receive Approval of State/Local Permits	Spring 2023
Complete closure of East BAP	November 2022 – January 2023
Dewater and remove CCR from West BAP	March 2023 – August 2023
Remove soil and Regrade area to drain	August 2023- October 2023
Complete closure of West BAP	October,17 2023

Appendix C

Groundwater Monitoring Well Network Evaluation Report

American Electric Power Service Corporation

East Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

May 25, 2016

ARCADIS

STATE OF TEXAS
Kenneth J. Brandner
Geology
1737
LICENSED
PROFESSIONAL GEOSCIENTIST

Kenneth Brandner

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matt J Lamb

Matthew J. Lamb
Project Manager

John W Holm

John Holm, P.E.
Professional Engineer

East Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
AEP

Prepared by:
ARCADIS U.S., Inc.
100 E Campus View Blvd
Suite 200
Columbus
Ohio 43235-1447
Tel 614 985 9100
Fax 614 985 9170

Our Ref.:
OH015976.0010

Date:
May 25, 2016

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91, for the East Bottom Ash Pond (BAP) CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above and isolated from the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zone, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the East BAP (Site). The evaluation of the location restriction criteria is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the East BAP CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant East BAP.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The East BAP CCR unit is located at the north end of the Plant and approximately 2,000 feet north-northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of East BAP CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the East BAP.

2.2.1 Embankment Configuration

The East BAP is partially incised into native soils with an embankment height of approximately 4 feet (AMEC, 2011). The East BAP embankments are constructed of compacted clay on a 3:1 slope (3 feet horizontal, 1 foot vertical) (Sargent & Lundy, 1983). The elevation of the top of the embankment around the perimeter of the East BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, May 2011). The interior bottom elevation of the East BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Johnson & Pace, June 2011).

2.2.2 Area/Volume

The East BAP is approximately 31.5 acres in size. The design maximum ash storage capacity of the East BAP is 188 acre feet (Sargent & Lundy, 1983). Johnson & Pace calculated the East BAP ash storage capacity in 2011 at 161 acre feet at an elevation of 355 feet amsl (maximum operating level) (Johnson & Pace, June 2011).

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, flue gas desulfurization sludge) have been generated. The East BAP, which was placed into operation in 1985, receives bottom ash and economizer ash sluiced from the power plant boiler (**Figure 3**). Clear water overflow from the East BAP discharges into the Clearwater Pond located directly south of the East BAP. Bottom ash and economizer ash are periodically excavated from the East BAP and hauled by truck to either the on-site landfill for disposal, or sold for offsite beneficial re-use.

The base of the East BAP was constructed in 1983 with a compacted clay liner (Sargent & Lundy, 1983). Following installation of the compacted clay liner, soil borings S-4 through S-7 were advanced below the base of the East BAP to total depths of six feet in September 1983 (Southwestern Laboratories, 1984). The lithologic data from soil borings S-4 through S-7 confirm at least six feet of clay is present below the base of the East BAP (Sargent & Lundy, 1984).

2.2.4 Surface Water Control

Surface water elevation in the East BAP is controlled by a weir box and a manually operated gate valve on a 36-inch-diameter discharge pipe at the southwest corner of the pond. Clear water overflow from the East BAP discharges through the 36-inch-diameter pipe into the 2.7- acre Clearwater Pond located directly south of the East BAP (**Figure 3**). Water in the Clearwater Pond is pumped (re-circulated) back into the boiler ash hopper.

2.3 Previous Investigations

The initial soils investigation and design of the East BAP was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, and design of the East BAP. As discussed above in Section 2.2.3, the design included installation of a clay liner below the East BAP.

In September-October 1983, Southwestern Laboratories conducted a soil investigation at the Plant, including advancement of four soil borings (S-4 through S-7) below the East BAP (Southwestern Laboratories, 1984).

In 1984, Sargent & Lundy conducted an evaluation of the East BAP. This report included evaluation of soil sample geotechnical data, and concluded a low-permeability clay liner was present below the East BAP (Sargent & Lundy, 1984).

In 2009, ETTL Engineers & Consultants (ETTL) conducted a geotechnical investigation of the East BAP earthen embankment. The investigation included installation of two soil borings through the embankment (E1, E2), completion of the soil borings as piezometers PE-1 and PE-2, respectively, and collection of soil samples for geotechnical analyses. The report concluded the embankment was stable and the existing embankment slopes were acceptable if conditions are maintained (ETTL, 2010). The conditions to be maintained included embankment protection from erosion (vegetative cover), removal of brush and trees two feet or more in height, and control of animal burrowing.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed a hydraulic analysis of the East BAP for a 10-year, 24-hour rainfall event in accordance with the TCEQ TPDES permit design criteria. The report concluded the storage capacity of the East BAP is hydraulically adequate (Johnson & Pace, May 2011).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the East BAP area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the East BAP, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow groundwater flow direction in the area of the East BAP is west-southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The East BAP is located approximately 2,000 feet north-northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the area of the East BAP does not discharge into Brandy Branch Reservoir.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 500 feet south (side gradient) of the East BAP in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile southwest (downgradient) of the East BAP for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (up gradient) of the Pirkey Power Plant.

3. Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be placed down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the area of the East BAP is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 15 feet that is located between an elevation of approximately 325 and 340 feet amsl (**Appendix A**). The base of the East BAP is at an elevation of 347 feet amsl. Therefore the separation distance between the uppermost aquifer and the base of the East BAP is approximately seven feet. This separation distance is further illustrated on cross section A-A' (**Figure 4)** and cross section E-E' (**Figure 8)**.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness (approximately 15 feet), the yield of the uppermost aqufier is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Available groundwater elevations are summarized on **Table 1** for 2011 through 2016. The most recent comprehensive groundwater data set from January 20, 2016 is depicted on **Figure 9**. The groundwater flow is west-southwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

Per 40 CFR 257.60(a), new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five ft) above the upper limit of the uppermost aquifer, or must demonstrate there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high conditions).

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers, that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the area of the East BAP is the clayey and silty sand stratum that is located between an elevation of approximately 325 and 340 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 19, 2015 to review existing well network conditions and locations. A well construction table that summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as

Table 2. Photo documentation of the located wells during the August 19, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-2, AD-3, AD-4, AD-12, and AD-18 were previously installed at the Site to monitor the uppermost aquifer (clayey and silty sand stratum) associated with the East BAP. As discussed above in Section 3.1.1, the uppermost aquifer below the East BAP is approximately 15 feet thick and is located between an elevation of approximately 325 and 340 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on Geologic Cross Section A-A' (**Figure 4**), existing monitoring well AD-4 is screened in the uppermost aquifer upgradient (east) of the East BAP, and existing monitoring well AD-3 is screened in the uppermost aquifer sidegradient (northwest) of the East BAP. Existing monitoring wells AD-4, AD-12 and AD-18 (also located east of the East BAP) will be utilized as upgradient monitoring wells for the East BAP. Existing monitoring well AD-2, located west-southwest of the East BAP, will be utilized as a downgradient monitoring well for the East BAP.

As shown on **Figure 9**, shallow groundwater flow direction in the area of the East BAP is west-southwesterly. One existing monitoring well (AD-2) was located hydraulically downgradient of the East BAP during the August 19, 2015 site visit, and three downgradient monitoring wells are required to monitor groundwater quality downgradient of a CCR unit. This data gap was addressed by installation of new downgradient monitoring wells AD-31 and AD-32 during December 2015 as shown on **Figure 9** and **10**. With the addition of monitoring wells AD-31 on the west side of the East BAP and AD-32 on the south central side of the East BAP, there are no gaps remaining in the groundwater monitoring network for the East BAP.

4. Recommended Monitoring Network and PE Certification

The recommended existing groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the East BAP (up gradient or down gradient), well depth, and well construction. The recommended network would provide an improved understanding of groundwater quality, hydraulics, and groundwater flow at the East BAP.

4.1 Recommended Monitoring Well Network Distribution

Three up gradient well locations (existing monitoring wells AD-4, AD-12, and AD-18) and three down gradient well locations (existing monitoring wells AD-2, AD-31, and AD-32) are recommended to establish a groundwater quality monitoring well network for the East BAP. In addition, existing sidegradient monitoring well AD-3 may be utilized as a piezometer to obtain additional groundwater flow direction and gradient data for the East BAP.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the East BAP is summarized on **Table 3** and illustrated on **Figure 10.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 325 and 340 feet amsl as shown on Geologic Cross Sections A-A' (**Figure 4**) and E-E' (**Figure 8**). The screen elevations are presented in **Table 3**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the East BAP was addressed by installation of monitoring wells AD-31 and AD-32 during December 2015. Monitoring wells AD-31 and AD-32 were installed by a Texas Department of Licensing and Regulation (TDLR)-licensed water well driller. Well construction data for the monitoring well network are summarized on **Tables 2** and **3**, and the monitoring well completion diagrams are provided in **Appendix A**.

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system will be adequate to meet the requirements of 40 CFR Part 257.91.

Kenneth J. Brandner
Printed Name of Registered Professional Engineer

Ken J Brandner
Signature

KENNETH J. BRANDNER
69586

69586	Texas	5-25-16
Registration No.	Registration State	Date

5. References

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Tables

Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen(b)		Bottom of Screen(b)		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers(c)																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
NM - Not Measured

Table 2
Well Construction Details
AEP Pirkey Power Plant - CCR Units
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen[b]		Bottom of Screen[b]	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18	341	40	319	20	339.48	40	319.48
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29	350	51	328	31	347.84	51	327.84
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.48	40.5	321.48
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13	344	35	322	15.0	341.81	35.0	321.81
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8	335	30	313	10.0	332.65	30.0	312.65
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13	347	25	335	15.0	345.48	25.0	335.48
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8	352	30	330	10.0	349.50	30.0	329.50
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13	339	35	317	15.0	337.30	35.0	317.30
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8	339	30	317	10.0	337.23	30.0	317.23
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8	348	30	326	10.0	345.57	30.0	325.57
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13	334	35	312	15.0	331.72	35.0	311.72
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3	285	20	268	5.0	282.68	20.0	267.68
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8	326	30	304	10.0	324.15	30.0	304.15
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8	334	40	302	10.0	332.41	40.0	302.41
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.33	37.5	312.33
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13	323	35	301	15.0	320.92	35.0	300.92
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8	342	30	320	10.0	340.21	30.0	320.21
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8	331	25	314	10.0	329.04	25.0	314.04
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18	340	35	323	20.0	337.75	35.0	322.75
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11	346	33	324	13.0	344.23	33.0	324.23
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12	347	30	329	15.0	344.30	30.0	329.30
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8	297	25	280	10.0	294.64	25.0	279.64
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20	296	3.0	313.01	18.0	298.01
Piezometers[c]																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26	330	38	318	28.0	328.30	38.0	318.30

General Note:
Elevations in feet above mean sea level.

Footnotes:
(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.
(c) Souce: EETL (October 2010).
(d) Source: Aukland Consulting LLC (January 26, 2016).

Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

Table 3
Proposed Well Network
AEP Pirkey Power Plant - East Bottom Ash Pond
Hallsville, Harrison County, Texas

Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Target Elevation[(a)] (ft amsl)	Screen Bottom Target Elevation[(a)] (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-4	Exisiting	Uppermost Water-Bearing Unit	East of East Bottom Ash Pond	Upgradient	337.7	317.7	20	Existing well installed in 1983; well will be utilitzed to establish backgroud water quality
AD-12	Exisiting	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-18	Exisiting	Uppermost Water-Bearing Unit	East of East Bottom Ash Pond	Upgradient	345.5	335.5	10	Existing well installed in 2011; well will be utilitzed to establish backgroud water quality
Downgradient								
AD-2	Existing	Uppermost Water-Bearing Unit	West-Southwest of East Bottom Ash Pond	Down gradient	321.3	301.3	20	Existing well installed in 1983; uppermost shallow aquifer adjacent to the East Bottom Ash Pond - downgradient
AD-31	Existing	Uppermost Water-Bearing Unit	West of East Bottom Ash Pond	Down gradient	337.8	322.8	15	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to the East Bottom Ash Pond - downgradient
AD-32	Existing	Uppermost Water-Bearing Unit	South of East Bottom Ash Pond	Down gradient	344.2	324.2	20	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to the East Bottom Ash Pond - downgradient
Piezometers								
AD-3	Exisiting	Uppermost Water-Bearing Unit	Northwest of East Bottom Ash Pond	Side gradient	335.8	315.8	20	Existing well installed in 2011; and utilitzed to obtain water level data for uppermost water-bearing unit

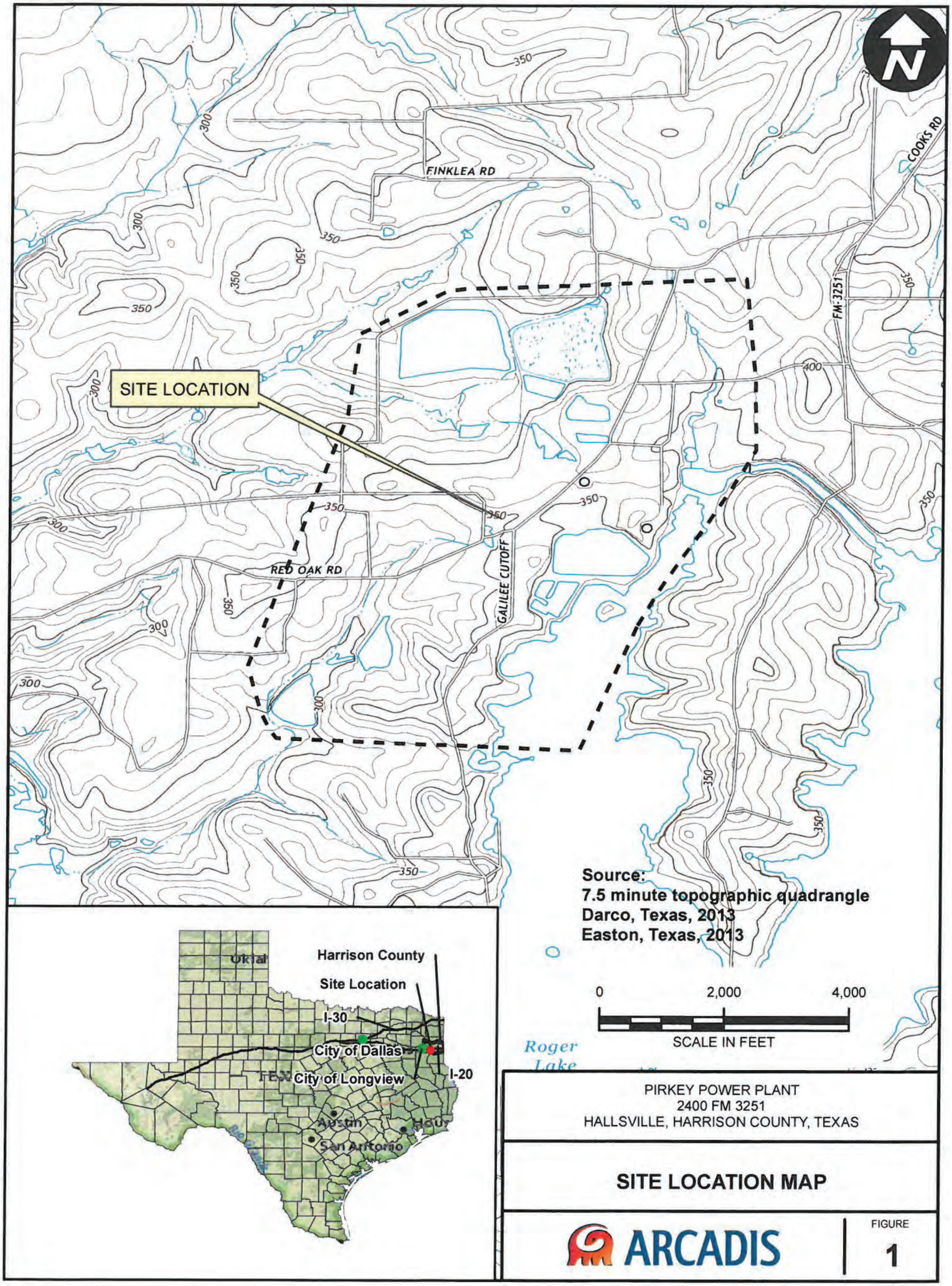
Footnotes:

a. Target elevations are an estimated range.

Acronyms and Abbreviations:

U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

Figures



Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

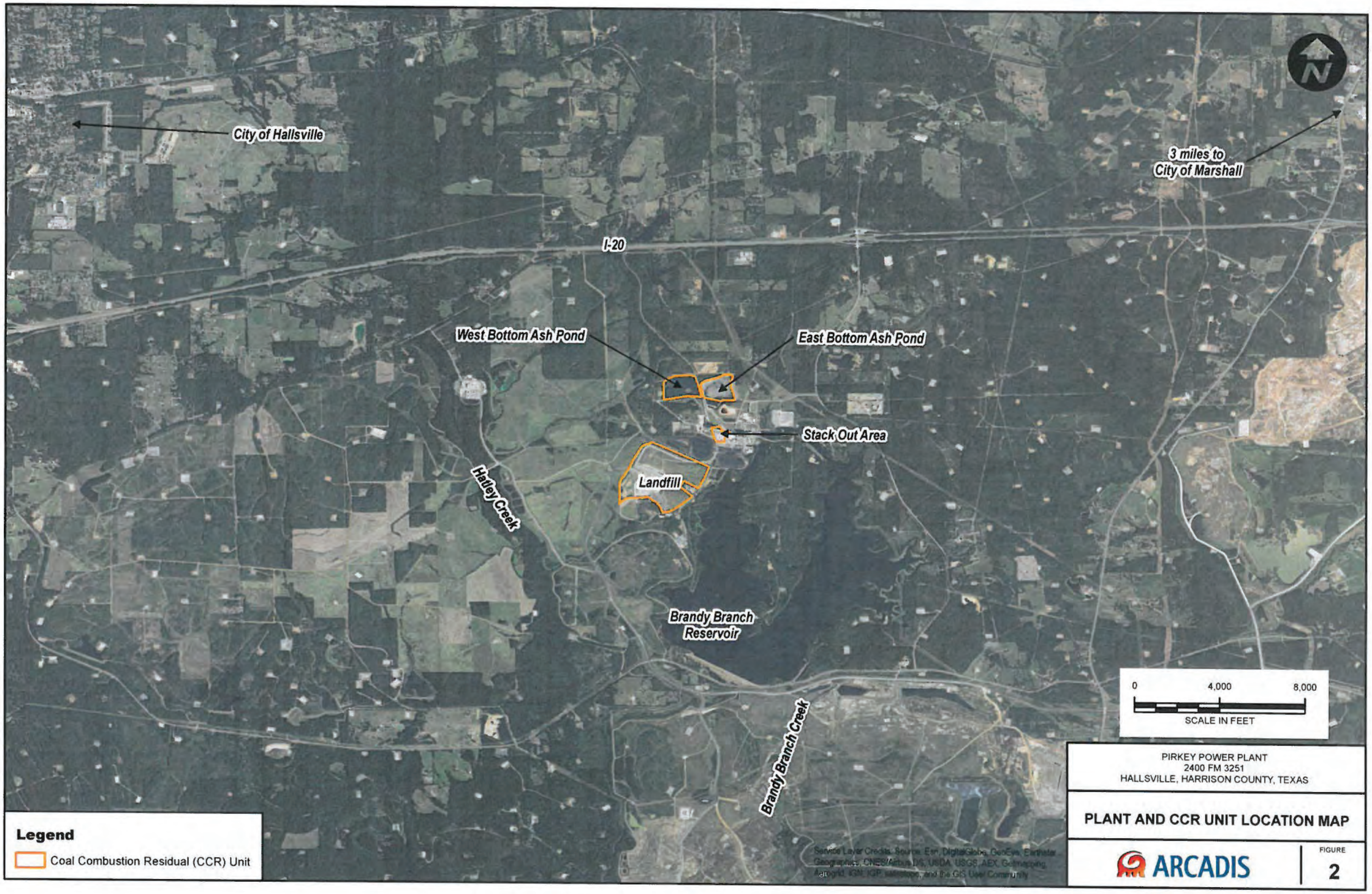
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

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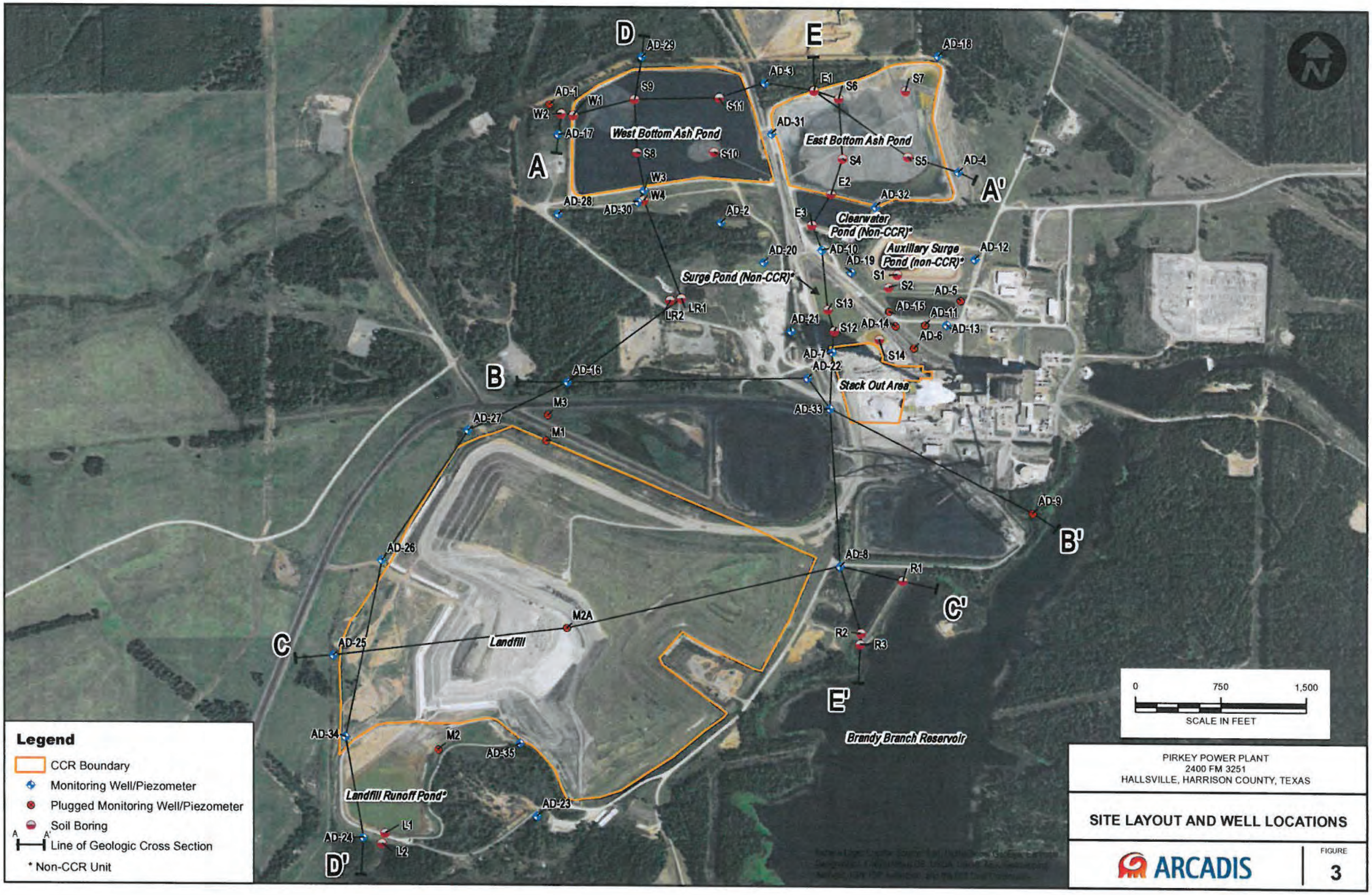
FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



Legend

- 🟧 CCR Boundary
- ◆ Monitoring Well/Piezometer
- ● Plugged Monitoring Well/Piezometer
- ◓ Soil Boring
- A├─┤A' Line of Geologic Cross Section
- * Non-CCR Unit

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

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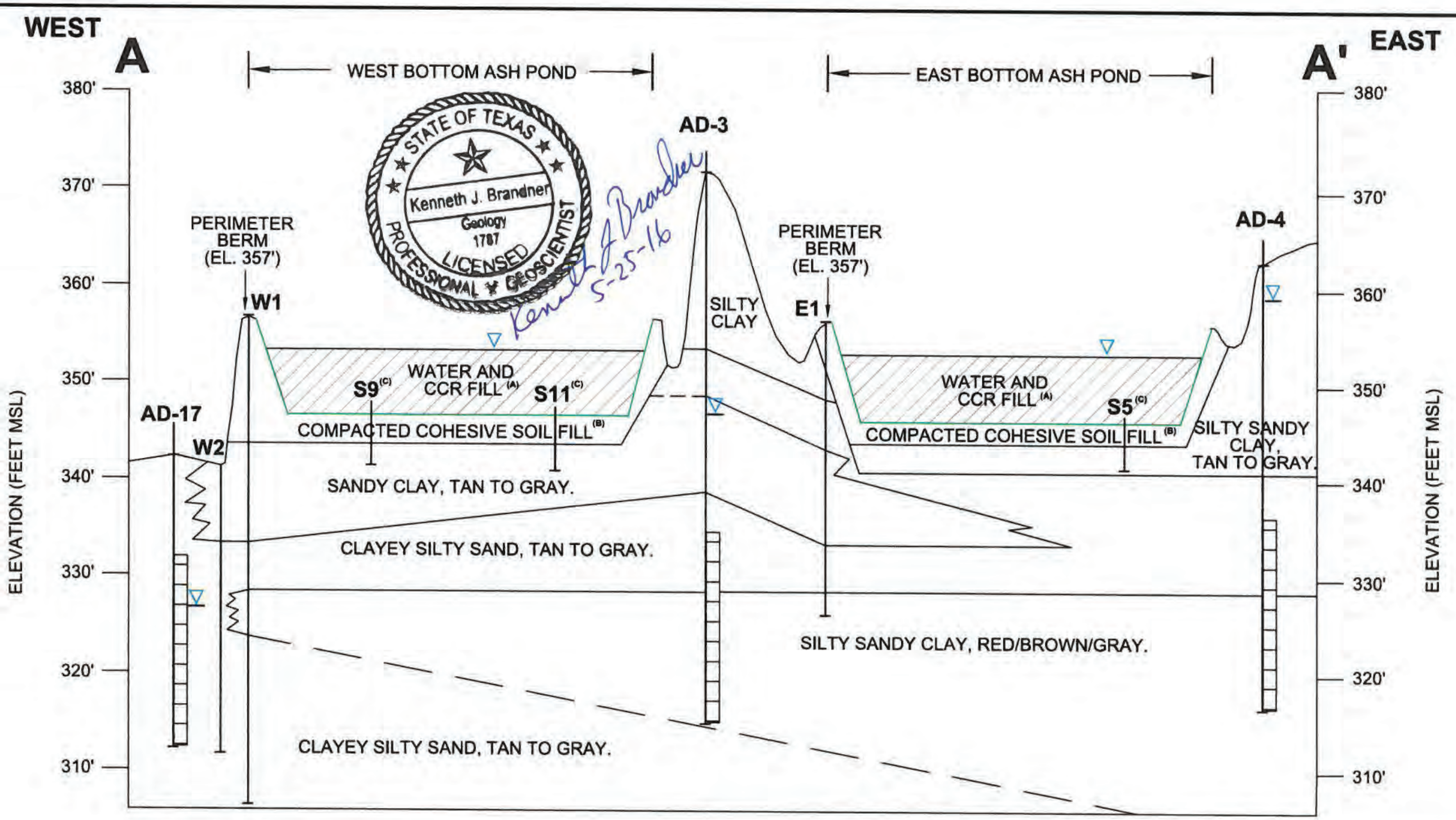
FIGURE
3

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



0 300'
HORIZONTAL SCALE

LEGEND

- ☐ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).

C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION A - A'

ARCADIS

FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:18 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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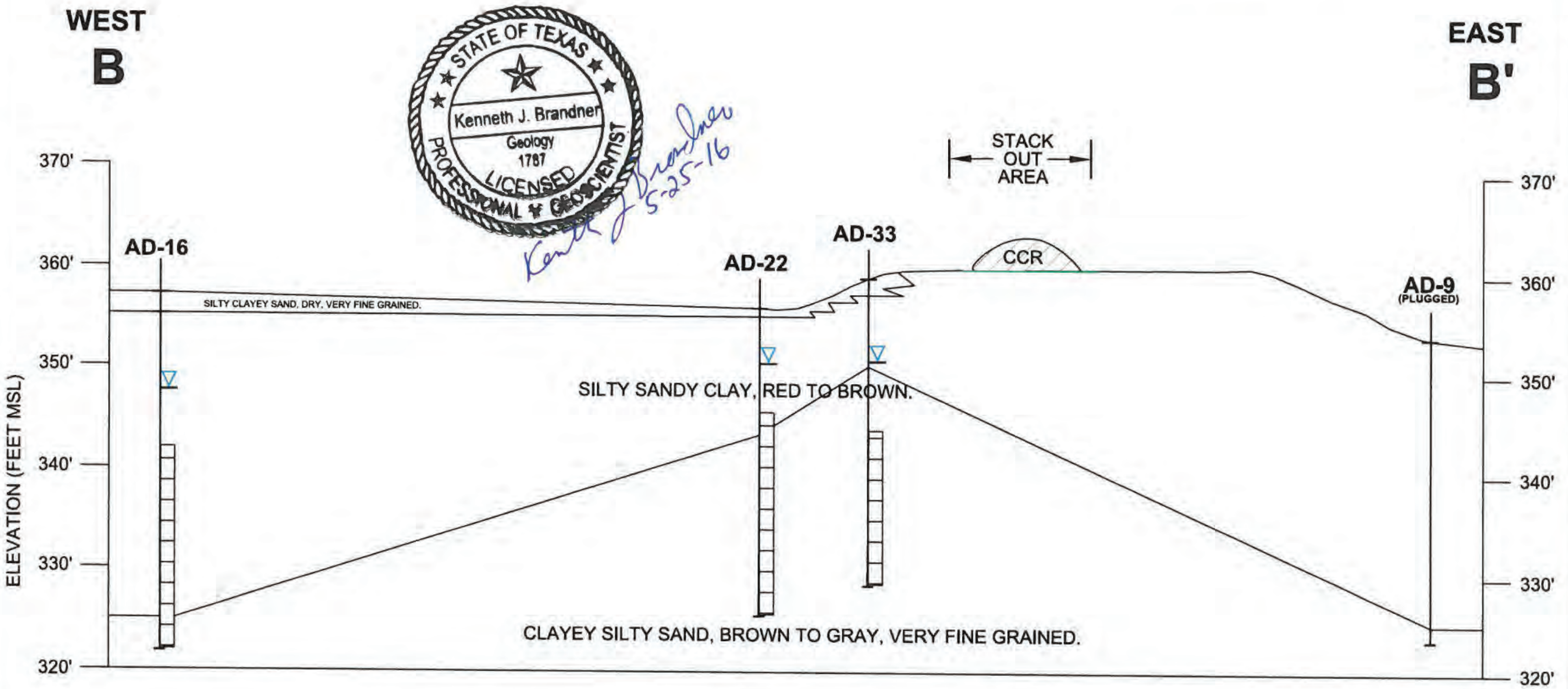

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0 300'
HORIZONTAL SCALE

LEGEND

- ⊟ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

NOTES:

A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.

B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 5 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 2/18/2016 1:49 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE: —
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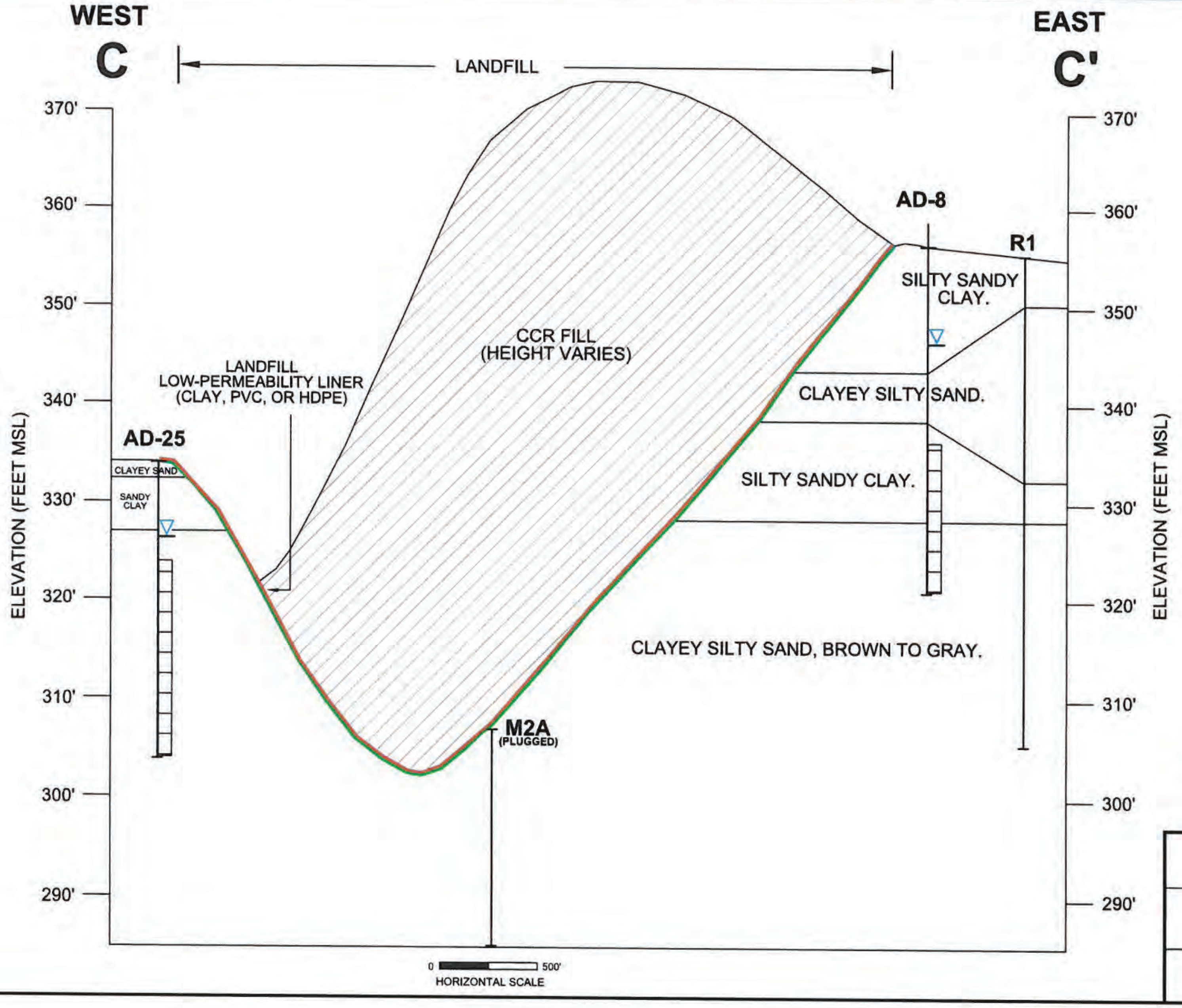

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LEGEND

- ⌸ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:25 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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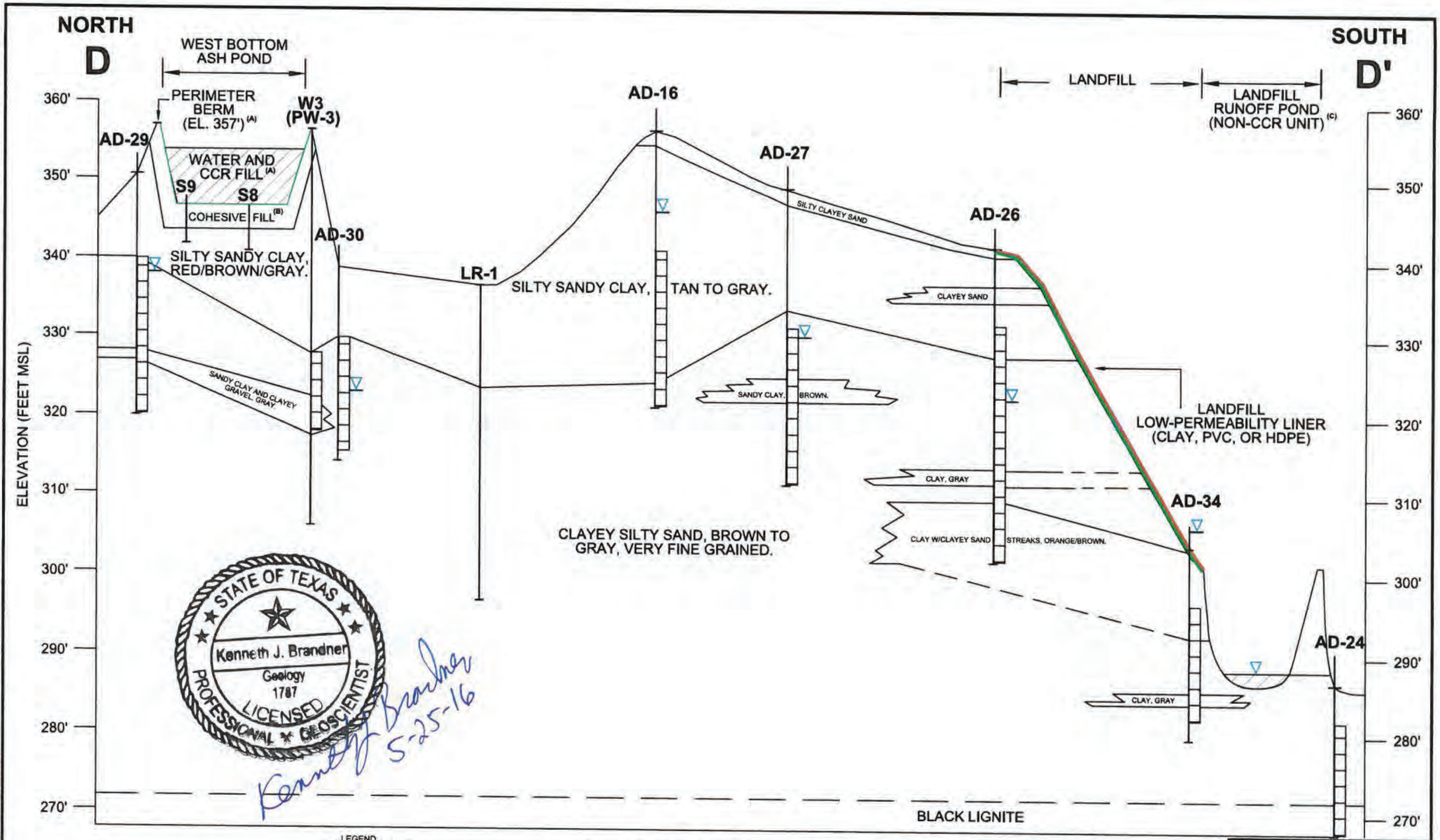

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LEGEND

⊟ MONITORING WELL SCREENED INTERVAL

▽ WATER LEVEL IN MONITORING WELL (1/20/16)

— BASE OF CCR UNIT

0 600'
HORIZONTAL SCALE

NOTES:
A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL. BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS

FIGURE
7

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 7 Cross Section D-D'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:30 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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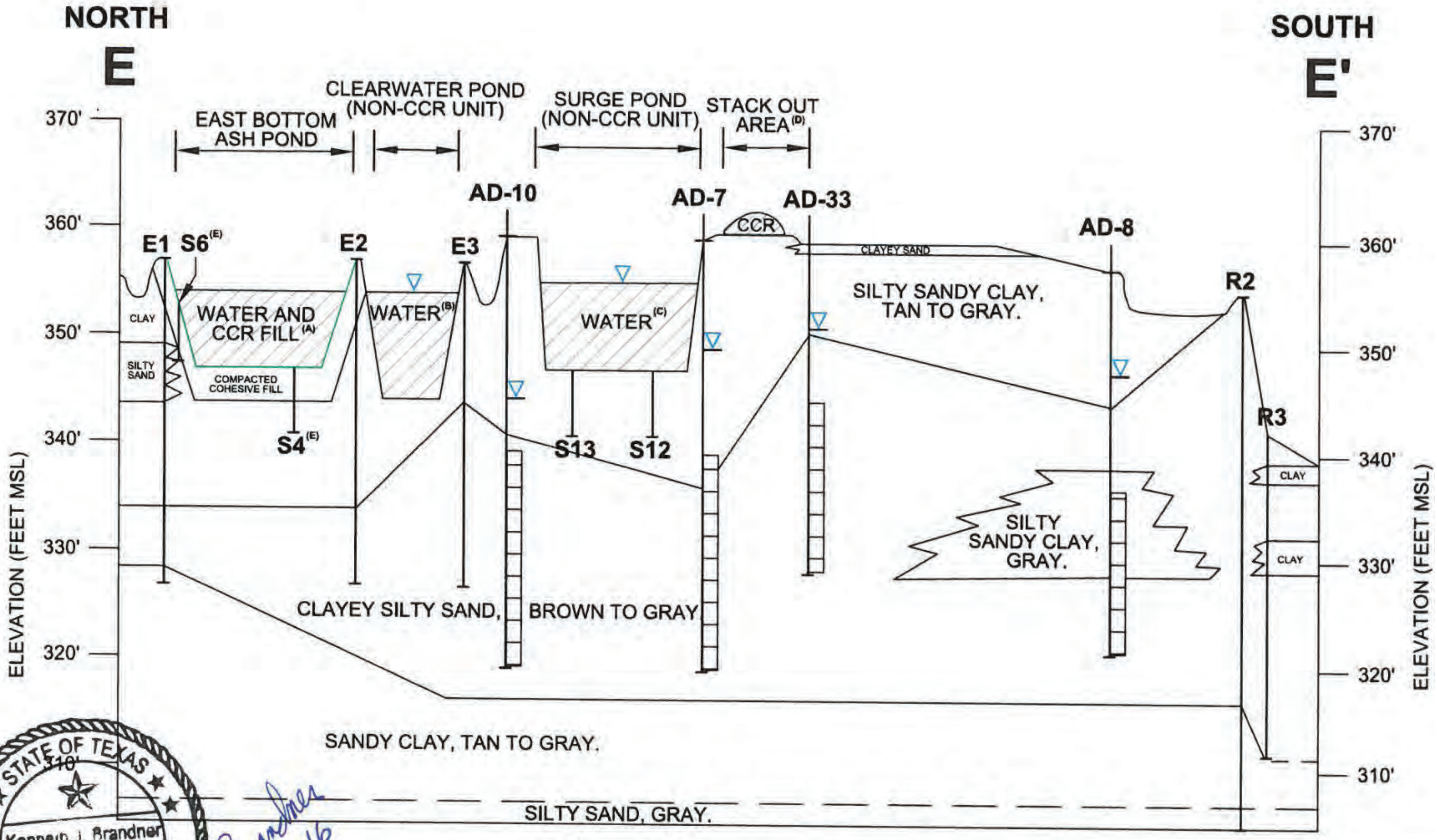

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0 500'
HORIZONTAL SCALE

LEGEND

⊟ MONITORING WELL SCREENED INTERVAL

▽ WATER LEVEL IN MONITORING WELL (1/20/16)

— BASE OF CCR UNIT

NOTES:

A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).
C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".
D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

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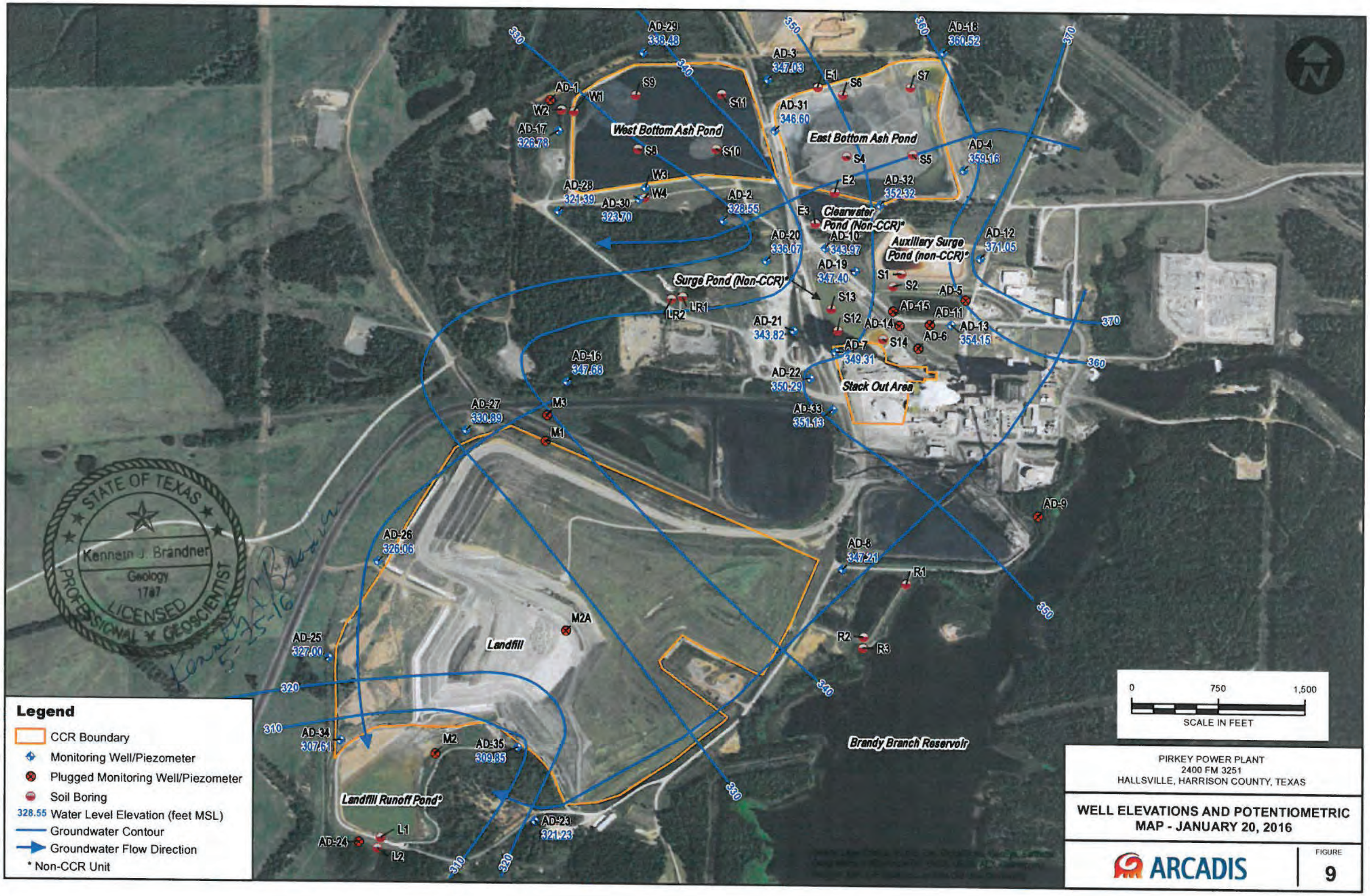
FIGURE
8



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5-25-16

Legend

- ▭ CCR Boundary
- ◆ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ● Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- — Groundwater Contour
- → Groundwater Flow Direction
- * Non-CCR Unit

0 750 1,500
SCALE IN FEET

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

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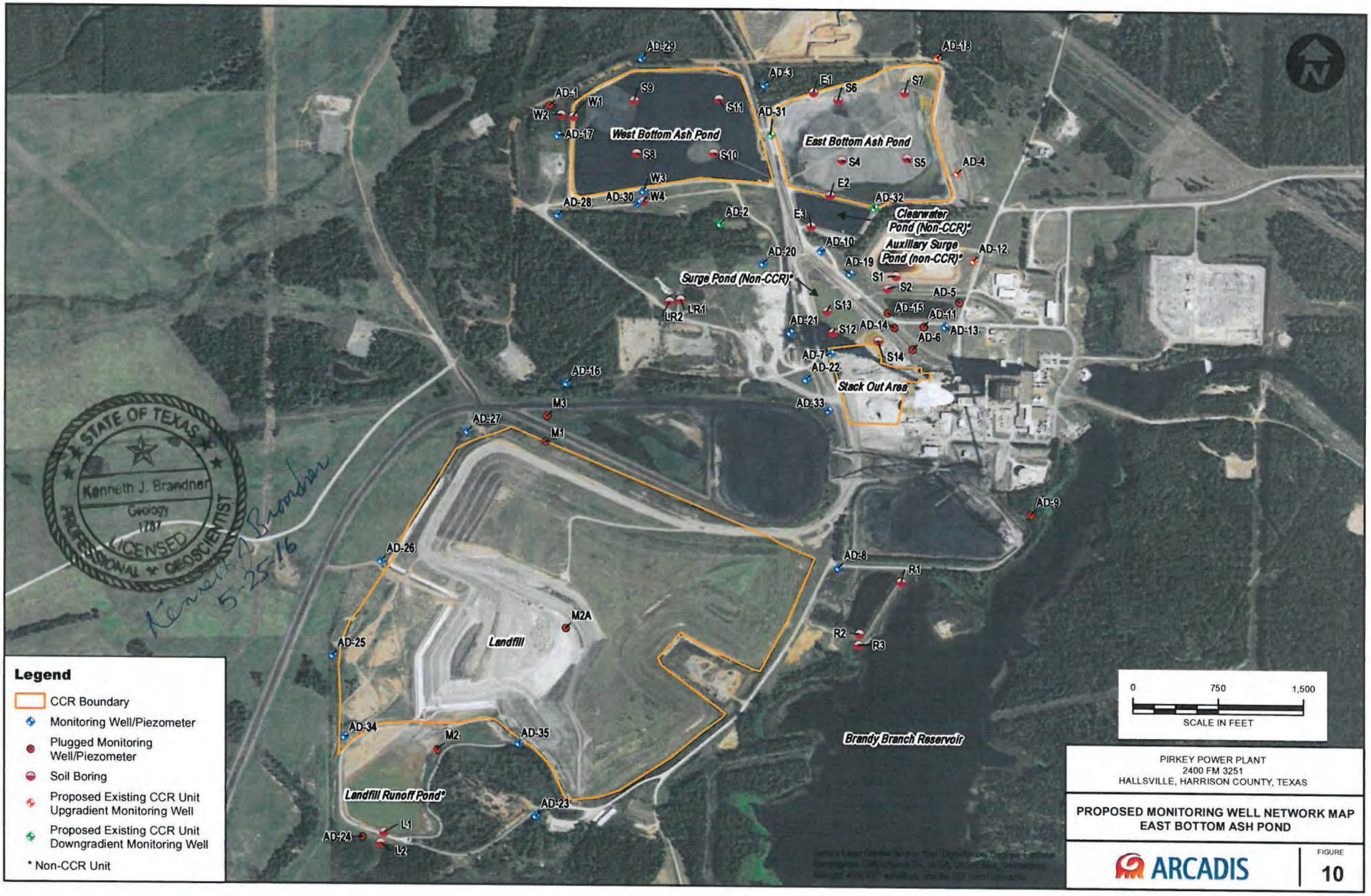
FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



Legend

- ▭ CCR Boundary
- ◆ Monitoring Well/Piezometer
- ● Plugged Monitoring Well/Piezometer
- ◐ Soil Boring
- ◆ Proposed Existing CCR Unit Upgradient Monitoring Well
- ◆ Proposed Existing CCR Unit Downgradient Monitoring Well
- * Non-CCR Unit

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP
EAST BOTTOM ASH POND

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FIGURE
10

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Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 10 - Proposed Well Network - East Bottom Ash Pond.mxd

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Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

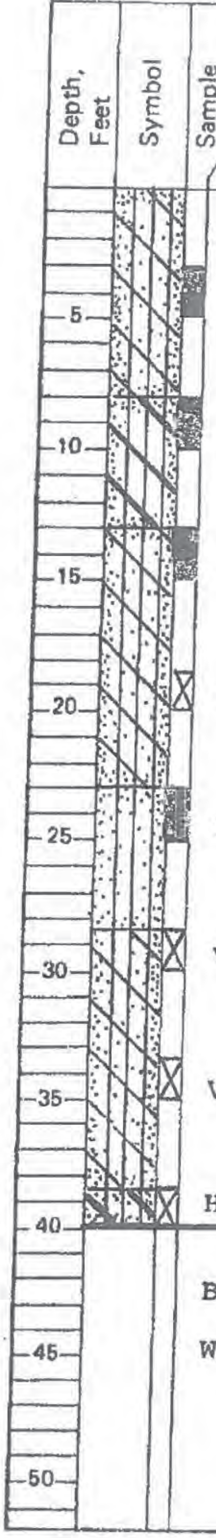
BORING NO.: MW-2
LOCATION: Hallsville

Date: 10-7-83 Type: Auger Ground Elevation:

Legend:

■ Sample X Penetration ▼ Water

Description of Stratum



Firm tan clayey silty sand

Medium tan and grey very sandy silty clay

Dense tan and grey clayey silty sand

Dense tan clayey silty sand 10-15-16 31 B/F

Dense tan silty sand

Very dense grey clayey silty sand 15-35=12" 50 B/F

Very dense grey clayey silty sand 21-29=9" 50 B/9"

Hard grey sandy silty clay 20-30=12" 50 B/F

Bottom of boring at 40 feet.

Water encountered at 25 feet.

832964

LOG OF BORING

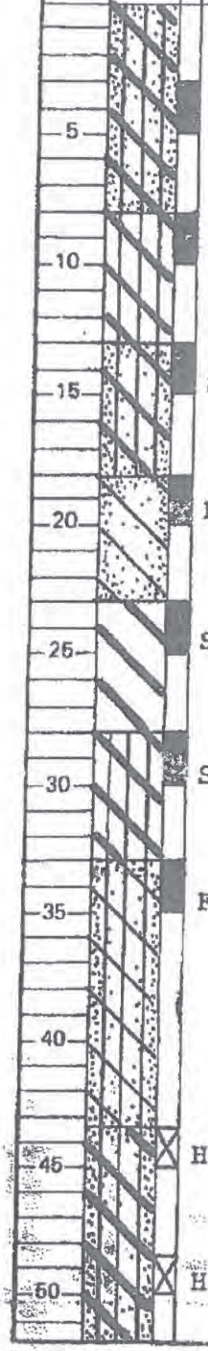
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-3
LOCATION: Hallsville,TX

Date: 11-4-83 Type: Auger Ground Elevation:

Legend:
▇ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff red, brown and grey sandy silty clay

Stiff red, tan and grey silty clay lenses w/iron ore

Stiff brown and grey sandy silty clay

Firm brown and grey sand w/clay lenses

Stiff brown and grey clay

Stiff brown and grey clay w/silt lenses

Firm grey clayey silty sand

Hard grey clay w/silty sand lenses 43-7=6" 50 B/6"

Hard brown and grey silty sandy clay 21-29=12" 50 B/F

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-3
LOCATION: Hallsville, TX

Date: 11-4-83
Type: Auger
Ground Elevation:

Legend:
■ Sample
✕ Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
55	▨	✕	Hard grey silty sandy clay 28-22=10" 50 B/10"
60			Bottom of boring at 57 feet. Water encountered at 42 feet.
65			
70			
75			
80			
85			
90			
95			
100			

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

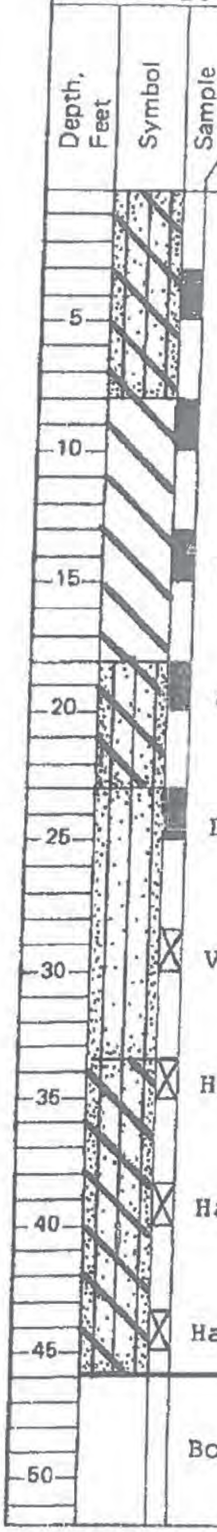
BORING NO.: MW-4
LOCATION: Hallsville

Date: 10-10-83
Type: Auger
Ground Elevation:

Legend:

■ Sample
X Penetration
▼ Water

Description of Stratum



Stiff tan and grey silty sandy clay w/iron ore

Very stiff tan and grey clay

Very stiff tan and grey clay w/iron ore seam

Stiff tan and grey silty sandy clay lenses

Firm grey silty sand

Very dense grey silty sand 30-20=12" 50 B/F

Hard grey silty sandy clay 30-20=8" 50 B/8"

Hard grey silty sandy clay 25-25=8" 50 B/8"

Hard grey silty sandy clay 25-25=10½" 50 B/10½"

Bottom of boring at 46 feet.

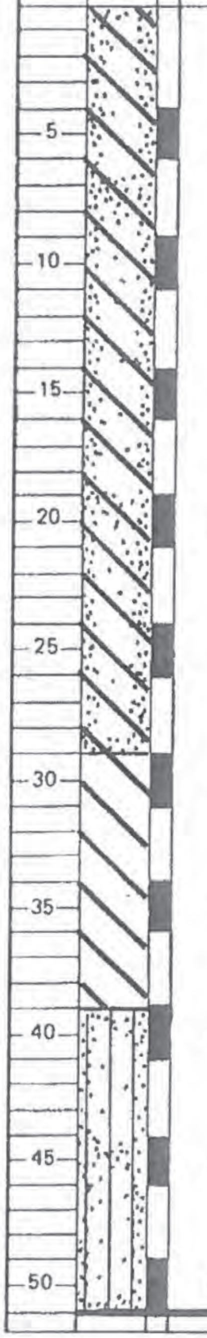
832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond BORING NO.: MW-12
CLIENT: Southwestern Electric Power Company LOCATION: Hallsville, TX
N 6+13.25; W-6+90.36
Date: 1/30/86 Type: Rotary Ground Elevation: 378.41

Legend:
■ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Depth, Feet	Description of Stratum
5	Brown and tan sandy clay
10	Brown, tan and gray sandy clay
15	Tan and gray sandy clay
20	Brown and tan sandy clay
25	Gray and tan sandy clay
30	Brown and gray clay
35	Brown and gray clay
40	Gray silty sand
45	Gray silty sand
50	Gray silty sand

Water encountered at 27.5 feet.
Bottom of Boring at 51 feet.

SOUTHWESTERN LABORATORIES

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ____ ■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-18

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

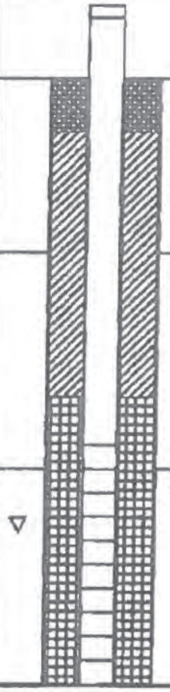
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 1/3/2011

PREPARED BY: Jeff Sammons **LOGGED BY:** Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.154' Datum: WGS-84 **WELL LOCATION:** Northeast of Bottom Ash Pond #1
LONGITUDE: W94°29.108'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
							
1 2 3 4 5 6 7			0-7	SM	Sandy Silt, some clay, very fine grained, gray, light brown, light brownish red, yellowish brown	None	Dry
8 9 10 11 12 13 14 15 16			7-16	CL	Clay, some sand, light gray, reddish gray, stiff, yellowish brown -iron oxide fracture at 9.5' -increasing sand content at 14', thin lenses of iron-oxide cemented sand at 14.5', 15', 15.5', stiff	None	Dry Moist
17 18 19 20 21 22 23 24 25			16-25	SM	Silty sand, some clay, gray, yellowish brown, dense, abundant gypsum crystals, abundant iron oxide cemented sandstone gravel in layers, saturated 19-21' -dark gray at 21' -clayey at 21-23' -greenish gray, trace clay, at 23' -clay lense, hard, dry, (shale), at 24.5-25'	None None None None None	Moist to V. Moist Saturated Dry
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40					Boring Terminated at 25'		

▒ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 25 feet
Filter Sand (Size/Interval): 13-25'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-15'
Screen Interval: 15-25'
Water level: 3'

Note: This log is not to be used separate from this report.

Hydrex
ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-31

PROJECT INFORMATION

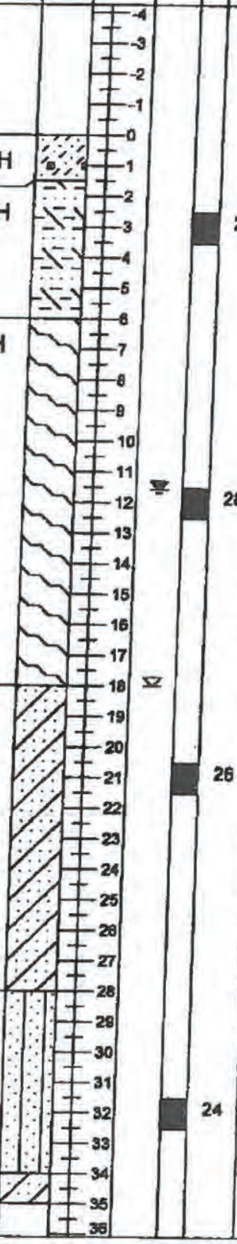
PROJECT:	Pirkey Power Plant
PROJECT NO.:	I-04-1021
LOGGED BY:	Jeffrey D. Sammons, P.G.
SUPERVISING PG:	Jeffrey D. Sammons, P.G.
COMPLETION:	12/08/2015
DEVELOPMENT:	12/16/2015
SITE LOCATION:	2400 FM 3251, Hallsville, Texas
WELL OWNER:	AEP

DRILLING INFORMATION

DRILLER:	Buford Collier
DRILLER'S LICENSE NO.:	50089
RIG TYPE:	Geoprobe 3230DT
METHOD OF DRILLING:	Hollow Stem Auger
SAMPLING METHODS:	Split Core
SURFACE ELEVATION:	360.76 (Top of Casing)
HOLE DIAMETER:	8.25"
LATITUDE	32 28' 2.40"
LONGITUDE	94 29' 20.90"

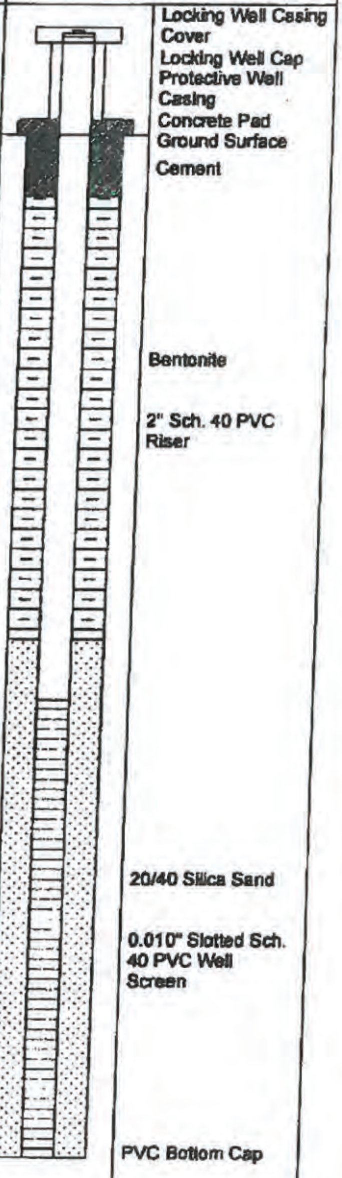
JDS 1-21-16
JEFFREY D. SAMMONS
GEOLOGY
#10070

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample **TBPG No. 50027**



DESCRIPTION	USCS	SOIL SYMBOLS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
SANDY CLAY AND GRAVEL: dark reddish brown, moist	CH									
FAT CLAY WITH SAND: some laminations of very fine to fine sand, reddish brown and light gray	CH				■	22	81	51	15	36
FAT CLAY: some silt with trace very fine to fine sand laminations, reddish brown, yellowish brown and light gray	CH									
- light gray with laminations of light reddish brown silt and very fine sand at 11'				▼	■	28	95	68	31	37
				▽						
CLAYEY SAND: very fine to fine sand, light reddish brown and light gray, very moist to saturated	SC				■	26	44	36	21	15
- dark gray and gray clay with thin seams of light reddish brown very fine sand at 22' to 23'										
SILTY SAND: fine to very fine sand, some clay lenses and thin layers of partially cemented sandstone, gray and dark gray with light reddish brown, very moist to saturated - dark gray and reddiswh brown at 29', saturated - trace clay, light brown at 30'	SM				■	24	5	24	NP	
CLAYEY SAND: very fine sand, dark gray, very moist to saturated	SC									

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-32**

JEFFREY D. SAMMONS
GEOLOGY #10070
JDS 1-21-16

PROJECT INFORMATION

PROJECT: **Pirkey Power Plant**
PROJECT NO.: **1-04-1021**
LOGGED BY: **Jeffrey D. Sammons, P.G.**
SUPERVISING PG: **Jeffrey D. Sammons, P.G.**
COMPLETION: **12/11/2015**
DEVELOPMENT: **12/16/2015**
SITE LOCATION: **2400 FM 3251, Hallsville, Texas**
WELL OWNER: **AEP**

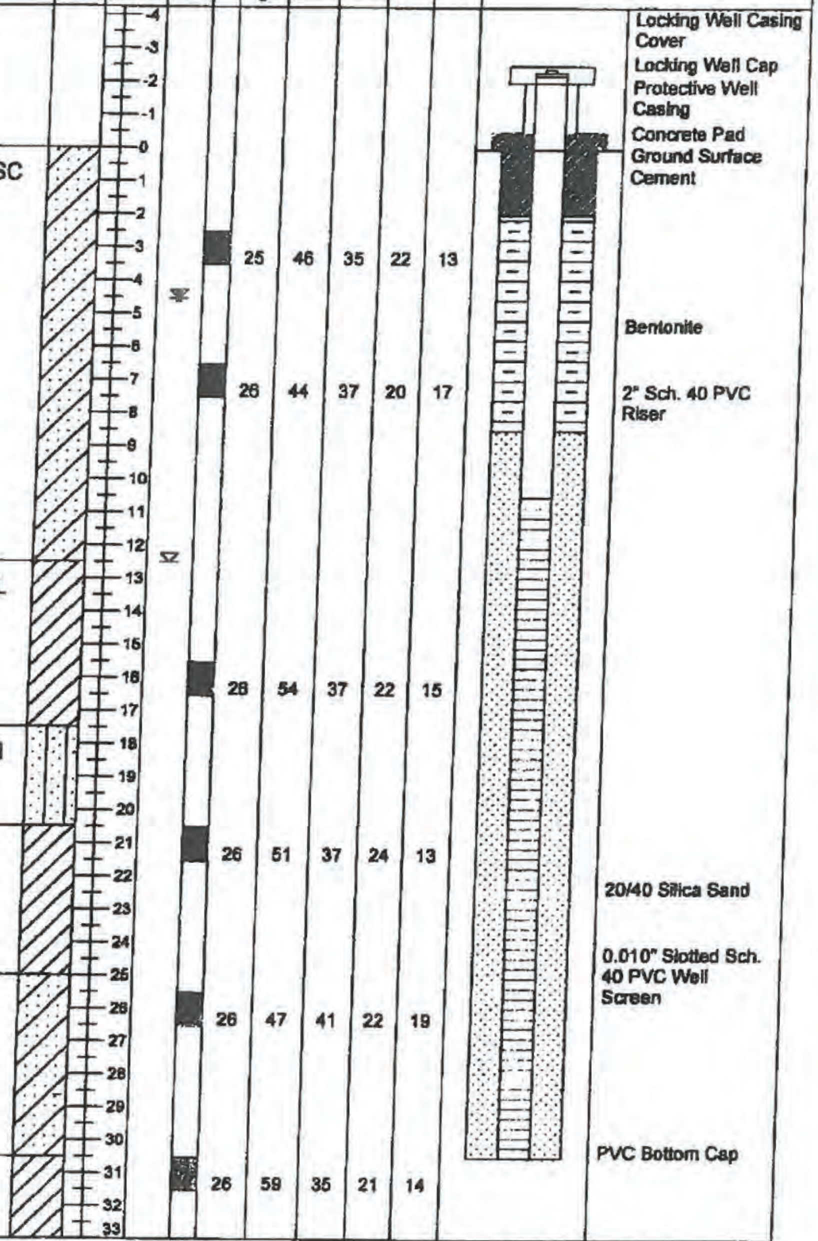
DRILLING INFORMATION

DRILLER: **Buford Collier**
DRILLER'S LICENSE NO.: **50089**
RIG TYPE: **Geoprobe 3230DT**
METHOD OF DRILLING: **Hollow Stem Auger**
SAMPLING METHODS: **Split Core**
SURFACE ELEVATION: **359.18 (Top of Casing)**
HOLE DIAMETER: **8.25"**
LATITUDE **32 27' 58.20"** LONGITUDE **94 29' 11.86"**

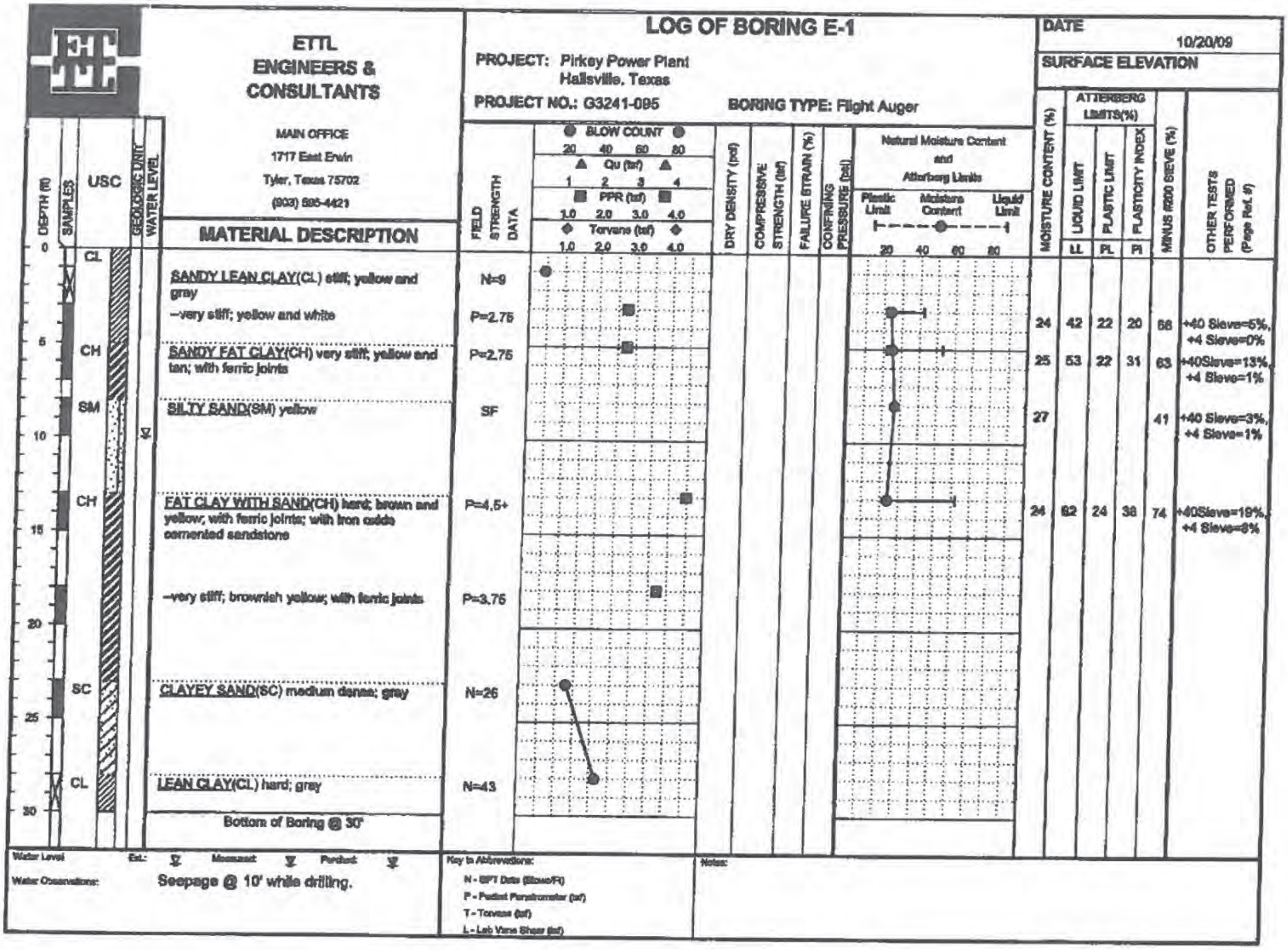
▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, dark reddish brown, moist	SC					
- interbeds of sand and clay, yellowish brown and light gray at 1'		25	46	35	22	13
- reddish brown and light gray at 2'						
- light gray and yellowish brown at 4',						
- grayish brown and light gray at 6'						
- grayish brown, light gray, and reddish brown at 7'		26	44	37	20	17
SANDY LEAN CLAY: some gravel seams and thin interbeds of cemented sand, light yellowish brown and light gray, moist to saturated within gravel seams	CL					
- some iron ore gravel at 16', very moist to saturated		28	54	37	22	15
SILTY SAND: very fine to fine sand, trace clay, brownish gray and dark brownish gray, saturated	SM					
- reddish brown and brown at 20'						
SANDY LEAN CLAY: gray and dark gray, very moist	CL	26	51	37	24	13
CLAYEY SAND: fine to very fine sand, gray and dark gray, very moist to saturated	SC	26	47	41	22	19
SANDY LEAN CLAY: gray and dark gray, very moist	CL	26	59	35	21	14



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.



ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING E-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; yellow and gray	N=9										
	–very stiff; yellow and white	P=2.75					24	42	22	20	66	+40 Sieve=5%, +4 Sieve=0%
CH	SANDY FAT CLAY(CH) very stiff; yellow and tan; with ferric joints	P=2.75					25	53	22	31	63	+40Sieve=13%, +4 Sieve=1%
SM	SILTY SAND(SM) yellow	SF					27				41	+40 Sieve=3%, +4 Sieve=1%
CH	FAT CLAY WITH SAND(CH) hard; brown and yellow; with ferric joints; with iron oxide cemented sandstone	P=4.5+					24	62	24	38	74	+40Sieve=19%, +4 Sieve=8%
	–very stiff; brownish yellow; with ferric joints	P=3.75										
SC	CLAYEY SAND(SC) medium dense; gray	N=26										
CL	LEAN CLAY(CL) hard; gray	N=43										

Bottom of Boring @ 30'

Water Level Est.: ▽ Measured: ▽ Perched: ▽

Water Observations: Seepage @ 10' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING E-2

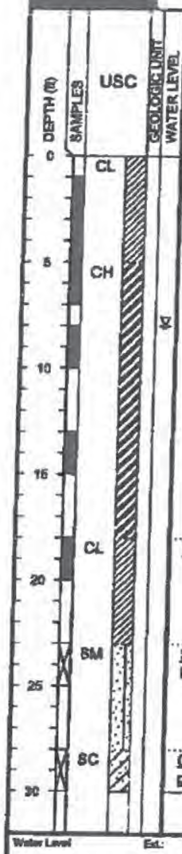
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY(CL) hard; gray and red; with gravel	P=4.5+										
	–very stiff; tan and red	P=2.5					18	47	17	30	69	+40Sieve=14%, +4 Sieve=5%
CH	SANDY FAT CLAY(CH) stiff; red and tan	P=1.75					21	50	18	34	69	+40 Sieve=8%, +4 Sieve=1%
	–red and gray	P=2.0										
	–very stiff; red, gray, and tan	P=2.25					23	57	18	38	71	+40 Sieve=6%, +4 Sieve=0%
CL	LEAN CLAY(CL) stiff; red and grey	P=1.5										
SM	SILTY SAND(SM) very dense; gray, red, and tan; saturated	N=74										
SC	CLAYEY SAND(SC) medium dense; greenish gray	N=18										
	Bottom of Boring @ 30'											

Water Level Est.: ⊻ Measured: ⊻ Perched: ⊻

Water Observations: Seepage @ 8' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-4
LOCATION: Hallsville,TX

Date: 9-14-83
Type:
Ground Elevation: 347.3

Legend:

■ Sample
X Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
	▨	■	Red and grey sandy silty clay
	▨	■	Red and grey sandy silty clay
5	▨	■	Red and grey sandy silty clay w/iron ore
			Bottom of boring at 6 feet.
10			No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			

832964

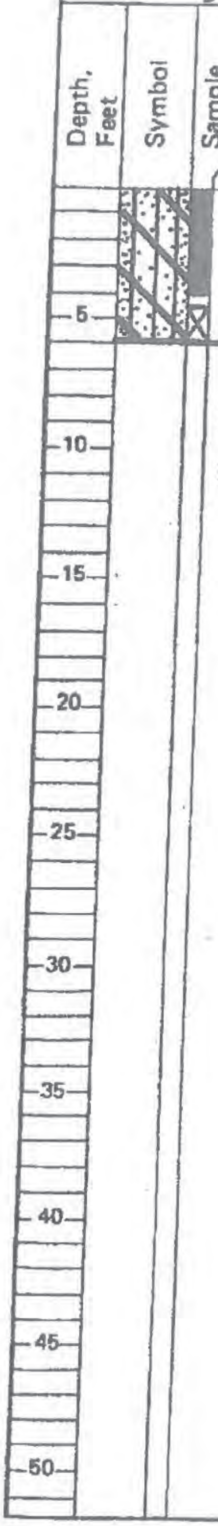
LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-5
LOCATION: Hallsville,TX

Date: 9-14-83
Type:
Ground Elevation: 347.1

Legend:
■ Sample
X Penetration
▼ Water



Description of Stratum

Red and grey silty sandy clay w/iron ore

Red and grey silty sandy clay w/iron ore

Red and grey silty sandy clay 7-13-15 28 B/F

Bottom of boring at 6 feet.

No water encountered.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-6
LOCATION: Hallsville, TX

Date: 9-14-83 Type: Ground Elevation: 353.6

Legend: ▇ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
			Red and grey silty clay lenses w/iron ore
			Red and grey silty sandy clay w/iron ore
5			Red and grey silty clay

Bottom of boring at 6 feet.

No water encountered.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-7
LOCATION: Hallsville,TX

Date: 9-14-83
Type:
Ground Elevation: 346.9

Legend:

■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
		■	Red, brown and grey silty clay
		■	Red, brown and grey silty clay w/silt lenses and iron ore
5		■	Red, brown and grey silty sandy clay
10			Bottom of boring at 6 feet. No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			

SOUTHWESTERN LABORATORIES

ARCADIS

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

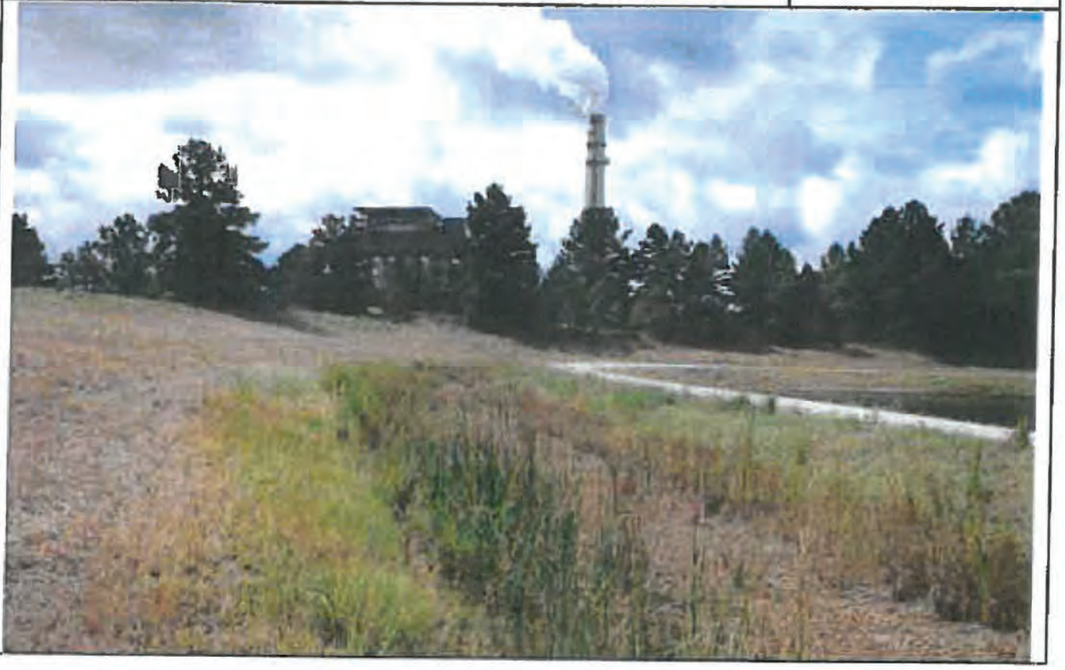
Photo No. 1 **Date:** 8/19/2015

Direction Photo Taken:

South

Description:

P8190374
Vegetative strip adjacent to East Ash Pond. Under new rule this potential wetland is likely non-jurisdictional.



ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 2 **Date:** 8/19/2015

Direction Photo Taken:

Description:

P8190372
AD- 4 Ground water monitoring well. East Bottom Ash Pond embankment in background.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 3 **Date:** 8/19/2015

Direction Photo Taken:

South

Description:

P8190378
View across East and West Botton Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 4 **Date:** 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190379
Road side ditch, not considered a wetland, due to lack of hydric vegetation and connectivity.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant

Location: Hallsville, Harrison County, Texas

Project No. OH015976.0001

Photo No. 5

Date: 8/19/2015

Direction Photo Taken:

North

Description:

P8190380
AD-18 Ground water monitoring well.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant

Location: Hallsville, Harrison County, Texas

Project No. OH015976.0001

Photo No. 6

Date: 8/19/2015

Direction Photo Taken:

North

Description:

P8190381
AD-18 Ground water monitoring well.

ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

American Electric Power Service Corporation

West Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

May 25, 2016

ARCADIS

West Bottom Ash Pond - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

STATE OF TEXAS
Kenneth J. Brandner
Geology
1787
LICENSED
PROFESSIONAL GEOSCIENTIST

Kenneth J Brandner

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matt J L

Matthew J. Lamb
Project Manager

John W Holm

John Holm, P.E.
Professional Engineer

Prepared for:
AEP

Prepared by:
ARCADIS U.S., Inc.
100 E Campus View Blvd
Suite 200
Columbus
Ohio 43235-1447
Tel 614 985 9100
Fax 614 985 9170

Our Ref.:
OH015976.0010

Date:
May 25, 2016

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91, for the West Bottom Ash Pond (BAP) CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above and isolated from the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zone, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the West BAP (Site). The evaluation of the location restriction criteria is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the West BAP CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant West BAP.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The West BAP CCR unit is located at the north end of the Plant and approximately 3,000 feet northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of West BAP CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the West BAP.

2.2.1 Embankment Configuration

The West BAP embankments have a maximum height of approximately 25 feet and are constructed of compacted clay on a slope ranging from 2.5:1 (2.5 feet horizontal, 1 foot vertical) to 3:1 (Sargent & Lundy, 1983). The elevation at the top of the embankment around the perimeter of the West BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, 2011). The interior bottom elevation of the West BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Akron Consulting, 2012).

2.2.2 Area/Volume

The West BAP is approximately 30.9 acres in size. The design maximum ash storage capacity of the West BAP is 188 acre feet at an elevation of 354 feet amsl (normal operating level) and 216.5 acre feet at an elevation of 355 feet amsl (maximum operating level) (Sargent & Lundy, 1983; Akron Consulting, 2012).

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, flue gas desulfurization sludge) have been generated. The West BAP, which was placed into operation in 1985, receives bottom ash and economizer ash sluiced from the power plant boiler (**Figure 3**). Clear water overflow from the West BAP discharges into the Clearwater Pond located southeast of the West BAP. Bottom ash and economizer ash are periodically excavated from the West BAP and hauled by truck to either the on-site landfill for disposal, or sold for offsite beneficial re-use.

The base of the West BAP was constructed in 1983 with a compacted clay liner (Sargent & Lundy, 1983). Following installation of the compacted clay liner, soil borings S-8 through S-11 were advanced below the base of the West BAP to total depths of six feet in September 1983 (Southwestern Laboratories, 1984). The lithologic data from soil borings S-8 through S-11 confirm at least six feet of clay is present below the base of the West BAP (Sargent & Lundy, 1984).

2.2.4 Surface Water Control

Surface water elevation in the West BAP is controlled by a weir box and a manually operated gate valve on a 36-inch-diameter discharge pipe at the southeast corner of the pond. Clear water overflow from the West BAP discharges through the 36-inch-diameter pipe into the 2.7-acre Clearwater Pond located southeast of the West BAP (Figure 3). Water in the Clearwater Pond is pumped (re-circulated) back into the boiler ash hopper.

2.3 Previous Investigations

The initial soils investigation and design of the West BAP was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, and design of the West BAP. As discussed above in Section 2.2.3, the design included installation of a clay liner below the West BAP.

In September-October 1983, Southwestern Laboratories conducted a soil investigation at the Plant, including advancement of four soil borings (S-8 through S-11) below the West BAP (Southwestern Laboratories, 1984).

In 1984, Sargent & Lundy conducted an evaluation of the West BAP. This report included evaluation of soil sample geotechnical data, and concluded a low-permeability clay liner was present below the West BAP (Sargent & Lundy, 1984).

In 2009, ETTL Engineers & Consultants (ETTL) conducted a geotechnical investigation of the West BAP earthen embankment. The investigation included installation of two soil borings through the embankment (W1, W3) and two soil borings along the outer toe of the embankment (W2, W4), completion of soil borings W1 and W3 as piezometers PW-1 and PW-3, respectively, and collection of soil samples for geotechnical analyses. The report concluded the embankment was stable and the existing embankment slopes were acceptable if conditions are maintained (ETTL, 2010). The conditions to be maintained included embankment protection from erosion (vegetative cover), removal of brush and trees two feet or more in height, and control of animal burrowing.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed a hydraulic analysis of the West BAP for a 10-year, 24-hour rainfall event in accordance with the TCEQ TPDES permit design criteria. The report concluded the storage capacity of the West BAP is hydraulically adequate (Johnson & Pace, 2011).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the West BAP area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the West BAP, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow groundwater flow direction in the area of the West BAP is west-southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The West BAP is located approximately 3,000 feet northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the area of the West BAP does not discharge into Brandy Branch Reservoir.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 500 feet southeast (side gradient) of the West BAP in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile south (side gradient) of the West BAP for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (up gradient) of the Pirkey Power Plant.

3. Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be located down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the area of the West BAP is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 15 feet that is located between an elevation of approximately 325 and 340 feet amsl (**Appendix A**). The base of the West BAP is at an elevation of 347 feet amsl. Therefore the separation distance between the uppermost aquifer and the base of the West BAP is approximately seven feet. This separation distance is further illustrated on cross section A-A' (**Figure 4)** and cross section D-D' (**Figure 7)**.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness (approximately 15 feet), the yield of the uppermost aquifer is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Available groundwater elevations are summarized on **Table 1** for 2011 through 2016. The most recent comprehensive groundwater data set from January 20, 2016 is depicted on **Figure 9**. The groundwater flow is west-southwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

Per 40 CFR 257.60(a), new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five ft) above the upper limit of the uppermost aquifer, or must demonstrate there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high conditions).

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers, that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the area of the West BAP is the clayey and silty sand stratum that is located between an elevation of approximately 325 and 340 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 19, 2015 to review existing well network conditions and locations. A well construction table that summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as **Table 2**. Photo documentation of the located wells during the August 19, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-3, AD-12, AD-17, AD-18, AD-28, and AD-29 were previously installed at the Site to monitor the uppermost aquifer (clayey and silty sand stratum) associated with the West BAP. As discussed above in Section 3.1.1, the uppermost aquifer below the West BAP is approximately 15 feet thick and is located between an elevation of approximately 325 and 340 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on Geologic Cross Section A-A' (**Figure 4**), existing monitoring well AD-3 is screened in the uppermost aquifer upgradient (east) of the West BAP, and existing monitoring well AD-17 is screened in the uppermost aquifer downgradient (west) of the West BAP. Existing monitoring wells AD-3, AD-12 and AD-18 (also located east of the West BAP) will be utilized as upgradient monitoring wells for the West BAP. Existing monitoring wells AD-17 and AD-28 (also located west of the West BAP) will be utilized as downgradient monitoring wells for the West BAP.

As shown on **Figure 9**, shallow groundwater flow direction in the area of the West BAP is west-southwesterly. Two existing monitoring wells (AD-17, AD-28) were located hydraulically downgradient of the West BAP during the August 19, 2015 site visit, and three downgradient monitoring wells are required to monitor groundwater quality downgradient of a CCR unit. This data gap was addressed by installation of new downgradient monitoring well AD-30 along the south central side of the West BAP during December 2015 as shown on **Figure 9** and **10**. With the addition of monitoring well AD-30, there are no gaps remaining in the groundwater monitoring network for the West BAP.

4. Recommended Monitoring Network and PE Certification

The recommended existing groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the West BAP (up gradient or down gradient), well depth, and well construction. The recommended network would provide an improved understanding of groundwater quality, hydraulics, and groundwater flow at the West BAP.

4.1 Recommended Monitoring Well Network Distribution

Three up gradient well locations (existing monitoring wells AD-3, AD-12, and AD-18) and three down gradient well locations (existing monitoring wells AD-17, AD-28, and AD-30) are recommended to establish a groundwater quality monitoring well network for the West BAP. In addition, existing side gradient monitoring well AD-29 may be utilized as a piezometer to obtain additional groundwater flow direction and gradient data for the West BAP.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the West BAP is summarized on **Table 3** and illustrated on **Figure 10.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring well network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 325 and 340 feet amsl as shown on Geologic Cross Sections A-A' (**Figure 4**) and D-D' (**Figure 7**). The screen elevations are presented in **Table 3**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the West BAP was addressed by installation of monitoring well AD-30 during December 2015. Monitoring well AD-30 was installed by a Texas Department of Licensing and Regulation (TDLR)-licensed water well driller. Well construction data for the monitoring well network are summarized on **Tables 2** and **3**, and the monitoring well completion diagrams are provided in **Appendix A**.

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system will be adequate to meet the requirements of 40 CFR Part 257.91.

Kenneth J. Brandner

Printed Name of Registered Professional Engineer

Kenneth J Brandner

Signature

KENNETH J. BRANDNER
69586

69586

Registration No.

Texas

Registration State

5-25-16

Date

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ARCADIS

Tables

Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen(b)		Bottom of Screen(b)		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers(c)																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
NM - Not Measured

Table 2
Well Construction Details
AEP Pirkey Power Plant - CCR Units
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen(b)		Bottom of Screen(b)	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18	341	40	319	20	339.48	40	319.48
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29	350	51	328	31	347.84	51	327.84
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.48	40.5	321.48
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13	344	35	322	15.0	341.81	35.0	321.81
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8	335	30	313	10.0	332.65	30.0	312.65
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13	347	25	335	15.0	345.48	25.0	335.48
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8	352	30	330	10.0	349.50	30.0	329.50
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13	339	35	317	15.0	337.30	35.0	317.30
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8	339	30	317	10.0	337.23	30.0	317.23
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8	348	30	326	10.0	345.57	30.0	325.57
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13	334	35	312	15.0	331.72	35.0	311.72
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3	285	20	268	5.0	282.68	20.0	267.68
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8	326	30	304	10.0	324.15	30.0	304.15
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8	334	40	302	10.0	332.41	40.0	302.41
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.33	37.5	312.33
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13	323	35	301	15.0	320.92	35.0	300.92
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8	342	30	320	10.0	340.21	30.0	320.21
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8	331	25	314	10.0	329.04	25.0	314.04
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18	340	35	323	20.0	337.75	35.0	322.75
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11	346	33	324	13.0	344.23	33.0	324.23
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12	347	30	329	15.0	344.30	30.0	329.30
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8	297	25	280	10.0	294.64	25.0	279.64
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20	296	3.0	313.01	18.0	298.01
Piezometers(c)																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26	330	38	318	28.0	328.30	38.0	318.30

General Note:
Elevations in feet above mean sea level.

Footnotes:
(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.
(c) Souce: EETL (October 2010).
(d) Source: Aukland Consulting LLC (January 26, 2016).

Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

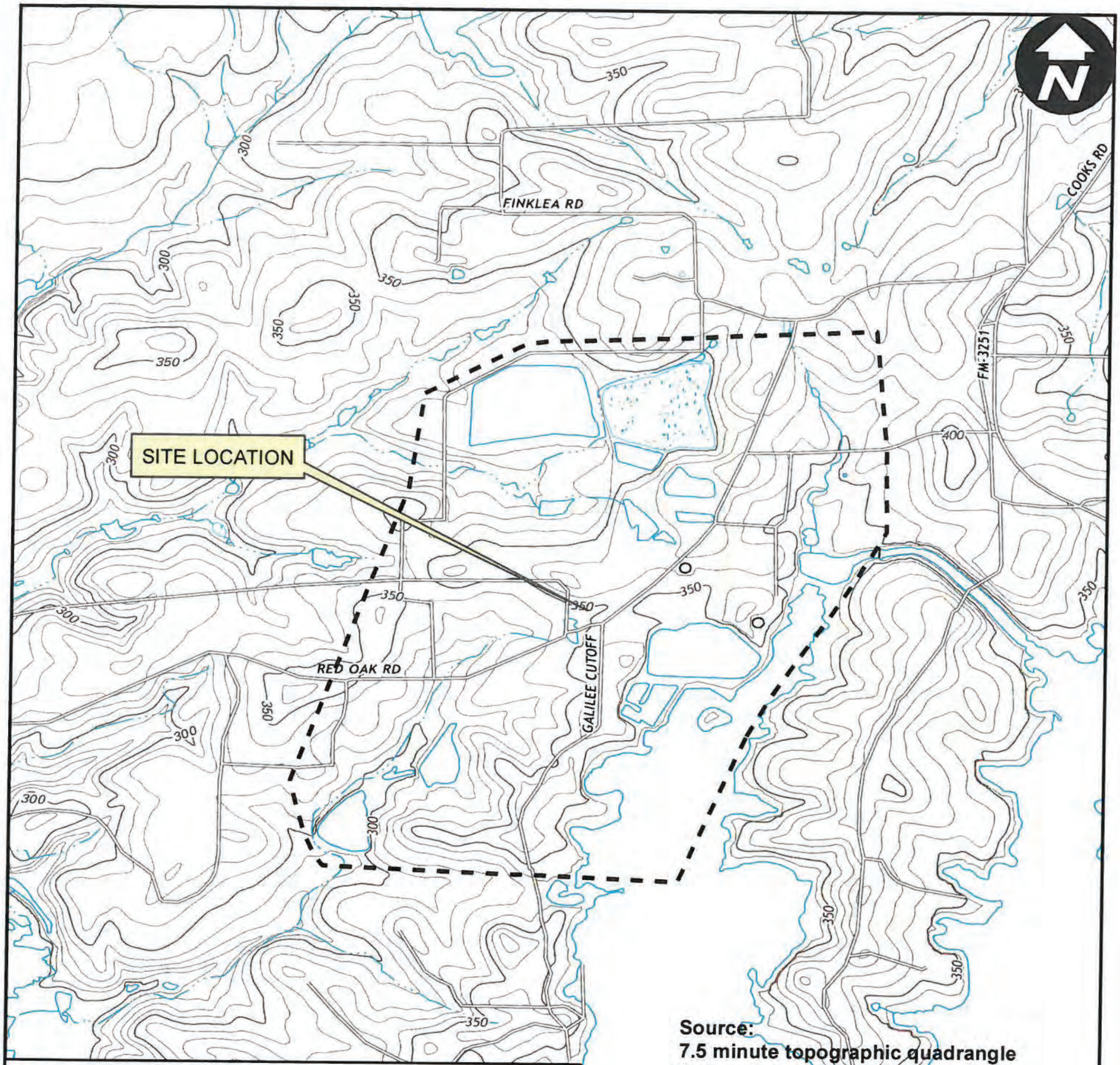
Table 3
Proposed Well Network
AEP Pirkey Power Plant - West Bottom Ash Pond
Hallsville, Harrison County, Texas

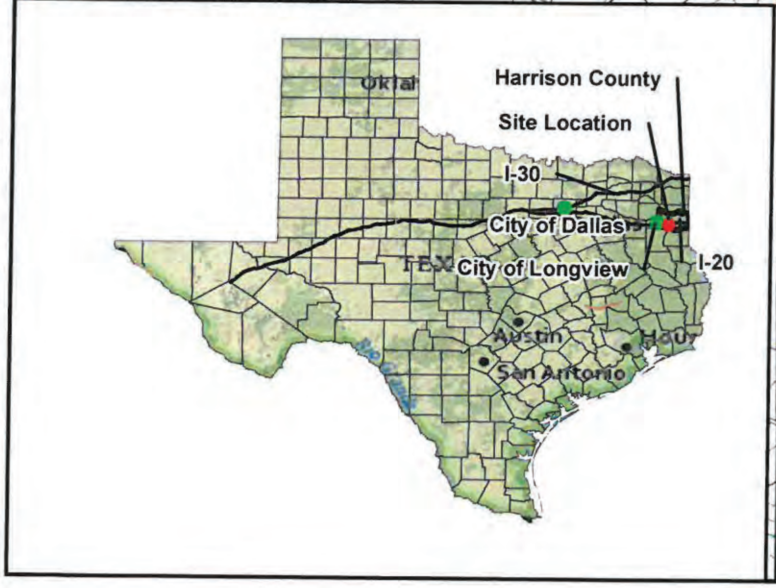
Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Target Elevation(a) (ft amsl)	Screen Bottom Target Elevation(a) (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-3	Exisiting	Uppermost Water-Bearing Unit	East of West Bottom Ash Pond	Upgradient	335.8	315.8	20	Existing well installed in 1983; well will be utilitzed to establish backgroud water quality
AD-12	Exisiting	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-18	Exisiting	Uppermost Water-Bearing Unit	East of West Bottom Ash Pond	Upgradient	345.5	335.5	10	Existing well installed in 2011; well will be utilitzed to establish backgroud water quality
Downgradient								
AD-17	Existing	Uppermost Water-Bearing Unit	West of West Bottom Ash Pond	Down gradient	332.7	312.7	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to the West Bottom Ash Pond - downgradient
AD-28	Existing	Uppermost Water-Bearing Unit	Southwest of West Bottom Ash Pond	Down gradient	320.9	300.9	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to the West Bottom Ash Pond - downgradient
AD-30	Existing	Uppermost Water-Bearing Unit	South of West Bottom Ash Pond	Down gradient	329.0	314.0	15	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to the West Bottom Ash Pond - downgradient
Piezometers								
AD-29	Exisiting	Uppermost Water-Bearing Unit	North of West Bottom Ash Pond	Side gradient	340.2	320.2	20	Existing well installed in 2011; and utilitzed to obtain water level data for uppermost water-bearing unit

Footnotes:
a. Target elevations are an estimated range.

Acronyms and Abbreviations:
U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

Figures





Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

0 2,000 4,000
SCALE IN FEET

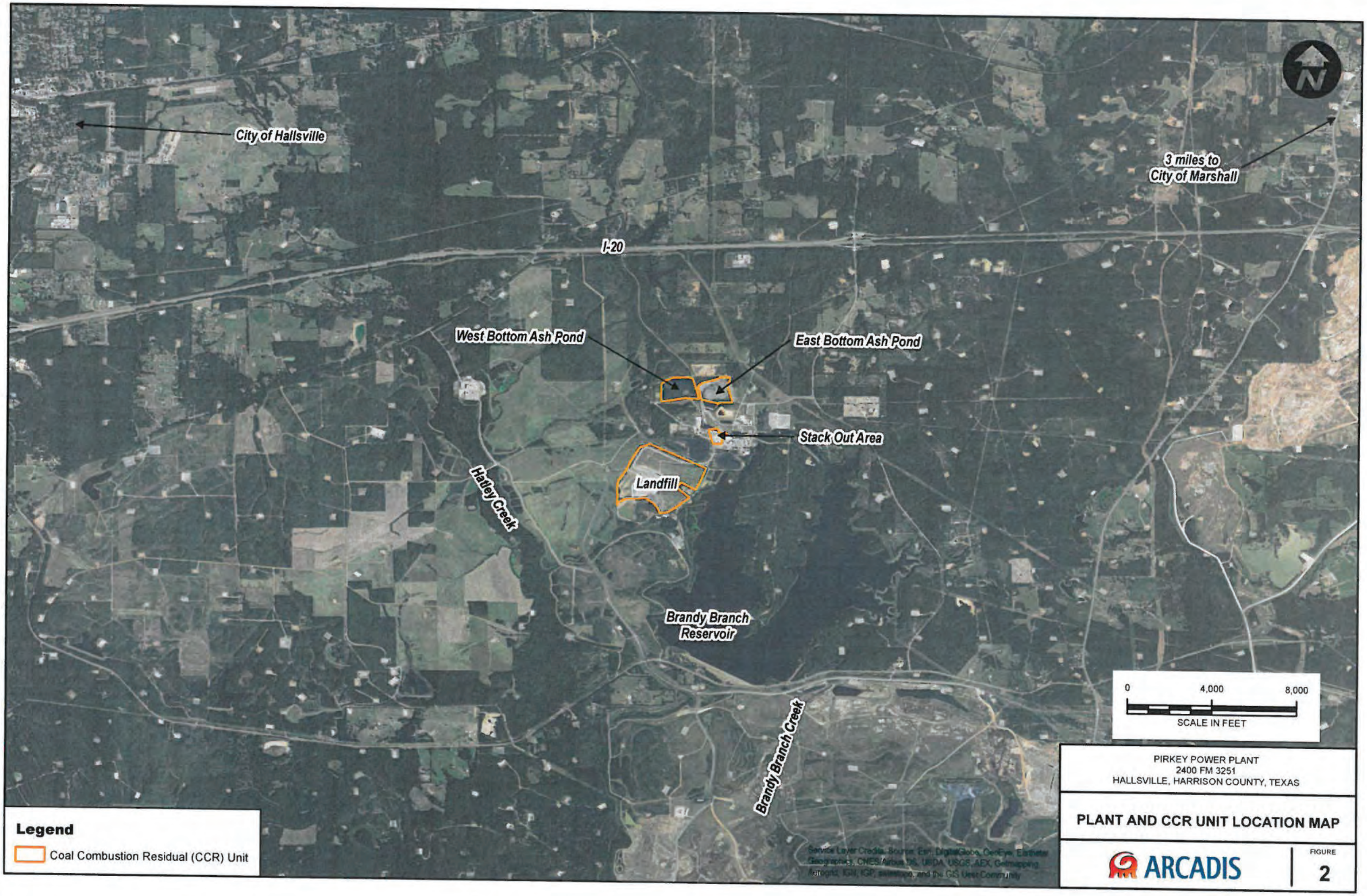
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd



Legend

☐ Coal Combustion Residual (CCR) Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

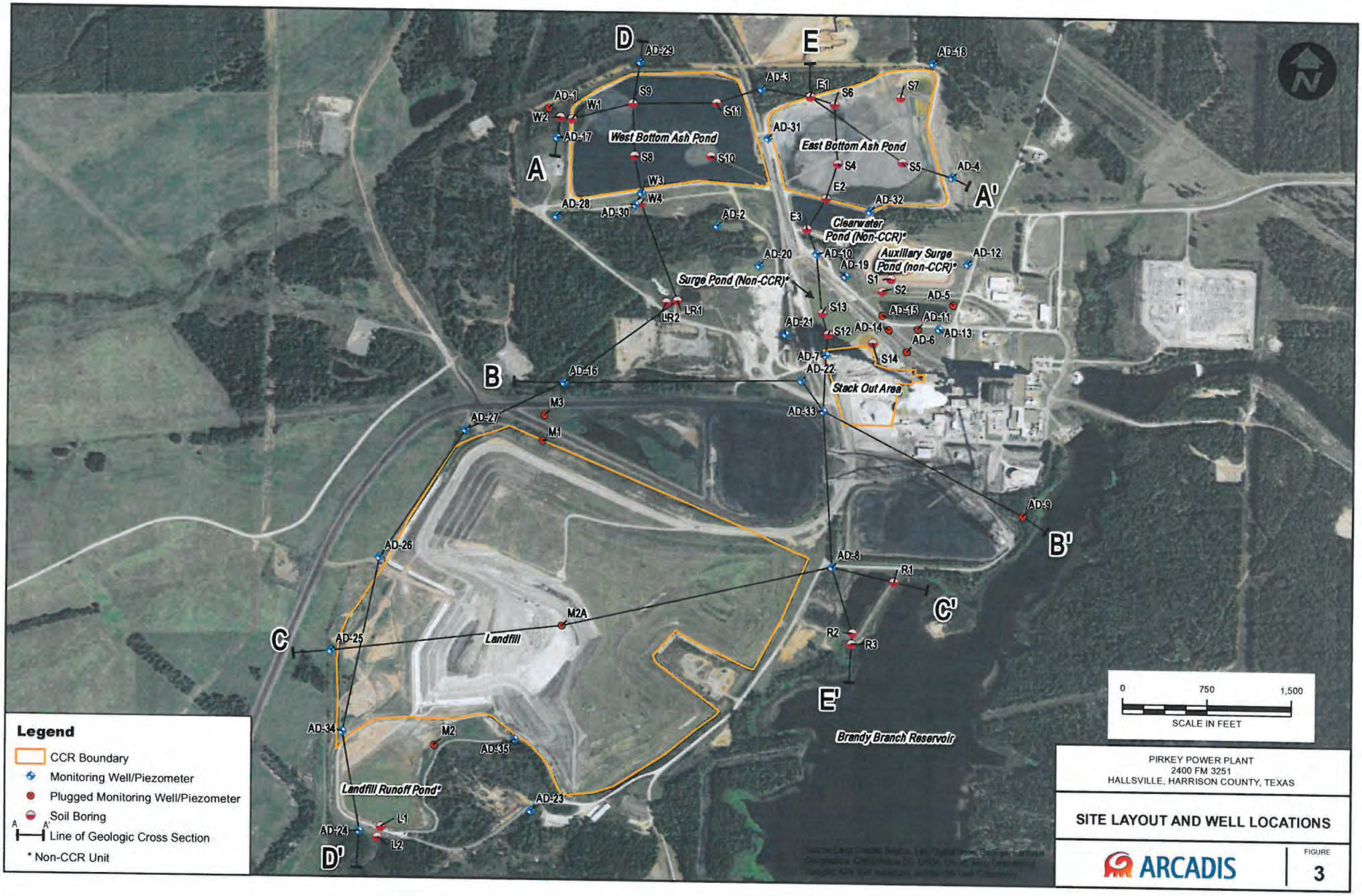
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

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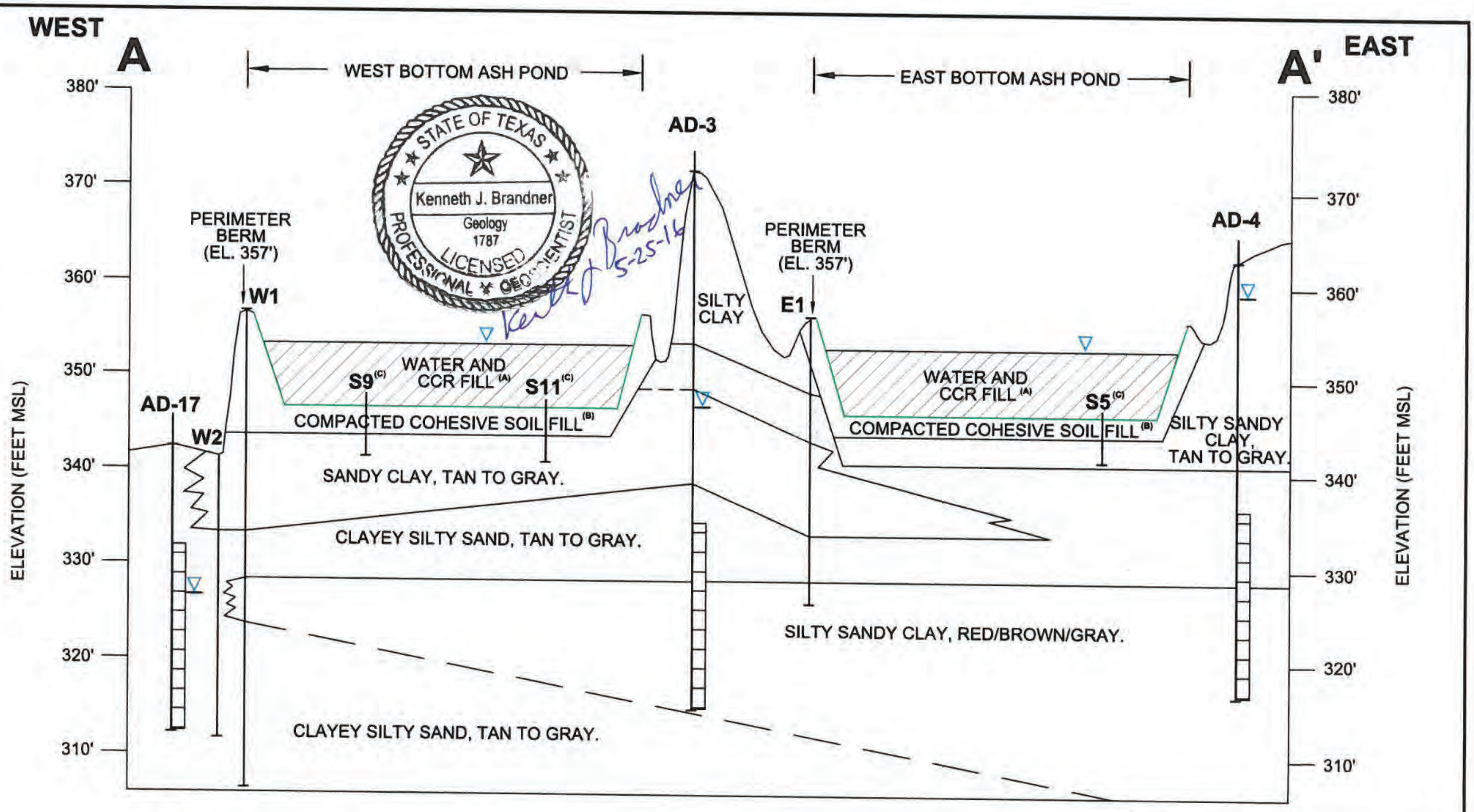
FIGURE
3

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



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5-25-16

0 300'
HORIZONTAL SCALE

LEGEND

▤ MONITORING WELL SCREENED INTERVAL

▽ WATER LEVEL IN MONITORING WELL (1/20/16)

— BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).

C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:18 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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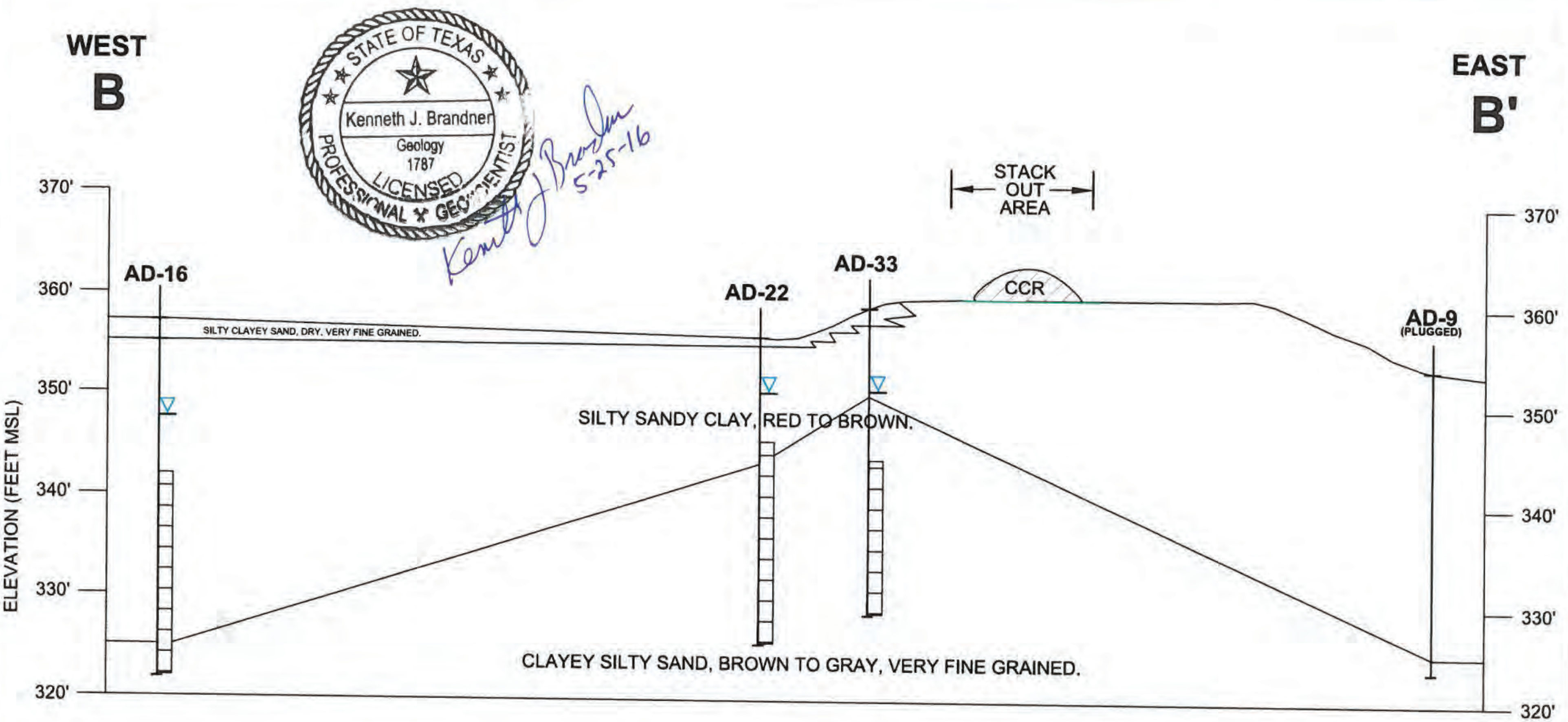

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LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

0 300'
HORIZONTAL SCALE

NOTES:
A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 5 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 2/16/2016 1:49 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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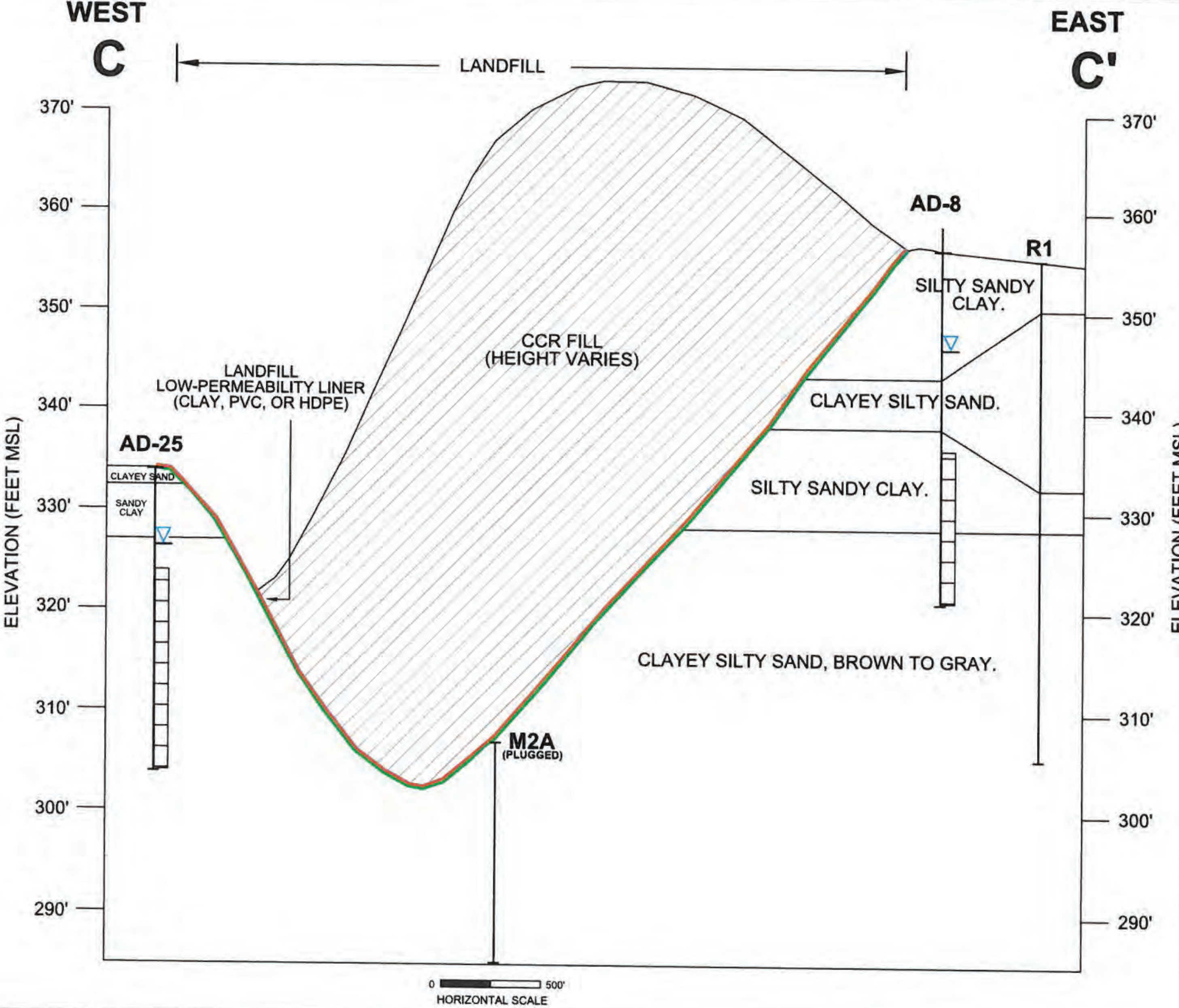

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LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:25 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 7 Cross Section D-D'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:30 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE: —
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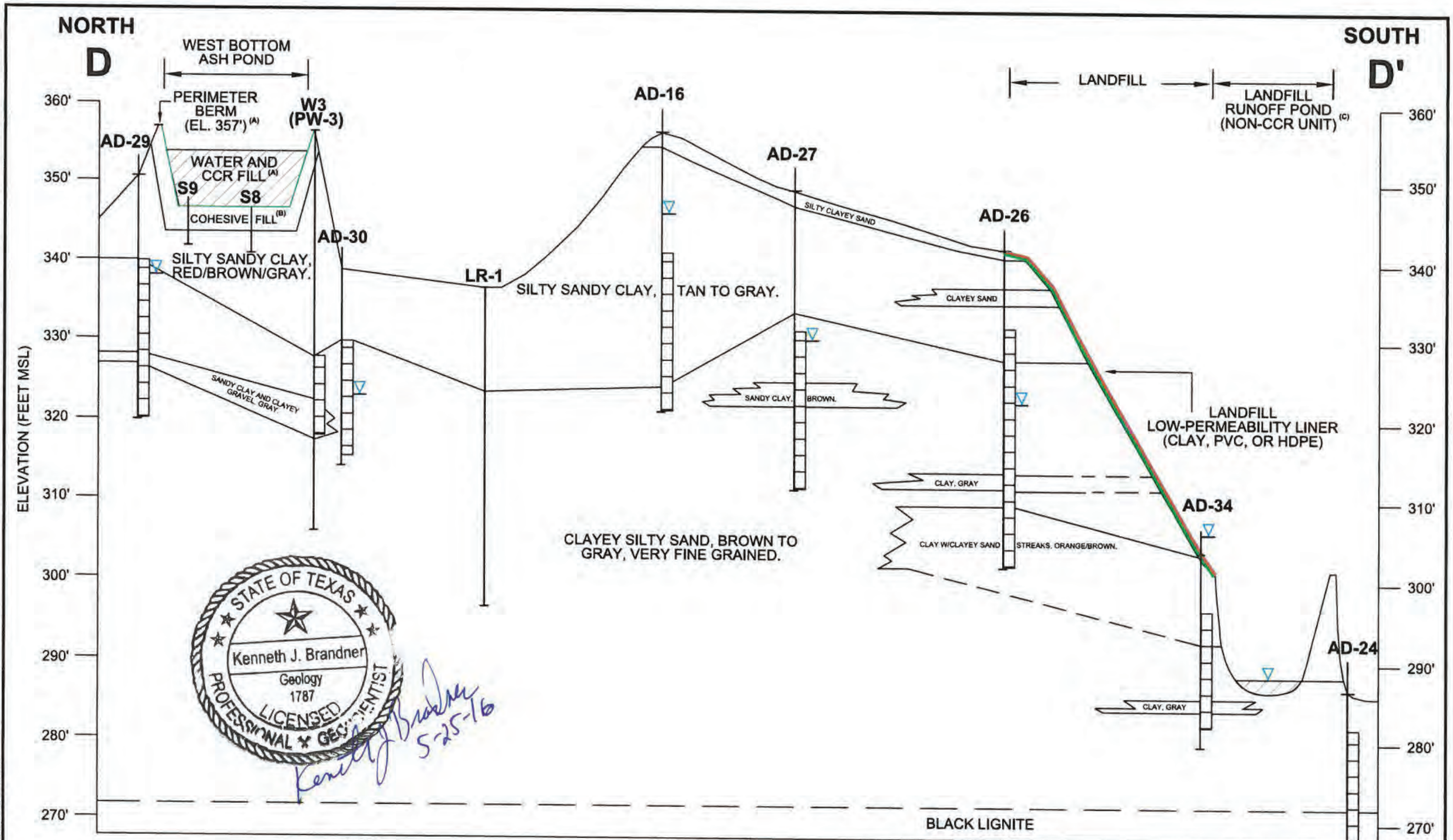

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0 600'
HORIZONTAL SCALE

LEGEND

- ▤ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).

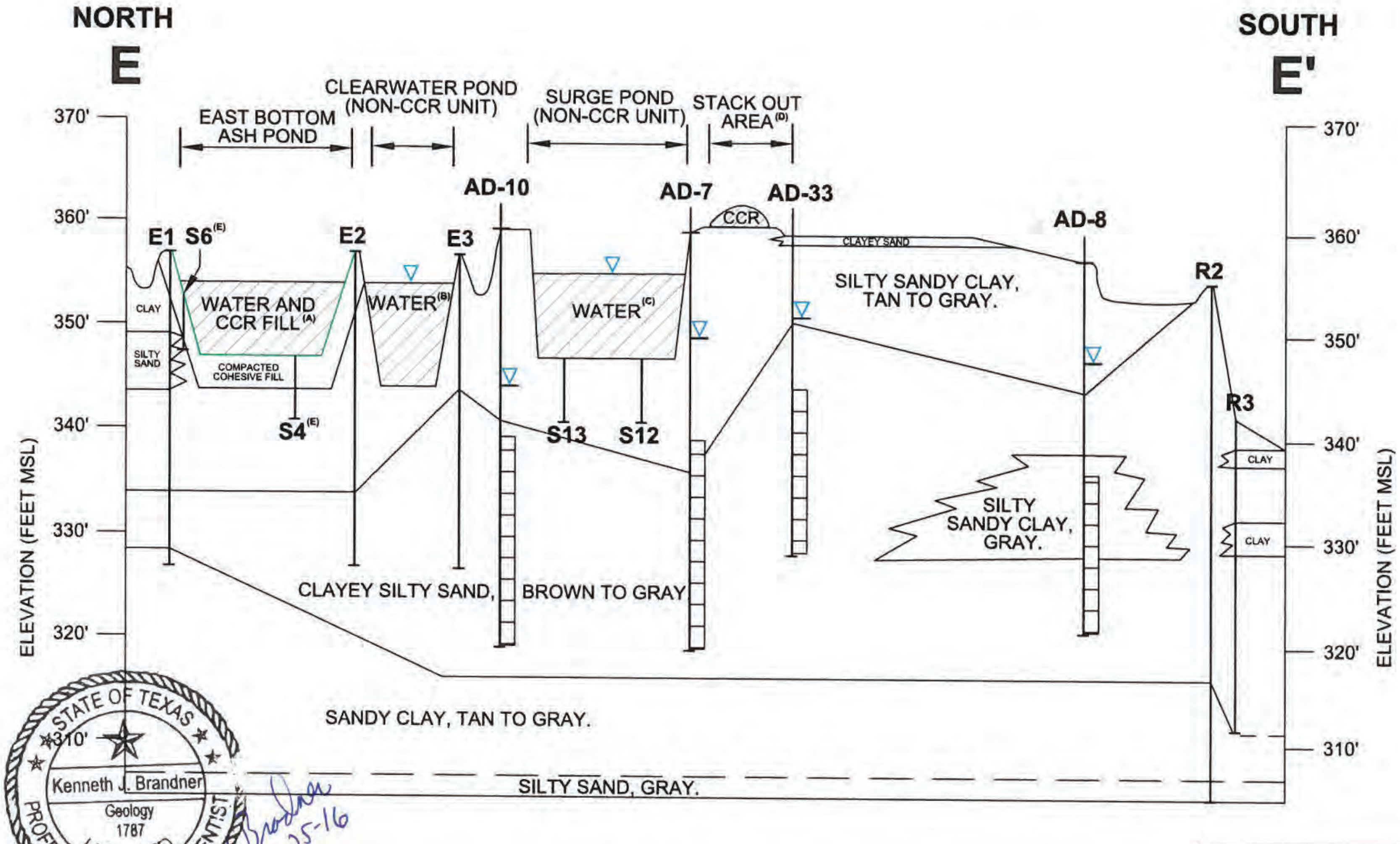
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS

FIGURE
7



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LEGEND

- ▤ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

0 500'
HORIZONTAL SCALE

NOTES:

A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).
C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".
D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION E - E'

ARCADIS

FIGURE
8

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 8 Cross Section E-E'.dwg LAYOUT: MODEL SAVED: 2/22/2016 11:26 AM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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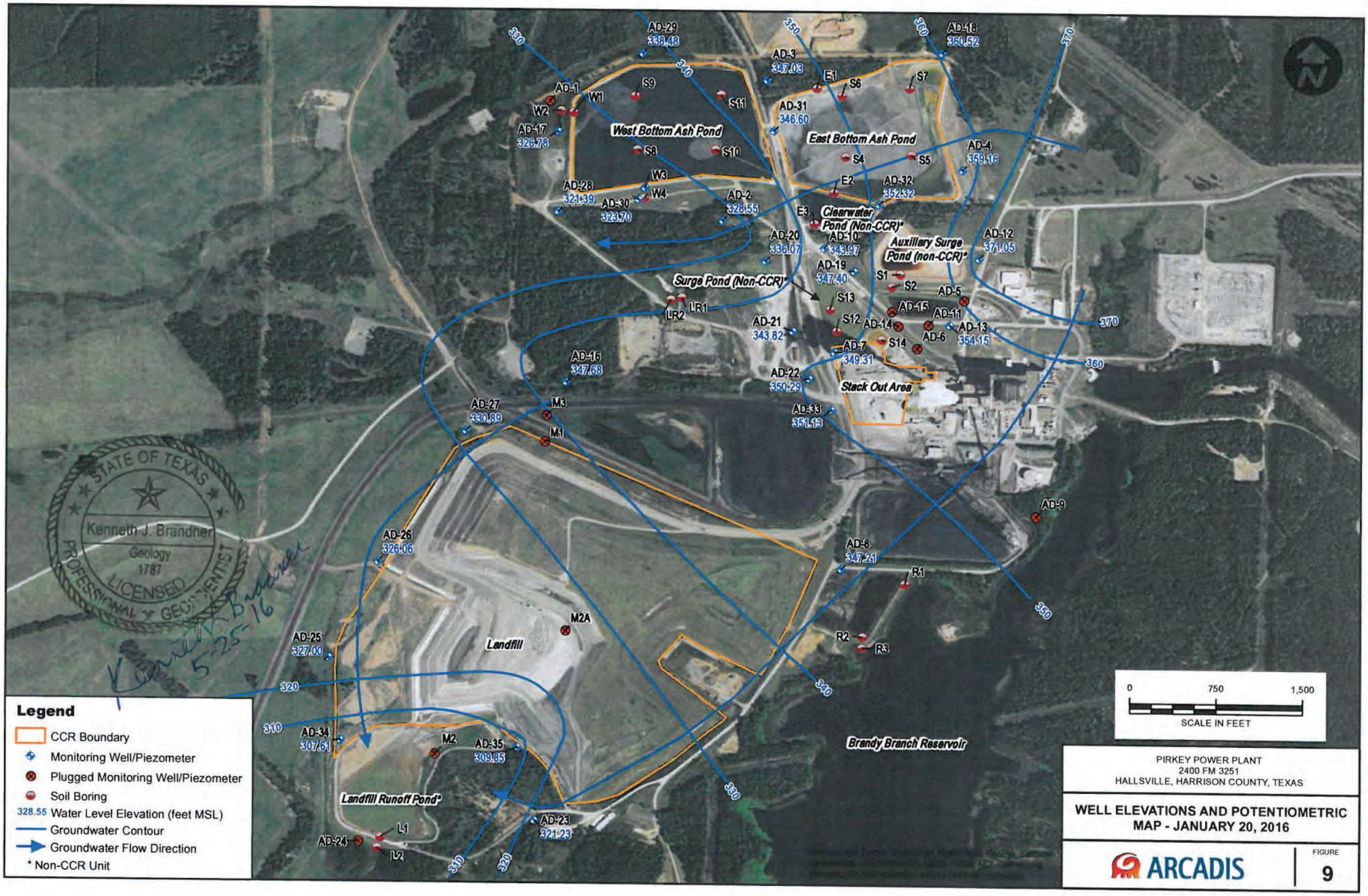

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5-25-16

Legend

- 🟧 CCR Boundary
- ◆ Monitoring Well/Piezometer
- ⊗ Plugged Monitoring Well/Piezometer
- ● Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- — Groundwater Contour
- → Groundwater Flow Direction
- * Non-CCR Unit

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

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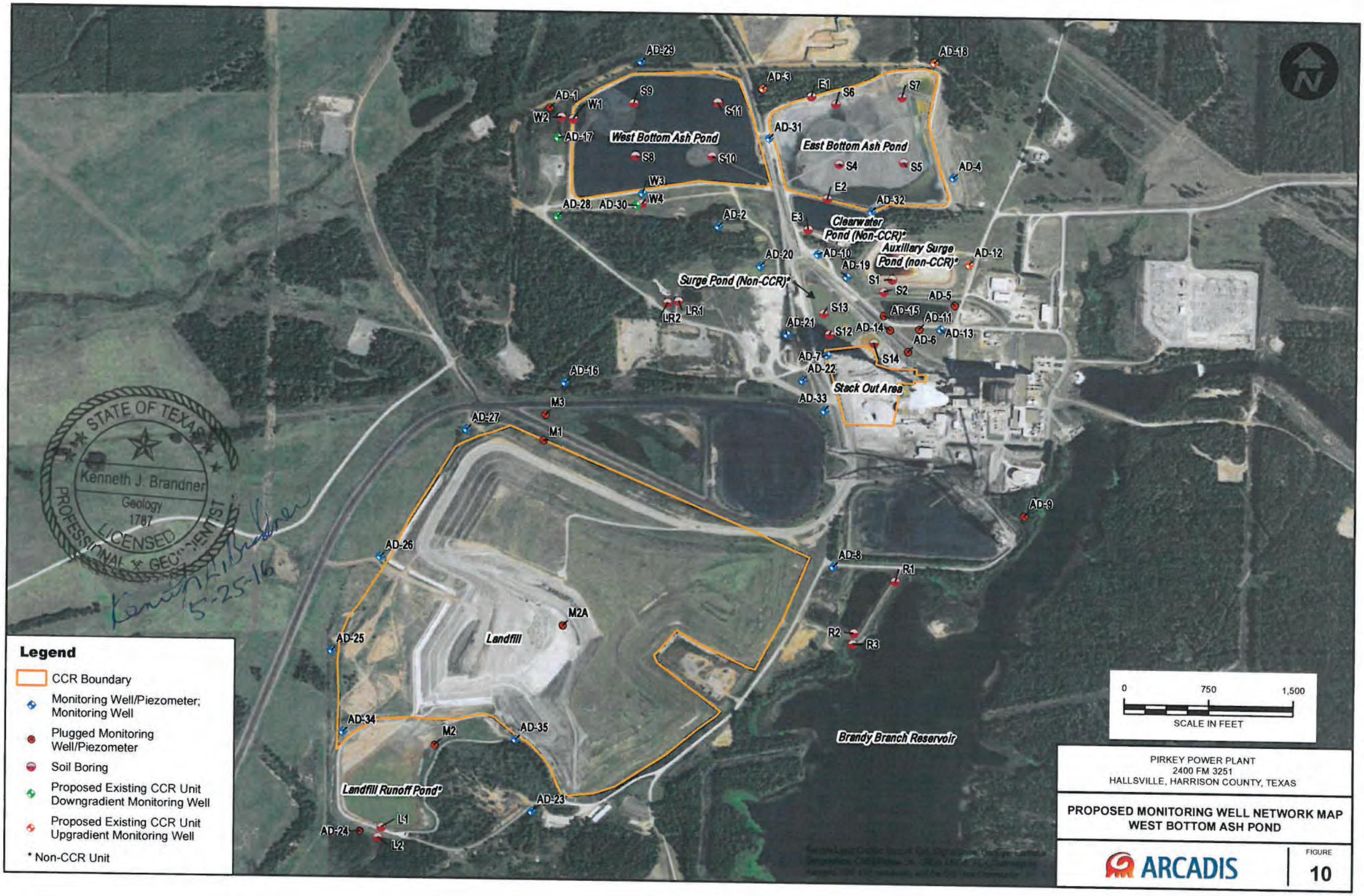
FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



STATE OF TEXAS
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LICENSED PROFESSIONAL GEOSCIENTIST

Kenneth J. Brandner
5-25-16

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP
WEST BOTTOM ASH POND

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FIGURE
10

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 10 - Proposed Well Network - West Bottom Ash Pond.mxd

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Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

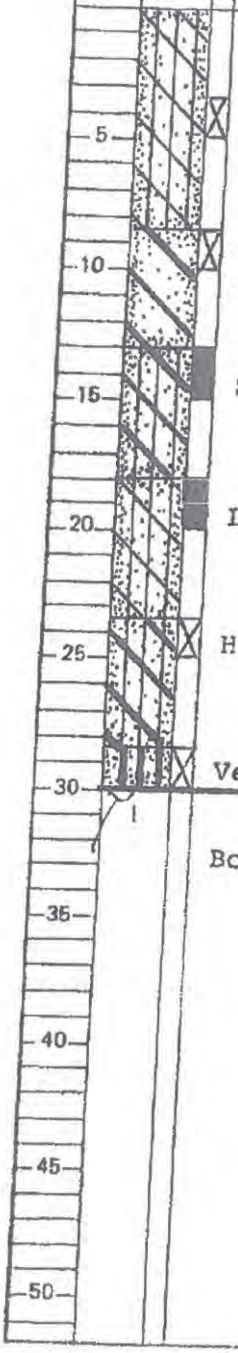
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-1
LOCATION: Hallsville

Date: 10-6-83
Type: Auger
Ground Elevation:

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Very dense brown and grey clayey silty sand w/clay seam
33-17=7" 50 B/7"

Very stiff tan and grey very sandy clay w/iron ore
6-9-21 30 B/F

Stiff grey silty sandy clay

Loose grey clayey silty sand

Hard grey silty sandy clay lenses 30-20=11" 50 B/11"

Very dense grey clayey sandy silt 19-31=11½" 50 B/11½"

Bottom of boring at 30 feet.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

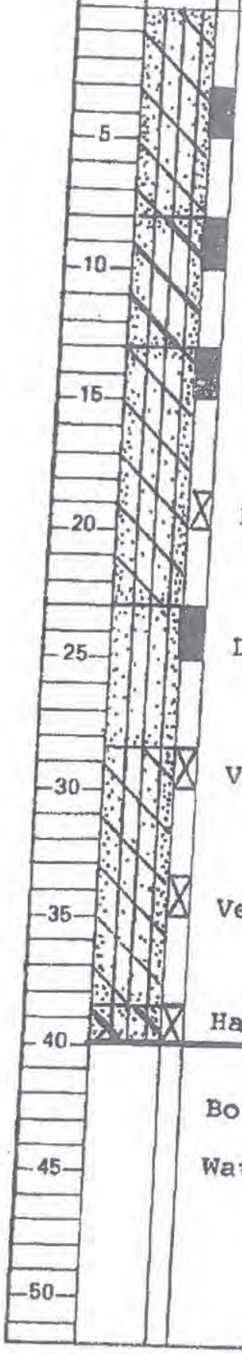
BORING NO.: MW-2
LOCATION: Hallsville

Date: 10-7-83 Type: Auger Ground Elevation:

Legend:

■ Sample X Penetration ▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Firm tan clayey silty sand

Medium tan and grey very sandy silty clay

Dense tan and grey clayey silty sand

Dense tan clayey silty sand 10-15-16 31 B/F

Dense tan silty sand

Very dense grey clayey silty sand 15-35=12" 50 B/F

Very dense grey clayey silty sand 21-29=9" 50 B/9"

Hard grey sandy silty clay 20-30=12" 50 B/F

Bottom of boring at 40 feet.

Water encountered at 25 feet.

832964

LOG OF BORING

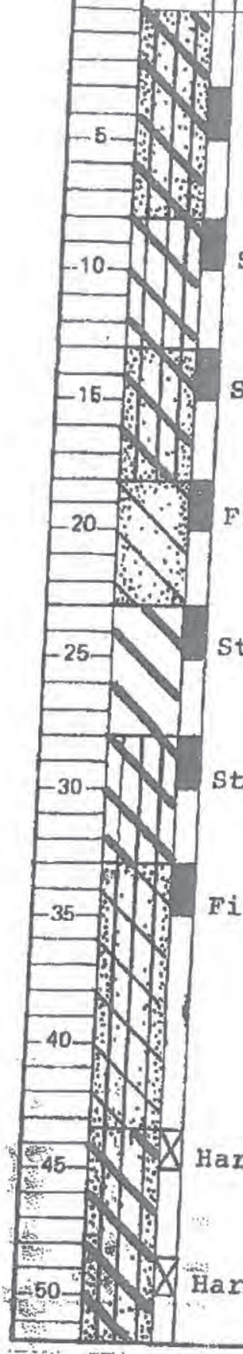
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-3
LOCATION: Hallsville,TX

Date: 11-4-83
Type: Auger
Ground Elevation:

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff red, brown and grey sandy silty clay

Stiff red, tan and grey silty clay lenses w/iron ore

Stiff brown and grey sandy silty clay

Firm brown and grey sand w/clay lenses

Stiff brown and grey clay

Stiff brown and grey clay w/silt lenses

Firm grey clayey silty sand

Hard grey clay w/silty sand lenses 43-7=6" 50 B/6"

Hard brown and grey silty sandy clay 21-29=12" 50 B/F

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-3
LOCATION: Hallsville,TX

Date: 11-4-83
Type: Auger
Ground Elevation:

Legend:

■ Sample
× Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
55		☒	Hard grey silty sandy clay 28-22=10" 50 B/10"

Bottom of boring at 57 feet.

Water encountered at 42 feet.

-60-
-65-
-70-
-75-
-80-
-85-
-90-
-95-
100

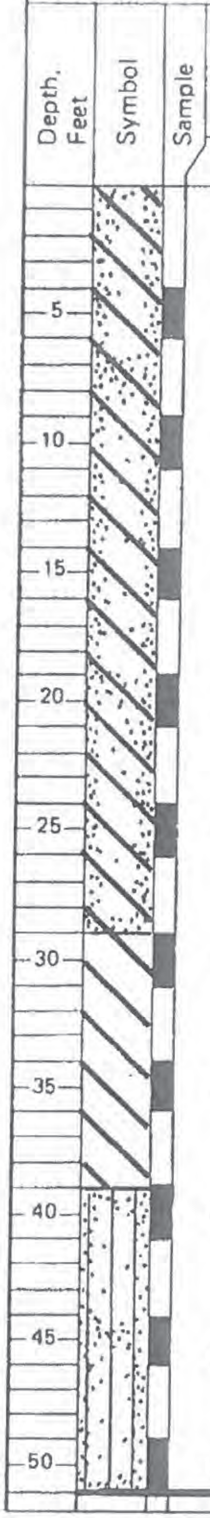
832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond
BORING NO.: MW-12
CLIENT: Southwestern Electric Power Company
LOCATION: Hallsville, TX
N 6+13.25; W-6+90.36
Date: 1/30/86
Type: Rotary
Ground Elevation: 378.41

Legend:

■ Sample
X Penetration
▼ Water



Description of Stratum

Brown and tan sandy clay

Brown, tan and gray sandy clay

Tan and gray sandy clay

Brown and tan sandy clay

Gray and tan sandy clay

Brown and gray clay

Brown and gray clay

Gray silty sand

Gray silty sand

Gray silty sand

Water encountered at 27.5 feet.
Bottom of Boring at 51 feet.

APEX PROJECT NO.: 110-089
☐ **BORING** **BORING NUMBER:** ______
☒ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-17

FACILITY NAME: AEP- Pirkey Power Plant
FACILITY ID NO.: N/A

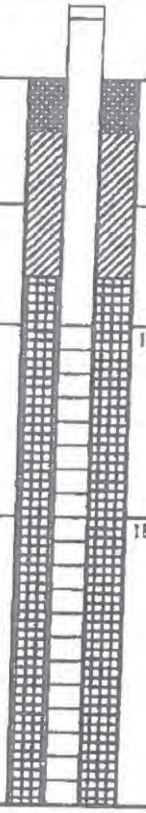
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.
COMPLETION DATE: 12/30/2010

PREPARED BY: Jeff Sammons
LOGGED BY: Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.039
LONGITUDE: W94°29.659'
Datum: WGS-84
WELL LOCATION: West of Bottom Ash Pond #2

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
							
1 2 3 4 5			0-5.5	SM	Silty sand, trace clay, reddish brown, brown, light gray, loose to dense -clayey at 0.5-1.5'	None	Moist
6 7 8 9 10			5.5-10	SC	Clayey sand, reddish brown, yellowish brown, laminated iron ore, iron ore concretions	None	Moist
11 12 13 14 15 16 17 18			10-18.5	SM	Silty sand, light reddish brown, yellowish brown, dense, some clay -trace clay, yellowish brown, 15-16' -iron ore concretions at 16' -light yellowish brown, light gray at 17' -laminated iron ore at 18.5'	None	V. Moist
19 20 21 22 23 24 25 26 27 28 29 30			18.5-30 ▽	SC	Clayey sand, yellowish brown, light gray, saturated sand lenses -gravelly at 21' -laminated ironstone at 22.5' -very dense, gray, light gray at 25' -some clay at 27.5, greenish gray, gray, to boring termination	None	Saturated Dry to Moist
31 32 33 34 35 36 37 38 39 40					Boring Terminated at 30'		

▒ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ☒ Above Ground

Riser Interval:	+3 (ags)-10'
Screen Interval:	10-30'
Water level:	23.26
Above Ground	3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089
☐ **BORING** **BORING NUMBER:** ____
■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-18

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

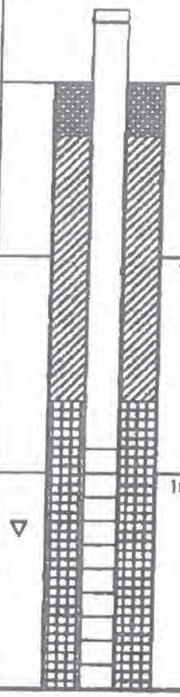
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 1/3/2011

PREPARED BY: Jeff Sammons **LOGGED BY:** Matt Lyon/Jeff Sammons

LATTITUDE: N 32°28.154' Datum: WGS-84 **WELL LOCATION:** Northeast of Bottom Ash Pond #1
LONGITUDE: W94°29.108'



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1 2 3 4 5 6 7			0-7	SM	Sandy Silt, some clay, very fine grained, gray, light brown, light brownish red, yellowish brown	None	Dry
8 9 10 11 12 13			7-16	CL	Clay, some sand, light gray, reddish grey, stiff, yellowish brown -iron oxide fracture at 9.5'	None	Dry
14 15 16					-increasing sand content at 14', thin lenses of iron-oxide cemented sand at 14.5', 15', 15.5', stiff		Moist
17 18 19 20			▽ 16-25	SM	Silty sand, some clay, gray, yellowish brown, dense, abundant gypsum crystals, abundant iron oxide cemented sandstone gravel in layers, saturated 19-21'	None None	Moist to V. Moist Saturated
21 22					-dark gray at 21' -clayey at 21-23'	None	
23 24					-greenish gray, trace clay, at 23'	None	
25					-clay lense, hard, dry, (shale), at 24.5-25'	None	Dry
26 27 28 29 30 31 32 33 34 35 36 37 38 39 40					Boring Terminated at 25'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 25 feet
Filter Sand (Size/Interval): 13-25'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-15'
Screen Interval: 15-25'
Water level:
Above Ground 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ☒ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-28

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

FACILITY ADDRESS: Hallsville, Texas

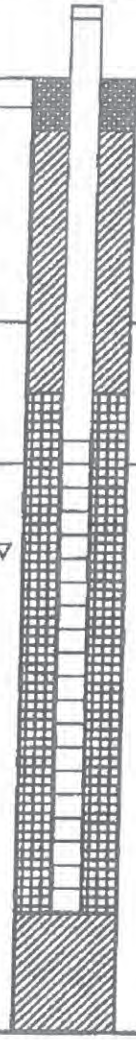
DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/28/2010

PREPARED BY: Jeff Sammons **LOGGED BY:** Jeff Sammons

LATTITUDE: N 32°27.926' Datum: WGS-84 **WELL LOCATION:** Southwest of Primary Bottom Ash Pond #2

LONGITUDE: W94°29.658'



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SM	Silty sand, light brown, very fine grained, loost	None	Moist
2			0.5-10	CL	Sandy clay, reddish brown, yellowish brown, stiff, hard, some	None	Dry
3					iron ore gravel at .5-1.5'		
4							
5					-light gray, dark reddish brown at 5'		
6					-iron oxide cemented stone at 6.5'		
7							
8							
9							
10							
11			10-16	SM	Silty sand, very fine grained, some clay, light yellowish brown,	None	Moist to V.
12					light gray, medium dense		Moist
13					-light yellowish brown at 11.5'		
14							
15							
16							
17			16-40	SC	Clayey sand, dark gray, medium dense	None	Moist
18							
19							
20			▽		-dark gray at 20'		
21					-cemented sandstone at 21'		
22					-no recovery from 22' to 35'		
23							
24							V. Moist to
25							Saturated
26							
27							
28							
29							
30							
31							
32							
33							
34							
35					-1.5" layer of cemented sandstone at 35'		
36							Dry to Moist
37							
38							
39							
40							
					Boring Terminated at 40'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet **Riser Interval:** +3 (ags)-15'

Filter Sand (Size/Interval): 13-35' **Screen Interval:** 15-35'

Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-13' **Water level:** 19.98'

Surface Completion ☐ Flush ☒ Above Ground 3.5'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089

☐ **BORING**
BORING NUMBER:

■ **MONITOR WELL**
MONITOR WELL NUMBER: AD-29

FACILITY NAME: AEP- Pirkey Power Plant

FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.

COMPLETION DATE: 1/3/2011

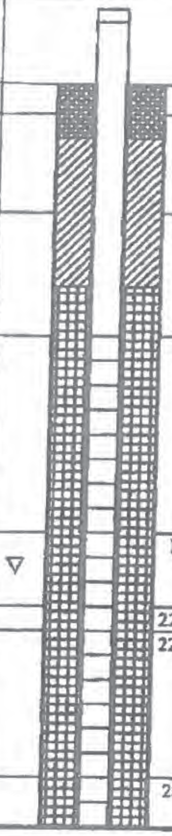
PREPARED BY: Jeff Sammons

LOGGED BY: Jeff Sammons

LATTITUDE: N 32°28.139'
LONGITUDE: W94°29.534

Datum: WGS-84

WELL LOCATION: North of Bottom Ash Pond #2



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SM	Silty sand, brown, light brown, very fine grained	None	Moist
2 3 4 5			0.5-5	CL	Clay, some sand, red, reddish brown, light gray, stiff	None	Dry
6 7 8 9 10			5-10	CL	Sandy clay, light gray, light red -abundant iron ore, yellowish brown, yellow, dry	None	Dry
11 12 13 14 15 16 17 18			10-18	SC	Clayey sand, yellowish brow, reddish brown, light gray, medium dense -light gray, yellow, at 11' -4" saturated sand seam, trace clay at 13' -purple, yellowish brown, reddish brown, medium dense to loose	None	Moist
19 20 21			▽ 18-22	SM	Silty sand, reddish brown to red -some iron ore gravel, some clay, saturated, gypsum crystals, at 20'	None	V. Moist
22			22-22.5	CL	Sandy clay, dark gray, stiff	None	Dry
23 24 25 26 27 28			22.5-28	SM	Silty sand, saturated, greenish gray, loose	None	Dry to Moist
29 30			28-30	SC	Clayey sand, greenish gray, dark gray, dark brown, dry, very dense, slightly cemented	None	Dry to Moist
31 32 33 34 39 40					Boring Terminated at 30'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-30**

JEFFREY D. SAMMONS
GEOLOGY
#10070
JDS 1-21-16

PROJECT INFORMATION

PROJECT: **Pirkey Power Plant**
PROJECT NO.: **I-04-1021**
LOGGED BY: **Jeffrey D. Sammons, P.G.**
SUPERVISING PG: **Jeffrey D. Sammons, P.G.**
COMPLETION: **12/08/2015**
DEVELOPMENT: **12/16/2015**
SITE LOCATION: **2400 FM 3251, Hallsville, Texas**
WELL OWNER: **AEP**

DRILLING INFORMATION

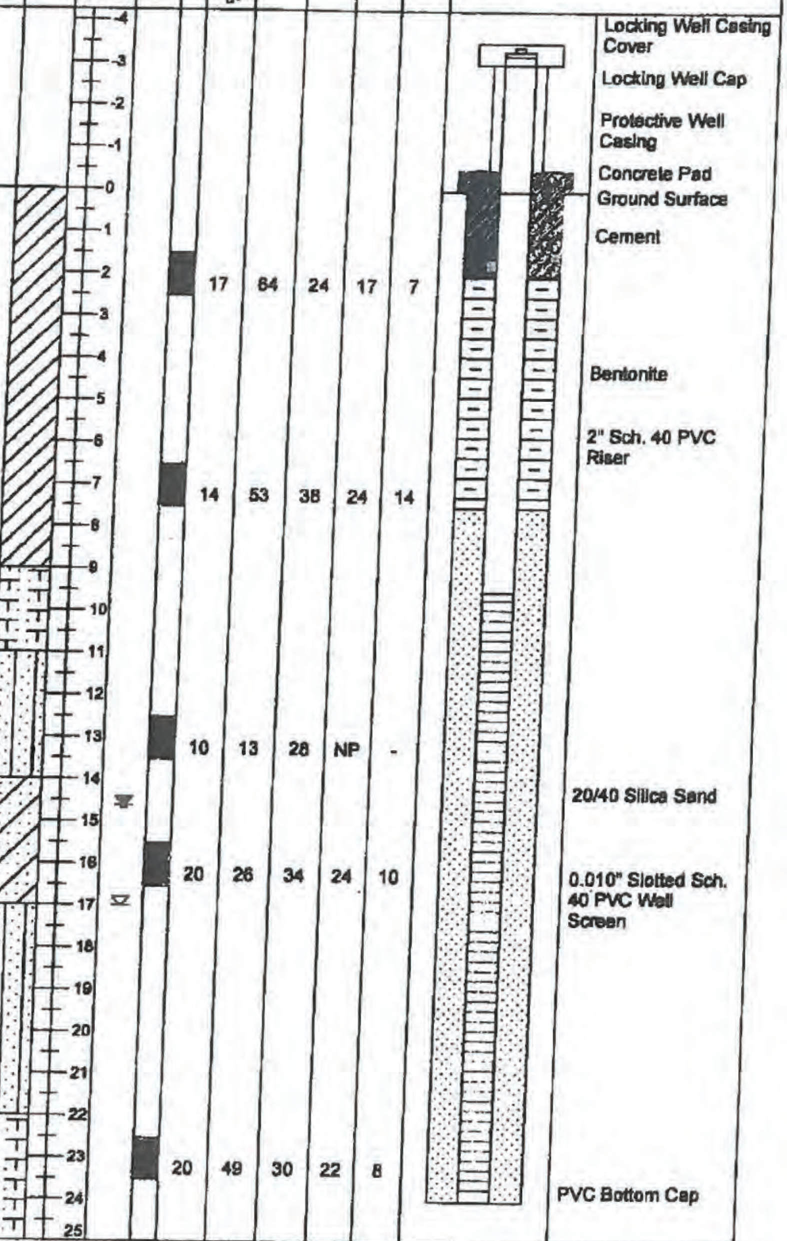
DRILLER: **Buford Collier**
DRILLER'S LICENSE NO.: **50089**
RIG TYPE: **Geoprobe 3230DT**
METHOD OF DRILLING: **Hollow Stem Auger**
SAMPLING METHODS: **Split Core**
SURFACE ELEVATION: **342.02 (Top of Casing)**
HOLE DIAMETER: **6.25"**
LATITUDE **32 27' 56.49"** LONGITUDE **94 29' 32.53"**

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	WATER LEVEL	% MOISTURE	% FINES	LL	PL	PI
SANDY LEAN CLAY: light reddish brown and light gray	CL		17	64	24	17	7
- trace sand and silt at 3.0' to 3.5', light reddish brown							
- some iron ore gravel at 7', light gray, reddish brown, light reddish brown, increasing sand content with depth			14	53	38	24	14
CLAYEY SILTY SAND: very fine to fine sand, reddish brown, light brown, and light gray	SM-SC						
SILTY SAND: very fine to fine sand, some lenses of clay and partially cemented sand, reddish brown and light gray, moist	SM		10	13	28	NP	-
CLAYEY SAND: very fine to fine sand with some fine to coarse iron ore gravel and partially cemented sand, reddish brown and light gray, moist	SC	▼	20	26	34	24	10
SILTY SAND: very fine to fine sand, some clay, light gray and reddish brown, saturated	SM	▽					
- some iron ore gravel at 19', gray and reddish brown, increasing clay content with depth, very moist							
SILTY CLAYEY SAND: fine to very fine sand, some clay lenses, gray and dark gray, moist	SM-SC		20	49	30	22	8

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

ETTL
ENGINEERS &
CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING LR-1

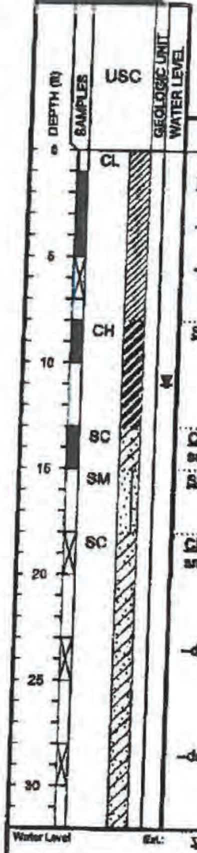
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

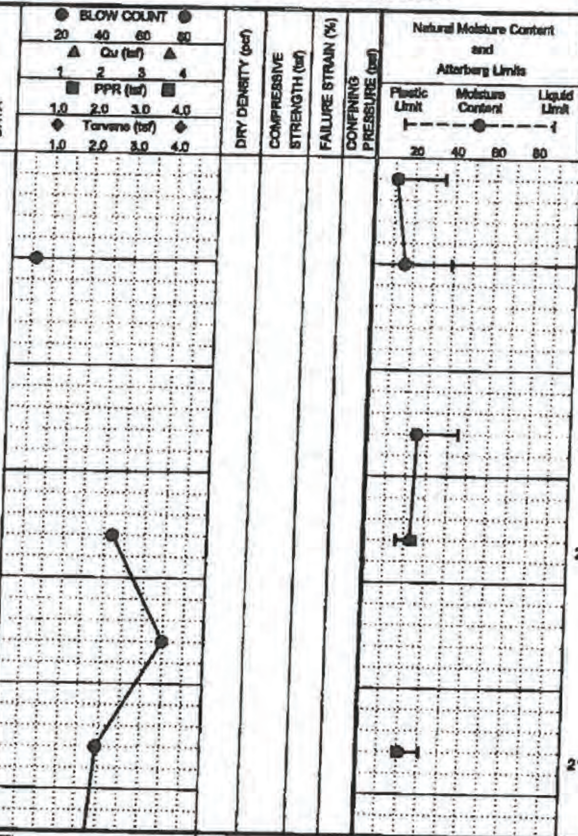
BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 337.2



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY WITH SAND(CL) very stiff; tan	P=3.5	11	35	13	22	70	+40 Sieve=3%, +4 Sieve=1%
	--tan and orange							
	--stiff; red and tan	N=12	16	39	16	23	68	+40 Sieve= 4%, +4 Sieve=2%
CH	SANDY FAT CLAY(CH) tan and orange							
SC	CLAYEY SAND(SC) gray; with clay and sand seams	SF	25	45	23	22	44	+40Sieve=13%, +4 Sieve=5%
SM	SILTY SAND(SM) dark gray							
SC	CLAYEY SAND(SC) very dense; gray; with small clay seams	N=54	23	26	16	10	20	+40 Sieve=2%, +4 Sieve=0%
	--dark gray	N=80						
	--dense; gray and brown	N=49	21	31	18	13	29	+40 Sieve=1%, +4 Sieve=0%



Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 13' while drilling. Water level @ 11' and open to 38' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.804', W 94°29.482'

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Tyler, Texas 75702
(903) 595-4421

LOG OF BORING LR-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

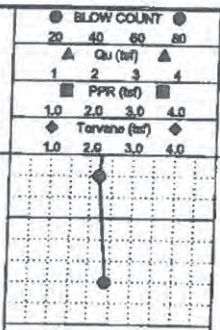
PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 337.2

DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	☒				–gray	N=44										
35																
	☒					N=48										
40					Bottom of Boring @ 40'											



Natural Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
20 40 60 80

ATTERBERG LIMITS(%)

Water Level: Est.: ∇ Measured: ▼ Perched: ∇

Water Observations: Seepage @ 13' while drilling. Water level @ 11' and open to 38' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.804', W 94°29.482'

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING LR-2

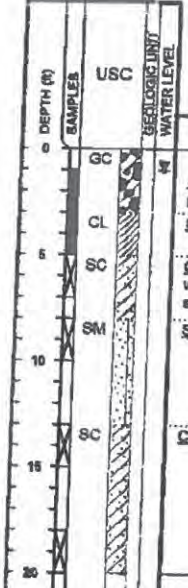
PROJECT: Pirkey Power Plant
Hallsville, Texas

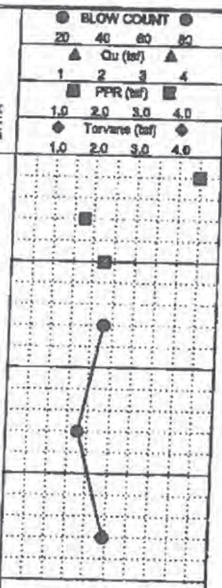
PROJECT NO.: G3241-095

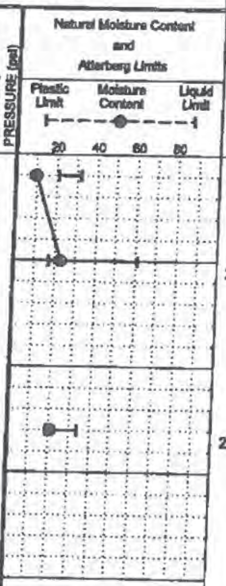
BORING TYPE: Flight Auger

DATE 10/20/08

SURFACE ELEVATION 328.0







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
GC	CLAYEY GRAVEL(GC) medium dense; tan, gray, and red; with ferric seams	P=4.5+					10	32	21	11	6	+40Sieve=84%, +4 Sieve=77%
CL	SANDY LEAN CLAY(CL) stiff; tan and gray	P=1.75										
SC	CLAYEY SAND(SC) very stiff; tan and gray; with ferric seams; with iron oxide cemented sandstone	P=2.25					28	61	17	44	41	+40Sieve=6%, +4 Sieve=0%
SM	SILTY SAND(SM) dense; gray	N=46										
SC	CLAYEY SAND(SC) dense; gray	N=35					21	34	19	15	31	+40Sieve=2%, +4 Sieve=0%
		N=49										

Bottom of Boring @ 20'

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 3' while drilling. Water level @ 1' and open to 18' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.801', W 94°29.491'

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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-1

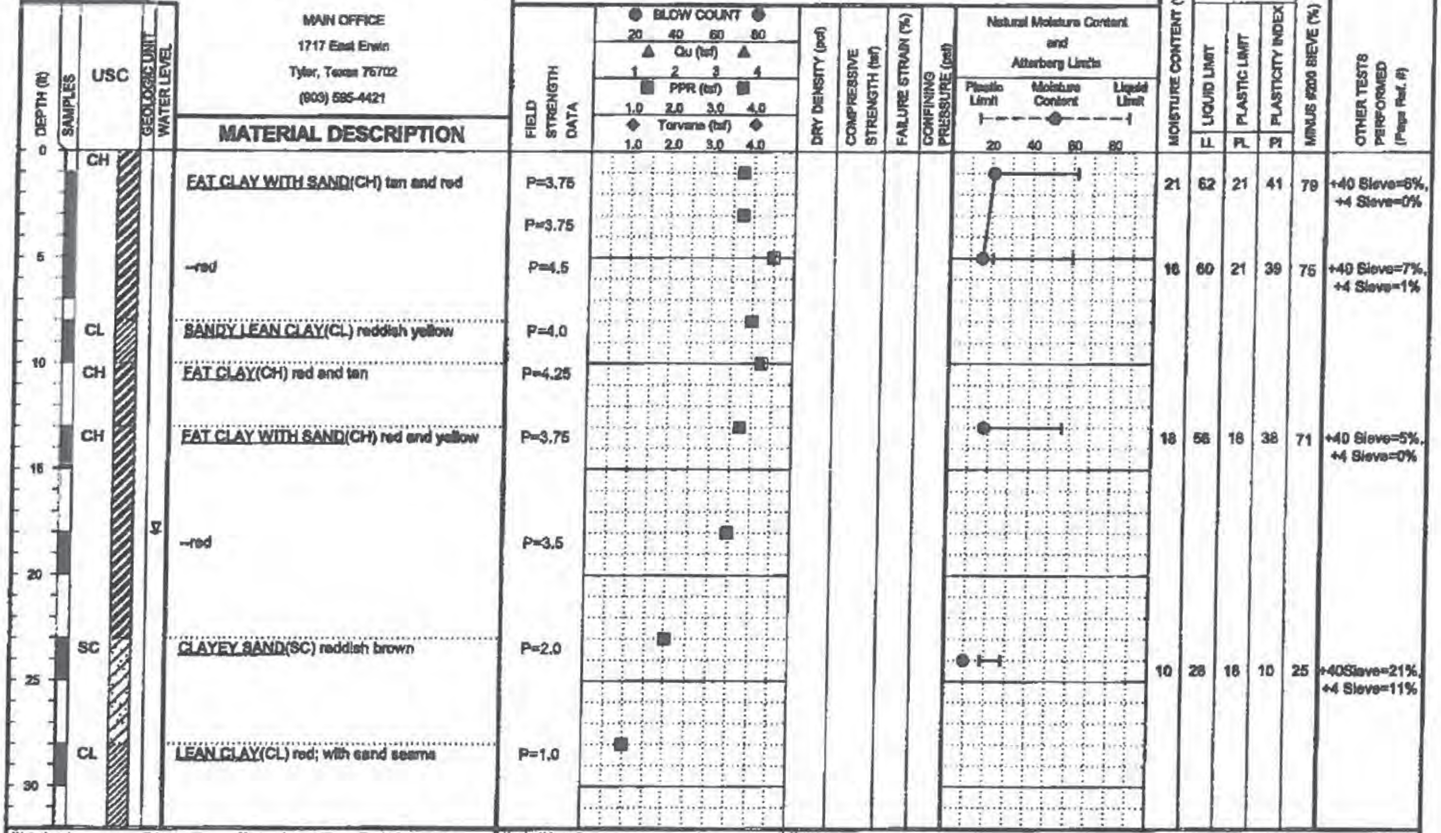
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.5



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CH	FAT CLAY WITH SAND(CH) tan and red	P=3.75	21	62	21	41	79	+40 Sieve=6%, +4 Sieve=0%
		P=3.75						
	--red	P=4.5	16	60	21	39	75	+40 Sieve=7%, +4 Sieve=1%
CL	SANDY LEAN CLAY(CL) reddish yellow	P=4.0						
CH	FAT CLAY(CH) red and tan	P=4.25						
CH	FAT CLAY WITH SAND(CH) red and yellow	P=3.75	18	56	18	38	71	+40 Sieve=5%, +4 Sieve=0%
	--red	P=3.5						
SC	CLAYEY SAND(SC) reddish brown	P=2.0	10	26	16	10	25	+40Sieve=21%, +4 Sieve=11%
CL	LEAN CLAY(CL) red; with sand seams	P=1.0						

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 18' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-1

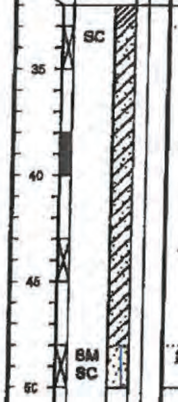
PROJECT: Pirkey Power Plant
Hallsville, Texas

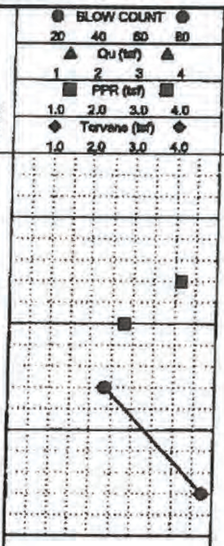
PROJECT NO.: G3241-095

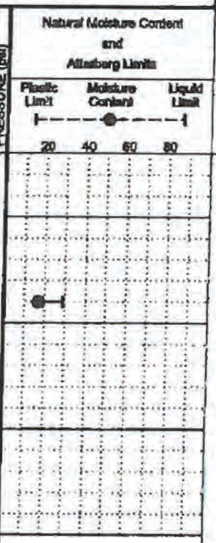
BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.5







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) grayish brown	N=32										
	–tannish gray	P=4.15					17	29	19	10	25	+40 Sieve=1%, +4 Sieve=0%
		P=2.8										
	–gray	N=47										
SM SC	SILTY CLAYEY SAND(SM-SC) gray	N=50/6"										

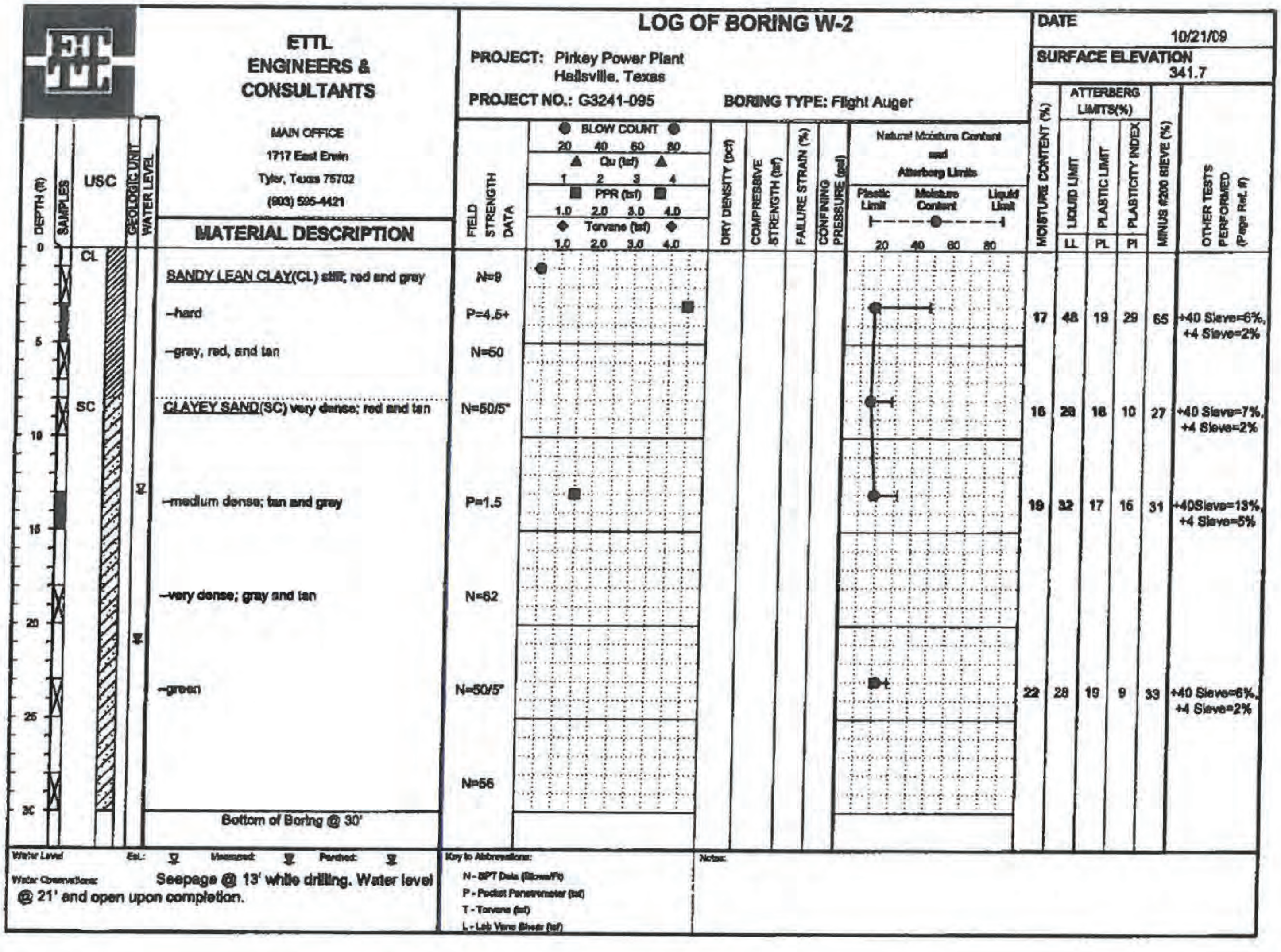
Bottom of Boring @ 50'

Water Level/ Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:



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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-2

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/21/09

SURFACE ELEVATION 341.7

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; red and gray	N=9						
	–hard	P=4.5+	17	48	19	29	65	+40 Sieve=6%, +4 Sieve=2%
	–gray, red, and tan	N=50						
SC	CLAYEY SAND(SC) very dense; red and tan	N=50/5"	16	26	16	10	27	+40 Sieve=7%, +4 Sieve=2%
	–medium dense; tan and gray	P=1.5	19	32	17	15	31	+40Sieve=13%, +4 Sieve=5%
	–very dense; gray and tan	N=62						
	–green	N=50/5"	22	28	19	9	33	+40 Sieve=6%, +4 Sieve=2%
		N=56						

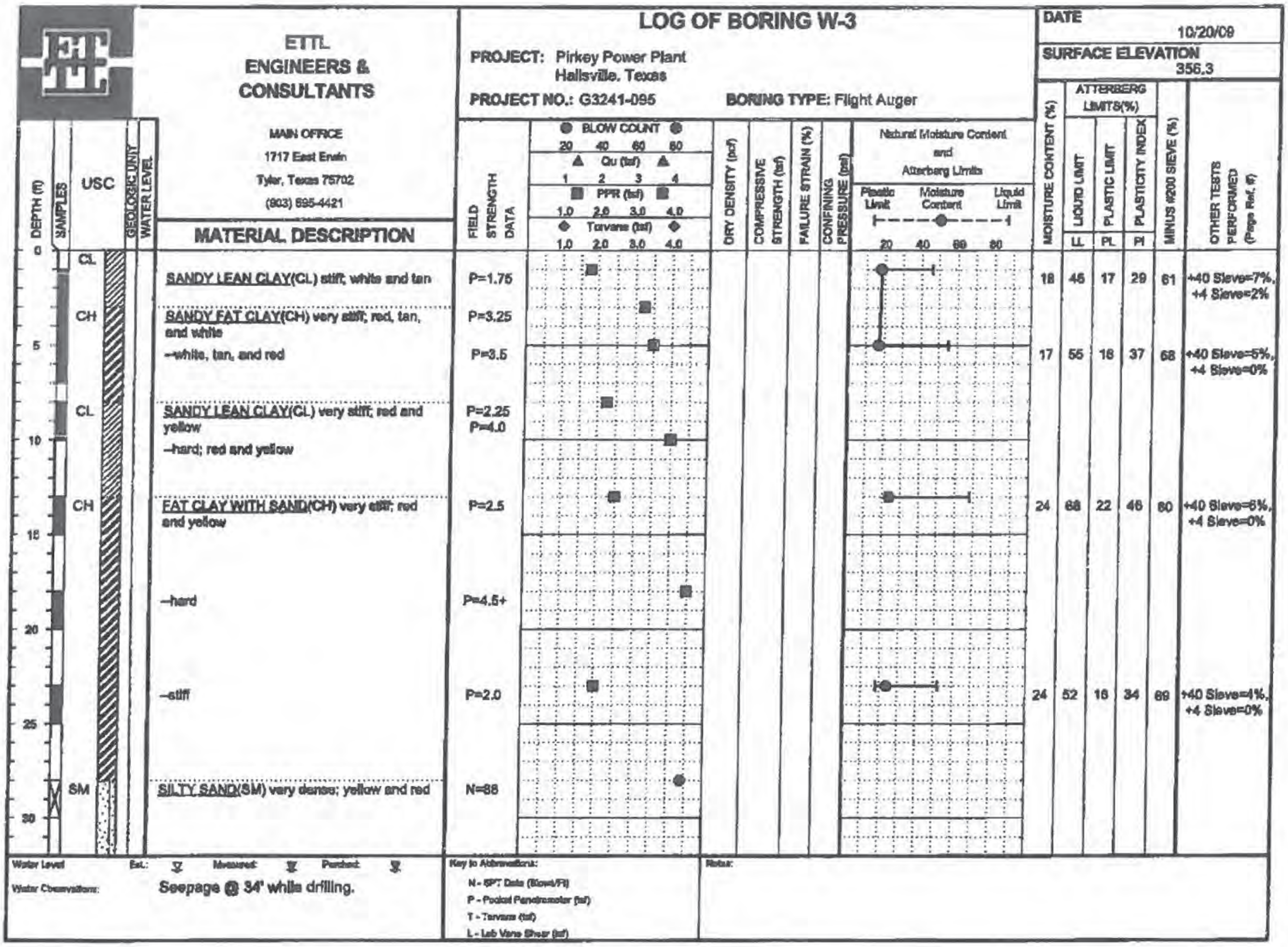
Bottom of Boring @ 30'

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling. Water level @ 21' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:



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(903) 595-4421

LOG OF BORING W-3

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.3

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; white and tan	P=1.75	18	46	17	29	61	+40 Sieve=7%, +4 Sieve=2%
CH	SANDY FAT CLAY(CH) very stiff; red, tan, and white	P=3.25						
	--white, tan, and red	P=3.5	17	55	18	37	68	+40 Sieve=5%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) very stiff; red and yellow	P=2.25						
	--hard; red and yellow	P=4.0						
CH	FAT CLAY WITH SAND(CH) very stiff; red and yellow	P=2.5	24	68	22	46	80	+40 Sieve=6%, +4 Sieve=0%
	--hard	P=4.5+						
	--stiff	P=2.0	24	52	18	34	69	+40 Sieve=4%, +4 Sieve=0%
SM	SILTY SAND(SM) very dense; yellow and red	N=88						

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 34' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

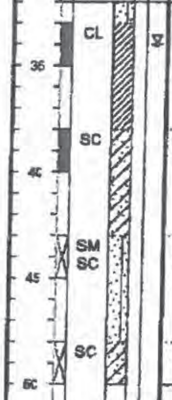
LOG OF BORING W-3

PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

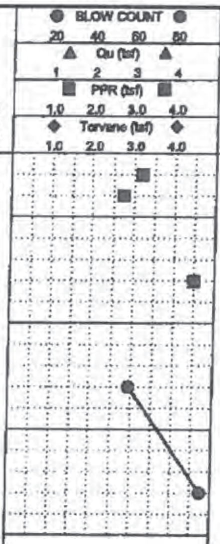
DATE 10/20/09

SURFACE ELEVATION 356.3

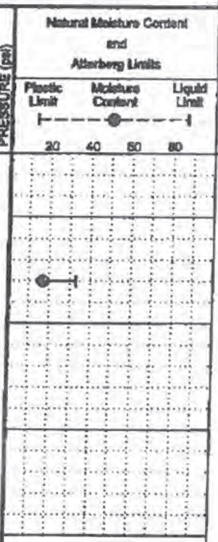


USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel	P=3.25						
SC	CLAYEY SAND(SC) very dense; dark gray	P=4.5+	17	33	17	16	38	+40 Sieve=1%, +4 Sieve=0%
SM SC	SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated	N=59						
SC	CLAYEY SAND(SC) very dense; dark gray	N=50/4"						

Bottom of Boring @ 50'



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



Water Level Est.: ⊻ Measured: ⊻ Perched: ⊻

Water Observations: Seepage @ 34' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

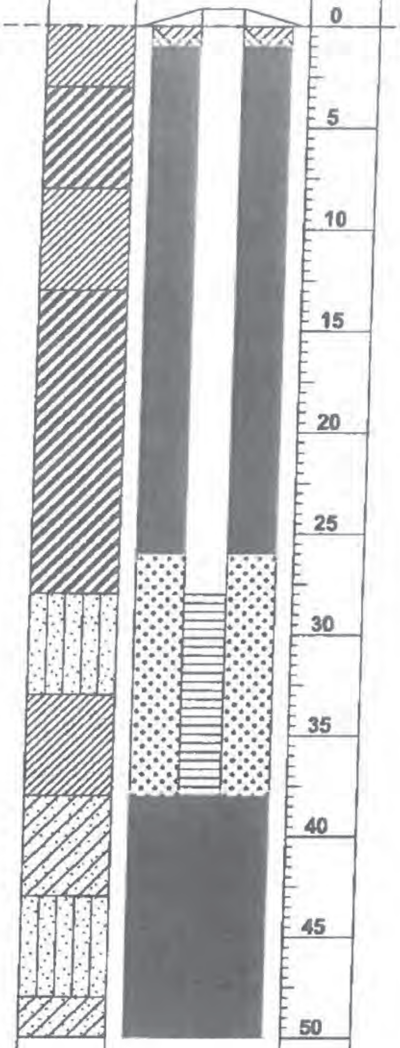
Notes:

ENVIRONMENTAL LOG **Client:** Pirkey Power Plant		**Well No.** PW-3 (W3) **Location** Hallsville, Texas
Project No: G3241-095	**Phase**	**Task**
Surface Elev.		**Page** 1 **of** 1

Depth Feet	Sampler	Overburden/Lithologic Description
0		Ground Surface
		SANDY LEAN CLAY(CL) stiff; white and tan
		SANDY FAT CLAY(CH) very stiff; red, tan, and white
5		—white, tan, and red
		SANDY LEAN CLAY(CL) very stiff; red and yellow
10		—hard; red and yellow
		FAT CLAY WITH SAND(CH) very stiff; red and yellow
15		
20		
25		
		SILTY SAND(SM) very dense; yellow and red
30		
		SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel
35		
		CLAYEY SAND(SC) very dense; dark gray
40		
		SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated
45		
		CLAYEY SAND(SC) very dense; dark gray
50		Bottom of Boring @ 50'

FID (ppm) | **Graphic Log** | **Well Construction Graphics** | **Depth Feet** | **Well Construction Details**

T.O.C. Elev.



Driller Doug Hinds	**Drilling Method** Flight Augers	**Bentonite Seal** 1-26' & 38-50'
Logged By Blake Hobbs	**Borehole Diameter** 6.5"	**Filter Pack Qty.** 26-38'
Drilling Started 10/20/09	**Well Casing** 2.0" **Dia.** 0.0' **to** 28.0'	**Filter Pack Type** 20/40 Sand
Drilling Completed	**Casing Type** PVC	**Static Water Level**
Construction Completed	**Well Screen** 2.0" **Dia.** 28.0' **to** 38.0'	
Development Completed	**Screen Type** Slotted	**Notes:**
Type of Well	**Slot Size** 0.010"	
	Grout Type Bentonite	

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Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-4

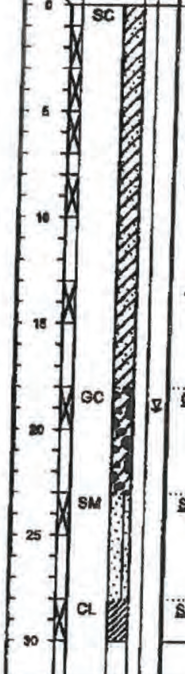
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

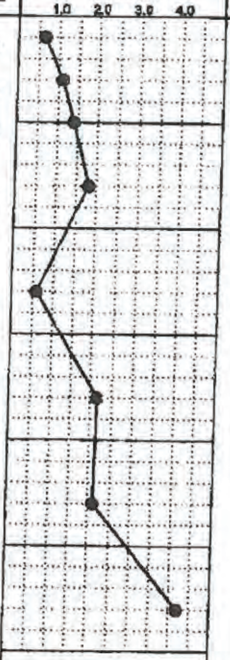
BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION 338.0



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) stiff; brown, red, and yellow	N=13						
	–with gravel	N=22	12	31	17	14	35	+40Sieve=31%, +4 Sieve=16%
	–red and tan; with iron oxide cemented sandstone	N=28						
	–dense; red and white; with clay seams	N=36	15	60	16	44	39	+40Sieve=11%, +4 Sieve=4%
	–medium dense; orangish gray; with gravel	N=12	17	30	14	16	22	+40Sieve=28%, +4 Sieve=17%
GC	CLAYEY GRAVEL(GC) dense; dark grey	N=43	20	31	16	15	7	+40Sieve=68%, +4 Sieve=62%
SM	SILTY SAND(SM) dense; dark gray	N=42						
CL	SANDY LEAN CLAY(CL) very dense; gray	N=84						
	Bottom of Boring @ 30'							



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 19' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-8
LOCATION: Hallsville,TX

Date: 9-15-83
Type:
Ground Elevation: 347.1

Legend:
▨ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum

Red and brown slightly sandy silty clay

Red and brown silty clay with silt lenses

5

Red and brown silty sandy clay

Bottom of boring at 6 feet.

No water encountered.

10

15

20

25

30

35

40

45

50

SOUTHWESTERN LABORATORIES

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-9
LOCATION: Hallsville,TX

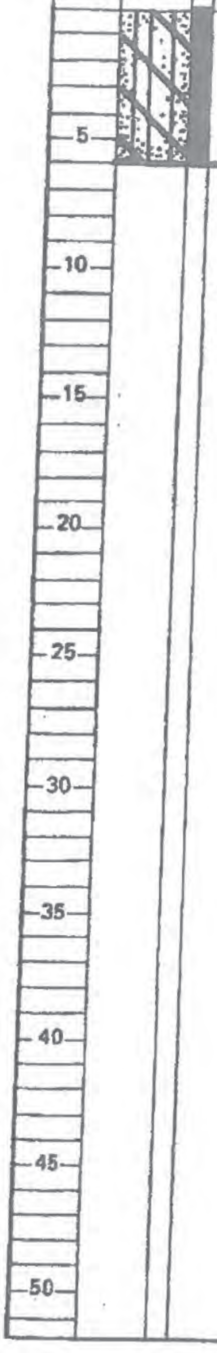
Date: 9-15-83
Type:
Ground Elevation: 348.1

Depth, Feet | Symbol | Sample

Legend:

■ Sample
X Penetration
▼ Water

Description of Stratum



Red and grey silty clay with silty sand

Red and grey silty sandy clay

Red and grey silty sandy clay

Bottom of boring at 6 feet.

No water encountered.

832964

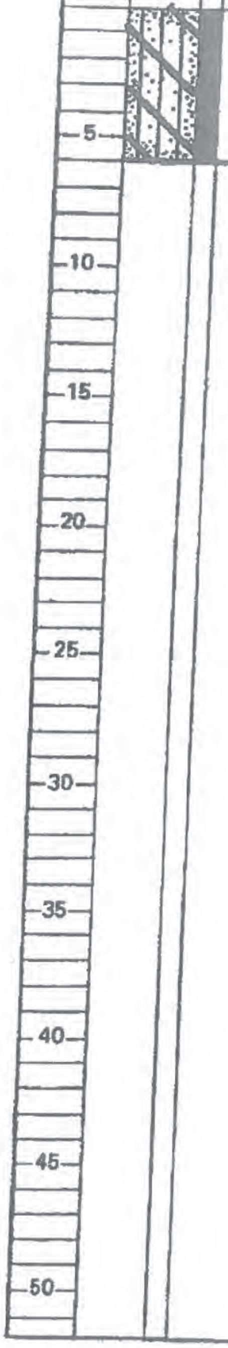
LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-10
LOCATION: Hallsville

Date: 10-6-83
Type: Auger
Ground Elevation: 347.4

Legend:
■ Sample
X Penetration
▼ Water



Description of Stratum

Very stiff tan and brown sandy silty clay

Very stiff tan and grey sandy silty clay

Stiff tan and grey sandy silty clay

Bottom of boring at 6 feet.

No water encountered.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-11
LOCATION: Hallsville

Date: 10-6-83
Type: Auger
Ground Elevation: 347.0

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet	Symbol	Sample	Description of Stratum
		■	Very stiff tan and grey sandy silty clay lenses
		■	Very stiff tan and grey silty clay lenses
5		■	Very stiff tan and grey silty clay lenses
			Bottom of boring at 6 feet.
10			No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			

ARCADIS

Appendix B

Photographic Log

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 1 **Date:** 8/19/2015

Direction Photo Taken:

South

Description:

P8190378
View across East and West Botton Ash Pond.

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 2 **Date:** 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190379
Road side ditch, not considered a wetland, due to lack of hydric vegetation and connectivity.

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PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 3

Date: 8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190383
Upland forest bordering north of West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 4

Date: 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190385
Pizometer along West Bottom Ash Pond perimeter embankment road.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
5	8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190386
Pizometer along West Bottom Ash Pond perimeter embankment road.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
6	8/19/2015

Direction Photo Taken:

North

Description:

P8190387

AD-3 in the wooded area east of West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No. 7 **Date:** 8/19/2015

Direction Photo Taken:

Description:

P8190390
Dry (non-wetland) ditch adjacent to railroad and West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No. 8 **Date:** 8/19/2015

Direction Photo Taken:

West Northwest

Description:

P8190392
West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 9

Date: 8/19/2015

Direction Photo Taken:

East Southeast

Description:

P8190396
West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 10

Date: 8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190399
Upland drainage at the toe of the West Bottom Ash Pond.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
11	8/19/2015

Direction Photo Taken:

Northeast

Description:

P8190403
Vegetated strip around culvert that drains East and West BAPs. This potential wetland may be jurisdictional and is associated with an intermittent stream.

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	Location:	Project No.
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	Date:
12	8/19/2015

Direction Photo Taken:

Southwest

Description:

P8190411
Small vegetated strip adjacent to access road south of southeast corner of West Botton Ash Pond.

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 13 **Date:** 8/19/2015

Direction Photo Taken:

West Northwest

Description:

P8190414
Looking across West Bottom Ash Pond

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 14 **Date:** 8/19/2015

Direction Photo Taken:

South Southeast

Description:

P8190417
West Bottom Ash Pond

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	**Location:**	**Project No.**
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	**Date:**
15	8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190419
Small vegetated strip in outside corner of access road south of southeast corner of West Botton Ash Pond.

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American Electric Power Service Corporation

Stack Out Area - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

May 25, 2016

STATE OF TEXAS
Kenneth J. Brandner
Geology
1737
LICENSED
PROFESSIONAL GEOSCIENTIST

Kenneth Brandner

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matthew J. Lamb

Matthew J. Lamb
Project Manager

John W Holm

John Holm, P.E.
Professional Engineer

Stack Out Area - CCR Groundwater Monitoring Well Network Evaluation

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
AEP

Prepared by:
ARCADIS U.S., Inc.
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Tel 614 985 9100
Fax 614 985 9170

Our Ref.:
OH015976.0010

Date:
May 25, 2016

Tables

Figures

Appendices

Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

1. Objective

This report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to assess the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91, for the Stack Out Area CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The CCR requirements include an evaluation of the adequacy of the groundwater monitoring well network to characterize groundwater quality up and down gradient of the CCR unit and an evaluation of whether the CCR unit meets up to 5 location restrictions, which include: the base of the CCR unit is 5 feet (ft) above and isolated from the uppermost aquifer, the CCR unit may not be located in a wetland, within 200 ft of the damage zone of a fault that has displacement during the Holocene, within a seismic impact zone, or in an unstable area.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report summarizes the evaluation of the groundwater monitoring well network in the uppermost aquifer at the Stack Out Area. The evaluation of the location restriction criteria is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the Stack Out Area CCR unit, as well as publically-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant Stack Out Area.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The Stack Out Area CCR unit is located in the central portion of the Plant, and approximately 1,200 feet northwest of Brandy Branch Reservoir (**Figures 1** and **2**).

2.2 Description of Stack Out Area CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the Stack Out Area.

2.2.1 Stack Out Area Configuration

The Stack Out Area is an approximate 7-acre storage area for stabilized flue gas desulfurization (FGD) sludge. As shown on **Figure 3**, the Stack Out Area is located directly south of the Surge Pond, directly west of Thickener Tanks 1A and 1B, and directly east of a road that runs south to the on-site Landfill. The dimensions of the Stack Out Area are approximately 650 feet from north to south by 450 feet from east to west.

Stabilized FGD sludge is temporarily stockpiled directly above natural ground surface (native clay) in the Stack Out Area using a radial stacker. The maximum height of the stabilized FGD sludge piles are approximately 41 feet above ground surface. There are no solids retention structures in the Stack Out Area. The stabilized FGD sludge piles are located no closer than approximately 50 feet from the perimeter of the Stack Out Area, thereby preventing the stabilized FGD sludge from migrating beyond the boundaries of the Stack Out Area.

2.2.2 Area/Volume

The Stack Out Area is approximately 7 acres in size. However, as discussed above in Section 2.2.1, the CCR piles in the Stack Out Area are located no closer than approximately 50 feet from the perimeter of the Stack Out Area, therefore the effective storage area of the Stack Out Area is approximately 4.4 acres (550 feet by 350 feet), and the maximum CCR storage volume based on a maximum CCR pile height of 41 feet is 180 acre feet.

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, FGD sludge) have been generated. The Stack Out Area receives stabilized FGD sludge (**Figure 3**). Prior to storing the FGD sludge in the Stack Out Area, the FGD sludge is dewatered using belt presses, and the dewatering fluid is routed to the Surge Pond for reuse as FGD makeup water. The stabilized FGD sludge is then stockpiled in the Stack Out Area using a radial stacker with an approximate 3-foot-wide by 120-foot-long conveyor belt.

The stabilized FGD sludge is temporarily stored at the Stack Out Area. The stabilized FGD sludge is removed using front-end loaders or similar equipment, placed into trucks, and disposed of at the on-site Landfill CCR Unit located near the south end of the Plant.

Lithologic data from soil borings and monitoring wells confirm the native soils underling the Stack Out Area consist of low-permeability clay. As shown on Geologic Cross Sections B-B' (**Figure 5**) and E-E' (**Figure 8**), the native clay directly below the Stack Out Area extends from the surface to an average depth of approximately 20 feet. Therefore, as shown on **Figures 5** and **8**, the separation distance between the base of the Stack Out Area and uppermost aquifer exceeds 5 feet.

2.2.4 Surface Water Control

The Stack Out Area contains dewatered FGD sludge that is stockpiled using a radial stacker, therefore no sluice water is present in the Stack Out Area. Storm water in the Stack Out Area follows surface topography via gravity sheet flow. The ground surface elevation in the Stack Out Area ranges from approximately 360 to 365 feet amsl (Akron Consulting, 2015). Storm water flow in the Stack Out Area is in a general northerly direction to the Surge Pond, which is a below-grade (incised) non-CCR unit.

2.3 Previous Investigations

The initial soils investigation and design of the Plant was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, including the Stack Out Area.

In 2009, ETTL Engineers & Consultants (ETTL) conducted geotechnical investigations of earthen embankments associated with several ponds at the Plant. The Stack Out Area was not included in this evaluation because there are no earthen embankments in the Stack Out Area (ETTL, 2010).

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, 2011).

In 2011, Johnson & Pace performed hydraulic analysis of several ponds at the Plant. The Stack Out Area was not included in this evaluation because there is no impounded water in the Stack Out Area (Johnson & Pace, May 2011).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

2.4 Hydrogeologic Setting

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of approximately 100 feet (Broom, 1966).

These features are further illustrated on five lines of cross section that were prepared through the Stack Out Area, with three lines trending from west to east (A-A'; B-B'; C-C'), and the other two lines trending from north to south (D-D'; E-E'). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A') through **Figure 8** (E-E').

2.4.1 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1° Fahrenheit (F) in January to 83.8°F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.2 Regional and Local Geologic Setting

The central and northern portions of the Plant, including the Stack Out Area, are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.3 Surface Water and Surface Water Groundwater Interactions

Figure 9 is a potentiometric surface map based on January 2016 water level data for the uppermost aquifer at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figure 9**, shallow groundwater flow direction in the Stack Out Area is northwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The Stack Out Area is located approximately 1,200 feet northwest of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy Branch Reservoir is approximately 340 feet amsl. As shown on **Figure 9**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore shallow groundwater in the Stack Out Area does not discharge into Brandy Branch Reservoir.

2.4.4 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled approximately 1,000 feet north of the Stack Out Area in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 350 to 430 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled approximately ¼-mile west (downgradient) of the Stack Out Area for NFR Energy in 2008 for use as a rig supply well. The water well was screened from 250 to 310 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth, and is located approximately ¼-mile east (upgradient) of the Pirkey Power Plant.

3. Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be placed down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the Stack Out Area is a very fine to fine grained clayey and silty sand stratum with an average thickness of approximately 20 feet that is located between an elevation of approximately 320 and 340 feet amsl (**Appendix A**). The base of the Stack Out Area is at an elevation of 360 feet amsl. The separation distance between the uppermost aquifer and the base of the Stack Out Area ranges from approximately 10 to 20 feet. This separation distance is further illustrated on cross section B-B' (**Figure 5)** and cross section E-E' (**Figure 8)**.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer unit (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness in the Stack Out Area (approximately 20 feet), the yield of the uppermost aquifer is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Available groundwater elevations are summarized on **Table 1** for 2011 through 2016. The most recent comprehensive groundwater data set from January 20, 2016 is depicted on **Figure 9**. The groundwater flow direction in the Stack Out Area is northwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

Per 40 CFR 257.60(a), new CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five ft) above the upper limit of the uppermost aquifer, or must demonstrate there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high conditions).

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers, that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the Stack Out Area is the clayey and silty sand stratum that is located between an elevation of approximately 320 and 340 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 19, 2015 to review existing well network conditions and locations. A well construction table that summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as

Table 2. Photo documentation of the located wells during the August 19, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-7, AD-12, AD-13, and AD-22 were previously installed at the Site to monitor the uppermost water-bearing unit (clayey and silty sand stratum) associated with the Stack Out Area. As discussed above in Section 3.1.1, the uppermost water-bearing unit below the Stack Out Area is approximately 20 feet thick and is located between an elevation of approximately 320 and 340 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on Geologic Cross Sections B-B' (**Figure 5**) and E-E' (**Figure 8**), existing monitoring wells AD-7 and AD-22 are screened in the uppermost water-bearing unit downgradient (northwest) of the Stack Out Area, and will be utilized as downgradient monitoring wells for the Stack Out Area. Existing monitoring wells AD-12 and AD-13 are screened in the uppermost water-bearing unit up gradient (east) of the Stack Out Area, and will be utilized as up gradient monitoring wells for the Stack Out Area.

As shown on **Figure 9**, shallow groundwater flow direction in the Stack Out Area is northwesterly. Two existing monitoring wells (AD-7 and AD-22) were located hydraulically downgradient of the Stack Out Area during the August 19, 2015 site visit, and three downgradient monitoring wells are required to monitor groundwater quality downgradient of a CCR unit. This data gap was addressed by installation of new downgradient monitoring well AD-33 during December 2015 as shown on **Figure 9** and **Figure 10**. With the addition of monitoring well AD-33 on the west side of the Stack Out Area, there are no gaps remaining in the groundwater monitoring network for the Stack Out Area.

4. Recommended Monitoring Network and PE Certification

The recommended existing groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the Stack Out Area (up gradient or down gradient), well depth, and well construction. The recommended network would provide an improved understanding of groundwater quality, hydraulics, and groundwater flow at the Stack Out Area.

4.1 Recommended Monitoring Well Network Distribution

Two up gradient well locations (existing monitoring wells AD-12 and AD-13) and three down gradient well locations (existing monitoring wells AD-7, AD-22, and AD-33) are recommended to establish a groundwater quality monitoring well network for the Stack Out Area.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the Stack Out Area is summarized on **Table 3** and illustrated on **Figure 10.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 320 and 340 feet amsl as shown on Geologic Cross Sections B-B' (**Figure 5**) and E-E' (**Figure 8**). The screen elevations are presented in **Table 3**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the Stack Out Area was addressed by installation of monitoring well AD-33 during December 2015. Monitoring well AD-33 was installed by a Texas Department of Licensing and Regulation (TDLR)-licensed water well driller. Well construction data for the monitoring well network are summarized on **Tables 2** and **3**, and the monitoring well completion diagrams are provided in **Appendix A.**

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system will be adequate to meet the requirements of 40 CFR Part 257.91.

Kenneth J. Brandner

Printed Name of Registered Professional Engineer

Kenneth J Brandner

Signature

KENNETH J. BRANDNER
69586

69586	Texas	5-25-16
Registration No.	Registration State	Date

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ARCADIS

Tables

Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen(b)		Bottom of Screen(b)		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																					
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85
Piezometers(c)																					
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	NM	NM	NM	NM	NM	NM	NM	NM	NM

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
NM - Not Measured

Table 2
Well Construction Details
AEP Pirkey Power Plant - CCR Units
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation(a)	Top of Casing Elevation(a)	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen(b)		Bottom of Screen(b)	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18	341	40	319	20	339.48	40	319.48
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29	350	51	328	31	347.84	51	327.84
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.48	40.5	321.48
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13	344	35	322	15.0	341.81	35.0	321.81
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8	335	30	313	10.0	332.65	30.0	312.65
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13	347	25	335	15.0	345.48	25.0	335.48
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8	352	30	330	10.0	349.50	30.0	329.50
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13	339	35	317	15.0	337.30	35.0	317.30
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8	339	30	317	10.0	337.23	30.0	317.23
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8	348	30	326	10.0	345.57	30.0	325.57
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13	334	35	312	15.0	331.72	35.0	311.72
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3	285	20	268	5.0	282.68	20.0	267.68
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8	326	30	304	10.0	324.15	30.0	304.15
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8	334	40	302	10.0	332.41	40.0	302.41
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.33	37.5	312.33
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13	323	35	301	15.0	320.92	35.0	300.92
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8	342	30	320	10.0	340.21	30.0	320.21
AD-30(d)	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8	331	25	314	10.0	329.04	25.0	314.04
AD-31(d)	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18	340	35	323	20.0	337.75	35.0	322.75
AD-32(d)	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11	346	33	324	13.0	344.23	33.0	324.23
AD-33(d)	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12	347	30	329	15.0	344.30	30.0	329.30
AD-34(d)	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8	297	25	280	10.0	294.64	25.0	279.64
AD-35(d)	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20	296	3.0	313.01	18.0	298.01
Piezometers(c)																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26	330	38	318	28.0	328.30	38.0	318.30

General Note:
Elevations in feet above mean sea level.

Footnotes:
(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.
(c) Souce: EETL (October 2010).
(d) Source: Aukland Consulting LLC (January 26, 2016).

Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

Table 3
Proposed Well Network
AEP Pirkey Power Plant - Stack Out Area
Hallsville, Harrison County, Texas

Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Target Elevation(a) (ft amsl)	Screen Bottom Target Elevation(a) (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-12	Exisiting	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-13	Exisiting	Uppermost Water-Bearing Unit	East of Stack Out Area	Upgradient	331.5	321.5	10	Existing well installed in 1988; well will be utilitzed to establish backgroud water quality
Downgradient								
AD-7	Existing	Uppermost Water-Bearing Unit	Northwest of Stack Out Area	Down gradient	339.6	319.6	20	Existing well installed in 1983; uppermost shallow aquifer adjacent to Stack Out Area - downgradient
AD-22	Existing	Uppermost Water-Bearing Unit	West of Stack Out Area	Down gradient	345.6	325.6	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to Stack Out Area - downgradient
AD-33	Existing	Uppermost Water-Bearing Unit	West of Stack Out Area	Down gradient	344.3	329.3	15	New monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to Stack Out Area - downgradient

Footnotes:
a. Target elevations are an estimated range.

Acronyms and Abbreviations:
U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

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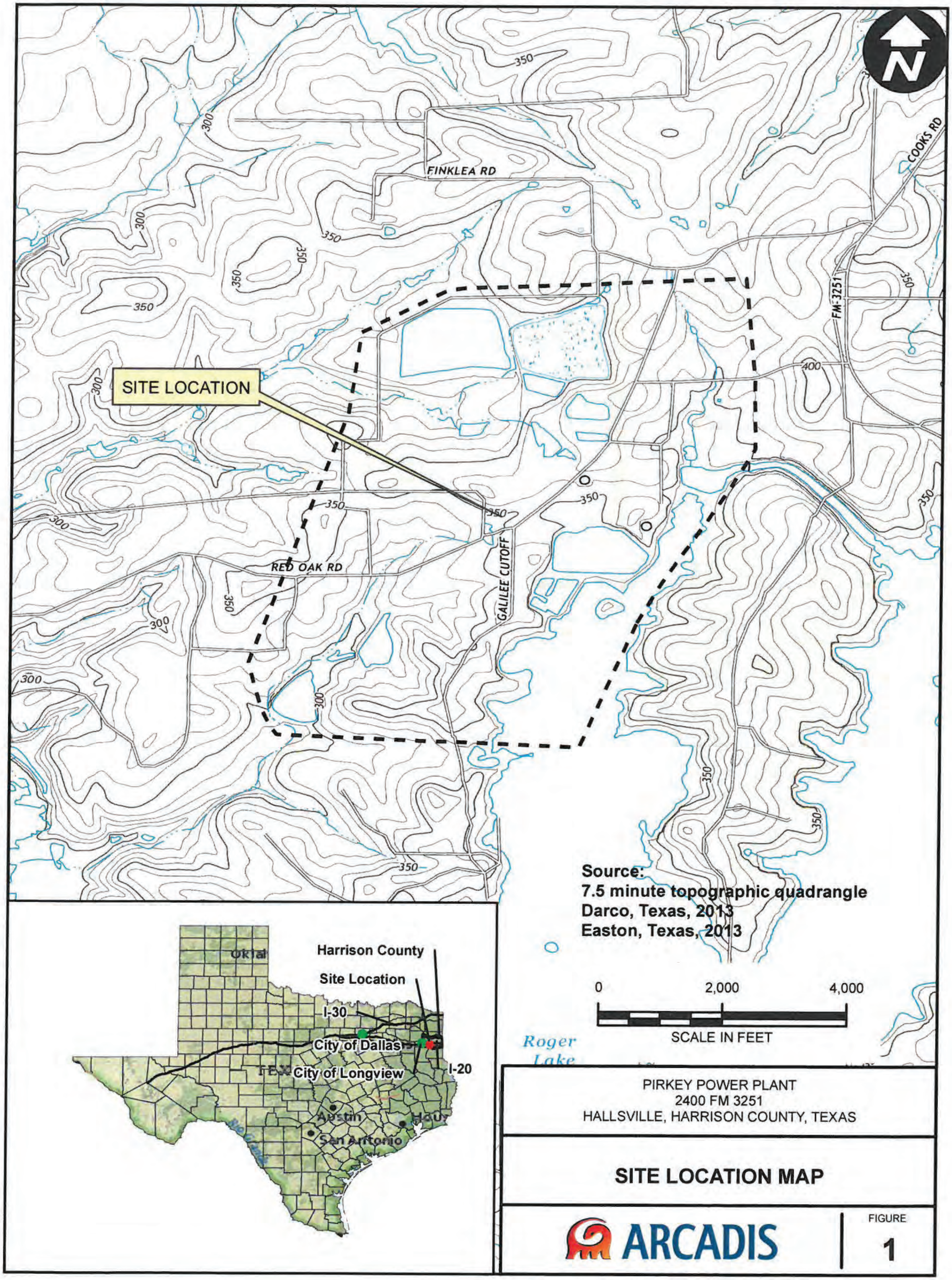
Figures



Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

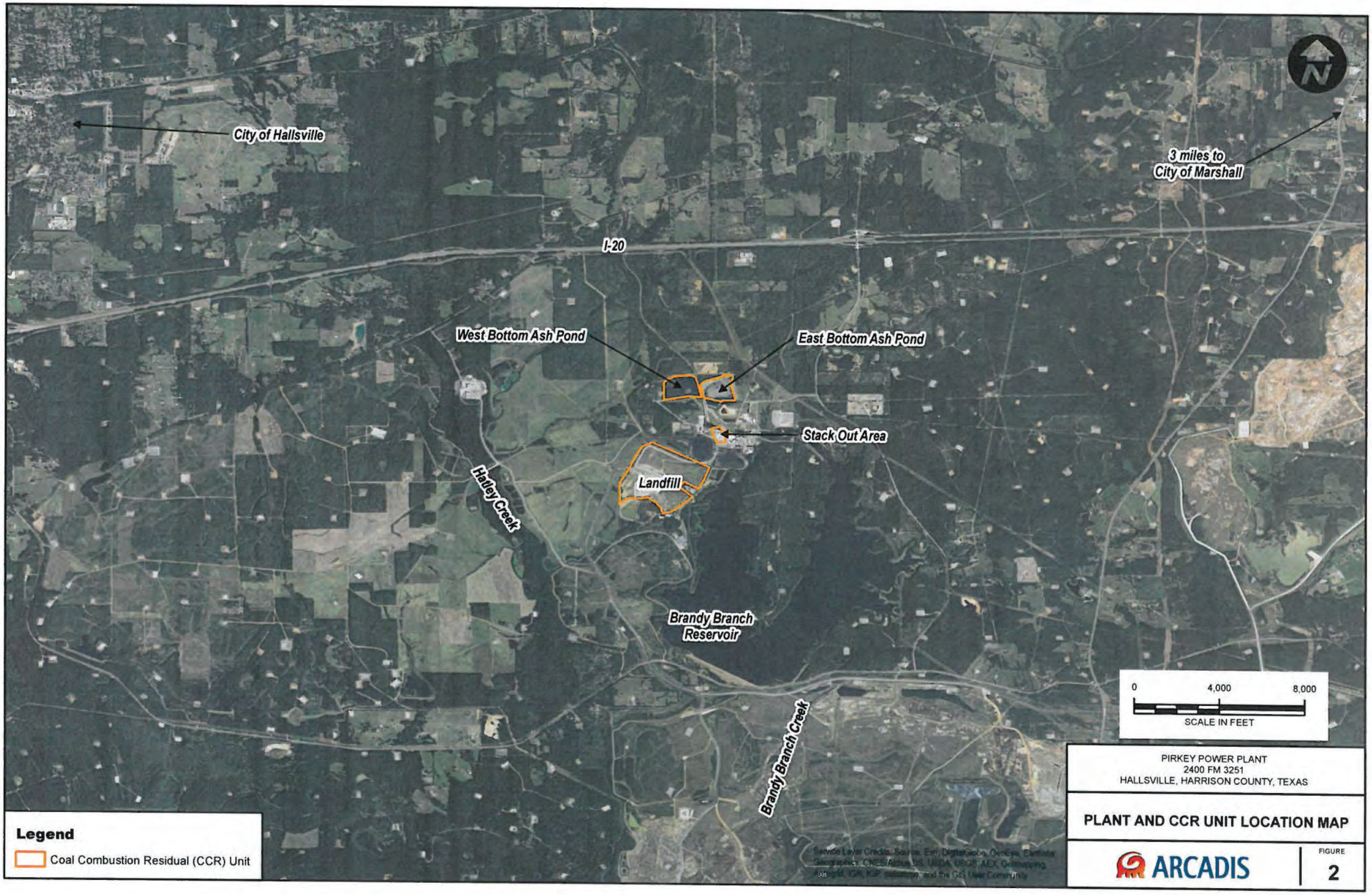
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

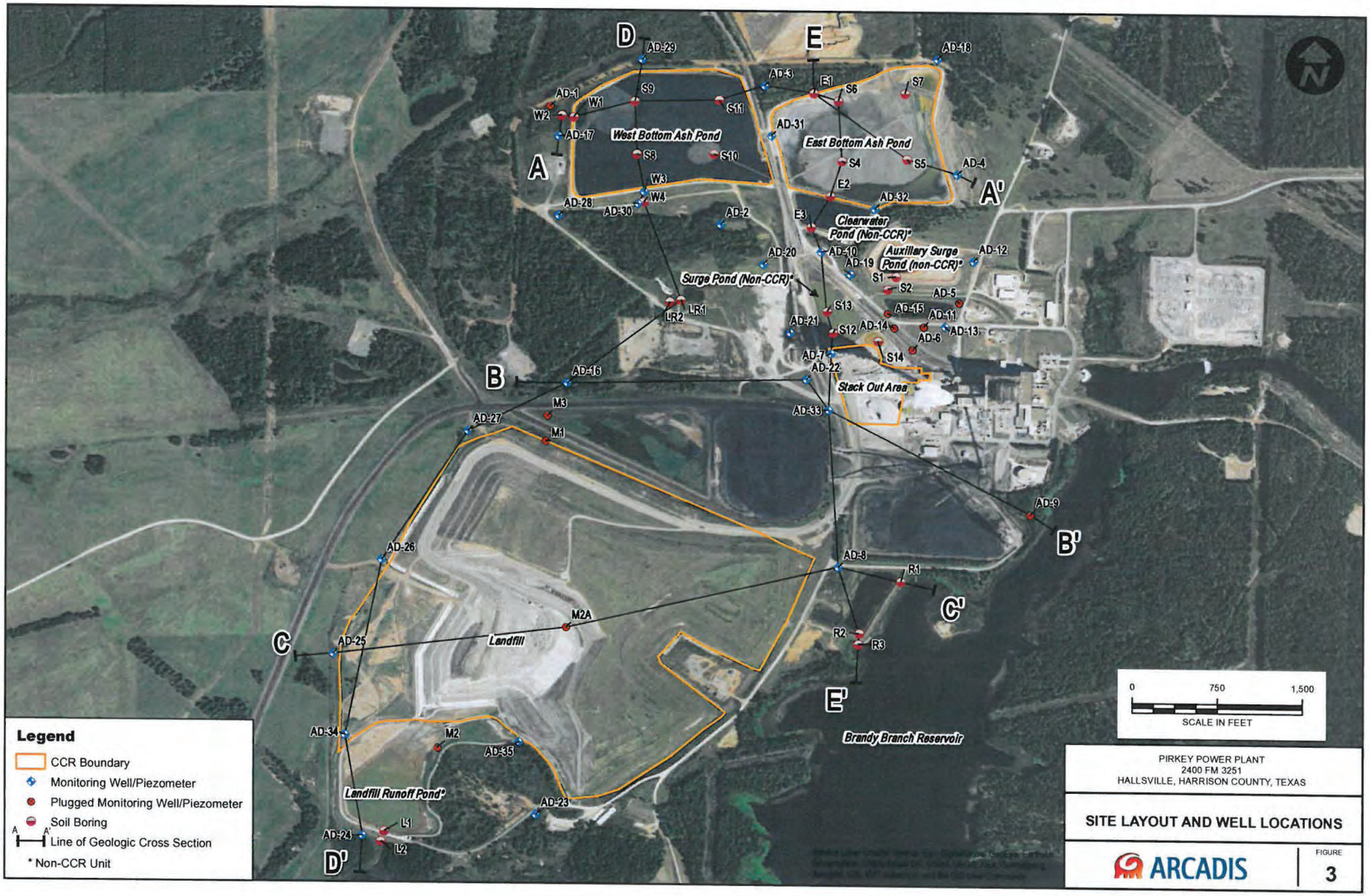
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



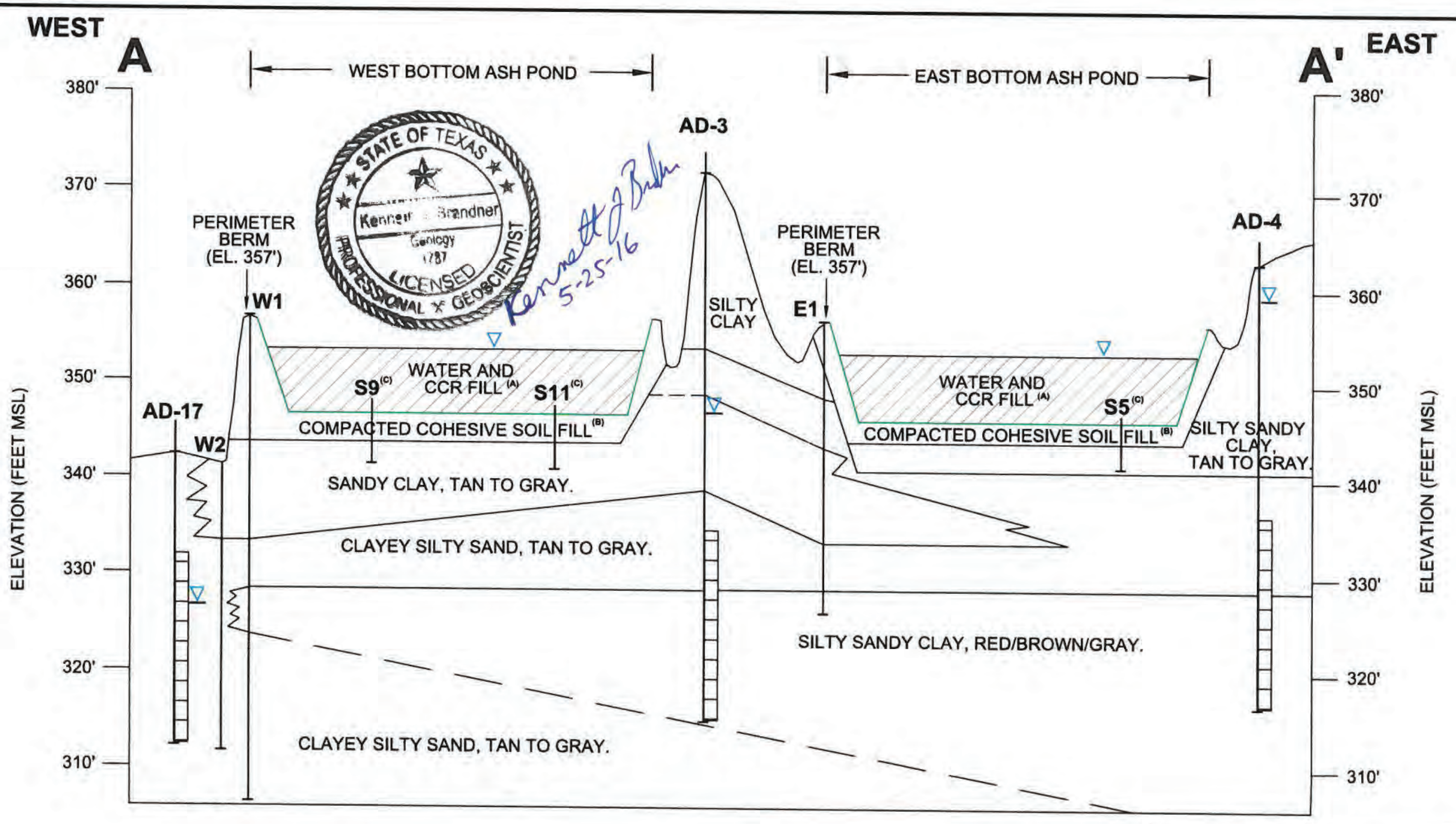
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE
3

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd



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5-25-16

0 300'
HORIZONTAL SCALE

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).

C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:18 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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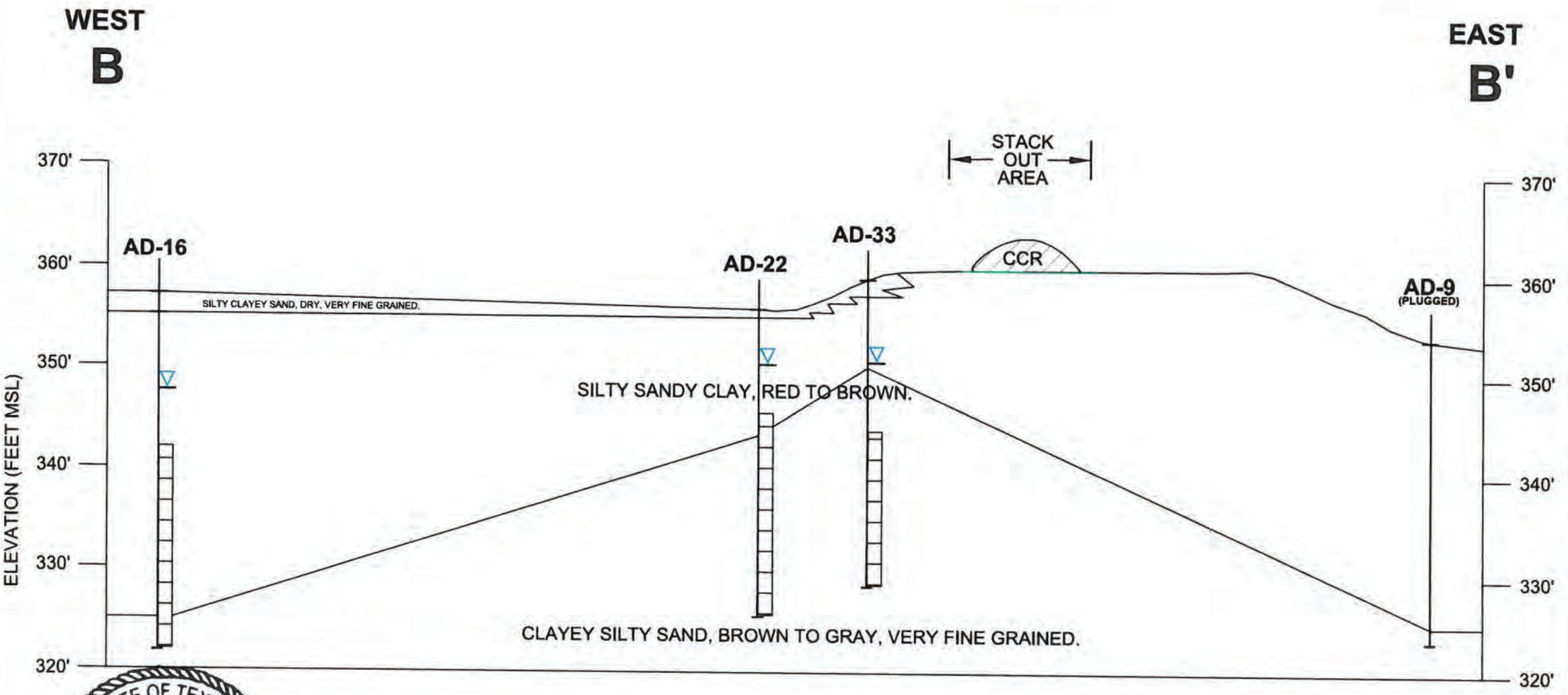

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LEGEND

▤ MONITORING WELL SCREENED INTERVAL

▽ WATER LEVEL IN MONITORING WELL (1/20/16)

— BASE OF CCR UNIT

NOTES:
A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

0 300'
HORIZONTAL SCALE

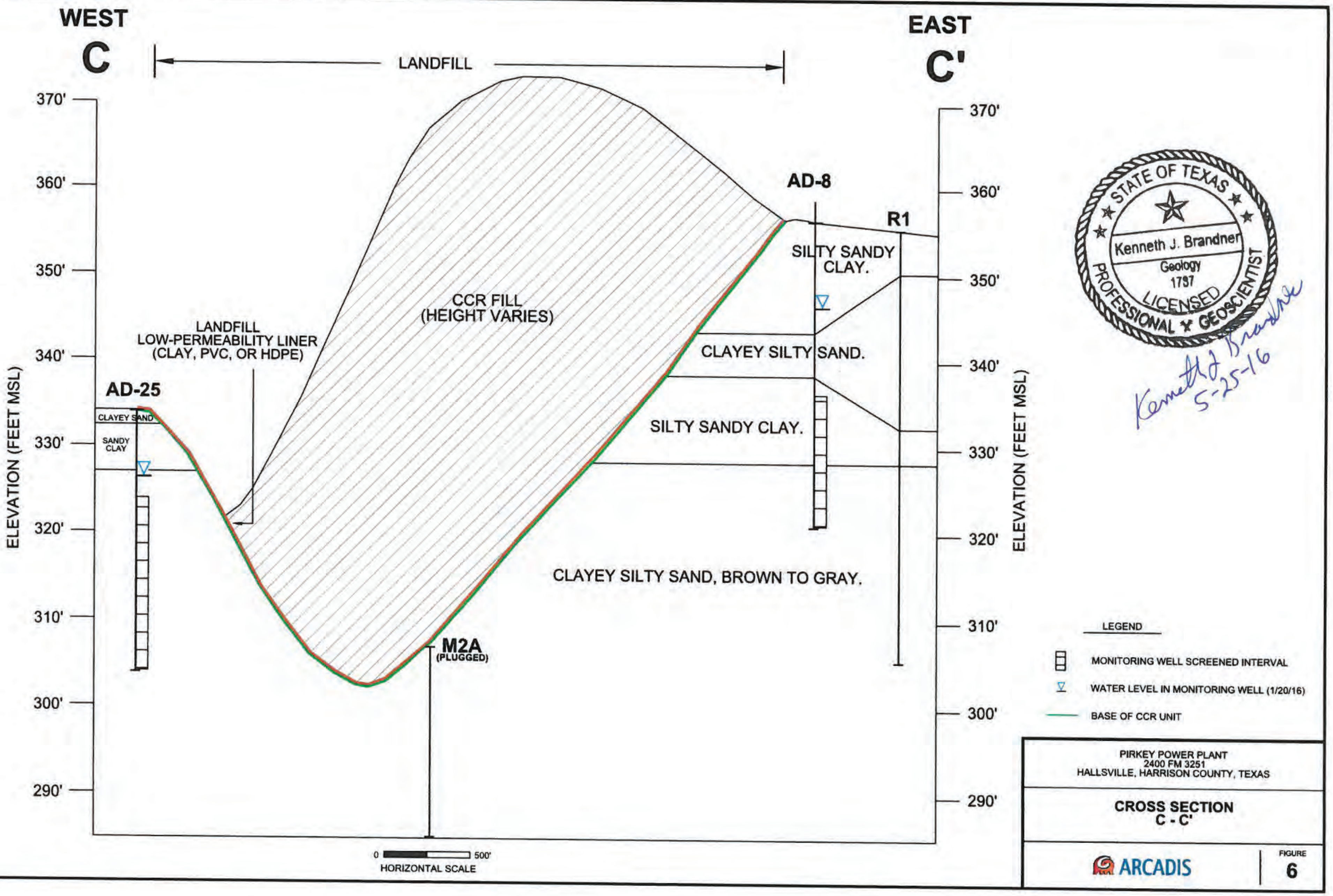
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF* G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 5 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 2/16/2016 1:49 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE: — PLOTTED: 2/18/2016 2:21 PM BY: LEASE, DIANA



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PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015978 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:25 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: — PLOTSTYLETABLE:
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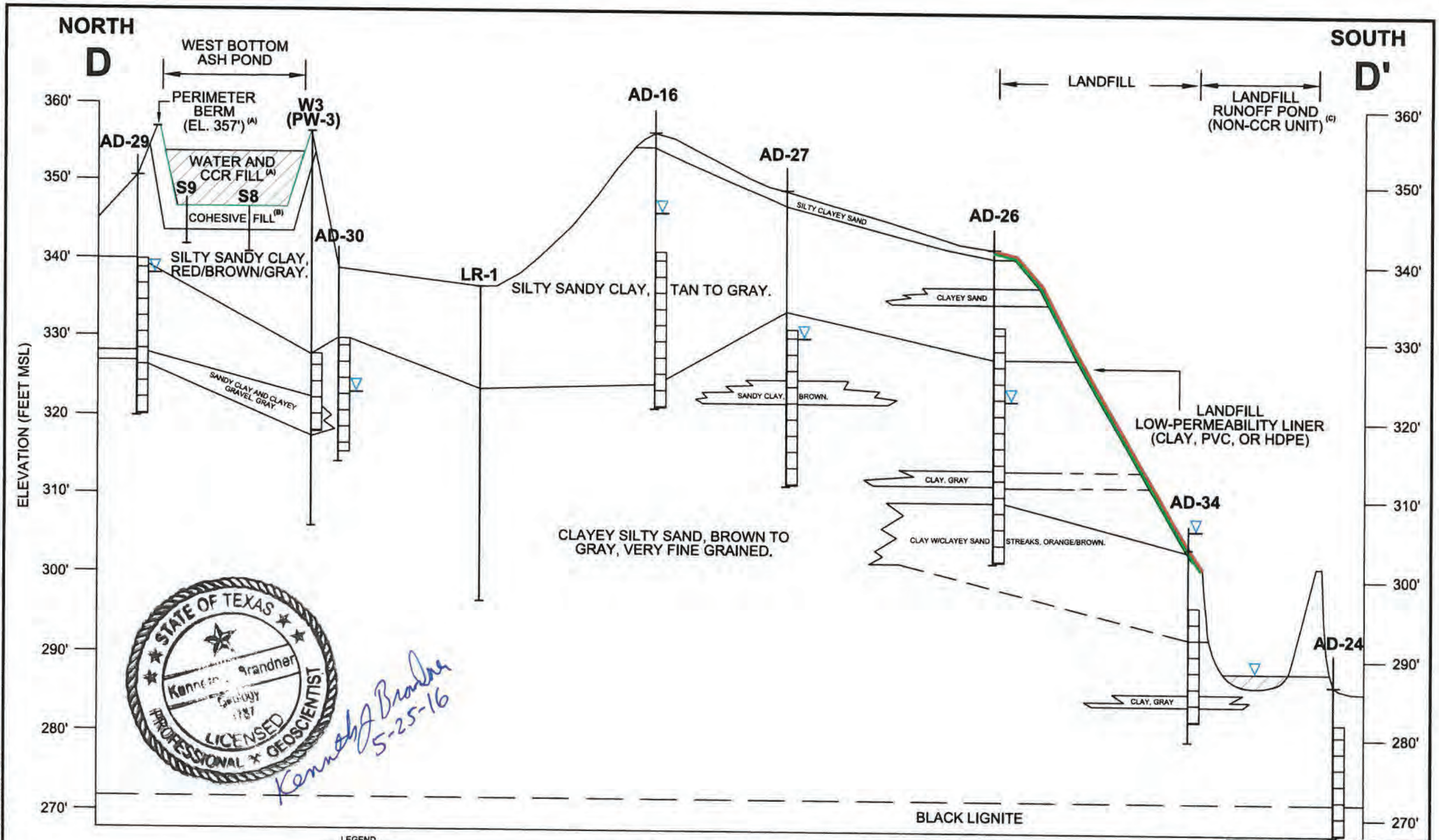

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LEGEND

- ⊟ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

0 600'
HORIZONTAL SCALE

NOTES:
A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
D - D'

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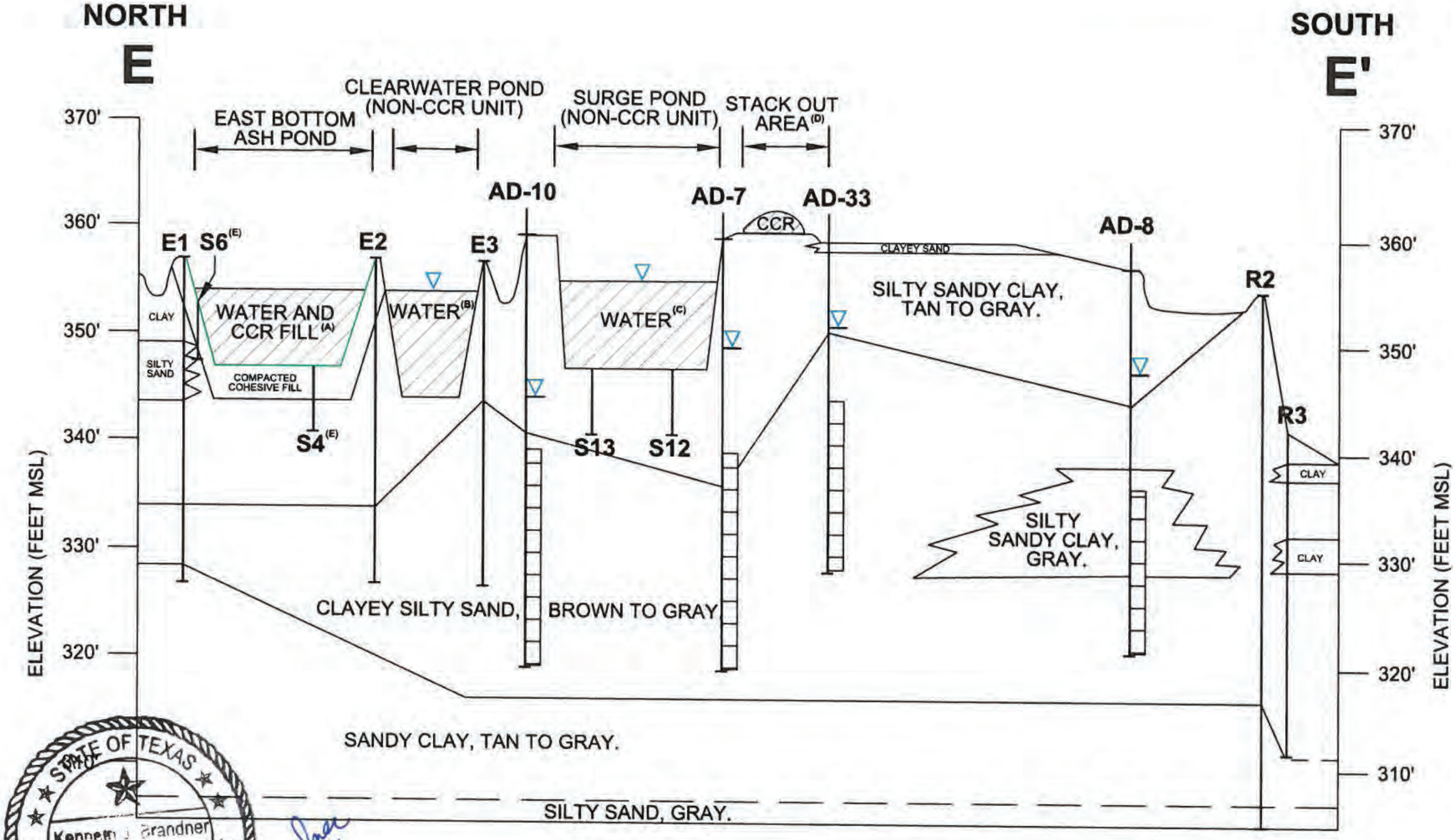
FIGURE
7



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PROFESSIONAL GEOSCIENTIST

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5-25-16

0 500'
HORIZONTAL SCALE

LEGEND

⊟	MONITORING WELL SCREENED INTERVAL
▽	WATER LEVEL IN MONITORING WELL (1/20/16)
—	BASE OF CCR UNIT

NOTES:

A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).

C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".

D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.

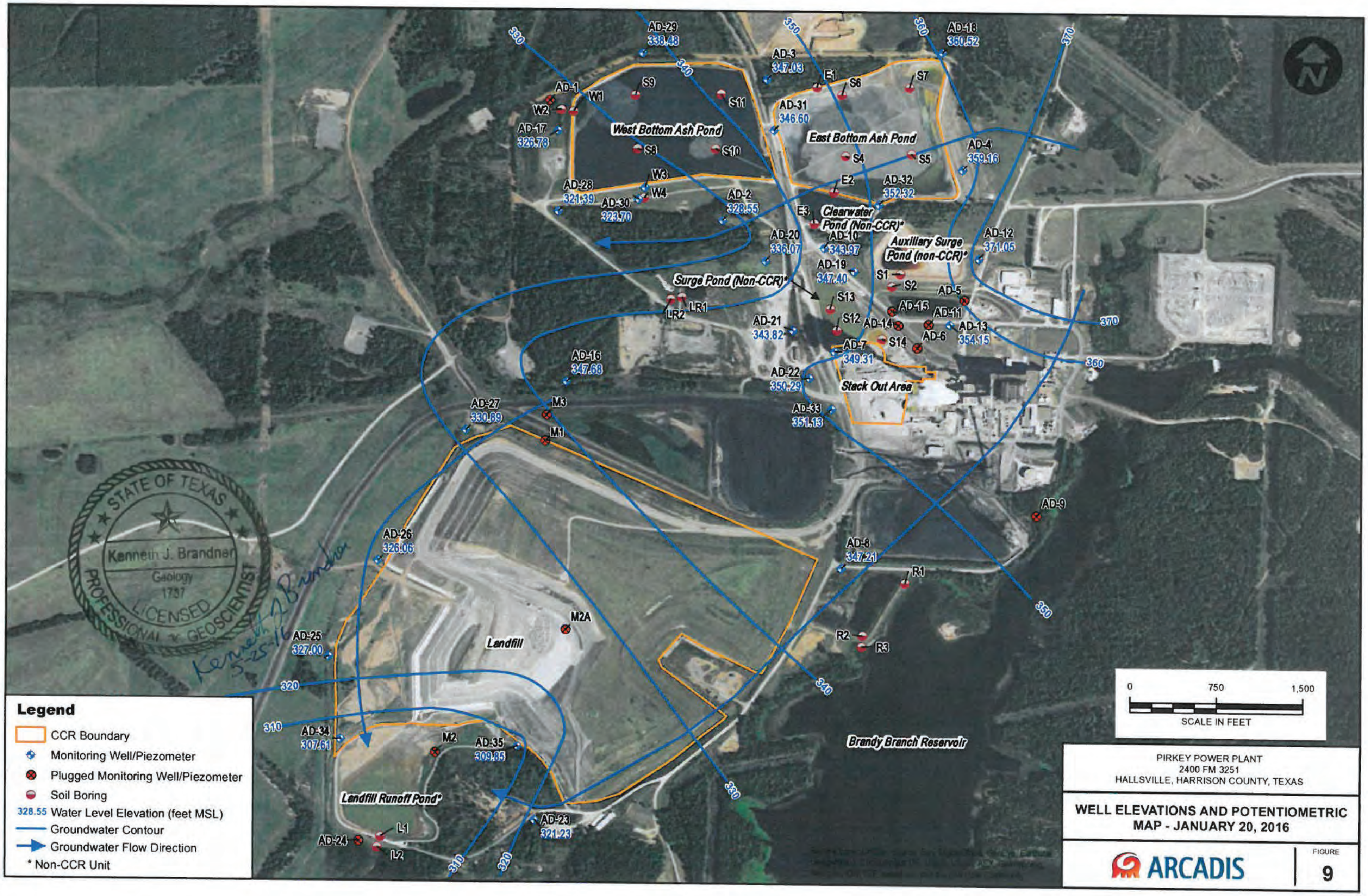
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8



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PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

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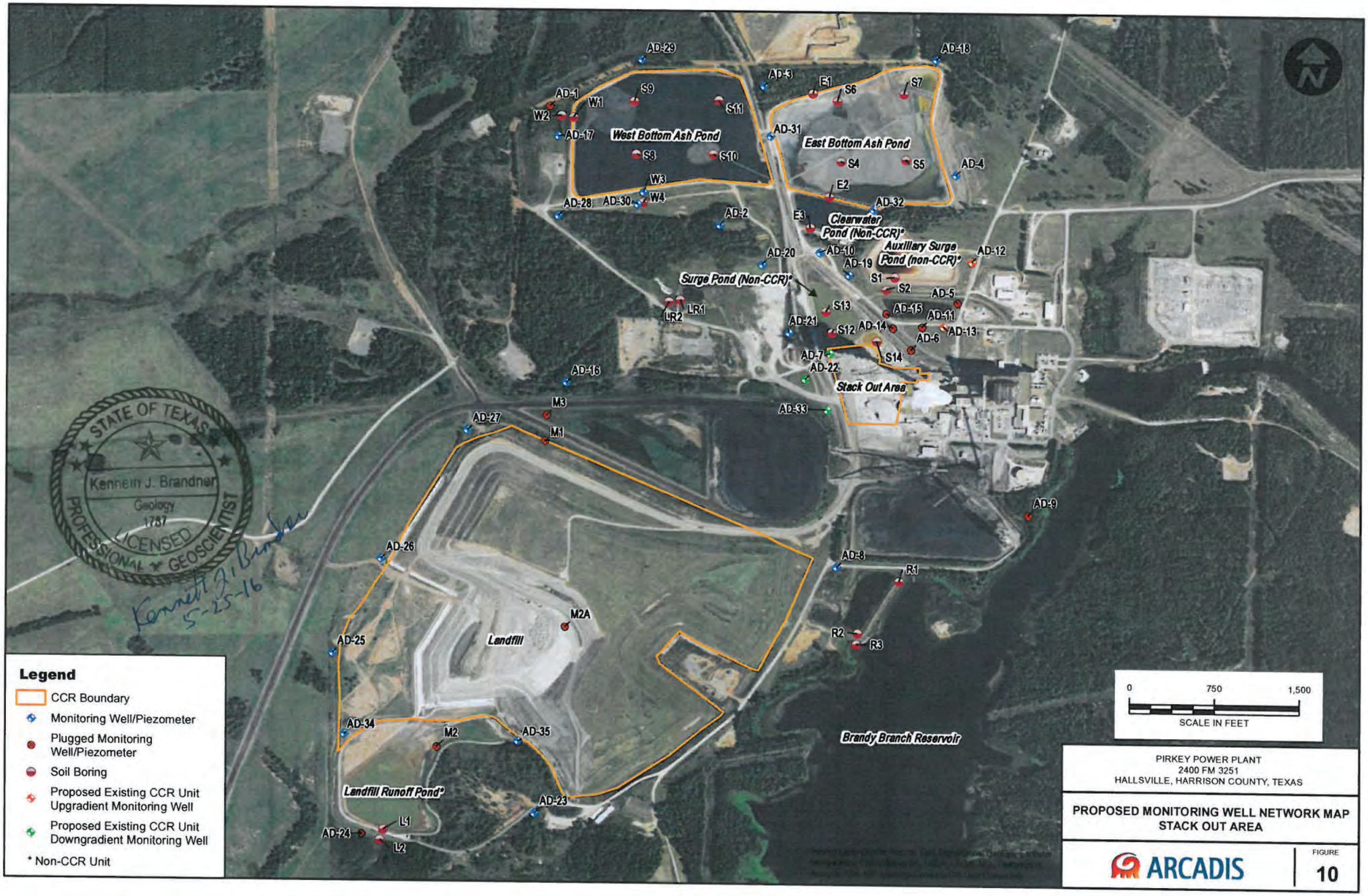
FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP
STACK OUT AREA

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FIGURE
10

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Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 10 - Proposed Well Network - Stack Out Area.mxd

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Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

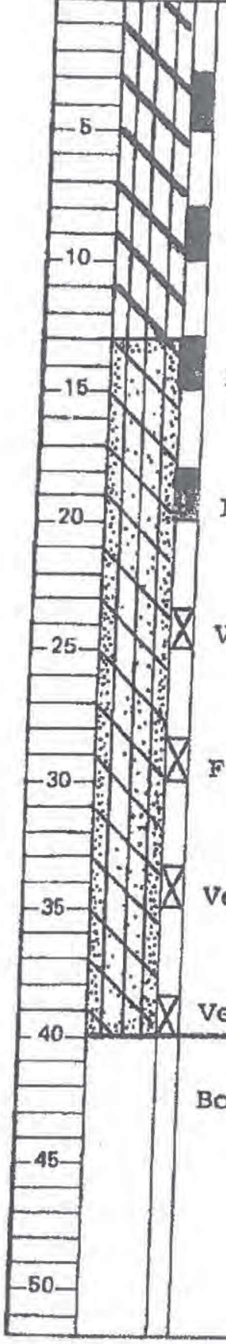
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-6
LOCATION: Hallsville

Date: 10-3-83
Type: Auger
Ground Elevation:

Legend:
▨ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff tan and grey clay w/silt lenses and iron ore

Very stiff tan and grey clay w/silt lenses and iron ore

Firm tan and grey clayey silty sand

Loose brown and grey clayey silty sand

Very dense grey clayey silty sand 25-25=11½" 50 B/11½"

Firm grey clayey silty sand 7-7-17 24 B/F

Very dense grey clayey silty sand 25-25=9" 50 B/9"

Very dense grey clayey silty sand 18-32=10½" 50 B/10½"

Bottom of boring at 40 feet.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

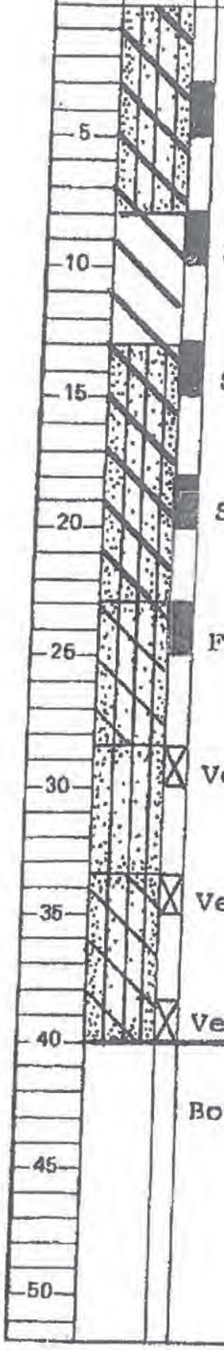
BORING NO.: MW-7
LOCATION: Hallsville

Date: 10-3-83
Type: Auger
Ground Elevation:

Legend:

■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample | Description of Stratum



Stiff red, tan and grey sandy silty clay w/iron ore

Stiff tan and grey clay w/iron ore

Stiff tan and grey silty sandy clay lenses w/iron ore

Stiff tan and grey very sandy silty clay

Firm tan and grey clayey silty sand

Very dense grey silty sand 23-27=12" 50 B/F

Very dense grey clayey silty sand 17-35=12" 50 B/F

Very dense grey clayey silty sand 25-25=10½" 50 B/10½"

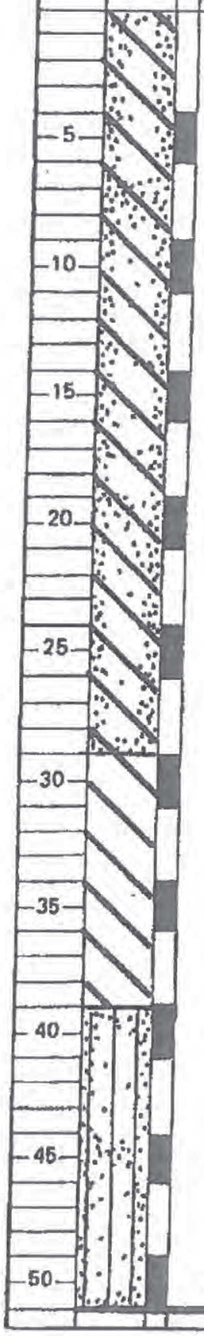
Bottom of boring at 40 feet.

832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond BORING NO.: MW-12
CLIENT: Southwestern Electric Power Company LOCATION: Hallsville, TX
N 6+13.25; W-6+90.36
Date: 1/30/86 Type: Rotary Ground Elevation: 378.41

Legend: ■ Sample X Penetration ▼ Water



Depth, Feet	Description of Stratum
5	Brown and tan sandy clay
10	Brown, tan and gray sandy clay
15	Tan and gray sandy clay
20	Brown and tan sandy clay
25	Gray and tan sandy clay
30	Brown and gray clay
35	Brown and gray clay
40	Gray silty sand
45	Gray silty sand
50	Gray silty sand

Water encountered at 27.5 feet.
Bottom of Boring at 51 feet.

Observation Well Installation Report

Location Pirkey Power Plant	Date 2-23-88	Station # Elev. 361.85 0+33.3N, 8+84.7 W	City Hallsville, Texas
Project 880284	Observation Well Number MW-13		Location
Type of Rig CME 55	Installed By DS, DY, LM	Date 2-23-88	Time

Method of Installation
Hollow-stem auger

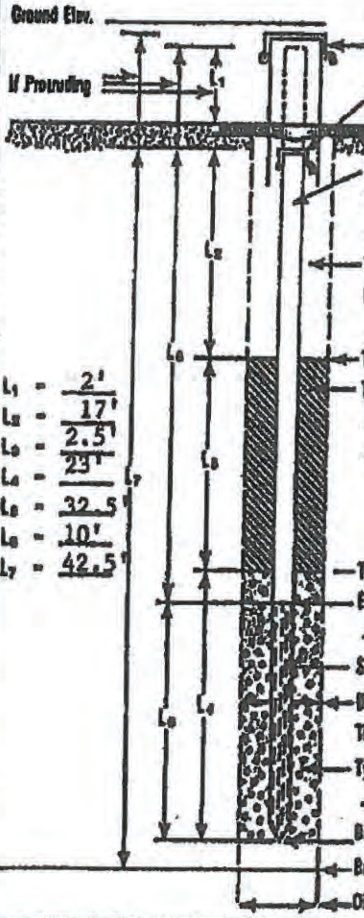
Log of Boring and Observation Well

Boring

Depth in ft.	Cored Interval	Description

Observation Well

Type of Observation Well: ☐ Flush ☒ Protruding ☒ Locking Cap ☐ Manhole



L_1 = 2'
L_2 = 17'
L_3 = 2.5'
L_4 = 23'
L_5 = 32.5'
L_6 = 10'
L_7 = 42.5'

Top of Riser Elev.
I.D. Of Riser Pipe 4"
Type of Pipe PVC Threaded
Type of Backfill Around Riser Bentonite & Portland Cement Grout
Top of Seal Elev
Type of Seal Material Bentonite Pellets 1/4"
Top of Filter Elev.
Elev. of Perforations
Size of Openings .010"
Diameter of Casing 4"
Tip
Type of Filter Material Tex Blast Blasting Sand
Bottom of Csg. Elev.
Bottom of Boring Elev.
Diameter of Boring 11"

Remarks
L2, L5, L7 are measured from the top of the PVC pipe, which protrudes 2' above the ground surface.

Inspected By

APEX PROJECT NO.: 110-089 ☐ BORING BORING NUMBER: ______ ☒ MONITOR WELL MONITOR WELL NUMBER: AD-22

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

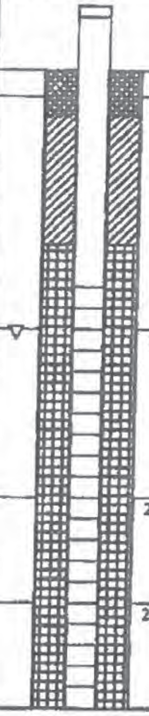
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/16/2010

PREPARED BY: David Bedford LOGGED BY: David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 WELL LOCATION: Triangle- South side Quansit Hut
LONGITUDE: W94°29'41.3"



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SC	Clayey sand, light brown, very fine grained	None	Moist
2 3 4 5 6 7 8 9 10 11 12			0.5-12	CL	Lean clay, light brown mottled with light gray Few iron ore (small) pebbles in clayey sandy streaks	None	Slightly Moist
13 14 15 16 17 18 19 20			▽ 12-20	SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained Slightly wet @ 12.5' from seepage Large amount of iron ore 15-17' Very firm 18-18.5'	None	Slightly Wet
21 22 23 24 25			20-25	SC	(Dense crystalline rock 21-21.1'), light brown clayey sand, greenish black, mica, black clay streaks, very fine grained, wet @ 20'	None	Wet
26 27 28 29 30			25-30	SM	Sand, greenish brown (1') grading to orangish brown, silty, very fine grained	None	Wet
31 32 33 34 35 36 37 38 39 40					Boring Terminated at 30'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ☒ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 12.5'
Above Ground 3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-33**

PROJECT INFORMATION

PROJECT: **Pirkey Power Plant**
PROJECT NO.: **I-04-1021**
LOGGED BY: **Jeffrey D. Sammons, P.G.**
SUPERVISING PG: **Jeffrey D. Sammons, P.G.**
COMPLETION: **12/11/2015**
DEVELOPMENT: **12/16/2015**
SITE LOCATION: **2400 FM 3251, Hallsville, Texas**
WELL OWNER: **AEP**

DRILLING INFORMATION

DRILLER: **Buford Collier**
DRILLER'S LICENSE NO.: **60089**
RIG TYPE: **Geoprobe 3230DT**
METHOD OF DRILLING: **Hollow Stem Auger**
SAMPLING METHODS: **Split Core**
SURFACE ELEVATION: **382.37 (Top of Casing)**
HOLE DIAMETER: **8.25"**
LATITUDE **32 27' 38.70"** LONGITUDE **94 28' 15.82"**

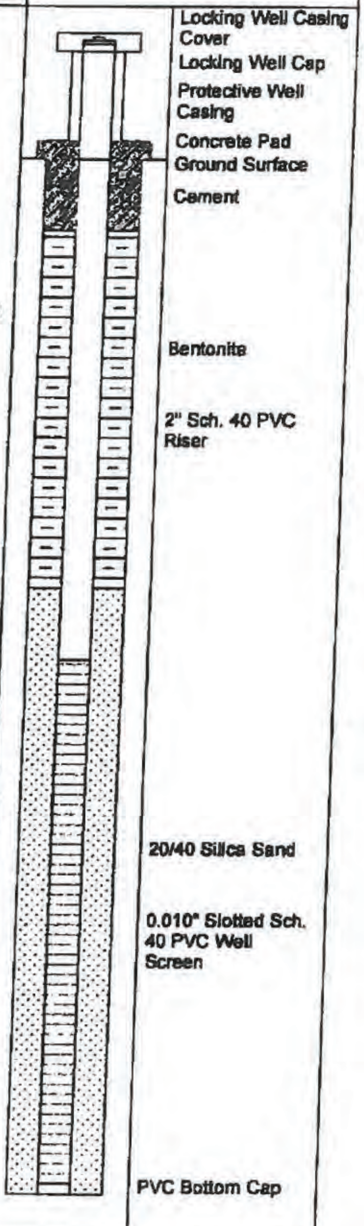
JDS 1.21.16
JEFFREY D. SAMMONS
GEOLOGY
#10070

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, some silt, dark brownish black and brown, very moist	SC	0							
FAT CLAY: trace sand and silt, reddish brown and light gray - some iron ore gravel at 2.0' - some silt and ironstone in thin seams at 2.5', light gray, yellowish brown, and reddish brown,	CH	1							
		4		■	29	93	74	32	42
CLAYEY SAND: Interbedded clays and fine to very fine sand and silt, some iron ore gravel, light reddish brown and light gray	SC	8	▼						
- some clay and trace of iron ore gravel at 11', light gray and reddish brown, moist		11		■	21	35	35	23	12
- trace clay at 13', thin saturated ironstone and gravel seams at 13' to 16', reddish brown, light reddish brown, and light gray - dark reddish brown at 15' - clay lense at 15.5' to 16.5', light reddish brown and light gray		13	▽						
SILTY CLAYEY SAND: very fine to fine sand, reddish brown, very moist to saturated	SM-SC	17							
- some clay lenses and iron ore gravel at 20' - clayey at 20.5' to 21' - trace clay at 21', light gray, saturated		21		■	23	19	27	18	9
- some iron ore gravel at 28', reddish brown, very moist		28							
CLAYEY SAND: very fine to fine sand, dark gray and gray, moist	SC	29		■	23	30	25	18	7

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: S-12
LOCATION: Hallsville, TX

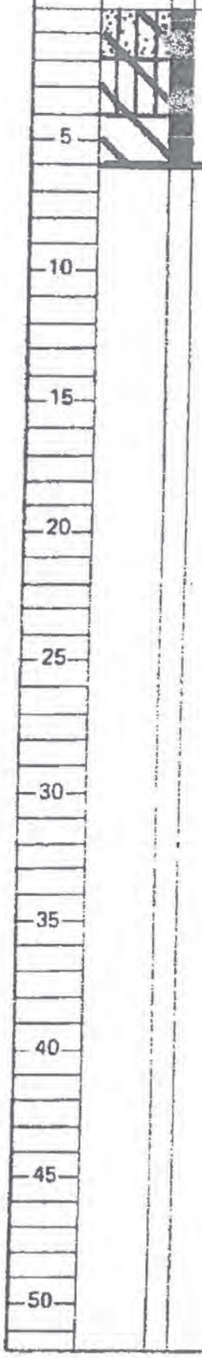
Date: 9-15-83
Type:
Ground Elevation: 348.3

Depth, Feet | Symbol | Sample

Legend:

■ Sample   X Penetration   ▼ Water

Description of Stratum



Red and grey sandy silty clay

Red and grey clay w/silt lenses

Red and grey clay

Bottom of boring at 6 feet.

No water encountered.

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

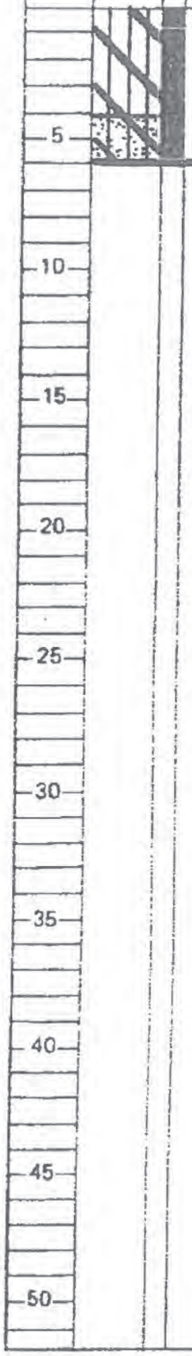
BORING NO.: S-14
LOCATION: Hallsville, TX

Date: 9-15-83
Type:
Ground Elevation: 352.9

Legend:
■ Sample
X Penetration
▼ Water

Depth, Feet | Symbol | Sample

Description of Stratum



Brown and red clay w/silt lenses

Brown and red slightly silty clay

Brown and red sandy silty clay

Bottom of boring at 6 feet.

No water encountered.

ARCADIS

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 1

Date: 8/19/2015

Direction Photo Taken:

East Southeast

Description:

P8190405
AD-21 Ground water monitoring well northeast of Stack Out Area.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 2

Date: 8/19/2015

Direction Photo Taken:

Southeast

Description:

P8190438
Stack Out Area

ARCADIS Design & Consultancy for natural and built assets

American Electric Power Service Corporation

Landfill - CCR Groundwater Monitoring Well Network Evaluation (Updated October 2018)

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

October 25, 2018

ARCADIS Design & Consultancy for natural and built assets

Kenneth Brandner

Kenneth Brandner, P.E., P.G.
Senior Project Engineer

Matthew J. Lamb /KJB

Matthew J. Lamb
Project Manager

Landfill - CCR Groundwater Monitoring Well Network Evaluation (Updated October 2018)

H.W. Pirkey Power Plant
2400 FM 3251
Harrison County
Hallsville, Texas

Prepared for:
AEP

Prepared by:
ARCADIS U.S., Inc.
100 E Campus View Blvd
Suite 200
Columbus
Ohio 43235-1447
Tel 614 985 9100
Fax 614 985 9170

Our Ref.:
TX015976.0003

Date:
October 25, 2018

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Acronyms and Abbreviation

AEP	American Electric Power Service Cooperation
amsl	above mean sea level
ARCADIS	ARCADIS U.S., Inc.
BAP	bottom ash pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FAP	fly ash pond
FGD	flue gas desulfurization
ft	feet
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
PTI	Permit to Install
TDS	total dissolved solids

1. Objective

This update report was prepared by ARCADIS U.S., Inc. (ARCADIS) for American Electric Power Service Corporation (AEP) to provide an updated assessment the adequacy of the groundwater monitoring well network included in the Coal Combustion Residual (CCR) requirements, as specified in Code of Federal Regulations (CFR) 40 CFR 257.91, for the Landfill CCR Unit at the AEP H.W. Pirkey Generating Plant (Plant) located at 2400 FM 3251 in Hallsville, Harrison County, Texas (**Figure 1**). The Landfill CCR Unit at the Plant is currently 130 acres in size. As shown on **Figure 2**, the Landfill will be expanded laterally to the south beginning in 2018 (2018 Lateral Expansion). The 2018 Lateral Expansion will be approximately 15 acres in size, and during Lateral Expansion construction activities one of the existing downgradient monitoring wells (monitoring well AD-35) will be plugged and replaced with new monitoring well AD-36.

Four regulated CCR units associated with the Plant were identified for review, which include the West BAP, East BAP, Stack Out Area, and Landfill (**Figure 2**). This report provides an updated evaluation of the groundwater monitoring well network in the uppermost aquifer at the Landfill, including the 2018 Lateral Expansion. The updated evaluation of the location restriction criteria for the Landfill 2018 Lateral Expansion is not included in this report and will be completed under separate cover.

This evaluation included a review of AEP-provided data associated with previously completed subsurface investigation activities in the vicinity of the Landfill CCR unit, including the 2018 Lateral Expansion area, as well as publicly-available geologic and hydrogeologic data. The following report also presents the current Conceptual Site Model based on all documents reviewed and will further describe the uppermost aquifer, include an evaluation of the adequacy of the existing monitoring well network, and provide recommendations for monitoring well augmentation, as necessary.

2. Background Information

The following section provides background information for the AEP H.W. Pirkey Generating Plant Landfill.

2.1 Facility Location Description

The AEP H.W. Pirkey Plant is located in southern Harrison County, approximately 5 miles southeast of Hallsville, Texas, and approximately 8 miles southwest of Marshall, Texas. The existing Landfill CCR unit is currently approximately 130 acres in size and is located in the southern portion of the Plant. The 2018 Landfill Lateral Expansion will cover approximately 15 acres directly south of the existing Landfill (**Figures 2** and **3**). Following completion of the 2018 Lateral Expansion, the Landfill will be approximately 145 acres in size.

2.2 Description of Landfill CCR Unit

The following section will discuss the embankment configuration, area, volume, construction and operational history, and surface water control associated with the Landfill.

2.2.1 Embankment Configuration

The Landfill was constructed in the southwestern portion of the Plant, and as shown on the U.S. Geological Survey 1983 topographic map (**Figure 1**), the southwestern portion of the Plant contained an unnamed intermittent tributary of Hatley Creek prior to Landfill construction in 1984. The Landfill was constructed within the unnamed tributary creek which had a bottom elevation ranging from approximately 290 feet amsl on the south side of the Landfill to 300 feet amsl on the north side of the Landfill. The native soil sidewalls of the tributary creek at the Landfill location have a maximum elevation of approximately 355 feet amsl. Therefore, as shown on Geologic Cross Section C-C' (**Figure 6**), the Landfill is partially incised within the tributary creek, and the tributary creek native soil sidewalls serve as a natural embankment for the lower portion of the Landfill.

The original Landfill design included emplacement of CCR materials in the Landfill with 3:1 slopes (3 feet horizontal, 1 foot vertical) with an approximate 10 foot wide bench for every 20 foot vertical rise of CCR material (VFL Technology Corporation, 1984). In addition to the Landfill CCR material embankments, earthen embankments are present around portions of the Landfill to control storm water flow.

The 2018 Landfill Lateral Expansion will cover approximately 15 acres directly south of the existing Landfill. In 2016, Auckland Consulting conducted a stability assessment of the 2018 Lateral Expansion area and concluded the embankments would be stable on slopes no steeper than 3:1 (Auckland, November 2016). The 2016 Auckland Consulting report stated the northern and eastern extents of the 2018 Lateral Expansion will be constructed contiguous to the existing Landfill disposal area, and ash disposal will be completed in multiple lifts, each with an approximate height of 20 feet, integrated with safety benches, and maximum side slopes of 3:1 to a maximum waste height of 120 feet.

2.2.2 Area/Volume

The existing Landfill is approximately 130 acres in size and was designed to receive 12,207,000 cubic yards (7,566 acre feet) of CCR materials including fly ash, bottom ash, economizer ash, and stabilized FGD sludge (VFL Technology Corporation, 1984). The design capacity of the CCR materials to be placed within the 2018 Lateral Expansion is approximately 2,200,000 cubic yards.

2.2.3 Construction and Operational History

The H.W. Pirkey Power Plant was constructed in 1983 and 1984, and began operation in 1985. Throughout the life of the Plant, CCR materials (fly ash, bottom ash, economizer ash, stabilized FGD sludge) have been generated. The CCR materials that are not taken offsite for beneficial reuse are disposed of in the Landfill. The Landfill was constructed in several phases beginning with the northeast portion (Phase 1) in 1984. The Landfill was expanded (east-central portion) in 1985 and 1987. The Landfill was subsequently expanded to the west and south during the 1990’s, including construction of the Landfill Stormwater Runoff Pond (non-CCR unit) directly south of the Landfill in 1993 and 1994.

In 2005, ETTL conducted a geotechnical evaluation of the Landfill and Landfill Stormwater Runoff Pond, including installation 30 soil borings, ten cone penetration test (CPT) borings, and geotechnical testing of soil samples. The Landfill was further expanded to the west between 2005 and 2015 to its current size of approximately 130 acres as shown on **Figure 3**.

The 2018 Landfill Lateral Expansion design includes emplacement of up to 120 feet of CCR materials with maximum side slopes of 3:1 above the Landfill liner system which will consist of a 60-mil HDPE top liner underlain by a 2-foot-thick compacted clay bottom liner. Prior to installation of the liner system, approximately 10 to 15 feet of cut into the existing soils will occur along the topographically higher southern portion of the Lateral Expansion, and emplacement of these soils (clayey sands, silty clayey sand and/or lean clays) as fill materials below the liner system in the topographically lower central and northern portions of the Lateral Expansion. As detailed below in Section 3.3.2, during Lateral Expansion construction activities, existing downgradient monitoring well AD-35, located within the Lateral Expansion construction zone, will be plugged and replaced with a new monitoring well (AD-36) located directly downgradient of the Lateral Expansion area.

2.2.4 Surface Water Control

Surface water in the area of the existing Landfill flows in a general southerly direction to the Landfill Stormwater Runoff Pond located directly southwest of the existing Landfill. Surface water in the area of the 2018 Landfill Lateral Expansion flows in a general westerly direction to the Landfill Stormwater Runoff Pond. The Landfill Stormwater Runoff Pond, which is approximately 16 acres in size, also receives (1) Landfill leachate that is gravity drained from the existing Landfill via underground lateral perforated pipes and permeable bottom ash materials that were installed above portions of the existing Landfill liner, (2) Landfill leachate that will gravity drain via underground lateral perforated pipes that will be installed above the 2018 Landfill Lateral Expansion liner system, and (3) shallow groundwater that will gravity drain via underground lateral perforated HDPE underdrain pipes that will be installed in permeable bottom ash materials approximately seven feet below the 60-mil HDPE liner of the 2018 Landfill Lateral Expansion.

2.3 Previous Investigations

The initial soils investigation and design of the Plant was provided in a January 31, 1983 report prepared by Sargent & Lundy entitled "*Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities*". This investigation included advancement of soil borings throughout the Plant, including the Landfill Area.

A soils investigation of the Landfill was conducted by Southwestern Laboratories in 1984. The investigation included installation of 45 soil borings and geotechnical analyses of soil samples. The report recommended installation of three feet of compacted clay as the bottom liner for the Landfill (Southwestern Laboratories, July 1984).

An engineering design report for the Landfill was prepared by VFL Technology Corporation in 1984. The Landfill design included a bottom compacted clay liner three feet in thickness, and Landfill side slopes of 3:1 (VFL Technology Corporation, 1984).

In 1985, Southwestern Laboratories conducted a geotechnical evaluation of the clay liner that was installed at the base of the Landfill, including installation of four soil borings and permeability testing of soil samples. The report concluded the clay liner was three feet thick with a permeability less than 1×10^{-7} centimeters per second (cm/sec) (Southwestern Laboratories, 1985).

In 1993, Alliance Inc. conducted a geotechnical investigation of the clay liner installed at the base of the Landfill following a Landfill expansion phase in 1993. The report concluded the clay liner was three feet or more in thickness, and the clay liner met the permeability specifications of $<1 \times 10^{-7}$ cm/sec (Alliance Inc., 1993).

In 1995, Central and South West Services prepared design specifications for Landfill expansion to the west and south. The design specifications included a geosynthetic clay liner overlain by a 0.060-inch (60 mil) HDPE liner (Central and South West Services, 1995).

In 2005, ETTL conducted a geotechnical evaluation of the Landfill and Landfill Stormwater Runoff Pond, including installation 30 soil borings, ten CPT borings, and geotechnical testing of soil samples. The geotechnical data was obtained to design Landfill expansions in 2005 through 2007.

In 2010 and January 2011, Apex Geoscience expanded the groundwater monitoring well system at the Plant, including installation of monitoring wells AD-16 through AD-29. Apex Geoscience also conducted video surveillance of the existing monitoring wells and plugged monitoring wells MW-1, MW-5, MW-6, MW-9, MW-11, MW-14, MW-15, M-2, and M-3 (Apex Geoscience, March 2011).

In 2012, Apex Geoscience conducted a geotechnical investigation for Landfill expansion activities planned at the western portion of the Landfill where surface lignite mining operations had previously been conducted to a depth of 50 to 100 feet using a dragline, and the spoils (reclaimed soil) were returned to the excavation. The report concluded the Landfill embankments would be stable with side slopes of 3:1 (Apex Geoscience, 2013).

In December 2015, Auckland Consulting further expanded the groundwater monitoring well system at the Plant, including installation of six monitoring wells (AD-30 through AD-35) (Auckland Consulting, 2016).

In 2016, Auckland Consulting conducted a geotechnical evaluation of the 2018 Landfill Lateral Expansion area, including installation of eight soil borings (B1 through B8) with total depths ranging from 40 to 62 feet below ground surface (bgl). Soil boring locations are shown on **Figure 11**, and copies of the soil boring logs are provided in **Appendix C.** Based on the results of the 2016 geotechnical evaluation, including slope stability modeling and settlement analysis, Auckland Consulting concluded the 2018 Landfill Lateral Expansion will be structurally stable with maximum side slopes of 3:1 to a maximum disposal height of 120 feet (Auckland, November 2016).

In 2018, Auckland Consulting installed seven piezometers (PZ-1 through PZ-7) within the 2018 Landfill Lateral Expansion area to obtain detailed depth to groundwater and groundwater flow direction data prior to construction of the Lateral Expansion. The piezometers were completed in the uppermost water-bearing unit with total depths ranging from 14 to 20 feet bgl. Piezometer locations are shown on **Figure 11**, and piezometer completion data is provided in **Appendix C**

2.4 Hydrogeologic Setting

2.4.1 General

The site area is located within the West Gulf Coastal Plain. Cretaceous formations crop out in belts that extend in a northeasterly direction parallel to the Gulf of Mexico, and dip gently southeast. The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation consists predominantly of clay and fine grained sand, and attains a maximum thickness of approximately 100 feet (Broom, 1966).

The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern portion of the Site in the area of the Landfill Stormwater Runoff Pond. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay, and attains a thickness of up to approximately 100 feet in Harrison county, Texas (Broom, 1966). As shown on Geologic Cross Sections C-C’ (**Figure 6**) and D-D’ (**Figure 7**), a thick sand stratum is located below and adjacent to the Landfill between an elevation of approximately 270 feet and 330 feet amsl. This sand stratum likely corresponds to the Carrizo Sand based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

The Carrizo Sand is underlain by the Eocene-age Wilcox Formation, which outcrops in topographically low areas near the Sabine River to the south and southeast of the Plant (Flawn, 1965). The Wilcox Formation consists of interbedded sand and clay with seams of lignite, and attains a thickness of approximately 700 feet (Broom, 1966). As shown on Geologic Cross Section D-D’ (**Figure 7**), a lignite seam was encountered below an elevation of approximately 270 feet amsl during drilling of monitoring well AD-24 at the south end of the Site. This lignite seam likely corresponds to the top of the Wilcox Formation based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

These features are further illustrated on five lines of cross section that were prepared through the existing Landfill Area, with three lines trending from west to east (A-A’; B-B’; C-C’), and the other two lines trending from north to south (D-D’; E-E’). The cross section location map is included as **Figure 3** and the lines of cross section are included as **Figure 4** (A-A’) through **Figure 8** (E-E’).

2.4.2 2018 Landfill Lateral Expansion Area

Based on the hydrogeologic data obtained from soil borings, monitoring wells, and piezometers installed in the 2018 Landfill Lateral Expansion area, three lines of cross section were prepared through the 2018 Landfill Lateral Expansion area. The cross section location map is included as **Figure 11** and the lines of cross section are included as **Figure 12** (F-F’), **Figure 13** (G-G’), and **Figure 14** (H-H’).

As shown on **Figures 12** through **14**, a reddish-brown to gray clayey and silty sand stratum is located below the Lateral Expansion area between an elevation of approximately 280 feet and 330 feet amsl. This sand stratum likely corresponds to the Carrizo Sand based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

As shown on **Figures 12** through **14**, a clay stratum with an average thickness of approximately 10 feet is located below the sand stratum, and a lignite seam is present below the clay stratum at an elevation of approximately 270 feet amsl. As discussed above in Section 2.4.1, this lignite seam likely corresponds to the top of the Wilcox Formation based on geologic maps of the Site area (Broom, 1966; Flawn, 1965).

2.4.3 Climate and Water Budget

Average temperatures in Harrison County, Texas range from 47.1˚ Fahrenheit (F) in January to 83.8˚F in July, and the mean annual growing season is 238 days. Average annual precipitation (including liquid water equivalent from snowfall) is approximately 47 inches (Broom, 1966).

2.4.4 Regional and Local Geologic Setting

The central and northern portions of the Plant are located on the outcrop of the Eocene-age Recklaw Formation. The Recklaw Formation is underlain by the Eocene-age Carrizo Sand, which outcrops in the topographically low southern end of the Plant where the existing Landfill, 2018 Landfill Lateral Expansion, and Landfill Stormwater Runoff Pond are located (Broom, 1966; Flawn, 1965).

Detailed regional geologic characterization can be found in several published reports including Texas Water Development Report 27 "*Ground-Water Resources of Harrison County, Texas*" (Broom, 1966), The University of Texas at Austin Bureau of Economic Geology "*Geologic Atlas of Texas – Tyler Sheet*" (Flawn, 1965), and U.S. Geological Survey Open-File Report 88-450K "*Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin*" (USGS, 1988).

Detailed regional and site geologic characterization can also be found in the 2010 ETTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (ETTL, 2010).

2.4.5 Surface Water and Surface Water Groundwater Interactions

Figures 9 and **10** are potentiometric surface maps based on January 2016 and August 2017 water level data, respectively, for the uppermost water bearing unit at the Site, and water level elevations in the Site monitoring wells are summarized on **Table 1**. As shown on **Figures 9** and **10**, shallow groundwater flow direction in the Landfill area is southwesterly at an average hydraulic gradient of approximately 0.01 foot per foot.

The Landfill is located approximately 400 feet west of Brandy Branch Reservoir, which was dammed during Plant construction in the 1980's. The normal pool level of Brandy

Branch Reservoir is approximately 340 feet amsl. As shown on **Figures 9** and **10**, shallow groundwater flow direction at the Site generally follows surface topography to the west and southwest toward Hatley Creek, which is located in a topographically low area approximately one mile west of the Site. Therefore, shallow groundwater in the Landfill area does not discharge into Brandy Branch Reservoir. Brandy Branch Reservoir likely recharges the uppermost water bearing unit in the southern portion of the Site, where the pool level in the Reservoir (340 feet amsl) is higher than water level elevations in monitoring wells located southwest (downslope) of the Reservoir.

Figure 15 is a current potentiometric surface map for the uppermost water-bearing unit in the 2018 Landfill Lateral Expansion area, and water level elevations for the 2018 Landfill Lateral Expansion area piezometers are summarized on **Table 2**. As shown on **Figure 15**, shallow groundwater flow direction in the 2018 Landfill Lateral Expansion area is westerly toward the Landfill Stormwater Runoff Pond at a hydraulic gradient of approximately 0.02 foot per foot. Water level elevations in the 2018 Landfill Lateral Expansion area piezometers are higher than the surface water elevation of the Landfill Stormwater Runoff Pond (approximately 298 feet amsl), which indicates shallow groundwater in the 2018 Landfill Lateral Expansion area discharges into the Landfill Stormwater Runoff Pond.

2.4.6 Water Users

A water well inventory conducted by Banks Information Solutions showed 12 water wells had been drilled within a ½-mile radius of the Site (Banks, 2015). The nearest water well was reportedly drilled directly east of the Landfill in 2004 by Bennett Drilling for use as a rig supply well. The water well was screened from 330 to 426 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The second closest water well was reportedly drilled directly south of the Landfill by Amoco Production Company in 1991 for use as an oil field rig supply well. The water well was screened from 163 to 243 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

The third closest water well was reportedly drilled approximately 200 feet southwest of the Landfill by Matador Operating in 2000 for use as an industrial well. The water well was screened from 340 to 420 feet below ground surface, therefore this water well is completed in a deeper water bearing unit relative to the uppermost water-bearing unit at the Site.

All of the water wells identified within a ½-mile radius of the Site were drilled to total depths of 160 feet or deeper except one water well (Well ID: 35-37-4E) that was drilled to a total depth of 55 feet in 1982. This water well was completed with concrete tile from the surface to total depth and is located approximately ¼-mile east (upgradient) of the Pirkey Power Plant.

3. Groundwater Monitoring Well Network Evaluation

The existing monitoring well network present at the Site was evaluated to determine if any of the wells were viable for continued use as part of the groundwater monitoring well network or also retained as part of a larger groundwater hydraulic monitoring well network. The hydrogeologic conditions were also evaluated to determine if the uppermost aquifer unit has an effective well network. The evaluation was completed in accordance with 40 CFR 257.91 to have an established monitoring well network that effectively monitors the uppermost aquifer up gradient and down gradient of the Site. The up gradient wells represent background groundwater quality and the down gradient wells are to be placed down gradient of the CCR unit boundary to monitor water quality.

3.1 Hydrostratigraphic Units

3.1.1 Horizontal and Vertical Position Relative to CCR Unit

Geologic data from soil borings, piezometers, and monitoring wells installed at the Site show the uppermost aquifer in the existing Landfill Area is a very fine to fine grained clayey and silty sand stratum located below and adjacent to the existing Landfill between an elevation of approximately 270 feet and 330 feet amsl (**Appendix A**). The location of the uppermost water bearing unit relative to the existing Landfill is shown on cross section C-C’ (**Figure 6)** and cross section D-D’ (**Figure 7)**.

The location of the uppermost water bearing unit relative to the 2018 Landfill Lateral Expansion is shown on cross section F-F’ (**Figure 12**), cross section G-G’ (**Figure 13**), and H-H’ (**Figure 14**). As shown on these geologic cross sections, the uppermost aquifer in the Landfill Lateral Expansion area is a clayey and silty sand stratum located between an elevation of approximately 280 feet and 330 feet amsl. Clay interbeds are present within the sand stratum, but the clay interbeds are discontinuous, indicating the entire saturated thickness of the sand stratum between approximately 280 feet and 330 feet amsl in the Lateral Expansion area is in hydraulic communication and represents the uppermost aquifer.

3.1.2 Overall Flow Conditions

Groundwater is recharged from regional precipitation infiltration. The uppermost aquifer (clayey and silty sand) is expected to have a hydraulic conductivity of approximately 10^{-4} centimeters per second (Fetter, 1980). Based on the hydraulic conductivity and saturated thickness in the Landfill area (up to 60 feet), the yield of the uppermost aquifer is anticipated to exceed the TCEQ non-useable (Class 3) limit of 150 gallons per day (TCEQ, 2010).

Groundwater elevations from the plant monitoring wells are summarized on **Table 1**. The plant-wide comprehensive groundwater elevation data set from August 24, 2017 is depicted on **Figure 10**. The groundwater flow direction in the Landfill area is south to southwesterly towards Hatley Creek, which is located approximately one mile west of the Site.

Current groundwater elevations in the Landfill 2018 Lateral Expansion area are summarized on **Table 2**, and a June 22, 2018 piezometric surface map is depicted on **Figure 15**. As shown on **Figure 15**, shallow groundwater flow direction in the 2018 Landfill Lateral Expansion area is westerly toward the Landfill Stormwater Runoff Pond at a hydraulic gradient of approximately 0.02 foot per foot. Water level elevations in the 2018 Landfill Lateral Expansion area piezometers are higher than the surface water elevation of the Landfill Stormwater Runoff Pond (approximately 298 feet amsl), which indicates shallow groundwater in the 2018 Landfill Lateral Expansion area discharges into the Landfill Stormwater Runoff Pond.

3.2 Uppermost Aquifer

3.2.1 CCR Rule Definition

The CCR rule definitions for an aquifer and the uppermost aquifer as specified in 40 CFR 257.53 indicates an aquifer is a geologic formation capable of yielding usable quantities of groundwater to wells or springs while an uppermost aquifer is defined as the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers, that are hydraulically interconnected with this aquifer within the facility's property boundary. Upper limit is measured at a point nearest to the natural groundwater surface to which the aquifer rises during the wet season.

3.2.1.1 Common Definitions

An aquifer is commonly defined as a geologic unit that stores and transmits water (readily or at sufficient flow rates) to supply wells and springs (USGS, 2015; Fetter, 2001). The uppermost aquifer is considered the first encountered aquifer nearest to the CCR unit.

3.2.2 Identified Onsite Hydrostratigraphic Unit

The identified Site hydrostratigraphic unit in the Landfill area is the clayey and silty sand stratum that is located between an elevation of approximately 270 and 330 feet amsl.

3.3 Review of Existing Monitoring Well Network

3.3.1 Overview

The Site was visited by ARCADIS and AEP personnel on August 19, 2015 to review existing well network conditions and locations. A well construction table that summarizes the location, ground surface elevation, borehole depth, installation date, and associated well construction details of the monitoring well network is included as

Table 3. Photo documentation of the located wells during the August 19, 2015 site visit is provided in **Appendix B**.

Monitoring wells AD-8, AD-12, AD-16, AD-23, AD-24, AD-25, AD-26, AD-27, AD-34, and AD-35 were previously installed at the Site to monitor the uppermost aquifer (clayey and silty sand stratum) associated with the Landfill. As discussed above in Section 3.1.1, the uppermost aquifer below and adjacent to the existing Landfill is up to 60 feet thick and is located between an elevation of approximately 270 and 330 feet amsl. The uppermost aquifer below the Landfill Lateral Expansion area is located between an elevation of approximately 280 and 330 feet amsl.

3.3.2 Gaps in Monitoring Network

As shown on **Figure 10**, shallow groundwater flow direction in the existing Landfill area is south to southwesterly. Four existing monitoring wells (AD-8, AD-12, AD-16, and AD-27) are located up gradient north and northeast of the Landfill and will be utilized as up gradient monitoring wells for the Landfill.

As shown on **Figure 10**, three existing monitoring wells (AD-23, AD-34, and AD-35) are located downgradient (south) of the Landfill and are currently utilized to monitor groundwater quality downgradient of the Landfill CCR unit. However, monitoring well MW-35 is located within the footprint of the proposed 2018 Landfill Lateral Expansion and will be plugged by a Texas Department of Licensing and Regulation (TDLR) licensed water well driller. This data gap will be addressed by installation of new downgradient monitoring well AD-36. As shown on **Figure 16**, monitoring well AD-36 will be located on the west (downgradient) side of the 2018 Landfill Lateral Expansion. With the addition of monitoring well AD-36 as a replacement for monitoring well AD-35, there will be no gaps in the groundwater monitoring network for the Landfill.

4. Recommended Monitoring Network and PE Certification

The recommended groundwater monitoring well network is intended to meet specifications stated in 40 CFR 257.91. Recommended wells are further discussed with respect to location to the Landfill (up gradient or down gradient), well depth, and well construction. The recommended network would provide an improved understanding of groundwater quality, hydraulics, and groundwater flow at the Landfill.

4.1 Recommended Monitoring Well Network Distribution

Four up gradient well locations (existing monitoring wells AD-8, AD-12, AD-16, and AD-27) and three downgradient well locations (existing monitoring wells AD-23, AD-34, and AD-35) are currently utilized as the groundwater quality monitoring well network for the Landfill. During the 2018 Landfill Lateral Expansion construction activities, monitoring well AD-35 will be plugged and replaced with a new monitoring well (AD-36) to be installed directly west (downgradient) of the Lateral Expansion. In addition, existing side gradient monitoring wells AD-25 and AD-26 may be utilized as piezometers to obtain additional groundwater flow direction and gradient data for the Landfill.

4.1.1 Location

The recommended monitoring well network for groundwater quality of the uppermost aquifer at the Landfill is summarized on **Table 4** and illustrated on **Figure 16.**

4.1.2 Depth

The screen depths for the monitoring wells recommended for inclusion in the monitoring network are within the shallow saturated sand stratum (uppermost aquifer) that occurs between an elevation of approximately 270 and 330 feet amsl in the existing Landfill area, and between an elevation of approximately 280 and 330 feet amsl in the Landfill Lateral Expansion area, as shown on Geologic Cross Sections C-C’ (**Figure 6**), D-D’ (**Figure 7**), F-F’ (**Figure 12**), G-G’ (**Figure 13**), and H-H’ (**Figure 14**). The screen elevations are presented in **Table 4**.

4.1.3 Well Construction

As discussed above in Section 3.3.2, the gap in the monitoring well network for the uppermost aquifer at the Landfill following plugging of monitoring well AD-35 will be addressed by installation of new monitoring well AD-36. Monitoring wells AD-35 will be plugged and monitoring well AD-36 will be installed by a TDLR-licensed water well driller. Well construction data for the monitoring well network are summarized on **Tables 3** and **4**, and the monitoring well completion diagrams for the existing monitoring wells are provided in **Appendix A**.

4.2 Professional Engineer's Certification

I, Kenneth J. Brandner, certify that this report was prepared under my direction and supervision, and that the information contained herein is true and accurate to the best of my knowledge. Based on my experience and knowledge of the site, the proposed groundwater monitoring system for the Landfill CCR unit will be adequate to meet the requirements of 40 CFR Part 257.91.

Kenneth J. Brandner
Printed Name of Registered Professional Engineer

Kenneth J Brandner
Signature

KENNETH J. BRANDNER
69586

69586
Registration No.

Texas
Registration State

10-25-18
Date

5. References

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Tables

Table 1
Water Level Data
AEP Pirkey Power Plant - CCR Storage Areas
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Screen[b]		Bottom of Screen[b]		4/13/2011	12/15/2011	6/20/2012	1/23/2013	7/7/2013	1/22/2014	7/9/2014	1/28/2015	1/20/2016	1/12/2017	3/1/2017	4/11/2017	8/24/2017
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl	GW Elev. ft. msl
Monitoring Wells																									
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	20	321.25	40	301.25	326.90	327.12	327.17	327.26	326.62	327.70	327.19	328.62	328.55	327.65	327.96	329.09	327.63
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	37	335.76	57	315.76	342.95	341.59	343.70	341.10	343.27	341.42	343.96	345.01	347.03	344.19	345.53	345.53	343.49
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	26	337.69	46	317.69	351.45	351.24	352.44	354.42	349.22	355.58	353.33	359.00	359.16	353.27	355.38	356.62	353.58
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	20	339.61	40	319.61	344.34	343.75	344.15	344.90	343.35	346.61	346.23	349.17	349.31	347.04	347.96	347.87	347.40
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	20	336.92	35	321.92	341.65	340.29	341.65	340.72	341.25	341.67	343.36	344.03	347.21	345.74	346.00	345.81	346.31
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	20	339.48	40	319.48	342.03	341.90	342.19	341.41	339.85	342.27	342.22	344.39	343.97	---	---	---	---
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	31	347.84	51	327.84	358.95	357.99	359.33	368.07	357.41	369.97	367.04	372.75	371.05	365.11	368.79	372.97	367.68
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	30.5	331.48	40.5	321.48	349.46	348.91	349.52	350.81	348.61	351.97	351.29	354.47	354.15	352.01	352.81	352.68	352.62
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	15.0	341.81	35.0	321.81	338.08	335.50	337.58	335.43	336.67	339.53	340.84	343.34	347.68	343.09	344.54	344.69	342.71
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	10.0	332.65	30.0	312.65	322.66	322.29	323.31	323.51	323.06	325.19	324.15	328.42	326.78	324.70	326.27	326.27	324.18
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	15.0	345.48	25.0	335.48	355.53	351.54	357.21	355.47	357.23	360.03	358.06	359.88	360.52	357.06	359.21	358.63	358.23
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	10.0	349.50	30.0	329.50	344.07	343.58	344.29	344.62	342.60	345.11	345.76	347.92	347.40	---	---	---	---
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	15.0	337.30	35.0	317.30	334.50	334.63	334.69	334.78	333.38	335.38	334.87	336.88	336.07	---	---	---	---
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	10.0	337.23	30.0	317.23	340.43	340.02	340.22	341.57	339.16	342.36	341.67	345.45	343.82	---	---	---	---
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	10.0	345.57	30.0	325.57	343.64	343.16	343.74	344.83	342.90	346.49	345.77	350.24	350.29	347.20	348.52	348.45	347.37
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	15.0	331.72	35.0	311.72	319.65	318.94	319.29	318.66	318.87	319.80	319.79	319.84	321.23	320.99	321.00	320.85	320.77
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	5.0	282.68	20.0	267.68	282.92	284.29	285.10	285.63	285.06	288.30	287.10	288.56	---	---	---	---	---
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	10.0	324.15	30.0	304.15	324.51	321.90	323.14	321.94	322.15	322.56	324.24	326.42	327.00	---	---	---	---
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	10.0	332.41	40.0	302.41	324.53	323.77	323.62	322.32	322.09	323.24	322.51	323.04	326.06	---	---	---	---
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	17.5	332.33	37.5	312.33	325.82	324.54	326.13	325.39	325.35	326.39	327.91	329.69	330.89	330.04	331.59	331.24	330.05
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	15.0	320.92	35.0	300.92	319.67	319.16	319.92	320.21	319.69	320.65	320.22	322.16	321.39	320.27	320.51	320.69	320.07
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	10.0	340.21	30.0	320.21	334.68	333.37	334.74	337.47	336.84	338.55	335.85	340.57	338.48	---	---	---	---
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	10.0	329.04	25.0	314.04	---	---	---	---	---	---	---	---	323.70	322.23	322.85	322.88	322.04
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	20.0	337.75	35.0	322.75	---	---	---	---	---	---	---	---	346.60	343.78	344.53	344.58	343.57
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	13.0	344.23	33.0	324.23	---	---	---	---	---	---	---	---	352.32	347.44	348.44	349.09	349.73
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	15.0	344.30	30.0	329.30	---	---	---	---	---	---	---	---	351.13	348.56	349.32	349.25	349.31
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	10.0	294.64	25.0	279.64	---	---	---	---	---	---	---	---	307.61	307.61	307.61	307.61	307.61
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	3.0	313.01	18.0	298.01	---	---	---	---	---	---	---	---	309.85	310.42	310.82	311.27	310.28
Piezometers[c]																									
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	28.0	328.30	38.0	318.30	---	---	---	---	---	---	---	---	---	---	---	---	---

(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011).
(c) Souce: EETL (October 2010).
(d) Source: Auckland Consulting LLC (January 26, 2016). Monitoring wells AD-30 through AD-35 installed during December 2015.
Groundwater Elevation Source: AEP, Pirkey Monitoring Well Groundwater Elevations through January 2015.
--- Not Measured

Table 2
Piezometer Water Level Data - 2018 Landfill Lateral Expansion Area
AEP Pirkey Power Plant
Hallsville, Harrision County, Texas

Piezomenter Completion Information

Piezometer ID:	PZ1	PZ2	PZ3	PZ4	PZ5	PZ6	PZ7	AD-23	AD-35
Northing	6871372.73	6871442.96	6871218.9	6871018.52	6870962.73	6870939.86	6871250.41		
Easting	3203056.63	3203345.4	3203322.02	3203009.98	3203281.7	3203544.92	3202996.36		
Screen length	10	10	10	10	10	10	10	20	15
TD (from GS)	14	14	14	14	20	20	14	37.44	18
Sand pack, top (from GS)	3	3	3	3	8	8	3		
Elev, GS								346.72	334.15
Elev, TOC	308.85	312.74	307.35	311.53	328.3	328.78	303.73	350.1	318.95

Piezometer Depth to Water Measurements (feet) below TOC

Date	PZ1	PZ2	PZ3	PZ4	PZ5	PZ6	PZ7	AD-23	AD-35
6/20/2018	9.98	9.99	4.29	8.66	20.47	13.23	2.84		
6/21/2018	9.99	9.95	4.07	8.37	20.47	13.24	2.75	29.4	7.95
6/22/2018	9.99	9.91	3.98	8.31	20.47	13.25	2.76	29.42	7.92
6/29/2018	10.01	10.1	4.34	8.85	20.63	13.4	2.98	29.39	8.14
7/6/2018	10.02	10.23	4.45	8.92	20.75	13.52	3.21	29.43	8.23

Piezometer Potentiometric Surface (Water Table) Elevations (feet AMSL)

Date	PZ1	PZ2	PZ3	PZ4	PZ5	PZ6	PZ7	AD-23	AD-35
6/20/2018	298.87	302.75	303.06	302.87	307.83	315.55	300.89		
6/21/2018	298.86	302.79	303.28	303.16	307.83	315.54	300.98	320.70	311.00
6/22/2018	298.86	302.83	303.37	303.22	307.83	315.53	300.97	320.68	311.03
6/29/2018	298.84	302.64	303.01	302.68	307.67	315.38	300.75	320.71	310.81
7/6/2018	298.83	302.51	302.9	302.61	307.55	315.26	300.52	320.67	310.72

Legend

GS	Ground surface	TOC	Top of piezometer casing
TD	Total depth	AMSL	Above mean sea level

Table 3
Well Construction Details
AEP Pirkey Power Plant - CCR Units
Hallsville, Harrison County, Texas

Well ID	Latitude	Longitude	Ground Surface Elevation[a]	Top of Casing Elevation[a]	Borehole depth ft. bls	Date Installed	Screen Material	Well diameter inches	Top of Filter Pack		Bottom of Filter Pack		Top of Screen[b]		Bottom of Screen[b]	
									Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl	Depth ft. bls	Elevation ft. msl
Monitoring Wells																
MW-2/AD-2	32° 27' 54.753"	94° 29' 25.282"	341.25	344.04	40	10/7/83	Sch. 40 PVC	4	18	323	40	301	20	321.25	40	301.25
MW-3/AD-3	32° 28' 6.829"	94° 29' 21.498"	372.76	375.30	57	11/4/83	Sch. 40 PVC	4	35	338	57	316	37	335.76	57	315.76
MW-4/AD-4	32° 27' 59.247"	94° 29' 4.692"	363.69	366.79	46	10/10/83	Sch. 40 PVC	4	24	340	46	318	26	337.69	46	317.69
MW-7/AD-7	32° 27' 43.611"	94° 29' 15.611"	359.61	362.79	40	10/3/83	Sch. 40 PVC	4	18	342	40	320	20	339.61	40	319.61
MW-8/AD-8	32° 27' 25.095"	94° 29' 14.925"	356.92	359.84	35	10/4/83	Sch. 40 PVC	4	18	339	35	322	20	336.92	35	321.92
MW-10/AD-10	32° 27' 52.446"	94° 29' 16.545"	359.48	362.21	40	10/10/83	Sch. 40 PVC	4	18	341	40	319	20	339.48	40	319.48
MW-12/AD-12	32° 27' 51.702"	94° 29' 3.238"	378.84	381.99	51	1/30/86	Sch. 40 PVC	4	29	350	51	328	31	347.84	51	327.84
MW-13/AD-13	32° 27' 46.002"	94° 29' 5.71"	361.98	364.76	40.5	2/23/88	Sch. 40 PVC	4	17.5	344.5	40.5	321.5	30.5	331.48	40.5	321.48
AD-16	32° 27' 40.871"	94° 29' 38.637"	356.81	360.05	35	12/30/10	Sch. 40 PVC	2	13	344	35	322	15.0	341.81	35.0	321.81
AD-17	32° 28' 2.315"	94° 29' 39.45"	342.65	346.09	30	12/30/10	Sch. 40 PVC	2	8	335	30	313	10.0	332.65	30.0	312.65
AD-18	32° 28' 9.245"	94° 29' 6.469"	360.48	363.42	25	1/3/11	Sch. 40 PVC	2	13	347	25	335	15.0	345.48	25.0	335.48
AD-19	32° 27' 50.512"	94° 29' 13.973"	359.50	362.82	30	12/30/10	Sch. 40 PVC	2	8	352	30	330	10.0	349.50	30.0	329.50
AD-20	32° 27' 51.346"	94° 29' 21.576"	352.30	355.79	35	12/28/10	Sch. 40 PVC	2	13	339	35	317	15.0	337.30	35.0	317.30
AD-21	32° 27' 45.403"	94° 29' 19.195"	347.23	350.72	30	12/27/10	Sch. 40 PVC	2	8	339	30	317	10.0	337.23	30.0	317.23
AD-22	32° 27' 41.349"	94° 29' 17.779"	355.57	358.51	30	12/16/10	Sch. 40 PVC	2	8	348	30	326	10.0	345.57	30.0	325.57
AD-23	32° 27' 3.384"	94° 29' 41.258"	346.72	350.10	35	12/15/10	Sch. 40 PVC	2	13	334	35	312	15.0	331.72	35.0	311.72
AD-24	32° 27' 1.455"	94° 29' 56.388"	287.68	291.14	20	12/27/10	Sch. 40 PVC	2	3	285	20	268	5.0	282.68	20.0	267.68
AD-25	32° 27' 17.187"	94° 29' 58.998"	334.15	337.09	30	12/14/10	Sch. 40 PVC	2	8	326	30	304	10.0	324.15	30.0	304.15
AD-26	32° 27' 25.426"	94° 29' 54.775"	342.41	345.25	40	12/14/10	Sch. 40 PVC	2	8	334	40	302	10.0	332.41	40.0	302.41
AD-27	32° 27' 36.66"	94° 29' 47.272"	349.83	352.62	37.5	12/15/10	Sch. 40 PVC	2	15.5	334.3	37.5	312.3	17.5	332.33	37.5	312.33
AD-28	32° 27' 55.439"	94° 29' 39.418"	335.92	339.40	40	12/28/10	Sch. 40 PVC	2	13	323	35	301	15.0	320.92	35.0	300.92
AD-29	32° 28' 8.271"	94° 29' 31.939"	350.21	353.37	30	1/3/11	Sch. 40 PVC	2	8	342	30	320	10.0	340.21	30.0	320.21
AD-30[d]	32° 27' 56.49"	94° 29' 32.53"	339.04	342.02	25	12/8/15	Sch. 40 PVC	2	8	331	25	314	10.0	329.04	25.0	314.04
AD-31[d]	32° 28' 02.48"	94° 29' 20.90"	357.75	360.75	35	12/8/15	Sch. 40 PVC	2	18	340	35	323	20.0	337.75	35.0	322.75
AD-32[d]	32° 27' 56.20"	94° 29' 11.86"	357.23	359.18	33	12/11/15	Sch. 40 PVC	2	11	346	33	324	13.0	344.23	33.0	324.23
AD-33[d]	32° 27' 38.70"	94° 29' 15.82"	359.30	362.37	30	12/11/15	Sch. 40 PVC	2	12	347	30	329	15.0	344.30	30.0	329.30
AD-34[d]	32° 27' 10.13"	94° 29' 57.93"	304.64	307.61	25	12/11/15	Sch. 40 PVC	2	8	297	25	280	10.0	294.64	25.0	279.64
AD-35[d]	32° 27' 09.64"	94° 29' 42.74"	316.01	318.95	20	12/11/15	Sch. 40 PVC	2	2.5	313.5	20	296	3.0	313.01	18.0	298.01
Piezometers[c]																
W-3 (PW-3)	32° 27' 57.6"	94° 29' 31.8"	356.30	356.30	38	10/20/09	Sch. 40 PVC	2	26	330	38	318	28.0	328.30	38.0	318.30

General Note:
Elevations in feet above mean sea level.

Footnotes:
(a) Source: Apex Geoscience Inc. (March 23, 2011).
(b) Screen length and screened intervals for AD-2 through AD-12 estimated from video surveillance (Apex Geoscience Inc., March 23, 2011). Top of sand pack estimated 2 feet above top of screened interval.
(c) Souce: EETL (October 2010).
(d) Source: Aukland Consulting LLC (January 26, 2016).

Acronyms and Abbreviations:
NA = Data not available
ft = feet
bls = below land surface
msl = mean sea level

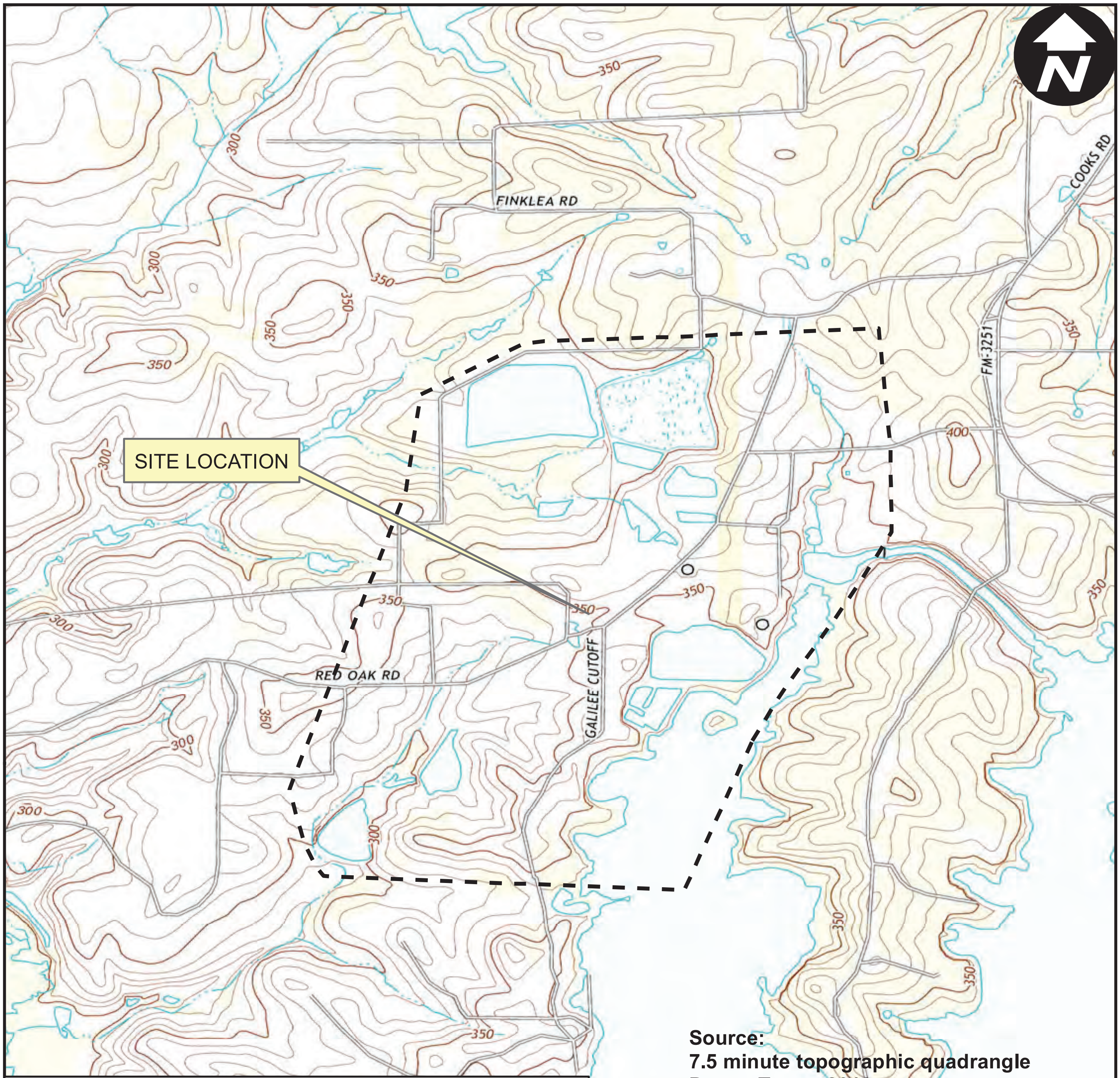
Table 4
Proposed Well Network
AEP Pirkey Power Plant - Landfill
Hallsville, Harrison County, Texas

Well ID	Exisiting/ Proposed	Hydrostratigraphic Unit Target	Location Description		Screen Top Target Elevation(a) (ft amsl)	Screen Bottom Target Elevation(a) (ft amsl)	Screen Length (ft)	Comments
Upgradient								
AD-8	Exisiting	Uppermost Water-Bearing Unit	Northeast of Landfill	Upgradient	336.9	321.9	15	Existing well installed in 1983; well will be utilitzed to establish backgroud water quality
AD-12	Exisiting	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilitzed to establish backgroud water quality
AD-16	Exisiting	Uppermost Water-Bearing Unit	North of Landfill	Upgradient	341.8	321.8	20	Existing well installed in 2010; well will be utilitzed to establish backgroud water quality
AD-27	Existing	Uppermost Water-Bearing Unit	Northwest of Landfill	Upgradient	332.3	312.3	20	Existing well installed in 2010; well will be utilitzed to establish backgroud water quality
Downgradient								
AD-23	Existing	Uppermost Water-Bearing Unit	South of Landfill	Down gradient	331.7	311.7	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to Landfill - downgradient
AD-34	Existing	Uppermost Water-Bearing Unit	Southwest of Landfill	Down gradient	294.6	279.6	15	Existing monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to Landfill - downgradient.
AD-35	Existing (to be plugged and replaced with AD-36 in 2018)	Uppermost Water-Bearing Unit	South of Landfill	Down gradient	313.0	298.0	15	Existing monitoring well installed during December 2015 in uppermost shallow aquifer adjacent to Landfill - downgradient. Will be plugged during Landfill 2018 Lateral Expansion construction and replaced with AD-36.
AD-36	Proposed	Uppermost Water-Bearing Unit	South of Existing Landfill, West of 2018 Lateral Expansion	Down gradient	304 (b)	294.0	10	Proposed monitoring well tentatively scheduled to be installed during 4th quarter 2018 in uppermost shallow aquifer adjacent to Landfill - downgradient.
Piezometers								
AD-25	Existing	Uppermost Water-Bearing Unit	West of Landfill	Side gradient	324.2	304.2	20	Existing well installed in 2010; uppermost shallow aquifer adjacent to Landfill - side gradient
AD-26	Existing	Uppermost Water-Bearing Unit	West of Landfill	Side gradient	332.4	302.4	30	Existing well installed in 2010; uppermost shallow aquifer adjacent to Landfill - side gradient

Footnotes:
a. Target elevations are an estimated range.
b. Ground surface elevation at proposed monitoring well location is approximately 308 feet amsl.

Acronyms and Abbreviations:
U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level

Figures



Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013

0 2,000 4,000
SCALE IN FEET

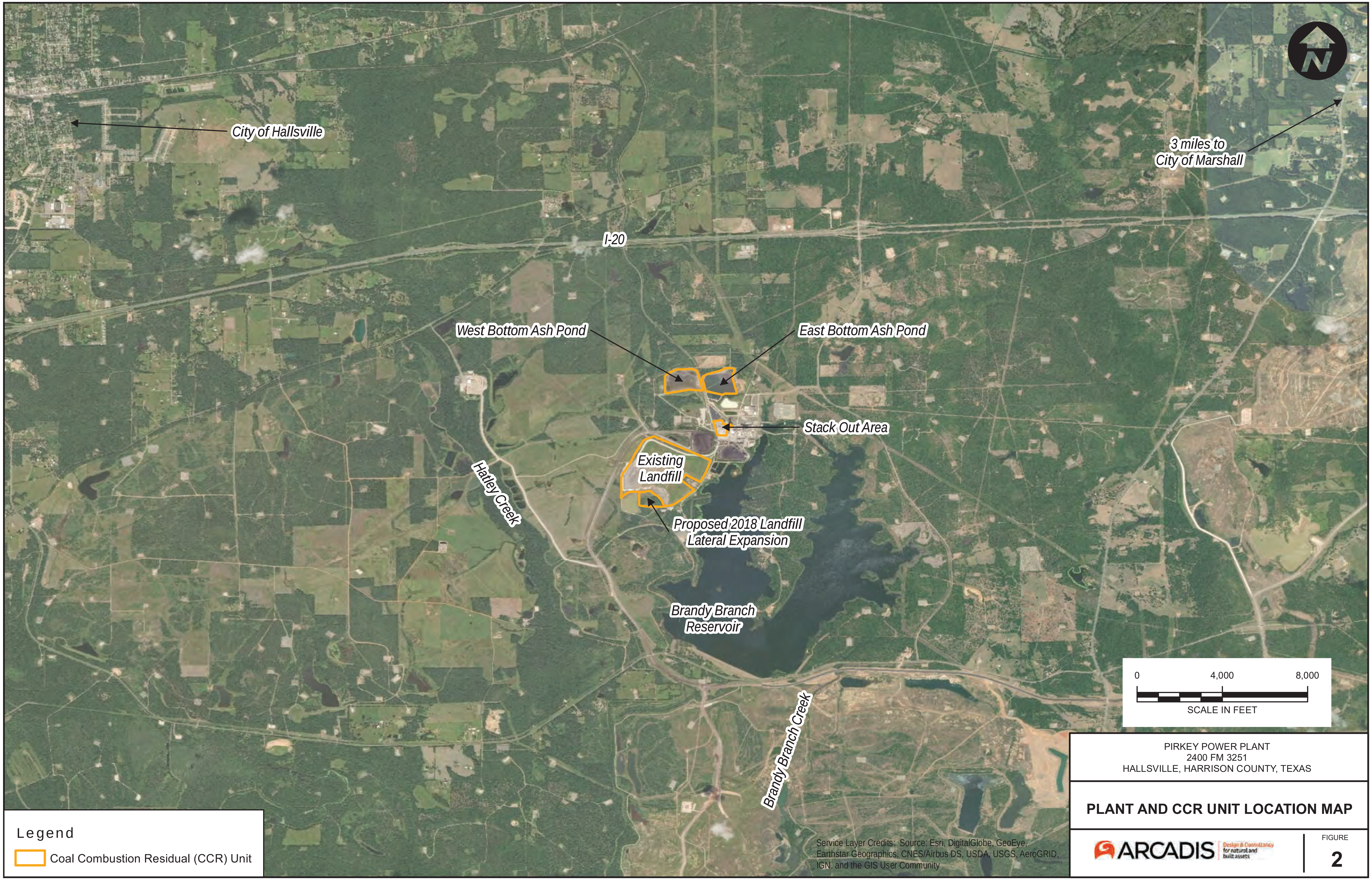
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LOCATION MAP

ARCADIS

FIGURE
1

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 1 - Site Location Map.mxd



PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

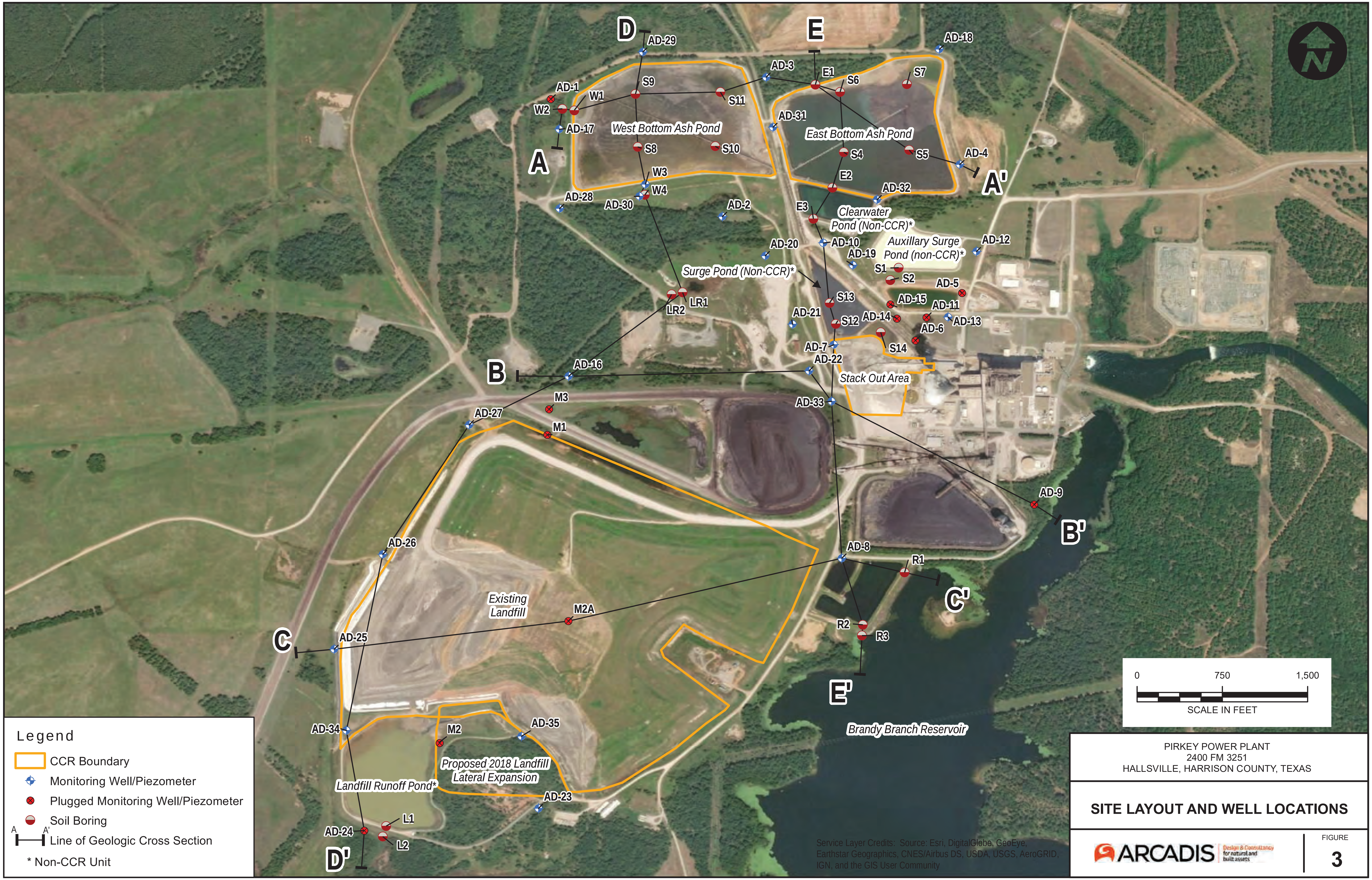
PLANT AND CCR UNIT LOCATION MAP

ARCADIS

FIGURE
2

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 2 - Plant and CCR Unit Location Map.mxd



Legend

🟧	CCR Boundary
⊕	Monitoring Well/Piezometer
⊗	Plugged Monitoring Well/Piezometer
◒	Soil Boring
A ├─┤ A'	Line of Geologic Cross Section

* Non-CCR Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS

FIGURE
3

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 3 - Site Layout and Well Locations.mxd

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 4 Cross Section A-A'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:18 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
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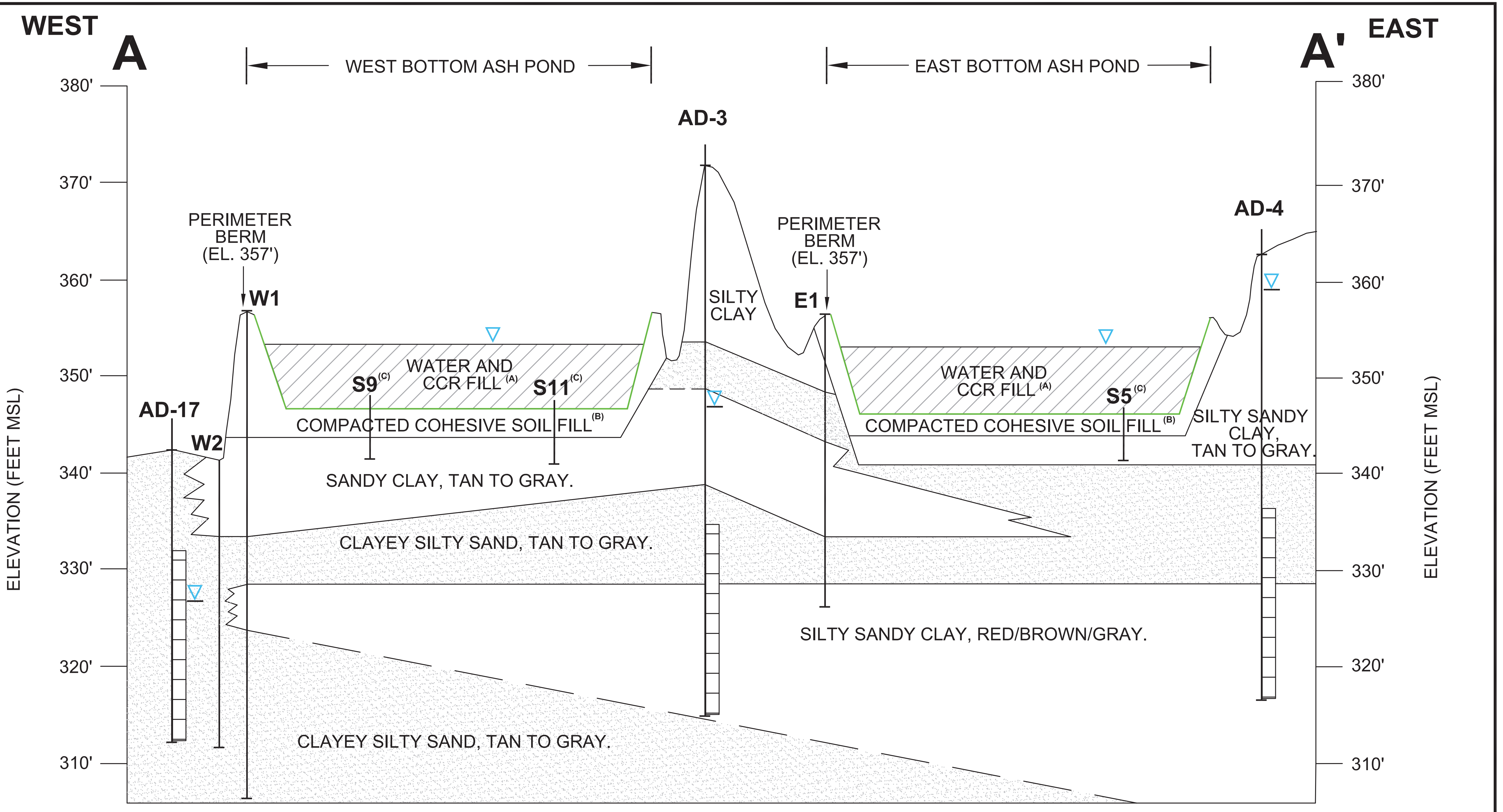


0 ▬ 300'
HORIZONTAL SCALE

LEGEND

- ▯ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- 🟩 BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).
C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

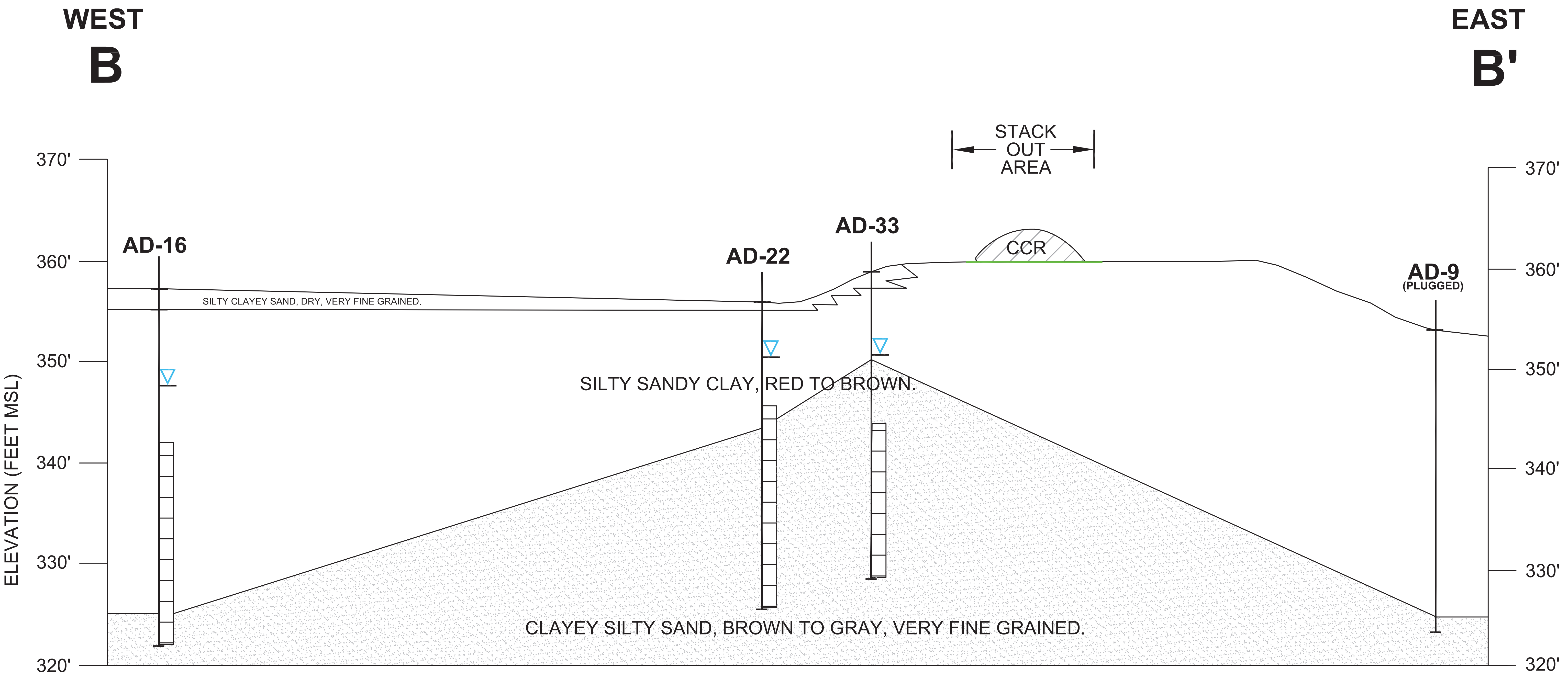
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
A - A'

ARCADIS

FIGURE
4

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 5 Cross Section B-B'.dwg LAYOUT: MODEL SAVED: 2/16/2016 1:49 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 2/19/2016 2:21 PM BY: LEASE, DIANA



0 300'
HORIZONTAL SCALE

LEGEND

- ⌸ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

NOTES:
A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE, ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
B - B'

ARCADIS

FIGURE
5

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 6 Cross Section C-C'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:25 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
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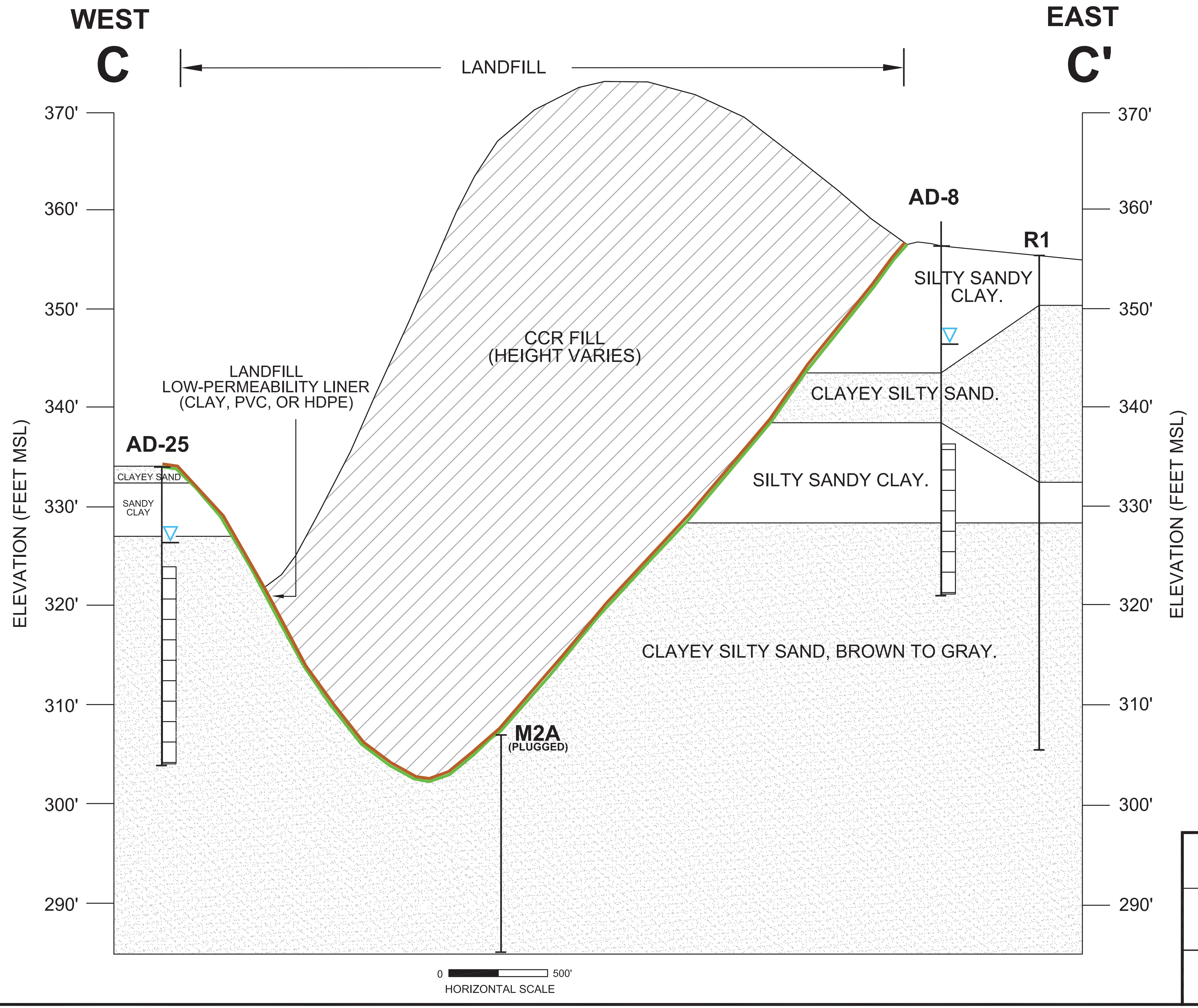


LEGEND

- ⌸ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

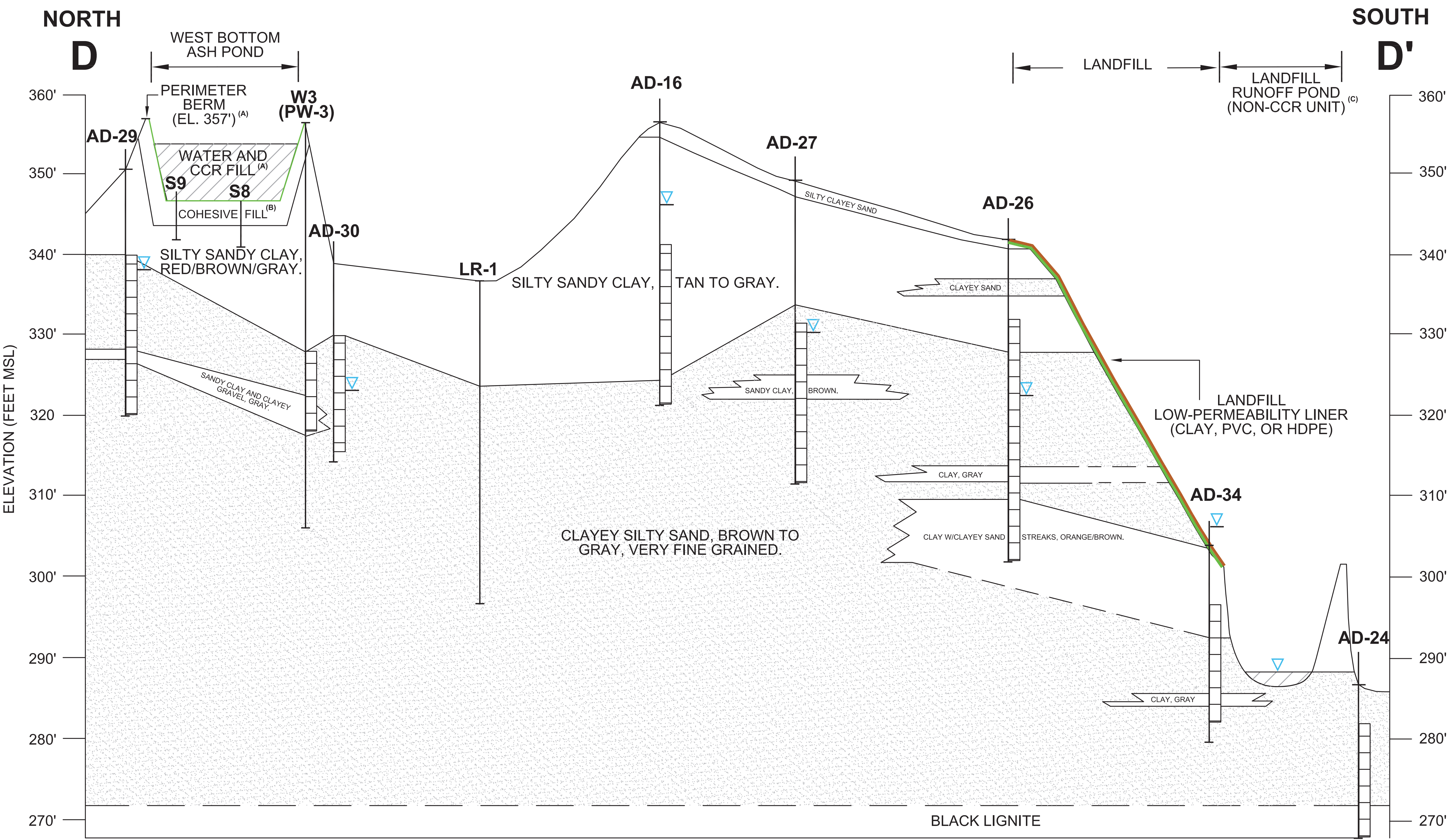
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C - C'

ARCADIS

FIGURE
6

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\OH015976 - CCR Plant Assessments\Pirkey Power Plant\Final 2016 Reports\West Bottom Ash Pond Location Restriction\Figures-Maps\Figure 7 Cross Section D-D'.dwg LAYOUT: MODEL SAVED: 2/19/2016 2:30 PM ACADVER: 19.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 2/22/2016 11:20 AM BY: LEASE, DIANA



0 600'
HORIZONTAL SCALE

LEGEND

- ⌸ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- 🟩 BASE OF CCR UNIT

NOTES:

A) TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT &LUNDY SEPTEMBER 1984; AMEC, AUGUST 2011).

