

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
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, P.E.
Director, Land Environment & Remediation Services
Environmental Services Division

Attachments

cc: Kirsten Hillyer – USEPA
Frank Behan – USEPA
Richard Huggins – USEPA

BOUNDLESS ENERGY

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

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.

SATISFACTION 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.

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.
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.

NATIVE 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/ccrule/>.

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.

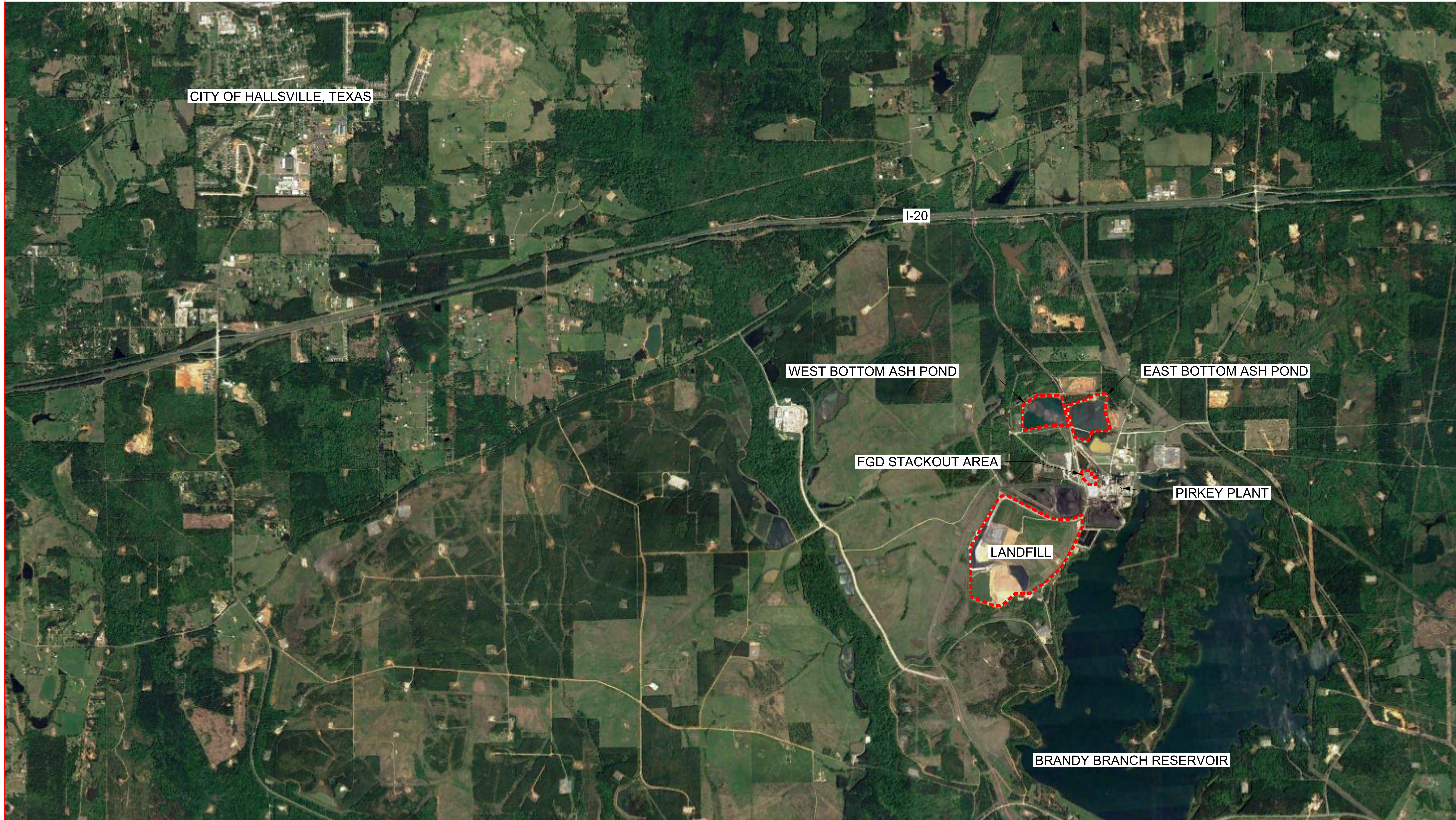
Table below summarizes the major tasks, durations and milestone dates associated with closing the EBAP and WBAP.

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



CITY OF HALLSVILLE, TEXAS

I-20

WEST BOTTOM ASH POND

EAST BOTTOM ASH POND

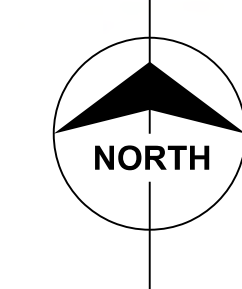
FGD STACKOUT AREA

PIRKEY PLANT

LANDFILL

BRANDY BRANCH RESERVOIR

Scale For Microfitting
Inches
Meters



0 1225' 2450'
SCALE IN FEET

Figure 1

PRELIMINARY - NOT FOR CONSTRUCTION

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

----- LIMITS OF CCR UNIT

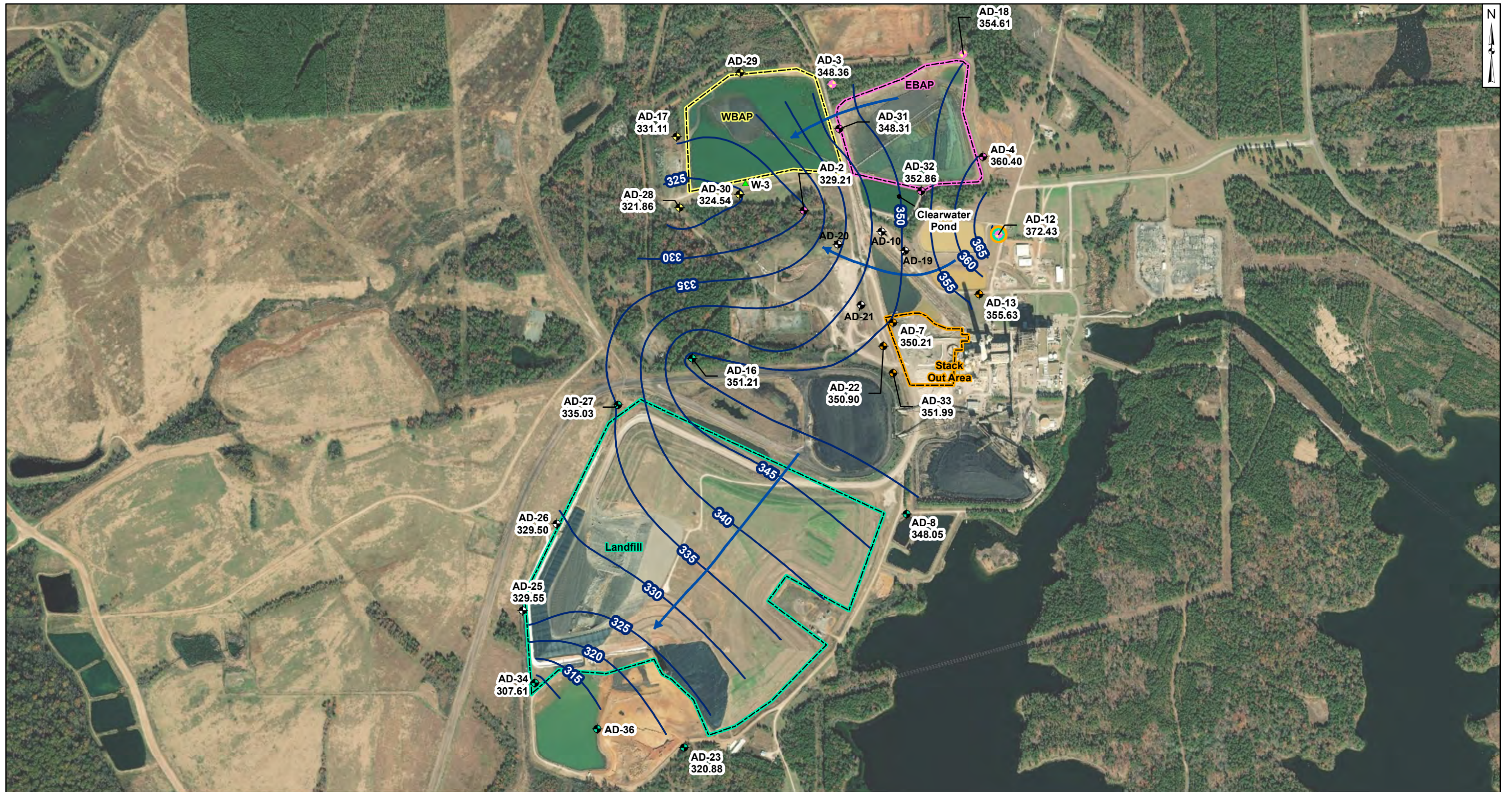
BURNS & MCDONNELL
 9400 WARD PARKWAY
 KANSAS CITY, MO 64114
 816-333-9400
 Burns & McDonnell Engineering Company, Inc.
 Firm Reg. No. F-845

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

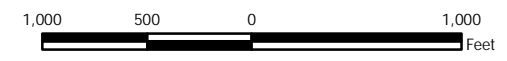
project	120792	contract	
drawing	SK - C501	rev.	A
sheet	of	sheets	
file 120792SK-C501.DGN			



- 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.



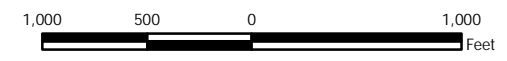
Potentiometric Contours - Uppermost Aquifer February 2019	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2020/01/16
Figure 2	



- 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.



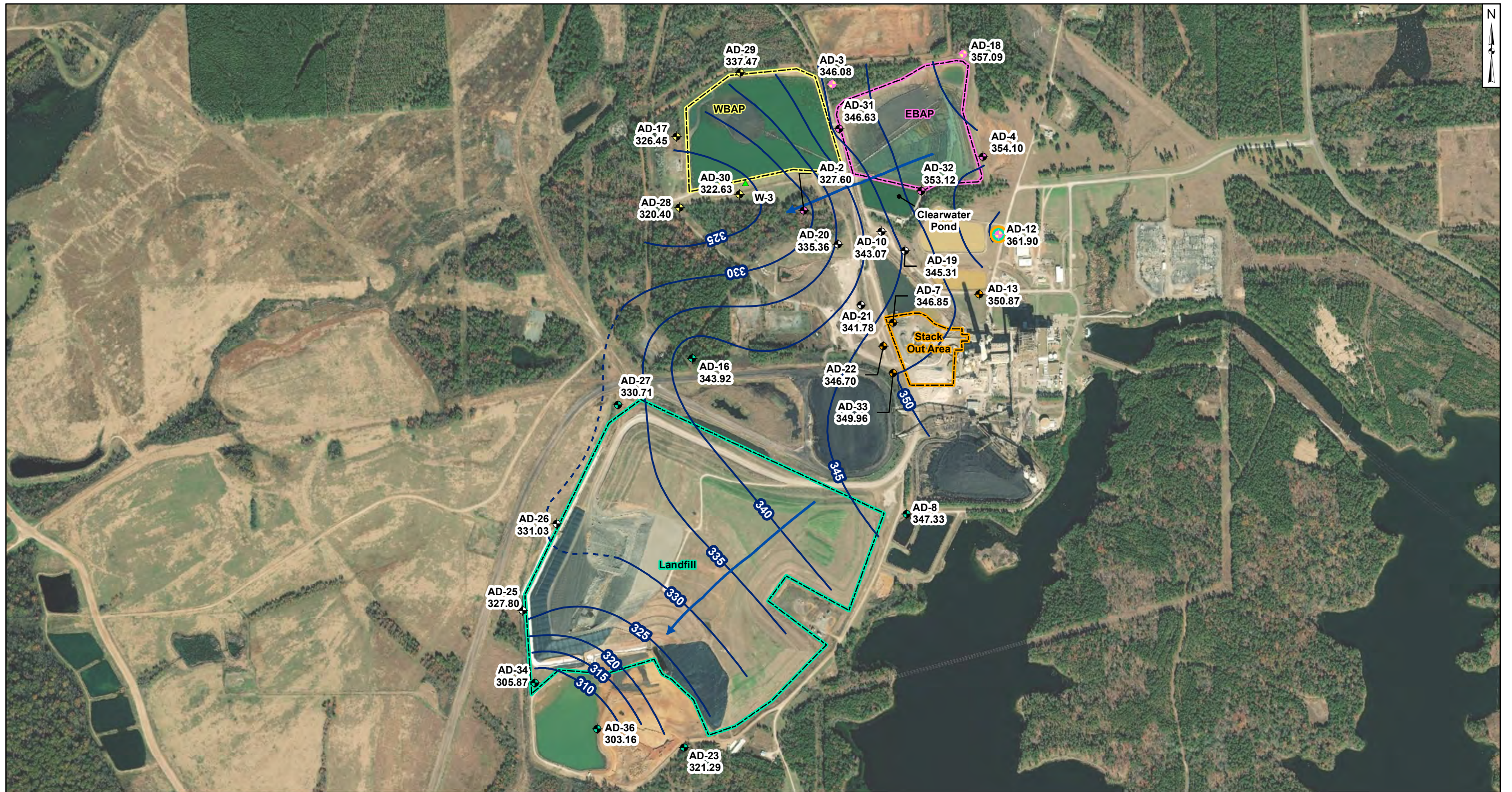
Potentiometric Contours - Uppermost Aquifer
May 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
3

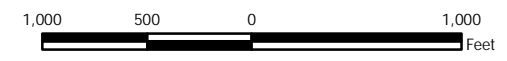
Columbus, Ohio 2020/01/16



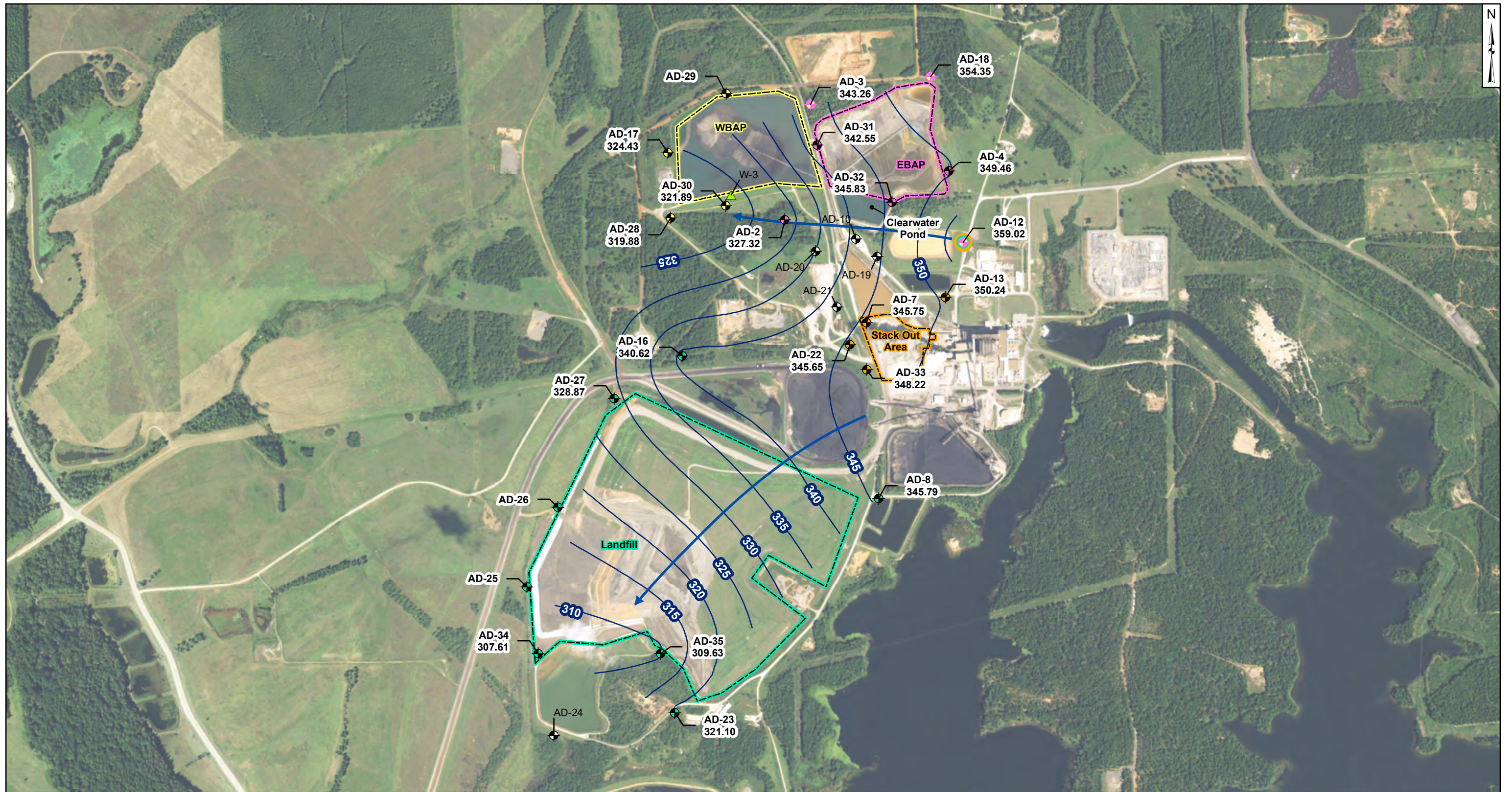
- Legend
- Groundwater Monitoring Wells**
- Out of Network
 - EBAP
 - WBAP
 - Landfill
 - Stackout Area
 - EBAP and WBAP
 - All CCR Unit Networks
 - Piezometer
 - Approximate Groundwater Flow Direction
 - Groundwater Elevation Contour
 - Groundwater Elevation Contour (Inferred)

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.



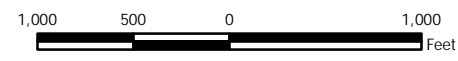
Potentiometric Contours - Uppermost Aquifer August 2019	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2020/01/16
Figure 4	



Legend	
Groundwater Monitoring Wells	All CCR Unit Networks
Out of Network	Piezometer
EBAP	Groundwater Elevation Contour
WBAP	Approximate Groundwater Flow Direction
Landfill	
Stack Out Area	
EBAP and WBAP	

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

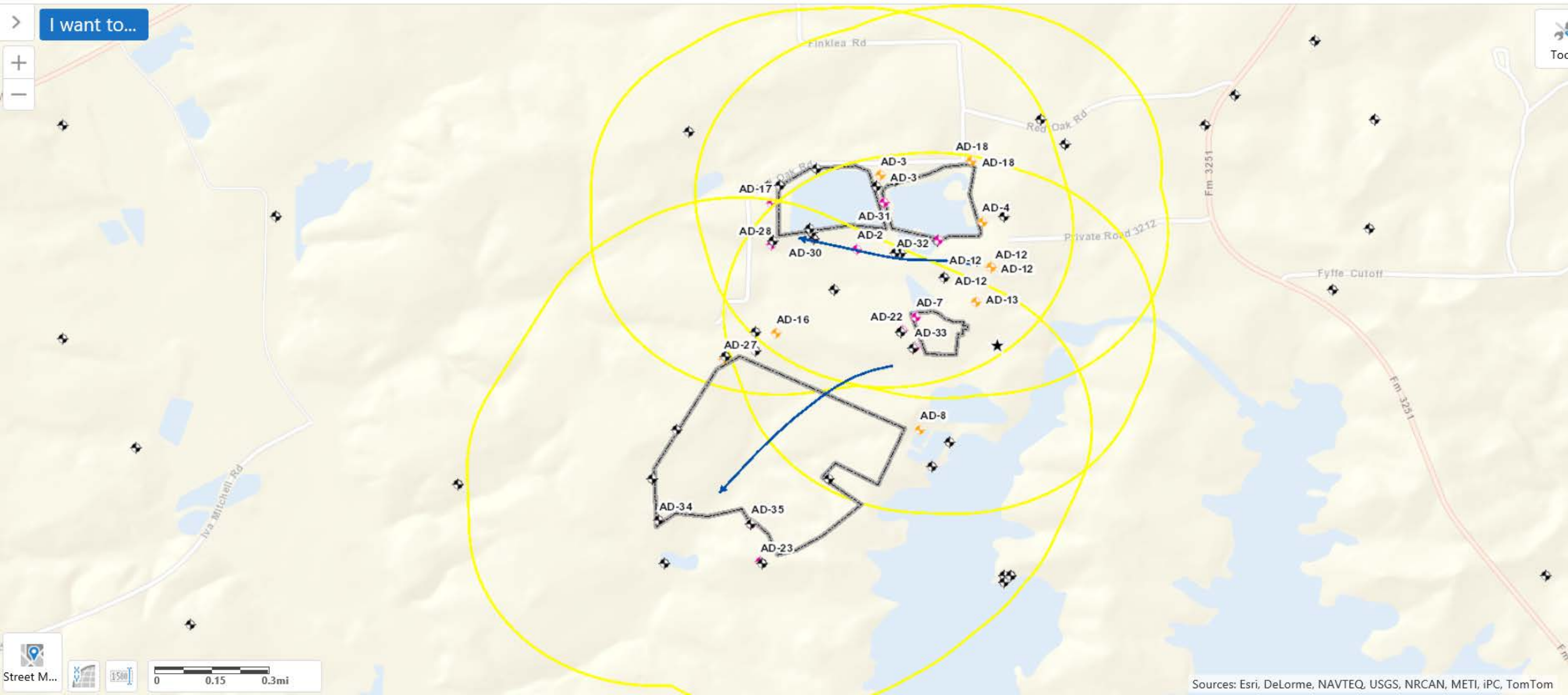
Geosyntec
consultants

Figure

5

Columbus, Ohio

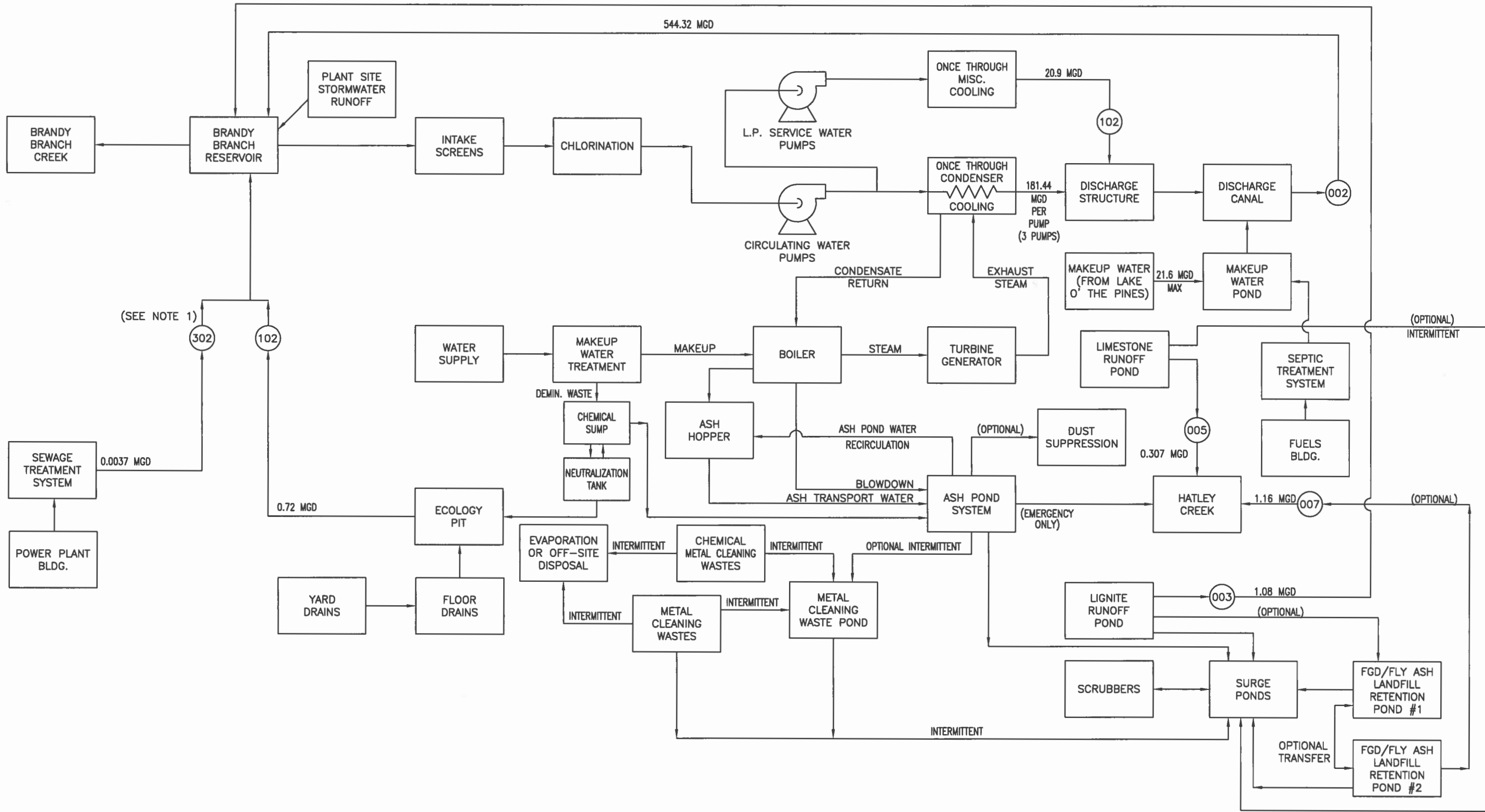
2017/12/13



Appendix **A**

Existing Water Balance

A B C D E F G H



4	ISSUED FOR REVISION		
PRELIMINARY - REFERENCE ONLY			
DATE	NO.	DESCRIPTION	APPD.
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
CIVIL ENGINEERING		
SCALE:	APPROVED BY:	
DR:	DATE: SEE REV 0	
CH:	AMERICAN ELECTRIC POWER	
SUP:	AEP SERVICE CORP.	
ENG:	1 RIVERSIDE PLAZA	
DATE: SEE REV 0	COLUMBUS, OH 43215	

A B C D E F G H

PLOT DATE: 02/04/00 11:00 AM
 PLOT TIME: 00:00:00
 BY: 11/11/00

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



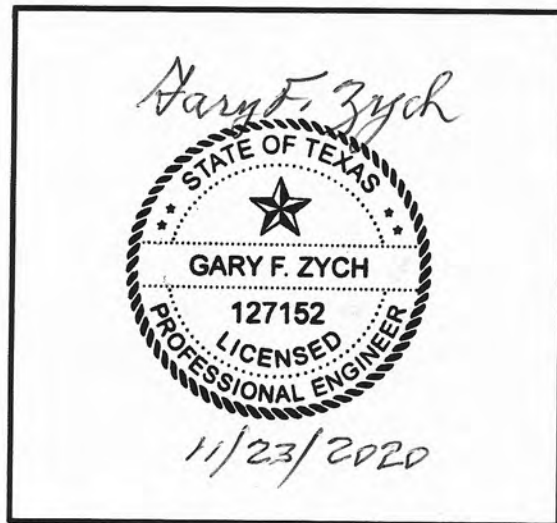
GERS – 20 –012

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



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)

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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



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

**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

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Figure 10	Proposed Monitoring Well Network Map – East Bottom Ash Pond

Appendices

A	Boring/Well Construction Logs
B	Photographic Log

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, E TTL Engineers & Consultants (E TTL) 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 E TTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (E TTL, 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 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 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

Kent J Brandner

Signature



69586

Registration No.

Texas

Registration State

5-25-16

Date



5. References

AMEC, "Report of Dam Safety Assessment of Coal Combustion Surface Impoundments, American Electric Power (AEP) and Southwest Electric Power Company (SWEPCO) H.W. Pirkey Power Plant, Hallsville, TX", August 2011.

Apex Geoscience Inc., "USWAG Monitoring Wells and Groundwater Evaluation, AEP Pirkey Power Station, Hallsville, Texas", March 2011.

Auckland Consulting LLC, "Monitoring Well Installation – 2015, Pirkey Generating Station, Hallsville, Texas", January 26, 2016.

Banks Information Solutions, "Water Well Report, Pirkey Power Plant, 2400 FM 3251, Hallsville, Texas, Harrison County", October 8, 2015.

Broom, M.E., and B. N. Myers, "Ground-Water Resources of Harrison County, Texas", Texas Water Development Board Report 27, August 1966.

ETTL Engineers & Consultants Inc., "Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas", October 2010.

Fetter, C.W., "Applied Hydrogeology", University of Wisconsin – Oshkosh, 1980.

Flawn, Peter T., "Geologic Atlas of Texas, Tyler Sheet", The University of Texas at Austin Bureau of Economic Geology, March 1965.

George, Peter G., et. al., "Aquifers of Texas", Texas Water Development Board Report 380, July 2011.

Johnson & Pace Incorporated, "Hydrology & Hydraulic Report, North Surge Pond, East & West Ash Ponds, Secondary Ash Pond, Landfill Pond, H.W. Pirkey Power Plant, Hallsville, Texas", May 2011.

Johnson & Pace Incorporated, "East Bottom Ash Pond June 2011 As-Built Plan & Profile, H.W. Pirkey Power Plant, Hallsville, Texas", June 2011.

Sargent & Lundy, "Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities", January 31, 1983.

Sargent & Lundy, "Henry W. Pirkey Power Plant Unit 1, Wastewater Ponds – Liner Verification & Monitoring Wells", September 14, 1984.



Southwestern Laboratories, "Subsurface Exploration, Waste Water Ponds, Pirkey Power Plant, Hallsville, Texas", September 7, 1984.

Texas Commission on Environmental Quality, "Groundwater Classification, RG-366/TRRP-8", March 2010.

USGS, Aquifers and Groundwater. 2015. Available online at www.usgs.gov.

USGS, "Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin", Open-File Report 88-450K, 1988.

USGS, "Texas Seismic Hazard Map", 2014.



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) Source: 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) Source: EETL (October 2010).
(d) Source: Auckland 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	Existing/ 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	Existing	Uppermost Water-Bearing Unit	East of East Bottom Ash Pond	Upgradient	337.7	317.7	20	Existing well installed in 1983; well will be utilized to establish background water quality
AD-12	Existing	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilized to establish background water quality
AD-18	Existing	Uppermost Water-Bearing Unit	East of East Bottom Ash Pond	Upgradient	345.5	335.5	10	Existing well installed in 2011; well will be utilized to establish background 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	Existing	Uppermost Water-Bearing Unit	Northwest of East Bottom Ash Pond	Side gradient	335.8	315.8	20	Existing well installed in 2011; and utilized to obtain water level data for uppermost water-bearing unit

Footnotes:

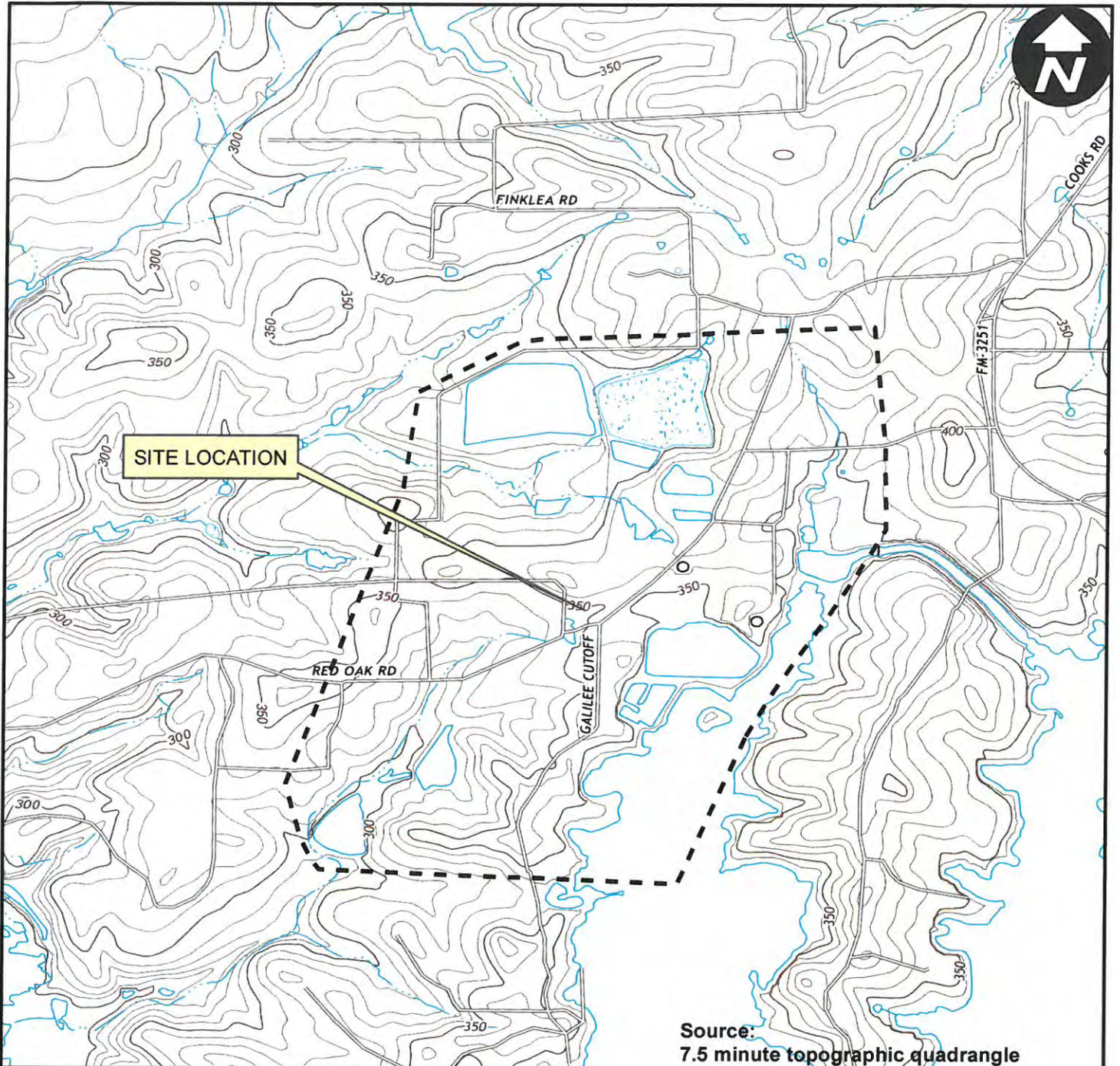
a. Target elevations are an estimated range.

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

Roger Lake



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

SITE LOCATION MAP



FIGURE

1

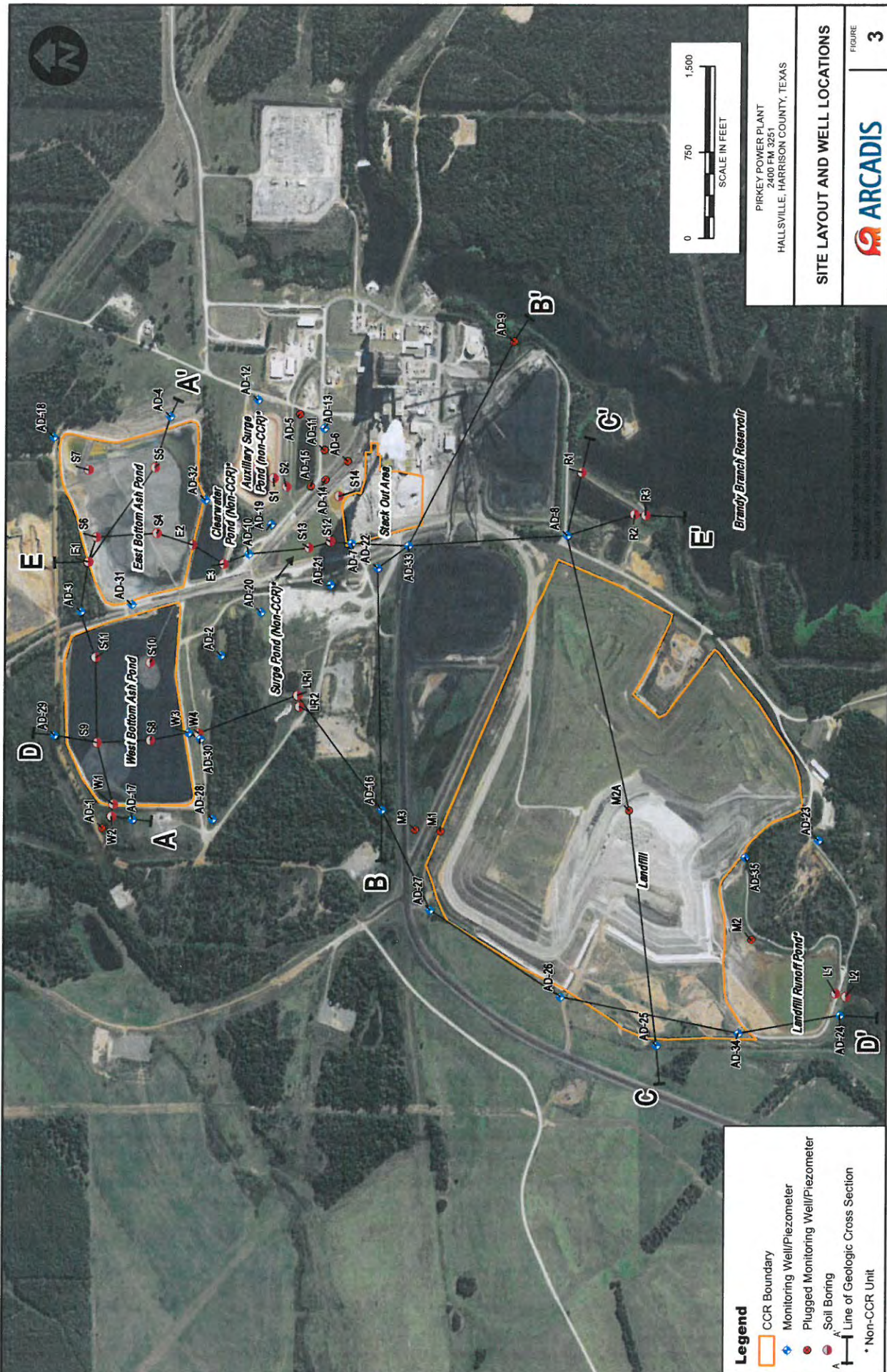


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNR/Airphoto, USDA, USDA, Aerial, Earthstar, etc. All rights reserved. No warranty is made by the copyright holder for any use not intended by the copyright holder.

PIRKEY POWER PLANT 2400 FM 3251 HALLSVILLE, HARRISON COUNTY, TEXAS	
PLANT AND CCR UNIT LOCATION MAP	
	FIGURE 2

Legend

- Coal Combustion Residual (CCR) Unit



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

SITE LAYOUT AND WELL LOCATIONS

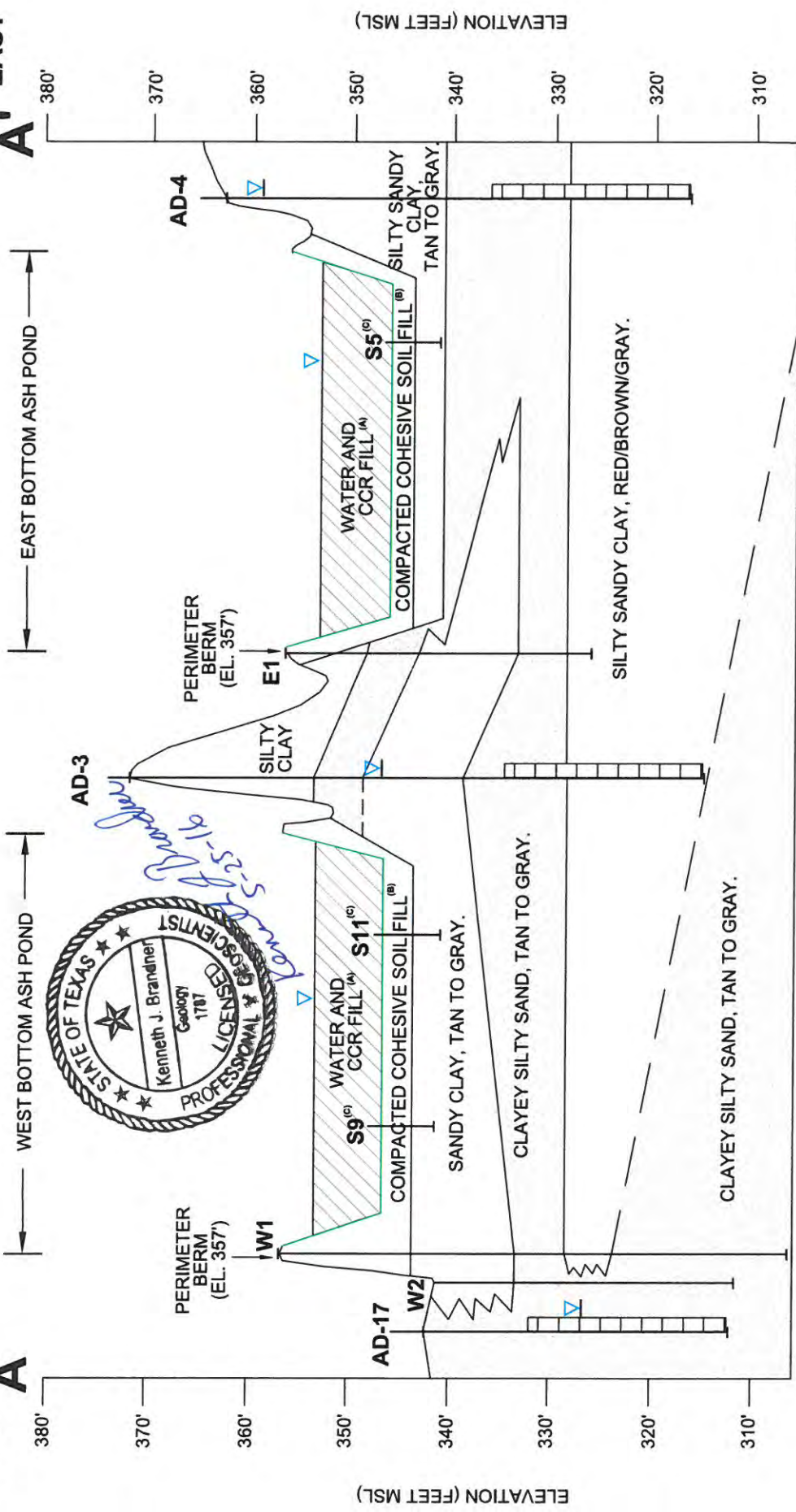
FIGURE **3**

Legend

- CCR Boundary
- Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- Line of Geologic Cross Section
- * Non-CCR Unit

WEST
A

EAST
A'



Ken Brandner
5-25-16

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) SOIL BORING 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984) AND SOIL BORING 344' TO 347' (SARGENT & LUNDY, AUGUST 2011).
- C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.



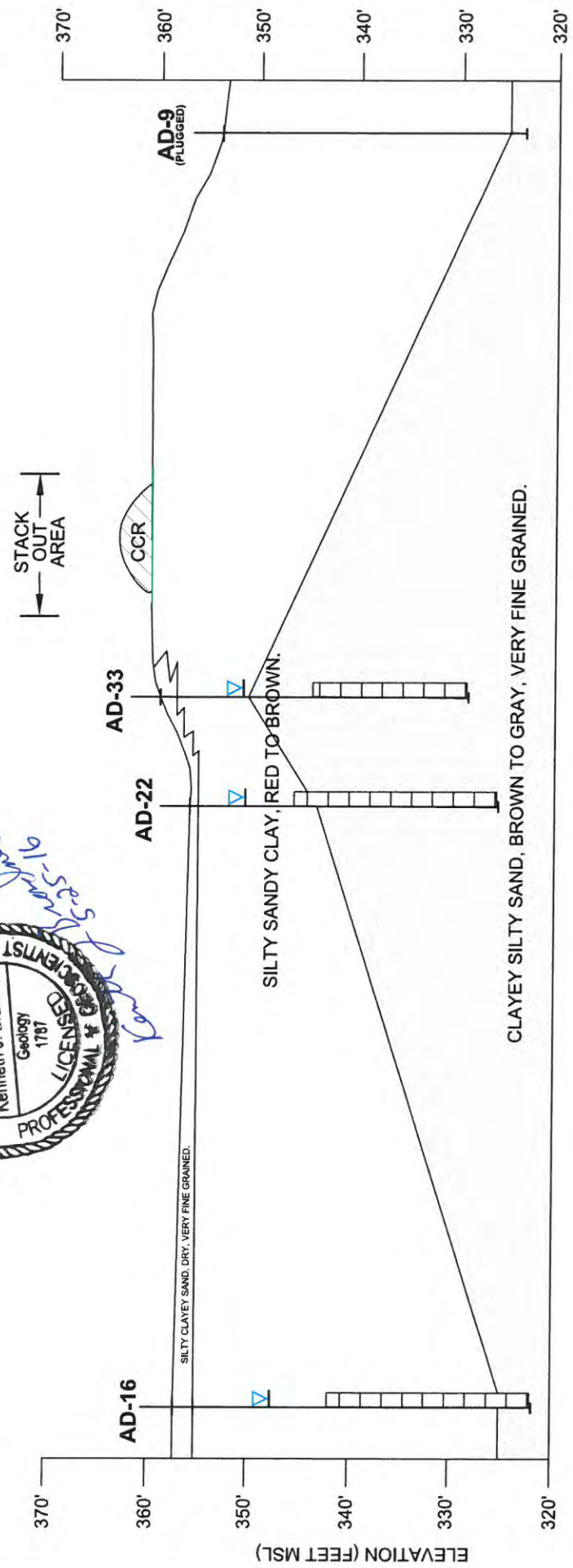
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

**CROSS SECTION
A - A'**

FIGURE
4

**WEST
B**

**EAST
B'**



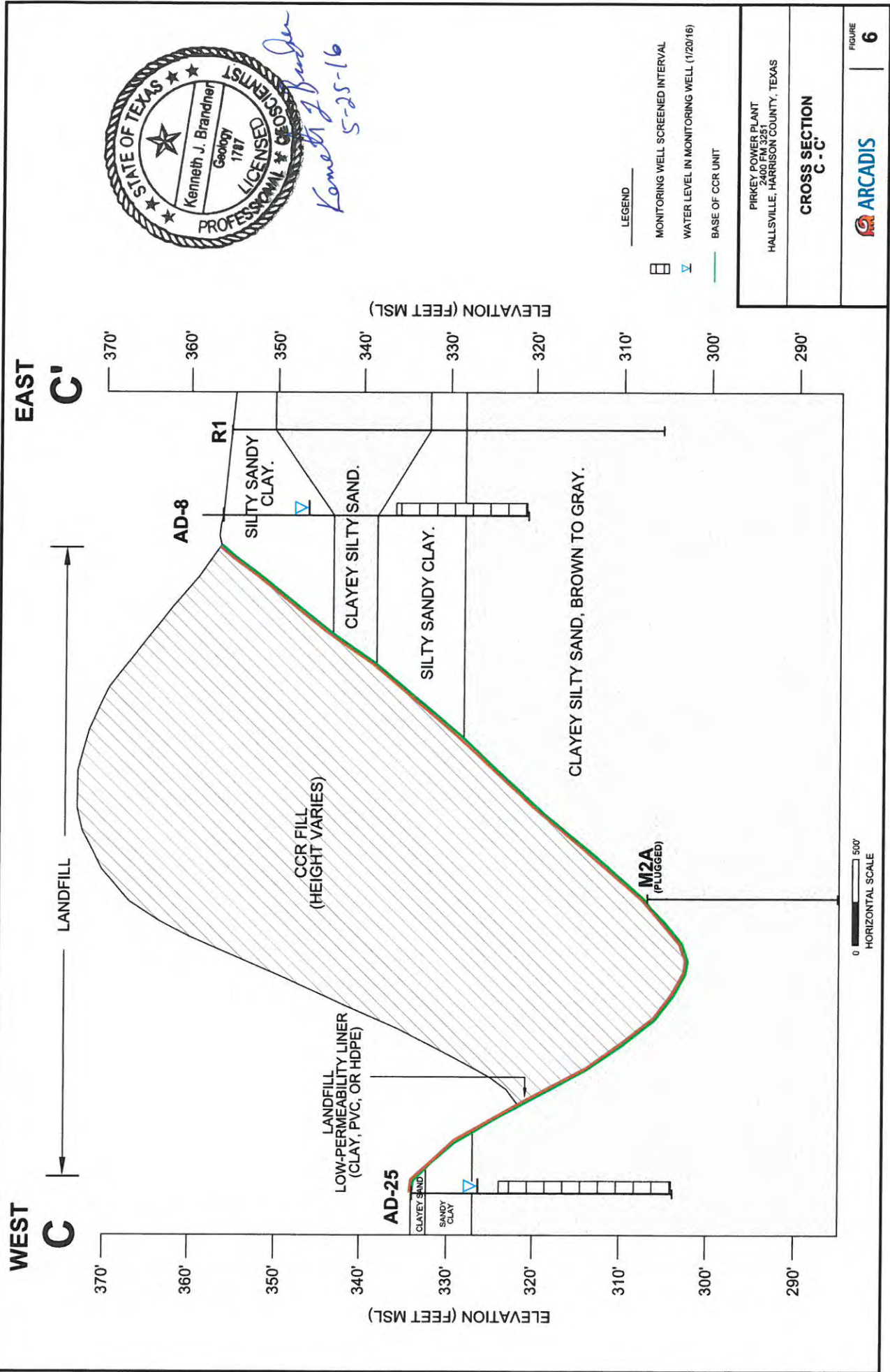
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

**CROSS SECTION
B - B'**

FIGURE
5

- 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.





CITY: DALLAS; DATE: 08/10/16; DRAWN BY: J. BRANDNER; CHECKED BY: K. HARRIS; PROJECT: PIRKEY POWER PLANT CCR FILL ASSESSMENT; SHEET: 6 OF 6; SCALE: AS SHOWN; TITLED: 2/22/2016 11:18 AM BY: J. BRANDNER; PLOTTED: 2/22/2016 11:18 AM BY: J. BRANDNER; PROJECT: PIRKEY POWER PLANT CCR FILL ASSESSMENT; SHEET: 6 OF 6; SCALE: AS SHOWN; TITLED: 2/22/2016 11:18 AM BY: J. BRANDNER; PLOTTED: 2/22/2016 11:18 AM BY: J. BRANDNER



Kenneth J. Brandner
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

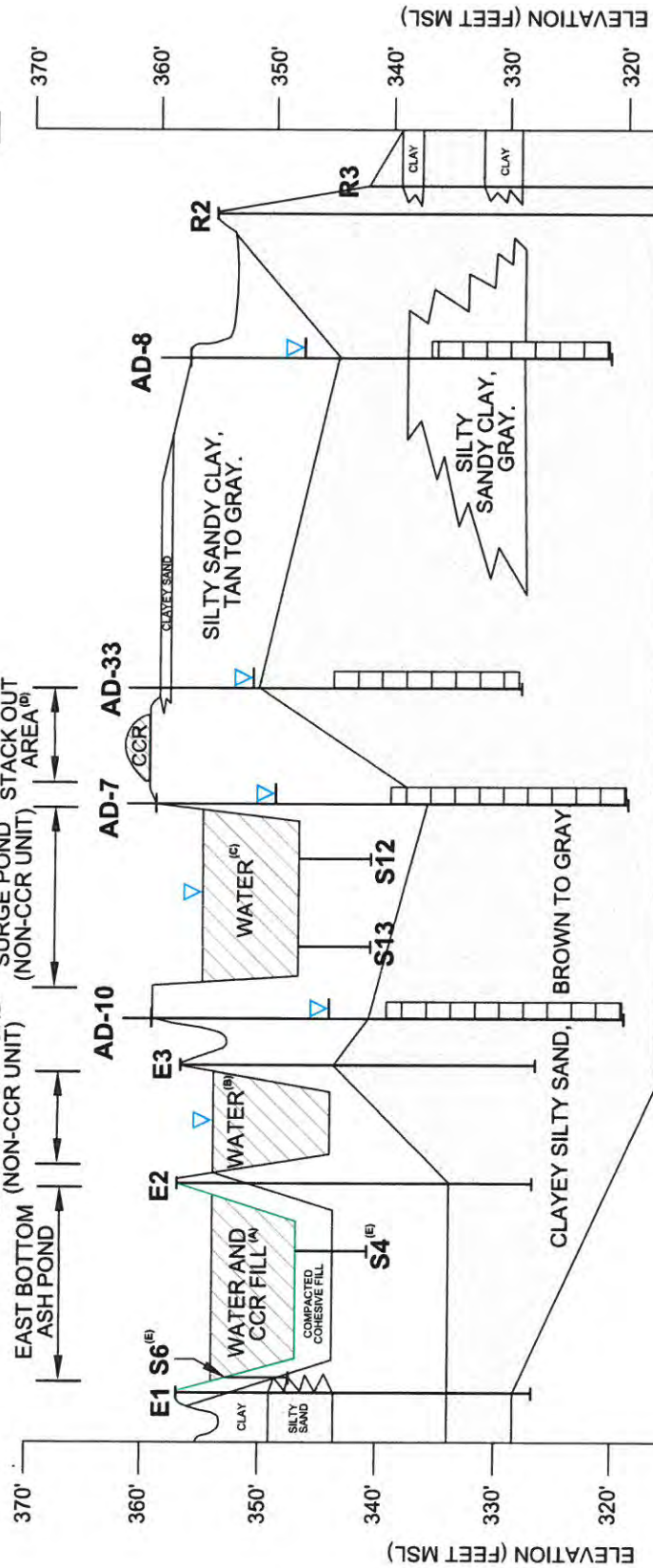
**CROSS SECTION
C - C'**

ARCADIS

FIGURE **6**

NORTH
E

SOUTH
E



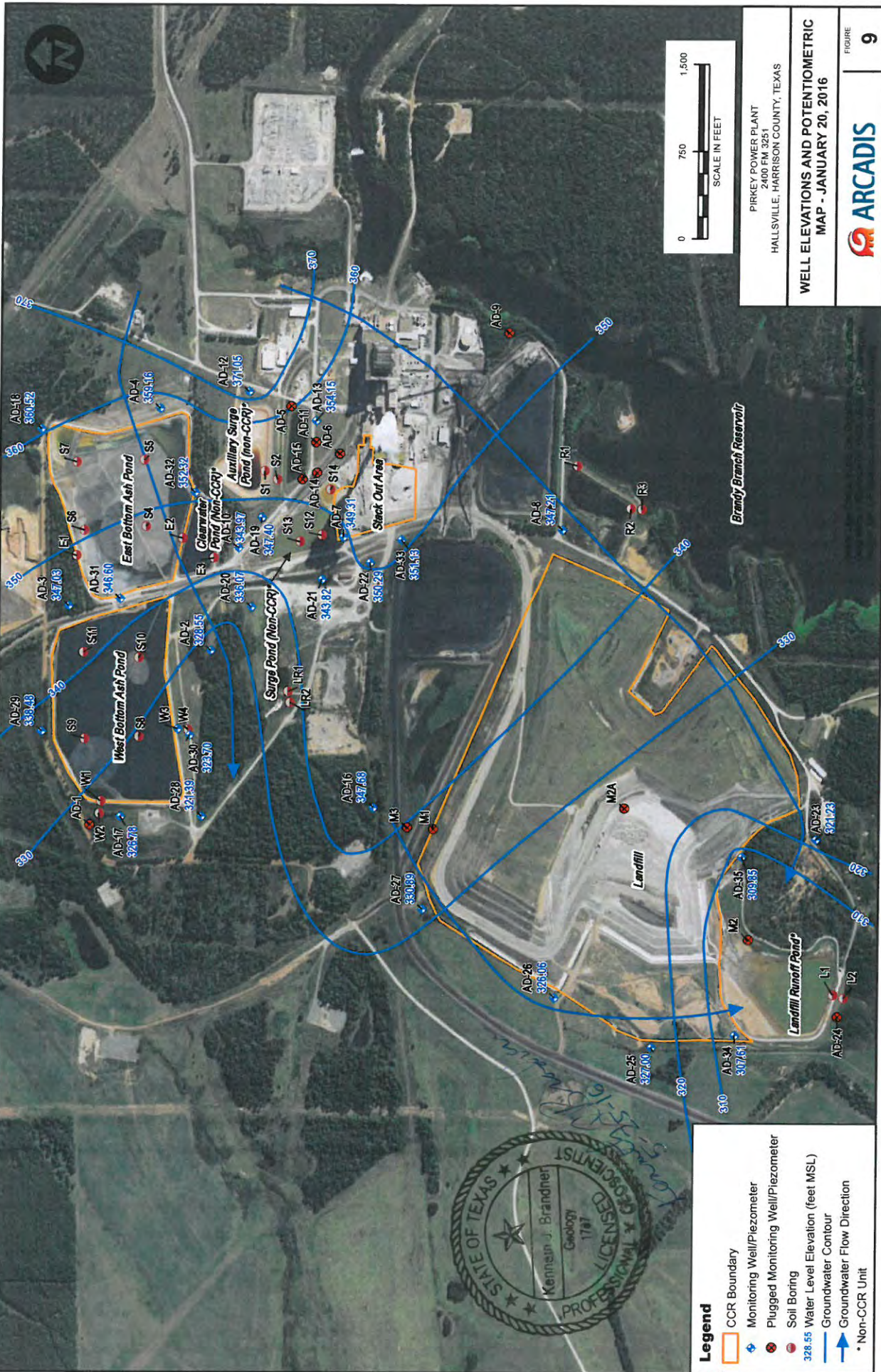
SANDY CLAY, TAN TO GRAY.
SILTY SAND, GRAY.



- NOTES:
- TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357.0 FEET MSL. (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 354.0 FEET MSL. (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF CLEARWATER POND PERIMETER BERM ELEVATION IS 344.0 FEET MSL. (SARGENT & LUNDY, JANUARY 1983).
 - TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 354.0 FEET MSL. (SARGENT & LUNDY, JANUARY 1983).
 - BASE ELEVATION OF SURGE POND (347.352MSL) AND POND DESIGN LEVEL (353MSL) TAKEN FROM JANUARY 31, 1983 SARGENT & LUNDY REPORT.
 - BASE OF STACK OUT AREA IS 345.0 FEET MSL. (SARGENT & LUNDY, JANUARY 1983).
 - BASE OF STACK OUT AREA IS 345.0 FEET MSL. (SARGENT & LUNDY, JANUARY 1983).
 - 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



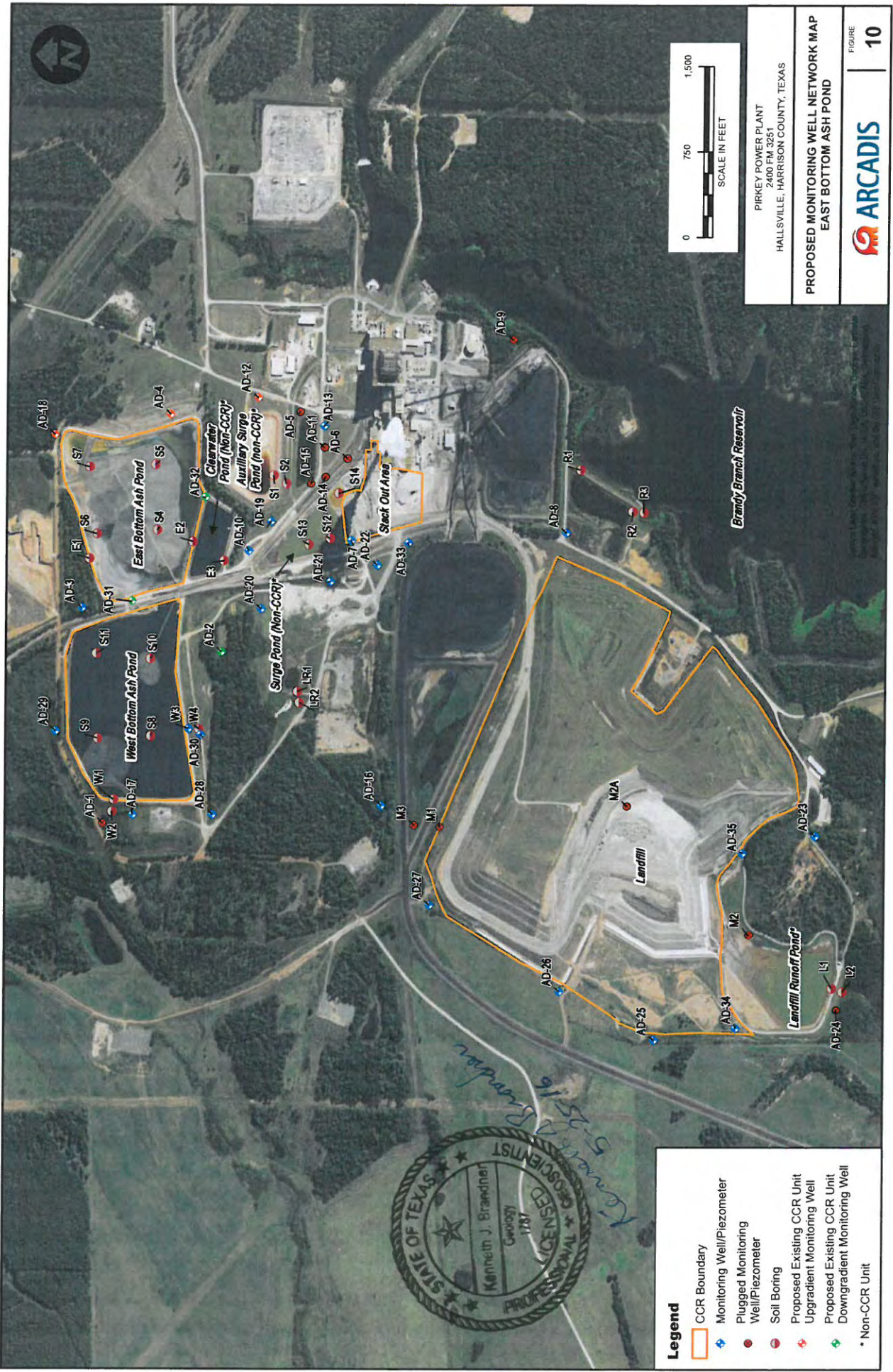
PIRKEY POWER PLANT
 2400 FM 3251
 HALLSVILLE, HARRISON COUNTY, TEXAS

**WELL ELEVATIONS AND POTENTIOMETRIC
 MAP - JANUARY 20, 2016**

ARCADIS

FIGURE
9

- 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

**PROPOSED MONITORING WELL NETWORK MAP
 EAST BOTTOM ASH POND**

ARCADIS

FIGURE
10

- 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





Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

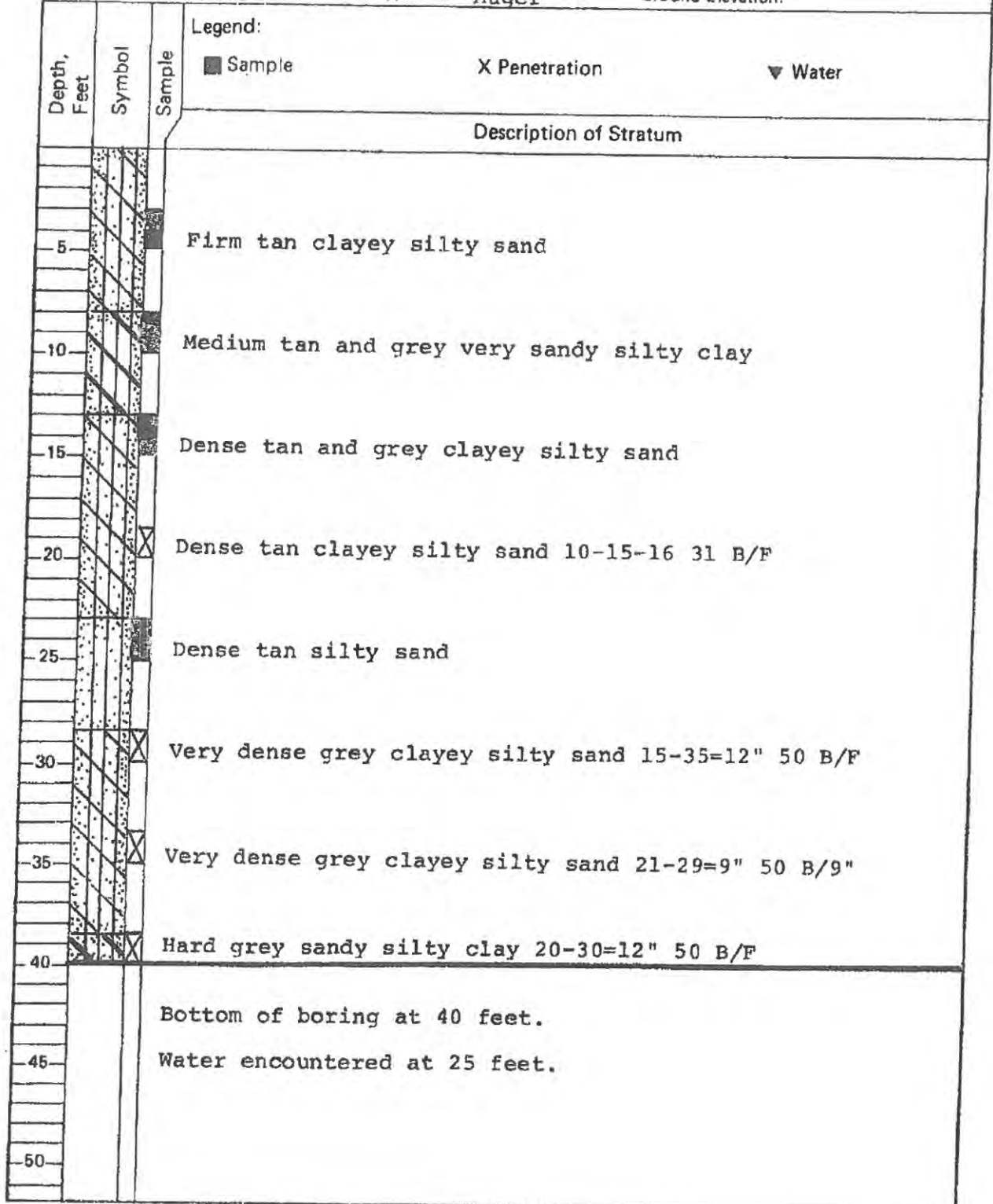
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-2
LOCATION: Hallsville

Date: 10-7-83

Type: Auger

Ground Elevation:



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					
5					Stiff red, brown and grey sandy silty clay
10					Stiff red, tan and grey silty clay lenses w/iron ore
15					Stiff brown and grey sandy silty clay
20					Firm brown and grey sand w/clay lenses
25					Stiff brown and grey clay
30					Stiff brown and grey clay w/silt lenses
35					Firm grey clayey silty sand
45			X		Hard grey clay w/silty sand lenses 43-7=6" 50 B/F
50			X		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:

Depth, Feet	Symbol	Sample	Legend:
			 Sample X Penetration ▼ Water
			Description of Stratum
55	X		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

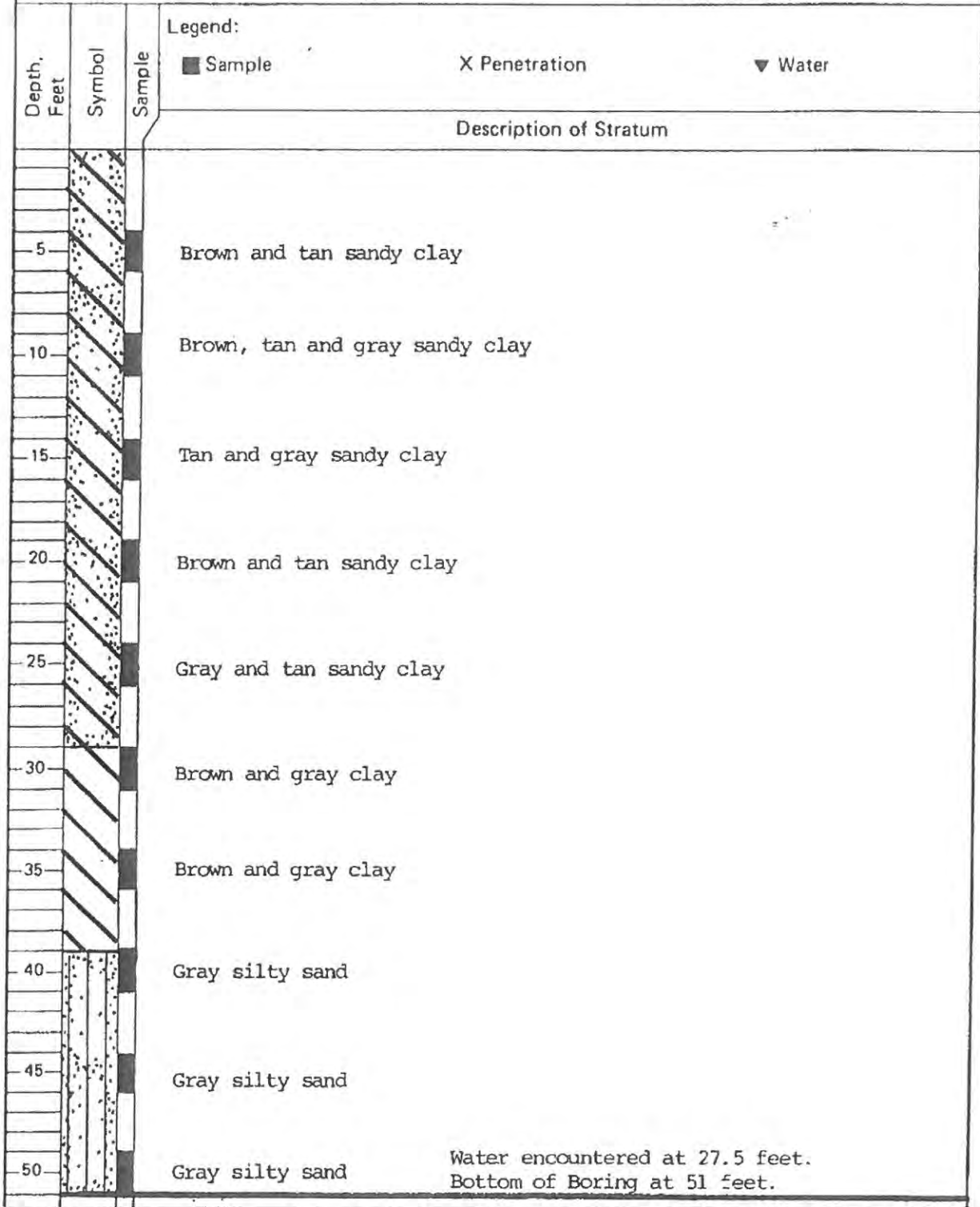
Ground Elevation:

Depth, Feet	Symbol	Sample	Legend:
			<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  Sample </div> <div style="text-align: center;">  X Penetration </div> <div style="text-align: center;">  Water </div> </div>
Description of Stratum			
5			Stiff tan and grey silty sandy clay w/iron ore
10			Very stiff tan and grey clay
15			Very stiff tan and grey clay w/iron ore seam
20			Stiff tan and grey silty sandy clay lenses
25			Firm grey silty sand
30		X	Very dense grey silty sand 30-20=12" 50 B/F
35		X	Hard grey silty sandy clay 30-20=8" 50 B/8"
40		X	Hard grey silty sandy clay 25-25=8" 50 B/8"
45		X	Hard grey silty sandy clay 25-25=10½" 50 B/10½"
50			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
 Date: 1/30/86 Type: Rotary N 6+13.25; W-6+90.36
 Ground Elevation: 378.41



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-stern 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

LATITUDE: 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				7-16	CL	Clay, some sand, light gray, reddish gray, stiff, yellowish brown -iron oxide fracture at 9.5'	None	Dry
3								
4								
5								
6								
7								
8				7-16	CL	Clay, some sand, light gray, reddish gray, stiff, yellowish brown -iron oxide fracture at 9.5'	None	Dry
9								
10								
11								
12								
13								
14								
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 Saturated
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
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 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.



Monitor Well

Monitor Well No.: AD-31



PROJECT INFORMATION	DRILLING INFORMATION
PROJECT: Pirkey Power Plant	DRILLER: Buford Collier
PROJECT NO.: I-04-1021	DRILLER'S LICENSE NO.: 80089
LOGGED BY: Jeffrey D. Sammons, P.G.	RIG TYPE: Geoprobe 3230DT
SUPERVISING PG: Jeffrey D. Sammons, P.G.	METHOD OF DRILLING: Hollow Stem Auger
COMPLETION: 12/08/2015	SAMPLING METHODS: Split Core
DEVELOPMENT: 12/16/2015	SURFACE ELEVATION: 380.76 (Top of Casing)
SITE LOCATION: 2400 FM 3261, Hallsville, Texas	HOLE DIAMETER: 8.25"
WELL OWNER: AEP	LATITUDE 32 28' 2.48" LONGITUDE 94 29' 20.90"

Water Level Upon Installation
 Water Level at Time of Drilling
 Geotechnical Lab Sample
 TBPB No. 50027

DESCRIPTION	USCS	SOIL SYMBOLS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI	WELL CONSTRUCTION
			4 3 2 1 0								Locking Well Casing Cover Locking Well Cap Protective Well Casing Concrete Pad Ground Surface Cement
SANDY CLAY AND GRAVEL: dark reddish brown, moist	CH	1									
FAT CLAY WITH SAND: some laminations of very fine to fine sand, reddish brown and light gray	CH	2			22	81	51	15	36		Bentonite 2" Sch. 40 PVC Riser
FAT CLAY: some silt with trace very fine to fine sand laminations, reddish brown, yellowish brown and light gray	CH	3									
- light gray with laminations of light reddish brown silt and very fine sand at 11'		4									
		5									
		6									20/40 Silica Sand 0.010" Slotted Sch. 40 PVC Well Screen PVC Bottom Cap
		7									
		8									
		9									
		10									
		11									
		12			26	85	68	31	37		
		13									
		14									
		15									
		16									
		17									
		18									
CLAYEY SAND: very fine to fine sand, light reddish brown and light gray, very moist to saturated	SC	19									
		20									
		21			26	44	36	21	15		
		22									
		23									
		24									
		25									
		26									
		27									
		28									
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	SM	28									
		29									
- dark gray and reddish brown at 29', saturated		30									
- trace clay, light brown at 30'		31									
		32			24	5	24	NP			
		33									
		34									
		35									
		36									



Monitor Well

Monitor Well No.: AD-32



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: 12/11/2016
 DEVELOPMENT: 12/16/2016
 SITE LOCATION: 2400 FM 3261, 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: 369.18 (Top of Casing)
 HOLE DIAMETER: 8.25"
 LATITUDE 32 27' 66.20" LONGITUDE 94 29' 11.86"

Water Level Upon Installation Water Level at Time of Drilling Geotechnical Lab Sample TBPQ No. 50027

DESCRIPTION	USCS	SOIL SYMBOLS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI	WELL CONSTRUCTION
			4								Locking Well Casing Cover Locking Well Cap Protective Well Casing Concrete Pad Ground Surface Cement Bentonite 2" Sch. 40 PVC Riser 20/40 Silica Sand 0.010" Slotted Sch. 40 PVC Well Screen PVC Bottom Cap
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		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		
			8								
			9								
			10								
			11								
			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		
			17								
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								
			21								
SANDY LEAN CLAY: gray and dark gray, very moist	CL		22		26	51	37	24	13		
			23								
			24								
			25								
CLAYEY SAND: fine to very fine sand, gray and dark gray, very moist to saturated	SC		26		26	47	41	22	19		
			27								
			28								
			29								
			30								
SANDY LEAN CLAY: gray and dark gray, very moist	CL		31		26	59	35	21	14		
			32								
			33								

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) 890-4421

LOG OF BORING E-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

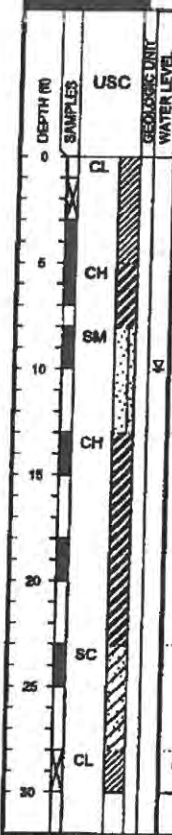
PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE

10/20/09

SURFACE ELEVATION



MATERIAL DESCRIPTION	
CL	SANDY LEAN CLAY (CL) stiff; yellow and gray -very stiff; yellow and white
CH	SANDY FAT CLAY (CH) very stiff; yellow and tan; with ferric joints
SM	SILTY SAND (SM) yellow
CH	FAT CLAY WITH SAND (CH) hard; brown and yellow; with ferric joints; with iron oxides cemented sandstone -very stiff; brownish yellow; with ferric joints
SC	CLAYEY SAND (SC) medium dense; gray
CL	LEAN CLAY (CL) hard; gray

FIELD STRENGTH DATA	BLOW COUNT				DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (ksf)	FAILURE STRAIN (%)	CONFINING PRESSURE (ksf)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)				OTHER TESTS PERFORMED (Page Ref. #)
	Qu (ksf)								Plastic Limit	Moisture Content	Liquid Limit	ATTERBERG LIMITS (%)			MINUS #200 SIEVE (%)	
	1	2	3	4								LL	PL	FI		
N=9	20	40	60	80					24	42	22	20	58	+40 Sieve=6%, +4 Sieve=0%, +40 Sieve=13%, +4 Sieve=1%, +40 Sieve=3%, +4 Sieve=1%, +40 Sieve=19%, +4 Sieve=8%		
P=2.75									25	53	22	31	63			
P=2.75									27				41			
SF																
P=4,5+									24	62	24	38	74			
P=3.75																
N=26																
N=43																

Water Level: Est. Measured Perched

Water Conditions: Seepage @ 10' while drilling.

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

Notes:



**ETTL
ENGINEERS &
CONSULTANTS**

MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(800) 895-4421

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



MATERIAL DESCRIPTION

CL LEAN CLAY (CL) hard; gray and red, with gravel
-very stiff; tan and red

CH SANDY FAT CLAY (CH) stiff; red and tan
-red and gray

CL LEAN CLAY (CL) stiff; red and gray

SM SILTY SAND (SM) very dense; gray, red, and tan; saturated

SC CLAYEY SAND (SC) medium dense; greenish gray

Bottom of Boring @ 30'

FIELD STRENGTH DATA	BLOW COUNT				DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (pcf)	FAILURE STRAIN (%)	CONFINING PRESSURE (pcf)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)				OTHER TESTS PERFORMED (Page Ref. #)
	20	40	60	80					Plastic Limit	Moisture Content	Liquid Limit	LL	PL	PI	MINUS #200 SIEVE (%)	
P=4.5+									18	47	17	30	69	+40 Sieve=14%, +4 Sieve=5%		
P=2.5									21	50	18	34	68	+40 Sieve=5%, +4 Sieve=1%		
P=1.75																
P=2.0																
P=2.25									23	57	18	38	71	+40 Sieve=6%, +4 Sieve=0%		
P=1.5																
N=74																
N=16																

Water Level: Est. Measured Perched
Water Observations: Seepage @ 8' while drilling.

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

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

Depth, Feet	Symbol	Sample	Legend:
			 Sample X Penetration ▼ Water
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			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-5
LOCATION: Hallsville, TX

Date: 9-14-83

Type:

Ground Elevation: 347.1

Depth,
Feet

Symbol

Sample

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.

5

10

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

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.: 5-7
LOCATION: Hallsville, TX

Date: 9-14-83

Type:

Ground Elevation: 346.9

Depth, Feet	Symbol	Sample	Legend:
			 Sample X Penetration ▼ Water

Description of Stratum

			Red, brown and grey silty clay
5	/	/	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.
11			
12			
13			
14			
15			
16			
17			
18			
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20			
21			
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23			
24			
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Appendix B

Photographic Log



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.



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.



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

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.

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.


**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



Kenneth J. Brandner

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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:
AEP

Prepared by:
ARCADIS U.S., Inc.
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Our Ref.:
OH015976.0010

Date:
May 25, 2016

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Figure 10	Proposed Monitoring Well Network Map – West Bottom Ash Pond

Appendices

A	Boring/Well Construction Logs
B	Photographic Log

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, E TTL Engineers & Consultants (E TTL) 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 (E TTL, 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 Sheel*" (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



69586

Registration No.

Texas

Registration State

5-25-16

Date

5. References

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

AMEC, "Report of Dam Safety Assessment of Coal Combustion Surface Impoundments, American Electric Power (AEP) and Southwest Electric Power Company (SWEPCO) H.W. Pirkey Power Plant, Hallsville, TX", August 2011.

Apex Geoscience Inc., "USWAG Monitoring Wells and Groundwater Evaluation, AEP Pirkey Power Station, Hallsville, Texas", March 2011.

Auckland Consulting LLC, "Monitoring Well Installation – 2015, Pirkey Generating Station, Hallsville, Texas", January 26, 2016.

Banks Information Solutions, "Water Well Report, Pirkey Power Plant, 2400 FM 3251, Hallsville, Texas, Harrison County", October 8, 2015.

Broom, M.E., and B. N. Myers, "Ground-Water Resources of Harrison County, Texas", Texas Water Development Board Report 27, August 1966.

ETTL Engineers & Consultants Inc., "Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas", October 2010.

Fetter, C.W., "Applied Hydrogeology", University of Wisconsin – Oshkosh, 1980.

Flawn, Peter T., "Geologic Atlas of Texas, Tyler Sheet", The University of Texas at Austin Bureau of Economic Geology, March 1965.

George, Peter G., et. al., "Aquifers of Texas", Texas Water Development Board Report 380, July 2011.

Johnson & Pace Incorporated, "Hydrology & Hydraulic Report, North Surge Pond, East & West Ash Ponds, Secondary Ash Pond, Landfill Pond, H.W. Pirkey Power Plant, Hallsville, Texas", May 2011.

Sargent & Lundy, "Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities", January 31, 1983.



**West Bottom Ash Pond-
CCR Groundwater
Monitoring Well Network
Evaluation**

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

Sargent & Lundy, "Henry W. Pirkey Power Plant Unit 1, Wastewater Ponds – Liner Verification & Monitoring Wells", September 14, 1984.

Southwestern Laboratories, "Subsurface Exploration, Waste Water Ponds, Pirkey Power Plant, Hallsville, Texas", September 7, 1984.

Texas Commission on Environmental Quality, "Groundwater Classification, RG-366/TRRP-8", March 2010.

USGS, Aquifers and Groundwater. 2015. Available online at www.usgs.gov.

USGS, "Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin", Open-File Report 88-450K, 1988.

USGS, "Texas Seismic Hazard Map", 2014.



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) Source: 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) Source: EETL (October 2010).

(d) Source: Auckland 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	Existing/ 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	Existing	Uppermost Water-Bearing Unit	East of West Bottom Ash Pond	Upgradient	335.8	315.8	20	Existing well installed in 1983; well will be utilized to establish background water quality
AD-12	Existing	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilized to establish background water quality
AD-18	Existing	Uppermost Water-Bearing Unit	East of West Bottom Ash Pond	Upgradient	345.5	335.5	10	Existing well installed in 2011; well will be utilized to establish background 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	Existing	Uppermost Water-Bearing Unit	North of West Bottom Ash Pond	Side gradient	340.2	320.2	20	Existing well installed in 2011; and utilized to obtain water level data for uppermost water-bearing unit

Footnotes:

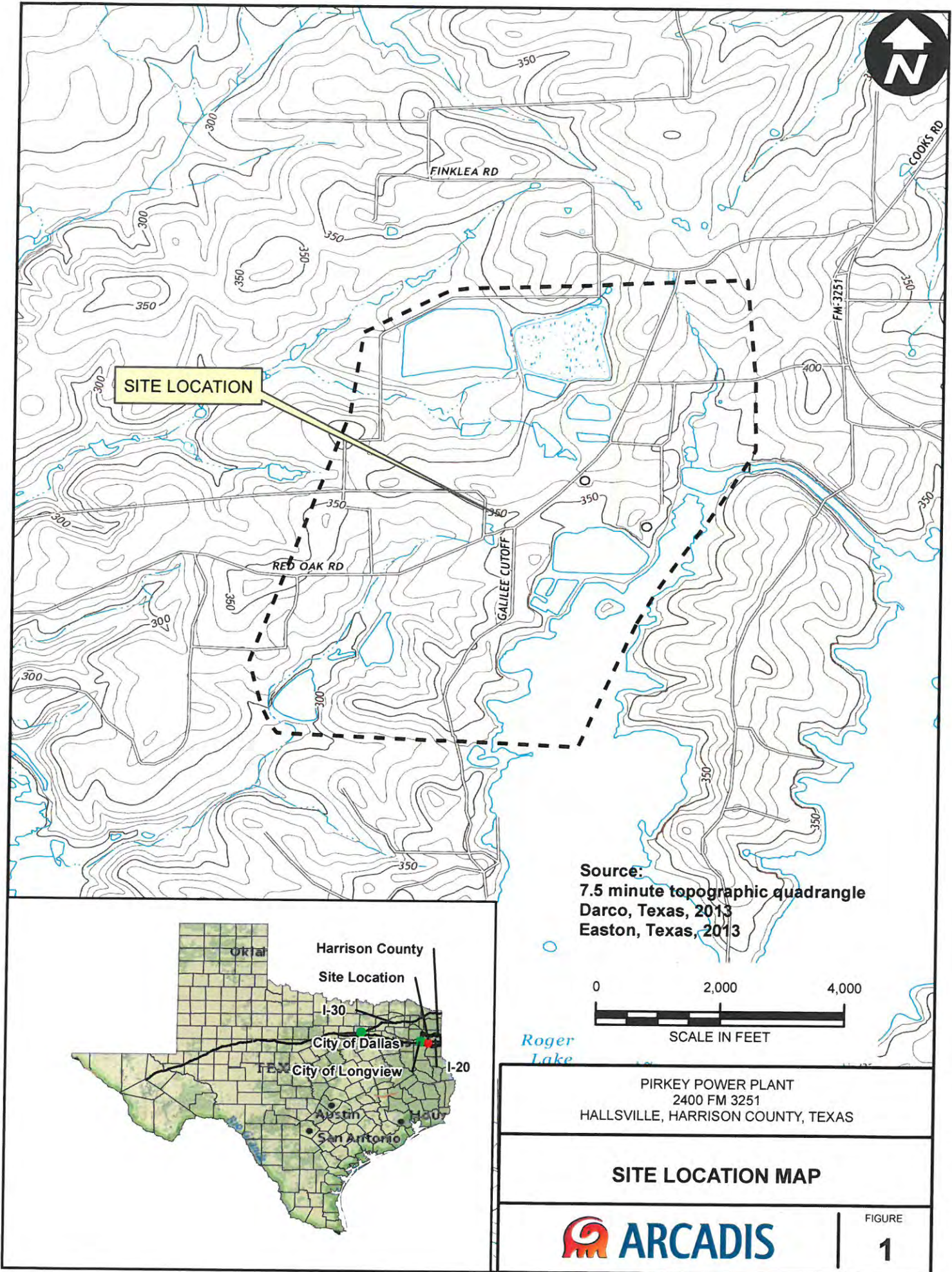
a. Target elevations are an estimated range.

Acronyms and Abbreviations:

U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level




Figures





Legend

-  Coal Combustion Residual (CCR) Unit

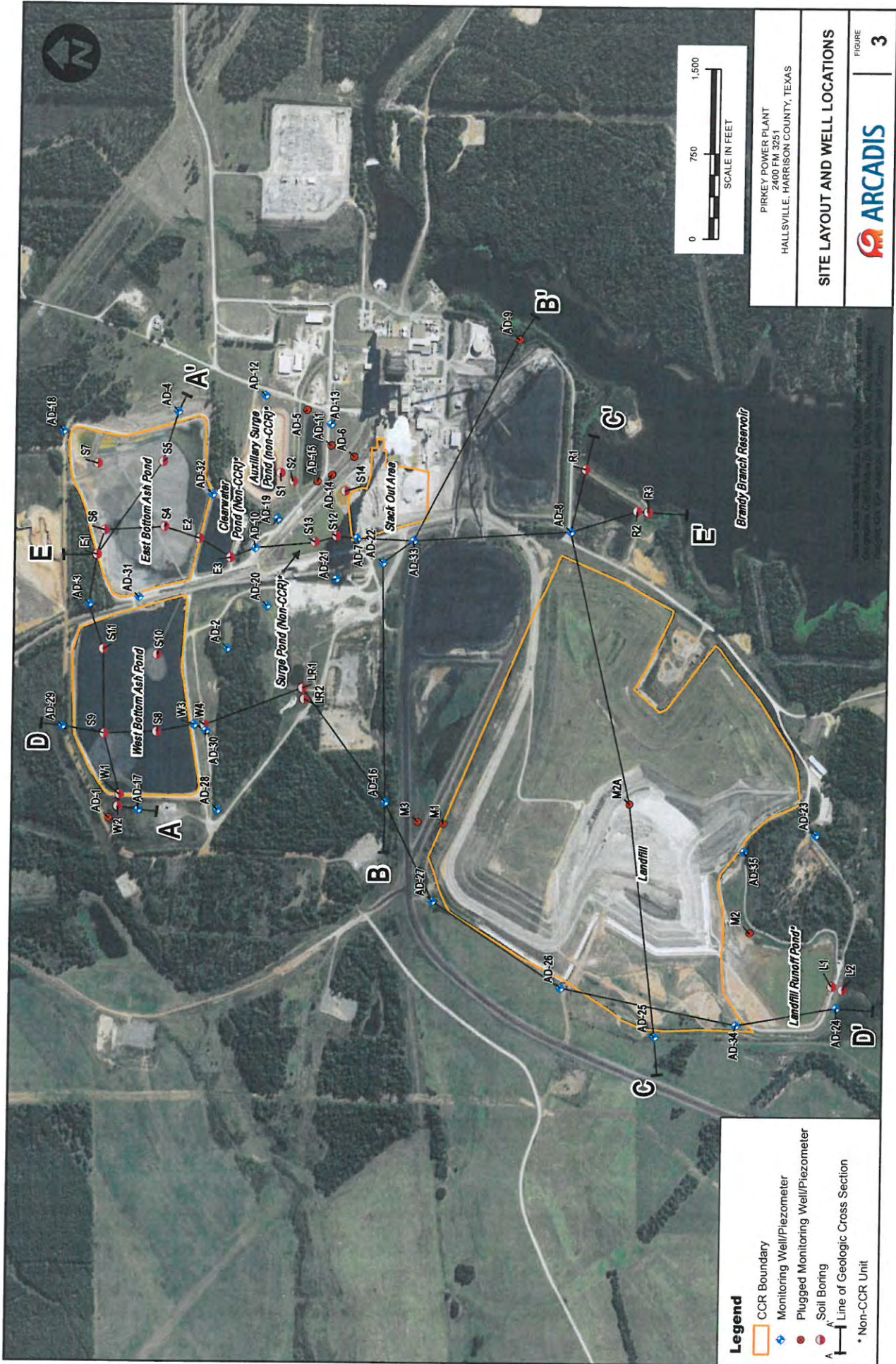
PLANT AND CCR UNIT LOCATION MAP

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

FIGURE
2

 **ARCADIS**

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



Legend

- CCR Boundary
- Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- Line of Geologic Cross Section
- * Non-CCR Unit



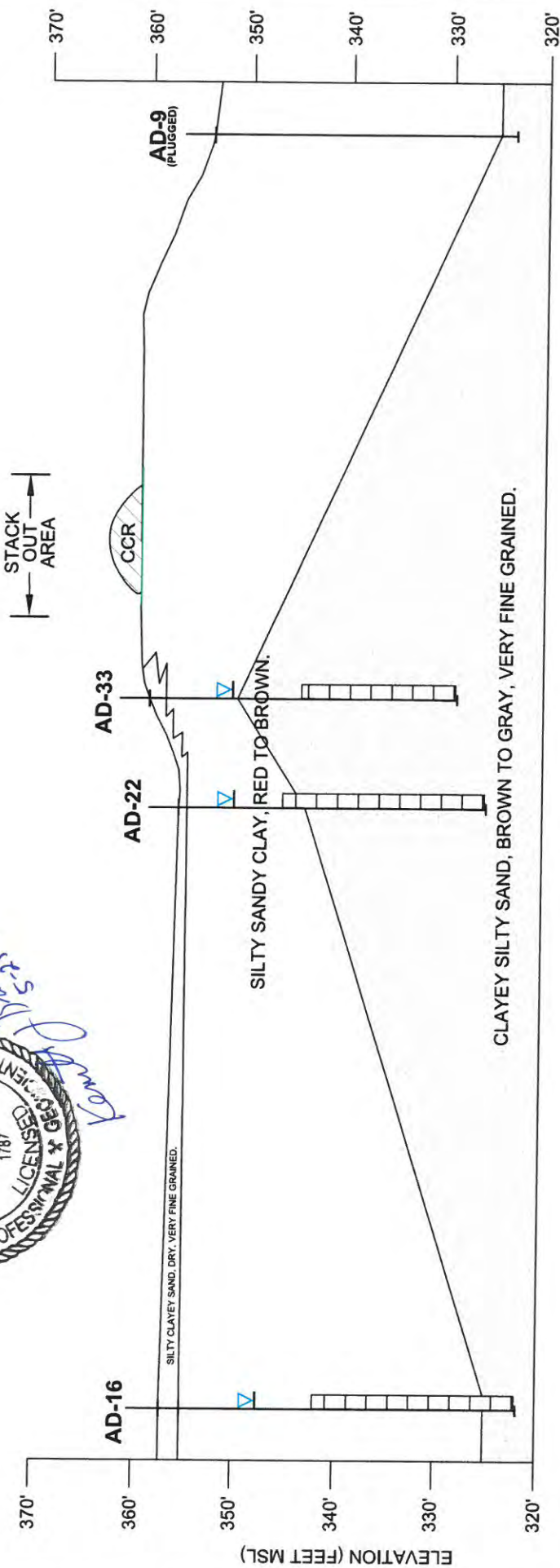
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

SITE LAYOUT AND WELL LOCATIONS

ARCADIS
FIGURE 3

WEST
B

EAST
B'



*Completed
 6/23/16
 J. Brandner*

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

CROSS SECTION
B - B'

ARCADIS

FIGURE
5

LEGEND

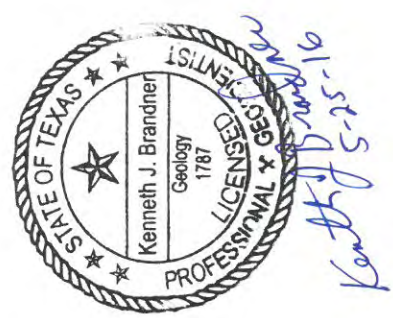
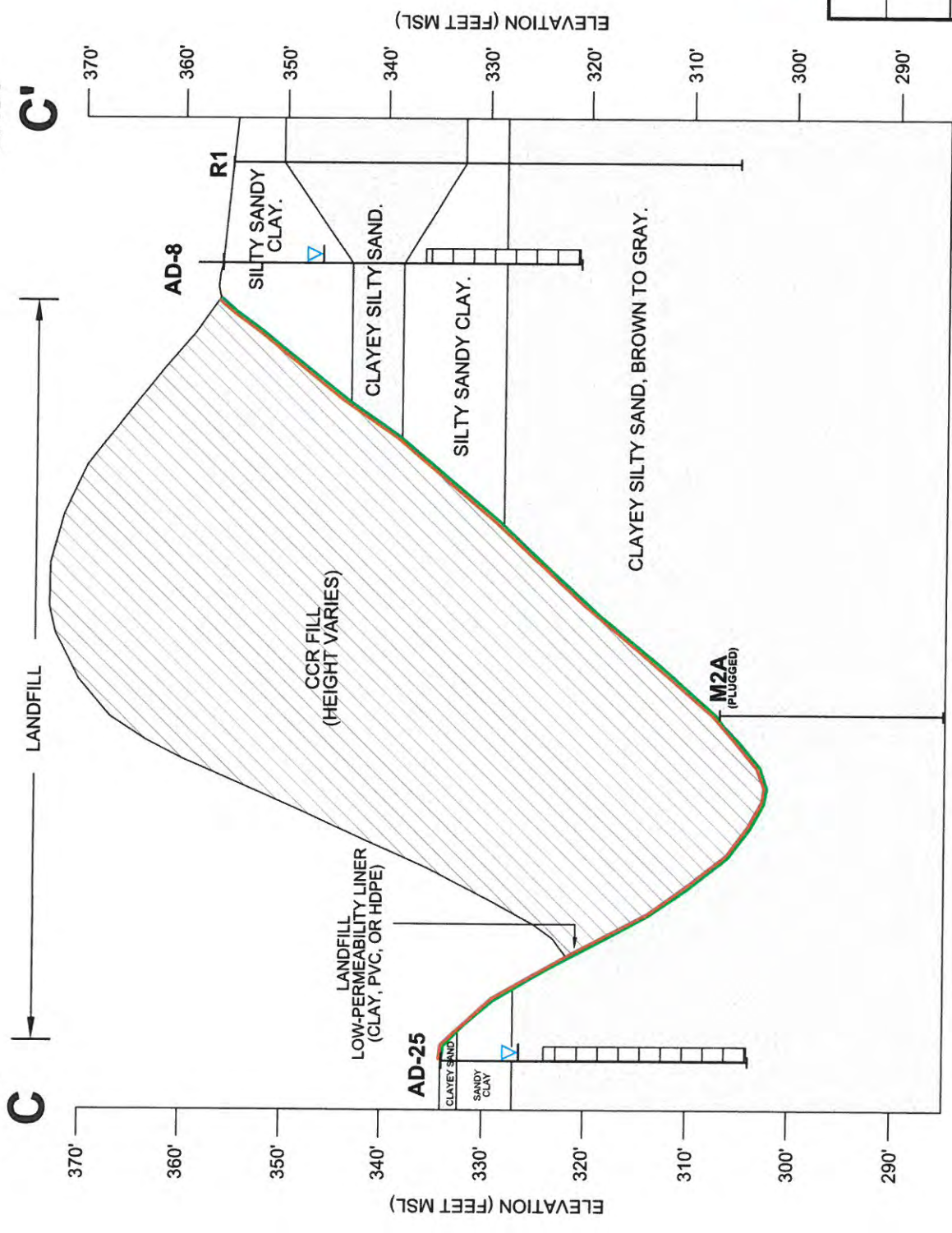
- Monitoring Well Screened Interval
- Water Level in Monitoring Well (1/20/16)
- Base of CCR Unit

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.