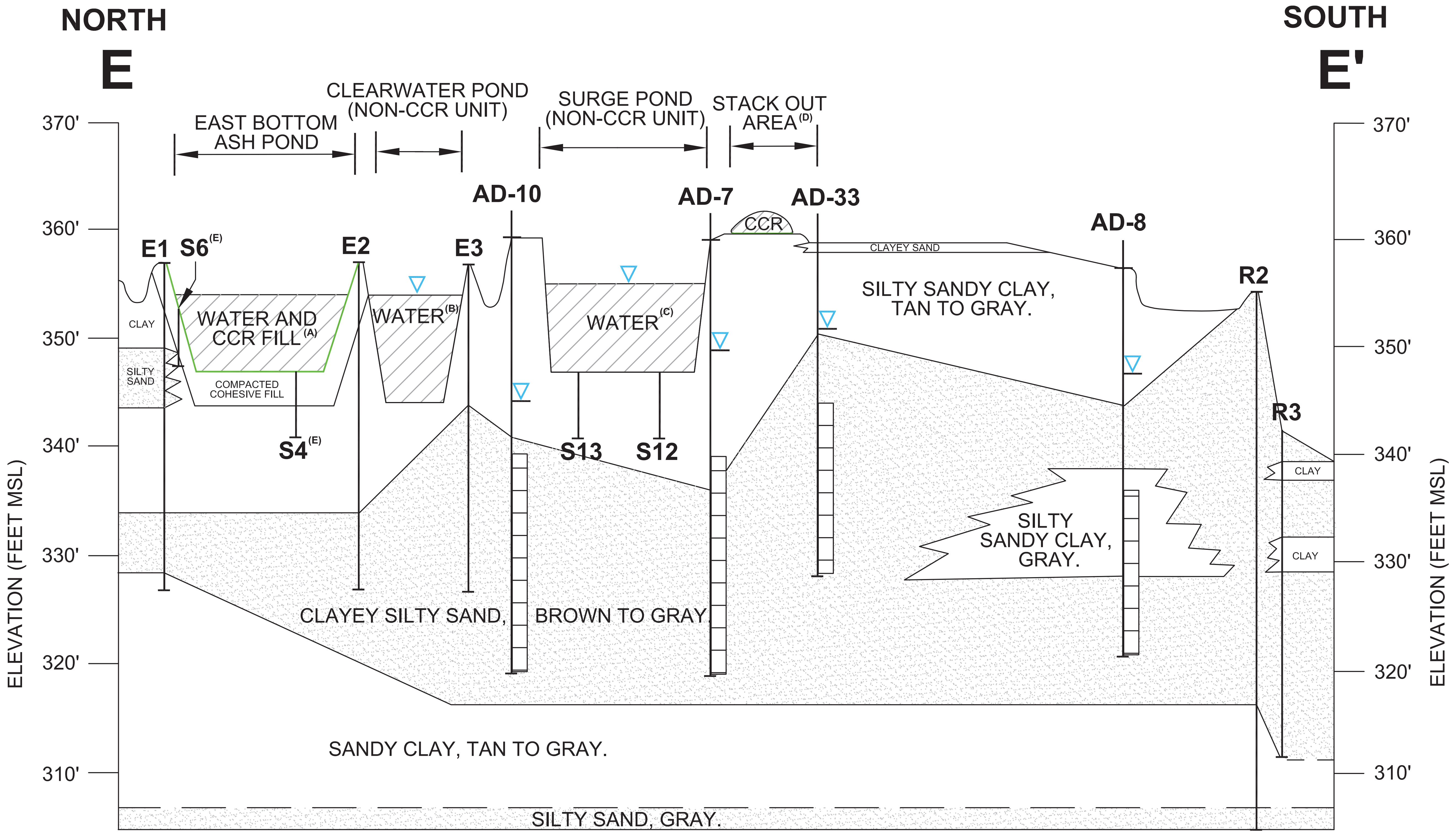
C) LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL, BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL. NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
D - D'

ARCADIS

FIGURE
7



0 500'
HORIZONTAL SCALE

LEGEND

- ▤ MONITORING WELL SCREENED INTERVAL
- ▽ WATER LEVEL IN MONITORING WELL (1/20/16)
- — BASE OF CCR UNIT

NOTES:

A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).

B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357',OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011). BASE ELEVATION OF CLEARWATER POND IS 344' (SARGENT & LUNDY, JANUARY 1983).

C) BASE ELEVATION OF SURGE POND (347-352'MSL) AND POND DESIGN LEVEL (355'MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT "DESIGN SUMMARY FOR LIGNITE STORAGE AREA AND WASTEWATER POND FACILITIES".

D) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE. ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.

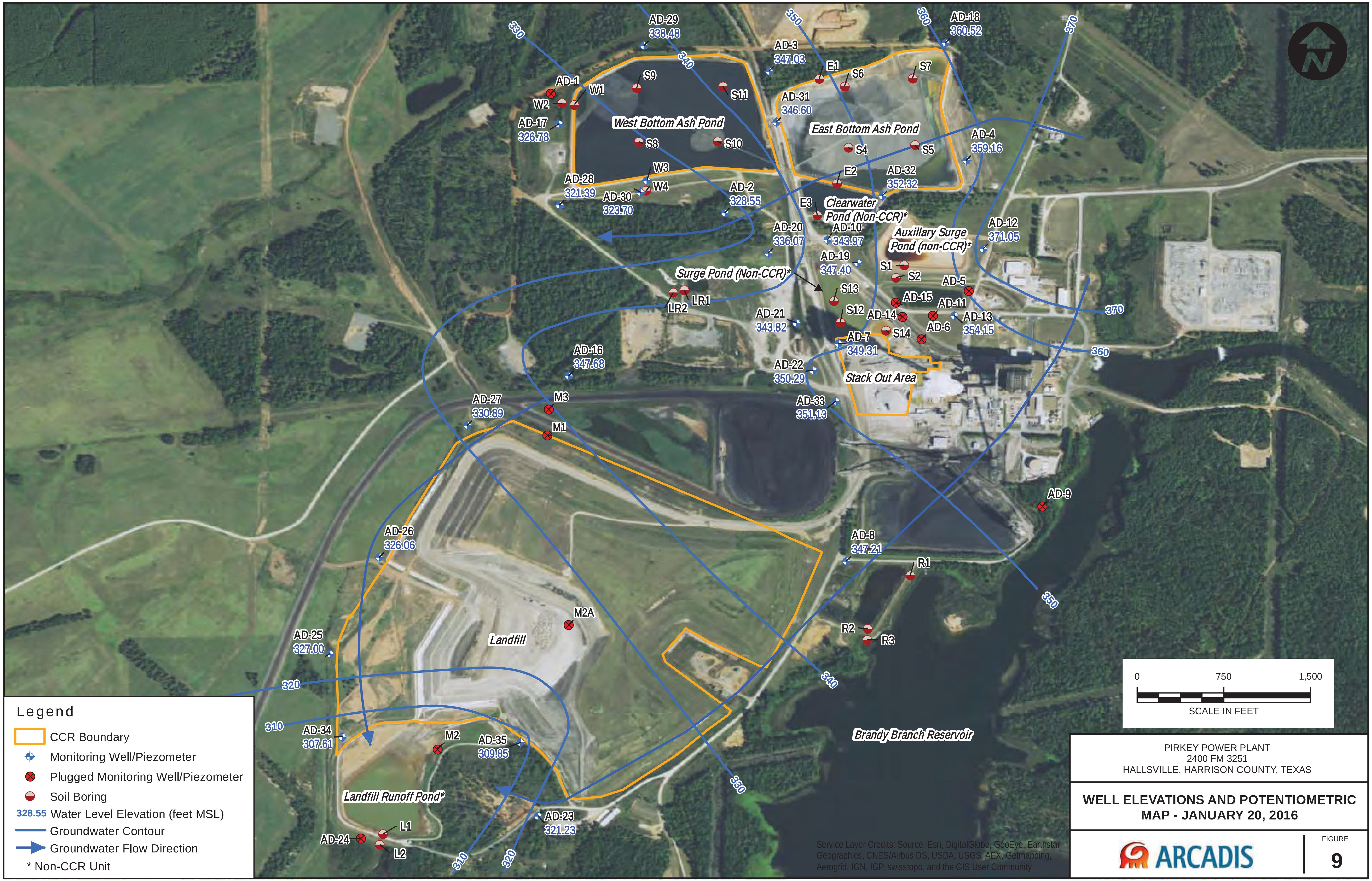
E) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
E - E'

ARCADIS

FIGURE
8



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

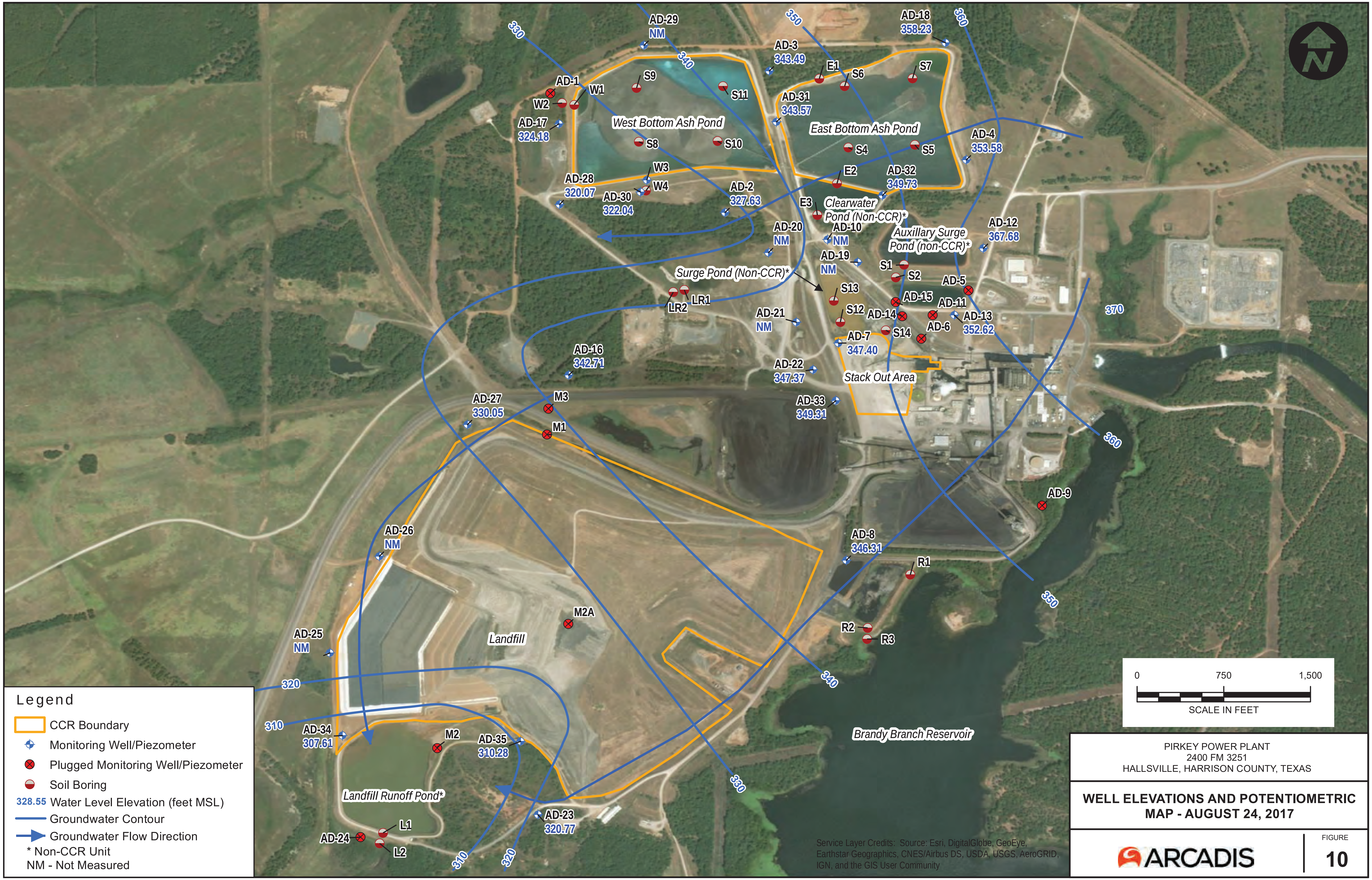
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - JANUARY 20, 2016

ARCADIS

FIGURE
9

Document Path: Z:\GISPROJECTS_ENV\AEP\Pirkey Plant\MXD\Figure 9 - Well Elevations and Potentiometric Map - January 20, 2016.mxd



Legend

- CCR Boundary
- Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- 328.55 Water Level Elevation (feet MSL)
- Groundwater Contour
- Groundwater Flow Direction

* Non-CCR Unit
NM - Not Measured

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

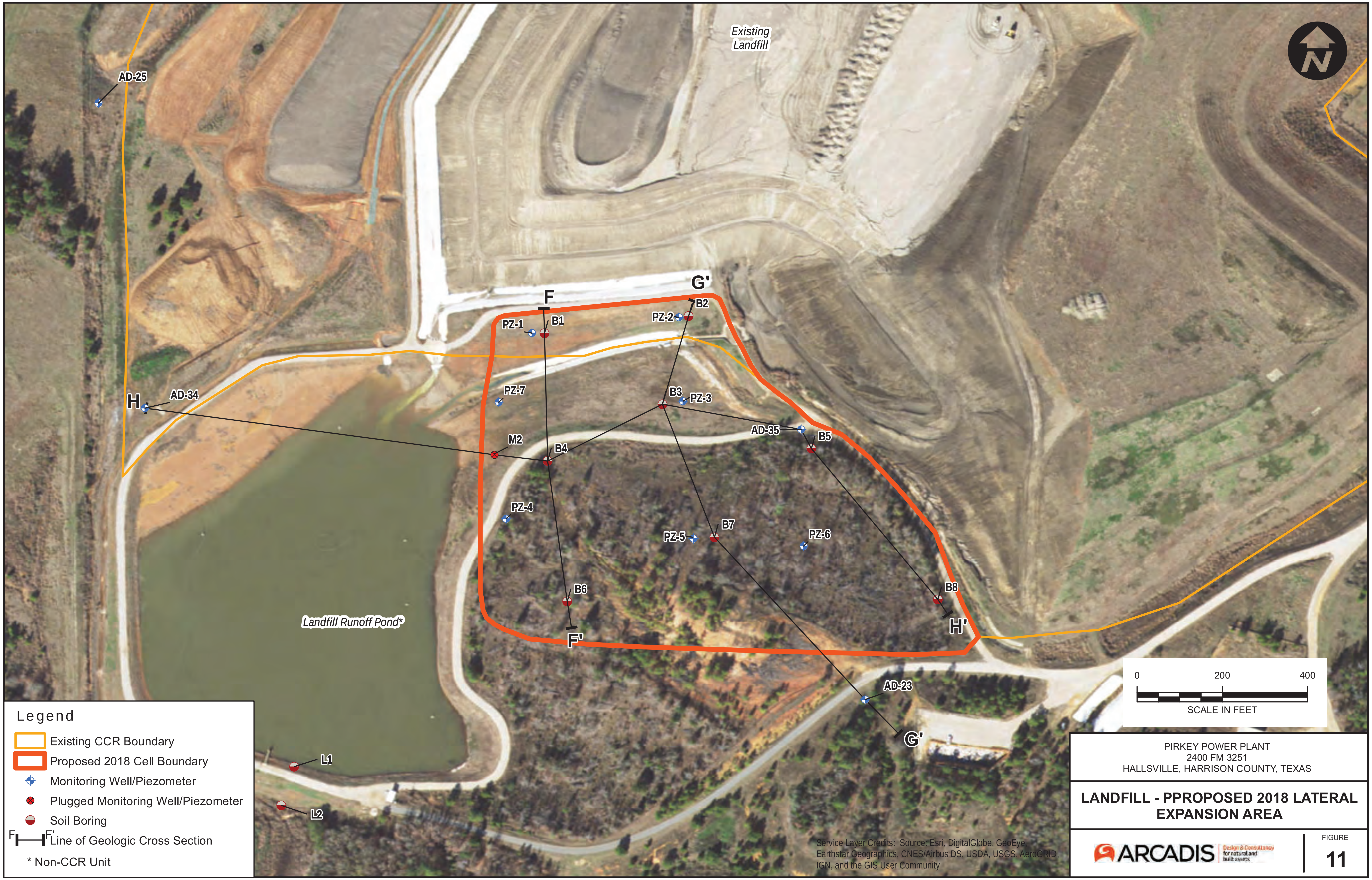
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

WELL ELEVATIONS AND POTENTIOMETRIC MAP - AUGUST 24, 2017

ARCADIS

FIGURE
10

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 10 - Well Elevations and Potentiometric Map - August 24, 2017.mxd



Legend

🟧 Existing CCR Boundary
🟥 Proposed 2018 Cell Boundary
⊕ Monitoring Well/Piezometer
⊗ Plugged Monitoring Well/Piezometer
● Soil Boring
F├──┤F' Line of Geologic Cross Section
* Non-CCR Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

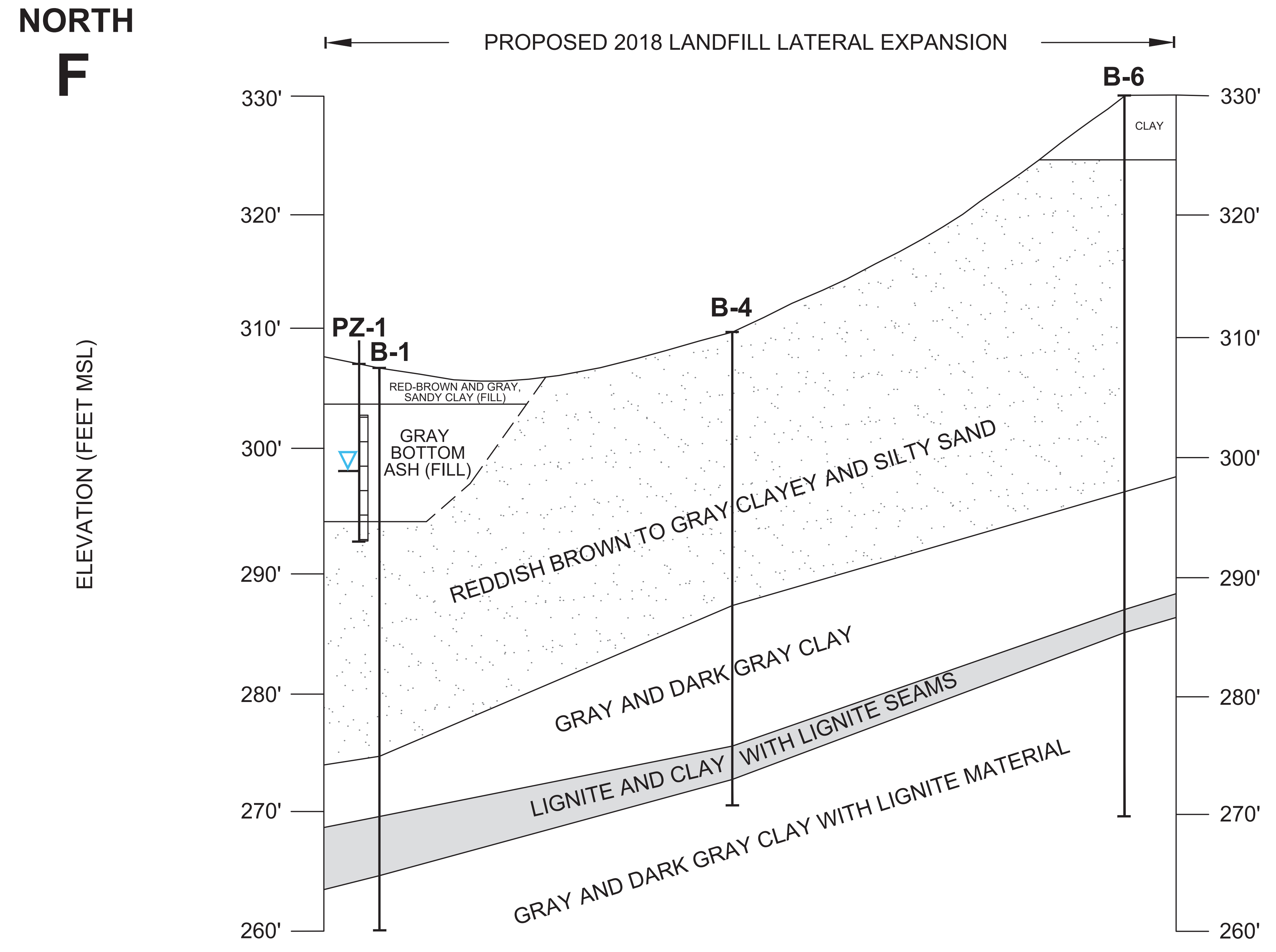
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

LANDFILL - PPROPOSED 2018 LATERAL EXPANSION AREA

ARCADIS Design & Consultancy for natural and built assets

FIGURE
11

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 11 - Landfill - 2018 Cell Expansion.mxd



0 100'
HORIZONTAL SCALE

LEGEND

⌸ MONITORING WELL /PIEZOMETER SCREENED INTERVAL

▽ WATER LEVEL IN PIEZOMETER/MONITORING WELL (6/22/18)

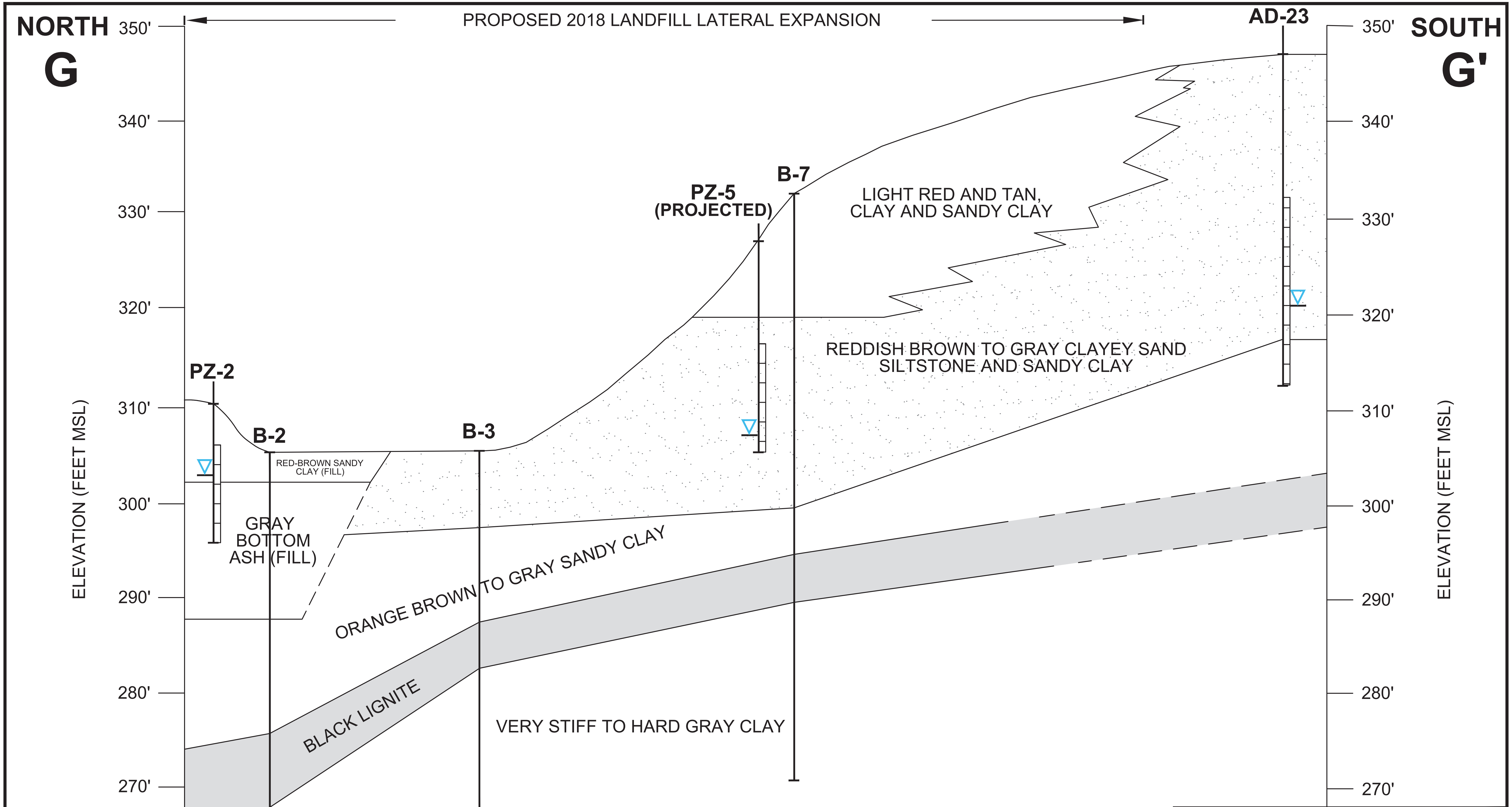
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
F - F'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
12

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0003 - Pirkey Landfill Expansion\Landfill Expansion Location Restriction Report\Figures-Maps\Figure 12 Cross-Sec F-F'.dwg LAYOUT: MODEL SAVED: 9/19/2018 3:27 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/19/2018 4:40 PM
BY: LEASE, DIANA



0 100'
HORIZONTAL SCALE

LEGEND

▯ MONITORING WELL/PIEZOMETER SCREENED INTERVAL

▽ WATER LEVEL IN PIEZOMETER/MONITORING WELL (6/22/18)

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
G - G'

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FIGURE
13

CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0003 - Pirkey Landfill Expansion\Landfill Expansion Location Restriction Report\Figures-Maps\Figure 13 Cross Sec G-G'.dwg LAYOUT: MODEL SAVED: 9/19/2018 4:47 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/20/2018 2:28 PM
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CITY: DIV/GROUP: DB: LD: AM: PD: TM: TR: LYR:ON=*;OFF=*REF*
G:\Active Projects\AEP\TX015976.0003 - Pirkey Landfill Expansion\Landfill Expansion Location Restriction Report\Figures-Maps\Figure 14 Cross Sec H-H'.dwg LAYOUT: MODEL SAVED: 9/19/2018 4:08 PM ACADVER: 20.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: ---- PLOTTED: 9/19/2018 4:52 PM
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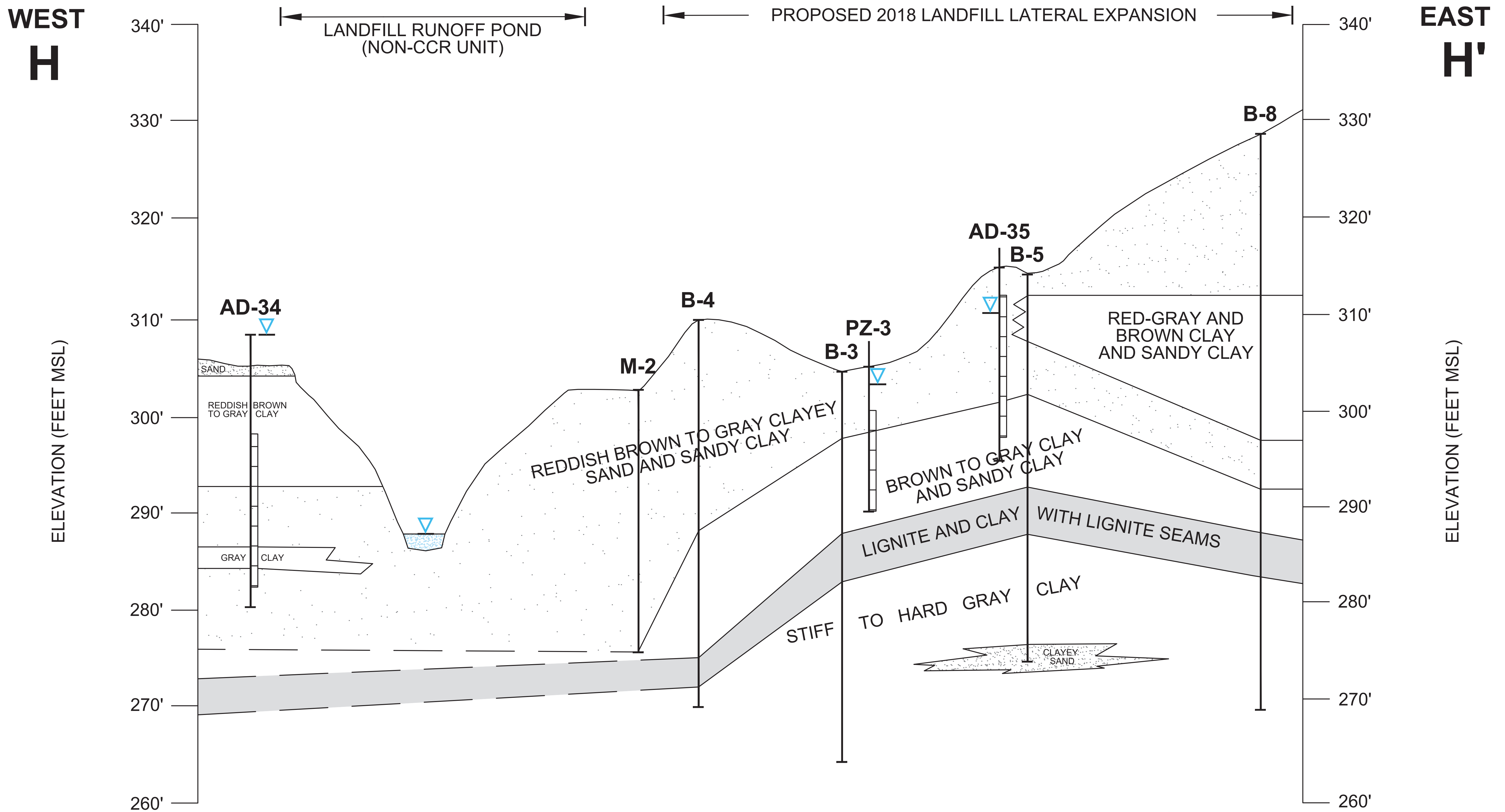


0 200'
HORIZONTAL SCALE

LEGEND

⌸ MONITORING WELL/PIEZOMETER SCREENED INTERVAL

▽ WATER LEVEL IN PIEZOMETER/MONITORING WELL (6/22/18)

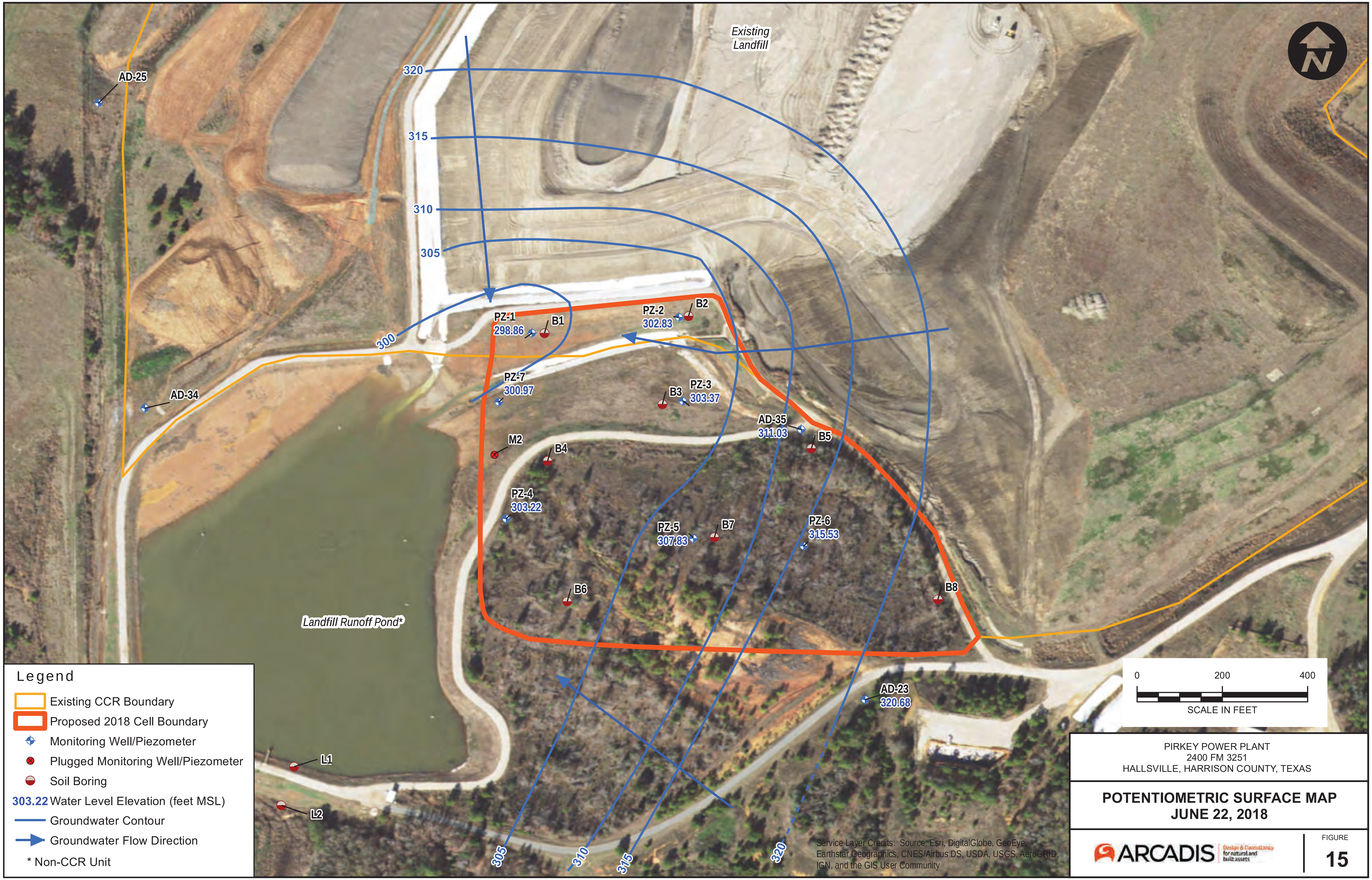
NOTE: LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL,
BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL.
NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
H - H'

ARCADIS Design & Consultancy for natural and built assets

FIGURE
14



Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

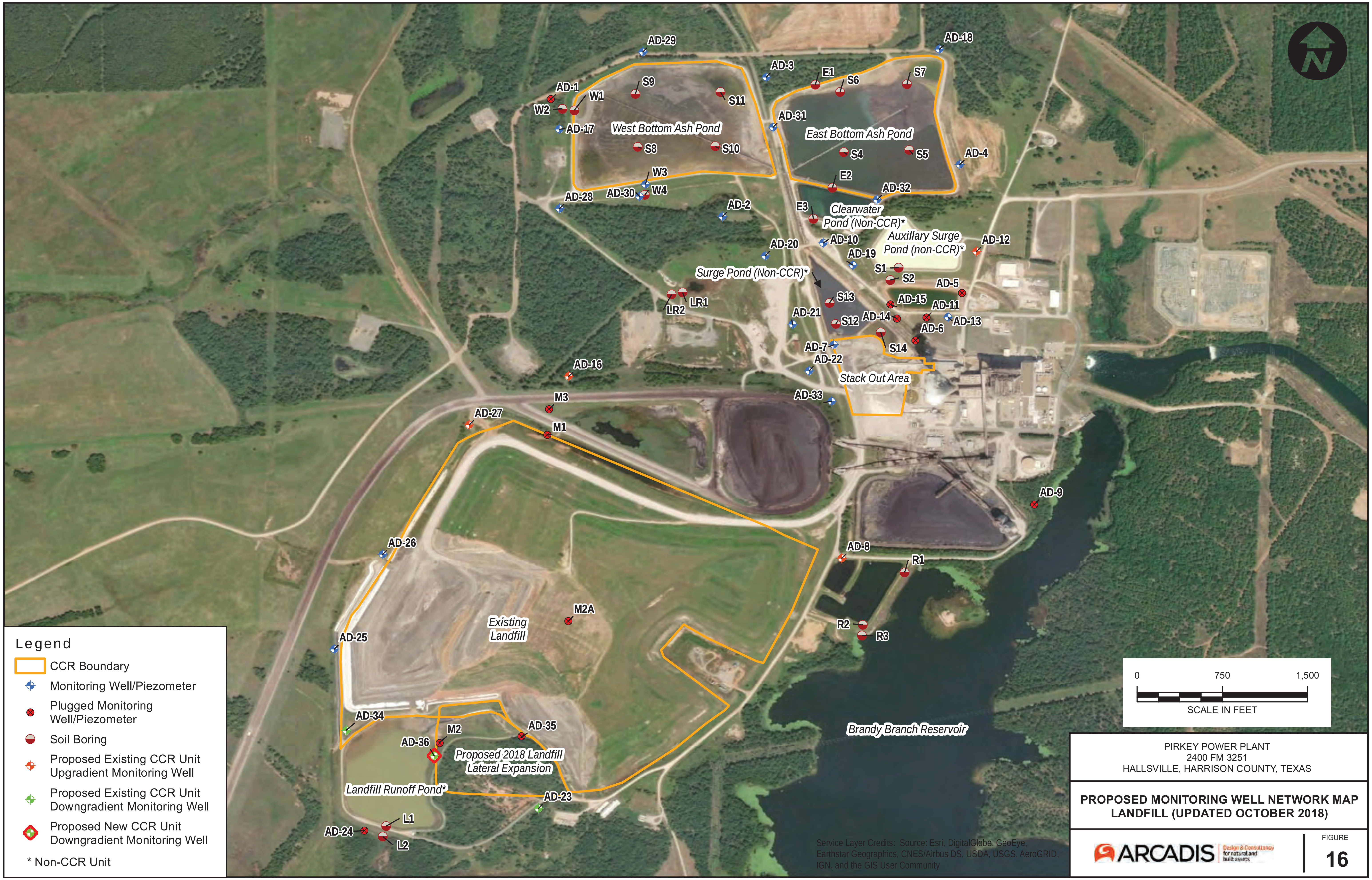
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

POTENTIOMETRIC SURFACE MAP
JUNE 22, 2018

ARCADIS Design & Consultancy for natural and built assets

FIGURE
15

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 15 - Potentiometric Surface Map June 22_2018.mxd



Legend

▭ CCR Boundary

⊕ Monitoring Well/Piezometer

⊗ Plugged Monitoring Well/Piezometer

◓ Soil Boring

⊕ Proposed Existing CCR Unit Upgradient Monitoring Well

⊕ Proposed Existing CCR Unit Downgradient Monitoring Well

⊕ Proposed New CCR Unit Downgradient Monitoring Well

* Non-CCR Unit

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

PROPOSED MONITORING WELL NETWORK MAP
LANDFILL (UPDATED OCTOBER 2018)

ARCADIS Design & Consultancy for natural and built assets

FIGURE
16

Document Path: Z:\GISProjects_ENV\AEP\Pirkey Plant\MXD\Figure 16 - Proposed Well Network - Landfill.mxd

Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-8
LOCATION: Hallsville

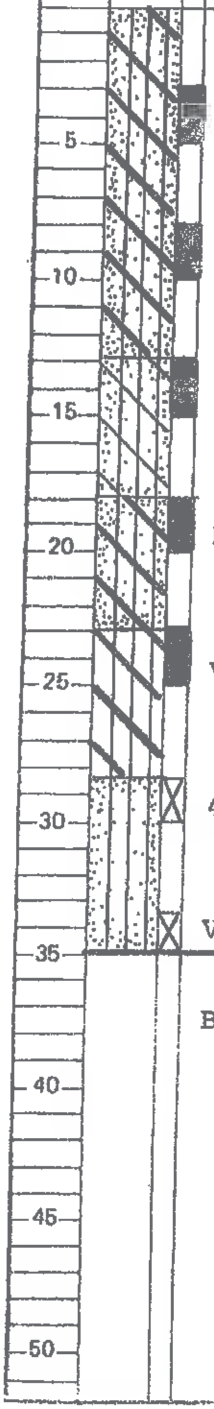
Date: 10-4-83
Type: Auger
Ground Elevation:

Depth, Feet | Symbol | Sample

Legend:

▪ Sample   X Penetration   ▼ Water

Description of Stratum



Stiff tan silty sandy clay w/iron ore

Stiff tan and grey silty sandy clay w/iron ore

Firm tan and grey clayey silty sand

Medium tan and grey very silty sandy clay w/iron ore

Very stiff grey silty clay lenses

43-7=5½" 50 B/5½"

Very dense tan and grey silty sand 50 B/5½"

Bottom of boring at 35 feet.

APEX PROJECT NO.: 110-089	☐ **BORING** **BORING NUMBER:**	☒ **MONITOR WELL** **MONITOR WELL NUMBER:**	AD-16

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/30/2010

PREPARED BY: Jeff Sammons **LOGGED BY:** Matt Lyon/Jeff Sammons

LATTITUDE: N 32°27.680' Datum: WGS-84 **WELL LOCATION:** North of Mine Haul Road

LONGITUDE: W94°29.642'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS		USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1 2				0-2	SM	Silty sand, very fine grained, light brown	None	Dry
3 4 5 6 7 8				2-8	CL	Sandy clay, yellowish brown, reddish brown -some iron oxide concretions at 2.5' -light gray at 5'	None	Dry
9 10				8-10	CL	Clay, red, light yellowish brown, gray, fat, hard, some very fine laminated sand seams	None	Dry
11				10-11	CL	Sandy clay, red, light gray, yellowish brown, stiff to hard	None	Dry
12 13 14				11-14.25	CL	Clay, yellowish brown, some sand, reddish brown, light gray, hard -clayey sand seam at 14-14.25', yellowish brown, light gray	None	Dry Moist
15 16 17 18				14.25-18	CL	Sandy clay, red, light gray, gray, very thin sand lenses interbedded in clay	None	Moist to V. Moist
19 20 21 22 23 24 25 26 27 28 29 30 31 32			▽ (23)	18-29.5	CL	Clay, reddish gray, light gray, yellowish brown, hard, gray -2" reddish brown iron oxide cemented sand laminations at 19.75' -very moist, 1" gravelly sand lense, very fine gypsum crystals at 21' -sandy 22', 22.5', 24' -gray, yellowish brown at 24-24.5' - dark gray, very fine gypsum crystals, trace sand, hard, dry, at 25'	None	Moist V. Moist Dry
33 34 35				32-35	SC	Clayey sand, greenish gray, light gray, some very fine gypsum crystals, dense	None	Moist
36 37 38 39 40						Boring Terminated at 35'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth:	35 feet	**Riser Interval:**	+3 (ags)-15'
Filter Sand (Size/Interval):	13-35'	**Screen Interval:**	15-35'
Grout (Type/Interval):	Grout from 0-2'; Bentonite from 2-13'	**Water level:**	23.37'
Surface Completion	☐ Flush	☒ Above Ground	3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ____ ■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-23

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

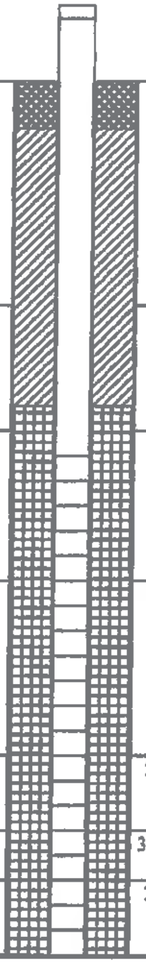
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/15/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 **WELL LOCATION:** ____
LONGITUDE: W94°29'41.3"

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
							
1 2 3 4 5 6 7 8 9			0-9	SC	Clayey sand, brown, with yellowish brown and orangish brown laminations, very fine grained, very silty, few light gray clay streaks	None	Moist
10 11 12 13 14			9-14	ML	Siltstone with light gray clay streaks, light gray with orangish brown streaks, few small iron ore pebbles	None	Moist
15 16 17 18 19 20			14-20	SM	Sand, light gray with orangish brown streaks, very silty, very fine grained, few clay laminations	None	Slightly Moist
21 22 23 24 25 26 27			20-27	ML	Siltstone, light gray with orangish brown streaks	None None	Very Moist V. Moist
28 29 30			27-30.5	SM	Sand, light brown mottled with orangish brown, very fine grained, very silty	None	Wet
31 32			▽ 30.5-31.5	SC	Slightly sandy clay, orangish brown mottle with orangish brown, silty, very fine grained (30-31.5')	None	Moist
33 34 35			31.5-35	CL	Lean clay, dense, small sandy streaks, dark gray, very fine grained (31.5-35')	None	Moist
36 37 38 39 40					Boring Terminated at 35'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth:	35 feet	Riser Interval:	+3 (ags)-15'
Filter Sand (Size/Interval):	13-35'	Screen Interval:	15-35'
Grout (Type/Interval):	Grout from 0-2'; Bentonite from 2-13'	Water level:	30.83
Surface Completion	Flush ■	Above Ground	3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-24

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

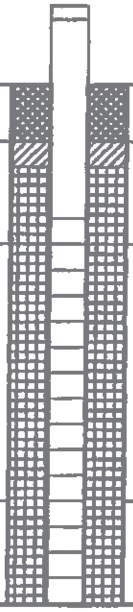
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/27/2010

PREPARED BY: Jeff Sammons **LOGGED BY:** Jeff Sammons

LATTITUDE: N 32°27.024' Datum: WGS-84 **WELL LOCATION:** South of LF pond dam
LONGITUDE: W94°29.940'

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS		USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
								
1 2				0-1.5	SM	Silty sand, very fine grained, some clay, brown and reddish brown, medium dense	None	Moist
3 4 5 6				1.5-6.5	SC	Clayey sand, silty, gray, yellowish brown, reddish brown, very fine grained, dense -some iron oxide concretions and gravel at 5-6', trace organic matter at 6', gray, dark gray, reddish brown, loose to med. dense	None	Dry Moist
7 8 9 10 11 12 13 14 15 16			▽	6.5-16	SM	Silty sand, very fine grained, red, loose, trace clay -some gravel at 10' -hard cemented sandstone with iron oxide at 11' - some clay at 15-16', medium dense, gray, dark gray	None	Saturated Moist
17 18 19 20				16-20	Lignite	Lignite, black, loose, saturated at 16-17' - medium dense, moist at 17-20'	None	Saturated
21 22 23 24 25 26 27 28 29 30						Boring Terminated @ 20'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 20 feet
Filter Sand (Size/Interval): 3-20'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-3'
Surface Completion ☐ Flush ■ Above Ground 3'

Riser Interval: +3 (ags)-5'
Screen Interval: 5-20'
Water level: 8.4

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089

☐ **BORING**
BORING NUMBER: ______

■ **MONITOR WELL**
MONITOR WELL NUMBER: AD-25

FACILITY NAME: AEP- Pirkey Power Plant

FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc.

COMPLETION DATE: 12/14/2010

PREPARED BY: David Bedford

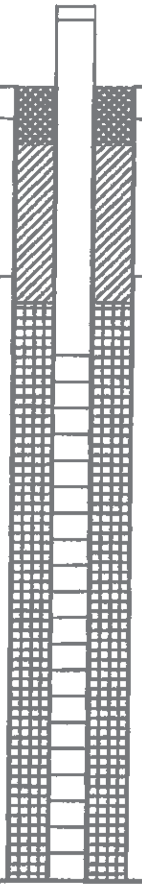
LOGGED BY: David Bedford

LATTITUDE: N 32°27'17.2"

Datum: WGS-84

LONGITUDE: W94°29'59.1"

WELL LOCATION: S. of Diesel ASTs



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS		USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1				0-1.5	SC	Clayey sand, brown, silty, very fine grained, moist	None	Moist
2				1.5-7	CH	Fat sandy clay, orangish brown, very fine grained, moist	None	Moist
3								
4								
5								
6								
7								
8				7-30	SC	Clayey sand, orangish brown mottled with dark gray,	None	Moist
9						very fine grained, few light gray clay inclusions		
10								
11								
12								
13								
14			▽			Wet @ 14'		Wet
15								
16						15-20' - few pieces of dark gray cystalline rock		
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32						Boring Terminated at 30'		
33								
34								
35								

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground 3'

Riser interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 12.69'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089
☐ **BORING** **BORING NUMBER:**
■ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-26

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

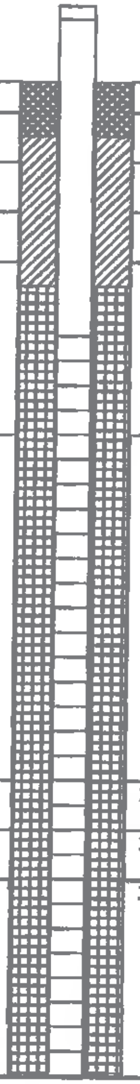
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/14/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'25.3" Datum: WGS-84 **WELL LOCATION:** By silt fence and plastic lined trench
LONGITUDE: W94°29'54.8"



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-1	SC	Slightly clayey sand, light brown, very fine grained, silty	None	Moist
2			1-3	CL	Sandy clay, lean, very fine grained, reddish brown	None	Moist
3							
4			3-5	CL	Lean, slightly sandy clay with clayey sand streaks, orangish brown, small coal pieces, very fine grained	None	Moist
5							
6			5-7	SC	Clayey sand, orangish brown, very fine grained, brown clay inclusions	None	Moist
7							
8			7-14	CL	Lean clay, orangish brown mottled with brown/light gray clayey sand streaks, very fine grained, few coal pieces	None	Moist
9							
10							
11							
12							
13							
14							
15			14-28	SC	Clayey sand, dark brown with orangish brown streaks, very fine grained, coal pieces	None	Slightly Wet
16							
17							
18							
19							
20			▽				Wet
21					20-22' - Large clay inclusions, brown		
22							Very Moist
23							
24							
25							
26					Wet from 25-26'		
27							
28							
29			28-30	CL	Lean clay, light gray with orangish brown streaks, few small sandy streaks, very fine grained	None	V. Moist
30							
31			30-32	SC	Clayey sand, light black, very fine grained, small pieces mica Wet from 30-30.5'	None	Wet
32							Moist
33			32-40	CL	Lean clay, orangish brown, small clayey sand streaks, very fine grained, brown streaks	None	Moist
34							
35							Slightly Wet
36							
37							
38							
39							
40							
					Boring Terminated at 40'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet
Filter Sand (Size/Interval): 8-40'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-40'
Water level: 19.45'
Above Ground 3'

Note: This log is not to be used separate from this report.

APEX PROJECT NO.: 110-089 ☐ **BORING** **BORING NUMBER:** ______ ☒ **MONITOR WELL** **MONITOR WELL NUMBER:** AD-27

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/15/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'36.8" Datum: WGS-84 **WELL LOCATION:** By corner lined ditch
LONGITUDE: W94°29'47.3"

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1 2			0-2	SC	Clayey sand, orangish brown with dark gray laminations, very fine grained	None	Slightly Moist
3 4 5 6 7 8 9 10			2-15.5	CL	Lean clay, dense, few thin sandy streaks, reddish orange, very fine grained, mottled with light brownish gray	None	Slightly Moist
11 12 13 14 15					Orange to brown with orangish brown streaks, at 10' becomes brittle		
16 17 18 19 20 21 22 23			15.5-23	SC	Clayey sand, greenish brown with orangish brown streaks, few thin tan clay streaks, very fine grained	None	Moist
24			23-24	SM	Sand, orangish brown, silty, very fine grained	None	Wet
25 26 27			24-27 ▽	CH	Fat clay, brown with orangish brown streaks, many sandy streaks, very fine grained	None	Very Moist
28 29 30			27-30	SM	Sand, greenish gray with orangish brown streaks, very fine to fine grained, wet	None	Wet
31 32 33 34 35			30-37.5	SC	Clayey sand with clay streaks, light greenish black, very fine grained	None	Slightly Wet
36 37					Wet red brittle shale from 35-35.2		
38 39 40					Boring Terminated at 37.5'		

▨ Cement ▧ Bentonite ▦ Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 40 feet **Riser Interval:** +3 (ags)-17.5'
Filter Sand (Size/Interval): 15.5-37.5' **Screen Interval:** 17.5-37.5'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-15.5' **Water level:** 26.73'
Surface Completion ☐ Flush ■ Above Ground 3'

Note: This log is not to be used separate from this report.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: AD-34

JDS 1-21-16
JEFFREY D. SAMMONS
GEOLOGY #10070

PROJECT INFORMATION

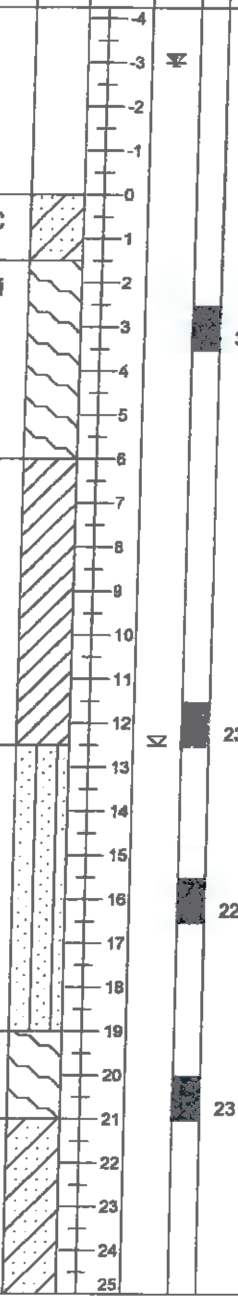
PROJECT:	**Pirkey Power Plant**
PROJECT NO.:	**I-04-1021**
LOGGED BY:	**Jeffrey D. Sammons, P.G.**
SUPERVISING PG:	**Jeffrey D. Sammons, P.G.**
COMPLETION:	**12/11/2015**
DEVELOPMENT:	**12/16/2015**
SITE LOCATION:	**2400 FM 3251, Hallsville, Texas**
WELL OWNER:	**AEP**

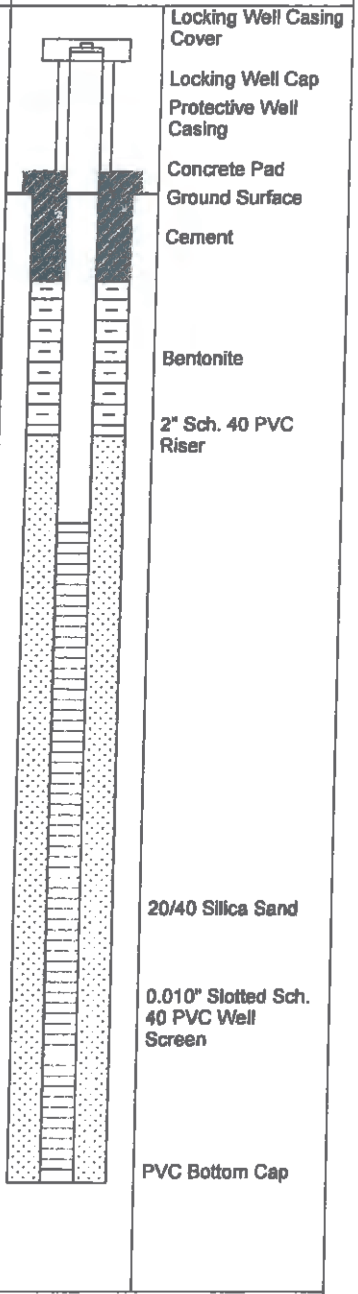
DRILLING INFORMATION

DRILLER:	**Buford Collier**
DRILLER'S LICENSE NO.:	**50089**
RIG TYPE:	**Geoprobe 3230DT**
METHOD OF DRILLING:	**Hollow Stem Auger**
SAMPLING METHODS:	**Split Core**
SURFACE ELEVATION:	**307.61 (Top of Casing)**
HOLE DIAMETER:	**8.25"**
LATITUDE	**32 27' 10.13"**
LONGITUDE	**94 29' 57.93"**

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample TBPG No. 50027

DESCRIPTION	USCS	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, some silt, reddish brownish, light reddish brown, light gray, moist	SC					
FAT CLAY: trace sand and silt, some iron oxide concretions, dark reddish brown, reddish brown, and and light gray, moist - some silt and very fine to fine sand at 5', light gray, light reddish brown, and light yellowish brown, moist to very moist	CH	31	89	63	23	40
SANDY LEAN CLAY: some very fine to fine sand, dark gray, moist - reddish brown, dark reddish brown, dark gray, light gray at 10' to 12.5'	CL	23	64	26	18	8
SILTY SAND: very fine to fine sand, some clay, gray and dark gray, saturated - increasing clay content with depth	SM	22	29	25	NP	-
FAT CLAY: trace sand and silt, gray, moist	CH	23	90	55	27	28
CLAYEY SAND: fine to very fine sand, dark gray, moist to very moist	SC					





NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-35**

JDS 1-21-16

JEFFREY D. SAMMONS

GEOLOGY #10070

PROJECT INFORMATION

PROJECT:	**Pirkey Power Plant**
PROJECT NO.:	**I-04-1021**
LOGGED BY:	**Jeffrey D. Sammons, P.G.**
SUPERVISING PG:	**Jeffrey D. Sammons, P.G.**
COMPLETION:	**12/11/2015**
DEVELOPMENT:	**12/16/2015**
SITE LOCATION:	**2400 FM 3251, Hallsville, Texas**
WELL OWNER:	**AEP**

DRILLING INFORMATION

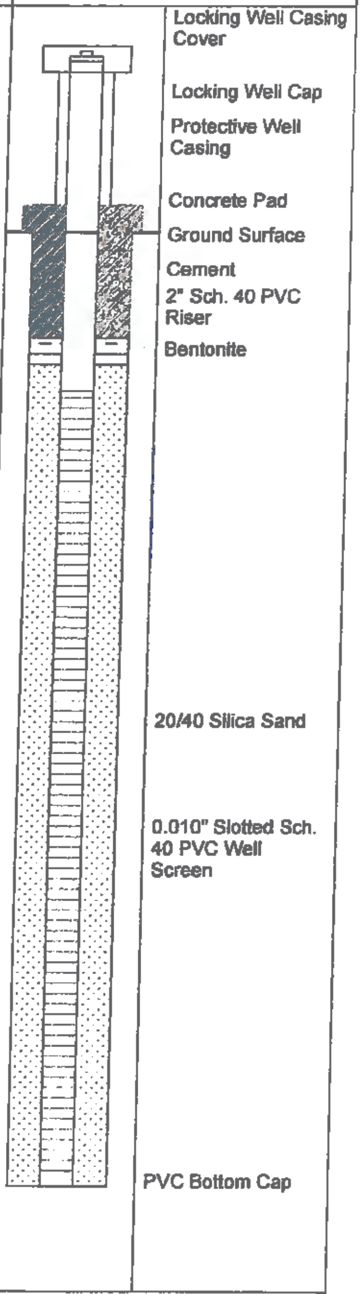
DRILLER:	**Buford Collier**
DRILLER'S LICENSE NO.:	**50089**
RIG TYPE:	**Geoprobe 3230DT**
METHOD OF DRILLING:	**Hollow Stem Auger**
SAMPLING METHODS:	**Split Core**
SURFACE ELEVATION:	**318.95 (Top of Casing)**
HOLE DIAMETER:	**8.25"**
LATITUDE	**32 27' 9.64"**
LONGITUDE	**94 29' 42.74"**

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ▨ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	SOIL SYMBOLS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, some iron ore gravel, reddish brownish, dark reddish brown, yellowish brown, gray, moist	SC		0–2		▨	13	46	32	15	17
SILTY SAND: very fine to fine sand, trace clay, trace iron ore gravel, light reddish brown, moist, increasing moisture content with depth - saturated at 10' to 11'	SM		2–11	▼ ▽	▨	12	26	16	NP	
CLAYEY SAND: very fine to fine sand, trace iron ore gravel, light reddish brown, very moist - thin seams of saturated very fine sand with trace of clay at 12.25' to 12.5' - light reddish brown and light gray, moist to very moist at 12.5' to 15'	SC		11–15		▨	19	33	31	18	13
LEAN CLAY: intebedded clays and silts with laminations of very fine sand, light gray, gray and light reddish brown, moist to very moist - thin lenses of very moist very fine sand and partially cemented very fine sand at 17.5' and 18', reddish brown	CL		15–20		▨	21	93	34	20	14

WELL CONSTRUCTION



NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

852164

LOG OF BORING

PROJECT: Monitoring Well Instllation

CLIENT: Southwestern Electric Power Company

BORING NO.: M-1

LOCATION: Hallsville, TX

S 12+32.79; W 35+34.55

Date: 1/29/86

Type: Rotary

Ground Elevation: 337.67

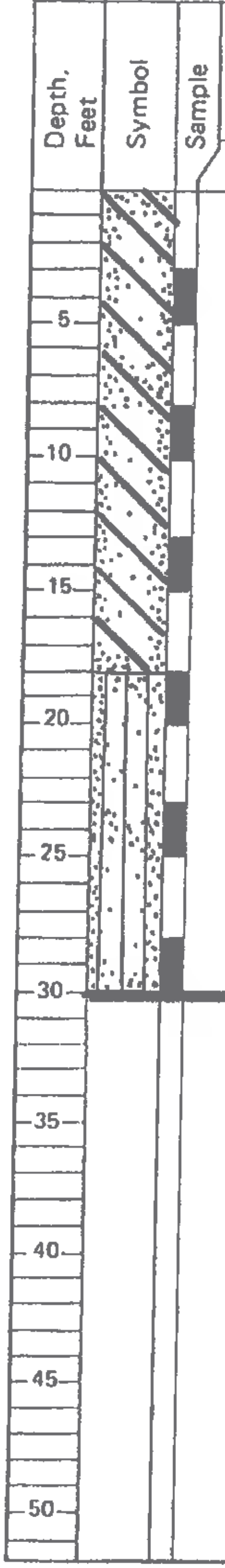
Legend:

■ Sample

X Penetration

▼ Water

Description of Stratum



Brown and tan sandy clay

Brown and tan sandy clay w/iron ore

Brown and tan sandy clay w/iron ore

Gray silty sand

Gray silty sand

Gray silty sand

Bottom of Boring at 30 feet.
Water encountered at 10 feet.

SOUTHWESTERN LABORATORIES

852164

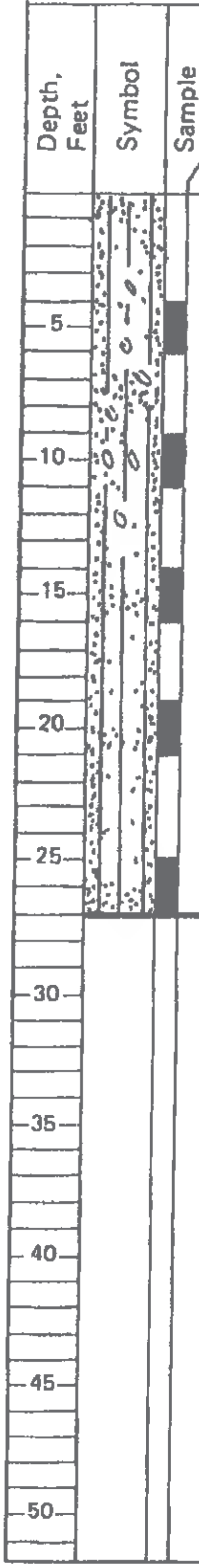
LOG OF BORING

PROJECT: Monitoring Well Installation
CLIENT: Southwestern Electric Power Company
BORING NO.: MW-2
LOCATION: Hallsville, TX
S 38+86.22; W 45+76.41

Date: 1/29/86
Type: Rotary
Ground Elevation: 302.19

Legend:
■ Sample
X Penetration
▼ Water

Description of Stratum



Brown silty sand w/iron ore

Brown silty sand w/iron ore

Brown and gray silty sand

Gray silty sand

Gray silty sand

Bottom of Boring at 27 feet.
Water encountered at 11 feet.

SOUTHWESTERN LABORATORIES

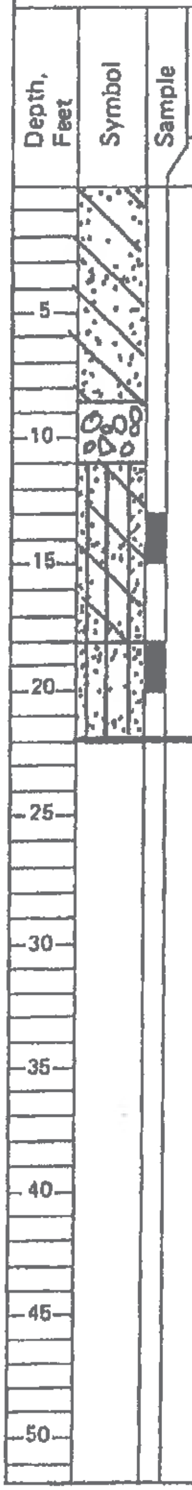
LOG OF BORING

852164

PROJECT:	Sludge Disposal Area	BORING NO.:	M. 2A
CLIENT:	Southwestern Electric Power Company	LOCATION:	Hallsville, TX
Date:	6/20/85	Type: Auger	Ground Elevation: 308.40

Legend: ▪ Sample X Penetration ▼ Water

Plant Site Coordinates: South S 27+55.45
West W 36+47.44



Description of Stratum

Red-brown clayey sand

Gravel

Gray clayey silty sand

Gray silty sand

Bottom of Boring at 22 feet.
Water encountered at 12 feet.

Bottom of Casing at 22 feet.
Screen length 15 feet.

SOUTHWESTERN LABORATORIES

Log of Boring	Number M-3	Location Harrison Co., miles SW Marshall City Ha

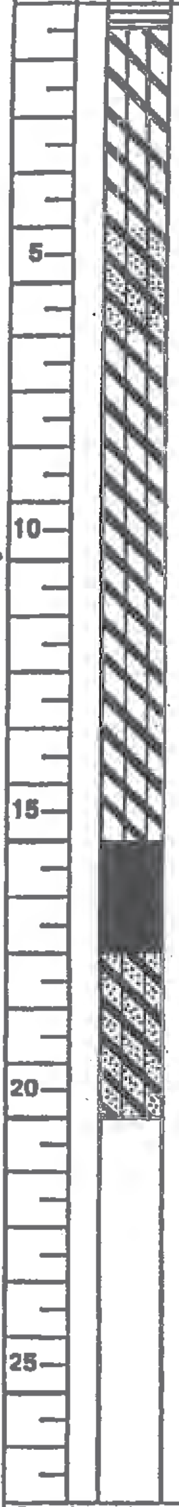
Project
New Monitor Well Installation, H.W. Pirkey Power Plant

Type
Groundwater Monitor Well

Surface Elevation
275.0'

Depth Feet | Samples | Hand Penetrometer (Tons/Sq. Ft.) | Standard Penetration (Blows/Foot)

STRATUM DESCRIPTION



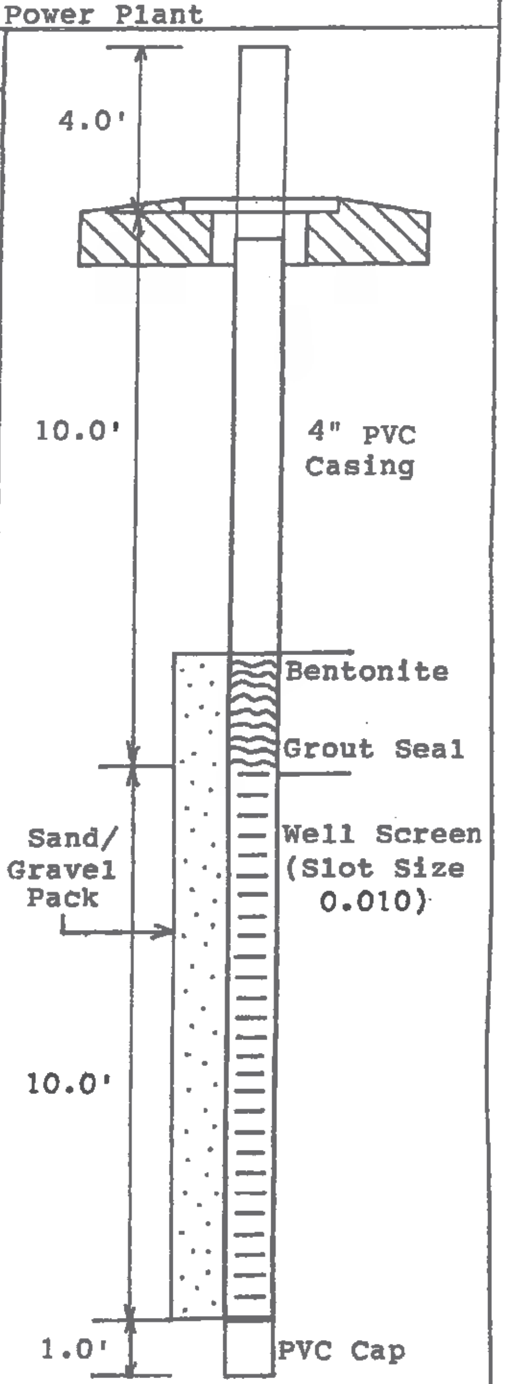
Sod
Brown Silty Clay

Brown Silty Sandy Clay

Red & Gray Silty Clay

Lignite

Tan Silty Sandy Clay



Completion Depth 20'	Date 7-1-93	Water Observations Water Encountered at 10.0'

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CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

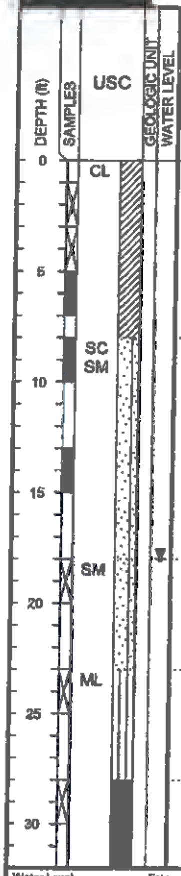
LOG OF BORING L-1

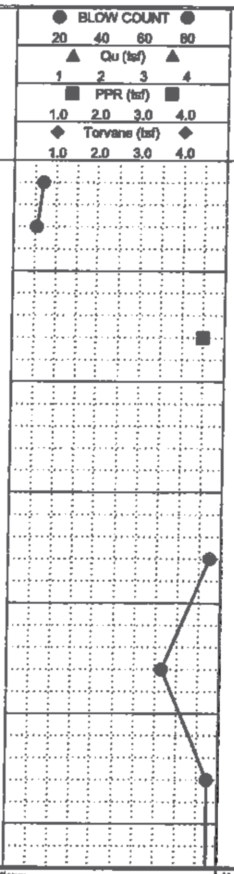
PROJECT: Pirkey Power Plant
Hallsville, Texas

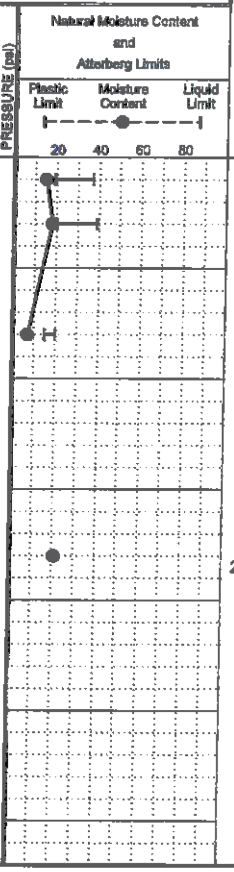
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 296.0







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	ATTERBERG LIMITS(%) PLASTIC LIMIT PL	ATTERBERG LIMITS(%) PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; orangish gray	N=14					15	37	19	18	74	+40 Sieve=7%, +4 Sieve=2%
	--reddish brown	N=11					18	39	20	19	74	+40 Sieve=11%, +4 Sieve=3%
SC SM	SILTY CLAYEY SAND(SC-SM) reddish brown; with gravel	P=4.5+					7	20	15	5	32	+40 Sieve=61%, +4 Sieve=33%
	--reddish tan; with iron oxide cemented sandstone	SF										
SM	SILTY SAND(SM) very dense; dark gray; laminated; saturated	N=50/3"					21				30	+40 Sieve=0%, +4 Sieve=0%
ML	SANDY SILT(ML) very dense; dark gray; with lignite @ 24'	N=73										
	LIGNITE very dense; black	N=50/0.5"										

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 17' while drilling. Water level @ 18' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING L-1

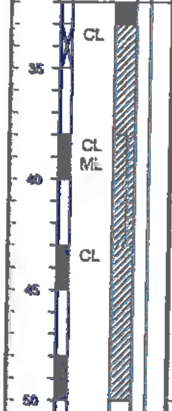
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

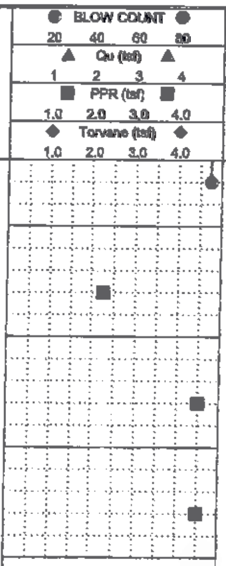
BORING TYPE: Flight Auger

DATE 10/19/08

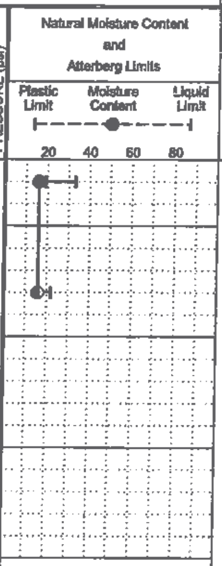
SURFACE ELEVATION 296.0



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	LEAN CLAY(CL) hard; light grey; with vertical black silty seam	N=50/3"	16	33	19	14	97	+40 Sieve=0%, +4 Sieve=0%
CL ML	SANDY SILT CLAY(CL-ML) hard; grey	P=2.25 P=4.5+	16	22	16	6	51	+40 Sieve=0%, +4 Sieve=0%
CL	LEAN CLAY(CL) hard; dark brown laminated	P=4.5+						
		P=4.5+						
	Bottom of Boring @ 50'							



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 17' while drilling. Water level @ 18' and open upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

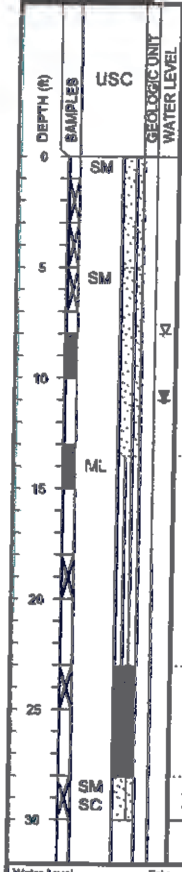
LOG OF BORING L-2

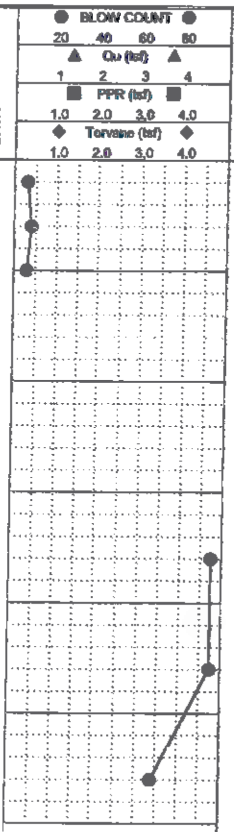
PROJECT: Pirkey Power Plant
Hallsville, Texas

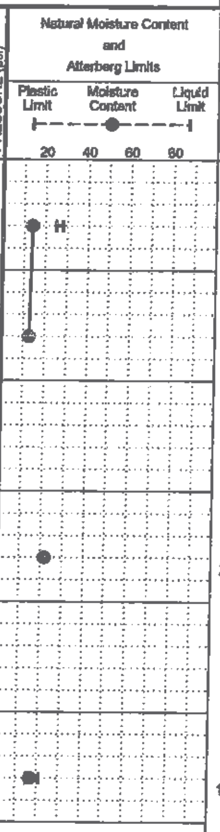
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/19/09

SURFACE ELEVATION 291.4







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SM	SILTY SAND(SM) loose; tan	N=6										
		N=8					14	28	25	3	45	+40 Sieve=22%, +4 Sieve=17%
SM	SILTY SAND(SM) loose; tan	N=6										
	--red and gray	SF					13				15	+40 Sieve=61%, +4 Sieve=45%
	--with gravel											
ML	--dark gray SANDY SILT(ML) dark gray	SF										
		N=50/4"					22				61	+40 Sieve=0%, +4 Sieve=0%
	LIGNITE very dense; black	N=50/3"										
SM SC	SILTY CLAYEY SAND(SM-SC) very dense; dark gray; laminated with gray silt	N=68					17	21	15	6	49	+40 Sieve=0%, +4 Sieve=0%
	Bottom of Boring @ 30'											

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 8' while drilling. Water level @ 26' and open to 26' upon completion. Water level @ 11' and open to 28' after

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.034', W 94°29.952'

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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING R-1

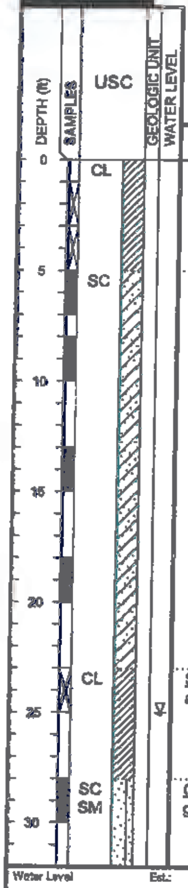
PROJECT: Pirkey Power Plant
Hallsville. Texas

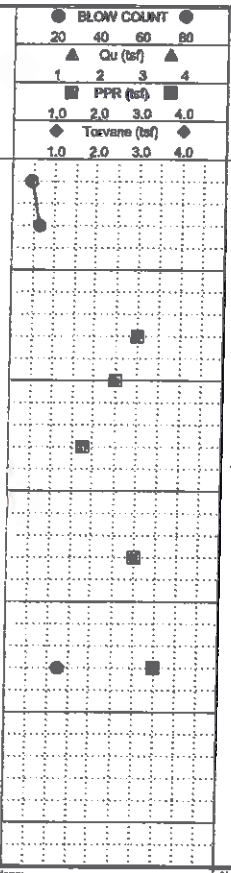
PROJECT NO.: G3241-095

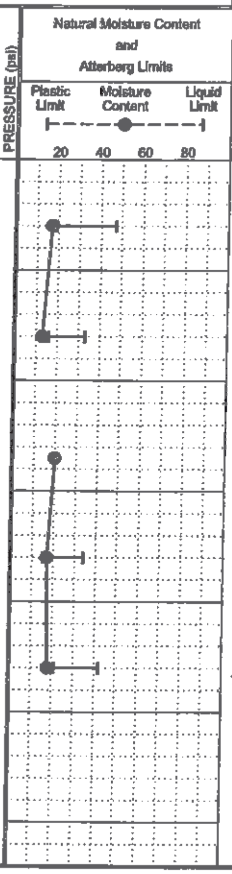
BORING TYPE: Flight Auger

DATE 10/19/09

SURFACE ELEVATION 356.3







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) medium stiff; red and brown; with gravel	N=9										
	—stiff; clay content increasing	N=13					17	47	19	28	52	+40Sieve=4%, +4 Sieve=1%
SC	CLAYEY SAND(SC) medium dense; reddish brown; with ferric seams	P=2.75										
		P=3.0					13	33	16	17	22	+40Sieve=36%, +4 Sieve=30%
		P=2.5										
	—with clay nodules	P=1.75 SF	106	1.10	4	9	20					
		P=3.0					17	34	15	19	39	+40Sieve=8%, +4 Sieve=1%
CL	SANDY LEAN CLAY(CL) very stiff; orange and tan; saturated	N=25 P=3.5					18	42	21	21	57	+40Sieve=9%, +4 Sieve=6%
SC SM	CLAYEY SILTY SAND(SC-SM) orange and gray	SF										

Water Level Est.: ∇ Measured: ∇ Perched: ∇

Water Observations: Seepage @ 25' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING R-1

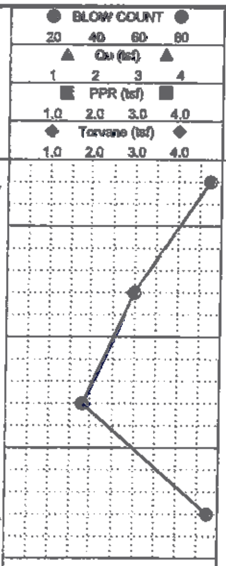
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

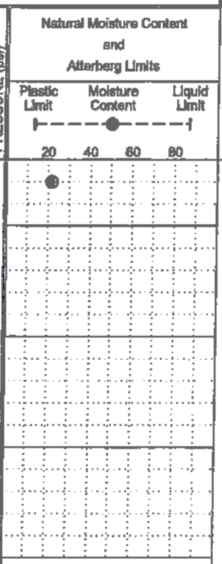
DATE 10/19/09

SURFACE ELEVATION 356.3

DEPTH (ft)	SAMPLES	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	X	SM	SILTY SAND(SM) very dense; gray; with gravel	N=50/5.5"	22				16	+40Sieve=2%, +4 Sieve=1%
40	X		--orange and gray	N=60						
45	X		--brown	N=36						
50	X		--brown and gray	N=50/5.75"						
			Bottom of Boring @ 50'							



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 25' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING R-2

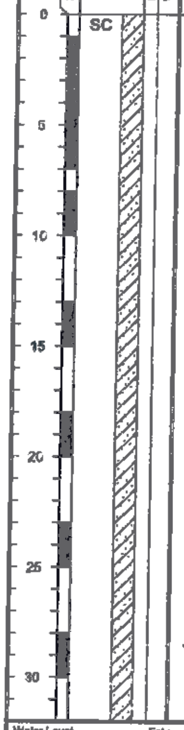
PROJECT: Pirkey Power Plant
Hallsville, Texas

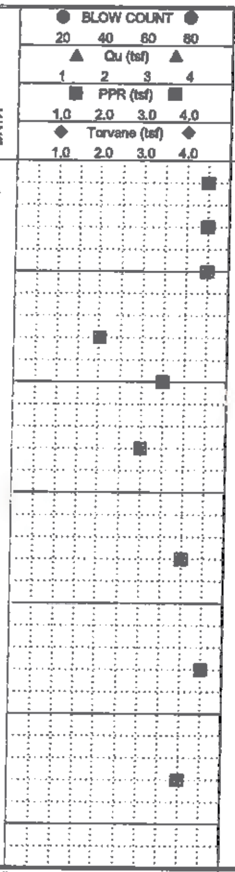
PROJECT NO.: G3241-095

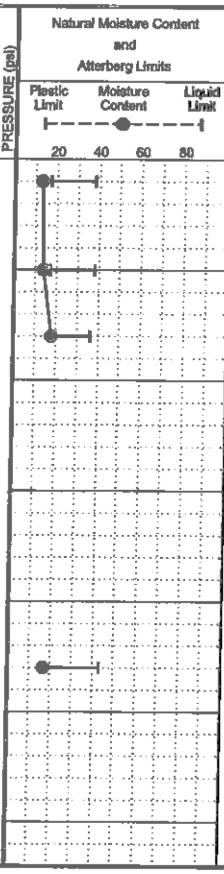
BORING TYPE: Flight Auger

DATE 10/19/09

SURFACE ELEVATION 355.1







USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) medium dense; reddish tan; with gravel	P=4.5+					13	38	17	21	44	+40Sieve=6%, +4 Sieve=2%
		P=4.5+										
	–red and orangish gray; with clay lenses	P=4.5					14	38	17	21	41	+40Sieve=9%, +4 Sieve=3%
	–gravelly and ferric seams	P=2.0					18	36	18	18	44	+40Sieve=12%, +4 Sieve=5%
		P=3.5										
	–orange and red	P=3.0										
		P=4.0										
	–red and tan	P=4.5+					17	43	18	25	42	+40Sieve=6%, +4 Sieve=0%
	–red and orange	P=4.0										

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 38' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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Tyler, Texas 75702
(903) 595-4421

LOG OF BORING R-2

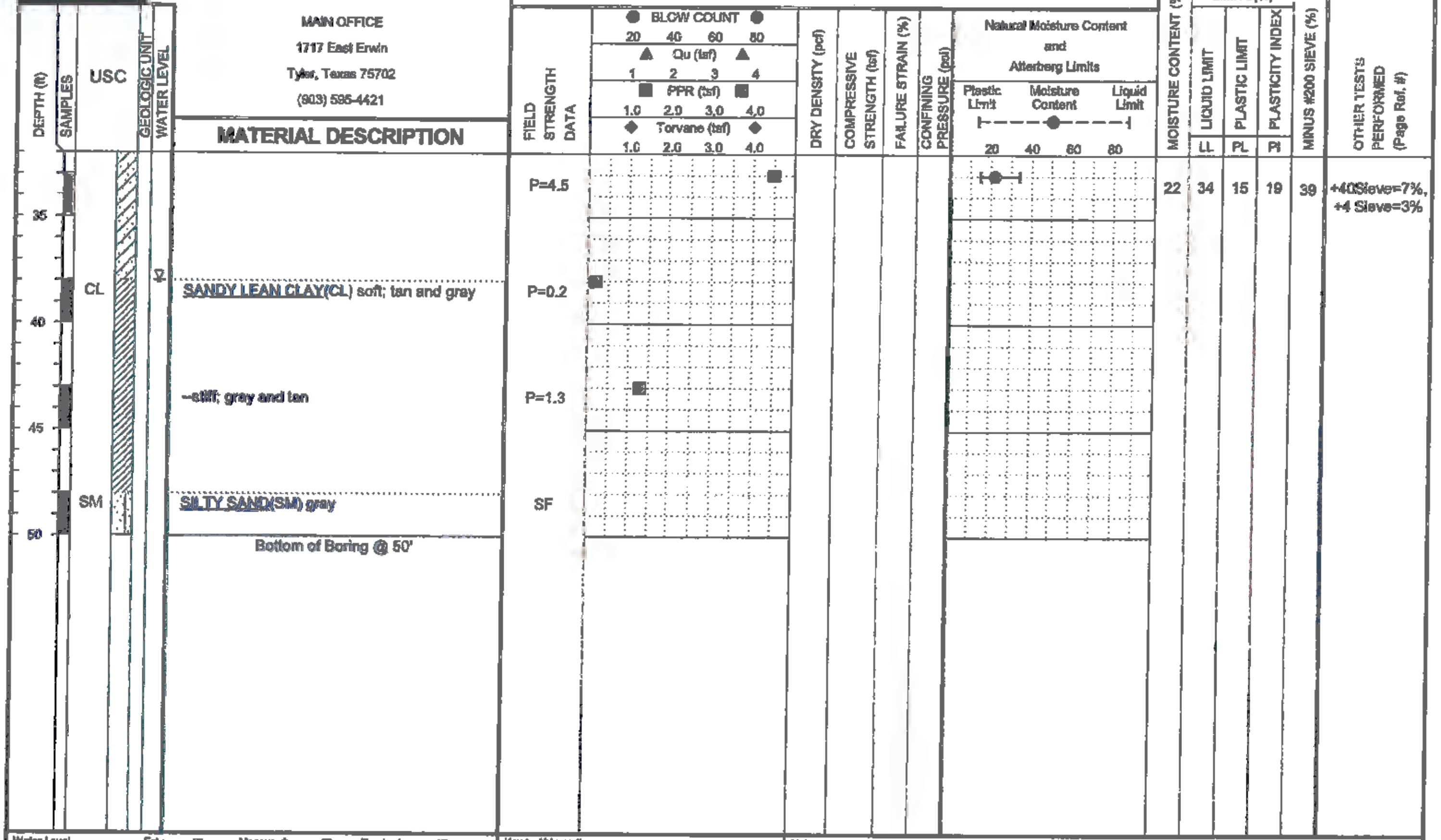
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/19/09

SURFACE ELEVATION 355.1



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
		P=4.5	22	34	15	19	39	+40Sieve=7%, +4 Sieve=3%
CL	SANDY LEAN CLAY(CL) soft; tan and gray	P=0.2						
	--stiff; gray and tan	P=1.3						
SM	SILTY SAND(SM) gray	SF						
	Bottom of Boring @ 50'							

Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 38' while drilling.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING R-3

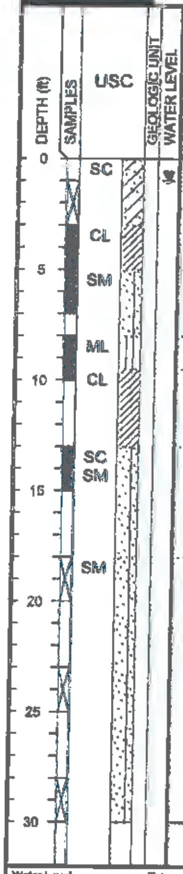
PROJECT: Pirkey Power Plant
Hallsville, Texas

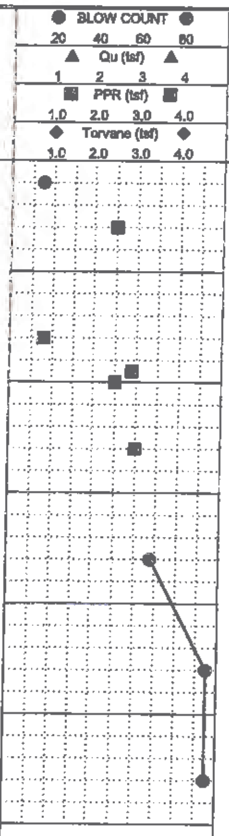
PROJECT NO.: G3241-095

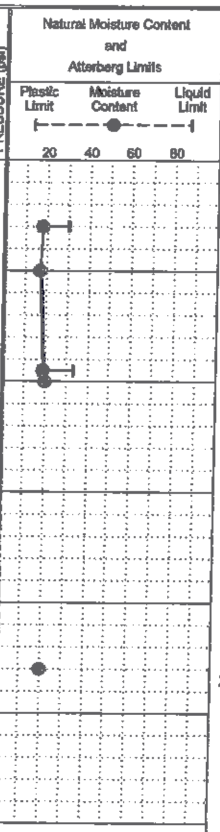
BORING TYPE: Flight Auger

DATE 10/19/09

SURFACE ELEVATION 342.5







MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) medium dense; tan	N=15										
CL	LEAN CLAY(CL) very stiff; tan and gray; laminated	P=2.5					18	30	16	14	88	+40Sieve=5%, +4 Sieve=1%
SM	SILTY SAND(SM) tan; with gravel	SF					17				30	+40Sieve=16%, +4 Sieve=9%
ML	SANDY SILT(ML) very loose; tan	P=0.8										
CL	LEAN CLAY(CL) very stiff; tan	P=2.5 P=2.9	108	1.60	7	7	19 20	33	17	16	86	+40Sieve=1%, +4 Sieve=0%
SC SM	SILTY CLAYEY SAND(SC-SM) medium dense; tan and gray	P=3.0										
SM	SILTY SAND(SM) very dense; tan and gray	N=68										
		N=50/6"					20				21	+40Sieve=1%, +4 Sieve=0%
		N=50/4"										
	Bottom of Boring @ 30'											

Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 6' while drilling. Water level @ 1' and open to 28' upon completion.

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:
GPS Coordinates: N 32°27.313', W 94°29.240'

Appendix B

Photographic Log

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 1	**Date:** 8/19/2015

Direction Photo Taken:

South

Description:

P8190454
Upland drainage area along southeastern side of Landfill.

ARCADIS

PHOTOGRAPHIC LOG

Project Name: AEP – Pirkey Power Plant	**Location:** Hallsville, Harrison County, Texas	**Project No.** OH015976.0001

Photo No. 2	**Date:** 8/19/2015

Direction Photo Taken:

South

Description:

P8190467
Lining for new landfill expansion cell

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	**Location:**	**Project No.**
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	**Date:**
3	8/19/2015

Direction Photo Taken:

East Northeast

Description:

P8190470
Lining for new landfill expansion cell

ARCADIS

PHOTOGRAPHIC LOG

Project Name:	**Location:**	**Project No.**
AEP – Pirkey Power Plant	Hallsville, Harrison County, Texas	OH015976.0001

Photo No.	**Date:**
4	8/19/2015

Direction Photo Taken:

East Northeast

Description:

P8190475
Upland ditch on east side of landfill.

Appendix C

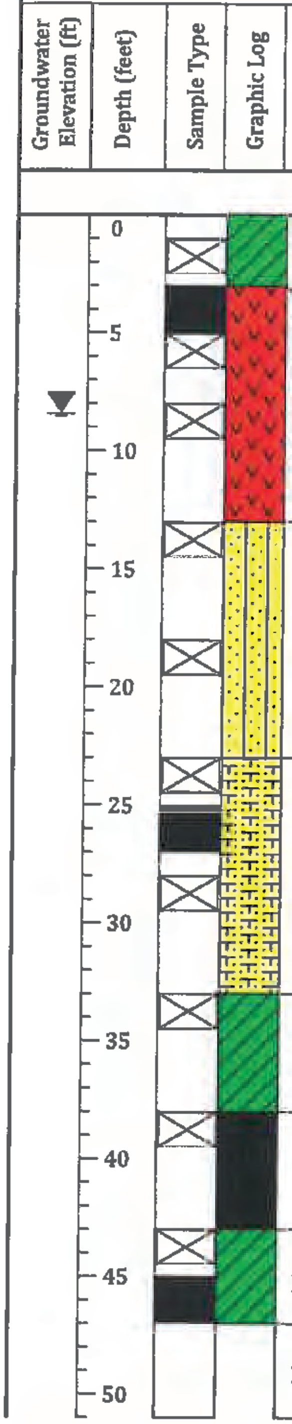
Soil Boring Logs and Piezometers - 2018 Landfill Lateral Expansion Area

Auckland Consulting LLC

LOG OF BORING B1

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/07/2016

GPS Coordinates: N32° 27' 12.0" W94° 29' 48.6"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Medium Stiff, red, brown and gray, Sandy Lean Clay (CL), mottled, few gravel	8			52	16	39	13	26	
Gray, Bottom Ash		N/A			15				64
	13								
	6								
Very Loose, brown, gray and red, Silty Clayey Sand (SC-SM), mottled, with organics (roots)	3			49	24	22	16	6	
- red, tan and gray at 18 ft	1								
Very Loose, light gray, red and tan, Silty Sand (SM), mottled	1			36	19	NP	NP	NP	
		N/A							
- loose, few clay below 28 ft	10			31	19				
Very Stiff, dark gray and gray, Sandy Lean Clay (CL)	24			55	21	29	13	16	
Black, Lignite	50/2								
Hard, dark gray and gray, Lean Clay (CL), laminated, few lignitic material	61								
		4.5		97	20	38	20	18	105
Boring terminated at 47 feet.									

Additional Information/Comments:

Logger: D. Diduch

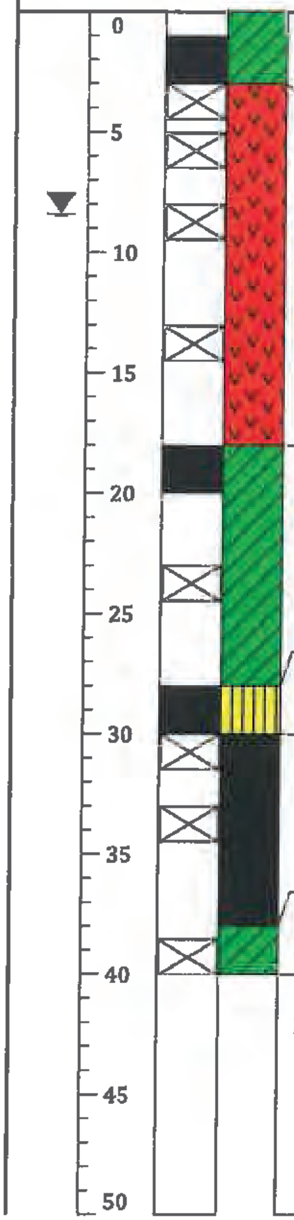
Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 8 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B2

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/06/2016

GPS Coordinates: N32° 27' 12.3" W94° 29' 45.3"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Very Stiff, red and brown, Sandy Lean Clay (CL), mottled, few gravel		2.5		57	18	30	12	18	
Gray, Bottom Ash	4								
	3								
	1								
	2								
Soft, dark gray, Sandy Lean Clay (CL)		0.5		62	20	34	13	21	91
- very soft below 23 ft	1								
Very Stiff, dark gray and gray, Sandy Silty Clay (CL-ML), with lignitic material		3.0		50	15	20	16	4	117
Black, Lignite	50/3								
	50/3								
Hard, gray and dark gray, Lean Clay (CL), laminated, trace gypsum	44			95	22	38	17	21	
Boring terminated at 40 feet.									

Additional Information/Comments:

Logger: D. Diduch

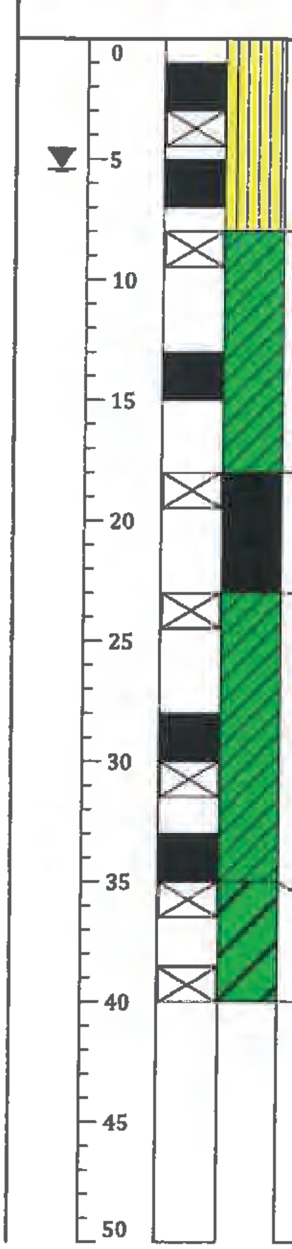
Notes/Comments: Seepage encountered at 8 ft during drilling. Water level at 8 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B3

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/08/2016

GPS Coordinates: N32° 27' 10.3" W94° 29' 45.9"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Soft, brown, tan and red, Sandy Silty Clay (CL-ML), mottled, with few organics		N/A							
	4			53	19	20	15	5	
		N/A							
Very Stiff, brown and gray, Lean Clay with Sand (CL), mottled, laminated	24			77	19	29	17	12	
- stiff below 13 ft		1.5		75	22	31	17	14	103
Black, Lignite	50/3.75								
Hard, gray, Lean Clay (CL), mottled, laminated, few lignitic material	55								
- very stiff between 28 ft and 30 ft		2.5		99	17	38	18	20	117
- hard below 30 ft	33								
- attempted, no recovery		N/A							
Very Stiff, gray, Fat Clay (CH), mottled, laminated, trace gypsum	27			97	23	51	17	34	
	26								
Boring terminated at 40 feet.									

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 5 ft during drilling. Water level at 5 feet upon completion.
N/A: Not Attempted

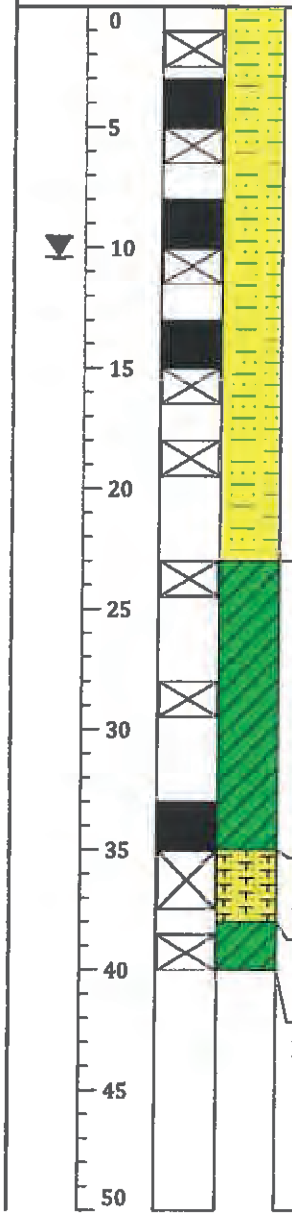
Auckland Consulting LLC

LOG OF BORING B4

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-011
Drill Date(s): 09/12/2016

GPS Coordinates: N32° 27' 9.0" W94° 29' 48.6"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Very Loose, reddish brown, Clayey Sand (SC), mottled	2								
- medium dense between 3 ft and 10 ft		3.5		27	14	23	14	9	
- few gravel below 5 ft	15								
		2.5		49	18	28	13	15	115
- loose between 10 ft and 15 ft	5								
		0.5		49	20	29	15	14	
- medium dense between 15 ft and 18 ft	27								
- very dense below 18 ft	60								
Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	32								
- very stiff at 28 ft	17			88	22	45	16	29	
- attempted, no recovery		N/A							
Very Dense, gray and tan, Silty Sand (SM), with lignitic material	50/2								
Hard, gray, dark gray and black, Lean Clay (CL), mottled, with lignitic material	95/11								
Boring terminated at 40 feet.									

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 10 ft during drilling. Water level at 10 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B5

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease

Project No.: 2016-011
Drill Date(s): 09/09/2016

GPS Coordinates: N32° 27' 9.2" W94° 29' 42.4"
Surface Elevation: N/A
Drilling Method: HSA

Groundwater Elevation (ft)	Depth (feet)	Sample Type	Graphic Log	Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
	0	☒	🟨	Loose, reddish brown, Clayey Sand (SC), mottled	8								
	5	■ ☒	🟩	Very Stiff, red and brown, Sandy Lean Clay (CL), mottled, few gravel	19	4.0	6.6	51	16	34	14	20	116
	10	■ ☒	🟨	Dense, red, tan and brown, Clayey Sand (SC), mottled	34	4.0		40	20				
▼	15	☒	🟩	Very Stiff, gray and tan, Lean Clay (CL), mottled, laminated	17			96	21	41	16	25	
	20	■ ☒	🟩	Very Stiff, gray and dark gray, Lean Clay with Sand (CL), mottled	38	3.0		55	18	29	17	12	
	25	☒	⬛	Black, Lignite	50/6								
	30	■ ☒	🟩	Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	39	4.0		99	21				
	35	☒	🟩	- very stiff at 33 ft	24								
	40	■ ☒	🟨	Medium Dense, gray and dark gray, Clayey Sand (SC)	27	2.5		45	27	36	16	20	
	45 50			Boring terminated at 42 feet.									

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 13 ft during drilling. Water level at 13 feet upon completion.
N/A: Not Attempted

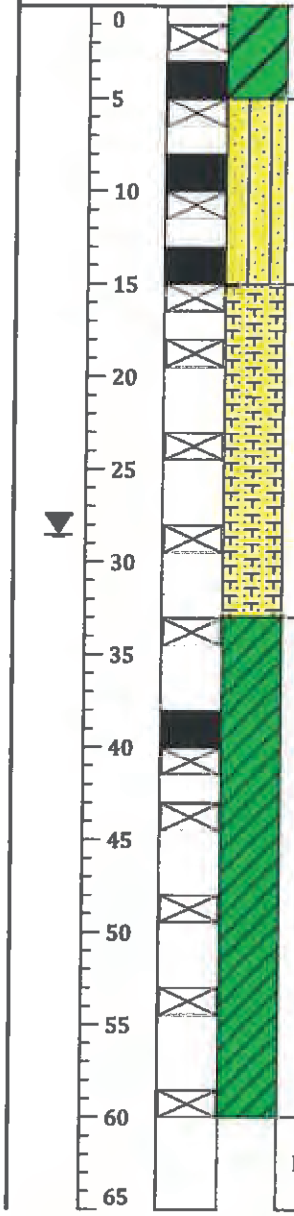
Auckland Consulting LLC

LOG OF BORING B6

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/16/2016

GPS Coordinates: N32° 27' 5.7" W94° 29' 48.0"
Surface Elevation: N/A
Drilling Method: HSA

Groundwater Elevation (ft) | Depth (feet) | Sample Type | Graphic Log



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Very Stiff, red and brown, Sandy Fat Clay (CH), mottled	17			55	19	61	25	36	
		4.5							
Medium Dense, light red, tan and brown, Silty Clayey Sand (SC-SM), mottled	28			48	11				
		3.5							
- tan, light red and gray below 8 ft, with few gravel between 8 ft and 10 ft	19								
		2.5		33	12	19	15	4	
Very Dense, tan, light red and gray, Silty Sand (SM), mottled	88/10								
	42								
- dense between 18 ft and 23 ft									
- medium dense between 23 ft and 28 ft	28								
- very dense below 28 ft	85/11			17	22	NP	NP	NP	
Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	72								
- little recovery, few sand between 38 ft and 40 ft		N/A							
	48			97	22	42	17	25	
- gray, dark gray and black, with lignitic material, laminated between 43 ft and 45 ft	50/3								
	40								
	60								
	40			98	19	42	17	25	
Boring terminated at 60 feet.									

Additional Information/Comments:

Logger: D. Diduch

Notes/Comments: Seepage encountered at 28 ft during drilling. Water level at 28 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B7

Project Name: Pirkey - 2019 Landfill Expansion

Project Location: Hallsville, Texas

Drilling Contractor: C&S Lease

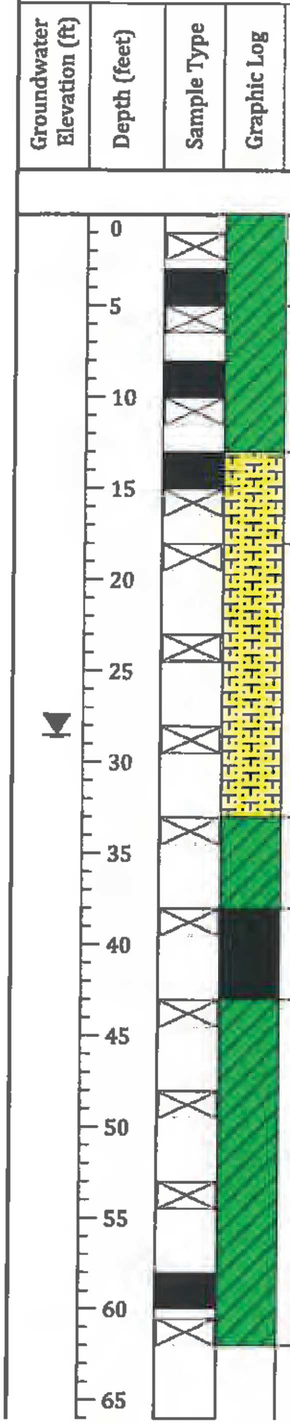
Project No.: 2016-011

Drill Date(s): 09/14/2016

GPS Coordinates: N32° 27' 7.1" W94° 29' 44.6"

Surface Elevation: N/A

Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Stiff, light red and tan, Sandy Lean Clay (CL), mottled	13			51	19				
		N/A							
Very Stiff, light tan, red and brown, Lean Clay (CL), mottled	20			85	17	29	14	15	
		N/A							
	21								
Very Dense, light gray, Silty Sand (SM)		N/A							
	87/10			45	10	NP	NP	NP	
Very Dense, red, brown and gray, Silty Sand (SM)	60								
	84/11			18	21				
	50/2								
Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	40								
Black, Lignite	50/5								
Hard, dark gray, Lean Clay (CL), mottled, laminated, trace gypsum	81								
	64								
	35			95	18	43	17	26	
- attempted, no recovery		N/A							
	77								
Boring terminated at 62 feet.									

Additional Information/Comments:

Logger: D. Diduch

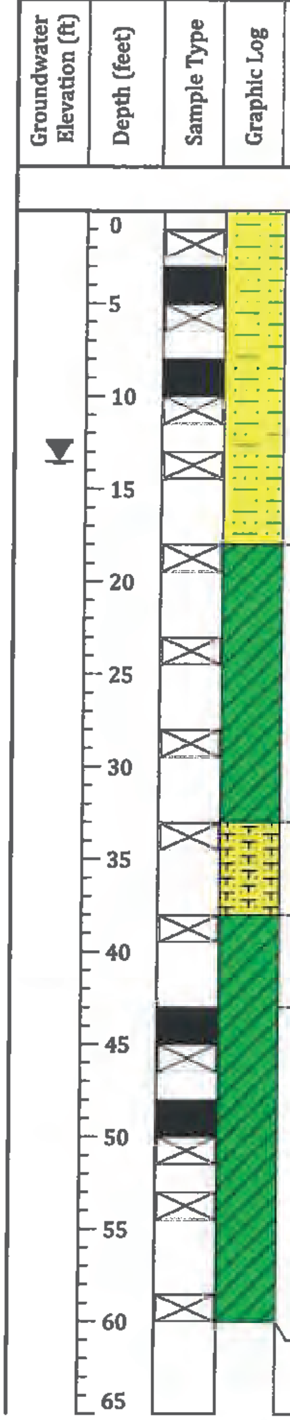
Notes/Comments: Seepage encountered at 28 ft during drilling. Water level at 28 feet upon completion.
N/A: Not Attempted

Auckland Consulting LLC

LOG OF BORING B8

Project Name: Pirkey - 2019 Landfill Expansion
Project Location: Hallsville, Texas
Drilling Contractor: C&S Lease
Project No.: 2016-011
Drill Date(s): 09/13/2016

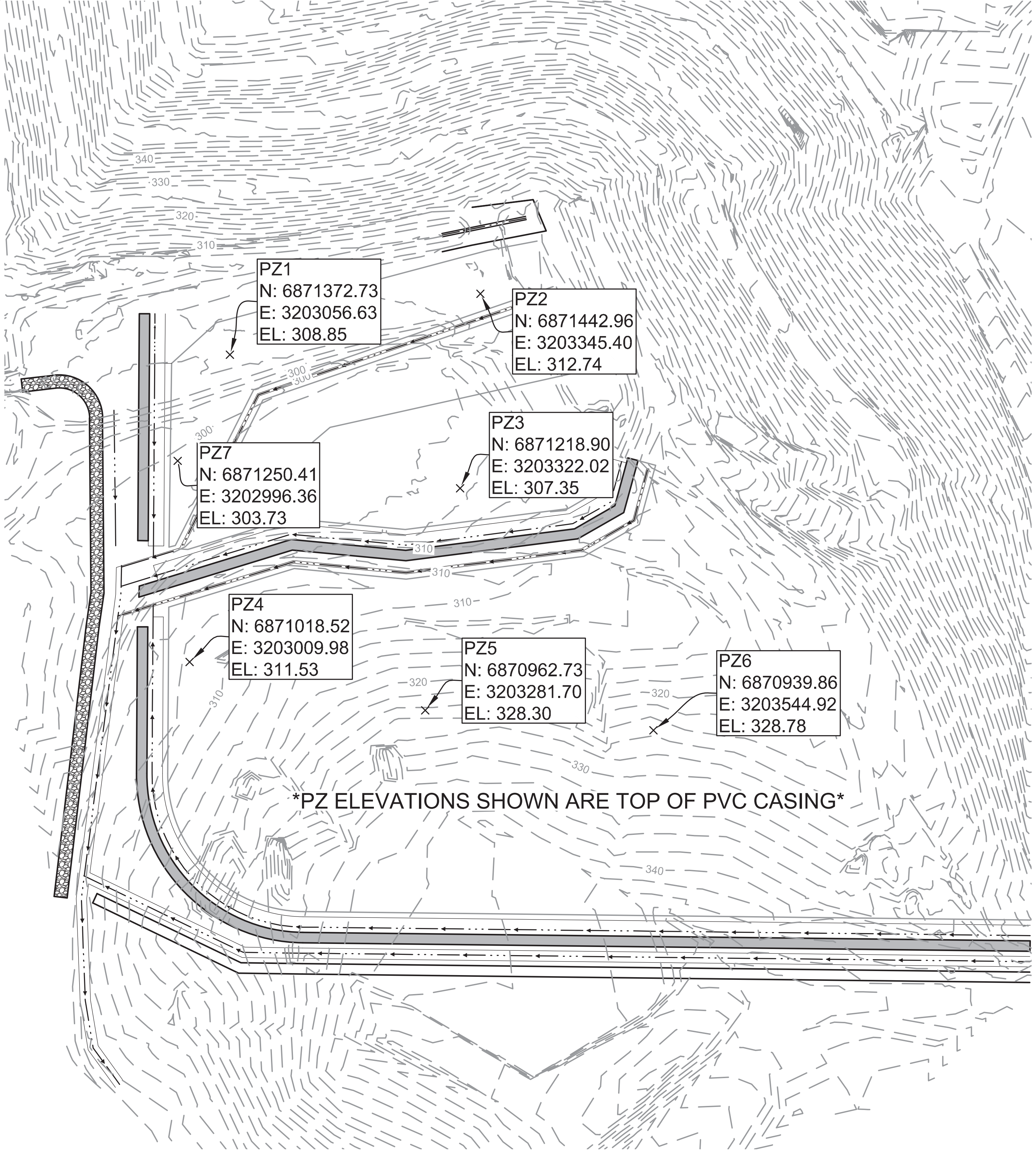
GPS Coordinates: N32° 27' 5.7" W94° 29' 39.6"
Surface Elevation: N/A
Drilling Method: HSA



Material Description	N-Value (Blows/ft)	Pocket Penetrometer (tsf)	Unconfined Strength (tsf)	Passing #200 Sieve (%)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	Unit Dry Weight (pcf)
Loose, red, tan, and brown, Clayey Sand (SC)	6								
		2.0		39	13	19	12	7	
	7								
		N/A							
- medium dense, light gray, red and tan below 8 ft	18			37	23				
	15								
Very Stiff, gray and brown, Lean Clay (CL), mottled, laminated	22			91	25	42	16	26	
- hard below 23 ft	79								
	79/11								
Very Dense, dark gray, Silty Sand (SM)	76/11			43	30	NP	NP	NP	
Very Stiff, gray and dark gray, Lean Clay (CL), mottled, laminated	21			97	23				
Stiff, gray and dark gray, Sandy Lean Clay (CL), mottled, with occasional lignitic seams		1.5		59	25	33	18	15	93
	22								
- attempted, no recovery		N/A							
	16			48	30				
	22								
- laminated at 58 ft	29			62	25	44	21	23	
Boring terminated at 60 feet.									

Additional Information/Comments:

Logger: D. Diduch
Notes/Comments: Seepage encountered at 13 ft during drilling. Water level at 13 feet upon completion.
N/A: Not Attempted



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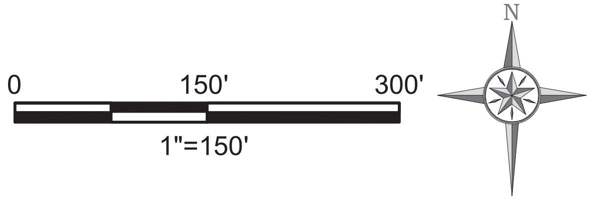

PZ WELL
AS-BUILT
LOCATIONS

STATE OF TEXAS WELL REPORT for Tracking #482280

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-1**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 11.79" N**
		Longitude:	**094° 29' 48.1" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/14/2018**

Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **Michael Aaron Dodson**

Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dla (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482283

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-2**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 12.36" N**
		Longitude:	**094° 29' 44.64" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**   Proposed Use: **Piezometer**

Drilling Start Date: **6/14/2018**   Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used**   **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **Michael Aaron Dodson**

Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**4**	**14**

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Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482286

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-3**
Address:	**502 N. Allen Strrreet** **Shreveport, LA 71101**	Grid #:	**35-37-4**
		Latitude:	**32° 27' 10.18" N**
Well Location:	**2400 Farm Road** **Hallsville, TX 75650**	Longitude:	**094° 29' 45.15" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/14/2018**

Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **Michael Aaron Dodson**

Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**4**	**14**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482290

Owner: **American Electric Power Company**

Address: **502 N. Allen Strreet**
Shreveport, LA 71101

Well Location: **2400 Farm Road**
Hallsville, TX 75650

Well County: **Harrison**

Owner Well #: **PZ-4**

Grid #: **35-37-4**

Latitude: **32° 27' 08.3" N**

Longitude: **094° 29' 48.73" W**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/15/2018** Drilling End Date: **6/15/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **Michael Aaron Dodson**

Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482295

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-5**
Address:	**502 N. Allen Strreet Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road Hallsville, TX 75650**	Latitude:	**32° 27' 07.7" N**
		Longitude:	**094° 29' 45.72" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**   Proposed Use: **Piezometer**

Drilling Start Date: **6/15/2018**   Drilling End Date: **6/15/2018**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**20**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
8	**20**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**1**	**Cement 1 Bags/Sacks**
1	**8**	**Bentonite 4 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used**   **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **Michael Aaron Dodson**

Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Sandy Clay**
5	**10**	**Very Soft Red/Brown Clay**
10	**15**	**Very Soft Red/Tan Sandy Clay**
15	**20**	**Tan/Red Silty Sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**10**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**10**	**20**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482297

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-6**
Address:	**502 N. Allen Strreet** **Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road** **Hallsville, TX 75650**	Latitude:	**32° 27' 07.69" N**
		Longitude:	**094° 29' 42.56" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Piezometer**

Drilling Start Date: **6/15/2018** Drilling End Date: **6/15/2018**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	0	20

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
8	20	Sand	20/40

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	1	Cement 1 Bags/Sacks
1	8	Bentonite 4 Bags/Sacks

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier**

License Number: **50089**

Apprentice Name: **Michael Aaron Dodson**

Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Sandy Clay**
5	**10**	**Very Soft Red/Brown Clay**
10	**15**	**Very Soft Red/Tan Sandy Clay**
15	**20**	**Tan/Red Silty Sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**10**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**10**	**20**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482288

Owner:	**American Electric Power Company**	Owner Well #:	**PZ-7**
Address:	**502 N. Allen Strreet** **Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road** **Hallsville, TX 75650**	Latitude:	**32° 27' 10.81" N**
		Longitude:	**094° 29' 48.7" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Piezometer**

Drilling Start Date: **6/14/2018**

Drilling End Date: **6/14/2018**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**14**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**14**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement 1 Bags/Sacks**
1	**3**	**Bentonite 2 Bags/Sacks**

Seal Method: **Poured**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Alternative Procedure Used**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**Red Soft Clay**
5	**10**	**Very Soft Red/Grey Clay**
10	**14**	**Very Soft Brown Sandy Clay**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**4**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**4**	**14**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Appendix D

Structural stability assessment required at § 257.73(d)

STRUCTURAL STABILITY ASSESSMENT

CFR 257.73(d)

East and West Bottom Ash Pond

Pirkey Plant
Hallsville, Texas

October, 2016

Prepared for: Southwest Electric Power Company (SWEPCO) - Pirkey Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

Document No. GERS-16-131

Structural Stability Assessment
CFR 257.73(d)
Pirkey Plant
East and West Bottom Ash Pond

PREPARED BY Brett A. Dreger DATE 10/12/2016
Brett A. Dreger, P.E.

REVIEWED BY DATE 10-13-16
Shah S. Baig, P.E.

APPROVED BY Gary F. Zych DATE 10/13/2016
Gary Zych, P.E.
Manager – AEP Geotechnical Engineering

10-13-2016
SHAHRIYAR S. BAIG
92172

I certify to the best of my knowledge, information and belief that the information contained in this structural stability assessment meets the requirements of 40 CFR 257.73(d)

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1.0 OBJECTIVE 257.73(d)

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of CFR 257.73(d) and document whether the design, construction, operations, and maintenance of the CCR unit is consistent with recognized and generally accepted good engineering practices. This is the initial assessment as per the Rule.

2.0 NAME AND DESCRIPTION OF CCR SURFACE IMPOUNDMENT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for storing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP).

The East BAP is located directly adjacent to and east of the West BAP. The East BAP receives sluiced bottom ash and has a surface area of 30.9 acres and a storage capacity of 188 acre-feet. The pond is almost entirely incised, with a reported maximum embankment height of 4 feet.

The West BAP, which also receives sluiced bottom ash, is located northwest of the main plant buildings and shares its eastern border with the western border of the East BAP. The West BAP receives sluiced bottom ash and has a surface area of 30 acres and a storage capacity of 188 acre-feet. The maximum embankment height is 25 feet. Design documents indicate that the main upstream embankment slopes are 3 feet horizontal to 1 foot vertical (3:1 H:V); while the main downstream slopes area 2.5:1 H:V.

3.0 STABLE FOUNDATION AND ABUTMENTS 257.73(d)(1)(i)

[Was the facility designed for and constructed on stable foundations and abutments? Describe any foundation improvements required as part of construction.]

The foundaion materials for the East BAP are native soils which consist of stiff to very stiff sandy lean clay (CL) and sandy fat clay (CH) with intermittent layers of medium dense to dense silty sand (SM) and clayey sand (SC). Atterberg Plasticity Indices of tested soils ranged between a low of 16 to a high of 39. Based on the subsurface investigation and engineering properties of the subsurface soils, it is concluded that the East Bottom Ash Pond dikes are supported on a stable foundation base.

The foundation materials for the West BAP are native soils which consist primarily of medium dense to very dense clayey sand (SC) with layers of of dense clayey gravel (GC) and very dense silty clayey sand (SC-SM). Atterberg Plasticity Indices of tested soils ranged between a low of 9 to a high of 46. Based on the subsurface investigation and engineering properties of the subsurface soils, it is concluded that the West Bottom Ash Pond dikes are supported on a stable foundation base.

Operation of the impoundment is performed so as to not adversely affect the foundation and abutments. As required by the CCR rules the Bottom Ash Pond Complex is inspected at least every 7 days by a qualified person. Also as a requirement of the CCR rules, the impoundment is also inspected annually by a professional engineer. Maintenance items are addressed as they are discovered as a part of those inspections.

4.0 SLOPE PROTECTION 257.73(D)(1)(II)

[DESCRIBE THE SLOPE PROTECTION MEASURES ON THE UPSTREAM AND DOWNSTREAM SLOPES.]

The east and west units have been constructed with a layer of bottom ash on the interior slope of the ash pond and limited riprap on random areas of the interior slopes that require slope protection from erosion and wave action. The exterior slopes consist of vegetative cover. Any erosion that may occur is repaired within a timely period.

5.0 EMBANKMENT CONSTRUCTION 257.73 (d)(1)(iii)

[Describe the specifications for compaction and/or recent boring to give a relative comparison of density.]

The East BAP is primarily incised into native soils with an embankment height of approximately 4 feet (AMEC, 2010). The East BAP embankments are constructed of compacted clay on a 3:1 slope (3 feet horizontal, 1 foot vertical) (Sargent & Lundy, 1983). The soils are primarily of stiff to very stiff sandy lean clay (CL) and sandy fat clay (CH) with intermittent layers of medium dense to dense silty sand (SM) and clayey sand (SC). The elevation of the top of embankment around the perimeter of the East BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, May 2011). The interior bottom elevation of the East BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Johnson & Pace, June 2011). Based on the subsurface investigation and the engineering properties of the subsurface soils, it is concluded that the East bottom Ash Pond embankments are adequately constructed.

The West BAP embankments have maximum height of approximately 25 feet and are constructed of compacted clay on a slope ranging from 2.5:1 (2.5 feet horizontal, 1 foot vertical) to 3:1 (Sargent & Lundy 1983). The elevation at the top of the embankment around the perimeter of the West BAP is approximately 357 feet amsl, and the normal operating level is approximately 354 feet amsl (Johnson & Pace, 2011). The embankment fill materials are primarily stiff to very stiff lean clay (CL) and/or fat clay (CH), overlying native soils consisting of primarily dense to very dense clayey sand (SC) with layers of dense gravel (GC) and very dense silty clayey sand (SC-SM). The interior bottom elevation of the West BAP is approximately 347 feet amsl (Sargent & Lundy, 1983; Akron Consulting, 2012). Based on the slope stability evaluation and the engineering properties of the subsurface soils, it is concluded that the West Bottom Ash Pond embankments are adequately constructed.

6.0 VEGETATION CONTROL 257.73 (d)(1)(iv)

[Describe the maintenance plan for vegetative cover.]

The vegetative slopes/areas are mowed to facilitate inspections and maintain the growth of the vegetative layer; and prevent the growth of woody vegetation.

7.0 SPILLWAY SYSTEM 257.73(d)(1)(v)

[Describe the spillway system and its capacity to pass the Inflow Design Flood as per its Hazard Classification.]

Hydrology and Hydraulic Analysis which includes calculations for each spillway structure are included in Inflow Design Flood Control Plan. The Inflow Design Flood for the East and West Bottom Ash Ponds is the 100-year storm event.

The surface water elevation in the East BAP is controlled by a weir box and a manually operated gate valve installed on a 36-inch diameter discharge pipe at the southwest corner of the pond. Clear water overflow from the East BAP discharges through the 36-inch diameter pipe into a 2.7 acre Clearwater Pond located directly south of the East BAP. Water in the Clearwater Pond is either pumped (re-circulated) back into the boiler ash hopper, or gravity discharged through a pipe at the southwest corner of the Clearwater Pond into an unnamed intermittent tributary of Hatley Creek via outfall 006 in accordance with Texas Pollutant discharge Elimination system (TPDES) Permit no. WQ0002496000.

The surface water elevation in the West BAP is controlled by a weir box and a manually operated gate valve installed on a 36-inch-diameter discharge pipe at the southeast corner of the pond. Clear water overflow from the West BAP discharges through the 36-inch diameter pipe into a 2.7 acre Clearwater Pond located southeast of the West BAP. Water in the Clearwater Pond is either pumped (re-circulated) back into the boiler ash hopper, or gravity discharged through a pipe at the southwest corner of the Clearwater Pond into an unnamed intermittent tributary of Hatley Creek via outfall 006 in accordance with Texas Pollutant discharge Elimination system (TPDES) Permit no. WQ0002496000.

Based on the Hydrology and Hydraulic analysis the East and West BAP’s spillway system can handle the 100-year storm event.

8.0 BURIED HYDRAULIC STRUCTURES 257.73 (d)(1)(vi)

[Describe the condition of the sections of any hydraulic structure that in buried beneath and/or in the embankment.]

Clear water overflow from the East BAP discharges through a 36-inch diameter corrugated steel pipe that passes into a 2.7 acre Clearwater Pond located directly south of the East BAP. The 36-inch diameter corrugated steel pipe passes under the embankment that separates the

East Bottom Ash Pond from the clear water pond. In 2012 when the clear Water pond was completely drained exposing the out fall end of the pipe, the 36 CMP appeared to be in stable and functional condition.

Clear water overflow from the West BAP discharges through a 36-inch diameter corrugated steel pipe that passes into a 2.7 acre Clearwater Pond located directly southeast of the West BAP. The 36-inch diameter corrugated steel pipe passes under the embankment that separates the West Bottom Ash Pond from the clear water pond. In 2012 when the clear Water pond was completely drained exposing the out fall end of the pipe, the 36 CMP appeared to be in stable and functional condition.

9.0 SUDDEN DRAWDOWN 257.73 (d)(1)(vii)

[If the downstream slope is susceptible to inundation, discuss the stability due to a sudden drawdown.]

The downstream slope of the Bottom Ash dikes will not be inundated from any adjacent water bodies.

Appendix E

The most recent safety factor assessment required at § 257.73(e)

PERIODIC SAFETY FACTOR ASSESSMENT

CFR 257.73(e)(1)

East Bottom Ash Pond

Pirkey Power Plant
Hallsville, Texas

October, 2016

Prepared for: Southwest Electric Power Company – Pirkey Power Plant
Hallsville, Texas

Prepared by: American Electric Power Service Corporation
1 Riverside Plaza
Columbus, OH 43215

Document ID Number: GERS-16-143

PERIODIC SAFETY FACTOR ASSESSMENT
CFR 257.73(e)(1)
PIRKEY POWER PLANT
EAST BOTTOM ASH PONDS

PREPARED BY Brett A. Dreger DATE 10/14/2016
Brett A. Dreger, P.E.

REVIEWED BY DATE 10-14-2016
Shahriyar S. Baig, P.E.

APPROVED BY Gary F. Zych DATE 10/14/2016
Gary F. Zych, P.E.
Department Manager – AEP Geotechnical Engineering

I certify to the best of my knowledge, information, and belief that the information contained in this the safety factor assessment meets the requirements of 40 CFR 257.73(e)(1).

1.0 INTRODUCTION

In April of 2015, the USEPA formally published national regulations for disposal of coal combustion Residuals (CCR) from electric utilities. As part of the rule, the owner or operator of the CCR unit must Obtain a certification from a qualified professional engineer stating that the CCR impoundments are in accordance with the rules. This report provides the documentation needed to fulfill the requirements of 40 CFR § 257.73(e), *Periodic Safety Factor Assessments*

2.0 PROJECT INFORMATION

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates two surface impoundments for storing CCR materials called the East Bottom Ash Pond (East BAP) and the West Bottom Ash Pond (West BAP).

The East BAP is incised on three sides with a splitter dike on the west side. The splitter dike is shared with West BAP and its stability is covered under the West BAP stability report titled Initial Safety Factor Assessment – West Bottom Ash Pond. A copy of the West BAP Safety Factor Assessment report is attached.

Initial Safety Factor Assessment – West Ash Pond
Pirkey Power Generating Station
Hallsville, Texas

Auckland Project No. 2015-008C (Revision No. 2)
January 14, 2016

Prepared For:

American Electric Power Company
1 Riverside Plaza
Columbus, Ohio 43215

Prepared By:

Auckland Consulting, LLC
Jacksonville, Texas

TBPE Firm Registration No. F-16721
Expires 2/29/2016

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Appendix

1.0 Introduction and Embankment Information

1.1 Introduction

The following report and evaluation provides the Initial Safety Factor Assessment of the West Ash Pond, an existing CCR impoundment (as defined by 40 CFR §257.2) located at the Pirkey Power Station near Hallsville, Texas. In accordance with 40 CFR §257.73(e)(1)(i) through (iv) this initial assessment provides field and laboratory data, model outputs (detailing multiple stability conditions) and summary of safety factors for the West Ash Pond. In accordance with 40 CFR §257.73(e)(2) this report provides the Initial Safety Factor Assessment certification for the West Ash Pond.

1.2 Referenced Information and Data

Soils data, comprised of field and laboratory testing, utilized in the preparation of this assessment were completed by ETTL Engineers and Consultants, Inc. and documented in the report *Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas* dated October 12, 2010. Based on a review of the provided field and laboratory data, it appears to be accurate and appropriate for use in the initial structural stability assessment of the West Ash Pond [40 CFR §257.73(e)(1)]. Furthermore, based on a recent site visit (October 2015), no modifications or elevation alterations have been made to the embankment since the referenced investigation. No additional field or laboratory activities were conducted. Soil data utilized in this evaluation is provided in the Appendix of this report.

To supplement existing data collected in the above reference report, an additional eight (8) Cone Penetrometer Test (CPT) soundings were advanced both along the crest and southern toe of the West Ash Pond. Sounding depths ranged between approximately 14 feet and 40 feet before encountering refusal. The data collected generally supports the findings from the 2010 study and confirms that embankment and foundation soils are relatively consistent. The location of and data from these CPT soundings are provided in the Appendix of this report.

The impoundment pool elevation data cited herein were provided in a separate hydrology and hydraulic (H&H) analysis report completed by Akron Consulting, LLC titled *Hydrology & Hydraulic Report, East & West Ash Ponds, H.W. Pirkey Power Plant – Hallsville, Texas,* dated December 15, 2015 (not included herein). The referenced report generally meets the demonstration requirements of 40 CFR §257.82(a).

Embankment profile dimensions and elevations were determined by using existing information provided by the client or representatives of the client. This information is also included in the Appendix of this report.

1.3 Embankment Evaluation Criteria

Based on information provided by the client, the existing embankment is constructed of lean clay (CL) and fat clay (CH) with existing side slopes (both up- and downstream) of approximately 3:1 (H:V), maximum embankment height of 20 feet and top of dam elevation of 358.0 feet (MSL). The upstream base elevation of the impoundment is approximately 347.0 feet (MSL). The crest width of the embankment is approximately 25 feet. Two (2) critical sections were evaluated for this initial safety factor assessment. Section No. 1 represents the northwest corner of the West Ash embankment and Section No. 2 represents the southern berm of the embankment.

It is our understanding that the maximum storage elevation of impounded CCR ash is 355.0 feet (MSL); however, the facility is managed to maintain an ash level less than this maximum level. The downstream toe of the West Ash Pond is not adjacent to other water bodies and therefore not subject to 40 CFR §257.73(d)(1)(A)(3)(vii).

In accordance with 40 CFR §257.73(e)(1)(i) and (ii), the maximum storage pool elevation for the West Ash Pond as determined by the 25-year, 24-hour storm event is 354.81 feet (MSL). For the purposes of this evaluation, the maximum storage pool elevation of 355.0 feet (MSL) was utilized. Likewise, the maximum (or flood) surcharge loading elevation as determined by the 100-year, 24-hour event is 355.01 feet (MSL), for this evaluation a maximum surcharge loading elevation of 355.0 feet (MSL) was utilized. Storage pool elevations were determined in accordance with 40 CFR §257.82(a).

2.0 Slope Stability Analyses

2.1 General

Soil parameters used for stability analyses of the existing embankment are based on findings of previous laboratory and field testing programs. The probable failure planes were analyzed using the analytical slope stability software, SLIDE by Rocscience, Inc. Methods of evaluation used in SLIDE are considered to be limited equilibrium methods of analysis, where each individual shear plane is evaluated to determine the resulting shear stress at the point of failure. For the purposes of this evaluation the Bishop Method of analysis, which analyzes circular failure planes through the slope was utilized.

Per 40 CFR §257.73(e)(1)(i) through (iii), three (3) modeled scenarios (presented below) were utilized to evaluate the stability of the existing embankment: steady state seepage (long term) condition under maximum storage pool, steady state seepage (long term) condition under maximum surcharge pool, and steady state seepage condition with seismic loading under maximum storage pool conditions. The following minimum factors of safety (FS) and soil stress parameters were utilized in modeling. Minimum factors of safety are based on demonstration requirements provided in 40 CFR §257.73(e)(1).

Summary of Embankment Condition and Factor of Safety		
Embankment Condition	**Soil Parameters**	**Minimum Factor of Safety**
Steady State Seepage – Maximum Pool	Effective Stress	1.50
Steady State Seepage – Surcharge Pool	Effective Stress	1.40
Steady State Seepage (Seismic) – Maximum Pool	Total Stress	1.00
NOTE: Minimum factors of safety based on demonstration requirements provided in 40 CFR §257.82 (e)(1).		

For evaluation of steady state seepage (long term) conditions with seismic, peak ground acceleration for this location was obtained from the USGS National Seismic Hazard Mapping Project (http://earthquake.usgs.gov/hazards). Based on the seismic survey data, the anticipated site specific peak ground acceleration (PGA) of 0.06g (acceleration at rock sites) for two (2) percent probability of exceedance in 50 years (40 CFR Part 257, Preamble page 21384). Correcting for acceleration at soft soil sites (Seismic Site Classification D) yields an estimated PGA of 0.13g. The seismic coefficient (k) used for pseudo static analysis is determined by reducing the estimated PGA by 50% yielding a seismic coefficient of 0.065g.

2.2 Liquefaction Assessment

Liquefaction of soils occurs when horizontal shearing stresses exceed the strength of existing loose, saturated sand. This sudden loss of shear strength and subsequent soil structure is typically associated with earthquake-induced horizontal movement. Recent engineering publications[1] provide criteria to assess liquefaction potential of sands (little to no fines) and clayey soils of low plasticity (e.g. clayey sands, silts). These criteria indicate that water content of fine-grained or cohesive soils needs to be high (≥ 0.85 *Liquid Limit [LL]), a clay fine content (defined as grains smaller than 0.002 mm) of less than 10 percent (< 10%), and relatively low soil density (assessed in terms of SPT blow counts). In addition, the accepted minimum seismic threshold acceleration to cause liquefaction in loose sands is 0.10g, the anticipated site specific PGA for this site is 0.06g.

Native fine grained (or cohesive) material underlying the West Ash Pond generally consist of medium dense to very dense clayey sand (SC), clayey gravel (GC) and silty clayey sand (SC-SM) Based on these soil characteristics and that the West Ash Pond is located in a zone of low peak ground acceleration (PGA), the risk of either embankment or underlying soils liquefying are negligible [40 CFR §257.73(e)(1)(iv)].

---

[1] Seed, R.B., et al, Recent Advances in Soil Liquefaction Engineering: A Unified and Consistent Framework, 26th Annual ASCE Los Angeles Spring Seminar, April 2003

2.3 Embankment and Foundation Stratigraphy

The models developed for this evaluation are based on the existing embankment geometry, results of field and laboratory testing and hydrologic site information provided by the client and recent field activities. Selection of critical slope sections (Section Nos. 1 and 2) was based on both height and subsurface sensitivity to loading. The following tables provide a summary of soil parameters used for these analyses. Specific soil parameters used for each model are presented in the Appendix.

Summary of Long Term, Total Stress Soil Parameters, Section No. 1:

Material Type	Unit Weight (pcf)	Consolidated-Undrained Cohesion (psf)	Consolidated-Undrained Angle of Internal Friction (degrees)
Embankment Fill	125	450	12
Lean Clay/Fat Clay (CL/CH)	125	530	13
Silty Sand/Clayey Sand (SM/SC)	125	0	28
Ash	100	0	30

NOTE: Properties used for Steady State Seepage with Seismic analysis.

Summary of Long Term, Effective Stress Soil Parameters, Section No. 1

Material Type	Unit Weight (pcf)	Consolidated-Drained Cohesion (psf)	Consolidated-Drained Angle of Internal Friction (degrees)
Embankment Fill	125	590	16
Lean Clay/Fat Clay (CL/CH)	125	320	17
Silty Sand/Clayey Sand (SM/SC)	125	430	28
Ash	100	0	30

NOTE: Properties used for Steady State Seepage analysis. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing.

Summary of Long Term, Total Stress Soil Parameters, Section No. 2			
Material Type	**Unit Weight (pcf)**	**Consolidated-Undrained Cohesion (psf)**	**Consolidated-Undrained Angle of Internal Friction (degrees)**
Embankment Fill	125	450	12
Lean Clay/Fat Clay (CL/CH)	125	530	13
Clayey Sand/Silty Sand (SC/SM)	125	0	28
Lean Clay (CL)	125	260	20
Ash	100	0	30
NOTE: Properties used for Steady State Seepage with Seismic analysis.			

Summary of Long Term, Effective Stress Soil Parameters, Section No. 2			
Material Type	**Unit Weight (pcf)**	**Consolidated-Drained Cohesion (psf)**	**Consolidated-Drained Angle of Internal Friction (degrees)**
Embankment Fill	125	590	16
Lean Clay/Fat Clay (CL/CH)	125	320	17
Clayey Sand/Silty Sand (SC/SM)	125	0	28
Lean Clay (CL)	125	290	22
Ash	100	0	30
NOTE: Properties used for Steady State Seepage analysis. Consolidated-drained conditions determined based on pore pressure measurements made during Consolidated-Undrained (CU) triaxial testing.			

2.4 Seepage Analysis Parameters

The analysis of embankment seepage is based on laboratory results and estimated values for permeability for various embankment and native foundation soils. These soil parameters were utilized in the models to establish a long term steady state condition and corresponding phreatic surface in the embankment. Hydraulic conductivity test results are provided in the Appendix. Hydraulic conductivity properties utilized in the seepage analysis are provided in the below table.

Hydraulic Conductivity of Embankment Soils, Section Nos. 1 and 2	
Material Type	**Permeability (ft/sec)**
Embankment Fill	1×10^{-8}
Lean Clay/Fat Clay (CL/CH)	1×10^{-8}
Clayey Sand/Silty Sand (SC/SM)	1×10^{-5}
Lean Clay (CL)	1×10^{-8}
Ash	1×10^{-4}

2.5 Stability Analysis Results

The following tables provides the results of the stability analysis for each of the conditions cited herein, as required by 40 CFR §257.73(e)(1)(i) through (iii). The graphical representations of each analysis are included in the Appendix.

Summary of Stability Analyses – Safety Factors, Section No. 1		
Modeled Condition	**Factor of Safety**	
	Actual	**Minimum**
Steady State Seepage – Maximum Pool	2.21	1.50
Steady State Seepage – Surcharge Pool	2.21	1.40
Steady State Seepage with Seismic – Maximum Pool	1.35	1.00

Summary of Stability Analyses – Safety Factors, Section No. 2

Modeled Condition	Factor of Safety	
	Actual	Minimum
Steady State Seepage – Maximum Pool	1.83	1.50
Steady State Seepage – Surcharge Pool	1.83	1.40
Steady State Seepage with Seismic – Maximum Pool	1.50	1.00

January 14, 2016

Based on the findings of this analysis, the evaluated embankments appear to be stable under the modeled conditions and demonstrate the minimum safety factors, as required by 40 CFR §257.73(e)(1)(i) through (iii).

3.0 Report Limitations

This report has been prepared for the exclusive use of our client for the specific application to the project discussed and has been prepared in accordance with the generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. The analyses contained in the report are based on the data obtained from the referenced soil borings performed within the project site. This report does not reflect variations that may occur between borings or across the site. Soil borings do not necessarily reflect strata variations that may exist at other locations within the project site.

4.0 Initial Structural Stability Assessment Certification

By means of this certification, (i) I have reviewed the requirements of 40 CFR §257.73(e)(1) – *Periodic Safety Factor Assessments*, (ii) I or my agent has visited and examined the facility, (iii) the referenced data used in this evaluation to the best of my knowledge appears correct and appropriate for use, (iv) and this Initial Safety Factor Assessment for the West Ash Pond (Pirkey Power Station) has been prepared to the best of my knowledge in accordance with §257.73(e)(1).

By: ______________________

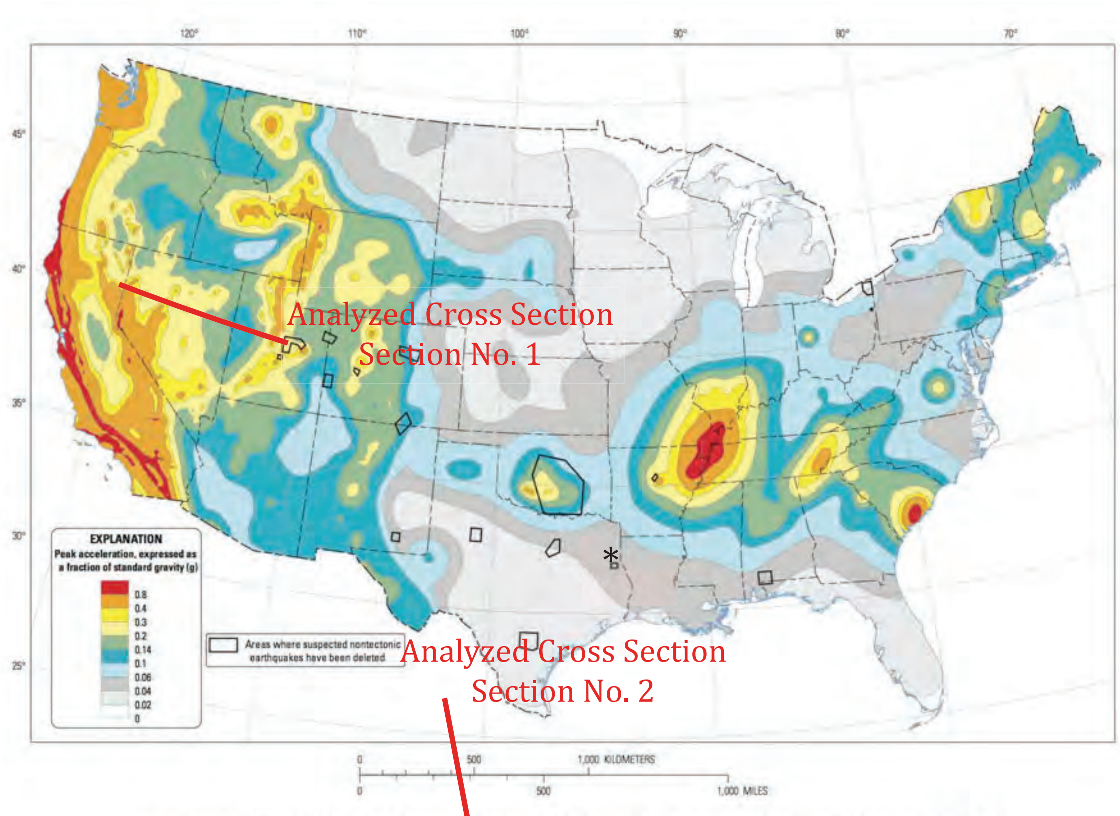
Dated: ______________________

JOHN J. TAYNTOR
99202

TBPE Firm Registration No. F-16721
Expires 2/29/2016

Appendix

Stability Analyses
Reference Data



Two-percent probability of exceedance in 50 years map of peak ground acceleration

* Approximate location of Pirkey Power Generating Station

Provided by USGS National Seismic Hazard Mapping Project.

Seismic Probability Map

Scale: N/A	**Pirkey Power Generating Station** **Initial Safety Factor Assessment - West Ash Pond** **Hallsville, Texas**
Auckland Project No. 2015-008C	

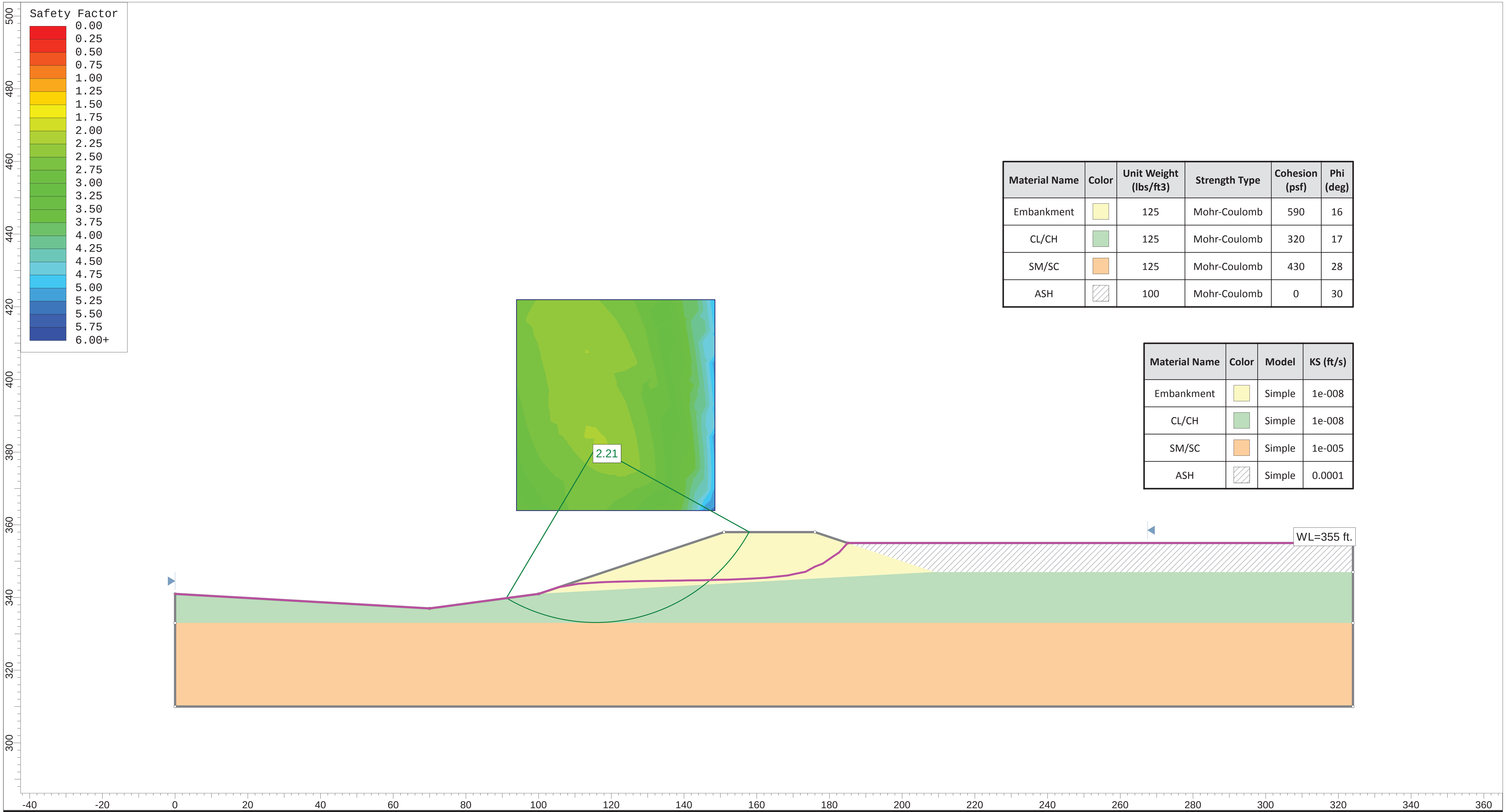
Provided by Google Earth.

Cone Penetrometer Test (CPT) Location Map

Scale: N/A

Auckland Project No. 2015-008C

Pirkey Power Generating Station
Initial Safety Factor Assessment - West Ash Pond
Hallsville, Texas



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	590	16
CL/CH	🟩	125	Mohr-Coulomb	320	17
SM/SC	🟧	125	Mohr-Coulomb	430	28
ASH	▨	100	Mohr-Coulomb	0	30

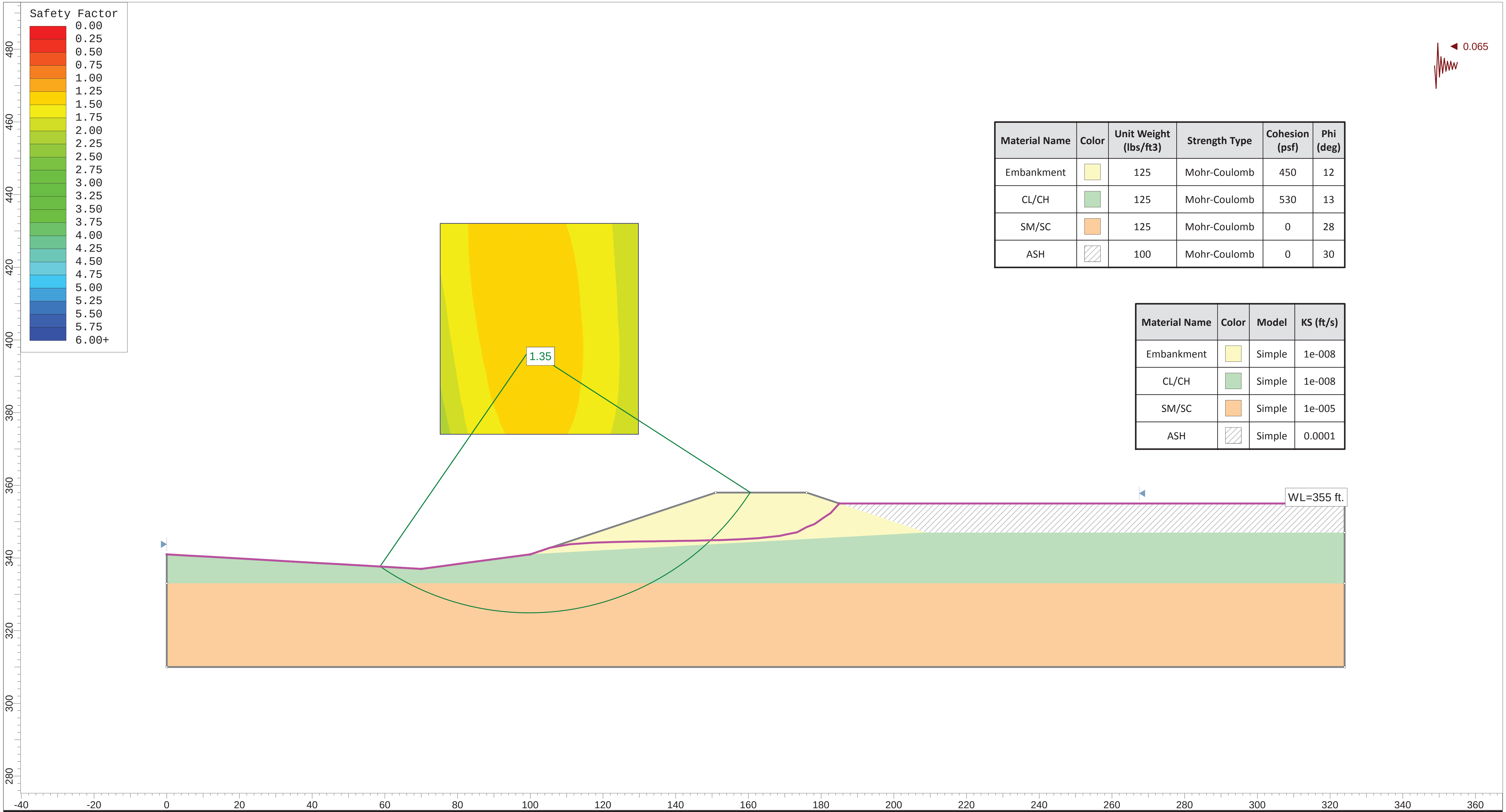
Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SM/SC	🟧	Simple	1e-005
ASH	▨	Simple	0.0001

Auckland Consulting LLC
PO Box 8155
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 1
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool

Drawn By	JJT	*Company*	
Date	12/15/2015	*File Name*	WEST ASH_Section 1_SSS_25yr.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	450	12
CL/CH	🟩	125	Mohr-Coulomb	530	13
SM/SC	🟧	125	Mohr-Coulomb	0	28
ASH	▨	100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SM/SC	🟧	Simple	1e-005
ASH	▨	Simple	0.0001

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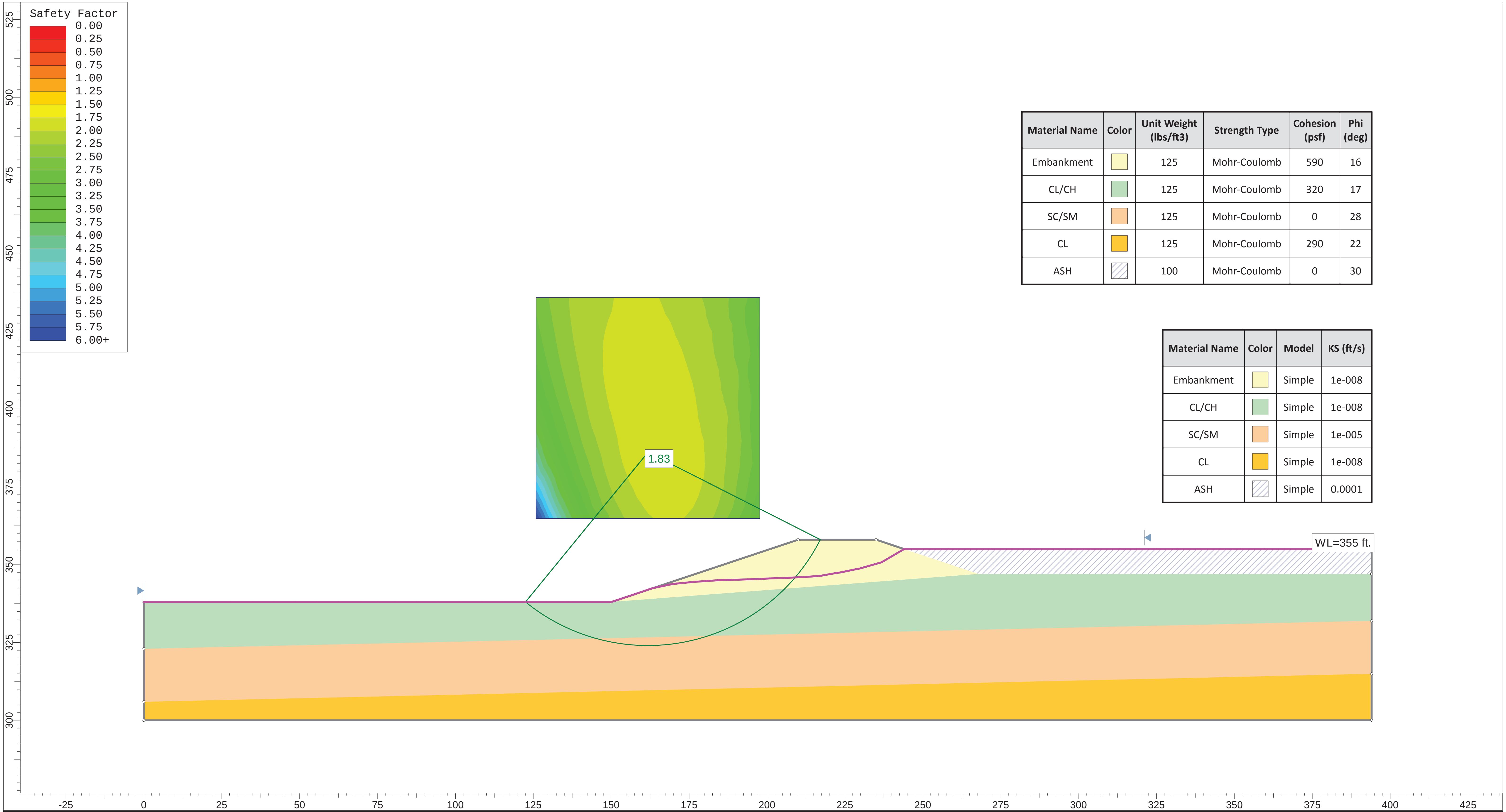
Jacksonville, Texas 75766

SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 1
Analysis Description	Steady State Seepage at Maximum Pool, Seismic Analysis
Drawn By	JJT
Company	
Date	12/23/2015
File Name	WEST ASH_Section 1_SSS_25yr_seismic.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	590	16
CL/CH	🟩	125	Mohr-Coulomb	320	17
SC/SM	🟧	125	Mohr-Coulomb	0	28
CL	🟨	125	Mohr-Coulomb	290	22
ASH	▨	100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SC/SM	🟧	Simple	1e-005
CL	🟨	Simple	1e-008
ASH	▨	Simple	0.0001

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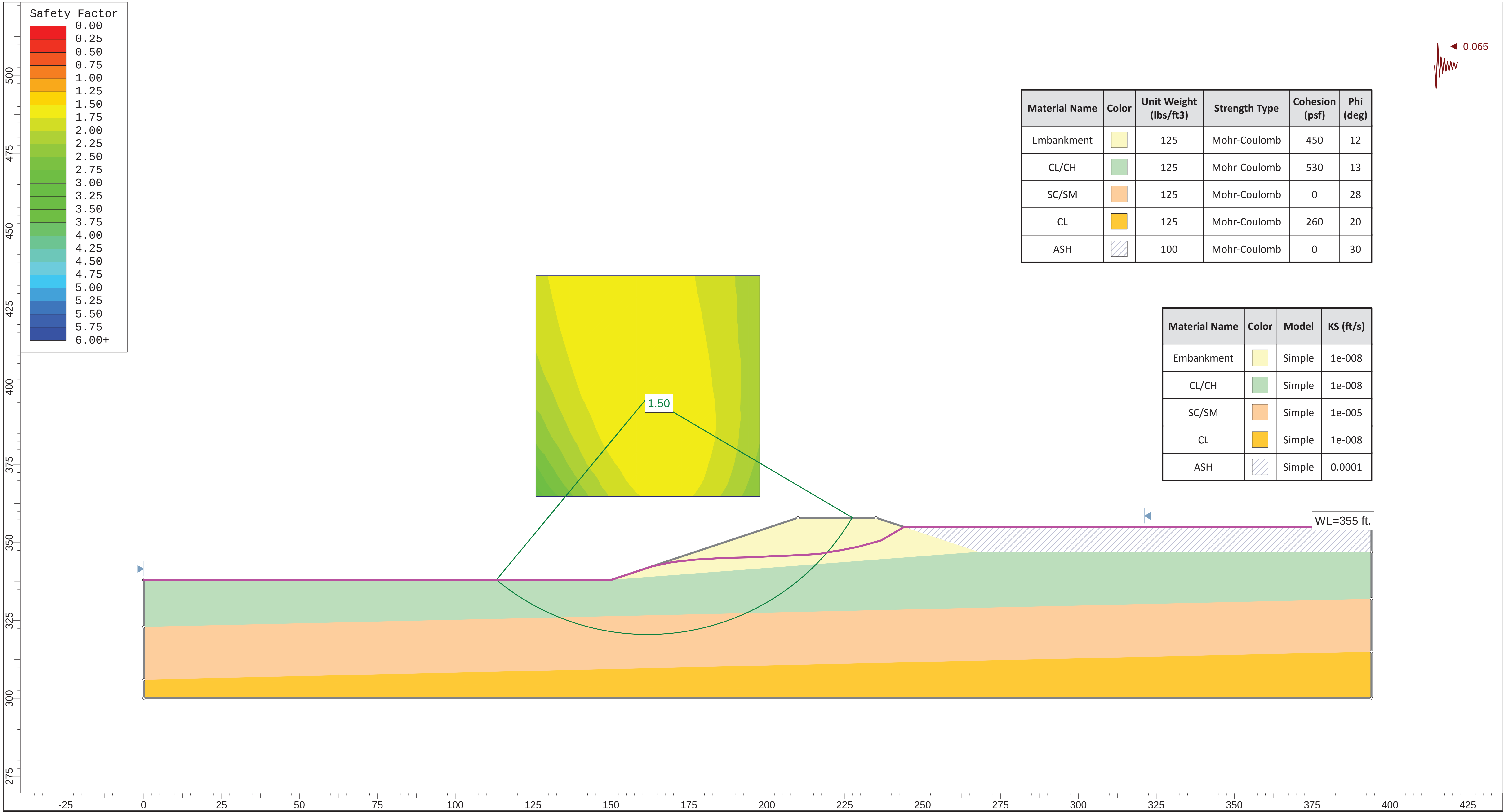
SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 2		
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool		
Drawn By	JJT	*Company*	
Date	12/15/2015	*File Name*	WEST ASH_Section 2_SSS_25yr.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment	🟨	125	Mohr-Coulomb	450	12
CL/CH	🟩	125	Mohr-Coulomb	530	13
SC/SM	🟧	125	Mohr-Coulomb	0	28
CL	🟨	125	Mohr-Coulomb	260	20
ASH	▨	100	Mohr-Coulomb	0	30

Material Name	Color	Model	KS (ft/s)
Embankment	🟨	Simple	1e-008
CL/CH	🟩	Simple	1e-008
SC/SM	🟧	Simple	1e-005
CL	🟨	Simple	1e-008
ASH	▨	Simple	0.0001

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SLIDEINTERPRET 6.036

Project	Pirkey Power Station - West Ash Pond, Section No. 2
Analysis Description	Steady State Seepage at Maximum Pool, Seismic Analysis
Drawn By	JJT
Company	
Date	12/23/2015
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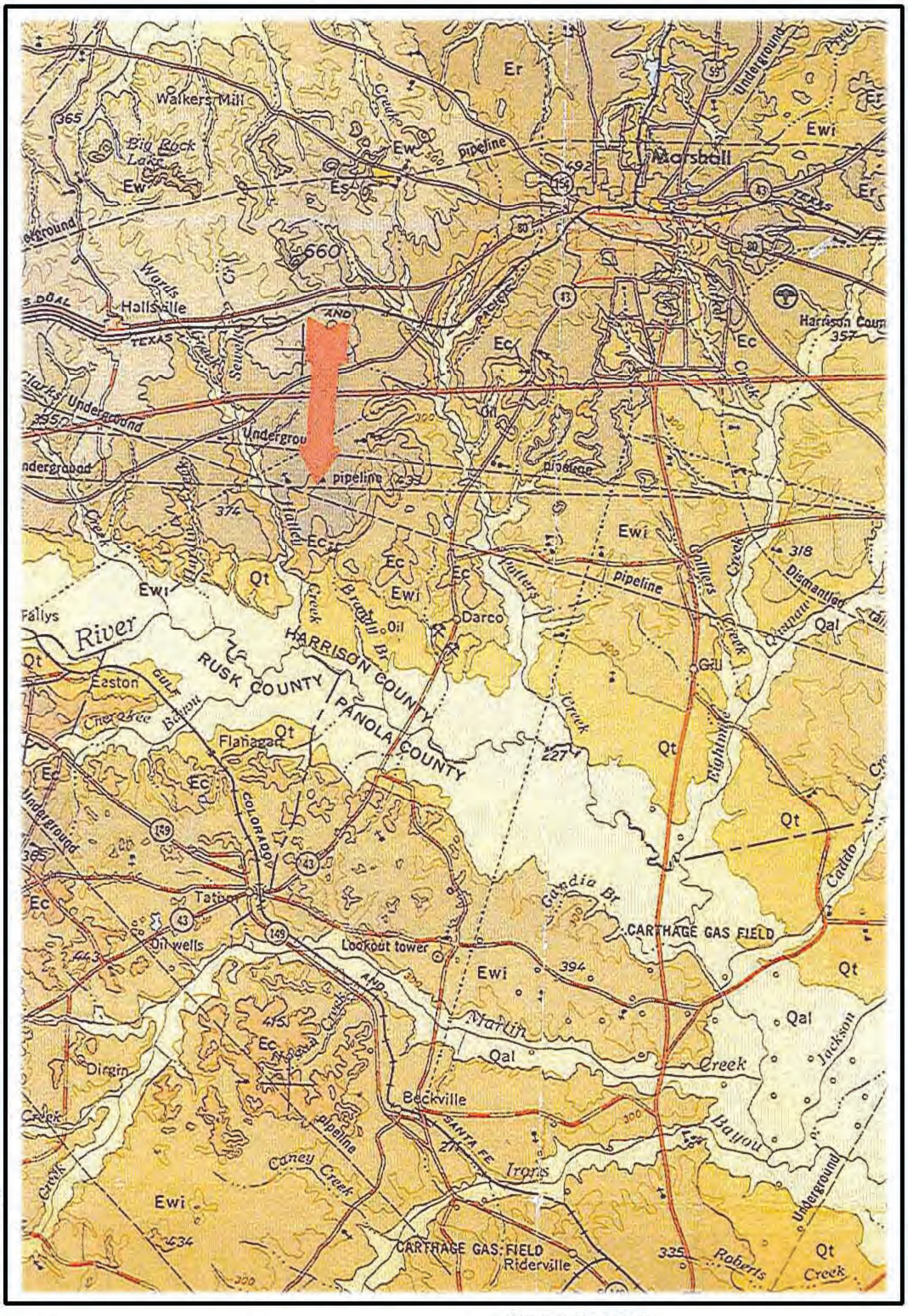
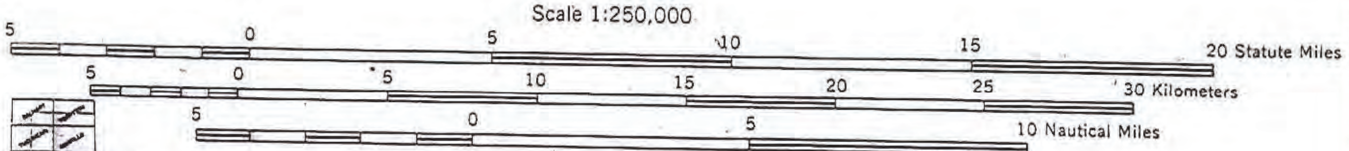


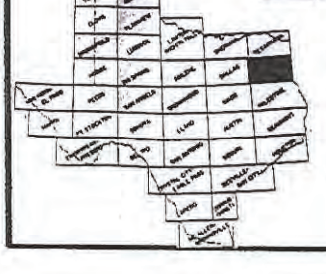
EXPLANATION

SEDIMENTARY ROCKS

QUATERNARY	Pleistocene Recent	Qal	**Alluvium** *Flood-plain deposits*
		Qt	**Fluviatile terrace deposits undivided**
TERTIARY	Eocene	Etg / Es	**Sparta Sand** *Quartz sand, fine to medium grained, light gray to brownish gray, slightly cohesive from silt and clay matrix, massive, locally cross-bedded, interbeds of sandy clay more abundant upward, locally carbonaceous; weathers various shades of light gray, at base hard, brown, ferruginous sandstone; lower part 170± feet thick, upper part absent. Locally includes Tyler Greensand Member, Etg, quartz-glauconite greensand, grayish green, massive, locally cross-bedded; weathers dark reddish brown, abundant ironstone concretions*
		Ew	**Weches Formation** *Glauconite and quartz sand, grayish green to grayish olive green, thin bedded, locally cross-bedded to lenticular, clay interbeds light brown to moderate light gray, silty, muscovitic, thin bedded; weathers moderate to dark reddish brown, locally forms limonitic and sideritic iron ore and clay ironstone concretions; marine megafossils in southern part; 25± feet thick, range 0-70 feet*
		Eqc	**Queen City Sand** *Quartz sand, fine grained to locally medium grained, light gray to brownish gray, locally carbonaceous, and clay, gray to brown, silty, slightly lignitic, sand most abundant to west; weathers red and white mottled, ironstone concretions and ledges common; local beds of glauconite-quartz greensand, cross-bedded, weathers to ferruginous ledges and rubble; 100-400 feet thick, thins southeastward*
		Er	**Reklaw Formation** *Upper 100± feet, clay, brownish black to brownish gray, silty, muscovitic, carbonaceous, laminated, interbeds of moderate reddish-brown clay; weathers light brown, ironstone concretions common; a few marine fossils. Lower 15± feet, quartz sand, fine to very fine grained, grayish green, glauconitic, argillaceous, massive, locally cross-bedded; weathers moderate brown to dark yellowish orange with clay ironstone ledges and rubble; fossils, clay ironstone, and clay decrease northward*
		Ec	**Carrizo Sand** *Upper part, very fine sand, silt, clayey silt, silty clay, medium to dark gray, carbonaceous; weathers moderate yellowish brown to dark reddish brown, indurated ledges of dark brownish-gray ironstone common. Lower part, quartz sand, fine to medium grained, light brownish gray, weakly cohesive, massive, locally cross-bedded; weathers light gray to various shades of red. Thickness 20-100 feet*
		Ewi	**Wilcox Group undivided** *Mostly silty and sandy clay, various shades of gray, local beds of clay, lignite, silt, and quartz sand, in part carbonaceous, laminated to massive, locally cross-bedded, weathers to various shades of gray, brown, yellow, and red. Calcareous siltstone and ironstone concretions common; abundant plant fossils, a few marine fossils in southeastern part; 500-1,000 feet thick.*
		E	**Eocene rocks undivided** *Reklaw Formation, Carrizo Sand, Wilcox Group, and Midway Group on Brooks dome not separately shown*
		Ewp	**Wills Point Formation** *Clay, medium bluish gray, greenish gray, grayish green, brownish gray, silt increases upward, laminated to locally massive, glauconitic near base, rough calcareous siltstone concretions common in upper part, locally lignitic in upper part, thin bed of rosette limestone near middle; weathers medium gray to yellowish gray; fossiliferous; 500± feet thick*
		Ek	**Kincaid Formation** *Clay, medium gray to dark gray, greenish gray, brownish gray, glauconitic, calcareous, selenitic, locally silty or sandy, locally phosphatic near base, thin beds of limestone in upper part, gray, hard, detrital; weathers medium gray; fossiliferous; 180± feet thick*
CRETACEOUS	Upper Cretaceous	Kke	**Kemp Clay** *Clay, dark gray to bluish gray, calcareous, silty, glauconitic, calcareous concretions common; weathers dark greenish gray and black; upper part only crops out*
		Ku	**Upper Cretaceous rocks undivided** *Navarro Group, Taylor Group, and Austin Chalk on Brooks dome not separately shown*

Scale 1:250,000





CONTOUR INTERVAL 100 FEET
WITH SUPPLEMENTARY CONTOURS AT 50 FOOT INTERVALS

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ENGINEERS &
CONSULTANTS
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

PLATE 2

SITE SURFACE GEOLOGY

JOB No.: G3241-095

DATE: DEC. 2009

SCALE: 1:250,000

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Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-1

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095

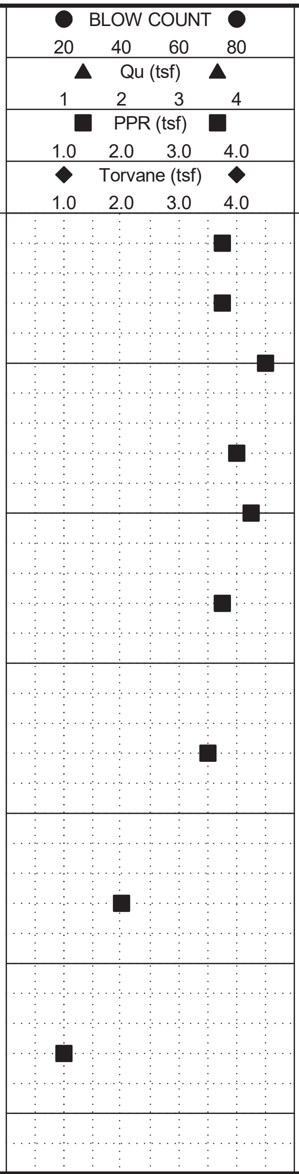
BORING TYPE: Flight Auger

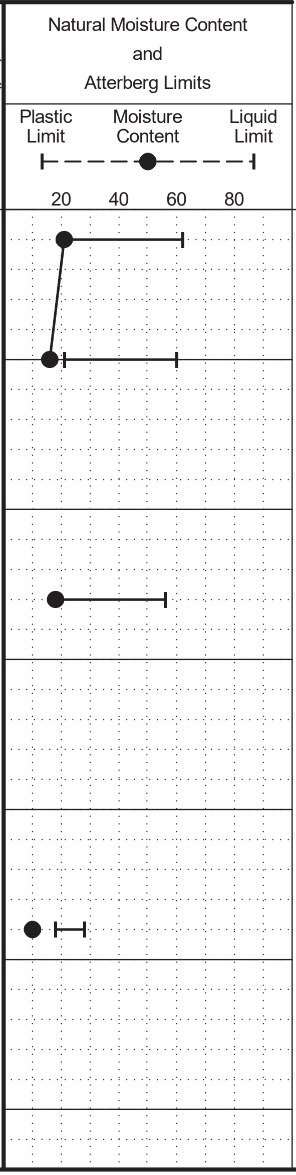
DATE 10/20/09

SURFACE ELEVATION 356.5

MATERIAL DESCRIPTION

DEPTH (ft)	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	CH		FAT CLAY WITH SAND(CH) tan and red	P=3.75					21	62	21	41	79	+40 Sieve=6%, +4 Sieve=0%
				P=3.75										
5			--red	P=4.5					16	60	21	39	75	+40 Sieve=7%, +4 Sieve=1%
	CL		SANDY LEAN CLAY(CL) reddish yellow	P=4.0										
10	CH		FAT CLAY(CH) red and tan	P=4.25										
	CH		FAT CLAY WITH SAND(CH) red and yellow	P=3.75					18	56	18	38	71	+40 Sieve=5%, +4 Sieve=0%
15														
		∇	--red	P=3.5										
20														
	SC		CLAYEY SAND(SC) reddish brown	P=2.0					10	28	18	10	25	+40Sieve=21%, +4 Sieve=11%
25														
	CL		LEAN CLAY(CL) red; with sand seams	P=1.0										
30														





Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-1

PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

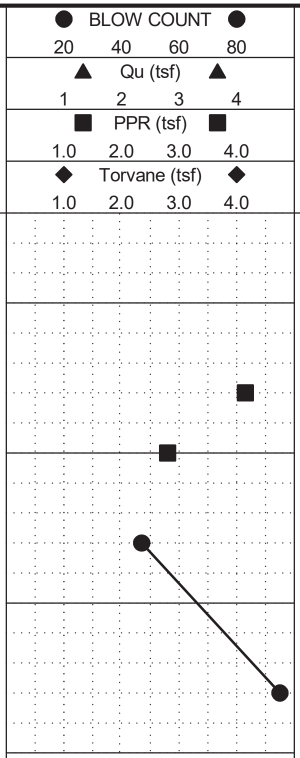
DATE 10/20/09

SURFACE ELEVATION 356.5

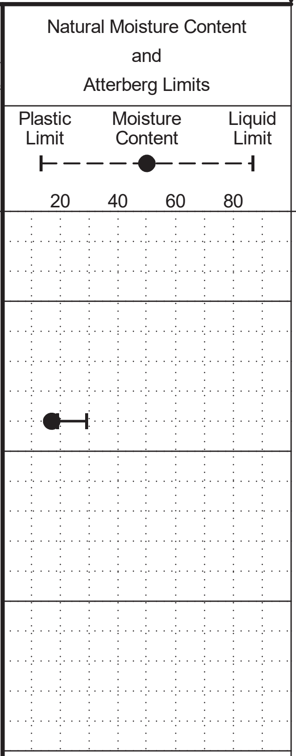
MATERIAL DESCRIPTION

USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
SC	CLAYEY SAND(SC) grayish brown	N=32						
	--tannish gray	P=4.15						
			17	29	19	10	25	+40 Sieve=1%, +4 Sieve=0%
		P=2.8						
	--gray	N=47						
SM SC	SILTY CLAYEY SAND(SM-SC) gray	N=50/6"						
	Bottom of Boring @ 50'							

DEPTH (ft): 35, 40, 45, 50



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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Tyler, Texas 75702
(903) 595-4421

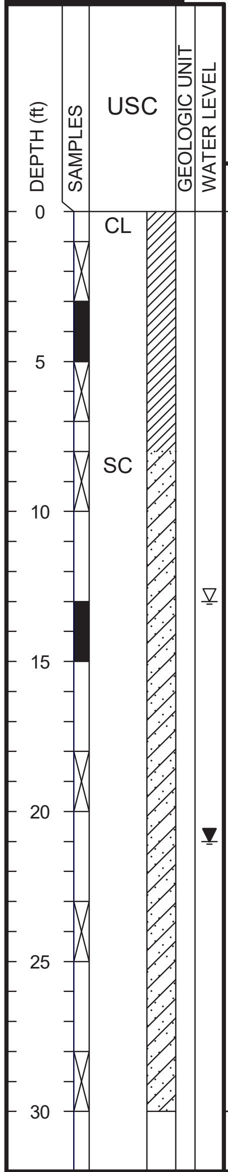
LOG OF BORING W-2

PROJECT: Pirkey Power Plant
Hallsville. Texas

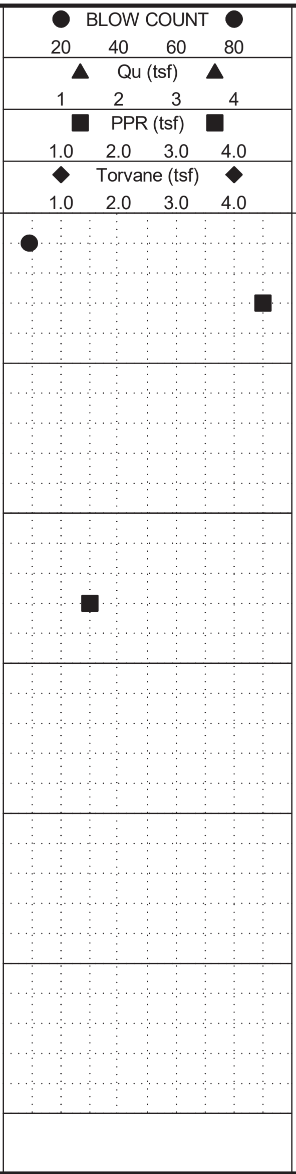
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/21/09

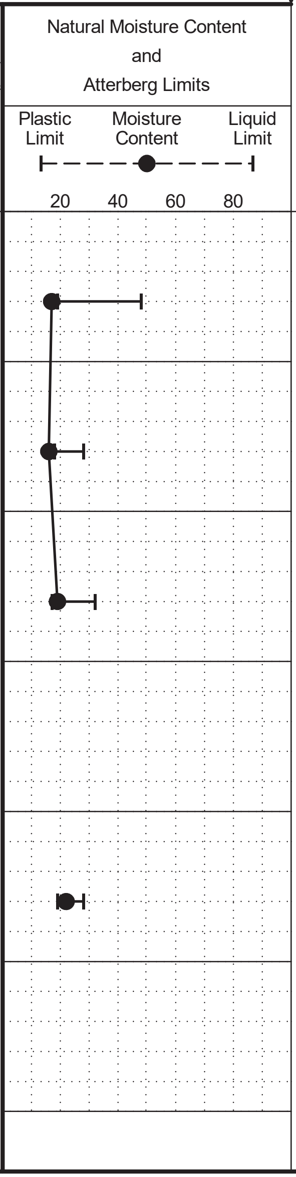
SURFACE ELEVATION 341.7



USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; red and gray	N=9						
	--hard	P=4.5+	17	48	19	29	65	+40 Sieve=6%, +4 Sieve=2%
	--gray, red, and tan	N=50						
SC	CLAYEY SAND(SC) very dense; red and tan	N=50/5"	16	28	18	10	27	+40 Sieve=7%, +4 Sieve=2%
	--medium dense; tan and gray	P=1.5	19	32	17	15	31	+40Sieve=13%, +4 Sieve=5%
	--very dense; gray and tan	N=62						
	--green	N=50/5"	22	28	19	9	33	+40 Sieve=6%, +4 Sieve=2%
		N=56						
	Bottom of Boring @ 30'							



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 13' while drilling. Water level @ 21' and open upon completion.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-3

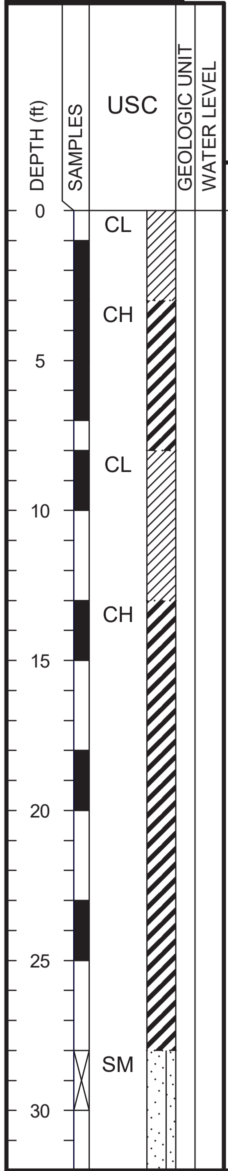
PROJECT: Pirkey Power Plant
Hallsville. Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

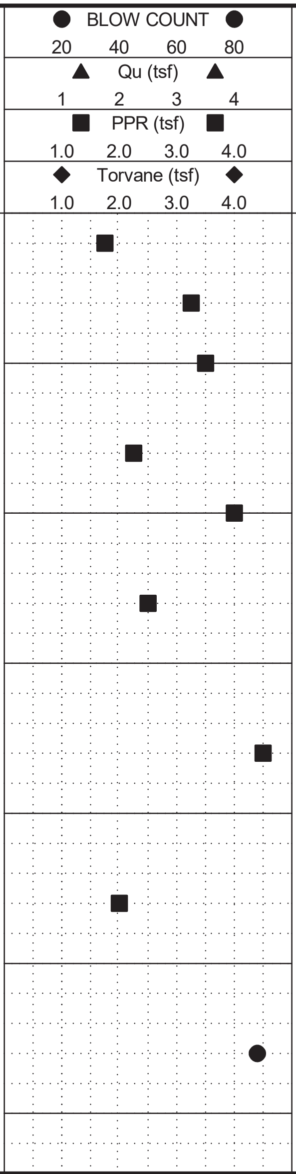
DATE 10/20/09

SURFACE ELEVATION 356.3

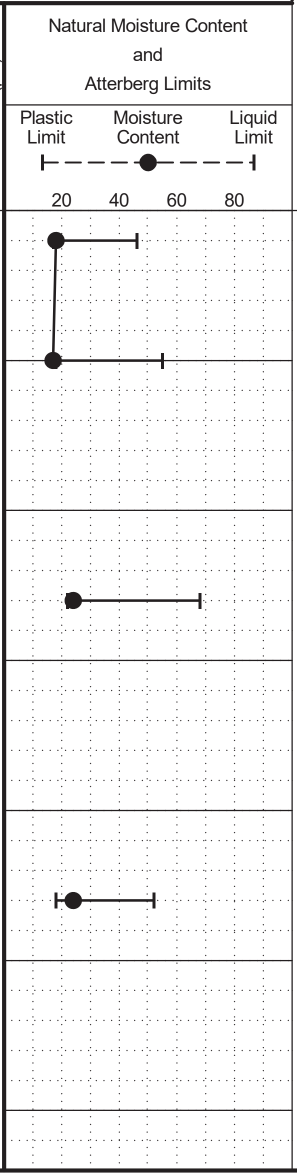


USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
CL	SANDY LEAN CLAY(CL) stiff; white and tan	P=1.75	18	46	17	29	61	+40 Sieve=7%, +4 Sieve=2%
CH	SANDY FAT CLAY(CH) very stiff; red, tan, and white	P=3.25						
	--white, tan, and red	P=3.5	17	55	18	37	68	+40 Sieve=5%, +4 Sieve=0%
CL	SANDY LEAN CLAY(CL) very stiff; red and yellow	P=2.25 P=4.0						
	--hard; red and yellow							
CH	FAT CLAY WITH SAND(CH) very stiff; red and yellow	P=2.5	24	68	22	46	80	+40 Sieve=6%, +4 Sieve=0%
	--hard	P=4.5+						
	--stiff	P=2.0	24	52	18	34	69	+40 Sieve=4%, +4 Sieve=0%
SM	SILTY SAND(SM) very dense; yellow and red	N=88						

ATTERBERG LIMITS(%)



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)



Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 34' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

ETTL ENGINEERS & CONSULTANTS

MAIN OFFICE
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Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-3

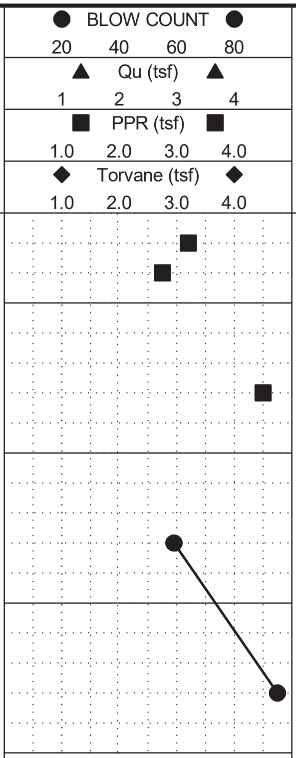
PROJECT: Pirkey Power Plant
Hallsville. Texas

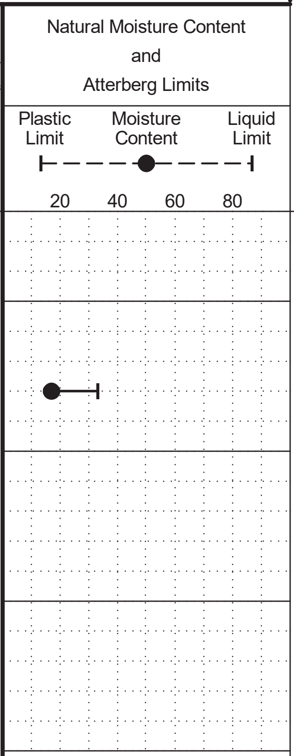
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

SURFACE ELEVATION 356.3

DEPTH (ft)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
35	■	CL	∇	SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel	P=3.25										
40	■	SC		CLAYEY SAND(SC) very dense; dark gray	P=4.5+					17	33	17	16	38	+40 Sieve=1%, +4 Sieve=0%
45	⊠	SM SC		SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated	N=59										
50	⊠	SC		CLAYEY SAND(SC) very dense; dark gray	N=50/4"										
				Bottom of Boring @ 50'											





Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 34' while drilling.

Key to Abbrevations:

N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:

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MAIN OFFICE
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Tyler, Texas 75702
(903) 595-4421

LOG OF BORING W-4

PROJECT: Pirkey Power Plant
Hallsville. Texas

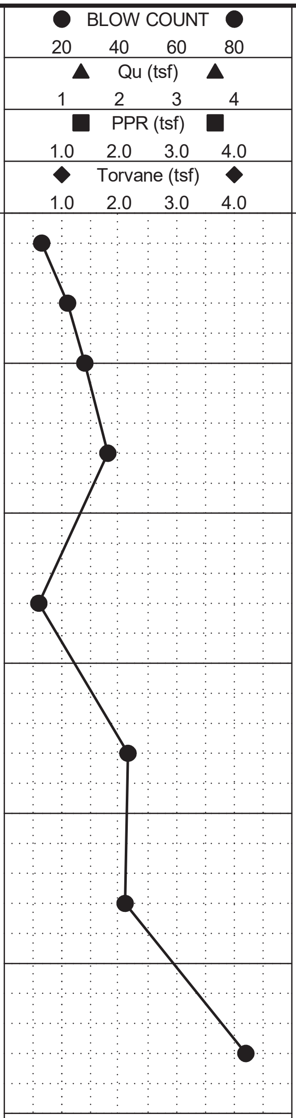
PROJECT NO.: G3241-095 **BORING TYPE:** Flight Auger

DATE 10/20/09

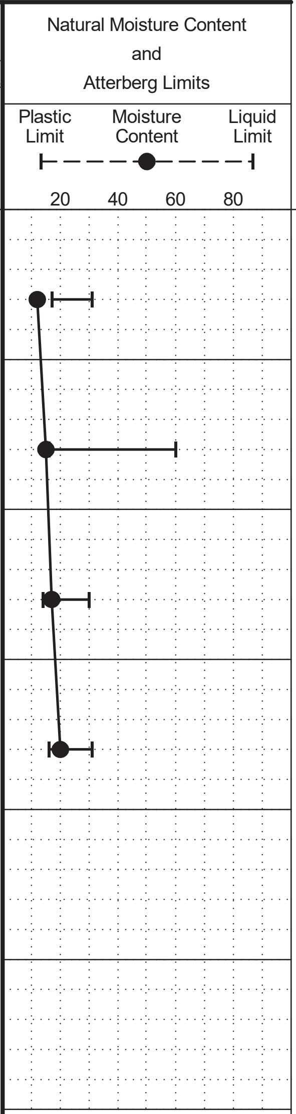
SURFACE ELEVATION 338.0

MATERIAL DESCRIPTION

DEPTH (ft)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
0	SC	CLAYEY SAND(SC) stiff; brown, red, and yellow	N=13						
		--with gravel	N=22	12	31	17	14	35	+40Sieve=31%, +4 Sieve=16%
5		--red and tan; with iron oxide cemented sandstone	N=28						
		--dense; red and white; with clay seams	N=36	15	60	16	44	39	+40Sieve=11%, +4 Sieve=4%
10									
		--medium dense; orangish gray; with gravel	N=12	17	30	14	16	22	+40Sieve=28%, +4 Sieve=17%
15									
	GC	CLAYEY GRAVEL(GC) dense; dark gray	N=43	20	31	16	15	7	+40Sieve=68%, +4 Sieve=52%
20									
	SM	SILTY SAND(SM) dense; dark gray	N=42						
25									
	CL	SANDY LEAN CLAY(CL) very dense; gray	N=84						
30		Bottom of Boring @ 30'							



DRY DENSITY (pcf) | COMPRESSIVE STRENGTH (tsf) | FAILURE STRAIN (%) | CONFINING PRESSURE (psi)

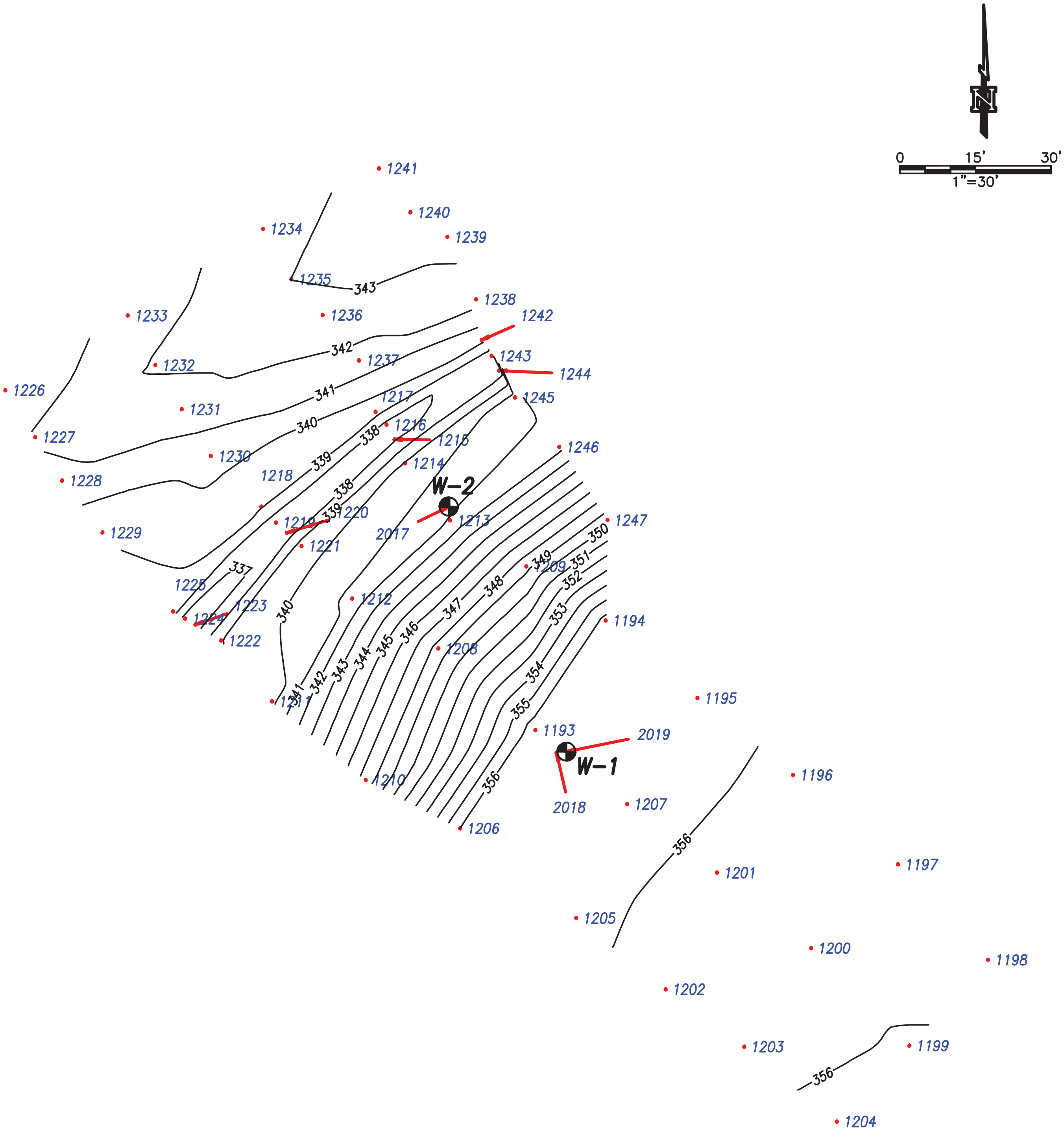


Water Level Est.: ∇ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 19' while drilling.

Key to Abbrevations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes:



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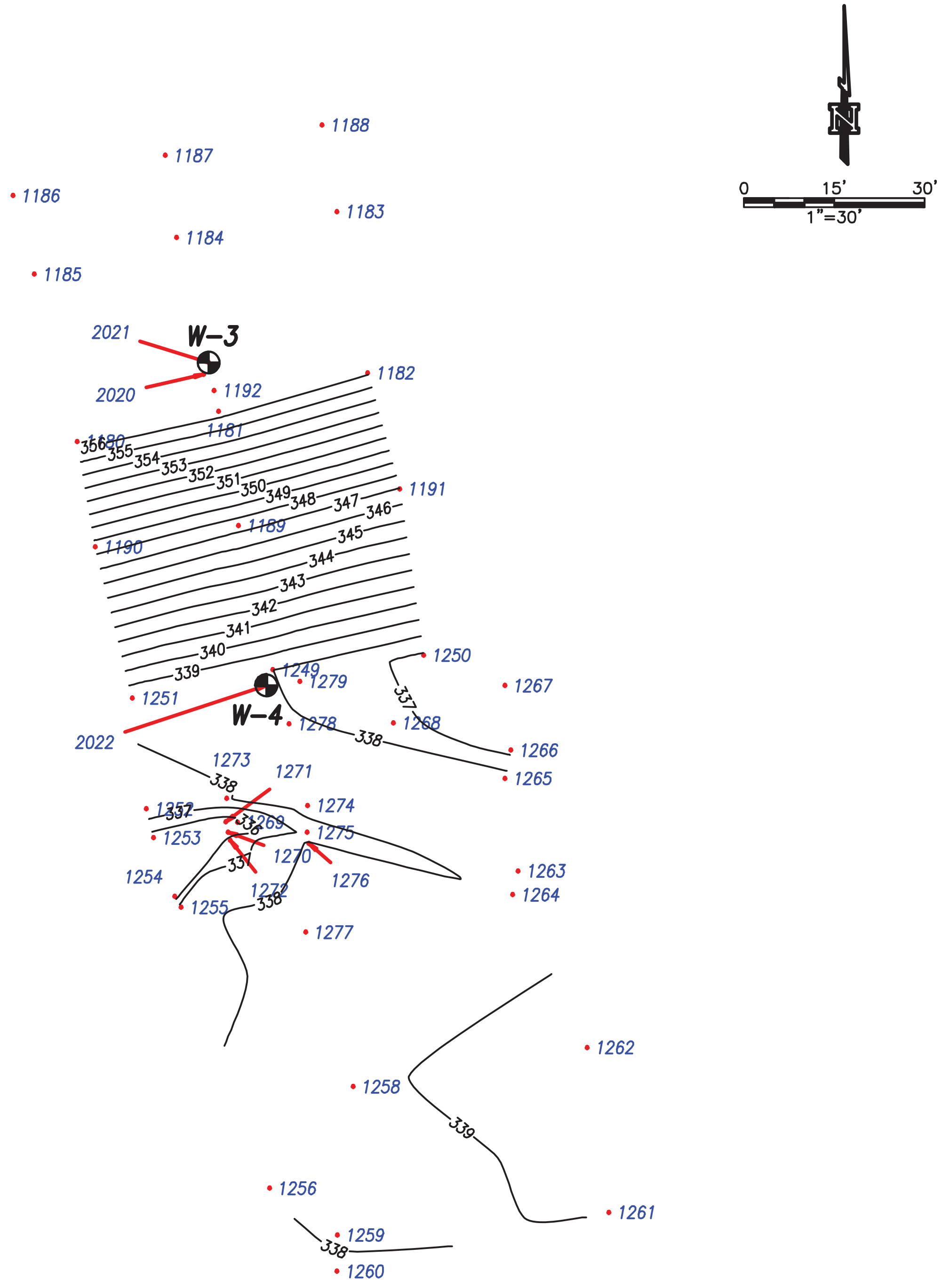
website: www.johnsonpace.com
JOB NO: 2313-013 FIELD BOOK: XXX/XXX DATE: NOV. 2009

EXHIBIT "I"

W-1 AND W-2 BOREHOLES
PIRKEY POWER PLANT
HALLSVILLE, TEXAS



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JOB NO: 2313-013 FIELD BOOK: XXX/XXX DATE: NOV. 2009

EXHIBIT "J"

W-3 AND W-4 BOREHOLES
PIRKEY POWER PLANT
HALLSVILLE, TEXAS

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : Pirkey Power Plants Embankments, Hallsville, Texas
Date: 11/3/2009 Panel Number : P 2 ; ASTM D 5084
Project No. : G 3241-09 Permometer Data

Boring No.:	W - 2	ap =	0.031416 cm2		**Set Mercury to Pipet Rp at**	Equilibrium	1.8	cm3
Sample:		aa =	0.767120 cm2			Pipet Rp	**6.7**	cm3
Depth (ft):	13' to 16'	M1 =	0.030180	C =	0.00043252	Annulus Ra	1.5	cm3
Other Location:		M2 =	1.040953	T =	0.203782344			

Material Description : Tan & Gray Clayey Sand

SAMPLE DATA

Wet Wt. sample + ring or tare :			571.51	g
Tare or ring Wt. :			0.0	g
Wet Wt: of Sample :			571.51	g
Diameter :	2.78	in	7.06	cm2
Length :	2.78	in	7.06	cm
Area:	6.06	in^2	39.10	cm2
Volume :	16.85	in^3	276.12	cm3
Unit Wt.(wet):	**129.15**	pcf	**2.07**	g/cm^3
Unit Wt.(dry):	**107.87**	pcf	**1.73**	g/cm^3

Before Test		After Test	
Tare No.:	T 13	Tare No.:	T 16
Wet Wt.+tare:	660.71	Wet Wt.+tare:	733.72
Dry Wt.+tare:	588.03	Dry Wt.+tare:	625.10
Tare Wt:	219.71	Tare Wt:	151.95
Dry Wt.:	368.32	Dry Wt.:	473.15
Water Wt.:	72.68	Water Wt.:	108.62
% moist.:	**19.7**	% moist.:	**23.0**

Specific Gravity: **2.80** Max Dry Density(pcf) = 107.9147 OMC = 19.732841
% of max = 100.0 +/- OMC = 0.00
Calculated % saturation: 103.59 Void ratio (e) = **0.62** Porosity (n)= **0.38**

TEST READINGS

Z1(Mercury Height Difference @ t1): 5.1 cm Hydraulic Gradient = 9.12

Date	elapsed t (seconds)	Z (pipet @ t)	ΔZπ (cm)	temp (deg C)	α (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
11/3/2009	76	4.5	2.1571965	24.5	0.899	2.96E-06	8.40E-03	
11/3/2009	106	4	2.6571965	24.5	0.899	2.86E-06	8.11E-03	
11/3/2009	140	3.5	3.1571965	24.5	0.899	2.87E-06	8.12E-03	
11/3/2009	182	3	3.6571965	24.5	0.899	2.92E-06	8.29E-03	

SUMMARY

ka = 2.90E-06 cm/sec Acceptance criteria = 25 %

ki			Vm	
k1 =	2.96E-06	cm/sec	2.1	%
k2 =	2.86E-06	cm/sec	1.4	%
k3 =	2.87E-06	cm/sec	1.3	%
k4 =	2.92E-06	cm/sec	0.7	%

$$V_m = \frac{|k_a - k_i|}{k_a} \times 100$$

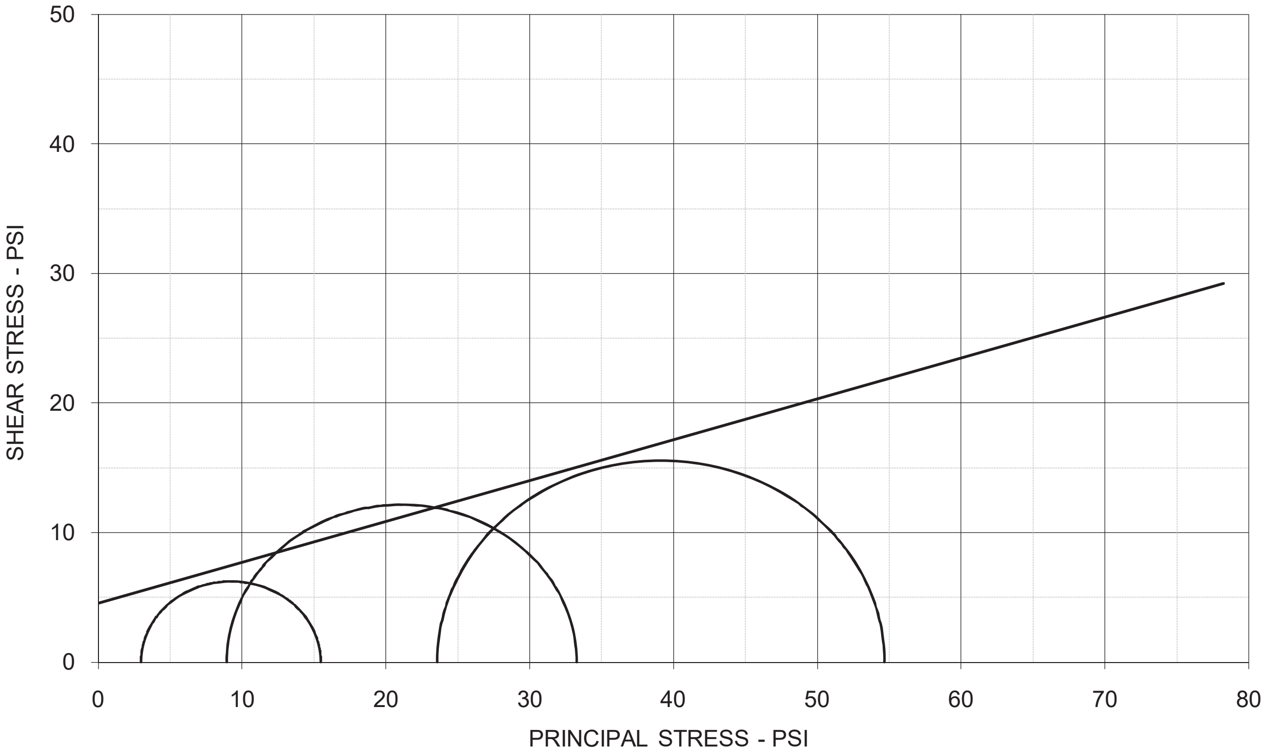
Hydraulic conductivity	k =	**2.90E-06**	cm/sec	**8.23E-03**	ft/day
Void Ratio	e =	**0.62**			
Porosity	n =	**0.38**			
Bulk Density	γ =	**2.07**	g/cm3	**129.2**	pcf
Water Content	W =	**0.34**	cm3/cm3	(at 20 deg C)	
Intrinsic Permeability	kint =	**2.97E-11**	cm2	(at 20 deg C)	

Liquid Limit LL		
Plastic Limit PL		
Plasticity Index PI		
- 200 Sieve		%
+ No 40 Sieve		%
+ No 4 Sieve		%

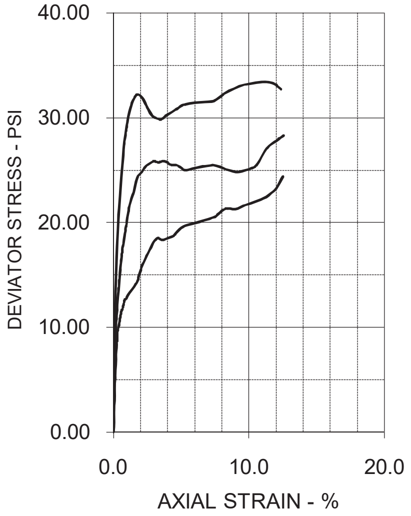
Respectfully Submitted

Robert M. Duke, P.E.

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	ϕ ' = 17.5 deg	c' = 4.6 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	25.3	23.6	23.9	
Dry Density - pcf	96.5	100.5	101.1	
Diameter - inches	2.05	2.02	2.04	
Height - inches	3.98	4.00	3.95	
AT TEST				
Final Moisture - %	28.8	28.1	24.5	
Dry Density - pcf	96.5	102.9	104.0	
Calculated Diameter (in.)	2.07	2.01	2.03	
Height - inches	4.02	3.98	3.91	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.49	24.34	31.06	
Total Pore Pressure - psi	57.0	61.1	66.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	2.1	1.5	
σ_1' Failure - psi	15.49	33.26	54.65	
σ_3' Failure - psi	3.00	8.92	23.59	

TEST DESCRIPTION

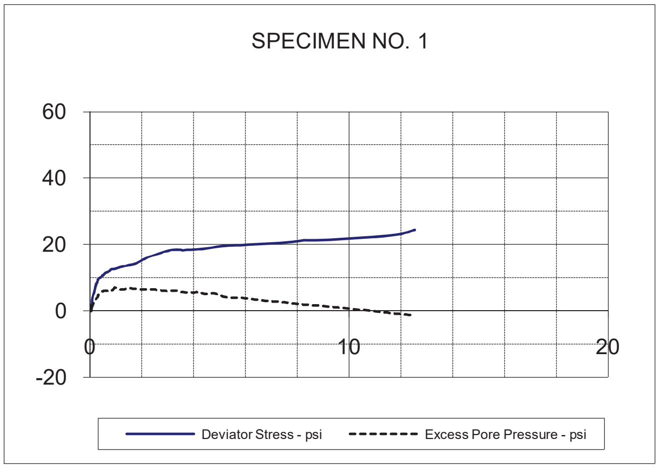
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-1 13' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 5%
LL: 56 PL: 18 PI: 38 Percent -200: 71%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

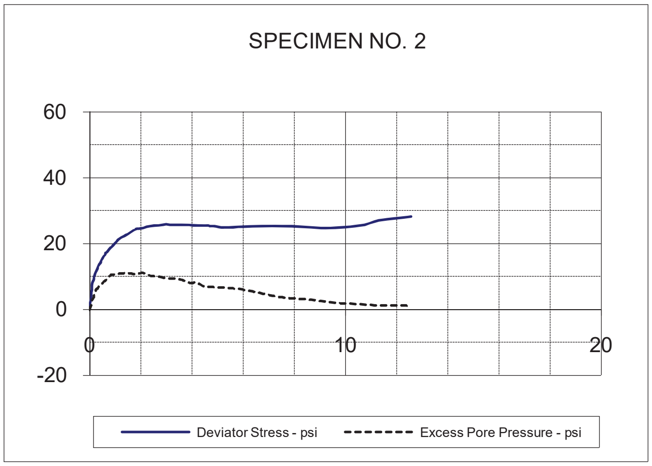
PROJECT INFORMATION

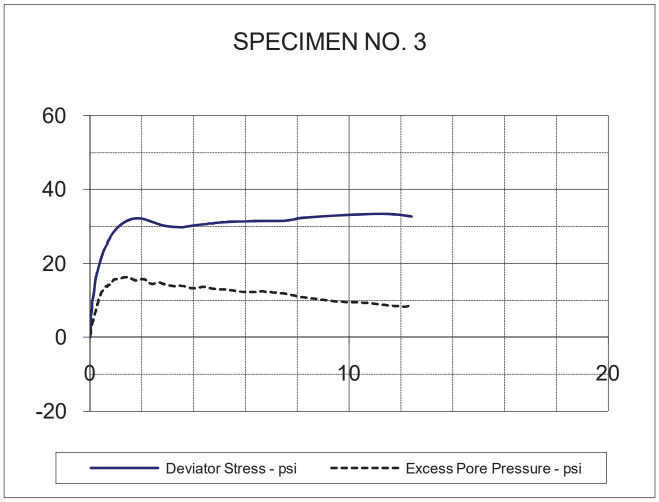
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

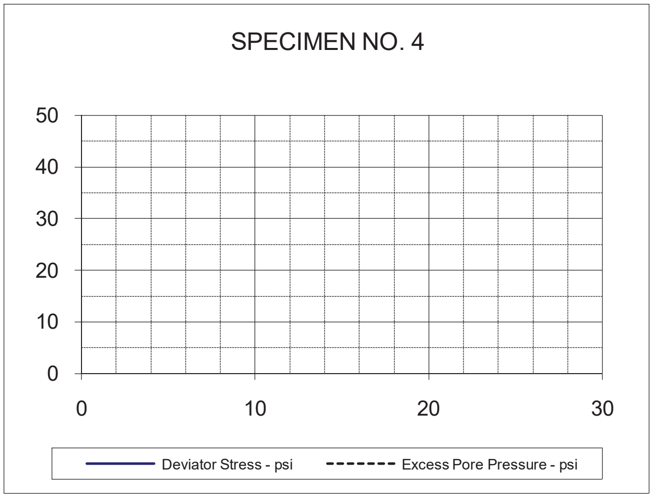
ETTL ENGINEERS & CONSULTANTS

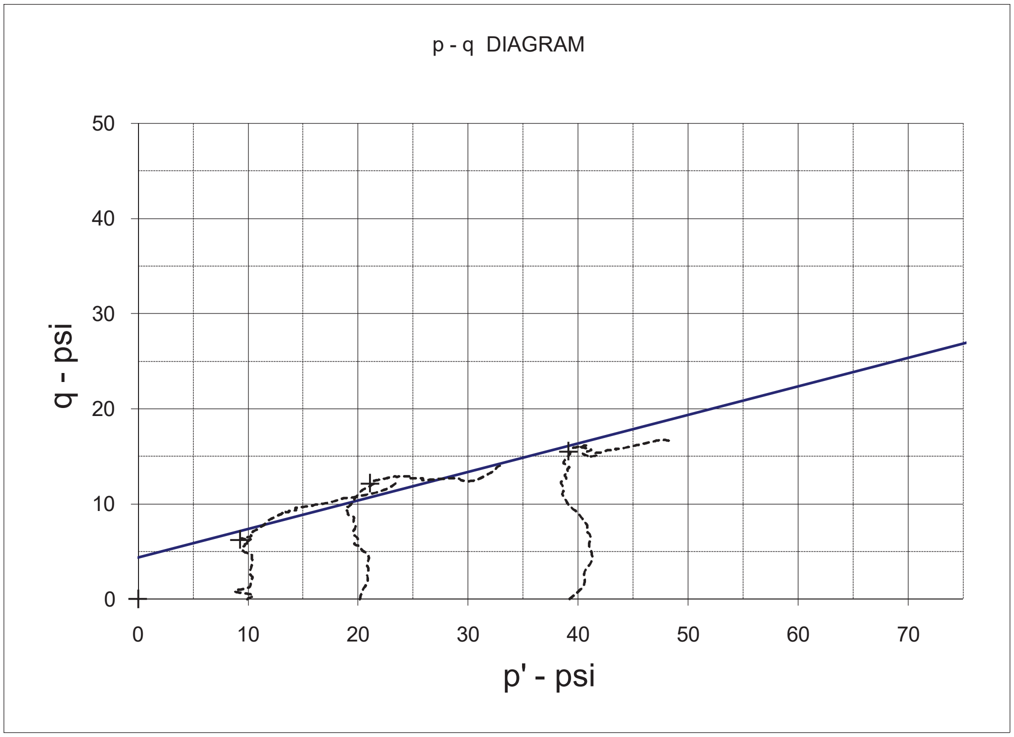
PLATE: B.1





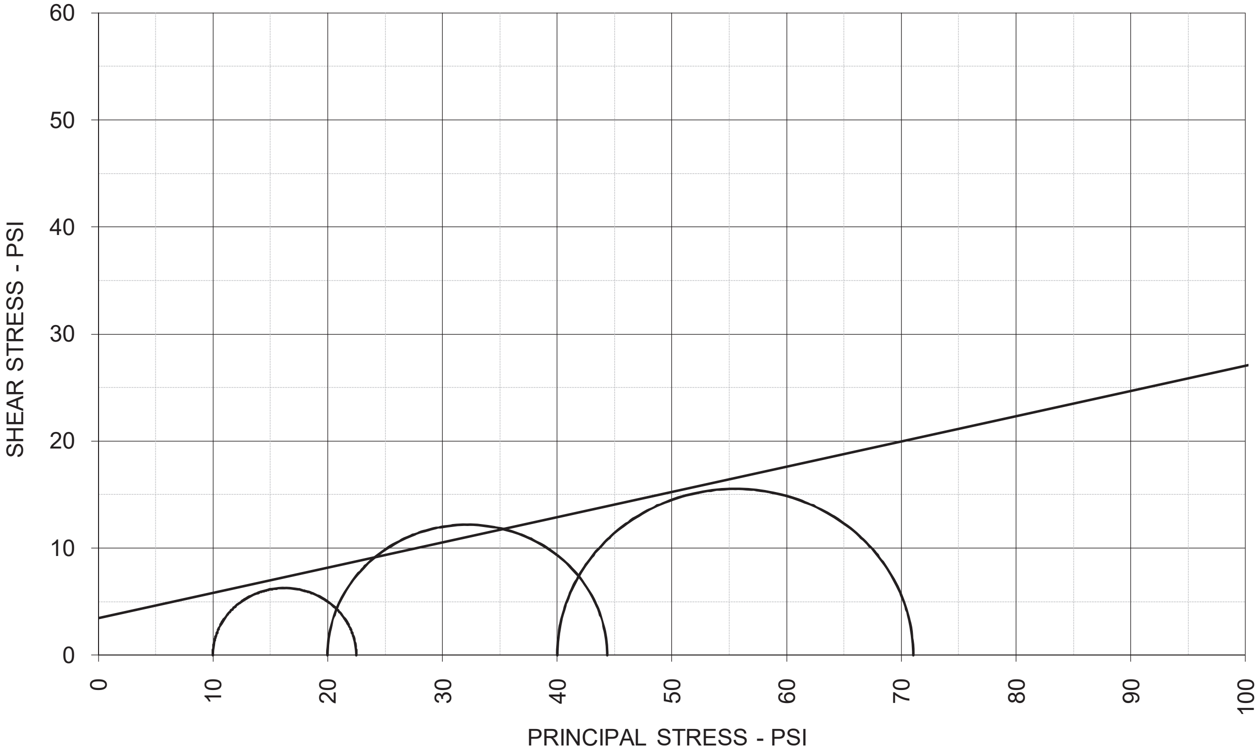




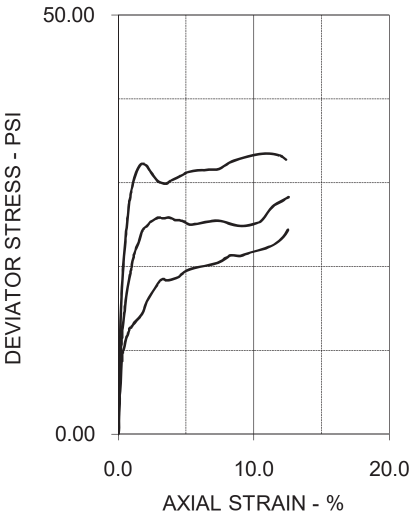


EFFECTIVE STRESS PARAMETERS	R^2 = 0.93	α (deg) = 16.7	a (psi) = 4.4
PROJECT: Pirkey Power Plant Embankments		TYPE OF TEST & NO: CU with PP	
PROJECT NO: G 3241 - 095		**ETTL ENGINEERS & CONSULTANTS**	PLATE: B.2
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand			

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	φ = 13.3 deg	c = 3.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	25.3	23.6	23.9	
Dry Density - pcf	96.5	100.5	101.1	
Diameter - inches	2.05	2.02	2.04	
Height - inches	3.98	4.00	3.95	
AT TEST				
Final Moisture - %	28.8	28.1	24.5	
Dry Density - pcf	96.5	102.9	104.0	
Calculated Diameter (in.)	2.07	2.01	2.03	
Height - inches	4.02	3.98	3.91	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	12.49	24.34	31.06	
Total Pore Pressure - psi	57.0	61.1	66.4	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	1.0	2.1	1.5	
σ_1 Failure - psi	22.49	44.34	71.06	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-1 13' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 5%
LL: 56 PL: 18 PI: 38 Percent -200: 71%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

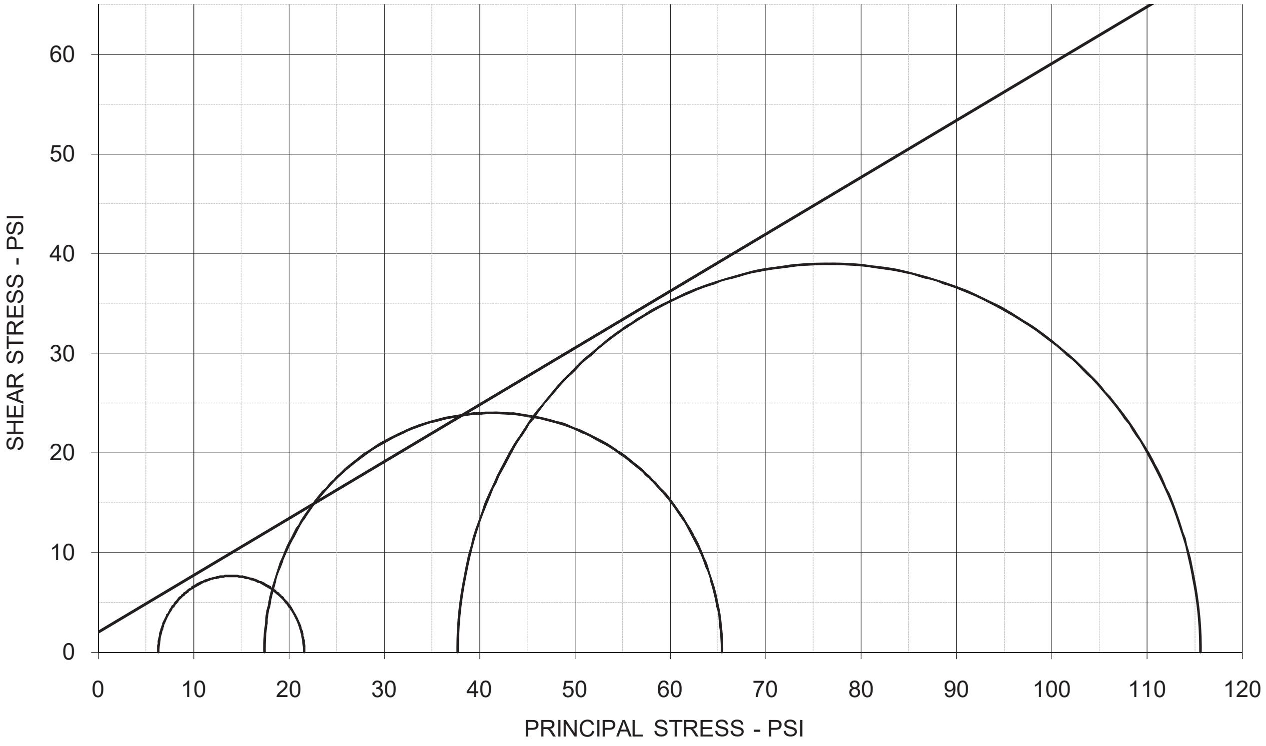
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

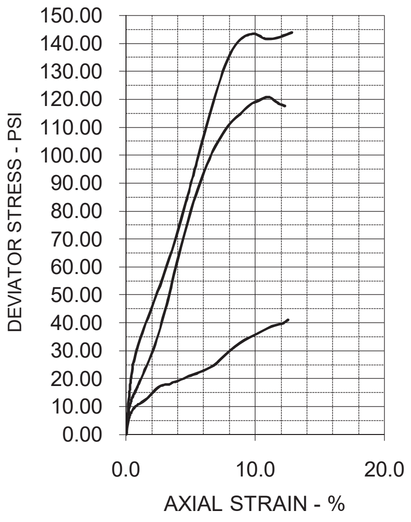
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 29.7 deg	c' = 2.0 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	18.7	19.2	18.5	
Dry Density - pcf	108.5	105.5	104.8	
Diameter - inches	2.04	2.04	2.02	
Height - inches	4.25	4.18	4.37	
AT TEST				
Final Moisture - %	21.3	21.7	20.7	
Dry Density - pcf	108.9	106.7	106.7	
Calculated Diameter (in.)	2.03	2.02	2.00	
Height - inches	4.21	4.13	4.31	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.27	47.96	77.89	
Total Pore Pressure - psi	63.7	52.6	52.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.1	3.2	4.3	
σ_1' Failure - psi	21.58	65.38	115.61	
σ_3' Failure - psi	6.31	17.42	37.72	

TEST DESCRIPTION

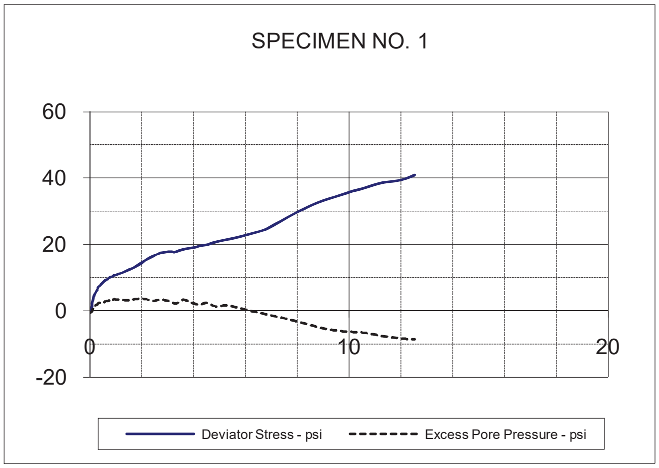
TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Dark Gray Clayey Sand
Sampled on Site, W-1 38' to 41' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 1%
LL: 29 PL: 19 PI: 10 Percent -200: 25%
REMARKS: Diameter and Both Ends Trimmed. + # 4 Sieve 0%

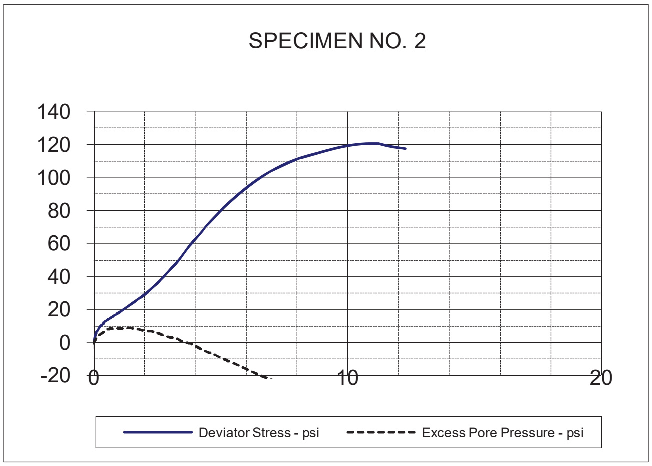
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

ETTL ENGINEERS & CONSULTANTS

PLATE: B.1


SPECIMEN NO. 1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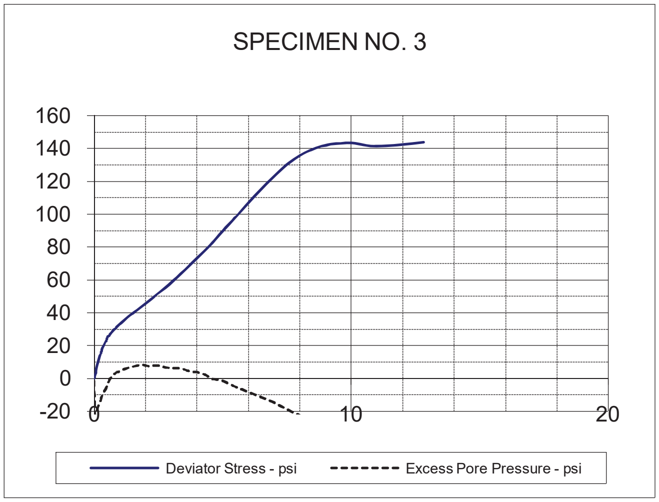
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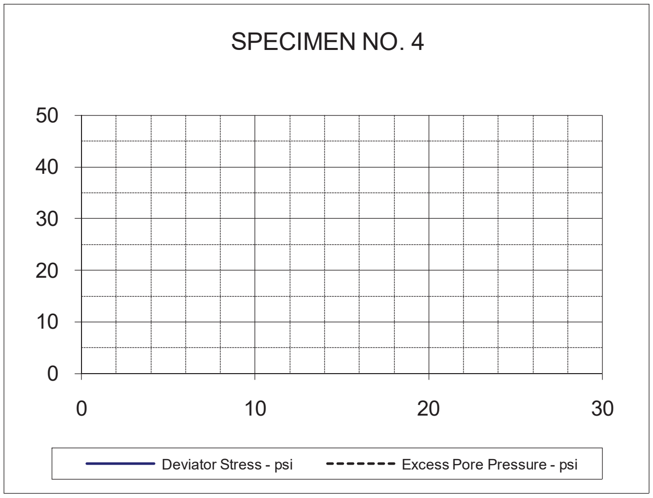
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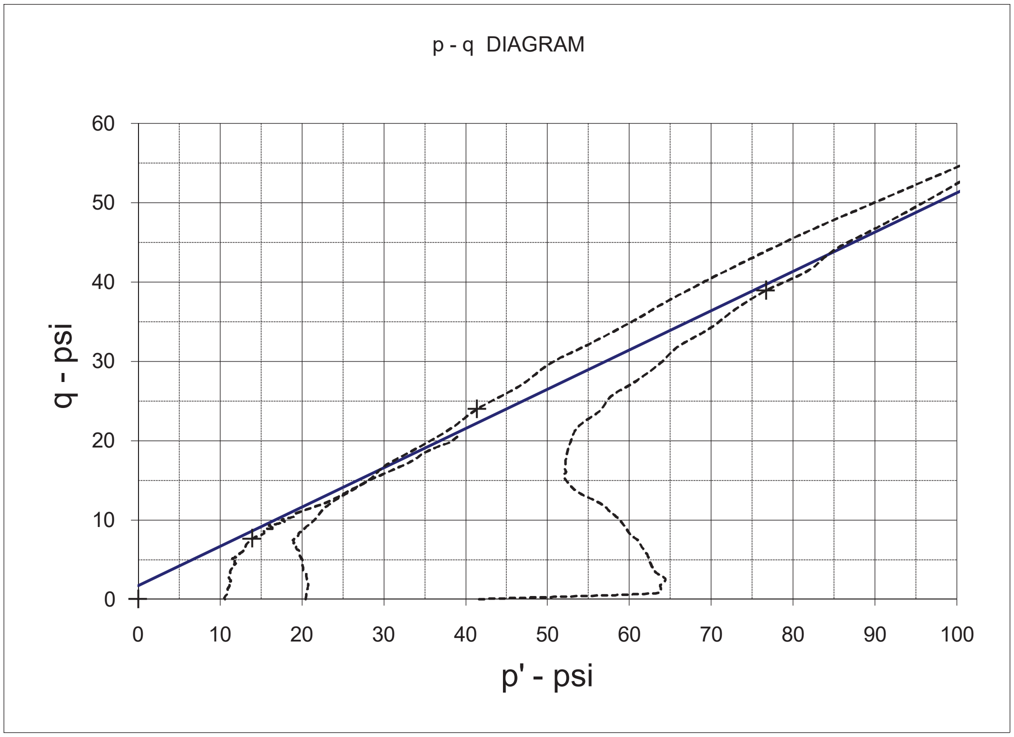
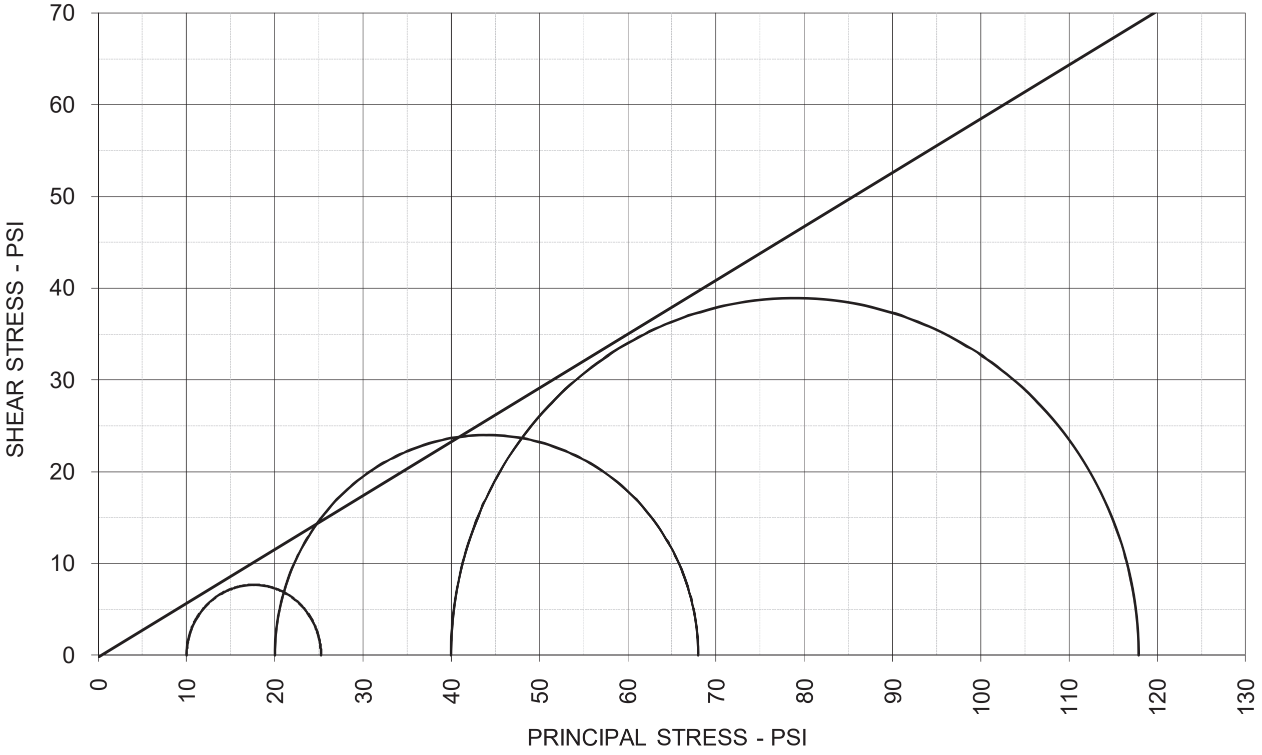

p - q DIAGRAM

EFFECTIVE STRESS PARAMETERS	R^2 = 0.99	α (deg) = 26.4	a (psi) = 1.7

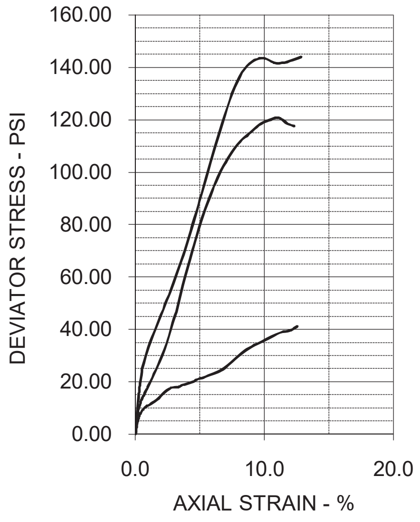
PROJECT: Pirkey Power Plant Embankments	TYPE OF TEST & NO: CU with PP
PROJECT NO: G 3241 - 095	**ETTL ENGINEERS & CONSULTANTS** PLATE: B.2
DESCRIPTION: Dark Gray Clayey Sand	

G 3241-095, W-1 38'-41' Native.xls

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	φ = 30.4 deg	c = -0.2 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	18.7	19.2	18.5	
Dry Density - pcf	108.5	105.5	104.8	
Diameter - inches	2.04	2.04	2.02	
Height - inches	4.25	4.18	4.37	
AT TEST				
Final Moisture - %	21.3	21.7	20.7	
Dry Density - pcf	108.9	106.7	106.7	
Calculated Diameter (in.)	2.03	2.02	2.00	
Height - inches	4.21	4.13	4.31	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.27	47.96	77.89	
Total Pore Pressure - psi	63.7	52.6	52.3	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.1	3.2	4.3	
σ_1 Failure - psi	25.27	67.96	117.89	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Native Shelby Tube Sample
DESCRIPTION: Dark Gray Clayey Sand
Sampled on Site, W-1 38' to 41' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 1%
LL: 29 PL: 19 PI: 10 Percent -200: 25%
REMARKS: Diameter and Both Ends Trimmed. + # 4 Sieve 0%

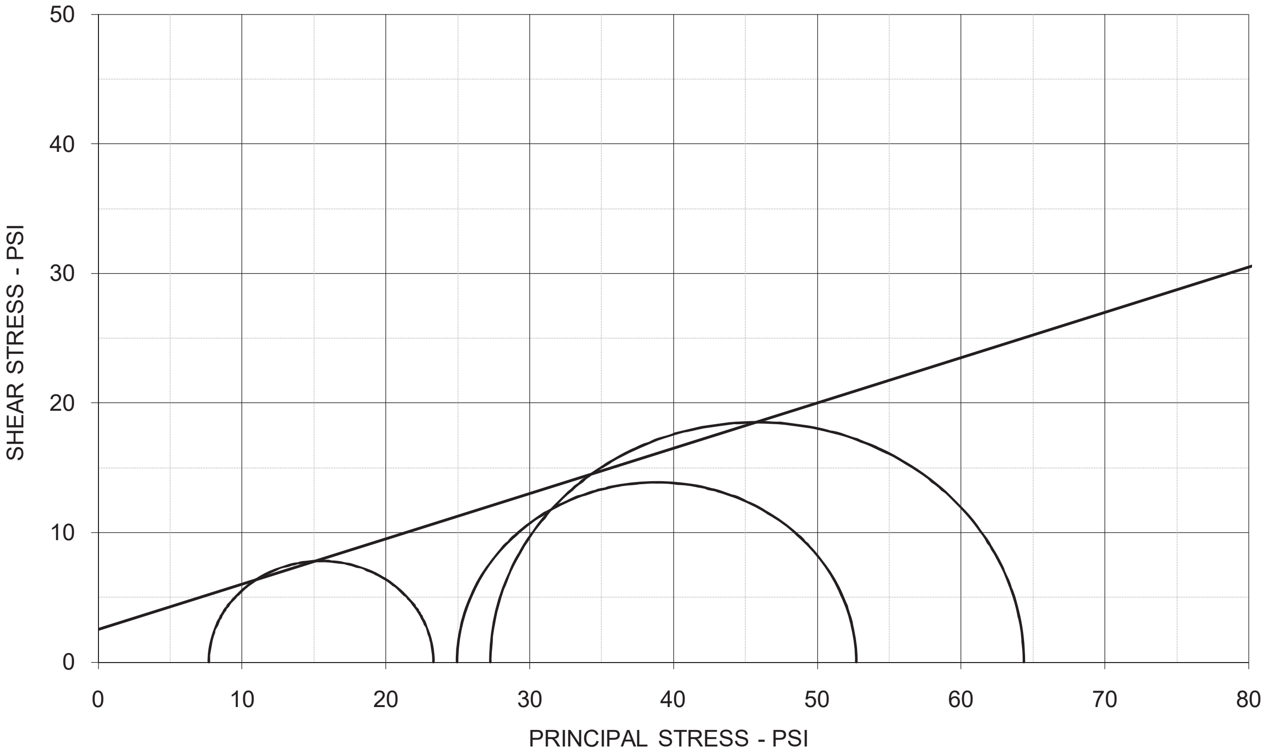
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

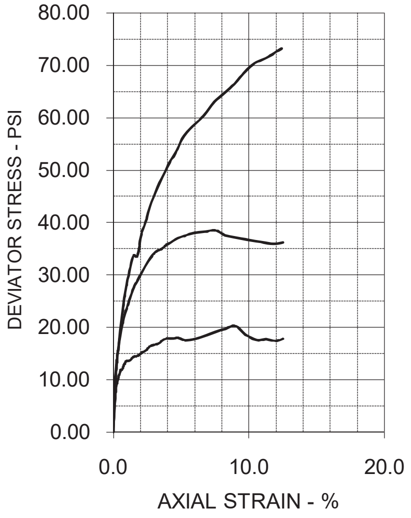
ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

TRIAXIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS	φ ' = 19.3 deg	c' = 2.5 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.4	21.5	23.6	
Dry Density - pcf	99.0	104.7	98.6	
Diameter - inches	1.99	2.01	2.00	
Height - inches	4.01	3.99	4.01	
AT TEST				
Final Moisture - %	27.8	20.6	27.1	
Dry Density - pcf	99.4	105.8	99.5	
Calculated Diameter (in.)	1.98	2.01	1.99	
Height - inches	3.99	3.97	3.98	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.62	27.77	37.08	
Total Pore Pressure - psi	52.3	45.0	62.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	1.0	4.8	
σ_1' Failure - psi	23.30	52.73	64.35	
σ_3' Failure - psi	7.68	24.96	27.27	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-3 10' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 6%
LL: 68 PL: 22 PI: 46 Percent -200: 80%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

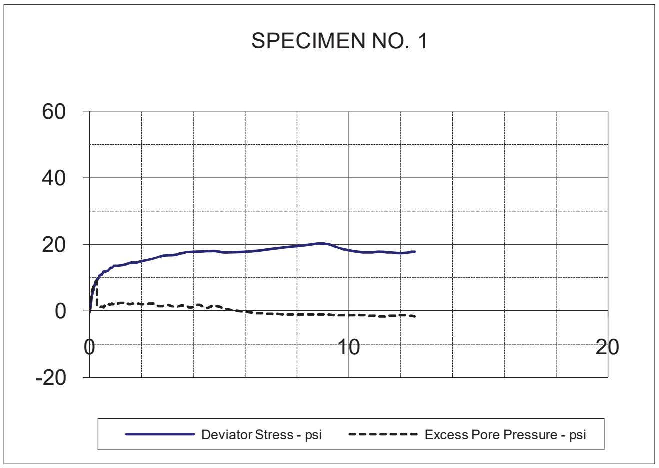
PROJECT INFORMATION

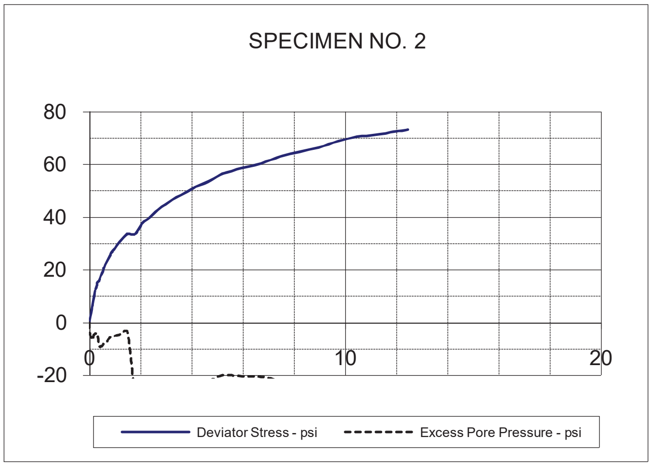
PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

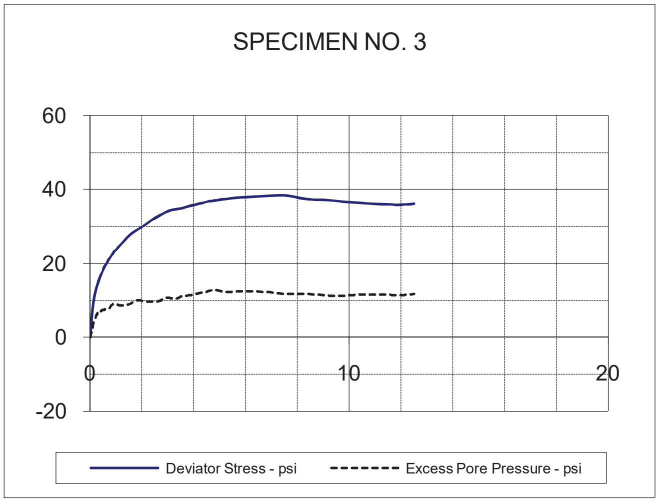
ETTL ENGINEERS & CONSULTANTS

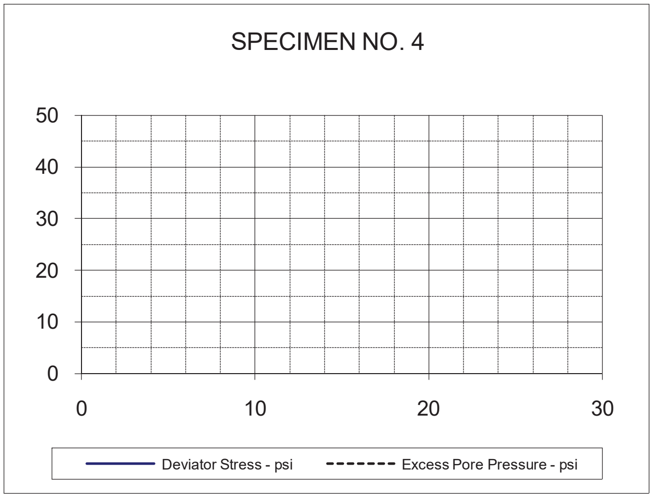
PLATE: B.1

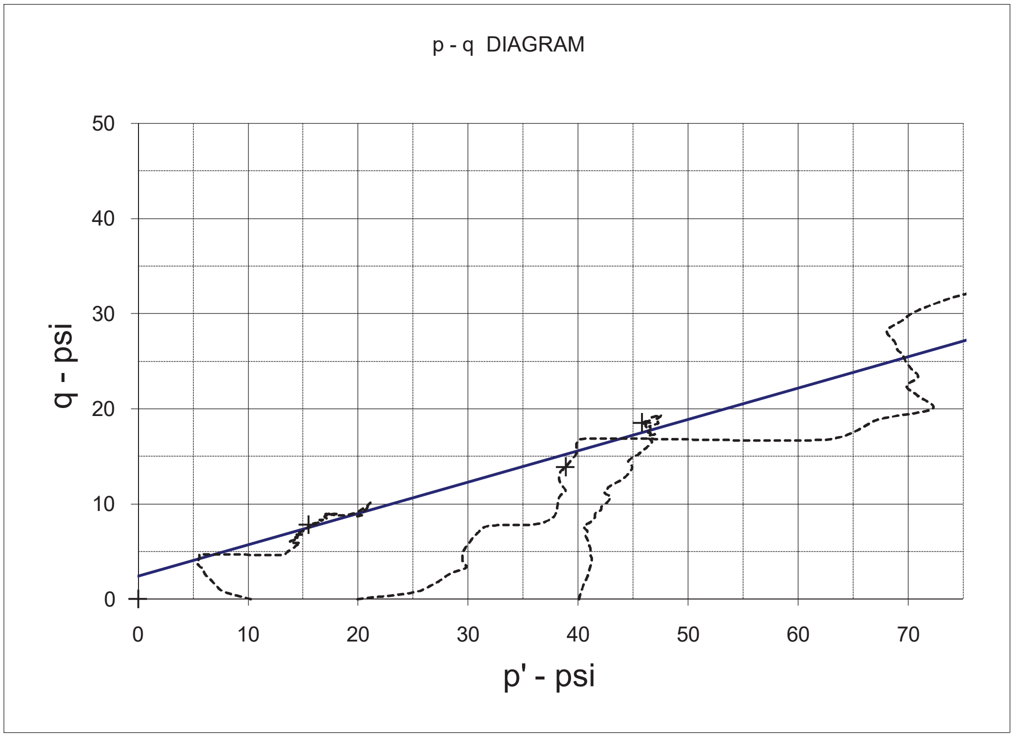
G 3241-095, W-3 10'-20'.xls


SPECIMEN NO. 1


SPECIMEN NO. 2


SPECIMEN NO. 3


SPECIMEN NO. 4


p - q DIAGRAM

EFFECTIVE STRESS PARAMETERS	R^2 = 0.95	α (deg) = 18.3	a (psi) = 2.4

PROJECT: Pirkey Power Plant Embankments

TYPE OF TEST & NO: CU with PP

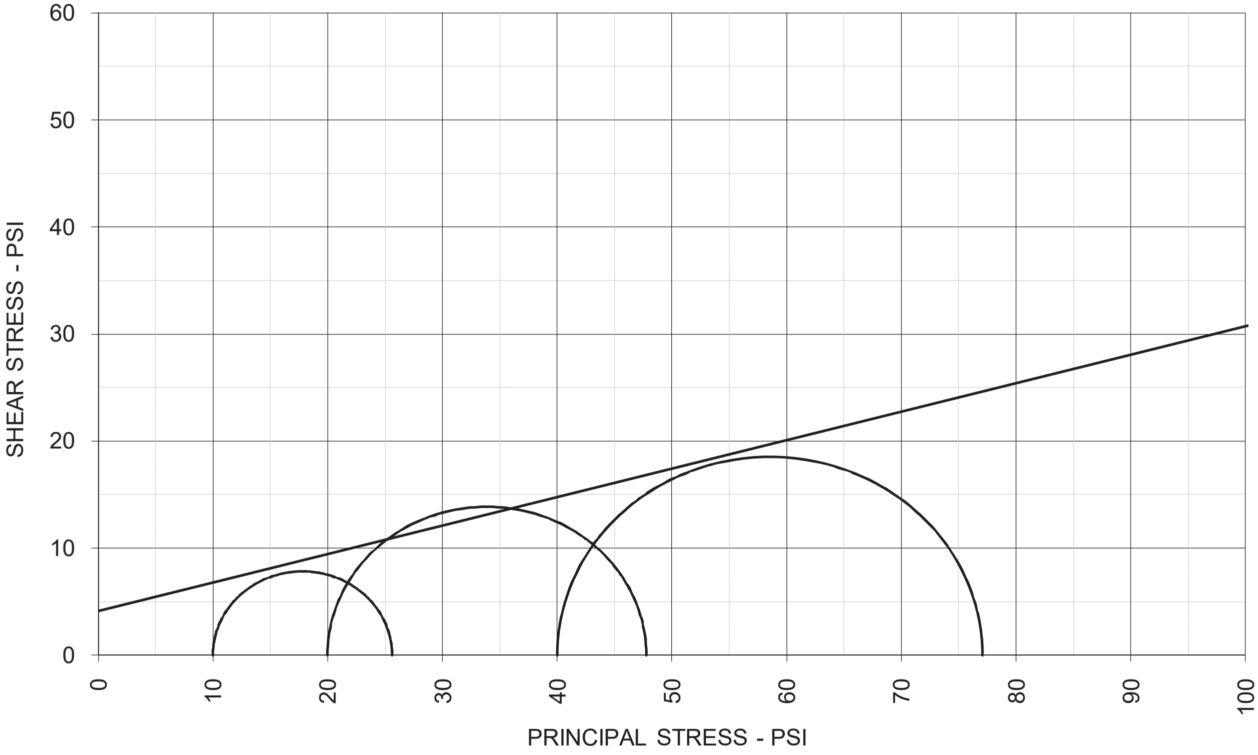
PROJECT NO: G 3241 - 095

DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand

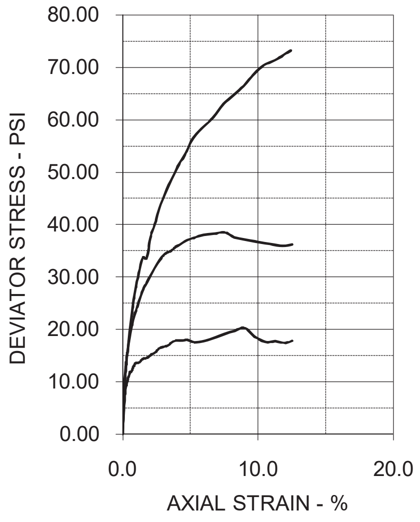
ETTL ENGINEERS & CONSULTANTS

PLATE: B.2

TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS	φ = 14.9 deg	c = 4.1 psi



SPECIMEN NO.	1	2	3	4
INITIAL				
Moisture Content - %	23.4	21.5	23.6	
Dry Density - pcf	99.0	104.7	98.6	
Diameter - inches	1.99	2.01	2.00	
Height - inches	4.01	3.99	4.01	
AT TEST				
Final Moisture - %	27.8	20.6	27.1	
Dry Density - pcf	99.4	105.8	99.5	
Calculated Diameter (in.)	1.98	2.01	1.99	
Height - inches	3.99	3.97	3.98	
Effect. Cell Pressure - psi	10.0	20.0	40.0	
Failure Stress - psi	15.62	27.77	37.08	
Total Pore Pressure - psi	52.3	45.0	62.7	
Strain Rate - inches/min.	0.00050	0.00050	0.00050	
Failure Strain - %	2.4	1.0	4.8	
σ_1 Failure - psi	25.62	47.77	77.08	
σ_3 Failure - psi	10.00	20.00	40.00	

TEST DESCRIPTION

TYPE OF TEST & NO: CU with PP
SAMPLE TYPE: Shelby Tube Sample
DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
Sampled on Site, W-3 10' to 20' deep
ASSUMED SPECIFIC GRAVITY: 2.7 + 40 Sieve 6%
LL: 68 PL: 22 PI: 46 Percent -200: 80%
REMARKS: Both Ends and Diameter Trimmed + # 4 Sieve 0%

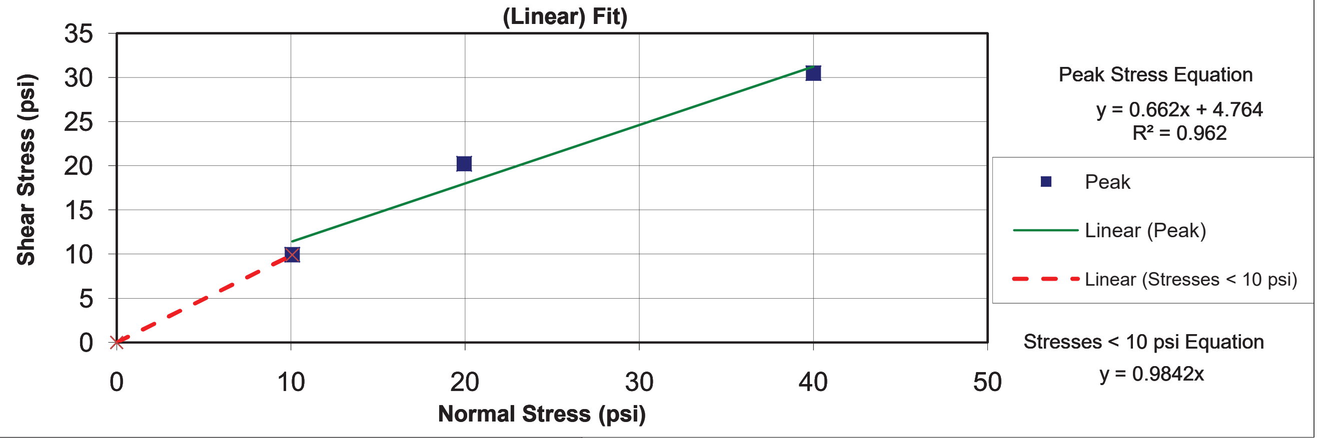
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
LOCATION: Hallsville, Texas
PROJECT NO: G 3241 - 095
CLIENT:
November 2009

ETTL ENGINEERS & CONSULTANTS

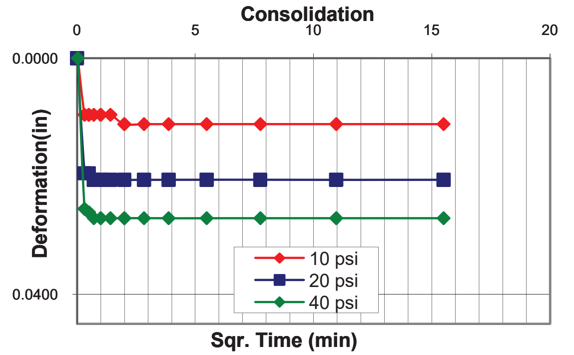
PLATE: B.3

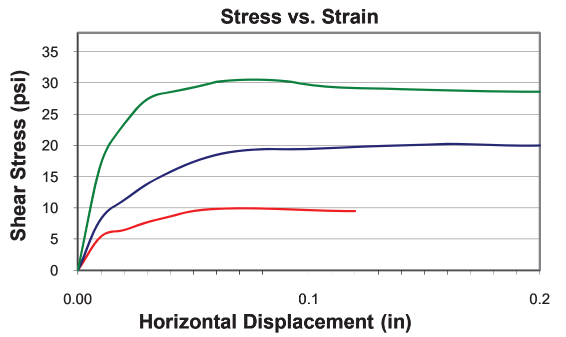
ASTM 3080 Direct Shear Test Report



Peak Stress Equation
$y = 0.662x + 4.764$
$R^2 = 0.962$

Stresses < 10 psi Equation
$y = 0.9842x$





Peak Strength Parameters

	Peak		Residual	
Friction Angle	33.5		-	
	(deg)		(deg)	
Cohesion	4.76	686.0	-	-
	(psi)	(psf)	(psi)	(psf)
Friction Angle Stresses < 10psi			44.5	(deg)
Specimen Number		1	2	3
Initial				
Moisture Content - %		18.5%	18.8%	21.4%
Dry Density- lb/ft^3		103.6	105.7	104.5
Height-inches		1.008	1.008	1.008
Diameter- inches		2.50	2.50	2.50
Final				
Moisture Content - %		24.4%	22.1%	24.1%
Dry Density- lb/ft^3		105.6	172.8	108.2
Height after shear-(inches)		0.997	0.620	0.978
Height after consolidation (inches)		0.997	0.987	0.981
Normal Stress-(psi)		10	20	40
Peak Failure Stress-(psi)		9.92	20.23	30.49
Residual Failure Stress-(psi)		-	-	-
Strain Rate - (inches/min)		0.0029	0.0027	0.0029

Project Information

		LL	PL	PI
Project :	Pirkey Power Plant Embankments	32	17	15
Client:	AEP			
Material Origin:	Hallsville, Tx			
Material Description:	Tan & Brown Clayey Sand with ferric seams	-200%	31	

Job No:	G 3241-095	**Technician:**	Owen Sanderson	**Remarks**
Boring No:	W-2	**Sample Type:**	Shelby Tube	When Calculating stresses < 10 psi: use appropriate Equation above (assuming no Cohesion)
Depth:	13'-16'	**Sampling method:**	Shelby Tube	
Date:	October 31, 2009	**Testing Device:**	Soiltest B-124BY 2.5 in. round	

C. Brandon Quinn. P.E.

C. Brandon Quinn

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

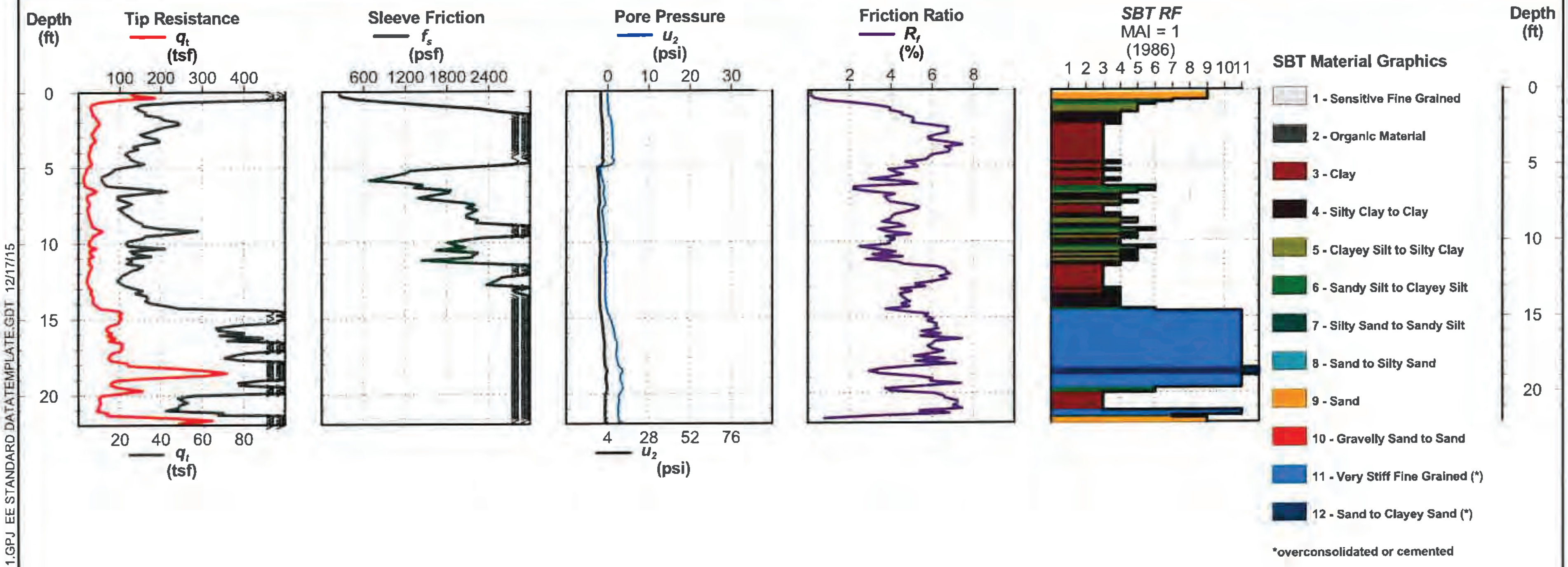
Cone Penetration Test

CPT-1

Latitude: 32.46619
Longitude: -94.48989

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 22.0 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

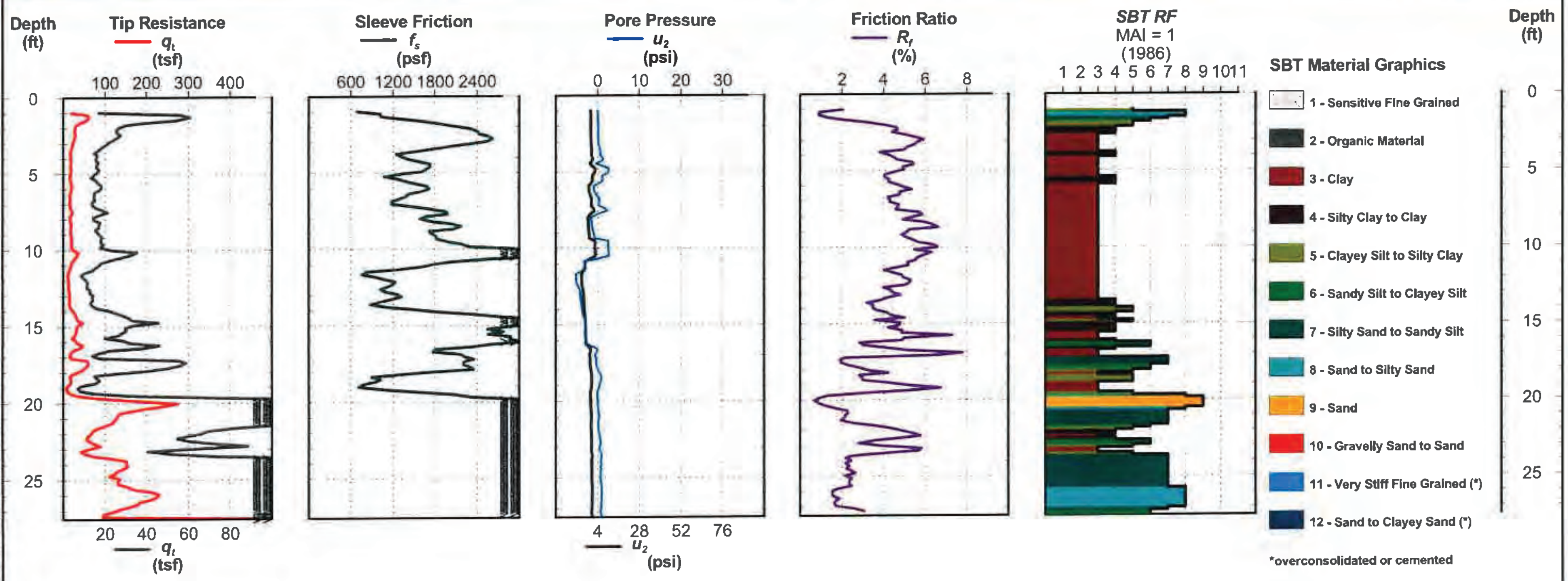
Cone Penetration Test

CPT-2

Latitude: 32.46613
Longitude: -94.49157

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 27.6 ft



EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

Electronic Filename: L0441CPT-2.cpt

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

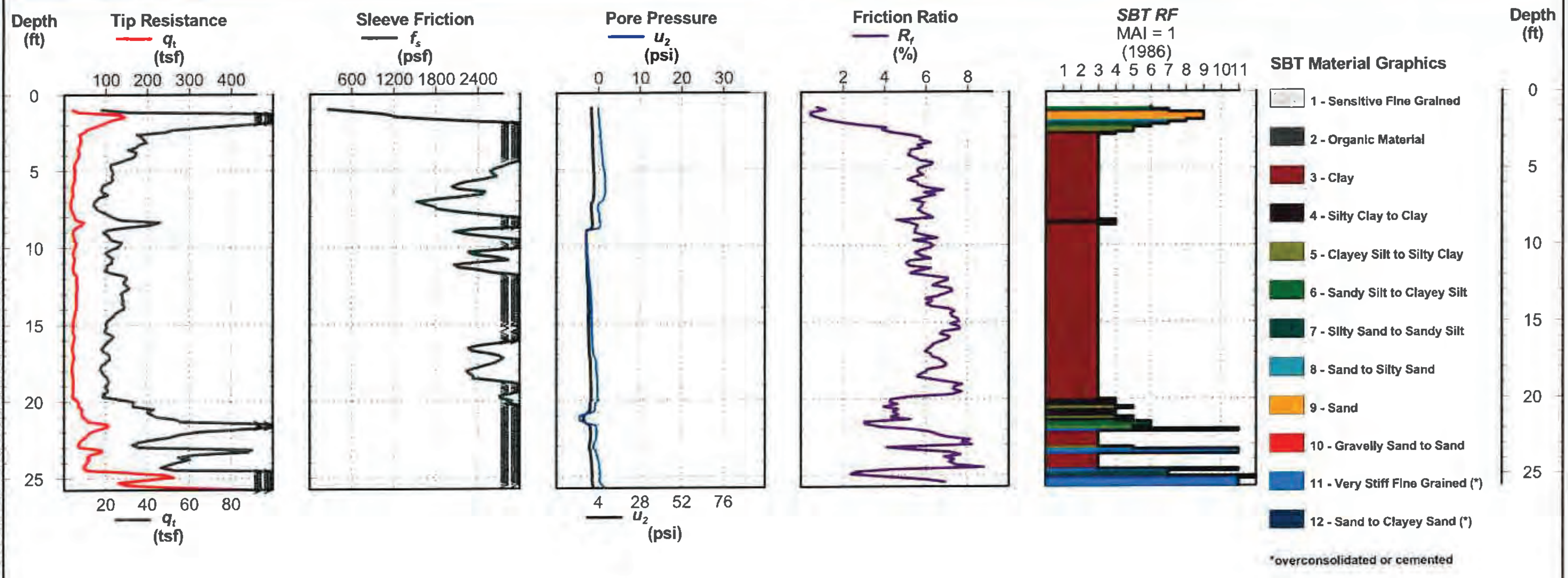
Cone Penetration Test

CPT-3

Latitude: 32.46587
Longitude: -94.49313

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 25.8 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

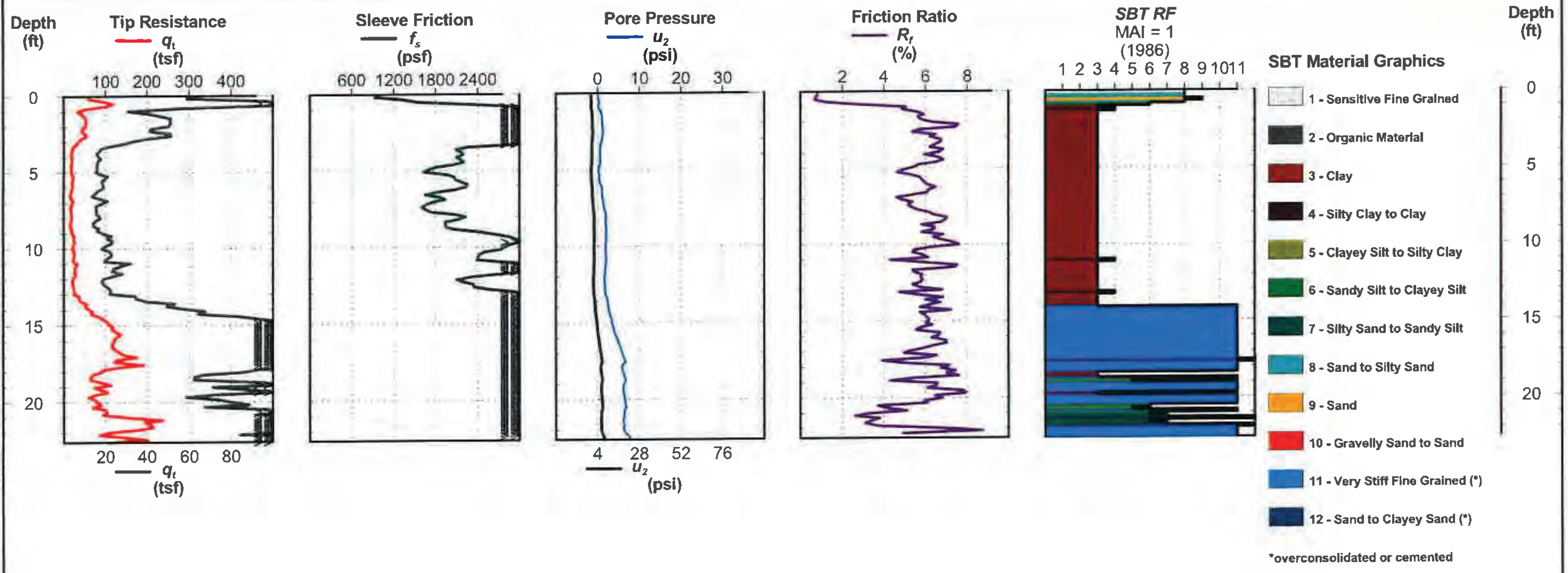
Cone Penetration Test

CPT-4

Latitude: 32.46672
Longitude: -94.49400

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 22.6 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Electronic Filename: L0441CPT-4.cpt

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

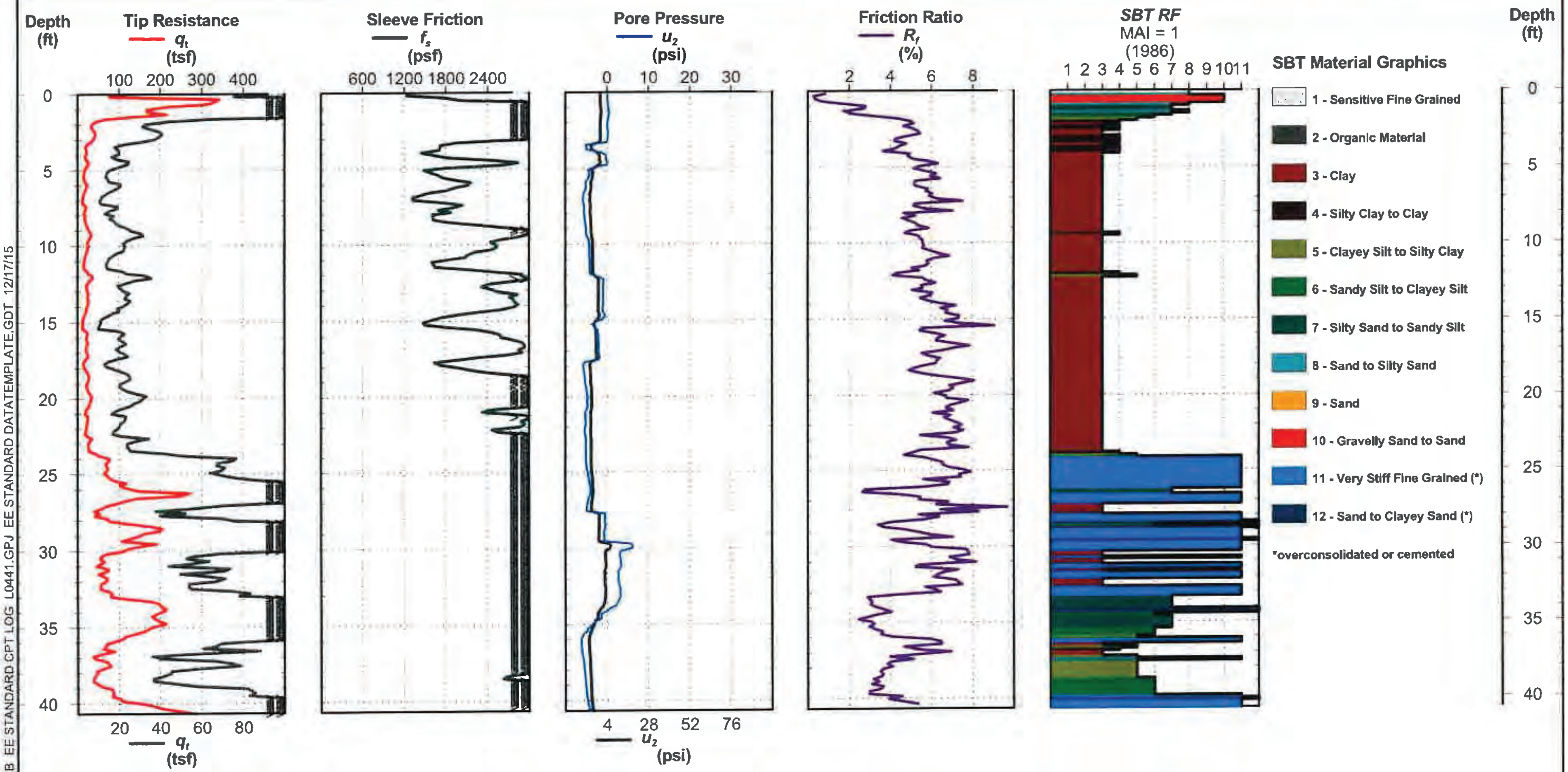
Cone Penetration Test

CPT-5

Latitude: 32.46803
Longitude: -94.49390

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 40.7 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Electronic Filename: L0441CPT-5.cpt

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

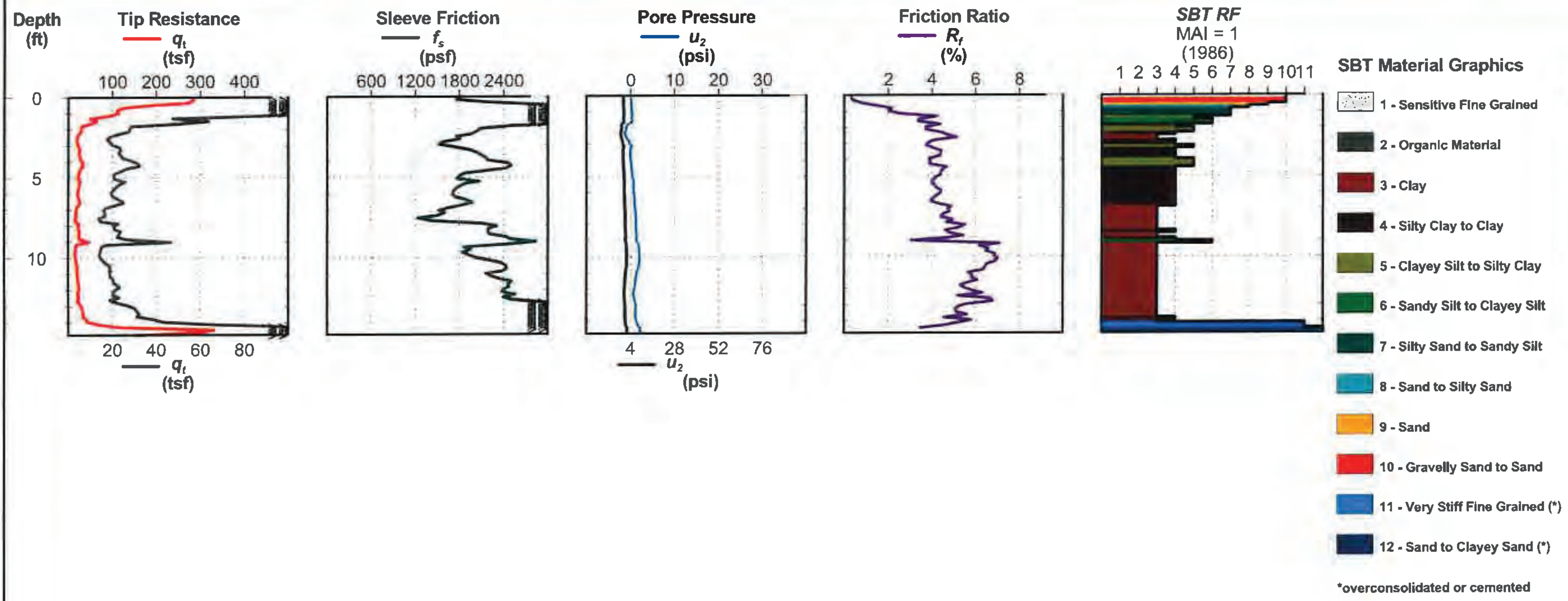
Cone Penetration Test

CPT-6

Latitude: 32.46887
Longitude: -94.49243

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 14.8 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Electronic Filename: L0441CPT-6.cpt

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

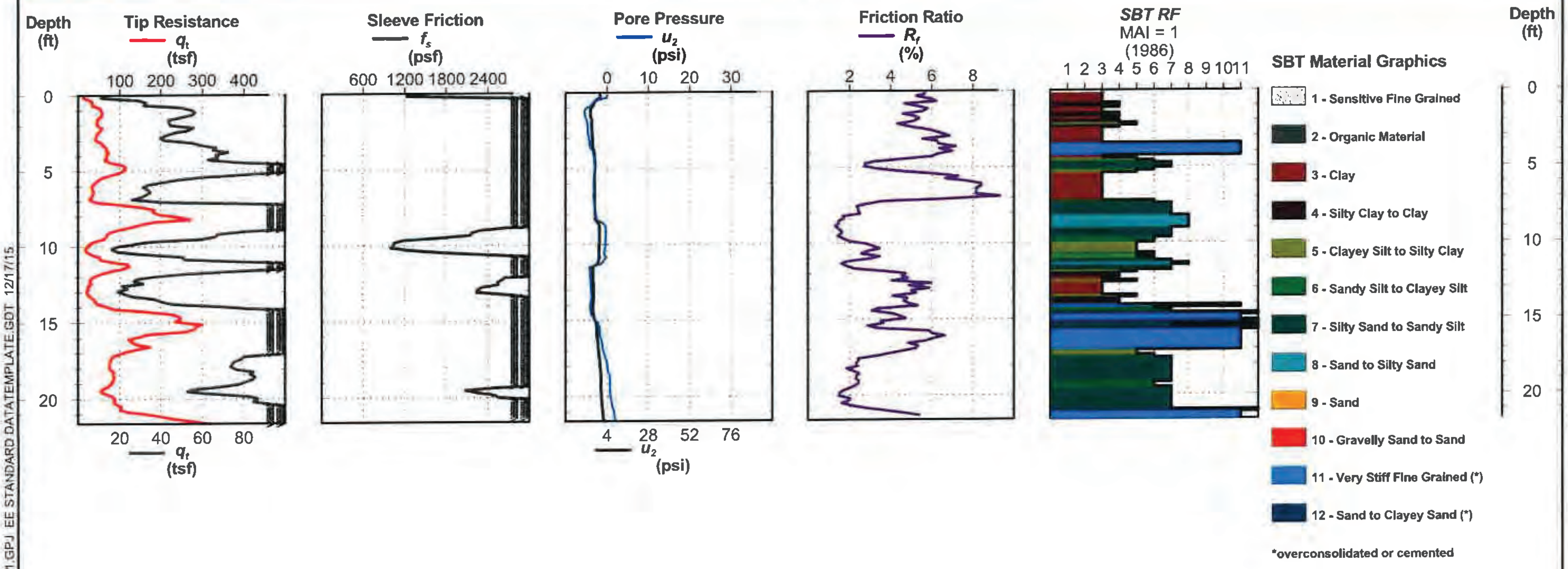
Cone Penetration Test

CPT-7

Latitude: 32.46572
Longitude: -94.49256

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 21.7 ft



Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

EUSTIS ENGINEERING

H W Pirkey Power Plant
West Primary Ash Pond
Future Landfill at K-Area
Hallsville, Texas
Project No: L0441

CPT ID/Net Area Ratio: DSG0709 / 0.8

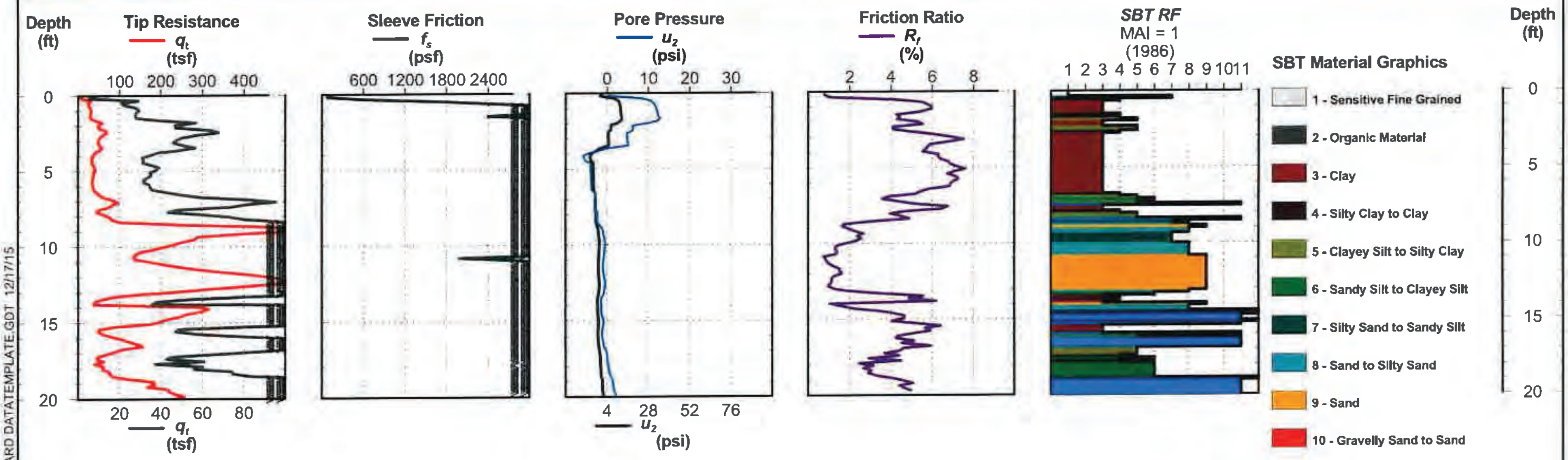
Cone Penetration Test

CPT-8

Latitude: 32.46603
Longitude: -94.49087

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 20.0 ft



EUSTIS GINT LIBRARY090314.GLB EE STANDARD CPT LOG L0441.GPJ EE STANDARD DATATEMPLATE.GDT 12/17/15

Notes: Soil behavior type was determined using friction ratio classification chart (after Robertson *et al.*, 1986).
Test performed in general accordance with ASTM D5778-12.

Electronic Filename: L0441CPT-8y.cpt

Appendix F

Annual Groundwater Monitoring Report

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
East Bottom Ash Pond CCR Management Unit
Hallsville, Texas

January 2020

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY
An AEP Company
BOUNDLESS ENERGY

Page

Table of Contents

I. Summary

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2020.

In general, the following activities were completed:

- Groundwater samples were collected for AD-2, AD-4, AD-12, AD-18, AD-31, and AD-32 in February, May, and August 2019 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq*. and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in Assessment monitoring at the beginning of 2019;
- Assessment of Corrective measure was initiated on March 26, 2019;
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32 on December 26, 2018. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 24, 2019. An alternate source for lithium was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on July 22, 2019. As result, assessment of corrective measure work stopped and the unit stayed in assessment monitoring.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32 on July 12, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 23, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-2 and AD-32 and for lithium at AD-31 and AD-32 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.
- The unit was in Assessment monitoring at the end of the 2019;
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was

guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations (Appendix IV).
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

East BAP Monitoring Wells	
Up Gradient	Down Gradient
AD-4	AD-2
AD-12	AD-31
AD-18	AD-32

III. Monitoring Wells Installed or Decommissioned

Several monitoring wells were installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry in mine spoils. Please see the list below. Well installation reports can be found in Appendix V.

Soil Boring ID	Monitor Well ID
	AD-37
	AD-38
	AD-39
	AD-40
SB-01A	AD-41
SB-04	AD-42
SB-04	AD-43
SB-05	AD-44
SB-05	AD-45
SB-06	AD-46
SB-06	AD-47
SB-07	AD-48
SB-07	AD-49
SB-08	AD-50
SB-08	AD-52
SB-08	AD-53
SB-09	AD-54
SB-09	AD-55
SB-11	AD-56
SB-11	AD-57

Three additional soil borings were installed to better understand the spatial variability of constituents at the site up gradient of the plant. The borings logs can be found in Appendix III in *Alternative Source Demonstration Report Federal CCR Rule* dated July 22, 2019. Two monitor wells were installed at these boring locations B-2 and B-3. Well construction diagrams and well development logs for monitoring wells B-2 and B-3 can also be found in *Alternative Source Demonstration Report Federal CCR Rule* dated July 22, 2019. The well installation reports are included in this report in Appendix V.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event are presented in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a one round of sampling in February in accordance with 40 CFR 257.95(d)(1). A May sampling event was conducted in accordance with 40 CFR 257.95(b) including all Appendix III parameters and those Appendix IV constituents parameters followed by an August round of sampling in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2020.

V. Statistical Evaluation of 2019 Events

The two statistical analysis reports are included in Appendix II.

Statistically significant levels (SSLs) above the groundwater protection standard were identified for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32 as summarized in *Statistical Analysis Summary East Bottom Ash Pond Report* (7/12/2019) in Appendix II.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-2 and AD-32 and for lithium at AD-31 and AD-32 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the east bottom ash pond SSLs above GWPSs. SSLs above the GWPS were determined for lithium and cobalt on December 26, 2018. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 24, 2019. An alternate source for lithium was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on July 22, 2019.

SSLs above the GWPS were determined for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32 on July 12, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 23, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-2 and AD-32 and for lithium at AD-31 and AD-32 on January 3, 2020. An alternate source investigation will be conducted for these SSLs.

The supporting information are found in Appendix III.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

The unit transitioned from detection monitoring to assessment monitoring transition on April 3, 2018. The unit transitioned into assessment of corrective measures on March 26, 2019 since there was no alternate source identified at that time. An alternate source was later identified for cobalt on April 24, 2019 and lithium on July 22, 2019. Assessment of corrective measures was discontinued and the unit remained in assessment monitoring.

Assessment monitoring will continue in 2020.

Regarding defining an alternate monitoring frequency, no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

No other information applies at this time.

IX. Description of Any Problems Encountered in 2019 and Actions Taken

No problems were encountered this year.

X. A Projection of Key Activities for the Upcoming Year

Key activities for next year include:

- Assessment monitoring sampling will be conducted;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for any SSLs above GWPS;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the next annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer February 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2020/01/16

Figure
1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- ▲ Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
May 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
2

Columbus, Ohio
2020/01/16

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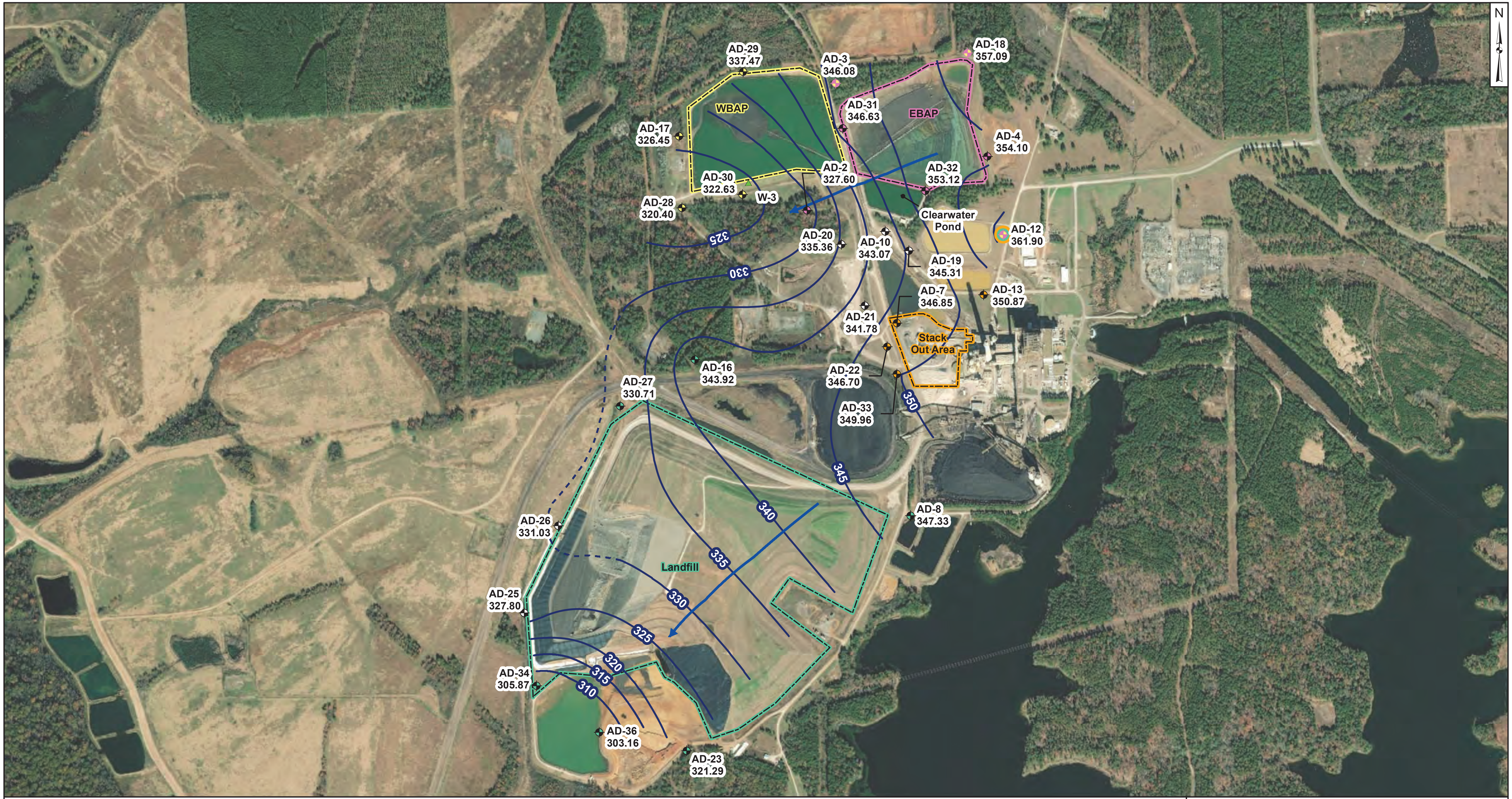

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
3

Columbus, Ohio
2020/01/16

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Table 1: Residence Time Calculation Summary
Pirkey East Bottom Ash Pond

			2019-02		2019-05		2019-08	
CCR Management Unit	Monitoring Well	Well Diameter (inches)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
East Bottom Ash Pond	AD-2 [2]	4.0	7.1	17.1	32.3	3.8	6.4	19.0
	AD-4 [1]	4.0	11.6	10.5	10.6	11.5	5.1	23.9
	AD-12 [1]	4.0	34.2	3.6	35.0	3.5	21.2	5.7
	AD-18 [1]	2.0	9.3	6.6	8.9	6.8	7.1	8.5
	AD-31 [2]	2.0	27.3	2.2	30.1	2.0	25.9	2.3
	AD-32 [2]	2.0	20.0	3.0	15.2	4.0	18.5	3.3

Notes:
[1] - Background Well
[2] - Downgradient Well

Table 1 - Groundwater Data Summary: AD-2
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	1.27	1.43	28	<0.083 U	4.4	238	68
7/14/2016	Background	1.34	1.38	28	<0.083 U	4.2	216	71
9/7/2016	Background	1.3	2.65	20	<0.083 U	4.2	216	49
10/13/2016	Background	1.48	1.29	31	<0.083 U	3.6	230	67
11/14/2016	Background	1.36	1.44	28	<0.083 U	3.9	240	72
1/12/2017	Background	1.48	1.6	30	<0.083 U	3.9	244	94
3/1/2017	Background	1.62	1.28	28	<0.083 U	4.1	262	80
4/11/2017	Background	1.65	1.71	50	<0.083 U	4.0	254	88
8/24/2017	Detection	1.46	2.06	24	<0.083 U	4.3	200	64
12/21/2017	Detection	1.38	2.92	24	< 0.083 U	- -	206	64
3/22/2018	Assessment	1.99	1.97	30	<0.083 U	4.2	220	105
8/21/2018	Assessment	2.14	1.65	46	<0.083 U	4.7	312	130
2/28/2019	Assessment	2.25	1.96	31.8	0.1 J	3.5	384	129
5/22/2019	Assessment	2.17	2.19	29.6	0.1 J	4.0	316	137
8/12/2019	Assessment	2.16	3.30	28.4	0.1 J	4.6	306	128

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-2
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	38	0.514594 J	<0.07 U	<0.23 U	10	1.446	<0.083 U	<0.68 U	<0.00013 U	0.098	<0.29 U	2.08256 J	<0.86 U
7/14/2016	Background	<0.93 U	<1.05 U	38	0.46511 J	<0.07 U	0.401928 J	11	0.723	<0.083 U	<0.68 U	0.051	0.068	0.862706 J	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	39	0.439699 J	<0.07 U	0.493592 J	10	1.489	<0.083 U	<0.68 U	0.048	0.675	<0.29 U	<0.99 U	1.26444 J
10/13/2016	Background	<0.93 U	<1.05 U	39	0.40165 J	<0.07 U	0.885421 J	11	2.65	<0.083 U	<0.68 U	0.052	0.048	<0.29 U	1.3807 J	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	34	0.367353 J	<0.07 U	<0.23 U	10	2.121	<0.083 U	<0.68 U	0.048	0.154	<0.29 U	1.23147 J	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	37	0.376129 J	<0.07 U	<0.23 U	10	1.656	<0.083 U	<0.68 U	0.052	0.093	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	37	0.413652 J	<0.07 U	<0.23 U	10	1.267	<0.083 U	<0.68 U	0.051	0.037	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	<1.05 U	37	0.435396 J	<0.07 U	0.243798 J	11	0.807	<0.083 U	<0.68 U	0.052	0.028	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	33.28	0.45 J	<0.07 U	<0.23 U	12.43	1.053	<0.083 U	<0.68 U	0.05379	0.042	<0.29 U	1.61 J	<0.86 U
8/21/2018	Assessment	<0.01 U	0.52	29.0	0.428	0.06	0.406	13.6	1.059	<0.083 U	0.338	0.0479	0.02 J	0.06 J	1.1	0.096
2/28/2019	Assessment	0.02 J	0.53	26.1	0.5 J	0.06	0.1 J	13.9	1.261	0.1 J	0.355	0.0591	0.027	<0.4 U	1.5	<0.1 U
5/22/2019	Assessment	<0.4 U	<0.6 U	25.6	<0.4 U	<0.2 U	<0.8 U	15.5	0.832	0.1 J	<0.4 U	0.0542	0.063	<8 U	0.9 J	<0.1 U
8/12/2019	Assessment	<0.02 U	0.35	22.8	0.402	0.06	0.292	13.0	1.812	0.1 J	0.288	0.056	0.044	<0.4 U	0.8	0.1 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-4
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.02	1.63	4	<0.083 U	5.4	148	23
7/14/2016	Background	0.02	2.32	4	<0.083 U	4.9	157	20
9/8/2016	Background	0.02	2.37	5	<0.083 U	4.9	136	20
10/13/2016	Background	0.03	2.87	6	<0.083 U	4.1	164	19
11/15/2016	Background	0.04	2.71	5	<0.083 U	4.3	152	19
1/12/2017	Background	0.03	2.94	5	<0.083 U	4.8	148	18
3/1/2017	Background	0.03	2.86	4	<0.083 U	4.7	148	18
4/10/2017	Background	0.04	1.91	5	<0.083 U	4.4	140	21
8/24/2017	Detection	0.06229	2.04	5	<0.083 U	4.6	94	20
3/22/2018	Assessment	0.0331	1.41	3	<0.083 U	4.8	132	23
8/21/2018	Assessment	0.018	2.38	7	<0.083 U	4.8	158	21
2/28/2019	Assessment	0.021	1.57	3.56	0.11	4.9	192	22.9
5/23/2019	Assessment	0.021	1.71	3.31	0.15	5.0	150	24.6
8/14/2019	Assessment	<0.02 U	1.97	6.22	0.12	5.5	146	21.7

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-4
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	3.95918 J	75	1	0.133362 J	0.396808 J	8	0.729	<0.083 U	<0.68 U	0.013	0.00891 J	<0.29 U	1.79183 J	<0.86 U
7/14/2016	Background	<0.93 U	8	127	1	<0.07 U	3	9	4.271	<0.083 U	<0.68 U	0.041	0.037	<0.29 U	1.73546 J	1.87362 J
9/8/2016	Background	<0.93 U	5	123	1	0.111076 J	2	8	0.193	<0.083 U	<0.68 U	0.04	0.01151 J	<0.29 U	<0.99 U	<0.86 U
10/13/2016	Background	<0.93 U	11	183	0.830588 J	<0.07 U	7	7	2.381	<0.083 U	<0.68 U	0.034	0.01005 J	<0.29 U	1.60451 J	0.868603 J
11/15/2016	Background	<0.93 U	<1.05 U	114	0.53145 J	<0.07 U	0.446412 J	6	1.072	<0.083 U	<0.68 U	0.035	0.01268 J	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	149	0.406228 J	<0.07 U	0.305795 J	4.5062 J	2.599	<0.083 U	<0.68 U	0.03	0.01146 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	131	0.354085 J	<0.07 U	<0.23 U	4.45689 J	1.089	<0.083 U	<0.68 U	0.033	0.01224 J	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	94	0.915299 J	0.0796 J	0.240917 J	8	0.684	<0.083 U	<0.68 U	0.047	0.00554 J	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	66.74	1.15	0.26 J	<0.23 U	9.39	1.283	<0.083 U	<0.68 U	0.05374	<0.005 U	<0.29 U	1.99 J	<0.86 U
8/21/2018	Assessment	<0.01 U	1.30	121	0.400	0.02 J	0.198	4.43	1.331	<0.083 U	0.098	0.0294	0.005 J	<0.02 U	0.04 J	0.096
2/28/2019	Assessment	<0.02 U	0.26	70.5	0.9 J	0.01 J	0.1 J	6.92	0.818	0.11	0.106	0.0513	<0.005 U	<0.4 U	0.03 J	<0.1 U
5/23/2019	Assessment	<0.4 U	<0.6 U	61.7	0.5 J	<0.2 U	1 J	7.86	0.5173	0.15	<0.4 U	0.0516	<0.005 U	<8 U	<0.6 U	<0.1 U
8/14/2019	Assessment	<0.02 U	0.17	73.5	1.04	<0.01 U	0.08 J	6.52	0.833	0.12	0.06 J	0.0484	<0.005 U	<0.4 U	0.04 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	<0.083 U	4.4	94	4
7/13/2016	Background	0.03	0.26	6	<0.083 U	3.1	75	4
9/7/2016	Background	0.04	0.343	6	<0.083 U	3.9	63	7
10/12/2016	Background	0.03	0.271	7	< 1 U	3.4	92	8
11/14/2016	Background	0.04	0.331	8	<0.083 U	2.6	80	6
1/11/2017	Background	0.03	0.315	7	<0.083 U	4.8	76	6
2/28/2017	Background	0.04	0.434	5	<0.083 U	3.6	50	4
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	72	7
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	52	6
3/21/2018	Assessment	0.01397	0.269	5	<0.083 U	4.2	<2 U	3
8/20/2018	Assessment	0.017	0.338	10	<0.083 U	4.4	94	4
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	36	3.6
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	80	4.0
8/12/2019	Assessment	<0.02 U	0.278	7.24	0.06 J	4.9	90	2.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	26	0.219521 J	<0.07 U	0.710981 J	1.58207 J	0.2073	<0.083 U	<0.68 U	<0.00013 U	<0.005 U	<0.29 U	1.73953 J	<0.86 U
7/13/2016	Background	<0.93 U	<1.05 U	23	0.190337 J	<0.07 U	0.68835 J	1.29444 J	2.909	<0.083 U	<0.68 U	0.008	<0.005 U	<0.29 U	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	30	0.232192 J	<0.07 U	0.353544 J	1.66591 J	0.881	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	<1.05 U	27	0.149553 J	<0.07 U	0.529033 J	1.56632 J	0.257	< 1 U	<0.68 U	0.012	<0.005 U	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	28	0.152375 J	<0.07 U	0.32826 J	1.47282 J	0.767	<0.083 U	<0.68 U	0.013	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	23	0.126621 J	<0.07 U	0.650158 J	1.09495 J	1.536	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	26	0.149219 J	<0.07 U	0.325811 J	1.29984 J	0.416	<0.083 U	<0.68 U	0.009	<0.005 U	<0.29 U	<0.99 U	0.994913 J
4/11/2017	Background	<0.93 U	<1.05 U	24	0.159412 J	<0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	<0.68 U	0.008	0.01364 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	25.82	0.16 J	<0.07 U	1.05	1.49 J	0.784	<0.083 U	<0.68 U	0.00722	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	<0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	<0.083 U	0.089	0.0143	<0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	<0.4 U	<0.6 U	22.5	<0.4 U	<0.2 U	<0.8 U	1.37	0.225	0.09	<0.4 U	0.00688	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	<0.6 U	21.7	<0.4 U	<0.2 U	<0.8 U	1.15	0.201	0.09	<0.4 U	0.00576	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.07 J	23.8	0.154	<0.01 U	0.204	1.3	0.237	0.06 J	0.08 J	0.00829	<0.005 U	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-18
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.01	0.548	8	<0.083 U	4.5	108	7
7/14/2016	Background	0.01	0.409	8	<0.083 U	4.7	116	7
9/8/2016	Background	0.01	0.343	8	<0.083 U	4.7	110	8
10/13/2016	Background	0.02	0.56	7	<0.083 U	4.1	124	10
11/15/2016	Background	0.02	0.59	7	<0.083 U	4.4	134	7
1/12/2017	Background	0.01	0.415	7	<0.083 U	4.7	128	10
3/1/2017	Background	0.01	0.224	6	<0.083 U	4.1	108	7
4/10/2017	Background	0.01	0.304	7	<0.083 U	4.1	102	8
8/24/2017	Detection	0.0278	0.435	8	<0.083 U	4.9	68	8
3/22/2018	Assessment	0.01642	0.292	6	<0.083 U	5.4	100	6
8/21/2018	Assessment	0.012	0.321	10	<0.083 U	5.1	118	8
2/28/2019	Assessment	<0.02 U	0.490	8.19	0.02 J	5.0	84	6.1
5/23/2019	Assessment	0.013	0.684	8.82	0.02 J	5.2	104	10.6
8/13/2019	Assessment	<0.02 U	0.647	8.49	0.01 J	5.2	90	6.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-18
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	<1.05 U	157	0.262755 J	0.109247 J	1	1.82932 J	0.847	<0.083 U	<0.68 U	0.004	0.01536 J	<0.29 U	1.71074 J	<0.86 U
7/14/2016	Background	<0.93 U	3.77261 J	139	0.243326 J	<0.07 U	3	2.16037 J	3.264	<0.083 U	<0.68 U	0.02	0.064	0.41347 J	2.45009 J	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	115	0.226343 J	<0.07 U	0.779959 J	1.09947 J	1.105	<0.083 U	<0.68 U	0.019	0.03	<0.29 U	<0.99 U	<0.86 U
10/13/2016	Background	<0.93 U	<1.05 U	112	0.192611 J	<0.07 U	0.631027 J	2.24885 J	1.161	<0.083 U	<0.68 U	0.026	0.01416 J	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	94	0.107171 J	<0.07 U	0.724569 J	1.66054 J	1.486	<0.083 U	<0.68 U	0.017	0.029	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	99	0.169196 J	<0.07 U	0.411433 J	1.62881 J	0.976	<0.083 U	<0.68 U	0.026	0.01887 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	99	0.105337 J	<0.07 U	0.572874 J	0.976724 J	0.468	<0.083 U	<0.68 U	0.017	0.01086 J	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	105	0.130316 J	<0.07 U	0.967681 J	0.98157 J	0.648	<0.083 U	<0.68 U	0.019	0.0096 J	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	97.75	0.09 J	<0.07 U	<0.23 U	0.97 J	0.942	<0.083 U	<0.68 U	0.01647	0.006 J	<0.29 U	1.53 J	<0.86 U
8/21/2018	Assessment	0.02 J	1.01	99.8	0.129	0.02 J	0.809	1.18	1.108	<0.083 U	0.280	0.0175	0.014 J	0.08 J	0.2	0.060
2/28/2019	Assessment	<0.4 U	<0.6 U	106	<0.4 U	<0.2 U	<0.8 U	1.11	0.615	0.02 J	0.7 J	0.0177	0.009 J	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	<0.6 U	131	<0.4 U	<0.2 U	<0.8 U	1.47	0.492	0.02 J	<0.4 U	0.0209	0.009 J	<8 U	<0.6 U	<0.1 U
8/13/2019	Assessment	<0.02 U	0.45	100	0.118	0.02 J	0.212	1.25	0.473	0.01 J	0.2 J	0.0183	0.023 J	<0.4 U	0.09 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-31
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.08	10.4	18	<0.083 U	4.5	286	63
7/13/2016	Background	0.03	4.27	18	<0.083 U	3.5	245	66
9/7/2016	Background	0.03	3.47	18	<0.083 U	3.7	260	60
10/12/2016	Background	0.04	4.41	18	<0.083 U	4.0	276	62
11/14/2016	Background	0.04	4.7	18	<0.083 U	3.2	266	66
1/11/2017	Background	0.03	4.43	19	<0.083 U	4.4	252	79
2/28/2017	Background	0.04	3.89	14	<0.083 U	3.6	212	68
4/11/2017	Background	0.04	3.64	16	<0.083 U	3.6	252	69
8/23/2017	Detection	0.01752	2.24	18	<0.083 U	4.5	228	52
12/21/2017	Detection	- -	- -	20	<0.083 U	- -	224	58
3/22/2018	Assessment	0.04078	3.11	16	<0.083 U	4.5	260	76
8/21/2018	Assessment	0.022	2.86	25	<0.083 U	4.9	274	72
2/28/2019	Assessment	0.03 J	2.77	18.8	0.1 J	5.0	74	74.8
5/23/2019	Assessment	0.021	3.29	18.7	0.13	5.1	240	79.9
8/12/2019	Assessment	<0.02 U	2.86	21.6	0.16	4.1	250	70.0

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-31
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	93	712	10	0.858875 J	212	50	7.32	<0.083 U	57	0.077	1.797	0.893978 J	1.84045 J	<0.86 U
7/13/2016	Background	<0.93 U	3.41559 J	69	1	<0.07 U	10	11	3.38	<0.083 U	<0.68 U	0.096	0.32	0.316083 J	1.11301 J	<0.86 U
9/7/2016	Background	<0.93 U	4.34007 J	88	2	<0.07 U	15	11	2.345	<0.083 U	<0.68 U	0.094	0.284	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	6	76	1	<0.07 U	14	11	3.88	<0.083 U	1.54023 J	0.097	0.347	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	11	125	2	0.174662 J	30	14	3.202	<0.083 U	3.93298 J	0.096	0.523	0.401556 J	1.03392 J	<0.86 U
1/11/2017	Background	<0.93 U	3.92088 J	77	1	<0.07 U	12	10	2.725	<0.083 U	<0.68 U	0.093	0.384	<0.29 U	<0.99 U	1.01921 J
2/28/2017	Background	<0.93 U	<1.05 U	44	0.998308 J	<0.07 U	3	9	2.684	<0.083 U	<0.68 U	0.09	0.138	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	3.31744 J	73	1	0.0944 J	12	11	3.521	<0.083 U	<0.68 U	0.097	0.333	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	3.32 J	70.83	1.24	0.12 J	9.62	11.12	2.955	<0.083 U	<0.68 U	0.09732	1.389	<0.29 U	1.98 J	<0.86 U
8/21/2018	Assessment	0.02 J	1.92	57.7	0.729	0.06	2.39	9.29	4.13	<0.083 U	1.41	0.0556	1.112	0.24	2.5	0.113
2/28/2019	Assessment	<0.4 U	<0.6 U	33.1	1 J	<0.2 U	<0.8 U	9.38	3.156	0.1 J	<0.4 U	0.0864	0.01 J	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	<0.6 U	37.9	0.9 J	<0.2 U	<0.8 U	10.3	3.4	0.13	<0.4 U	0.0928	0.057	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.53	35.0	0.850	0.06	0.365	8.69	2.196	0.16	0.325	0.0875	1.027	<0.4 U	0.4	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-32
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.708	7.41	12	<0.083 U	4.3	206	124
7/13/2016	Background	5.23	33.9	32	0.67 J	3.3	835	461
9/7/2016	Background	5.78	37.4	35	<0.083 U	3.1	884	479
10/12/2016	Background	4.26	27.1	29	0.8585 J	3.3	720	430
11/14/2016	Background	5.52	35.9	34	0.7468 J	3.0	922	621
1/11/2017	Background	5.05	40	35	<0.083 U	3.9	894	683
2/28/2017	Background	2.73	18.4	19	<0.083 U	3.1	490	285
4/11/2017	Background	1.46	11	15	0.4468 J	3.2	372	200
8/23/2017	Detection	0.716	7.15	14	1.962	4.3	288	115
12/21/2017	Detection	2.56	17.1	22	0.5932 J	- -	504	324
3/21/2018	Assessment	0.628	6.32	15	<0.083 U	4.1	288	113
8/21/2018	Assessment	2.45	17.8	28	<0.083 U	3.9	548	321
2/28/2019	Assessment	0.679	6.62	17.5	0.40	3.2	222	121
5/21/2019	Assessment	0.555	5.35	18.6	0.31	3.2	292	105
8/12/2019	Assessment	1.77	13.3	24.9	0.67	4.0	448	228

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-32
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	3.77019 J	35	3	0.293016 J	5	27	2.501	<0.083 U	<0.68 U	0.016	0.925	<0.29 U	<0.99 U	<0.86 U
7/13/2016	Background	<0.93 U	13	58	8	0.729634 J	18	74	6.41	0.67 J	<0.68 U	0.119	13.916	0.76212 J	3.88793 J	<0.86 U
9/7/2016	Background	<0.93 U	3.25886 J	35	8	0.601583 J	6	70	4.846	<0.083 U	<0.68 U	0.111	1.68	<0.29 U	<0.99 U	1.09263 J
10/12/2016	Background	<0.93 U	10	50	7	0.589066 J	15	65	17.32	0.8585 J	<0.68 U	0.972	7.285	<0.29 U	1.93488 J	<0.86 U
11/14/2016	Background	<0.93 U	6	37	9	0.78793 J	8	75	3.731	0.7468 J	<0.68 U	0.114	3.624	<0.29 U	<0.99 U	1.078 J
1/11/2017	Background	<0.93 U	6	37	7	0.602157 J	9	69	4.342	<0.083 U	<0.68 U	0.115	7.202	<0.29 U	<0.99 U	0.991051 J
2/28/2017	Background	<0.93 U	4.56273 J	30	5	0.389491 J	5	45	4.001	<0.083 U	<0.68 U	0.095	7.927	<0.29 U	2.53854 J	<0.86 U
4/11/2017	Background	<0.93 U	<1.05 U	26	4	0.440252 J	3	35	4.32	0.4468 J	<0.68 U	0.095	2.755	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	3.05 J	41.25	3.17	0.55 J	5.38	25.8	4.922	<0.083 U	<0.68 U	0.103	6.4	<0.29 U	2.18 J	<0.86 U
8/21/2018	Assessment	0.01 J	4.81	17.2	3.70	0.47	0.646	43.5	6.01	<0.083 U	0.714	0.0689	2.649	0.04 J	15.0	0.238
2/28/2019	Assessment	<0.4 U	2 J	28.9	3.34	0.2 J	2 J	25.0	4.67	0.40	<0.4 U	0.0919	1.135	<8 U	3 J	<2 U
5/21/2019	Assessment	<0.4 U	0.8 J	35.6	2.77	0.3 J	1 J	23.5	5.37	0.31	0.4 J	0.0897	1.371	<8 U	1 J	0.2 J
8/12/2019	Assessment	<0.02 U	3.43	38.5	3.65	0.40	1.7	33.7	5.70	0.67	0.996	0.0964	4.127	<0.4 U	7.3	0.2 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
EAST BOTTOM ASH POND
H.W. Pirkey Plant
Hallsville, Texas

Submitted to

AMERICAN
ELECTRIC
POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec
consultants

engineers | scientists | innovators

941 Chatham Lane
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Columbus, Ohio 43221

July 12, 2019

CHA8473

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LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the East Bottom Ash Pond (EBAP), an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, calcium, chloride, total dissolved solids (TDS), and sulfate at the EBAP. An alternative source was not identified at the time, so two assessment monitoring events were conducted at the EBAP in 2018, in accordance with 40 CFR 257.95. SSLs were identified for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32. An alternative source demonstration (ASD) was successfully completed for cobalt (Geosyntec, 2019).