WEST
C

EAST
C'



- 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

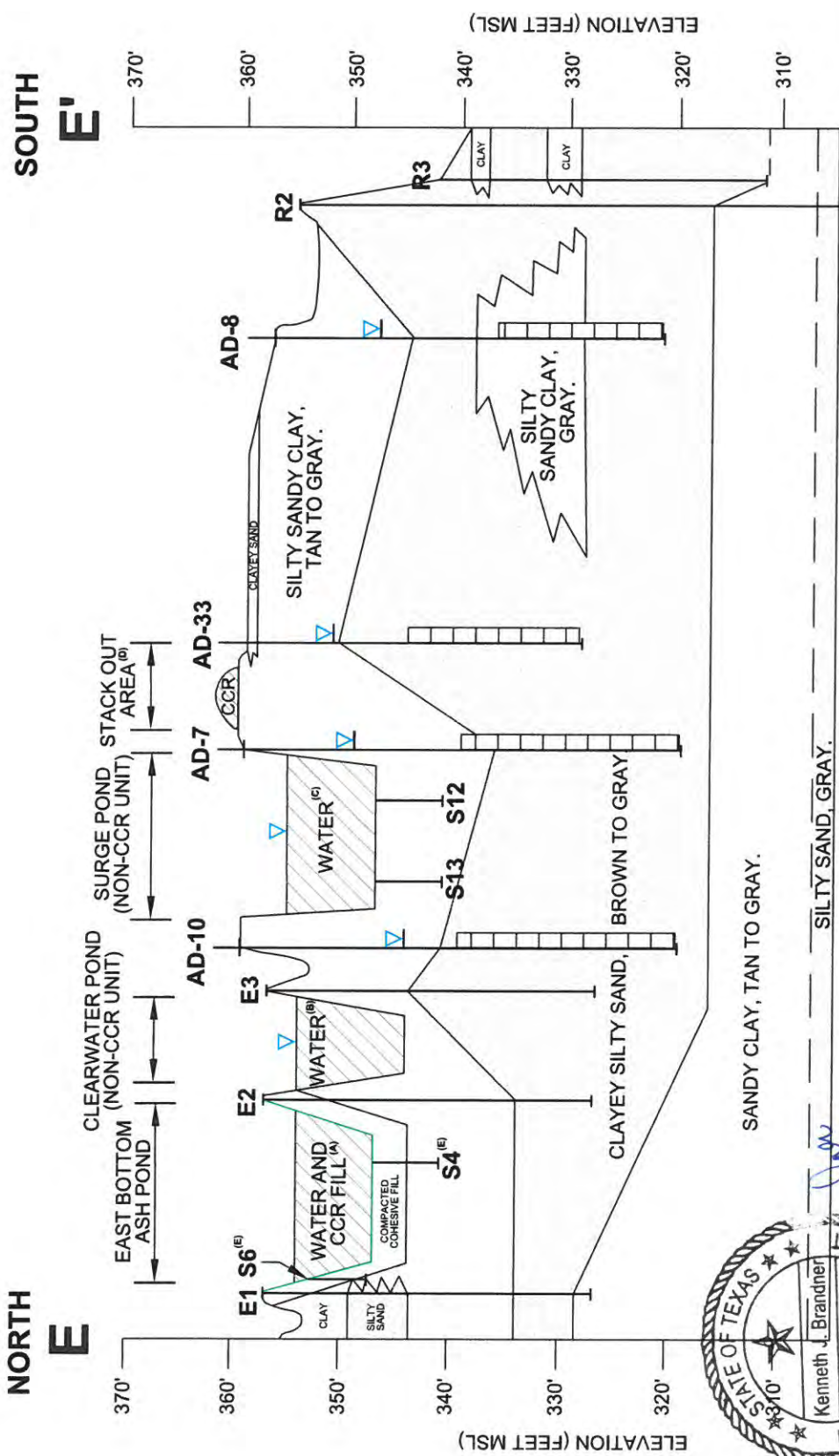
**CROSS SECTION
C - C'**

ARCADIS

FIGURE **6**



CITY: DINGDORF; DB: LD; AM: PD; TL: TR; LY: CCM-00FF-98F; C:\K&E\Projects\AM\01578 - CCR Soil Remediation\Drawings\Power Plant\2016 Reports\West Bottom Area Pond Location\Revised\figure 6 Cross Section C-C' Layout; MODEL: C:\Users\jbrandner\AppData\Local\Temp\20160505_111313.dwg; PLOTTED: 2/22/2016 11:13 AM; BY: LEASE DANA



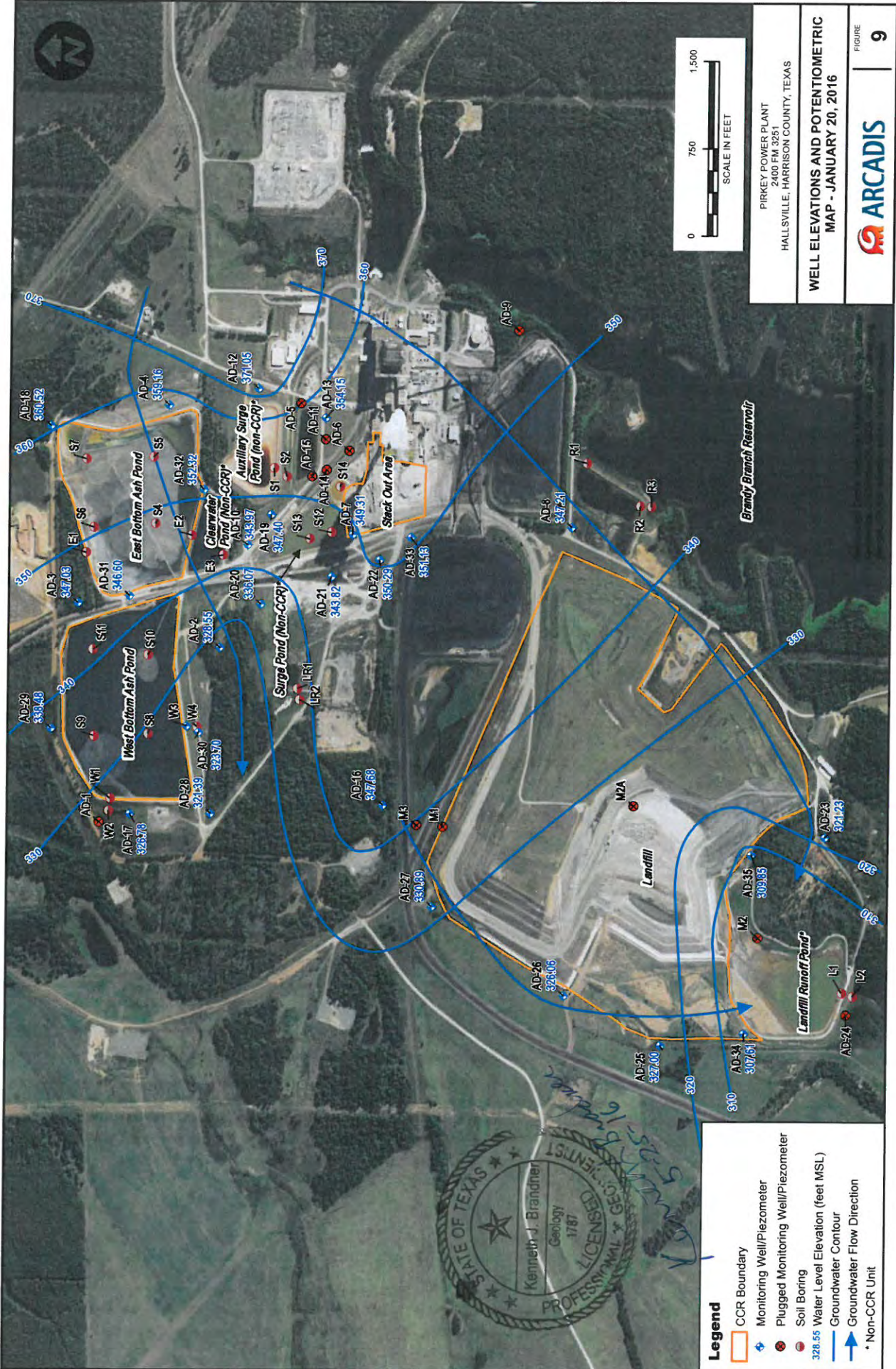
- NOTES:
- A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357'. OPERATING LEVEL IS 356' (JOHNSON & PAGE, MAY 2011); BASE ELEVATION IS 355' (SARGENT & LUNDY, JANUARY 1983).
 - B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 354'. OPERATING LEVEL IS 354' (SARGENT & PAGE, MAY 2011); BASE 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.
 - D) BASE OF STACK-OUT AREA CCR UNIT IS 320' AND WASTE WATER POND FACILITIES* MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION FROM SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.
 - 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'**

FIGURE
8



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

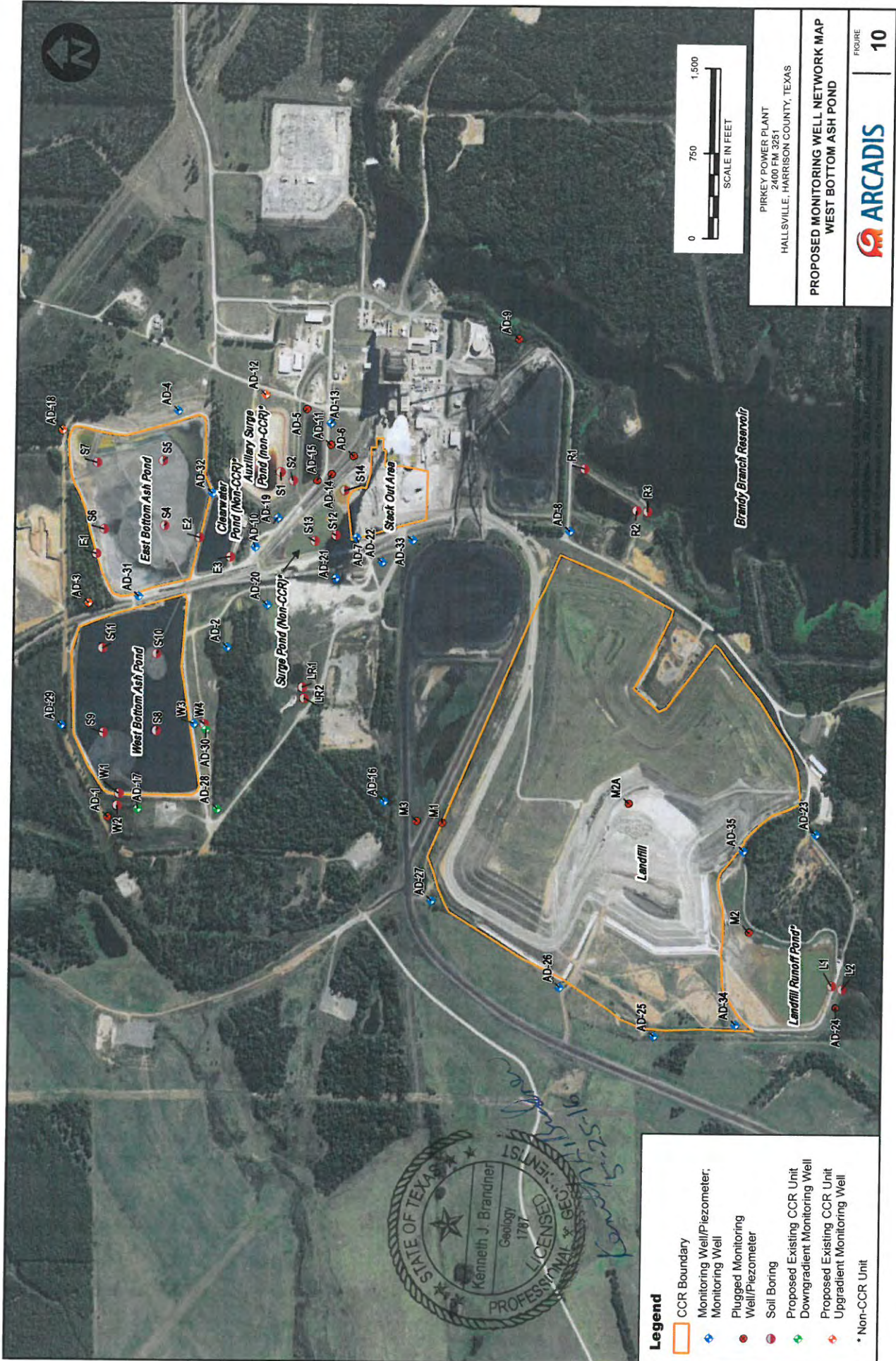
**WELL ELEVATIONS AND POTENTIOMETRIC
 MAP - JANUARY 20, 2016**

ARCADIS

FIGURE
9

- 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

**PROPOSED MONITORING WELL NETWORK MAP
WEST BOTTOM ASH POND**

ARCADIS

FIGURE | **10**

- 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





Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-1
LOCATION: Hallsville

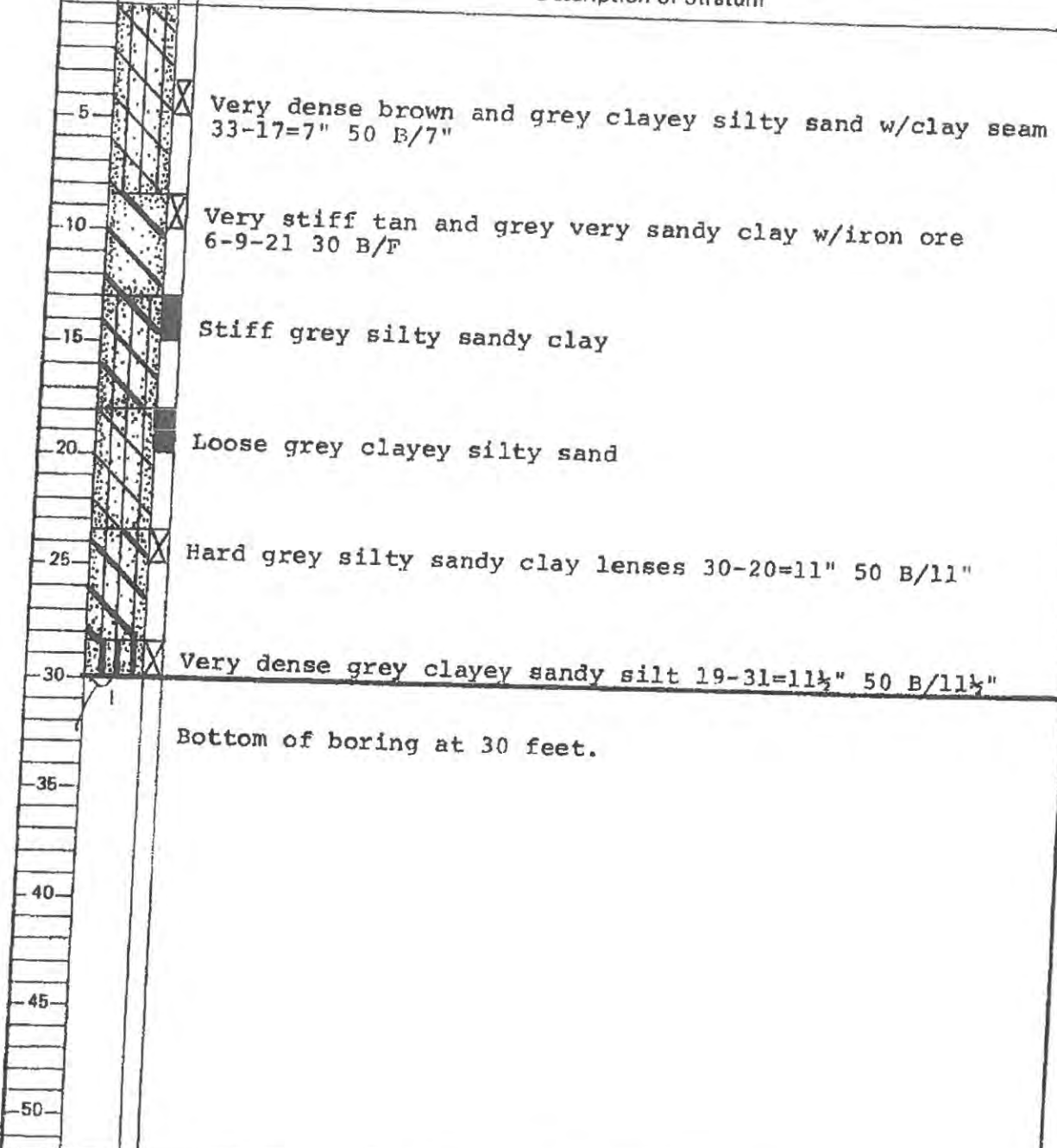
Date: 10-6-83

Type: Auger

Ground Elevation:

Depth, Feet	Symbol	Sample	Legend:
			■ Sample
			X Penetration
			▼ Water

Description of Stratum



832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-2
LOCATION: Hallsville

Date: 10-7-83

Type: Auger

Ground Elevation:

Depth, Feet	Symbol	Sample	Legend:
			■ Sample X Penetration ▼ Water
Description of Stratum			

5			Firm tan clayey silty sand
10			Medium tan and grey very sandy silty clay
15			Dense tan and grey clayey silty sand
20		X	Dense tan clayey silty sand 10-15-16 31 B/F
25			Dense tan silty sand
30		X	Very dense grey clayey silty sand 15-35=12" 50 B/F
35		X	Very dense grey clayey silty sand 21-29=9" 50 B/9"
40		X	Hard grey sandy silty clay 20-30=12" 50 B/F
45			Bottom of boring at 40 feet. Water encountered at 25 feet.
50			

832964

LOG OF BORING

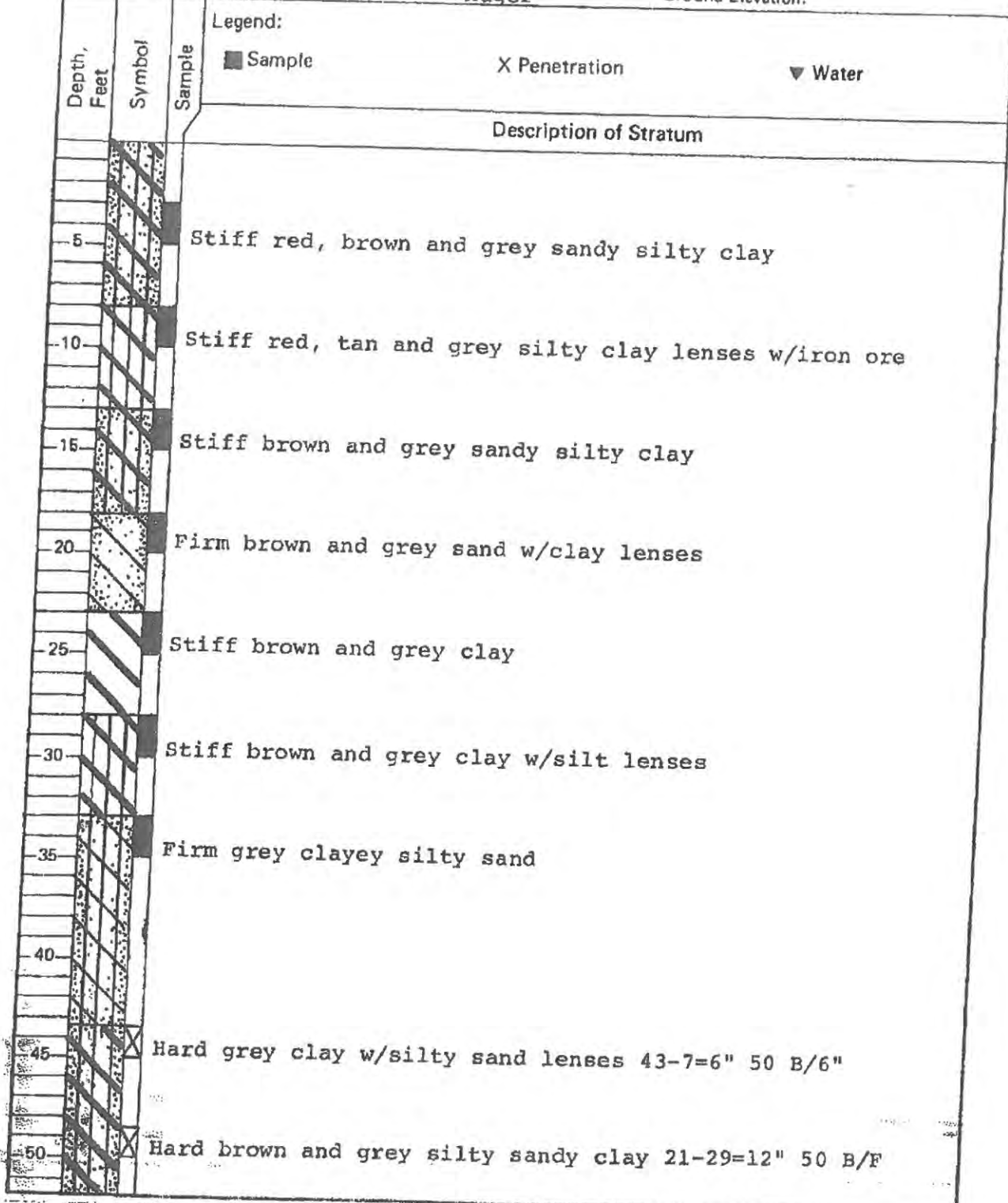
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

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

Date: 11-4-83

Type: Auger

Ground Elevation:



Legend:

■ Sample

X Penetration

▼ Water

Description of Stratum

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:

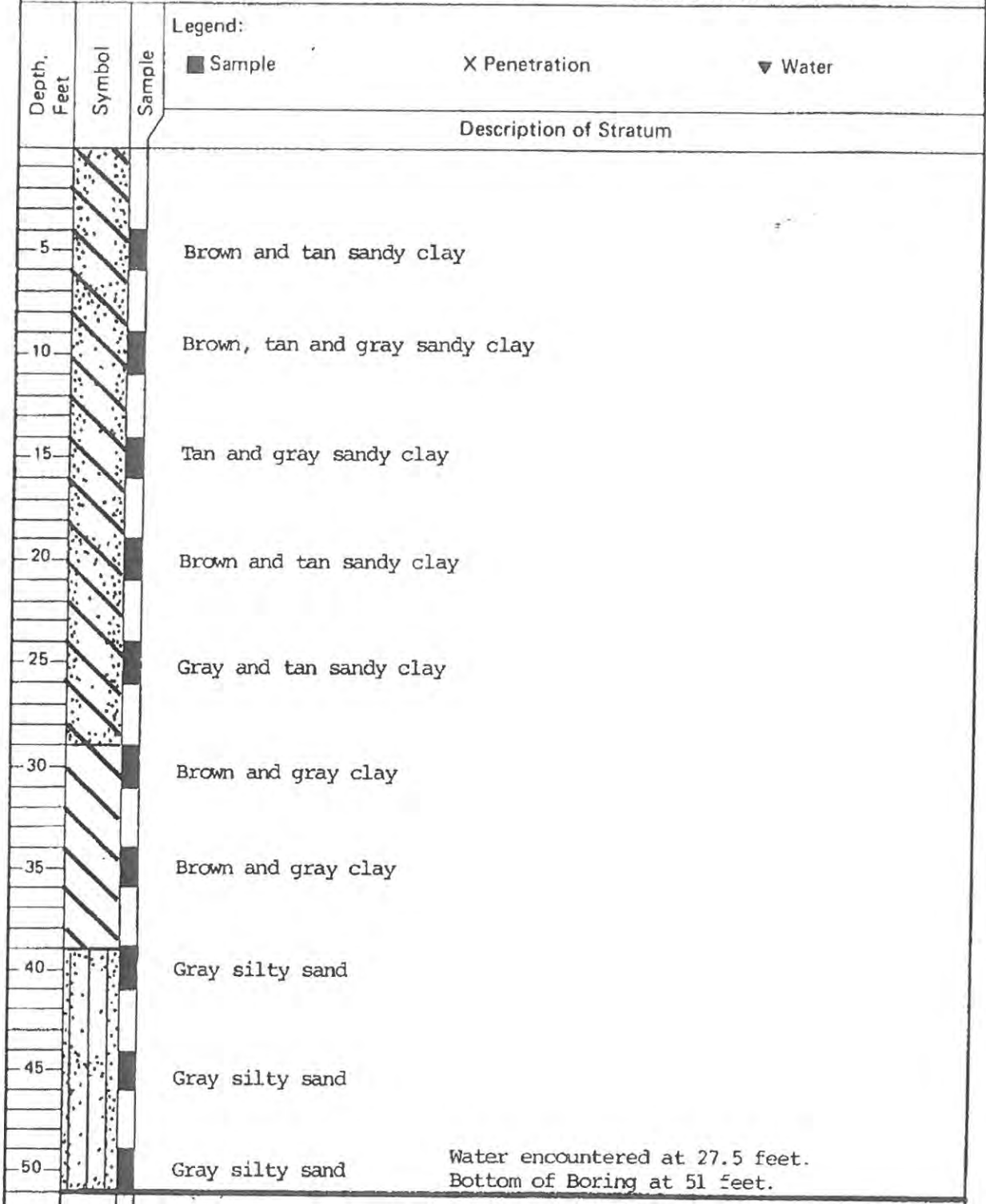
Depth, Feet	Symbol	Sample	Legend:		
			■ Sample	× Penetration	▼ Water
			Description of Stratum		
55		×	Hard grey silty sandy clay 28-22=10" 50 B/10"		
60			Bottom of boring at 57 feet.		
65			Water encountered at 42 feet.		
70					
75					
80					
85					
90					
95					
100					

832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond BORING NO.: MW-12
 CLIENT: Southwestern Electric Power Company LOCATION: Hallsville, TX

Date: 1/30/86 Type: Rotary N 6+13.25; W-6+90.36
 Ground Elevation: 378.41



APEX PROJECT NO.: 110-089 BORING MONITOR WELL
 BORING NUMBER: _____ 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
 LATITUDE: N 32°28.039 Datum: WGS-84 WELL LOCATION: West of Bottom Ash Pond #2
 LONGITUDE: W94°29.659'

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

Cement Bentonite Filter Sand Water Level

Apex
 geoscience inc.

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

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

APEX PROJECT NO.: 110-089 BORING MONITOR WELL
 BORING NUMBER: _____ 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
 LATITUDE: 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 -iron oxide fracture at 9.5'	None	Dry
9								
10								
11								
12								
13								
14								
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							None	Saturated
19								
20								
21								
22								
23								
24								
25								
26								
27								
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 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'

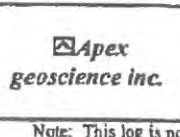
Note: This log is not to be used separate from this report.

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
 LATITUDE: 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 iron ore gravel at .5-1.5'	None	Dry
3								
4								
5								
6						-light gray, dark reddish brown at 5'		
7						-iron oxide cemented stone at 6.5'		
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								
14						-light yellowish brown at 11.5'		
15								
16								
17				16-40	SC	Clayey sand, dark gray, medium dense	None	Moist
18								
19								
20								
21						-dark gray at 20'		
22						-cemented sandstone at 21'		
23						-no recovery from 22' to 35'		
24								
25								V. Moist to 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


 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 MONITOR WELL
 BORING NUMBER: _____ 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

LATITUDE: N 32°28.139' Datum: WGS-84 WELL LOCATION: North of Bottom Ash Pond #2
 LONGITUDE: W94°29.534

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				0.5-5	CL Clay, some sand, red, reddish brown, light gray, stiff	None	Dry	
3								
4								
5								
6					5-10	CL Sandy clay, light gray, light red	None	Dry
7						-abundant iron ore, yellowish brown, yellow, dry		
8								
9								
10								
11					10-18	SC Clayey sand, yellowish brow, reddish brown, light gray, medium dense	None	Moist
12						-light gray, yellow, at 11'		
13						-4" saturated sand seam, trace clay at 13'		
14								
15								
16								
17								
18						-purple, yellowish brown, reddish brown, medium dense to loose		
19					18-22	SM Silty sand, reddish brown to red	None	V. Moist
20		▽				-some iron ore gravel, some clay, saturated, gypsum crystals, at 20'		
21								
22					22-22.5	CL Sandy clay, dark gray, stiff	None	Dry
23					22.5-28	SM Silty sand, saturated, greenish gray, loose	None	Dry to Moist
24								
25								
26								
27								
28								
29					28-30	SC Clayey sand, greenish gray, dark gray, dark brown, dry, very dense, slightly cemented	None	Dry to Moist
30								
31								
32					Boring Terminated at 30'			
33								
34								
39								
40								

Cement
 Bentonite
 Filter Sand
 Water Level

Apex geoscience inc.

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

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



Monitor Well

Monitor Well No.: AD-30



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.: 50088
 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 56.48" LONGITUDE 94 29 32.63"

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	WELL CONSTRUCTION
			-4 -3 -2 -1 0								Locking Well Casing Cover Locking Well Cap Protective Well Casing Concrete Pad Ground Surface Cement
SANDY LEAN CLAY: light reddish brown and light gray	CL		1 2 3 4 5 6								Bentonite
- trace sand and silt at 3.0' to 3.5', light reddish brown			7 8			17	64	24	17	7	2" Sch. 40 PVC Riser
- some iron ore gravel at 7', light gray, reddish brown, light reddish brown, increasing sand content with depth			9 10			14	53	38	24	14	
CLAYEY SILTY SAND: very fine to fine sand, reddish brown, light brown, and light gray	SM-SC		11 12								
SILTY SAND: very fine to fine sand, some lenses of clay and partially cemented sand, reddish brown and light gray, moist	SM		13 14			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		15 16 17 18			20	26	34	24	10	20/40 Silica Sand
SILTY SAND: very fine to fine sand, some clay, light gray and reddish brown, saturated	SM		19 20 21								0.010" Slotted Sch. 40 PVC Well Screen
- some iron ore gravel at 19', gray and reddish brown, increasing clay content with depth, very moist			22 23			20	49	30	22	8	PVC Bottom Cap
SILTY CLAYEY SAND: fine to very fine sand, some clay lenses, gray and dark gray, moist	SM-SC		24 25								

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



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LOG OF BORING LR-1

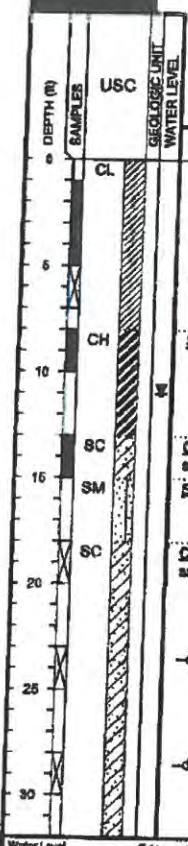
PROJECT: Pirkey Power Plant
Halleville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/20/09

SURFACE ELEVATION
337.2



MATERIAL DESCRIPTION	
CL	LEAN CLAY WITH SAND (CL) very stiff, tan -tan and orange -stiff, red and tan
CH	SANDY FAT CLAY (CH) tan and orange
SC	CLAYEY SAND (SC) gray; with clay and sand seams
SM	SILTY SAND (SM) dark gray
SC	CLAYEY SAND (SC) very dense; gray, with small clay seams -dark gray -dense; gray and brown

FIELD STRENGTH DATA	BLOW COUNT		DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (tsf)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)				OTHER TESTS PERFORMED (Page Ref. #)		
	20	40					60	Plastic Limit	Moisture Content	Liquid Limit	LL	PL	PI		MINUS #200 SIEVE (%)	
	1	2					3									4
P=3.5	20	40	60				20	40	80	80	11	35	18	22	70	+40 Sieve=3%, +4 Sieve=1%
N=12	1.0	2.0	3.0	4.0							16	39	16	23	68	+40 Sieve=4%, +4 Sieve=2%
8F	1.0	2.0	3.0	4.0							25	45	23	22	44	+40 Sieve=13%, +4 Sieve=5%
N=54	1.0	2.0	3.0	4.0							23	26	16	10	20	+40 Sieve=2%, +4 Sieve=0%
N=80																
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 - NPT Data (Blow/P)
 F - Proctol Penetration (tsf)
 T - Torvane (tsf)
 L - Lab Vane Shear (tsf)

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



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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

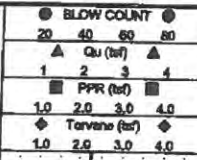


MATERIAL DESCRIPTION

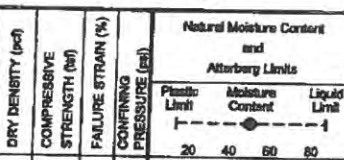
gray

Bottom of Boring @ 40'

FIELD STRENGTH DATA



N=44
N=48



MOISTURE CONTENT (%)			ATTERBERG LIMITS (%)			MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
LL	PL	PI	LL	PL	PI		

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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LOG OF BORING LR-2

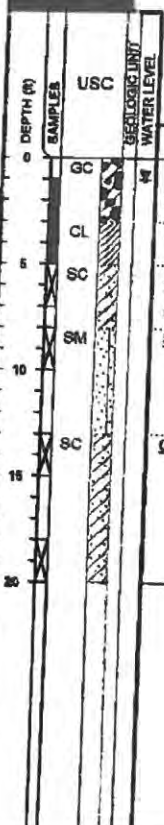
PROJECT: Pirkey Power Plant
Halleville, Texas

PROJECT NO.: G3241-095

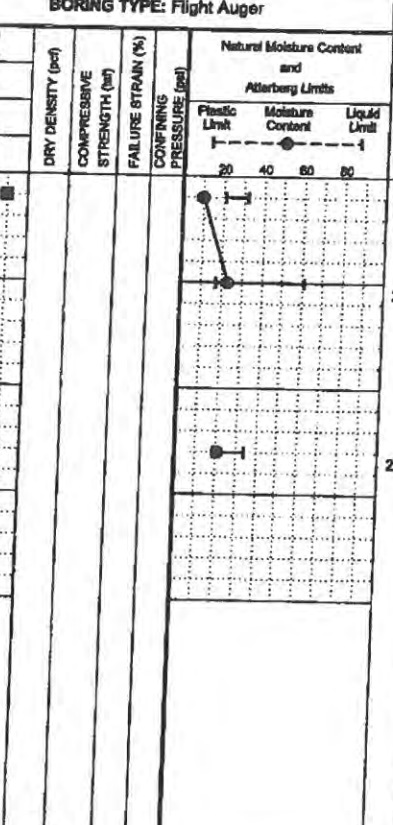
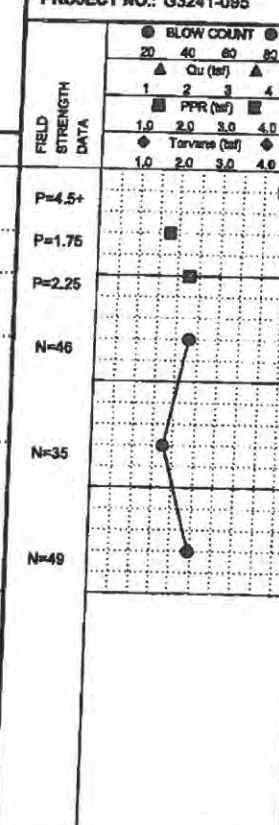
BORING TYPE: Flight Auger

DATE: 10/20/08

SURFACE ELEVATION: 328.0



FIELD STRENGTH DATA	BLOW COUNT				DRY DENSITY (pcf)	COMPRESSION STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psf)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			OTHER TESTS PERFORMED (Page Ref. #)		
	20	40	60	80					PL	Moisture Content	Liquid Limit		LL	PL	PI		MINUS #200 SIEVE (%)	
P=4.5+	1	2	3	4					20	40	60	80	10	32	21	11	6	+40 Sieve=84%, +4 Sieve=77%
P=1.75													28	61	17	44	41	+40 Sieve=6%, +4 Sieve=0%
P=2.25																		
N=46																		
N=35													21	34	19	15	31	+40 Sieve=2%, +4 Sieve=0%
N=49																		



MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	LL	PL	PI		
10	32	21	11	6	+40 Sieve=84%, +4 Sieve=77%
28	61	17	44	41	+40 Sieve=6%, +4 Sieve=0%
21	34	19	15	31	+40 Sieve=2%, +4 Sieve=0%

Water Level: Est. Measured Perched

Notes: 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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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	GEOLOGIC UNIT	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	BLOW COUNT	DRY DENSITY (pcf)	COMPRESSION STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (tsf)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)			OTHER TESTS PERFORMED (Page Ref. #)	
												Plastic Limit	Moisture Content	Liquid Limit	LI	PL	PI		MINUS #200 SIEVE (%)
0																			
3		CH			FAT CLAY WITH SAND(CH) tan and red	P=3.75	20					21	62	21	41	79	+40 Sieve=5%, +4 Sieve=0%		
4					-red	P=3.75													
5						P=4.5						16	60	21	39	75	+40 Sieve=7%, +4 Sieve=1%		
6		CL			SANDY LEAN CLAY(CL) reddish yellow	P=4.0													
7		CH			FAT CLAY(CH) red and tan	P=4.25													
8																			
9		CH			FAT CLAY WITH SAND(CH) red and yellow	P=3.75						18	55	18	38	71	+40 Sieve=5%, +4 Sieve=0%		
10																			
11					-red	P=3.5													
12																			
13		SC			CLAYEY SAND(SC) reddish brown	P=2.0						10	28	18	10	25	+40 Sieve=21%, +4 Sieve=11%		
14																			
15																			
16		CL			LEAN CLAY(CL) red; with sand seams	P=1.0													
17																			
18																			
19																			
20																			
21																			
22																			
23																			
24																			
25																			
26																			
27																			
28																			
29																			
30																			

Water Level: Observed: Perched:
Water Observations: Seepage @ 18' while drilling.

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

Notes:



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LOG OF BORING W-1

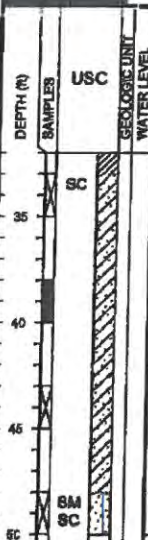
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/20/09

SURFACE ELEVATION: 356.6



MATERIAL DESCRIPTION	
35 - 48	CLAYEY SAND(SC) grayish brown -tanish gray -gray
48 - 50	SILTY CLAYEY SAND(SM-SC) gray
50	Bottom of Boring @ 50'

FIELD STRENGTH DATA	BLOW COUNT			
	20	40	60	80
N=32				
P=4.15				
P=2.8				
N=47				
N=60/5*				

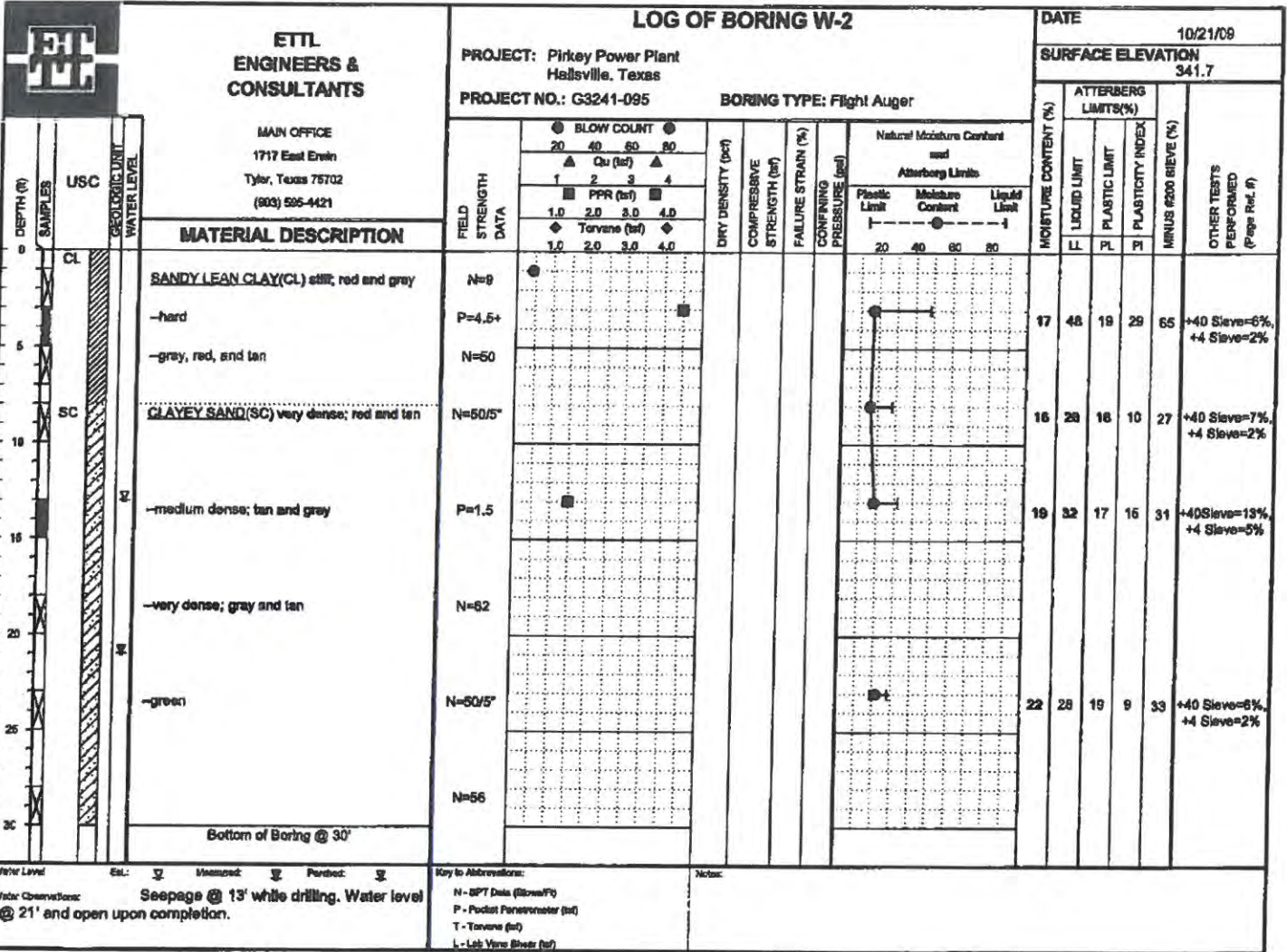
DRY DENSITY (pcf)	COMPRESSIONIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psf)	Natural Moisture Content and Atterberg Limits		
				Plastic Limit	Moisture Content	Liquid Limit
				17	29	19
				10	25	10

MOISTURE CONTENT (%)				OTHER TESTS PERFORMED (Page Ref. #)	
L	PL	PI	MINUS #200 SIEVE (%)		
17	29	19	10	+40 Sieve=1%, +4 Sieve=0%	

Water Level: Est. Measured: Perched:
 Water Observations: Seepage @ 18' while drilling.

Key to Abbreviations:
 N - SPT Data (Blows/Ft)
 P - Pore Pressure (tsf)
 T - Torque (tsf)
 L - Lab Vane Shear (tsf)

Notes:





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LOG OF BORING W-3

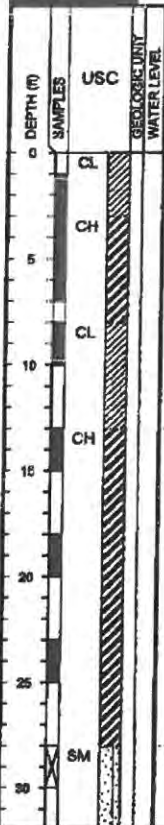
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/20/09

SURFACE ELEVATION: 356.3



MATERIAL DESCRIPTION

SANDY LEAN CLAY (CL) stiff, white and tan

SANDY FAT CLAY (CH) very stiff, red, tan, and white
-white, tan, and red

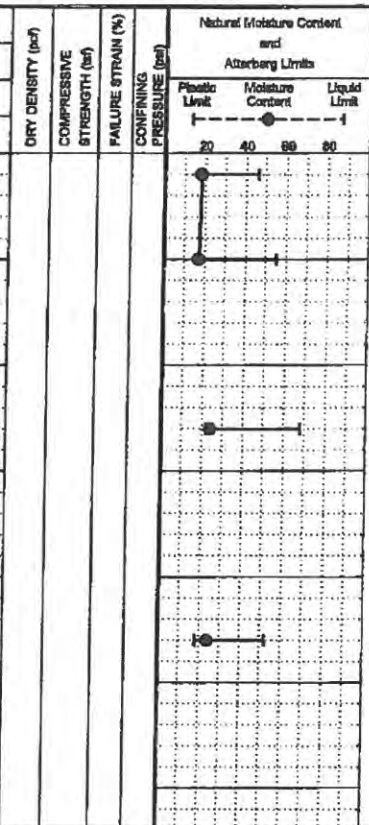
SANDY LEAN CLAY (CL) very stiff, red and yellow
-hard; red and yellow

FAT CLAY WITH SAND (CH) very stiff, red and yellow
-hard

-stiff

SILTY SAND (SM) very dense; yellow and red

FIELD STRENGTH DATA	BLOW COUNT			
	20	40	60	80
	▲	▲	▲	▲
	1	2	3	4
	■	■	■	■
	1.0	2.0	3.0	4.0
	◆	◆	◆	◆
	1.0	2.0	3.0	4.0



MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref., #)
	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
18	46	17	29	61	+40 Sieve=7%, +4 Sieve=2%
17	55	18	37	68	+40 Sieve=5%, +4 Sieve=0%
24	68	22	46	80	+40 Sieve=6%, +4 Sieve=0%
24	52	16	34	69	+40 Sieve=4%, +4 Sieve=0%

Water Level Est. Measured Predicted

Water Observations: Seepage @ 34' while drilling.

Key to Abbreviations:
N - SP7 Data (Blow/ft)
P - Pocket Penetrometer (tsf)
T - Tensile (tsf)
L - Lab Vane Shear (tsf)

Notes:



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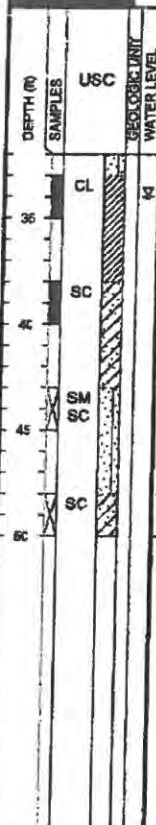
LOG OF BORING W-3

PROJECT: Pirkey Power Plant
Hallsville, Texas
PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/20/09

SURFACE ELEVATION: 358.3



MATERIAL DESCRIPTION	
CL	SANDY LEAN CLAY (CL) very stiff, gray, with iron oxide cemented sandstone gravel
SC	CLAYEY SAND (SC) very dense, dark gray
SM SC	SILTY CLAYEY SAND (SM-SC) very dense, gray, saturated
SC	CLAYEY SAND (SC) very dense, dark gray
Bottom of Boring @ 60'	

FIELD STRENGTH DATA	BLOW COUNT			
	20	40	60	80
P=3.25				
P=4.5+				
N=59				
N=50M*				

DRY DENSITY (pcf)	COMPRESSION STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (tsf)	Natural Moisture Content and Atterberg Limits		
				Plastic Limit	Moisture Content	Liquid Limit

MOISTURE CONTENT (%)				ATTERBERG LIMITS (%)			MIRUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
L	PL	P	PI	LI	PL	PI		
17	33	17	16	38			+40 Sieve=1%, +4 Sieve=0%	

Water Level: Est. Measured: Perched:
 Water Observations: Seepage @ 34' while drilling.

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

Notes:

(W3)

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

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





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LOG OF BORING W-4

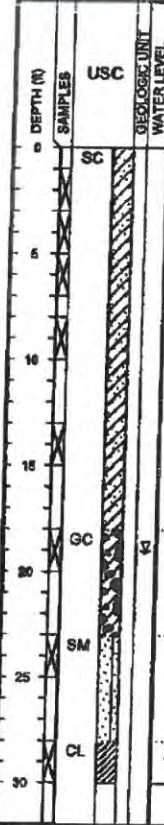
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/20/08

SURFACE ELEVATION: 338.0



MATERIAL DESCRIPTION	
SC	CLAYEY BAND(SC) stiff; brown, red, and yellow -with gravel -red and tan; with iron oxide cemented sandstone -dense; red and white; with clay seams -medium dense; orangish gray; with gravel
GC	CLAYEY GRAVEL(GC) dense; dark gray
SM	SILTY SAND(SM) dense; dark gray
CL	SANDY LEAN CLAY(CL) very dense; gray
Bottom of Boring @ 30'	

FIELD STRENGTH DATA	BLOW COUNT			
	20	40	60	80
N=13	1.0	2.0	3.0	4.0
N=22	1.0	2.0	3.0	4.0
N=28	1.0	2.0	3.0	4.0
N=36	1.0	2.0	3.0	4.0
N=12	1.0	2.0	3.0	4.0
N=43	1.0	2.0	3.0	4.0
N=42	1.0	2.0	3.0	4.0
N=84	1.0	2.0	3.0	4.0

DRY DENSITY (pcf)	COMPRESSION STRENGTH (psf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psf)	Natural Moisture Content and Atterberg Limits			
				Plastic Limit	Moisture Content	Liquid Limit	
				20	40	60	80

MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			MIRUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)		
12	31	17	14	35	+40Sieve=31%, +4 Sieve=16%
15	60	16	44	39	+40Sieve=11%, +4 Sieve=4%
17	30	14	16	22	+40Sieve=28%, +4 Sieve=17%
20	31	16	15	7	+40Sieve=98%, +4 Sieve=62%

Water Level: Estimated Measured Parachute
 Water Observations: Seepage @ 18' while drilling.

Key to Abbreviations:
 N - SPT Rate (Blows/ft)
 P - Pocket Penetrometer (psf)
 T - Torque (ft)
 L - Lab Vane Shear (psf)

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

Depth, Feet	Symbol	Sample	Legend:
			<input checked="" type="checkbox"/> Sample X Penetration ▼ Water

Description of Stratum

5		Red and brown slightly sandy silty clay
		Red and brown silty clay with silt lenses
		Red and brown silty sandy clay

Bottom of boring at 6 feet.
No water encountered.

10		
15		
20		
25		
30		
35		
40		
45		
50		



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:
			Description of Stratum
			■ Sample X Penetration ▼ Water
			Red and grey silty clay with silty sand Red and grey silty sandy clay Red and grey silty sandy clay
5			
			Bottom of boring at 6 feet.
			No water encountered.
10			
15			
20			
25			
30			
35			
40			
45			
50			

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

Depth, Feet	Symbol	Sample	Legend:
			<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">■ Sample</div> <div style="text-align: center;">X Penetration</div> <div style="text-align: center;">▼ Water</div> </div>
			Description of Stratum
5	[Hatched Box]	[Solid Box]	Very stiff tan and brown sandy silty clay
			Very stiff tan and grey sandy silty clay
			Stiff tan and grey sandy silty clay
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-11
LOCATION: Hallsville

Date: 10-6-83

Type: Auger

Ground Elevation: 347.0

Depth, Feet	Symbol	Sample	Legend:
			<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> Sample </div> <div style="text-align: center;"> X Penetration </div> <div style="text-align: center;"> ▼ Water </div> </div>
			Description of Stratum
5	▨		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
10			Bottom of boring at 6 feet. No water encountered.
15			
20			
25			
30			
35			
40			
45			
50			



Appendix B

Photographic Log



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 Bottom Ash Pond.



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.



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.			

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.			

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			



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.



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.





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



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.





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.



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 Bottom 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


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.





Imagine the result

**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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Matthew J. Lamb
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John 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:
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OH015976.0010

Date:
May 25, 2016

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Appendices

A	Boring/Well Construction Logs
B	Photographic Log

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 Sheef*" (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 E TTL report entitled "*Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas*" (E TTL, 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



69586

Registration No.

Texas

Registration State

5-25-16

Date



5. References

Akron Consulting, Ltd., "October 2015 Stackout Aerial", October 2015.

AMEC, "Report of Dam Safety Assessment of Coal Combustion Surface Impoundments, American Electric Power (AEP) and Southwest Electric Power Company (SWEPCO) H.W. Pirkey Power Plant, Hallsville, TX", August 2011.

Apex Geoscience Inc., "USWAG Monitoring Wells and Groundwater Evaluation, AEP Pirkey Power Station, Hallsville, Texas", March 2011.

Auckland Consulting, LLC, "Monitoring Well Installation – 2015, Pirkey Generating Station, Hallsville, Texas", January 26, 2016.

Banks Information Solutions, "Water Well Report, Pirkey Power Plant, 2400 FM 3251, Hallsville, Texas, Harrison County", October 8, 2015.

Broom, M.E., and B. N. Myers, "Ground-Water Resources of Harrison County, Texas", Texas Water Development Board Report 27, August 1966.

ETTL Engineers & Consultants Inc., "Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas", October 2010.

Fetter, C.W., "Applied Hydrogeology", University of Wisconsin – Oshkosh, 1980.

Flawn, Peter T., "Geologic Atlas of Texas, Tyler Sheet", The University of Texas at Austin Bureau of Economic Geology, March 1965.

George, Peter G., et. al., "Aquifers of Texas", Texas Water Development Board Report 380, July 2011.

Johnson & Pace Incorporated, "Hydrology & Hydraulic Report, North Surge Pond, East & West Ash Ponds, Secondary Ash Pond, Landfill Pond, H.W. Pirkey Power Plant, Hallsville, Texas", May 2011.

Johnson & Pace Incorporated, "East Bottom Ash Pond June 2011 As-Built Plan & Profile, H.W. Pirkey Power Plant, Hallsville, Texas", June 2011.

Sargent & Lundy, "Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities", January 31, 1983.



Sargent & Lundy, "Henry W. Pirkey Power Plant Unit 1, Wastewater Ponds – Liner Verification & Monitoring Wells", September 14, 1984.

Southwestern Laboratories, "Subsurface Exploration, Waste Water Ponds, Pirkey Power Plant, Hallsville, Texas", September 7, 1984.

Texas Commission on Environmental Quality, "Groundwater Classification, RG-366/TRRP-8", March 2010.

USGS, Aquifers and Groundwater. 2015. Available online at www.usgs.gov.

USGS, "Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin", Open-File Report 88-450K, 1988.

USGS, "Texas Seismic Hazard Map", 2014.



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) Source: 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) Source: EETL (October 2010).

(d) Source: Auckland 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	Existing/ 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	Existing	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilized to establish background water quality
AD-13	Existing	Uppermost Water-Bearing Unit	East of Stack Out Area	Upgradient	331.5	321.5	10	Existing well installed in 1988; well will be utilized to establish background 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:

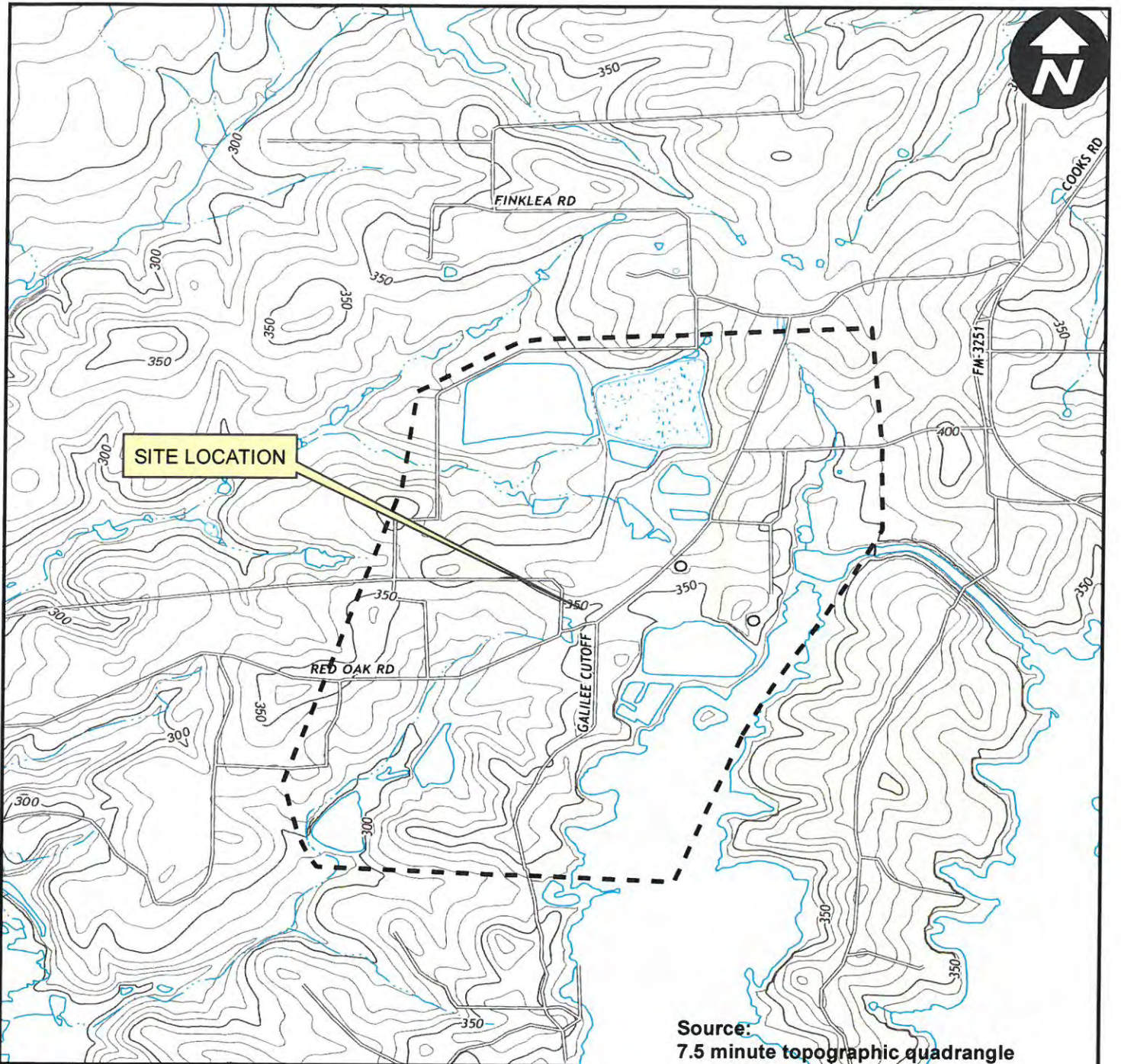
a. Target elevations are an estimated range.

Acronyms and Abbreviations:

U=Upgradient
D=Downgradient
ft = feet
amsl = above mean sea level



Figures



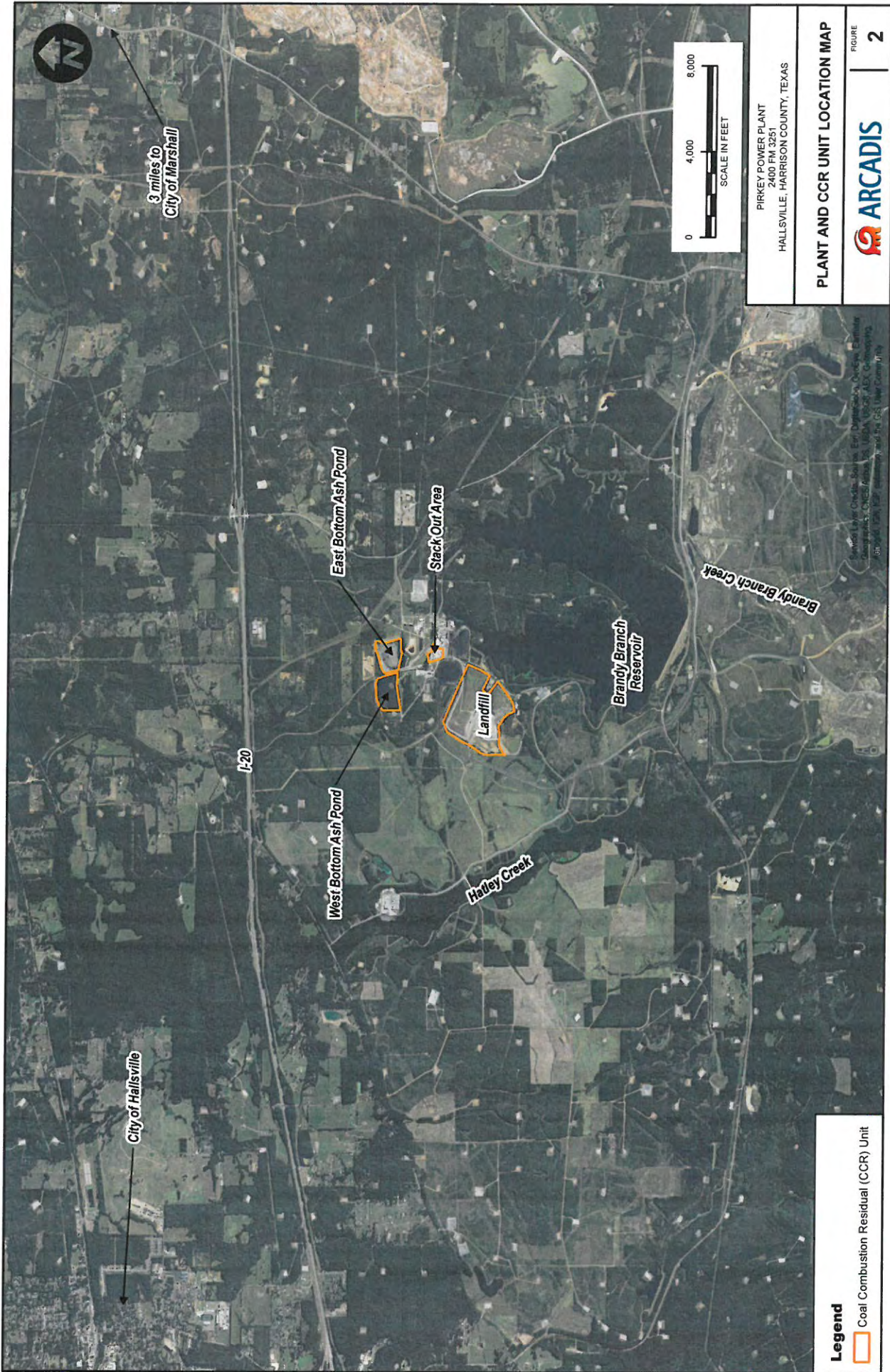
Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013



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

SITE LOCATION MAP





Source: Esri, DigitalGlobe, GeoEye, Earthstar (United States), CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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

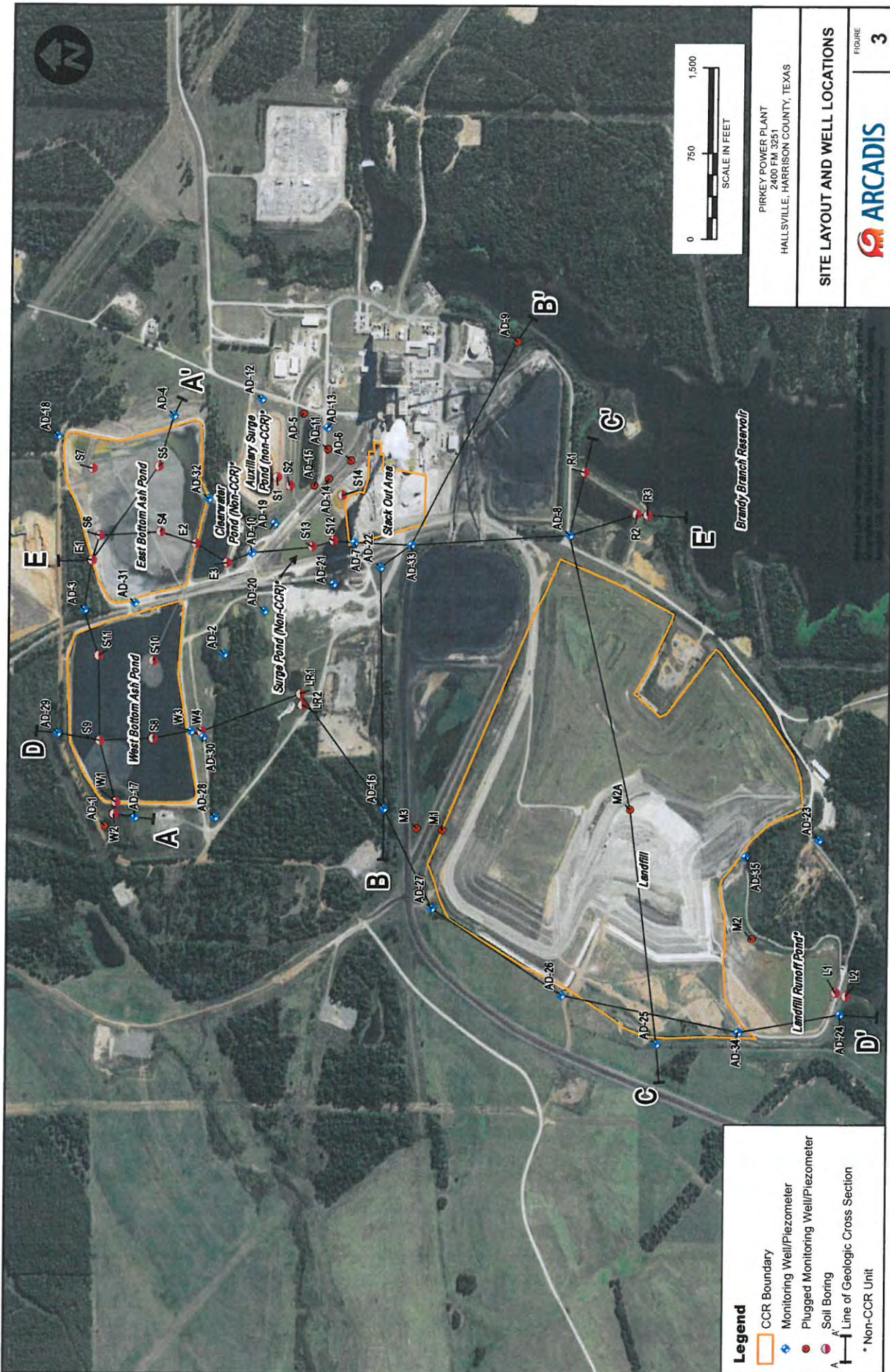
PLANT AND CCR UNIT LOCATION MAP

FIGURE | **2**

ARCADIS

Legend

Coal Combustion Residual (CCR) Unit



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

FIGURE 3

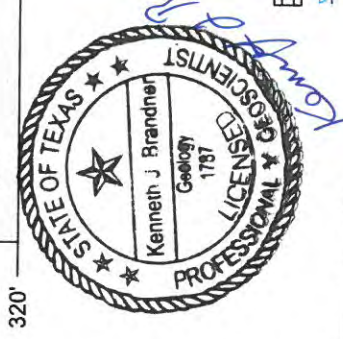
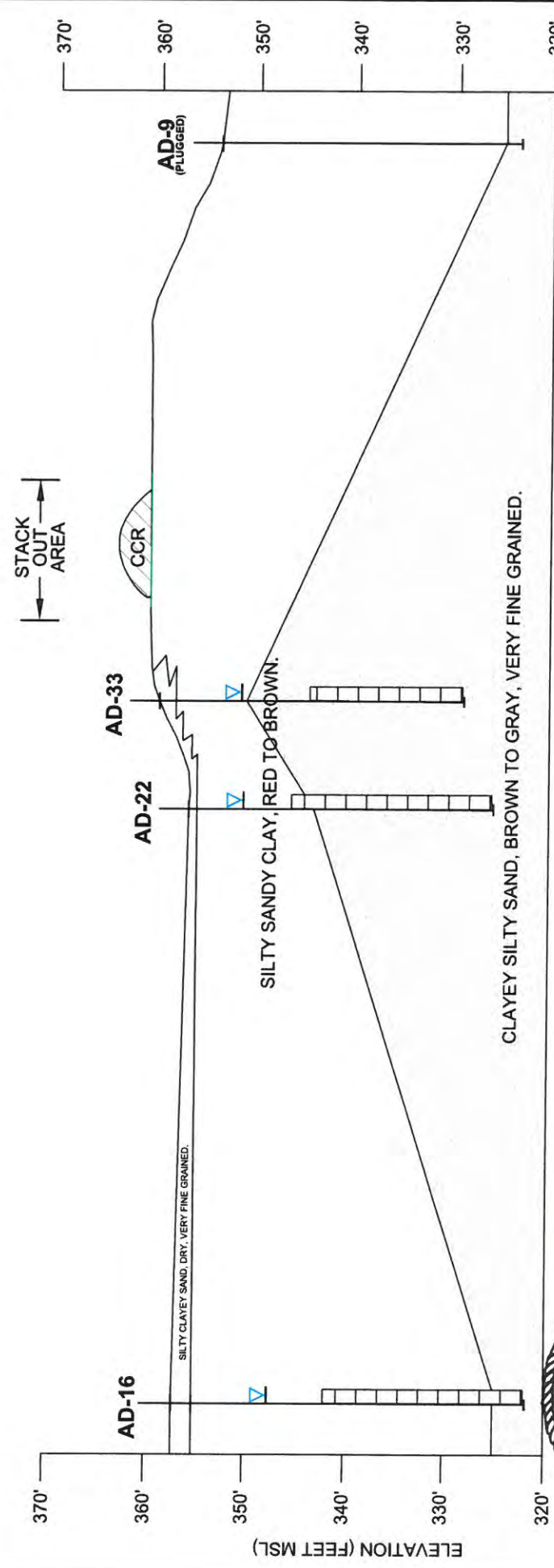
ARCADIS

Legend

- CCR Boundary
- Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- Line of Geologic Cross Section
- * Non-CCR Unit

**WEST
B**

**EAST
B'**



CLAYEY SILTY SAND, BROWN TO GRAY, VERY FINE GRAINED.

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

**CROSS SECTION
B - B'**

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

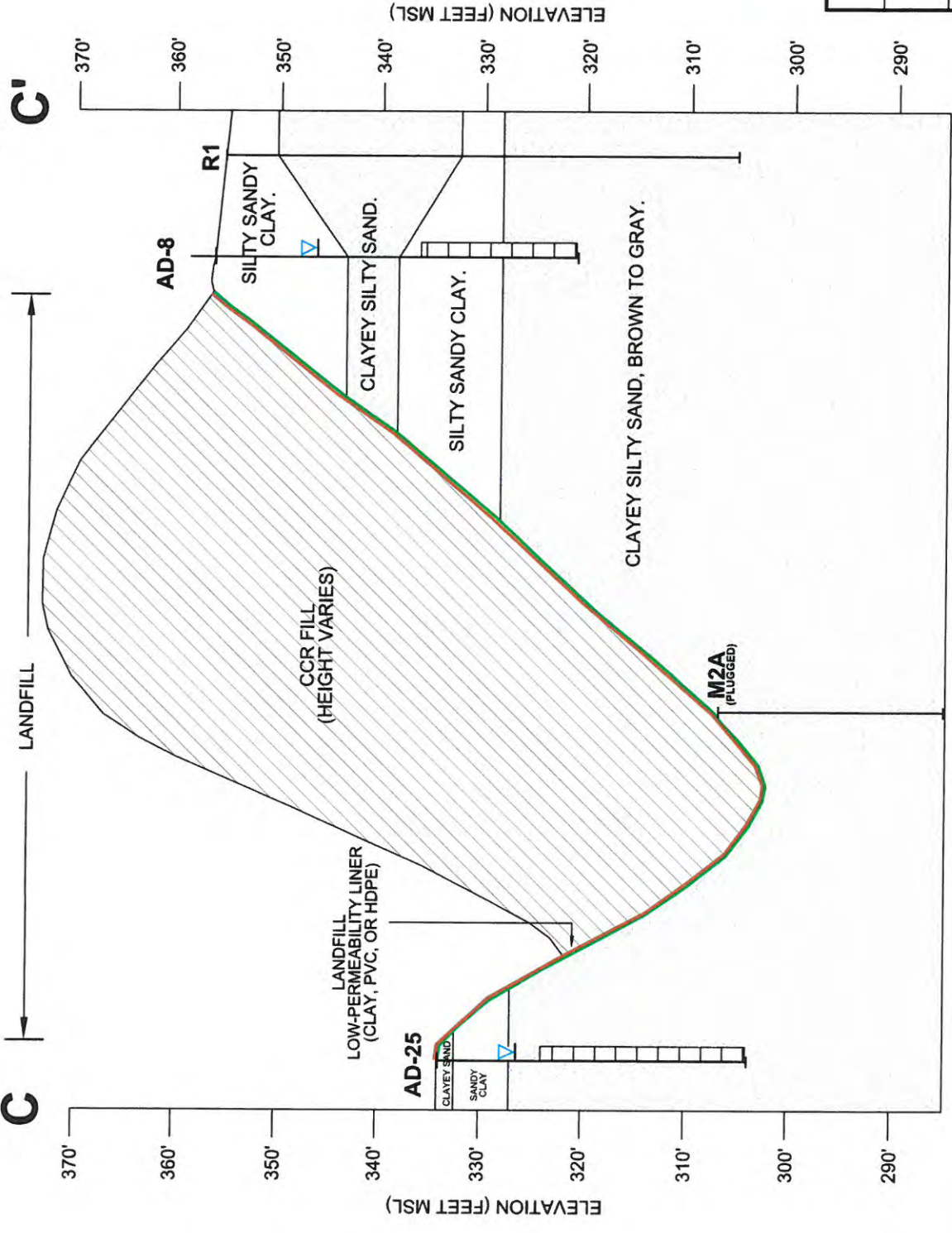
NOTES:
 A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE, ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
 B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.



FIGURE
5

**WEST
C**

**EAST
C**



ELEVATION (FEET MSL)

ELEVATION (FEET MSL)

LEGEND

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

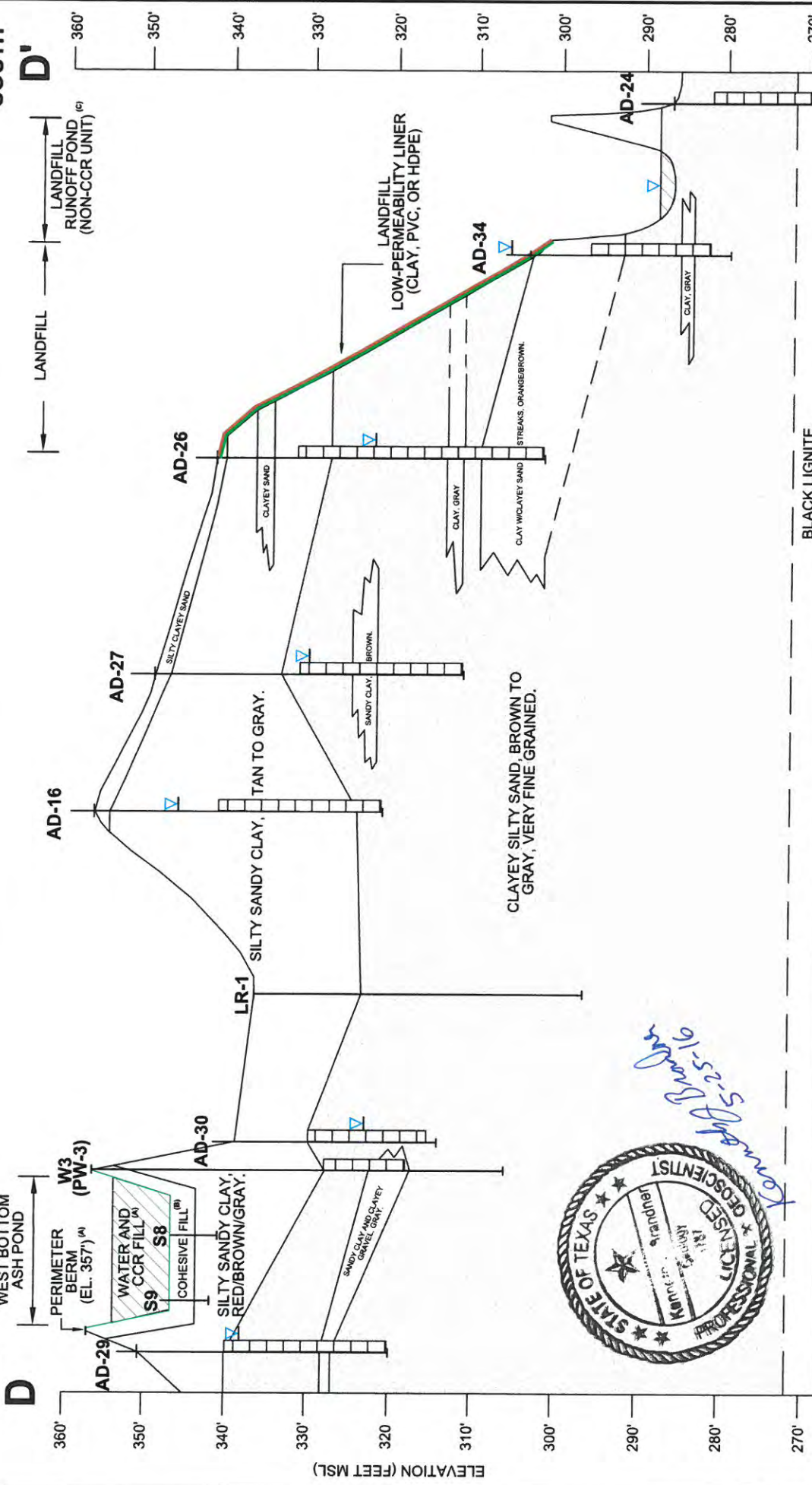
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

CROSS SECTION
C-C



NORTH

SOUTH



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

CROSS SECTION
D - D'

ARCADIS

FIGURE
7

LEGEND

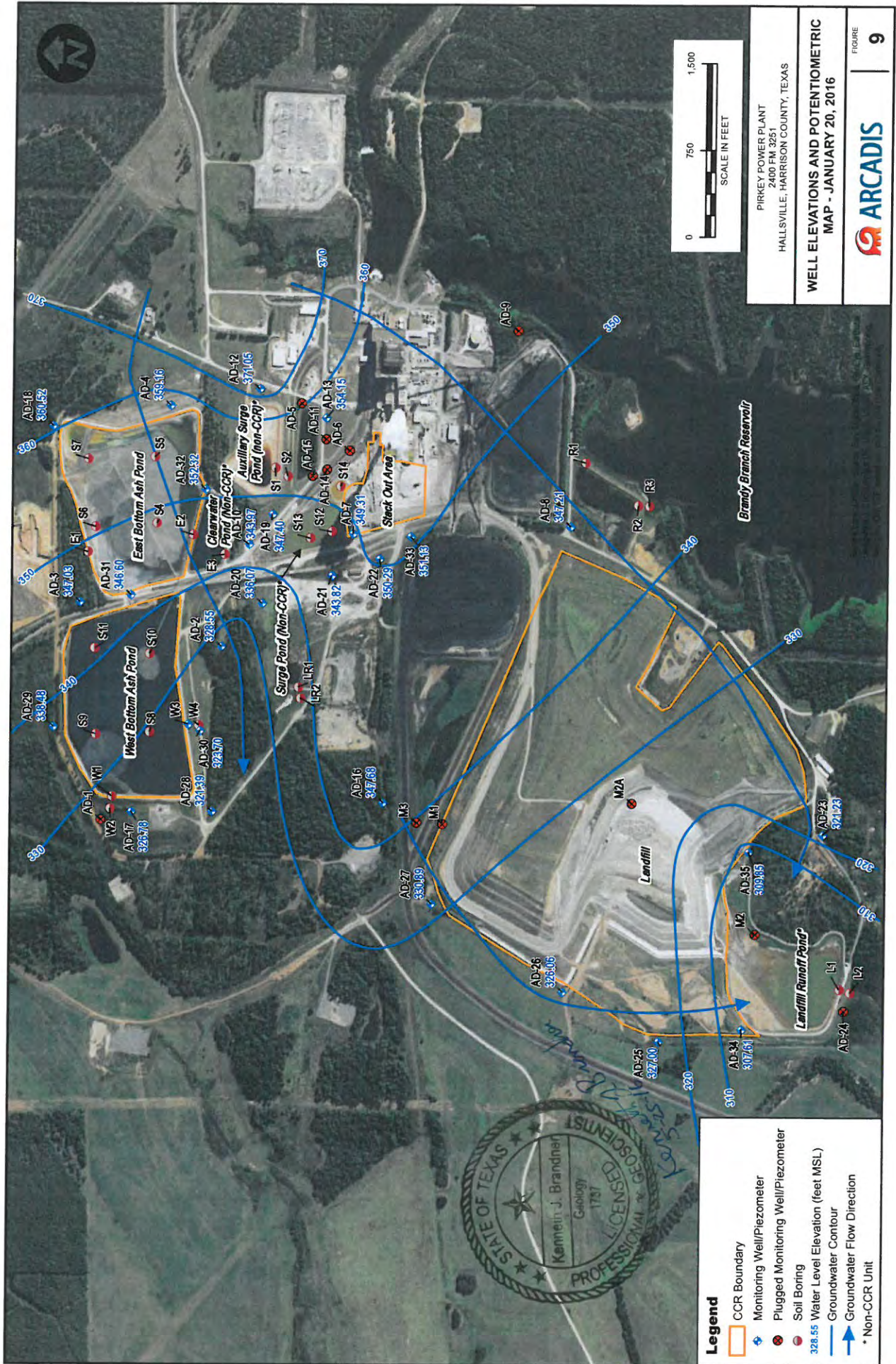
- MONITORING WELL SCREENED INTERVAL
- WATER LEVEL IN MONITORING WELL (12/01/16)
- BASE OF CCR UNIT

NOTES:

- TOP OF WEST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357'. OPERATING LEVEL WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, SEPTEMBER 1984; AMEC, AUGUST 2011).
- TOP OF WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, SEPTEMBER 1984; AMEC, AUGUST 2011).
- OPERATING LEVEL WEST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, SEPTEMBER 1984; AMEC, AUGUST 2011).

PERIMETER BERM APPROXIMATE ELEVATION 302' MSL. BASE OF LANDFILL RUNOFF POND IS 288' MSL. OPERATING LEVEL 289' MSL (JOHNSON & PACE MAY 2011).





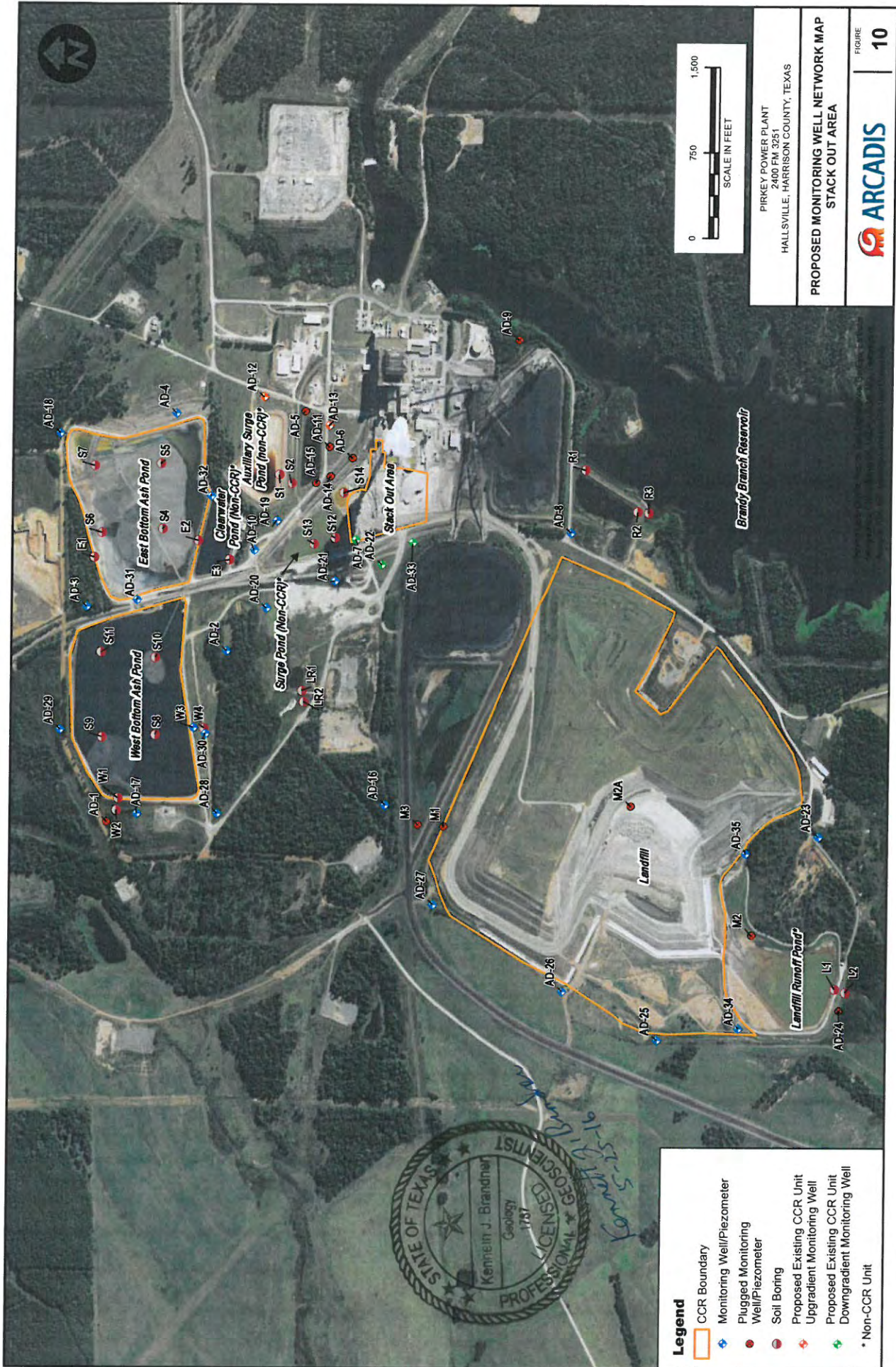
PIRKEY POWER PLANT
 2400 FM 3251
 HALLSVILLE, HARRISON COUNTY, TEXAS

**WELL ELEVATIONS AND POTENTIOMETRIC
 MAP - JANUARY 20, 2016**

ARCADIS

FIGURE 9

- 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

PROPOSED MONITORING WELL NETWORK MAP
STACK OUT AREA

FIGURE | **10**

- 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





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:

Depth, Feet	Symbol	Sample	Legend:		
			■ Sample	X Penetration	▼ Water
Description of Stratum					
5					Stiff tan and grey clay w/silt lenses and iron ore
10					Very stiff tan and grey clay w/silt lenses and iron ore
15					Firm tan and grey clayey silty sand
20					Loose brown and grey clayey silty sand
25			X		Very dense grey clayey silty sand 25-25=11½" 50 B/11½"
30			X		Firm grey clayey silty sand 7-7-17 24 B/F
35			X		Very dense grey clayey silty sand 25-25=9" 50 B/9"
40			X		Very dense grey clayey silty sand 18-32=10½" 50 B/10½"
Bottom of boring at 40 feet.					
45					
50					

832964

LOG OF BORING

PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-7
LOCATION: Hallsville

Date: 10-3-83

Type: Auger

Ground Elevation:

Depth, Feet	Symbol	Sample	Legend:
			 Sample X Penetration ▼ Water

Description of Stratum

5	■	Stiff red, tan and grey sandy silty clay w/iron ore
10	■	Stiff tan and grey clay w/iron ore
15	■	Stiff tan and grey silty sandy clay lenses w/iron ore
20	■	Stiff tan and grey very sandy silty clay
25	■	Firm tan and grey clayey silty sand
30	X	Very dense grey silty sand 23-27=12" 50 B/F
35	X	Very dense grey clayey silty sand 17-35=12" 50 B/F
40	X	Very dense grey clayey silty sand 25-25=10 1/2" 50 B/10 1/2"
45		Bottom of boring at 40 feet.
50		

832964

LOG OF BORING

PROJECT: Monitor Wells at Metal Cleaning Waste Pond BORING NO.: MW-12
 CLIENT: Southwestern Electric Power Company LOCATION: Hallsville, TX
 Date: 1/30/86 Type: Rotary N 6+13.25; W-6+90.36
 Ground Elevation: 378.41

Depth, Feet	Symbol	Sample	Legend:		
			■ Sample	X Penetration	▼ Water
Description of Stratum					
5	[Symbol]		Brown and tan sandy clay		
10	[Symbol]		Brown, tan and gray sandy clay		
15	[Symbol]		Tan and gray sandy clay		
20	[Symbol]		Brown and tan sandy clay		
25	[Symbol]		Gray and tan sandy clay		
30	[Symbol]		Brown and gray clay		
35	[Symbol]		Brown and gray clay		
40	[Symbol]		Gray silty sand		
45	[Symbol]		Gray silty sand		
50	[Symbol]		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

Spring			Observation Well	
Depth in ft.	Correl Interval	Description	Type of Observation Well:	<input type="checkbox"/> Flush <input checked="" type="checkbox"/> Protruding <input checked="" type="checkbox"/> Locking Cap <input type="checkbox"/> Manhole
			Ground Elev. _____ Top of Bore Elev. _____ Protection Casing or Cap L.D. of Riser Pipe _____ 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 Cap. 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 MONITOR WELL
 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

LATITUDE: N 32°27'03.3" Datum: WGS-84 WELL LOCATION: Triangle- South side Quansit Hut
 LONGITUDE: W 94°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				0.5-12	CL	Lean clay, light brown mottled with light gray	None	Slightly Moist
3						Few iron ore (small) pebbles in clayey sandy streaks		
4								
5								
6								
7								
8								
9								
10								
11								
12								
13				12-20	SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained	None	Slightly Wet
14						Slightly wet @ 12.5' from seepage Large amount of iron ore 15-17'		
15								
16								
17								
18								
19								
20								
21								
22				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
23						Sand, greenish brown (1') grading to orangish brown, silty, very fine grained		
24								
25								
26								
27								
28								
29								
30								
31						Boring Terminated at 30'		
32								
33								
34								
35								
36								
37								
38								
39								
40								

Cement
 Bentonite
 Filter Sand
 Water Level



Total Depth: 30 feet Riser Interval: +3 (bgs)-10'
 Filter Sand (Size/Interval): 8-30' Screen Interval: 10-30'
 Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8' Water level: 12.5'
 Surface Completion Flush Above Ground 3'

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



Monitor Well

Monitor Well No.: AD-33



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: 12/11/2016
 DEVELOPMENT: 12/16/2016
 SITE LOCATION: 2400 FM 3281, Hallsville, Texas
 WELL OWNER: AEP

DRILLING INFORMATION

DRILLER: Buford Collier
 DRILLER'S LICENSE NO.: 60088
 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' 16.82"

Water Level Upon Installation
 Water Level at Time of Drilling
 Geotechnical Lab Sample
 TBPB No. 50027

DESCRIPTION	USCS	SOIL SYMBOLS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI	WELL CONSTRUCTION
			4								Locking Well Casing Cover Locking Well Cap Protective Well Casing Concrete Pad Ground Surface Cement Bentonite 2" Sch. 40 PVC Riser 20/40 Silica Sand 0.010" Slotted Sch. 40 PVC Well Screen PVC Bottom Cap
CLAYEY SAND: very fine to fine sand, some silt, dark brownish black and brown, very moist	SC	[Symbol]	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	[Symbol]	2		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 - some clay and trace of iron ore gravel at 11', light gray and reddish brown, moist - 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	SC	[Symbol]	8		21	35	35	23	12		
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	[Symbol]	17		23	19	27	18	9		
CLAYEY SAND: very fine to fine sand, dark gray and gray, moist	SC	[Symbol]	28		23	30	25	18	7		

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		
5			Red and grey clay		
			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-14
LOCATION: Hallsville, TX

Date: 9-15-83

Type:

Ground Elevation: 352.9

Depth, Feet	Symbol	Sample	Legend:		
			■ Sample	X Penetration	▼ Water
Description of Stratum					
			Brown and red clay w/silt lenses		
			Brown and red slightly silty clay		
5			Brown and red sandy silty clay		
			Bottom of boring at 6 feet.		
10			No water encountered.		
15					
20					
25					
30					
35					
40					
45					
50					



Appendix B

Photographic Log



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.



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



**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

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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Appendices

A	Boring/Well Construction Logs
B	Photographic Log
C	Soil Boring Logs and Piezometers - 2018 Landfill Lateral Expansion Area

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 E TTL 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

69586

Registration No.

Texas

Registration State

10-25-18

Date



5. References

Alliance, Inc., "Henry W. Pirkey Power Plant Sludge Disposal Area Expansion, Phase I, Section IV", September 1993.

AMEC, "Report of Dam Safety Assessment of Coal Combustion Surface Impoundments, American Electric Power (AEP) and Southwest Electric Power Company (SWEPCO) H.W. Pirkey Power Plant, Hallsville, TX", August 2011.

Apex Geoscience Inc., "USWAG Monitoring Wells and Groundwater Evaluation, AEP Pirkey Power Station, Hallsville, Texas", March 2011.

Apex Geoscience Inc., "Geotechnical Investigation, Landfill Sedimentation Pond – Expansion, AEP/Pirkey Power Station, Hallsville, Texas", April 2011.

Apex Geoscience Inc., "Geotechnical Evaluation, Pirkey Power Station – Sludge Disposal Area, 2015 Expansion Phase – Addendum No. 2, Hallsville, Texas", November 27, 2012 (Revised January 17, 2013).

ARCADIS U.S., Inc., "Landfill – CCR Groundwater Monitoring Well Network Evaluation, H.W. Pirkey Power Plant, 2400 FM 3251, Harrison County, Hallsville, Texas", May 25, 2016.

Auckland Consulting LLC, "Monitoring Well Installation – 2015, Pirkey Generating Station, Hallsville, Texas", January 26, 2016.

Auckland Consulting LLC, "Stability Assessment – 2019 Landfill Expansion, Pirkey Power Plant, Hallsville, Texas", November 21, 2016.

Banks Information Solutions, "Water Well Report, Pirkey Power Plant, 2400 FM 3251, Hallsville, Texas, Harrison County", October 8, 2015.

Broom, M.E., and B. N. Myers, "Ground-Water Resources of Harrison County, Texas", Texas Water Development Board Report 27, August 1966.

Central and South West Services, Inc., "Coal Fly Ash/Flue Gas Desulfurization Material Landfill, Pirkey Power Station, Harrison County, Texas", June 8, 1995.

ETTL Engineers & Consultants Inc., "Geology and Geotechnical Report, Henry W. Pirkey Power Plant Sludge Disposal Area, 2005 and 2007 Expansion Phase, Harrison County, Texas", March 2005.

ETTL Engineers & Consultants Inc., “Geotechnical Investigation, Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas”, October 2010.

Fetter, C.W., “Applied Hydrogeology”, University of Wisconsin – Oshkosh, 1980.

Flawn, Peter T., “Geologic Atlas of Texas, Tyler Sheet”, The University of Texas at Austin Bureau of Economic Geology, March 1965.

George, Peter G., et. al., “Aquifers of Texas”, Texas Water Development Board Report 380, July 2011.

Johnson & Pace Incorporated, “Lignite Pond and Landfill Runoff Pond Berm Plan & Profile”, March 2010.

Johnson & Pace Incorporated, “Hydrology & Hydraulic Report, North Surge Pond, East & West Ash Ponds, Secondary Ash Pond, Landfill Pond, H.W. Pirkey Power Plant, Hallsville, Texas”, May 2011.

Johnson & Pace Incorporated, “East Bottom Ash Pond June 2011 As-Built Plan & Profile, H.W. Pirkey Power Plant, Hallsville, Texas”, June 2011.