A semi-annual assessment monitoring event was also completed in February 2019, with the results of the February 2019 event documented in this report. The groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The February 2019 monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. SSLs were identified for cobalt and lithium. Thus, either the unit will move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, one set of samples was collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(d)(1). Although antimony, fluoride, lead, molybdenum, and thallium were not detected at any locations during the March 2018 screening event, samples from the February 2019 semi-annual sampling event were analyzed for all Appendix III and Appendix IV parameters. A summary of data collected during this assessment monitoring event may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.14 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the EBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained to meet the requirements of 40 CFR 257.95(d)(1) were screened for potential outliers. No outliers were identified.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95%

confidence. Non-parametric tolerance limits were calculated for arsenic, barium, beryllium, cadmium, cobalt, and selenium due to apparent non-normal distributions, for antimony, fluoride, lead, molybdenum, and thallium due to a high non-detect frequency, and for chromium and mercury due to both an apparent non-normal distribution and a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey EBAP:

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.0100 mg/L), AD-31 (0.00943 mg/L), and AD-32 (0.0333 mg/L).
- LCLs for lithium exceeded the GWPS of 0.052 mg/L at AD-31 (0.077 mg/L) and AD-32 (0.075 mg/L).

As a result, the Pirkey EBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring

2.2.3 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations. Prediction limits were calculated for the Appendix III parameters to represent background values. As described in the January 2018 *Statistical Analysis Summary* report (Geosyntec, 2018), intrawell tests were used to evaluate potential SSIs for pH, whereas interwell tests were used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS.

Prediction limits for the interwell tests were recalculated using data collected during the February 2019 assessment monitoring event. Three data points (i.e., one sample from three background wells) were added to the background dataset for each interwell test. New data were tested for outliers prior to being added to the background dataset. The updated prediction limits were calculated for a one-of-two retesting procedure, as during detection monitoring. The values of the updated prediction limits were similar to the values of the prediction limits calculated during detection monitoring. The revised interwell prediction limits were used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS.

For the intrawell tests, limited data made it possible to add only one data point (i.e., one sample from each compliance well) to each background dataset. Because one sample result is insufficient to compare against the existing background dataset, the prediction limits were not updated for the intrawell tests at this time. The intrawell prediction limits calculated during detection monitoring were used to evaluate potential SSIs for pH.

Data collected during the February 2019 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.047 mg/L at AD-2 (2.25 mg/L) and AD-32 (0.679 mg/L).

- The calcium concentration exceeded the interwell UPL of 2.94 mg/L at AD-32 (6.62 mg/L).

- Chloride concentrations exceeded the interwell UPL of 9.23 mg/L at AD-2 (31.8 mg/L), AD-31 (18.8 mg/L), and AD-32 (17.5 mg/L).

- The reported pH value exceeded the intrawell UPL of 4.9 SU at AD-31 (5.0 SU).

- Sulfate concentrations exceeded the interwell UPL of 23.0 mg/L at AD-2 (129 mg/L), AD-31 (74.8 mg/L), and AD-32 (121 mg/L).

- TDS concentrations exceeded the interwell UPL of 178 mg/L at AD-2 (384 mg/L) and AD-32 (222 mg/L).

While the prediction limits were calculated assuming a one-of-two testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey EBAP during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the February 2019 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. SSLs were identified for cobalt and lithium. Appendix III parameters were also evaluated, with exceedances identified for boron, calcium, chloride, pH, sulfate, and TDS.

Based on this evaluation, the Pirkey EBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Pirkey Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – East Bottom Ash Pond, H.W. Pirkey Power Plant, Hallsville, Texas. January 3, 2018.

Geosyntec. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. April.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March 2009.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - East Bottom Ash Pond

Parameter	Unit	AD-2	AD-4	AD-12	AD-18	AD-31	AD-32
		2/28/2019	2/28/2019	2/27/2019	2/28/2019	2/28/2019	2/28/2019
Antimony	µg/L	0.0200 J	0.100 U	2.00 U	2.00 U	2.00 U	2.00 U
Arsenic	µg/L	0.530	0.260	2.00 U	2.00 U	2.00 U	2.00 J
Barium	µg/L	26.1	70.5	22.5	106	33.1	28.9
Beryllium	µg/L	0.500 J	0.900 J	2.00 U	2.00 U	1.00 J	3.34
Boron	mg/L	2.25	0.0210	0.0300 J	0.100 U	0.0300 J	0.679
Cadmium	µg/L	0.0600	0.0100 J	1.00 U	1.00 U	1.00 U	0.200 J
Calcium	mg/L	1.96	1.57	0.400 J	0.490	2.77	6.62
Chloride	mg/L	31.8	3.56	6.08	8.19	18.8	17.5
Chromium	µg/L	0.100 J	0.100 J	4.00 U	4.00 U	4.00 U	2.00 J
Cobalt	µg/L	13.9	6.92	1.37	1.11	9.38	25.0
Combined Radium	pCi/L	1.26	0.818	0.225	0.615	3.16	4.67
Fluoride	mg/L	0.100 J	0.110	0.0900	0.0200 J	0.100 J	0.400
Lead	µg/L	0.355	0.106	2.00 U	0.700 J	2.00 U	2.00 U
Lithium	mg/L	0.0591	0.0513	0.00688	0.0177	0.0864	0.0919
Mercury	mg/L	0.0000270	0.0000250 U	0.0000250 U	0.00000900 J	0.0000100 J	0.00114
Molybdenum	µg/L	2.00 U	2.00 U	40.0 U	40.0 U	40.0 U	40.0 U
Selenium	µg/L	1.50	0.0300 J	4.00 U	4.00 U	4.00 U	3.00 J
Total Dissolved Solids	mg/L	384	192	36.0	84.0	74.0	222
Sulfate	mg/L	129	22.9	3.60	6.10	74.8	121
Thallium	µg/L	0.500 U	0.500 U	10.0 U	10.0 U	10.0 U	10.0 U
pH	SU	3.45	4.90	5.17	5.02	5.00	3.23

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
-: Not sampled

Table 2: Groundwater Protection Standards
Pirkey Plant - East Bottom Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.002
Arsenic, Total (mg/L)	0.01		0.011
Barium, Total (mg/L)	2		0.18
Beryllium, Total (mg/L)	0.004		0.0012
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.007
Cobalt, Total (mg/L)	n/a	0.006	0.0094
Combined Radium, Total (pCi/L)	5		3.64
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.052
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.002
Selenium, Total (mg/L)	0.05		0.004
Thallium, Total (mg/L)	0.002		0.0019

Notes:
Grey cell indicates calculated UTL is higher than MCL.
MCL = Maximum Contaminant Level
RSL = Regional Screening Level
Calculated UTL (Upper Tolerance Limit) represents site-specific background values.
The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Appendix III Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Units	Description	AD-2	AD-31	AD-32
			2/28/2019	2/27/2019	2/28/2019
Boron	mg/L	Interwell Background Value (UPL)	0.047		
		Detection Monitoring Result	**2.25**	0.030	**0.679**
Calcium	mg/L	Interwell Background Value (UPL)	2.94		
		Detection Monitoring Result	1.96	2.77	**6.62**
Chloride	mg/L	Interwell Background Value (UPL)	9.23		
		Detection Monitoring Result	**31.8**	**18.8**	**17.5**
Fluoride	mg/L	Interwell Background Value (UPL)	1.0		
		Detection Monitoring Result	0.1	0.1	0.4
pH	SU	Intrawell Background Value (UPL)	4.6	4.9	4.5
		Intrawell Background Value (LPL)	3.4	2.7	2.3
		Detection Monitoring Result	3.5	**5.0**	3.2
Sulfate	mg/L	Interwell Background Value (UPL)	23.0		
		Detection Monitoring Result	**129**	**74.8**	**121**
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	178		
		Detection Monitoring Result	**384**	74.0	**222**

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

DAVID ANTHONY MILLER

112498

112498

License Number

TEXAS

Licensing State

07.12.19

Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

July 10, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
150 E. Wilson Bridge Rd., #232
Worthington, OH 43085

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the evaluation of groundwater data from the February 2019 sample event for American Electric Power Company's Pirkey EBAP. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling at each of the wells below began at Pirkey EBAP for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following: upgradient wells AD-4, AD-12, and AD-18; and downgradient wells AD-2, AD-31, and AD-32A.

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and

- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Values in background which have previously been flagged as outliers may be seen in a lighter font and disconnected symbol on the graphs. During the August 2019 event, a value of 0.015 mg/L was reported for selenium at well AD-32. That value was flagged as an outlier during this analysis since the reported value during the February 2019 event was significantly lower (0.003 mg/L) and similar to historical concentrations. A summary of flagged values follows this letter (Figure B).

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 resample plan were constructed for boron, calcium, chloride, fluoride, sulfate and TDS; and intrawell prediction limits combined with a 1-of-2 resample plan were constructed for pH (Figure C and D, respectively). The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data are screened for any newly suspected outliers or obvious trending patterns using time series plots. All values flagged as outliers may be seen on the Outlier Summary report following this letter. No obvious trending patterns were observed in the upgradient wells.

Intrawell prediction limits utilize the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data set will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified, and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result; therefore, no further action is necessary. Prediction limits exceedances were noted for several of the Appendix III parameters, and the results of those findings may be found in the Prediction Limit Summary tables following this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether data are statistically increasing, decreasing or stable (Figure E). No statistically significant trends were noted, except for statistically significantly increasing trends for boron and sulfate in well AD-2. The Trend Test Summary Table follows this letter.

Evaluation of Appendix IV Parameters

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure F). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure G).

Note that the reporting limit during the February 2019 event for molybdenum at wells AD-12, AD-18, AD-31 and AD-32 was 0.04 mg/L compared to a historical reporting limit of 0.002 mg/L. Wells AD-2 and AD-4, however, had a reporting limit of 0.002 mg/L during this event. A substitution of 0.04 mg/L was used for all nondetects for molybdenum. This value is lower than the CCR Rule level of 0.1 mg/L.

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, CCR-Rule specified levels or ACL as discussed above (Figure H). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. A few confidence intervals exceedances were noted for cobalt and lithium. A summary of the confidence interval results follows this letter.

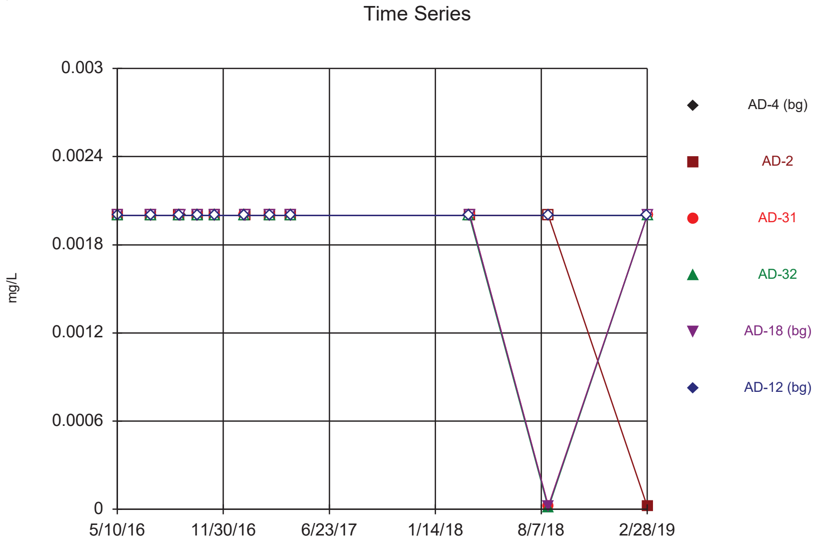
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey EBAP. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Antimony, total Analysis Run 7/7/2019 11:54 AM View: Time Series
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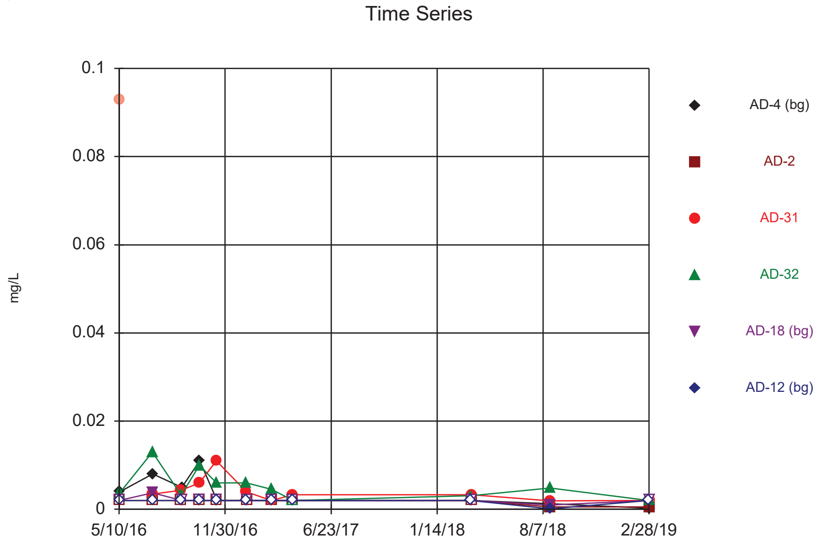

Constituent: Arsenic, total Analysis Run 7/7/2019 11:54 AM View: Time Series
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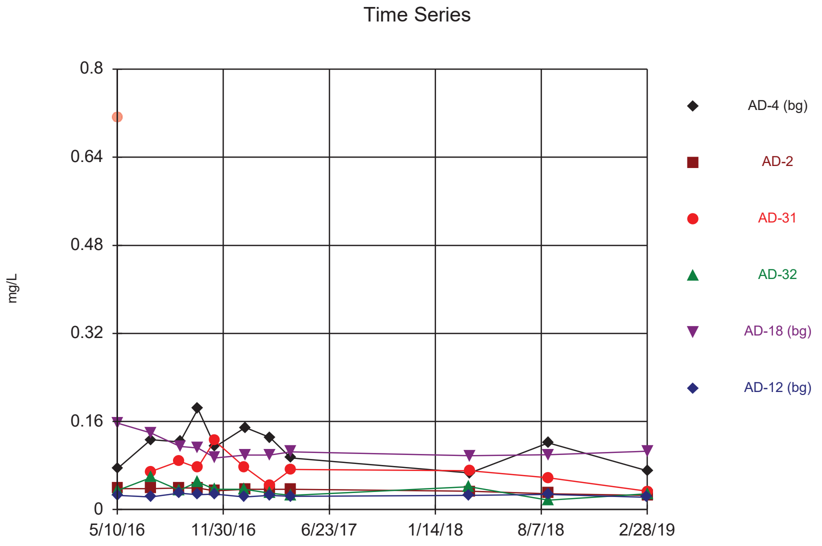
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



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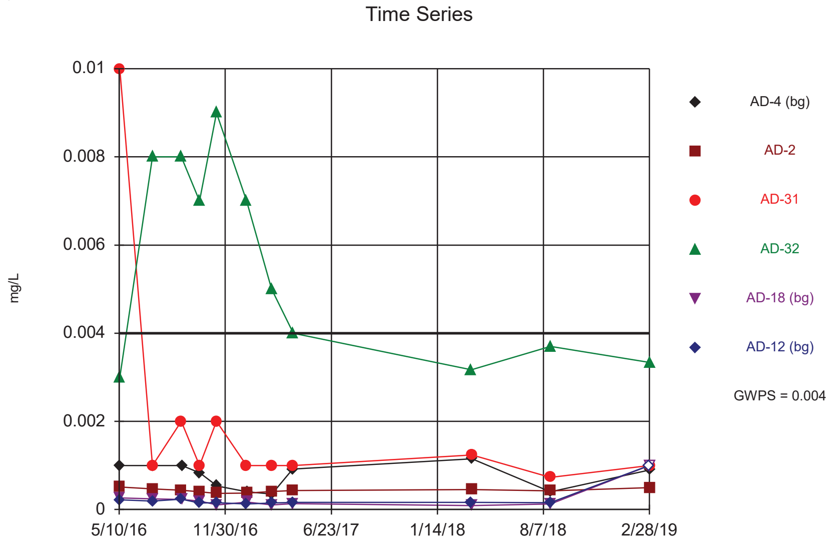

Constituent: Beryllium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
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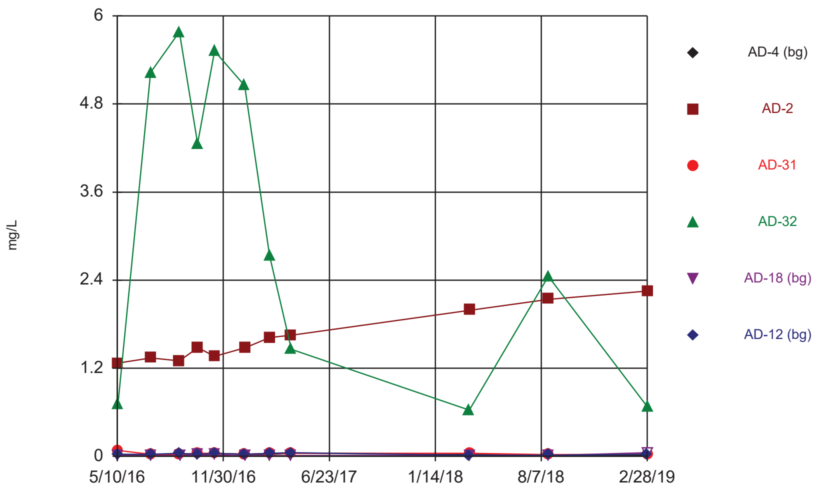
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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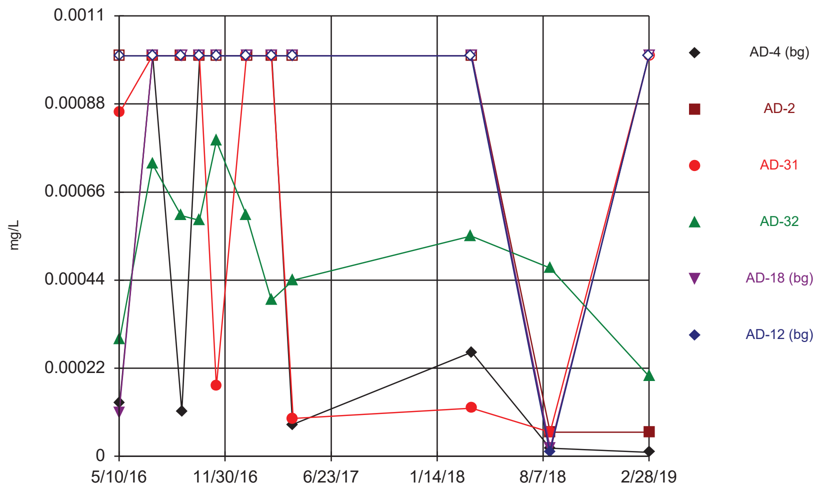
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Cadmium, total   Analysis Run 7/7/2019 11:54 AM   View: Time Series
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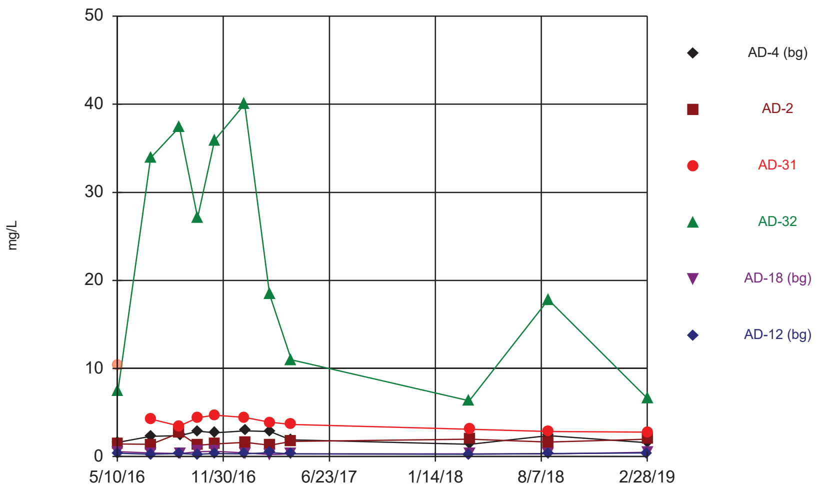
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



Constituent: Calcium, total   Analysis Run 7/7/2019 11:54 AM   View: Time Series
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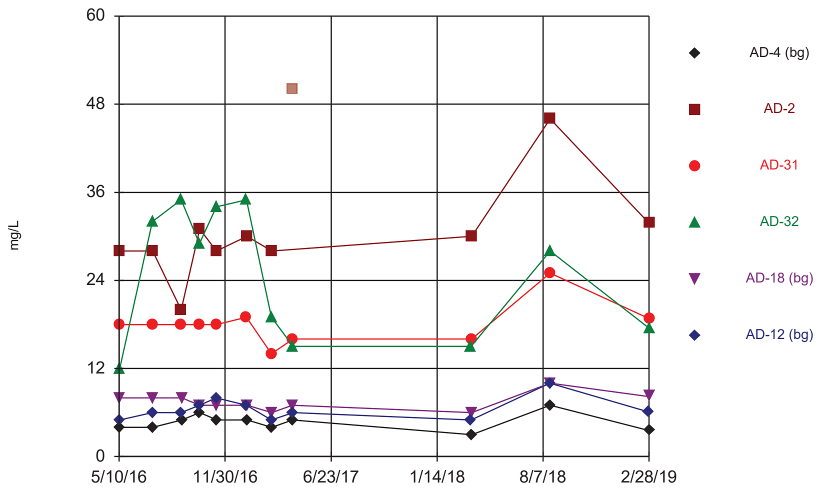
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



Constituent: Chloride, total   Analysis Run 7/7/2019 11:54 AM   View: Time Series
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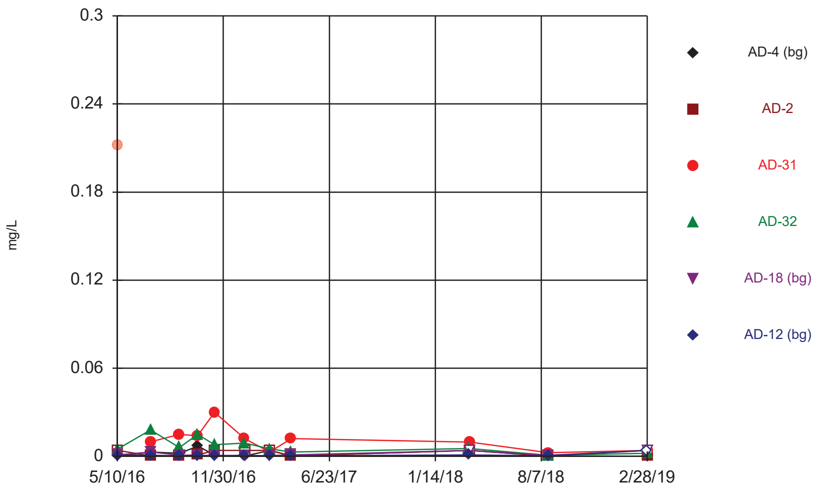
Hollow symbols indicate censored values.

Time Series



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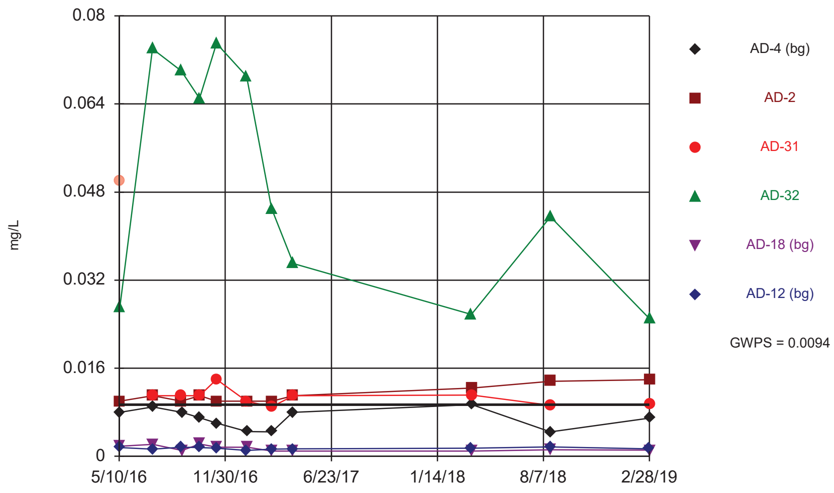
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



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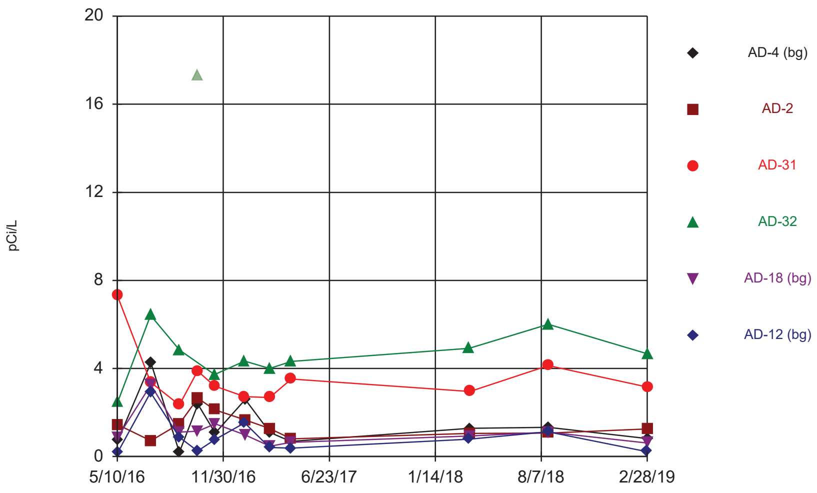
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 7/7/2019 11:54 AM View: Time Series
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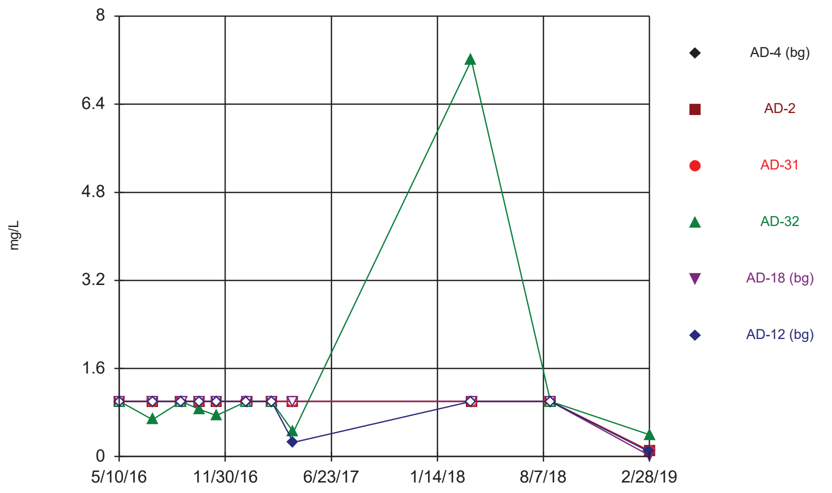
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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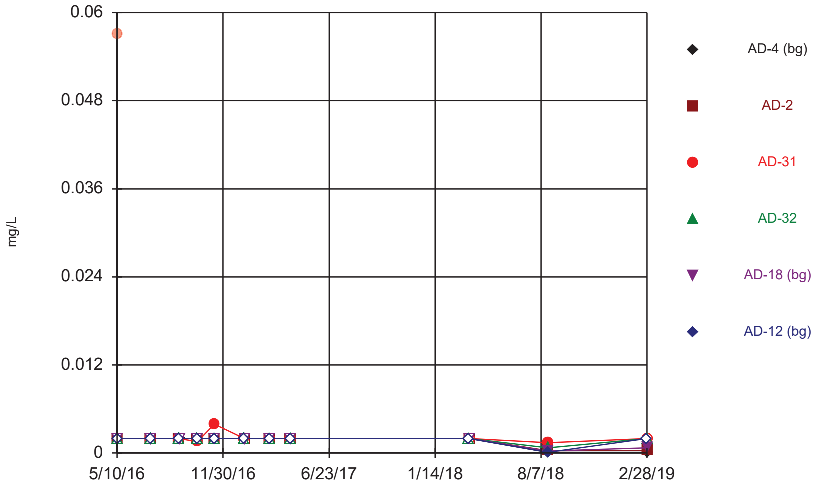
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Lead, total   Analysis Run 7/7/2019 11:54 AM   View: Time Series
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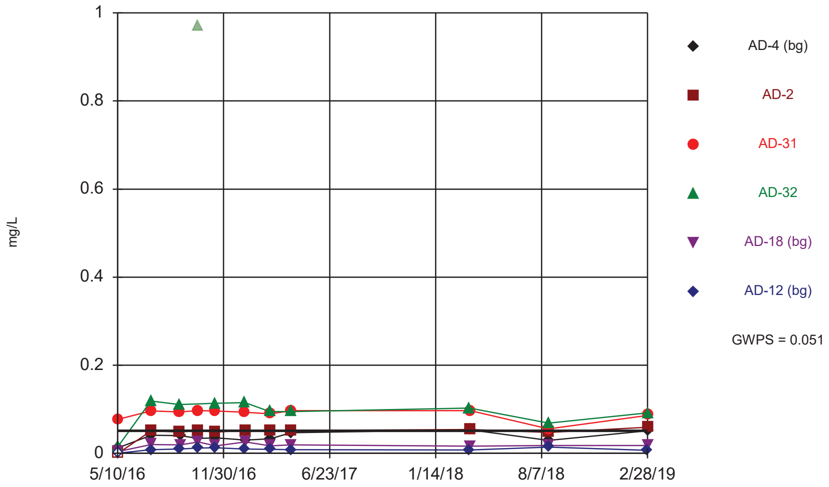
Hollow symbols indicate censored values.

Time Series



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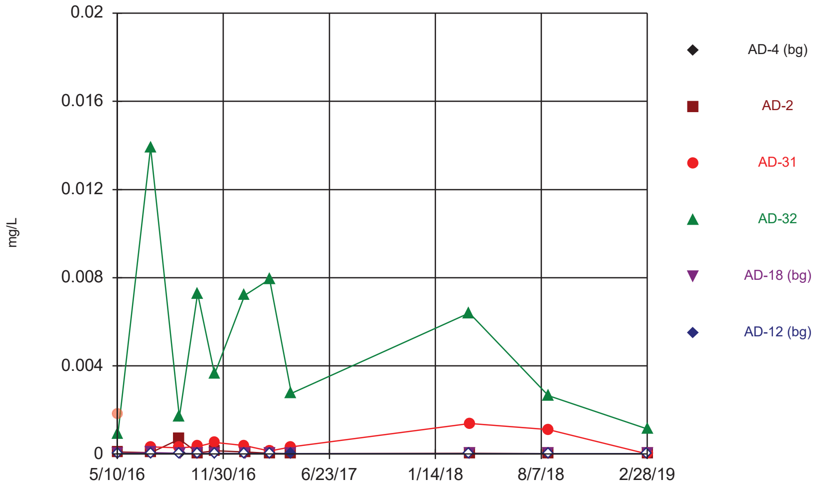
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

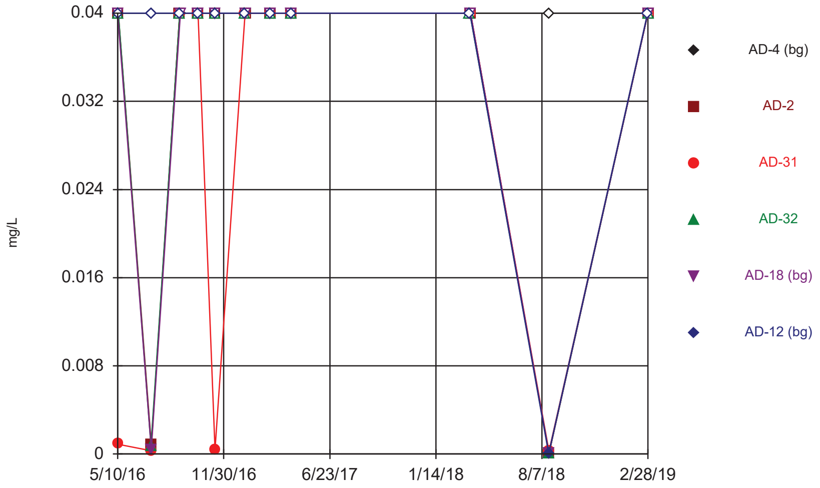
Time Series



Constituent: Mercury, total   Analysis Run 7/7/2019 11:54 AM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

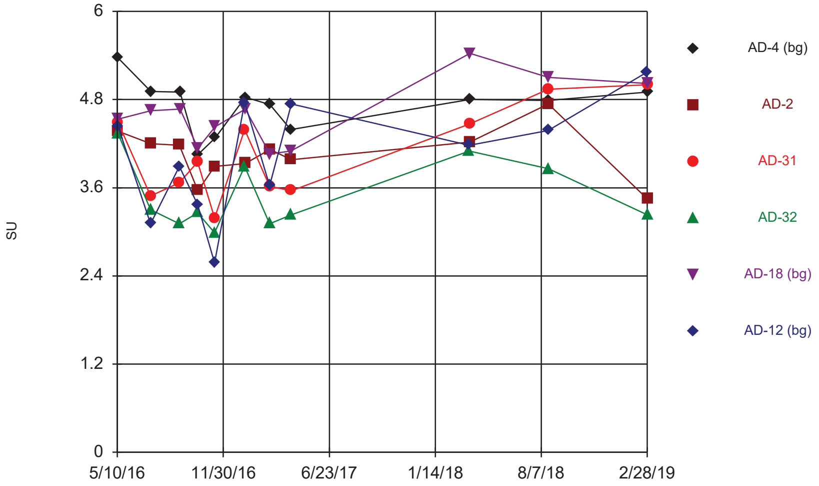
Time Series



Constituent: Molybdenum, total   Analysis Run 7/7/2019 11:54 AM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

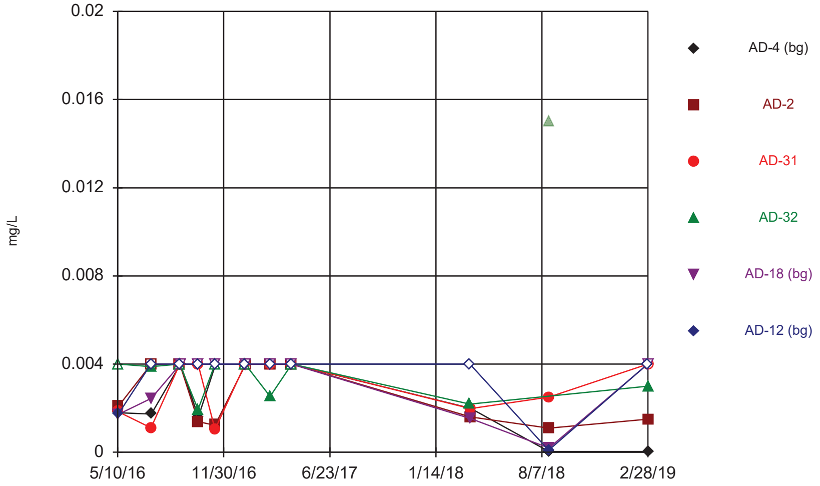
Time Series



Constituent: pH, field Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

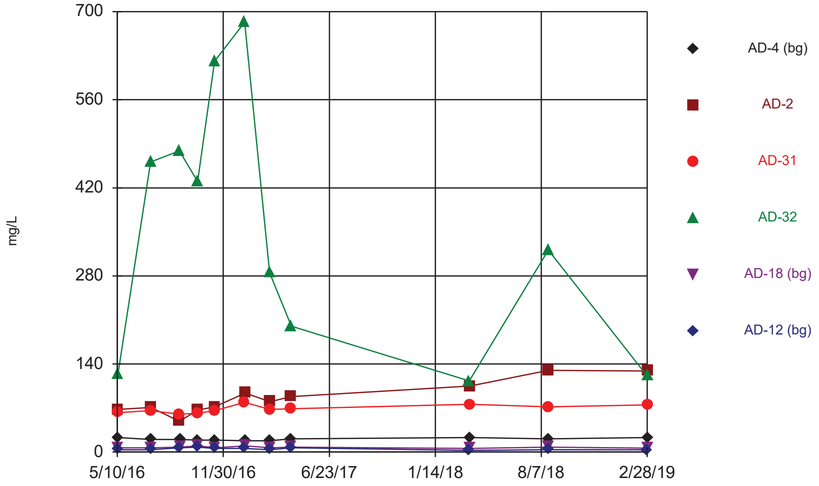
Time Series



Constituent: Selenium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

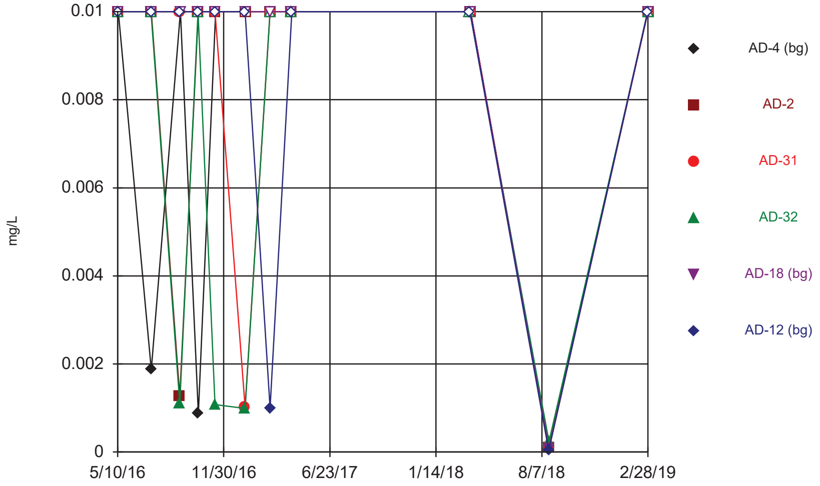
Time Series



Constituent: Sulfate, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

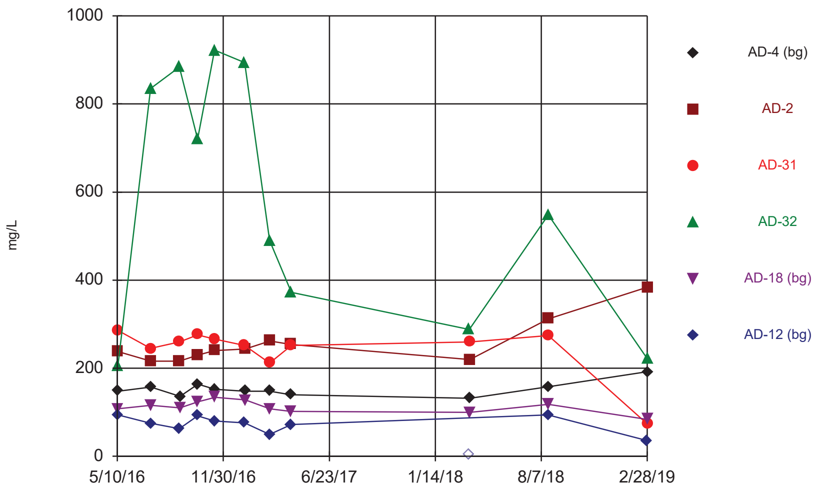
Time Series



Constituent: Thallium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Total Dissolved Solids [TDS]   Analysis Run 7/7/2019 11:54 AM   View: Time Series
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Outlier Summary

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 12:46 PM

	AD-31 Arsenic, total (mg/L)	AD-31 Barium, total (mg/L)	AD-31 Calcium, total (mg/L)	AD-2 Chloride, total (mg/L)	AD-31 Chromium, total (mg/L)	AD-31 Cobalt, total (mg/L)	AD-32 Combined Radium 226 + 228 (pCi/L)	AD-31 Lead, total (mg/L)	AD-32 Lithium, total (mg/L)	AD-31 Mercury, total (mg/L)
5/11/2016	0.093 (o)	0.712 (o)	10.4 (o)		0.212 (o)	0.05 (o)		0.057 (o)		0.001797 (o)
10/12/2016							17.32 (o)		0.972 (o)	
4/11/2017				50 (o)						
3/21/2018										
8/21/2018										

	AD-32 Selenium, total (mg/L)	AD-12 Total Dissolved Solids [TDS] (mg/L)
5/11/2016		
10/12/2016		
4/11/2017		
3/21/2018		<5 (o)
8/21/2018	0.015 (o)	

Interwell Prediction Limit Summary - Significant Results

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP   Printed 7/5/2019, 12:37 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-2**	**0.04655**	**n/a**	**2/28/2019**	**2.25**	**Yes**	**33**	**0.0252**	**0.012**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-32**	**0.04655**	**n/a**	**2/28/2019**	**0.679**	**Yes**	**33**	**0.0252**	**0.012**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Calcium, total (mg/L)	**AD-32**	**2.94**	**n/a**	**2/28/2019**	**6.62**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Chloride, total (mg/L)	**AD-2**	**9.23**	**n/a**	**2/28/2019**	**31.8**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-31**	**9.23**	**n/a**	**2/28/2019**	**18.8**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-32**	**9.23**	**n/a**	**2/28/2019**	**17.5**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Sulfate, total (mg/L)	**AD-2**	**23**	**n/a**	**2/28/2019**	**129**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Sulfate, total (mg/L)	**AD-31**	**23**	**n/a**	**2/28/2019**	**74.8**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Sulfate, total (mg/L)	**AD-32**	**23**	**n/a**	**2/28/2019**	**121**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Total Dissolved Solids [TDS] (mg/L)	**AD-2**	**178.4**	**n/a**	**2/28/2019**	**384**	**Yes**	**32**	**113.7**	**36.26**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Total Dissolved Solids [TDS] (mg/L)	**AD-32**	**178.4**	**n/a**	**2/28/2019**	**222**	**Yes**	**32**	**113.7**	**36.26**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**

Interwell Prediction Limit Summary - All Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 12:37 PM

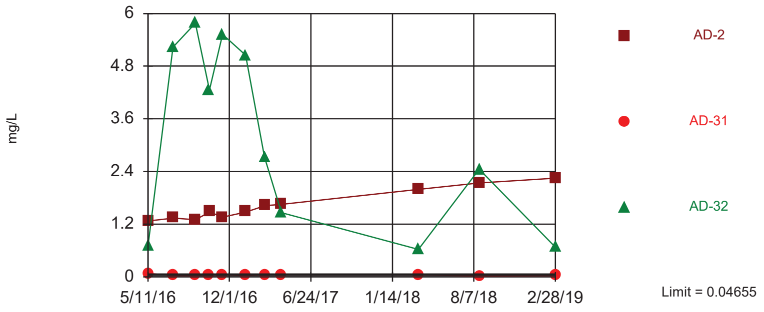
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-2**	**0.04655**	**n/a**	**2/28/2019**	**2.25**	**Yes**	**33**	**0.0252**	**0.012**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	AD-31	0.04655	n/a	2/28/2019	0.03	No	33	0.0252	0.012	3.03	None	No	0.002505	Param Inter 1 of 2
Boron, total (mg/L)	**AD-32**	**0.04655**	**n/a**	**2/28/2019**	**0.679**	**Yes**	**33**	**0.0252**	**0.012**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Calcium, total (mg/L)	AD-2	2.94	n/a	2/28/2019	1.96	No	33	n/a	n/a	0	n/a	n/a	0.001673	NP Inter (normality) 1 of 2
Calcium, total (mg/L)	AD-31	2.94	n/a	2/28/2019	2.77	No	33	n/a	n/a	0	n/a	n/a	0.001673	NP Inter (normality) 1 of 2
Calcium, total (mg/L)	**AD-32**	**2.94**	**n/a**	**2/28/2019**	**6.62**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Chloride, total (mg/L)	**AD-2**	**9.23**	**n/a**	**2/28/2019**	**31.8**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-31**	**9.23**	**n/a**	**2/28/2019**	**18.8**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-32**	**9.23**	**n/a**	**2/28/2019**	**17.5**	**Yes**	**33**	**6.207**	**1.699**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Fluoride, total (mg/L)	AD-2	1	n/a	2/28/2019	0.1	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-31	1	n/a	2/28/2019	0.1	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-32	1	n/a	2/28/2019	0.4	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Sulfate, total (mg/L)	**AD-2**	**23**	**n/a**	**2/28/2019**	**129**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Sulfate, total (mg/L)	**AD-31**	**23**	**n/a**	**2/28/2019**	**74.8**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Sulfate, total (mg/L)	**AD-32**	**23**	**n/a**	**2/28/2019**	**121**	**Yes**	**33**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.001673**	**NP Inter (normality) 1 of 2**
Total Dissolved Solids [TDS] (mg/L)	**AD-2**	**178.4**	**n/a**	**2/28/2019**	**384**	**Yes**	**32**	**113.7**	**36.26**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Total Dissolved Solids [TDS] (mg/L)	AD-31	178.4	n/a	2/28/2019	74	No	32	113.7	36.26	0	None	No	0.002505	Param Inter 1 of 2
Total Dissolved Solids [TDS] (mg/L)	**AD-32**	**178.4**	**n/a**	**2/28/2019**	**222**	**Yes**	**32**	**113.7**	**36.26**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-2, AD-32

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=0.0252, Std. Dev.=0.012, n=33, 3.03% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9111, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

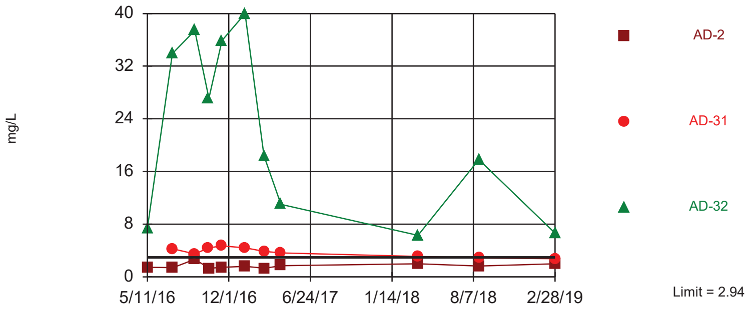
Constituent: Boron, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-32

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 33 background values. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 3 points to limit.

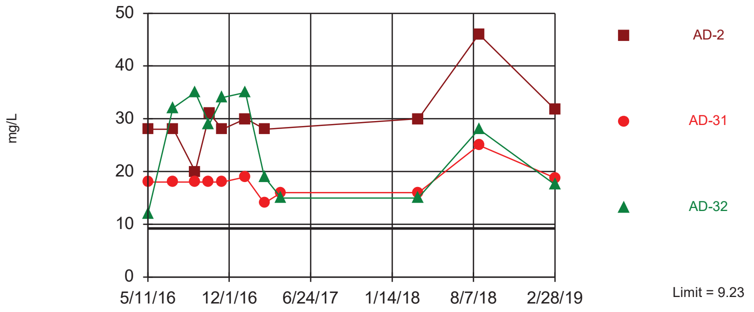
Constituent: Calcium, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-2, AD-31, AD-32

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=6.207, Std. Dev.=1.699, n=33. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9559, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

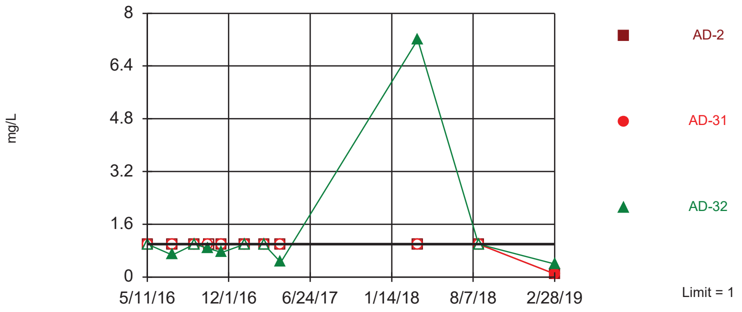
Constituent: Chloride, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Interwell Non-parametric



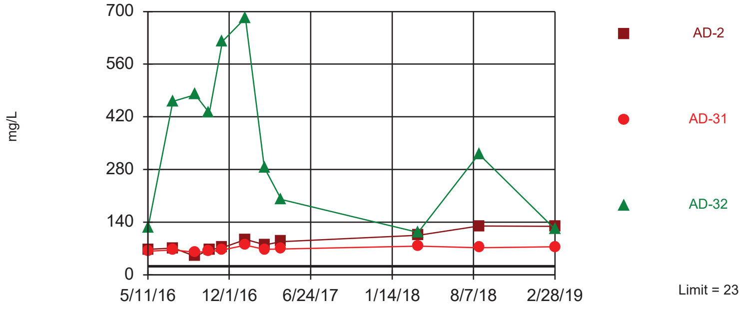
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 33 background values. 87.88% NDs. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 3 points to limit.

Constituent: Fluoride, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Exceeds Limit: AD-2, AD-31, AD-32

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 33 background values. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 3 points to limit.

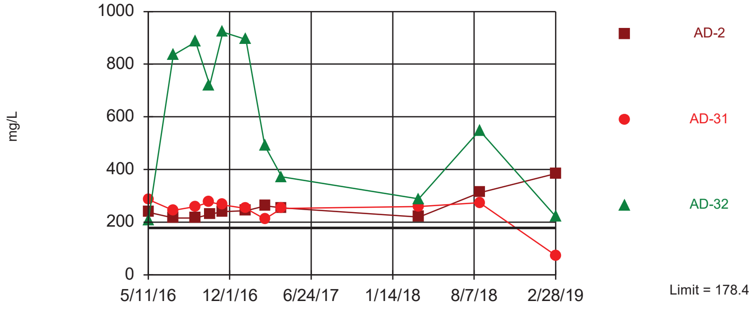
Constituent: Sulfate, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Exceeds Limit: AD-2, AD-32

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=113.7, Std. Dev.=36.26, n=32. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9872, critical = 0.904. Kappa = 1.784 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 12:28 PM View: PL's Interwell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Intrawell Prediction Limit Summary - Significant Results

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP   Printed 7/5/2019, 12:39 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH, field (SU)	**AD-31**	**4.903**	**2.687**	**2/28/2019**	**5**	**Yes**	**8**	**3.795**	**0.4507**	**0**	**None**	**No**	**0.001253**	Param 1 of 2

Intrawell Prediction Limit Summary - All Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 12:39 PM

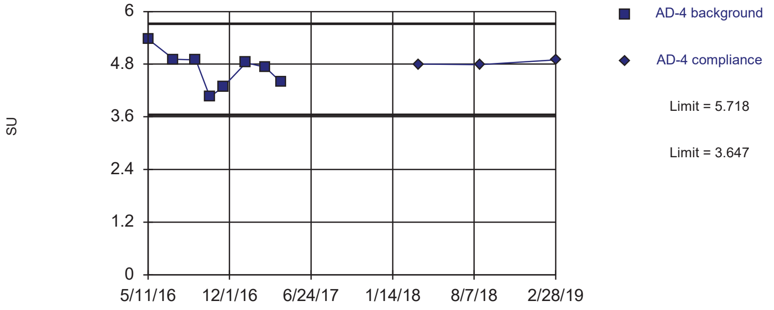
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH, field (SU)	AD-4	5.718	3.647	2/28/2019	4.9	No	8	4.683	0.4215	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-2	4.637	3.421	2/28/2019	3.45	No	8	4.029	0.2473	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	**AD-31**	**4.903**	**2.687**	**2/28/2019**	**5**	**Yes**	**8**	**3.795**	**0.4507**	**0**	**None**	**No**	**0.001253**	Param 1 of 2
pH, field (SU)	AD-32	4.549	2.259	2/28/2019	3.23	No	8	3.404	0.4657	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-18	5.063	3.75	2/28/2019	5.02	No	8	4.406	0.267	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-12	5.764	1.866	2/27/2019	5.17	No	8	3.815	0.7928	0	None	No	0.001253	Param 1 of 2

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.683, Std. Dev.=0.4215, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9603, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

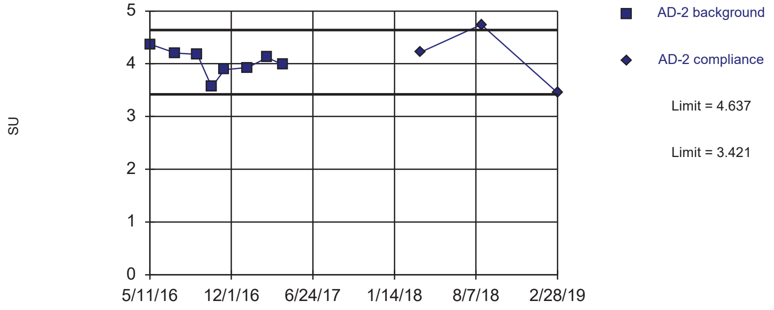
Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.029, Std. Dev.=0.2473, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.956, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

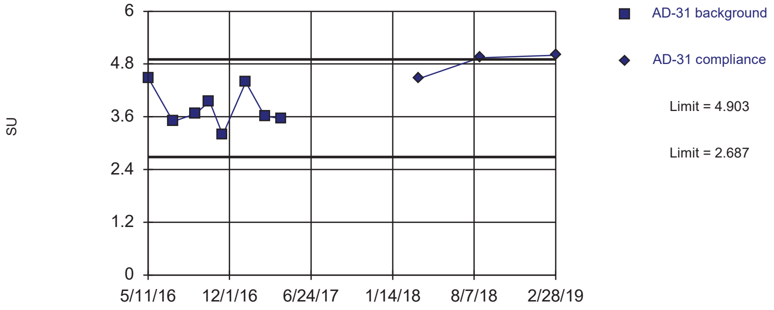
Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.795, Std. Dev.=0.4507, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9179, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

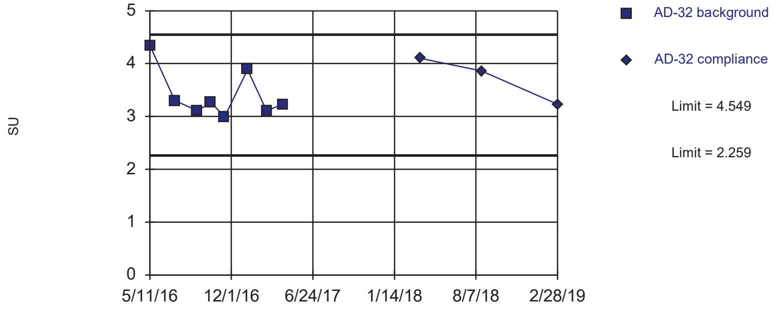
Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



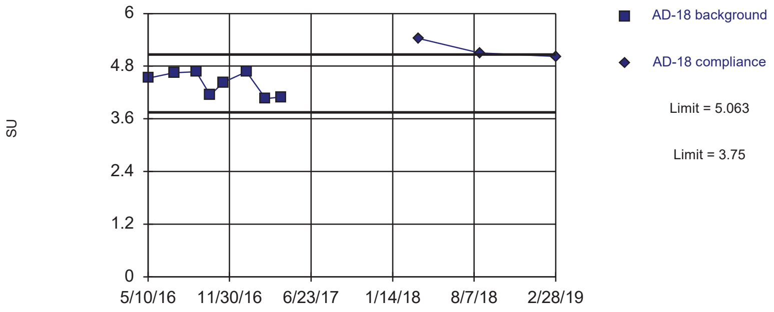
Background Data Summary: Mean=3.404, Std. Dev.=0.4657, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7949, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Within Limits

Prediction Limit

Intrawell Parametric



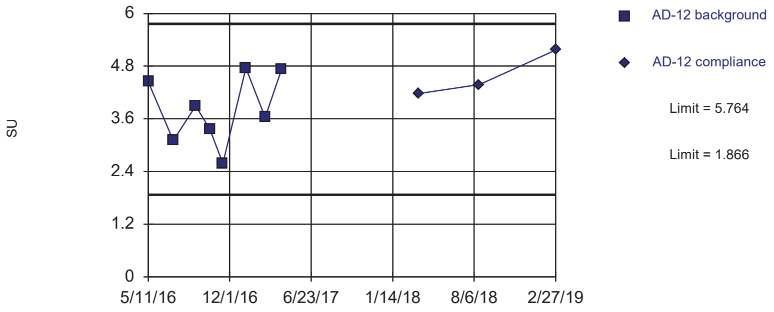
Background Data Summary: Mean=4.406, Std. Dev.=0.267, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8312, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Trend Test Summary Table - Significant Results

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP   Printed 7/5/2019, 1:08 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	**AD-2**	**0.3802**	**50**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Sulfate, total (mg/L)	**AD-2**	**25.54**	**41**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**

Trend Test Summary Table - All Results

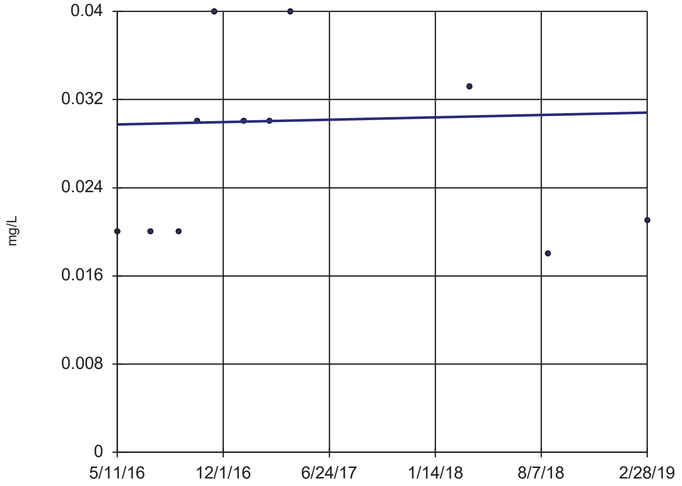
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 1:08 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-4 (bg)	0.0003806	10	34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	**AD-2**	**0.3802**	**50**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Boron, total (mg/L)	AD-32	-1.705	-25	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-18 (bg)	0.0008764	17	34	No	11	9.091	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0	-4	-34	No	11	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-4 (bg)	-0.1181	-5	-34	No	11	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-32	-8.602	-19	-34	No	11	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-18 (bg)	-0.04371	-13	-34	No	11	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-12 (bg)	0.01357	5	34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-4 (bg)	0	-2	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-2	1.659	22	30	No	10	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-31	0	4	34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-32	-3.583	-11	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-18 (bg)	0	-7	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.03234	10	34	No	11	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-4 (bg)	-0.05639	-10	-34	No	11	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-31	0.441	19	34	No	11	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-18 (bg)	0.1747	12	34	No	11	0	n/a	n/a	0.01	NP
pH, field (SU)	AD-12 (bg)	0.5174	19	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-4 (bg)	0	4	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	**AD-2**	**25.54**	**41**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Sulfate, total (mg/L)	AD-31	5.856	32	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-32	-92.31	-15	-34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-18 (bg)	0	-7	-34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.5376	-15	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-4 (bg)	0	2	34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-2	48.67	34	34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-32	-176.2	-15	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-18 (bg)	-7.565	-16	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-18.79	-14	-30	No	10	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-4 (bg)



n = 11

Slope = 0.0003806 units per year.

Mann-Kendall statistic = 10 critical = 34

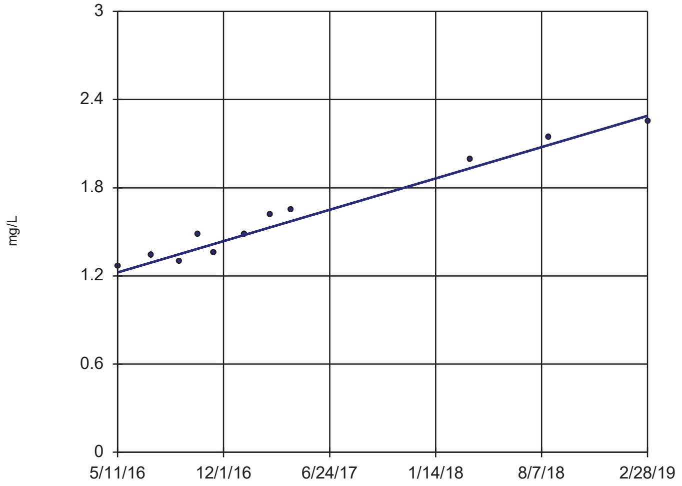
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-2



n = 11

Slope = 0.3802 units per year.

Mann-Kendall statistic = 50 critical = 34

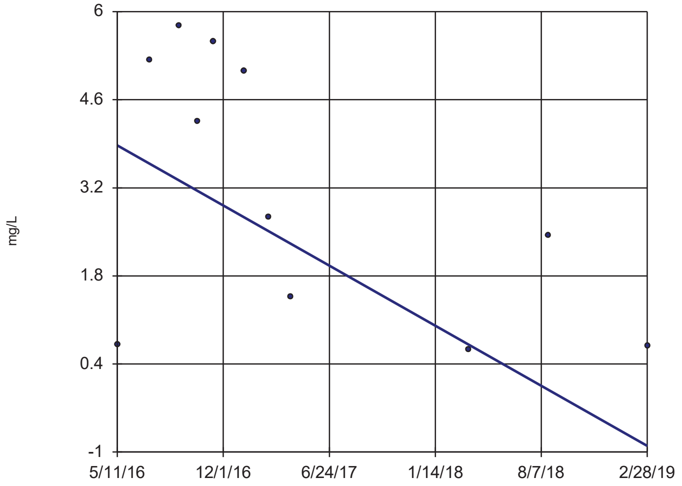
Increasing trend significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-32



n = 11

Slope = -1.705 units per year.

Mann-Kendall statistic = -25 critical = -34

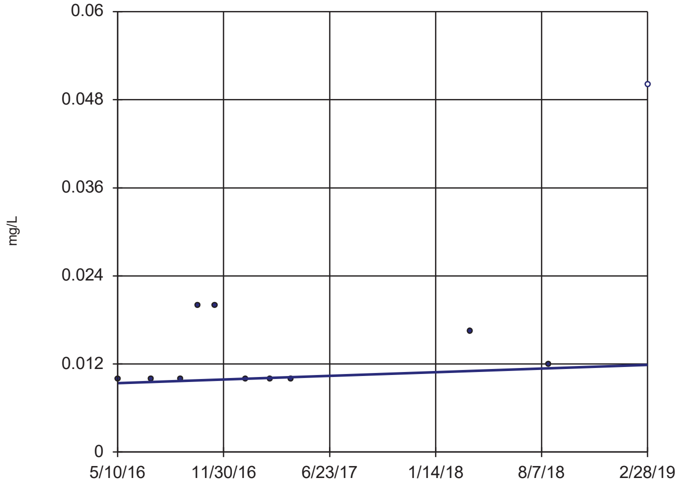
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = 0.0008764 units per year.

Mann-Kendall statistic = 17 critical = 34

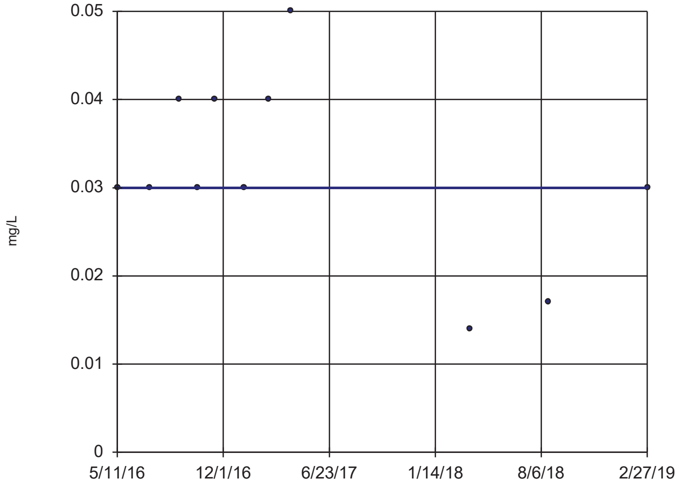
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0
units per year.

Mann-Kendall
statistic = -4
critical = -34

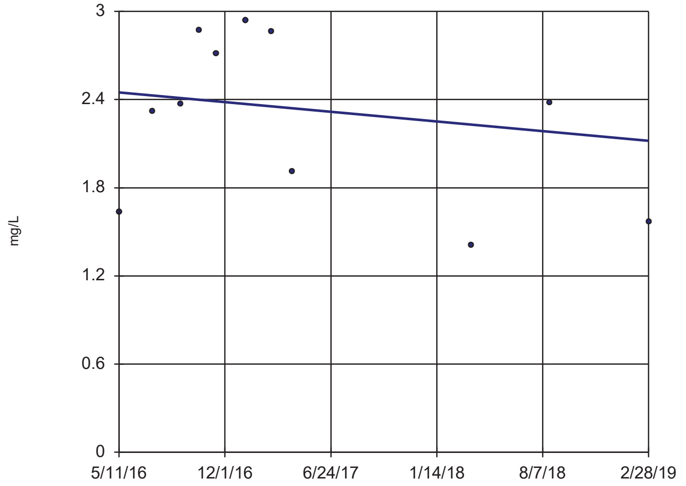
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-4 (bg)



n = 11

Slope = -0.1181
units per year.

Mann-Kendall
statistic = -5
critical = -34

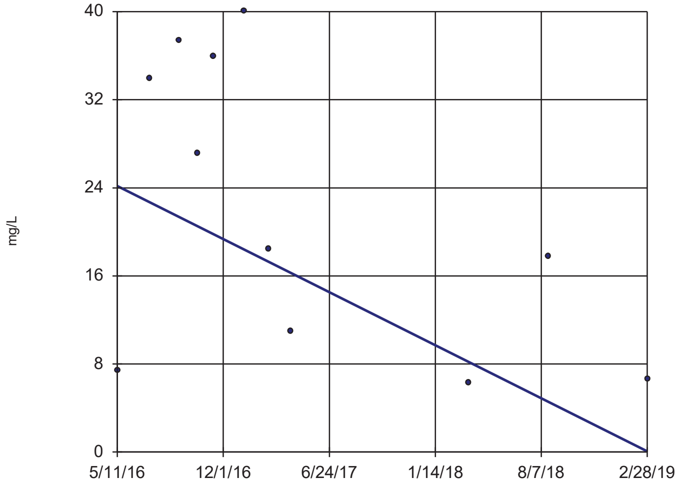
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Calcium, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-32



n = 11

Slope = -8.602
units per year.

Mann-Kendall
statistic = -19
critical = -34

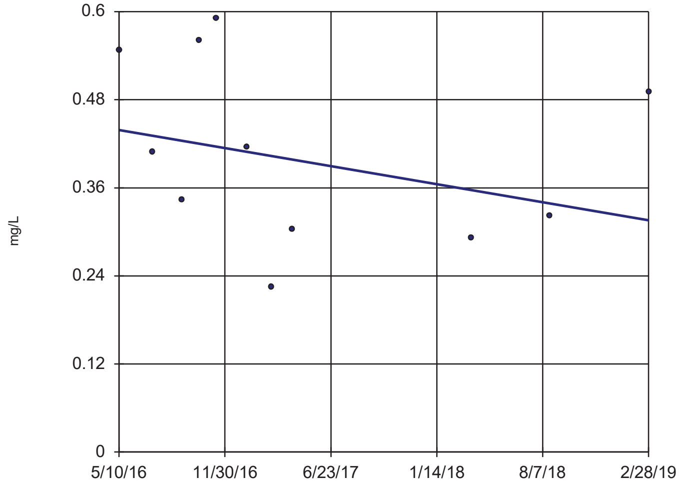
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Calcium, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = -0.04371
units per year.

Mann-Kendall
statistic = -13
critical = -34

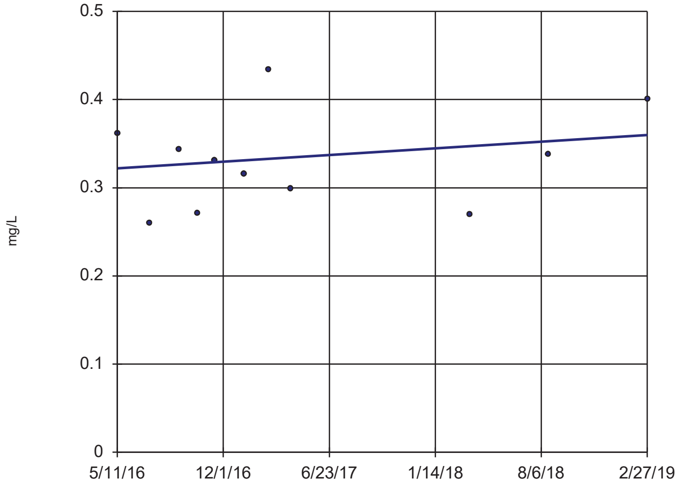
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Calcium, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.01357 units per year.

Mann-Kendall statistic = 5 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

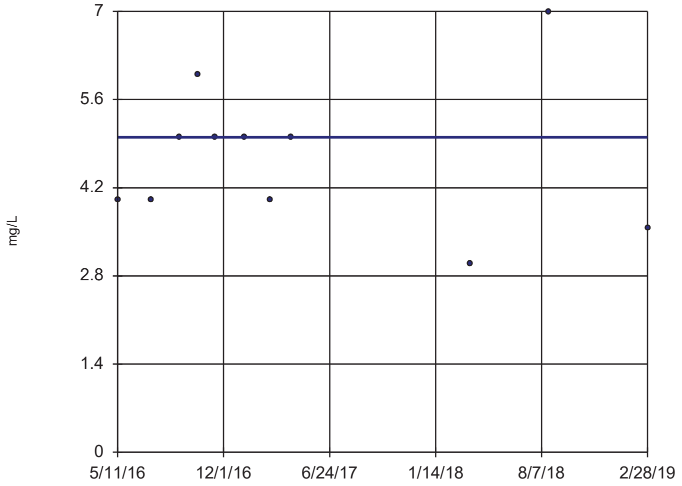
Constituent: Calcium, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-4 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -2 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

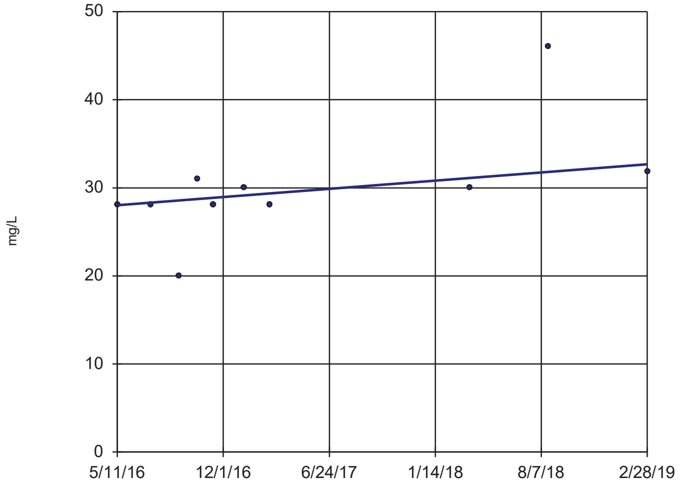
Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-2



n = 10

Slope = 1.659 units per year.

Mann-Kendall statistic = 22 critical = 30

Trend not significant at 99% confidence level (α = 0.005 per tail).

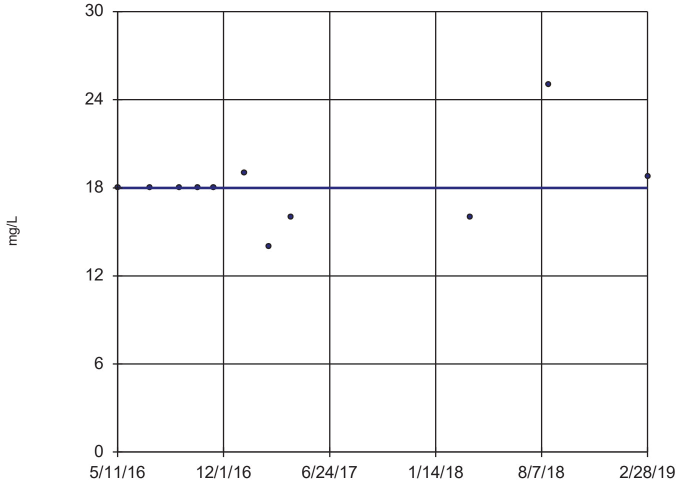
Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-31



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = 4 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

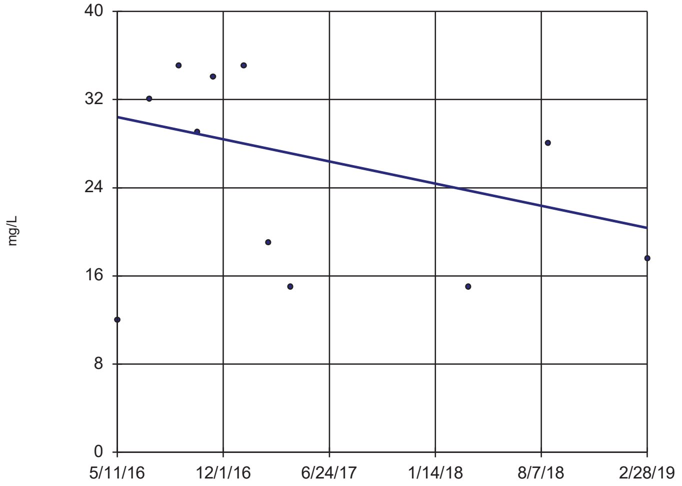
Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-32



n = 11

Slope = -3.583 units per year.

Mann-Kendall statistic = -11 critical = -34

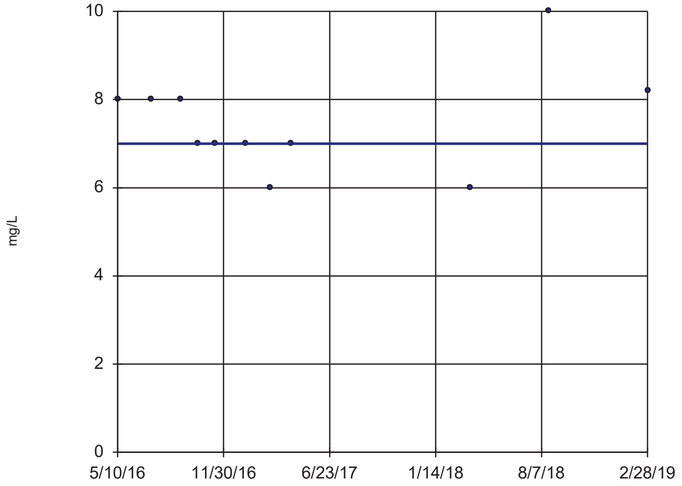
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -7 critical = -34

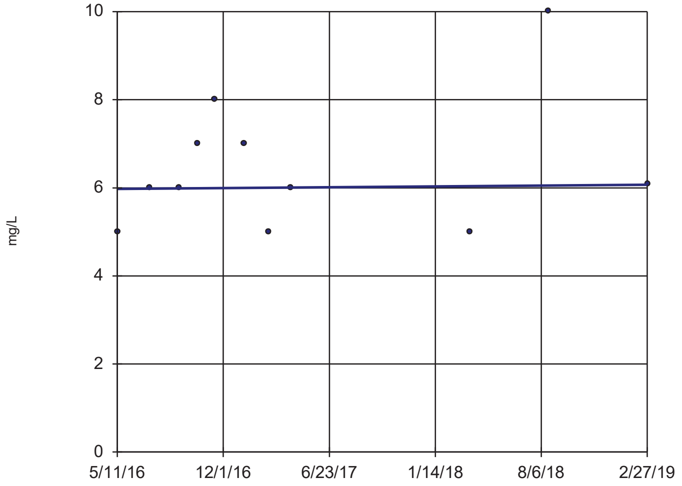
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.03234 units per year.

Mann-Kendall statistic = 10 critical = 34

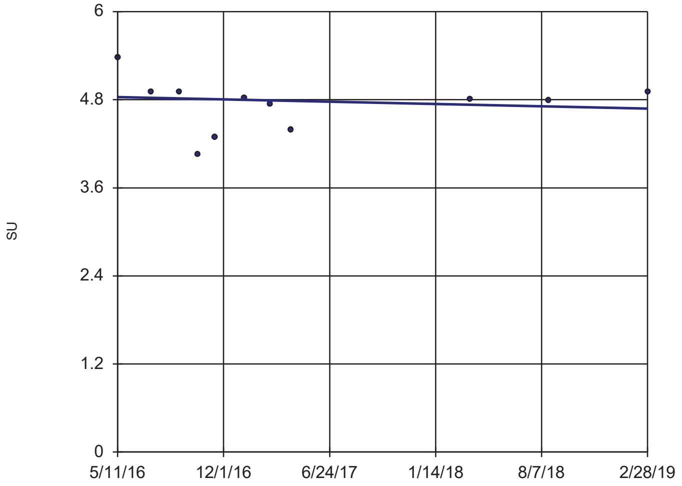
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-4 (bg)



n = 11

Slope = -0.05639 units per year.

Mann-Kendall statistic = -10 critical = -34

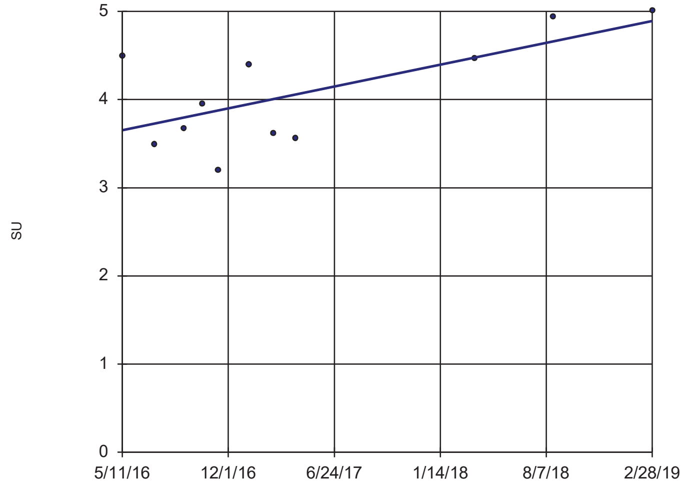
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-31



n = 11

Slope = 0.441
units per year.

Mann-Kendall
statistic = 19
critical = 34

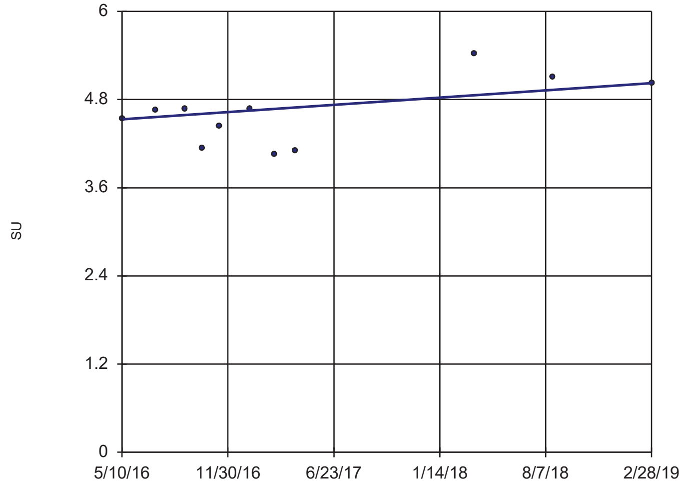
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = 0.1747
units per year.

Mann-Kendall
statistic = 12
critical = 34

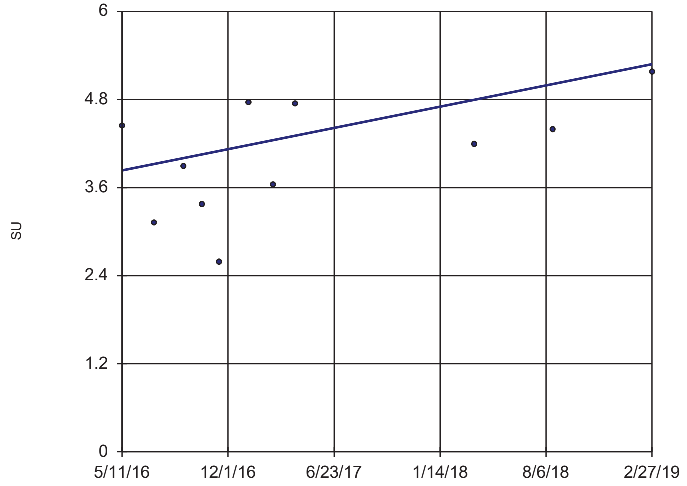
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.5174
units per year.

Mann-Kendall
statistic = 19
critical = 34

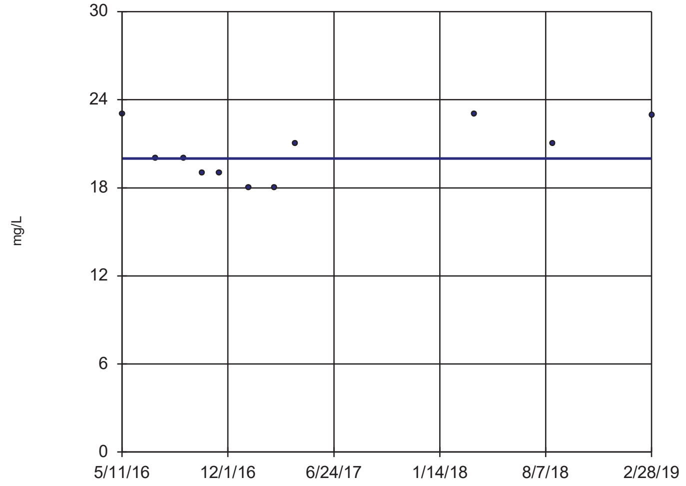
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: pH, field   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-4 (bg)



n = 11

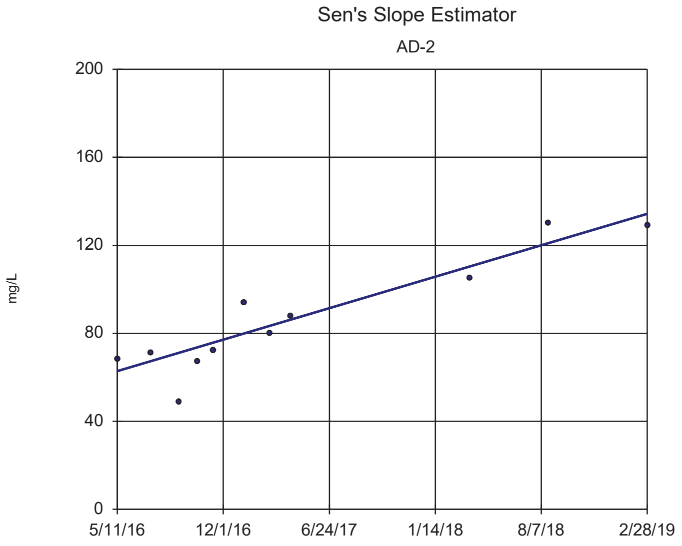
Slope = 0
units per year.

Mann-Kendall
statistic = 4
critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

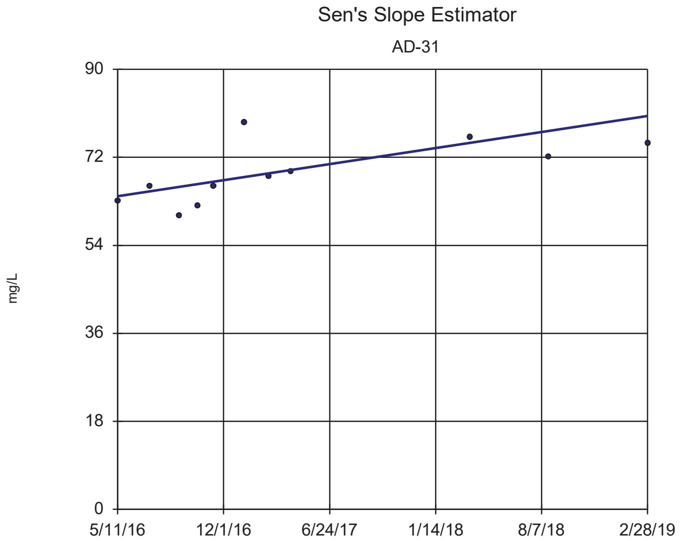
Slope = 25.54
units per year.

Mann-Kendall
statistic = 41
critical = 34

Increasing trend
significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Sulfate, total   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

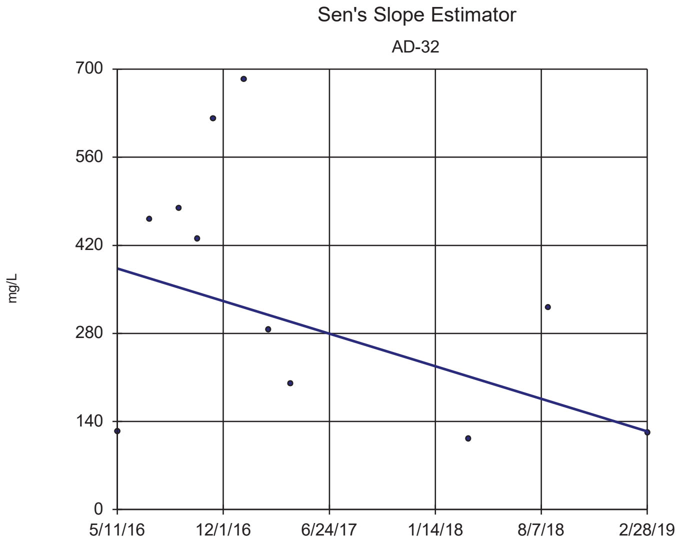
Slope = 5.856
units per year.

Mann-Kendall
statistic = 32
critical = 34

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Sulfate, total   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

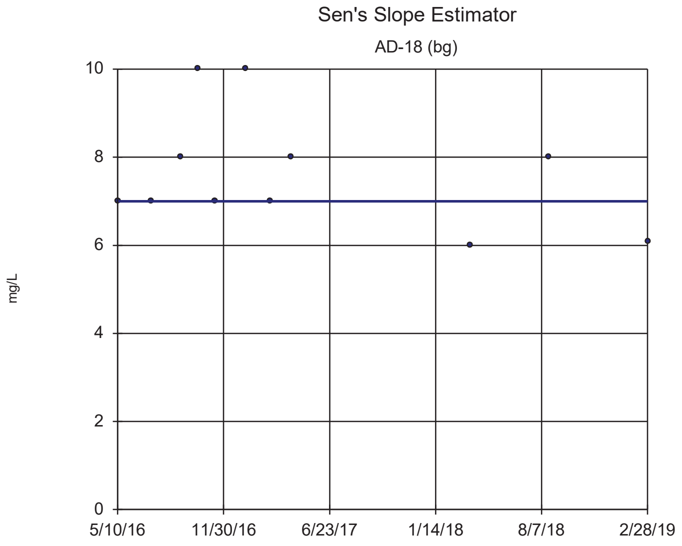
Slope = -92.31
units per year.

Mann-Kendall
statistic = -15
critical = -34

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Sulfate, total   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

Slope = 0
units per year.

Mann-Kendall
statistic = -7
critical = -34

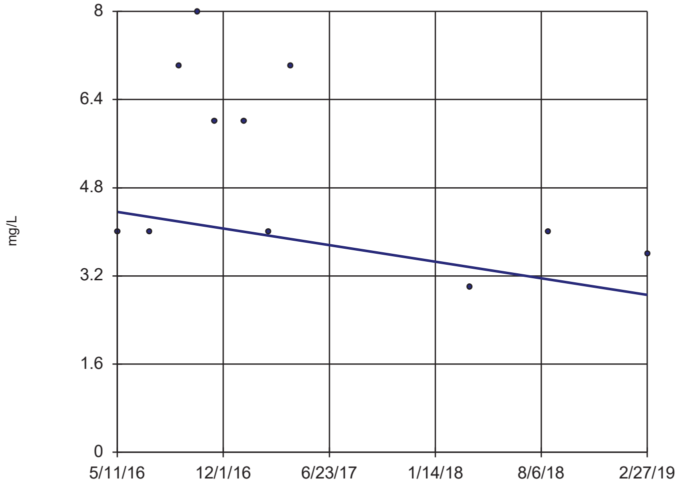
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Sulfate, total   Analysis Run 7/5/2019 1:06 PM   View: Trend Tests
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = -0.5376
units per year.

Mann-Kendall
statistic = -15
critical = -34

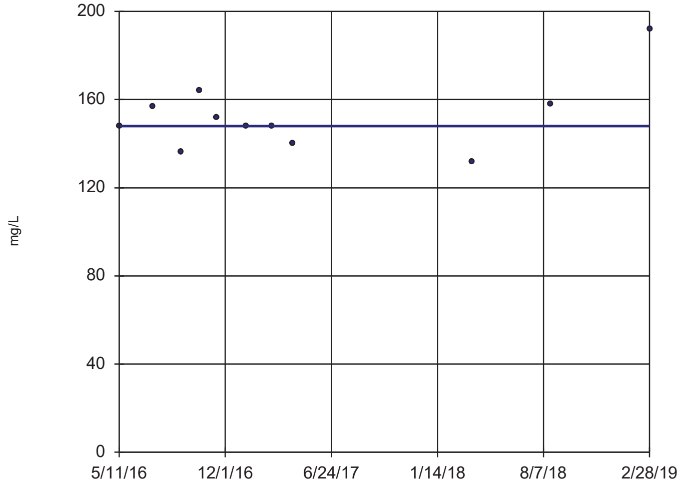
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-4 (bg)



n = 11

Slope = 0
units per year.

Mann-Kendall
statistic = 2
critical = 34

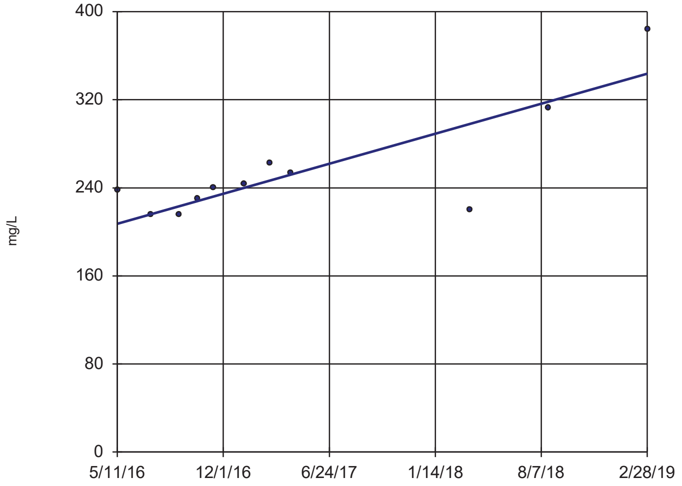
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-2



n = 11

Slope = 48.67
units per year.

Mann-Kendall
statistic = 34
critical = 34

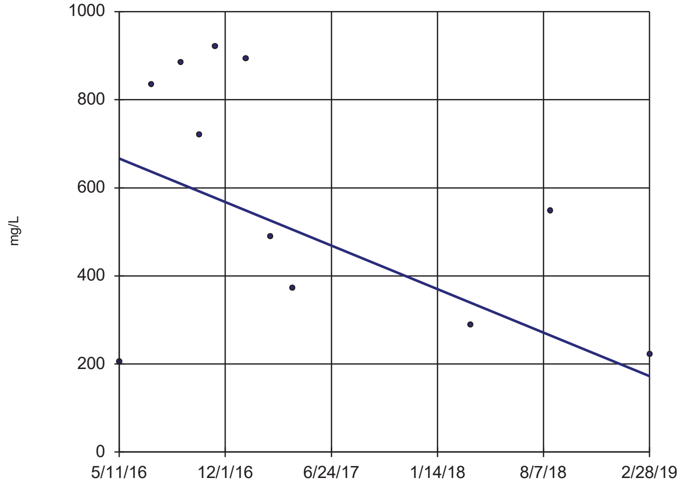
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-32



n = 11

Slope = -176.2
units per year.

Mann-Kendall
statistic = -15
critical = -34

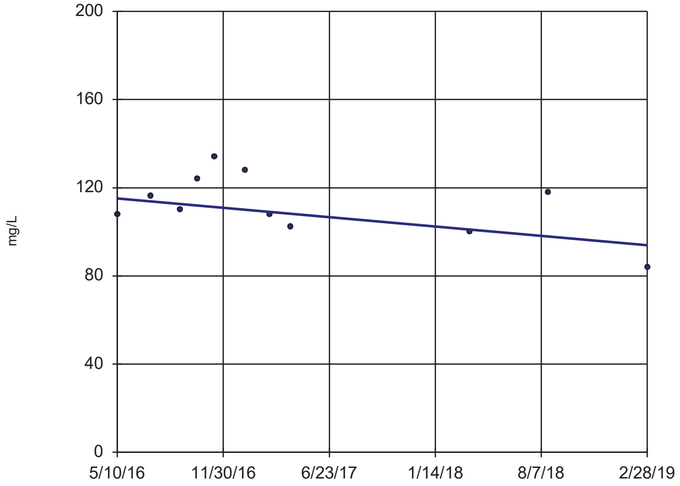
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = -7.565 units per year.

Mann-Kendall statistic = -16 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

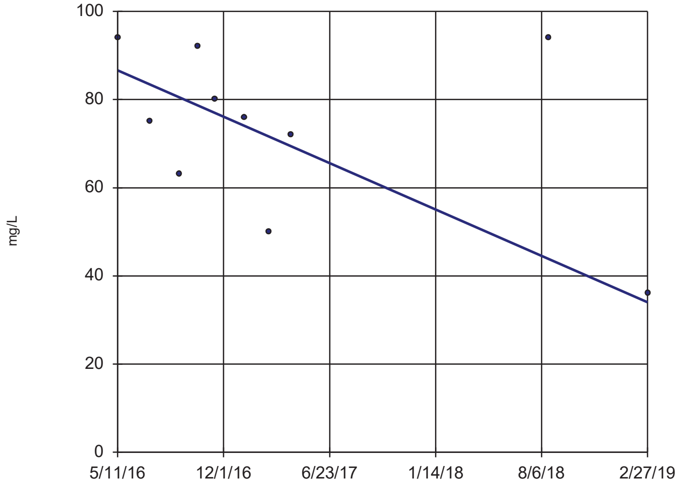
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 10

Slope = -18.79 units per year.

Mann-Kendall statistic = -14 critical = -30

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tolerance Limit Summary Table - Appendix IV Parameters

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP   Printed 7/5/2019, 12:55 PM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.002	33	n/a	n/a	96.97	n/a	n/a	0.184	NP Inter(NDs)
Arsenic, total (mg/L)	n/a	0.011	33	n/a	n/a	72.73	n/a	n/a	0.184	NP Inter(normality)
Barium, total (mg/L)	n/a	0.183	33	n/a	n/a	0	n/a	n/a	0.184	NP Inter(normality)
Beryllium, total (mg/L)	n/a	0.00115	33	n/a	n/a	6.061	n/a	n/a	0.184	NP Inter(normality)
Cadmium, total (mg/L)	n/a	0.001	33	n/a	n/a	72.73	n/a	n/a	0.184	NP Inter(normality)
Chromium, total (mg/L)	n/a	0.007	33	n/a	n/a	15.15	n/a	n/a	0.184	NP Inter(Cohens/xform)
Cobalt, total (mg/L)	n/a	0.00939	33	n/a	n/a	0	n/a	n/a	0.184	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	n/a	3.455	33	1.012	0.3872	0	None	sqrt(x)	0.05	Inter
Fluoride, total (mg/L)	n/a	1	33	n/a	n/a	87.88	n/a	n/a	0.184	NP Inter(NDs)
Lead, total (mg/L)	n/a	0.002	33	n/a	n/a	84.85	n/a	n/a	0.184	NP Inter(NDs)
Lithium, total (mg/L)	n/a	0.05207	33	0.02139	0.01402	3.03	None	No	0.05	Inter
Mercury, total (mg/L)	n/a	0.000064	33	n/a	n/a	36.36	n/a	n/a	0.184	NP Inter(Cohens/xform)
Molybdenum, total (mg/L)	n/a	0.002	33	n/a	n/a	90.91	n/a	n/a	0.184	NP Inter(NDs)
Selenium, total (mg/L)	n/a	0.004	33	n/a	n/a	63.64	n/a	n/a	0.184	NP Inter(normality)
Thallium, total (mg/L)	n/a	0.001874	33	n/a	n/a	81.82	n/a	n/a	0.184	NP Inter(NDs)

Confidence Interval Summary Table - Significant Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 1:02 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-2**	**0.0136**	**0.01**	**0.0094**	**n/a**	**Yes**	**11**	**0**	**No**	**0.006**	**NP (normality)**
Cobalt, total (mg/L)	**AD-31**	**0.01192**	**0.009429**	**0.0094**	**n/a**	**Yes**	**10**	**0**	**sqrt(x)**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-32**	**0.0675**	**0.03328**	**0.0094**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Lithium, total (mg/L)	**AD-31**	**0.097**	**0.077**	**0.052**	**n/a**	**Yes**	**11**	**0**	**No**	**0.006**	**NP (normality)**
Lithium, total (mg/L)	**AD-32**	**0.1154**	**0.07511**	**0.052**	**n/a**	**Yes**	**10**	**0**	**x^2**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results

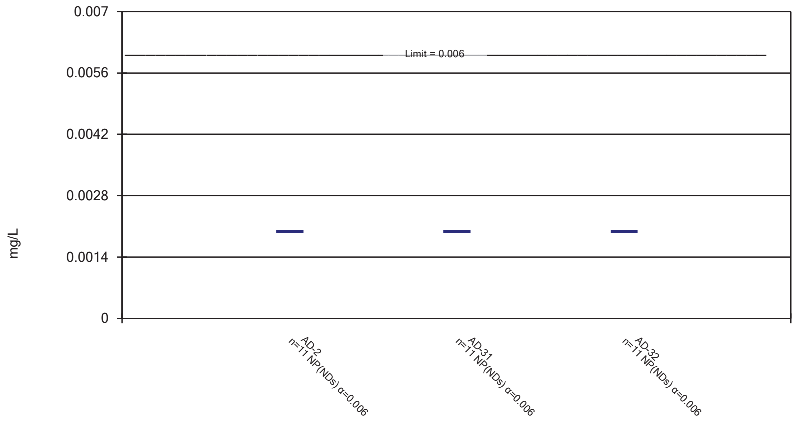
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 7/5/2019, 1:02 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-2	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-31	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-32	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Arsenic, total (mg/L)	AD-2	0.002	0.00053	0.011	n/a	No	11	81.82	No	0.006	NP (NDs)
Arsenic, total (mg/L)	AD-31	0.006	0.002	0.011	n/a	No	10	20	No	0.011	NP (Cohens/xfrm)
Arsenic, total (mg/L)	AD-32	0.007737	0.002689	0.011	n/a	No	11	9.091	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-2	0.03849	0.03229	2	n/a	No	11	0	x^3	0.01	Param.
Barium, total (mg/L)	AD-31	0.09365	0.04907	2	n/a	No	10	0	No	0.01	Param.
Barium, total (mg/L)	AD-32	0.04527	0.02662	2	n/a	No	11	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-2	0.0004741	0.0003971	0.004	n/a	No	11	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-31	0.002	0.0009983	0.004	n/a	No	11	0	No	0.006	NP (normality)
Beryllium, total (mg/L)	AD-32	0.007452	0.003677	0.004	n/a	No	11	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-2	0.001	0.00006	0.005	n/a	No	11	81.82	No	0.006	NP (NDs)
Cadmium, total (mg/L)	AD-31	0.001	0.0000944	0.005	n/a	No	11	54.55	No	0.006	NP (normality)
Cadmium, total (mg/L)	AD-32	0.0006616	0.0003662	0.005	n/a	No	11	0	No	0.01	Param.
Chromium, total (mg/L)	AD-2	0.004	0.0002438	0.1	n/a	No	11	45.45	No	0.006	NP (normality)
Chromium, total (mg/L)	AD-31	0.01835	0.004053	0.1	n/a	No	10	10	No	0.01	Param.
Chromium, total (mg/L)	AD-32	0.01144	0.002569	0.1	n/a	No	11	0	No	0.01	Param.
Cobalt, total (mg/L)	**AD-2**	**0.0136**	**0.01**	**0.0094**	**n/a**	**Yes**	**11**	**0**	**No**	**0.006**	**NP (normality)**
Cobalt, total (mg/L)	**AD-31**	**0.01192**	**0.009429**	**0.0094**	**n/a**	**Yes**	**10**	**0**	**sqrt(x)**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-32**	**0.0675**	**0.03328**	**0.0094**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Combined Radium 226 + 228 (pCi/L)	AD-2	1.886	0.9373	5	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-31	4.384	2.647	5	n/a	No	11	0	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-32	5.566	3.585	5	n/a	No	10	0	No	0.01	Param.
Fluoride, total (mg/L)	AD-2	1	1	4	n/a	No	11	90.91	No	0.006	NP (NDs)
Fluoride, total (mg/L)	AD-31	1	1	4	n/a	No	11	90.91	No	0.006	NP (NDs)
Fluoride, total (mg/L)	AD-32	1	0.4468	4	n/a	No	11	45.45	No	0.006	NP (normality)
Lead, total (mg/L)	AD-2	0.002	0.000355	0.015	n/a	No	11	81.82	No	0.006	NP (NDs)
Lead, total (mg/L)	AD-31	0.002	0.00154	0.015	n/a	No	10	70	No	0.011	NP (normality)
Lead, total (mg/L)	AD-32	0.002	0.002	0.015	n/a	No	11	90.91	No	0.006	NP (NDs)
Lithium, total (mg/L)	AD-2	0.05472	0.04503	0.052	n/a	No	11	9.091	x^4	0.01	Param.
Lithium, total (mg/L)	**AD-31**	**0.097**	**0.077**	**0.052**	**n/a**	**Yes**	**11**	**0**	**No**	**0.006**	**NP (normality)**
Lithium, total (mg/L)	**AD-32**	**0.1154**	**0.07511**	**0.052**	**n/a**	**Yes**	**10**	**0**	**x^2**	**0.01**	**Param.**
Mercury, total (mg/L)	AD-2	0.000147	0.00002779	0.002	n/a	No	11	0	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-31	0.0008212	0.0001268	0.002	n/a	No	10	0	sqrt(x)	0.01	Param.
Mercury, total (mg/L)	AD-32	0.008327	0.001765	0.002	n/a	No	11	0	No	0.01	Param.
Molybdenum, total (mg/L)	AD-2	0.002	0.0008627	0.1	n/a	No	11	81.82	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-31	0.002	0.0003161	0.1	n/a	No	11	63.64	No	0.006	NP (normality)
Molybdenum, total (mg/L)	AD-32	0.002	0.0007621	0.1	n/a	No	11	81.82	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-2	0.004	0.001231	0.05	n/a	No	11	45.45	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-31	0.004	0.001113	0.05	n/a	No	11	54.55	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-32	0.004	0.00218	0.05	n/a	No	10	50	No	0.011	NP (normality)
Thallium, total (mg/L)	AD-2	0.01	0.001264	0.002	n/a	No	11	81.82	No	0.006	NP (NDs)
Thallium, total (mg/L)	AD-31	0.01	0.001019	0.002	n/a	No	11	81.82	No	0.006	NP (NDs)
Thallium, total (mg/L)	AD-32	0.01	0.0009911	0.002	n/a	No	11	63.64	No	0.006	NP (normality)

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

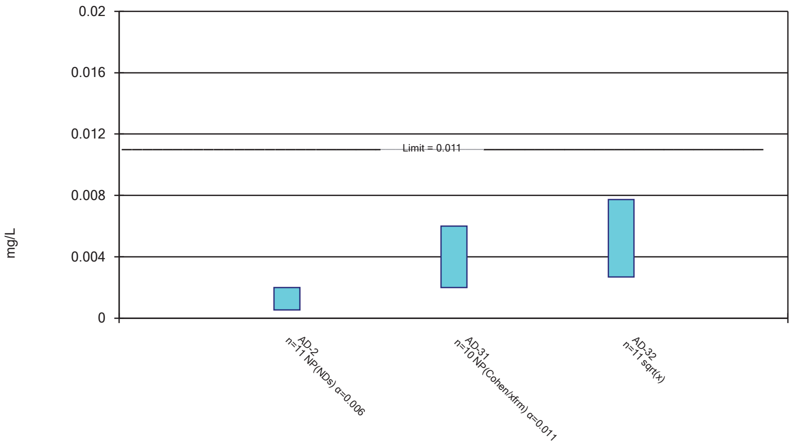


Constituent: Antimony, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

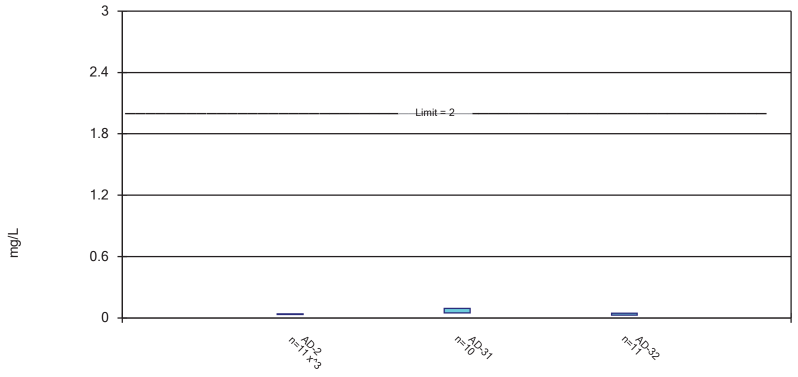


Constituent: Arsenic, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

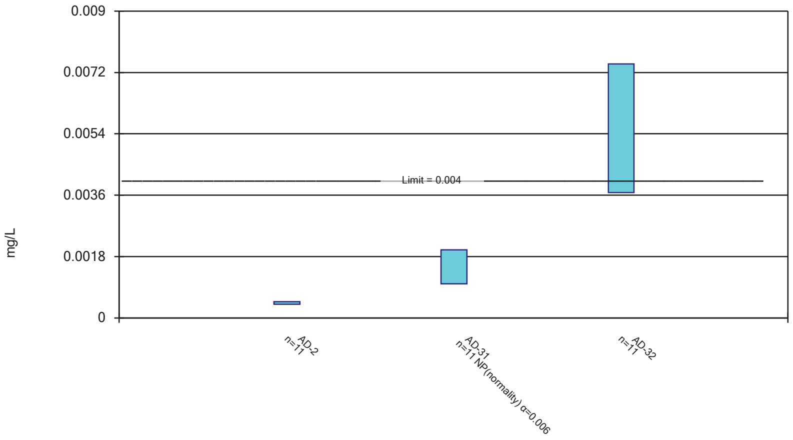


Constituent: Barium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

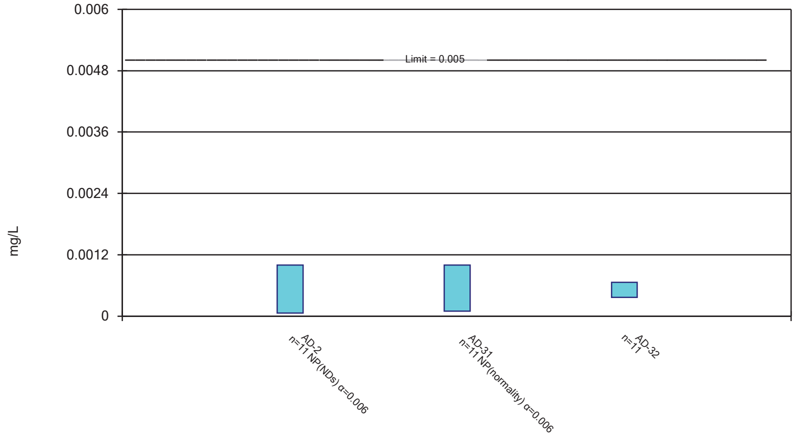


Constituent: Beryllium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

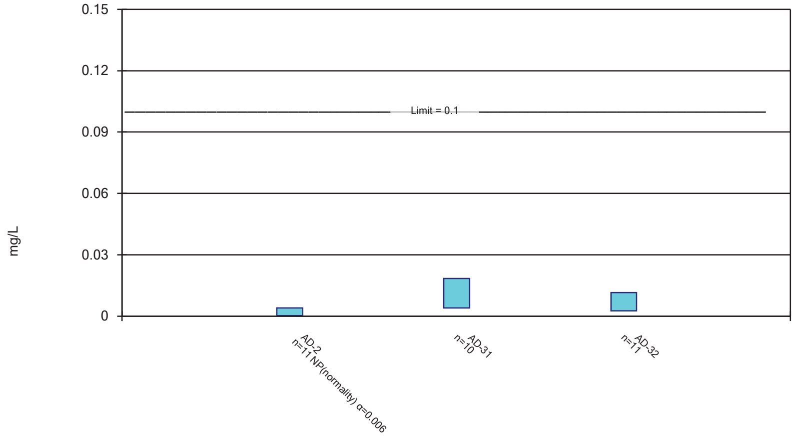


Constituent: Cadmium, total   Analysis Run 7/5/2019 1:00 PM   View: Confidence Intervals - App IV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

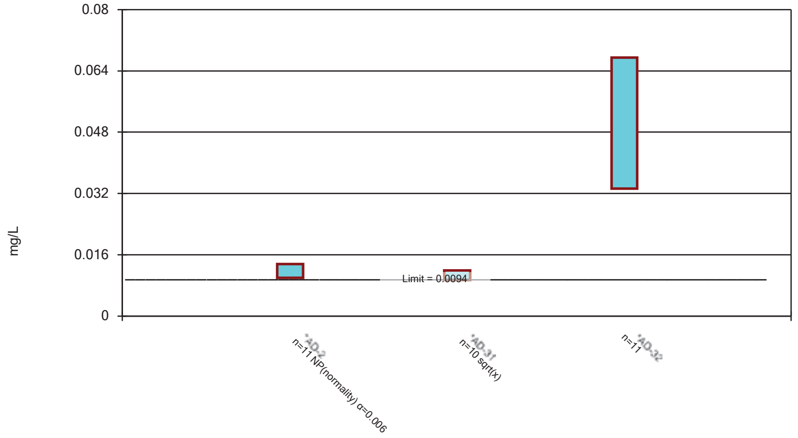


Constituent: Chromium, total   Analysis Run 7/5/2019 1:00 PM   View: Confidence Intervals - App IV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

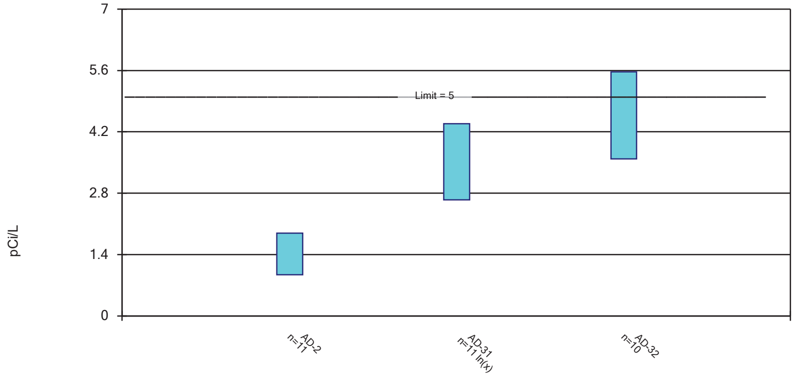


Constituent: Cobalt, total   Analysis Run 7/5/2019 1:00 PM   View: Confidence Intervals - App IV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

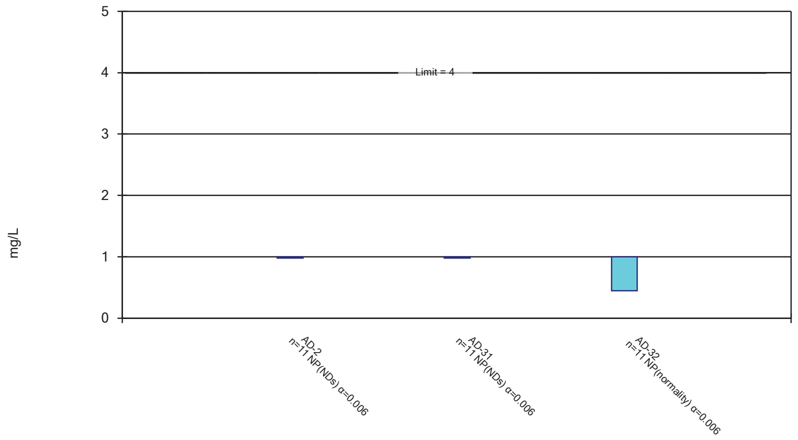


Constituent: Combined Radium 226 + 228   Analysis Run 7/5/2019 1:00 PM   View: Confidence Intervals - A
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

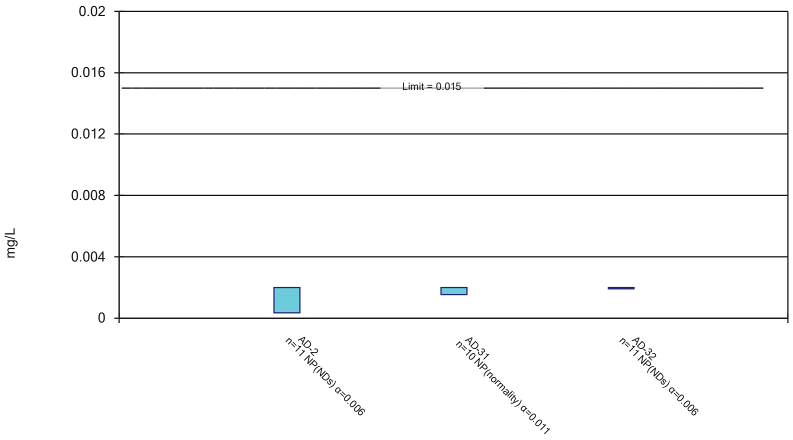


Constituent: Fluoride, total   Analysis Run 7/5/2019 1:00 PM   View: Confidence Intervals - App IV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

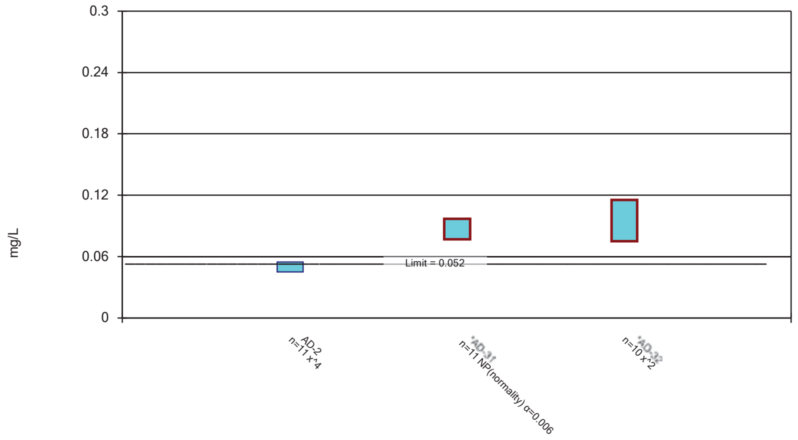


Constituent: Lead, total   Analysis Run 7/5/2019 1:00 PM   View: Confidence Intervals - App IV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

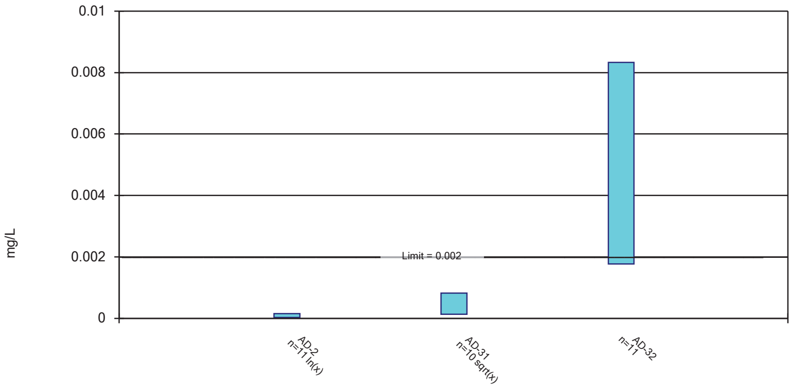


Constituent: Lithium, total   Analysis Run 7/5/2019 1:00 PM   View: Confidence Intervals - App IV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

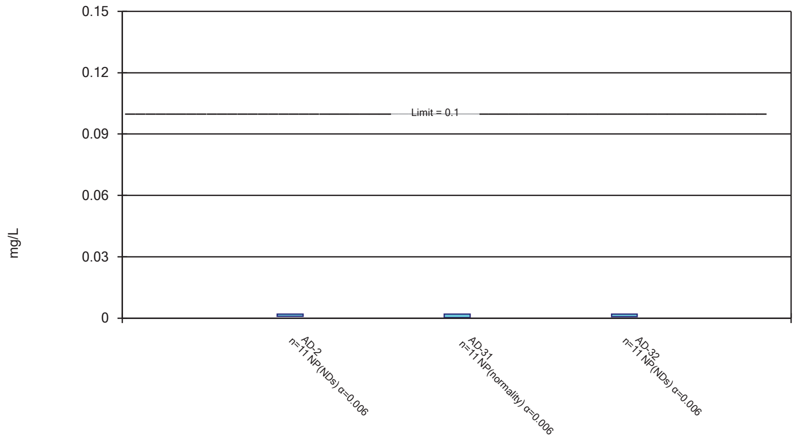


Constituent: Mercury, total   Analysis Run 7/5/2019 1:00 PM   View: Confidence Intervals - App IV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

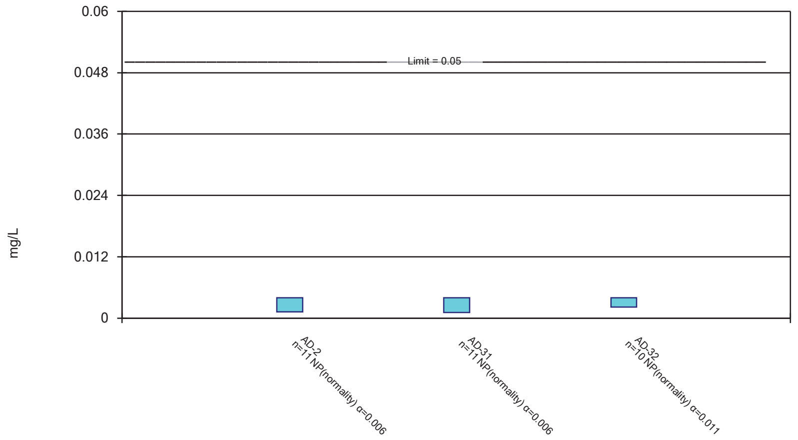


Constituent: Molybdenum, total   Analysis Run 7/5/2019 1:00 PM   View: Confidence Intervals - App IV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

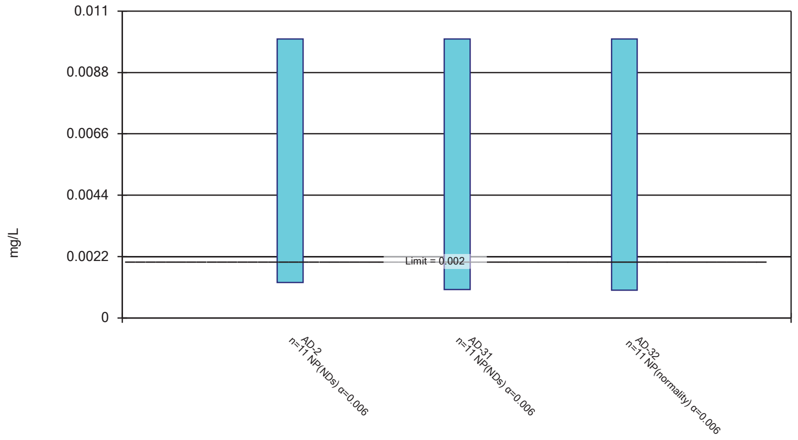


Constituent: Selenium, total   Analysis Run 7/5/2019 1:00 PM   View: Confidence Intervals - App IV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



Constituent: Thallium, total   Analysis Run 7/5/2019 1:00 PM   View: Confidence Intervals - App IV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

STATISTICAL ANALYSIS SUMMARY
EAST BOTTOM ASH POND
H.W. Pirkey Plant
Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

December 26, 2019

CHA8473

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LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
SU	Standard Units
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the East Bottom Ash Pond (EBAP), an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, calcium, chloride, total dissolved solids (TDS), and sulfate at the EBAP. An alternative source was not identified at the time, so the EBAP has been in assessment monitoring since. During the most recent assessment monitoring event, completed in July 2019, SSLs were identified for cobalt at wells AD-2, AD-31, and AD-32 and for lithium at wells AD-31 and AD-31. An alternative source demonstration (ASD) was successfully completed for cobalt and lithium (Geosyntec, 2019); thus, the unit remained in assessment monitoring. Two assessment monitoring events were conducted at the EBAP in May and August 2019, in accordance with 40 CFR 257.95. The results of these events are documented in this report.

Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. SSLs were identified for cobalt and lithium. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

EAST BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (May 2019) and 257.95(d)(1) (August 2019). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.23 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the EBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained during the May and August 2019 sampling events were screened for potential outliers. While possible outliers were identified for beryllium at wells AD-2 and AD-31 and for molybdenum at well AD-32, these values were not removed from the dataset as they were either non-detects or were similar to concentrations in adjacent wells.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for barium, beryllium, cobalt, and mercury due to apparent non-normal distributions, for antimony, arsenic, cadmium, fluoride, lead, molybdenum, selenium, and thallium due to a high non-detect frequency, and for chromium due to both an apparent non-normal distribution and a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey EBAP:

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.0100 mg/L) and AD-32 (0.0310 mg/L).

- LCLs for lithium exceeded the GWPS of 0.0616 mg/L at AD-31 (0.0859 mg/L) and AD-32 (0.0878 mg/L).

As a result, the Pirkey EBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Establishment of Appendix III Prediction Limits

Upper prediction limits (UPL) were previously established for all Appendix III parameters following the background monitoring period (Geosyntec, 2018). Intrawell tests were used to evaluate potential SSIs for pH, whereas interwell tests were used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS. While interwell prediction limits have been updated periodically during the assessment monitoring period as sufficient data became available, this represents the first update to the background dataset for parameters evaluated using intrawell tests.

Mann-Whitney (Wilcoxon rank-sum) tests were performed to determine whether the newer data are affected by a release from the EBAP. Because the interwell Appendix III limits and the Appendix IV GWPSs are based on data from upgradient wells which we would not expect to have been impacted by a release, these tests were used for intrawell Appendix III tests only. Mann-Whitney tests were used to compare the medians of historical data (May 2016-April 2017) to the new compliance samples (August 2017- February 2019) for pH. Results were evaluated to determine if the medians of the two groups were similar at the 99% confidence level. Where no significant difference was found, the new compliance data were added to the background dataset. Where a statistically significant difference was found between the medians of the two groups, the data were reviewed to evaluate the cause of the difference and to determine if adding newer data to the background dataset, replacing the background dataset with the newer data, or continuing to use the existing background dataset was most appropriate. If the differences appeared to have been caused by a release, then the previous background dataset continued to be used.

The complete Mann-Whitney test results and a summary of the significant findings can be found in Attachment B. A statistically significant difference was identified for pH in well AD-18. However, because this is an upgradient well and limited data are available, the background data were updated to include all data through February 2019.

After the revised background set was established, a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., “J-flagged” data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment B.

UPLs were updated using all the historical data through February 2019 to represent background values. LPLs were also updated for pH. The updated prediction limits are summarized in Table 3. Intrawell tests continued to be used to evaluate potential SSIs for pH, whereas interwell tests continued to be used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS. The intrawell UPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where the initial result did not exceed the UPL, a second sample was not collected. The retesting procedures allowed achieving an acceptably high statistical power to detect changes at downgradient wells for constituents evaluated using intrawell prediction limits.

2.2.4 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the May and August 2019 assessment monitoring events from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 4. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0510 mg/L at AD-2 (2.17 mg/L and 2.16 mg/L) and AD-32 (0.555 mg/L and 1.77 mg/L).

- Calcium concentrations exceeded the interwell UPL of 2.94 mg/L at AD-2 (3.30 mg/L), AD-31 (3.29 mg/L), and AD-32 (5.35 mg/L and 13.3 mg/L).

- Chloride concentrations exceeded the interwell UPL of 9.16 mg/L at AD-2 (29.6 mg/L and 28.4 mg/L), AD-31 (18.7 mg/L and 21.6 mg/L), and AD-32 (18.6 mg/L and 24.9 mg/L).

- Sulfate concentrations exceeded the interwell UPL of 23.0 mg/L at AD-2 (137 mg/L and 128 mg/L), AD-31 (79.9 mg/L and 70.0 mg/L), and AD-32 (105 mg/L and 228 mg/L).

- TDS concentrations exceeded the interwell UPL of 178 mg/L at AD-2 (316 mg/L and 306 mg/L), AD-31 (240 mg/L and 250 mg/L), and AD-32 (292 mg/L and 448 mg/L).

While the prediction limits were calculated assuming a 1-of-2 testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey EBAP during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. While potential outliers for beryllium and lithium were identified in the May and August 2019 data, no values were removed from the dataset. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. SSLs were identified for cobalt and lithium. Appendix III parameters were compared to recalculated prediction limits, with exceedances identified for boron, calcium, chloride, sulfate, and TDS.

Based on this evaluation, the Pirkey EBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Plant. January 2017.

Geosyntec Consultants. 2018. Statistical Analysis Summary – East Bottom Ash Pond, H.W. Pirkey Plant, Hallsville, Texas. January 15, 2018.

Geosyntec Consultants. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. September.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - East Bottom Ash Pond

Component	Unit	AD-2		AD-4		AD-12		AD-18		AD-31		AD-32	
		5/22/2019	**8/12/2019**	**5/23/2019**	**8/14/2019**	**5/21/2019**	**8/12/2019**	**5/23/2019**	**8/13/2019**	**5/23/2019**	**8/12/2019**	**5/21/2019**	**8/12/2019**
Antimony	µg/L	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U
Arsenic	µg/L	2.00 U	0.350	2.00 U	0.170	2.00 U	0.0700 J	2.00 U	0.450	2.00 U	0.530	0.800 J	3.43
Barium	µg/L	25.6	22.8	61.7	73.5	21.7	23.8	131	100	37.9	35.0	35.6	38.5
Beryllium	µg/L	2.00 U	0.402	0.500 J	1.04	2.00 U	0.154	2.00 U	0.118	0.900 J	0.850	2.77	3.65
Boron	mg/L	2.17	2.16	0.0210	0.0500 U	0.0200	0.0500 U	0.0130	0.0500 U	0.0210	0.0500 U	0.555	1.77
Cadmium	µg/L	1.00 U	0.0600	1.00 U	0.0500 U	1.00 U	0.0500 U	1.00 U	0.0200 J	1.00 U	0.0600	0.300 J	0.400
Calcium	mg/L	2.19	3.30	1.71	1.97	0.300 J	0.278	0.684	0.647	3.29	2.86	5.35	13.3
Chloride	mg/L	29.6	28.4	3.31	6.22	6.30	7.24	8.82	8.49	18.7	21.6	18.6	24.9
Chromium	µg/L	4.00 U	0.292	1.00 J	0.0800 J	4.00 U	0.204	4.00 U	0.212	4.00 U	0.365	1.00 J	1.70
Cobalt	µg/L	15.5	13.0	7.86	6.52	1.15	1.30	1.47	1.25	10.3	8.69	23.5	33.7
Combined Radium	pCi/L	0.832	1.81	0.517	0.833	0.201	0.237	0.492	0.473	3.40	2.20	5.37	5.70
Fluoride	mg/L	0.100 J	0.100 J	0.150	0.120	0.0900	0.0600 J	0.0200 J	0.0100 J	0.130	0.160	0.310	0.670
Lead	µg/L	2.00 U	0.288	2.00 U	0.0600 J	2.00 U	0.0800 J	2.00 U	0.200 J	2.00 U	0.325	0.400 J	0.996
Lithium	mg/L	0.0542	0.0560	0.0516	0.0484	0.00576	0.00829	0.0209	0.0183	0.0928	0.0875	0.0897	0.0964
Mercury	mg/L	0.0000630	0.0000440	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.00000900 J	0.0000230 J	0.0000570	0.00103	0.00137	0.00413
Molybdenum	µg/L	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U
Selenium	µg/L	0.900 J	0.800	4.00 U	0.0400 J	4.00 U	0.200 J	4.00 U	0.0900 J	4.00 U	0.400	1.00 J	7.30
Total Dissolved Solids	mg/L	316	306	150	146	80.0	90.0	104	90.0	240	250	292	448
Sulfate	mg/L	137	128	24.6	21.7	4.00	2.60	10.6	6.60	79.9	70.0	105	228
Thallium	µg/L	0.500 U	0.100 J	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.200 J	0.200 J
pH	SU	4.04	4.55	4.97	5.49	4.09	4.94	5.20	5.22	5.14	4.06	3.21	4.01

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above the method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit

Table 2: Groundwater Protection Standards
Pirkey Plant - East Bottom Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.0025
Arsenic, Total (mg/L)	0.01		0.011
Barium, Total (mg/L)	2		0.18
Beryllium, Total (mg/L)	0.004		0.0012
Cadmium, Total (mg/L)	0.005		0.0005
Chromium, Total (mg/L)	0.1		0.007
Cobalt, Total (mg/L)	n/a	0.006	0.0094
Combined Radium, Total (pCi/L)	5		3.33
Fluoride, Total (mg/L)	4		0.5
Lead, Total (mg/L)	0.015		0.0025
Lithium, Total (mg/L)	n/a	0.04	0.062
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.020
Selenium, Total (mg/L)	0.05		0.0025
Thallium, Total (mg/L)	0.002		0.0019

Notes:

Grey cell indicates calculated UTL is higher than MCL or CCR Rule-specified value.

MCL = Maximum Contaminant Level

Calculated UTL (Upper Tolerance Limit) represents site-specific background values.

The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Revised Prediction Limits
Pirkey - East Bottom Ash Pond

Parameter	Unit	Description	AD-2	AD-31	AD-32
Boron	mg/L	Interwell Background Value (UPL)	0.0510		
Calcium	mg/L	Interwell Background Value (UPL)	2.94		
Chloride	mg/L	Interwell Background Value (UPL)	9.16		
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
pH	SU	Intrawell Background Value (UPL)	4.8	5.4	4.6
		Intrawell Background Value (LPL)	3.3	2.8	2.5
Sulfate	mg/L	Interwell Background Value (UPL)	23.0		
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	176		

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

Table 4: Appendix III Data Summary
Pirkey - East Bottom Ash Pond

Parameter	Unit	Description	AD-2		AD-31		AD-32	
			5/22/2019	8/12/2019	5/23/2019	8/12/2019	5/21/2019	8/12/2019
Boron	mg/L	Interwell Background Value (UPL)	0.0510					
		Detection Monitoring Result	**2.17**	**2.16**	0.0210	0.0200	**0.555**	**1.77**
Calcium	mg/L	Interwell Background Value (UPL)	2.94					
		Detection Monitoring Result	2.19	**3.30**	**3.29**	2.86	**5.35**	**13.3**
Chloride	mg/L	Interwell Background Value (UPL)	9.16					
		Detection Monitoring Result	**29.6**	**28.4**	**18.7**	**21.6**	**18.6**	**24.9**
Fluoride	mg/L	Interwell Background Value (UPL)	1.00					
		Detection Monitoring Result	0.100	0.100	0.130	0.160	0.310	0.670
pH	SU	Intrawell Background Value (UPL)	4.8		5.4		4.6	
		Intrawell Background Value (LPL)	3.3		2.8		2.5	
		Detection Monitoring Result	4.0	4.6	5.1	4.1	3.2	4.0
Sulfate	mg/L	Interwell Background Value (UPL)	23.0					
		Detection Monitoring Result	**137**	**128**	**79.9**	**70.0**	**105**	**228**
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	176					
		Detection Monitoring Result	**316**	**306**	**240**	**250**	**292**	**448**

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

DAVID ANTHONY MILLER
112498

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

01.03.20
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

December 9, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey EBAP - Assessment Monitoring Event & Background Update 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the evaluation of groundwater data and the background update for American Electric Power Company's Pirkey EBAP. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling at each of the wells below began at Pirkey EBAP for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following: upgradient wells AD-4, AD-12, and AD-18; and downgradient wells AD-2, AD-31, and AD-32.

Data were sent electronically, and the statistical analysis was reviewed by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC. The analysis was conducted according to the Statistical Analysis Plan and initial screening evaluation prepared in November 2017 by GSC and approved by Dr. Kirk Cameron.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and

- **Appendix IV** (Assessment Monitoring) – antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Values in background which have been flagged as outliers may be seen in a lighter font and disconnected symbol on the graphs. During the August 2018 event, a value of 0.015 mg/L was reported for selenium at well AD-32. That value was flagged as an outlier since the reported value during the February 2019 event was significantly lower (0.003 mg/L) and similar to historical concentrations.

Background data at all wells were initially evaluated during the background screening conducted in December 2017 for the following: 1) outliers; 2) trends; 3) most appropriate statistical method for Appendix III parameters based on site characteristics of groundwater data upgradient of the facility; and 4) eligibility of downgradient wells when intrawell statistical methods are recommended. A summary of that screening is provided below. Data are evaluated in this report for inclusion of more recent data into background to update the prediction limits. Power curves were provided during the initial background screening to demonstrate that the selected statistical methods for Appendix III parameters comply with the USEPA Unified Guidance recommendations as discussed below.

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for pH.
2) Interwell prediction limits, combined with a 1-of-2 resample plan for boron, calcium, chloride, fluoride, sulfate and TDS.

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, simple substitution of one-half the reporting limit may be utilized in the statistical analysis. The reporting limit

utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Summary of Background Screening Conducted in December 2017

Outlier Evaluation

Time series plots are used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III and Appendix IV parameters were formally tested using Tukey's box plot method and, when identified, flagged in the computer database with "o" and deselected prior to construction of statistical limits. The reports were submitted with the background screening.

Tukey's outlier test noted several outliers which were flagged in the database. Any values flagged as outliers are plotted in a lighter font on the time series graph. While the test identified a couple low outliers for chloride, lead and lithium in downgradient wells, these values were not flagged because they were similar in concentration to surrounding wells. It was noted that the first background sample in well AD-31 for several constituents was higher than all subsequent samples. This could be representative of well drilling processes, or an indication of sampling or analytical error. Therefore, these values were flagged as outliers since they do not appear to represent the population of groundwater at this well. In some cases, the test could not identify suspect outliers due to the upper and lower quartiles being equal. When extreme values were present in background, however, they were flagged as outliers, such as fluoride in upgradient well AD-12. A substitution of the most recent reporting limit was applied when varying detection limits existed in data.

No true seasonal patterns were observed on the time series plots for any of the detected data; therefore, no deseasonalizing adjustments were made to the data. When seasonal patterns are observed, data may be deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release.

While trends may be visual, a quantification of the trend and its significance is needed. The Sen's Slope/Mann Kendall trend test was used to evaluate all data at each well to identify statistically significant increasing or decreasing trends. In the absence of suspected contamination, significant trending data are typically not included as part of the background data used for construction of prediction limits. This step serves to eliminate the trend and, thus, reduce variation in background. When statistically significant decreasing trends are present, earlier data are evaluated to determine whether earlier concentration levels are significantly different than current reported concentrations and will be deselected as necessary. When the historical records of data are truncated for the reasons above, a summary report will be provided to show the date ranges used in construction of the statistical limits.

The results of the trend analyses were submitted with the background screening report and showed a couple statistically significant increasing and decreasing trends. These trends were relatively low in magnitude when compared to average concentrations; therefore, no adjustments were made to the data sets.

Appendix III – Determination of Spatial Variation

The Analysis of Variance (ANOVA) was used to statistically evaluate differences in average concentrations among upgradient wells, which assists in identifying the most appropriate statistical approach. Interwell tests, which compare downgradient well data to statistical limits constructed from pooled upgradient well data, are appropriate when average concentrations are similar across upgradient wells. Intrawell tests, which compare compliance data from a single well to screened historical data within the same well, are appropriate when upgradient wells exhibit spatial variation; when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective; and when downgradient water quality is unimpacted compared to upgradient water quality for the same parameter.

The ANOVA identified no variation for fluoride, making this constituent suitable for interwell analyses. Variation was identified in groundwater upgradient of the site for all other Appendix III parameters. Therefore, these data were further evaluated as described for the appropriateness of intrawell testing to accommodate the groundwater quality. A summary table of the ANOVA results is included with the reports.

Appendix III - Statistical Limits

Intrawell limits constructed from carefully screened background data from within each well serve to provide statistical limits that are conservative (i.e. lower) from a regulatory perspective, and that will rapidly identify a change in more recent compliance data from within a given well. This statistical method removes the element of variation from across wells and eliminates the chance of mistaking natural spatial variation for a release from the facility. Prior to performing intrawell prediction limits, several steps are required to reasonably demonstrate downgradient water quality does not have existing impacts from the practices of the facility.

Exploratory data analysis was used as a general comparison of concentrations in downgradient wells for all Appendix III parameters recommended for intrawell analyses to concentrations reported in upgradient wells. Upper tolerance limits are used in conjunction with confidence intervals to determine whether the estimated averages in downgradient wells are higher than observed levels upgradient of the facility. The upper tolerance limits were constructed to represent the extreme upper range of possible background levels at the site.

In cases where downgradient average concentrations are higher than observed concentrations upgradient for a given constituent, an independent study and hydrogeological investigation would be required to identify local geochemical conditions and expected groundwater quality for the region to justify an intrawell approach. Such an assessment is beyond the scope of services provided by Groundwater Stats Consulting. When there is not an obvious explanation for observed concentration differences in downgradient wells relative to reported concentrations in upgradient wells, interwell prediction limits will initially be selected for the statistical method until further evidence shows that concentrations are due to natural variation rather than a result of the facility.

Parametric tolerance limits were constructed with a target of 99% confidence and 95% coverage using pooled upgradient well data for each of the Appendix III parameters recommended for intrawell analyses. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. As more data are collected, the background population is better represented and the confidence and coverage levels increase.

Confidence intervals were constructed on downgradient wells for each of the Appendix III parameters, using the tolerance limits discussed above, to determine intrawell eligibility for parameters exhibiting spatial variation. When the entire confidence interval is above a background standard for a given parameter, interwell methods are initially recommended as the statistical method. Therefore, only parameters with confidence intervals which did not exceed background standards are eligible for intrawell prediction limits.

Confidence intervals for the above parameters were found to be within their respective background limit for pH, while the confidence intervals for all other Appendix III parameters evaluated were above the background standards for parameters exhibiting spatial variation. Therefore, intrawell methods were recommended for pH, and interwell methods were recommended for all other Appendix III parameters. As mentioned earlier, if a demonstration supports natural variation in groundwater, intrawell methods will be considered for all parameters.

All available data through April 2017 at each well were used to establish intrawell background limits based on a 1-of-2 resample plan that will be used for future comparisons. Interwell prediction limits, combined with a 1-of-2 resample plan, were constructed from upgradient wells for the Appendix III parameters discussed above. Downgradient measurements will be compared to these background limits during each subsequent semi-annual sampling event.

Natural systems continuously evolve due to physical changes made to the environment. Examples include capping a landfill, paving areas near a well, or lining a drainage channel to prevent erosion. Periodic updating of background statistical limits will be necessary to accommodate these types of changes In the interwell case, newer data will be carefully screened during each event for new outliers or extreme trending data. In the intrawell case, data for all wells and constituents are re-evaluated when a minimum of 4 new data points from each well are available to determine whether earlier concentrations are representative of present-day groundwater quality. In some cases, the earlier portion of data are deselected prior to construction of limits in order to provide sensitive limits that will rapidly detect changes in groundwater quality. Even though the data are excluded from the calculation, the values will continue to be reported and shown in tables and graphs.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of an additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered to be a false positive result and, therefore, no further action is necessary.

Background Update Summary – November 2019

Prior to updating background data sets, all Appendix III and data through February 2019 were re-evaluated using Tukey's outlier test and visual screening (Figure C). Tukey's Outlier test identified an outlier for fluoride in well AD-32 which was flagged in the database. Additionally, the reported nondetect value of <5.0 mg/L for TDS in upgradient well AD-12 was flagged as it is not consistent with remaining measurements within this well. As mentioned above, flagged data are displayed in a lighter font and as a disconnected symbol on the time series reports, as well as in a lighter font on the accompanying data pages. An updated summary of Tukey's test results and flagged outliers follows this letter.

The Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through April 2017 to the new compliance samples at each well through February 2019 to evaluate whether the groups are significantly different at the 99% confidence level. When no differences are noted, background data may be updated with more recent compliance data (Figure D). Typically, when the test concludes that the medians of the two groups are significantly different, particularly in the downgradient wells, the background are not updated to include the newer data but will be reconsidered in the future.

A statistically significant difference was identified for pH in well AD-18. However, because this is an upgradient well and limited data are available, the background data were updated to include all data through February 2019. These data will be re-evaluated during the next background update. If earlier measurements no longer represent present-day conditions, the earlier portion of the record will be deselected prior to construction of statistical limits. A summary of these results follows this letter and the test results are included with the Mann Whitney test section at the end of this report.

Intrawell prediction limits using all historical data through February 2019 combined with a 1-of-2 resample plan, were constructed for pH and a summary of the updated limits follows this letter (Figure E). Future compliance observations at each well will be compared to these background limits during each subsequent semi-annual sampling event.

The Sen's Slope/Mann Kendall trend test was used to evaluate data at upgradient wells for boron, calcium, chloride, fluoride, sulfate and TDS, which are tested using interwell prediction limits, to identify statistically significant increasing or decreasing trends. The results of the trend analyses showed all data are consistent over time with no statistically significant increasing or decreasing trends (Figure F).

Interwell prediction limits, combined with a 1-of-2 resample plan, were updated using all available data from upgradient wells for the same time period for the parameters listed above (Figure G). Interwell prediction limits pool upgradient well data to establish a background limit for an individual constituent. A summary table of the updated limits may be found following this letter in the Prediction Limit Summary Tables.

Evaluation of Appendix IV Parameters

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure H). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. The test identified a few outliers such as: beryllium in wells AD-2 and AD-31 and molybdenum in well AD-32 (which were reported nondetects). The value identified for beryllium in well AD-2 was not flagged due to the low concentrations within this well and all values being similar to neighboring wells, indicating natural variability. The nondetect values were not flagged as outliers for molybdenum in well AD-32, but it was noted these limits are higher than historical limits and have been reported at these levels for two events. A nondetect adjustment may be required depending on what the future reporting limit is set at for nondetects. Additionally, several other values that were not identified by Tukey's test (often due to the natural log transformation) were flagged as they were significantly different from the other reported measurements within the same well. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure I).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, CCR-Rule specified levels or ACL as discussed above (Figure J). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. When a GWPS is exceeded, if an Alternate Source Demonstration cannot be made, corrective action would be initiated. The following confidence interval exceedances were noted: cobalt in wells AD-2 and AD-32, and lithium in wells AD-31 and AD-32. A summary of the confidence interval results follows this letter.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey EBAP. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

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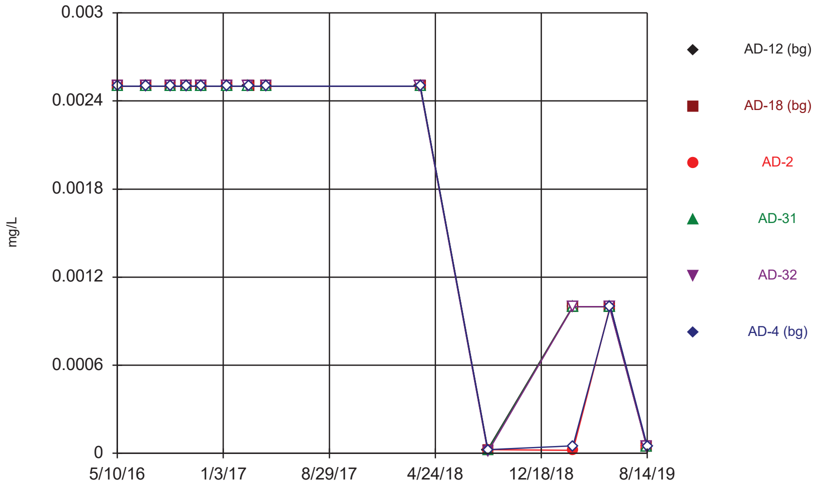
Hollow symbols indicate censored values.

Time Series



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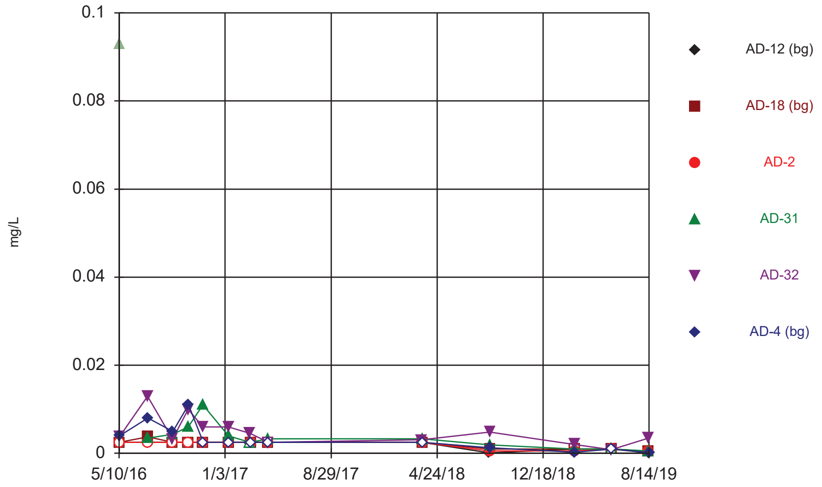
Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

Time Series



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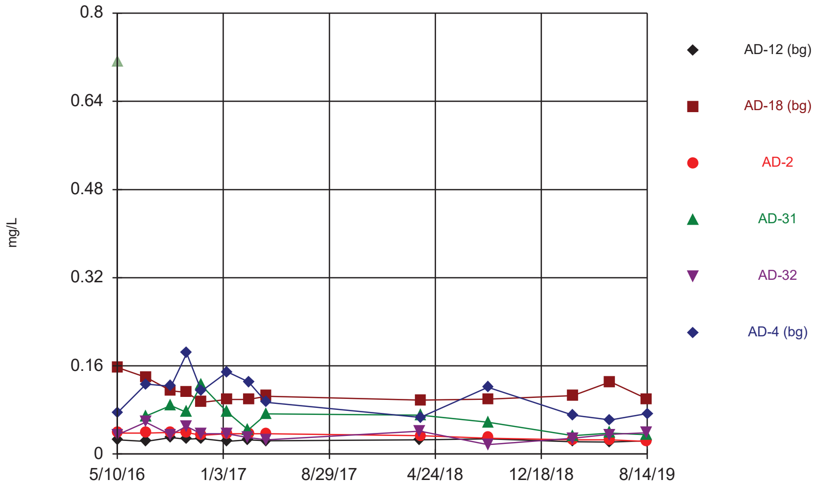
Sanitas™ v.9.6.23 . EPA

Time Series



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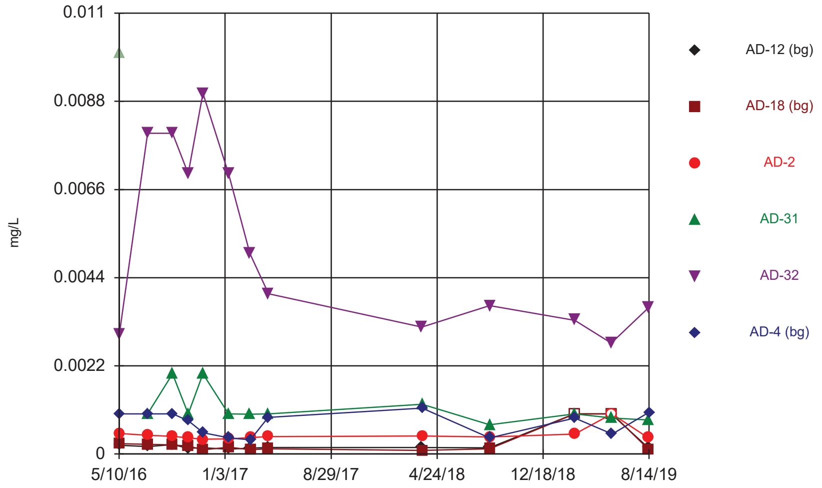
Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

Time Series



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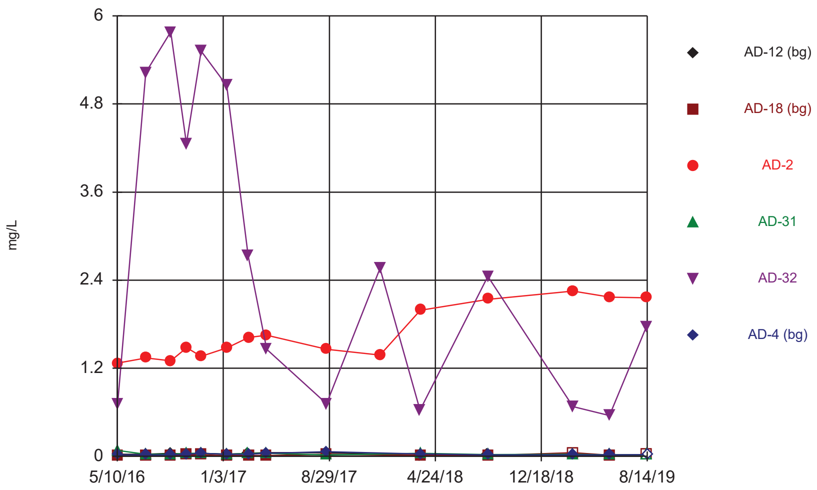

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Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

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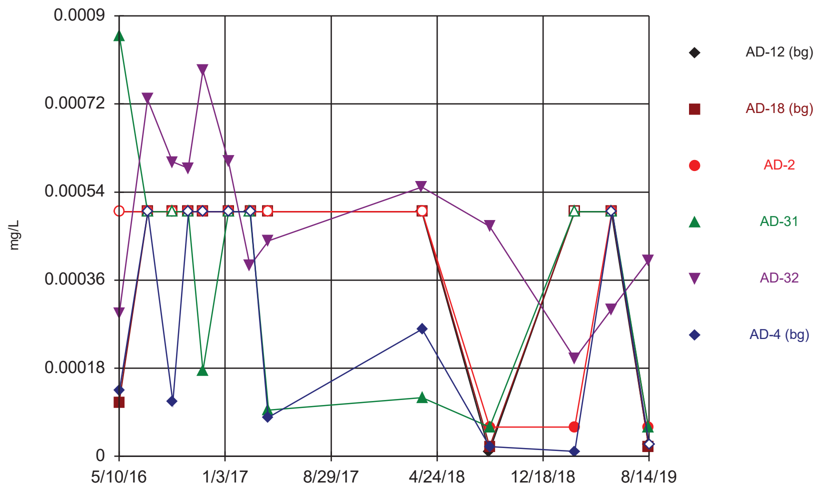

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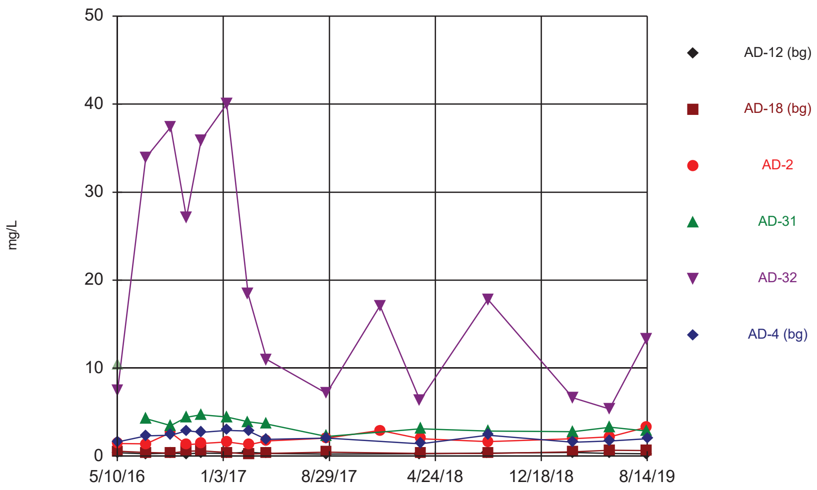
Sanitas™ v.9.6.23 . EPA

Time Series



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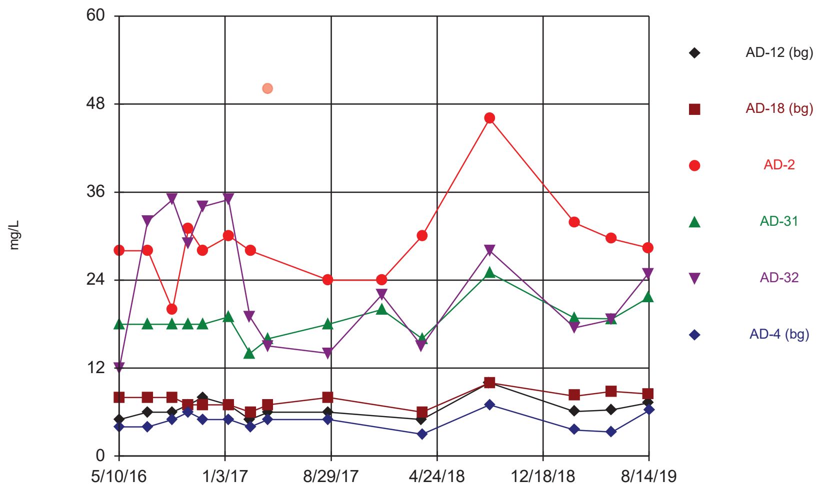
Sanitas™ v.9.6.23 . EPA

Time Series



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Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

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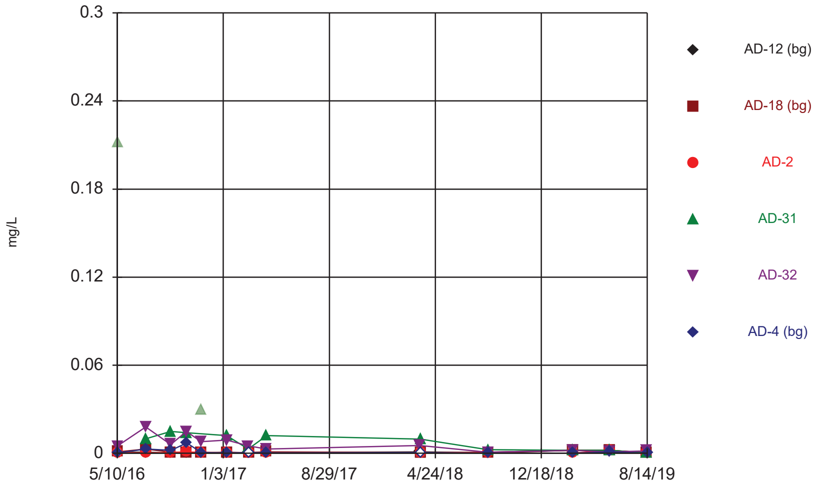

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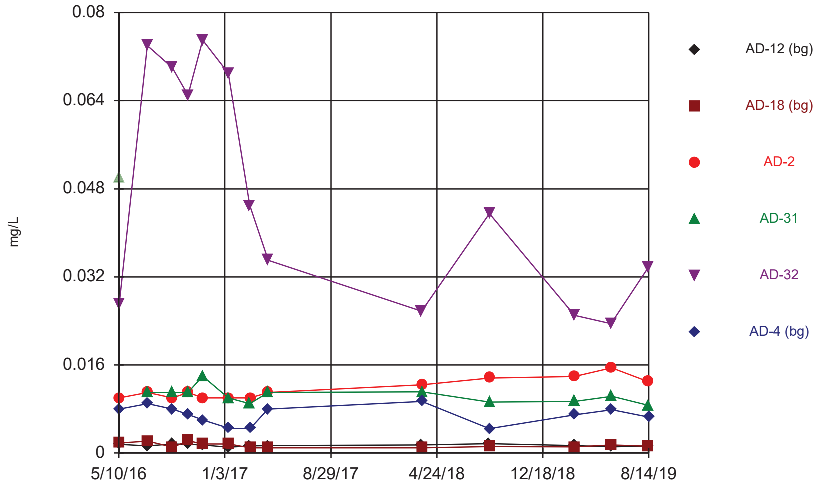
Sanitas™ v.9.6.23 . EPA

Time Series



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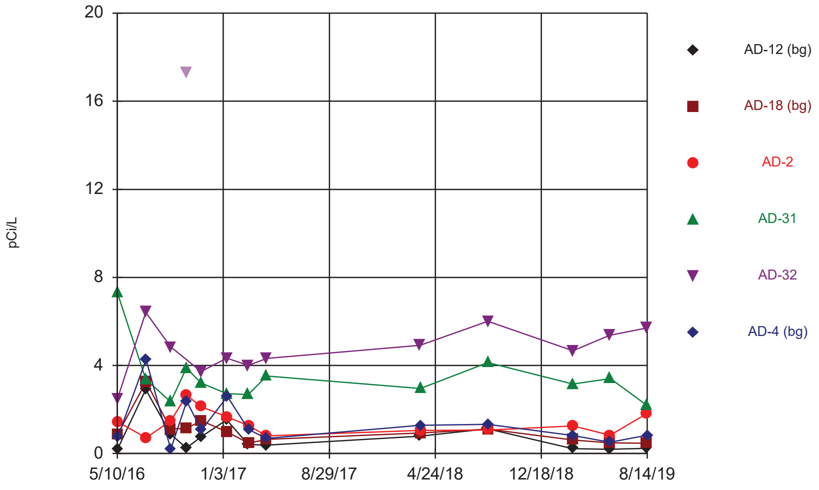
Sanitas™ v.9.6.23 . EPA

Time Series



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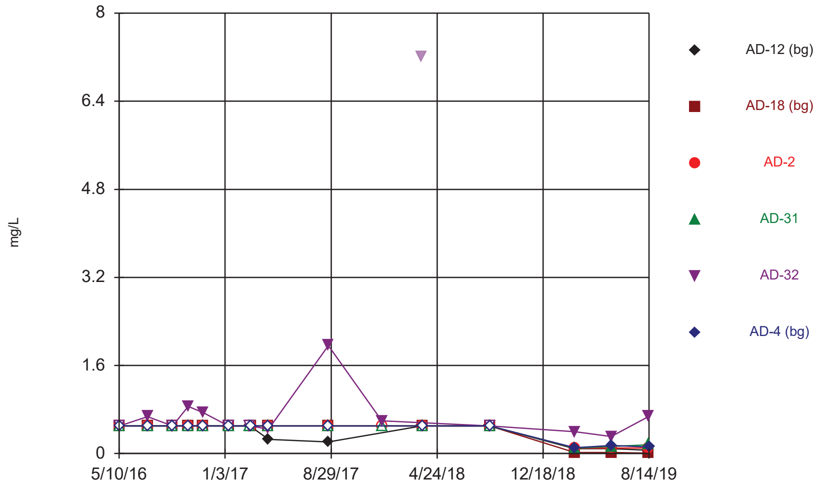
Hollow symbols indicate censored values.

Time Series



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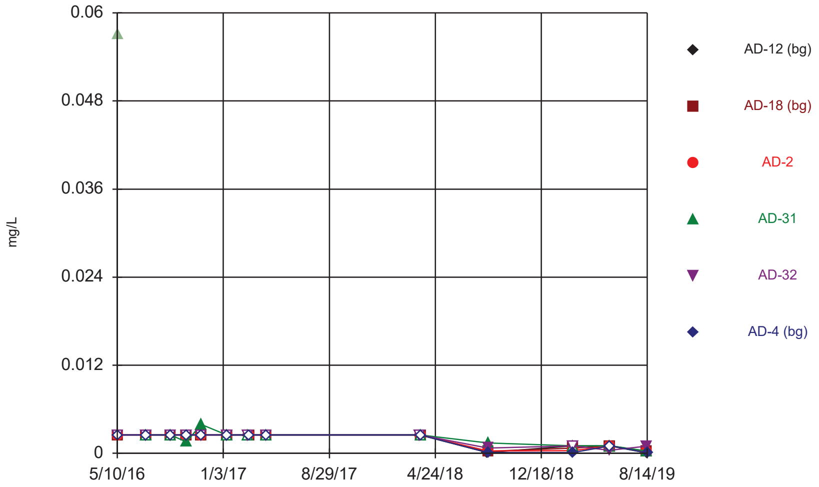
Time Series



Constituent: Lead, total Analysis Run 11/25/2019 11:33 AM View: All Data
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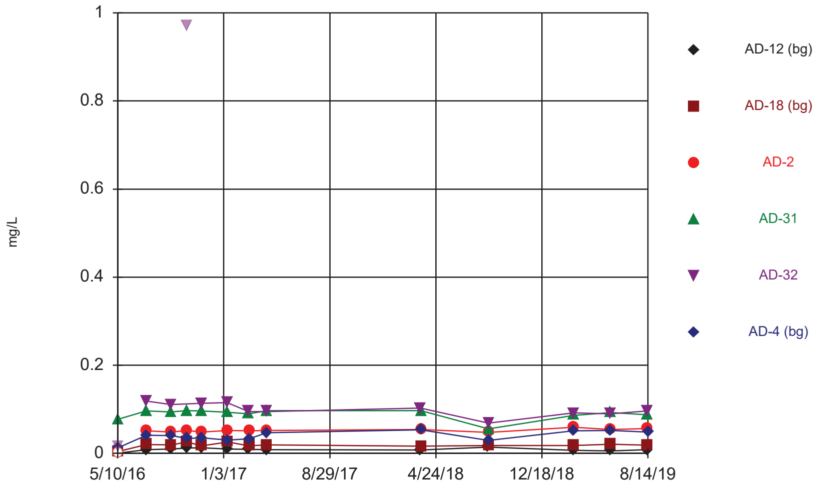
Time Series



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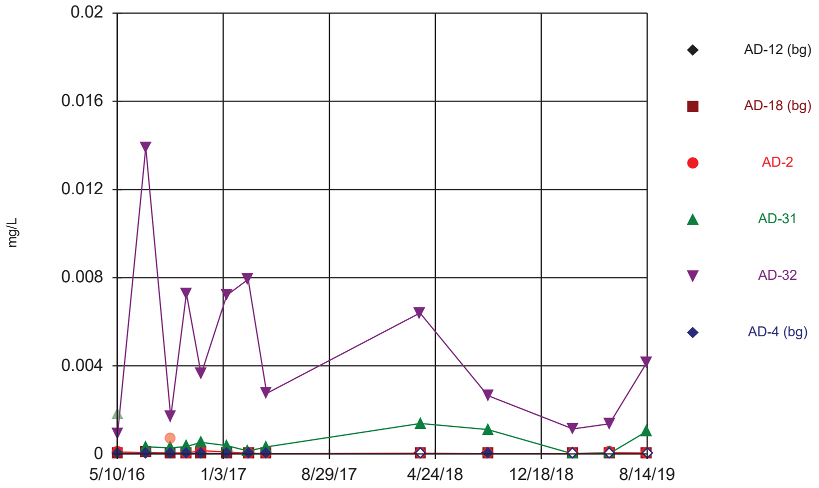
Time Series



Constituent: Mercury, total Analysis Run 11/25/2019 11:33 AM View: All Data
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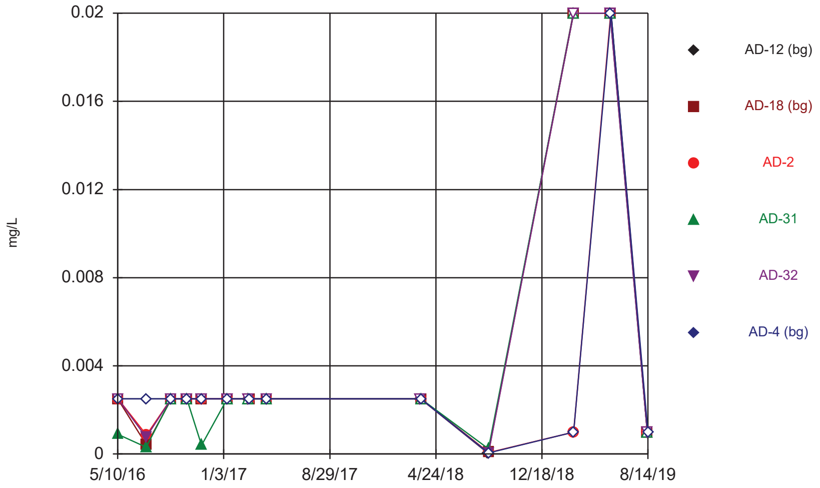
Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.

Time Series



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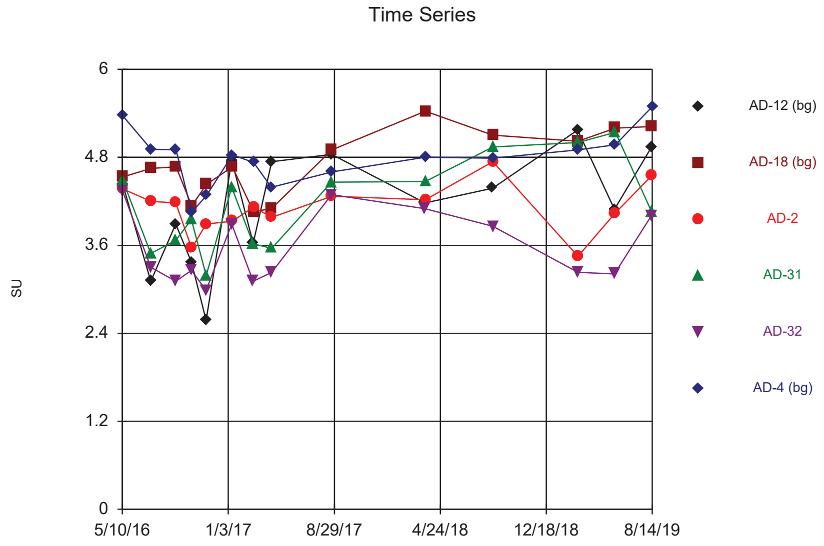
Sanitas™ v.9.6.23 . EPA



Constituent: pH, field   Analysis Run 11/25/2019 11:33 AM   View: All Data
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Sanitas™ v.9.6.23 . EPA
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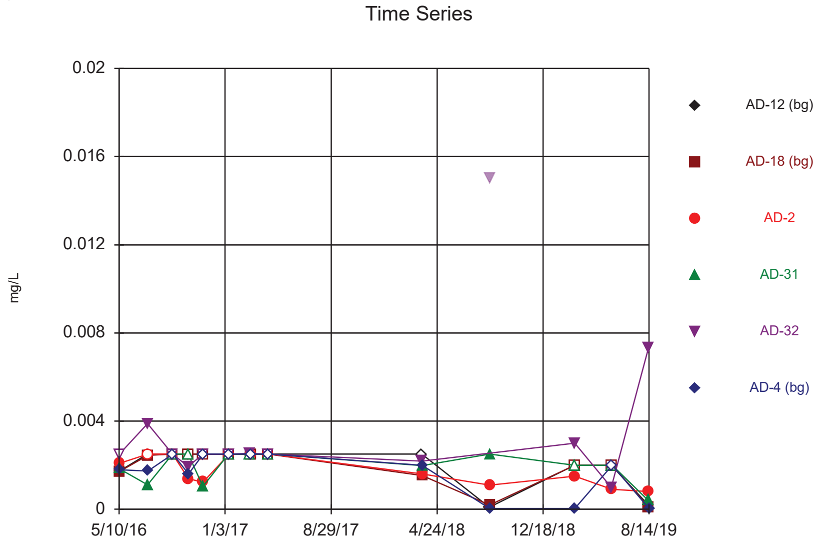

Constituent: Selenium, total   Analysis Run 11/25/2019 11:33 AM   View: All Data
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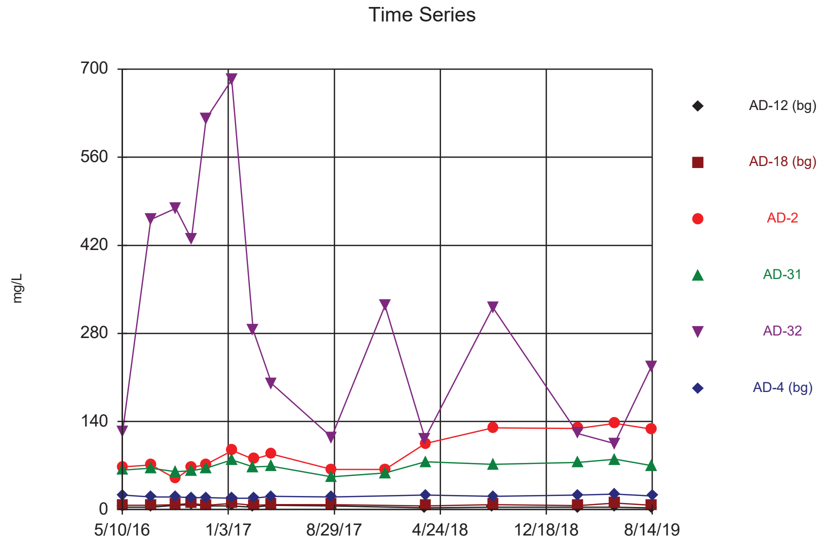
Sanitas™ v.9.6.23 . EPA



Constituent: Sulfate, total   Analysis Run 11/25/2019 11:33 AM   View: All Data
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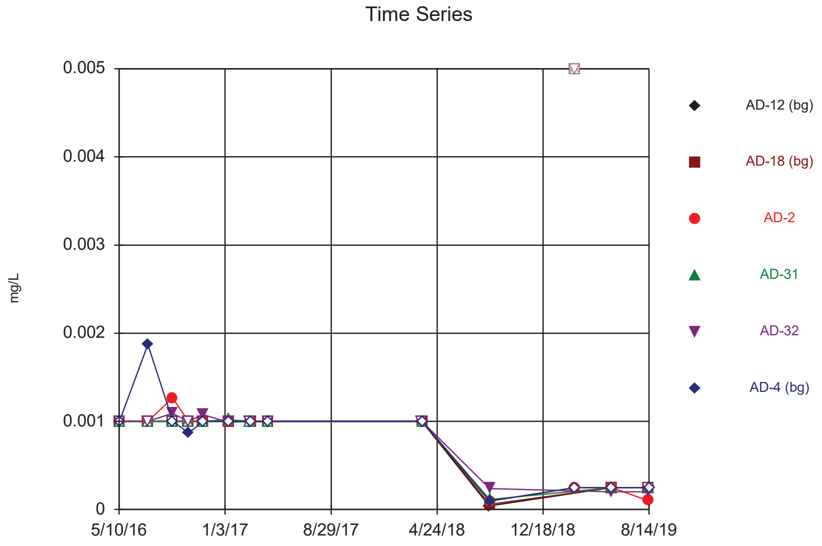
Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.



Constituent: Thallium, total   Analysis Run 11/25/2019 11:33 AM   View: All Data
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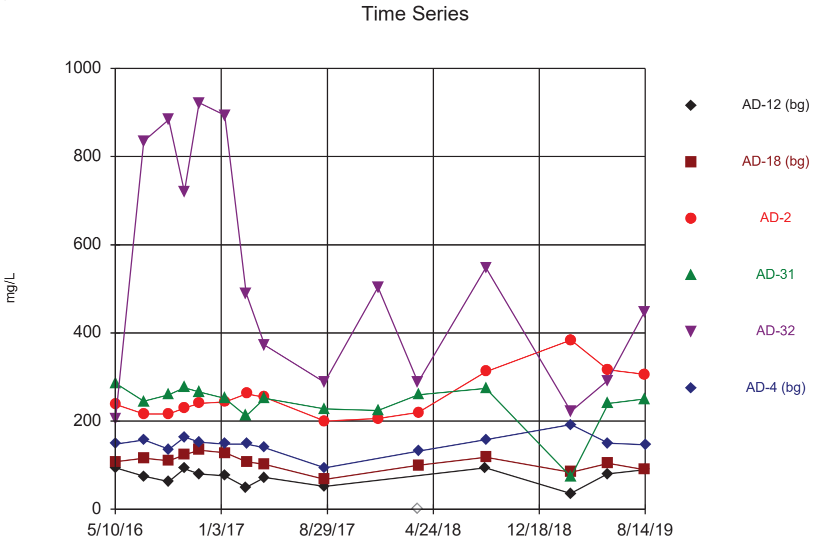
Sanitas™ v.9.6.23 . EPA
Hollow symbols indicate censored values.



Constituent: Total Dissolved Solids [TDS] Analysis Run 11/25/2019 11:33 AM View: All Data
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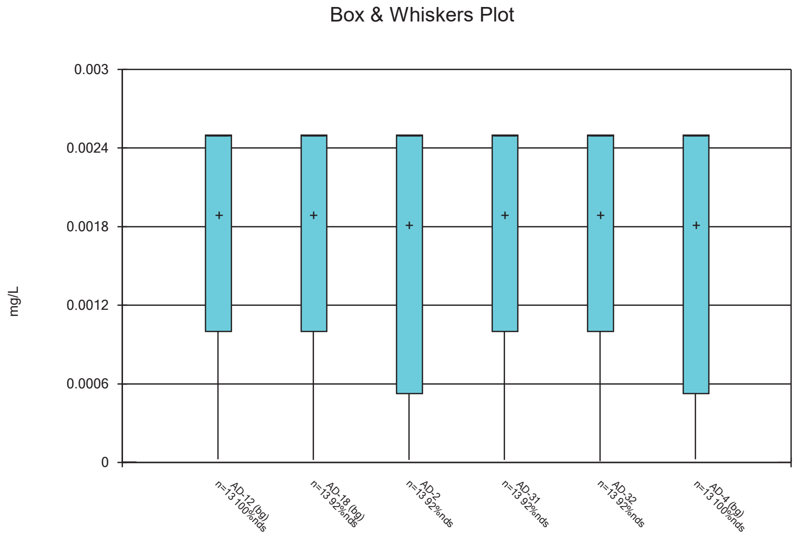
Sanitas™ v.9.6.23 . EPA



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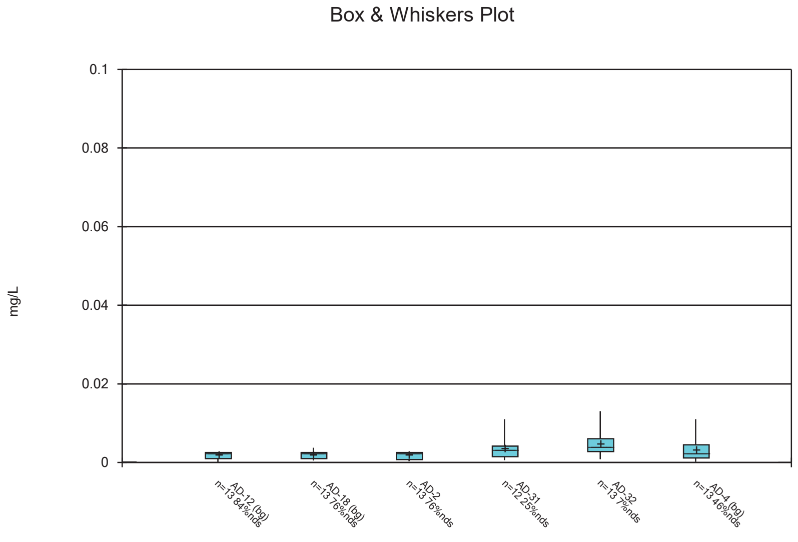
Sanitas™ v.9.6.23 . EPA



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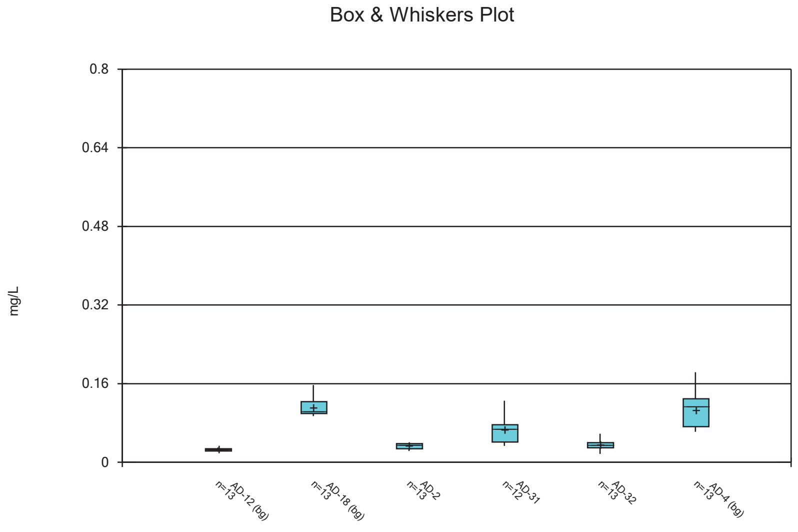
Sanitas™ v.9.6.23 . EPA



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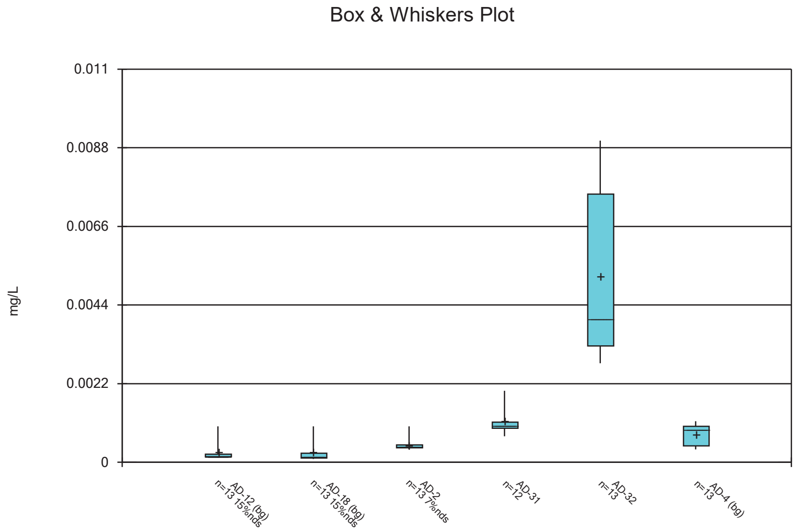

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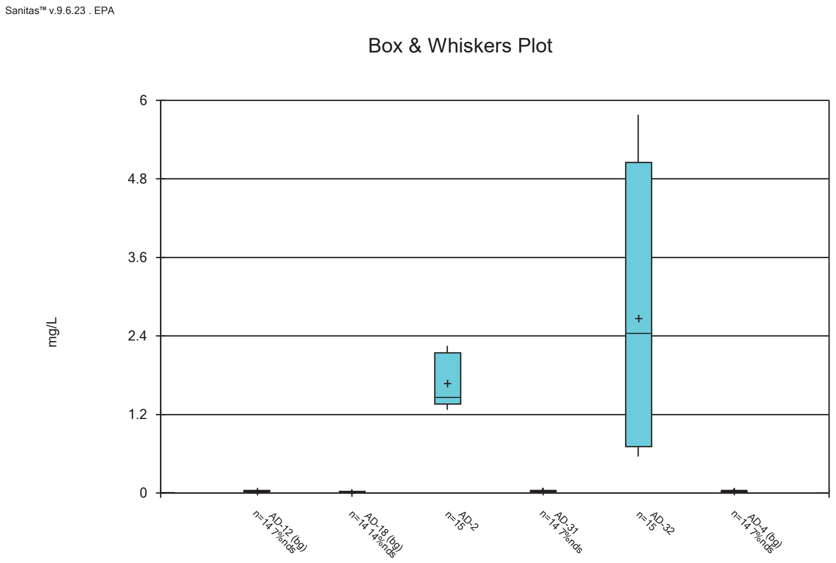

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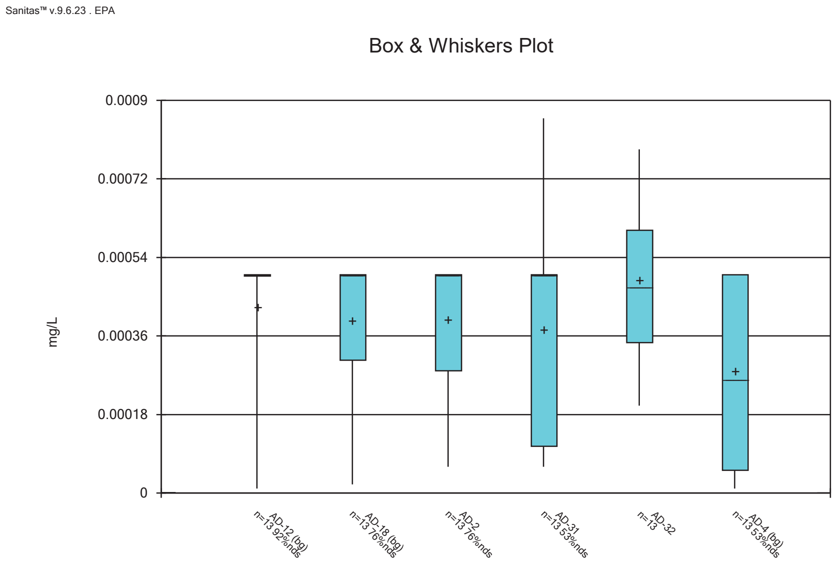

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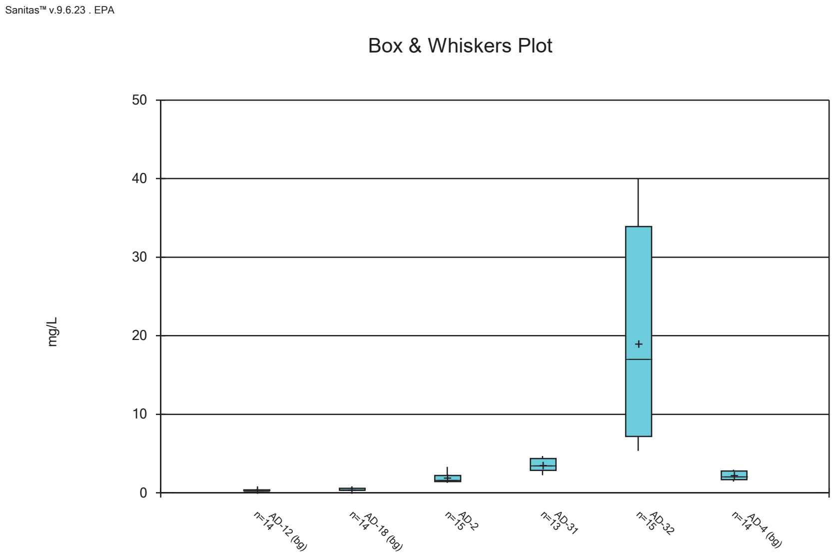

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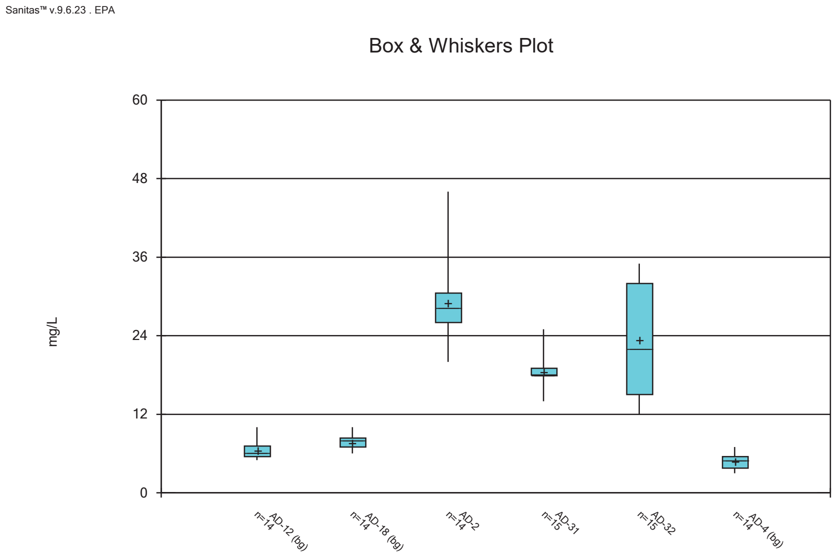

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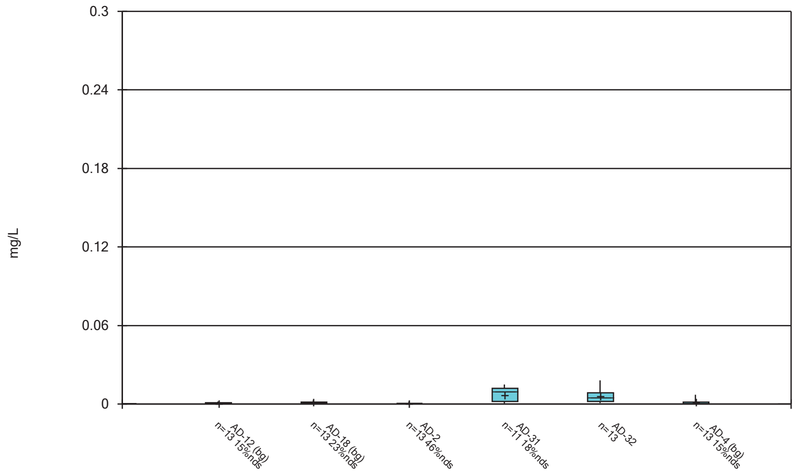
Sanitas™ v.9.6.23 . EPA

Box & Whiskers Plot



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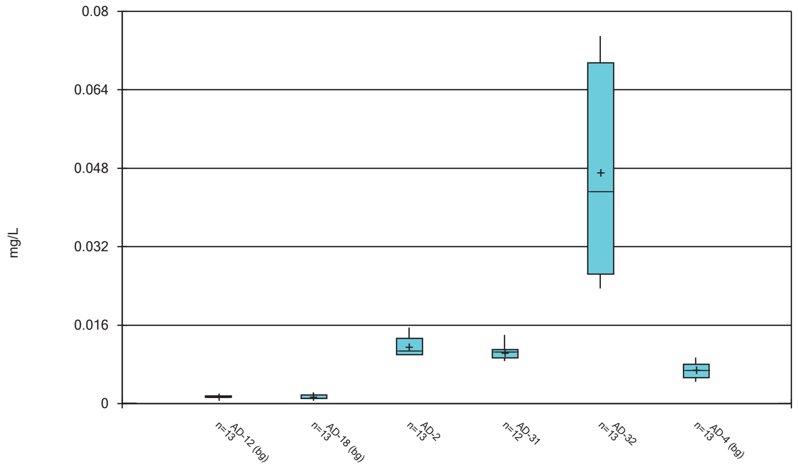
Box & Whiskers Plot

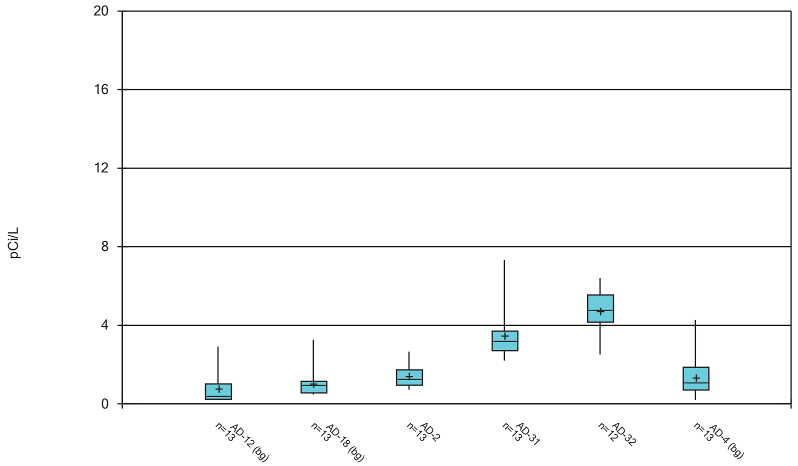


Constituent: Cobalt, total   Analysis Run 11/25/2019 11:37 AM   View: All Data

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Box & Whiskers Plot

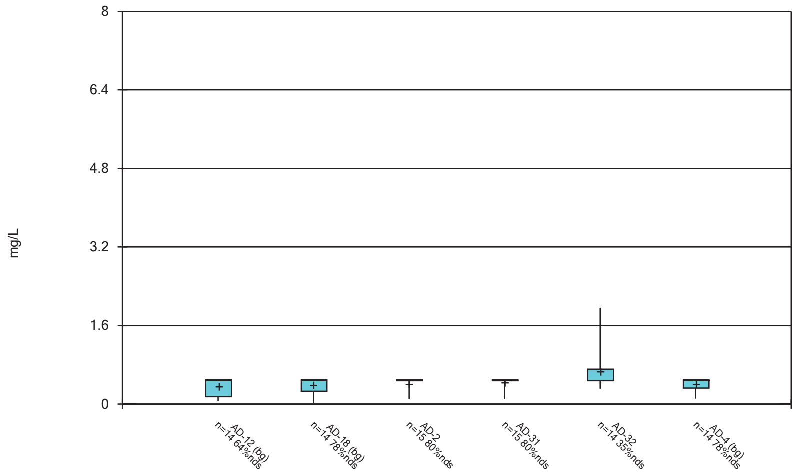


Constituent: Combined Radium 226 + 228   Analysis Run 11/25/2019 11:37 AM   View: All Data

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

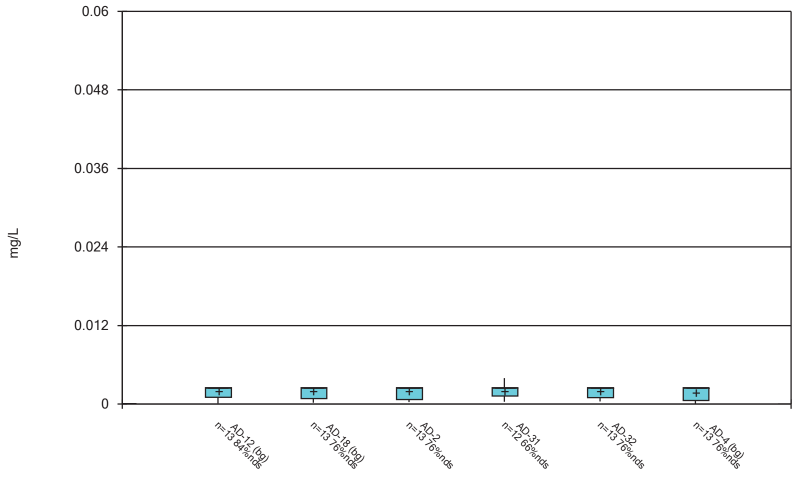
Sanitas™ v.9.6.23 . EPA

Box & Whiskers Plot



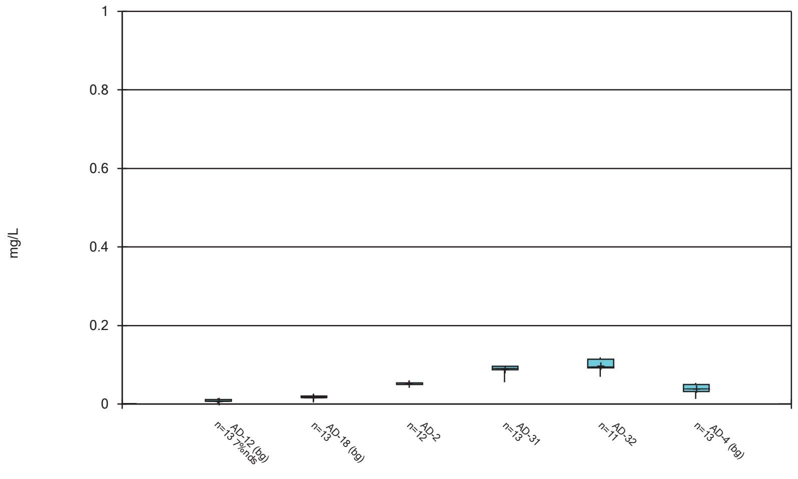
Constituent: Fluoride, total   Analysis Run 11/25/2019 11:37 AM   View: All Data

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP



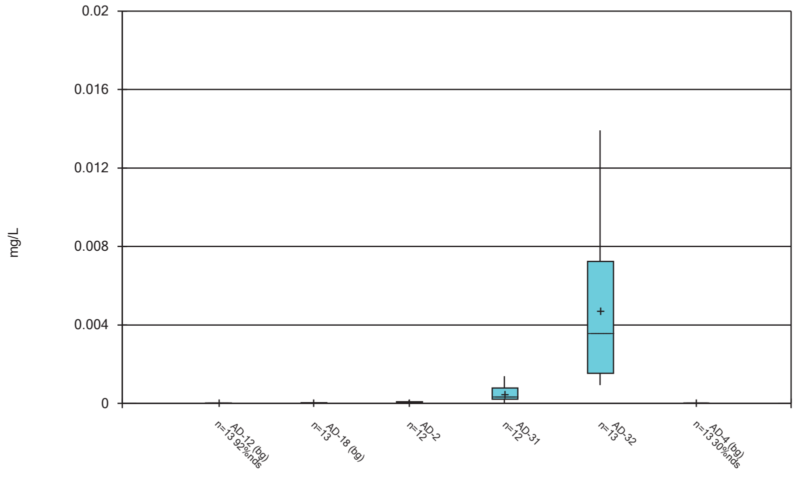
Box & Whiskers Plot

Constituent: Lead, total   Analysis Run 11/25/2019 11:37 AM   View: All Data
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP



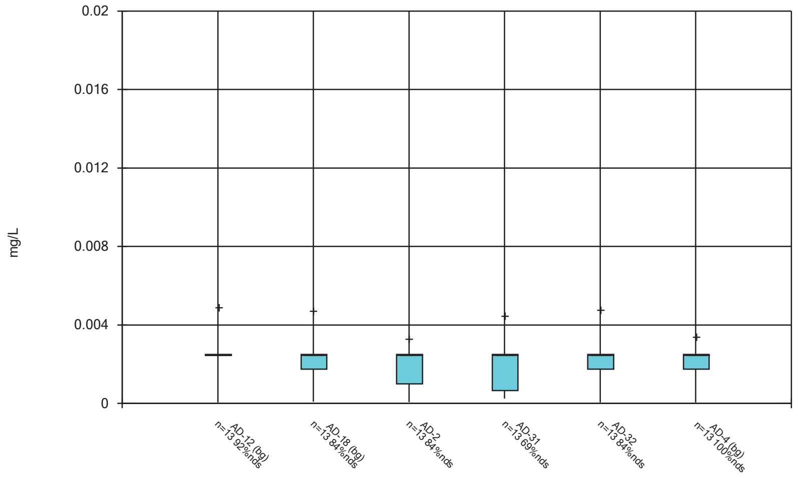
Box & Whiskers Plot

Constituent: Lithium, total   Analysis Run 11/25/2019 11:37 AM   View: All Data
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP



Box & Whiskers Plot

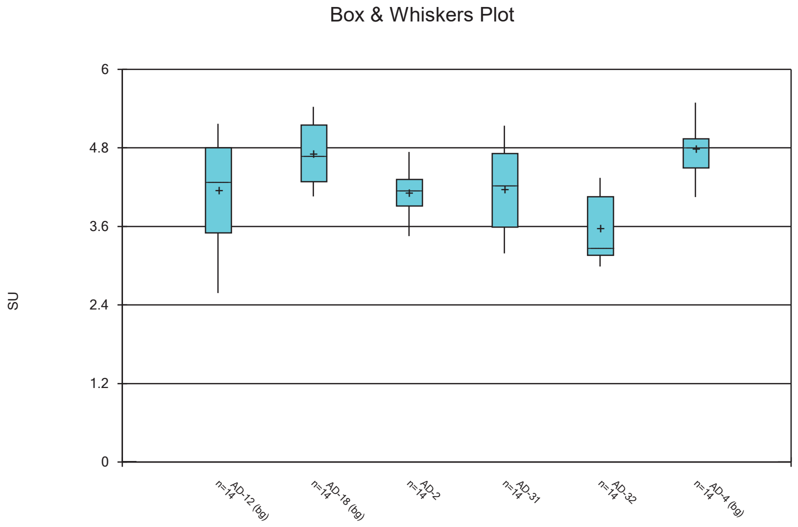
Constituent: Mercury, total   Analysis Run 11/25/2019 11:37 AM   View: All Data
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP



Box & Whiskers Plot

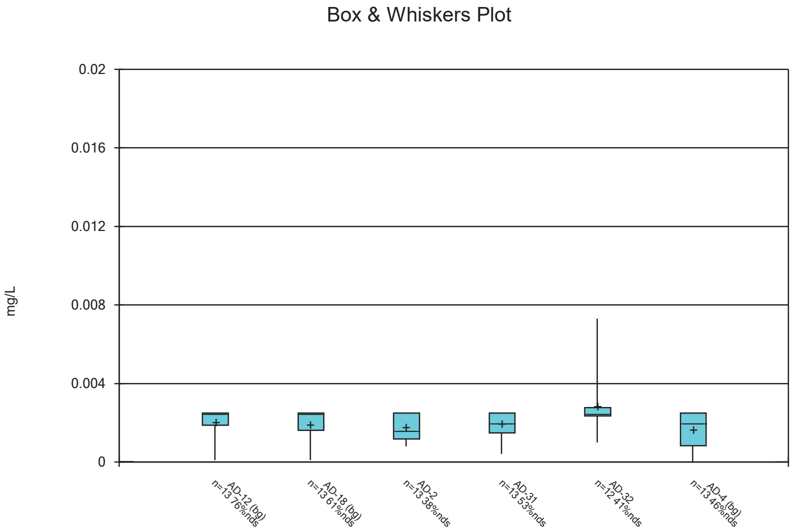
Constituent: Molybdenum, total   Analysis Run 11/25/2019 11:37 AM   View: All Data
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA



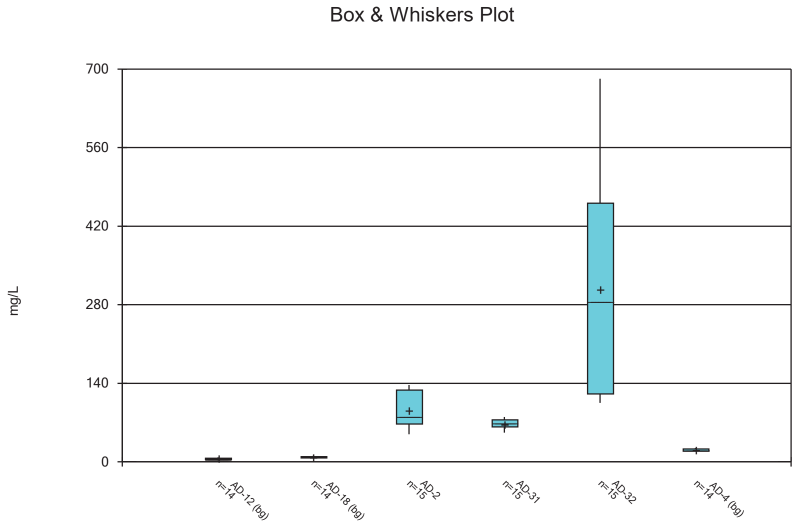
Constituent: pH, field   Analysis Run 11/25/2019 11:37 AM   View: All Data
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA



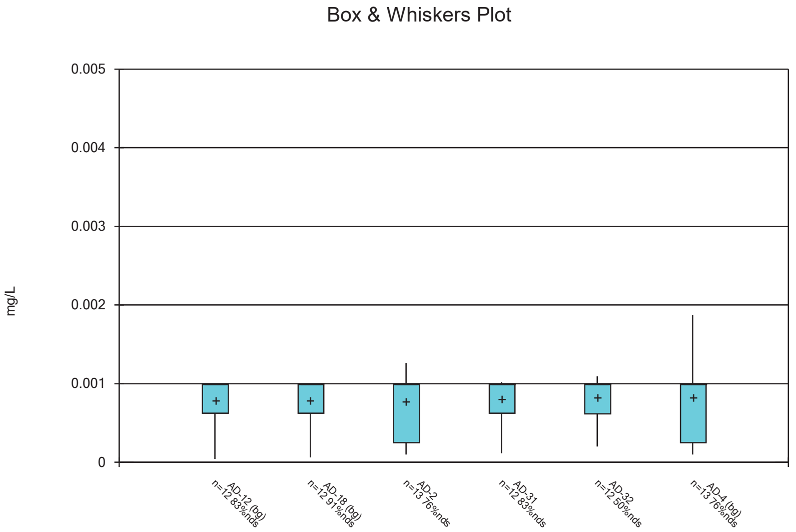
Constituent: Selenium, total   Analysis Run 11/25/2019 11:37 AM   View: All Data
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA



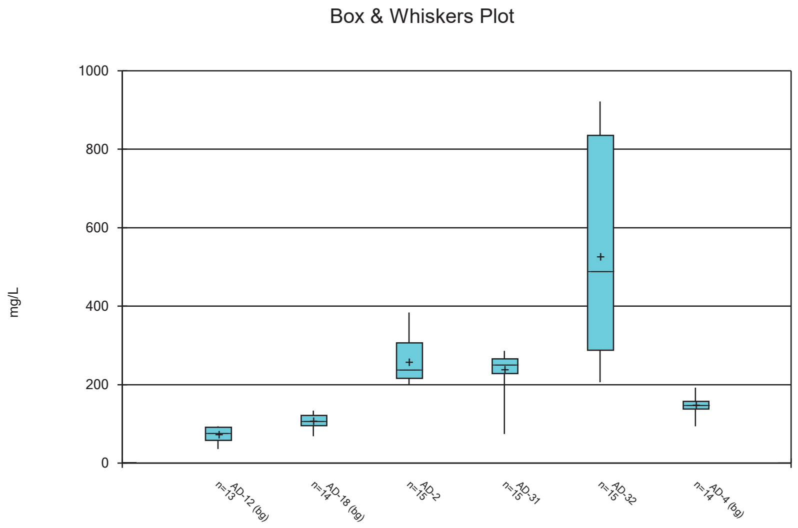
Constituent: Sulfate, total   Analysis Run 11/25/2019 11:37 AM   View: All Data
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA



Constituent: Thallium, total   Analysis Run 11/25/2019 11:37 AM   View: All Data
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA



Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/25/2019 11:37 AM   View: All Data

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Outlier Summary

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 11:50 AM

	AD-31 Arsenic, total (mg/L)	AD-31 Barium, total (mg/L)	AD-31 Beryllium, total (mg/L)	AD-31 Calcium, total (mg/L)	AD-2 Chloride, total (mg/L)	AD-31 Chromium, total (mg/L)	AD-31 Cobalt, total (mg/L)	AD-32 Combined Radium 226 + 228 (pCi/L)	AD-32 Fluoride, total (mg/L)	AD-31 Lead, total (mg/L)
5/11/2016	0.093 (o)	0.712 (o)	0.01 (o)	10.4 (o)		0.212 (o)	0.05 (o)			0.057 (o)
9/7/2016										
10/12/2016								17.32 (o)		
11/14/2016						0.03 (o)				
4/11/2017					50 (o)					
3/21/2018									7.2 (o)	
8/21/2018										
2/27/2019										
2/28/2019										

	AD-2 Lithium, total (mg/L)	AD-32 Lithium, total (mg/L)	AD-2 Mercury, total (mg/L)	AD-31 Mercury, total (mg/L)	AD-32 Selenium, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-18 Thallium, total (mg/L)	AD-31 Thallium, total (mg/L)	AD-32 Thallium, total (mg/L)	AD-12 Total Dissolved Solids [TDS] (mg/L)
5/11/2016	<0.001 (o)	0.016 (o)		0.001797 (o)						
9/7/2016			0.000675 (o)							
10/12/2016		0.972 (o)								
11/14/2016										
4/11/2017										
3/21/2018										<5 (o)
8/21/2018					0.015 (o)					
2/27/2019						<0.01 (o)				
2/28/2019							<0.01 (o)	<0.01 (o)	<0.01 (o)	

Interwell Outlier Analysis - All Results (No Significant)

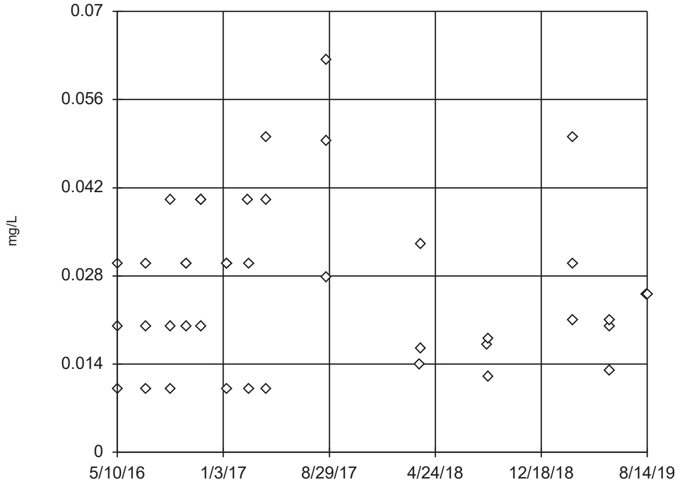
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 10:07 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Boron, total (mg/L)	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	42	0.02619	0.01281	x^(1/3)	ShapiroWilk
Calcium, total (mg/L)	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	42	0.9856	0.9174	ln(x)	ShapiroWilk
Chloride, total (mg/L)	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	42	6.291	1.698	sqrt(x)	ShapiroWilk
Fluoride, total (mg/L)	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	42	0.7652	0.4008	ln(x)	ShapiroWilk
Sulfate, total (mg/L)	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	42	11.18	7.187	ln(x)	ShapiroWilk
Total Dissolved Solids [TDS] (m...	AD-12,AD-...	No	n/a	n/a w/com...	NP	NaN	41	110.1	35.78	normal	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 42

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

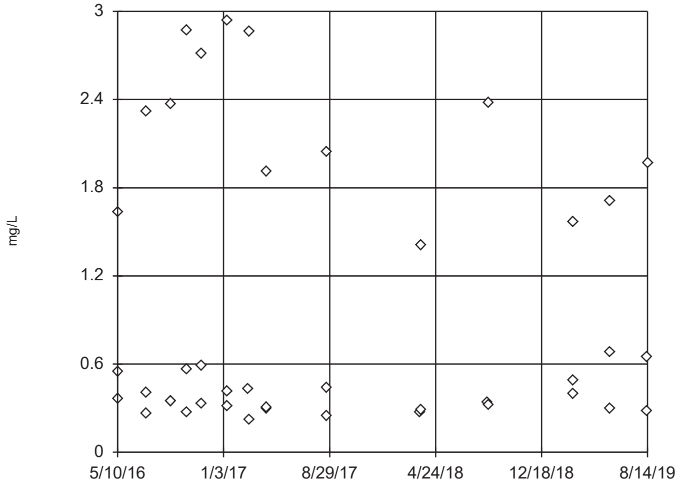
High cutoff = 0.1226, low cutoff = 0.0004167, based on IQR multiplier of 3.

Constituent: Boron, total   Analysis Run 11/25/2019 10:05 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 42

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

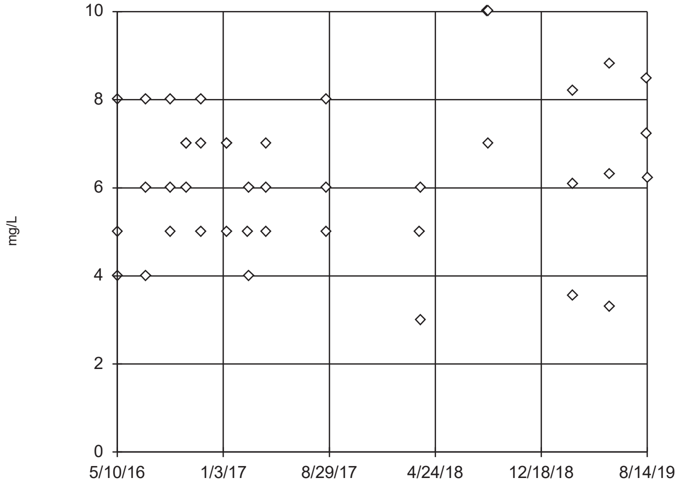
High cutoff = 360, low cutoff = 0.001554, based on IQR multiplier of 3.

Constituent: Calcium, total   Analysis Run 11/25/2019 10:05 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 42

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

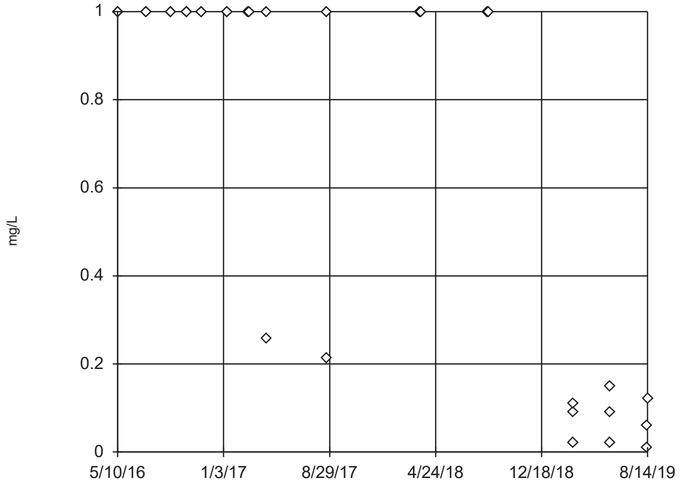
High cutoff = 18.75, low cutoff = 0.4429, based on IQR multiplier of 3.

Constituent: Chloride, total   Analysis Run 11/25/2019 10:05 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 42

No outliers found. Tukey's method selected by user.

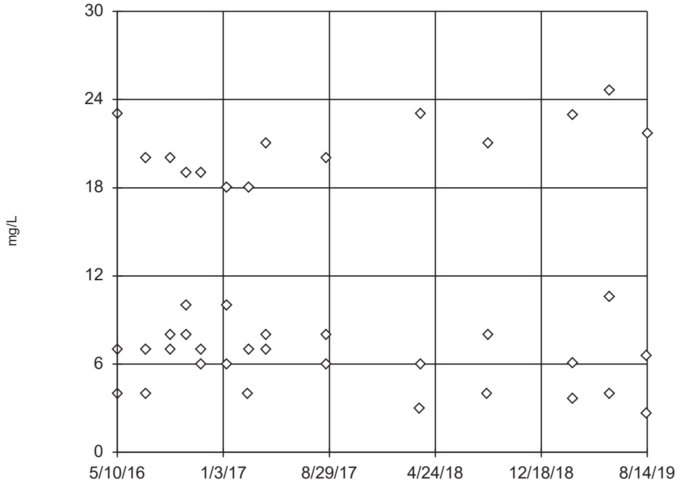
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 78.31, low cutoff = 0.002985, based on IQR multiplier of 3.

Constituent: Fluoride, total   Analysis Run 11/25/2019 10:06 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 42

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

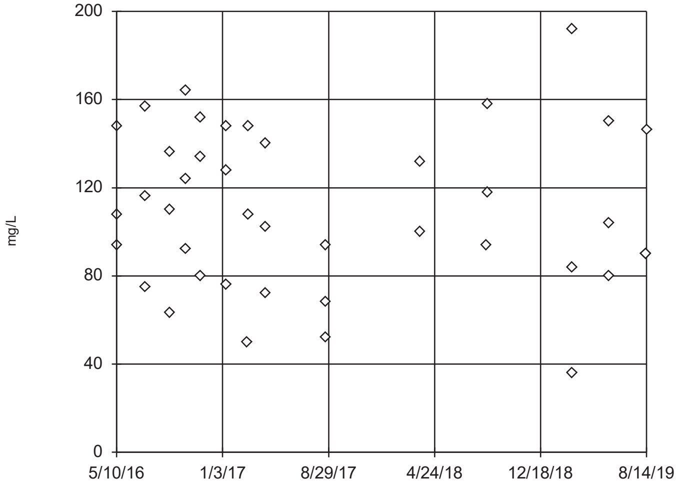
High cutoff = 668.5, low cutoff = 0.175, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/25/2019 10:06 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4



n = 41

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 326, low cutoff = -101, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/25/2019 10:06 AM View: Interwell AIII

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Intrawell Outlier Analysis - All Results (No Significant)

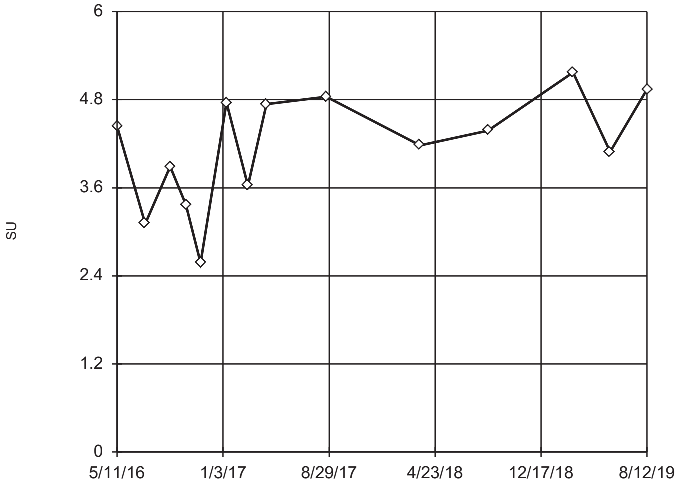
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 10:08 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
pH, field (SU)	AD-12 (bg)	No	n/a	n/a	NP	NaN	14	4.151	0.7593	x^3	ShapiroWilk
pH, field (SU)	AD-18 (bg)	No	n/a	n/a	NP	NaN	14	4.723	0.4418	x^2	ShapiroWilk
pH, field (SU)	AD-2	No	n/a	n/a	NP	NaN	14	4.107	0.3452	x^2	ShapiroWilk
pH, field (SU)	AD-31	No	n/a	n/a	NP	NaN	14	4.174	0.6174	x^(1/3)	ShapiroWilk
pH, field (SU)	AD-32	No	n/a	n/a	NP	NaN	14	3.566	0.4853	ln(x)	ShapiroWilk
pH, field (SU)	AD-4 (bg)	No	n/a	n/a	NP	NaN	14	4.786	0.3829	normal	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-12 (bg)



n = 14

No outliers found. Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

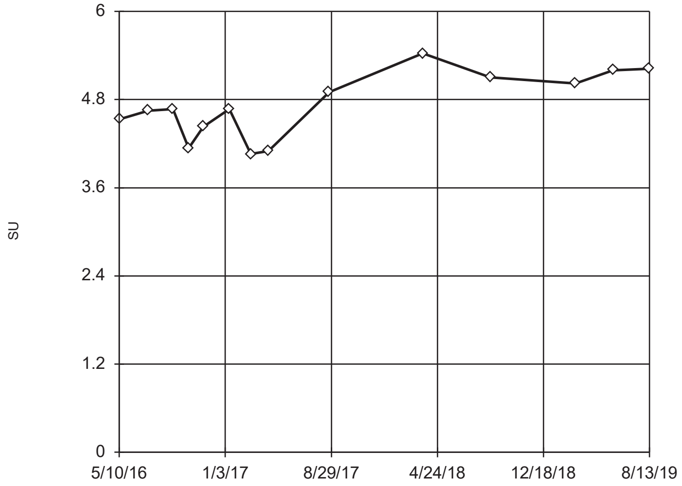
High cutoff = 6.792, low cutoff = -5.425, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-18 (bg)



n = 14

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

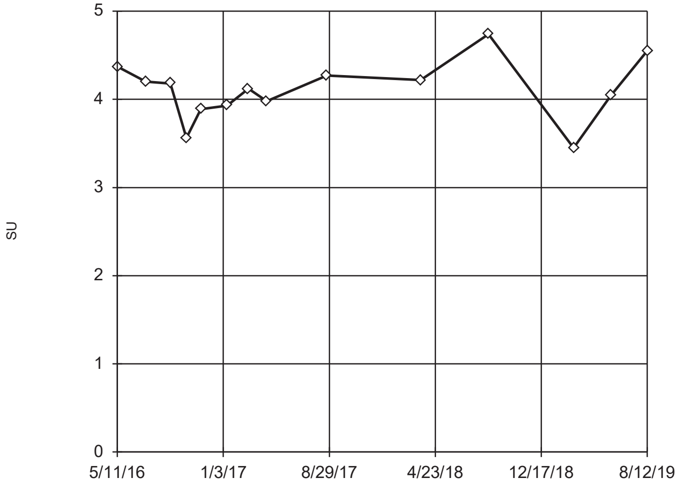
High cutoff = 7.138, low cutoff = -2.459, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 14

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

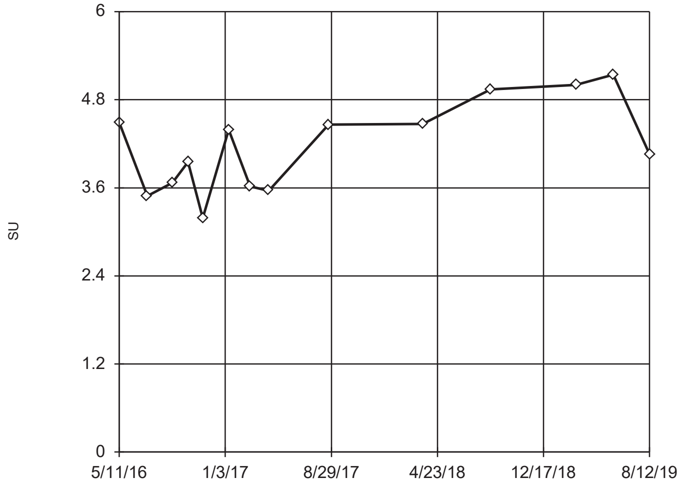
High cutoff = 5.366, low cutoff = 2.271, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 14

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

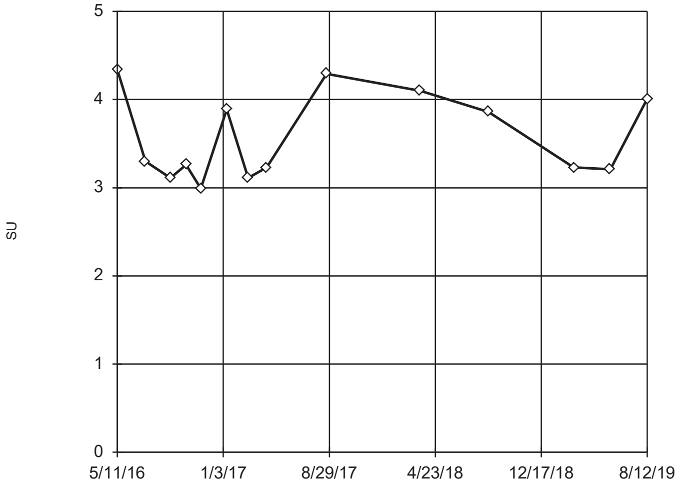
High cutoff = 9.423, low cutoff = 1.315, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 14

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 8.57, low cutoff = 1.495, based on IQR multiplier of 3.

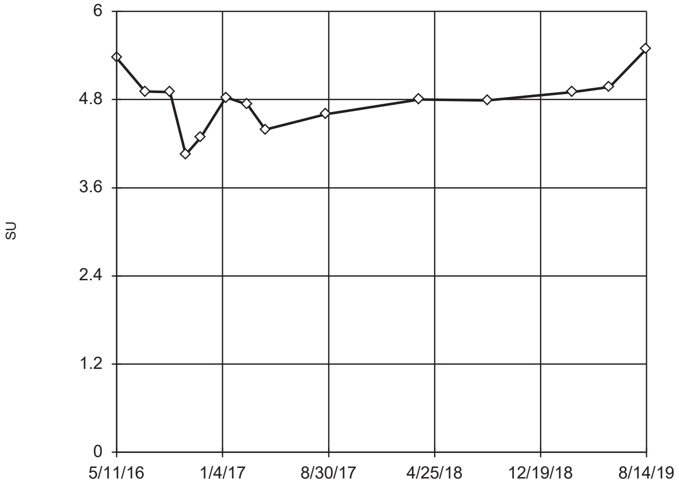
Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-4 (bg)



n = 14

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 6.275, low cutoff = 3.16, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/25/2019 10:08 AM View: Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Downgradient Appendix IV Outlier Analysis - Significant Results

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP   Printed 11/25/2019, 10:18 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Beryllium, total (mg/L)	**AD-2**	**Yes**	**0.001**	**5/22/2019**	**NP**	**NaN**	**13**	**0.000...**	**0.0001631**	**ln(x)**	**ShapiroWilk**
Beryllium, total (mg/L)	**AD-31**	**Yes**	**0.01**	**5/11/2016**	**NP**	**NaN**	**13**	**0.001824**	**0.002489**	**ln(x)**	**ShapiroWilk**
Fluoride, total (mg/L)	**AD-32**	**Yes**	**7.2**	**3/21/2018**	**NP**	**NaN**	**15**	**1.257**	**1.69**	**ln(x)**	**ShapiroWilk**
Molybdenum, total (mg/L)	**AD-32**	**Yes**	**0.00004,0...**	**8/21/2018...**	**NP**	**NaN**	**13**	**0.009446**	**0.01368**	**x^(1/3)**	**ShapiroWilk**

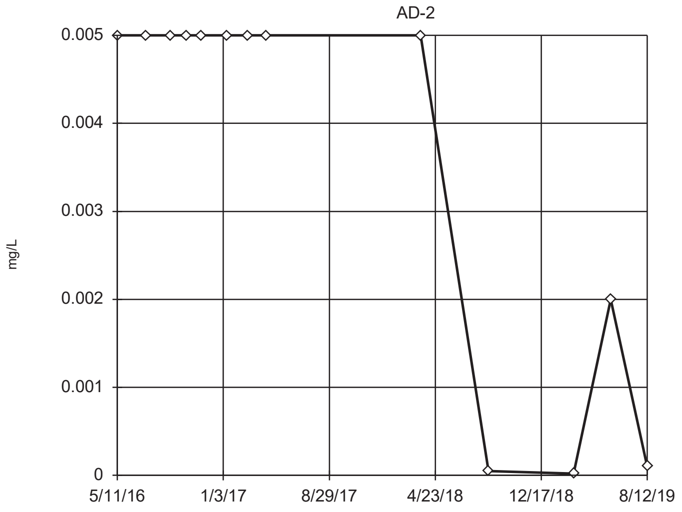
Downgradient Appendix IV Outlier Analysis - All Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 10:18 AM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.003628	0.002196	sqrt(x)	ShapiroWilk
Antimony, total (mg/L)	AD-31	n/a	n/a	n/a	NP	NaN	13	0.003778	0.001988	unknown	ShapiroWilk
Antimony, total (mg/L)	AD-32	n/a	n/a	n/a	NP	NaN	13	0.003778	0.001989	unknown	ShapiroWilk
Arsenic, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.003723	0.002031	x^(1/3)	ShapiroWilk
Arsenic, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.003897	0.002691	x^(1/3)	ShapiroWilk
Arsenic, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.005052	0.003274	x^(1/3)	ShapiroWilk
Barium, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.03352	0.0057	x^6	ShapiroWilk
Barium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.06554	0.02637	x^(1/3)	ShapiroWilk
Barium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.03612	0.01024	sqrt(x)	ShapiroWilk
Beryllium, total (mg/L)	**AD-2**	**Yes**	**0.001**	**5/22/2019**	**NP**	**NaN**	**13**	**0.000...**	**0.0001631**	**ln(x)**	**ShapiroWilk**
Beryllium, total (mg/L)	**AD-31**	**Yes**	**0.01**	**5/11/2016**	**NP**	**NaN**	**13**	**0.001824**	**0.002489**	**ln(x)**	**ShapiroWilk**
Beryllium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.005202	0.002256	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.000...	0.0004122	sqrt(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	13	0.000...	0.0004484	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.000...	0.0001743	normal	ShapiroWilk
Chromium, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.000...	0.0009898	ln(x)	ShapiroWilk
Chromium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.009698	0.008089	x^(1/3)	ShapiroWilk
Chromium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.006133	0.005302	x^(1/3)	ShapiroWilk
Cobalt, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.01165	0.001847	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.01048	0.001419	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.04704	0.02056	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-2	No	n/a	n/a	NP	NaN	13	1.398	0.5579	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-31	No	n/a	n/a	NP	NaN	13	3.454	1.289	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	AD-32	No	n/a	n/a	NP	NaN	12	4.735	1.074	x^2	ShapiroWilk
Fluoride, total (mg/L)	AD-2	n/a	n/a	n/a	NP	NaN	15	0.82	0.3726	unknown	ShapiroWilk
Fluoride, total (mg/L)	AD-31	n/a	n/a	n/a	NP	NaN	15	0.826	0.3604	unknown	ShapiroWilk
Fluoride, total (mg/L)	**AD-32**	**Yes**	**7.2**	**3/21/2018**	**NP**	**NaN**	**15**	**1.257**	**1.69**	**ln(x)**	**ShapiroWilk**
Lead, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.003691	0.002086	sqrt(x)	ShapiroWilk
Lead, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.003434	0.00182	sqrt(x)	ShapiroWilk
Lead, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.003778	0.001939	ln(x)	ShapiroWilk
Lithium, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.04812	0.01467	x^6	ShapiroWilk
Lithium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	13	0.0892	0.01162	x^6	ShapiroWilk
Lithium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	12	0.09291	0.02791	x^4	ShapiroWilk
Mercury, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.000...	0.0001745	ln(x)	ShapiroWilk
Mercury, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	12	0.000...	0.0004424	x^(1/3)	ShapiroWilk
Mercury, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.004692	0.003739	ln(x)	ShapiroWilk
Molybdenum, total (mg/L)	AD-2	n/a	n/a	n/a	NP	NaN	13	0.006533	0.01022	unknown	ShapiroWilk
Molybdenum, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	13	0.008758	0.01402	ln(x)	ShapiroWilk
Molybdenum, total (mg/L)	**AD-32**	**Yes**	**0.00004,0...**	**8/21/2018...**	**NP**	**NaN**	**13**	**0.009446**	**0.01368**	**x^(1/3)**	**ShapiroWilk**
Selenium, total (mg/L)	AD-2	No	n/a	n/a	NP	NaN	13	0.002739	0.001887	ln(x)	ShapiroWilk
Selenium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	13	0.003221	0.001784	sqrt(x)	ShapiroWilk
Selenium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	12	0.003903	0.001797	sqrt(x)	ShapiroWilk
Thallium, total (mg/L)	AD-2	n/a	n/a	n/a	NP	NaN	13	0.00142	0.0008116	unknown	ShapiroWilk
Thallium, total (mg/L)	AD-31	No	n/a	n/a	NP	NaN	13	0.002164	0.002461	ln(x)	ShapiroWilk
Thallium, total (mg/L)	AD-32	No	n/a	n/a	NP	NaN	13	0.001985	0.002521	ln(x)	ShapiroWilk

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening



n = 13

No outliers found. Tukey's method selected by user.

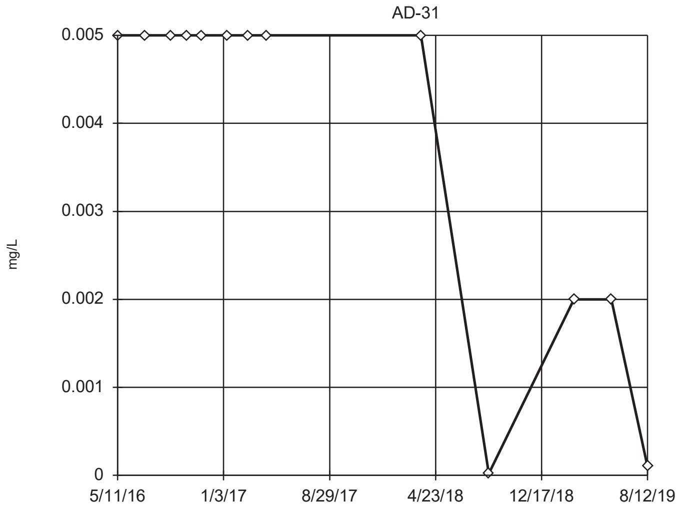
Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0403, low cutoff = -0.01055, based on IQR multiplier of 3.

Constituent: Antimony, total   Analysis Run 11/25/2019 10:13 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening



n = 13

No outliers found. Tukey's method selected by user.

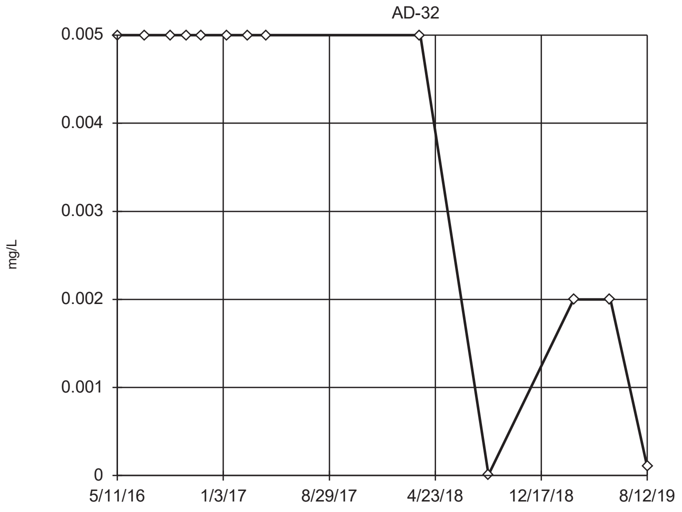
Ladder of Powers transformations did not improve normality; analysis run on raw data.

The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Antimony, total   Analysis Run 11/25/2019 10:13 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening



n = 13

No outliers found. Tukey's method selected by user.

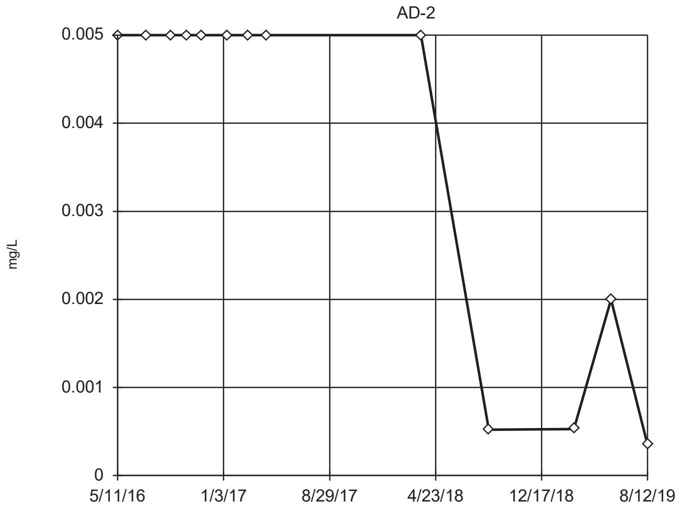
Ladder of Powers transformations did not improve normality; analysis run on raw data.

The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Antimony, total   Analysis Run 11/25/2019 10:13 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

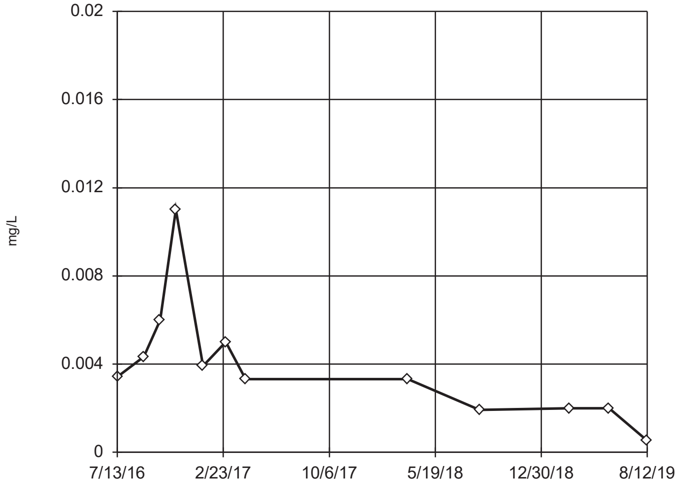
High cutoff = 0.05215, low cutoff = -0.0009749, based on IQR multiplier of 3.

Constituent: Arsenic, total   Analysis Run 11/25/2019 10:13 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

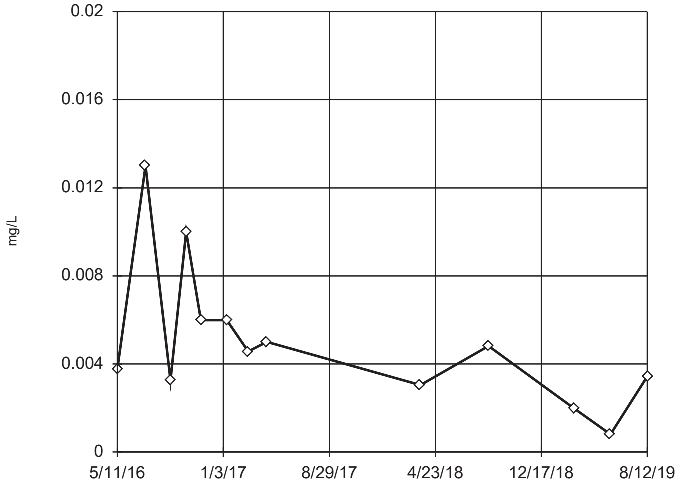
High cutoff = 0.02445, low cutoff = 2.2e-8, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

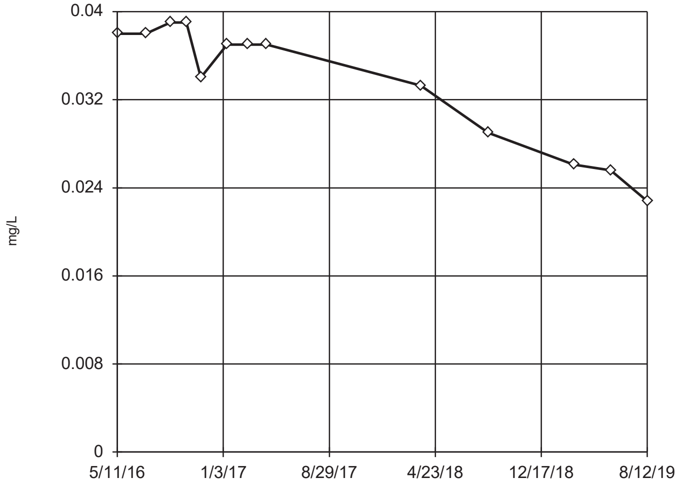
High cutoff = 0.02362, low cutoff = 0.00007109, based on IQR multiplier of 3.

Constituent: Arsenic, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

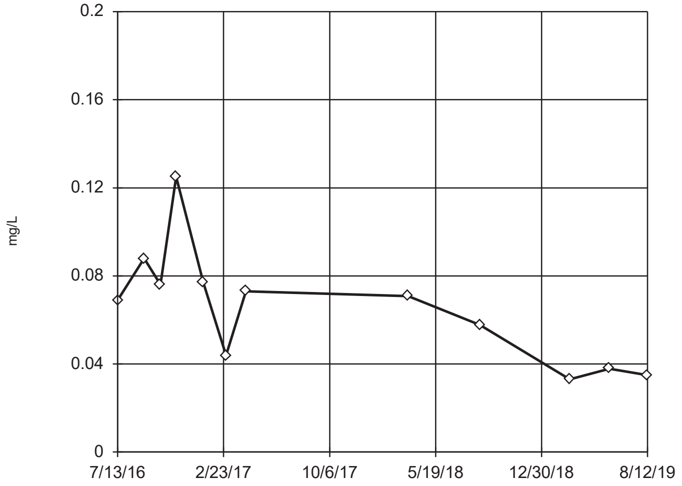
High cutoff = 0.04693, low cutoff = -0.04395, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

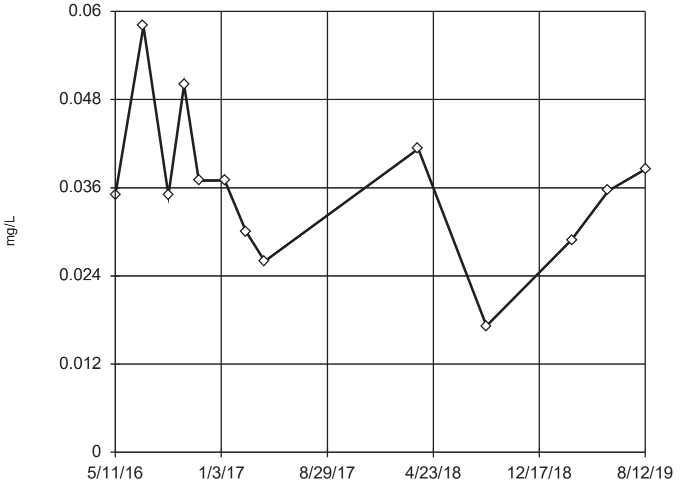
High cutoff = 0.2936, low cutoff = 0.001136, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

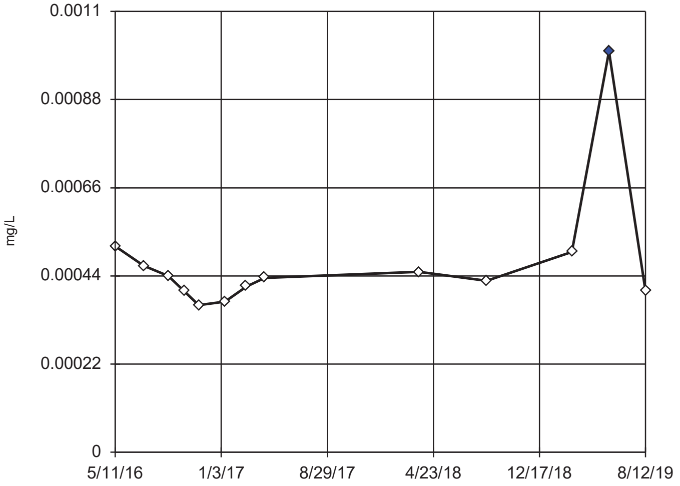
High cutoff = 0.0807, low cutoff = 0.007613, based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

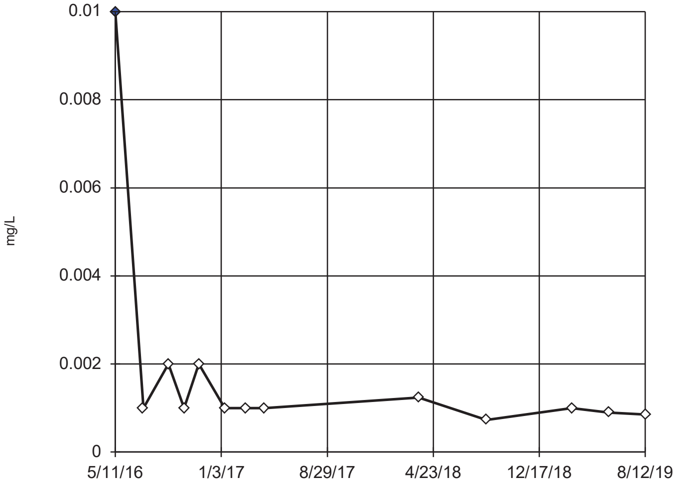
High cutoff = 0.0008336, low cutoff = 0.0002325, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 13

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

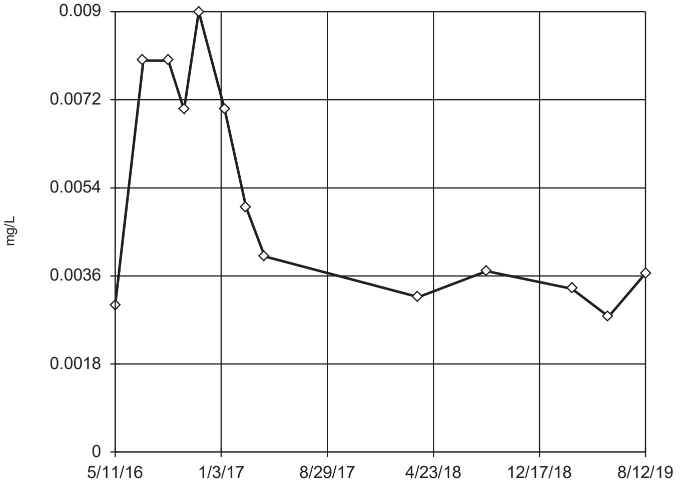
High cutoff = 0.007222, low cutoff = 0.0002067, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

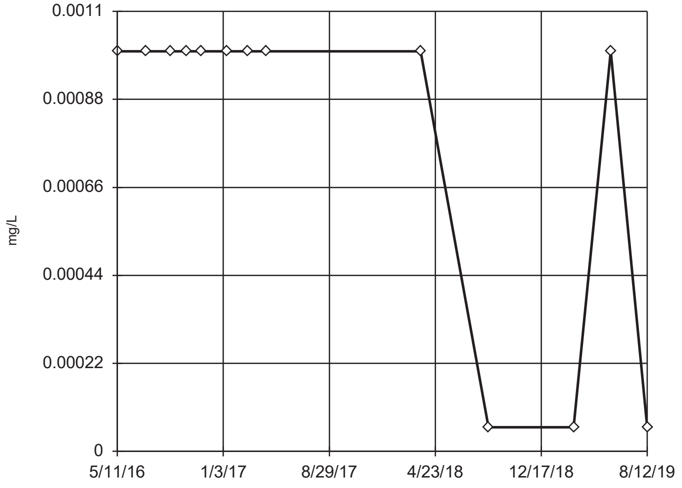
High cutoff = 0.09103, low cutoff = 0.0002675, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

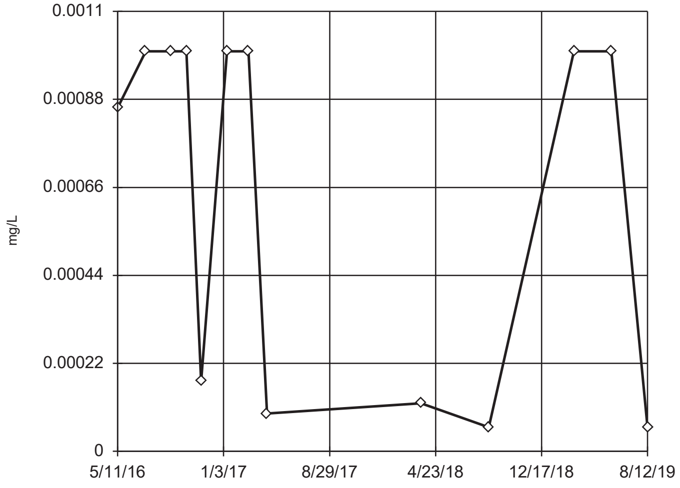
High cutoff = 0.004548, low cutoff = -0.0002602, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/25/2019 10:13 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

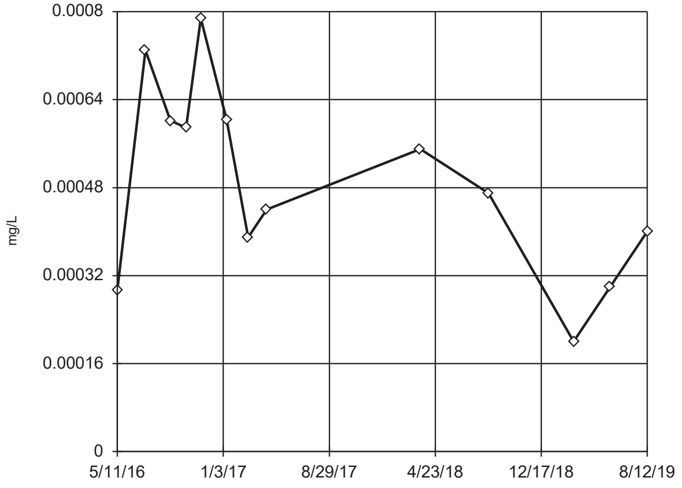
High cutoff = 0.8294, low cutoff = 1.3e-7, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/25/2019 10:13 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

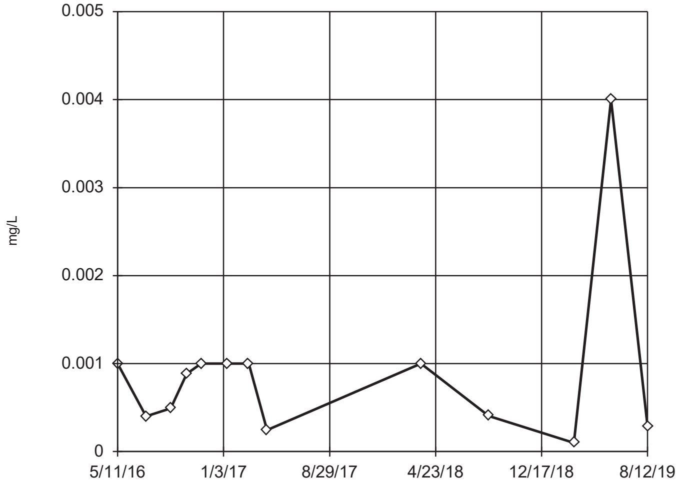
High cutoff = 0.001373, low cutoff = -0.0004266, based on IQR multiplier of 3.

Constituent: Cadmium, total   Analysis Run 11/25/2019 10:13 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

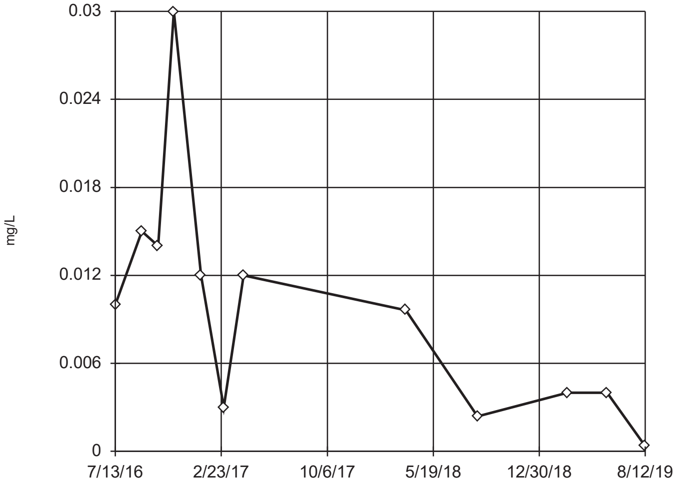
High cutoff = 0.02487, low cutoff = 0.00001377, based on IQR multiplier of 3.

Constituent: Chromium, total   Analysis Run 11/25/2019 10:13 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

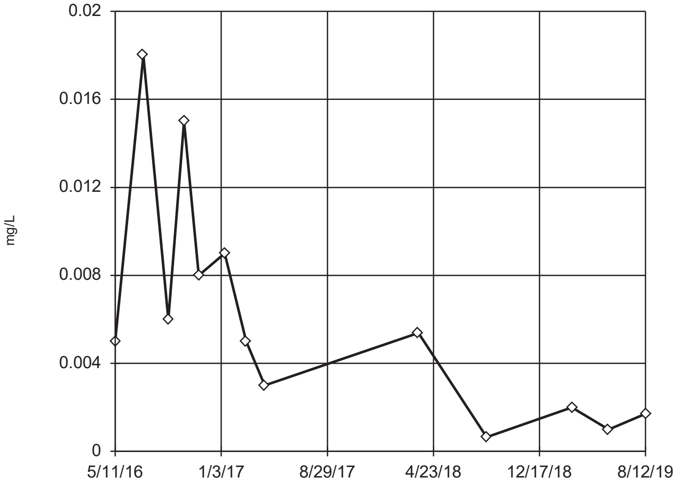
High cutoff = 0.1144, low cutoff = -0.0009705, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

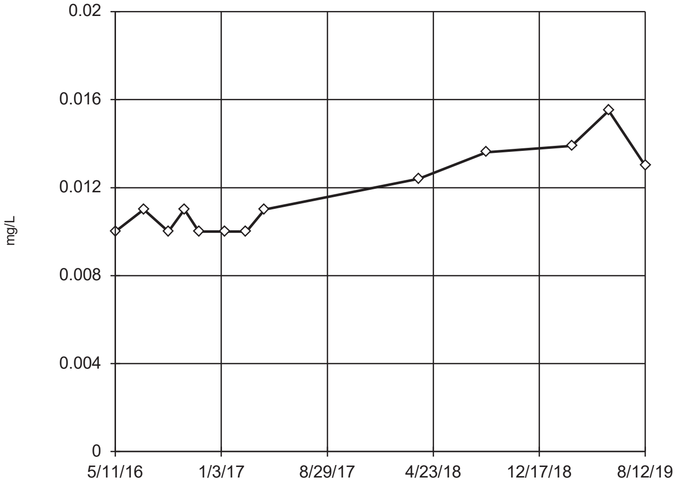
High cutoff = 0.08992, low cutoff = -0.001786, based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

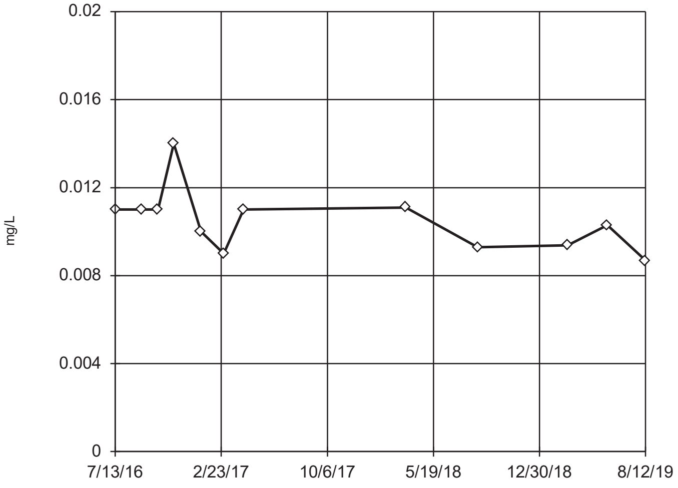
High cutoff = 0.03126, low cutoff = 0.004254, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

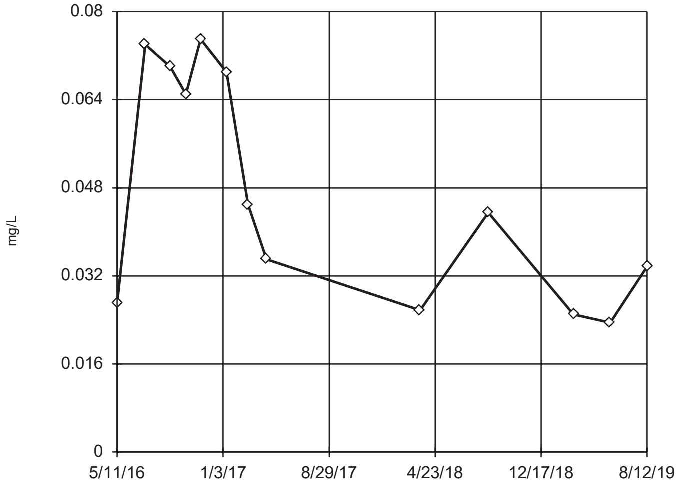
High cutoff = 0.018, low cutoff = 0.005705, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

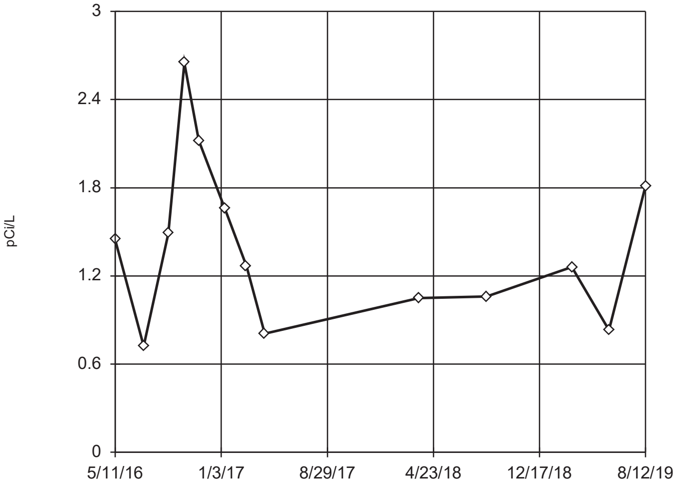
High cutoff = 1.269, low cutoff = 0.001446, based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

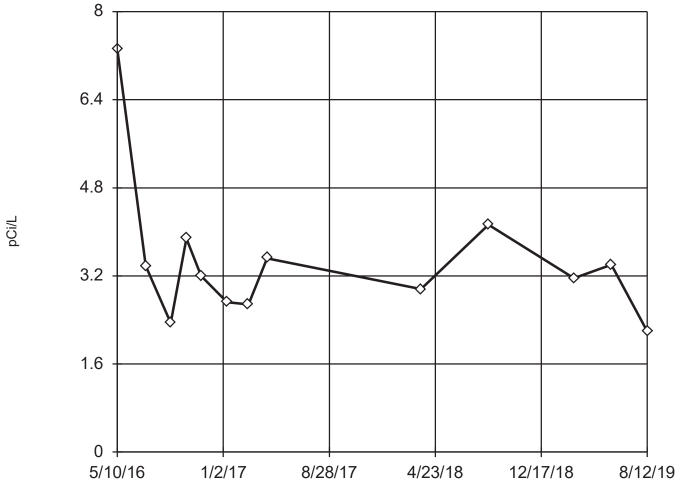
High cutoff = 11.03, low cutoff = 0.1468, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

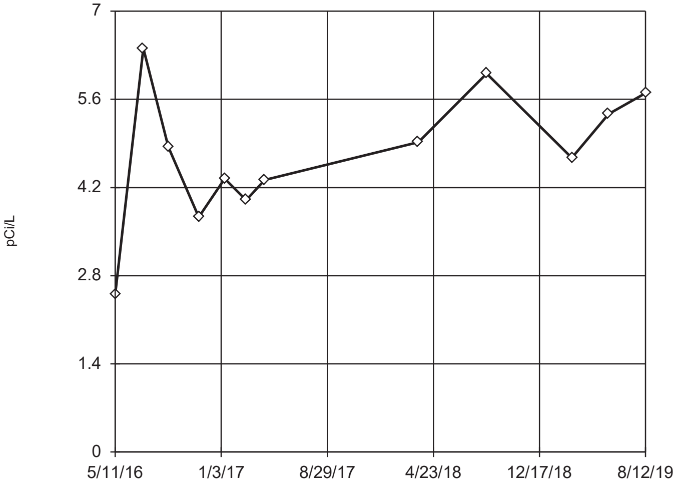
High cutoff = 9.436, low cutoff = 1.059, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 12

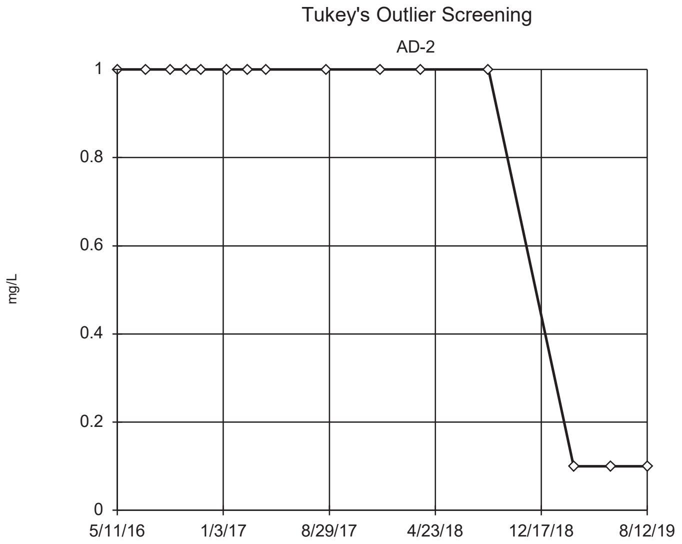
No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 8.405, low cutoff = -4.759, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 15

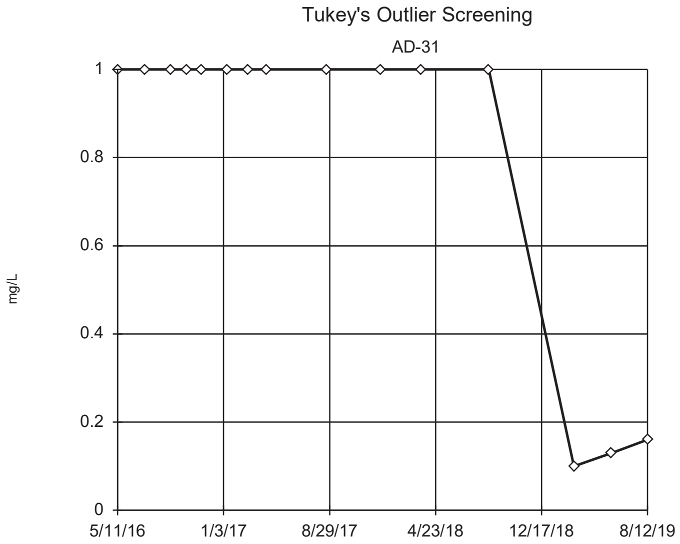
No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Fluoride, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 15

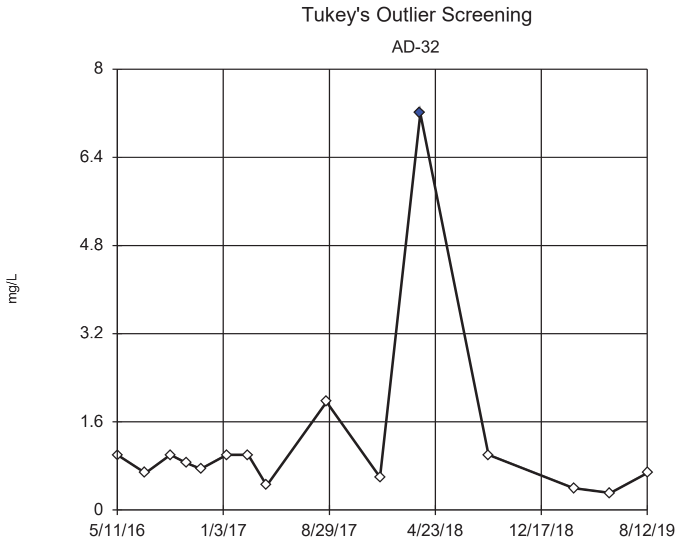
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Fluoride, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 15

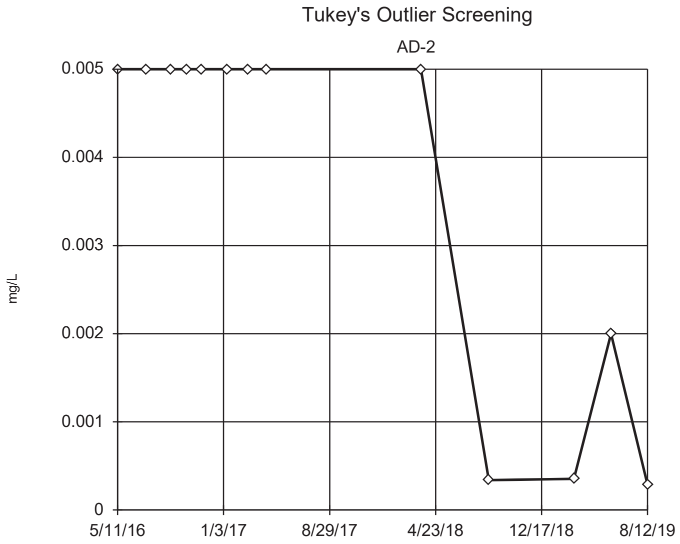
Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 4.791, low cutoff = 0.1238, based on IQR multiplier of 3.

Constituent: Fluoride, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

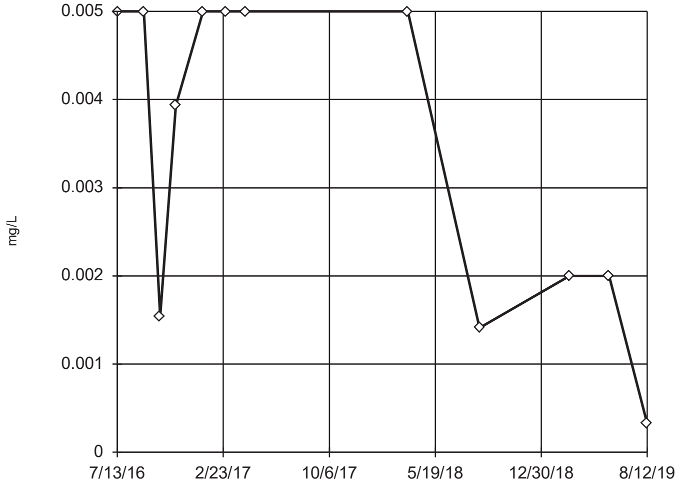
High cutoff = 0.03516, low cutoff = -0.007226, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

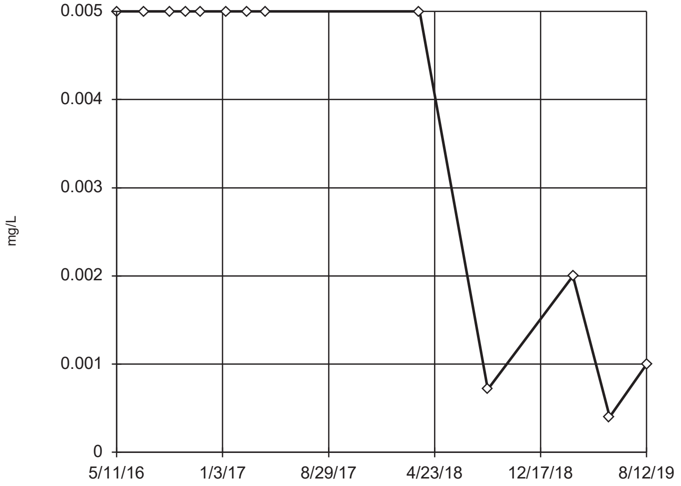
High cutoff = 0.02462, low cutoff = -0.001953, based on IQR multiplier of 3.

Constituent: Lead, total   Analysis Run 11/25/2019 10:13 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

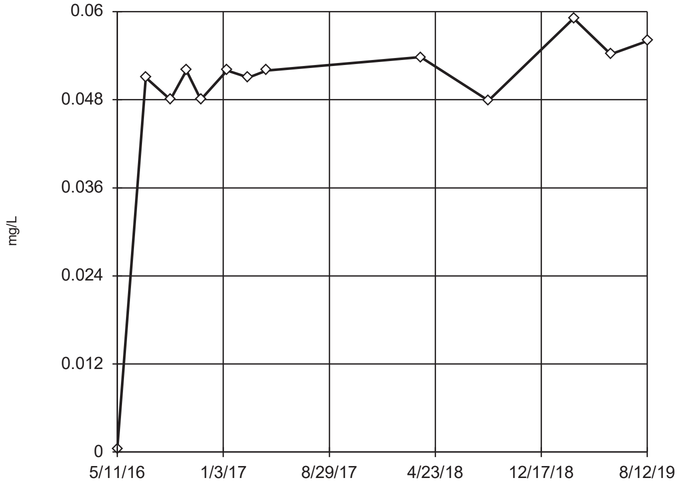
High cutoff = 0.2223, low cutoff = 0.00003174, based on IQR multiplier of 3.

Constituent: Lead, total   Analysis Run 11/25/2019 10:13 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

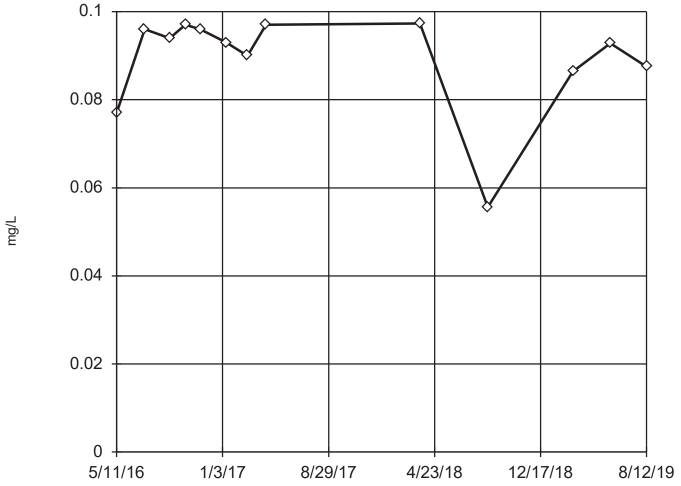
High cutoff = 0.063, low cutoff = -0.05425, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 11/25/2019 10:14 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 13

No outliers found. Tukey's method selected by user.

Data were x^6 transformed to achieve best W statistic (graph shown in original units).

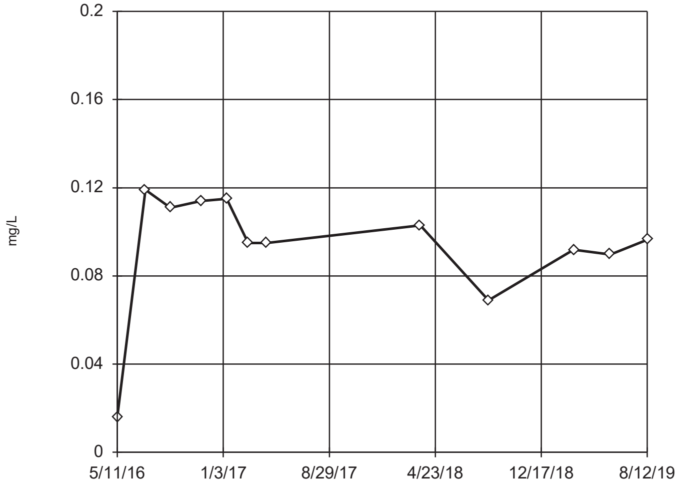
High cutoff = 0.1116, low cutoff = -0.09409, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 11/25/2019 10:14 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 12

No outliers found. Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

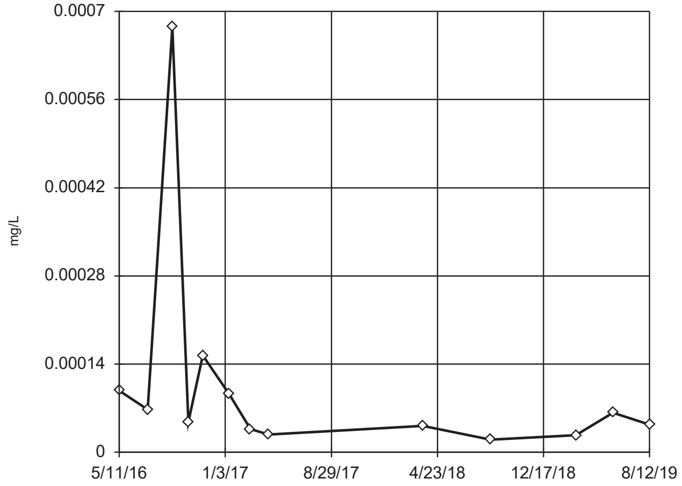
High cutoff = 0.1446, low cutoff = -0.1202, based on IQR multiplier of 3.

Constituent: Lithium, total   Analysis Run 11/25/2019 10:14 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-2



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

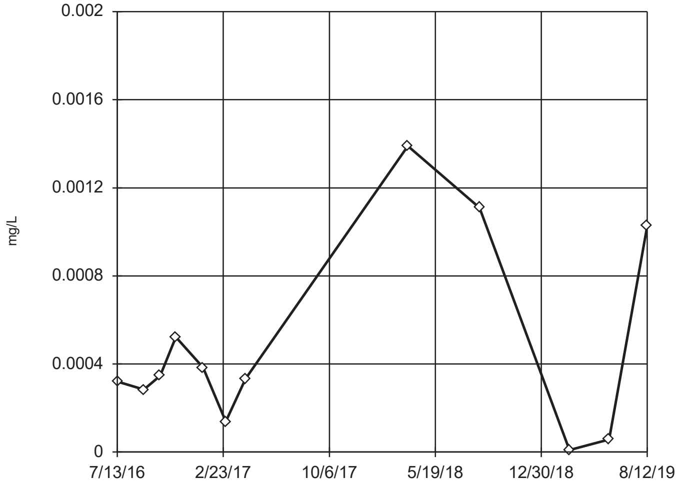
High cutoff = 0.002491, low cutoff = 0.000001234, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 11/25/2019 10:14 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-31



n = 12

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

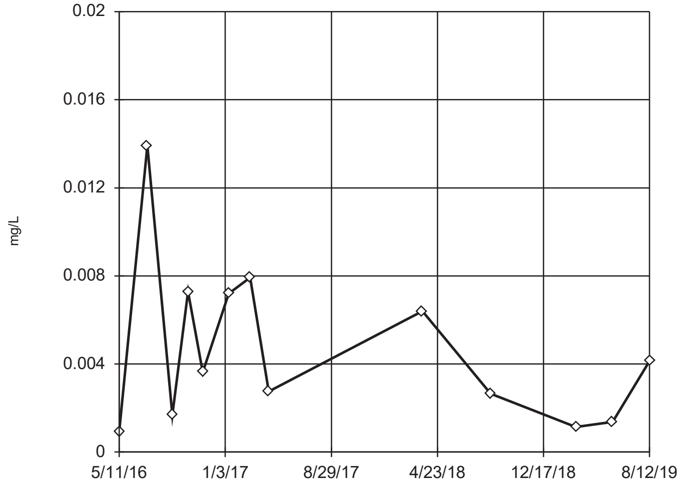
High cutoff = 0.006519, low cutoff = -0.00005221, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 11/25/2019 10:14 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

AD-32



n = 13

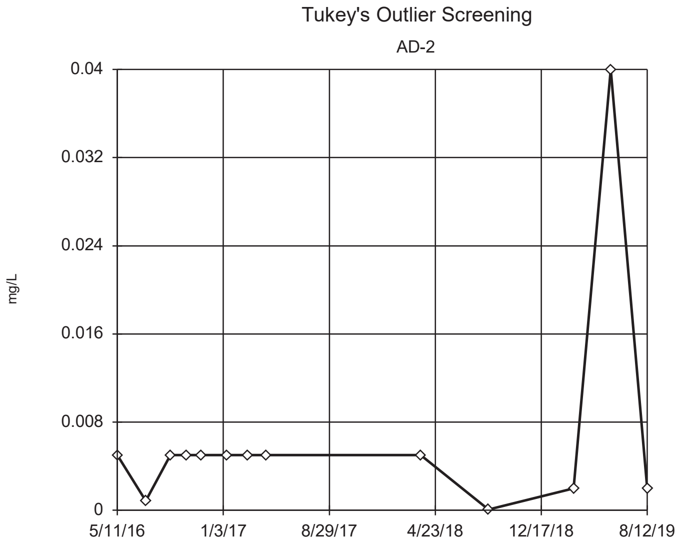
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.7875, low cutoff = 0.00001396, based on IQR multiplier of 3.

Constituent: Mercury, total   Analysis Run 11/25/2019 10:14 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 13

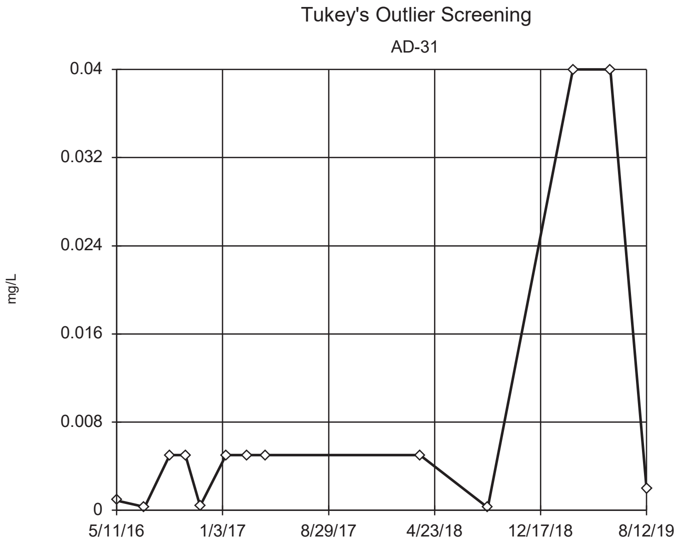
No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Molybdenum, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 13

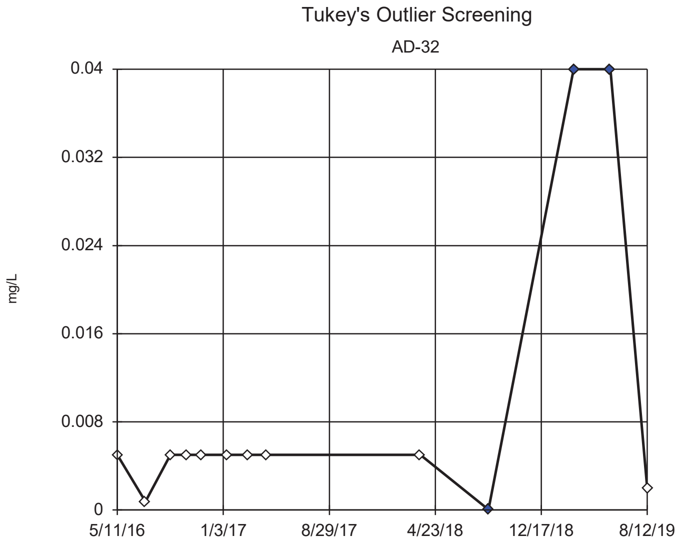
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.906, low cutoff = 0.000001031, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 13

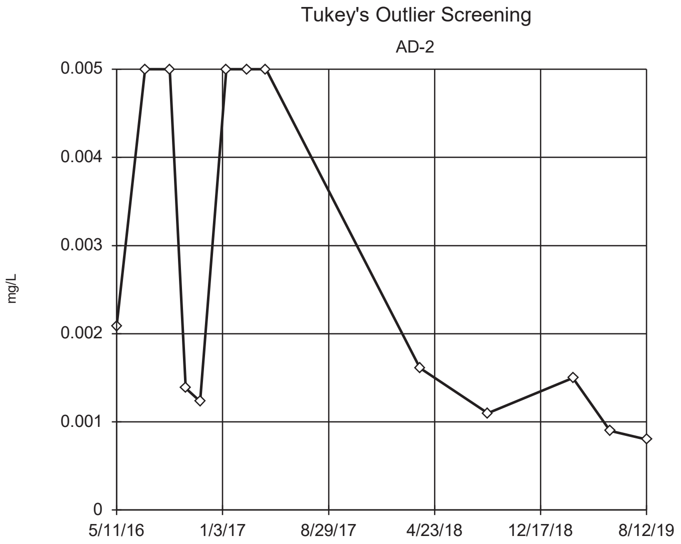
Outliers are drawn as solid. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.01357, low cutoff = 0.0005312, based on IQR multiplier of 3.

Constituent: Molybdenum, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 13

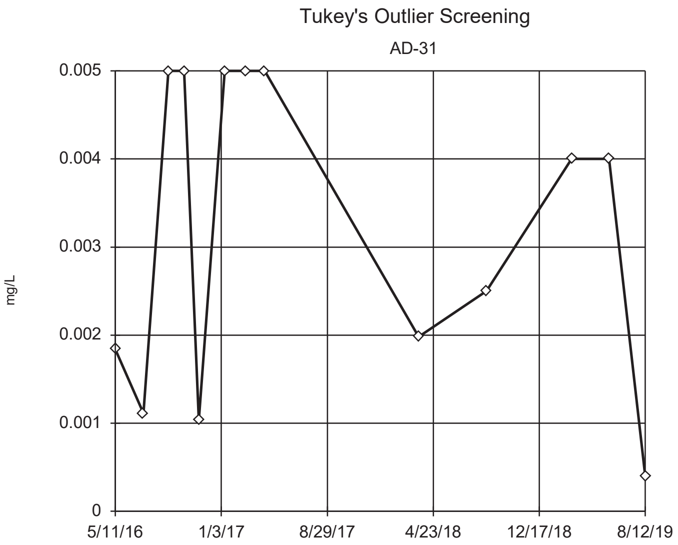
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.3964, low cutoff = 0.00001468, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 13

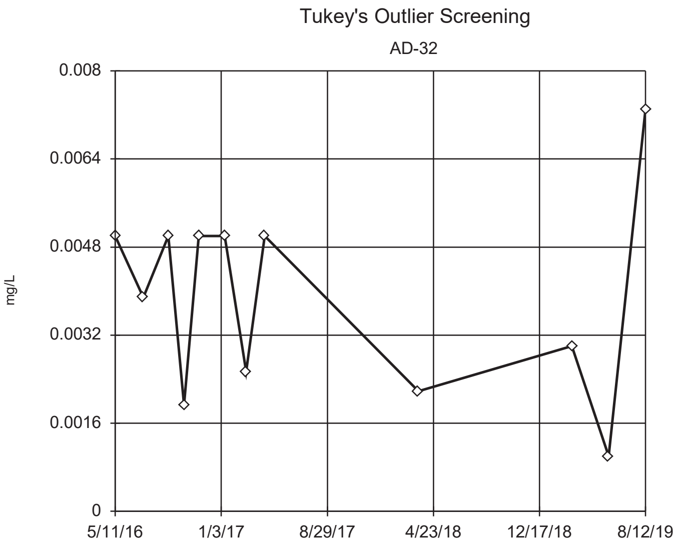
No outliers found.
Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.02838, low cutoff = -0.003553, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 12

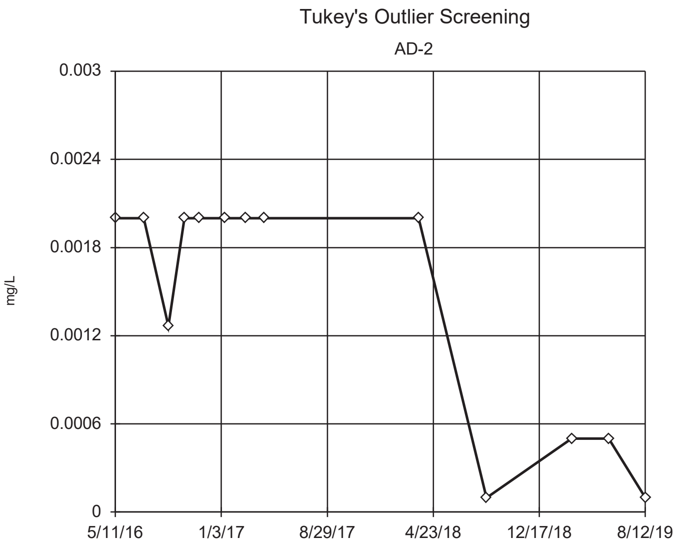
No outliers found.
Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.01883, low cutoff = -0.0003234, based on IQR multiplier of 3.

Constituent: Selenium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 13

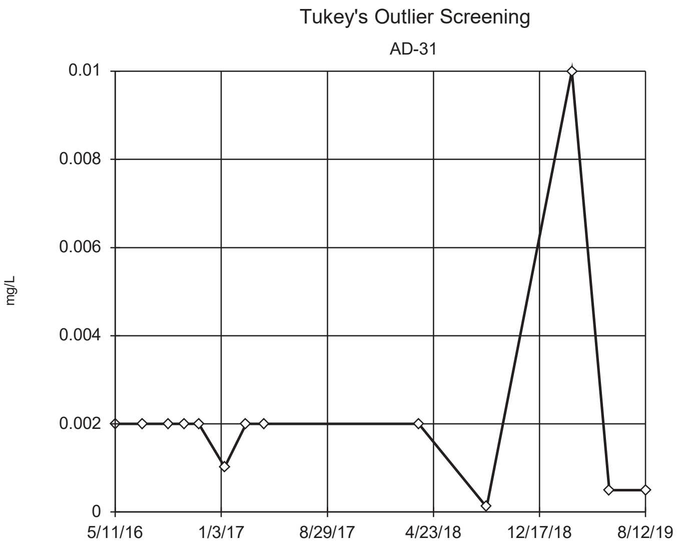
No outliers found.
Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Thallium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 13

No outliers found.
Tukey's method selected by user.

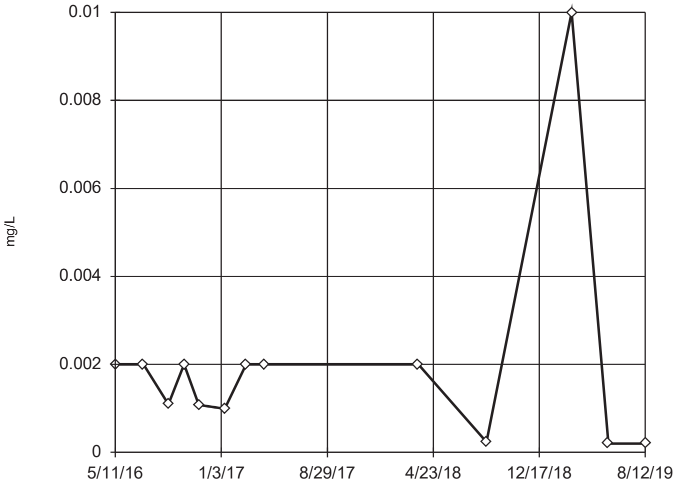
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04398, low cutoff = 0.00003246, based on IQR multiplier of 3.

Constituent: Thallium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening

AD-32



n = 13

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1397,
low cutoff = 0.000006954,
based on IQR multiplier of 3.

Constituent: Thallium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Mann-Whitney - All Results

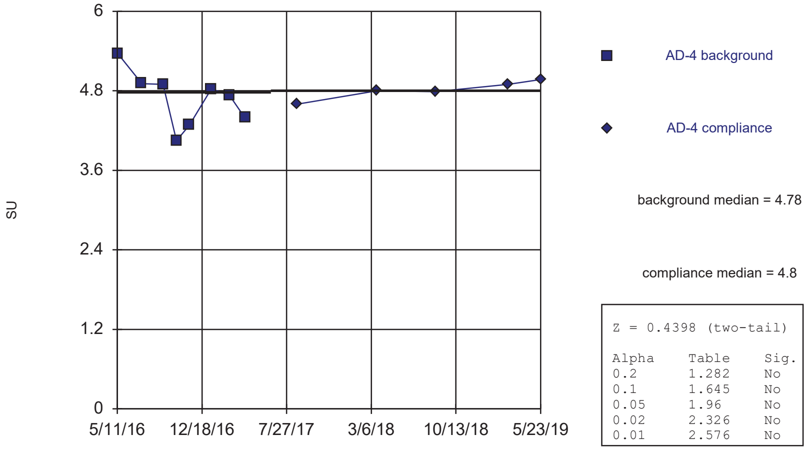
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/7/2019, 1:55 PM

Constituent	Well	Calc.	0.01	Sig.	Method
pH, field (SU)	AD-4 (bg)	0.4398	No	No	Mann-W
pH, field (SU)	AD-2	0.8051	No	No	Mann-W
pH, field (SU)	AD-31	2.562	No	No	Mann-W
pH, field (SU)	AD-32	0.8807	No	No	Mann-W
pH, field (SU)	**AD-18 (bg)**	**2.858**	**Yes**	**Yes**	**Mann-W**
pH, field (SU)	AD-12 (bg)	1.537	No	No	Mann-W

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-4 (bg)



background median = 4.78

compliance median = 4.8

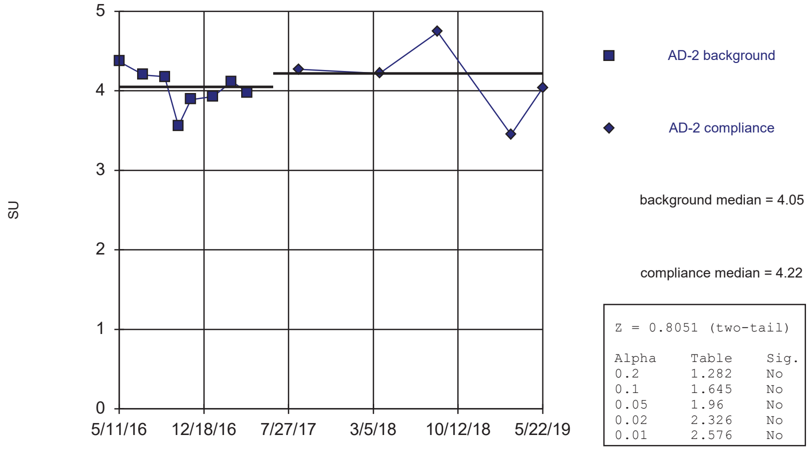
```
Z = 0.4398 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: pH, field   Analysis Run 12/7/2019 1:53 PM   View: PL's Intrawell
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-2



background median = 4.05

compliance median = 4.22

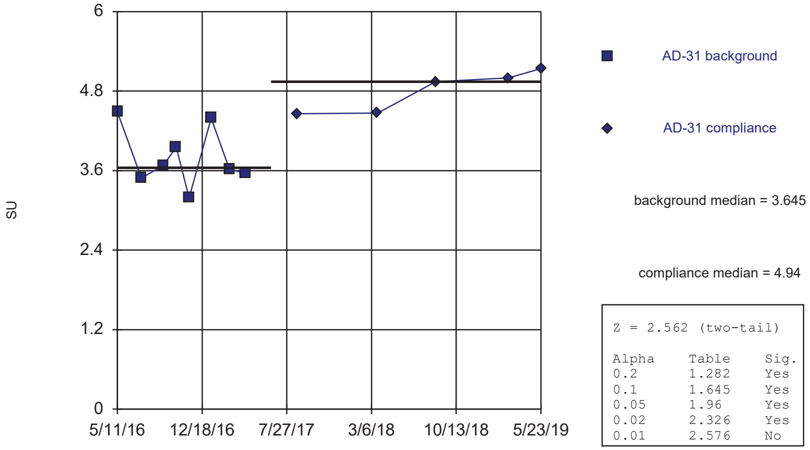
```
Z = 0.8051 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: pH, field   Analysis Run 12/7/2019 1:53 PM   View: PL's Intrawell
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-31



background median = 3.645

compliance median = 4.94

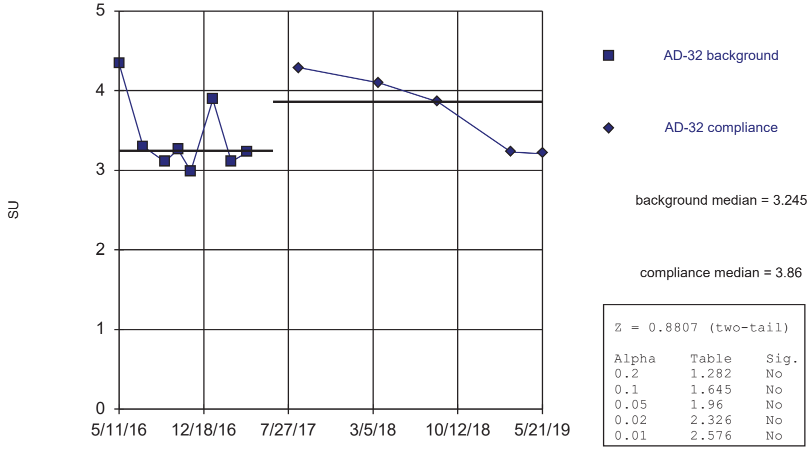
```
Z = 2.562 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      Yes
0.02      2.326     Yes
0.01      2.576     No
```

Constituent: pH, field   Analysis Run 12/7/2019 1:53 PM   View: PL's Intrawell
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-32

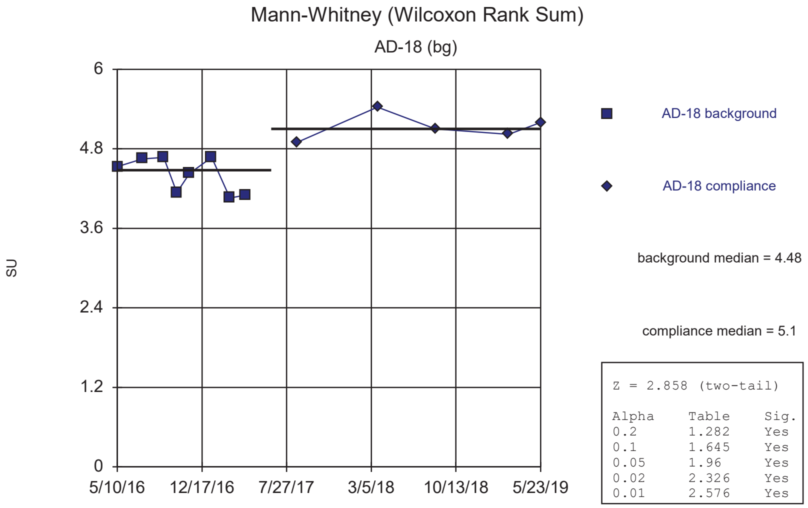


background median = 3.245

compliance median = 3.86

```
Z = 0.8807 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

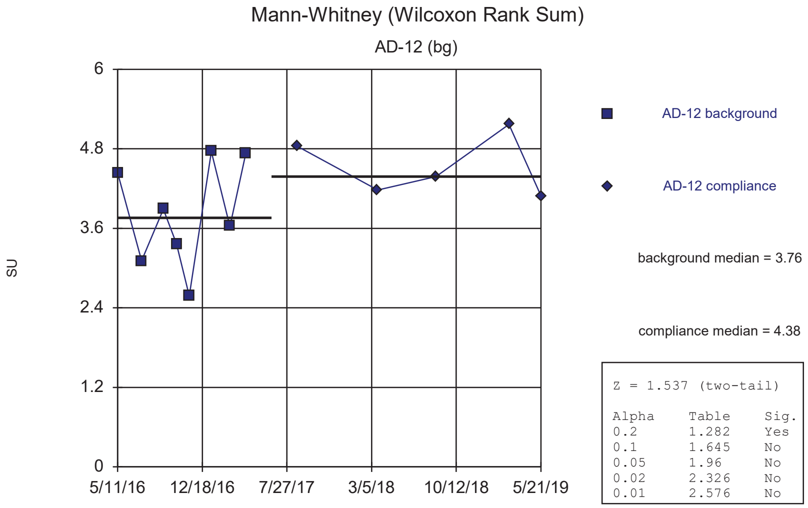
Constituent: pH, field   Analysis Run 12/7/2019 1:53 PM   View: PL's Intrawell
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP



Z = 2.858 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	Yes
0.01	2.576	Yes

Constituent: pH, field   Analysis Run 12/7/2019 1:53 PM   View: PL's Intrawell
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP



Z = 1.537 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: pH, field   Analysis Run 12/7/2019 1:53 PM   View: PL's Intrawell
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Intrawell Prediction Limit Summary

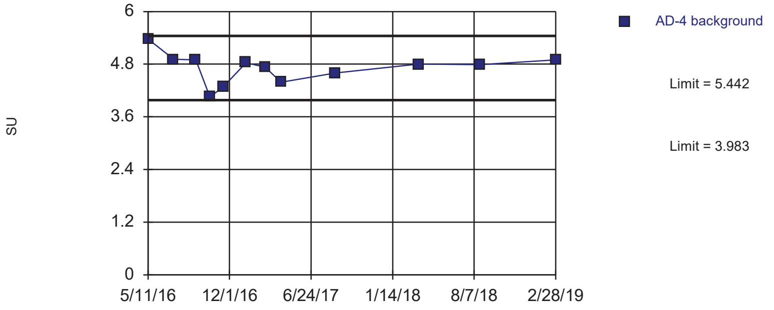
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/7/2019, 2:15 PM

Constituent	Well	Upper Lim.	Lower Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH, field (SU)	AD-4	5.442	3.983	n/a	12	4.713	0.3454	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-2	4.812	3.339	n/a	12	4.076	0.3486	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-31	5.368	2.837	n/a	12	4.103	0.5991	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-32	4.613	2.506	n/a	12	3.559	0.4988	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-18	5.539	3.745	n/a	12	4.642	0.4247	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-12	5.754	2.427	n/a	12	4.091	0.7877	0	None	No	0.001253	Param Intra 1 of 2

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-4 (bg)



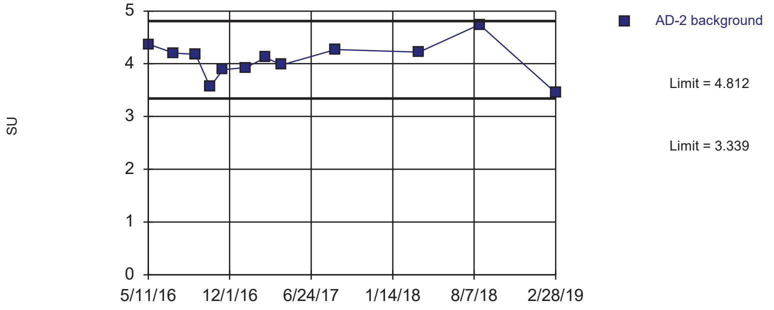
Background Data Summary: Mean=4.713, Std. Dev.=0.3454, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9373, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:13 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-2



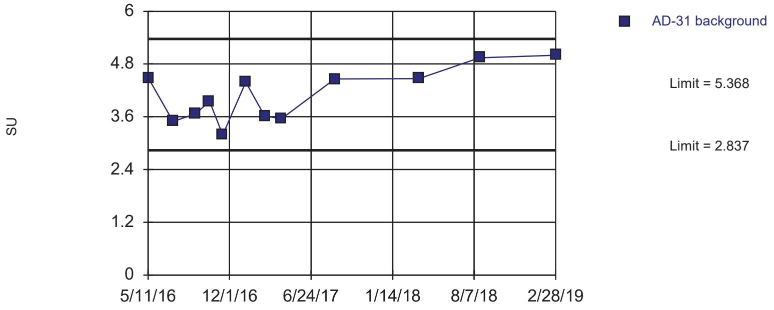
Background Data Summary: Mean=4.076, Std. Dev.=0.3486, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9599, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:13 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-31



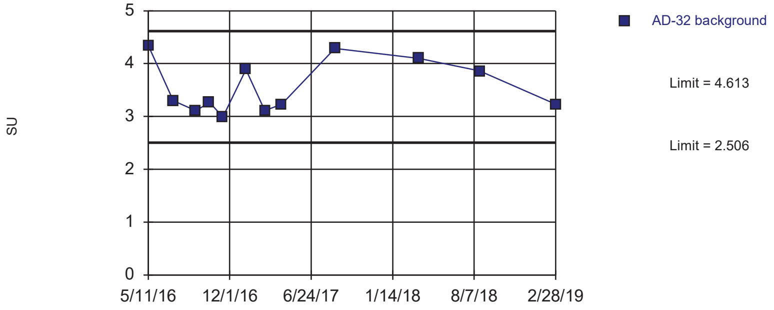
Background Data Summary: Mean=4.103, Std. Dev.=0.5991, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9264, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:13 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-32

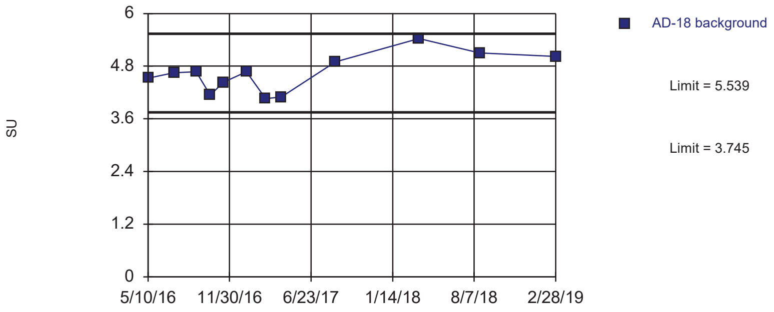


Background Data Summary: Mean=3.559, Std. Dev.=0.4988, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8528, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:14 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Prediction Limit

Intrawell Parametric, AD-18 (bg)



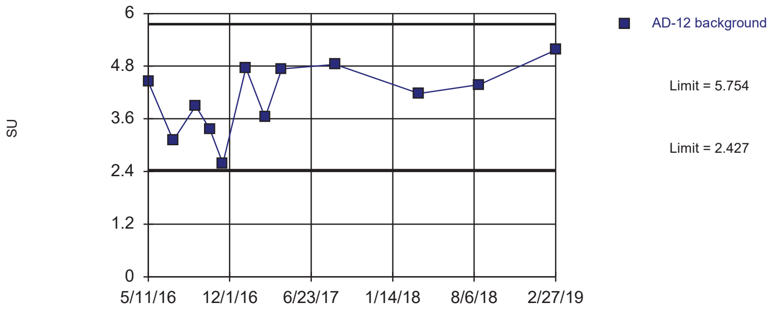
Background Data Summary: Mean=4.642, Std. Dev.=0.4247, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9561, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:14 PM View: PL's Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Prediction Limit

Intrawell Parametric, AD-12 (bg)



Background Data Summary: Mean=4.091, Std. Dev.=0.7877, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9544, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/7/2019 2:14 PM View: PL's Intrawell

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Trend Test - All Results (No Significant)

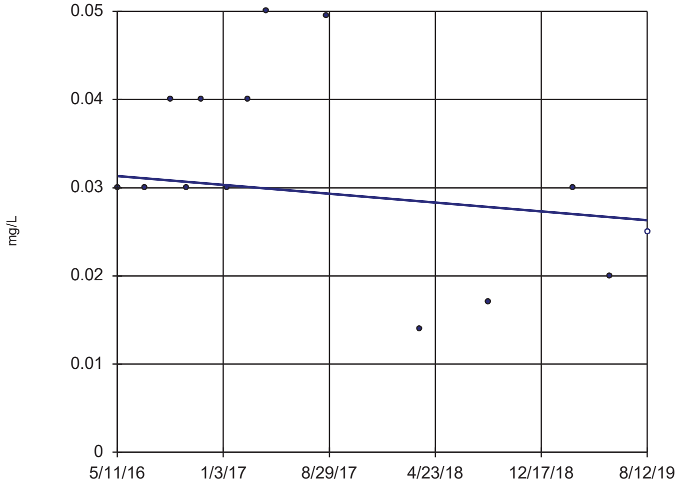
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 10:48 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-12 (bg)	-0.001536	-16	-48	No	14	7.143	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-18 (bg)	0.001347	35	48	No	14	14.29	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-4 (bg)	0.00035	11	48	No	14	7.143	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-12 (bg)	-0.008986	-7	-48	No	14	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-18 (bg)	0.03037	11	48	No	14	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	AD-4 (bg)	-0.1891	-19	-48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.1051	23	48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-18 (bg)	0.0768	18	48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-4 (bg)	0	0	48	No	14	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-12 (bg)	-0.08118	-46	-48	No	14	64.29	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-18 (bg)	0	-35	-48	No	14	78.57	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-4 (bg)	0	-32	-48	No	14	78.57	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.7952	-35	-48	No	14	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-18 (bg)	0	-4	-48	No	14	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-4 (bg)	0.9835	26	48	No	14	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (m...	AD-12 (bg)	-4.348	-10	-43	No	13	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (m...	AD-18 (bg)	-7.565	-34	-48	No	14	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (m...	AD-4 (bg)	-0.7733	-6	-48	No	14	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.001536
units per year.

Mann-Kendall
statistic = -16
critical = -48

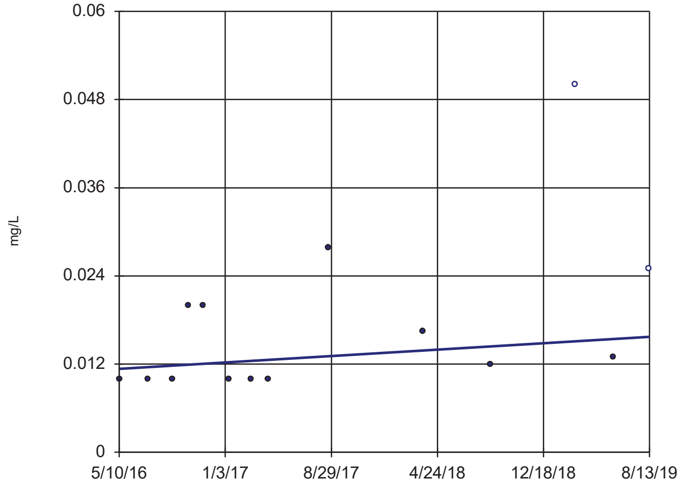
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0.001347
units per year.

Mann-Kendall
statistic = 35
critical = 48

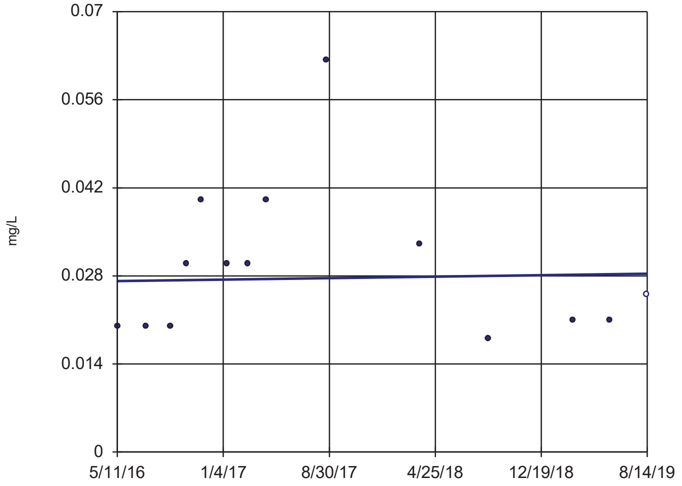
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-4 (bg)



n = 14

Slope = 0.00035
units per year.

Mann-Kendall
statistic = 11
critical = 48

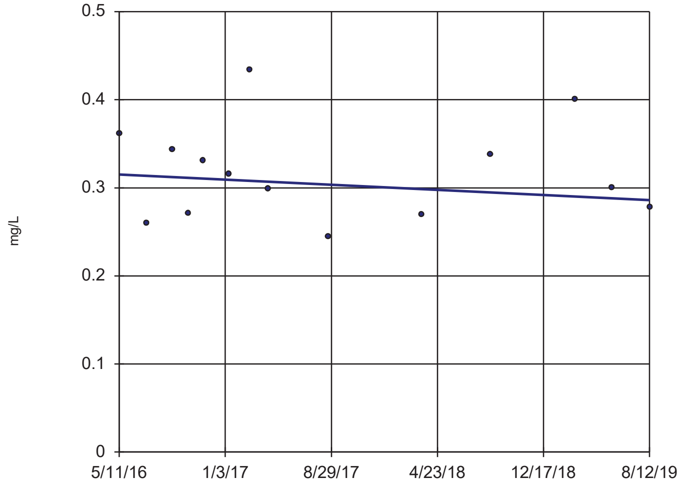
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.008986
units per year.

Mann-Kendall
statistic = -7
critical = -48

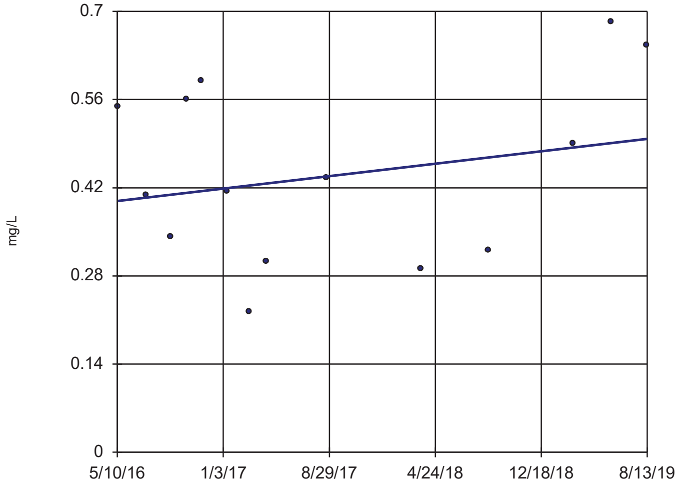
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Calcium, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0.03037
units per year.

Mann-Kendall
statistic = 11
critical = 48

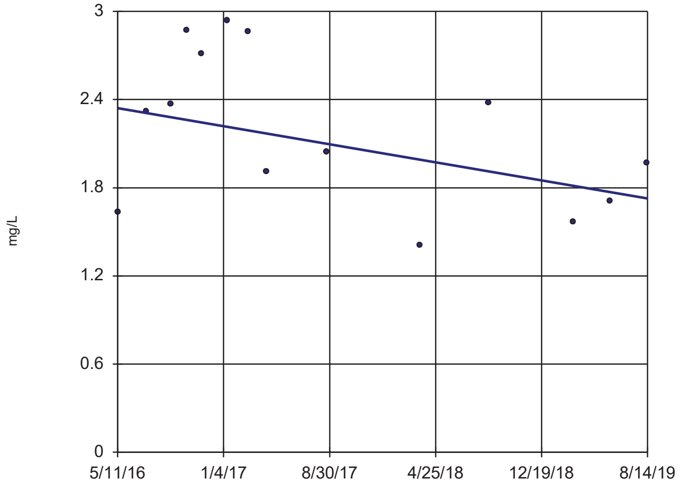
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Calcium, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-4 (bg)



n = 14

Slope = -0.1891
units per year.

Mann-Kendall
statistic = -19
critical = -48

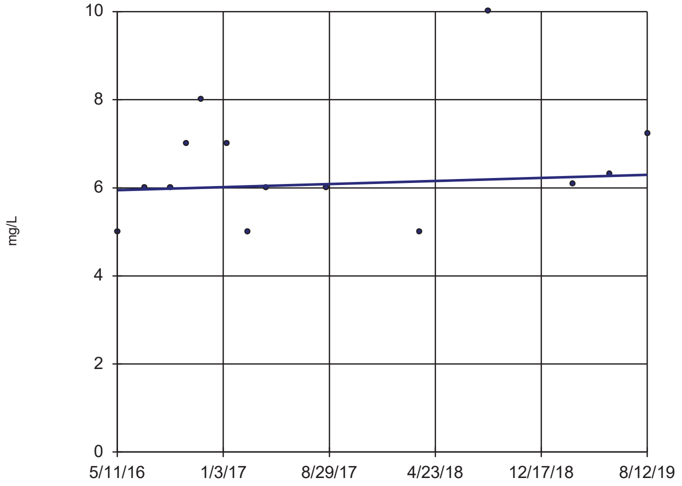
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Calcium, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0.1051
units per year.

Mann-Kendall
statistic = 23
critical = 48

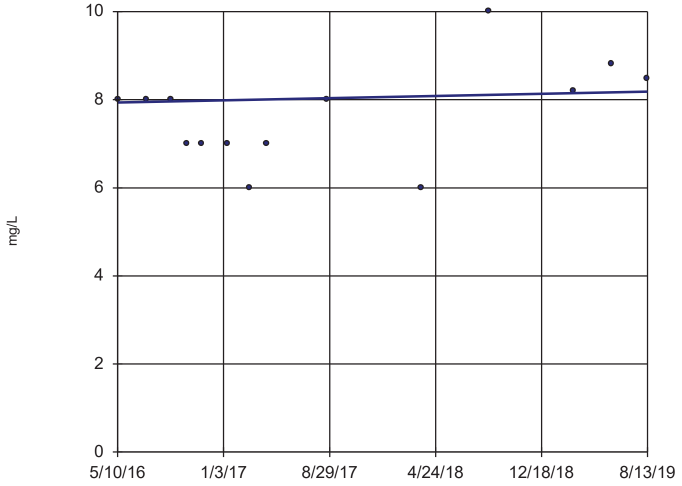
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0.0768
units per year.

Mann-Kendall
statistic = 18
critical = 48

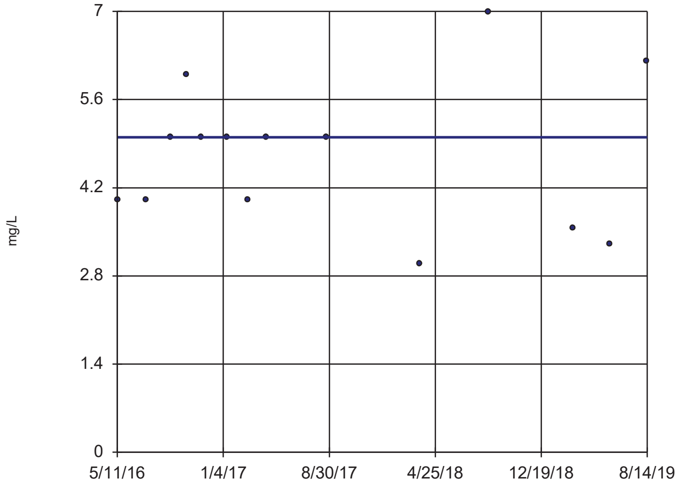
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG

Sen's Slope Estimator

AD-4 (bg)



n = 14

Slope = 0
units per year.

Mann-Kendall
statistic = 0
critical = 48

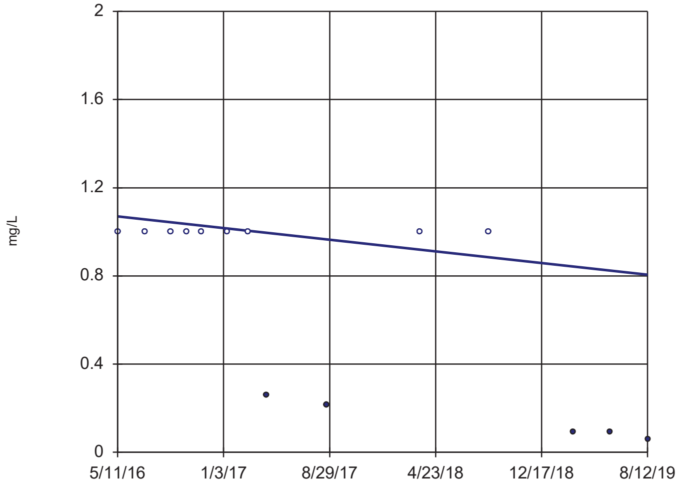
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.08118
units per year.

Mann-Kendall
statistic = -46
critical = -48

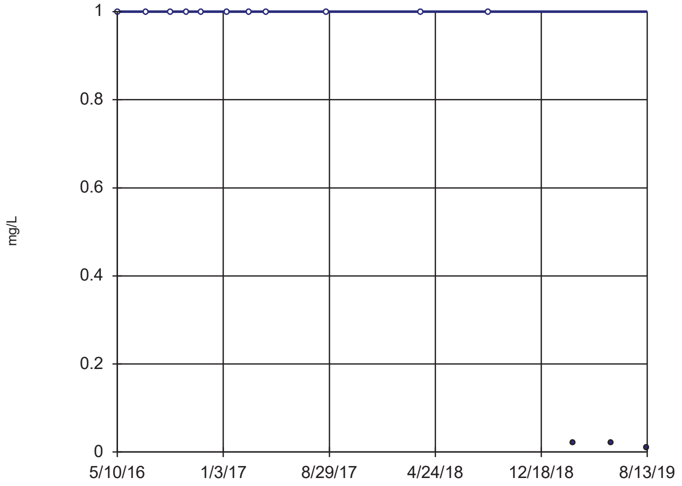
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0
units per year.

Mann-Kendall
statistic = -35
critical = -48

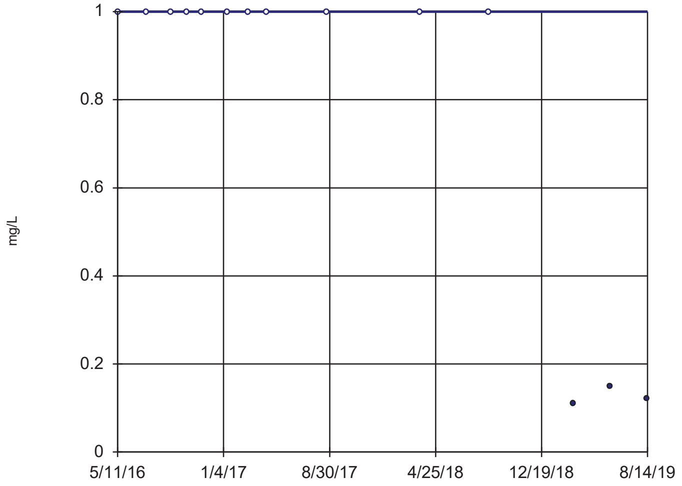
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-4 (bg)



n = 14

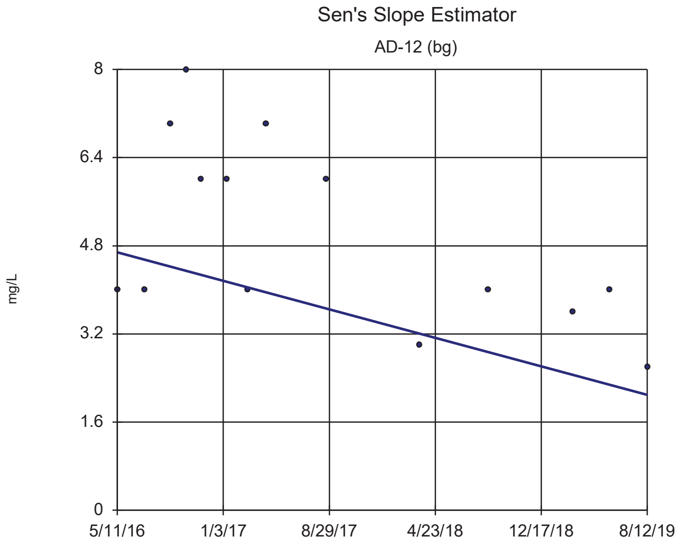
Slope = 0
units per year.

Mann-Kendall
statistic = -32
critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 14

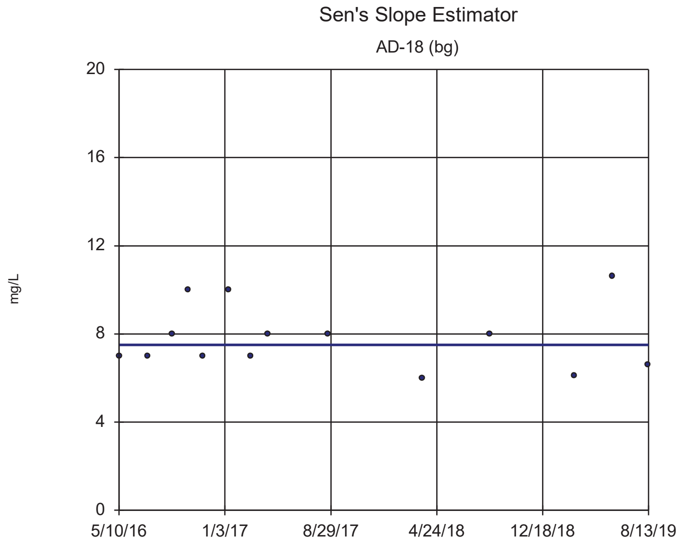
Slope = -0.7952
units per year.

Mann-Kendall
statistic = -35
critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 14

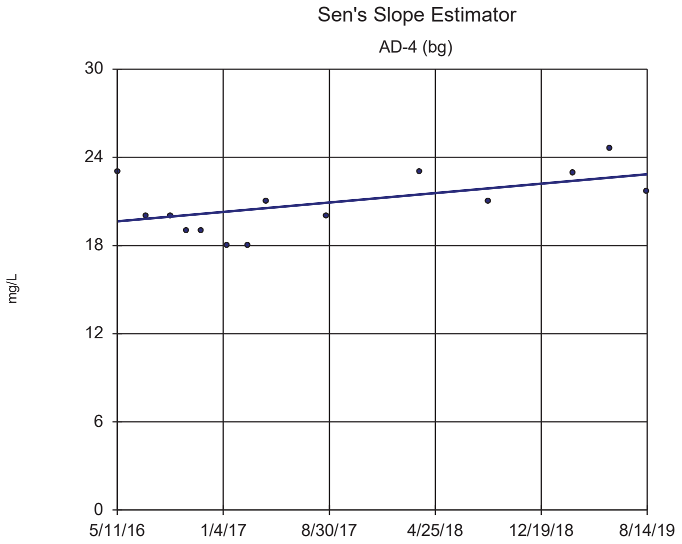
Slope = 0
units per year.

Mann-Kendall
statistic = -4
critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 14

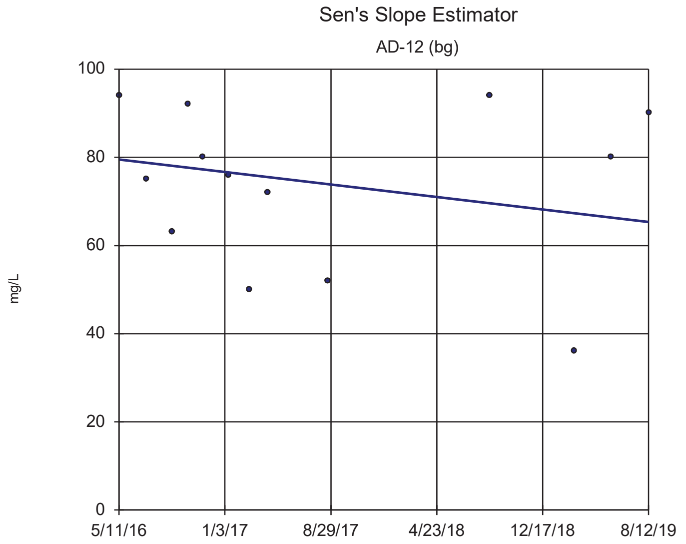
Slope = 0.9835
units per year.

Mann-Kendall
statistic = 26
critical = 48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . UG



n = 13

Slope = -4.348
units per year.

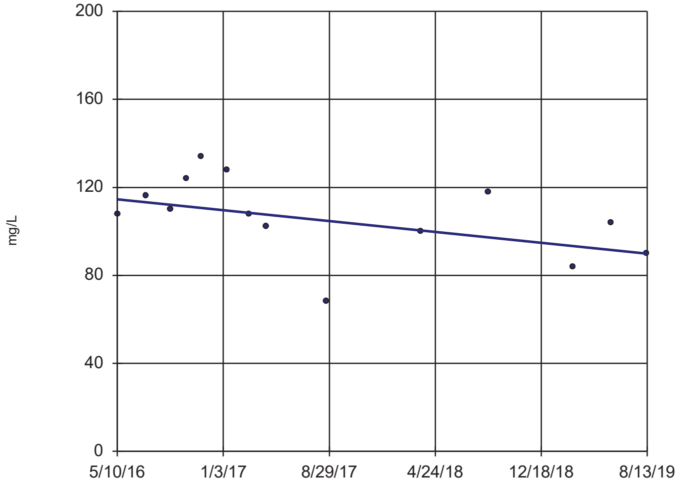
Mann-Kendall
statistic = -10
critical = -43

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = -7.565 units per year.

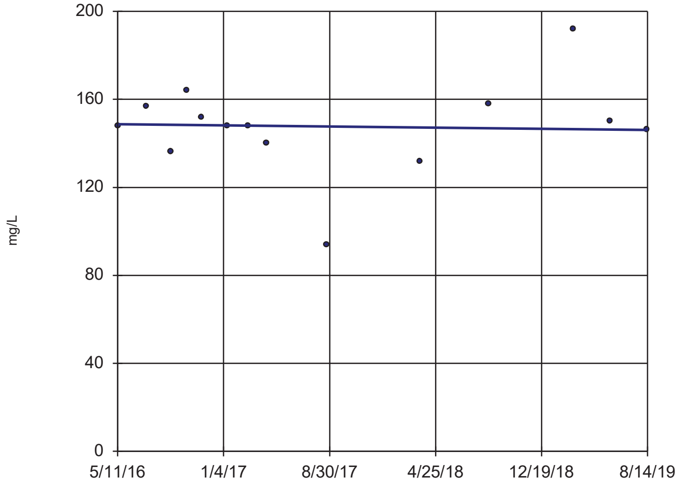
Mann-Kendall statistic = -34 critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sen's Slope Estimator

AD-4 (bg)



n = 14

Slope = -0.7733 units per year.

Mann-Kendall statistic = -6 critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS]   Analysis Run 11/25/2019 10:48 AM   View: Interwell AIII
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Interwell Prediction Limit Summary

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP   Printed 12/7/2019, 2:23 PM

Constituent	Well	Upper Lim.	Lower Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	n/a	0.05098	n/a	n/a	36	0.02697	0.01359	2.778	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	n/a	2.94	n/a	n/a	36	n/a	n/a	0	n/a	n/a	0.001409	NP (normality) 1 of 2
Chloride, total (mg/L)	n/a	9.158	n/a	n/a	36	6.218	1.665	0	None	No	0.002505	Param 1 of 2
Fluoride, total (mg/L)	n/a	1	n/a	n/a	36	n/a	n/a	86.11	n/a	n/a	0.001409	NP (NDs) 1 of 2
Sulfate, total (mg/L)	n/a	23	n/a	n/a	36	n/a	n/a	0	n/a	n/a	0.001409	NP (normality) 1 of 2
Total Dissolved Solids [TDS] (mg/L)	n/a	175.6	n/a	n/a	35	110.1	37.01	0	None	No	0.002505	Param 1 of 2

Upper Tolerance Limits

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 11:27 AM

Constituent	Well	Upper Lim.	Date	Observ.	Sig.	Bg N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.0025	n/a	n/a	n/a	39	97.44	n/a	0.1353	NP Inter(NDs)
Arsenic, total (mg/L)	n/a	0.011	n/a	n/a	n/a	39	69.23	n/a	0.1353	NP Inter(NDs)
Barium, total (mg/L)	n/a	0.183	n/a	n/a	n/a	39	0	n/a	0.1353	NP Inter(normal...
Beryllium, total (mg/L)	n/a	0.00115	n/a	n/a	n/a	39	10.26	n/a	0.1353	NP Inter(normal...
Cadmium, total (mg/L)	n/a	0.0005	n/a	n/a	n/a	39	74.36	n/a	0.1353	NP Inter(NDs)
Chromium, total (mg/L)	n/a	0.007	n/a	n/a	n/a	39	17.95	n/a	0.1353	NP Inter(Cohens...
Cobalt, total (mg/L)	n/a	0.00939	n/a	n/a	n/a	39	0	n/a	0.1353	NP Inter(normal...
Combined Radium 226 + 228 (pCi/L)	n/a	3.325	n/a	n/a	n/a	39	0	x^(1/3)	0.05	Inter
Fluoride, total (mg/L)	n/a	0.5	n/a	n/a	n/a	42	73.81	n/a	0.116	NP Inter(NDs)
Lead, total (mg/L)	n/a	0.0025	n/a	n/a	n/a	39	79.49	n/a	0.1353	NP Inter(NDs)
Lithium, total (mg/L)	n/a	0.0616	n/a	n/a	n/a	39	2.564	sqrt(x)	0.05	Inter
Mercury, total (mg/L)	n/a	0.000064	n/a	n/a	n/a	39	41.03	n/a	0.1353	NP Inter(normal...
Molybdenum, total (mg/L)	n/a	0.02	n/a	n/a	n/a	39	92.31	n/a	0.1353	NP Inter(NDs)
Selenium, total (mg/L)	n/a	0.0025	n/a	n/a	n/a	39	61.54	n/a	0.1353	NP Inter(NDs)
Thallium, total (mg/L)	n/a	0.001874	n/a	n/a	n/a	37	83.78	n/a	0.1499	NP Inter(NDs)

Confidence Interval Summary Table - Significant Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 11/25/2019, 11:31 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-2**	**0.0139**	**0.01**	**0.0094**	**Yes**	**13**	**0**	**No**	**0.01**	**NP (normality)**
Cobalt, total (mg/L)	**AD-32**	**0.06086**	**0.03096**	**0.0094**	**Yes**	**13**	**0**	**x^(1/3)**	**0.01**	**Param.**
Lithium, total (mg/L)	**AD-31**	**0.09599**	**0.08587**	**0.0616**	**Yes**	**13**	**0**	**x^6**	**0.01**	**Param.**
Lithium, total (mg/L)	**AD-32**	**0.112**	**0.08778**	**0.0616**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results

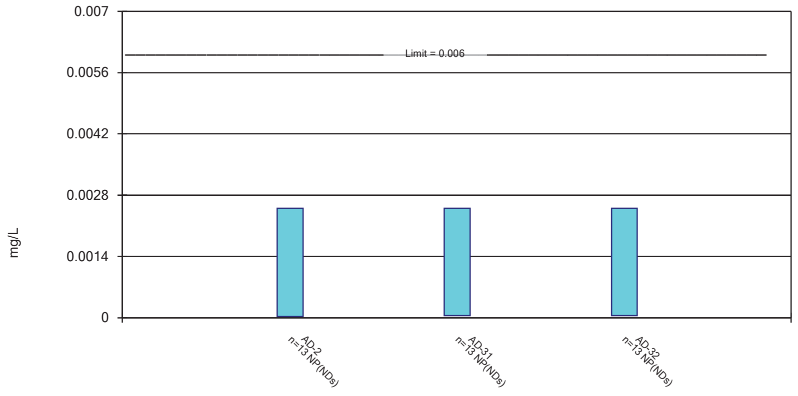
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP   Printed 11/25/2019, 11:31 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-2	0.0025	0.000025	0.006	No	13	92.31	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-31	0.0025	0.00005	0.006	No	13	92.31	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-32	0.0025	0.00005	0.006	No	13	92.31	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-2	0.0025	0.00052	0.011	No	13	76.92	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-31	0.006	0.001	0.011	No	12	25	No	0.01	NP (Cohens/xfrm)
Arsenic, total (mg/L)	AD-32	0.006899	0.002442	0.011	No	13	7.692	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-2	0.03766	0.0307	2	No	13	0	x^4	0.01	Param.
Barium, total (mg/L)	AD-31	0.08623	0.04485	2	No	12	0	No	0.01	Param.
Barium, total (mg/L)	AD-32	0.04373	0.0285	2	No	13	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-2	0.0005146	0.0003761	0.004	No	13	7.692	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-31	0.002	0.00085	0.004	No	12	0	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-32	0.006729	0.003501	0.004	No	13	0	sqrt(x)	0.01	Param.
Cadmium, total (mg/L)	AD-2	0.0005	0.00006	0.005	No	13	76.92	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-31	0.0008589	0.0000944	0.005	No	13	53.85	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-32	0.0006183	0.0003591	0.005	No	13	0	No	0.01	Param.
Chromium, total (mg/L)	AD-2	0.0008854	0.0002438	0.1	No	13	46.15	No	0.01	NP (Cohens/xfrm)
Chromium, total (mg/L)	AD-31	0.01219	0.002111	0.1	No	11	18.18	No	0.01	Param.
Chromium, total (mg/L)	AD-32	0.009243	0.002217	0.1	No	13	0	sqrt(x)	0.01	Param.
Cobalt, total (mg/L)	**AD-2**	**0.0139**	**0.01**	**0.0094**	**Yes**	**13**	**0**	**No**	**0.01**	**NP (normality)**
Cobalt, total (mg/L)	AD-31	0.01159	0.009367	0.0094	No	12	0	No	0.01	Param.
Cobalt, total (mg/L)	**AD-32**	**0.06086**	**0.03096**	**0.0094**	**Yes**	**13**	**0**	**x^(1/3)**	**0.01**	**Param.**
Combined Radium 226 + 228 (pCi/L)	AD-2	1.813	0.983	5	No	13	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-31	4.122	2.631	5	No	13	0	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-32	5.578	3.893	5	No	12	0	No	0.01	Param.
Fluoride, total (mg/L)	AD-2	0.5	0.1	4	No	15	80	No	0.01	NP (NDs)
Fluoride, total (mg/L)	AD-31	0.5	0.16	4	No	15	80	No	0.01	NP (NDs)
Fluoride, total (mg/L)	AD-32	0.7468	0.4468	4	No	14	35.71	No	0.01	NP (normality)
Lead, total (mg/L)	AD-2	0.0025	0.000338	0.015	No	13	76.92	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-31	0.003933	0.001	0.015	No	12	66.67	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-32	0.0025	0.000714	0.015	No	13	76.92	No	0.01	NP (NDs)
Lithium, total (mg/L)	AD-2	0.05473	0.04944	0.0616	No	12	0	No	0.01	Param.
Lithium, total (mg/L)	**AD-31**	**0.09599**	**0.08587**	**0.0616**	**Yes**	**13**	**0**	**x^6**	**0.01**	**Param.**
Lithium, total (mg/L)	**AD-32**	**0.112**	**0.08778**	**0.0616**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Mercury, total (mg/L)	AD-2	0.00009047	0.00002986	0.002	No	12	0	No	0.01	Param.
Mercury, total (mg/L)	AD-31	0.0007825	0.0001414	0.002	No	12	0	sqrt(x)	0.01	Param.
Mercury, total (mg/L)	AD-32	0.007473	0.001912	0.002	No	13	0	No	0.01	Param.
Molybdenum, total (mg/L)	AD-2	0.02	0.0008627	0.1	No	13	84.62	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-31	0.02	0.0003161	0.1	No	13	69.23	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-32	0.02	0.0007621	0.1	No	13	84.62	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-2	0.0025	0.0009	0.05	No	13	38.46	No	0.01	NP (Cohens/xfrm)
Selenium, total (mg/L)	AD-31	0.0025	0.001034	0.05	No	13	53.85	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-32	0.003888	0.001935	0.05	No	12	41.67	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-2	0.001264	0.0001	0.002	No	13	76.92	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-31	0.001019	0.00025	0.002	No	12	83.33	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-32	0.001078	0.0002	0.002	No	12	50	No	0.01	NP (normality)

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

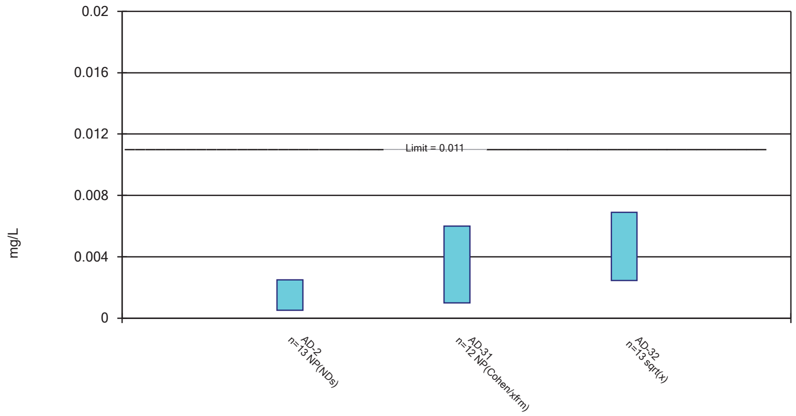


Constituent: Antimony, total   Analysis Run 11/25/2019 11:29 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

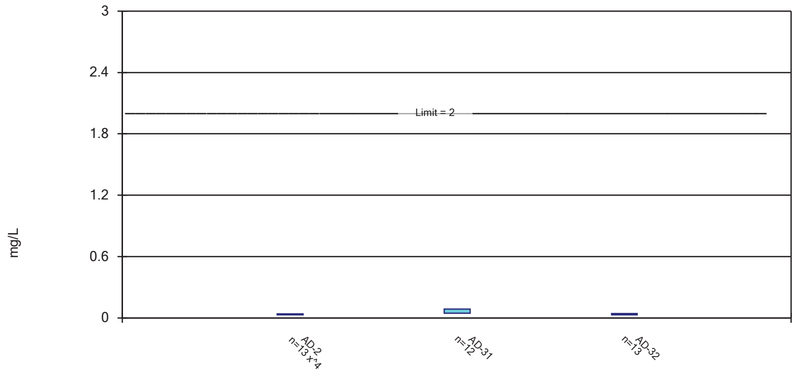


Constituent: Arsenic, total   Analysis Run 11/25/2019 11:29 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

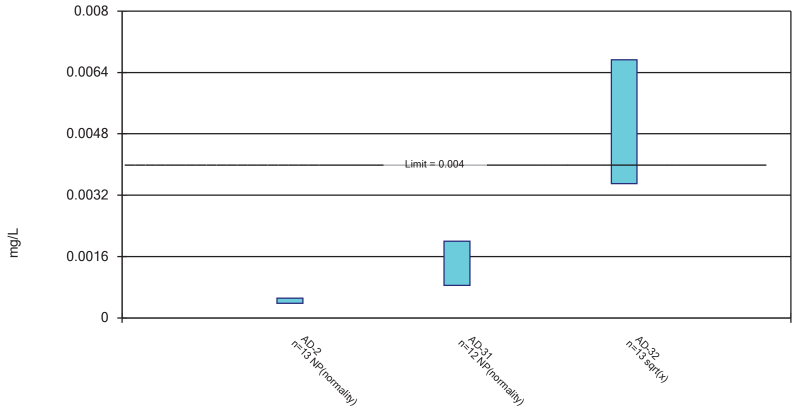


Constituent: Barium, total   Analysis Run 11/25/2019 11:29 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

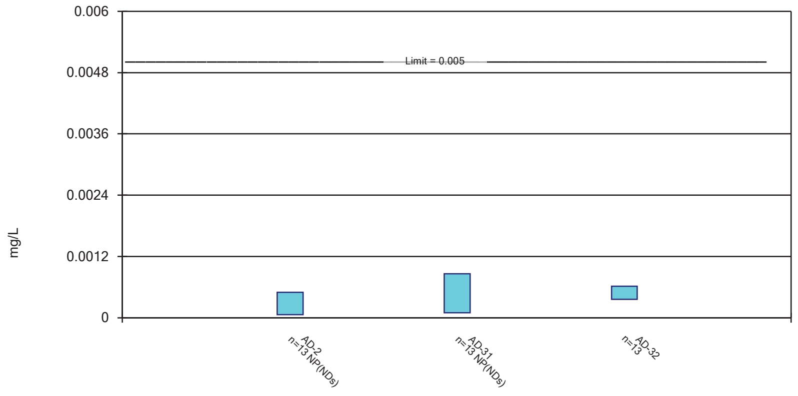


Constituent: Beryllium, total   Analysis Run 11/25/2019 11:29 AM   View: Interwell AIV
Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



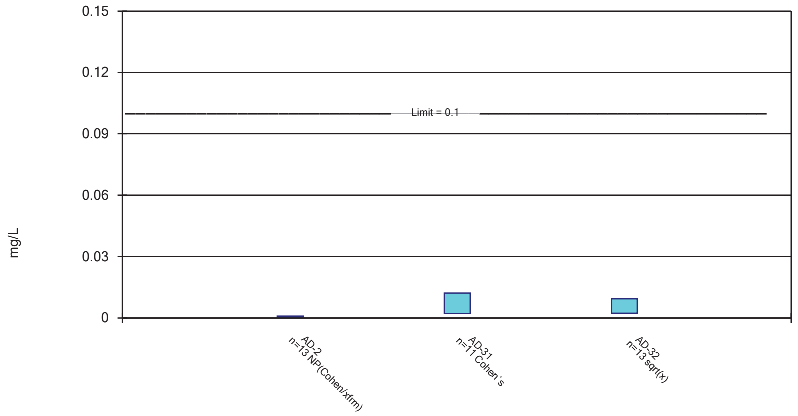
Constituent: Cadmium, total   Analysis Run 11/25/2019 11:29 AM   View: Interwell AIV

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



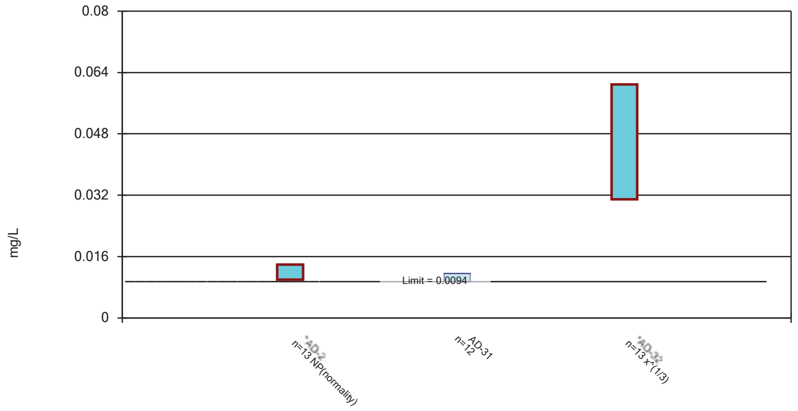
Constituent: Chromium, total   Analysis Run 11/25/2019 11:29 AM   View: Interwell AIV

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



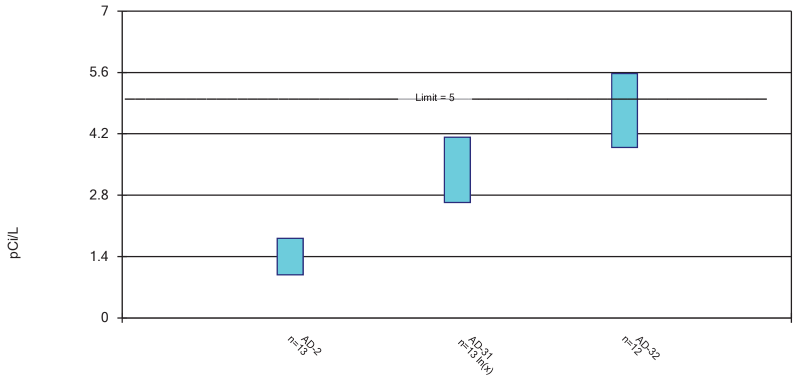
Constituent: Cobalt, total   Analysis Run 11/25/2019 11:29 AM   View: Interwell AIV

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



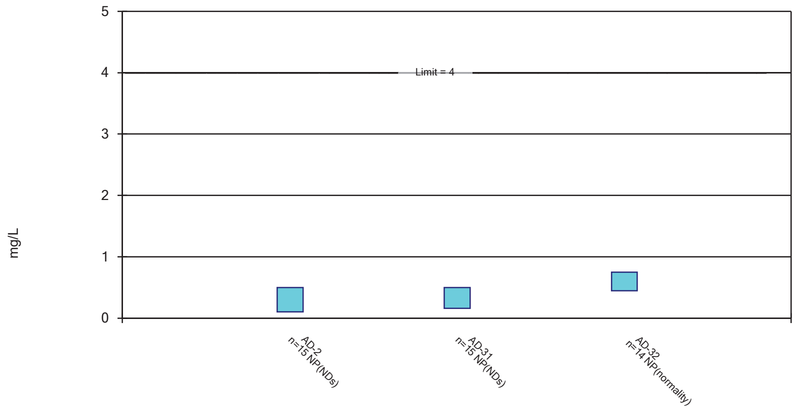
Constituent: Combined Radium 226 + 228   Analysis Run 11/25/2019 11:29 AM   View: Interwell AIV

Pirkey EBAP   Client: Geosyntec   Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



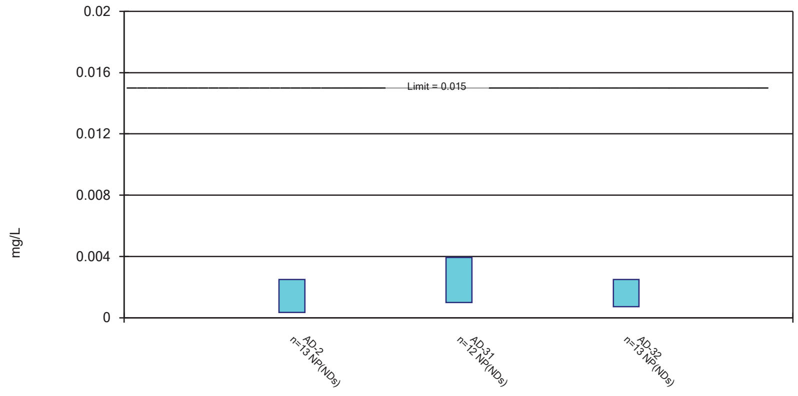
Constituent: Fluoride, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



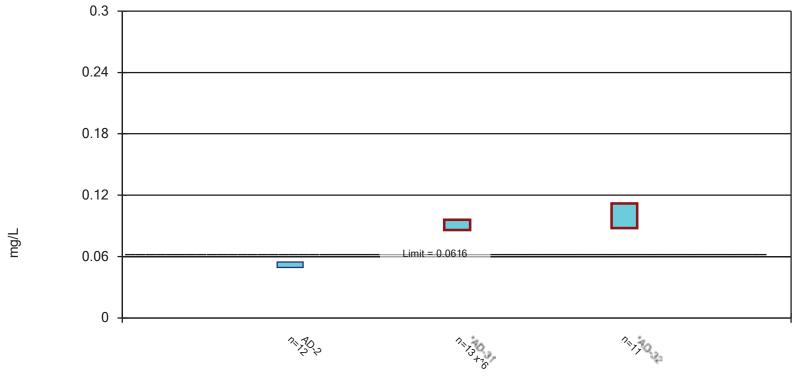
Constituent: Lead, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



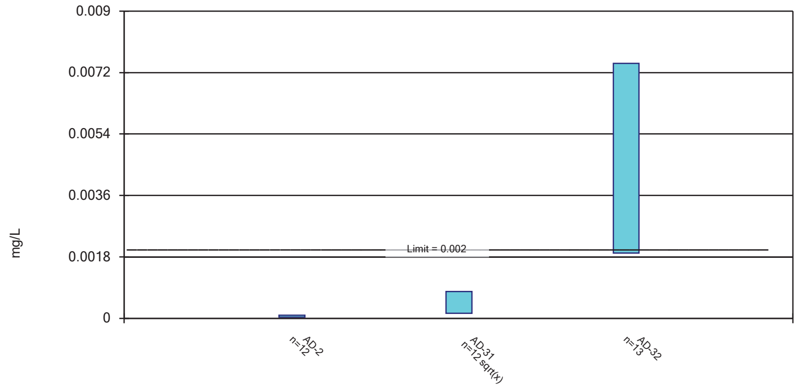
Constituent: Lithium, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



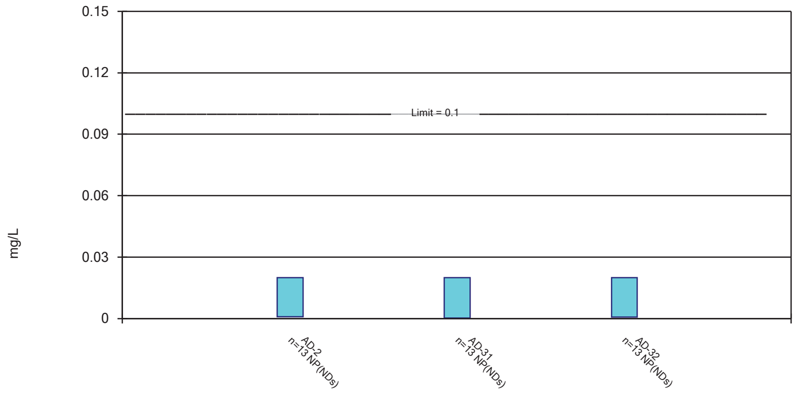
Constituent: Mercury, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

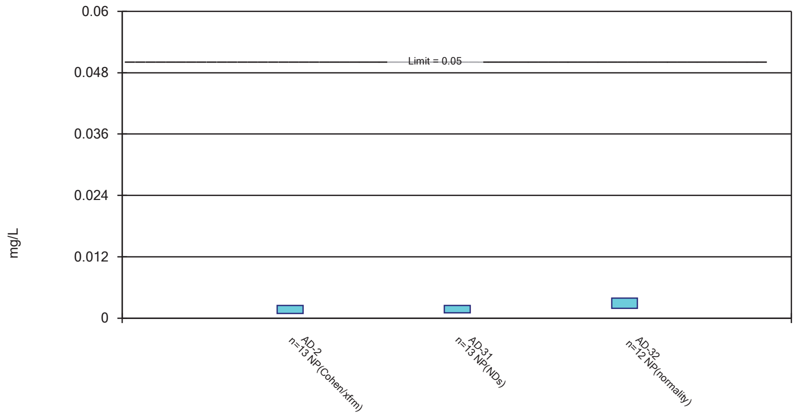


Constituent: Molybdenum, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

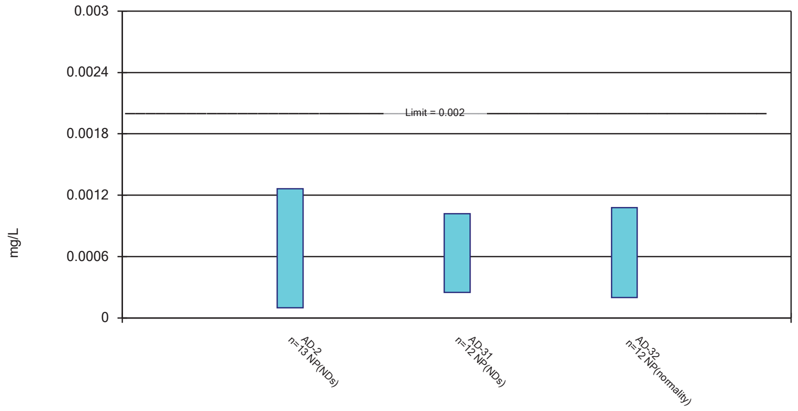


Constituent: Selenium, total Analysis Run 11/25/2019 11:30 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.23 . EPA

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Thallium, total Analysis Run 11/25/2019 11:30 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
East Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants
engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

April 24, 2019

CHA8462

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ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASL	Alternate Screening Level
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the East Bottom Ash Pond (EBAP, Figure 1). In 2018, two assessment monitoring events were conducted at the EBAP in accordance with 40 CFR 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or alternate screening level (ASL) provided in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey EBAP:

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.010 mg/L), AD-31 (0.00949 mg/L), and AD-32 (0.0353 mg/L).
- LCLs for lithium exceeded the GWPS of 0.051 mg/L at AD-31 (0.0556 mg/L) and AD-32 (0.0722 mg/L).

No other SSLs were identified (Geosyntec, 2018).

1.1 <u>CCR Rule Requirements</u>

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a*

> *qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSLs identified for cobalt should not be attributed to the EBAP. The SSLs identified for lithium will be addressed in a separate submittal.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for cobalt were based on a Type IV cause and not by a release from the Pirkey EBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for cobalt and the proposed alternative source are described below.

2.1 Alternative Source for Cobalt

Initial review of site geochemistry, site historical data, and laboratory QA/QC data did not identify alternative sources due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSLs for cobalt have been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

The onsite hydrostratigraphic unit for the EBAP was identified as the clayey and silty sand stratum located between an elevation of approximately 325 and 340 feet above mean sea level (Arcadis, 2016). This unit is within the Reklaw Formation, which consists predominantly of clay and fine-grained sand and is underlain by the Eocene-age Carrizo Sand. The presence of lignite in the area is well-documented (Broom and Myers, 1966; ETTL, 2010).

Soil samples collected across the site identified cobalt in the aquifer material at varying concentrations, including locations near the EBAP (Table 1). While data are not available for AD-2, the highest reported cobalt concentration of 15 milligrams per kilogram (mg/kg) was collected at AD-30, which is located approximately 650 feet to the northwest of AD-2 (Figure 2). In addition, up to 1.9 mg/kg and 9.1 mg/kg of cobalt were detected in the samples at EBAP downgradient wells AD-31 and AD-32, respectively. Up to 3.6 mg/kg of cobalt was detected in the samples at upgradient well AD-18.

Mineralogic samples collected from across the site identified pyrite (cubic FeS_2) and marcasite (orthorhombic FeS_2) at concentrations up to 3% by dry weight (Table 1). Pyrite and marcasite were detected in the shallow (12 feet below ground surface [ft bgs]) sample collected at AD-31 at a combined concentration of 2%. Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2019).

While cobalt was detected in the samples collected at AD-32, pyrite and marcasite were not detected. However, the boring log for AD-32 noted that iron ore was present at 16 ft bgs, which is within the screened interval of the well (Attachment A). The presence of limonite ($FeO(OH)$) in the Reklaw formation has been noted (Brooms and Myers, 1966), which is a likely weathering product of the iron ore identified in the boring log. In addition to iron sulfides, cobalt can also substitute in or adsorb onto iron oxides such as limonite (Hitzman et al., 2019; Appelo and Postman, 2005). While soil analytical and mineralogical data are not available for AD-2, the wide distribution of cobalt and iron-containing minerals across the site suggests that naturally occurring cobalt may be present in the aquifer media near AD-2.

Naturally occurring cobalt in the aquifer media is presented as the alternative source for cobalt concentrations in the groundwater which exceed the GWPS at the EBAP. Evidence from the EBAP itself shows that a release from the pond is not a probable source for cobalt in groundwater. An analysis of a sample of the bottom ash sluiced to the EBAP gave a reported cobalt concentration of 6.1 mg/kg (Attachment B). When Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) was conducted on the ash sample to evaluate cobalt mobility under simulated landfill conditions, cobalt was not detected above the reporting limit of 0.010 milligrams per liter (mg/L) in the leachate sample (Attachment B). Cobalt was detected with an estimated concentration of 0.0024 mg/L in a grab sample of the pond water (Attachment C). However, the reported concentration of cobalt in the pond water sample is more than an order of magnitude lower than the average concentration of cobalt observed at all three wells where SSLs were identified. Results of the pond sample analyses are summarized in Table 2.

Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions, as SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. According to a recent study, cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5 SU, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

The EBAP was not identified as the source of cobalt at AD-2, AD-31, or AD-32 based on the documented low mobility of cobalt under the pond conditions. This is further supported by the lack of detected cobalt in the SPLP analysis and the low observed cobalt concentration in the pond water itself. Instead, the widespread distribution of cobalt within the aquifer material is presented as the alternate source. This cobalt could be present as substitutions within iron-containing minerals such as pyrite, marcasite, or limonite, all of which are observed across the site.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSLs for cobalt at AD-2, AD-31, and AD-32 identified during assessment monitoring in 2018 was not due to a release from the EBAP. The identified SSLs were, instead, attributed to natural variation in the underlying geology. Therefore, no further action for cobalt is warranted, and the EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment D.

SECTION 4

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FIGURES

Legend

● AD-15

● Monitoring Wells

Location Boundaries

CCR Units

▭ EBAP

▭ Landfill

▭ Stack Out Area

▭ WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.

0 380 760 1,520 2,280 3,040 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2019/03/25

Figure

1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_20190322.mxd. HDuff. 3/25/2019. Project/Phase/Task.

Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

Legend

⌖ Monitoring Wells

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- ft bgs: feet below ground surface
- mg/kg: milligrams per kilogram

0 125 250 500 750 1,000 Feet

Soil Chemical and Mineralogical Analysis Results

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio

2019/03/25

Figure 2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Pirkey_SoilChem_minerals_March2019.mxd. SKaroly. 3/25/2019. Project/Phase/Task.

TABLES

Table 1: Soil Cobalt and Mineralogy Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Sample Depth (ft bgs)	Cobalt (mg/kg)	Pyrite/Marcasite (%)
AD-15	13	0.85	--
	40-43	0.79	--
AD-16	10	0.17	0
	19	0.44	1
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-33	11	0.61	1
	21	0.64	--
AD-34	6	1.10	1
	24	6.50	2
AD-35	2	2.10	2
	17	0.18	0

Notes:

'--' - analysis not completed

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

Samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation.

Table 2: Summary of Key Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant

Sample	Unit	Cobalt Concentration
Bottom Ash (Solid Material)	mg/kg	6.1
SPLP Leachate of Bottom Ash	mg/L	<0.01
EBAP Pond Water	mg/L	0.0024 J
AD-2 - Average	mg/L	0.0109
AD-31 - Average	mg/L	0.0107
AD-32 - Average	mg/L	0.0529

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

Average values were calculated using all cobalt data collected under 40 CFR 257 Subpart D.

ATTACHMENT A

AD-32 Boring Log

Hydrex ENVIRONMENTAL, INC.

Monitor Well

Monitor Well No.: **AD-32**

JDS 1-21-16
JEFFREY D. SAMMONS
GEOLOGY
#10070

PROJECT INFORMATION

PROJECT:	**Pirkey Power Plant**
PROJECT NO.:	**I-04-1021**
LOGGED BY:	**Jeffrey D. Sammons, P.G.**
SUPERVISING PG:	**Jeffrey D. Sammons, P.G.**
COMPLETION:	**12/11/2015**
DEVELOPMENT:	**12/16/2015**
SITE LOCATION:	**2400 FM 3251, Hallsville, Texas**
WELL OWNER:	**AEP**

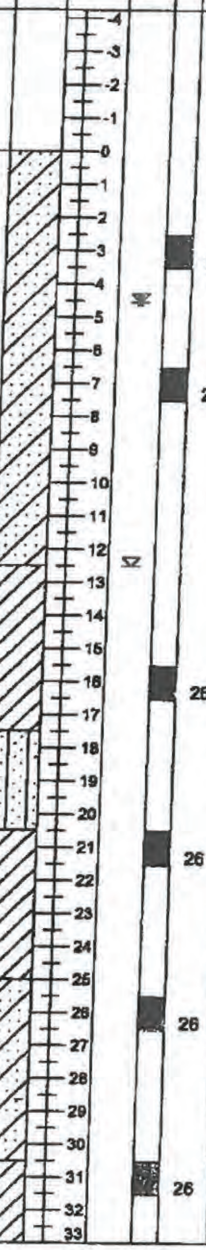
DRILLING INFORMATION

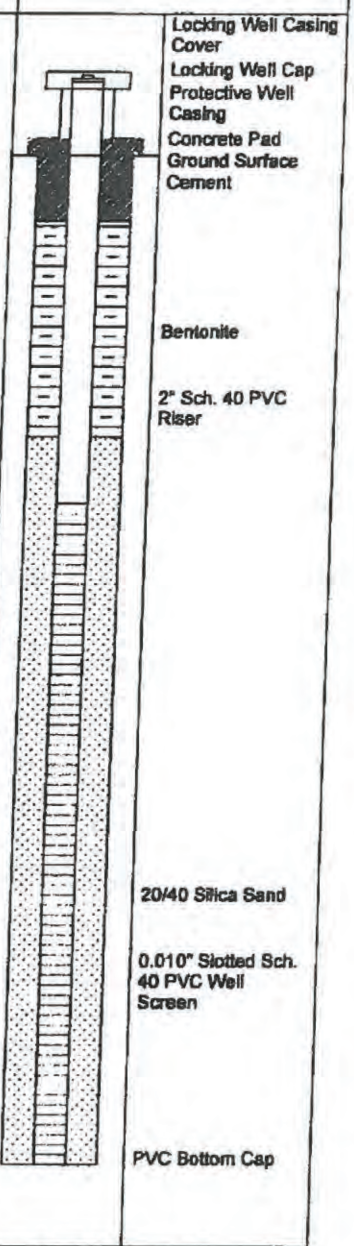
DRILLER:	**Buford Collier**
DRILLER'S LICENSE NO.:	**60089**
RIG TYPE:	**Geoprobe 3230DT**
METHOD OF DRILLING:	**Hollow Stem Auger**
SAMPLING METHODS:	**Split Core**
SURFACE ELEVATION:	**359.18 (Top of Casing)**
HOLE DIAMETER:	**8.25"**
LATITUDE	**32 27' 58.20"**
LONGITUDE	**94 29' 11.86"**

▼ Water Level Upon Installation ▽ Water Level at Time of Drilling ■ Geotechnical Lab Sample

TBPG No. 50027

DESCRIPTION	USCS	% MOISTURE	% FINES	LL	PL	PI
CLAYEY SAND: very fine to fine sand, dark reddish brown, moist	SC					
- interbeds of sand and clay, yellowish brown and light gray at 1'						
- reddish brown and light gray at 2'		25	46	35	22	13
- light gray and yellowish brown at 4',						
- grayish brown and light gray at 6'						
- grayish brown, light gray, and reddish brown at 7'		26	44	37	20	17
SANDY LEAN CLAY: some gravel seams and thin interbeds of cemented sand, light yellowish brown and light gray, moist to saturated within gravel seams	CL					
- some iron ore gravel at 16', very moist to saturated		28	54	37	22	15
SILTY SAND: very fine to fine sand, trace clay, brownish gray and dark brownish gray, saturated	SM					
- reddish brown and brown at 20'						
SANDY LEAN CLAY: gray and dark gray, very moist	CL	26	51	37	24	13
CLAYEY SAND: fine to very fine sand, gray and dark gray, very moist to saturated	SC	26	47	41	22	19
SANDY LEAN CLAY: gray and dark gray, very moist	CL	26	59	35	21	14





NOTES: This log should not be used separately from the original report. Not all USCS descriptors were laboratory verified.

ATTACHMENT B

Bottom Ash and Bottom Ash SPLP Laboratory Analytical Data

Client Sample Results

Client Sample ID: CCR SAMPLE-EBAP-1

Date Collected: 02/11/19 17:00
Date Received: 02/13/19 09:40

Lab Sample ID: 490-168389-2

Matrix: Solid
Percent Solids: 75.6

Method: 9056 - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	1.3	U	1.3	1.1	mg/Kg	☼		02/14/19 01:19	1

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	13	U	13	1.3	mg/Kg	☼	02/13/19 16:11	02/19/19 19:24	1
Arsenic	**3.1**		2.6	1.6	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Barium	**330**		2.6	1.3	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Beryllium	**0.64**	**J**	1.3	0.26	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Boron	**110**		13	5.7	mg/Kg	☼	02/13/19 16:11	02/18/19 22:55	1
Cadmium	1.3	U	1.3	0.13	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Chromium	**13**		1.3	1.2	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Cobalt	**6.1**		2.6	1.3	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Lead	**0.82**	**J**	1.3	0.66	mg/Kg	☼	02/13/19 16:11	02/19/19 19:24	1
Lithium	**3.7**	**J**	13	1.3	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Molybdenum	13	U	13	6.6	mg/Kg	☼	02/13/19 16:11	02/16/19 23:21	1
Selenium	2.6	U	2.6	1.5	mg/Kg	☼	02/13/19 16:11	02/19/19 19:24	1
Thallium	2.6	U	2.6	0.79	mg/Kg	☼	02/13/19 16:11	02/19/19 19:24	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.13	U	0.13	0.039	mg/Kg	☼	02/14/19 10:07	02/14/19 13:20	1

Client Sample ID: CCR SAMPLE-EBAP-1

Date Collected: 02/11/19 17:00
Date Received: 02/13/19 09:40

Lab Sample ID: 490-168389-2
Matrix: Solid

Method: 9056 - Anions, Ion Chromatography - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	**0.023**	**J B**	0.10	0.010	mg/L			02/19/19 23:58	1

Method: 6010C - Metals (ICP) - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:58	1
Arsenic	0.010	U	0.010	0.0086	mg/L		02/19/19 16:41	02/20/19 13:58	1
Barium	**0.23**		0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:58	1
Beryllium	0.0040	U	0.0040	0.0020	mg/L		02/19/19 16:41	02/20/19 13:58	1
Boron	**0.032**	**J**	0.050	0.020	mg/L		02/19/19 16:41	02/20/19 13:58	1
Cadmium	0.0010	U	0.0010	0.00050	mg/L		02/19/19 16:41	02/20/19 13:58	1
Chromium	0.0050	U	0.0050	0.0030	mg/L		02/19/19 16:41	02/20/19 13:58	1
Cobalt	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:58	1
Lead	0.0050	U	0.0050	0.0020	mg/L		02/19/19 16:41	02/20/19 13:58	1
Lithium	**0.011**	**J B ***	0.050	0.010	mg/L		02/19/19 16:41	02/20/19 13:58	1
Molybdenum	0.050	U	0.050	0.030	mg/L		02/19/19 16:41	02/20/19 13:58	1
Selenium	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:58	1
Thallium	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:58	1

Method: 7470A - Mercury (CVAA) - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.00020	U	0.00020	0.00010	mg/L		02/19/19 16:03	02/21/19 15:47	1

General Chemistry

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	**75.6**		0.1	0.1	%			02/17/19 12:25	1

ATTACHMENT C

Bottom Ash Pond Water Laboratory Analytical Data

Client Sample ID: SW-EGAP-1

Date Collected: 12/15/18 14:50
Date Received: 12/18/18 10:30

Lab Sample ID: 490-165222-6

Matrix: Water

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	**0.30**	**J**	1.0	0.010	mg/L			12/20/18 19:46	1
Sulfate	**750**		500	3.0	mg/L			12/30/18 09:58	100
Chloride	**22**	**B**	6.0	0.40	mg/L			12/30/18 09:41	2

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.0030	U	0.0030	0.00080	mg/L		12/19/18 14:26	12/27/18 15:18	1
Arsenic	**0.00055**	**J**	0.0050	0.00040	mg/L		12/28/18 12:47	01/03/19 11:14	1
Barium	**0.050**	**J B**	0.20	0.00010	mg/L		12/19/18 14:26	12/27/18 15:18	1
Beryllium	0.0040	U	0.0040	0.00010	mg/L		12/19/18 14:26	12/26/18 22:18	1
Boron	**4.5**	**J**	5.0	0.18	mg/L		12/28/18 12:47	12/30/18 12:35	5
Cadmium	0.0050	U	0.0050	0.00010	mg/L		12/19/18 14:26	12/27/18 15:18	1
Calcium	**140**		1.0	0.053	mg/L		12/19/18 14:26	12/26/18 22:18	1
Chromium	0.0050	U	0.0050	0.00050	mg/L		12/19/18 14:26	12/27/18 15:18	1
Cobalt	**0.0024**	**J**	0.0050	0.00010	mg/L		12/19/18 14:26	12/27/18 15:18	1
Lead	0.0050	U	0.0050	0.00010	mg/L		12/19/18 14:26	12/21/18 21:34	1
Lithium	**0.023**	**J**	0.040	0.0030	mg/L		12/19/18 14:26	12/21/18 21:34	1
Molybdenum	**0.0075**	**J**	0.010	0.0010	mg/L		12/19/18 14:26	12/26/18 22:18	1
Selenium	**0.0059**	**J**	0.010	0.00030	mg/L		12/19/18 14:26	12/26/18 22:18	1
Thallium	0.0020	U	0.0020	0.00080	mg/L		12/19/18 14:26	12/21/18 21:34	1

Method: 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.00020	U	0.00020	0.00010	mg/L		12/20/18 12:26	12/21/18 12:23	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**1100**		25	7.0	mg/L			12/19/18 23:00	1

Beth Ann Gross

ATTACHMENT D

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

REGISTERED PROFESSIONAL ENGINEER
BETH A.
GROSS
18167
OKLAHOMA

____
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

4/25/2019
Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
East Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

July 22, 2019

CHA8462

20190722 Pirkey EBAP Li ASD

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ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASL	Alternate Screening Level
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
DPT	Direct Push Technology
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
HSA	Hollow Stem Auger
LCL	Lower Confidence Limit
LOI	Loss on Ignition
MCL	Maximum Contaminant Level
NTU	Nephelometric Turbidity Unit
PVC	Polyvinyl Chloride
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscope
SSL	Statistically Significant Level
TSS	Total Suspended Solids
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
USCS	Unified Soil Classification System
VAP	Vertical Aquifer Profiling
WBAP	West Bottom Ash Pond
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the East Bottom Ash Pond (EBAP, **Figure 1**). In 2018, two assessment monitoring events were conducted at the EBAP in accordance with 40 CFR 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or alternate screening level (ASL) provided in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at statistically significant levels (SSLs) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey EBAP:

- LCLs for lithium exceeded the GWPS of 0.051 mg/L at AD-31 (0.0556 mg/L) and AD-32 (0.0722 mg/L); and

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.010 mg/L), AD-31 (0.00949 mg/L), and AD-32 (0.0353 mg/L).

No other SSLs were identified (Geosyntec, 2018).

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a*

> *qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSLs identified for lithium should not be attributed to the EBAP. An alternative source for cobalt at wells AD-2, AD-31, and AD-32 was previously identified and documented in an ASD (Geosyntec, 2019).

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for lithium were based on a Type IV cause and not by a release from the Pirkey EBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for lithium and the proposed alternative source are described below.

2.1 Alternative Source for Lithium

Initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify alternative sources due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSLs for lithium have been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

Lithium concentrations vary spatially across the Site and do not necessarily appear correlated with the locations of CCR units or other Plant operations in general. While AD-31 and AD-32 have higher lithium concentrations than the upgradient wells in the EBAP network (i.e., AD-4, AD-12, and AD-18), upgradient as well as downgradient wells having similar or higher concentrations of lithium were observed within the networks for other CCR units at the Site (**Table 1**). Additionally, a boring advanced in November 2018 immediately upgradient of the EBAP (SB-01/AD-40) (**Figure 1**) revealed a strong dependence of lithium concentration with elevation, as groundwater collected at shallow intervals had low lithium concentrations e.g., (0.0207 mg/L at 30-40 feet below ground surface [ft bgs]) and groundwater collected at deeper intervals had elevated lithium concentrations (e.g., 0.0844 mg/L at 90-100 ft bgs).

These results suggest that lithium concentrations in groundwater at the site have variability in both their lateral and vertical distribution across the Site. In addition to variable lithium concentrations, it was noted that the recorded turbidity at each groundwater monitoring well is typically above the recommended maximum value of 10 nephelometric turbidity units (NTU) during groundwater sampling (**Table 1**). The recorded turbidity of samples collected during the background monitoring period was occasionally above 400 NTU, and some readings noted that the turbidity saturated the field instrument (~1000 NTU). Based on these observations, additional field work was completed to better understand the spatial distribution of lithium and its relationship to turbidity. The additional field investigation was conducted in May 2019.

2.1.1 May 2019 Field Investigation

Geosyntec advanced three borings upgradient of the EBAP between May 7 and 17, 2019 (**Figure 2**) to collect groundwater chemistry data at locations sufficiently far upgradient to completely avoid all known (present and historical) Plant activities. One shallow boring, B-1, was advanced to 36 ft bgs on a parcel owned by AEP approximately 2,000 feet to the north. Two deep borings, B-2 and B-3, were advanced to refusal at 93 and 97 ft bgs, respectively, in locations closer to the plant, but upgradient of the EBAP. Permanent wells were installed at locations B-2 and B-3 for ongoing monitoring.

Prior to boring installation, all borings locations were hand-augured to five ft bgs to check for presence of utilities. A Geoprobe® drilling rig with 2" Direct Push Technology (DPT) was used to log and sample the shallow B-1 boring and the shallow intervals of borings B-2 and B-3. Upon refusal with the DPT rig, a truck-mounted 8" hollow stem auger (HSA) drilling rig with a continuous sampler was used to log and sample borings B-2 and B-3 below DPT refusal depth. Soils were logged continuously from the surface using the Unified Soil Classification System (USCS). Boring logs are provided in **Attachment A**. Both soil and groundwater sampling were conducted at each of the three borings. Boring B-1 was not used for a permanent well and was backfilled to the surface with Portland cement and bentonite.

2.1.1.1 Soil Sampling

The onsite hydrostratigraphic unit for the EBAP was identified as the clayey and silty sand stratum located between an elevation of approximately 325 and 340 feet above mean sea level (Arcadis, 2016). This unit is within the Reklaw Formation, which consists predominantly of clay and fine-grained sand and is underlain by the Eocene-age Carrizo Sand. The presence of lignite in the area is well-documented (Broom and Myers, 1966; ETTL, 2010). Geosyntec collected nine additional soil samples to better understand the distribution of lithium in soils in upgradient locations and with depth.

One soil sample at boring B-1, five samples at B-2 (including a sample of coal/lignite material found within the stratigraphic column), and three samples at boring B-3 were collected for total metals analysis via EPA Method 6010. Soil samples were collected just above the groundwater table, at the base of the deep borings, and at intervals of interest. The depths and rationale for each sample collected are summarized in **Table 2**. Except for the coal fragments collected in boring B-2 at 81.5 ft bgs, soil samples represent composite samples of the indicated depth interval.

Lithium concentrations of soil samples collected during the May 2019 field investigation varied from 2.59 mg/kg (B-3, 19.5-20.5 ft bgs) to 13.1 mg/kg (B-2, 87-88 ft bgs), which generally is consistent with soils previously sampled around the site. Results of the coal fragments from 81.5 ft bgs in boring B-2 indicated that the coal contained 4.32 mg/kg lithium. This is comparable to the lithium concentrations of the shallower (< 20 ft bgs) soil samples, which averaged 4.1 mg/kg (n=5), and less than the average concentrations observed in the co-located deeper lithology of 10.54 mg/kg (n=3). Lower lithium in shallower soil intervals could indicate weathering has mobilized lithium from those intervals.

2.1.1.2 Groundwater Sampling

Borings B-2 and B-3 were sampled via vertical aquifer profiling (VAP) techniques, in which multiple temporary well screens were set at the varying depth intervals of interest. Generally, a sample was taken after encountering the water table, followed by subsequent attempts to collect additional samples at ten-foot intervals. Shallow groundwater samples (< 24 ft bgs) were collected from temporary drop screens installed via DPT in offsets from the originally logged location. Two sampling depths were attempted using DPT in borings B-2 and B-3, one at the water table and one ten feet below the water table. In both borings, only the shallower water-table interval produced enough water to sample due to clayey lithology below the water table. One shallow groundwater grab sample was collected at boring B-1 using DPT and temporary well screen methodology.

Following DPT refusal, VAP samples were collected from the same HSA borehole being logged and soil-sampled at borings B-2 and B-3. After removing the HSA continuous sampler, a four-inch diameter polyvinyl chloride (PVC) casing with a five-foot long well screen were temporarily installed through the HSA tooling, and the augers were retracted to expose the well screen to the formation. Following sampling, the well casing and screen was removed and decontaminated, and drilling resumed for another ten feet. Four samples from boring B-2 and six samples from boring B-3 were collected using the HSA VAP methodology. Five-foot intervals in boring B-2 at 68-73 and 88-93 ft bgs and boring B-3 at 92.5-97.5 bgs did not produce enough water to collect a sample due to clay lithology. **Table 3** summarizes the groundwater samples collected in May 2019.

Groundwater VAP sampling was generally completed using a modified low-flow methodology. When possible, flow rates below 500 ml/min were used during purging, and drawdown was monitored. Geochemical parameters and turbidity were monitored, though stability was not observed during purging the temporary well screens. Wells were purged for a minimum of 20 minutes prior to sampling. However, turbidity remained visibly high at all sampling intervals prior to sample collection.

Groundwater VAP samples were sent to the lab on ice for quick turn-around analysis of total lithium concentrations via EPA Method 6010. Due to the high turbidity in the total lithium samples, extra sample volume was collected in an unpreserved one-liter plastic sample bottle for lab filtration using a 0.45-µm filter and analysis of dissolved lithium. Groundwater samples were also analyzed a full scan of metals, total dissolved solids, major anions, and alkalinity.

Total (unfiltered) lithium concentrations varied from 45 µg/L to 1,140 µg/L (**Table 3**). Lithium concentrations in the lab filtered samples varied from 6 µg/L to 105 µg/L. The lab filtered results were generally lower than the total lithium results, suggesting a correlation between turbidity and lithium concentration. Select total lithium concentrations were higher than previously observed at the Site. This is likely due to the fact that the samples were collected without a developed filter pack and with elevated turbidity. Additional groundwater results are available in **Attachment B**. Total metals data for parameters other than lithium are not available for samples from B-2 as they were analyzed using incorrect laboratory techniques.

2.1.1.3 Permanent Well Sampling

Permanent wells were installed at boring B-2 and B-3, with the screened interval based on VAP sampling results. The HSA drilling rig was used to install a well screen at 38 to 48 ft bgs at boring B-2 and 29 to 34 ft bgs at boring B-3. These elevations are consistent with the screened elevations at AD-31 and AD-32. Well construction diagrams are available in **Attachment C**. Wells were installed per state regulations and certified by a Texas licensed driller. After an appropriate set-up time for the bentonite seal, the wells were developed with a Proactive Typhoon pump until turbidity and geochemical parameters stabilized (**Attachment D**). Following well development, both new permanent wells were sampled using low-flow methodology (**Attachment E**).

Total lithium concentrations in permanent wells B-2 and B-3 were measured at 0.053 mg/l and 0.061 mg/l, respectively (**Figure 3**). These concentrations are slightly above the GWPS of 0.051 mg/L. Because these wells were installed at upgradient locations unimpacted by Site activities, they suggest that lithium concentrations above the GWPS are located in the vicinity of the EBAP, but not necessarily related to the prevailing groundwater flow direction. Samples were also collected from AD-31 and AD-32 using low-flow methodology, with special effort taken to purge the well until turbidity was below 10 NTU (**Attachment E**). The reported lithium concentrations for these samples were near or below the lowest value observed during monitoring at these locations to date (**Figure 4**). While not a direct correlation, these results suggest that elevated turbidity may be associated with higher lithium concentrations.

2.1.1.4 Investigation of Suspended Solids

It was noted during VAP and permanent well sampling that lithium is biased toward higher concentrations when samples are very turbid. Therefore, an additional investigation was conducted to evaluate the suspended matter and determine whether it could be serving as a background source of lithium. Unpreserved groundwater samples from intervals VAP-B3-(40-45) and VAP-B3-(50-55) were processed to separate the particulate from the groundwater. Aliquots of each sample were centrifuged at approximately 700 Relative Centrifugal Force for five minutes. The supernatant was then decanted, and the solid pellet was transferred to a small glass vial for chemical analysis. The supernatant had a yellowish color, suggesting that especially fine particulate remained in suspension, but accounted for very little mass.

In addition to the centrifuged material from VAP-B3-(40-45), a sample of the bulk soil from interval B2-(19-20) was submitted for analysis by X-ray diffraction (XRD). XRD is commonly used to identify and quantify crystalline solids among an assemblage of solids. Solids that are amorphous (non-crystalline), such as humic substances and other organic matter, cannot be detected with compositional specificity by XRD.

Results of the XRD analysis indicate the presence of common soil minerals (**Table 4**). The bulk soil [B-2-(19-20)] contained a higher fraction of quartz (67%), which is typical of an unconsolidated sandy aquifer. Soil in this depth interval also contained several percent by weight of clay minerals, including kaolinite, chlorite, illite and smectite. Goethite (a mineral composed of iron(III) hydroxide) comprises 2% of the sample and a form of amorphous (non-crystalline) matter makes up approximately 7% of the sample.

The centrifuged sample [VAP-B3-(40-45)] contained less quartz (15%), a higher fraction of clay minerals (42% kaolinite, 4% chlorite, 6% illite and 12% smectite), and 15% (roughly estimated) amorphous matter. According to the XRD results, this soil fraction contains 2% hematite, an iron(III) oxide (Fe_2O_3) and 3% pyrite.

Sulfur and iron were among the elements identified in the VAP-B3-(50-55) centrifuged solid material sample by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Results, reported as weight percent oxides and sulfide in **Table 5**, show 3.4% FeS_2 and 2.8% Fe_2O_3. While these results express chemical composition rather than mineralogy, it is reasonable to infer that FeS_2 represents pyrite and Fe_2O_3 represents hematite (Fe_2O_3) and goethite ($Fe_2O_3 \cdot H_2O$) based on the XRD results. Silica, aluminum and potassium oxides correspond to the quartz and clay minerals identified in **Table 4**.

The abundance of smectite in both XRD samples bears consideration. Smectite is a group name for certain clay minerals with a 2:1 silicate structure which form crystals that are typically sub-micrometer in size. Common types of smectite include montmorillonite and beidellite, but a lithium-bearing form called hectorite is also well known (USGS, 2001). Smectites have among the highest cation-exchange capacities of all clay minerals: their interlayer regions can sorb roughly 100 milli-equivalents of cation charge per 100 grams of clay (100 meq/100 g). Exchangeable metals often include calcium and sodium, but almost all metals with +1 or +2 charge are potential exchange species. The SEM/EDS results also confirm that aluminum and silicon are major constituents, which supports the XRD finding that clays are the predominant mineral in suspension. The presence of potassium also helps confirm the presence of illite (mica), which was identified by XRD.

It is noteworthy that the centrifuged solid material had a higher fraction of amorphous (non-crystalline) material, which could include organic solids. Moreover, this amorphous material may be what contains the abundance of clay minerals. While the XRD results are inconclusive, one possibility is that the amorphous material is lignite and the clays are associated with its mineral fraction.

Because XRD cannot identify if lithium is present within a sample, the centrifuged solid material was submitted for total metals analysis. An additional sample of suspended matter from VAP interval B3-(50-55) was also submitted for metals analysis, as it had the highest total lithium of all the VAP samples that were collected. Lithium was detected in B3-(50-55) and B3-(40-45) (**Table 6**) at concentrations comparable to lithium in the bulk soil (**Table 2**). These results provide evidence that the particulates captured during groundwater sampling contain lithium.

Metals in a lignite sample from the nearby surficial mine were compared to concentrations in the suspended matter (**Figure 5)**. The concentrations of lithium and other constituents are similar, suggesting that some fraction of the suspended solids consists of degraded lignite. Thin seams of lignite were noted in boring logs at the depth most monitoring wells at the Site were installed (**Attachment A**).

Loss on ignition (LOI) testing was completed to quantify mass loss after heating the sample to 550°C in an oxygen-rich environment, which allows for measurement of the combustible carbon and loss of semi-volatile constituents. Centrifuged solid material from both the VAP B3-(40-45) and B3-(50-55) fraction were air-dried in pre-weighed pans to 103˚C to remove excess water from the samples. The samples were weighed again and then heated to 550˚C until the mass of the fraction was steady, signifying complete combustion of the volatile fraction. The B3-(40-45) sample had a volatile fraction of 13.1%, and the B3-(50-55) sample had a volatile fraction of 11.4% of the total mass, respectively. These fractions are believed to represent organic compounds, such as lignite. The volatile fraction in the 40-45 ft sample (13.1%) is in good agreement with the determination of 15% amorphous matter by XRD (**Table 4**). By difference, the solid fractions consist of 87-89% refractory minerals including clays, metal oxides, and pyrite. Because lignite typically contains ~20 % hydrocarbons (plus oxygen and nitrogen), and only 6-19% mineral matter (Ghassemi, 2001), the results of the LOI tests suggest that most of the organic fraction of the lignite has been lost to degradation, primarily leaving the mineral fraction in place of the original lignite deposit.

Based on chemical analysis of the two solid samples, the iron content is 1.1% for B-2 and 2.6% for B-3, which is comparable to the amount of iron in the lignite sample (1.4%) from the Plant (**Table 6**). While some of the iron is associated with the oxidized iron minerals, goethite and hematite, which were detected by XRD (**Table 4**), some iron is likely present in pyrite as well. As noted above, pyrite was detected by XRD in the particulate sample (B-3) and iron and sulfur were both detected in the particulate by SEM/EDS, but the results were not quantified.

Together with the evidence presented for pyrite in the suspended solids and in locally-mined lignite, the solid phase results support the proposed alternative source for lithium, which is naturally suspended matter that likely originates from lignite and is ubiquitous in the shallow aquifer.

The total metal concentrations in the centrifuged solid material samples and the total groundwater concentrations were used to calculated partition coefficients values (K_d) for multiple constituents, including lithium. The calculated K_d values were comparable to literature K_d values reported for organic-rich soil media such as bogs and peats (**Table 7**) (Sheppard et al, 2009; 2011). Additionally, total suspended solids (TSS) concentrations were calculated using the solids and groundwater concentrations and compared to TSS concentration measured using gravimetric techniques (**Table 7**). These values were also comparable, providing further evidence that lithium behavior at the site is similar to its adsorption and mobility at other organic-rich sites described in the literature.

2.1.2 Proposed Mechanism for Lithium Transport in Groundwater

Based on the chemistry results, it is proposed that lithium is associated with clay minerals that make up the mineral fraction of lignite, which is deposited in thin beds at various depths within the aquifer. Clay particles which remain suspended due to their association with the lignite matrix are the vehicle for lithium transport. It appears that these particles remain in suspension during low-flow groundwater sampling even after very long purge times, as evidenced by the historical high turbidities measured in Site groundwater. During groundwater sampling, an abundance of suspended matter is mobilized with the sample which, after nitric-acid preservation, releases the lithium into solution where it often results in elevated concentrations.

A simple model to illustrate the effect of suspended solids on total (unfiltered) lithium is shown in **Figure 6**. This model used the partition coefficients described in Section 2.1.1 to calculate the dissolved phase concentrations of lithium plus the contribution of lithium to groundwater by the particulate (see **Table 7**). Although results for the two sources are not identical, the figure shows that when the abundance of suspended matter reaches a certain level (approximately 10 g/L or higher) the total lithium (dissolved plus suspended) can greatly exceed that of the dissolved phase alone. According to the model, lithium concentrations are less variable when lower concentrations of suspended solids are present in groundwater. This provides an explanation for why observed lithium concentrations at the Site are not clearly correlated with turbidity. The analytical data, geologic information, and sorption model presented above provide a mechanism for the distribution and transport of naturally occurring lithium in Site groundwater.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSLs for lithium at wells AD-31 and AD-32 identified during assessment monitoring in 2018 were not due to a release from the EBAP. The identified SSLs were, instead, attributed to natural variation in the underlying geology. Therefore, no further action for lithium is warranted, and the EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in **Attachment F**.

SECTION 4

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Figures

Legend

- ◆ Monitoring Well
- ▭ EBAP
- ▭ Landfill
- ▭ Stack Out Area
- ▭ WBAP

Notes

- Monitoring well coordinates provided by AEP.
-AD-15 location is approximated

800 400 0 800 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio

2019/07/10

Figure

1

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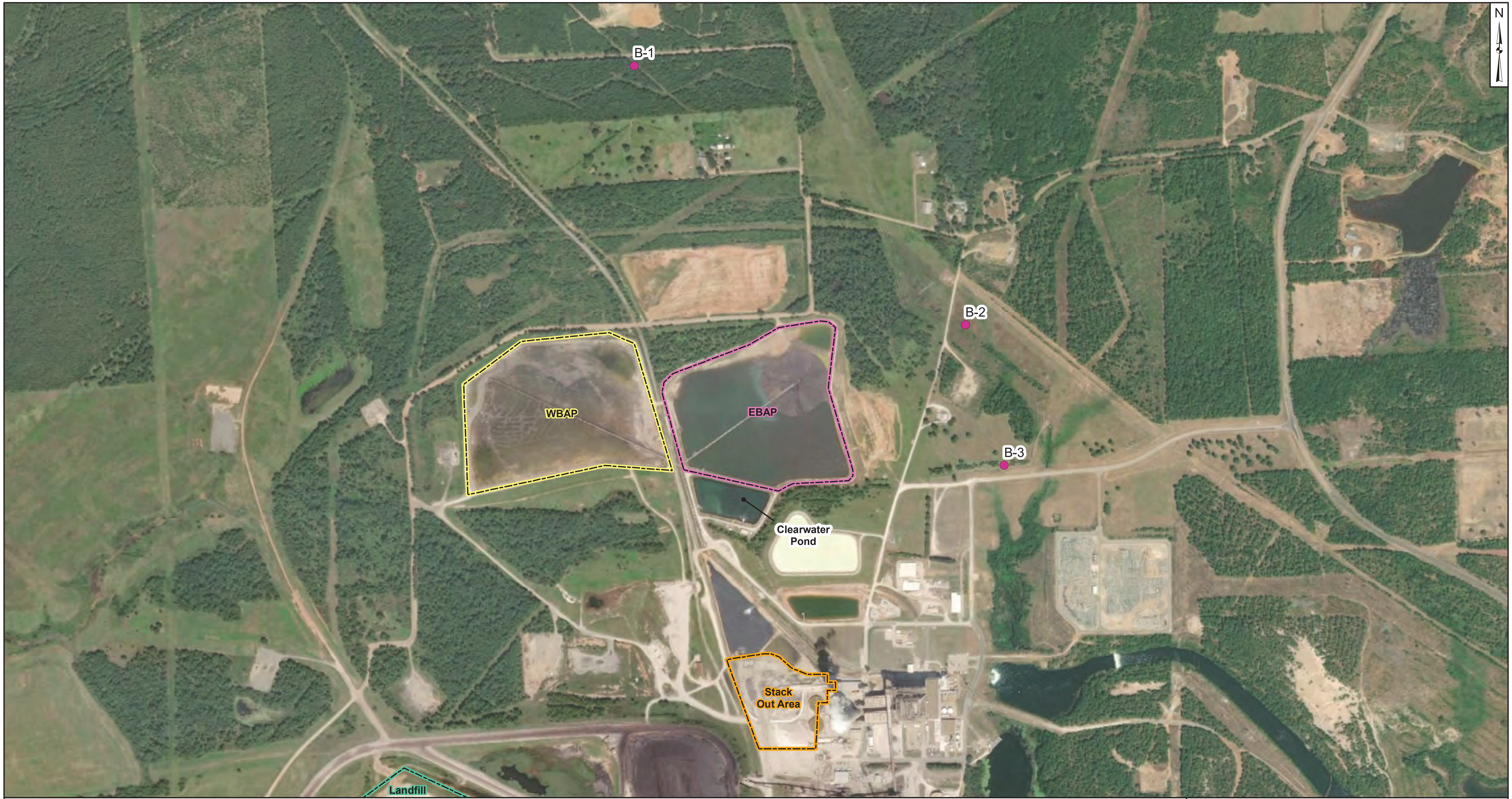

Legend

- ● Soil Boring Location
- ▭ EBAP
- ▭ Landfill
- ▭ Stack Out Area
- ▭ WBAP

Notes

-Data provided by AEP, 2019.

-Soil Boring locations are approximate.

0 350 700 1,400 2,100 Feet

Soil Boring Locations

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/07/10

Figure 2

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Legend

● Borehole

⊕ Monitoring Well

Location Boundaries

🟪 EBAP

🟩 Landfill

🟧 Stack Out Area

🟨 WBAP

Notes

- Lithium concentrations in mg/l
- Monitoring well coordinates and water level data (collected on August 20-21, 2018) provided by AEP.
- Data provided by AEP 2019
- AD-15 location is approximated

0 150 300 600 900 1,200
Feet

Lithium Values
May 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio | 2019/07/10

Figure
3

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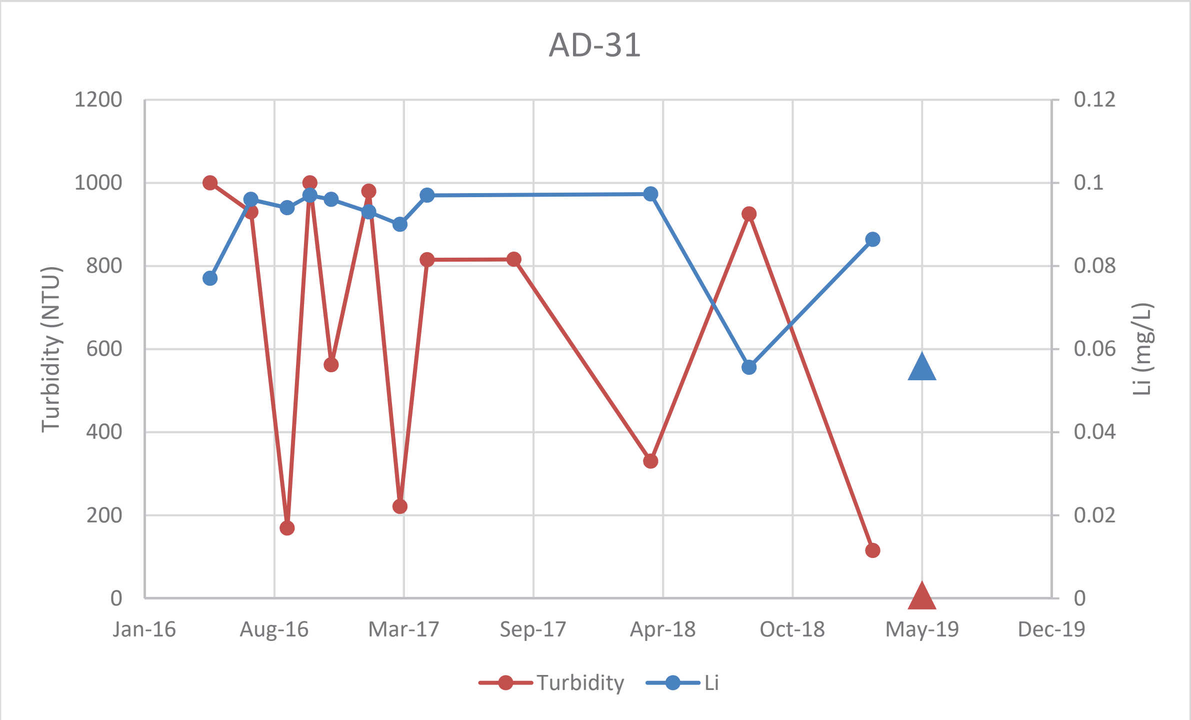
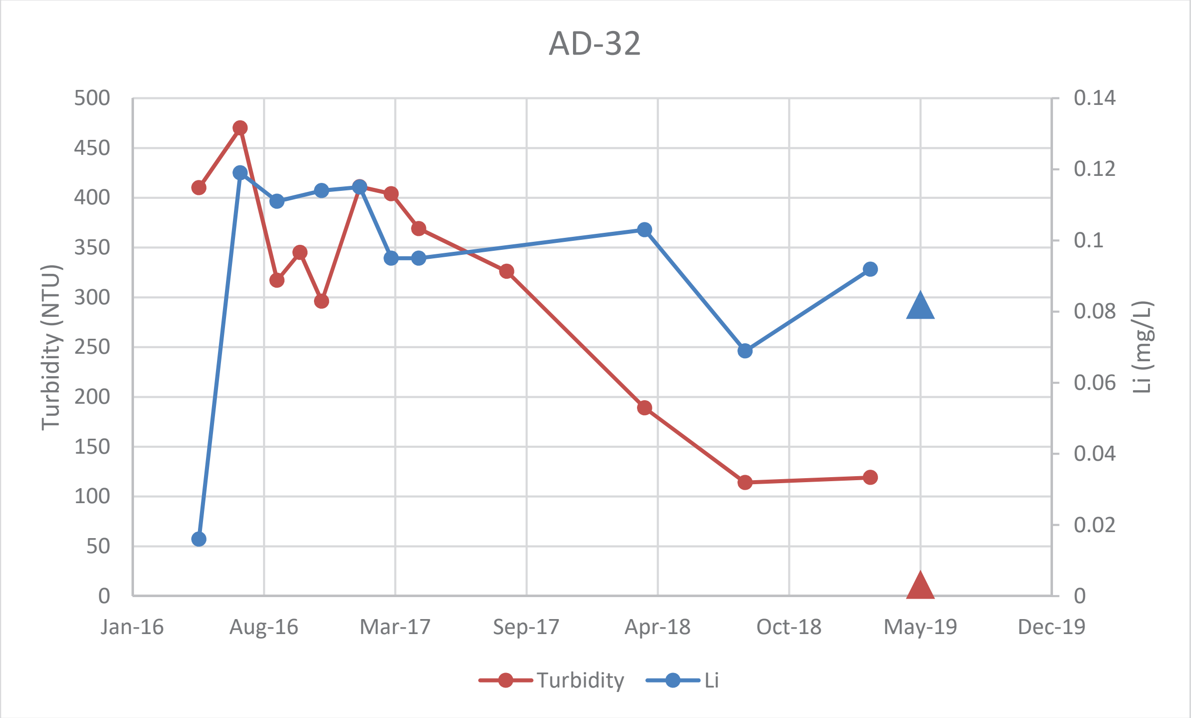




Notes:
NTU: nephelometric turbidity units
mg/L: milligrams per liter

Lithium and Turbidity Time Series Graphs

Pirkey East Bottom Ash Pond

Geosyntec consultants

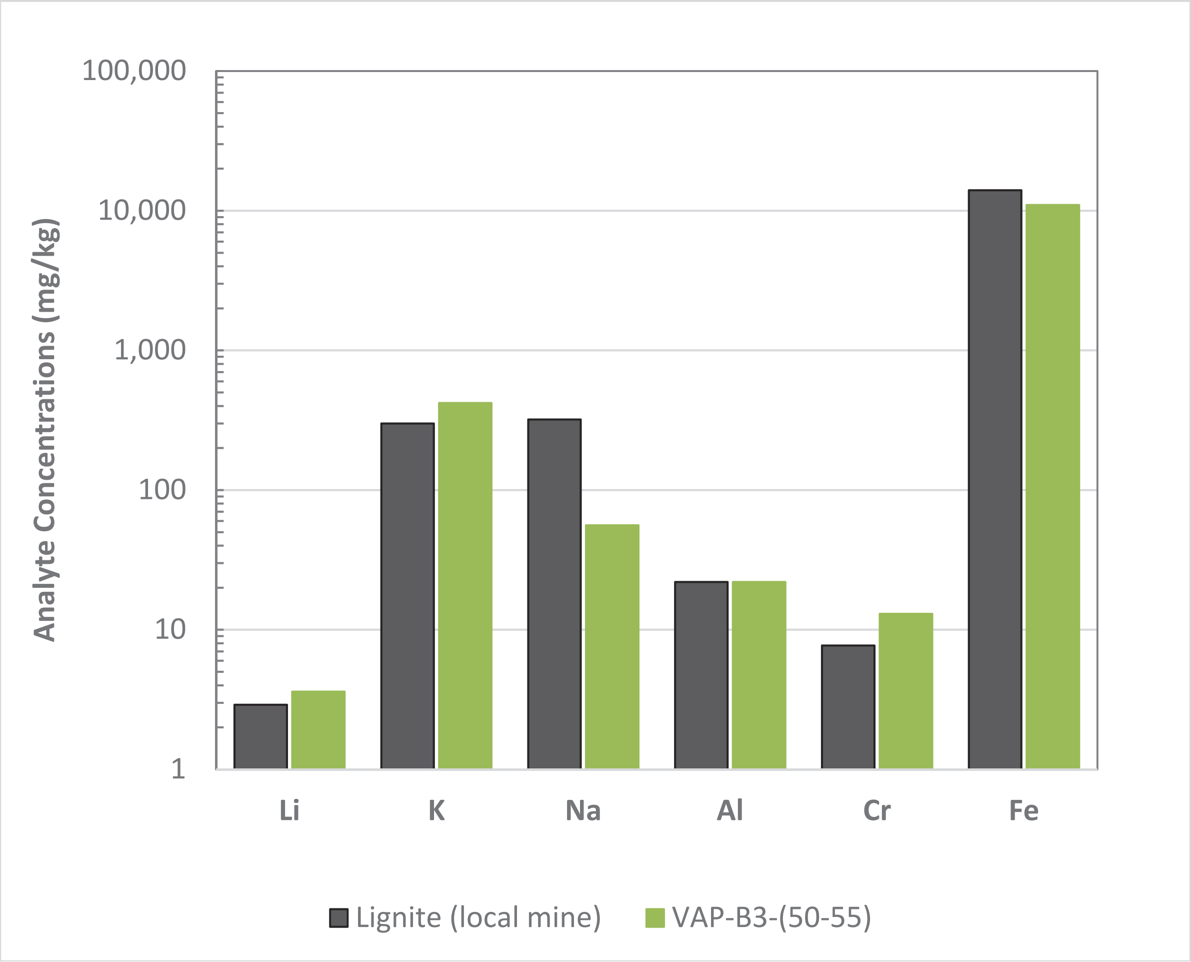
AMERICAN ELECTRIC POWER

Figure
4

Columbus, Ohio

7-Jul-2019

internal info: path, date revised, author



Notes: VAP-B3-(50-55) sample was obtained by centrifuging suspended solids in groundwater at the 50-55 ft interval. Locally mined lignite was collected from the coal pile at the Site.

Total Metals Concentrations

Pirkey East Bottom Ash Pond

Geosyntec consultants

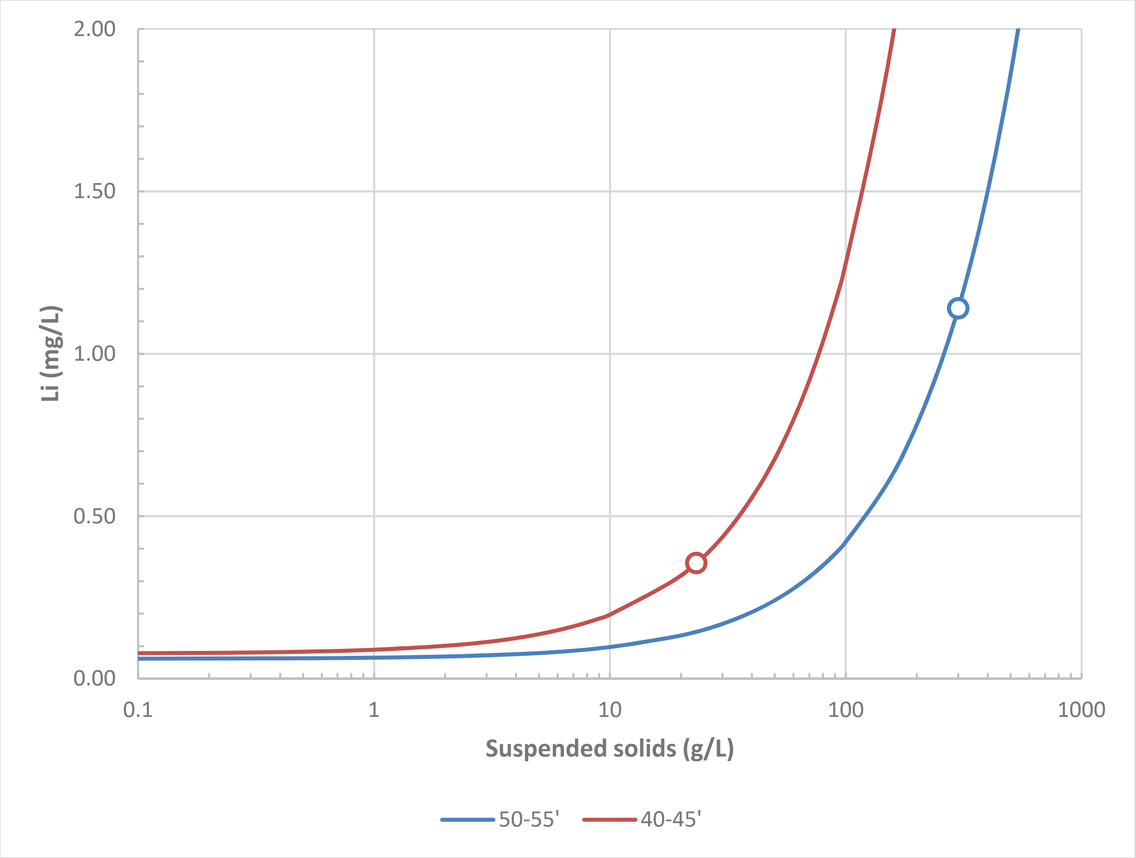
AMERICAN ELECTRIC POWER

Columbus, Ohio

7-Jul-2019

Figure

5



Notes: Model for lithium concentrations based on sorption on suspended solids. The model was generated using the results from VAP-B3-(50-55) and –(45-55). Symbols represent results of unfiltered samples.

Calculated Lithium Sorption Model

Pirkey East Bottom Ash Pond

Geosyntec consultants

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Figure

6

Columbus, Ohio

7-Jul-2019

internal info: path, date revised, author

Tables

Table 1: August 2018 Groundwater Lithium and Turbidity Results
Pirkey Plant - East Bottom Ash Pond

Well	Lithium (mg/L)	Turbidity (NTU)	CCR Unit Network
AD-2	0.0479	155	EBAP
AD-3	0.0876	190	WBAP
AD-4	0.0294	201	EBAP
AD-7	0.0877	103	Stackout
AD-8	0.0221	103	Landfill
AD-12	0.0143	177	EBAP/WBAP/Landfill/Stackout
AD-13	0.146	181	Stackout
AD-16	0.0347	100	Landfill
AD-17	0.0234	124	WBAP
AD-18	0.0175	278	EBAP/WBAP
AD-22	0.132	235	Stackout
AD-23	0.00634	995	Landfill
AD-27	0.0921	279	Landfill
AD-28	0.0307	216	WBAP
AD-30	0.0118	142	WBAP
AD-31	0.0556	925	EBAP
AD-32	0.0689	114	EBAP
AD-33	0.0178	102	Stackout
AD-34	0.114	131	Landfill
AD-35	0.00876	258	Landfill

Notes:
mg/L: milligrams per liter
NTU: nephelometric turbidity units
EBAP: East Bottom Ash Pond
WBAP: West Bottom Ash Pond
Stackout: Stackout Pad

Table 2: Soil Sampling Results
Pirkey Plant - East Bottom Ash Pond

	Boring	**B-1**	**B-2**					**B-3**		
	Depth (ft bgs)	**16-21**	**9.5-10.5**	**19-20**	**71-72**	**81.5**	**87-88**	**9.5-10.5**	**19.5-20.5**	**96.5-97**
	Sampling Rationale	Soil above groundwater table	Soil 10 ft bgs	Soil above groundwater table	Soil with abundant coal material	Coal Fragments	Soil at auger refusal depth (93 ft bgs)	Soil 10 ft bgs	Soil above groundwater table	Soil at auger refusal depth (97 ft bgs)
	Soil Type	Sandy clay/clay/ clayey sand	Fat clay	Clay, medium plasticity	Coal/sand interbeds with clay	--	Silty clay, low plasticity	Silty clay	Fat clay	Silty clay, low plasticity
Metals Concentrations (mg/kg)	**Aluminum**	NM	NM	NM	NM	NM	NM	15600	8170	NM
	Antimony	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25
	Arsenic	14.3	17.9	12.3	7.94	5.01	1.88	17.4	9.96	0.89
	Barium	51.7	53.8	39.5	39.4	53.7	27.5	47.2	206	35.5
	Beryllium	0.376	0.477	0.385	0.217	1.99	0.233	0.419	0.301	0.273
	Boron	11.9	11	13.1	13.6	48.3	12.1	11.2	5.44	7.8
	Cadmium	0.185	0.116	0.234	0.208	<0.05	<0.05	<0.05	<0.05	0.05
	Calcium	183	117	195	245	1820	479	36	45.4	226
	Chromium	37.6	33.3	26.2	6.93	42.5	16.1	31.2	19.6	13.2
	Cobalt	2.95	2.36	3.62	10.3	7.21	3.11	1.3	0.593	1.11
	Iron	41000	36900	42800	38100	22600	17300	25300	13800	2880
	Lead	12.1	9.31	8.29	6.87	9.5	10.5	8.8	5.21	9.1
	Lithium	5	5.3	3.97	7.42	4.32	13.1	3.64	2.59	11.1
	Magnesium	968	2840	1720	362	716	845	1400	528	365
	Manganese	15.6	10.4	12.7	38.8	48.8	32.1	10.5	6.9	16.1
	Molybdenum	0.828	0.608	0.479	3.38	1.63	0.8	0.692	0.654	0.334
	Nickel	NM	NM	NM	NM	NM	NM	3.05	4.26	NM
	Potassium	1370	2360	1860	456	276	663	2230	1120	437
	Selenium	1.57	1.02	1.13	2.04	2.52	1.84	0.666	0.448	1.39
	Sodium	53.1	139	51.7	57.6	86.3	53.7	47.3	56.3	39.9
	Strontium	62.5	47.9	13.4	6.52	15.5	10.5	12.8	6.51	8.24
	Thallium	<0.25	<0.25	<0.25	0.306	0.799	<0.25	<0.25	<0.25	<0.25
Dry Weight (%)		74.3	78.5	78.9	84.7	75.3	87.3	80.3	78.5	86.8

Notes:

ft bgs - feet below ground surface

< - Analyte not detected above analytical detection limit

NM - Not measured

Table 3: Groundwater Lithium Sampling Results
Pirkey Plant - East Bottom Ash Pond

Boring	Depth Interval (ft bgs)	Drilling Method	Lithium Concentration (mg/L)	
			Total	Lab Filtered
B-1	16-21	DPT	0.202	0.022
B-2	10-14	DPT	0.045	0.006
	38-43	HSA	0.140 (0.142)	0.056 (<0.05)
	48-53	HSA	0.112	<0.05
	58-63	HSA	0.143	<0.05
	78-83	HSA	0.201	0.097
B-3	20-24	DPT	0.053	0.013
	33-37	HSA	0.152	0.105
	40-45	HSA	0.356	0.077
	50-55	HSA	1.140	0.061
	60-65	HSA	0.098	0.052
	72.5-77.5	HSA	0.812	0.009
	82.5-87.5	HSA	0.102	0.023

Notes:
< - Analyte not detected above analytical detection limit
DPT: Direct push technology
HSA: Hollow stem auger
Results for other groundwater parameters available for B-1 and B-3 in Attachment B.
Total lithium results from unfiltered sample volume collected in HNO_3 preserved bottle.
Lab filtered results from laboratory vacuum-filtered sample volume collected in unpreserved bottle.
Duplicate results in parentheses.

Table 4: X-Ray Diffraction Results
Pirkey Plant - East Bottom Ash Pond

	B-2(19-20)	**VAP-B3-(40-45)**
Quartz	67	15
Plagioclase Feldspar	ND	0.5
Orthoclase	<0.5	ND
Calcite	<0.5	ND
Dolomite	1	ND
Siderite	ND	0.5
Goethite	2	ND
Hematite	ND	2
Pyrite	ND	3
Kaolinte	4	42
Chlorite	1	4
Illite/Mica	2	6
Smectite	16	12
Amorphous	7	15

Notes:

ND: Not detected

<0.5 indicates mineral phase is present but below quantification limits.

B-2(19-20) sample represents bulk soil.

VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

Table 5: SEM/EDS Microscopy Results
Pirkey Plant - East Bottom Ash Pond

	Centrifuged Material (Weight Percent)
Al_2O_3	31.1%
SiO_2	60.9%
FeS_2	3.4%
K_2O	1.7%
TiO_2	ND
Fe_2O_3	2.8%

Notes:

ND: component not detected

concentration below the analytical detection limit

Centrifuged material was the solid material which separate from the groundwater sample at VAP interval B3-(50-55) after centrifugation.

Oxide calculations are expressed on a dry basis and do not include molecular structural water.

Table 6: Centrifuged Solids Total Metals Results
Pirkey Plant - East Bottom Ash Pond

Depth (ft bgs)		B3-(40-45)	B3-(50-55)	Lignite
Analyte Concentrations (mg/kg)	Aluminum	68 J	22 J	22 J
	Boron	6.4 J	2.3 J	77
	Calcium	1,200	160 J	7,700
	Chromium	37	13	7.7
	Iron	26,000	11,000	14,000
	Lithium	12	3.6 J	2.9 J
	Magnesium	880	260	1,900
	Potassium	960	420 J	300 J
	Sodium	270 J	56 J	320 J
	Mercury	1.1	0.026 J	0.13 J

Notes:
ft bgs - feet below ground surface
< - Analyte not detected above analytical detection limit
mg/kg: milligrams per kilogram
J - Estimated analyte concentration below the reporting limit and above the method detection limit
B-3 samples are centrifuged solid material separated from groundwater samples collected at the designated interval.
Lignite was collected from a local mine.

Table 7: Calculated Site-Specific Partition Coefficients
Pirkey Plant - East Bottom Ash Pond

Source	B-3 40-45 ft bgs						Literature Value
Unit	mg/L	mg/L	mg/L	mg/kg	g/L	L/kg	L/kg
Element	**Aqueous Phase**	**Aqueous + Suspended**	**Suspended**	**Adsorbed**	**Calculated Suspended Solids**	**Kd**	**Kd**
Li	0.0770	0.356	0.279	12	23	156	43-370
K	2.46	19.1	16.6	960	17	390	42-1200
Na	12.6	18.1	5.50	270	20	21	5.2-82
Mg	1.92	12.6	10.7	880	12	458	46-1400
Ca	1.84	7.00	5.16	1200	4	652	24-460
Cr	0.0442	0.253	0.209	37	6	838	140-5,500
B	0.02	0.03	0.01	6.4	2	320	63-170
Fe	2.03	361	359	26000	14	12808	4900-160000
Measured Total Suspended Solids					10		

Source	B-3 50-55 ft bgs						Literature Value
Unit	mg/L	mg/L	mg/L	mg/kg	g/L	L/kg	L/kg
Element	**Aqueous Phase**	**Aqueous + Suspended**	**Suspended**	**Adsorbed**	**Calculated Suspended Solids**	**Kd**	**Kd**
Li	0.061	1.14	1.079	3.6	300	59	43-370
K	2.86	53.3	50.44	420	120	147	42-1200
Na	12.8	17.9	5.1	56	91	4	5.2-82
Mg	0.925	41	40.075	260	154	281	46-1400
Ca	0.749	16.4	15.651	160	98	214	24-460
Cr	0.0213	1.9	1.879	13	145	611	140-5,500
B	0.203	0.675	0.472	2.3	205	11	63-170
Fe	3.88	1440	1436	11000	131	2835	4900-160000
Measured Total Suspended Solids					51		

Notes:
mg/L: milligrams per liter
mg/kg: milligrams per kilogram
g/L: grams per liter
L/kg: liters per kilogram
Kd: partition coefficient
Adsorbed values are total metals concentrations reported by USEPA Method 6010B.
Literature values represent maximum and minimum values for the parameter as reported in Sheppard et al, 2009 (Table 4-1, all sites) and Sheppard et al, 2011 (Table 3-3 cultivated peat and wetland peat only).

Attachment A

Boring Logs

Soil Boring Log

Project: AEP Pirkey
Boring/Well Name: B-1
Project Location: Hallsville, TX
Boring Date: 5/14/2019

Soil Profile

Depth Scale Feet	Water Table	Description		PID
		0.0' - 5.0' were hand augered on a previous date.		
0		0.0'-1.0':	No Recovery	
		1.0'-4.0':	Light gray and dark red clay, medium plasticity, low stiffness; trace silt	
		4.0'-5.1':	No Recovery	
5		5.1'-5.5':	Light gray and dark red clay, high plasticity, low stiffness	
		5.5'-8.0':	Light gray and orange clay, high plasticity, low stiffnedd; trace silt	
		8.0'-8.9':	Light gray and dark red clay, high plasticity, low stiffness	
		8.9'-9.6':	Light purple and gray clay, high plasticity, low stiffness; trace silt	
		9.6'-10.5':	Light gray sandy clay, very fine grained; sand grains are orange	
10		10.5'-10.7':	Light gray fine grained sand, very well sorted	
		10.7'-10.9':	Moist, Tan and orange fine grained sand, very well sorted	
		10.9'-12.0':	Light purple and gray sandy clay	
		12.0'-12.5':	No Recovery	
		12.5'-13.0':	Moist, Light brown silty clay	
15		13.0'-14.1':	Moist, light brown silty sand, fine grained, moderate sorting	
		14.1'-16.0':	Light purple and gray clay, medium stiffness, medium plasticity	
		16.0'-17.3':	Wet, light brown sandy clay	
	🟦	17.3'-20.0':	Maroon/Purple clay, high stiffness, medium plasticity	
20		20.0'-20.9':	Wet, Light brown clayey sand	
		20.9'-24.0':	Maroon/Purple clay, high stiffness, low plasticity; trace brown silt	
		24.0'-24.3':	Maroon/Purple clay, high stiffness, low plasticity; trace brown silt	
		24.3'-26.5':	Dark purple/black clay, high stiffness, no plasticity	
25		26.5'-28.0':	Moist, Dark gray clayey sand, fine grained	
		28.0'-28.7':	Wet, Brown and dark gray clayey sand	
		28.7'-29.7':	Dark gray fine grained sand, well sorted; trace sand	
		29.7'-30.3':	Dark gray clay, medium stiffness, Medium plasticity	
30		30.3'-30.6':	Tan silt with gravel	
		30.6'-32.0':	Dark gray/black and purple clay, very high stiffness, no plasticity	
		32.0'-33.8':	Wet, Brown and dark green silty clay, low plasticity	
		33.8'-35.1':	Moist, Dark green fine grained sand, well sorted	
35		35.1'-36.0':	Moist, Dark gray fine grained sand, well sorted; trace clay	
			EOB @ 36' BGS	
			Boring backfilled with bentonite	
40				

Drill Rig Geoprobe 7822 DT
Drilling Contractor: Best Drilling
Driller: Ramon Gutierrez

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey
Boring/Well Name: B-2
Project Location: Hallsville, TX
Boring Date: 5/13/2019 to 5/17/2019

Soil Profile

0.0' - 5.0' were hand augered on a previous date.

Depth Scale Feet	Water Table	Description		PID
0		0.0'-0.5':	Black, soft fine grained silty sand, vegetation	
		0.5-2.0':	Red/brown fine grained sand, moderate sorting	
		2.5-5.0':	Alternating layers red+brown sandy clay, low plasticity	
5		5.0-5.5':	No Recovery	
		5.5-6.7':	Gray + brown/red sandy clay, medium plasticity, low stiffness	
		6.7'-8.0':	Gray clay, medium plasticity, medium hardness with brown/red sand lenses throughout	
		8.0-11.0':	Gray clay with brown striations, high stiffness, high plasticity, tree roots present @ 8.3' bgs	
10		11.0-11.5':	Gray clay, medium stiffness, high plasticity, trace gravel @ 11.25'	
		11.5-12.0':	(Gray) clayey (red-brown) sand, poorly sorted, soft	
		12.0-14.0':	No Recovery	
		14.0-14.75':	Reddish brown + gray sandy clay, trace gravel @ 14.5', medium stiffness, medium plasticity	
		14.75-16.0':	Gray + red clay, medium hardness, high plasticity, trace brown fine grained sand	
15		16.0-18.5':	No Recovery	
	■	18.5-18.75':	Soft, red + gray clay, high plasticity, trace silt	
		18.75-18.95':	Tan, sand fine-coarse grained, poorly sorted, small coal fragment	
		18.95-20.0':	Red/dark gray clay, high stiffness, medium plasticity	
20		20.0-21.1':	No recovery	
		21.1'-21.8':	Wet, sandy clay, light brown + red	
		21.8-24.0':	Red + dark gray clay, hard stiffness, medium plasticity; 1" gravel lens present @ 22.5'	
		24.0-24.5':	Light brown sandy clay, wet, very soft, no plasticity	
		24.5-24.8':	Red-brown sandy clay, wet, medium plasticity	
25		24.8-28.0':	Purple + gray clay, high stiffness, no plasticity, trace fine grained sand @ 25.0' & 26.7'	
		28.0-29.9':	Dark purple clay, high stiffness, no plasticity	
30		29.9-30.7':	Black/dark gray clay, high stiffness, no plasticity	
		30.7-32.0':	Balck/dark gray silty clay, medium stiffness, medium plasticity	
		32.0-33.5':	Dark gray silty clay, soft, high plasticity	
		33.5-36':	Black silty clay, high stiffness, no plasticity	
35		36-36.5':	No recovery	
		36.5-40':	Dark green fine grained sand, well sorted	
40				

Geoprobe refusal @ 40' bgs. HSA continued drilling, log continued on next page.

Drill Rig Geoprobe 7822 DT & HSA Rig
Drilling Contractor: Best Drilling & AEP Drillers
Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey
Boring/Well Name: B-2
Project Location: Hallsville, TX
Boring Date: 5/13/2019 to 5/17/2019

Depth Scale Feet	Water Table	Soil Profile Description		PID
35		0.0' - 40.0' were drilled with DPT, logged on previous page. HSA boring log follows.		
		38.1-38.3':	Dark brown silty sand, fine grained, trace clay, loose, wet, well graded	
		38.3-38.4':	Very dark brown clayey sand; thin seam of red-brown lean clay @ 38.4', med soft	
		38.4-38.5':	Dark green silty sand, fine grained, wet	
		38.5-39.0':	Dark brown silty sand, fine grained, trace clay, loose, wet, well graded	
		39.0-39.2':	Laminated sandy clay/clayey sands, gray to dark gray, loose/soft, wet	
40		39.2-43.1':	No Recovery	
		43.1-44.5':	Greenish gray w. graded fine sand w/ trace silt, loose, wet; thin layer of light gray silty sand @ 44.5'	
		44.5-47.0':	Dark brown clayey sand/sandy clay, fine sand, w. graded, low plastiicty, dense/stiff, moist	
		47.0-48.1':	No Recovery	
45				
		48.1-54.2':	Same clayey sand/sandy clay as above; thin bed of gray fine grained sand, trace clay @ 51.6'	
50				
		54.2-55.0':	Dark brown hard, sandy clay, low plas	
55		55.0-57.1':	Dark brown clayey sand/sandy clay, fine sand, w. graded, low plastiicty, dense/stiff, moist	
		57.1-58.1':	Dark brown clayey sand w/ thin intermittent balck hard material layers, possible coal/plant debris	
		58.1-61.9':	Dark grayish brown clayey sand, fine grained, w. graded, moise, med-dense to loose	
60		61.9-63.1':	Same clayey sand as above with thin bands of mottled dark brown silty clay with gray silty sand	
		63.1-64.6':	Gray silty sands mottled 50/50 w/ dark brown sandy clays, trace coal fragments, stiff/dense	
65		64.6-68.1	Grades from above to thinly laminated interbeds of silty/clayey sands and sandy clay. Clays are dark brown, sand is gray. Low plasticity, moist, dense/stiff	
		68.1-70.7':	Dark brown sandy clay w/ 1% mottles of gray silty sand, low plasticity, trace moist, silty, stiff	
70		70.7-71.3':	Dark brown clayey sand, fine grained, trace coal fragments, moist, dense/med dense	
		71.3-71.5':	Interval of coal/sand interbeds w/ clay, friable	
		71.5-73.5':	Dark brown sandy clay, low plas, trace moist, stiff to hard	
		73.5-74.5':	Sandy clay grading to clayey sand (fine grained, w. graded moist)	
		74.5-75.1':	Gray silty sand, fine grained, moist, w. graded, med. Dense	
75				

Drill Rig Geoprobe 7822 DT & HSA Rig
Drilling Contractor: Best Drilling & AEP Drillers
Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey
Boring/Well Name: B-2
Project Location: Hallsville, TX
Boring Date: 5/13/2019 to 5/17/2019

Soil Profile

Depth Scale Feet	Water Table	Description		PID
75		75.1-75.3':	SAA except trace clay	
		75.3-75.6':	Interval of gray sand interbedded w/ dark brown silty/sandy clay	
		75.6-79.2':	Dark brown clayey sand w/ some 1-2 mm lenses of gray sand mottled throughout, moist, fine grained, dense. Dark brown interbeds of silty clay @ 78.1-79.2'	
		79.2-80.4':	Dark brown sandy clay mottled w/ gray sand, stiff, low plasticity, trace moist, trace coal fragments	
80		80.4-82.1':	Dark grayish brown silty sand w/ trace clay, loose; coal fragment @ 81.6'	
		82.1-83.6':	Dark brown silty clay w/ some sand, low plasticity, hard, trace moist; thin lighter color laminations @ 83.1'	
		83.6-85.5':	Dark grayish brown sandy clay, fine sand, low plasticity, very stiff, trace mottles of sandier material, trace moist	
85		85.5-93.1':	Dark reddish brown silty clay w/ trace fine sand, trace moist, hard, low plasticity, trace mottles of light gray sand, some black mottling. Color fades to dark brown when exposed to air.	
90		90.1'	Thin gray sand seam	
		92.3'	Thin gray sand seam	
			HSA refusal, EOB @ 93.1' bgs	
			Boring grouted to surface, permanent well installed in offset w/ screen @ 38-48' bgs.	
95				
100				
105				
110				
115				

Drill Rig: Geoprobe 7822 DT & HSA Rig
Drilling Contractor: Best Drilling & AEP Drillers
Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey
Boring/Well Name: B-3
Project Location: Hallsville, TX
Boring Date: 5/7/19, 5/13/19

Soil Profile

Depth Scale Feet	Water Table	Description		PID
		0.0' - 5.0' were hand augered		
0		0.0-2.0':	Clay, medium-red brown, some fine to medium grain material, poorly graded, silty clays, medium plasticity, medium dense, dry, mottled	
		2.0-3.0':	Clay, light brown, some fine to medium grain material, poorly graded, silty clays, medium plasticity, medium dense, dry, mottled	
		3.0-4.0':	Organic clay, Grey to light brown, soft, medium density, some medium grain sand, moist	
		4.0-4.5':	Organic clay, light brown, soft, medium density, moist	
		4.5-5.0':	Organic clay, light brown to reddish brown, soft, medium density, moist	
5		5.0-9.5':	Organic clay, light brown to reddish brown, soft, medium density, moist	
		9.5-10.5':	Silty clay, reddish-orange, poorly graded, medium to low plasticity, wet (perched zone)	
10		10.5-11.0':	Poorly-graded gravel, lense of cobbly material, moist	
		11.0-13.0':	Clayey sand, mottled clay and sand	
		13.0-13.9':	Sandy clay, brown to orange, low plasticity, some cobbles, loose, wet, nonplastic	
		13.9-15.0':	Sand, orange, loose, nonplastic, very fine grained, moist	
15		15.0-16.0':	Sandy clay, medium plasticity, cohesive, medium stiff, moist	
		16.0-18.0':	Sand, orange, gray organic staining, moist	
		18.0-18.5':	A lense of fat clay, grayish purple, medium to high plasticity, moist	
		18.5-19.5':	Sand, orange to grayish orange, moist	
		19.5-20.0':	Fat clay, greyish purple, dense, medium stiff to stiff, medium to high plasticity, moist.	
20	🟦	20.0-22.1':	Sand, light brown to orange, fine to medium grained, wet	
		22.1-22.3':	Lense of fat clay, dark grey to purple, stiff, high plasticity, wet	
		22.3-22.6':	Sand, light brown to orange, fine grained, moist	
		22.6-23.0':	Gravelly sand, orange to gray mottles, loose, well graded	
		23.0-24.0':	Sandy clay, grayish purple and brown mottles, moist	
25		24.0-25.6':	Sand, tan to light brown, fine to medium grained, well sorted, moist	
		25.6-26.4':	Clay, purple and gray, medium plasticity, trace fine grained sand	
		26.4-26.8':	Clayey sand, tan to light brown, fine grained, medium sorted	
		26.8-27.3':	Clay, purple, medium stiffness, medium plasticity	
		27.3-28.0':	Clay, dark gray, hard, trace silt, high plasticity	
30		28.0-28.6':	no recovery	
		28.6-29.2':	Sand, light brown, fine grained, moderate sorting, wet, from casing trip	
		29.2-29.5':	Silty clay, dark gray, fine grained, low plasticity	
		29.5-32.0':	Clay, dark gray to black, hard, low plasticity, trace silt	
		32.0-32.7':	Clay, dark gray, medium stiff, medium plasticity, trace silt	
35		32.7-33.1':	Clayey silt, dark gray, medium plasticity	
		33.1-36.0':	Sand, dark gray, fine grained, well sorted, moist	
		36.0-36.3':	no recovery	
		36.3-36.9':	Silty sand, dark gray to black, very fine grained, well sorted, moist	
		36.9-37.3':	Sand, gray, fine grained, well sorted, moist	
40		37.3-38.4':	Silty clay, dark gray, soft, low plasticity, 1" coal seam at 37.8 ft bgs	

Drill Rig Geoprobe 7822 DT & HSA Rig
Drilling Contractor: Best Drilling & AEP Drillers
Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey
Boring/Well Name: B-3
Project Location: Hallsville, TX
Boring Date: 5/7/19, 5/13/19

Soil Profile

Depth Scale Feet	Water Table	Description		PID
		38.4-40.0':	Clay, dark gray to black, very stiff, low plasticity (DPT refusal @ 40' bgs, HSA drilling continued below)	
40		40.0-42.5':	Silty clay with trace sand, dark gray, very stiff to hard, mottled	
		42.5-46.4':	Interbedded sandy clays and clayey sands, dark gray to black, moist, very dense, stiff, low plasticity, low cohesivity, coal and plant fragments at 45.1 to 45.25 feet bgs	
45		46.4-47.5':	Sandy clay with silt, dark gray to black, hard, low plasticity, moist, fine grained sand	
		47.5-48.7':	Sand with trace silt, brown, poorly graded, some brown clay laminations, coal seam from 48.4 to 48.7 feet bgs,	
		48.7-49.6':	Sand, gray to brown, well graded, with dark clayey interbeds/laminations, trace silt, loose to medium dense, moist	
		49.6-52.8':	Sand, brown to grayish brown, well graded, trace silt, loose to medium dense, moist to wet	
50		52.8-53.6':	Interbedded sandy clays and clayey sands, gray to dark gray, moist, dense to very dense	
		53.6-53.7':	Silty clay, dark brown, very stiff	
		53.7-55.0':	Interbedded sandy clays and clayey sands, gray to dark gray, moist, dense to very dense	
55		55.0-58.8':	Interbedded sandy clays and clayey sands, gray to dark gray, moist, dense to very dense	
		58.8-59.0':	Sand with some clay and silt, very dark gray, fine grained, massive bedding, moist	
		59.0-60.0':	no recovery	
60		60.0-60.7':	Sand with some silt and trace clay, very dark gray, fine grained, massive bedding, moist	
		60.7-61.6':	Sand with some silt and trace clay, gray, fine grained, massive bedding, moist, laminations of dark gray clayey sand	
		61.6-61.8':	Silty clay, dark gray, hard, no plasticity	
		61.8-63.0':	Silty clay, dark gray, fine grained, well graded, at 62.8 feet bgs a layer of dark gray silty clay	
		63.0-65.0':	no recovery	
65		65.0-67.5':	Silty sand, grayish brown, fine grained, well graded, wet, loose	
		67.5-72.5':	No recovery, heavy sands. Water introduced to retrieve samples. During flushing, some grayish brown silty sand observed	
70		72.5-73.1':	Silty sand, grayish brown, fine grained, well graded, wet, loose	
		73.1-73.6':	Sand with trace silt, gray, fine grained, well graded, wet, loose	
		73.6-74.7':	Thin layer of dark brown friable material, possibly plant material	
		74.7-74.8':	Thin layer of stiff sand and silt, dark brown	
		74.8-76.0':	Silty sand, grayish brown, fine grained, well graded, wet, loose	
75		76.0-76.1':	Thin layer of clay, dark brown, stiff, trace coal fragments	
		76.1-76.4':	Silty sand, grayish brown, fine grained, well graded, wet, loose	
		76.4-76.5':	Silty clay, dark brown, stiff	
		76.5-77.5':	Silty sand, grayish brown, fine grained, well graded, wet, loose	
		77.5-82.9':	Silty sand, dark gray to brown, fine grained, well graded, medium dense to dense, moist to wet, trace clay	
80				

Drill Rig Geoprobe 7822 DT & HSA Rig
Drilling Contractor: Best Drilling & AEP Drillers
Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Soil Boring Log

Project: AEP Pirkey

Boring/Well Name: B-3

Project Location: Hallsville, TX

Boring Date: 5/7/19, 5/13/19

Soil Profile

Depth Scale Feet	Water Table	Description		PID
80				
		82.9-84.3':	Silty sand, gray to dark gray, fine grained, well graded, medium dense to dense, moist to wet, trace clay	
		84.3-85.2':	Clayey sand, dark grayish brown, fine grained, well graded, moist	
		85.2-85.3':	Silty sand, gray	
85				
		85.3-85.5':	Silty sand, gray to dark gray, fine grained, well graded, medium dense to dense, moist to wet, trace clay	
		85.5-86.3':	Silty clay with sand, dark brown, low plasticity, hard, moist, laminated with gray sand layers ~1-2mm thick	
		86.3-87.5':	Clayey sand, dark grayish brown, fine grained, well graded, moist	
		87.5-88.2':	Clayey sand, dark grayish brown, fine grained, well graded, moist	
		88.2-89.1':	Clayey sand, dark grayish brown, fine grained, well graded, moist. Clay laminations darker than surrounding sand	
90				
		89.1-89.4':	Interval of interbedded sandy clays and clayey sands, breaks apart along bedding planes, medium dense, medium stiff	
		89.4-92.5':	Silty clay, dark brown to black, hard, trace moisture, low plasticity	
		92.5-97.5':	Silty clay, dark brown to black, hard, trace moisture, low plasticity. Thin gray sand layer at 94.7 feet bgs	
95				
			HSA refusal, EOB @ 97.1' bgs	
			Boring grouted to surface.	
			Permanent well installed in offset boring, screen set @ 29-34' bgs.	
100				
105				
110				
115				
120				

Drill Rig Geoprobe 7822 DT & HSA Rig

Drilling Contractor: Best Drilling & AEP Drillers

Driller: Ramon Gutierrez & Zack Racer

Geosyntec Consultants

Attachment B

Groundwater Analytical Results

Attachment B: Groundwater Analytical Data
Pirkey Plant - East Bottom Ash Pond

Boring	Depth (ft bgs)	Metals (mg/l)															
		Antimony		Arsenic		Barium		Beryllium		Boron		Cadmium		Calcium		Chromium	
		Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered
B-1	**16-21**	<0.00093	<0.0035805	0.214	0.0041586	3.28	0.0267562	0.01693	<0.000077	0.293	0.038043	0.03747	<0.0002695	41.8	1.34	1.08	<0.0008855
B-3	**20-24**	<0.00093	<0.0465	0.141	0.0472	0.779	0.132	0.00571	<0.001	0.105	0.308	0.00032	<0.0035	4.19	1.42	0.46	<0.0115
	33-37	0.00113	0.005776	0.02767	<0.113925	0.299	0.114	0.00427	<0.00217	0.104	0.443	<0.00007	<0.007595	15.6	5.95	0.208	<0.024955
	40-45	<0.00093	<0.17856	0.141	0.0851	1.64	0.0314	0.04958	<0.00384	0.292	0.453	0.00266	<0.01344	7	<1.8432	0.253	<0.04416
	50-55	<0.0465	<0.086025	0.662	<0.097125	4.76	0.09501	0.098	<0.00185	0.675	0.203	<0.0035	<0.006475	16.4	0.749	1.9	<0.021275
	60-65	<0.00093	<0.0465	0.05695	0.0472	0.412	0.0849	0.00559	<0.001	0.06661	0.071	0.00265	<0.0035	1.37	<0.48	0.307	<0.0115
	72.5-77.5	<0.00093	0.0022	0.932	0.0116	7.97	0.0123	0.132	<0.0002	1.52	0.375	0.277	<0.0007	36.9	0.209	3.25	0.0005
	82.5-87.5	<0.00093	0.0014372	0.04923	0.0058415	0.583	0.0083163	0.00297	<0.000111	0.214	0.311	0.00368	<0.0003885	1.44	0.21	0.152	<0.0012765

Boring	Depth (ft bgs)	Metals (mg/l)															
		Cobalt		Iron		Lead		Lithium		Magnesium		Manganese		Molybdenum		Potassium	
		Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered
B-1	**16-21**	0.192	0.001279	988	0.669	0.392	<0.002618	0.202	0.0217358	40	0.59	1.14	0.0206	0.02491	<0.0011165	37.1	1.07
B-3	**20-24**	0.02653	0.01	430	3.91	0.07225	<0.034	0.05327	0.0127	8	1.15	0.189	<0.05	0.00807	0.0022	15.2	1.26
	33-37	0.02721	0.00368	95.2	<1.085	0.0148	<0.07378	0.152	0.105	5.19	3.12	1.02	0.599	0.07587	0.012642	9.29	5.39
	40-45	0.23	0.00467	361	2.03	0.149	<0.13056	0.356	0.07701	12.6	<1.92	0.819	<0.192	0.01355	<0.05568	19.1	2.46
	50-55	0.786	0.01441	1440	3.88	0.703	<0.0629	1.14	0.060508	41	<0.925	3.46	0.0968	0.106	<0.026825	53.3	2.86
	60-65	0.07494	0.004	122	2.07	0.04529	<0.034	0.09786	0.0518	2.75	0.6	0.29	0.07	0.01507	0.0019	7.59	2.76
	72.5-77.5	1.37	0.0015	3250	0.587	0.636	<0.0068	0.812	0.0089	67.3	0.139	7.78	0.01	0.057	0.0013	57.9	1.26
	82.5-87.5	0.05576	0.000855	281	0.0745	0.05542	<0.003774	0.102	0.0228905	2.75	0.124	0.282	0.00751	0.01954	0.0172347	11.1	1.59

Boring	Depth (ft bgs)	Metals (mg/L)								General Chemistry (mg/L)		Anions (mg/L)			
		Selenium		Sodium		Strontium		Thallium		Total Alkalinity	Total Dissolved Solids	Chloride	Fluoride	Sulfate	Bromide
		Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Lab Filtered	Total	Total	Total	Total	Total	Total
B-1	**16-21**	0.0124	<0.0038115	10.7	8.31	2.3	0.00834	0.00339	0.002654	5.72	220	4.31	<0.04	13.8	<0.1
B-3	**20-24**	0.00647	<0.0495	25.6	22.6	0.078	<0.05	0.00309	0.026	0.76	156	33.7	0.04	14.6	0.2
	33-37	0.00142	<0.107415	22	17.1	0.079	<0.1085	0.00151	0.00642	49.54	132	10.9	0.1	19.4	<0.1
	40-45	0.01837	<0.19008	18.1	12.6	0.229	<0.192	0.00229	<0.16512	1.54	1394	8.91	<0.04	21.1	<0.1
	50-55	0.0269	<0.091575	17.9	12.8	0.686	<0.0925	0.067	<0.07955	12.68	734	13.4	<0.04	17.3	<0.1
	60-65	0.00539	<0.0495	8.13	7.64	0.053	<0.05	<0.00086	<0.043	3.14	148	12	<0.04	7.9	<0.1
	72.5-77.5	0.04618	<0.0099	156	65.5	0.575	0	0.00092	<0.0086	140.74	632	44.5	0.04	24.5	<0.1
	82.5-87.5	0.00987	<0.0054945	148	103	0.101	0.00278	0.00224	<0.004773	210.08	1026	35.8	0.35	13	<0.1

Notes:

< - Analyte not detected above analytical detection limit

NM - Not measured

Total lithium results from unfiltered sample volume collected in HNO3 preserved bottle.

Lab filtered results from laboratory vaccum-filtered sample volume collected in unpreserved bottle.

Total metals data are not available for B-2 sample intervals due to incorrect analytical techniques.

Attachment C

Well Construction Diagrams

Geosyntec
consultants

Well Construction Log

Site: AEP Pirkey Power Plant

Well ID: B-2

Drilling Company: AEP Service

Drillers: Zach Racer

Geologist: Nathan Quick

Date: 5/20/19

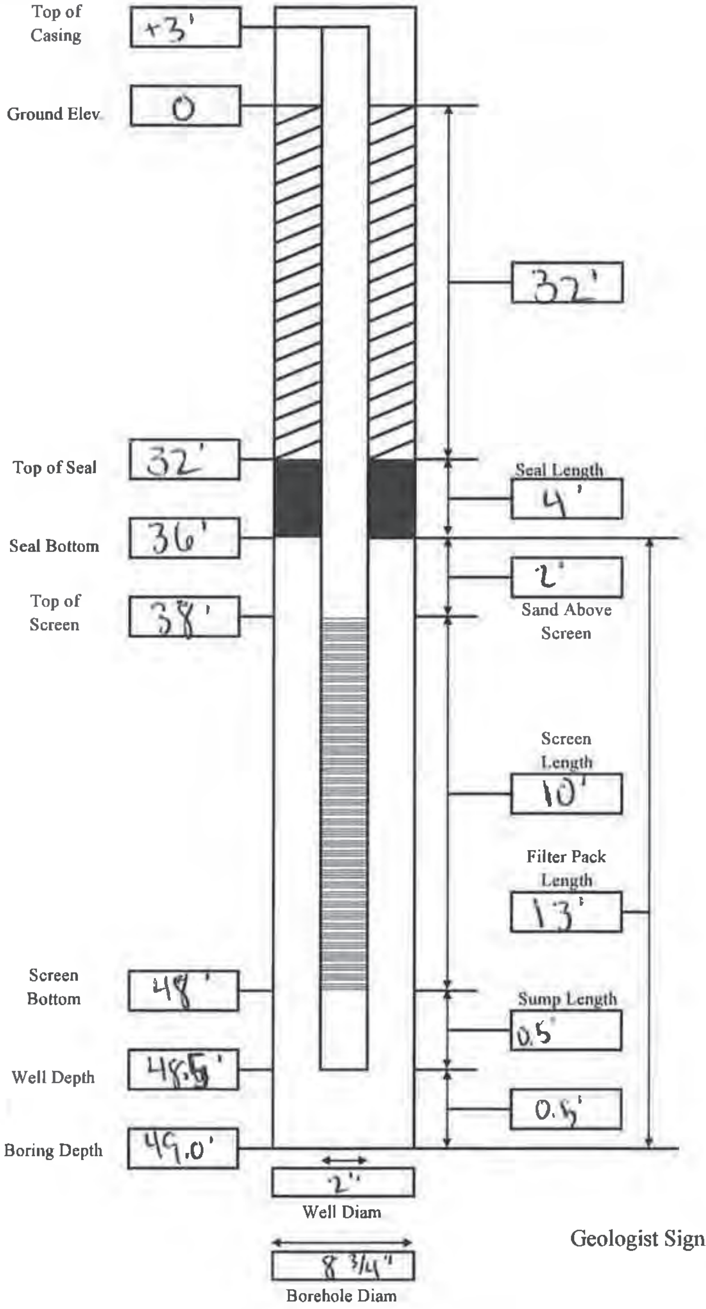
Drilling Method: Hollow Stem Auger

Boring Depth: 49'

Boring Diameter: 8 3/4"

Well Depth: 48.5'

Well Diameter: 2"



Top of Casing: +3'

Ground Elev.: 0

32'

Top of Seal: 32'

Seal Length: 4'

Seal Bottom: 36'

Sand Above Screen: 2'

Top of Screen: 38'

Screen Length: 10'

Filter Pack Length: 13'

Screen Bottom: 48'

Sump Length: 0.5'

Well Depth: 48.5'

0.5'

Boring Depth: 49.0'

Well Diam: 2"

Borehole Diam: 8 3/4"

Well Construction:

Material: Sch. 40 PVC

Inside Diamter: 2"

Screen Slot Size: 0.01'

Screen Beg.: 38 End: 48

Sump [✓ Y] / N

Type/Lenth: Sch. 40 PVC, 10"

Filter Pack:

Type/Brand: Pioneer Sands 20/40

Amount Used: 8.5 bags (50 lbs per bag)

Placement Method: surface

Seal:

Type/Brand: Plug Pel coated bentonite chips

Amount Used: 100 lbs

Vol. Fluid Added:

Set-up Time: 1.5 hours

Placement Method: surface

Grout:

Type/Brand:

Amount Used:

Vol. Fluid Added:

Placement Method: tremie

Well Completion:

[✓ Above Grade] / Below Grade

Guard Posts? [✓ Y] / N

Pad Size: 2x2

Cover Type/Size: Stainless steel

Comments:

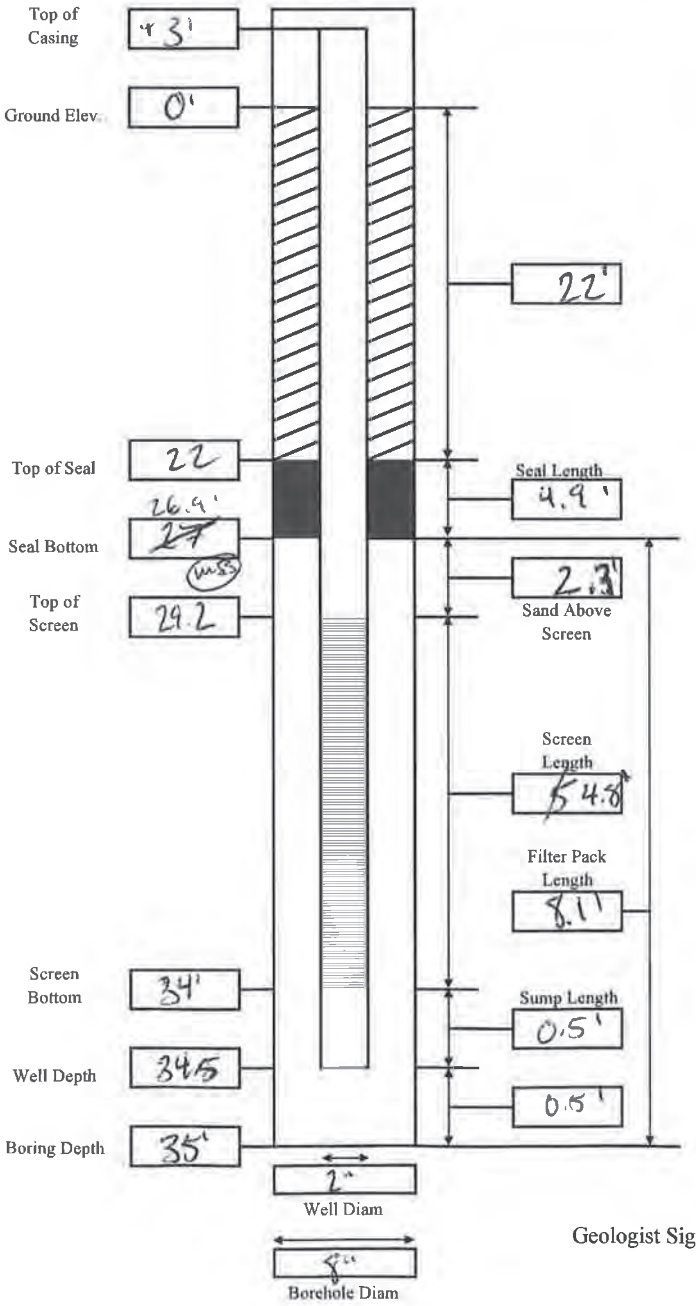
Geologist Signature:

Geosyntec
consultants

Well Construction Log

Site: AEP Pirkey Power Plant
Well ID: B-3
Drilling Company: AEP/Best Drilling
Drillers: Z. Rowe
Geologist: M. Bizjack

Date: 5/15/19
Drilling Method: HSA
Boring Depth: 35'
Boring Diameter: 8"
Well Depth: 35'
Well Diameter: 2"



Top of Casing: +3'
~361 Ground Elev: 0'
22'
Top of Seal: 22
Seal Length: 4.9'
Seal Bottom: ~~27~~ 26.9' (mss)
Top of Screen: 29.2
Sand Above Screen: 2.3'
Screen Length: ~~5~~ 4.8'
Filter Pack Length: 8.1'
Screen Bottom: 34'
Sump Length: 0.5'
Well Depth: 34.5
0.5'
Boring Depth: 35'
Well Diam: 2"
Borehole Diam: 8"

Well Construction:
Material: Sched 40 PVC
Inside Diamter: Sched 40
Screen Slot Size: 10µm
Screen Beg.: ~~34~~ 29' End: 34'
Sump [✓ Y] N
Type/Lenth: End cap, 0.5'

Filter Pack:
Type/Brand: Pioneer 20/40 0.45-0.48
Amount Used: ~~6~~ 5.5 bags (275 lbs)
Placement Method: Manual

Seal:
Type/Brand: 3/8" Pel-plug coated Bentonite Pellets
Amount Used: 2 buckets (100 lbs)
Vol. Fluid Added:
Set-up Time: >8hr
Placement Method: Manual

Grout:
Type/Brand: Halliburton Quik Grout
Amount Used:
Vol. Fluid Added:
Placement Method: Pump

Well Completion:
[✓ Above Grade] / Below Grade
Guard Posts? Y / N
Pad Size: 2x2
Cover Type/Size:

Comments:

Geologist Signature: Matt B

Attachment D

Well Development Logs

well development

~~LOW FLOW~~ GROUNDWATER SAMPLING LOG

Geosyntec consultants

MONITORING WELL ID: B-2

PROJECT: AEP Pirkey

PROJECT NO: CHA8462.12

SITE LOCATION: Hallsville, TX

DATE MONITORED: 5/22/19 **WATER QUALITY METER MAKE/MODEL:** Horiba

DATE PURGED: 5/22/19 **LATEST CALIBRATION DATE/TIME:** 5/22/19

SAMPLING PERSONNEL: N.Quick **DUP OR MS/MSD:**

MONITORING WELL INFORMATION

Well Diameter: 2 IN.

Static Depth to Groundwater (DTW): 12.31 FT.

Total Depth of Monitoring Well (TD): 51.50 FT. btoc

Screen Length (SL) from Boring Logs: 10 FT.

Depth to Top of Well Screen (TD-SL): NM FT.

Height of Water Column in Monitoring Well (H=TD-DTW): FT.

Pump Depth FT.

Coversion Factors:

Well Volume (2-in): Hx0.17 gal/ft

1 L = 0.264 gal

Purge Method: Tornado pump

LOW FLOW MONITORING PARAMETERS

Time	Volume Purged	pH	Specific Conductivity	Dissolved Oxygen	Temp.	ORP	Depth to Water	Flow Rate	Turbidity, Odor, Color	
Hr : Min	mL	-	mS/cm	mg/L	C	mV	Feet	L/min	--	
Targets	--	+/- 0.1	+/- 3%	+/- 10%	+/- 1 C	+/- 10 mV	<0.3 ft. drawdown	<0.5 L/min	nTU	--
1157		5.89	0.219	9.87	24.01	42	21.31	.5	1000+	light brown, silty
1202		5.93	0.241	9.47	22.11	25	22.21	.5	950	light brown
1207		5.94	0.217	9.36	22.09	23	22.31	.5	890	"
1212		5.87	0.214	9.64	21.89	30	22.83	.5	669	"
1217		5.82	0.201	9.50	22.18	42	22.31	.5	390	"
1222		5.82	0.201	9.50	22.25	38	20.58	.5	260	cloudy
1227		5.82	0.198	9.62	22.12	41	19.41	.5	152	cloudy
1232		5.76	0.194	9.44	22.11	40	18.83	.5	84.9	
1237		5.76	0.194	8.92	22.08	46	18.15	.5	75.2	
1242		5.72	0.194	9.54	22.15	45	17.97	.5	72.4	
1247		5.73	0.194	9.34	22.21	42	17.45	.5	66.9	
1 1252		5.75	0.195	9.50	22.34	44	22.15	.5	146	light brown
1302		5.79	0.200	9.76	22.31	49	22.41	.5	352	"
1312		5.75	0.194	9.41	22.30	51	22.71	.5	105	cloudy
1322		5.75	0.189	9.43	22.41	53	23.00	.5	574	clear
1332		5.75	0.189	9.53	22.48	56	23.15	.5	50.7	"

Notes: 1) well was surged using pump to make sure all fines were removed

end of development

1. Water quality parameter measurements obtained every 3 to 5 minutes.
2. Well is **STABLE** once 3 consecutive measurements have been obtained for as many as 3 water quality parameters
3. Low flow rate target is 0.1 to 0.5 liters/min (0.026 to 0.132 Gallons per Minute).

Purge Flow Rate (pump purge only) gal per min liter per min (3.8 x gpm)

TOTAL Volume Purged gallons liters

Date & Time of Sample Collection - **DATE** - **TIME** NQ **INITIALS** *revised: Feb. 2007*

Well Development

~~LOW FLOW~~ GROUNDWATER SAMPLING LOG

1 of 2

Geosyntec consultants

MONITORING WELL ID: B-3

PROJECT: AEP Pirkey

PROJECT NO: CHA8462.12

SITE LOCATION: Hallsville, TX

DATE MONITORED: 5/17/19 **WATER QUALITY METER MAKE/MODEL:** Horiba

DATE PURGED: 5/17/19 **LATEST CALIBRATION DATE/TIME:** 5/17/19

SAMPLING PERSONNEL: N. Quick **DUP OR MS/MSD:** –

MONITORING WELL INFORMATION

Well Diameter: 2 IN.

Static Depth to Groundwater (DTW): 9.07' FT.

Total Depth of Monitoring Well (TD): 36.95 FT.

Screen Length (SL) from Boring Logs: FT.

Depth to Top of Well Screen (TD-SL): FT.

Height of Water Column in Monitoring Well (H=TD-DTW): FT.

Pump Depth FT.

Coversion Factors:

Well Volume (2-in): Hx0 17 gal/ft

1 L = 0 264 gal

Purge Method: tornado pump

LOW FLOW MONITORING PARAMETERS

Time	Volume Purged	pH	Specific Conductivity	Dissolved Oxygen	Temp	ORP	Depth to Water	Flow Rate	Turbidity, Odor, Color
Hr : Min	mL	-	mS/cm	mg/L	C	mV	Feet	L/min	--
Targets	--	+/- 0.1	+/- 3%	+/- 10%	+/- 1 C	+/- 10 mV	<0.3 ft. drawdown	~~<0.5 L/min~~ NTU	--
0944		6.07	.605	3.30	20.39	89			brown, silty
0947		6.14	0.516	0.51	20.72	28			brown
0951		5.84	.438	3.42	21.37	69			brown
		well is purging dry, pump is kicking off + on due to low water level; to let well recharge + continue to develop							
1034		6.18	.450	4.01	22.09	88	19.34		
		pump removed to check connections;							
1900		6.17	0.263	3.78	22.15	78	15.29		
					went dry				
1216		5.81	0.282	2.64	22.74	85	15.32		light brown
1220		5.64	0.195	2.07	22.04	102			cloudy
1225		5.65	0.194	1.87	22.24	98	23.05	888	cloudy
1235		5.71	0.191	1.59	22.98	85		683	cloudy
1240		5.71	0.190	1.48	23.05	87	25.75	605	cloudy
1250		5.69	0.188	1.43	23.36	83		462	
1257		5.69	0.184	1.19	23.14	81	28.14	370	

Notes:

1. Water quality parameter measurements obtained every 3 to 5 minutes
2. Well is **STABLE** once 3 consecutive measurements have been obtained for as many as 3 water quality parameters
3. Low flow rate target is 0 1 to 0 5 liters/min (0 026 to 0 132 Gallons per Minute)

Purge Flow Rate (pump purge only) ______ gal per min ______ liter per min (3.8 x gpm)

TOTAL Volume Purged ______ gallons ______ liters

Date & Time of Sample Collection – **DATE** – **TIME** NQ **INITIALS** *revised: Feb. 2007*

2 of 2

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Development ~~LOW FLOW~~ GROUNDWATER SAMPLING LOG

MONITORING WELL ID: B-3

PROJECT: AEP Pirkey

PROJECT NO: CHA8462.12

SITE LOCATION: Hallsville, TX

DATE MONITORED: 5/17/19

WATER QUALITY METER MAKE/MODEL: Horiba

DATE PURGED: 5/17/19

LATEST CALIBRATION DATE/TIME: 5/17/19

SAMPLING PERSONNEL: N. Quick

DUP OR MS/MSD: –

MONITORING WELL INFORMATION

Well Diameter: 2 IN.

Static Depth to Groundwater (DTW): 9.02 FT.

Total Depth of Monitoring Well (TD): 36.65 FT.

Screen Length (SL) from Boring Logs: FT.

Depth to Top of Well Screen (TD-SL): FT.

Height of Water Column in Monitoring Well (H=TD-DTW): FT.

Pump Depth FT.

Coversion Factors:

Well Volume (2-in): Hx0.17 gal/ft

1 L = 0.264 gal

Purge Method: tornado pump

LOW FLOW MONITORING PARAMETERS

Time	Volume Purged	pH	Specific Conductivity	Dissolved Oxygen	Temp.	ORP	Depth to Water	Flow Rate	Turbidity, Odor, Color	
Hr : Min	mL	-	mS/cm	mg/L	C	mV	Feet	L/min	--	
Targets	--	+/- 0.1	+/- 3%	+/- 10%	+/- 1 C	+/- 10 mV	<0.3 ft. drawdown	<0.5 L/min	nTU	--
1305		5.68	0.182	1.08	23.31	87	28.09		312	
1310		5.67	0.181	1.03	23.25	83			275	
1315		5.67	0.179	1.01	23.70	81	25.81		238	
1325		5.66	0.178	1.00	23.62	82			192	
1330		5.65	0.176	0.89	23.80	81	25.34		165	clear/slightly
										cloudy
			end of	development						

Notes:

1. Water quality parameter measurements obtained every 3 to 5 minutes
2. Well is **STABLE** once 3 consecutive measurements have been obtained for as many as 3 water quality parameters
3. Low flow rate target is 0.1 to 0.5 liters/min (0.026 to 0.132 Gallons per Minute)

Purge Flow Rate (pump purge only) gal per min liter per min (3.8 x gpm)

TOTAL Volume Purged gallons liters

Date & Time of Sample Collection – **DATE** – **TIME** NQ **INITIALS** *revised: Feb. 2007*

Attachment E

Low-Flow Groundwater Sampling Logs

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GROUNDWATER SAMPLING LOG

Page 1 of 2

SITE NAME: **AEP Pirkey Power Plant**

SITE LOCATION: **Hallsville, TX**

WELL NO: B-2

SAMPLE ID: B-2-well-20190522-1 + -2

DATE: 5/22/19

WELL DIAMETER (inches): 2

TUBING DIAMETER (inches): 3/8

WELL SCREEN INTERVAL: 38 feet to 48 feet bgs

STATIC DEPTH TO WATER (feet): 12.61

PURGE PUMP TYPE OR BAILER: hurricane

WELL VOLUME PURGE: (TOTAL WELL DEPTH − STATIC DEPTH TO WATER) X WELL CAPACITY = WELL VOLUME

(51.50 ft − 12.61 ft) X 0.16 gal/ft = 6.22 gallons

EQUIPMENT VOLUME PURGE: PUMP VOL. + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOL = EQUIPMENT VOLUME

Gal + (0.006 gal/ft X ft) + gal = gal

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 45

FINAL PUMP OR TUBING DEPTH IN WELL (feet): 45

PURGING INITIATED AT: 1636

PURGING ENDED AT: 1825

TOTAL VOLUME PURGED (gallons):

TIME	CUMUL.VOL. PURGED (gallons)	PURGE RATE (gpm or [✓ mL/min])	DEPTH TO WATER (feet)	pH (S.U.)	TEMP. (°C)	COND. (mS/cm)	DO (mg/L)	TURBIDITY (NTUs)	ORP (mV)
1637		250	14.24	5.74	22.99	0.195	2.50	1000+	79
1642		250	15.68	5.72	21.89	0.184	3.95	1000+	54
1647		250	16.62	5.71	21.52	0.196	5.47	705	53
1652		250	17.38	5.72	21.29	0.201	9.21	454	56
1657		250	18.24	5.70	21.23	0.197	8.33	271	61
1702		250	18.51	5.68	21.22	0.197	2.25	178	52
1707		250	18.99	5.65	21.12	0.196	2.42	136	68
1712		250	19.21	5.64	20.83	0.195	1.89	92.2	65
1717		250	19.29	5.61	21.16	0.192	1.95	89.2	69
1722		250	19.40	5.60	20.91	0.195	2.42	90.6	65
1727		250	19.55	5.59	20.94	0.193	2.97	102	71
1732		250	19.61	5.58	20.89	0.195	3.09	62.5	74

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88

TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016

SAMPLED BY (PRINT) / AFFILIATION: Nathan Quick / Geosyntec

SAMPLER(S) SIGNATURES: Nat Qr

SAMPLING INITIATED AT: 1825

SAMPLING ENDED AT:

PUMP OR TUBING DEPTH IN WELL (feet): 45

SAMPLE PUMP FLOW RATE (mL per minute): 250

TUBING MATERIAL CODE:

FIELD DECON: Y N

FLD-FILTERED: [✓ Y] N FILTER SIZE: 45 µm

Filtration Equipment:

EQUIPMENT. BLANK: Y [✓ N]

Sample ID:

DUPLICATE: Y [✓ N]

SAMPLE ID CODE	# Bottles	MATERIAL CODE	VOLUME	PRESERV. USED	ANALYSIS/ METHOD	SAMPLING EQUIPMENT CODE

REMARKS:

MATERIAL CODES: AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

SAMPLING/PURGING EQUIPMENT CODES: APP = After Peristaltic Pump; B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; RFPP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); VT = Vacuum Trap; O = Other (Specify)

STABILIZATION CRITERIA	pH = ± 0.2	ORP = ± 20 mV	Specific Conductance = 3 **readings within** ± 3%
Dissolved Oxygen =	A) ≤ **10% saturation** (≤ 1.82 mg/l @ 20 °C , ≤ 1.65 mg/l @ 25 °C , ≤ 1.51 mg/l @ 30 °C) B) **readings within ± 0.2 mg/L (for readings ≤ 2 mg/L), whichever greater**		
Turbidity =	**A)** ≤ 10 NTUs; OR **B)** 3 readings within ± 10%		

Nat Qr

Geosyntec consultants

GROUNDWATER SAMPLING LOG

Page 2 of 2

SITE NAME: **AEP Pirkey Power Plant**	SITE LOCATION: **Hallsville, TX**

WELL NO: B-2		SAMPLE ID: B-2-well-20190522-1/-2		DATE: 5/22/19
WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 3/8	WELL SCREEN INTERVAL : 38 feet to 48 feet bgs	STATIC DEPTH TO WATER (feet): 12.61	PURGE PUMP TYPE OR BAILER: hurricane

WELL VOLUME PURGE: (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY = WELL VOLUME

(51.50 ft – 12.61 ft) X 0.16 gal/ft = 6.22 gallons

EQUIPMENT VOLUME PURGE: PUMP VOL. + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOL = EQUIPMENT VOLUME

Gal + (gal/ft X ft) + gal = gal

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 45	FINAL PUMP OR TUBING DEPTH IN WELL (feet): 45	PURGING INITIATED AT: 1630	PURGING ENDED AT: 1825	TOTAL VOLUME PURGED (gallons):

TIME	CUMUL.VOL. PURGED (gallons)	PURGE RATE (gpm or [✓ mL/min])	DEPTH TO WATER (feet)	pH (S.U.)	TEMP. (°C)	COND. (mS/cm)	DO (mg/L)	TURBIDITY (NTUs)	ORP (mV)
1737		250	19.64	5.56	20.80	0.197	3.42	61.2	75
1742		250	19.67	5.55	20.85	0.199	1.71	52.9	74
1747		250	19.70	5.53	20.86	0.200	1.82	44.3	72
1752		250	19.68	5.53	20.81	0.200	1.93	42.4	76
1757		250	19.64	5.52	20.75	0.202	2.01	30.7	70
1802		250	19.62	5.50	20.82	0.200	1.97	25.7	73
1807		250	19.62	5.49	20.73	0.198	1.93	25.0	75
1812		250	19.63	5.49	20.75	0.199	1.95	40.2	74
1817		250	19.60	5.48	20.82	0.193	1.67	27.7	80
1822		250	19.61	5.48	20.77	0.192	1.65	19.5	79
		sampled via dedicated tubing; 2 hour max met							

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88

TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016

SAMPLED BY (PRINT) / AFFILIATION: Nathan Quek / Geosyntec	SAMPLER(S) SIGNATURES:	SAMPLING INITIATED AT: 1825	SAMPLING ENDED AT:
PUMP OR TUBING DEPTH IN WELL (feet):	SAMPLE PUMP FLOW RATE (mL per minute): 250	TUBING MATERIAL CODE:	
FIELD DECON: Y N	FLD-FILTERED: [✓ Y] N FILTER SIZE: .45 µm Filtration Equipment :	EQUIPMENT. BLANK: Y [✓ N] Sample ID:	DUPLICATE: Y [✓ N]

SAMPLE ID CODE	# Bottles	MATERIAL CODE	VOLUME	PRESERV. USED	ANALYSIS/ METHOD	SAMPLING EQUIPMENT CODE

REMARKS:

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING/PURGING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP** = Peristaltic Pump **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **VT** = Vacuum Trap; **O** = Other (Specify)

STABILIZATION CRITERIA	pH = ± 0.2	ORP = ± 20 mV	Specific Conductance = 3 **readings within** ± **3%**
Dissolved Oxygen =	A) **≤ 10% saturation** (≤ 1.82 mg/l @ 20 °C , ≤ 1.65 mg/l @ 25 °C , ≤ 1.51 mg/l @ 30 °C) B) **readings within ± 0.2 mg/L (for readings ≤ 2 mg/L), whichever greater**		
Turbidity =	**A)** ≤ 10 NTUs; OR **B)** 3 readings within ± 10%		

Geosyntec consultants

GROUNDWATER SAMPLING LOG

page 1 of 2

SITE NAME: **AEP Pirkey Power Plant**		SITE LOCATION: **Hallsville, TX**	
WELL NO: B-3	SAMPLE ID: B-3-well-20190521		DATE: 5/21/19
WELL DIAMETER (inches): 2"	TUBING DIAMETER (inches): 3/8	WELL SCREEN INTERVAL : feet to feet	STATIC DEPTH TO WATER (feet): 10.15	PURGE PUMP TYPE OR BAILER: hurricane

WELL VOLUME PURGE: (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY = WELL VOLUME

(ft – 10.15 ft) X 0.16 gal/ft = gallons

EQUIPMENT VOLUME PURGE: PUMP VOL. + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOL = EQUIPMENT VOLUME

Gal + NA ~~0.0006~~ gal/ft X ft) + gal = gal

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 38.5	FINAL PUMP OR TUBING DEPTH IN WELL (feet): 38.5	PURGING INITIATED AT: 1106	PURGING ENDED AT: 1245	TOTAL VOLUME PURGED (gallons):

TIME	CUMUL.VOL. PURGED (gallons)	PURGE RATE (gpm or [✓ mL/min])	DEPTH TO WATER (feet)	pH (S.U.)	TEMP. (°C)	COND. (mS/cm)	DO (mg/L)	TURBIDITY (NTUs)	ORP (mV)
1110		200	10.87	6.57	26.79	0.241	9.14	47.7	125
1115		200	11.91	6.16	24.77	0.257	9.78	525	98
1120		200	14.72	6.01	23.45	0.219	3.01	504	105
1125		200	18.01	5.98	22.95	0.207	5.89	550	87
1130		200	22.18	5.82	23.18	0.250	8.87	602	85
1135		200	24.91	5.81	23.29	0.225	8.82	625	88
1145		200	25.52	5.76	23.56	0.217	8.79	572	89
1155		200	26.12	5.78	23.51	0.189	8.90	501	89
1205		200	26.23	5.68	23.39	0.180	4.71	128	88
1210		200	26.31	5.66	23.28	0.181	5.02	58	88
1215		200	26.51	5.65	23.40	0.174	4.64	64	90
1225		200	26.63	5.65	23.53	0.166	4.52	66.2	81

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88

TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016

SAMPLED BY (PRINT) / AFFILIATION: Nathan Quirk / Geosyntec	SAMPLER(S) SIGNATURES:	SAMPLING INITIATED AT: 1245	SAMPLING ENDED AT: 1305
PUMP OR TUBING DEPTH IN WELL (feet):	SAMPLE PUMP FLOW RATE (mL per minute): 200	TUBING MATERIAL CODE:	
FIELD DECON: Y N	FLD-FILTERED: [✓ Y] N FILTER SIZE: 45 µm Filtration Equipment :	EQUIPMENT. BLANK: Y [✓ N] Sample ID:	DUPLICATE: Y [✓ N]

SAMPLE ID CODE	# Bottles	MATERIAL CODE	VOLUME	PRESERV. USED	ANALYSIS/ METHOD	SAMPLING EQUIPMENT CODE

REMARKS:

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING/PURGING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP** = Peristaltic Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **VT** = Vacuum Trap; **O** = Other (Specify)

STABILIZATION CRITERIA	pH = **± 0.2**	ORP = **± 20 mV**	Specific Conductance = 3 **readings within ± 3%**
Dissolved Oxygen =	A) **≤ 10% saturation** (≤ 1.82 mg/l @ 20 °C , ≤ 1.65 mg/l @ 25 °C , ≤ 1.51 mg/l @ 30 °C)		
	B) **readings within ± 0.2 mg/L (for readings ≤ 2 mg/L), whichever greater**		
Turbidity =	**A)** ≤ 10 NTUs; OR		
	B) 3 readings within ± 10%		

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LOW FLOW GROUNDWATER SAMPLING LOG

Geosyntec consultants

MONITORING WELL ID: B-3

PROJECT: AEP Pirkey

PROJECT NO: CHA8462.12

SITE LOCATION: Hallsville, TX

DATE MONITORED: 5/21/19 **WATER QUALITY METER MAKE/MODEL:** Horiba

DATE PURGED: 5/21/19 **LATEST CALIBRATION DATE/TIME:** 5/21/19

SAMPLING PERSONNEL: N. Quick **DUP OR MS/MSD:** -

MONITORING WELL INFORMATION

Well Diameter: 2 IN.

Static Depth to Groundwater (DTW): 10.15 FT.

Total Depth of Monitoring Well (TD): 39. FT.

Screen Length (SL) from Boring Logs: 10 FT.

Depth to Top of Well Screen (TD-SL): FT.

Height of Water Column in Monitoring Well (H=TD-DTW): FT.

Pump Depth FT.

Coversion Factors:

Well Volume (2-in): Hx0.17 gal/ft

1 L = 0.264 gal

Purge Method:

~~[illegible]~~ via low flow

LOW FLOW MONITORING PARAMETERS

Time	Volume Purged	pH	Specific Conductivity	Dissolved Oxygen	Temp.	ORP	Depth to Water	Flow Rate	Turbidity, Odor, Color
Hr : Min	mL	-	mS/cm	mg/L	C	mV	Feet	L/min	--
Targets	--	+/- 0.1	+/- 3%	+/- 10%	+/- 1 C	+/- 10 mV	<0.3 ft. drawdown	<0.5 L/min	nTU --
1230		5.63	0.169	4.01	23.88	103		.20	74.2
	sampled via	dedicated tubing							

Notes:

1. Water quality parameter measurements obtained every 3 to 5 minutes
2. Well is **STABLE** once 3 consecutive measurements have been obtained for as many as 3 water quality parameters
3. Low flow rate target is 0.1 to 0.5 liters/min (0.026 to 0.132 Gallons per Minute)

Purge Flow Rate (pump purge only) ______ gal per min ______ liter per min (3.8 x gpm)

TOTAL Volume Purged ______ gallons ______ liters

Date & Time of Sample Collection 5/21/19 **DATE** 1245 **TIME** NQ **INITIALS** *revised: Feb. 2007*

Nat Q

Geosyntec consultants

GROUNDWATER SAMPLING LOG

SITE NAME: **AEP Pirkey Power Plant**	SITE LOCATION: **Hallsville, TX**

WELL NO: AD-31	SAMPLE ID: AD-31-20190515	DATE: 5/15/19

WELL DIAMETER (inches): 2	TUBING DIAMETER (inches): 3/8	WELL SCREEN INTERVAL : 30.5 feet to 40.5 feet	STATIC DEPTH TO WATER (feet): 10.90	PURGE PUMP TYPE OR BAILER: Hurricane SS

WELL VOLUME PURGE: (TOTAL WELL DEPTH – STATIC DEPTH TO WATER) X WELL CAPACITY = WELL VOLUME
(40.5 ft – 10.92 ft) X 0.16 gal/ft = 4.73 gallons

EQUIPMENT VOLUME PURGE: PUMP VOL. + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOL = EQUIPMENT VOLUME
Gal + (gal/ft X ft) + gal = gal

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 35.0	FINAL PUMP OR TUBING DEPTH IN WELL (feet): 38.0	PURGING INITIATED AT: 1220	PURGING ENDED AT: 1250	TOTAL VOLUME PURGED (gallons):

TIME	CUMUL.VOL. PURGED (gallons)	PURGE RATE (gpm or mL/min)	DEPTH TO WATER (feet)	pH (S.U.)	TEMP. (°C)	COND. (mS/cm)	DO (mg/L)	TURBIDITY (NTUs)	ORP (mV)
1223	NM	400	11.32	3.19	26.94	0.302	3.81	736	435
1229	NM	400	11.43	3.18	25.04	0.311	0.48	610	439
1236	NM	400	12.54	3.11	24.13	0.319	0.38	37.9	450
ob ~~1044~~ 1243	NM	400	11.49	3.03	23.83	0.317	0.33	13.1	452
1248	NM	350	11.39	3.06	24.34	0.319	0.32	8.38	449

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88
TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016

SAMPLED BY (PRINT) / AFFILIATION: Olivia Bramlet / Geosyntec	SAMPLER(S) SIGNATURES:	SAMPLING INITIATED AT: 1259	SAMPLING ENDED AT: 1337
PUMP OR TUBING DEPTH IN WELL (feet): 35.0	SAMPLE PUMP FLOW RATE (mL per minute):	TUBING MATERIAL CODE:	

FIELD DECON: Y N	FLD-FILTERED: Y N FILTER SIZE: _____ μm Filtration Equipment : ____________	EQUIPMENT. BLANK: Y [✓ N] Sample ID:	DUPLICATE: Y [✓ N]

SAMPLE ID CODE	# Bottles	MATERIAL CODE	VOLUME	PRESERV. USED	ANALYSIS/ METHOD	SAMPLING EQUIPMENT CODE

REMARKS:

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING/PURGING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP** = Peristaltic Pump **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **VT** = Vacuum Trap; **O** = Other (Specify)

STABILIZATION CRITERIA	pH = **± 0.2**	ORP = **± 20 mV**	Specific Conductance = 3 **readings within ± 3%**
Dissolved Oxygen =	A) **≤ 10% saturation** (≤ 1.82 mg/l @ 20 °C , ≤ 1.65 mg/l @ 25 °C , ≤ 1.51 mg/l @ 30 °C)		
	B) **readings within ± 0.2 mg/L (for readings ≤ 2 mg/L), whichever greater**		
Turbidity =	**A)** ≤ 10 NTUs; OR		
	B) 3 readings within ± 10%		

Geosyntec consultants

GROUNDWATER SAMPLING LOG

SITE NAME: **AEP Pirkey Power Plant**

SITE LOCATION: **Hallsville, TX**

WELL NO: AD32

SAMPLE ID: AD-32-20190515

DATE: 5/15/2019

WELL DIAMETER (inches): 2

TUBING DIAMETER (inches): 3/8

WELL SCREEN INTERVAL: 13.0 feet to 33.0 feet

STATIC DEPTH TO WATER (feet): 4.61

PURGE PUMP TYPE OR BAILER: Hurricane SS

WELL VOLUME PURGE: (TOTAL WELL DEPTH − STATIC DEPTH TO WATER) X WELL CAPACITY = WELL VOLUME

(33.0 ft − 4.61 ft) X 0.16 gal/ft = 4.54 gallons

EQUIPMENT VOLUME PURGE: PUMP VOL. + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOL = EQUIPMENT VOLUME

Gal + (gal/ft X ft) + gal = gal

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 23.0

FINAL PUMP OR TUBING DEPTH IN WELL (feet):

PURGING INITIATED AT: DB 1015 ~~[illegible]~~

PURGING ENDED AT: 1113

TOTAL VOLUME PURGED (gallons):

TIME	CUMUL.VOL. PURGED (gallons)	PURGE RATE (gpm or [✓ mL/min])	DEPTH TO WATER (feet)	pH (S.U.)	TEMP. (°C)	COND. (mS/cm)	DO (mg/L)	TURBIDITY (NTUs)	ORP (mV)
1021	NM	280	4.89	2.35	24.22	0.339	0.68	827	389
1030	NM	300	4.99	2.23	23.04	0.226	0.37	92.3	402
1040	NM	400	5.06	2.05	22.85	0.348	0.30	39.7	418
1046	NM	400	5.08	2.00	22.95	0.351	0.28	26.8	~~423~~ 422
1054	NM	480	5.24	1.96	22.76	0.354	0.37	20.1	427
1102	NM	400	5.08	1.89	23.72	0.354	0.29	18.2	428
1110	NM	350	5.05	1.85	23.81	0.354	0.26	11.8	431

WELL CAPACITY (Gallons Per Foot): **0.75"** = 0.02; **1"** = 0.04; **1.25"** = 0.06; **2"** = 0.16; **3"** = 0.37; **4"** = 0.65; **5"** = 1.02; **6"** = 1.47; **12"** = 5.88

TUBING INSIDE DIA. CAPACITY (Gal./Ft.): **1/8"** = 0.0006; **3/16"** = 0.0014; **1/4"** = 0.0026; **5/16"** = 0.004; **3/8"** = 0.006; **1/2"** = 0.010; **5/8"** = 0.016

SAMPLED BY (PRINT) / AFFILIATION: Olivia Bramlet / Geosyntec

SAMPLER(S) SIGNATURES:

SAMPLING INITIATED AT: 1115

SAMPLING ENDED AT: 1128

PUMP OR TUBING DEPTH IN WELL (feet): 23.0

SAMPLE PUMP FLOW RATE (mL per minute): 350

TUBING MATERIAL CODE:

FIELD DECON: Y N

FLD-FILTERED: Y N FILTER SIZE: _____ µm

Filtration Equipment: ____________

EQUIPMENT. BLANK: Y [✓ N]

Sample ID:

DUPLICATE: [✓ Y] N

SAMPLE ID CODE	# Bottles	MATERIAL CODE	VOLUME	PRESERV. USED	ANALYSIS/ METHOD	SAMPLING EQUIPMENT CODE
AD-32-20190515	4					
AD-32-20190515 DUP	4					

REMARKS: After sampling the Horiba unit, checked w/ cal solution & reading low @ 2.96 pH – pH on form likely low. All WL measurements from top of casing.

MATERIAL CODES: **AG** = Amber Glass; **CG** = Clear Glass; **PE** = Polyethylene; **PP** = Polypropylene; **S** = Silicone; **T** = Teflon; **O** = Other (Specify)

SAMPLING/PURGING EQUIPMENT CODES: **APP** = After Peristaltic Pump; **B** = Bailer; **BP** = Bladder Pump; **ESP** = Electric Submersible Pump; **PP** = Peristaltic Pump; **RFPP** = Reverse Flow Peristaltic Pump; **SM** = Straw Method (Tubing Gravity Drain); **VT** = Vacuum Trap; **O** = Other (Specify)

STABILIZATION CRITERIA	pH = **± 0.2**	ORP = **± 20 mV**	Specific Conductance = 3 **readings within ± 3%**
Dissolved Oxygen =	A) **≤ 10% saturation** (≤ 1.82 mg/l @ 20 °C, ≤ 1.65 mg/l @ 25 °C, ≤ 1.51 mg/l @ 30 °C) B) **readings within ± 0.2 mg/L (for readings ≤ 2 mg/L), whichever greater**		
Turbidity =	**A)** ≤ 10 NTUs; OR **B)** 3 readings within ± 10%		

Attachment F

Certification by a Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

BETH ANN GROSS
79864

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

July 22, 2019
Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
East Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

September 23, 2019

CHA8462

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FIGURES

TABLES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
VAP	Vertical Aquifer Profiling
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the East Bottom Ash Pond (EBAP, Figure 1). In February 2019, a semi-annual assessment monitoring event was conducted at the EBAP in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey EBAP:

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.0100 mg/L), AD-31 (0.00943 mg/L), and AD-32 (0.0333 mg/L).

- LCLs for lithium exceeded the GWPS of 0.052 mg/L at AD-31 (0.077 mg/L) and AD-32 (0.075 mg/L).

No other SSLs were identified (Geosyntec, 2019a).

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a*

> *qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSLs identified for cobalt and lithium should not be attributed to the EBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for cobalt and lithium were based on a Type IV cause and not by a release from the Pirkey EBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for cobalt and lithium and the proposed alternative source are described below.

2.1 Proposed Alternative Sources

Initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify alternative sources due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSLs for cobalt and lithium have been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

2.1.1 Cobalt

In a previous ASD for cobalt at the EBAP, evidence was provided to show that the observed cobalt concentrations were due to natural variation (Geosyntec, 2019b). The previous ASD discussed that the EBAP itself did not appear to be a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP leachate above the reporting limit of 0.01 mg/L. Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions. SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. Cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

Cobalt was detected at an estimated concentration of 0.0024 mg/L in a grab sample of the pond water. However, the reported concentration of cobalt in the pond water sample is significantly lower than the average concentration of cobalt observed at all three wells where SSLs were identified (Table 1). Since the previous ASD was prepared, there have been no notable changes in coal handling or sourcing at the plant that would have affected the composition of the ash or pond water.

Since completion of the prior ASD, four additional permanent wells (B-2, B-3, AD-40, and AD-41) have been installed upgradient of the EBAP. The most recent data available for select wells in the vicinity of the EBAP, including the new upgradient locations, are shown in Figure 2. Groundwater cobalt concentrations at upgradient locations vary from 0.0008 mg/L to 0.0345 mg/L at AD-40 and B-3, respectively. This wide range in cobalt concentrations provides further evidence for the natural variation of cobalt at the Site, particularly as the concentrations at B-3 exceed both the GWPS for the EBAP and the LCLs calculated for cobalt at the wells of interest.

As noted in the prior ASD, soil samples collected across the site, including from locations near the EBAP, identified cobalt in the aquifer solids at varying concentrations. Since completion of the prior ASD, additional soil samples have been collected from locations upgradient of the EBAP. Select soil sample data from the previous ASD and recently collected data are summarized in Table 2. Cobalt was identified in the aquifer solids at varying concentrations, with the highest value of 23.5 milligrams per kilogram (mg/kg) reported at AD-41, which is upgradient of the EBAP (Figure 3). Other testing included collection of aquifer solids to evaluate for the presence of cobalt-containing minerals. X-ray diffraction evidence identified pyrite and marcasite (both iron sulfides) at select locations at concentrations up to 3% by weight (Table 2). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2019).

Groundwater samples were collected from upgradient location B-3 via vertical aquifer profiling (VAP), as described in an ASD previously generated for lithium exceedances at the EBAP (Geosyntec, 2019c). The VAP groundwater samples were centrifuged to separate solid and liquid phases, and the solid material was submitted for analysis of total metals and mineralogy by X-ray diffraction (XRD). The samples were also submitted for analysis of chemical composition and mineralogy by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Following installation of permanent monitoring wells at B-2 and B-3, groundwater samples were collected by purging groundwater through the filter pack using a submersible pump. An additional groundwater sample was collected at AD-32. These permanent well groundwater samples were filtered through a 1.5-micron filter and the solid material retained on the filter was submitted for analysis of total metals and by SEM/EDS.

Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from B-2 and B-3 (Table 2). Cobalt was detected in the AD-32 solid material at 5.4 mg/kg, which is comparable to the concentration observed in bulk soil collected at the same location at the screened interval (9.1 mg/kg). These results provide further evidence that cobalt concentrations reported during groundwater sampling are naturally occurring and associated with the solid phase in the aquifer.

According to XRD results of the centrifuged solid sample [VAP-B3-(40-45)], pyrite was present as approximately 3% of the solid phase, with hematite (an iron(III) oxide) present at 2% (Table 3). Logging completed while the VAP boring was advanced identified lignite at several intervals, including 45 and 48 ft bgs (Figure 4). Furthermore, SEM/EDS of both centrifuged solid samples [VAP-B3-(40-45) and VAP-B3-(50-55)] identified pyrite in backscattered electron micrographs by the distinctive framboid pattern (Harris, 1981; Sawlowicz, 2000). Major peaks involving iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (Attachment A). While cobalt was not identified in the EDS spectrum, it would likely be present at concentrations below the detection limit. Pyrite was also identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site.

The wide distribution of pyrite across the site provides evidence that naturally occurring cobalt, which may substitute for iron in pyrite, may also be present in the aquifer solids near the EBAP. The presence of lignite in the area is well-documented, including at upgradient and downgradient locations relative to the EBAP (Broom and Myers, 1966; ETTL, 2010). Additionally, the pond was not identified as the source of cobalt at wells downgradient of the EBAP in the previous ASD based on the documented low mobility of cobalt under the pond conditions and lack of detectable cobalt in the pond itself.

2.1.2 Lithium

An ASD was previously generated for lithium exceedances at the EBAP which attributed the observed concentrations to natural variation in the aquifer, and more specifically to variations in naturally suspended matter that likely originates from lignite and is ubiquitous in the aquifer (Geosyntec, 2019c). New data gathered since completion of the prior ASD provides additional evidence that the observed lithium concentrations at AD-31 and AD-32 are due to natural variation in the aquifer.

Groundwater samples were collected in August 2019 at B-2, B-3, and AD-32 using low-flow sampling techniques. Total lithium concentrations in permanent upgradient wells B-2 and B-3 were measured at 0.055 mg/l and 0.090 mg/l, respectively, both of which are above the GWPS of 0.052 mg/L (Figure 5). Lithium was detected at AD-32 at 0.103 mg/L, which is comparable to the observed concentration at B-3. Because B-2 and B-3 were installed at upgradient locations Site activities, they suggest that lithium concentrations above the GWPS are naturally present in the vicinity of the EBAP.

The previous ASD generated for lithium at the EBAP developed a proposed mechanism for lithium mobility in groundwater which pointed to desorption from clay minerals associated with naturally occurring lignite material as the source of lithium in both up and downgradient wells at the EBAP (Geosyntec, 2019c).

As described in Section 2.1.1, groundwater samples were collected from B-2, B-3, and AD-32 and filtered to separate captured solid material. Both the solid material and the filtered groundwater were submitted for total metals analysis. Lithium was detected in the solid material at concentrations comparable to bulk soil at all locations, providing evidence that the particulates captured during groundwater sampling contain lithium (Table 4).

The total metal concentrations in the solid materials separated from the groundwater samples during filtration and the filtered groundwater concentrations were used to calculated partition coefficients values (K_d) for lithium, potassium, and sodium. These constituents were selected as they are all monovalent cations, and so have similar geochemical behavior. Partition coefficients are used to express the tendency of a chemical (e.g. lithium) to become adsorbed onto soil (or sediment). K_d is a ratio of the amount of chemical adsorbed per unit weight of the soil to the concentration of the chemical in solution (i.e., groundwater), as shown in the following equation:

$$K_d = \frac{mg\ adsorbed/kg\ soil}{mg/L\ solution}$$

K_d is characteristic of the soil, so its value varies with soil type. While K_d values were previously calculated using results from the VAP samples, the K_d values presented in this ASD are more likely to represent turbid groundwater which would be captured during regular sampling events, as they were calculated using material collected from permanent wells with conventional filter packs.

K_d values for groundwater and particulate collected from wells B-2, B-3, and AD-32 are comparable to literature K_d values reported for organic-rich media such as bogs and peat beds (Table 5) (Sheppard et al., 2009; 2011). These calculations provide further evidence that lithium mobility in Site groundwater is similar to other sites with organic-rich soils. Additionally, the calculated K_d values for Pirkey soils are consistent with the literature, with potassium being the largest (most sorbable) and sodium the smallest (least sorbable). Furthermore, the values are similar for groundwater from all three wells, suggesting a universal mechanism is controlling the mobilities of lithium, sodium, and potassium in groundwater.

Previously completed XRD analysis of the centrifuged solid material samples [VAP-B3-(40-45) and VAP-B3-50-55] found that clay minerals made up at least 60% of the aquifer solid (Table 3). Clay minerals include kaolinite, smectite, and illite/mica. SEM/EDS analysis identified the presence of silicon, aluminum and oxygen, all of which are indicative of clay minerals (Attachment A). The backscattered electron micrographs of these samples also identified clay particles by morphology. The largest clay particles (> 5 μm) are likely kaolinite, while smectite and illite dominate the smaller size fraction. These results are comparable to preliminary investigation of the VAP material completed by SEM/EDS described in the previous ASD, all of which presented evidence for clay fractions (Geosyntec, 2019c).

These multiple lines of evidence show that elevated lithium concentrations at AD-31 and AD-32 are not due to a release from the EBAP, and instead can be attributed to natural variation. This variation appears related to the distribution of clay fractions associated with lignite materials in the soil aquifer material.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSLs are not due to a release from the Pirkey EBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and provides evidence that the SSLs for cobalt at AD-2, AD-31, and AD-32 and for lithium at AD-31 and AD-32 identified during assessment monitoring in February 2019 were not due to a release from the EBAP. The identified SSLs were, instead, attributed to natural variation in the underlying geology. Therefore, no further action for cobalt or lithium is warranted, and the EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

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TABLES

Table 1: Summary of Key Cobalt Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant

Sample	**Unit**	**Cobalt Concentration**
Bottom Ash (Solid Material)	mg/kg	6.1
SPLP Leachate of Bottom Ash	mg/L	<0.01
EBAP Pond Water	mg/L	0.0024 J
AD-2 - Average	mg/L	0.0111
AD-31 - Average	mg/L	0.0107
AD-32 - Average	mg/L	0.0504

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

Average values were calculated using all cobalt data collected under 40 CFR 257 Subpart D, excluding any identified outliers.

Table 2: Soil Cobalt and Mineralogy Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	**Sample Depth (ft bgs)**	**Cobalt (mg/kg)**	**Pyrite/Marcasite (%)**
Bulk Soil Samples			
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-41	15	< 1.0	--
	35	23.5	---
	95	1.90	---
B-2	10	2.36	---
	16	3.62	---
	71	10.30	---
	82	7.21	---
	87	3.11	---
B-3	10	1.30	---
	20	0.59	---
	97	1.11	---
Solid Material Retained After Filtration			
AD-32	13-33	5.4	--
B-2	38-48	4.3	--
B-3	29-34	12.0	--
	VAP 40-45	18.0	3

Notes:

'--' - analysis not completed

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

For AD-XX locations, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-X locations were collected from cores removed from the borehole during well lithology logging.

Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

Table 3: X-Ray Diffraction Results
East Bottom Ash Pond - H. W. Pirkey Plant

Constituent	**VAP-B3-(40-45)**
Quartz	15
Plagioclase Feldspar	0.5
Orthoclase	ND
Calcite	ND
Dolomite	ND
Siderite	0.5
Goethite	ND
Hematite	2
Pyrite	3
Kaolinte	42
Chlorite	4
Illite/Mica	6
Smectite	12
Amorphous	15

Notes:

ND: Not detected

VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

Table 4: Soil Lithium Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	**Sample Depth (ft bgs)**	**Lithium (mg/kg)**
Bulk Soil Samples		
AD-32	11	0.53
	20-25	1.60
B-2	10	5.30
	16	3.97
	71	7.42
	87	13.10
B-3	10	3.64
	20	2.59
	97	11.10
Lignite	N/A	2.9 J
Solid Material ained After Filtration		
AD-32	3-33	9.8 J
B-2	3-48	6.5 J
B-3	9-34	7.8 J
	V 40-45	13.0

Notes:

J - estimated value

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

For AD-32, samples were collected from a tional boreholes advanced in the immediate area of the location identified by the well Samples were not collected from the cuttings of the borings advanced for well installation. mples for B-X locations were collected from cores removed from the borehole during w ithology logging.

Depths for samples collected after filtratic present the screened interval for the permanent well where the sample was collected.

VAP - vertical aquifer profiling

Table 5: Calculated Site-Specific Partition Coefficients
East Bottom Ash Pond - H. W. Pirkey Plant

Source	B-2			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.081	6.5	80	43-370
K	2.6	1100	423	42-1200
Na	14	130	9	5.2-82

Source	B-3			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.097	7.8	80	43-370
K	2.9	1100	379	42-1200
Na	32	240	8	5.2-82
Source	AD-32			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.11	9.8	89	43-370
K	3.9	1800	462	42-1200
Na	57	220	4	5.2-82

Notes:
mg/L: milligrams per liter
mg/kg: milligrams per kilogram
L/kg: liters per kilogram
Kd: partition coefficient
Adsorbed values are total metals concentrations reported by USEPA Method 6010B.
Literature values represent maximum and minimum values for the parameter as reported in Sheppard et al, 2009 (Table 4-1, all sites) and Sheppard et al, 2011 (Table 3-3 cultivated peat and wetland peat only).

FIGURES

Legend

● AD-15

● Monitoring Wells

Location Boundaries

CCR Units

▭ EBAP

▭ Landfill

▭ Stack Out Area

▭ WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.

0 380 760 1,520 2,280 3,040 Feet

Site Layout

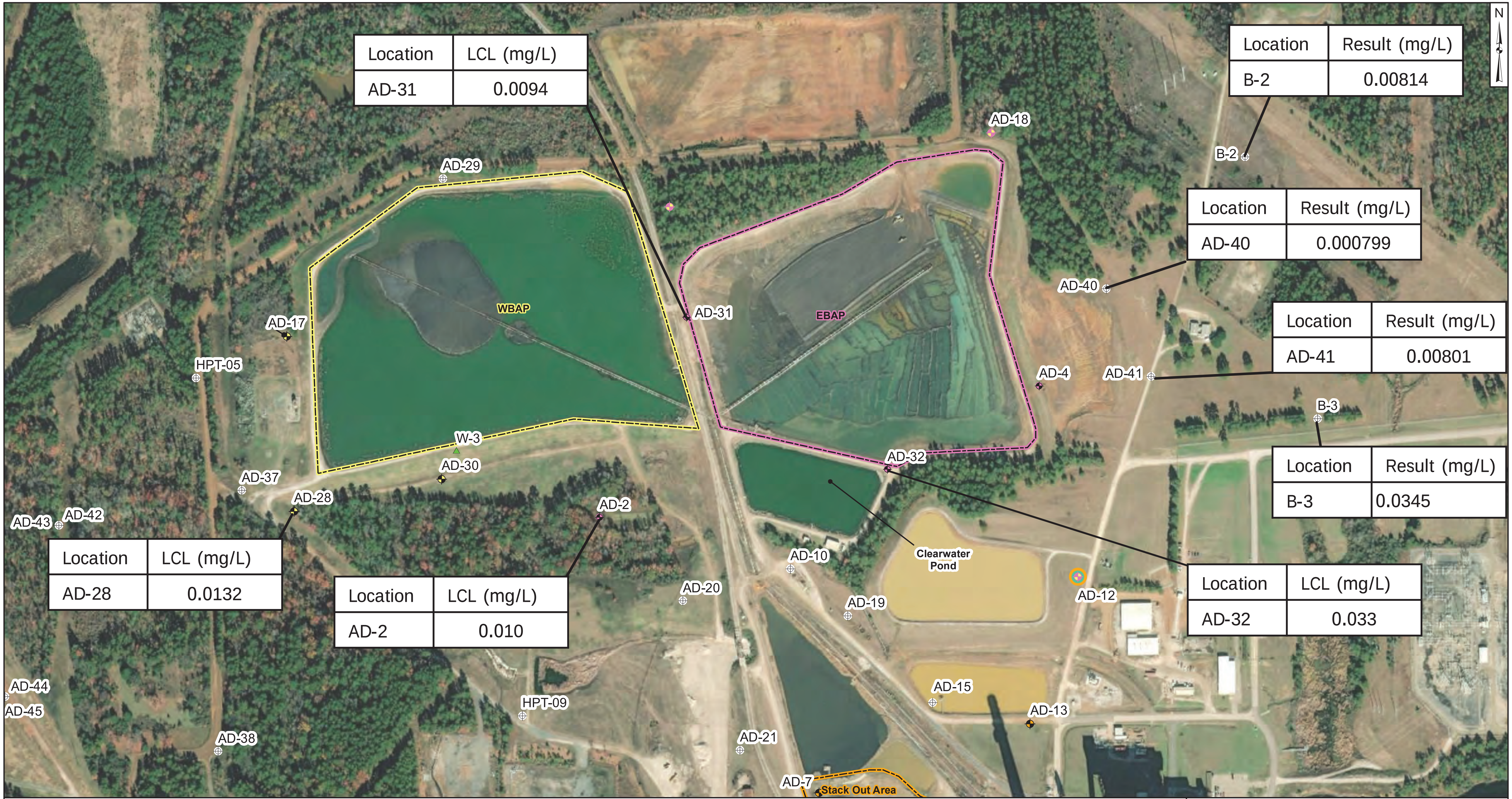
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/03/25

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_20190322.mxd. HDuff. 3/25/2019. Project/Phase/Task.



Location	LCL (mg/L)
AD-31	0.0094

Location	Result (mg/L)
B-2	0.00814

Location	Result (mg/L)
AD-40	0.000799

Location	Result (mg/L)
AD-41	0.00801

Location	Result (mg/L)
B-3	0.0345

Location	LCL (mg/L)
AD-32	0.033

Location	LCL (mg/L)
AD-28	0.0132

Location	LCL (mg/L)
AD-2	0.010

Legend

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- ▭ EBAP
- ▭ Stack Out Area
- ▭ WBAP

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- AD-15 location is approximated
- LCL: lower confidence limit
- Cobalt concentrations and LCL values displayed in milligrams per liter (mg/L).

400 200 0 400
Feet

Cobalt Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio 2019/09/17

Figure
2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Pirkey_Cobalt_20190912.mxd. ARevezzo. 9/17/2019. Project/Phase/Task.

Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	B-2				
Depth (ft bgs)	10	16	71	82	87
Cobalt (mg/kg)	2.36	3.62	10.30	7.21	3.11
Pyrite/Marcasite (%)	-	-	-	-	-

Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-41		
Depth (ft bgs)	15	35	95
Cobalt (mg/kg)	< 1.0	23.5	1.9
Pyrite/Marcasite (%)	-	-	-

Location	B-3		
Depth (ft bgs)	10	20	97
Cobalt (mg/kg)	1.30	0.59	1.11
Pyrite/Marcasite (%)	-	-	-

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Legend

⊕	Monitoring Wells
▭	EBAP
▭	WBAP

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.

300 150 0 300
Feet

Soil Chemical and Mineralogical Analysis Results

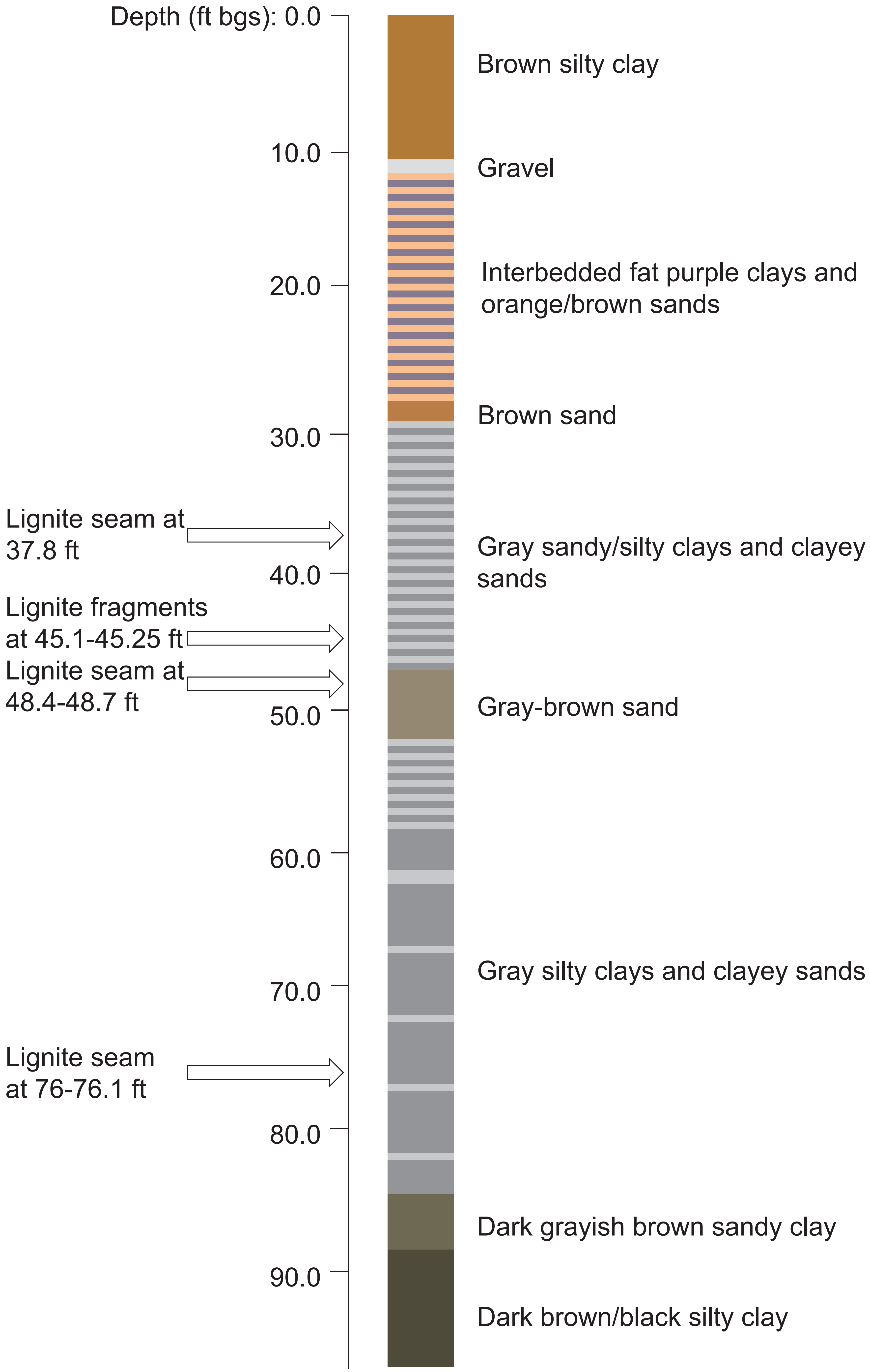
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/09/18

Figure
3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\Pirkey_SoilChem_minerals_March2019.mxd. hduff. 9/18/2019. Project/Phase/Task.



Notes:
- Ft = feet
- Bgs = below ground surface
- Boring completed May 2019
- Total depth of 97.5 ft bgs
- Well installed in offset boring screened at 29-34 ft bgs

Boring B-3 Visual Lithology Log

AEP Pirkey Powerplant
Hallsville, TX

Geosyntec
consultants

CHA8462

September 2019

Figure

4

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-05 Field Investigation\Field Forms\Compiled Boring Logs\Visual boring logs

Legend

● Borehole

⊕ Monitoring Well

Location Boundaries

▭ EBAP

▭ WBAP

Notes

- Lithium concentrations in micrograms per liter ug/L
- Monitoring well coordinates, site features, and data provided by AEP.
- AD-31 and AD-32 collected February 2019. B-2 and B-3 data from August 2019.

300 150 0 300

Feet

Lithium Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2019/09/18

Figure

5

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_Li_201909.mxd. hduff. 9/18/2019. CHA8462/12/02.

ATTACHMENT A

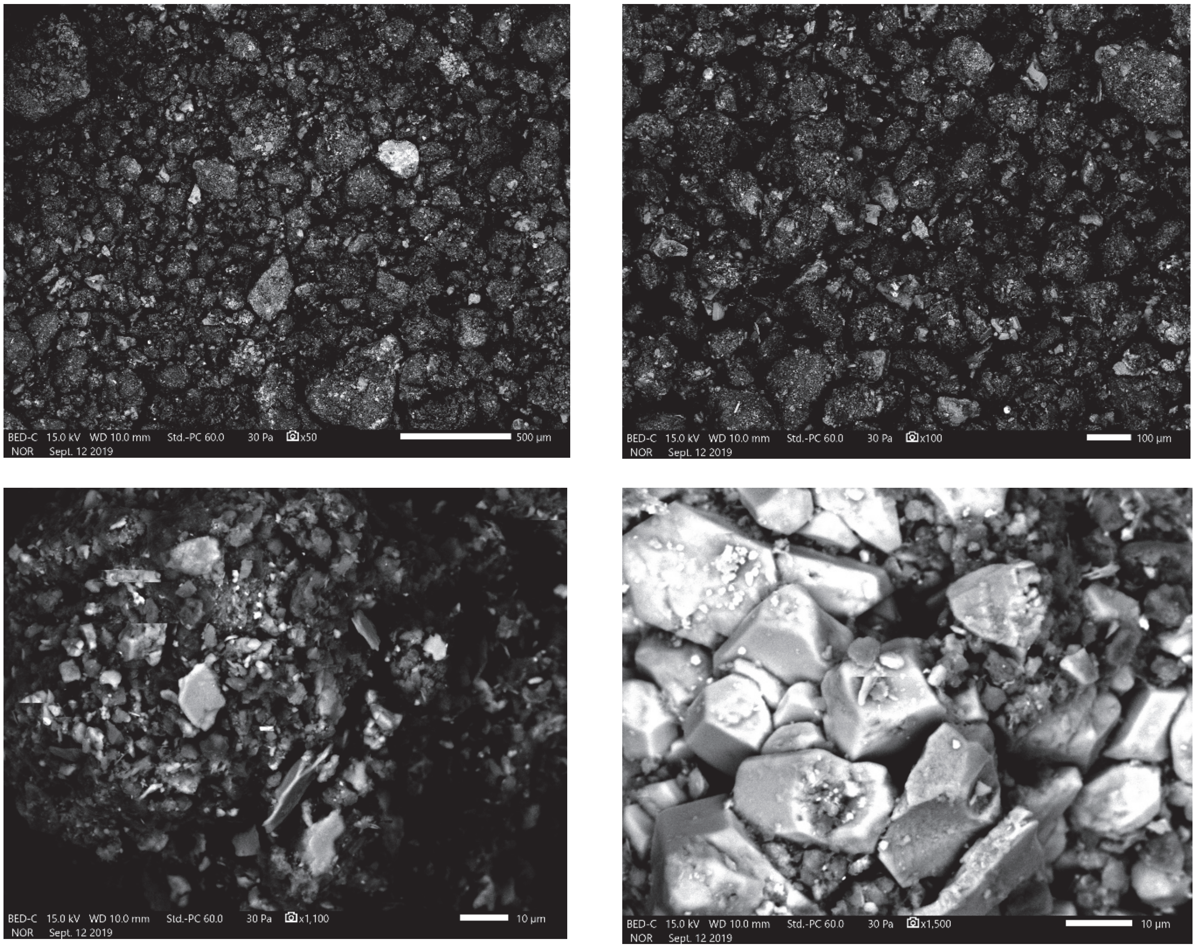
SEM/EDS Analysis

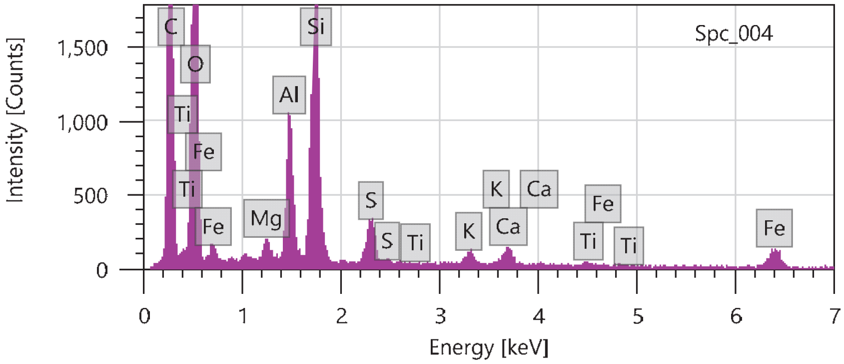
CTLGROUP

September 16, 2019

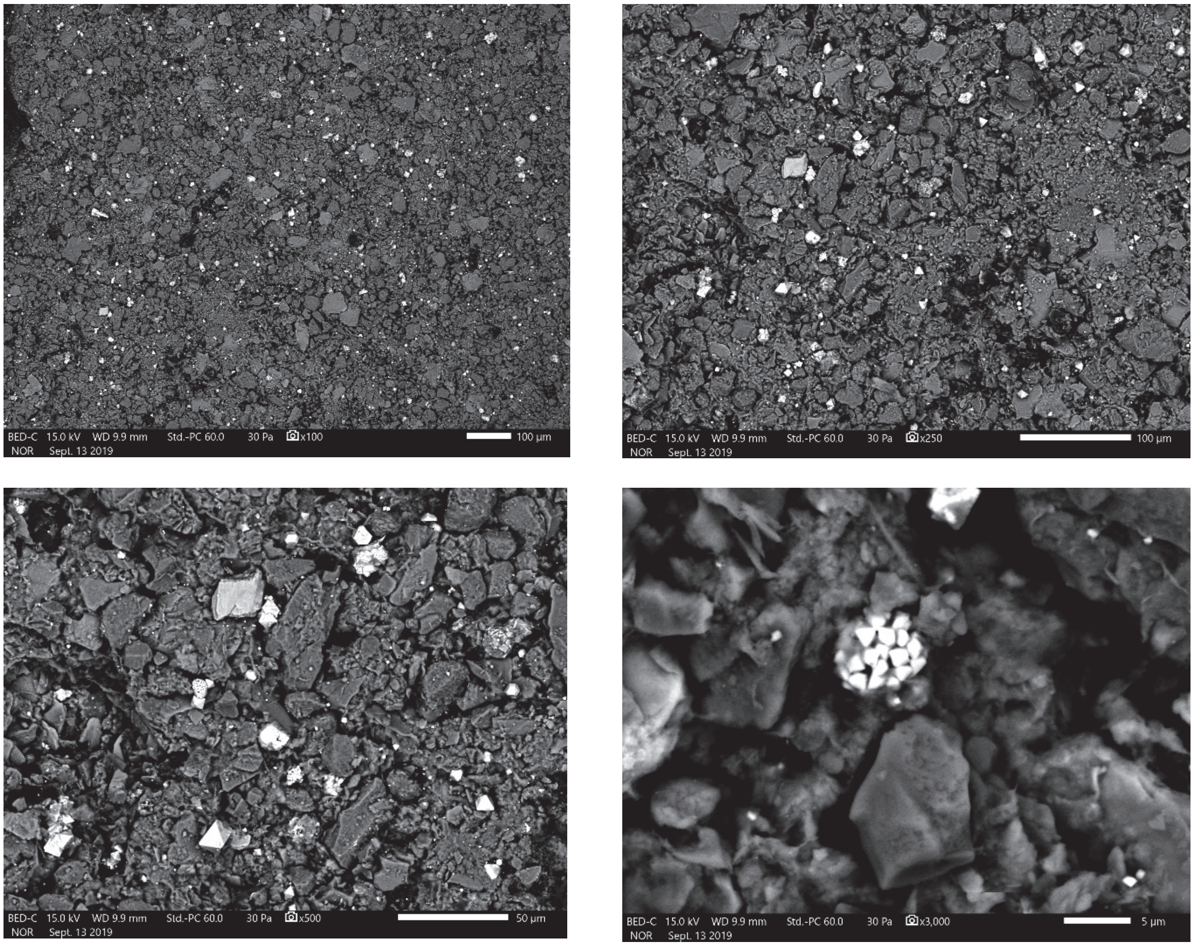
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221

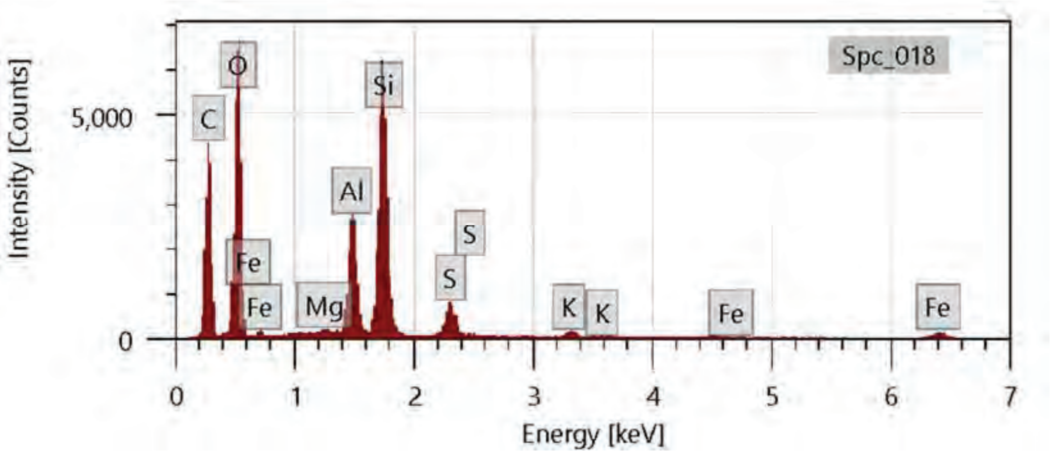
via Email: BSass@geosyntec.com



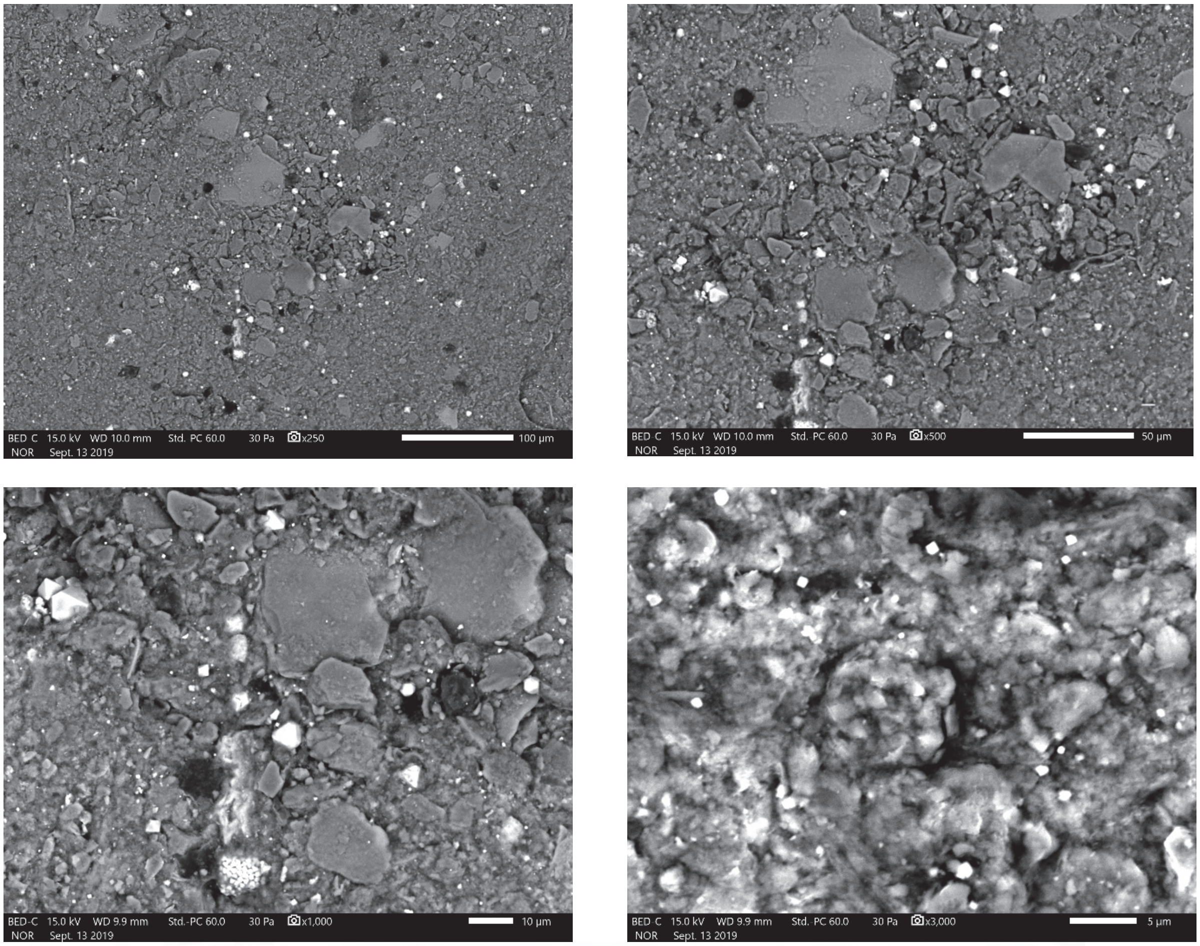


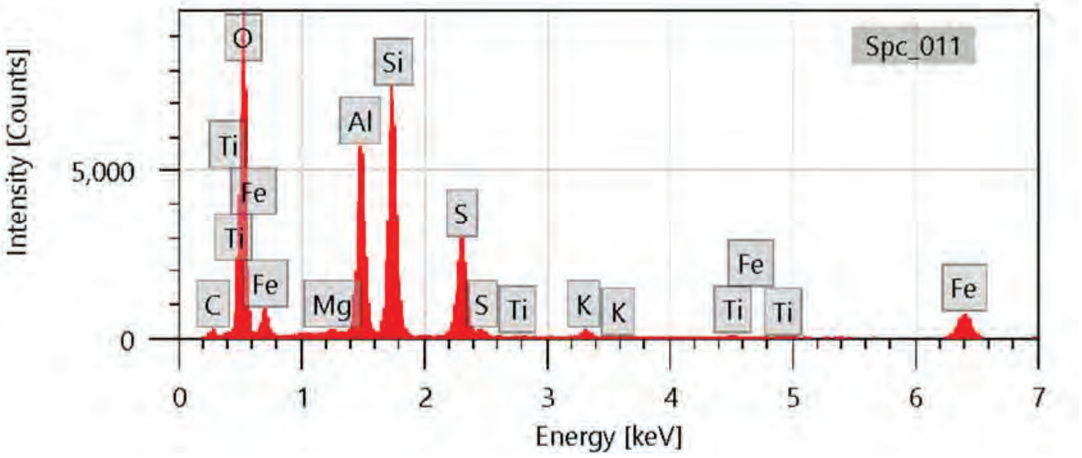
Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





Sample VAP B3 50-55. Backscattered electron micrographs show the sample at 250X, 500X, 1000X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 3000X. Bright particles are mostly pyrite (framboid in bottom left micrograph); occasional particles of Fe-Ti oxide are detected. Major peaks for oxygen, silicon, and aluminum suggest clay. Large blocky particles are mostly quartz, feldspar, and clay.

ATTACHMENT B

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

BETH ANN GROSS
79864

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

10/3/2019
Date

APPENDIX IV

Notices of groundwater monitoring program transitions are included in this appendix.

Pirkey Plant

Notice for Initiating an Assessment of Corrective Measures

CCR Unit – East Bottom Ash Pond

As required by 40 CFR 257.95(g)(5), this is a notification that an Assessment of Corrective Measures was initiated on March 26, 2019 for Pirkey Plant’s East Bottom Ash Pond due to the statistically significant level detected above the established groundwater protection standard for lithium. This notification is being placed in the plant’s operating record, as required by 40 CFR 257.105(h)(9).

APPENDIX V

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #506035

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 26' 52.08" N**
		Longitude:	**094° 29' 58.82" W**
Well County:	**Harrison**	Elevation:	**No Data**

****Plugged Within 48 Hours****

****This well has been plugged**** **<u>Plugging Report Tracking #185184</u>**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/19/2019** Drilling End Date: **2/20/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**60**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
31	**38**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Plug Information:

Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
SAND	**50**	**60**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	1	clay brown
1	5	silty sand
5	9.5	clay
9.5	11	sand
11	32	clay
32	39	sand and clay
39	55	sand
55	60	fine sand

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	Riser	New Plastic (PVC)	40	0	40
2	Screen	New Plastic (PVC)	40 0.1	40	50

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS PLUGGING REPORT for Tracking #185184

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 26' 52.08" N**
		Longitude:	**094° 29' 58.82" W**
		Elevation:	**No Data**
Well County:	**Harrison**		

Well Type: **Monitor**

Drilling Information

Company: **Plains Environmental Services** Date Drilled: **2/20/2019**

Driller: **Jesse Kalvig** License Number: **5025**

Well Report Tracking #506035

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Plugging Information

Date Plugged: **2/21/2019** Plugger: **Jesse Kalvig**

Plug Method: **Pour in 3/8 bentonite chips when standing water in well is less than 100 feet depth, cement top 2 feet**

Casing Left in Well:

DIa (in.)	*Top (ft.)*	*Bottom (ft.)*
2	**15**	**50**

Plug(s) Placed in Well:

Top (ft.)	*Bottom (ft.)*	*Description (number of sacks & material)*
1	**40**	**Bentonite 10 Bags/Sacks**

Certification Data: The driller certified that the driller plugged this well (or the well was plugged under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the reports(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

STATE OF TEXAS WELL REPORT for Tracking #506039

Owner: **H W PIRKEY POWER PLANT**

Owner Well #: **AD37**

Address: **2400 FM 3251**
HALLSVILLE, TX 75650

Grid #: **35-37-1**

Well Location: **2400 FM 3251**
HALLSVILLE, TX 75650

LOCATED ON OWNERS PROPERTY

Latitude: **32° 27' 56.32" N**

Longitude: **094° 29' 41.78" W**

Elevation: **No Data**

Well County: **Harrison**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**17**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
1	**10**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**8.5**	**CLAYS WITH SOME SAND**
8.5	**10.5**	**SAND**
10.5	**13**	**CLAY SOME SAND**
13	**15**	**SAND WITH SOME CLAYS**
15	**17**	**CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**12**	**17**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506038

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD38**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 27' 46.12" N**
		Longitude:	**094° 29' 43.34" W**
		Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/21/2019**

Drilling End Date: **2/21/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
1	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	5	CLAY RED
5	7	CLAY GRAY/RED
7	11.5	SAND/CLAY
11.5	17.5	SAND SOME CLAYS
17.5	18	CLAY SLITS

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	Riser	New Plastic (PVC)	40	0	13
2	Screen	New Plastic (PVC)	40 0.1	13	18

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506037

Owner: **H W PIRKEY POWER PLANT**

Address: **2400 FM 3251**
HALLSVILLE, TX 75650

Well Location: **2400 FM 3251**
HALLSVILLE, TX 75650

LOCATED ON OWNERS PROPERTY

Well County: **Harrison**

Owner Well #: **AD39**

Grid #: **35-37-4**

Latitude: **32° 26' 52.05" N**

Longitude: **094° 29' 58.84" W**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/20/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**12**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
1	**5**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**CLAY**
1	**5**	**CLAY/SAND**
5	**9.5**	**CLAY**
9.5	**12**	**SAND/CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**7**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**7**	**12**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508688

Owner: **AEP Pirkey Power Plant**

Owner Well #: **AD-40 (MW)**

Address: **2400 FM 3251**
Hallsville, TX 75650

Grid #: **35-37-1**

Well Location: **2400 FM 3251**
Hallsville, TX 75650

Latitude: **32° 28' 03" N**

Longitude: **094° 29' 00.5" W**

Well County: **Harrison**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**40**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
27	**40**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**13**	**Cement**
13	**27**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**40**	**red and grey sand with occasional clay intervals**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**30**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**30**	**40**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508686

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB(MW)-01A**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/9/2019**

Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**100**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
86	**100**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**86**	**Bentonite 17 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**85**	**red and grey sand with occasional clay intervals**
85	**88**	**grey clay**
88	**100**	**grey sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**90**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**90**	**100**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508703

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 shallow (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019**

Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**22**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**22**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**3**	**Cement**
3	**8**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name:	**James K. Collum**	License Number:	**3184**
Apprentice Name:	**Jason Smith**	Apprentice Number:	**60448**
Comments:	**No Data**		

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**22**	**red and grey sand w/occ. lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**12**	**22**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508695

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 deep (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**80**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
56	**80**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**8**	**Cement**
8	**56**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**36**	**red and grey sand w/occ. lignite layers**
36	**41**	**red and tan clay**
41	**69**	**red and grey sand with occasional clay iand lignite layers**
69	**80**	**grey sandy clay with lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**59**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**59**	**69**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508712

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
		Latitude:	**32° 27' 48" N**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/24/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**25**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
12	**25**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**12**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**25**	**brown sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**15**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**15**	**25**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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STATE OF TEXAS WELL REPORT for Tracking #508708

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019**

Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
45	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**45**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**28**	**brown sand**
28	**41**	**brown and grey silty clay**
41	**70**	**grey sand with occasional lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**50**	**60**

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STATE OF TEXAS WELL REPORT for Tracking #506040

Owner: **H W PIRKEY POWER PLANT**

Owner Well #: **SB6S**

Address: **2400 FM 3251**
HALLSVILLE, TX 75650

Grid #: **35-37-1**

Latitude: **32° 27' 30.34" N**

Well Location: **2400 FM 3251**
HALLSVILLE, TX 75650

Longitude: **094° 29' 27.76" W**

LOCAATED ON OWNERS PROPERTY

Elevation: **No Data**

Well County: **Harrison**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**18**	**SANDS AND CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506041

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6D**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 27' 30.28" N**
		Longitude:	**094° 29' 27.75" W**
		Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019**

Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**65**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**53**	**Bentonite 19 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**24**	**SANDS AND CLAYS**
24	**29**	**CLAYS**
29	**42.5**	**SANDS AND CLAYS**
42.5	**48.5**	**SANDS WITH SOME CLAY**
48.5	**56**	**CLAYS WITH SOME SAND**
56	**65**	**SILY SANDS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**55**	**65**

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P.O. Box 12157
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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508722

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 shallow (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/3/2019** Drilling End Date: **3/3/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**45**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
32	**45**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**32**	**Bentonite 6 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**45**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**35**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**35**	**45**

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508720

Owner: **AEP Pirkey Power Plant**

Owner Well #: **SB-7 deep (MW)**

Address: **2400 FM 3251**
Hallsville, TX 75650

Grid #: **35-36-6**

Latitude: **32° 27' 27" N**

Well Location: **2400 FM 3251**
Hallsville, TX 75650

Longitude: **094° 30' 08" W**

Well County: **Harrison**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
57	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**12**	**Cement**
12	**57**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**70**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**60**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**60**	**70**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508724

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**35**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**35**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**23**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**35**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**25**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**25**	**35**

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508729

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 medium (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**65**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
52	**65**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**12**	**Cement**
12	**53**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**65**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508777

Owner: **AEP Pirkey Power Plant**

Address: **2400 FM 3251**
Hallsville, TX 75650

Well Location: **2400 FM 3251**
Hallsville, TX 75650

Well County: **Harrison**

Owner Well #: **SB-8 deep (MW)**

Grid #: **35-36-6**

Latitude: **32° 27' 10" N**

Longitude: **094° 30' 12" W**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	0	93

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
77	93	Sand	16/30

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	12	Cement
12	77	Bentonite 15 Bags/Sacks

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**90**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**
90	**93**	**gray clay (old pit base?)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**80**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**80**	**90**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508781

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/5/2019** Drilling End Date: **3/5/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**30**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
17	**30**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**12**	**Cement**
12	**17**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**20**	**30**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508779

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/4/2019**

Drilling End Date: **3/4/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**60**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
48	**60**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**48**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**60**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**50**	**60**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508718

Owner: **AEP Pirkey Power Plant**

Address: **2400 FM 3251**
Hallsville, TX 75650

Well Location: **2400 FM 3251**
Hallsville, TX 75650

Well County: **Harrison**

Owner Well #: **SB-11 shallow (MW)**

Grid #: **35-36-6**

Latitude: **32° 26' 41" N**

Longitude: **094° 30' 11" W**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/8/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**15**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
3	**15**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**1**	**Cement**
1	**3**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**18**	**tan and brown sandy, silty clay and occasional gravel**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**5**	**15**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508717

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/7/2019**

Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**43**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
30	**43**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**30**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**18**	**tan and brown sandy, silty clay and occasional gravel**
18	**43**	**red and grey sand w/occ. clay layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**33**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**33**	**43**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525309

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**B-2**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
		Latitude:	**32° 27' 54.7" N**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Longitude:	**094° 28' 25.01" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **5/13/2019** Drilling End Date: **5/17/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	0	49

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
36	49	Sand	20/40

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	32	Concrete 1 Bags/Sacks
32	36	Bentonite 1 Bags/Sacks

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht** License Number: **4997**

Apprentice Name: **Ramon Gutierrez** Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**0.5**	**SILTY SAND, black**
0.5	**2**	**SAND, red/brown**
2	**5**	**SANDY CLAY, alternating layers red + brown**
5	**5.5**	**NO RECOVERY**
5.5	**6.7**	**SANDY CLAY, gray + brown/red**
6.7	**8**	**CLAY, gray**
8	**11**	**CLAY, gray with brown striations**
11	**11.5**	**CLAY, gray**
11.5	**12**	**CLAYEY, gray SAND, red-brown**
12	**14**	**NO RECOVERY**
14	**14.75**	**SANDY CLAY, reddish brown + gray**
14.75	**16**	**CLAY, gray + red & trace brown fine grained SAND**
16	**18.5**	**NO RECOVERY**
18.5	**18.75**	**CLAY, red & gray, trace SILT**
18.75	**18.95**	**SAND, tan**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**38**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**38**	**48**
2	**SUMP**	**New Plastic (PVC)**	**40**	**48**	**48.5**

18.95	20	CLAY, red/drk. gray
20	21.1	NO RECOVERY
21.1	21.8	SANDY CLAY, lt. brown + red
21.8	24	CLAY, red + drk. gray
24	24.5	SANDY CLAY, lt. brown
24.5	24.8	SANDY CLAY, red-brown
24.8	28	CLAY, purple + gray
28	29.9	CLAY, drk. purple
29.9	30.7	CLAY, black/drk. gray
30.7	32	SILTY CLAY, black/drk. gray
32	33.5	SILTY CLAY, drk. gray
33.5	36	SILTY CLAY, black
36	36.5	NO RECOVERY
36.5	38.1	SAND, drk. green
38.1	38.3	SILTY SAND, drk. brown
38.3	38.4	CLAYEY SAND, very drk. brown
38.4	38.5	SILTY SAND, drk. green
38.5	39	SILTY SAND, drk. brown
39	39.2	Laminated SANDY CLAY/CLAYEY SANDS, gray to drk. gray
39.2	43.1	NO RECOVERY
43.1	44.5	Fine graded SAND w/trace SILT, greenish gray
44.5	47	CLAYEY SAND/SANDY CLAY, drk. brown
47	48.1	NO RECOVERY
48.1	49	CLAYEY SAND/SANDY CLAY, drk. brown

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525308

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**B-3**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 54.7" N**
		Longitude:	**094° 28' 25.01" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **5/15/2019** Drilling End Date: **5/15/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8	**0**	**35**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
26.9	**35**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**22**	**Concrete 1 Bags/Sacks**
22	**26.9**	**Bentonite 1 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht** License Number: **4997**

Apprentice Name: **Ramon Gutierrez** Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**2**	**CLAY, medium red-brown**
2	**3**	**CLAY, lt. brown**
3	**4**	**Organic CLAY, gray to lt. brown**
4	**4.5**	**Organic CLAY, lt. brown**
4.5	**5**	**Organic CLAY, lt. brown to reddish brown**
5	**9.5**	**Organic CLAY, lt. brown to reddish brown**
9.5	**10.5**	**SILTY CLAY, reddish-orange**
10.5	**11**	**Poorly graded gravel**
11	**13**	**CLAYEY SAND,**
13	**13.9**	**SANDY CLAY, brown to orange**
13.9	**15**	**SAND, orange**
15	**16**	**SANDY CLAY**
16	**18**	**SAND, orange**
18	**18.5**	**Fat CLAY, grayish purple**
18.5	**19.5**	**SAND, orange to grayish orange**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**29.2**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**29.2**	**34**
2	**SUMP**	**New Plastic (PVC)**	**40** **0.010**	**34**	**34.5**

19.5	20	Fat CLAY, grayish purple
20	22.1	SAND, lt. brown to orange
22.1	22.3	Lenes of fat CLAY, drk. gray to purple
22.3	22.6	SAND, lt. brown to orange
22.6	23	Gravelly SAND
23	24	SANDY CLAY, grayish purple
24	25.6	SAND, tan to lt. brown
25.6	26.4	CLAY, purple and gray
26.4	26.8	CLAYEY SAND, tan to lt. brown
26.8	27.3	CLAY, purple
27.3	28	CLAY, drk. gray
28	28.6	NO RECOVERY
28.6	29.2	SAND, lt. brown
29.2	29.5	SILTY CLAY, drk. gray
29.5	32	CLAY, drk. gray to black
32	32.7	CLAY, drk. gray
32.7	33.1	CLAYEY SILT, drk. gray
33.1	35	SAND, drk. gray

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525304

Owner: **AEP Pirkey Power Plant**

Owner Well #: **B-6**

Address: **2400 FM 3251**
Hallsville, TX 75650

Grid #: **35-37-1**

Latitude: **32° 27' 54.7" N**

Well Location: **2400 FM 3251**
Hallsville, TX 75650

Longitude: **094° 28' 25.01" W**

Well County: **Harrison**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **5/20/2019** Drilling End Date: **5/20/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
4	0	40

Drilling Method: **Direct Push**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
27	40	Sand	20/40

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	25	Concrete 1 Bags/Sacks
25	27	Bentonite 1 Bags/Sacks

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht**

License Number: **4997**

Apprentice Name: **Ramon Gutierrez**

Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**0.4**	**Topsoil with vegetation, black SILT**
0.4	**1.8**	**SILT, brown**
1.8	**7**	**SILTY CLAY, red & lt. gray**
2.3	**23.5**	**SILT, drk. red**
7	**7.2**	**SILT, brown**
7.2	**7.6**	**SILTY CLAY, red & lt. gray**
7.6	**8**	**CLAY, lt. gray**
8	**9**	**CLAY, lt. gray & lt. red**
9	**9.3**	**SILTY CLAY, lt. gray & brown**
9.3	**9.8**	**CLAY, lt. gray**
9.8	**12**	**CLAY, reddish-brown**
12	**12.8**	**SILTY CLAY, red & brown**
12.8	**16**	**SILTY CLAY, drk. brown**
16	**18.1**	**CLAY, red & brown**
18.1	**18.8**	**SILTY CLAY, brown**
18.8	**18.9**	**CLAY, brown**
18.9	**19.1**	**SILT, lt. gray & brown**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**29**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**29**	**39**
2	**SUMP**	**New Plastic (PVC)**	**40**	**39**	**39.5**

19.1	19.4	SILTY CLAY, brown
19.4	20	CLAYEY SILT, lt. gray & brown
20	20.9	CLAY, red/brown
20.9	22.1	CLAYEY SILT, lt. brown
22.1	23.2	SILTY CLAY, lt. brown & gray
23.5	24	SILTY CLAY, lt. brown & gray
24	25.9	NO RECOVERY
25.9	26.1	CLAYEY SILT, lt. brown
26.1	26.3	SILTY CLAY, brown
26.3	28	SILTY CLAY, black & drk. green
28	28.7	Trace CLAY, brown SILT
28.7	29.6	SILTY CLAY, drk. brown & green
29.6	29.9	CLAY, drk. brown
29.9	30.3	CLAYEY SAND, drk. green & drk. brown
30.3	32	Fine grained SAND, drk. green
32	34.4	Fine grained SAND, gray & brown
34.4	34.5	SILT w/gravel, tan/brown
34.5	34.7	CLAY, drk. brown
34.7	35.1	Fine grained SAND, drk. green
35.1	36	Fine grained SANDY SILT, drk. green & black
36	37.4	Fine grained SAND, drk. brown
37.4	38.5	Fine grained SILTY SAND, drk. gray & drk. green
38.5	40	SANDY SILT, drk. green & black

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
West Bottom Ash Pond CCR Management Unit
Hallsville, Texas

January 2020

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY℠
An AEP Company
BOUNDLESS ENERGY℠

Page

Table of Contents

I. Overview

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2019.

In general, the following activities were completed:

- Groundwater samples were collected for AD-3, AD-12, AD-17, AD-18, AD-28, and AD-30 in February, May, and August 2019 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq*. and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on December 26, 2018. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on March 26, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on July 10, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 23, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.
- The unit was in assessment monitoring and the beginning and the end of 2019.

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;

- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations (Appendix IV).
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

West Bottom Ash Pond Monitoring Wells	
Up Gradient	Down Gradient
AD-3	AD-17
AD-12	AD-28
AD-18	AD-30

III. Monitoring Wells Installed or Decommissioned

Several monitoring wells were installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry in mine spoils. Please see the list below. Well installation reports can be found in Appendix V.

Soil Boring ID	Monitor Well ID
	AD-37
	AD-38
	AD-39
	AD-40
SB-01A	AD-41
SB-04	AD-42
SB-04	AD-43
SB-05	AD-44
SB-05	AD-45
SB-06	AD-46
SB-06	AD-47
SB-07	AD-48
SB-07	AD-49
SB-08	AD-50
SB-08	AD-52
SB-08	AD-53
SB-09	AD-54
SB-09	AD-55
SB-11	AD-56
SB-11	AD-57

Three additional soil borings were installed to better understand the spatial variability of constituents at the site up gradient of the plant. Two monitor wells were installed at these boring locations B-2 and B-3. Well reports for soil boring B-2 and B-3 can also be found in Appendix V.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event also are shown in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a one round of sampling in February in accordance with 40 CFR 257.95(d)(1). A May sampling event was conducted in accordance with 40 CFR 257.95(b) including all Appendix III parameters and those Appendix IV constituents parameters followed by an August round of sampling in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2020.

V. Statistical Evaluation of 2019 Events

The two statistical analysis reports are included in Appendix II.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on July 10, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 23, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the west bottom ash pond SSLs above GWPSs. SSLs above the GWPS were determined for cobalt on December 26, 2018. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on March 26, 2019.

SSLs above the GWPS were determined for cobalt at wells AD-28 on July 10, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 23, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt at wells AD-28 on January 3, 2020. An alternate source investigation will be conducted for these SSLs.

The supporting information are found in Appendix III.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

The unit transitioned from detection monitoring to assessment monitoring transition on April 3, 2018.

Assessment monitoring will continue in 2020.

Regarding defining an alternate monitoring frequency, no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

No other information applies at this time.

IX. Description of Any Problems Encountered in 2019 and Actions Taken

No significant problems were encountered.

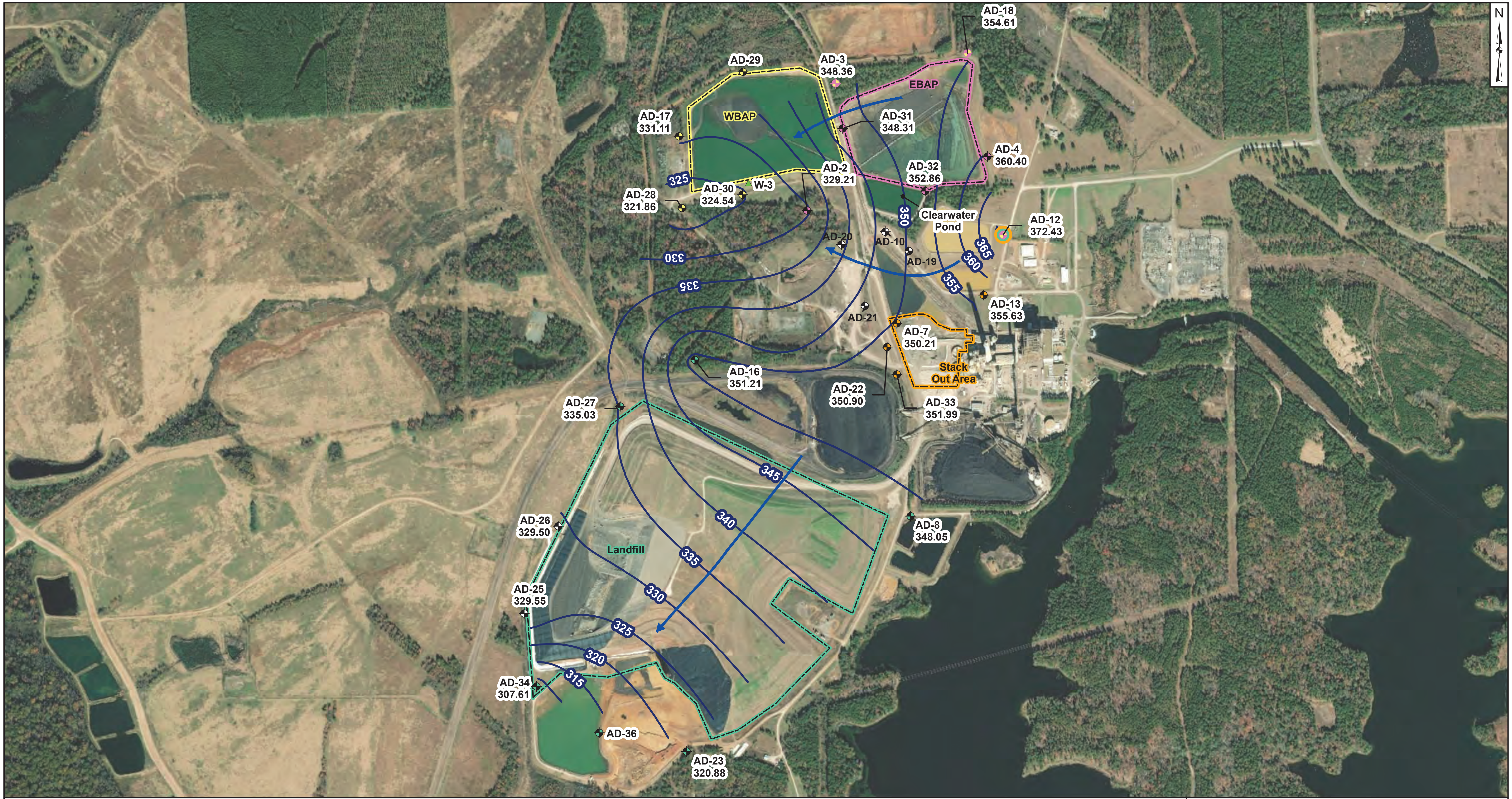
X. A Projection of Key Activities for the Upcoming Year

Key activities for 2020 include:

- Assessment monitoring sampling will be conducted;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for any SSLs above GWPS;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the fourth annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

Potentiometric Contours - Uppermost Aquifer
February 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure

1

Columbus, Ohio

2020/01/16

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- ── Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
May 2019

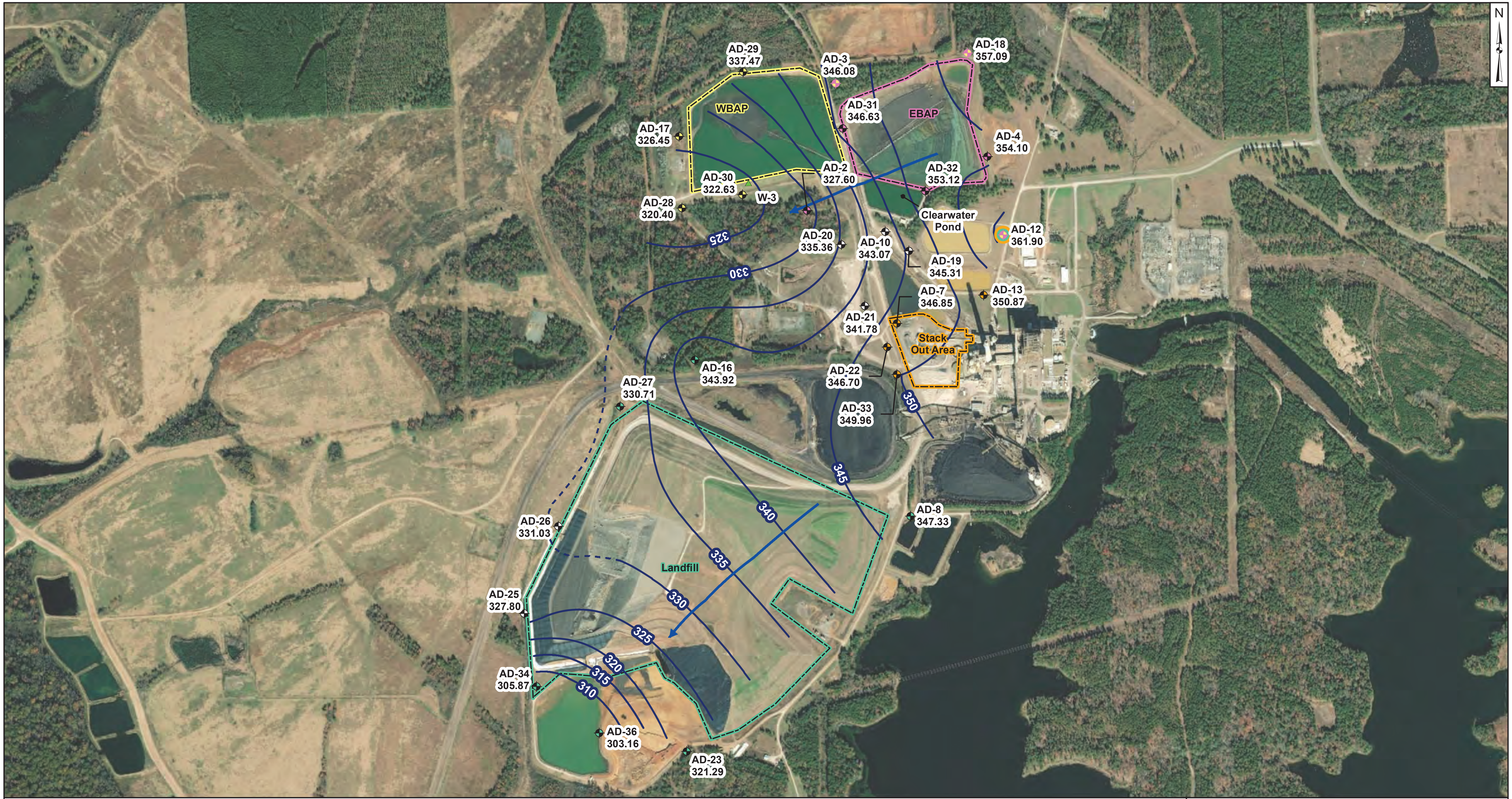
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2020/01/16

Figure
2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201905-May.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2020/01/16

Figure
3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201908-August.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Table 1: Residence Time Calculation Summary
Pirkey West Bottom Ash Pond

			2019-02		2019-05		2019-08	
CCR Management Unit	Monitoring Well	Well Diameter (inches)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
West Bottom Ash Pond	AD-3 [1]	4.0	17.6	6.9	17.6	6.9	11.3	10.7
	AD-12 [1]	4.0	34.2	3.6	35.0	3.5	21.4	5.7
	AD-17 [2]	2.0	15.3	4.0	16.0	3.8	11.4	5.3
	AD-18 [1]	2.0	9.3	6.6	8.9	6.8	7.1	8.5
	AD-28 [2]	2.0	15.8	3.8	14.2	4.3	13.0	4.7
	AD-30 [2]	2.0	14.9	4.1	14.1	4.3	15.4	3.9

Notes:
[1] - Background Well
[2] - Downgradient Well

Table 1 - Groundwater Data Summary: AD-3
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	**mg/L**	**mg/L**	**mg/L**	**SU**	**mg/L**	**mg/L**
5/11/2016	Background	0.04	2.9	6	<0.083 U	4.9	136	18
7/14/2016	Background	0.06	4.67	6	<0.083 U	4.7	161	30
9/8/2016	Background	0.06	4.28	7	<0.083 U	4.5	145	28
10/13/2016	Background	0.05	4.93	8	<0.083 U	5.5	168	31
11/14/2016	Background	0.07	4.61	7	<0.083 U	5.4	170	29
1/12/2017	Background	0.05	3.81	7	<0.083 U	5.3	152	27
3/1/2017	Background	0.05	2.55	5	<0.083 U	5.1	124	16
4/10/2017	Background	0.06	2.6	10	<0.083 U	4.9	140	19
8/24/2017	Detection	0.08625	2.37	6	<0.083 U	5.6	68	17
3/22/2018	Assessment	0.05508	3.41	5	<0.083 U	5.3	140	26
8/21/2018	Assessment	0.055	4.79	9	<0.083 U	5.6	166	34
2/27/2019	Assessment	0.034	3.46	6.16	0.04 J	5.3	50	21.8
5/23/2019	Assessment	0.045	6.19	5.99	0.09	4.9	154	29.5
8/13/2019	Assessment	0.05 J	5.08	6.83	0.19	5.1	168	32.5

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-3
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	59	0.412956 J	0.0947139 J	0.724945 J	3.12937 J	1.059	<0.083 U	<0.68 U	0.025	0.00992 J	0.774997 J	3.29747 J	<0.86 U
7/14/2016	Background	<0.93 U	2.10876 J	70	0.583927 J	<0.07 U	1	7	1.69	<0.083 U	<0.68 U	0.095	0.025	1.16077 J	2.50173 J	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	70	0.502486 J	<0.07 U	0.974129 J	7	1.491	<0.083 U	<0.68 U	0.087	0.00618 J	<0.29 U	<0.99 U	<0.86 U
10/13/2016	Background	<0.93 U	4.22879 J	82	0.591063 J	0.159178 J	2	9	3.42	<0.083 U	<0.68 U	0.991	0.0073 J	<0.29 U	1.92667 J	<0.86 U
11/14/2016	Background	<0.93 U	1.98138 J	64	0.310985 J	<0.07 U	0.42234 J	8	1.532	<0.083 U	<0.68 U	0.092	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	62	0.281878 J	<0.07 U	0.551806 J	4.96138 J	2.01	<0.083 U	<0.68 U	0.079	0.0057 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	62	0.279961 J	<0.07 U	<0.23 U	2.54266 J	0.862	<0.083 U	<0.68 U	0.046	<0.005 U	<0.29 U	1.78128 J	1.13014 J
4/10/2017	Background	<0.93 U	<1.05 U	61	0.284613 J	<0.07 U	0.250858 J	2.40319 J	0.991	<0.083 U	<0.68 U	0.046	<0.005 U	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	57.94	0.22 J	<0.07 U	0.86 J	3.74 J	0.739	<0.083 U	<0.68 U	0.06189	<0.005 U	<0.29 U	1.13 J	<0.86 U
8/21/2018	Assessment	<0.01 U	1.01	63.3	0.240	0.02 J	0.496	7.18	1.837	<0.083 U	0.355	0.0876	<0.005 U	0.1 J	0.1	0.057
2/27/2019	Assessment	0.04 J	0.13	54.2	<0.4 U	0.03 J	0.04 J	2.31	0.3144	0.04 J	0.05 J	0.0525	<0.005 U	<0.4 U	0.05 J	<0.1 U
5/23/2019	Assessment	<0.4 U	<0.6 U	61.8	<0.4 U	<0.2 U	<0.8 U	4.94	0.988	0.09	<0.4 U	0.0734	<0.005 U	<8 U	<0.6 U	<0.1 U
8/13/2019	Assessment	<0.02 U	2.41	58.3	0.196	0.02 J	0.206	6.55	1.378	0.19	0.417	0.108	<0.005 U	<0.4 U	0.1 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	<0.083 U	4.4	94	4
7/13/2016	Background	0.03	0.26	6	<0.083 U	3.1	75	4
9/7/2016	Background	0.04	0.343	6	<0.083 U	3.9	63	7
10/12/2016	Background	0.03	0.271	7	< 1 U	3.4	92	8
11/14/2016	Background	0.04	0.331	8	<0.083 U	2.6	80	6
1/11/2017	Background	0.03	0.315	7	<0.083 U	4.8	76	6
2/28/2017	Background	0.04	0.434	5	<0.083 U	3.6	50	4
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	72	7
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	52	6
3/21/2018	Assessment	0.01397	0.269	5	<0.083 U	4.2	<2 U	3
8/20/2018	Assessment	0.017	0.338	10	<0.083 U	4.4	94	4
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	36	3.6
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	80	4.0
8/12/2019	Assessment	<0.02 U	0.278	7.24	0.06 J	4.9	90	2.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	26	0.219521 J	<0.07 U	0.710981 J	1.58207 J	0.2073	<0.083 U	<0.68 U	<0.00013 U	<0.005 U	<0.29 U	1.73953 J	<0.86 U
7/13/2016	Background	<0.93 U	<1.05 U	23	0.190337 J	<0.07 U	0.68835 J	1.29444 J	2.909	<0.083 U	<0.68 U	0.008	<0.005 U	<0.29 U	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	30	0.232192 J	<0.07 U	0.353544 J	1.66591 J	0.881	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	<1.05 U	27	0.149553 J	<0.07 U	0.529033 J	1.56632 J	0.257	< 1 U	<0.68 U	0.012	<0.005 U	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	28	0.152375 J	<0.07 U	0.32826 J	1.47282 J	0.767	<0.083 U	<0.68 U	0.013	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	23	0.126621 J	<0.07 U	0.650158 J	1.09495 J	1.536	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	26	0.149219 J	<0.07 U	0.325811 J	1.29984 J	0.416	<0.083 U	<0.68 U	0.009	<0.005 U	<0.29 U	<0.99 U	0.994913 J
4/11/2017	Background	<0.93 U	<1.05 U	24	0.159412 J	<0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	<0.68 U	0.008	0.01364 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	25.82	0.16 J	<0.07 U	1.05	1.49 J	0.784	<0.083 U	<0.68 U	0.00722	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	<0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	<0.083 U	0.089	0.0143	<0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	<0.4 U	<0.6 U	22.5	<0.4 U	<0.2 U	<0.8 U	1.37	0.225	0.09	<0.4 U	0.00688	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	<0.6 U	21.7	<0.4 U	<0.2 U	<0.8 U	1.15	0.201	0.09	<0.4 U	0.00576	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.07 J	23.8	0.154	<0.01 U	0.204	1.3	0.237	0.06 J	0.08 J	0.00829	<0.005 U	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-17
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.02	0.648	12	<0.083 U	4.3	68	4
7/14/2016	Background	0.03	1.28	34	<0.083 U	3.3	96	4
9/8/2016	Background	0.03	1.19	29	<0.083 U	3.9	88	6
10/13/2016	Background	0.03	1.34	32	0.393 J	3.6	96	6
11/15/2016	Background	0.03	1.3	30	0.3446 J	3.7	88	6
1/12/2017	Background	0.03	1.08	26	<0.083 U	4.4	90	6
3/1/2017	Background	0.04	0.57	19	<0.083 U	4.0	80	5
4/10/2017	Background	0.03	0.395	20	<0.083 U	4.2	88	9
8/24/2017	Detection	0.04495	1.06	25	0.245 J	4.6	98	6
12/21/2017	Detection	- -	- -	26	<0.083 U	- -	76	8
3/22/2018	Assessment	0.03113	0.0981	13	<0.083 U	4.4	44	5
8/21/2018	Assessment	0.044	0.997	35	<0.083 U	3.9	98	7
2/28/2019	Assessment	0.03 J	0.2 J	10.2	0.12	3.7	68	2.4
5/23/2019	Assessment	0.019	0.2 J	10.3	0.13	4.0	58	2.4
8/13/2019	Assessment	0.03 J	0.777	26.3	0.24	4.8	88	1.8

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-17
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	1.21333 J	143	0.507354 J	0.0868344 J	1	5	2.082	<0.083 U	<0.68 U	<0.00013 U	0.06	<0.29 U	2.55378 J	<0.86 U
7/14/2016	Background	<0.93 U	1.3096 J	334	0.85295 J	0.0833036 J	2	14	3.12	<0.083 U	<0.68 U	0.027	0.138	0.485824 J	<0.99 U	<0.86 U
9/8/2016	Background	<0.93 U	1.76675 J	327	0.948023 J	<0.07 U	5	14	4.473	<0.083 U	<0.68 U	0.028	0.142	<0.29 U	<0.99 U	1.0754 J
10/13/2016	Background	<0.93 U	<1.05 U	324	0.753919 J	<0.07 U	0.542006 J	14	6.64	0.393 J	<0.68 U	0.026	0.05	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	290	0.708598 J	<0.07 U	0.448238 J	13	7.94	0.3446 J	<0.68 U	0.026	0.078	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	234	0.541302 J	<0.07 U	0.723126 J	10	9.6	<0.083 U	<0.68 U	0.023	0.055	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	176	0.499114 J	<0.07 U	0.359001 J	8	2.31	<0.083 U	<0.68 U	0.019	0.084	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	140	0.511666 J	<0.07 U	0.689417 J	7	3.67	<0.083 U	<0.68 U	0.016	0.069	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	94.77	0.38 J	<0.07 U	1.21	4.57 J	1.669	<0.083 U	<0.68 U	0.01186	0.125	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	<0.01 U	0.41	223	0.588	0.04	0.367	10.9	2.505	<0.083 U	0.181	0.0234	0.216	<0.02 U	0.5	0.051
2/28/2019	Assessment	<0.4 U	<0.6 U	71.4	<0.4 U	<0.2 U	<0.8 U	2.93	0.772	0.12	<0.4 U	0.00912	0.107	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	<0.6 U	82.9	<0.4 U	<0.2 U	0.9 J	3.15	1.62	0.13	<0.4 U	0.00911	0.103	<8 U	<0.6 U	<0.1 U
8/13/2019	Assessment	<0.02 U	0.40	216	0.554	0.04 J	0.732	9.03	6.40	0.24	0.2 J	0.0193	0.447	<0.4 U	0.3	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-18
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.01	0.548	8	<0.083 U	4.5	108	7
7/14/2016	Background	0.01	0.409	8	<0.083 U	4.7	116	7
9/8/2016	Background	0.01	0.343	8	<0.083 U	4.7	110	8
10/13/2016	Background	0.02	0.56	7	<0.083 U	4.1	124	10
11/15/2016	Background	0.02	0.59	7	<0.083 U	4.4	134	7
1/12/2017	Background	0.01	0.415	7	<0.083 U	4.7	128	10
3/1/2017	Background	0.01	0.224	6	<0.083 U	4.1	108	7
4/10/2017	Background	0.01	0.304	7	<0.083 U	4.1	102	8
8/24/2017	Detection	0.0278	0.435	8	<0.083 U	4.9	68	8
3/22/2018	Assessment	0.01642	0.292	6	<0.083 U	5.4	100	6
8/21/2018	Assessment	0.012	0.321	10	<0.083 U	5.1	118	8
2/28/2019	Assessment	<0.02 U	0.490	8.19	0.02 J	5.0	84	6.1
5/23/2019	Assessment	0.013	0.684	8.82	0.02 J	5.2	104	10.6
8/13/2019	Assessment	<0.02 U	0.647	8.49	0.01 J	5.2	90	6.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-18
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	<1.05 U	157	0.262755 J	0.109247 J	1	1.82932 J	0.847	<0.083 U	<0.68 U	0.004	0.01536 J	<0.29 U	1.71074 J	<0.86 U
7/14/2016	Background	<0.93 U	3.77261 J	139	0.243326 J	<0.07 U	3	2.16037 J	3.264	<0.083 U	<0.68 U	0.02	0.064	0.41347 J	2.45009 J	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	115	0.226343 J	<0.07 U	0.779959 J	1.09947 J	1.105	<0.083 U	<0.68 U	0.019	0.03	<0.29 U	<0.99 U	<0.86 U
10/13/2016	Background	<0.93 U	<1.05 U	112	0.192611 J	<0.07 U	0.631027 J	2.24885 J	1.161	<0.083 U	<0.68 U	0.026	0.01416 J	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	94	0.107171 J	<0.07 U	0.724569 J	1.66054 J	1.486	<0.083 U	<0.68 U	0.017	0.029	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	99	0.169196 J	<0.07 U	0.411433 J	1.62881 J	0.976	<0.083 U	<0.68 U	0.026	0.01887 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	99	0.105337 J	<0.07 U	0.572874 J	0.976724 J	0.468	<0.083 U	<0.68 U	0.017	0.01086 J	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	105	0.130316 J	<0.07 U	0.967681 J	0.98157 J	0.648	<0.083 U	<0.68 U	0.019	0.0096 J	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	97.75	0.09 J	<0.07 U	<0.23 U	0.97 J	0.942	<0.083 U	<0.68 U	0.01647	0.006 J	<0.29 U	1.53 J	<0.86 U
8/21/2018	Assessment	0.02 J	1.01	99.8	0.129	0.02 J	0.809	1.18	1.108	<0.083 U	0.280	0.0175	0.014 J	0.08 J	0.2	0.060
2/28/2019	Assessment	<0.4 U	<0.6 U	106	<0.4 U	<0.2 U	<0.8 U	1.11	0.615	0.02 J	0.7 J	0.0177	0.009 J	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	<0.6 U	131	<0.4 U	<0.2 U	<0.8 U	1.47	0.492	0.02 J	<0.4 U	0.0209	0.009 J	<8 U	<0.6 U	<0.1 U
8/13/2019	Assessment	<0.02 U	0.45	100	0.118	0.02 J	0.212	1.25	0.473	0.01 J	0.2 J	0.0183	0.023 J	<0.4 U	0.09 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-28
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.277	2.16	6	0.9005 J	4.7	106	18
7/14/2016	Background	0.301	1.69	6	0.4478 J	5.1	96	17
9/7/2016	Background	0.332	1.25	6	0.3966 J	4.1	94	19
10/13/2016	Background	0.23	3.21	6	0.532 J	5.3	124	19
11/15/2016	Background	0.32	1.64	8	0.9199 J	4.2	112	16
1/12/2017	Background	0.285	1.22	7	0.7158 J	4.1	84	17
3/1/2017	Background	0.293	1.25	5	<0.083 U	3.4	96	18
4/10/2017	Background	0.293	1.2	7	0.6732 J	4.1	104	20
8/24/2017	Detection	0.281	1.22	6	0.557 J	5.1	96	18
12/21/2017	Detection	0.277	1.14	- -	- -	- -	- -	- -
3/22/2018	Assessment	0.254	1.4	5	0.6327 J	5.2	100	23
8/21/2018	Assessment	0.330	1.39	9	0.4982 J	5.0	96	22
2/27/2019	Assessment	0.458	1.65	6.29	0.81	5.0	32	19.6
5/22/2019	Assessment	0.313	1.24	4.48	0.69	4.6	100	20.1
8/12/2019	Assessment	0.366	1.72	6.04	0.65	4.7	128	22.5

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-28
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	1.58838 J	2.49885 J	223	0.968775 J	<0.07 U	1	18	1.212	0.9005 J	<0.68 U	0.004	0.146	<0.29 U	1.10335 J	<0.86 U
7/14/2016	Background	<0.93 U	1.52986 J	170	0.663081 J	<0.07 U	0.982579 J	15	2.29	0.4478 J	<0.68 U	0.034	0.162	<0.29 U	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	168	0.728735 J	<0.07 U	0.605543 J	14	1.44	0.3966 J	<0.68 U	0.03	0.069	<0.29 U	<0.99 U	1.24745 J
10/13/2016	Background	<0.93 U	6	152	0.42032 J	<0.07 U	6	18	2.547	0.532 J	<0.68 U	0.066	0.085	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	1.40867 J	148	0.520895 J	<0.07 U	0.638766 J	13	3.35	0.9199 J	<0.68 U	0.032	0.029	0.294156 J	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	154	0.475597 J	<0.07 U	<0.23 U	12	2.67	0.7158 J	<0.68 U	0.031	0.025	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	163	0.576508 J	<0.07 U	0.968975 J	14	2.082	<0.083 U	<0.68 U	0.031	0.025	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	162	0.654819 J	<0.07 U	0.324151 J	15	2.331	0.6732 J	<0.68 U	0.03	0.026	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	166	0.95 J	<0.07 U	<0.23 U	14.36	1.288	0.6327 J	<0.68 U	0.02561	0.046	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	0.03 J	0.64	143	0.598	0.05	0.688	14.4	2.028	0.4982 J	0.266	0.0307	0.028	0.05 J	0.3	0.03 J
2/27/2019	Assessment	<0.4 U	<0.6 U	154	0.9 J	<0.2 U	<0.8 U	14.3	2.318	0.81	<0.4 U	0.0266	0.061	<8 U	<0.6 U	<2 U
5/22/2019	Assessment	<0.4 U	<0.6 U	148	0.5 J	<0.2 U	<0.8 U	13.8	1.948	0.69	<0.4 U	0.0227	0.028	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	0.02 J	0.64	113	0.473	0.04 J	0.416	12.8	2.381	0.65	0.1 J	0.0380	0.092	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-30
Pirkey - WBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.258	0.591	18	<0.083 U	4.7	112	14
7/14/2016	Background	0.384	0.499	22	<0.083 U	4.8	118	14
9/7/2016	Background	0.515	0.27	24	<0.083 U	4.4	110	15
10/13/2016	Background	0.625	0.373	24	<0.083 U	4.2	140	18
11/15/2016	Background	0.701	0.326	25	<0.083 U	4.3	132	19
1/12/2017	Background	0.697	0.286	26	<0.083 U	5.2	136	22
3/1/2017	Background	0.824	0.273	22	<0.083 U	4.8	136	25
4/11/2017	Background	0.837	0.242	24	<0.083 U	4.2	124	27
8/24/2017	Detection	1.39	0.294	25	<0.083 U	5.2	176	46
12/21/2017	Detection	1.27	0.363	26	<0.083 U	- -	152	48
3/22/2018	Assessment	0.937	0.345	17	<0.083 U	5.2	140	44
8/21/2018	Assessment	1.57	0.716	29	<0.083 U	4.8	188	66
2/28/2019	Assessment	0.491	0.3 J	14.6	<0.04 U	4.2	- -	31.5
4/3/2019	Assessment	- -	- -	- -	- -	- -	135	- -
5/23/2019	Assessment	0.520	1.74	18.8	0.04 J	4.9	112	29.2
8/12/2019	Assessment	1.25	0.302	28.1	0.03 J	4.9	160	39.8

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-30
Pirkey - WBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**pCi/L**	**mg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
5/11/2016	Background	1.71137 J	1.92931 J	54	0.155441 J	<0.07 U	3	2.21375 J	1.057	<0.083 U	<0.68 U	<0.00013 U	0.278	<0.29 U	<0.99 U	<0.86 U
7/14/2016	Background	<0.93 U	<1.05 U	54	0.126875 J	<0.07 U	0.994219 J	2.13856 J	4.701	<0.083 U	<0.68 U	0.01	0.649	1.14165 J	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	52	0.153878 J	<0.07 U	0.769517 J	1.83325 J	0.312	<0.083 U	<0.68 U	0.009	0.214	<0.29 U	<0.99 U	1.34697 J
10/13/2016	Background	<0.93 U	<1.05 U	56	0.0606961 J	<0.07 U	0.543859 J	2.26228 J	2.27	<0.083 U	<0.68 U	0.01	0.709	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	52	0.0603858 J	<0.07 U	<0.23 U	1.91681 J	4.07	<0.083 U	<0.68 U	0.009	0.584	<0.29 U	1.2068 J	0.959001 J
1/12/2017	Background	<0.93 U	<1.05 U	51	0.0580655 J	<0.07 U	0.504125 J	1.76108 J	0.355	<0.083 U	<0.68 U	0.009	1.588	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	0.997045 J	<1.05 U	55	0.0632093 J	<0.07 U	0.740184 J	1.69598 J	0.354	<0.083 U	<0.68 U	0.008	2.59	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	<1.05 U	55	0.0611 J	<0.07 U	0.535696 J	1.80383 J	1.861	<0.083 U	<0.68 U	0.008	1.207	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	56.42	0.09 J	<0.07 U	1.47	2.6 J	1.108	<0.083 U	<0.68 U	0.00837	0.104	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	<100 U	0.77	62.9	0.07 J	<0.05 U	1.22	2.93	0.987	<0.083 U	0.2 J	0.0118	1.123	<0.2 U	0.4 J	0.1 J
2/28/2019	Assessment	<0.4 U	<0.6 U	43.3	<0.4 U	<0.2 U	4 J	1.67	1.144	<0.04 U	<0.4 U	0.00707	0.461	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	0.6 J	59.2	<0.4 U	<0.2 U	1 J	3.26	1.089	0.04 J	<0.4 U	0.00841	0.165	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.21	58.0	0.07 J	<0.01 U	0.374	2.10	1.217	0.03 J	0.06 J	0.00804	0.345	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
WEST BOTTOM ASH POND
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
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July 10, 2019

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LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
WBAP	West Bottom Ash Pond

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the West Bottom Ash Pond (WBAP), an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, and sulfate at the WBAP. An alternative source was not identified at the time, so two assessment monitoring events were conducted at the WBAP in 2018, in accordance with 40 CFR 257.95. An SSL for cobalt was identified at well AD-28. An ASD was successfully completed (Geosyntec, 2019); thus, the unit remained in assessment monitoring.

A semi-annual assessment monitoring event was completed in February 2019, with the results of the February 2019 event documented in this report. Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The February 2019 monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. An SSL was identified for cobalt. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, one set of samples was collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(d)(1). Although antimony, arsenic, cadmium, lead, molybdenum, and thallium were not detected during the March 2018 screening event, samples from the February 2019 semi-annual sampling event were analyzed for all Appendix III and Appendix IV parameters. A summary of data collected during this assessment monitoring event may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.14 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the WBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained to meet the requirements of 40 CFR 257.95(d)(1) were screened for potential outliers. Thallium was not detected at any wells and was replaced with the reporting limit of 0.01 mg/L. Because this was higher than previous reporting limits, these values were flagged as outliers. However, the removal of these values as outliers did not affect the statistical evaluation of this event, as thallium was not detected during the March 2018 screening event.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for cobalt, mercury, and selenium due to apparent non-normal distributions and for antimony, arsenic, cadmium, fluoride, lead, molybdenum, and selenium due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey WBAP:

- The LCL for cobalt exceeded the GWPS of 0.009 mg/L at AD-28 (0.0132 mg/L).

As a result, the Pirkey WBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring

2.2.3 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations. Prediction limits were calculated for the Appendix III parameters to represent background values. As described in the January 2018 *Statistical Analysis Summary* report (Geosyntec, 2018), intrawell tests were used to evaluate potential SSIs for calcium, pH, sulfate and TDS, whereas interwell tests were used to evaluate potential SSIs for boron, chloride and fluoride.

Prediction limits for the interwell tests were recalculated using data collected during the February 2019 assessment monitoring event. Three data points (i.e., one sample from three background wells) were added to the background dataset for each interwell test. New data were tested for outliers prior to being added to the background dataset. The updated prediction limits were calculated for a one-of-two retesting procedure, as during detection monitoring. The values of the updated prediction limits were similar to the values of the prediction limits calculated during detection monitoring. The revised interwell prediction limits were used to evaluate potential SSIs for boron, chloride, and fluoride.

For the intrawell tests, limited data made it possible to add only one data point (i.e., one sample from each compliance well) to each background dataset. Because one sample result is insufficient to compare against the existing background dataset, the prediction limits were not updated for the intrawell tests at this time. The intrawell prediction limits calculated during detection monitoring were used to evaluate potential SSIs for calcium, pH, sulfate, and TDS.

Data collected during the February 2019 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0700 mg/L at AD-28 (0.330 mg/L) and AD-30 (1.57 mg/L).

- The calcium concentration exceeded the intrawell UPL of 0.664 mg/L at AD-30 (0.716 mg/L).

- Chloride exceeded the interwell background value of 9.61 mg/L at AD-17 (35.0 mg/L) and AD-30 (29.0 mg/L).

- The sulfate concentration exceeded the intrawell background value of 155 mg/L at AD-30 (188 mg/L)

- TDS concentrations exceeded the intrawell UPL of 21.2 mg/L at AD-28 (22.0 mg/L) and the intrawell UPL of 31.6 mg/L at AD-30 (66.0 mg/L).

While the prediction limits were calculated assuming a 1-of-2 testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey WBAP during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the February 2019 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. An SSL was identified for cobalt. Appendix III parameters were also evaluated, with exceedances identified for boron, calcium, chloride, sulfate, and TDS.

Based on this evaluation, the Pirkey WBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Pirkey Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – West Bottom Ash Pond, H.W. Pirkey Power Plant, Hallsville, Texas. January 3, 2018.

Geosyntec. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant - West Bottom Ash Pond. March.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - West Bottom Ash Pond

Parameter	Unit	AD-3	AD-12	AD-17	AD-18	AD-28	AD-30	
		2/27/2019	2/27/2019	2/28/2019	2/28/2019	2/27/2019	2/28/2019	4/3/2019
Antimony	µg/L	0.0400 J	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	-
Arsenic	µg/L	0.130	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	-
Barium	µg/L	54.2	22.5	71.4	106	154	43.3	-
Beryllium	µg/L	2.00 U	2.00 U	2.00 U	2.00 U	0.900 J	2.00 U	-
Boron	mg/L	0.0340	0.0300 J	0.0300 J	0.100 U	0.458	0.491	-
Cadmium	µg/L	0.0300 J	1.00 U	1.00 U	1.00 U	1.00 U	1.00 U	-
Calcium	mg/L	3.46	0.400 J	0.200 J	0.490	1.65	0.300 J	-
Chloride	mg/L	6.16	6.08	10.2	8.19	6.29	14.6	-
Chromium	µg/L	0.0400 J	4.00 U	4.00 U	4.00 U	4.00 U	4.00 J	-
Cobalt	µg/L	2.31	1.37	2.93	1.11	14.3	1.67	-
Combined Radium	pCi/L	0.314	0.225	0.772	0.615	2.32	1.14	-
Fluoride	mg/L	0.0400 J	0.0900	0.120	0.0200 J	0.810	0.200 U	-
Lead	µg/L	0.0500 J	2.00 U	2.00 U	0.700 J	2.00 U	2.00 U	-
Lithium	mg/L	0.0525	0.00688	0.00912	0.0177	0.0266	0.00707	-
Mercury	mg/L	0.0000250 U	0.0000250 U	0.000107	0.00000900 J	0.0000610	0.000461	-
Molybdenum	µg/L	2.00 U	40.0 U	40.0 U	40.0 U	40.0 U	40.0 U	-
Selenium	µg/L	0.0500 J	4.00 U	4.00 U	4.00 U	4.00 U	4.00 U	-
Total Dissolved Solids	mg/L	50.0	36.0	68.0	84.0	32.0	-	135
Sulfate	mg/L	21.8	3.60	2.40	6.10	19.6	31.5	-
Thallium	µg/L	0.500 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	-
pH	SU	5.31	5.17	3.70	5.02	4.99	4.20	-

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.
-: Not sampled

Table 2: Groundwater Protection Standards
Pirkey Plant - West Bottom Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.002
Arsenic, Total (mg/L)	0.01		0.0042
Barium, Total (mg/L)	2		0.16
Beryllium, Total (mg/L)	0.004		0.0012
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.0029
Cobalt, Total (mg/L)	n/a	0.006	0.009
Combined Radium, Total (pCi/L)	5		3.57
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.002
Lithium, Total (mg/L)	n/a	0.04	0.14
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.04
Selenium, Total (mg/L)	0.05		0.004
Thallium, Total (mg/L)	0.002		0.002

Notes:

Grey cell indicates calculated UTL is higher than MCL.

MCL = Maximum Contaminant Level

RSL = Regional Screening Level

Calculated UTL (Upper Tolerance Limit) represents site-specific background values.

The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Appendix III Data Summary
Pirkey - West Bottom Ash Pond

Parameter	**Units**	**Description**	AD-17	AD-28	AD-30
			8/21/2018	8/21/2018	8/21/2018
Boron	mg/L	Interwell Background Value (UPL)	0.0700		
		Detection Monitoring Data	0.0440	**0.330**	**1.57**
Calcium	mg/L	Intrawell Background Value (UPL)	1.90	3.41	0.664
		Detection Monitoring Data	0.997	1.39	**0.716**
Chloride	mg/L	Interwell Background Value (UPL)	9.61		
		Detection Monitoring Data	**35.0**	9.00	**29.0**
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
		Detection Monitoring Data	0.0830	0.498	0.0830
pH	SU	Intrawell Background Value (UPL)	4.8	5.9	5.4
		Intrawell Background Value (LPL)	3.0	2.8	3.7
		Detection Monitoring Data	3.9	5.0	4.8
TDS	mg/L	Intrawell Background Value (UPL)	109	132	155
		Detection Monitoring Data	98.0	96.0	**188**
Sulfate	mg/L	Intrawell Background Value (UPL)	9.64	21.2	31.6
		Detection Monitoring Data	7.00	**22.0**	**66.0**

Notes

UPL: Upper prediction limit

LPL: Lower prediction limit

TDS: Total dissolved solids

Bold values exceed the background value.

Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

DAVID ANTHONY MILLER
112498

112498
License Number

TEXAS
Licensing State

07.10.19
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

July 10, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey WBAP
Assessment Monitoring Event – February 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of groundwater data for the February 2019 sample event for American Electric Power Inc.'s Pirkey West Bottom Ash Pond. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-3, AD-12, and AD-18; and
- **Downgradient wells:** AD-17, AD-28, and AD-30.

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) - boron, calcium, chloride, fluoride, pH, sulfate, and TDS;

- **Appendix IV** (Assessment Monitoring) – antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Values previously flagged during the screening as outliers may be seen in a lighter font and disconnected symbol on the time series graphs, and a summary of those values follows this letter (Figure B).

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, chloride and fluoride; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, pH, sulfate and TDS for the February 2019 data (Figures C & D, respectively). The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data are screened for any newly suspected outliers or obvious trending patterns using time series plots. All values flagged as outliers may be seen on the Outlier Summary report following this letter. No obvious trending patterns were observed in the upgradient wells.

Intrawell prediction limits utilize the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data set will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

Note that the reporting limit for fluoride for the February 2019 event at well AD-30 was <0.2 mg/L whereas all historical reporting limits for all wells is <1.0 mg/L. Therefore, <1.0 mg/L was substituted for all nondetects which is less than the Groundwater Protection Standard of 4 mg/L. Additionally, in the case of TDS at well AD-30, the April 2019 sample was compared against background.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified, and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. Prediction limit exceedances were noted for boron at wells AD-28 and AD-30, and chloride at wells AD-17 and AD-30. The results of those findings may be found in the Prediction Limit Summary tables following this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable (Figure E). Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site. Such patterns are an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances, except for a statistically significant increasing trend for boron in well AD-30.

Evaluation of Appendix IV Parameters

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure F). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure G).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of the MCL, CCR-Rule specified level or ACL as discussed above (Figure H). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. Note that the reporting limit for thallium for this event was <0.01 mg/L which is higher than the historical reporting limit of <0.002 mg/L and higher than the GWPS. Since the <0.01 mg/L values do not provide any useful information regarding whether the observations exceed the GWPS, they are flagged as outliers.

No confidence interval exceedances were found except for cobalt in well AD-28. A summary of the confidence interval results follows this letter.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey West Bottom Ash Pond. If you have any questions or comments, please feel free to contact me.

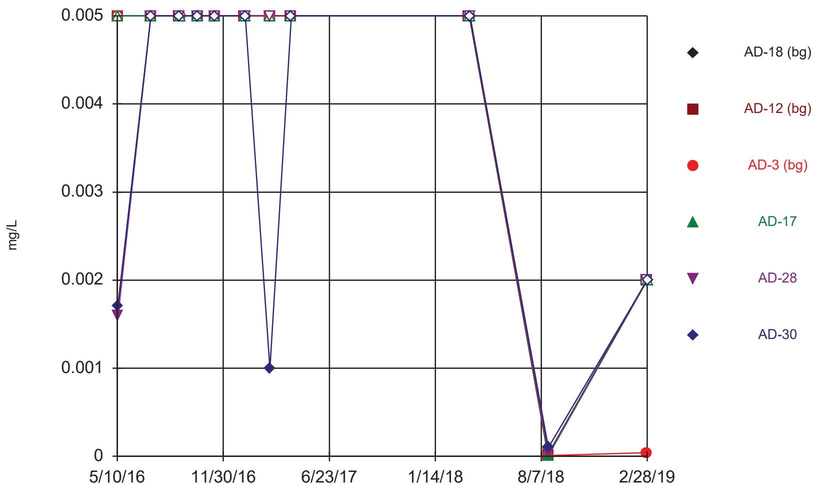
For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

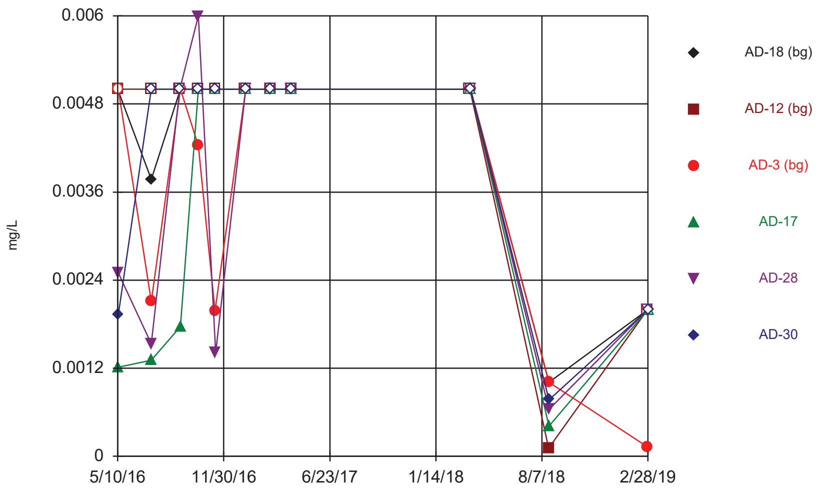
Time Series



Constituent: Antimony, total   Analysis Run 7/9/2019 1:50 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

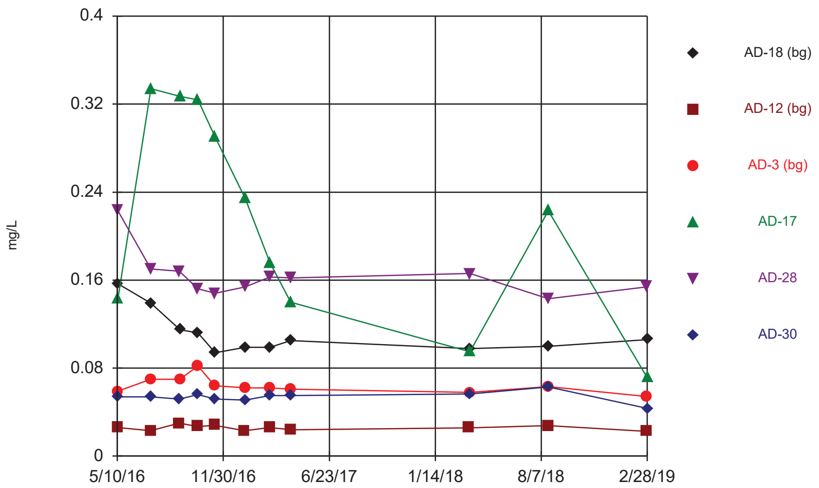
Time Series



Constituent: Arsenic, total   Analysis Run 7/9/2019 1:50 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

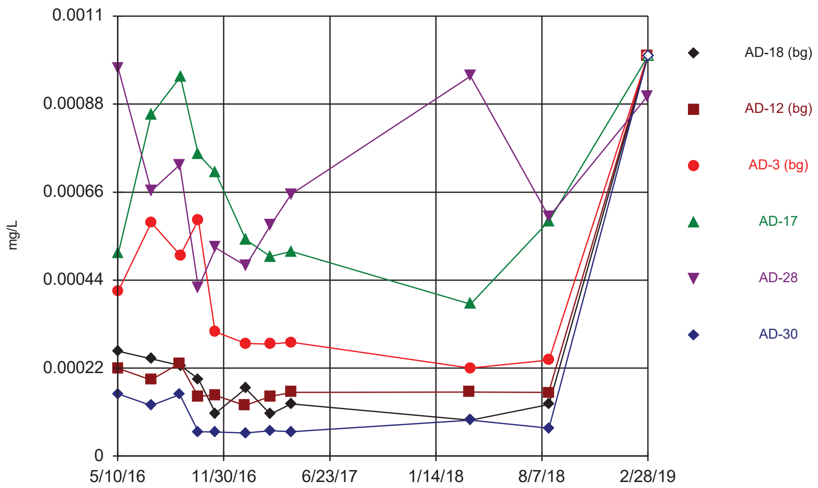
Time Series



Constituent: Barium, total   Analysis Run 7/9/2019 1:50 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

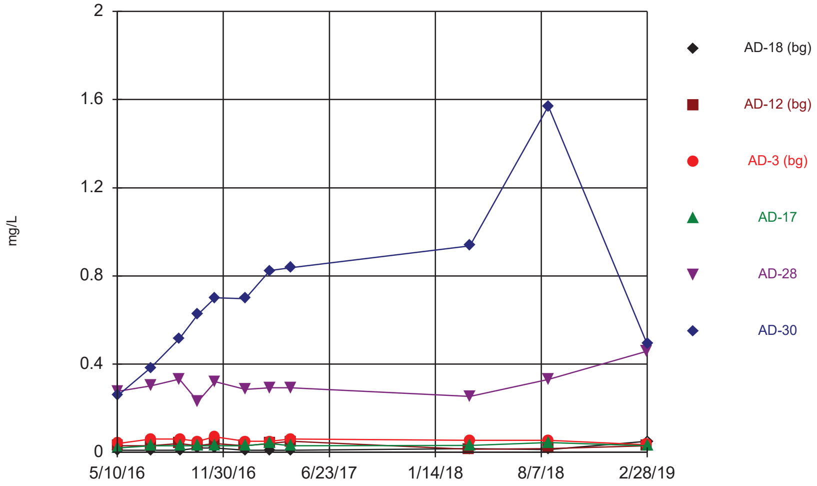
Time Series



Constituent: Beryllium, total   Analysis Run 7/9/2019 1:50 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Boron, total Analysis Run 7/9/2019 1:50 PM View: Time Series
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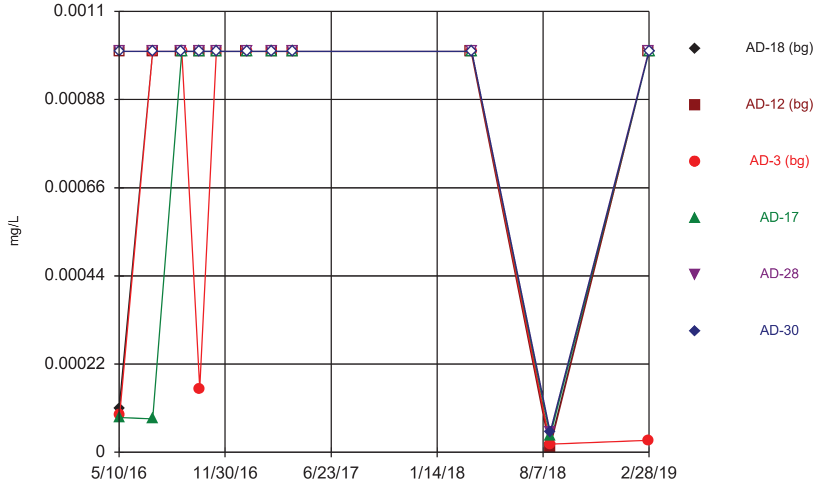
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

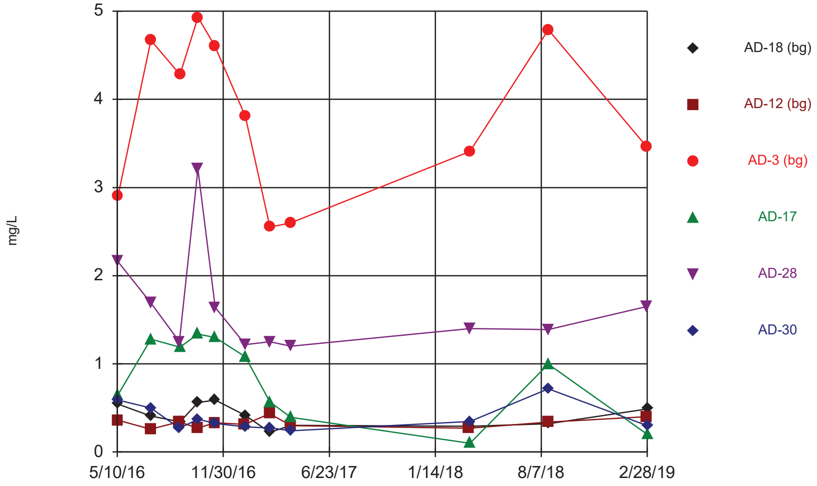
Time Series



Constituent: Cadmium, total Analysis Run 7/9/2019 1:50 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

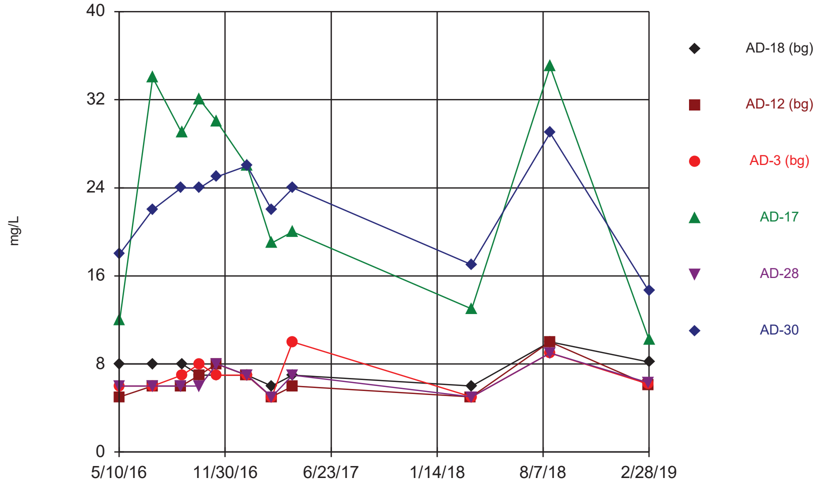
Time Series



Constituent: Calcium, total Analysis Run 7/9/2019 1:50 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



Constituent: Chloride, total Analysis Run 7/9/2019 1:50 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
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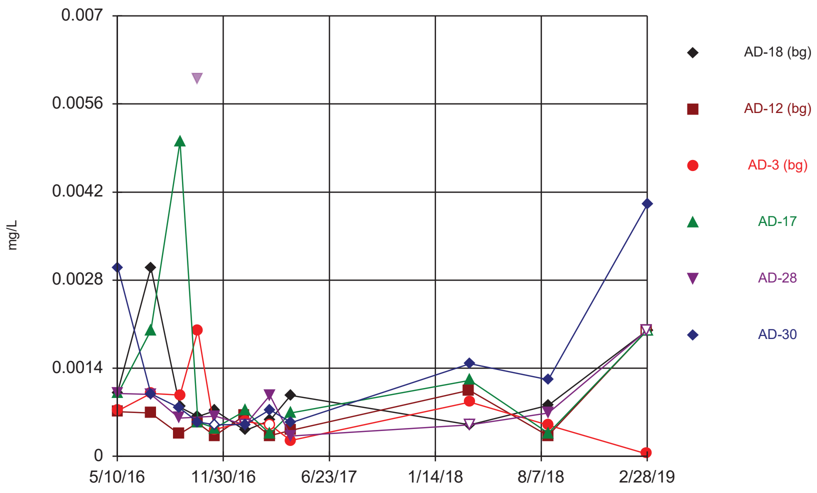
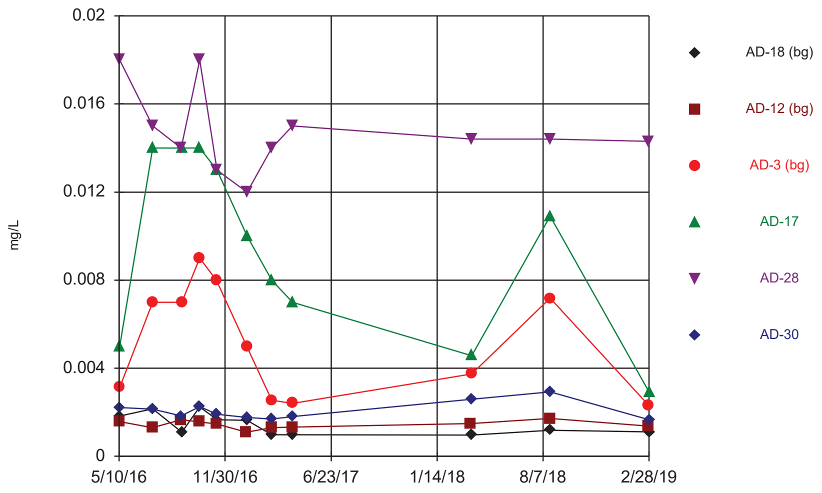
Time Series



Constituent: Chromium, total   Analysis Run 7/9/2019 1:51 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

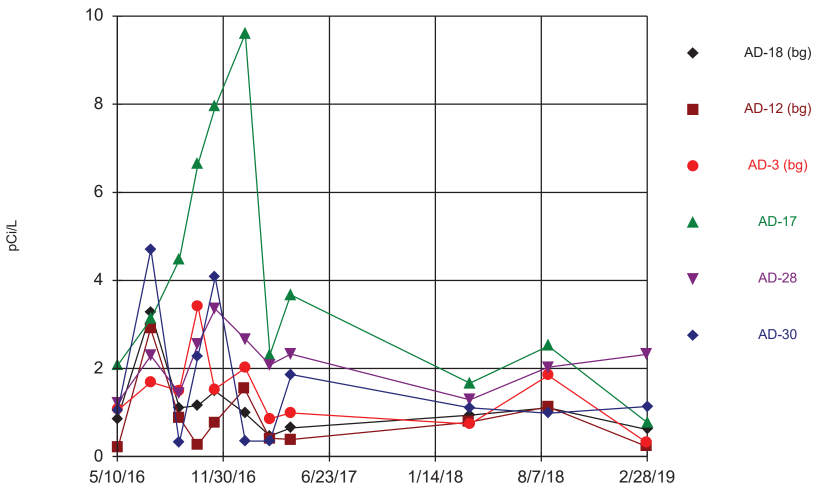
Time Series



Constituent: Cobalt, total   Analysis Run 7/9/2019 1:51 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

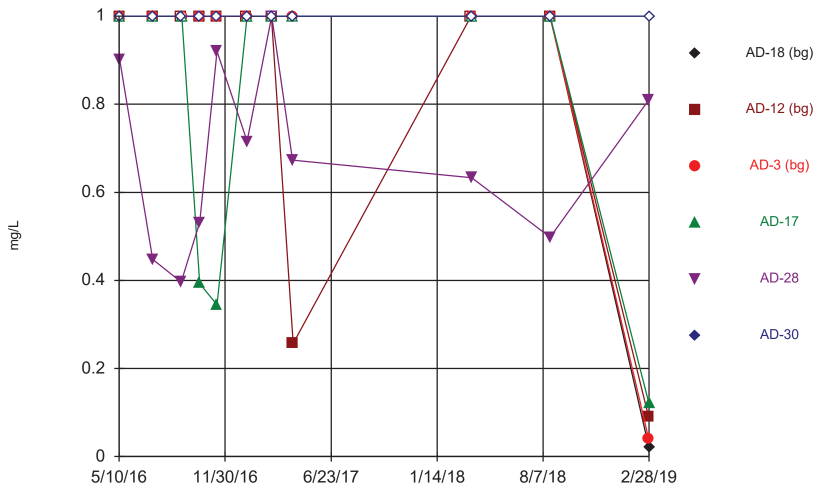
Time Series



Constituent: Combined Radium 226 + 228   Analysis Run 7/9/2019 1:51 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

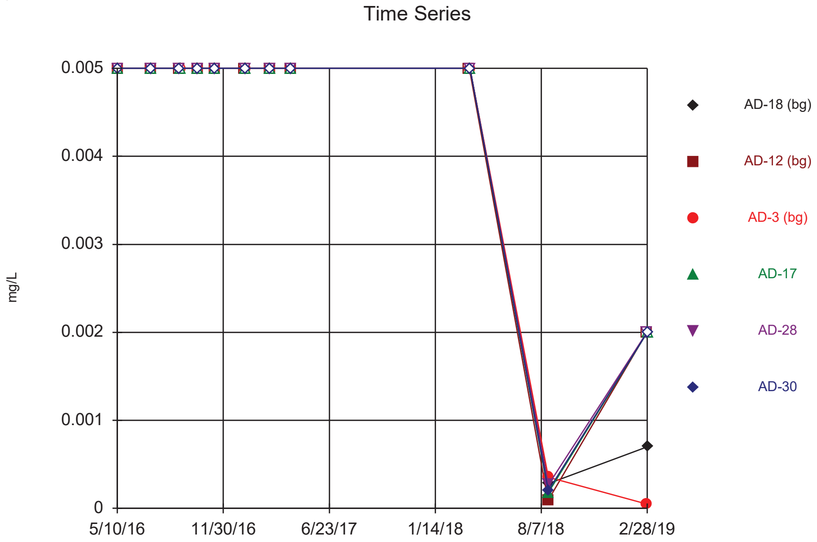
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



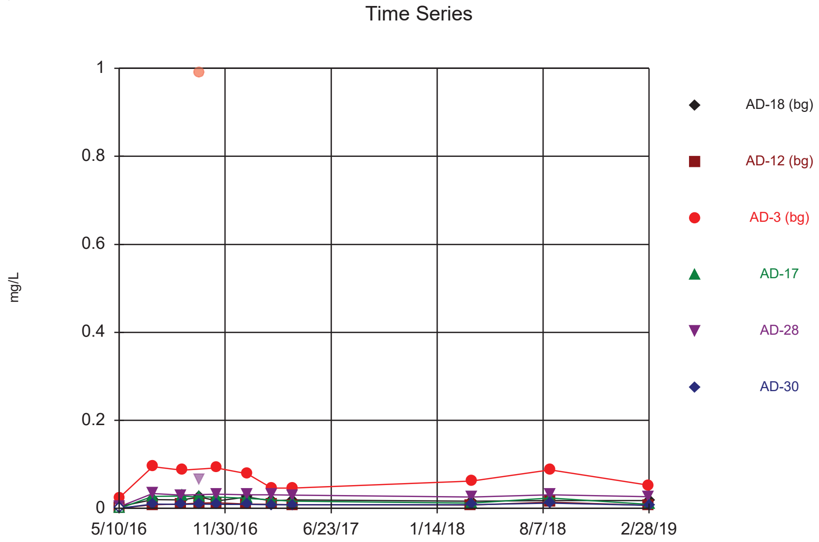
Constituent: Fluoride, total   Analysis Run 7/9/2019 1:51 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



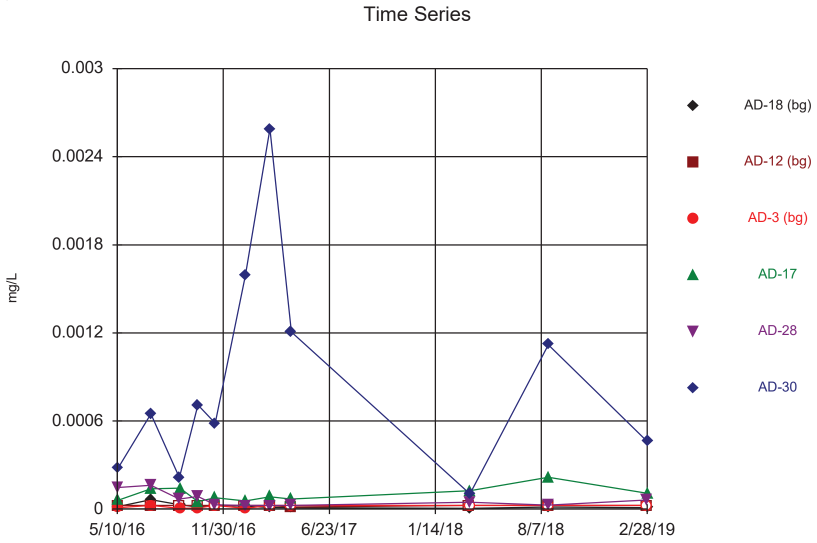
Constituent: Lead, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



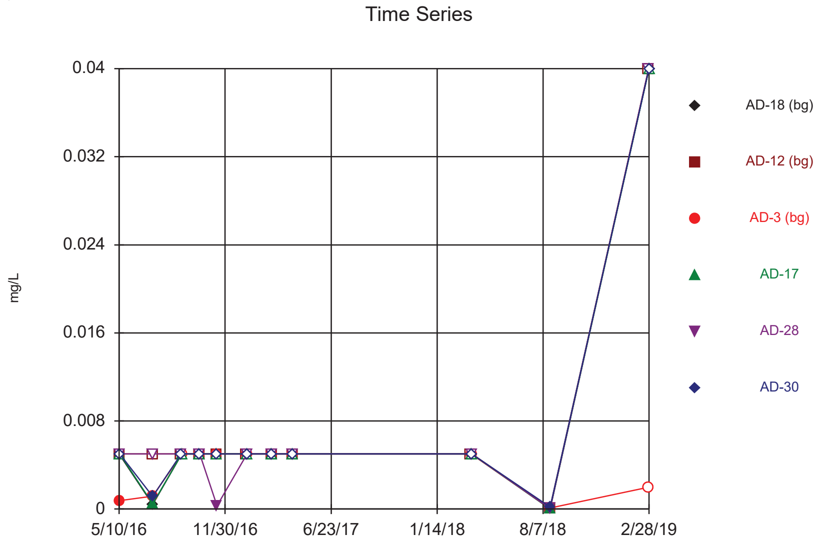
Constituent: Lithium, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



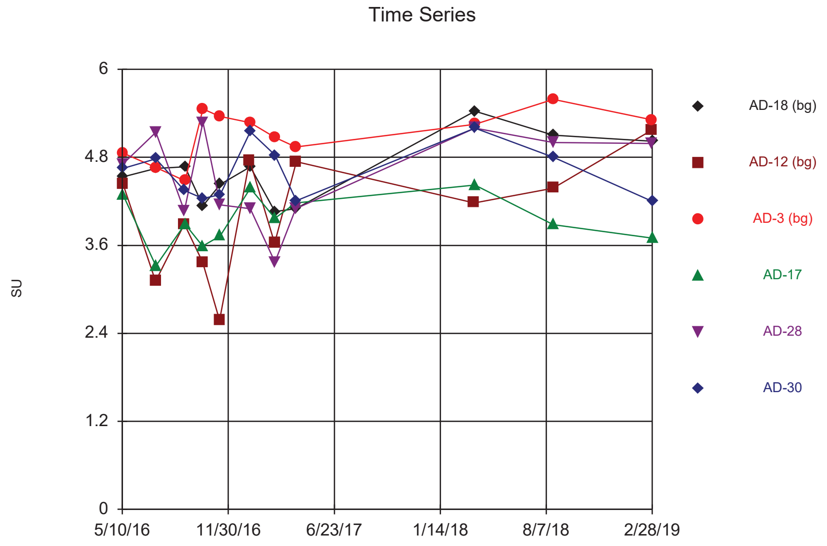
Constituent: Mercury, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



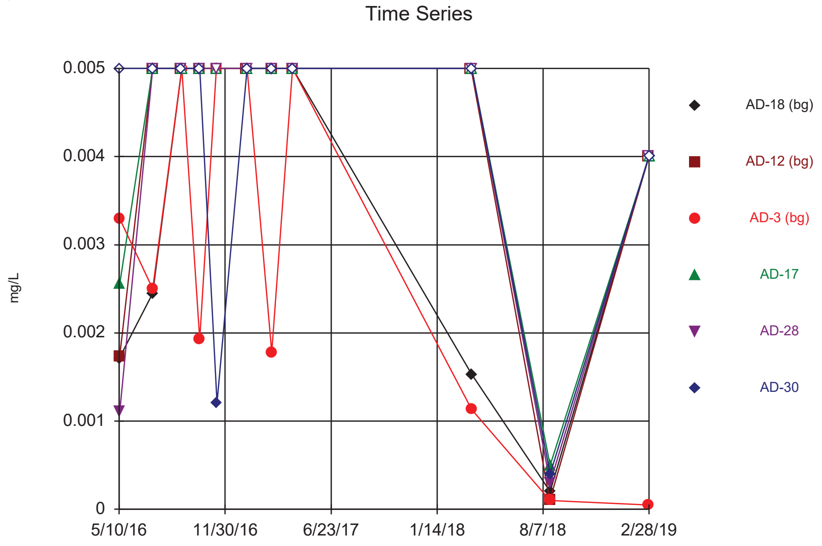
Constituent: Molybdenum, total Analysis Run 7/9/2019 1:51 PM View: Time Series
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



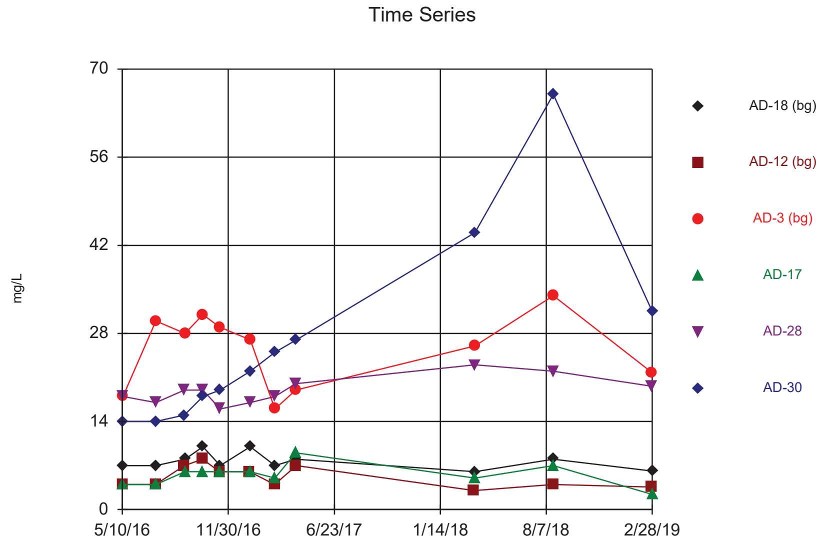
Constituent: pH, field   Analysis Run 7/9/2019 1:51 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



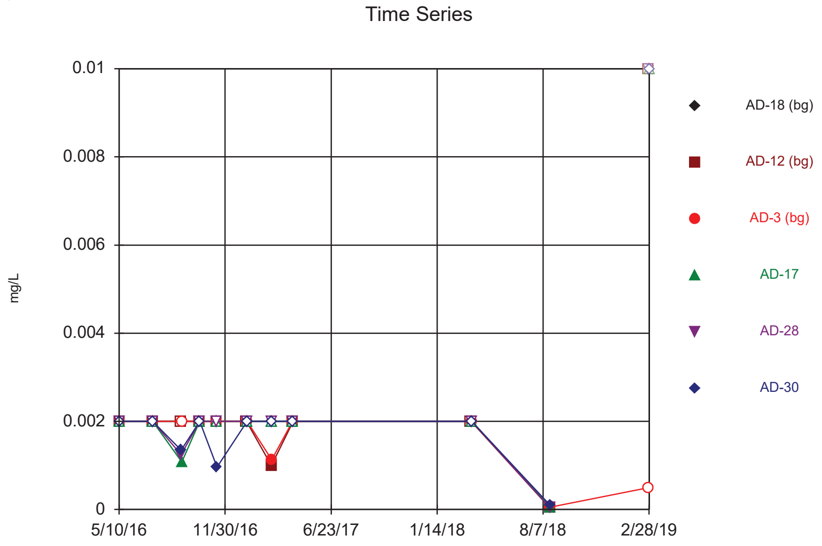
Constituent: Selenium, total   Analysis Run 7/9/2019 1:51 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



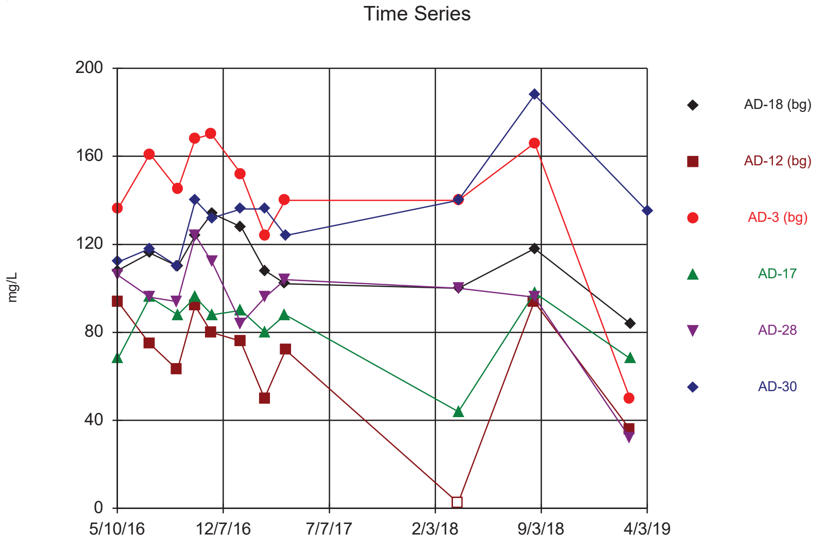
Constituent: Sulfate, total   Analysis Run 7/9/2019 1:51 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Thallium, total   Analysis Run 7/9/2019 1:51 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Total Dissolved Solids [TDS]   Analysis Run 7/9/2019 1:51 PM   View: Time Series
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Outlier Summary

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 7/9/2019, 2:03 PM

	AD-28 Chromium, total (mg/L)	AD-3 Lithium, total (mg/L)	AD-28 Lithium, total (mg/L)	AD-18 Thallium, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-17 Thallium, total (mg/L)	AD-28 Thallium, total (mg/L)	AD-30 Thallium, total (mg/L)
10/13/2016	0.006 (o)	0.991 (o)	0.066 (o)					
2/27/2019					<0.01 (o)		<0.01 (o)	
2/28/2019				<0.01 (o)		<0.01 (o)		<0.01 (o)

Interwell Prediction Limit Summary - Significant Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/7/2019, 8:01 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-28**	**0.0668**	**n/a**	**2/27/2019**	**0.458**	**Yes**	**33**	**0.03374**	**0.01858**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-30**	**0.0668**	**n/a**	**2/28/2019**	**0.491**	**Yes**	**33**	**0.03374**	**0.01858**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-17**	**9.608**	**n/a**	**2/28/2019**	**10.2**	**Yes**	**33**	**2.624**	**0.2676**	**0**	**None**	**sqrt(x)**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-30**	**9.608**	**n/a**	**2/28/2019**	**14.6**	**Yes**	**33**	**2.624**	**0.2676**	**0**	**None**	**sqrt(x)**	**0.002505**	**Param Inter 1 of 2**

Interwell Prediction Limit Summary - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/7/2019, 8:01 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-17	0.0668	n/a	2/28/2019	0.03	No	33	0.03374	0.01858	3.03	None	No	0.002505	Param Inter 1 of 2
Boron, total (mg/L)	**AD-28**	**0.0668**	**n/a**	**2/27/2019**	**0.458**	**Yes**	**33**	**0.03374**	**0.01858**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-30**	**0.0668**	**n/a**	**2/28/2019**	**0.491**	**Yes**	**33**	**0.03374**	**0.01858**	**3.03**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-17**	**9.608**	**n/a**	**2/28/2019**	**10.2**	**Yes**	**33**	**2.624**	**0.2676**	**0**	**None**	**sqrt(x)**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	AD-28	9.608	n/a	2/27/2019	6.29	No	33	2.624	0.2676	0	None	sqrt(x)	0.002505	Param Inter 1 of 2
Chloride, total (mg/L)	**AD-30**	**9.608**	**n/a**	**2/28/2019**	**14.6**	**Yes**	**33**	**2.624**	**0.2676**	**0**	**None**	**sqrt(x)**	**0.002505**	**Param Inter 1 of 2**
Fluoride, total (mg/L)	AD-17	1	n/a	2/28/2019	0.12	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-28	1	n/a	2/27/2019	0.81	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-30	1	n/a	2/28/2019	1ND	No	33	n/a	n/a	87.88	n/a	n/a	0.001673	NP Inter (NDs) 1 of 2

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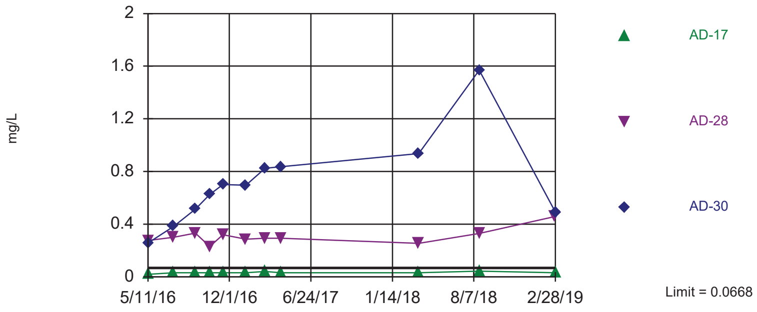
Exceeds Limit: AD-28, AD-30

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=0.03374, Std. Dev.=0.01858, n=33, 3.03% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9114, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

Constituent: Boron, total Analysis Run 7/7/2019 8:00 PM View: PLs - Interwell

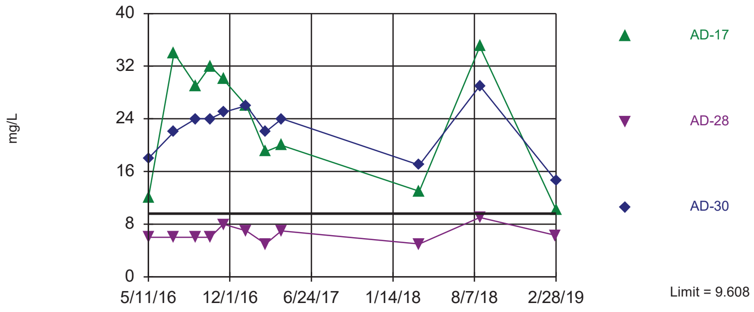
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-17, AD-30

Prediction Limit

Interwell Parametric



Background Data Summary (based on square root transformation): Mean=2.624, Std. Dev.=0.2676, n=33. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9176, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

Constituent: Chloride, total Analysis Run 7/7/2019 8:00 PM View: PLs - Interwell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

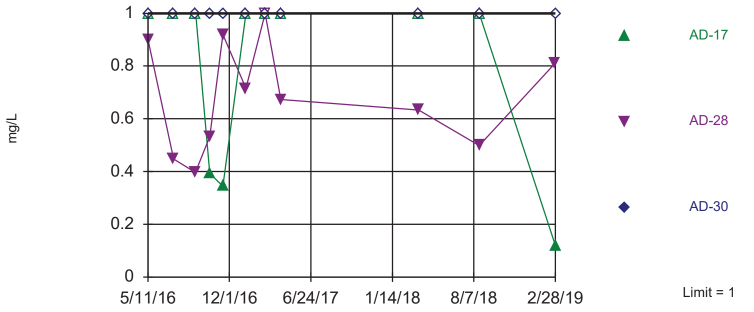
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 33 background values. 87.88% NDs. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 3 points to limit.

Constituent: Fluoride, total Analysis Run 7/7/2019 8:00 PM View: PLs - Interwell

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Intrawell Prediction Limit Summary - All Results (No Significant)

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 7/7/2019, 8:07 PM

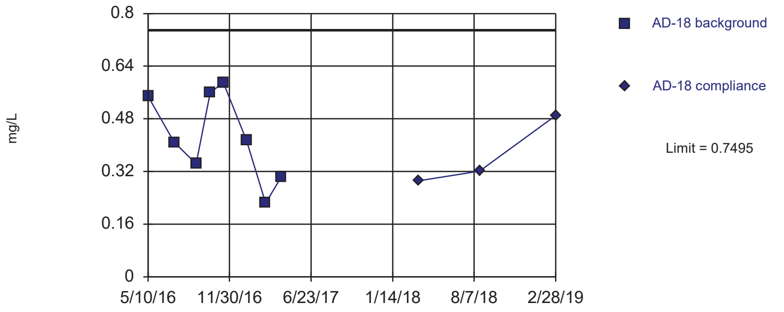
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-18	0.7495	n/a	2/28/2019	0.49	No	8	0.4241	0.1324	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-12	0.4631	n/a	2/27/2019	0.4	No	8	0.3269	0.05542	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-3	6.204	n/a	2/27/2019	3.46	No	8	3.794	0.9807	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-17	1.903	n/a	2/28/2019	0.2	No	8	0.9754	0.3773	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-28	3.411	n/a	2/27/2019	1.65	No	8	1.703	0.695	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-30	0.6643	n/a	2/28/2019	0.3	No	8	0.3575	0.1248	0	None	No	0.002505	Param Intra 1 of 2
pH, field (SU)	AD-18	5.063	3.75	2/28/2019	5.02	No	8	4.406	0.267	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-12	5.764	1.866	2/27/2019	5.17	No	8	3.815	0.7928	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-3	5.857	4.168	2/27/2019	5.31	No	8	5.013	0.3437	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-17	4.812	3.025	2/28/2019	3.7	No	8	3.919	0.3634	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-28	5.925	2.805	2/27/2019	4.99	No	8	4.365	0.6348	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-30	5.403	3.722	2/28/2019	4.2	No	8	4.563	0.3421	0	None	No	0.001253	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-18	11.39	n/a	2/28/2019	6.1	No	8	2.821	0.2255	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-12	9.636	n/a	2/27/2019	3.6	No	8	5.75	1.581	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-3	39.6	n/a	2/27/2019	21.8	No	8	24.75	6.042	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-17	9.636	n/a	2/28/2019	2.4	No	8	5.75	1.581	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-28	21.22	n/a	2/27/2019	19.6	No	8	18	1.309	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-30	31.56	n/a	2/28/2019	31.5	No	8	19.25	5.007	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-18	144	n/a	2/28/2019	84	No	8	116.3	11.29	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	110.7	n/a	2/27/2019	36	No	8	75.25	14.41	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-3	189.4	n/a	2/27/2019	50	No	8	149.5	16.23	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-17	109.2	n/a	2/28/2019	68	No	8	86.75	9.13	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-28	132.3	n/a	2/27/2019	32	No	8	102	12.33	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-30	154.7	n/a	4/3/2019	135	No	8	126	11.66	0	None	No	0.002505	Param Intra 1 of 2

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.4241, Std. Dev.=0.1324, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9343, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

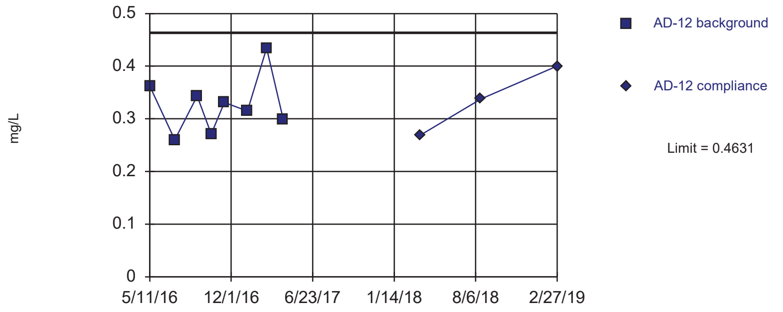
Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3269, Std. Dev.=0.05542, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9467, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

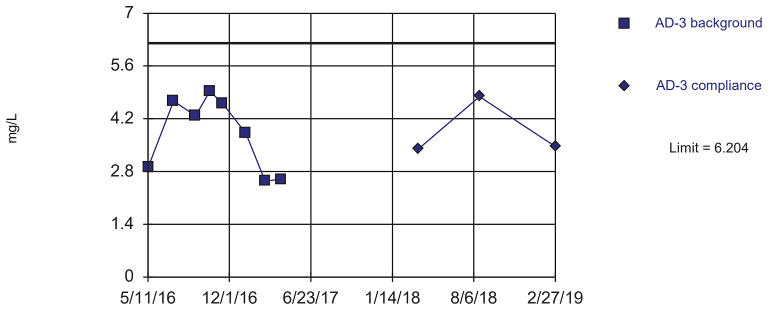
Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.794, Std. Dev.=0.9807, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8697, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

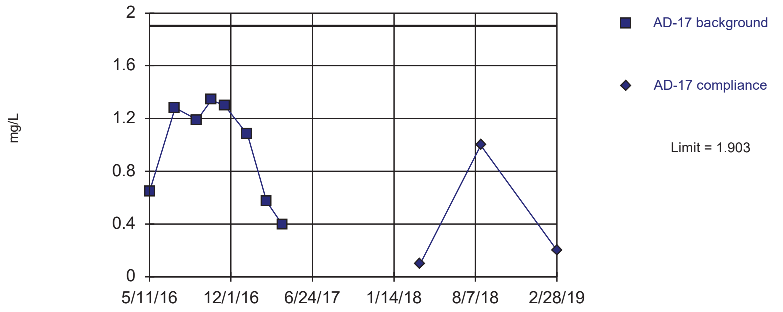
Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.9754, Std. Dev.=0.3773, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8479, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

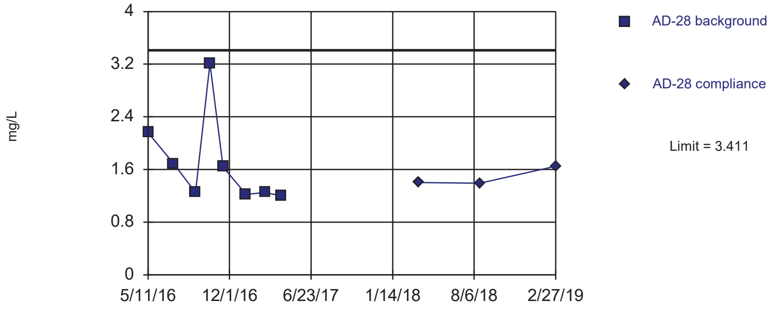
Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1.703, Std. Dev.=0.695, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.769, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

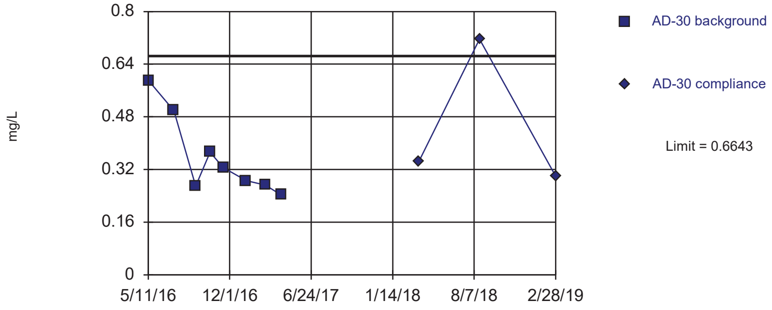
Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3575, Std. Dev.=0.1248, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.844, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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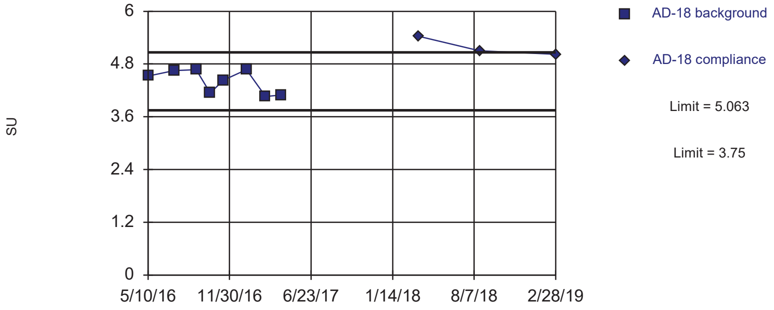
Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.406, Std. Dev.=0.267, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8312, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

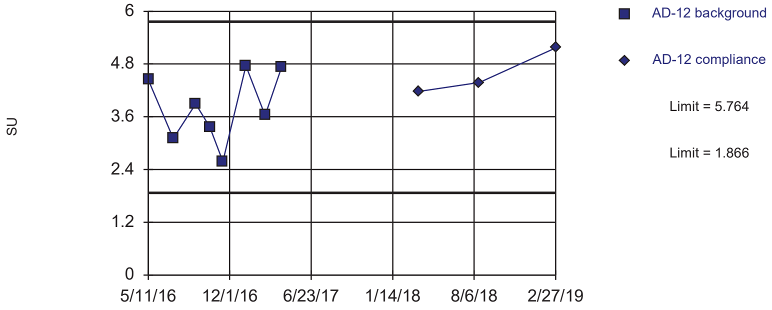
Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

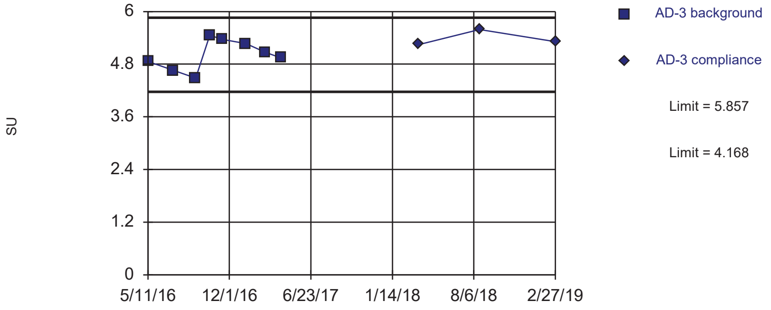
Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.013, Std. Dev.=0.3437, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.965, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

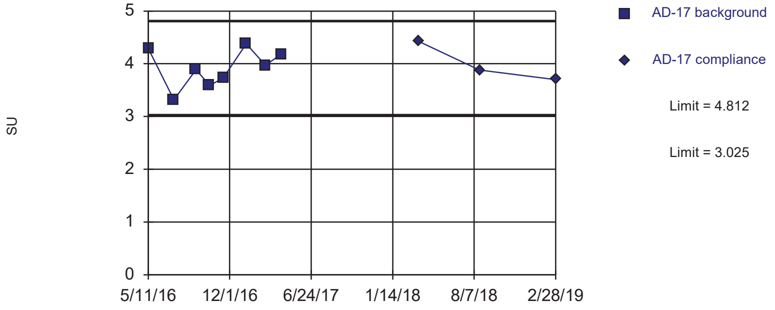
Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.919, Std. Dev.=0.3634, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9678, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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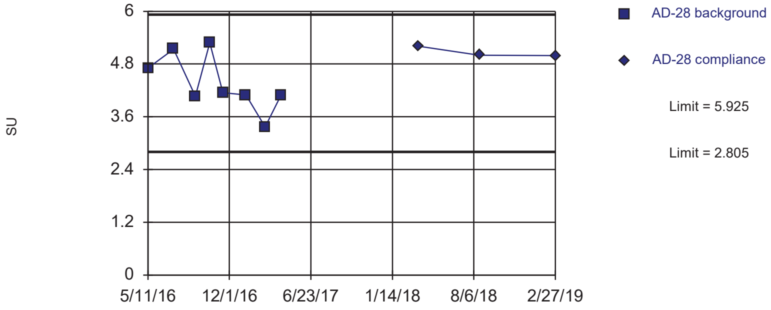
Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.365, Std. Dev.=0.6348, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9117, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

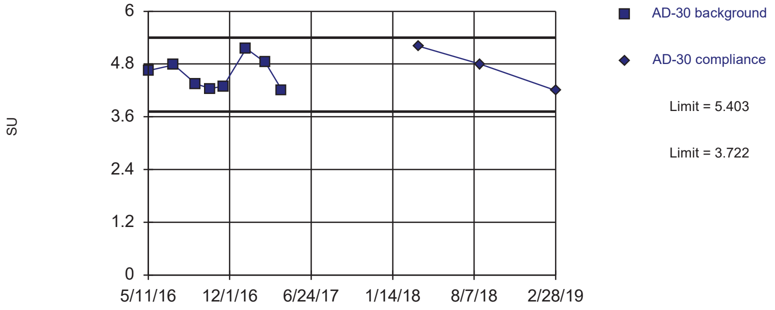
Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.563, Std. Dev.=0.3421, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8981, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

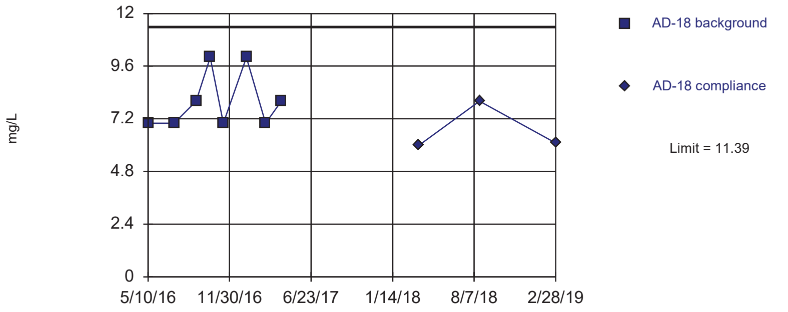
Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square root transformation): Mean=2.821, Std. Dev.=0.2255, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7543, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

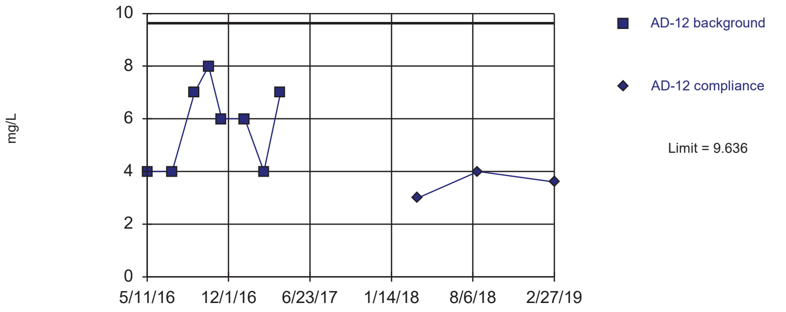
Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.75, Std. Dev.=1.581, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.866, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

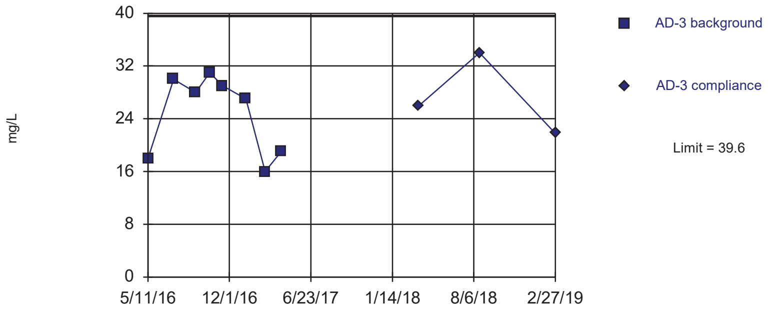
Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=24.75, Std. Dev.=6.042, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8428, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

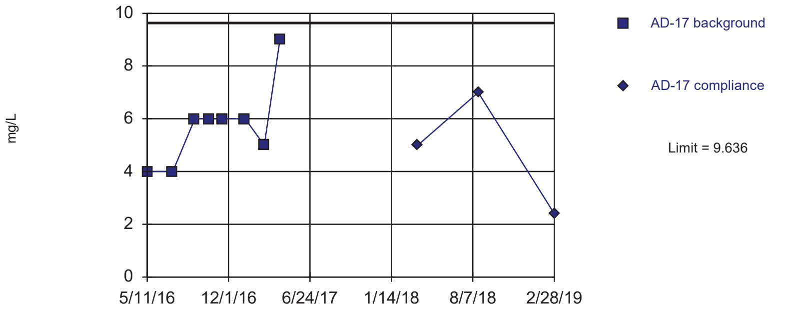
Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.75, Std. Dev.=1.581, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8396, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

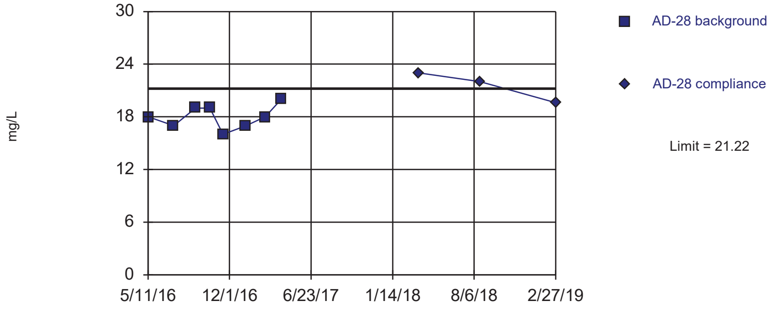
Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=18, Std. Dev.=1.309, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9646, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

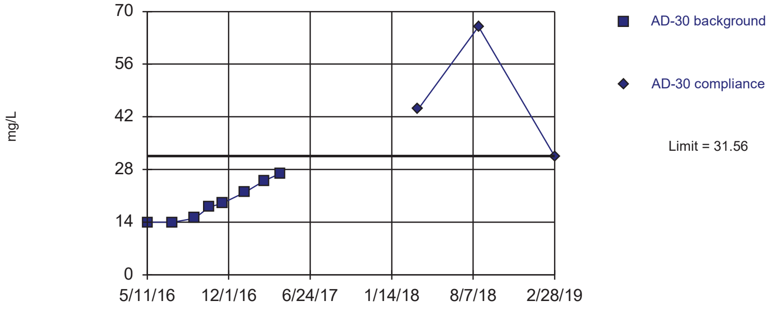
Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=19.25, Std. Dev.=5.007, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9081, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

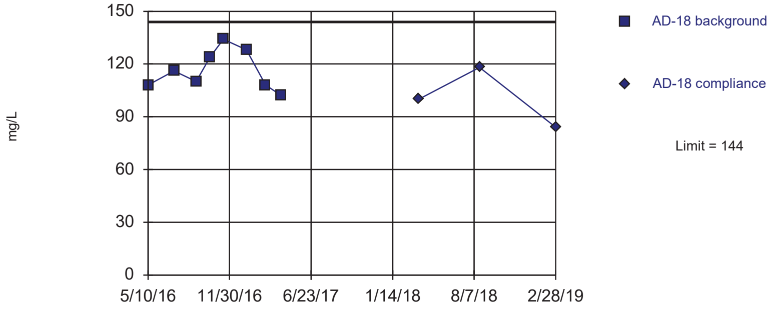
Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=116.3, Std. Dev.=11.29, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9317, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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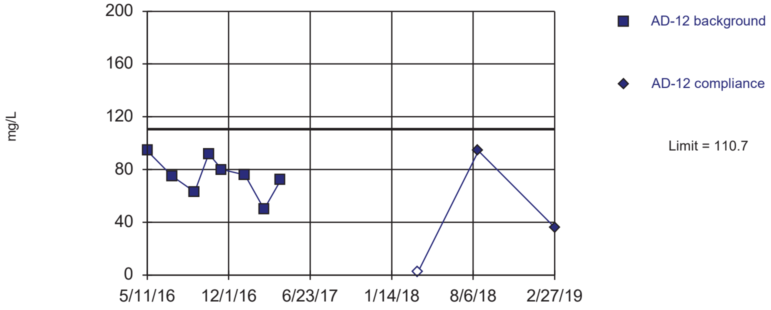
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=75.25, Std. Dev.=14.41, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9549, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

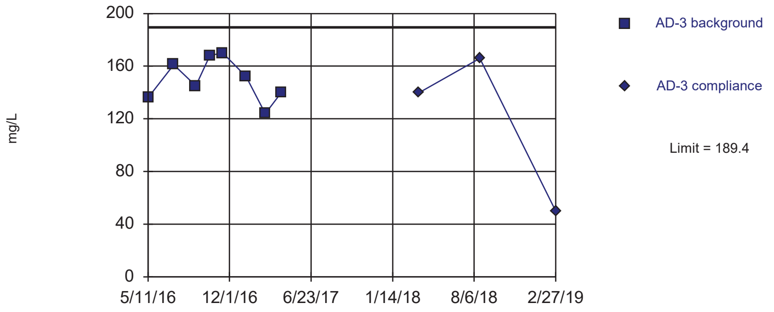
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=149.5, Std. Dev.=16.23, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9574, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

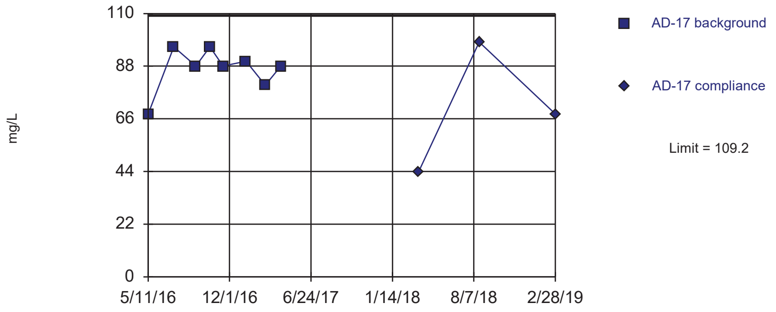
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=86.75, Std. Dev.=9.13, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8566, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

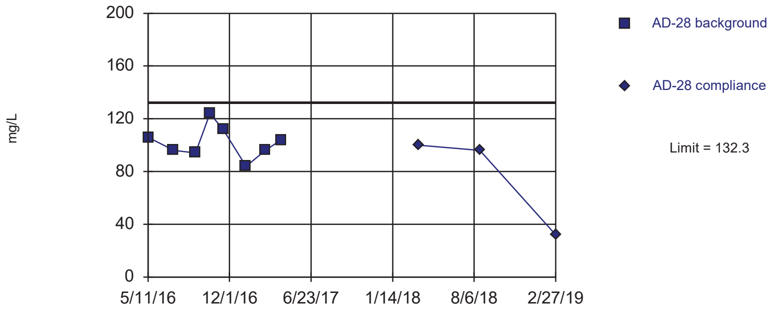
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=102, Std. Dev.=12.33, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9681, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

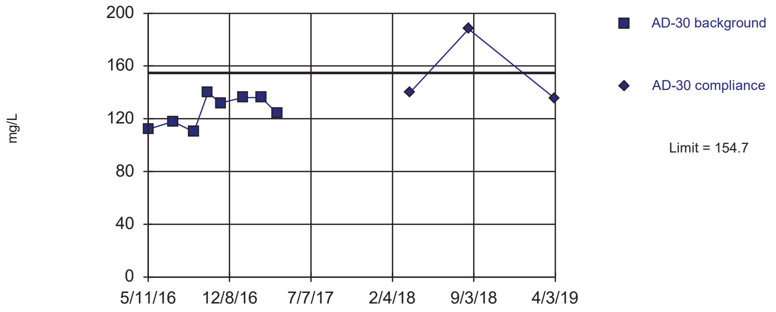
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=126, Std. Dev.=11.66, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.904, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Trend Test Summary Table - Significant Results

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 7/7/2019, 8:20 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	**AD-30**	**0.5226**	**37**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**

Trend Test Summary Table - All Results

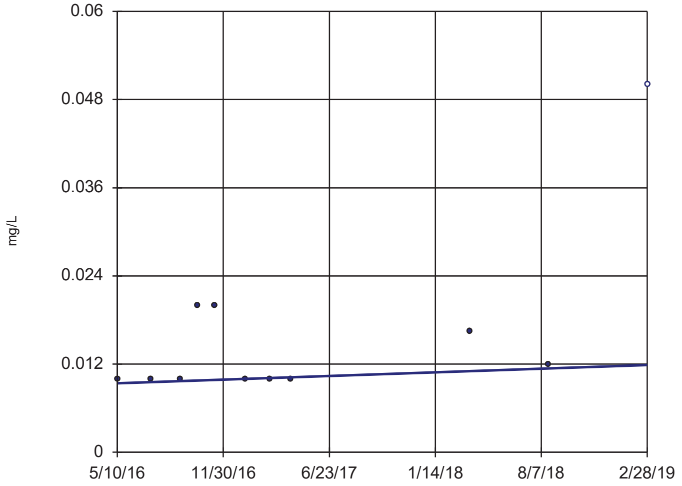
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 7/7/2019, 8:20 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-18 (bg)	0.0008764	17	34	No	11	9.091	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0	-4	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-3 (bg)	-0.0002401	-7	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-28	0.01986	12	34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	**AD-30**	**0.5226**	**37**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	AD-18 (bg)	0	-7	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.03234	10	34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-3 (bg)	0.05714	6	34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-17	-7.599	-15	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-30	0	3	34	No	11	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = 0.0008764
units per year.

Mann-Kendall
statistic = 17
critical = 34

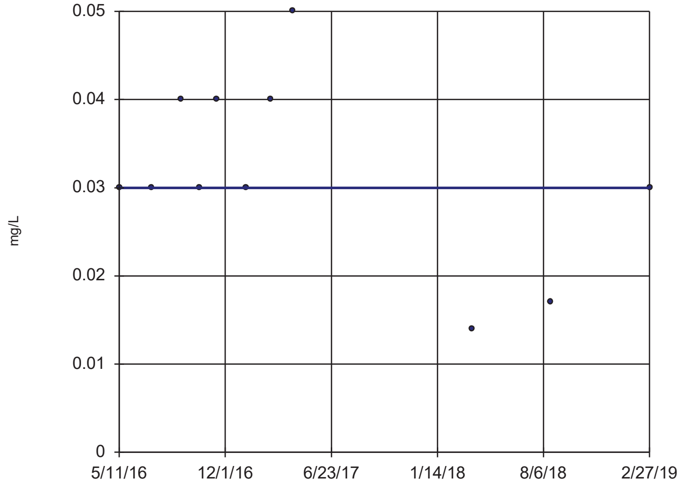
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0
units per year.

Mann-Kendall
statistic = -4
critical = -34

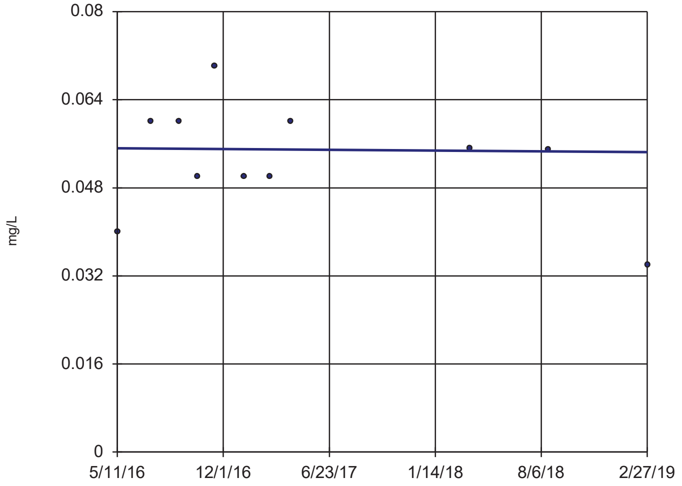
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-3 (bg)



n = 11

Slope = -0.0002401
units per year.

Mann-Kendall
statistic = -7
critical = -34

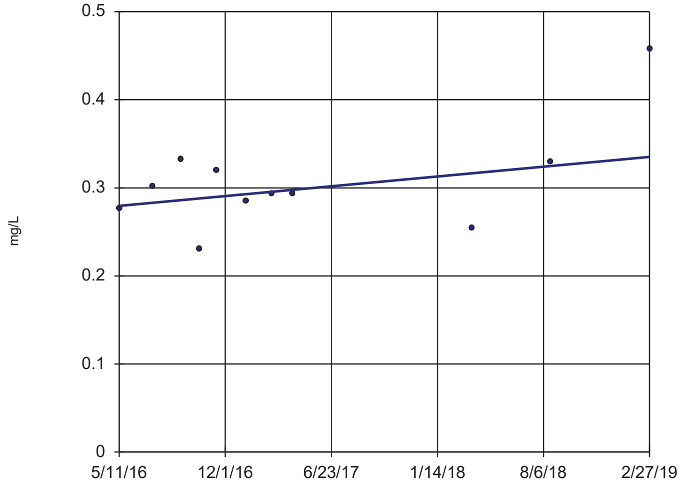
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-28



n = 11

Slope = 0.01986
units per year.

Mann-Kendall
statistic = 12
critical = 34

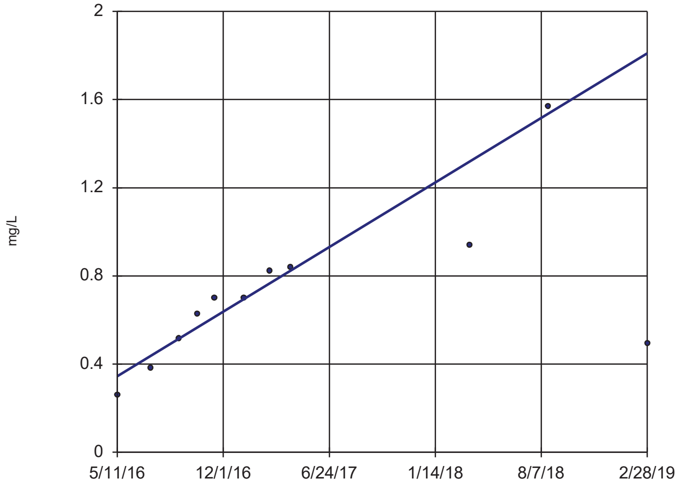
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-30



n = 11

Slope = 0.5226
units per year.

Mann-Kendall
statistic = 37
critical = 34

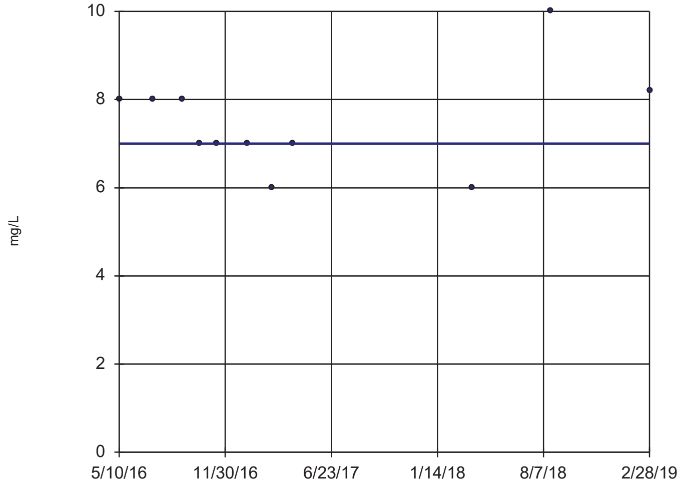
Increasing trend
significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 11

Slope = 0
units per year.

Mann-Kendall
statistic = -7
critical = -34

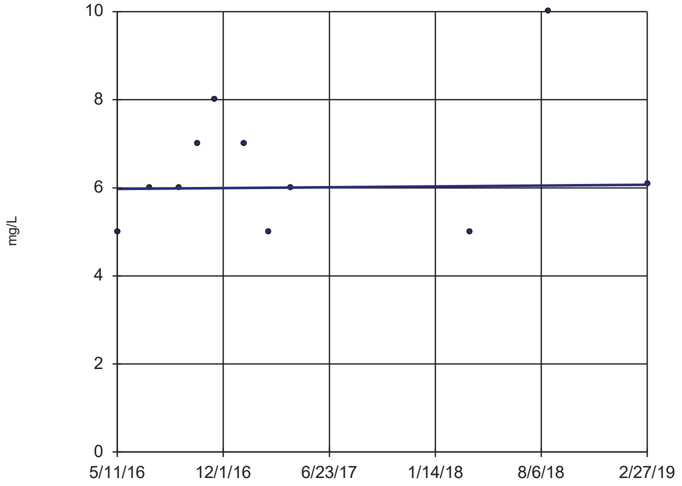
Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.03234
units per year.

Mann-Kendall
statistic = 10
critical = 34

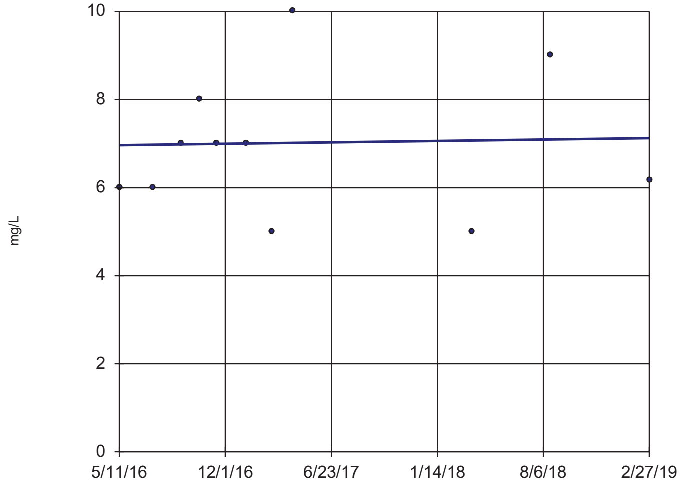
Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-3 (bg)



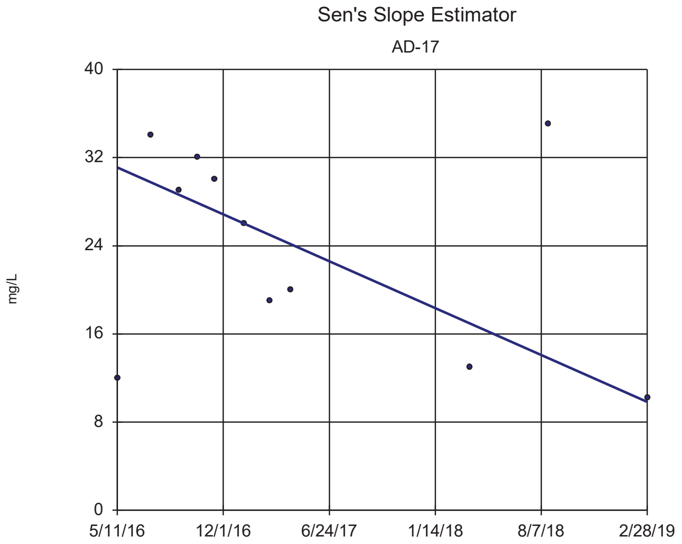
n = 11

Slope = 0.05714
units per year.

Mann-Kendall
statistic = 6
critical = 34

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP



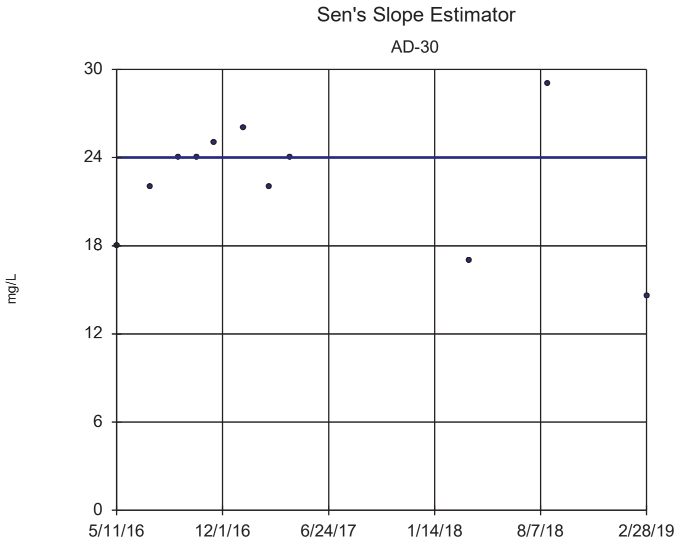
n = 11

Slope = -7.599
units per year.

Mann-Kendall
statistic = -15
critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP



n = 11

Slope = 0
units per year.

Mann-Kendall
statistic = 3
critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Tolerance Limit Summary Table

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/8/2019, 5:28 AM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.002	33	n/a	n/a	87.88	n/a	n/a	0.184	NP Inter(NDs)
Arsenic, total (mg/L)	n/a	0.004229	33	n/a	n/a	75.76	n/a	n/a	0.184	NP Inter(NDs)
Barium, total (mg/L)	n/a	0.1593	33	0.06703	0.03743	0	None	No	0.01	Inter
Beryllium, total (mg/L)	n/a	0.001196	33	-8.334	0.6511	9.091	None	ln(x)	0.01	Inter
Cadmium, total (mg/L)	n/a	0.001	33	n/a	n/a	78.79	n/a	n/a	0.184	NP Inter(NDs)
Chromium, total (mg/L)	n/a	0.002894	33	0.02814	0.01041	12.12	None	sqrt(x)	0.01	Inter
Cobalt, total (mg/L)	n/a	0.009	33	n/a	n/a	0	n/a	n/a	0.184	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	n/a	3.565	33	1.016	0.3538	0	None	sqrt(x)	0.01	Inter
Fluoride, total (mg/L)	n/a	1	33	n/a	n/a	87.88	n/a	n/a	0.184	NP Inter(NDs)
Lead, total (mg/L)	n/a	0.002	33	n/a	n/a	84.85	n/a	n/a	0.184	NP Inter(NDs)
Lithium, total (mg/L)	n/a	0.1387	32	0.283	0.09452	3.125	None	x^(1/3)	0.01	Inter
Mercury, total (mg/L)	n/a	0.000064	33	n/a	n/a	48.48	n/a	n/a	0.184	NP Inter(normality)
Molybdenum, total (mg/L)	n/a	0.04	33	n/a	n/a	81.82	n/a	n/a	0.184	NP Inter(NDs)
Selenium, total (mg/L)	n/a	0.004	33	n/a	n/a	60.61	n/a	n/a	0.184	NP Inter(normality)
Thallium, total (mg/L)	n/a	0.002	33	n/a	n/a	84.85	n/a	n/a	0.184	NP Inter(NDs)

Confidence Interval Summary Table - Significant Results

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 7/9/2019, 12:58 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-28**	**0.01626**	**0.01321**	**0.009**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results

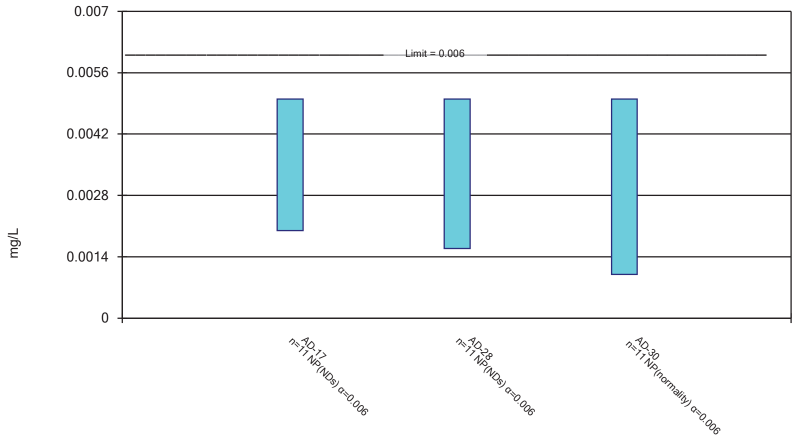
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/9/2019, 12:58 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-17	0.005	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-28	0.005	0.001588	0.006	n/a	No	11	81.82	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-30	0.005	0.000997	0.006	n/a	No	11	72.73	No	0.006	NP (normality)
Arsenic, total (mg/L)	AD-17	0.005	0.001213	0.01	n/a	No	11	63.64	No	0.006	NP (normality)
Arsenic, total (mg/L)	AD-28	0.005	0.001409	0.01	n/a	No	11	54.55	No	0.006	NP (normality)
Arsenic, total (mg/L)	AD-30	0.005	0.001929	0.01	n/a	No	11	81.82	No	0.006	NP (NDs)
Barium, total (mg/L)	AD-17	0.2942	0.1343	2	n/a	No	11	0	No	0.01	Param.
Barium, total (mg/L)	AD-28	0.17	0.148	2	n/a	No	11	0	No	0.006	NP (normality)
Barium, total (mg/L)	AD-30	0.05771	0.04986	2	n/a	No	11	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-17	0.0008327	0.0004929	0.004	n/a	No	11	9.091	No	0.01	Param.
Beryllium, total (mg/L)	AD-28	0.000836	0.0005198	0.004	n/a	No	11	0	No	0.01	Param.
Beryllium, total (mg/L)	AD-30	0.0001554	0.0000604	0.004	n/a	No	11	9.091	No	0.006	NP (normality)
Cadmium, total (mg/L)	AD-17	0.001	0.0000833	0.005	n/a	No	11	72.73	No	0.006	NP (normality)
Cadmium, total (mg/L)	AD-28	0.001	0.001	0.005	n/a	No	11	90.91	No	0.006	NP (NDs)
Cadmium, total (mg/L)	AD-30	0.001	0.001	0.005	n/a	No	11	90.91	No	0.006	NP (NDs)
Chromium, total (mg/L)	AD-17	0.002321	0.0004231	0.1	n/a	No	11	9.091	x^(1/3)	0.01	Param.
Chromium, total (mg/L)	AD-28	0.001	0.0006055	0.1	n/a	No	10	30	No	0.011	NP (normality)
Chromium, total (mg/L)	AD-30	0.001864	0.0005964	0.1	n/a	No	11	9.091	ln(x)	0.01	Param.
Cobalt, total (mg/L)	AD-17	0.01285	0.005951	0.009	n/a	No	11	0	No	0.01	Param.
Cobalt, total (mg/L)	**AD-28**	**0.01626**	**0.01321**	**0.009**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Cobalt, total (mg/L)	AD-30	0.002411	0.001739	0.009	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-17	6.421	1.722	5	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-28	2.675	1.609	5	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-30	2.662	0.5223	5	n/a	No	11	0	sqrt(x)	0.01	Param.
Fluoride, total (mg/L)	AD-17	1	0.3446	4	n/a	No	11	72.73	No	0.006	NP (normality)
Fluoride, total (mg/L)	AD-28	0.8546	0.5139	4	n/a	No	11	9.091	No	0.01	Param.
Fluoride, total (mg/L)	AD-30	1	1	4	n/a	No	11	100	No	0.006	NP (NDs)
Lead, total (mg/L)	AD-17	0.005	0.002	0.015	n/a	No	11	90.91	No	0.006	NP (NDs)
Lead, total (mg/L)	AD-28	0.005	0.002	0.015	n/a	No	11	90.91	No	0.006	NP (NDs)
Lead, total (mg/L)	AD-30	0.005	0.002	0.015	n/a	No	11	90.91	No	0.006	NP (NDs)
Lithium, total (mg/L)	AD-17	0.02643	0.01174	0.14	n/a	No	11	9.091	No	0.01	Param.
Lithium, total (mg/L)	AD-28	0.03262	0.02484	0.14	n/a	No	10	0	x^3	0.01	Param.
Lithium, total (mg/L)	AD-30	0.01021	0.006832	0.14	n/a	No	11	9.091	x^2	0.01	Param.
Mercury, total (mg/L)	AD-17	0.0001439	0.00006042	0.002	n/a	No	11	0	No	0.01	Param.
Mercury, total (mg/L)	AD-28	0.00009517	0.00002722	0.002	n/a	No	11	0	x^(1/3)	0.01	Param.
Mercury, total (mg/L)	AD-30	0.001473	0.000255	0.002	n/a	No	11	0	No	0.01	Param.
Molybdenum, total (mg/L)	AD-17	0.005	0.0004858	0.1	n/a	No	11	81.82	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-28	0.005	0.0002942	0.1	n/a	No	11	81.82	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-30	0.005	0.001142	0.1	n/a	No	11	81.82	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-17	0.005	0.002554	0.05	n/a	No	11	81.82	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-28	0.005	0.001103	0.05	n/a	No	11	81.82	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-30	0.005	0.001207	0.05	n/a	No	11	81.82	No	0.006	NP (NDs)
Thallium, total (mg/L)	AD-17	0.002	0.001075	0.002	n/a	No	10	80	No	0.011	NP (NDs)
Thallium, total (mg/L)	AD-28	0.002	0.001247	0.002	n/a	No	10	80	No	0.011	NP (NDs)
Thallium, total (mg/L)	AD-30	0.002	0.000959	0.002	n/a	No	10	70	No	0.011	NP (normality)

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

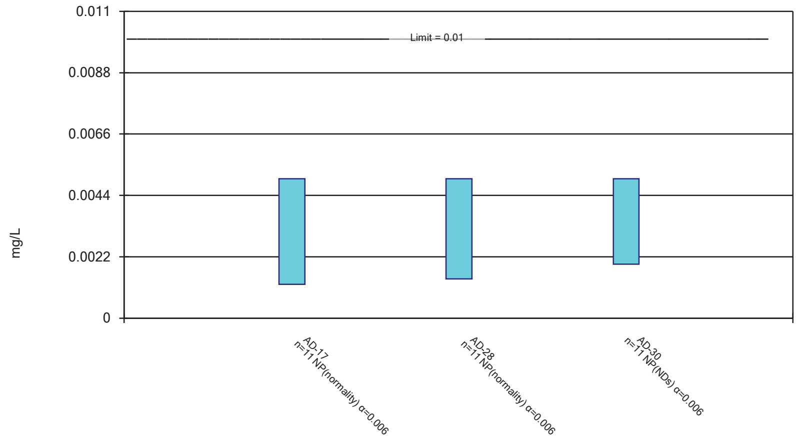


Constituent: Antimony, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

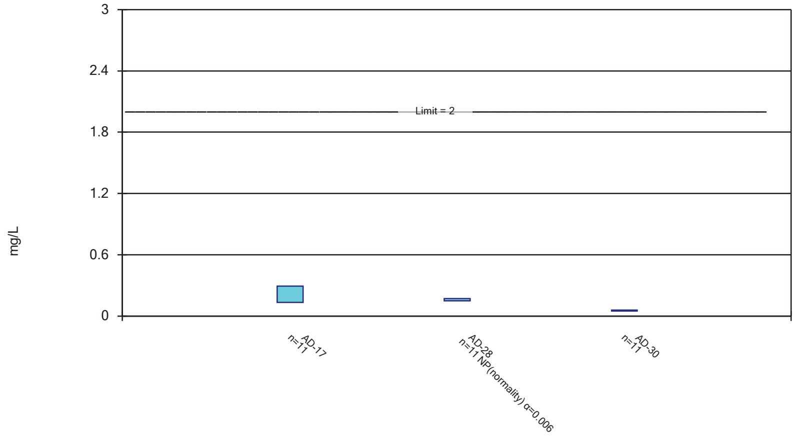


Constituent: Arsenic, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

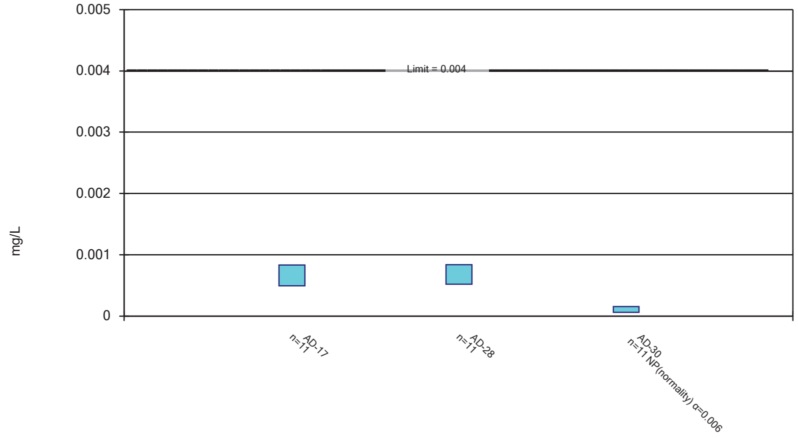


Constituent: Barium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

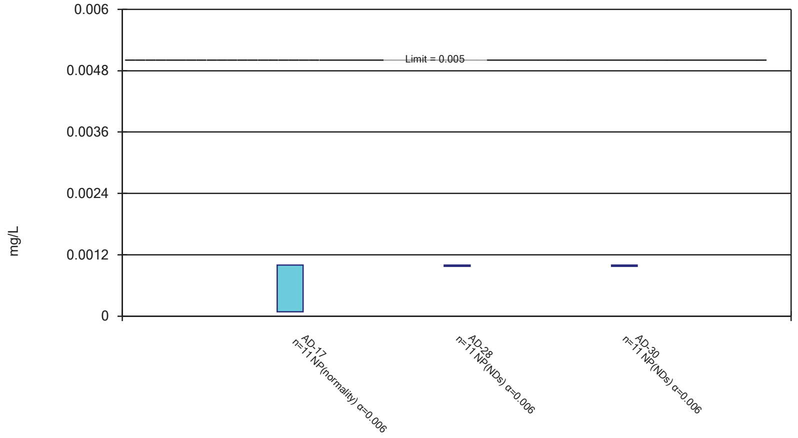


Constituent: Beryllium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

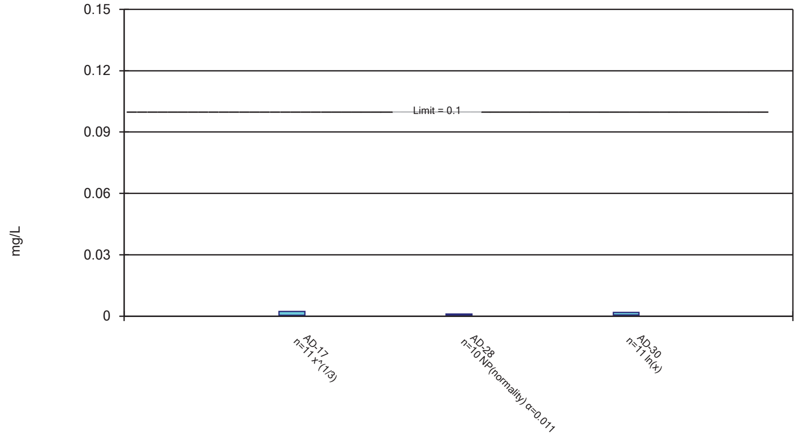


Constituent: Cadmium, total   Analysis Run 7/9/2019 12:53 PM   View: Confidence Intervals - App IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

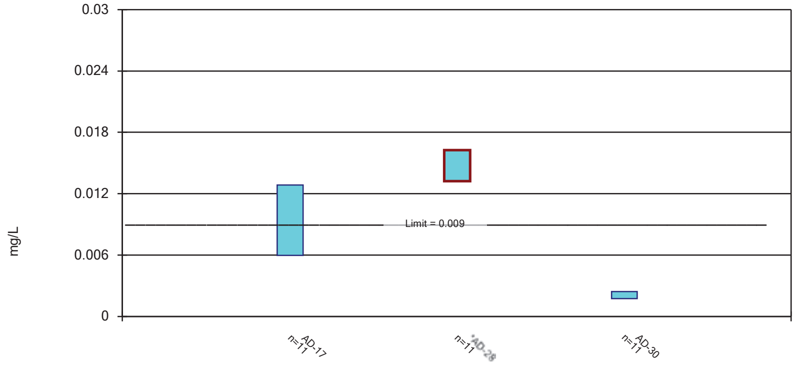


Constituent: Chromium, total   Analysis Run 7/9/2019 12:53 PM   View: Confidence Intervals - App IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

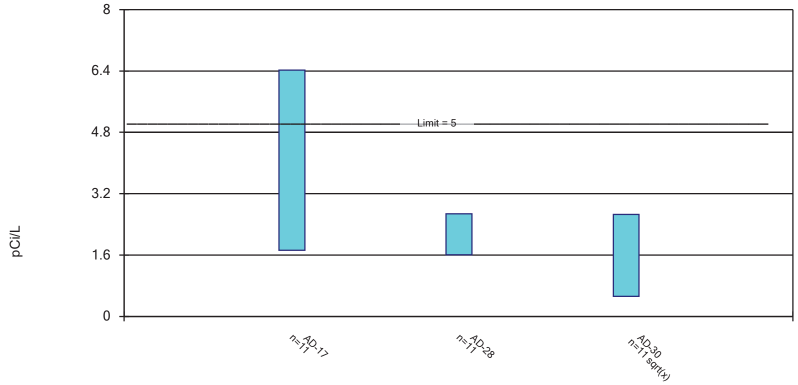


Constituent: Cobalt, total   Analysis Run 7/9/2019 12:53 PM   View: Confidence Intervals - App IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

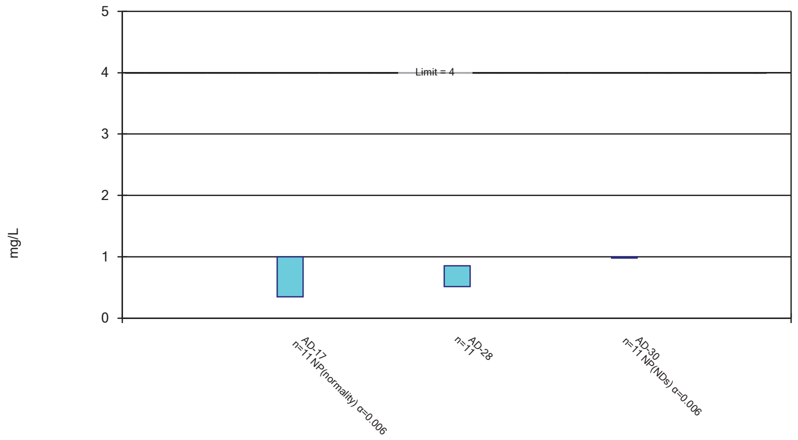


Constituent: Combined Radium 226 + 228   Analysis Run 7/9/2019 12:53 PM   View: Confidence Intervals -
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

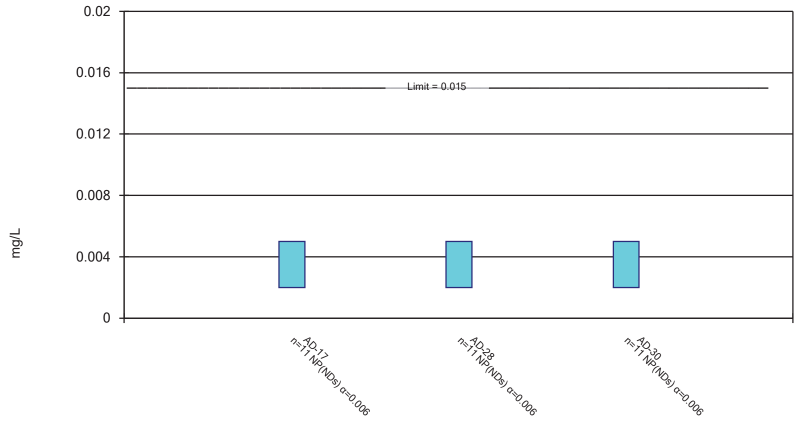


Constituent: Fluoride, total   Analysis Run 7/9/2019 12:53 PM   View: Confidence Intervals - App IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

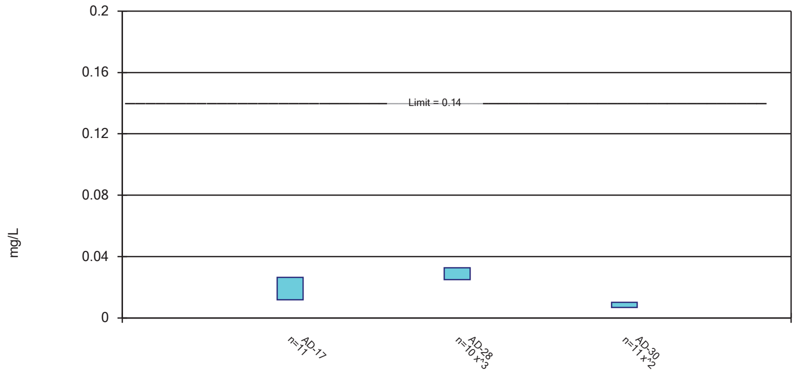


Constituent: Lead, total   Analysis Run 7/9/2019 12:53 PM   View: Confidence Intervals - App IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

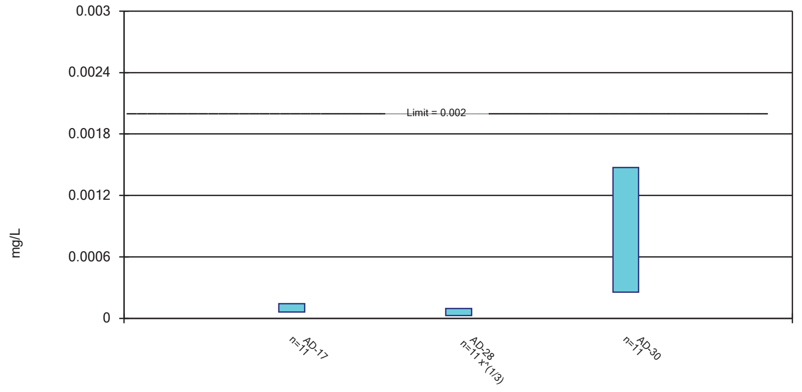


Constituent: Lithium, total   Analysis Run 7/9/2019 12:53 PM   View: Confidence Intervals - App IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

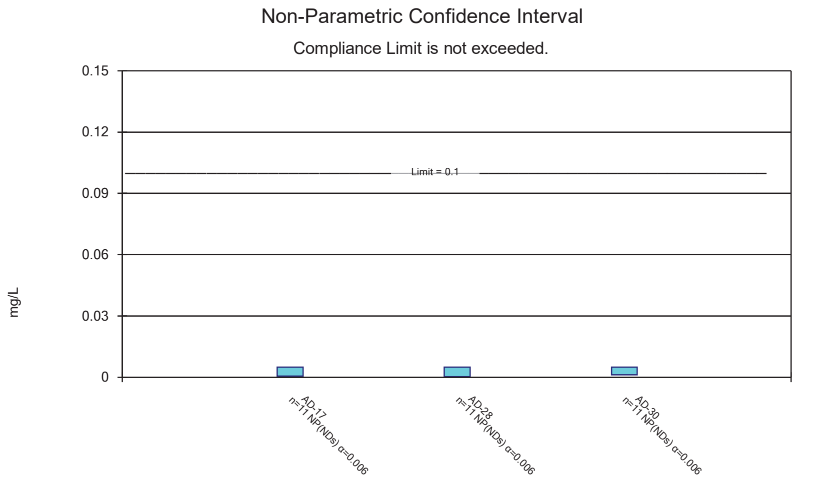
Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



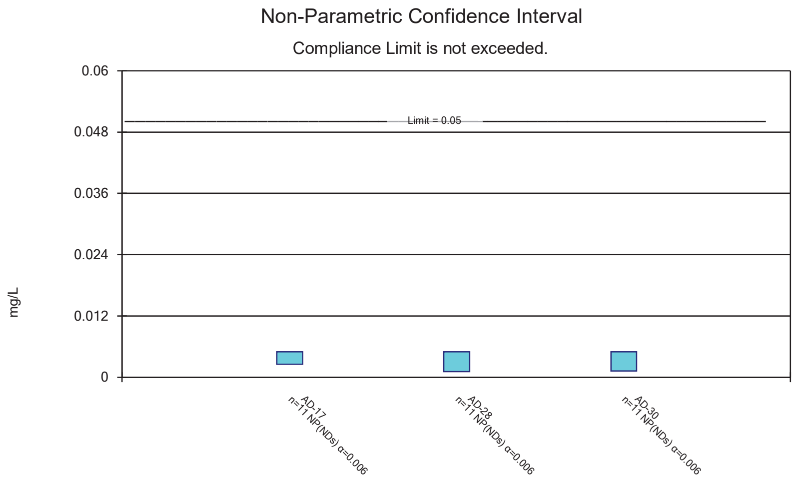
Constituent: Mercury, total   Analysis Run 7/9/2019 12:53 PM   View: Confidence Intervals - App IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



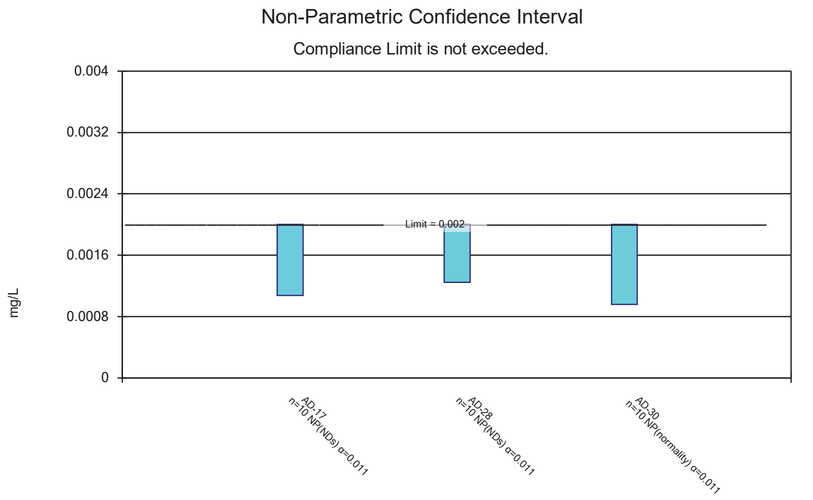
Constituent: Molybdenum, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Selenium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Thallium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

STATISTICAL ANALYSIS SUMMARY
WEST BOTTOM ASH POND
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

December 26, 2019

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
SU	Standard Units
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
WBAP	West Bottom Ash Pond

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the West Bottom Ash Pond (WBAP), an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, and sulfate at the WBAP. An alternative source was not identified at the time, so the WBAP has been in assessment monitoring since. During the most recent assessment monitoring event, completed in February 2019, an SSL for cobalt was identified at well AD-28. An ASD was successfully completed (Geosyntec, 2019); thus, the unit remained in assessment monitoring. Two assessment monitoring events were conducted at the WBAP in May and August 2019, in accordance with 40 CFR 257.95. The results of these events are documented in this report.

Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. An SSL was identified for cobalt. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

WEST BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (May 2019) and 257.95(d)(1) (August 2019). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.23 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the WBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained in May and August 2019 were screened for potential outliers. No outliers were identified.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for arsenic, barium, beryllium, cobalt, fluoride, mercury, and selenium due to apparent non-normal distributions and for antimony, cadmium, lead, molybdenum, and thallium due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSL was identified at the Pirkey WBAP:

- The LCL for cobalt exceeded the GWPS of 0.009 mg/L at AD-28 (0.0132 mg/L).

As a result, the Pirkey WBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Establishment of Appendix III Prediction Limits

Upper prediction limits (UPL) were previously established for all Appendix III parameters following the background monitoring period (Geosyntec, 2018). Intrawell tests were used to evaluate potential SSIs for calcium, pH, sulfate and TDS, whereas interwell tests were used to evaluate potential SSIs for boron, chloride and fluoride. While interwell prediction limits have been updated periodically during the assessment monitoring period as sufficient data became available, this represents the first update to the background dataset for parameters evaluated using intrawell tests.

Mann-Whitney (Wilcoxon rank-sum) tests were performed to determine whether the newer data are affected by a release from the WBAP. Because the interwell Appendix III limits and the Appendix IV GWPSs are based on data from upgradient wells which we would not expect to have been impacted by a release, these tests were used for intrawell Appendix III tests only. Mann-Whitney tests were used to compare the medians of historical data (May 2016 - April 2017) to the new compliance samples (August 2017 – February 2019) for calcium, pH, sulfate and TDS. Results were evaluated to determine if the medians of the two groups were similar at the 99% confidence level. Where no significant difference was found, the new compliance data were added to the background dataset. Where a statistically significant difference was found between the medians of the two groups, the data were reviewed to evaluate the cause of the difference and to determine if adding newer data to the background dataset, replacing the background dataset with the newer data, or continuing to use the existing background dataset was most appropriate. If the differences appeared to have been caused by a release, then the previous background dataset would have continued to be used.

The complete Mann-Whitney test results and a summary of the significant findings can be found in Attachment B. Significant differences were found between the two groups for pH in upgradient well AD-18 and for sulfate in downgradient well AD-30. Typically, when the test concludes that the medians of the two groups are significantly different, particularly in the downgradient wells, the background are not updated to include the newer data but will be reconsidered in the future. In the case of pH in upgradient well AD-18, the more recent reported measurements are slightly higher than those reported historically; therefore, this record was updated so that only the most recent eight samples are used to construct the prediction limits and, thus, better represent the groundwater quality upgradient of the facility. At downgradient well AD-30, the dataset was not updated, and the previously calculated prediction limit was used to more conservatively evaluate possible exceedances for sulfate.

After the revised background set was established, a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., “J-flagged” data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment B.

UPLs were updated using all the historical data through February 2019 to represent background values. LPLs were also updated for pH. The updated prediction limits are summarized in Table 3. Intrawell tests continued to be used to evaluate potential SSIs for calcium, pH, sulfate and TDS, whereas interwell tests continued to be used to evaluate potential SSIs for boron, chloride and fluoride. The intrawell UPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where the initial result did not exceed the UPL, a second sample was not collected. The retesting procedures allowed achieving an acceptably high statistical power to detect changes at downgradient wells for constituents evaluated using intrawell prediction limits.

2.2.4 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the May and August 2019 assessment monitoring events from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 4. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0768 at AD-28 (0.313 mg/L and 0.366 mg/L) and AD-30 (0.520 mg/L and 1.25 mg/L).

- Chloride concentrations exceeded the interwell UPL of 9.50 mg/L at AD-17 (10.3 mg/L and 26.3 mg/L) and AD-30 (18.8 mg/L and 28.1 mg/L).

- Sulfate concentrations exceeded the intrawell UPL of 31.6 mg/L at AD-30 (39.8 mg/L).

Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey WBAP during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the May and August 2019 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. An SSL was identified for cobalt. Appendix III parameters were compared to recalculated prediction limits, with exceedances identified for boron, chloride, and sulfate.

Based on this evaluation, the Pirkey WBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – West Bottom Ash Pond, H.W. Pirkey Power Plant, Hallsville, Texas. January 15, 2018.

Geosyntec. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant - West Bottom Ash Pond. September.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - West Bottom Ash Pond

Component	**Unit**	**AD-3**		**AD-12**		**AD-17**		**AD-18**		**AD-28**		**AD-30**	
		8/13/2019	**5/23/2019**	**5/21/2019**	**8/12/2019**	**5/23/2019**	**8/13/2019**	**5/22/2019**	**8/12/2019**	**5/22/2019**	**8/12/2019**	**5/23/2019**	**8/12/2019**
Antimony	µg/L	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.0200 J	2.00 U	0.100 U
Arsenic	µg/L	2.00 U	2.41	2.00 U	0.0700 J	2.00 U	0.400	2.00 U	0.450	2.00 U	0.640	0.600 J	0.210
Barium	µg/L	61.8	58.3	21.7	23.8	82.9	216	131	100	148	113	59.2	58.0
Beryllium	µg/L	2.00 U	0.196	2.00 U	0.154	2.00 U	0.554	2.00 U	0.118	0.500 J	0.473	2.00 U	0.0700 J
Boron	mg/L	0.0450	0.0500 J	0.0200	0.0500 U	0.0190	0.0300 J	0.0130	0.0500 U	0.313	0.366	0.520	1.25
Cadmium	µg/L	1.00 U	0.0200 J	1.00 U	0.0500 U	1.00 U	0.0400 J	1.00 U	0.0200 J	1.00 U	0.0400 J	1.00 U	0.0500 U
Calcium	mg/L	6.19	5.08	0.300 J	0.278	0.200 J	0.777	0.684	0.647	1.24	1.72	1.74	0.302
Chloride	mg/L	5.99	6.83	6.30	7.24	10.3	26.3	8.82	8.49	4.48	6.04	18.8	28.1
Chromium	µg/L	4.00 U	0.206	4.00 U	0.204	0.900 J	0.732	4.00 U	0.212	4.00 U	0.416	1.00 J	0.374
Cobalt	µg/L	4.94	6.55	1.15	1.30	3.15	9.03	1.47	1.25	13.8	12.8	3.26	2.10
Combined Radium	pCi/L	0.988	1.38	0.201	0.237	1.62	6.40	0.492	0.473	1.95	2.38	1.09	1.22
Fluoride	mg/L	0.0900	0.190	0.0900	0.0600 J	0.130	0.240	0.0200 J	0.0100 J	0.690	0.650	0.0400 J	0.0300 J
Lead	µg/L	2.00 U	0.417	2.00 U	0.0800 J	2.00 U	0.200 J	2.00 U	0.200 J	2.00 U	0.100 J	2.00 U	0.0600 J
Lithium	mg/L	0.0734	0.108	0.00576	0.00829	0.00911	0.0193	0.0209	0.0183	0.0227	0.0380	0.00841	0.00804
Mercury	mg/L	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.000103	0.000447	0.00000900 J	0.0000230 J	0.0000280	0.0000920	0.000165	0.000345
Molybdenum	µg/L	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U
Selenium	µg/L	4.00 U	0.100 J	4.00 U	0.200 J	4.00 U	0.300	4.00 U	0.0900 J	4.00 U	0.200 J	4.00 U	0.200 J
Total Dissolved Solids	mg/L	154	168	80.0	90.0	58.0	88.0	104	90.0	100	128	112	160
Sulfate	mg/L	29.5	32.5	4.00	2.60	2.40	1.80	10.6	6.60	20.1	22.5	29.2	39.8
Thallium	µg/L	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U
pH	SU	4.90	5.12	4.09	4.94	3.96	4.75	5.20	5.22	4.62	4.66	4.86	4.87

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above the method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit

Table 2: Groundwater Protection Standards
Pirkey Plant - West Bottom Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.005
Barium, Total (mg/L)	2		0.16
Beryllium, Total (mg/L)	0.004		0.002
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.0032
Cobalt, Total (mg/L)	n/a	0.006	0.009
Combined Radium, Total (pCi/L)	5		3.31
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	0.015		0.005
Lithium, Total (mg/L)	n/a	0.04	0.14
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.01
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.002

Notes:

Grey cell indicates calculated UTL is higher than MCL or CCR Rule-specified value.

MCL = Maximum Contaminant Level

Calculated UTL (Upper Tolerance Limit) represents site-specific background values.

The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Revised Prediction Limits
Pirkey - West Bottom Ash Pond

Parameter	Unit	Description	AD-17	AD-28	AD-30
Boron	mg/L	Interwell Background Value (UPL)	0.0768		
Calcium	mg/L	Intrawell Background Value (UPL)	1.79	2.76	0.680
Chloride	mg/L	Interwell Background Value (UPL)	9.50		
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
pH	SU	Intrawell Background Value (UPL)	4.8	5.9	5.5
		Intrawell Background Value (LPL)	3.2	3.3	3.8
Sulfate	mg/L	Intrawell Background Value (UPL)	9.32	23.2	31.6
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	115	129	189

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

Table 4: Appendix III Data Summary
Pirkey - West Bottom Ash Pond

Parameter	Unit	Description	AD-17		AD-28		AD-30	
			5/23/2019	8/13/2019	5/22/2019	8/12/2019	5/23/2019	8/12/2019
Boron	mg/L	Interwell Background Value (UPL)	0.0768					
		Detection Monitoring Result	0.0190	0.0300	**0.313**	**0.366**	**0.520**	**1.25**
Calcium	mg/L	Intrawell Background Value (UPL)	1.79		2.76		0.680	
		Detection Monitoring Result	0.200	0.777	1.24	1.72	1.74	0.302
Chloride	mg/L	Interwell Background Value (UPL)	9.50					
		Detection Monitoring Result	**10.3**	**26.3**	4.48	6.04	**18.8**	**28.1**
Fluoride	mg/L	Interwell Background Value (UPL)	1.00					
		Detection Monitoring Result	0.130	0.240	0.690	0.650	0.0400	0.0300
pH	SU	Intrawell Background Value (UPL)	4.8		5.9		5.5	
		Intrawell Background Value (LPL)	3.2		3.3		3.8	
		Detection Monitoring Result	4.0	4.8	4.6	4.7	4.9	4.9
Sulfate	mg/L	Intrawell Background Value (UPL)	9.32		23.2		31.6	
		Detection Monitoring Result	2.40	1.80	20.1	22.5	29.2	**39.8**
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	115		129		189	
		Detection Monitoring Result	58.0	88.0	100	128	112	160

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
112498

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

112498	TEXAS	01.03.20
License Number	Licensing State	Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

December 10, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey WBAP
Background Update – 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the background update of groundwater data for American Electric Power Inc.'s Pirkey West Bottom Ash Pond. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-3, AD-12, and AD-18
- **Downgradient wells:** AD-17, AD-28, and AD-30

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis report was reviewed by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to Groundwater Stats Consulting. The analysis was prepared according to the background screening conducted in December 2017 that was approved by Dr. Kirk Cameron.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS;

- **Appendix IV** (Assessment Monitoring) – antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series and box plots for both Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figures A and B, respectively). Values flagged as outliers from this screening may be seen in a lighter font and disconnected symbol on the time series graphs, and a summary of those values follows this letter (Figure C).

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for calcium and pH, sulfate, and TDS;
2) Interwell prediction limits combined with a 1-of-2 resample plan for boron, chloride, and fluoride.

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, the reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory and there is no replacement of historical reporting limits with the most recent reporting limit. It was noted that the more recent reporting limits are significantly lower than those reported historically.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Historical Summary - Evaluation of Appendix III Parameters – December 2017

Outlier Evaluation

Time series plots were used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III parameters were formally tested using Tukey's box plot method and, when identified, flagged in the computer database with "o" and deselected prior to construction of statistical limits.

During the previous background screening, no values were flagged as outliers for Appendix III parameters. The current assumption is that changes in concentrations are reflective of natural variation upgradient of the facility; however, a separate study and hydrogeological investigation would be required to fully understand the geochemical conditions and expected groundwater quality for the region. That study and assessment is beyond the scope of services provided by Groundwater Stats Consulting.

Statistical Limits

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, chloride and fluoride; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, pH, sulfate, and TDS for the February 2019 data. The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data were screened for any newly suspected outliers or obvious trending patterns using time series plots. Intrawell prediction limits utilized the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the set background data will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

Note that the reporting limit for fluoride for the February 2019 event at well AD-30 was <0.2 mg/L whereas all historical reporting limits for all wells at that time was <1.0 mg/L. Therefore, <1.0 mg/L was substituted for all nondetects which is less than the Groundwater Protection Standard of 4 mg/L. Additionally, in the case of TDS at well AD-30, the April 2019 sample was compared against background.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified, and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. Prediction limit exceedances were noted for boron at wells AD-28 and AD-30, and chloride at wells AD-17 and AD-30.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable. Upgradient wells were included in the trend analyses to identify whether similar patterns exist upgradient of the site. Such patterns are an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances, except for a statistically significant increasing trend for boron in well AD-30.

Appendix III Background Update – November 2019

Prior to updating background data, samples are re-evaluated for all wells for intrawell parameters and all upgradient wells for interwell parameters using Tukey's outlier test and visual screening with the February 2019 samples. Samples during August and December 2017 that were previously absent were also incorporated into this analysis. No values were noted or flagged as outliers for Appendix III parameters. As mentioned above, any flagged data are displayed in a lighter font and as a disconnected symbol on the time series reports, as well as in a lighter font on the accompanying data pages. An updated summary of Tukey's test results and flagged outliers follows this letter.

For constituents requiring intrawell prediction limits, the Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through April 2017 to the new compliance samples at each well through February 2019 to evaluate whether the groups are statistically different at the 99% confidence level, in which case background data may be updated with compliance data (Figure D). Statistically significant differences were found between the two groups for pH in upgradient well AD-18, and sulfate in downgradient well AD-30.

Typically, when the test concludes that the medians of the two groups are significantly different, particularly in the downgradient wells, the background are not updated to include the newer data but will be reconsidered in the future. Although the differences for pH in well AD-18 occurred in an upgradient well, more recent data are fairly similar to background, thus better representing the groundwater quality upgradient of the facility. As a result, the background for well AD-18 was updated to be the most recent 8 samples rather than the data set as a whole.

Regarding downgradient well AD-30 for sulfate, more recent concentrations exhibited substantial increases and exceeded median compliance values of all other wells and, therefore, the background will not be updated at this time. A summary of these results follows this letter and the test results are included with the Mann Whitney test section at the end of this report. Additionally, summaries of well/constituent pairs using a truncated portion of their data follow this letter (Figure E).

Intrawell prediction limits using all historical data through February 2019, except in the cases mentioned above, combined with a 1-of-2 resample plan, were constructed and a summary of the updated limits follows this letter (Figure F).

For parameters tested using interwell analyses, the Sen's Slope/Mann-Kendall trend test was used on upgradient wells to determine whether concentrations are statistically increasing, decreasing or stable (Figure G). No statistically significant increasing or decreasing trends were noted. A summary of those results is included with the trend tests.

Interwell prediction limits, combined with a 1-of-2 resample plan, were updated using all available data from upgradient wells through February 2019 for boron, chloride, and fluoride (Figure H). Interwell prediction limits pool upgradient well data to establish a background limit for an individual constituent. A summary table of the updated limits may be found following this letter in the Prediction Limit Summary Tables.

Evaluation of Appendix IV Parameters – November 2019

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure I).

Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Tukey's outlier test identified both high and low values for lithium in well AD-28, and molybdenum for wells AD-17, AD-28, and AD-30. The low value for lithium was not flagged due to the value being consistent with values reported for other wells for the same event. Additionally, low values for molybdenum in the aforementioned wells were not flagged due to the values being consistent across all downgradient wells for each given event and occurring more than once. These values appear to provide an accurate representation of the populations within their respective wells.

Note that the reporting limit for thallium for the February 2019 event was <0.01 mg/L, which is higher than the historical reporting limit of <0.002 mg/L and the GWPS. Since the <0.01 mg/L values cannot help distinguish whether other observations exceed the GWPS, they are flagged as outliers.

Tukey's outlier test on pooled upgradient well data did not identify any outliers; however, a high value was flagged for lithium in well AD-3 because the stability of background samples indicates that this value does not accurately represent the population of its respective well. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure J).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of the MCL, CCR-Rule specified level, or ACL as discussed above (Figure K). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No confidence interval exceedances were found except for cobalt in well AD-28. A summary of the confidence interval results follows this letter.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey West Bottom Ash Pond. If you have any questions or comments, please feel free to contact us.

For Groundwater Stats Consulting,

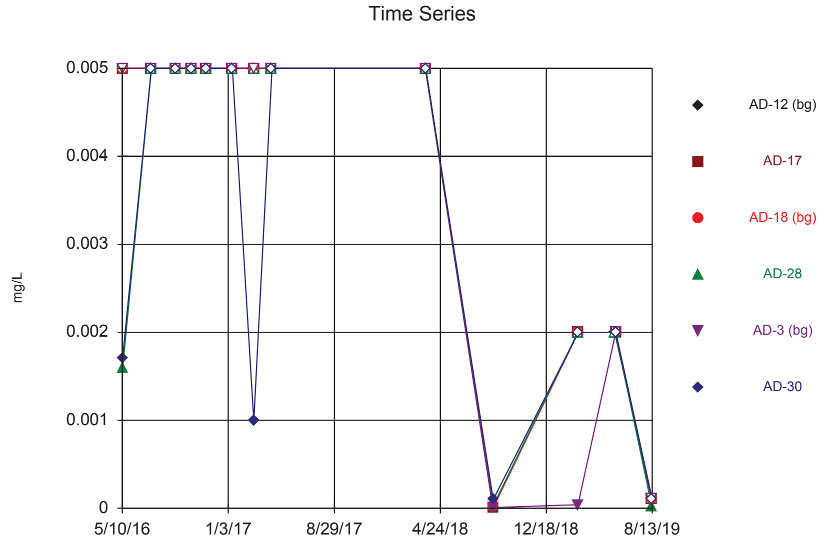
ACollins

Andrew T. Collins
Groundwater Analyst

Kristina Rayner

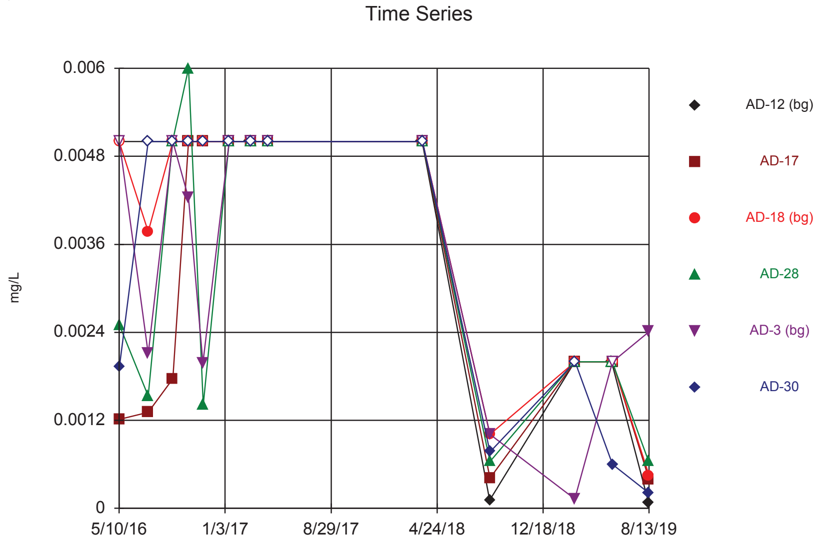
Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Antimony, total Analysis Run 12/6/2019 8:34 AM
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Arsenic, total Analysis Run 12/6/2019 8:34 AM
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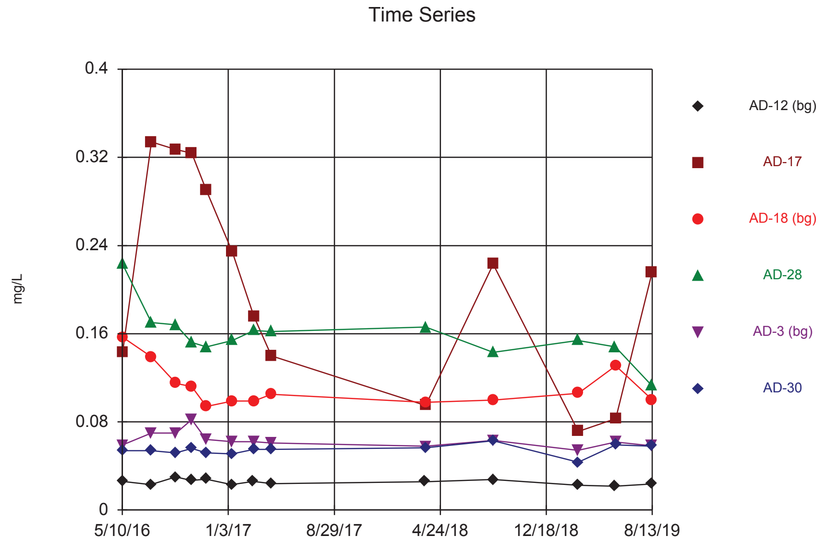
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Barium, total Analysis Run 12/6/2019 8:34 AM
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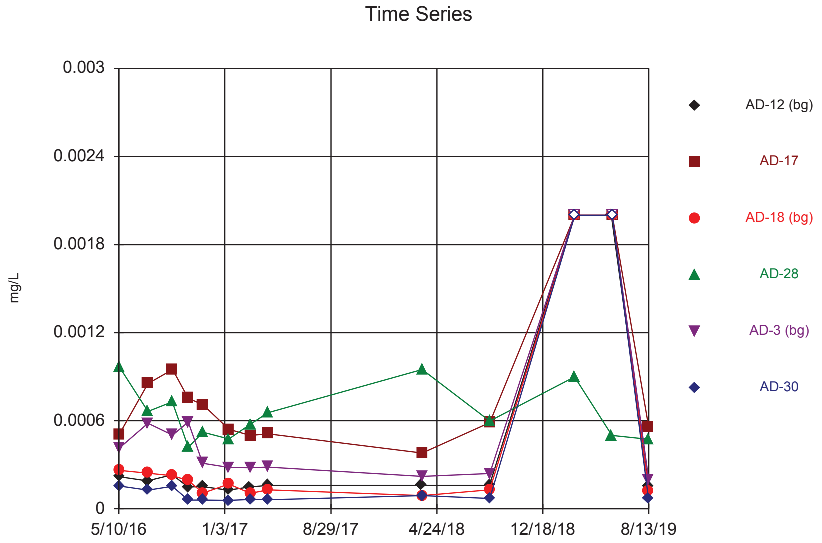
Hollow symbols indicate censored values.



Constituent: Beryllium, total Analysis Run 12/6/2019 8:34 AM
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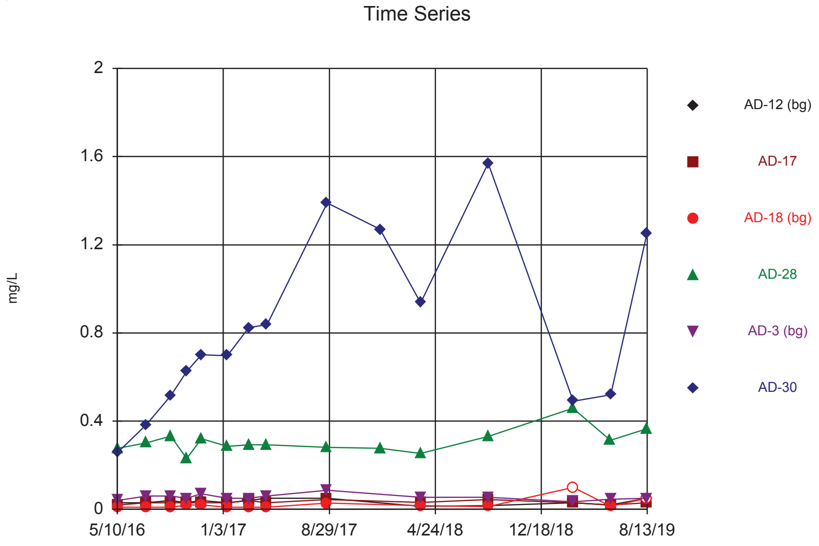
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Boron, total   Analysis Run 12/6/2019 8:34 AM
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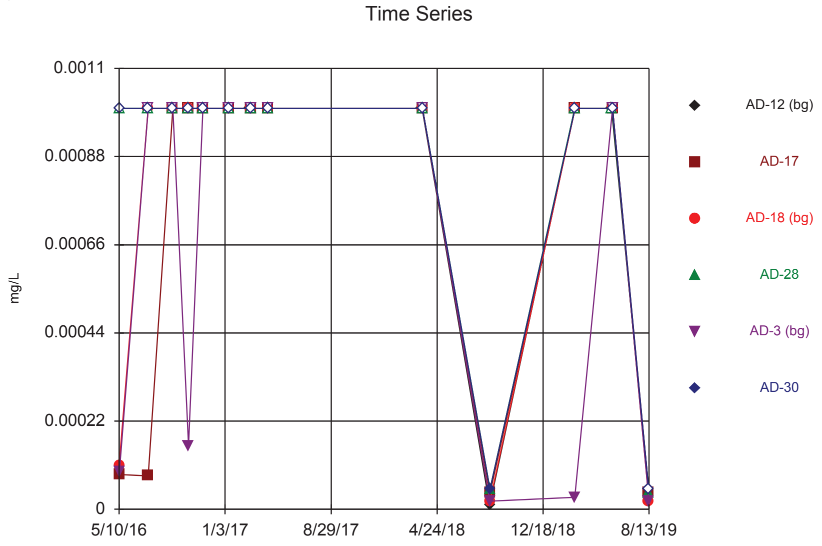
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Cadmium, total   Analysis Run 12/6/2019 8:34 AM
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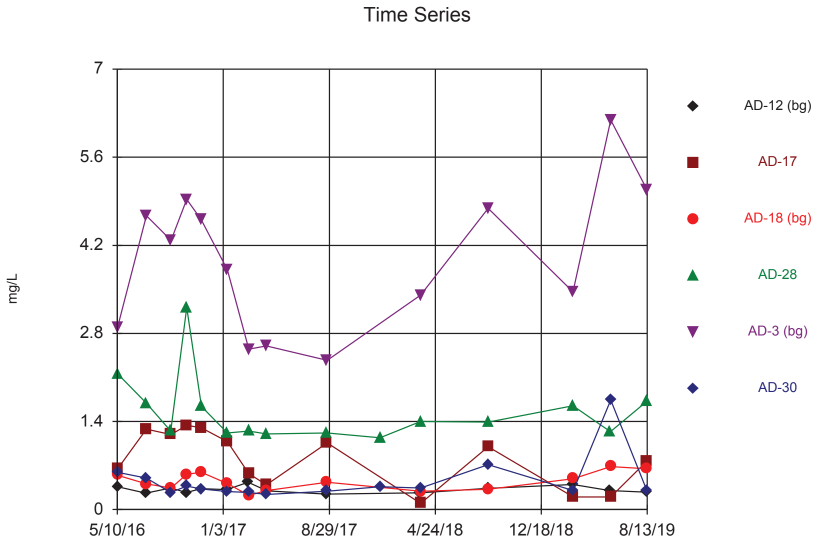
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Calcium, total   Analysis Run 12/6/2019 8:34 AM
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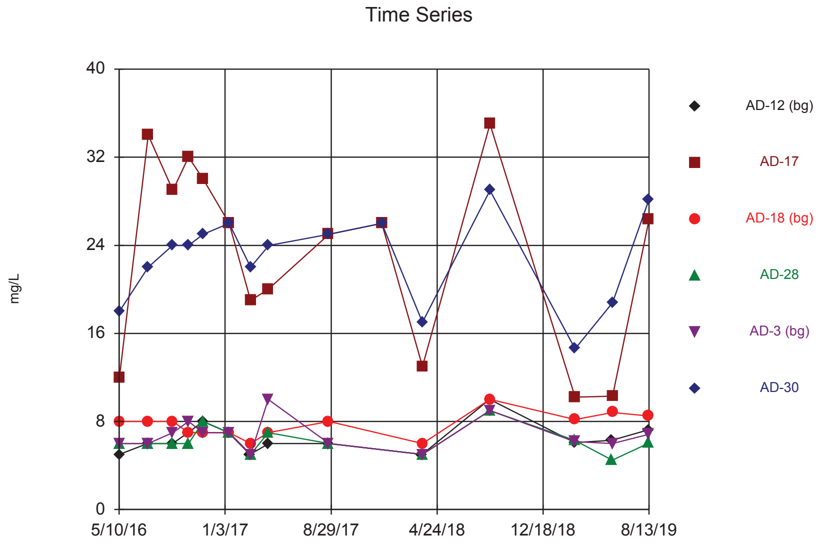

Constituent: Chloride, total   Analysis Run 12/6/2019 8:34 AM
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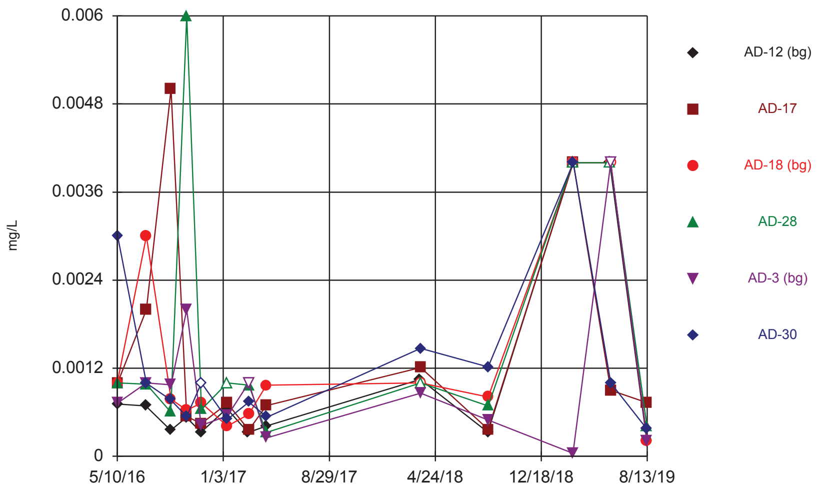
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Chromium, total   Analysis Run 12/6/2019 8:34 AM
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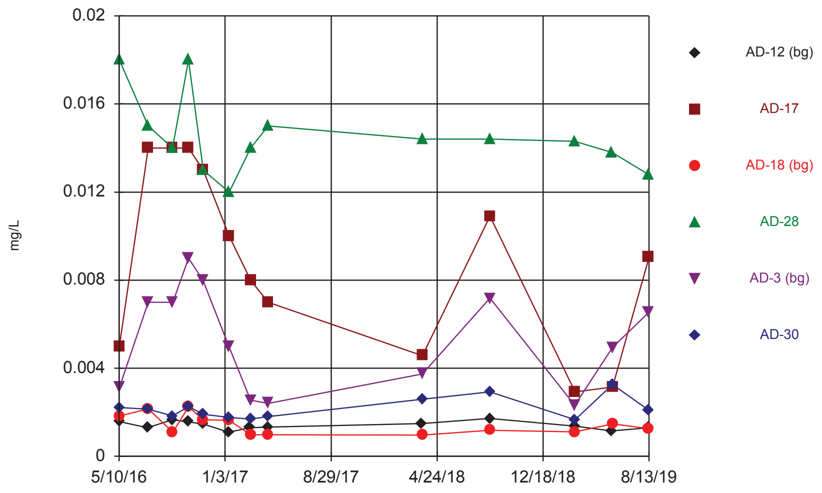
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Time Series



Constituent: Cobalt, total   Analysis Run 12/6/2019 8:34 AM
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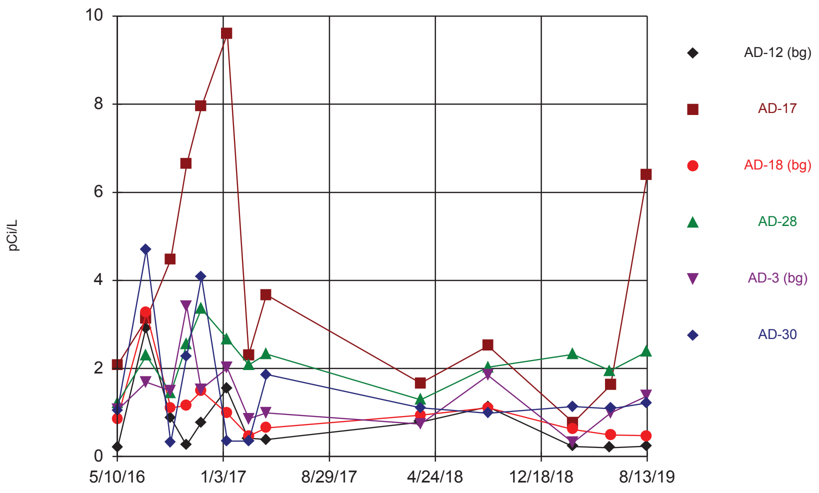
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Time Series



Constituent: Combined Radium 226 + 228   Analysis Run 12/6/2019 8:34 AM
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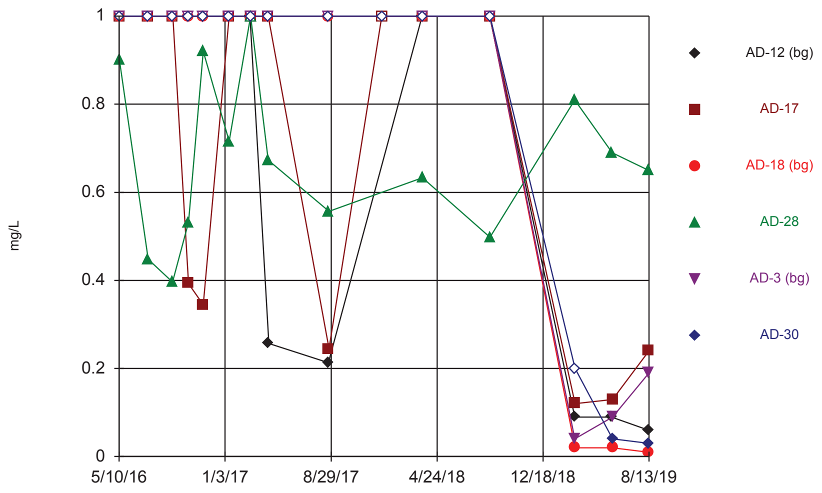
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Fluoride, total   Analysis Run 12/6/2019 8:34 AM
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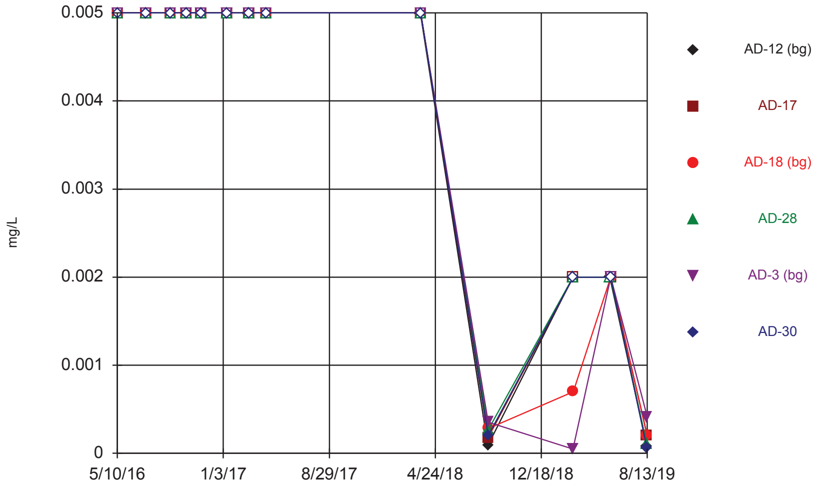
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Lead, total Analysis Run 12/6/2019 8:34 AM

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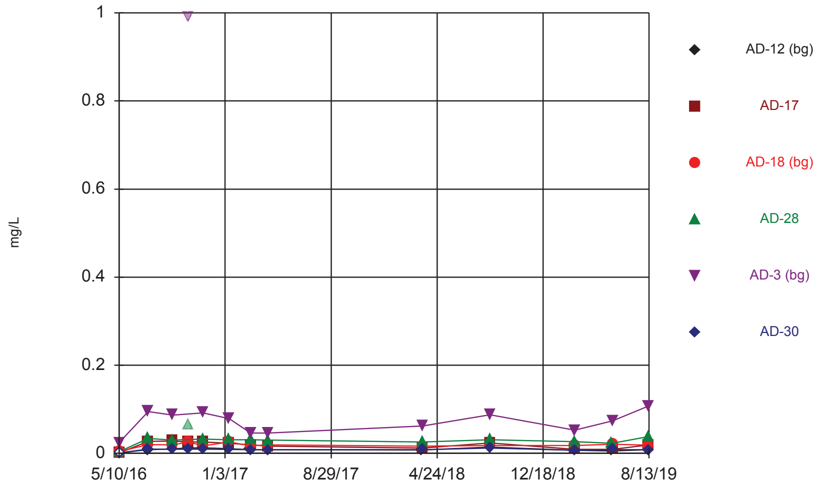
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Lithium, total Analysis Run 12/6/2019 8:34 AM

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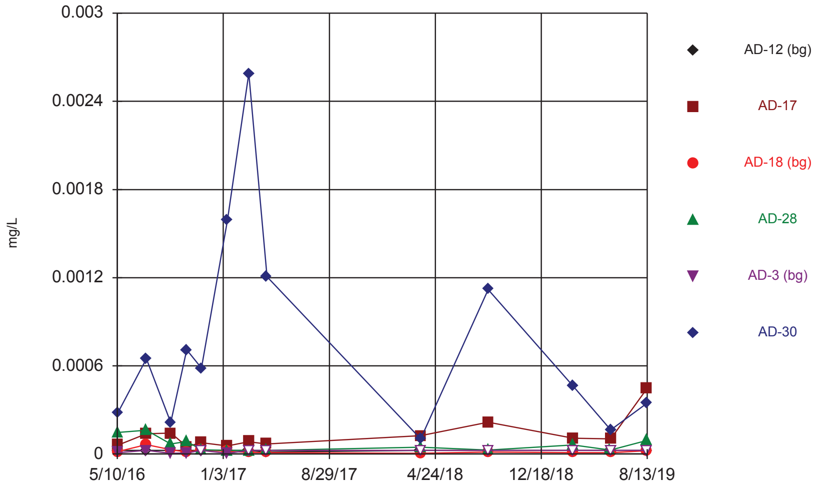
Time Series



Constituent: Mercury, total Analysis Run 12/6/2019 8:34 AM

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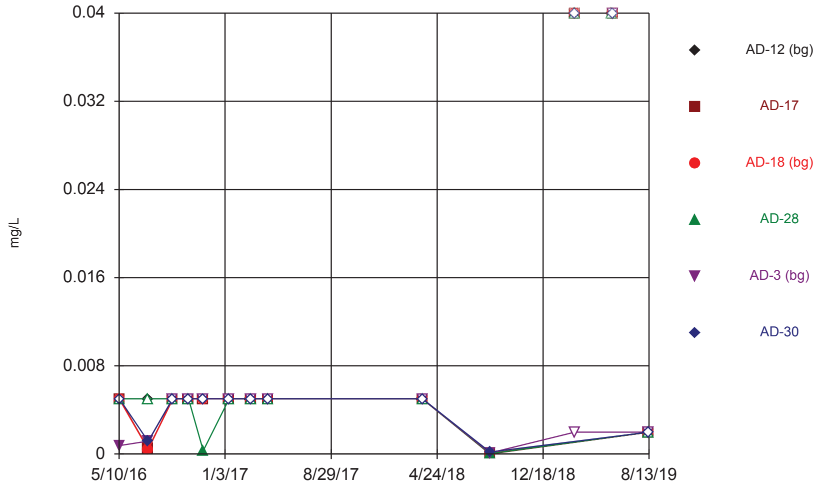
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series

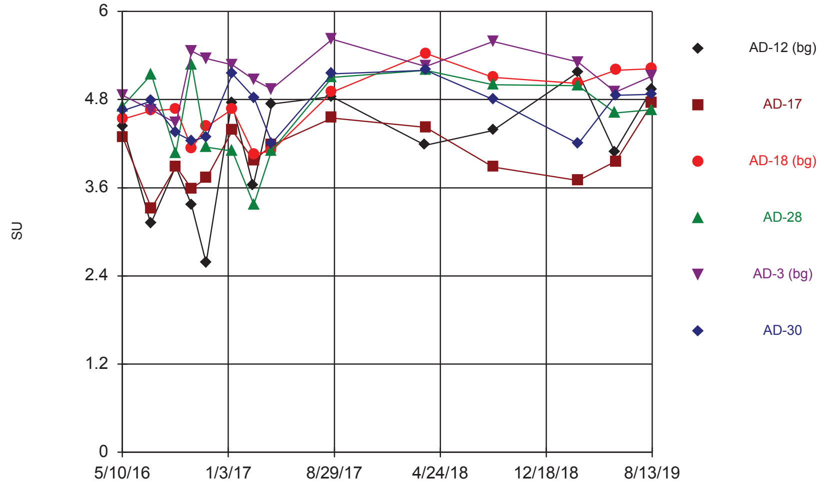


Constituent: Molybdenum, total Analysis Run 12/6/2019 8:34 AM

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Time Series



Constituent: pH, field   Analysis Run 12/6/2019 8:34 AM

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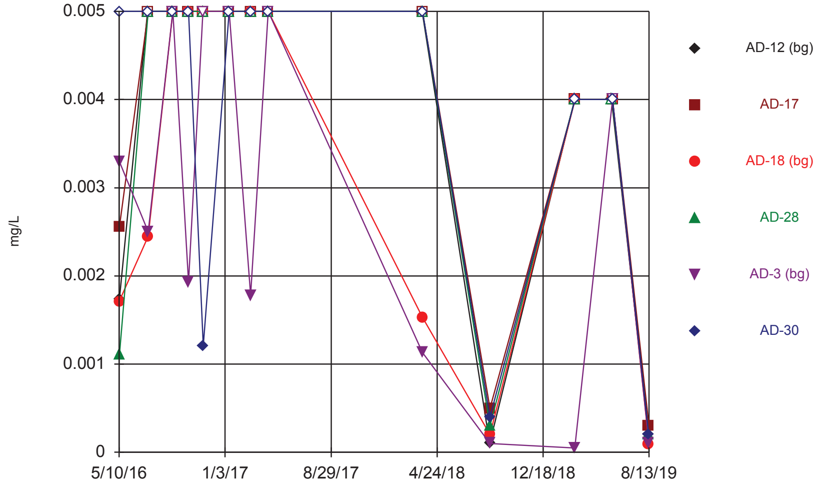
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series

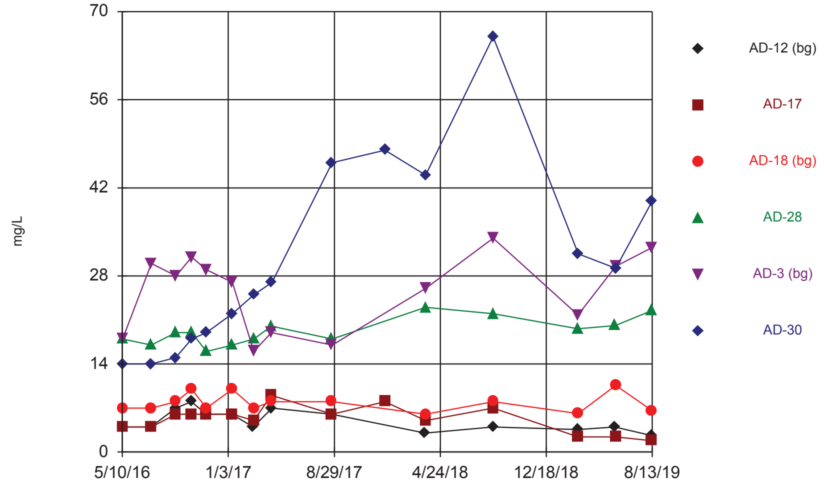


Constituent: Selenium, total   Analysis Run 12/6/2019 8:34 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Time Series



Constituent: Sulfate, total   Analysis Run 12/6/2019 8:35 AM

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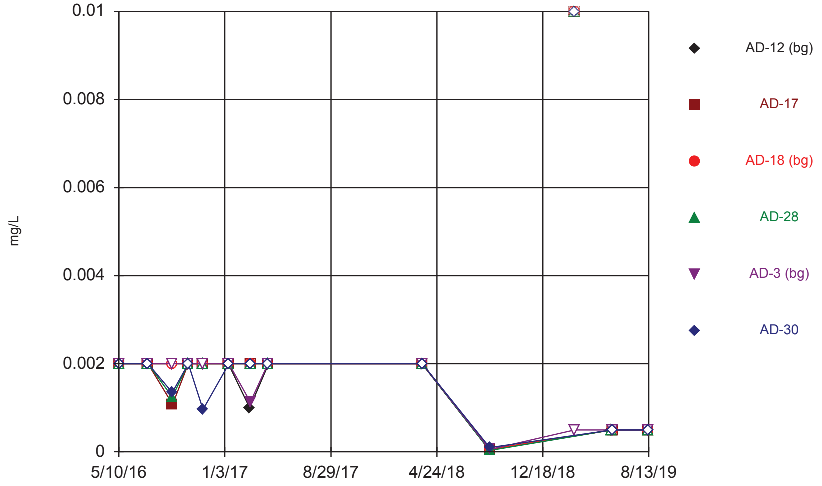
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Thallium, total   Analysis Run 12/6/2019 8:35 AM

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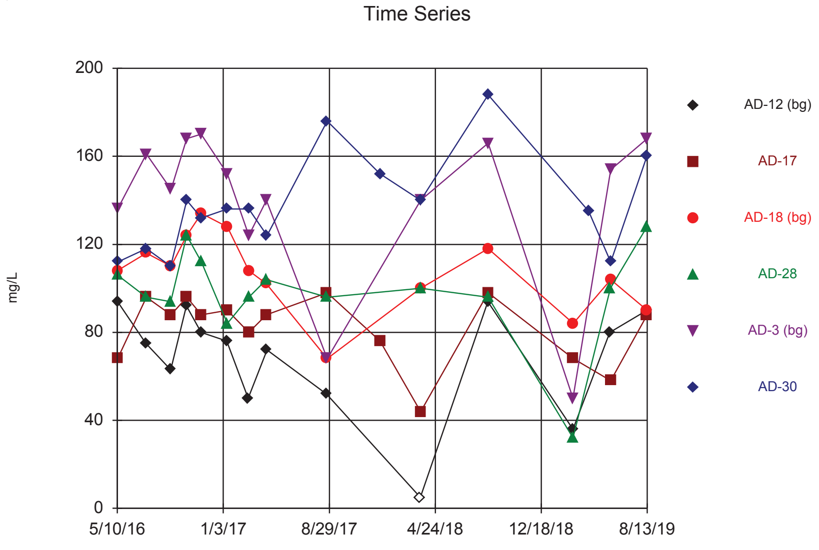
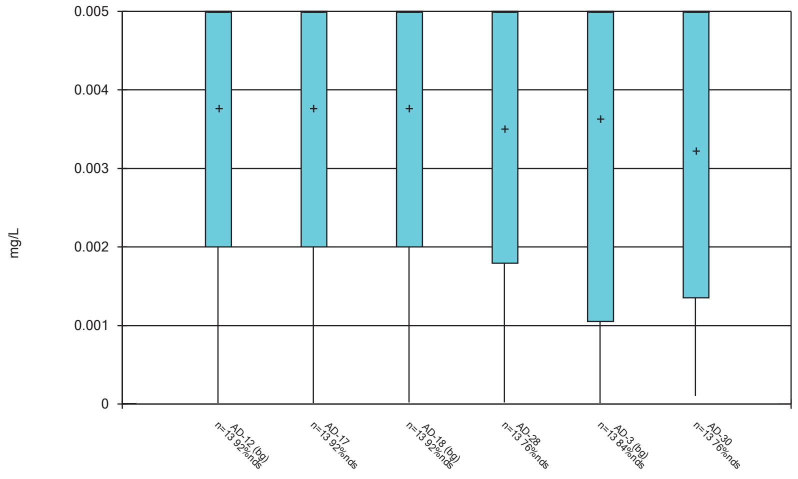
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/6/2019 8:35 AM

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

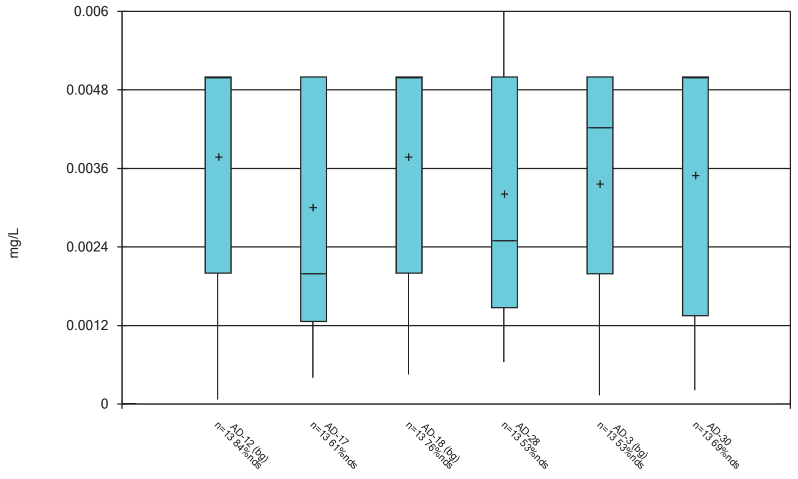


Box & Whiskers Plot

Constituent: Antimony, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

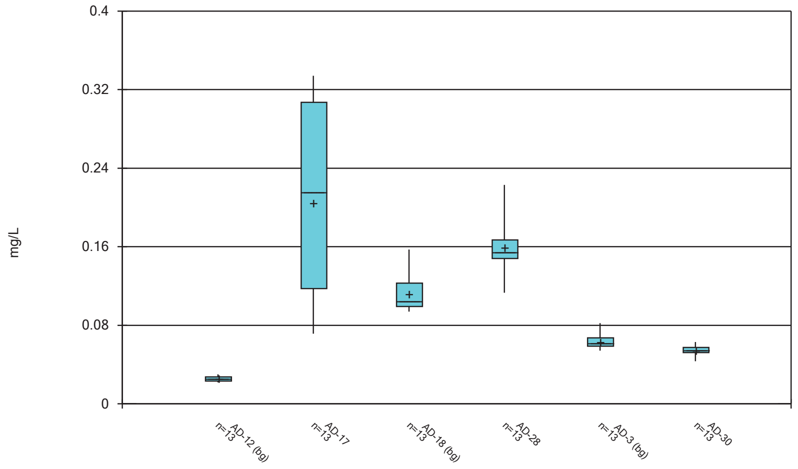


Box & Whiskers Plot

Constituent: Arsenic, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

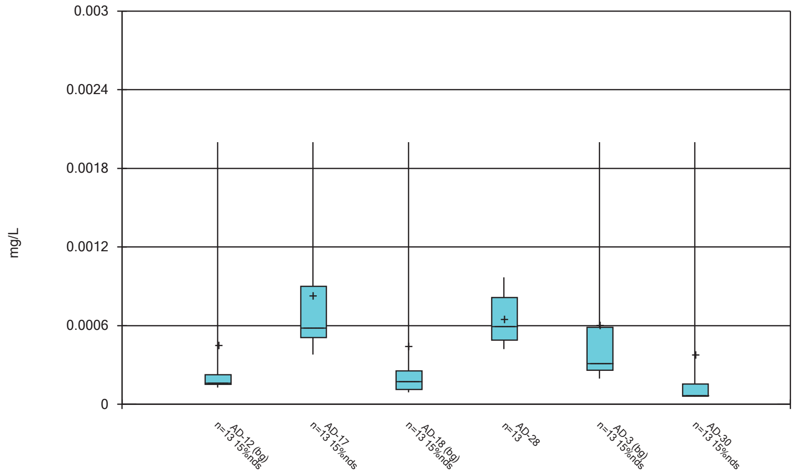


Box & Whiskers Plot

Constituent: Barium, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



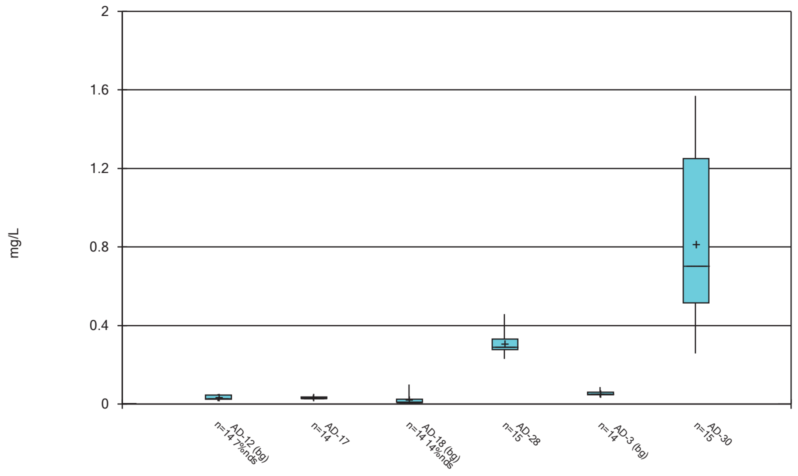
Box & Whiskers Plot

Constituent: Beryllium, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

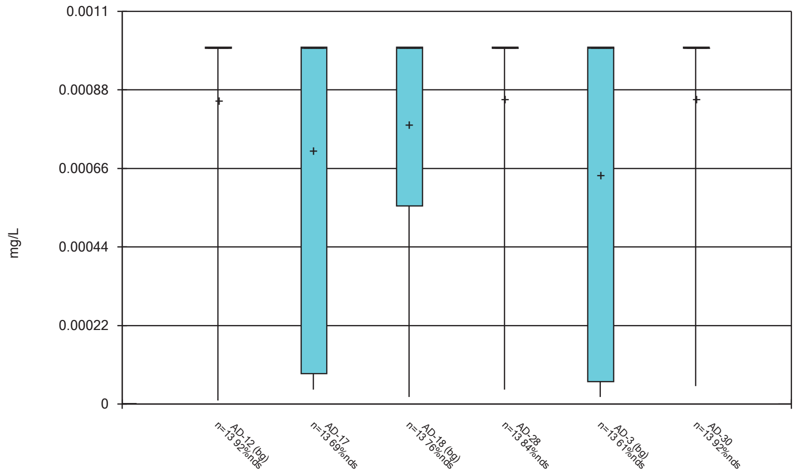
Box & Whiskers Plot



Constituent: Boron, total   Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

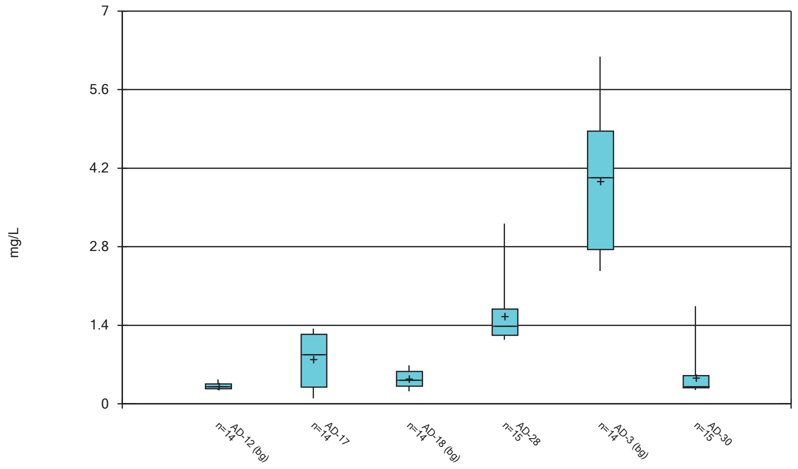
Box & Whiskers Plot



Constituent: Cadmium, total   Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

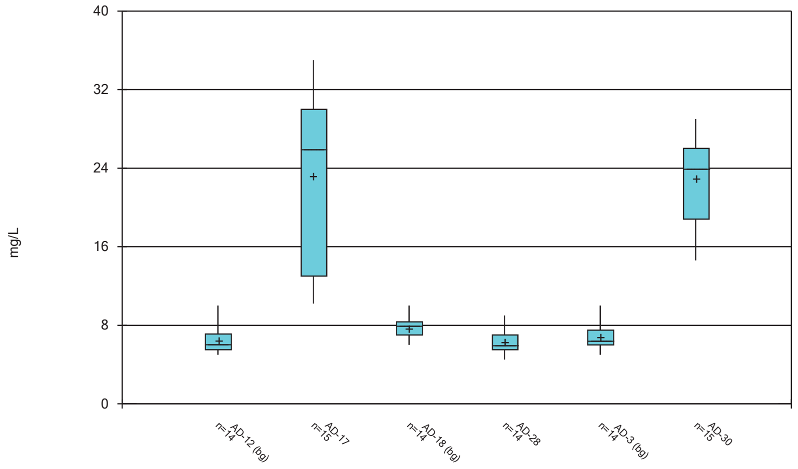
Box & Whiskers Plot



Constituent: Calcium, total   Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

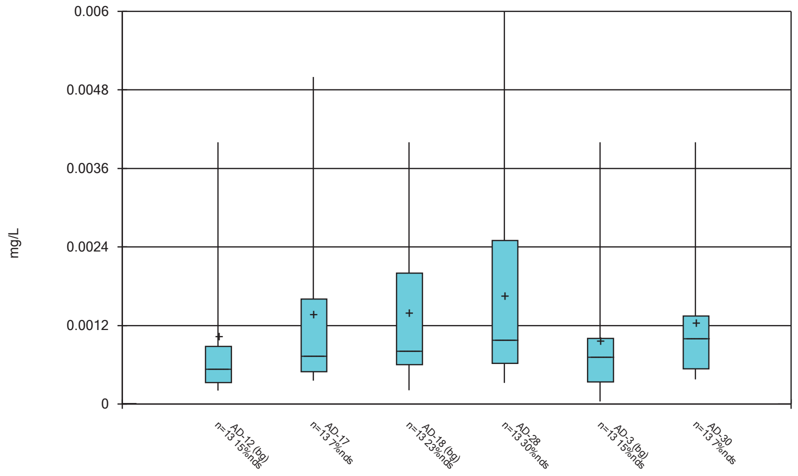
Box & Whiskers Plot



Constituent: Chloride, total   Analysis Run 12/6/2019 8:36 AM
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

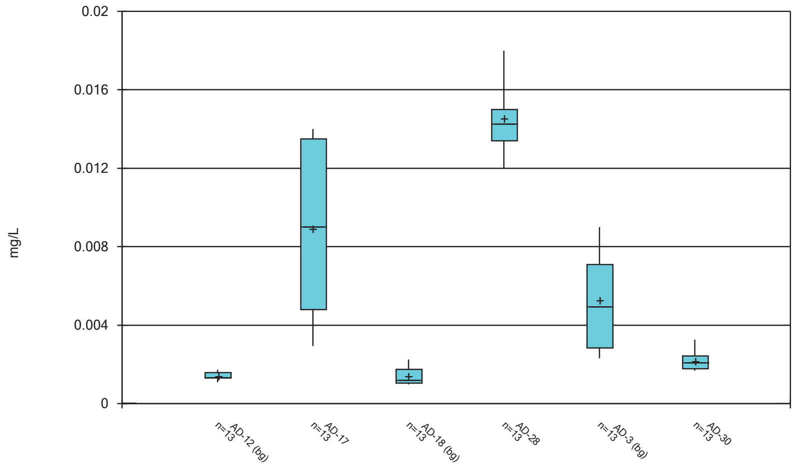


Constituent: Chromium, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

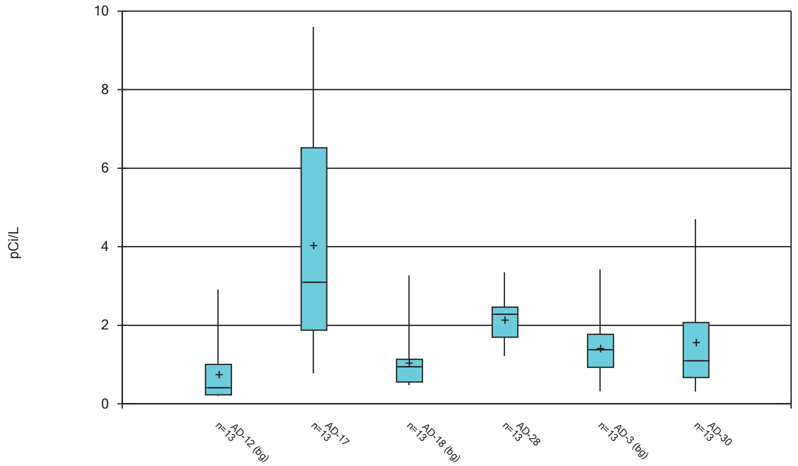


Constituent: Cobalt, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

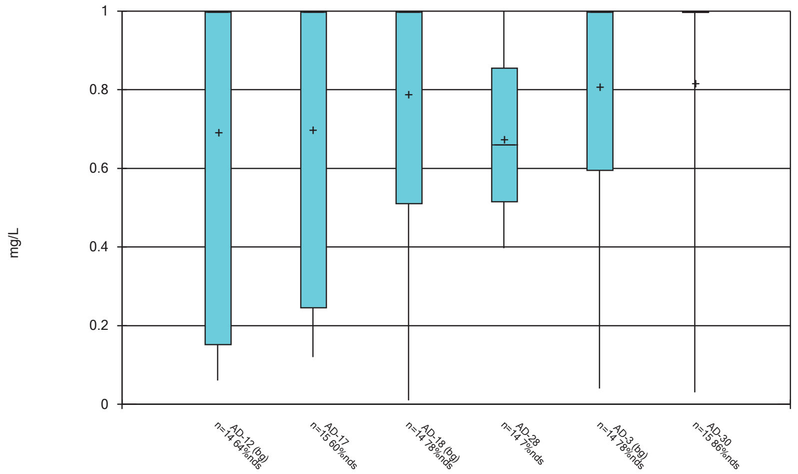


Constituent: Combined Radium 226 + 228   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

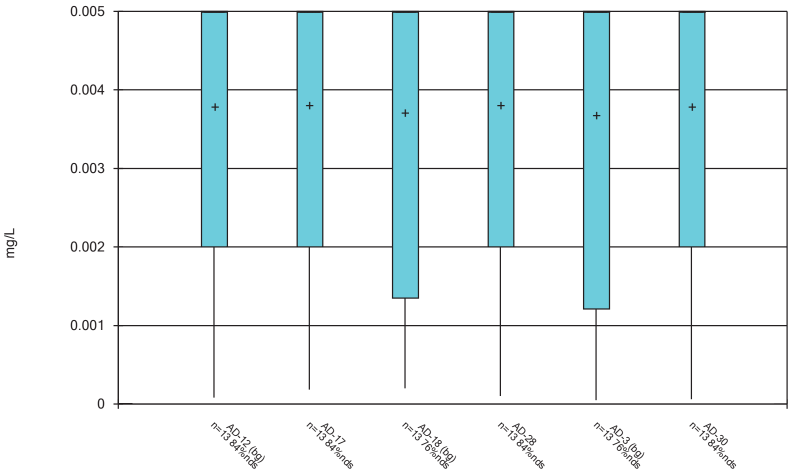


Constituent: Fluoride, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

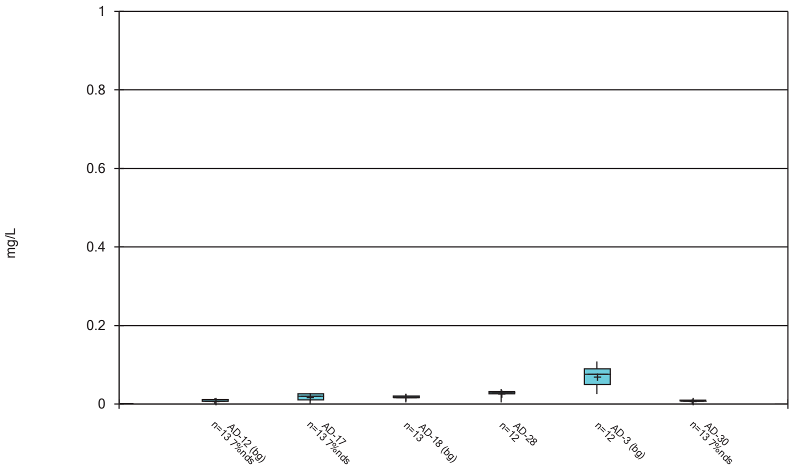


Constituent: Lead, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

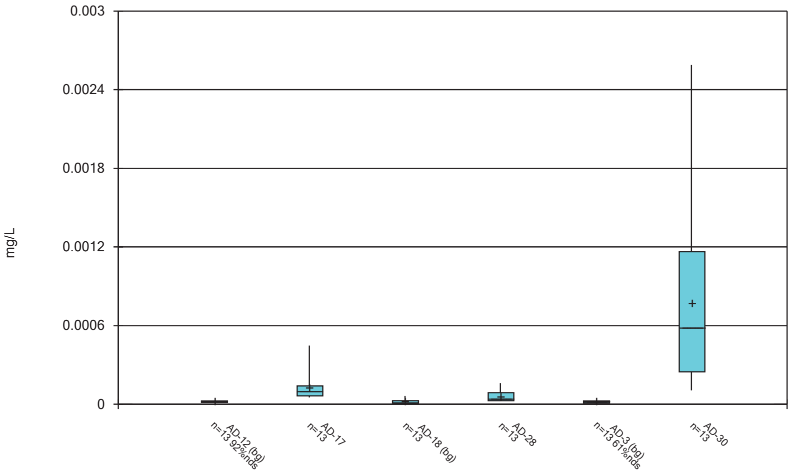


Constituent: Lithium, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

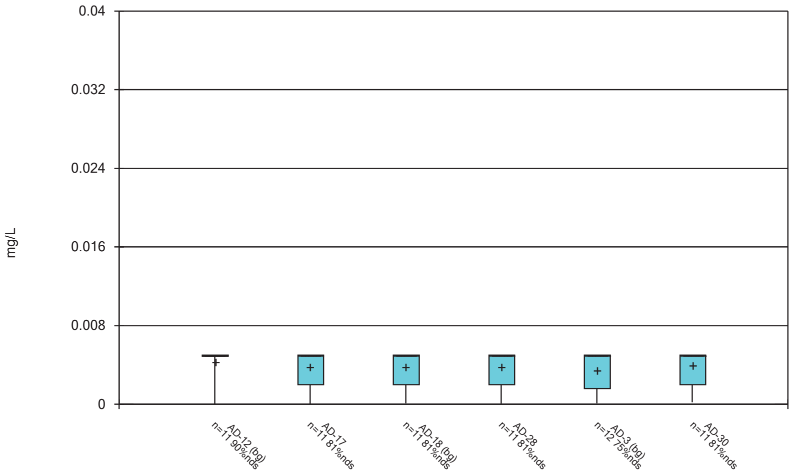


Constituent: Mercury, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

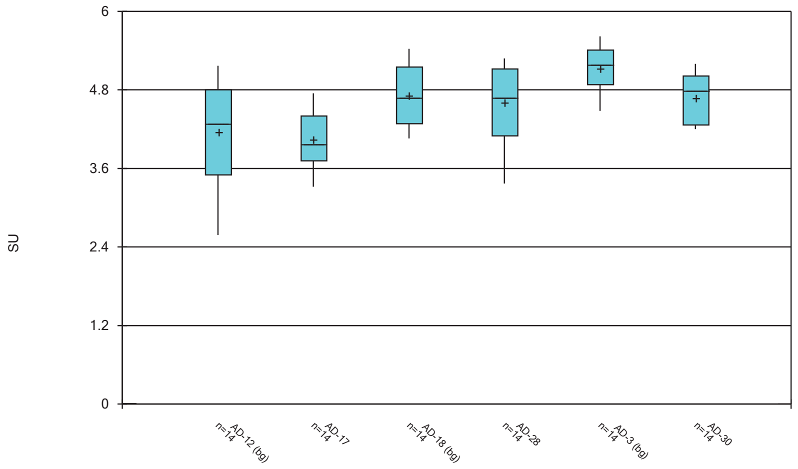


Constituent: Molybdenum, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

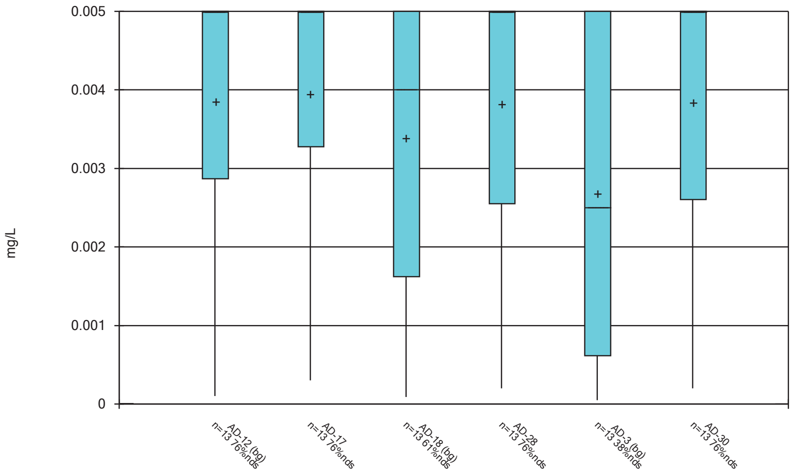


Constituent: pH, field   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

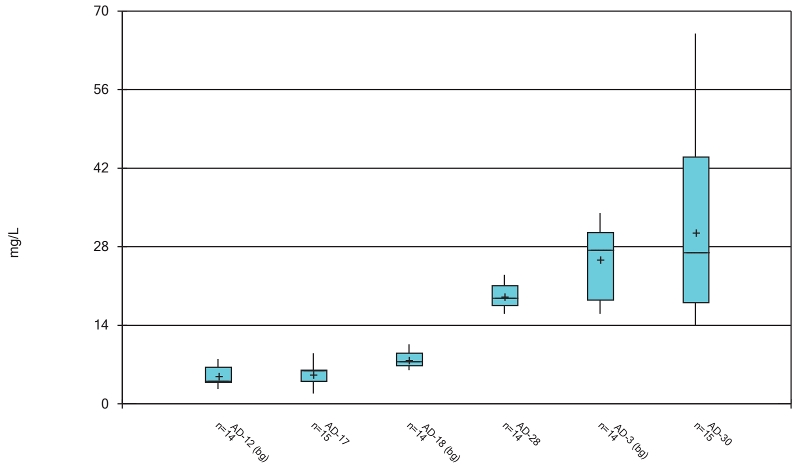


Constituent: Selenium, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

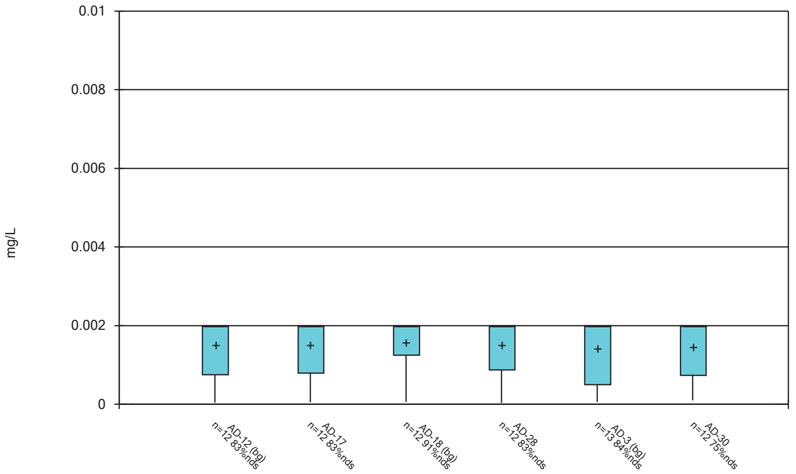


Constituent: Sulfate, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

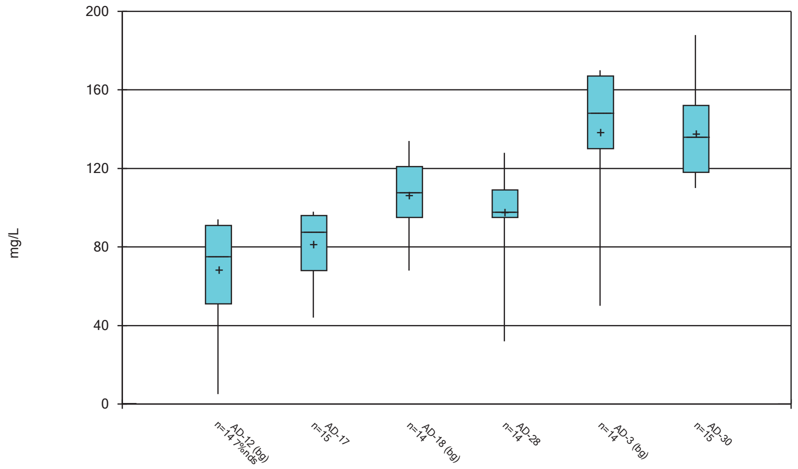
Box & Whiskers Plot



Constituent: Thallium, total   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Box & Whiskers Plot



Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/6/2019 8:36 AM

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Outlier Summary

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 12/6/2019, 8:40 AM

	AD-28 Lithium, total (mg/L)	AD-3 Lithium, total (mg/L)	AD-12 Molybdenum, total (mg/L)	AD-17 Molybdenum, total (mg/L)	AD-18 Molybdenum, total (mg/L)	AD-28 Molybdenum, total (mg/L)	AD-3 Molybdenum, total (mg/L)	AD-30 Molybdenum, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-17 Thallium, total (mg/L)
10/13/2016	0.066 (o)	0.991 (o)								
2/27/2019			<0.04 (o)			<0.04 (o)			<0.01 (o)	
2/28/2019				<0.04 (o)	<0.04 (o)			<0.04 (o)		<0.01 (o)
5/21/2019			<0.04 (o)							
5/22/2019						<0.04 (o)				
5/23/2019				<0.04 (o)	<0.04 (o)		<0.04 (o)	<0.04 (o)		

	AD-18 Thallium, total (mg/L)	AD-28 Thallium, total (mg/L)	AD-30 Thallium, total (mg/L)
10/13/2016			
2/27/2019		<0.01 (o)	
2/28/2019	<0.01 (o)		<0.01 (o)
5/21/2019			
5/22/2019			
5/23/2019			

Welch's t-test/Mann-Whitney - Significant Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/9/2019, 7:40 AM

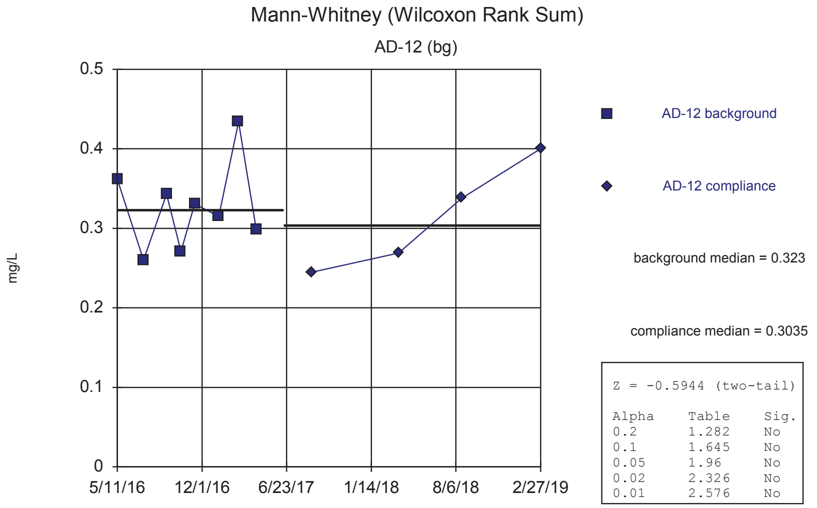
Constituent	Well	Calc.	0.01	Method
pH, field (SU)	**AD-18 (bg)**	**2.637**	**Yes**	**Mann-W**
Sulfate, total (mg/L)	**AD-30**	**2.858**	**Yes**	**Mann-W**

Welch's t-test/Mann-Whitney - All Results

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 12/9/2019, 7:40 AM

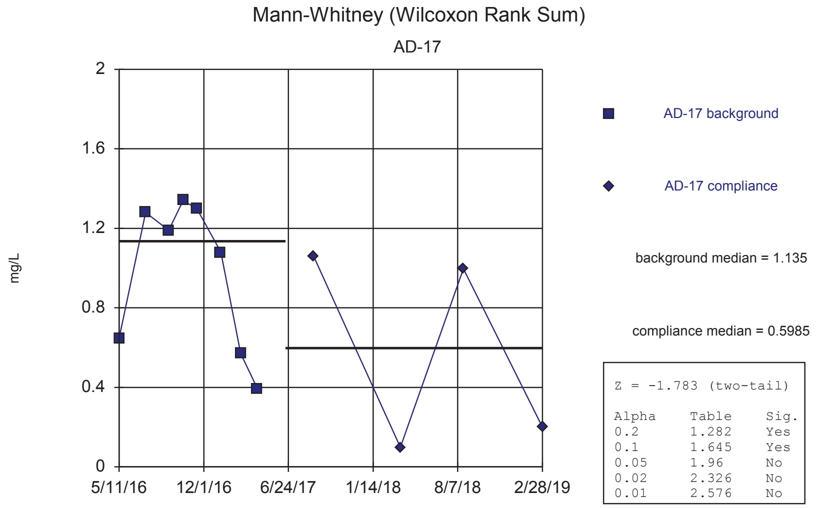
Constituent	Well	Calc.	0.01	Method
Calcium, total (mg/L)	AD-12 (bg)	-0.5944	No	Mann-W
Calcium, total (mg/L)	AD-17	-1.783	No	Mann-W
Calcium, total (mg/L)	AD-18 (bg)	-0.5944	No	Mann-W
Calcium, total (mg/L)	AD-28	-0.8807	No	Mann-W
Calcium, total (mg/L)	AD-3 (bg)	-0.5944	No	Mann-W
Calcium, total (mg/L)	AD-30	0.8051	No	Mann-W
pH, field (SU)	AD-12 (bg)	1.613	No	Mann-W
pH, field (SU)	AD-17	0.7643	No	Mann-W
pH, field (SU)	**AD-18 (bg)**	**2.637**	**Yes**	**Mann-W**
pH, field (SU)	AD-28	1.446	No	Mann-W
pH, field (SU)	AD-3 (bg)	1.783	No	Mann-W
pH, field (SU)	AD-30	0.8507	No	Mann-W
Sulfate, total (mg/L)	AD-12 (bg)	-1.919	No	Mann-W
Sulfate, total (mg/L)	AD-17	0.151	No	Mann-W
Sulfate, total (mg/L)	AD-18 (bg)	-1.147	No	Mann-W
Sulfate, total (mg/L)	AD-28	1.802	No	Mann-W
Sulfate, total (mg/L)	AD-3 (bg)	-0.2548	No	Mann-W
Sulfate, total (mg/L)	**AD-30**	**2.858**	**Yes**	**Mann-W**
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-1.361	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-17	-0.4434	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-18 (bg)	-1.957	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-28	-1.124	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-3 (bg)	-1.361	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-30	2.557	No	Mann-W

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG



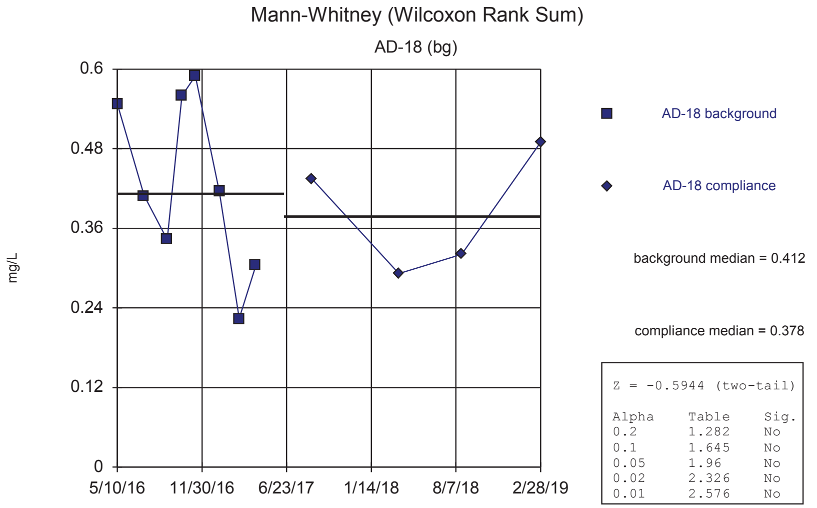
Constituent: Calcium, total   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG



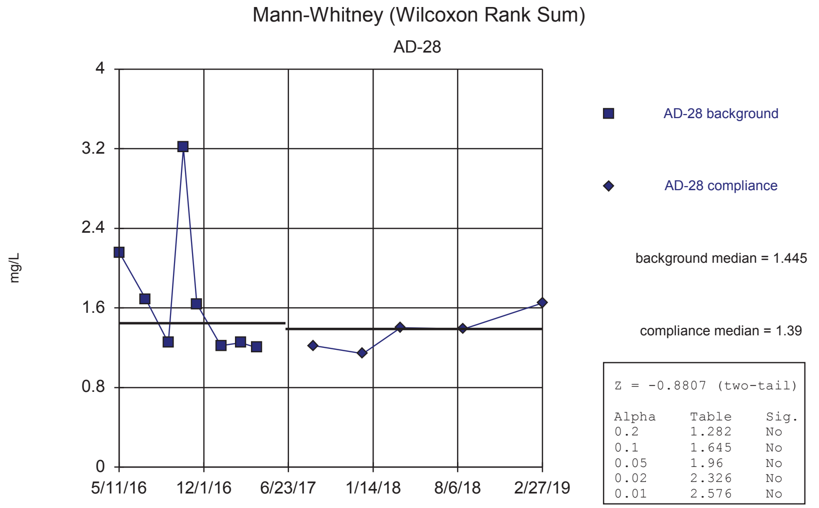
Constituent: Calcium, total   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG



Constituent: Calcium, total   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

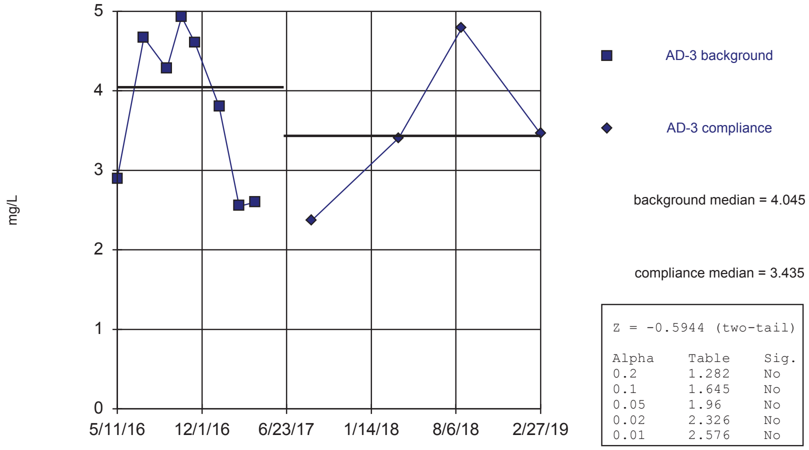


Constituent: Calcium, total   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-3 (bg)



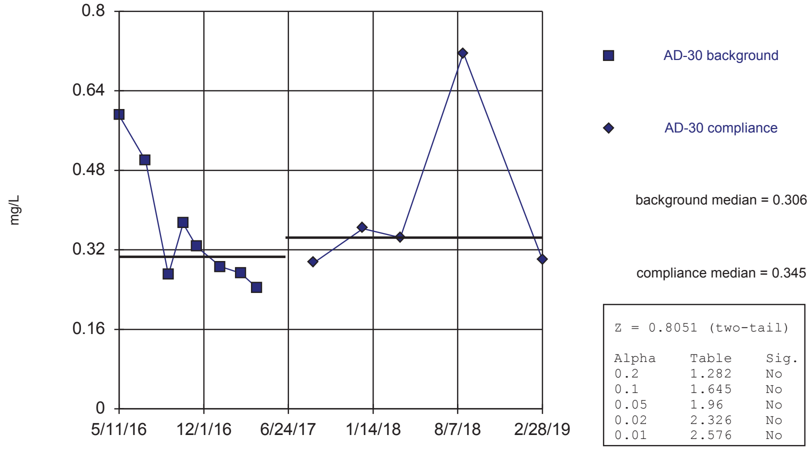
```
Z = -0.5944 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Calcium, total   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-30