Sargent & Lundy, “Henry W. Pirkey Power Plant, Design Summary for Lignite Storage Area and Wastewater Pond Facilities”, January 31, 1983.

Sargent & Lundy, “Henry W. Pirkey Power Plant Unit 1, Wastewater Ponds – Liner Verification & Monitoring Wells”, September 14, 1984.

Southwestern Laboratories, “Subsurface Exploration for Section 1 Phase 1 of Sludge Disposal Area, Henry W. Pirkey Power Plant”, July 1984.

Southwestern Laboratories, “Subsurface Exploration, Waste Water Ponds, Pirkey Power Plant, Hallsville, Texas”, September 7, 1984.

Southwestern Laboratories, “Liner Verification, Sludge Disposal Area, Pirkey Power Plant”, April 18, 1985.

Texas Commission on Environmental Quality, “Groundwater Classification, RG-366/TRRP-8”, March 2010.

USGS, Aquifers and Groundwater. 2015. Available online at www.usgs.gov.

USGS, "Petroleum Geology and the Distribution of Conventional Crude Oil, Natural Gas, and Natural Gas Liquids, East Texas Basin", Open-File Report 88-450K, 1988.

USGS, "Texas Seismic Hazard Map", 2014.

VFL Technology Corporation, "Engineering Design and Operations Report, Pirkey Station Solid Waste Disposal Site", November 1, 1984.

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) Source: 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, Harrison County, Texas

Piezometer Completion Information

Piezometer ID:	<u>PZ1</u>	<u>PZ2</u>	<u>PZ3</u>	<u>PZ4</u>	<u>PZ5</u>	<u>PZ6</u>	<u>PZ7</u>	<u>AD-23</u>	<u>AD-35</u>
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

<u>Date</u>	<u>PZ1</u>	<u>PZ2</u>	<u>PZ3</u>	<u>PZ4</u>	<u>PZ5</u>	<u>PZ6</u>	<u>PZ7</u>	<u>AD-23</u>	<u>AD-35</u>
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)

<u>Date</u>	<u>PZ1</u>	<u>PZ2</u>	<u>PZ3</u>	<u>PZ4</u>	<u>PZ5</u>	<u>PZ6</u>	<u>PZ7</u>	<u>AD-23</u>	<u>AD-35</u>
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) Source: EETL (October 2010).
(d) Source: Auckland 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	Existing/ 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	Existing	Uppermost Water-Bearing Unit	Northeast of Landfill	Upgradient	336.9	321.9	15	Existing well installed in 1983; well will be utilized to establish background water quality
AD-12	Existing	Uppermost Water-Bearing Unit	Northeast of Stack Out Area	Upgradient	347.8	327.8	20	Existing well installed in 1986; well will be utilized to establish background water quality
AD-16	Existing	Uppermost Water-Bearing Unit	North of Landfill	Upgradient	341.8	321.8	20	Existing well installed in 2010; well will be utilized to establish background 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 utilized to establish background 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

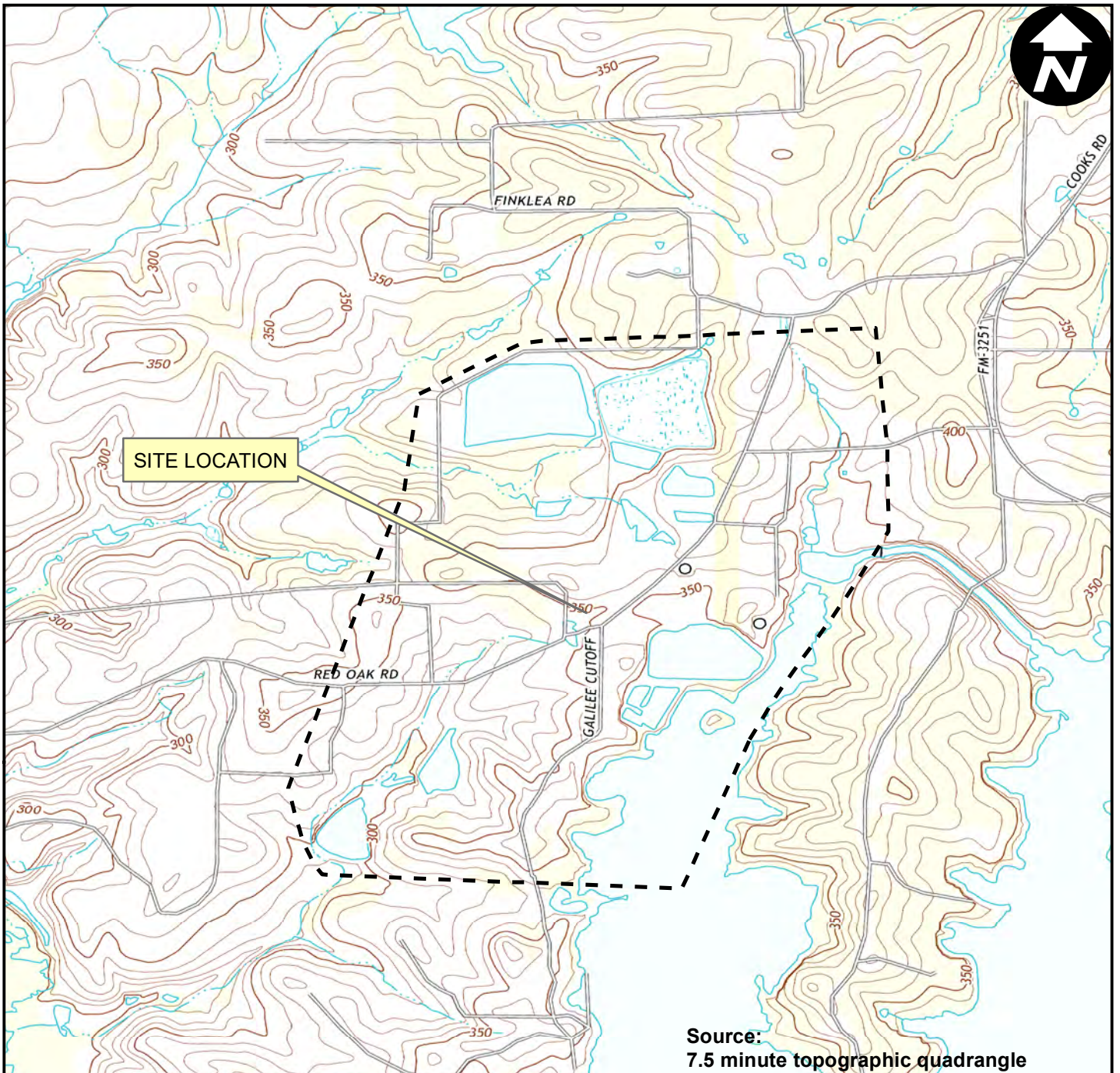
Footnotes:

- a. Target elevations are an estimated range.
- b. Ground surface elevation at proposed monitoring well location is approximately 308 feet amsl.

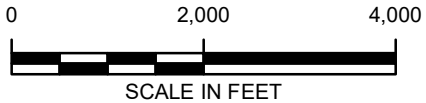
Acronyms and Abbreviations:

- U=Upgradient
- D=Downgradient
- ft = feet
- amsl = above mean sea level

Figures



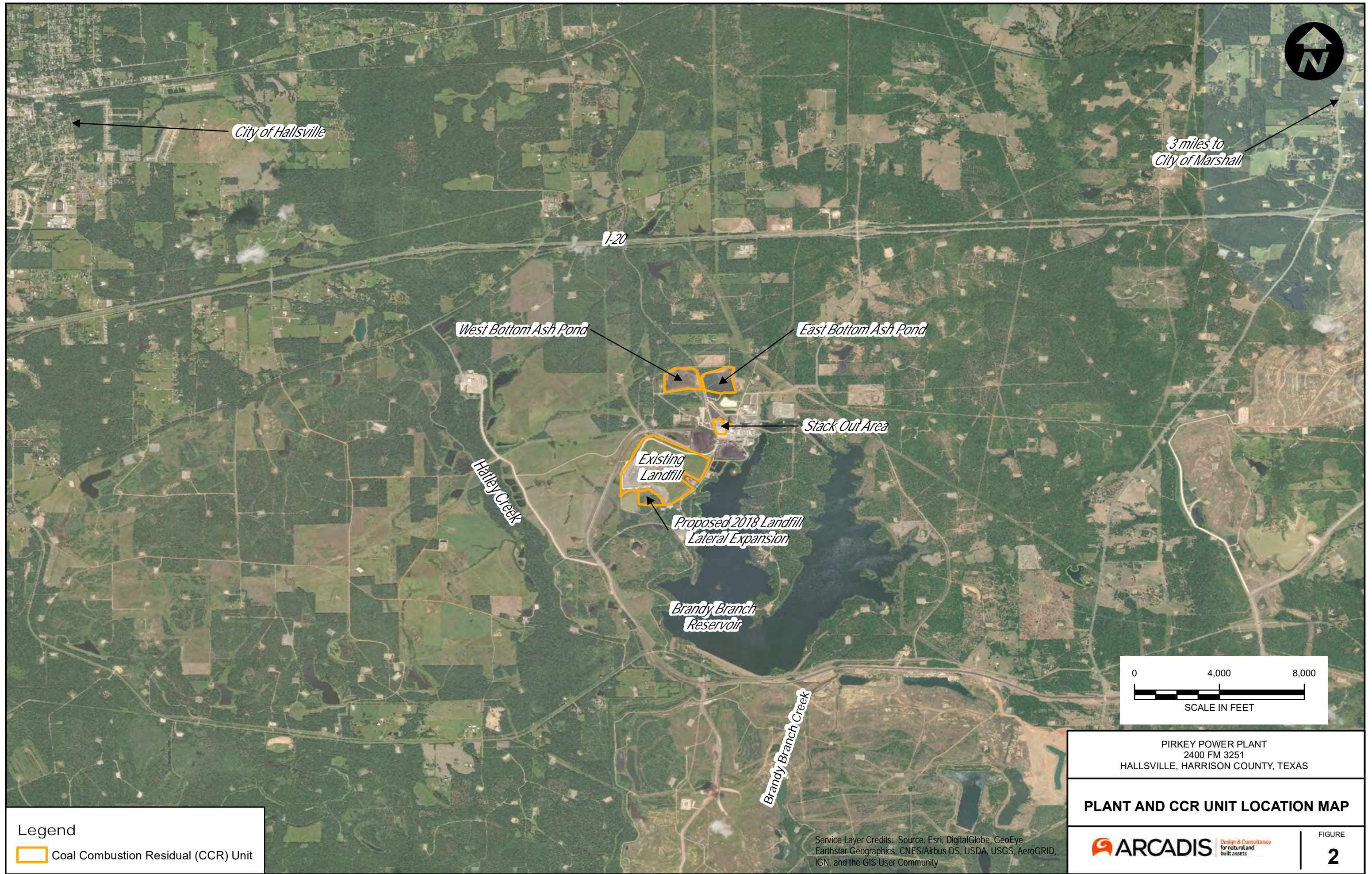
Source:
7.5 minute topographic quadrangle
Darco, Texas, 2013
Easton, Texas, 2013




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

SITE LOCATION MAP





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


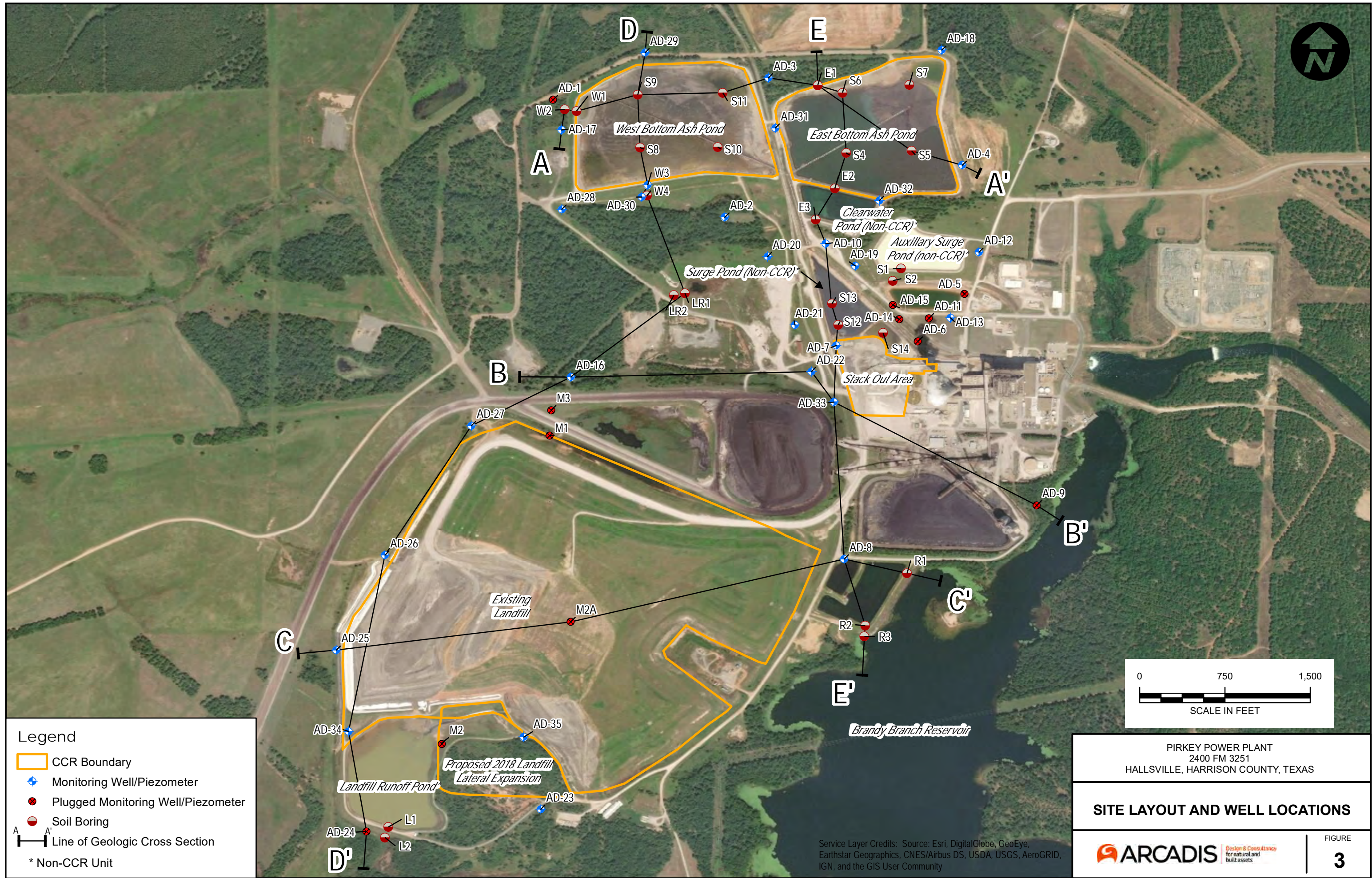
 **ARCADIS** Design & Consultancy for natural and built assets

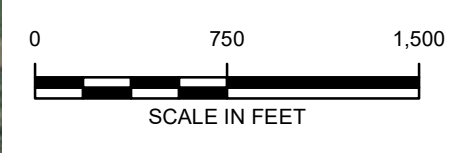
FIGURE **2**



Legend

- CCR Boundary
- ◆ Monitoring Well/Piezometer
- Plugged Monitoring Well/Piezometer
- Soil Boring
- Line of Geologic Cross Section

* Non-CCR Unit



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

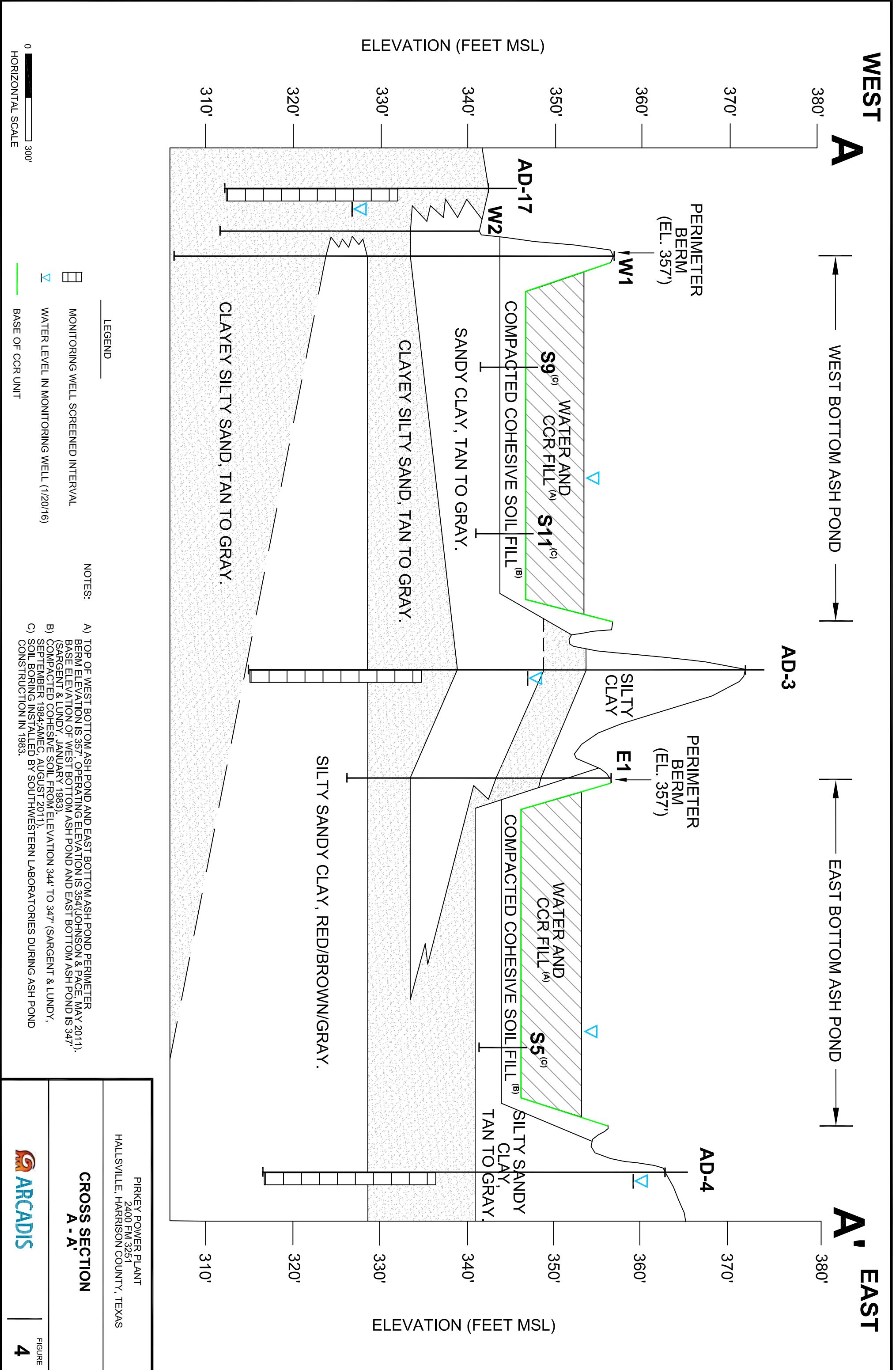
SITE LAYOUT AND WELL LOCATIONS

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built assets

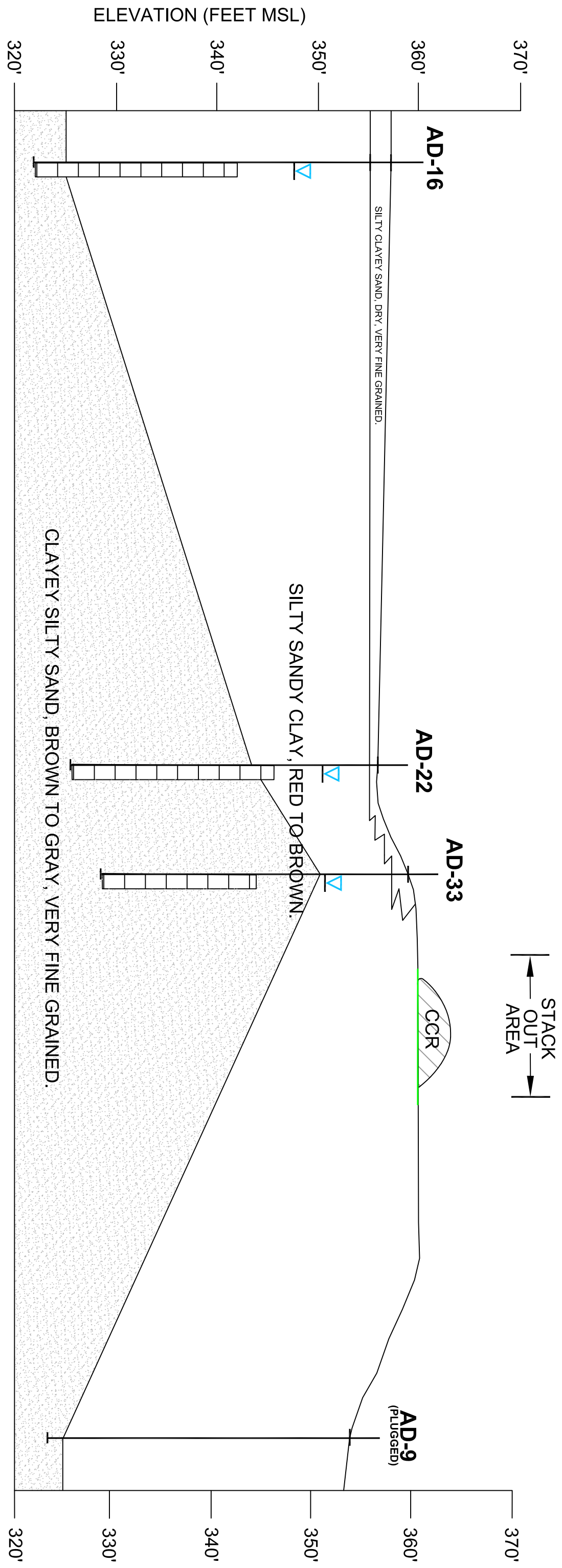
FIGURE

3

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



WEST
B **EAST**
B'



LEGEND

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

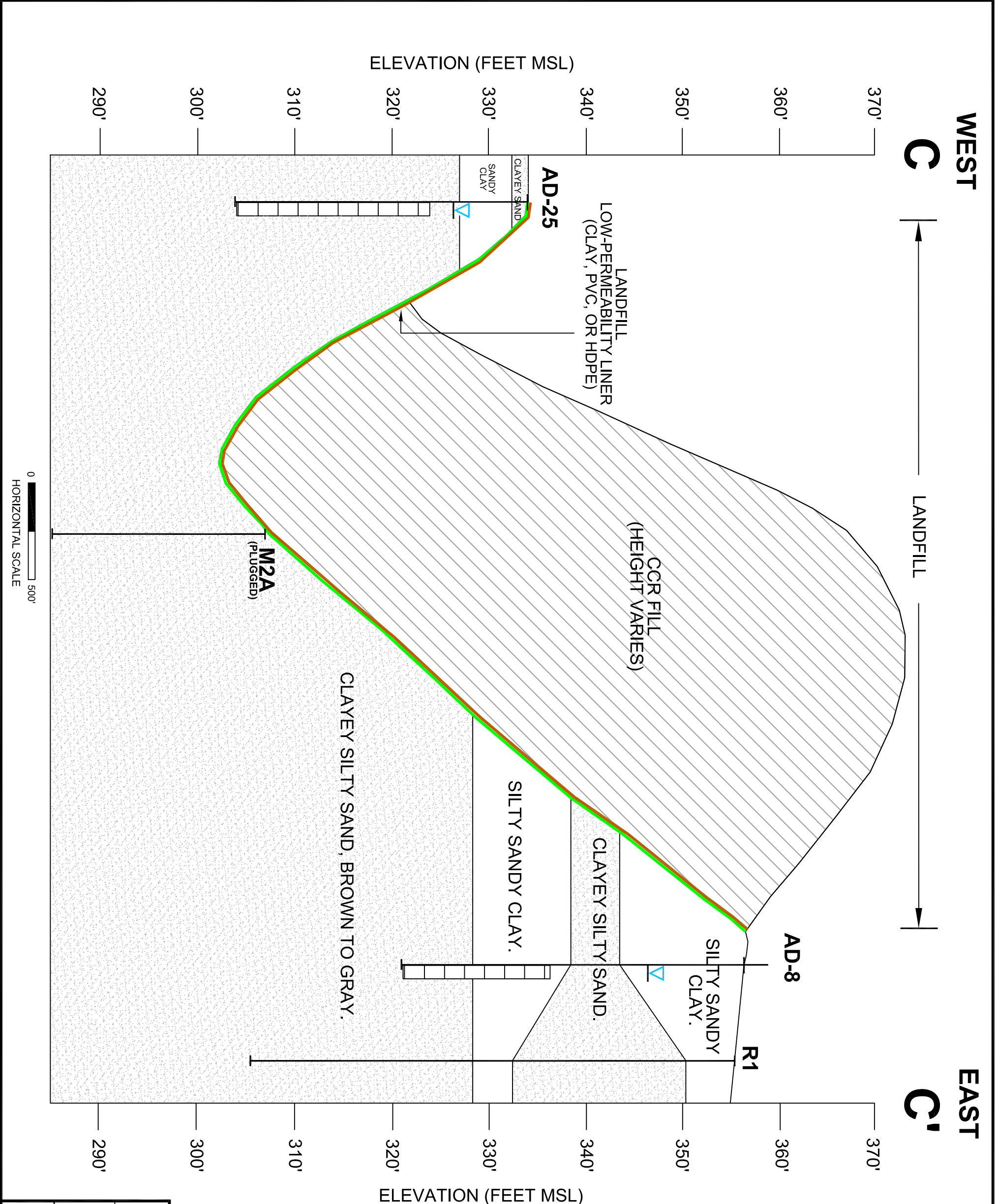
- NOTES:**
- A) BASE OF STACK OUT AREA CCR UNIT LOCATED AT GRADE, ELEVATION TAKEN FROM MAY 2012 AND JUNE 23, 2015 TOPOGRAPHIC SURVEYS BY BEACON AVIATION.
 - B) ELEVATION OF CCR MATERIAL ABOVE STACK OUT AREA VARIES.



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

CROSS SECTION
B - B'



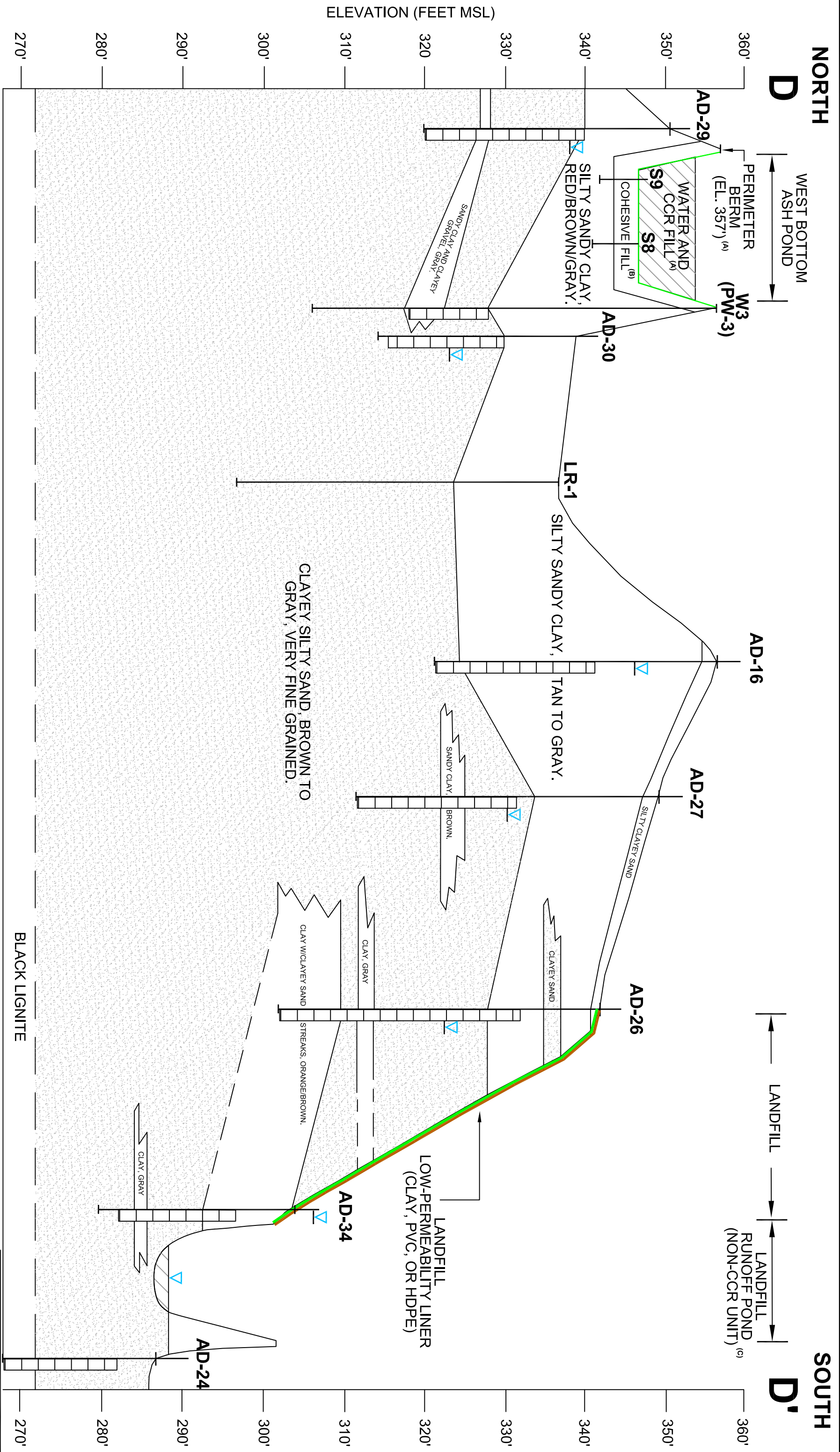


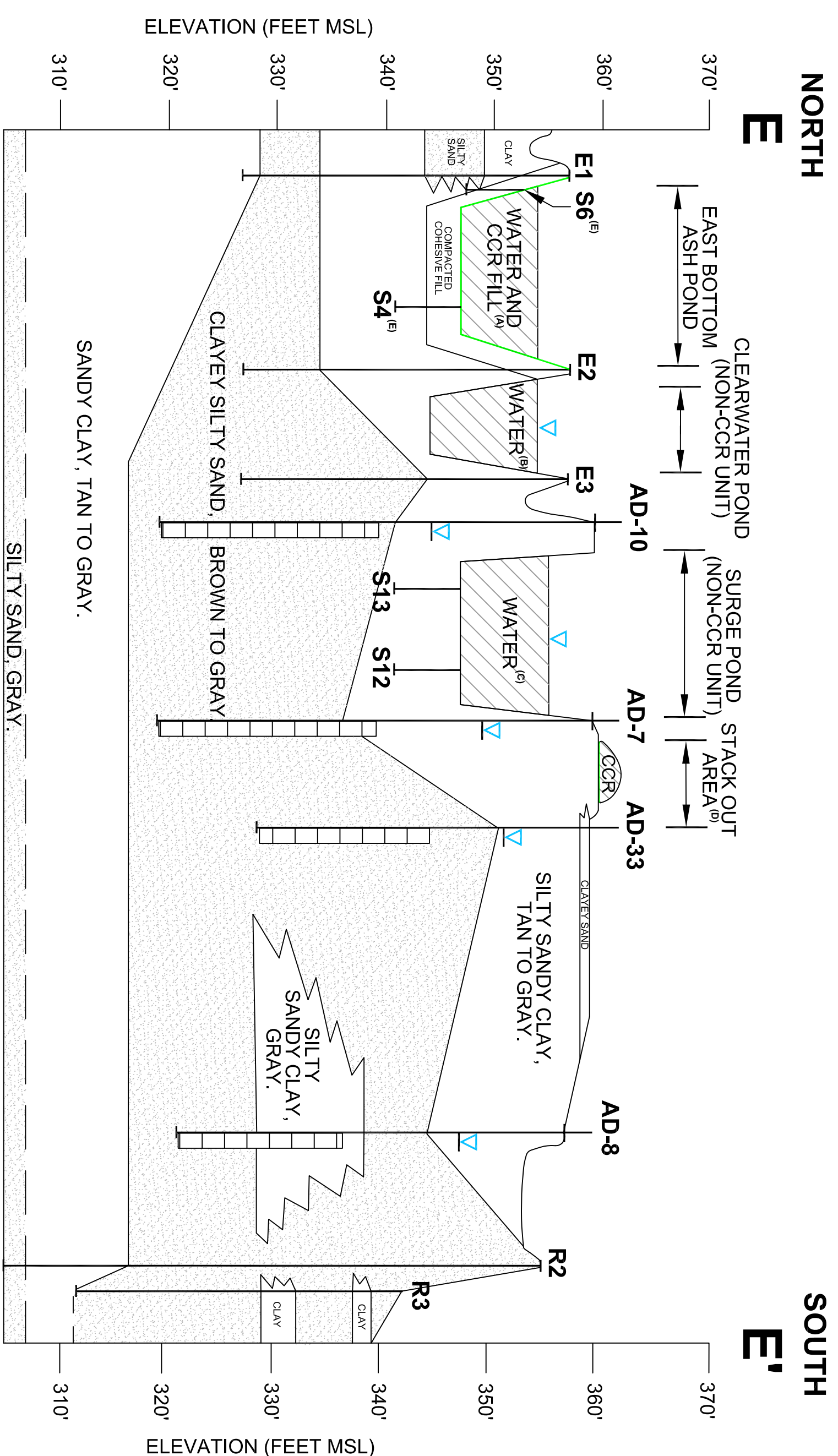
- LEGEND**
- MONITORING WELL SCREENED INTERVAL
 - WATER LEVEL IN MONITORING WELL (1/20/16)
 - BASE OF CCR UNIT

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

**CROSS SECTION
 C - C'**





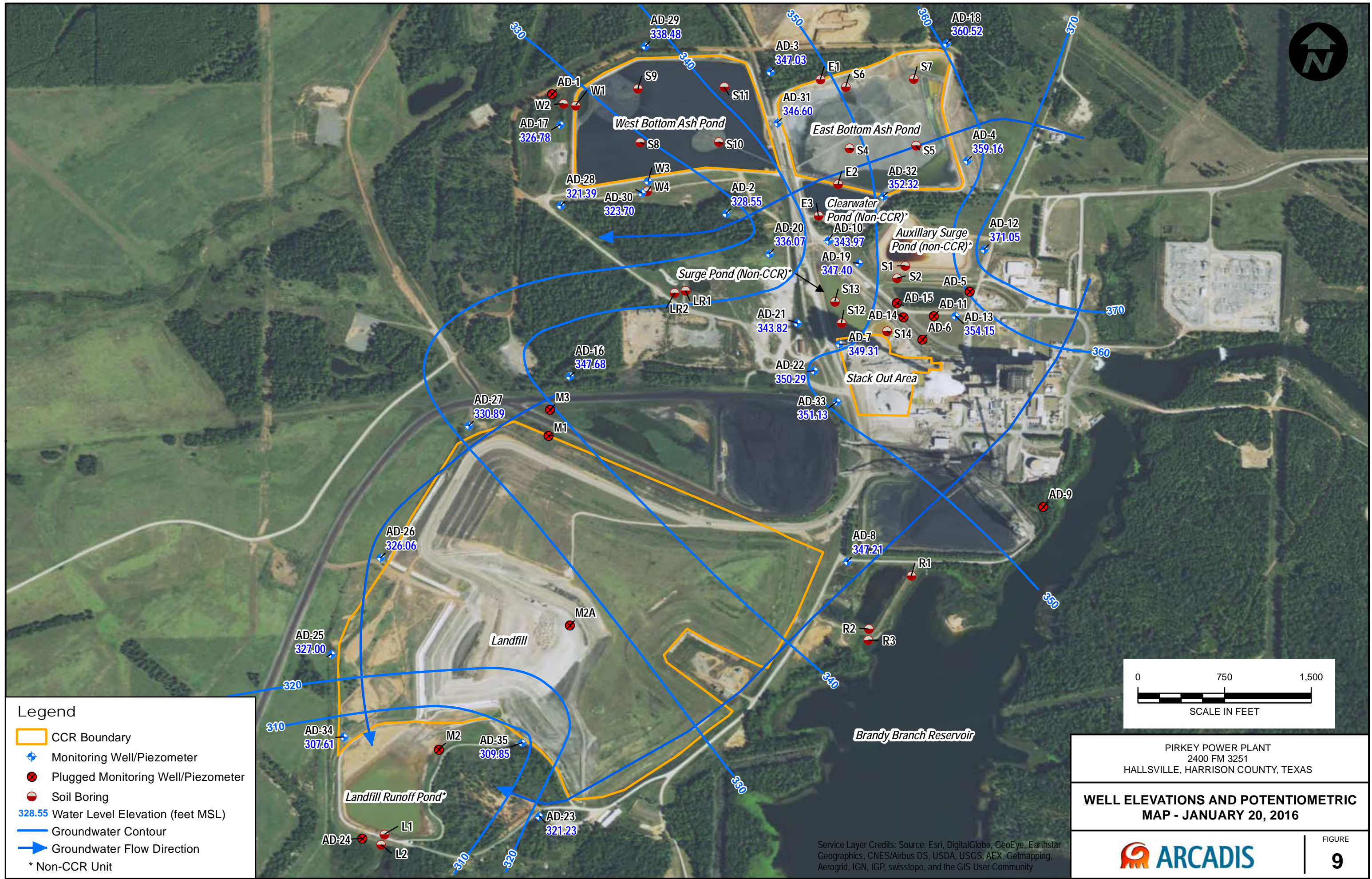


- NOTES:
- A) TOP OF EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON & PACE, MAY 2011); BASE ELEVATION OF EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
 - B) TOP OF CLEARWATER POND PERIMETER BERM ELEVATION IS 357', OPERATING LEVEL IS 354' (JOHNSON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

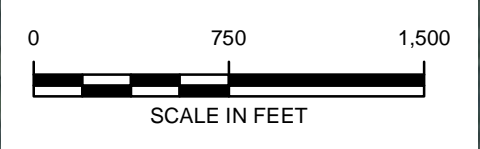
CROSS SECTION
E - E'





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



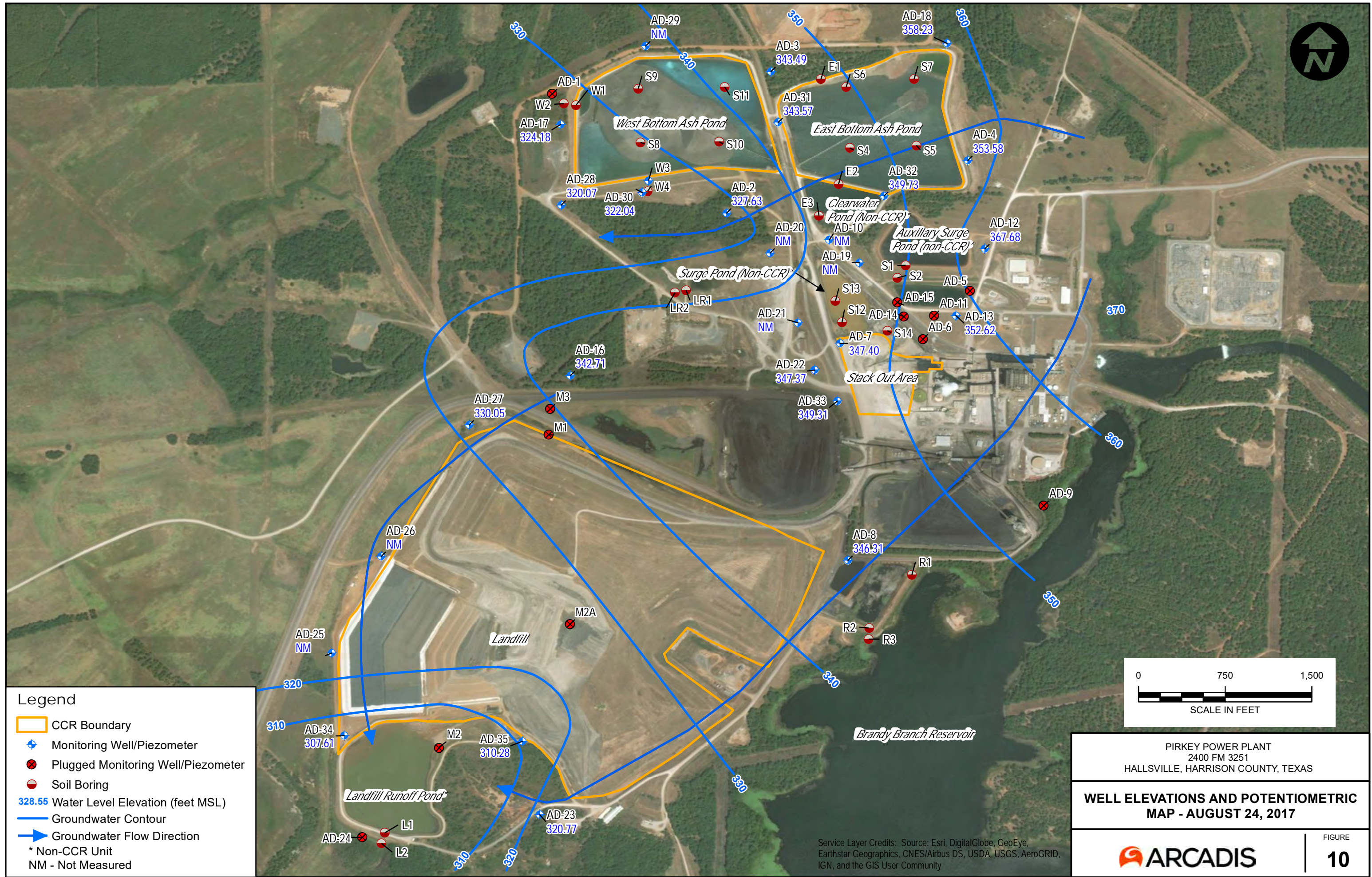
PIRKEY POWER PLANT
 2400 FM 3251
 HALLSVILLE, HARRISON COUNTY, TEXAS

**WELL ELEVATIONS AND POTENTIOMETRIC
 MAP - JANUARY 20, 2016**

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

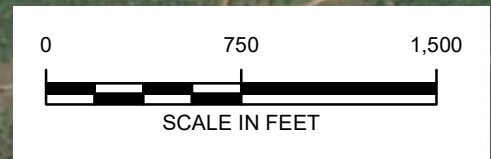
ARCADIS

FIGURE
9



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



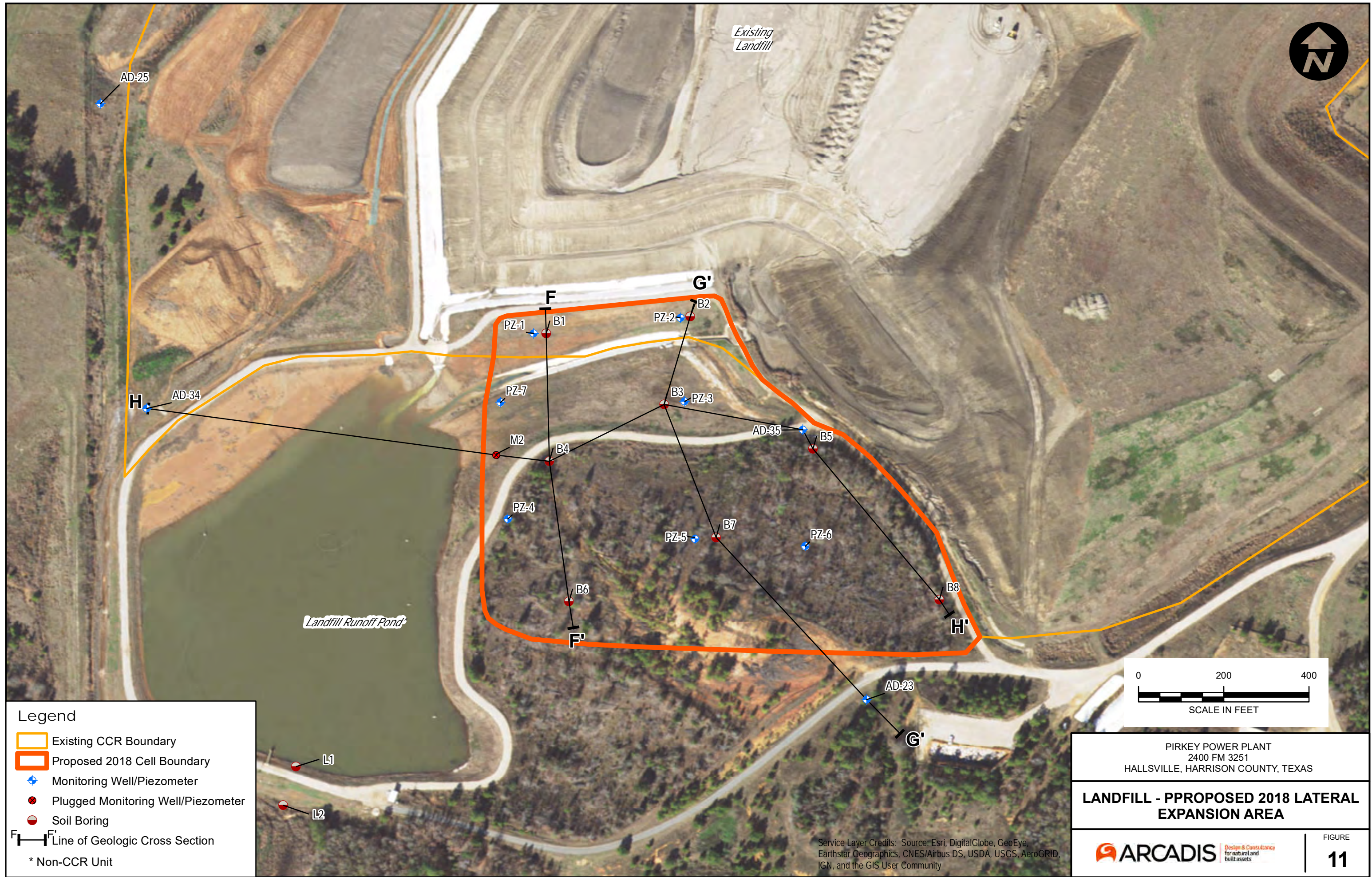
PIRKEY POWER PLANT
2400 FM 3251
HALLSVILLE, HARRISON COUNTY, TEXAS

**WELL ELEVATIONS AND POTENTIOMETRIC
MAP - AUGUST 24, 2017**

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

ARCADIS

FIGURE
10



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

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

**LANDFILL - PPROPOSED 2018 LATERAL
EXPANSION AREA**



Design & Constancy
for natural and
built assets

FIGURE

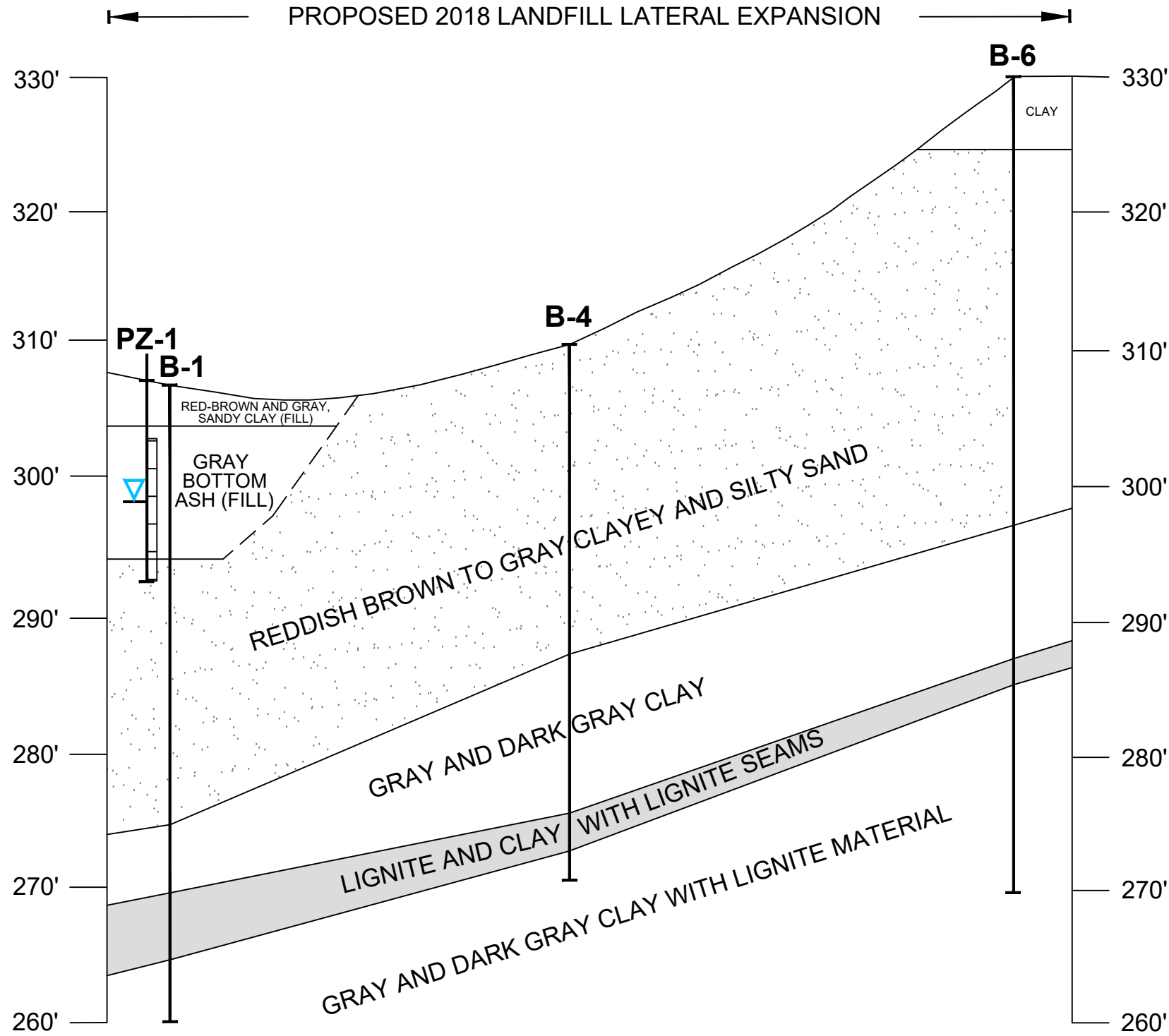
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NORTH
F

SOUTH
F'



ELEVATION (FEET MSL)

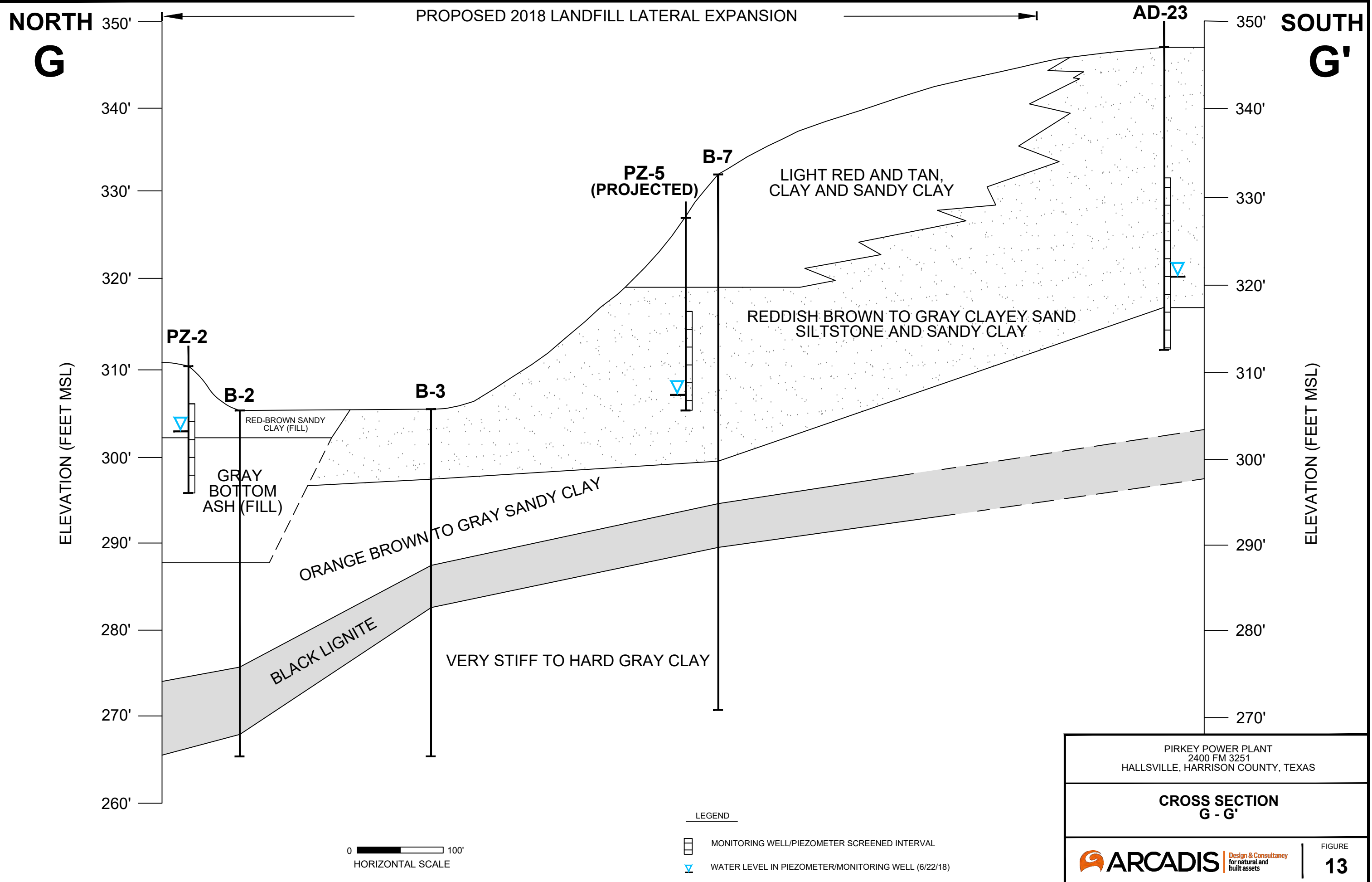
ELEVATION (FEET MSL)



- 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'	
	Design & Consultancy for natural and built assets
FIGURE 12	

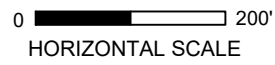
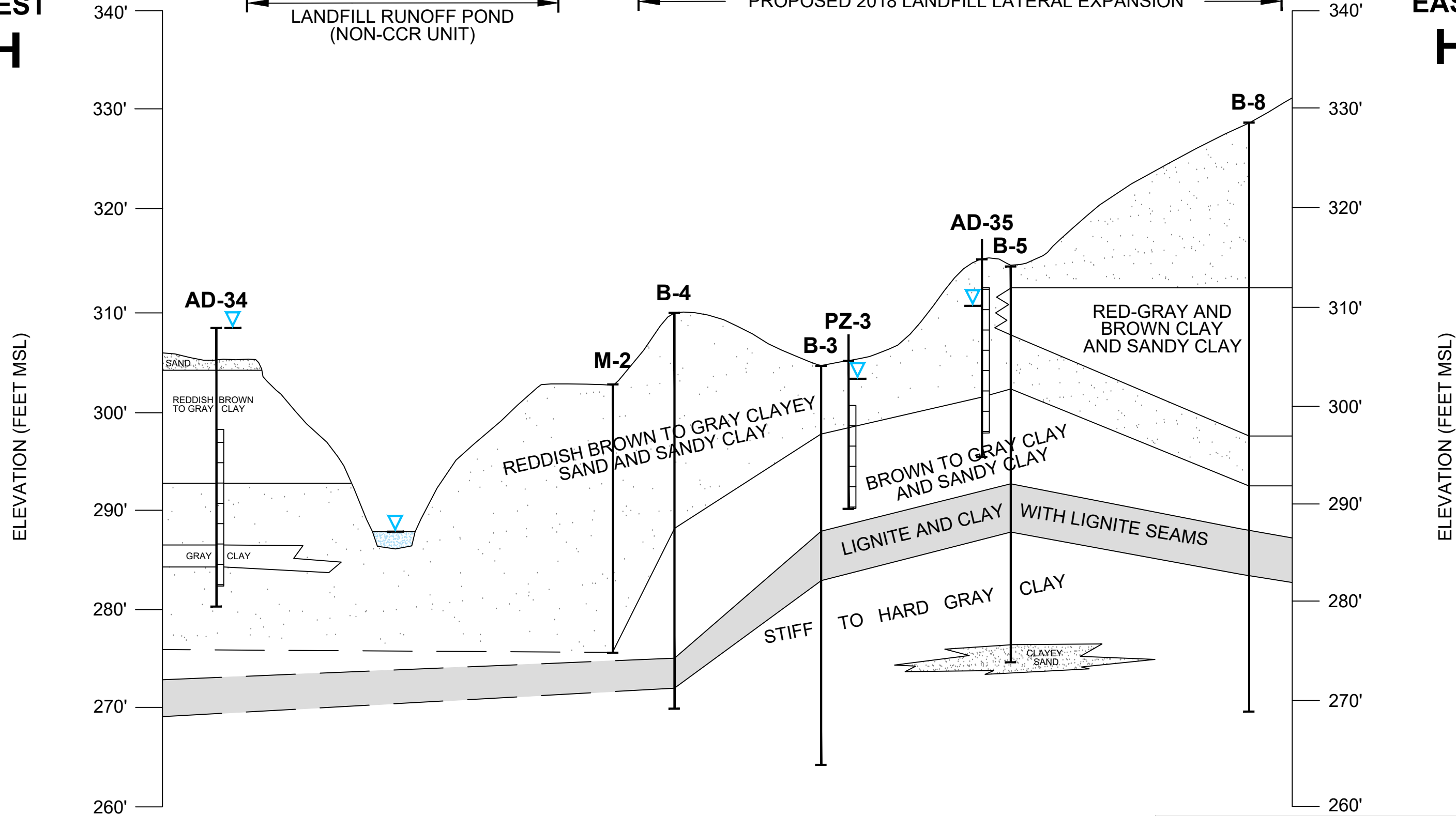
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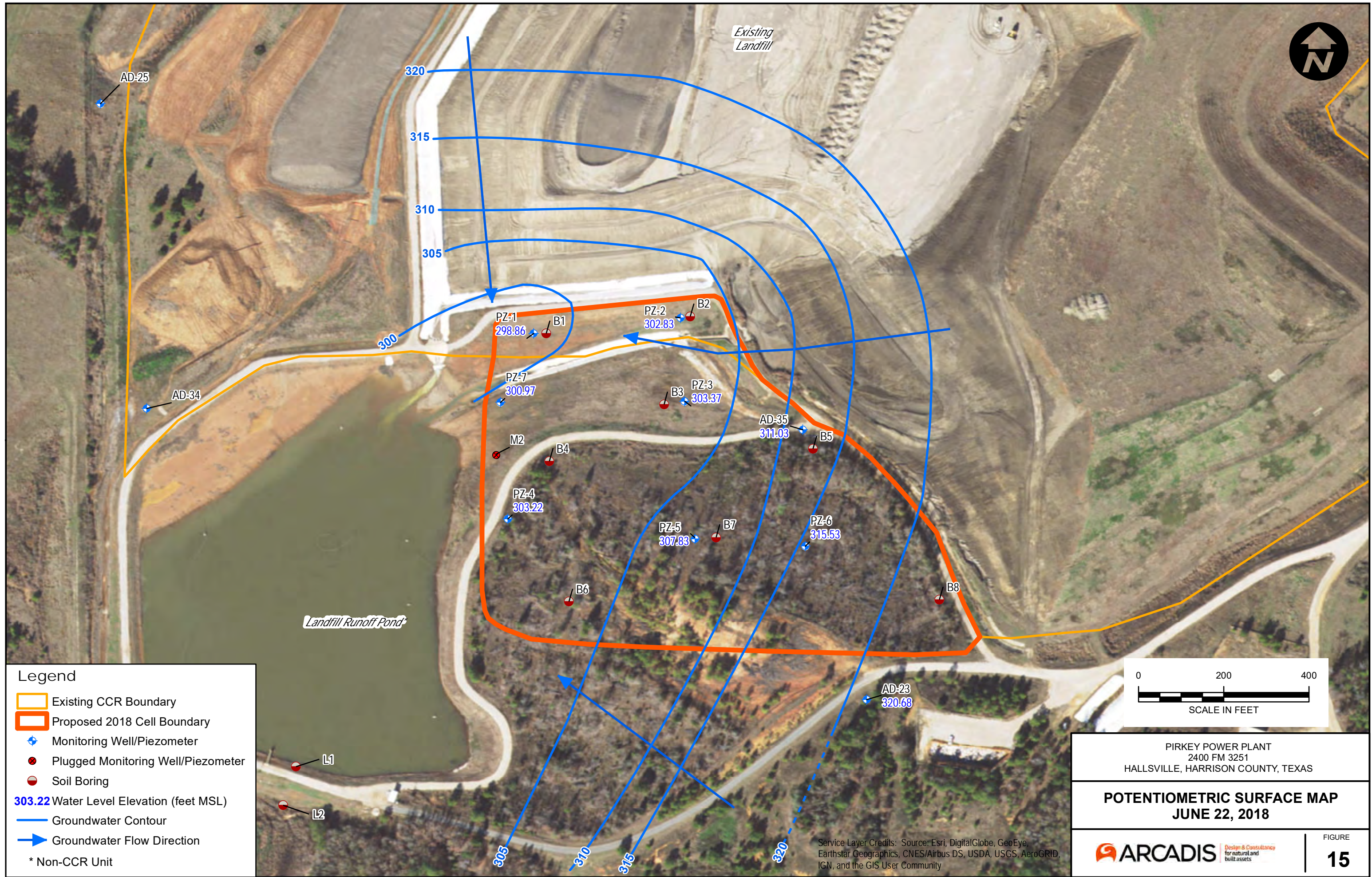
**WEST
H**

**EAST
H'**



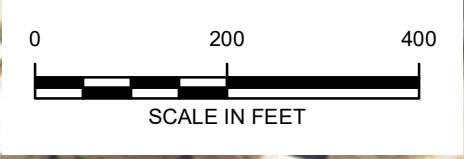
NOTE: LANDFILL RUNOFF POND PERIMETER BERM APPROXIMATE ELEVATION 302' MSL,
 BASE OF LANDFILL RUNOFF POND APPROXIMATE ELEVATION 286' MSL.
 NORMAL OPERATING LEVEL 288' MSL (JOHNSON & PACE MAY 2011).

PIRKEY POWER PLANT 2400 FM 3251 HALLSVILLE, HARRISON COUNTY, TEXAS	
CROSS SECTION H - H'	
	Design & Consultancy for natural and built assets
FIGURE 14	



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



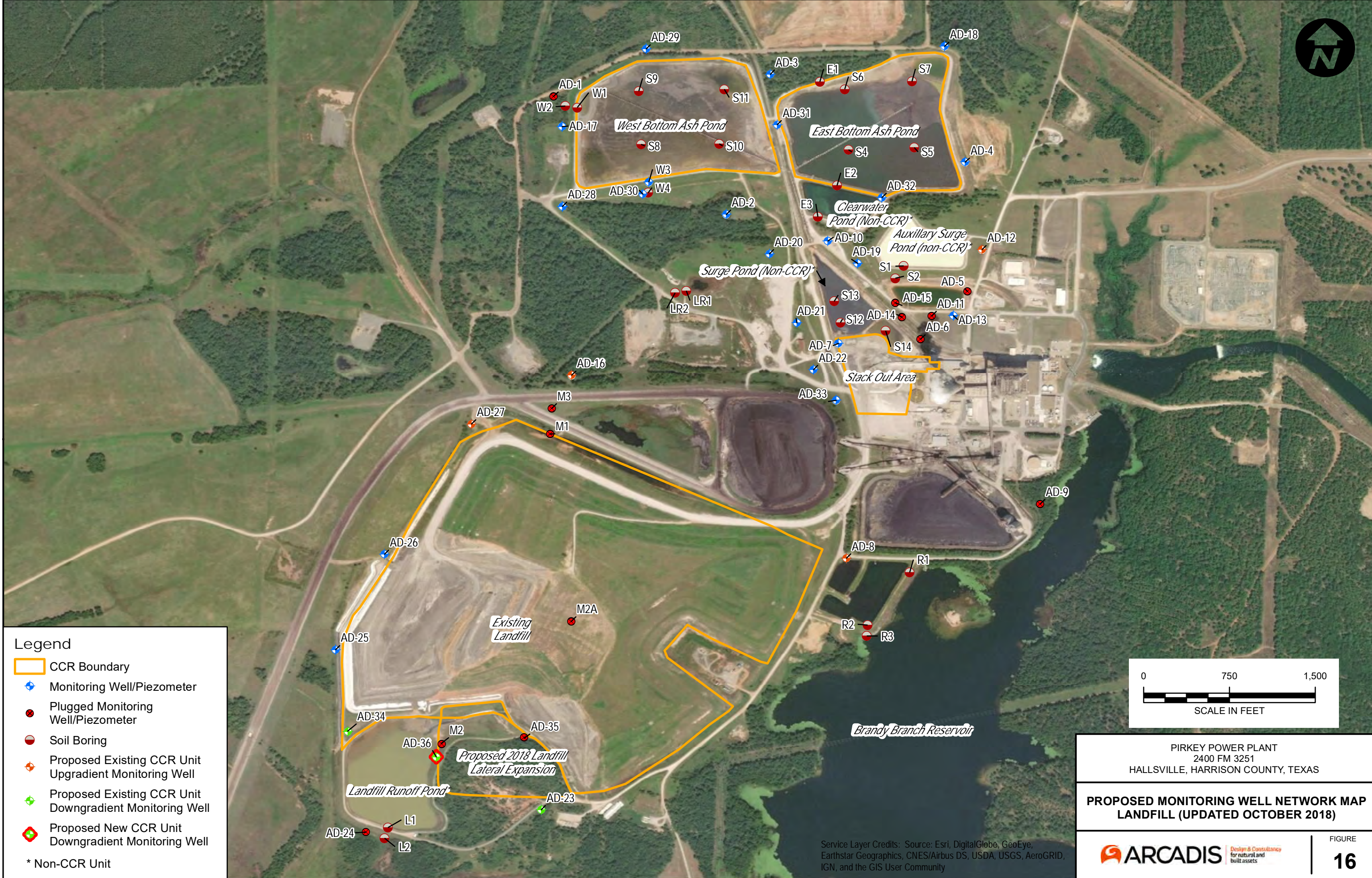
PIRKEY POWER PLANT
 2400 FM 3251
 HALLSVILLE, HARRISON COUNTY, TEXAS

POTENTIOMETRIC SURFACE MAP
JUNE 22, 2018

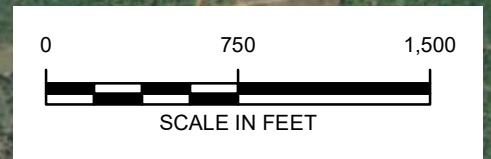
Design & Constancy
for natural and
built assets

FIGURE
15

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, 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
 - Proposed New CCR Unit Downgradient Monitoring Well
- * Non-CCR Unit



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

**PROPOSED MONITORING WELL NETWORK MAP
LANDFILL (UPDATED OCTOBER 2018)**

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



Appendix A

Boring/Well Construction Logs

832964

LOG OF BORING

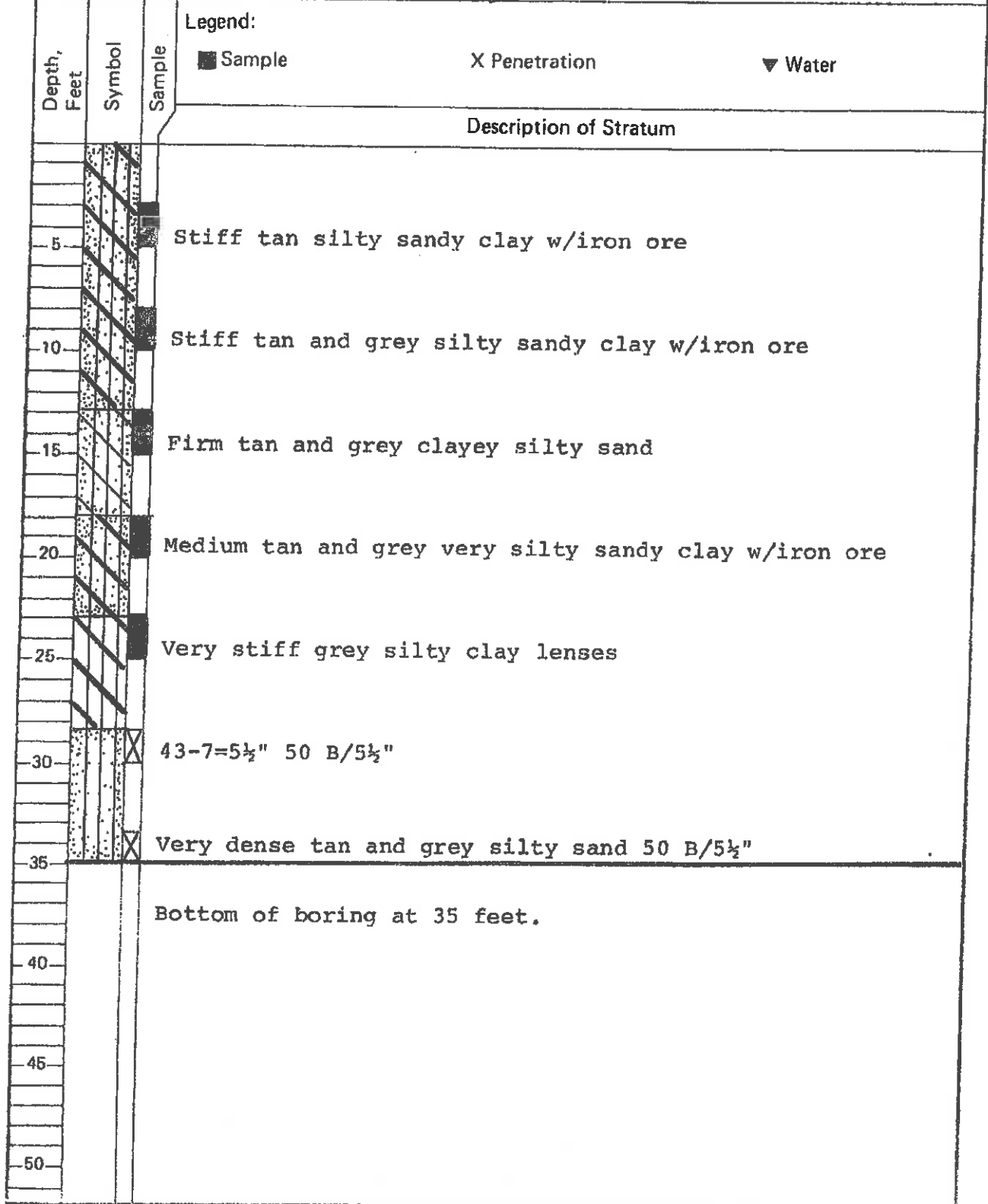
PROJECT: Waste Water Ponds
CLIENT: SWEPCO

BORING NO.: MW-8
LOCATION: Hallsville

Date: 10-4-83

Type: Auger

Ground Elevation:



APEX PROJECT NO.: 110-089 **BORING** **MONITOR WELL**
BORING NUMBER: _____ **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
LATITUDE: 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				0-2	SM	Silty sand, very fine grained, light brown	None	Dry
2				2-8	CL	Sandy clay, yellowish brown, reddish brown -some iron oxide concretions at 2.5' -light gray at 5'	None	Dry
3				8-10	CL	Clay, red, light yellowish brown, gray, fat, hard, some very fine laminated sand seams	None	Dry
4				10-11	CL	Sandy clay, red, light gray, yellowish brown, stiff to hard	None	Dry
5				11-14.25	CL	Clay, yellowish brown, some sand, reddish brown, light gray, hard	None	Dry
6				14.25-18	CL	-clayey sand seam at 14-14.25', yellowish brown, light gray Sandy clay, red, light gray, gray, very thin sand lenses interbedded in clay	None	Moist V. Moist
7				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
8				32-35	SC	Clayey sand, greenish gray, light gray, some very fine gypsum crystals, dense	None	Moist
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

Cement Bentonite Filler 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.

<input type="checkbox"/> BORING APEX PROJECT NO.: <u>110-089</u> BORING NUMBER: _____	<input checked="" type="checkbox"/> MONITOR WELL MONITOR WELL NUMBER: <u>AD-23</u>
FACILITY NAME: <u>AEP- Pirkey Power Plant</u>	FACILITY ID NO.: <u>N/A</u>
FACILITY ADDRESS: <u>Hallsville, Texas</u>	
DRILLING COMPANY/METHOD/RIG: <u>Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig</u>	
DRILLER: <u>Ed Wilson, Apex Geoscience Inc.</u>	COMPLETION DATE: <u>12/15/2010</u>
PREPARED BY: <u>David Bedford</u>	LOGGED BY: <u>David Bedford</u>
LATITUDE: <u>N 32°27'03.3"</u> Datum: <u>WGS-84</u>	WELL LOCATION: _____
LONGITUDE: <u>W94°29'41.3"</u>	

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture			
1-9				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		
10-14				9-14	ML	Siltstone with light gray clay streaks, light gray with orangish brown streaks, few small iron ore pebbles	None	Moist		
15-20				14-20	SM	Sand, light gray with orangish brown streaks, very silty, very fine grained, few clay laminations	None	Slightly Moist		
21-27				20-27	ML	Siltstone, light gray with orangish brown streaks	None	Very Moist		
28-30				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		
33-35				31.5-35	CL	Lean clay, dense, small sandy streaks, dark gray, very fine grained (31.5-35')	None	Moist		
36-40				Boring Terminated at 35'						

Cement
 Bentonite
 Filter Sand
 Water Level



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.

BORING MONITOR WELL
 BORING NUMBER: _____ MONITOR WELL NUMBER: AD-24

APEX PROJECT NO.: 110-089

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

LATITUDE: 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				0-1.5	SM	Silty sand, very fine grained, some clay, brown and reddish brown, medium dense	None	Moist	
2				1.5-6.5	SC	Clayey sand, silty, gray, yellowish brown, reddish brown, very fine grained, dense	None	Dry	
3						-some iron oxide concretions and gravel at 5-6', trace organic matter at 6', gray, dark gray, reddish brown, loose to med. dense		Moist	
4									
5									
6									
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						- some clay at 15-16', medium dense, gray, dark gray		Moist	
15									
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



Total Depth: 20 feet Risers Interval: +3 (ags)-5'
 Filter Sand (Size/Interval): 3-20' Screen Interval: 5-20'
 Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-3' Water level: 8.4
 Surface Completion Flush Above Ground 3'

Note: This log is not to be used separate from this report.
 Boring Logs, 110-089, AD-24

BORING MONITOR WELL
 APEX PROJECT NO.: 110-089 BORING NUMBER: _____ 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
 LATITUDE: 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							
22					20-22' - Large clay inclusions, brown		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	None	Wet
32					Wet from 30-30.5'		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



Total Depth: 40 feet Riser Interval: +3 (ags)-10'
 Filter Sand (Size/Interval): 8-40' Screen Interval: 10-40'
 Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8' Water level: 19.45'
 Surface Completion Flush 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-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
 LATITUDE: 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				0-2	SC	Clayey sand, orangish brown with dark gray laminations, very fine grained	None	Slightly Moist
2				2-15.5	CL	Lean clay, dense, few thin sandy streaks, reddish orange, very fine grained, mottled with light brownish gray	None	Slightly Moist
3								
4								
5								
6								
7								
8								
9								
10								
11								
12						Orange to brown with orangish brown streaks, at 10' becomes brittle		
13								
14								
15								
16				15.5-23	SC	Clayey sand, greenish brown with orangish brown streaks, few thin tan clay streaks, very fine grained	None	Moist
17								
18								
19								
20								
21								
22								
23								
24				23-24	SM	Sand, orangish brown, silty, very fine grained	None	Wet
25				24-27	CH	Fat clay, brown with orangish brown streaks, many sandy streaks, very fine grained	None	Very Moist
26								
27			▽					
28				27-30	SM	Sand, greenish gray with orangish brown streaks, very fine to fine grained, wet	None	Wet
29								
30								
31				30-37.5	SC	Clayey sand with clay streaks, light greenish black, very fine grained	None	Slightly Wet
32								
33								
34								
35								
36						Wet red brittle shale from 35-35.2		
37								
38								
39						Boring Terminated at 37.5'		
40								

Cement Bentonite Filter Sand Water Level

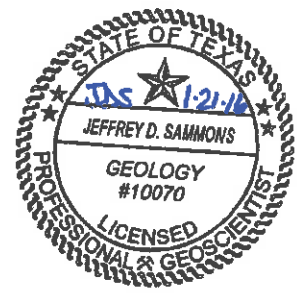
Apex geoscience inc. Total Depth: 40 feet Riser Interval: +3 (ags)-17.5'
 Filter Sand (Size/Interval): 15.5-37.5' Screen Interval: 17.5-37.5'
 Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-15.5' Water Level: 26.73'
 Surface Completion Flush Above Ground 3'

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



Monitor Well

Monitor Well No.: AD-34



PROJECT INFORMATION		DRILLING INFORMATION	
PROJECT:	Pirkey Power Plant	DRILLER:	Buford Collier
PROJECT NO.:	I-04-1021	DRILLER'S LICENSE NO.:	60089
LOGGED BY:	Jeffrey D. Sammons, P.G.	RIG TYPE:	Geoprobe 3230DT
SUPERVISING PG:	Jeffrey D. Sammons, P.G.	METHOD OF DRILLING:	Hollow Stem Auger
COMPLETION:	12/11/2015	SAMPLING METHODS:	Split Core
DEVELOPMENT:	12/16/2015	SURFACE ELEVATION:	307.61 (Top of Casing)
SITE LOCATION:	2400 FM 3251, Hallsville, Texas	HOLE DIAMETER:	8.26"
WELL OWNER:	AEP	LATITUDE	32 27' 10.13"
		LONGITUDE	94 29' 57.93"

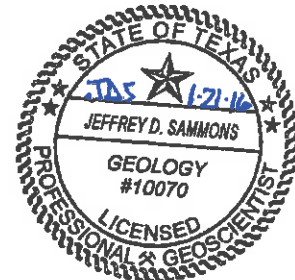
Water Level Upon Installation
 Water Level at Time of Drilling
 Geotechnical Lab Sample
 TBPB No. 50027

DESCRIPTION	USCS	SOIL SYMBOLS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI	WELL CONSTRUCTION
			4								<p> Locking Well Casing Cover Locking Well Cap Protective Well Casing Concrete Pad Ground Surface Cement Bentonite 2" Sch. 40 PVC Riser 20/40 Silica Sand 0.010" Slotted Sch. 40 PVC Well Screen PVC Bottom Cap </p>
			3								
			2								
			1								
CLAYEY SAND: very fine to fine sand, some silt, reddish brownish, light reddish brown, light gray, moist	SC		0								
FAT CLAY: trace sand and silt, some iron oxide concretions, dark reddish brown, reddish brown, and and light gray, moist	CH		1								
			2								
			3			31	89	63	23	40	
			4								
- some silt and very fine to fine sand at 5', light gray, light reddish brown, and light yellowish brown, moist to very moist			5								
SANDY LEAN CLAY: some very fine to fine sand, dark gray, moist	CL		6								
			7								
			8								
			9								
- reddish brown, dark reddish brown, dark gray, light gray at 10' to 12.5'			10								
			11								
SILTY SAND: very fine to fine sand, some clay, gray and dark gray, saturated	SM		12			23	64	26	18	8	
			13								
			14								
			15								
			16			22	29	25	NP	-	
- increasing clay content with depth			17								
			18								
			19								
FAT CLAY: trace sand and silt, gray, moist	CH		20								
			21			23	90	55	27	28	
CLAYEY SAND: fine to very fine sand, dark gray, moist to very moist	SC		22								
			23								
			24								
			25								



Monitor Well

Monitor Well No.: AD-35



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"

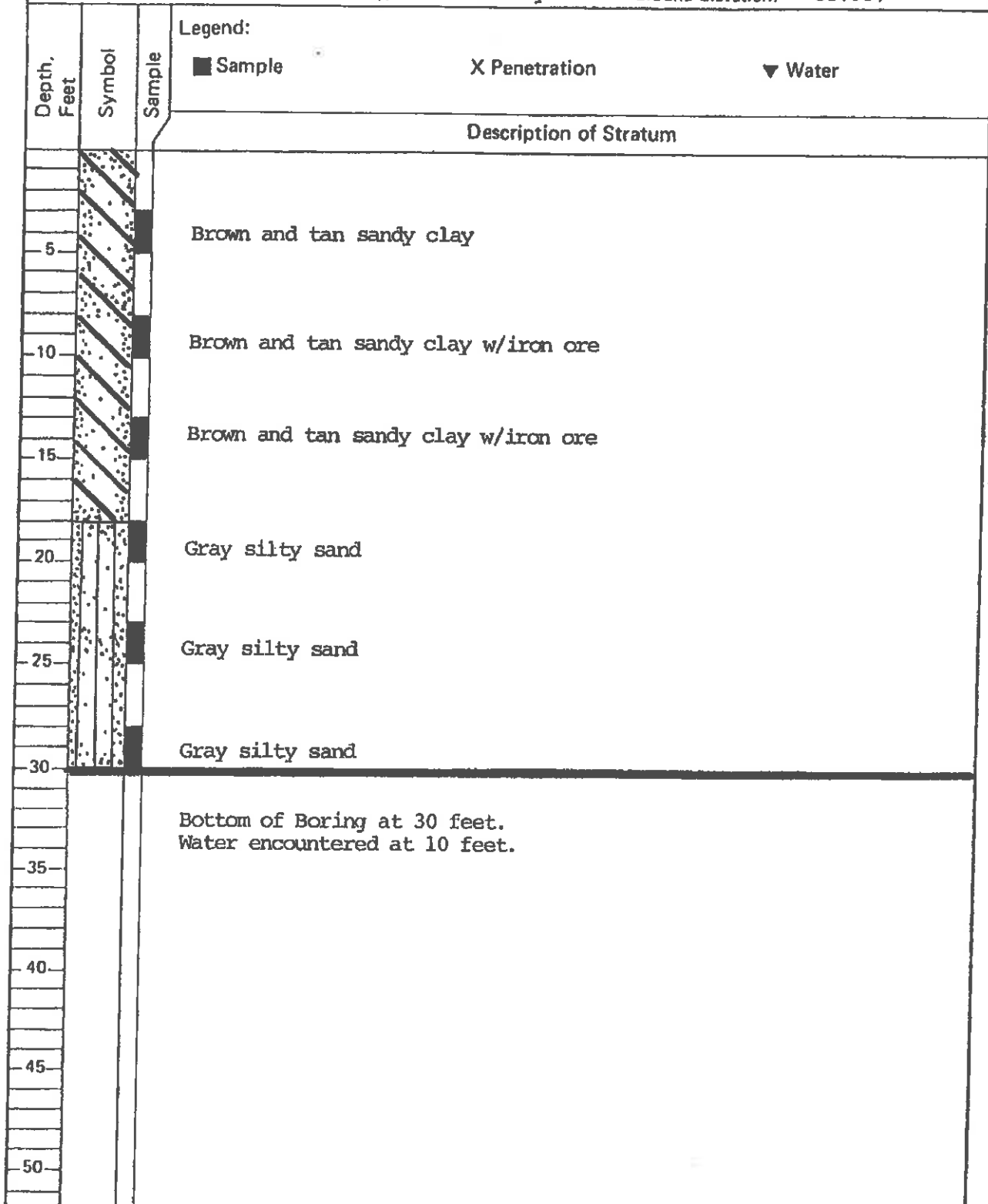
Water Level Upon Installation
 Water Level at Time of Drilling
 Geotechnical Lab Sample
 TBPB No. 50027

DESCRIPTION	USCS	SOIL SYMBOLS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI	WELL CONSTRUCTION
			4								Locking Well Casing Cover
			3								Locking Well Cap
			2								Protective Well Casing
			1								Concrete Pad
			0								Ground Surface
CLAYEY SAND: very fine to fine sand, some iron ore gravel, reddish brownish, dark reddish brown, yellowish brown, gray, moist	SC	[Diagonal Hatching]	-1								Cement
			-2		13	46	32	15	17		2" Sch. 40 PVC Riser
SILTY SAND: very fine to fine sand, trace clay, trace iron ore gravel, light reddish brown, moist, increasing moisture content with depth	SM	[Dotted]	-3								Bentonite
			-4								
			-5		12	26	16	NP			
			-6								
			-7								
			-8								
			-9								
- saturated at 10' to 11'			-10								20/40 Silica Sand
			-11								
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	[Diagonal Hatching]	-12		19	33	31	18	13		0.010" Slotted Sch. 40 PVC Well Screen
			-13								
			-14								
			-15								
LEAN CLAY: interbedded clays and silts with laminations of very fine sand, light gray, gray and light reddish brown, moist to very moist	CL	[Diagonal Hatching]	-16								
			-17		21	93	34	20	14		
- thin lenses of very moist very fine sand and partially cemented very fine sand at 17.5' and 18', reddish brown			-18								PVC Bottom Cap
			-19								
			-20								

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

LOG OF BORING

852164
 PROJECT: Monitoring Well Installation
 CLIENT: Southwestern Electric Power Company
 Date: 1/29/86 Type: Rotary
 BORING NO.: M-1
 LOCATION: Hallsville, TX
 S 12+32.79; W 35+34.55
 Ground Elevation: 337.67



LOG OF BORING

852164
 PROJECT: Monitoring Well Installation
 CLIENT: Southwestern Electric Power Company
 Date: 1/29/86 Type: Rotary

BORING NO.: M-2
 LOCATION: Hallsville, TX
 S 38+86.22; W 45+76.41
 Ground Elevation: 302.19

Legend:
 ■ Sample X Penetration ▼ Water

Depth, Feet	Symbol	Sample	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

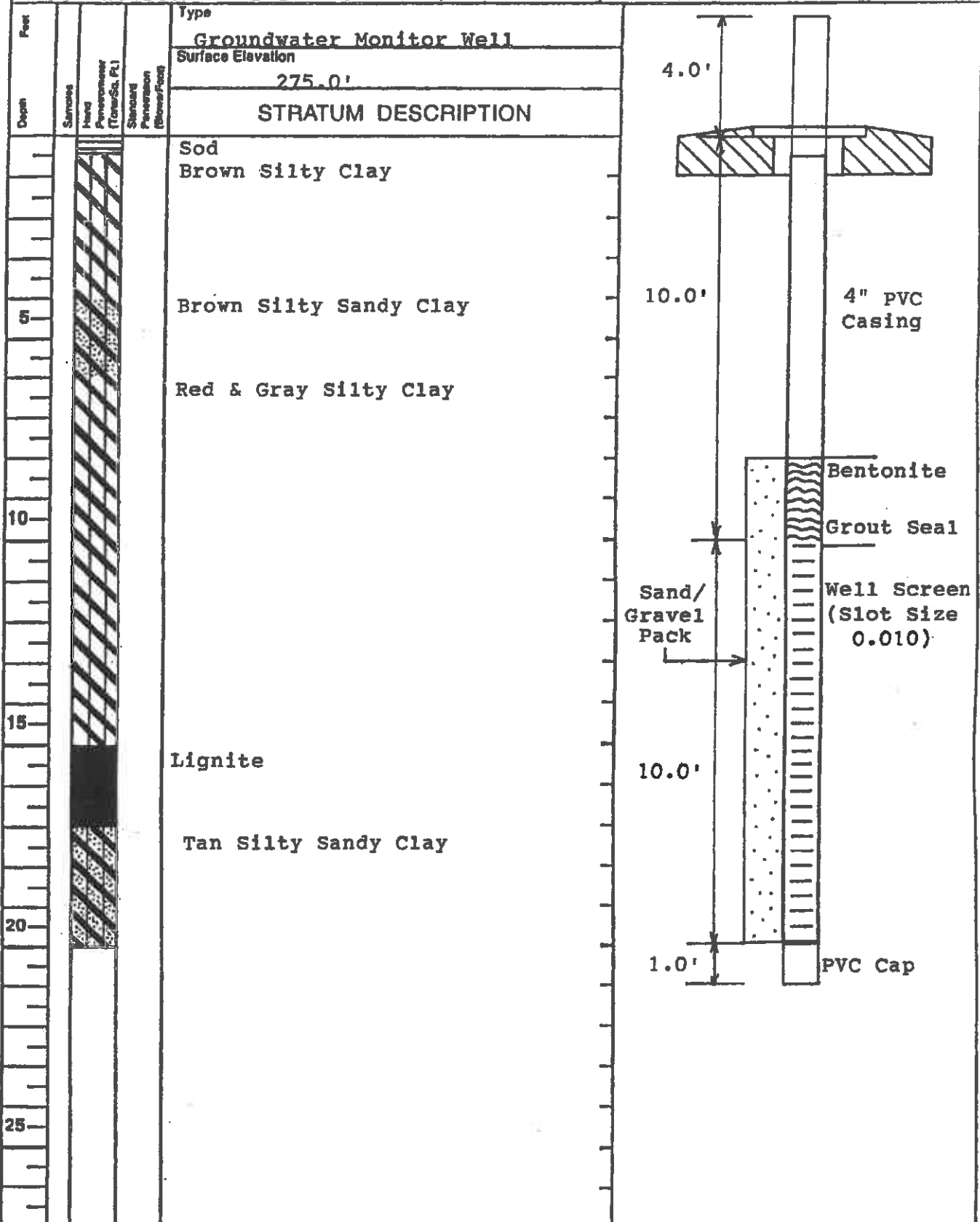
Log of Boring

Number
M-3

Location
Harrison Co., miles SW Marshall City Ha

Project

New Monitor Well Installation, H.W. Pirkey Power Plant



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) 585-4421

LOG OF BORING L-1

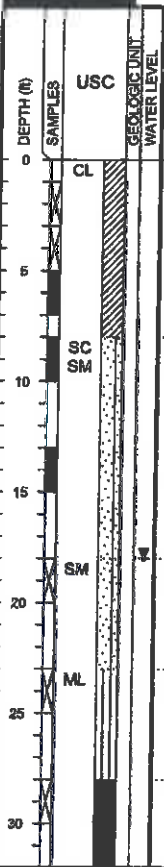
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/19/09

SURFACE ELEVATION: 298.0



MATERIAL DESCRIPTION

SANDY LEAN CLAY (CL) stiff, orangish gray
-reddish brown

SILTY CLAYEY SAND (SC-SM) reddish brown; with gravel

-reddish tan; with iron oxide cemented sandstone

SILTY SAND (SM) very dense; dark gray; laminated; saturated

SANDY SILT (ML) very dense; dark gray; with lignite @ 24'

LIGNITE very dense; black

FIELD STRENGTH DATA	BLOW COUNT				DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psf)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)				OTHER TESTS PERFORMED (Page Ref. #)	
	20	40	60	80					Plastic Limit	Moisture Content	Liquid Limit	LL	PL	PI	MINUS #200 SIEVE (%)		
N=14	●								●			15	37	19	18	74	+40 Sieve=7%, +4 Sieve=2% +40 Sieve=11%, +4 Sieve=3%
N=11	●								●			18	39	20	19	74	
P=4,5+									●			7	20	15	5	32	+40 Sieve=61%, +4 Sieve=33%
SF																	
N=50/3"									●			21				30	+40 Sieve=0%, +4 Sieve=0%
N=73									●								
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:



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1717 East Erwin
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LOG OF BORING L-1

PROJECT: Pirkey Power Plant
Hallsville, Texas

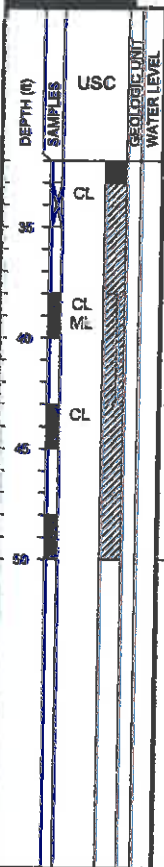
PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE

10/19/08

SURFACE ELEVATION
286.0



MATERIAL DESCRIPTION	
35' - 40'	LEAN CLAY (CL) hard; light gray; with vertical black silty seam
40' - 45'	SANDY SILT CLAY (CL-ML) hard; gray
45' - 50'	LEAN CLAY (CL) hard; dark brown laminated
Bottom of Boring @ 50'	

FIELD STRENGTH DATA	BLOW COUNT				DRY DENSITY (pcf)	COMPRESSION STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psf)	Natural Moisture Content and Atterberg Limits			
	20	40	60	80					Plastic Limit	Moisture Content	Liquid Limit	
N=50/3*	1	2	3	4					20	40	60	80
P=2.25 P=4.5+												
P=4.5+												
P=4.5+												

MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
15	33	19	14	97	+40 Sieve=0%, +4 Sieve=0%
16	22	16	6	51	+40 Sieve=0%, +4 Sieve=0%

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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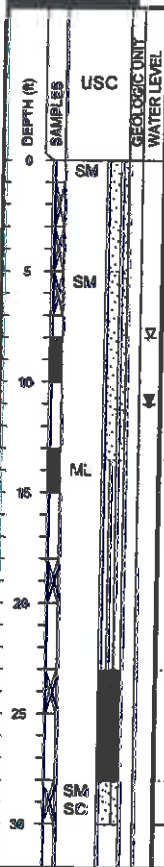
LOG OF BORING L-2

PROJECT: Pirkey Power Plant
Hallsville, Texas
PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/19/09

SURFACE ELEVATION: 291.4



MATERIAL DESCRIPTION	
0 - 4	SILTY SAND(SM) loose; tan
4 - 11	SILTY SAND(SM) loose; tan --red and gray --with gravel
11 - 24	SANDY SILT(ML) dark gray --dark gray
24 - 26	LIGNITE very dense; black
26 - 30	SILTY CLAYEY SAND(SM-SC) very dense; dark gray; laminated with gray silt

FIELD STRENGTH DATA	BLOW COUNT				DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psf)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			OTHER TESTS PERFORMED (Page Ref. #)	
	20	40	60	80					Plastic Limit	Moisture Content	Liquid Limit		LI	PL	PI		MINUS #200 SIEVE (%)
	1	2	3	4													
N=6	●	●	●	●													
N=8	●	●	●	●													
N=6	●	●	●	●													
SF																	
SF																	
N=50/4"																	
N=50/3"																	
N=68																	

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 (psf)
T - Torvane (tsf)
L - Lab Vane Shear (tsf)

Notes: GPS Coordinates: N 32°27.034', W 94°29.952'



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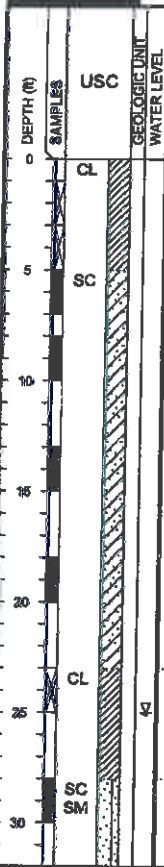
LOG OF BORING R-1

PROJECT: Pirkey Power Plant
Hallsville, Texas
PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE: 10/19/09

SURFACE ELEVATION: 356.3



MATERIAL DESCRIPTION

SANDY LEAN CLAY (CL) medium stiff; red and brown; with gravel
—stiff; clay content increasing

CLAYEY SAND (SC) medium dense; reddish brown; with ferric seams

—with clay nodules

SANDY LEAN CLAY (CL) very stiff; orange and tan; saturated

CLAYEY SILTY SAND (SC-SM) orange and gray

FIELD STRENGTH DATA	BLOW COUNT		DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			OTHER TESTS PERFORMED (Page Ref. #)	
	20	40				60	80	Plastic Limit		Moisture Content	Liquid Limit	LL		PL
N=9	1	2	3	4										
N=13	1	2	3	4					17	47	16	28	52	+40 Sieve=4%, +4 Sieve=1%
P=2.75														
P=3.0									13	33	16	17	22	+40 Sieve=36%, +4 Sieve=30%
P=2.5														
P=1.75 SF						106	1.10	4	9	20				
P=3.0									17	34	15	19	39	+40 Sieve=8%, +4 Sieve=1%
N=25 P=3.5									18	42	21	21	57	+40 Sieve=8%, +4 Sieve=6%
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

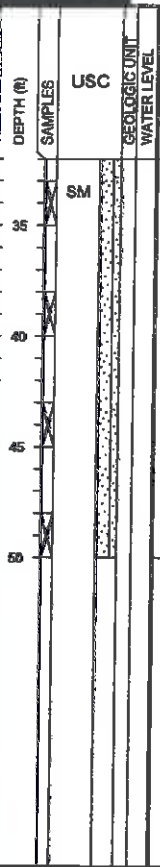
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

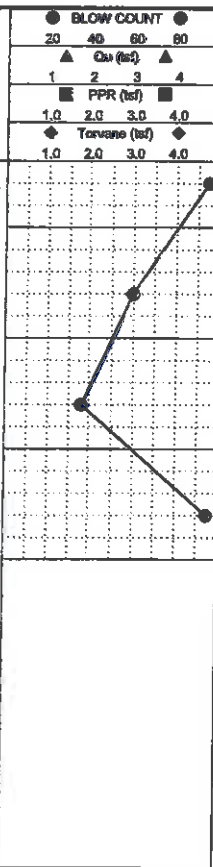
DATE: 10/19/08

SURFACE ELEVATION
356.3



MATERIAL DESCRIPTION	
SM	SILTY SAND(SM) very dense; gray; with gravel
	-orange and gray
	-brown
	-brown and gray
Bottom of Boring @ 50'	

FIELD STRENGTH DATA
N=50/5.5'
N=60
N=36
N=50/6.75'



DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (tsf)	Natural Moisture Content and Atterberg Limits
				Plastic Limit Moisture Content Liquid Limit 20 40 60 80

MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			MINIUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	LL	PL	PI		
22				16	+40 Sieve=2%, +4 Sieve=1%

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-2

PROJECT: Pirkey Power Plant
Haltsville, Texas

PROJECT NO.: G3241-095

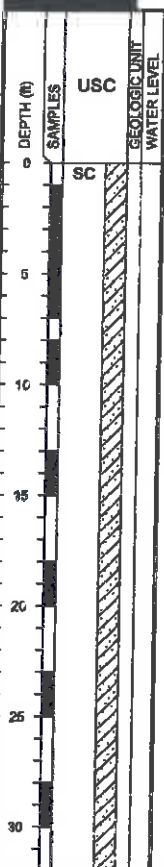
BORING TYPE: Flight Auger

DATE

10/19/09

SURFACE ELEVATION

355.1



MATERIAL DESCRIPTION

CLAYEY SAND(SC) medium dense; reddish tan; with gravel

-red and orangish gray; with clay lenses

-gravelly and ferric seams

-orange and red

-red and tan

-red and orange


FIELD STRENGTH DATA	BLOW COUNT				DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psf)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			OTHER TESTS PERFORMED (Page Ref. #)
	20	40	60	80					Plastic Limit	Moisture Content	Liquid Limit		LL	PL	PI	
P=4.5+									~65	~15	~13	~38	~17	~21	~44	+40 Sieve=6%, +4 Sieve=2%
P=4.5+									~65	~15	~14	~38	~17	~21	~41	+40 Sieve=8%, +4 Sieve=3%
P=2.0									~65	~15	~18	~36	~18	~18	~44	+40 Sieve=12%, +4 Sieve=5%
P=3.5									~65	~15						
P=3.0									~65	~15						
P=4.0									~65	~15						
P=4.5+									~65	~15	~17	~43	~18	~25	~42	+40 Sieve=6%, +4 Sieve=0%
P=4.0									~65	~15						

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:

 ETTL ENGINEERS & CONSULTANTS		LOG OF BORING R-2						DATE 10/19/09																	
		PROJECT: Pirkey Power Plant Hallsville, Texas PROJECT NO.: G3241-095			BORING TYPE: Flight Auger			SURFACE ELEVATION 355.1																	
MAIN OFFICE 1717 East Erwin Tyler, Texas 75702 (903) 595-4421		MATERIAL DESCRIPTION		FIELD STRENGTH DATA		DRY DENSITY (pcf)		COMPRESSION STRENGTH (tsf)		FAILURE STRAIN (%)		CONFINING PRESSURE (psf)		Natural Moisture Content and Atterberg Limits		MOISTURE CONTENT (%)		ATTERBERG LIMITS (%)		PLASTICITY INDEX		MINUS #200 SIEVE (%)		OTHER TESTS PERFORMED (Page Ref. #)	
DEPTH (ft)	SAMPLES	USC	GEOLOGIC UNIT	WATER LEVEL	FIELD STRENGTH DATA	DRY DENSITY (pcf)	COMPRESSION STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psf)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)	PLASTICITY INDEX	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)										
35					P=4.5					Plastic Limit: 22 Moisture Content: 34 Liquid Limit: 15 Plasticity Index: 19	22	34	15	19	+40Sieve=7%, +4 Sieve=3%										
38			CL		P=0.2																				
40																									
45					P=1.3																				
50			SM		SF																				
				Bottom of Boring @ 50'																					

Water Level: Measured Perched
 Water Observations: Seepage @ 38" while drilling.