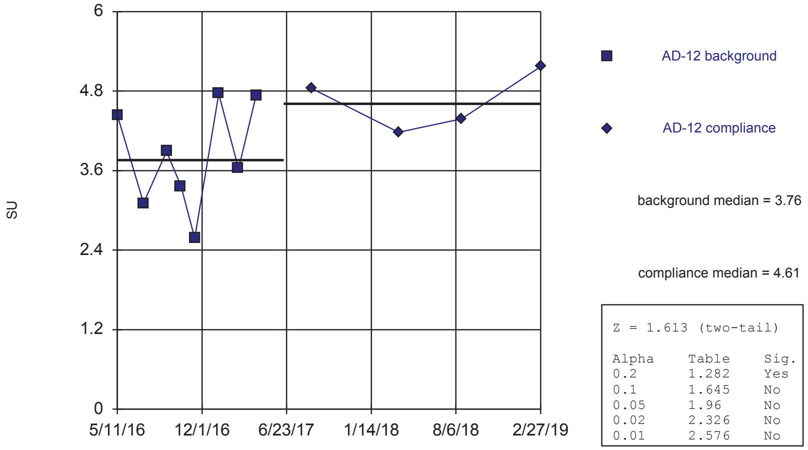
```
Z = 0.8051 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Calcium, total   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



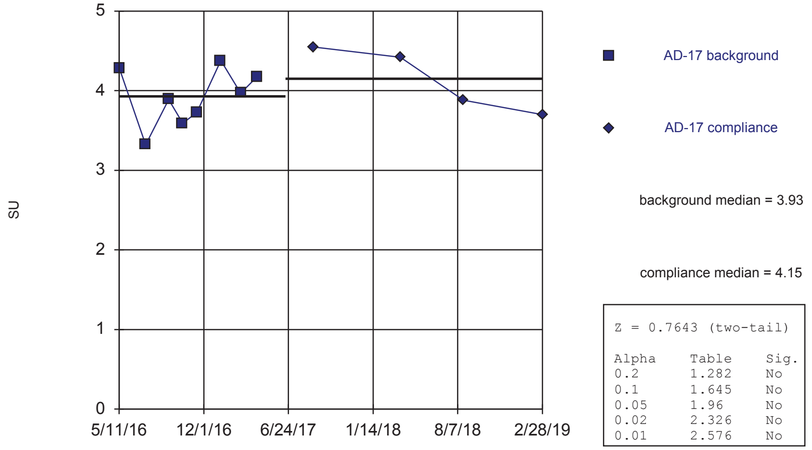
```
Z = 1.613 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: pH, field   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-17

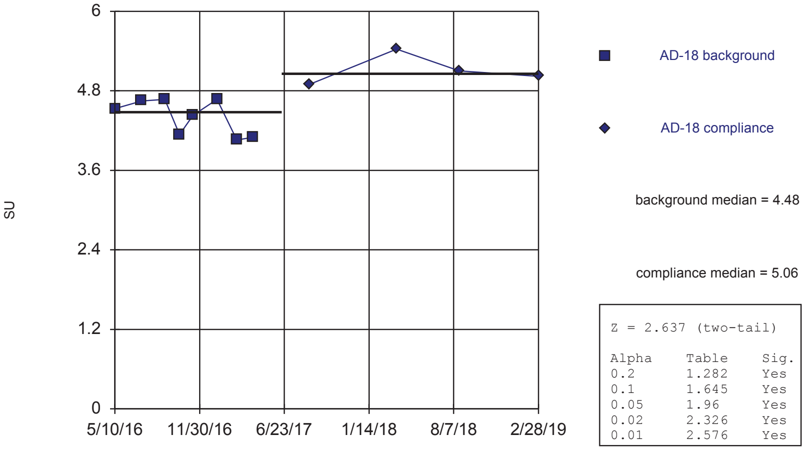


```
Z = 0.7643 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: pH, field   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

AD-18 (bg)



background median = 4.48

compliance median = 5.06

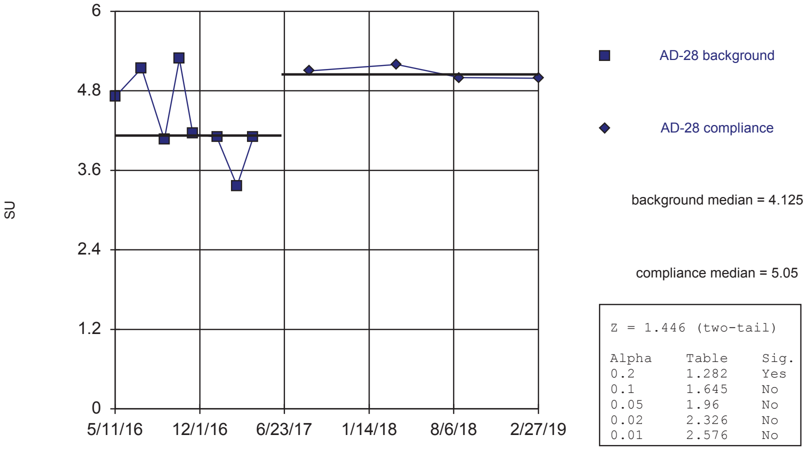
```
Z = 2.637 (two-tail)

Alpha    Table    Sig.
0.2      1.282    Yes
0.1      1.645    Yes
0.05     1.96     Yes
0.02     2.326    Yes
0.01     2.576    Yes
```

Constituent: pH, field   Analysis Run 12/9/2019 7:39 AM   View: Intrawell

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

AD-28



background median = 4.125

compliance median = 5.05

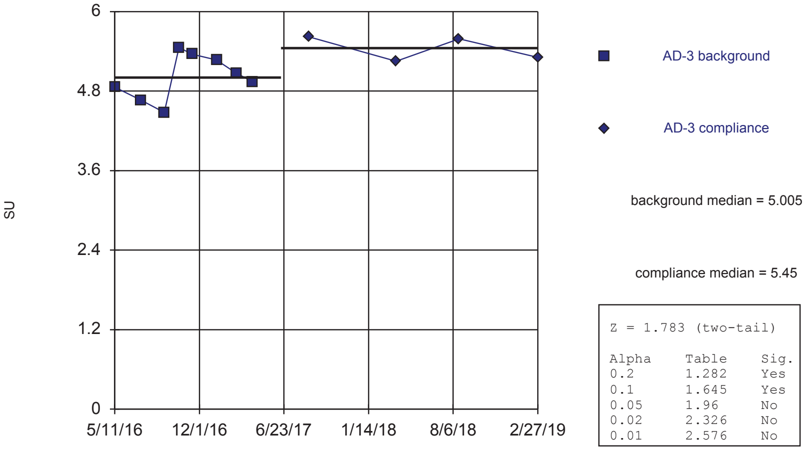
```
Z = 1.446 (two-tail)

Alpha    Table    Sig.
0.2      1.282    Yes
0.1      1.645    No
0.05     1.96     No
0.02     2.326    No
0.01     2.576    No
```

Constituent: pH, field   Analysis Run 12/9/2019 7:39 AM   View: Intrawell

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

AD-3 (bg)



background median = 5.005

compliance median = 5.45

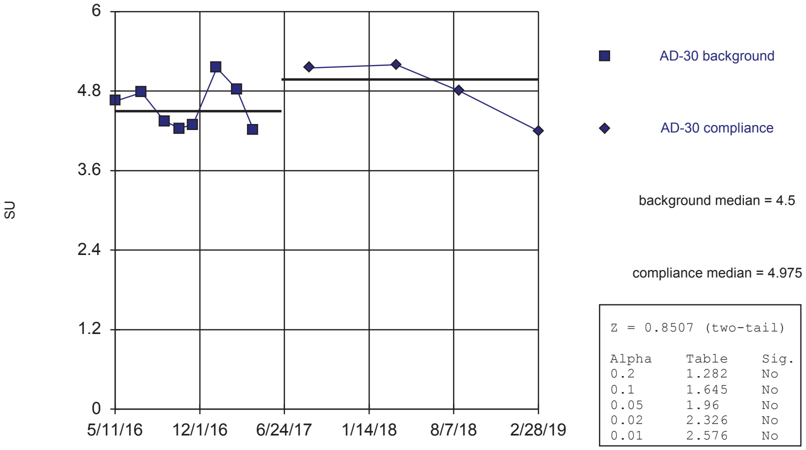
```
Z = 1.783 (two-tail)

Alpha    Table    Sig.
0.2      1.282    Yes
0.1      1.645    Yes
0.05     1.96     No
0.02     2.326    No
0.01     2.576    No
```

Constituent: pH, field   Analysis Run 12/9/2019 7:39 AM   View: Intrawell

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

AD-30



background median = 4.5

compliance median = 4.975

```
Z = 0.8507 (two-tail)

Alpha    Table    Sig.
0.2      1.282    No
0.1      1.645    No
0.05     1.96     No
0.02     2.326    No
0.01     2.576    No
```

Constituent: pH, field   Analysis Run 12/9/2019 7:39 AM   View: Intrawell

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

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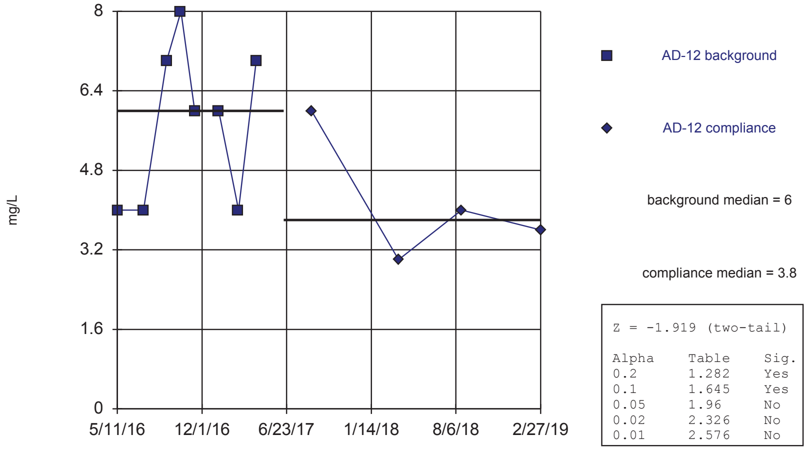
Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



background median = 6

compliance median = 3.8

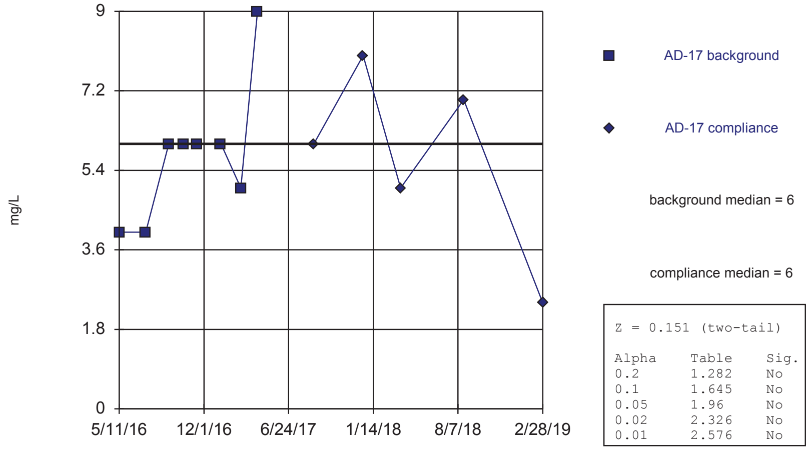
```
Z = -1.919 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Sulfate, total   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-17



background median = 6

compliance median = 6

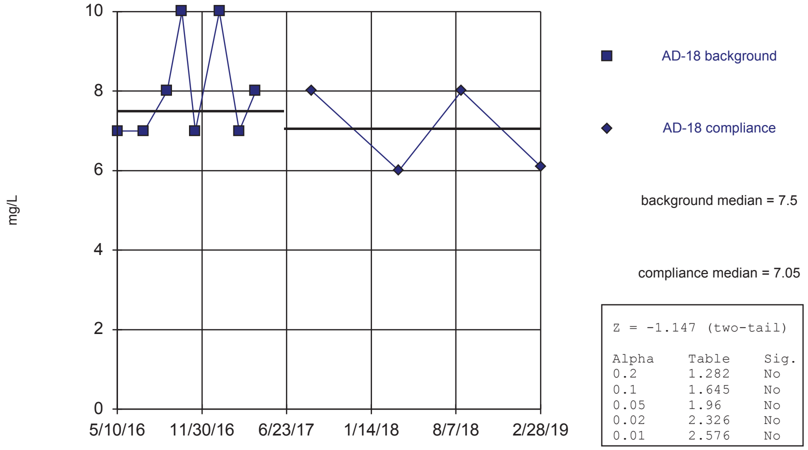
```
Z = 0.151 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Sulfate, total   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-18 (bg)



background median = 7.5

compliance median = 7.05

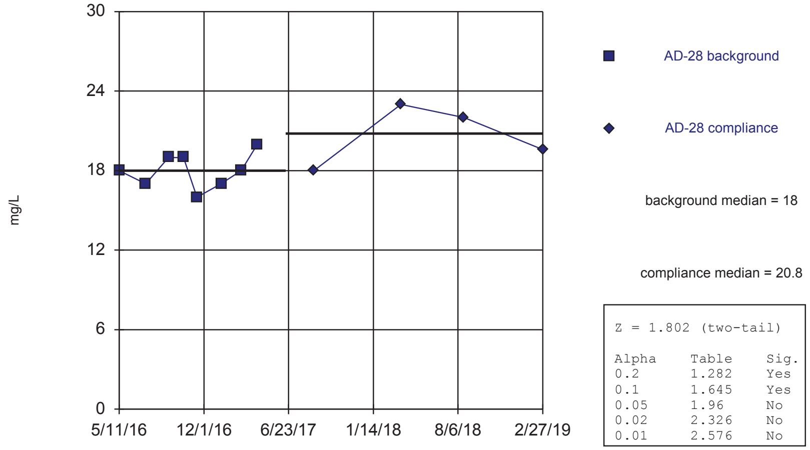
```
Z = -1.147 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Sulfate, total   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-28



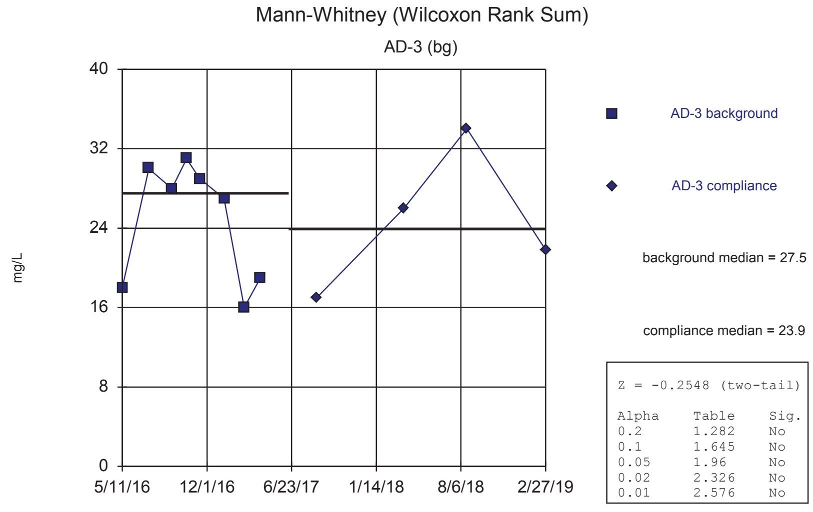
background median = 18

compliance median = 20.8

```
Z = 1.802 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Sulfate, total   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

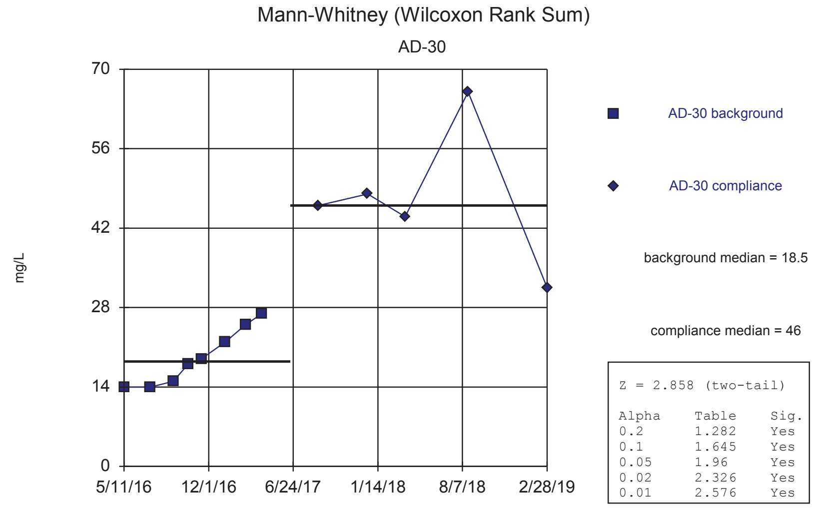


Z = -0.2548 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

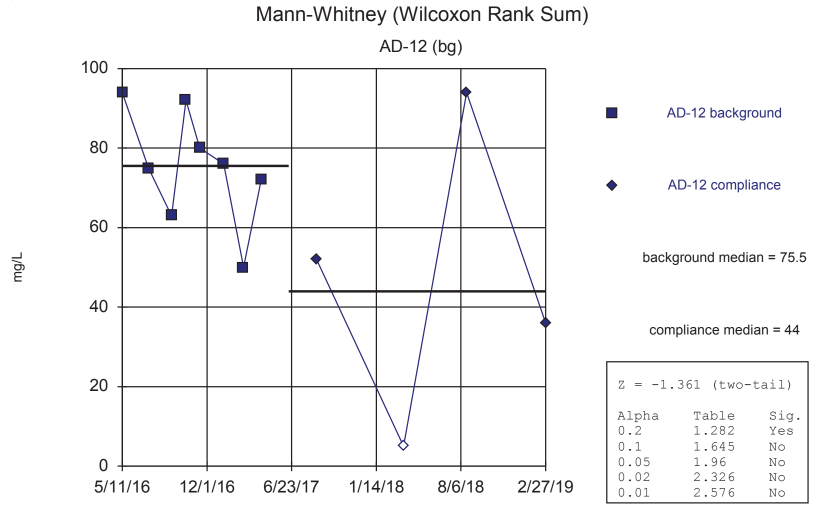


Z = 2.858 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	Yes
0.01	2.576	Yes

Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

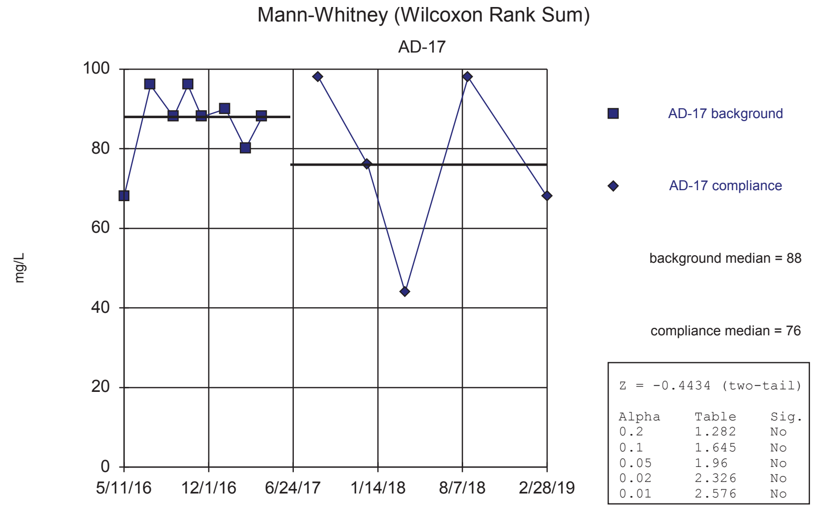


Z = -1.361 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG



Z = -0.4434 (two-tail)

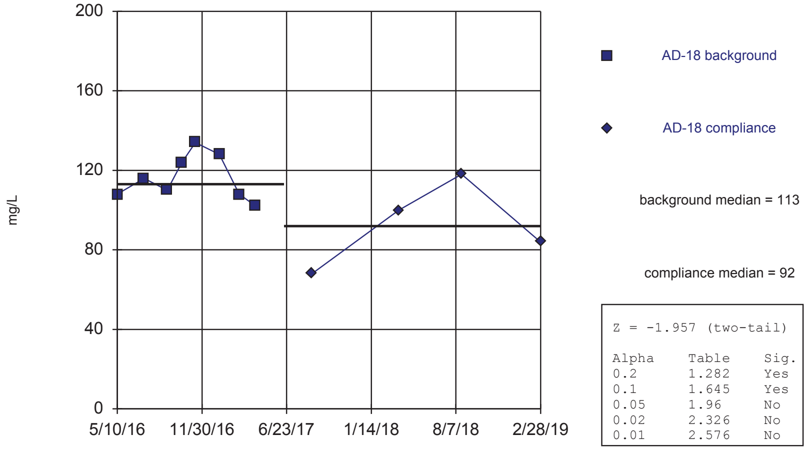
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-18 (bg)



Z = -1.957 (two-tail)

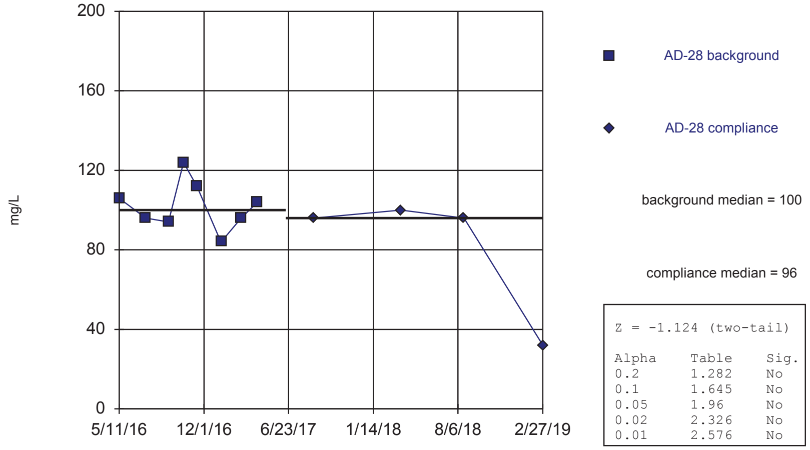
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-28



Z = -1.124 (two-tail)

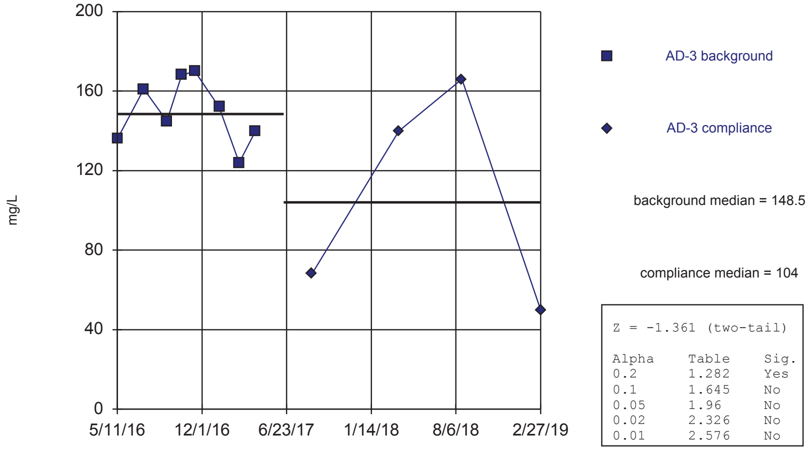
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-3 (bg)



Z = -1.361 (two-tail)

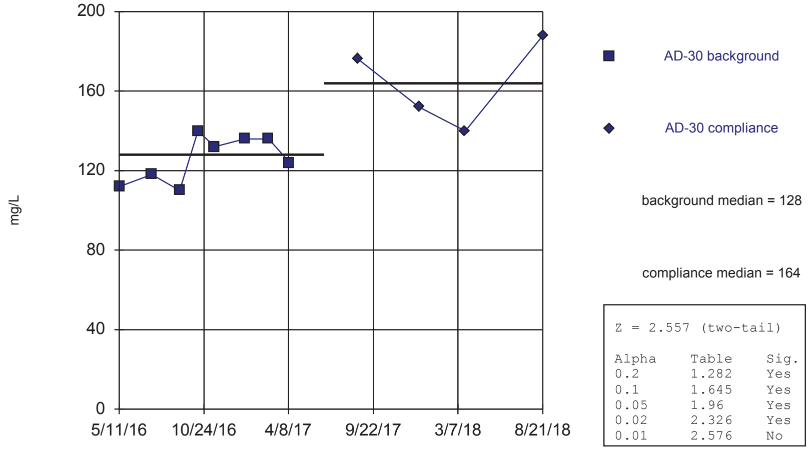
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-30



Z = 2.557 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	Yes
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/9/2019 7:39 AM   View: Intrawell
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Date Ranges

Date: 12/9/2019 7:43 AM

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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pH, field (SU)
    AD-18 background:11/15/2016-2/28/2019

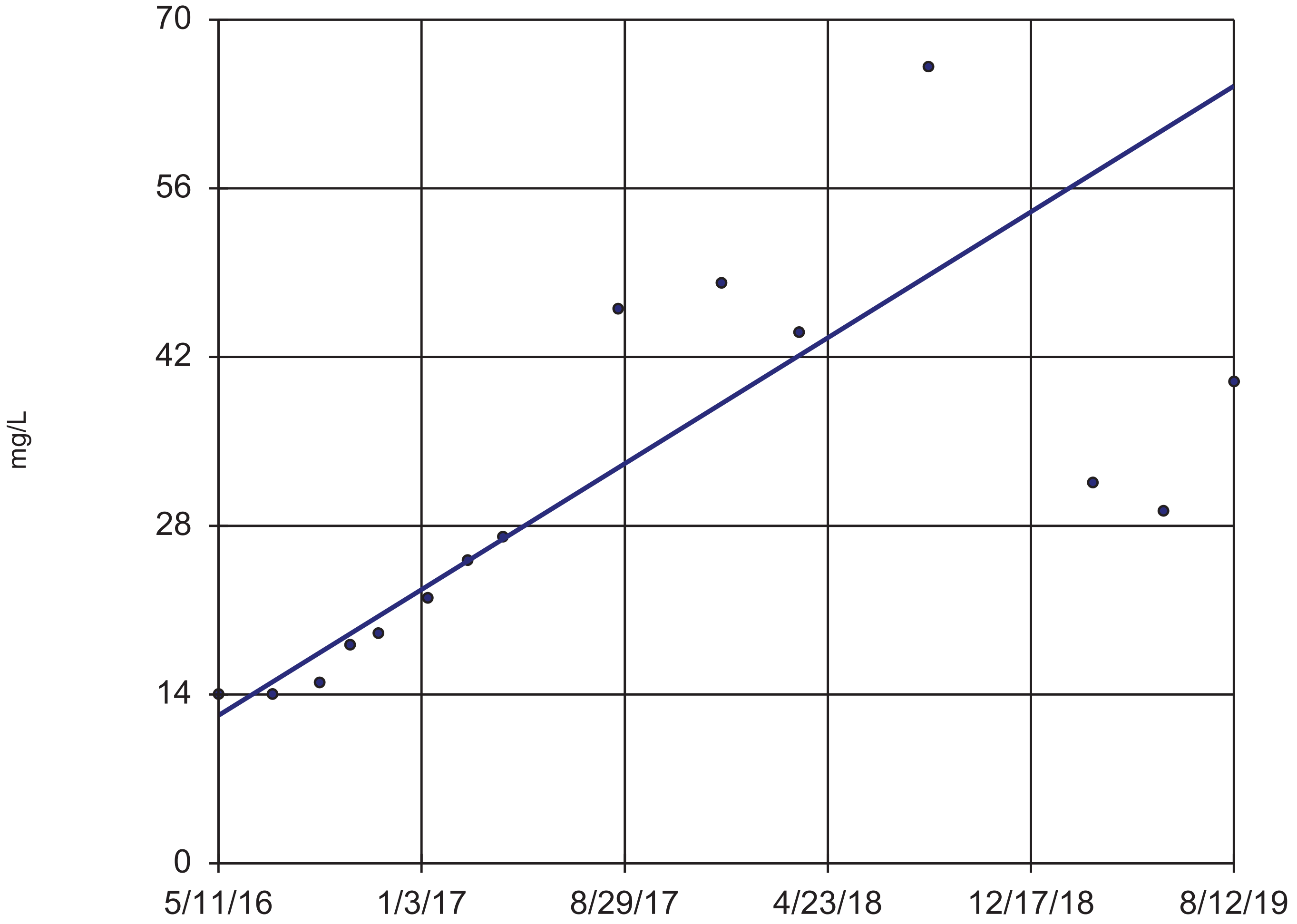
Trend Tests Summary Table - All Resuts

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 11/25/2019, 6:30 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Sulfate, total (mg/L)	**AD-30**	**16.04**	**74**	**53**	**Yes**	**15**	**0**	**n/a**	**n/a**	**0.01**	**NP**

Sen's Slope Estimator

AD-30



n = 15

Slope = 16.04
units per year.

Mann-Kendall
statistic = 74
critical = 53

Increasing trend
significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Sulfate, total Analysis Run 11/25/2019 6:29 PM View: Intrawell Trend Tests

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Intrawell Prediction Limit Summary Table - All Results

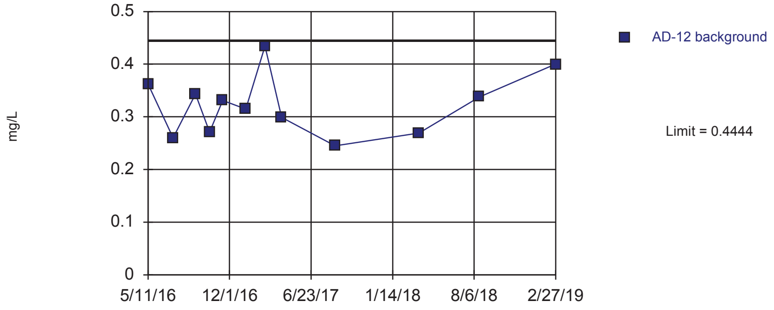
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 12/9/2019, 7:45 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-12	0.4444	n/a	n/a	1 future	n/a	12	0.3223	0.05781	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-17	1.786	n/a	n/a	1 future	n/a	12	0.8465	0.4447	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-18	0.6601	n/a	n/a	1 future	n/a	12	0.4109	0.118	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-28	2.758	n/a	n/a	1 future	n/a	13	0.4061	0.2931	0	None	ln(x)	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-3	5.702	n/a	n/a	1 future	n/a	12	3.698	0.9488	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-30	0.6804	n/a	n/a	1 future	n/a	13	0.604	0.1064	0	None	sqrt(x)	0.002505	Param Intra 1 of 2
pH, field (SU)	AD-12	5.754	2.427	n/a	1 future	n/a	12	4.091	0.7877	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-17	4.787	3.196	n/a	1 future	n/a	12	3.992	0.3766	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-18	5.917	3.511	n/a	1 future	n/a	8	4.714	0.4895	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-28	5.903	3.298	n/a	1 future	n/a	12	4.601	0.6168	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-3	5.917	4.395	n/a	1 future	n/a	12	5.156	0.3603	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-30	5.474	3.834	n/a	1 future	n/a	12	4.654	0.3882	0	None	No	0.001253	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-12	8.669	n/a	n/a	1 future	n/a	12	5.217	1.635	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-17	9.318	n/a	n/a	1 future	n/a	13	5.723	1.731	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-18	10.4	n/a	n/a	1 future	n/a	12	7.675	1.291	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-28	23.21	n/a	n/a	1 future	n/a	12	18.88	2.049	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-3	37.65	n/a	n/a	1 future	n/a	12	24.73	6.115	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	121.8	n/a	n/a	1 future	n/a	12	65.75	26.52	8.333	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-17	115.4	n/a	n/a	1 future	n/a	13	82.92	15.65	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-18	147.5	n/a	n/a	1 future	n/a	12	108.3	18.52	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-28	129.1	n/a	n/a	1 future	n/a	12	9479	3403	0	None	x^2	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-3	194.3	n/a	n/a	1 future	n/a	12	19577	8603	0	None	x^2	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-30	189	n/a	n/a	1 future	n/a	12	138.7	23.82	0	None	No	0.002505	Param Intra 1 of 2

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-12 (bg)



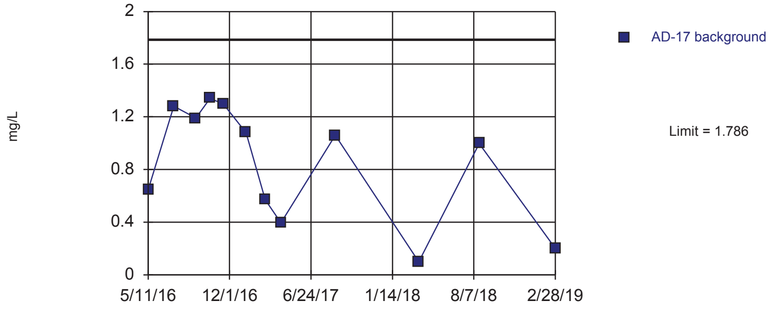
Background Data Summary: Mean=0.3223, Std. Dev.=0.05781, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9547, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17



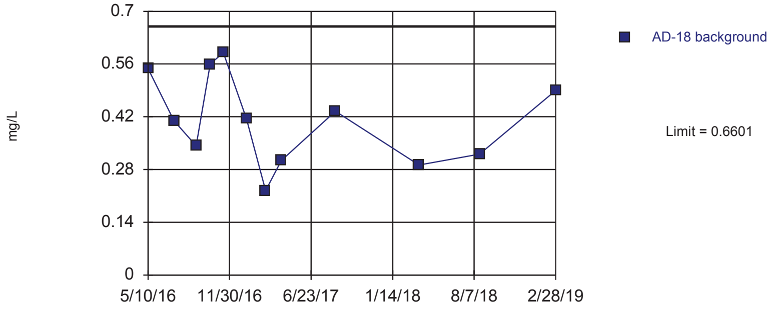
Background Data Summary: Mean=0.8465, Std. Dev.=0.4447, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8925, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-18 (bg)



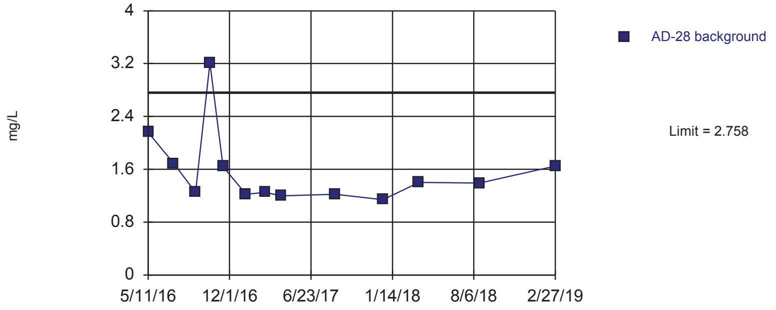
Background Data Summary: Mean=0.4109, Std. Dev.=0.118, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.954, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-28



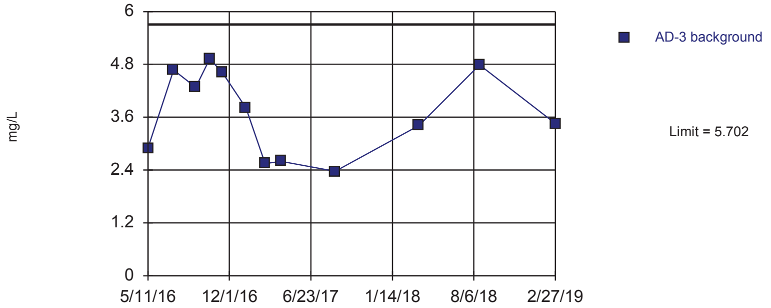
Background Data Summary (based on natural log transformation): Mean=0.4061, Std. Dev.=0.2931, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8147, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3 (bg)



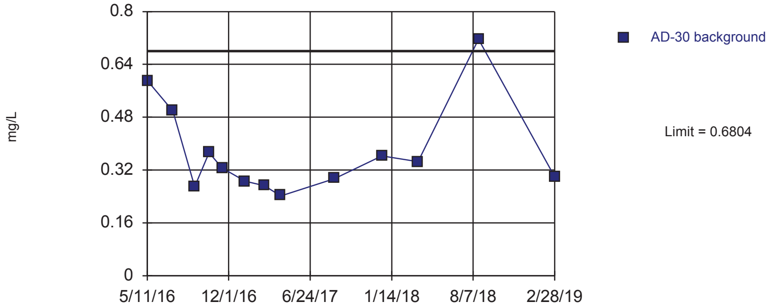
Background Data Summary: Mean=3.698, Std. Dev.=0.9488, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9055, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-30



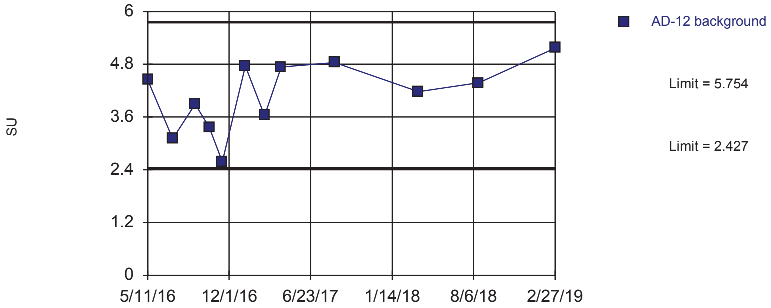
Background Data Summary (based on square root transformation): Mean=0.604, Std. Dev.=0.1064, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8451, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-12 (bg)



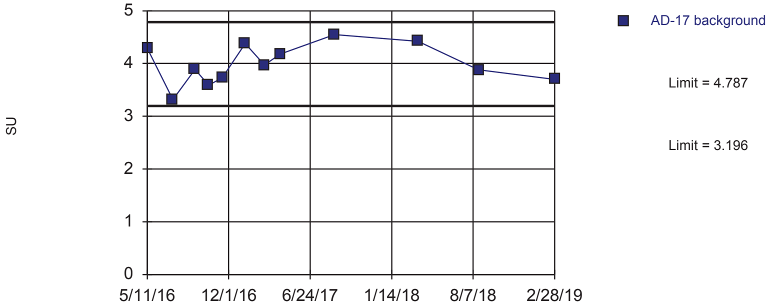
Background Data Summary: Mean=4.091, Std. Dev.=0.7877, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9544, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17



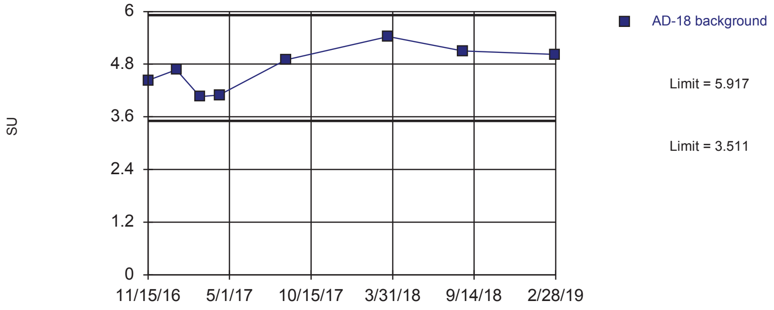
Background Data Summary: Mean=3.992, Std. Dev.=0.3766, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9666, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-18 (bg)



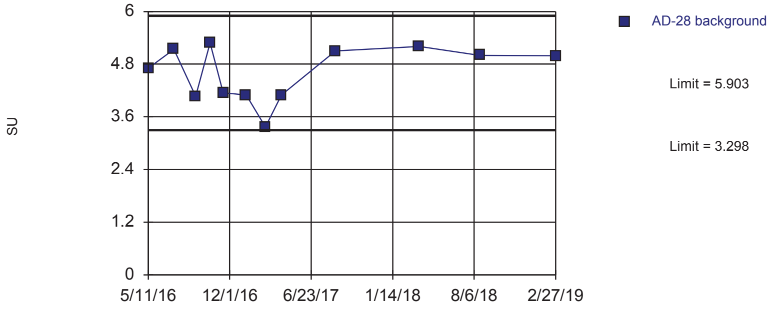
Background Data Summary: Mean=4.714, Std. Dev.=0.4895, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9485, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-28



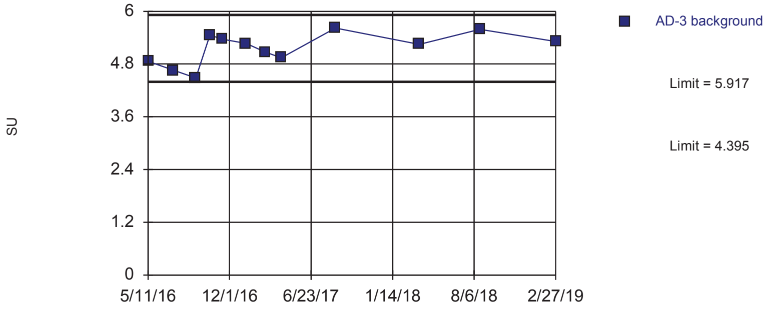
Background Data Summary: Mean=4.601, Std. Dev.=0.6168, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8727, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3 (bg)



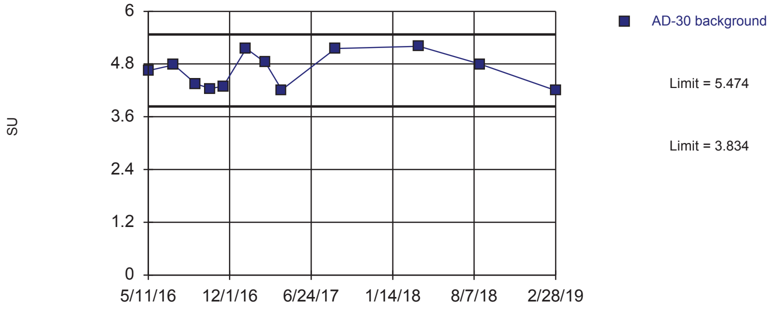
Background Data Summary: Mean=5.156, Std. Dev.=0.3603, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9481, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-30



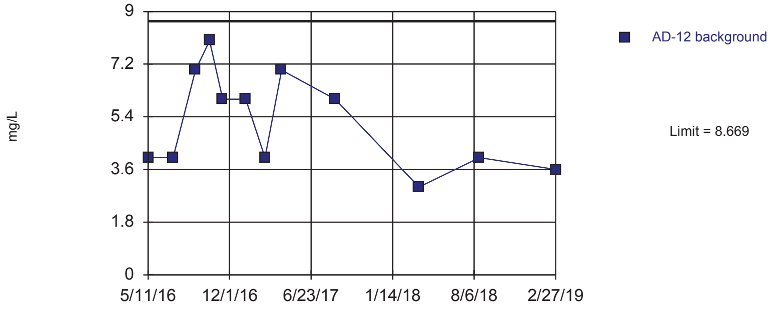
Background Data Summary: Mean=4.654, Std. Dev.=0.3882, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8754, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-12 (bg)



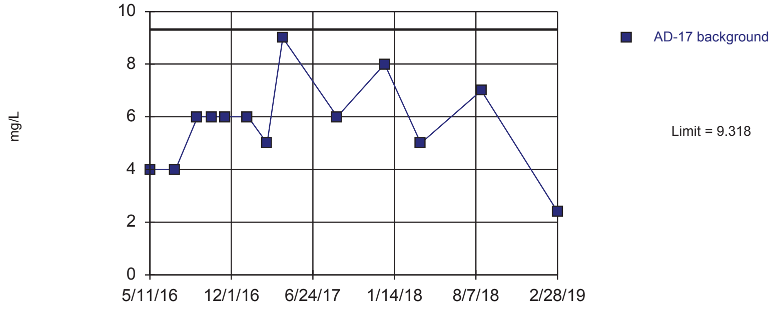
Background Data Summary: Mean=5.217, Std. Dev.=1.635, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8967, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17



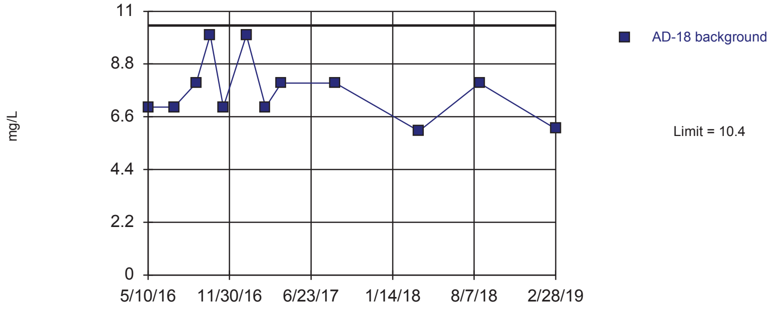
Background Data Summary: Mean=5.723, Std. Dev.=1.731, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9585, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-18 (bg)



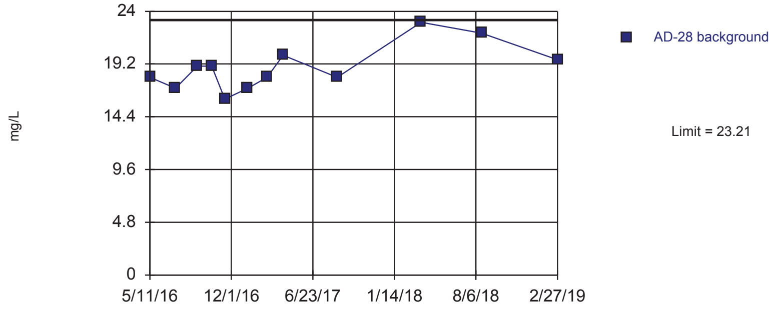
Background Data Summary: Mean=7.675, Std. Dev.=1.291, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8734, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-28



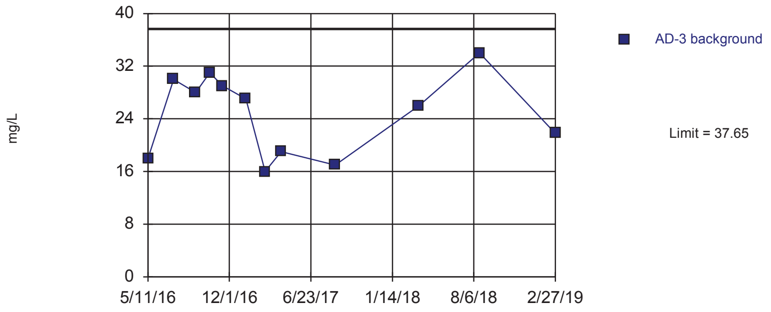
Background Data Summary: Mean=18.88, Std. Dev.=2.049, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9359, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3 (bg)



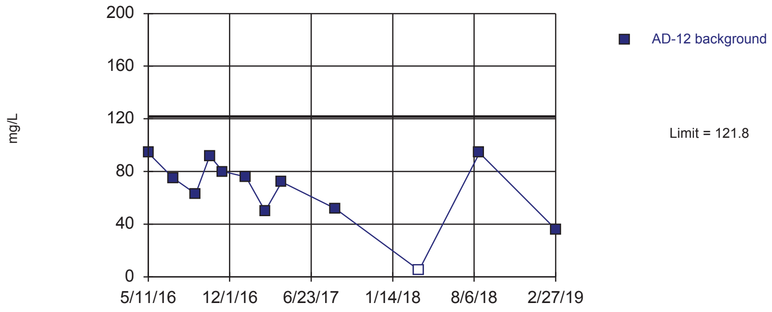
Background Data Summary: Mean=24.73, Std. Dev.=6.115, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9257, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Sulfate, total Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-12 (bg)



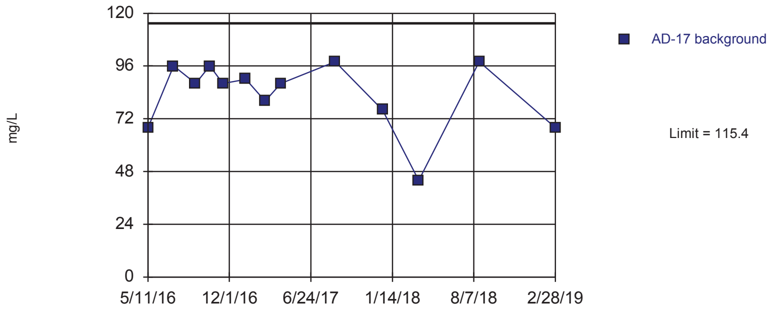
Background Data Summary: Mean=65.75, Std. Dev.=26.52, n=12, 8.333% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9032, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-17



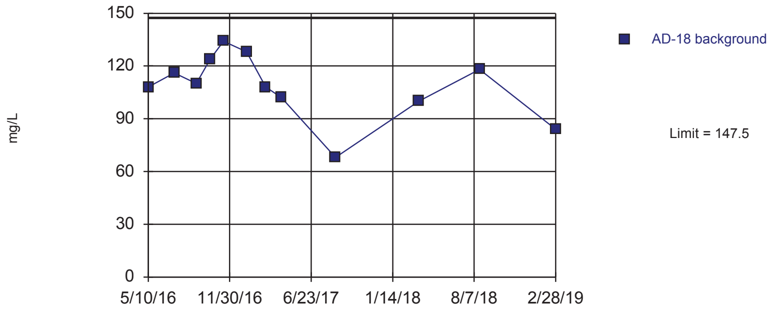
Background Data Summary: Mean=82.92, Std. Dev.=15.65, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8562, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-18 (bg)



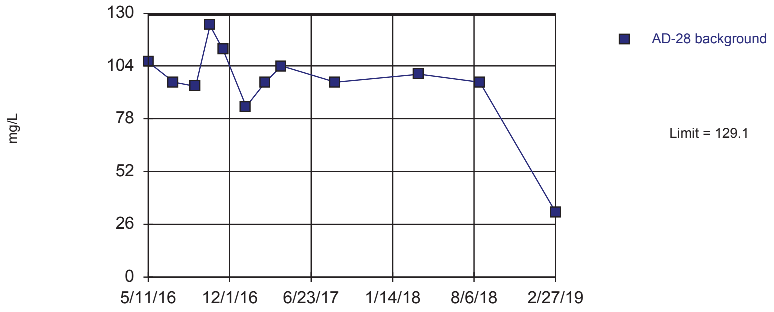
Background Data Summary: Mean=108.3, Std. Dev.=18.52, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9453, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-28



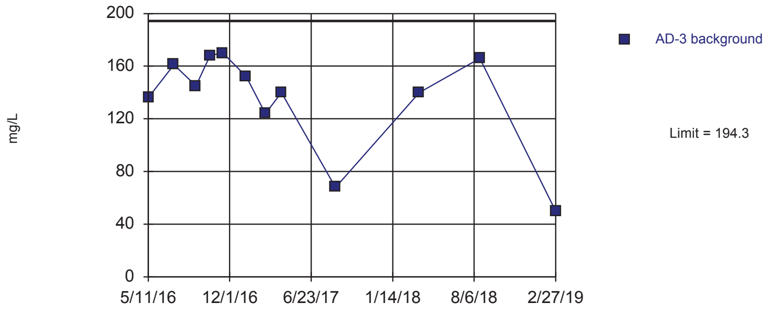
Background Data Summary (based on square transformation): Mean=9479, Std. Dev.=3403, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8775, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-3 (bg)



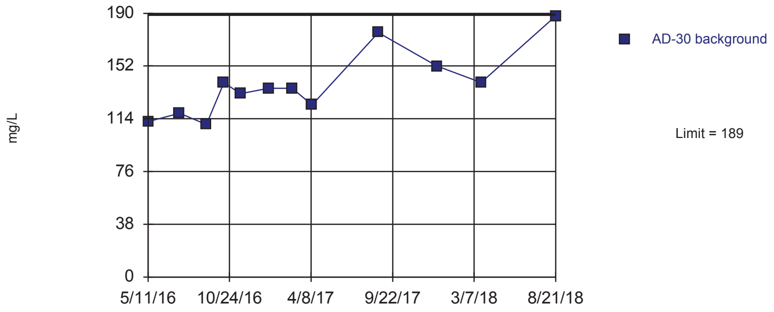
Background Data Summary (based on square transformation): Mean=19577, Std. Dev.=8603, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8758, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-30



Background Data Summary: Mean=138.7, Std. Dev.=23.82, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9068, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:43 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Interwell Prediction Limit Summary Table - All Results

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 12/9/2019, 7:47 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	n/a	0.07675	n/a	n/a	3 future	n/a	36	0.03686	0.02259	2.778	None	No	0.002505	Param Inter 1 of 2
Chloride, total (mg/L)	n/a	9.495	n/a	n/a	3 future	n/a	36	2.62	0.2615	0	None	sqrt(x)	0.002505	Param Inter 1 of 2
Fluoride, total (mg/L)	n/a	1	n/a	n/a	3 future	n/a	36	n/a	n/a	86.11	n/a	n/a	0.001409	NP Inter (NDs) 1 of 2

Trend Tests Summary Table - Upgradient Wells

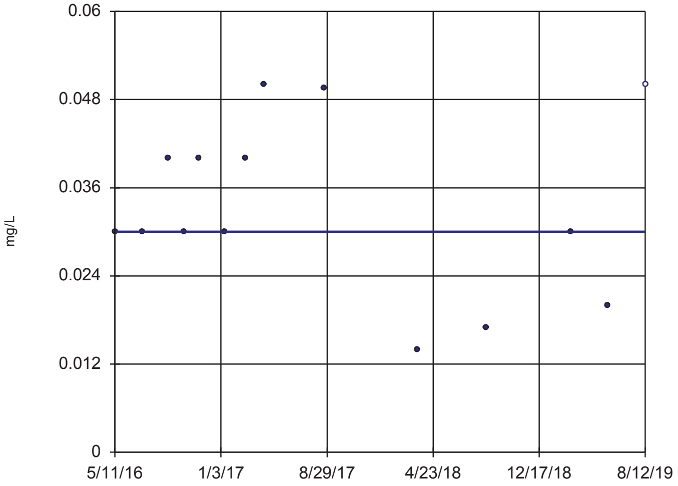
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/6/2019, 9:02 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-12 (bg)	0	3	48	No	14	7.143	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-18 (bg)	0.001357	37	48	No	14	14.29	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-3 (bg)	-0.00212	-14	-48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.1051	23	48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-18 (bg)	0.0768	18	48	No	14	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-3 (bg)	0	-4	-48	No	14	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-12 (bg)	-0.08118	-46	-48	No	14	64.29	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-18 (bg)	0	-35	-48	No	14	78.57	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-3 (bg)	0	-30	-48	No	14	78.57	n/a	n/a	0.01	NP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0
units per year.

Mann-Kendall
statistic = 3
critical = 48

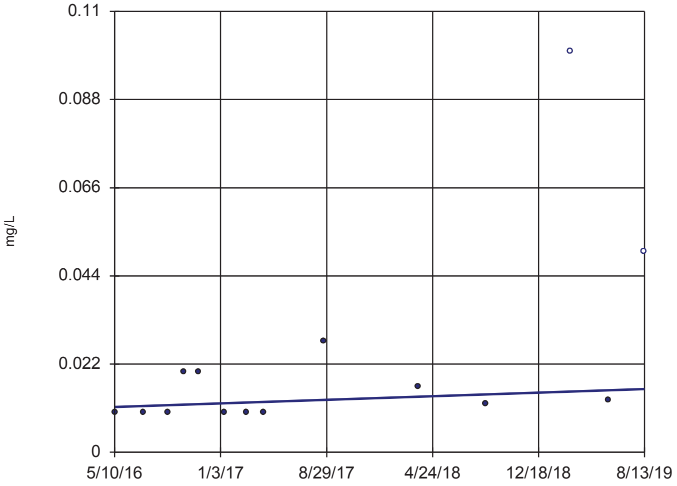
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0.001357
units per year.

Mann-Kendall
statistic = 37
critical = 48

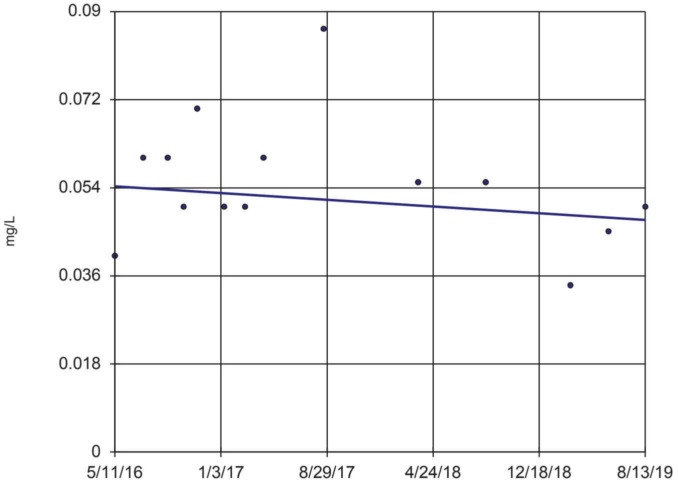
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-3 (bg)



n = 14

Slope = -0.00212
units per year.

Mann-Kendall
statistic = -14
critical = -48

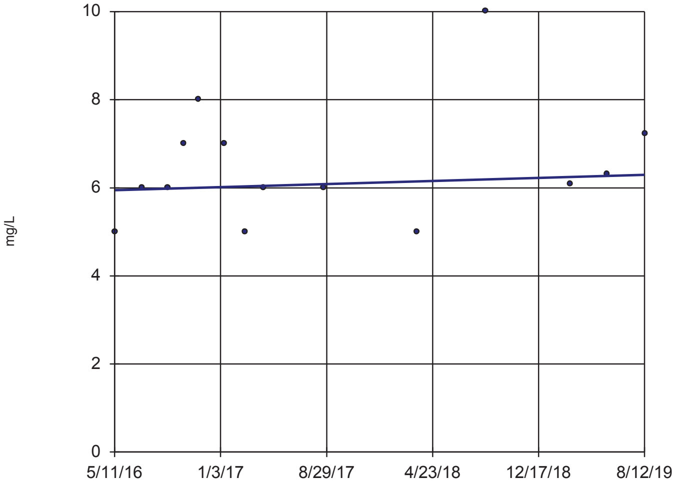
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0.1051
units per year.

Mann-Kendall
statistic = 23
critical = 48

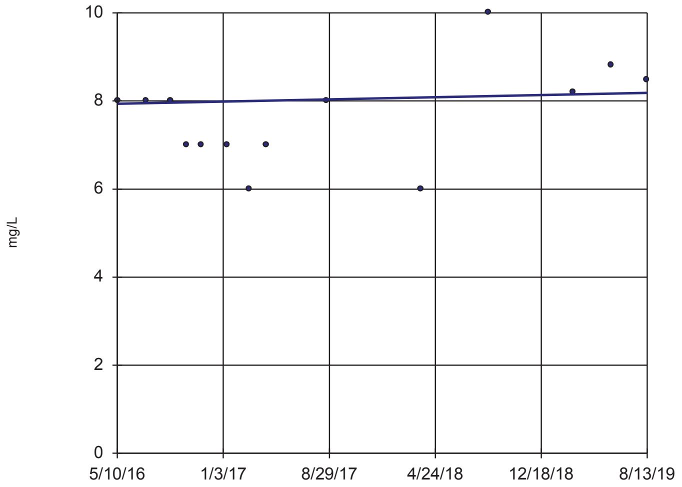
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0.0768
units per year.

Mann-Kendall
statistic = 18
critical = 48

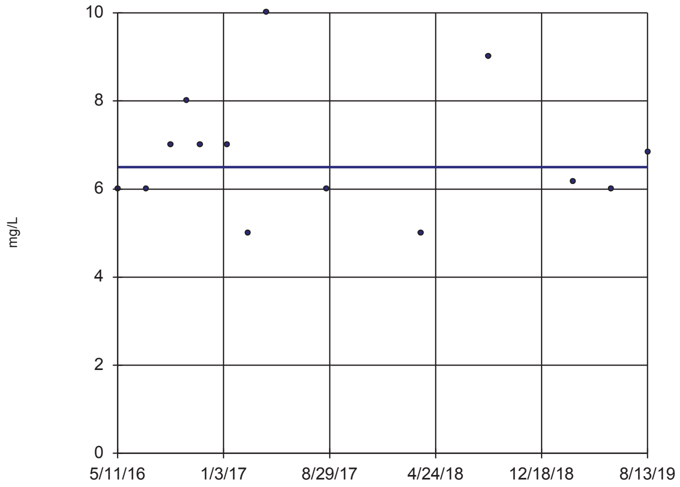
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 12/6/2019 9:02 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-3 (bg)



n = 14

Slope = 0
units per year.

Mann-Kendall
statistic = -4
critical = -48

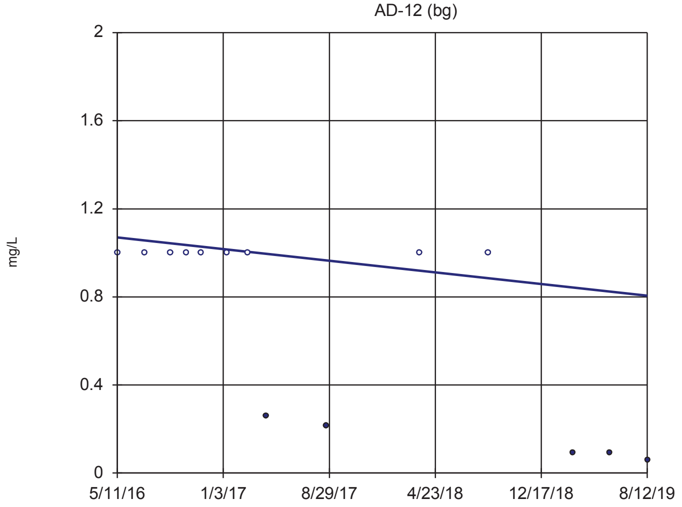
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 12/6/2019 9:02 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.08118
units per year.

Mann-Kendall
statistic = -46
critical = -48

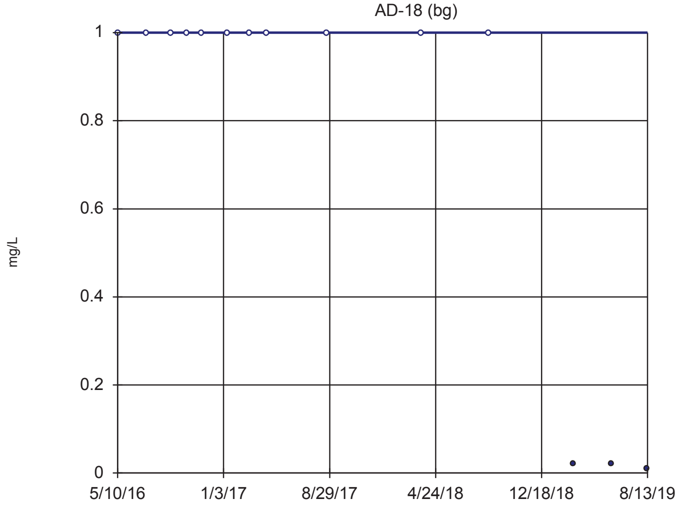
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 9:02 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-18 (bg)



n = 14

Slope = 0
units per year.

Mann-Kendall
statistic = -35
critical = -48

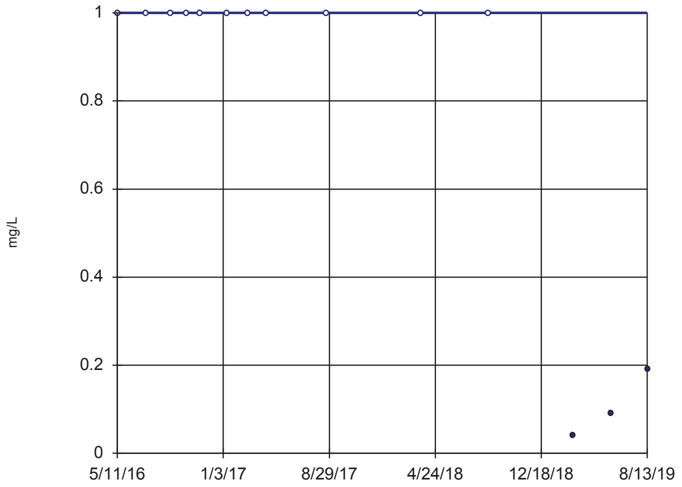
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 9:02 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-3 (bg)



n = 14

Slope = 0
units per year.

Mann-Kendall
statistic = -30
critical = -48

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total   Analysis Run 12/6/2019 9:02 AM   View: Interwell

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Upper Tolerance Limits - App IV

Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP   Printed 12/6/2019, 9:09 AM

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.005	39	n/a	n/a	89.74	n/a	n/a	0.1353	NP Inter(NDs)
Arsenic, total (mg/L)	0.005	39	n/a	n/a	71.79	n/a	n/a	0.1353	NP Inter(normality)
Barium, total (mg/L)	0.157	39	n/a	n/a	0	n/a	n/a	0.1353	NP Inter(normality)
Beryllium, total (mg/L)	0.002	39	n/a	n/a	15.38	n/a	n/a	0.1353	NP Inter(normality)
Cadmium, total (mg/L)	0.001	39	n/a	n/a	76.92	n/a	n/a	0.1353	NP Inter(NDs)
Chromium, total (mg/L)	0.003171	39	-7.563	0.7605	17.95	Kaplan-Meier	ln(x)	0.01	Inter
Cobalt, total (mg/L)	0.009	39	n/a	n/a	0	n/a	n/a	0.1353	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	3.305	39	0.9749	0.3544	0	None	sqrt(x)	0.01	Inter
Fluoride, total (mg/L)	1	42	n/a	n/a	73.81	n/a	n/a	0.116	NP Inter(normality)
Lead, total (mg/L)	0.005	39	n/a	n/a	79.49	n/a	n/a	0.1353	NP Inter(NDs)
Lithium, total (mg/L)	0.1378	38	0.2867	0.09613	2.632	None	x^(1/3)	0.01	Inter
Mercury, total (mg/L)	0.000064	39	n/a	n/a	51.28	n/a	n/a	0.1353	NP Inter(normality)
Molybdenum, total (mg/L)	0.005	34	n/a	n/a	82.35	n/a	n/a	0.1748	NP Inter(NDs)
Selenium, total (mg/L)	0.005	39	n/a	n/a	58.97	n/a	n/a	0.1353	NP Inter(normality)
Thallium, total (mg/L)	0.002	37	n/a	n/a	86.49	n/a	n/a	0.1499	NP Inter(NDs)

PIRKEY WBAP GWPS				
Constituent Name	**MCL**	**CCR-Rule Specified**	**Background Limit**	**GWPS**
Antimony, Total (mg/L)	0.006		0.005	0.006
Arsenic, Total (mg/L)	0.01		0.005	0.01
Barium, Total (mg/L)	2		0.16	2
Beryllium, Total (mg/L)	0.004		0.002	0.004
Cadmium, Total (mg/L)	0.005		0.001	0.005
Chromium, Total (mg/L)	0.1		0.0032	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.009	0.009
Combined Radium, Total (pCi/L)	5		3.31	5
Fluoride, Total (mg/L)	4		1	4
Lead, Total (mg/L)	0.015		0.005	0.015
Lithium, Total (mg/L)	n/a	0.04	0.14	0.14
Mercury, Total (mg/L)	0.002		0.000064	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.005	0.1
Selenium, Total (mg/L)	0.05		0.005	0.05
Thallium, Total (mg/L)	0.002		0.002	0.002

**Grey cell indicates Background Limit is higher than MCL.*

**MCL = Maximum Contaminant Level*

**GWPS = Groundwater Protection Standard*

Confidence Intervals - Significant Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/6/2019, 9:13 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-28**	**0.01583**	**0.0132**	**0.009**	**Yes**	**13**	**0.01452**	**0.001766**	**0**	**None**	**No**	**0.01**	**Param.**

Confidence Intervals - All Results

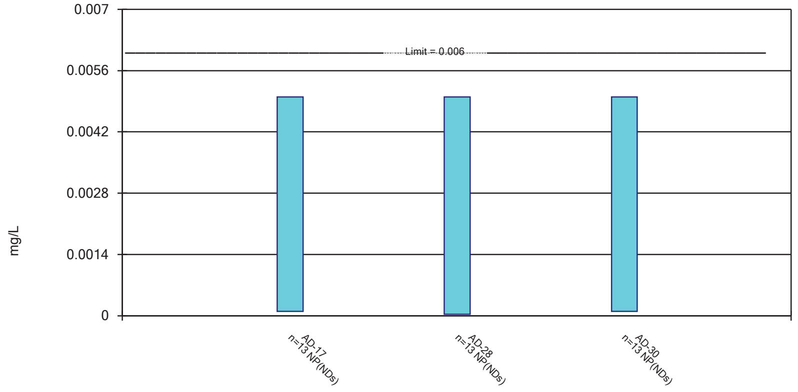
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/6/2019, 9:13 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	AD-17	0.005	0.0001	0.006	No	13	0.003778	0.001989	92.31	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-28	0.005	0.00003	0.006	No	13	0.003511	0.002047	76.92	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-30	0.005	0.0001	0.006	No	13	0.003224	0.002078	76.92	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-17	0.005	0.00041	0.01	No	13	0.003008	0.00198	61.54	None	No	0.01	NP (normality)
Arsenic, total (mg/L)	AD-28	0.006	0.001409	0.01	No	13	0.003209	0.001969	53.85	None	No	0.01	NP (normality)
Arsenic, total (mg/L)	AD-30	0.005	0.0006	0.01	No	13	0.003501	0.002029	69.23	None	No	0.01	NP (normality)
Barium, total (mg/L)	AD-17	0.2749	0.1338	2	No	13	0.2043	0.09487	0	None	No	0.01	Param.
Barium, total (mg/L)	AD-28	0.1761	0.1408	2	No	13	0.1588	0.0243	0	None	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-30	0.058	0.05105	2	No	13	0.05452	0.004672	0	None	No	0.01	Param.
Beryllium, total (mg/L)	AD-17	0.000948	0.0004991	0.004	No	13	0.0008342	0.0005407	15.38	None	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-28	0.0007879	0.000509	0.004	No	13	0.0006484	0.0001876	0	None	No	0.01	Param.
Beryllium, total (mg/L)	AD-30	0.0001554	0.0000604	0.004	No	13	0.0003823	0.0007188	15.38	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-17	0.001	0.0000833	0.005	No	13	0.0007115	0.0004505	69.23	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-28	0.001	0.00005	0.005	No	13	0.0008531	0.0003586	84.62	None	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-30	0.001	0.00005	0.005	No	13	0.0008538	0.0003568	92.31	None	No	0.01	NP (NDs)
Chromium, total (mg/L)	AD-17	0.00177	0.0005093	0.1	No	13	0.001382	0.001464	7.692	None	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-28	0.004	0.000416	0.1	No	13	0.001663	0.00179	30.77	None	No	0.01	NP (Cohens/xfrm)
Chromium, total (mg/L)	AD-30	0.001742	0.0005665	0.1	No	13	0.001242	0.001068	7.692	None	x^(1/3)	0.01	Param.
Cobalt, total (mg/L)	AD-17	0.01198	0.005801	0.009	No	13	0.008891	0.004155	0	None	No	0.01	Param.
Cobalt, total (mg/L)	**AD-28**	**0.01583**	**0.0132**	**0.009**	**Yes**	**13**	**0.01452**	**0.001766**	**0**	**None**	**No**	**0.01**	**Param.**
Cobalt, total (mg/L)	AD-30	0.002535	0.001801	0.009	No	13	0.002168	0.0004933	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-17	6.109	2.015	5	No	13	4.062	2.753	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-28	2.585	1.706	5	No	13	2.145	0.5906	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-30	2.349	0.6237	5	No	13	1.579	1.37	0	None	sqrt(x)	0.01	Param.
Fluoride, total (mg/L)	AD-17	1	0.24	4	No	15	0.6982	0.3883	60	None	No	0.01	NP (normality)
Fluoride, total (mg/L)	AD-28	0.8025	0.5437	4	No	14	0.6731	0.1827	7.143	None	No	0.01	Param.
Fluoride, total (mg/L)	AD-30	1	0.2	4	No	15	0.818	0.3785	86.67	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-17	0.005	0.0002	0.015	No	13	0.003799	0.001947	84.62	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-28	0.005	0.000266	0.015	No	13	0.003797	0.00195	84.62	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-30	0.005	0.0002	0.015	No	13	0.003789	0.001966	84.62	None	No	0.01	NP (NDs)
Lithium, total (mg/L)	AD-17	0.02464	0.01211	0.14	No	13	0.01837	0.008427	7.692	None	No	0.01	Param.
Lithium, total (mg/L)	AD-28	0.03356	0.02389	0.14	No	12	0.02797	0.008512	0	None	x^2	0.01	Param.
Lithium, total (mg/L)	AD-30	0.009892	0.007132	0.14	No	13	0.008284	0.002493	7.692	None	x^2	0.01	Param.
Mercury, total (mg/L)	AD-17	0.0001652	0.00006705	0.002	No	13	0.0001288	0.000106	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-28	0.00008396	0.00003015	0.002	No	13	0.00006323	0.00004673	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-30	0.001162	0.0002761	0.002	No	13	0.0007703	0.0007062	0	None	sqrt(x)	0.01	Param.
Molybdenum, total (mg/L)	AD-17	0.005	0.0004858	0.1	No	11	0.003864	0.002	81.82	None	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-28	0.005	0.0002942	0.1	No	11	0.003849	0.002027	81.82	None	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-30	0.005	0.001142	0.1	No	11	0.00394	0.001859	81.82	None	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-17	0.005	0.0005	0.05	No	13	0.00395	0.001732	76.92	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-28	0.005	0.0003	0.05	No	13	0.003816	0.001917	76.92	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-30	0.005	0.0004	0.05	No	13	0.003831	0.001889	76.92	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-17	0.002	0.0005	0.002	No	12	0.001511	0.0007555	83.33	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-28	0.002	0.0005	0.002	No	12	0.001523	0.0007519	83.33	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-30	0.002	0.0005	0.002	No	12	0.00145	0.0007383	75	None	No	0.01	NP (normality)

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

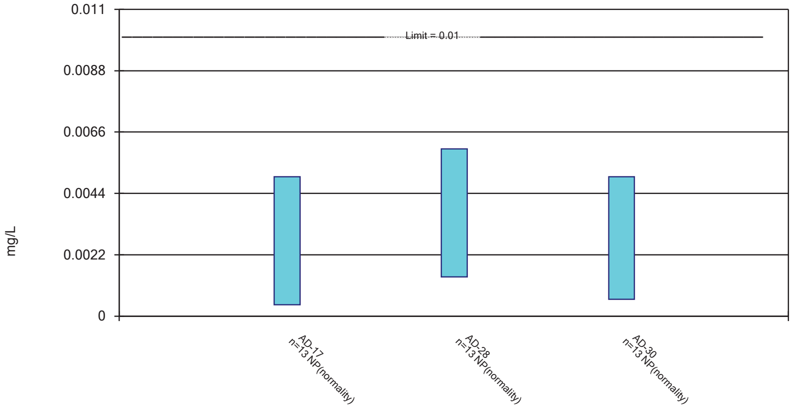


Constituent: Antimony, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

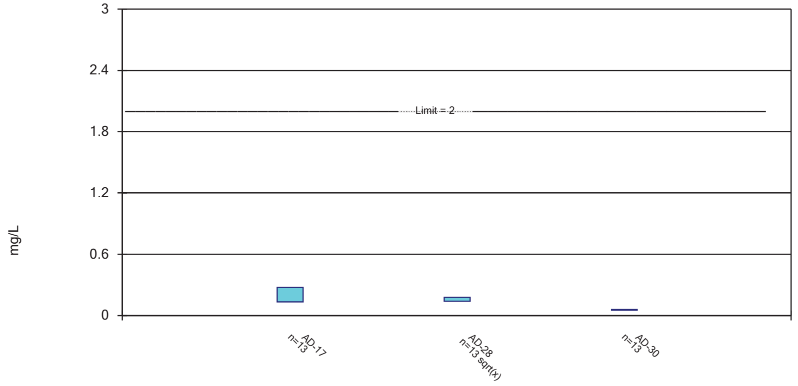


Constituent: Arsenic, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

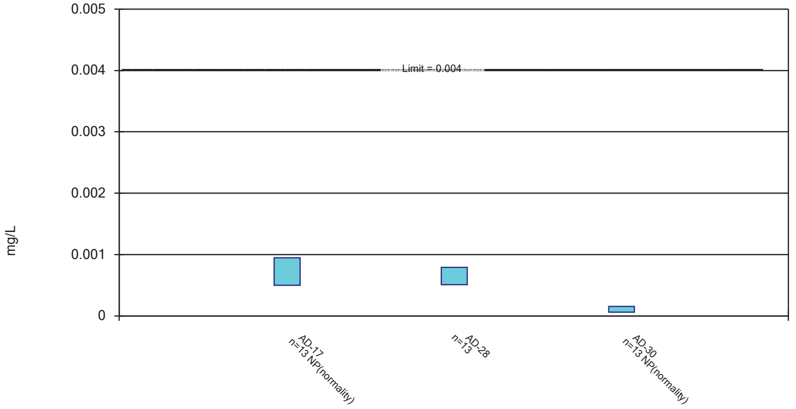


Constituent: Barium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

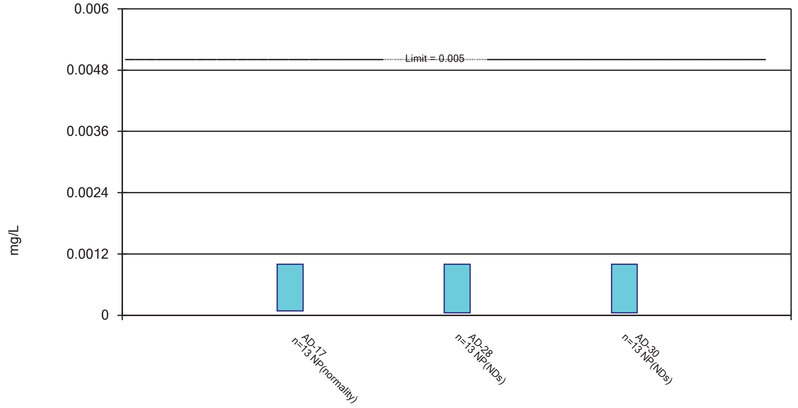


Constituent: Beryllium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

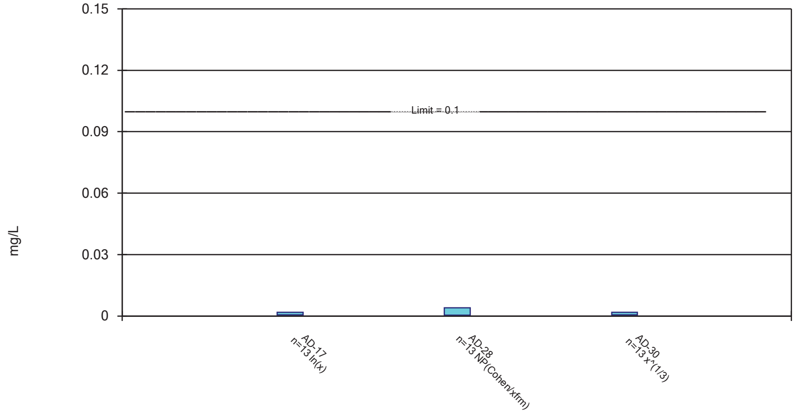


Constituent: Cadmium, total   Analysis Run 12/6/2019 9:10 AM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

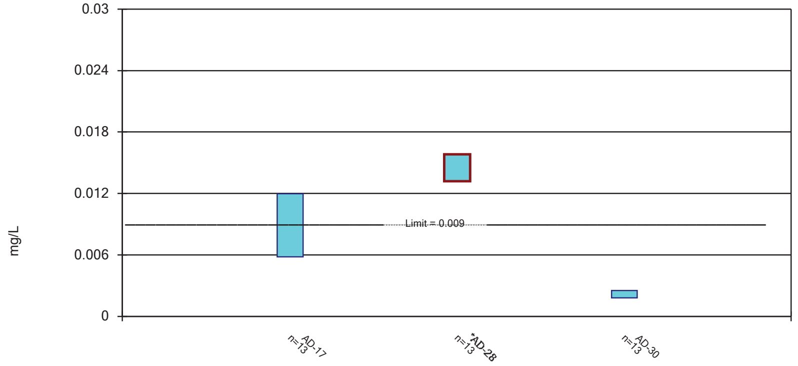


Constituent: Chromium, total   Analysis Run 12/6/2019 9:10 AM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

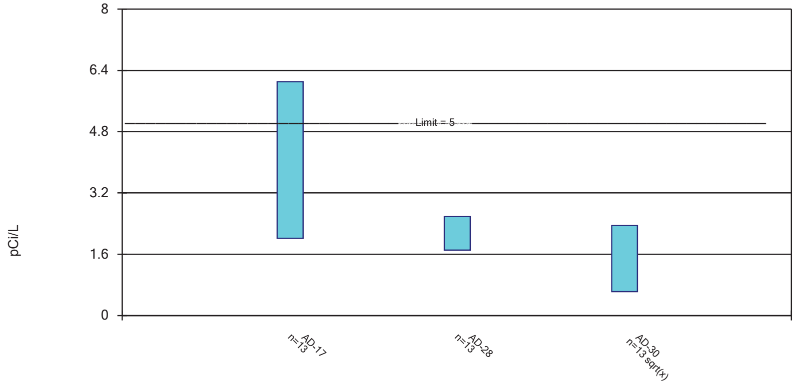


Constituent: Cobalt, total   Analysis Run 12/6/2019 9:10 AM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

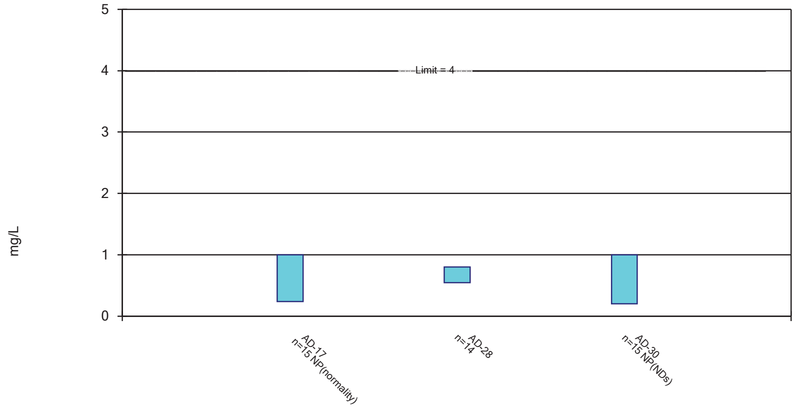


Constituent: Combined Radium 226 + 228   Analysis Run 12/6/2019 9:10 AM   View: Appendix IV
Pirkey WBAP   Client: Geosyntec   Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

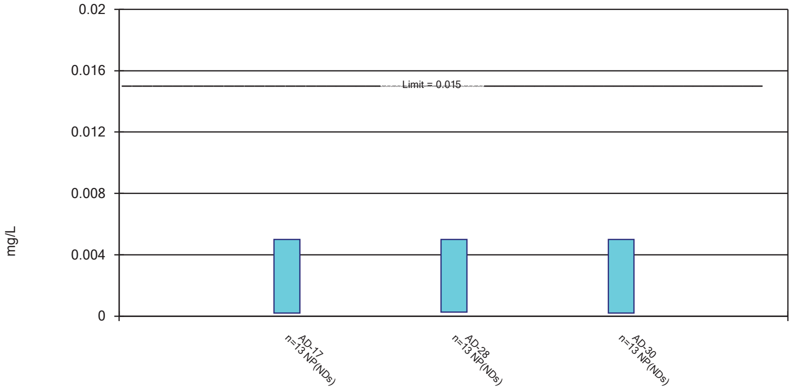


Constituent: Fluoride, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

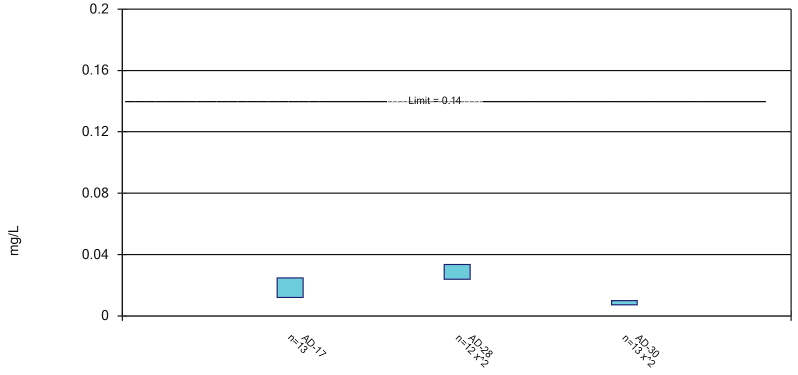


Constituent: Lead, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

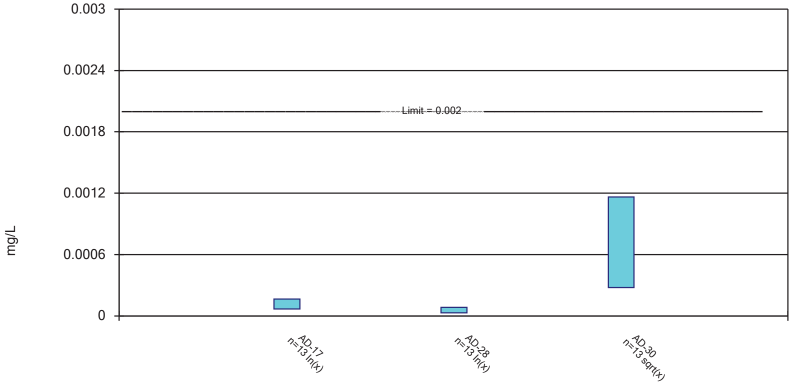


Constituent: Lithium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

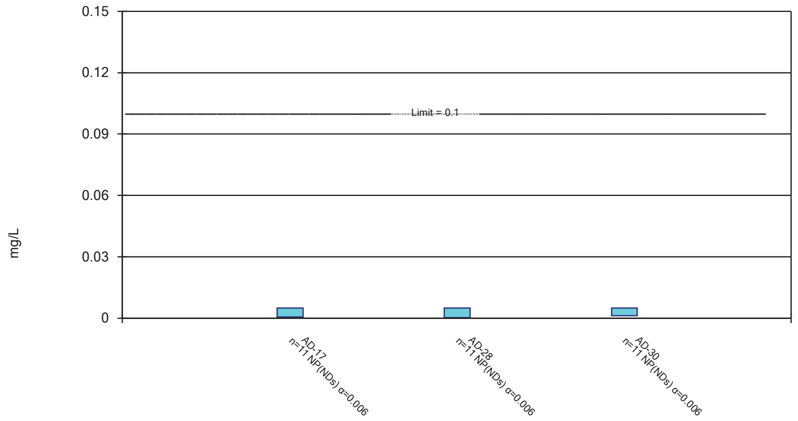


Constituent: Mercury, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

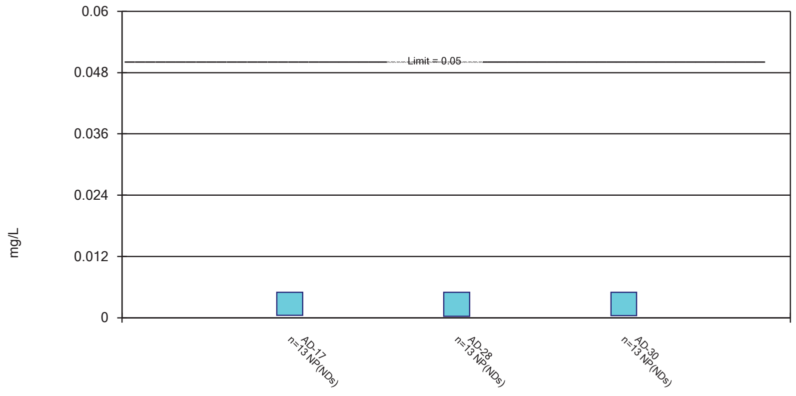


Constituent: Molybdenum, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

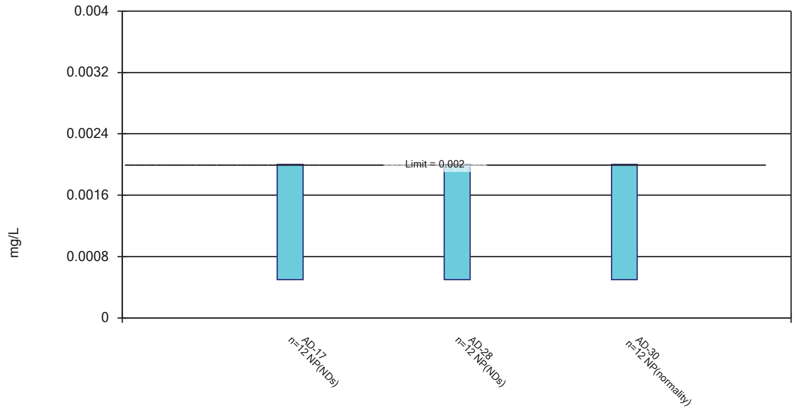


Constituent: Selenium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Thallium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
West Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

March 26, 2019

CHA8462

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FIGURES

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ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
WBAP	West Bottom Ash Pond

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the West Bottom Ash Pond (WBAP, Figure 1). In 2018, two assessment monitoring events were conducted at the WBAP in accordance with 40 CFR 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or regional screening level (RSL). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). An SSL was identified for cobalt at AD-28 at the WBAP where the LCL of 0.0131 mg/L was above the calculated GWPS of 0.009 mg/L (Geosyntec, 2018). No other SSLs were identified.

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for cobalt at AD-28 should not be attributed to the WBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSL identified for cobalt at AD-28 was based on a Type IV cause and not by a release from the Pirkey WBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSL identified for cobalt and the proposed alternative source are described below.

2.1 Proposed Alternative Source

Initial review of site geochemistry, site historical data, and laboratory QA/QC data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSL has been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

The onsite hydrostratigraphic unit for the WBAP was identified as the clayey and silty sand stratum located between an elevation of approximately 325 and 340 feet above mean sea level (Arcadis, 2016). This unit is within the Reklaw Formation, which consists predominantly of clay and fine-grained sand and is underlain by the Eocene-age Carrizo Sand. The presence of lignite in the area is well-documented (Broom and Myers, 1966; ETTL, 2010). The Sabine Mining Company operates a lignite surface mining operation immediately to the southwest of the site which supplies lignite to the Pirkey Plant.

Soil samples collected across the site identified cobalt in the aquifer material at varying concentrations (Table 1), including locations near the WBAP. The highest reported cobalt concentration of 15 milligrams per kilogram (mg/kg) was collected at AD-30, which is located south of the WBAP and approximately 600 feet northeast of AD-28 (Figure 2). Additionally, mineralogic samples collected from these locations identified the presence of pyrite (cubic FeS_2) and marcasite (orthorhombic FeS_2) at concentrations up to 3% of the total composition of the material (Table 1). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2019). While not detected in the mineralogical analyses, the presence of limonite (FeO(OH)) in the Reklaw formation has been noted (Brooms and Myers, 1966). In addition to iron sulfides, cobalt can also substitute in iron oxides such as limonite (Hitzman et al., 2019). While soil analytical and mineralogical data are not available for AD-28, the wide distribution of cobalt and iron sulfides across the site suggests that naturally occurring cobalt may be present in the aquifer media near AD-28.

Naturally occurring cobalt in the aquifer media is proposed as the alternate source for cobalt concentrations in the groundwater which exceed the GWPS at AD-28. Further investigation shows that a release from the WBAP itself does not appear to be a source for cobalt. Analysis of the bottom ash sluiced to the WBAP had a reported cobalt concentration of 5.8 mg/kg (Attachment A). When Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) was conducted on the ash sample to evaluate cobalt mobility under simulated conditions, cobalt was not detected above the reporting limit of 0.01 milligrams per liter (mg/L) in the leachate sample (Attachment A). Cobalt was also not detected above the reporting limit of 0.005 mg/L in a grab sample of the pond water (Attachment B). The reporting limit for both the SPLP and pond water analyses are both over an order of magnitude lower than the average concentration of cobalt observed at AD-28 during the background and assessment monitoring period. The analytical sample results are summarized in Table 2.

Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions, as SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. According to a recent study, cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

The pond was not identified as the source of cobalt at AD-28 based on the documented low mobility of cobalt under the pond conditions. This is further supported by the lack of detected cobalt in the SPLP and pond water analyses. Instead, the widespread distribution of cobalt within the aquifer material is proposed as the alternate source. This cobalt could be present as substitutions within iron-containing minerals such as pyrite, marcasite, or limonite, all of which are observed across the site.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSL is not due to a release from the Pirkey WBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of cobalt for AD-28 identified during assessment monitoring in 2018 was not due to a release from the WBAP. The identified SSL was, instead, attributed to natural variation in the underlying geology. Therefore, no further action is warranted, and the Pirkey WBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment C.

SECTION 4

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USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

FIGURES

Legend

● AD-15

● Monitoring Wells

Location Boundaries

CCR Units

▭ EBAP

▭ Landfill

▭ Stack Out Area

▭ WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.

0 380 760 1,520 2,280 3,040 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2019/03/25

Figure 1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_20190322.mxd. HDuff. 3/25/2019. Project/Phase/Task.

Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

Legend

⌖ Monitoring Wells

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- ft bgs: feet below ground surface
- mg/kg: milligrams per kilogram

0 125 250 500 750 1,000 Feet

Soil Chemical and Mineralogical Analysis Results

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio

2019/03/25

Figure

2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Pirkey_SoilChem_minerals_March2019.mxd. SKaroly. 3/25/2019. Project/Phase/Task.

TABLES

Table 1: Soil Cobalt and Mineralogy Data
West Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Sample Depth (ft bgs)	Cobalt (mg/kg)	Pyrite/Marcasite (%)
AD-15	13	0.85	--
	40-43	0.79	--
AD-16	10	0.17	0
	19	0.44	1
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-33	11	0.61	1
	21	0.64	--
AD-34	6	1.10	1
	24	6.50	2
AD-35	2	2.10	2
	17	0.18	0

Notes:
'--' - analysis not completed
mg/kg- milligram per kilogram
ft bgs - feet below ground surface

Samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation.

Table 2: Summary of Key Analytical Data
West Bottom Ash Pond - H.W. Pirkey Plant

Sample	**Unit**	**Cobalt Concentration**
Bottom Ash	mg/kg	5.8
SPLP Leachate	mg/L	<0.01
WBAP Pond Water	mg/L	<0.005
AD-28 - Average	mg/L	0.0148

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

AD-28 - Average value was calculated using all cobalt data collected under 40 CFR 257 Subpart D.

ATTACHMENT A

Bottom Ash and Bottom Ash SPLP Laboratory Analytical Data

Client Sample Results

Client Sample ID: CCR SAMPLE-WBAP-1

Date Collected: 02/11/19 16:40
Date Received: 02/13/19 09:40

Lab Sample ID: 490-168389-1

Matrix: Solid
Percent Solids: 75.9

Method: 9056 - Anions, Ion Chromatography - Soluble

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	1.3	U	1.3	1.0	mg/Kg	☼		02/14/19 00:30	1

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	11	U	11	1.1	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Arsenic	**2.2**		2.2	1.3	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Barium	**250**		2.2	1.1	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Beryllium	**0.25**	**J**	1.1	0.22	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Boron	**93**		11	4.8	mg/Kg	☼	02/13/19 16:11	02/18/19 22:40	1
Cadmium	1.1	U	1.1	0.11	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Chromium	**12**		1.1	1.0	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Cobalt	**5.8**		2.2	1.1	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Lead	**1.2**	**F1**	1.1	0.56	mg/Kg	☼	02/13/19 16:11	02/19/19 18:53	1
Lithium	**4.2**	**J**	11	1.1	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Molybdenum	11	U	11	5.6	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1
Selenium	2.2	U	2.2	1.2	mg/Kg	☼	02/13/19 16:11	02/19/19 18:53	1
Thallium	2.2	U	2.2	0.67	mg/Kg	☼	02/13/19 16:11	02/16/19 23:06	1

Method: 7471B - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.13	U	0.13	0.039	mg/Kg	☼	02/14/19 10:07	02/14/19 13:12	1

Client Sample Results

Client: Burns & McDonnell
Project/Site: CCR App III & IV GW Monitoring - Texas

TestAmerica Job ID: 490-168389-1
SDG: AEP-Pirkey Plant

Client Sample ID: CCR SAMPLE-WBAP-1

Lab Sample ID: 490-168389-1

Date Collected: 02/11/19 16:40
Date Received: 02/13/19 09:40

Matrix: Solid

Method: 9056 - Anions, Ion Chromatography - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	**0.035**	**J B**	0.10	0.010	mg/L			02/19/19 23:08	1

Method: 6010C - Metals (ICP) - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:32	1
Arsenic	0.010	U	0.010	0.0086	mg/L		02/19/19 16:41	02/20/19 13:32	1
Barium	**0.11**		0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:32	1
Beryllium	0.0040	U	0.0040	0.0020	mg/L		02/19/19 16:41	02/20/19 13:32	1
Boron	**0.15**		0.050	0.020	mg/L		02/19/19 16:41	02/20/19 13:32	1
Cadmium	0.0010	U	0.0010	0.00050	mg/L		02/19/19 16:41	02/20/19 13:32	1
Chromium	0.0050	U	0.0050	0.0030	mg/L		02/19/19 16:41	02/20/19 13:32	1
Cobalt	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:32	1
Lead	0.0050	U	0.0050	0.0020	mg/L		02/19/19 16:41	02/20/19 13:32	1
Lithium	**0.016**	**J B ***	0.050	0.010	mg/L		02/19/19 16:41	02/20/19 13:32	1
Molybdenum	0.050	U	0.050	0.030	mg/L		02/19/19 16:41	02/20/19 13:32	1
Selenium	**0.0052**	**J**	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:32	1
Thallium	0.010	U	0.010	0.0050	mg/L		02/19/19 16:41	02/20/19 13:32	1

Method: 7470A - Mercury (CVAA) - SPLP West

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.00020	U	0.00020	0.00010	mg/L		02/19/19 16:03	02/21/19 15:39	1

General Chemistry

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Percent Solids	**75.9**		0.1	0.1	%			02/17/19 12:25	1

ATTACHMENT B

Bottom Ash Pond Water Laboratory Analytical Data

Client Sample Results

Client Sample ID: SW-WBAP-1

Date Collected: 12/15/18 14:15
Date Received: 12/18/18 10:30

Lab Sample ID: 490-165222-5

Matrix: Water

Method: 9056A - Anions, Ion Chromatography

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoride	**0.88**	**J**	1.0	0.010	mg/L			12/20/18 19:29	1
Sulfate	**1400**		1000	6.0	mg/L			12/30/18 09:25	200
Chloride	**61**	**B**	15	1.0	mg/L			12/30/18 09:08	5

Method: 6020A - Metals (ICP/MS) - Total Recoverable

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	0.0030	U	0.0030	0.00080	mg/L		12/19/18 14:26	12/27/18 15:30	1
Arsenic	**0.0030**	**J**	0.0050	0.00040	mg/L		12/28/18 12:47	01/03/19 11:39	1
Barium	0.20	U	0.20	0.00010	mg/L		12/19/18 14:26	12/27/18 15:30	1
Beryllium	**0.00029**	**J**	0.0040	0.00010	mg/L		12/19/18 14:26	12/26/18 22:24	1
Boron	**7.3**	**J ***	10	0.35	mg/L		12/28/18 12:47	01/03/19 11:48	10
Cadmium	0.0050	U	0.0050	0.00010	mg/L		12/19/18 14:26	12/27/18 15:30	1
Calcium	**220**		1.0	0.053	mg/L		12/19/18 14:26	12/26/18 22:24	1
Chromium	0.0050	U	0.0050	0.00050	mg/L		12/19/18 14:26	12/27/18 15:30	1
Cobalt	0.0050	U	0.0050	0.00010	mg/L		12/19/18 14:26	12/27/18 15:30	1
Lead	**0.00077**	**J**	0.0050	0.00010	mg/L		12/19/18 14:26	12/21/18 21:37	1
Lithium	**0.053**		0.040	0.0030	mg/L		12/19/18 14:26	12/21/18 21:37	1
Molybdenum	**0.0047**	**J**	0.010	0.0010	mg/L		12/19/18 14:26	12/26/18 22:24	1
Selenium	**0.015**		0.010	0.00030	mg/L		12/19/18 14:26	12/26/18 22:24	1
Thallium	0.0020	U	0.0020	0.00080	mg/L		12/19/18 14:26	12/21/18 21:37	1

Method: 7470A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.00020	U	0.00020	0.00010	mg/L		12/20/18 12:26	12/21/18 12:20	1

General Chemistry

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids	**2000**		50	14	mg/L			12/19/18 23:00	1

Beth Ann Gross

ATTACHMENT C

BETH ANN GROSS
79864

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864	Texas	3/26/2019
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
West Bottom Ash Pond
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

September 23, 2019

CHA8462

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LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
VAP	Vertical Aquifer Profiling
WBAP	West Bottom Ash Pond
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the West Bottom Ash Pond (WBAP, Figure 1). In February 2019, a semi-annual assessment monitoring event was conducted at the WBAP in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were previously established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). At the WBAP, an SSL was identified for cobalt at AD-28, where the LCL of 0.0132 milligrams per liter (mg/L) was above the calculated GWPS of 0.009 mg/L (Geosyntec, 2019a). No other SSLs were identified.

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for cobalt at AD-28 should not be attributed to the WBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSL identified for cobalt at AD-28 was based on a Type IV cause and not by a release from the Pirkey WBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSL identified for cobalt and the proposed alternative source are described below.

2.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSL has been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

AD-28 is located at the southwest corner of the pond, as shown in Figure 1. In a previous ASD for cobalt at the WBAP, evidence was provided to show that cobalt is present in the aquifer media at the site and that the observed cobalt concentrations were due to natural variation (Geosyntec, 2019b). The previous ASD discussed how the WBAP itself did not appear to be a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP leachate above the reporting limit of 0.01 mg/L. Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions. SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. Cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

Cobalt was also not detected above the reporting limit of 0.005 mg/L in a grab sample of the pond water. As shown in Table 1, the reporting limits for the SPLP ash leachate test and pond water analysis are both below the average concentration of cobalt observed at AD-28 during the background and assessment monitoring periods (0.0147 mg/L). Since the previous ASD was prepared, there have been no notable changes in coal handling or sourcing at the plant that would have affected the composition of the ash or pond water.

Since completion of the prior ASD, four additional permanent wells (B-2, B-3, AD-40, and AD-41) have been installed upgradient of the WBAP. The most recent data available for select wells in the vicinity of the WBAP, including the new upgradient locations, are shown in Figure 2. Groundwater cobalt concentrations at upgradient locations vary from 0.0008 mg/L to 0.0345 mg/L at AD-40 and B-3, respectively. This wide range in cobalt concentrations provides further evidence for the natural variation of cobalt at the Site, particularly as the concentrations at B-3 exceed both the GWPS for the WBAP and the LCL calculated for cobalt at AD-28 (the well of interest).

As noted in the prior ASD, soil samples collected across the site, including from locations near the WBAP, identified cobalt in the aquifer solids at varying concentrations. Since completion of the prior ASD, additional soil samples have been collected from locations upgradient of the WBAP. Select soil sample data from the previous ASD and recently collected data are summarized in Table 2. Cobalt was identified in the aquifer solids at varying concentrations, with the highest value of 24 milligrams per kilogram (mg/kg) reported at AD-41, which is upgradient of the EBAP (Figure 3). Other testing included collection of aquifer solids to evaluate for the presence of cobalt-containing minerals. X-ray diffraction evidence identified pyrite and marcasite (both iron sulfides) at select locations at concentrations up to 3% by weight (Table 2). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2019).

Groundwater samples were collected from upgradient location B-3 via vertical aquifer profiling (VAP), as described in an ASD previously generated for the EBAP (Geosyntec, 2019c). The VAP groundwater samples were centrifuged to separate solid and liquid phases, and the solid material was submitted for analysis of total metals and mineralogy by X-ray diffraction (XRD). The samples were also submitted for analysis of chemical composition and mineralogy by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Following installation of permanent monitoring wells at B-2 and B-3, groundwater samples were collected by purging groundwater through the filter pack using a submersible pump. An additional groundwater sample was collected at AD-30. These permanent well groundwater samples were filtered through a 1.5-micron filter, and the solid material retained on the filter was submitted for analysis of total metals and by SEM/EDS.

Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from B-2 and B-3 (Table 2). Cobalt was detected in the AD-30 solid material at estimated value of 9.3 mg/kg, which is comparable to the concentration observed in bulk soil collected at the same location at the screened interval (15 mg/kg). These results provide further evidence that cobalt concentrations reported during groundwater sampling are naturally occurring and associated with the solid phase in the aquifer.

According to XRD results of the centrifuged solid sample [VAP-B3-(40-45)], pyrite was present as approximately 3% of the solid phase, with hematite (an iron(III) oxide) present at 2% (Table 3). Logging completed while the VAP boring was advanced identified coal at several intervals, including 45 and 48 ft bgs (Figure 4). Furthermore, SEM/EDS of both centrifuged solid samples [VAP-B3-(40-45) and VAP-B3-(50-55)] identified pyrite in backscattered electron micrographs by the distinctive framboid pattern (Harris, 1981; Sawlowicz, 2000). Major peaks involving iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (Attachment A). While cobalt was not identified in the EDS spectrum, it is likely present at concentrations below the detection limit. Pyrite was also identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site.

While soil analytical and mineralogical data are not available for AD-28, the wide distribution of pyrite across the site suggests that naturally occurring cobalt, which may substitute for iron in pyrite, may also be present in the aquifer solids near AD-28. The presence of lignite in the area is well-documented, including at upgradient and downgradient locations relative to the WBAP (Broom and Myers, 1966; ETTL, 2010). Additionally, the pond was not identified as the source of cobalt at AD-28 in the previous ASD based on the documented low mobility of cobalt under the pond conditions and lack of detectable cobalt in the pond itself.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSL is not due to a release from the Pirkey WBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of cobalt for AD-28 identified during assessment monitoring in . February 2019 was not due to a release from the WBAP. The identified SSL was, instead, attributed to natural variation in the underlying geology, including the presence of pyrite in the solid aquifer material. Therefore, no further action is warranted, and the Pirkey WBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

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TABLES

Table 1: Summary of Key Analytical Data
West Bottom Ash Pond - H.W. Pirkey Plant

Sample	Unit	Cobalt Concentration
Bottom Ash	mg/kg	5.8
SPLP Leachate	mg/L	<0.01
WBAP Pond Water	mg/L	<0.005
AD-28 - Average	mg/L	0.0147

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

AD-28 - Average value was calculated using all cobalt data collected under 40 CFR 257 Subpart D.

Table 2: Soil Cobalt and Mineralogy Data
West Bottom Ash Pond - H.W. Pirkey Plant

Location ID	**Sample Depth (ft bgs)**	**Cobalt (mg/kg)**	**Pyrite/Marcasite (%)**
Bulk Soil Samples			
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-41	15	< 1.0	--
	35	23.5	---
	95	1.90	---
B-2	10	2.36	---
	16	3.62	---
	71	10.30	---
	82	7.21	---
	87	3.11	---
B-3	10	1.30	---
	20	0.59	---
	97	1.11	---
Solid Material Retained After Filtration			
AD-30	15-25	9.3 J	--
B-2	38-48	4.3 J	--
B-3	29-34	12.0	--
	VAP 40-45	18.0	3

Notes:

'--' - analysis not completed

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

J = estimated value

For AD-XX locations, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-X locations were collected from cores removed from the borehole during well lithology logging.

Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

Table 3: X-Ray Diffraction Results
West Bottom Ash Pond - H. W. Pirkey Plant

Constituent	**VAP-B3-(40-45)**
Quartz	15
Plagioclase Feldspar	0.5
Orthoclase	ND
Calcite	ND
Dolomite	ND
Siderite	0.5
Goethite	ND
Hematite	2
Pyrite	3
Kaolinte	42
Chlorite	4
Illite/Mica	6
Smectite	12
Amorphous	15

Notes:

ND: Not detected

VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

FIGURES

Legend

● AD-15

● Monitoring Wells

Location Boundaries

CCR Units

▭ EBAP

▭ Landfill

▭ Stack Out Area

▭ WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.

0 380 760 1,520 2,280 3,040 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

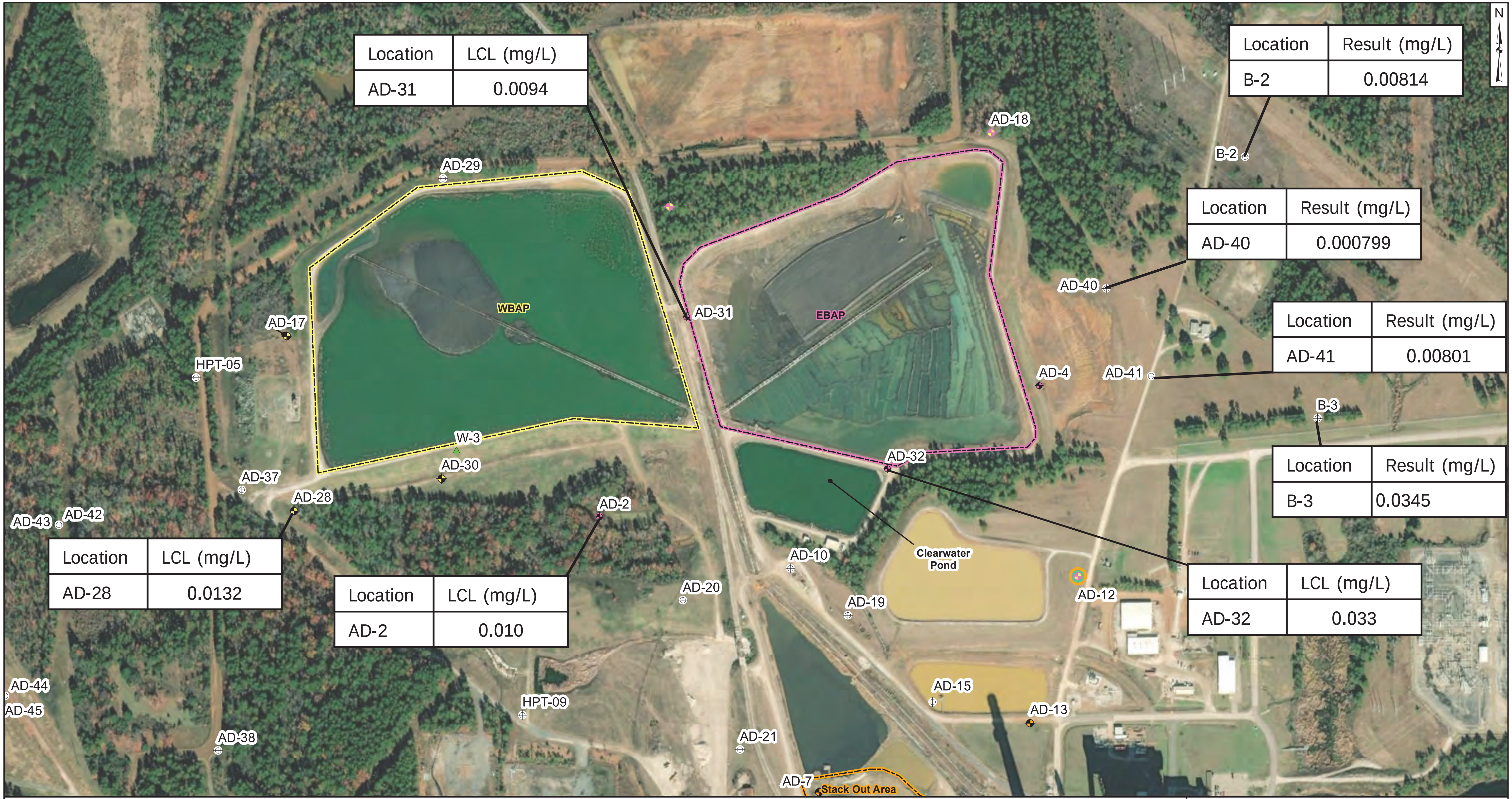
Columbus, Ohio

2019/03/25

Figure

1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_20190322.mxd. HDuff. 3/25/2019. Project/Phase/Task.



Location	LCL (mg/L)
AD-31	0.0094

Location	Result (mg/L)
B-2	0.00814

Location	Result (mg/L)
AD-40	0.000799

Location	Result (mg/L)
AD-41	0.00801

Location	Result (mg/L)
B-3	0.0345

Location	LCL (mg/L)
AD-32	0.033

Location	LCL (mg/L)
AD-28	0.0132

Location	LCL (mg/L)
AD-2	0.010

Legend

⊕ Out of Network	▭ EBAP
◆ EBAP	▭ Stack Out Area
◆ WBAP	▭ WBAP
◆ Stackout Area	
◆ EBAP and WBAP	
◎ All CCR Unit Networks	
▲ Piezometer	

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- AD-15 location is approximated
- LCL: lower confidence limit
- Cobalt concentrations and LCL values displayed in milligrams per liter (mg/L).

400 200 0 400
Feet

Cobalt Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio | 2019/09/17

Figure
2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Pirkey_Cobalt_20190912.mxd. ARevezzo. 9/17/2019. Project/Phase/Task.

Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	B-2				
Depth (ft bgs)	10	16	71	82	87
Cobalt (mg/kg)	2.36	3.62	10.30	7.21	3.11
Pyrite/Marcasite (%)	-	-	-	-	-

Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-41		
Depth (ft bgs)	15	35	95
Cobalt (mg/kg)	< 1.0	23.5	1.9
Pyrite/Marcasite (%)	-	-	-

Location	B-3		
Depth (ft bgs)	10	20	97
Cobalt (mg/kg)	1.30	0.59	1.11
Pyrite/Marcasite (%)	-	-	-

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Legend

⌖	Monitoring Wells
▭	EBAP
▭	WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.

300 150 0 300
Feet

Soil Chemical and Mineralogical Analysis Results

AEP Pirkey Power Plant
Hallsville, Texas

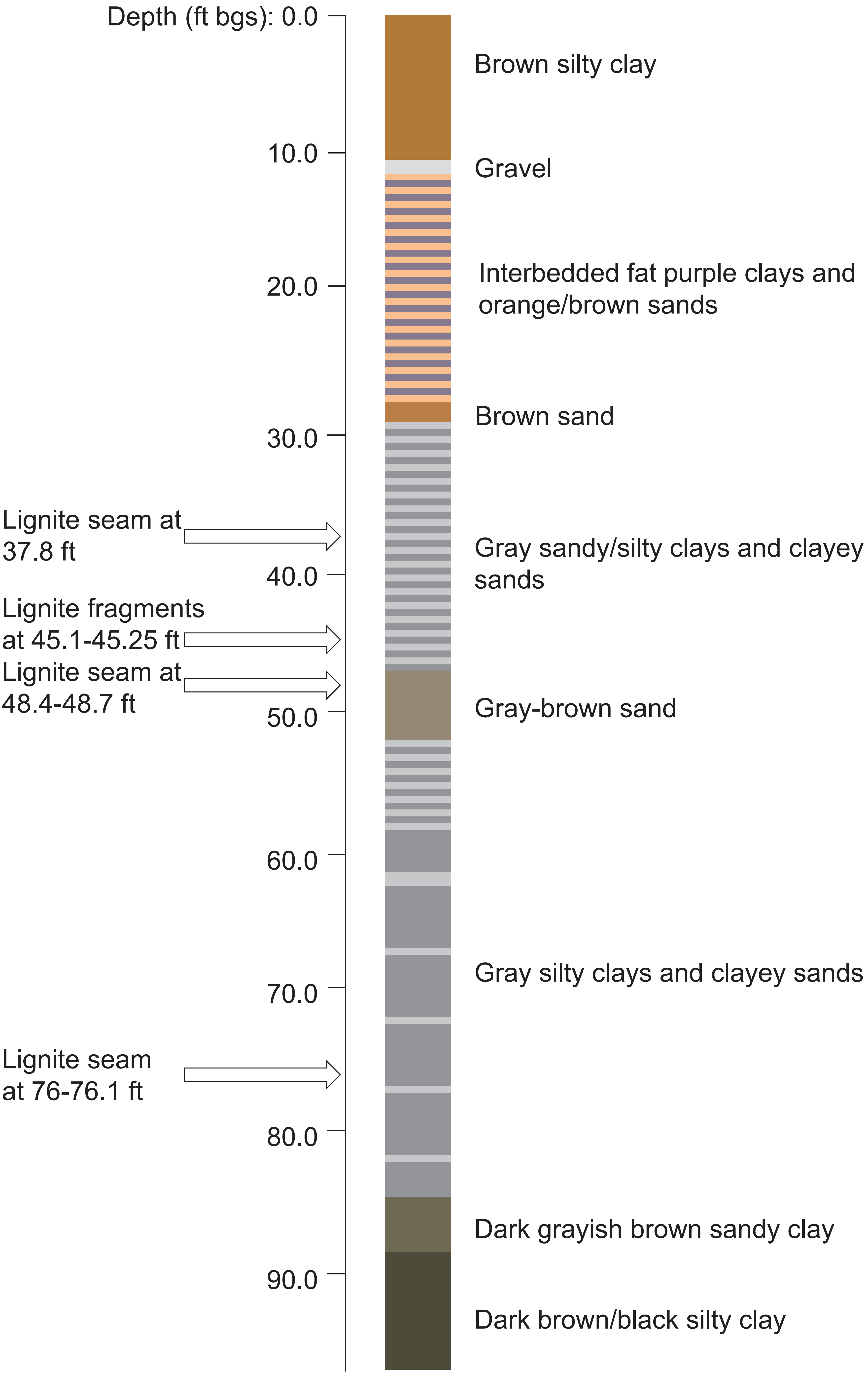
Geosyntec
consultants

Columbus, Ohio

2019/09/18

Figure
3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\Pirkey_SoilChem_minerals_March2019.mxd. hduff. 9/18/2019. Project/Phase/Task.



Notes:
- Ft = feet
- Bgs = below ground surface
- Boring completed May 2019
- Total depth of 97.5 ft bgs
- Well installed in offset boring screened at 29-34 ft bgs

Boring B-3 Visual Lithology Log

AEP Pirkey Powerplant
Hallsville, TX

Geosyntec
consultants

CHA8462	September 2019	**Figure** 4

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-05 Field Investigation\Field Forms\Compiled Boring Logs\Visual boring logs

ATTACHMENT A

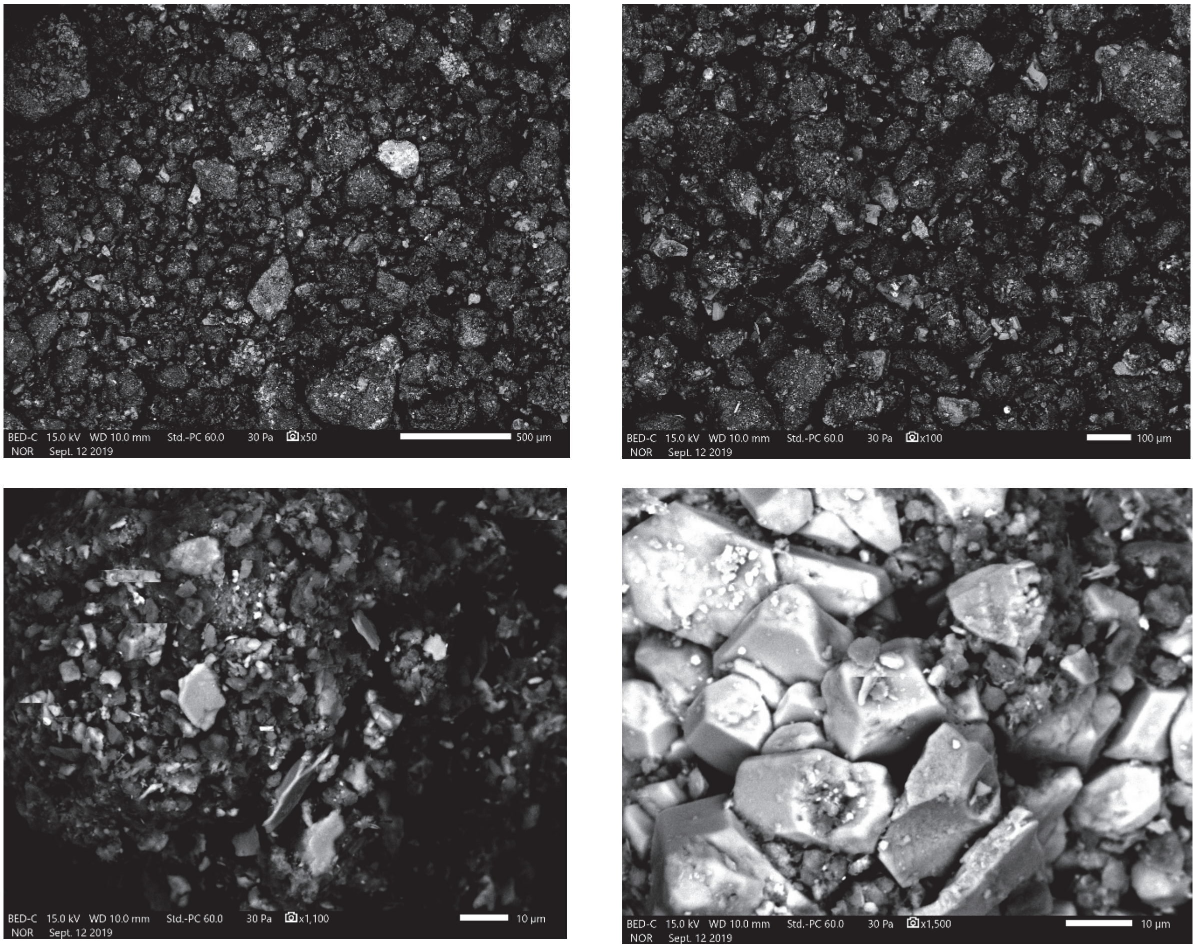
SEM/EDS Analysis

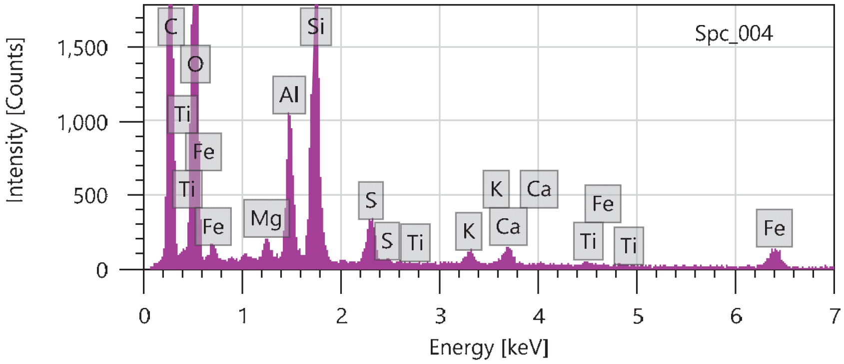
CTLGROUP

September 16, 2019

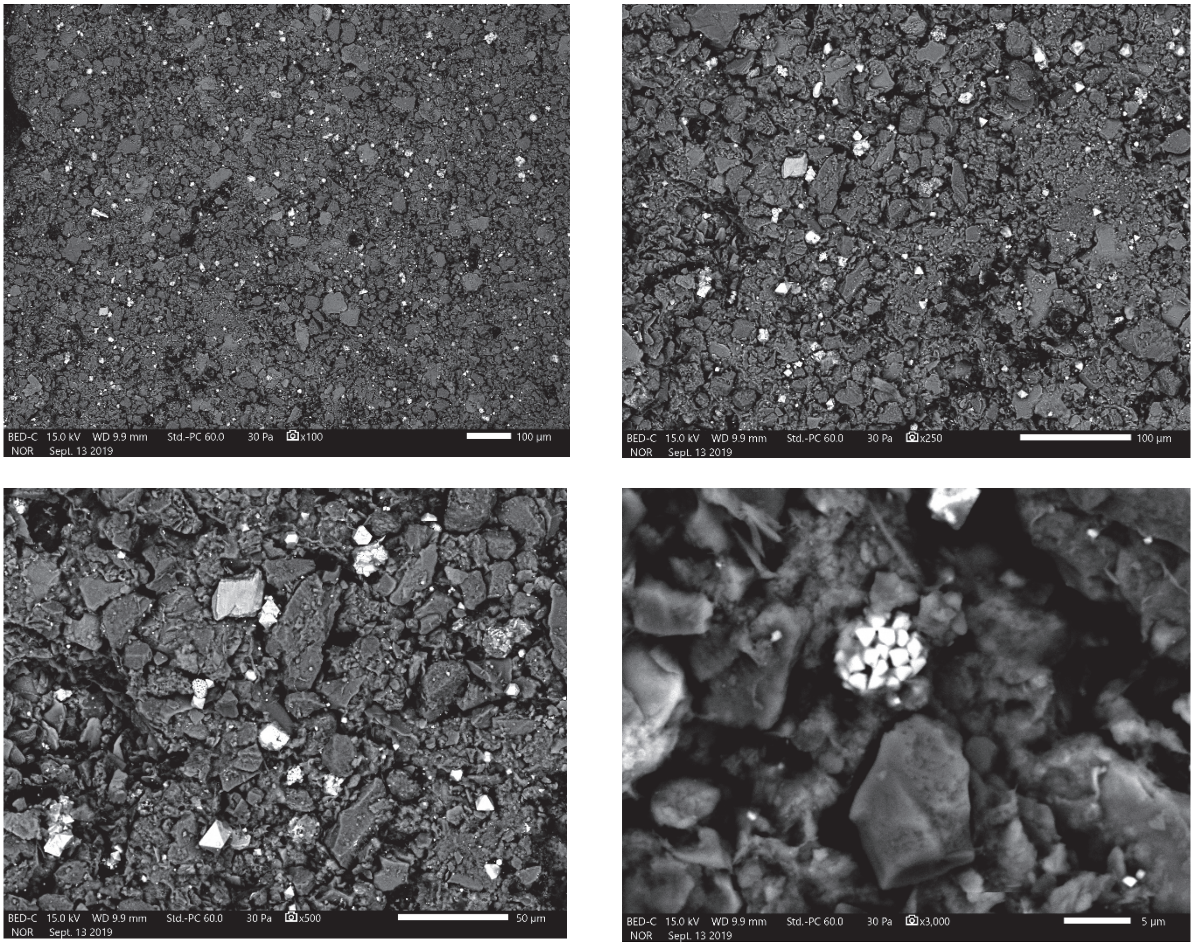
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221

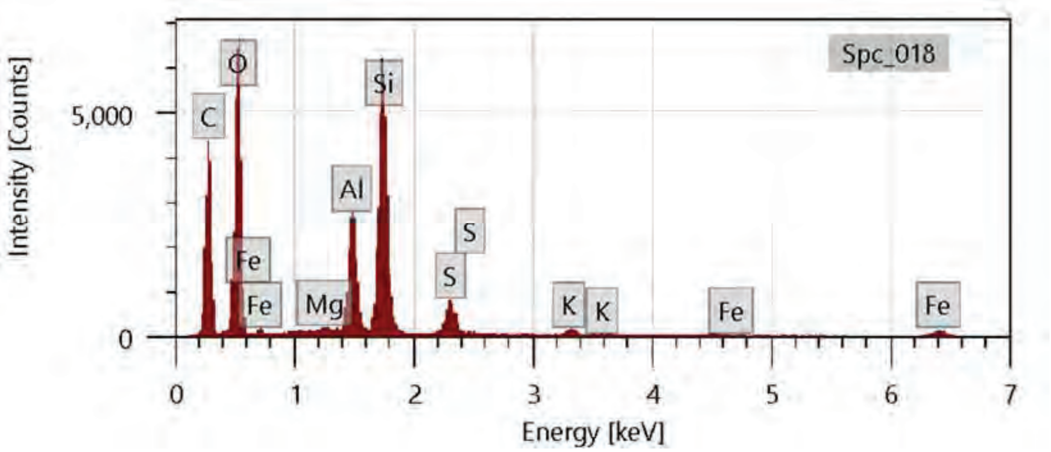
via Email: BSass@geosyntec.com



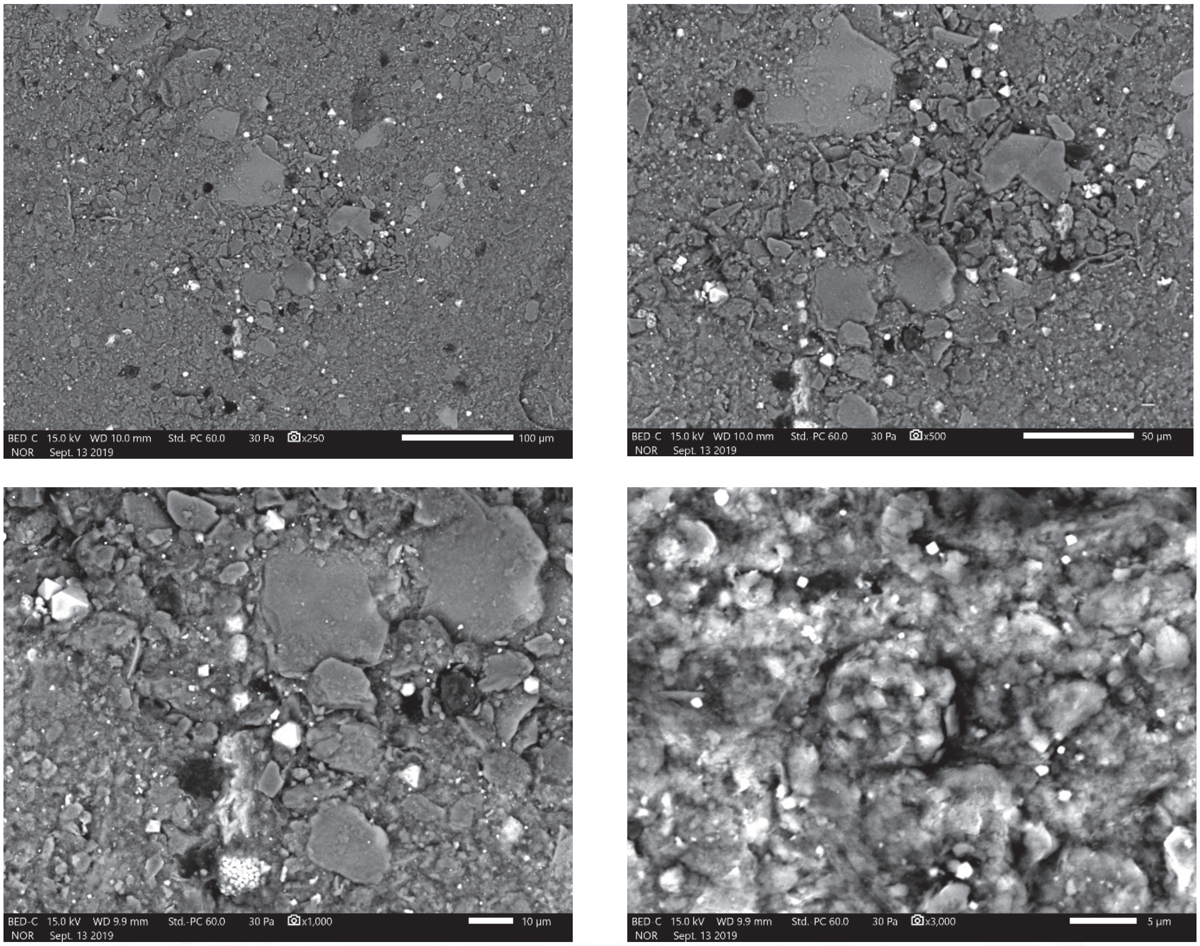


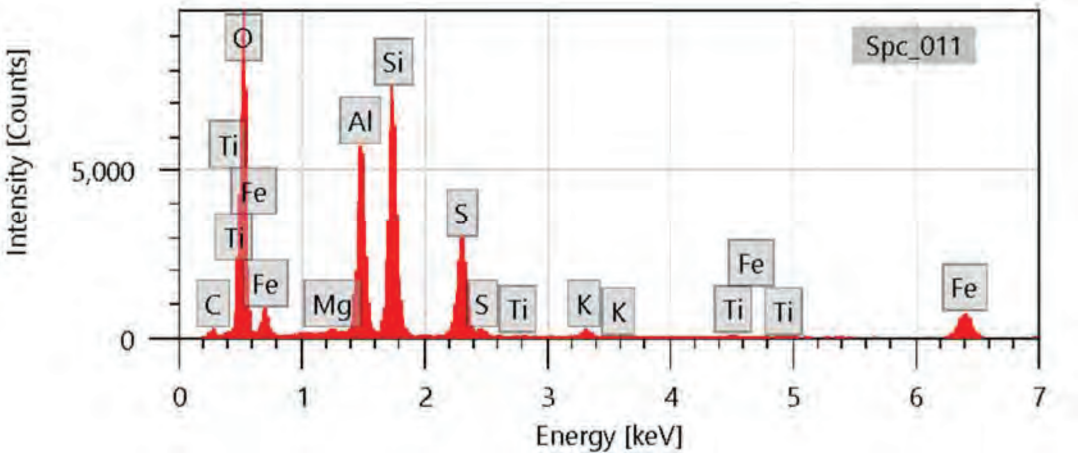
Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





Sample VAP B3 50-55. Backscattered electron micrographs show the sample at 250X, 500X, 1000X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 3000X. Bright particles are mostly pyrite (framboid in bottom left micrograph); occasional particles of Fe-Ti oxide are detected. Major peaks for oxygen, silicon, and aluminum suggest clay. Large blocky particles are mostly quartz, feldspar, and clay.

ATTACHMENT B

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey West Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

BETH ANN GROSS
79864

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

10/3/2019
Date

APPENDIX IV

Notices of groundwater monitoring program transitions are included in this appendix.

APPENDIX V

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #506035

Owner: **H W PIRKEY POWER PLANT**

Owner Well #: **SB10**

Address: **2400 FM 3251**
HALLSVILLE, TX 75650

Grid #: **35-37-4**

Latitude: **32° 26' 52.08" N**

Well Location: **2400 FM 3251**
HALLSVILLE, TX 75650

Longitude: **094° 29' 58.82" W**

LOCATED ON OWNERS PROPERTY

Elevation: **No Data**

Well County: **Harrison**

****Plugged Within 48 Hours****

****This well has been plugged****

<u>Plugging Report Tracking #185184</u>

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/19/2019** Drilling End Date: **2/20/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**60**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
31	**38**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Plug Information:

Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
SAND	**50**	**60**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**clay brown**
1	**5**	**silty sand**
5	**9.5**	**clay**
9.5	**11**	**sand**
11	**32**	**clay**
32	**39**	**sand and clay**
39	**55**	**sand**
55	**60**	**fine sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**40**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**40**	**50**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS PLUGGING REPORT for Tracking #185184

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 26' 52.08" N**
		Longitude:	**094° 29' 58.82" W**
Well County:	**Harrison**	Elevation:	**No Data**

Well Type: **Monitor**

Drilling Information

Company:	**Plains Environmental Services**	Date Drilled:	**2/20/2019**
Driller:	**Jesse Kalvig**	License Number:	**5025**

Well Report Tracking #506035

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Plugging Information

Date Plugged: **2/21/2019** Plugger: **Jesse Kalvig**

Plug Method: **Pour in 3/8 bentonite chips when standing water in well is less than 100 feet depth, cement top 2 feet**

Casing Left in Well:

DIa (in.)	*Top (ft.)*	*Bottom (ft.)*
2	**15**	**50**

Plug(s) Placed in Well:

Top (ft.)	*Bottom (ft.)*	*Description (number of sacks & material)*
1	**40**	**Bentonite 10 Bags/Sacks**

Certification Data: The driller certified that the driller plugged this well (or the well was plugged under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the reports(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

STATE OF TEXAS WELL REPORT for Tracking #506039

Owner: **H W PIRKEY POWER PLANT**

Owner Well #: **AD37**

Address: **2400 FM 3251**
HALLSVILLE, TX 75650

Grid #: **35-37-1**

Well Location: **2400 FM 3251**
HALLSVILLE, TX 75650

LOCATED ON OWNERS PROPERTY

Latitude: **32° 27' 56.32" N**

Longitude: **094° 29' 41.78" W**

Elevation: **No Data**

Well County: **Harrison**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**17**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
1	**10**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**8.5**	**CLAYS WITH SOME SAND**
8.5	**10.5**	**SAND**
10.5	**13**	**CLAY SOME SAND**
13	**15**	**SAND WITH SOME CLAYS**
15	**17**	**CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**12**	**17**

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Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506038

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD38**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 27' 46.12" N**
		Longitude:	**094° 29' 43.34" W**
		Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/21/2019** Drilling End Date: **2/21/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
1	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**CLAY RED**
5	**7**	**CLAY GRAY/RED**
7	**11.5**	**SAND/CLAY**
11.5	**17.5**	**SAND SOME CLAYS**
17.5	**18**	**CLAY SLITS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506037

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD39**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650 LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 26' 52.05" N**
		Longitude:	**094° 29' 58.84" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019**

Drilling End Date: **2/20/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**12**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
1	**5**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**CLAY**
1	**5**	**CLAY/SAND**
5	**9.5**	**CLAY**
9.5	**12**	**SAND/CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**7**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**7**	**12**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508688

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**AD-40 (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/10/2019**

Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**40**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
27	**40**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**13**	**Cement**
13	**27**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**40**	**red and grey sand with occasional clay intervals**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**30**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**30**	**40**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508686

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB(MW)-01A**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/9/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**100**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
86	**100**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**86**	**Bentonite 17 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**85**	**red and grey sand with occasional clay intervals**
85	**88**	**grey clay**
88	**100**	**grey sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**90**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**90**	**100**

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508703

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**22**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
8	**22**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**3**	**Cement**
3	**8**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**22**	**red and grey sand w/occ. lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**12**	**22**

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STATE OF TEXAS WELL REPORT for Tracking #508695

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019**

Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**80**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
56	**80**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**56**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**36**	**red and grey sand w/occ. lignite layers**
36	**41**	**red and tan clay**
41	**69**	**red and grey sand with occasional clay iand lignite layers**
69	**80**	**grey sandy clay with lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**59**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**59**	**69**

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508712

Owner: **AEP Pirkey Power Plant**

Address: **2400 FM 3251**
Hallsville, TX 75650

Well Location: **2400 FM 3251**
Hallsville, TX 75650

Well County: **Harrison**

Owner Well #: **SB-5 shallow (MW)**

Grid #: **35-37-1**

Latitude: **32° 27' 48" N**

Longitude: **094° 29' 53" W**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/24/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**25**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
12	**25**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**8**	**Cement**
8	**12**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**25**	**brown sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**15**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**15**	**25**

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508708

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019**

Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
45	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**45**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**28**	**brown sand**
28	**41**	**brown and grey silty clay**
41	**70**	**grey sand with occasional lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**50**	**60**

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Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506040

Owner: **H W PIRKEY POWER PLANT**

Owner Well #: **SB6S**

Address: **2400 FM 3251**
HALLSVILLE, TX 75650

Grid #: **35-37-1**

Latitude: **32° 27' 30.34" N**

Well Location: **2400 FM 3251**
HALLSVILLE, TX 75650

Longitude: **094° 29' 27.76" W**

LOCAATED ON OWNERS PROPERTY

Elevation: **No Data**

Well County: **Harrison**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**10**	**CLAYS**
10	**18**	**SANDS AND CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

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Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506041

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6D**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 27' 30.28" N**
		Longitude:	**094° 29' 27.75" W**
		Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019**

Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**65**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
1	**53**	**Bentonite 19 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**24**	**SANDS AND CLAYS**
24	**29**	**CLAYS**
29	**42.5**	**SANDS AND CLAYS**
42.5	**48.5**	**SANDS WITH SOME CLAY**
48.5	**56**	**CLAYS WITH SOME SAND**
56	**65**	**SILY SANDS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508722

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/3/2019**

Drilling End Date: **3/3/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	0	45

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
32	45	Sand	16/30

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	12	Cement
12	32	Bentonite 6 Bags/Sacks

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**45**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**35**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**35**	**45**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508720

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 deep (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
57	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**12**	**Cement**
12	**57**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**70**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**60**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**60**	**70**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508724

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**35**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**35**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**23**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**35**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**25**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**25**	**35**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508729

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 medium (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/27/2019**

Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	0	65

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
52	65	Sand	16/30

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	12	Cement
12	53	Bentonite 4 Bags/Sacks

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**65**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**55**	**65**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508777

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 deep (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/24/2019**

Drilling End Date: **2/26/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**93**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
77	**93**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**77**	**Bentonite 15 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**90**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**
90	**93**	**gray clay (old pit base?)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**80**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**80**	**90**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508781

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/5/2019**

Drilling End Date: **3/5/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**30**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
17	**30**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**17**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508779

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**   Proposed Use: **Monitor**

Drilling Start Date: **3/4/2019**   Drilling End Date: **3/4/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**60**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
48	**60**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**48**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**   **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

	Strata Depth (ft.)	Water Type
Water Quality:	**No Data**	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**60**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508718

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/8/2019**

Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**15**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**15**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement**
1	**3**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**5**	**15**

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Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508717

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/7/2019**

Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**43**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
30	**43**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**30**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**
18	**43**	**red and grey sand w/occ. clay layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**33**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**33**	**43**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525309

Owner: **AEP Pirkey Power Plant**

Owner Well #: **B-2**

Address: **2400 FM 3251**
Hallsville, TX 75650

Grid #: **35-37-1**

Latitude: **32° 27' 54.7" N**

Well Location: **2400 FM 3251**
Hallsville, TX 75650

Longitude: **094° 28' 25.01" W**

Well County: **Harrison**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **5/13/2019** Drilling End Date: **5/17/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**49**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
36	**49**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**32**	**Concrete 1 Bags/Sacks**
32	**36**	**Bentonite 1 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht** License Number: **4997**

Apprentice Name: **Ramon Gutierrez** Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**0.5**	**SILTY SAND, black**
0.5	**2**	**SAND, red/brown**
2	**5**	**SANDY CLAY, alternating layers red + brown**
5	**5.5**	**NO RECOVERY**
5.5	**6.7**	**SANDY CLAY, gray + brown/red**
6.7	**8**	**CLAY, gray**
8	**11**	**CLAY, gray with brown striations**
11	**11.5**	**CLAY, gray**
11.5	**12**	**CLAYEY, gray SAND, red-brown**
12	**14**	**NO RECOVERY**
14	**14.75**	**SANDY CLAY, reddish brown + gray**
14.75	**16**	**CLAY, gray + red & trace brown fine grained SAND**
16	**18.5**	**NO RECOVERY**
18.5	**18.75**	**CLAY, red & gray, trace SILT**
18.75	**18.95**	**SAND, tan**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**38**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**38**	**48**
2	**SUMP**	**New Plastic (PVC)**	**40**	**48**	**48.5**

18.95	20	CLAY, red/drk. gray
20	21.1	NO RECOVERY
21.1	21.8	SANDY CLAY, lt. brown + red
21.8	24	CLAY, red + drk. gray
24	24.5	SANDY CLAY, lt. brown
24.5	24.8	SANDY CLAY, red-brown
24.8	28	CLAY, purple + gray
28	29.9	CLAY, drk. purple
29.9	30.7	CLAY, black/drk. gray
30.7	32	SILTY CLAY, black/drk. gray
32	33.5	SILTY CLAY, drk. gray
33.5	36	SILTY CLAY, black
36	36.5	NO RECOVERY
36.5	38.1	SAND, drk. green
38.1	38.3	SILTY SAND, drk. brown
38.3	38.4	CLAYEY SAND, very drk. brown
38.4	38.5	SILTY SAND, drk. green
38.5	39	SILTY SAND, drk. brown
39	39.2	Laminated SANDY CLAY/CLAYEY SANDS, gray to drk. gray
39.2	43.1	NO RECOVERY
43.1	44.5	Fine graded SAND w/trace SILT, greenish gray
44.5	47	CLAYEY SAND/SANDY CLAY, drk. brown
47	48.1	NO RECOVERY
48.1	49	CLAYEY SAND/SANDY CLAY, drk. brown

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525308

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**B-3**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 54.7" N**
		Longitude:	**094° 28' 25.01" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **5/15/2019** Drilling End Date: **5/15/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8	**0**	**35**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
26.9	**35**	**Sand**	**20/40**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**22**	**Concrete 1 Bags/Sacks**
22	**26.9**	**Bentonite 1 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht** License Number: **4997**

Apprentice Name: **Ramon Gutierrez** Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	2	CLAY, medium red-brown
2	3	CLAY, lt. brown
3	4	Organic CLAY, gray to lt. brown
4	4.5	Organic CLAY, lt. brown
4.5	5	Organic CLAY, lt. brown to reddish brown
5	9.5	Organic CLAY, lt. brown to reddish brown
9.5	10.5	SILTY CLAY, reddish-orange
10.5	11	Poorly graded gravel
11	13	CLAYEY SAND,
13	13.9	SANDY CLAY, brown to orange
13.9	15	SAND, orange
15	16	SANDY CLAY
16	18	SAND, orange
18	18.5	Fat CLAY, grayish purple
18.5	19.5	SAND, orange to grayish orange

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	Riser	New Plastic (PVC)	40	0	29.2
2	Screen	New Plastic (PVC)	40 0.010	29.2	34
2	SUMP	New Plastic (PVC)	40 0.010	34	34.5

19.5	20	Fat CLAY, grayish purple
20	22.1	SAND, lt. brown to orange
22.1	22.3	Lenes of fat CLAY, drk. gray to purple
22.3	22.6	SAND, lt. brown to orange
22.6	23	Gravelly SAND
23	24	SANDY CLAY, grayish purple
24	25.6	SAND, tan to lt. brown
25.6	26.4	CLAY, purple and gray
26.4	26.8	CLAYEY SAND, tan to lt. brown
26.8	27.3	CLAY, purple
27.3	28	CLAY, drk. gray
28	28.6	NO RECOVERY
28.6	29.2	SAND, lt. brown
29.2	29.5	SILTY CLAY, drk. gray
29.5	32	CLAY, drk. gray to black
32	32.7	CLAY, drk. gray
32.7	33.1	CLAYEY SILT, drk. gray
33.1	35	SAND, drk. gray

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #525304

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**B-6**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 54.7" N**
		Longitude:	**094° 28' 25.01" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **5/20/2019** Drilling End Date: **5/20/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
4	0	40

Drilling Method: **Direct Push**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
27	40	Sand	20/40

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	25	Concrete 1 Bags/Sacks
25	27	Bentonite 1 Bags/Sacks

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **BEST DRILLING SERVICES, INC.**

P.O. BOX 845
FRIENDSWOOD, TX 77549

Driller Name: **Ali Firouzbakht**

License Number: **4997**

Apprentice Name: **Ramon Gutierrez**

Apprentice Number: **56591**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**0.4**	**Topsoil with vegetation, black SILT**
0.4	**1.8**	**SILT, brown**
1.8	**7**	**SILTY CLAY, red & lt. gray**
2.3	**23.5**	**SILT, drk. red**
7	**7.2**	**SILT, brown**
7.2	**7.6**	**SILTY CLAY, red & lt. gray**
7.6	**8**	**CLAY, lt. gray**
8	**9**	**CLAY, lt. gray & lt. red**
9	**9.3**	**SILTY CLAY, lt. gray & brown**
9.3	**9.8**	**CLAY, lt. gray**
9.8	**12**	**CLAY, reddish-brown**
12	**12.8**	**SILTY CLAY, red & brown**
12.8	**16**	**SILTY CLAY, drk. brown**
16	**18.1**	**CLAY, red & brown**
18.1	**18.8**	**SILTY CLAY, brown**
18.8	**18.9**	**CLAY, brown**
18.9	**19.1**	**SILT, lt. gray & brown**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**29**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**29**	**39**
2	**SUMP**	**New Plastic (PVC)**	**40**	**39**	**39.5**

19.1	**19.4**	**SILTY CLAY, brown**
19.4	**20**	**CLAYEY SILT, lt. gray & brown**
20	**20.9**	**CLAY, red/brown**
20.9	**22.1**	**CLAYEY SILT, lt. brown**
22.1	**23.2**	**SILTY CLAY, lt. brown & gray**
23.5	**24**	**SILTY CLAY, lt. brown & gray**
24	**25.9**	**NO RECOVERY**
25.9	**26.1**	**CLAYEY SILT, lt. brown**
26.1	**26.3**	**SILTY CLAY, brown**
26.3	**28**	**SILTY CLAY, black & drk. green**
28	**28.7**	**Trace CLAY, brown SILT**
28.7	**29.6**	**SILTY CLAY, drk. brown & green**
29.6	**29.9**	**CLAY, drk. brown**
29.9	**30.3**	**CLAYEY SAND, drk. green & drk. brown**
30.3	**32**	**Fine grained SAND, drk. green**
32	**34.4**	**Fine grained SAND, gray & brown**
34.4	**34.5**	**SILT w/gravel, tan/brown**
34.5	**34.7**	**CLAY, drk. brown**
34.7	**35.1**	**Fine grained SAND, drk. green**
35.1	**36**	**Fine grained SANDY SILT, drk. green & black**
36	**37.4**	**Fine grained SAND, drk. brown**
37.4	**38.5**	**Fine grained SILTY SAND, drk. gray & drk. green**
38.5	**40**	**SANDY SILT, drk. green & black**

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Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
FGD Stackout Area CCR Management Unit
Hallsville, Texas

January 2020

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY
An AEP Company
BOUNDLESS ENERGY

Page

Table of Contents

I. Summary

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2020.

In general, the following activities were completed:

- Groundwater samples were collected for AD-7, AD-12, AD-13, AD-22, and AD-33 in February, May, and August 2019 analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in Assessment monitoring at the beginning and the end of 2019;
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for mercury at wells AD-22 on December 26, 2018. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on February 14, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-22 on July 11, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on October 3, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-7 and AD-22 and cobalt at AD-22 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;

- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations (Appendix IV).
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

FGD Stackout Area Monitoring Wells	
Up Gradient	Down Gradient
AD-12	AD-7
AD-13	AD-22
	AD-33

III. Monitoring Wells Installed or Decommissioned

Several monitoring wells were installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry in mine spoils. Please see the list below. Well installation reports can be found in Appendix V.

Soil Boring ID	Monitor Well ID
	AD-37
	AD-38
	AD-39
	AD-40
SB-01A	AD-41
SB-04	AD-42
SB-04	AD-43
SB-05	AD-44
SB-05	AD-45
SB-06	AD-46
SB-06	AD-47
SB-07	AD-48
SB-07	AD-49
SB-08	AD-50
SB-08	AD-52
SB-08	AD-53
SB-09	AD-54
SB-09	AD-55
SB-11	AD-56
SB-11	AD-57

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event also are shown in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a one round of sampling in February in accordance with 40 CFR 257.95(d)(1). A May sampling event was conducted in accordance with 40 CFR 257.95(b) including all Appendix III parameters and those Appendix IV constituents parameters followed by an August round of sampling in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2020.

V. Statistical Evaluation of 2019 Events

The two statistical analysis reports are included in Appendix II.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-22 on July 11, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on October 3, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-7 and AD-22 and cobalt at AD-22 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the SSLs above GWPSs. SSLs above the GWPS at AD-22 were determined for mercury on December 26, 2018. An alternate source for mercury was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on February 14, 2019.

SSLs above the GWPS were determined for beryllium at wells AD-22 on July 10, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on October 3, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-7 and AD-22 and cobalt at well AD-22 on January 3, 2020. An alternate source investigation will be conducted for these SSLs.

The supporting information are found in Appendix III.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

The unit transitioned from detection monitoring to assessment monitoring transition on April 3, 2018.

Assessment monitoring will continue in 2020.

Regarding defining an alternate monitoring frequency, no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

No other information applies at this time.

IX. Description of Any Problems Encountered in 2019 and Actions Taken

No significant problems were encountered.

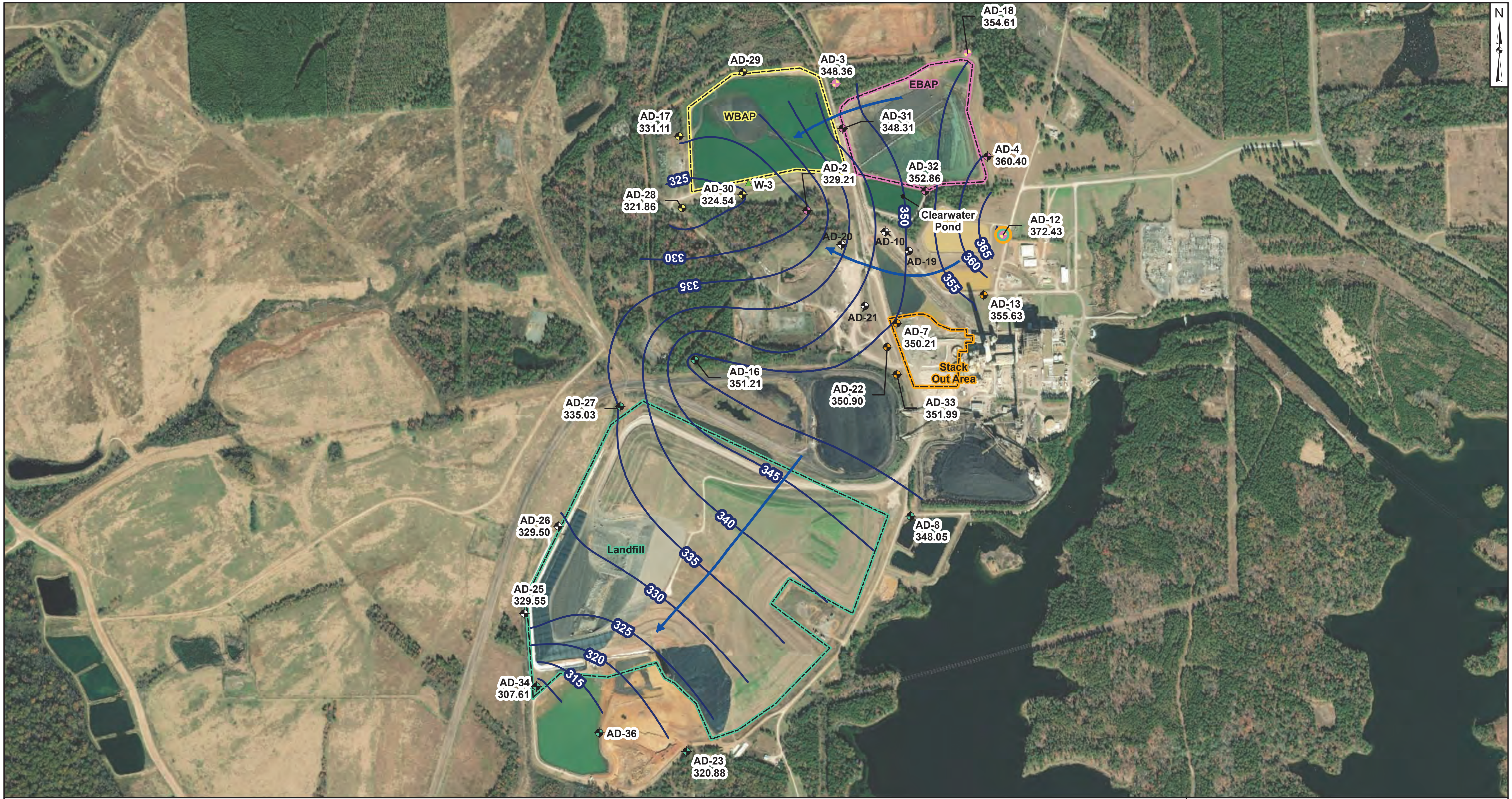
X. A Projection of Key Activities for the Upcoming Year

Key activities for 2020 include:

- Assessment monitoring sampling will be conducted;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for any SSLs above GWPS;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the fourth annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP

- ◎ All CCR Unit Networks
- ▲ Piezometer
- ➞ Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)

Notes
- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
February 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
1

Columbus, Ohio
2020/01/16

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- ― Groundwater Elevation Contour
- → Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

Potentiometric Contours - Uppermost Aquifer
May 2019

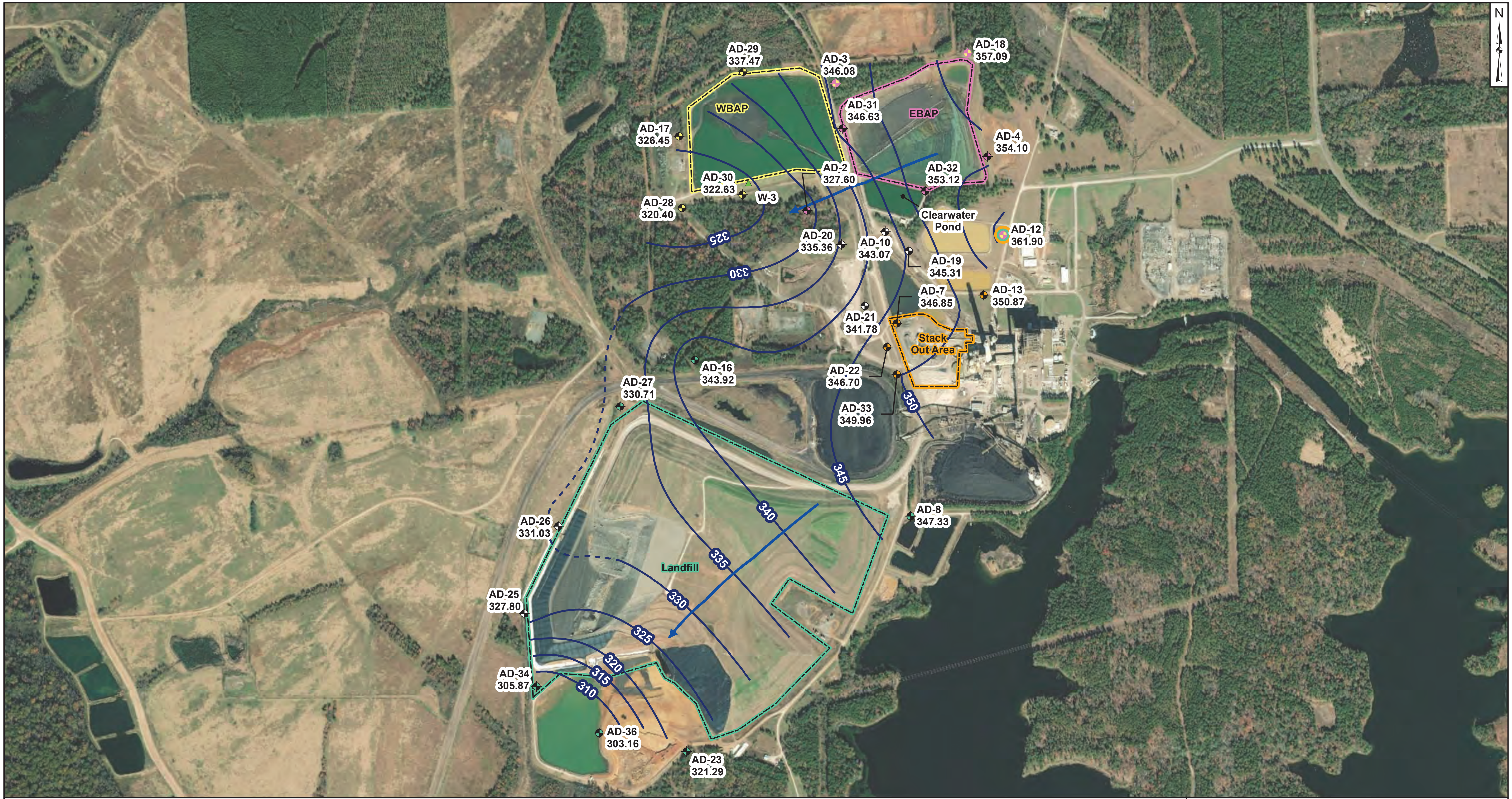
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
2

Columbus, Ohio
2020/01/16

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201905-May.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- ⊕ Out of Network
- ⊕ EBAP
- ⊕ WBAP
- ⊕ Landfill
- ⊕ Stackout Area
- ⊕ EBAP and WBAP

- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
3

Columbus, Ohio
2020/01/16

Table 1: Residence Time Calculation Summary
Pirkey Plant Stackout Area

			2019-02		2019-05		2019-08	
CCR Management Unit	Monitoring Well	Well Diameter (inches)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
Stack Out Area	AD-7 [2]	4.0	11.2	10.8	7.1	17.1	13.8	8.8
	AD-12 [1]	4.0	34.2	3.6	35.0	3.5	21.4	5.7
	AD-13 [1]	4.0	28.6	4.2	14.8	8.2	19.4	6.3
	AD-22 [2]	2.0	6.9	8.8	9.6	6.3	9.1	6.7
	AD-33 [2]	2.0	5.3	11.5	6.9	8.9	12.2	5.0

Notes:

[1] - Background Well

[2] - Downgradient Well

Table 1 - Groundwater Data Summary: AD-7
Pirkey - Stackout
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	2.39	6.58	28	0.6493 J	4.0	302	92
7/13/2016	Background	0.716	2.97	16	<0.083 U	3.6	204	40
9/7/2016	Background	0.978	3.15	18	<0.083 U	4.1	208	42
10/13/2016	Background	0.67	2.81	17	<0.083 U	3.8	212	38
11/14/2016	Background	0.682	2.63	16	<0.083 U	4.0	216	38
1/11/2017	Background	1.39	3.92	19	<0.083 U	3.5	204	46
2/28/2017	Background	1.51	4.78	20	<0.083 U	3.7	240	46
4/10/2017	Background	3.24	5.06	28	0.4117 J	3.6	322	65
8/24/2017	Detection	0.943	2.99	18	2.994	3.7	176	51
12/21/2017	Detection	0.718	3.26	19	<0.083 U	- -	176	39
3/21/2018	Assessment	2.47	5.37	20	<0.083 U	3.6	266	90
8/20/2018	Assessment	1.36	3.76	33	<0.083 U	4.3	180	54
2/27/2019	Assessment	2.10	5.2	29.9	0.50	2.9	268	69.1
5/22/2019	Assessment	0.195	5.77	28.0	0.58	3.4	334	91.6
8/12/2019	Assessment	3.54	4.20	36.7	0.30	4.0	266	59.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-7
Pirkey - Stackout
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	1.38216 J	37	8	0.87394 J	0.766043 J	52	4.344	0.6493 J	<0.68 U	0.044	0.309	<0.29 U	1.04661 J	<0.86 U
7/13/2016	Background	<0.93 U	1.18444 J	50	3	0.66774 J	1	24	0.942	<0.083 U	<0.68 U	0.099	0.261	<0.29 U	<0.99 U	1.03212 J
9/7/2016	Background	<0.93 U	<1.05 U	50	4	0.730872 J	0.316008 J	27	3.132	<0.083 U	<0.68 U	0.099	0.059	<0.29 U	<0.99 U	<0.86 U
10/13/2016	Background	<0.93 U	1.08028 J	61	4	0.858417 J	1	23	3.81	<0.083 U	<0.68 U	0.101	0.154	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	60	4	1	<0.23 U	22	3.538	<0.083 U	<0.68 U	0.099	0.039	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	58	5	0.756968 J	<0.23 U	31	3.77	<0.083 U	<0.68 U	0.101	0.02275 J	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	53	5	0.838869 J	<0.23 U	34	3.92	<0.083 U	<0.68 U	0.101	0.185	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	51	7	0.723565 J	0.295188 J	44	4.35	0.4117 J	<0.68 U	0.111	0.191	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	40.31	6.81	0.82 J	<0.23 U	45.34	3.99	<0.083 U	<0.68 U	0.108	0.117	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	0.01 J	0.47	51.6	2.07	0.68	0.075	25.6	0.787	<0.083 U	0.362	0.0877	0.006 J	<0.02 U	1.0	0.179
2/27/2019	Assessment	<0.4 U	2.12	42.9	7.01	0.73	0.225	41.0	4.75	0.50	1 J	0.106	0.201	<0.4 U	7.1	<2 U
5/22/2019	Assessment	<0.4 U	2 J	37.8	6.47	0.6 J	<0.8 U	46.0	4.72	0.58	0.8 J	0.0975	0.26	<8 U	3 J	<0.1 U
8/12/2019	Assessment	<0.02 U	0.64	41.9	3.24	0.75	0.1 J	29.7	3.278	0.30	0.529	0.102	0.09	<0.4 U	1.7	0.2 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - Stackout
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	<0.083 U	4.4	94	4
7/13/2016	Background	0.03	0.26	6	<0.083 U	3.1	75	4
9/7/2016	Background	0.04	0.343	6	<0.083 U	3.9	63	7
10/12/2016	Background	0.03	0.271	7	< 1 U	3.4	92	8
11/14/2016	Background	0.04	0.331	8	<0.083 U	2.6	80	6
1/11/2017	Background	0.03	0.315	7	<0.083 U	4.8	76	6
2/28/2017	Background	0.04	0.434	5	<0.083 U	3.6	50	4
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	72	7
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	52	6
3/21/2018	Assessment	0.01397	0.269	5	<0.083 U	4.2	<2 U	3
8/20/2018	Assessment	0.017	0.338	10	<0.083 U	4.4	94	4
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	36	3.6
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	80	4.0
8/12/2019	Assessment	<0.02 U	0.278	7.24	0.06 J	4.9	90	2.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - Stackout
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	26	0.219521 J	<0.07 U	0.710981 J	1.58207 J	0.2073	<0.083 U	<0.68 U	<0.00013 U	<0.005 U	<0.29 U	1.73953 J	<0.86 U
7/13/2016	Background	<0.93 U	<1.05 U	23	0.190337 J	<0.07 U	0.68835 J	1.29444 J	2.909	<0.083 U	<0.68 U	0.008	<0.005 U	<0.29 U	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	30	0.232192 J	<0.07 U	0.353544 J	1.66591 J	0.881	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	<1.05 U	27	0.149553 J	<0.07 U	0.529033 J	1.56632 J	0.257	< 1 U	<0.68 U	0.012	<0.005 U	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	28	0.152375 J	<0.07 U	0.32826 J	1.47282 J	0.767	<0.083 U	<0.68 U	0.013	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	23	0.126621 J	<0.07 U	0.650158 J	1.09495 J	1.536	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	26	0.149219 J	<0.07 U	0.325811 J	1.29984 J	0.416	<0.083 U	<0.68 U	0.009	<0.005 U	<0.29 U	<0.99 U	0.994913 J
4/11/2017	Background	<0.93 U	<1.05 U	24	0.159412 J	<0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	<0.68 U	0.008	0.01364 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	25.82	0.16 J	<0.07 U	1.05	1.49 J	0.784	<0.083 U	<0.68 U	0.00722	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	<0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	<0.083 U	0.089	0.0143	<0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	<0.4 U	<0.6 U	22.5	<0.4 U	<0.2 U	<0.8 U	1.37	0.225	0.09	<0.4 U	0.00688	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	<0.6 U	21.7	<0.4 U	<0.2 U	<0.8 U	1.15	0.201	0.09	<0.4 U	0.00576	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.07 J	23.8	0.154	<0.01 U	0.204	1.3	0.237	0.06 J	0.08 J	0.00829	<0.005 U	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-13
Pirkey - Stackout
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.06	8.77	28	0.748 J	5.6	236	52
7/13/2016	Background	0.06	9.08	32	0.3474 J	5.6	192	59
9/7/2016	Background	0.05	8.48	23	<0.083 U	5.2	228	41
10/13/2016	Background	0.06	7.53	26	0.6297 J	5.8	236	47
11/14/2016	Background	0.06	7.21	26	0.3114 J	6.1	250	47
1/11/2017	Background	0.04	6.14	22	<0.083 U	5.8	188	37
2/28/2017	Background	0.07	7.88	28	<0.083 U	5.9	172	56
4/11/2017	Background	0.08	9.11	32	0.4278 J	5.2	200	58
8/23/2017	Detection	0.07408	9.5	21	0.344 J	6.0	160	38
3/21/2018	Assessment	0.07169	10.3	25	<0.083 U	5.9	176	48
8/20/2018	Assessment	0.065	8.40	39	0.0845 J	5.9	210	66
2/27/2019	Assessment	0.08 J	11.0	40.8	0.25	5.2	176	80.8
5/21/2019	Assessment	0.061	10.1	34.8	0.40	5.3	190	69.5
8/12/2019	Assessment	0.064	8.68	42.3	0.39	5.9	310	73.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-13
Pirkey - Stackout
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	4.25914 J	38	0.586539 J	0.293832 J	<0.23 U	42	0.989	0.748 J	<0.68 U	0.081	0.00969 J	<0.29 U	<0.99 U	1.11268 J
7/13/2016	Background	<0.93 U	9	44	2	0.0875208 J	<0.23 U	47	2.332	0.3474 J	<0.68 U	0.158	0.01928 J	<0.29 U	3.63671 J	0.928756 J
9/7/2016	Background	<0.93 U	<1.05 U	47	0.631177 J	0.219799 J	<0.23 U	38	1.219	<0.083 U	<0.68 U	0.139	<0.005 U	<0.29 U	<0.99 U	1.44332 J
10/13/2016	Background	<0.93 U	7	43	0.963478 J	<0.07 U	<0.23 U	42	2.422	0.6297 J	<0.68 U	0.142	<0.005 U	<0.29 U	2.59885 J	<0.86 U
11/14/2016	Background	<0.93 U	2.07189 J	39	0.717704 J	0.310257 J	<0.23 U	42	1.723	0.3114 J	<0.68 U	0.136	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	2.73936 J	39	0.302907 J	0.11238 J	<0.23 U	32	1.844	<0.083 U	<0.68 U	0.133	0.00732 J	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	1.64435 J	34	0.290018 J	<0.07 U	<0.23 U	44	1.728	<0.083 U	<0.68 U	0.153	<0.005 U	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	4.43115 J	45	0.736525 J	2	<0.23 U	56	1.309	0.4278 J	<0.68 U	0.156	<0.005 U	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	3.23 J	42.23	0.46 J	0.86 J	<0.23 U	39.91	2.093	<0.083 U	<0.68 U	0.145	<0.005 U	<0.29 U	3.86 J	<0.86 U
8/20/2018	Assessment	0.01 J	5.79	40.9	0.648	<0.005 U	0.103	48.8	1.735	0.0845 J	0.01 J	0.146	<0.005 U	<0.02 U	0.2	0.03 J
2/27/2019	Assessment	<0.4 U	2.17	38.5	<0.4 U	<0.2 U	<0.8 U	48.7	0.909	0.25	<0.4 U	0.165	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	2 J	35.0	<0.4 U	<0.2 U	<0.8 U	44.7	0.875	0.40	<0.4 U	0.153	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	1.64	35.0	0.235	<0.01 U	0.06 J	44.5	1.642	0.39	<0.05 U	0.139	<0.005 U	<0.4 U	<0.03 U	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-22
Pirkey - Stackout
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.08	15.3	76	1.266	4.0	672	284
7/14/2016	Background	0.04	9.5	52	0.3891 J	3.9	412	162
9/7/2016	Background	0.04	6.95	42	<0.083 U	4.1	341	114
10/12/2016	Background	0.03	7.68	52	0.473 J	4.7	388	148
11/14/2016	Background	0.04	7.55	48	0.2834 J	4.4	362	177
1/12/2017	Background	0.02	6.47	51	<0.083 U	4.2	344	137
3/1/2017	Background	0.05	13.6	69	<0.083 U	4.1	624	266
4/11/2017	Background	0.04	10.8	72	0.5041 J	4.1	446	215
8/23/2017	Detection	0.05075	7.77	54	1.196	4.6	350	121
12/21/2017	Detection	0.06278	7.29	61	<0.083 U	- -	344	120
3/21/2018	Assessment	0.0818	15.2	79	<0.083 U	3.9	656	377
8/20/2018	Assessment	0.031	9.43	92	<0.083 U	4.2	476	184
2/27/2019	Assessment	0.07 J	15.2	76.7	1.33	4.9	584	337
5/22/2019	Assessment	0.073	16.5	63.3	1.06	5.1	506	360
8/12/2019	Assessment	0.03 J	8.96	79.6	0.45	4.8	484	198

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-22
Pirkey - Stackout
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	23	71	13	2	24	129	6.994	1.266	0.97266 J	0.139	13.41	<0.29 U	1.97127 J	1.16089 J
7/14/2016	Background	<0.93 U	12	48	6	0.674427 J	12	67	2.325	0.3891 J	<0.68 U	0.169	17	<0.29 U	<0.99 U	0.895409 J
9/7/2016	Background	<0.93 U	23	108	5	0.833408 J	33	54	3.412	<0.083 U	2.72959 J	0.131	19.829	<0.29 U	<0.99 U	1.25036 J
10/12/2016	Background	<0.93 U	10	54	4	0.333745 J	7	54	3.39	0.473 J	<0.68 U	0.14	7.984	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	3.69822 J	66	4	0.596378 J	2	47	3.63	0.2834 J	<0.68 U	0.115	8.634	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	6	67	4	0.385609 J	2	43	3.173	<0.083 U	<0.68 U	0.104	13.32	<0.29 U	1.09664 J	<0.86 U
3/1/2017	Background	<0.93 U	1.61319 J	29	10	1	<0.23 U	105	4.385	<0.083 U	<0.68 U	0.218	0.22	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	11	130	6	2	5	78	3.045	0.5041 J	1.89388 J	0.176	7.201	<0.29 U	1.86563 J	<0.86 U
3/21/2018	Assessment	<0.93 U	3.56 J	24.13	12.1	1.87	<0.23 U	121	6.22	<0.083 U	<0.68 U	0.277	1.206	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	0.02 J	5.18	22.7	3.30	0.46	0.829	62.9	3.088	<0.083 U	0.386	0.132	1.448	0.07 J	2.5	0.162
2/27/2019	Assessment	<0.4 U	6.3	17.0	13.3	1.55	0.8 J	123	5.99	1.33	0.5 J	0.269	0.642	<8 U	16.7	<2 U
5/22/2019	Assessment	<0.4 U	5.89	16.7	12.5	1.52	<0.8 U	129	6.71	1.06	<0.4 U	0.288	0.837	<8 U	5.9	0.2 J
8/12/2019	Assessment	<0.02 U	2.19	15.3	3.38	0.44	0.2 J	57.5	3.088	0.45	0.1 J	0.151	0.325	<0.4 U	2.0	0.2 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-33
Pirkey - Stackout
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.126	2.44	8	<0.083 U	4.1	326	56
7/14/2016	Background	0.173	1.69	16	<0.083 U	3.1	176	108
9/7/2016	Background	0.152	1.81	10	<0.083 U	3.6	176	64
10/12/2016	Background	0.162	1.39	9	0.357 J	3.4	180	46
11/14/2016	Background	0.182	1.63	8	<0.083 U	3.1	190	54
1/12/2017	Background	0.144	1.26	10	<0.083 U	4.3	168	58
2/28/2017	Background	0.14	1.25	7	<0.083 U	3.9	146	51
4/10/2017	Background	0.114	1.29	9	<0.083 U	3.4	178	49
8/23/2017	Detection	0.07952	1.06	9	0.670 J	4.4	132	40
12/21/2017	Detection	0.09993	0.946	- -	- -	- -	- -	- -
3/21/2018	Assessment	0.115	1.42	7	<0.083 U	4.4	160	58
8/21/2018	Assessment	0.098	1.09	12	<0.083 U	3.6	156	48
2/27/2019	Assessment	0.134	1.73	8.89	0.25	3.3	146	62.8
5/22/2019	Assessment	0.111	1.65	8.57	0.23	4.1	204	60.4
8/12/2019	Assessment	0.097	1.03	8.85	0.19	4.2	156	44.3

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-33
Pirkey - Stackout
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	2.53645 J	60	2	<0.07 U	4	12	1.303	<0.083 U	<0.68 U	<0.00013 U	0.288	<0.29 U	<0.99 U	<0.86 U
7/14/2016	Background	<0.93 U	4.91616 J	64	2	<0.07 U	9	12	4.28	<0.083 U	<0.68 U	0.029	0.707	<0.29 U	<0.99 U	1.19199 J
9/7/2016	Background	<0.93 U	67	163	4	0.984692 J	125	33	3.461	<0.083 U	14	0.048	1.826	0.736517 J	1.61343 J	<0.86 U
10/12/2016	Background	<0.93 U	2.15866 J	59	1	<0.07 U	4	10	2.208	0.357 J	<0.68 U	0.027	0.145	<0.29 U	<0.99 U	1.56738 J
11/14/2016	Background	<0.93 U	1.46353 J	52	1	<0.07 U	1	9	1.953	<0.083 U	<0.68 U	0.024	0.197	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	1.12979 J	56	1	<0.07 U	2	9	2.596	<0.083 U	<0.68 U	0.027	0.36	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	1.069 J	55	1	<0.07 U	<0.23 U	9	0.942	<0.083 U	<0.68 U	0.026	0.41	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	55	1	<0.07 U	3	10	9.024	<0.083 U	<0.68 U	0.027	0.341	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	1.78 J	57.26	1.4	0.15 J	4.64	10.42	1.643	<0.083 U	<0.68 U	0.02669	0.825	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	0.01 J	0.65	43.8	0.905	0.04	0.147	7.72	6.32	<0.083 U	0.151	0.0178	0.745	<0.02 U	1.7	0.05 J
2/27/2019	Assessment	<0.4 U	1 J	49.5	1 J	<0.2 U	<0.8 U	10.5	2.235	0.25	<0.4 U	0.0262	0.464	<8 U	3 J	<2 U
5/22/2019	Assessment	<0.4 U	<0.6 U	52.4	1 J	<0.2 U	<0.8 U	10.5	1.178	0.23	<0.4 U	0.0245	0.481	<8 U	1 J	<0.1 U
8/12/2019	Assessment	<0.02 U	0.41	38.6	1.00	0.04 J	0.1 J	7.02	1.141	0.19	0.1 J	0.0233	0.564	<0.4 U	1.1	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
FLUE GAS DESULFERIZATION (FGD) STACKOUT AREA
H.W. Pirkey Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

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July 11, 2019

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LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
FGD	Flue Gas Desulfurization
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the Flue Gas Desulfurization (FGD) Stackout Area, an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, and sulfate at the FGD Stackout Area. An alternative source was not identified at the time, so two assessment monitoring events were conducted at the FGD Stackout Area in 2018, in accordance with 40 CFR 257.95. An SSL was identified for mercury at well AD-22. An ASD was successfully completed which resulted in a revision to the dataset for mercury at well AD-22 (Geosyntec, 2019). Thus, the unit remained in assessment monitoring.

A semi-annual assessment monitoring event was also completed in February 2019, with the results of the February 2019 event documented in this report. The groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The February 2019 monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. An SSL was identified for beryllium. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

FGD STACKOUT AREA EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, one set of samples was collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(d)(1). Although antimony, fluoride, lead, molybdenum, and thallium were not detected at any locations during the March 2018 screening event, samples from the February 2019 semi-annual sampling event were analyzed for all Appendix III and Appendix IV parameters. A summary of data collected during this assessment monitoring event may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.14 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the FGD Stackout Area were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained to meet the requirements of 40 CFR 257.95(d)(1) were screened for potential outliers. Non-detect values for molybdenum at AD-12, AD-13, AD-22, and AD-33 were flagged as outliers because the reporting limit during the February 2019 sampling event for these wells 0.04 mg/L compared to a historical reporting limit of 0.002 mg/L. Well AD-7 had a reporting limit of 0.002 mg/L during this event. The removal of these values as outliers did not affect the statistical evaluation of this event, as molybdenum was not detected during the March 2018 screening event.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for arsenic, cadmium, chromium, cobalt, fluoride, lithium, selenium, and thallium due to apparent non-normal distributions and for antimony, lead, mercury, and molybdenum due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSL was identified at the Pirkey FGD Stackout Area:

- The LCL for beryllium exceeded the GWPS of 0.004 mg/L at AD-22 (0.00413).

As a result, the Pirkey FGD Stackout Area will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Evaluation of Potential Appendix III SSIs

While an SSLs was identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations. Prediction limits were calculated for the Appendix III parameters to represent background values. As described in the January 2018 *Statistical Analysis Summary* report (Geosyntec, 2018), intrawell tests were used to evaluate potential SSIs for calcium, pH, and TDS, whereas interwell tests were used to evaluate potential SSIs for boron, chloride, fluoride, and sulfate.

Prediction limits for the interwell tests were recalculated using data collected during the February 2019 assessment monitoring event. Three data points (i.e., one sample from three background wells) were added to the background dataset for each interwell test. New data were tested for outliers prior to being added to the background dataset. The updated prediction limits were calculated for a one-of-two retesting procedure, as during detection monitoring. The values of the updated prediction limits were similar to the values of the prediction limits calculated during detection monitoring. The revised interwell prediction limits were used to evaluate potential SSIs for boron, chloride, fluoride, and sulfate.

For the intrawell tests, limited data made it possible to add only one data point (i.e., one sample from each compliance well) to each background dataset. Because one sample result is insufficient to compare against the existing background dataset, the prediction limits were not updated for the intrawell tests at this time. The intrawell prediction limits calculated during detection monitoring were used to evaluate potential SSIs for calcium, pH, and TDS.

Data collected during the February 2019 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0840 mg/L at AD-33 (0.134 mg/L) and AD-7 (2.1 mg/L).
- The chloride concentration exceeded the interwell UPL of 40.8 mg/L at AD-22 (76.7 mg/L).
- The fluoride concentration exceeded the interwell UPL or 1.0 mg/L at AD-22 (1.33 mg/L).
- The reported pH values exceeded the intrawell UPL of 4.8 SU at AD-22 (4.9 SU) and were below the intrawell lower prediction limit (LPL) of 3.2 SU at AD-7 (2.9 SU).
- The sulfate concentration exceeded the interwell UPL of 80.8 mg/L at AD-22 (337 mg/L).

While the prediction limits were calculated assuming a 1-of-2 testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey FGD Stackout Area during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. Following a review of outliers in the February 2019 data the non-detect molybdenum results from AD-12, AD-13, AD-22, and AD-33, which were replaced with the reporting limit, were removed as outliers. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. An SSLs was identified for beryllium. Appendix III parameters were also evaluated, with exceedances identified for boron, chloride, fluoride, pH, and sulfate.

Based on this evaluation, the Pirkey FGD Stackout Area unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Pirkey Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Flue Gas Desulfurization Stackout Area, H.W. Pirkey Power Plant, Hallsville, Texas. January 3, 2018.

Geosyntec. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant Flue Gas Desulfurization (FGD) Stackout Area. February 13, 2019.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March 2009.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - Stackout

Parameter	Unit	AD-7	AD-12	AD-13	AD-22	AD-33
		2/27/2019	2/27/2019	2/27/2019	2/27/2019	2/27/2019
Antimony	µg/L	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
Arsenic	µg/L	2.12	2.00 U	2.17	6.30	1.00 J
Barium	µg/L	42.9	22.5	38.5	17.0	49.5
Beryllium	µg/L	7.01	2.00 U	2.00 U	13.3	1.00 J
Boron	mg/L	2.10	0.0300 J	0.0800 J	0.0700 J	0.134
Cadmium	µg/L	0.730	1.00 U	1.00 U	1.55	1.00 U
Calcium	mg/L	5.20	0.400 J	11.0	15.2	1.73
Chloride	mg/L	29.9	6.08	40.8	76.7	8.89
Chromium	µg/L	0.225	4.00 U	4.00 U	0.800 J	4.00 U
Cobalt	µg/L	41.0	1.37	48.7	123	10.5
Combined Radium	pCi/L	4.75	0.225	0.909	5.99	2.24
Fluoride	mg/L	0.500	0.0900	0.250	1.33	0.250
Lead	µg/L	1.00 J	2.00 U	2.00 U	0.500 J	2.00 U
Lithium	mg/L	0.106	0.00688	0.165	0.269	0.0262
Mercury	mg/L	0.000201	0.0000250 U	0.0000250 U	0.000642	0.000464
Molybdenum	µg/L	2.00 U	40.0 U	40.0 U	40.0 U	40.0 U
Selenium	µg/L	7.10	4.00 U	4.00 U	16.7	3.00 J
Total Dissolved Solids	mg/L	268	36.0	176	584	146
Sulfate	mg/L	69.1	3.60	80.8	337	62.8
Thallium	µg/L	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
pH	SU	2.90	5.17	5.16	4.85	3.30

Notes:

µg/L: micrograms per liter

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.

J: Estimated value. Parameter was detected in concentrations below the reporting limit.

Table 2: Groundwater Protection Standards
Pirkey Plant - Stackout

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.002
Arsenic, Total (mg/L)	0.01		0.007
Barium, Total (mg/L)	2		0.053
Beryllium, Total (mg/L)	0.004		0.0019
Cadmium, Total (mg/L)	0.005		0.002
Chromium, Total (mg/L)	0.1		0.004
Cobalt, Total (mg/L)	n/a	0.006	0.056
Combined Radium, Total (pCi/L)	5		3.18
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.002
Lithium, Total (mg/L)	n/a	0.04	0.17
Mercury, Total (mg/L)	0.002		0.000025
Molybdenum, Total (mg/L)	n/a	0.1	0.002
Selenium, Total (mg/L)	0.05		0.004
Thallium, Total (mg/L)	0.002		0.002

Notes:

Grey cell indicates calculated UTL is higher than MCL.

MCL = Maximum Contaminant Level

RSL = Regional Screening Level

Calculated UTL (Upper Tolerance Limit) represents site-specific background values.

The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Appendix III Data Summary
Pirkey Plant - FGD Stackout Area

Parameter	Units	Description	AD-22	AD-33	AD-7
			2/27/2019	2/27/2019	2/27/2019
Boron	mg/L	Interwell Background Value (UPL)	0.0840		
		Detection Monitoring Result	0.07	**0.134**	**2.1**
Calcium	mg/L	Intrawell Background Value (UPL)	17.75	2.59	7.40
		Detection Monitoring Result	15.2	1.73	5.20
Chloride	mg/L	Interwell Background Value (UPL)	40.8		
		Detection Monitoring Result	**76.7**	8.89	29.9
Fluoride	mg/L	Interwell Background Value (UPL)	1.0		
		Detection Monitoring Result	**1.33**	0.25	0.5
pH	SU	Intrawell Background Value (UPL)	4.8	4.7	4.3
		Intrawell Background Value (LPL)	3.5	2.6	3.2
		Detection Monitoring Result	**4.9**	3.3	**2.9**
Sulfate	mg/L	Interwell Background Value (UPL)	80.8		
		Detection Monitoring Result	**337**	62.8	69.1
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	765	210	354
		Detection Monitoring Result	584	146	268

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD Stackout Area CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

DAVID ANTHONY MILLER
112498

112498

License Number

TEXAS

Licensing State

07.11.19

Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CON G

July 10, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey Stackout
Assessment Monitoring Event – February 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of the groundwater data for the February 2019 sample event for American Electric Power Inc.'s Pirkey Stackout. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-12 and AD-13; and
- **Downgradient wells:** AD-22, AD-33, and AD-7.

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS;
- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Values flagged as outliers may be seen in a lighter font and disconnected symbol on the time series graphs. A summary of flagged values also follows this letter (Figure B).

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, chloride, fluoride, and sulfate; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, pH and TDS (Figures C & D, respectively). The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data are screened for any newly suspected outliers or obvious trending patterns using time series plots. All values flagged as outliers may be seen on the Outlier Summary report following this letter. No obvious trending patterns were observed in the upgradient wells.

Intrawell prediction limits utilize the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data set will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. Prediction limit exceedances were noted for boron in wells AD-33 and AD-7; calcium in well AD-13; chloride, fluoride and sulfate in well AD-22; and pH in wells AD-22 and AD-7. The results of those findings may be found in the Prediction Limit Summary tables following this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable (Figure E). Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site which is an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances.

Evaluation of Appendix IV Parameters

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure F). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure G).

Note that the reporting limit during the February 2019 event for molybdenum at wells AD-12, AD-13, AD-22 and AD-33 was 0.04 mg/L compared to a historical reporting limit of 0.002 mg/L. Well AD-7, however, had a reporting limit of 0.002 mg/L during this event. The resulting nondetects reported at 0.04 mg/L are censored at much higher levels than the rest of the data; therefore, contain little or no useful information and are flagged as outliers.

The reporting limit (or practical quantitation limit) for this event for thallium also increased from the historical reporting limit of 0.002 mg/L to 0.01 mg/L for all wells. However, since no detections were present above the method detection limit of 0.002

mg/L for this event, the historical reporting limit of 0.002 mg/L was substituted for these nondetects.

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, CCR-Rule specified levels, or ACL as discussed above (Figure H). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No confidence interval exceedances were noted except for beryllium in well AD-22. The lower confidence interval of 0.0041 mg/L is slightly higher than the MCL of 0.004 mg/L. A summary of the confidence interval results follows this letter.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Stackout. If you have any questions or comments, please feel free to contact me.

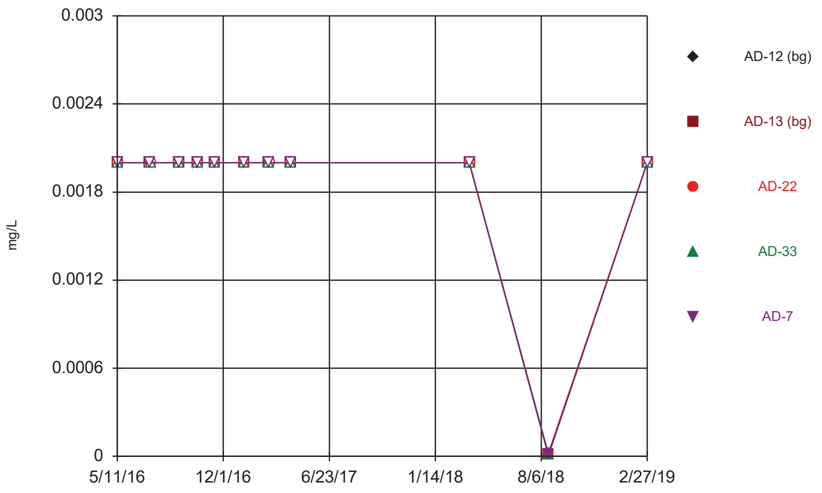
For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

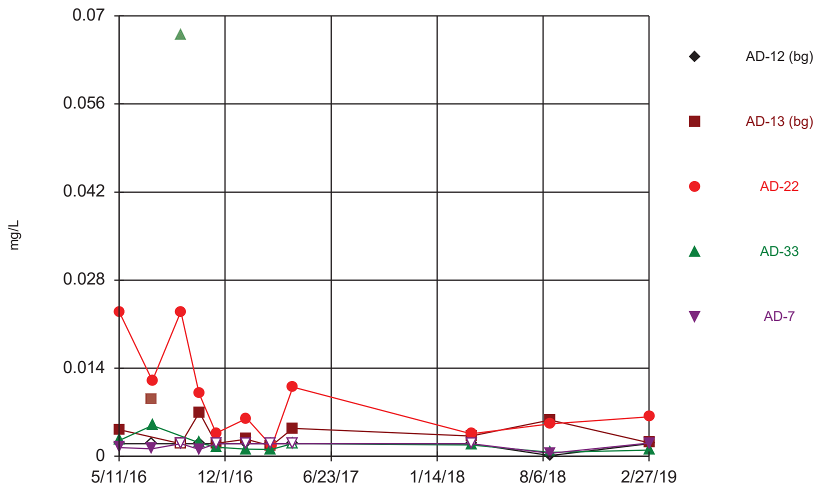
Time Series



Constituent: Antimony, total   Analysis Run 7/8/2019 9:16 AM   View: Time Series
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

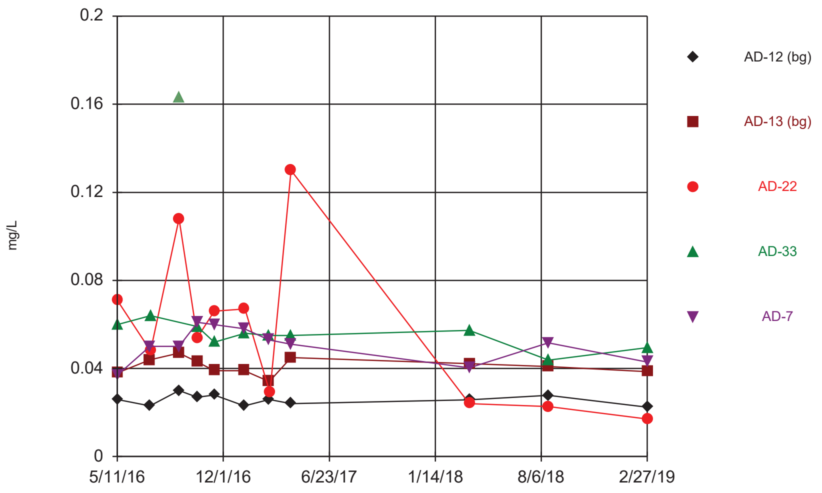
Time Series



Constituent: Arsenic, total   Analysis Run 7/8/2019 9:16 AM   View: Time Series
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

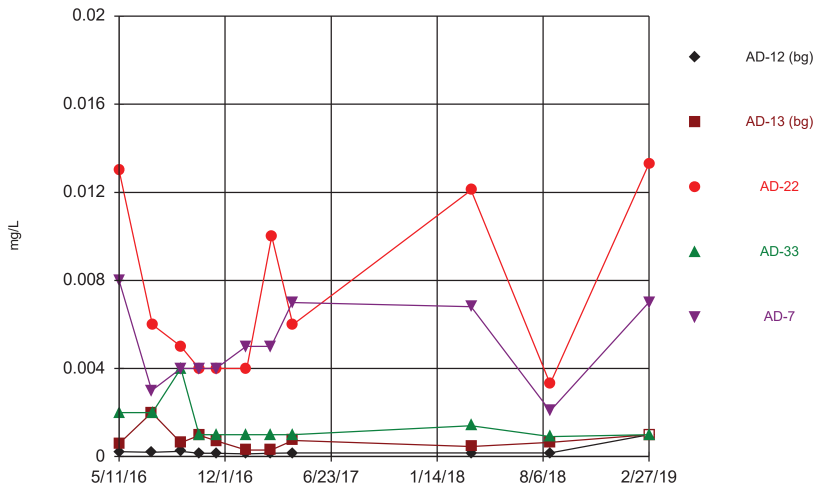
Time Series



Constituent: Barium, total   Analysis Run 7/8/2019 9:16 AM   View: Time Series
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

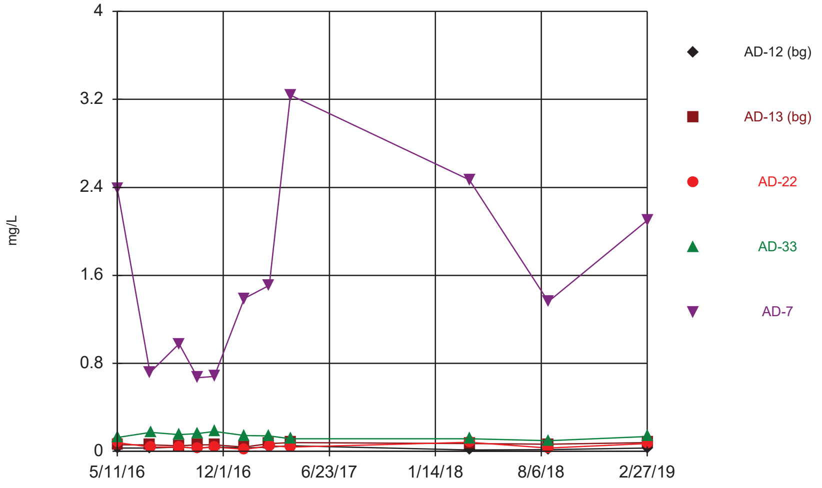
Time Series



Constituent: Beryllium, total   Analysis Run 7/8/2019 9:16 AM   View: Time Series
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

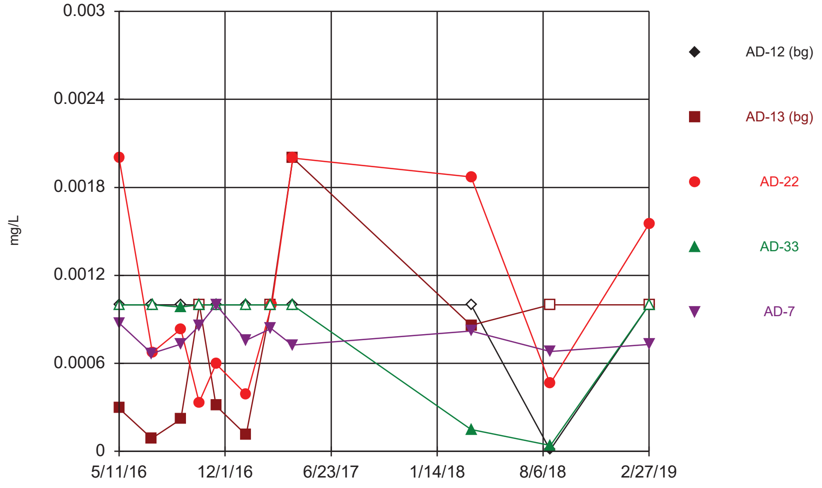
Time Series



Constituent: Boron, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

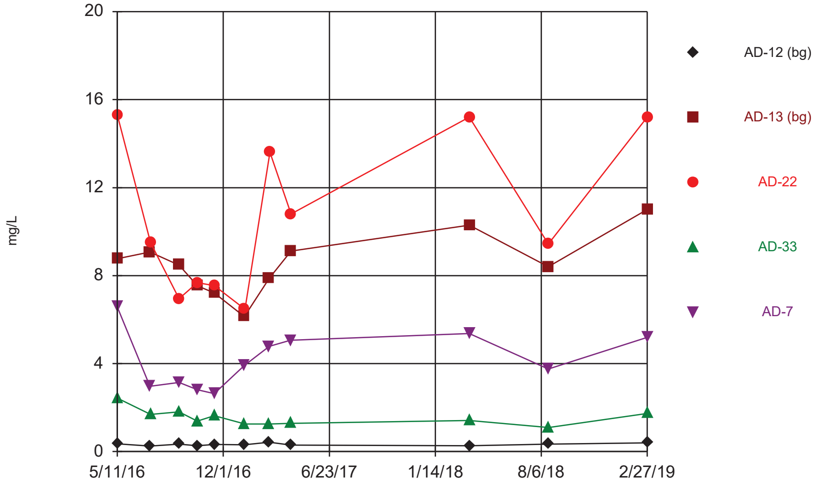
Time Series



Constituent: Cadmium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

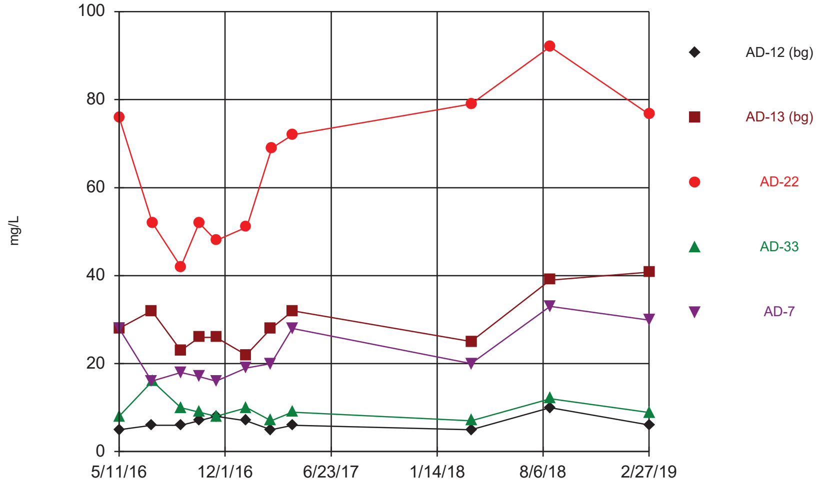
Time Series



Constituent: Calcium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

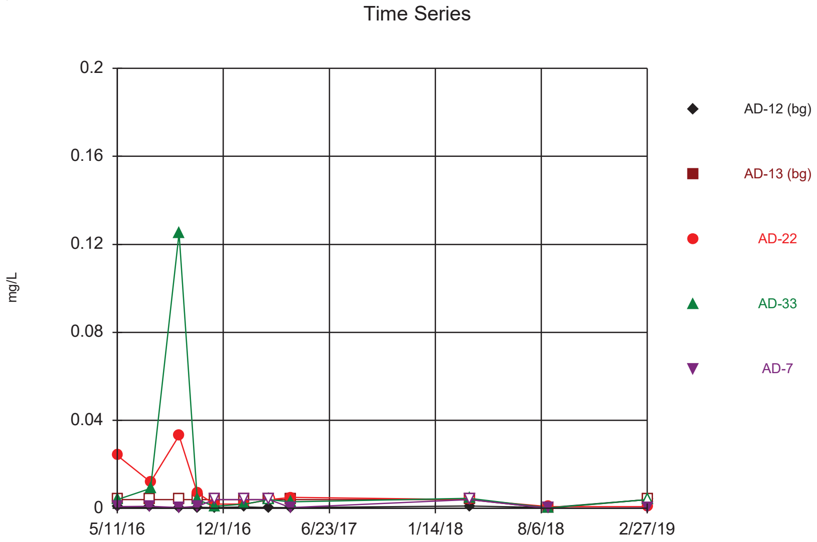
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



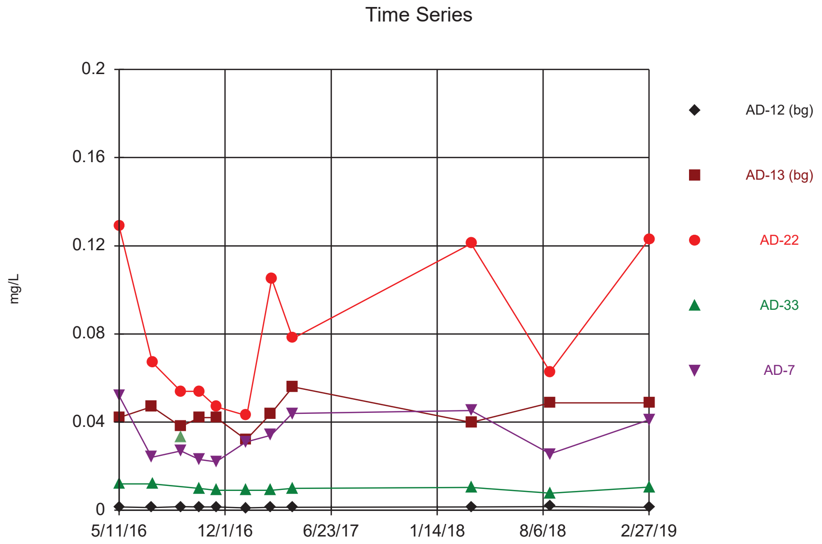
Constituent: Chloride, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



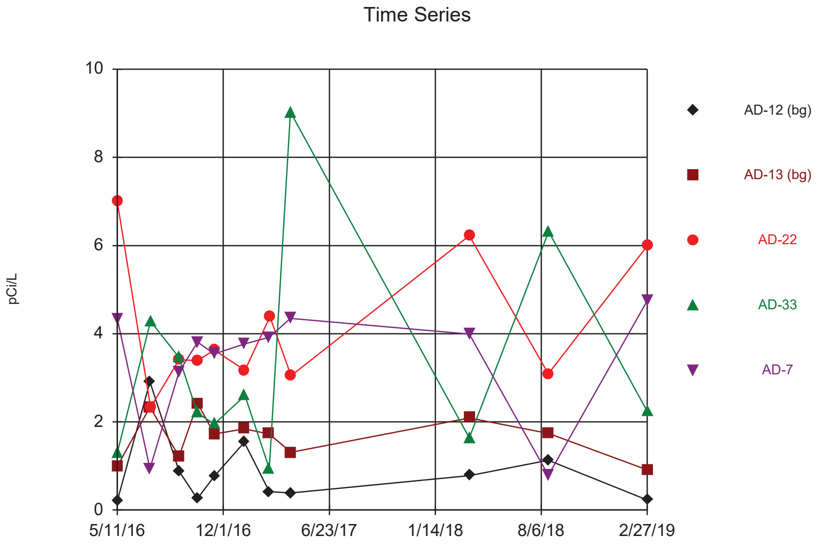
Constituent: Chromium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



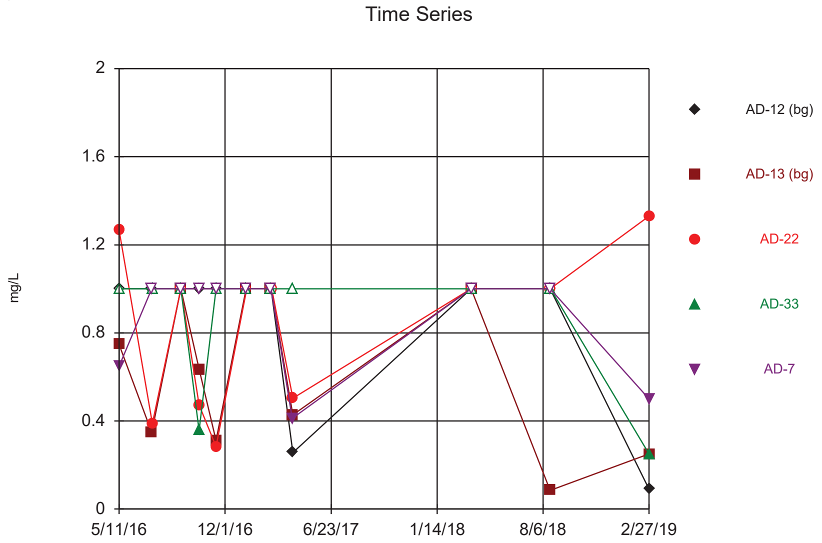
Constituent: Cobalt, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Combined Radium 226 + 228 Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

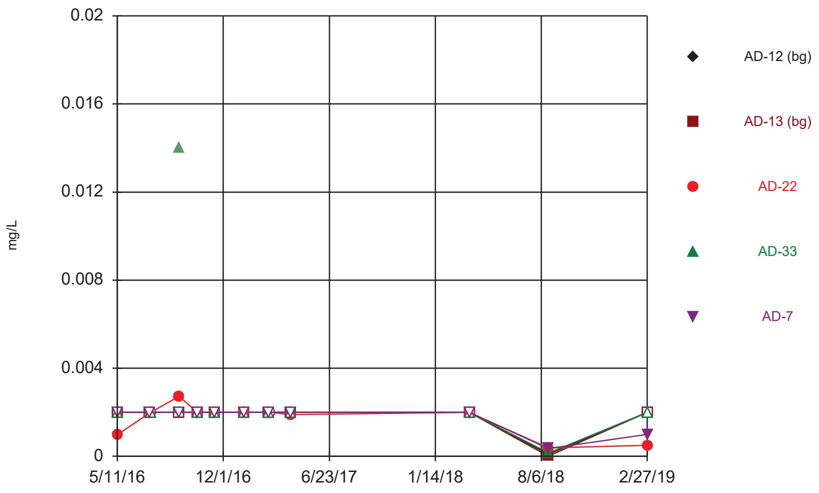
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Fluoride, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

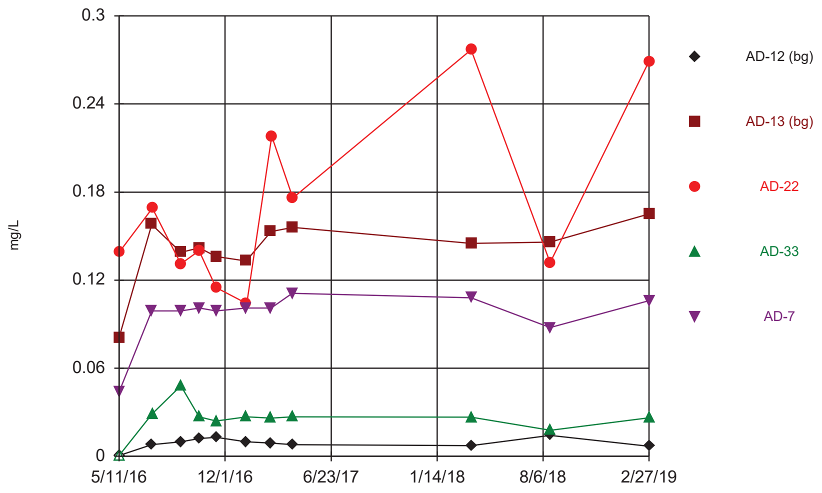
Time Series



Constituent: Lead, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

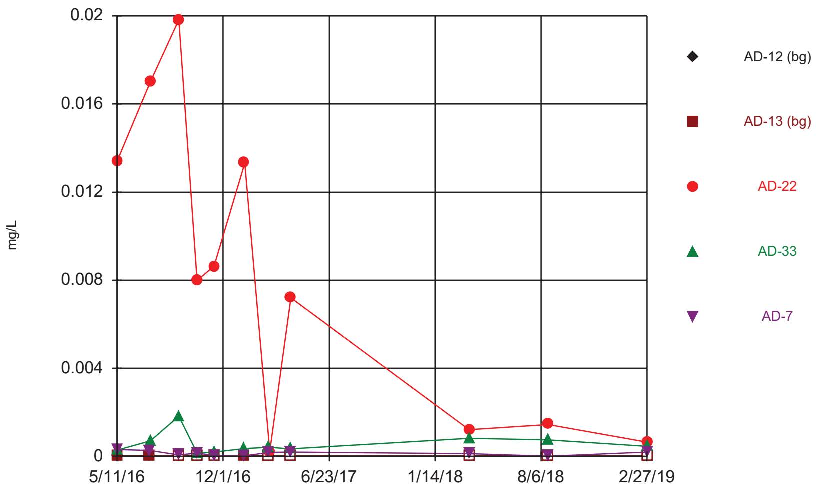
Time Series



Constituent: Lithium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

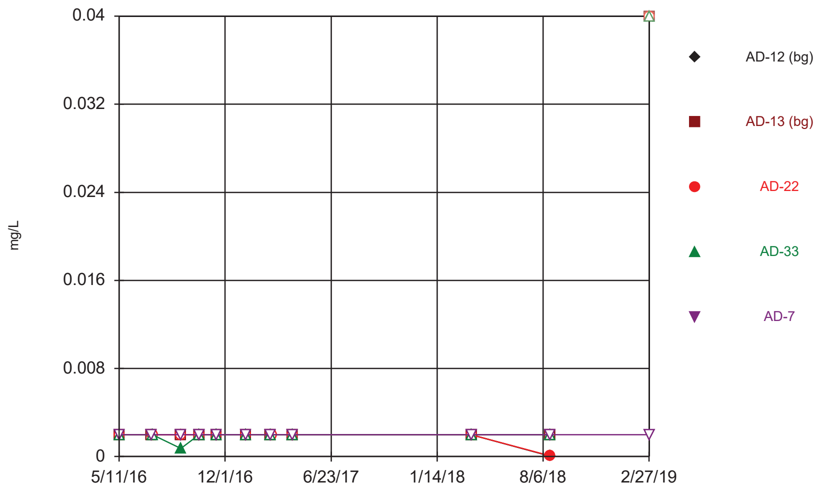
Time Series



Constituent: Mercury, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

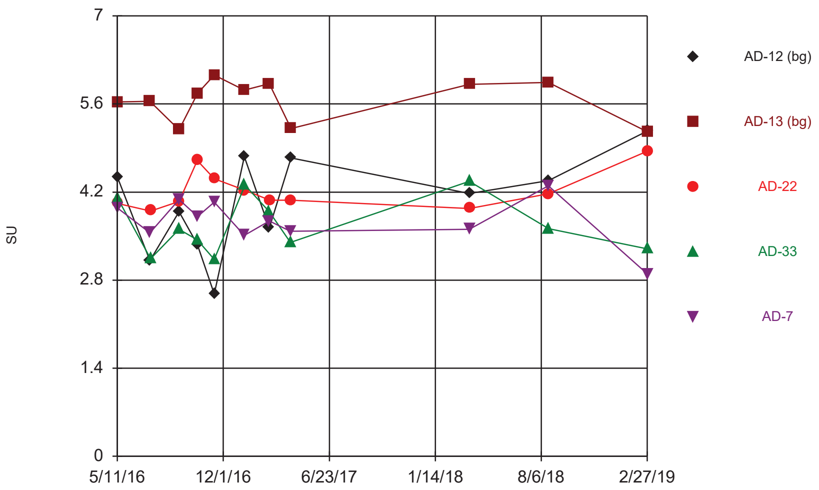
Time Series



Constituent: Molybdenum, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

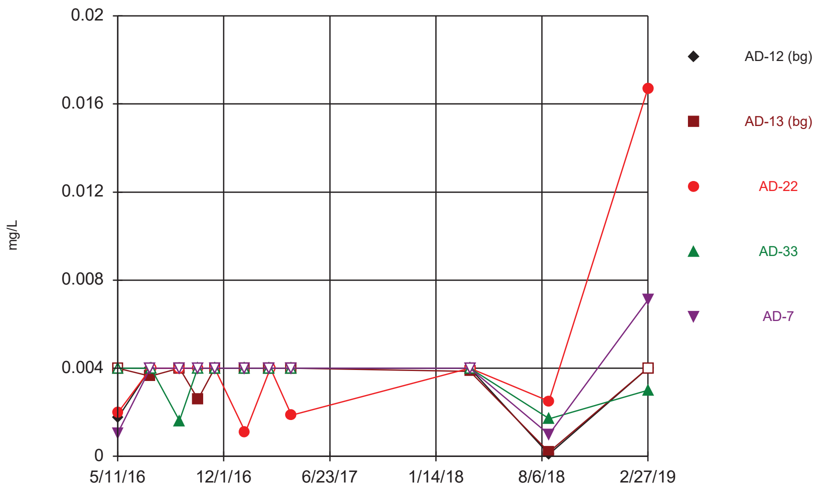
Time Series



Constituent: pH, field Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

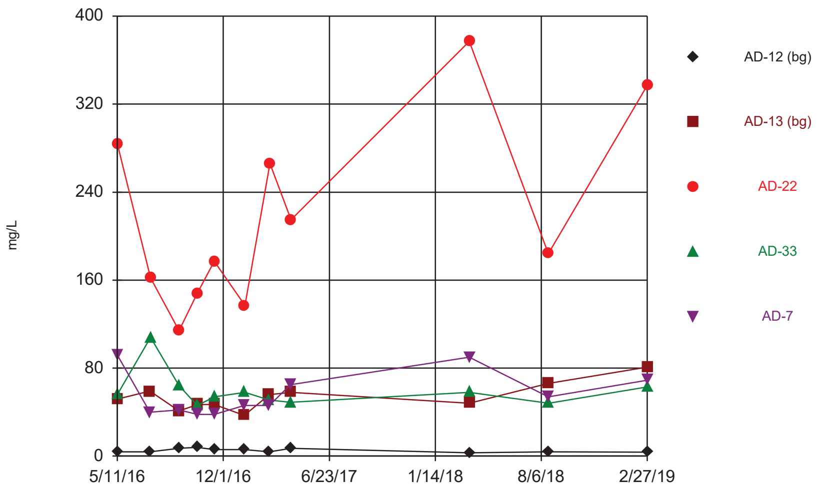
Time Series



Constituent: Selenium, total Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

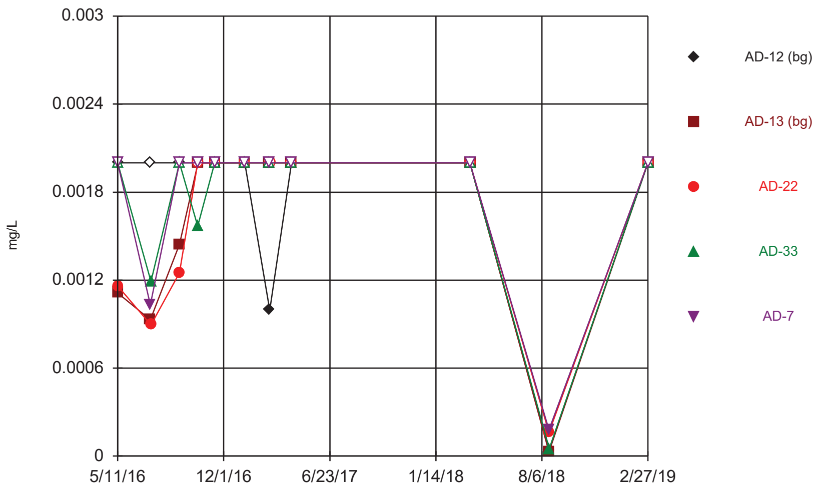
Time Series



Constituent: Sulfate, total Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

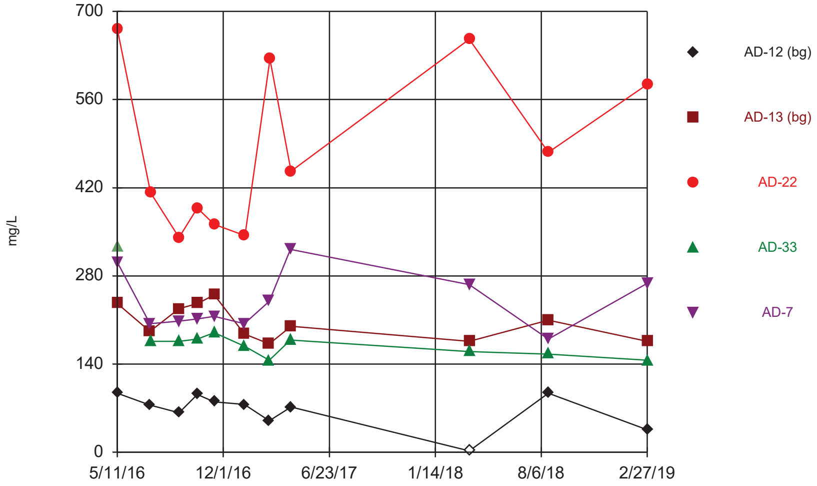
Time Series



Constituent: Thallium, total Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Total Dissolved Solids [TDS]   Analysis Run 7/8/2019 9:17 AM   View: Time Series
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Outlier Summary

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/8/2019, 9:14 AM

	AD-13 Arsenic, total (mg/L)	AD-33 Arsenic, total (mg/L)	AD-33 Barium, total (mg/L)	AD-33 Cobalt, total (mg/L)	AD-33 Lead, total (mg/L)	AD-12 Molybdenum, total (mg/L)	AD-13 Molybdenum, total (mg/L)	AD-22 Molybdenum, total (mg/L)	AD-33 Molybdenum, total (mg/L)	AD-33 Total Dissolved Solids [TDS] (mg/L)
5/11/2016										326 (o)
7/13/2016	0.009 (o)									
9/7/2016		0.067 (o)	0.163 (o)	0.033 (o)	0.014 (o)					
2/27/2019						<0.04 (o)	<0.04 (o)	<0.04 (o)	<0.04 (o)	

Interwell Prediction Limit Summary - Significant Results

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 7/5/2019, 2:49 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-33**	**0.08395**	**n/a**	**2/27/2019**	**0.134**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-7**	**0.08395**	**n/a**	**2/27/2019**	**2.1**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-22**	**40.8**	**n/a**	**2/27/2019**	**76.7**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**
Fluoride, total (mg/L)	**AD-22**	**1**	**n/a**	**2/27/2019**	**1.33**	**Yes**	**22**	**n/a**	**n/a**	**59.09**	**n/a**	**n/a**	**0.003586**	**NP Inter (NDs) 1 of 2**
Sulfate, total (mg/L)	**AD-22**	**80.8**	**n/a**	**2/27/2019**	**337**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**

Interwell Prediction Limit Summary - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 2:49 PM

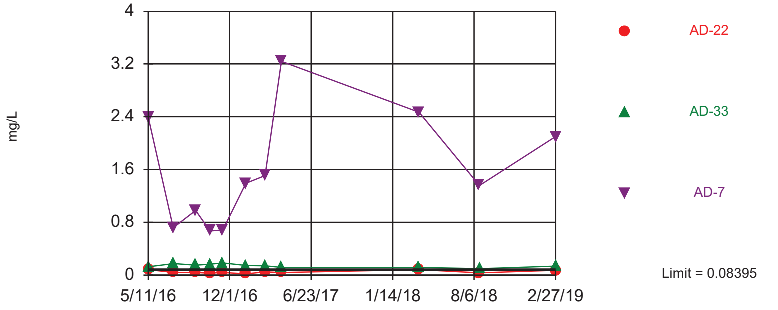
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-22	0.08395	n/a	2/27/2019	0.07	No	22	0.04762	0.01946	0	None	No	0.002505	Param Inter 1 of 2
Boron, total (mg/L)	**AD-33**	**0.08395**	**n/a**	**2/27/2019**	**0.134**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-7**	**0.08395**	**n/a**	**2/27/2019**	**2.1**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-22**	**40.8**	**n/a**	**2/27/2019**	**76.7**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**
Chloride, total (mg/L)	AD-33	40.8	n/a	2/27/2019	8.89	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2
Chloride, total (mg/L)	AD-7	40.8	n/a	2/27/2019	29.9	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2
Fluoride, total (mg/L)	**AD-22**	**1**	**n/a**	**2/27/2019**	**1.33**	**Yes**	**22**	**n/a**	**n/a**	**59.09**	**n/a**	**n/a**	**0.003586**	**NP Inter (NDs) 1 of 2**
Fluoride, total (mg/L)	AD-33	1	n/a	2/27/2019	0.25	No	22	n/a	n/a	59.09	n/a	n/a	0.003586	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-7	1	n/a	2/27/2019	0.5	No	22	n/a	n/a	59.09	n/a	n/a	0.003586	NP Inter (NDs) 1 of 2
Sulfate, total (mg/L)	**AD-22**	**80.8**	**n/a**	**2/27/2019**	**337**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**
Sulfate, total (mg/L)	AD-33	80.8	n/a	2/27/2019	62.8	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2
Sulfate, total (mg/L)	AD-7	80.8	n/a	2/27/2019	69.1	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-33, AD-7

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=0.04762, Std. Dev.=0.01946, n=22. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9482, critical = 0.878. Kappa = 1.866 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

Constituent: Boron, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell

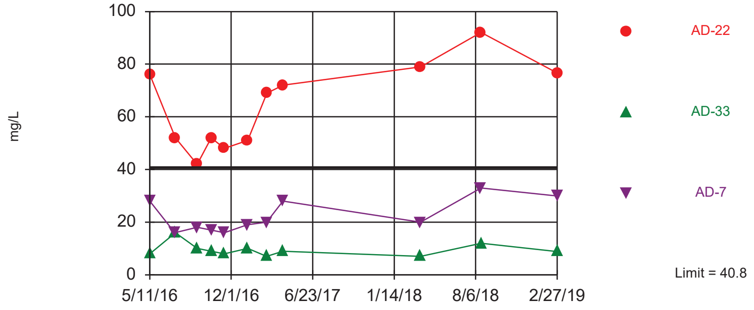
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-22

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 22 background values. Annual per-constituent alpha = 0.02133. Individual comparison alpha = 0.003586 (1 of 2). Comparing 3 points to limit.

Constituent: Chloride, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell

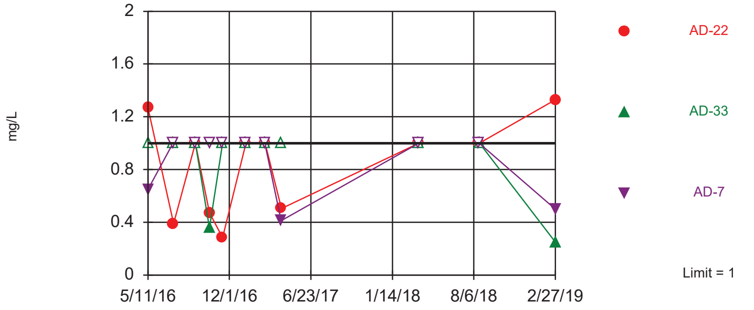
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Exceeds Limit: AD-22

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 22 background values. 59.09% NDs. Annual per-constituent alpha = 0.02133. Individual comparison alpha = 0.003586 (1 of 2). Comparing 3 points to limit.

Constituent: Fluoride, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell

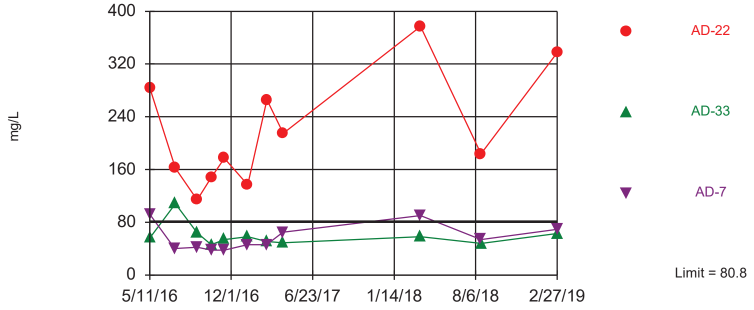
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-22

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 22 background values. Annual per-constituent alpha = 0.02133. Individual comparison alpha = 0.003586 (1 of 2). Comparing 3 points to limit.

Constituent: Sulfate, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Intrawell Prediction Limit Summary - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 2:56 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	**AD-13**	**10.58**	**n/a**	**2/27/2019**	**11**	**Yes**	**8**	**8.025**	**1.038**	**0**	**None**	**No**	**0.002505**	Param 1 of 2
pH, field (SU)	**AD-22**	**4.819**	**3.544**	**2/27/2019**	**4.85**	**Yes**	**8**	**4.181**	**0.2594**	**0**	**None**	**No**	**0.001253**	Param 1 of 2
pH, field (SU)	**AD-7**	**4.336**	**3.229**	**2/27/2019**	**2.9**	**Yes**	**8**	**3.783**	**0.2251**	**0**	**None**	**No**	**0.001253**	Param 1 of 2

Intrawell Prediction Limit Summary - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 2:56 PM

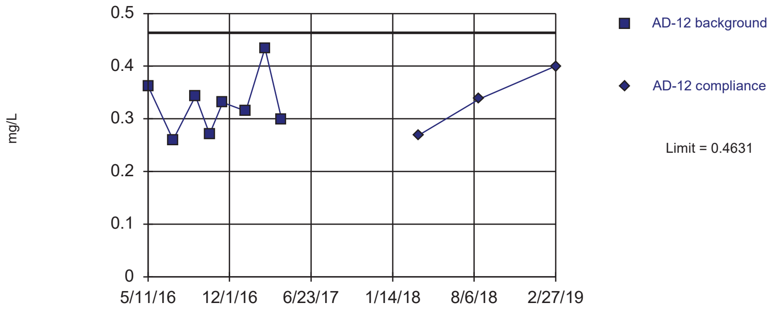
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-12	0.4631	n/a	2/27/2019	0.4	No	8	0.3269	0.05542	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	**AD-13**	**10.58**	**n/a**	**2/27/2019**	**11**	**Yes**	**8**	**8.025**	**1.038**	**0**	**None**	**No**	**0.002505**	Param 1 of 2
Calcium, total (mg/L)	AD-22	17.75	n/a	2/27/2019	15.2	No	8	9.731	3.263	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-33	2.586	n/a	2/27/2019	1.73	No	8	1.595	0.403	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-7	7.397	n/a	2/27/2019	5.2	No	8	3.988	1.387	0	None	No	0.002505	Param 1 of 2
pH, field (SU)	AD-12	5.764	1.866	2/27/2019	5.17	No	8	3.815	0.7928	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-13	6.427	4.883	2/27/2019	5.16	No	8	5.655	0.3139	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	**AD-22**	**4.819**	**3.544**	**2/27/2019**	**4.85**	**Yes**	**8**	**4.181**	**0.2594**	**0**	**None**	**No**	**0.001253**	Param 1 of 2
pH, field (SU)	AD-33	4.704	2.553	2/27/2019	3.3	No	8	3.629	0.4375	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	**AD-7**	**4.336**	**3.229**	**2/27/2019**	**2.9**	**Yes**	**8**	**3.783**	**0.2251**	**0**	**None**	**No**	**0.001253**	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	110.7	n/a	2/27/2019	36	No	8	75.25	14.41	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-13	282.1	n/a	2/27/2019	176	No	8	212.8	28.2	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-22	764.6	n/a	2/27/2019	584	No	8	448.6	128.6	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-33	210.3	n/a	2/27/2019	146	No	7	173.4	13.75	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-7	354.3	n/a	2/27/2019	268	No	8	238.5	47.1	0	None	No	0.002505	Param 1 of 2

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3269, Std. Dev.=0.05542, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9467, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

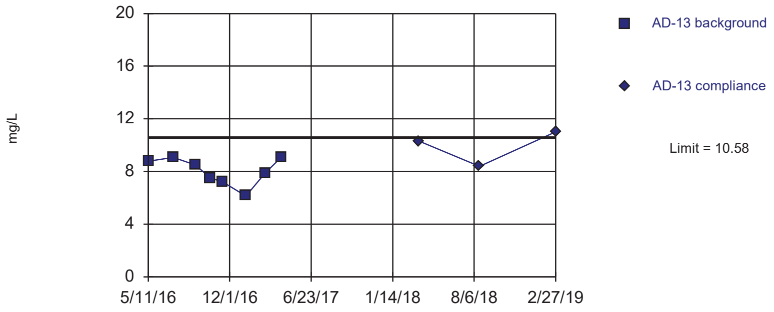
Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=8.025, Std. Dev.=1.038, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9241, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

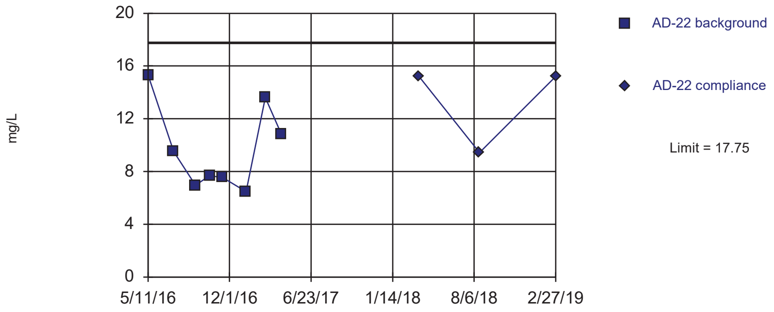
Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=9.731, Std. Dev.=3.263, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8841, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

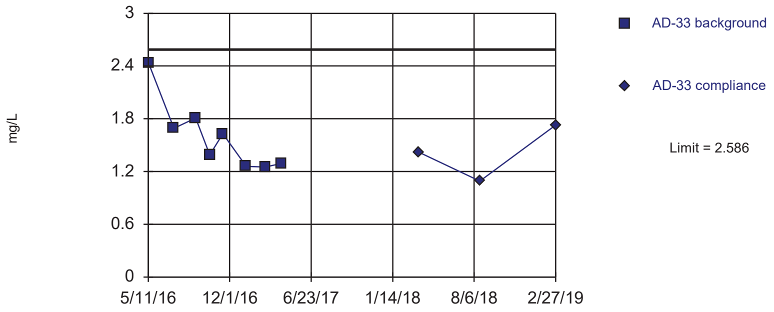
Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1.595, Std. Dev.=0.403, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8403, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

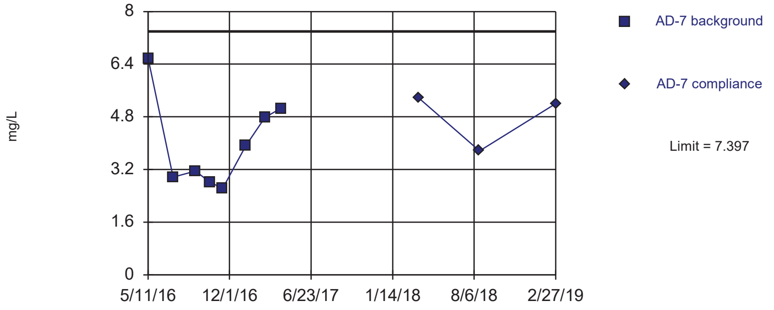
Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.988, Std. Dev.=1.387, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8893, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

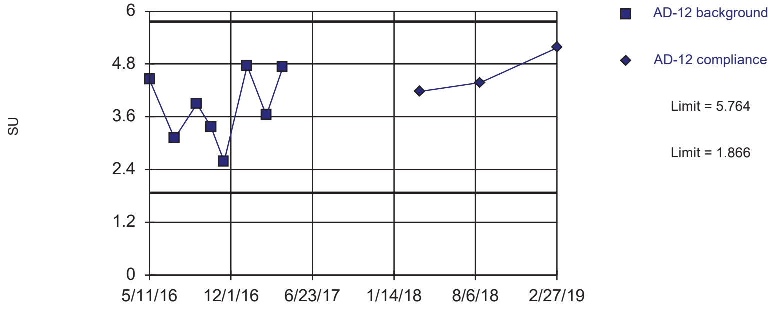
Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

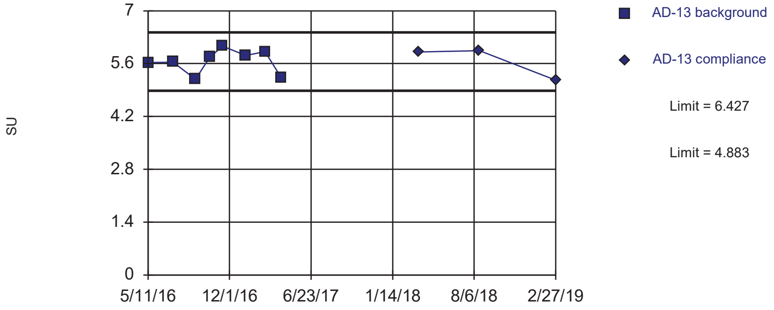
Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.655, Std. Dev.=0.3139, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9084, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

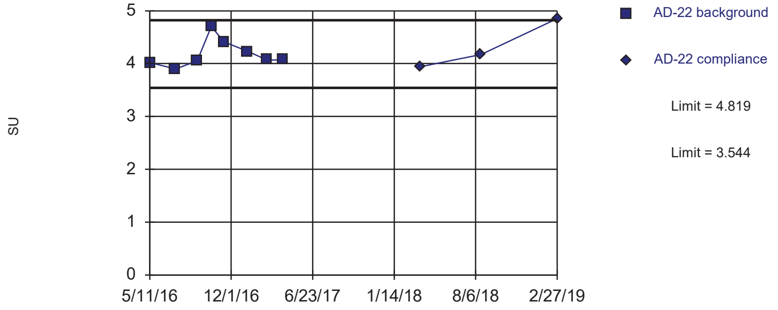
Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.181, Std. Dev.=0.2594, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8669, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

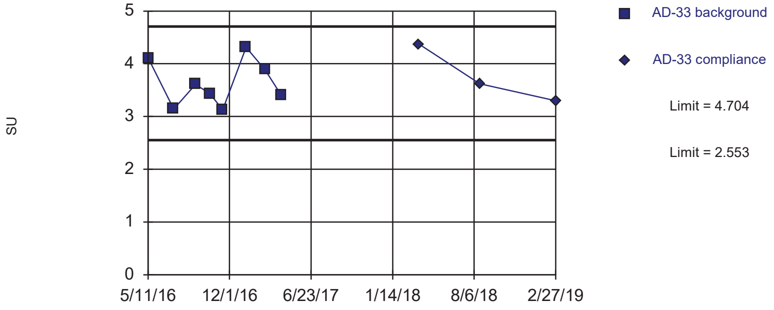
Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.629, Std. Dev.=0.4375, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9295, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

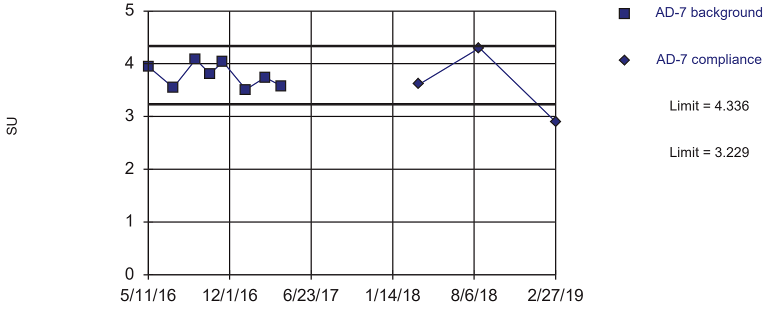
Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.783, Std. Dev.=0.2251, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9108, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

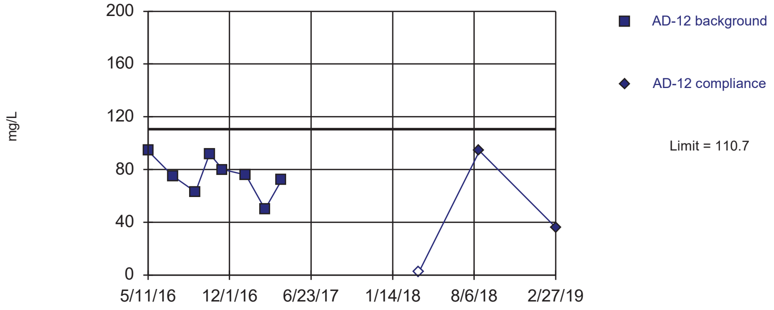
Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=75.25, Std. Dev.=14.41, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9549, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

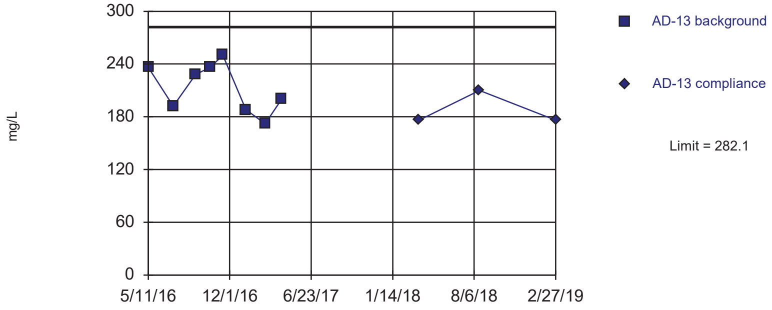
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=212.8, Std. Dev.=28.2, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9216, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

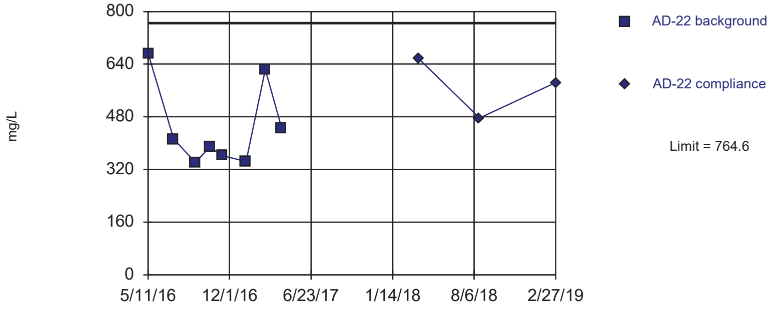
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=448.6, Std. Dev.=128.6, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8034, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

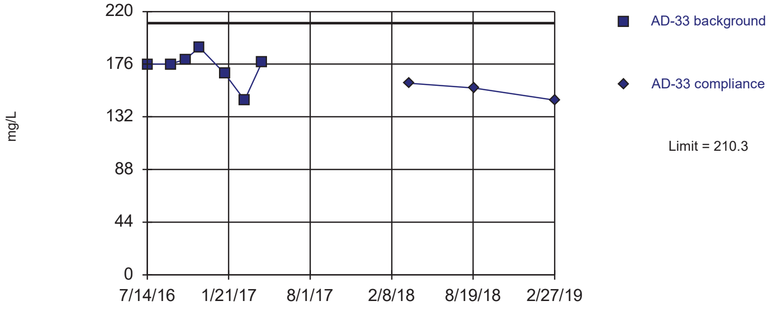
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=173.4, Std. Dev.=13.75, n=7. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8665, critical = 0.73. Kappa = 2.685 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

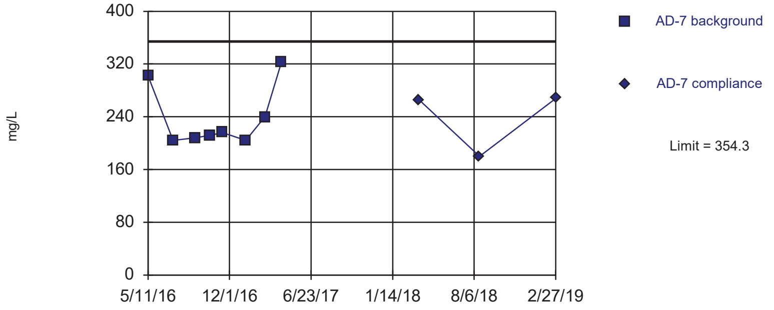
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=238.5, Std. Dev.=47.1, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7544, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

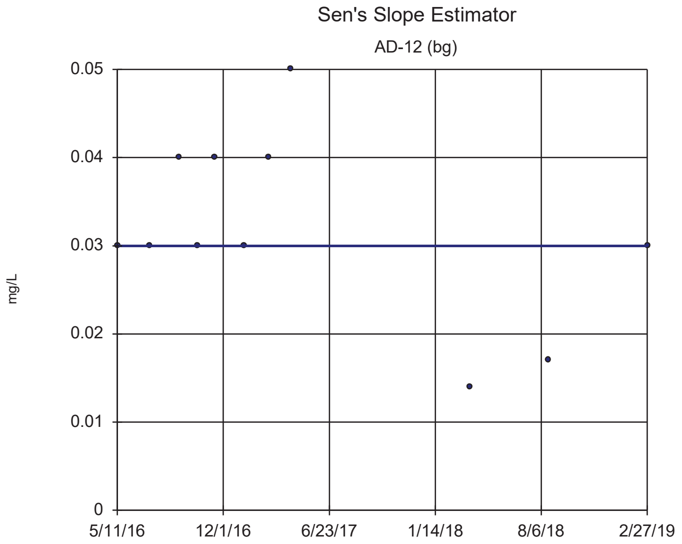
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Trend Test Summary Table - All Results (No Significant)

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 3:15 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-12 (bg)	0	-4	-31	No	11	0	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-13 (bg)	0.007612	26	31	No	11	0	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-33	-0.02412	-25	-31	No	11	0	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-7	0.4535	17	31	No	11	0	n/a	n/a	0.02	NP
Calcium, total (mg/L)	AD-12 (bg)	0.01357	5	31	No	11	0	n/a	n/a	0.02	NP
Calcium, total (mg/L)	AD-13 (bg)	0.7229	11	31	No	11	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-12 (bg)	0.03234	10	31	No	11	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-13 (bg)	4.571	16	31	No	11	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-22	14.72	26	31	No	11	0	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	AD-12 (bg)	0	-15	-31	No	11	81.82	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	AD-13 (bg)	-0.09446	-11	-31	No	11	36.36	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	AD-22	0.06272	13	31	No	11	45.45	n/a	n/a	0.02	NP
pH, field (SU)	AD-12 (bg)	0.5174	19	31	No	11	0	n/a	n/a	0.02	NP
pH, field (SU)	AD-13 (bg)	0.07474	9	31	No	11	0	n/a	n/a	0.02	NP
pH, field (SU)	AD-22	0.06308	14	31	No	11	0	n/a	n/a	0.02	NP
pH, field (SU)	AD-7	-0.2147	-11	-31	No	11	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.5376	-15	-31	No	11	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-13 (bg)	8.297	20	31	No	11	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-22	64.82	19	31	No	11	0	n/a	n/a	0.02	NP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-12 (bg)

n = 11

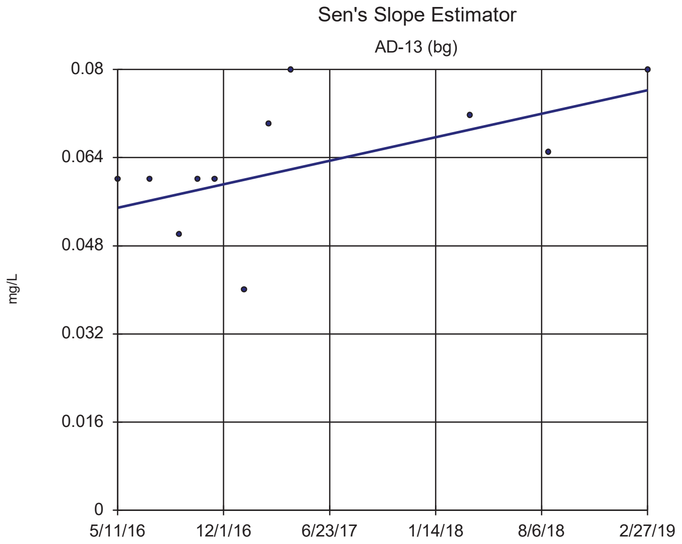
Slope = 0
units per year.

Mann-Kendall
statistic = -4
critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-13 (bg)

n = 11

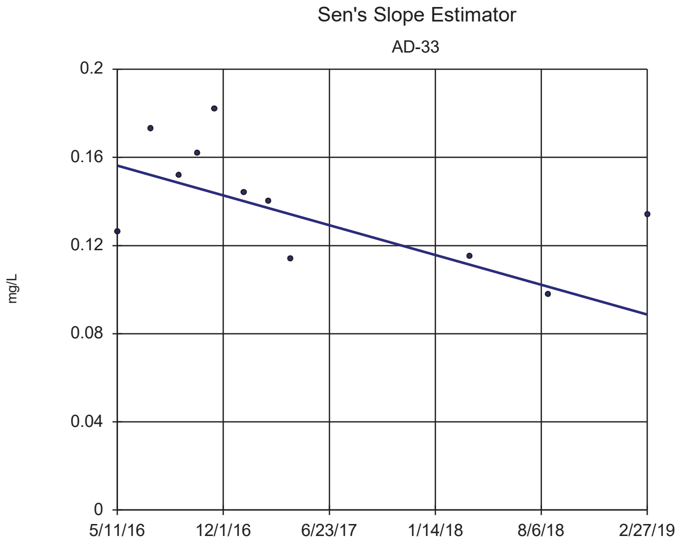
Slope = 0.007612
units per year.

Mann-Kendall
statistic = 26
critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-33

n = 11

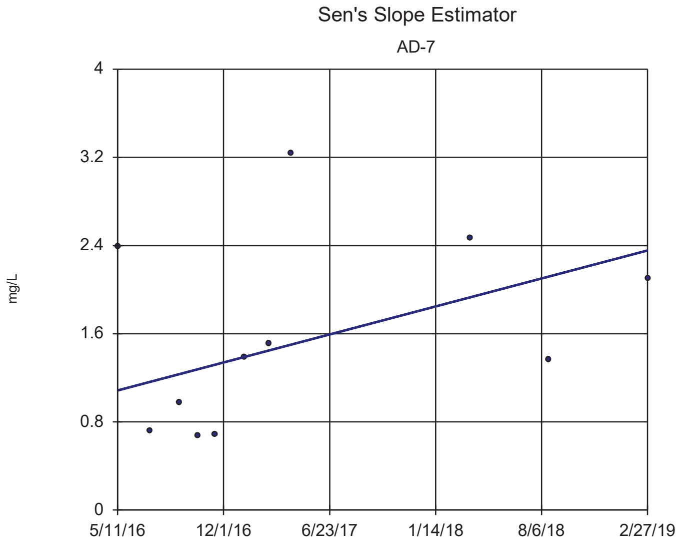
Slope = -0.02412
units per year.

Mann-Kendall
statistic = -25
critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Sen's Slope Estimator

AD-7

n = 11

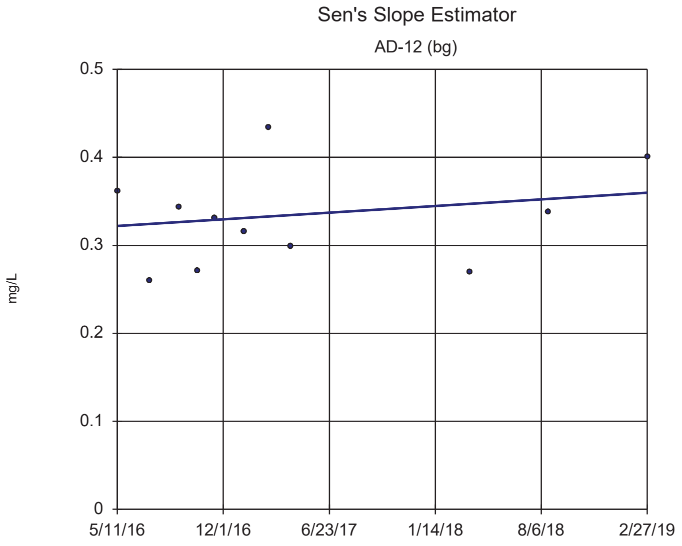
Slope = 0.4535
units per year.

Mann-Kendall
statistic = 17
critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

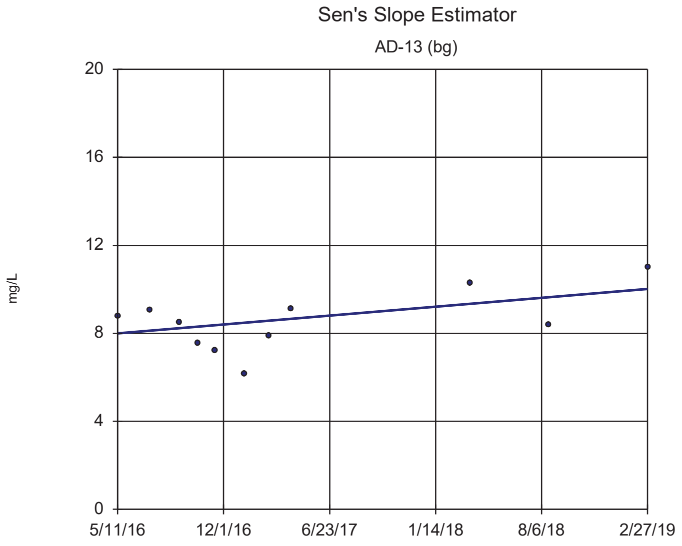
Slope = 0.01357
units per year.

Mann-Kendall
statistic = 5
critical = 31

Trend not significant at 98%
confidence level
(α = 0.01 per
tail).

Constituent: Calcium, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

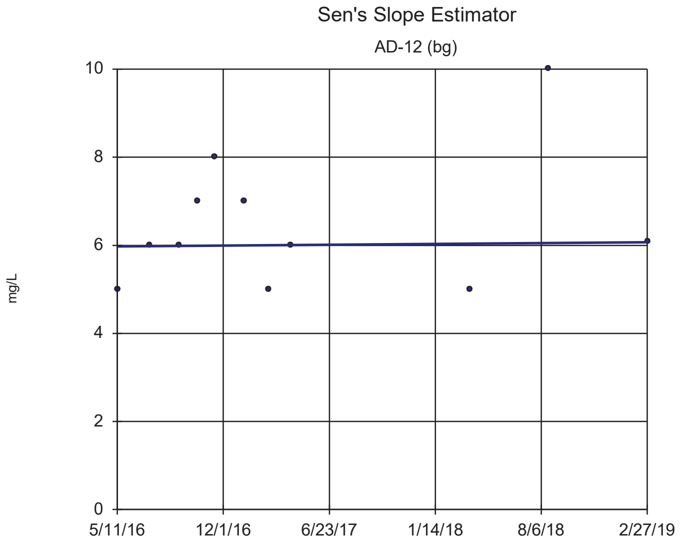
Slope = 0.7229
units per year.

Mann-Kendall
statistic = 11
critical = 31

Trend not significant at 98%
confidence level
(α = 0.01 per
tail).

Constituent: Calcium, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

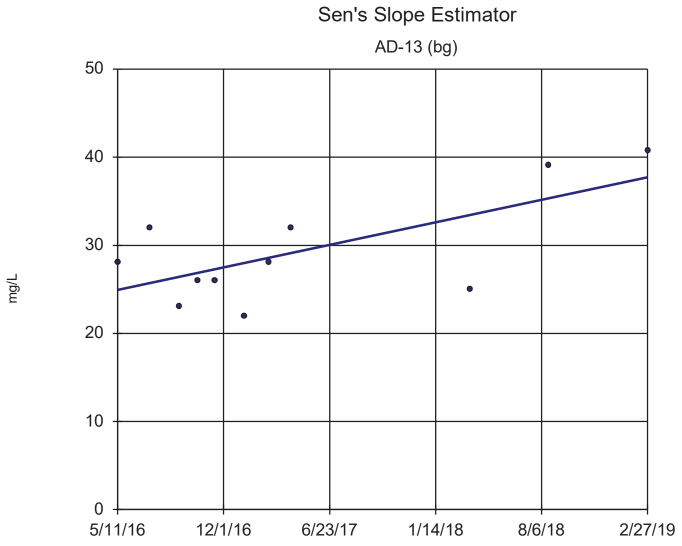
Slope = 0.03234
units per year.

Mann-Kendall
statistic = 10
critical = 31

Trend not significant at 98%
confidence level
(α = 0.01 per
tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

Slope = 4.571
units per year.

Mann-Kendall
statistic = 16
critical = 31

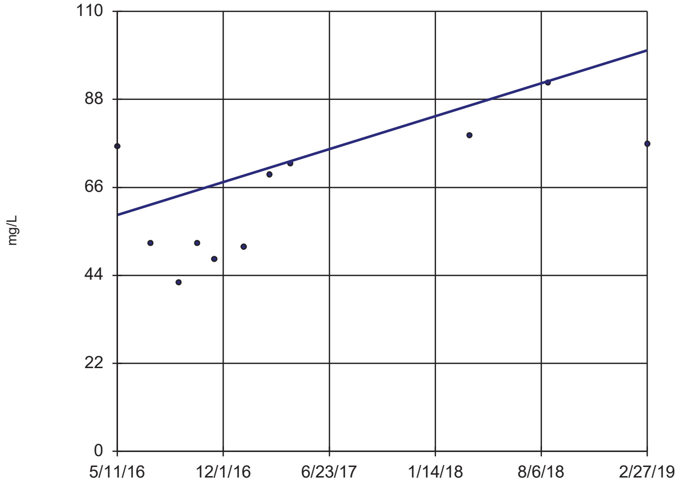
Trend not significant at 98%
confidence level
(α = 0.01 per
tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-22



n = 11

Slope = 14.72 units per year.

Mann-Kendall statistic = 26 critical = 31

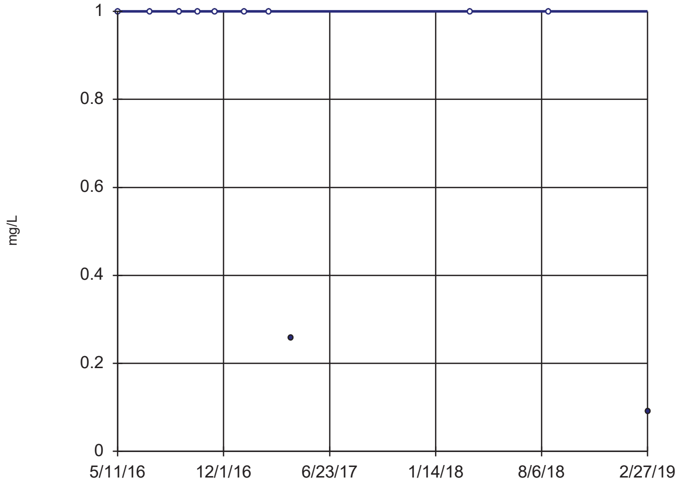
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -15 critical = -31

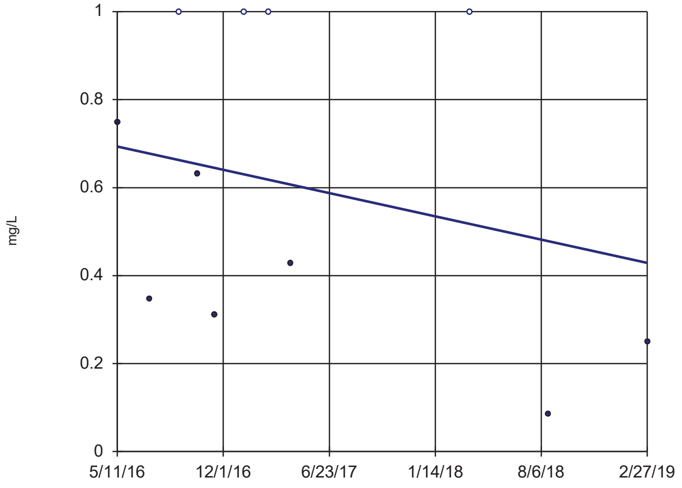
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = -0.09446 units per year.

Mann-Kendall statistic = -11 critical = -31

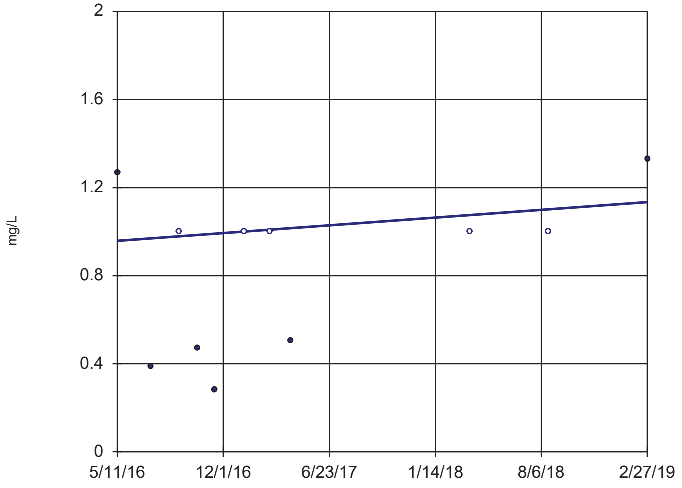
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-22



n = 11

Slope = 0.06272 units per year.

Mann-Kendall statistic = 13 critical = 31

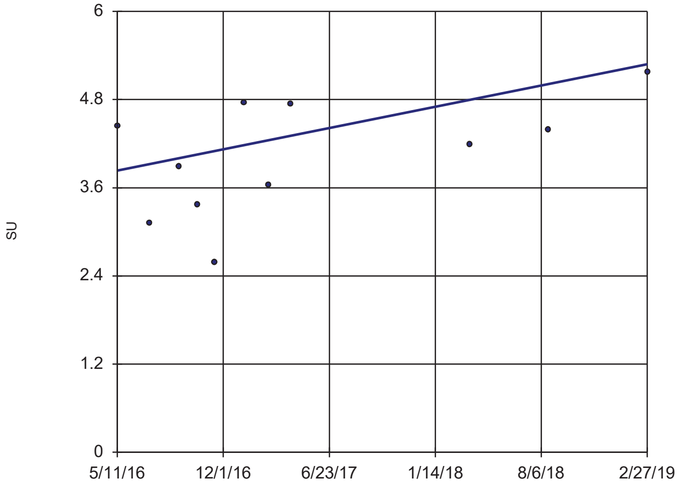
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.5174 units per year.

Mann-Kendall statistic = 19 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

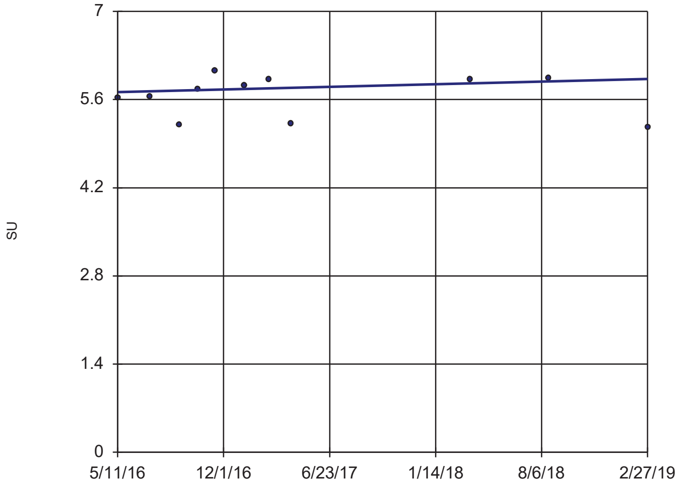
Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = 0.07474 units per year.

Mann-Kendall statistic = 9 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

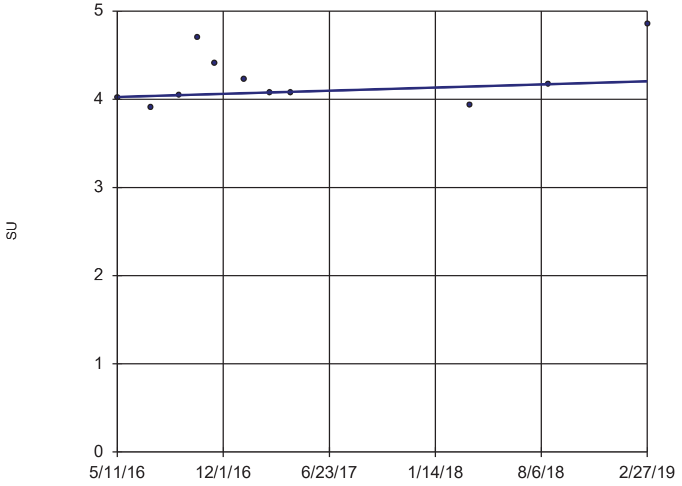
Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-22



n = 11

Slope = 0.06308 units per year.

Mann-Kendall statistic = 14 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

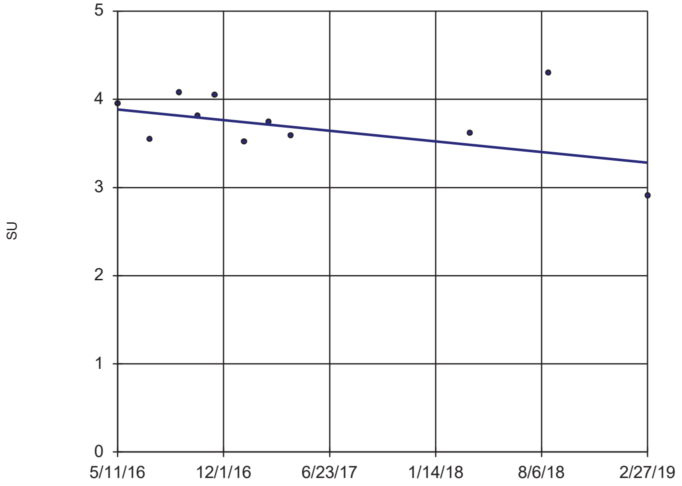
Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-7



n = 11

Slope = -0.2147 units per year.

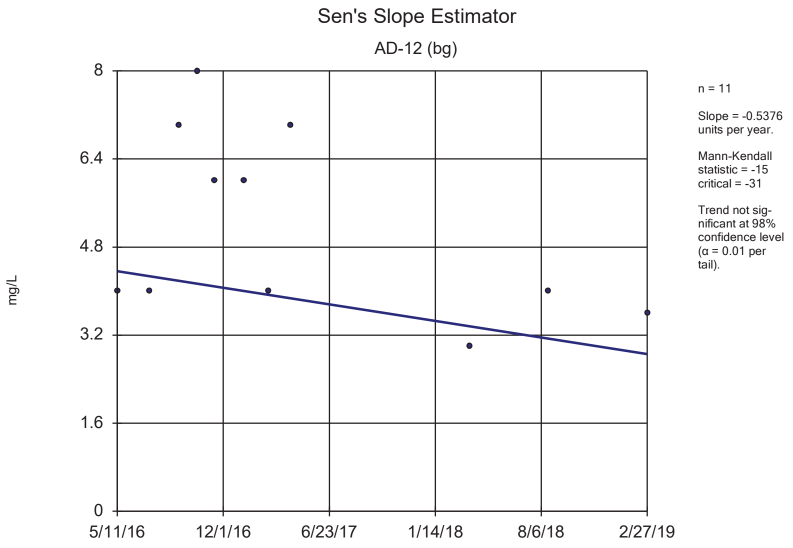
Mann-Kendall statistic = -11 critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests

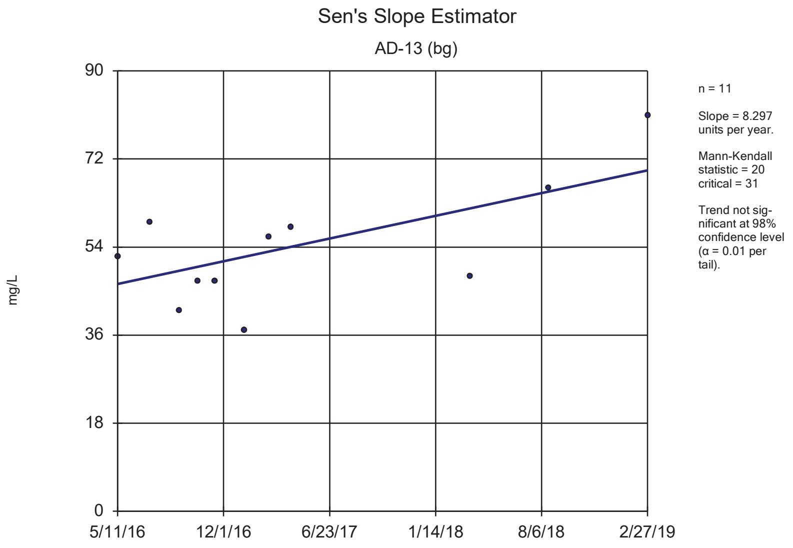
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



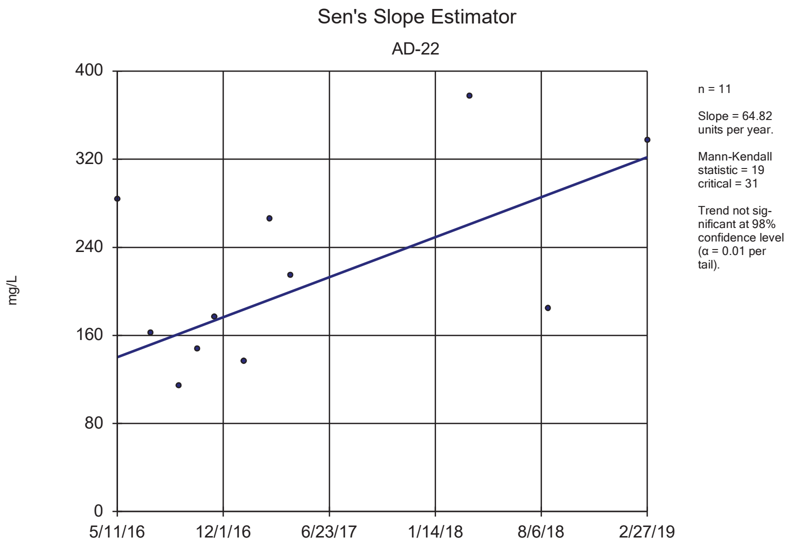
Constituent: Sulfate, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Sulfate, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Sulfate, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit Summary Table - Appendix IV Parameters

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 3:07 PM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.002	22	n/a	n/a	90.91	n/a	n/a	0.3235	NP Inter(NDs)
Arsenic, total (mg/L)	n/a	0.007	21	n/a	n/a	52.38	n/a	n/a	0.3406	NP Inter(normality)
Barium, total (mg/L)	n/a	0.05302	22	0.03335	0.008372	0	None	No	0.05	Inter
Beryllium, total (mg/L)	n/a	0.001876	22	0.07377	0.02109	9.091	None	x^(1/3)	0.05	Inter
Cadmium, total (mg/L)	n/a	0.002	22	n/a	n/a	63.64	n/a	n/a	0.3235	NP Inter(normality)
Chromium, total (mg/L)	n/a	0.004	22	n/a	n/a	50	n/a	n/a	0.3235	NP Inter(normality)
Cobalt, total (mg/L)	n/a	0.056	22	n/a	n/a	0	n/a	n/a	0.3235	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	n/a	3.075	22	1.264	0.7707	0	None	No	0.05	Inter
Fluoride, total (mg/L)	n/a	1	22	n/a	n/a	59.09	n/a	n/a	0.3235	NP Inter(normality)
Lead, total (mg/L)	n/a	0.002	22	n/a	n/a	90.91	n/a	n/a	0.3235	NP Inter(NDs)
Lithium, total (mg/L)	n/a	0.165	22	n/a	n/a	4.545	n/a	n/a	0.3235	NP Inter(normality)
Mercury, total (mg/L)	n/a	0.000025	22	n/a	n/a	81.82	n/a	n/a	0.3235	NP Inter(NDs)
Molybdenum, total (mg/L)	n/a	0.002	22	n/a	n/a	95.45	n/a	n/a	0.3235	NP Inter(NDs)
Selenium, total (mg/L)	n/a	0.004	22	n/a	n/a	72.73	n/a	n/a	0.3235	NP Inter(normality)
Thallium, total (mg/L)	n/a	0.002	22	n/a	n/a	72.73	n/a	n/a	0.3235	NP Inter(normality)

Confidence Interval Summary Table - Significant Results

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 7/9/2019, 9:05 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.01023**	**0.004131**	**0.004**	**n/a**	**Yes**	**11**	**0**	**x^(1/3)**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results

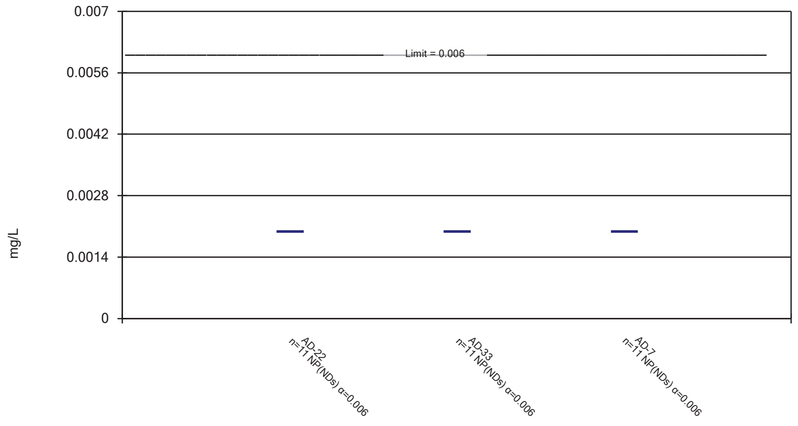
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/9/2019, 9:05 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-22	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-33	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-7	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Arsenic, total (mg/L)	AD-22	0.01483	0.003766	0.01	n/a	No	11	0	sqrt(x)	0.01	Param.
Arsenic, total (mg/L)	AD-33	0.003379	0.0009104	0.01	n/a	No	10	10	sqrt(x)	0.01	Param.
Arsenic, total (mg/L)	AD-7	0.005	0.00108	0.01	n/a	No	11	54.55	No	0.006	NP (normality)
Barium, total (mg/L)	AD-22	0.08797	0.02781	2	n/a	No	11	0	No	0.01	Param.
Barium, total (mg/L)	AD-33	0.06025	0.05007	2	n/a	No	10	0	No	0.01	Param.
Barium, total (mg/L)	AD-7	0.05694	0.04393	2	n/a	No	11	0	No	0.01	Param.
Beryllium, total (mg/L)	**AD-22**	**0.01023**	**0.004131**	**0.004**	**n/a**	**Yes**	**11**	**0**	**x^(1/3)**	**0.01**	**Param.**
Beryllium, total (mg/L)	AD-33	0.002	0.001	0.004	n/a	No	11	0	No	0.006	NP (normality)
Beryllium, total (mg/L)	AD-7	0.006658	0.003504	0.004	n/a	No	11	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-22	0.001618	0.0005097	0.005	n/a	No	11	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-33	0.001	0.00015	0.005	n/a	No	11	72.73	No	0.006	NP (normality)
Cadmium, total (mg/L)	AD-7	0.0008719	0.0007063	0.005	n/a	No	11	0	No	0.01	Param.
Chromium, total (mg/L)	AD-22	0.01336	0.0007646	0.1	n/a	No	11	18.18	sqrt(x)	0.01	Param.
Chromium, total (mg/L)	AD-33	0.009869	0.000489	0.1	n/a	No	11	18.18	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-7	0.0006464	0.0001661	0.1	n/a	No	11	36.36	x^(1/3)	0.01	Param.
Cobalt, total (mg/L)	AD-22	0.1078	0.05293	0.056	n/a	No	11	0	No	0.01	Param.
Cobalt, total (mg/L)	AD-33	0.01117	0.00875	0.056	n/a	No	10	0	No	0.01	Param.
Cobalt, total (mg/L)	AD-7	0.04224	0.02483	0.056	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-22	5.437	2.864	5	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-33	4.932	1.447	5	n/a	No	11	0	sqrt(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-7	4.352	2.698	5	n/a	No	11	0	x^2	0.01	Param.
Fluoride, total (mg/L)	AD-22	0.8655	0.2814	4	n/a	No	11	45.45	No	0.01	Param.
Fluoride, total (mg/L)	AD-33	1	0.357	4	n/a	No	11	81.82	No	0.006	NP (NDs)
Fluoride, total (mg/L)	AD-7	1	0.5	4	n/a	No	11	72.73	No	0.006	NP (normality)
Lead, total (mg/L)	AD-22	0.002	0.0005	0.015	n/a	No	11	54.55	No	0.006	NP (normality)
Lead, total (mg/L)	AD-33	0.002	0.002	0.015	n/a	No	10	90	No	0.011	NP (NDs)
Lead, total (mg/L)	AD-7	0.002	0.001	0.015	n/a	No	11	81.82	No	0.006	NP (NDs)
Lithium, total (mg/L)	AD-22	0.2199	0.1201	0.17	n/a	No	11	0	No	0.01	Param.
Lithium, total (mg/L)	AD-33	0.029	0.0178	0.17	n/a	No	11	9.091	No	0.006	NP (normality)
Lithium, total (mg/L)	AD-7	0.107	0.08978	0.17	n/a	No	11	0	x^4	0.01	Param.
Mercury, total (mg/L)	AD-22	0.01023	-0.00006233	0.002	n/a	No	8	0	No	0.01	Param.
Mercury, total (mg/L)	AD-33	0.0008791	0.0002363	0.002	n/a	No	11	0	sqrt(x)	0.01	Param.
Mercury, total (mg/L)	AD-7	0.0002241	0.00005679	0.002	n/a	No	11	0	No	0.01	Param.
Molybdenum, total (mg/L)	AD-22	0.002	0.002	0.1	n/a	No	10	90	No	0.011	NP (NDs)
Molybdenum, total (mg/L)	AD-33	0.002	0.002	0.1	n/a	No	10	90	No	0.011	NP (NDs)
Molybdenum, total (mg/L)	AD-7	0.002	0.002	0.1	n/a	No	11	100	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-22	0.003928	0.001214	0.05	n/a	No	11	54.55	ln(x)	0.01	Param.
Selenium, total (mg/L)	AD-33	0.005	0.0017	0.05	n/a	No	11	72.73	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-7	0.005	0.001047	0.05	n/a	No	11	72.73	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-22	0.002	0.0008954	0.002	n/a	No	11	63.64	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-33	0.002	0.001192	0.002	n/a	No	11	72.73	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-7	0.002	0.001032	0.002	n/a	No	11	81.82	No	0.006	NP (NDs)

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

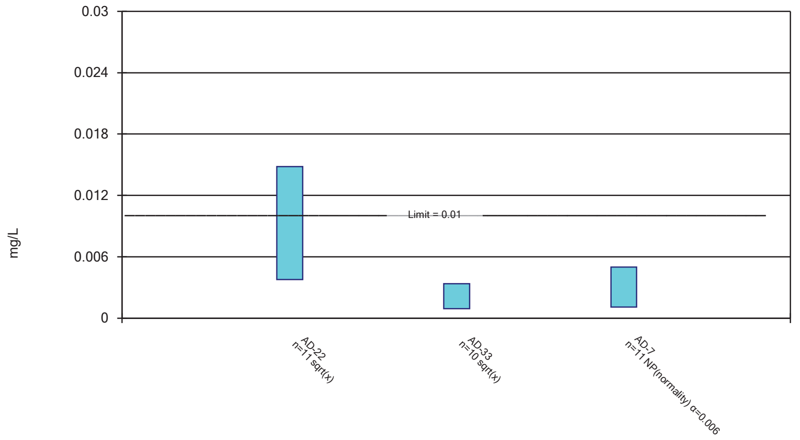


Constituent: Antimony, total   Analysis Run 7/9/2019 9:03 AM   View: Confidence Intervals - App IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

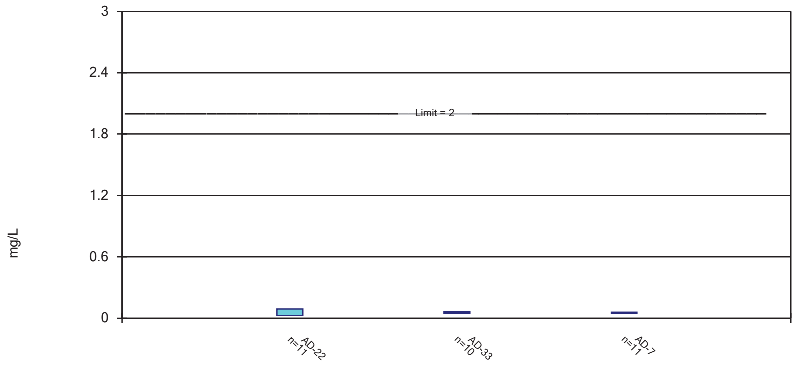


Constituent: Arsenic, total   Analysis Run 7/9/2019 9:03 AM   View: Confidence Intervals - App IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

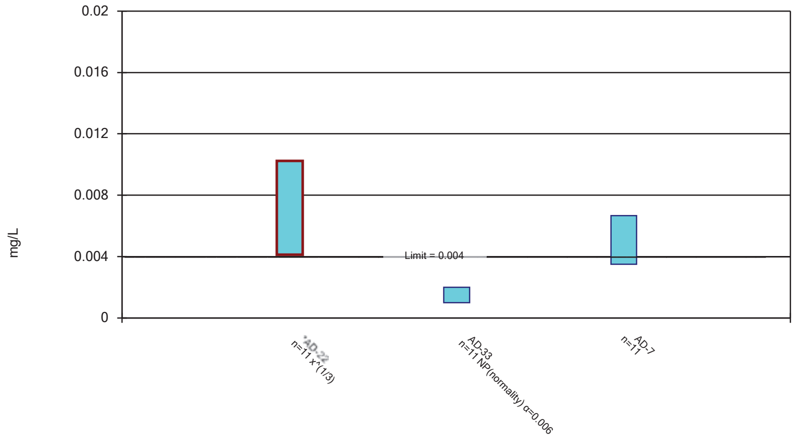


Constituent: Barium, total   Analysis Run 7/9/2019 9:03 AM   View: Confidence Intervals - App IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

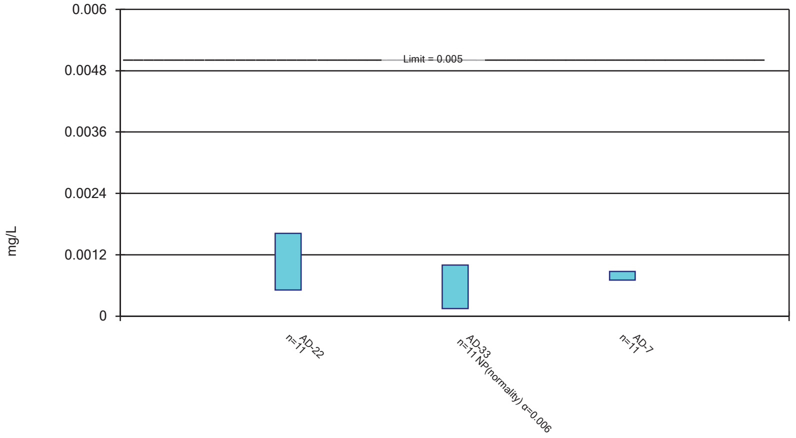


Constituent: Beryllium, total   Analysis Run 7/9/2019 9:03 AM   View: Confidence Intervals - App IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

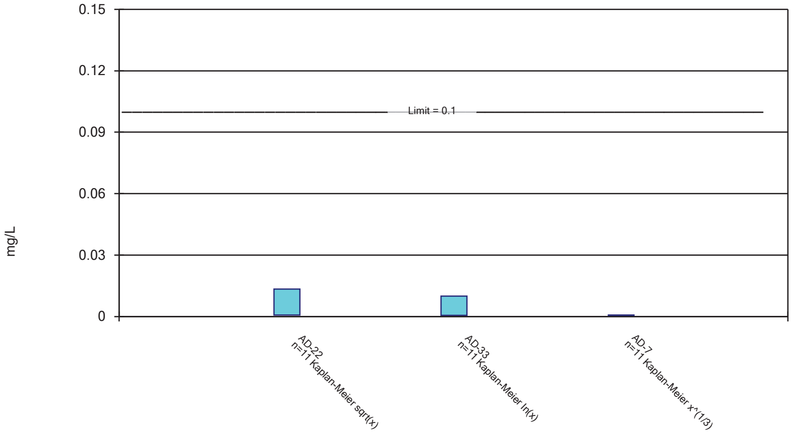


Constituent: Cadmium, total   Analysis Run 7/9/2019 9:03 AM   View: Confidence Intervals - App IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

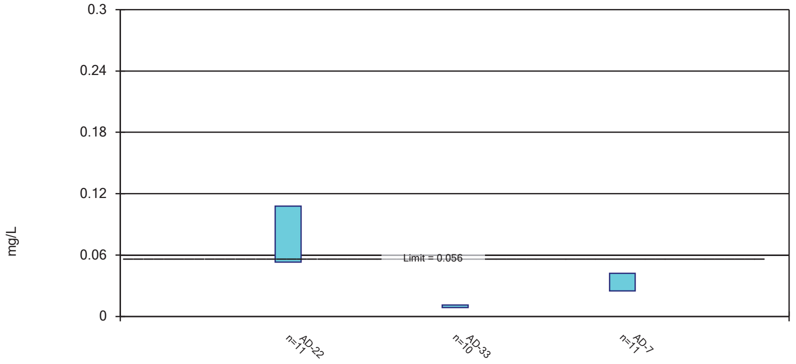


Constituent: Chromium, total   Analysis Run 7/9/2019 9:03 AM   View: Confidence Intervals - App IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

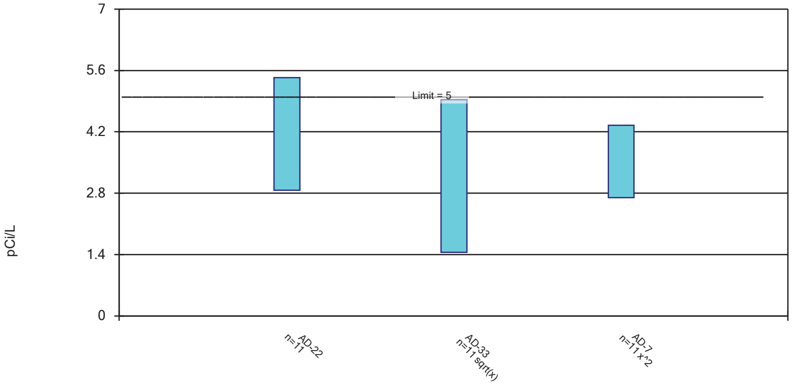


Constituent: Cobalt, total   Analysis Run 7/9/2019 9:03 AM   View: Confidence Intervals - App IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

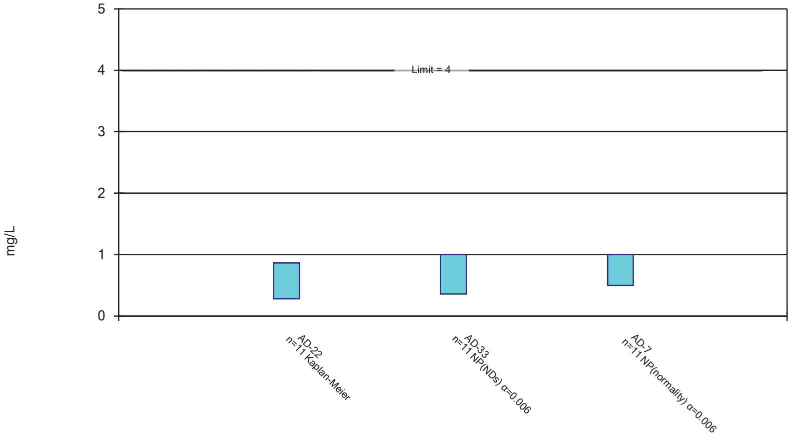


Constituent: Combined Radium 226 + 228   Analysis Run 7/9/2019 9:03 AM   View: Confidence Intervals - A
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

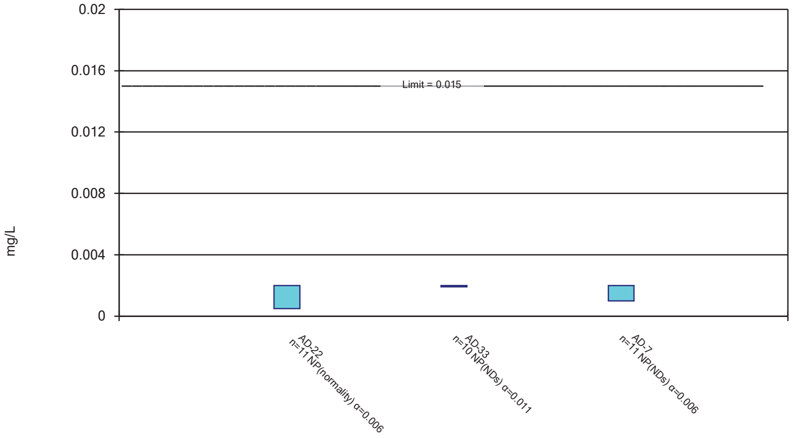


Constituent: Fluoride, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

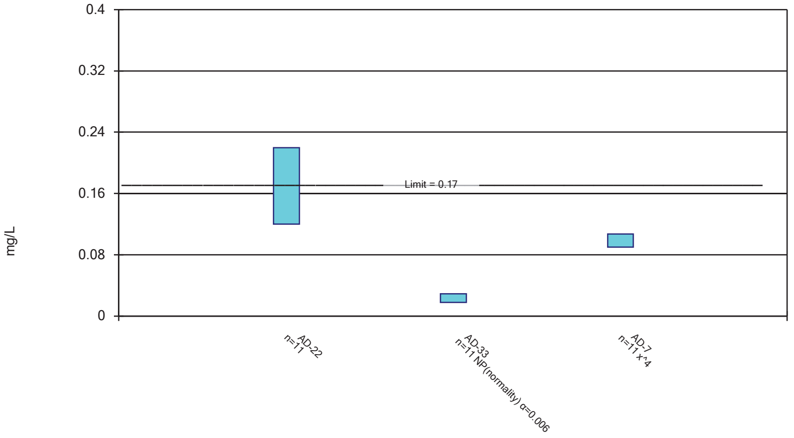


Constituent: Lead, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

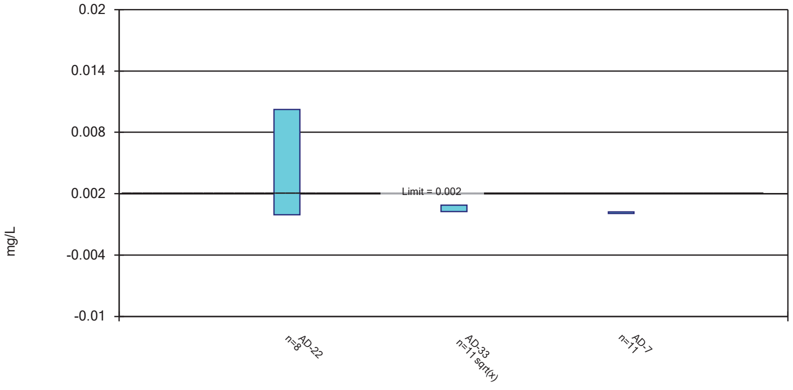


Constituent: Lithium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

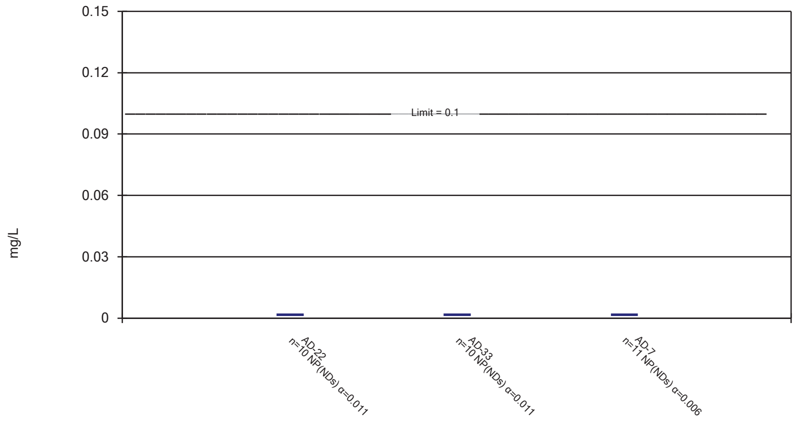


Constituent: Mercury, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

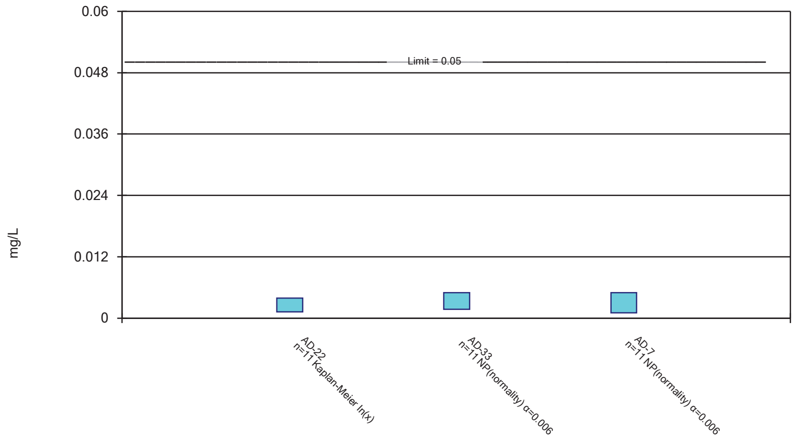


Constituent: Molybdenum, total   Analysis Run 7/9/2019 9:03 AM   View: Confidence Intervals - App IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

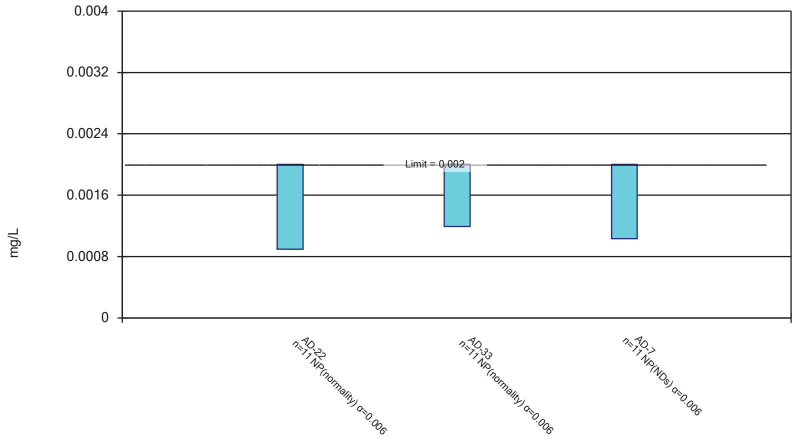


Constituent: Selenium, total   Analysis Run 7/9/2019 9:03 AM   View: Confidence Intervals - App IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



Constituent: Thallium, total   Analysis Run 7/9/2019 9:03 AM   View: Confidence Intervals - App IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

STATISTICAL ANALYSIS SUMMARY
FLUE GAS DESULFURIZATION (FGD) STACKOUT AREA
H.W. Pirkey Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants
engineers | scientists | innovators

941 Chatham Lane
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January 2, 2020

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LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
FGD	Flue Gas Desulfurization
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
SU	Standard Units
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the Flue Gas Desulfurization (FGD) Stackout Area, an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, and sulfate at the FGD Stackout Area. An alternative source was not identified at the time, so the FGD Stackout Area has been in assessment monitoring since. During the most recent assessment monitoring event, completed in February 2019, an SSL for beryllium was identified at AD-22. An ASD was successfully prepared for beryllium (Geosyntec, 2019); thus, the unit remained in assessment monitoring. Two assessment monitoring events were conducted at the FGD Stackout Area in May and August 2019, in accordance with 40 CFR 257.95. The results of these events are documented in this report.

Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. SSL were identified for beryllium and cobalt. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

FLUE GAS DESULFURIZATION (FGD) STACKOUT AREA EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (May 2019) and 257.95(d)(1) (August 2019). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.23 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the FGD Stackout Area were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained in May and August 2019 were screened for potential outliers. Outliers were identified for molybdenum at AD-7, AD-12, AD-13, AD-22, and AD-33. At these locations, molybdenum was not detected and was replaced with the reporting limit of 0.04 mg/L, which is higher than previous reporting limits.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for beryllium, cadmium, cobalt, fluoride, lithium, selenium, and thallium due to apparent non-normal distributions and for antimony, mercury, and molybdenum due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). Seasonal patterns were observed for beryllium and cobalt at AD-7 and AD-22 and for combined radium at AD-7. The data for these well/parameter pairs was deseasonalized so that the resulting confidence limits correctly account for seasonality as a predictable pattern rather than random variation or a release.

An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey FGD Stackout Area:

- The deseasonalized LCL for beryllium exceeded the GWPS of 0.00400 mg/L at AD-7 (0.00603 mg/L) and AD-22 (0.00447 mg/L).

- The deseasonalized LCL for cobalt exceeded the GWPS of 0.0560 mg/L at AD-22 (0.0727 mg/L).

As a result, the Pirkey FGD Stackout Area will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Establishment of Appendix III Prediction Limits

Upper prediction limits (UPL) were previously established for all Appendix III parameters following the background monitoring period (Geosyntec, 2018). Intrawell tests were used to evaluate potential SSIs for calcium, pH, and TDS, whereas interwell tests were used to evaluate potential SSIs for boron, chloride, fluoride, and sulfate. While interwell prediction limits have been updated periodically during the assessment monitoring period as sufficient data became available, this represents the first update to the background dataset for parameters evaluated using intrawell tests.

Mann-Whitney (Wilcoxon rank-sum) tests were performed to determine whether the newer data are affected by a release from the FGD Stackout Area. Because the interwell Appendix III limits and the Appendix IV GWPSs are based on data from upgradient wells which we would not expect to have been impacted by a release, these tests were used for intrawell Appendix III tests only. Mann-Whitney tests were used to compare the medians of historical data (May 2016 - April 2017) to the new compliance samples (August 2017 – February2019) for calcium, pH, and TDS. Results were evaluated to determine if the medians of the two groups were similar at the 99% confidence level. Where no significant difference was found, the new compliance data were added to the background dataset. Where a statistically significant difference was found between the medians of the two groups, the data were reviewed to evaluate the cause of the difference and to determine if adding newer data to the background dataset, replacing the background dataset with the newer data, or continuing to use the existing background dataset was most appropriate. If the differences appeared to have been caused by a release, then the previous background dataset continued to be used.

The complete Mann-Whitney test results and a summary of the significant findings can be found in Attachment B. No significant differences were found between the two groups for calcium, pH, or TDS.

After the revised background set was established, a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., “J-flagged” data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment B.

UPLs were updated using all the historical data through May 2019 to represent background values. LPLs were also updated for pH. The updated prediction limits are summarized in Table 3. Intrawell tests continued to be used to evaluate potential SSIs for calcium, pH, and TDS, whereas interwell tests continued to be used to evaluate potential SSIs for boron, chloride, fluoride, and sulfate. The intrawell UPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where the initial result did not exceed the UPL, a second sample was not collected. The retesting procedures allowed achieving an acceptably high statistical power to detect changes at downgradient wells for constituents evaluated using intrawell prediction limits.

2.2.4 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the May and August 2019 assessment monitoring events from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 4. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0845 mg/L at AD-33 (0.111 mg/L and 0.0970 mg/L) and AD-7 (0.195 mg/L and 3.54 mg/L).
- Calcium concentrations exceeded the intrawell UPL of 15.2 mg/L at AD-22 (16.5 mg/L) and the intrawell UPL of 5.32 mg/L at AD-7 (5.77 mg/L).
- Chloride concentrations exceeded the interwell UPL of 40.8 mg/L AD-22 (63.3 mg/L and 79.6 mg/L).
- The fluoride concentration exceeded the interwell UPL of 1.00 mg/L at AD-22 (1.06 mg/L).
- The May 2019 pH measurement at AD-22 (5.1 SU) exceeded the GWPS of 4.9 SU.
- Sulfate concentrations exceeded the interwell UPL of 80.8 mg/L at AD-22 (360 mg/L and 198 mg/L) and AD-7 (91.6 mg/L).
- TDS concentrations exceeded the intrawell UPL of 203 mg/L at AD-33 (204 mg/L) and the intrawell UPL of 291 mg/L at AD-7 (334 mg/L).

Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey FGD Stackout Area during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified potential outliers for molybdenum in the May data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. SSLs were identified for beryllium and cobalt. Appendix III parameters were compared to recalculated prediction limits, with exceedances identified for boron, calcium, chloride, fluoride, pH, sulfate, and TDS.

Based on this evaluation, the Pirkey FGD Stackout Area CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Plant. January 2017.

Geosyntec Consultants. 2018. Statistical Analysis Summary – Flue Gas Desulfurization (FGD) Stackout Area, H.W. Pirkey Plant, Hallsville, Texas. January.

Geosyntec Consultants. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area, Hallsville, Texas. October.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - Stackout Pad

Component	Unit	AD-7		AD-12		AD-13		AD-22		AD-33	
		5/22/2019	8/12/2019	5/21/2019	8/12/2019	5/21/2019	8/12/2019	5/22/2019	8/12/2019	5/22/2019	8/12/2019
Antimony	µg/L	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U
Arsenic	µg/L	2.00 J	0.640	2.00 U	0.0700 J	2.00 J	1.64	5.89	2.19	2.00 U	0.410
Barium	µg/L	37.8	41.9	21.7	23.8	35.0	35.0	16.7	15.3	52.4	38.6
Beryllium	µg/L	6.47	3.24	2.00 U	0.154	2.00 U	0.235	12.5	3.38	1.00 J	1.00
Boron	mg/L	0.195	3.54	0.0200	0.0500 U	0.0610	0.0640	0.0730	0.0300 J	0.111	0.0970
Cadmium	µg/L	0.600 J	0.750	1.00 U	0.0500 U	1.00 U	0.0500 U	1.52	0.440	1.00 U	0.0400 J
Calcium	mg/L	5.77	4.20	0.300 J	0.278	10.1	8.68	16.5	8.96	1.65	1.03
Chloride	mg/L	28.0	36.7	6.30	7.24	34.8	42.3	63.3	79.6	8.57	8.85
Chromium	µg/L	4.00 U	0.100 J	4.00 U	0.204	4.00 U	0.0600 J	4.00 U	0.200 J	4.00 U	0.100 J
Cobalt	µg/L	46.0	29.7	1.15	1.30	44.7	44.5	129	57.5	10.5	7.02
Combined Radium	pCi/L	4.72	3.28	0.201	0.237	0.875	1.64	6.71	3.09	1.18	1.14
Fluoride	mg/L	0.580	0.300	0.0900	0.0600 J	0.400	0.390	1.06	0.450	0.230	0.190
Lead	µg/L	0.800 J	0.529	2.00 U	0.0800 J	2.00 U	0.200 U	2.00 U	0.100 J	2.00 U	0.100 J
Lithium	mg/L	0.0975	0.102	0.00576	0.00829	0.153	0.139	0.288	0.151	0.0245	0.0233
Mercury	mg/L	0.000260	0.0000900	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.000837	0.000325	0.000481	0.000564
Molybdenum	µg/L	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U
Selenium	µg/L	3.00 J	1.70	4.00 U	0.200 J	4.00 U	0.200 U	5.90	2.00	1.00 J	1.10
Total Dissolved Solids	mg/L	334	266	80.0	90.0	190	310	506	484	204	156
Sulfate	mg/L	91.6	59.6	4.00	2.60	69.5	73.6	360	198	60.4	44.3
Thallium	µg/L	0.500 U	0.200 J	0.500 U	0.500 U	0.500 U	0.500 U	0.200 J	0.200 J	0.500 U	0.500 U
pH	SU	3.37	4.01	4.09	4.94	5.32	5.94	5.06	4.76	4.12	4.16

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above the method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit

Table 2: Groundwater Protection Standards
Pirkey Plant - Stackout

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.006
Barium, Total (mg/L)	2		0.051
Beryllium, Total (mg/L)	0.004		0.002
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.002
Cobalt, Total (mg/L)	n/a	0.006	0.056
Combined Radium, Total (pCi/L)	5		2.94
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.17
Mercury, Total (mg/L)	0.002		0.000025
Molybdenum, Total (mg/L)	n/a	0.1	0.005
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.002

Notes:

Grey cell indicates calculated UTL is higher than MCL or CCR Rule-specified value.

MCL = Maximum Contaminant Level

Calculated UTL (Upper Tolerance Limit) represents site-specific background values.

The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3: Revised Prediction Limits
Pirkey Plant - Stackout Pad

Parameter	Unit	Description	AD-22	AD-33	AD-7
Boron	mg/L	Interwell Background Value (UPL)	0.0845		
Calcium	mg/L	Intrawell Background Value (UPL)	15.2	2.29	5.32
Chloride	mg/L	Interwell Background Value (UPL)	40.8		
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
pH	SU	Intrawell Background Value (UPL)	4.9	4.7	4.5
		Intrawell Background Value (LPL)	3.6	2.7	3.0
Sulfate	mg/L	Interwell Background Value (UPL)	80.8		
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	651	203	291

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

Table 4: Appendix III Data Summary
Pirkey Plant - Stackout Pad

Parameter	Unit	Description	AD-22		AD-33		AD-7	
			5/22/2019	8/12/2019	5/22/2019	8/12/2019	5/22/2019	8/12/2019
Boron	mg/L	Interwell Background Value (UPL)	0.0845					
		Detection Monitoring Result	0.0730	0.0300	**0.111**	**0.0970**	**0.195**	**3.54**
Calcium	mg/L	Intrawell Background Value (UPL)	15.2		2.29		5.32	
		Detection Monitoring Result	**16.5**	8.96	1.65	1.03	**5.77**	4.20
Chloride	mg/L	Interwell Background Value (UPL)	40.8					
		Detection Monitoring Result	**63.3**	**79.6**	8.57	8.85	28.0	36.7
Fluoride	mg/L	Interwell Background Value (UPL)	1.00					
		Detection Monitoring Result	**1.06**	0.450	0.230	0.190	0.580	0.300
pH	SU	Intrawell Background Value (UPL)	4.9		4.7		4.5	
		Intrawell Background Value (LPL)	3.6		2.7		3.0	
		Detection Monitoring Result	**5.1**	4.8	4.1	4.2	3.4	4.0
Sulfate	mg/L	Interwell Background Value (UPL)	80.8					
		Detection Monitoring Result	**360**	**198**	60.4	44.3	**91.6**	59.6
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	651		203		291	
		Detection Monitoring Result	506	484	**204**	156	**334**	266

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey Flue Gas Desulfurization (FGD) Stackout Area CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER

112498

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

112498
License Number

TEXAS
Licensing State

01.03.20
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

December 10, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey Stackout
Statistical Analysis & Background Update – 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the background update of groundwater data for American Electric Power Inc.'s Pirkey Stackout. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-12 and AD-13; and
- **Downgradient wells:** AD-22, AD-33, and AD-7.

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis report was reviewed by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to Groundwater Stats Consulting. The analysis was prepared according to the background screening conducted in December 2017 that was approved by Dr. Cameron.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) - boron, calcium, chloride, fluoride, pH, sulfate, and TDS;
- **Appendix IV** (Assessment Monitoring) – antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots and box plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B). Values previously flagged during the screening as outliers may be seen in a lighter font and disconnected symbol on the time series graphs, and a summary of those values follows this letter.

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for calcium and pH, and TDS;
2) Interwell prediction limits combined with a 1-of-2 resample plan for boron, chloride, fluoride, and sulfate.

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, the reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory. There is no replacement of historical reporting limits with the most recent reporting limit. It was noted that the most recent RL are significantly lower than those reported historically.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.

- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Historical Summary - Evaluation of Appendix III Parameters – December 2017

Outlier Evaluation

Time series plots were used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III parameters were formally tested using Tukey's box plot method and, when identified, flagged in the computer database with "o" and deselected prior to construction of statistical limits.

During the previous background screening, a high value was flagged as an outlier for TDS in downgradient well AD-33. The current assumption is that changes in concentrations are reflective of natural variation upgradient of the facility; however, a separate study and hydrogeological investigation would be required to fully understand the geochemical conditions and expected groundwater quality for the region. That study and assessment is beyond the scope of services provided by Groundwater Stats Consulting.

Statistical Limits

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, chloride, fluoride, and sulfate; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, pH and TDS. The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data were screened for any newly suspected outliers or obvious trending patterns using time series plots. Intrawell prediction limits utilized the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the set background data will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. Prediction limit exceedances were noted for boron in wells AD-33 and AD-7; calcium in well AD-13; chloride, fluoride and sulfate in well AD-22; and pH in wells AD-22 and AD-7. The results of those findings were included in the previous screening and may be found in the Prediction Limit Summary tables.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable. Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site which is an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances.

Appendix III Background Update – November 2019

Prior to updating background data, samples are re-evaluated for all wells for intrawell parameters and all upgradient wells for interwell parameters using Tukey's outlier test and visual screening with the May and August 2019 samples. Additionally, samples during August and December 2017 that were previously absent were incorporated into this analysis. No values were flagged for Appendix III parameters except for fluoride in downgradient well AD-7, and the previously flagged outlier for TDS in well AD-33 was also flagged for this background screening. As mentioned above, any flagged data are displayed in a lighter font and as a disconnected symbol on the time series reports, as well as in a lighter font on the accompanying data pages. An updated summary of Tukey's test results and flagged outliers follows this letter (Figure C).

For constituents requiring intrawell prediction limits, the Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through April 2017 to the new compliance samples at each well through February 2019 to evaluate whether the groups are statistically different at the 99% confidence level, in which case background data may be updated with compliance data.

No statistically significant differences were found between the two groups for any well/parameter pairs. Typically, when the test concludes that the medians of the two groups are significantly different, particularly in the downgradient wells, the background are not updated to include the newer data but will be reconsidered in the future. A summary of these results follows this letter and the test results are included with the Mann Whitney test section at the end of this report (Figure D).

Intrawell prediction limits using all historical data through February 2019 combined with a 1-of-2 resample plan, were constructed for a majority of the well/constituent pairs and a summary of the updated limits follows this letter (Figure E). Seasonal trends appeared to be present for calcium and TDS in wells AD-22 and AD-7 and, therefore, prediction limits were constructed using de-seasonalized values (Figure F).

For parameters tested using interwell analyses, the Sen's Slope/Mann-Kendall trend test was used on upgradient wells to determine whether concentrations are statistically increasing, decreasing or stable (Figure G). No statistically significant increasing or decreasing trends were noted with the exception of fluoride in upgradient well AD-12. The magnitude of this trend, however, is low relative to the average concentrations in these wells. Therefore, no adjustments were required at this time. A summary of these results is included with the trend tests.

Interwell prediction limits, combined with a 1-of-2 resample plan, were updated using all available data from upgradient wells through February 2019 for boron, chloride, fluoride, and sulfate (Figure H). Interwell prediction limits pool upgradient well data to establish a background limit for an individual constituent. A summary table of the updated limits may be found following this letter in the Prediction Limit Summary Tables.

Evaluation of Appendix IV Parameters – November 2019

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure I). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Tukey's test did identify several outliers that were flagged in the database.

Note that the reporting limit during the February 2019 event for molybdenum at wells AD-12, AD-13, AD-22 and AD-33 was 0.04 mg/L compared to a historical reporting limit of 0.002 mg/L. Well AD-7, however, had a reporting limit of 0.002 mg/L during this event. The resulting nondetects reported at 0.04 mg/L are censored at much higher levels than the rest of the data and, therefore, are flagged as outliers.

The reporting limit (or practical quantitation limit) for the February 2019 event for thallium also increased from the historical reporting limit of 0.002 mg/L to 0.01 mg/L for all wells. However, since no detections were present above the method detection limit of 0.002 mg/L for this event, the historical reporting limit of 0.002 mg/L was used for historic nondetects and the nondetects with a reporting limit of 0.01 mg/L were flagged as outliers.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure J).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of the MCL, CCR-Rule specified levels, or ACL as discussed above (Figure K). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No confidence interval exceedances were noted; however, seasonal patterns were noted in some wells and additional confidence intervals were constructed using deseasonalized data as discussed below. A summary of the confidence interval results follows this letter.

Seasonal patterns were observed on the time series plots for beryllium and cobalt in wells AD-22 and AD-7, and combined radium 226 + 228 in well AD-7. When seasonal patterns are observed, data are deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release. It was noted that cadmium in well AD-22 may also be exhibiting some seasonal influence; however, all reported measurements are well below the GWPS and, therefore, this record did not require additional adjustments. Confidence intervals were constructed with deseasonalized values for those wells and constituents mentioned above and the results follow this letter (Figure L). The GWPS was exceeded by wells AD-22 and AD-7 for beryllium, and by well AD-22 for cobalt.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for Pirkey Stackout. If you have any questions or comments, please feel free to contact us.

For Groundwater Stats Consulting,

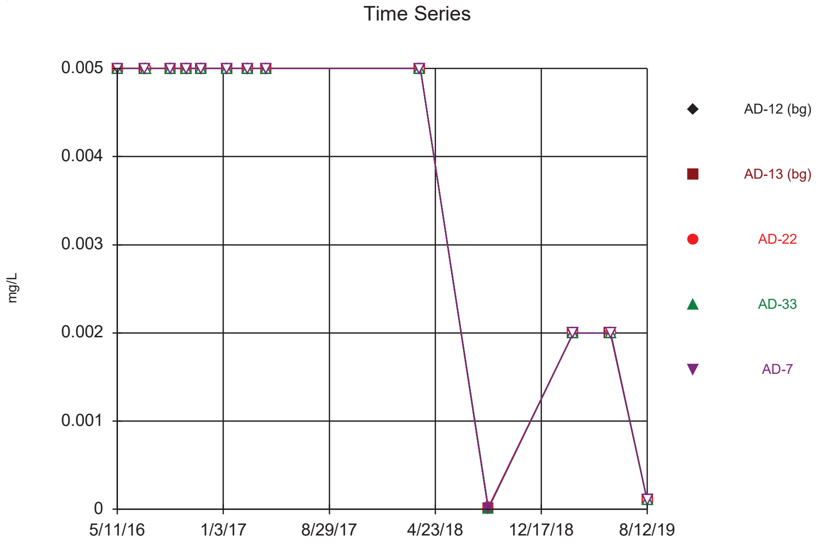
ACollins

Andrew T. Collins
Groundwater Analyst

Kristina Rayner

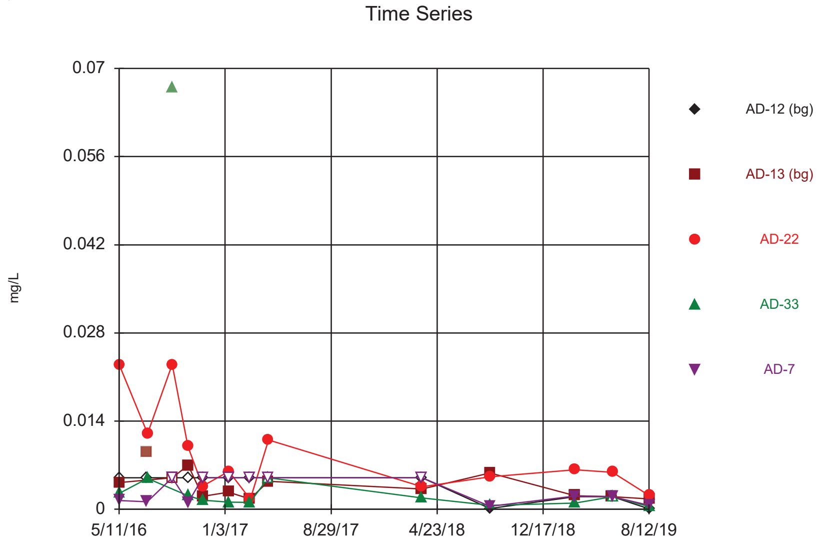
Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Antimony, total Analysis Run 12/10/2019 12:28 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Arsenic, total Analysis Run 12/10/2019 12:28 PM View: Time Series
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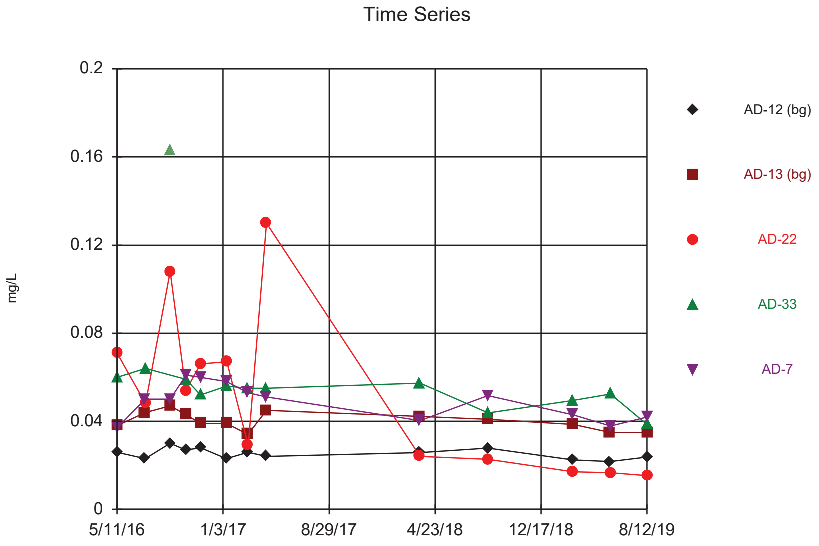
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG



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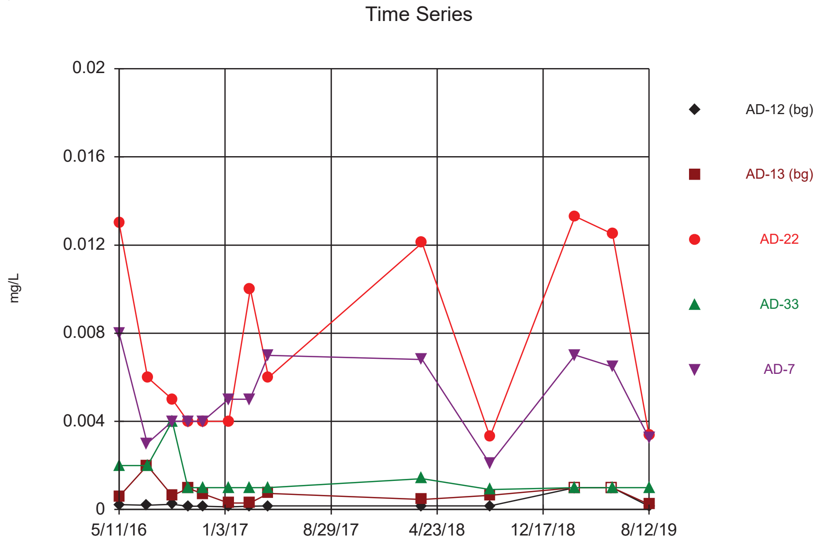
Hollow symbols indicate censored values.



Constituent: Beryllium, total Analysis Run 12/10/2019 12:28 PM View: Time Series
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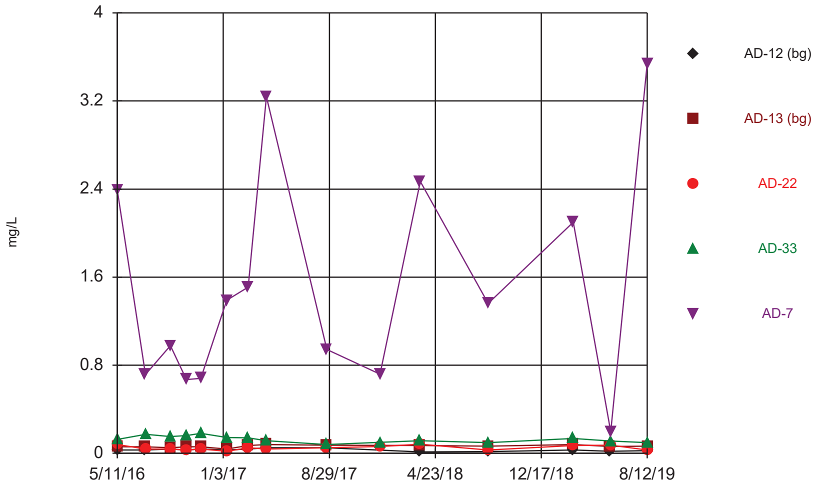
Hollow symbols indicate censored values.

Time Series



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Hollow symbols indicate censored values.

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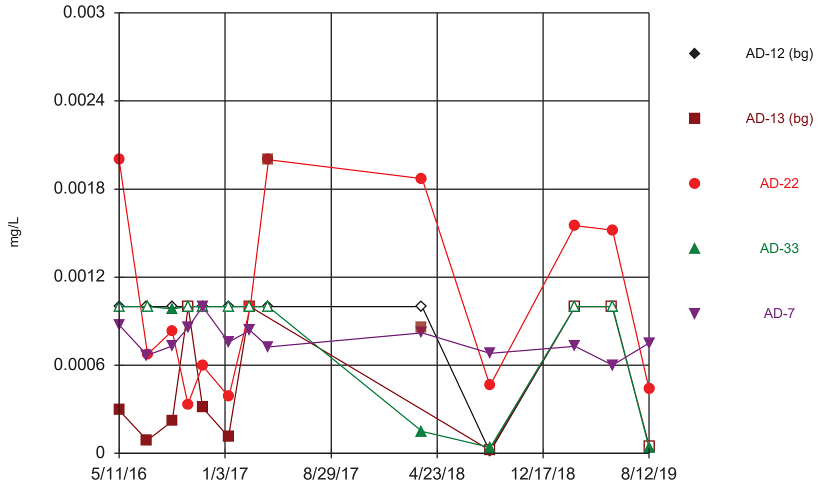

Constituent: Cadmium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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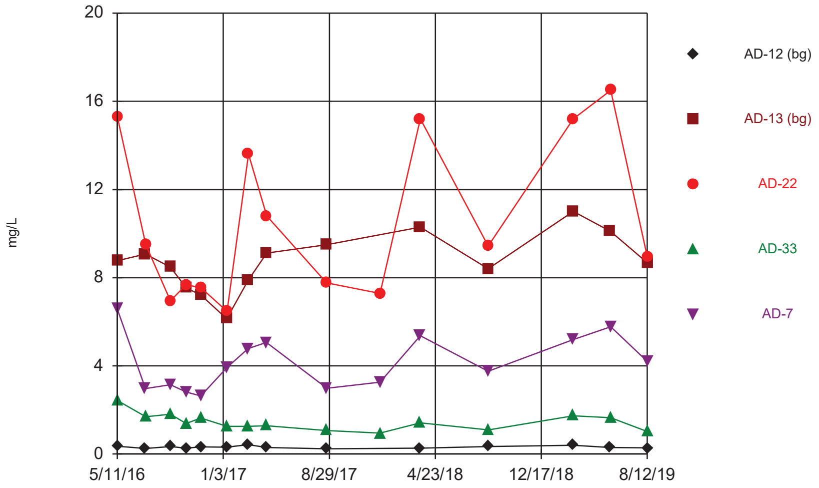
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



Constituent: Calcium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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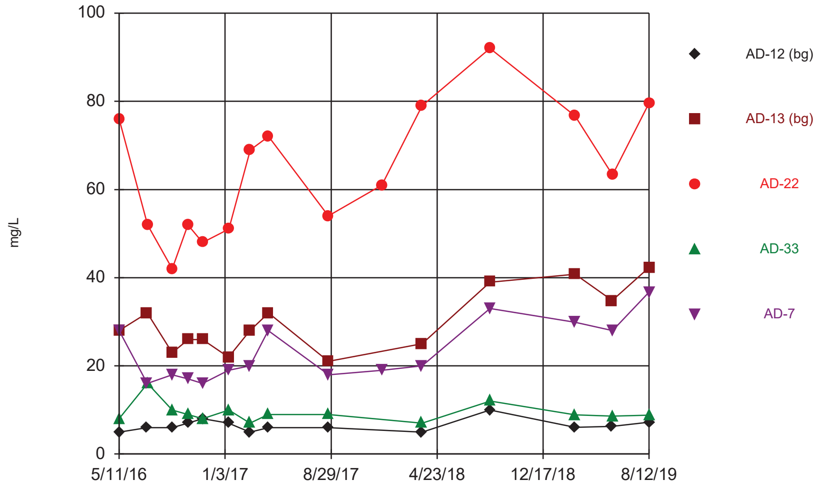
Time Series



Constituent: Chloride, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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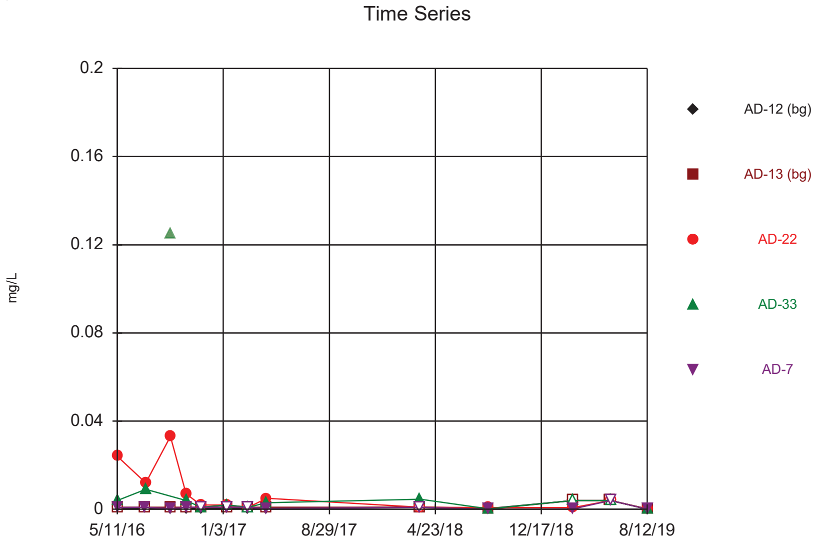
Hollow symbols indicate censored values.



Constituent: Chromium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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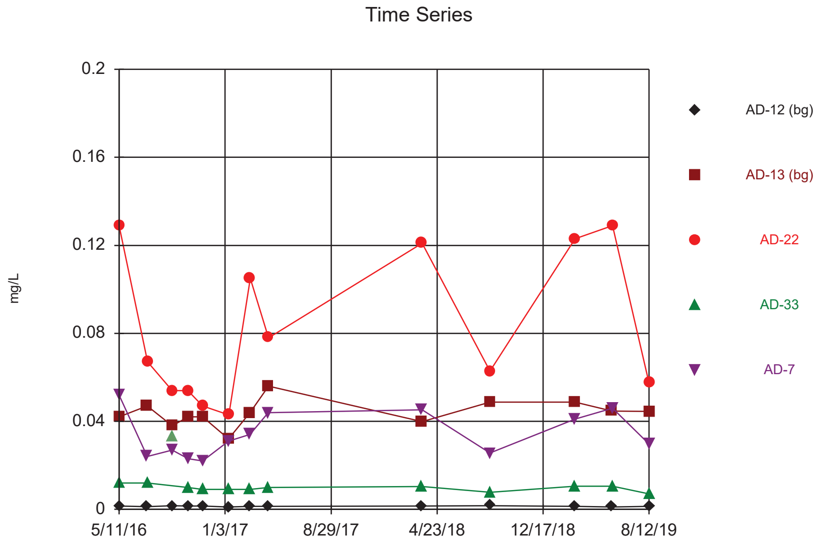
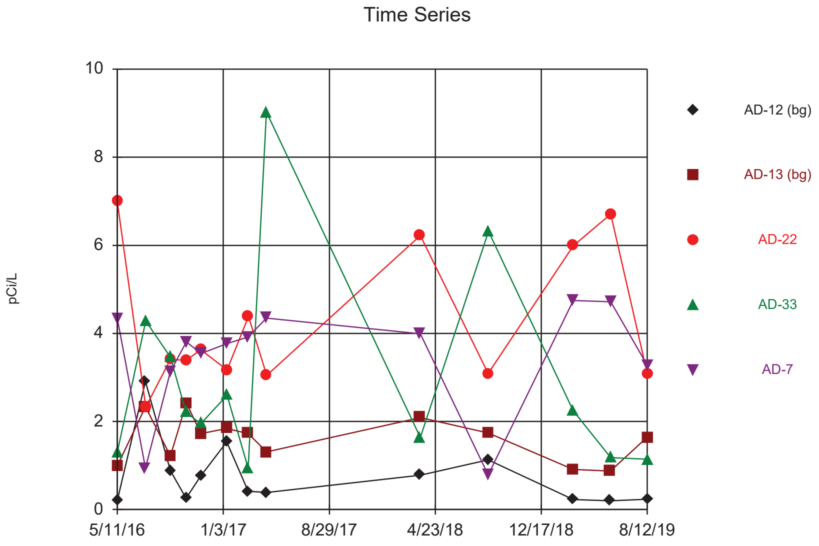
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Cobalt, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Combined Radium 226 + 228 Analysis Run 12/10/2019 12:29 PM View: Time Series
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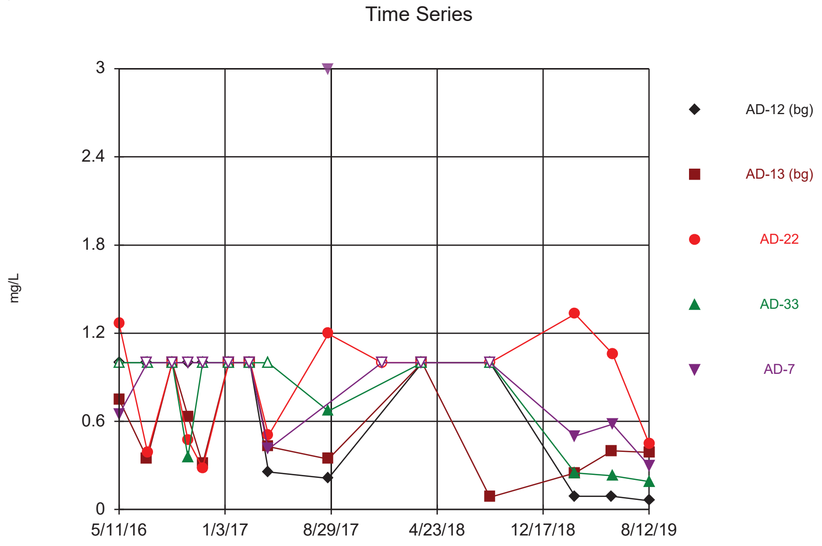
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Fluoride, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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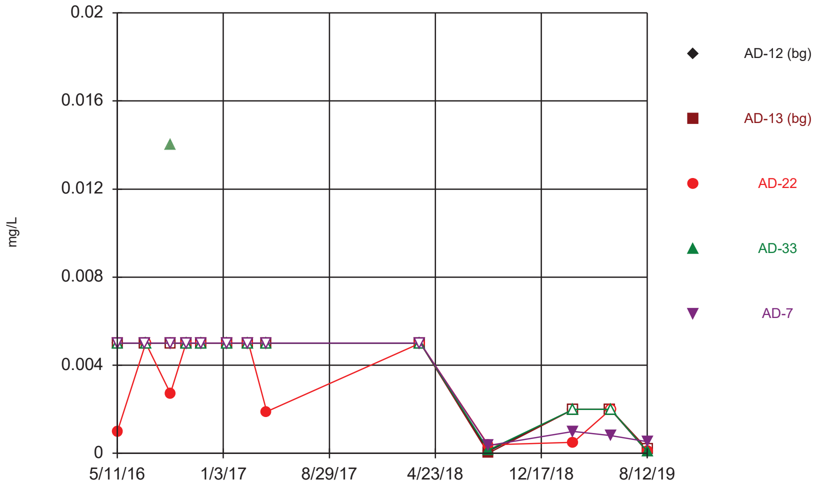
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

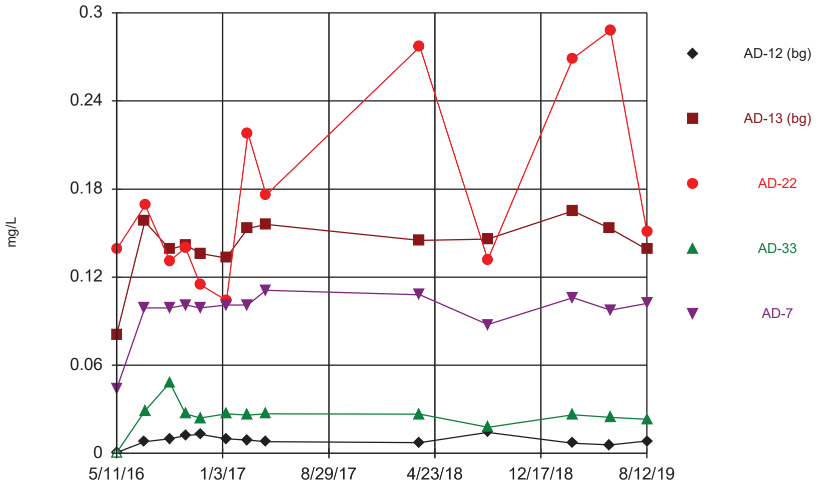
Time Series



Constituent: Lead, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Lithium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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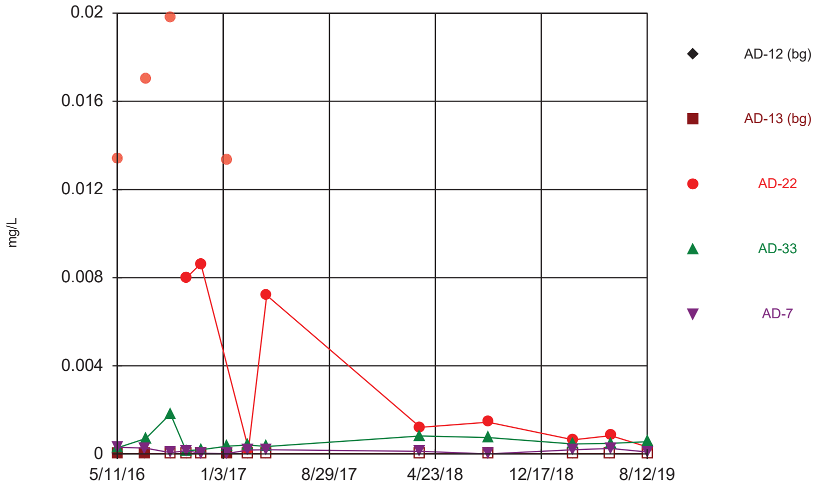
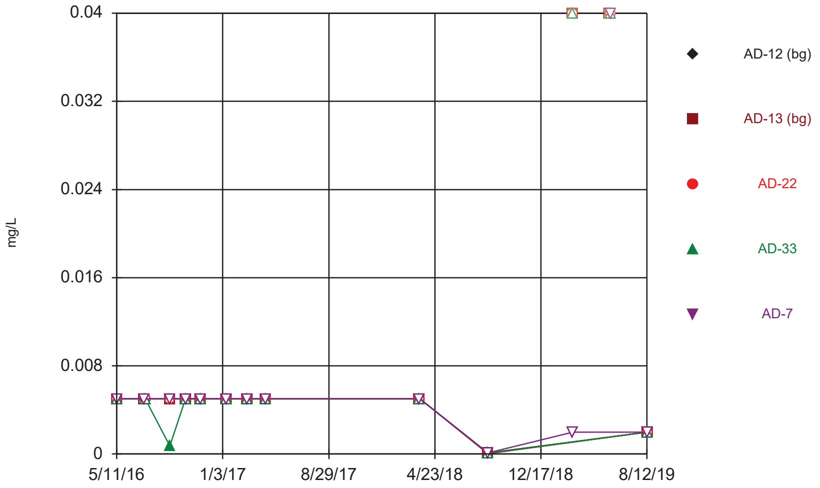


Constituent: Mercury, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

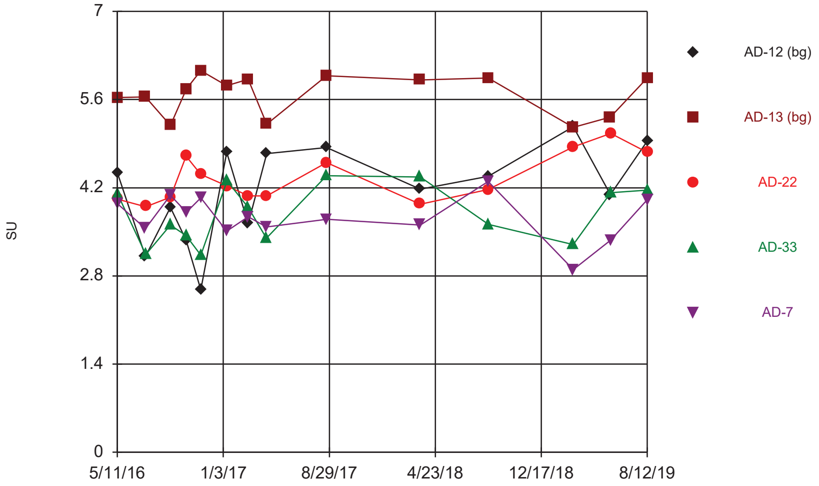
Time Series



Constituent: Molybdenum, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

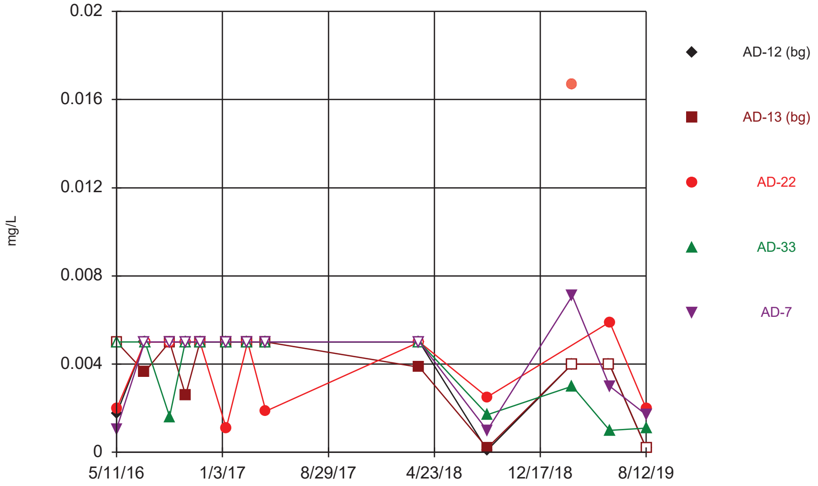
Time Series



Constituent: pH, field Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Selenium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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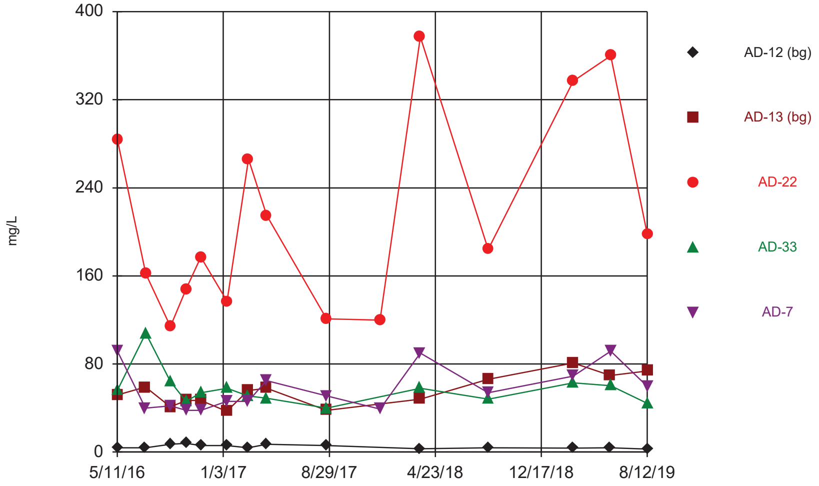
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



Constituent: Sulfate, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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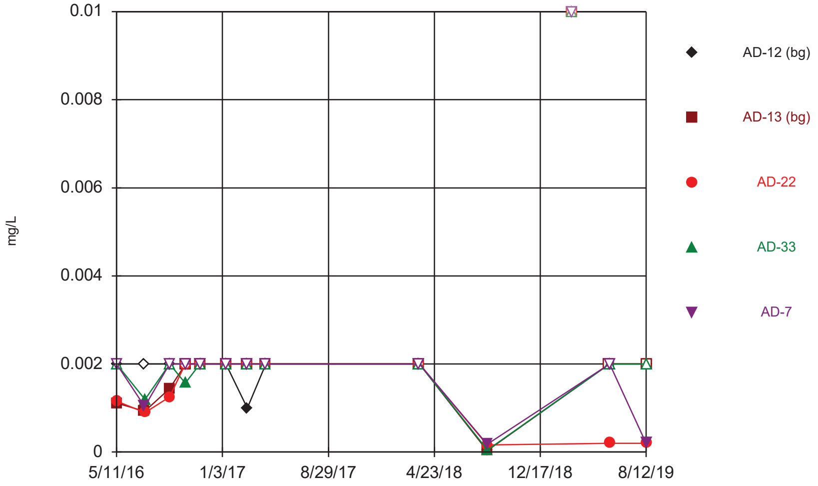
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Thallium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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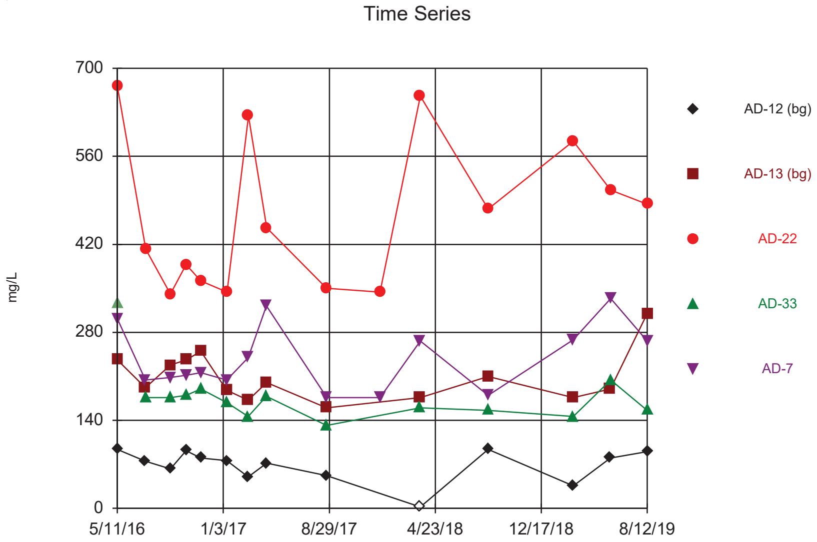
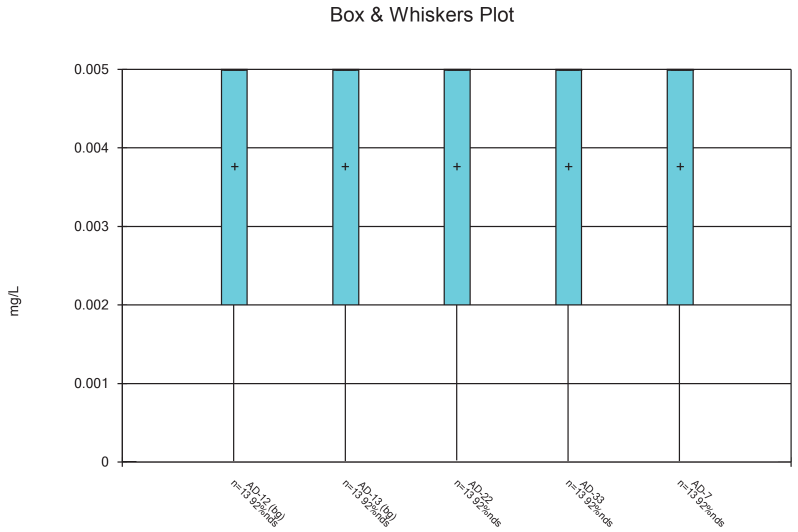


Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/10/2019 12:29 PM   View: Time Series
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

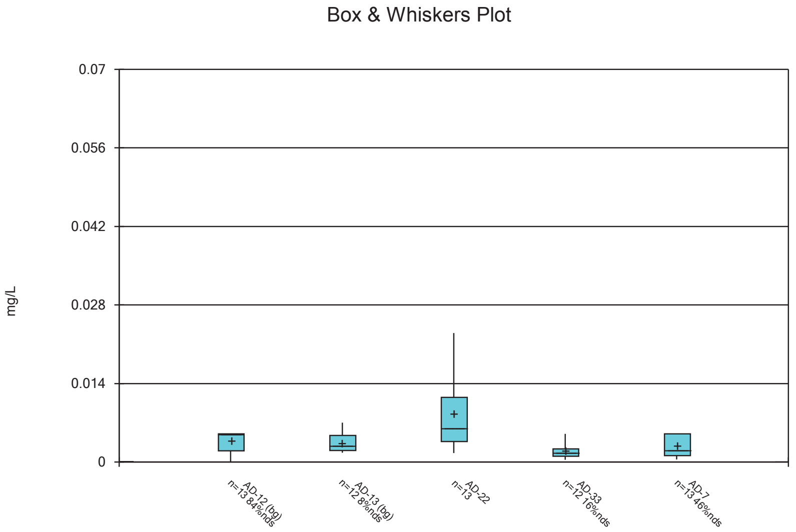
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Antimony, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

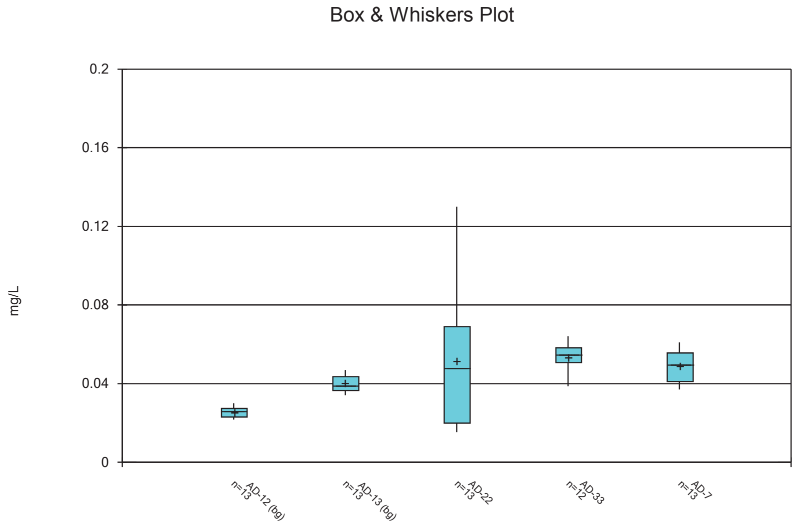
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Arsenic, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

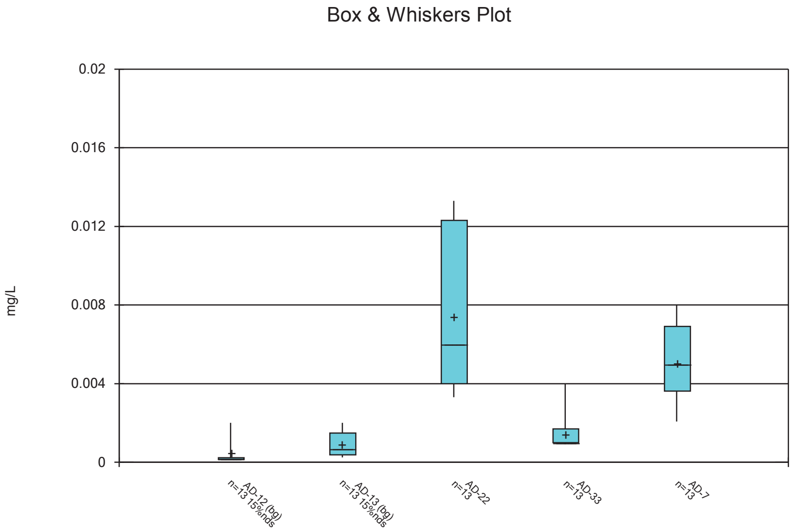
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Barium, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

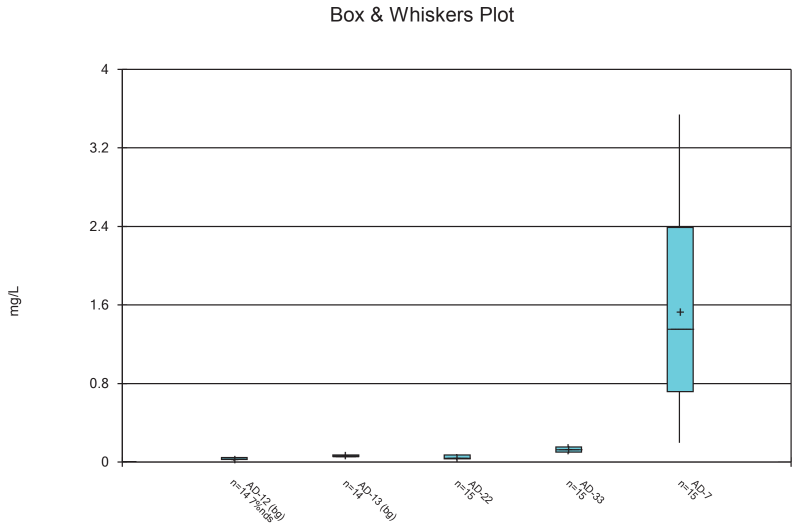
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Beryllium, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

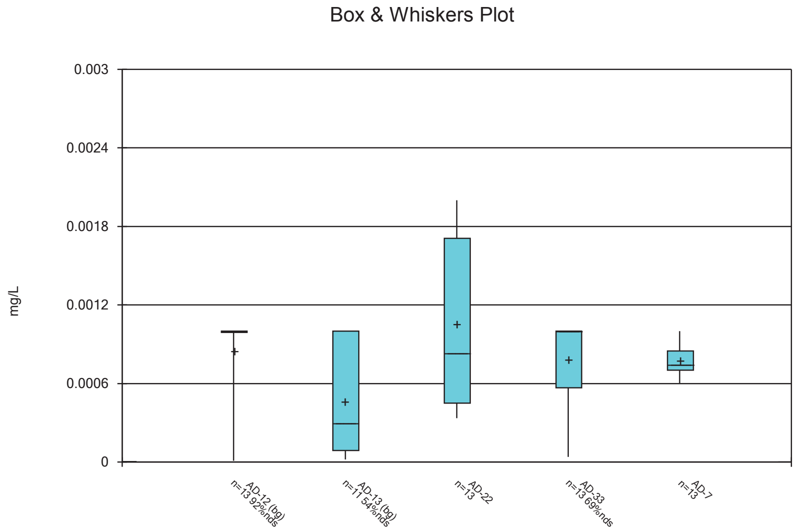
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Boron, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

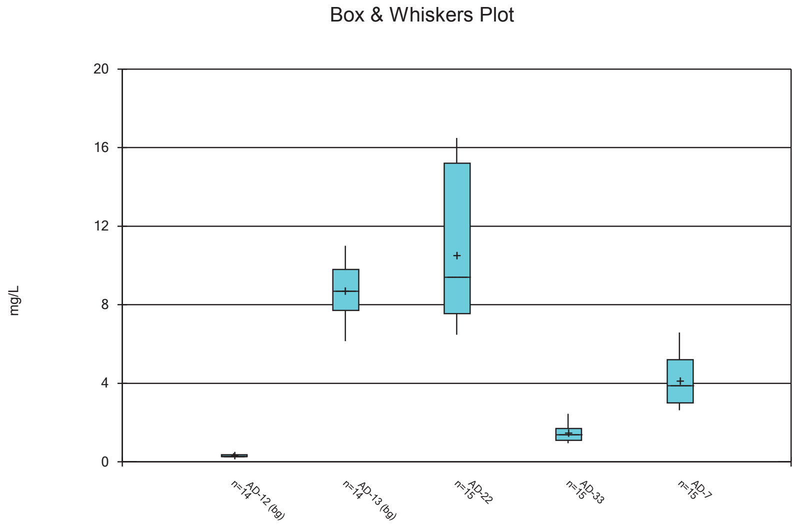
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Cadmium, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

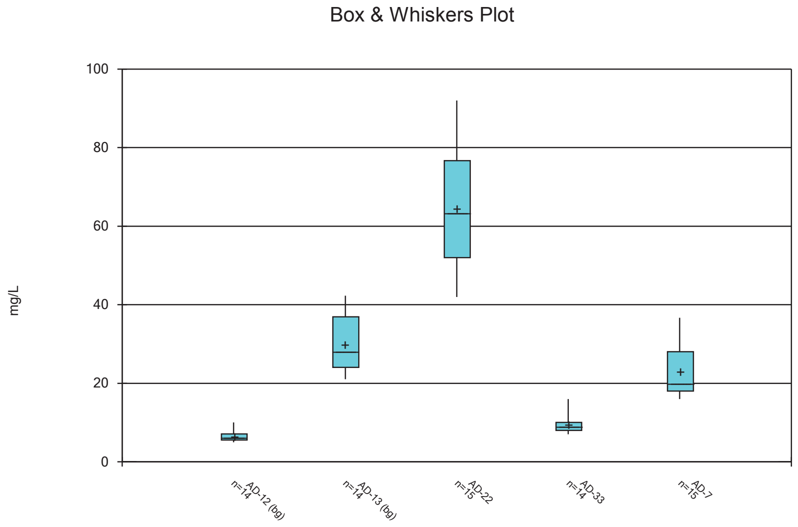
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



Constituent: Calcium, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

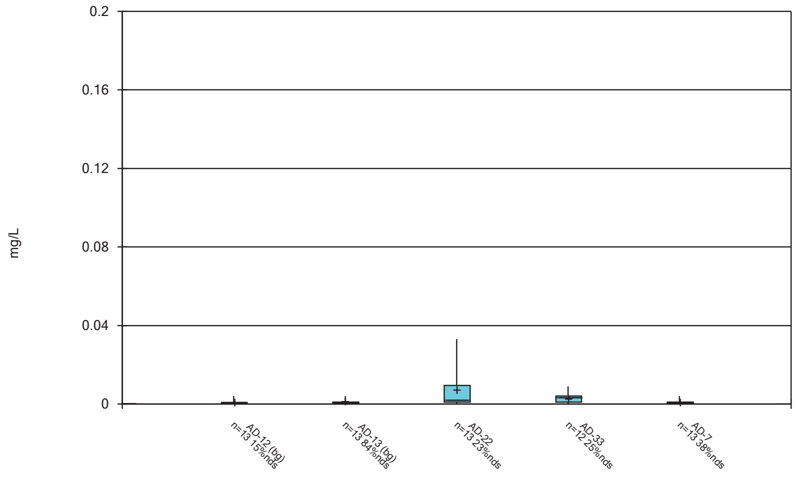


Constituent: Chloride, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

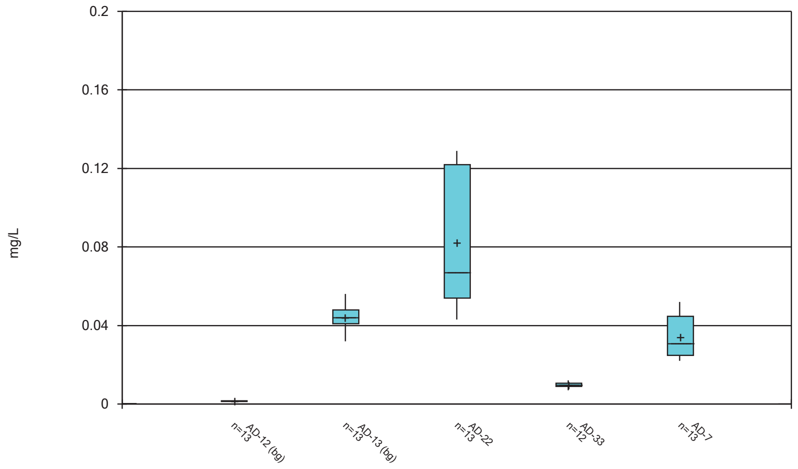
Box & Whiskers Plot



Constituent: Chromium, total   Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

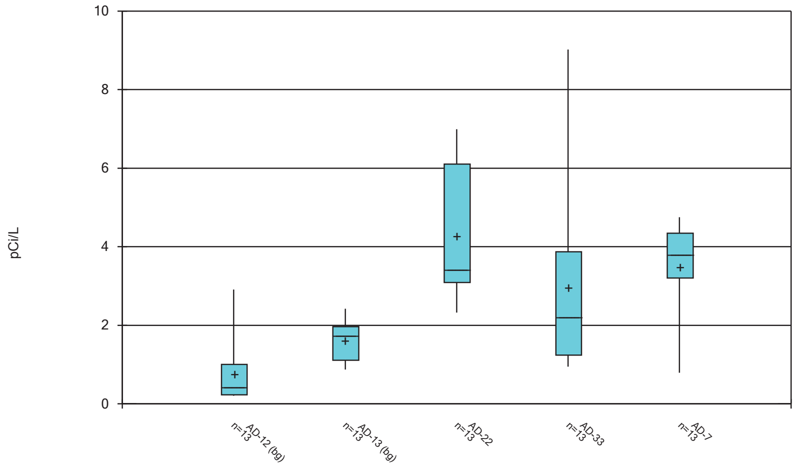
Box & Whiskers Plot



Constituent: Cobalt, total   Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

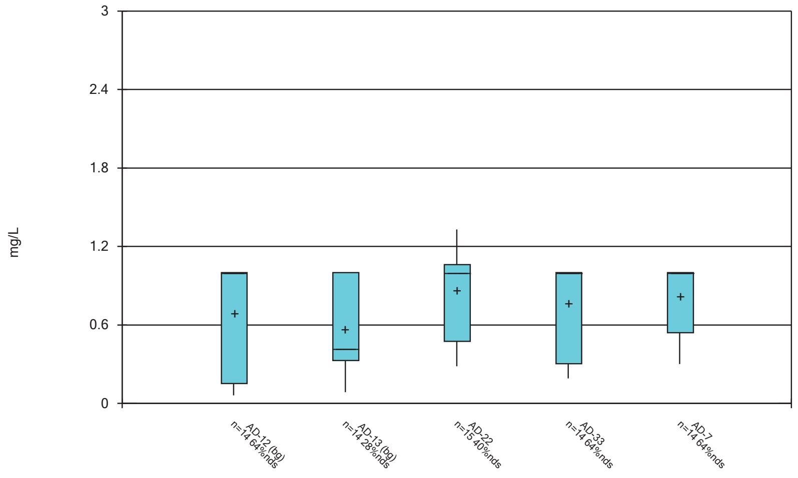
Box & Whiskers Plot



Constituent: Combined Radium 226 + 228   Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

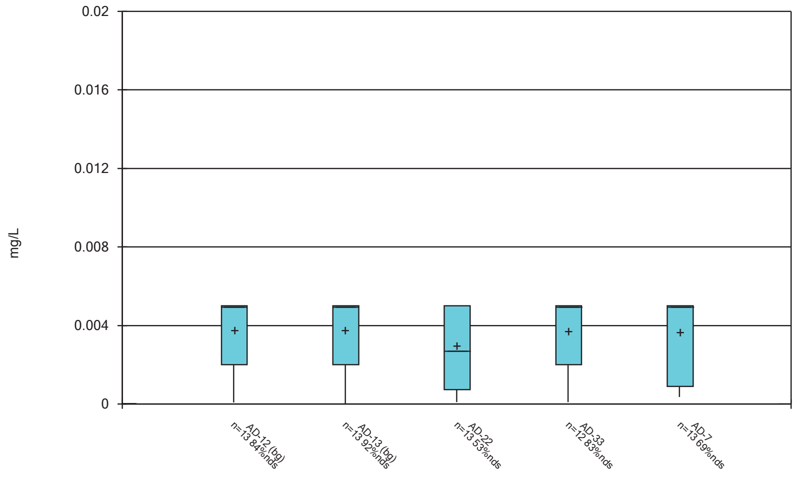
Box & Whiskers Plot



Constituent: Fluoride, total   Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

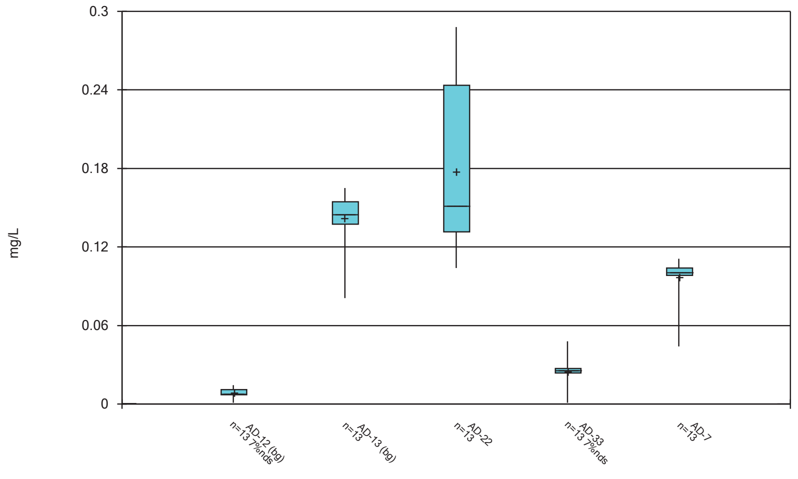


Constituent: Lead, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

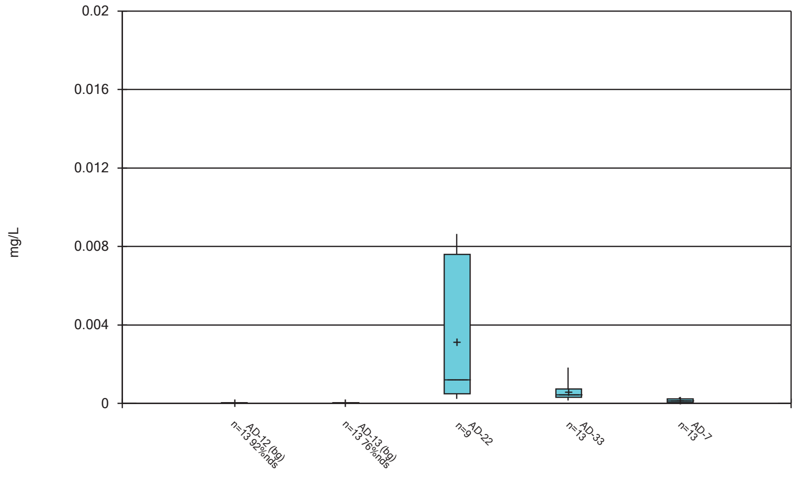


Constituent: Lithium, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

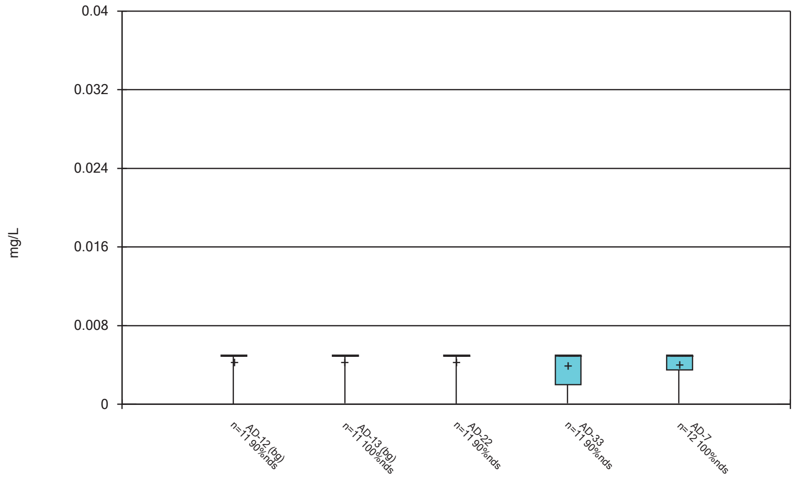


Constituent: Mercury, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot

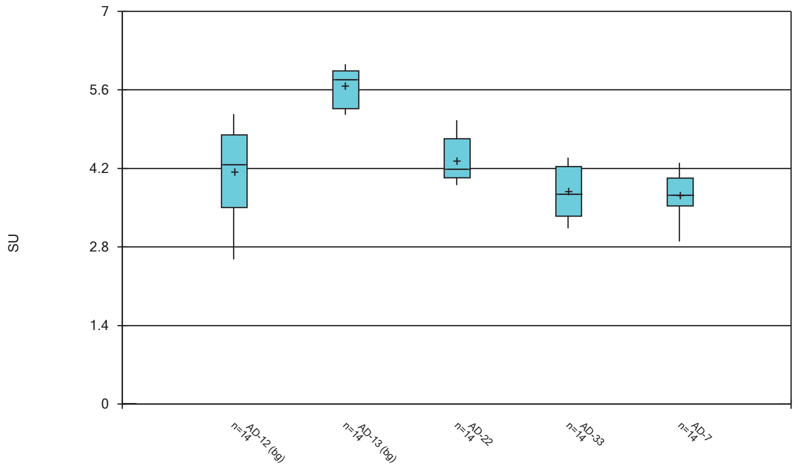


Constituent: Molybdenum, total   Analysis Run 12/6/2019 11:13 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

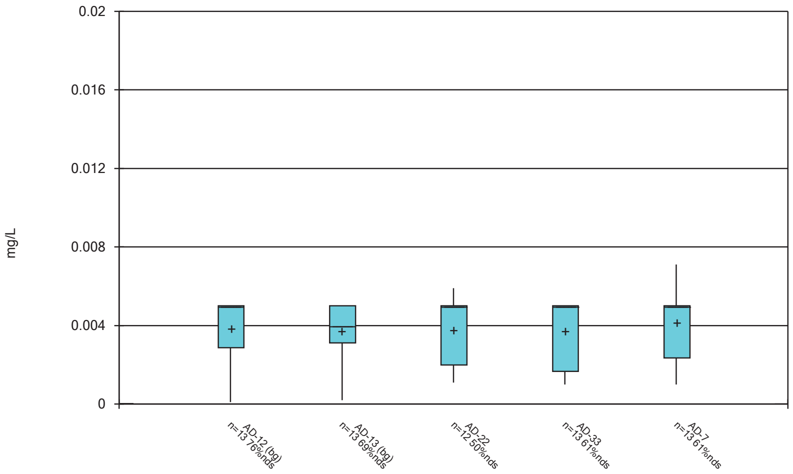
Box & Whiskers Plot



Constituent: pH, field   Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

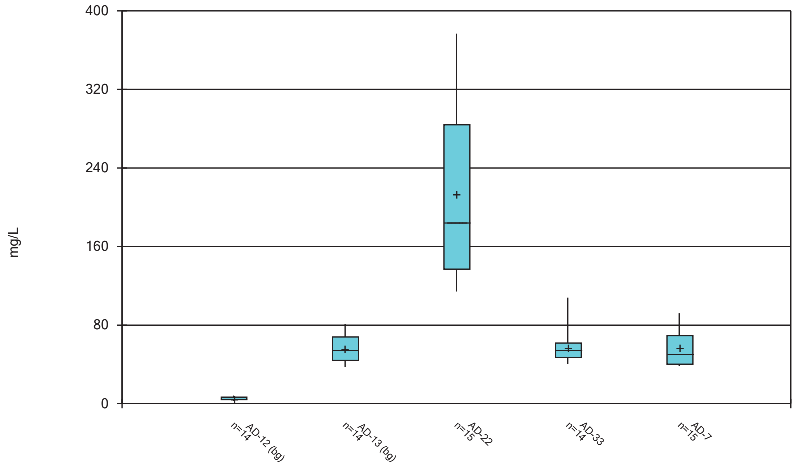
Box & Whiskers Plot



Constituent: Selenium, total   Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

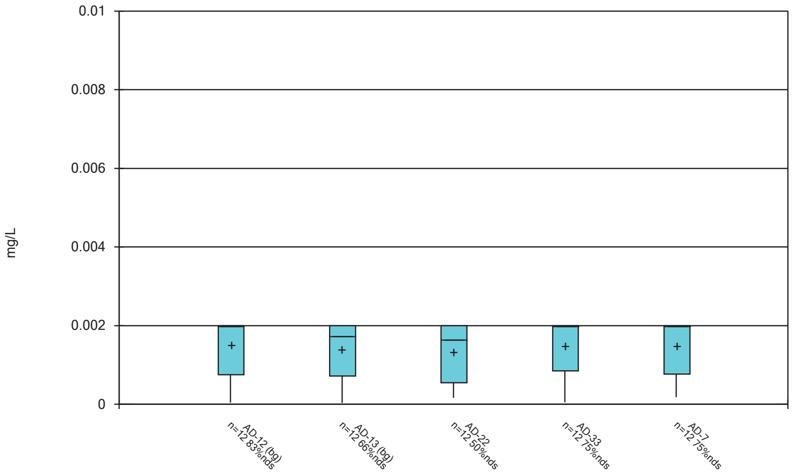
Box & Whiskers Plot



Constituent: Sulfate, total   Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

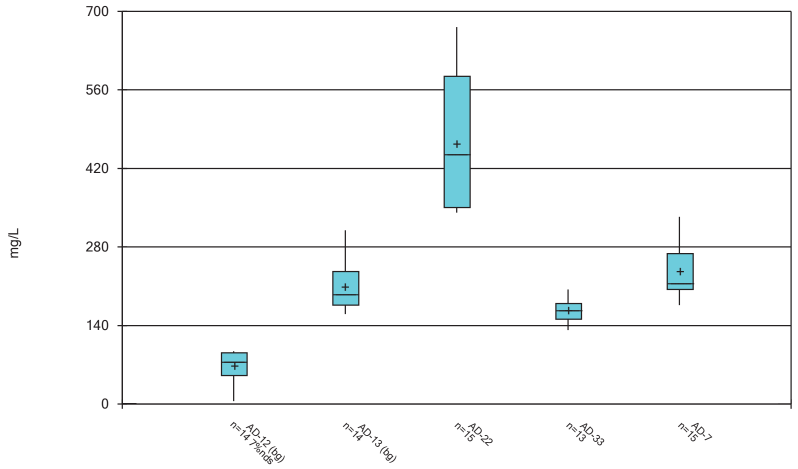
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Thallium, total   Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Box & Whiskers Plot



Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/6/2019 11:14 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Outlier Summary

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 12/10/2019, 12:26 PM

	AD-13 Arsenic, total (mg/L)	AD-33 Arsenic, total (mg/L)	AD-33 Barium, total (mg/L)	AD-13 Cadmium, total (mg/L)	AD-33 Chromium, total (mg/L)	AD-33 Cobalt, total (mg/L)	AD-7 Fluoride, total (mg/L)	AD-33 Lead, total (mg/L)	AD-22 Mercury, total (mg/L)	AD-12 Molybdenum, total (mg/L)
5/11/2016									0.01341 (o)	
7/13/2016	0.009 (o)									
7/14/2016									0.017 (o)	
9/7/2016		0.067 (o)	0.163 (o)		0.125 (o)	0.033 (o)		0.014 (o)	0.019829 (o)	
1/12/2017									0.01332 (o)	
4/11/2017				0.002 (o)						
8/24/2017							2.994 (o)			
3/21/2018				0.00086 (Jo)						
2/27/2019										<0.04 (o)
5/21/2019										<0.04 (o)
5/22/2019										

	AD-13 Molybdenum, total (mg/L)	AD-22 Molybdenum, total (mg/L)	AD-33 Molybdenum, total (mg/L)	AD-7 Molybdenum, total (mg/L)	AD-22 Selenium, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-13 Thallium, total (mg/L)	AD-22 Thallium, total (mg/L)	AD-33 Thallium, total (mg/L)	AD-7 Thallium, total (mg/L)
5/11/2016										
7/13/2016										
7/14/2016										
9/7/2016										
1/12/2017										
4/11/2017										
8/24/2017										
3/21/2018										
2/27/2019	<0.04 (o)	<0.04 (o)	<0.04 (o)		0.0167 (o)	<0.002 (o)	<0.002 (o)	<0.002 (o)	<0.002 (o)	<0.002 (o)
5/21/2019	<0.04 (o)									
5/22/2019		<0.04 (o)	<0.04 (o)	<0.04 (o)						

	AD-33 Total Dissolved Solids [TDS] (mg/L)
5/11/2016	326 (o)
7/13/2016	
7/14/2016	
9/7/2016	
1/12/2017	
4/11/2017	
8/24/2017	
3/21/2018	
2/27/2019	
5/21/2019	
5/22/2019	

Upgradient Outlier Analysis - All Results

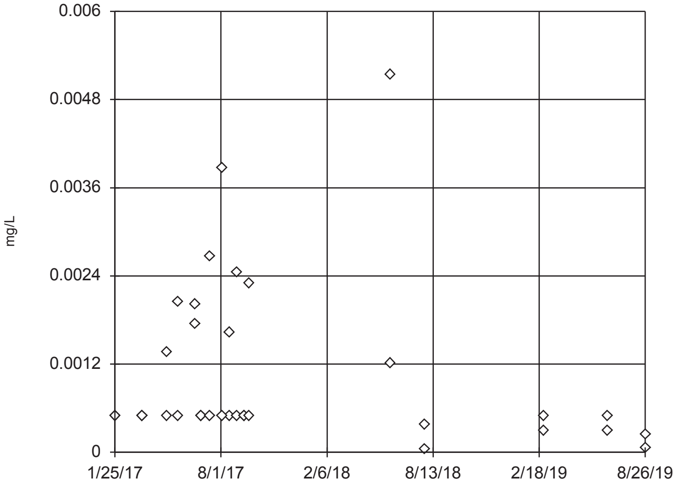
Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP   Printed 12/5/2019, 7:06 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.001066	0.001141	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.0167	0.01515	x^(1/3)	ShapiroWilk
Barium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	1.517	0.909	sqrt(x)	ShapiroWilk
Beryllium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.0006003	0.0009429	ln(x)	ShapiroWilk
Boron (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.3369	0.09923	x^(1/3)	ShapiroWilk
Cadmium (mg/L)	SP-4,SP-5	n/a	n/a	NP	NaN	34	0.0006194	0.001226	unknown	ShapiroWilk
Chloride (mg/L)	**SP-4,SP-5**	**Yes**	**52,62,1834**	**NP**	**NaN**	**34**	**562.2**	**280.7**	**sqrt(x)**	**ShapiroWilk**
Chromium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.008442	0.01735	ln(x)	ShapiroWilk
Cobalt (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.004423	0.008256	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	SP-4,SP-5	No	n/a	NP	NaN	33	8.197	3.807	normal	ShapiroWilk
Fluoride (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	36	3.171	0.7808	x^2	ShapiroWilk
Lead (mg/L)	**SP-4,SP-5**	**Yes**	**0.03663**	**NP**	**NaN**	**34**	**0.003275**	**0.006578**	**ln(x)**	**ShapiroWilk**
Lithium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.09636	0.02338	sqrt(x)	ShapiroWilk
Mercury (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.00002218	0.000009233	x^(1/3)	ShapiroWilk
Molybdenum (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.006372	0.003953	x^(1/3)	ShapiroWilk
pH, field (SU)	SP-4,SP-5	No	n/a	NP	NaN	32	7.796	0.449	ln(x)	ShapiroWilk
Selenium (mg/L)	SP-4,SP-5	n/a	n/a	NP	NaN	34	0.001084	0.0007727	unknown	ShapiroWilk
Sulfate (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	31.97	29.27	ln(x)	ShapiroWilk
Thallium (mg/L)	SP-4,SP-5	n/a	n/a	NP	NaN	34	0.0005265	0.0002563	unknown	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	**SP-4,SP-5**	**Yes**	**3008**	**NP**	**NaN**	**34**	**1328**	**333.4**	**ln(x)**	**ShapiroWilk**

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.06435, low cutoff = 0.00001309, based on IQR multiplier of 3.

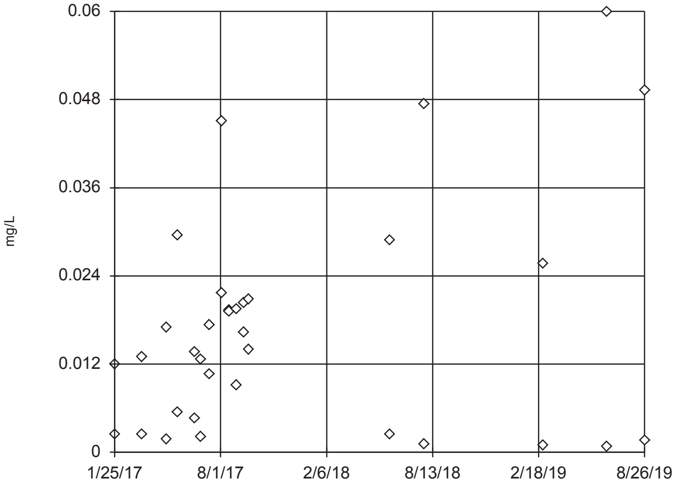
Constituent: Antimony Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.3424, low cutoff = -0.02368, based on IQR multiplier of 3.

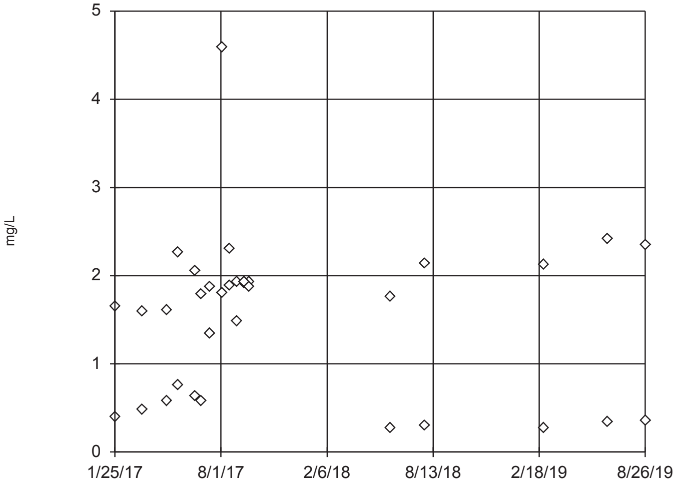
Constituent: Arsenic Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 11.31, low cutoff = -1.424, based on IQR multiplier of 3.

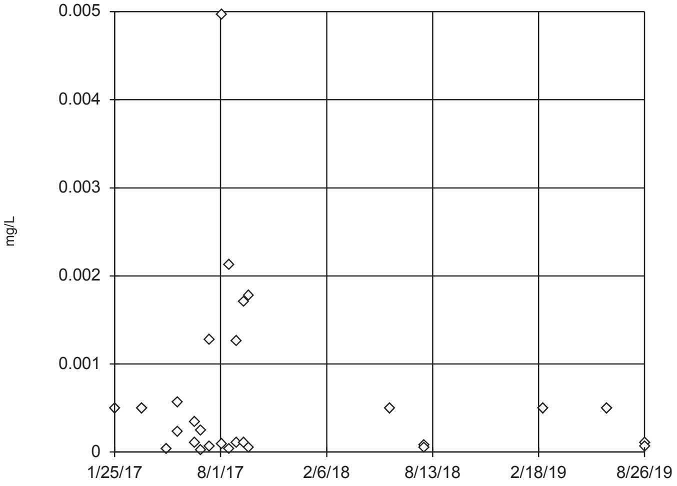
Constituent: Barium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1952, low cutoff = 1.8e-7, based on IQR multiplier of 3.

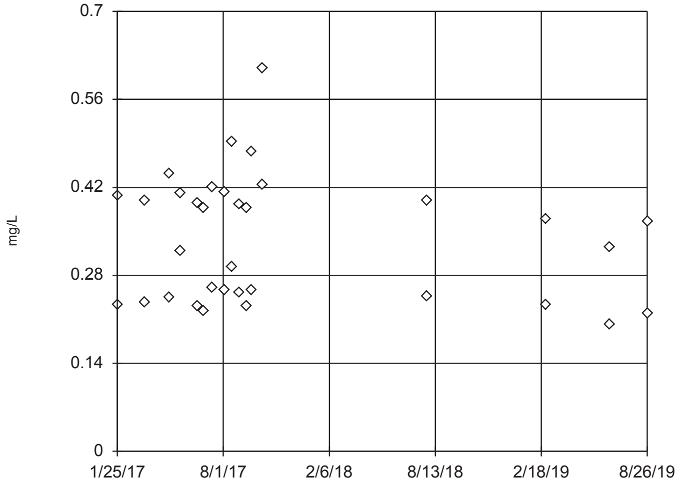
Constituent: Beryllium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.34, low cutoff = 0.01787, based on IQR multiplier of 3.

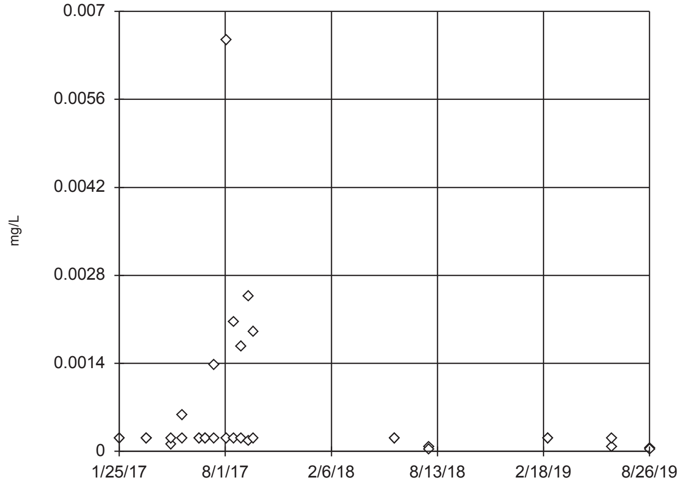
Constituent: Boron   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

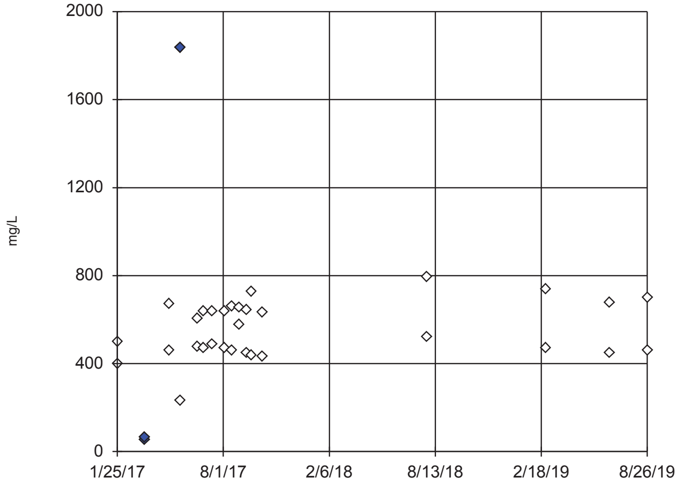
Constituent: Cadmium   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

Outliers are drawn as solid.
Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1487, low cutoff = 69.92, based on IQR multiplier of 3.

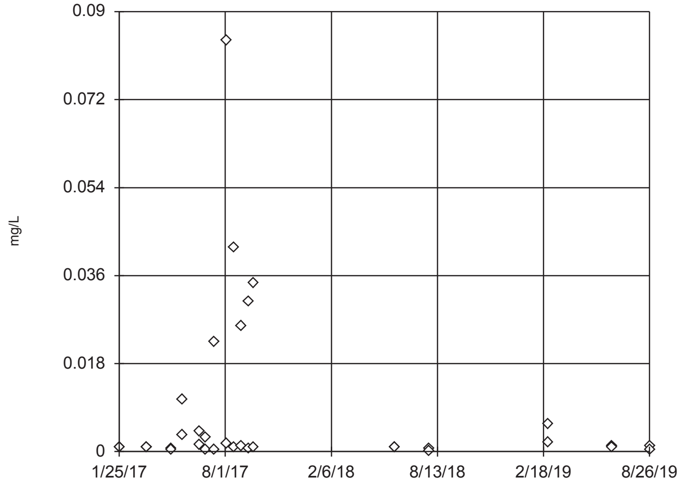
Constituent: Chloride   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.453, low cutoff = 0.000002366, based on IQR multiplier of 3.

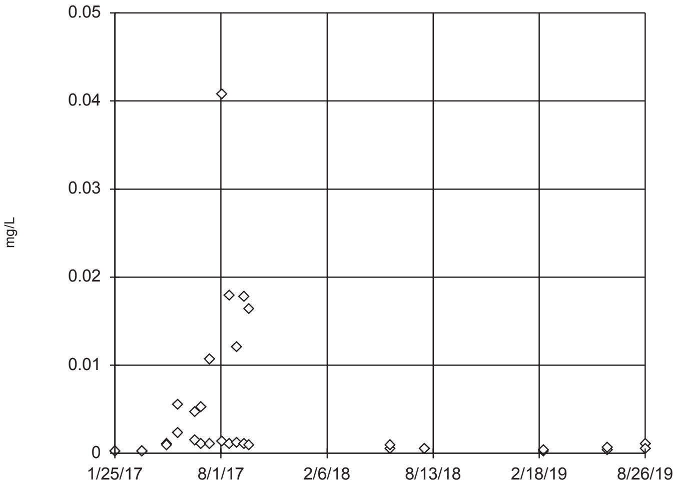
Constituent: Chromium   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5.308, low cutoff = 4.5e-7, based on IQR multiplier of 3.

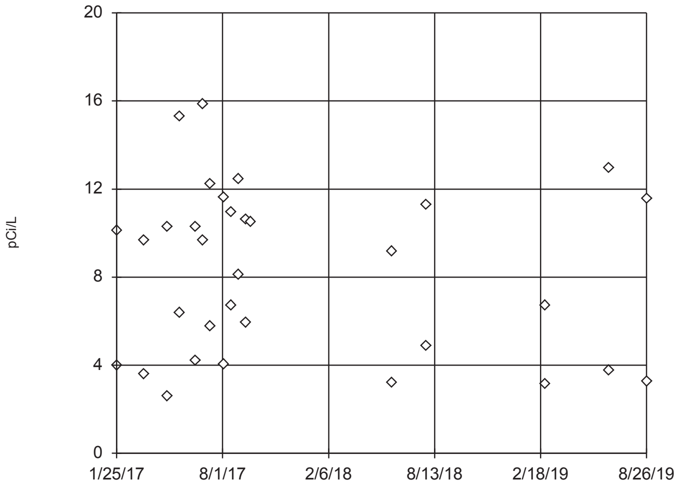
Constituent: Cobalt Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 33

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 32.17, low cutoff = -16.94, based on IQR multiplier of 3.

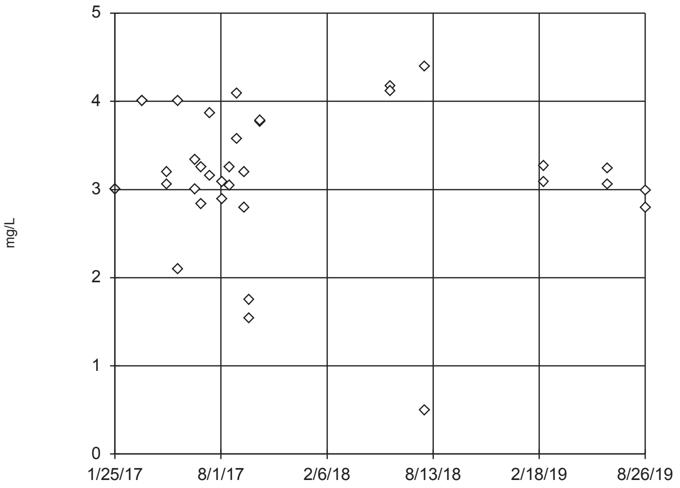
Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 36

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5.492, low cutoff = -2.631, based on IQR multiplier of 3.

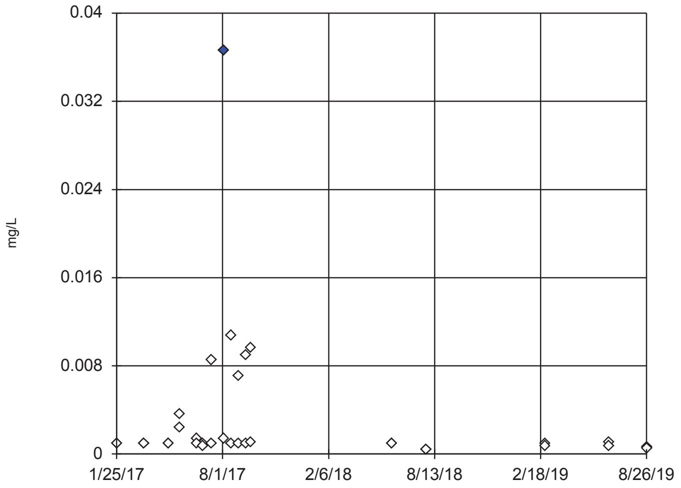
Constituent: Fluoride Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.01438, low cutoff = 0.0001192, based on IQR multiplier of 3.

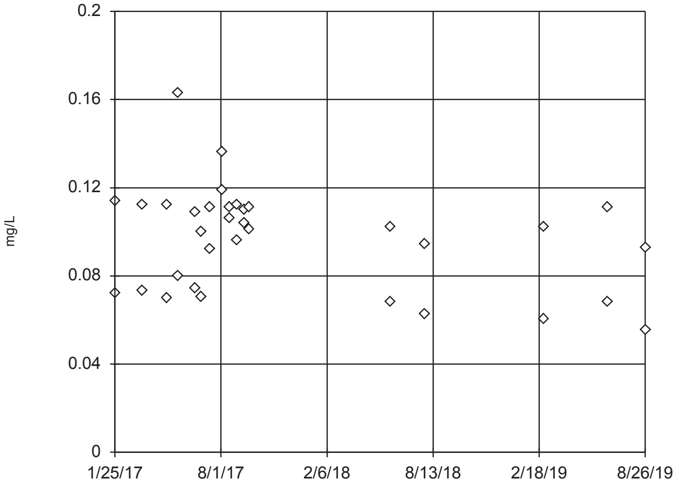
Constituent: Lead Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found.
Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.2755, low cutoff = 0.00601, based on IQR multiplier of 3.

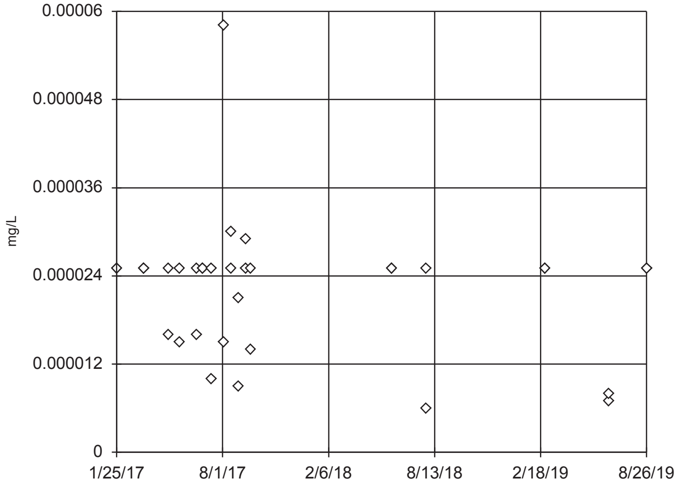
Constituent: Lithium   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.00007499, low cutoff = 0.000001728, based on IQR multiplier of 3.

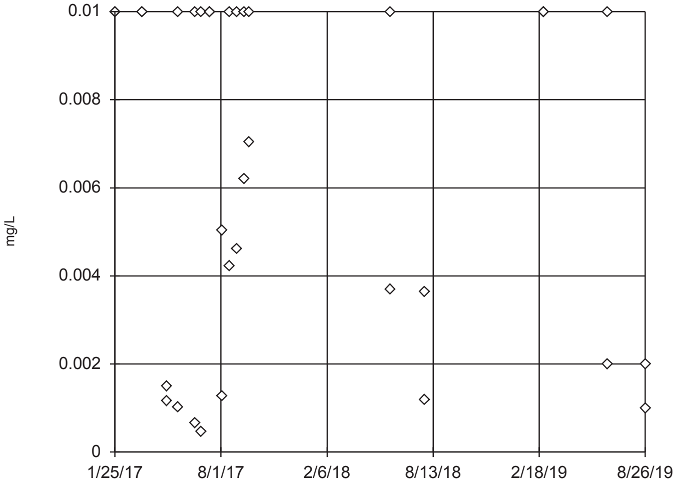
Constituent: Mercury   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found.
Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1258, low cutoff = -0.004525, based on IQR multiplier of 3.

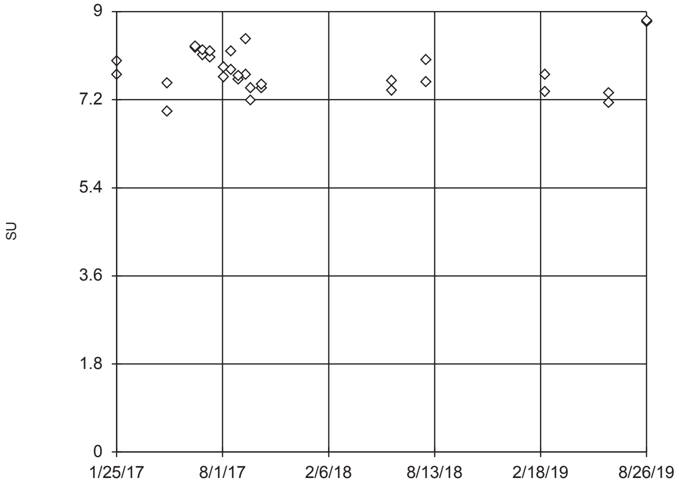
Constituent: Molybdenum   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 32

No outliers found.
Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 10.49, low cutoff = 5.804, based on IQR multiplier of 3.

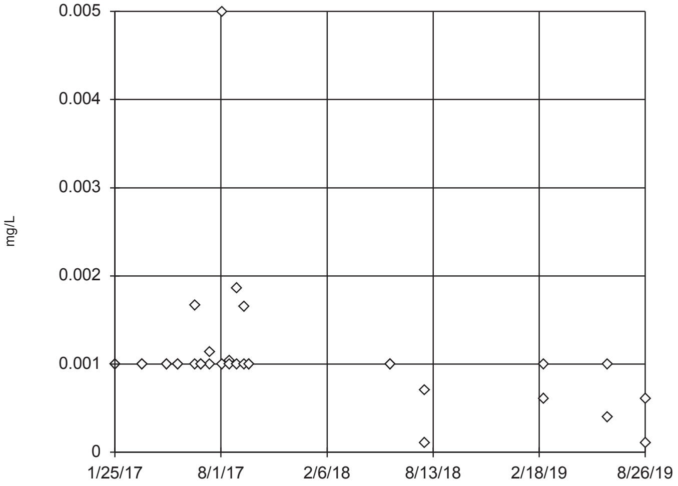
Constituent: pH, field   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

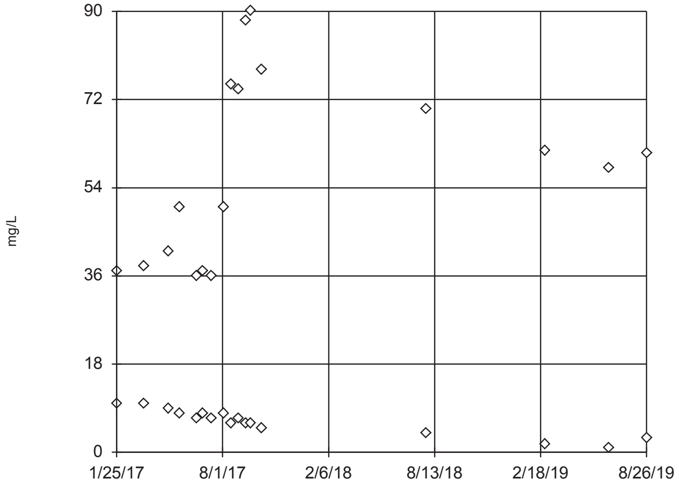
Constituent: Selenium   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 45988, low cutoff = 0.008382, based on IQR multiplier of 3.

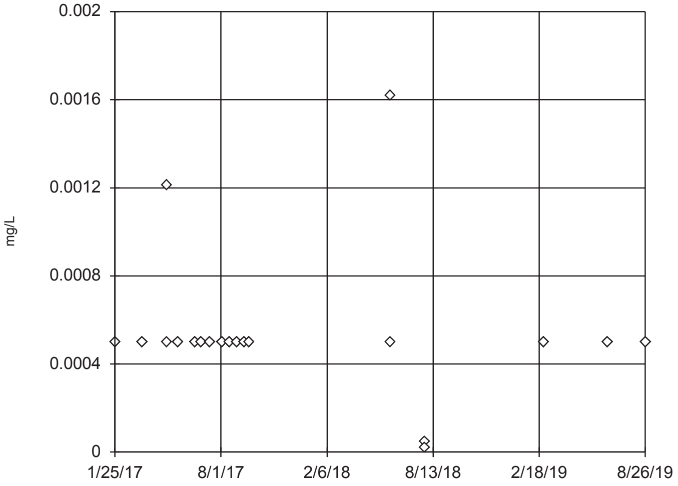
Constituent: Sulfate   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

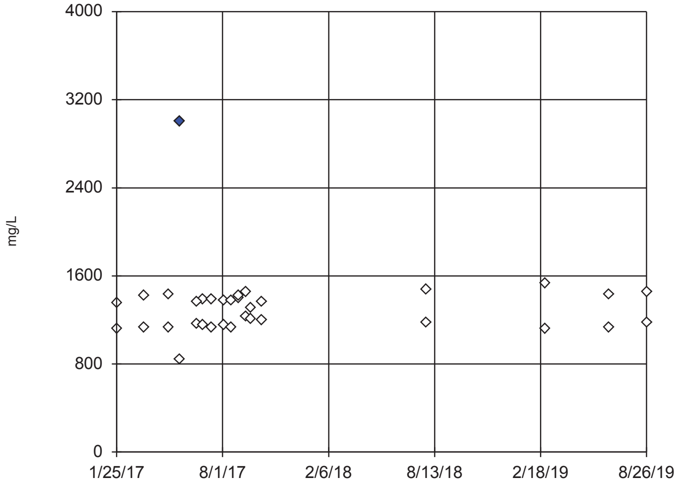
Constituent: Thallium   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2753, low cutoff = 589.4, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/5/2019 7:05 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Outlier Analysis - Significant Results

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP   Printed 12/5/2019, 7:09 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Combined Radium 226 + 228 (pCi/L)	**SP-1**	**Yes**	**14.29**	**NP**	**NaN**	**16**	**4.103**	**2.814**	**ln(x)**	**ShapiroWilk**

Outlier Analysis - All Results

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP   Printed 12/5/2019, 7:09 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony (mg/L)	SP-1	No	n/a	NP	NaN	16	0.003233	0.002181	x^(1/3)	ShapiroWilk
Antimony (mg/L)	SP-10	No	n/a	NP	NaN	13	0.002672	0.001941	ln(x)	ShapiroWilk
Antimony (mg/L)	SP-11	No	n/a	NP	NaN	13	0.003377	0.003125	x^(1/3)	ShapiroWilk
Antimony (mg/L)	SP-2	No	n/a	NP	NaN	16	0.003766	0.002879	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-1	No	n/a	NP	NaN	16	0.003415	0.001954	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-10	No	n/a	NP	NaN	13	0.006745	0.004118	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-11	No	n/a	NP	NaN	13	0.005585	0.003026	sqrt(x)	ShapiroWilk
Arsenic (mg/L)	SP-2	No	n/a	NP	NaN	16	0.003491	0.002932	ln(x)	ShapiroWilk
Barium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.2006	0.03818	ln(x)	ShapiroWilk
Barium (mg/L)	SP-10	No	n/a	NP	NaN	13	1.744	1.731	x^(1/3)	ShapiroWilk
Barium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.2556	0.169	ln(x)	ShapiroWilk
Barium (mg/L)	SP-2	No	n/a	NP	NaN	16	1.251	0.5881	ln(x)	ShapiroWilk
Beryllium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.0003881	0.0004295	ln(x)	ShapiroWilk
Beryllium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.0002218	0.0002294	ln(x)	ShapiroWilk
Beryllium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.0002799	0.000199	sqrt(x)	ShapiroWilk
Beryllium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.0003344	0.0004011	ln(x)	ShapiroWilk
Cadmium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.000355	0.0001958	ln(x)	ShapiroWilk
Cadmium (mg/L)	SP-10	n/a	n/a	NP	NaN	13	0.0001731	0.00006575	unknown	ShapiroWilk
Cadmium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.0009385	0.001086	ln(x)	ShapiroWilk
Cadmium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.0003475	0.000205	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-1	No	n/a	NP	NaN	17	122.3	10.05	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-10	No	n/a	NP	NaN	13	93.32	58.74	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-11	No	n/a	NP	NaN	13	453.3	447.6	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-2	No	n/a	NP	NaN	16	107.1	35.8	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-4 (bg)	No	n/a	NP	NaN	17	400.9	478.9	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-5 (bg)	No	n/a	NP	NaN	17	67.18	24.87	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.001149	0.0006792	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.01004	0.03012	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.01025	0.01287	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.001531	0.001234	x^(1/3)	ShapiroWilk
Cobalt (mg/L)	SP-1	No	n/a	NP	NaN	16	0.001367	0.001295	ln(x)	ShapiroWilk
Cobalt (mg/L)	SP-10	No	n/a	NP	NaN	13	0.002623	0.001741	x^(1/3)	ShapiroWilk
Cobalt (mg/L)	SP-11	No	n/a	NP	NaN	13	0.006188	0.004931	x^(1/3)	ShapiroWilk
Cobalt (mg/L)	SP-2	No	n/a	NP	NaN	16	0.001122	0.0008247	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	**SP-1**	**Yes**	**14.29**	**NP**	**NaN**	**16**	**4.103**	**2.814**	**ln(x)**	**ShapiroWilk**
Combined Radium 226 + 228 (pCi/L)	SP-10	No	n/a	NP	NaN	13	6.984	8.061	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	SP-11	No	n/a	NP	NaN	13	3.502	6.649	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	SP-2	No	n/a	NP	NaN	13	12.31	6.281	ln(x)	ShapiroWilk
Fluoride (mg/L)	SP-1	No	n/a	NP	NaN	17	0.9669	0.8403	ln(x)	ShapiroWilk
Fluoride (mg/L)	SP-10	No	n/a	NP	NaN	15	5.447	2.95	x^2	ShapiroWilk
Fluoride (mg/L)	SP-11	No	n/a	NP	NaN	15	3.185	0.8592	normal	ShapiroWilk
Fluoride (mg/L)	SP-2	No	n/a	NP	NaN	17	2.871	0.7089	x^2	ShapiroWilk
Lead (mg/L)	SP-1	No	n/a	NP	NaN	16	0.002924	0.002167	ln(x)	ShapiroWilk
Lead (mg/L)	SP-10	No	n/a	NP	NaN	13	0.001517	0.0007715	x^(1/3)	ShapiroWilk
Lead (mg/L)	SP-11	No	n/a	NP	NaN	13	0.003791	0.00305	sqrt(x)	ShapiroWilk
Lead (mg/L)	SP-2	No	n/a	NP	NaN	16	0.003164	0.002194	ln(x)	ShapiroWilk
Lithium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.007072	0.006362	ln(x)	ShapiroWilk
Lithium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.2841	0.02877	x^3	ShapiroWilk
Lithium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.08066	0.03839	x^(1/3)	ShapiroWilk
Lithium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.07643	0.02586	x^3	ShapiroWilk
Mercury (mg/L)	SP-1	n/a	n/a	NP	NaN	16	0.00002194	0.000006277	unknown	ShapiroWilk
Mercury (mg/L)	SP-10	No	n/a	NP	NaN	13	0.00001762	0.000007974	normal	ShapiroWilk
Mercury (mg/L)	SP-11	No	n/a	NP	NaN	13	0.00002062	0.00001449	ln(x)	ShapiroWilk
Mercury (mg/L)	SP-2	No	n/a	NP	NaN	16	0.00002069	0.000007939	normal	ShapiroWilk
Molybdenum (mg/L)	SP-1	No	n/a	NP	NaN	16	0.01242	0.004984	normal	ShapiroWilk

Outlier Analysis - All Results

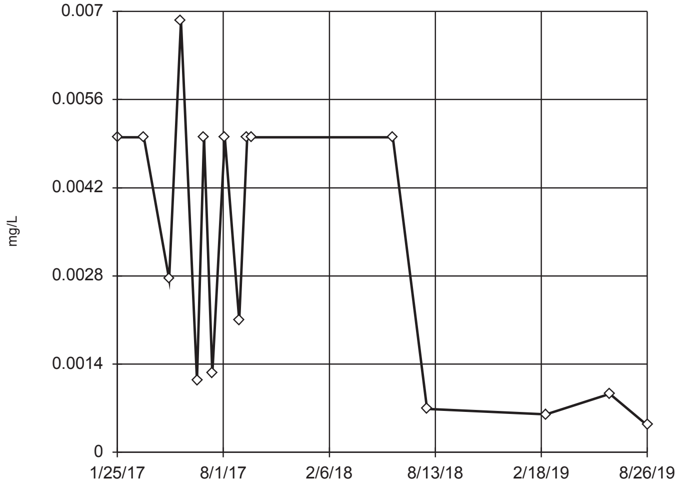
Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP   Printed 12/5/2019, 7:09 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Molybdenum (mg/L)	SP-10	No	n/a	NP	NaN	13	0.09942	0.2528	ln(x)	ShapiroWilk
Molybdenum (mg/L)	SP-11	No	n/a	NP	NaN	13	0.03278	0.02353	x^2	ShapiroWilk
Molybdenum (mg/L)	SP-2	No	n/a	NP	NaN	16	0.02792	0.007558	normal	ShapiroWilk
Selenium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.005163	0.002543	ln(x)	ShapiroWilk
Selenium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.002548	0.00244	x^(1/3)	ShapiroWilk
Selenium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.003052	0.002409	x^(1/3)	ShapiroWilk
Selenium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.01075	0.01048	ln(x)	ShapiroWilk
Thallium (mg/L)	SP-1	n/a	n/a	NP	NaN	16	0.001693	0.000682	unknown	ShapiroWilk
Thallium (mg/L)	SP-10	n/a	n/a	NP	NaN	13	0.0004646	0.0001276	unknown	ShapiroWilk
Thallium (mg/L)	SP-11	n/a	n/a	NP	NaN	13	0.0004638	0.0001304	unknown	ShapiroWilk
Thallium (mg/L)	SP-2	n/a	n/a	NP	NaN	16	0.00176	0.0006558	unknown	ShapiroWilk

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.05525, low cutoff = -0.001289, based on IQR multiplier of 3.

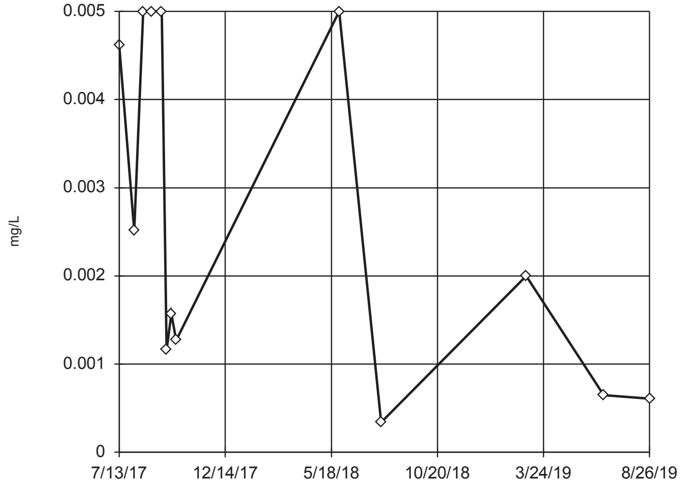
Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.9546, low cutoff = 0.000004548, based on IQR multiplier of 3.

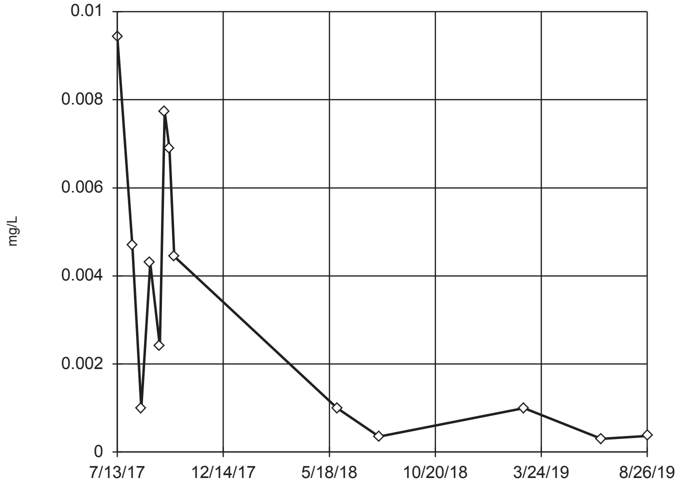
Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.09601, low cutoff = -0.007201, based on IQR multiplier of 3.

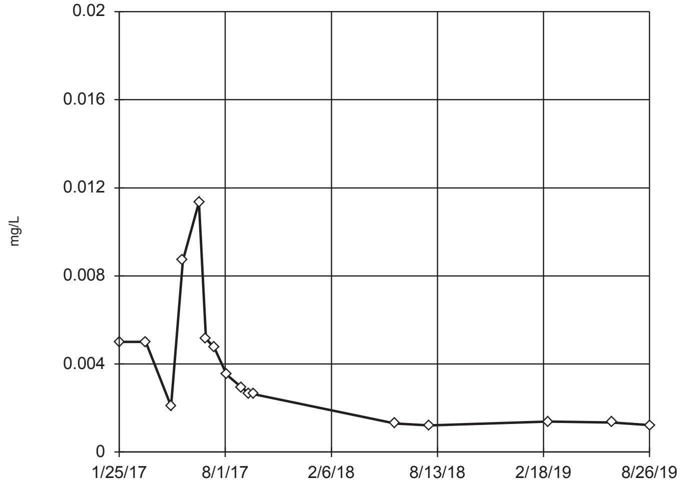
Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.2459, low cutoff = 0.00002775, based on IQR multiplier of 3.

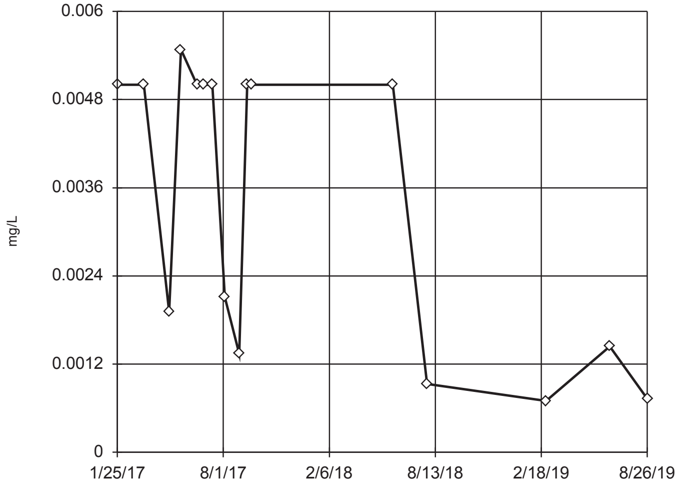
Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.2332, low cutoff = 0.00002979, based on IQR multiplier of 3.

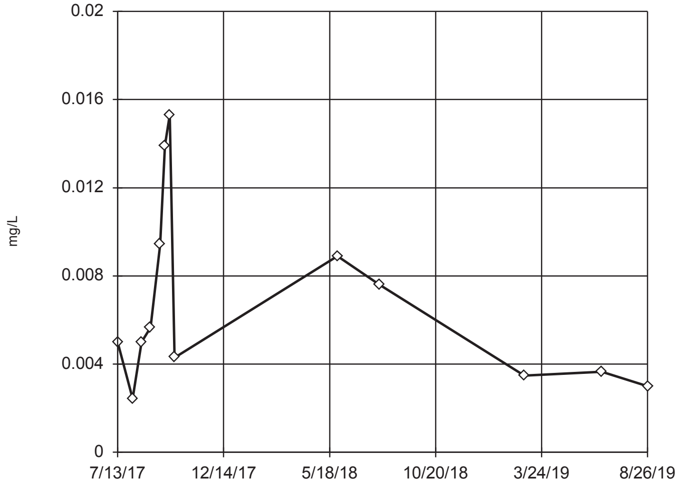
Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1546, low cutoff = 0.0002113, based on IQR multiplier of 3.

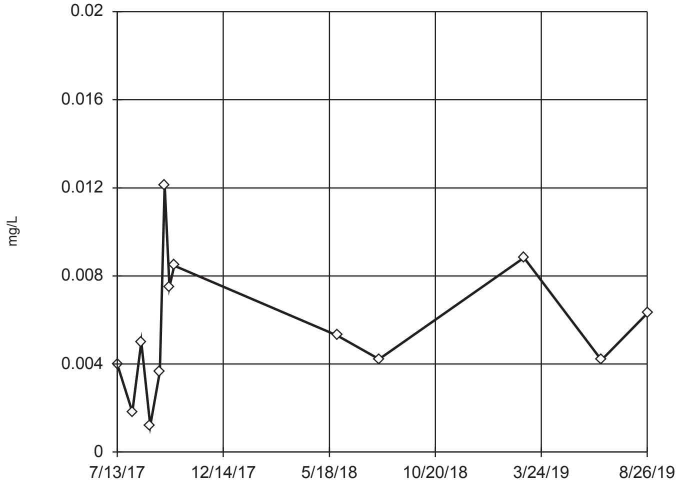
Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.02951, low cutoff = -0.0004253, based on IQR multiplier of 3.

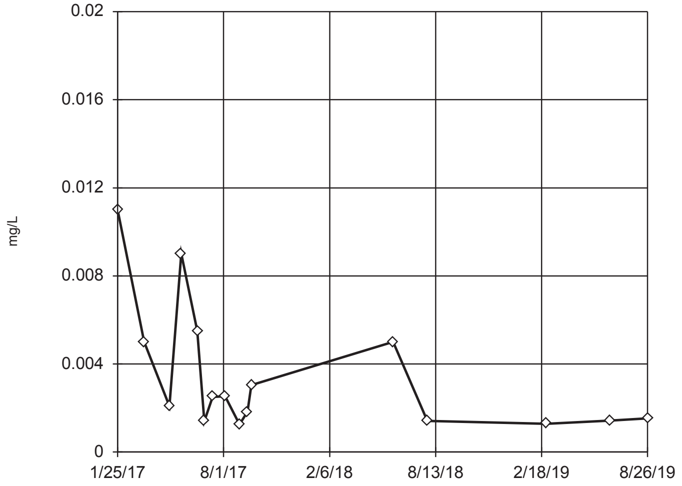
Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

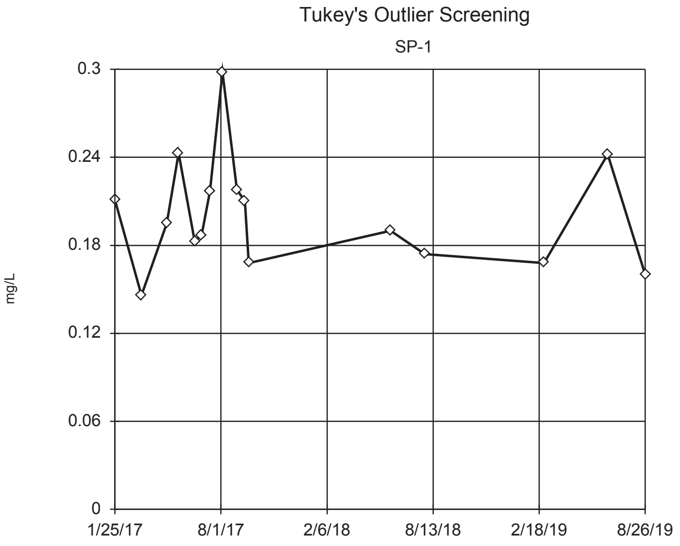
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.216, low cutoff = 0.00003299, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



n = 16

No outliers found. Tukey's method selected by user.

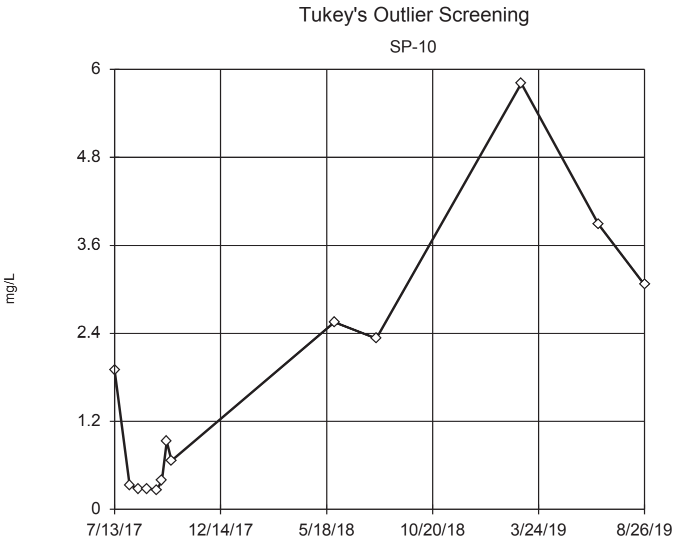
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.4478, low cutoff = 0.08305, based on IQR multiplier of 3.

Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



n = 13

No outliers found. Tukey's method selected by user.

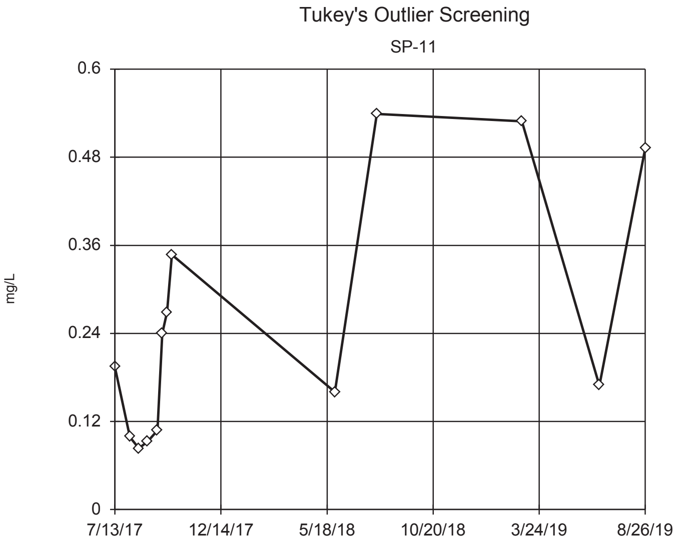
Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 47.27, low cutoff = -3.605, based on IQR multiplier of 3.

Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



n = 13

No outliers found. Tukey's method selected by user.

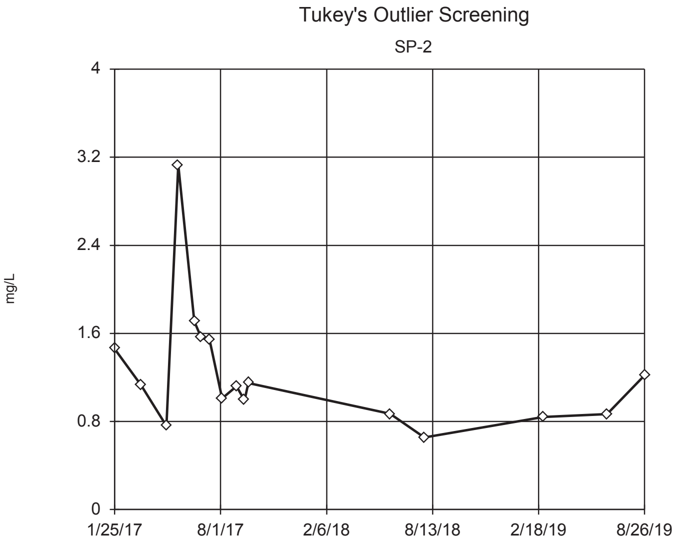
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 26.47, low cutoff = 0.001612, based on IQR multiplier of 3.

Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 7.717, low cutoff = 0.1688, based on IQR multiplier of 3.

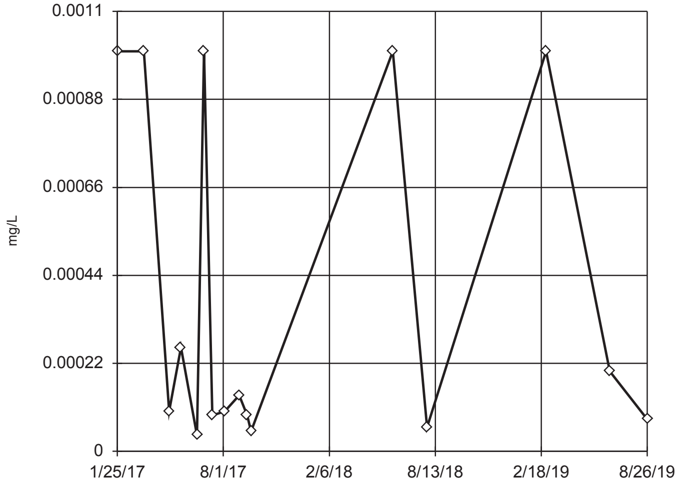
Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.637, low cutoff = 5.2e-8, based on IQR multiplier of 3.

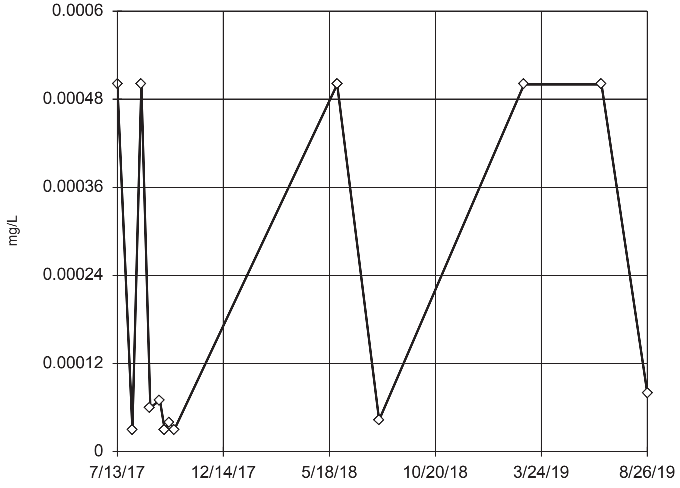
Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.504, low cutoff = 1.2e-8, based on IQR multiplier of 3.

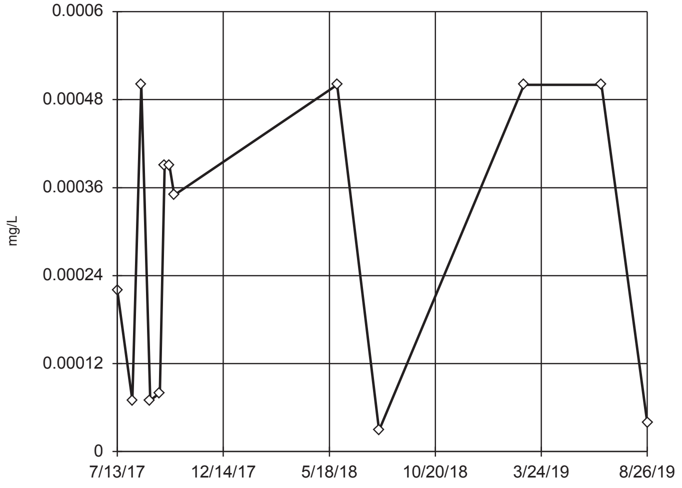
Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.00414, low cutoff = -0.00113, based on IQR multiplier of 3.

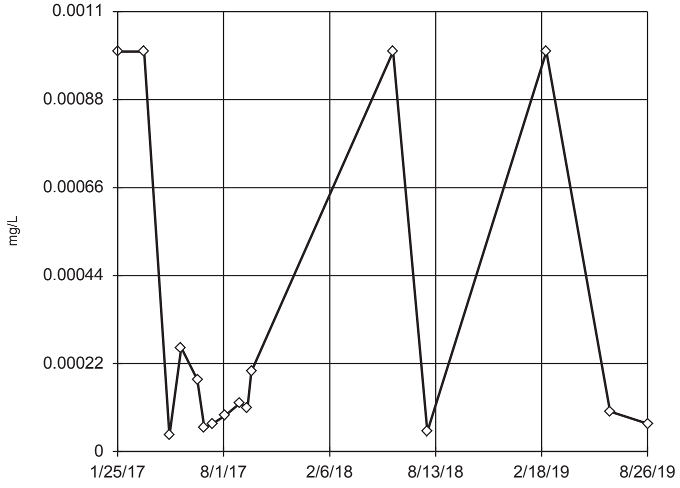
Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1971, low cutoff = 1.8e-7, based on IQR multiplier of 3.

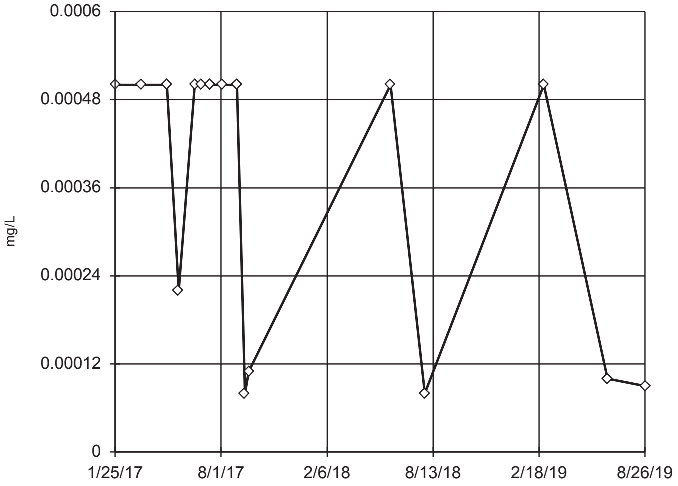
Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.05417, low cutoff = 9.7e-7, based on IQR multiplier of 3.

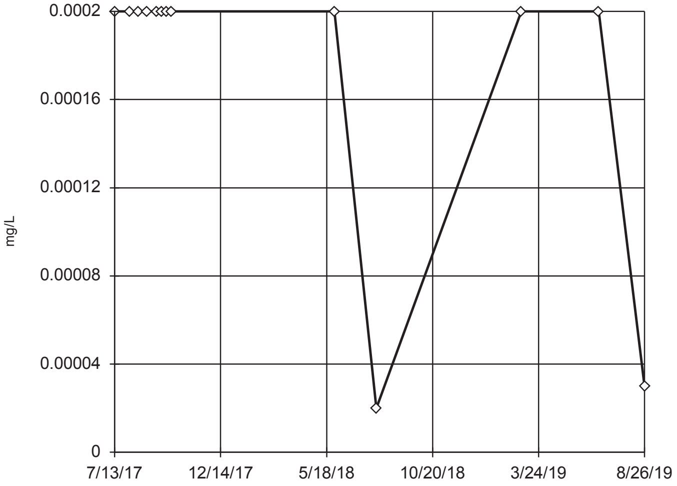
Constituent: Cadmium   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

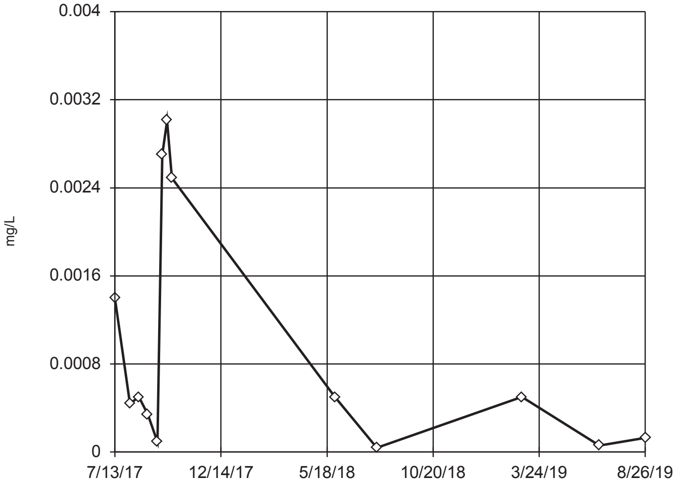
Constituent: Cadmium   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 9.602, low cutoff = 2.1e-8, based on IQR multiplier of 3.

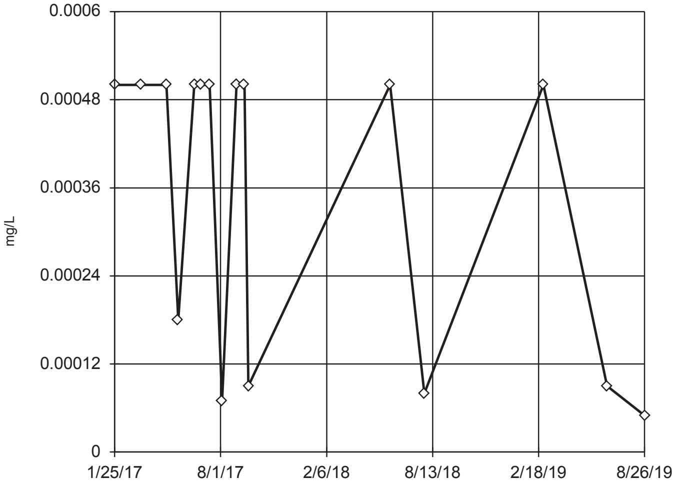
Constituent: Cadmium   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

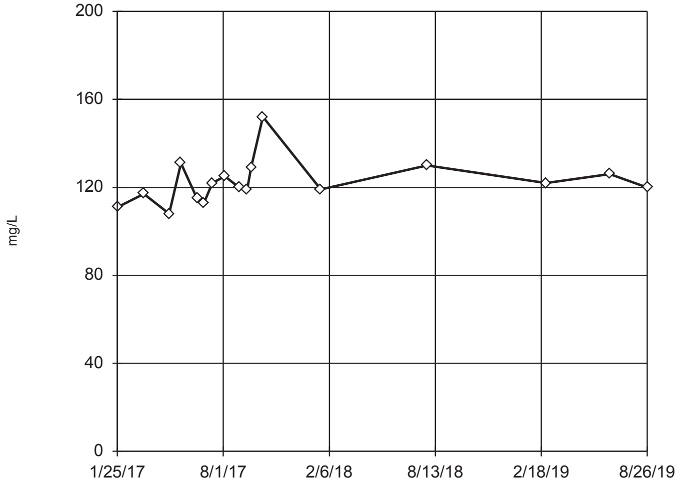
High cutoff = 0.08573, low cutoff = 5.2e-7, based on IQR multiplier of 3.

Constituent: Cadmium   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



n = 17

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

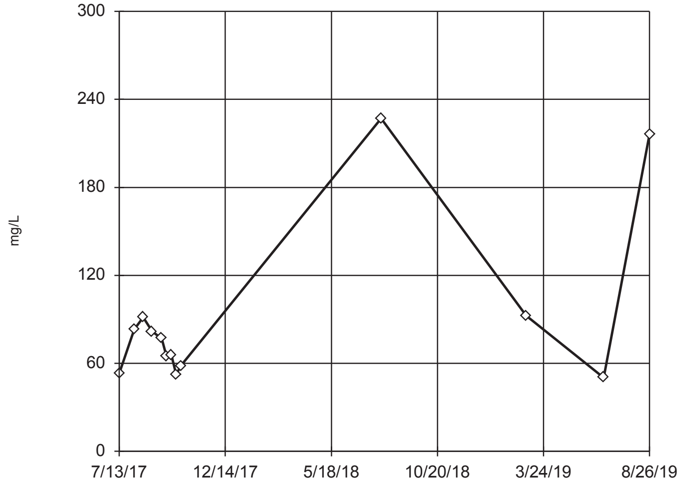
High cutoff = 169.3, low cutoff = 87.36, based on IQR multiplier of 3.

Constituent: Calcium   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

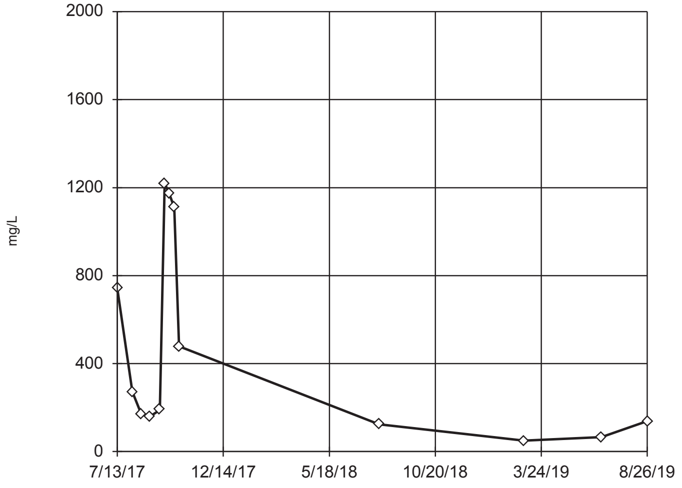
High cutoff = 416, low cutoff = 12.3, based on IQR multiplier of 3.

Constituent: Calcium   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

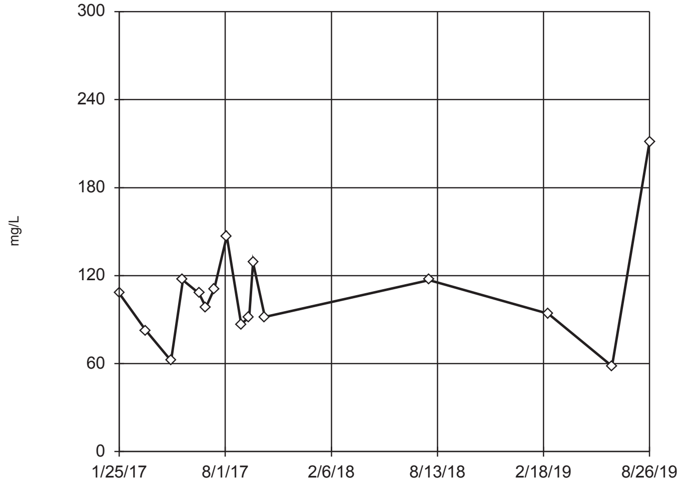
High cutoff = 299778, low cutoff = 0.3975, based on IQR multiplier of 3.

Constituent: Calcium   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 263.5, low cutoff = 39.64, based on IQR multiplier of 3.

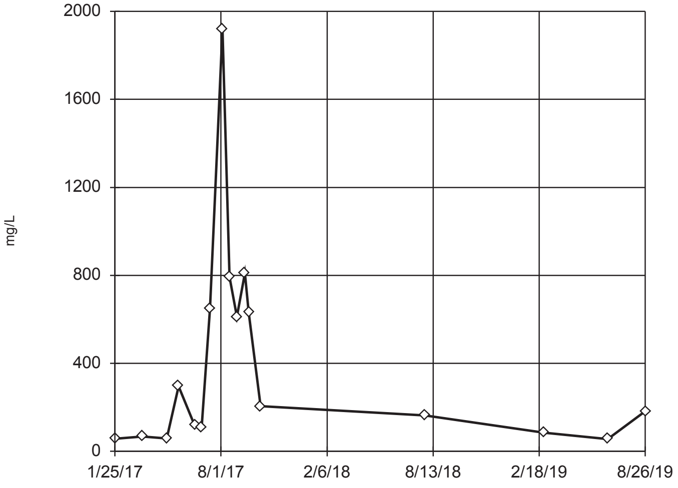
Constituent: Calcium   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-4 (bg)



n = 17

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 383715, low cutoff = 0.1261, based on IQR multiplier of 3.

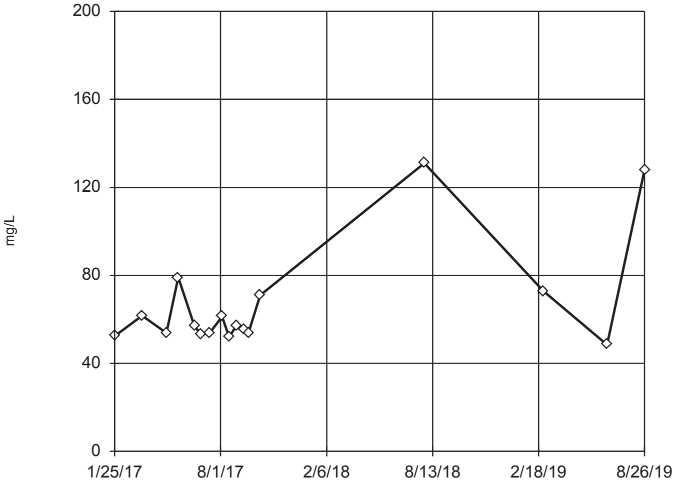
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-5 (bg)



n = 17

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 176, low cutoff = 21.8, based on IQR multiplier of 3.

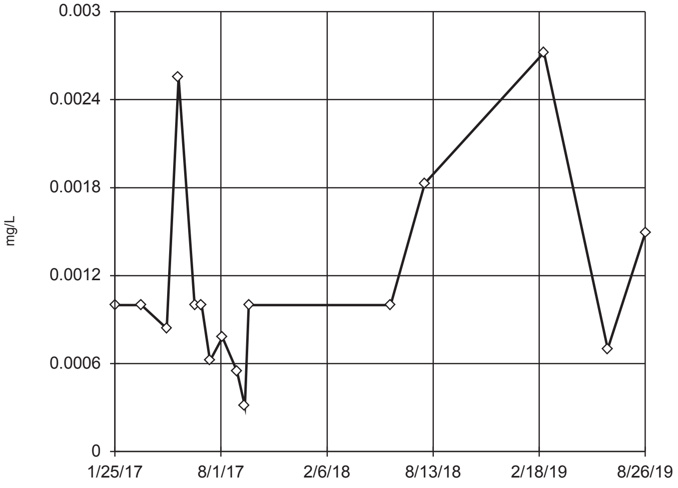
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.005503, low cutoff = 0.0001639, based on IQR multiplier of 3.

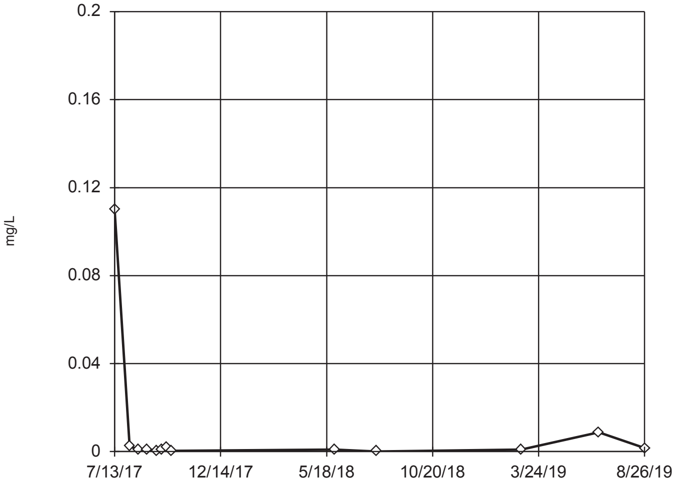
Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

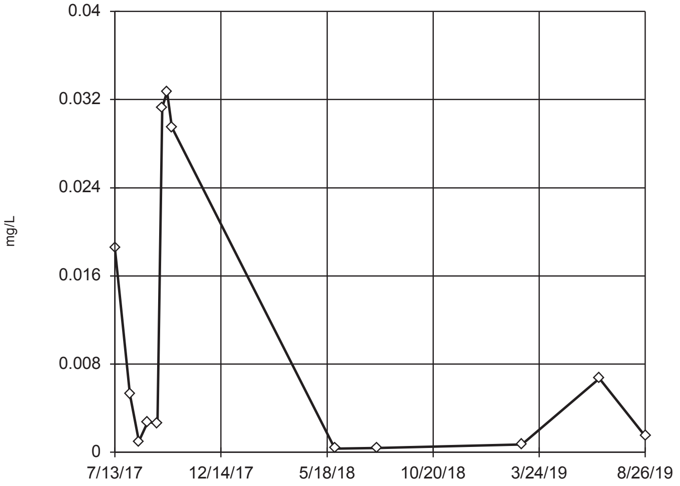
High cutoff = 0.1338, low cutoff = 0.000009664, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

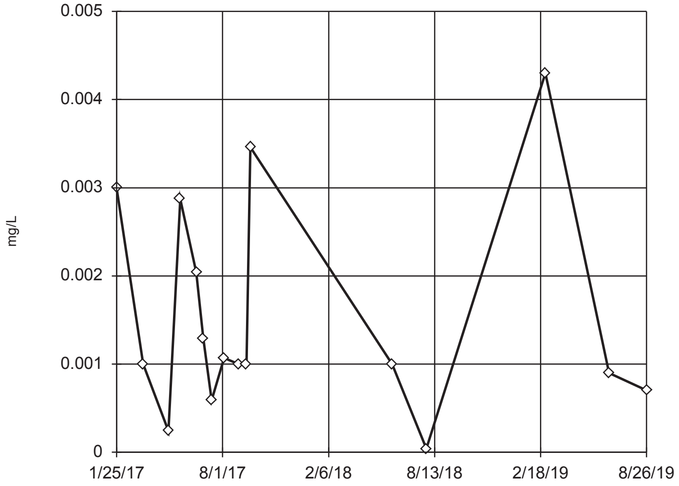
High cutoff = 509.3, low cutoff = 3.8e-8, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

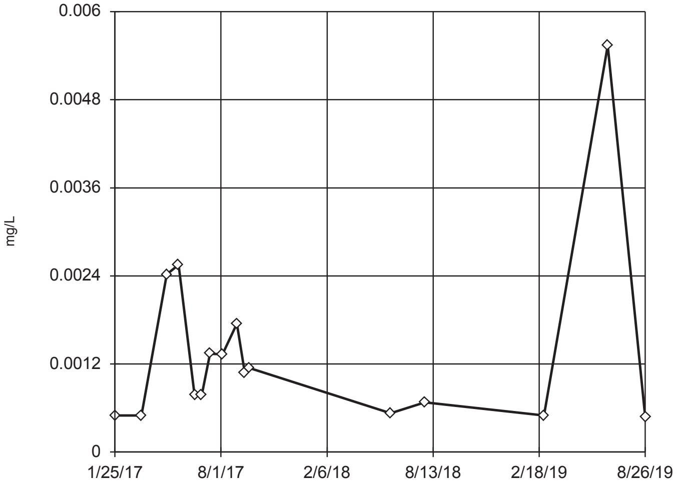
High cutoff = 0.01754, low cutoff = -0.00003478, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

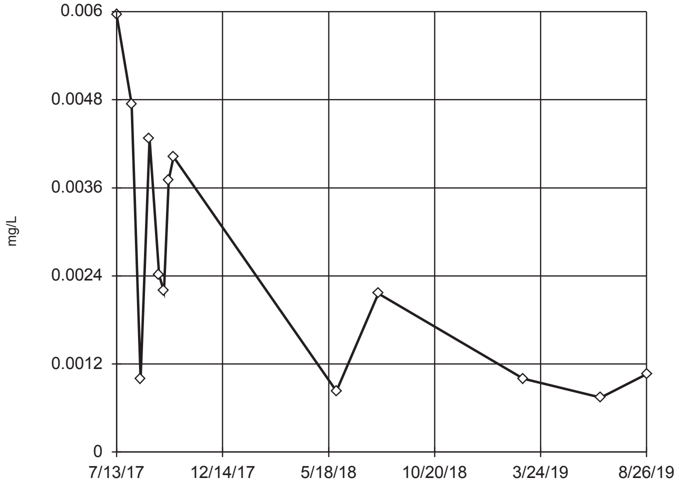
High cutoff = 0.04031, low cutoff = 0.00001956, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04017, low cutoff = -0.0005485, based on IQR multiplier of 3.

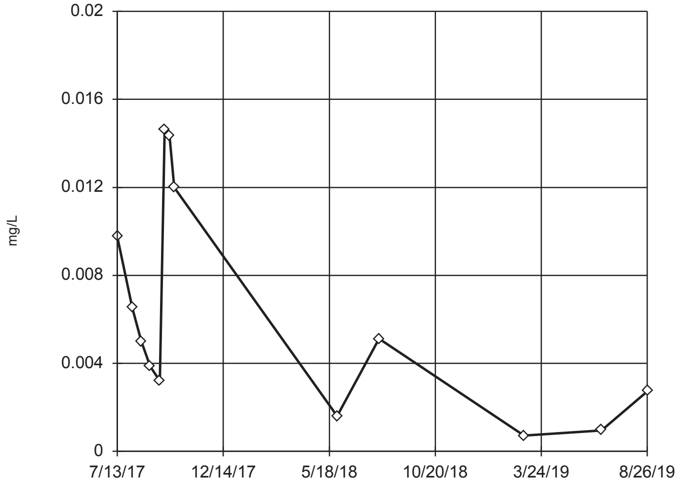
Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1248, low cutoff = -0.003371, based on IQR multiplier of 3.

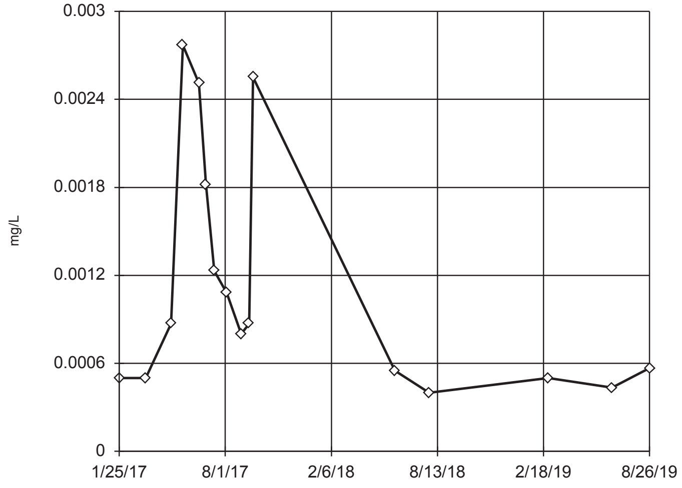
Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04009, low cutoff = 0.00001866, based on IQR multiplier of 3.

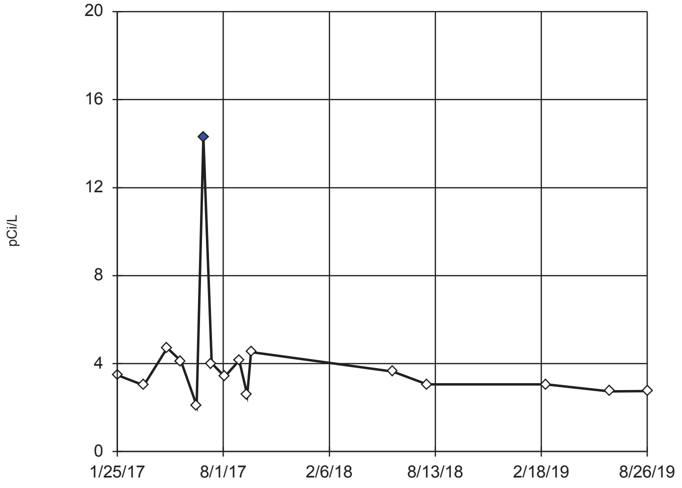
Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

Outlier is drawn as solid. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 12.25, low cutoff = 0.9717, based on IQR multiplier of 3.

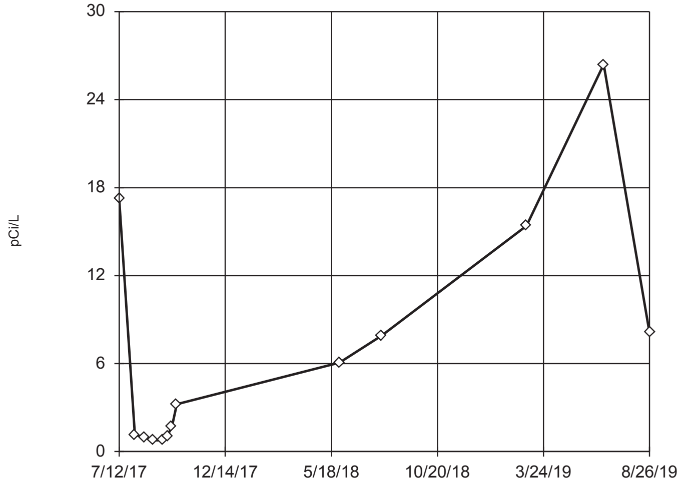
Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 14360, low cutoff = 0.0008, based on IQR multiplier of 3.

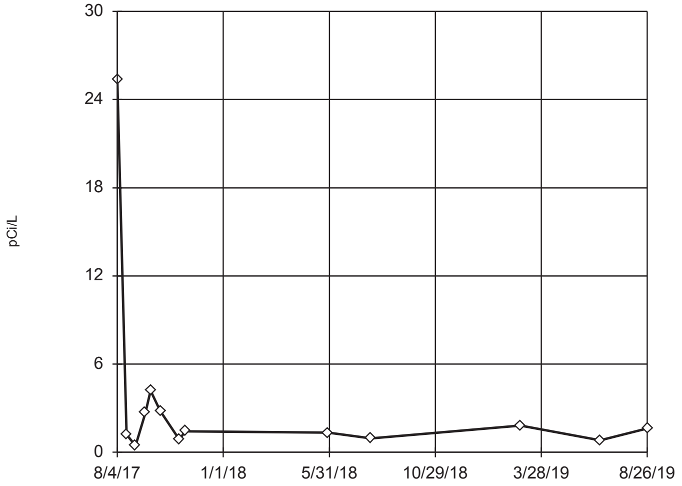
Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 77.88, low cutoff = 0.03186, based on IQR multiplier of 3.

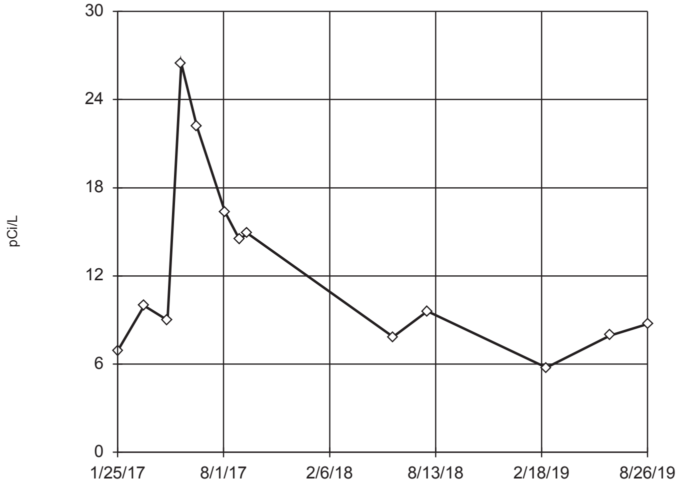
Constituent: Combined Radium 226 + 228   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 120.3, low cutoff = 1.024, based on IQR multiplier of 3.

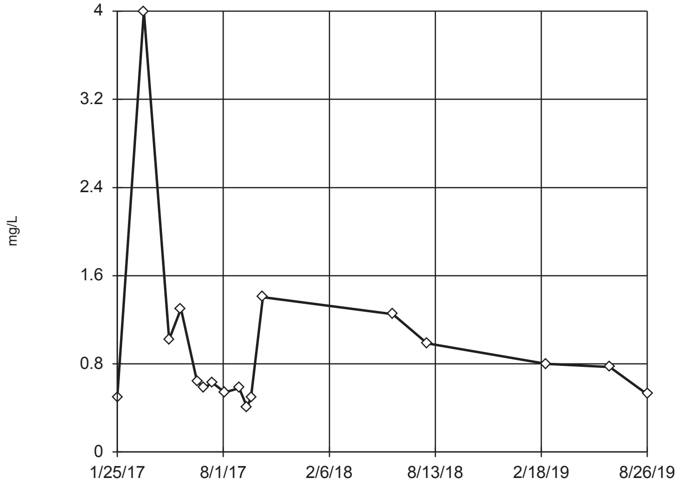
Constituent: Combined Radium 226 + 228   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 17

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 10.71, low cutoff = 0.05624, based on IQR multiplier of 3.

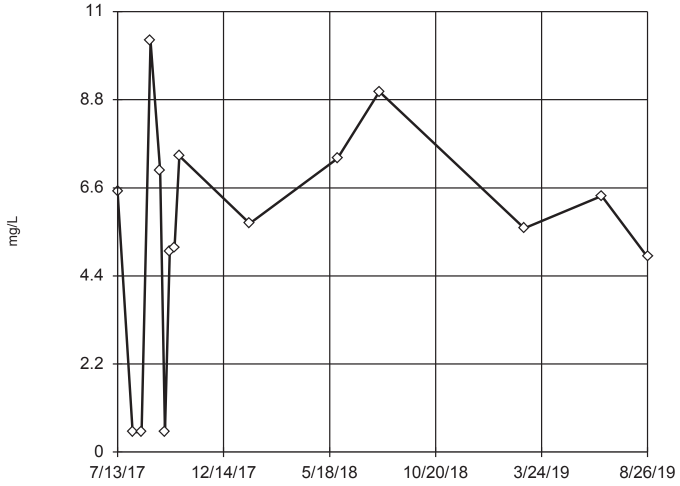
Constituent: Fluoride   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 15

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 11.99, low cutoff = -8.134, based on IQR multiplier of 3.

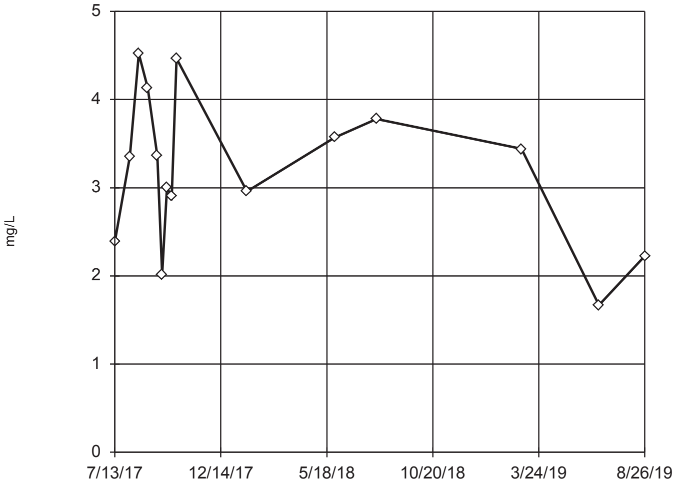
Constituent: Fluoride   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 15

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 7.962, low cutoff = -1.796, based on IQR multiplier of 3.

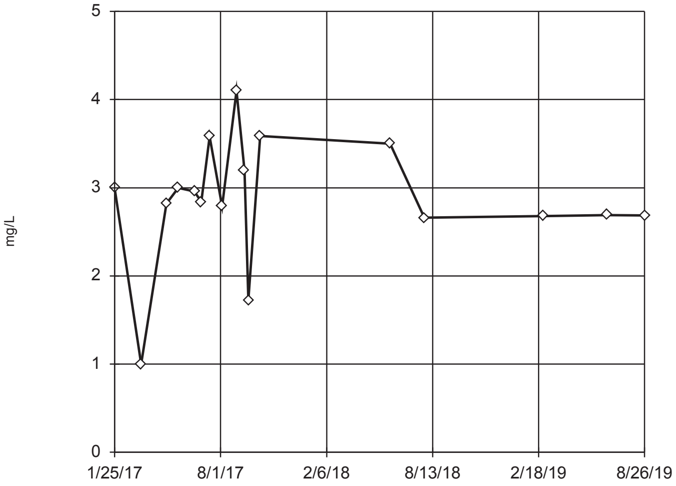
Constituent: Fluoride   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 17

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 4.831, low cutoff = -2.217, based on IQR multiplier of 3.

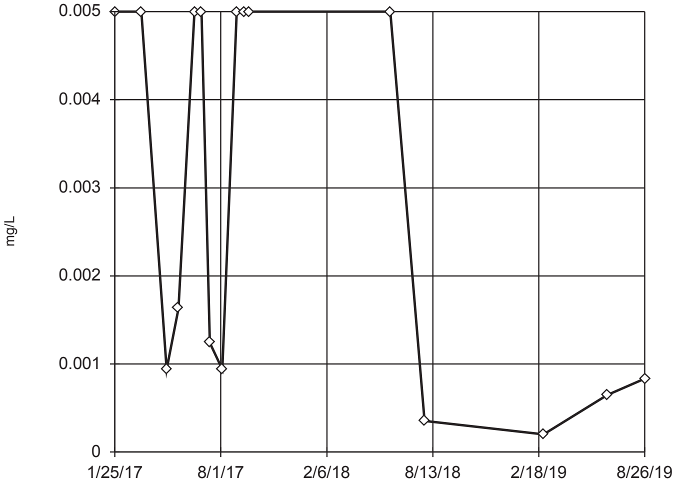
Constituent: Fluoride   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.8988, low cutoff = 0.000004929, based on IQR multiplier of 3.

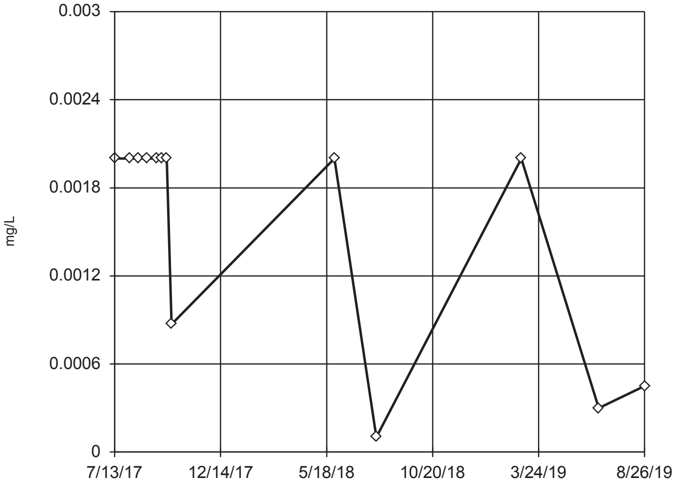
Constituent: Lead   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.01487, low cutoff = -0.00003896, based on IQR multiplier of 3.

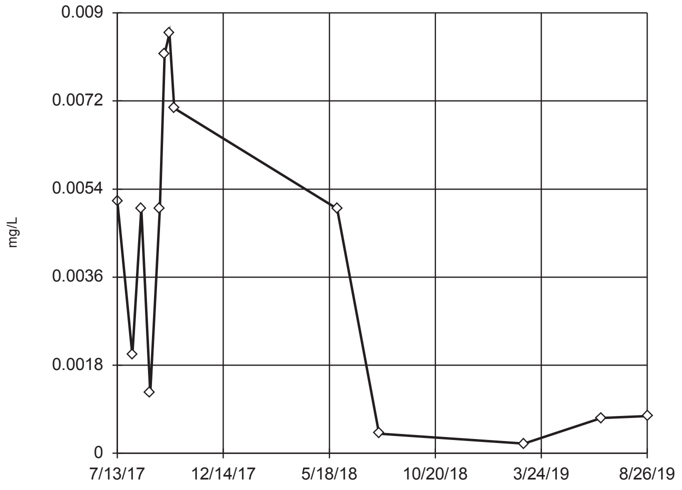
Constituent: Lead   Analysis Run 12/5/2019 7:07 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.05286, low cutoff = -0.01557, based on IQR multiplier of 3.

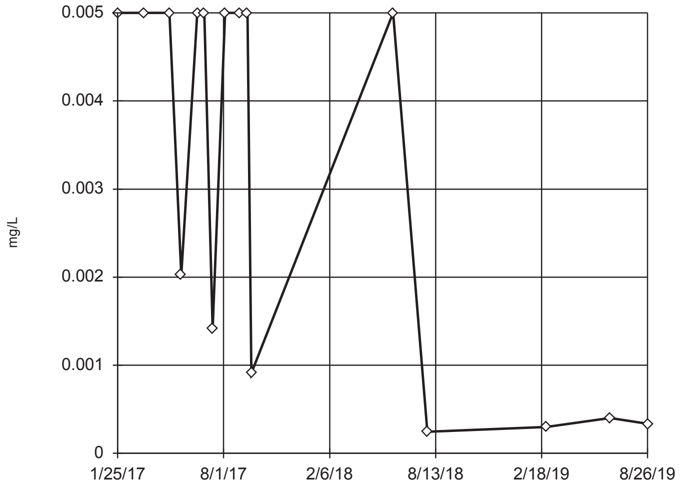
Constituent: Lead Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.846, low cutoff = 0.00000106, based on IQR multiplier of 3.

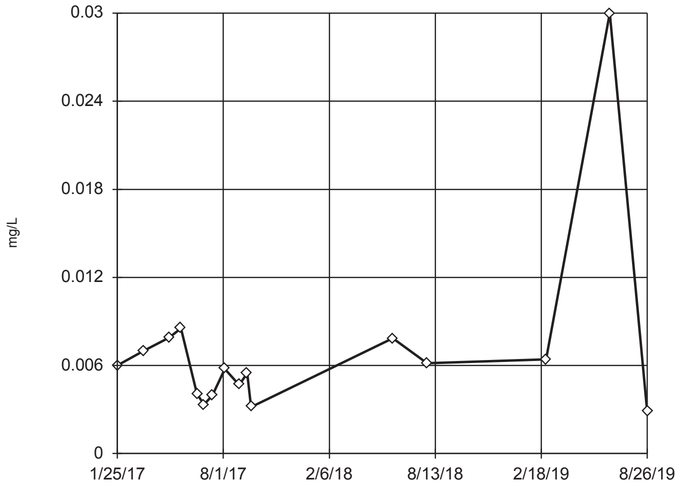
Constituent: Lead Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.04684, low cutoff = 0.0006345, based on IQR multiplier of 3.

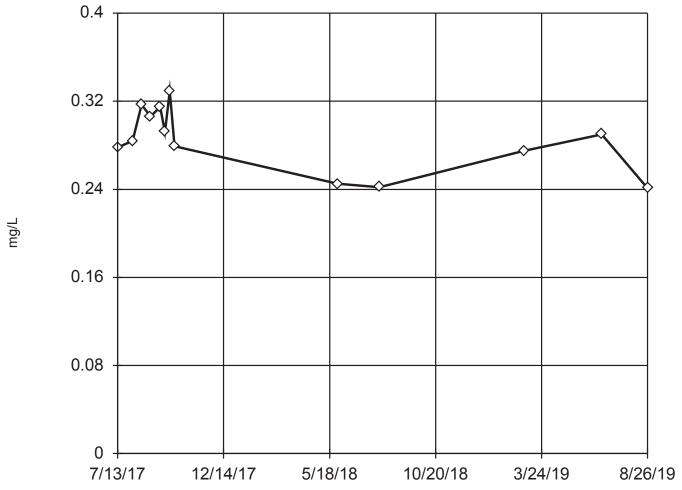
Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.4053, low cutoff = -0.2662, based on IQR multiplier of 3.

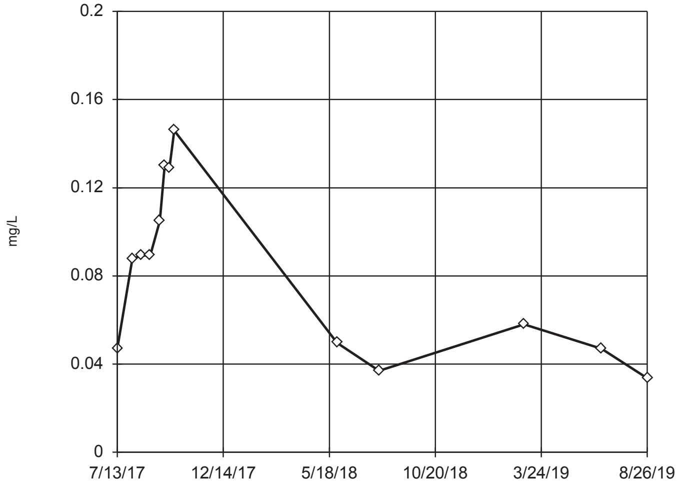
Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.662, low cutoff = -0.00001086, based on IQR multiplier of 3.

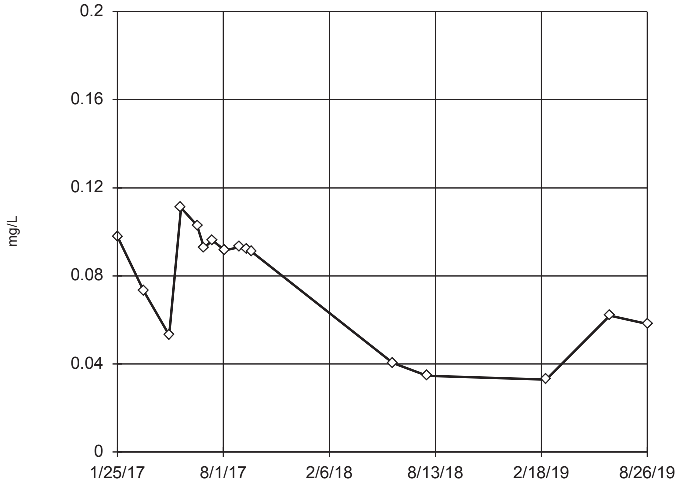
Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1421, low cutoff = -0.1227, based on IQR multiplier of 3.

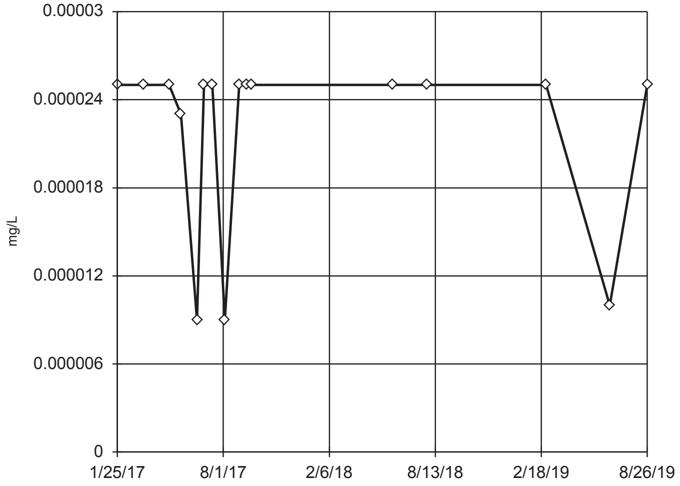
Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because both the lower and upper quartiles represent reporting limits.

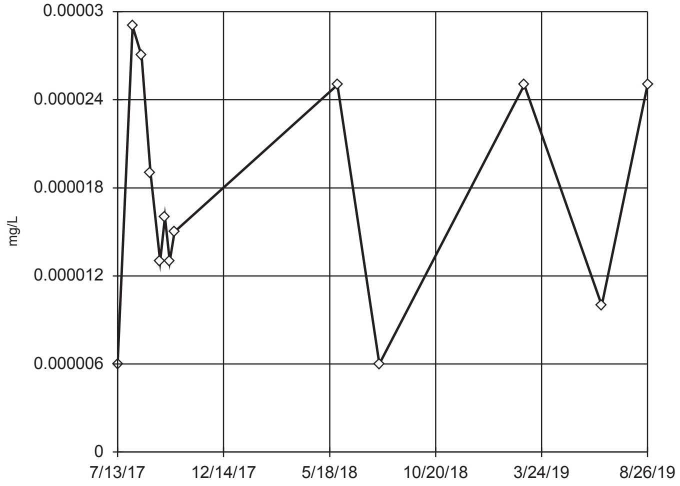
Constituent: Mercury Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.0000655, low cutoff = -0.000029, based on IQR multiplier of 3.

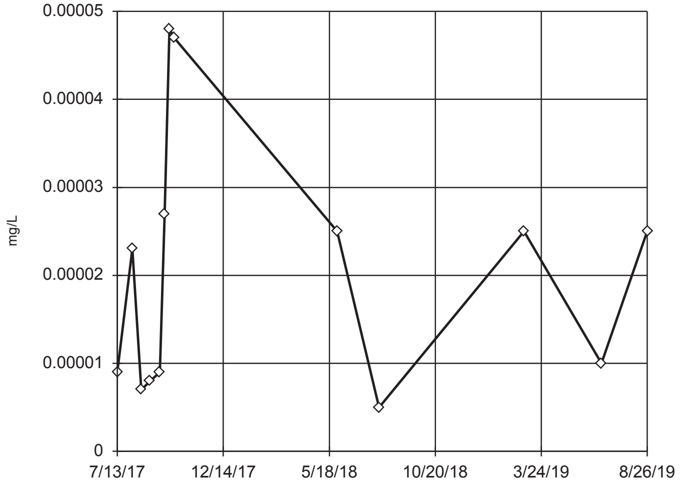
Constituent: Mercury Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0007458, low cutoff = 3.0e-7, based on IQR multiplier of 3.

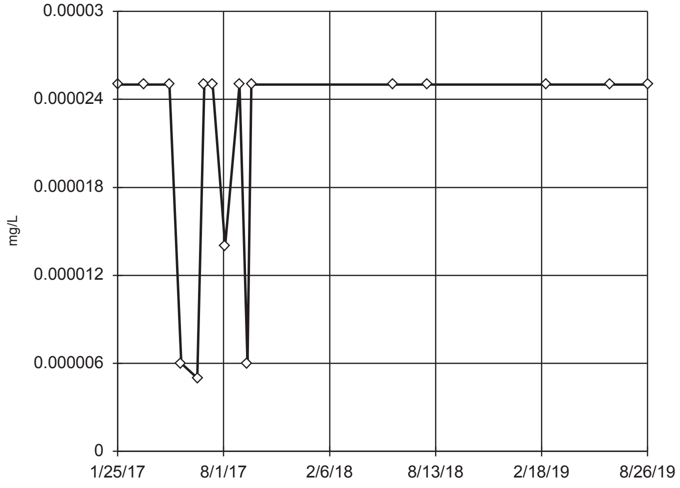
Constituent: Mercury   Analysis Run 12/5/2019 7:08 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.0000415, low cutoff = 0.000003, based on IQR multiplier of 3.

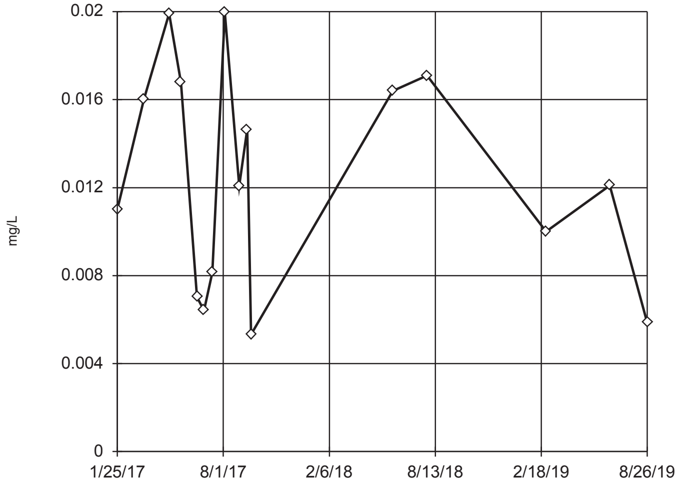
Constituent: Mercury   Analysis Run 12/5/2019 7:08 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.0436, low cutoff = -0.01944, based on IQR multiplier of 3.

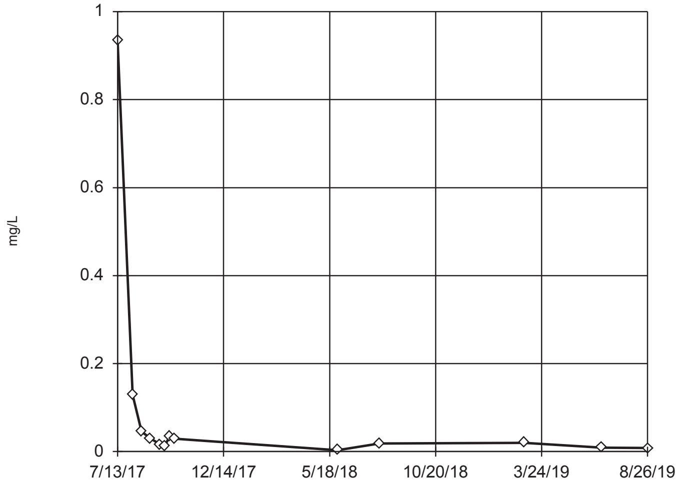
Constituent: Molybdenum   Analysis Run 12/5/2019 7:08 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 1.972, low cutoff = 0.0002265, based on IQR multiplier of 3.

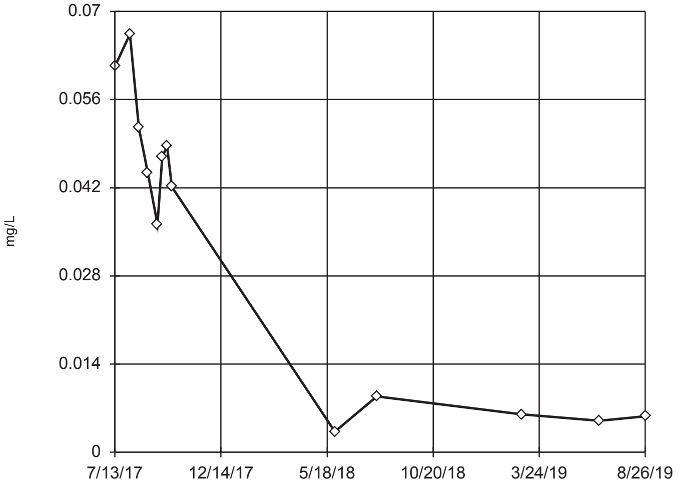
Constituent: Molybdenum   Analysis Run 12/5/2019 7:08 PM

Northeastern BAP   Client: Geosyntec   Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.09964, low cutoff = -0.08594, based on IQR multiplier of 3.

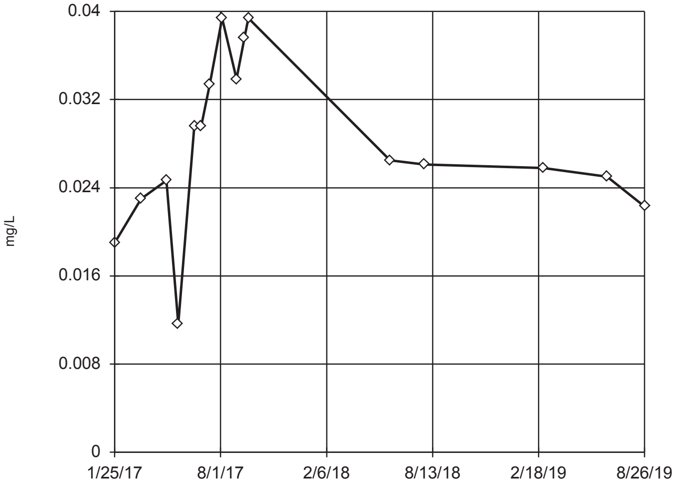
Constituent: Molybdenum Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.06286, low cutoff = -0.00543, based on IQR multiplier of 3.

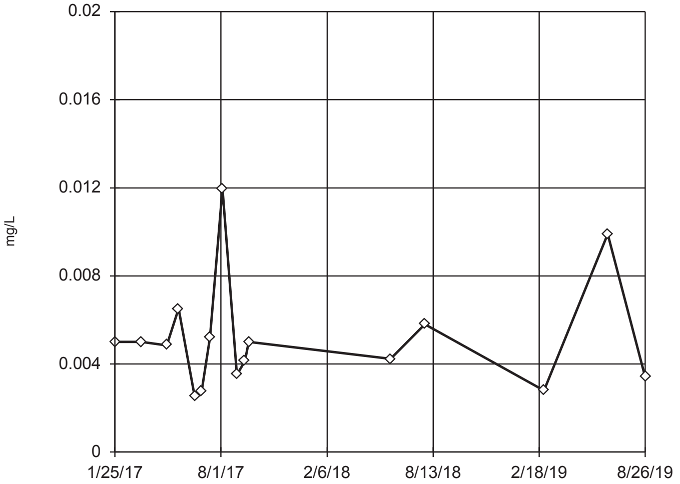
Constituent: Molybdenum Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.02215, low cutoff = 0.0008574, based on IQR multiplier of 3.

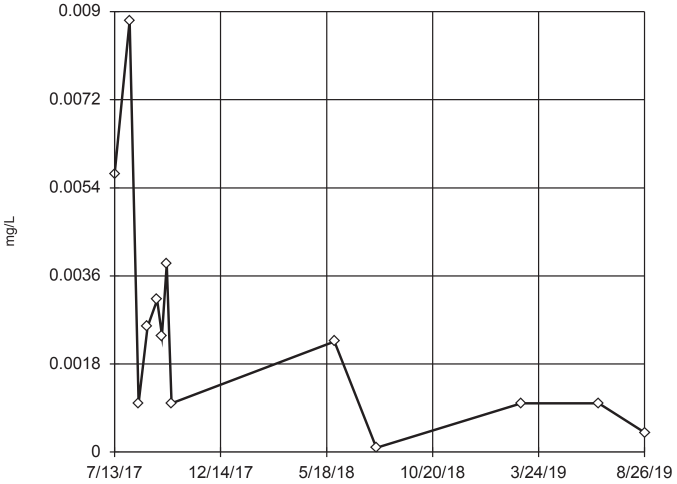
Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

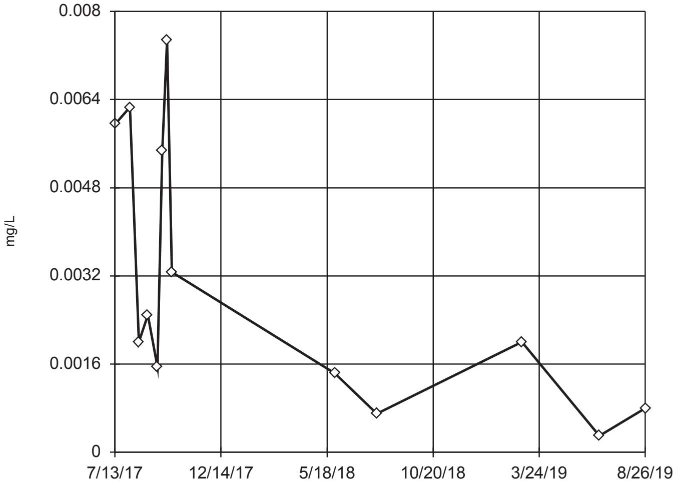
High cutoff = 0.02841, low cutoff = -0.0001561, based on IQR multiplier of 3.

Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

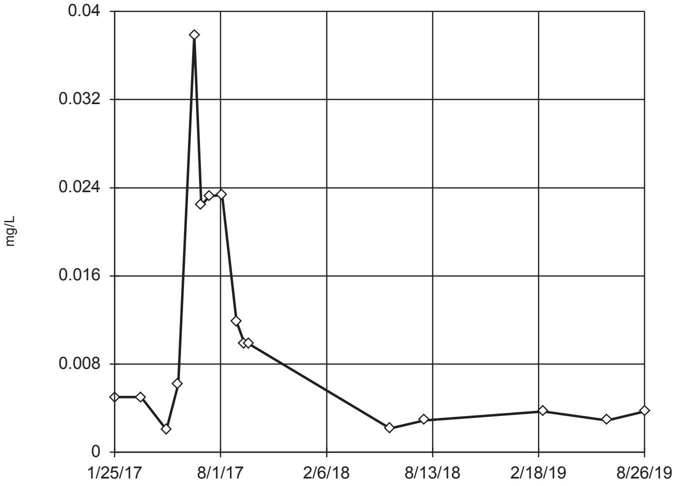
High cutoff = 0.0671, low cutoff = -0.001951, based on IQR multiplier of 3.

Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

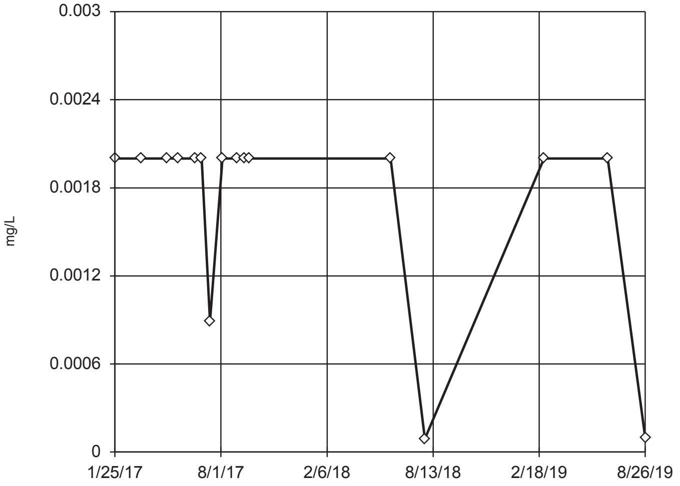
High cutoff = 2.01, low cutoff = 0.00002657, based on IQR multiplier of 3.

Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



n = 16

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

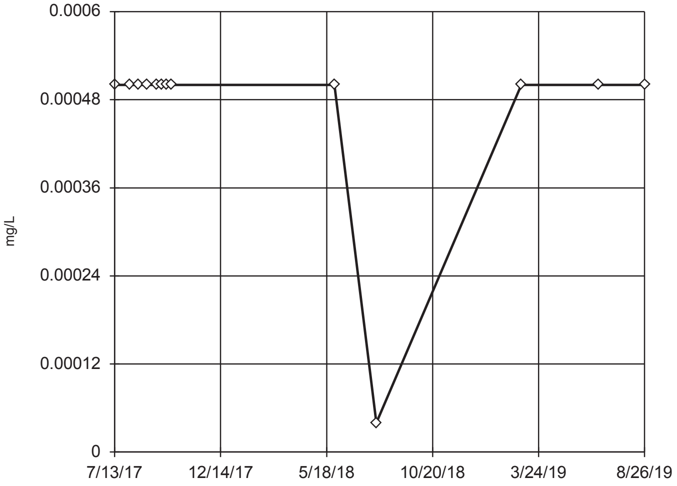
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-10



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

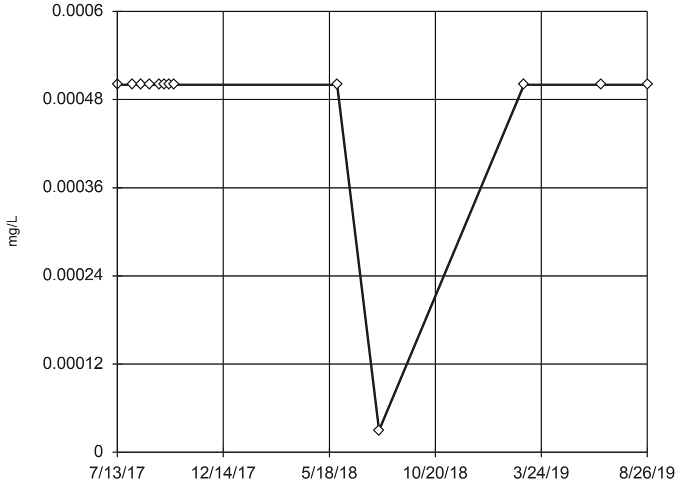
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found. Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

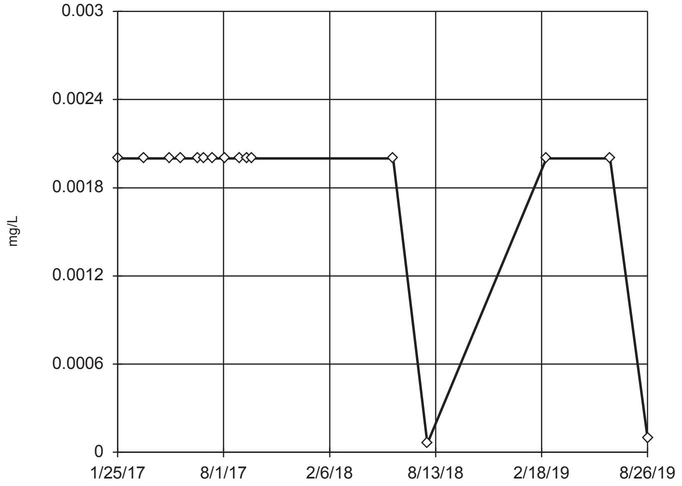
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-2



n = 16

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Welch's t-test/Mann-Whitney - All Results (No Significant Results)

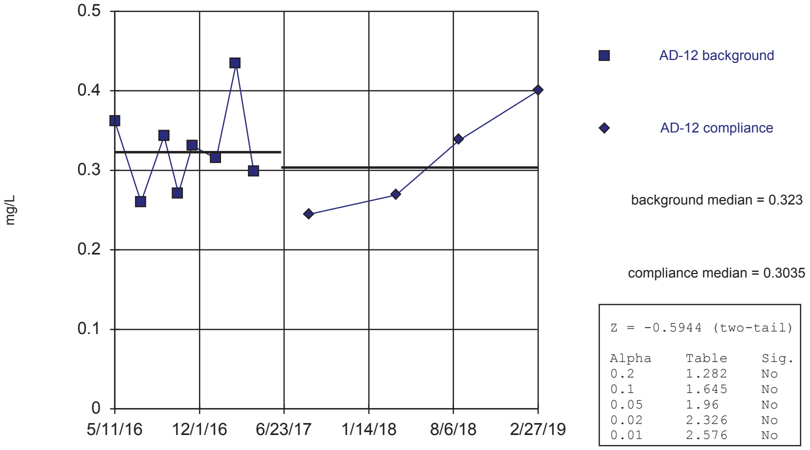
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 7:57 AM

Constituent	Well	Calc.	0.01	Method
Calcium, total (mg/L)	AD-12 (bg)	-0.5944	No	Mann-W
Calcium, total (mg/L)	AD-13 (bg)	1.953	No	Mann-W
Calcium, total (mg/L)	AD-22	0.5131	No	Mann-W
Calcium, total (mg/L)	AD-33	-1.537	No	Mann-W
Calcium, total (mg/L)	AD-7	0.6587	No	Mann-W
pH, field (SU)	AD-12 (bg)	1.613	No	Mann-W
pH, field (SU)	AD-13 (bg)	0.5944	No	Mann-W
pH, field (SU)	AD-22	0.7656	No	Mann-W
pH, field (SU)	AD-33	1.104	No	Mann-W
pH, field (SU)	AD-7	-0.4246	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-1.361	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-13 (bg)	-1.79	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-22	0.2932	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-33	-2.278	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-7	-1.248	No	Mann-W

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



background median = 0.323

compliance median = 0.3035

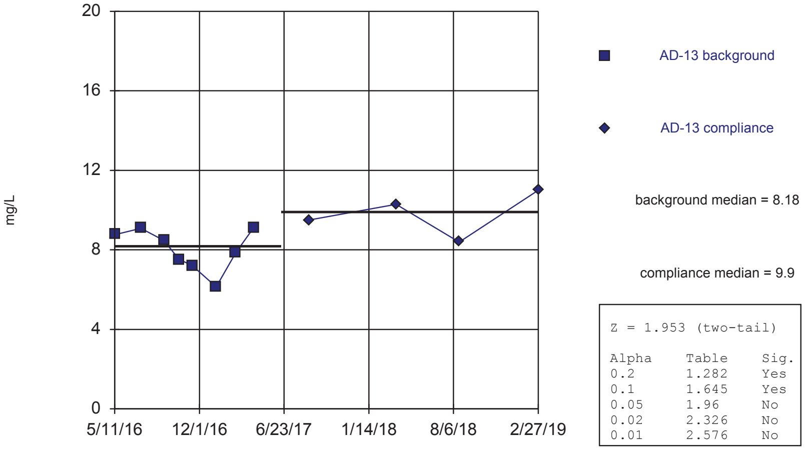
```
Z = -0.5944 (two-tail)

Alpha      Table      Sig.
0.2        1.282      No
0.1        1.645      No
0.05       1.96       No
0.02       2.326      No
0.01       2.576      No
```

Constituent: Calcium, total   Analysis Run 12/9/2019 7:57 AM   View: Intrawell
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-13 (bg)



background median = 8.18

compliance median = 9.9

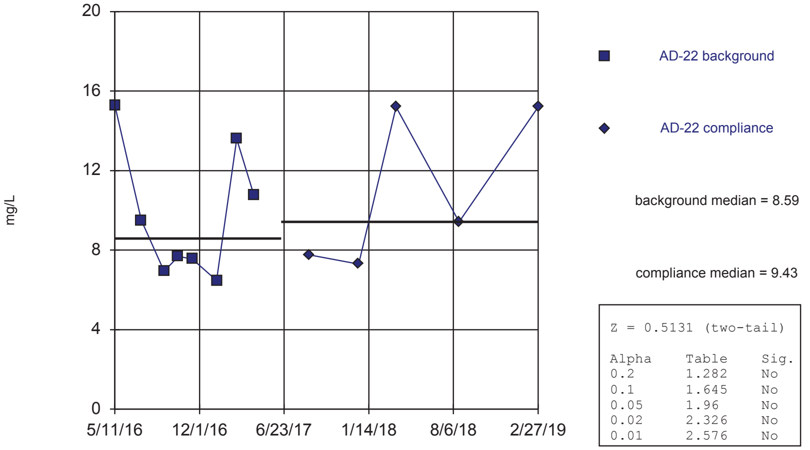
```
Z = 1.953 (two-tail)

Alpha      Table      Sig.
0.2        1.282      Yes
0.1        1.645      Yes
0.05       1.96       No
0.02       2.326      No
0.01       2.576      No
```

Constituent: Calcium, total   Analysis Run 12/9/2019 7:57 AM   View: Intrawell
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-22



background median = 8.59

compliance median = 9.43

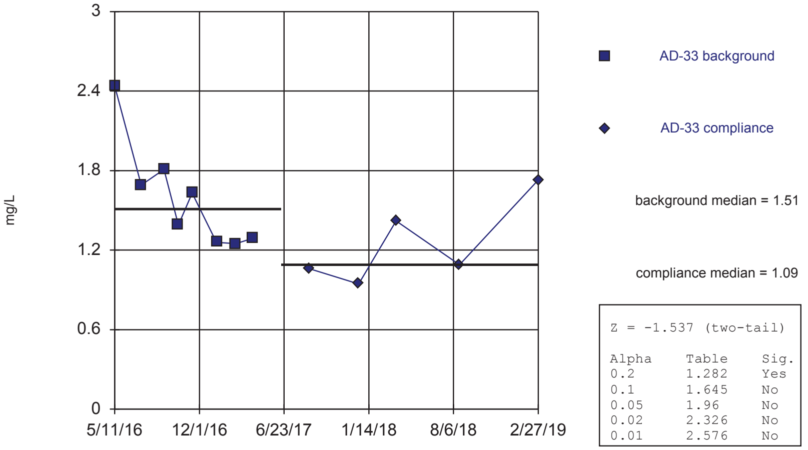
```
Z = 0.5131 (two-tail)

Alpha      Table      Sig.
0.2        1.282      No
0.1        1.645      No
0.05       1.96       No
0.02       2.326      No
0.01       2.576      No
```

Constituent: Calcium, total   Analysis Run 12/9/2019 7:57 AM   View: Intrawell
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-33



background median = 1.51

compliance median = 1.09

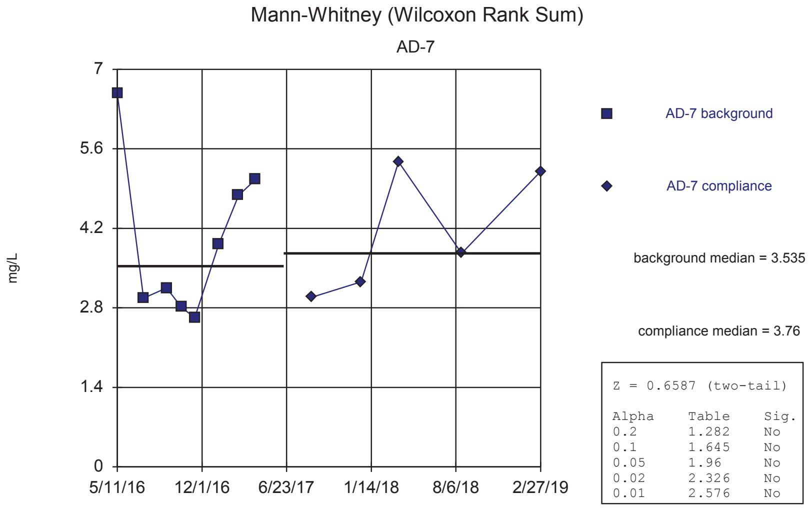
```
Z = -1.537 (two-tail)

Alpha      Table      Sig.
0.2        1.282      Yes
0.1        1.645      No
0.05       1.96       No
0.02       2.326      No
0.01       2.576      No
```

Constituent: Calcium, total   Analysis Run 12/9/2019 7:57 AM   View: Intrawell
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-7



background median = 3.535

compliance median = 3.76

```
Z = 0.6587 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

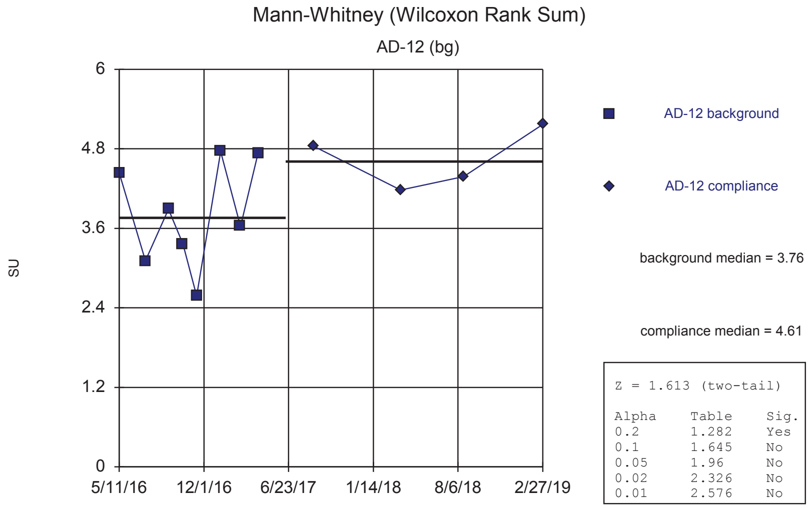
Constituent: Calcium, total   Analysis Run 12/9/2019 7:57 AM   View: Intrawell

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



background median = 3.76

compliance median = 4.61

```
Z = 1.613 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

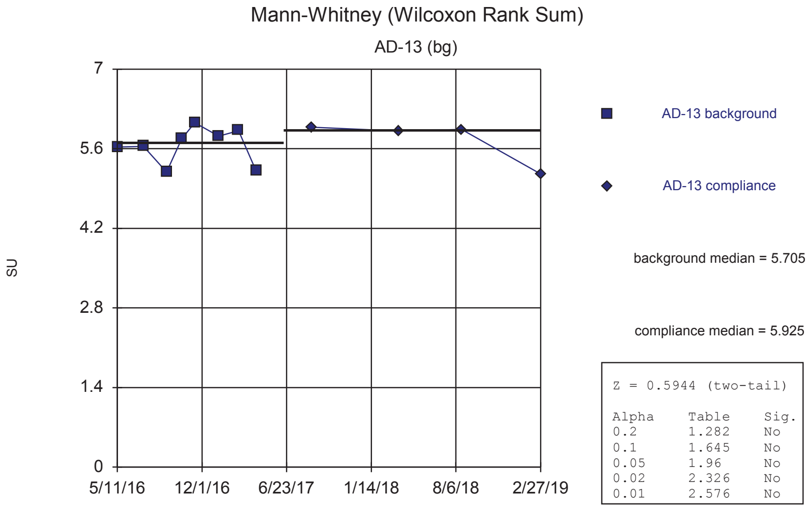
Constituent: pH, field   Analysis Run 12/9/2019 7:57 AM   View: Intrawell

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-13 (bg)



background median = 5.705

compliance median = 5.925

```
Z = 0.5944 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

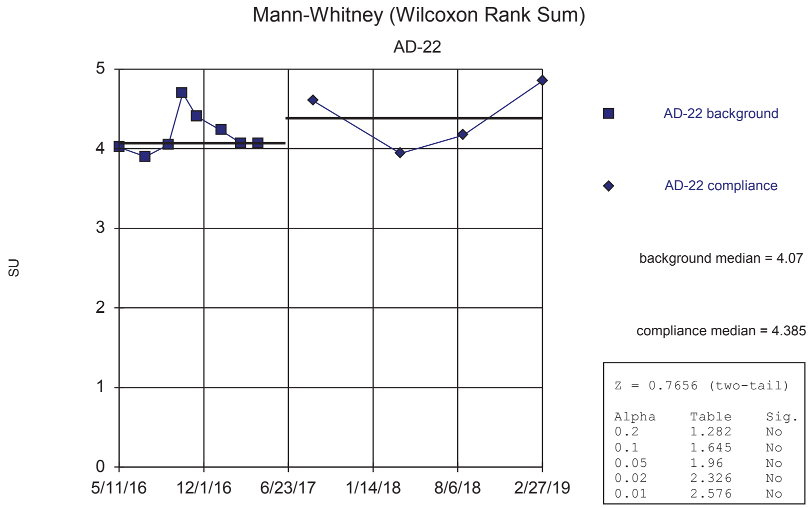
Constituent: pH, field   Analysis Run 12/9/2019 7:57 AM   View: Intrawell

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-22



background median = 4.07

compliance median = 4.385

```
Z = 0.7656 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

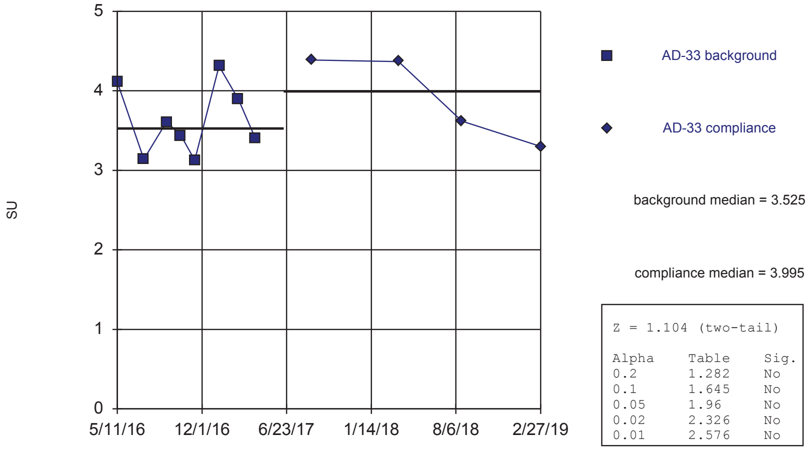
Constituent: pH, field   Analysis Run 12/9/2019 7:57 AM   View: Intrawell

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-33



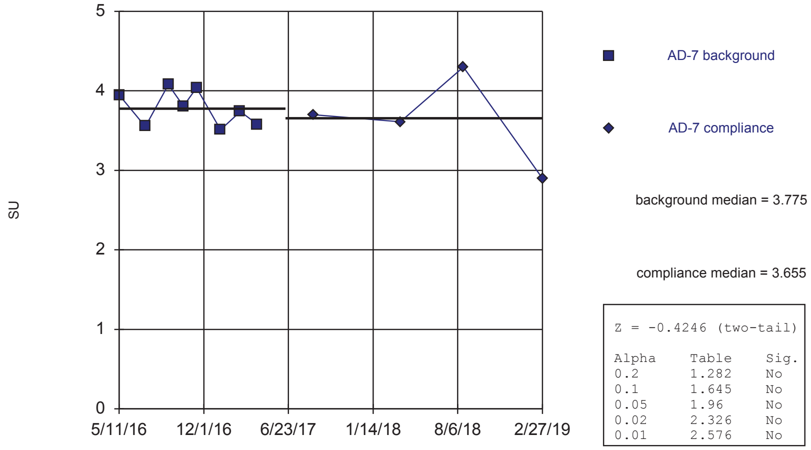
```
Z = 1.104 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-7



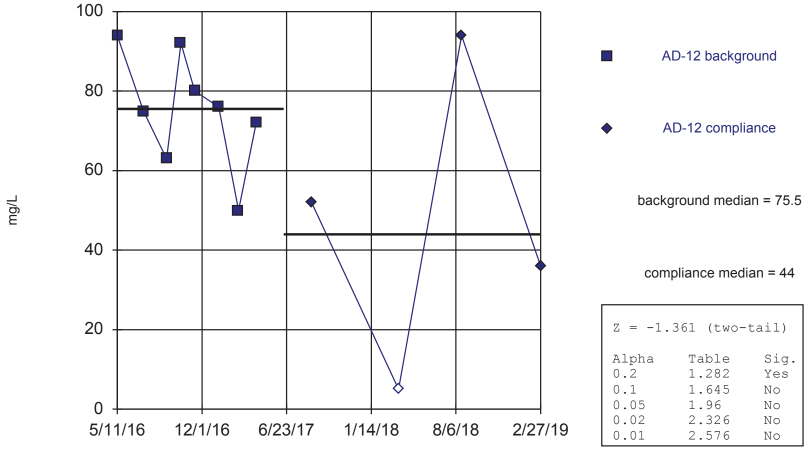
```
Z = -0.4246 (two-tail)

Alpha     Table     Sig.
0.2       1.282     No
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



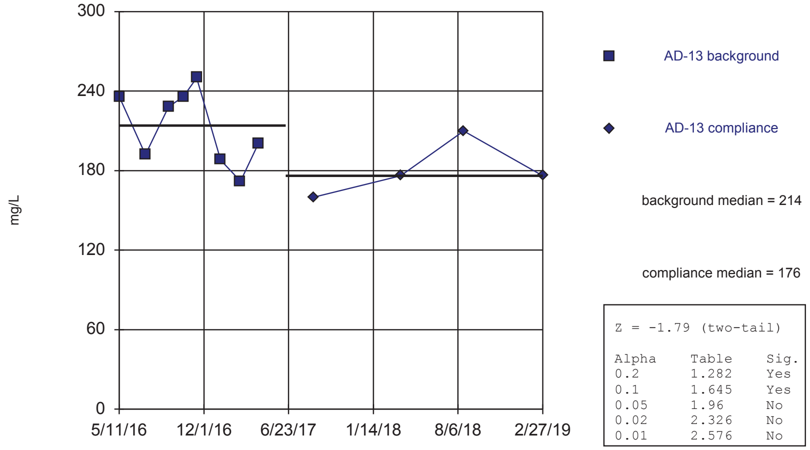
```
Z = -1.361 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     No
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

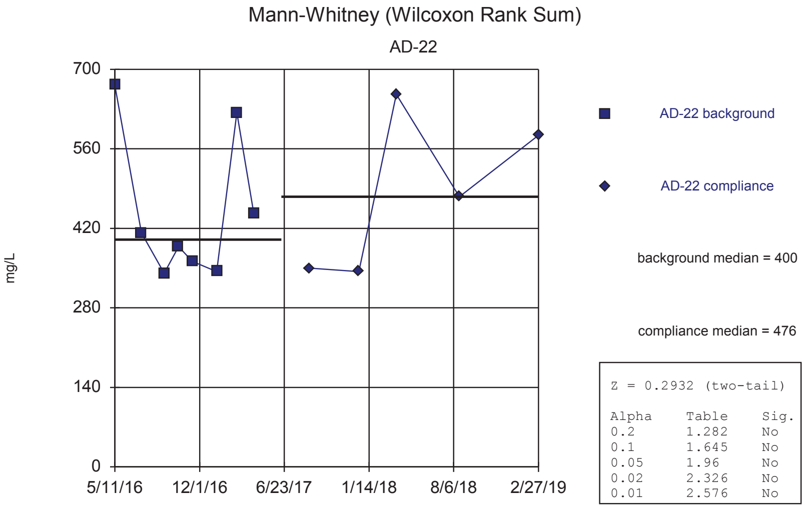
AD-13 (bg)



```
Z = -1.79 (two-tail)

Alpha     Table     Sig.
0.2       1.282     Yes
0.1       1.645     Yes
0.05      1.96      No
0.02      2.326     No
0.01      2.576     No
```

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

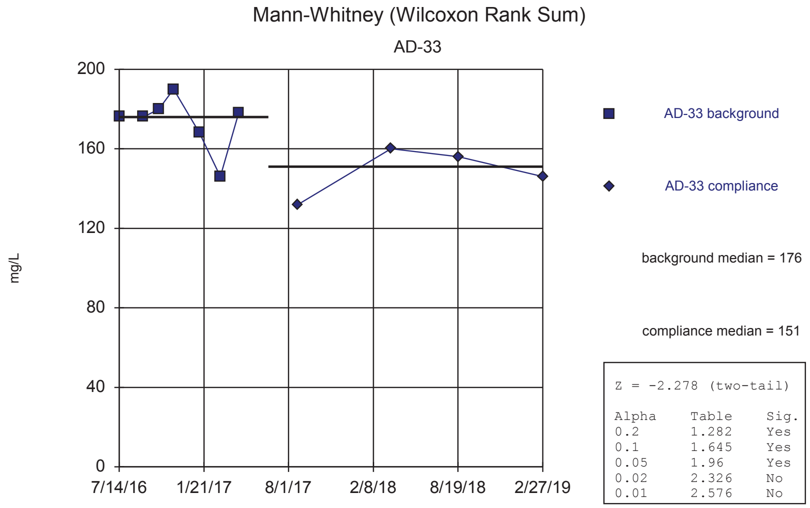
Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG



```
Z = 0.2932 (two-tail)

Alpha    Table    Sig.
0.2      1.282    No
0.1      1.645    No
0.05     1.96     No
0.02     2.326    No
0.01     2.576    No
```

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/9/2019 7:57 AM   View: Intrawell
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

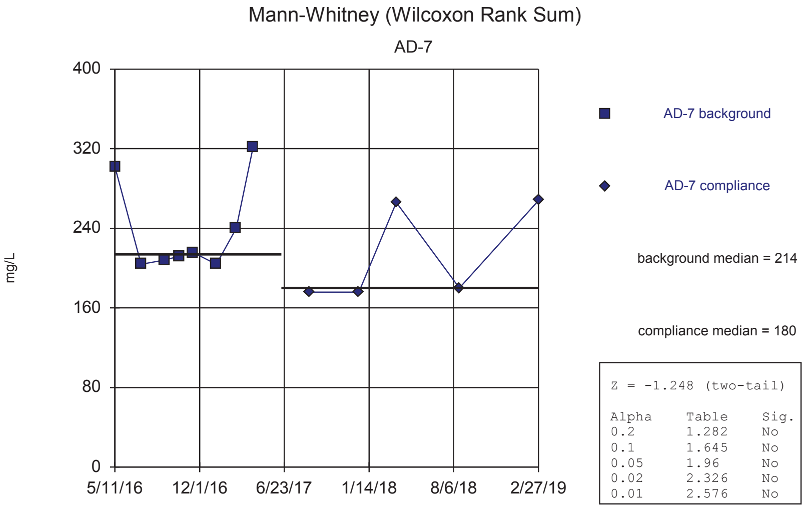
Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG



```
Z = -2.278 (two-tail)

Alpha    Table    Sig.
0.2      1.282    Yes
0.1      1.645    Yes
0.05     1.96     Yes
0.02     2.326    No
0.01     2.576    No
```

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/9/2019 7:57 AM   View: Intrawell
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG



```
Z = -1.248 (two-tail)

Alpha    Table    Sig.
0.2      1.282    No
0.1      1.645    No
0.05     1.96     No
0.02     2.326    No
0.01     2.576    No
```

Constituent: Total Dissolved Solids [TDS]   Analysis Run 12/9/2019 7:57 AM   View: Intrawell
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Intrawell Prediction Limit Summary Table - All Results

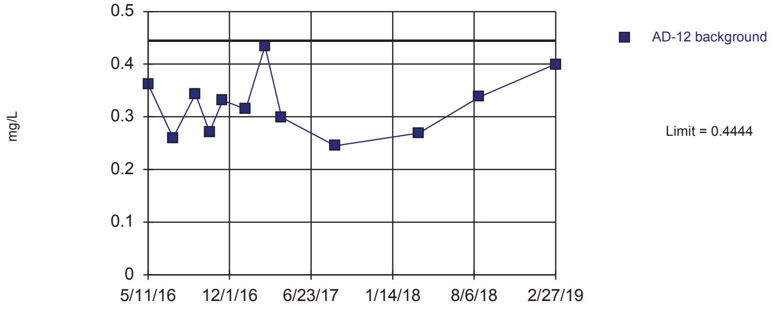
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 12/9/2019, 8:00 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-12	0.4444	n/a	n/a	1 future	n/a	12	0.3223	0.05781	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-13	11.44	n/a	n/a	1 future	n/a	12	8.617	1.337	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-33	2.292	n/a	n/a	1 future	n/a	13	1.462	0.3998	0	None	No	0.002505	Param Intra 1 of 2
pH, field (SU)	AD-12	5.754	2.427	n/a	1 future	n/a	12	4.091	0.7877	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-13	6.376	4.995	n/a	1 future	n/a	12	5.686	0.3269	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-22	4.917	3.585	n/a	1 future	n/a	12	4.251	0.3153	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-33	4.725	2.726	n/a	1 future	n/a	12	3.726	0.4733	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-7	4.486	2.976	n/a	1 future	n/a	12	3.731	0.3575	0	None	No	0.001253	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	121.8	n/a	n/a	1 future	n/a	12	65.75	26.52	8.333	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-13	264.6	n/a	n/a	1 future	n/a	12	202	29.65	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-33	203.2	n/a	n/a	1 future	n/a	11	164.4	17.84	0	None	No	0.002505	Param Intra 1 of 2

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-12 (bg)



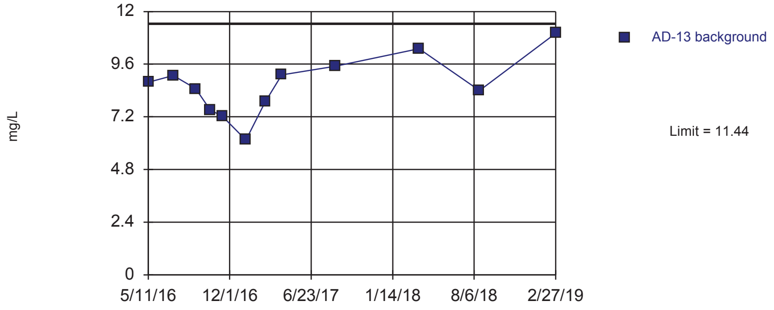
Background Data Summary: Mean=0.3223, Std. Dev.=0.05781, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9547, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-13 (bg)



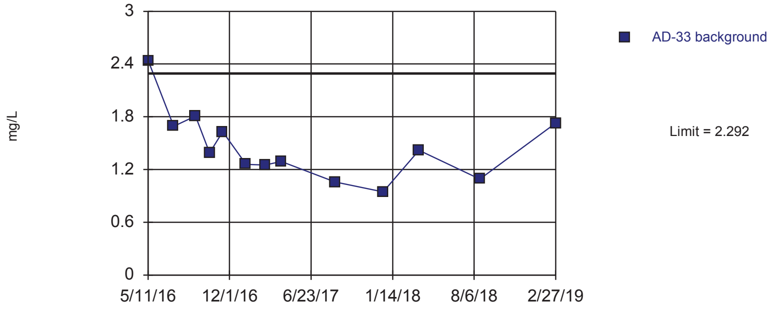
Background Data Summary: Mean=8.617, Std. Dev.=1.337, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9916, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-33



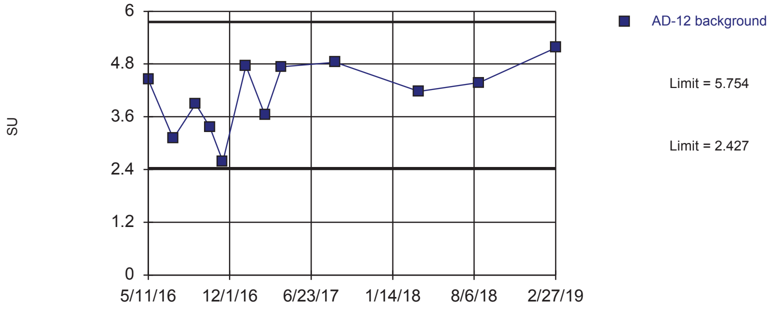
Background Data Summary: Mean=1.462, Std. Dev.=0.3998, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9183, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-12 (bg)

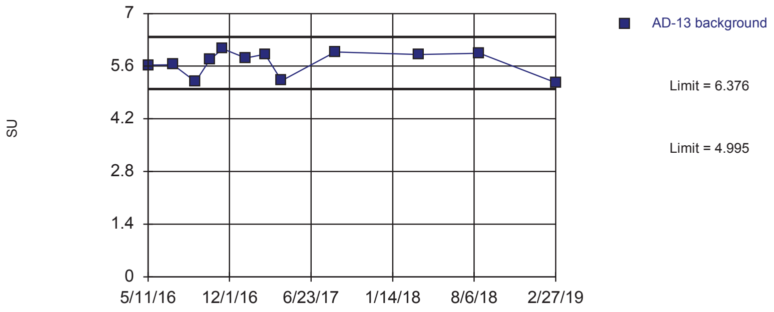


Background Data Summary: Mean=4.091, Std. Dev.=0.7877, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9544, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-13 (bg)

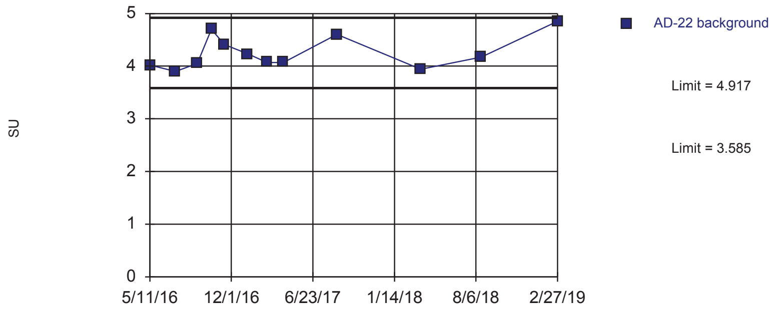


Background Data Summary: Mean=5.686, Std. Dev.=0.3269, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8494, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-22

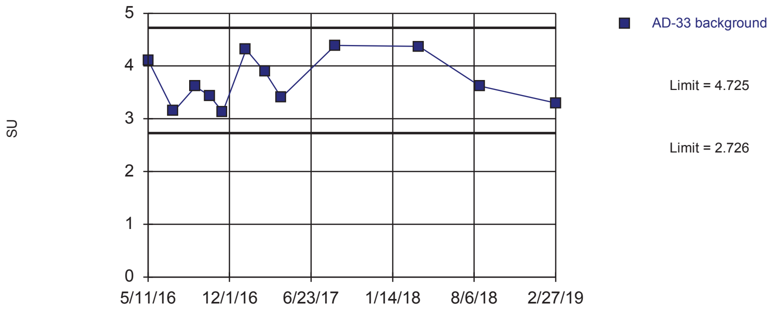


Background Data Summary: Mean=4.251, Std. Dev.=0.3153, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.885, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-33

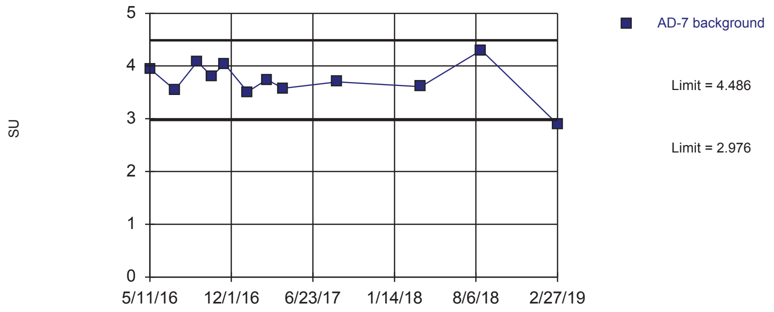


Background Data Summary: Mean=3.726, Std. Dev.=0.4733, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9014, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-7



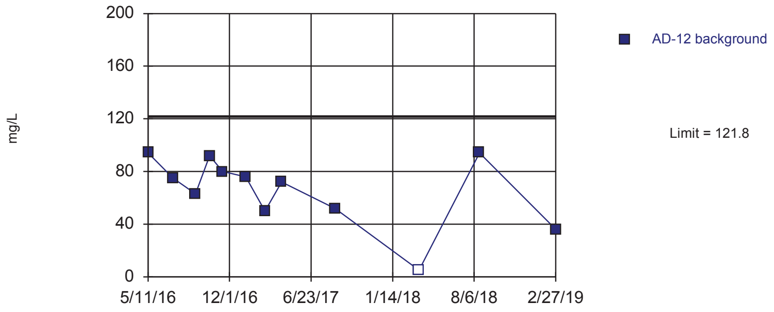
Background Data Summary: Mean=3.731, Std. Dev.=0.3575, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9396, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-12 (bg)



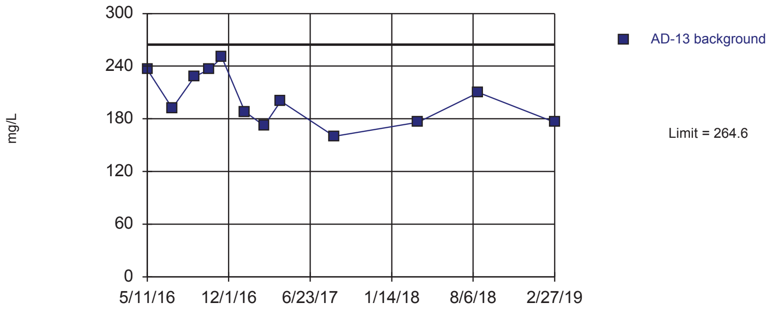
Background Data Summary: Mean=65.75, Std. Dev.=26.52, n=12, 8.333% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9032, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-13 (bg)



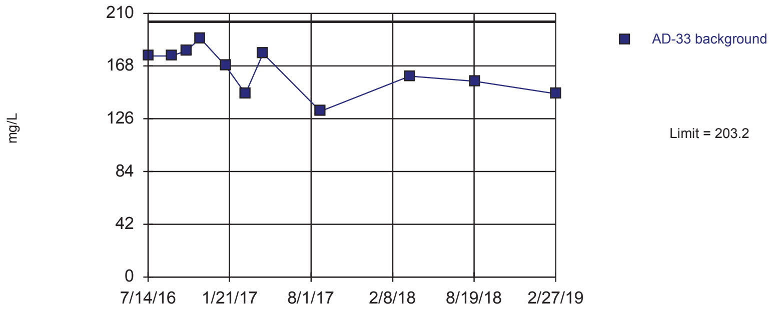
Background Data Summary: Mean=202, Std. Dev.=29.65, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9362, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-33



Background Data Summary: Mean=164.4, Std. Dev.=17.84, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9491, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Deseasonalized Intrawell Prediction Limit Summary Table - All Results

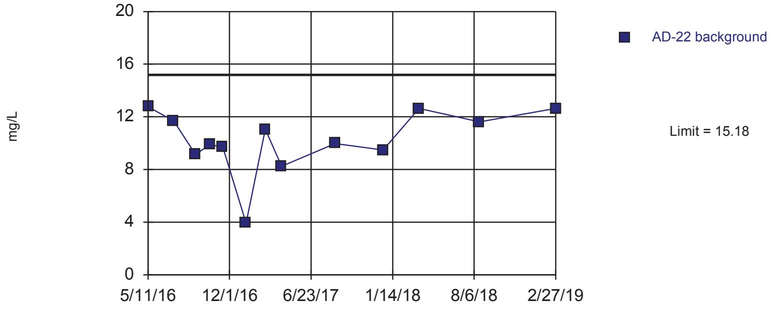
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 8:06 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-22	15.18	n/a	n/a	1 future	n/a	13	10.21	2.393	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-7	5.315	n/a	n/a	1 future	n/a	13	4.037	0.6157	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-22	651.2	n/a	n/a	1 future	n/a	13	461.5	91.38	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-7	291.3	n/a	n/a	1 future	n/a	13	228.8	30.1	0	None	No	0.002505	Param Intra 1 of 2

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-22



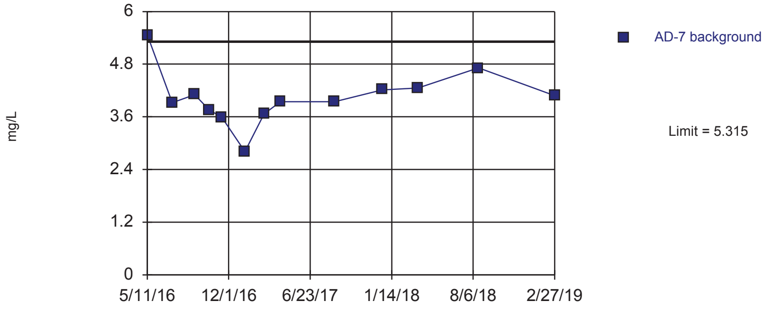
Background Data Summary: Mean=10.21, Std. Dev.=2.393, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8604, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total, Alt. Values Analysis Run 12/9/2019 8:05 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-7



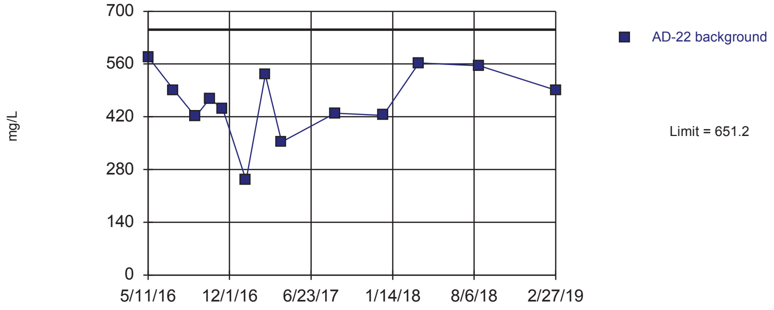
Background Data Summary: Mean=4.037, Std. Dev.=0.6157, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9217, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total, Alt. Values Analysis Run 12/9/2019 8:05 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-22



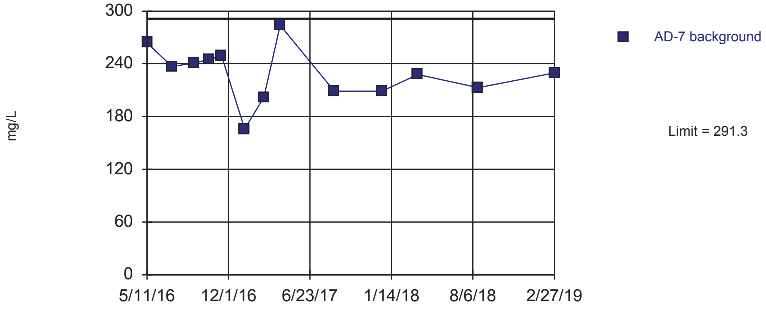
Background Data Summary: Mean=461.5, Std. Dev.=91.38, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9344, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS], Alt. Values Analysis Run 12/9/2019 8:05 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-7



Background Data Summary: Mean=228.8, Std. Dev.=30.1, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9799, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS], Alt. Values Analysis Run 12/9/2019 8:06 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Trend Tests Summary Table - Upgradient Wells

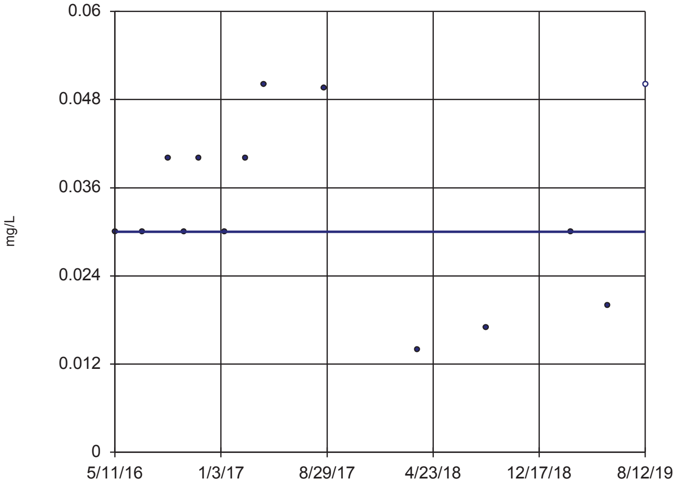
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/6/2019, 11:26 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-12 (bg)	0	3	44	No	14	7.143	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-13 (bg)	0.002834	32	44	No	14	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-12 (bg)	0.1051	23	44	No	14	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-13 (bg)	4.358	32	44	No	14	0	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	**AD-12 (bg)**	**-0.08118**	**-46**	**-44**	**Yes**	**14**	**64.29**	**n/a**	**n/a**	**0.02**	**NP**
Fluoride, total (mg/L)	AD-13 (bg)	-0.08825	-23	-44	No	14	28.57	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.7952	-35	-44	No	14	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-13 (bg)	7.178	38	44	No	14	0	n/a	n/a	0.02	NP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0
units per year.