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

Notes:



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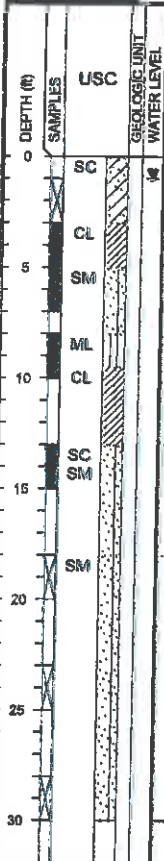
MAIN OFFICE
1717 East Erwin
Tyler, Texas 75702
(903) 696-4421

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

0 - 1.5'	CLAYEY SAND(SC) medium dense; tan
1.5 - 3.0'	LEAN CLAY(CL) very stiff; tan and gray; laminated
3.0 - 4.5'	SILTY SAND(SM) tan; with gravel
4.5 - 6.0'	SANDY SILT(ML) very loose; tan
6.0 - 8.0'	LEAN CLAY(CL) very stiff; tan
8.0 - 12.0'	SILTY CLAYEY SAND(SC-SM) medium dense; tan and gray
12.0 - 30.0'	SILTY SAND(SM) very dense; tan and gray

Bottom of Boring @ 30'

FIELD STRENGTH DATA	SLOW COUNT				DRY DENSITY (pcf)	COMPRESSION STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psf)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)	
	1	2	3	4					Plastic Limit	Moisture Content	Liquid Limit							
N=15	●								20	40	60	80	18	30	16	14	88	+40 Sieve=5%, +4 Sieve=1%
P=2.5	▲																30	+40 Sieve=16%, +4 Sieve=9%
SF	■												17					
P=0.8	◆												19	33	17	16	96	+40 Sieve=1%, +4 Sieve=0%
P=2.5 P=2.9	◆				108	1.80	7	7					20					
P=3.0	◆																	
N=68	●																	
N=50/6"	●												20				21	+40 Sieve=1%, +4 Sieve=0%
N=50/4"	●																	

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

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			

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: East Northeast			
Description: P8190470 Lining for new landfill expansion cell			

 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: East Northeast			
Description: P8190475 Upland ditch on east side of landfill.			

Appendix C

Soil Boring Logs and Piezometers -
2018 Landfill Lateral Expansion Area



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	13	N/A		15					64
	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	N/A		36	19	NP	NP	NP	
	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			97	20	38	20	18	105
	50			Boring terminated at 47 feet.		4.5							

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



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

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)
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	0			Very Stiff, red and brown, Sandy Lean Clay (CL), mottled, few gravel		2.5		57	18	30	12	18	
	4			Gray, Bottom Ash	4								
	5				3								
	10				1								
	15				2								
	20			Soft, dark gray, Sandy Lean Clay (CL)		0.5		62	20	34	13	21	91
	25			- very soft below 23 ft	1								
	30			Very Stiff, dark gray and gray, Sandy Silty Clay (CL-ML), with lignitic material		3.0		50	15	20	16	4	117
	35			Black, Lignite	50/3								
	40			Hard, gray and dark gray, Lean Clay (CL), laminated, trace gypsum	44			95	22	38	17	21	
	45			Boring terminated at 40 feet.									
	50												

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



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

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)
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	0			Soft, brown, tan and red, Sandy Silty Clay (CL-ML), mottled, with few organics		N/A							
	5				4			53	19	20	15	5	
						N/A							
	10			Very Stiff, brown and gray, Lean Clay with Sand (CL), mottled, laminated	24			77	19	29	17	12	
	15			- stiff below 13 ft		1.5		75	22	31	17	14	103
	20			Black, Lignite	50/3.75								
	25			Hard, gray, Lean Clay (CL), mottled, laminated, few lignitic material	55								
	30			- very stiff between 28 ft and 30 ft		2.5		99	17	38	18	20	117
				- hard below 30 ft		33							
	35			- attempted, no recovery		N/A							
				Very Stiff, gray, Fat Clay (CH), mottled, laminated, trace gypsum	27			97	23	51	17	34	
	40				26								
				Boring terminated at 40 feet.									
	45												
	50												

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



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

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			Very Loose, reddish brown, Clayey Sand (SC), mottled	2								
	5			- medium dense between 3 ft and 10 ft - few gravel below 5 ft	15	3.5		27	14	23	14	9	
	10			- loose between 10 ft and 15 ft	5	2.5		49	18	28	13	15	115
	15			- medium dense between 15 ft and 18 ft	27	0.5		49	20	29	15	14	
	20			- very dense below 18 ft	60								
	25			Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	32								
	30			- very stiff at 28 ft	17			88	22	45	16	29	
	35			- attempted, no recovery		N/A							
	35			Very Dense, gray and tan, Silty Sand (SM), with lignitic material	50/2								
	40			Hard, gray, dark gray and black, Lean Clay (CL), mottled, with lignitic material	95/11								
	40			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



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			Boring terminated at 42 feet.									
	50												

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



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)
	0			Very Stiff, red and brown, Sandy Fat Clay (CH), mottled	17			55	19	61	25	36	
	5			Medium Dense, light red, tan and brown, Silty Clayey Sand (SC-SM), mottled	28	4.5		48	11				
	10			- tan, light red and gray below 8 ft, with few gravel between 8 ft and 10 ft	19	3.5							
	15			Very Dense, tan, light red and gray, Silty Sand (SM), mottled	88/10	2.5		33	12	19	15	4	
	20			- dense between 18 ft and 23 ft	42								
	25			- medium dense between 23 ft and 28 ft	28								
	30			- very dense below 28 ft	85/11			17	22	NP	NP	NP	
	35			Hard, gray and dark gray, Lean Clay (CL), mottled, laminated	72								
	40			- little recovery, few sand between 38 ft and 40 ft	48	N/A		97	22	42	17	25	
	45			- gray, dark gray and black, with lignitic material, laminated between 43 ft and 45 ft	50/3								
	50				40								
	55				60								
	60				40			98	19	42	17	25	
	65			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



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				
	5			Very Stiff, light tan, red and brown, Lean Clay (CL), mottled	20	N/A		85	17	29	14	15	
	10				21	N/A							
	15			Very Dense, light gray, Silty Sand (SM)	87/10	N/A		45	10	NP	NP	NP	
	20			Very Dense, red, brown and gray, Silty Sand (SM)	60								
	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							
	65			Boring terminated at 62 feet.	77								

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



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)	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)
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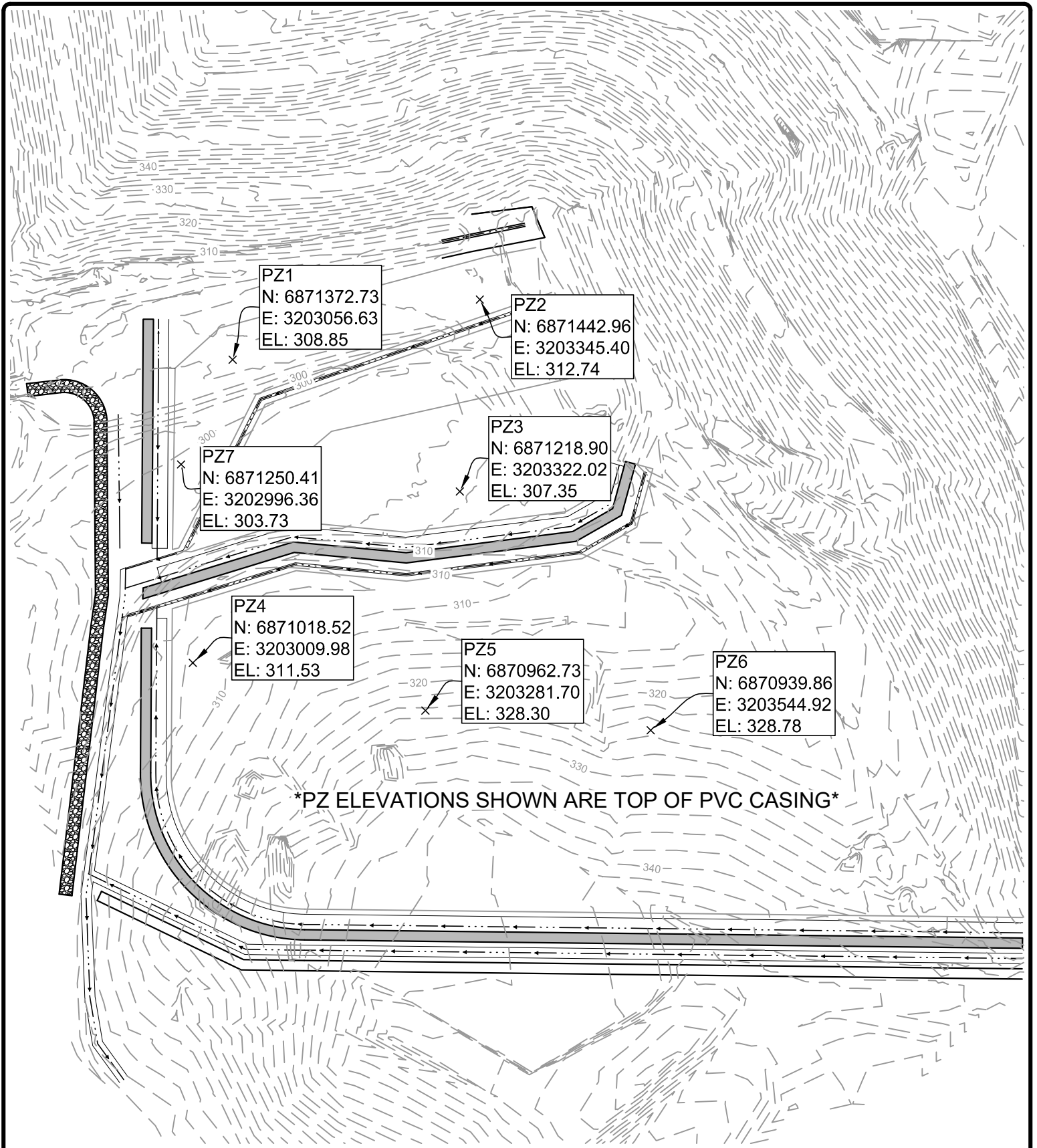
	0			Loose, red, tan, and brown, Clayey Sand (SC)	6								
	5				7	2.0		39	13	19	12	7	
	10			- medium dense, light gray, red and tan below 8 ft	18	N/A		37	23				
	15				15								
	20			Very Stiff, gray and brown, Lean Clay (CL), mottled, laminated	22			91	25	42	16	26	
	25			- hard below 23 ft	79								
	30				79/11								
	35			Very Dense, dark gray, Silty Sand (SM)	76/11			43	30	NP	NP	NP	
	40			Very Stiff, gray and dark gray, Lean Clay (CL), mottled, laminated	21			97	23				
	45			Stiff, gray and dark gray, Sandy Lean Clay (CL), mottled, with occasional lignitic seams	22	1.5		59	25	33	18	15	93
	50			- attempted, no recovery		N/A							
	55				16			48	30				
	60			- laminated at 58 ft	22								
	60			Boring terminated at 60 feet.	29			62	25	44	21	23	
	65												

Additional Information/Comments:

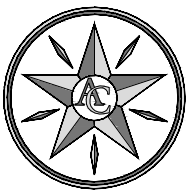
Logger: D. Diduch

Notes/Comments: Seepage encountered at 13 ft during drilling. Water level at 13 feet upon completion.

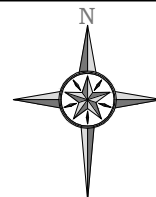
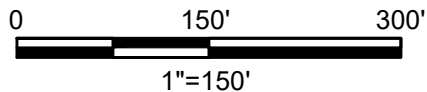
N/A: Not Attempted



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

Water Quality:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	5	Red Soft Clay
5	10	Very Soft Red/Grey Clay
10	14	Very Soft Brown Sandy Clay

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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

Water Quality:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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.

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Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
 DESCRIPTION & COLOR OF FORMATION MATERIAL

Casing:
 BLANK PIPE & WELL SCREEN DATA

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0	5	Red Soft Clay
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10	14	Very Soft Brown Sandy Clay

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	No Data	No Data

Chemical Analysis Made: **No**

Did the driller knowingly penetrate any strata which contained injurious constituents?: **No**

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Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
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Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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5	10	Very Soft Red/Grey Clay
10	14	Very Soft Brown Sandy Clay

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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

Water Quality:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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.

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Kilgore, TX 75663

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Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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10	14	Very Soft Brown Sandy Clay

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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Water Quality:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	No Data	No Data

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Apprentice Name: **Michael Aaron Dodson** Apprentice Number: **59693**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
2	Riser	New Plastic (PVC)	40	0	10
2	Screen	New Plastic (PVC)	40 0.010	10	20

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(512) 334-5540

STATE OF TEXAS WELL REPORT for Tracking #482297

Owner: American Electric Power Company	Owner Well #: PZ-6
Address: 502 N. Allen Street Shreveport, LA 71101	Grid #: 35-37-4
Well Location: 2400 Farm Road Hallsville, TX 75650	Latitude: 32° 27' 07.69" N
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	8.25	0	20

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	8	20	Sand	20/40

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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.

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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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
2	Riser	New Plastic (PVC)	40	0	10
2	Screen	New Plastic (PVC)	40 0.010	10	20

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Water Quality:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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.

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Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	5	Red Soft Clay
5	10	Very Soft Red/Grey Clay
10	14	Very Soft Brown Sandy Clay

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
2	Riser	New Plastic (PVC)	40	0	4
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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



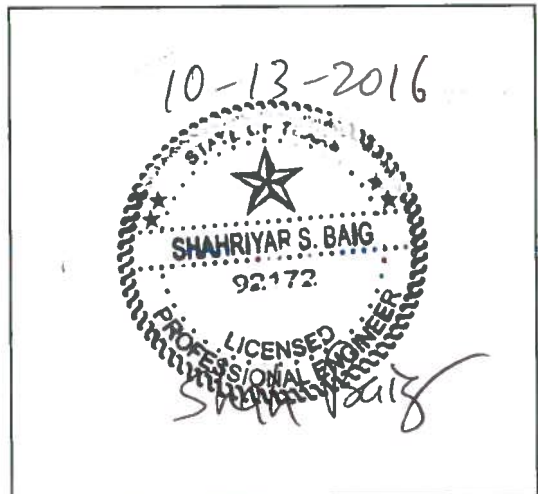
Document No. GERS-16-131

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 Shah S. Baig 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



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 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 foundation 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 is 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



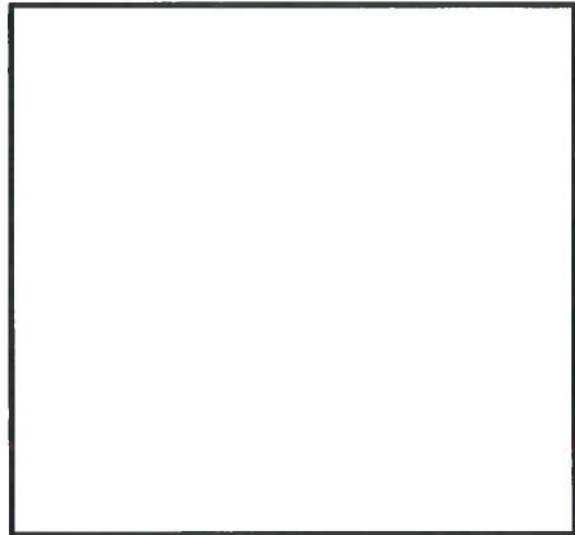
Document ID Number: GERS-16-143

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 Shahriyar S. Baig 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 E TTL 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 publications¹ 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 ($\geq 0.85 \cdot \text{Liquid Limit [LL]}$), 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:  _____

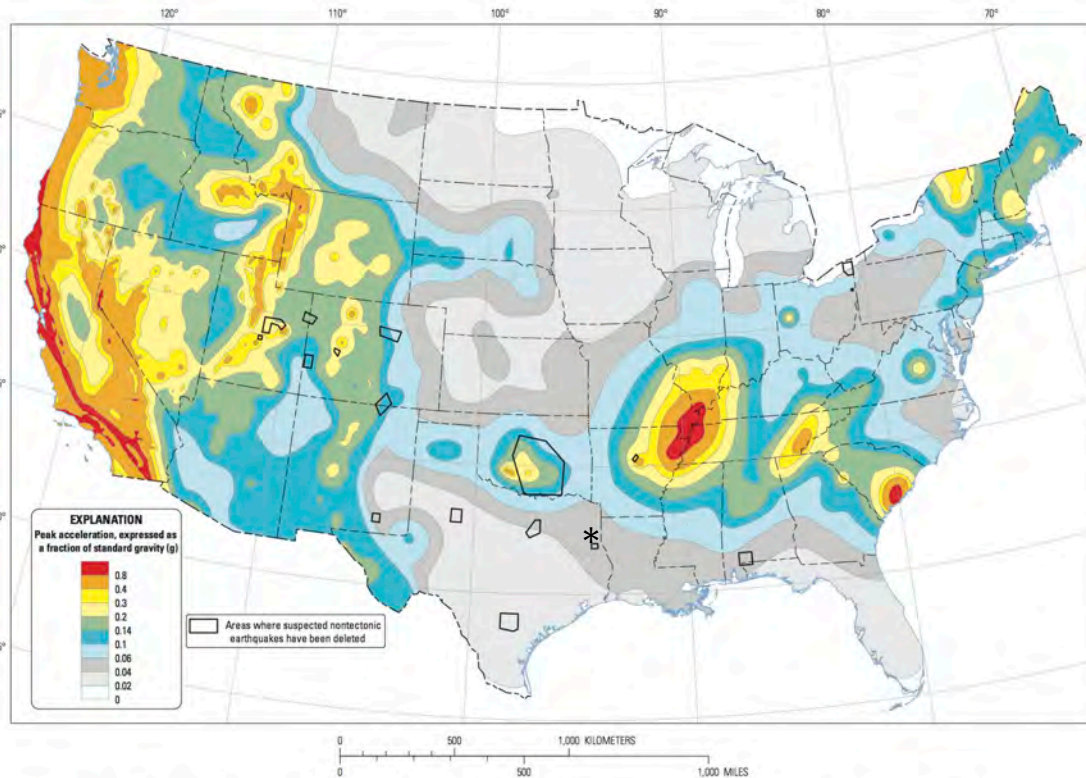
Dated: January 14, 2016



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**



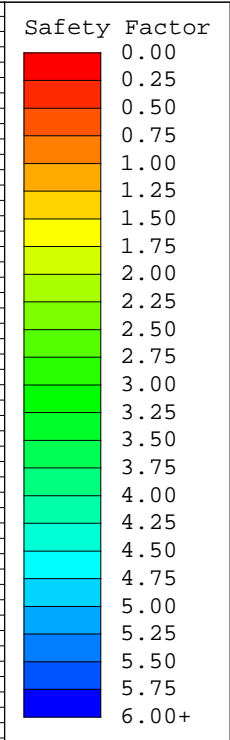
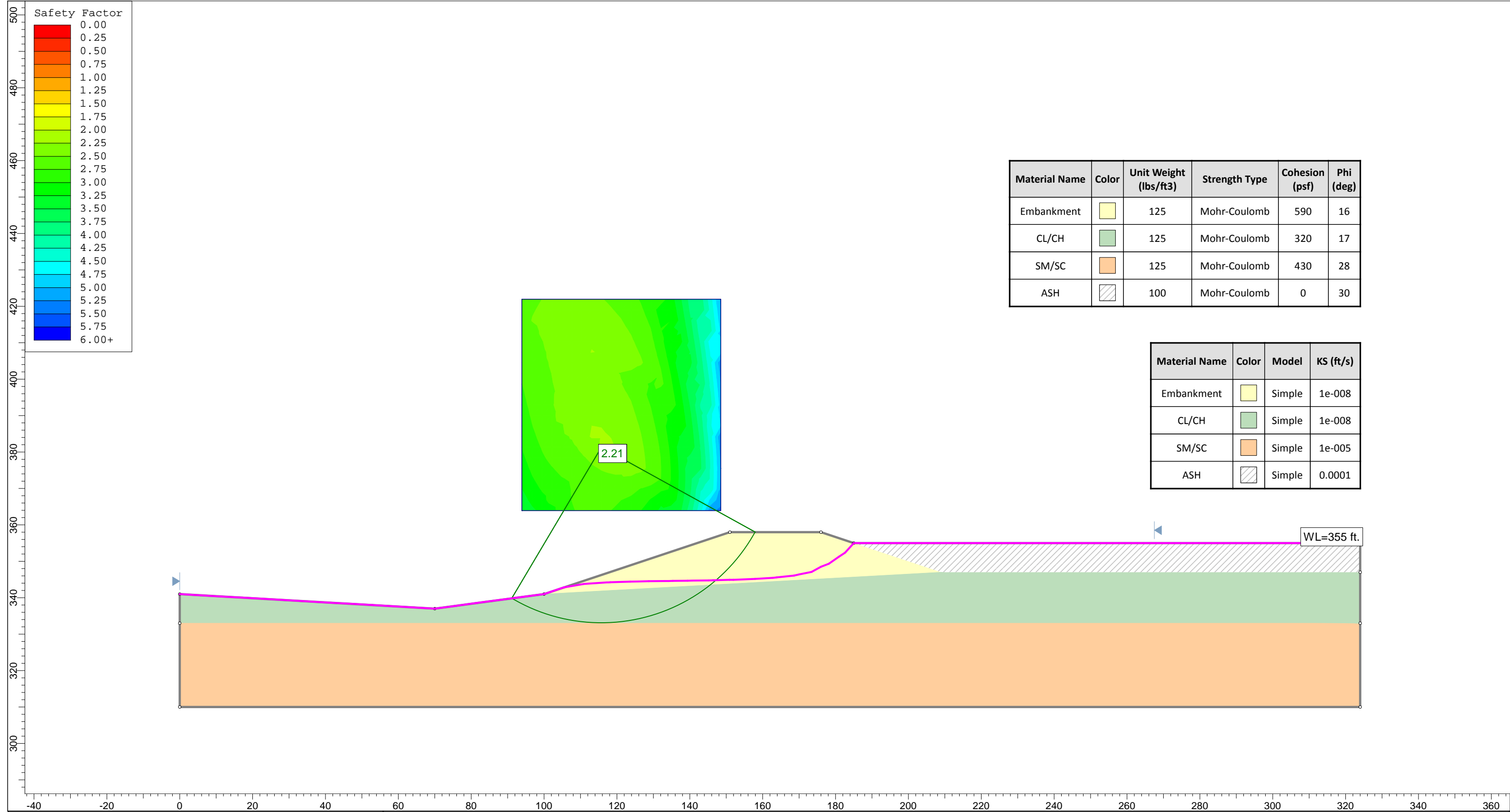
Provided by Google Earth.

Cone Penetrometer Test (CPT) Location Map

Scale: N/A

Auckland Project No. 2015-008C

**Pirkey Power Generating Station
Initial Safety Factor Assessment - West Ash Pond
Hallsville, Texas**

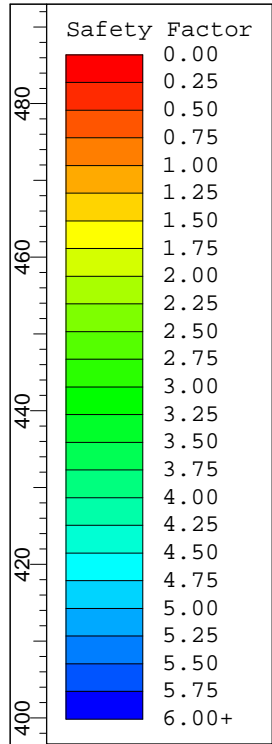


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		125	Mohr-Coulomb	590	16
CL/CH		125	Mohr-Coulomb	320	17
SM/SC		125	Mohr-Coulomb	430	28
ASH		100	Mohr-Coulomb	0	30

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

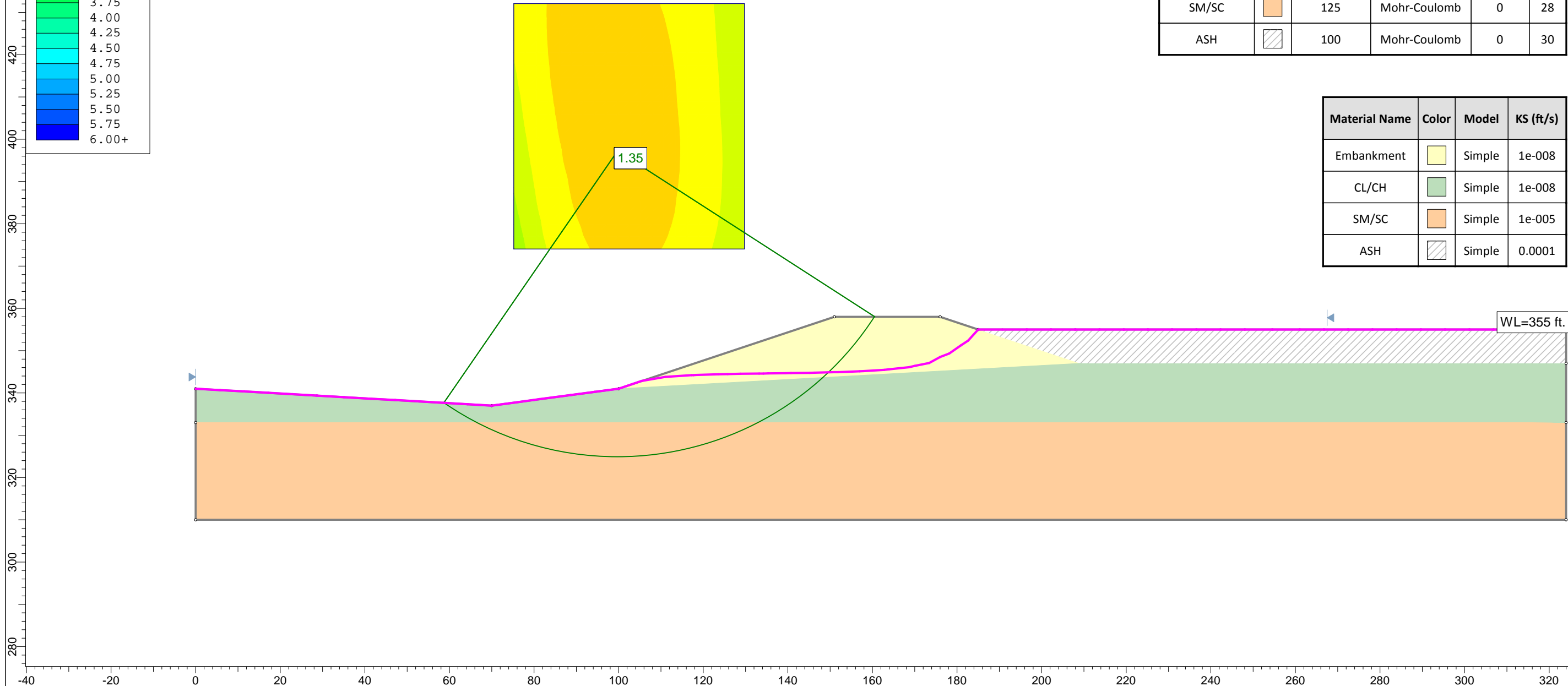
Auckland Consulting LLC
 PO Box 8155
 Jacksonville, Texas 75766

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



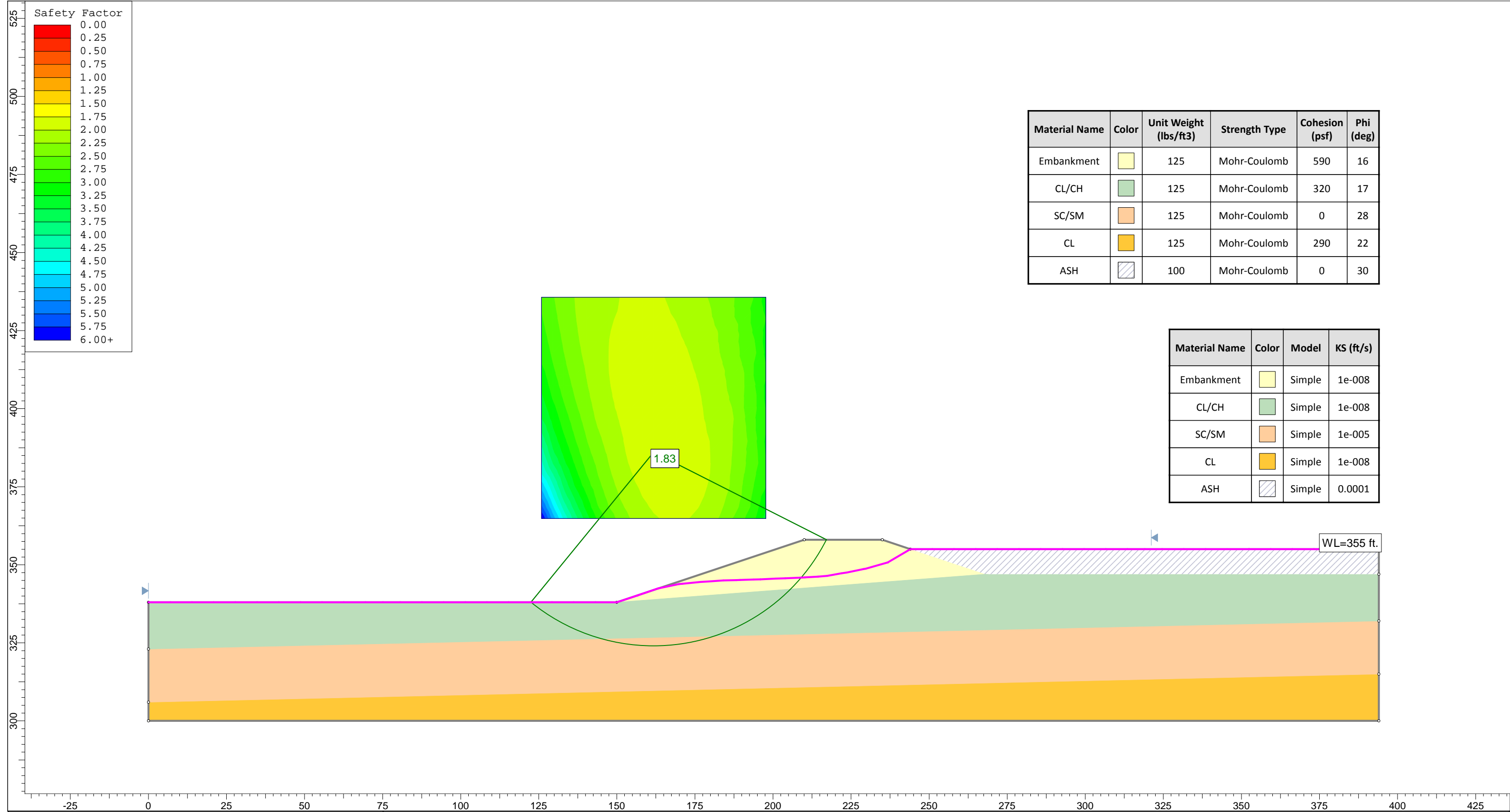
Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		125	Mohr-Coulomb	450	12
CL/CH		125	Mohr-Coulomb	530	13
SM/SC		125	Mohr-Coulomb	0	28
ASH		100	Mohr-Coulomb	0	30

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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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

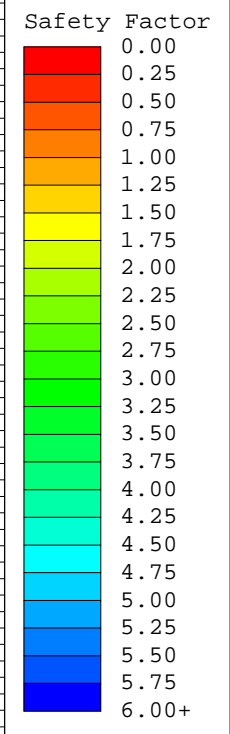
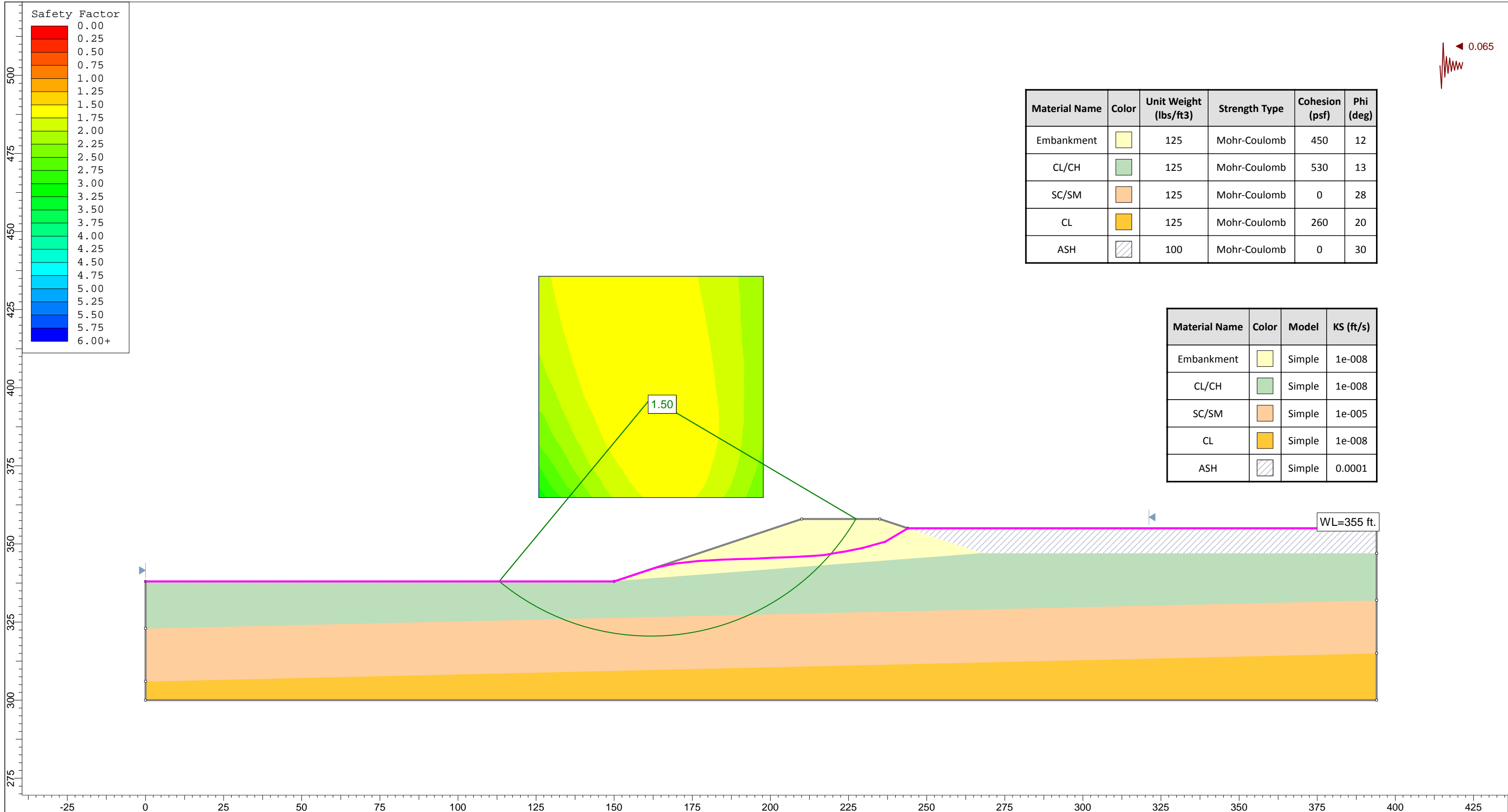


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		125	Mohr-Coulomb	590	16
CL/CH		125	Mohr-Coulomb	320	17
SC/SM		125	Mohr-Coulomb	0	28
CL		125	Mohr-Coulomb	290	22
ASH		100	Mohr-Coulomb	0	30

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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 PO Box 8155
 Jacksonville, Texas 75766

Project	Pirkey Power Station - West Ash Pond, Section No. 2		
Analysis Description	Steady State Seepage at Maximum and Surcharge Pool		
Drawn By	JJT	Company	
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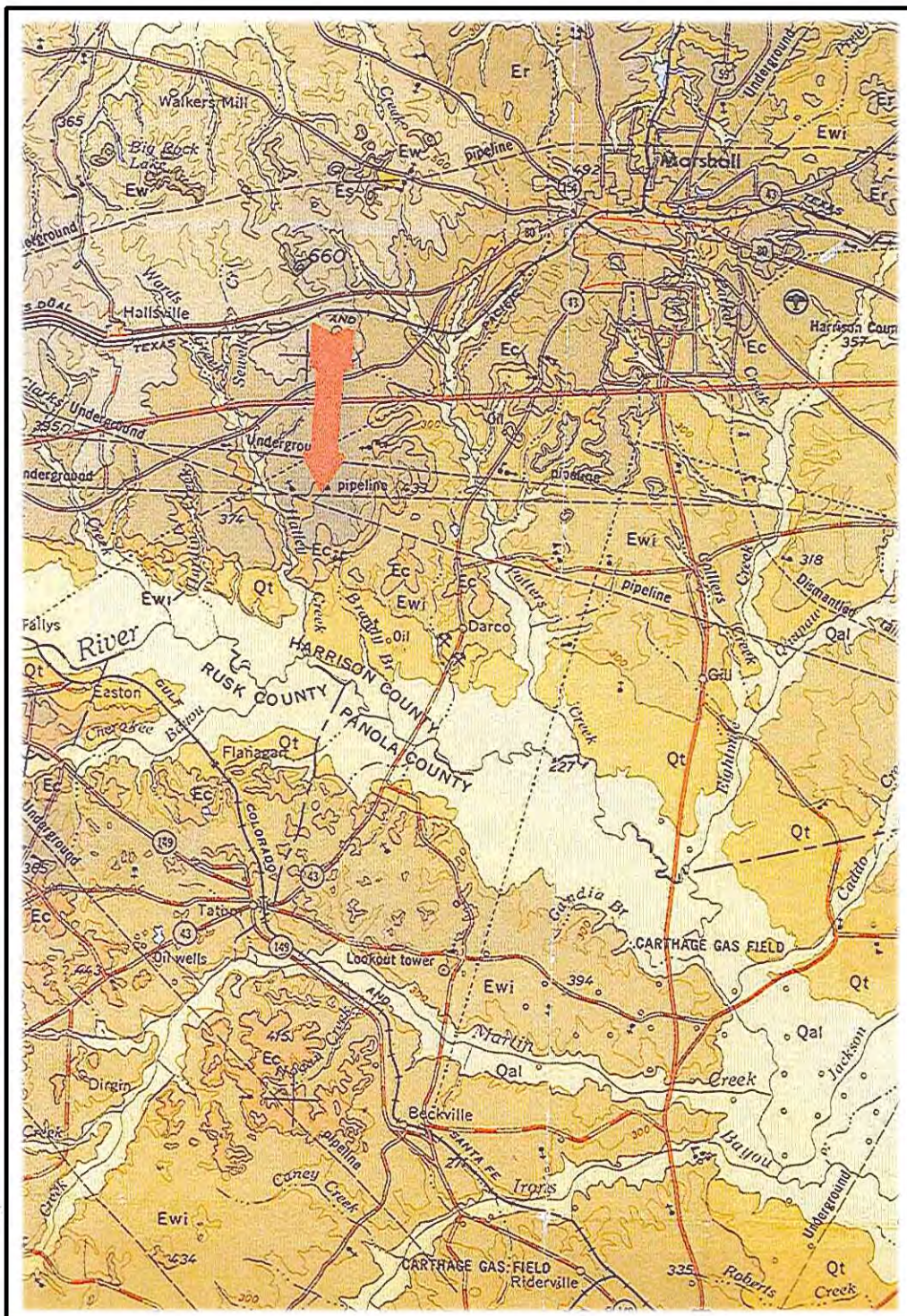


Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Embankment		125	Mohr-Coulomb	450	12
CL/CH		125	Mohr-Coulomb	530	13
SC/SM		125	Mohr-Coulomb	0	28
CL		125	Mohr-Coulomb	260	20
ASH		100	Mohr-Coulomb	0	30

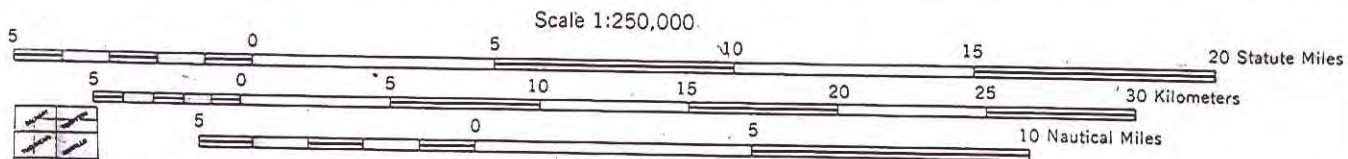
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Embankment		Simple	1e-008
CL/CH		Simple	1e-008
SC/SM		Simple	1e-005
CL		Simple	1e-008
ASH		Simple	0.0001

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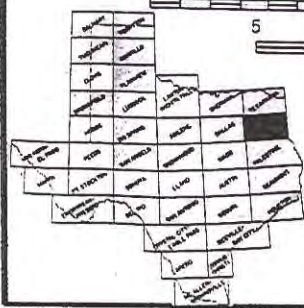
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Analysis Description	Steady State Seepage at Maximum Pool, Seismic Analysis		
Drawn By	JJT	Company	
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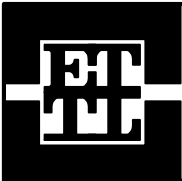
EXPLANATION	
SEDIIMENTARY ROCKS	
Qal	Alluvium Flood-plain deposits
Qt	Fluvial terrace deposits undivided
Etg Ca	
Sp	Sparta Sand Quartz sand, fine to medium grained, light gray to brownish gray, slightly coherent from silt and clay matrix, massive, locally cross-bedded, interbeds of sand clay more abundant upward, locally carbonaceous; weathers various shades of light gray, at base hard, brown, [fragments of greenish] lower part 1700 feet thick, upper part absent. Locality includes Tyler Green sand Member, [?], quartzite, greenish gray, greenish gray, massive, locally cross-bedded; weathers dark reddish brown, abundant ironstone concretions
Wf	Weches Formation Glaucous and quartz sand, greenish gray to grayish olive green, thin bedded, locally cross-bedded to irregular, clay interbeds light brown to moderate light gray, silt, massive, thin bedded; weathers moderate to dark reddish brown, locally forms massive impure limestone in southern part; 250 feet thick, range 0-70 feet
Ec	Queen City Sand Quartz sand, fine grained to locally medium grained, light gray to brownish gray, locally carbonaceous to silty, massive, thin bedded; weathers moderate to dark reddish brown, locally forms massive impure limestone in southern part; 100-150 feet thick, thin sandstone
Cr	Roklaw Formation Upper 1000 feet, clay, brownish black to brownish gray, silty, massive, carbonaceous, locally cross-bedded; weathers reddish-brown clay; weathers light brown, ironstone concretions common; a few marls (local). Lower 120 feet, quartz sand, fine to very fine grained, greenish gray, silty, massive, carbonaceous, massive, locally cross-bedded; weathers moderate brown to dark reddish orange with clay ironstone ledges and white (local) clay concretions, and clay decrease upward
Ca	Carizo Sand Upper part, very fine sand, silt, clayey silt, silty clay, medium to dark gray, carbonaceous; weathers moderate reddish brown to dark reddish brown, indurated ledges of dark brownish gray ironstone common. Lower part, quartz sand, fine to medium grained, light brownish gray, locally carbonaceous, 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 sand, lignite, silt, and quartz sand, in part carbonaceous, laminated to massive, locally cross-bedded; weathers to various shades of gray, brown, yellow, and red; weathers silty and limestone concretions common; abundant plant fossils, a few marine fossils in sandstone part; 200-300 feet thick
Ec	Eocene rocks undivided Roklaw Formation, Carizo Sand, Wilcox Group, and Midway Group in breaks shown, not separately shown
Ewp	Wills Point Formation Clay, medium black gray, greenish gray, grayish brown, brownish gray, silt increases upward, laminated to locally massive, silty, silty near base, thin carbonaceous silty limestone concretions common in upper part, lignite in upper part, thin bedded, yellowish gray; fossiliferous; 200 feet thick
Ca	Kinead Formation Clay, medium gray to dark gray, greenish gray, brownish gray, silty, massive, carbonaceous, locally silty or sandy, locally phosphatic near base, thin beds of limestone in upper part, gray, hard, detrital; weathers medium gray; fossiliferous; 100 feet thick
Kca	Kemp Clay Clay, dark gray to black gray, carbonaceous, silty, glauconitic, calcareous, micaceous; weathers dark greenish gray and black; upper part only shown
Ku	Upper Cretaceous rocks undivided Nesqueon Group, Taylor Group, and Austin Chalk in breaks shown, not separately shown



CONTOUR INTERVAL 100 FEET
WITH SUPPLEMENTARY CONTOURS AT 50 FOOT INTERVALS



	ETTL ENGINEERS & CONSULTANTS <small>MAIN OFFICE 1717 East Spauldine Dallas, Texas 75202 (972) 592-4421</small>	PLATE 2 SITE SURFACE GEOLOGY	JOB No.: G3241-095 DATE: DEC. 2009 SCALE: 1:250,000
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LOG OF BORING W-1

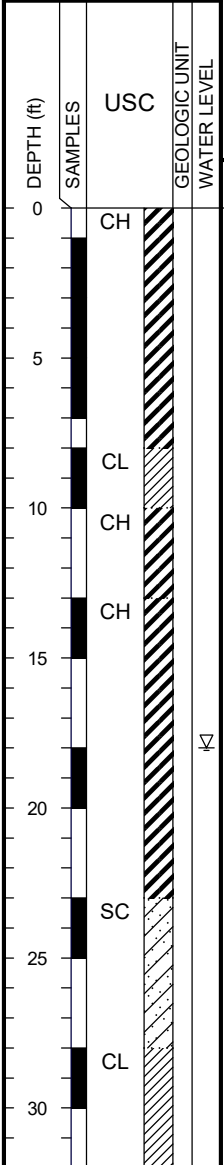
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE
10/20/09

SURFACE ELEVATION
356.5



MATERIAL DESCRIPTION

FAT CLAY WITH SAND(CH) tan and red

--red

SANDY LEAN CLAY(CL) reddish yellow

FAT CLAY(CH) red and tan

FAT CLAY WITH SAND(CH) red and yellow

--red

CLAYEY SAND(SC) reddish brown

LEAN CLAY(CL) red; with sand seams

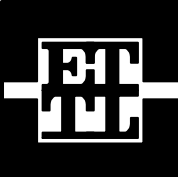
FIELD STRENGTH DATA	BLOW COUNT				DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			OTHER TESTS PERFORMED (Page Ref. #)	
	20 40 60 80								Plastic Limit	Moisture Content	Liquid Limit		LL	PL	PI		MINUS #200 SIEVE (%)
	1 2 3 4																
	1.0 2.0 3.0 4.0																
P=3.75				■					●	—	—	21	62	21	41	79	+40 Sieve=6%, +4 Sieve=0%
P=3.75				■					●	—	—	16	60	21	39	75	+40 Sieve=7%, +4 Sieve=1%
P=4.5				■					●	—	—	18	56	18	38	71	+40 Sieve=5%, +4 Sieve=0%
P=4.0				■					●	—	—	10	28	18	10	25	+40 Sieve=21%, +4 Sieve=11%
P=4.25				■					●	—	—						
P=3.75				■					●	—	—						
P=3.5				■					●	—	—						
P=2.0				■					●	—	—						
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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LOG OF BORING W-1

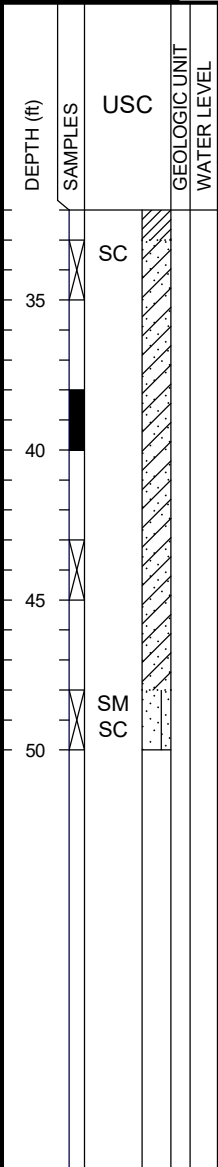
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE
10/20/09

SURFACE ELEVATION
356.5



MATERIAL DESCRIPTION

CLAYEY SAND(SC) grayish brown

--tannish gray

--gray

SILTY CLAYEY SAND(SM-SC) gray

Bottom of Boring @ 50'

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

N=32

P=4.15

P=2.8

N=47

N=50/6"

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

PLASTIC LIMIT

PLASTICITY INDEX

MINUS #200 SIEVE (%)

OTHER TESTS
PERFORMED
(Page Ref. #)

17 29 19 10 25

+40 Sieve=1%,
+4 Sieve=0%

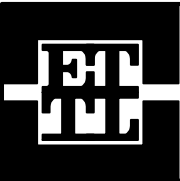
Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: Seepage @ 18' 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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LOG OF BORING W-2

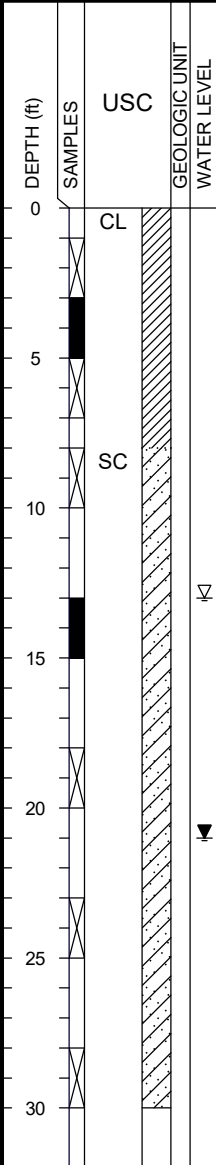
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE
10/21/09

SURFACE ELEVATION
341.7



MATERIAL DESCRIPTION

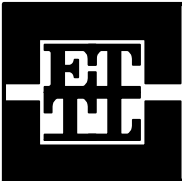
SANDY LEAN CLAY(CL) stiff; red and gray
--hard
--gray, red, and tan
CLAYEY SAND(SC) very dense; red and tan
--medium dense; tan and gray
--very dense; gray and tan
--green
Bottom of Boring @ 30'

FIELD STRENGTH DATA	BLOW COUNT				DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			OTHER TESTS PERFORMED (Page Ref. #)	
	20	40	60	80					Plastic Limit	Moisture Content	Liquid Limit		LL	PL	PI		MINUS #200 SIEVE (%)
	1	2	3	4													
N=9	●																
P=4.5+				■								17	48	19	29	65	+40 Sieve=6%, +4 Sieve=2%
N=50																	
N=50/5"												16	28	18	10	27	+40 Sieve=7%, +4 Sieve=2%
P=1.5				■								19	32	17	15	31	+40 Sieve=13%, +4 Sieve=5%
N=62																	
N=50/5"												22	28	19	9	33	+40 Sieve=6%, +4 Sieve=2%
N=56																	

Water Level Est.: ▽ Measured: ▼ Perched: ▼
Water Observations: Seepage @ 13' while drilling. Water level @ 21' and open upon completion.

Key to Abbreviations:
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L - Lab Vane Shear (tsf)

Notes:



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LOG OF BORING W-3

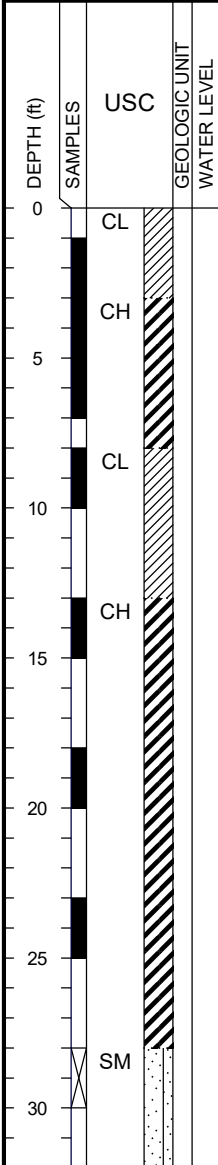
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE 10/20/09

SURFACE ELEVATION
356.3



MATERIAL DESCRIPTION

SANDY LEAN CLAY(CL) stiff; white and tan

SANDY FAT CLAY(CH) very stiff; red, tan,
and white
--white, tan, and red

SANDY LEAN CLAY(CL) very stiff; red and
yellow
--hard; red and yellow

FAT CLAY WITH SAND(CH) very stiff; red
and yellow

--hard

--stiff

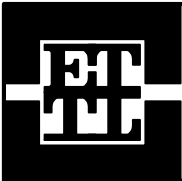
SILTY SAND(SM) very dense; yellow and red

FIELD STRENGTH DATA	BLOW COUNT				DRY DENSITY (pcf)	COMPRESSIVE STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits			MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			OTHER TESTS PERFORMED (Page Ref. #)	
	Qu (tsf)								Plastic Limit	Moisture Content	Liquid Limit		LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		MINUS #200 SIEVE (%)
	1	2	3	4													
	PPR (tsf)																
P=1.75	●	▲	■	◆					55	18	68	29	61	+40 Sieve=7%, +4 Sieve=2%			
P=3.25									55	18	37	68	68	+40 Sieve=5%, +4 Sieve=0%			
P=3.5									55	18	37	68	68	+40 Sieve=5%, +4 Sieve=0%			
P=2.25 P=4.0									55	18	37	68	68	+40 Sieve=5%, +4 Sieve=0%			
P=2.5									55	18	37	68	80	+40 Sieve=6%, +4 Sieve=0%			
P=4.5+									55	18	37	68	80	+40 Sieve=6%, +4 Sieve=0%			
P=2.0									55	18	37	68	69	+40 Sieve=4%, +4 Sieve=0%			
N=88									55	18	37	68	69	+40 Sieve=4%, +4 Sieve=0%			

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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LOG OF BORING W-3

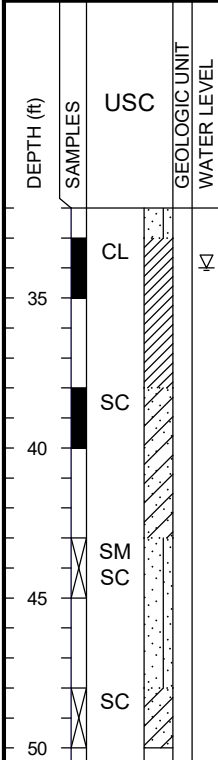
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE
10/20/09

SURFACE ELEVATION
356.3



MATERIAL DESCRIPTION

SANDY LEAN CLAY(CL) very stiff; gray; with iron oxide cemented sandstone gravel

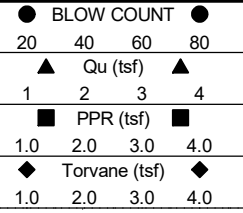
CLAYEY SAND(SC) very dense; dark gray

SILTY CLAYEY SAND(SM-SC) very dense; gray; saturated

CLAYEY SAND(SC) very dense; dark gray

Bottom of Boring @ 50'

FIELD STRENGTH DATA



P=3.25

P=4.5+

N=59

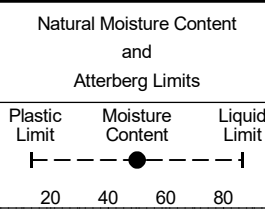
N=50/4"

DRY DENSITY (pcf)

COMPRESSIVE STRENGTH (tsf)

FAILURE STRAIN (%)

CONFINING PRESSURE (psi)



MOISTURE CONTENT (%)	ATTERBERG LIMITS (%)			MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
LL	PL	PI			
17	33	17	16	38	+40 Sieve=1%, +4 Sieve=0%

Water Level Est.: Measured: Perched:

Water Observations: Seepage @ 34' while drilling.

Key to Abbreviations:

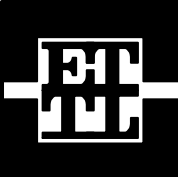
N - SPT Data (Blows/Ft)

P - Pocket Penetrometer (tsf)

T - Torvane (tsf)

L - Lab Vane Shear (tsf)

Notes:



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LOG OF BORING W-4

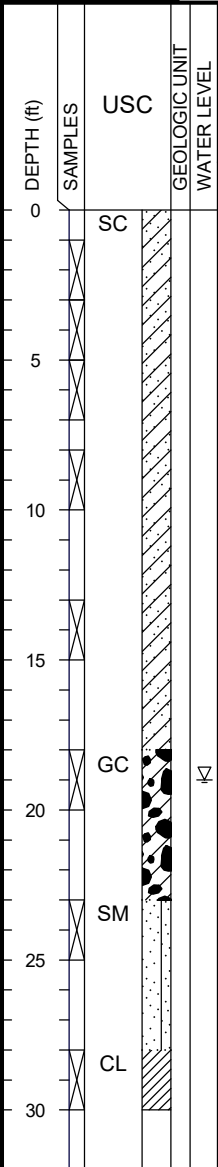
PROJECT: Pirkey Power Plant
Hallsville, Texas

PROJECT NO.: G3241-095

BORING TYPE: Flight Auger

DATE
10/20/09

SURFACE ELEVATION
338.0



MATERIAL DESCRIPTION

CLAYEY SAND(SC) stiff; brown, red, and yellow

--with gravel

--red and tan; with iron oxide cemented sandstone

--dense; red and white; with clay seams

--medium dense; orangish gray; with gravel

CLAYEY GRAVEL(GC) dense; dark gray

SILTY SAND(SM) dense; dark gray

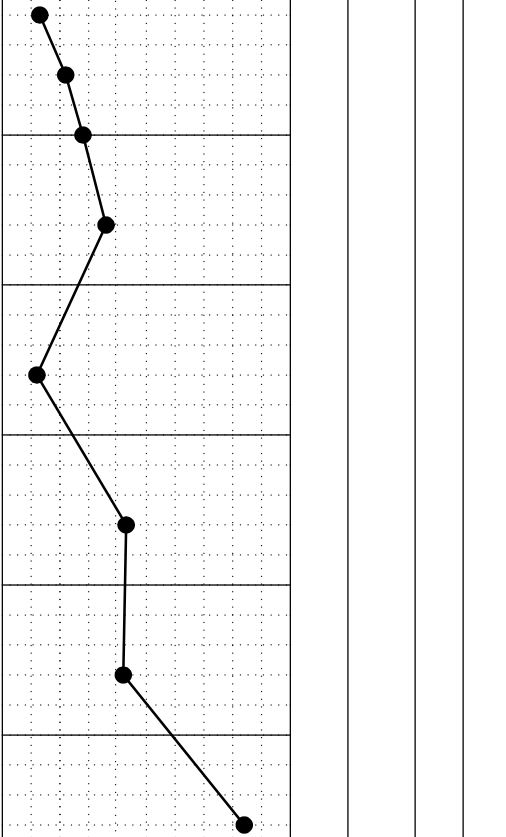
SANDY LEAN CLAY(CL) very dense; gray

Bottom of Boring @ 30'

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

N=13
N=22
N=28
N=36
N=12
N=43
N=42
N=84



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(%)			MINUS #200 SIEVE (%)	OTHER TESTS PERFORMED (Page Ref. #)
	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX		
LL	PL	PI			
12	31	17	14	35	+40Sieve=31%, +4 Sieve=16%
15	60	16	44	39	+40Sieve=11%, +4 Sieve=4%
17	30	14	16	22	+40Sieve=28%, +4 Sieve=17%
20	31	16	15	7	+40Sieve=68%, +4 Sieve=52%

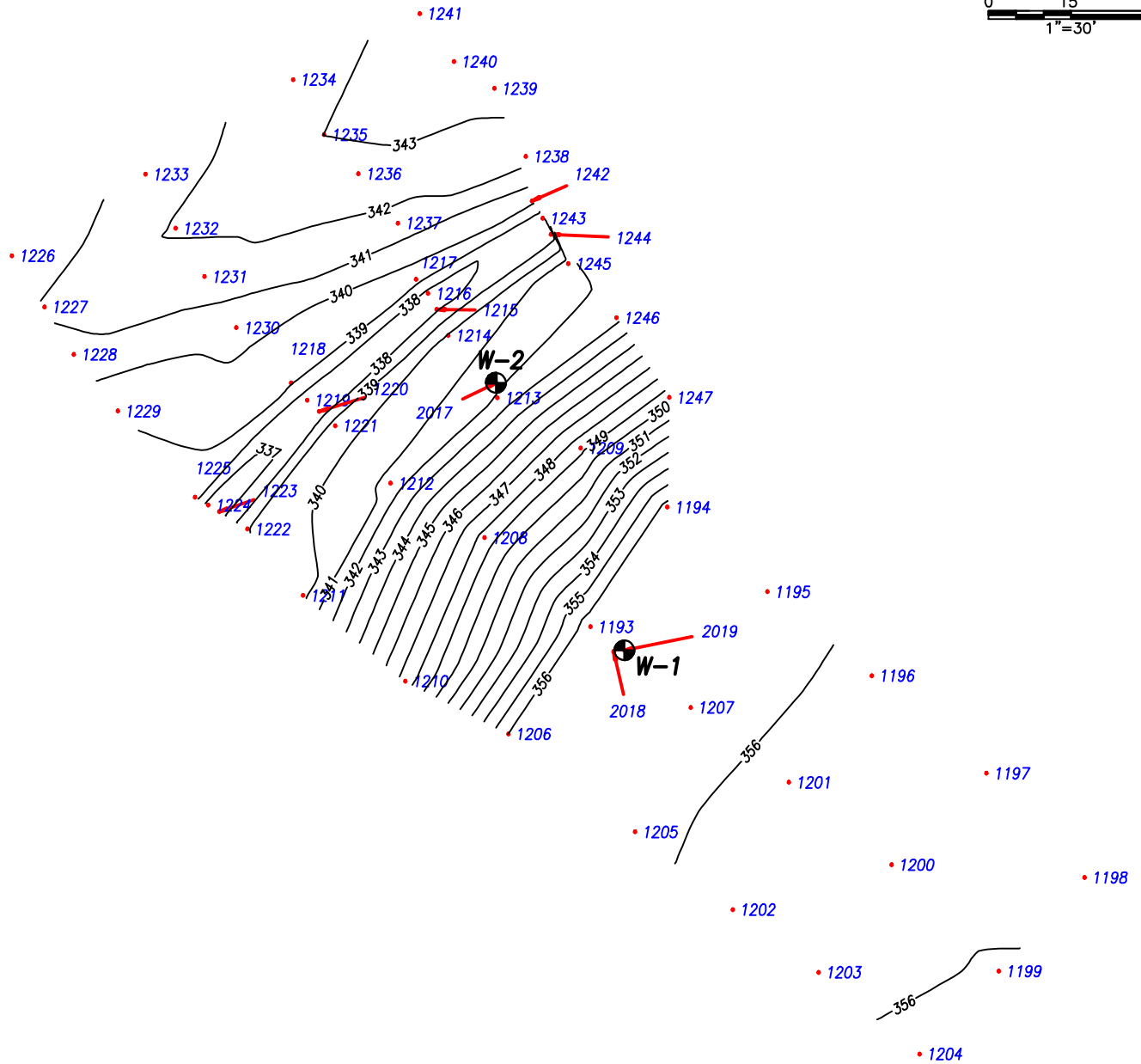
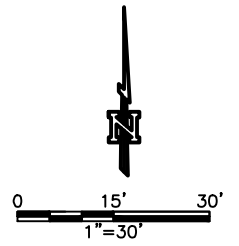
Water Level Est.: ▽ Measured: ▼ Perched: ▽

Water Observations: Seepage @ 19' while drilling.

Key to Abbreviations:

- N - SPT Data (Blows/Ft)
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- L - Lab Vane Shear (tsf)

Notes:



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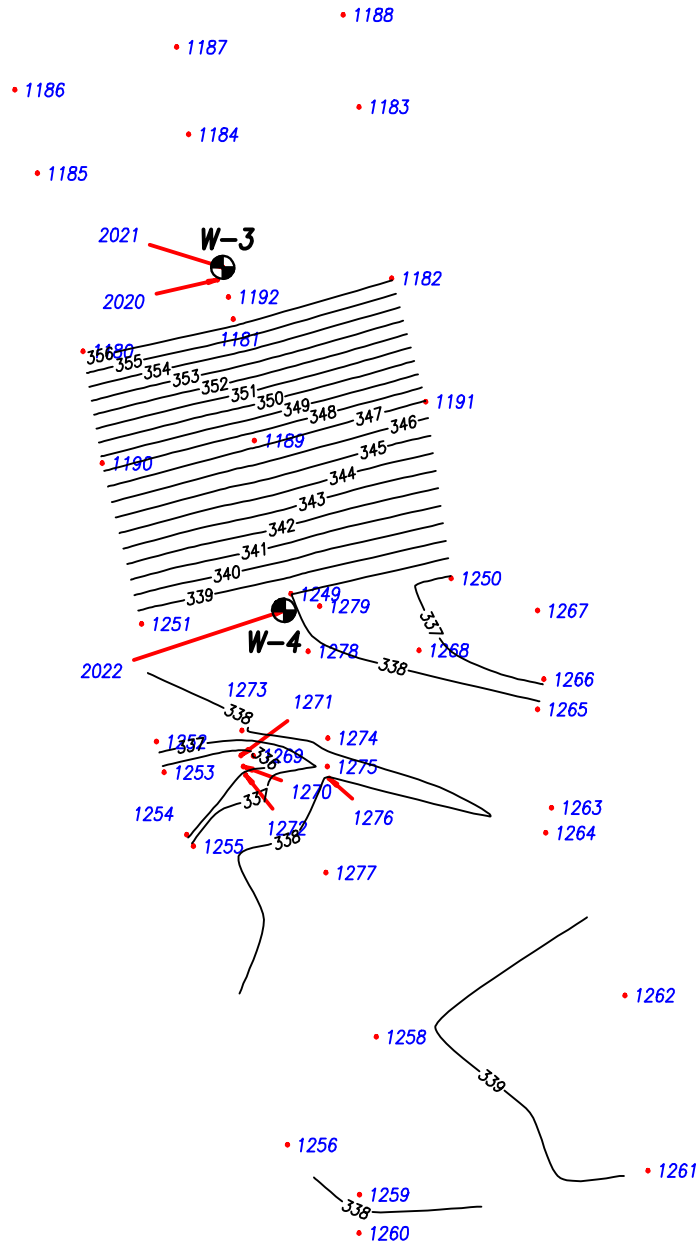
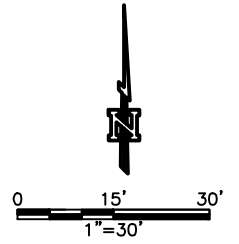
(903)753-0663 FAX (903)753-8803

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 Permmeter Data

Boring No.:	W - 2	ap =	0.031416 cm2	Set Mercury to Dinat Dnat	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	Before Test	Tare No.:	T 13	After Test
Length :	2.78 in	7.06	cm		Wet Wt.+tare:	660.71	Tare No.:
Area:	6.06 in ²	39.10	cm2		Dry Wt.+tare:	588.03	T 16
Volume :	16.85 in ³	276.12	cm3		Tare Wt.:	219.71	Wet Wt.+tare:
Unit Wt.(wet):	129.15 pcf	2.07	g/cm ³		Dry Wt.:	368.32	Dry Wt.+tare:
Unit Wt.(dry):	107.87 pcf	1.73	g/cm ³		Water Wt.:	72.68	625.10
					% moist.:	19.7	Tare Wt.:
							151.95
							473.15
							108.62
							% 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 %	Vm = $\frac{ ka-ki }{ka} \times 100$
k2 =	2.86E-06 cm/sec	1.4 %	
k3 =	2.87E-06 cm/sec	1.3 %	
k4 =	2.92E-06 cm/sec	0.7 %	

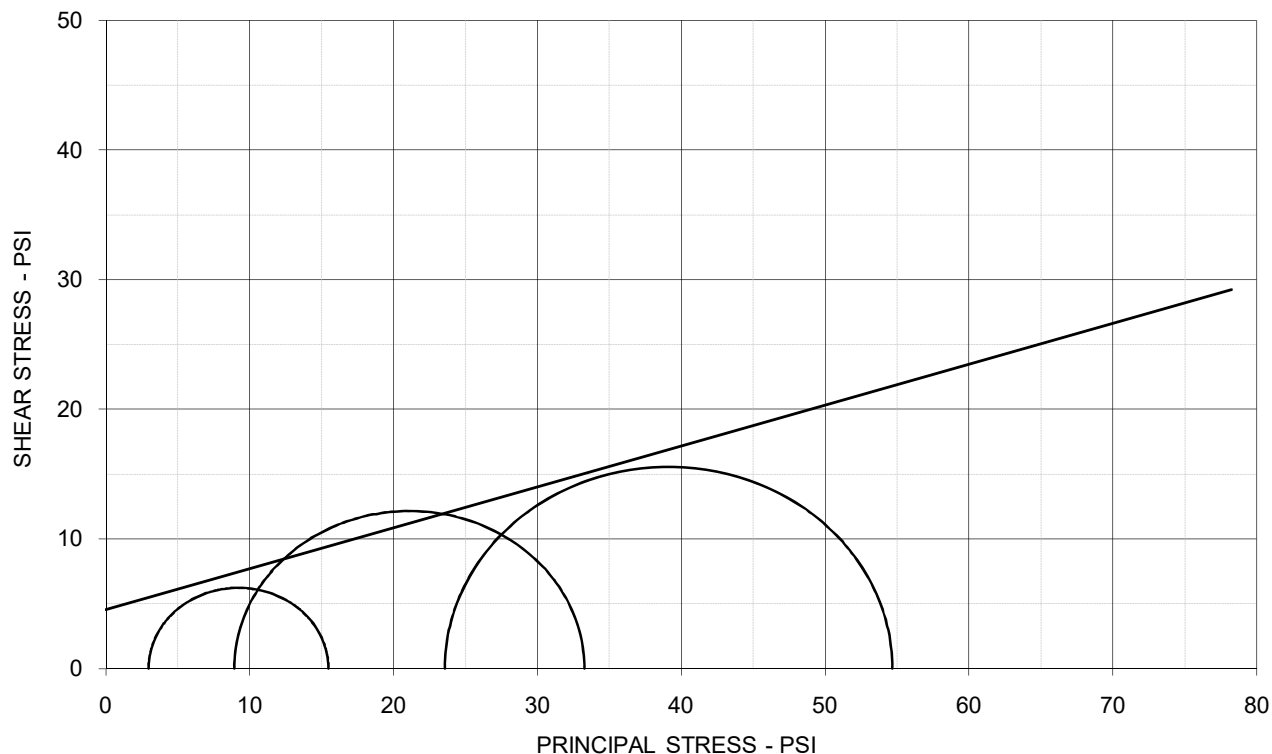
Hydraulic conductivity	k =	2.90E-06	cm/sec	8.23E-03	ft/day
Void Ratio	e =	0.62			
Porosity	n =	0.38			
Bulk Density	γ =	2.07	g/cm3	129.2	pcf
Water Content	W =	0.34	cm3/cm3	(at 20 deg C)	
Intrinsic Permeability	kint =	2.97E-11	cm2	(at 20 deg C)	

Liquid Limit LL		
Plastic Limit PL		
Plasticity Index PI		
- 200 Sieve		%
+ No 40 Sieve		%
+ No 4 Sieve		%

Respectfully Submitted

Robert M. Duke, P.E.

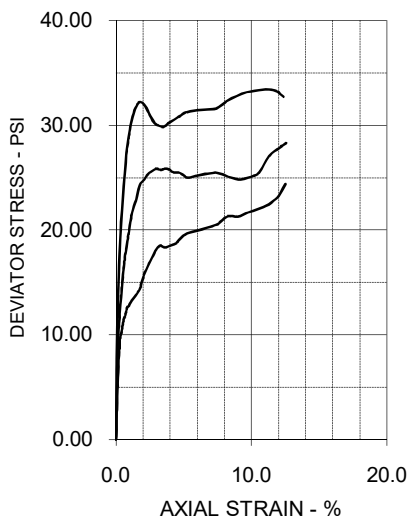
TRIAxIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS

$\phi' = 17.5 \text{ deg}$

$c' = 4.6 \text{ psi}$



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

PROJECT INFORMATION

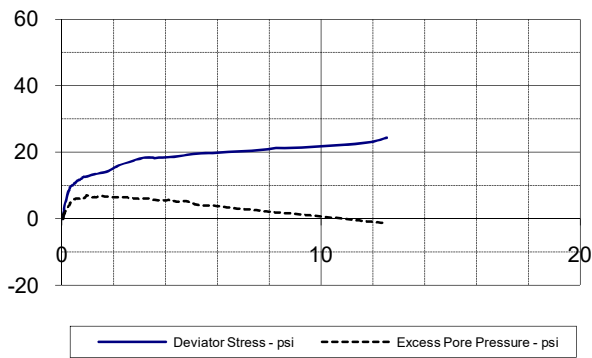
TYPE OF TEST & NO: CU with PP
 SAMPLE TYPE: Shelby Tube Sample
 DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
 Sampled on Site, W-1 13' to 20' deep
 ASSUMED SPECIFIC GRAVITY: 2.7 +40 Sieve 5%
 LL: 56 PL: 18 PI: 38 Percent -200: 71%
 REMARKS: Both Ends and Diameter Trimmed + #4 Sieve 0%
 G 3241 095, W 1 13' 20'.xls

PROJECT: Pirkey Power Plant Embankments
 LOCATION: Hallsville, Texas
 PROJECT NO: G 3241 - 095
 CLIENT:
 November 2009

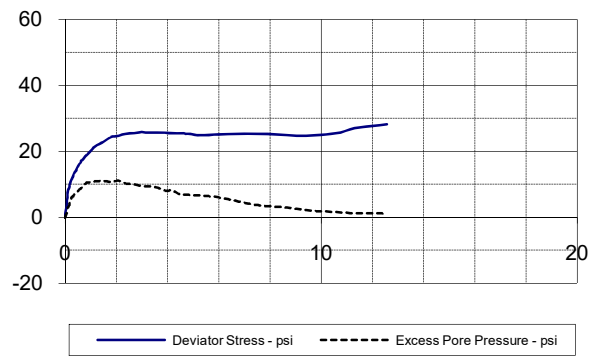
ETTL ENGINEERS & CONSULTANTS

PLATE: B.1

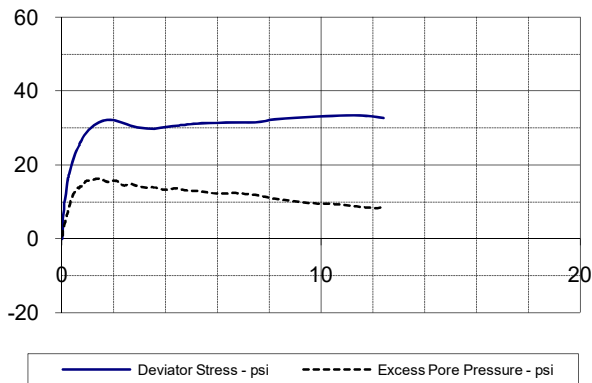
SPECIMEN NO. 1



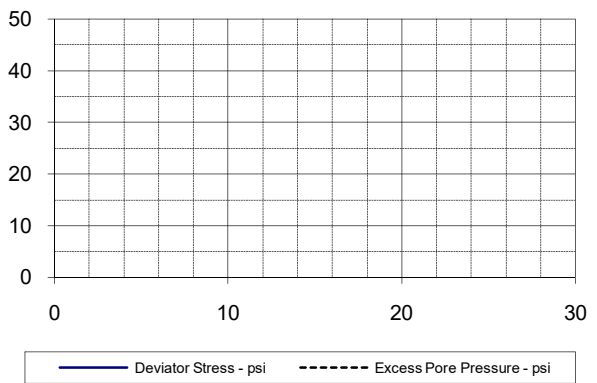
SPECIMEN NO. 2



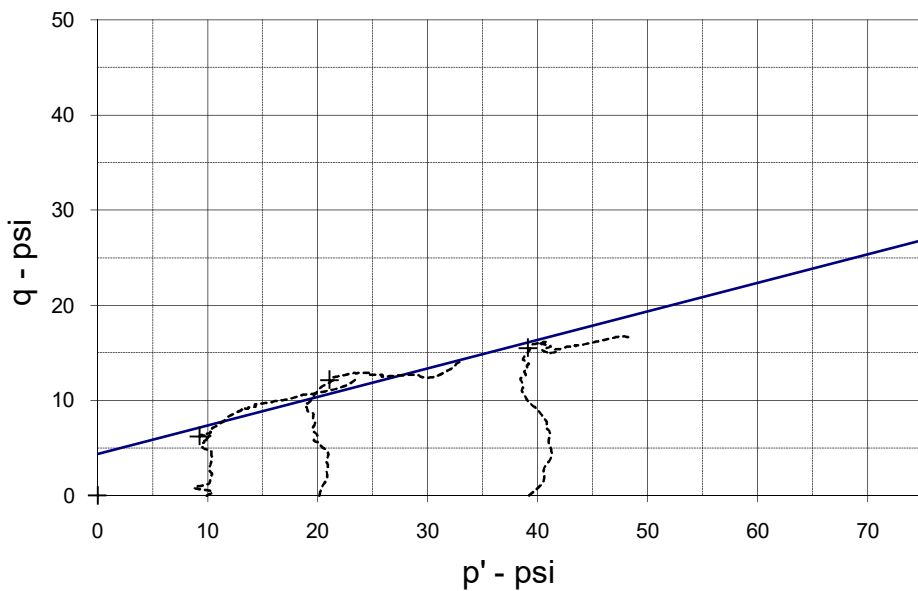
SPECIMEN NO. 3



SPECIMEN NO. 4

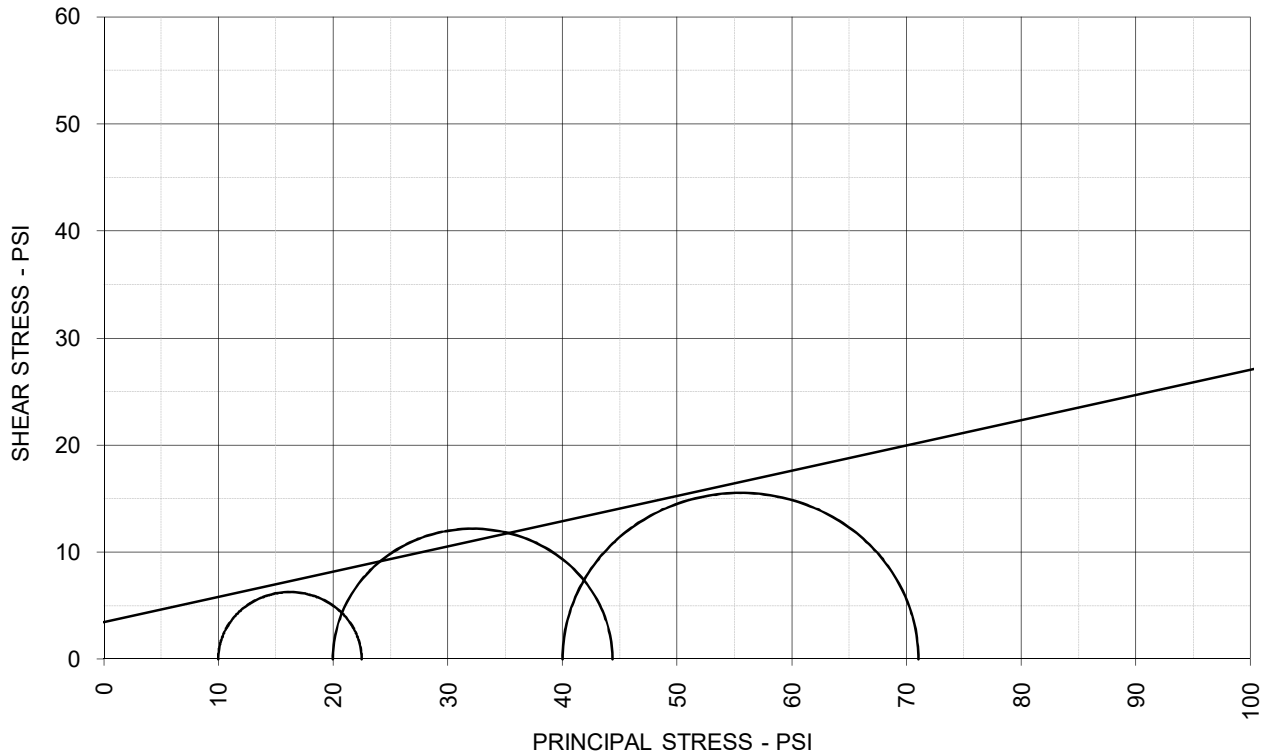


p - q DIAGRAM



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			

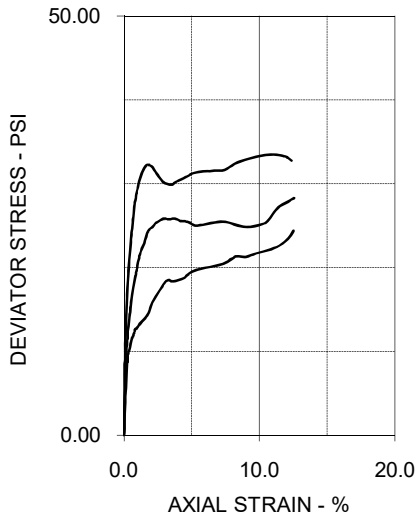
TRIAxIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS

$\phi = 13.3 \text{ deg}$

$c = 3.5 \text{ psi}$



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%

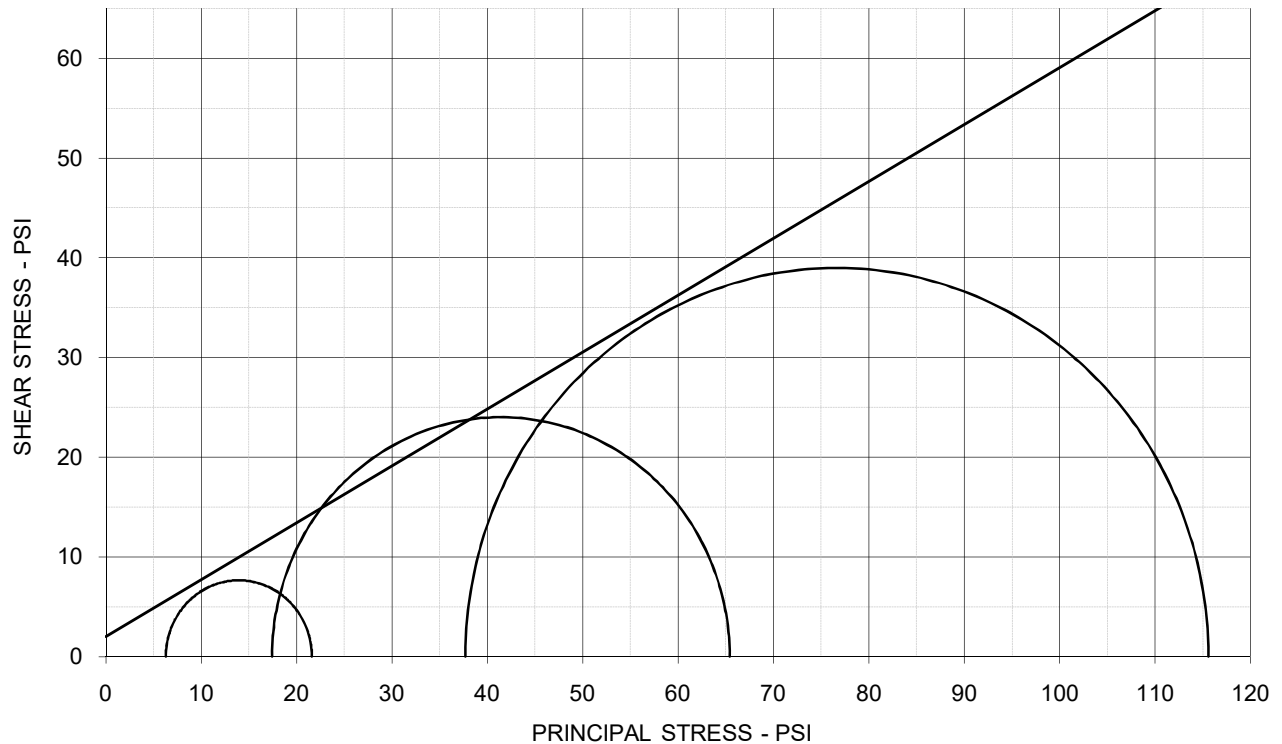
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
 LOCATION: Hallsville, Texas
 PROJECT NO: G 3241 - 095
 CLIENT:
 November 2009

ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

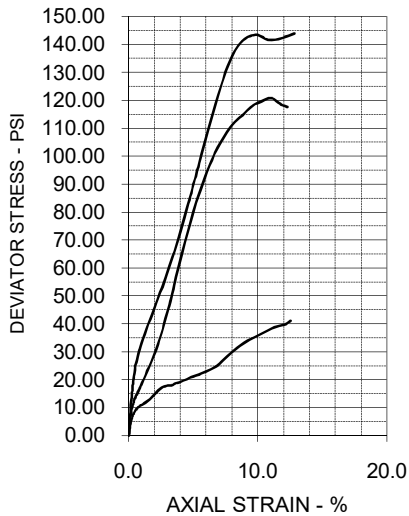
TRIAxIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS

$\phi' = 29.7$ 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%
 © 3241-095, W-1 38'-41' Native.xls

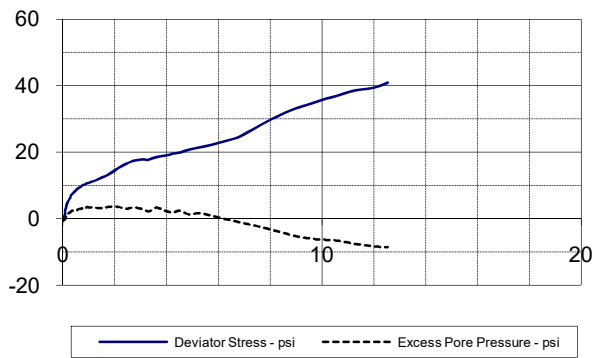
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
 LOCATION: Hallsville, Texas
 PROJECT NO: G 3241 - 095
 CLIENT:
 November 2009

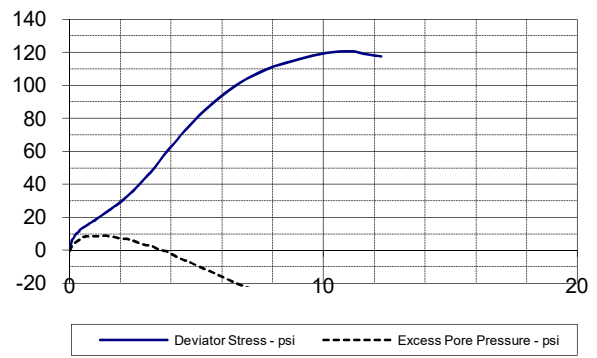
ETTL ENGINEERS & CONSULTANTS

PLATE: B.1

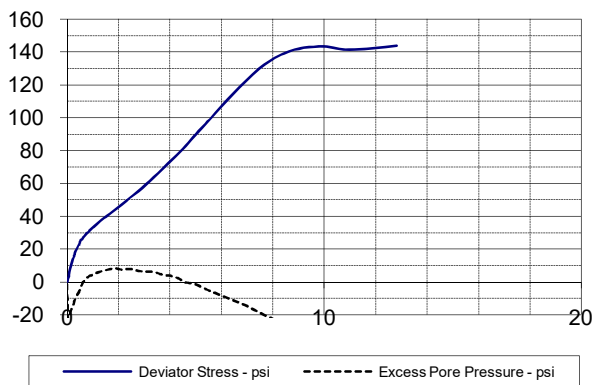
SPECIMEN NO. 1



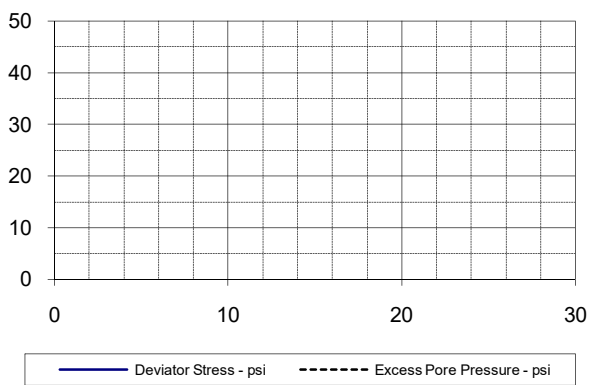
SPECIMEN NO. 2



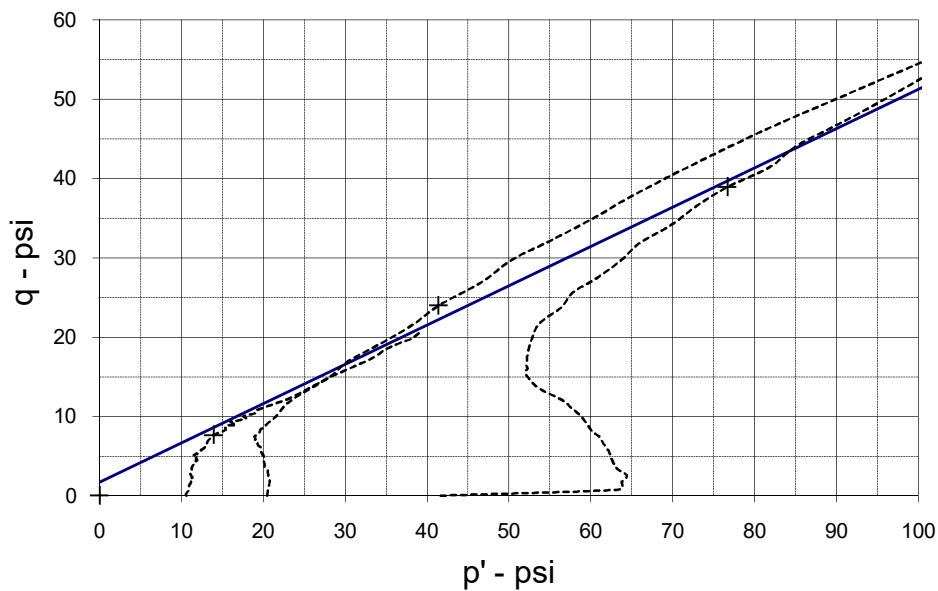
SPECIMEN NO. 3



SPECIMEN NO. 4

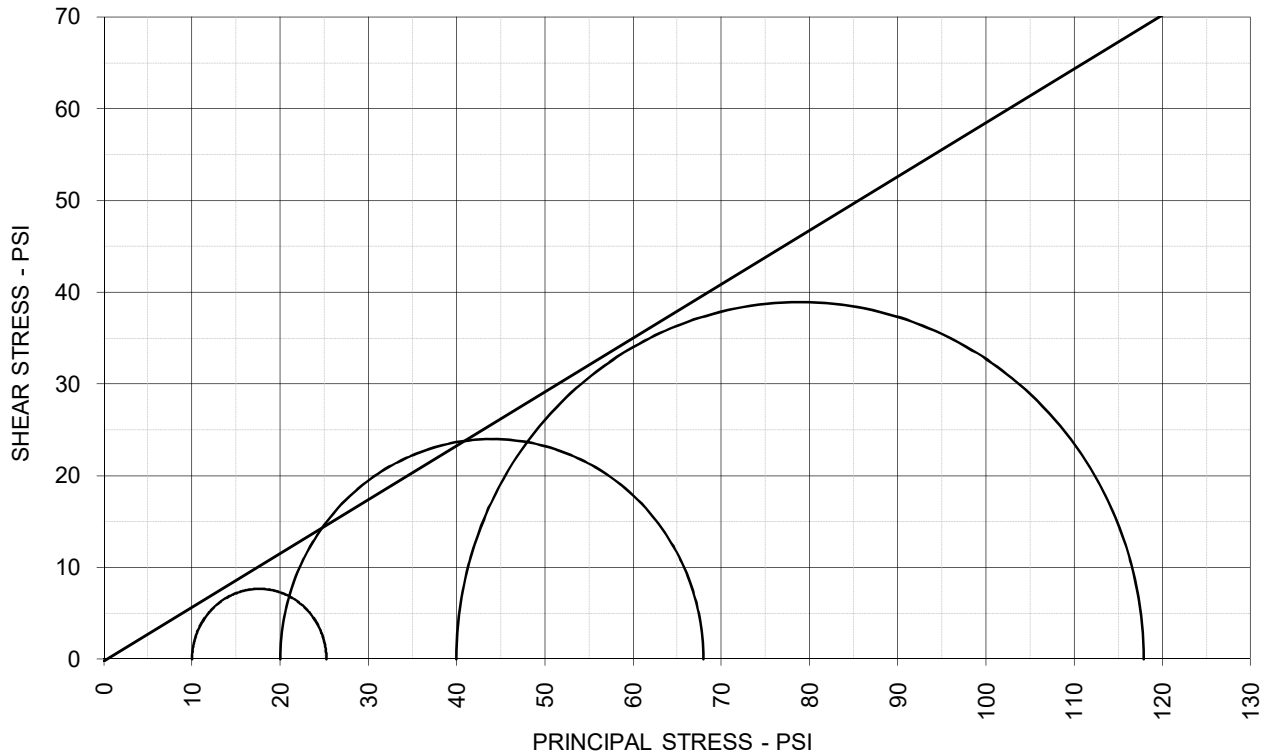


p - q DIAGRAM



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			

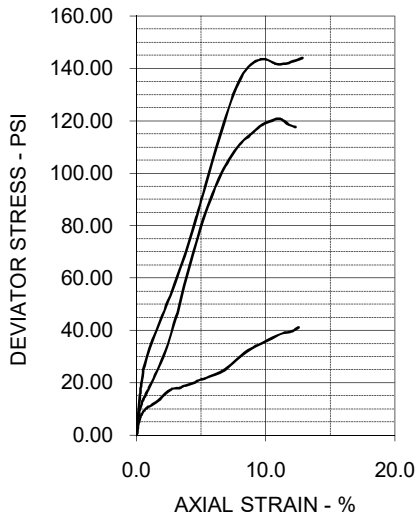
TRIAxIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS

$\phi = 30.4 \text{ deg}$

$c = -0.2 \text{ psi}$



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%

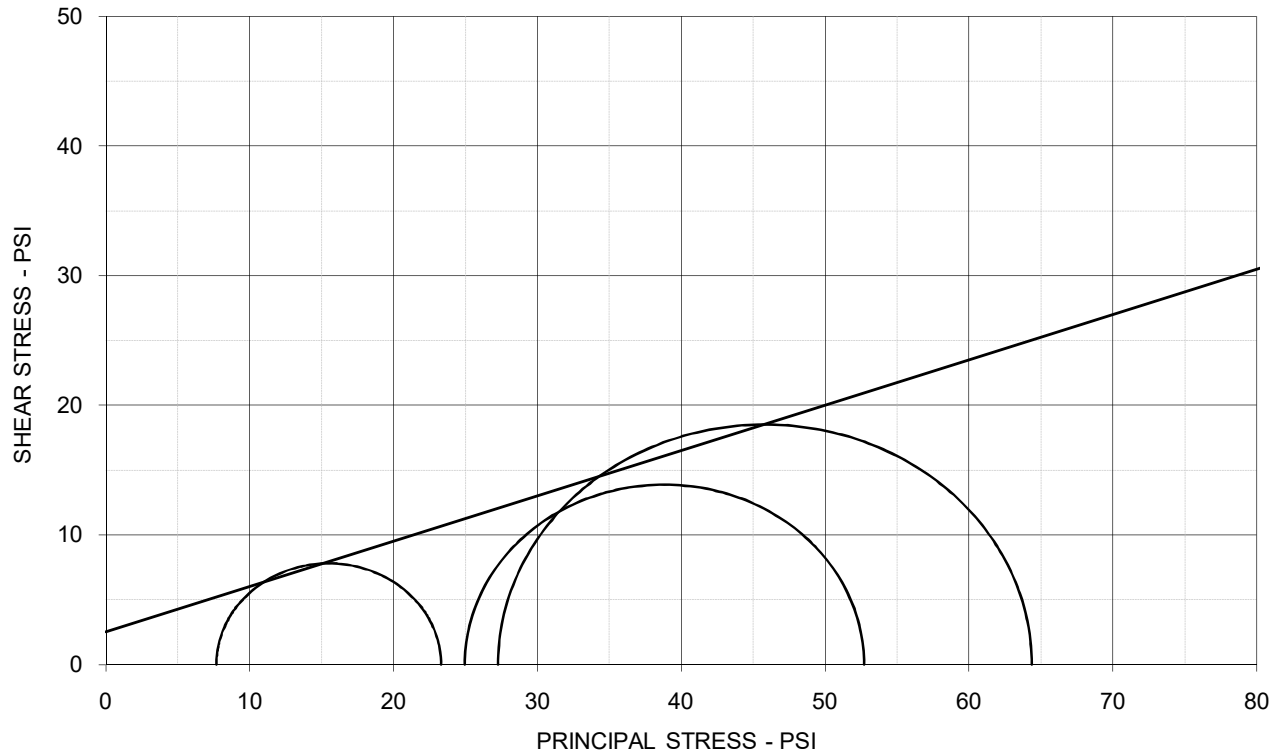
PROJECT INFORMATION

PROJECT: Pirkey Power Plant Embankments
 LOCATION: Hallsville, Texas
 PROJECT NO: G 3241 - 095
 CLIENT:
 November 2009

ETTL ENGINEERS & CONSULTANTS

PLATE: B.3

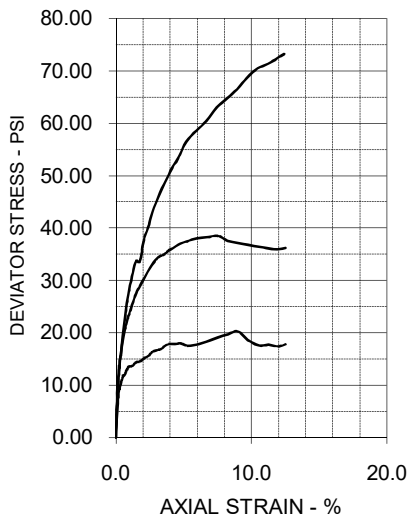
TRIAxIAL SHEAR TEST REPORT



EFFECTIVE STRESS PARAMETERS

$\phi' = 19.3 \text{ deg}$

$c' = 2.5 \text{ psi}$



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

PROJECT INFORMATION

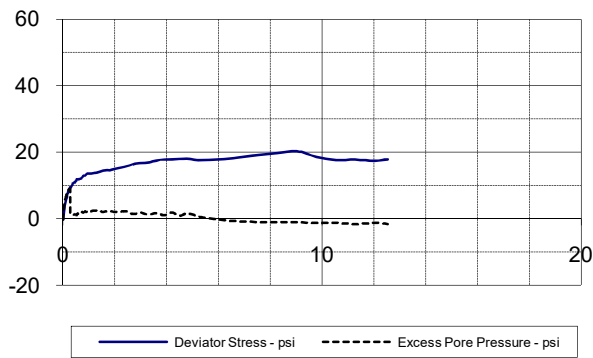
TYPE OF TEST & NO: CU with PP
 SAMPLE TYPE: Shelby Tube Sample
 DESCRIPTION: Red, Tan & Gray Fat Clay w/ Sand
 Sampled on Site, W-3 10' to 20' deep
 ASSUMED SPECIFIC GRAVITY: 2.7 +40 Sieve 6%
 LL: 68 PL: 22 PI: 46 Percent -200: 80%
 REMARKS: Both Ends and Diameter Trimmed + #4 Sieve 0%
 G 3241 095, W 3 10' 20'.xls

PROJECT: Pirkey Power Plant Embankments
 LOCATION: Hallsville, Texas
 PROJECT NO: G 3241 - 095
 CLIENT:
 November 2009

ETTL ENGINEERS & CONSULTANTS

PLATE: B.1

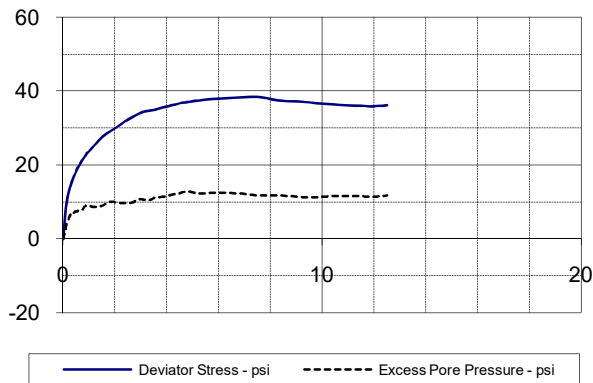
SPECIMEN NO. 1



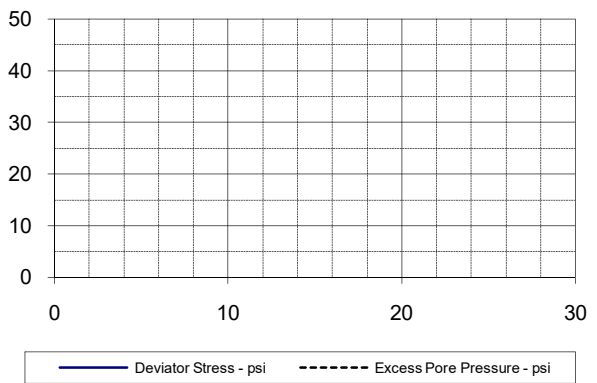
SPECIMEN NO. 2



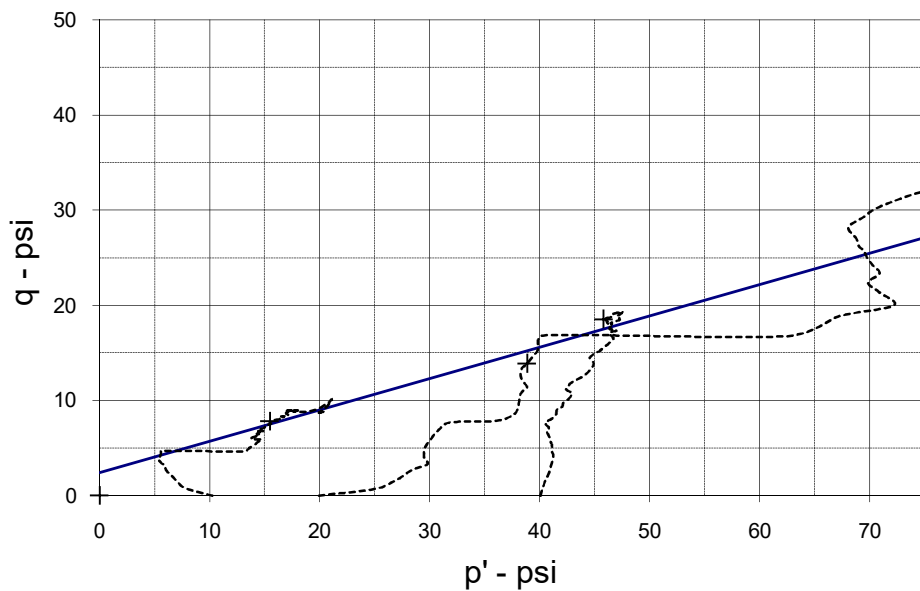
SPECIMEN NO. 3



SPECIMEN NO. 4

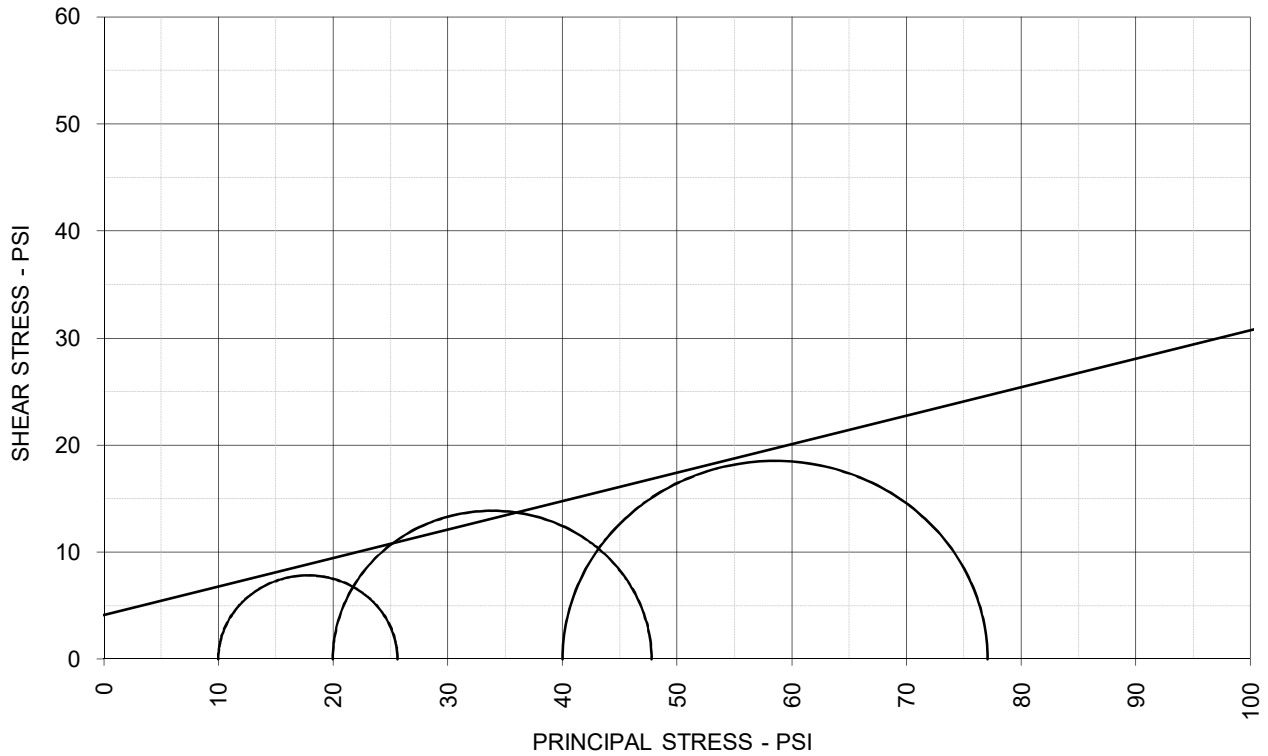


p - q DIAGRAM



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			

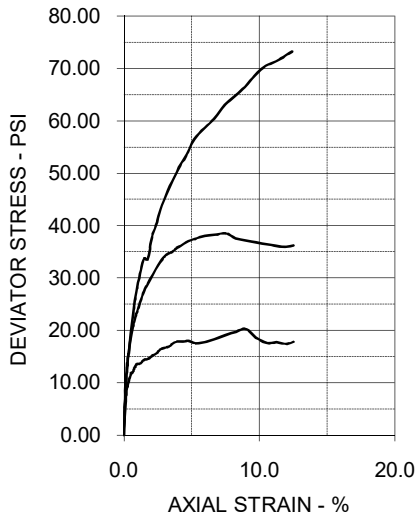
TRIAXIAL SHEAR TEST REPORT



TOTAL STRESS PARAMETERS

$\phi = 14.9 \text{ deg}$

$c = 4.1 \text{ psi}$



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

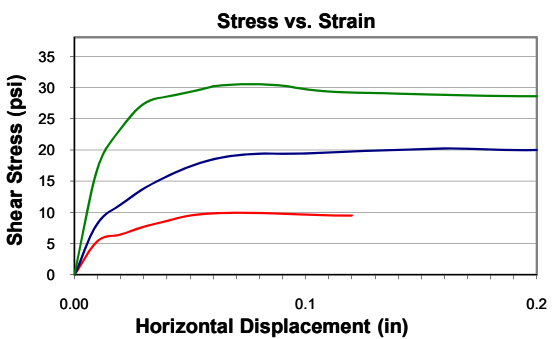
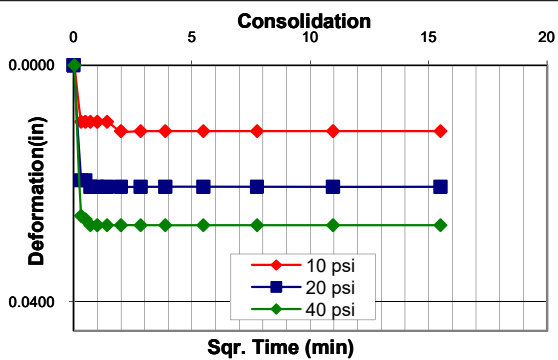
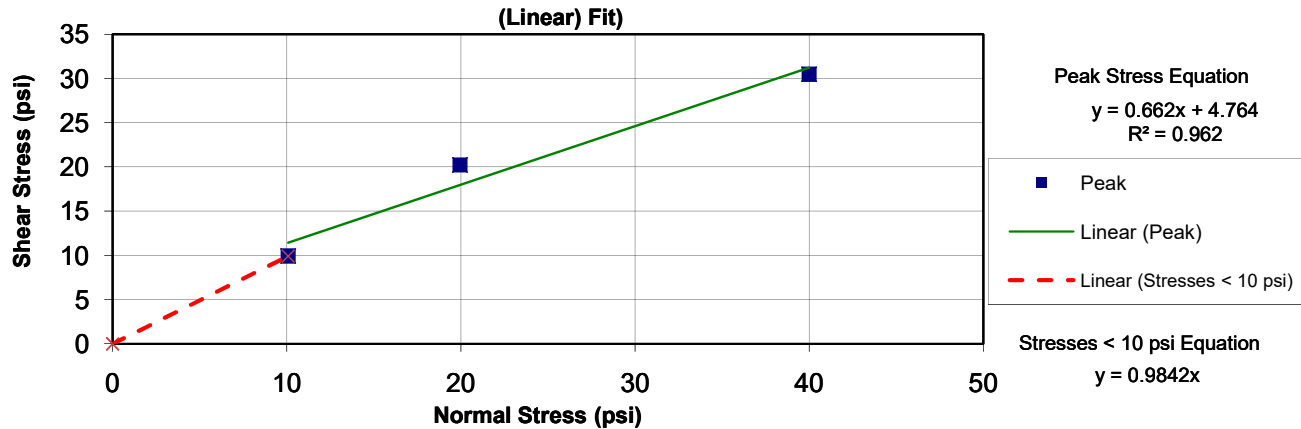
PLATE: B.3



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	-200%	31	
Material Description:	Tan & Brown Clayey Sand with ferric seams	Remarks		
Job No:	G 3241-095	When Calculating stresses < 10 psi: use appropriate Equation above (assuming no Cohesion)		
Boring No:	W-2			
Depth:	13'-16'			
Date:	October 31, 2009			
Technician:	Owen Sanderson			
Sample Type:	Shelby Tube			
Sampling method:	Shelby Tube			
Testing Device:	Soiltest B-124BY 2.5 in. round			

C. Brandon Quinn, P.E.



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

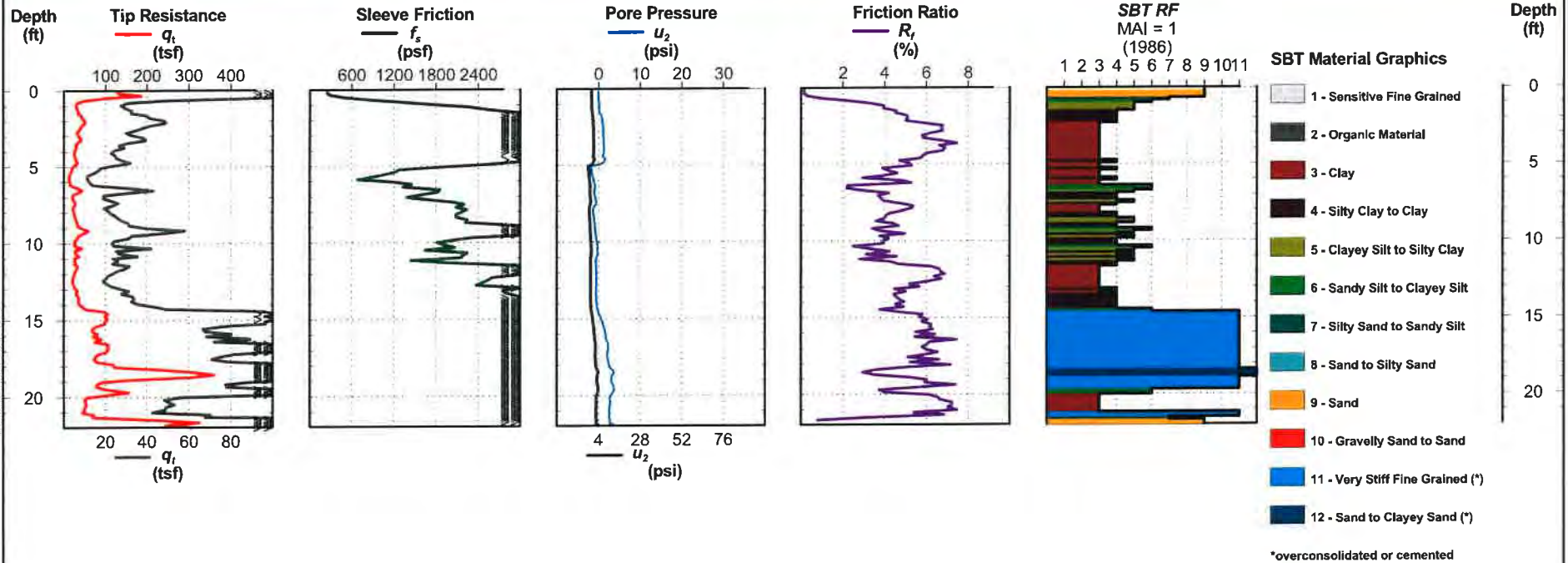
Cone Penetration Test

CPT-1

Latitude: 32.46619
Longitude: -94.48989

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 22.0 ft



EUSTIS GINT LIBRARY\090314.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.



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

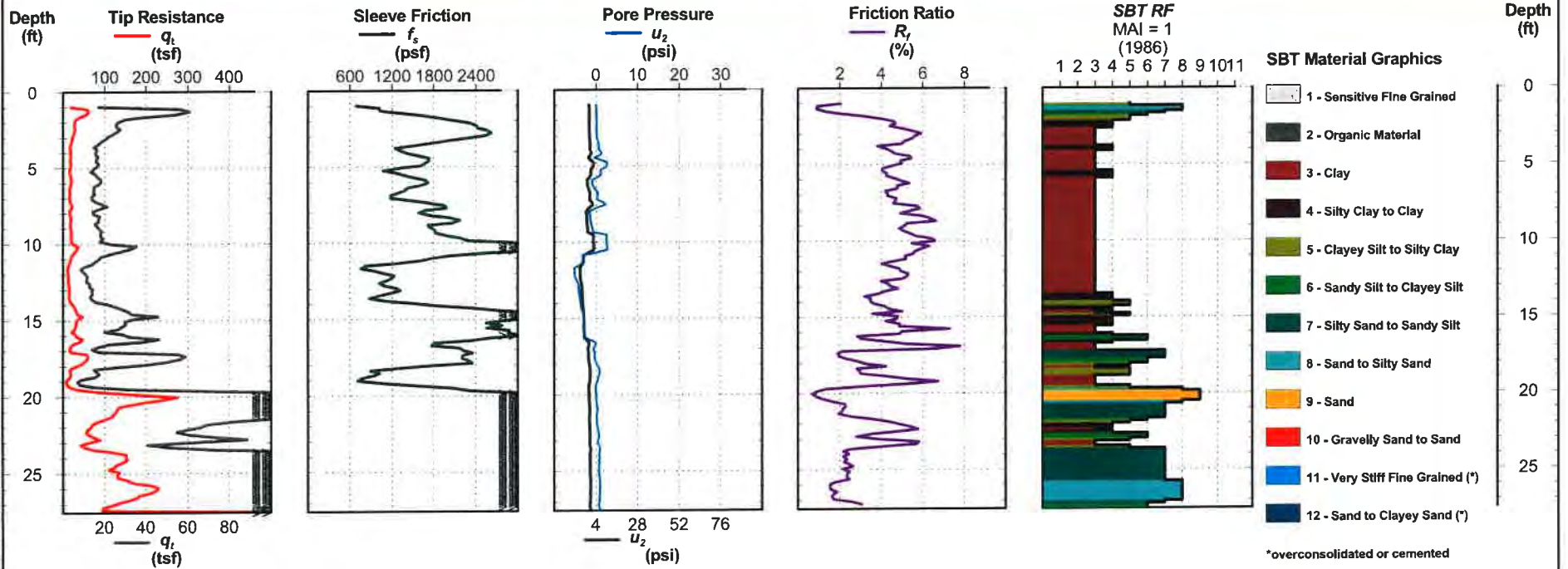
Cone Penetration Test

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 LIBRARY\090314.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.



H W Pirkey Power Plant
 West Primary Ash Pond
 Future Landfill at K-Area
 Hallsville, Texas
 Project No: L0441

Cone Penetration Test

CPT-3

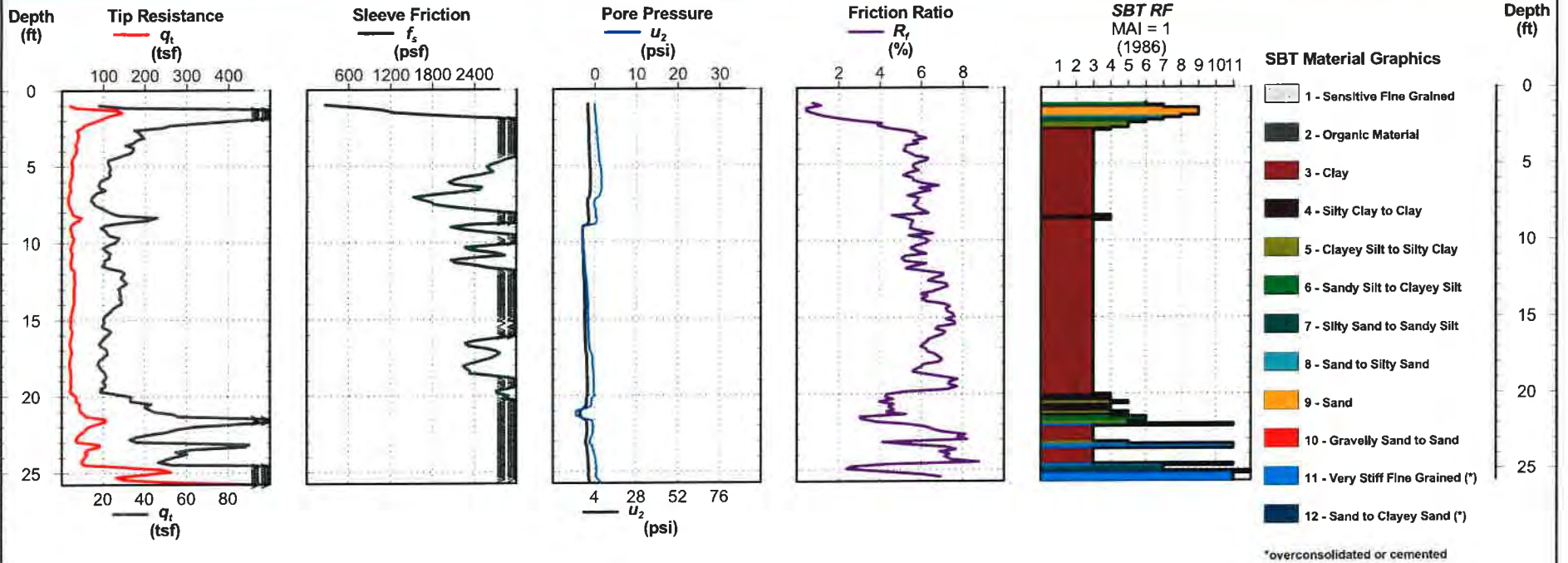
EUSTIS ENGINEERING

CPT ID/Net Area Ratio: DSG0709 / 0.8

Date: 12/8/15
 Operator: P. Thurmond

Latitude: 32.46587
 Longitude: -94.49313

Water Depth: See Text
 Total Depth: 25.8 ft



EUSTIS GINT LIBRARY\090314.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.



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

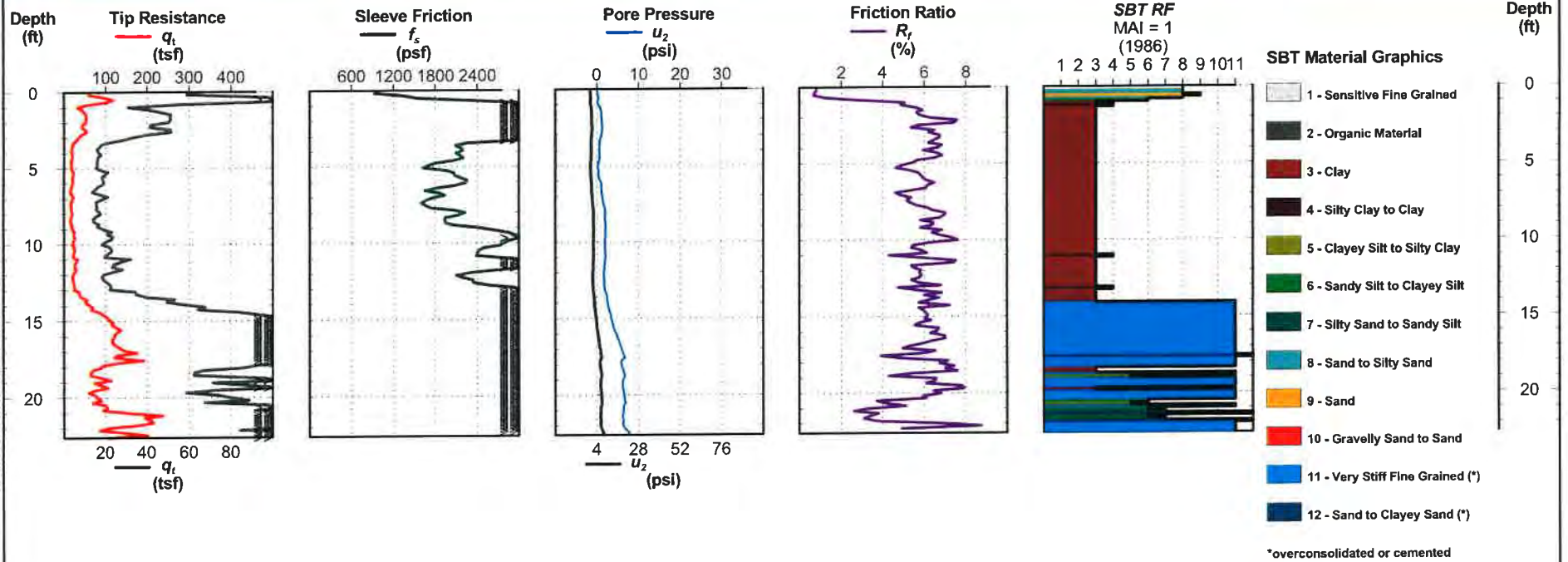
Cone Penetration Test

CPT-4

Latitude: 32.46672
Longitude: -94.49400

Date: 12/8/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 22.6 ft



EUSTIS GINT LIBRARY\090314_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.



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

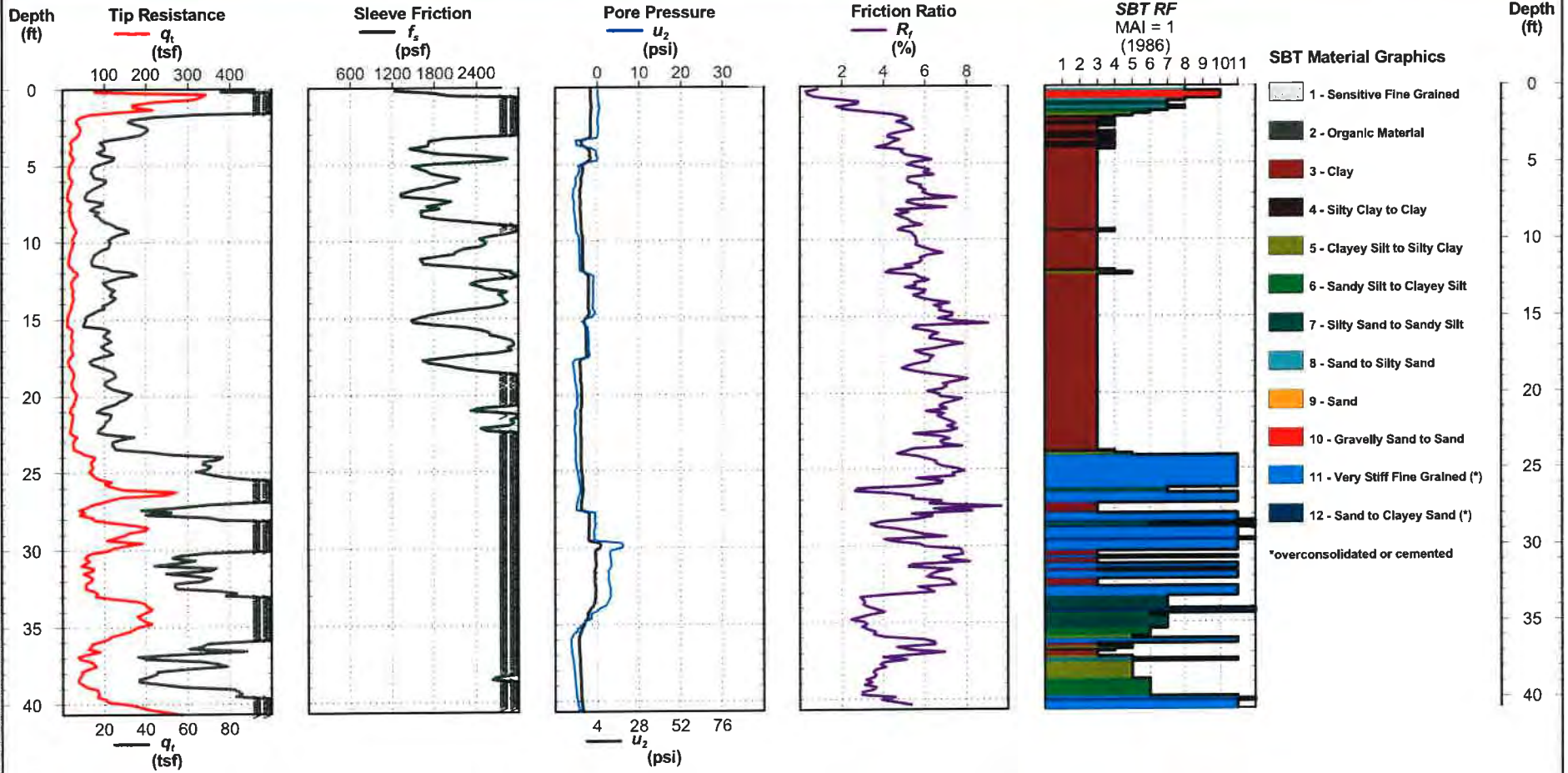
Cone Penetration Test

CPT-5

Latitude: 32.46803
Longitude: -94.49390

Date: 12/9/15
Operator: P. Thurmond

Water Depth: See Text
Total Depth: 40.7 ft



EUSTIS GINT LIBRARY\030314.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.



H W Pirkey Power Plant
 West Primary Ash Pond
 Future Landfill at K-Area
 Hallsville, Texas
 Project No: L0441

Cone Penetration Test

CPT-6

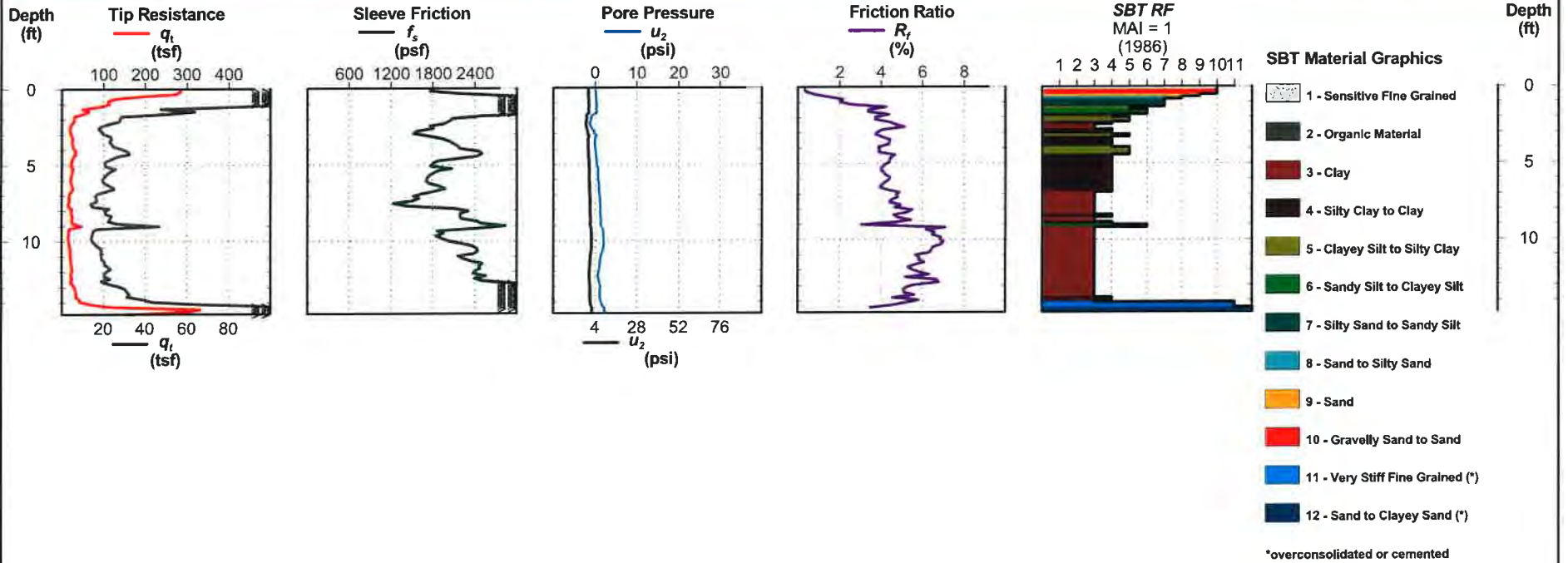
EUSTIS ENGINEERING

CPT ID/Net Area Ratio: DSG0709 / 0.8

Date: 12/9/15
 Operator: P. Thurmond

Latitude: 32.46887
 Longitude: -94.49243

Water Depth: See Text
 Total Depth: 14.8 ft



EUSTIS GINT_LIBRARY090314.SLB_EE_STANDARD_CPT_LOG_L0441.GPJ_EE_STANDARD_DATA_TEMPLATE_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.



H W Pirkey Power Plant
 West Primary Ash Pond
 Future Landfill at K-Area
 Hallsville, Texas
 Project No: L0441

Cone Penetration Test

CPT-7

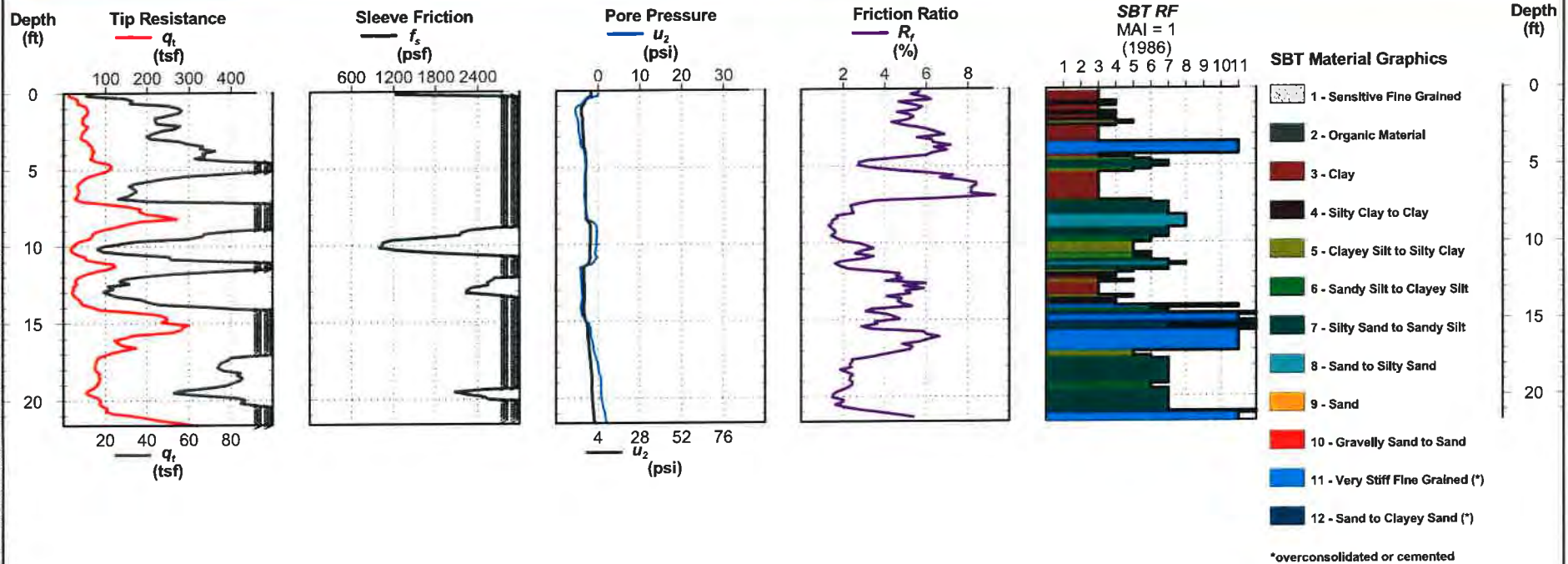
Latitude: 32.46572
 Longitude: -94.49256

EUSTIS ENGINEERING

CPT ID/Net Area Ratio: DSG0709 / 0.8

Date: 12/9/15
 Operator: P. Thurmond

Water Depth: See Text
 Total Depth: 21.7 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.



H W Pirkey Power Plant
 West Primary Ash Pond
 Future Landfill at K-Area
 Hallsville, Texas
 Project No: L0441

Cone Penetration Test

CPT-8

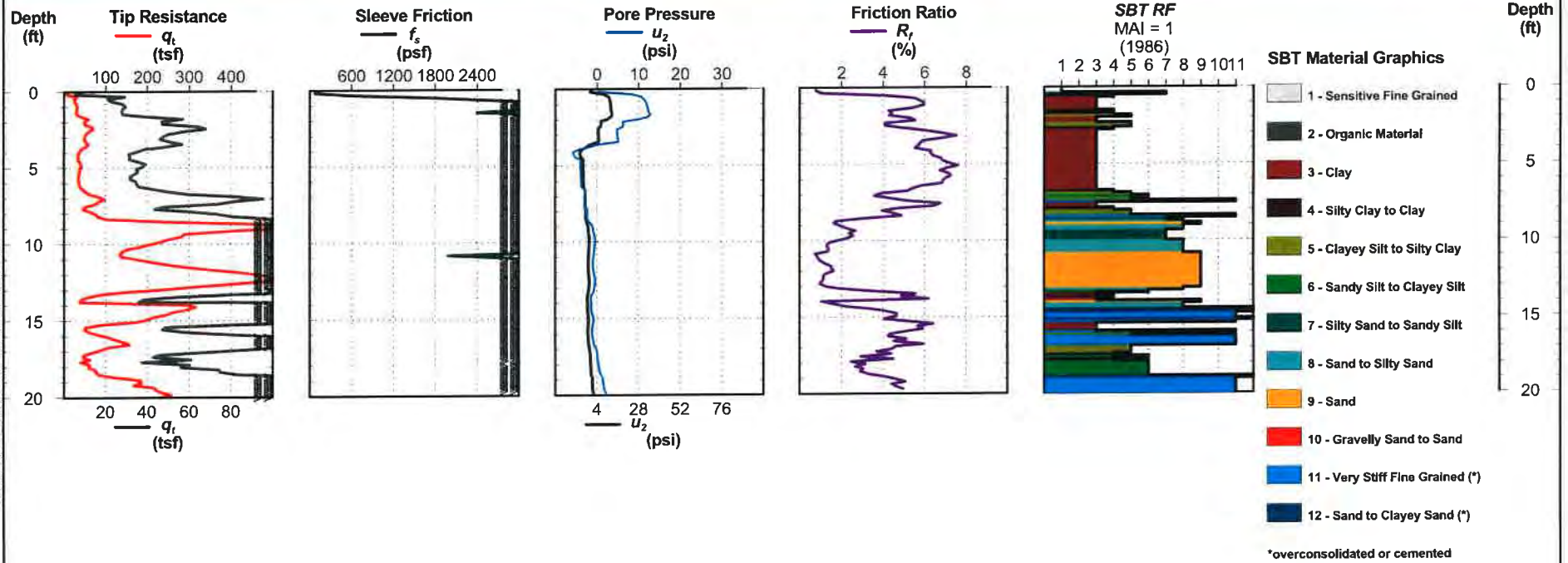
Latitude: 32.46603
 Longitude: -94.49087

EUSTIS ENGINEERING

CPT ID/Net Area Ratio: DSG0709 / 0.8

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 DATA TEMPLATE.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.

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



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 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.

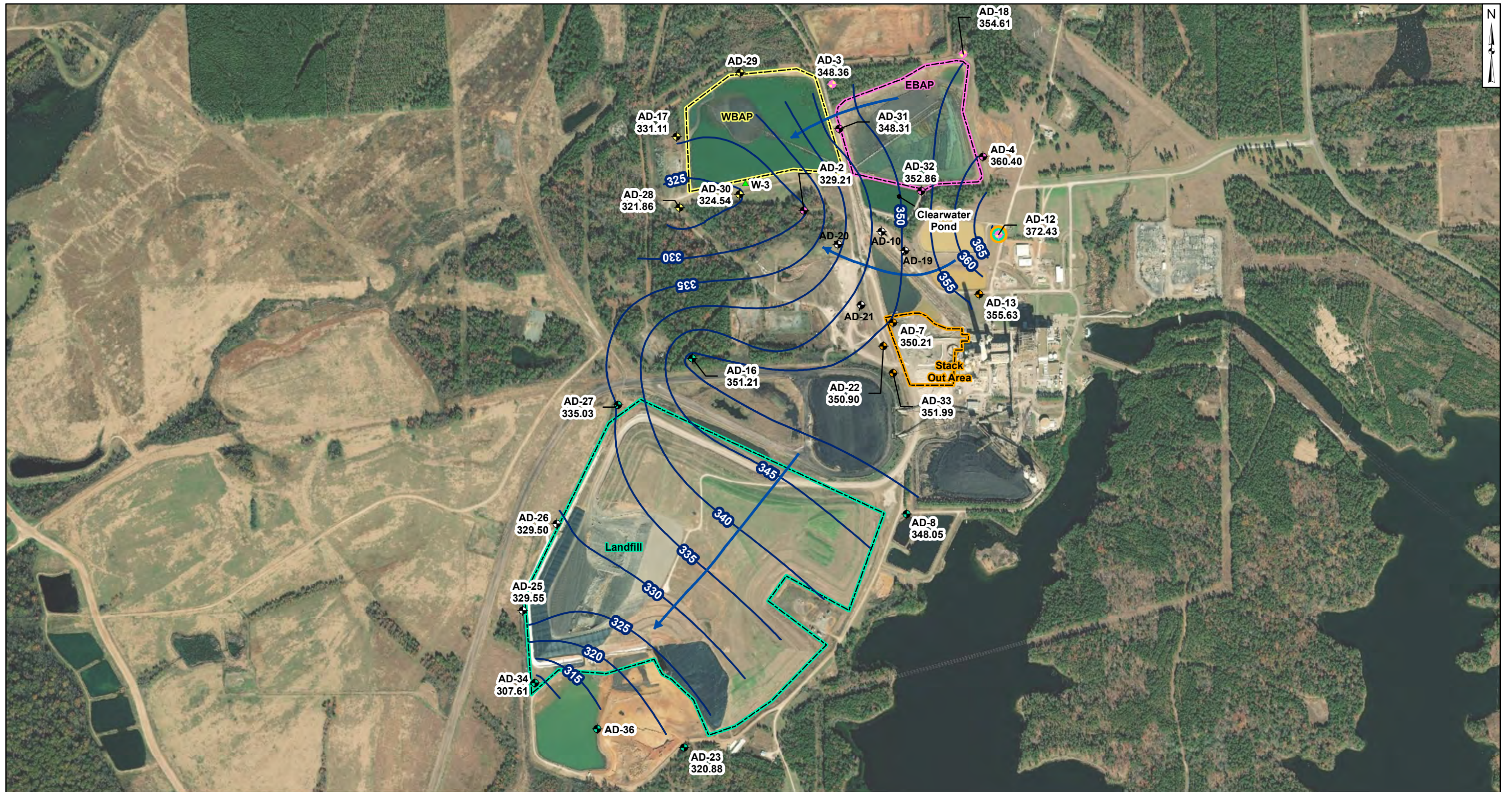
X. A Projection of Key Activities for the Upcoming Year

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

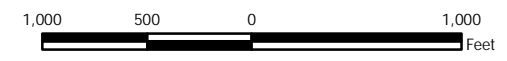
Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.



- 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.



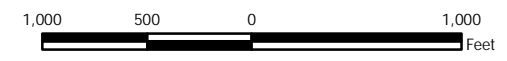
Potentiometric Contours - Uppermost Aquifer February 2019	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2020/01/16
Figure 1	



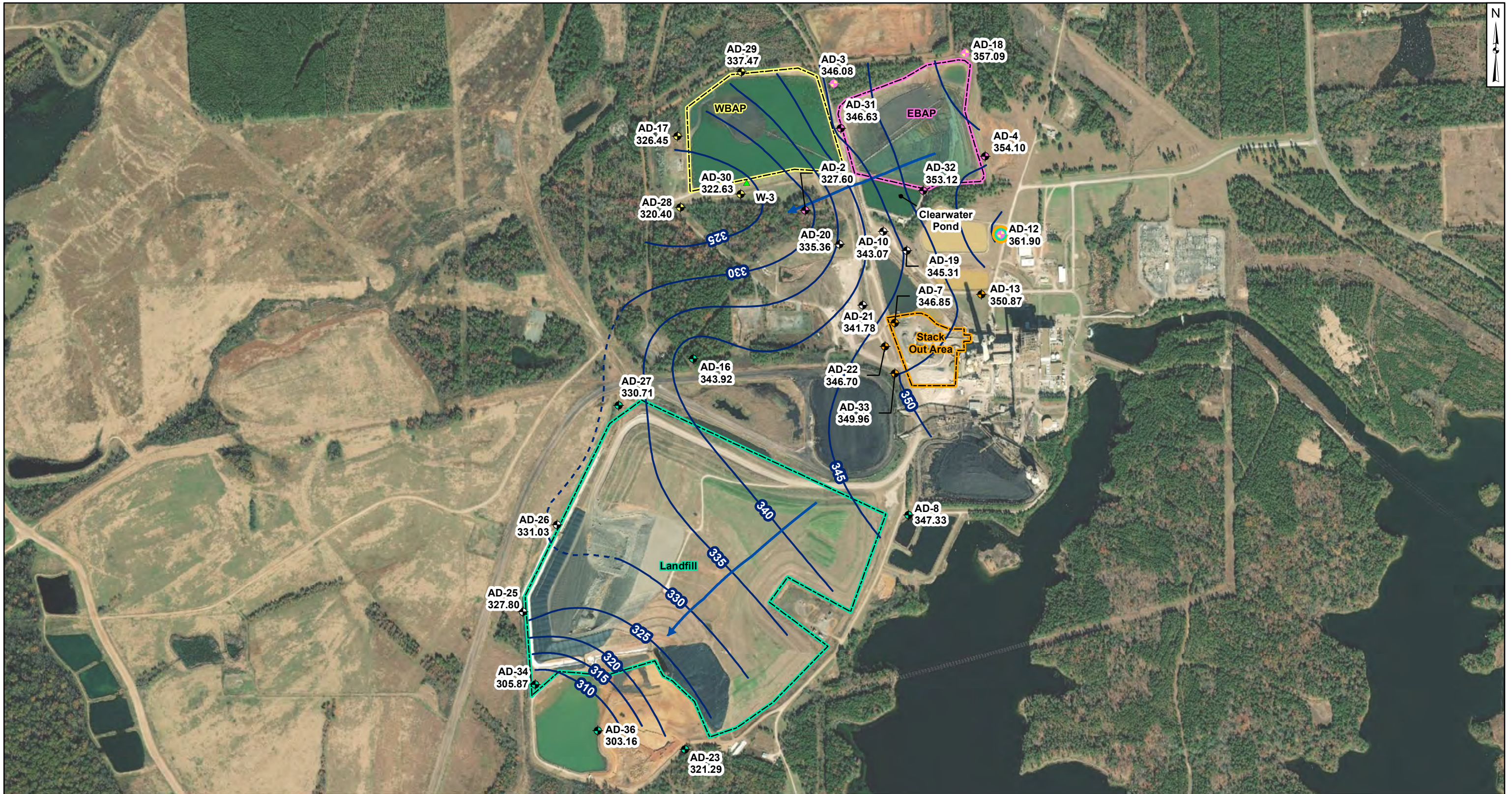
- Legend**
- Groundwater Monitoring Wells**
- ◆ Out of Network
 - ◆ EBAP
 - ◆ WBAP
 - ◆ Landfill
 - ◆ Stackout Area
 - ◆ EBAP and WBAP
 - All CCR Unit Networks
 - ▲ Piezometer
 - Groundwater Elevation Contour
 - ➔ Approximate Groundwater Flow Direction

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.



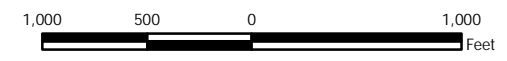
Potentiometric Contours - Uppermost Aquifer May 2019	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2020/01/16
Figure 2	



- 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.



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 East Bottom Ash Pond**

Geosyntec Consultants, Inc.

CCR Management Unit	Monitoring Well	Well Diameter (inches)	2019-02		2019-05		2019-08	
			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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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



1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by



engineers | scientists | innovators

941 Chatham Lane
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July 12, 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
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

112498

License Number

TEXAS

Licensing State

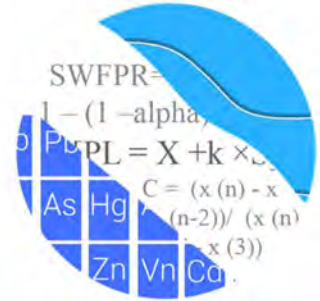
07.12.19

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.

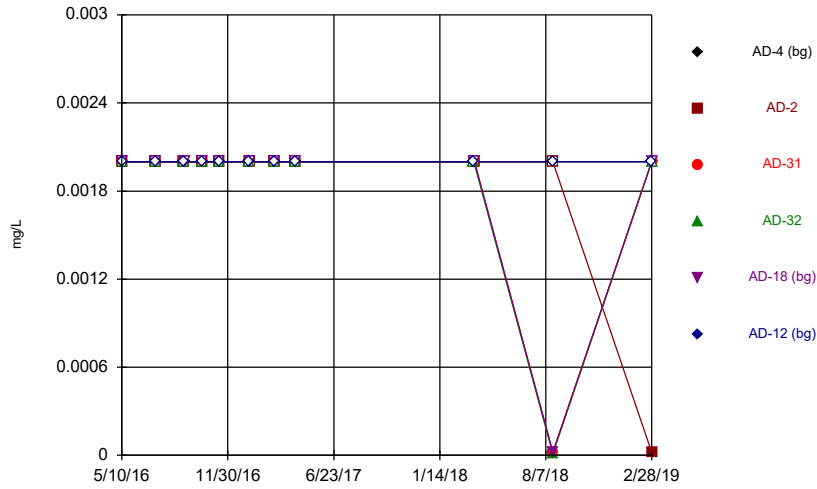
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey EBAP. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

A handwritten signature in cursive script that reads "Kristina Rayner". The signature is written in a dark grey or black ink on a white background.

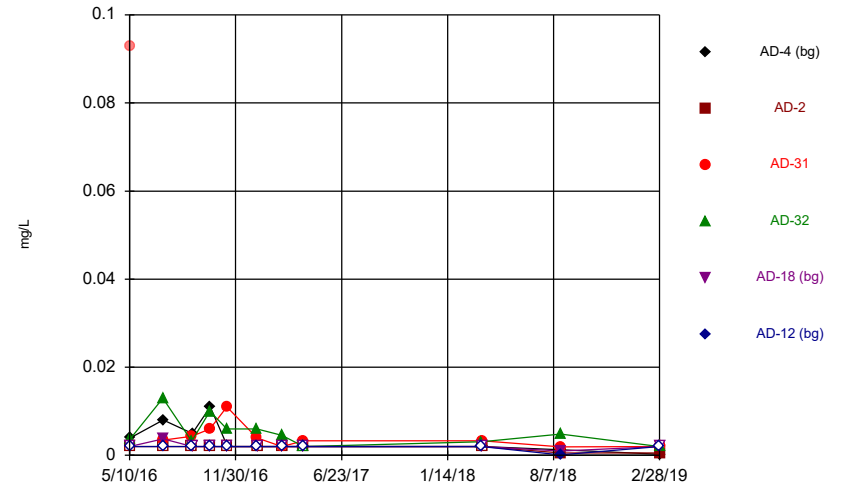
Kristina L. Rayner
Groundwater Statistician

Time Series



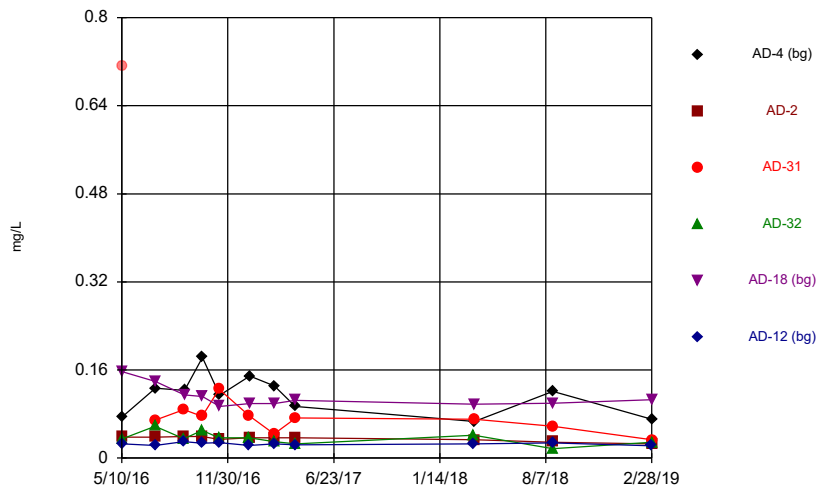
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Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



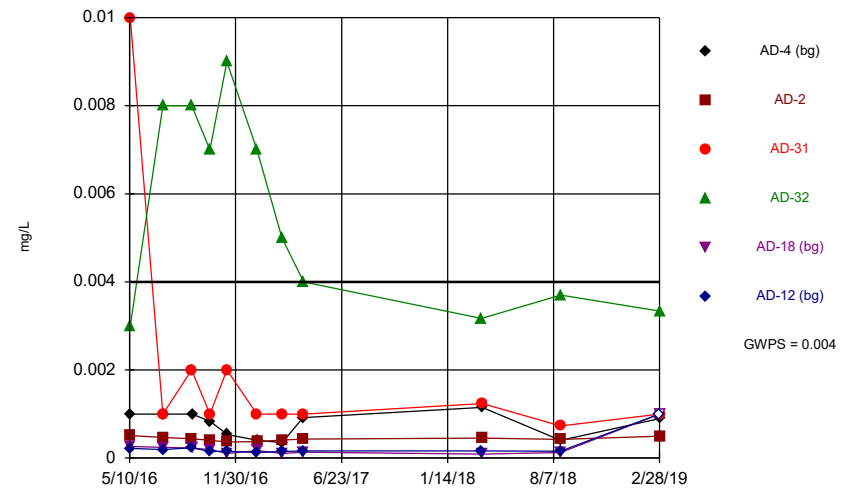
Constituent: Arsenic, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



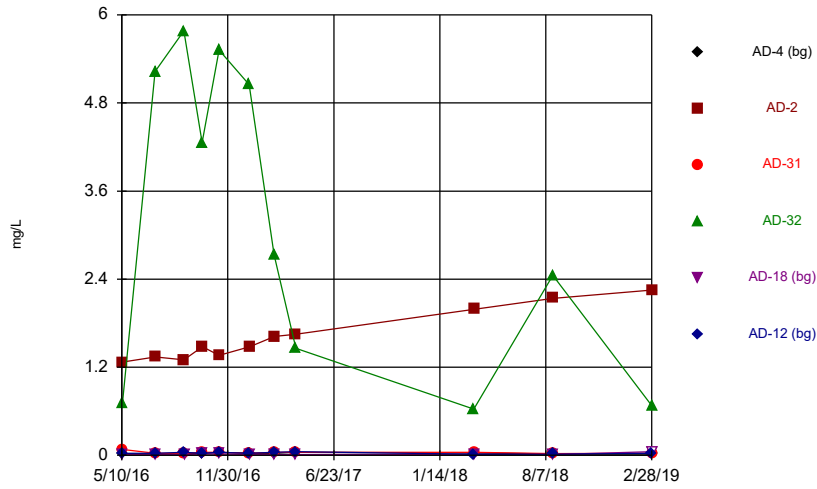
Constituent: Barium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



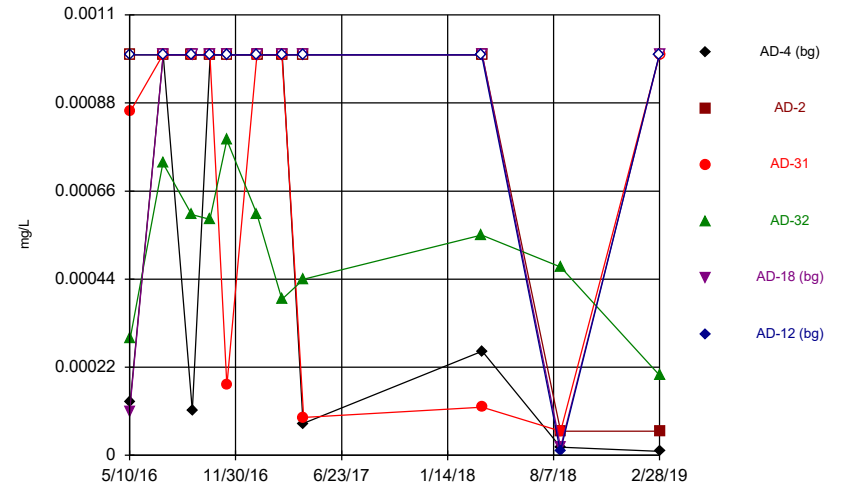
Constituent: Beryllium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



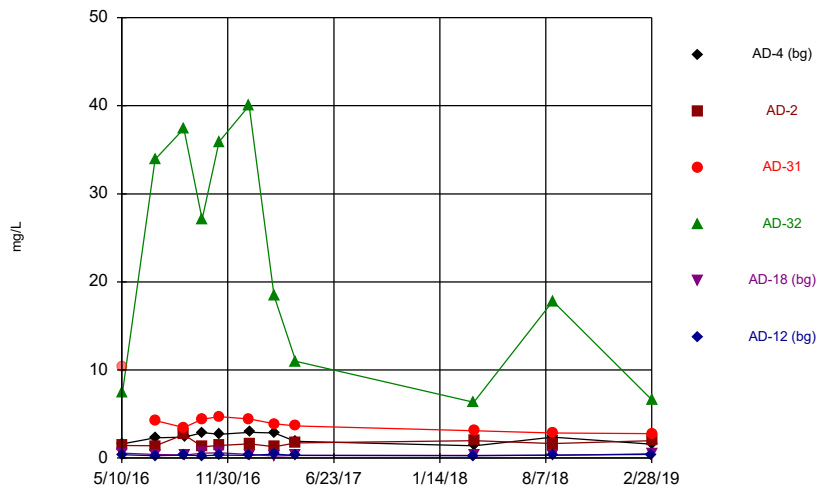
Constituent: Boron, total Analysis Run 7/7/2019 11:54 AM View: Time Series
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



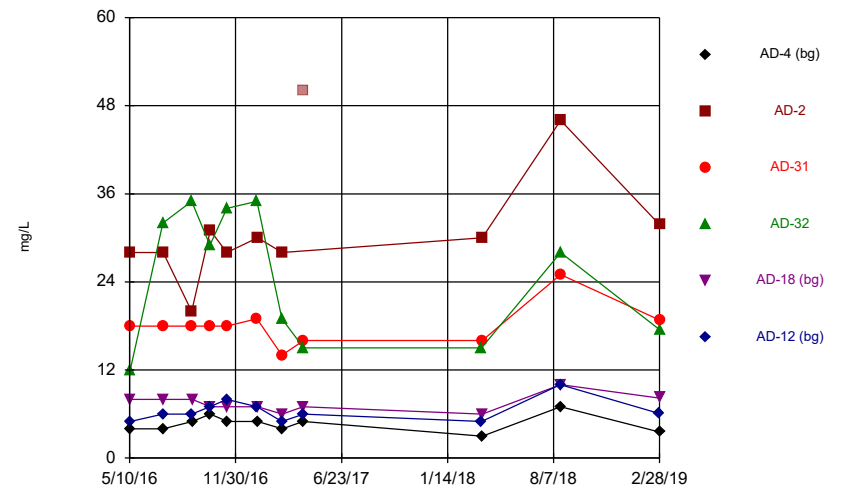
Constituent: Cadmium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



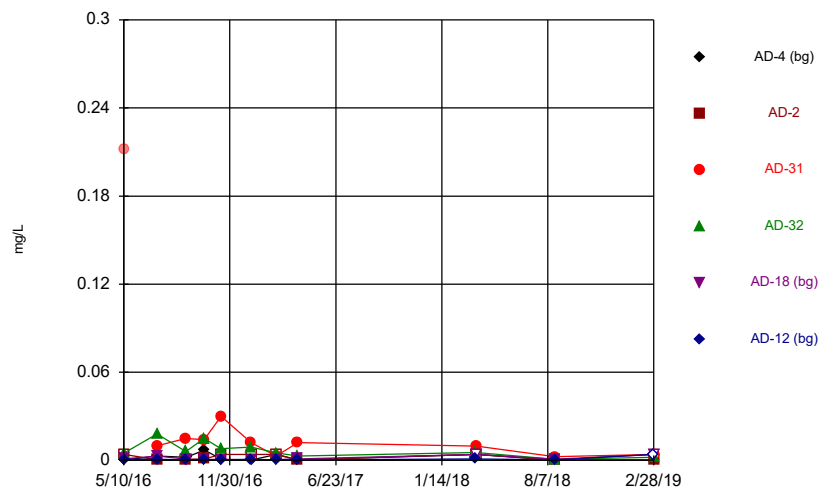
Constituent: Calcium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



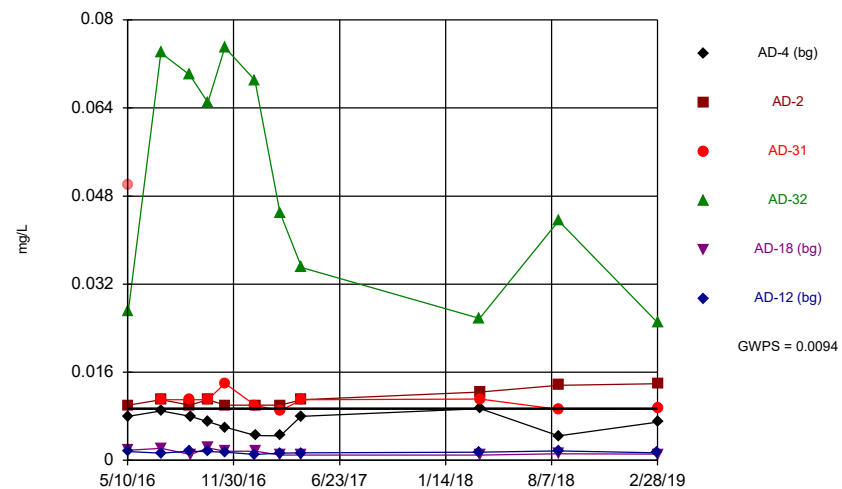
Constituent: Chloride, total Analysis Run 7/7/2019 11:54 AM View: Time Series
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



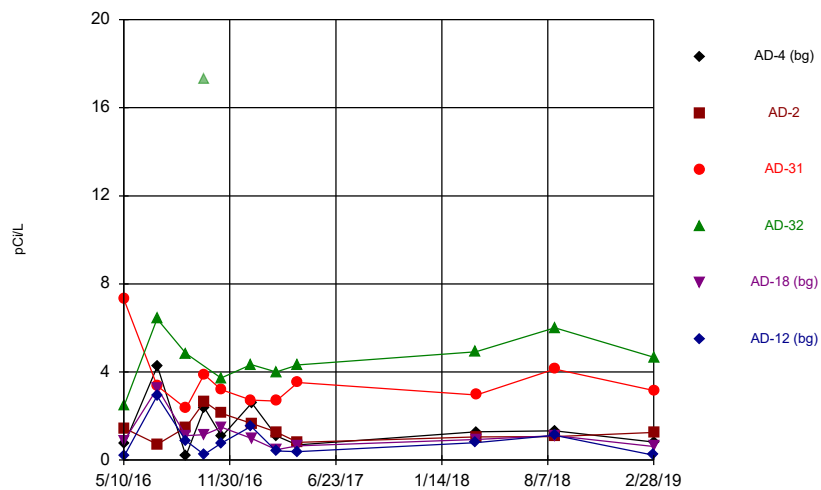
Constituent: Chromium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



Constituent: Cobalt, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

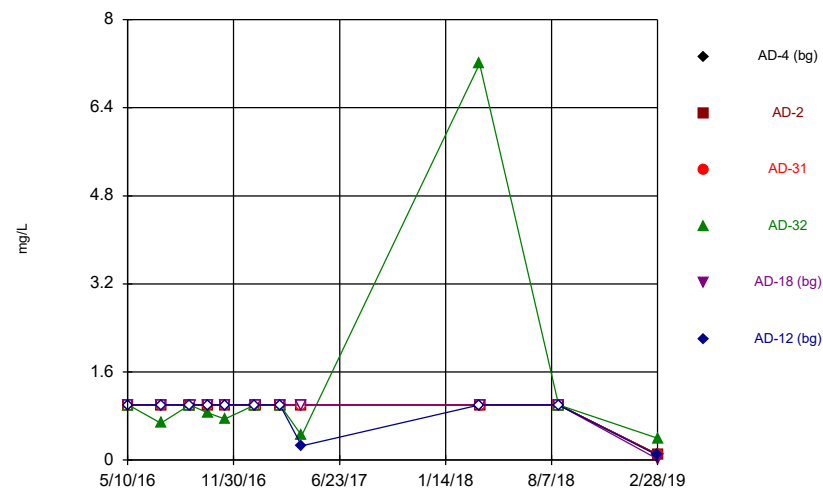
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

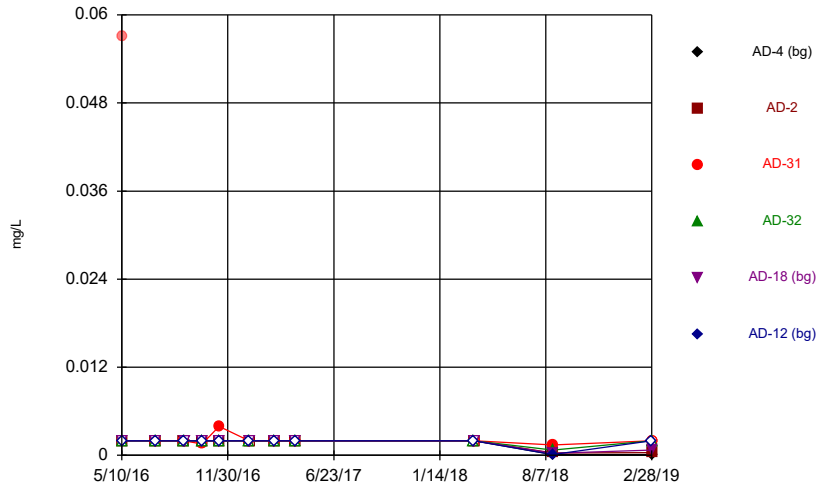
Hollow symbols indicate censored values.

Time Series



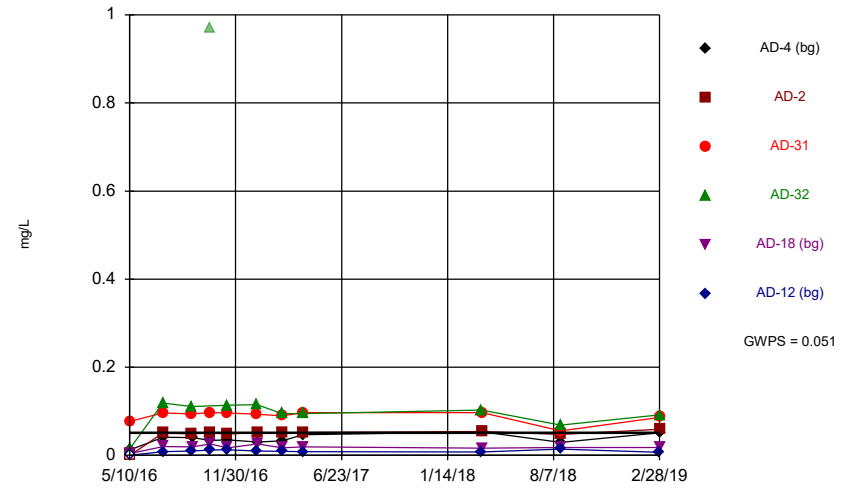
Constituent: Fluoride, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



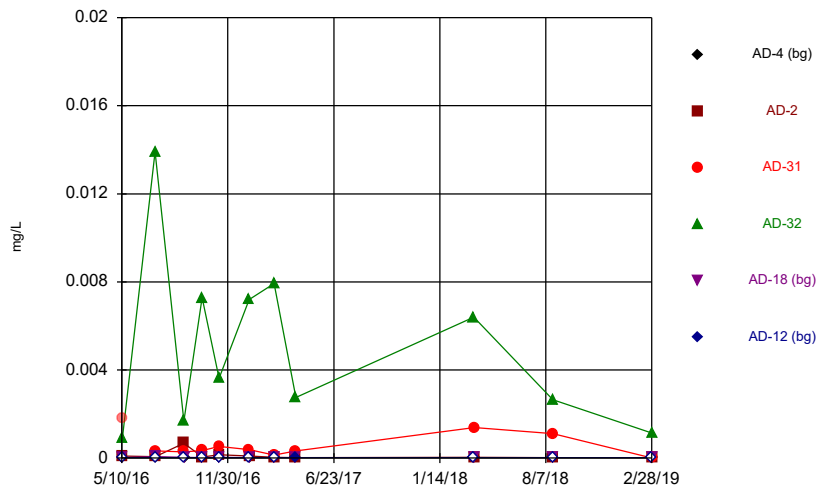
Constituent: Lead, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



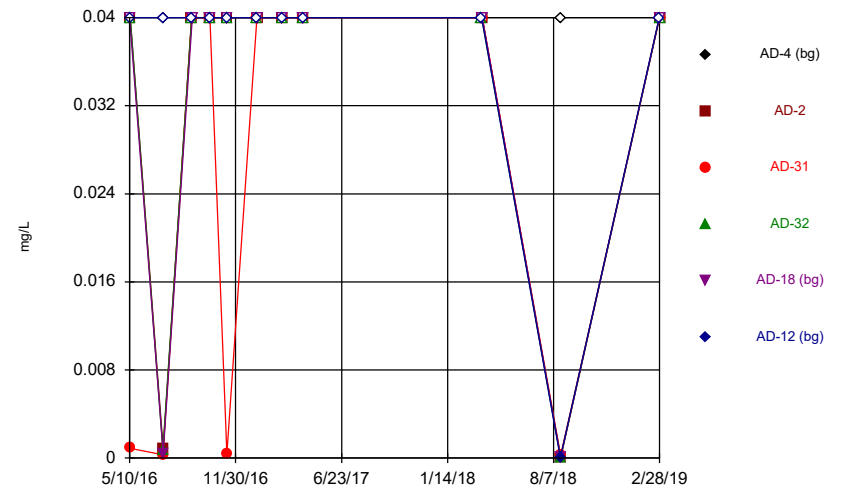
Constituent: Lithium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



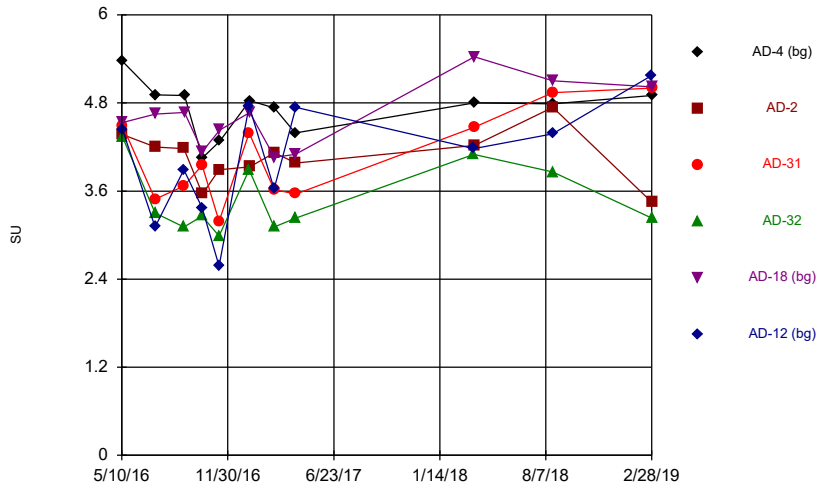
Constituent: Mercury, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



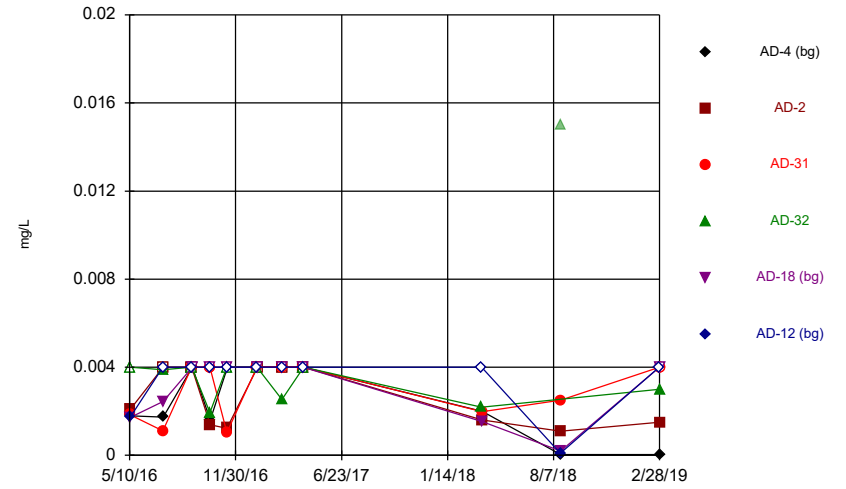
Constituent: Molybdenum, total Analysis Run 7/7/2019 11:54 AM View: Time Series
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



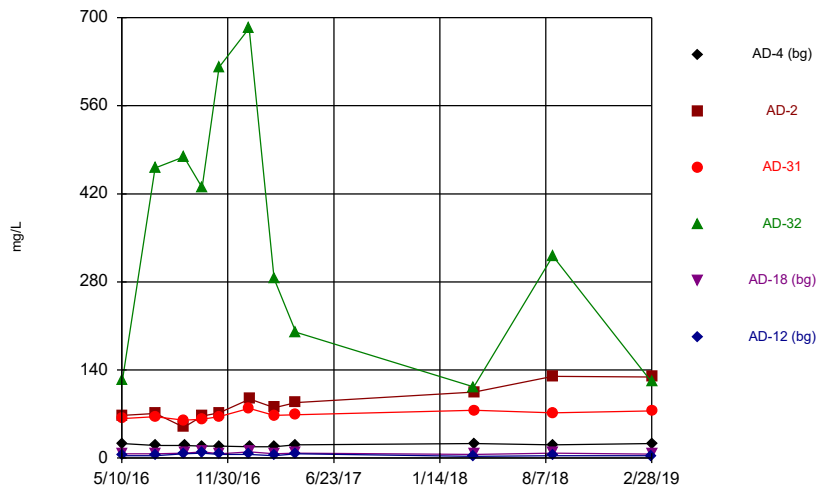
Constituent: pH, field Analysis Run 7/7/2019 11:54 AM View: Time Series
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



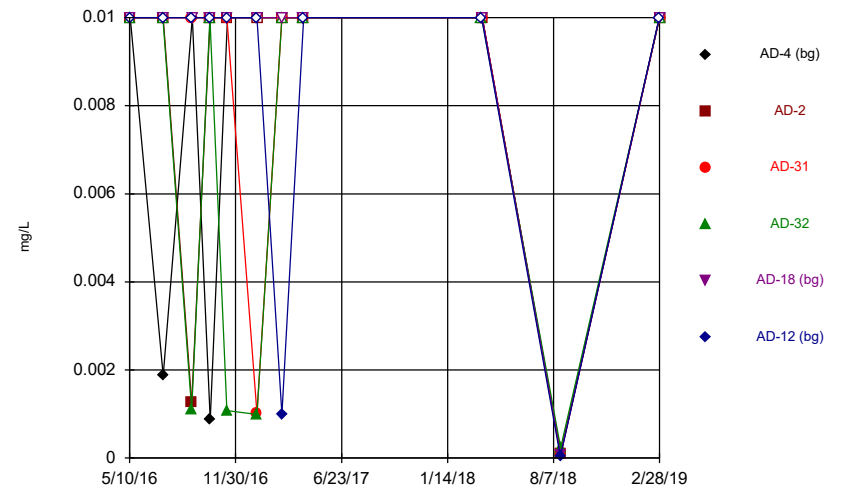
Constituent: Selenium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



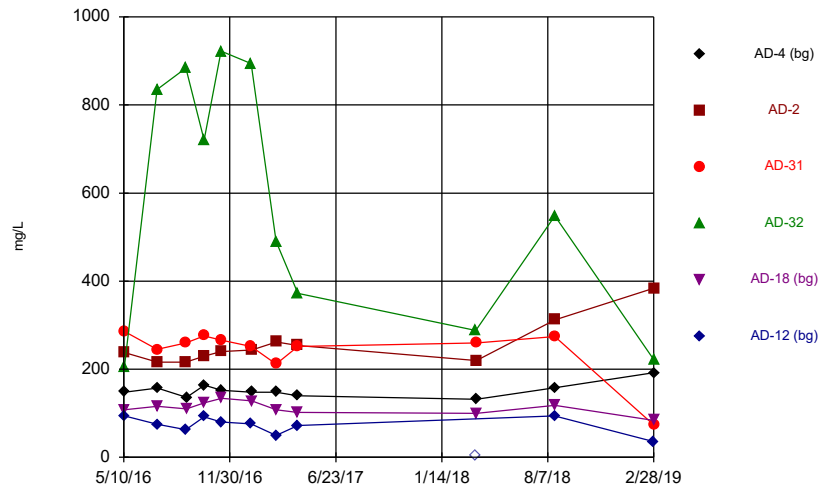
Constituent: Sulfate, total Analysis Run 7/7/2019 11:54 AM View: Time Series
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



Constituent: Thallium, total Analysis Run 7/7/2019 11:54 AM View: Time Series
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

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

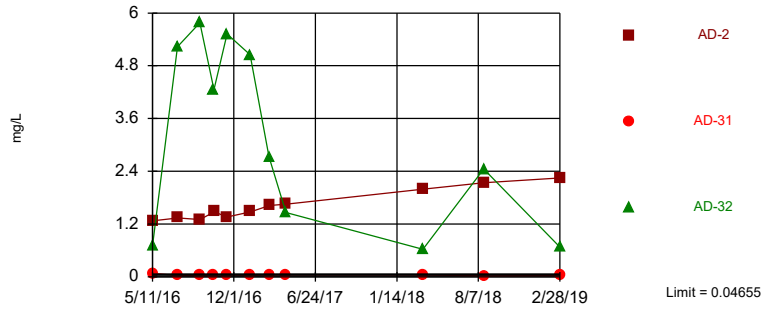
Interwell Prediction Limit Summary - All Results

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

Exceeds Limit: AD-2, AD-32

Prediction Limit
Interwell Parametric

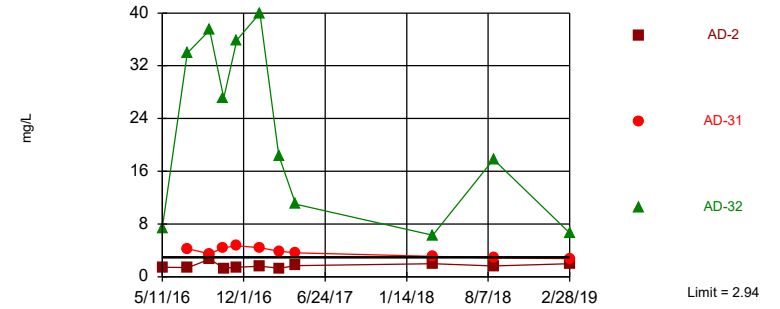


Background Data Summary: Mean=0.0252, Std. Dev.=0.012, n=33, 3.03% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9111, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

Constituent: Boron, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Exceeds Limit: AD-32

Prediction Limit
Interwell Non-parametric

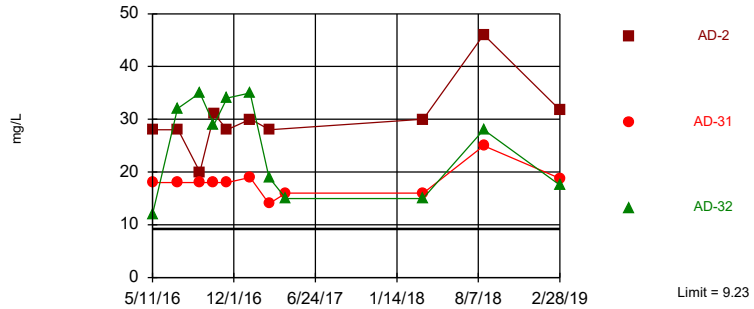


Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 33 background values. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 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

Exceeds Limit: AD-2, AD-31, AD-32

Prediction Limit
Interwell Parametric

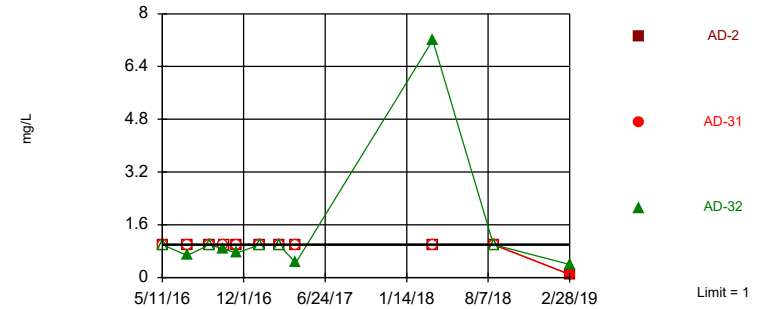


Background Data Summary: Mean=6.207, Std. Dev.=1.699, n=33. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9559, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

Constituent: Chloride, total Analysis Run 7/5/2019 12:28 PM View: PL's Interwell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Within Limit

Prediction Limit
Interwell Non-parametric

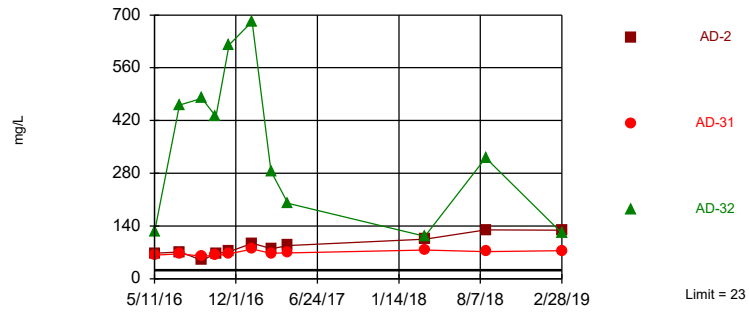


Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 33 background values. 87.88% NDs. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 3 points to limit.