Mann-Kendall
statistic = 3
critical = 44

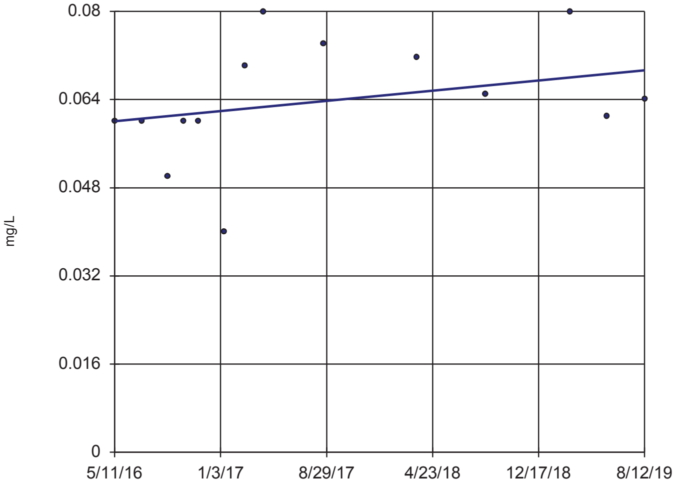
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Boron, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = 0.002834
units per year.

Mann-Kendall
statistic = 32
critical = 44

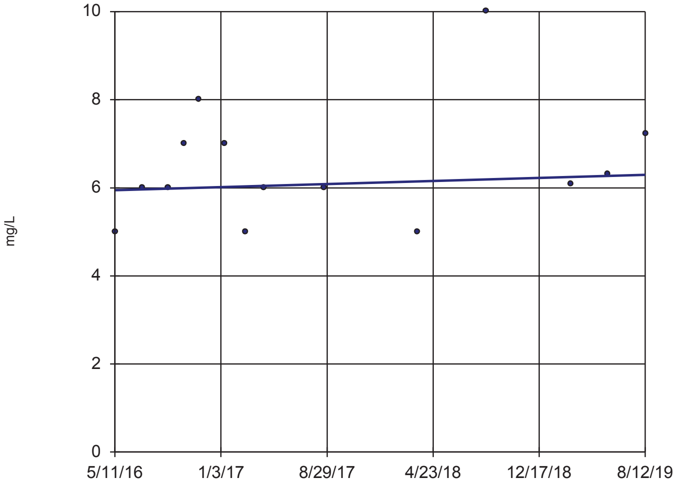
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Boron, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0.1051
units per year.

Mann-Kendall
statistic = 23
critical = 44

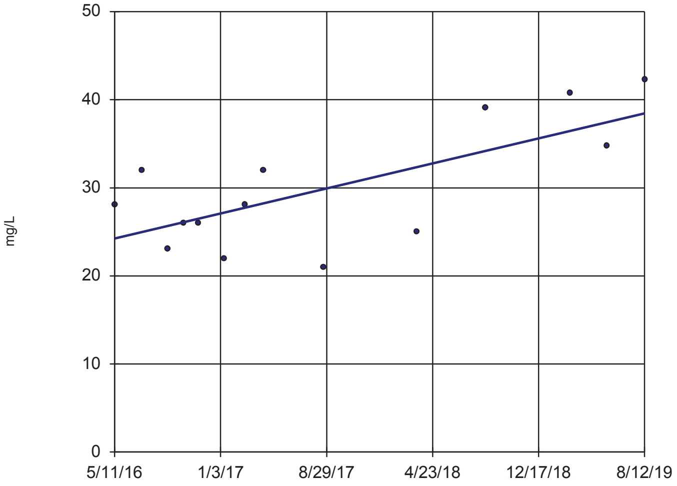
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Chloride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = 4.358
units per year.

Mann-Kendall
statistic = 32
critical = 44

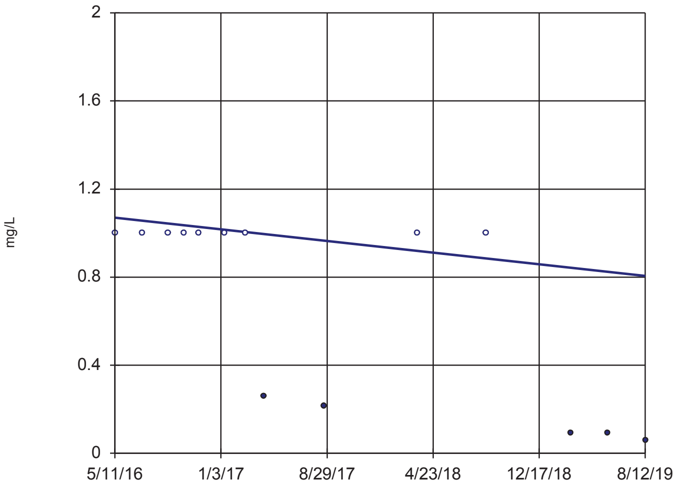
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Chloride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.08118 units per year.

Mann-Kendall statistic = -46 critical = -44

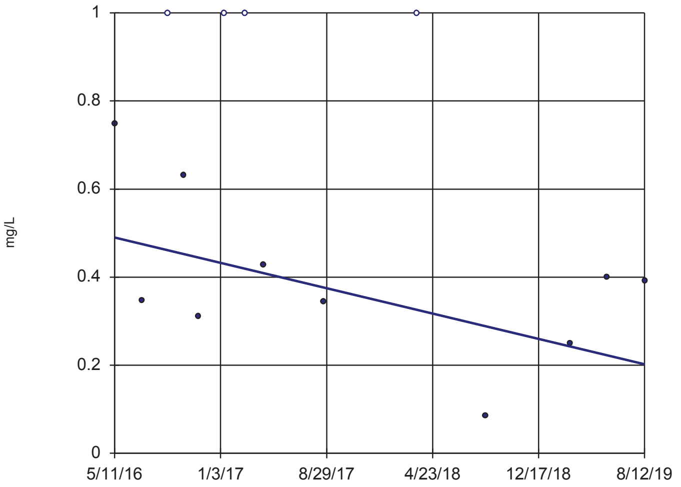
Decreasing trend significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = -0.08825 units per year.

Mann-Kendall statistic = -23 critical = -44

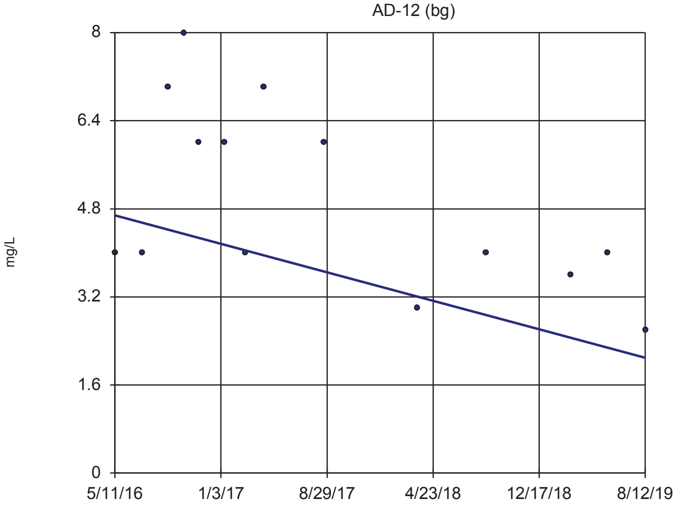
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.7952 units per year.

Mann-Kendall statistic = -35 critical = -44

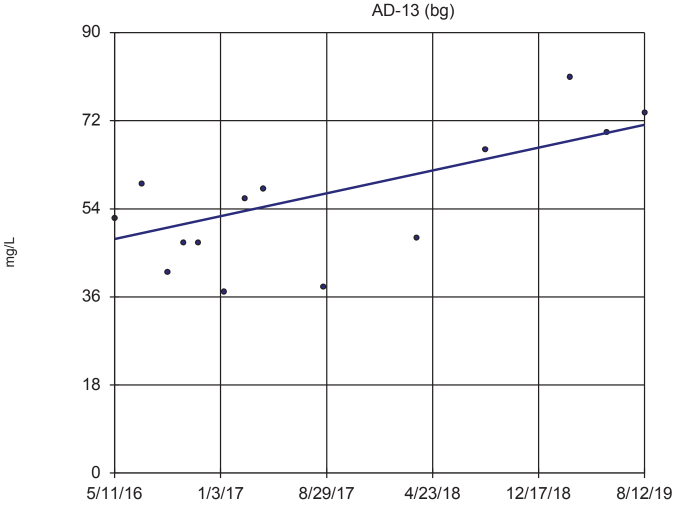
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Sulfate, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = 7.178 units per year.

Mann-Kendall statistic = 38 critical = 44

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Sulfate, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Interwell Prediction Limit Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 8:08 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	n/a	0.08453	n/a	n/a	3 future	n/a	24	0.0488	0.01937	0	None	No	0.002505	Param Inter 1 of 2
Chloride, total (mg/L)	n/a	40.8	n/a	n/a	3 future	n/a	24	n/a	n/a	0	n/a	n/a	0.003036	NP Inter (normality) 1 of 2
Fluoride, total (mg/L)	n/a	1	n/a	n/a	3 future	n/a	24	n/a	n/a	54.17	n/a	n/a	0.003036	NP Inter (NDs) 1 of 2
Sulfate, total (mg/L)	n/a	80.8	n/a	n/a	3 future	n/a	24	n/a	n/a	0	n/a	n/a	0.003036	NP Inter (normality) 1 of 2

Upper Tolerance Limits - App IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/6/2019, 11:38 AM

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.005	26	n/a	n/a	92.31	n/a	n/a	0.2635	NP Inter(NDs)
Arsenic, total (mg/L)	0.006425	25	0.002391	0.00176	48	Kaplan-Meier	No	0.05	Inter
Barium, total (mg/L)	0.0514	26	0.03266	0.008226	0	None	No	0.05	Inter
Beryllium, total (mg/L)	0.002	26	n/a	n/a	15.38	n/a	n/a	0.2635	NP Inter(normality)
Cadmium, total (mg/L)	0.001	24	n/a	n/a	75	n/a	n/a	0.292	NP Inter(normality)
Chromium, total (mg/L)	0.001869	26	-7.997	0.7528	50	Kaplan-Meier	ln(x)	0.05	Inter
Cobalt, total (mg/L)	0.056	26	n/a	n/a	0	n/a	n/a	0.2635	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	2.935	26	1.183	0.769	0	None	No	0.05	Inter
Fluoride, total (mg/L)	1	28	n/a	n/a	46.43	n/a	n/a	0.2378	NP Inter(normality)
Lead, total (mg/L)	0.005	26	n/a	n/a	88.46	n/a	n/a	0.2635	NP Inter(NDs)
Lithium, total (mg/L)	0.165	26	n/a	n/a	3.846	n/a	n/a	0.2635	NP Inter(normality)
Mercury, total (mg/L)	0.000025	26	n/a	n/a	84.62	n/a	n/a	0.2635	NP Inter(NDs)
Molybdenum, total (mg/L)	0.005	22	n/a	n/a	95.45	n/a	n/a	0.3235	NP Inter(NDs)
Selenium, total (mg/L)	0.005	26	n/a	n/a	73.08	n/a	n/a	0.2635	NP Inter(normality)
Thallium, total (mg/L)	0.002	24	n/a	n/a	75	n/a	n/a	0.292	NP Inter(normality)

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric

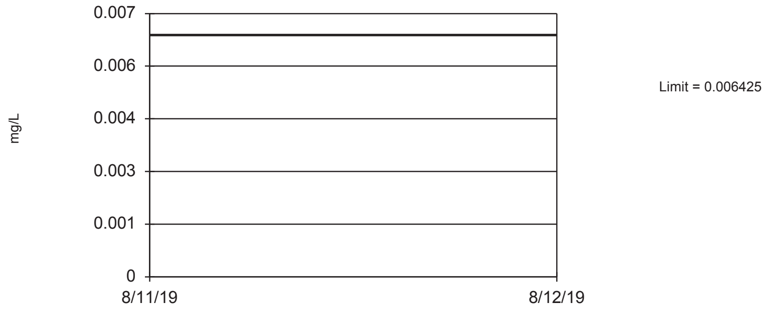
Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 26 background values. 92.31% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Antimony, total   Analysis Run 12/6/2019 11:37 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Parametric



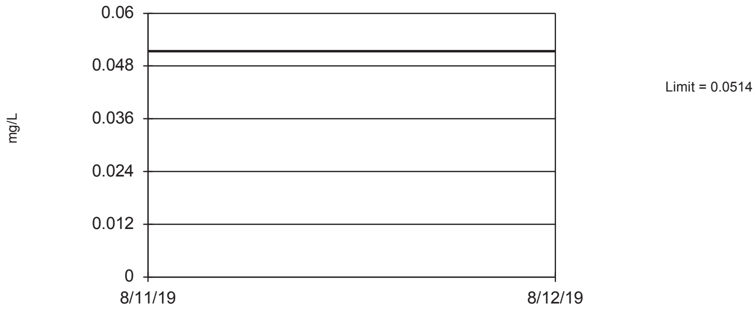
95% coverage. Background Data Summary (after Kaplan-Meier Adjustment): Mean=0.002391, Std. Dev.=0.00176, n=25, 48% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8904, critical = 0.888. Report alpha = 0.05.

Constituent: Arsenic, total   Analysis Run 12/6/2019 11:37 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Parametric



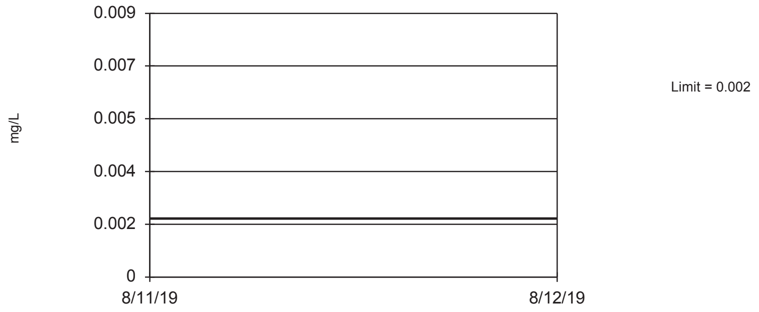
95% coverage. Background Data Summary: Mean=0.03266, Std. Dev.=0.008226, n=26. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9085, critical = 0.891. Report alpha = 0.05.

Constituent: Barium, total   Analysis Run 12/6/2019 11:37 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



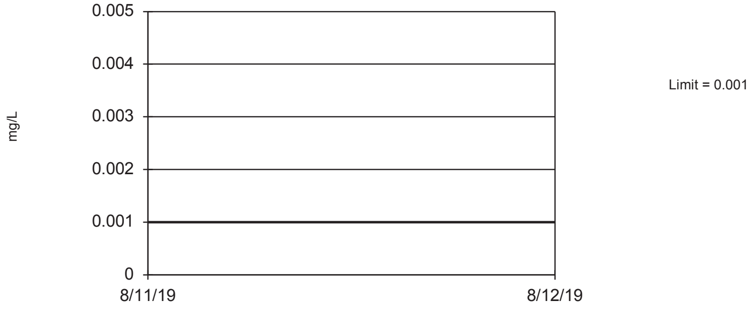
Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 15.38% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Beryllium, total   Analysis Run 12/6/2019 11:37 AM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



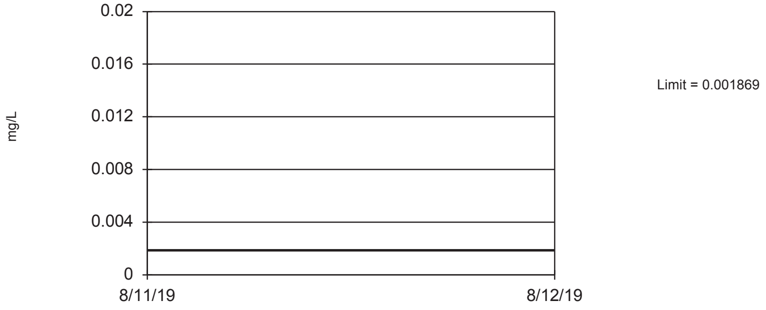
Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 24 background values. 75% NDs. 82.62% coverage at alpha=0.01; 88.09% coverage at alpha=0.05; 97.07% coverage at alpha=0.5. Report alpha = 0.292.

Constituent: Cadmium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Parametric



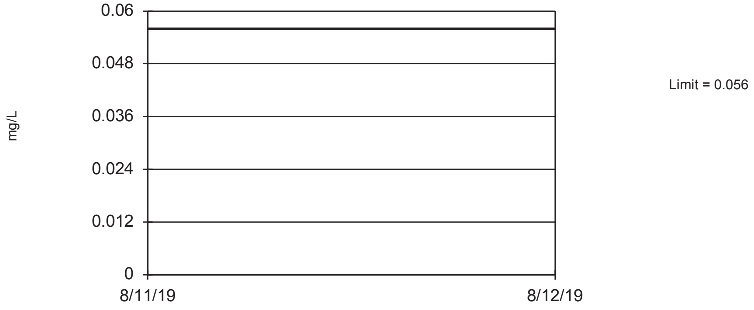
95% coverage. Background Data Summary (based on natural log transformation) (after Kaplan-Meier Adjustment): Mean=-7.997, Std. Dev.=0.7528, n=26, 50% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9156, critical = 0.891. Report alpha = 0.05.

Constituent: Chromium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



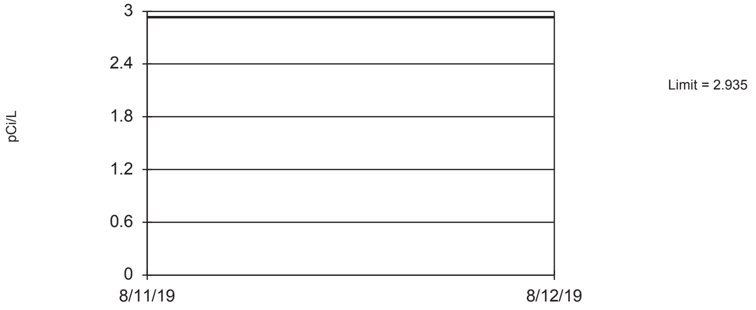
Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Cobalt, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Parametric



95% coverage. Background Data Summary: Mean=1.183, Std. Dev.=0.769, n=26. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9406, critical = 0.891. Report alpha = 0.05.

Constituent: Combined Radium 226 + 228 Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric

Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 28 background values. 46.43% NDs. 84.96% coverage at alpha=0.01; 90.04% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2378.

Constituent: Fluoride, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric

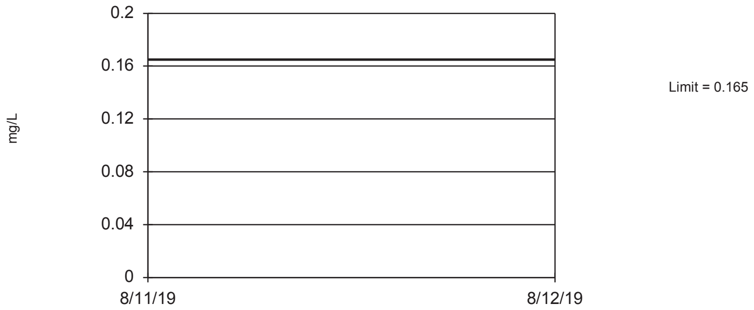
Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 26 background values. 88.46% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Lead, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



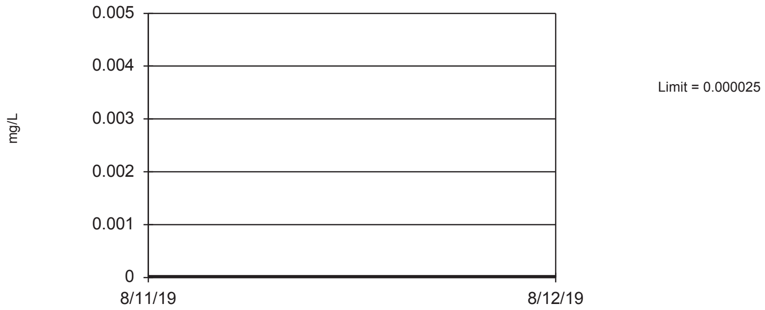
Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 3.846% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Lithium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 26 background values. 84.62% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Mercury, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric

Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 22 background values. 95.45% NDs. 81.05% coverage at alpha=0.01; 87.3% coverage at alpha=0.05; 97.07% coverage at alpha=0.5. Report alpha = 0.3235.

Constituent: Molybdenum, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric

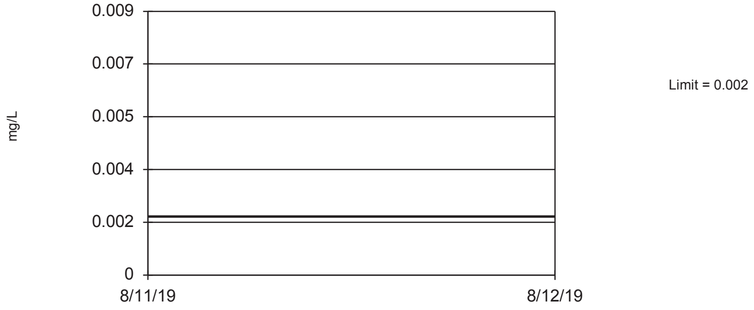
Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 73.08% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Selenium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 24 background values. 75% NDs. 82.62% coverage at alpha=0.01; 88.09% coverage at alpha=0.05; 97.07% coverage at alpha=0.5. Report alpha = 0.292.

Constituent: Thallium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

PIRKEY STACKOUT GWPS				
Constituent Name	**MCL**	**CCR-Rule Specified**	**Background Limit**	**GWPS**
Antimony, Total (mg/L)	0.006		0.005	0.006
Arsenic, Total (mg/L)	0.01		0.006	0.01
Barium, Total (mg/L)	2		0.051	2
Beryllium, Total (mg/L)	0.004		0.002	0.004
Cadmium, Total (mg/L)	0.005		0.001	0.005
Chromium, Total (mg/L)	0.1		0.002	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.056	0.056
Combined Radium, Total (pCi/L)	5		2.94	5
Fluoride, Total (mg/L)	4		1	4
Lead, Total (mg/L)	0.015		0.005	0.015
Lithium, Total (mg/L)	n/a	0.04	0.17	0.17
Mercury, Total (mg/L)	0.002		0.000025	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.005	0.1
Selenium, Total (mg/L)	0.05		0.005	0.05
Thallium, Total (mg/L)	0.002		0.002	0.002

**Grey cell indicates ACL is higher than MCL.*

**MCL = Maximum Contaminant Level*

**GWPS = Groundwater Protection Standard*

Confidence Intervals - All Results (No Significant Results)

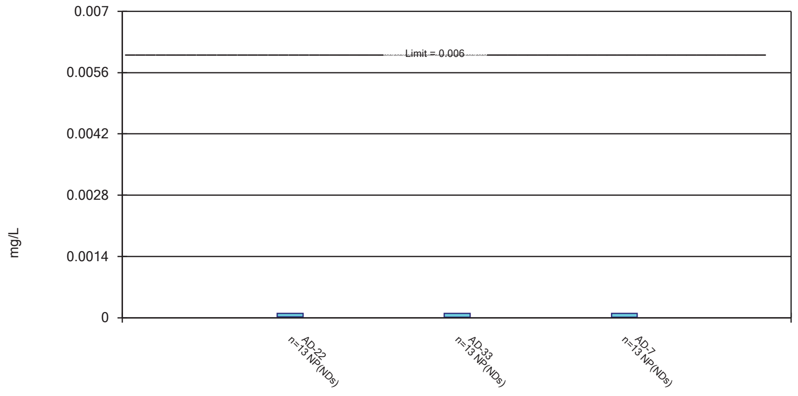
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 4:00 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	AD-22	0.0001	0.00002	0.006	No	13	0.00009385	0.00002219	92.31	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-33	0.0001	0.00001	0.006	No	13	0.00009308	0.00002496	92.31	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-7	0.0001	0.00001	0.006	No	13	0.00009308	0.00002496	92.31	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-22	0.0119	0.003558	0.01	No	13	0.008725	0.007096	0	None	ln(x)	0.01	Param.
Arsenic, total (mg/L)	AD-33	0.002226	0.0007882	0.01	No	12	0.001759	0.001185	16.67	Kaplan-...	ln(x)	0.01	Param.
Arsenic, total (mg/L)	AD-7	0.00212	0.00064	0.01	No	13	0.001606	0.000583	46.15	None	No	0.01	NP (normality)
Barium, total (mg/L)	AD-22	0.06983	0.02348	2	No	13	0.05145	0.03652	0	None	ln(x)	0.01	Param.
Barium, total (mg/L)	AD-33	0.059	0.04908	2	No	12	0.05355	0.007029	0	None	x^4	0.01	Param.
Barium, total (mg/L)	AD-7	0.05491	0.04271	2	No	13	0.04881	0.008201	0	None	No	0.01	Param.
Beryllium, total (mg/L)	AD-33	0.002	0.000905	0.004	No	13	0.001408	0.0008662	0	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-22	0.001419	0.0005284	0.005	No	13	0.001051	0.0006467	0	None	ln(x)	0.01	Param.
Cadmium, total (mg/L)	AD-33	0.001	0.00015	0.005	No	13	0.0007857	0.0004051	69.23	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-7	0.0008453	0.0006926	0.005	No	13	0.0007716	0.0001049	0	None	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-22	0.006766	0.0005802	0.1	No	13	0.007602	0.009954	23.08	Kaplan-...	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-33	0.003782	0.0004179	0.1	No	12	0.003324	0.002412	25	Kaplan-...	sqrt(x)	0.01	Param.
Chromium, total (mg/L)	AD-7	0.0005141	0.0001399	0.1	No	13	0.001829	0.001811	38.46	Kaplan-...	ln(x)	0.01	Param.
Cobalt, total (mg/L)	AD-33	0.01095	0.008577	0.056	No	12	0.009762	0.001509	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-22	5.243	3.065	5	No	13	4.266	1.616	0	None	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-33	3.871	1.394	5	No	13	2.945	2.369	0	None	ln(x)	0.01	Param.
Fluoride, total (mg/L)	AD-22	0.9636	0.3593	4	No	15	0.8634	0.3438	40	Kaplan-...	x^2	0.01	Param.
Fluoride, total (mg/L)	AD-33	1	0.25	4	No	14	0.7641	0.3458	64.29	None	No	0.01	NP (normality)
Fluoride, total (mg/L)	AD-7	1	0.5	4	No	14	0.8172	0.2657	64.29	None	No	0.01	NP (normality)
Lead, total (mg/L)	AD-22	0.00273	0.000386	0.015	No	13	0.001583	0.0008065	53.85	None	No	0.01	NP (normality)
Lead, total (mg/L)	AD-33	0.002	0.000151	0.015	No	12	0.001688	0.0007297	83.33	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-7	0.002	0.000529	0.015	No	13	0.001592	0.0006531	69.23	None	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-22	0.2166	0.1302	0.17	No	13	0.1776	0.06412	0	None	ln(x)	0.01	Param.
Lithium, total (mg/L)	AD-33	0.029	0.0178	0.17	No	13	0.02515	0.01008	7.692	None	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-7	0.1054	0.09375	0.17	No	13	0.09663	0.01678	0	None	x^6	0.01	Param.
Mercury, total (mg/L)	AD-22	0.005651	0.0003861	0.002	No	9	0.003167	0.003618	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-33	0.0007483	0.0002828	0.002	No	13	0.0005656	0.0004313	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-7	0.0002192	0.00007226	0.002	No	13	0.0001458	0.00009883	0	None	No	0.01	Param.
Molybdenum, total (mg/L)	AD-22	0.002	0.002	0.1	No	11	0.001825	0.0005819	90.91	None	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-33	0.002	0.002	0.1	No	11	0.001885	0.000381	90.91	None	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-7	0.002	0.002	0.1	No	12	0.002	0	100	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-22	0.0059	0.001866	0.05	No	12	0.003778	0.001715	50	None	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-33	0.005	0.0011	0.05	No	13	0.003724	0.001742	61.54	None	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-7	0.0071	0.001047	0.05	No	13	0.004142	0.001857	61.54	None	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-22	0.0009472	0.0002236	0.002	No	12	0.0005724	0.0003552	50	Kaplan-...	x^(1/3)	0.01	Param.
Thallium, total (mg/L)	AD-33	0.001192	0.00005	0.002	No	12	0.0006091	0.0003905	75	None	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-7	0.001032	0.0002	0.002	No	12	0.0004926	0.0002079	75	None	No	0.01	NP (normality)

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

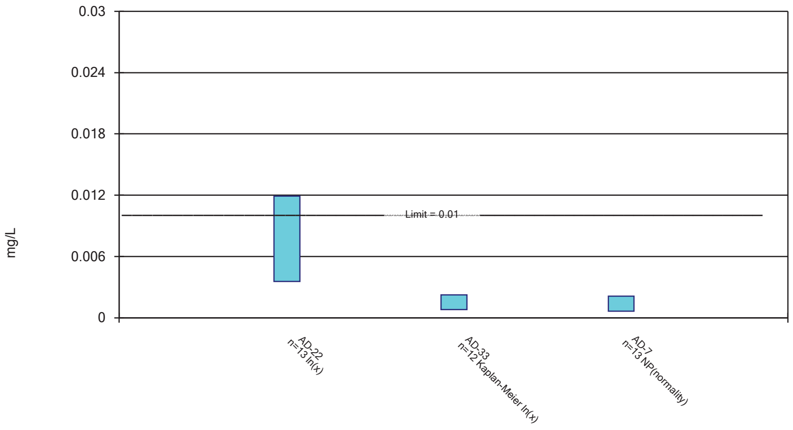


Constituent: Antimony, total   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

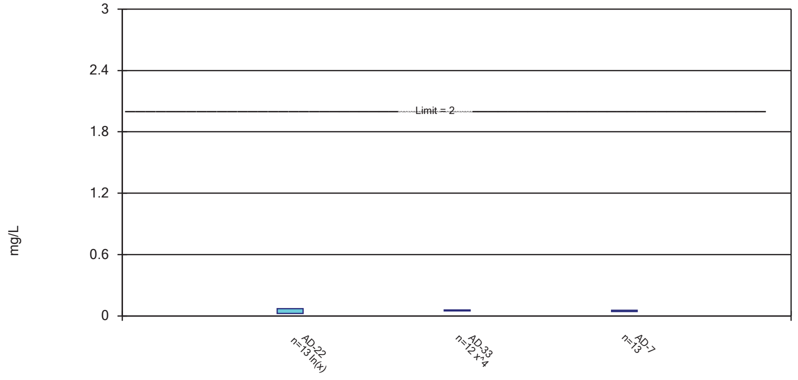


Constituent: Arsenic, total   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

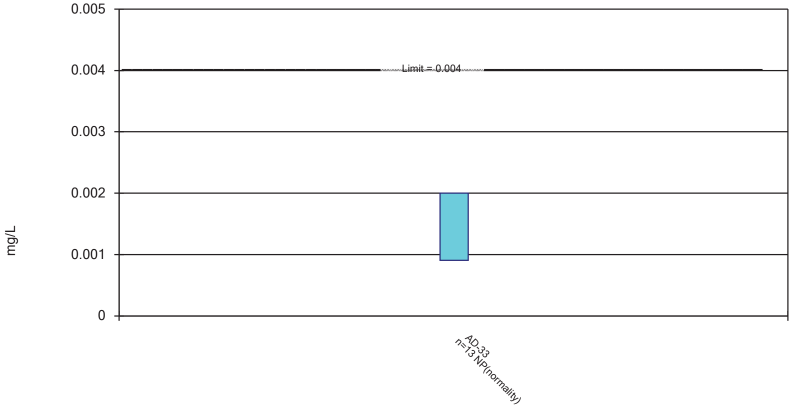


Constituent: Barium, total   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.

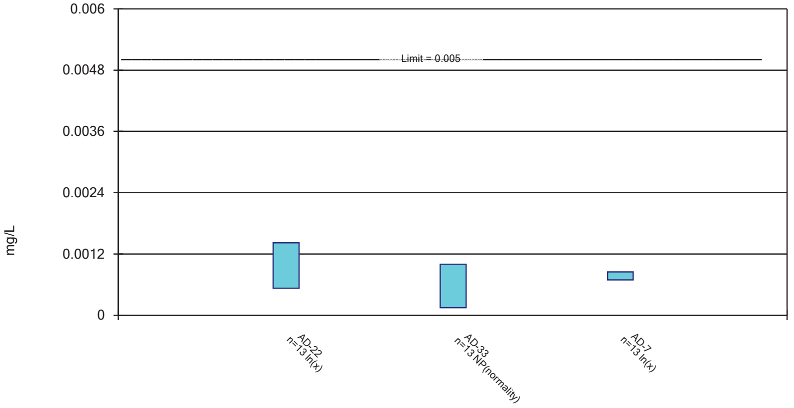


Constituent: Beryllium, total   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

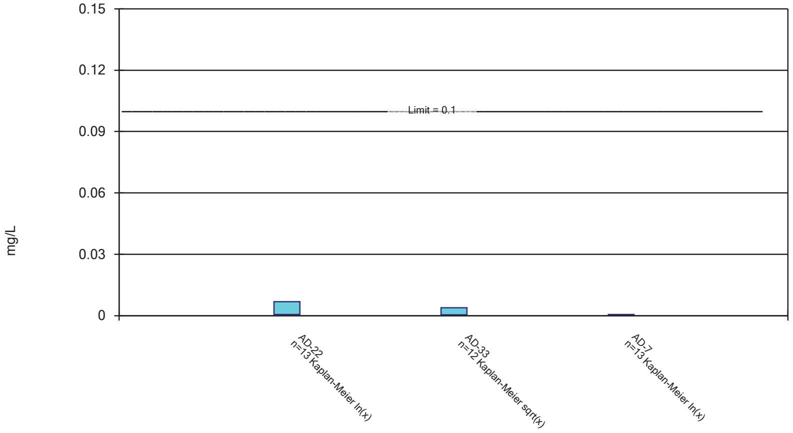


Constituent: Cadmium, total   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

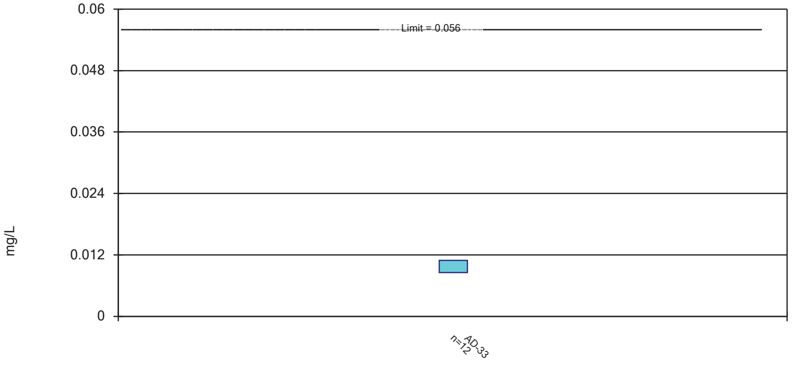


Constituent: Chromium, total   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

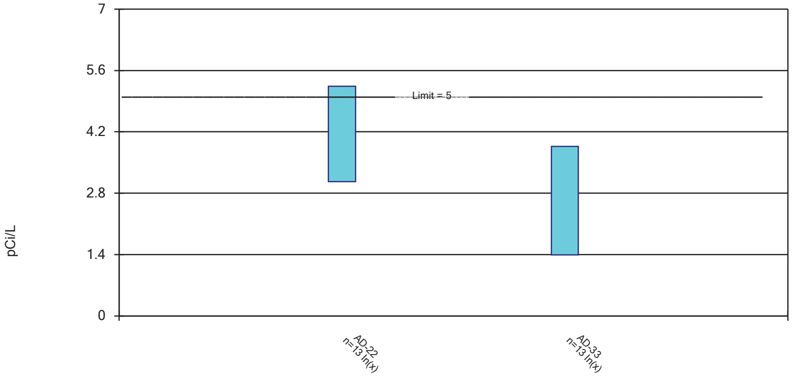


Constituent: Cobalt, total   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

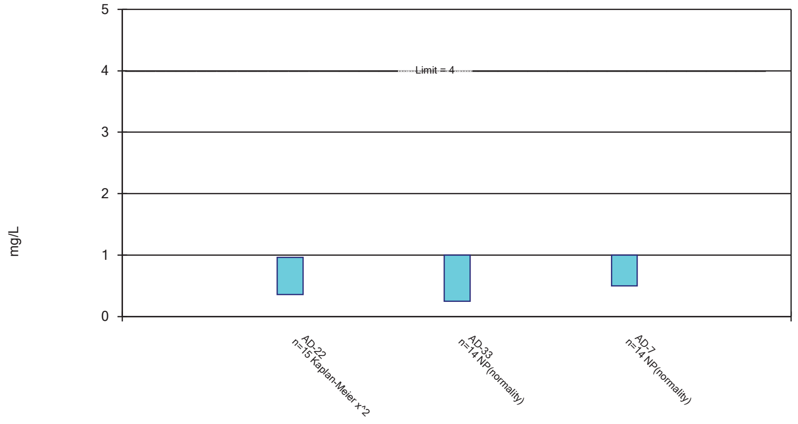


Constituent: Combined Radium 226 + 228   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV
Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



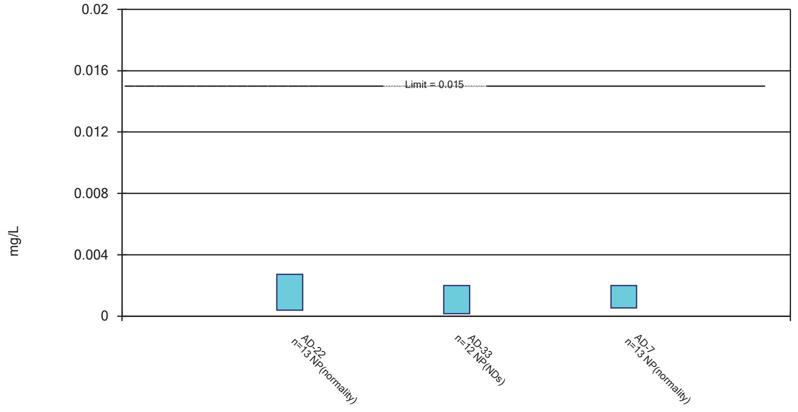
Constituent: Fluoride, total   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



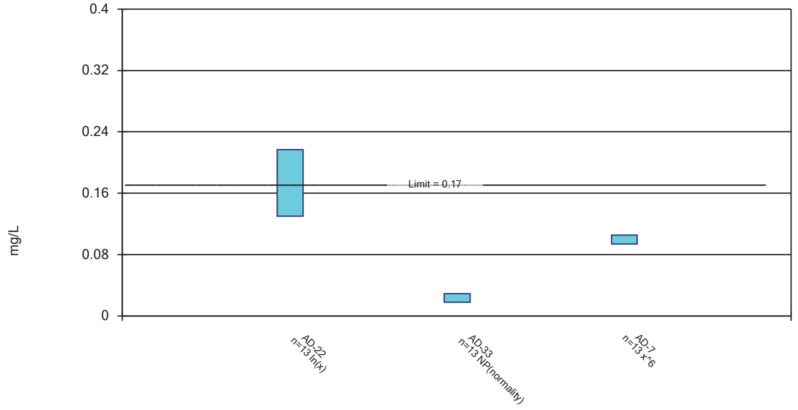
Constituent: Lead, total   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



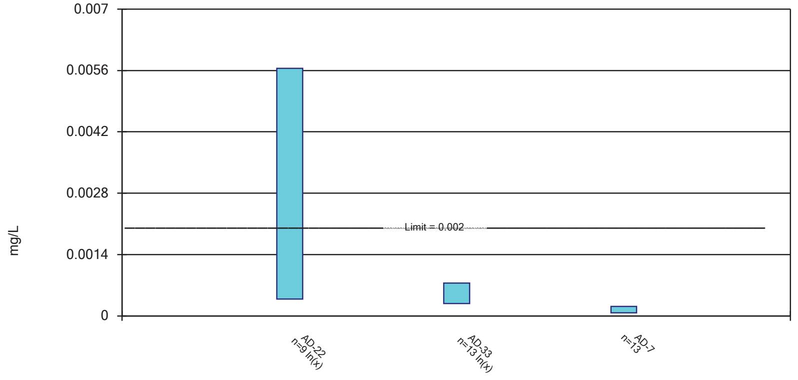
Constituent: Lithium, total   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



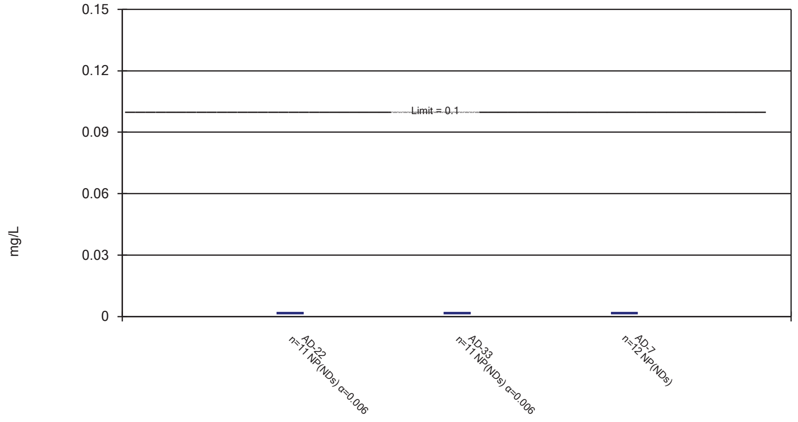
Constituent: Mercury, total   Analysis Run 12/9/2019 3:59 PM   View: Appendix IV

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted.



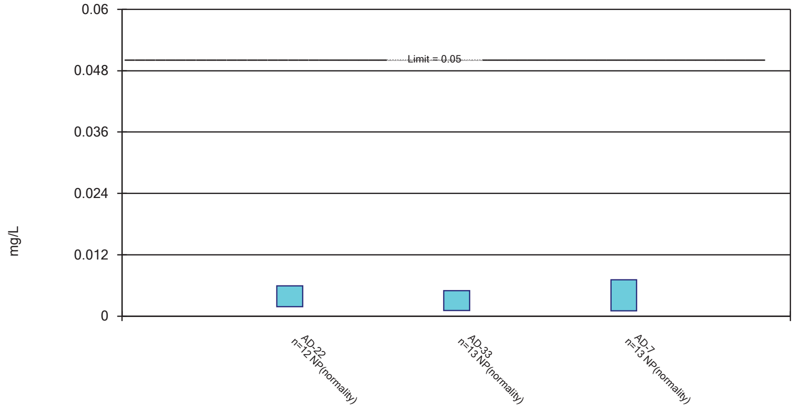
Constituent: Molybdenum, total   Analysis Run 12/9/2019 4:00 PM   View: Appendix IV

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01.



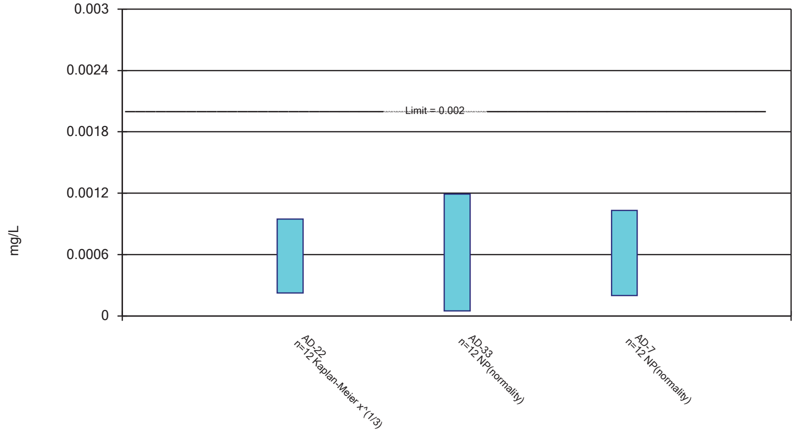
Constituent: Selenium, total   Analysis Run 12/9/2019 4:00 PM   View: Appendix IV

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Thallium, total   Analysis Run 12/9/2019 4:00 PM   View: Appendix IV

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Deseasonalized Confidence Intervals - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 3:57 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.009355**	**0.006032**	**0.004**	**Yes**	**13**	**0.007429**	**0.002706**	**0**	**None**	**x^2**	**0.01**	**Param.**
Beryllium, total (mg/L)	**AD-7**	**0.005761**	**0.004471**	**0.004**	**Yes**	**13**	**0.005046**	**0.0009302**	**0**	**None**	**x^3**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-22**	**0.09829**	**0.07274**	**0.056**	**Yes**	**13**	**0.08234**	**0.02336**	**0**	**None**	**x^3**	**0.01**	**Param.**

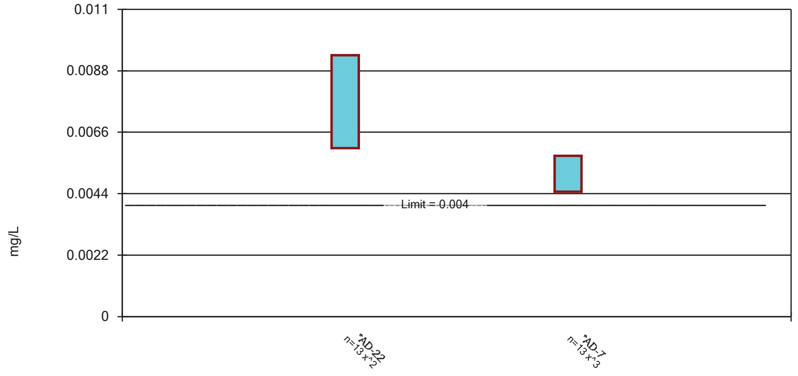
Deseasonalized Confidence Intervals - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 3:56 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.009355**	**0.006032**	**0.004**	**Yes**	**13**	**0.007429**	**0.002706**	**0**	**None**	**x^2**	**0.01**	**Param.**
Beryllium, total (mg/L)	**AD-7**	**0.005761**	**0.004471**	**0.004**	**Yes**	**13**	**0.005046**	**0.0009302**	**0**	**None**	**x^3**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-22**	**0.09829**	**0.07274**	**0.056**	**Yes**	**13**	**0.08234**	**0.02336**	**0**	**None**	**x^3**	**0.01**	**Param.**
Cobalt, total (mg/L)	AD-7	0.03833	0.03041	0.056	No	13	0.0342	0.005454	0	None	x^2	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-7	4.162	3.027	5	No	13	3.487	0.9136	0	None	x^3	0.01	Param.

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

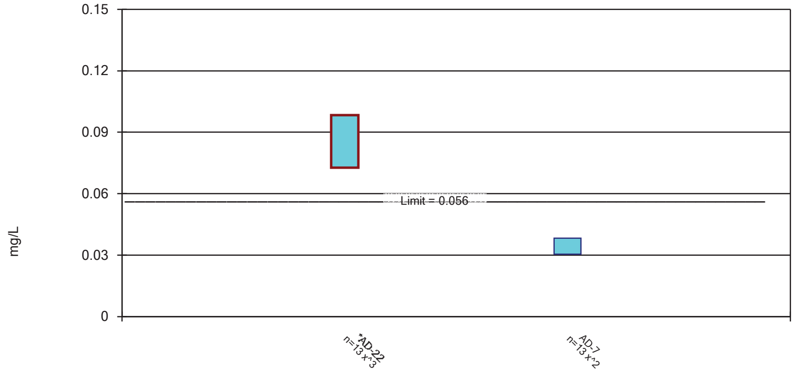


Constituent: Beryllium, total, Alt. Values Analysis Run 12/9/2019 3:55 PM View: Appendix IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

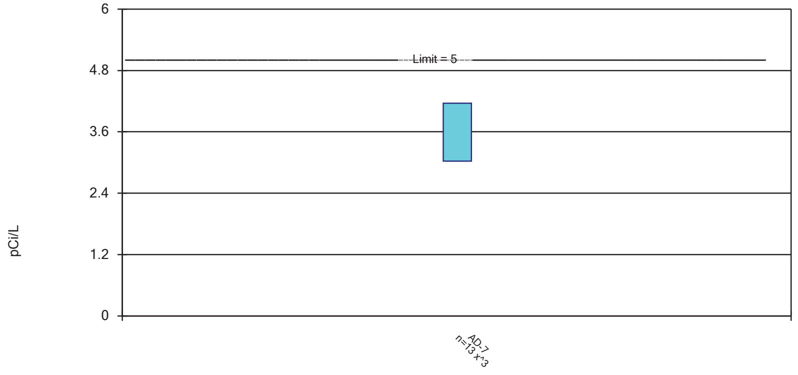


Constituent: Cobalt, total, Alt. Values Analysis Run 12/9/2019 3:55 PM View: Appendix IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228, Alt. Values Analysis Run 12/9/2019 3:55 PM View: Appendix I

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

February 14, 2019

CHA8473

TABLE OF CONTENTS

FIGURES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FGD	Flue Gas Desulfurization
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

In 2018, two assessment monitoring events were conducted at the FGD Stackout Area at the H.W. Pirkey Plant in accordance with 40 CFR 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or regional screening level (RSL). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). An SSL was identified for mercury at AD-22 at the FGD Stackout Area (Geosyntec, 2018).

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for mercury at AD-22 should not be attributed to the Pirkey FGD Stackout Area.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSL identified for mercury at AD-22 was based on a Type III cause at AD-22 and not by a release from the Pirkey FGD Stackout Area.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSL identified for mercury and the proposed alternative source are described below.

2.1 Proposed Alternative Source

Initial review of site geochemistry, site historical data, and laboratory QA/QC data did not identify ASDs due to a Type I (sampling causes) or Type II (laboratory causes) issue. As described below, the SSL was attributed to a statistical evaluation cause, which is a Type III issue.

A review of mercury results at AD-22 suggests that mercury concentrations have decreased at AD-22 over time (Figure 1). As indicated by the Unified Guidance (USEPA, 2009), collecting "data over time and successively re-computing confidence limits is appropriate for stable (i.e., stationary) populations", but "can give misleading or false results when the underlying population is changing". In such cases, Section 7.4.4 of the Unified Guidance recommends the following:

> *An important preliminary step is to track the individual compliance point measurements on a time series plot. If a discrete shift in concentration level is evident, a confidence limit should be computed on the most recent stable measurements. Limiting the observations in this fashion to a specific time period is often termed a 'moving window.' The reduction in sample size will often be more than offset by the gain in statistical power. More recent measurements may exhibit less variation around the shifted mean value, resulting in a shorter confidence interval. The sample size included in the moving window should be sufficient to achieve the desired statistical power…However, measurements that are clearly unrepresentative of the newly shifted distribution should not be included, even if the sample size suffers.*

Based on the above recommendations, the mercury results at AD-22 were visually inspected on a time series plot and were tested for statistically significant trends via Mann-Kendall analysis. While the Mann-Kendall analysis indicated no significant increasing or decreasing trend ($\alpha = 0.02$) using all of the data, decreasing concentrations over time were observed on the time series plot (Figure 1). As a result, the statistical evaluation was limited to the "moving window" of the seven most recent data points (i.e., results collected from October 2016 onward), which were observed to exhibit similar behavior in terms of trend, average concentration, and variance. A confidence interval was calculated using this truncated dataset. The calculated LCL for mercury at AD-22 is 0.22 µg/L ($\alpha = 0.008$), which is below the GWPS for mercury of 2 µg/L. This confidence limit is considered more representative of current conditions at AD-22, and therefore there is no SSL for mercury at AD-22. The results of the statistical tests are included as Appendix A.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSL is not due to a release from the Pirkey FGD Stackout Area, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of mercury for AD-22 identified during assessment monitoring in 2018 was not due to a release from the Pirkey FGD Stackout Area. The identified SSL was, instead, attributed to an error in the statistical evaluation. Therefore, no further action is warranted, and the Pirkey FGD Stackout Area will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

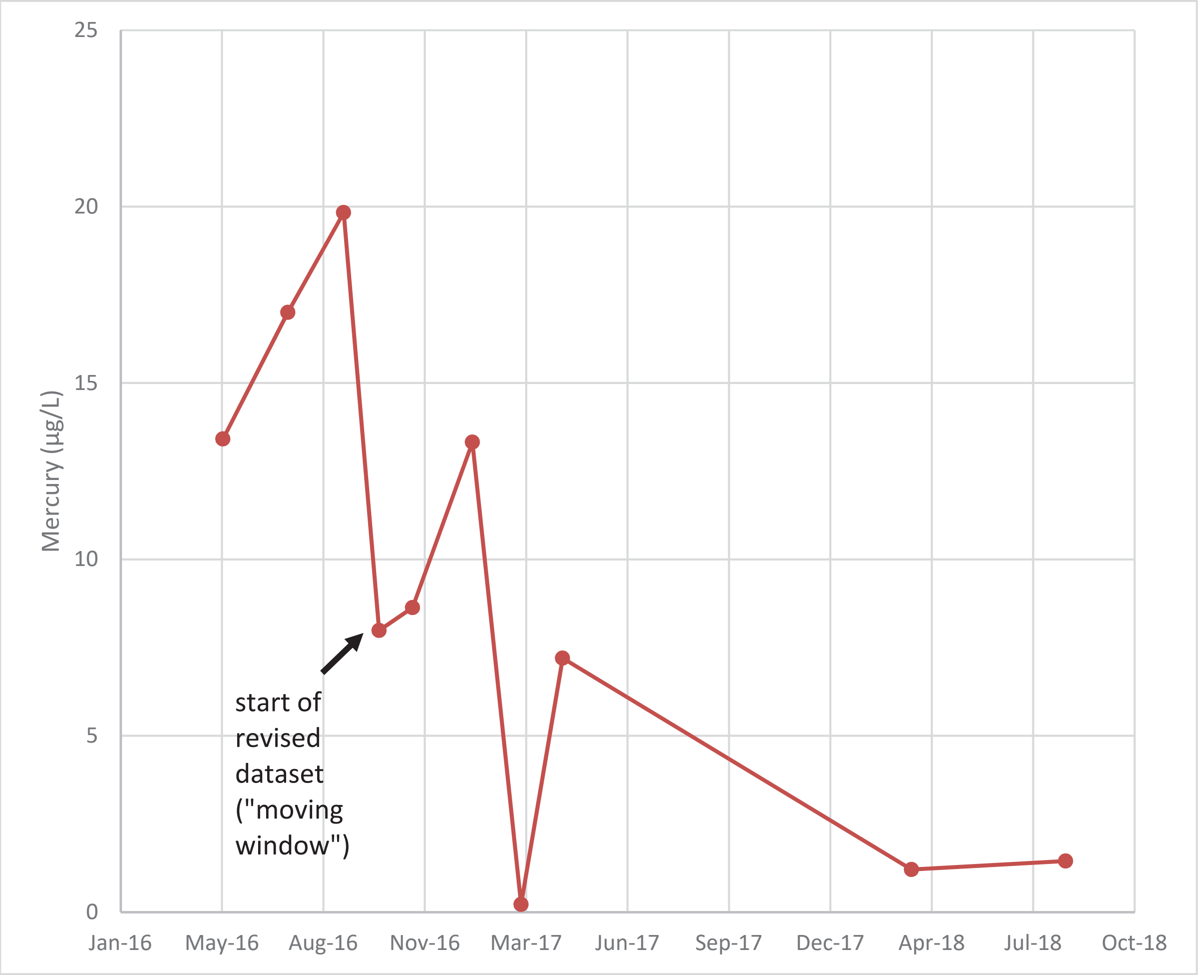
REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.

Geosyntec Consultants, 2018. Statistical Analysis Summary – H.W. Pirkey Power Plant. Hallsville, Texas. December.

United States Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.



Notes: The dataset was truncated to all values after October 2016 based on similar behavior in terms of trend, average, concentration, and variance.

Mercury Time Series Graph for AD-22

Pirkey FGD Stackout Pad

Geosyntec consultants

AMERICAN ELECTRIC POWER

Columbus, Ohio

14-Feb-2019

Figure

1

internal info: path, date revised, author

ATTACHMENT A

Statistical Analysis Output

Trend Test Summary Table

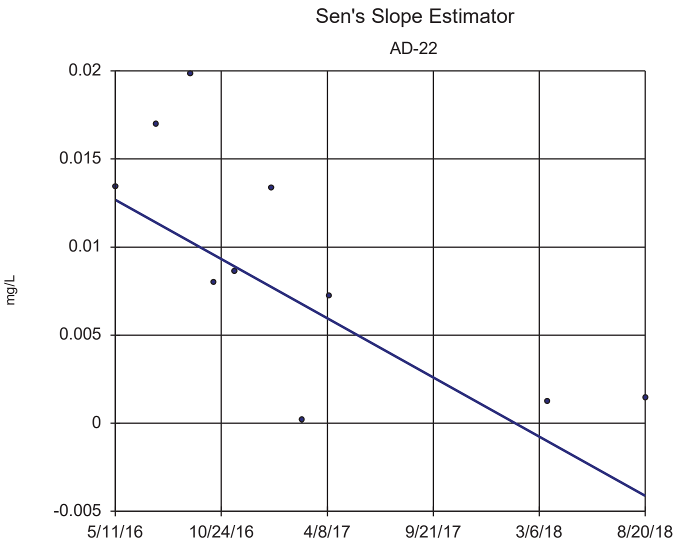
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 2/5/2019, 8:16 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Mercury, total (mg/L)	AD-22	-0.00738	-25	-27	No	10	0	n/a	n/a	0.02	NP

Confidence Interval Summary Table

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout   Printed 2/5/2019, 8:16 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Mercury, total (mg/L)	AD-22	0.01332	0.00022	0.002	No	7	0	No	0.008	NP (selected)



n = 10

Slope = -0.00738 units per year.

Mann-Kendall statistic = -25 critical = -27

Trend not significant at 98% confidence level (α = 0.01 per tail).

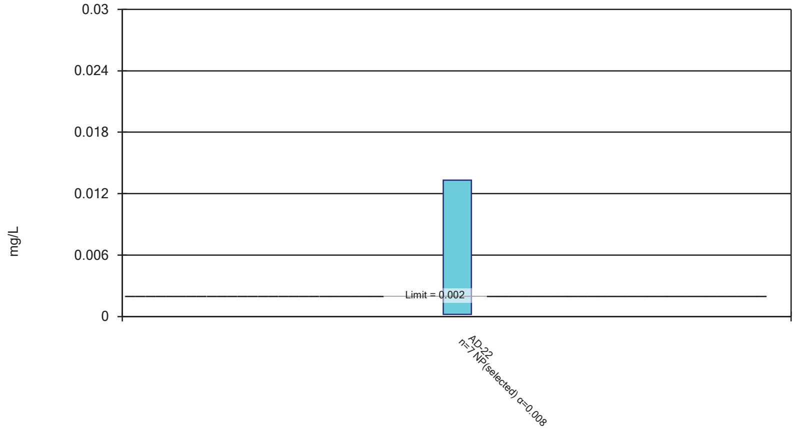
Constituent: Mercury, total   Analysis Run 2/5/2019 12:58 PM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

Sanitas™ v.9.6.12 Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



Normality testing disabled.

Constituent: Mercury, total   Analysis Run 2/5/2019 8:15 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

ATTACHMENT B

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD Stackout Area CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

BETH ANN GROSS
79864

Geosyntec Consultants
8217 Shoal Creek Blvd , Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No F-1182

79864	Texas	February 18, 2019
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area Hallsville, Texas

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October 3, 2019

CHA8462

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FIGURES

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LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
FGD	Flue Gas Desulfurization
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the Flue Gas Desulfurization (FGD) Stackout Area (Figure 1). In February 2019, a semi-annual assessment monitoring event was conducted at the FGD Stackout Area in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were previously established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether these parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). At the FGD Stackout Area, an SSL was identified for beryllium at AD-22, where the LCL of 0.00413 milligrams per liter (mg/L) was above the calculated GWPS of 0.00400 mg/L (Geosyntec, 2019). No other SSLs were identified.

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for beryllium at AD-22 should not be attributed to the FGD Stackout Area.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSL identified for beryllium at AD-22 was based on a Type IV cause and not by a release from the Pirkey FGD Stackout Area.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSL identified for beryllium and the proposed alternative source are described below.

2.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSL has been attributed to natural variation associated with the seasonal effects, which is a Type IV issue.

As shown in Figure 2, beryllium concentrations at AD-22 appear to correlate with groundwater elevations in the well. These changes approximately correspond to annual cycles, with higher beryllium concentrations occurring in early spring and lower concentrations in early fall. EPRI guidance suggests evaluating major ion chemistry to assess if natural variability is due to seasonal change (EPRI, 2017). As shown in a Schoeller diagram in Figure 3, concentrations of almost all major ions tends to be higher in the early spring, with declining concentrations later in the year. A Kruskal-Wallis test, in which non-parametric analysis of variance testing for differences between seasons is completed, was performed to evaluate seasonality. The Kruskal-Wallis test found significant results at the 5% significance level (Attachment A).

Additional evidence shows that the beryllium concentration at AD-22 is correlated with seasonal changes in other constituents, including lithium and calcium (Figure 4). The correlation between beryllium and both monovalent (lithium) and divalent (calcium) cations suggests that the increases in beryllium concentration are related to cation exchange phenomenon in the native soil.

A review of the boring log for AD-22 shows that clay is present from 0.5 to 12 feet below ground surface (ft bgs), which corresponds to elevations of 343 to 354.5 feet above mean sea level (ft amsl) (Attachment B). Groundwater elevations during the background monitoring period fluctuated between approximately 344 and 351 ft amsl, resulting in variation in the amount of the clay that was in contact with groundwater. At higher groundwater elevations, more clay material is in contact with groundwater, allowing greater desorption of cations from the cation exchange sites on the clay. As shown in Figure 2, higher groundwater elevations correlated with higher beryllium concentrations.

A groundwater sample was collected from AD-22 and then passed through a 1.5-micron filter. The solid material retained on the filter was submitted for analysis of total metals and by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS).

The SEM/EDS analysis showed that the solid material separated from groundwater was composed of abundant clay-size particles with mainly aluminum and silicon identified in the EDS output (Attachment C). The presence of these clay particles provides evidence to support the hypothesis that elevated beryllium is due to desorption from the cation exchange sites on the clays.

The exceedance for beryllium at AD-22 was attributed to the effects of seasonal groundwater elevation changes, and the resulting cation exchange between groundwater and the confining clay above the aquifer material, on groundwater quality. Additionally, the lack of other Appendix IV exceedances and the marginal difference between the LCL for AD-22 and the GWPS provides additional evidence that the beryllium exceedance should not be attributed to the FGD Stackout Area.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSL is not due to a release from the Pirkey FGD Stackout Area, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of beryllium at AD-22 identified during assessment monitoring in February 2019 was not due to a release from the FGD Stackout Area. The identified SSL was, instead, attributed to seasonal effects on groundwater quality, which is an effect of natural variation. Therefore, no further action is warranted, and the Pirkey FGD Stackout Area will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment D.

SECTION 4

REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.

Geosyntec Consultants, 2019. Statistical Analysis Summary, FGD Stackout Area. H.W. Pirkey Power Plant. Hallsville, Texas. July.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

FIGURES

Monitoring Well Network

⊕ Downgradient Sampling Location

⊕ Upgradient Sampling Locatoin

▭ FGD Stackout Pad

Notes

- Monitoring well coordinates and water level data provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.

500 250 0 500
Feet

Site Layout
FGD Stackout Area

AEP Pirkey Power Plant Hallsville, Texas

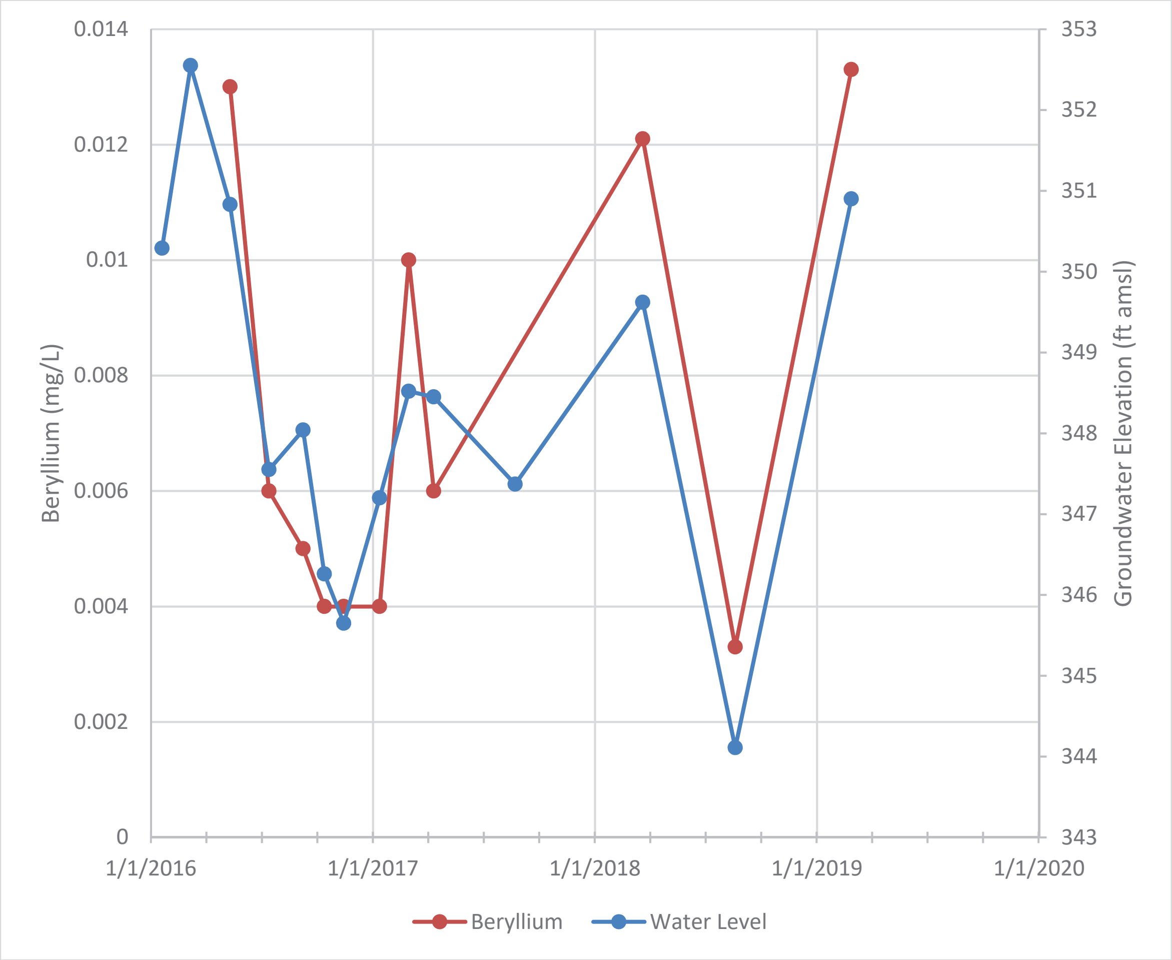
Geosyntec
consultants

Columbus, Ohio | 2018/01/26

Figure

1

C:\Users\mmuenich\Documents\local_projects\AEP_GIS\Pirkey\MXDs\AEP-Pirkey_Stacker_Site_Layout.mxd. MMuenich. 1/26/2018. Project/Phase/Task.



Notes: Beryllium concentrations are shown in milligrams per liter (mg/L). Groundwater elevation is shown as feet above mean sea level (ft amsl).

Beryllium v. Groundwater Elevation

Pirkey FGD Stackout Pad

Geosyntec consultants

AMERICAN ELECTRIC POWER

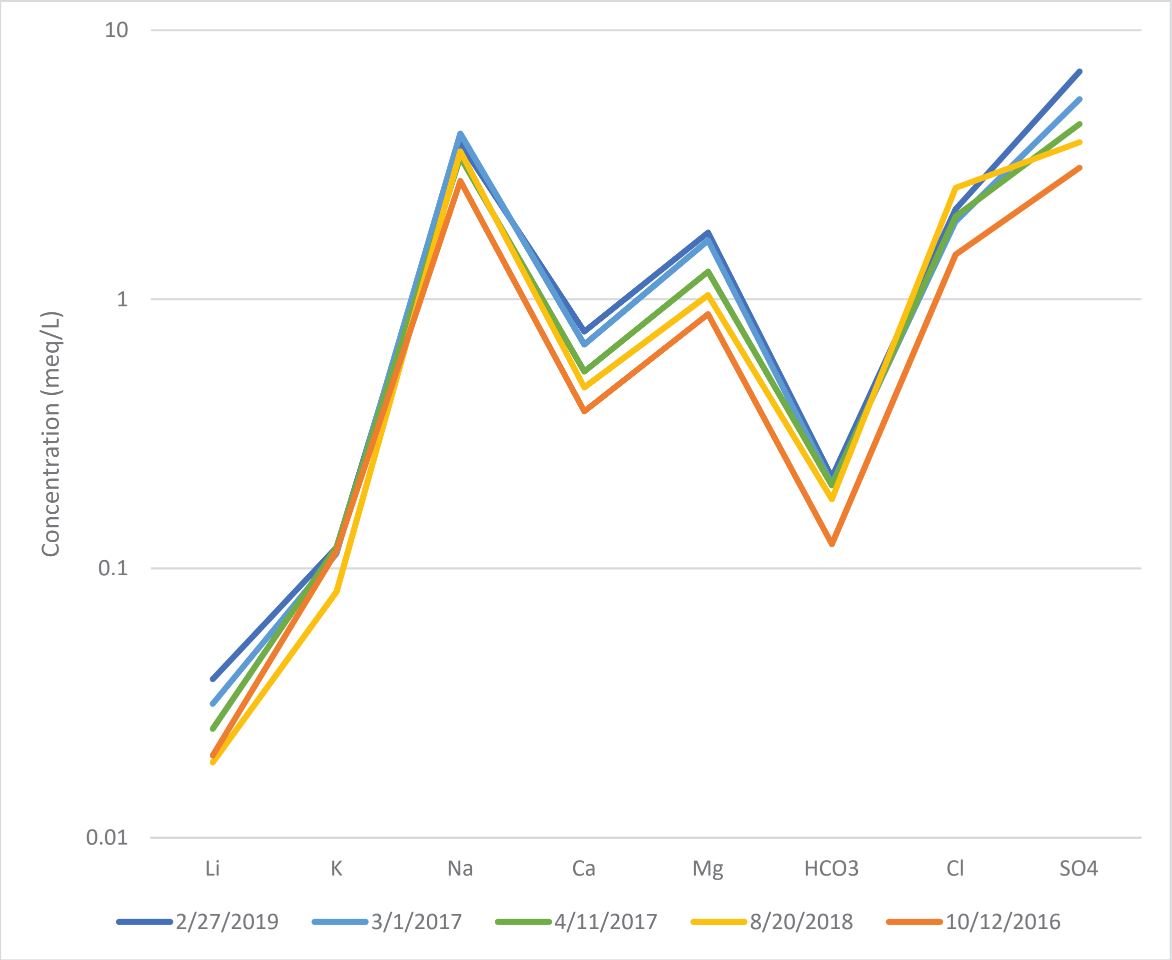
Columbus, Ohio

23-Sep-2019

Figure

2

internal info: path, date revised, author



Notes: Concentrations are shown in milliequivalents per liter (meq/L).

AD-22 Schoeller Diagram

Pirkey FGD Stackout Pad

Geosyntec consultants

AMERICAN ELECTRIC POWER

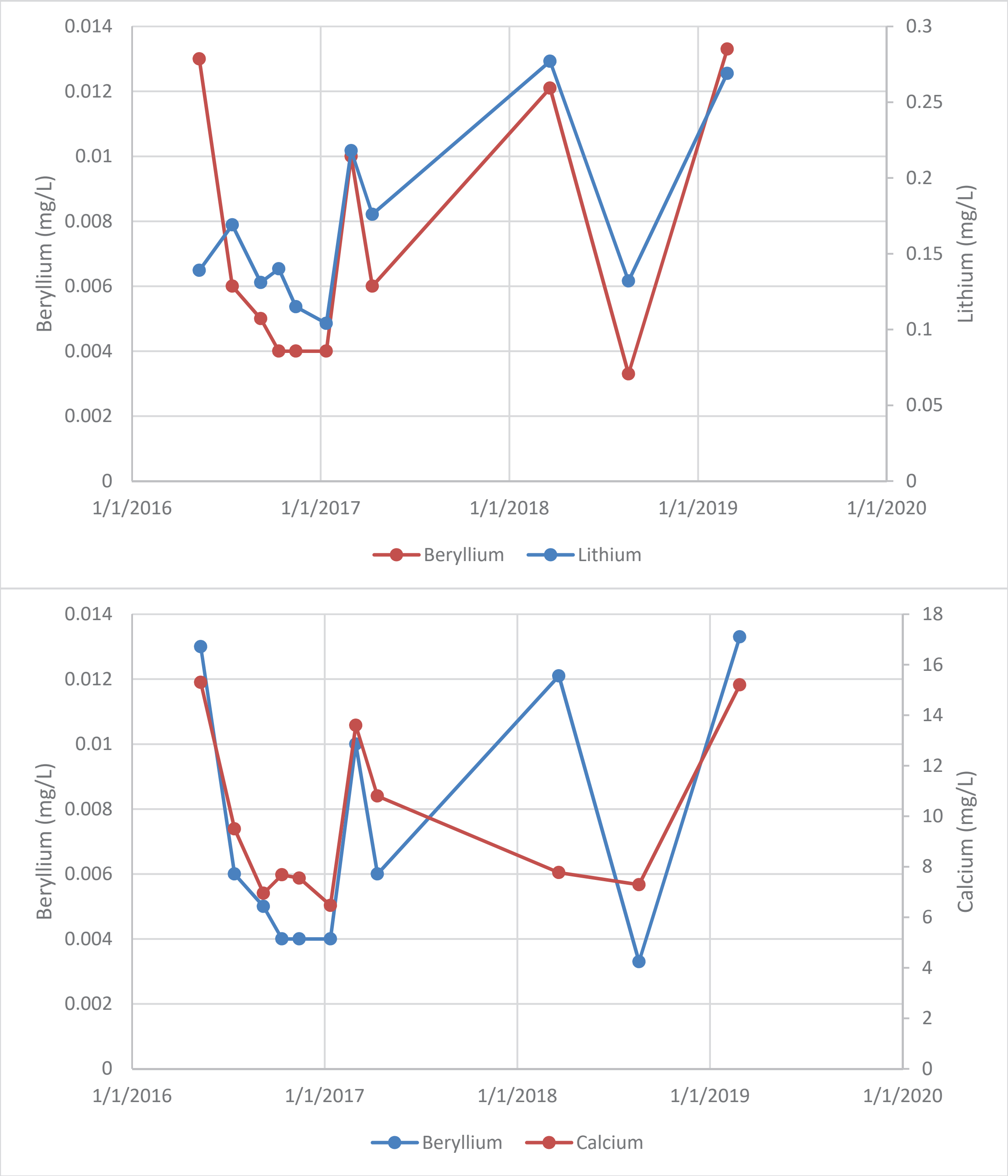
Columbus, Ohio

23-Sep-2019

Figure

3

internal info: path, date revised, author



Notes: Beryllium, lithium, and calcium concentrations are shown in milligrams per liter (mg/L).

Beryllium v. Cations

Pirkey FGD Stackout Pad

Geosyntec consultants

AMERICAN ELECTRIC POWER

Columbus, Ohio

23-Sep-2019

Figure

4

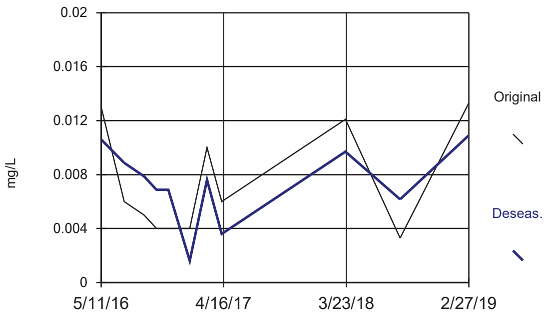
internal info: path, date revised, author

ATTACHMENT A

Statistical Evaluation - Seasonality at AD-22

Seasonality: AD-22

For the selected data, the Kruskal-Wallis test indicates SEASONALITYat the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one season has a significantly different median concentration of this constituent than any other season.
Calculated Kruskal-Wallis statistic = 4.511
Tabulated Chi-Squared value = 3.841 with 1 degrees of freedom at the 5% significance level.
There were 2 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.
Kruskal-Wallis statistic (H) = 4.408
Adjusted Kruskal-Wallis statistic (H') = 4.511



Constituent: Beryllium, total   Analysis Run 9/22/2019 7:11 AM

Pirkey Stackout   Client: Geosyntec   Data: Pirkey Stackout

ATTACHMENT B

AD-22 Boring Log

☐ BORING ■ MONITOR WELL

APEX PROJECT NO.: 110-089 **BORING NUMBER:** **MONITOR WELL NUMBER:** AD-22

FACILITY NAME: AEP- Pirkey Power Plant **FACILITY ID NO.:** N/A

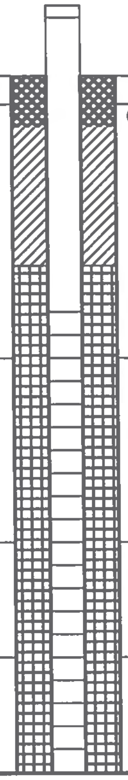
FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. **COMPLETION DATE:** 12/16/2010

PREPARED BY: David Bedford **LOGGED BY:** David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 **WELL LOCATION:** Triangle- South side Quansit Hut
LONGITUDE: W94°29'41.3"



DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SC	Clayey sand, light brown, very fine grained	None	Moist
2 3 4 5 6 7 8 9 10 11 12			0.5-12	CL	Lean clay, light brown mottled with light gray Few iron ore (small) pebbles in clayey sandy streaks	None	Slightly Moist
13 14 15 16 17 18 19 20			▽ 12-20	SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained Slightly wet @ 12.5' from seepage Large amount of iron ore 15-17' Very firm 18-18.5'	None	Slightly Wet
21 22 23 24 25			20-25	SC	(Dense crystalline rock 21-21.1'), light brown clayey sand, greenish black, mica, black clay streaks, very fine grained, wet @ 20'	None	Wet
26 27 28 29 30			25-30	SM	Sand, greenish brown (1') grading to orangish brown, silty, very fine grained	None	Wet
31 32 33 34 35 36 37 38 39 40					Boring Terminated at 30'		

▩ Cement ▨ Bentonite ▦ Filter Sand ▽ Water Level

Apex
geoscience inc.

Total Depth: 30 feet
Filter Sand (Size/Interval): 8-30'
Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8'
Surface Completion ☐ Flush ■ Above Ground

Riser Interval: +3 (ags)-10'
Screen Interval: 10-30'
Water level: 12.5'
Above Ground 3'

Note: This log is not to be used separate from this report.

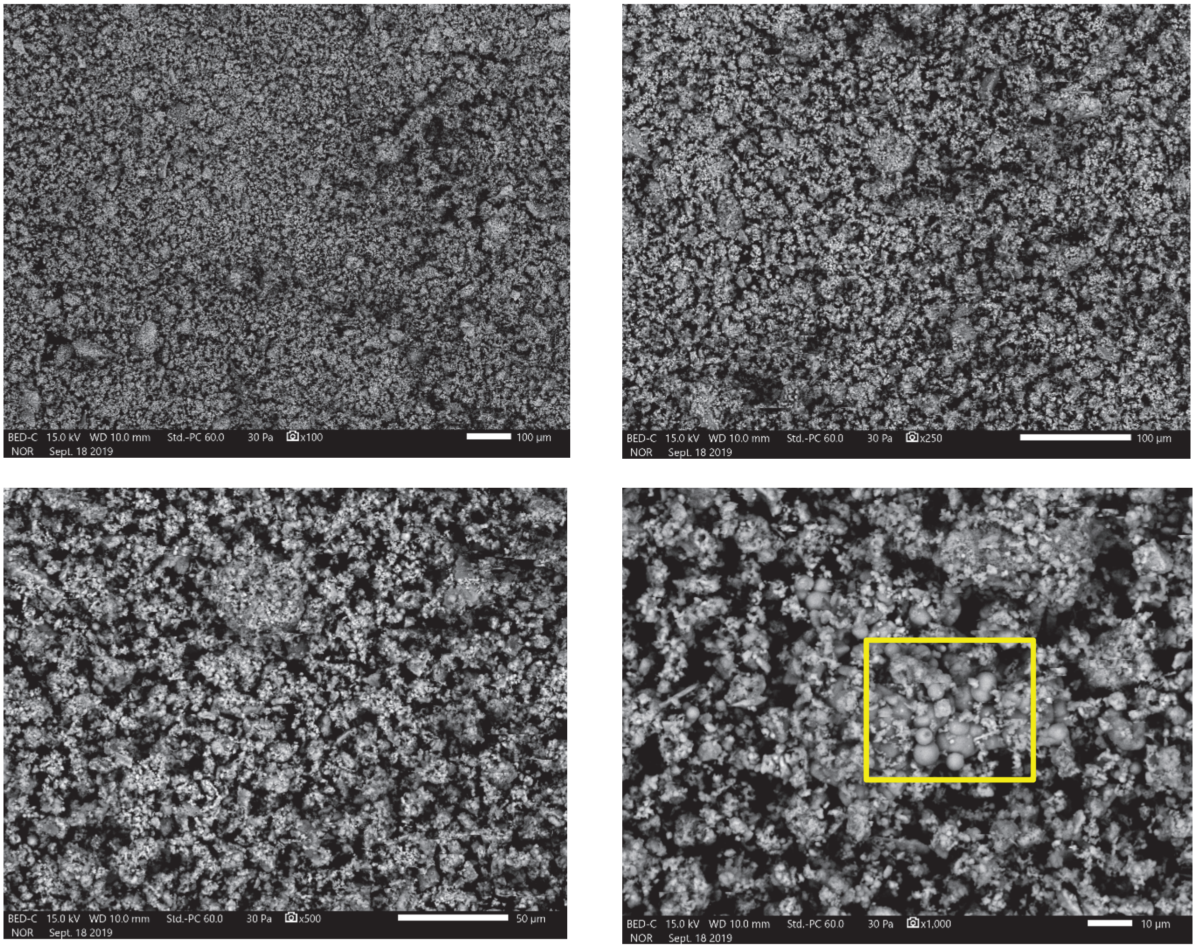
ATTACHMENT C

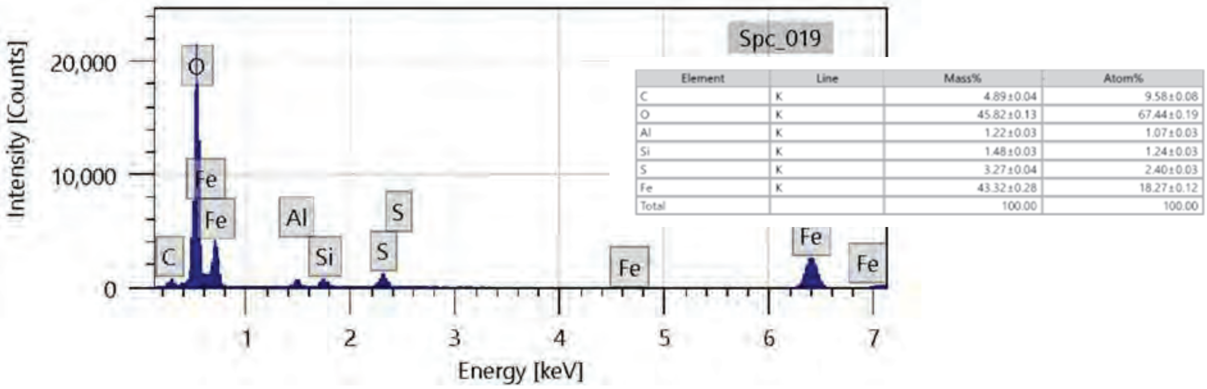
SEM/EDS Analysis

September 22, 2019

Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221

via Email: BSass@geosyntec.com





Element	Line	Mass%	Atom%
C	K	4.89±0.04	9.58±0.08
O	K	45.82±0.13	67.44±0.19
Al	K	1.22±0.03	1.07±0.03
Si	K	1.48±0.03	1.24±0.03
S	K	3.27±0.04	2.40±0.03
Fe	K	43.32±0.28	18.27±0.12
Total		100.00	100.00

Sample AD-22. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 1000 X. EDS spectrum at bottom is an area scan of the region shown in the 1000X micrograph. The analysis is shown on the right. The globular phase appears to consist mainly of iron oxide/hydroxide.

ATTACHMENT D

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD Stackout Area CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

BETH ANN GROSS
79864

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

10/3/2019
Date

APPENDIX IV

Notices of groundwater monitoring program transitions are included in this appendix.

APPENDIX V

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #506035

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 26' 52.08" N**
		Longitude:	**094° 29' 58.82" W**
Well County:	**Harrison**	Elevation:	**No Data**

****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #185184**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/19/2019** Drilling End Date: **2/20/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**60**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
31	**38**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Plug Information:

Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
SAND	**50**	**60**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**clay brown**
1	**5**	**silty sand**
5	**9.5**	**clay**
9.5	**11**	**sand**
11	**32**	**clay**
32	**39**	**sand and clay**
39	**55**	**sand**
55	**60**	**fine sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**40**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**40**	**50**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS PLUGGING REPORT for Tracking #185184

Owner: **H W PIRKEY POWER PLANT**

Owner Well #: **SB10**

Address: **2400 FM 3251**
HALLSVILLE, TX 75650

Grid #: **35-37-4**

Latitude: **32° 26' 52.08" N**

Well Location: **2400 FM 3251**
HALLSVILLE, TX 75650

Longitude: **094° 29' 58.82" W**

LOCATED ON OWNERS PROPERTY

Elevation: **No Data**

Well County: **Harrison**

Well Type: **Monitor**

Drilling Information

Company: **Plains Environmental Services**

Date Drilled: **2/20/2019**

Driller: **Jesse Kalvig**

License Number: **5025**

Well Report Tracking #506035

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Plugging Information

Date Plugged: **2/21/2019**

Plugger: **Jesse Kalvig**

Plug Method: **Pour in 3/8 bentonite chips when standing water in well is less than 100 feet depth, cement top 2 feet**

Casing Left in Well:

DIa (in.)	*Top (ft.)*	*Bottom (ft.)*
2	**15**	**50**

Plug(s) Placed in Well:

Top (ft.)	*Bottom (ft.)*	*Description (number of sacks & material)*
1	**40**	**Bentonite 10 Bags/Sacks**

Certification Data: The driller certified that the driller plugged this well (or the well was plugged under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the reports(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

STATE OF TEXAS WELL REPORT for Tracking #506039

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD37**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 27' 56.32" N**
		Longitude:	**094° 29' 41.78" W**
		Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019**

Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**17**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
1	**10**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**8.5**	**CLAYS WITH SOME SAND**
8.5	**10.5**	**SAND**
10.5	**13**	**CLAY SOME SAND**
13	**15**	**SAND WITH SOME CLAYS**
15	**17**	**CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**12**	**17**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506038

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD38**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 27' 46.12" N**
		Longitude:	**094° 29' 43.34" W**
		Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/21/2019** Drilling End Date: **2/21/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**CLAY RED**
5	**7**	**CLAY GRAY/RED**
7	**11.5**	**SAND/CLAY**
11.5	**17.5**	**SAND SOME CLAYS**
17.5	**18**	**CLAY SLITS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506037

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD39**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650 LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 26' 52.05" N**
		Longitude:	**094° 29' 58.84" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/20/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**12**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
1	**5**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**CLAY**
1	**5**	**CLAY/SAND**
5	**9.5**	**CLAY**
9.5	**12**	**SAND/CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**7**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**7**	**12**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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STATE OF TEXAS WELL REPORT for Tracking #508688

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**AD-40 (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**40**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
27	**40**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**13**	**Cement**
13	**27**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**40**	**red and grey sand with occasional clay intervals**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**30**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**30**	**40**

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Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508686

Owner: **AEP Pirkey Power Plant**

Owner Well #: **SB(MW)-01A**

Address: **2400 FM 3251**
Hallsville, TX 75650

Grid #: **35-37-1**

Well Location: **2400 FM 3251**
Hallsville, TX 75650

Latitude: **32° 28' 03" N**

Longitude: **094° 29' 00.5" W**

Well County: **Harrison**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/9/2019**   Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**100**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
86	**100**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**10**	**Cement**
10	**86**	**Bentonite 17 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**   **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**85**	**red and grey sand with occasional clay intervals**
85	**88**	**grey clay**
88	**100**	**grey sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**90**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**90**	**100**

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508703

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**22**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
8	**22**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**3**	**Cement**
3	**8**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**22**	**red and grey sand w/occ. lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**12**	**22**

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508695

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**80**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
56	**80**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**56**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**36**	**red and grey sand w/occ. lignite layers**
36	**41**	**red and tan clay**
41	**69**	**red and grey sand with occasional clay iand lignite layers**
69	**80**	**grey sandy clay with lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**59**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**59**	**69**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508712

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/24/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**25**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
12	**25**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**12**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**25**	**brown sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**15**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**15**	**25**

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508708

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 deep (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019**

Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
45	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**45**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**28**	**brown sand**
28	**41**	**brown and grey silty clay**
41	**70**	**grey sand with occasional lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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STATE OF TEXAS WELL REPORT for Tracking #506040

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6S**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCAATED ON OWNERS PROPERTY**	Latitude:	**32° 27' 30.34" N**
		Longitude:	**094° 29' 27.76" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**10**	**CLAYS**
10	**18**	**SANDS AND CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506041

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6D**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 27' 30.28" N**
		Longitude:	**094° 29' 27.75" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**65**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
1	**53**	**Bentonite 19 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**10**	**CLAYS**
10	**24**	**SANDS AND CLAYS**
24	**29**	**CLAYS**
29	**42.5**	**SANDS AND CLAYS**
42.5	**48.5**	**SANDS WITH SOME CLAY**
48.5	**56**	**CLAYS WITH SOME SAND**
56	**65**	**SILY SANDS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**55**	**65**

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Texas Department of Licensing and Regulation
P.O. Box 12157
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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508722

Owner: **AEP Pirkey Power Plant**

Address: **2400 FM 3251**
Hallsville, TX 75650

Well Location: **2400 FM 3251**
Hallsville, TX 75650

Well County: **Harrison**

Owner Well #: **SB-7 shallow (MW)**

Grid #: **35-36-6**

Latitude: **32° 27' 27" N**

Longitude: **094° 30' 08" W**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/3/2019** Drilling End Date: **3/3/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	0	45

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
32	45	Sand	16/30

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	12	Cement
12	32	Bentonite 6 Bags/Sacks

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**45**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**35**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**35**	**45**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508720

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
57	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**12**	**Cement**
12	**57**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**70**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**60**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**60**	**70**

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508724

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 shallow (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**35**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**35**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**23**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**35**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**25**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**25**	**35**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508729

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 medium (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
		Latitude:	**32° 27' 10" N**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/27/2019**

Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**65**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
52	**65**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**53**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information:	**Mhc x-ploration corp** **P.O. Box 7405** **Tyler, TX 75711**
Driller Name:	**James K. Collum**
License Number:	**3184**
Apprentice Name:	**Jason Smith**
Apprentice Number:	**60448**
Comments:	**No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**65**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**55**	**65**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508777

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/24/2019**

Drilling End Date: **2/26/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**93**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
77	**93**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**77**	**Bentonite 15 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**90**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**
90	**93**	**gray clay (old pit base?)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**80**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**80**	**90**

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508781

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/5/2019**

Drilling End Date: **3/5/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**30**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
17	**30**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**17**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

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Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508779

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **3/4/2019** Drilling End Date: **3/4/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**60**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
48	**60**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**48**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**60**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508718

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/8/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**15**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**15**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement**
1	**3**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508717

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**　　Proposed Use: **Monitor**

Drilling Start Date: **3/7/2019**　　Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**43**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
30	**43**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**30**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**　　**Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**
License Number: **3184**

Apprentice Name: **Jason Smith**
Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**
18	**43**	**red and grey sand w/occ. clay layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**33**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**33**	**43**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Annual Groundwater Monitoring Report

Southwestern Electric Power Company
H. W. Pirkey Power Plant
Landfill CCR Management Unit
Hallsville, Texas

January 2020

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY℠
An AEP Company
BOUNDLESS ENERGY℠

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I. **Summary**

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2020.

In general, the following activities were completed:

- Groundwater samples were collected for the wells the landfill groundwater monitoring network in February, May, and August 2019 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in Assessment monitoring at the beginning and end of 2019;
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cadmium and cobalt at wells AD-34 on December 26, 2018. Since the Alternate source demonstration was not completed, and assessment of corrective measures was initiated on March 26, 2019. An alternate source for cadmium and cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 22, 2019. As a result, assessment of corrective measure work stopped, and the unit stayed in assessment monitoring;
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt and lithium at wells AD-34 on July 11, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 24, 2019;
- An alternate source for the statistically significant increases (SSI) over background that caused this unit to transition to assessment monitoring was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on January 7, 2020. As a result, the unit is returning to detection monitoring;
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in Appendix I;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations (Appendix IV).
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

Landfill Monitoring Wells	
Up Gradient	Down Gradient
AD-8	AD-23
AD-12	AD-34
AD-16	AD-35 (decommissioned)
AD-27	AD-36 (installed 2019)

III. Monitoring Wells Installed or Decommissioned

There was one monitoring well (AD-36) installed in 2019 to replace AD-35 that was plugged in 2018. The well installation report can be found in Appendix V. The AD-35 was in the footprint of a new cell for the landfill. The network design has been updated, as summarized in the *Groundwater Monitoring System Design and Construction Certification Report*.

Several monitoring wells were installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry in mine spoils. Please see a list below.

Soil Boring ID	Monitor Well ID
	AD-37
	AD-38
	AD-39
	AD-40
SB-01A	AD-41
SB-04	AD-42
SB-04	AD-43
SB-05	AD-44
SB-05	AD-45
SB-06	AD-46
SB-06	AD-47
SB-07	AD-48
SB-07	AD-49
SB-08	AD-50
SB-08	AD-52
SB-08	AD-53
SB-09	AD-54
SB-09	AD-55
SB-11	AD-56
SB-11	AD-57

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event also are shown in Appendix I, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., one round of sampling was conducted in February from wells AD-8, AD-12, AD-16, AD-23, AD-27, and AD-34 in accordance with 40 CFR 257.95(d)(1). A May sampling event from wells AD-8, AD-12, AD-16, AD-23, AD-27, and AD-34 was conducted in accordance with 40 CFR 257.95(b) including all

Appendix III parameters and those Appendix IV constituents parameters. Wells AD-8, AD-12, AD-16, AD-23, AD-27, AD-34, and AD-36 were sampled in August in accordance with 40 CFR 257.95(d)(1). Detection monitoring will continue in 2020.

V. Statistical Evaluation of 2019 Events

The one statistical analysis report available for this reporting period is included in Appendix II.

Statistically significant levels (SSLs) above the groundwater protection standard were identified for lithium and cobalt at AD-34 as summarized in *Statistical Analysis Summary Landfill Report* on July 11, 2019 in Appendix II.

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the cadmium and cobalt SSLs above the GWPS at AD-34. An alternate source for cadmium and cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 22, 2019. As a result, assessment of corrective measure work stopped, and the unit stayed in assessment monitoring;

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for cobalt and lithium at wells AD-34 on July 11, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on September 24, 2019.

An alternate source for the statistically significant increases (SSI) over background that caused to unit to transition to assessment monitoring was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on January 7, 2020. As a result, the unit is returning to detection monitoring.

Documentation supporting these findings are found in Appendix III.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

On April 3, 2018, no alternate source was found for SSIs over background, so the unit transitioned to assessment monitoring. On December 26, 2019, SSLs above GWPS were identified. On March 26, 2019, no alternate sources were identified for the unit, so it transitioned into assessment of corrective measures. On April 22, 2019, an alternate source was identified, so the unit did not continue assessment of corrective measures work and remained in assessment monitoring.

On January 7, 2020, an alternate source was found for the SSIs determined for boron, total dissolved solids (TDS), and sulfate as summarized in *Groundwater Monitoring Statistical Evaluation Report* (1/3/2018), so the unit returned to detection monitoring.

Detection monitoring will continue in 2020.

Regarding defining an alternate monitoring frequency, no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

No other information applies at this time.

IX. Description of Any Problems Encountered in 2019 and Actions Taken

No problems were encountered this year.

X. A Projection of Key Activities for the Upcoming Year

Key activities for 2020 include:

- Detection monitoring sampling will be conducted;
- Evaluation of the detection monitoring results from a statistical analysis viewpoint, looking for any SSIs over background;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the fourth annual groundwater report.

APPENDIX I

Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
February 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2020/01/16

Figure
1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer
May 2019

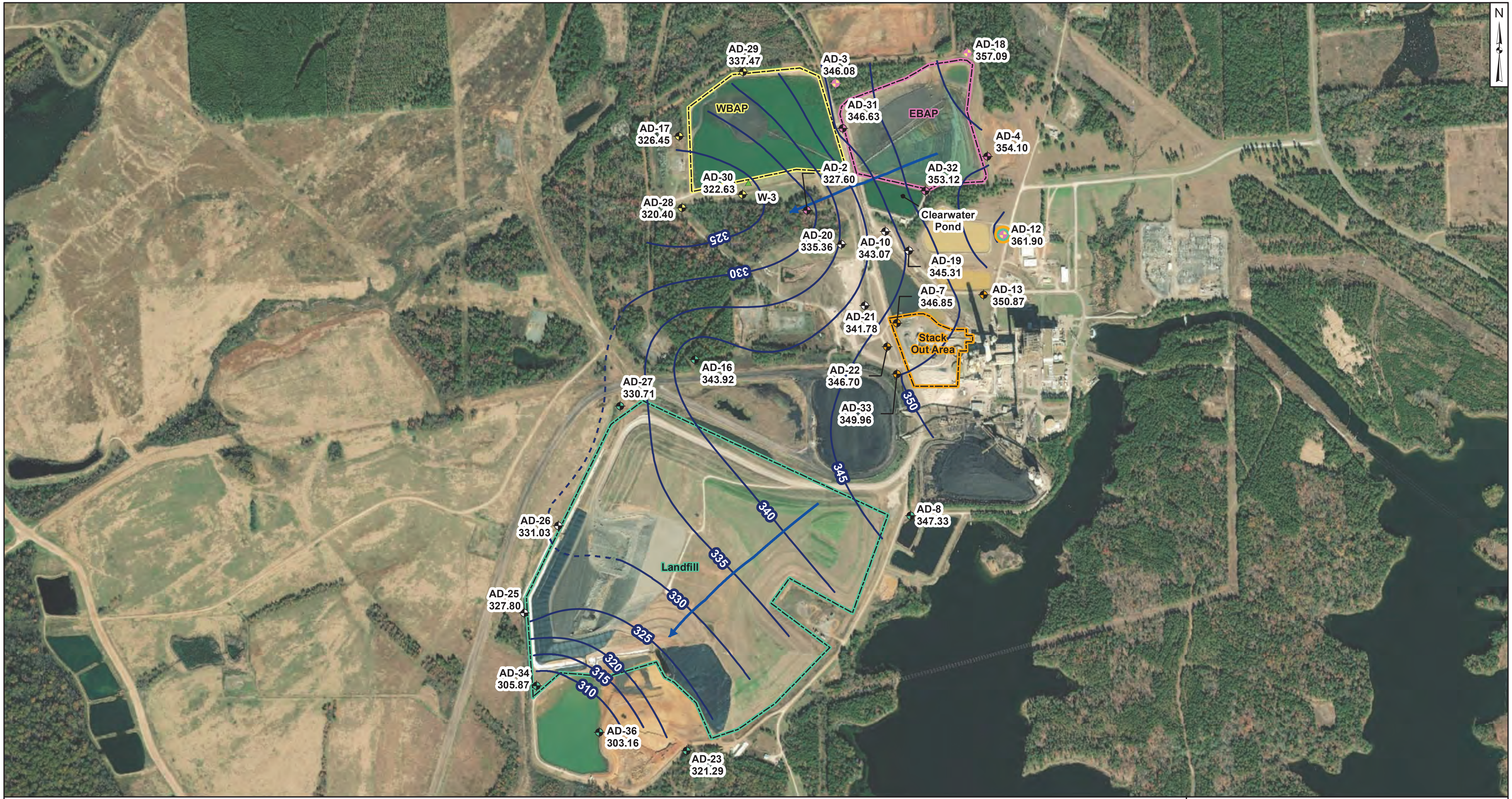
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
2

Columbus, Ohio
2020/01/16

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201905-May.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

- ◆ Out of Network
- ◆ EBAP
- ◆ WBAP
- ◆ Landfill
- ◆ Stackout Area
- ◆ EBAP and WBAP
- ◎ All CCR Unit Networks
- ▲ Piezometer
- → Approximate Groundwater Flow Direction
- — Groundwater Elevation Contour
- - - Groundwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000
Feet

Potentiometric Contours - Uppermost Aquifer August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2020/01/16

Figure
3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201908-August.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Table 1: Residence Time Calculation Summary
Pirkey Landfill

			2019-02		2019-05		2019-08	
CCR Management Unit	Monitoring Well	Well Diameter (inches)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
Landfill	AD-8 [1]	4.0	10.4	11.7	6.6	18.5	6.8	17.8
	AD-12 [1]	4.0	34.2	3.6	35.0	3.5	21.4	5.7
	AD-16 [1]	2.0	26.4	2.3	28.3	2.2	22.6	2.7
	AD-23 [2]	2.0	10.8	5.6	10.3	5.9	10.9	5.6
	AD-27 [1]	2.0	19.4	3.1	18.4	3.3	16.7	3.6
	AD-34 [2]	2.0	32.3	1.9	33.6	1.8	28.5	2.1
	AD-36 [2]	2.0	NC	NC	NC	NC	34.4	1.8

Notes:
[1] - Background Well
[2] - Downgradient Well

Table 1 - Groundwater Data Summary: AD-8
Pirkey - Landfill
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	1.58	109	9	<0.083 U	6.1	432	181
7/13/2016	Background	0.775	20.7	13	2	6.2	280	131
9/8/2016	Background	1.04	50.7	12	2	5.1	285	121
10/12/2016	Background	0.793	20.8	13	2	3.7	276	184
11/15/2016	Background	0.769	17.2	13	3	3.7	296	208
1/11/2017	Background	0.734	18.6	13	3	3.6	280	228
2/28/2017	Background	0.777	18.1	10	2	3.7	250	157
4/11/2017	Background	0.779	17.1	12	3	3.9	284	168
8/23/2017	Detection	0.411	19.4	9	0.587 J	3.9	110	56
3/21/2018	Assessment	1.03	56.1	8	1.1987	5.7	278	140
8/20/2018	Assessment	0.714	14.5	18	5.1991	3.7	300	168
2/28/2019	Assessment	1.05	103	6.83	0.40	5.7	462	175
5/21/2019	Assessment	1.11	85.5	4.48	0.33	5.9	296	127
8/13/2019	Assessment	0.818	27.6	12.7	3.39	4.6	260	128

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-8
Pirkey - Landfill
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	<1.05 U	38	1	<0.07 U	1	1.80288 J	0.9155	<0.083 U	1.02541 J	<0.00013 U	0.027	<0.29 U	15	1.19926 J
7/13/2016	Background	<0.93 U	1.16508 J	61	7	0.175996 J	1	20	6.75	2	1.46729 J	0.032	0.211	<0.29 U	<0.99 U	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	48	2	<0.07 U	0.835837 J	9	1.658	2	<0.68 U	0.018	0.048	<0.29 U	3.84567 J	<0.86 U
10/12/2016	Background	<0.93 U	1.46586 J	61	6	<0.07 U	0.74214 J	18	6.72	2	2.30733 J	0.032	0.112	<0.29 U	2.51464 J	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	52	6	0.118693 J	0.805286 J	18	6.14	3	2.85553 J	0.03	0.16	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	1.53134 J	60	6	0.108717 J	2	18	6.29	3	2.99592 J	0.032	0.157	<0.29 U	1.4083 J	<0.86 U
2/28/2017	Background	<0.93 U	1.68597 J	52	6	0.13889 J	0.633257 J	18	7.64	2	3.26919 J	0.031	0.153	<0.29 U	1.78549 J	<0.86 U
4/11/2017	Background	<0.93 U	<1.05 U	51	6	0.128137 J	0.887504 J	19	5.56	3	2.44168 J	0.031	0.01068 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	37.9	2.57	<0.07 U	<0.23 U	9.38	2.499	1.1987	0.95 J	0.01503	0.049	<0.29 U	27.68	<0.86 U
8/20/2018	Assessment	0.02 J	4.05	33.4	4.55	0.18	0.759	15.9	0.145	5.1991	4.46	0.0221	0.105	0.02 J	9.8	0.083
2/28/2019	Assessment	<0.4 U	<0.6 U	46.8	<0.4 U	<0.2 U	<0.8 U	0.8 J	1.066	0.40	<0.4 U	0.002 J	<0.005 U	<8 U	30.8	<2 U
5/21/2019	Assessment	<0.4 U	1 J	42.8	1 J	<0.2 U	<0.8 U	<0.4 U	1.786	0.33	<0.4 U	0.0003 J	0.009 J	<8 U	23.9	<0.1 U
8/13/2019	Assessment	0.03 J	2.13	44.1	4.05	0.16	0.368	12.7	3.77	3.39	1.31	0.0255	0.059	<0.4 U	7.5	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - Landfill
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	<0.083 U	4.4	94	4
7/13/2016	Background	0.03	0.26	6	<0.083 U	3.1	75	4
9/7/2016	Background	0.04	0.343	6	<0.083 U	3.9	63	7
10/12/2016	Background	0.03	0.271	7	< 1 U	3.4	92	8
11/14/2016	Background	0.04	0.331	8	<0.083 U	2.6	80	6
1/11/2017	Background	0.03	0.315	7	<0.083 U	4.8	76	6
2/28/2017	Background	0.04	0.434	5	<0.083 U	3.6	50	4
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	72	7
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	52	6
3/21/2018	Assessment	0.01397	0.269	5	<0.083 U	4.2	<2 U	3
8/20/2018	Assessment	0.017	0.338	10	<0.083 U	4.4	94	4
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	36	3.6
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	80	4.0
8/12/2019	Assessment	<0.02 U	0.278	7.24	0.06 J	4.9	90	2.6

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - Landfill
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	26	0.219521 J	<0.07 U	0.710981 J	1.58207 J	0.2073	<0.083 U	<0.68 U	<0.00013 U	<0.005 U	<0.29 U	1.73953 J	<0.86 U
7/13/2016	Background	<0.93 U	<1.05 U	23	0.190337 J	<0.07 U	0.68835 J	1.29444 J	2.909	<0.083 U	<0.68 U	0.008	<0.005 U	<0.29 U	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	30	0.232192 J	<0.07 U	0.353544 J	1.66591 J	0.881	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	<1.05 U	27	0.149553 J	<0.07 U	0.529033 J	1.56632 J	0.257	< 1 U	<0.68 U	0.012	<0.005 U	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	28	0.152375 J	<0.07 U	0.32826 J	1.47282 J	0.767	<0.083 U	<0.68 U	0.013	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	23	0.126621 J	<0.07 U	0.650158 J	1.09495 J	1.536	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	26	0.149219 J	<0.07 U	0.325811 J	1.29984 J	0.416	<0.083 U	<0.68 U	0.009	<0.005 U	<0.29 U	<0.99 U	0.994913 J
4/11/2017	Background	<0.93 U	<1.05 U	24	0.159412 J	<0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	<0.68 U	0.008	0.01364 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	25.82	0.16 J	<0.07 U	1.05	1.49 J	0.784	<0.083 U	<0.68 U	0.00722	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	<0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	<0.083 U	0.089	0.0143	<0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	<0.4 U	<0.6 U	22.5	<0.4 U	<0.2 U	<0.8 U	1.37	0.225	0.09	<0.4 U	0.00688	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	<0.6 U	21.7	<0.4 U	<0.2 U	<0.8 U	1.15	0.201	0.09	<0.4 U	0.00576	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.07 J	23.8	0.154	<0.01 U	0.204	1.3	0.237	0.06 J	0.08 J	0.00829	<0.005 U	<0.4 U	0.2 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-16
Pirkey - Landfill
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.02	1.21	8	<0.083 U	3.9	116	16
7/14/2016	Background	0.03	2	9	<0.083 U	3.8	148	45
9/8/2016	Background	0.03	1.83	9	<0.083 U	3.9	133	33
10/13/2016	Background	0.03	1.15	9	<0.083 U	3.9	124	16
11/14/2016	Background	0.03	1.58	9	<0.083 U	4.4	124	23
1/12/2017	Background	0.02	1.76	10	<0.083 U	3.7	112	43
3/1/2017	Background	0.03	1.29	9	<0.083 U	3.2	108	22
4/10/2017	Background	0.02	1.21	11	<0.083 U	3.4	106	24
8/24/2017	Detection	0.03648	0.945	12	<0.083 U	4.3	96	14
3/22/2018	Assessment	0.0171	1.03	14	<0.083 U	4.0	96	13
8/21/2018	Assessment	0.020	1.17	17	<0.083 U	4.0	128	15
2/27/2019	Assessment	0.03 J	0.704	20.3	0.07 J	4.1	76	17.7
5/23/2019	Assessment	0.022	1.06	20.8	0.06 J	4.6	128	26.9
8/15/2019	Assessment	<0.02 U	0.874	20.0	0.06 J	5.1	110	15.4

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-16
Pirkey - Landfill
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	1.83497 J	61	0.453643 J	0.0817904 J	1	4.23727 J	1.294	<0.083 U	<0.68 U	0.006	0.01506 J	<0.29 U	2.26113 J	1.3697 J
7/14/2016	Background	<0.93 U	<1.05 U	64	0.565692 J	<0.07 U	1	6	1.438	<0.083 U	<0.68 U	0.036	0.02395 J	1.1177 J	<0.99 U	<0.86 U
9/8/2016	Background	8.00	<1.05 U	70	0.810547 J	0.0926258 J	2	8	1.931	<0.083 U	<0.68 U	0.032	0.00753 J	<0.29 U	<0.99 U	1.75243 J
10/13/2016	Background	<0.93 U	1.52475 J	56	0.250902 J	<0.07 U	1	3.33761 J	1.843	<0.083 U	<0.68 U	0.033	<0.005 U	<0.29 U	1.70284 J	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	55	0.38481 J	<0.07 U	0.561291 J	4.34297 J	2.123	<0.083 U	<0.68 U	0.028	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	<1.05 U	58	0.70928 J	<0.07 U	0.406161 J	8	2.629	<0.083 U	<0.68 U	0.031	0.01045 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	1.50766 J	76	0.487946 J	<0.07 U	0.558767 J	5	1.417	<0.083 U	<0.68 U	0.021	<0.005 U	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	77	0.435552 J	<0.07 U	0.822329 J	5	0.932	<0.083 U	<0.68 U	0.019	0.00733 J	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	83.66	0.27 J	<0.07 U	1.59	3.6 J	2.11	<0.083 U	<0.68 U	0.02224	0.018 J	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	0.03 J	0.42	69.0	0.213	0.03	0.211	3.78	1.92	<0.083 U	0.082	0.0347	0.014 J	<0.02 U	0.1	0.051
2/27/2019	Assessment	<0.4 U	7.74	56.2	<0.4 U	<0.2 U	<0.8 U	3.21	0.848	0.07 J	<0.4 U	0.0154	0.011 J	<8 U	<0.6 U	<2 U
5/23/2019	Assessment	<0.4 U	5.80	83.4	<0.4 U	<0.2 U	<0.8 U	3.16	1.957	0.06 J	<0.4 U	0.0227	<0.005 U	<8 U	<0.6 U	<0.1 U
8/15/2019	Assessment	<0.02 U	1.40	80.1	0.203	0.02 J	0.215	2.95	2.108	0.06 J	0.1 J	0.0208	0.024 J	<0.4 U	0.1 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-23
Pirkey - Landfill
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.01	0.535	4	<0.083 U	4.0	72	10
7/13/2016	Background	0.03	0.317	4	<0.083 U	2.7	59	11
9/8/2016	Background	0.02	0.26	5	<0.083 U	3.5	64	12
10/12/2016	Background	0.03	0.321	6	<0.083 U	3.7	68	13
11/15/2016	Background	0.03	0.249	5	<0.083 U	3.5	100	14
1/11/2017	Background	0.02	0.319	6	<0.083 U	3.7	60	13
2/28/2017	Background	0.03	0.217	4	<0.083 U	4.0	48	9
4/11/2017	Background	0.03	0.543	7	0.2688 J	4.2	76	11
8/23/2017	Detection	0.04021	0.276	6	0.198 J	4.1	64	11
12/21/2017	Detection	0.04498	0.469	- -	- -	- -	- -	- -
3/21/2018	Assessment	0.01762	0.227	4	<0.083 U	3.9	72	10
8/20/2018	Assessment	0.017	0.247	9	<0.083 U	3.8	92	11
2/28/2019	Assessment	0.02 J	0.3 J	6.94	0.04 J	5.1	70	7.2
5/23/2019	Assessment	0.017	0.3 J	6.82	0.04 J	4.8	54	9.1
8/13/2019	Assessment	<0.02 U	0.325	7.12	0.03 J	5.0	126	7.4

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-23
Pirkey - Landfill
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	2.89148 J	1.65098 J	48	0.186855 J	0.0739811 J	2	2.29646 J	6.86	<0.083 U	<0.68 U	0.000135818 J	0.01188 J	<0.29 U	1.91991 J	<0.86 U
7/13/2016	Background	3.79558 J	<1.05 U	48	0.192156 J	0.0925427 J	2	2.72879 J	5.69	<0.083 U	<0.68 U	0.006	0.01721 J	1.34973 J	2.00038 J	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	53	0.20435 J	<0.07 U	5	2.01019 J	6.68	<0.083 U	2.23756 J	0.006	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	1.29835 J	7	120	0.463688 J	0.13648 J	41	3.91303 J	12.89	<0.083 U	31	1.01	0.095	0.563586 J	2.10924 J	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	50	0.129296 J	<0.07 U	6	1.66943 J	7.54	<0.083 U	3.21271 J	0.006	0.02438 J	0.403857 J	1.34763 J	<0.86 U
1/11/2017	Background	<0.93 U	2.03681 J	73	0.159 J	<0.07 U	15	2.25934 J	8.06	<0.083 U	11	0.009	0.092	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	1.65681 J	<1.05 U	41	0.116844 J	<0.07 U	0.295768 J	1.05228 J	5.74	<0.083 U	<0.68 U	0.005	<0.005 U	<0.29 U	1.3076 J	<0.86 U
4/11/2017	Background	<0.93 U	3.9673 J	86	0.318917 J	0.107977 J	22	2.60853 J	10.31	0.2688 J	15	0.01	0.118	0.31517 J	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	56.1	0.17 J	<0.07 U	5.7	1.09 J	7.55	<0.083 U	3.52 J	0.00709	0.02 J	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	0.03 J	0.87	53.5	0.147	0.01 J	1.77	0.803	11	<0.083 U	4.79	0.00634	0.025	0.07 J	1.0	0.176
2/28/2019	Assessment	<0.4 U	1 J	46.9	<0.4 U	<0.2 U	4.16	1 J	6.14	0.04 J	3.46	0.00646	0.035	<8 U	1 J	<2 U
5/23/2019	Assessment	<0.4 U	0.7 J	56.4	<0.4 U	<0.2 U	3 J	0.7 J	9.66	0.04 J	8.99	0.00537	0.058 J	<8 U	<0.6 U	0.2 J
8/13/2019	Assessment	<0.02 U	0.67	49.3	0.137	0.01 J	1.25	0.837	7.65	0.03 J	4.65	0.00527	0.039	<0.4 U	0.8	0.1 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-27
Pirkey - Landfill
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.02	4.41	8	0.6176 J	3.9	198	51
7/13/2016	Background	0.03	4.43	8	<0.083 U	2.7	192	54
9/8/2016	Background	0.03	4.17	8	<0.083 U	2.9	196	52
10/12/2016	Background	0.03	4.09	8	<0.083 U	3.0	216	58
11/15/2016	Background	0.03	4.52	8	<0.083 U	3.5	216	92
1/11/2017	Background	0.02	3.74	9	<0.083 U	4.1	180	58
3/1/2017	Background	0.03	4.31	8	<0.083 U	2.8	216	56
4/10/2017	Background	0.03	4.01	9	<0.083 U	3.3	180	54
8/24/2017	Detection	0.0358	3.58	9	0.197 J	3.7	168	52
3/22/2018	Assessment	0.03901	5.58	11	<0.083 U	3.9	192	78
8/21/2018	Assessment	0.024	4.58	10	<0.083 U	3.5	196	65
2/28/2019	Assessment	0.07 J	4.02	11.7	0.20	4.7	42	52.8
5/23/2019	Assessment	0.023	3.89	11.4	0.20	4.4	204	55.2
8/16/2019	Assessment	0.02 J	3.94	10.5	0.18	3.9	198	53.2

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-27
Pirkey - Landfill
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**pCi/L**	**mg/L**	**µg/L**	**mg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**
5/11/2016	Background	1.20808 J	2.15232 J	43	5	0.431235 J	0.87101 J	20	2.031	0.6176 J	<0.68 U	0.066	<0.005 U	<0.29 U	1.10872 J	<0.86 U
7/13/2016	Background	0.956365 J	1.27952 J	45	5	0.434627 J	2	21	2.406	<0.083 U	<0.68 U	0.097	0.02241 J	0.434679 J	<0.99 U	<0.86 U
9/8/2016	Background	<0.93 U	<1.05 U	47	6	0.398469 J	2	20	2.71	<0.083 U	<0.68 U	0.095	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	2.14429 J	46	5	0.424977 J	2	20	4.43	<0.083 U	<0.68 U	0.096	<0.005 U	<0.29 U	1.35863 J	<0.86 U
11/15/2016	Background	<0.93 U	<1.05 U	41	5	0.419182 J	2	22	3.69	<0.083 U	<0.68 U	0.095	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	1.56781 J	46	5	0.30207 J	1	18	2.62	<0.083 U	<0.68 U	0.1	0.00659 J	<0.29 U	<0.99 U	<0.86 U
3/1/2017	Background	<0.93 U	<1.05 U	43	5	0.286804 J	2	21	3.48	<0.083 U	<0.68 U	0.1	<0.005 U	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	45	5	0.414787 J	0.954802 J	21	2.58	<0.083 U	<0.68 U	0.104	<0.005 U	<0.29 U	<0.99 U	<0.86 U
3/22/2018	Assessment	<0.93 U	<1.05 U	40.53	5.29	0.48 J	3.09	25.63	2.808	<0.083 U	<0.68 U	0.108	0.012 J	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	0.02 J	1.71	39.5	4.90	0.46	1.14	24.6	2.619	<0.083 U	0.296	0.0921	0.006 J	0.07 J	3.7	0.137
2/28/2019	Assessment	<0.4 U	1 J	39.5	5.32	0.5 J	<0.8 U	18.9	2.95	0.20	<0.4 U	0.0892	<0.005 U	<8 U	2 J	<2 U
5/23/2019	Assessment	<0.4 U	<0.6 U	41.0	5.22	0.3 J	<0.8 U	19.9	3.93	0.20	<0.4 U	0.0885	<0.005 U	<8 U	0.6 J	0.2 J
8/16/2019	Assessment	<0.02 U	0.71	34.1	4.27	0.39	0.313	19.0	4.69	0.18	0.2 J	0.0897	0.012 J	<0.4 U	1.9	0.1 J

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-34
Pirkey - Landfill
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.08	37.8	7	<0.083 U	4.0	1516	974
7/13/2016	Background	0.111	33.2	8	<0.083 U	3.6	1396	837
9/8/2016	Background	0.09	39.5	8	<0.083 U	3.3	1520	870
10/12/2016	Background	0.09	35.8	7	0.6272 J	3.6	1464	1084
11/15/2016	Background	0.1	36.3	7	0.9978 J	3.7	1428	1006
1/11/2017	Background	0.07	39.9	8	<0.083 U	3.2	1378	1334
2/28/2017	Background	0.08	37	6	<0.083 U	3.7	1402	993
4/10/2017	Background	0.09	38.2	8	0.5241 J	3.0	1490	1016
8/23/2017	Detection	0.107	36.2	7	0.619 J	3.7	1128	1231
12/21/2017	Detection	- -	- -	8	0.6669 J	- -	1260	1020
3/21/2018	Assessment	0.171	40.1	6	<0.083 U	3.7	1424	956
8/20/2018	Assessment	0.067	37.0	10	<0.083 U	3.7	1462	1064
2/27/2019	Assessment	0.08 J	39.9	7.64	0.86	2.9	1470	970
5/21/2019	Assessment	0.060	42.0	7.34	0.69	3.3	1154	1080
8/13/2019	Assessment	0.070	39.8	7.46	1.13	3.7	1648	1060

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-34
Pirkey - Landfill
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	12	72	3	6	34	301	9.64	<0.083 U	12	0.176	0.105	0.688222 J	<0.99 U	<0.86 U
7/13/2016	Background	<0.93 U	25	177	4	6	81	296	7.75	<0.083 U	39	0.183	0.313	2.11044 J	7	<0.86 U
9/8/2016	Background	<0.93 U	9	31	3	8	12	306	7.91	<0.083 U	1.01746 J	0.158	0.064	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	10	39	3	5	15	297	10.12	0.6272 J	3.69632 J	0.174	0.036	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	7	23	2	8	6	292	13.21	0.9978 J	<0.68 U	0.154	0.025	<0.29 U	4.50827 J	<0.86 U
1/11/2017	Background	<0.93 U	6	29	2	7	8	284	11.9	<0.083 U	<0.68 U	0.164	0.032	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	7	11	2	6	<0.23 U	294	9.87	<0.083 U	<0.68 U	0.158	<0.005 U	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	4.49903 J	23	2	11	7	299	2.407	0.5241 J	<0.68 U	0.167	0.0164 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	6.51	10.6	2.24	11.97	<0.23 U	279	8.85	<0.083 U	<0.68 U	0.156	<0.005 U	<0.29 U	3.24 J	<0.86 U
8/20/2018	Assessment	0.01 J	14.4	7.77	1.77	4.34	0.977	249	10.17	<0.083 U	1.32	0.114	0.005 J	0.03 J	13.0	0.070
2/27/2019	Assessment	<0.4 U	15.9	9.93	2.42	4.57	0.9 J	260	8.56	0.86	1 J	0.153	0.015 J	<8 U	14.8	<2 U
5/21/2019	Assessment	<0.4 U	12.7	10.5	2.25	4.48	0.8 J	272	10.82	0.69	1 J	0.158	<0.005 U	<8 U	4.9	<0.1 U
8/13/2019	Assessment	<0.02 U	11.2	9.28	1.82	4.27	0.758	262	11.11	1.13	1.16	0.180	<0.005 U	<0.4 U	8.1	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-35
Pirkey - Landfill
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.109	17.4	17	<0.083 U	4.7	162	50
7/13/2016	Background	0.07	5.35	18	<0.083 U	4.6	114	28
9/8/2016	Background	0.04	3.42	14	<0.083 U	4.0	104	21
10/12/2016	Background	0.05	2.43	14	0.3552 J	3.6	116	23
11/15/2016	Background	0.06	2	14	<0.083 U	4.3	142	29
1/11/2017	Background	0.06	10.4	18	<0.083 U	4.7	128	62
2/28/2017	Background	0.123	22.5	19	<0.083 U	3.5	140	84
4/11/2017	Background	0.07	10.8	25	<0.083 U	4.8	160	75
8/23/2017	Detection	0.04134	4.33	16	<0.083 U	4.9	92	35
3/21/2018	Assessment	0.142	24.5	28	<0.083 U	4.6	228	102
8/20/2018	Assessment	0.156	12.5	38	2.9285	4.2	290	149

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-35
Pirkey - Landfill
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	<0.93 U	11	124	0.327886 J	0.109137 J	21	10	2.465	<0.083 U	7	<0.00013 U	0.061	0.439174 J	<0.99 U	<0.86 U
7/13/2016	Background	<0.93 U	9	185	0.394115 J	<0.07 U	19	6	4.21	<0.083 U	4.37246 J	0.013	0.11	<0.29 U	<0.99 U	<0.86 U
9/8/2016	Background	<0.93 U	1.13012 J	116	0.19327 J	<0.07 U	5	3.44039 J	2.065	<0.083 U	<0.68 U	0.011	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	4.07365 J	110	0.141123 J	<0.07 U	6	2.98973 J	6.01	0.3552 J	1.53293 J	0.012	0.01021 J	<0.29 U	<0.99 U	<0.86 U
11/15/2016	Background	<0.93 U	12	143	0.304515 J	0.241047 J	30	7	4.83	<0.083 U	7	0.019	0.073	0.583418 J	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	2.14698 J	115	0.0923255 J	0.0922067 J	5	4.0586 J	3.65	<0.083 U	<0.68 U	0.01	0.01907 J	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	4.03612 J	94	0.0943688 J	<0.07 U	3	4.75282 J	2.02	<0.083 U	1.23627 J	0.008	0.02305 J	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	1.39833 J	92	0.0696 J	0.329193 J	1	6	2.707	<0.083 U	<0.68 U	0.007	<0.005 U	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	5.28	53.17	0.18 J	0.61 J	4.24	11.63	2.013	<0.083 U	0.77 J	0.00401	0.023 J	<0.29 U	1.4 J	<0.86 U
8/20/2018	Assessment	0.02 J	2.90	111	0.702	0.12	0.770	11.9	6.27	2.9285	1.43	0.00876	0.005 J	0.04 J	4.5	0.128

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-36
Pirkey - Landfill
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
8/13/2019	Background	0.065	0.240	9.46	0.05 J	4.71	92	2.2

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-36
Pirkey - Landfill
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
8/13/2019	Background	<0.02 U	0.15	10.8	0.234	<0.01 U	0.203	0.901	1.298	0.05 J	<0.05 U	0.0161	<0.005 U	<0.4 U	0.09 J	<0.1 U

Notes:
µg/L: micrograms per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
LANDFILL
H. W. Pirkey Power Plant
Hallsville, Texas

Submitted to

AMERICAN
ELECTRIC
POWER™

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

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engineers | scientists | innovators

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July 11, 2019

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LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LF	Landfill
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the Landfill (LF), an existing CCR unit at the H.W. Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, sulfate, and total dissolved solids (TDS) at the LF. An alternative source was not identified at the time, so two assessment monitoring events were conducted at the LF in 2018, in accordance with 40 CFR 257.95. SSLs for cadmium and cobalt were identified at well AD-34. An ASD was successfully completed (Burns & McDonnell, 2019); thus, the unit remained in assessment monitoring.

A semi-annual assessment monitoring event was also completed in February 2019, with the results of the February 2019 event documented in this report. Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact the usability of the data.

The February 2019 monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. SSLs were identified for cobalt and lithium. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

LANDFILL EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, one set of samples was collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(d)(1). AD-35 was decommissioned in November 2018 and replaced with AD-36, which was installed in April 2019. Thus, only two downgradient wells were sampled for this assessment event. Although antimony, molybdenum, and thallium were not detected at any locations during the March 2018 screening event, samples from the February 2019 semi-annual sampling event were analyzed for all Appendix III and Appendix IV parameters. A summary of data collected during this assessment monitoring event may be found in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.14 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the LF were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained to meet the requirements of 40 CFR 257.95(d)(1) were screened for potential outliers. No outliers were identified.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for arsenic, beryllium, cadmium, cobalt, fluoride, lead, lithium, mercury, and selenium due to apparent non-normal distributions and for antimony, molybdenum, and thallium due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey LF:

- LCLs for cobalt exceeded the GWPS of 0.026 mg/L at AD-34 (0.272 mg/L).
- LCLs for lithium exceeded the GWPS of 0.110 mg/L at AD-34 (0.145 mg/L).

As a result, the Pirkey LF will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring

2.2.3 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations. Prediction limits were calculated for the Appendix III parameters to represent background values. As described in the January 2018 *Statistical Analysis Summary* report (Geosyntec, 2018), intrawell tests were used to evaluate potential SSIs for boron, calcium, chloride, and fluoride, whereas interwell tests were used to evaluate potential SSIs for pH, sulfate, and TDS.

Prediction limits for the interwell tests were recalculated using data collected during the February 2019 assessment monitoring event. Five data points (i.e., one sample from five background wells) were added to the background dataset for each interwell test. New data were tested for outliers prior to being added to the background dataset. The updated prediction limits were calculated for a one-of-two retesting procedure, as during detection monitoring. The values of the updated prediction limits were similar to the values of the prediction limits calculated during detection monitoring. The revised interwell prediction limits were used to evaluate potential SSIs for pH, sulfate, and TDS.

For the intrawell tests, limited data made it possible to add only one data point (i.e., one sample from each compliance well) to each background dataset. Because one sample result is insufficient to compare against the existing background dataset, the prediction limits were not updated for the intrawell tests at this time. The intrawell prediction limits calculated during detection monitoring were used to evaluate potential SSIs for boron, calcium, chloride, and fluoride.

Data collected during the February 2019 assessment monitoring event were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Sulfate concentrations exceeded the interwell UPL of 228 mg/L at AD-34 (970 mg/L).
- TDS concentrations exceeded the interwell UPL of 348 mg/L at AD-34 (1476 mg/L).

While the prediction limits were calculated assuming a one-of-two testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey LF during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the February 2019 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. SSLs were identified for cobalt and lithium. Appendix III parameters were also evaluated, with exceedances identified for sulfate and TDS.

Based on this evaluation, the Pirkey LF unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Pirkey Plant. January 2017.

Burns & McDonnell Engineering Company, Inc. 2019. Alternative Source Demonstration Evaluation Report. April.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Landfill, H. W. Pirkey Power Plant, Hallsville, Texas. January 3, 2018.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - Landfill

Parameter	Unit	AD-8	AD-12	AD-16	AD-23	AD-27	AD-34
		2/28/2019	2/27/2019	2/27/2019	2/28/2019	2/28/2019	2/27/2019
Antimony	µg/L	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
Arsenic	µg/L	2.00 U	2.00 U	7.74	1.00 J	1.00 J	15.9
Barium	µg/L	46.8	22.5	56.2	46.9	39.5	9.93
Beryllium	µg/L	2.00 U	2.00 U	2.00 U	2.00 U	5.32	2.42
Boron	mg/L	1.05	0.0300 J	0.0300 J	0.0200 J	0.0700 J	0.0800 J
Cadmium	µg/L	1.00 U	1.00 U	1.00 U	1.00 U	0.500 J	4.57
Calcium	mg/L	103	0.400 J	0.704	0.300 J	4.02	39.9
Chloride	mg/L	6.83	6.08	20.3	6.94	11.7	7.64
Chromium	µg/L	4.00 U	4.00 U	4.00 U	4.16	4.00 U	0.900 J
Cobalt	µg/L	0.800 J	1.37	3.21	1.00 J	18.9	260
Combined Radium	pCi/L	1.07	0.225	0.848	6.14	2.95	8.56
Fluoride	mg/L	0.400	0.0900	0.0700 J	0.0400 J	0.200	0.860
Lead	µg/L	2.00 U	2.00 U	2.00 U	3.46	2.00 U	1.00 J
Lithium	mg/L	0.00200 J	0.00688	0.0154	0.00646	0.0892	0.153
Mercury	mg/L	0.0000250 U	0.0000250 U	0.0000110 J	0.0000350	0.0000250 U	0.0000150 J
Molybdenum	µg/L	40.0 U	40.0 U	40.0 U	40.0 U	40.0 U	40.0 U
Selenium	µg/L	30.8	4.00 U	4.00 U	1.00 J	2.00 J	14.8
Total Dissolved Solids	mg/L	462	36.0	76.0	70.0	42.0	1470
Sulfate	mg/L	175	3.60	17.7	7.20	52.8	970
Thallium	µg/L	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
pH	SU	5.69	5.17	4.13	5.11	4.67	2.92

Notes:

µg/L: micrograms per liter

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.

J: Estimated value. Parameter was detected in concentrations below the reporting limit.

Table 2: Groundwater Protection Standards
Pirkey Plant - Landfill

Constituent Name	MCL	CCR Rule Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.008
Arsenic, Total (mg/L)	0.01		0.0077
Barium, Total (mg/L)	2		0.080
Beryllium, Total (mg/L)	0.004		0.007
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.0051
Cobalt, Total (mg/L)	n/a	0.006	0.026
Combined Radium, Total (pCi/L)	5		7.36
Fluoride, Total (mg/L)	4		5.2
Lead, Total (mg/L)	n/a	0.015	0.0045
Lithium, Total (mg/L)	n/a	0.04	0.11
Mercury, Total (mg/L)	0.002		0.00021
Molybdenum, Total (mg/L)	n/a	0.1	0.0050
Selenium, Total (mg/L)	0.05		0.031
Thallium, Total (mg/L)	0.002		0.002

Notes:
Grey cell indicates calculated UTL is higher than MCL.
MCL = Maximum Contaminant Level
Calculated UTL (Upper Tolerance Limit) represents site-specific background values.
The higher of the calculated UTL or MCL/RSL is used as the GWPS.

Table 3: Appendix III Data Summary
Pirkey Plant - Landfill

Parameter	Units	Description	AD-23	AD-34
			2/28/2019	2/27/2019
Boron	mg/L	Intrawell Background Value (UPL)	0.030	0.120
		Detection Monitoring Result	0.02	0.08
Calcium	mg/L	Intrawell Background Value (UPL)	0.65	42.5
		Detection Monitoring Result	0.3	39.9
Chloride	mg/L	Intrawell Background Value (UPL)	7.89	9.20
		Detection Monitoring Result	6.94	7.64
Fluoride	mg/L	Intrawell Background Value (UPL)	1.0	1.0
		Detection Monitoring Result	0.04	0.86
pH	SU	Interwell Background Value (UPL)	5.5	
		Interwell Background Value (LPL)	2.5	
		Detection Monitoring Result	5.1	2.9
Sulfate	mg/L	Interwell Background Value (UPL)	228	
		Detection Monitoring Result	7.2	**970**
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	348	
		Detection Monitoring Result	70	**1476**

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

Background values are shaded gray.

ATTACHMENT A

Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey Landfill CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER
Printed Name of Licensed Professional Engineer

David Anthony Miller
Signature

DAVID ANTHONY MILLER
112498

112498
License Number

TEXAS
Licensing State

07.11.19
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

July 11, 2019

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey Landfill
Assessment Monitoring Event – February 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of the groundwater data for the February 2019 sample event for American Electric Power Company's Pirkey Landfill. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, is listed below. Note that downgradient well AD-35 was originally in the well network but has been abandoned and replaced with a new well. No data are currently available from the new well but will be included in future analyses.

- **Upgradient wells:** AD-8, AD-12, AD-16 and AD-27; and
- **Downgradient wells:** AD-23 and AD-34

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS;
- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Values previously flagged during the screening as outliers may be seen in a lighter font and disconnected symbol on the time series graphs. A summary of flagged values follows this letter (Figure B).

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for pH, sulfate and TDS; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, calcium, chloride and fluoride (Figures C and D, respectively). The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data are screened for any newly suspected outliers or obvious trending patterns using time series plots. All values flagged as outliers may be seen on the Outlier Summary report following this letter. No obvious trending patterns were observed in the upgradient wells.

Intrawell prediction limits utilize the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data set will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. No exceedances were noted except for chloride at wells AD-16 and AD-27; and sulfate and TDS at well AD-34. Downgradient well AD-35 had exceedances for the August 2018 event as previously noted in that report for boron, chloride and fluoride. The results of those findings may be found in the Prediction Limit Summary tables following this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable. Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site which is an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances. Statistically significant increasing trends were noted for chloride in upgradient wells AD-16 and AD-27, which is an indication groundwater concentrations are changing naturally upgradient of the facility.

Evaluation of Appendix IV Parameters

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure F). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure G).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, CCR-rule specified levels or ACL as discussed above (Figure H). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. Two exceedances were noted which included cobalt and lithium in well AD-34. A summary of the confidence interval results follows this letter.

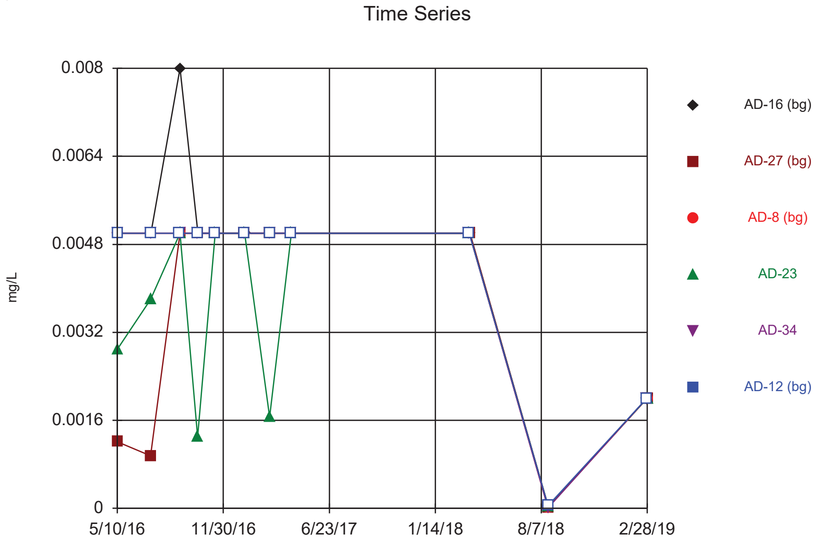
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Landfill. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina Rayner

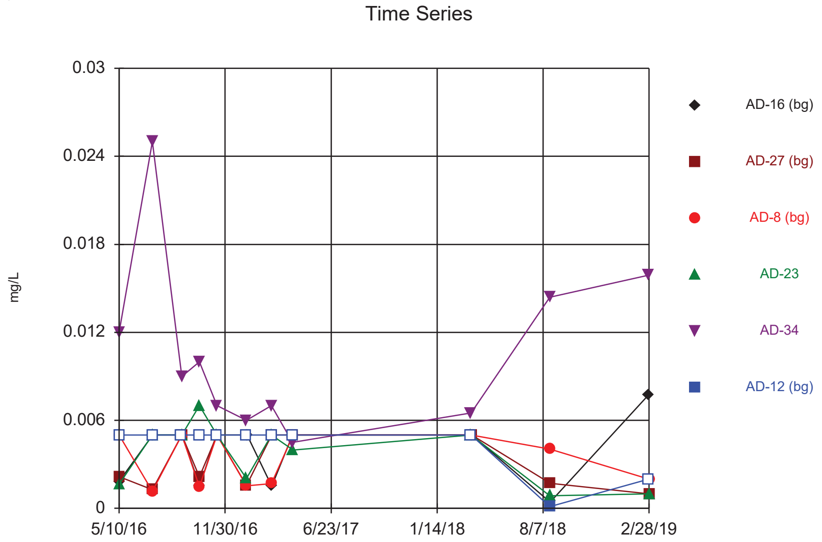
Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



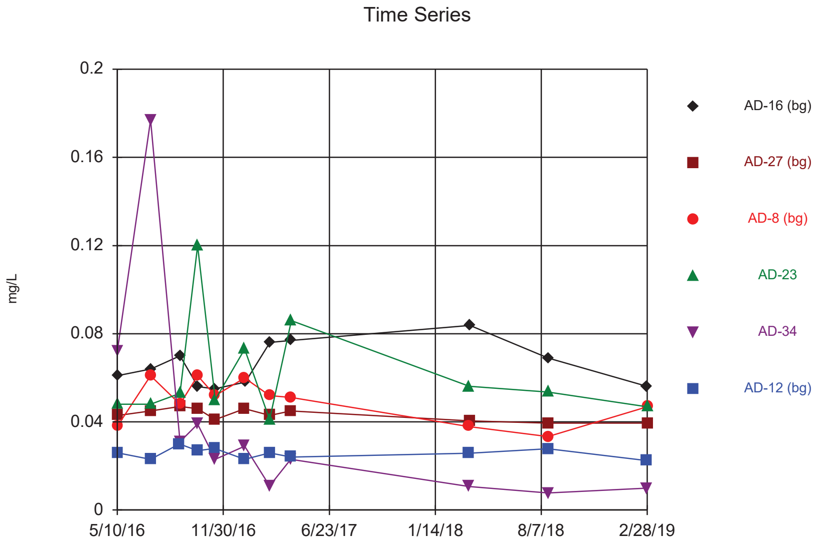
Constituent: Antimony, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



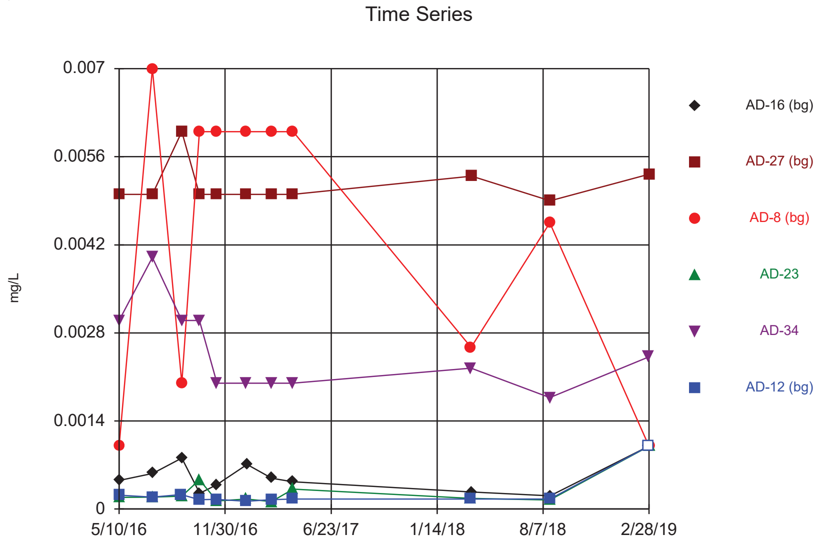
Constituent: Arsenic, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



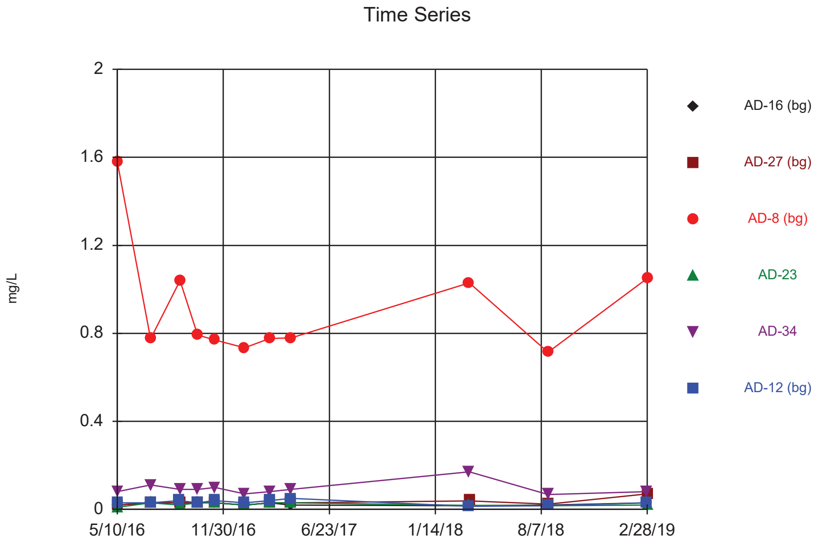
Constituent: Barium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



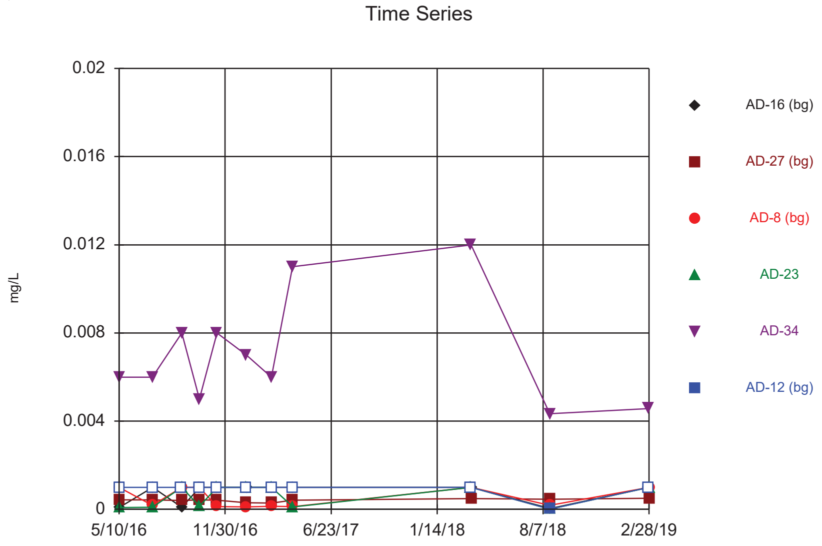
Constituent: Beryllium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



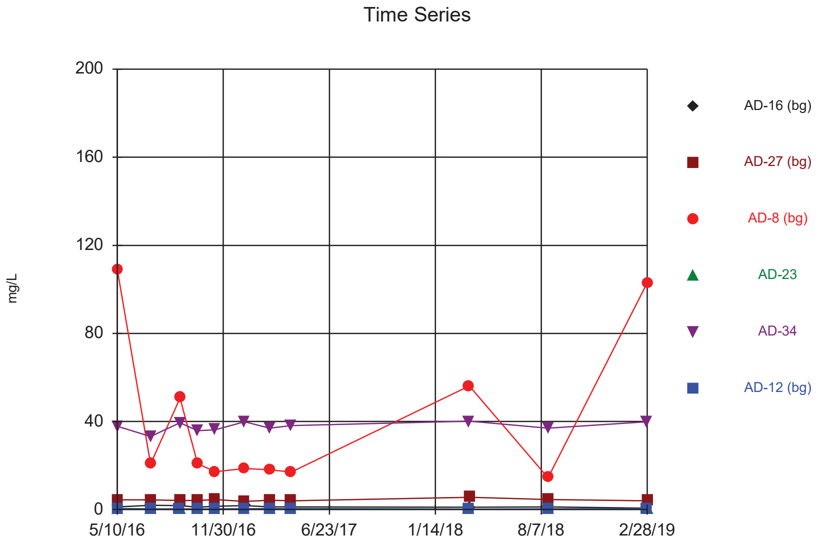
Constituent: Boron, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



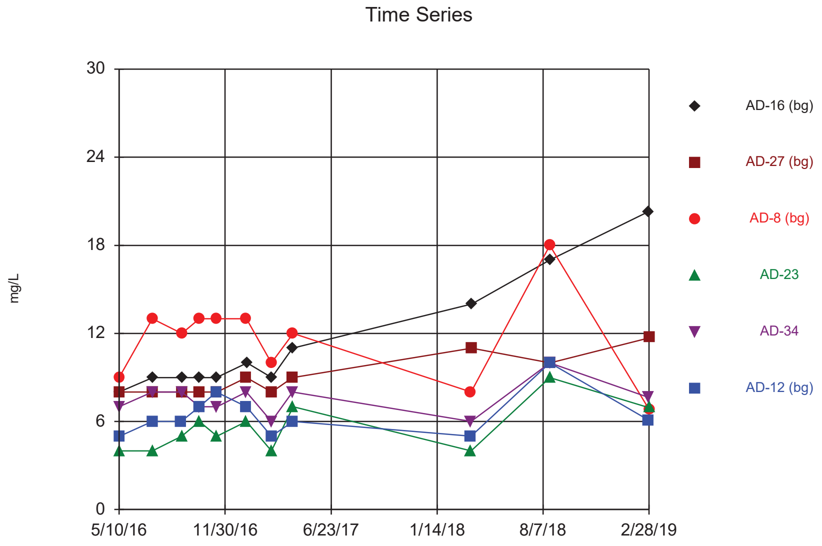
Constituent: Cadmium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



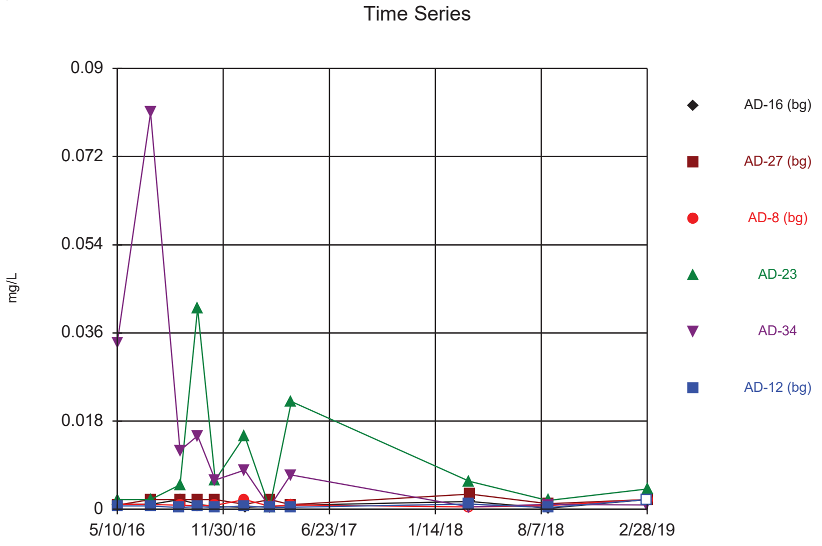
Constituent: Calcium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



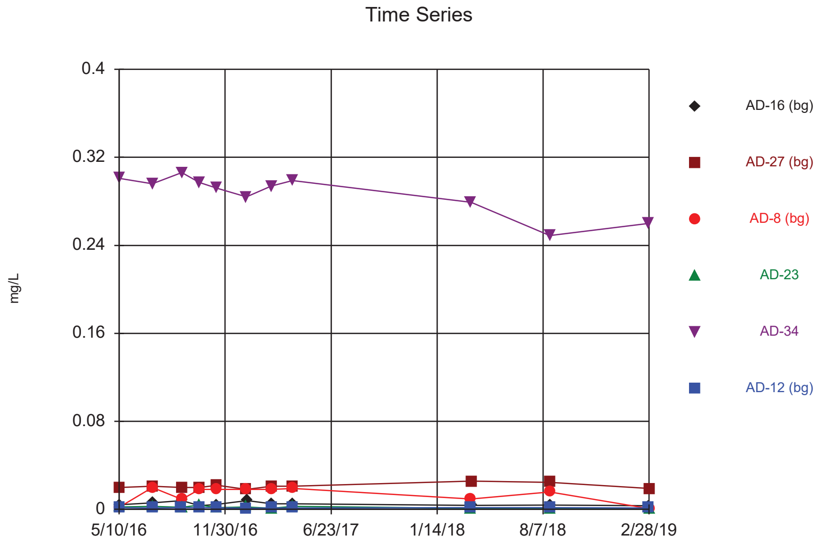
Constituent: Chloride, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



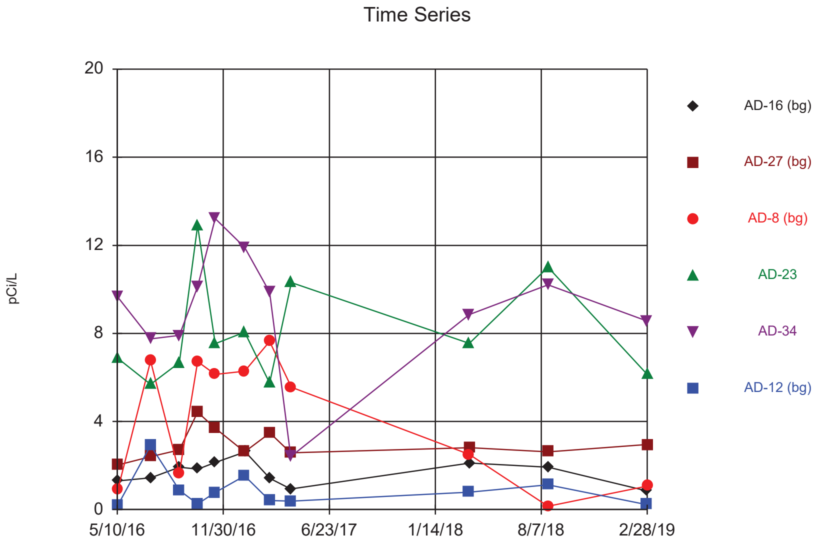
Constituent: Chromium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



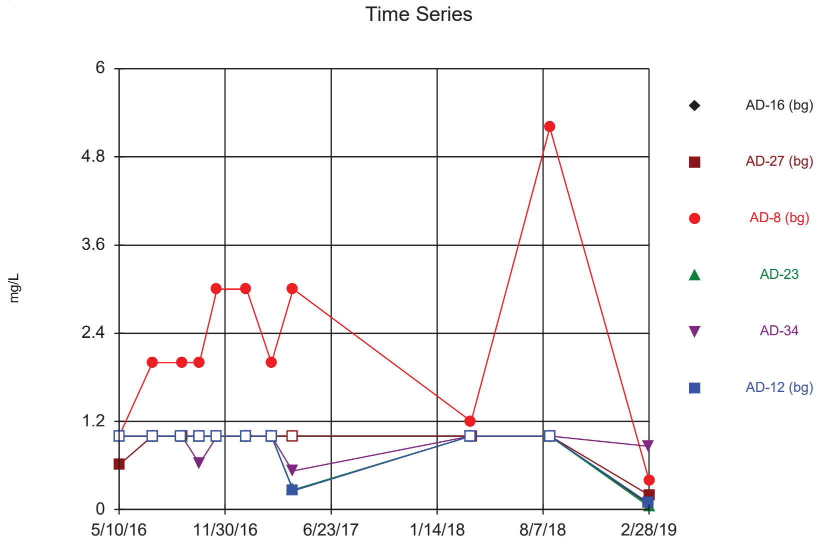
Constituent: Cobalt, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Combined Radium 226 + 228 Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

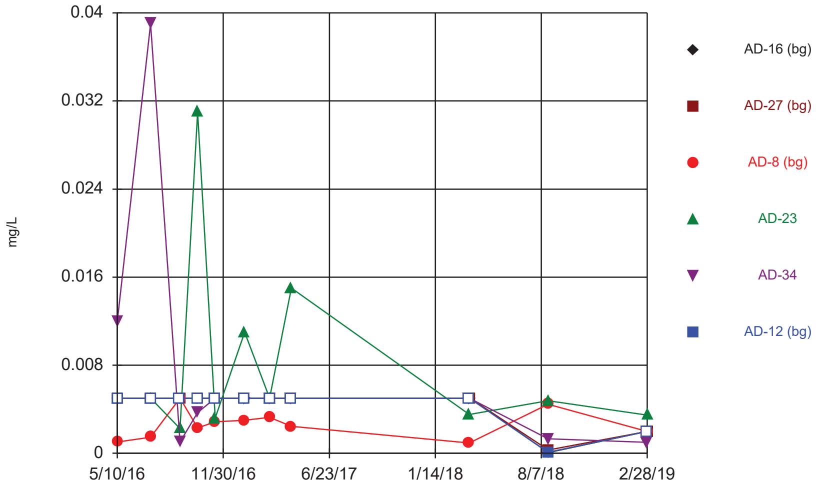
Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Fluoride, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

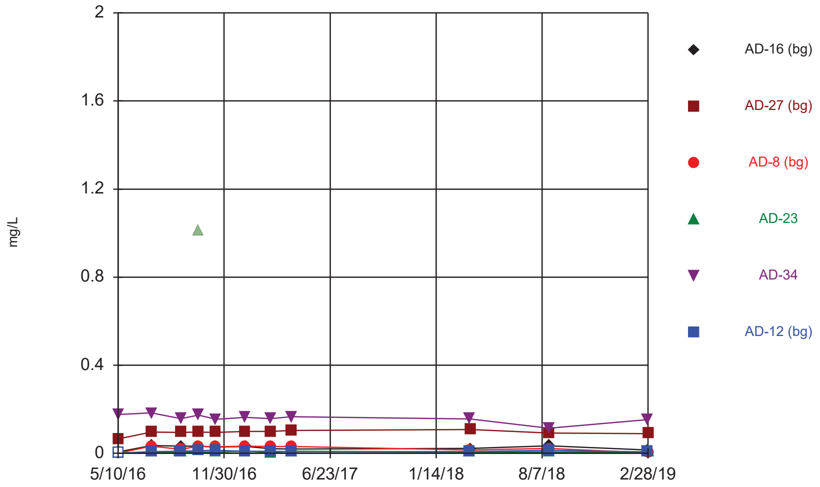
Time Series



Constituent: Lead, total   Analysis Run 7/11/2019 1:49 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

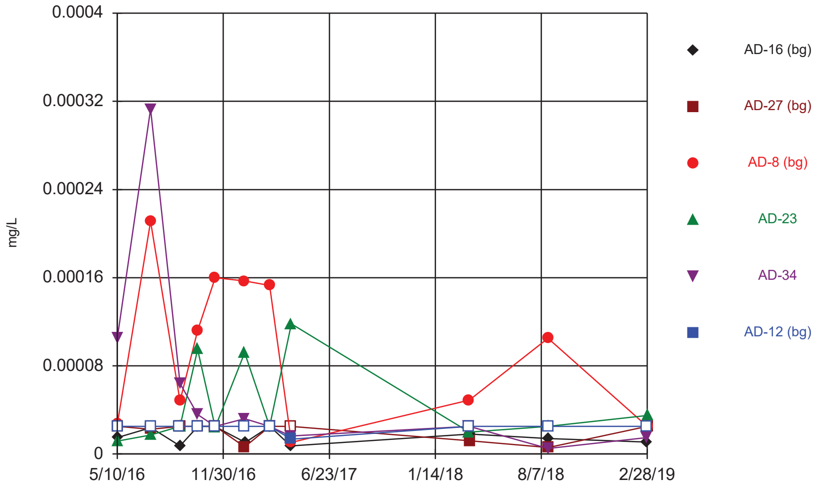
Time Series



Constituent: Lithium, total   Analysis Run 7/11/2019 1:49 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

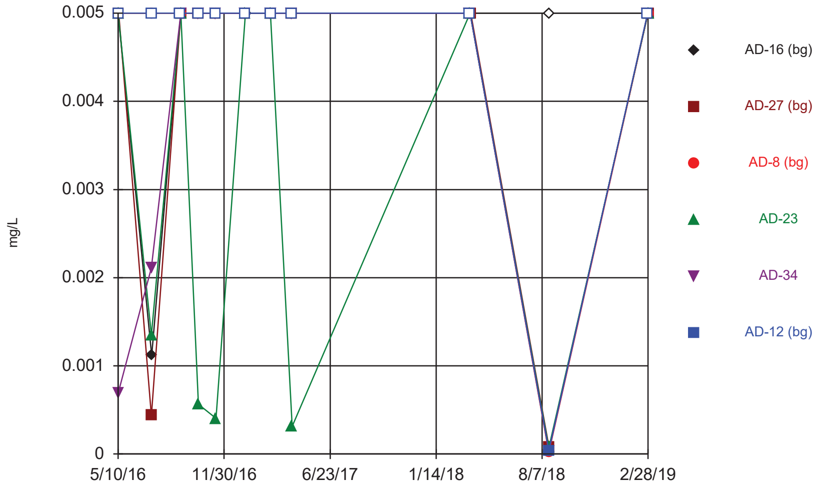
Time Series



Constituent: Mercury, total   Analysis Run 7/11/2019 1:49 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

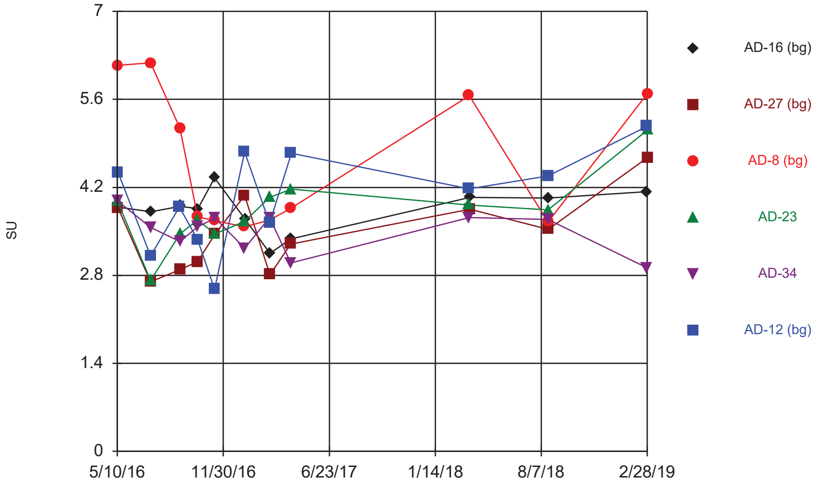
Time Series



Constituent: Molybdenum, total   Analysis Run 7/11/2019 1:49 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

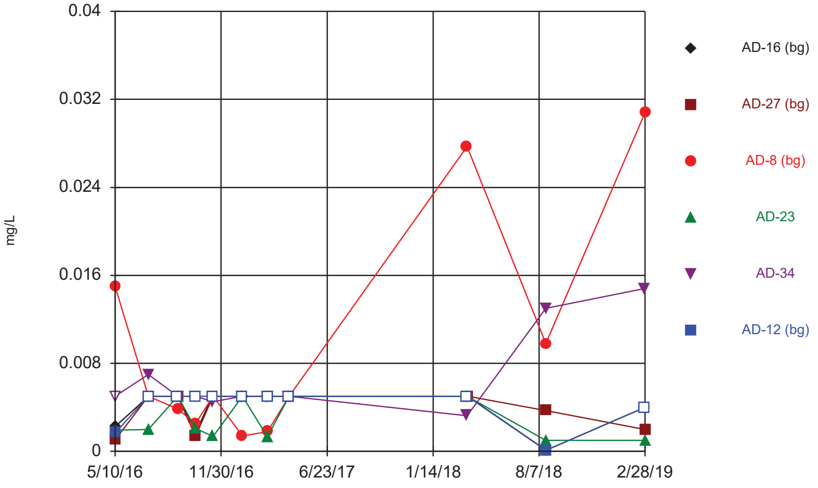
Time Series



Constituent: pH, field Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

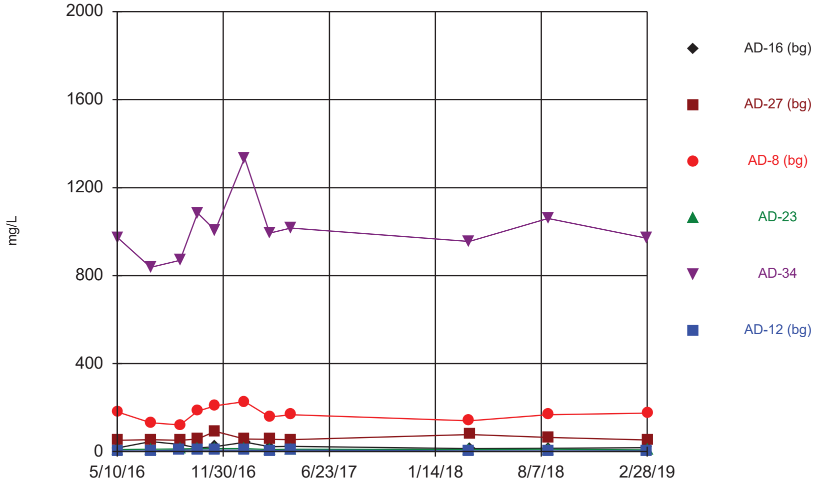
Time Series



Constituent: Selenium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

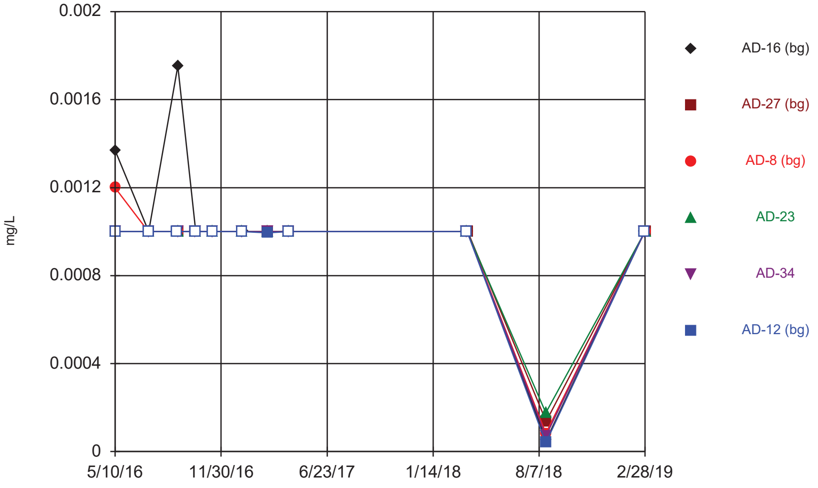
Time Series



Constituent: Sulfate, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Thallium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

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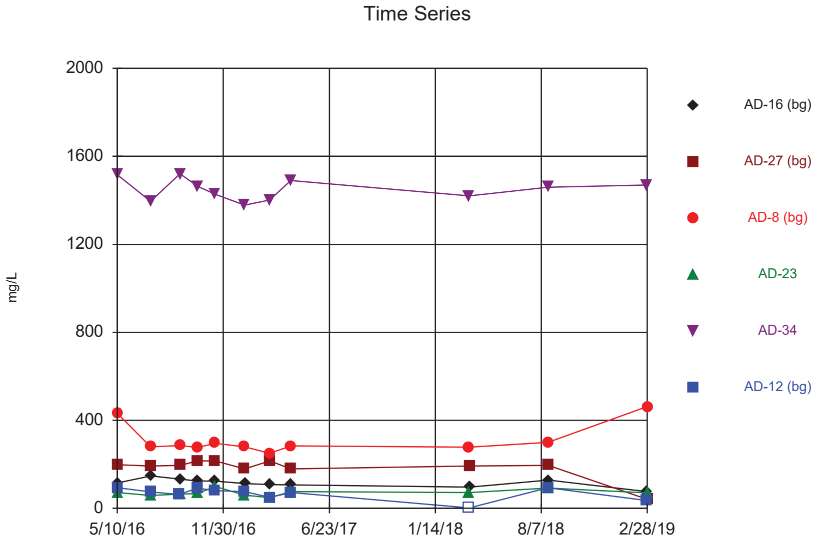
Hollow symbols indicate censored values.



Constituent: Total Dissolved Solids [TDS]   Analysis Run 7/11/2019 1:49 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Outlier Summary

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 7/1/2019, 10:17 AM

	AD-23 Lithium, total (mg/L)
10/12/2016	1.01 (o)

Interwell Prediction Limit Summary - Significant Results

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 7/11/2019, 1:46 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Sulfate, total (mg/L)	**AD-34**	**228**	**n/a**	**2/27/2019**	**970**	**Yes**	**44**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0009861**	NP (normality) 1 of 2
Total Dissolved Solids [TDS] (mg/L)	**AD-34**	**348**	**n/a**	**2/27/2019**	**1470**	**Yes**	**44**	**169.4**	**102.7**	**2.273**	**None**	**No**	**0.002505**	Param 1 of 2

Interwell Prediction Limit Summary - All Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/11/2019, 1:46 PM

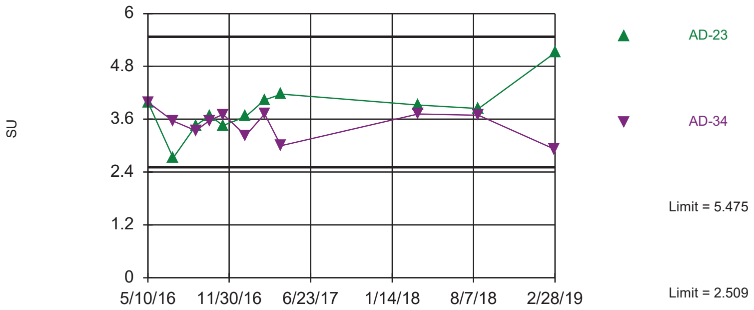
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH, field (SU)	AD-23	5.475	2.509	2/28/2019	5.11	No	44	3.992	0.8529	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-34	5.475	2.509	2/27/2019	2.92	No	44	3.992	0.8529	0	None	No	0.001253	Param 1 of 2
Sulfate, total (mg/L)	AD-23	228	n/a	2/28/2019	7.2	No	44	n/a	n/a	0	n/a	n/a	0.0009861	NP (normality) 1 of 2
Sulfate, total (mg/L)	**AD-34**	**228**	**n/a**	**2/27/2019**	**970**	**Yes**	**44**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0009861**	NP (normality) 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-23	348	n/a	2/28/2019	70	No	44	169.4	102.7	2.273	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	**AD-34**	**348**	**n/a**	**2/27/2019**	**1470**	**Yes**	**44**	**169.4**	**102.7**	**2.273**	**None**	**No**	**0.002505**	Param 1 of 2

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=3.992, Std. Dev.=0.8529, n=44. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9258, critical = 0.924. Kappa = 1.739 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001253. Comparing 2 points to limit. Assumes 1 future value.

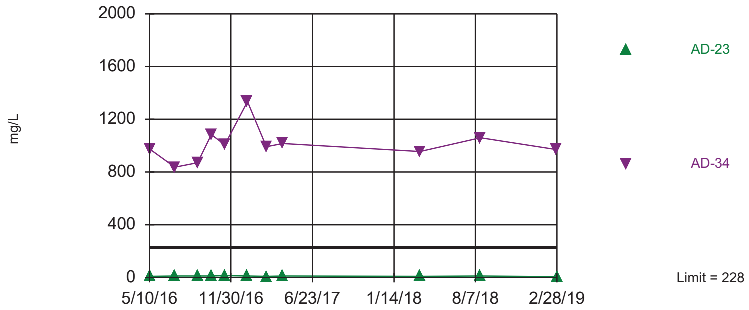
Constituent: pH, field Analysis Run 7/11/2019 1:42 PM View: PL's - Interwell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-34

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 44 background values. Annual per-constituent alpha = 0.005902. Individual comparison alpha = 0.0009861 (1 of 2). Comparing 2 points to limit. Assumes 1 future value.

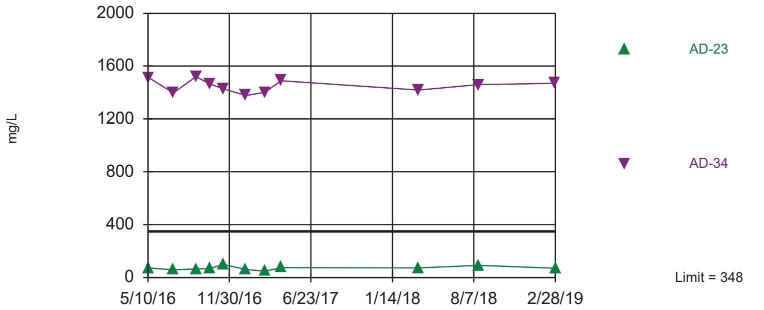
Constituent: Sulfate, total Analysis Run 7/11/2019 1:42 PM View: PL's - Interwell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: AD-34

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=169.4, Std. Dev.=102.7, n=44, 2.273% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9299, critical = 0.924. Kappa = 1.739 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 2 points to limit. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:42 PM View: PL's - Interwell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Intrawell Prediction Limit Summary - Significant Results

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 7/11/2019, 1:41 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Chloride, total (mg/L)	**AD-16**	**11.43**	**n/a**	**2/27/2019**	**20.3**	**Yes**	**8**	**9.25**	**0.8864**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Chloride, total (mg/L)	**AD-27**	**9**	**n/a**	**2/28/2019**	**11.7**	**Yes**	**8**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.02144**	**NP Intra (normality) 1 of 2**

Intrawell Prediction Limit Summary - All Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/11/2019, 1:41 PM

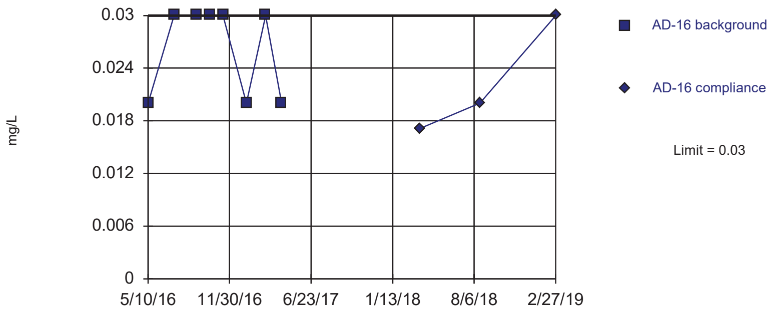
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-16	0.03	n/a	2/27/2019	0.03	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Boron, total (mg/L)	AD-27	0.03	n/a	2/28/2019	0.07	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Boron, total (mg/L)	AD-8	1.58	n/a	2/28/2019	1.05	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Boron, total (mg/L)	AD-23	0.03	n/a	2/28/2019	0.02	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Boron, total (mg/L)	AD-34	0.1201	n/a	2/27/2019	0.08	No	8	0.08888	0.01271	0	None	No	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-12	0.05454	n/a	2/27/2019	0.03	No	8	0.03625	0.00744	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-16	2.318	n/a	2/27/2019	0.704	No	8	1.504	0.3311	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-27	4.848	n/a	2/28/2019	4.02	No	8	4.21	0.2595	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-8	109	n/a	2/28/2019	103	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Calcium, total (mg/L)	AD-23	0.6535	n/a	2/28/2019	0.3	No	8	0.3451	0.1255	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-34	42.53	n/a	2/27/2019	39.9	No	8	37.21	2.163	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-12	0.4631	n/a	2/27/2019	0.4	No	8	0.3269	0.05542	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	**AD-16**	**11.43**	**n/a**	**2/27/2019**	**20.3**	**Yes**	**8**	**9.25**	**0.8864**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Chloride, total (mg/L)	**AD-27**	**9**	**n/a**	**2/28/2019**	**11.7**	**Yes**	**8**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.02144**	**NP Intra (normality) 1 of 2**
Chloride, total (mg/L)	AD-8	15.69	n/a	2/28/2019	6.83	No	8	11.88	1.553	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-23	7.893	n/a	2/28/2019	6.94	No	8	5.125	1.126	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-34	9.204	n/a	2/27/2019	7.64	No	8	7.375	0.744	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-12	8.794	n/a	2/27/2019	6.08	No	8	6.25	1.035	0	None	No	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-16	1	n/a	2/27/2019	0.07	No	8	n/a	n/a	100	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-27	1	n/a	2/28/2019	0.2	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-8	3.988	n/a	2/28/2019	0.4	No	8	2.25	0.7071	12.5	None	No	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-23	1	n/a	2/28/2019	0.04	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-34	1	n/a	2/27/2019	0.86	No	8	n/a	n/a	62.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-12	1	n/a	2/27/2019	0.09	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

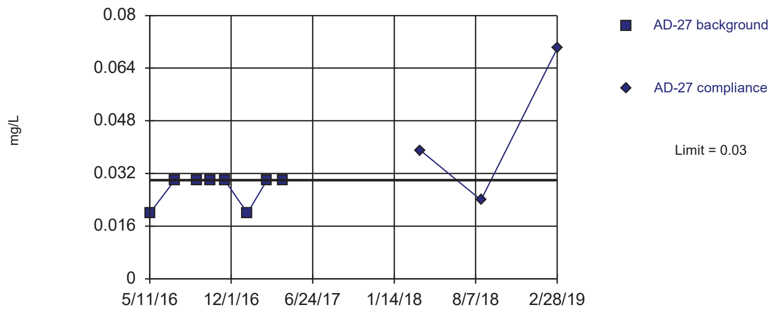
Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

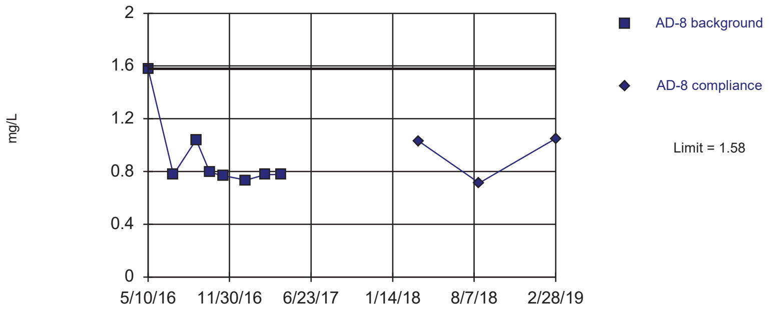
Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

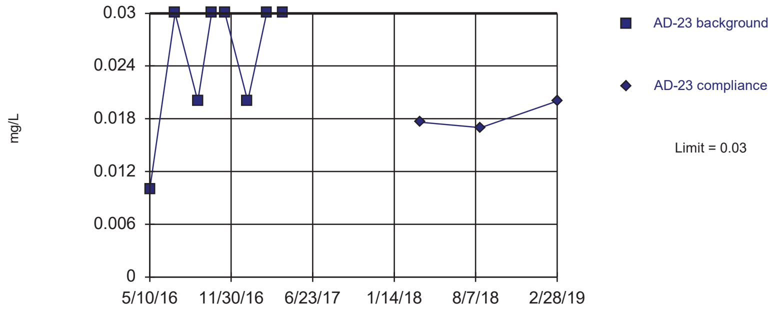
Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

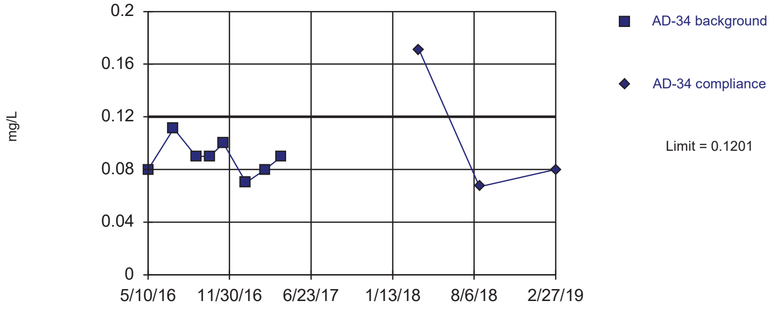
Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.08888, Std. Dev.=0.01271, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9562, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

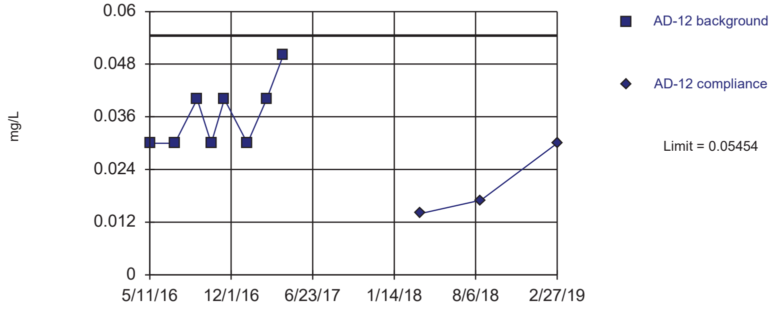
Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.03625, Std. Dev.=0.00744, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7968, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

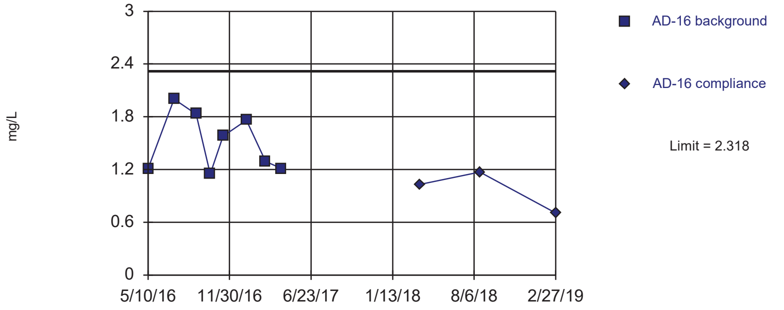
Constituent: Boron, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1.504, Std. Dev.=0.3311, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8818, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

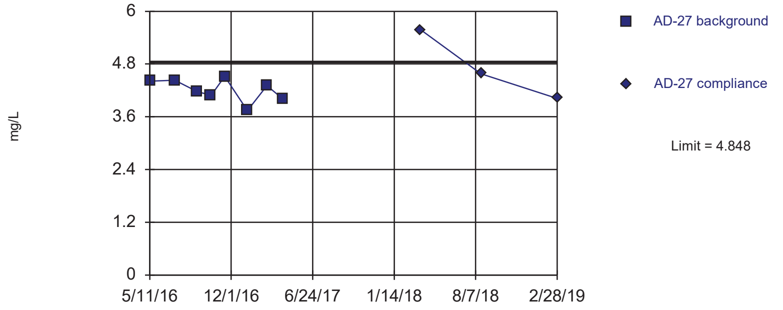
Constituent: Calcium, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.21, Std. Dev.=0.2595, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9482, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

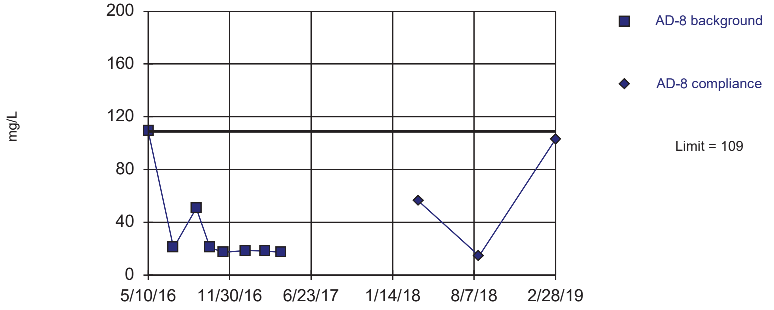
Constituent: Calcium, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

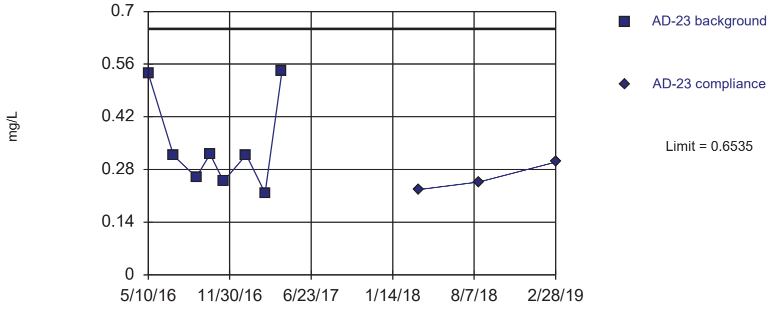
Constituent: Calcium, total   Analysis Run 7/11/2019 1:39 PM   View: PL's - Intrawell
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3451, Std. Dev.=0.1255, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.809, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

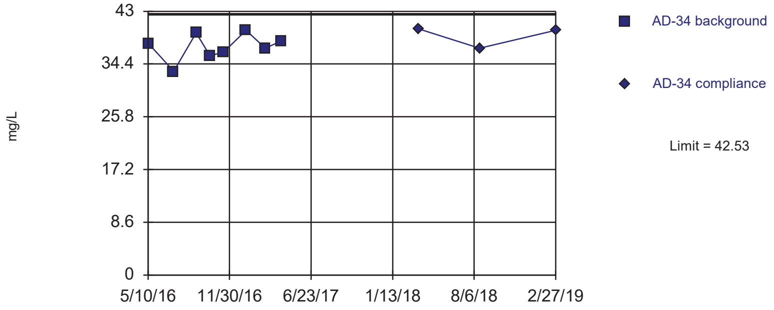
Constituent: Calcium, total   Analysis Run 7/11/2019 1:39 PM   View: PL's - Intrawell
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=37.21, Std. Dev.=2.163, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9581, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

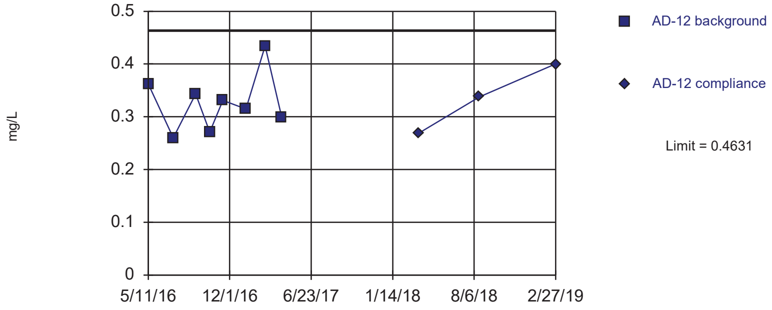
Constituent: Calcium, total   Analysis Run 7/11/2019 1:39 PM   View: PL's - Intrawell
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3269, Std. Dev.=0.05542, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9467, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

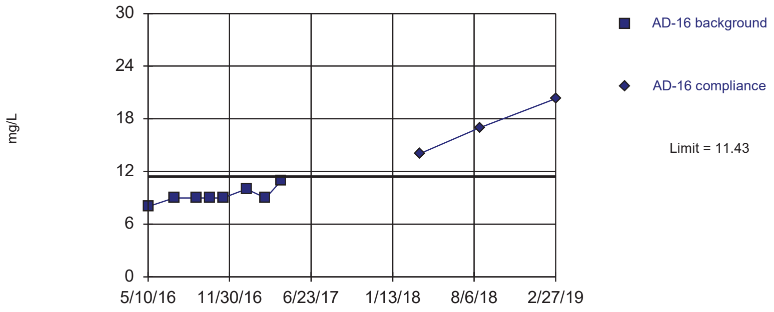
Constituent: Calcium, total   Analysis Run 7/11/2019 1:39 PM   View: PL's - Intrawell
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=9.25, Std. Dev.=0.8864, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8264, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

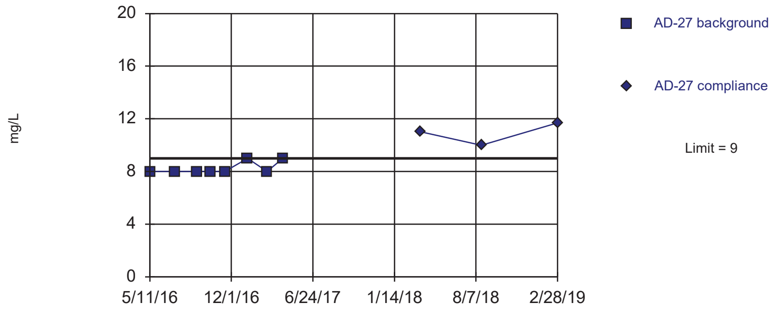
Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

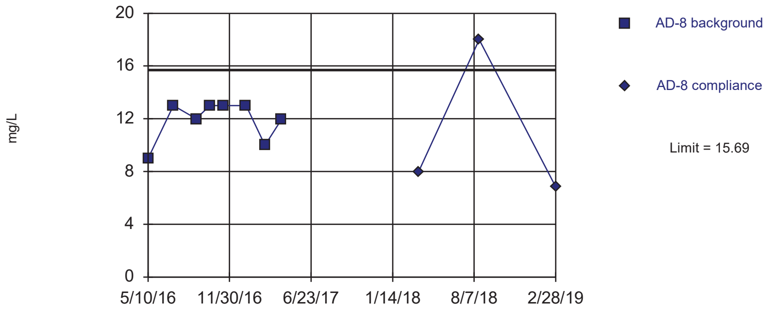
Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=11.88, Std. Dev.=1.553, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7682, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

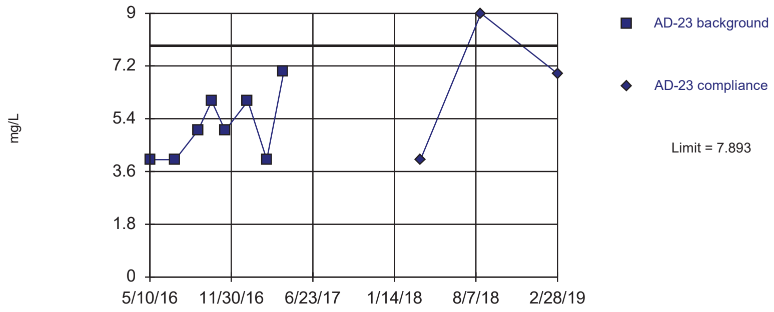
Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.125, Std. Dev.=1.126, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8815, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

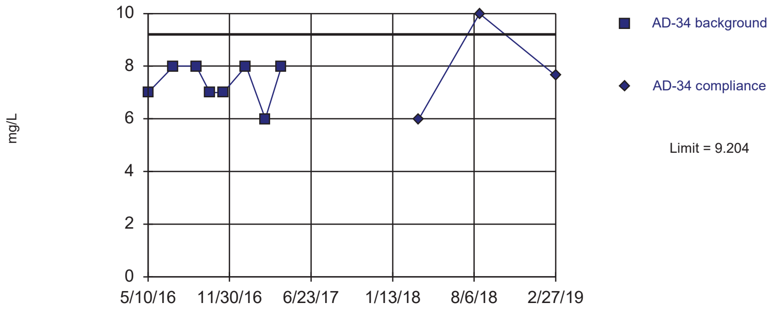
Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=7.375, Std. Dev.=0.744, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7968, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

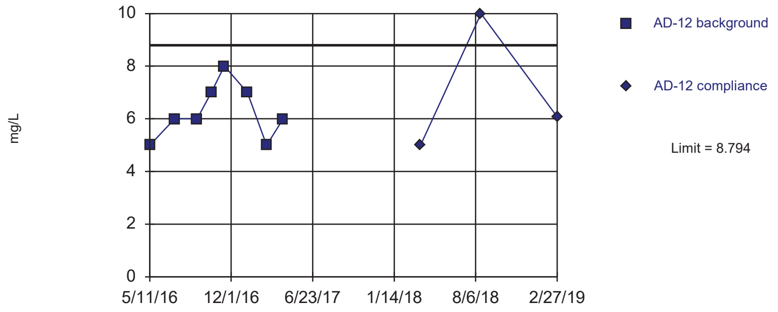
Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.25, Std. Dev.=1.035, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9171, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

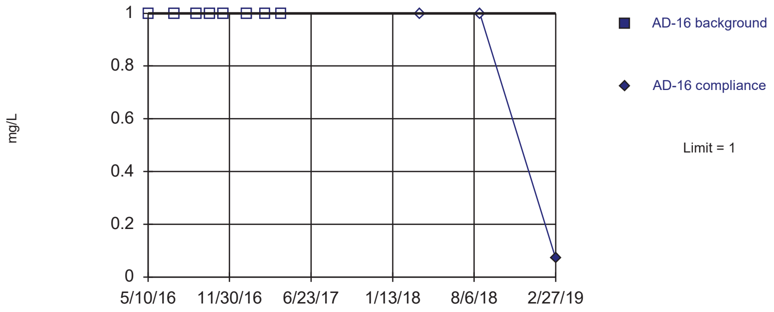
Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 8) were censored; limit is most recent reporting limit. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

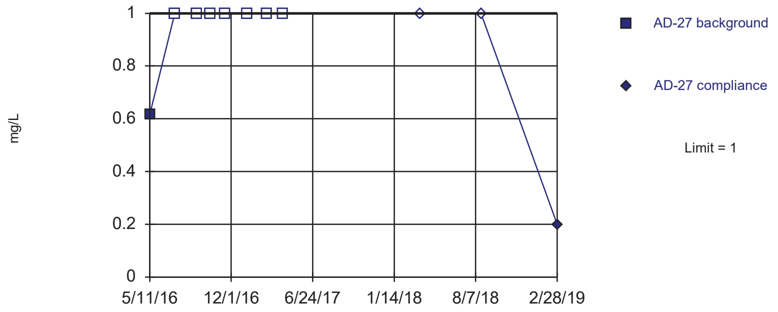
Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

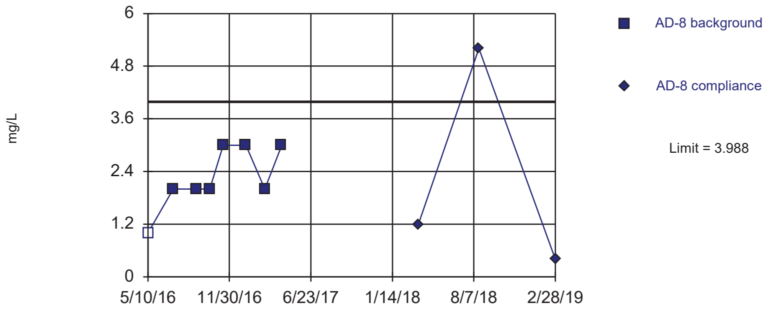
Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=2.25, Std. Dev.=0.7071, n=8, 12.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8268, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

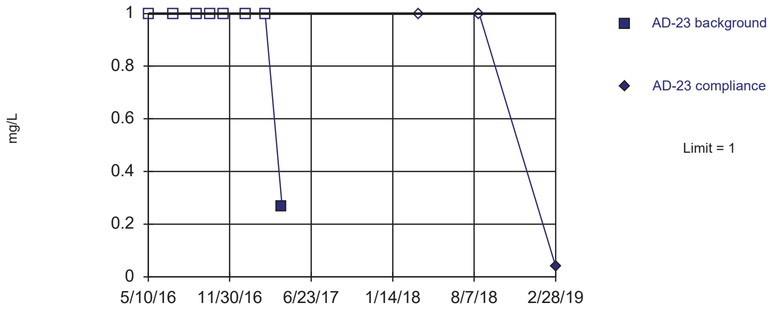
Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

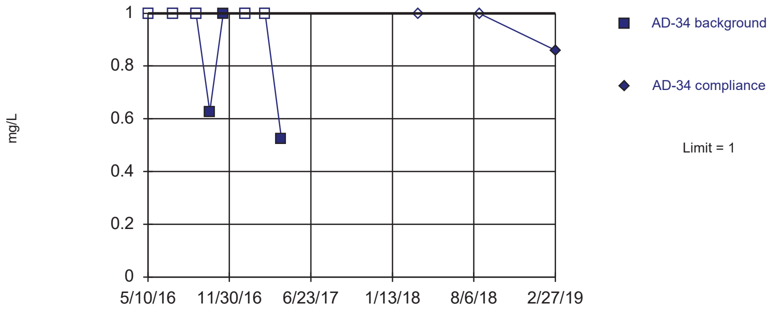
Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 62.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

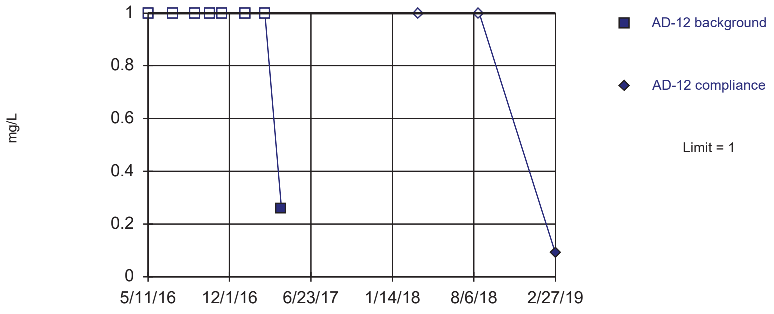
Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

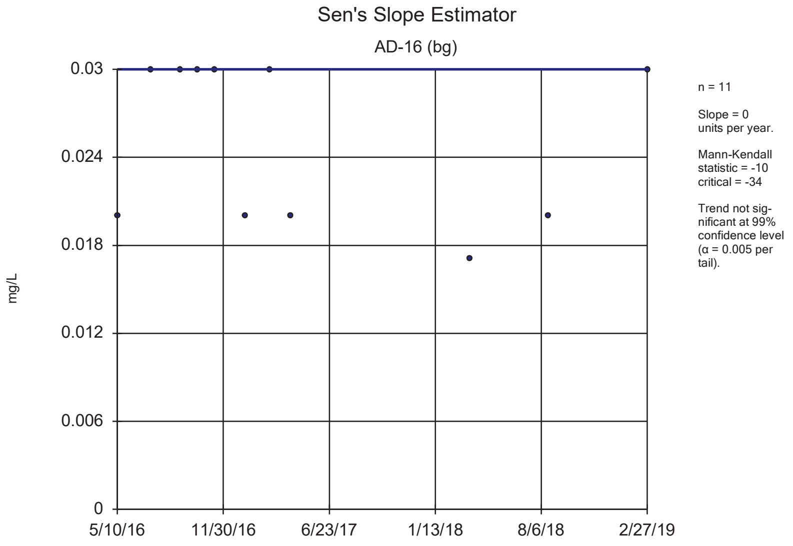
Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Trend Test Summary Table - All Results

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 7/11/2019, 1:55 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-16 (bg)	0	-10	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-27 (bg)	0.001755	17	34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-8 (bg)	-0.02823	-7	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0	-4	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	**AD-16 (bg)**	**3.702**	**43**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	**AD-27 (bg)**	**1.267**	**35**	**34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	AD-8 (bg)	-0.5368	-8	-34	No	11	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.03234	10	34	No	11	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-16 (bg)	0	-10	-34	No	11	90.91	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-27 (bg)	0	-1	-34	No	11	81.82	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-8 (bg)	0	8	34	No	11	9.091	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-12 (bg)	0	-15	-34	No	11	81.82	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-16 (bg)	-3.411	-16	-34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-27 (bg)	3.411	13	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-8 (bg)	5.333	4	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-34	32.31	9	34	No	11	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.5376	-15	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-16 (bg)	-20.21	-32	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-27 (bg)	-10.77	-15	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-8 (bg)	2.271	4	34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-34	-5.947	-3	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-19.73	-20	-34	No	11	9.091	n/a	n/a	0.01	NP

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

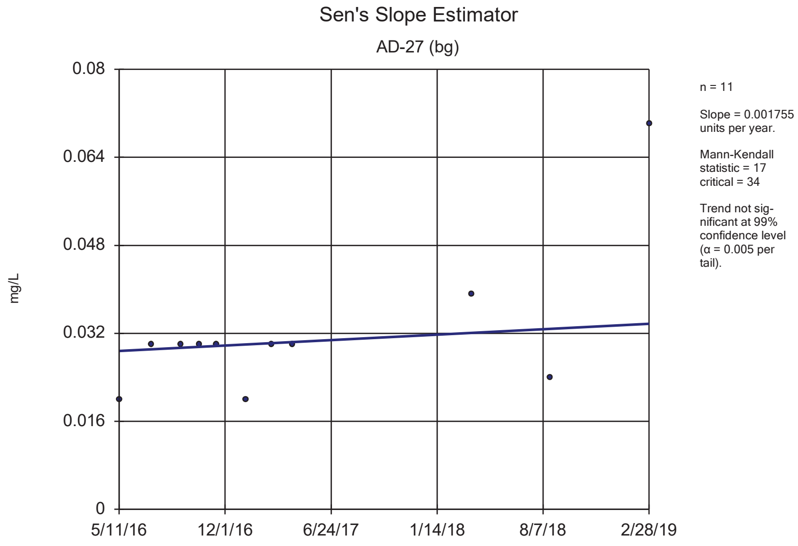
Slope = 0
units per year.

Mann-Kendall
statistic = -10
critical = -34

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

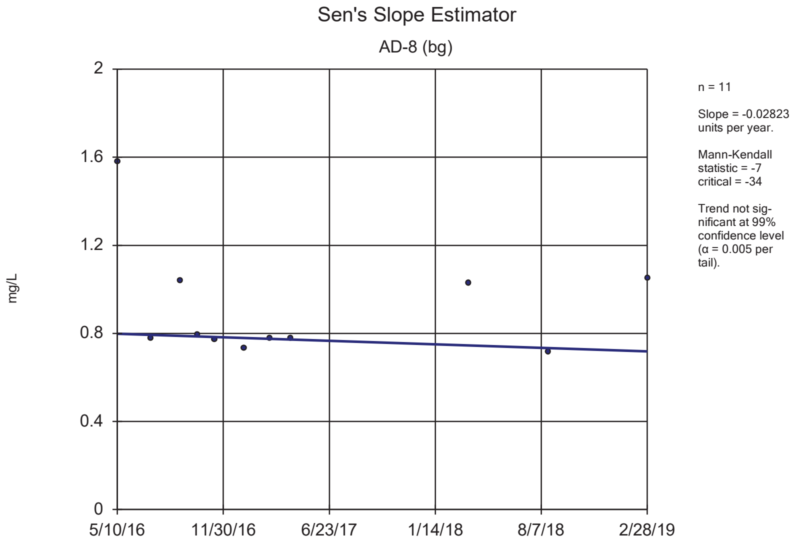
Slope = 0.001755
units per year.

Mann-Kendall
statistic = 17
critical = 34

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

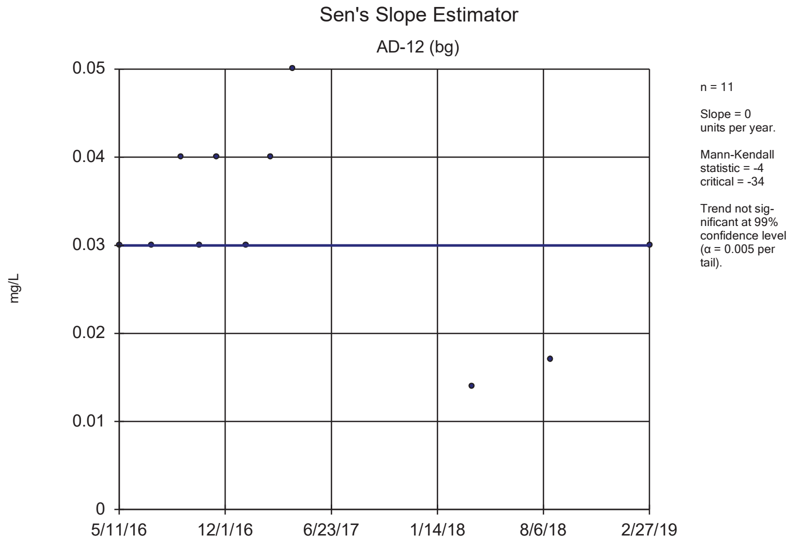
Slope = -0.02823
units per year.

Mann-Kendall
statistic = -7
critical = -34

Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

Slope = 0
units per year.

Mann-Kendall
statistic = -4
critical = -34

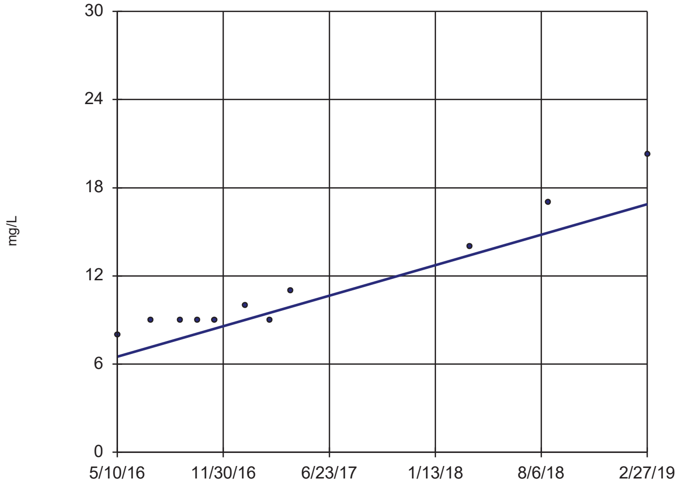
Trend not significant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-16 (bg)



n = 11

Slope = 3.702 units per year.

Mann-Kendall statistic = 43 critical = 34

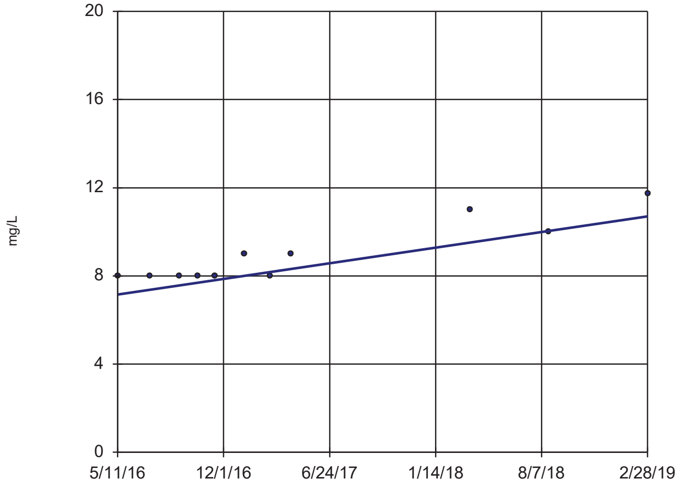
Increasing trend significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total   Analysis Run 7/11/2019 1:50 PM   View: Trend Tests
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 11

Slope = 1.267 units per year.

Mann-Kendall statistic = 35 critical = 34

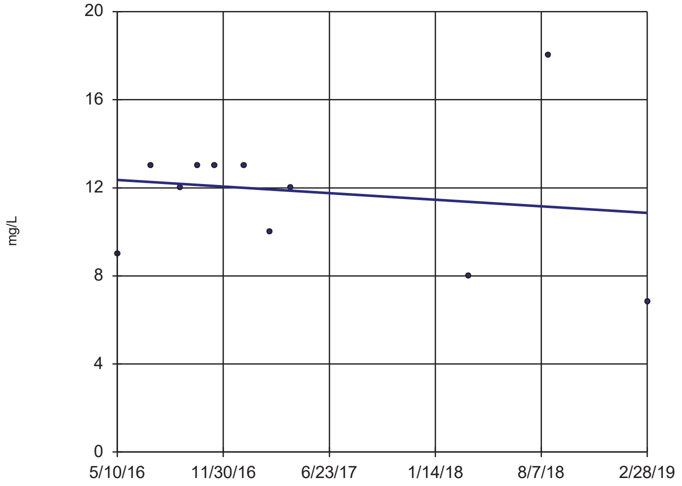
Increasing trend significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total   Analysis Run 7/11/2019 1:50 PM   View: Trend Tests
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 11

Slope = -0.5368 units per year.

Mann-Kendall statistic = -8 critical = -34

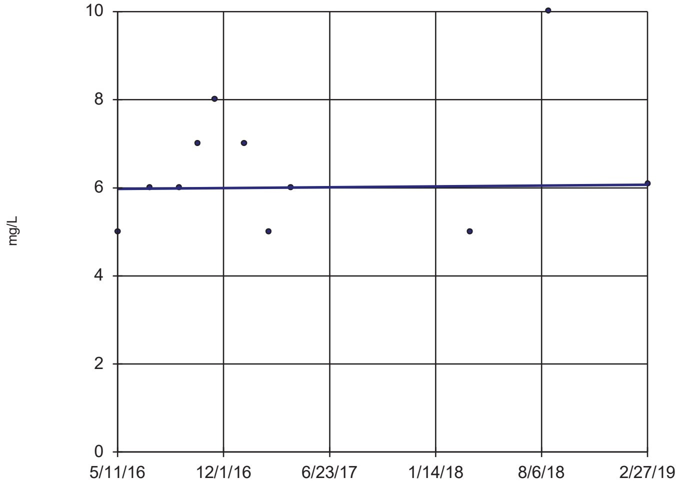
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total   Analysis Run 7/11/2019 1:50 PM   View: Trend Tests
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

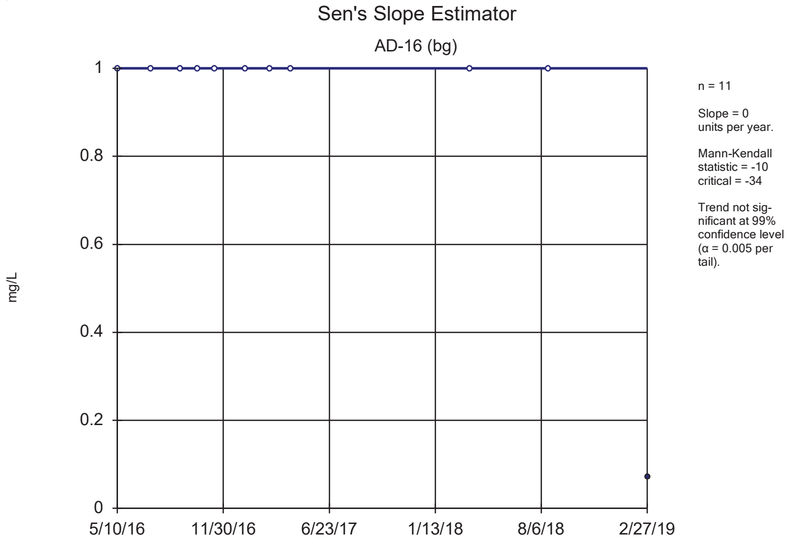
Slope = 0.03234 units per year.

Mann-Kendall statistic = 10 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

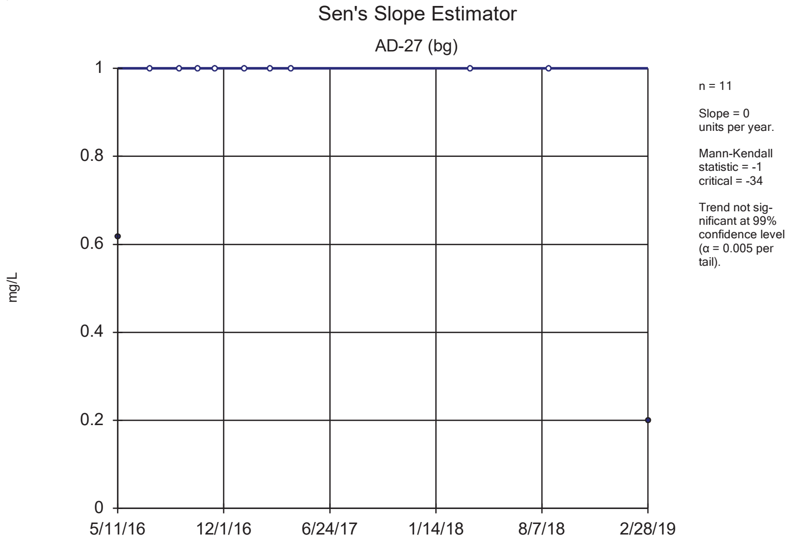
Constituent: Chloride, total   Analysis Run 7/11/2019 1:50 PM   View: Trend Tests
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



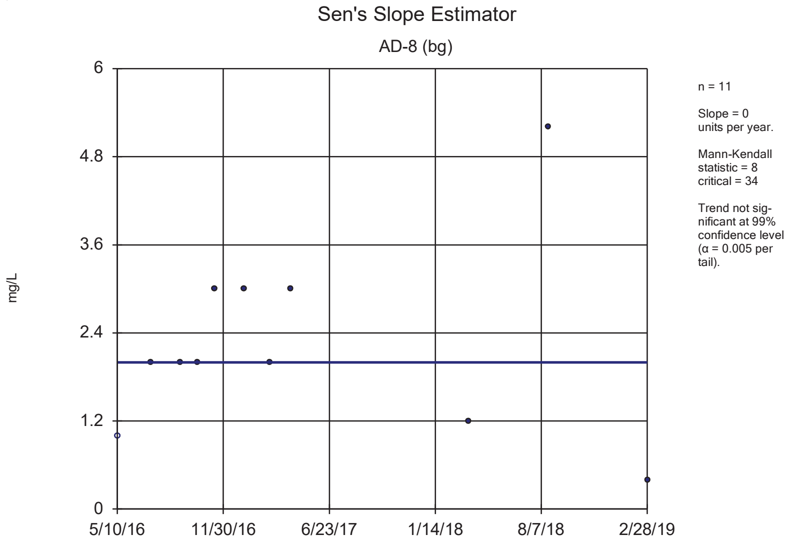
Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



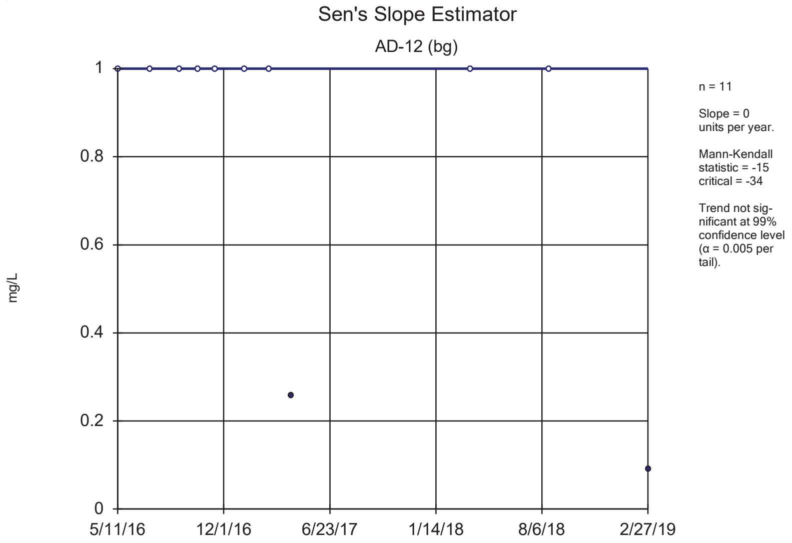
Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

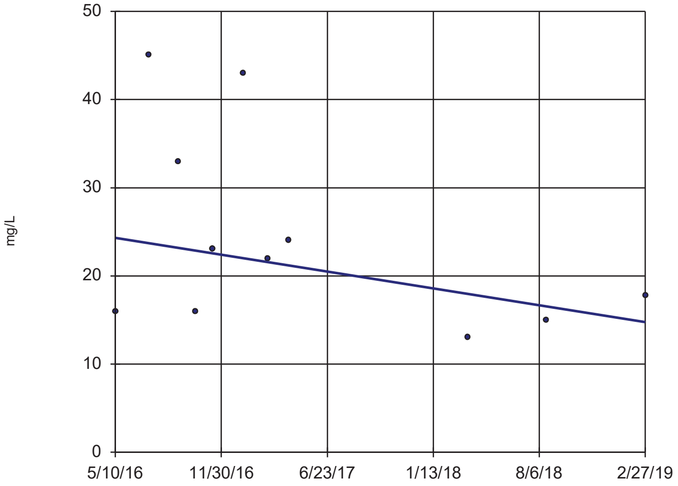


Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-16 (bg)



n = 11

Slope = -3.411 units per year.

Mann-Kendall statistic = -16 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

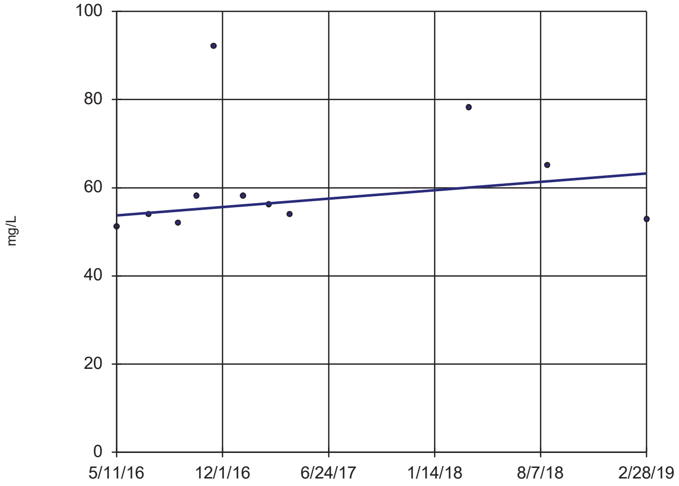
Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 11

Slope = 3.411 units per year.

Mann-Kendall statistic = 13 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

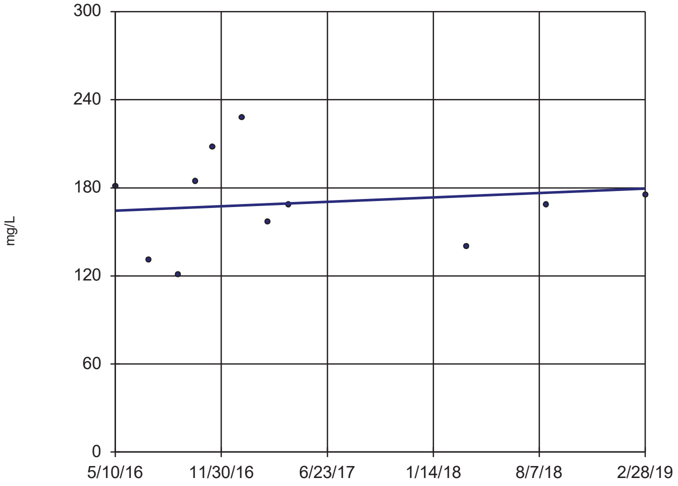
Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 11

Slope = 5.333 units per year.

Mann-Kendall statistic = 4 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

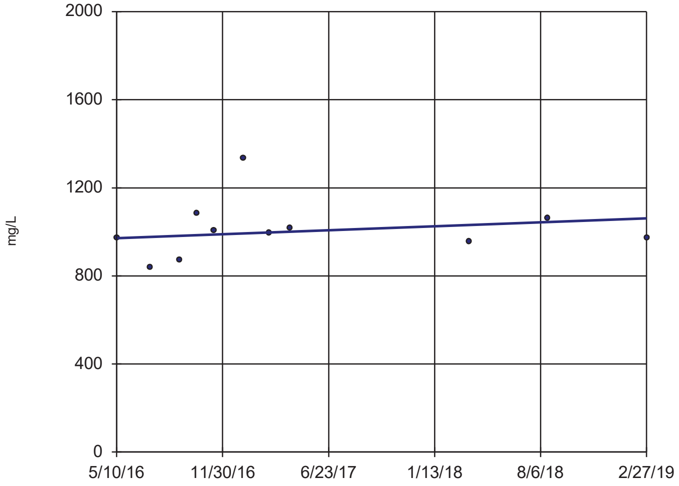
Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-34



n = 11

Slope = 32.31 units per year.

Mann-Kendall statistic = 9 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

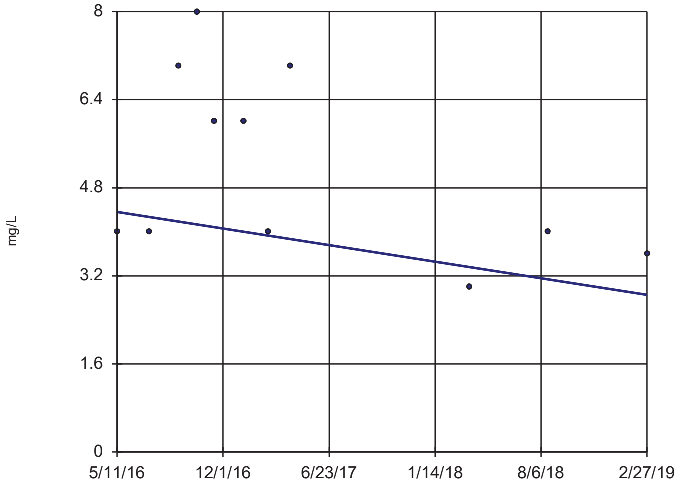
Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = -0.5376 units per year.

Mann-Kendall statistic = -15 critical = -34

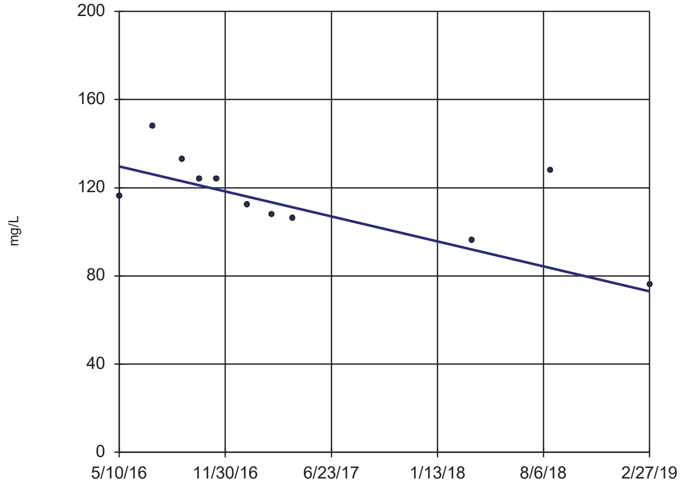
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-16 (bg)



n = 11

Slope = -20.21 units per year.

Mann-Kendall statistic = -32 critical = -34

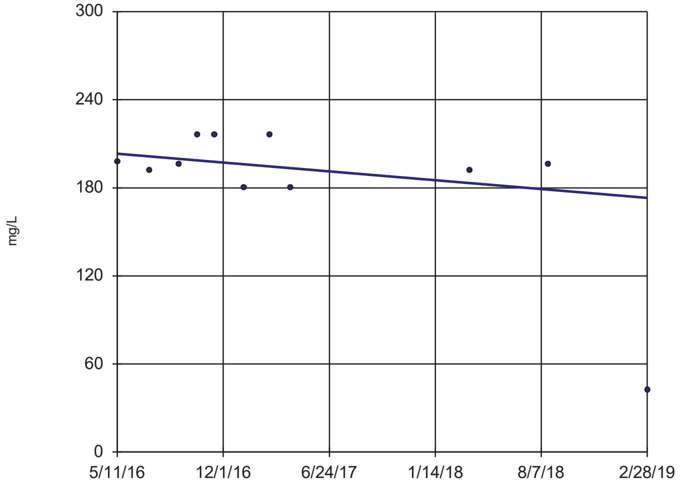
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 11

Slope = -10.77 units per year.

Mann-Kendall statistic = -15 critical = -34

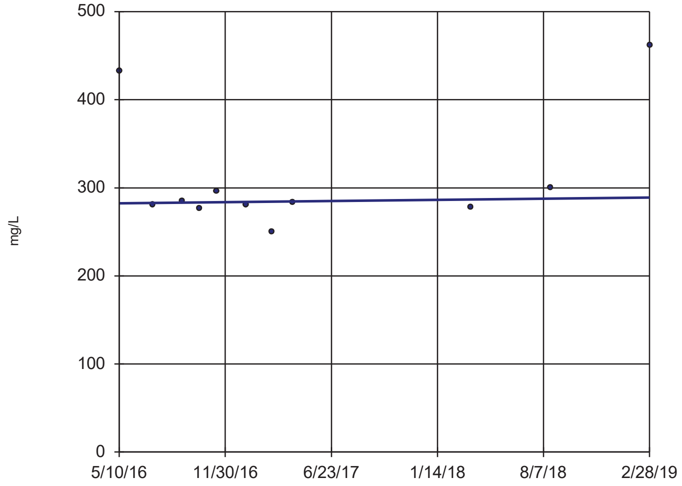
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 11

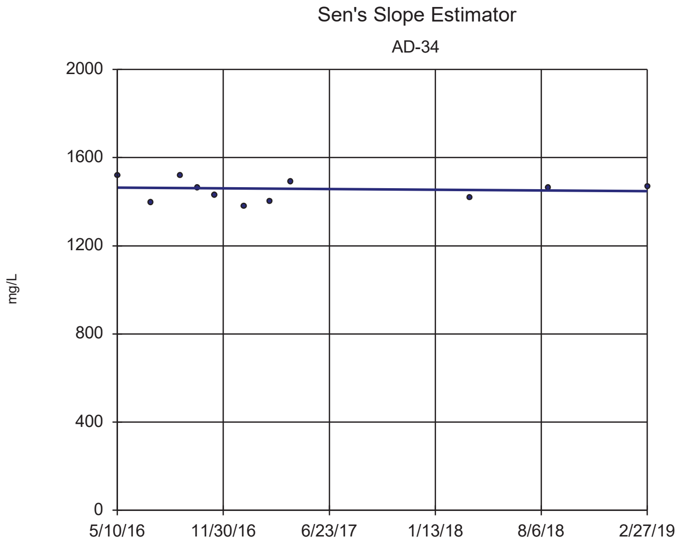
Slope = 2.271 units per year.

Mann-Kendall statistic = 4 critical = 34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



n = 11

Slope = -5.947 units per year.

Mann-Kendall statistic = -3 critical = -34

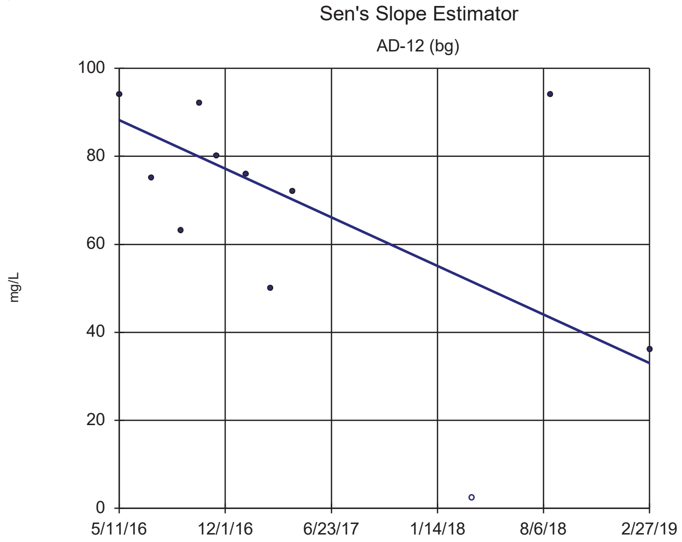
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS]   Analysis Run 7/11/2019 1:51 PM   View: Trend Tests

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.



n = 11

Slope = -19.73 units per year.

Mann-Kendall statistic = -20 critical = -34

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS]   Analysis Run 7/11/2019 1:51 PM   View: Trend Tests

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Tolerance Limit Summary Table

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/1/2019, 9:49 AM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.008	44	n/a	n/a	86.36	n/a	n/a	0.1047	NP Inter(NDs)
Arsenic, total (mg/L)	n/a	0.00774	44	n/a	n/a	61.36	n/a	n/a	0.1047	NP Inter(normality)
Barium, total (mg/L)	n/a	0.07981	44	0.04604	0.01609	0	None	No	0.05	Inter
Beryllium, total (mg/L)	n/a	0.007	44	n/a	n/a	6.818	n/a	n/a	0.1047	NP Inter(normality)
Cadmium, total (mg/L)	n/a	0.001	44	n/a	n/a	52.27	n/a	n/a	0.1047	NP Inter(normality)
Chromium, total (mg/L)	n/a	0.005116	44	-6.886	0.7673	11.36	None	ln(x)	0.05	Inter
Cobalt, total (mg/L)	n/a	0.0256	44	n/a	n/a	0	n/a	n/a	0.1047	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	n/a	7.355	44	1.427	0.6124	0	None	sqrt(x)	0.05	Inter
Fluoride, total (mg/L)	n/a	5.2	44	n/a	n/a	65.91	n/a	n/a	0.1047	NP Inter(normality)
Lead, total (mg/L)	n/a	0.00446	44	n/a	n/a	72.73	n/a	n/a	0.1047	NP Inter(normality)
Lithium, total (mg/L)	n/a	0.108	44	n/a	n/a	4.545	n/a	n/a	0.1047	NP Inter(normality)
Mercury, total (mg/L)	n/a	0.000211	44	n/a	n/a	47.73	n/a	n/a	0.1047	NP Inter(normality)
Molybdenum, total (mg/L)	n/a	0.005	44	n/a	n/a	88.64	n/a	n/a	0.1047	NP Inter(NDs)
Selenium, total (mg/L)	n/a	0.0308	44	n/a	n/a	61.36	n/a	n/a	0.1047	NP Inter(normality)
Thallium, total (mg/L)	n/a	0.002	44	n/a	n/a	81.82	n/a	n/a	0.1047	NP Inter(NDs)

Confidence Interval Summary Table - Significant Results

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 7/11/2019, 1:58 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-34**	**0.3019**	**0.2721**	**0.026**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Lithium, total (mg/L)	**AD-34**	**0.1748**	**0.1447**	**0.11**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results

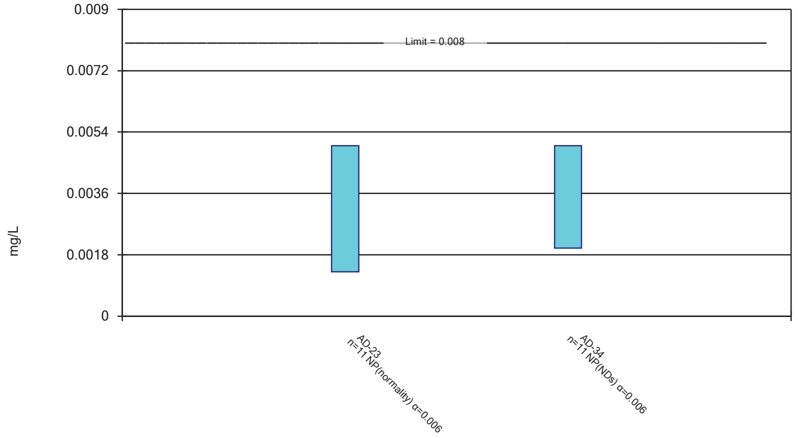
Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 7/11/2019, 1:58 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-23	0.005	0.001298	0.008	n/a	No	11	54.55	No	0.006	NP (normality)
Antimony, total (mg/L)	AD-34	0.005	0.002	0.008	n/a	No	11	90.91	No	0.006	NP (NDs)
Arsenic, total (mg/L)	AD-23	0.007638	0.002243	0.01	n/a	No	11	45.45	No	0.01	Param.
Arsenic, total (mg/L)	AD-34	0.01563	0.005694	0.01	n/a	No	11	0	No	0.01	Param.
Barium, total (mg/L)	AD-23	0.086	0.0469	2	n/a	No	11	0	No	0.006	NP (normality)
Barium, total (mg/L)	AD-34	0.06141	0.01018	2	n/a	No	11	0	x^(1/3)	0.01	Param.
Beryllium, total (mg/L)	AD-23	0.0004637	0.0001293	0.007	n/a	No	11	9.091	No	0.006	NP (normality)
Beryllium, total (mg/L)	AD-34	0.003022	0.001947	0.007	n/a	No	11	0	sqrt(x)	0.01	Param.
Cadmium, total (mg/L)	AD-23	0.001	0.000074	0.005	n/a	No	11	54.55	No	0.006	NP (normality)
Cadmium, total (mg/L)	AD-34	0.009173	0.004993	0.005	n/a	No	11	0	No	0.01	Param.
Chromium, total (mg/L)	AD-23	0.01641	0.001398	0.1	n/a	No	11	0	sqrt(x)	0.01	Param.
Chromium, total (mg/L)	AD-34	0.034	0.0005	0.1	n/a	No	11	18.18	No	0.006	NP (Cohens/xfrm)
Cobalt, total (mg/L)	AD-23	0.002737	0.00116	0.026	n/a	No	11	0	No	0.01	Param.
Cobalt, total (mg/L)	**AD-34**	**0.3019**	**0.2721**	**0.026**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Combined Radium 226 + 228 (pCi/L)	AD-23	10.01	6.077	7.36	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-34	11.43	6.828	7.36	n/a	No	11	0	No	0.01	Param.
Fluoride, total (mg/L)	AD-23	1	0.2688	5.2	n/a	No	11	81.82	No	0.006	NP (NDs)
Fluoride, total (mg/L)	AD-34	1	0.6272	5.2	n/a	No	11	63.64	No	0.006	NP (normality)
Lead, total (mg/L)	AD-23	0.015	0.003213	0.015	n/a	No	11	27.27	No	0.006	NP (Cohens/xfrm)
Lead, total (mg/L)	AD-34	0.012	0.001017	0.015	n/a	No	11	45.45	No	0.006	NP (Cohens/xfrm)
Lithium, total (mg/L)	AD-23	0.008535	0.00387	0.11	n/a	No	10	0	No	0.01	Param.
Lithium, total (mg/L)	**AD-34**	**0.1748**	**0.1447**	**0.11**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Mercury, total (mg/L)	AD-23	0.000095	0.00001721	0.002	n/a	No	11	18.18	No	0.006	NP (Cohens/xfrm)
Mercury, total (mg/L)	AD-34	0.000105	0.000015	0.002	n/a	No	11	18.18	No	0.006	NP (Cohens/xfrm)
Molybdenum, total (mg/L)	AD-23	0.005	0.0003152	0.1	n/a	No	11	54.55	No	0.006	NP (normality)
Molybdenum, total (mg/L)	AD-34	0.005	0.0006882	0.1	n/a	No	11	72.73	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-23	0.005	0.001	0.05	n/a	No	11	36.36	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-34	0.013	0.004508	0.05	n/a	No	11	54.55	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-23	0.001	0.001	0.002	n/a	No	11	90.91	No	0.006	NP (NDs)
Thallium, total (mg/L)	AD-34	0.001	0.001	0.002	n/a	No	11	90.91	No	0.006	NP (NDs)

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

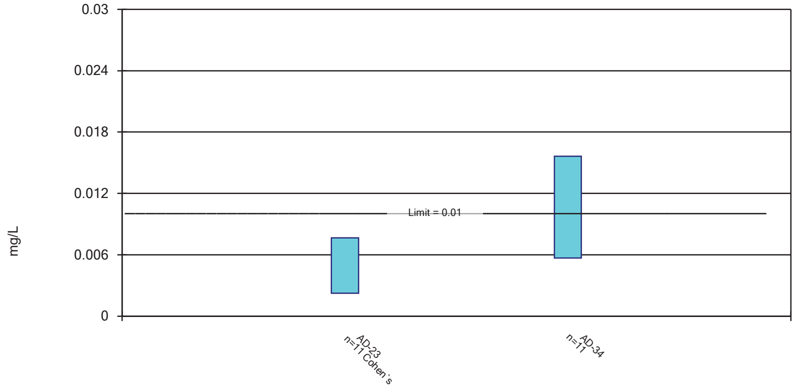


Constituent: Antimony, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

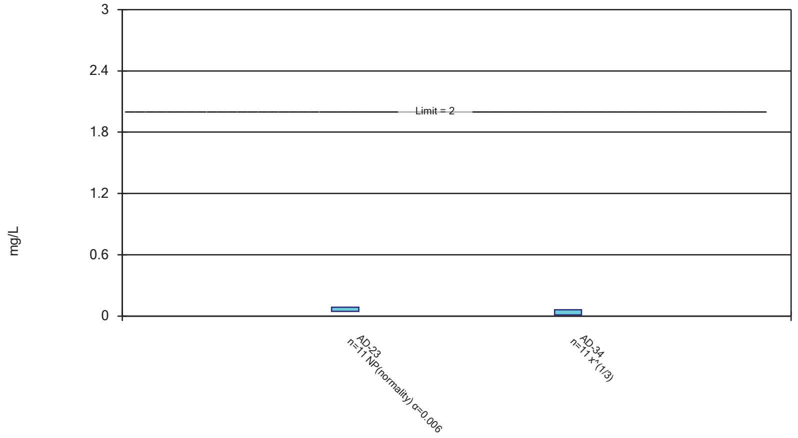


Constituent: Arsenic, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

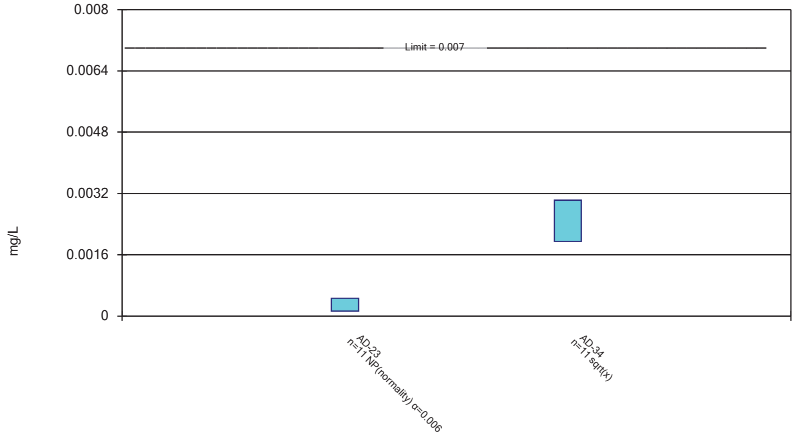


Constituent: Barium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

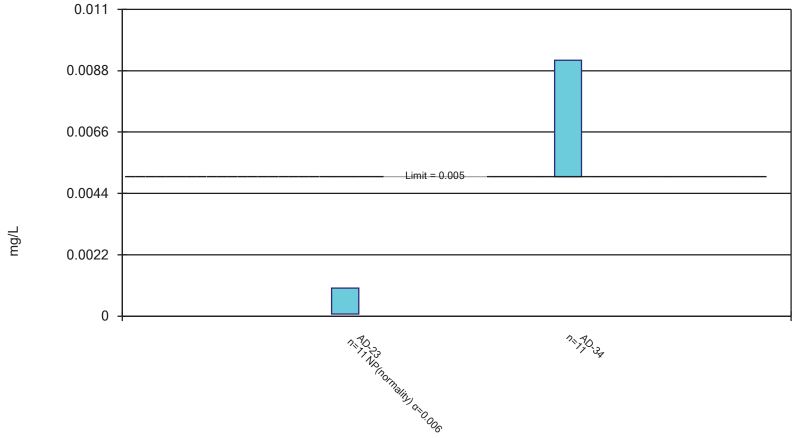


Constituent: Beryllium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

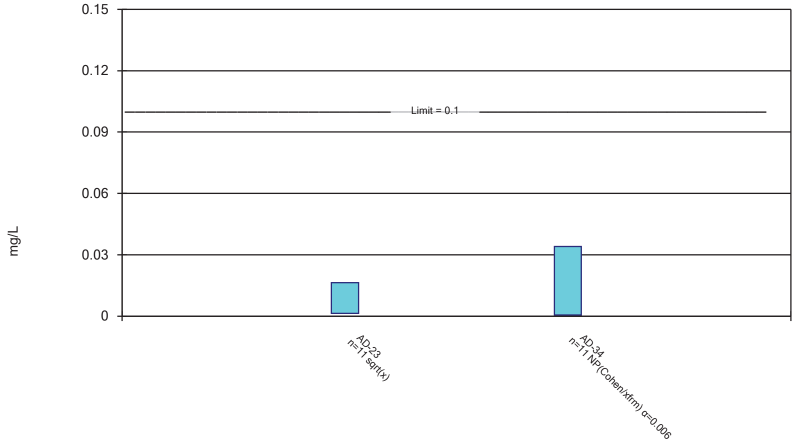


Constituent: Cadmium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.

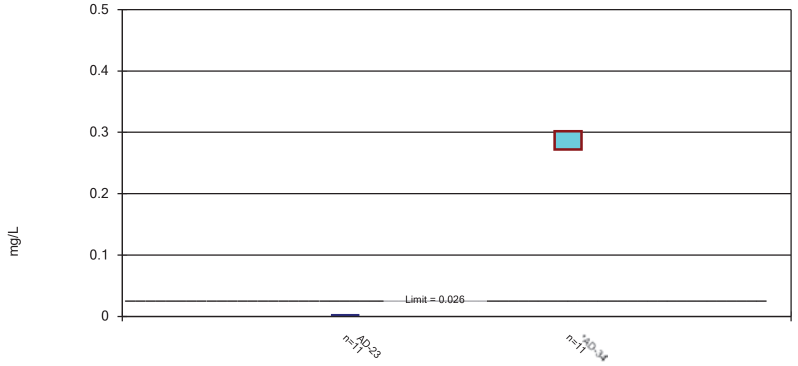


Constituent: Chromium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

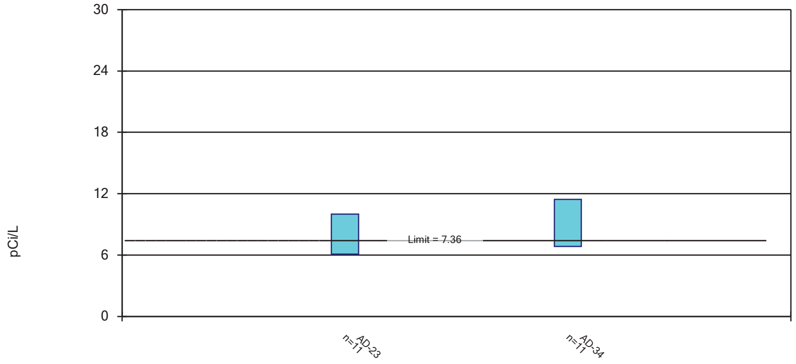


Constituent: Cobalt, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG

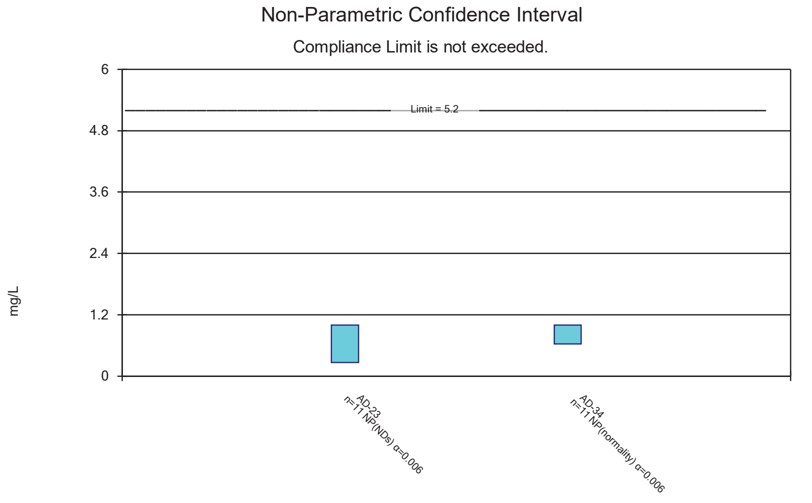
Parametric Confidence Interval

Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



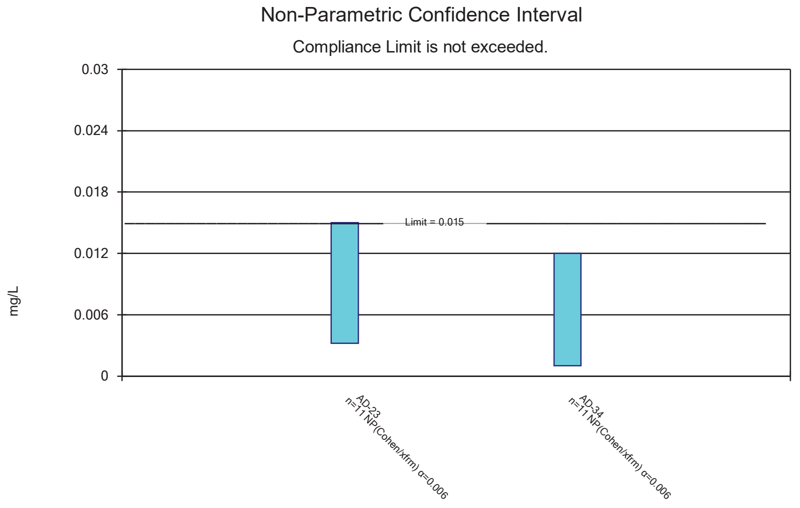
Constituent: Combined Radium 226 + 228 Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals -
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



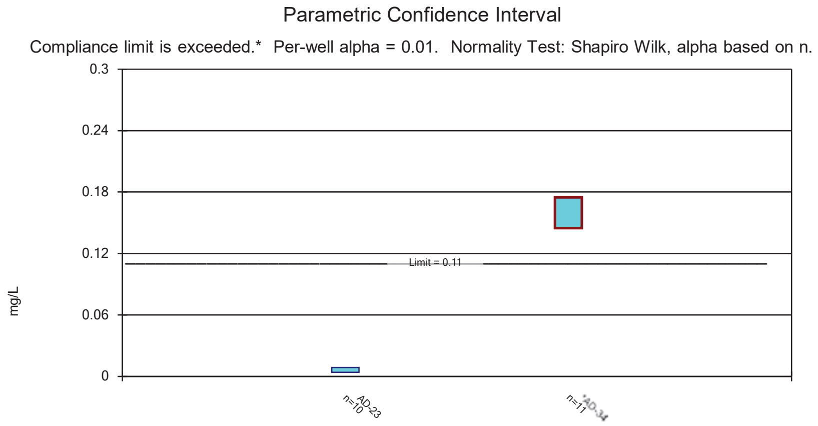
Constituent: Fluoride, total   Analysis Run 7/11/2019 1:56 PM   View: Confidence Intervals - App IV
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



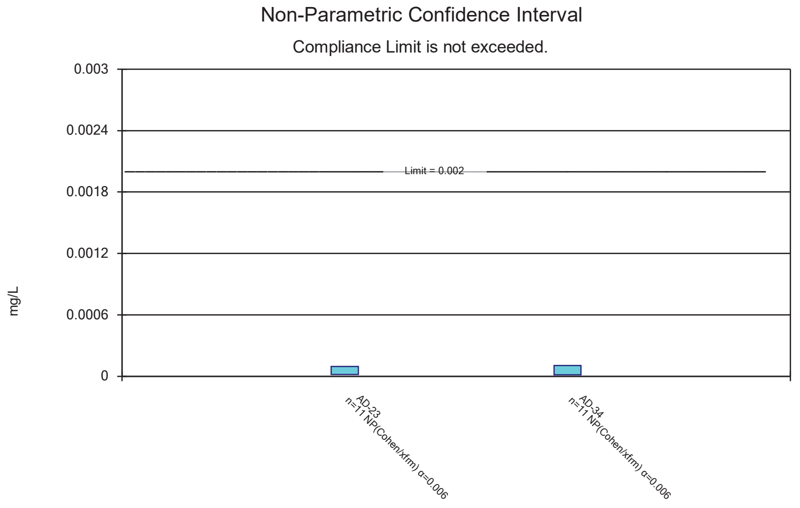
Constituent: Lead, total   Analysis Run 7/11/2019 1:56 PM   View: Confidence Intervals - App IV
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



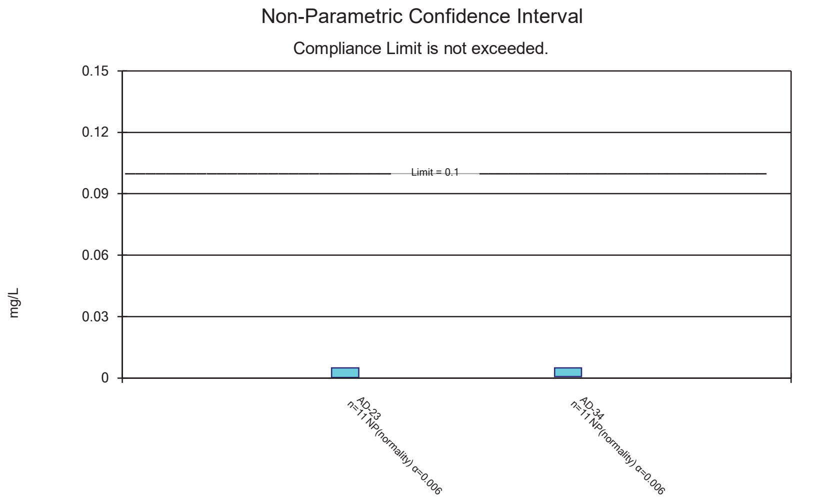
Constituent: Lithium, total   Analysis Run 7/11/2019 1:56 PM   View: Confidence Intervals - App IV
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



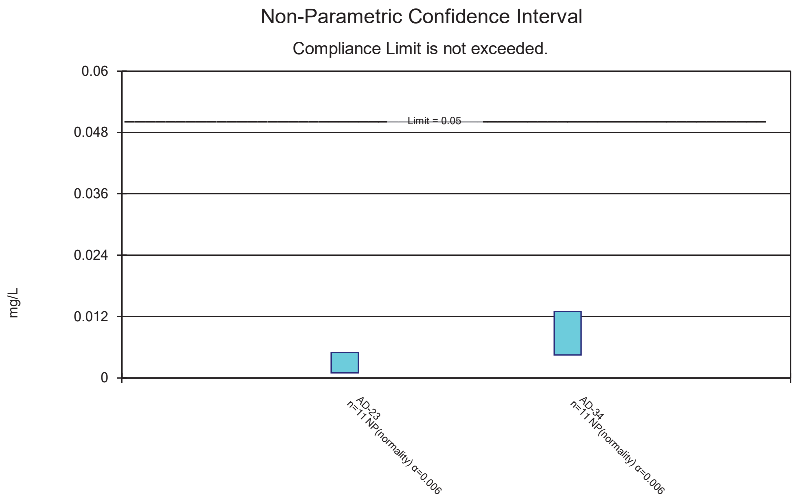
Constituent: Mercury, total   Analysis Run 7/11/2019 1:56 PM   View: Confidence Intervals - App IV
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



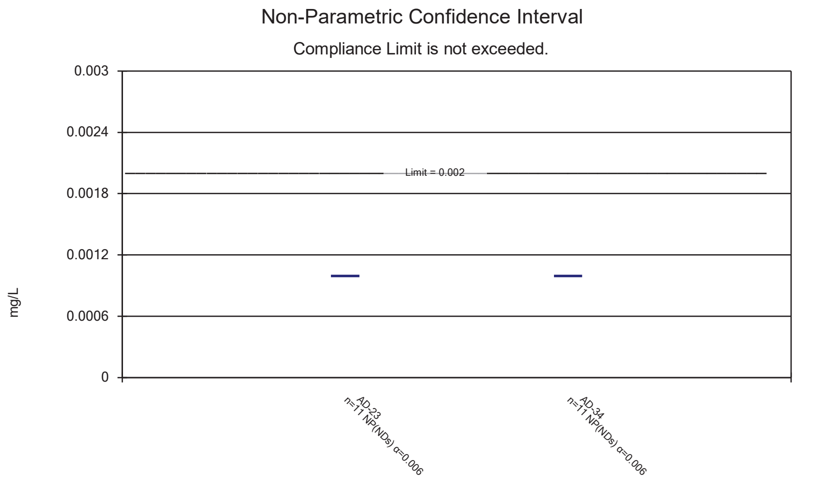
Constituent: Molybdenum, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Selenium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.19d Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Thallium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

Alternate Source Demonstration Evaluation Report

American Electric Power

Henry W. Pirkey Power Plant
Landfill CCR Management Unit
Project No. 112112

Revision 1
4/22/2019
(Original Report date 3/26/2019)

Alternate Source Demonstration Evaluation Report

prepared for

American Electric Power
Henry W. Pirkey Power Plant
Landfill CCR Management Unit
Hallsville, Texas

Project No. 112112

Revision 1
4/22/2019
(Original Report date 3/26/2019)

prepared by

Burns & McDonnell Engineering Company, Inc.
St. Louis, Missouri

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INDEX AND CERTIFICATION

American Electric Power
Alternate Source Demonstration Evaluation Report
Project No. 112112

Report Index

Certification

I hereby certify, as a Professional Engineer in the state of Texas, that the information in this document was assembled under my direct personal charge. This report is not intended or represented to be suitable for reuse by the American Electric Power or others without specific verification or adaptation by the Engineer.

ERIC STEVEN DULLE
128008

4-22-19

Eric Dulle, P.E. (Texas 128008)

Date: 4/22/2019

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EXECUTIVE SUMMARY

APPENDIX A - DATA SUMMARY TABLES

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LIST OF ABBREVIATIONS

Abbreviation	Term/Phrase/Name
AEP	American Electric Power
amsl	Above Mean Sea Level
ASD	Alternate Source Demonstration
Burns & McDonnell	Burns & McDonnell Engineering Company, Inc.
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPA	U. S. Environmental Protection Agency
ft	Feet
GWPS	Groundwater Protection Standard
LCL	Lower confidence limit
MCL	Maximum contaminant level
MDL	Method detection limit
mg/L	Milligram per Liter
MS	Matrix spike
MSD	Matrix spike duplicate
SWEPCO	Southwestern Electric Power Company
SSL	Statistically Significant Level
UTL	Upper tolerance limit

1.0 INTRODUCTION

Burns & McDonnell Engineering Company, Inc. (Burns & McDonnell) has prepared on behalf of AEP this Alternate Source Demonstration (ASD) Evaluation Report (ASD Evaluation Report) for the existing coal combustion residuals (CCR) landfill (Landfill) located at the American Electric Power (AEP) Southwestern Electric Power Company (SWEPCO) Henry W. Pirkey Power Plant (Pirkey Plant or Site) in Hallsville, Texas.

In 2018, two assessment monitoring events were conducted at the Pirkey Plant Landfill in accordance with 40 Code of Federal Regulations (CFR) 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and U. S. Environmental Protection Agency's (EPA) Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance (Unified Guidance; EPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or GWPSs established under 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). An SSL was identified for cadmium and cobalt at AD-34 at the Landfill (Geosyntec, 2018).

This ASD is produced in conformance with requirements in the "Standards for the Disposal of Coal Combustion Residuals (CCR) in Landfills and Surface Impoundments" in 40 CFR 257.95(g)(3)(ii).

1.1 Purpose and Scope of Evaluation

The purpose of this evaluation is to determine if concentrations of certain CCR constituents measured in groundwater samples collected from Site groundwater monitoring wells at SSLs above GWPSs established for the Landfill in accordance with 40 CFR 257.95(h) resulted from a source other than the Landfill or from natural variation in groundwater quality. Specifically, the LCL for cadmium (0.00511 milligram per liter [mg/L]) at AD-34 was above the Landfill GWPS of 0.005 mg/L and the LCL for cobalt (0.277 mg/L) at AD-34 was above the Landfill GWPS of 0.026 mg/L. The scope of the evaluation included reviews of historical site records, existing groundwater monitoring system well data, and supplemental data collected from December 2018 through March 2019 to support this evaluation.

1.2 Site Setting

As shown on Figure 1-1, the Landfill is bound by an access road followed by Brandy Branch Reservoir to the east, the Stormwater Runoff Pond followed by former lignite mining areas to the south, former lignite mining areas to the west, and a coal pile and coal pile runoff pond to the north. Western portions of the Landfill are underlain by former lignite mining (reclaimed) land. The local surface topography slopes downward to the southwest towards Hatley Creek, located approximately 0.7 miles west of the Landfill. An unnamed tributary of Hatley Creek originates south of the Stormwater Runoff Pond and flows to the southwest towards Hatley Creek.

The Landfill, including closed, active, and under construction areas, occupies approximately 137 acres. The landfill consists of 10 cells identified by their date of construction (1984, 1987, 1993, 1995, 1997, 1999, 2005E, 2005W, 2012 and 2015) and there are three (3) leachate collection outlets along the southern edge of the active cell and the areas under construction. According to the Arcadis 2018 Landfill Lateral Expansion – CCR Location Restriction Evaluation (Arcadis 2018), AEP initiated an evaluation for the lateral expansion of the landfill. The expansion will cover approximately 15 acres and will be located directly southeast of the current landfill.

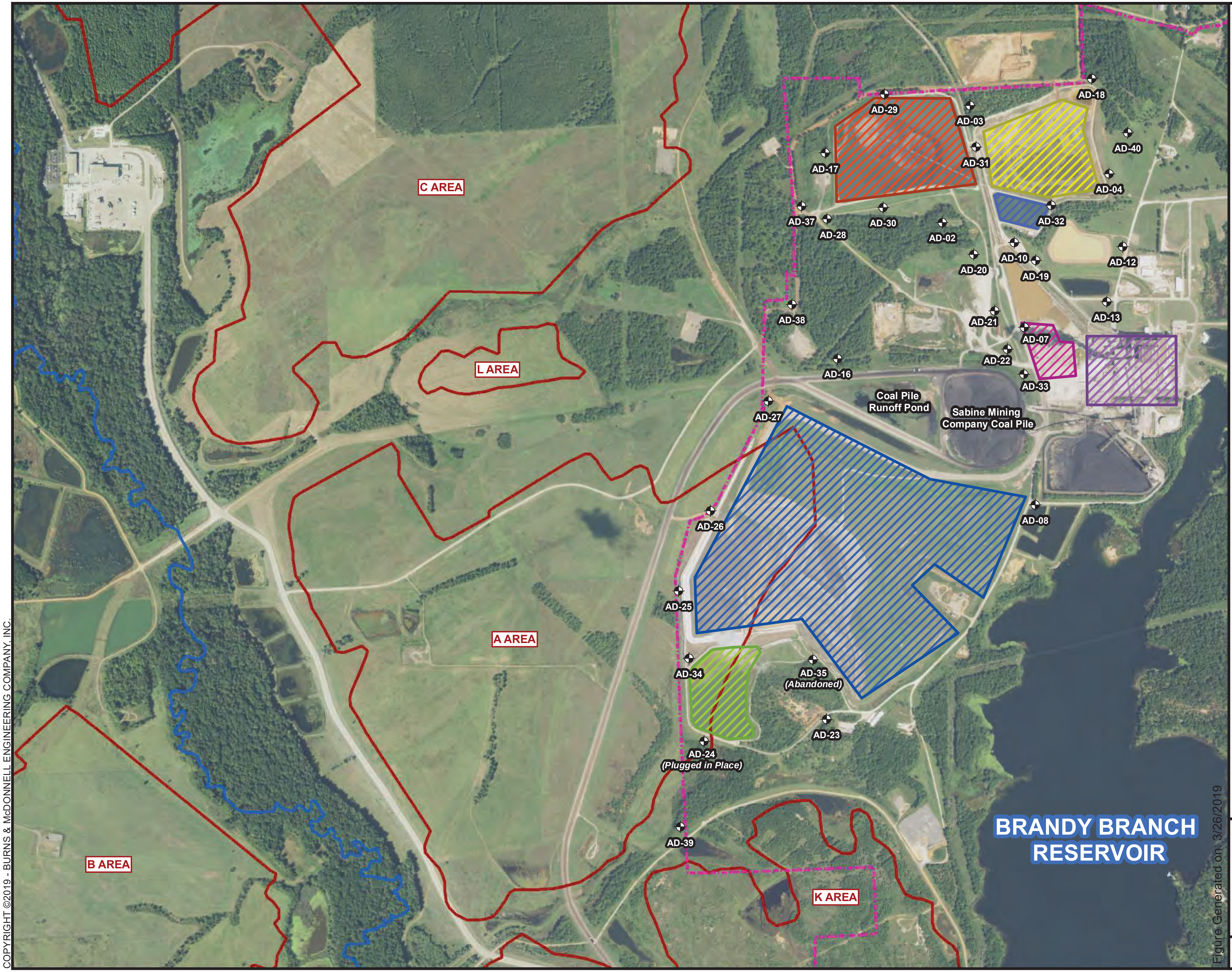

Figure Generated on: 3/26/2019

LEGEND

- ⊕ AEP CCR WELL
- ▨ FGD STACKOUT AREA
- ▨ LANDFILL
- ▨ STORMWATER RUNOFF POND
- ▨ CLEARWATER POND
- ▨ EAST BOTTOM ASH POND
- ▨ WEST BOTTOM ASH POND
- ▨ AEP PIRKEY PLANT
- — HATLEY CREEK
- -·- PROPERTY BOUNDARY
- ☐ MINE AREAS

NOTES

1) PROPERTY BOUNDARY PROVIDED BY AKRON CONSULTING, LLC.

2) MOST RECENT SAMPLE AND BORING LOCATIONS - 3/20/19.

N

0 625 1,250 2,500 Feet

FIGURE 1-1
SITE LAYOUT MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

BURNS & McDONNELL.

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2.0 SUPPLEMENTAL DATA COLLECTION

This section of the ASD Evaluation Report describes sampling and analysis conducted during supplemental data collection activities to support the Landfill ASD evaluation at the Site in February and March 2019.

2.1 Overview

Supplemental data collection activities included the collection and analysis of groundwater samples from existing Landfill sentinel wells AD-25 and AD-26 and newly installed sentinel well (SB-10/AD-39) and nature and extent wells located west and southwest of the Landfill (SB-07, SB-08, SB-09, SB-10, and SB-11). In addition, these activities included the collection and analysis of a Landfill leachate sample and surface water sample of the water impounded in the Landfill Stormwater Runoff Pond located southwest of the Landfill. A summary of sample locations is provided in Table 2-1 below and sample locations are shown on Figure 2-1.

Table 2-1: Supplemental Data Collection Summary

Sample Media	Location (Designation)	Purpose/Notes
Landfill Leachate	Landfill	Characterize leachate from Landfill
Surface Water	Landfill Stormwater Runoff Pond	Characterize water quality for runoff collected in Landfill Stormwater Runoff Pond
Groundwater	AD-25 (sentinel well), AD-26 (sentinel well), SB-07 (nature and extent well), SB-08 (nature and extent well), SB-09 (nature and extent well), SB-10 (nature and extent well), SB-11 (nature and extent well), and AD-39 (sentinel well)	Characterize groundwater quality in former lignite mining (reclaimed) areas and areas to the southwest of the Landfill
Soil	SB-6, SB-7, SB-8, SB-9, SB-10 and SB-11	Characterize soil conditions in former lignite mining (reclaimed) areas and background (SB-6)

A summary of the Landfill leachate and stormwater runoff pond results is provided in Appendix A, Table A-1, a summary of groundwater sampling results is provided in Appendix A, Table A-2, and a summary of soil sampling results are summarized in Appendix A, Table A-3. A synoptic round of water level measurements was collected on March 13, 2019 at existing monitoring and sentinel wells and at newly installed nature and extent and sentinel monitoring wells. These measurements are summarized in

Appendix A, Table A-4. Figure 2-2 presents the potentiometric surface map prepared using the March 13, 2019 synoptic round of water level measurements.

LEGEND

⊕ AEP CCR WELL
▲ LEACHATE SAMPLE
⊕ SOIL BORING
◉ SURFACE WATER
— HATLEY CREEK
-·- PROPERTY BOUNDARY
▭ MINE AREAS

NOTES

1) PROPERTY BOUNDARY PROVIDED BY AKRON CONSULTING, LLC.
2) MOST RECENT SAMPLE AND BORING LOCATIONS - 3/20/19.

N

0 500 1,000 2,000 Feet

Figure Generated on: 3/26/2019

FIGURE 2-1
SAMPLE LOCATION MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

BURNS & McDONNELL.

COPYRIGHT ©2019 - BURNS & McDONNELL ENGINEERING COMPANY, INC.

Figure Generated on: 3/26/2019

LEGEND

- ⊕ AEP CCR WELL
- ● SOIL BORING
- — GROUNDWATER CONTOURS 3/12/19
- — HATLEY CREEK
- -·- PROPERTY BOUNDARY
- ☐ MINE AREAS

NOTES

1) PROPERTY BOUNDARY PROVIDED BY AKRON CONSULTING, LLC.
2) GROUNDWATER CONTOURS PLOTTED AT 5'/CONTOUR.
3) GROUNDWATER CONTOURS DRAFTED BASED ON ELEVATIONS COLLECTED ON 3/12/19

N

0 500 1,000 2,000 Feet

FIGURE 2-2
POTENTIOMETRIC SURFACE MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

BURNS & McDONNELL.

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3.0 ALTERNATE SOURCE EVALUATION SUMMARY

This section of the ASD Evaluation Report presents lines of evidence that CCR constituents, at concentrations above GWPSs at the Landfill, resulted from sources other than the Landfill.

3.1 Coal Mine Drainage

Water levels at monitoring well AD-34 are consistently above the ground surface and represent artesian conditions. Prior to the installation of AD-34 and landfill cell and stormwater runoff pond expansion in 2015, groundwater from the former lignite (reclaimed) mine discharged to the ground surface in the area of AD-34. Figure 3-1 shows two aerial photographs in the area of AD-34. The December 2009 photo depicts surface flow from the mine drainage with the future location of monitoring well AD-34 located adjacent to the historical surface discharge of mine drainage (AD-34 was installed in December 2015). The August 2018 photo shows the current well location relative to the Landfill Pond Road and the 2015 Cell.

Studies of coal mine draining have identified the presence of cadmium and cobalt in coal mine drainage water. One such study summarizes analytical results for water samples from 128 untreated coal mine drainage discharges (Hyman and Watzlaf, 1997). For samples included in this study, 119 of 128 were analyzed for cadmium and 110 of 128 were analyzed for cobalt. The average of the detected cadmium concentrations was 0.014 mg/L and average of the detected cobalt concentrations 0.794 mg/L. In another EPA study, 15 samples of runoff water from coal mine reclamation areas were analyzed for cadmium and the average of the detected cadmium concentrations was 0.019 mg/L (USEPA, 1982). The runoff water samples for this study were not analyzed for cobalt. A study published in 2008 included analysis of cadmium results for 140 abandoned coal mines in Pennsylvania. For the 99 abandoned bituminous coal sites included in the study the median cadmium concentration was 0.023 mg/L (Cravotta III, 2008). The data from these studies indicates that untreated coal mine drainage similar to conditions at the Landfill affect groundwater conditions. Therefore, impacts from coal mine drainage in the area of AD-34 and coal mine drainage is a source of cadmium and cobalt.

DECEMBER 2009 - PRE 2015 CELL AND POND EXPANSION

APRIL 2017 - POST 2015 CELL AND POND EXPANSION

LEGEND

⊕ AEP CCR WELL

▪▪ PROPERTY_BOUNDARY

▭ RUNOFF FROM MINE DRAINAGE

NOTE

1) 2009 AND 2017 AERIAL PHOTO SOURCE: GOOGLE EARTH

2) MONITORING WELL AD-34 WAS INSTALLED ON: DECEMBER 11TH, 2015

N

0 30 60 120 Feet

FIGURE 3-1
HISTORICAL COAL MINE
DRAINAGE MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

BURNS McDONNELL

Figure Generated On: 4/19/2019

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3.2 Historical Cadmium Concentrations

Table 3-1 presents historical concentrations of cadmium in samples from sentinel wells AD-25 and AD-26 and Table 3-2 presents historical concentrations of cadmium in samples from monitoring well AD-34.

Table 3-1: Historical Cadmium Concentrations for AD-25 and AD-26

Well Location	Sample Date	Cadmium (mg/L)
AD-25	4/12/2011	0.008
	12/14/2011	0.004
	6/19/2012	0.003
	1/22/2013	0.001
	7/17/2013	0.002
	1/21/2014	0.009
	7/8/2014	0.013
AD-26	4/12/2011	0.004
	12/14/2011	0.005
	6/19/2012	0.003
	1/22/2013	0.005
	7/17/2013	0.004
	1/21/2014	0.003
	7/8/2014	0.012

Notes: mg/L = milligram per liter

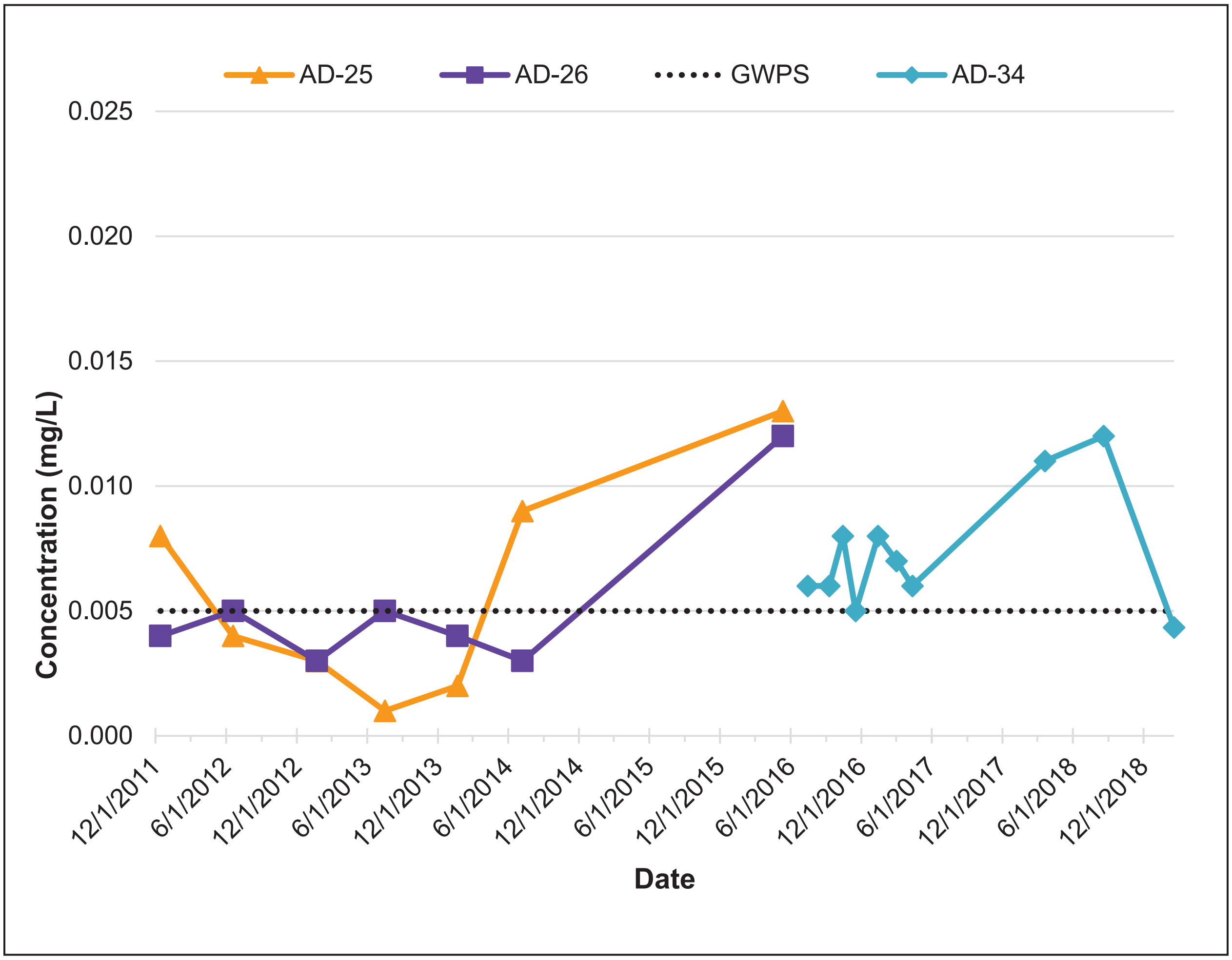
Table 3-2: Historical Cadmium Concentrations for AD-34

Well Location	Sample Date	Cadmium (mg/L)
AD-34	5/10/2016	0.006
	7/13/2016	0.006
	9/8/2016	0.008
	10/12/2016	0.005
	11/15/2016	0.008
	1/11/2017	0.007
	2/28/2017	0.006
	4/10/2017	0.011
	3/21/2018	0.012
	8/20/2018	0.00434

Notes: mg/L = milligram per liter

Figure 3-2 shows concentrations of cadmium over time in sentinel wells AD-25 and AD-26 along with concentrations of cadmium over time in samples from monitoring well AD-34. A comparison of these historical results indicates that recent cadmium concentrations in samples from AD-34 are within the range of historical cadmium concentrations in samples from sentinel wells located immediately hydraulically upgradient of AD-34. These cadmium concentrations are also at levels consistent with the average and median concentrations for water affected by former coal mining activities discussed in Section 3.1. It should also be noted that the cadmium concentrations in the sentinel and monitoring wells exhibit natural variability over time. This data indicates former lignite coal mining is a source cadmium at AD-34.

Figure 3-2: Cadmium Concentrations at AD-25, AD-26 and AD-34



3.3 Historical Cobalt Concentrations

Table 3-3 presents historical concentrations of cobalt in samples from monitoring well AD-34. Historical samples from AD-25 and AD-26 were not analyzed for cobalt. A comparison between AD-34 historical and recent results indicate that recent cobalt concentrations are generally consistent over time and have been within a relatively narrow range. The February 2019 concentration of cobalt at sentinel well AD-25, located immediately hydraulically upgradient of AD-34, is approximately two times higher than the average concentration at AD-34 and is slightly lower than the average concentration for coal mine drainage water discussed in Section 3.1. This data indicates former lignite coal mining is a source of cobalt at AD-34.

Table 3-3: Cobalt Concentrations for AD-25, AD-26, and AD-34

Well Location	Sample Date	Cobalt (mg/L)
AD-25	2/18/2019	0.63
AD-26	2/18/2019	0.19 F
AD-34	5/10/2016	0.301
	7/13/2016	0.296
	9/8/2016	0.306
	10/12/2016	0.297
	11/15/2016	0.292
	1/11/2017	0.284
	2/28/2017	0.294
	4/10/2017	0.299
	3/21/2018	0.279
	8/20/2018	0.249

Notes: mg/L = milligram per liter, F = Matrix Spike (MS) and/or MS Duplicate (MSD) Recovery is outside acceptable limits

3.4 Comparison of Groundwater and Landfill Sample Results

This section presents a comparison of concentrations of leachate from the Landfill and the adjacent stormwater runoff pond to evaluate if they are a potential source of cadmium and cobalt in AD-34. Table 3-4 shows the most recent analytical sampling results for monitoring wells and sentinel wells in the area of the Landfill. This table also notes if the monitoring or sentinel well is considered hydraulically upgradient, downgradient, or cross-gradient of the Landfill and if the monitoring or sentinel well is in a former lignite mining area. As presented in Table 3-4, cadmium and cobalt were detected at very low concentrations in the Landfill leachate and stormwater runoff pond samples. Cadmium concentrations from both potential sources (i.e., Landfill leachate and stormwater runoff pond samples) are an order of magnitude (i.e., ten times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area. Cobalt concentrations in the Landfill leachate and stormwater runoff pond samples are three orders of magnitude (i.e., 1,000 times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area. Cadmium and cobalt concentrations were highest in samples from nature and extent wells and sentinel wells in former lignite mining area.

Two CCR constituents detected at relatively high levels in the Landfill leachate and stormwater runoff ponds were chloride and molybdenum. Chloride is a conservative (non-reactive) ion and can be used to evaluate the potential influence of leachate on groundwater quality and molybdenum metal transport can be similar to other metals associated with CCR. The highest concentrations of chloride and molybdenum were detected in the Landfill leachate and stormwater runoff pond samples. Molybdenum was not detected above the laboratory reporting limit in the most recent samples collected from monitoring and sentinel wells and the concentration of molybdenum in the Landfill leachate and stormwater runoff pond water samples was four to five orders of magnitude (i.e., 10,000 to 100,000 times) higher than the detected levels at upgradient and downgradient sentinel wells. Chloride concentrations at nature and extent wells, sentinel wells and monitoring wells ranged from 2.5 mg/L to 38 mg/L, were variable among the well groupings, and were an order of magnitude (i.e., ten times) lower than chloride concentrations in the Landfill leachate and stormwater runoff pond. The comparison of the results demonstrates little correlation between the concentration of key constituents in groundwater and leachate samples indicating that the Landfill and the stormwater runoff pond are not a source of cadmium and cobalt in AD-34.

Additionally, concentrations in downgradient wells AD-23, AD-35, and AD-39 are similar to concentrations in upgradient wells, indicating that the Landfill is not affecting groundwater conditions in these downgradient wells. Also, AD-34 concentrations are more similar to concentrations in nature and extent wells and sentinel wells (also installed within the former lignite mine area), further indicating that former lignite mining area is a source of cadmium and cobalt in AD-34.

The highest concentrations of cobalt in recent groundwater samples from the area of the Landfill were from wells installed within the former lignite mining area and the highest cobalt concentration was detected at AD-25 located immediately upgradient of AD-34. Similarly, the highest concentrations of cadmium were detected in wells installed within the former lignite mining area. Lower cadmium concentrations further to the west of the Landfill may be the result of increased pH in these areas reducing the solubility and mobility of cadmium in groundwater. This pattern of high cadmium and cobalt groundwater concentrations indicate that the former lignite mining area is a source of cadmium and cobalt in AD-34.

Table 3-4: Other Notable Constituents

Sample Location/Type	Former Lignite Mine (Reclaimed) Area	Sample Date	Cadmium (mg/L)	Chloride (mg/L)	Cobalt (mg/L)	Molybdenum (mg/L)
Upgradient Monitoring Wells						
AD-8	No	8/20/2018	0.00018	18	0.0159	0.00002
AD-12	No	8/20/2018	0.00001	10	0.00172	0.00004
AD-27	No	8/21/2018	0.00046	10	0.0246	0.00007
Landfill						
Leachate	--	3/6/2019	0.0003 J	640	0.00043 J	3.7

Sample Location/Type	Former Lignite Mine (Reclaimed) Area	Sample Date	Cadmium (mg/L)	Chloride (mg/L)	Cobalt (mg/L)	Molybdenum (mg/L)
Stormwater Runoff Pond	--	3/6/2019	0.0001 J	110	0.00091 JF	0.52
Downgradient Monitoring Wells						
AD-23	No	8/20/2018	0.00001 J	9	0.000803	0.00007 J
AD-34	Yes	8/20/2018	0.00434	10	0.249	0.00003 J
AD-35	No	8/20/2018	0.00012	38	0.0119	0.00004 J
AD-39	No	3/7/2019	0.005 U	2.5 JB	0.0036 J	0.01 U
Cross-gradient and Downgradient Sentinel and Nature and Extent Wells (former lignite mining area)						
AD-25	Yes	2/18/2019	0.0029	6.2 B	0.63	0.01 U
AD-26	Yes	2/18/2019	0.0035	34	0.19 F	0.01 U
SB-07	Yes	3/6/2019	0.0005 U	18.3	0.0235	0.001 U
SB-08	Yes	2/28/2019	0.0002 J	22 B	0.037	0.01 U
SB-09	Yes	3/6/2019	0.0008	32.7	0.0878	0.001 U
SB-11	No	3/11/2019	0.0005 U	14.5	0.0228	0.001 U

Notes: mg/L = milligram per liter; B = Compound was found in the blank and sample; F = Matrix Spike (MS) and/or MS Duplicate (MSD) Recovery is outside acceptable limits; J = Result is less than the reporting limit but greater than or equal to the Method Detection Limit (MDL) and the concentration is an approximate value; U = Indicates the analyte was analyzed for but not detected above the MDL.

3.5 Soil Sampling Results

Soil sample analytical results are summarized in Appendix A, Table A-3. Concentrations of cobalt were generally an order of magnitude (i.e., ten times) higher than the concentrations of cadmium detected in the soil samples in the area of the Landfill. Groundwater concentrations exhibit a similar pattern with cobalt concentrations and are generally at least an order of magnitude higher than the cadmium concentrations in groundwater. The highest concentrations of both cadmium and cobalt were detected in soil samples collected in former lignite mining area (four of the five soil sampling locations were in former lignite mining (reclaimed) area). The pattern for groundwater concentrations is also similar with the highest cobalt and cadmium concentrations found in the former lignite mining area. This pattern of high cadmium and cobalt groundwater concentrations indicate that the former lignite mining area is a source of cadmium and cobalt in AD-34.

4.0 SUMMARY AND CONCLUSIONS

This section of the ASD Evaluation Report provides a summary of the notable observations and conclusions resulting from a review of the groundwater, leachate, stormwater runoff pond water sample, and soil sample results for the Site. The following observations and conclusions provide multiple lines of evidence that the source of cadmium and cobalt concentration above the GWPS at AD-34 is the former lignite mining area.

- Monitoring well AD-34 is located in reclaimed mine spoils from former lignite mining operations and is in an area where historical coal mine drainage discharged to the ground surface. AD-34 is located hydraulically downgradient of portions of former lignite mining area and portions of the landfill.

- Recent cadmium concentrations in groundwater samples from AD-34 are similar to historical cadmium concentrations in groundwater samples from nature and extent wells in reclaimed mine spoils located immediately hydraulically upgradient of AD-34 (AD-25 and AD-26) and are similar to concentrations found in coal mine drainage impacted water. This data is evidence that former lignite coal mining is a source of cadmium at AD-34.

- The February 2019 concentration of cobalt at sentinel well AD-25 located immediately hydraulically upgradient of AD-34 is approximately two times higher than the average concentration at AD-34 and is slightly lower than the average concentration found in coal mine drainage impacted water. This data is evidence that former lignite coal mining is a source of cobalt at AD-34.

- Cadmium and cobalt were detected at very low concentrations in the Landfill leachate and stormwater runoff pond samples as well as upgradient monitoring wells. Cadmium and cobalt concentrations were highest in samples from monitoring wells, sentinel well, and nature and extent well in former lignite mining (reclaimed) areas. Conversely, the highest concentrations of chloride and molybdenum were detected in the Landfill leachate and stormwater runoff pond samples. The lack of correlation between key constituents in groundwater and leachate samples and lack of correlation among wells is evidence that the Landfill and stormwater runoff pond are not the source of cadmium and cobalt at AD-34.

- The highest concentrations of cadmium and cobalt were consistently detected in wells in the former lignite mining area. This pattern of high cadmium and cobalt groundwater concentrations is evidence that the former lignite mining area is the source of cadmium and cobalt in AD-34.

- The pattern for the highest soil sample concentrations was similar to the groundwater pattern with the highest concentrations of both cadmium and cobalt detected in soil samples from the former lignite mining area (four of the five soil sampling locations were in former lignite mining area). This pattern of high cadmium and cobalt soil concentrations is evidence that the former lignite mining area is a source of cadmium and cobalt at AD-34.

Per EPA’s Solid Waste Disposal Facility Criteria Technical Manual, Subpart E (EPA530-R-93-017, November 1993), this ASD has documented that:

- An alternative source exists. The highest concentrations of cadmium and cobalt in groundwater and soil samples were consistently detected in wells in the former lignite mining area. Literature documents coal mine impacted sites have high concentration of cadmium and cobalt. Previous studies of coal mine discharges have identified similar elevated concentrations of cadmium and cobalt.

- Hydraulic connection exists between the alternative source and the groundwater monitoring well(s) with the significant increase. The established Landfill monitoring well network and newly installed shallow sentinel wells in the area of the Landfill are all screened within the same hydrostratigraphic zone of the uppermost aquifer and former lignite mining area and non-mined area are hydraulically connected.

- Constituent(s) are present at the alternative source or along the flow path from the alternative source prior to possible release from the [CCR] unit. The highest concentrations of cadmium and cobalt were consistently detected in wells in the former lignite mining area and as shown on Figure 2-2 former lignite mining areas are located hydraulically upgradient from AD-34.

- The relative concentration and distribution of constituents in the zone of contamination are more strongly linked to the alternative source than to the [CCR] unit when the fate and transport characteristics of the constituents are considered. The highest concentrations of cadmium and cobalt were consistently detected in wells in the former lignite mining area. Cadmium concentrations in Landfill leachate was an order of magnitude (i.e., ten times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area. Cobalt concentrations in Landfill leachate are three orders of magnitude (i.e. 1,000 times) lower than concentrations at AD-34, AD-25, and AD-26 in the former lignite mining area.

- The concentration observed in groundwater could not have resulted from the [CCR] unit given the waste constituents and concentrations in the [CCR] unit leachate and wastes, and site hydrogeologic conditions. Cadmium concentration in the Landfill leachate was an order of magnitude (i.e., ten times) lower than concentrations detected at AD-34, AD-25, and AD-26 located in the former lignite mining area. Cobalt concentrations in Landfill leachate are three orders of magnitude (i.e. 1,000 times) lower than concentrations at AD-34, AD-25, and AD-26 located in the former lignite mining area.
- The data supporting conclusions regarding the alternative source are historically consistent with hydrogeologic conditions and findings of the monitoring program. As discussed in Sections 3.2 and 3.3 cadmium and cobalt concentrations have shown some natural variability but are generally consistent over time.

As summarized above, there are multiple lines of evidence demonstrating that the source of cadmium and cobalt concentrations in samples from monitoring well AD-34 resulting in an SSL above the GWPS is the former lignite mining spoils located beneath portions of the Landfill and to the west of the Landfill.

5.0 REFERENCES

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APPENDIX A - DATA SUMMARY TABLES

Table A-1 - Landfill Sample Results
Appendix III/Appendix IV

Sample Area:		Landfill	Landfill
Sample ID:		**LANDFILL LEACHATE-1**	**LANDFILL STORMWATER RUNOFF POND-1**
Sample Type:		Water	Water
Screened Interval (ft bgs):		Surface	Surface
Date Sampled:		2/11/2019	2/11/2019
Appendix III			
Boron	mg/L	5000.0 U	1000.0 U
Calcium	mg/L	590.0	290.0
Chloride	mg/L	640.0	110.0
Fluoride	mg/L	0.5 J	0.75 J
pH	-	9.6	8.85
Sulfate	mg/L	2200.0 B	1100.0 B
Total Dissolved Solids	mg/L	5100.0	2000.0
Appendix IV			
Antimony	mg/L	0.0044 B	0.0026 J B
Arsenic	mg/L	0.045	0.0048 J
Barium	mg/L	0.048 J	0.071 J F1
Beryllium	mg/L	0.00011 J	0.004 U
Cadmium	mg/L	0.0003 J	0.00012 J F1
Chromium	mg/L	0.005 U	0.0005 J F1
Cobalt	mg/L	0.00043 J	0.00091 J F1
Fluoride	mg/L	0.5 J	0.75 J
Lead	mg/L	0.00029 J B	0.00014 J B
Lithium	mg/L	0.042	0.014 J
Mercury	mg/L	0.0005	0.0002 U F1
Molybdenum	mg/L	3.7	0.52
Selenium	mg/L	0.13	0.037
Thallium	mg/L	0.002 U	0.002 U
Combined Ra 226/228	pCi/L	0.528 U	0.375 U

NA - Data Not Yet Available from Lab.

B - Compound was found in the blank and sample.

J - Result is less than the Reporting Limit (RL) but greater than or equal to the Method Detection Limit (MDL) and the concentrat

U - Indicates the analyte was analyzed for but not detected.

M1 - Matrix Spike (MS) recovery exceeded Quality Control (QC) limits. Batch accepted based on laboratory control sample (LC

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MS Duplicate (MSD) Recovery is outside acceptable limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

Sample Area:		Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill
Sample ID:		**SB-7 / 35-45**	**SB-7 / 60-70**	**SB-8 / 25-35**	**SB-8/55-65**	**SB-8/80-90**	**SB-9 / 20-30**	**SB-9 / 50-60**	**SB-10 / 40-50**
Sample Type:		Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Screened Interval (ft bgs):		35-45	60-70	25-35	55-65	80-90	20-30	50-60	40-50
Date Sampled:		3/4/2019	3/4/2019	2/28/2019	3/1/2019	3/1/2019	3/1/2019	2/23/2019	2/23/2019
Appendix III									
Boron	mg/L	0.174	0.186	0.2 J	0.16 J	0.19 J	0.203	0.204	0.23 J
Calcium	mg/L	18.6	37.3	38.0	53.0	71.0	54.7	170.0	5.7
Chloride	mg/L	18.3	18.2	22 B	12 B	30 B ^	32.7	6.8	20.0 B F1
Fluoride	mg/L	0.21	0.29	0.32 J	0.12 J	0.084 J	1.6	0.48	0.23 J
pH	-	5.6	6.1	4.7	5.3	6.3	6.1	4.8	7.5
Sulfate	mg/L	131.0	348.0 M1	350 B	1400 B	300 B	747.0	2580.0	48.0 B
Total Dissolved Solids	mg/L	346.0	614.0	690.0	1000.0	650.0	968.0	3830.0	310.0
Appendix IV									
Antimony	mg/L	0.001 U	0.001 U	0.003 U	0.003 U	0.003 U	0.001 U	0.001	0.003 U
Arsenic	mg/L	0.0037	0.0161	0.0012 J	0.0087	0.005 U	0.0038	0.0232 U M1	0.00099 J
Barium	mg/L	0.109	0.0974	0.087 J	0.028 J	0.048 J	0.258	0.0144	0.067 J
Beryllium	mg/L	0.0005 U	0.0005 U	0.0011 J	0.00078 J	0.00088 J	0.0029	0.005	0.00033 J
Cadmium	mg/L	0.0005 U	0.0005 U	0.00024 J	0.005 U	0.005 U	0.00082	0.0005 U	0.005 U
Chromium	mg/L	0.005 U	0.005 U	0.005 U	0.005	0.005 U	0.005 U	0.01 U D3	0.0033 J
Cobalt	mg/L	0.0235	0.0701	0.037	0.029	0.0049 J	0.0878	0.163	0.0015 J
Fluoride	mg/L	0.21	0.29	0.32 J	0.12 J	0.084 J	1.6	0.48	0.23 J
Lead	mg/L	0.001 U	0.001 U	0.005 U	0.0015 J	0.005 U	0.001 U	0.001 U M1	0.0012 J
Lithium	mg/L	0.103	0.2	0.059	0.17	0.16	0.0684	0.3	0.045
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.001 U	0.001 U	0.01 U	0.01 U	0.01 U	0.001 U	0.001 U	0.0013 J
Selenium	mg/L	0.001 U	0.001 U	0.01 U	0.01 U	0.01 U	0.009	0.0166 U M1	0.01 U
Thallium	mg/L	0.001 U	0.001 U	0.002 U	0.002 U	0.002 U	0.001 U	0.001 M1	0.002 U
Combined Ra 226/228	pCi/L	5.38 ± 1.37	5.22 ± 1.39	NA	NA	NA	10.9 ± 2.14	7.53 ± 1.52	NA

NA - Data Not Yet Available from Lab.

B - Compound was found in the blank and sample.

J - Result is less than the Reporting Limit (RL) but greater than or equal to the Method Detction Limite (MDL) and the concentration is an approximate value.

U - Indicates the analyte was analyzed for but not detected.

M1 - Matrix Spike (MS) recovery exceeded Quality Control (QC) limits. Batch accepted based on laboratory control sample (LCS) recovery.

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MS Duplicate (MSD) Recovery is outside acceptable limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

Sample Area:		Landfill	Landfill	Landfill	Landfill	Landfill
Sample ID:		**SB-11/5-15**	**SB-11/33-43**	**AD-25**	**AD-26**	**AD-39**
Sample Type:		Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
Screened Interval (ft bgs):		5-15	33-43	MW	MW	MW
Date Sampled:		3/11/2019	3/11/2019	2/18/2019	2/18/2019	2/22/2019
Appendix III						
Boron	mg/L	0.1 U	0.276	0.055 J *	0.12 J	1.1 J
Calcium	mg/L	10.2	17.3	83.0	95.0	44
Chloride	mg/L	14.5	26.1	6.2 B	34.0	2.5 J B
Fluoride	mg/L	0.82	0.2 U	2.8	3.6	0.059 J
pH	-	5.1	6.9	3.51	3.37	5.89
Sulfate	mg/L	159.0	97.4	1500.0 B	1500.0 B	120.0 B
Total Dissolved Solids	mg/L	294.0	314.0	2100.0	2000.0	260.0
Appendix IV						
Antimony	mg/L	0.001 U	0.001 U	0.0011 J B	0.0016 J ^ B	0.0030 U
Arsenic	mg/L	0.001 U	0.001	0.013	0.0037 J	0.0075
Barium	mg/L	0.0914	0.0456	0.0079 J	0.012 J	0.024 J
Beryllium	mg/L	0.0006	0.0005 U	0.0091	0.0084	0.0040 U
Cadmium	mg/L	0.0005 U	0.0005 U	0.0027 J	0.0035 J	0.0050 U
Chromium	mg/L	0.005 U	0.005 U	0.0011 J	0.0022 J	0.0033 J
Cobalt	mg/L	0.0228	0.0023	0.6	0.19 F1	0.0036 J
Fluoride	mg/L	0.82	0.2 U	2.8	3.6	0.059 J
Lead	mg/L	0.001 U	0.001 U	0.00075 J	0.00065 J	0.0050 U
Lithium	mg/L	0.0111	0.0576	0.13	0.16	0.040 U
Mercury	mg/L	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Molybdenum	mg/L	0.001 U	0.001 U	0.01 U	0.01 U	0.010 U
Selenium	mg/L	0.001 U	0.001 U	0.00062 J	0.01 U	0.010 U
Thallium	mg/L	0.001 U	0.001 U	0.002 U	0.002 U	0.0020 U
Combined Ra 226/228	pCi/L	8.47 ± 1.64	4.59 ± 1.10	NA	NA	NA

NA - Data Not Yet Available from Lab.

B - Compound was found in the blank and sample.

J - Result is less than the Reporting Limit (RL) but greater than or equal to the Method Detction Limite (MDL) and the concentration is an approximate value.

U - Indicates the analyte was analyzed for but not detected.

M1 - Matrix Spike (MS) recovery exceeded Quality Control (QC) limits. Batch accepted based on laboratory control sample (LCS) recovery.

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MS Duplicate (MSD) Recovery is outside acceptable limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

Table A-3 - Soil Sample Results
Uranium and Thorium/Appendix IV+Boron

Sample Area:		Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill	Landfill
Sample ID:		**SB-6 / 6-7**	**SB-6 / 16-17**	**SB-7 / 7-8**	**SB-7 / 22-23**	**SB-8 / 6-7**	**SB-8 / 25-26**	**SB-9 5-6**	**SB-9 20-21**
Sample Type:		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
Sampled Interval (ft bgs):		6-7	16-17	7-8	22-23	6-7	25-26	5-6	20-21
Date Sampled:		2/22/2019	2/22/2019	2/28/2019	2/28/2019	2/27/2019	2/27/2019	3/4/2019	3/4/2019
Isotopic Uranium & Thorium (6020/Alpha Spec)									
Uranium-233/234	pCi/g	0.534	0.355	0.539	0.217	0.604	0.314	NA	NA
Uranium-235/236	pCi/g	0.0459 U	0.0342 U	0.0243 U	-0.00247 U	0.0108 U	0.0380	NA	NA
Uranium-238	pCi/g	0.596	0.325	0.581	0.271	0.564	0.433	NA	NA
Uranium	mg/kg	60.0 U	64.0 U	1.1	0.59 J	0.93	0.71	NA	NA
Thorium-228	pCi/g	0.537	0.839	0.610	0.324	0.584	0.356	NA	NA
Thorium-230	pCi/g	0.477	0.382	0.579	0.357	0.583	0.427	NA	NA
Thorium-232	pCi/g	0.604	0.559	0.464	0.472	0.724	0.382	NA	NA
Thorium	mg/kg	60.0 U	64.0 U	4.4	4.3	4.2	3.7	NA	NA
Appendix IV + Boron									
Antimony	mg/kg	1.2 U	1.3 U	0.40 U	0.42 U	0.38 U	0.40 U	▨	▨
Arsenic	mg/kg	6.9	6.9	6.9	23	2.7	18	▨	▨
Barium	mg/kg	51	15 J	66	41	18 J	10 J	▨	▨
Boron	mg/kg	23 U	25 U	3.4 J	7.1 J	3.7 J	3.4 U	▨	▨
Beryllium	mg/kg	0.28 J	0.20 J	0.50	0.37 J	0.35 J	0.36 J	▨	▨
Cadmium	mg/kg	0.067 J	0.094 J	0.095 J	0.12 J	0.085 J	0.12 J	▨	▨
Chromium	mg/kg	23	21	12	12	4.2	18	▨	▨
Cobalt	mg/kg	1.5 J	6.4 U	3.1 J	12	5.5 J	2.4 J	▨	▨
Fluoride	mg/kg	1.1 U	0.95 J	3.1	2.5	0.75 U	0.75 U	▨	▨
Lead	mg/kg	7.4	4.7	9.3	6.2	9.1	6.1	▨	▨
Lithium	mg/kg	4.6 J	0.98 J	3.8 J	7.2	2.4 J	2.1 J	▨	▨
Mercury	mg/kg	0.032 U	0.044 U	0.033 J	0.018 J	0.042	0.017 U	▨	▨
Molybdenum	mg/kg	0.80 J	0.52 J	0.39 J	0.26 U	0.40 J	0.47 J	▨	▨
Selenium	mg/kg	1.2 U	0.74 J	0.70 J	0.70 J	0.58 J	0.67 J	▨	▨
Thallium	mg/kg	2.3 U	2.5 U	0.38 U	0.40 U	0.36 U	0.38 U	▨	▨
Combined Ra 226/228	pCi/L	NA	NA	NA	NA	NA	NA	▨	▨

▨ - Analyte Not Requested

NA - Data Not Yet Available from Lab

B - Compound was found in the blank and sample.

J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

U - Indicates the analyte was analyzed for but not detected.

H - Sample was prepped or analyzed beyond the specified holding time.

M1 - Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.

D3 - Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference.

F1 - MS and/or MSD Recovery is outside acceptable limits.

F2 - MS/MSD RPD exceeds control limits.

* - LCS and/or LCSD is outside acceptable limits.

^ - Instrument related QC outside acceptable limits.

	Sample Area:	Landfill	Landfill	Landfill	Landfill
	Sample ID:	**SB-10/6.5-7.5**	**SB-10/10-11**	**SB-11 / 8-9**	**SB-11 / 10-11**
	Sample Type:	Soil	Soil	Soil	Soil
	Sampled Interval (ft bgs):	6.5-7.5	10-11	8-9	10-11
	Date Sampled:	2/19/2019	2/19/2019	3/11/2019	3/7/2019
Isotopic Uranium & Thorium (6020/Alpha Spec)					
Uranium-233/234	pCi/g	0.353	0.319	▨	▨
Uranium-235/236	pCi/g	0.0535	0.0470 U	▨	▨
Uranium-238	pCi/g	0.240	0.263	▨	▨
Uranium	mg/kg	0.47	1.0	▨	▨
Thorium-228	pCi/g	0.848	0.741	▨	▨
Thorium-230	pCi/g	0.449	0.396	▨	▨
Thorium-232	pCi/g	0.831	0.612	▨	▨
Thorium	mg/kg	4.7	11.0	▨	▨
Appendix IV + Boron					
Antimony	mg/kg	1.1 U	1.2 U	1.1 U M1	1.1 U
Arsenic	mg/kg	23	18	2.0	1.7
Barium	mg/kg	6.4 J	7.6 J	14.5	9.8
Boron	mg/kg	23 U	24 U	11.4 U	11.1 U
Beryllium	mg/kg	0.044 J	0.082 J	0.57 U	0.55 U
Cadmium	mg/kg	0.13 J	0.11 J	0.57 U	0.55 U
Chromium	mg/kg	15	21	10.9	9.0
Cobalt	mg/kg	5.7 U	5.9 U	1.1 U	1.1 U
Fluoride	mg/kg	1.2 U	1.2 U	24.0 U M1	25.4 U
Lead	mg/kg	5.3	5.6	4.8	3.7
Lithium	mg/kg	5.7 U	1.1 J	5.2	2.0
Mercury	mg/kg	0.025 J	0.020 J	0.048 U	0.054 U
Molybdenum	mg/kg	0.77 J	1.1 J	5.7 U	5.5 U
Selenium	mg/kg	1.1 U	1.5	1.1 U	1.1 U
Thallium	mg/kg	2.3 U	2.4 U	1.1 U	1.1 U
Combined Ra 226/228	pCi/L	NA	NA	NA	NA

▨ - Analyte Not Requested

NA - Data Not Yet Available from Lab

B - Compound was found in the blank and sample.

J - Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

U - Indicates the analyte was analyzed for but not detected.

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^ - Instrument related QC outside acceptable limits.

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ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
Landfill
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants
engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

September 24, 2019

CHA8462

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FIGURES

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ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LF	Landfill
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the Landfill (LF, Figure 1). In February 2019, a semi-annual assessment monitoring event was conducted at the LF in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey LF:

- The LCL for cobalt at AD-34 was 0.272 milligrams per liter (mg/L), which exceeded the GWPS of 0.026 mg/L.
- The LCL for lithium at AD-34 was 0.145 mg/L, which exceeded the GWPS of 0.110 mg/L.

No other SSLs were identified (Geosyntec, 2019a).

1.1 CCR Rule Requirements

United States Environmental Protection Agency (USEPA) regulations regarding assessment monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State*

> *Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section….*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSLs identified for cobalt and lithium at AD-34 should not be attributed to the Pirkey LF.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for cobalt and lithium at AD-34 were based on a Type V cause and not by a release from the Pirkey LF.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for cobalt and lithium and the proposed alternative source are described below.

2.1 Proposed Alternative Sources

Initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to a Type I (sampling causes), Type II (laboratory causes), or Type III (statistical causes) issue. As described below, the SSLs were attributed to impacts from a former lignite mining area, which is a Type V issue.