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

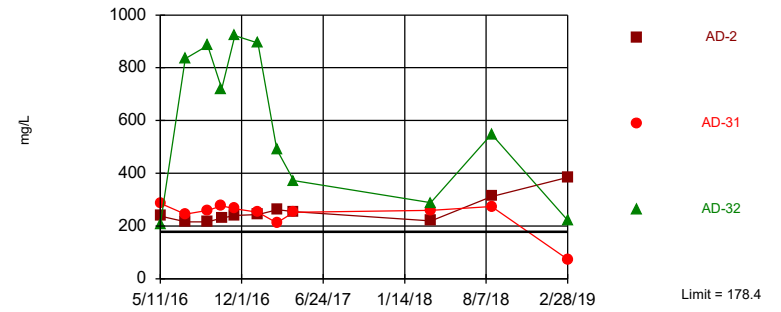


Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 33 background values. Annual per-constituent alpha = 0.009997. Individual comparison alpha = 0.001673 (1 of 2). Comparing 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

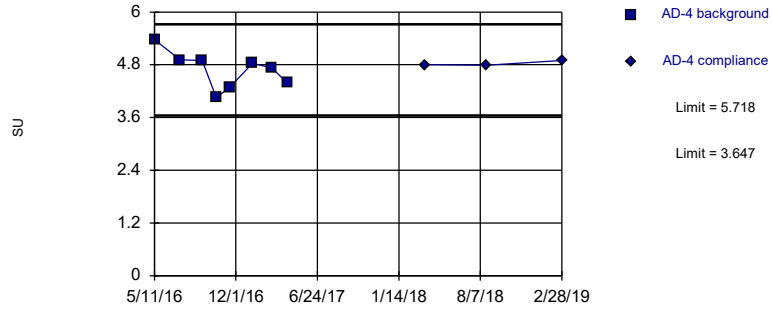
Intrawell Prediction Limit Summary - All Results

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

Within Limits

Prediction Limit
Intrawell Parametric

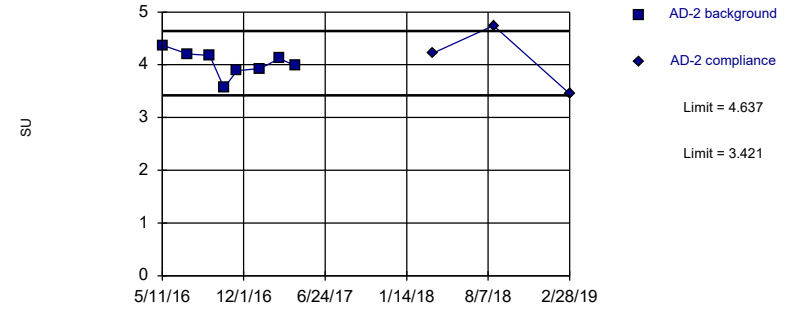


Background Data Summary: Mean=4.683, Std. Dev.=0.4215, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9603, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Within Limits

Prediction Limit
Intrawell Parametric

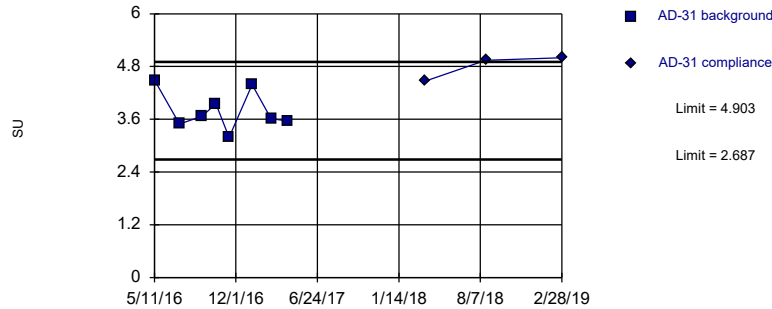


Background Data Summary: Mean=4.029, Std. Dev.=0.2473, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.956, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Exceeds Limits

Prediction Limit
Intrawell Parametric

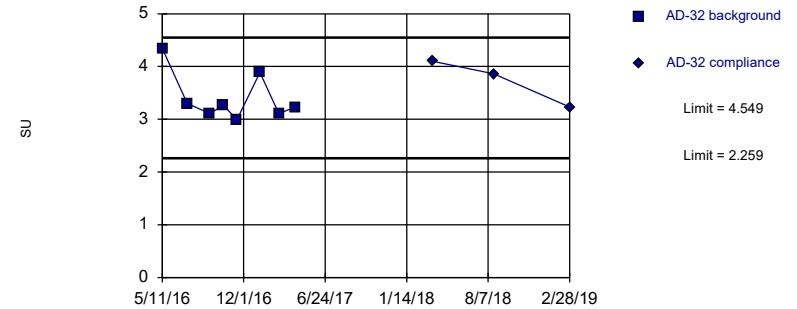


Background Data Summary: Mean=3.795, Std. Dev.=0.4507, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9179, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 12:37 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Within Limits

Prediction Limit
Intrawell Parametric

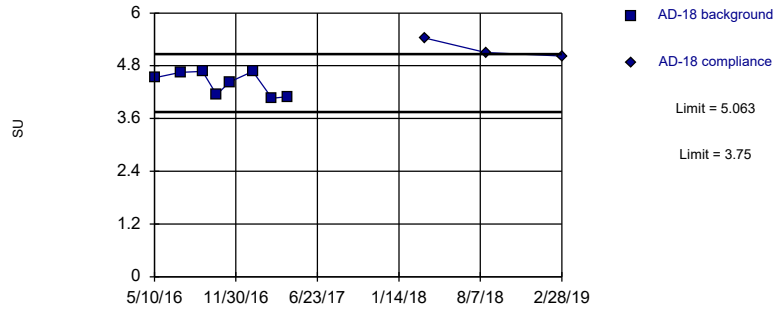


Background Data Summary: Mean=3.404, Std. Dev.=0.4657, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7949, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

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

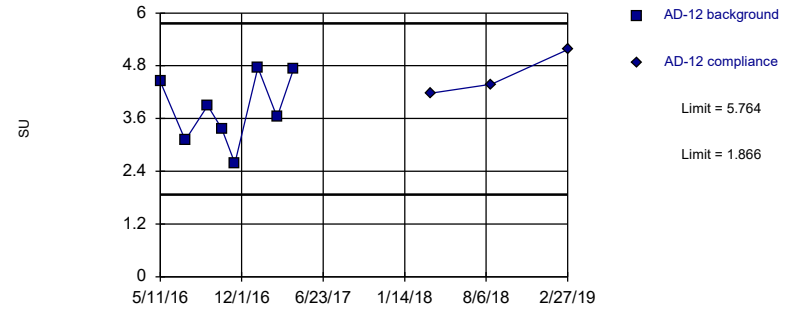


Background Data Summary: Mean=4.406, Std. Dev.=0.267, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8312, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

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

<u>Constituent</u>	<u>Well</u>	<u>Slope</u>	<u>Calc.</u>	<u>Critical</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Normality</u>	<u>Xform</u>	<u>Alpha</u>	<u>Method</u>
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

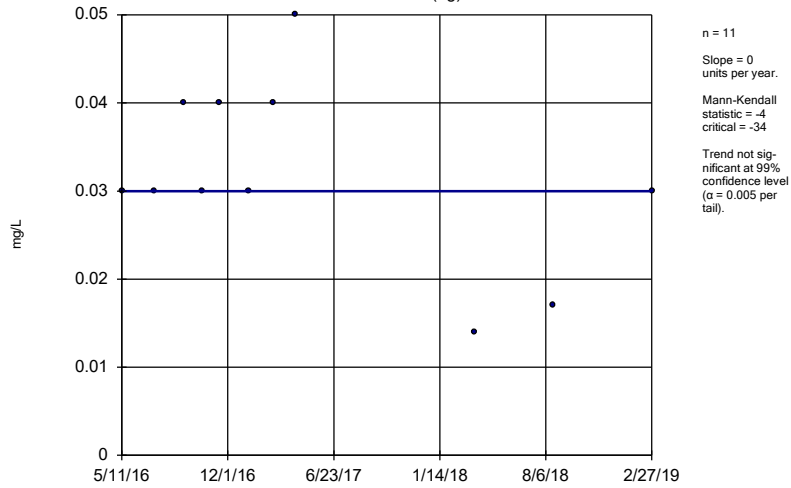
Trend Test Summary Table - All Results

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

Sen's Slope Estimator

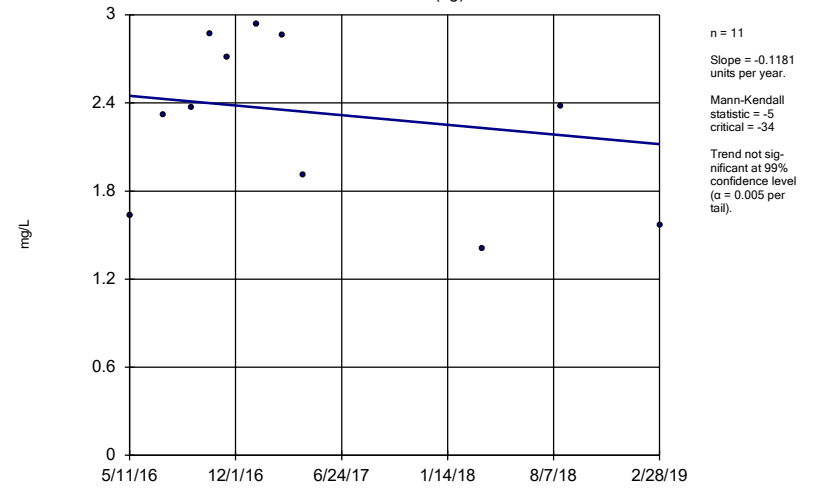
AD-12 (bg)



Constituent: Boron, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

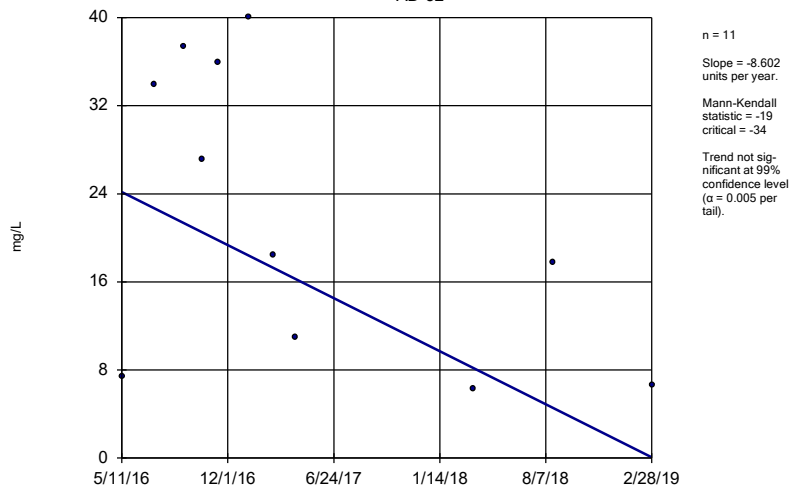
AD-4 (bg)



Constituent: Calcium, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

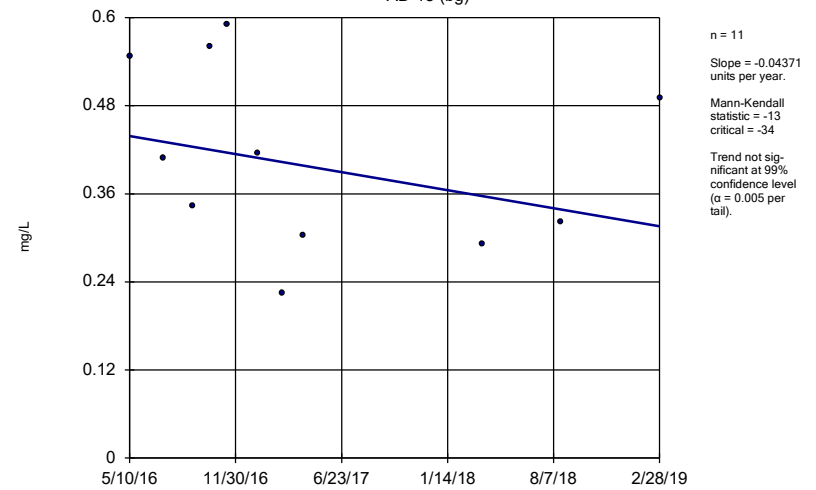
AD-32



Constituent: Calcium, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

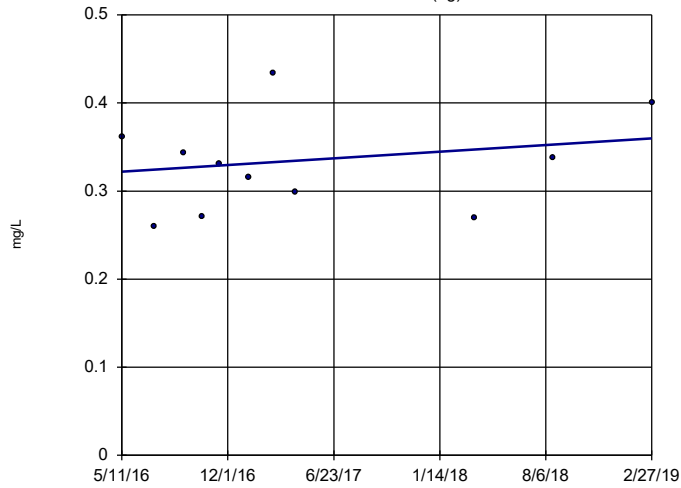
AD-18 (bg)



Constituent: Calcium, total Analysis Run 7/5/2019 1:05 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-12 (bg)

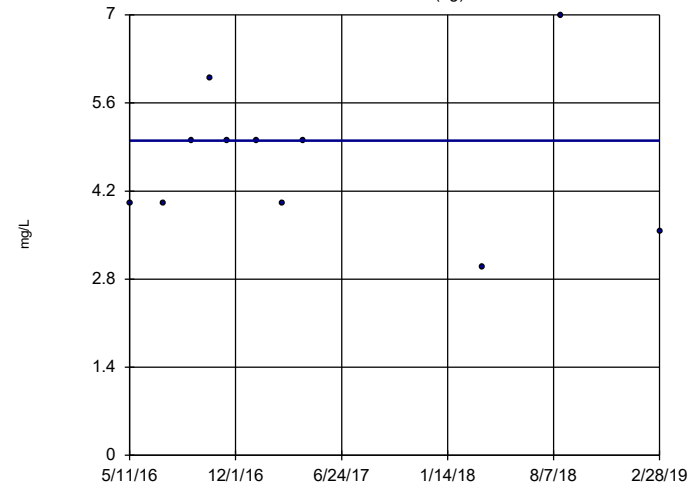


n = 11
 Slope = 0.01357
 units per year.
 Mann-Kendall
 statistic = 5
 critical = 34
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Calcium, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-4 (bg)

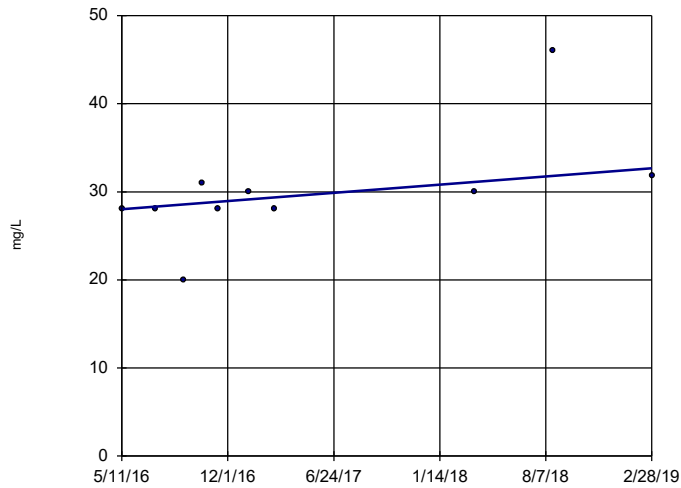


n = 11
 Slope = 0
 units per year.
 Mann-Kendall
 statistic = -2
 critical = -34
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-2

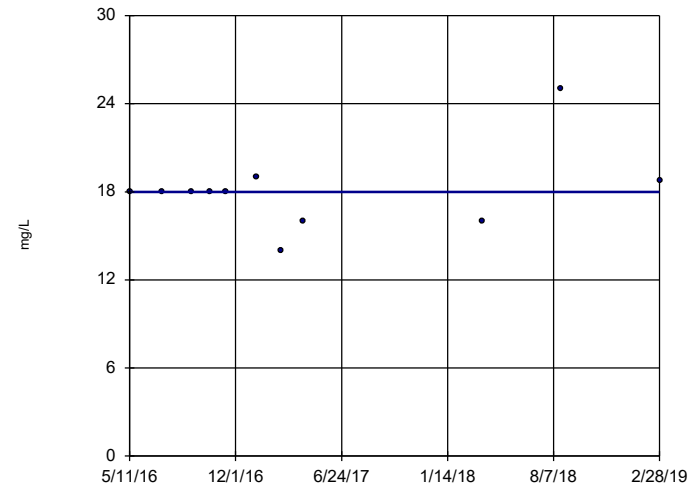


n = 10
 Slope = 1.659
 units per year.
 Mann-Kendall
 statistic = 22
 critical = 30
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-31

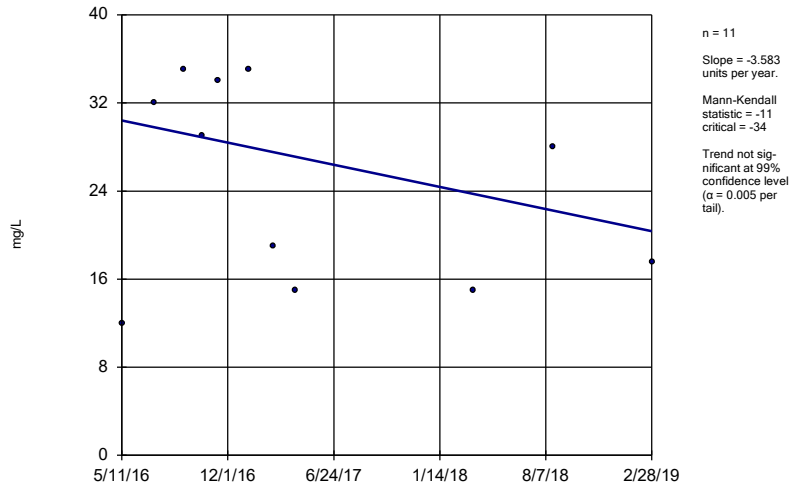


n = 11
 Slope = 0
 units per year.
 Mann-Kendall
 statistic = 4
 critical = 34
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

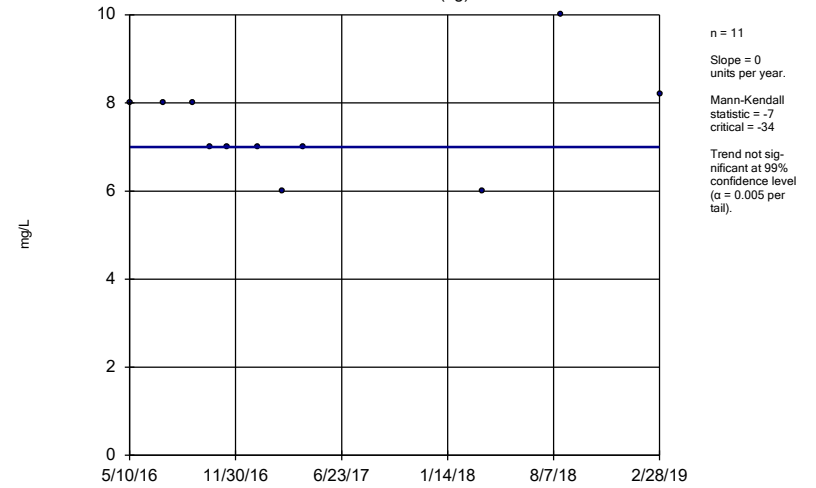
AD-32



Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

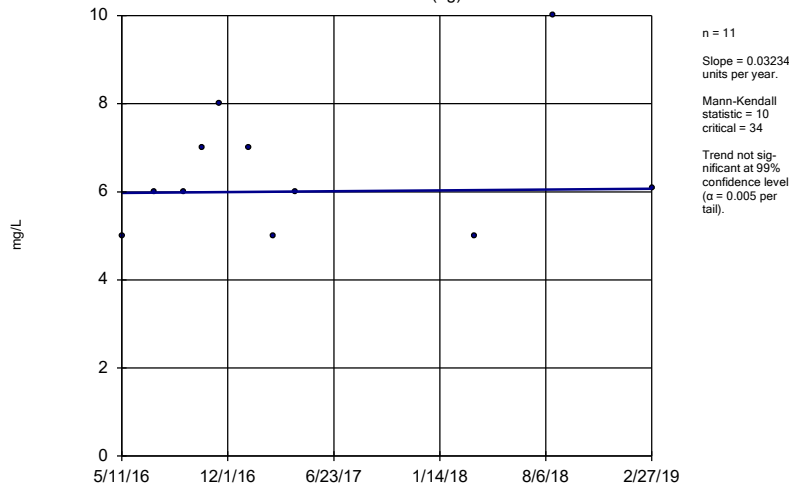
AD-18 (bg)



Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

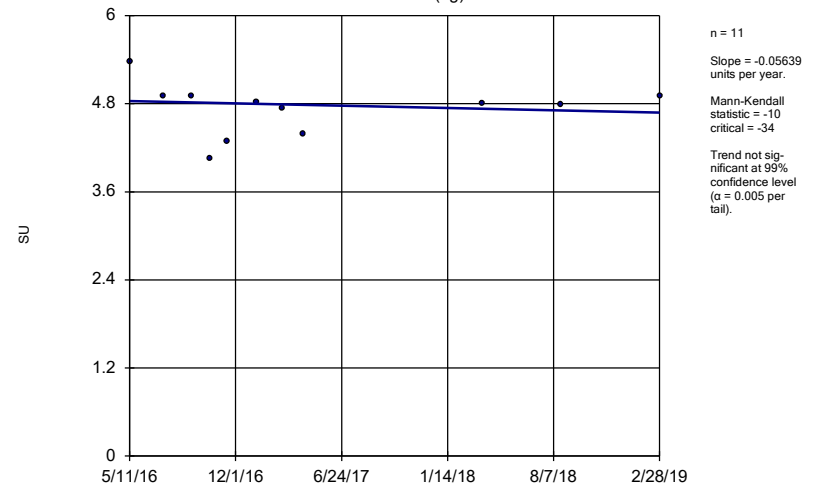
AD-12 (bg)



Constituent: Chloride, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

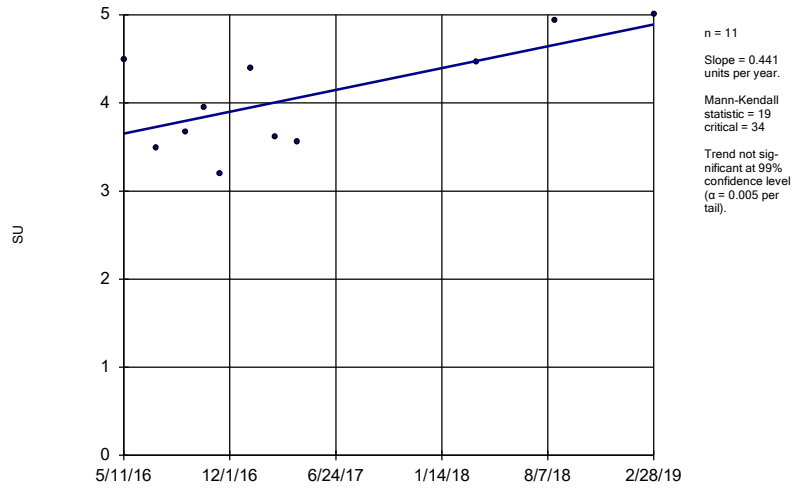
AD-4 (bg)



Constituent: pH, field Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

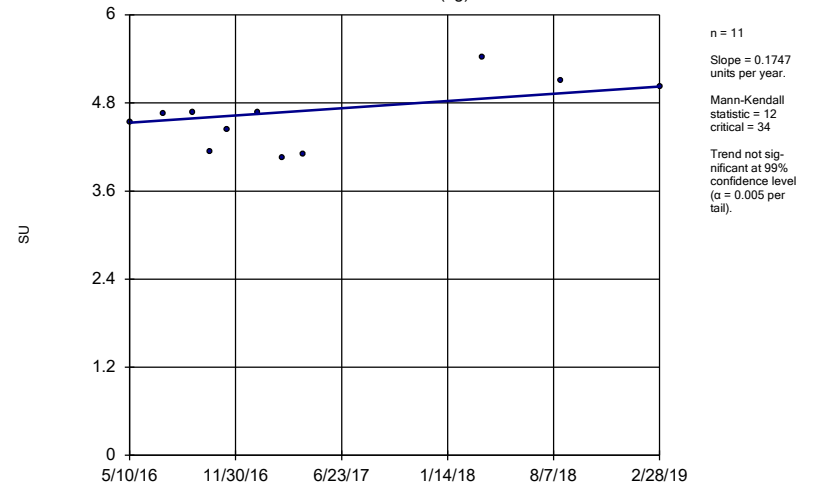
AD-31



Constituent: pH, field Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

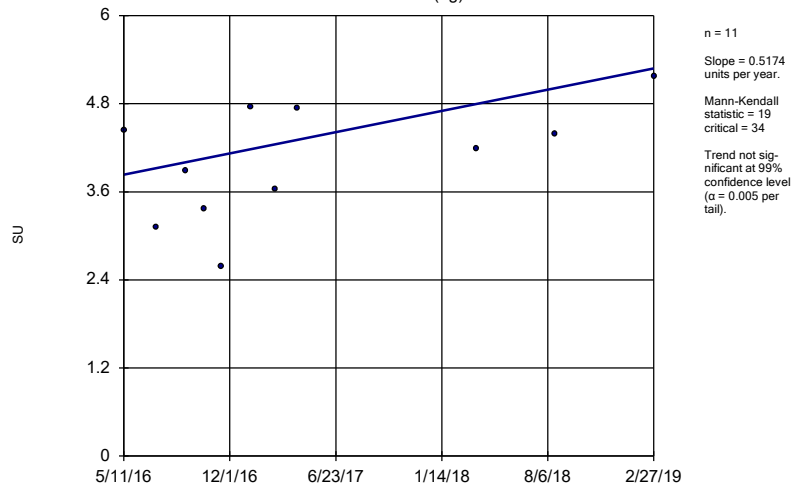
AD-18 (bg)



Constituent: pH, field Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

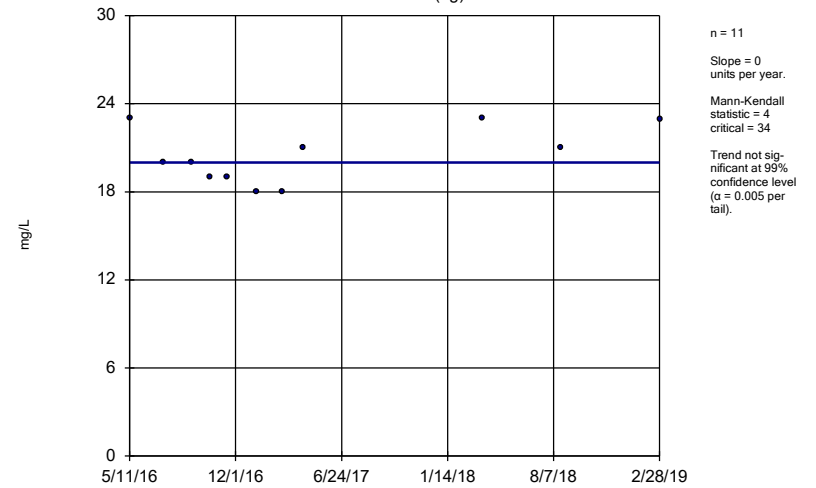
AD-12 (bg)



Constituent: pH, field Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

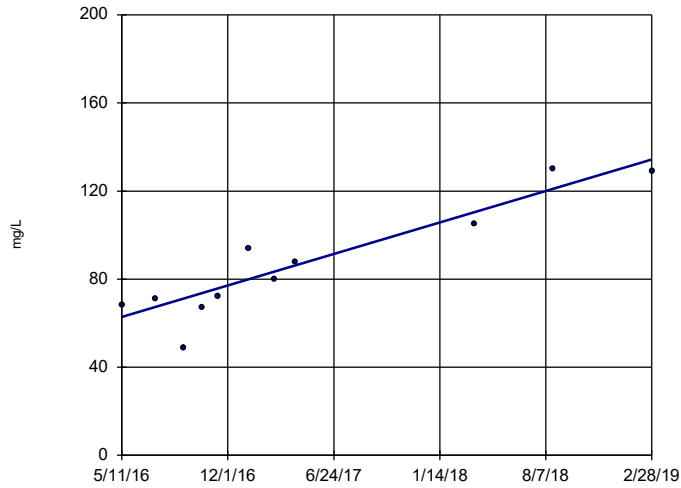
AD-4 (bg)



Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-2

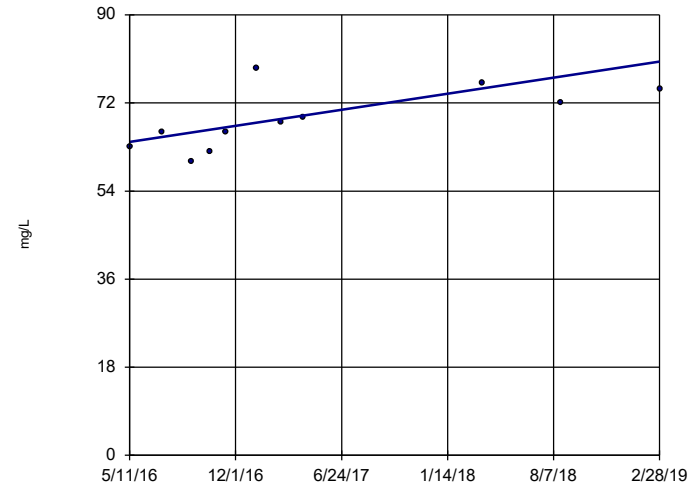


n = 11
 Slope = 25.54 units per year.
 Mann-Kendall statistic = 41
 critical = 34
 Increasing trend significant at 99% confidence level ($\alpha = 0.005$ per tail).

Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-31

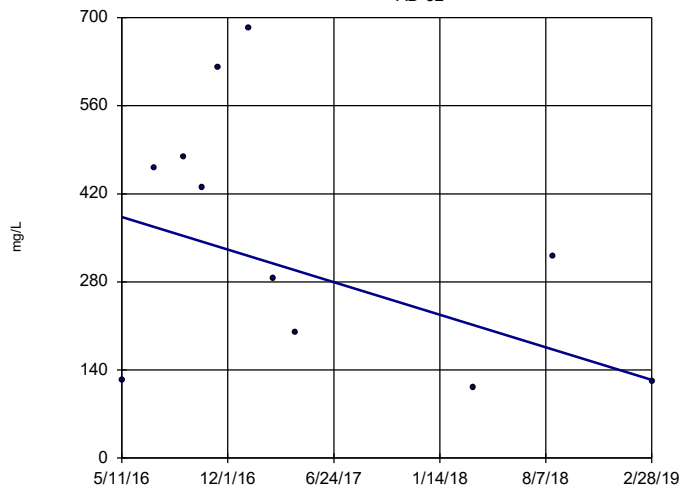


n = 11
 Slope = 5.856 units per year.
 Mann-Kendall statistic = 32
 critical = 34
 Trend not significant at 99% confidence level ($\alpha = 0.005$ per tail).

Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-32

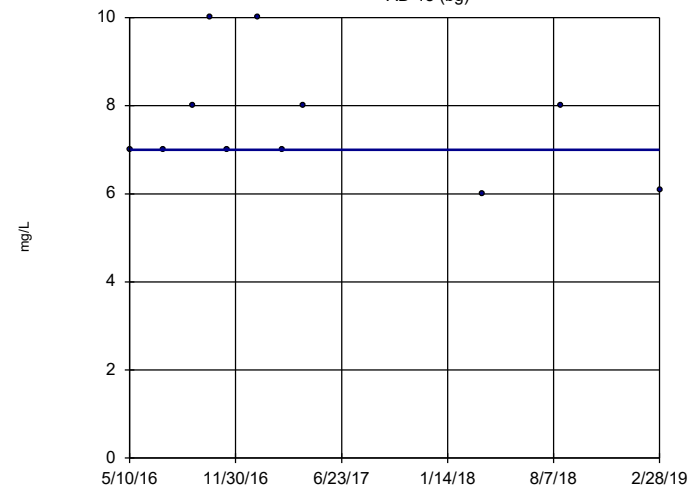


n = 11
 Slope = -92.31 units per year.
 Mann-Kendall statistic = -15
 critical = -34
 Trend not significant at 99% confidence level ($\alpha = 0.005$ per tail).

Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-18 (bg)

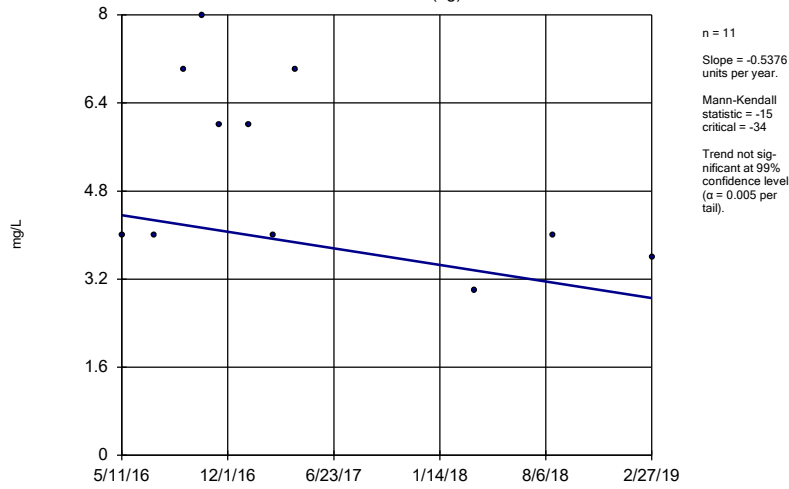


n = 11
 Slope = 0 units per year.
 Mann-Kendall statistic = -7
 critical = -34
 Trend not significant at 99% confidence level ($\alpha = 0.005$ per tail).

Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

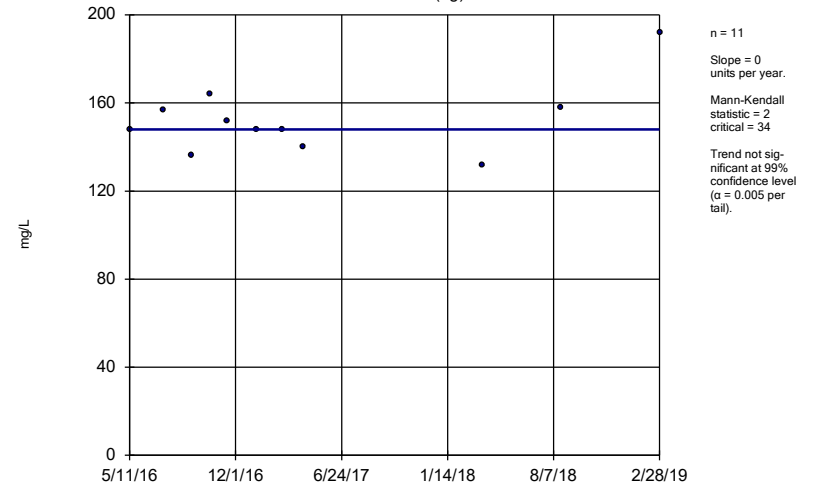
AD-12 (bg)



Constituent: Sulfate, total Analysis Run 7/5/2019 1:06 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

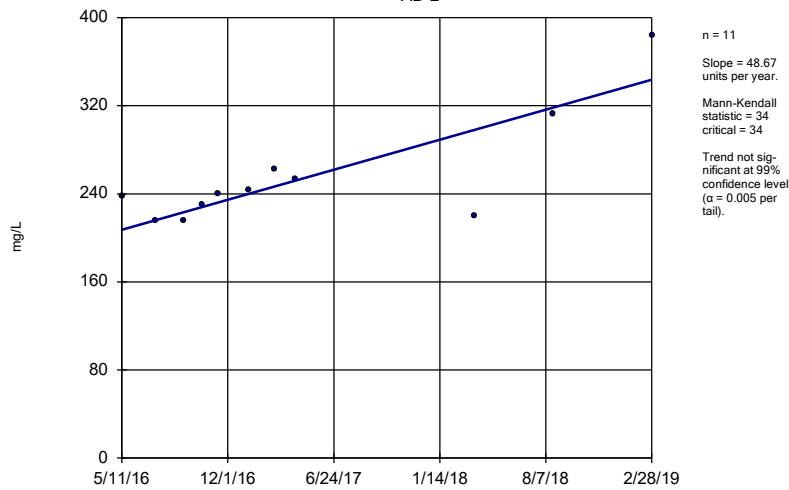
AD-4 (bg)



Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

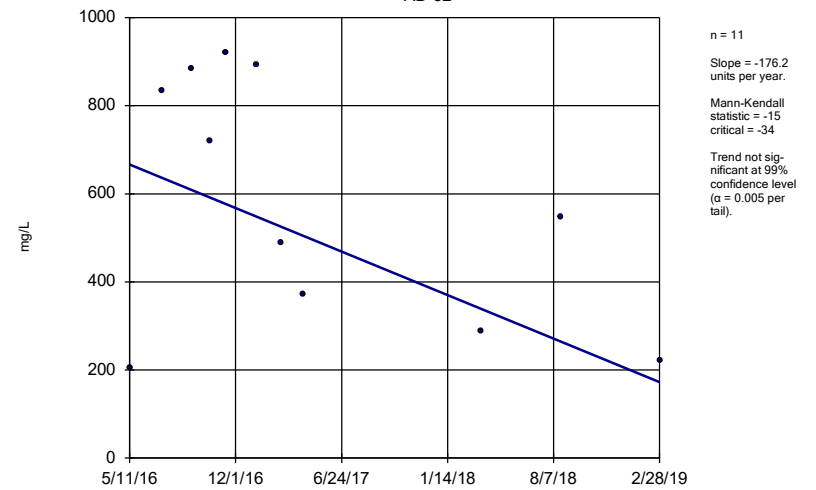
AD-2



Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

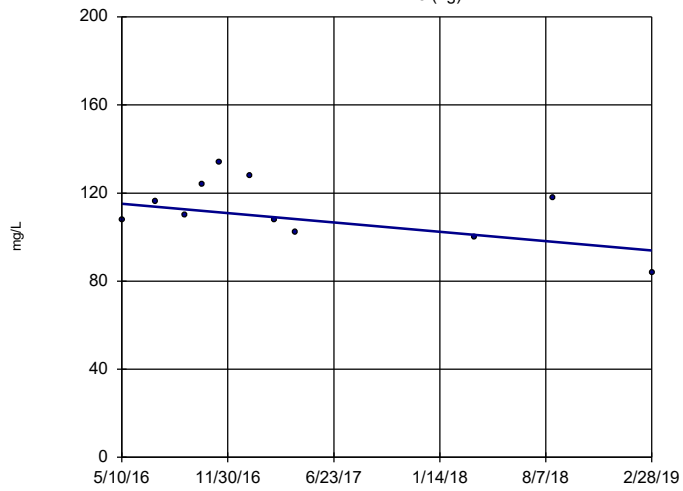
Sen's Slope Estimator

AD-32



Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 1:06 PM View: Trend Tests
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

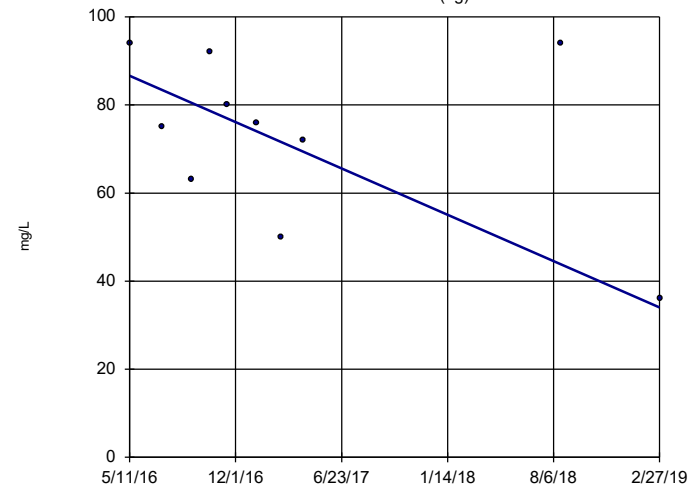
Sen's Slope Estimator AD-18 (bg)



n = 11
Slope = -7.565
units per year.
Mann-Kendall
statistic = -16
critical = -34
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ 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

Sen's Slope Estimator AD-12 (bg)



n = 10
Slope = -18.79
units per year.
Mann-Kendall
statistic = -14
critical = -30
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ 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

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Bg N</u>	<u>Bg Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
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.

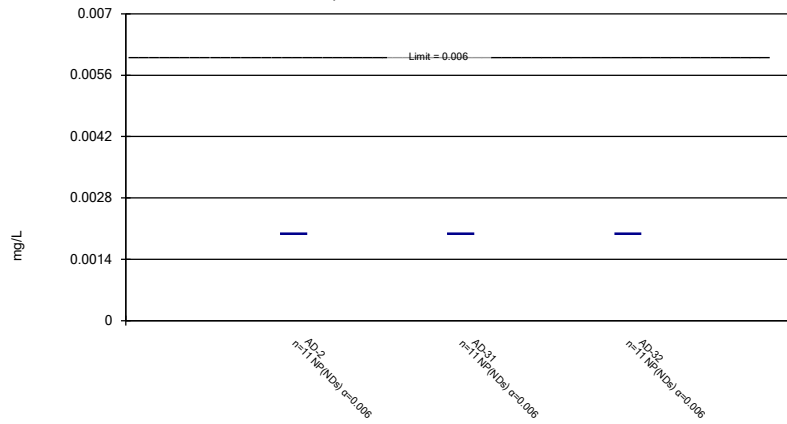
Confidence Interval Summary Table - All Results

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)

Non-Parametric Confidence Interval

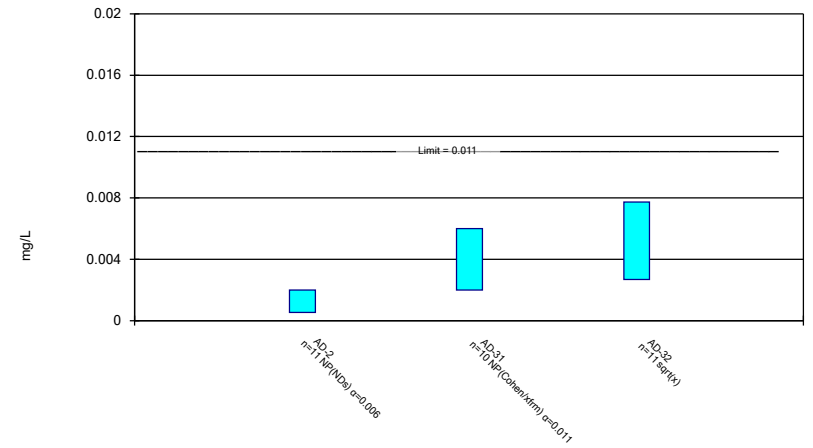
Compliance Limit is not exceeded.



Constituent: Antimony, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

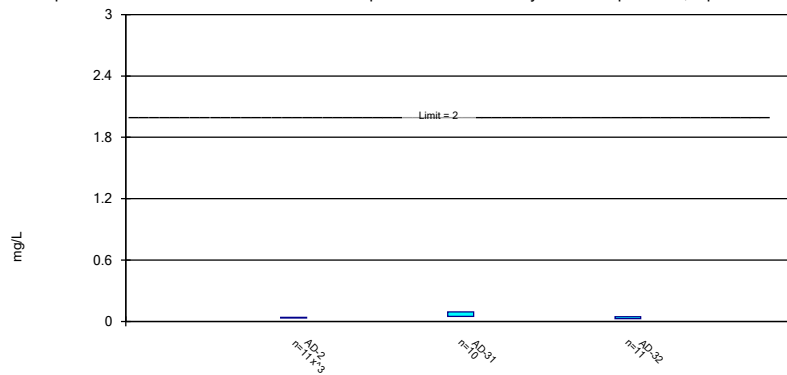
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Arsenic, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric Confidence Interval

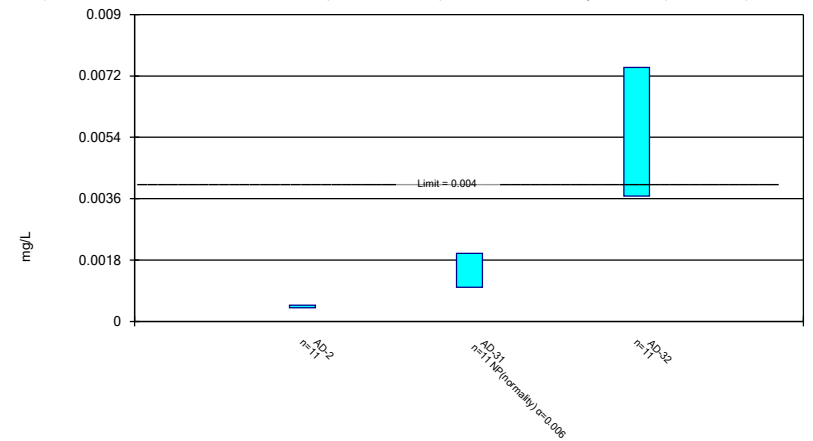
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Barium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

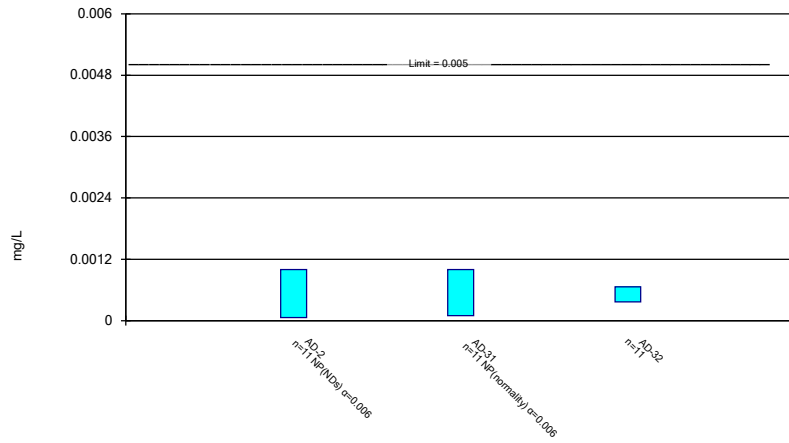
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

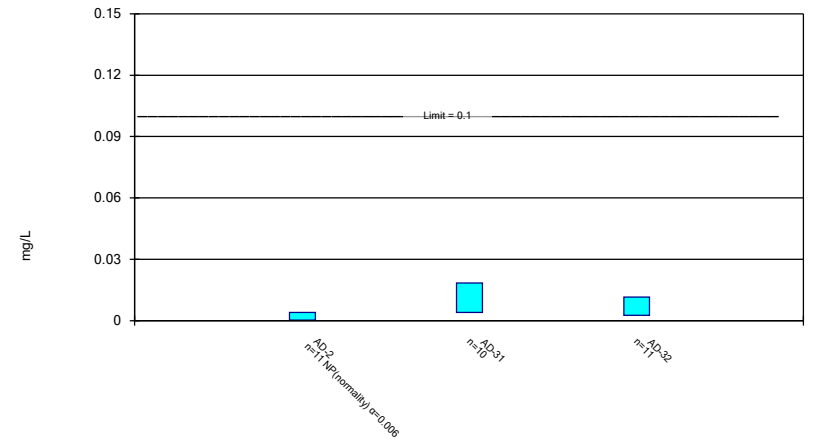
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cadmium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

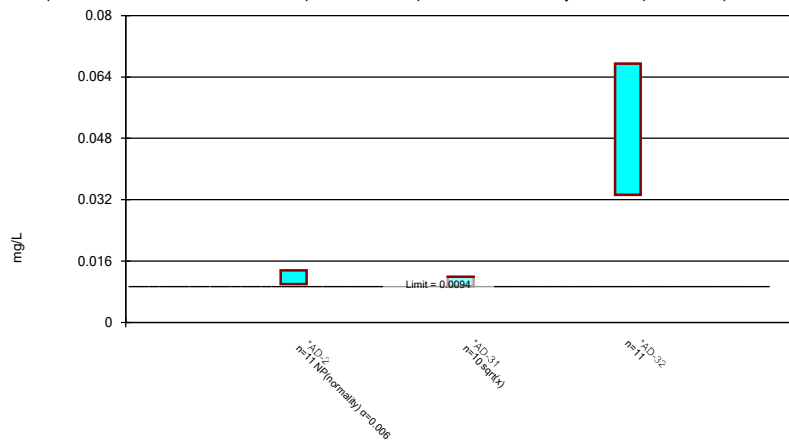
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chromium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

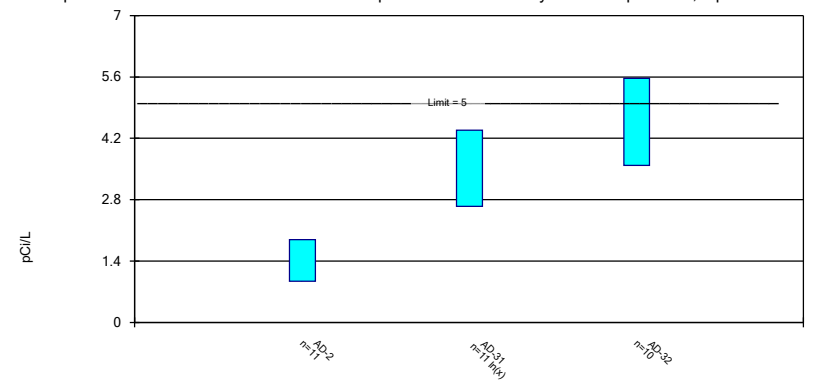
Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cobalt, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric Confidence Interval

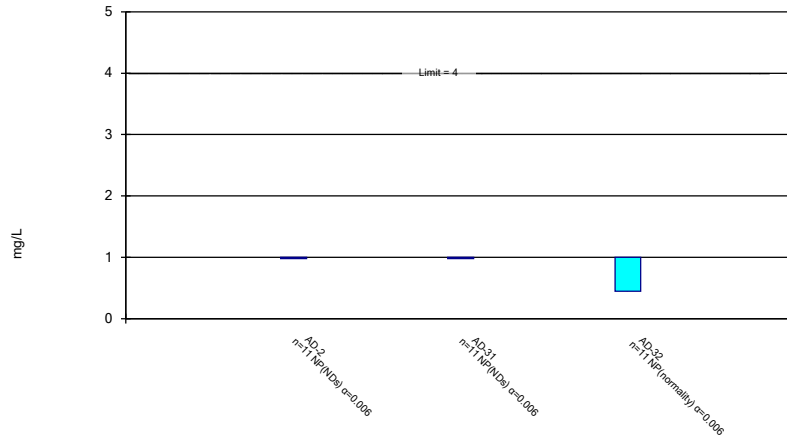
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - A
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Non-Parametric Confidence Interval

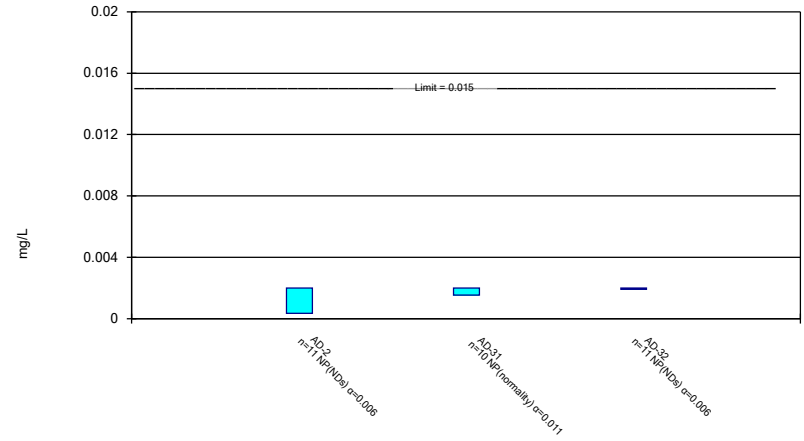
Compliance Limit is not exceeded.



Constituent: Fluoride, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Non-Parametric Confidence Interval

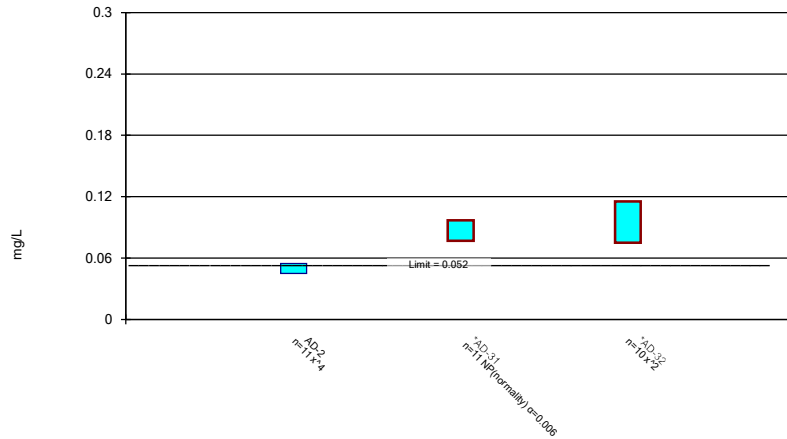
Compliance Limit is not exceeded.



Constituent: Lead, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

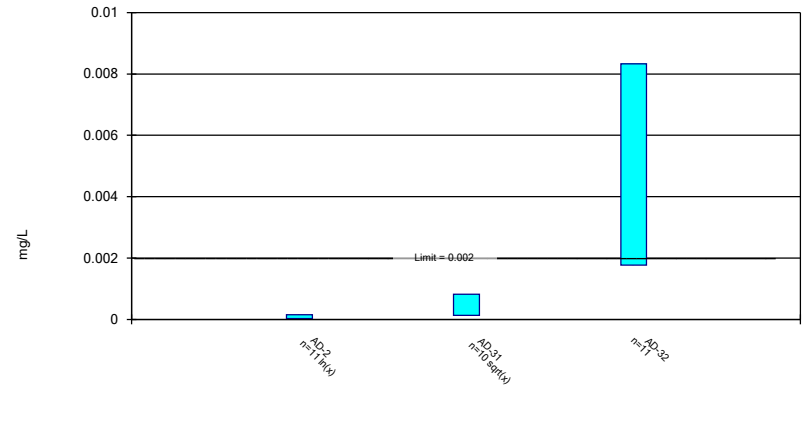
Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Lithium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric Confidence Interval

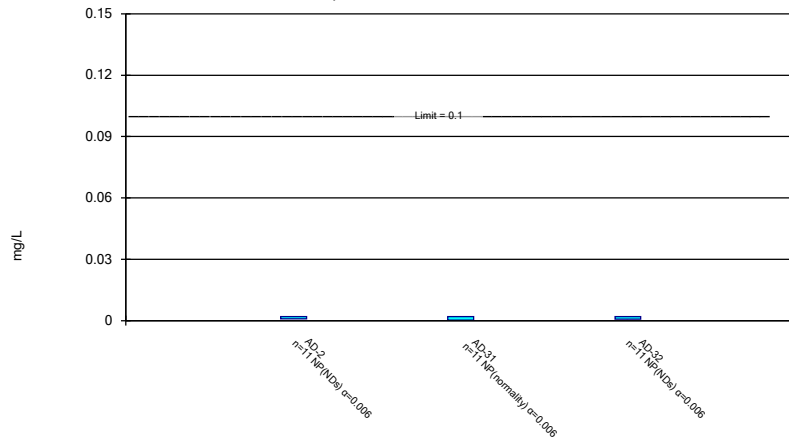
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Mercury, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Non-Parametric Confidence Interval

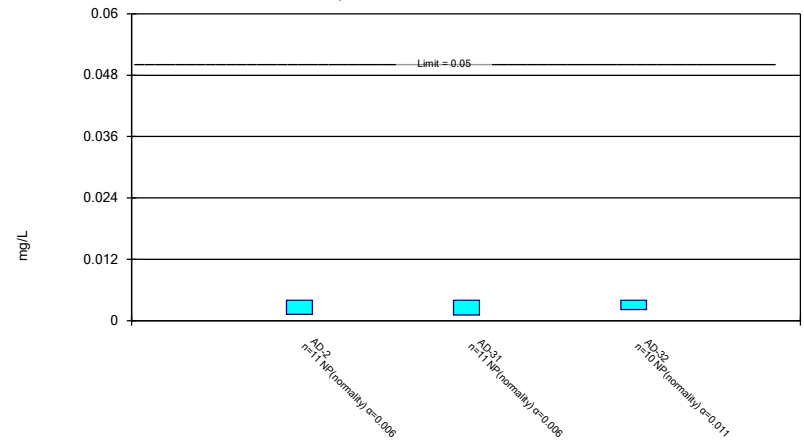
Compliance Limit is not exceeded.



Constituent: Molybdenum, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Non-Parametric Confidence Interval

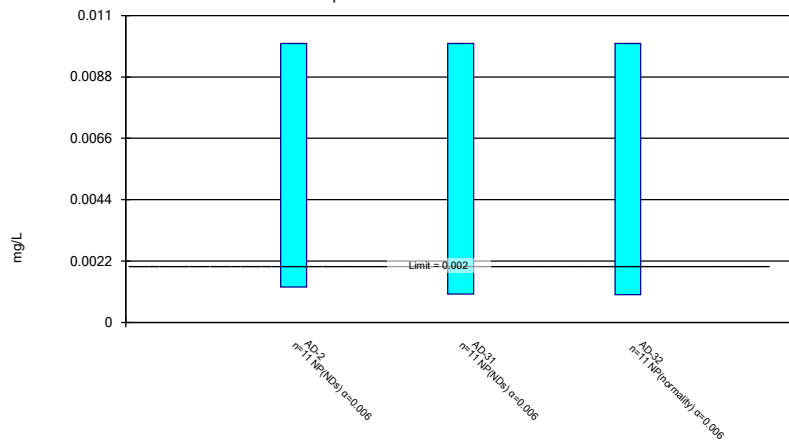
Compliance Limit is not exceeded.



Constituent: Selenium, total Analysis Run 7/5/2019 1:00 PM View: Confidence Intervals - App IV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

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



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CHA8473

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LIST OF ATTACHMENTS

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Attachment B	Statistical Analysis Output

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-Francia 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

Signature



112498

License Number

TEXAS

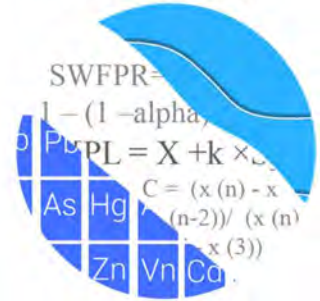
Licensing State

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.

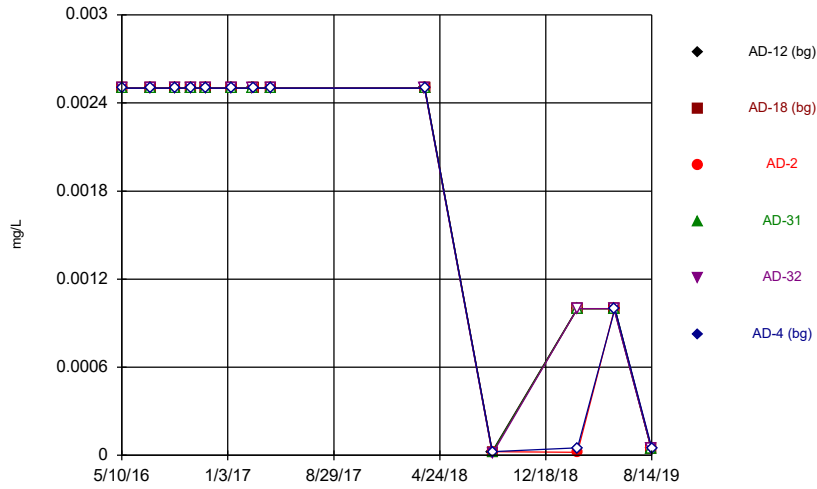
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey EBAP. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

A handwritten signature in black ink that reads "Kristina Rayner". The signature is written in a cursive, flowing style.

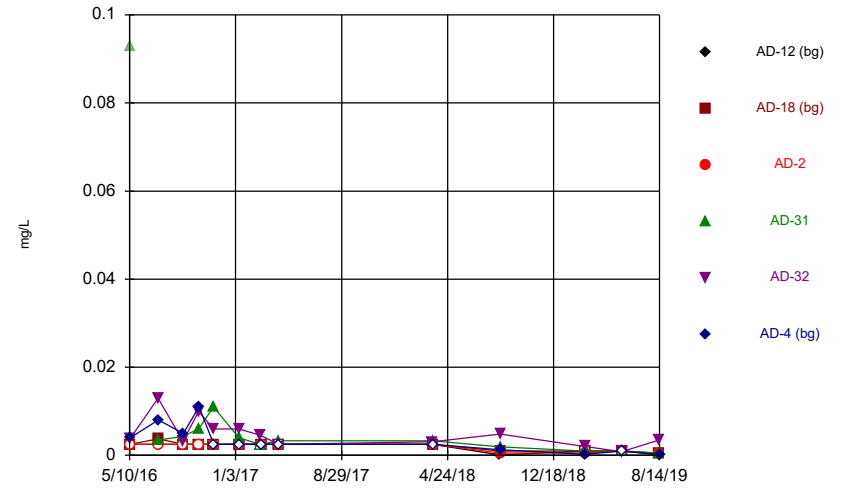
Kristina L. Rayner
Groundwater Statistician

Time Series



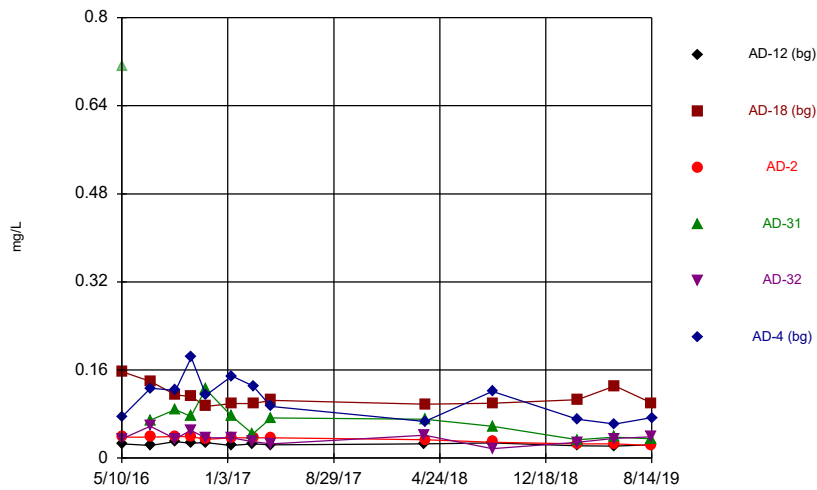
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Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



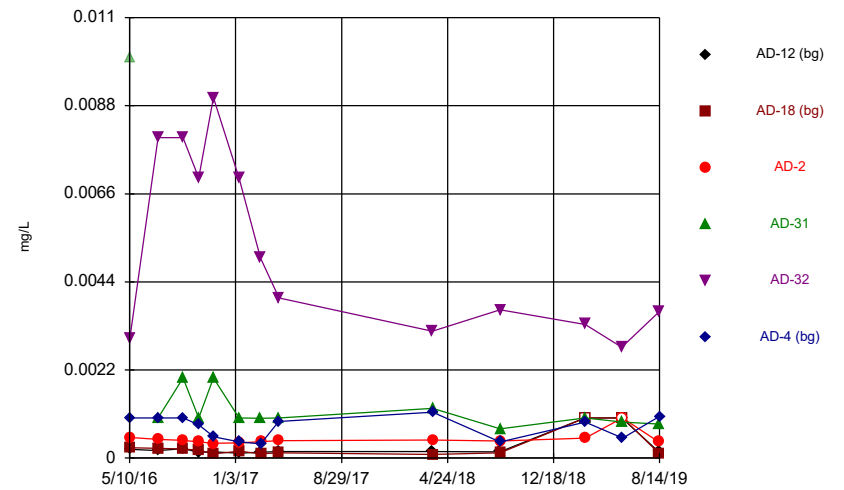
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Time Series



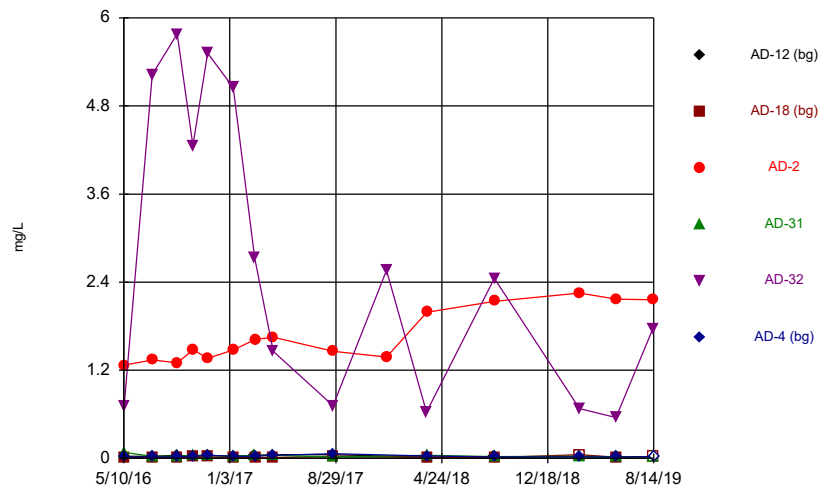
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Time Series



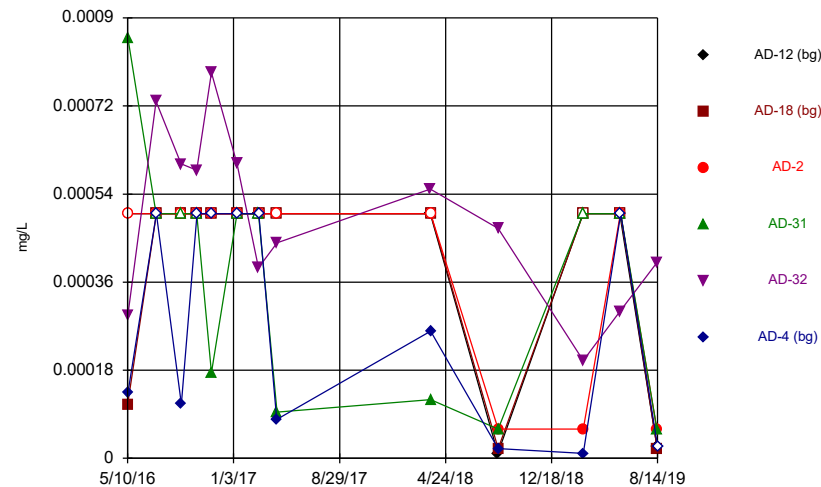
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Time Series



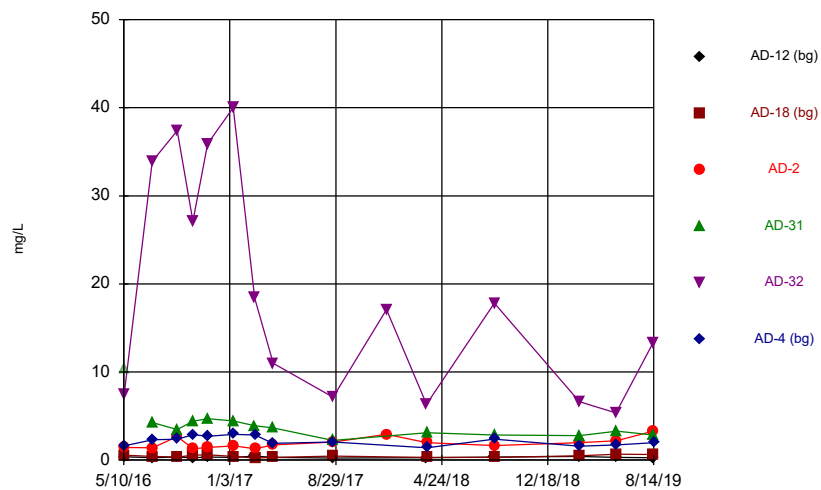
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Time Series



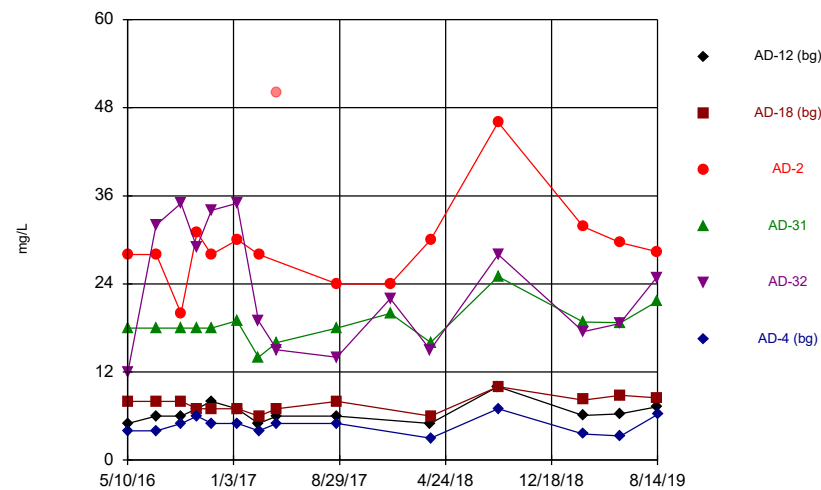
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Time Series



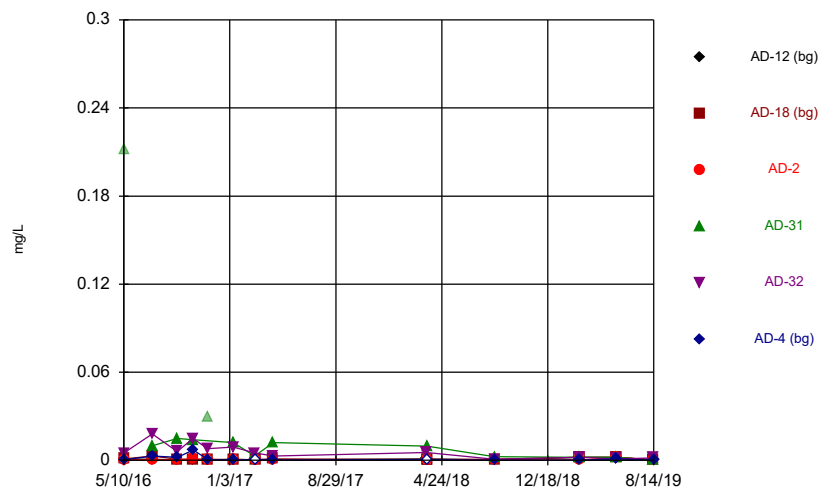
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Time Series



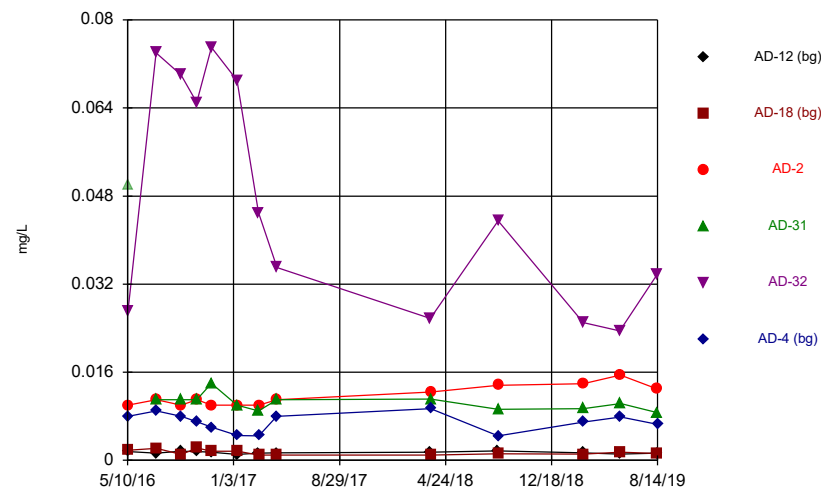
Constituent: Chloride, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



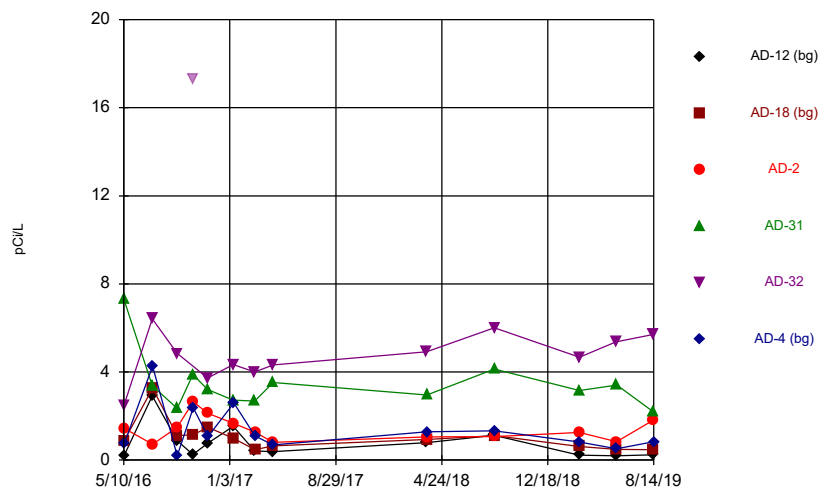
Constituent: Chromium, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



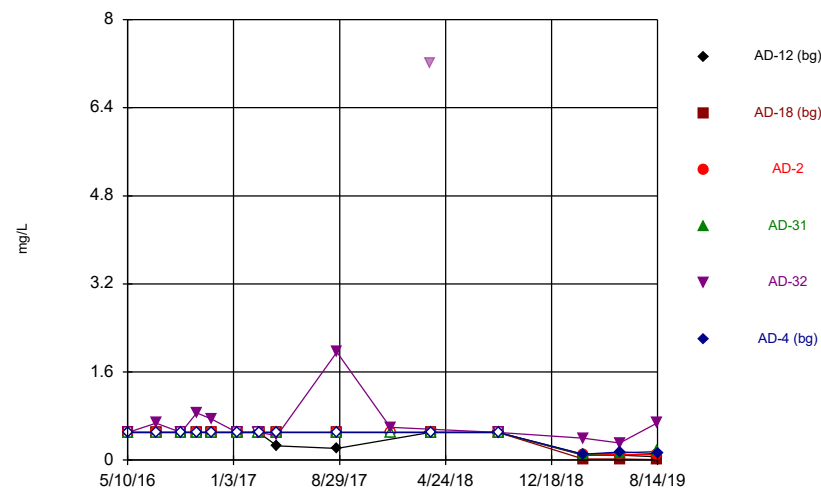
Constituent: Cobalt, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



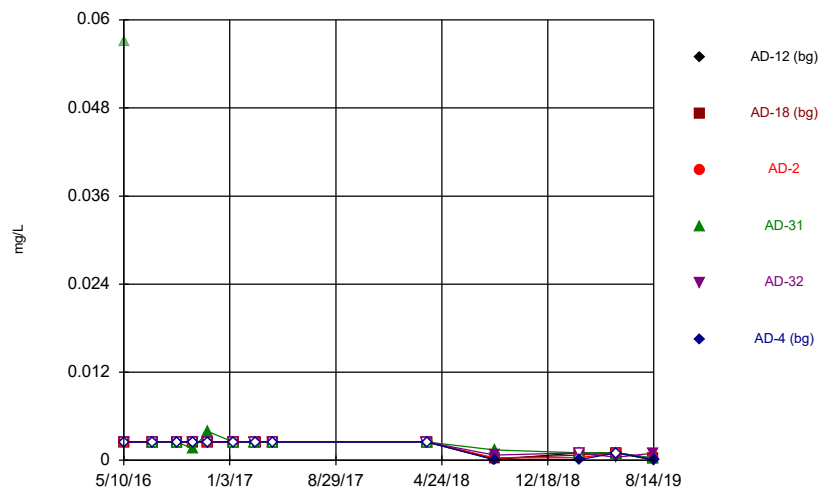
Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



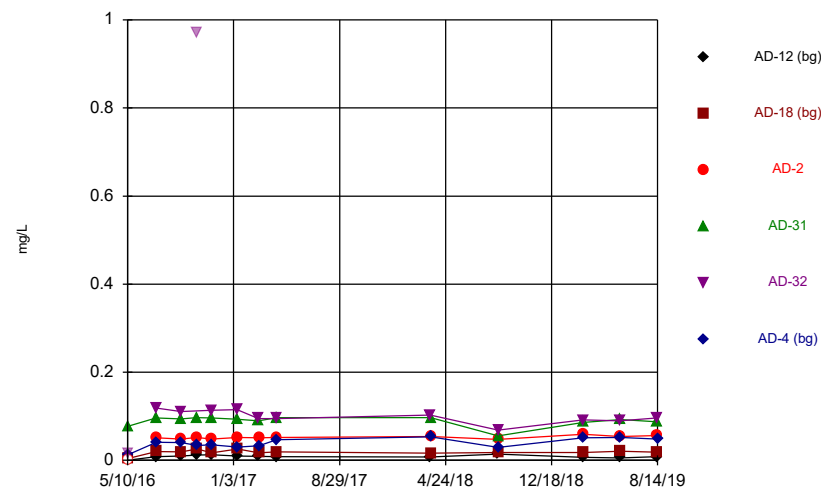
Constituent: Fluoride, total Analysis Run 11/25/2019 11:32 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



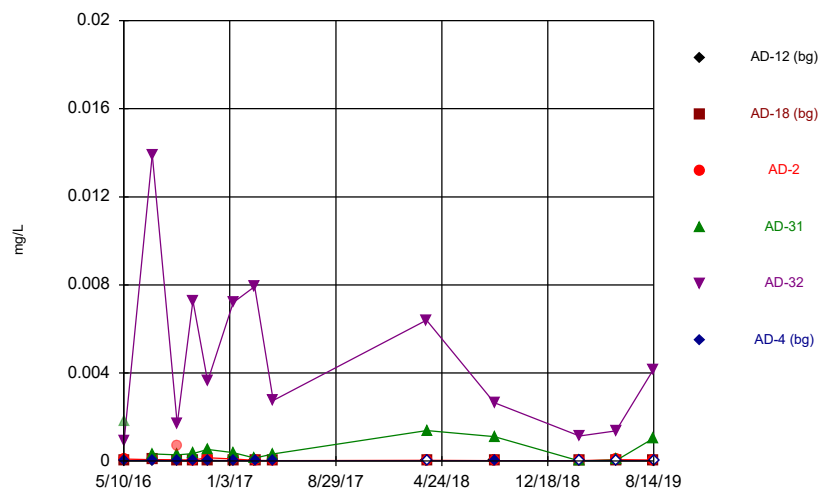
Constituent: Lead, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



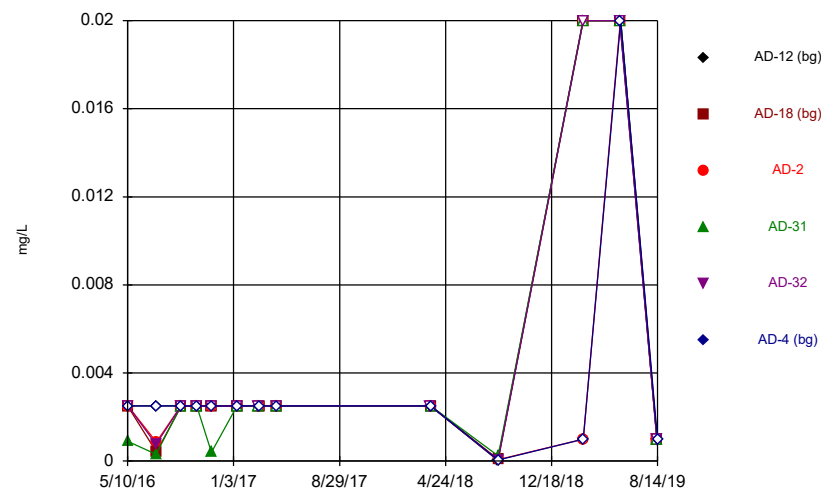
Constituent: Lithium, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



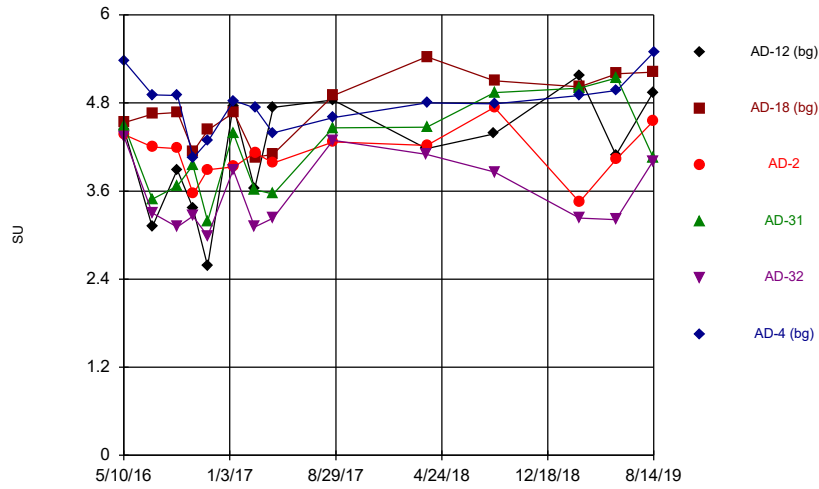
Constituent: Mercury, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series



Constituent: Molybdenum, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

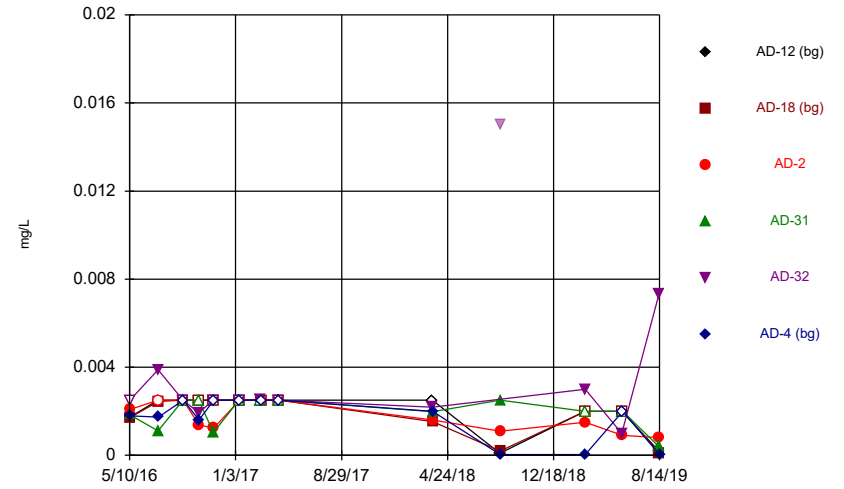
Time Series



Constituent: pH, field Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

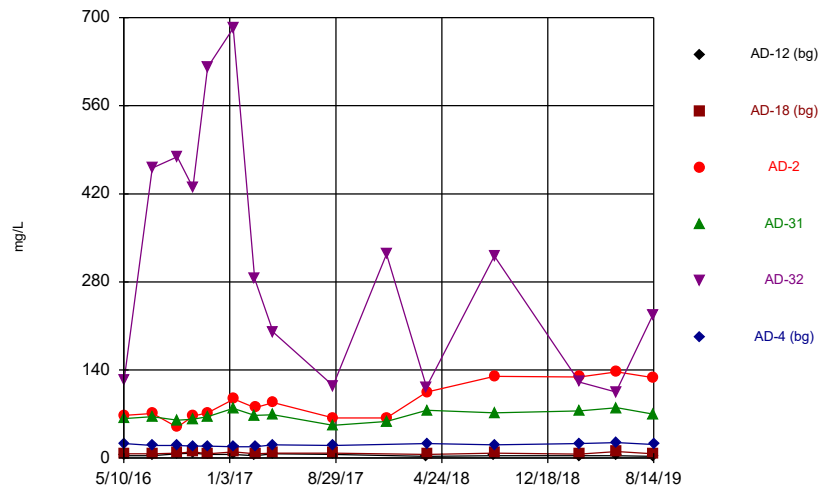
Hollow symbols indicate censored values.

Time Series



Constituent: Selenium, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

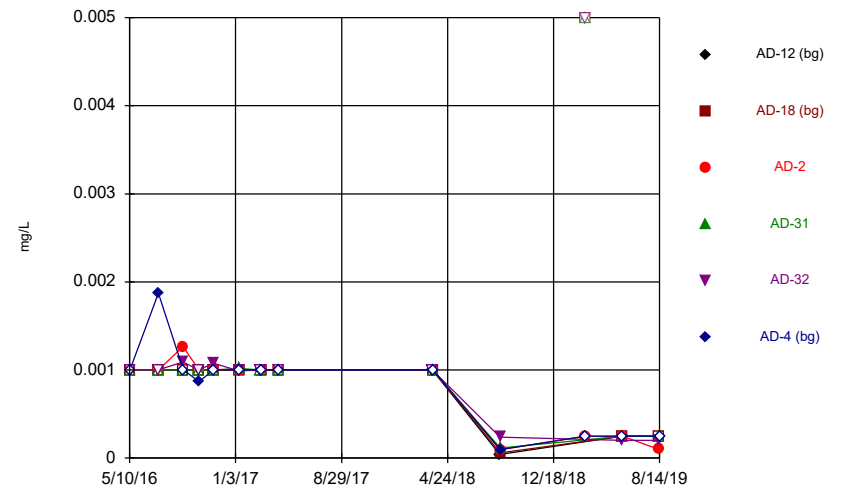
Time Series



Constituent: Sulfate, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

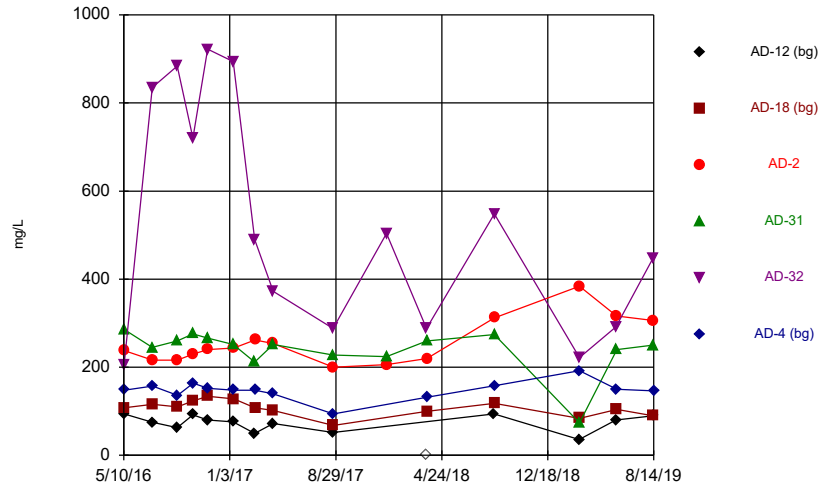
Hollow symbols indicate censored values.

Time Series

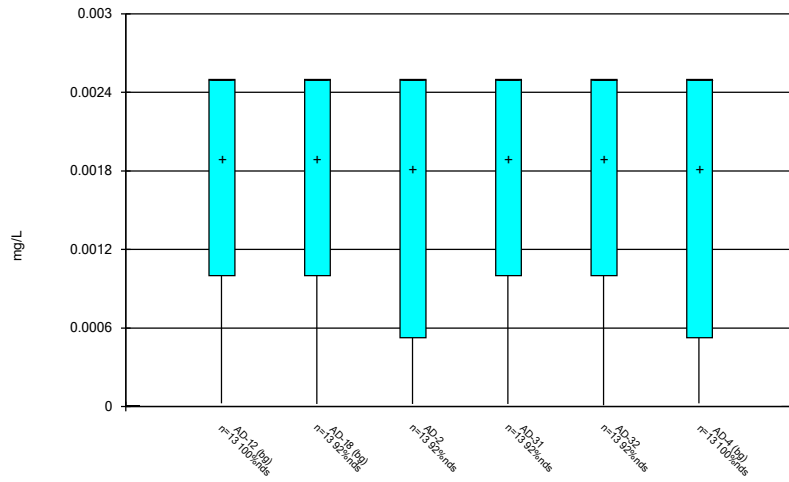


Constituent: Thallium, total Analysis Run 11/25/2019 11:33 AM View: All Data
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Time Series

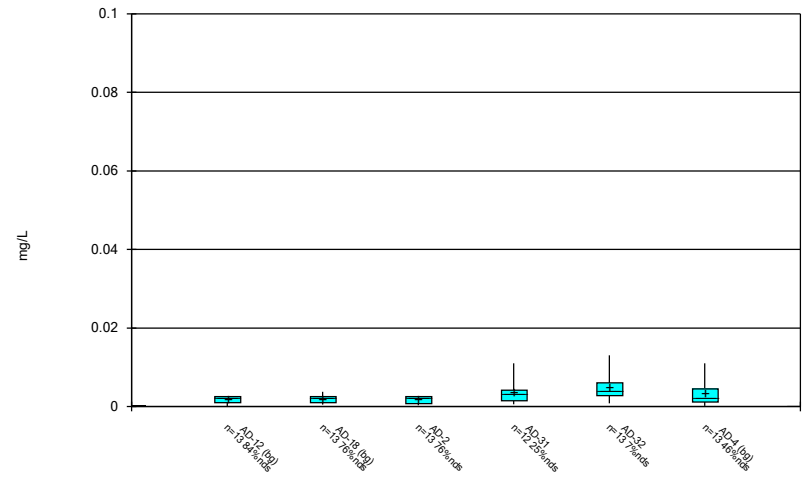


Box & Whiskers Plot



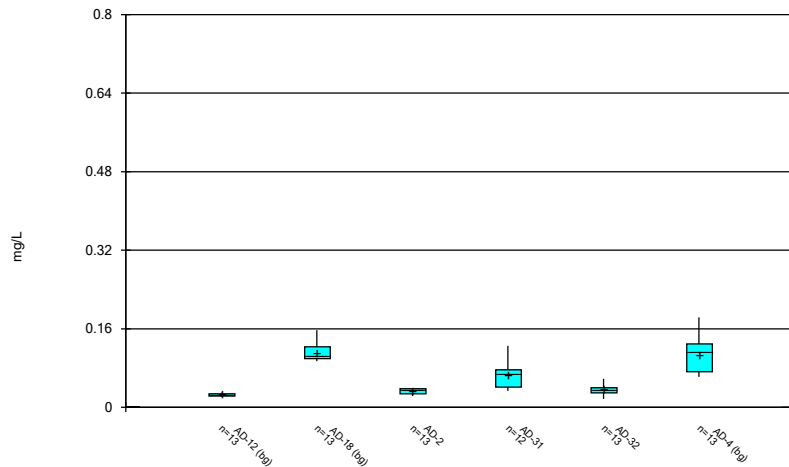
Constituent: Antimony, total Analysis Run 11/25/2019 11:36 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



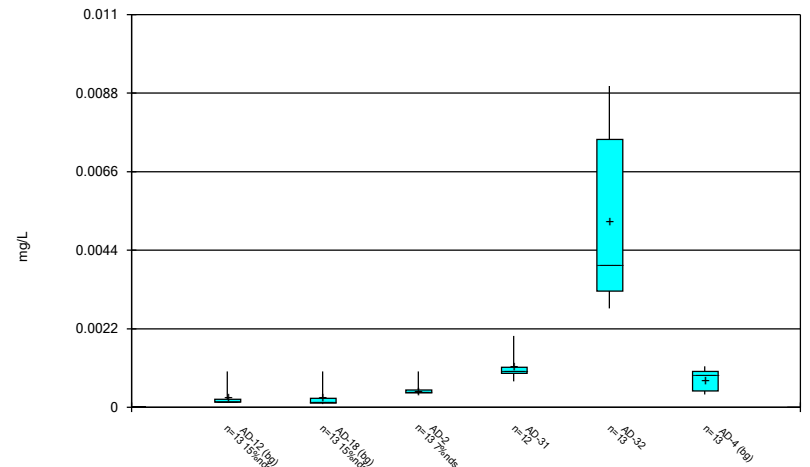
Constituent: Arsenic, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



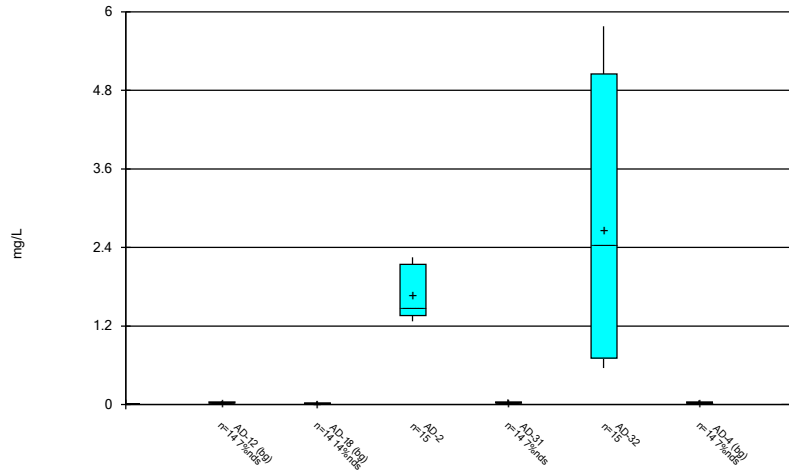
Constituent: Barium, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



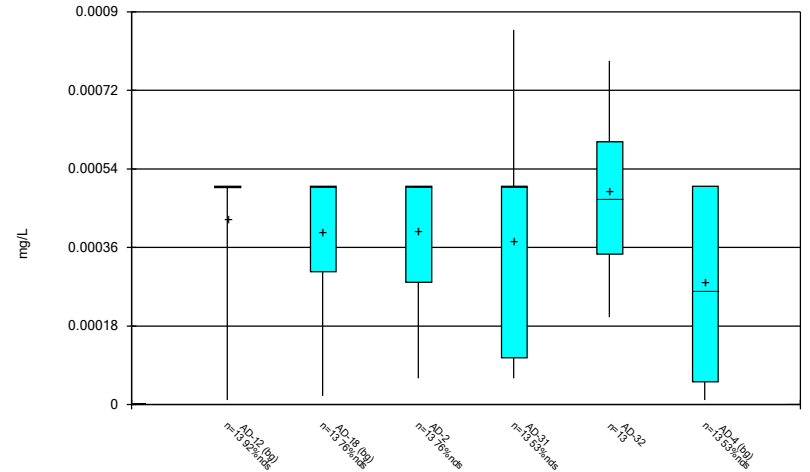
Constituent: Beryllium, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



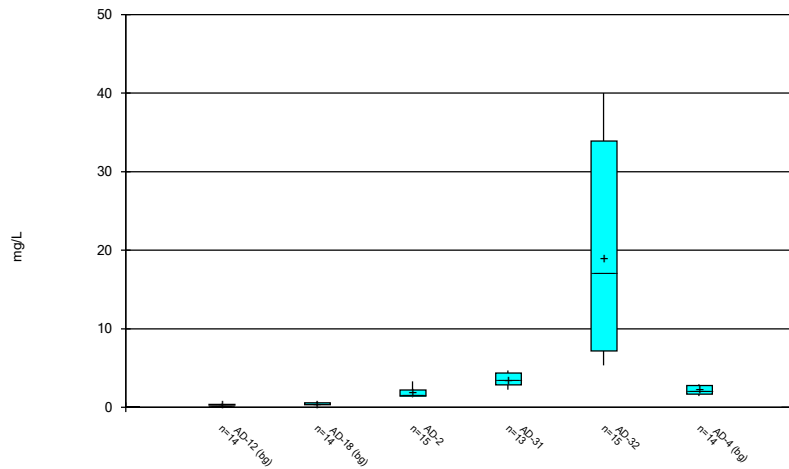
Constituent: Boron, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



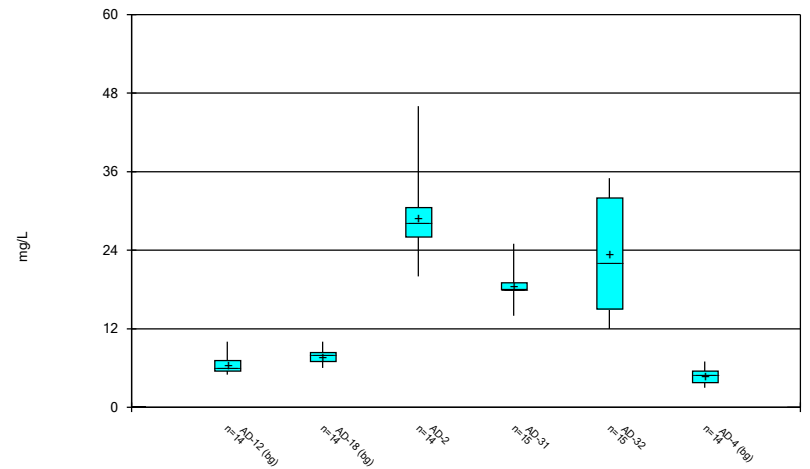
Constituent: Cadmium, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



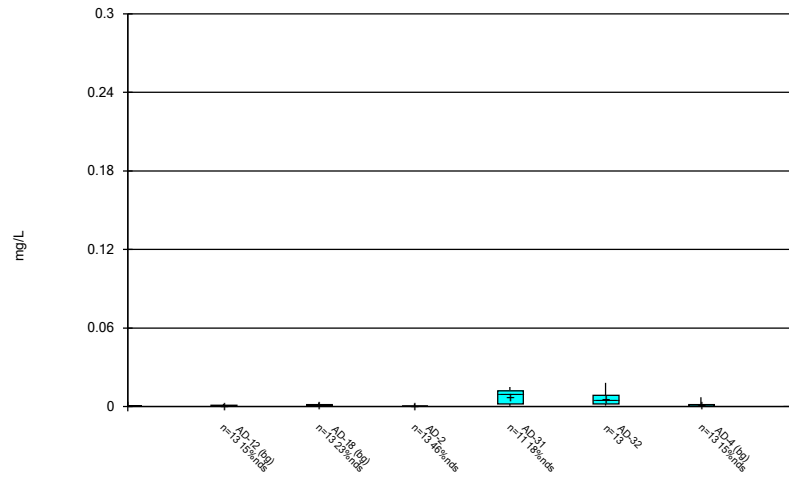
Constituent: Calcium, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



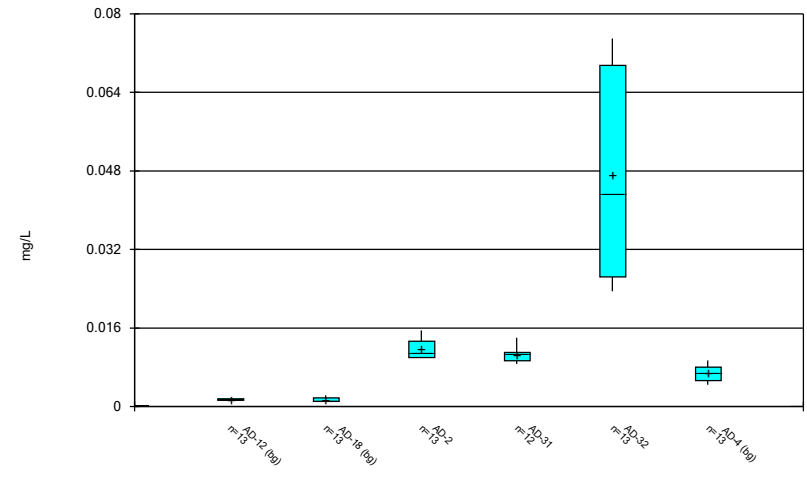
Constituent: Chloride, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



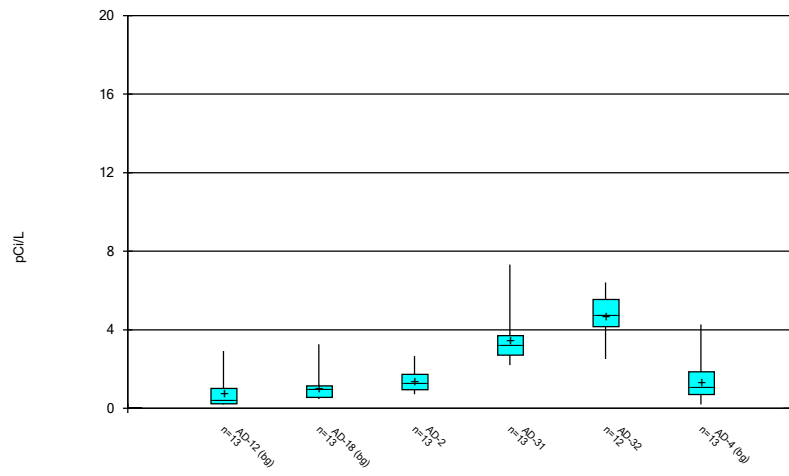
Constituent: Chromium, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



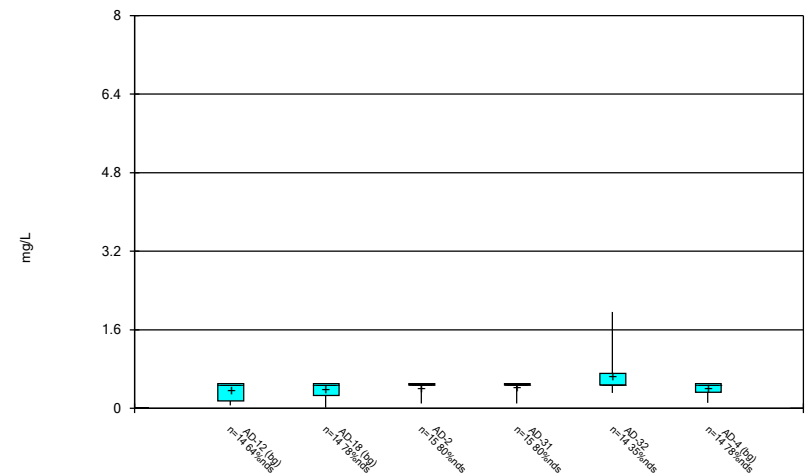
Constituent: Cobalt, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



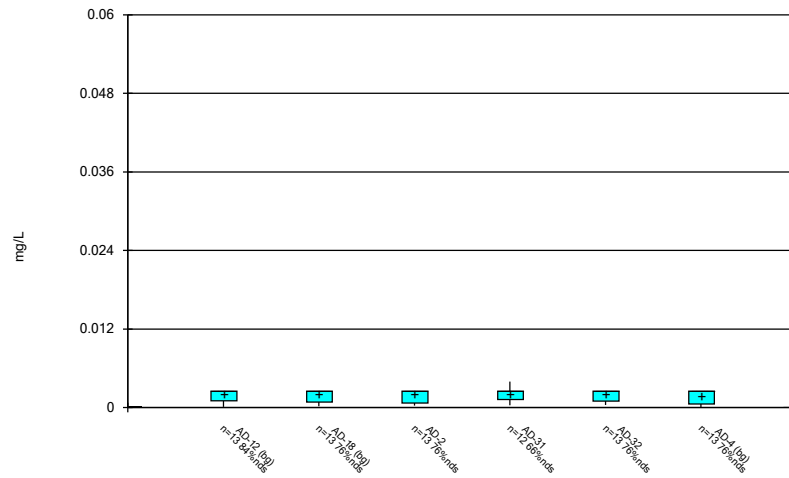
Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



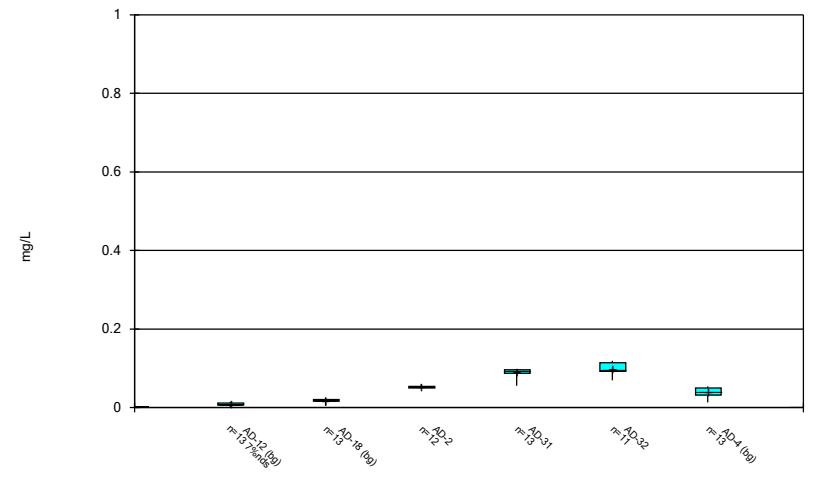
Constituent: Fluoride, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



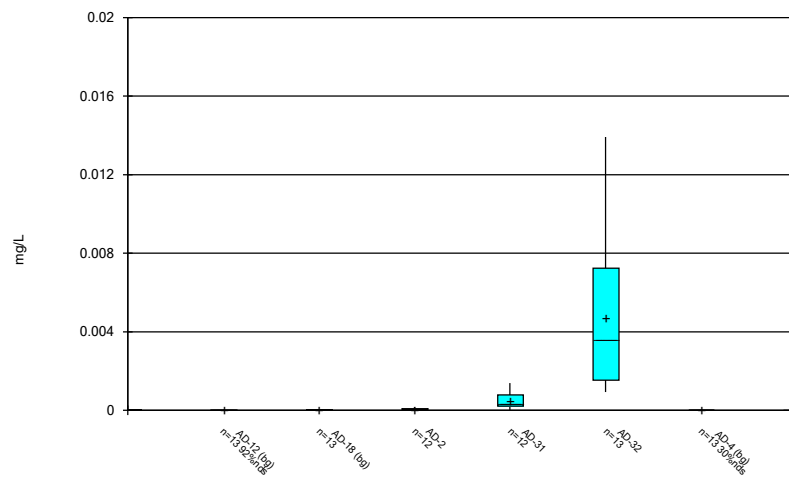
Constituent: Lead, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



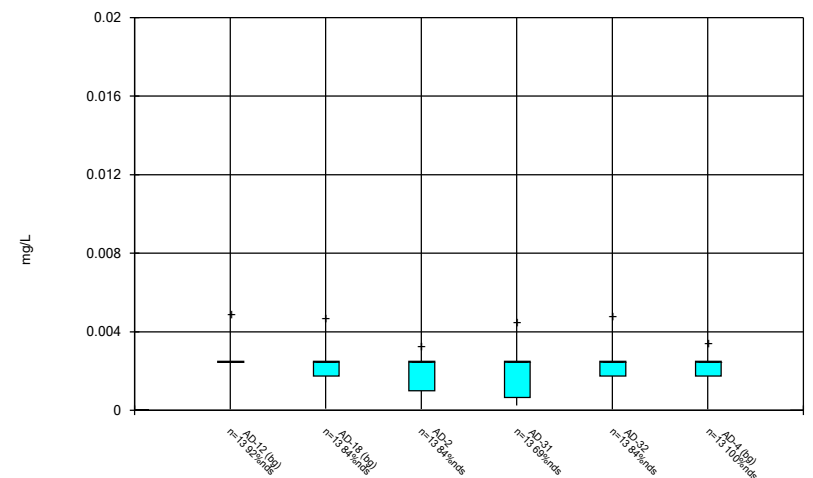
Constituent: Lithium, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



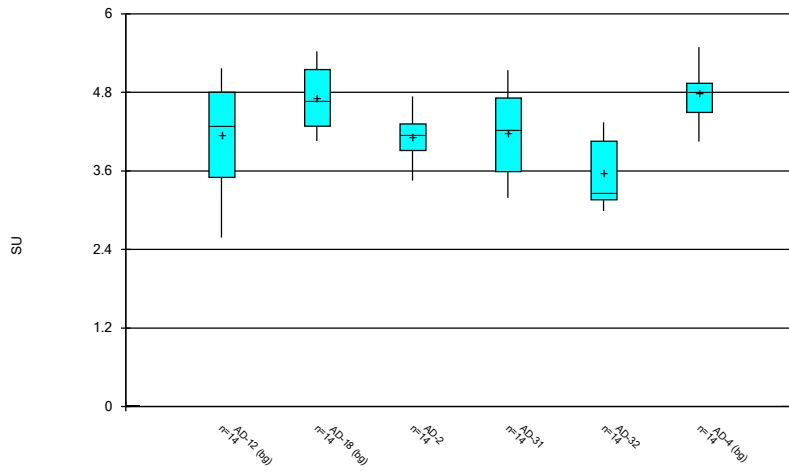
Constituent: Mercury, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



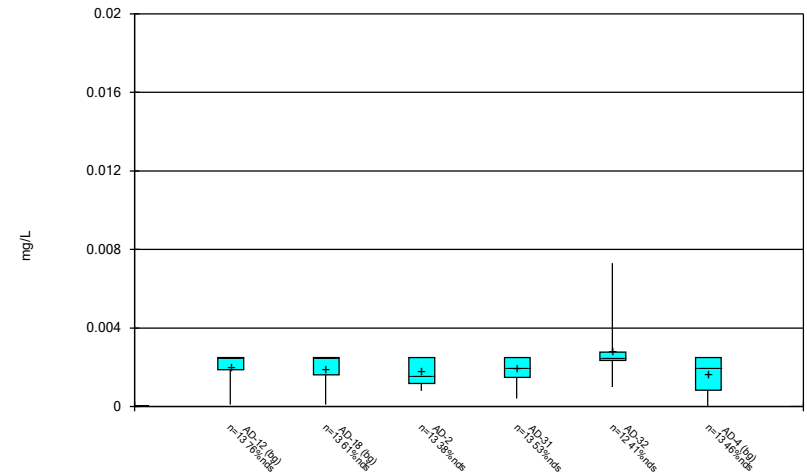
Constituent: Molybdenum, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



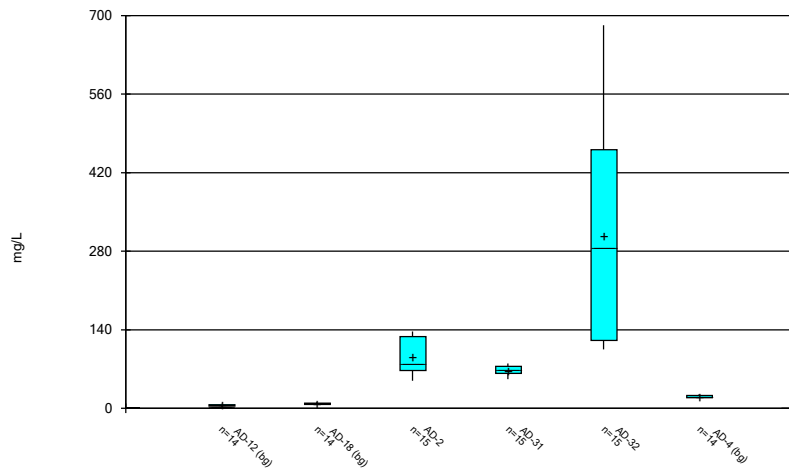
Constituent: pH, field Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



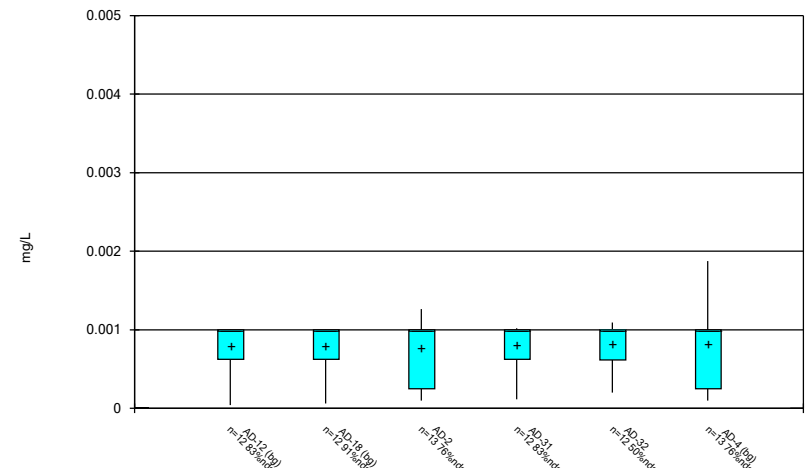
Constituent: Selenium, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



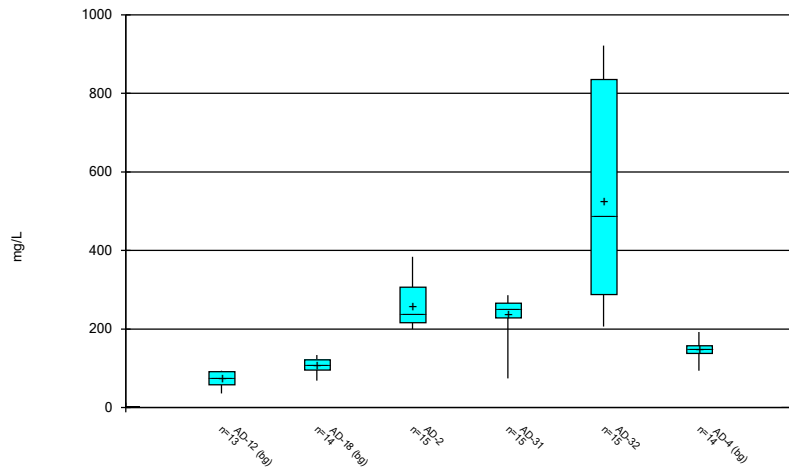
Constituent: Sulfate, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



Constituent: Thallium, total Analysis Run 11/25/2019 11:37 AM View: All Data
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



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

Date	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										

Date	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)		

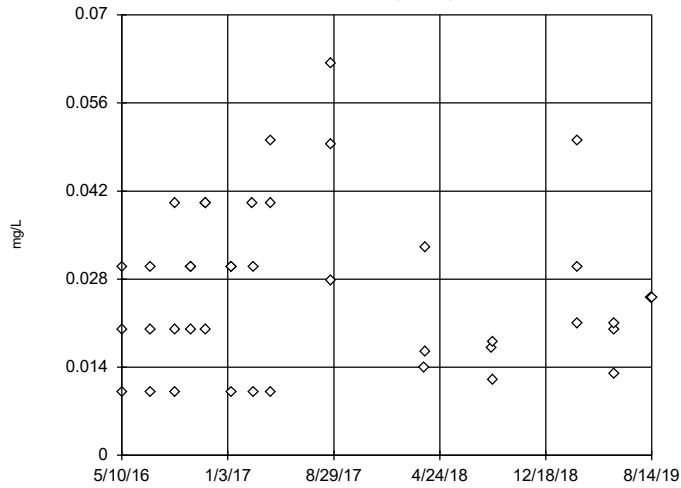
Interwell Outlier Analysis - All Results (No Significant)

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

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4

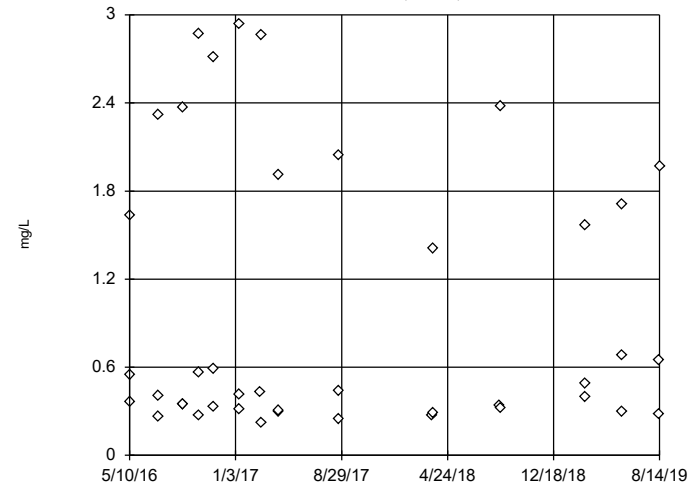


n = 42
 No outliers found.
 Tukey's method selected by user.
 Data were cube root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.1226, low cutoff = 0.0004167, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/25/2019 10:05 AM View: Interwell All
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4

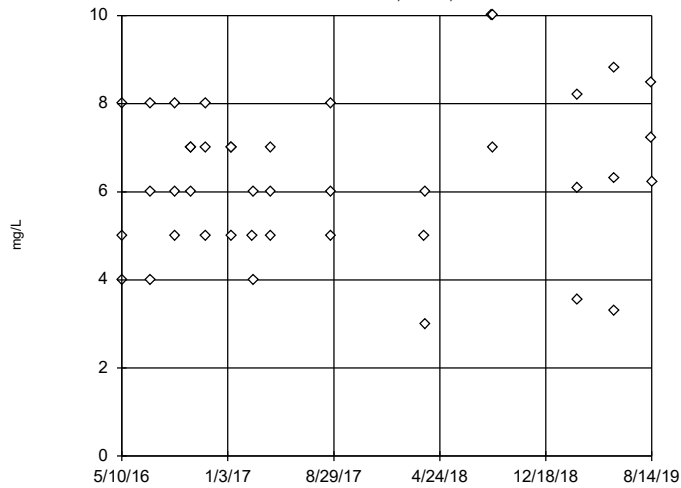


n = 42
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 360, low cutoff = 0.001554, based on IQR multiplier of 3.

Constituent: Calcium, total Analysis Run 11/25/2019 10:05 AM View: Interwell All
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening, Pooled Background

AD-12,AD-18,AD-4

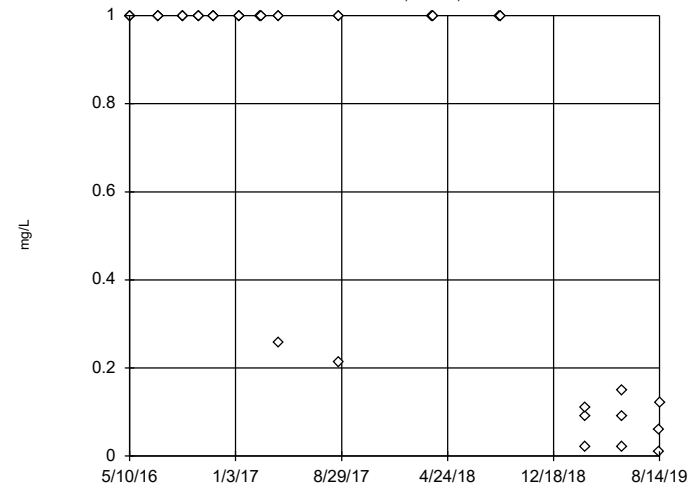


n = 42
 No outliers found.
 Tukey's method selected by user.
 Data were square root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 18.75, low cutoff = 0.4429, based on IQR multiplier of 3.

Constituent: Chloride, total Analysis Run 11/25/2019 10:05 AM View: Interwell All
 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 = 78.31, low cutoff = 0.002985, based on IQR multiplier of 3.

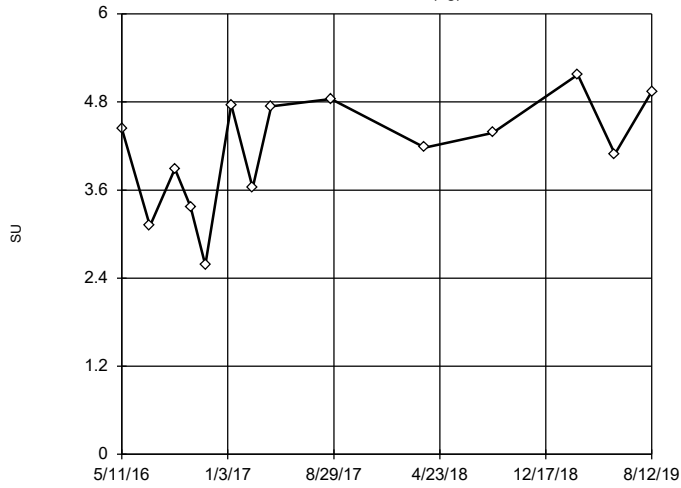
Constituent: Fluoride, total Analysis Run 11/25/2019 10:06 AM View: Interwell All
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

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

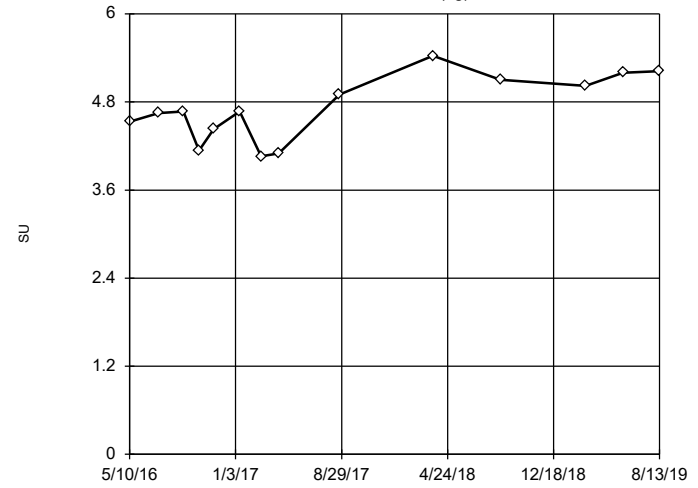
Tukey's Outlier Screening AD-12 (bg)



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

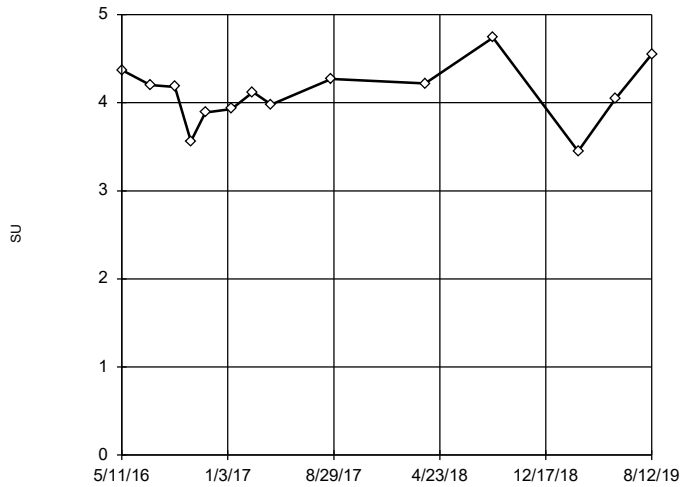
Tukey's Outlier Screening AD-18 (bg)



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

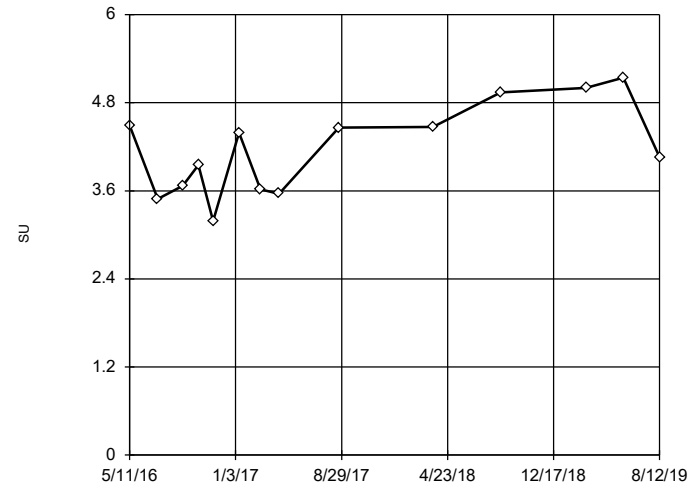
Tukey's Outlier Screening AD-2



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

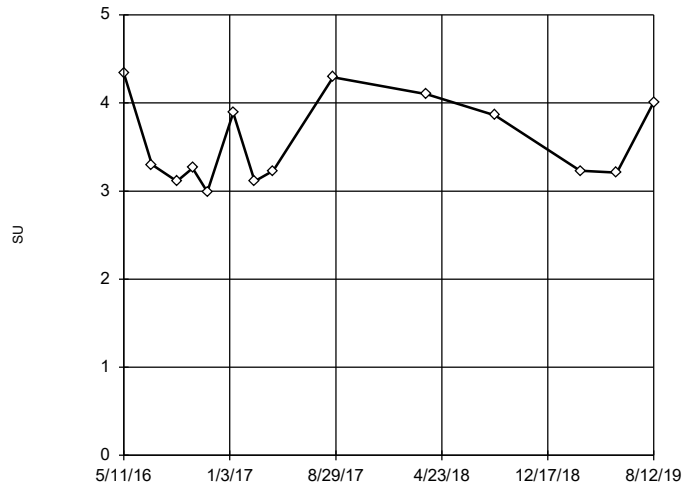
Tukey's Outlier Screening AD-31



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

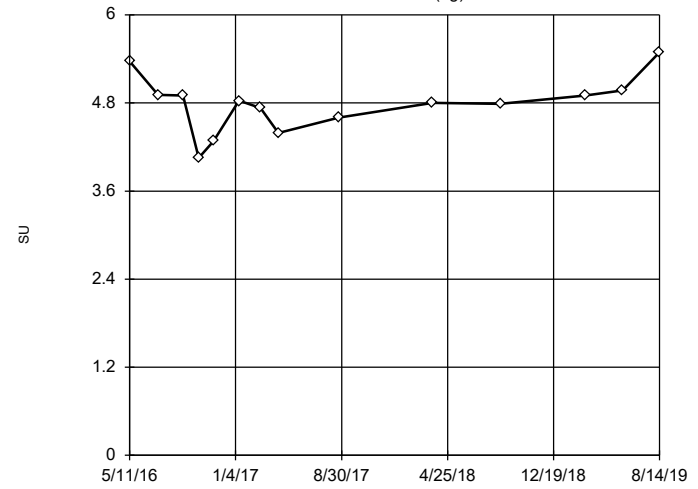
Tukey's Outlier Screening
AD-32



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

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

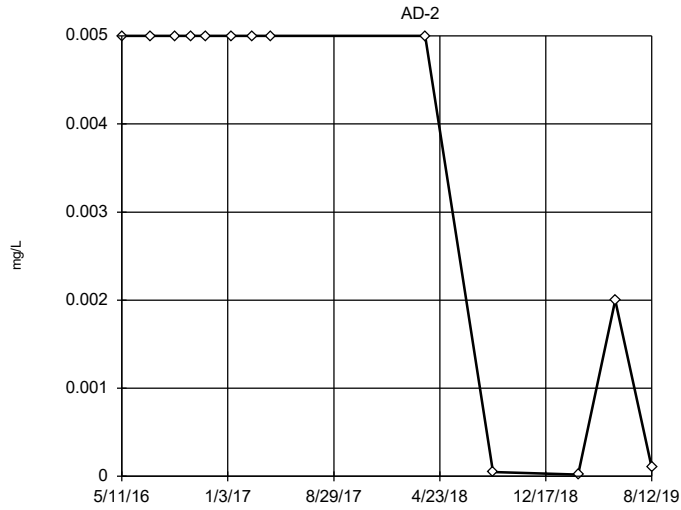
Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Beryllium, total (mg/L)	AD-2	Yes	0.001	5/22/2019	NP	NaN	13	0.000...	0.0001631	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	AD-31	Yes	0.01	5/11/2016	NP	NaN	13	0.001824	0.002489	ln(x)	ShapiroWilk
Fluoride, 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

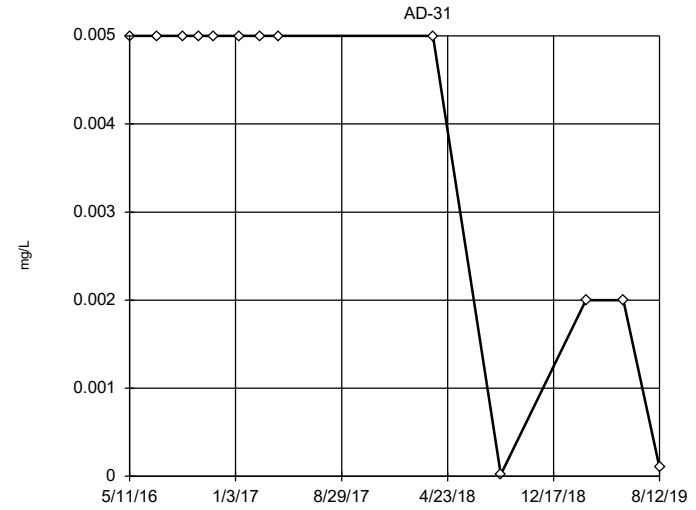
Tukey's Outlier Screening



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

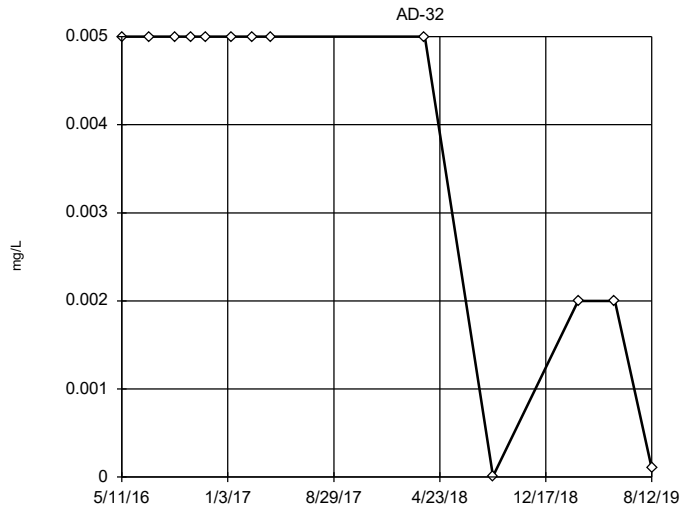
Tukey's Outlier Screening



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

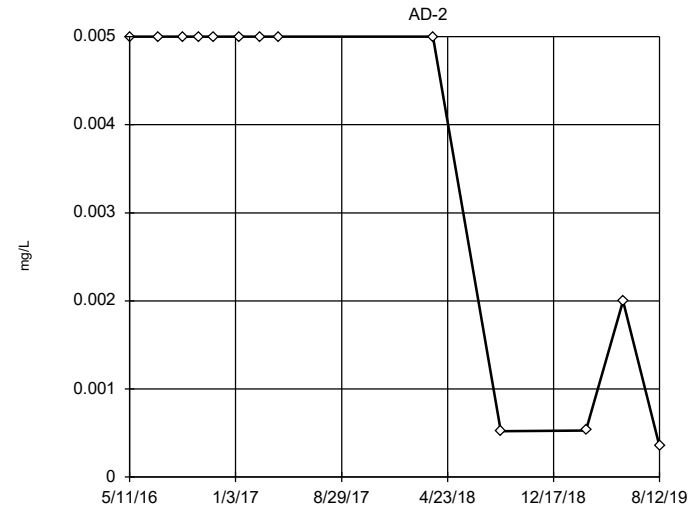
Tukey's Outlier Screening



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

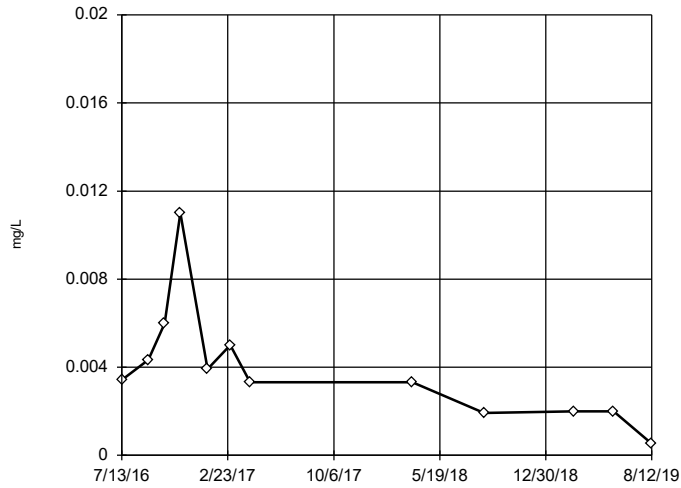
Tukey's Outlier Screening



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

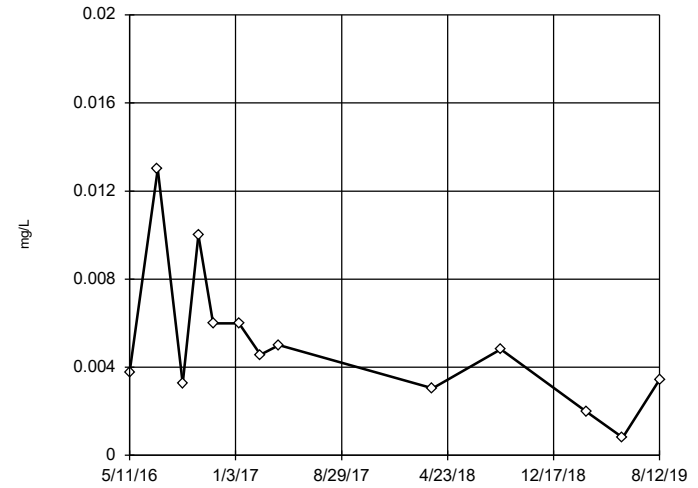
Tukey's Outlier Screening
AD-31



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

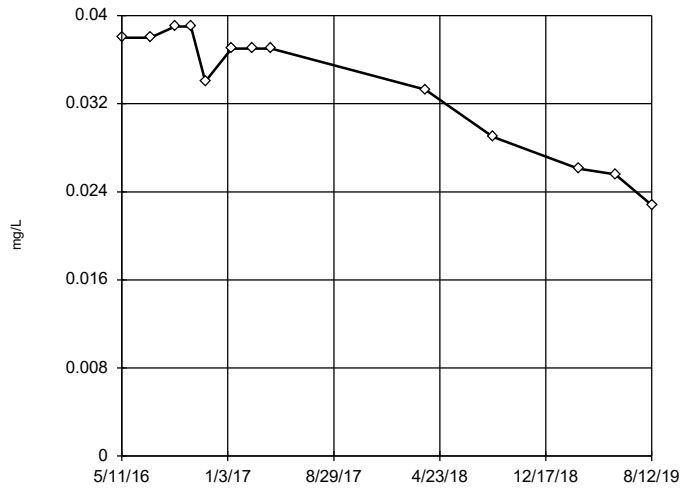
Tukey's Outlier Screening
AD-32



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

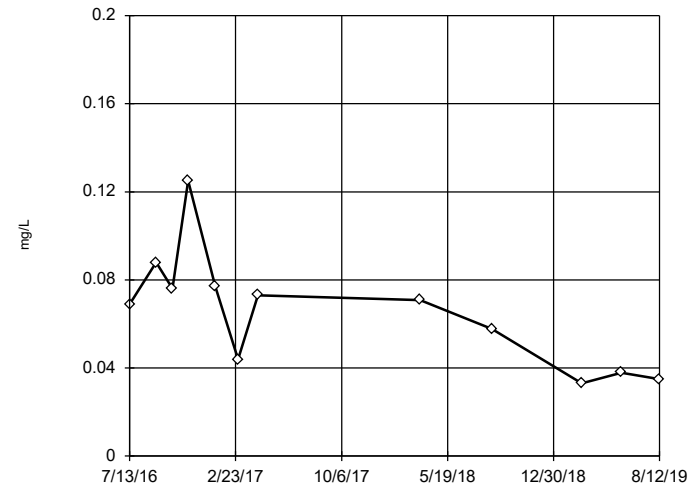
Tukey's Outlier Screening
AD-2



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

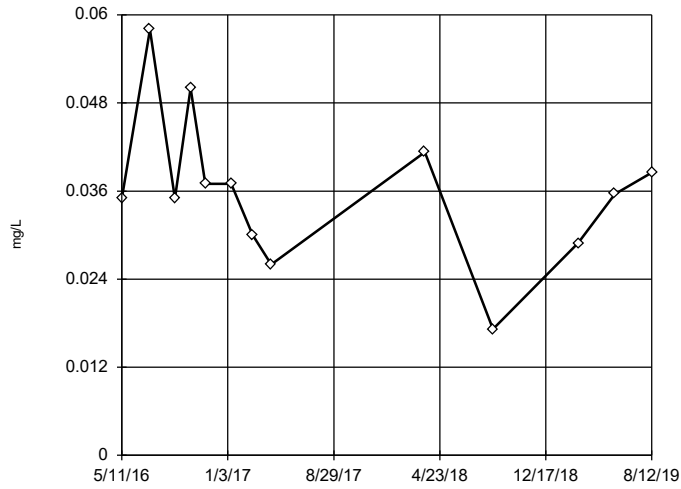
Tukey's Outlier Screening
AD-31



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

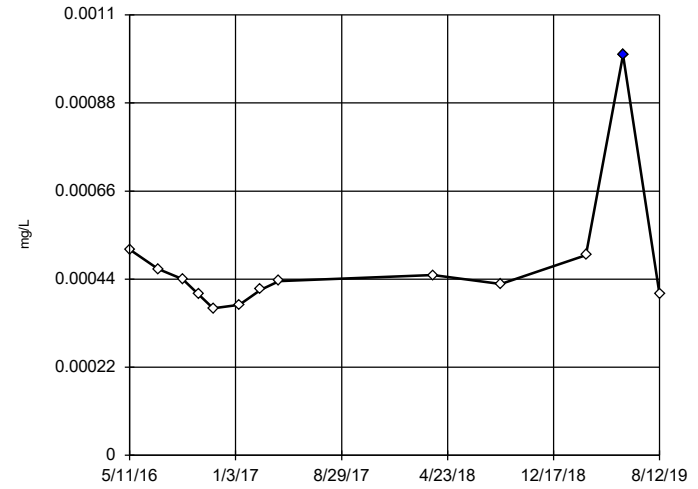
Tukey's Outlier Screening AD-32



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

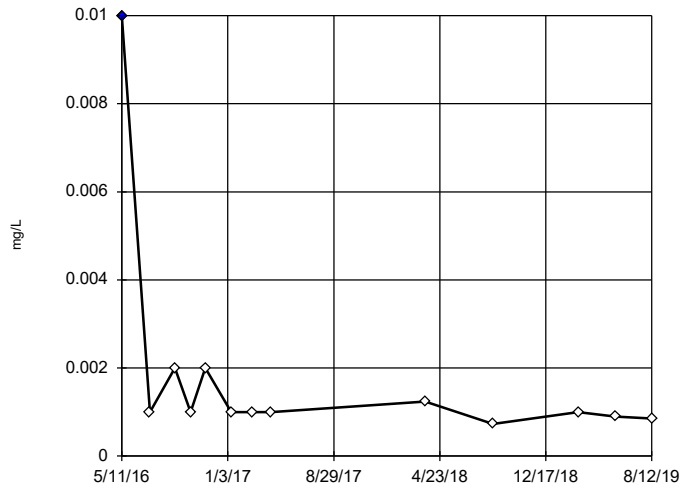
Tukey's Outlier Screening AD-2



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

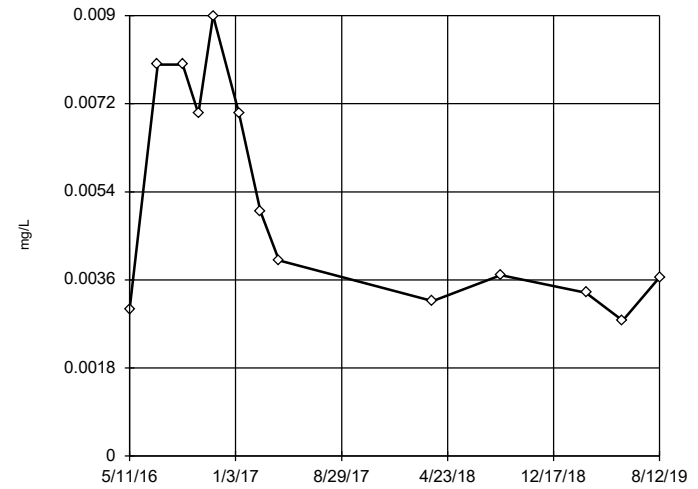
Tukey's Outlier Screening AD-31



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

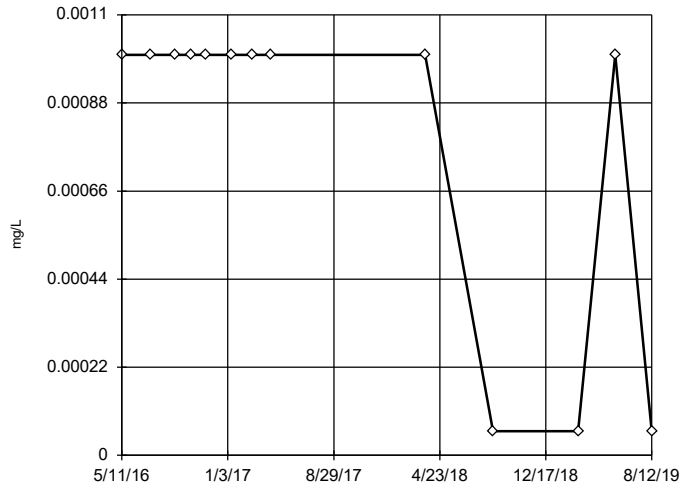
Tukey's Outlier Screening AD-32



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

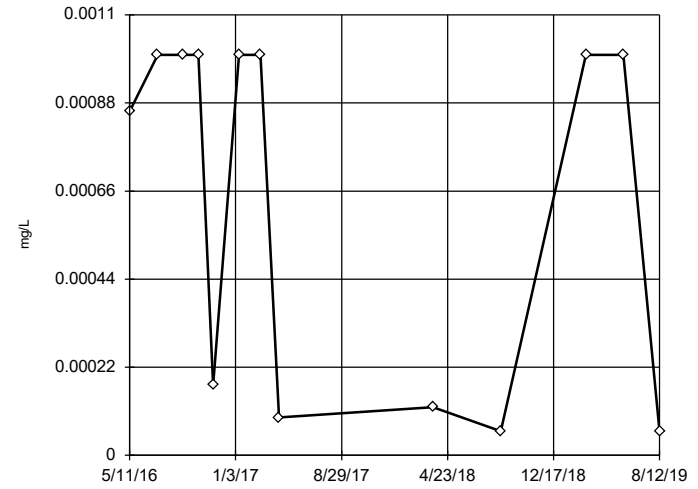
Tukey's Outlier Screening
AD-2



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

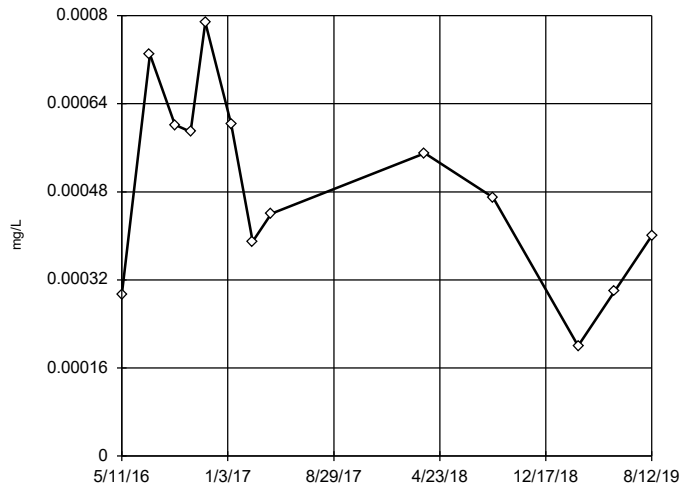
Tukey's Outlier Screening
AD-31



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

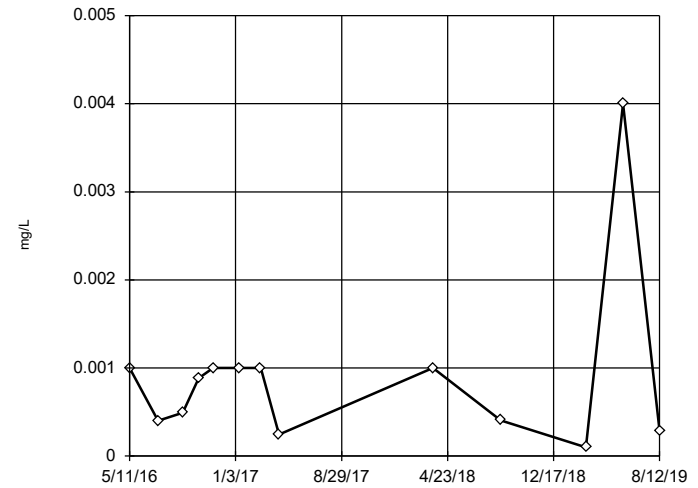
Tukey's Outlier Screening
AD-32



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

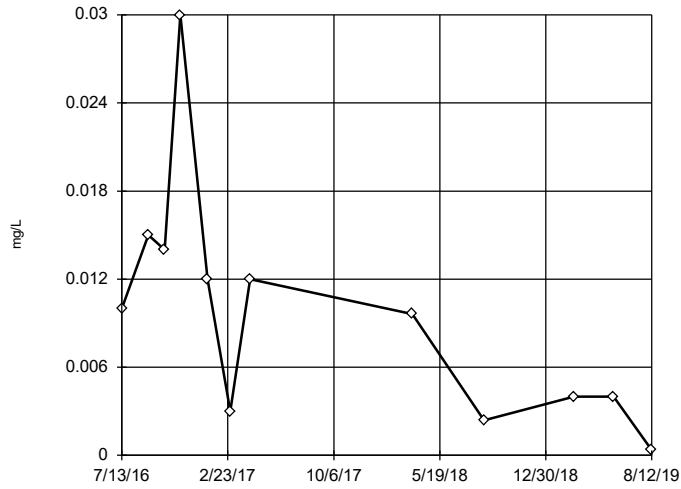
Tukey's Outlier Screening
AD-2



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

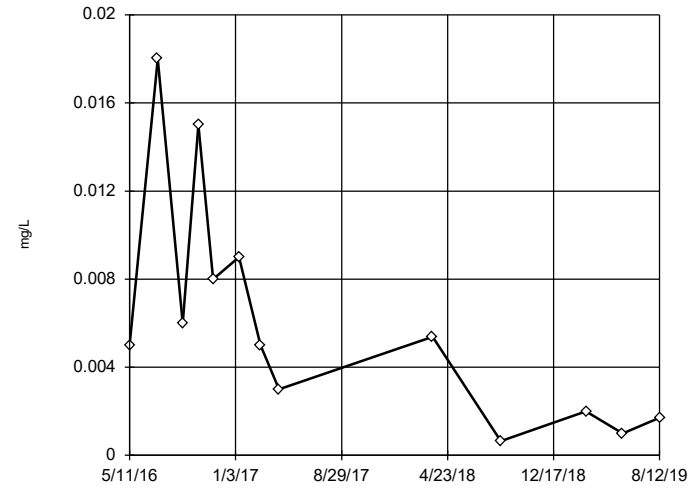
Tukey's Outlier Screening AD-31



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

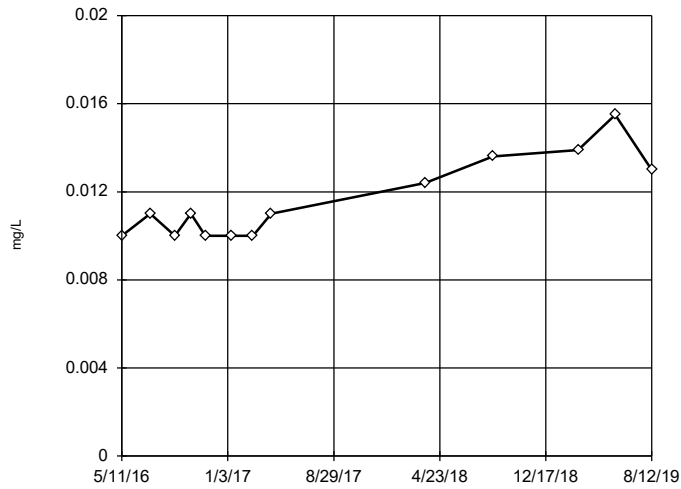
Tukey's Outlier Screening AD-32



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

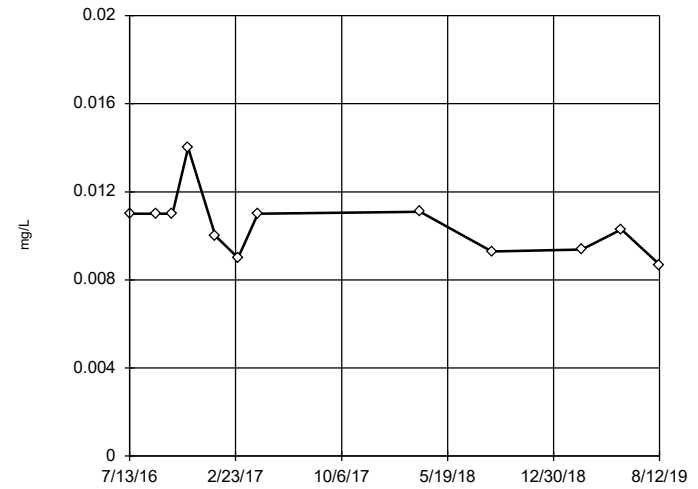
Tukey's Outlier Screening AD-2



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

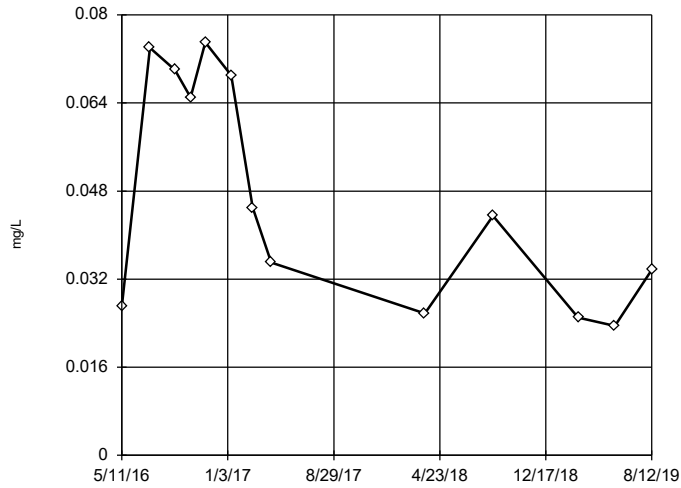
Tukey's Outlier Screening AD-31



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

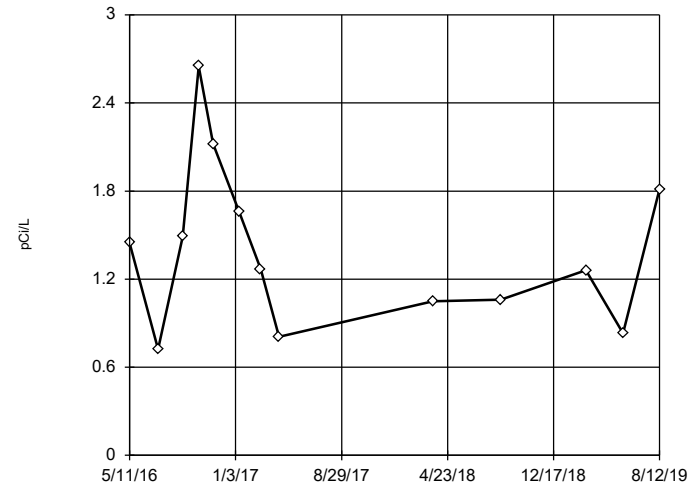
Tukey's Outlier Screening
AD-32



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

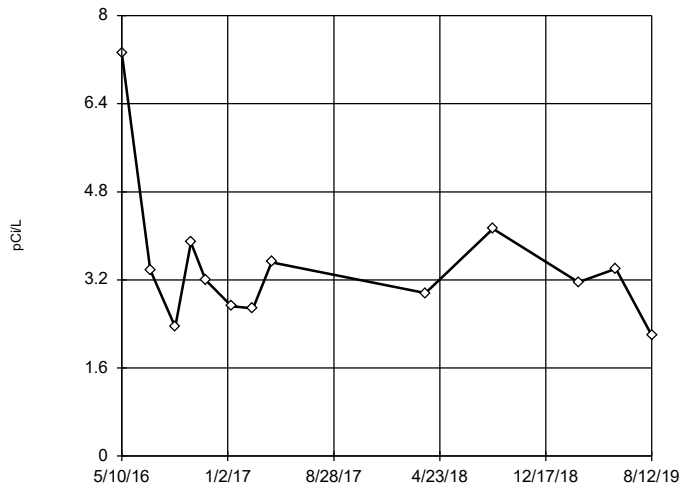
Tukey's Outlier Screening
AD-2



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

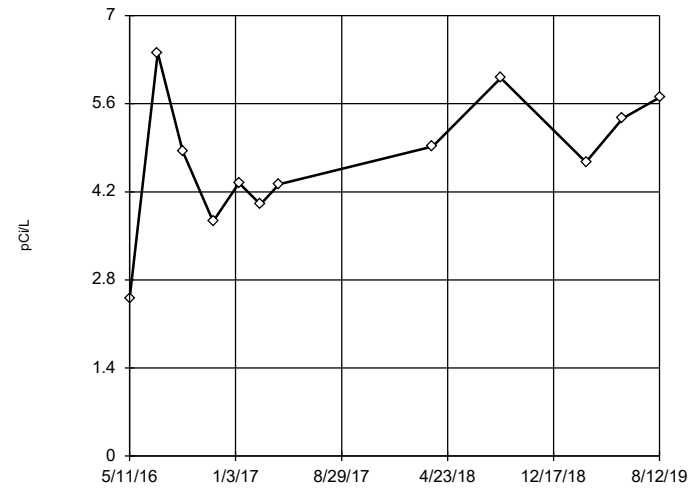
Tukey's Outlier Screening
AD-31



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

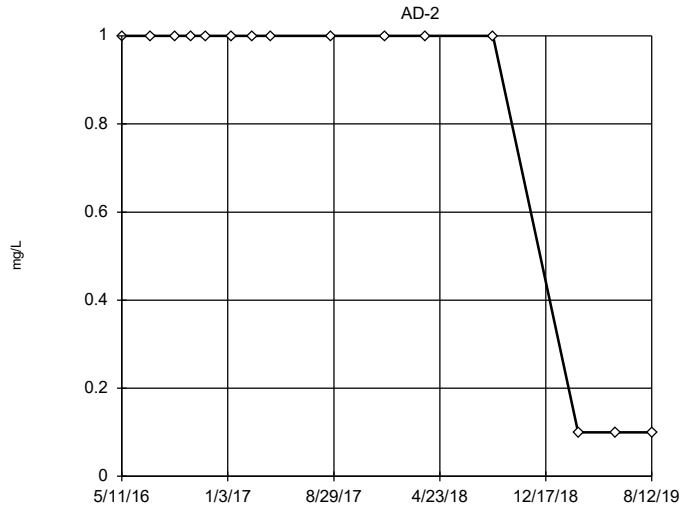
Tukey's Outlier Screening
AD-32



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

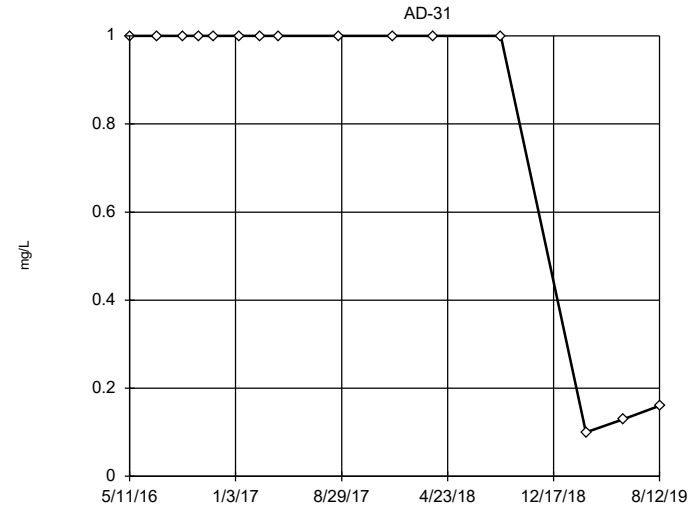
Tukey's Outlier Screening



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

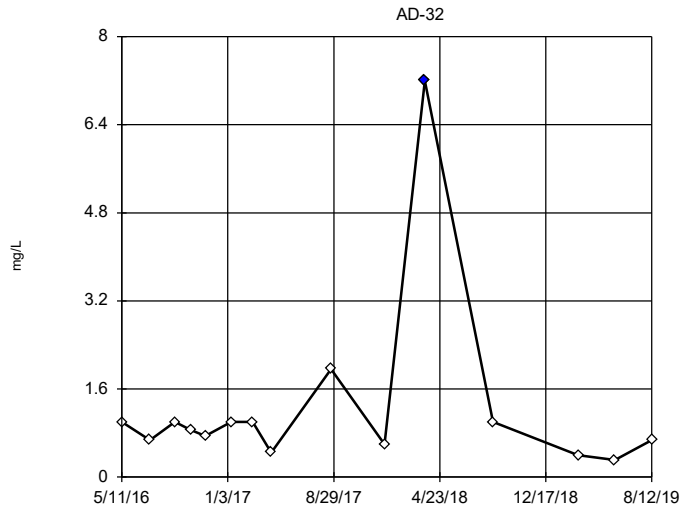
Tukey's Outlier Screening



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

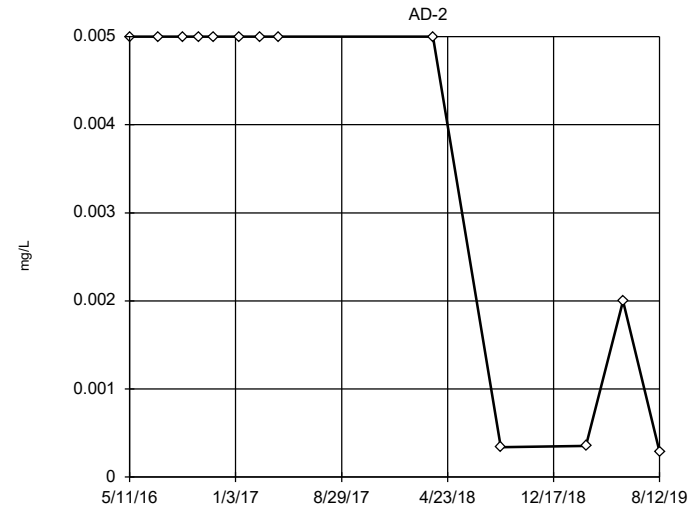
Tukey's Outlier Screening



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.

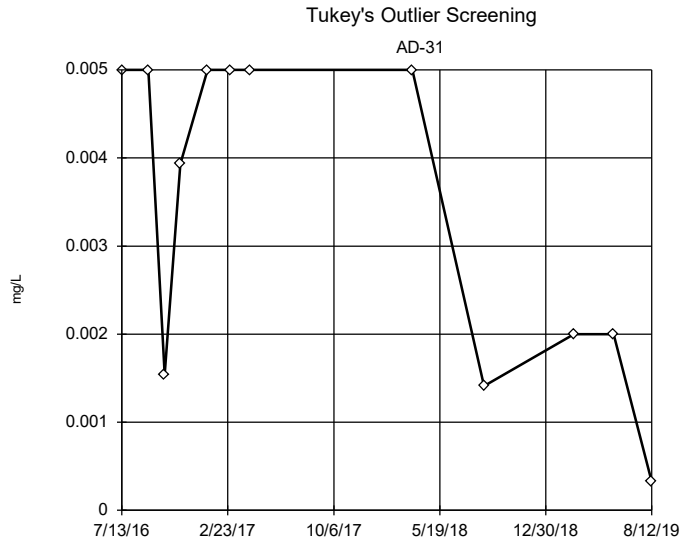
Constituent: Fluoride, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Tukey's Outlier Screening



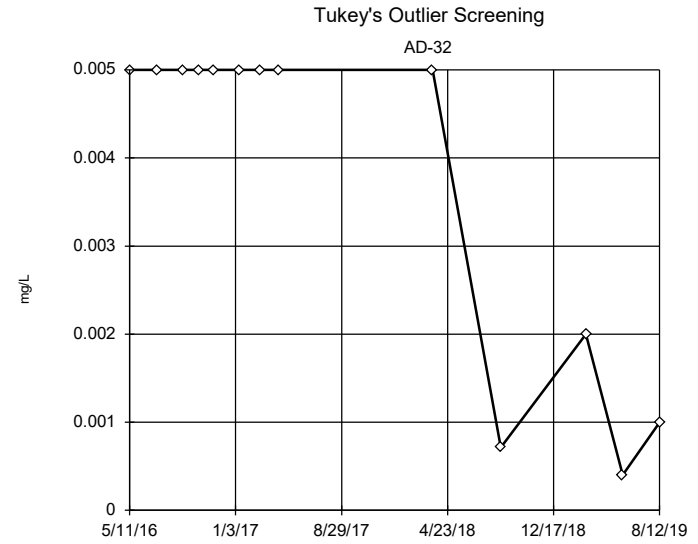
n = 13
 No outliers found.
 Tukey's method selected by user.
 Data were square root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.03516, low cutoff = -0.007226, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP



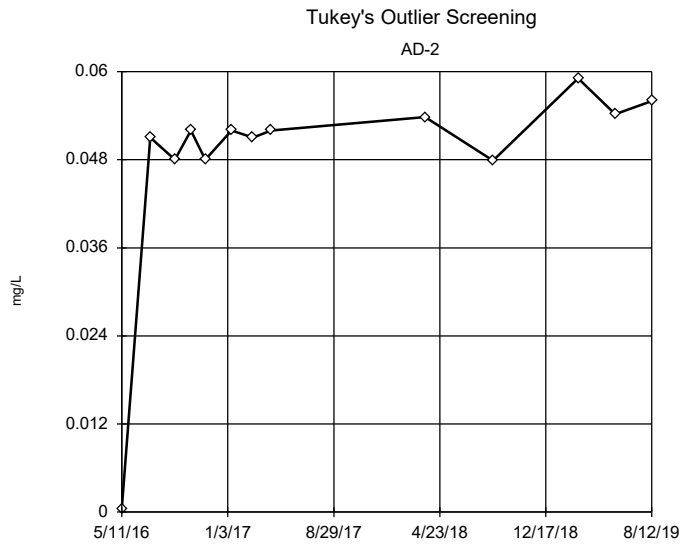
n = 12
No outliers found.
Tukey's method selected by user.
Data were square root transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.02462, low cutoff = -0.001953, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP



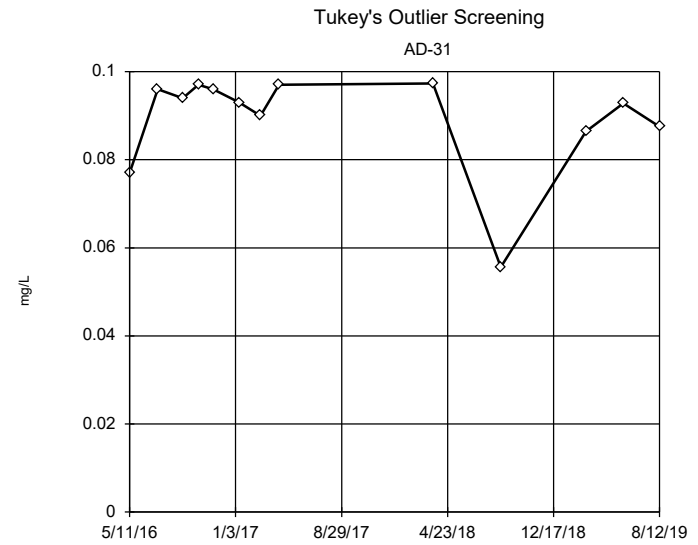
n = 13
No outliers found.
Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.2223, low cutoff = 0.00003174, based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/25/2019 10:13 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP



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.

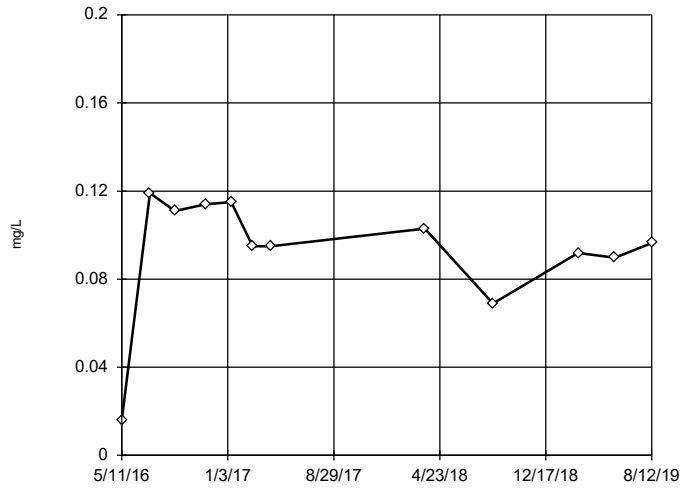
Constituent: Lithium, total Analysis Run 11/25/2019 10:14 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP



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

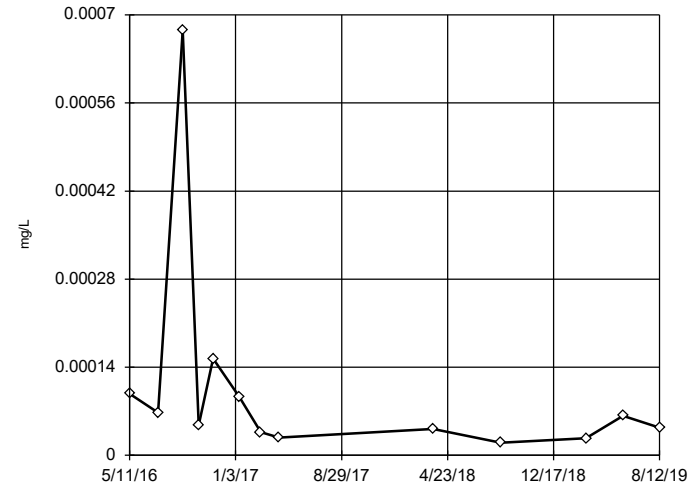
Tukey's Outlier Screening AD-32



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

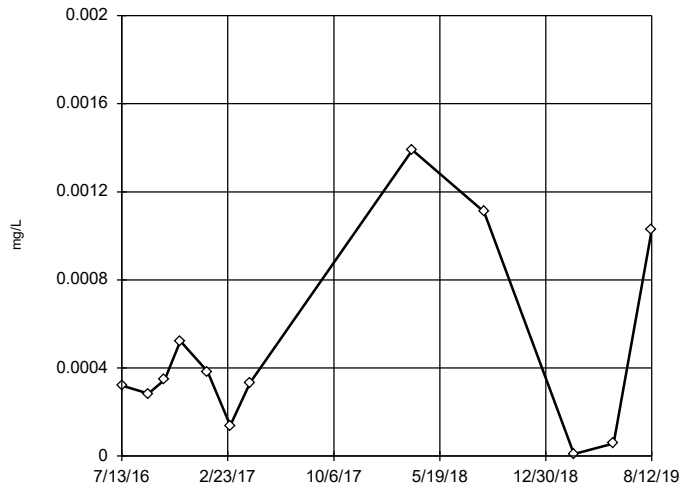
Tukey's Outlier Screening AD-2



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 = 0.00001234,
 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

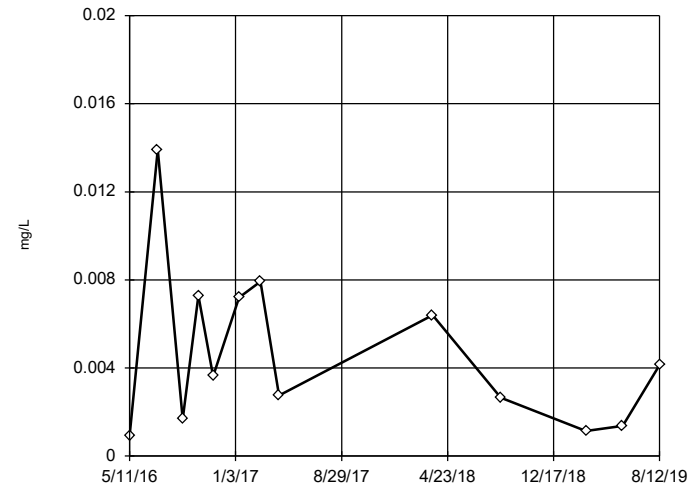
Tukey's Outlier Screening AD-31



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

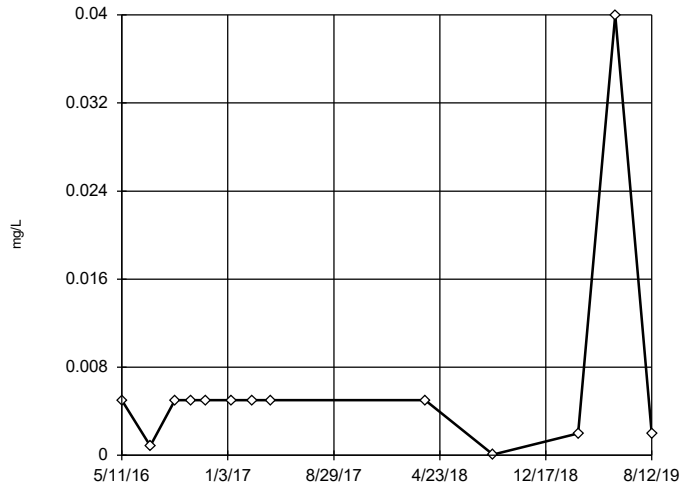
Tukey's Outlier Screening AD-32



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

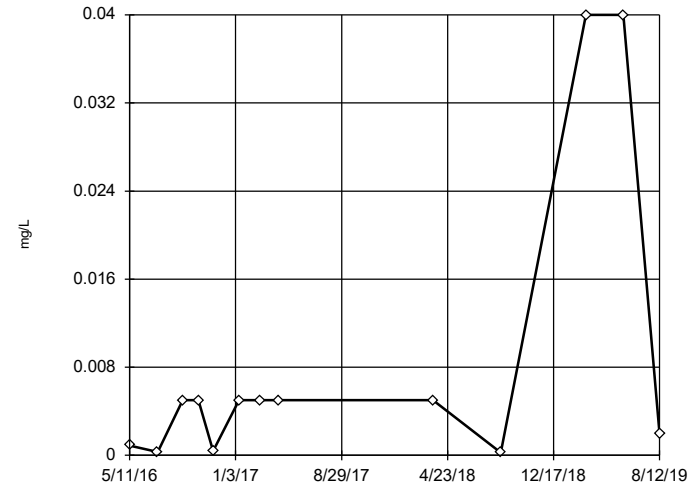
Tukey's Outlier Screening
AD-2



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

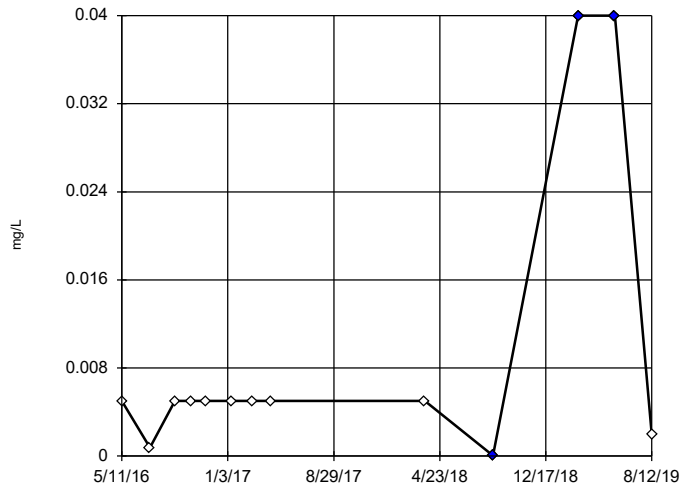
Tukey's Outlier Screening
AD-31



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 = 2.906, low cutoff = 0.00001031, 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

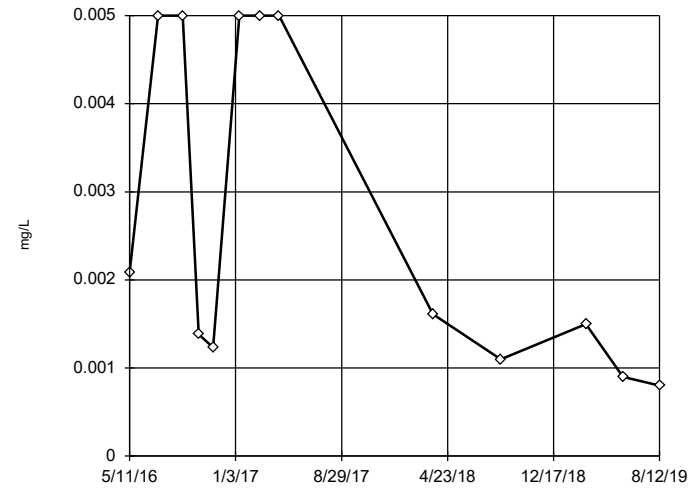
Tukey's Outlier Screening
AD-32



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

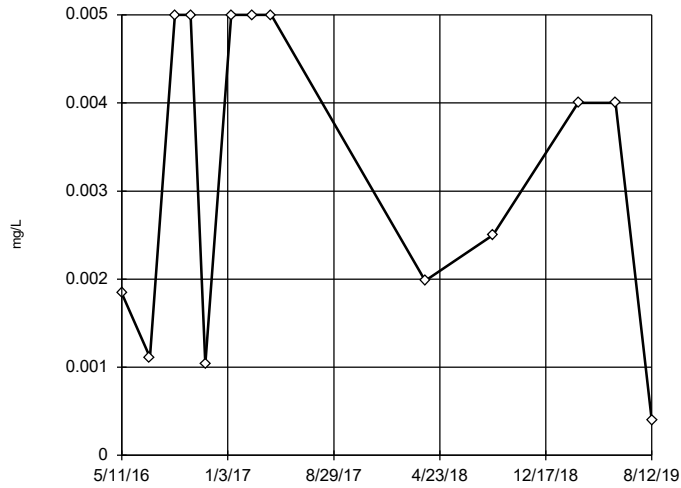
Tukey's Outlier Screening
AD-2



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 = 0.3964, 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

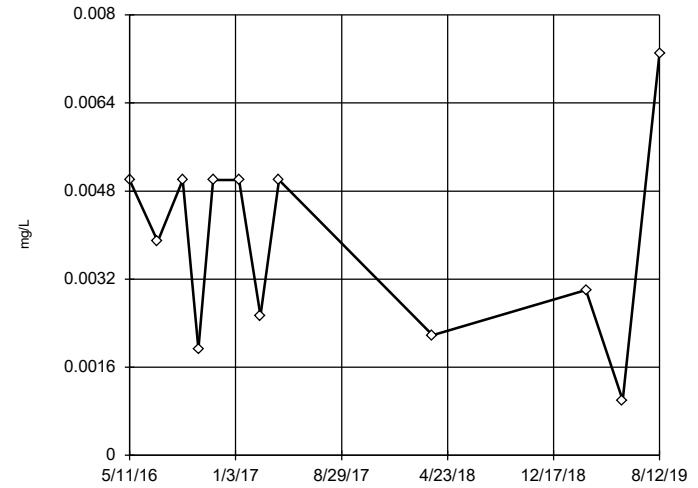
Tukey's Outlier Screening
AD-31



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

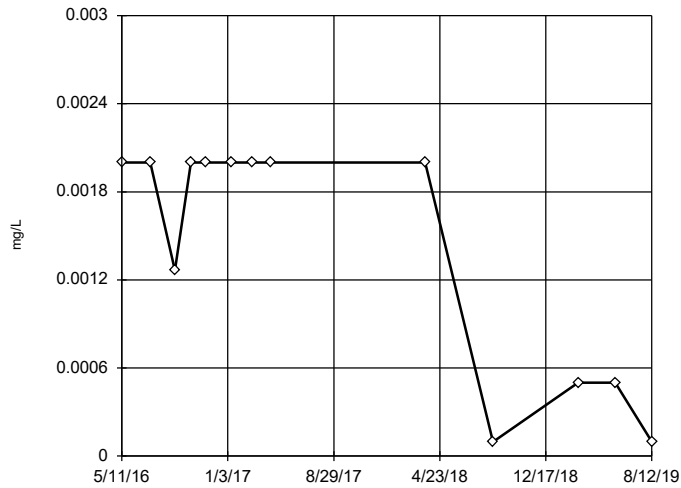
Tukey's Outlier Screening
AD-32



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

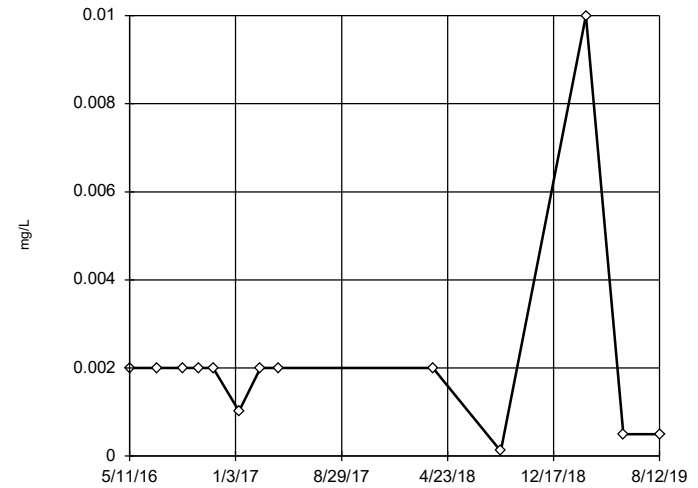
Tukey's Outlier Screening
AD-2



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).
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

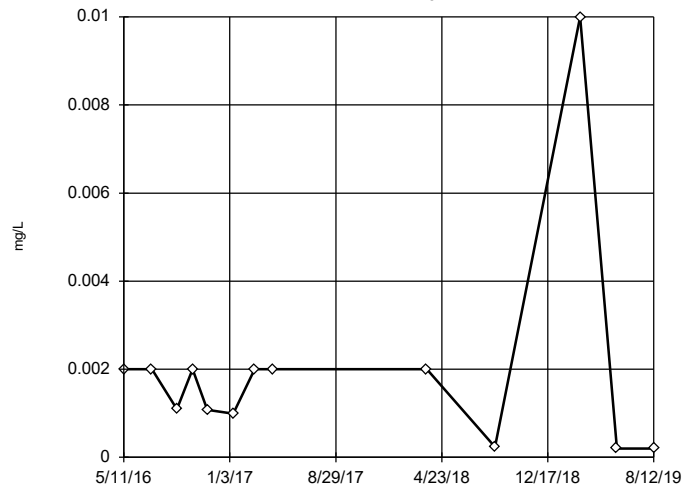
Tukey's Outlier Screening
AD-31



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 = 0.04398, 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 = 0.00006954,
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

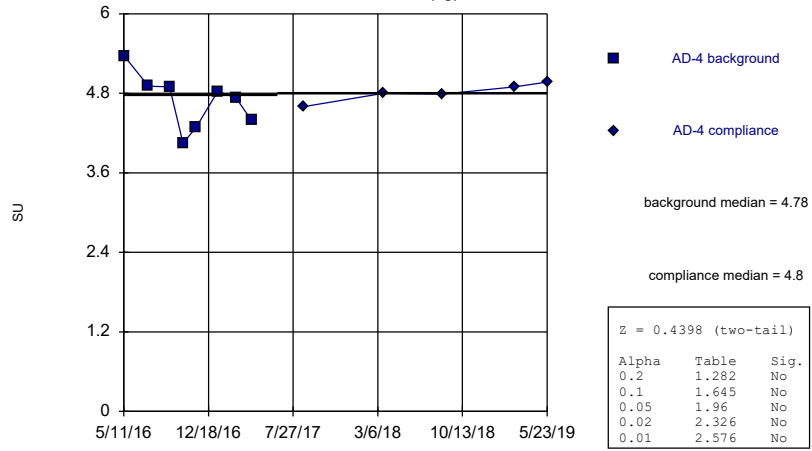
Mann-Whitney - All Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/7/2019, 1:55 PM

<u>Constituent</u>	<u>Well</u>	<u>Calc.</u>	<u>0.01</u>	<u>Sig.</u>	<u>Method</u>
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

Mann-Whitney (Wilcoxon Rank Sum)

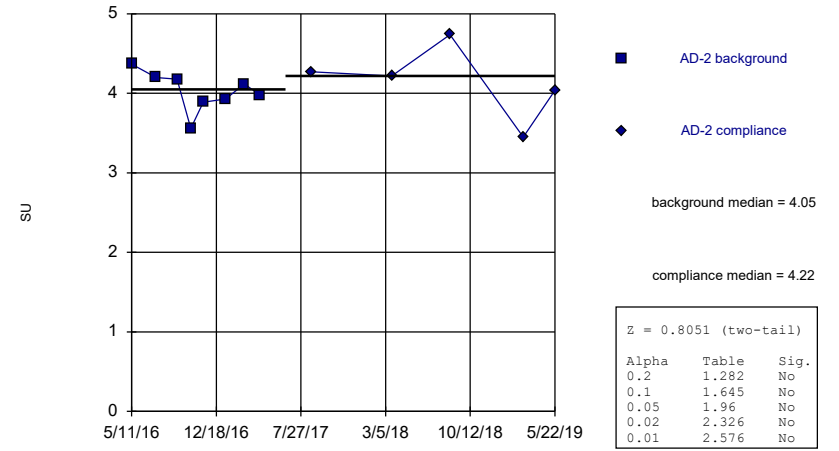
AD-4 (bg)



Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Mann-Whitney (Wilcoxon Rank Sum)

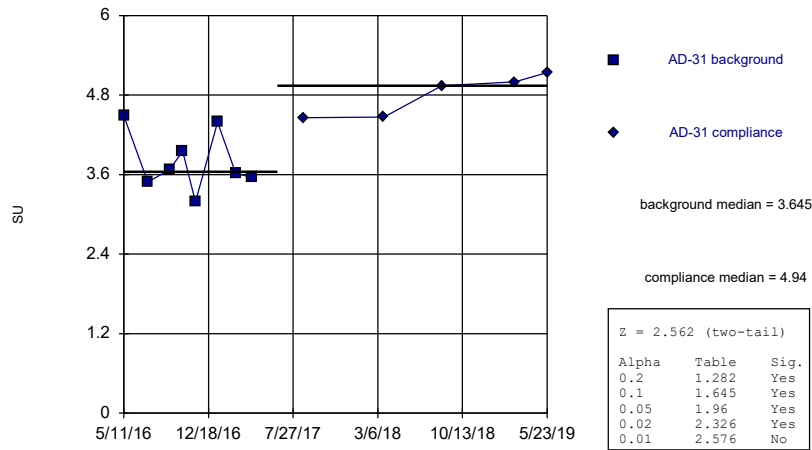
AD-2



Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Mann-Whitney (Wilcoxon Rank Sum)

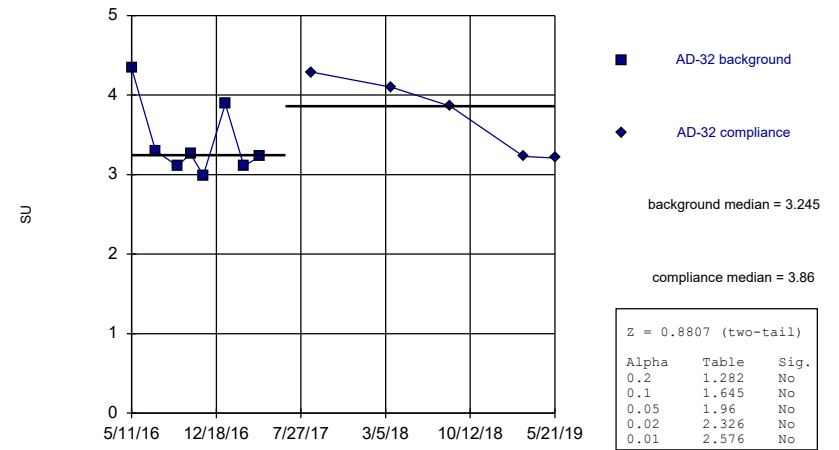
AD-31



Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

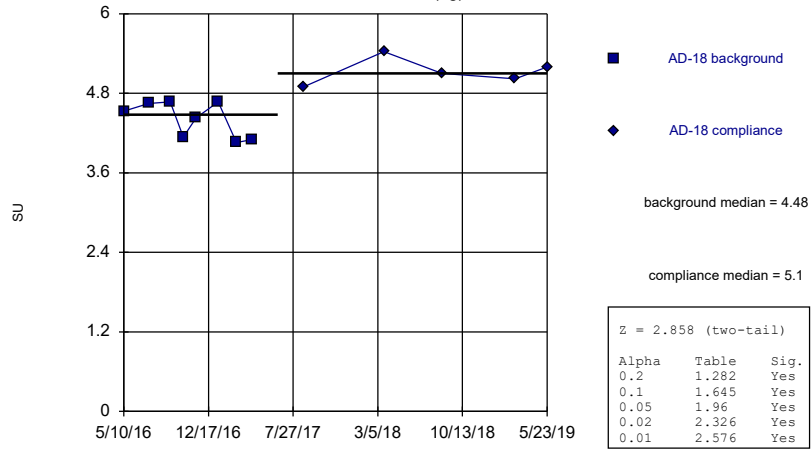
Mann-Whitney (Wilcoxon Rank Sum)

AD-32



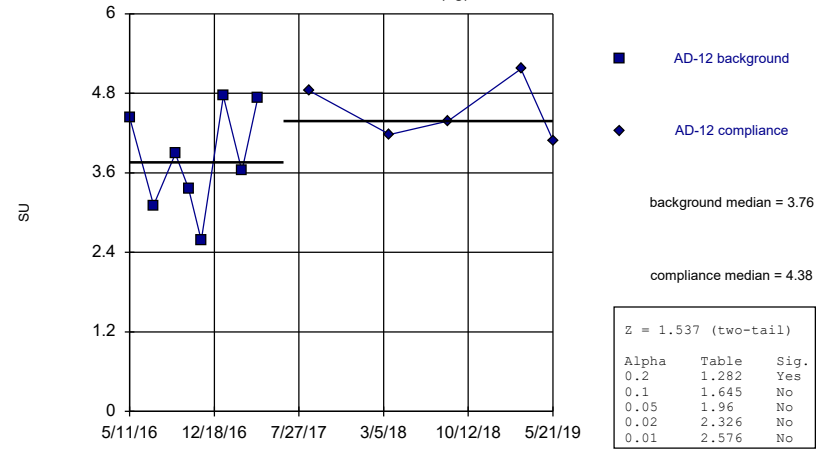
Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Mann-Whitney (Wilcoxon Rank Sum)
AD-18 (bg)



Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Mann-Whitney (Wilcoxon Rank Sum)
AD-12 (bg)



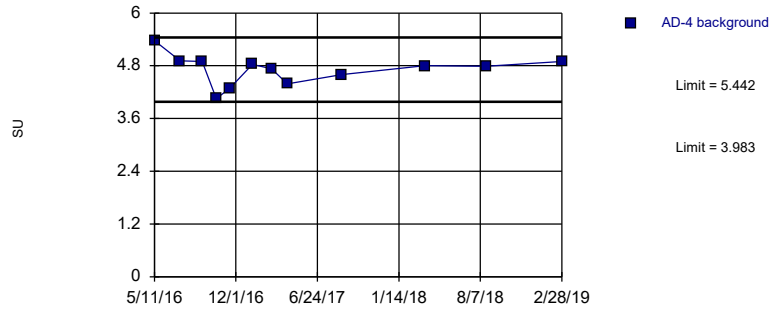
Constituent: pH, field Analysis Run 12/7/2019 1:53 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Intrawell Prediction Limit Summary

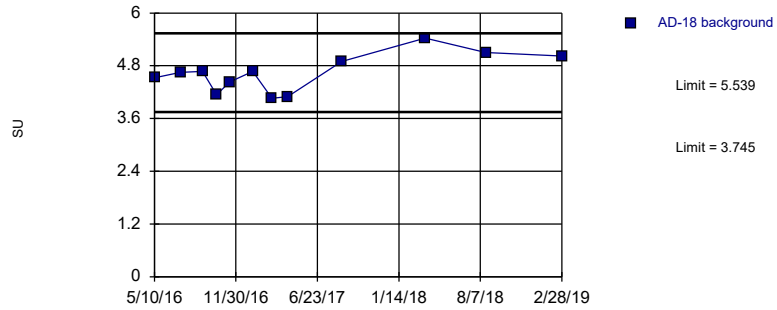
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 12/7/2019, 2:15 PM

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

Prediction Limit
Intrawell Parametric, AD-4 (bg)



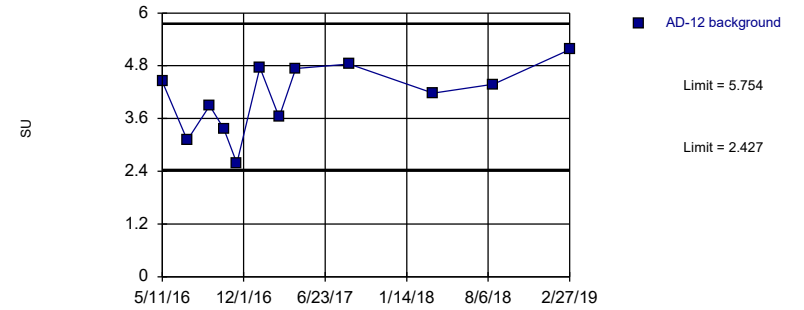
Prediction Limit
Intrawell Parametric, AD-18 (bg)



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.

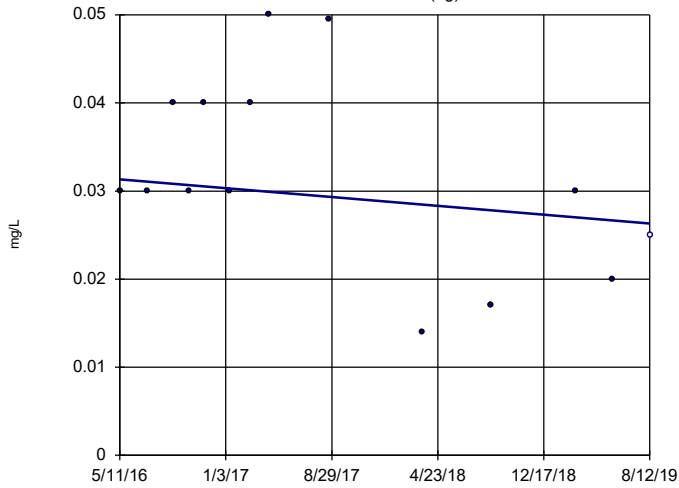
Constituent: pH, field Analysis Run 12/7/2019 2:14 PM View: PL's Intrawell
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

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

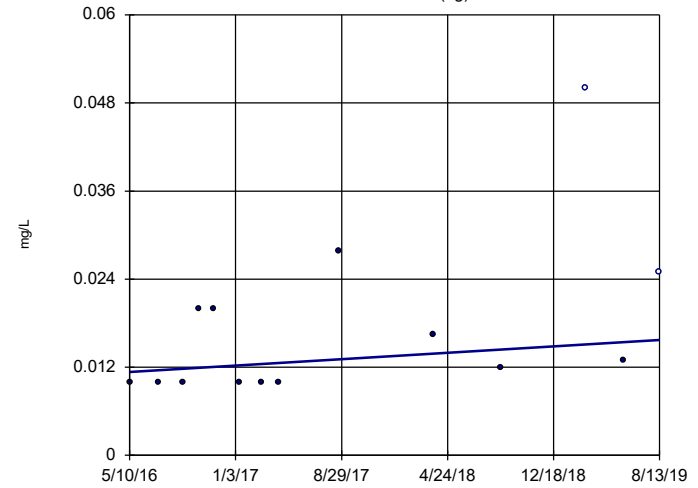
Sen's Slope Estimator AD-12 (bg)



n = 14
Slope = -0.001536
units per year.
Mann-Kendall
statistic = -16
critical = -48
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ per
tail).

Constituent: Boron, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

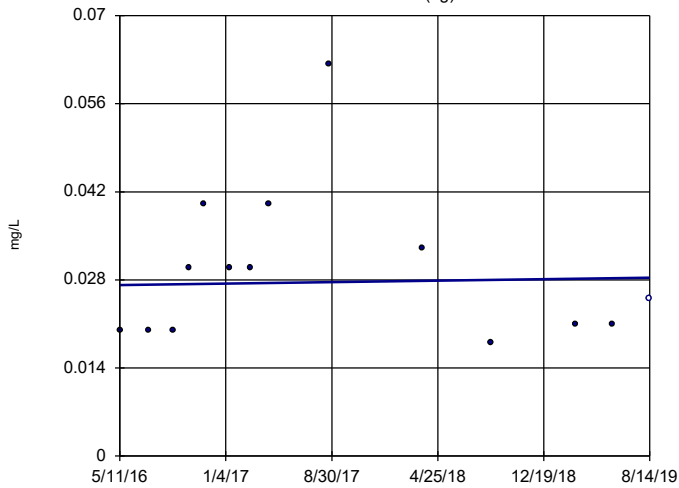
Sen's Slope Estimator AD-18 (bg)



n = 14
Slope = 0.001347
units per year.
Mann-Kendall
statistic = 35
critical = 48
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ per
tail).

Constituent: Boron, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

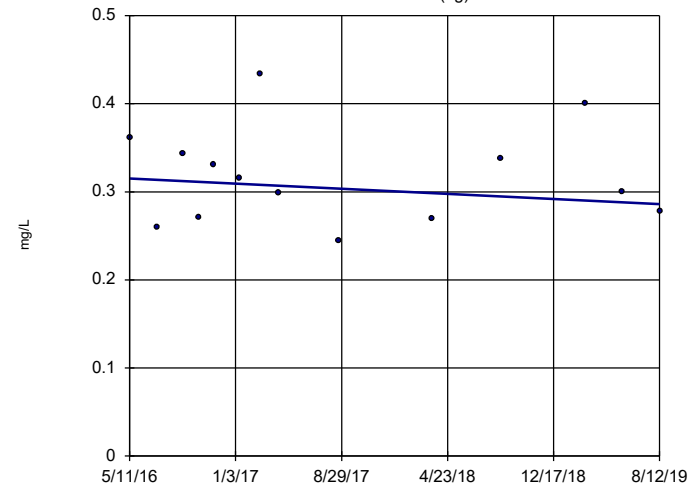
Sen's Slope Estimator AD-4 (bg)



n = 14
Slope = 0.00035
units per year.
Mann-Kendall
statistic = 11
critical = 48
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ per
tail).

Constituent: Boron, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

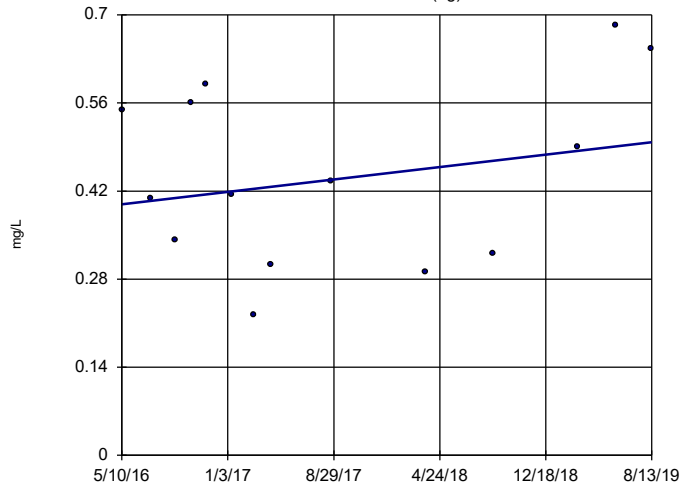
Sen's Slope Estimator AD-12 (bg)



n = 14
Slope = -0.008986
units per year.
Mann-Kendall
statistic = -7
critical = -48
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ per
tail).