During the previous assessment monitoring event, SSLs for cadmium and cobalt were identified at AD-34 (Geosyntec, 2018). An ASD was generated which identified impacts from a former lignite mining area as the source for the elevated cadmium and cobalt concentrations (Burns and McDonnell, 2019). As shown in Figure 1, AD-34 is the only downgradient well in the LF monitoring network which is set within mine spoil in the former mining area (identified as Area A in the figure). Other nearby monitoring wells in the mine spoil include AD-25 and AD-26; however, neither is in the LF network.

Additionally, the previous ASD noted that the cobalt and cadmium concentrations in the leachate from the LF and from the LF stormwater runoff pond are several orders of magnitude lower than concentrations observed at AD-34. A comparison of the LF leachate and runoff values to the LCLs and the most recent sampling results finds that the LF liquids have significantly lower concentrations of both lithium and cobalt (Table 1), indicating that the LF is not a likely source for these constituents.

The previous ASD found that cadmium and cobalt concentrations at AD-25, AD-26, and AD-34 were comparable to each other but different from other network wells. A Piper diagram was generated to assess whether major ion concentrations are affected by screen placement in the mine spoil area (Figure 2). The Piper diagram shows that AD-34 groundwater appears more similar to AD-25 and AD-26 groundwater based on the distribution of major ions. Groundwater in the mine spoil area is dominated by sulfate and magnesium, whereas wells in the LF network have higher proportions of chloride, sodium, and potassium.

Monitoring wells AD-48, AD-49 and AD-52 through AD-55 were installed in the former mining area in 2019. When these wells are included on a Piper diagram, it is apparent they have chemistry similar to AD-34 (Figure 3). These findings suggest that impacts from the former lignite mine have affected the geochemistry of the groundwater at wells set within its footprint. The effect of the former lignite mining area on cobalt and lithium is described in more detail below.

2.1.1 Cobalt ASD

As described above, an ASD LF previously attributed the observed cobalt exceedance to impacts from the former lignite mining area (Burns and McDonnell, 2019). Additional sampling since completion of the previous ASD provides further evidence that the observed cobalt exceedances at AD-34 are due to impacts from the former mining area and are not related to the LF.

Boring logs from AD-48 through AD-50 and AD-52 through AD-57 (provided in Attachment A) were used to generate a cross-section to illustrate the extent of the fill associated with the former mining activities. Weathering of pyrite, which is present throughout the mine area, is responsible for low pH (3.3 to 6.3) and elevated sulfate (152 to 2,110 mg/L) in the groundwater (Table 2). Acidic pH and elevated sulfate concentrations are known effects of groundwater on mine waste (Johnson, 2003). As shown in Figure 4, cobalt is generally elevated wherever well screens are placed in the mine fill. Cobalt concentrations are below the GWPS in wells that are screened outside the footprint of the former mining area, such as AD-56 and AD-57. AD-48 and AD-53 are the only wells screened in mine spoils which do not have cobalt concentrations above the GWPS. However, AD-48 is set near an upgradient edge of the former mining area, and so is likely to be recharged by unimpacted groundwater. Additionally, it has slightly elevated pH compared to locations with higher cobalt concentrations AD-53 has much higher pH than the other mine spoil wells (6.3 SU in Table 2), which is consistent with low cobalt solubility at circumneutral pH (Izquierdo and Querol, 2012).

Soil was collected at select locations during the installation of monitoring wells AD-46 through AD-57 and analyzed for total cobalt. Additional samples were collected from borings advanced adjacent to existing wells AD-16 and AD-34. Cobalt was detected in all samples, with higher concentrations below 10 ft bgs, which suggests that it is naturally prevalent across the aquifer solid material (Table 3). A groundwater sample was collected from AD-34 and then passed through a 1.5-micron filter. The solid material retained on the filter was submitted for total metals analysis, with cobalt identified in the material at an estimated concentration of 2.2 milligrams per kilogram (mg/kg). This concentration is comparable to concentrations observed in the bulk soil within the footprint of the former mining area, ranging from 2.4 to 12 mg/kg (Figure 5).

Cobalt concentrations in the bulk soil samples are slightly higher in the former mining area, which could be an indicator that the fill material has higher proportions of cobalt-containing minerals (Table 3). Analysis by X-ray diffraction (XRD) identified pyrite and marcasite (both iron sulfides) at AD-34 at concentrations up to 2% by weight (Table 4). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2019).

These lines of evidence, combined with the low concentrations of cobalt in the LF leachate and stormwater runoff pond, illustrate that the cobalt exceedance at AD-34 is not due to a release from the LF. Instead, the exceedance is due to changes in the groundwater chemistry associated with the former lignite mining area.

2.1.2 Lithium ASD

An SSL for lithium was not previously identified at the LF. As described below, the current exceedances can be attributed to impacts from the former mining area.

Lithium concentrations generally appear to be higher for wells that are located within the footprint of the former mining area (Figure 6). This relationship becomes more apparent when comparing concentrations for wells in the former mining area which are not set within the mine spoil. The observed lithium concentration at AD-50, which is screened in non-mine fill, is more than an order of magnitude lower than the concentrations at AD-52 and AD-53, both of which were installed immediately adjacent to AD-50 and screened within the mine spoil (Figure 7). Lithium concentrations are also below the GWPS at AD-39 (not shown on the cross-section), AD-56, and AD-57, which are set outside the footprint of the former mining area.

An ASD previously generated for lithium exceedances at Pirkey's East Bottom Ash Pond (EBAP) identified natural variation in the aquifer as the source of lithium near that unit. The ASD developed a proposed mechanism for lithium mobility in groundwater which pointed to desorption from clay minerals associated with naturally occurring lignite material as the source of lithium in both up and downgradient wells at the EBAP (Geosyntec, 2019b).

The total metal concentrations in the solid materials separated from the groundwater samples during filtration and the filtered groundwater concentrations were used to calculated partition coefficients values (K_d) for lithium, potassium, and sodium. These constituents were selected as they are all monovalent cations, and so have similar geochemical behavior. Partition coefficients are used to express the tendency of a chemical (e.g. lithium) to become adsorbed onto soil (or sediment). K_d is a ratio of the amount of chemical adsorbed per unit weight of the soil to the concentration of the chemical in solution (i.e., groundwater), as shown in the following equation:

$$K_d = \frac{mg\ adsorbed/kg\ soil}{mg/L\ solution}$$

K_d is characteristic of the soil, so its value varies with soil type. The K_d values for groundwater and particulate collected from AD-34 were compared to literature K_d values reported for organic-rich media such as bogs and peat beds (Table 5) (Sheppard et al., 2009; 2011). The calculated values are generally slightly lower than the literature values. However, the relationship between calculated K_d values for different constituents is consistent with the literature, with potassium being the largest (most sorbable) and sodium the smallest (least sorbable). These results support the proposed mechanism; however, there is less sorbing capacity in soil near AD-34 due to natural variations in the aquifer material.

According to XRD analysis of soil collected adjacent to AD-34, approximately 90% of the soil is composed of quartz, which is an inert mineral. Small fractions (1-2%) of clay minerals (illite, smectite), which have adsorptive capacity were identified in the XRD pattern as well. Suspended solids were separated from groundwater collected from AD-34 and analyzed for chemical composition and mineralogy by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Clay particles were identified in the backscattered electron micrographs of this sample by morphology (Attachment B). Aluminum was identified in the particles, which provides evidence for clay aluminosilicate minerals in addition to quartz.

The lines of evidence described above show that elevated lithium concentrations at AD-34 are not due to a release from the LF, particularly as the lithium concentration in LF leachate is much lower than in groundwater at wells set within the former mine area. Instead, changes associated with the former mining area appear to be mobilizing lithium which is natural present in the aquifer and likely associated with clay fractions in the soil aquifer material.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSLs are not due to a release from the Pirkey LF, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSLs for cobalt and lithium at AD-34 identified during assessment monitoring in February 2019 were not due to a release from the Pirkey LF. The identified SSLs were, instead, attributed to impacts from a former lignite mining area. Therefore, no further action for cobalt or lithium is warranted, and the LF will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment C.

SECTION 4

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FIGURES

Legend

- ▭ A Area
- 🟢 Upgradient Wells
- 🔵 Downgradient Wells
- 🟡 Out of network

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- Area A is a former lignite (reclaimed) mine.

875 437.5 0 875 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

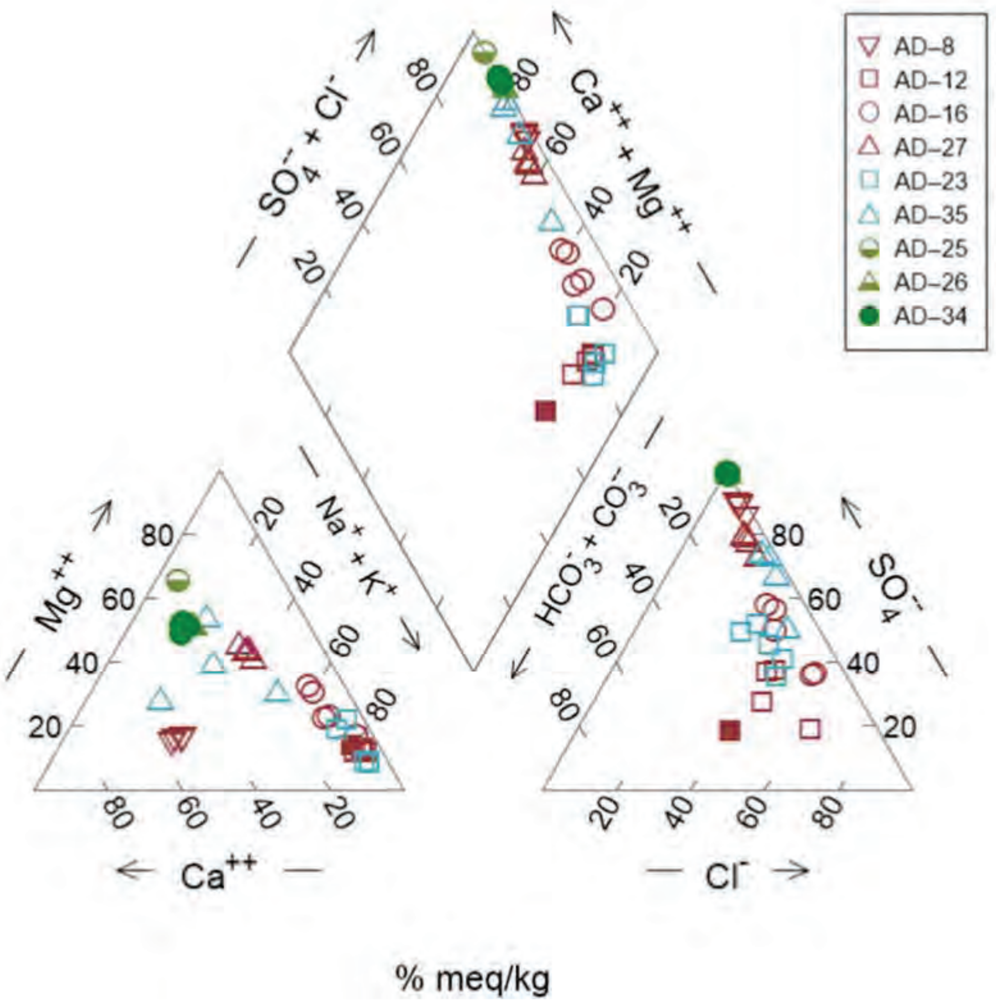
Geosyntec consultants

Columbus, Ohio

2019/09/19

Figure
1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Sitelayout_20190919.mxd. hduff. 9/19/2019. Project/Phase/Task.



Notes: All data with complete data sets are shown except for AD-8 2/28/2019 data, which appeared to have an outlier.

Red symbology: Upgradient Locations
Blue symbology: Downgradient Locations
Green symbology: Downgradient locations screened in mine spoils.

Piper Diagram – Select Wells

Pirkey Landfill

Geosyntec consultants

AMERICAN ELECTRIC POWER

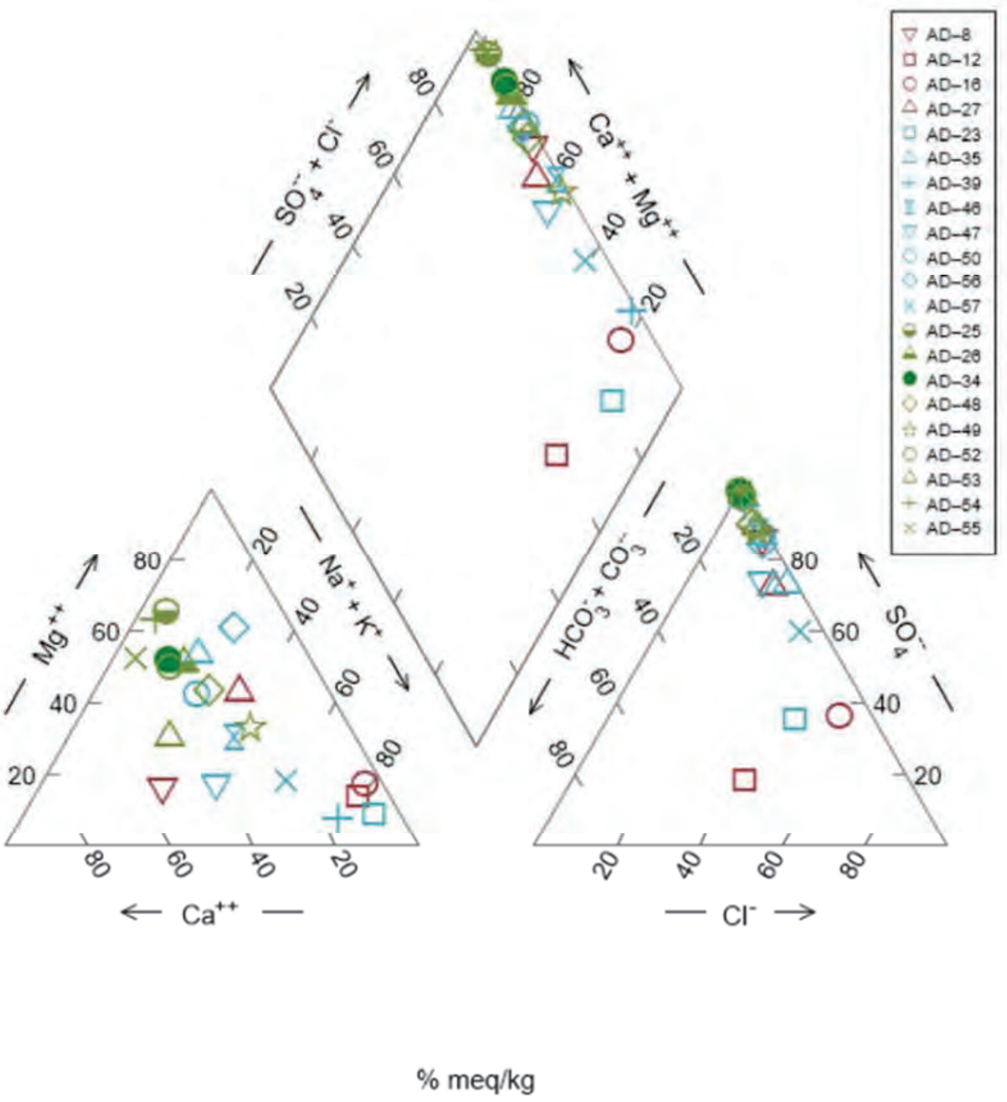
Columbus, Ohio

19-Sep-2019

Figure

2

internal info: path, date revised, author



Notes: Wells in the LF network use February 2019 data, except AD-8 which used August 2018 due to an apparent outlier. Wells out of the network use August 2019 data.

Red symbology: Upgradient Locations
Blue symbology: Downgradient Locations
Green symbology: Downgradient locations screened in mine fill.

internal info: path, date revised, author

Piper Diagram – Landfill Area Wells

Pirkey Landfill

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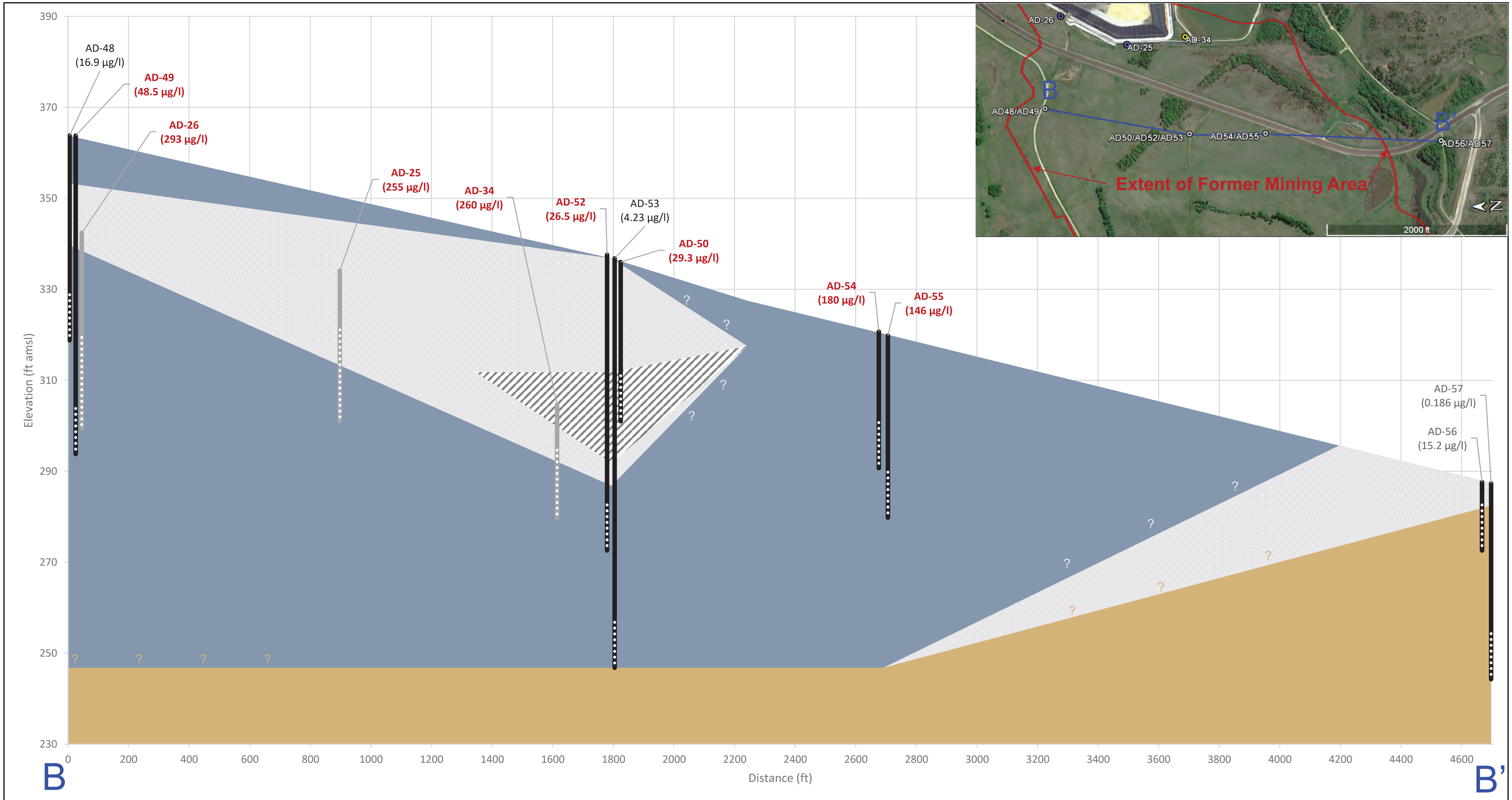
AMERICAN ELECTRIC POWER

Columbus, Ohio

19-Sep-2019

Figure

3



Legend

▨ Mine Spoil (clay, gray, lignite/other inclusions)

☐ Other Fill (sand to sandy clay, to clayey gravel, gray, some lignite/other inclusions)

▨ No recovery (assumed same lithology as Other Fill)

▨ Native sediments (gray sands and clays)

▬ Monitoring Well (Li Conc.)

▬ Projected Monitoring Well

▬ Well Screen

? ? Inferred Contact

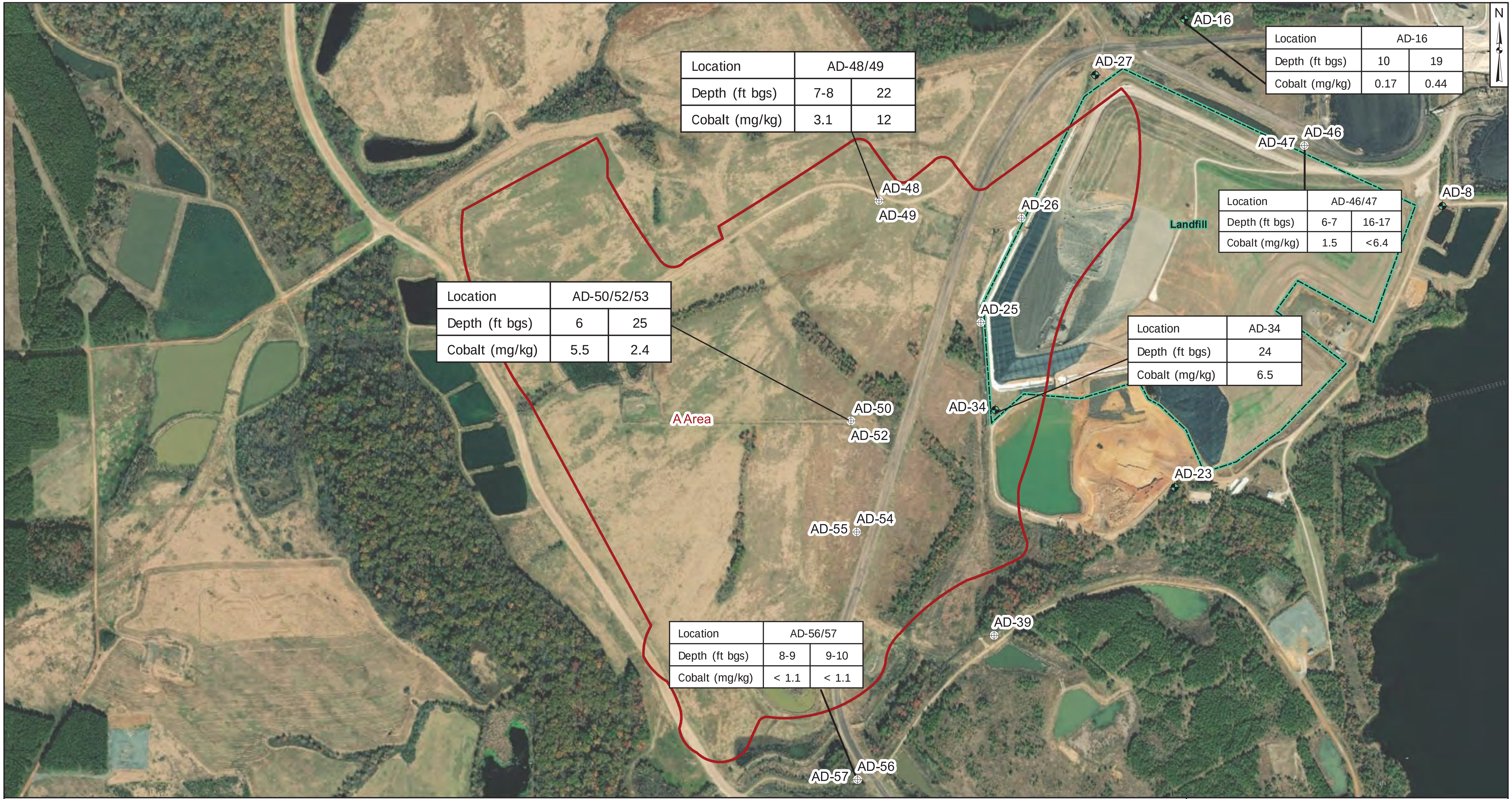
Notes:
Gray wells are projected onto the plane of the cross section, and are generally screened within fill and mine spoil. Lithology for these wells was not used to construct cross section. Positions are approximate.
Cobalt concentrations in micrograms per liter (µg/l)
Groundwater results for all locations collected August 2019, except AD-34 collected February 2019
Bolded locations have concentrations which exceed the groundwater protection standard (GWPS) of 26 µg/L

Landfill Area Cross Section with Cobalt Concentrations
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Figure
4

CHA8462
September 2019



Location	AD-48/49	
Depth (ft bgs)	7-8	22
Cobalt (mg/kg)	3.1	12

Location	AD-16	
Depth (ft bgs)	10	19
Cobalt (mg/kg)	0.17	0.44

Location	AD-46/47	
Depth (ft bgs)	6-7	16-17
Cobalt (mg/kg)	1.5	<6.4

Location	AD-50/52/53	
Depth (ft bgs)	6	25
Cobalt (mg/kg)	5.5	2.4

Location	AD-34
Depth (ft bgs)	24
Cobalt (mg/kg)	6.5

Location	AD-56/57	
Depth (ft bgs)	8-9	9-10
Cobalt (mg/kg)	< 1.1	< 1.1

Legend

⊕ Out of Network	🟩 Landfill
◆ Landfill	🟥 A Area

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- Cobalt concentrations displayed in milligrams per kilogram (mg/kg).
- ft bgs: feet below ground surface.
- A Area is former lignite (reclaimed) mine.
- Non detectds are shown as less than the reporting limit.

600 300 0 600

Feet

Cobalt Soil Values - Landfill Area
August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

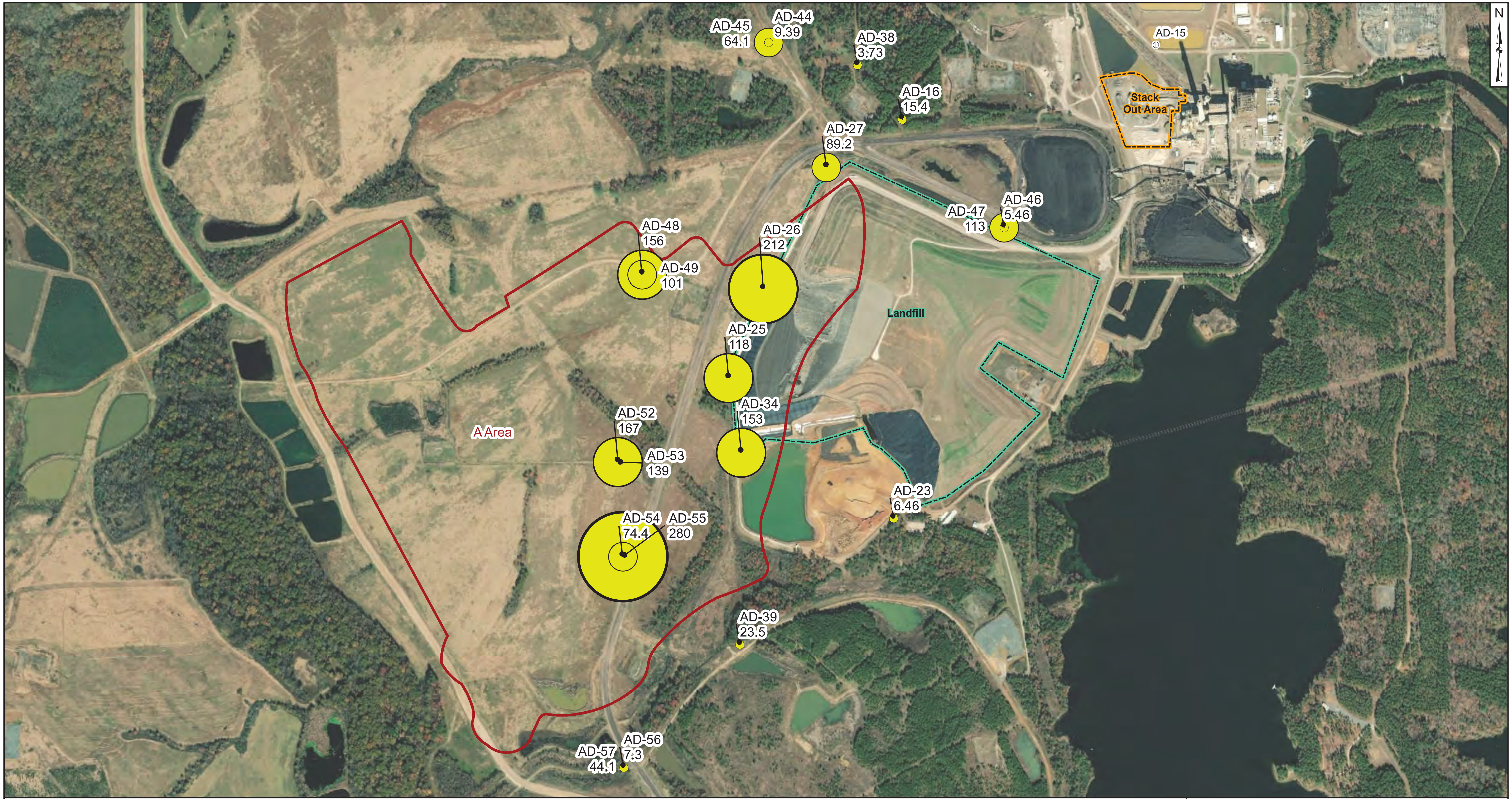
Columbus, Ohio

2019/09/23

Figure

5

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_PirkeyLF_CoSoil_20190916.mxd. hduff. 9/23/2019. Project/Phase/Task.



Legend

🟥 A Area
🟩 Landfill
🟧 Stack Out Area

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- Location of AD-15 is approximate.
- Circle size is proportional to lithium concentration.
- Lithium concentrations displayed in micrograms per liter (ug/L) and are represented with data from the August 2019 sampling event. Wells AD-16, AD-23, AD-27, and AD-34 are representated with data from the Feburary 2019 sampling event.
- Area A is a former lignite (reclaimed) mine.

900 450 0 900
Feet

Spatial Distribution of Lithium in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2019/09/17

Figure
6

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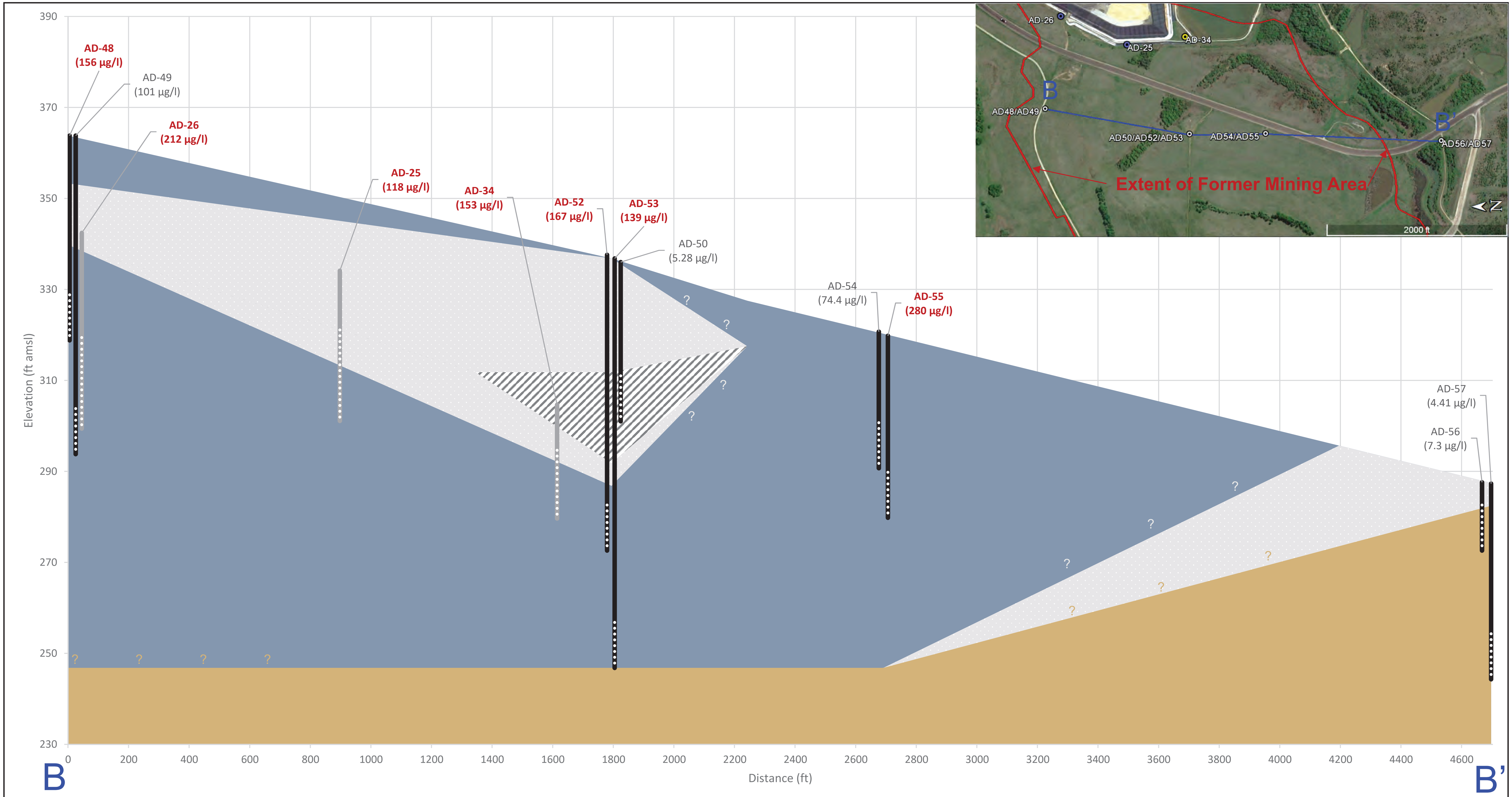


Legend

▆	Mine Spoil (clay, gray, lignite/other inclusions)	▬	Monitoring Well (Li Conc.)
☐	Other Fill (sand to sandy clay, to clayey gravel, gray, some lignite/other inclusions)	▭	Projected Monitoring Well
▨	No recovery (assumed same lithology as Other Fill)	┅	Well Screen
▆	Native sediments (gray sands and clays)	? ?	Inferred Contact

Notes:
- Gray wells are projected onto the plane of the cross section, and are generally screened within fill and mine spoil. Lithology for these wells was not used to construct cross section. Positions are approximate.
- Lithium concentrations in micrograms per liter (µg/l)
- Groundwater results for all locations collected August 2019, except AD-34 collected February 2019
- Bolded locations have concentrations which exceed the groundwater protection standard (GWPS) of 110 µg/L

Landfill Area Cross Section with Lithium Concentrations

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

CHA8462
September 2019

Figure

7

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-08 ASDs_2nd Round 2018\A-Landfill Area Cross section

TABLES

Table 1: Leachate and Stormwater Pond Data Comparison
East Bottom Ash Pond - H.W. Pirkey Plant

Sample	Sample Date	Cobalt Concentration (µg/L)	Lithium Concentration (µg/L)
Leachate	2/11/2019	0.43 J	42
Leachate Stormwater Pond	2/11/2019	0.50 J	14 J
AD-34	LCL	272	145
	2/27/2019	260	153

Notes:

mg/L - milligram per liter

J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

LCL - lower confidence limit

Table 2: Groundwater Concentrations
East Bottom Ash Pond - H.W. Pirkey Plant

Location	Included in Network?	Screened in Mine Fill?	Sample Date	pH (SU)	Cobalt Concentration (µg/L)	Lithium Concentration (µg/L)	Sulfate Concentration (mg/L)
AD-8	Yes	No	2/28/2019	5.7	0.8 J	2.0	175
AD-12	Yes	No	2/27/2019	5.2	1.37	6.88	3.6
AD-16	Yes	No	2/27/2019	4.3	3.21	15.4	17.7
AD-23	Yes	No	2/28/2019	5.1	1.0 J	6.46	7.2
AD-25	No	Yes	8/13/2019	3.6	255	118	775
AD-26	No	Yes	8/16/2019	3.9	293	212	1490
AD-27	Yes	No	2/28/2019	4.7	18.9	89.2	52.8
AD-34	Yes	Yes	2/27/2019	4.7	260	153	970
AD-35	Yes - Abandoned	No	8/20/2018	4.2	11.9	8.76	149
AD-38	No	No	8/15/2019	4.2	5.46	3.73	6.1
AD-39	No	No	8/16/2019	5.4	5.15	23.5	272
AD-44	No	No	8/15/2019	4.5	4.92	9.39	17.4
AD-45	No	No	8/15/2019	5.5	0.331	64.1	16.8
AD-46	No	No	8/15/2019	4.8	13.6	5.46	231
AD-47	No	No	8/15/2019	4.8	4.05	113	37.8
AD-48	No	Yes	8/15/2019	5.6	16.9	156	152
AD-49	No	Yes	8/15/2019	5.5	48.5	101	200
AD-50	No	No	8/16/2019	5.3	29.3	5.28	302
AD-52	No	Yes	8/16/2019	5.6	26.5	167	642
AD-53	No	Yes	8/16/2019	6.3	4.23	139	322
AD-54	No	Yes	8/16/2019	3.7	180	74.4	1290
AD-55	No	Yes	8/16/2019	3.3	146	280	2110
AD-56	No	No	8/16/2019	4.7	15.2	7.3	130
AD-57	No	No	8/16/2019	4.0	0.186	44.1	45.1

Notes:

SU - specific units

µg/L - micrograms per liter

mg/L - milligrams per liter

J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

Table 3: Soil Cobalt Data
Landfill - H.W. Pirkey Plant

Location ID	Sample Depth (ft bgs)	Cobalt (mg/kg)
Bulk Soil Samples		
AD-16	10	0.17
	19	0.44
AD-34	6	1.10
	24	6.50
AD-46/47	6	1.5 J
	16	<6.40
AD-48/49	7	3.1 J
	22	12.0
AD-50/52/53	6	5.5 J
	25	2.4 J
AD-56/57	15	< 1.1
	35	<1.1
Solid Material Retained After Filtration		
AD-34	10-25	2.4 J

Notes:
< - Not detected. Result shown as less than the method detection limit.
mg/kg- milligram per kilogram
ft bgs - feet below ground surface
J - Estimated value
Samples shaded gray were not collected from mine fill.
Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

Table 4: AD-34 X-Ray Diffraction Results
Landfill - H. W. Pirkey Plant

Depth	6 ft bgs	24 ft bgs
Quartz	94	91
O Feldspar	2	2
P Feldspar	1	1
Calcite	--	--
Dolomite	--	--
Siderite	1	1
Pyrite/Marcasite	1	2
Illite/Smectite	--	1
Illite	1	1
Kaolinite	--	--
Chlorite	--	--

Notes:
-- : not detected
Results are reported as percentages.

Table 5: Calculated Site-Specific Partition Coefficients
Landfill - H. W. Pirkey Plant

Source	AD-34			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.18	1.1	6	43-370
K	8.1	170	21	42-1200
Na	17	18	1	5.2-82

Notes:
mg/L: milligrams per liter
mg/kg: milligrams per kilogram
L/kg: liters per kilogram
Kd: partition coefficient
Adsorbed values are total metals concentrations reported by USEPA Method 6010B.
Literature values represent maximum and minimum values for the parameter as reported in Sheppard et al, 2009 (Table 4-1, all sites) and Sheppard et al, 2011 (Table 3-3 cultivated peat and wetland peat only).

ATTACHMENT A

Boring Logs

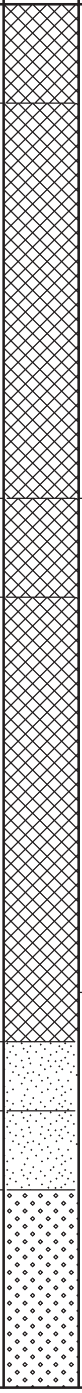
Drilling Log

BURNS McDONNELL

Project Name: AEP Pirkey CSM		Project No.: 111173	Boring/Monitoring Well Number: SB-07
Coordinates: N 6872868 E 3201272.9		Ground Elevation: 363.80	Page: 1 of 5
Total Depth (feet): 70	Hole Size (inches): 6.75"	Driller: J. Smith	
Drilling Rig: Ardco 4x4		Drilling Company: MHC X-Ploration	
Date: 2/28/2019	Logged By: C. Hoglund	Reviewed by:	Approved by:

▽ Depth to water while drilling

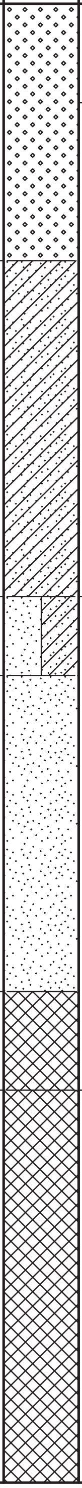
▼ Depth to water after drilling



Elevation (MSL)	Depth (feet bgs)	Description	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
363 362 361 360 359	1 2 3 4 5	SILT and very fine grained SAND, dark grayish Brown (10YR 4/2), trace to little clay, wet, low to medium consistency, low to medium plasticity; FILL. SAND, reddish Yellow (7.5YR 6/6), very fine to fine grained, poorly sorted, with rock fragments (gravel, ironstone, and sandstone), with to some clay, soft to medium consistency, medium to high plasticity; FILL. Mine Reclaim. - with clay below 4.0'	NA	NA	NA	NA	NA	NA	NA	Log cuttings from 0'-5.0'.
358 357 356 355 354	6 7 8 9 10	CLAY, light Brown (7.5YR 6/4), trace silt, trace very fine grained sand, iron staining throughout, some inclusions (sandstone, and gravel), soft to medium; FILL. Mine Reclaim. CLAY, dark Gray (7.5YR 4/1), with very fine grained sand, some to little silt, with to some orange, red, and light gray clay, some inclusions (lignite, coal, ironstone, and gravel), damp, medium to stiff, medium to high plasticity; FILL. Mine Reclaim. - thin very fine grained sand seam, some to little clay, moist at 8.9'	MC	1		NA	2.9/5	NA	NA	Sampled SB-7/7'-8' (1045)
353 352 351 350	11 12 13	SAND, Gray (10YR 5/1), very fine grained, poorly graded, little to some silt, damp to wet, silty sand seam at top, low to medium plasticity; SP. SAND, Gray (10YR 5/1), with silt, trace clay, few to trace inclusions (lignite, coal, and sandstone), damp, medium density; SP. SAND and GRAVEL, Gray (10YR 5/1), very fine grained sand, poorly sorted, little to some silt, damp, trace to few lignite clasts;	MC	2		NA	4.5/5	NA	NA	No free water observed

Drilling Log, continued

Project Name	AEP Pirkey CSM	Boring/Monitoring Well Number	SB-07
Project Number	111173	Page	2 of 5
		Date	2/28/2019



Elevation (MSL)	Depth (feet bgs)	Description	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
349	15	SAND and GRAVEL, Gray (10YR 5/1), very fine grained sand, poorly sorted, little to some silt, damp, trace to few lignite clasts; - trace to few white to light gray angular sanstone rock fragments below 14.0'	MC	2		NA	4.5/5	NA	NA	
348	16									
347	17	SAND, dark Gray (10YR 4/1), very fine grained, poorly sorted, with clay, trace muscovite flakes, trace to few lignite clasts, some silt, damp, soft, medium plasticity; SC.	MC	3		NA	4.3/5	NA	NA	
346	18	- moist, trace clay below 18.5'								
345	19									
344	20	SAND, dark Gray (10YR 4/1), very fine grained, poorly graded, trace to little clay, trace to little silt, trace lignite-clay clasts, moist, medium to dense, low plasticity; SP-SC.								
343	21	SAND, Gray (10YR 5/1), very fine grained, poorly graded, some silte, few muscovite flakes, moist to wet; SP.								
342	22		MC	4		NA	2.5/5	NA	NA	Sampled SB-7/22'-23'
341	23	- trace to few inclusions (lignite, coal, ironstone, sandstone, and gravel) below 23.0'								
340	24	CLAY, dark Gray (10YR 4/1) with very fine grained sand, some silt, trace to few inclusions (lignite, coal, sandstone, and gravel), damp, low to medium consistency, low to medium plasticity; FILL. Mine Reclaim.								
339	25	CLAY, Gray (10YR 5/1), some silt, few very fine grained sand, little to some inclusions (coal, lignite, sandstone, ironstone, and gravel), medium consistency, low to medium plasticity; FILL. Mine Reclaim.	NA	NA	NA	NA	NA	NA	NA	Switch to rock drill bit at 25.0' feet. Begin logging from soil cuttings below 25.0'
338	26									
337	27									
336	28									
335										

Drilling Log, continued

BURNS McDONNELL		Boring/Monitoring Well Number SB-07
	Project Name AEP Pirkey CSM	Page 3 of 5
	Project Number 111173	Date 2/28/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
334	30	CLAY, Gray (10YR 5/1), some silt, few very fine grained sand, little to some inclusions (coal, lignite, sandstone, ironstone, and gravel), medium consistency, low to medium plasticity; FILL. Mine Reclaim.	▨	NA	NA	NA	NA	NA	NA	NA	
333	31		▨								
332	32	CLAY, Gray (10YR 5/1), some silt, trace to little very fine grained sand, few to some inclusions (lignite, coal, sandstone, ironstone and gravel), medium consistency, low to medium plasticity; FILL. Mine Reclaim.	▨								
331	33		▨								
330	34		▨								
329	35		▨								
328	36		▨								
327	37		▨								
326	38		▨								
325	39		▨								
324	40		▨								
323	41		▨								
322	42		▨								
321	43		▨								
320			▨								

Drilling Log, continued

		Boring/Monitoring Well Number	SB-07
Project Name	AEP Pirkey CSM	Page	4 of 5
Project Number	111173	Date	2/28/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
		CLAY, Gray (10YR 5/1), some silt, trace to little very fine grained sand, few to some inclusions (lignite, coal, sandstone, ironstone and gravel), medium consistency, low to medium plasticity; FILL. Mine Reclaim.	▨	NA	NA	NA	NA	NA	NA	NA	
319	45		▨								
318	46		▨								
317	47		▨								
316	48		▨								
315	49		▨								
314	50		▨								
313	51		▨								
312	52		▨								
311	53		▨								
310	54		▨								
309	55		▨								
308	56		▨								
307	57		▨								
306	58		▨								
305			▨								

Drilling Log, continued

BURNS McDONNELL		Boring/Monitoring Well Number	SB-07
Project Name	AEP Pirkey CSM	Page	5 of 5
Project Number	111173	Date	2/28/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
		CLAY, Gray (10YR 5/1), some silt, trace to little very fine grained sand, few to some inclusions (lignite, coal, sandstone, ironstone and gravel), medium consistency, low to medium plasticity; FILL. Mine Reclaim. - some to with inclusions (ironstone, sandstone, coal, lignite, and red clay) below 59.0'	▨	NA	NA	NA	NA	NA	NA	NA	
304	60		▨								
303	61		▨								
302	62		▨								
301	63		▨								
300	64		▨								
299	65	- trace to few red clay clasts below 65.0'	▨								
298	66		▨								
297	67		▨								
296	68		▨								
295	69		▨								
294	70	Boring terminated at 70 feet bgs.									Temporary Piezometer Installed on 2/28/2019
	71										
	72										
	73										

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-48 (SB-7S)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	300920.8669
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924528.403
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

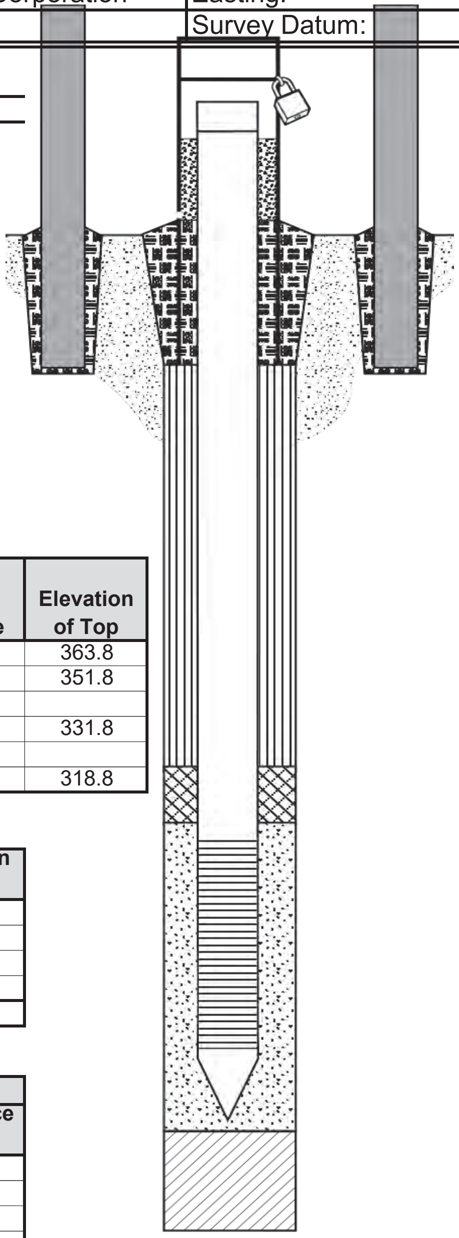
Elevations	
Top of Casing (TOC)	366.4
Ground Surface (GS)	363.8
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	3/3/2019
Installation Complete	3/3/2019
Well Completed	3/3/2019
Development Start	3/6/2019
Development Complete	3/6/2019

Annular Material Measurements	Depth to Top from GS	Total Footage	Elevation of Top
Annular Seal	0	12.0	363.8
Bentonite Seal	12	20.0	351.8
Secondary Filter Pack			
Filter Pack	32	13.0	331.8
Backfill	0		
Bottom of Borehole	45		318.8

Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	35.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	332.09
Bottom Cap	0.28	322.09
Total Depth from TOC	44.59	

Groundwater Levels		
Date & Time	**Depth**	**Reference Point**



Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
Material: steel
Size: 4"
Length: 5'
Pea Gravel (Y/N): N
Weep Hole (Y/N): N
Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
Dimensions: 4' x 4' x 4"
Material: concrete

Annular Seal:
Type & Size: bentonite chips 3/8"
Manufacturer: Cetco
Amount Used: (included with bentonite seal)

Bentonite Seal:
Type & Size: pellets 3/8"
Manufacturer: PDS
Amount Used: 6 bags

Secondary Filter Pack:
Type & Size: --
Manufacturer: --
Amount Used: --

Primary Filter Pack:
Type & Size: sand 16/30
Manufacturer: U.S. Silica Company
Amount Used: 7.5 bags

Well Casing:
Type: PVC
Diameter: 2"
Sch. or Weight: Sch. 40
Manufacturer: Campbell Monoflex
Screen Type: PVC factory slot
Screen Slot Size: 0.010"
Bottom Cap Type: threaded

Centralizers (Y/N): N
Material: --
Number: --
Depth(s): --

Backfill Material:
Type & Size: NA
Manufacturer: --
Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508722

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/3/2019** Drilling End Date: **3/3/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	0	45

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
32	45	Sand	16/30

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	12	Cement
12	32	Bentonite 6 Bags/Sacks

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**45**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**35**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**35**	**45**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-49 (SB-7D)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	300924.7371
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924521.039
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	366.5
Ground Surface (GS)	363.8
Reference Point (RP)	ground surface

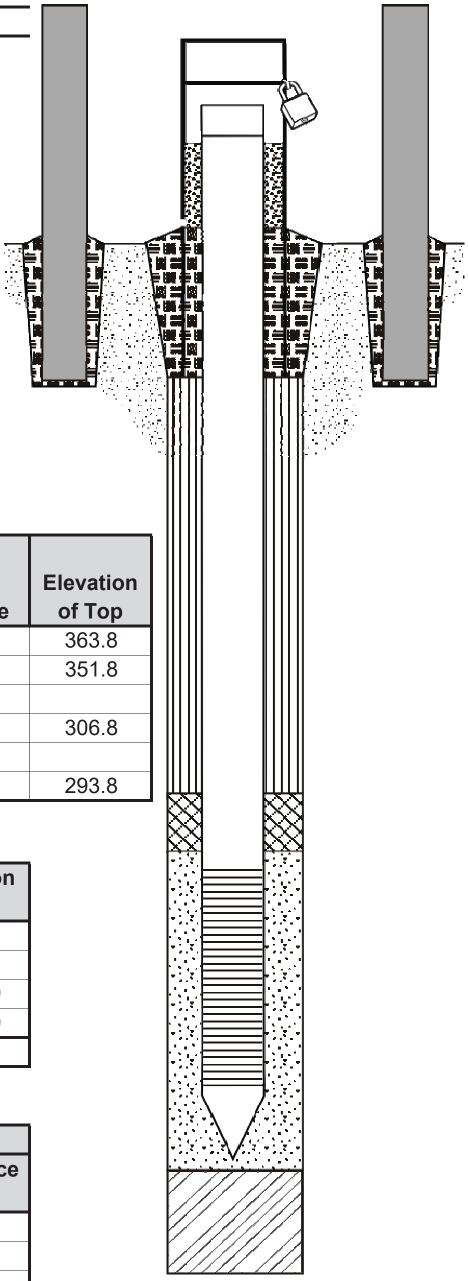
Dates	
Drilling/Installation Start	2/28/2019
Installation Complete	2/28/2019
Well Completed	2/28/2019
Development Start	3/4/2019
Development Complete	3/4/2019

Annular Material Measurements	Depth to Top from GS	Total Footage	Elevation of Top
Annular Seal	0	12.0	363.8
Bentonite Seal	12	45.0	351.8
Secondary Filter Pack			
Filter Pack	57	13.0	306.8
Backfill	0		
Bottom of Borehole	70		293.8

Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	60.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	307.19
Bottom Cap	0.28	297.19
Total Depth from TOC	69.59	

Groundwater Levels

Date & Time	Depth	Reference Point



Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
Material: steel
Size: 4"
Length: 5'
Pea Gravel (Y/N): N
Weep Hole (Y/N): N
Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
Dimensions: 4' x 4' x 4"
Material: concrete

Annular Seal:
Type & Size: bentonite chips
Manufacturer: NA
Amount Used: (included with bentonite seal)

Bentonite Seal:
Type & Size: chips
Manufacturer: NA
Amount Used: 10 bags

Secondary Filter Pack:
Type & Size: --
Manufacturer: --
Amount Used: --

Primary Filter Pack:
Type & Size: sand 16/30
Manufacturer: NA
Amount Used: 5 bags

Well Casing:
Type: PVC
Diameter: 2"
Sch. or Weight: Sch. 40
Manufacturer: Environmental Manufacturing
Screen Type: PVC factory slot
Screen Slot Size: 0.010"
Bottom Cap Type: threaded

Centralizers (Y/N): N
Material: --
Number: --
Depth(s): --

Backfill Material:
Type & Size: NA
Manufacturer: --
Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508720

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 deep (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
57	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**12**	**Cement**
12	**57**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**70**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**60**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**60**	**70**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Drilling Log

BURNS McDONNELL	Project Name AEP Pirkey CSM	Project No. 111173	Boring/Monitoring Well Number SB-08
	Coordinates N 6871089.8 E 3201042.6	Ground Elevation 336.80	Page 1 of 7
	Total Depth (feet) 93 / Hole Size (inches) 6.75"	Driller J. Smith	
Drilling Rig Ardco 4x4		Drilling Company MHC X-Ploration	
Date 2/24/2019 to 2/26/2019	Logged By: C. Hoglund	Reviewed by:	Approved by:

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	▽ Depth to water while drilling ▼ Depth to water after drilling Remarks
336 335 334 333 332	1 2 3 4 5	CLAY, Red (2.5YR 5/6), with silt, some very fine grained sand, little to some lignite and rock fragments, wet, medium to high plasticity, low consitency; FILL. - with very fine grained sand below 4.0'	▨	HA	1		NA	5/5			Hand dig from 0.0'-5.0'
331 330 329 328 327	6 7 8 9 10	CLAY, dark Gray (10YR 4/1) to dark grayish Brown (10YR 4/2), with silt, with very fine sand, damp, medium to stiff, low to medium plasticity; FILL. - with silt to very fine sand lenses - few to little iron staining lenses, few ironstone inclusions - trace to few very fine grained sandstone inclusions, little to some lignite and rock fragments below 7.0' - increased very fine grained sand and inclusions below 8.0'	▨	MC	1		NA	4/5	NA	NA	
326	11	SAND, Gray (10YR 6/1) to dark Gray (10YR 4/1), very fine grained, poorly sorted, trace silt, some light gray thin beds, trace to few black coal lenses and streaks, moist to damp, low to medium density; SP.	░	MC	2		NA	3.2/5	NA	NA	No free water observed
325 324 323	12 13	SAND, Gray (10YR 6/1) to dark Gray (10YR 4/1), very fine graded, poorly sorted, trace to little clay, few to some inclusions (sandstone, ironstone, lignite, and rock fragments), trace to few thin sandstone beds, damp to moist, low to medium plasticity; SP.	░								

Drilling Log, continued

BURNS McDONNELL

Project Name AEP Pirkey CSM
Project Number 111173
Boring/Monitoring Well Number SB-08
Page 2 of 7
Date 2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
322	15		⁘	MC	2		NA	3.2/5	NA	NA	
321	16	SAND, Gray (10YR 6/1) to dark Gray (10YR 4/1), with clay, some silt, few to some inclusions (sandstone, lignite, ironstone, and rock fragments), moist, low to medium density, low to medium plasticity; SC. - with iron staining, massive, below 16.3'	▨								
320	17		▨								
319	18		▨	MC	3		NA	2.1/5	NA	NA	
318	19		▨								
317	20		▨								
316	21		▨								
315	22		▨								
314	23		▨	MC	4		NA	0.6/5	NA	NA	
313	24		▨								
312	25	No Recovery from 25.0'-45.0'.	NR								
311	26										
310	27			MC	5		NA	0/5	NA	NA	
309	28										
308											

Drilling Log, continued

BURNS McDONNELL		Boring/Monitoring Well Number	SB-08
	Project Name AEP Pirkey CSM	Page	3 of 7
	Project Number 111173	Date	2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
		No Recovery from 25.0'-45.0'.	NR								
				MC	5		NA	0/5	NA	NA	
307	30										
306	31										
305	32										
				MC	6		NA	0/5	NA	NA	
304	33										
303	34										
302	35										
301	36										
300	37										
				MC	7		NA	0/5	NA	NA	
299	38										
298	39										
297	40			NA	NA	NA	NA	NA	NA	NA	Switch to rock drill bit. No Recovery.
296	41										
295	42										
294	43										
293											

Drilling Log, continued

BURNS McDONNELL

Project Name	AEP Pirkey CSM	Boring/Monitoring Well Number	SB-08
Project Number	111173	Page	4 of 7
		Date	2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
		No Recovery from 25.0'-45.0'.	NR	NA	NA	NA	NA	NA	NA	NA	
292	45	CLAY, Gray (10YR 6/1 to 5/1), with sand, some to few silt, some inclusions (sandstone, lignite, coal, and gravel), low to medium consistency, medium to high plasticity; CL.	▨								Offset 6.0' north. Resume drilling. Begin logging from soil cuttings below 45.0'.
291	46		▨								
290	47		▨								
289	48		▨								
288	49		▨								
287	50	- increased lignite inclusions below 49.8' CLAY, Gray (10YR 6/1) to dark Gray (10YR 4/1), with sand, some silt, some to with inclusions (lignite, coal, red clay, ironstone, sandstone, and gravel), low to medium consistency, medium to high plasticity; FILL. Mine Reclaim.	▩								
286	51		▩								
285	52		▩								
284	53		▩								
283	54		▩								
282	55		▩								
281	56		▩								
280	57		▩								
279	58		▩								
278			▩								

Drilling Log, continued

BURNS McDONNELL		Boring/Monitoring Well Number	SB-08
	Project Name AEP Pirkey CSM	Page	5 of 7
	Project Number 111173	Date	2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
277	60	CLAY, Gray (10YR 6/1) to dark Gray (10YR 4/1), with sand, some silt, some to with inclusions (lignite, coal, red clay, ironstone, sandstone, and gravel), low to medium consistency, medium to high plasticity; FILL. Mine Reclaim.	▨	NA	NA	NA	NA	NA	NA	NA	
276	61		▨								
275	62		▨								
274	63		▨								
273	64		▨								
272	65		▨								
271	66		▨								
270	67		▨								
269	68		▨								
268	69		▨								
267	70		▨								
266	71		▨								
265	72		▨								
264	73		▨								
263			▨								

Drilling Log, continued

BURNS McDONNELL		Boring/Monitoring Well Number SB-08
	Project Name AEP Pirkey CSM	Page 6 of 7
	Project Number 111173	Date 2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
	74	CLAY, Gray (10YR 6/1) to dark Gray (10YR 4/1), with sand, some silt, some to with inclusions (lignite, coal, red clay, ironstone, sandstone, and gravel), low to medium consistency, medium to high plasticity; FILL. Mine Reclaim.	▨	NA	NA	NA	NA	NA	NA	NA	
262	75		▨								
261	76		▨								
260	77		▨								
259	78		▨								
258	79		▨								
257	80		▨								
256	81		▨								
255	82		▨								
254	83		▨								
253	84		▨								
252	85		▨								
251	86		▨								
250	87		▨								
249	88		▨								

Drilling Log, continued

Project Name	AEP Pirkey CSM
Project Number	111173
Boring/Monitoring Well Number	SB-08
Page	7 of 7
Date	2/24/2019 to 2/26/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
	89		☒	NA	NA	NA	NA	NA	NA	NA	
247	90	CLAY, light Gray (10YR 7/1), some silt, medium to stiff, low to medium plasticity; CL.	▨								
246	91		▨								
245	92		▨								
244	93	Boring terminated at 93 feet bgs.									Temporary Piezometer Installed on 2/26/2019
	94										
	95										
	96										
	97										
	98										
	99										
	100										
	101										
	102										
	103										

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-50 (SB-8S)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	299140.5817
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924282.637
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

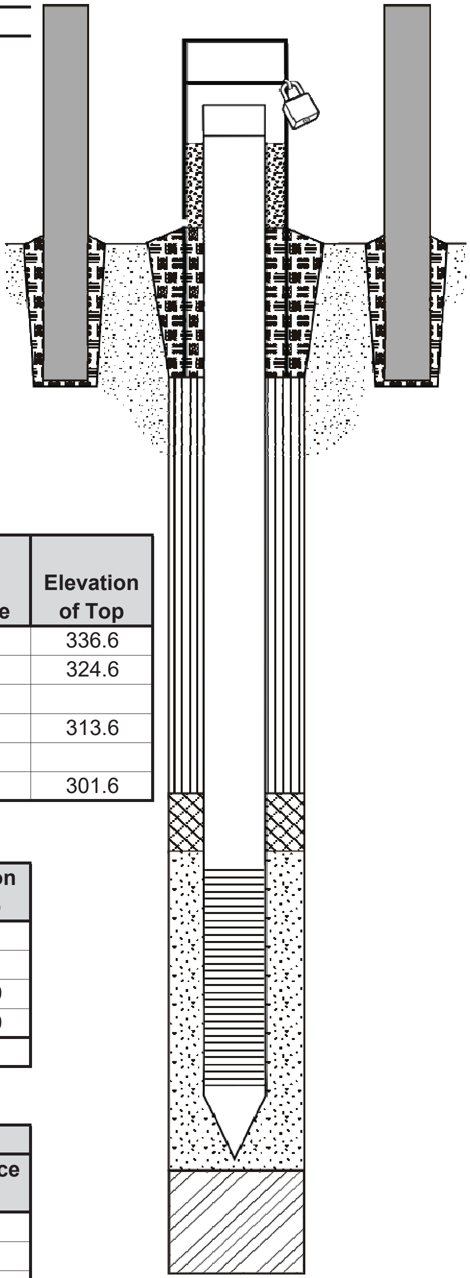
Elevations	
Top of Casing (TOC)	339.0
Ground Surface (GS)	336.6
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	2/27/2019
Installation Complete	2/27/2019
Well Completed	2/27/2019
Development Start	2/28/2019
Development Complete	3/1/2019

Annular Material Measurements	**Depth to Top from GS**	**Total Footage**	**Elevation of Top**
Annular Seal	0	12.0	336.6
Bentonite Seal	12	11.0	324.6
Secondary Filter Pack			
Filter Pack	23	12.0	313.6
Backfill	0		
Bottom of Borehole	35		301.6

Casing Materials Measurements	**Total Footage**	**Elevation of Top**
Total Riser Installed	25.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	314.69
Bottom Cap	0.28	304.69
Total Depth from TOC	34.59	

Groundwater Levels		
Date & Time	**Depth**	**Reference Point**



Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
Material: steel
Size: 4"
Length: 5'
Pea Gravel (Y/N): N
Weep Hole (Y/N): N
Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
Dimensions: 4' x 4' x 4"
Material: concrete

Annular Seal:
Type & Size: Chips
Manufacturer: NA
Amount Used: (included with bentonite seal)

Bentonite Seal:
Type & Size: Medium Chips
Manufacturer: NA
Amount Used: 4 bags

Secondary Filter Pack:
Type & Size: --
Manufacturer: --
Amount Used: --

Primary Filter Pack:
Type & Size: sand 16/30
Manufacturer: NA
Amount Used: 2 bags

Well Casing:
Type: PVC
Diameter: 2"
Sch. or Weight: Sch. 40
Manufacturer: Environmental Manufacturing
Screen Type: PVC factory slot
Screen Slot Size: 0.010"
Bottom Cap Type: threaded

Centralizers (Y/N): N
Material: --
Number: --
Depth(s): --

Backfill Material:
Type & Size: NA
Manufacturer: --
Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508724

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/27/2019**

Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**35**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**35**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**23**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name:	**James K. Collum**	License Number:	**3184**
Apprentice Name:	**Jason Smith**	Apprentice Number:	**60448**
Comments:	**No Data**		

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**35**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**25**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**25**	**35**

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Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-52 (SB-8I)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	299148.2762
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924262.209
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	340.7
Ground Surface (GS)	337.6
Reference Point (RP)	ground surface

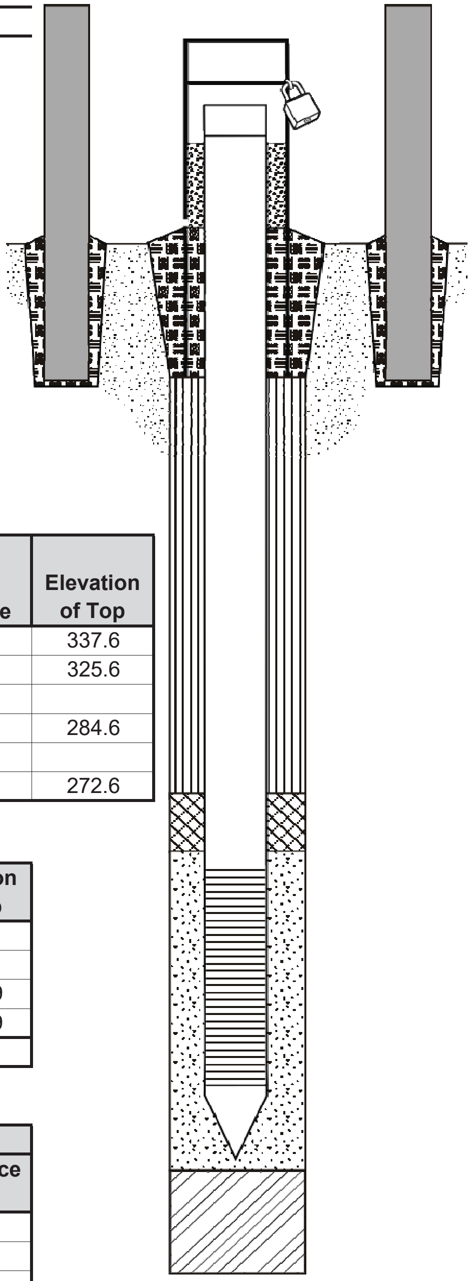
Dates	
Drilling/Installation Start	2/27/2019
Installation Complete	2/27/2019
Well Completed	2/27/2019
Development Start	2/28/2019
Development Complete	3/1/2019

Annular Material Measurements	**Depth to Top from GS**	**Total Footage**	**Elevation of Top**
Annular Seal	0	12.0	337.6
Bentonite Seal	12	41.0	325.6
Secondary Filter Pack			
Filter Pack	53	12.0	284.6
Backfill	0		
Bottom of Borehole	65		272.6

Casing Materials Measurements	**Total Footage**	**Elevation of Top**
Total Riser Installed	55.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	286.39
Bottom Cap	0.28	276.39
Total Depth from TOC	64.59	

Groundwater Levels

Date & Time	**Depth**	**Reference Point**



Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
Material: steel
Size: 4"
Length: 5'
Pea Gravel (Y/N): N
Weep Hole (Y/N): N
Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
Dimensions: 4' x 4' x 4"
Material: concrete

Annular Seal:
Type & Size: Chips
Manufacturer: NA
Amount Used: (included with bentonite seal)

Bentonite Seal:
Type & Size: Medium Chips
Manufacturer: NA
Amount Used: 4 bags

Secondary Filter Pack:
Type & Size: --
Manufacturer: --
Amount Used: --

Primary Filter Pack:
Type & Size: sand 16/30
Manufacturer: NA
Amount Used: NA

Well Casing:
Type: PVC
Diameter: 2"
Sch. or Weight: Sch. 40
Manufacturer: Environmental Manufacturing
Screen Type: PVC factory slot
Screen Slot Size: 0.010"
Bottom Cap Type: threaded

Centralizers (Y/N): N
Material: --
Number: --
Depth(s): --

Backfill Material:
Type & Size: NA
Manufacturer: --
Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508729

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 medium (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/27/2019**

Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**65**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
52	**65**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**53**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**65**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-53 (SB-8D)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	299148.8657
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924273.815
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	339.4
Ground Surface (GS)	336.8
Reference Point (RP)	ground surface

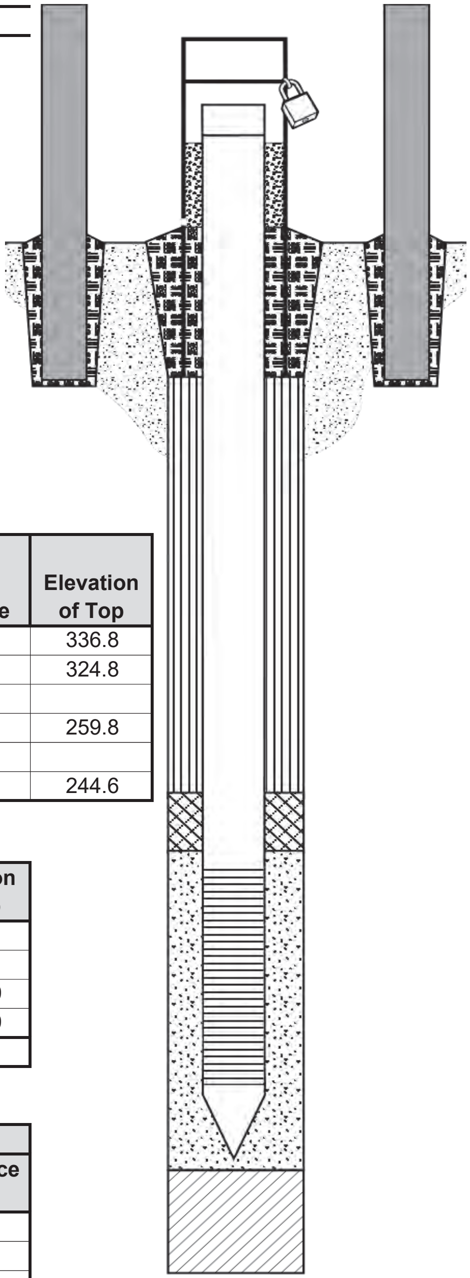
Dates	
Drilling/Installation Start	2/24/2019
Installation Complete	2/26/2019
Well Completed	2/26/2019
Development Start	2/28/2019
Development Complete	3/1/2019

Annular Material Measurements	**Depth to Top from GS**	**Total Footage**	**Elevation of Top**
Annular Seal	0	12.0	336.8
Bentonite Seal	12	65.0	324.8
Secondary Filter Pack			
Filter Pack	77	16.0	259.8
Backfill	0		
Bottom of Borehole	93		244.6

Casing Materials Measurements	**Total Footage**	**Elevation of Top**
Total Riser Installed	80.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	261.39
Bottom Cap	0.28	251.39
Total Depth from TOC	89.59	

Groundwater Levels

Date & Time	**Depth**	**Reference Point**



Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
Material: steel
Size: 4"
Length: 5'
Pea Gravel (Y/N): N
Weep Hole (Y/N): N
Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
Dimensions: 4' x 4' x 4"
Material: concrete

Annular Seal:
Type & Size: Chips
Manufacturer: NA
Amount Used: (included with bentonite seal)

Bentonite Seal:
Type & Size: Medium Chips
Manufacturer: NA
Amount Used: 16 bags

Secondary Filter Pack:
Type & Size: --
Manufacturer: --
Amount Used: --

Primary Filter Pack:
Type & Size: sand 16/30
Manufacturer: NA
Amount Used: 6 bags

Well Casing:
Type: PVC
Diameter: 2"
Sch. or Weight: Sch. 40
Manufacturer: Environmental Manufacturing
Screen Type: PVC factory slot
Screen Slot Size: 0.010"
Bottom Cap Type: threaded

Centralizers (Y/N): N
Material: --
Number: --
Depth(s): --

Backfill Material:
Type & Size: NA
Manufacturer: --
Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508777

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 deep (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**93**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
77	**93**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**77**	**Bentonite 15 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**90**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**
90	**93**	**gray clay (old pit base?)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**80**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**80**	**90**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Drilling Log

BURNS McDONNELL	Project Name AEP Pirkey CSM	Project No. 111173	Boring/Monitoring Well Number SB-09
	Coordinates N 6870180 E 3201109.5	Ground Elevation 319.80	Page 1 of 5
	Total Depth (feet) 60 / Hole Size (inches) 6.75"	Driller J. Smith	
Drilling Rig Ardco 4x4		Drilling Company MHC X-Ploration	
Date 3/4/2019	Logged By: D. Barker	Reviewed by:	Approved by:

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks ▽ Depth to water while drilling ▼ Depth to water after drilling
319 318 317 316 315	1 2 3 4 5	CLAY, Gray (7.5YR 6/1) to light Gray (7.5YR 7/1), with silt and sand, strong Brown (7.5YR 5/6 to 5/8) and Red (2.5YR 4/6 to 4/8), damp, soft, high plasticity; FILL. Mine Reclaim.	▨	NA	NA	NA	NA	NA	NA	NA	Log from soil cuttings from 0'-5'.
314	6	SILT, with clay, with very fine grained sand, very dark Gray (7.5YR 3/1) to dark Brown (7.5YR 3/2) to strong Brown (7.5YR 5/6), damp, soft, trace plasticity; FILL. Mine Reclaim.	▨	NA	NA	NA	NA	NA	NA	NA	Sampled SB-09 5'-6'
313 312 311	7 8 9	3 Feet of slough (Based on driller's feel).						0.5/5			
310	10	SAND, with silt, with clay, pinkish Gray (7.5YR 7/2) to strong Brown (7/5YR 5/6) to Red (2.5YR 4/6 to 4/8), very fine to fine grained, damp, loose; FILL. Mine Reclaim.	▨								
309 308 307 306	11 12 13	CLAY, trace silt, trace sand, very dark Gray (7.5YR 3/1) to dark Brown (7.5YR 3/2) to Brown (7.5YR 5/3), damp, soft, high plasticity; FILL. Mine Reclaim	▨	NA	NA	NA	NA	NA 0.5/5	NA	NA	No free water observed

Drilling Log, continued

BURNS McDONNELL		Boring/Monitoring Well Number	SB-09
	Project Name AEP Pirkey CSM	Page	2 of 5
	Project Number 111173	Date	3/4/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
305		CLAY, trace silt, trace sand, very dark Gray (7.5YR 3/1) to dark Brown (7.5YR 3/2) to Brown (7.5YR 5/3), damp, soft, high plasticity; FILL. Mine Reclaim	▨	NA	NA	NA	NA	NA 0.5/5	NA	NA	
304	15 16	SAND, with silt, with clay, very dark Gray (7.5YR 3/1) to dark Brown (7.5YR 3/2), very fine grained, damp; FILL. Mine Reclaim.	▨	NA	NA	NA	NA	NA	NA	NA	
303	17	1 Foot of slough (Based on driller's feel).									
302 301 300	18 19	SILT and SAND and CLAY, pinkish White (7.5YR 8/2) to dark Red (2.5YR 3/6), very fine to fine grained; FILL. Mine Reclaim.	▨					0.5/5			
299 298 297 296 295	20 21 22 23 24	SILT, with sand, with clay, very dark Gray (7.5YR 3/1) to dark Brown (7.5YR 3/2), very fine to fine grained, damp, soft to hard, medium plasticity; FILL. Mine Reclaim.	▨	NA	NA	NA	NA	NA	NA	NA	Log from soil cuttings below 20.0'. Sampled SB-09 20'-21'
294 293 292 291	25 26 27 28	SILT and SAND and CLAY, reddish Yellow (7.5YR 6/6); FILL. Mine Reclaim.	▨								

Drilling Log, continued

BURNS McDONNELL		Boring/Monitoring Well Number SB-09
	Project Name AEP Pirkey CSM	Page 3 of 5
	Project Number 111173	Date 3/4/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
		SILT and SAND and CLAY, reddish Yellow (7.5YR 6/6); FILL. Mine Reclaim.	▨	NA	NA	NA	NA	NA	NA	NA	
290	30										
289	31										
288	32										
287	33										
286	34										
285	35										
284	36										
283	37										
282	38										
281	39										
280	40	SILT and SAND and CLAY, reddish Yellow (7.5YR 6/6), with cemented sand fragments, with lignite fragments; FILL. Mine Reclaim.	▨								
279	41										
278	42										
277	43										
276											

Drilling Log, continued

BURNS McDONNELL		Boring/Monitoring Well Number	SB-09
	Project Name: AEP Pirkey CSM	Page	4 of 5
	Project Number: 111173	Date	3/4/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
		SILT and SAND and CLAY, reddish Yellow (7.5YR 6/6), with cemented sand fragments, with lignite fragments; FILL. Mine Reclaim.	▨	NA	NA	NA	NA	NA	NA	NA	
275	45		▨								
274	46		▨								
273	47		▨								
272	48		▨								
271	49		▨								
270	50	SILT and SAND and CLAY, dark Gray (7.5YR 4/1), with cemented sand fragments, with lignite fragments, damp, soft to medium, high plasticity; FILL. Mine Reclaim.	▨								
269	51		▨								
268	52		▨								
267	53		▨								
266	54		▨								
265	55		▨								
264	56		▨								
263	57		▨								
262	58		▨								
261			▨								

Drilling Log, continued

Project Name	AEP Pirkey CSM	Boring/Monitoring Well Number	SB-09
Project Number	111173	Page	5 of 5
		Date	3/4/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
260			▨	NA	NA	NA	NA	NA	NA	NA	
	60	Boring terminated at 60 feet bgs.									Temporary Piezometer Installed on 3/4/2019
	61										
	62										
	63										
	64										
	65										
	66										
	67										
	68										
	69										
	70										
	71										
	72										
	73										

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-54 (SB-9S)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	298239.4104
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924320.3597
Driller:	Jason Smith	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	323.7
Ground Surface (GS)	320.7
Reference Point (RP)	ground surface

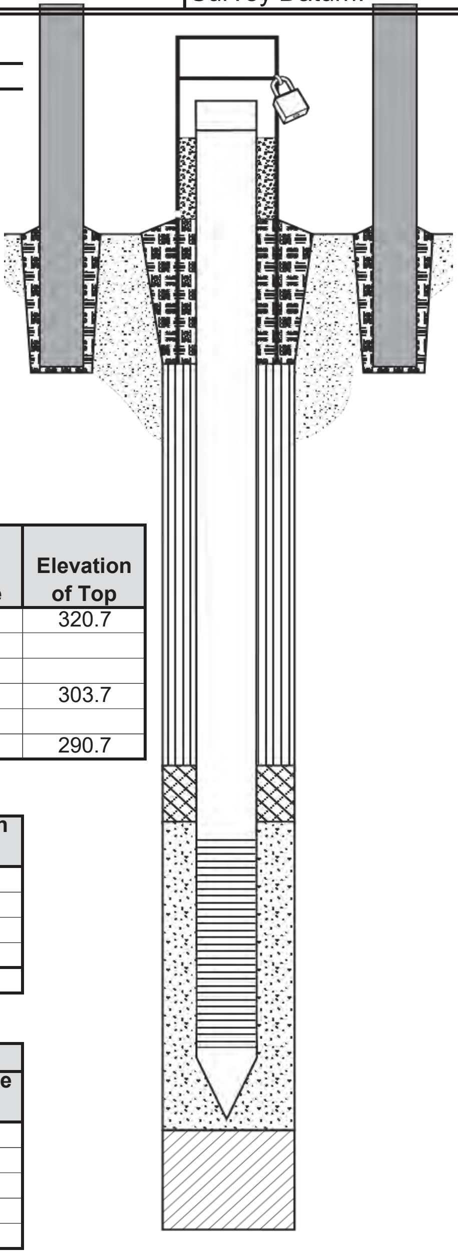
Dates	
Drilling/Installation Start	3/5/2019
Installation Complete	3/5/2019
Well Completed	3/18-25/2019
Development Start	3/6/2019
Development Complete	3/6/2019

Annular Material Measurements	**Depth to Top from GS**	**Total Footage**	**Elevation of Top**
Annular Seal		17.0	320.7
Bentonite Seal	0		
Secondary Filter Pack			
Filter Pack	17	13.0	303.7
Backfill	0		
Bottom of Borehole	30		290.7

Casing Materials Measurements	**Total Footage**	**Elevation of Top**
Total Riser Installed	30.00	NA
Total Riser Cutoff	7.12	NA
Screen	10.00	300.82
Bottom Cap	0.43	290.82
Total Depth from TOC	33.31	

Groundwater Levels

Date & Time	**Depth**	**Reference Point**



Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
Material: steel
Size: 4"
Length: 5'
Pea Gravel (Y/N): N
Weep Hole (Y/N): N
Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
Dimensions: 4' x 4' x 4"
Material: concrete

Annular Seal:
Type & Size: bentonite chips 3/8"
Manufacturer: Cetco
Amount Used: 1 bag / 50 lbs

Bentonite Seal:
Type & Size: pellets 3/8"
Manufacturer: PDS
Amount Used: 1 bucket / 50 lbs

Secondary Filter Pack:
Type & Size: --
Manufacturer: --
Amount Used: --

Primary Filter Pack:
Type & Size: sand 16/30
Manufacturer: U.S. Silica Company
Amount Used: 7.5 bags / 375 lbs

Well Casing:
Type: PVC
Diameter: 2"
Sch. or Weight: Sch. 40
Manufacturer: Campbell Monoflex
Screen Type: PVC factory slot
Screen Slot Size: 0.010"
Bottom Cap Type: threaded

Centralizers (Y/N): N
Material: --
Number: --
Depth(s): --

Backfill Material:
Type & Size: NA
Manufacturer: --
Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508781

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/5/2019** Drilling End Date: **3/5/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**30**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
17	**30**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**17**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**20**	**30**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-55 (SB-9D)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	298238.4991
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924332.0518
Driller:	Jason Smith	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	321.9
Ground Surface (GS)	319.8
Reference Point (RP)	ground surface

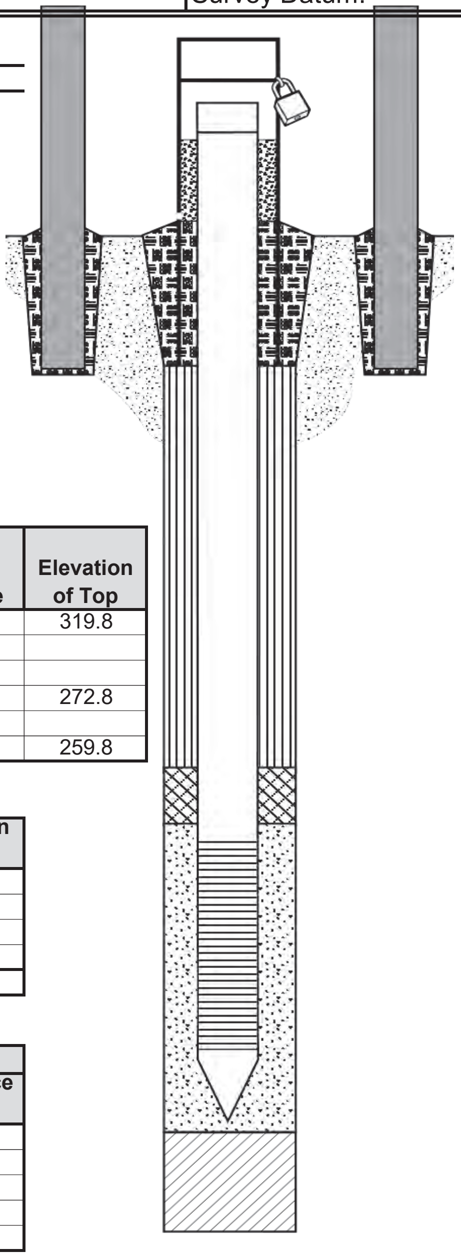
Dates	
Drilling/Installation Start	3/4/2019
Installation Complete	3/4/2019
Well Completed	3/18-25/2019
Development Start	3/5/2019
Development Complete	3/5/2019

Annular Material Measurements	**Depth to Top from GS**	**Total Footage**	**Elevation of Top**
Annular Seal		47.0	319.8
Bentonite Seal	0		
Secondary Filter Pack			
Filter Pack	47	13.0	272.8
Backfill	0		
Bottom of Borehole	60		259.8

Casing Materials Measurements	**Total Footage**	**Elevation of Top**
Total Riser Installed	60.00	NA
Total Riser Cutoff	7.89	NA
Screen	10.00	269.79
Bottom Cap	0.43	259.79
Total Depth from TOC	62.54	

Groundwater Levels

Date & Time	**Depth**	**Reference Point**



Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
Material: steel
Size: 4"
Length: 5'
Pea Gravel (Y/N): N
Weep Hole (Y/N): N
Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
Dimensions: 4' x 4' x 4"
Material: concrete

Annular Seal:
Type & Size: bentonite chips 3/8"
Manufacturer: Cetco
Amount Used: 8 bags / 400 lbs

Bentonite Seal:
Type & Size: pellets 3/8"
Manufacturer: PDS
Amount Used: 2 buckets / 100 lbs

Secondary Filter Pack:
Type & Size: --
Manufacturer: --
Amount Used: --

Primary Filter Pack:
Type & Size: sand 16/30
Manufacturer: U.S. Silica Company
Amount Used: 5 bags / 250 lbs

Well Casing:
Type: PVC
Diameter: 2"
Sch. or Weight: Sch. 40
Manufacturer: Campbell Monoflex
Screen Type: PVC factory slot
Screen Slot Size: 0.010"
Bottom Cap Type: threaded

Centralizers (Y/N): N
Material: --
Number: --
Depth(s): --

Backfill Material:
Type & Size: NA
Manufacturer: --
Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508779

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/4/2019**

Drilling End Date: **3/4/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**60**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
48	**60**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**48**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name:	**James K. Collum**	License Number:	**3184**
Apprentice Name:	**Jason Smith**	Apprentice Number:	**60448**
Comments:	**No Data**		

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**60**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Drilling Log

Project Name AEP Pirkey CSM	Project No. 111173	Boring/Monitoring Well Number SB-11	
Coordinates	Ground Elevation	Page 1 of 3	
Total Depth (feet) 43	Hole Size (inches) 6.75"	Driller J. Smith	
Drilling Rig Ardco 4x4		Drilling Company MHC X-Ploration	
Date 3/7/2019	Logged By: J.Hermanson	Reviewed by:	Approved by:

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks ▽ Depth to water while drilling ▼ Depth to water after drilling
		SILT, Brown (7.5YR 4/2), with very fine grained sand, damp, low to medium, low to medium plasticity; FILL.	▩	MC	1		NA	4/5	NA	NA	
	1 2 3 4	clayey GRAVEL, gravel-sand-clay mixture, strong Brown (7.5YR 5/6), coarse grained gravel, fine grained sand, wet, trace to medium plasticity; FILL.	▩								
	5 6 7	CLAY, dark yellowish Brown (10YR 4/6), some sand, damp to moist, medium plasticity; CL.	▨	MC	2		NA	3/5	NA	NA	
	8	SAND, light Gray (7.5YR 7/1), fine grained, trace clay, damp, medium density; SP.	░								
	9	CLAY, light Gray (7.5YR 7/1) with reddish Brown (5YR 5/9) mottling, some sand, damp to moist, trace to medium plasticity; CL.	▨								
	10 11	SAND, pinkish Gray (7.5YR 7/2), fine grained, trace clay, wet, medium density; SP.	░	MC	3		NA	3/5	NA	NA	▽ Free water observed at approximately 10.0'
	12 13	CLAY, light reddish Gray (2.5YR 7/1), trace sand, damp, medium density, medium plasticity; CL.	▨								

Drilling Log, continued

BURNS McDONNELL		Boring/Monitoring Well Number	SB-11
Project Name	AEP Pirkey CSM	Page	2 of 3
Project Number	111173	Date	3/7/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
		clayey GRAVEL, gravel-sand-clay mixture, strong Brown (7.5YR 5/6), fine grained gravel, fine grained sand, moist to wet; GC.		MC	3		NA	3/5	NA	NA	
	15 16	CLAY, light Gray (7.5YR 7/1), trace sand, damp to moist, soft to medium, medium plasticity; CL. - increasing sand and moisture content below 15.6'									
	17	CLAY, light Gray (5YR 7/1), some sand, with sand laminations, damp to moist, medium to stiff, trace to medium plasticity; CL. - increased moisture content below 17.5'		MC	4		NA	4/5	NA	NA	
	18 19 20	SAND, Gray (7.5YR 5/1), very fine grained, with clay laminations, trace iron ore laminations, dry, dense; SP.									
	21 22 23			MC	5		NA	4/5	NA	NA	
	24	- iron ore laminations grade out, increased sand content below 24.0'									
	25 26 27 28			MC	6		NA	5/10	NA	NA	

Drilling Log, continued

BURNS McDONNELL		Boring/Monitoring Well Number	SB-11
	Project Name: AEP Pirkey CSM	Page	3 of 3
	Project Number: 111173	Date	3/7/2019

Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
		SAND, Gray (7.5YR 5/1), very fine grained, with clay laminations, trace iron ore laminations, dry, dense; SP.									
	30										
	31										
	32			MC	6		NA	5/10	NA	NA	
	33										
	34										
	35										
	36										
	37										
	38										
	39			MC	7		NA	8/8	NA	NA	
	40	SAND, dark Gray (7.5YR 4/1), very fine grained, trace clay, moist, medium density; SP.									
	41										
	42	SAND, Gray (7.5YR 5/1), very fine grained, with clay laminations, dry, dense; SP.									
	43	Refusal on obstruction - End of boring at 43 feet bgs.									Abandoned with cement-bentonite grout on 3/7/2019

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-56 (SB-11S)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	296233.6811
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924310.063
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash
Borehole Diameter: 6.75-inch

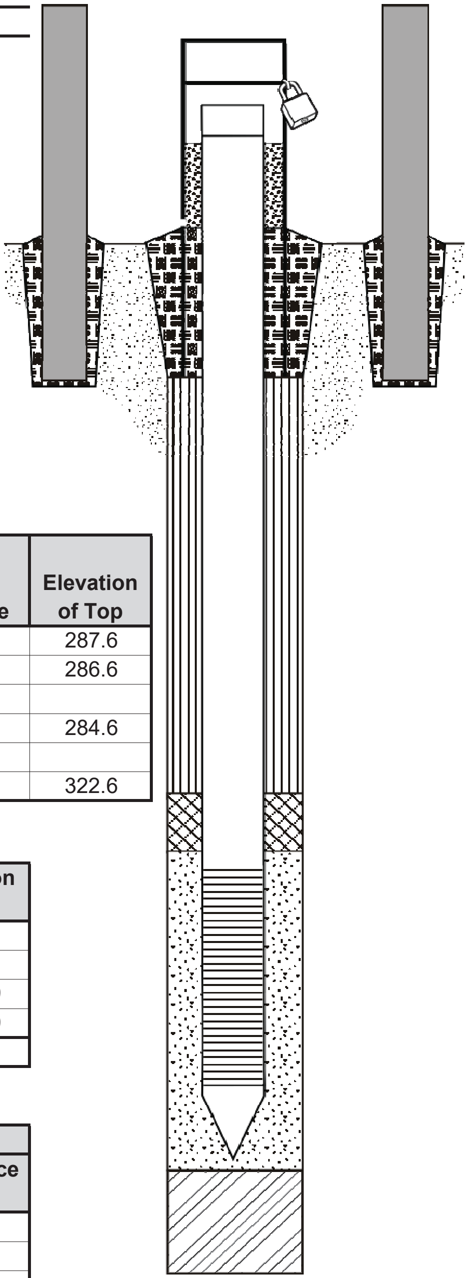
Elevations	
Top of Casing (TOC)	290.0
Ground Surface (GS)	287.6
Reference Point (RP)	ground surface

Dates	
Drilling/Installation Start	3/8/2019
Installation Complete	3/8/2019
Well Completed	3/8/2019
Development Start	3/10/2019
Development Complete	3/11/2019

Annular Material Measurements	**Depth to Top from GS**	**Total Footage**	**Elevation of Top**
Annular Seal	0	1.0	287.6
Bentonite Seal	1	2.0	286.6
Secondary Filter Pack			
Filter Pack	3	12.0	284.6
Backfill	0		
Bottom of Borehole	15		322.6

Casing Materials Measurements	**Total Footage**	**Elevation of Top**
Total Riser Installed	5.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	336.39
Bottom Cap	0.28	326.39
Total Depth from TOC	14.59	

Groundwater Levels		
Date & Time	**Depth**	**Reference Point**



Cap Type: J-plug
Lock Keyed to: AEP monitoring well

Protective Cover:
Material: steel
Size: 4"
Length: 5'
Pea Gravel (Y/N): N
Weep Hole (Y/N): N
Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:
Dimensions: 4' x 4' x 4"
Material: concrete

Annular Seal:
Type & Size: Chips
Manufacturer: NA
Amount Used: (included with bentonite seal)

Bentonite Seal:
Type & Size: Medium Chips
Manufacturer: NA
Amount Used: 1 bag

Secondary Filter Pack:
Type & Size: --
Manufacturer: --
Amount Used: --

Primary Filter Pack:
Type & Size: sand 16/30
Manufacturer: NA
Amount Used: 6 bags

Well Casing:
Type: PVC
Diameter: 2"
Sch. or Weight: Sch. 40
Manufacturer: Environmental Manufacturing
Screen Type: PVC factory slot
Screen Slot Size: 0.010"
Bottom Cap Type: threaded

Centralizers (Y/N): N
Material: --
Number: --
Depth(s): --

Backfill Material:
Type & Size: NA
Manufacturer: --
Amount Used: --

STATE OF TEXAS WELL REPORT for Tracking #508718

Owner: **AEP Pirkey Power Plant**

Owner Well #: **SB-11 shallow (MW)**

Address: **2400 FM 3251**
Hallsville, TX 75650

Grid #: **35-36-6**

Well Location: **2400 FM 3251**
Hallsville, TX 75650

Latitude: **32° 26' 41" N**

Longitude: **094° 30' 11" W**

Well County: **Harrison**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/8/2019** Drilling End Date: **3/8/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**6.75**	**0**	**15**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
Filter Pack Intervals:	**3**	**15**	**Sand**	**16/30**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**0**	**1**	**Cement**
	1	**3**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

Monitoring Well Construction Diagram

Project Number:	111173	**Well Number:**	**AD-57 (SB-11D)**
Project Name:	AEP-Pirkey	**Property Owner:**	AEP
Geologist:	David Barker	Northing:	296232.0764
Drilling Company:	MHC X-Ploration Corporation	Easting:	2924300.047
Driller:	James K. Collum	Survey Datum:	Texas State Plane North Central (4202)

Drilling Method: Rotary Wash

Borehole Diameter: 6.75-inch

Elevations	
Top of Casing (TOC)	290.0
Ground Surface (GS)	287.3
Reference Point (RP)	ground surface

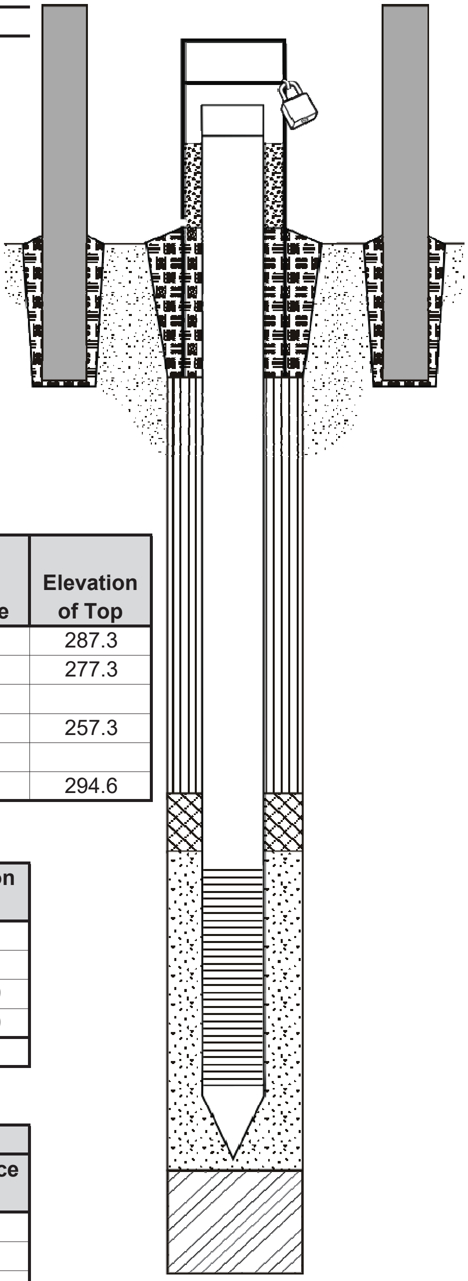
Dates	
Drilling/Installation Start	3/7/2019
Installation Complete	3/8/2019
Well Completed	3/8/2019
Development Start	3/10/2019
Development Complete	3/11/2019

Annular Material Measurements	**Depth to Top from GS**	**Total Footage**	**Elevation of Top**
Annular Seal	0	10.0	287.3
Bentonite Seal	10	20.0	277.3
Secondary Filter Pack			
Filter Pack	30	13.0	257.3
Backfill	0		
Bottom of Borehole	43		294.6

Casing Materials Measurements	**Total Footage**	**Elevation of Top**
Total Riser Installed	33.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	308.39
Bottom Cap	0.28	298.39
Total Depth from TOC	42.59	

Groundwater Levels

Date & Time	**Depth**	**Reference Point**



Cap Type: J-plug

Lock Keyed to: AEP monitoring well

Protective Cover:

Material: steel

Size: 4"

Length: 5'

Pea Gravel (Y/N): N

Weep Hole (Y/N): N

Guage Mark (Y/N): Y

Bollards (# and type): 4 - steel

Surface Pad:

Dimensions: 4' x 4' x 4"

Material: concrete

Annular Seal:

Type & Size: Chips

Manufacturer: NA

Amount Used: (included with bentonite seal)

Bentonite Seal:

Type & Size: Medium Chips

Manufacturer: NA

Amount Used: 5 bags

Secondary Filter Pack:

Type & Size: --

Manufacturer: --

Amount Used: --

Primary Filter Pack:

Type & Size: sand 16/30

Manufacturer: NA

Amount Used: 5 bags

Well Casing:

Type: PVC

Diameter: 2"

Sch. or Weight: Sch. 40

Manufacturer: Environmental Manufacturing

Screen Type: PVC factory slot

Screen Slot Size: 0.010"

Bottom Cap Type: threaded

Centralizers (Y/N): N

Material: --

Number: --

Depth(s): --

Backfill Material:

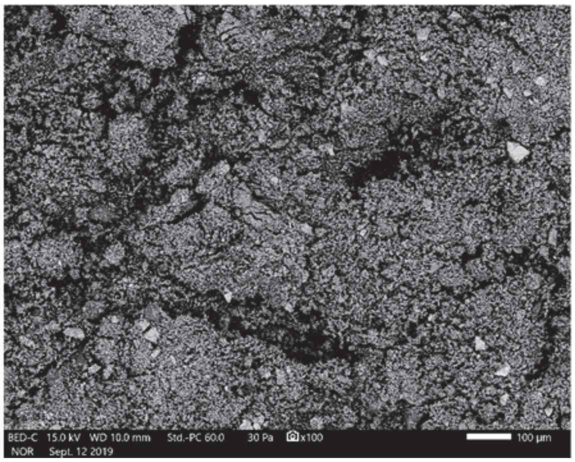
Type & Size: NA

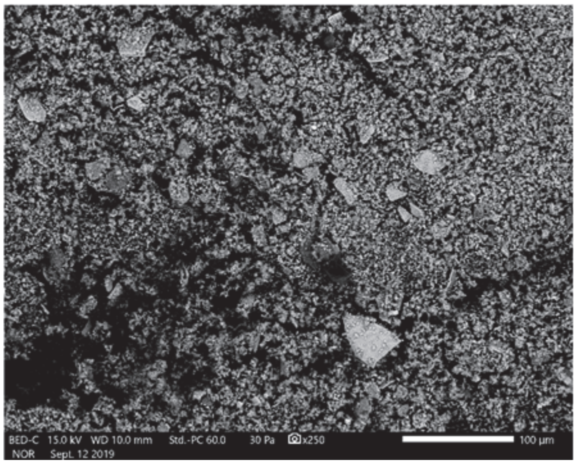
Manufacturer: --

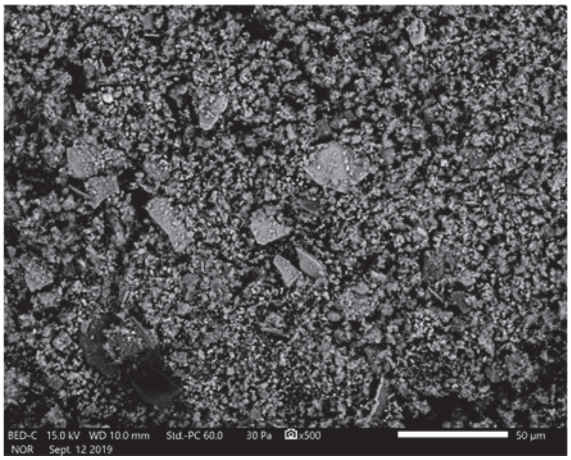
Amount Used: --

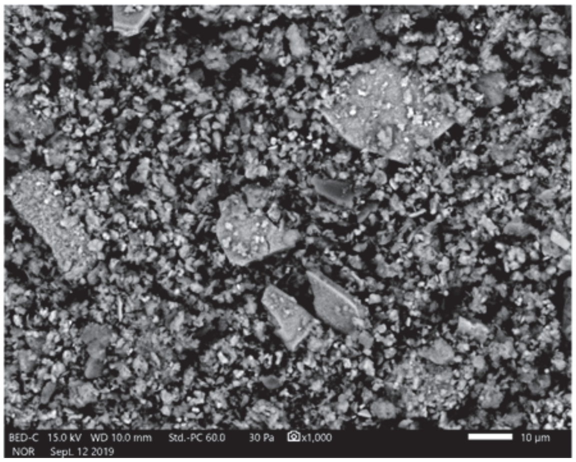
ATTACHMENT B

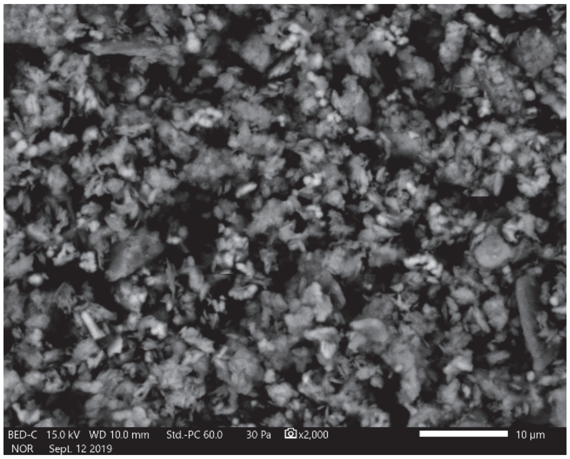
SEM/EDS Analysis

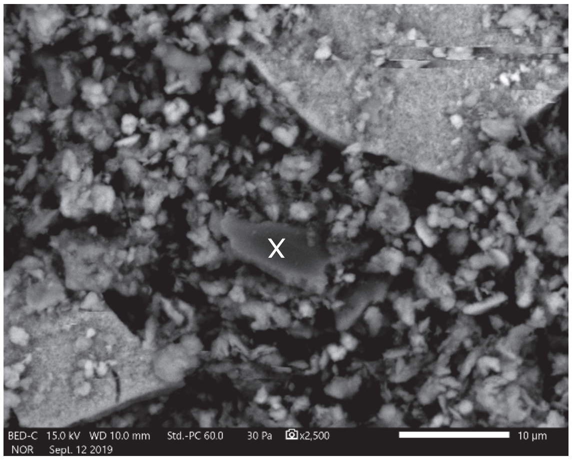


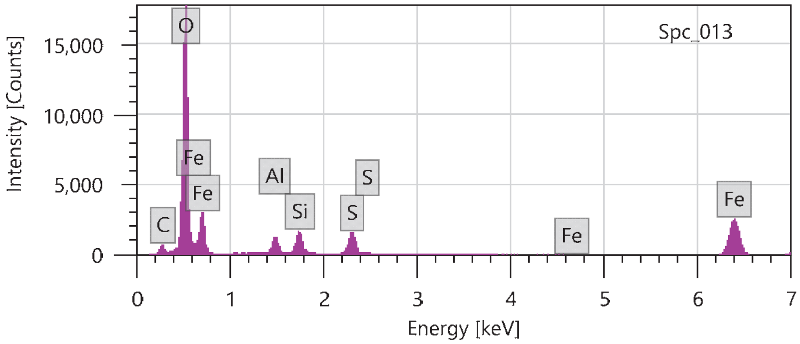












Sample AD-34. BSE spectrum is an area scan for the region shown at 2,000X. Most large blocky particles are quartz or feldspar. X is clay.

ATTACHMENT C

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey FGD LF CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

BETH ANN GROSS
79864

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

10/3/2019
Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant
Landfill
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants
engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

January 7, 2020

CHA8462

TABLE OF CONTENTS

FIGURES

TABLES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LF	Landfill
MCL	Maximum Contaminant Level
RCRA	Resource Conservation and Recovery Act
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
SU	Standard Units
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the Landfill (LF). Eight background monitoring events were conducted at the LF, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. Interwell tests were used to calculate background for pH, sulfate, and total dissolved solids (TDS), and intrawell tests were used for boron, calcium, chloride, and fluoride. During the initial detection monitoring event completed in August 2017, statistically significant increases (SSIs) for boron, sulfate, and TDS were observed, and the unit transitioned to assessment monitoring. Semi-annual assessment monitoring events were conducted at the LF between March 2018 and May 2019 in accordance with 40 CFR 257.95.

In 2019, AEP collected additional geologic data in the vicinity of the LF and updated the conceptual site model. Based on this updated interpretation, it has been determined that interwell upper prediction limits (UPLs) are not appropriate for detection monitoring.

United States Environmental Protection Agency (USEPA) regulations (USEPA, 2015) regarding detection monitoring programs for coal combustion residuals (CCR) landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration (ASD) when an SSI is identified (40 CFR 257.94(e)(2)):

> *The owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.*

Pursuant to 40 CFR 257.94(e)(2) of the CCR Rule (40 CFR 257), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report, which documents: (1) the change from interwell to intrawell background values for all Appendix III parameters; (2) the alternative source for sulfate and TDS (statistical evaluation cause) in August 2017; (3) exceedances and possible exceedances observed for Appendix III parameters between August 2017 and February 2019; and (iv) the alternative source for boron (natural variation) in August 2017.

SECTION 2

SUMMARY OF GROUNDWATER MONITORING

2.1 Monitoring Network

The groundwater monitoring network for the Pirkey LF currently consists of three upgradient wells (AD-8, AD-16, and AD-27), and three downgradient wells (AD-23, AD-34, and AD-36) (Figure 1). Following the initial detection monitoring event, these wells have been monitored on a semi-annual basis in accordance with 40 CFR 257.95 for Appendix IV parameters. AD-35 was monitored between August 2017 and August 2018 as a downgradient well in the monitoring network before being removed in November 2018 due to landfill expansion activities. Thus, a discussion of AD-35 is not included in this report. AD-35 was replaced by a new downgradient monitoring well, AD-36, which was installed in April 2019 and added to the monitoring network. Eight sampling events are currently being completed at AD-36 to establish background at this well.

2.2 Statistics Completed to Date

2.2.1 Background Established 2018

Between May 2016 and April 2017, sampling was completed at each of the network wells to establish background concentrations for Appendix III and Appendix IV parameters under the CCR rule. The monitoring well data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis in accordance with the statistical analysis plan developed for the unit (AEP, 2017) and USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The background data were reviewed for outliers, which were removed (when appropriate) prior to calculating UPLs for each Appendix III parameter to represent background values. Interwell tests were selected for pH, sulfate, and TDS, whereas intrawell tests were selected for boron, calcium, chloride, and fluoride (Geosyntec, 2018a).

A 1-of-2 resample plan was established for both interwell and intrawell tests to determine if there were exceedances above background values. In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of an additional sample to confirm whether there had been an exceedance. If the resample confirms the exceedance, an SSI is identified and the unit transitions to assessment monitoring. If the resample falls within the statistical limit, the initial exceedance is considered to be a false positive result and no further action is necessary. In the case of an SSI, an ASD may be prepared in accordance with 40 CFR 257.94(e)(2), which documents that a source other than the unit caused the SSI and permits the unit to remain in detection monitoring.

2.2.2 Initial Detection Monitoring Event

Detection monitoring began in August 2017 after the background monitoring period. The initial detection monitoring event was completed in August and December 2017. This event resulted in SSIs above background for boron at AD-23 and sulfate and TDS at AD-34 (Geosyntec, 2018a).

Table 1 summarizes the analytical results and compares the results with calculated prediction limits. As shown in Table 1:

- Boron concentrations of 0.0402 mg/L (initial sample) and 0.0450 mg/L (verification sample) exceeded the UPL of 0.030 mg/L at AD-23;

- Sulfate concentrations of 1,231 and 1,020 mg/L exceeded the interwell UPL of 207 mg/L at AD-34; and

- TDS values of 1,128 and 1,260 mg/L exceeded the interwell UPL of 335 mg/L at AD-34.

2.2.3 Assessment Monitoring

The unit transitioned to assessment monitoring after SSIs were identified for boron, sulfate, and TDS. An alternative source for these parameters was not identified at that time. Therefore, background limits were established for the Appendix IV parameters using upper tolerance limits (UTLs) constructed with 95% confidence and 95% coverage using pooled upgradient well data in accordance with the facility's statistical analysis plan (AEP, 2017) and the *Unified Guidance* (USEPA, 2009). Next, the groundwater protection standard (GWPS) for each parameter was established as the greater of the background concentration and either the Maximum Contaminant Level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2).

Two assessment monitoring events for Appendix IV parameters were conducted in March 2018 and August 2018 in accordance with 40 CFR 257.95(b) and 40 CFR 257.95(d)(1), respectively. Following the August 2018 assessment monitoring event, statistically significant levels (SSLs) for cadmium and cobalt were identified at well AD-34 (Geosyntec, 2018b). Specifically:

- The lower confidence limit (LCL) for cadmium (0.00511 mg/L) was above the GWPS of 0.00500 mg/L; and

- The LCL for cobalt (0.277 mg/L) was above the GWPS of 0.0260 mg/L.

An ASD concluding that the elevated concentrations could be attributed to lignite mine spoils in the vicinity of AD-34 was completed (Burns & McDonnell, 2019); thus, the LF unit remained in assessment monitoring.

Following an assessment monitoring event in February 2019, which was completed in accordance with 40 CFR 257.95(d)(1), the data were submitted to GSC for statistical analysis. GWPSs were re-established for the Appendix IV parameters in accordance with the statistical analysis plan developed for the unit. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at an SSL above the GWPS. SSLs for cobalt and lithium were identified at well AD-34 (Geosyntec, 2019a). Specifically:

- The LCL for cobalt at AD-34 was 0.272 mg/L, which exceeded the GWPS of 0.026 mg/L; and,
- The LCL for lithium at AD-34 was 0.145 mg/L, which exceeded the GWPS of 0.110 mg/L.

An ASD was successfully completed which argued that the cobalt and lithium concentrations were related to the mine spoils near AD-34 (Geosyntec, 2019b).

2.3 Need for Updated Statistical Tests

SSLs of cadmium, cobalt, and lithium were identified at AD-34 during assessment monitoring; however, the elevated concentrations were attributed in ASDs to the presence of lignite mine spoils in the vicinity of AD-34. No other SSLs were identified for the Appendix IV parameters.

The presence of the lignite mine spoils also affects the concentrations of detection monitoring parameters at wells located near the spoils. The SSIs for sulfate and TDS identified during the first detection monitoring event were based on observed exceedances of an interwell UPL for these parameters. At the time an alternative source could not be determined for boron, sulfate, and TDS. However, based on updated knowledge of the site geology and geochemistry, as described subsequently in Section 3, the use of intrawell statistics is more appropriate to evaluate possible exceedances of Appendix III parameters.

SECTION 3

REVIEW OF SITE CONDITIONS

3.1 Site Layout

The LF, including closed, active, and areas under construction, occupies approximately 137 acres (Figure 1). The LF is bound by Brandy Branch Reservoir to the east, the Stormwater Runoff Pond (pond south of AD-34 and AD-36) to the south, former lignite mining areas to the west, and a coal pile and coal pile runoff pond to the north. A portion of the west side of the LF is underlain by former lignite mining (reclaimed) land, which is identified as 'A Area' in Figure 1. The local surface topography slopes to the southwest towards Hatley Creek, located approximately 0.7 miles west of the LF. As discussed in Section 2.1, groundwater in the vicinity of the LF is monitored with a network of upgradient and downgradient wells. As shown in Figure 1, AD-34 is the only downgradient well in the LF monitoring network which is set within mine spoil in the former mining area (A Area).

3.2 Site Geochemistry

A geochemical investigation shows that wells screened within the former mining area have a different groundwater composition than wells screened in undisturbed geology. A Piper diagram was generated to assess whether major ion concentrations are affected by screen placement in the mine spoil area (Figure 2). The Piper diagram shows that AD-34 groundwater appears more similar to wells which were screened in the mine spoil area (AD-25, AD-26, AD-48, AD-49, AD-52 through AD-55) than wells that are in the well network. Groundwater in the mine spoil area is dominated by sulfate and magnesium, whereas wells screened in native material have higher proportions of chloride, sodium, and potassium.

Sulfate and TDS are elevated in wells screened within mine spoils in A Area adjacent to the LF, as shown in Figures 3 and 4, respectively. Increased sulfate and TDS concentrations in waters affected by mine spoils are well known (Skousen and Zipper, 2014; Cunningham and Jones, 1990). The effect of mine spoils on the sulfate and TDS concentrations is supported by the lower reported values at AD-50 (illustrated with a smaller radius circle), which is set within the mine spoil footprint but screened in clean fill.

AD-54 and AD-55, which have the highest sulfate and TDS concentrations in the area, are located more than 1,400 feet from the edge of the LF. Groundwater seepage velocities in the area are consistently less than 25 feet per year (AEP, 2019). Impacts from waste placement would take more than fifty years to reach the AD-54/AD-55 cluster, and waste placement did not start at the unit until 1985. Therefore, elevated concentrations of sulfate and TDS within the mine spoil area are unlikely to be related to a release from the unit and instead can be attributed to the effects of the mine spoils on groundwater chemistry.

Additionally, the concentrations of all Appendix III parameters at AD-34 are consistent over time. As shown in Figure 5, the August 2017 and December 2017 values, which were considered SSIs for sulfate and TDS in the initial statistical evaluation, are within the normal range for this monitoring well. This suggests that there are not ongoing impacts that are affecting groundwater chemistry at AD-34, which would be indicative of a release.

Because AD-34 is the only well in the monitoring network that is screened within mine spoils, intrawell statistics are more appropriate for screening Appendix III parameters for SSIs than the interwell approach.

SECTION 4

STATISTICAL REVISION

4.1 Statistical Output from Groundwater Stats Consulting

The presence of mine spoils near AD-34 and their effect on groundwater chemistry was not known when interwell statistics were selected to calculate background concentrations for pH, sulfate, and TDS following the background monitoring period. After AEP updated their conceptual site model in 2019 and became aware of the issue, the need to modify the statistical tests for these parameters became apparent.

Statistical analysis of the LF data was revised in accordance with the January 2017 Statistical Analysis Plan (AEP, 2017). Intrawell prediction limits were calculated for pH, sulfate, and TDS using the background dataset collected prior to initiation of detection monitoring (Table 2). The intrawell background value UPLs for all Appendix III parameters were then used to determine SSIs at the LF downgradient well network for the detection monitoring data collected between August 2017 and February 2019, which are summarized in Table 3. The tests were selected with using a one-of-two retesting procedure.

The revised statistical output for pH, sulfate, and TDS is provided in Attachment A. While all parameters are included, only the tests for pH, sulfate, and TDS were revised.

4.2 Review of August 2017-February 2019 Detection Monitoring Results

Bold values in Table 1 highlight concentrations above the UPL for Appendix III parameters using the current intrawell background values. Exceedances and possible exceedances were noted for boron, chloride, and pH. An exceedance was only confirmed if two consecutive samples were above the UPL based on the selected one-of-two retesting procedure. These exceedances or possible exceedances are discussed below.

4.2.1 August 2017

As discussed in Section 2.2.2, boron concentrations in well AD-23 for the first detection monitoring event exceeded the intrawell UPL of 0.0300 mg/L, resulting in an SSI. The boron concentrations were 0.0402 mg/L for the August 2017 (initial) and 0.0450 mg/L for the December 2017 (verification) sampling events. However, subsequent samples collected from March 2018 through May 2019 were below the UPL, as shown in Figure 6. Additionally, Figure 7 shows that upgradient well AD-8 has consistently higher concentrations of boron than AD-23. Based on a broader understanding of spatial and temporal variations at the LF, it is concluded that the August and December 2017 boron values represent a temporary increase of natural origin and do not suggest a release from the LF. Therefore, natural variation was determined to be the alternative source for this exceedance. Certification of this ASD by a certified professional engineer is included with this report as Attachment B.

4.2.2 March 2018

A possible exceedance for boron was noted for well AD-34 in March 2018. Boron was detected at 0.171 mg/L, which is above the intrawell UPL of 0.120 mg/L. Verification sampling was not completed at the time because the unit had transitioned to assessment monitoring, but the subsequent semi-annual monitoring result in August 2018 was below the UPL, as shown in Figure 8. This result is now being considered the verification sampling event; thus, no SSI was identified for boron at AD-34 for the March 2018 sampling event. Subsequent samples for boron at AD-34 were also below the intrawell UPL, suggesting that the March 2018 concentration was a natural variation and not a release from the LF.

4.2.3 August 2018

A possible exceedance for chloride was noted for wells AD-23 and AD-34 in August 2018. Chloride was detected at 9 mg/l in well AD-23, which is above the intrawell UPL of 7.89 mg/L, and at 10 mg/L in well AD-34, which is above the intrawell UPL of 9.2 mg/L. Verification sampling was not completed at the time because the unit had transitioned to assessment monitoring, but subsequent semi-annual monitoring results in February 2019 were below intrawell UPLs for both wells, as shown in Figure 9. These results are now being considered the verification sampling events for both wells; thus, no SSIs were identified for chloride at either well for the August 2018 sampling event.

4.2.4 February 2019

A possible exceedance for pH (5.1 standard units [SU]) was identified at well AD-23 in February 2019. Verification sampling was completed in May 2019, and the pH result of 4.8 did not exceed the intrawell UPL for pH of 4.8 at AD-23. Thus, no SSI was identified.

4.3 Return to Detection Monitoring

SSIs for boron, sulfate, and TDS were concluded for the first detection monitoring period in August 2017, and the evaluation of alternative sources was not pursued given the conceptual site model available at the time. However, with the updated statistical tests for sulfate and TDS presented in this report, there is no longer an SSI of sulfate and TDS at AD-34. Further, the initial higher concentrations for boron are now considered to be representative of natural variation rather than an SSI, as described in Section 4.2.1.

The completion of this ASD to address the SSIs initially reported for boron, sulfate, and TDS removes the regulatory need for assessment monitoring of the LF. Therefore, all data collected during the previous assessment monitoring periods may be evaluated as detection monitoring events. As demonstrated in Section 4, SSIs are not determined for any of the Appendix III parameters monitored for the LF.

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

Well AD-34 is the only monitoring location within the Pirkey LF monitoring network that is set within a former mining area. The placement of mine spoils within the former mining area has resulted in different groundwater geochemistry at AD-34 compared to the other locations in the LF network. The information presented in this report supports the position that the detection monitoring statistics should be revised to use intrawell tests for all Appendix III parameters. Revised intrawell prediction limits were calculated using a one-of-two resampling procedure. Using the revised UPLs for sulfate and TDS, no exceedances of sulfate or TDS were identified during the August 2017 detection monitoring event.

All sampling events for Appendix III parameters completed since the end of the background monitoring period were evaluated in Section 4 using intrawell background value UPLs. One SSI was identified for boron during the August 2017 detection monitoring event. Section 4.2.1 of this report provides lines of evidence showing that an alternative source (natural variation) is responsible for the boron SSI. No other SSIs were observed in the sampling events completed from August 2017 through February 2019.

This ASD for sulfate and TDS (statistical evaluation cause) and boron (natural variation) was prepared in accordance with 40 CFR 257.94(e)(2). Certification of this ASD is provided in Attachment B. The unit will return to detection monitoring, and a public posting will be made in accordance with 40 CFR 257.95(e).

SECTION 6

REFERENCES

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Geosyntec Consultants. 2018b. Statistical Analysis Summary – Landfill. H.W. Pirkey Power Plant. Hallsville, Texas. December.

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FIGURES

Legend

- ⊕ Upgradient Well
- ⊕ Downgradient Well
- ⊕ Out of Network Well
- ⊕ Abandoned Well
- ☐ A Area
- ☐ Landfill

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- A Area is a former lignite (reclaimed) mine.
- AD-35 was abandoned in November 2018 and a new downgradient well, AD-36, was installed in April 2019.
- Aerial imagery provided by DigitalGlobe and dated 12/1/2018.

1,000 500 0 1,000
Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

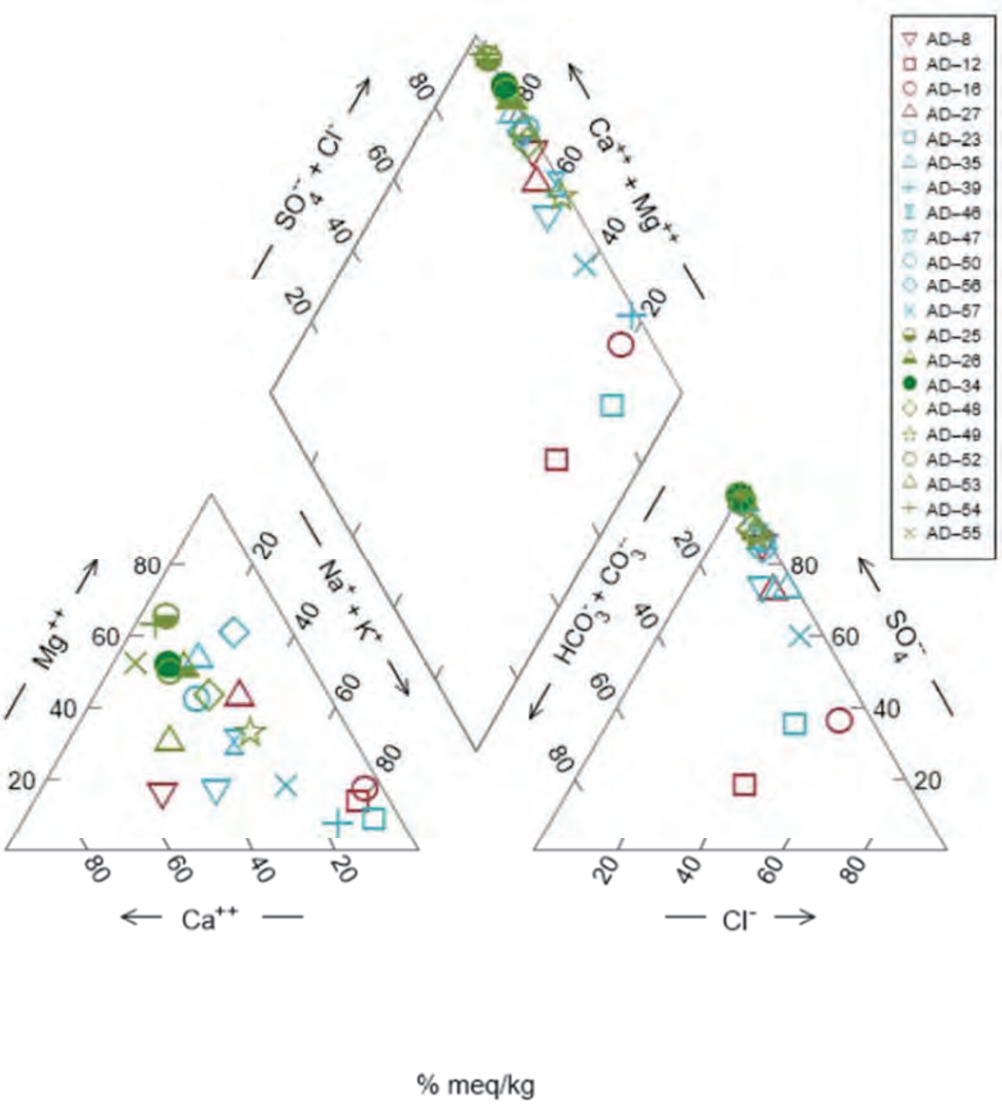
Geosyntec
consultants

Columbus, Ohio

2020/01/06

Figure
1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Sitelayout_20191224.mxd. ARevezzo. 1/6/2020. Project/Phase/Task.



Notes: Wells in the LF network use February 2019 data, except AD-8 which used August 2018 data due to an apparent outlier. Wells out of the network use August 2019 data.

Red symbology: Upgradient locations
Blue symbology: Downgradient locations screened in natural geology or clean fill.
Green symbology: Downgradient locations screened in mine fill.

Piper Diagram – Landfill Area Wells

Pirkey Landfill

Geosyntec consultants

AMERICAN ELECTRIC POWER

Columbus, Ohio

19-Sep-2019

Figure

2

Legend

- ● Wells not screened in mine spoil
- ● Wells screened in mine spoil
- ▭ A Area
- ▭ Landfill

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- Size of point symbol corresponds to sulfate concentration.
- Sulfate concentrations displayed in milligrams per liter (mg/L).
- Sulfate concentrations from the August 2019 sampling event are used, as this is the most complete dataset available.
- Sulfate concentrations for monitoring well AD-35 is represented with data from the August 2018 sampling event; AD-25 is represented with data from the February 2019 sampling event.
- A Area is a former lignite (reclaimed) mine.

900 450 0 900
Feet

Landfill Area Sulfate Values

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio
2020/01/06

Figure
3

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_PirkeyLF_Sulfate_20191219.mxd. ARevezzo. 1/6/2020.

Legend

- 🔵 Wells not screened in mine spoil
- 🔴 Wells screened in mine spoil
- ▭ A Area
- ▭ Landfill

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- Size of point symbol corresponds to total dissolved solids (TDS) concentration.
- Total Dissolved Solids (TDS) concentrations displayed in milligrams per liter (mg/L).
- TDS concentrations from the August 2019 sampling event are used, as this is the most complete dataset available.
- TDS concentrations for monitoring well AD-35 is representated with data from the August 2018 sampling event; AD-25 is represented with data from the February 2019 sampling event.
- A Area is a former lignite (reclaimed) mine.

900 450 0 900
Feet

Landfill Area Total Dissolved Soilds Values

AEP Pirkey Power Plant
Hallsville, Texas

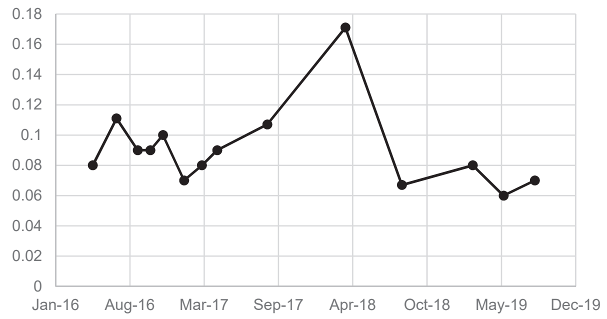
Geosyntec
consultants

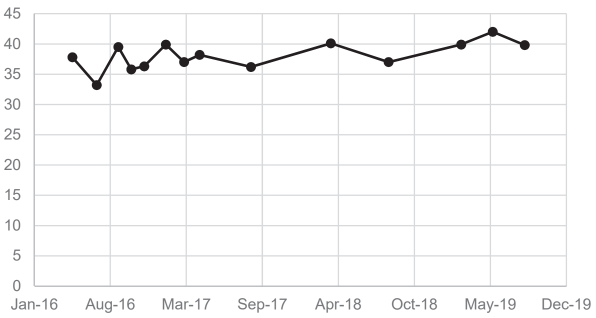
Columbus, Ohio

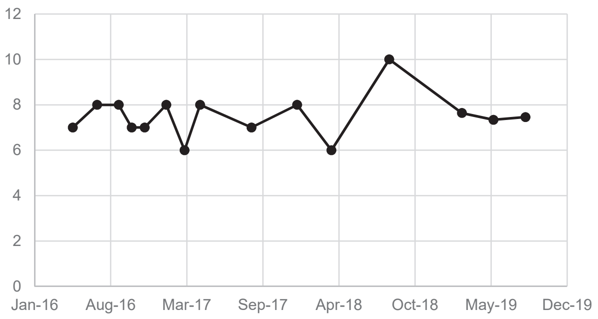
2020/01/06

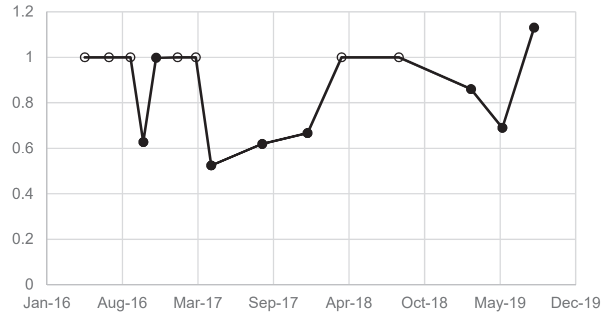
Figure
4

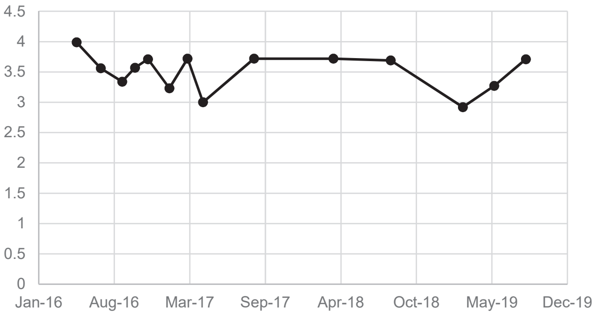
P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_PirkeyLF_TDS_20191219.mxd. ARevezzo. 1/6/2020.

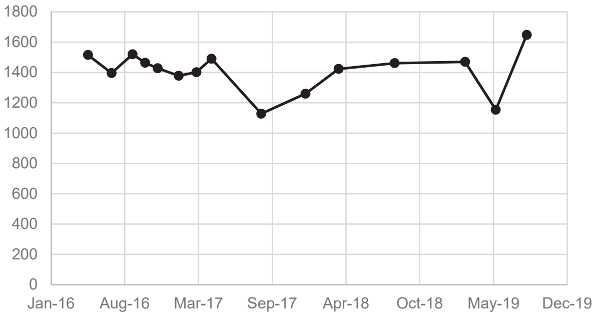

Boron

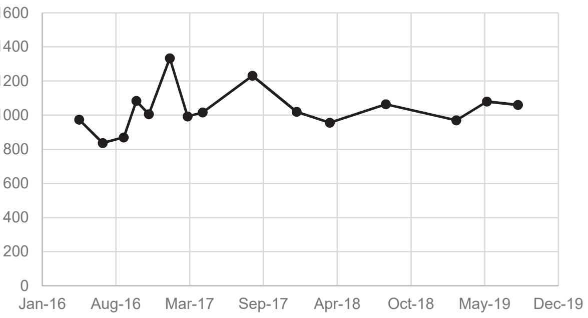

Calcium


Chloride


Fluoride


pH


TDS


Sulfate

Notes:
- Open circles indicate reporting limit for non-detections
- pH values reported as standard units (SU); all other parameters reported as milligrams per liter (mg/L).

AD-34 Appendix III Time Series Graphs

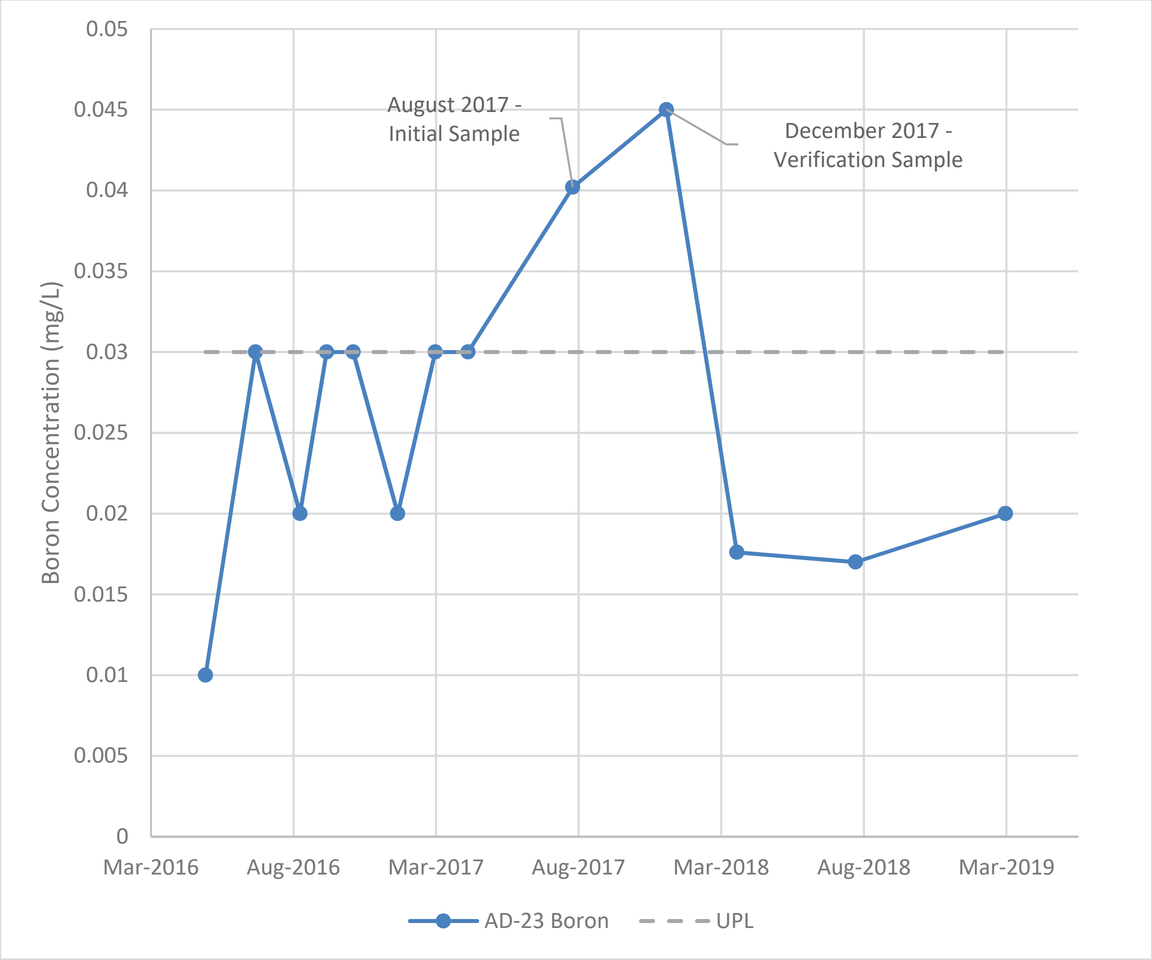
H.W. Pirkey Power Plant Landfill

Geosyntec consultants

Figure **5**

Columbus, OH | 12/20/2019

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-11 Pirkey LF Revision to DM Memo\Report



Notes:
mg/L: milligrams per liter
UPL: Upper prediction limit

AD-23 Boron Time Series Graph

Pirkey Landfill

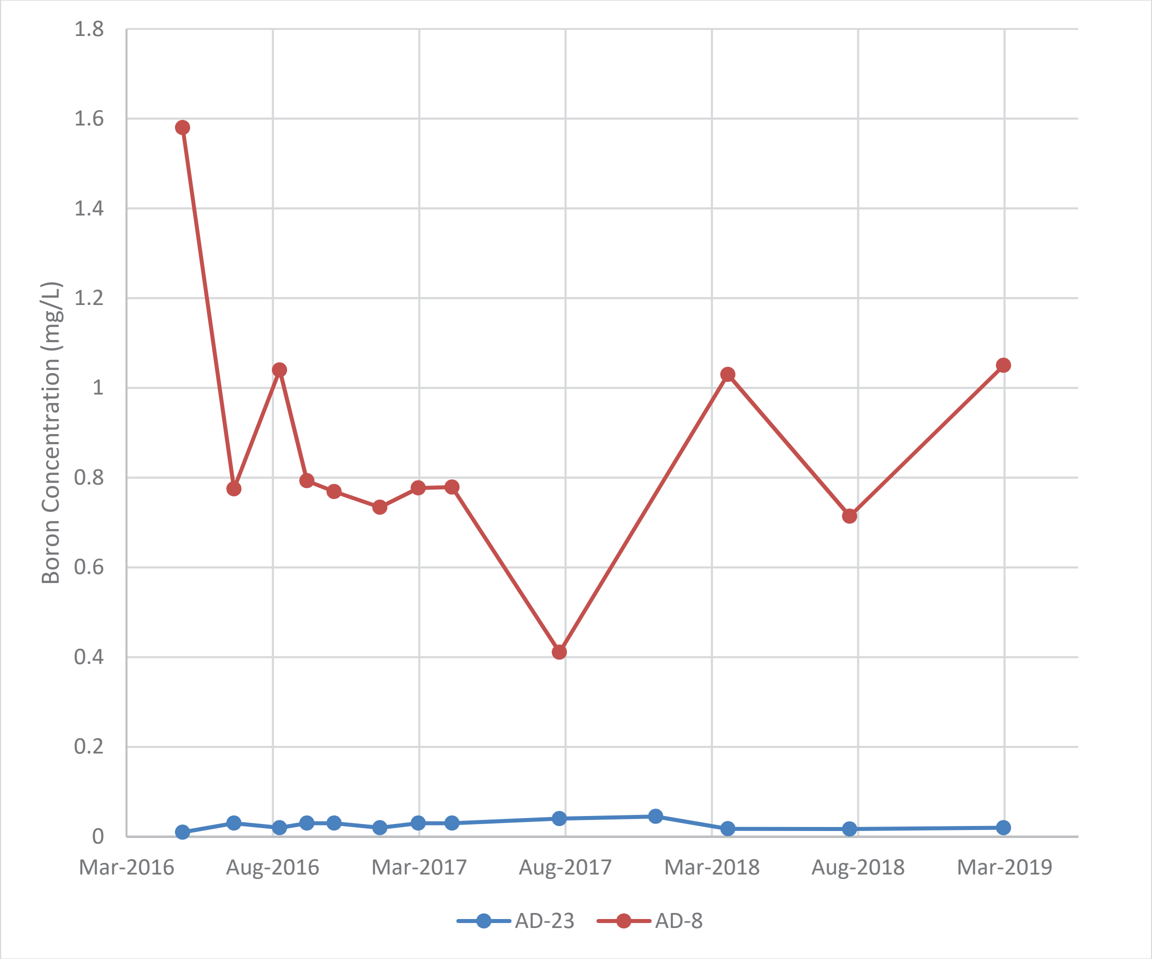
Geosyntec consultants

AMERICAN ELECTRIC POWER

Figure
6

Columbus, Ohio

12-Dec-2019



Notes:
mg/L: milligrams per liter
AD-8 is an upgradient well in the Pirkey LF monitoring network.

AD-23 and AD-8 Boron Time Series Graphs

Pirkey Landfill

Geosyntec consultants

AMERICAN ELECTRIC POWER

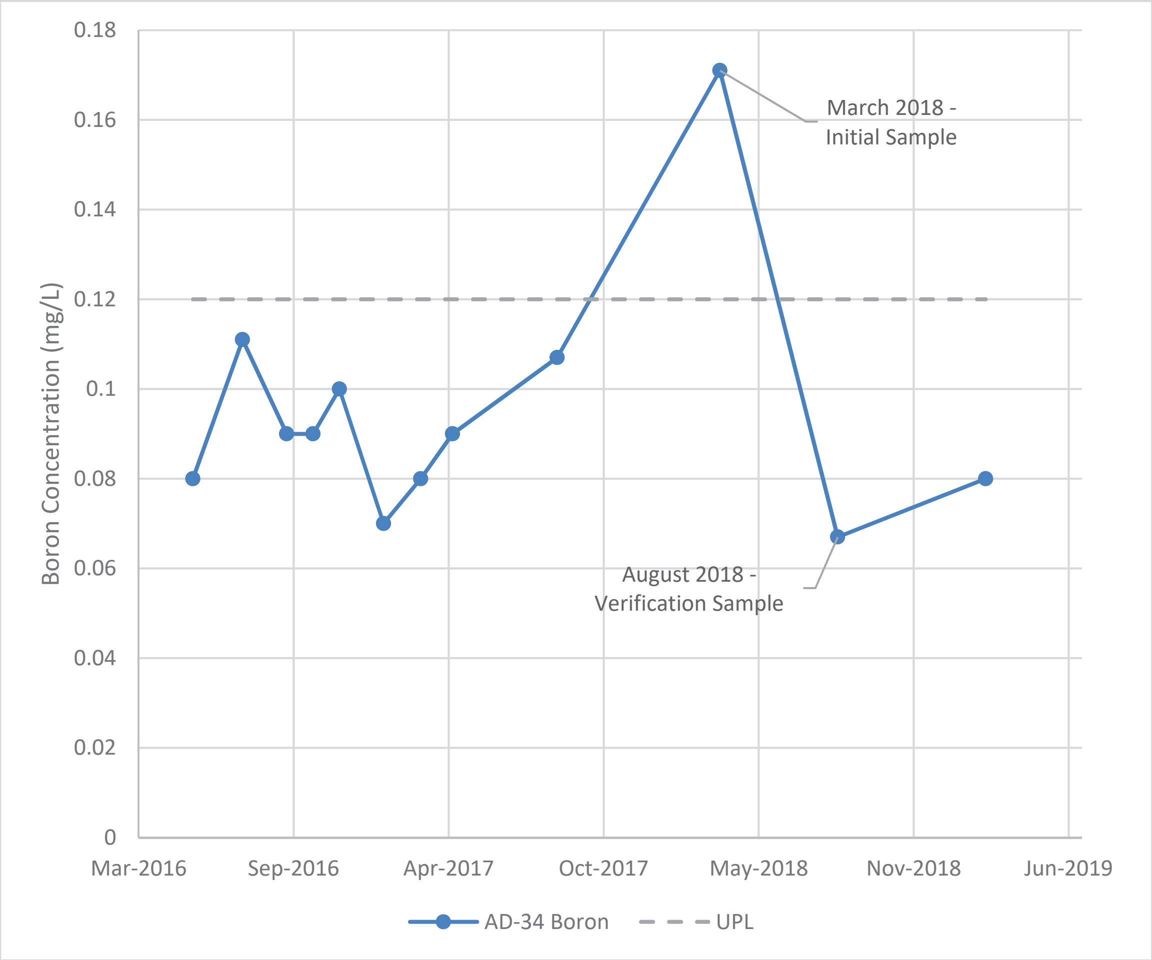
Figure

7

Columbus, Ohio

12-Dec-2019

internal info: path, date revised, author



Notes:
mg/L: milligrams per liter
UPL: Upper prediction limit

internal info: path, date revised, author

AD-34 Boron Time Series Graph

Pirkey Landfill

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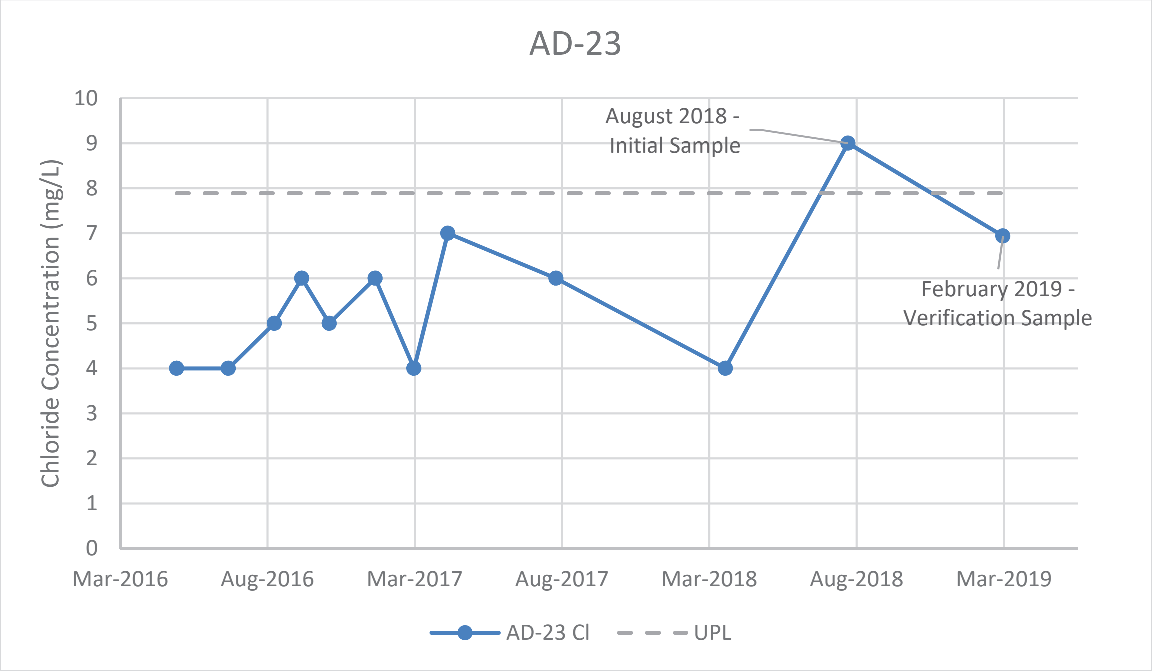
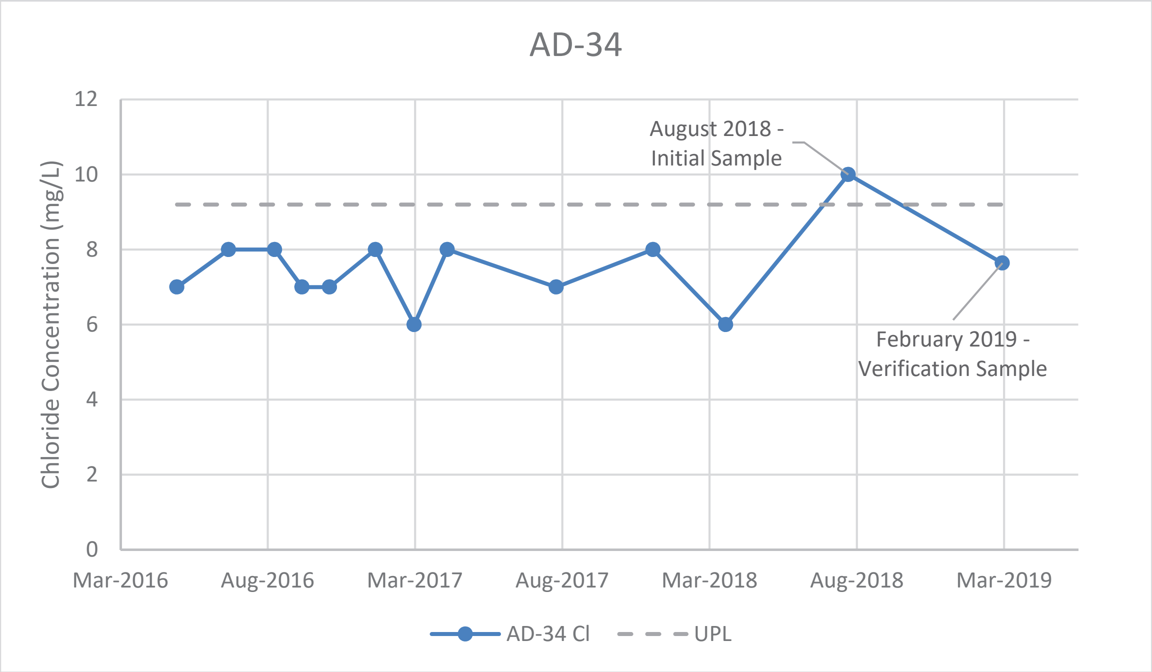
Figure

8

Columbus, Ohio

12-Dec-2019





Notes:
mg/L: milligrams per liter
UPL: Upper prediction limit

AD-23 and AD-34
Chloride Time Series Graphs

Pirkey Landfill

Geosyntec consultants

AMERICAN ELECTRIC POWER

Columbus, Ohio

12-Dec-2019

Figure

9

internal info: path, date revised, author

TABLES

Table 1: Initial Detection Monitoring Data Evaluation
Pirkey Plant - Landfill

Parameter	Units	Description	AD-23		AD-34		AD-35
			8/23/2017	12/21/2017	8/23/2017	12/21/2017	8/23/2017
Boron	mg/L	Intrawell Background Value (UPL)	0.030		0.120		0.143
		Detection Monitoring Result	**0.0402**	**0.0450**	0.107	--	0.0413
Calcium	mg/L	Intrawell Background Value (UPL)	0.610		42.5		27.7
		Detection Monitoring Result	0.276	0.469	36.2	--	4.33
Chloride	mg/L	Intrawell Background Value (UPL)	7.89		9.2		26.5
		Detection Monitoring Result	6	--	7	8	16
Fluoride	mg/L	Intrawell Background Value (UPL)	1.00		1.00		1.00
		Detection Monitoring Result	0.198	--	0.62	0.67	<0.083
pH	SU	Interwell Background Value (UPL)	5.4				
		Interwell Background Value (LPL)	2.5				
		Detection Monitoring Result	4.1	--	3.7	--	4.9
Sulfate	mg/L	Interwell Background Value (UPL)	207				
		Detection Monitoring Result	11.0	--	**1231**	**1020**	35.0
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	335				
		Detection Monitoring Result	64.0	--	**1128**	**1260**	92

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

<: Non-detect value. Parameters which were not detected are shown as less than the MDL.

Background values are shaded gray.

--: Not Sampled

Based on a 1-of-2 resampling, a statistically significant increase (SSI) is only identified when both samples in the detection monitoring period are above the UPL.

Table 2 - 2016-2017 Background Groundwater Data
Pirkey Plant - Landfill

Parameter	Unit	AD-8							
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/11/2017
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.005U	0.00117J	0.005U	0.00147J	0.005U	0.00153J	0.00169J	0.005U
Barium	mg/L	0.038	0.061	0.048	0.061	0.052	0.06	0.052	0.051
Beryllium	mg/L	0.001	0.007	0.002	0.006	0.006	0.006	0.006	0.006
Boron	mg/L	1.58	0.775	1.04	0.793	0.769	0.734	0.777	0.779
Cadmium	mg/L	0.001U	0.00018J	0.001U	0.001U	0.00012J	0.00011J	0.00014J	0.00013J
Calcium	mg/L	109	20.7	50.7	20.8	17.2	18.6	18.1	17.1
Chloride	mg/L	9	13	12	13	13	13	10	12
Chromium	mg/L	0.001	0.001	0.00084J	0.00074J	0.00081J	0.002	0.00063J	0.00089J
Cobalt	mg/L	0.0018J	0.02	0.009	0.018	0.018	0.018	0.018	0.019
Combined Radium	pCi/L	0.9155	6.75	1.658	6.72	6.14	6.29	7.64	5.56
Fluoride	mg/L	1U	2	2	2	3	3	2	3
Lead	mg/L	0.00103J	0.00147J	0.005U	0.00231J	0.00286J	0.003J	0.00327J	0.00244J
Lithium	mg/L	0.001U	0.032	0.018	0.032	0.03	0.032	0.031	0.031
Mercury	mg/L	0.00003	0.00021	0.00005	0.00011	0.00016	0.00016	0.00015	0.00001J
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Selenium	mg/L	0.015	0.005U	0.00385J	0.00251J	0.005U	0.00141J	0.00179J	0.005U
Total Dissolved Solids	mg/L	432	280	285	276	296	280	250	284
Sulfate	mg/L	181	131	121	184	208	228	157	168
Thallium	mg/L	0.0012J	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	6.1	6.2	5.1	3.7	3.7	3.6	3.7	3.9

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled

Table 2 - 2016-2017 Background Groundwater Data
Pirkey Plant - Landfill

Parameter	Unit	AD-12							
		5/11/2016	**7/13/2016**	**9/7/2016**	**10/12/2016**	**11/14/2016**	**1/11/2017**	**2/28/2017**	**4/11/2017**
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Barium	mg/L	0.026	0.023	0.03	0.027	0.028	0.023	0.026	0.024
Beryllium	mg/L	0.00022J	0.00019J	0.00023J	0.00015J	0.00015J	0.00013J	0.00015J	0.00016J
Boron	mg/L	0.03	0.03	0.04	0.03	0.04	0.03	0.04	0.05
Cadmium	mg/L	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U	0.001U
Calcium	mg/L	0.362	0.26	0.343	0.271	0.331	0.315	0.434	0.299
Chloride	mg/L	5	6	6	7	8	7	5	6
Chromium	mg/L	0.00071J	0.00069J	0.00035J	0.00053J	0.00033J	0.00065J	0.00033J	0.00042J
Cobalt	mg/L	0.00158J	0.00129J	0.00167J	0.00157J	0.00147J	0.00109J	0.0013J	0.00133J
Combined Radium	pCi/L	0.2073	2.909	0.881	0.257	0.767	1.536	0.416	0.3895
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	0.2565J
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Lithium	mg/L	0.001U	0.008	0.01	0.012	0.013	0.01	0.009	0.008
Mercury	mg/L	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00002U	0.00001J
Molybdenum	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Selenium	mg/L	0.00174J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Total Dissolved Solids	mg/L	94	75	63	92	80	76	50	72
Sulfate	mg/L	4	4	7	8	6	6	4	7
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.00099J	0.002U
pH	SU	4.4	3.1	3.9	3.4	2.6	4.8	3.6	4.7

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled

Table 2 - 2016-2017 Background Groundwater Data
Pirkey Plant - Landfill

Parameter	**Unit**	**AD-16**							
		5/10/2016	**7/14/2016**	**9/8/2016**	**10/13/2016**	**11/14/2016**	**1/11/2017**	**3/1/2017**	**4/10/2017**
Antimony	mg/L	0.005U	0.005U	0.008	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.00183J	0.005U	0.005U	0.00152J	0.005U	0.005U	0.00151J	0.005U
Barium	mg/L	0.061	0.064	0.07	0.056	0.055	0.058	0.076	0.077
Beryllium	mg/L	0.00045J	0.00057J	0.00081J	0.00025J	0.00038J	0.00071J	0.00049J	0.00044J
Boron	mg/L	0.02	0.03	0.03	0.03	0.03	0.02	0.03	0.02
Cadmium	mg/L	0.00008J	0.001U	0.00009J	0.001U	0.001U	0.001U	0.001U	0.001U
Calcium	mg/L	1.21	2	1.83	1.15	1.58	1.76	1.29	1.21
Chloride	mg/L	8	9	9	9	9	10	9	11
Chromium	mg/L	0.001	0.001	0.002	0.001	0.00056J	0.00041J	0.00056J	0.00082J
Cobalt	mg/L	0.00424J	0.006	0.008	0.00334J	0.00434J	0.008	0.005	0.005
Combined Radium	pCi/L	1.294	1.438	1.931	1.843	2.123	2.629	1.417	0.932
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Lithium	mg/L	0.006	0.036	0.032	0.033	0.028	0.031	0.021	0.019
Mercury	mg/L	0.00002J	0.00002J	0.00001J	0.00002U	0.00002U	0.00001J	0.00002U	0.00001J
Molybdenum	mg/L	0.005U	0.00112J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Selenium	mg/L	0.00226J	0.005U	0.005U	0.0017J	0.005U	0.005U	0.005U	0.005U
Total Dissolved Solids	mg/L	116	148	133	124	124	112	108	106
Sulfate	mg/L	16	45	33	16	23	43	22	24
Thallium	mg/L	0.00137J	0.002U	0.00175J	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	3.9	3.8	3.9	3.9	4.4	3.7	3.2	3.4

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled

Table 2 - 2016-2017 Background Groundwater Data
Pirkey Plant - Landfill

Parameter	Unit	AD-23							
		5/10/2016	**7/13/2016**	**9/8/2016**	**10/12/2016**	**11/15/2016**	**1/11/2017**	**2/28/2017**	**4/11/2017**
Antimony	mg/L	0.00289J	0.0038J	0.005U	0.0013J	0.005U	0.005U	0.00166J	0.005U
Arsenic	mg/L	0.00165J	0.005U	0.005U	0.007	0.005U	0.00204J	0.005U	0.00397J
Barium	mg/L	0.048	0.048	0.053	0.12	0.05	0.073	0.041	0.086
Beryllium	mg/L	0.00019J	0.00019J	0.0002J	0.00046J	0.00013J	0.00016J	0.00012J	0.00032J
Boron	mg/L	0.01	0.03	0.02	0.03	0.03	0.02	0.03	0.03
Cadmium	mg/L	0.00007J	0.00009J	0.001U	0.00014J	0.001U	0.001U	0.001U	0.00011J
Calcium	mg/L	0.535	0.317	0.26	0.321	0.249	0.319	0.217	0.543
Chloride	mg/L	4	4	5	6	5	6	4	7
Chromium	mg/L	0.002	0.002	0.005	0.041	0.006	0.015	0.0003J	0.022
Cobalt	mg/L	0.0023J	0.00273J	0.00201J	0.00391J	0.00167J	0.00226J	0.00105J	0.00261J
Combined Radium	pCi/L	6.86	5.69	6.68	12.89	7.54	8.06	5.74	10.31
Fluoride	mg/L	1U	1U	1U	1U	1U	1U	1U	0.2688J
Lead	mg/L	0.005U	0.005U	0.00224J	0.031	0.00321J	0.011	0.005U	0.015
Lithium	mg/L	0.00014J	0.006	0.006	1.01*	0.006	0.009	0.005	0.01
Mercury	mg/L	0.00001J	0.00002J	0.00002U	0.0001	0.00002J	0.00009	0.00002U	0.00012
Molybdenum	mg/L	0.005U	0.00135J	0.005U	0.00056J	0.0004J	0.005U	0.005U	0.00032J
Selenium	mg/L	0.00192J	0.002J	0.005U	0.00211J	0.00135J	0.005U	0.00131J	0.005U
Total Dissolved Solids	mg/L	72	59	64	68	100	60	48	76
Sulfate	mg/L	10	11	12	13	14	13	9	11
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	4.0	2.7	3.5	3.7	3.5	3.7	4.0	4.2

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not sampled
*: Value was removed from the dataset as an outlier prior to completion of statistical analyses.

Table 2 - 2016-2017 Background Groundwater Data
Pirkey Plant - Landfill

Parameter	Unit	AD-27							
		5/11/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	3/1/2017	4/10/2017
Antimony	mg/L	0.00121J	0.00096J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.00215J	0.00128J	0.005U	0.00214J	0.005U	0.00157J	0.005U	0.005U
Barium	mg/L	0.043	0.045	0.047	0.046	0.041	0.046	0.043	0.045
Beryllium	mg/L	0.005	0.005	0.006	0.005	0.005	0.005	0.005	0.005
Boron	mg/L	0.02	0.03	0.03	0.03	0.03	0.02	0.03	0.03
Cadmium	mg/L	0.00043J	0.00043J	0.0004J	0.00042J	0.00042J	0.0003J	0.00029J	0.00041J
Calcium	mg/L	4.41	4.43	4.17	4.09	4.52	3.74	4.31	4.01
Chloride	mg/L	8	8	8	8	8	9	8	9
Chromium	mg/L	0.00087J	0.002	0.002	0.002	0.002	0.001	0.002	0.00095J
Cobalt	mg/L	0.02	0.021	0.02	0.02	0.022	0.018	0.021	0.021
Combined Radium	pCi/L	2.031	2.406	2.71	4.43	3.69	2.62	3.48	2.58
Fluoride	mg/L	0.6176J	1U	1U	1U	1U	1U	1U	1U
Lead	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Lithium	mg/L	0.066	0.097	0.095	0.096	0.095	0.1	0.1	0.104
Mercury	mg/L	0.00002U	0.00002J	0.00002U	0.00002U	0.00002U	0.00001J	0.00002U	0.00002U
Molybdenum	mg/L	0.005U	0.00043J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Selenium	mg/L	0.00111J	0.005U	0.005U	0.00136J	0.005U	0.005U	0.005U	0.005U
Total Dissolved Solids	mg/L	198	192	196	216	216	180	216	180
Sulfate	mg/L	51	54	52	58	92	58	56	54
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	3.9	2.7	2.9	3.0	3.5	4.1	2.8	3.3

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Parameter was detected in concentrations below the reporting limit

-: Not sampled

Table 2 - 2016-2017 Background Groundwater Data
Pirkey Plant - Landfill

Parameter	Unit	AD-34							
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/10/2017
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.012	0.025	0.009	0.01	0.007	0.006	0.007	0.0045J
Barium	mg/L	0.072	0.177	0.031	0.039	0.023	0.029	0.011	0.023
Beryllium	mg/L	0.003	0.004	0.003	0.003	0.002	0.002	0.002	0.002
Boron	mg/L	0.08	0.111	0.09	0.09	0.1	0.07	0.08	0.09
Cadmium	mg/L	0.006	0.006	0.008	0.005	0.008	0.007	0.006	0.011
Calcium	mg/L	37.8	33.2	39.5	35.8	36.3	39.9	37	38.2
Chloride	mg/L	7	8	8	7	7	8	6	8
Chromium	mg/L	0.034	0.081	0.012	0.015	0.006	0.008	0.001U	0.007
Cobalt	mg/L	0.301	0.296	0.306	0.297	0.292	0.284	0.294	0.299
Combined Radium	pCi/L	9.64	7.75	7.91	10.12	13.21	11.9	9.87	2.407
Fluoride	mg/L	1U	1U	1U	0.6272J	0.9978J	1U	1U	0.5241J
Lead	mg/L	0.012	0.039	0.00102J	0.0037J	0.005U	0.005U	0.005U	0.005U
Lithium	mg/L	0.176	0.183	0.158	0.174	0.154	0.164	0.158	0.167
Mercury	mg/L	0.0001	0.00031	0.00006	0.00004	0.00002	0.00003	0.00002U	0.00002J
Molybdenum	mg/L	0.00069J	0.00211J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Selenium	mg/L	0.005U	0.007	0.005U	0.005U	0.00451J	0.005U	0.005U	0.005U
Total Dissolved Solids	mg/L	1516	1396	1520	1464	1428	1378	1402	1490
Sulfate	mg/L	974	837	870	1084	1006	1334	993	1016
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	4.0	3.6	3.3	3.6	3.7	3.2	3.7	3.0

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Parameter was not present in concentrations above method detection limit and is reported as the reporting limit

J: Estimated value. Parameter was detected in concentrations below the reporting limit

-: Not sampled

Table 2 - 2016-2017 Background Groundwater Data
Pirkey Plant - Landfill

Parameter	Unit	AD-35							
		5/10/2016	7/13/2016	9/8/2016	10/12/2016	11/15/2016	1/11/2017	2/28/2017	4/11/2017
Antimony	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Arsenic	mg/L	0.011	0.009	0.00113J	0.00407J	0.012	0.00215J	0.00404J	0.0014J
Barium	mg/L	0.124	0.185	0.116	0.11	0.143	0.115	0.094	0.092
Beryllium	mg/L	0.00033J	0.00039J	0.00019J	0.00014J	0.0003J	0.00009J	0.00009J	0.00007J
Boron	mg/L	0.109	0.07	0.04	0.05	0.06	0.06	0.123	0.07
Cadmium	mg/L	0.00011J	0.001U	0.001U	0.001U	0.00024J	0.00009J	0.001U	0.00033J
Calcium	mg/L	17.4	5.35	3.42	2.43	2	10.4	22.5	10.8
Chloride	mg/L	17	18	14	14	14	18	19	25
Chromium	mg/L	0.021	0.019	0.005	0.006	0.03	0.005	0.003	0.001
Cobalt	mg/L	0.01	0.006	0.00344J	0.00299J	0.007	0.00406J	0.00475J	0.006
Combined Radium	pCi/L	2.465	4.21	2.065	6.01	4.83	3.65	2.02	2.707
Fluoride	mg/L	1U	1U	1U	0.3552J	1U	1U	1U	1U
Lead	mg/L	0.007	0.00437J	0.005U	0.00153J	0.007	0.005U	0.00124J	0.005U
Lithium	mg/L	0.001U	0.013	0.011	0.012	0.019	0.01	0.008	0.007
Mercury	mg/L	0.00006	0.00011	0.00002U	0.00001J	0.00007	0.00002J	0.00002J	0.00002U
Molybdenum	mg/L	0.00044J	0.005U	0.005U	0.005U	0.00058J	0.005U	0.005U	0.005U
Selenium	mg/L	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
Total Dissolved Solids	mg/L	162	114	104	116	142	128	140	160
Sulfate	mg/L	50	28	21	23	29	62	84	75
Thallium	mg/L	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U	0.002U
pH	SU	4.7	4.6	4.0	3.6	4.3	4.7	3.5	4.8

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Component was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Component was detected in concentrations below the reporting limit
-: Not sampled

Table 3: Detection Monitoring Data Evaluation - Updated Background Prediction Limits
Pirkey Plant - Landfill

Parameter	**Units**	**Description**	AD-23						AD-34				
			8/23/2017	12/21/2017	3/21/2018	8/20/2018	2/28/2019	5/23/2019	8/23/2017	12/21/2017	3/21/2018	8/20/2018	2/28/2019
Boron	mg/L	Intrawell Background Value (UPL)	0.030						0.120				
		Detection Monitoring Result	**0.0402**	**0.0450**	0.0176	0.0170	0.0200	--	0.107	--	**0.171**	0.0670	0.080
Calcium	mg/L	Intrawell Background Value (UPL)	0.654						42.5				
		Detection Monitoring Result	0.276	0.469	0.227	0.247	0.300	--	36.2	--	40.1	37.0	39.9
Chloride	mg/L	Intrawell Background Value (UPL)	7.89						9.2				
		Detection Monitoring Result	6	--	4	**9**	6.94	--	7	8	6	**10**	7.64
Fluoride	mg/L	Intrawell Background Value (UPL)	1.00						1.00				
		Detection Monitoring Result	0.198	--	<0.083	<0.083	0.040	--	0.619	0.67	<0.083	<0.083	0.86
pH	SU	Intrawell Background Value (UPL)	4.8						4.3				
		Intrawell Background Value (LPL)	2.5						2.7				
		Detection Monitoring Result	4.1	--	3.9	3.8	**5.1**	4.8	3.7	--	3.7	3.7	2.9
Sulfate	mg/L	Intrawell Background Value (UPL)	15.8						1388				
		Detection Monitoring Result	11	--	10	11	7.2	--	1231	1020	956	1060	970
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	106						1587				
		Detection Monitoring Result	64.0	--	72.0	92.0	70.0	--	1128	1260	1420	1460	1470

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

<: Non-detect value. Parameters which were not detecteda re shown as less than the method detection limit (MDL).

Background values are shaded gray.

--: Not Sampled

Based on a 1-of-2 resampling, a statistically significant increase (SSI) is only identified when both samples in the detection monitoring period are above the UPL.

Based on a revised understanding of the site, the Appendix III prediction limits were recalculated for intrawell tests using the background dataset.

ATTACHMENT A

Revised Statistical Output

GROUNDWATER STATS
CONSULTING

January 8, 2020

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of the groundwater data for American Electric Power Company's Pirkey Landfill. The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, is listed below. Note that downgradient well AD-35 was originally in the well network but has been abandoned and replaced with a new well. No data are currently available from the new well but will be included in future analyses.

- **Upgradient wells:** AD-8, AD-12, AD-16 and AD-27; and
- **Downgradient wells:** AD-23 and AD-34

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC.

The CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) - boron, calcium, chloride, fluoride, pH, sulfate, and TDS;
- **Appendix IV** (Assessment Monitoring) – antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (see attached). Values previously flagged during the screening as outliers may be seen in a lighter font and disconnected symbol on the time series graphs. A summary of flagged values follows this letter (see attached).

Evaluation of Appendix III Parameters

Intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, calcium, chloride, fluoride, pH, sulfate and TDS. The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Intrawell prediction limits utilize the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data set will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. The summary table of those results follows this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable. Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site which is an indication of natural variability in groundwater unrelated to practices at the site. When changing concentrations are noted upgradient of the facility, it is an indication that groundwater quality is changing naturally and unrelated to the facility.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Landfill. If you have any questions or comments, please feel free to contact me.

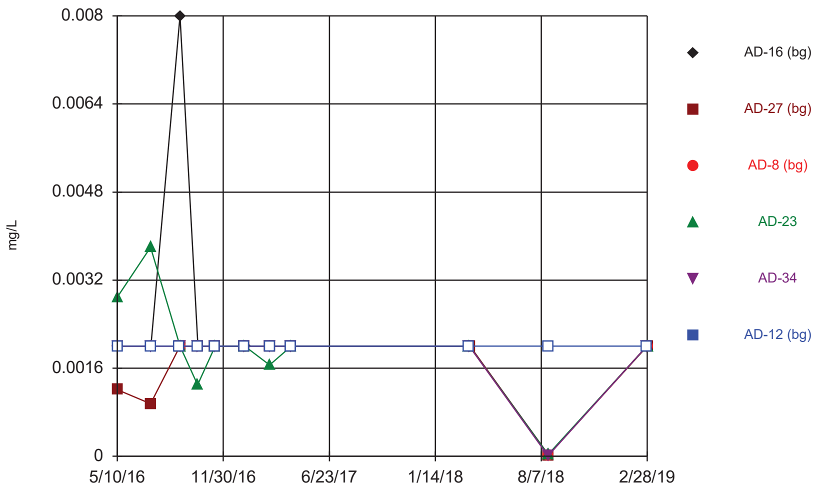
For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

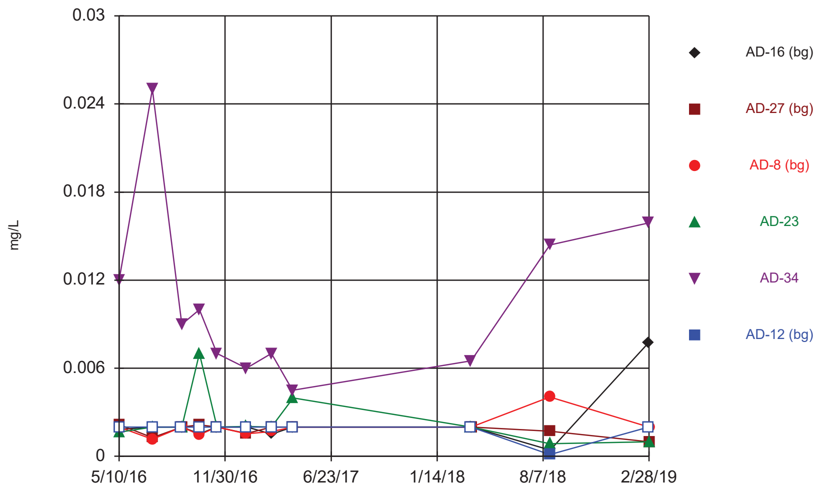
Time Series



Constituent: Antimony, total   Analysis Run 9/5/2019 1:36 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

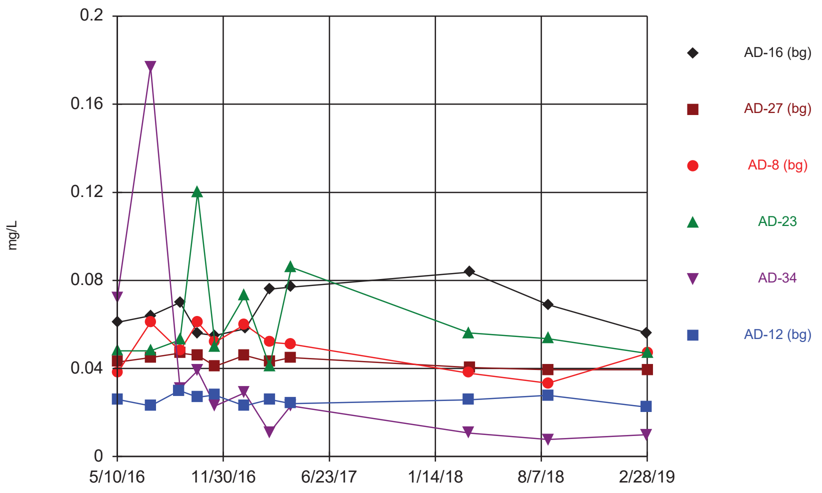
Time Series



Constituent: Arsenic, total   Analysis Run 9/5/2019 1:36 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

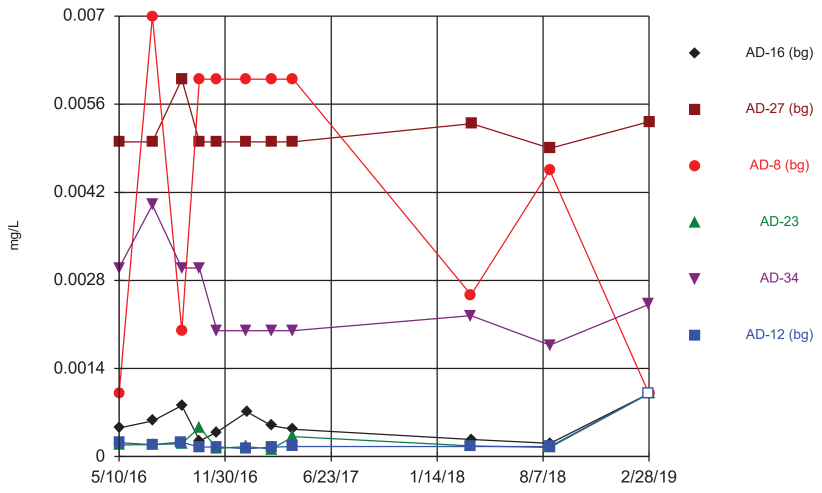
Time Series



Constituent: Barium, total   Analysis Run 9/5/2019 1:36 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

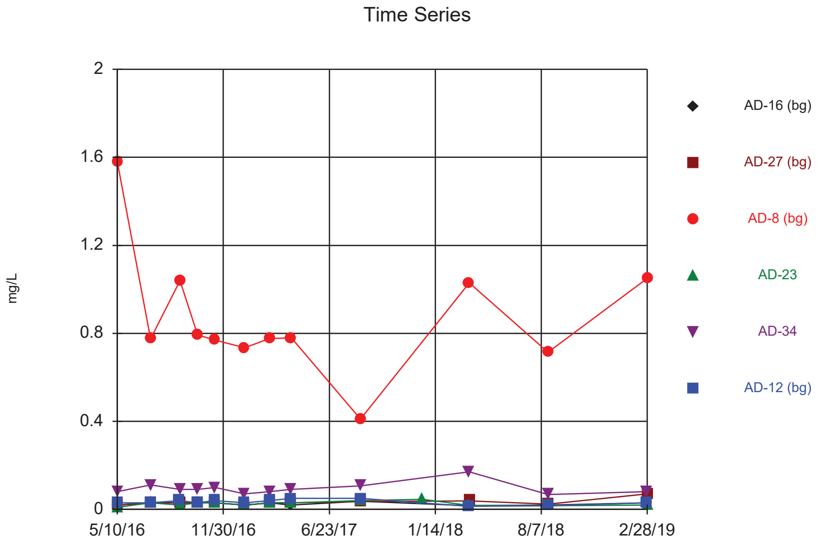
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



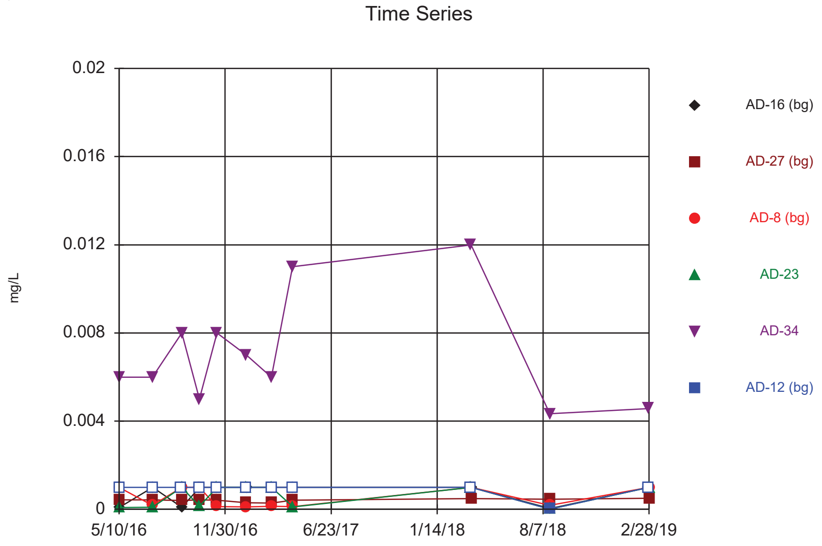
Constituent: Beryllium, total   Analysis Run 9/5/2019 1:36 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



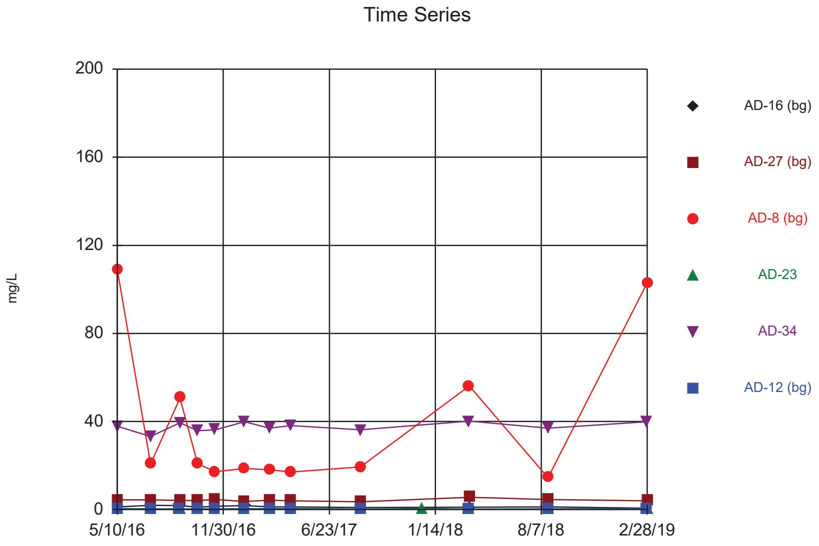
Constituent: Boron, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



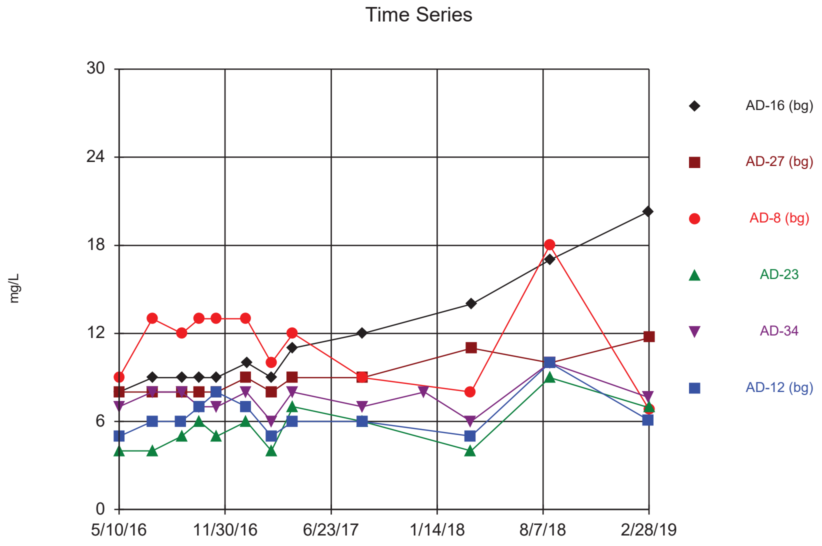
Constituent: Cadmium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Calcium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

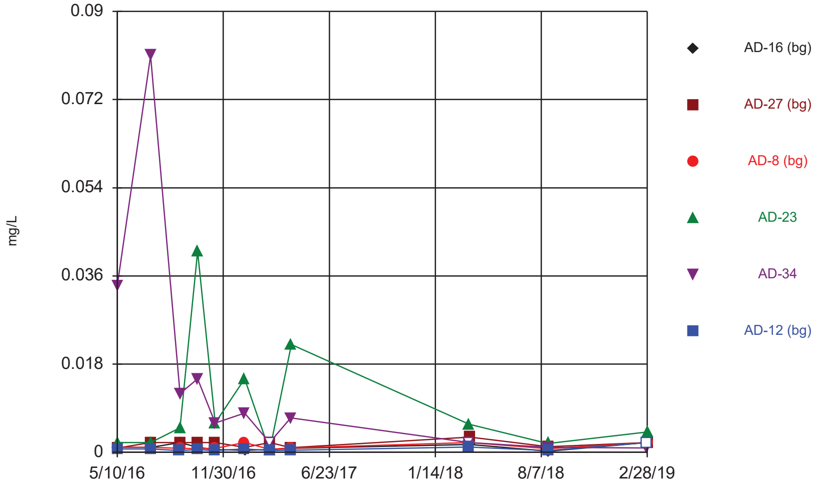
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Chloride, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

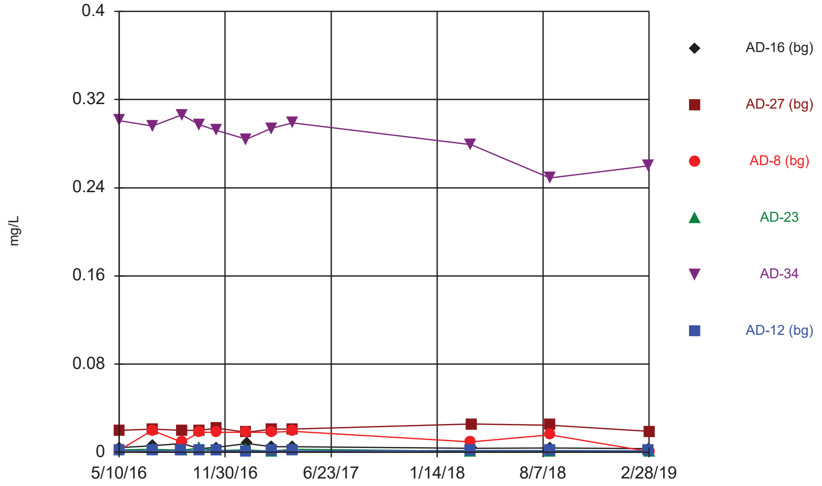
Time Series



Constituent: Chromium, total   Analysis Run 9/5/2019 1:36 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

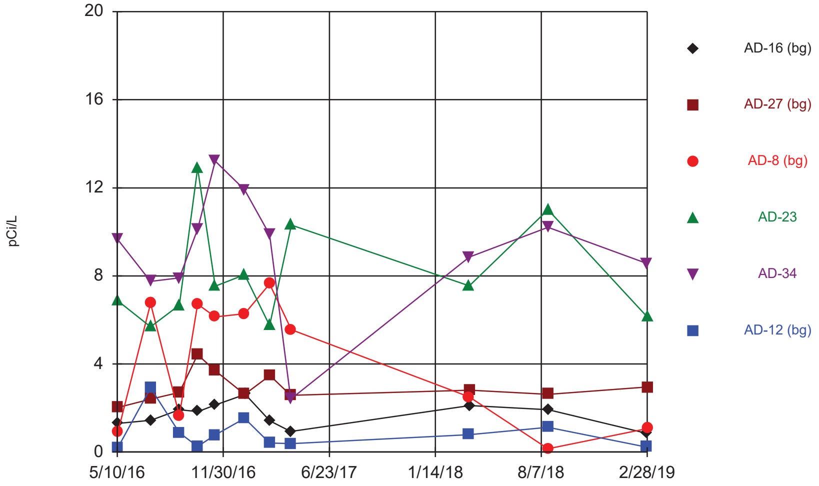
Time Series



Constituent: Cobalt, total   Analysis Run 9/5/2019 1:36 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

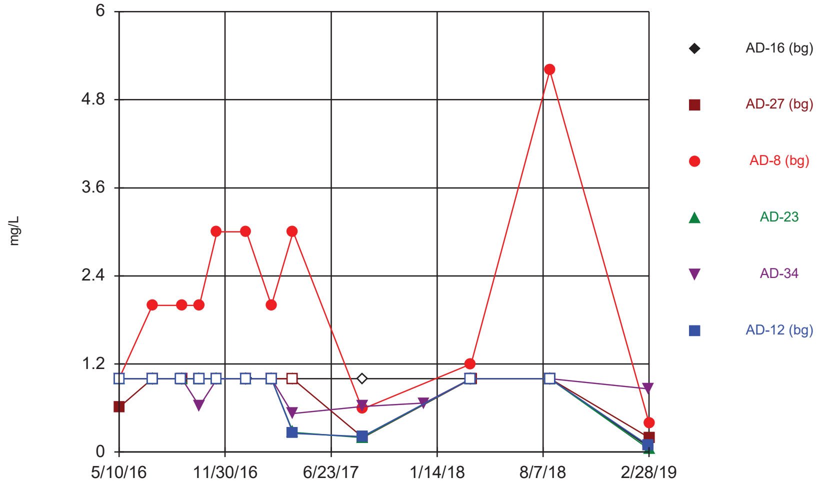
Time Series



Constituent: Combined Radium 226 + 228   Analysis Run 9/5/2019 1:36 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

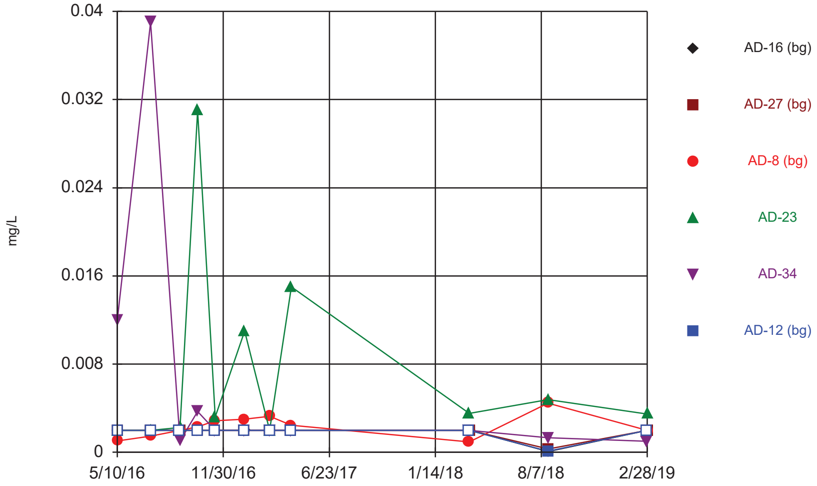
Time Series



Constituent: Fluoride, total   Analysis Run 9/5/2019 1:36 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

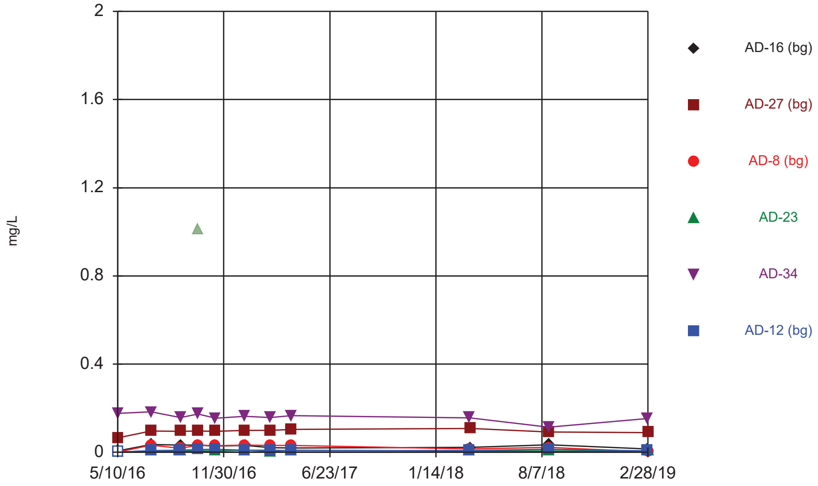
Time Series



Constituent: Lead, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

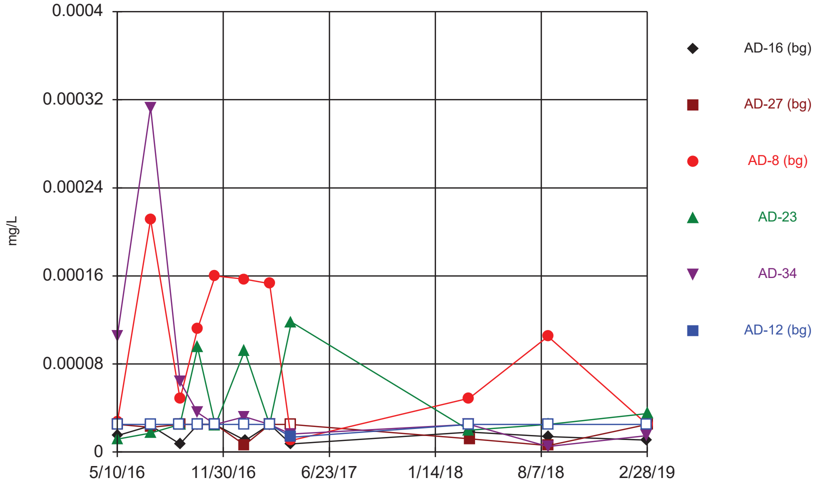
Time Series



Constituent: Lithium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

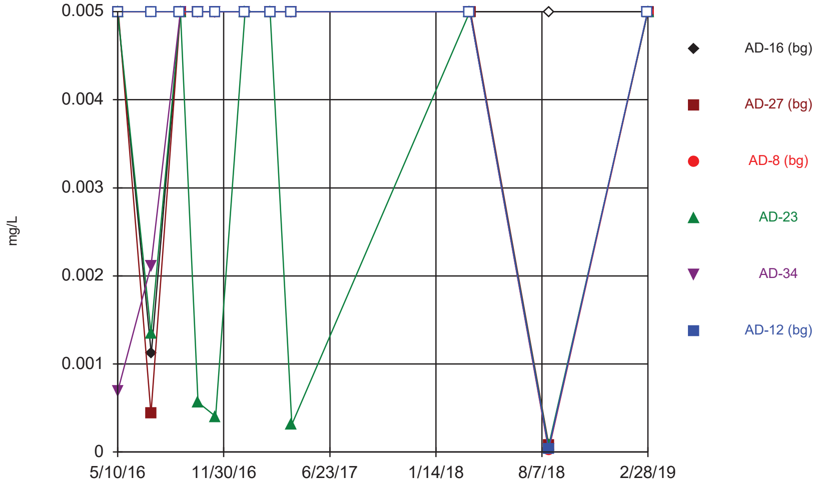
Time Series



Constituent: Mercury, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

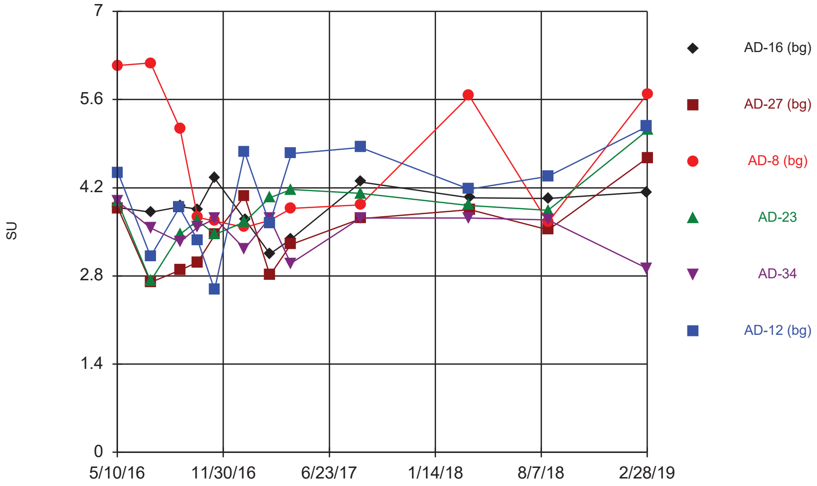
Time Series



Constituent: Molybdenum, total Analysis Run 9/5/2019 1:37 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

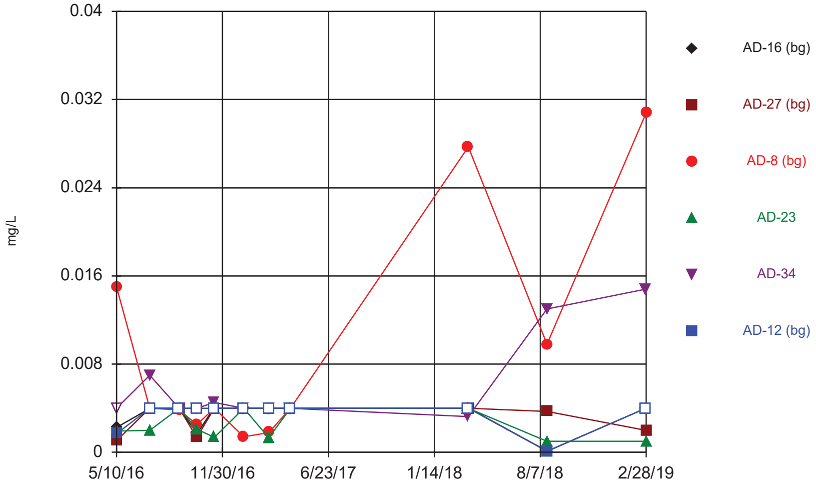
Time Series



Constituent: pH, field   Analysis Run 9/5/2019 1:37 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

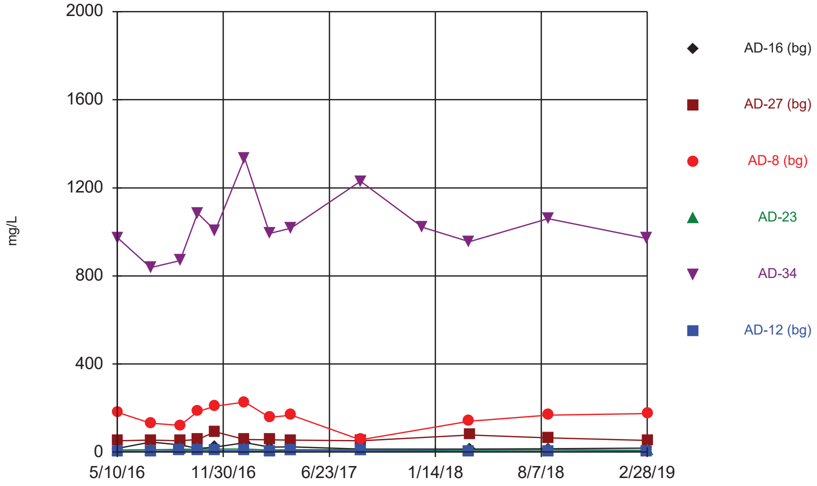
Time Series



Constituent: Selenium, total   Analysis Run 9/5/2019 1:37 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

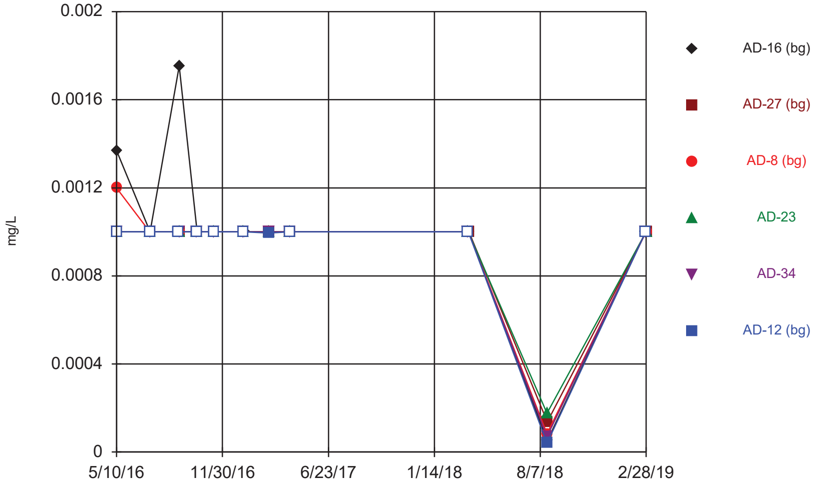
Time Series



Constituent: Sulfate, total   Analysis Run 9/5/2019 1:37 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

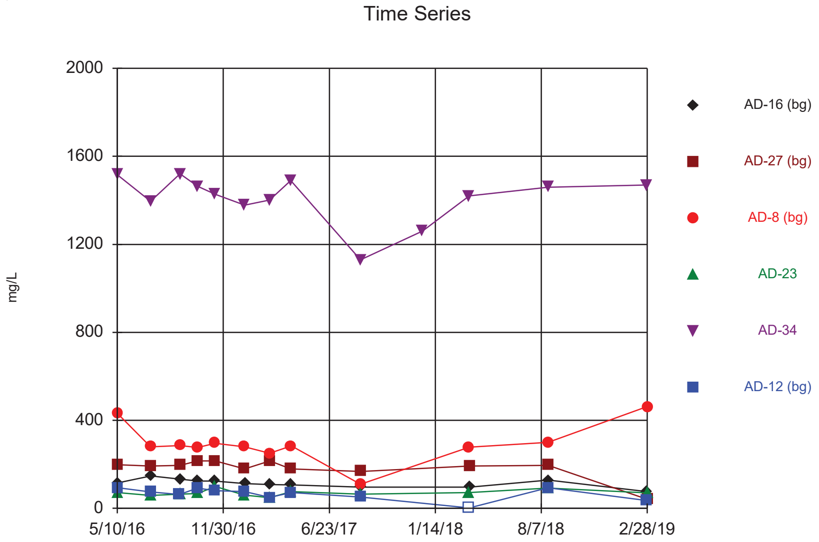
Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Thallium, total   Analysis Run 9/5/2019 1:37 PM   View: Time Series
Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Total Dissolved Solids [TDS]   Analysis Run 9/5/2019 1:37 PM   View: Time Series

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill

Outlier Summary

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 9/5/2019, 1:41 PM

	AD-23 Lithium, total (mg/L)
10/12/2016	1.01 (o)

Intrawell Prediction Limit Summary - All Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 11/26/2019, 8:05 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-16**	**0.03**	**n/a**	**8/24/2017**	**0.0365**	**Yes**	**8**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.02144**	**NP Intra (normality) 1 of 2**
Boron, total (mg/L)	**AD-27**	**0.03**	**n/a**	**8/24/2017**	**0.0358**	**Yes**	**8**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.02144**	**NP Intra (normality) 1 of 2**
Boron, total (mg/L)	AD-8	1.58	n/a	8/23/2017	0.411	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Boron, total (mg/L)	**AD-23**	**0.03**	**n/a**	**8/23/2017**	**0.0402**	**Yes**	**8**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.02144**	**NP Intra (normality) 1 of 2**
Boron, total (mg/L)	AD-34	0.1201	n/a	8/23/2017	0.107	No	8	0.08888	0.01271	0	None	No	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-35	0.1433	n/a	8/23/2017	0.0413	No	8	0.07275	0.02871	0	None	No	0.002505	Param Intra 1 of 2
Boron, total (mg/L)	AD-12	0.05454	n/a	8/23/2017	0.0495	No	8	0.03625	0.00744	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-16	2.318	n/a	8/24/2017	0.945	No	8	1.504	0.3311	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-27	4.848	n/a	8/24/2017	3.58	No	8	4.21	0.2595	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-8	109	n/a	8/23/2017	19.4	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Calcium, total (mg/L)	AD-23	0.6535	n/a	8/23/2017	0.276	No	8	0.3451	0.1255	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-34	42.53	n/a	8/23/2017	36.2	No	8	37.21	2.163	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-35	27.73	n/a	8/23/2017	4.33	No	8	9.288	7.502	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-12	0.4631	n/a	8/23/2017	0.245	No	8	0.3269	0.05542	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	**AD-16**	**11.43**	**n/a**	**8/24/2017**	**12**	**Yes**	**8**	**9.25**	**0.8864**	**0**	**None**	**No**	**0.002505**	**Param Intra 1 of 2**
Chloride, total (mg/L)	AD-27	9	n/a	8/24/2017	9	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Chloride, total (mg/L)	AD-8	15.69	n/a	8/23/2017	9	No	8	11.88	1.553	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-23	7.893	n/a	8/23/2017	6	No	8	5.125	1.126	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-34	9.204	n/a	8/23/2017	7	No	8	7.375	0.744	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-35	26.47	n/a	8/23/2017	16	No	8	17.38	3.701	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-12	8.794	n/a	8/23/2017	6	No	8	6.25	1.035	0	None	No	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-16	1	n/a	8/24/2017	1ND	No	8	n/a	n/a	100	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-27	1	n/a	8/24/2017	0.197	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-8	3.988	n/a	8/23/2017	0.587	No	8	2.25	0.7071	12.5	None	No	0.002505	Param Intra 1 of 2
Fluoride, total (mg/L)	AD-23	1	n/a	8/23/2017	0.198	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-34	1	n/a	8/23/2017	0.619	No	8	n/a	n/a	62.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-35	1	n/a	8/23/2017	1ND	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
Fluoride, total (mg/L)	AD-12	1	n/a	8/23/2017	0.213	No	8	n/a	n/a	87.5	n/a	n/a	0.02144	NP Intra (NDs) 1 of 2
pH, field (SU)	AD-16	4.644	2.864	8/24/2017	4.29	No	8	3.754	0.3622	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-27	4.51	2.022	8/24/2017	3.71	No	8	3.266	0.506	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-8	7.306	1.689	8/23/2017	3.93	No	8	4.498	1.143	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-23	4.776	2.519	8/23/2017	4.11	No	8	3.648	0.4592	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-34	4.285	2.745	8/23/2017	3.72	No	8	3.515	0.3135	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-35	5.552	3.02	8/23/2017	4.86	No	8	4.286	0.515	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-12	5.764	1.866	8/23/2017	4.84	No	8	3.815	0.7928	0	None	No	0.001253	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-16	55.68	n/a	8/24/2017	14	No	8	27.75	11.36	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-27	92	n/a	8/24/2017	52	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Sulfate, total (mg/L)	AD-8	261.3	n/a	8/23/2017	56	No	8	172.3	36.21	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-23	15.77	n/a	8/23/2017	11	No	8	11.63	1.685	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-34	1388	n/a	8/23/2017	1230	No	8	1014	151.9	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-35	107.6	n/a	8/23/2017	35	No	8	46.5	24.85	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	AD-12	9.636	n/a	8/23/2017	6	No	8	5.75	1.581	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-16	156	n/a	8/24/2017	96	No	8	121.4	14.09	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-27	237	n/a	8/24/2017	168	No	8	199.3	15.34	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-8	432	n/a	8/23/2017	110	No	8	n/a	n/a	0	n/a	n/a	0.02144	NP Intra (normality) 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-23	106.3	n/a	8/23/2017	64	No	8	68.38	15.42	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-34	1587	n/a	8/23/2017	1130	No	8	1449	55.98	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-35	185.9	n/a	8/23/2017	92	No	8	133.3	21.43	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	110.7	n/a	8/23/2017	52	No	8	75.25	14.41	0	None	No	0.002505	Param Intra 1 of 2

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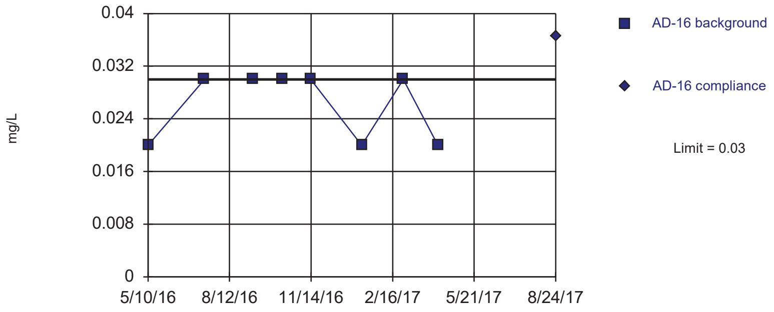
Exceeds Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

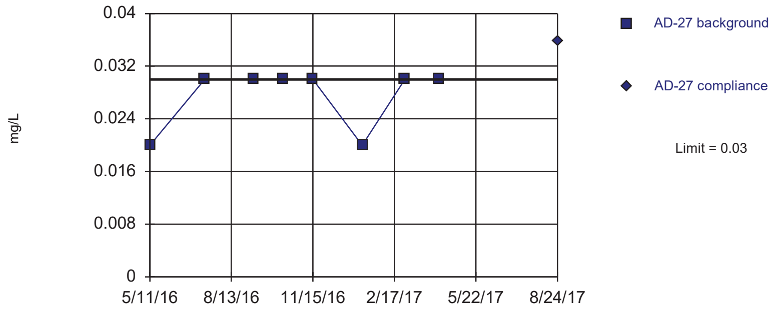
Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
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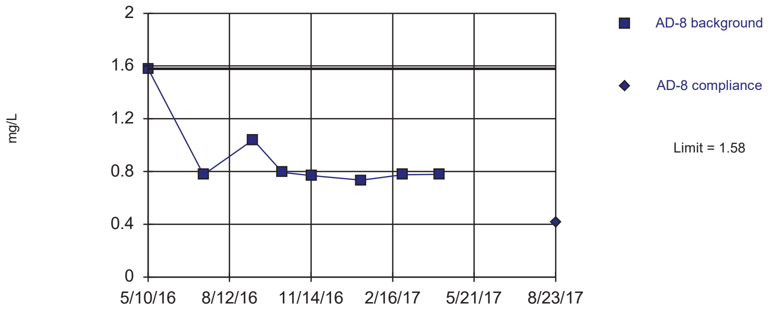
Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

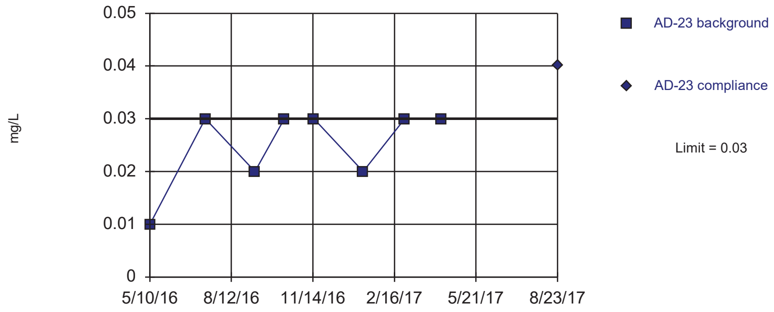
Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

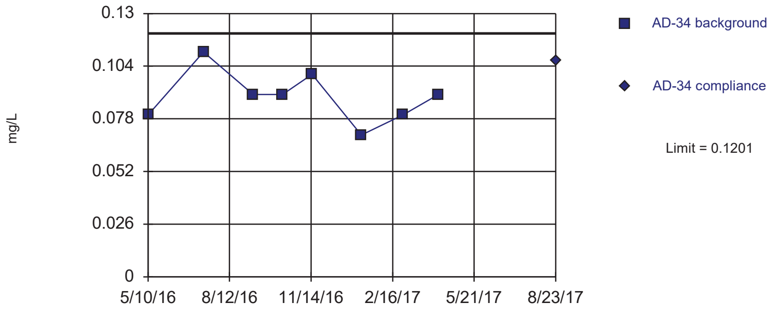
Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.08888, Std. Dev.=0.01271, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9562, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

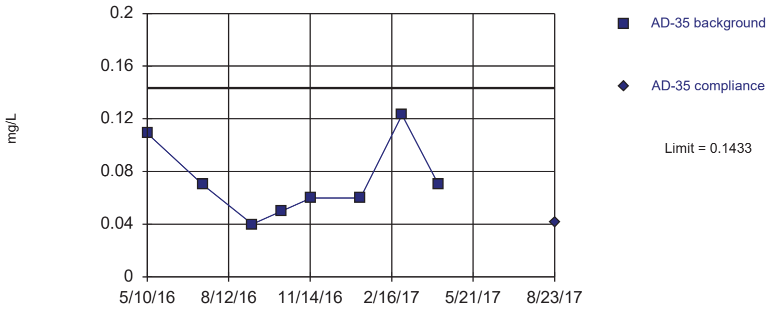
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.07275, Std. Dev.=0.02871, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8787, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

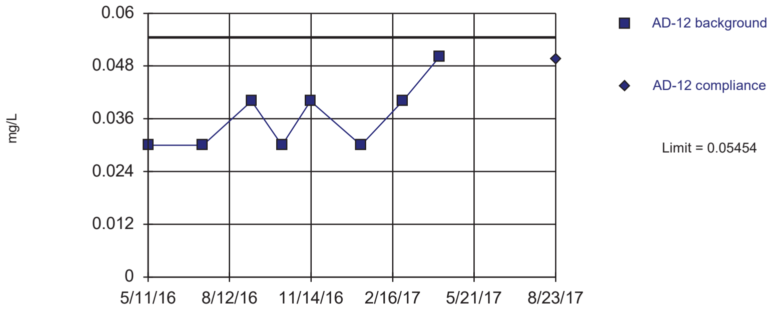
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.03625, Std. Dev.=0.00744, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7968, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

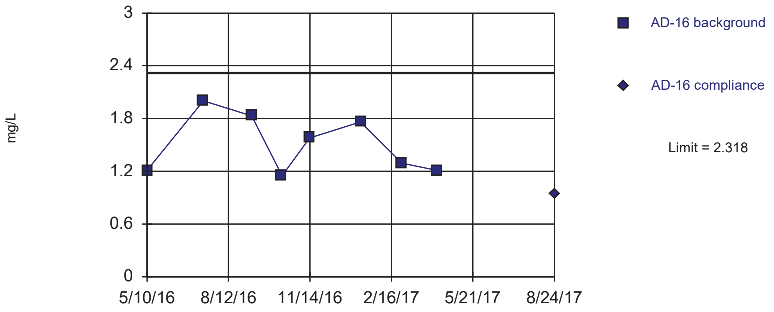
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1.504, Std. Dev.=0.3311, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8818, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell

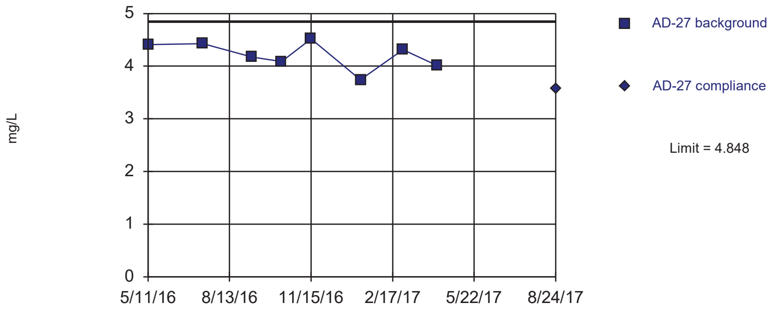
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.21, Std. Dev.=0.2595, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9482, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

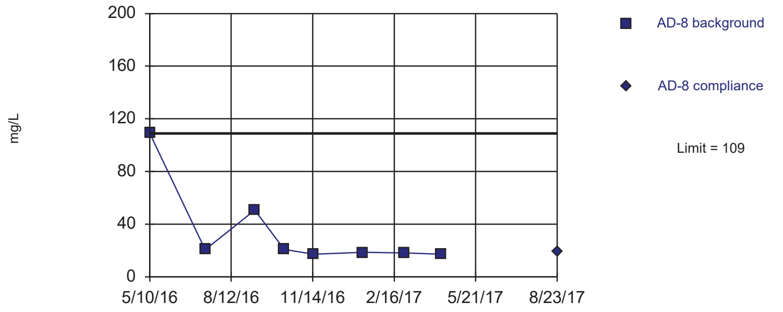
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

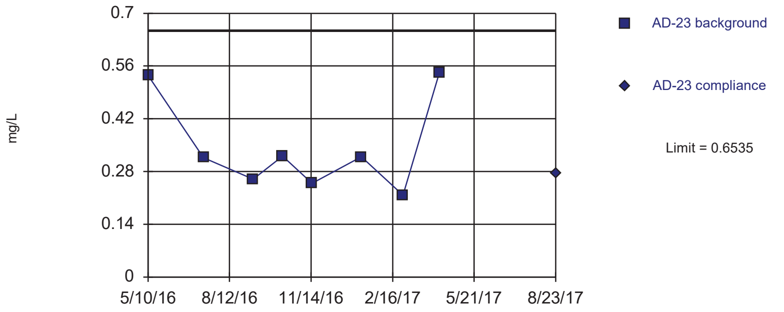
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3451, Std. Dev.=0.1255, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.809, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

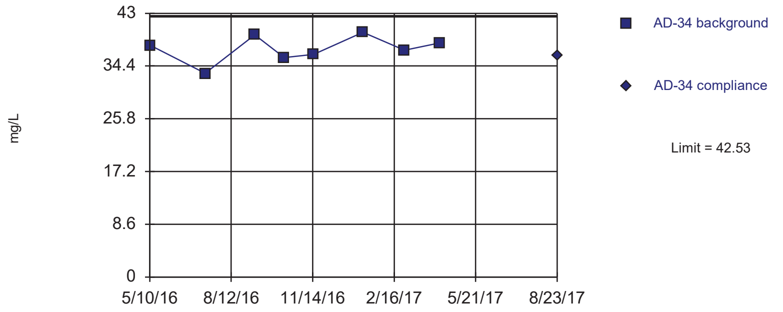
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=37.21, Std. Dev.=2.163, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9581, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

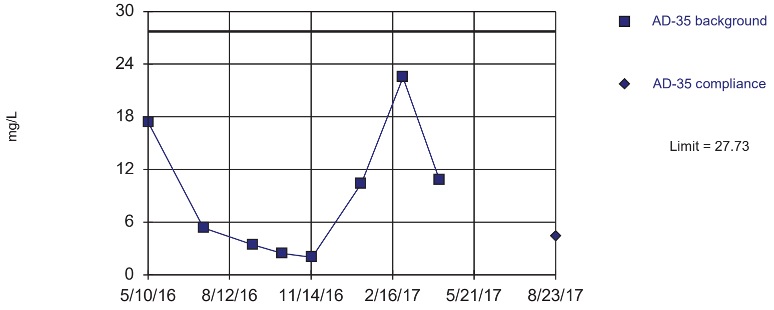
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=9.288, Std. Dev.=7.502, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8888, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

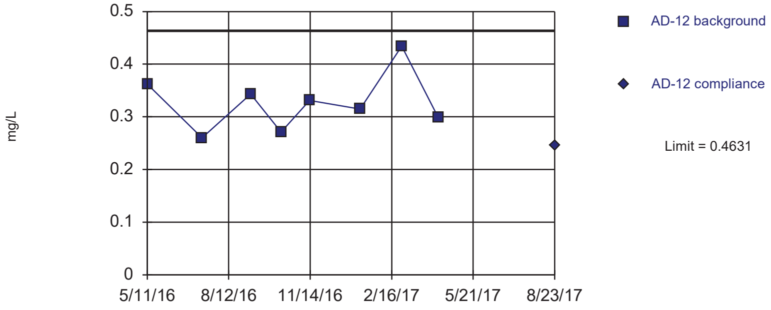
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=0.3269, Std. Dev.=0.05542, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9467, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

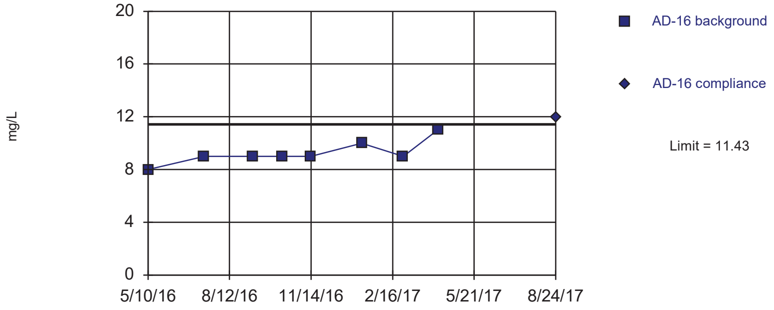
Constituent: Calcium, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=9.25, Std. Dev.=0.8864, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8264, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

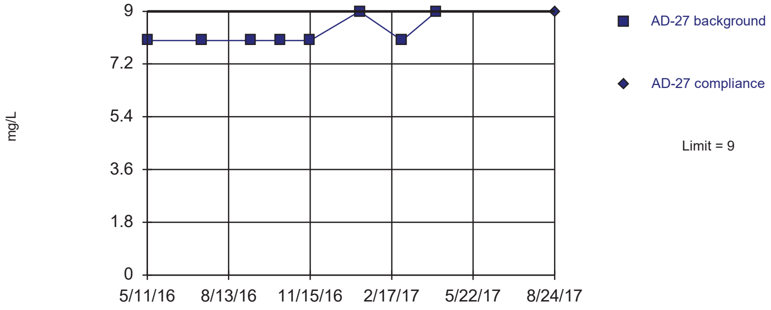
Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

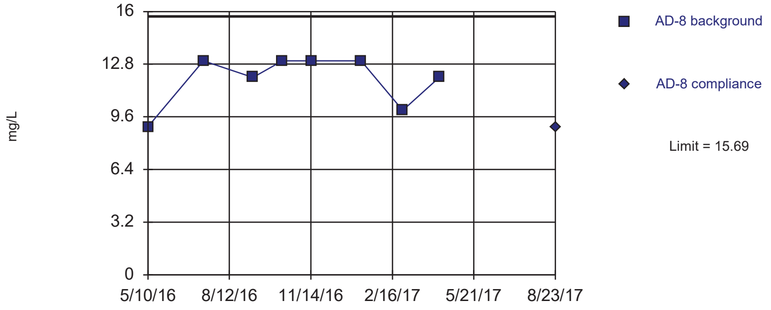
Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=11.88, Std. Dev.=1.553, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7682, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

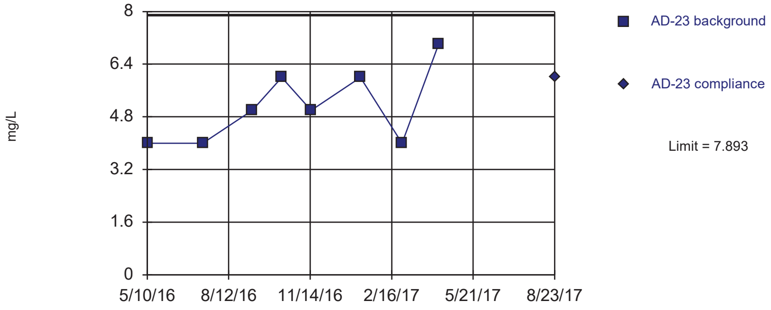
Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.125, Std. Dev.=1.126, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8815, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

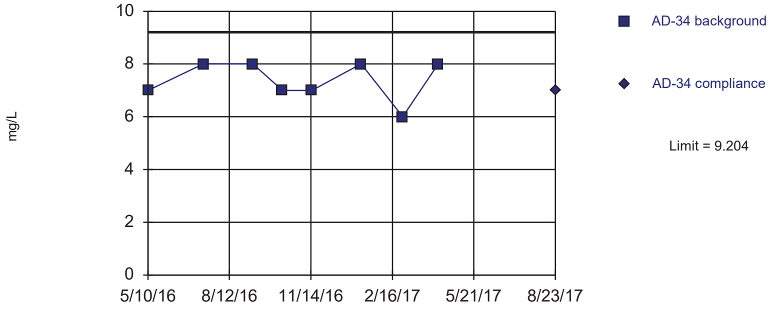
Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=7.375, Std. Dev.=0.744, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7968, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

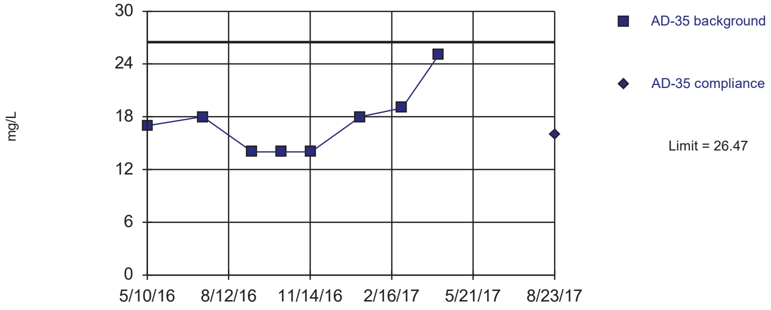
Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=17.38, Std. Dev.=3.701, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8434, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

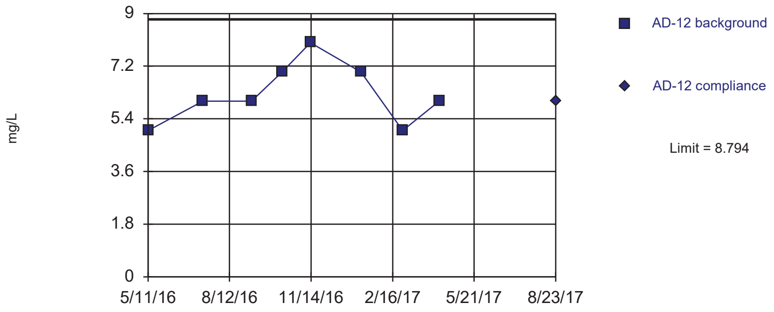
Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.25, Std. Dev.=1.035, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9171, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

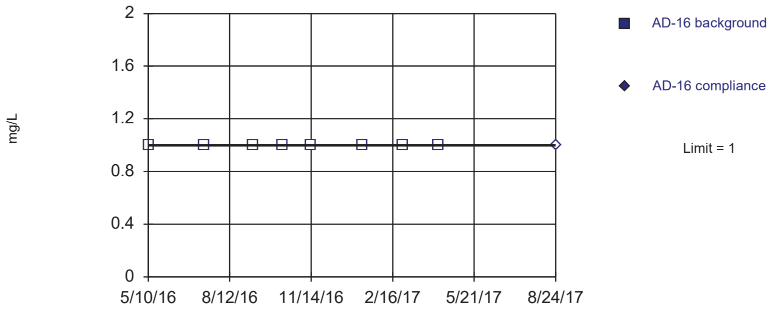
Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 8) were censored; limit is most recent reporting limit. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

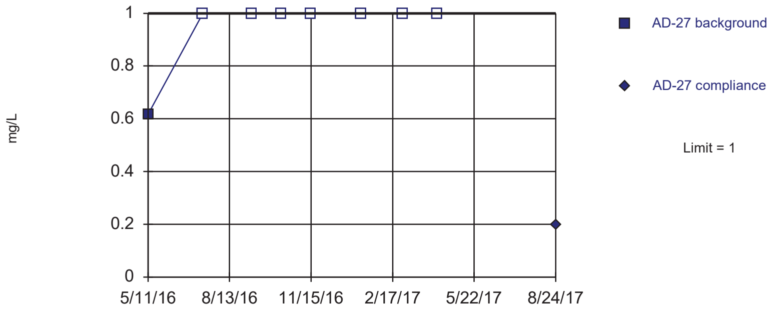
Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

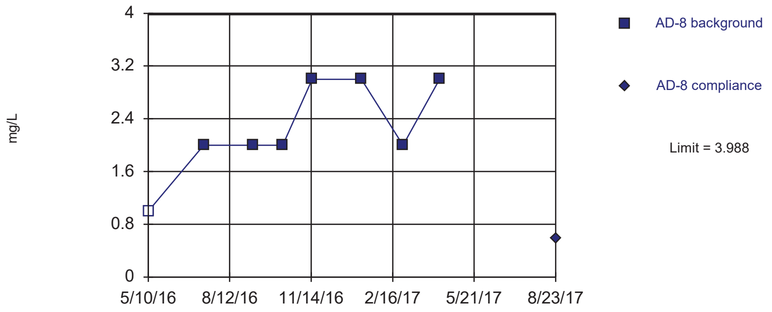
Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=2.25, Std. Dev.=0.7071, n=8, 12.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8268, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

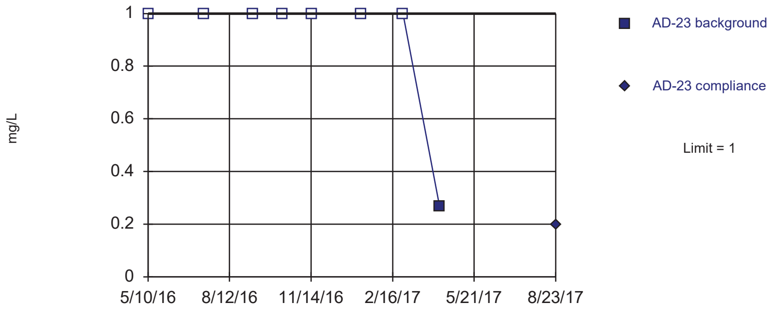
Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

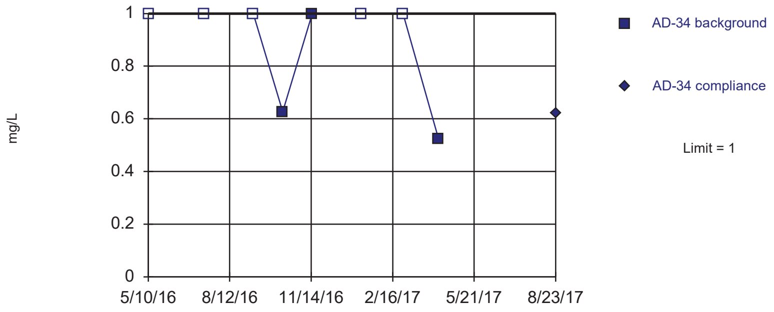
Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 62.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

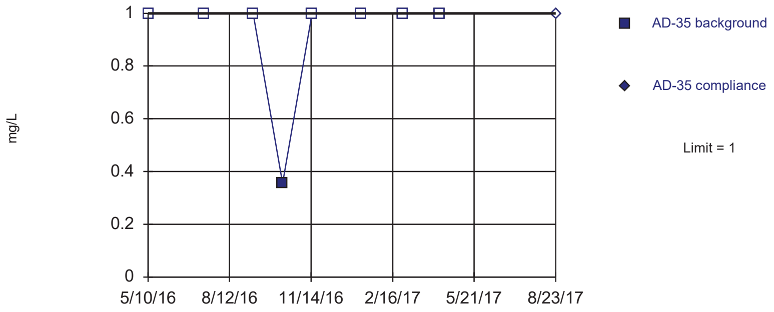
Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

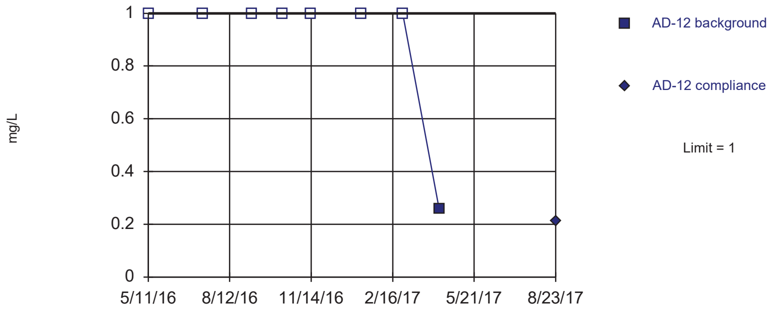
Constituent: Fluoride, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

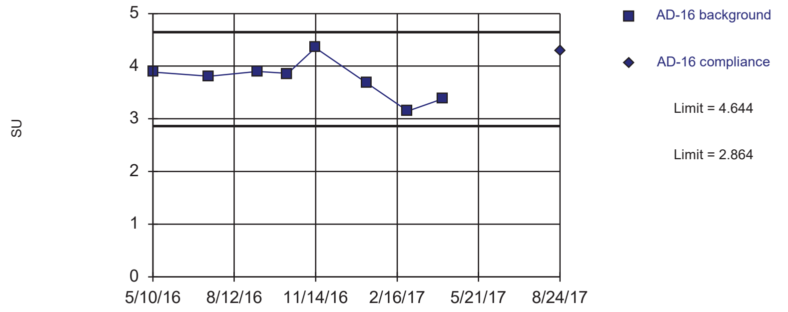
Constituent: Fluoride, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.754, Std. Dev.=0.3622, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9388, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

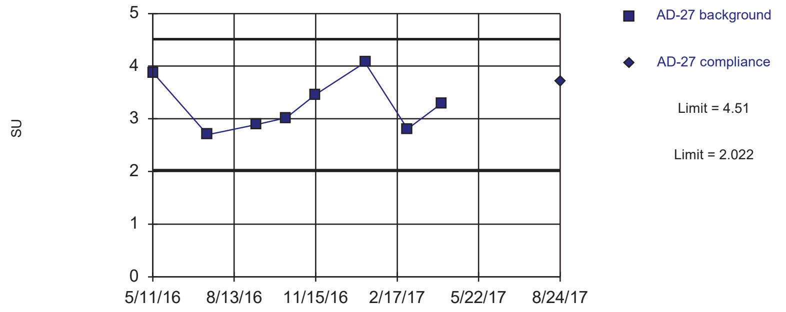
Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.266, Std. Dev.=0.506, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.918, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

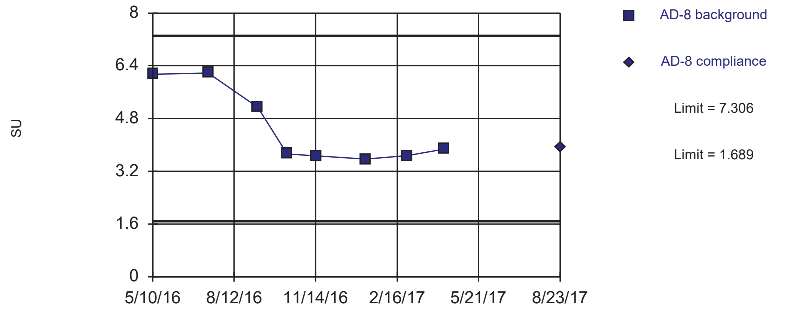
Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.498, Std. Dev.=1.143, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7532, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

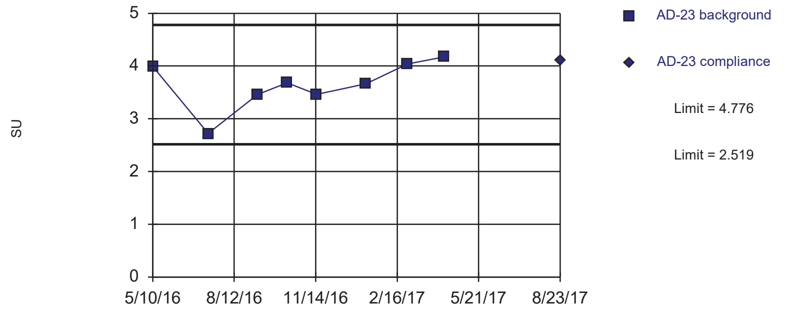
Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.648, Std. Dev.=0.4592, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.903, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

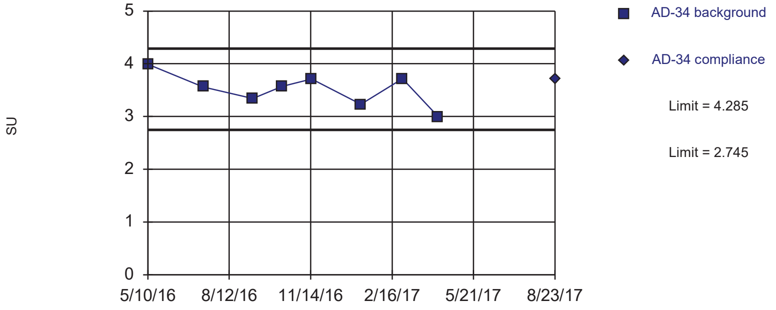
Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.515, Std. Dev.=0.3135, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9758, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

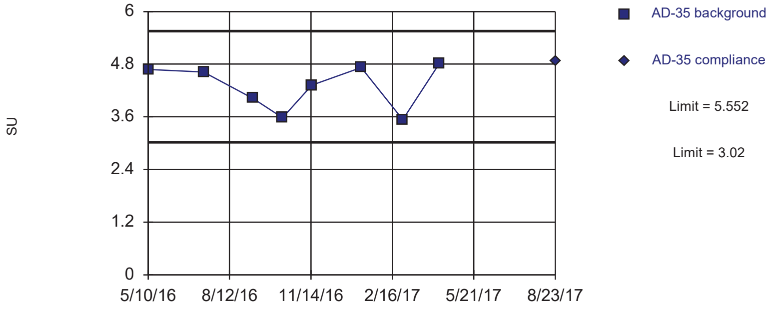
Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.286, Std. Dev.=0.515, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8567, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

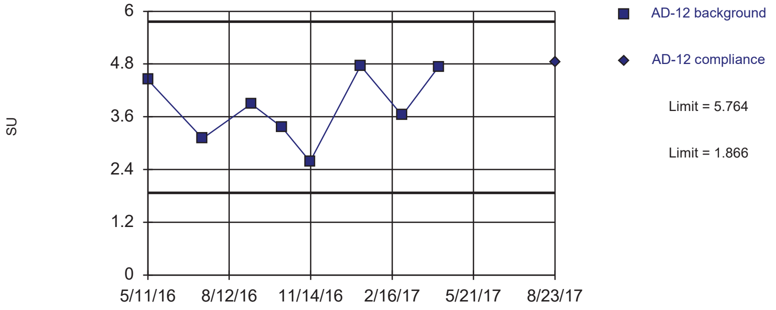
Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

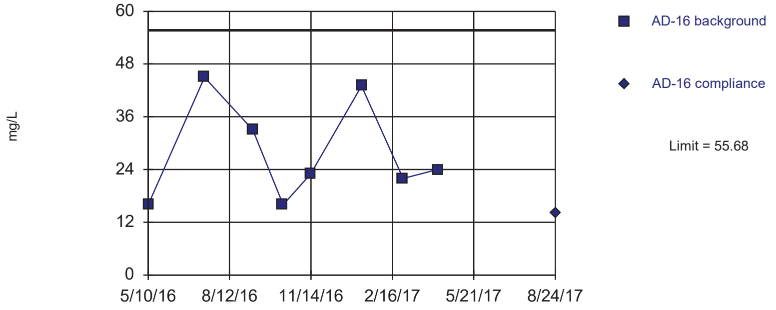
Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=27.75, Std. Dev.=11.36, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8719, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

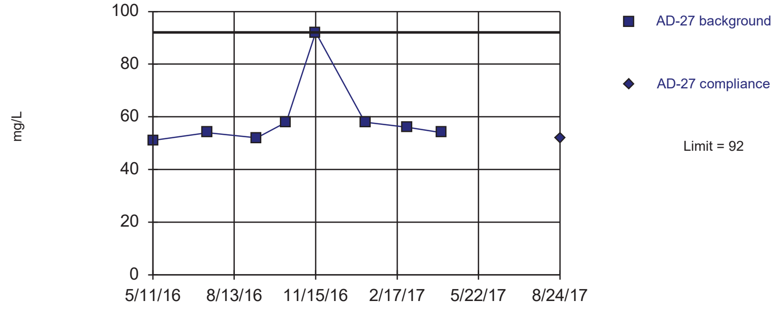
Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

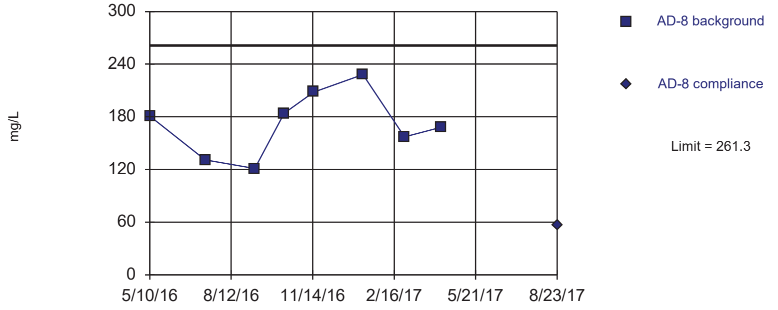
Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=172.3, Std. Dev.=36.21, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.974, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

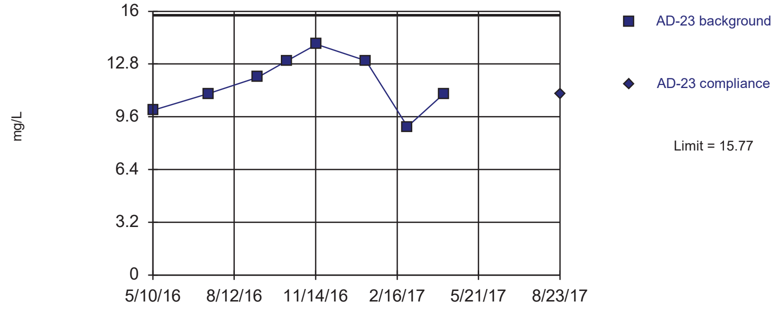
Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=11.63, Std. Dev.=1.685, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9652, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

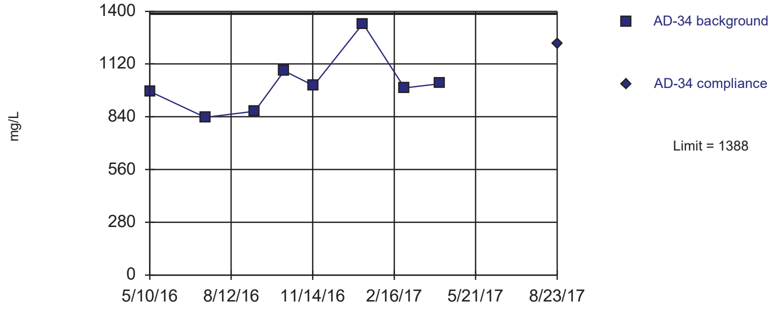
Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1014, Std. Dev.=151.9, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8781, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

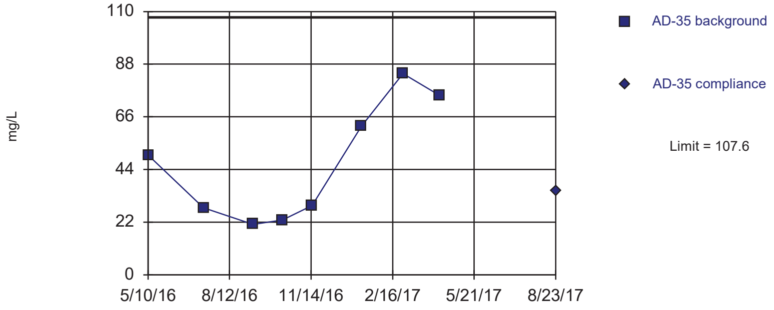
Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=46.5, Std. Dev.=24.85, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8804, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

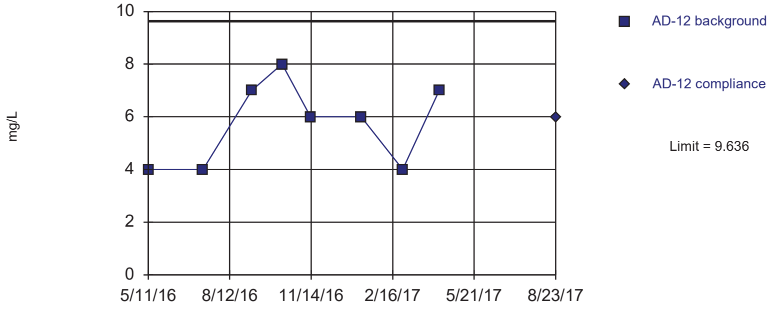
Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.75, Std. Dev.=1.581, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.866, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

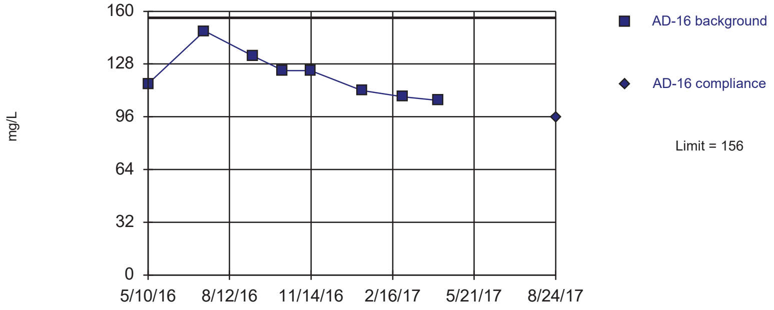
Constituent: Sulfate, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=121.4, Std. Dev.=14.09, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9257, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

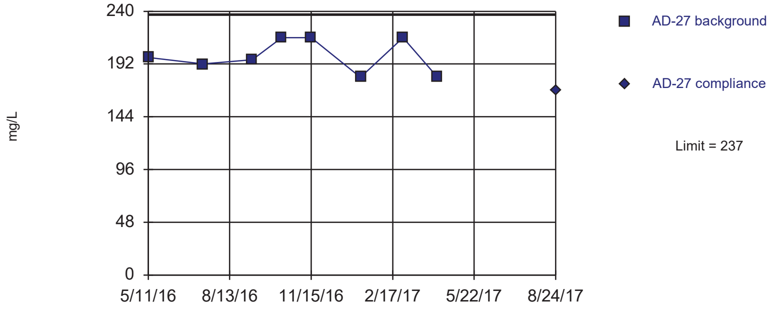
Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=199.3, Std. Dev.=15.34, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8523, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

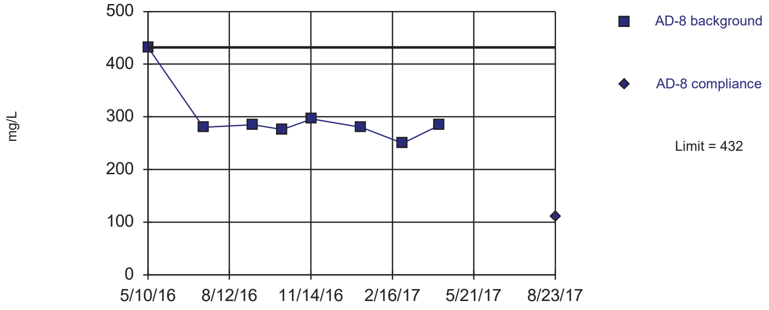
Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

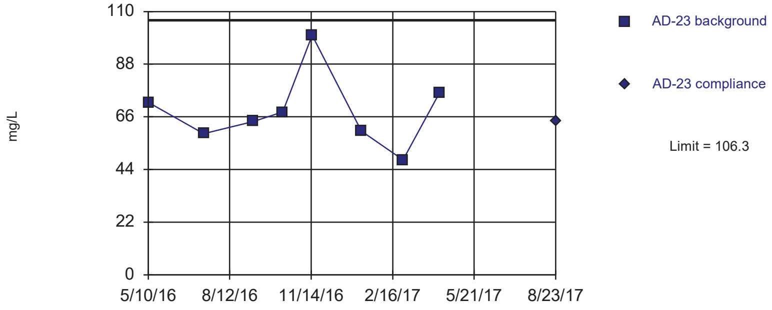
Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=68.38, Std. Dev.=15.42, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9219, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

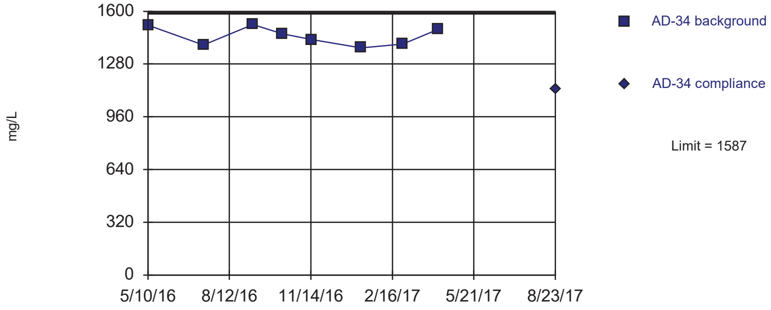
Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=1449, Std. Dev.=55.98, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9097, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

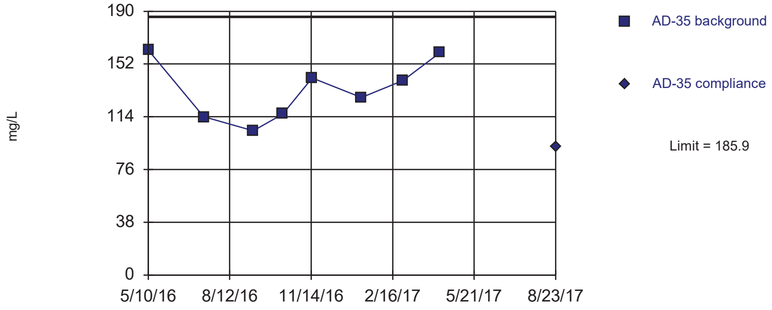
Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Intrawell Parametric



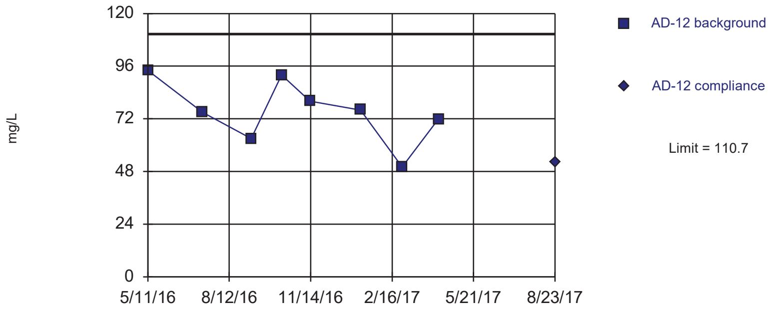
Background Data Summary: Mean=133.3, Std. Dev.=21.43, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.936, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=75.25, Std. Dev.=14.41, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9549, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Trend Test Summary Table - Signfiicant Results

Pirkey LF   Client: Geosyntec   Data: Pirkey Landfill   Printed 9/5/2019, 1:43 PM

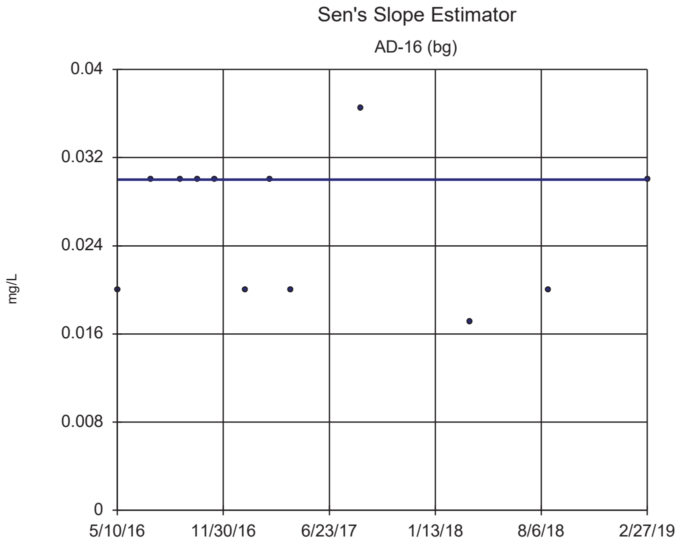
Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Chloride, total (mg/L)	**AD-16 (bg)**	**3.476**	**54**	**38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	**AD-27 (bg)**	**1.144**	**44**	**38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Total Dissolved Solids [TDS] (mg/L)	**AD-16 (bg)**	**-20.86**	**-40**	**-38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**

Trend Test Summary Table - All Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 9/5/2019, 1:43 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-16 (bg)	0	-5	-38	No	12	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-27 (bg)	0.005714	26	38	No	12	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-8 (bg)	-0.03662	-12	-38	No	12	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0	-1	-38	No	12	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	**AD-16 (bg)**	**3.476**	**54**	**38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	**AD-27 (bg)**	**1.144**	**44**	**38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride, total (mg/L)	AD-8 (bg)	-1.386	-16	-38	No	12	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	AD-12 (bg)	0.01522	10	38	No	12	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-16 (bg)	0	-11	-38	No	12	91.67	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-27 (bg)	0	-6	-38	No	12	75	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-8 (bg)	0	1	38	No	12	8.333	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	AD-12 (bg)	0	-22	-38	No	12	75	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-16 (bg)	-3.711	-23	-38	No	12	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-27 (bg)	1.909	11	38	No	12	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-8 (bg)	-1.069	-1	-38	No	12	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-34	31.48	14	43	No	13	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.565	-18	-38	No	12	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	**AD-16 (bg)**	**-20.86**	**-40**	**-38**	**Yes**	**12**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Total Dissolved Solids [TDS] (mg/L)	AD-27 (bg)	-16.41	-22	-38	No	12	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-8 (bg)	-0.5925	-1	-38	No	12	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-34	-23.3	-12	-43	No	13	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-20.7	-27	-38	No	12	8.333	n/a	n/a	0.01	NP

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 12

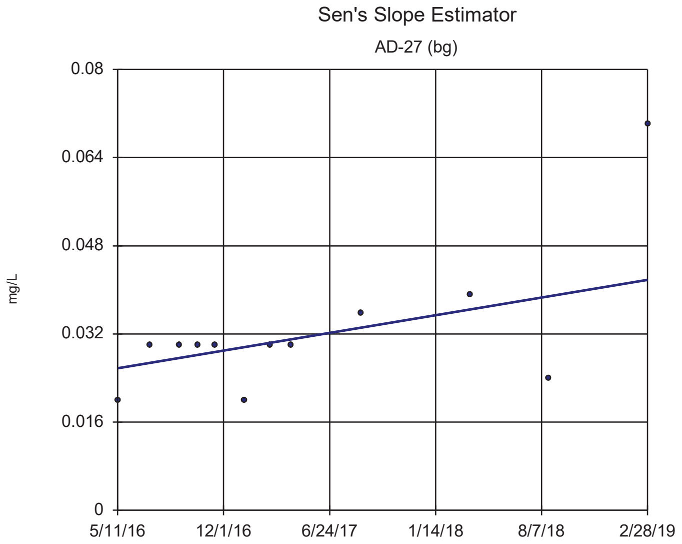
Slope = 0
units per year.

Mann-Kendall
statistic = -5
critical = -38

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 12

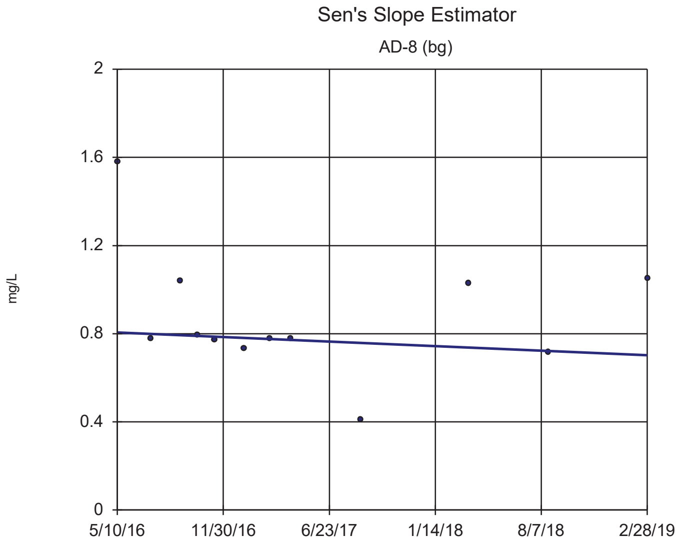
Slope = 0.005714
units per year.

Mann-Kendall
statistic = 26
critical = 38

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 12

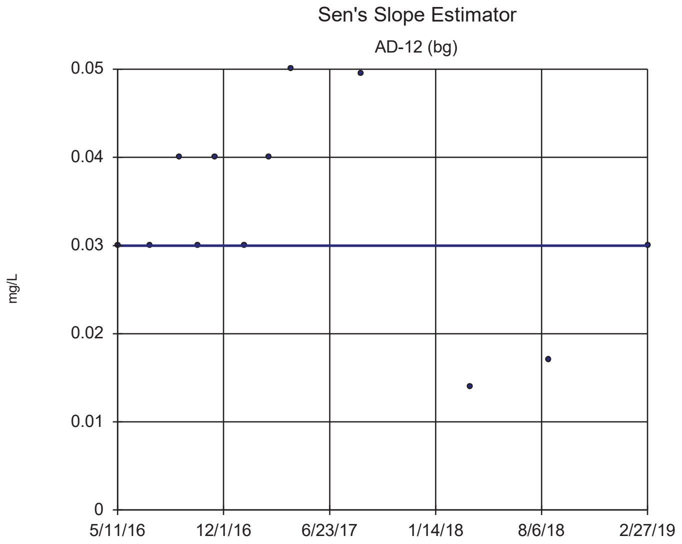
Slope = -0.03662
units per year.

Mann-Kendall
statistic = -12
critical = -38

Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = -1
critical = -38

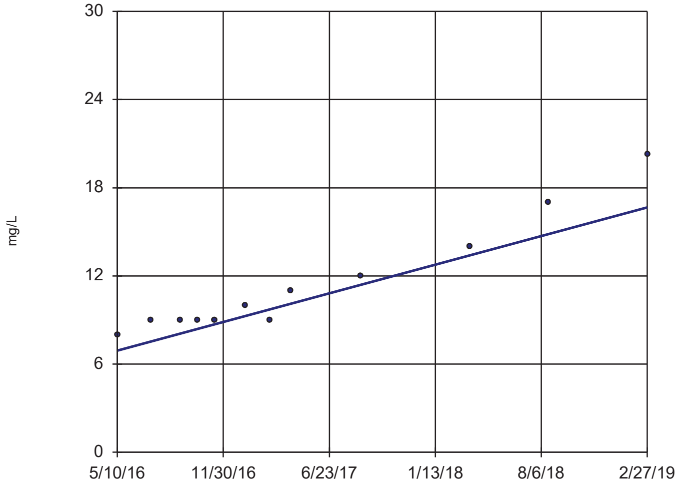
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).

Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-16 (bg)



n = 12

Slope = 3.476 units per year.

Mann-Kendall statistic = 54 critical = 38

Increasing trend significant at 99% confidence level (α = 0.005 per tail).

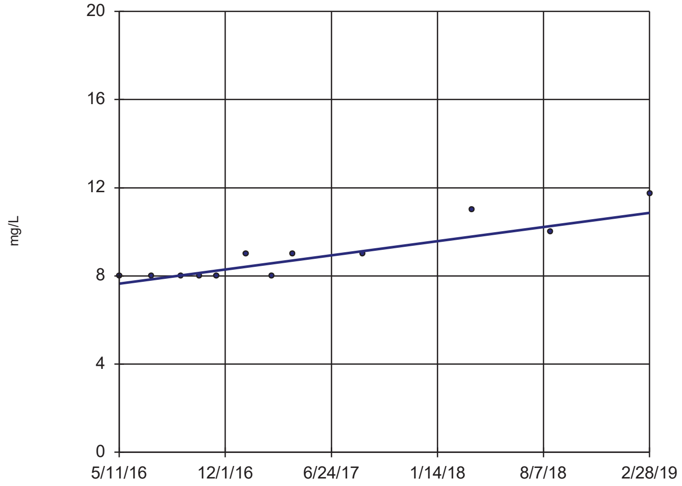
Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 12

Slope = 1.144 units per year.

Mann-Kendall statistic = 44 critical = 38

Increasing trend significant at 99% confidence level (α = 0.005 per tail).

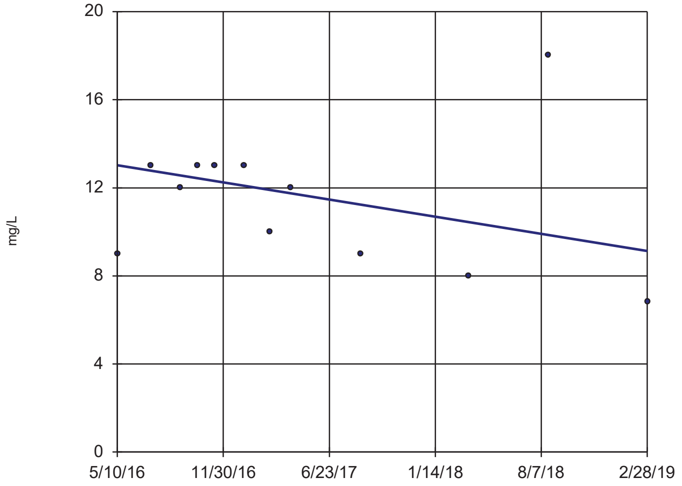
Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 12

Slope = -1.386 units per year.

Mann-Kendall statistic = -16 critical = -38

Trend not significant at 99% confidence level (α = 0.005 per tail).

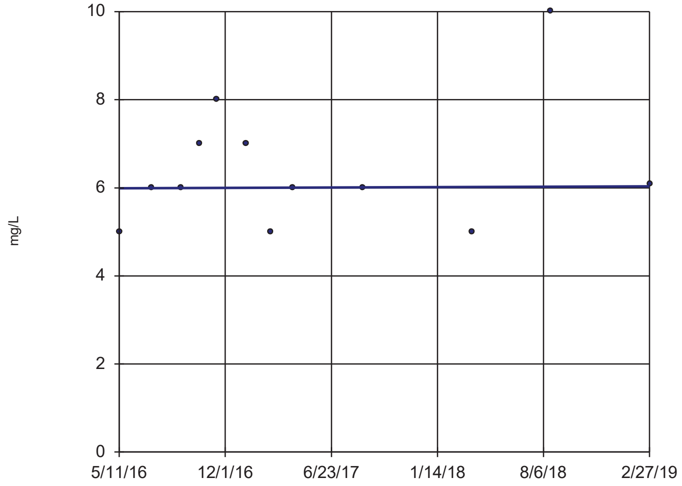
Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 12

Slope = 0.01522 units per year.

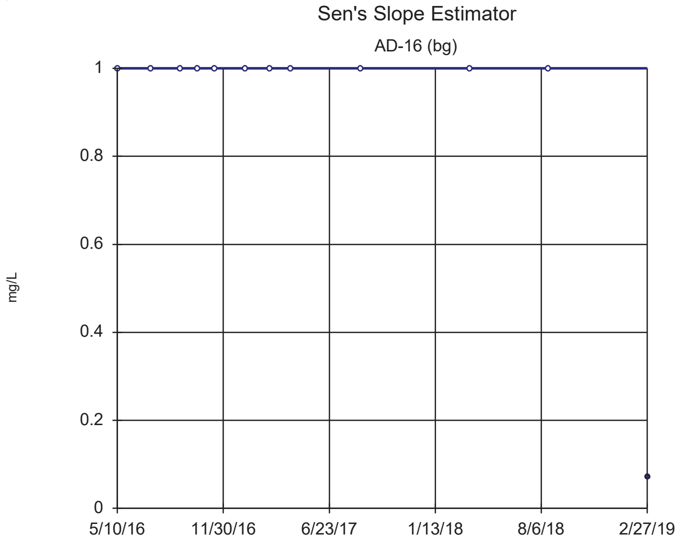
Mann-Kendall statistic = 10 critical = 38

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



n = 12

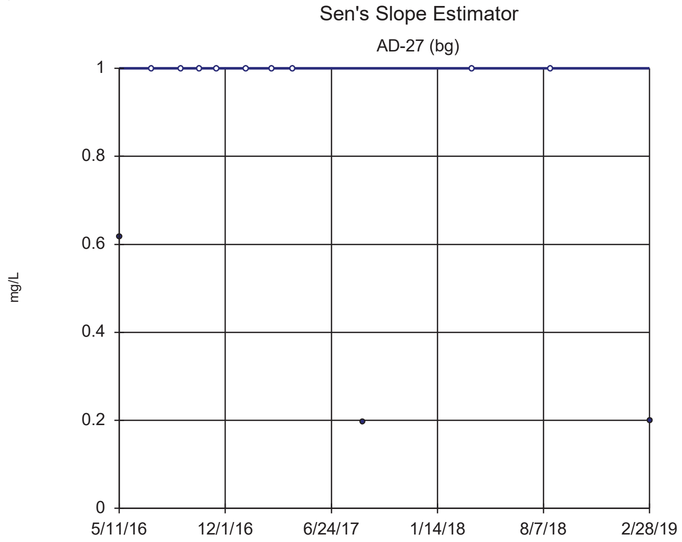
Slope = 0
units per year.

Mann-Kendall
statistic = -11
critical = -38

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



n = 12

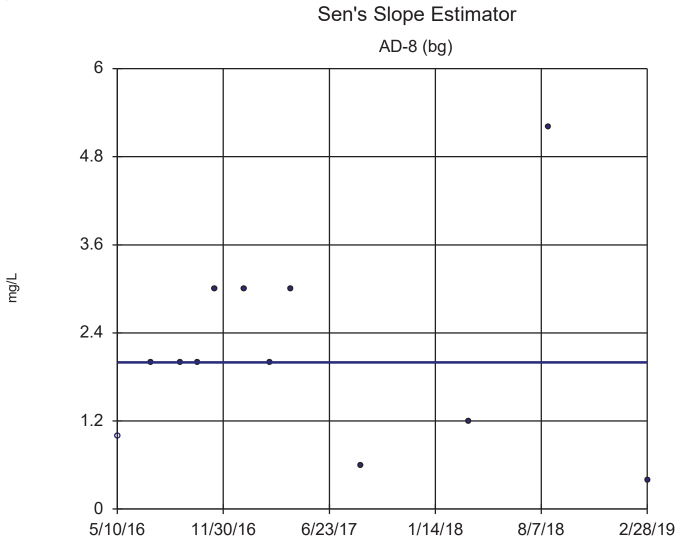
Slope = 0
units per year.

Mann-Kendall
statistic = -6
critical = -38

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



n = 12

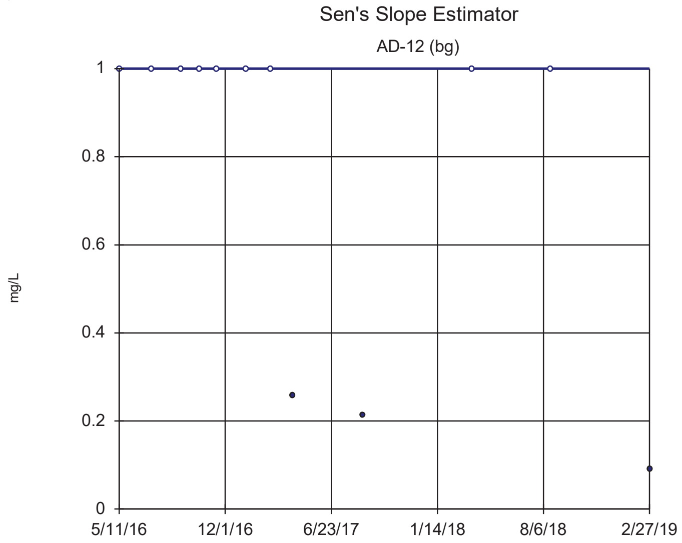
Slope = 0
units per year.

Mann-Kendall
statistic = 1
critical = 38

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



n = 12

Slope = 0
units per year.

Mann-Kendall
statistic = -22
critical = -38

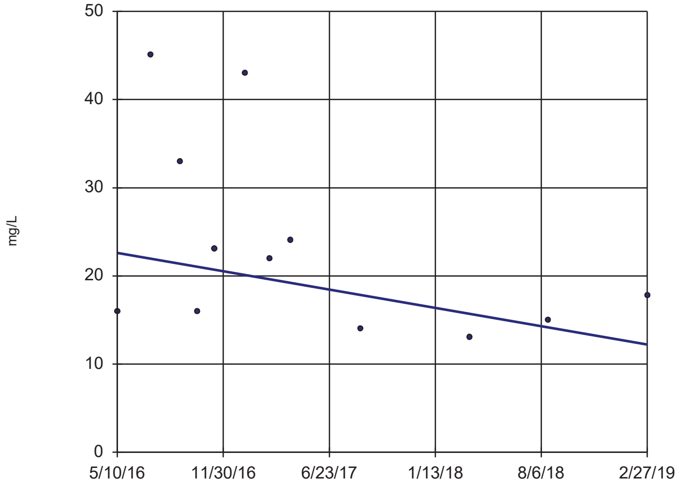
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-16 (bg)



n = 12

Slope = -3.711 units per year.

Mann-Kendall statistic = -23 critical = -38

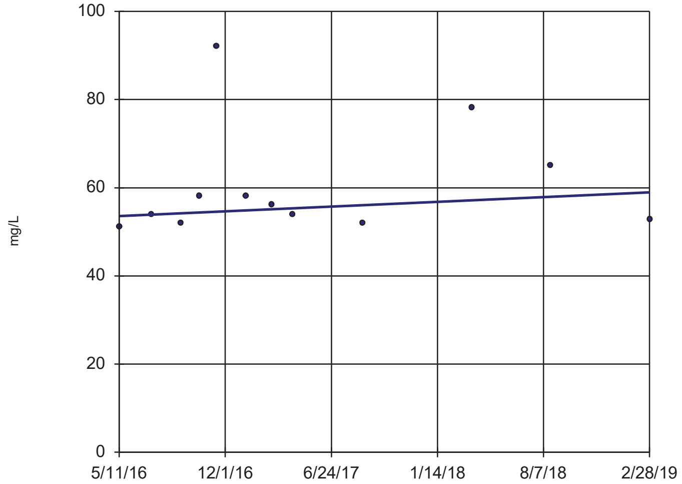
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-27 (bg)



n = 12

Slope = 1.909 units per year.

Mann-Kendall statistic = 11 critical = 38

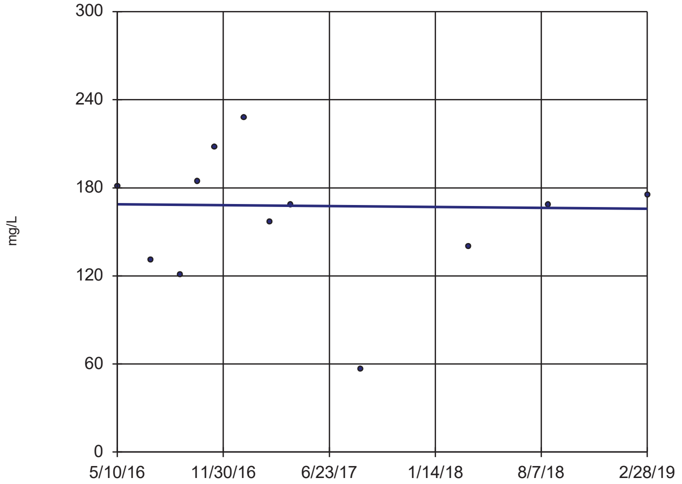
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-8 (bg)



n = 12

Slope = -1.069 units per year.

Mann-Kendall statistic = -1 critical = -38

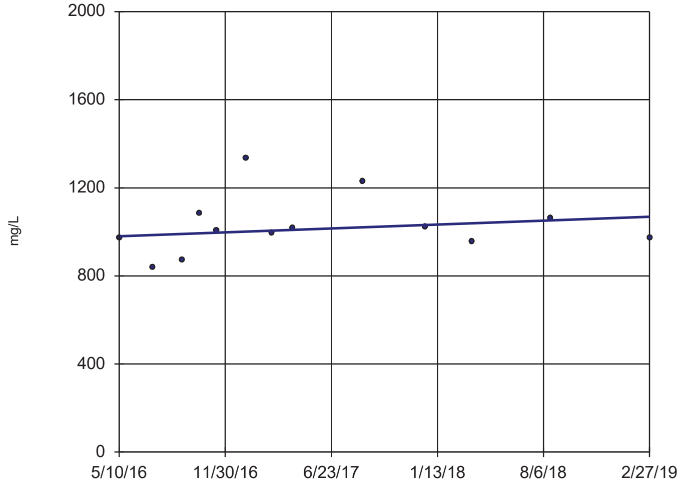
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-34



n = 13

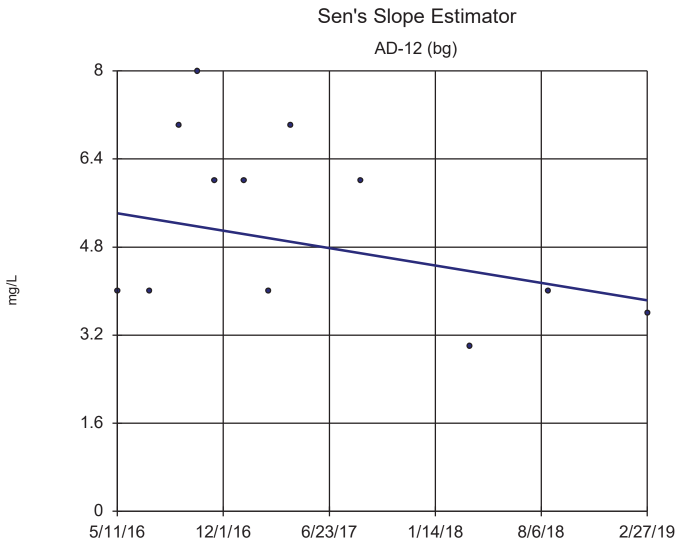
Slope = 31.48 units per year.

Mann-Kendall statistic = 14 critical = 43

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 12

Slope = -0.565 units per year.

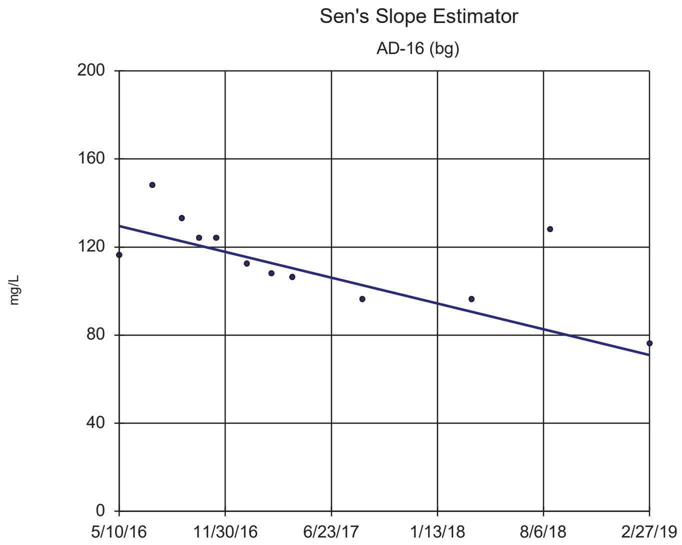
Mann-Kendall statistic = -18 critical = -38

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 12

Slope = -20.86 units per year.

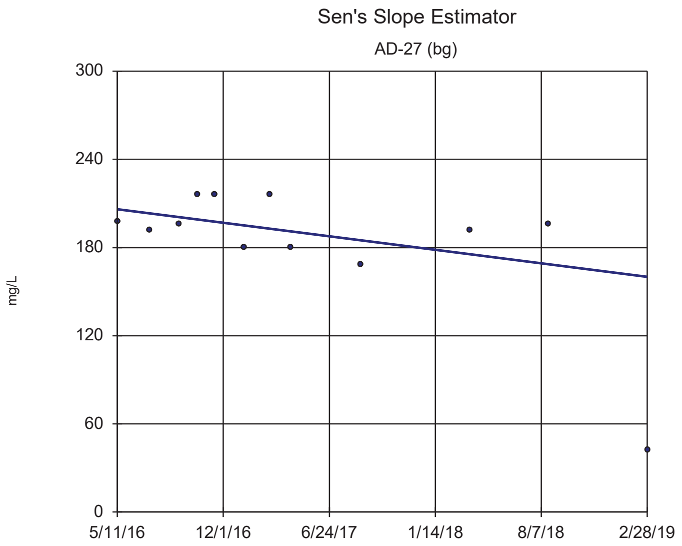
Mann-Kendall statistic = -40 critical = -38

Decreasing trend significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 12

Slope = -16.41 units per year.

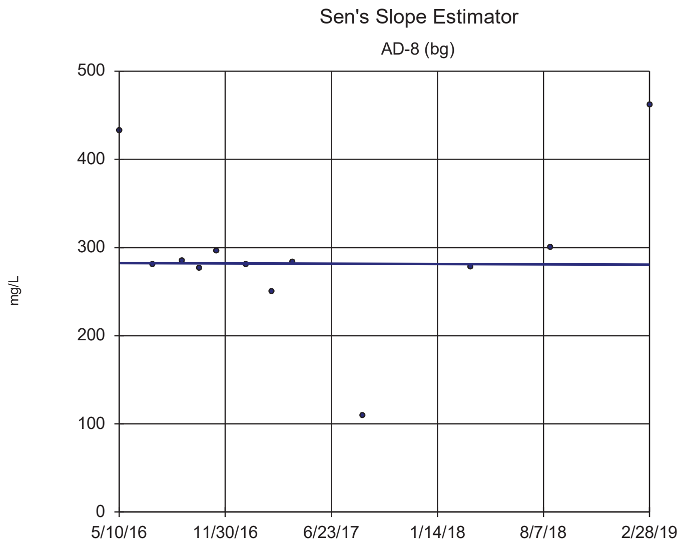
Mann-Kendall statistic = -22 critical = -38

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 12

Slope = -0.5925 units per year.

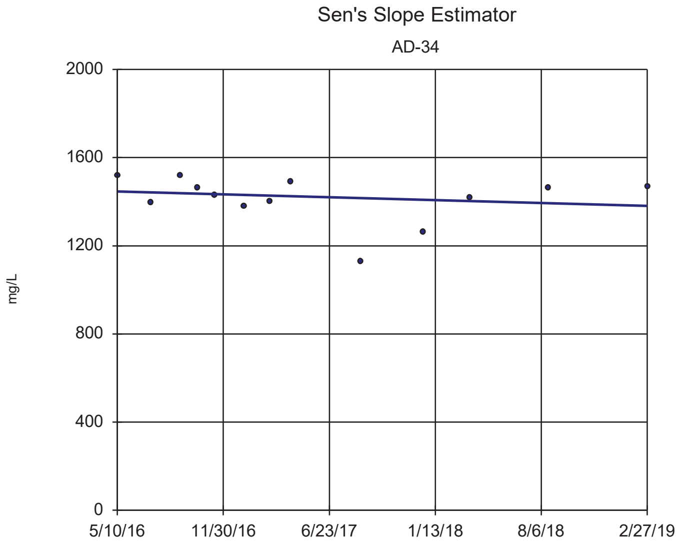
Mann-Kendall statistic = -1 critical = -38

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG



n = 13

Slope = -23.3 units per year.

Mann-Kendall statistic = -12 critical = -43

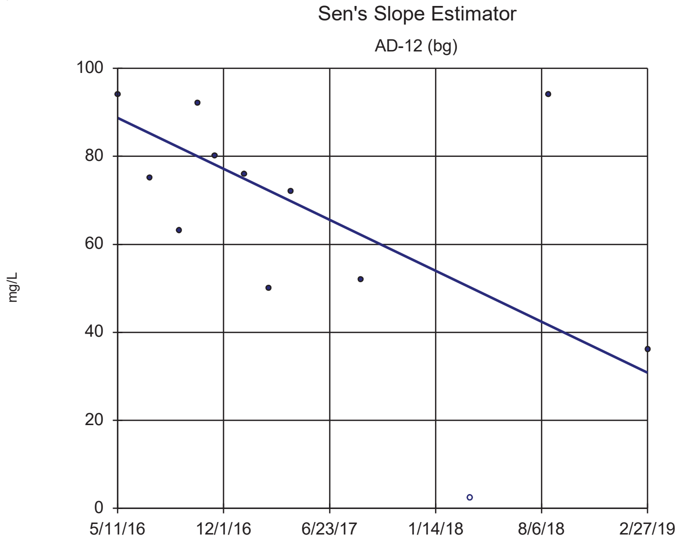
Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sanitas™ v.9.6.21g Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.



n = 12

Slope = -20.7 units per year.

Mann-Kendall statistic = -27 critical = -38

Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests

Pirkey LF Client: Geosyntec Data: Pirkey Landfill

ATTACHMENT B

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey LF CCR management area and that the requirements of 40 CFR 257.94(e)(2) have been met.

BETH ANN GROSS
79864

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
2039 Centre Point Blvd., Suite 103
Tallahassee, FL 32308

Texas Registered Engineering Firm
No. F-1182

79864	Texas	1/7/2020
License Number	Licensing State	Date

APPENDIX IV

Notices of groundwater monitoring program transitions are included in this appendix.

APPENDIX V

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #511623

Owner:	**American Electric Power Company**	Owner Well #:	**AD-36**
Address:	**502 N. Allen Street** **Shreveport, LA 71101**	Grid #:	**35-37-4**
Well Location:	**2400 Farm Road** **Hallsville, TX 75650**	Latitude:	**32° 27' 05.39" N**
		Longitude:	**094° 29' 50.99" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **4/24/2019**

Drilling End Date: **4/24/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	**8.25**	**0**	**15**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	**4**	**15**	**Sand**	**20/40**

Annual Seal Data: **No Data**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C & S Lease Service**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name:	**Buford E. Collier**	License Number:	**50089**
Apprentice Name:	**David Diduch**	Apprentice Number:	**60297**
Comments:	**No Data**		

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**9**	**Sandy clay with gravel, mainly fill**
9	**11**	**Clayey sand, mainly Iron ore**
11	**14**	**Sandy clay**
14	**15**	**clayey sand with iron ore**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506035

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 26' 52.08" N**
		Longitude:	**094° 29' 58.82" W**
Well County:	**Harrison**	Elevation:	**No Data**

****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #185184**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/19/2019** Drilling End Date: **2/20/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
8.25	**0**	**60**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
31	**38**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Plug Information:

Description (number of sacks & material)	Top Depth (ft.)	Bottom Depth (ft.)
SAND	**50**	**60**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**clay brown**
1	**5**	**silty sand**
5	**9.5**	**clay**
9.5	**11**	**sand**
11	**32**	**clay**
32	**39**	**sand and clay**
39	**55**	**sand**
55	**60**	**fine sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**40**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**40**	**50**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS PLUGGING REPORT for Tracking #185184

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 26' 52.08" N**
		Longitude:	**094° 29' 58.82" W**
		Elevation:	**No Data**
Well County:	**Harrison**		

Well Type: **Monitor**

Drilling Information

Company: **Plains Environmental Services**

Date Drilled: **2/20/2019**

Driller: **Jesse Kalvig**

License Number: **5025**

Well Report Tracking #506035

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Plugging Information

Date Plugged: **2/21/2019**

Plugger: **Jesse Kalvig**

Plug Method: **Pour in 3/8 bentonite chips when standing water in well is less than 100 feet depth, cement top 2 feet**

Casing Left in Well:

DIa (in.)	*Top (ft.)*	*Bottom (ft.)*
2	**15**	**50**

Plug(s) Placed in Well:

Top (ft.)	*Bottom (ft.)*	*Description (number of sacks & material)*
1	**40**	**Bentonite 10 Bags/Sacks**

Certification Data: The driller certified that the driller plugged this well (or the well was plugged under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the reports(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

STATE OF TEXAS WELL REPORT for Tracking #506039

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD37**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 27' 56.32" N**
		Longitude:	**094° 29' 41.78" W**
		Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019**

Drilling End Date: **2/22/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**17**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**10**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**8.5**	**CLAYS WITH SOME SAND**
8.5	**10.5**	**SAND**
10.5	**13**	**CLAY SOME SAND**
13	**15**	**SAND WITH SOME CLAYS**
15	**17**	**CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**12**	**17**

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506038

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD38**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 27' 46.12" N**
		Longitude:	**094° 29' 43.34" W**
		Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/21/2019**

Drilling End Date: **2/21/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
1	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**5**	**CLAY RED**
5	**7**	**CLAY GRAY/RED**
7	**11.5**	**SAND/CLAY**
11.5	**17.5**	**SAND SOME CLAYS**
17.5	**18**	**CLAY SLITS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506037

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD39**
Address:	**2400 FM 3251** **HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251** **HALLSVILLE, TX 75650** **LOCATED ON OWNERS PROPERTY**	Latitude:	**32° 26' 52.05" N**
		Longitude:	**094° 29' 58.84" W**
		Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019**

Drilling End Date: **2/20/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	**8.25**	**0**	**12**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	**1**	**5**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**CLAY**
1	**5**	**CLAY/SAND**
5	**9.5**	**CLAY**
9.5	**12**	**SAND/CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**7**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**7**	**12**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508688

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**AD-40 (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	0	40

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
27	40	Sand	16/30

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	13	Cement
13	27	Bentonite 4 Bags/Sacks

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**40**	**red and grey sand with occasional clay intervals**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**30**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**30**	**40**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508686

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB(MW)-01A**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/9/2019**

Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**100**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
86	**100**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**86**	**Bentonite 17 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**85**	**red and grey sand with occasional clay intervals**
85	**88**	**grey clay**
88	**100**	**grey sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**90**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**90**	**100**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508703

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019**

Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**22**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**22**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**3**	**Cement**
3	**8**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**22**	**red and grey sand w/occ. lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**12**	**22**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508695

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 deep (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	0	80

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
56	80	Sand	16/30

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	8	Cement
8	56	Bentonite 9 Bags/Sacks

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**36**	**red and grey sand w/occ. lignite layers**
36	**41**	**red and tan clay**
41	**69**	**red and grey sand with occasional clay iand lignite layers**
69	**80**	**grey sandy clay with lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**59**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**59**	**69**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508712

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
		Latitude:	**32° 27' 48" N**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/24/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**25**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
12	**25**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**12**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**25**	**brown sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**15**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**15**	**25**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508708

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
45	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**45**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	*Water Type*
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**28**	**brown sand**
28	**41**	**brown and grey silty clay**
41	**70**	**grey sand with occasional lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506040

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6S**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650 LOCAATED ON OWNERS PROPERTY**	Latitude:	**32° 27' 30.34" N**
		Longitude:	**094° 29' 27.76" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
8.25	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
1	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**18**	**SANDS AND CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #506041

Owner: **H W PIRKEY POWER PLANT**

Address: **2400 FM 3251**
HALLSVILLE, TX 75650

Well Location: **2400 FM 3251**
HALLSVILLE, TX 75650

LOCATED ON OWNERS PROPERTY

Well County: **Harrison**

Owner Well #: **SB6D**

Grid #: **35-37-1**

Latitude: **32° 27' 30.28" N**

Longitude: **094° 29' 27.75" W**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**65**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**53**	**Bentonite 19 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **No Data**

Surface Completion NOT by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig**

License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**24**	**SANDS AND CLAYS**
24	**29**	**CLAYS**
29	**42.5**	**SANDS AND CLAYS**
42.5	**48.5**	**SANDS WITH SOME CLAY**
48.5	**56**	**CLAYS WITH SOME SAND**
56	**65**	**SILY SANDS**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**55**	**65**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508722

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 shallow (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/3/2019**

Drilling End Date: **3/3/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**45**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
32	**45**	**Sand**	**16/30**

Annual Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**32**	**Bentonite 6 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**45**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**35**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**35**	**45**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508720

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
57	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**57**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**70**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**60**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**60**	**70**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508724

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
		Latitude:	**32° 27' 10" N**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/27/2019**

Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**35**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**35**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**23**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**35**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**25**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**25**	**35**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508729

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 medium (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **2/27/2019**

Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**65**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
52	**65**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**53**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**65**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508777

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	0	93

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
77	93	Sand	16/30

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	12	Cement
12	77	Bentonite 15 Bags/Sacks

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**90**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**
90	**93**	**gray clay (old pit base?)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**80**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**80**	**90**

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P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508781

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/5/2019**

Drilling End Date: **3/5/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**30**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
17	**30**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**12**	**Cement**
12	**17**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

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Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508779

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 deep (MW)**
Address:	**2400 FM 3251** **Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251** **Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/4/2019**

Drilling End Date: **3/4/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**60**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
48	**60**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**48**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed**

Surface Completion by Driller

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum**

License Number: **3184**

Apprentice Name: **Jason Smith**

Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**60**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508718

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/8/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**15**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**15**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement**
1	**3**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40** **0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #508717

Owner: **AEP Pirkey Power Plant**

Address: **2400 FM 3251**
Hallsville, TX 75650

Well Location: **2400 FM 3251**
Hallsville, TX 75650

Well County: **Harrison**

Owner Well #: **SB-11 deep (MW)**

Grid #: **35-36-6**

Latitude: **32° 26' 41" N**

Longitude: **094° 30' 11" W**

Elevation: **No Data**

Type of Work: **New Well**

Proposed Use: **Monitor**

Drilling Start Date: **3/7/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
6.75	**0**	**43**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
30	**43**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
0	**10**	**Cement**
10	**30**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

Distance to Property Line (ft.): **No Data**

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **Yes**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	*Bottom (ft.)*	*Description*
0	**18**	**tan and brown sandy, silty clay and occasional gravel**
18	**43**	**red and grey sand w/occ. clay layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

DIa (in.)	*Type*	*Material*	*Sch./Gage*	*Top (ft.)*	*Bottom (ft.)*
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**33**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**33**	**43**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540

5.2 – TCEQ New Cease Receipt of Waste and Initiation of Closure Deadline for Coal Combustion Residual Unit, East/West Bottom Ash Pond, October 2020

Jon Niermann, *Chairman*
Emily Lindley, *Commissioner*
Bobby Janecka, *Commissioner*
Toby Baker, *Executive Director*

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Protecting Texas by Reducing and Preventing Pollution

October 30, 2020

Mr. David A. Miller, P.E.
Director, Land Environment & Remediation Services
Environmental Services Division
American Electric Power
1 Riverside Plaza
Columbus, Ohio 43215

Re: New Cease Receipt of Waste and Initiation of Closure Deadline for Coal Combustion Residual Unit
Southwestern Electric Power Company – Hallsville, Harrison County
Industrial Solid Waste Registration No. 33240
AEP Pirkey Power Plant
RN100214287/CN600126767

Dear Mr. Miller:

The Industrial and Hazardous Waste (I&HW) Permits Section of the Texas Commission on Environmental Quality (TCEQ) received your request for an extension to cease receipt of Coal Combustion Residuals (CCR) waste and initiate of closure activities. The request was dated and received on October 23, 2020.

The TCEQ acknowledges your request to extend the receipt of CCR waste and the initiation of closure activities until April 11, 2021, in compliance with the U.S. Environmental Protection Agency's (EPA) new Title 40 Code of Federal Regulations (40 CFR) §257.101(a)(1) or new 40 CFR §257.101(b)(1)(i). Your request may be extended further, upon a successful demonstration, approved by the EPA under new 40 CFR §257.103(f), of site-specific alternative deadlines to initiate closure. You must submit documentation of the initial EPA request and EPA's final decision to the TCEQ; and you must maintain records adequate to document your compliance with the site-specific deadline approved by the EPA. Please submit the EPA-related documents to IHWPER@tceq.texas.gov.

This extension applies to the following unit:

- TCEQ Waste Management Unit No. 005 – East/West Bottom Ash Pond

Please continue to keep the TCEQ updated as conditions change. You may contact me at (512) 239-2331 or via email at charly.fritz@tceq.texas.gov.

Sincerely,

Charly Fritz

Charly Fritz, Deputy Director
Waste Permits Division

CF/FR/tw

cc: Mr. Brian D Newton, Manager, American Electric Power

printed on recycled paper

5.3 – Closure Plan, FGD Stack Out Area, October 2016

CLOSURE PLAN

CCR 257.102(b)

FGD Stack Out Area

Pirkey Power Plant
Hallsville, Texas

October, 2016

Prepared for : Southwest Electric Power Company - Pirkey Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

GERS – 16 – 095

CLOSURE PLAN
CCR 257.102(b)
PIRKEY POWER PLANT
FGD STACK OUT AREA

PREPARED BY Brett A. Dreger DATE 9/28/2016
Brett A. Dreger, P.E.

REVIEWED BY DATE 9-28-16
Shahriyar S. Baig, P.E.

APPROVED BY Gary F. Zych DATE 9/29/2016
Gary F. Zych, P.E.
Department Manager – AEP Geotechnical Engineering

09-28-2016
STATE OF TEXAS
SHAHRIYAR S. BAIG
92172
LICENSED PROFESSIONAL ENGINEER

I certify to the best of my knowledge, information, and belief that the information contained in this closure plan meets the requirements of 40 CFR § 257.102

Table of CONTENTS

1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of CCR 257.102(b) for Closure Plans of Existing CCR Units.

2.0 DESCRIPTION OF THE CCR UNIT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas. It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates a FGD Stack Out Pad Area to collect and temporarily store the CCR materials until they can be hauled to the Plant's Landfill facility.

The Pirkey FGD Stack Out Area is a Class 2, Industrial Solid Waste Facility and designated as a waste pile per the Texas Commission on Environmental Quality TCEQ).

The FGD Stack Out Area is located directly adjacent to and west of the main plant area. The FGD Stack Out Area receives a mixture of fly ash and scrubber sludge material that is deposited by a radial stacker equipment. The FGD Stack Out Area is approximately 5 acres and has a storage capacity of 18.6 acre-feet or 30,000 cubic yards. The FGD Stack Out Area gently grades into an existing surge pond.

3.0 DESCRIPTION OF CLOSURE PLAN 257.102(b)(1)(i)

[A narrative description of how the CCR unit will be closed in accordance with this section]

Closure of the Pirkey FGD Stack Out Area will be by removal of the CCR material and regrading the area for positive drainage.

4.0 CLOSURE IN PLACE 257.102 (b)(1)(ii)

[If closure of the CCR unit will be accomplished through removal of CCR from the CCR unit, a description of the procedures to remove the CCR and decontaminate the CCR unit in accordance with paragraph (c) of this section.]

Closure by removal of CCR will include removal of all CCR from the CCR unit. The removal of all CCR from the CCR unit and any areas subsequently determined to have been affected by releases from the CCR unit will be accomplished by excavation of the CCR material, then hauling and placing of the material in the Pirkey Landfill. The procedures for removal or decontamination of any areas affected by releases from the CCR unit to the underlying and surrounding soils will be determined following an evaluation of the nature and extent of any contamination. Following removal of the final quantities of CCR, the stack out area will be graded and modified as necessary to maintain positive drainage.

4.1 CLOSURE PERFORMANCE STANDARDS 257.102 (c)

[An owner or operator may elect to close a CCR unit by removing and decontaminating all areas affected by releases from the CCR unit. CCR removal and decontamination of the CCR unit are complete when constituent concentrations throughout the CCR unit and any areas affected by releases from the CCR unit have been removed and groundwater monitoring concentrations do

not exceed the groundwater protection standard established pursuant to §257.95(h) for constituents listed in appendix IV to this part.]

Closure of the CCR unit will be completed when all CCR in the unit and any areas affected by releases from the CCR unit have been removed and groundwater monitoring demonstrates that all concentrations of the assessment monitoring constituents listed in appendix IV to part 257 do not exceed either statistically equivalent background levels or MCLs for two consecutive sampling events using the statistical procedures in § 257.93(g).

5.0 ESTIMATE OF MAXIMUM CCR VOLUME 257.102 (b)(1)(iv)

[An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit.]

The estimated maximum CCR volume on-site is 30,000 Cubic Yards for the FGD Stack Out Area.

6.0 ESTIMATE OF LARGEST AREA OF CCR REQUIRING COVER 257.102 (b)(1)(v)

[An estimate of the largest area of CCR unit ever requiring a final cover

The FGD Stack Out Area will be closed by removal off CCR materials as such this section is not applicable.

7.0 CLOSURE SCHEDULE 257.102(b)(1)(vi)

[A schedule for completing all activities necessary to satisfy the closure criteria in the section, including an estimate of the year in which all closure activities for the CCR unit will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR unit, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phases of the CCR surface impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of the CCR unit closure.

At this time there are currently no plans to close this CCR unit. Once the CCR unit requires closure a schedule to satisfy this section will be prepared.

5.4 – Closure Plan, Landfill Area, December 2021

CLOSURE PLAN

CCR 257.102(b)

Landfill Area

Pirkey Power Plant
Hallsville, Texas

October, 2016
(Revised December, 2021)

Prepared for: Southwestern Electric Power Company - Pirkey Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

1 Riverside Plaza

Columbus, OH 43215

GERS – 21 – 085

CLOSURE PLAN
CCR 257.102(b)
PIRKEY POWER PLANT
LANDFILL AREA

PREPARED BY Brett A. Dreger DATE 12/29/2021
Brett A. Dreger, P.E.

REVIEWED BY Gary F. Zych DATE 12/30/2021
Gary F. Zych, P.E.

APPROVED BY Gary F. Zych DATE 12/30/2021
Gary F. Zych, P.E.
Section Manager –Geotechnical Engineering
American Electric Power Service Corporation (F-3341)

Gary F. Zych
STATE OF TEXAS
GARY F. ZYCH
127152
LICENSED
PROFESSIONAL ENGINEER
12/30/2021

I certify to the best of my knowledge, information, and belief that the information contained in this closure plan meets the requirements of 40 CFR § 257.102

I certify to the best of my knowledge, information and belief that design of the final cover system as described in this closure plan meets the requirements of 40 CFR § 257.102.

Table of CONTENTS

1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of CCR 257.102(b) (30 TAC 352.1221) for Closure Plans of Existing CCR Units.

2.0 DESCRIPTION OF THE CCR UNIT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas. It is owned and operated by Southwestern Electric Power Company (SWEPCO). The facility operates a landfill for the disposal of CCR materials.

The Pirkey Landfill is a Class 2, Industrial Solid Waste Facility per the Texas Commission on Environmental Quality, Industrial Solid Waste Management Technical Guideline No. 3.

3.0 DESCRIPTION OF CLOSURE PLAN 257.102(b)(1)(i)

[A narrative description of how the CCR unit will be closed in accordance with this section]

The Pirkey Landfill will be closed in place periodically throughout the life capacity of the facility. Closure of the landfill will be done in accordance with the Texas Commission on Environmental Quality (TCEQ) Industrial Solid Waste Management Technical Guideline No. 3. The closure will consist of regrading the existing onsite materials and the installation of an impermeable cap (geomembrane) system with either a vegetative cover or an artificial turf cover.

The Texas guidelines for the cap system of a Type 2 solid waste facility consists of:
3-feet of compacted clay (1.0 x 10-7 cm/sec)
18-inches of vegetative cover soil

The CCR Rule states that the cap system shall be no less permeable than the base liner. The base liner of the unclosed area at the landfill was constructed as a composite liner consisting of geosynthetic clay liner and a geomembrane. Since the base liner includes a geomembrane which is less permeable than compacted clay, the cap system will need to be modified to include a geomembrane.

Environmental Services have discussed the modified composite cap system with the Texas Commission of Environmental Quality (TCEQ). TCEQ only considers that a geomembrane is equivalent to 12-inches of compacted clay. Therefore, the modified cap to be compliant with both the CCR Rule and TCEQ Guidelines and will consist of:

2-feet of compacted clay (1.0 x 10-7 cm/sec)
Geomembrane
Geocomposite on slopes steeper that 10%
24-inches of vegetative cover soil

Environmental Services has also discussed an alternate engineered turf cap system with the Texas Commission of Environmental Quality (TCEQ). TCEQ has considered an alternate cap system consisting of engineered turf material. Therefore, the alternate cap system to be compliant with both the CRR Rule and TCEQ guidelines and will consist of:

1.5-feet of Intermediate Soil Cover
50 Mil LLDPE Micro-spike Geomembrane
Agru - Engineered Turf Material
2-inches of Sand Ballast Infill Material

4.0 CLOSURE IN PLACE 257.102 (b)(1)(iii)

[If closure of the CCR unit will be accomplished by leaving the CCR in place, a description of the final cover system, designed in accordance with paragraph(d) of this section, and the methods and procedures to be used to install the final cover. The closure plan must also discuss how the final cover system will achieve the performance standards specified in paragraph (d) of this section.]

The final modified composite cap system will consist of a flexible geomembrane that will have a permeability that is less than or equal to the permeability of the natural subsoils and is no greater than 1 x 10^{-5} cm/sec. In addition to the minimum requirements for the closure plan set by the CCR rule 257.102(b), the Texas Commission on Environmental Quality (TCEQ) guidelines state that the closure plan will include two (2) feet of compacted clay cap with a hydraulic conductivity no greater than 1x10^{-7} cm/sec be placed below the geomembrane layer. Over the geomembrane will be installed a geocomposite material and an infiltration layer consisting of 18" of earthen material and an erosion layer consisting of 6" of earthen material that is capable of sustaining native plant growth. The final cover will be seeded and mulched to promote growth of a vegetative cover. The final cover slope will be a minimum of 2% and will convey water to a TPDES permitted outfall.

The final engineered turf cap system will consists of 1.5 feet of intermediate soil cover over the final graded CCR material with a 50 Mil LLDPE Micro-Spike geomembrane cover. Over the geomembrane will be installed an Agru – Engineered Turf Material that will be covered with 2-inches of sand ballast infill material. The final cover slopes will be a minimum of 2% and will convey water to a TPDES permitted outfall.

4.1 CLOSURE PERFORMANCE STANDARDS 257.102 (d)(1)

4.1.1 SECTION 257.102(d)(1)(i)

[Control, minimize or eliminate, the maximum extent feasible, post-closure infiltration of liquids into the waste and releases of CCR, leachate, or contaminated run-off to the ground or surface waters or to the atmosphere.]

The final cover system will cover the CCR material and will have a permeability that is no less than the base liner is no greater than 1 x 10^{-5} cm/sec.

4.1.2 SECTION 257.102(d)(1)(ii)

[Preclude the probability of future impoundment of water, sediment, or slurry.]

The final surface areas will be graded to a minimum slope of 2% to prevent the ponding of surface water runoff. Drainage features will be designed to have positive drainage.

4.1.3 SECTION 257.102(d)(1)(iii)

[Include measures that provide for major slope stability to prevent the sloughing or movement of the final cover system during the closure and post-closure care period.]

The final cover system will be gently graded with a minimum of 2% slope. The final configuration of the landfill will meet the stability requirements to prevent the sloughing or movement of the final cover system during the closure and post-closure care period.

4.1.4 SECTION 257.102(d)(1)(iv)

[Minimize the need for further maintenance of the CCR unit.]

The landfill facility will be either vegetated or covered with artificial turf material to prevent erosion. Maintenance of the final cover system will include mowing the vegetated areas and replenishing the sand ballast infill as needed.

4.1.5 SECTION 257.102(d)(1)(v)

[Be completed in the shortest amount of time consistent with recognized and generally accepted good engineering practices.]

The CCR unit will be closed in a timeframe consistent with recognized and generally accepted good engineering practices. As the fill reaches the approved final grades, periodic closure activities may occur.

4.2 DRAINING AND STABILIZING OF THE SURFACE IMPOUNDMENT 257.102(d)(2)

This section is not applicable to a landfill.

4.3 FINAL COVER SYSTEM 257.102 (d)(3)

[If a CCR unit is closed by leaving CCR in place, the owner or operator must install a final cover system that is designed to minimize infiltration and erosion, and at a minimum, meets the requirements of paragraph (d)(3)(i) of this section, or the requirements of the alternative final cover system specified in paragraph (d)(3)(ii) of this section.

The final cover system must be designed and constructed to meet the criteria in paragraphs (d)(3)(i)(A) through (D) of this section. The design of the final cover system must be included in the written closure plan.]

The final modified composite cap system will consist of a flexible geomembrane that will have a permeability that is less than or equal to the permeability of the natural subsoils and is no greater than 1 x 10^{-5} cm/sec. In addition to the minimum requirements for the closure plan set by the CCR rule 257.102(b), the Texas Commission on Environmental Quality (TCEQ) guidelines state that the closure plan will include two (2) feet of compacted clay cap with a hydraulic conductivity no greater than 1x10^{-7} cm/sec be placed below the geomembrane layer. Over the geomembrane will be installed a installed a geocomposite material and an infiltration layer consisting of 18” of earthen material and an erosion layer consisting of 6” of earthen material that is capable of sustaining native plant growth. The final cover will be seeded and mulched to promote growth of a vegetative cover. The final cover slope will be a minimum of 2% and will convey water to a TPDES permitted outfall.

The final engineered turf cap system will consists of 1.5 feet of intermediate soil cover over the final graded CCR material with a 50 Mil LLDPE Micro-Spike geomembrane cover. Over the geomembrane will be installed an Agru – Engineered Turf Material that will be covered with 2-inches of sand ballast infill material. The final cover slopes will be a minimum of 2% and will convey water to a TPDES permitted outfall.

The final cover slopes will be a minimum of 2% and will convey water to a TPDES permitted outfall. The final cover slope will also be a minimum of 2% to accommodate settling and subsidence.

5.0 ESTIMATE OF MAXIMUM CCR VOLUME 257.102 (b)(1)(iv)

[An estimate of the maximum inventory of CCR ever on-site over the active life of the CCR unit.]

The estimated maximum CCR volume on-site is 18,500,000 Cubic Yards of CCR material for the Landfill Area.

6.0 ESTIMATE OF LARGEST AREA OF CCR REQUIRING COVER 257.102 (b)(1)(v)

[An estimate of the largest area of CCR unit ever requiring a final cover

The largest area of the CCR unit requiring a final cover is 17 acres for the Landfill Area.

7.0 CLOSURE SCHEDULE 257.102(b)(1)(vi)

[A schedule for completing all activities necessary to satisfy the closure criteria in the section, including an estimate of the year in which all closure activities for the CCR unit will be completed. The schedule should provide sufficient information to describe the sequential steps that will be taken to close the CCR unit, including identification of major milestones such as coordinating with and obtaining necessary approvals and permits from other agencies, the dewatering and stabilization phases of the CCR surface impoundment closure, or installation of the final cover system, and the estimated timeframes to complete each step or phase of the CCR unit closure.

At this time, the facility will close once it reaches final grades. The Pirkey Plant will cease coal-fired generation at the end of March 2023. Closure of the other CCR units at the power plant must completed before the landfill initiates final closure. Once final closure of the landfill commences, the work will be completed within six months as per the CCR Rule 257.102.

ATTACHMENT 6
Post Closure Plans

30 TAC §352.301 – Closure and Post-Closure Care Application Submittal

EBAP – Post-Closure Care Plan- NA (closure by removal)

WBAP – Post-Closure Care Plan- NA (closure by removal)

FGDSA – Post-Closure Care Plan- NA (closure by removal)

Landfill – Post-Closure Care Plan

6.1 – Post Closure Plan, East Bottom Ash Pond, November 2021

POST CLOSURE PLAN
CFR 257.104(d)
PIRKEY POWER PLANT
EAST BOTTOM ASH POND

The Written Closure Plan for the subject pond was revised in November 2020. The CCR surface impoundment will be closed by removal in accordance with CFR 257.102(c) – Closure by Removal. As such, a Post Closure Plan is not required for the facility as noted in CFR 257.104(a)(2).

The initial Post Closure Plan prepared in 2016 is no longer valid.

I certify to the best of my knowledge, information, and belief that the information contained above meets the requirements of 40 CFR § 257.104.

Gary F. Zych

Gary F. Zych, P.E.
Manger – Geotechnical Engineering Section
American Electric Power Service Corporation

STATE OF TEXAS
GARY F. ZYCH
127152
LICENSED
PROFESSIONAL ENGINEER

11/30/2021

6.2 – Post Closure Plan, West Bottom Ash Pond, November 2021

POST CLOSURE PLAN
CFR 257.104(d)
PIRKEY POWER PLANT
WEST BOTTOM ASH POND

The Written Closure Plan for the subject pond was revised in November 2020. The CCR surface impoundment will be closed by removal in accordance with CFR 257.102(c) – Closure by Removal. As such, a Post Closure Plan is not required for the facility as noted in CFR 257.104(a)(2).

The initial Post Closure Plan prepared in 2016 is no longer valid.

I certify to the best of my knowledge, information, and belief that the information contained above meets the requirements of 40 CFR § 257.104.

Gary F. Zych

STATE OF TEXAS
GARY F. ZYCH
127152
LICENSED
PROFESSIONAL ENGINEER

11/30/2021

Gary F. Zych, P.E.
Manger – Geotechnical Engineering Section
American Electric Power Service Corporation

6.3 – Post Closure Plan, Landfill, October 2016

POST CLOSURE PLAN

CFR 257.104(d)

Landfill

Pirkey Plant
Hallsville, Texas

October, 2016

Prepared for : Southwest Electric Power Company – Pirkey Power Plant

Hallsville, Texas

Prepared by: American Electric Power Service Corporation

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GERS – 16 – 099

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PIRKEY PLANT
LANDFILL

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I certify to the best of my knowledge, information, and belief that the information contained in this post closure plan meets the requirements of 40 CFR § 257.104

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1.0 OBJECTIVE

This report was prepared by AEP- Geotechnical Engineering Services (GES) section to fulfill requirements of CFR 257.104(d) for Post Closure Plans of CCR units.

2.0 DESCRIPTION OF THE CCR IMPOUNDMENT

The Henry W. Pirkey Power Station is located at 2400 FM 3251 and south of Hallsville, Texas.
It is owned and operated by Southwest Electric Power Company (SWEPCO). The facility operates a landfill for the disposal of CCR materials.

The Pirkey Landfill is a Class 2, Industrial Solid Waste Facility per the Texas Commission on Environmental Quality, Industrial Solid Waste Management Technical Guideline No. 3.

3.0 DESCRIPTION OF POST CLOSURE PLAN 257.104(d)(1)(i)

[A description of the monitoring and maintenance activities required in paragraph (b) of this section for the CCR unit, and the frequency at which these activities will be performed.]

3.1 SECTION 257.104(b)(1)

[Maintaining the integrity and effectiveness of the final cover system including making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover.]

Inspections are performed for the items noted below. The inspection frequencies are scheduled to properly detect any issues so that repairs can be performed before significant harm occurs.

- Embankment: The entire waste embankment, including top surface and side-slopes, will be inspected for slides, settlement, subsidence, displacement, and cover condition (see below).
- Soil Dike: The soil dike will be inspected for slides, displacement, seepage, and erosion.
- Cover: The final cover will be inspected for erosion and for the condition of the vegetated cover, i.e., gaps in vegetation or presence of undesirable trees or brush. The integrity of the cover drainage system will also be inspected.
- Final Cover Surface: The Final Cover surface will be inspected for any ponding of water or flat areas. Due to the design contours required to achieve the final cap grade, special attention will be focused to ensure that no settlement, subsidence, erosion, depressions or flat areas exist and that no water is allowed to pond above the cap system.
- Surface Drainage System: The surface drainage system, including channels, culverts, slope drains, etc., will be inspected for erosion, integrity of channel lining, ponding, and accumulated sediment.
- Leachate Collection Piping: The discharge pipes of the Leachate Collection System at the Leachate Collection Pond will be inspected for clogging or damage. Other exposed portions of the Leachate Collection System including cleanouts will be inspected for damage. Similarly, the Leachate Collection Pond will be inspected for general damage to the pond and perimeter berms, and for accumulation of sediment in the pond.

Maintenance during the post-closure care period will be performed as discussed below, based upon the facility inspections described above.

- Erosion Damage Repair: Any areas exhibiting erosion will be repaired by replacing and compacting the material in-kind to design grade/specifications, and reseeding the area to the specifications. Applications of additional fertilizer, selective herbicides, rodent control measures, etc. will be implemented as necessary. In the selection of fertilizers and herbicides, ensure their use will not impact the groundwater negatively. Follow-up monitoring of the repaired area will be conducted to ascertain the integrity of the repair.
- Settlement, Subsidence, Displacement: Any areas at the closed site exhibiting evidence of settlement, subsidence, or displacement will be examined to determine the cause of the movement. If backfilling or placing additional fill material is needed to maintain the integrity of the closed structure, it will be performed in accordance with the site/closure specifications, including seeding. If the condition reoccurs or persists, or if the severity of the condition initially is judged to warrant it, a detailed investigation of the cause will be performed and remedial action will be performed. Similarly, any areas of the soil dike exhibiting sliding, displacement, or seepage will be investigated. Repairs will be made as necessary. Follow-up monitoring of the area will be performed to ascertain that the problem has been corrected.
- Closure Cap Surface: Any areas that show signs of ponding water or flat contours will be examined and rectified. Due to the design contours required to achieve the final cap grade, special attention will be focused on the cap surface to ensure that any areas that hold water are re-graded to promote drainage, re-seeded to promote vegetative growth, and maintained to ensure that the ponding of water does not persist.
- Surface Water Drainage System: The channel linings are designed to withstand the design velocities. Maintenance of the surface water drainage system will consist of removing sediment and/or undesirable vegetation from the surface water runoff control system (channels and culverts) as required. Eroded areas will be repaired by back-filling and reseeding according to the specifications. Damage to culverts will be repaired; structure replacement will be performed if needed.
- Leachate Collection System: Maintenance of the leachate collection system, collection sump, and leachate pumps will consist of repairing and/or replacing in-kind any damaged or eroded portions of the system and pond, cleaning pipes, and removing leachate and sediment from the collection sump and the Leachate Collection Pond, as needed.

3.1 SECTION 257.104(b)(3)

[Maintaining the groundwater monitoring system and monitoring the groundwater in accordance with the requirements of §257.90 through 257.98.]

The groundwater monitoring system will be inspected for the general integrity of the wells, well casings and well protective casings. Any damaged portions of the monitoring wells and/or their protective casings will be replaced in-kind.

Monitoring the groundwater will be in accordance with the groundwater monitoring plan for this facility and in accordance with the requirements of §§257.90 through 257.98.

4.0 POST-CLOSURE CONTACT 257.104 (d)(1)(ii)

[The name, address, telephone number and email address of the person or office to contact about the facility during the post-closure care period.]

The name, address, and telephone number of the person to contact about the Facility during the post closure period shall be provided upon notice of closure.

5.0 POST-CLOSURE PLANNED USE 257.104 (d)(1)(iii)

[A description of the planned uses of the property during the post-closure period. Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other component of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in this subpart…]

The post-closure use of the property will be undisturbed vacant land space. The only activities occurring on the closed CCR unit will be related to the Post-Closure care activities. All other activities will be prohibited.

ATTACHMENT 7

Post-Closure Care Cost Estimate for Landfill

PIRKEY PLANT - LANDFILL
POST CLOSURE CARE ESTIMATE - ANNUAL MONITORING & MAINTENANCE Revised GES 11/23/2021
Post Closure Care Period: 30 years

	Area (Acres)
Total Landfill Area Constructed: 154 ac	157
Composite Cap with Vegetaion Cover:	100
Closure Turf Cap with Engineered Turf Cover:	57

			Value	Unit	Unit Price	Cost	
1.0 Ground Water Monitoring:							
1.1 Total Number of Monitoring Wells			7	Each			
1.2 Total Number of Samples per Year	frequency of sampling	2	14	EA/YR			
1.3 Cost of Sampling				$	$475	$6,650	
1.4 Laboratory testing of samples				$	$350	$4,900	
1.5 Statistical review and reporting		2			$2,500	$5,000	
Total Costs for Ground Water Monitoring				**$**		**$16,550**	
2.0 Leachate Monitoring							
2.1 Total Number of Samples per year	quarterly sampling		4	EA/YR			
2.2 Unit Cost per Sample				$/EA	$1,000		
Total Costs for Leachate Monitoring	**not required**			**$**		**$4,000**	
3.0 Surface Water Monitoring							
3.1 Total Number of Samples per year	collected with Leachate monitoring		2	EA/YR			
3.2 Unit Cost per Sample				$/EA	$1,000		
3.3 Total Monitoring Costs				$		**$2,000**	
4.0 O&M of Leachate Collection and Treatment System							
4.1 Inspection & Flushing of Collection and Conveyance Pipes	annual flushing	crew $2000/day	5	days	$2,000	$10,000	
4.2 Inspection & Cleaning of Sumps/Manholes	annual visual inspection		0	LS			
4.3 Repair/Replacement of Sump and Conveyance Piping				LS			
4.4 Amount of Leachate Generated from HELP Model				Gallons/YR			
4.5 Leachate Disposal Cost	assume no disposal cost			$/Gallon			
4.6 Total Annual Leachate Disposal Cost				$			
4.7 Annual Pump Electricity Costs				$/YR/pump			
Total Costs for O&M Leachate System				**$**		**$10,000**	**only every other year**
5.0 O&M Ground Water Monitoring Wells							
5.1 Inspection & Maintenance:	part of sample collection time		2	Each	$1,000	$2,000	
5.2 Repair of Monitoring Wells			0	Each	$2,500	$0	
Total Costs for Ground Water Monitoring Wells						**$2,000**	
6.0 Maintenance of Cover System:							
6.1 Mowing Frequency per Year			2	Each			
6.2 Unit Cost per mowing				$/ac	$50		
6.3 Total Mowing Costs:				$		$15,700	
6.4 Area to be Reseeded:	1% of seeded cap area		0	SY			
6.5 Reseeding Unit Costs:				$/SY	$0.50		
6.6 Total Reseeding Costs:				$		$0	
6.7 Cap Repairs per Year	24 hrs/yr @ $500/hr		24	HR			
6.8 Cap Repair Unit Costs				$/SY	$500.00		
6.9 Total Cap Repair Costs:				$		$12,000	
6.10 Annual Sand Infill of Closure Turf Material			405	$/ton	$50.00	$20,250	
Total Costs for Maintenance of Cover System:	other maintenance in 4.0			$		**$47,950**	
7.0 O&M of Surface Water Management System							
7.1 Inspection & Routine Maintenance	Included in 5.0 above		4	Each	$0	$0	
7.2 Conveyance Ditch/Piping Cleaning & Repair	part of maintenance above		0	LS	$15,000	$0	
7.3 Outlet Cleaning & Repair			0	LS	$1,000	$0	
Total Costs for O&M of Surface Water System				$		**$0**	
8.0 O&M of Access Control Structures:							
8.1 Inspection & Routine Maintenance	Included in 5.0 above		4	Each	$0	$0	
8.2 Fence, Gate & Sign Repair	no fencing at project		0	LS	$1,000	$0	
8.3 Roadway Maintenance	part of maintenance above		0	LS	$2,000	$0	
Total Costs for O&M of Access Control Structures				$		**$0**	
9.0 Vector and Rodent Control:							
9.1 Vector and Rodent Control	part of maintenance above		1	LS/Year	$0	**$0**	
10.0 Inspections:							
10.1 Annual engineering Inspections	based on current contracts		1	Each/YR	$20,000	$20,000	
10.2 Benchmark Inspection	Included in 10.1 above		1	Each/YR	$0	$0	
10.3 Security Inspections	Included in 10.1 above		4	Each/YR	$0	$0	
Total Costs for Inspections						**$20,000**	
	part of sampling and maintenance.						
11.0 Final Closure							
11.1 Mobilization/Demobilization			1	LS	$0	$0	
11.2 Engineering Fees & Reports			1	LS	$0	$0	
11.3 Survey & Deed Notation			1	LS	$0	$0	
11.4 Closure Certification			1	LS	$0	$0	
Total Costs for Final Closure						**$0**	
TOTAL ANNUAL POST CLOSURE CARE COSTS:						**$102,500**	
Non-annual Post Closure Care Costs:							
Replacement of Groundwater Monitoring Wells			0	Each	$15,000	$0	
Total Costs for Non-annual Post Closure Costs:						$0	
TOTAL POST CLOSURE CARE DIRECT COSTS: (30 years)						$3,075,000	
TOTAL POST CLOSURE LANDFILL MONITORING & MAINTENANCE COSTS						$3,075,000	