Constituent: Calcium, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

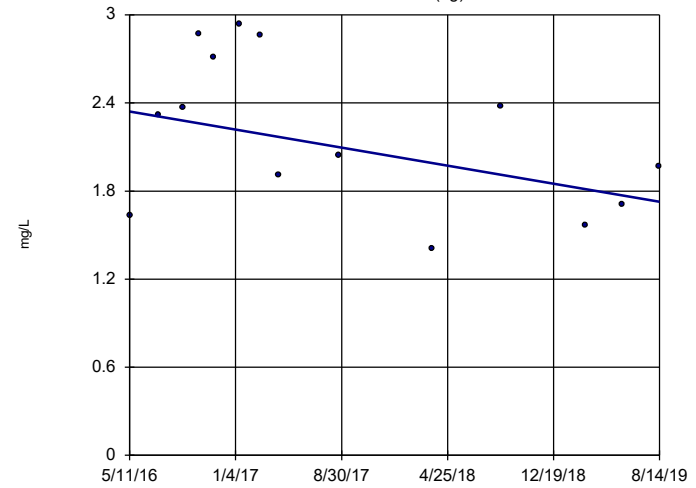
Sen's Slope Estimator AD-18 (bg)



n = 14
 Slope = 0.03037
 units per year.
 Mann-Kendall
 statistic = 11
 critical = 48
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Calcium, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

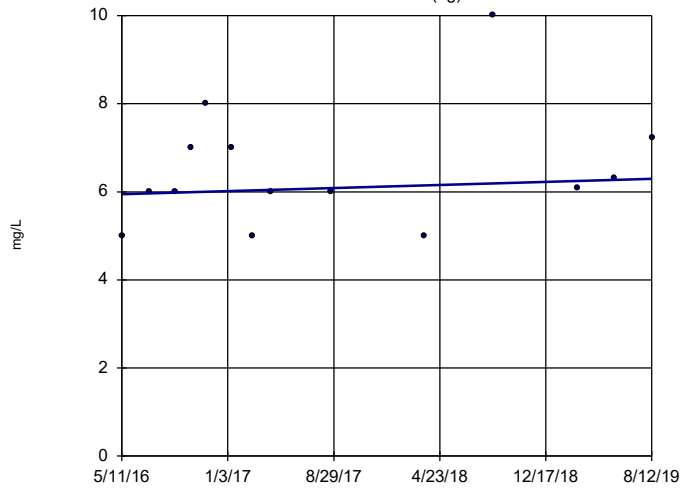
Sen's Slope Estimator AD-4 (bg)



n = 14
 Slope = -0.1891
 units per year.
 Mann-Kendall
 statistic = -19
 critical = -48
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Calcium, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

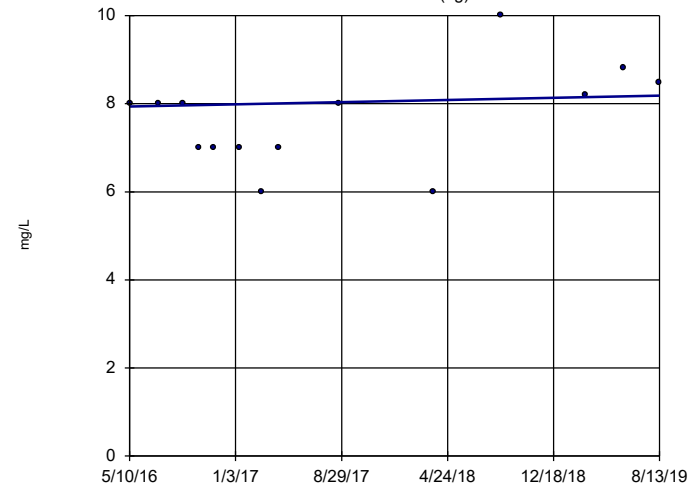
Sen's Slope Estimator AD-12 (bg)



n = 14
 Slope = 0.1051
 units per year.
 Mann-Kendall
 statistic = 23
 critical = 48
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator AD-18 (bg)

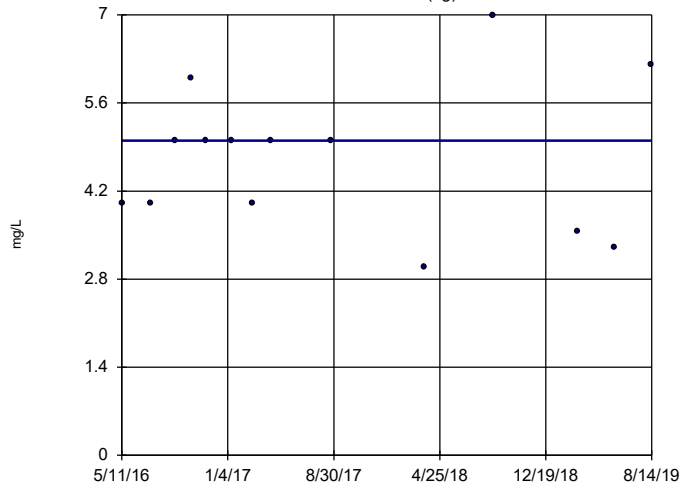


n = 14
 Slope = 0.0768
 units per year.
 Mann-Kendall
 statistic = 18
 critical = 48
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 11/25/2019 10:48 AM View: Interwell AIII
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-4 (bg)

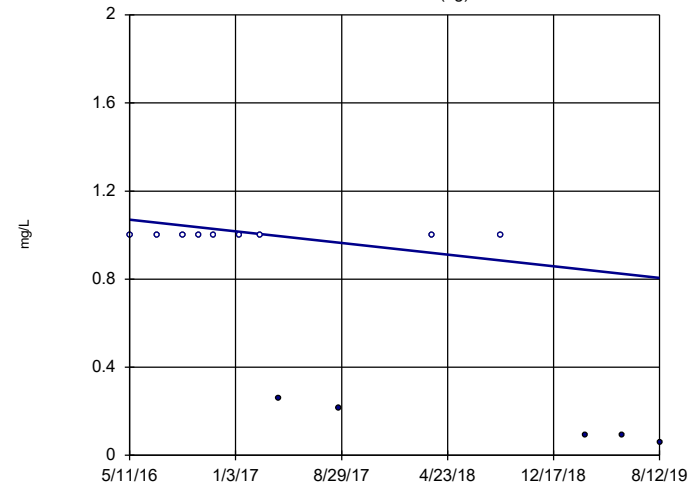


n = 14
 Slope = 0
 units per year.
 Mann-Kendall
 statistic = 0
 critical = 48
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 11/25/2019 10:48 AM View: Interwell All
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-12 (bg)

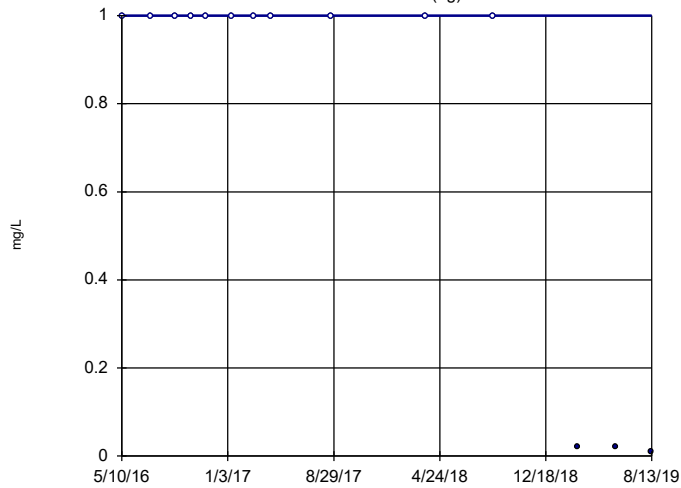


n = 14
 Slope = -0.08118
 units per year.
 Mann-Kendall
 statistic = -46
 critical = -48
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Fluoride, total Analysis Run 11/25/2019 10:48 AM View: Interwell All
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

AD-18 (bg)

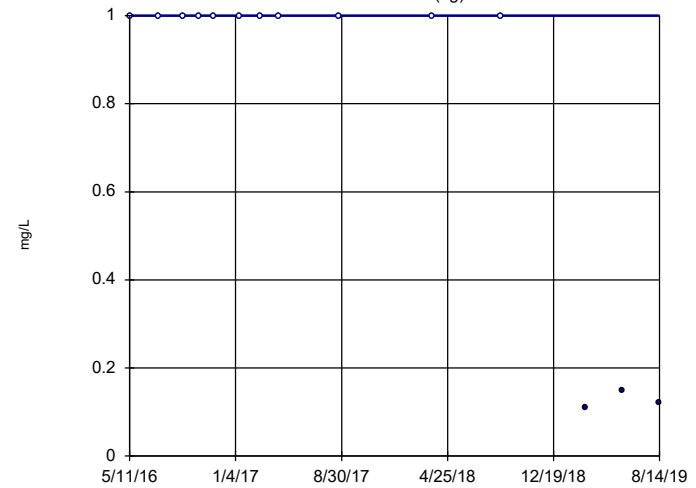


n = 14
 Slope = 0
 units per year.
 Mann-Kendall
 statistic = -35
 critical = -48
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Fluoride, total Analysis Run 11/25/2019 10:48 AM View: Interwell All
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sen's Slope Estimator

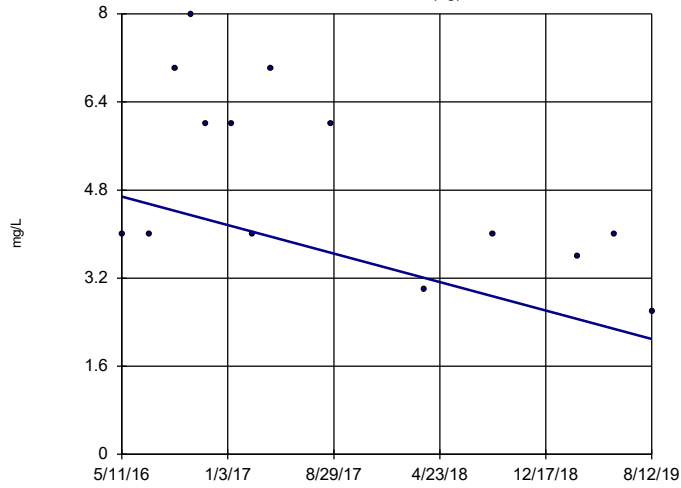
AD-4 (bg)



n = 14
 Slope = 0
 units per year.
 Mann-Kendall
 statistic = -32
 critical = -48
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Fluoride, total Analysis Run 11/25/2019 10:48 AM View: Interwell All
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

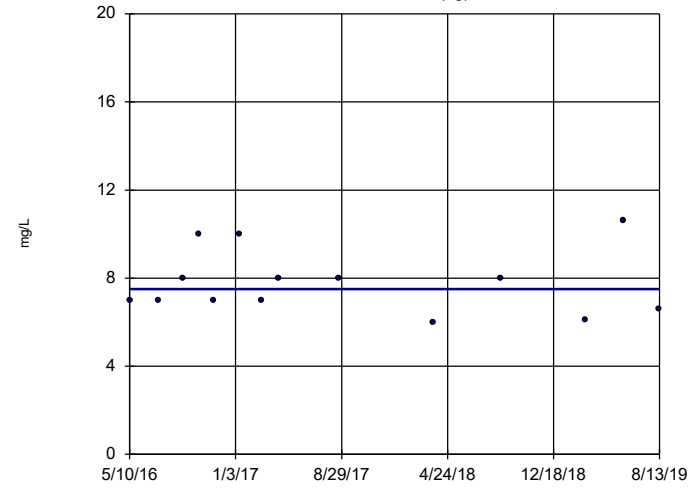
Sen's Slope Estimator AD-12 (bg)



n = 14
 Slope = -0.7952
 units per year.
 Mann-Kendall
 statistic = -35
 critical = -48
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Sulfate, total Analysis Run 11/25/2019 10:48 AM View: Interwell All
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

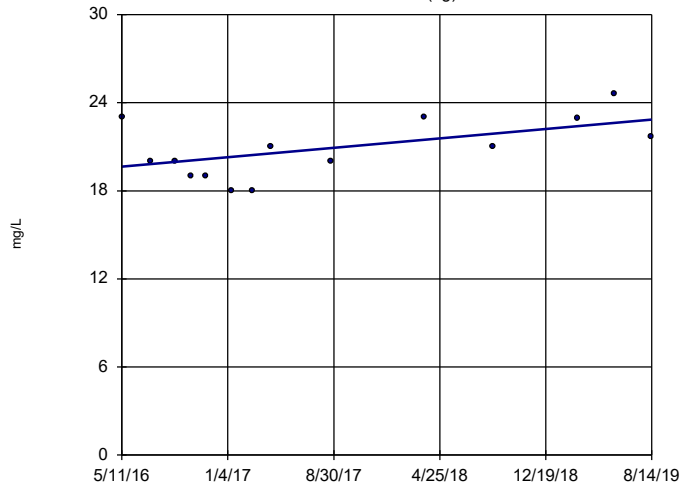
Sen's Slope Estimator AD-18 (bg)



n = 14
 Slope = 0
 units per year.
 Mann-Kendall
 statistic = -4
 critical = -48
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Sulfate, total Analysis Run 11/25/2019 10:48 AM View: Interwell All
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

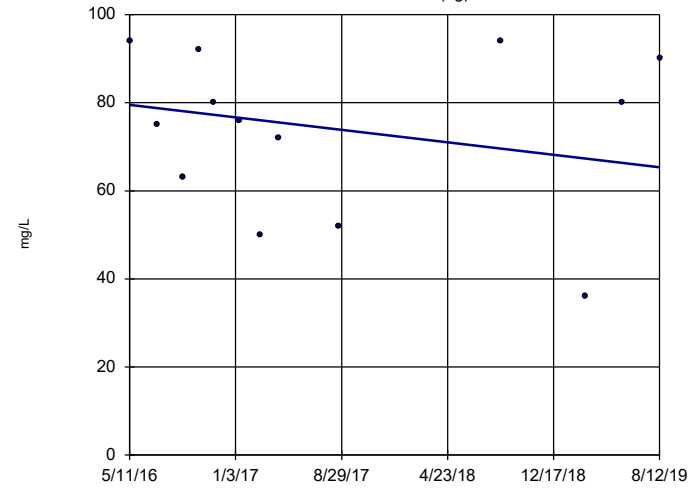
Sen's Slope Estimator AD-4 (bg)



n = 14
 Slope = 0.9835
 units per year.
 Mann-Kendall
 statistic = 26
 critical = 48
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Sulfate, total Analysis Run 11/25/2019 10:48 AM View: Interwell All
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

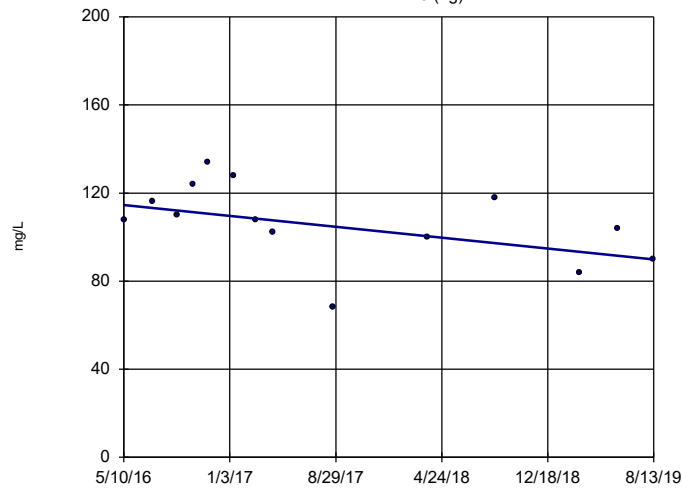
Sen's Slope Estimator AD-12 (bg)



n = 13
 Slope = -4.348
 units per year.
 Mann-Kendall
 statistic = -10
 critical = -43
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/25/2019 10:48 AM View: Interwell All
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

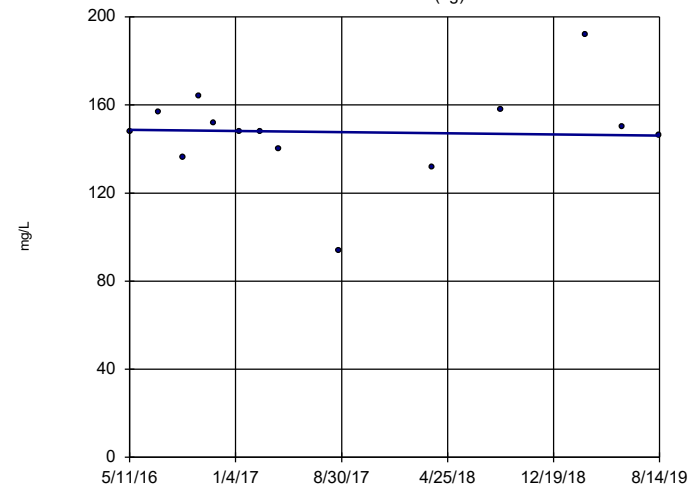
Sen's Slope Estimator AD-18 (bg)



n = 14
Slope = -7.565
units per year.
Mann-Kendall
statistic = -34
critical = -48
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ per
tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/25/2019 10:48 AM View: Interwell All
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 sig-
nificant at 99%
confidence level
($\alpha = 0.005$ per
tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/25/2019 10:48 AM View: Interwell All
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.

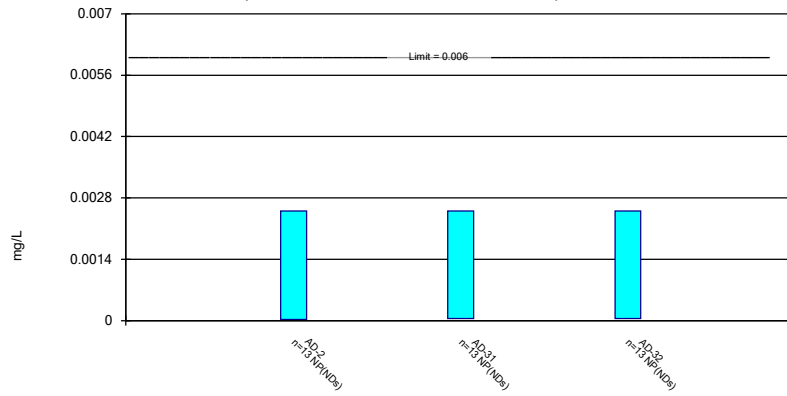
Confidence Interval Summary Table - All Results

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)

Non-Parametric Confidence Interval

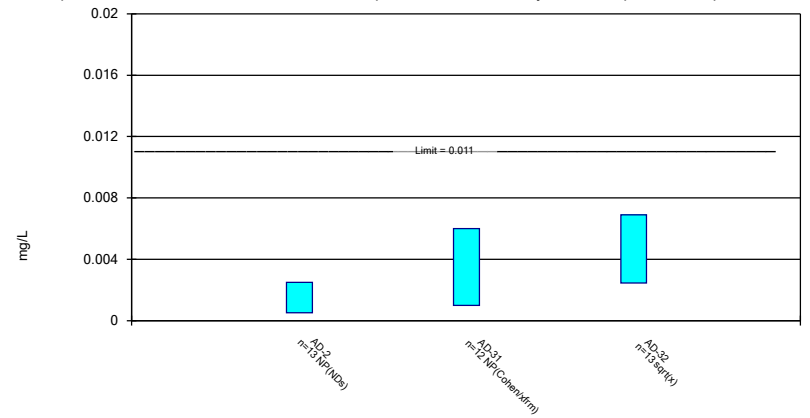
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Antimony, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

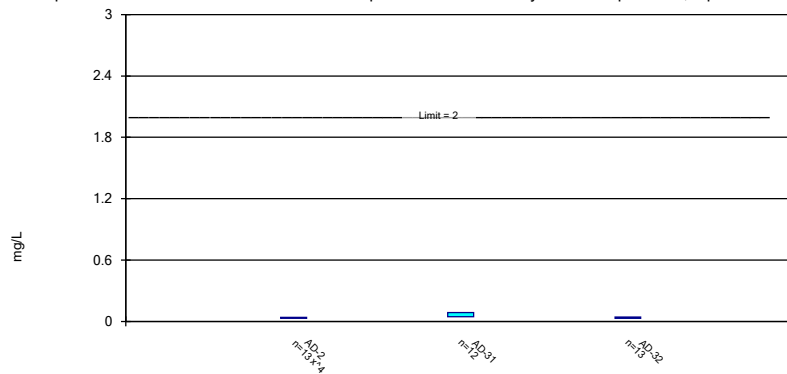
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Arsenic, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric Confidence Interval

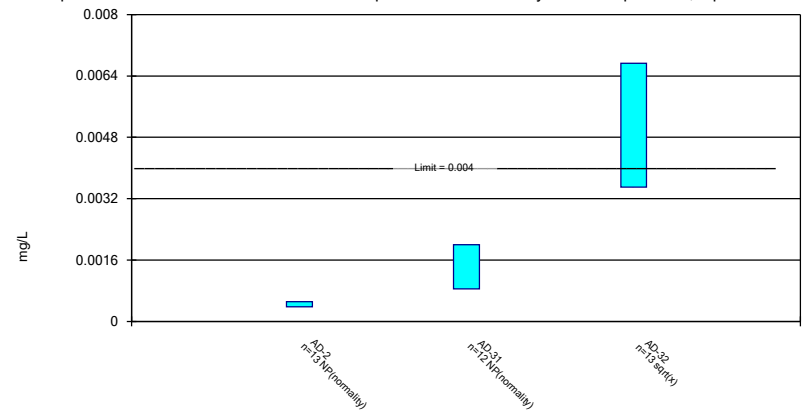
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Barium, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

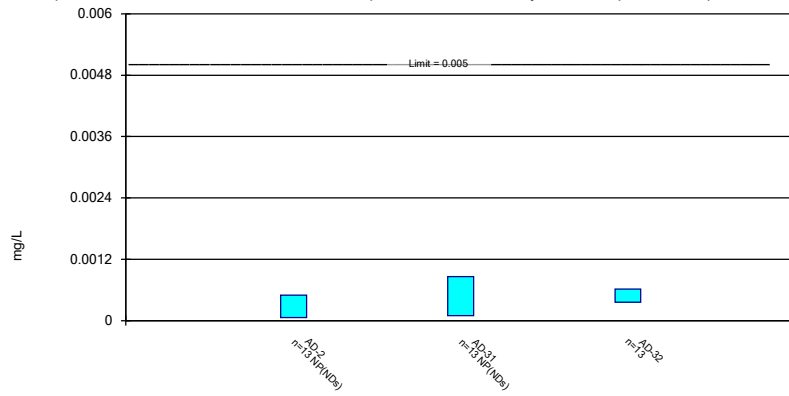
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

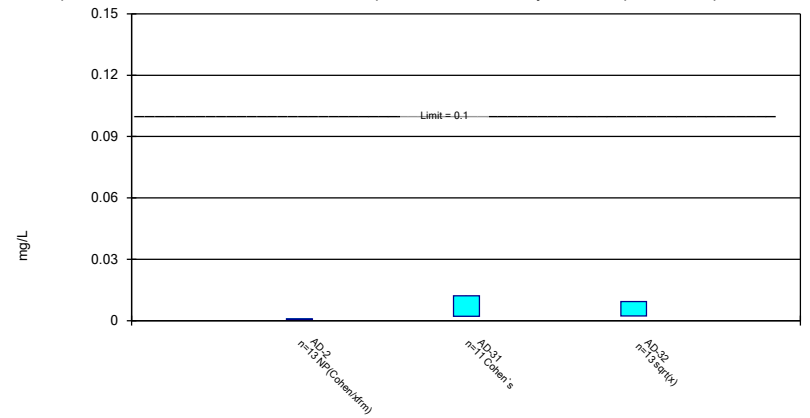
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cadmium, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

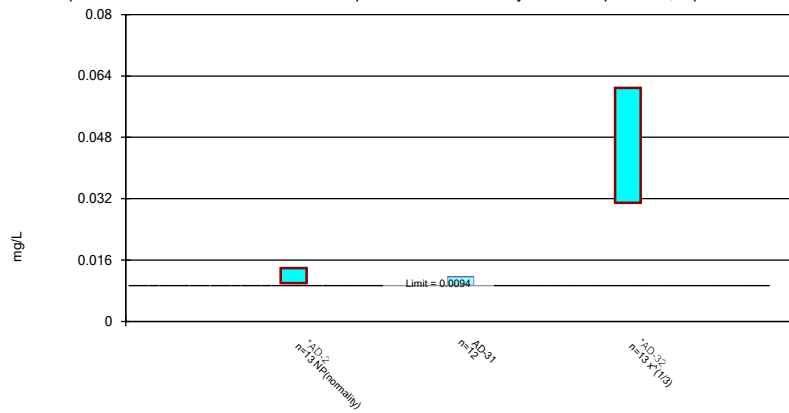
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chromium, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

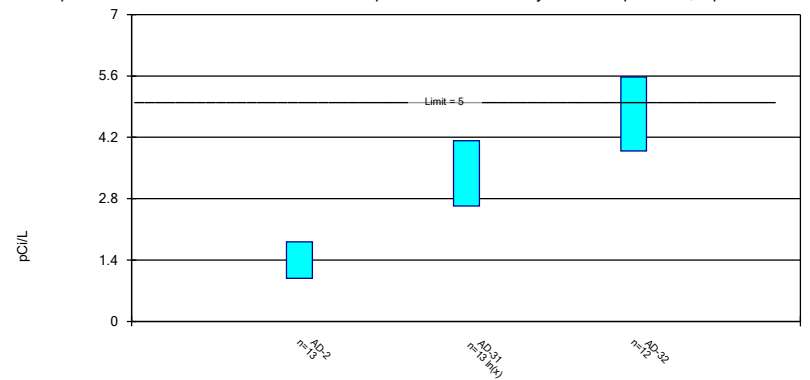
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cobalt, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric Confidence Interval

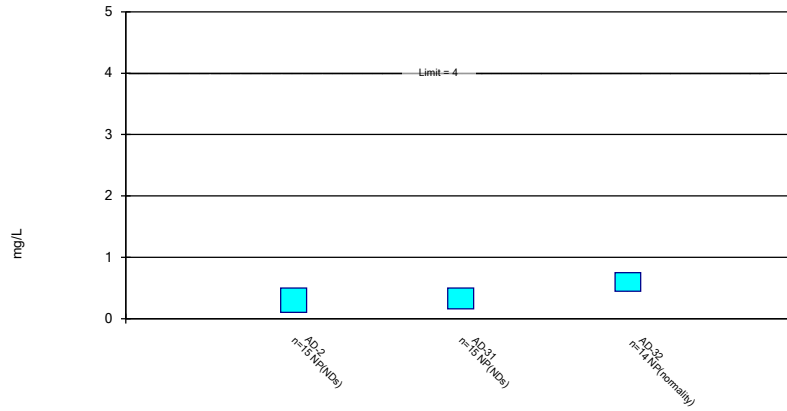
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
 Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Non-Parametric Confidence Interval

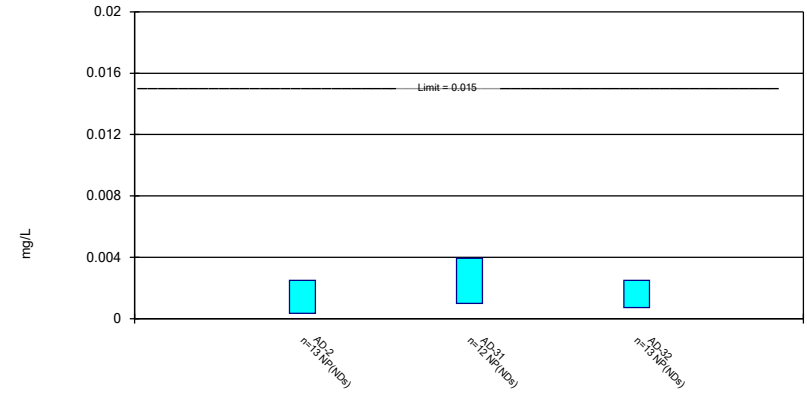
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Fluoride, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Non-Parametric Confidence Interval

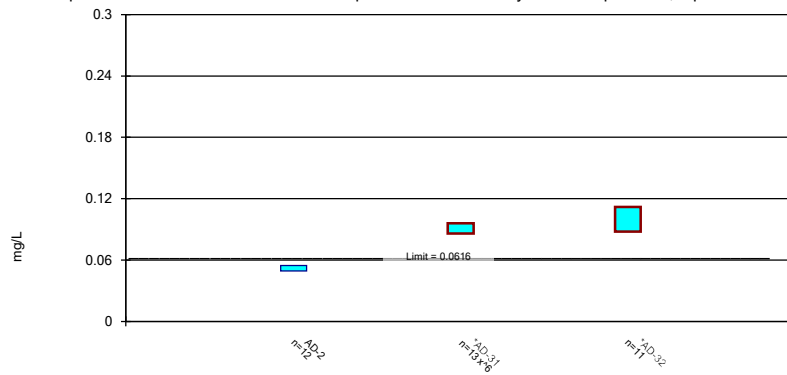
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Lead, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric Confidence Interval

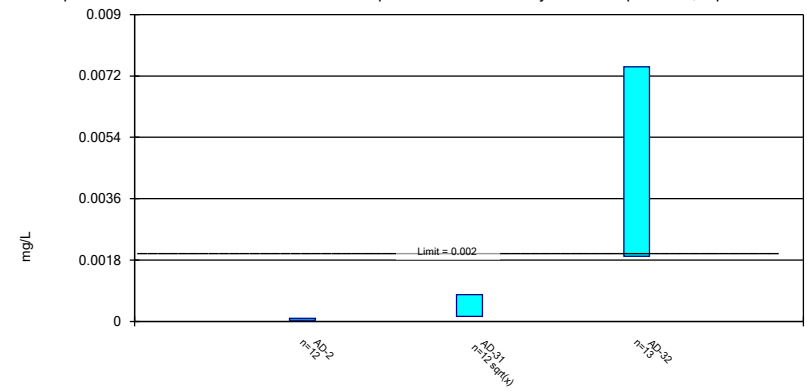
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



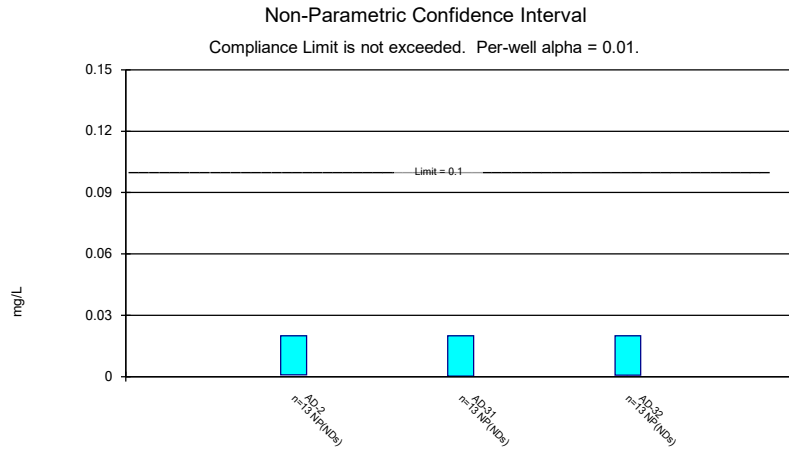
Constituent: Lithium, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric Confidence Interval

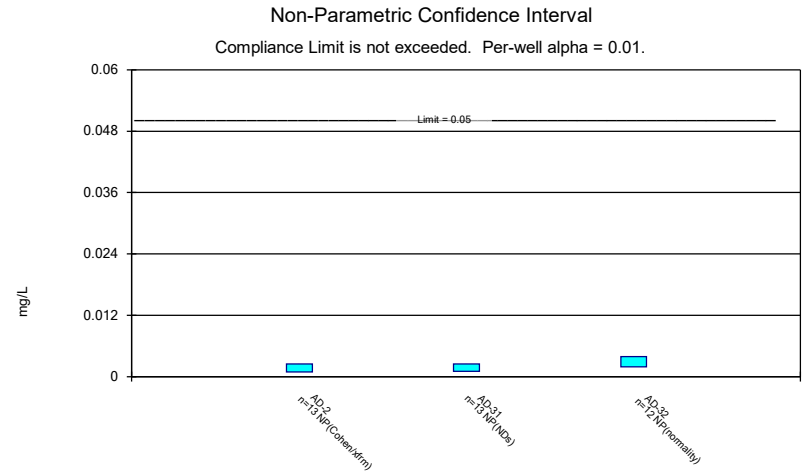
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



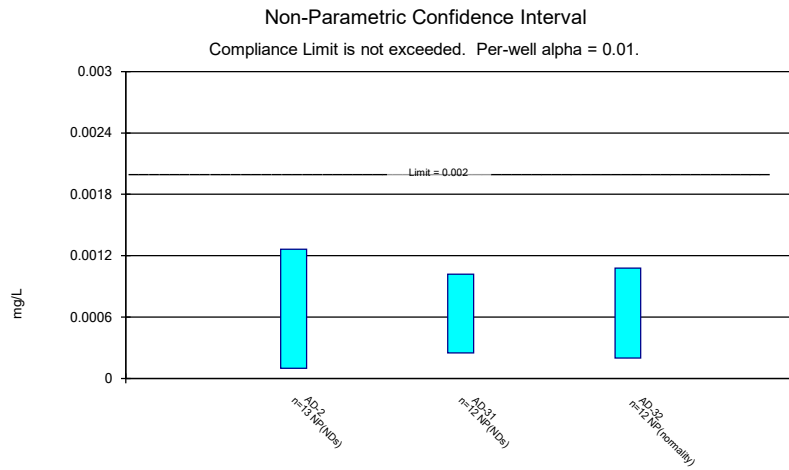
Constituent: Mercury, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP



Constituent: Molybdenum, total Analysis Run 11/25/2019 11:29 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP



Constituent: Selenium, total Analysis Run 11/25/2019 11:30 AM View: Interwell AIV
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP



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



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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Attachment C Bottom Ash Pond Water Laboratory Analytical Data
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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 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 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 ($\text{FeO}(\text{OH})$) 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

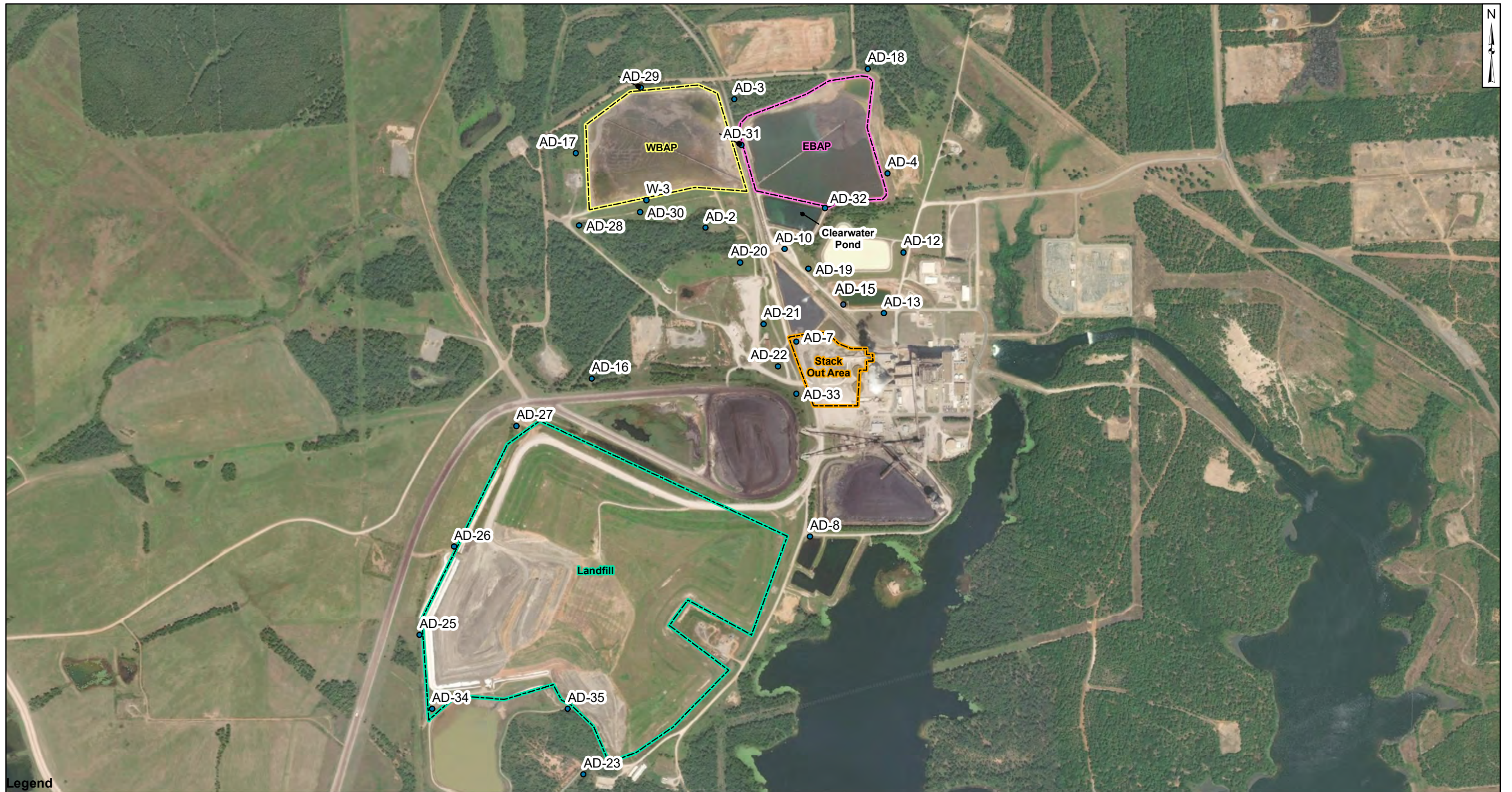
The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSLs for cobalt at AD-2, AD-31, and AD-32 identified during assessment monitoring in 2018 was not due to a release from the EBAP. The identified SSLs were, instead, attributed 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

REFERENCES

- AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.
- Appelo, C. and Postma, D. 2005. *Geochemistry, Groundwater and Pollution*. 2nd Edition, Balkema, Rotterdam.
- Arcadis, 2016. East Bottom Ash Pond – CCR Groundwater Monitoring Well Network Evaluation. H.W. Pirkey Power Plant. May.
- Broom, M.E. and Myers, B.N., 1966. Ground-Water Resources of Harrison County, Texas. Texas Water Development Board Report 27. August.
- EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. 3002010920. October.
- ETTL, 2010. Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas, Geotechnical Investigation. October.
- Geosyntec Consultants, 2018. Statistical Analysis Summary, East Bottom Pond. H.W. Pirkey Power Plant. Hallsville, Texas. December.
- Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.
- Izquierdo, M. and Querol, X., 2012. Leaching Behaviour of Elements from Coal Combustion Fly Ash: An Overview. *International Journal of Coal Geology*, 94, 54-66.
- Krupka, K. M. and Serne, R. J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.
- United States Environmental Protection Agency (USEPA), 1994. Method 1312 – Synthetic Precipitation Leaching Procedure, Revision 0, September 1994, Final Update to the Third Edition of the Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846.
- USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

FIGURES



Legend

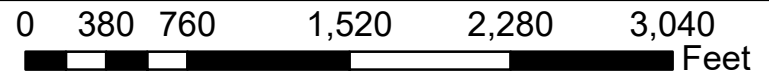
- AD-15
- Monitoring Wells

Location Boundaries

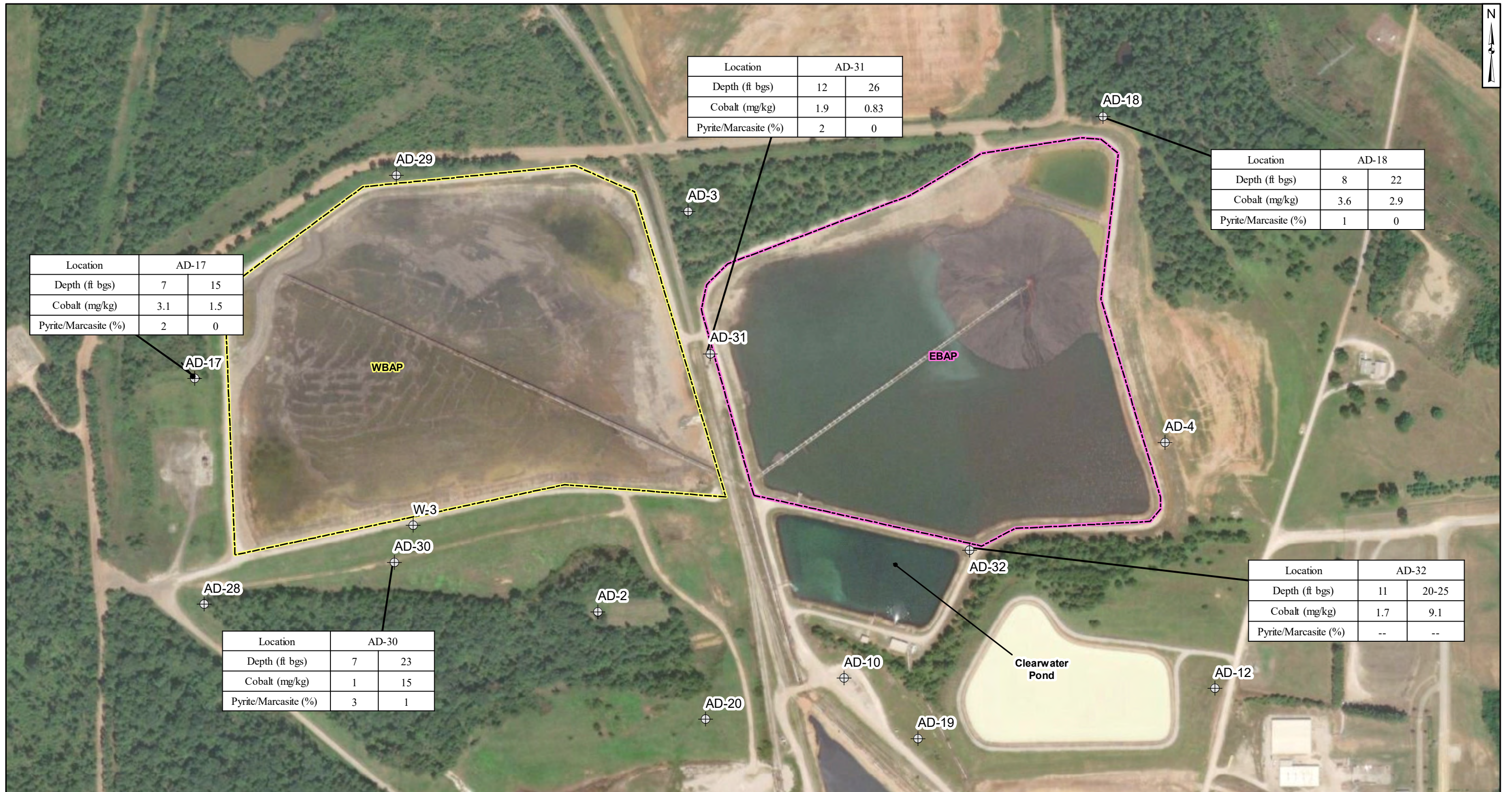
- CCR Units**
- EBAP
 - Landfill
 - Stack Out Area
 - WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.



Site Layout	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2019/03/25
Figure 1	



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

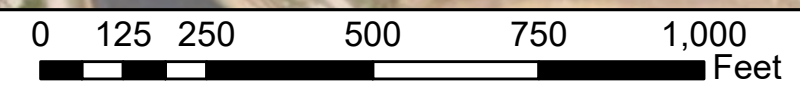
Location	AD-17	
Depth (ft bgs)	7	15
Cobalt (mg/kg)	3.1	1.5
Pyrite/Marcasite (%)	2	0

Location	AD-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

Notes
 - Monitoring well coordinates provided by AEP.
 - Data provided by AEP, 2019
 - ft bgs: feet below ground surface
 - mg/kg: milligrams per kilogram



Soil Chemical and Mineralogical
Analysis Results

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio 2019/03/25

Figure
2

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



Monitor Well

Monitor Well No.: AD-32



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: 12/11/2016
 DEVELOPMENT: 12/16/2016
 SITE LOCATION: 2400 FM 3261, 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: 389.18 (Top of Casing)
 HOLE DIAMETER: 8.25"
 LATITUDE 32 27' 56.20" LONGITUDE 94 29' 11.86"

Water Level Upon Installation Water Level at Time of Drilling Geotechnical Lab Sample TBPQ No. 50027

DESCRIPTION	USCS	SOIL SYMBOLS	DEPTH	WATER LEVEL	SAMPLE	% MOISTURE	% FINES	LL	PL	PI	WELL CONSTRUCTION
			4								Locking Well Casing Cover Locking Well Cap Protective Well Casing Concrete Pad Ground Surface Cement Bentonite 2" Sch. 40 PVC Riser 20/40 Silica Sand 0.010" Slotted Sch. 40 PVC Well Screen PVC Bottom Cap
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								
			1								
			2		25	46	35	22	13		
			3								
			4								
			5								
			6								
			7		26	44	37	20	17		
			8								
			9								
			10								
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		11								
			12								
			13								
			14								
			15								
			16		28	54	37	22	15		
			17								
SILTY SAND: very fine to fine sand, trace clay, brownish gray and dark brownish gray, saturated - reddish brown and brown at 20'	SM		18								
			19								
			20								
SANDY LEAN CLAY: gray and dark gray, very moist	CL		21		26	51	37	24	13		
			22								
			23								
			24								
			25								
CLAYEY SAND: fine to very fine sand, gray and dark gray, very moist to saturated	SC		26		26	47	41	22	19		
			27								
			28								
			29								
			30								
SANDY LEAN CLAY: gray and dark gray, very moist	CL		31		26	59	35	21	14		
			32								
			33								

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: 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-EBAP-1

Lab Sample ID: 490-168389-2

Date Collected: 02/11/19 17:00

Matrix: Solid

Date Received: 02/13/19 09:40

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 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-EBAP-1

Lab Sample ID: 490-168389-2

Date Collected: 02/11/19 17:00

Matrix: Solid

Date Received: 02/13/19 09:40

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 Results

Client: Burns & McDonnell
Project/Site: CSM Refinement

TestAmerica Job ID: 490-165222-1
SDG: AEP Pirkey plant

Client Sample ID: SW-EGAP-1

Lab Sample ID: 490-165222-6

Date Collected: 12/15/18 14:50

Matrix: Water

Date Received: 12/18/18 10:30

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

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

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

4/25/2019
Date

**ALTERNATIVE SOURCE
DEMONSTRATION REPORT
FEDERAL CCR RULE**

**H.W. Pirkey Power Plant
East Bottom Ash Pond
Hallsville, Texas**

Submitted to



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

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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; E TTL, 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- μ m 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 μ g/L to 1,140 μ g/L (**Table 3**). Lithium concentrations in the lab filtered samples varied from 6 μ g/L to 105 μ g/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 ($\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$) 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 calculate 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

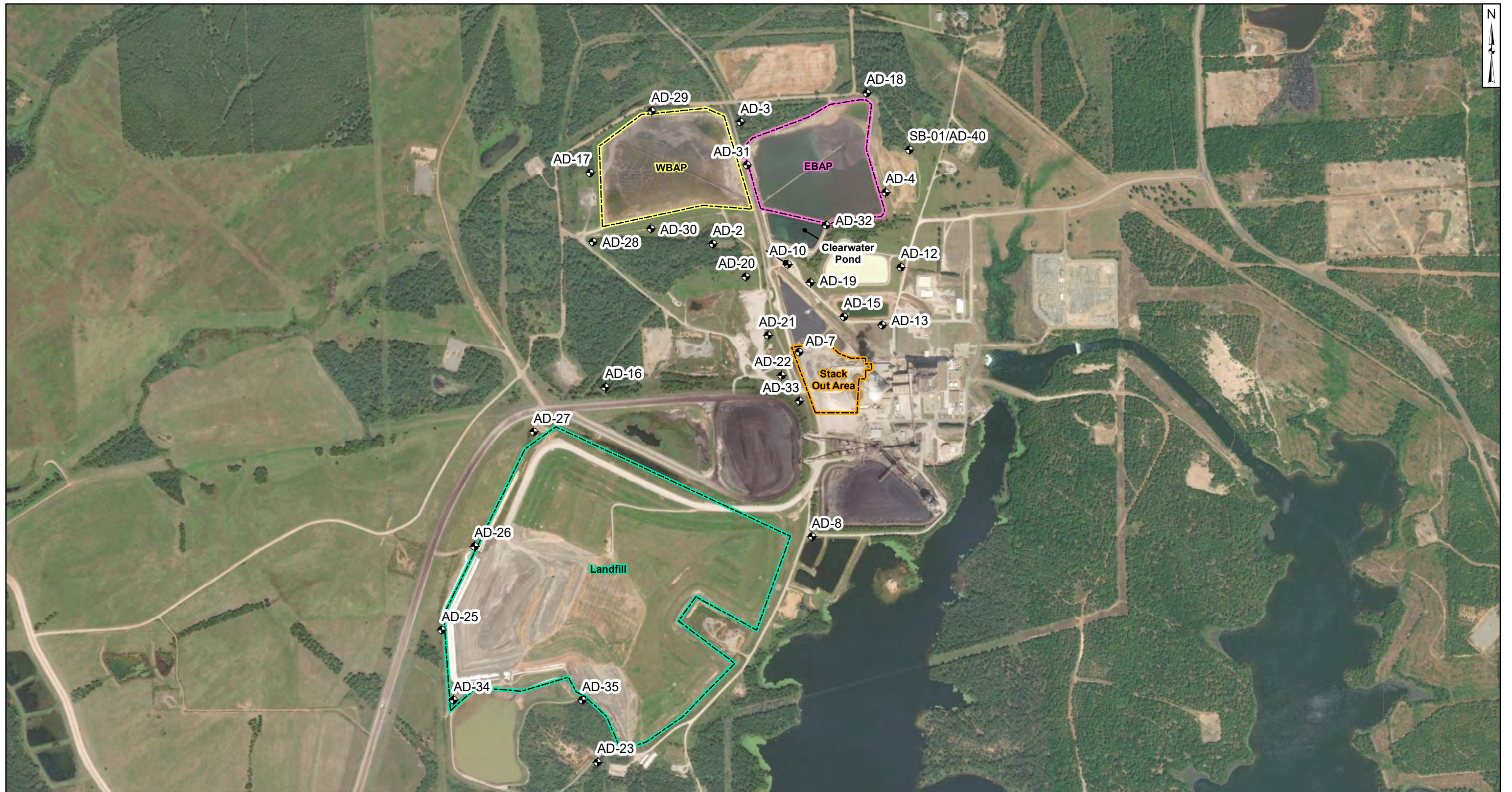
The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSLs for lithium at wells AD-31 and AD-32 identified during assessment monitoring in 2018 were not due to a release from the EBAP. The identified SSLs were, instead, attributed 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

REFERENCES

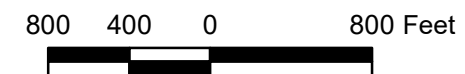
- AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.
- Arcadis, 2016. East Bottom Ash Pond – CCR Groundwater Monitoring Well Network Evaluation. H.W. Pirkey Power Plant. May.
- Broom, M.E. and Myers, B.N., 1966. Ground-Water Resources of Harrison County, Texas. Texas Water Development Board Report 27. August.
- EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. 3002010920. October.
- ETTL, 2010. Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas, Geotechnical Investigation. October.
- Ghassemi, A. 2001. Handbook of Pollution Control and Waste Minimization. CRC Press, 2001.
- Geosyntec Consultants, 2018. Statistical Analysis Summary, East Bottom Pond. H.W. Pirkey Power Plant. Hallsville, Texas. December.
- Geosyntec Consultants, 2019. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Power Plant. April.
- Sheppard, S., Long, J., Sanipelli, B., and Sohlenius, G. 2009. Solid/Liquid Partition Coefficients (Kd) for selected soils and sediments at Forsmark and Laxemar-Simpevarp. SKB – Swedish Nuclear Fuel and Waste Management Co. R-09-27. March.
- Sheppard, S., Sohlenius, G., Omberg, L., Borgiel, M., Grolaner, S., and Nordén, S. 2011. Solid/liquid partition coefficients (Kd) and plant/soil concentration ratios (CR) for selected soils, tills, and sediments in Forsmark.
- USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.
- United States Geological Survey (USGS). 2001. A Laboratory Manual for X-Ray Powder Diffraction. Open-File Report 01-041.

Figures



- Legend**
- ◆ Monitoring Well
 - EBAP
 - Landfill
 - Stack Out Area
 - WBAP

Notes
 - Monitoring well coordinates provided by AEP.
 -AD-15 location is approximated



Site Layout

AEP Pirkey Power Plant
 Hallsville, Texas

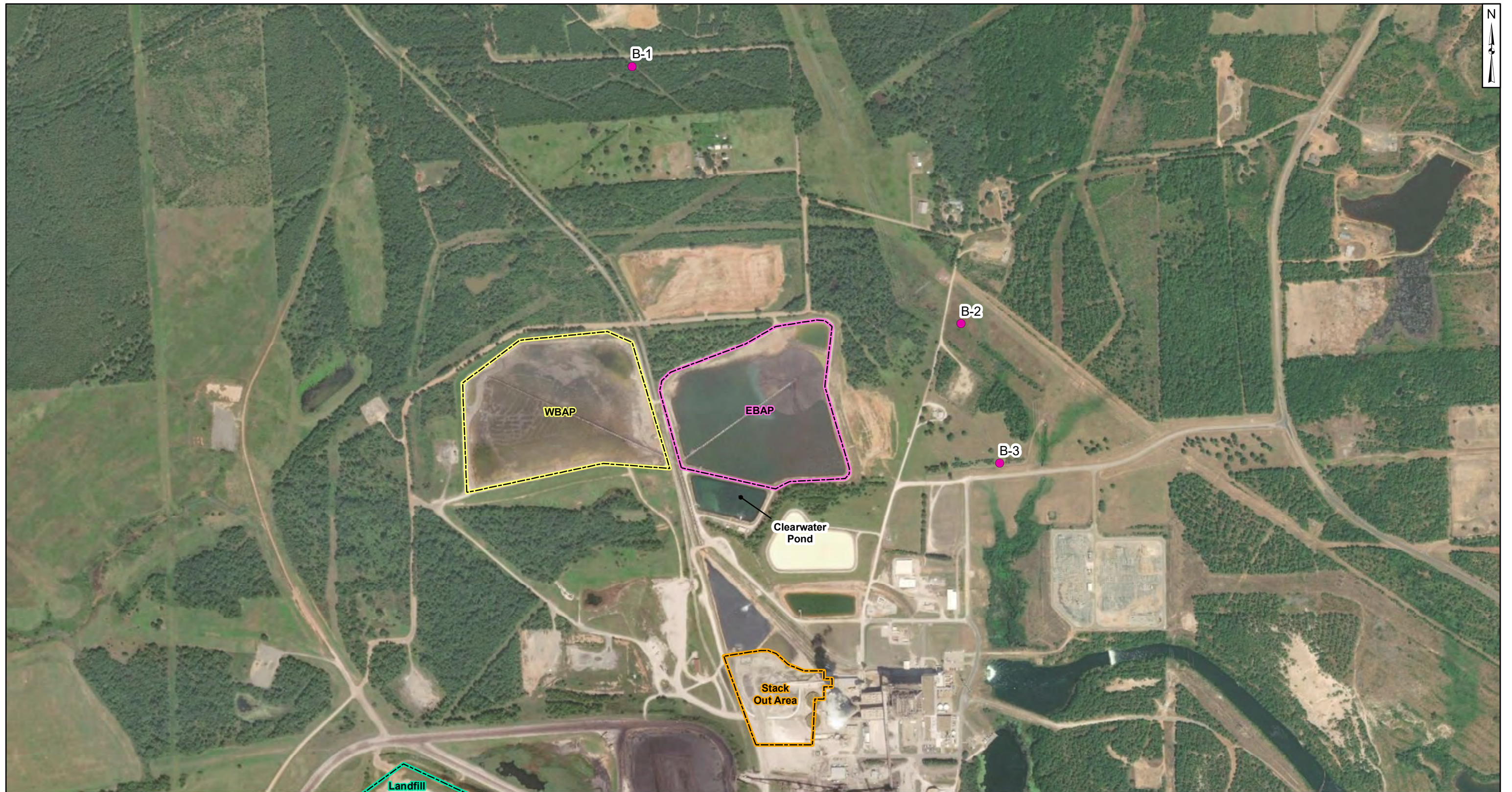
Geosyntec
 consultants

Figure

1

Columbus, Ohio

2019/07/10



Legend

- Soil Boring Location
- EBAP
- Landfill
- Stack Out Area
- WBAP

Notes
 -Data provided by AEP, 2019.
 -Soil Boring locations are approximate.



Soil Boring Locations

AEP Pirkey Power Plant
 Hallsville, Texas

Geosyntec
 consultants

Figure

2

Columbus, Ohio

2019/07/10



AD-31	Lithium May 2019
	0.056

B-2	Lithium
	0.053

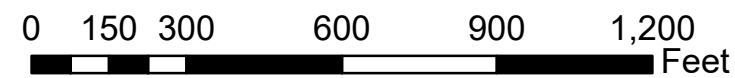
AD-32	Lithium May 2019
	0.082

B-3	Lithium
	0.061

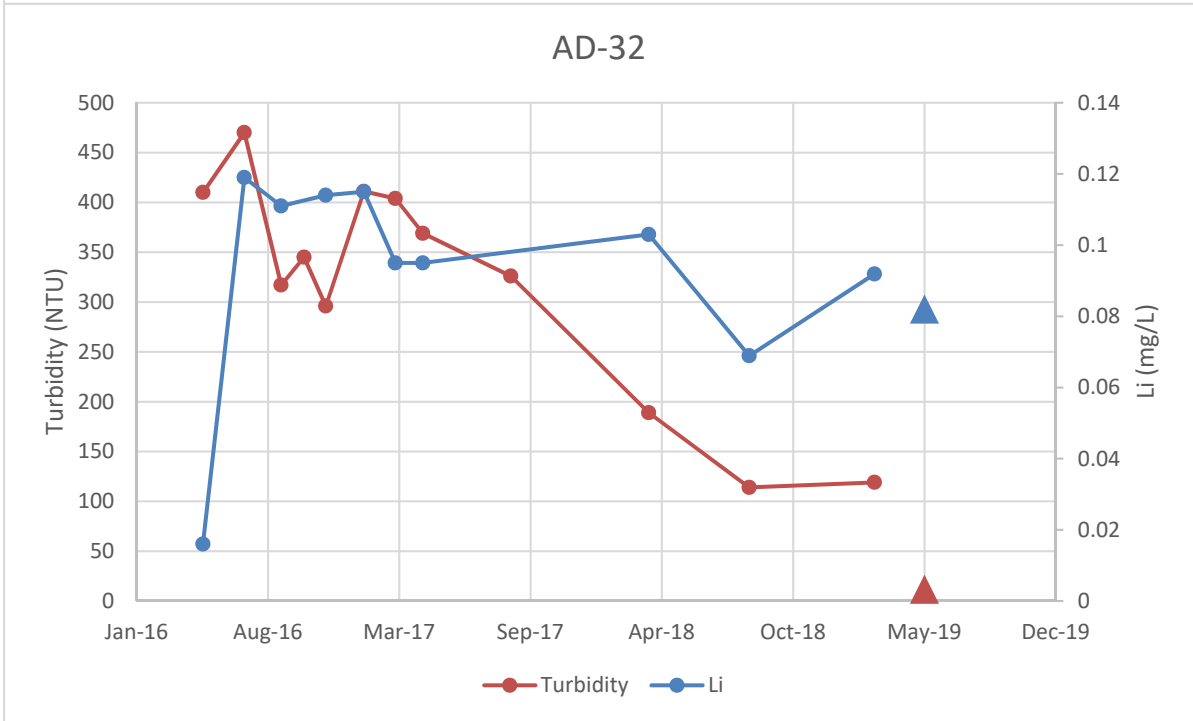
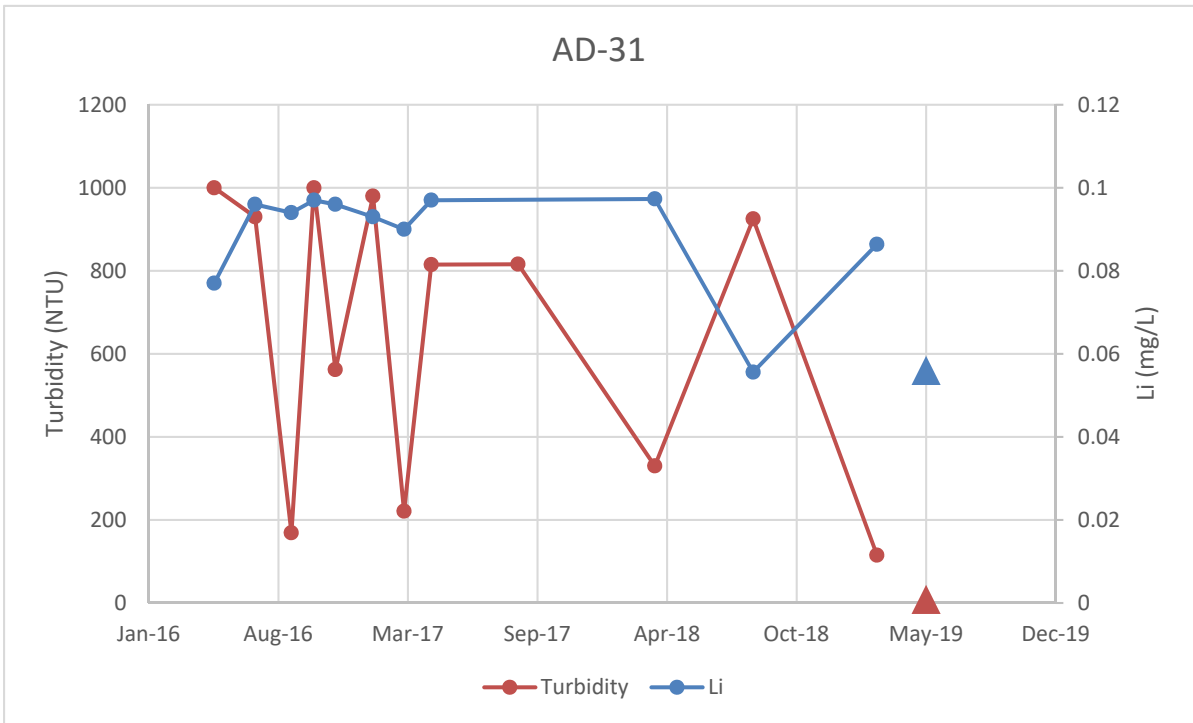
- Legend**
- Borehole
 - ⊕ Monitoring Well
- Location Boundaries**
- EBAP
 - Landfill
 - Stack Out Area
 - WBAP

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



Lithium Values May 2019	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2019/07/10
Figure 3	



Notes:
 NTU: nephelometric turbidity units
 mg/L: milligrams per liter

Lithium and Turbidity Time Series Graphs

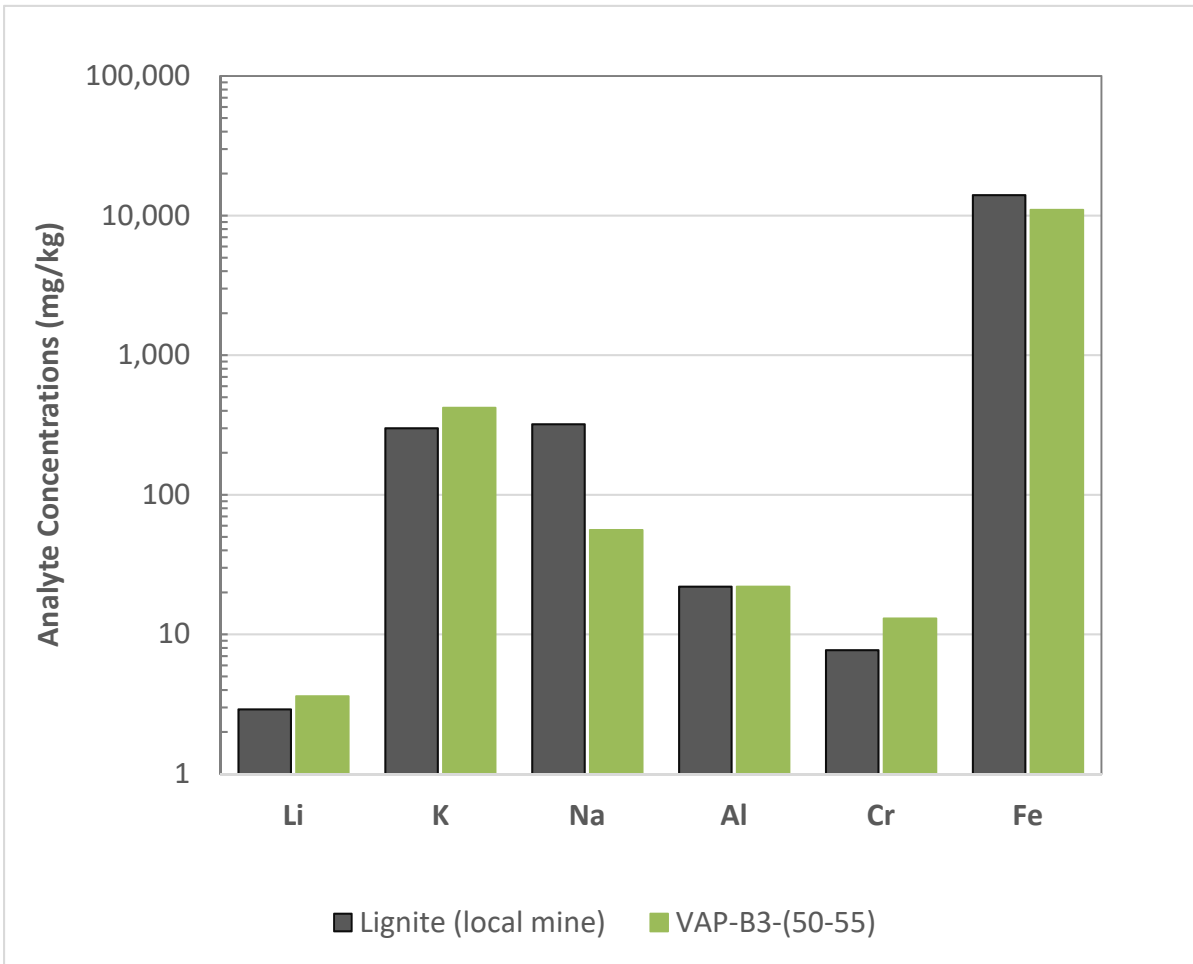
Pirkey East Bottom Ash Pond



Figure
4

Columbus, Ohio

7-Jul-2019



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.

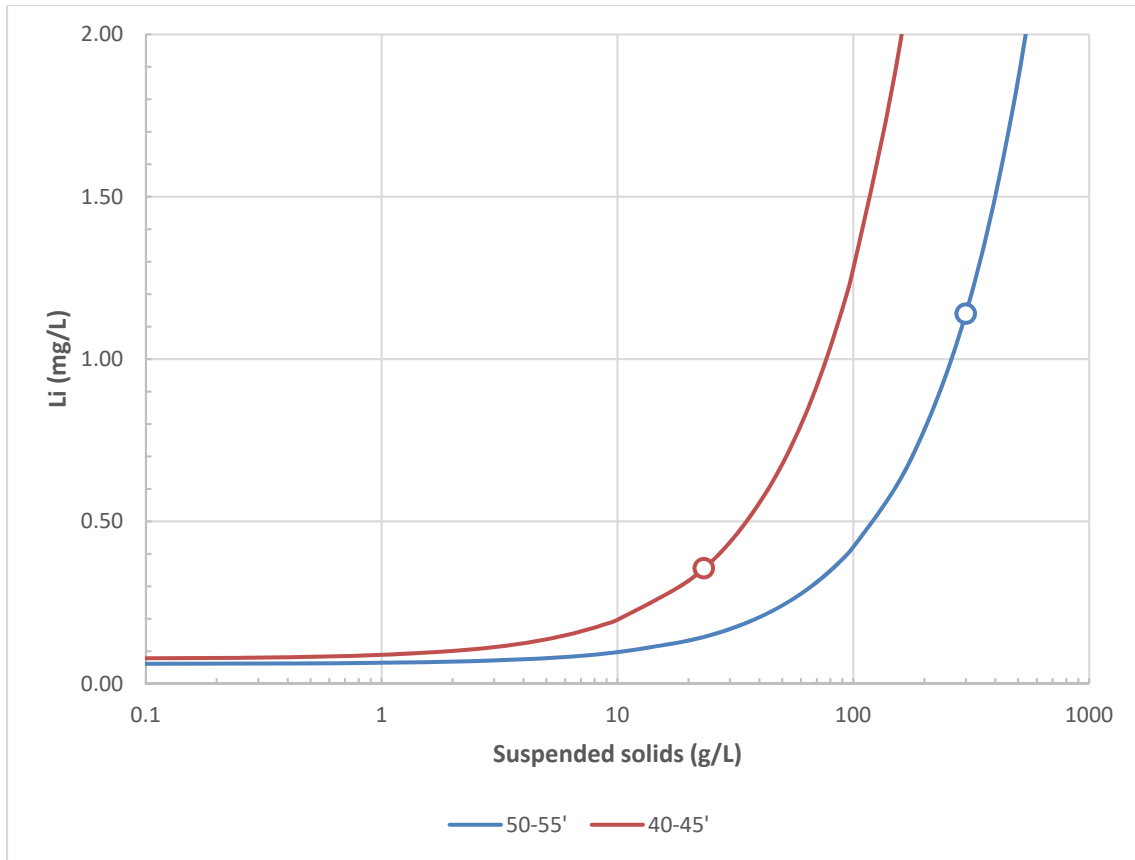
Total Metals Concentrations
Pirkey East Bottom Ash Pond



Figure
5

Columbus, Ohio

7-Jul-2019



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



Figure
6

Columbus, Ohio

7-Jul-2019

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			
	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	
Depth (ft bgs)										
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 HNO₃ 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**

Geosyntec Consultants, Inc.

	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
Kaolinite	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 ₂ O ₃	31.1%
SiO ₂	60.9%
FeS ₂	3.4%
K ₂ O	1.7%
TiO ₂	ND
Fe ₂ O 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

	Depth Scale Feet	Water Table	Soil Profile Description	PID
	0		0.0' - 5.0' were hand augered on a previous date.	
			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 stiffness; 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

	Depth Scale Feet	Water Table	Soil Profile Description	PID
	0		0.0' - 5.0' were hand augered on a previous date.	
			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': Black/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
			0.0' - 40.0' were drilled with DPT, logged on previous page. HSA boring log follows.	
	35		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)	
	75		74.5-75.1': Gray silty sand, fine grained, moist, w. graded, med. Dense	

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
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	
95		HSA refusal, EOB @ 93.1' bgs Boring grouted to surface, permanent well installed in offset w/ screen @ 38-48' bgs.	
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

	Depth Scale Feet	Water Table	Soil Profile Description	PID
	0		0.0' - 5.0' were hand augered	
			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

	Depth Scale Feet	Water Table	Soil Profile Description	PID
	40		38.4-40.0': Clay, dark gray to black, very stiff, low plasticity (DPT refusal @ 40' bgs, HSA drilling continued below) 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

	Depth Scale Feet	Water Table	Soil Profile 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			
	100		HSA refusal, EOB @ 97.1' bgs Boring grouted to surface. Permanent well installed in offset boring, screen set @ 29-34' bgs.	
	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 vacuum-filtered sample volume collected in unpreserved bottle.

Total metals data are not available for B-2 sample intervals due to incorrect analytical techniques.

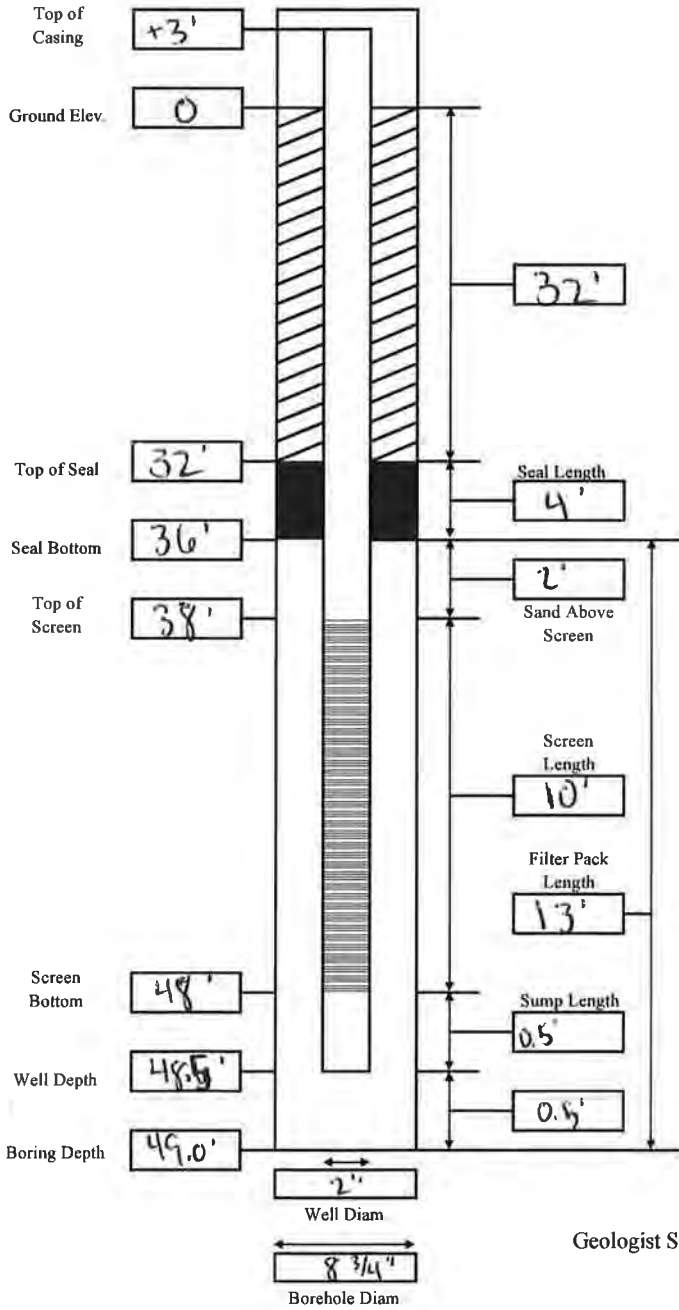
Attachment C
Well Construction Diagrams

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Well Construction Log

Site: AEP Pinkey 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"



Well Construction:
 Material: Sch. 40 PVC
 Inside Diameter: 2"
 Screen Slot Size: 0.01'
 Screen Beg.: 38' End: 48'
 Sump: / N
 Type/Length: 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 concrete/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? / N
 Pad Size: 2x2
 Cover Type/Size: Stainless steel

Comments: _____

Geologist Signature: Nathan Quick

Nathan Quick

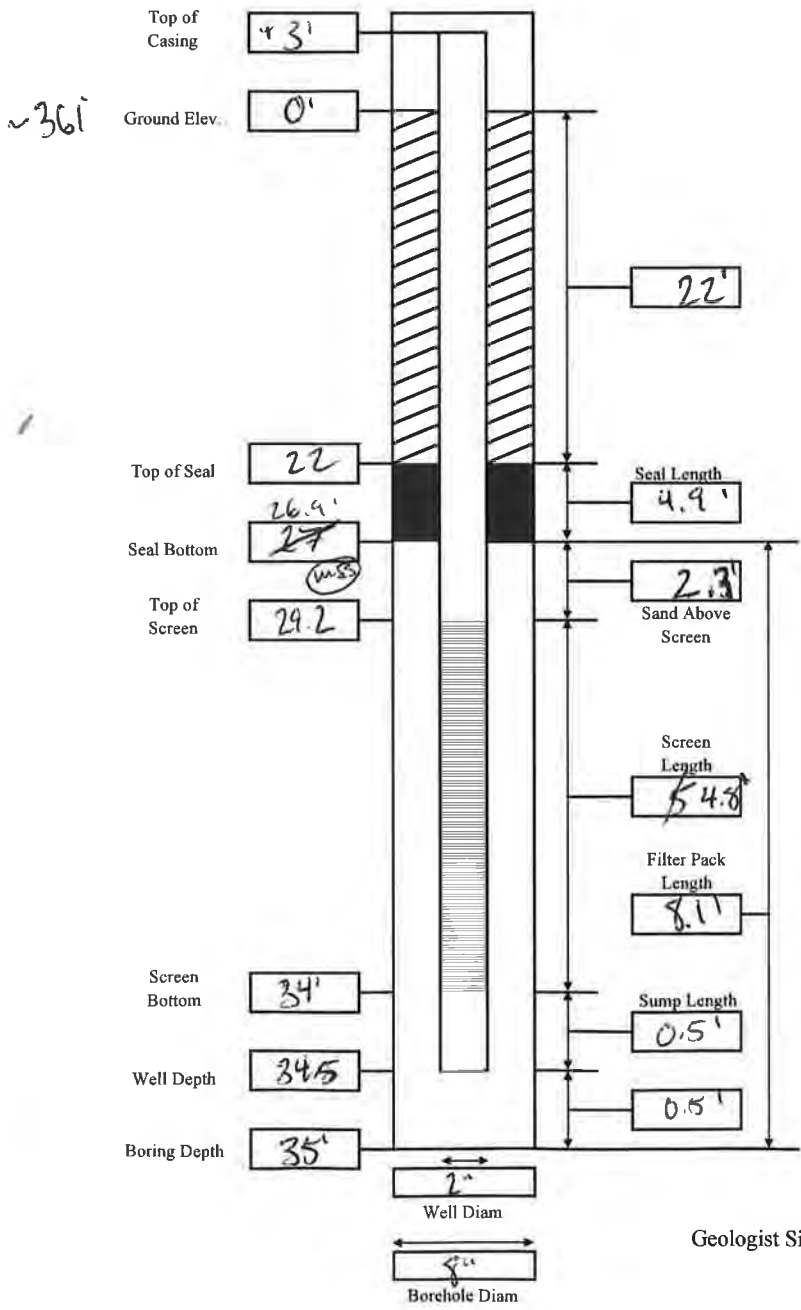
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Well Construction Log

Site: AEP Piskey Power Plant
 Well ID: B-3
 Drilling Company: AEP/Best Drilling
 Drillers: Z. Row
 Geologist: M. Bizjak

Date: 5/15/19
 Drilling Method: HSA
 Boring Depth: 35'
 Boring Diameter: 8"
 Well Depth: 35'
 Well Diameter: 2"



Well Construction:
 Material: Sched 40 PVC
 Inside Diameter: Sched 40
 Screen Slot Size: 10mm
 Screen Beg.: 34.29' End: 34'
 Sump Y N
 Type/Length: End cap, 0.5'

Filter Pack:
 Type/Brand: Pioneer 20/40 0.45-0.48
 Amount Used: 1/2 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 Quick 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: M. Bizjak

Attachment D
Well Development Logs

well development

LOW FLOW GROUNDWATER SAMPLING LOG

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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. Cook 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. btol

Screen Length (SL) from Boring Logs: 10 FT.

Depth to Top of Well Screen (TD-SL): Mc 10 FT.

Height of Water Column in Monitoring Well (H=TD-DTW): _____ FT.

Pump Depth _____ FT.

Conversion 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
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 purged using pump to make sure all lines 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 Mc INITIALS revised: Feb. 2007

N. Cook

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): 9.07' FT.
 Total Depth of Monitoring Well (TD): 36.45 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.

Conversion 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 ATV	--	
0944		6.07	1.005	3.30	20.39	89			brown, silty	
0947		6.14	0.516	0.51	20.72	28			brown	
0951		5.84	1.438	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	1.450	4.01	22.09	88	19.34			
		pump demand to check connections;								
1100		6.17	0.263	3.78	22.15	78	15.25			
		went dry								
1216		5.81	0.282	2.104	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

Nator

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): 30.65 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.

Coverison 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 NA INITIALS *revised: Feb. 2007*

Watch

Attachment E
Low-Flow Groundwater Sampling Logs

GROUNDWATER SAMPLING LOG

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 <small>bs</small>		STATIC DEPTH TO WATER (feet): 12.01		PURGE PUMP TYPE OR BAILER: hurricane	
WELL VOLUME PURGE: (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) X WELL CAPACITY = WELL VOLUME (51.50 ft - 12.01 ft) X 0.2016 gal/ft = 10.22 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: 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)
1637		250	14.24	5.74	22.99	0.195	2.50	1000+	79
1642		250	15.08	5.72	21.89	0.184	3.95	1000+	54
1647		250	16.62	5.71	21.52	0.190	5.47	705	53
1652		250	17.38	5.72	21.79	0.201	9.21	454	50
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	102.5	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: <i>Nathan Quick</i>			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: <input checked="" type="checkbox"/> N FILTER SIZE: 45 µm		EQUIPMENT. BLANK: Y <input checked="" type="checkbox"/>		DUPLICATE: Y <input checked="" type="checkbox"/>			
Filtration Equipment:		Sample ID:							
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 = Bailor; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; RFPF = 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%							

Nathan Quick

GROUNDWATER SAMPLING LOG

SITE NAME: AEP Pirkey Power Plant				SITE LOCATION: Hallsville, TX					
WELL NO: B-2			SAMPLE ID: B-2-well-2090522-1-2			DATE: 5/22/19			
WELL DIAMETER (inches): 2		TUBING DIAMETER (inches): 3/8		WELL SCREEN INTERVAL: 38 feet to 48 feet <small>0.5</small>		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 melt									
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: <i>Nat Quirk</i>			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 <input type="checkbox"/> N <input checked="" type="checkbox"/>		FLD-FILTERED: <input checked="" type="checkbox"/> N <input type="checkbox"/> FILTER SIZE: 45 µm		EQUIPMENT. BLANK: Y <input type="checkbox"/> N <input checked="" type="checkbox"/>		DUPLICATE: Y <input type="checkbox"/> N <input checked="" type="checkbox"/>			
Filtration Equipment: _____		Sample ID:							
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 APP = After Peristaltic Pump; B = Bailor; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump EQUIPMENT CODES: 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%							

GROUNDWATER SAMPLING LOG

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 + MP 0:0000 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	19.01	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	84
1155		200	26.12	5.78	23.51	0.189	8.90	501	84
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: <i>Nathan Quirk</i>			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: <input type="radio"/> N FILTER SIZE: 45 μm		EQUIPMENT. BLANK: Y <input checked="" type="radio"/>			DUPLICATE: Y <input checked="" type="radio"/>		
		Filtration Equipment: _____		Sample ID:					
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%							

Nathan Quirk

LOW FLOW GROUNDWATER SAMPLING LOG

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:	<u>2</u>	IN.	Conversion Factors: Well Volume (2-in): Hx0.17 gal/ft 1 L = 0.264 gal
Static Depth to Groundwater (DTW):	<u>10.15</u>	FT.	
Total Depth of Monitoring Well (TD):	<u>39.</u>	FT.	
Screen Length (SL) from Boring Logs:	<u>10</u>	FT.	
Depth to Top of Well Screen (TD-SL):		FT.	
Height of Water Column in Monitoring Well (H=TD-DTW):		FT.	Purge Method: <u>NW low flow</u>
Pump Depth		FT.	

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:


- Water quality parameter measurements obtained every 3 to 5 minutes.
- Well is **STABLE** once 3 consecutive measurements have been obtained for as many as 3 water quality parameters
- 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 Quick

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 1/2	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 55					
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): 35.0		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
1244	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		EQUIPMENT. BLANK: Y <input checked="" type="radio"/> N			DUPLICATE: Y <input checked="" type="radio"/> 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%							

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 23.0 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: 10:15	PURGING ENDED AT: 11:13	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	250	4.89	2.35	24.22	0.339	0.68	82.7	389
1030	NM	300	4.94	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 ⁰ 422
1054	NM	450	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: 11:15	SAMPLING ENDED AT: 11:28		
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			EQUIPMENT. BLANK: Y <input checked="" type="radio"/> N			DUPLICATE: <input checked="" type="radio"/> N		
Filtration Equipment: _____			Sample ID: _____						
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 Hoban unit, checked w/ cal solution & reading low @ 2.96 pH - pH on form likely low. All ML 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 APP: APP = After Peristaltic Pump; B = Bailor; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump EQUIPMENT CODES: RFP = 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
Printed Name of Licensed Professional Engineer

Beth Ann Gross

Signature



Geosyntec Consultants
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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



1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec 
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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
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 calculate 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:

$$K_d = \frac{mg \text{ adsorbed}/kg \text{ soil}}{mg/L \text{ solution}}$$

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

REFERENCES

- AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.
- Broom, M.E. and Myers, B.N., 1966. Ground-Water Resources of Harrison County, Texas. Texas Water Development Board Report 27. August.
- EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. 3002010920. October.
- ETTL, 2010. Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas, Geotechnical Investigation. October.
- Geosyntec Consultants, 2019a. Statistical Analysis Summary – East Bottom Ash Pond. H. W. Pirkey Plant. Hallsville, Texas. July.
- Geosyntec Consultants, 2019b. Alternative Source Demonstration – Federal CCR Rule. H. W. Pirkey Power Plant. East Bottom Ash Pond. Hallsville, Texas. April.
- Geosyntec Consultants, 2019c. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. Hallsville, Texas. July.
- Harris, L. A, Kenik, E. A., and Yust, C. S. 1981. Reactions in pyrite framboids induced by electron beam heating in a HVEM. *Scanning Electron Microscopy*, 1, web.
- Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.
- Izquierdo, M. and Querol, X., 2012. Leaching Behaviour of Elements from Coal Combustion Fly Ash: An Overview. *International Journal of Coal Geology*, 94, 54-66.
- Krupka, K. M. and Serne, R. J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.
- Sawlowicz, Z. 2000. *Framboids: From Their Origin to Application*. Pr. Mineral. (Mineralogical Transactions), 88, web.
- Sheppard, S., Sohlenius, G., Omberg, L.G., Borgiel, M., Grolander, S., and Nordén, S. 2011. Solid/Liquid Partition Coefficients (K_d) and Plant/Soil Concentration Ratios (CR) for Selected

Soil, Tills, and Sediments at Forsmark. R-11-24. Swedish Nuclear Fuel and Waste Management Co. R-11-24. November.

Sheppard, S., Long, J., Sanipelli, B., and Sohlenius, G. 2009. Solid/Liquid Partition Coefficients (K_d) for Selected Soil and Sediments at Forsmark and Laxemar-Simpevarp. R-09-27. Swedish Nuclear Fuel and Waste Management Co. March.

United States Environmental Protection Agency (USEPA), 1994. Method 1312 – Synthetic Precipitation Leaching Procedure, Revision 0, September 1994, Final Update to the Third Edition of the Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

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**

Geosyntec Consultants, Inc.

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**

Geosyntec Consultants, Inc.

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

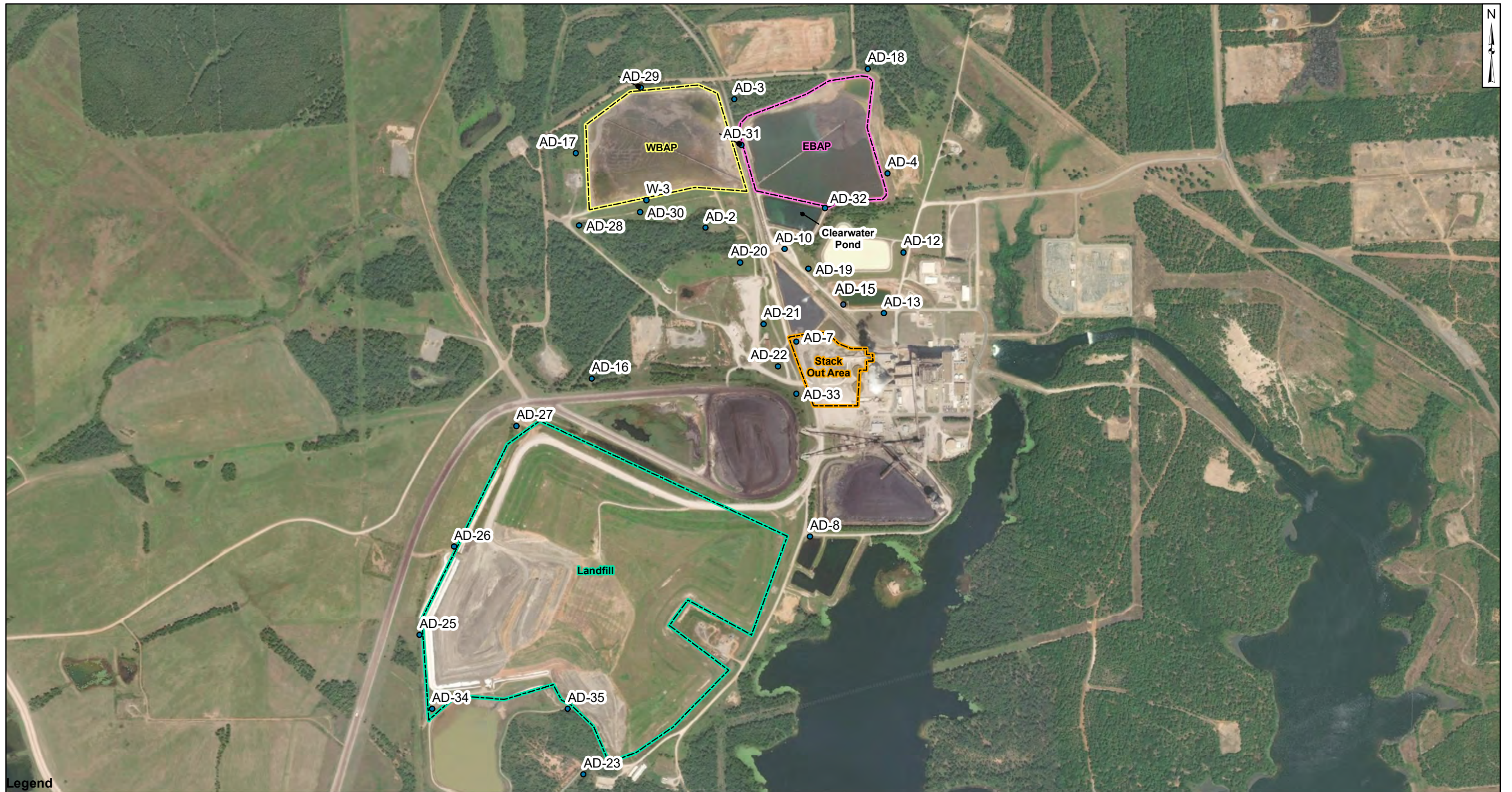
L/kg: liters per kilogram

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

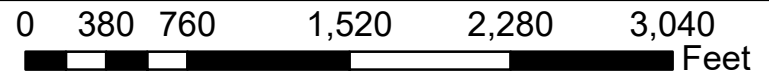
- AD-15
- Monitoring Wells

Location Boundaries

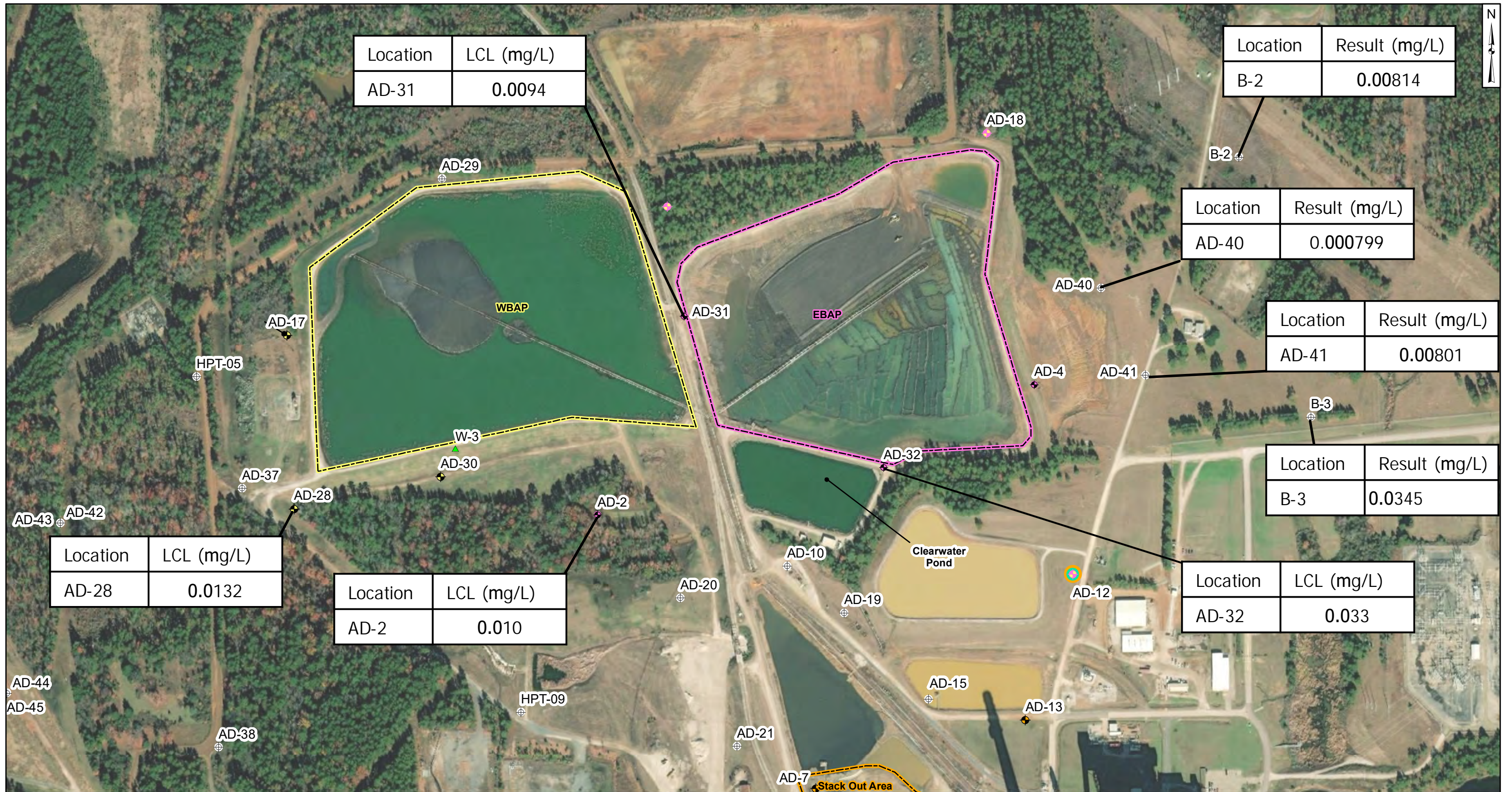
- CCR Units**
- EBAP
 - Landfill
 - Stack Out Area
 - WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.



Site Layout	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2019/03/25
Figure 1	



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-28	0.0132

Location	LCL (mg/L)
AD-2	0.010

Location	LCL (mg/L)
AD-32	0.033

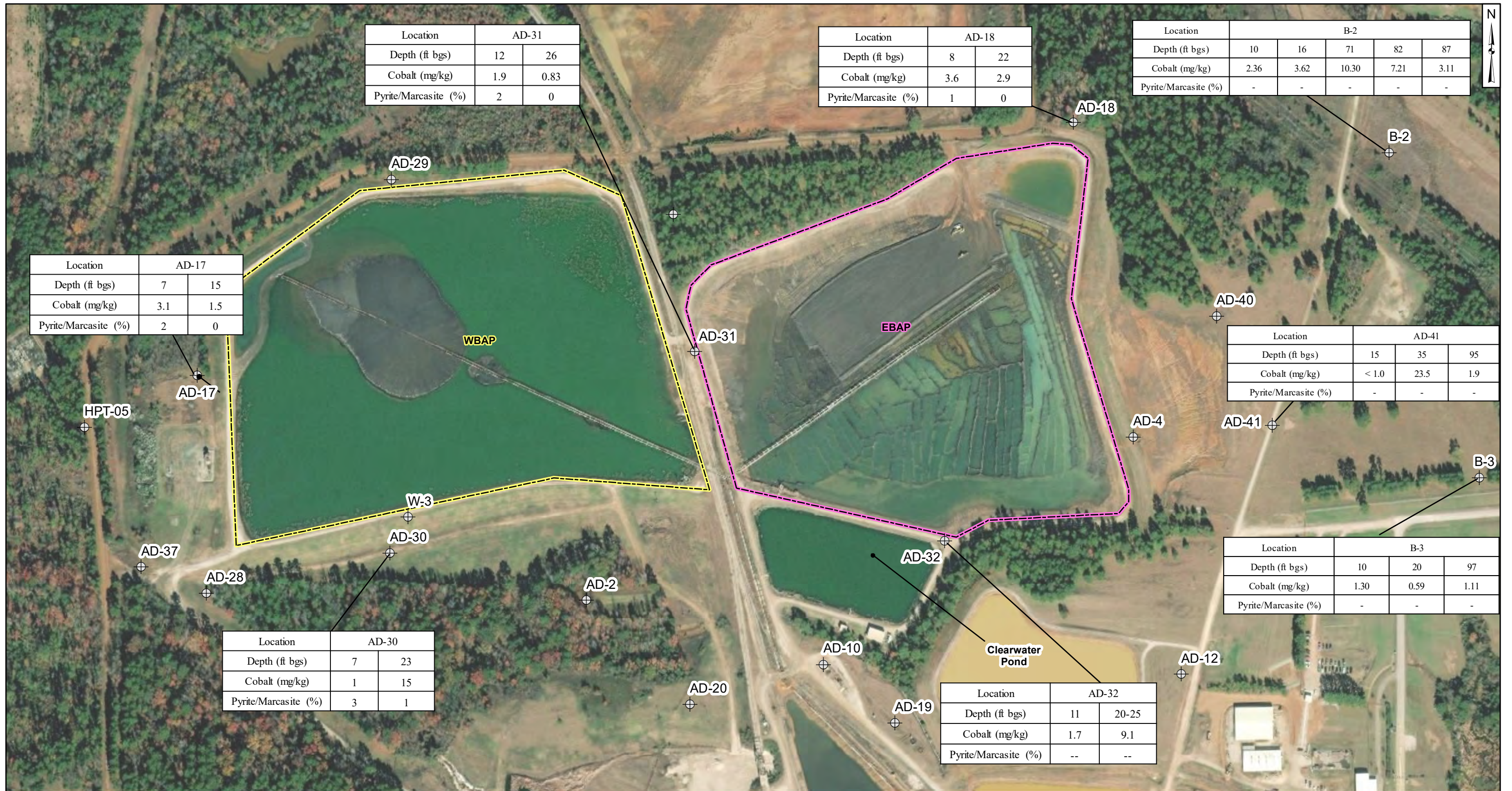
- Legend**
- ⊕ Out of Network
 - ◆ EBAP
 - ◆ WBAP
 - ◆ Stackout Area
 - ◆ EBAP and WBAP
 - ⊕ All CCR Unit Networks
 - ▲ Piezometer
 - ▭ EBAP
 - ▭ Stack Out Area
 - ▭ WBAP

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).



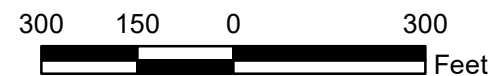
Cobalt Distribution in Groundwater	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2019/09/17
Figure 2	



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.



Soil Chemical and Mineralogical Analysis Results

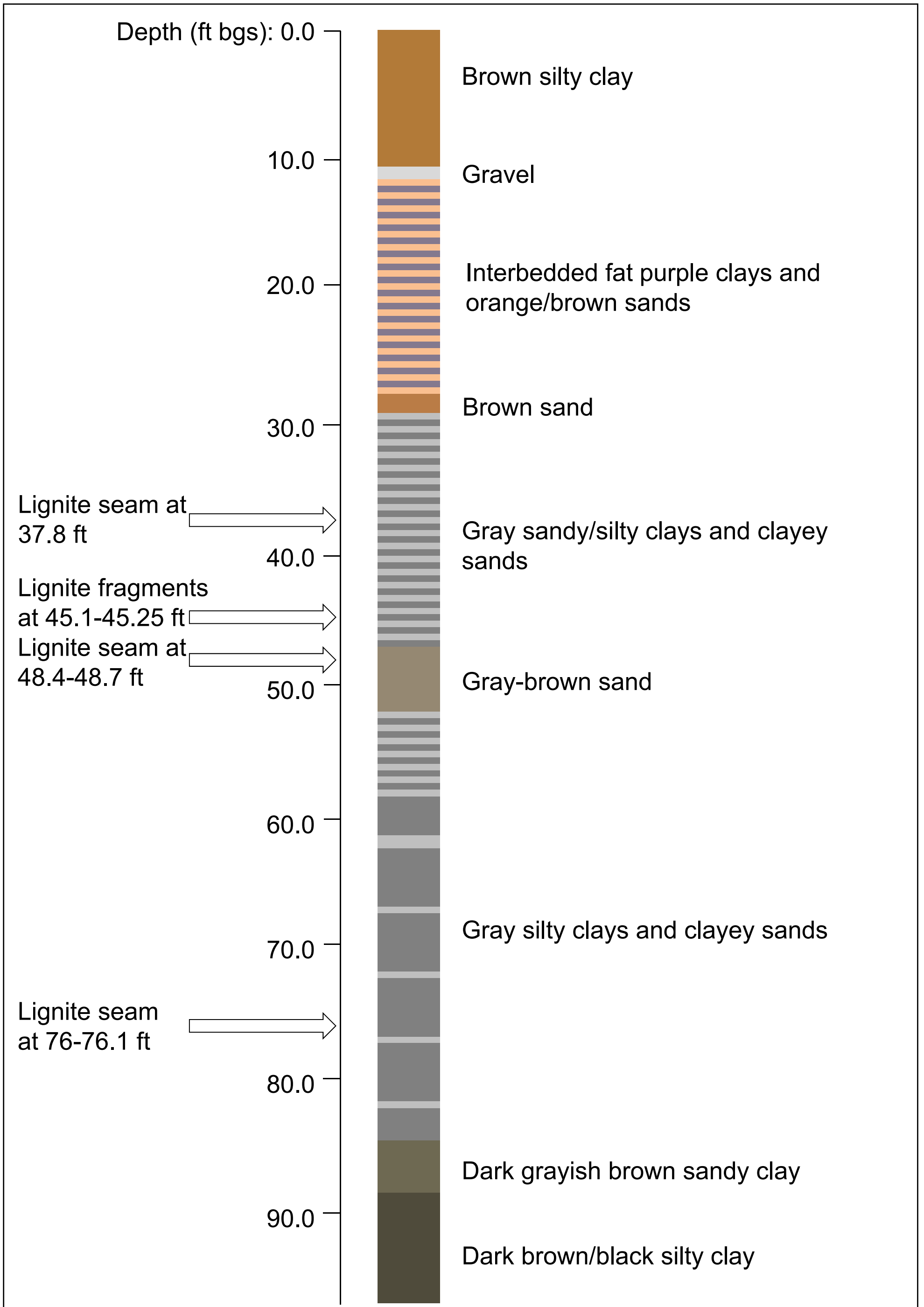
AEP Pirkey Power Plant
 Hallsville, Texas

Geosyntec
 consultants

Figure
3

Columbus, Ohio

2019/09/18



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

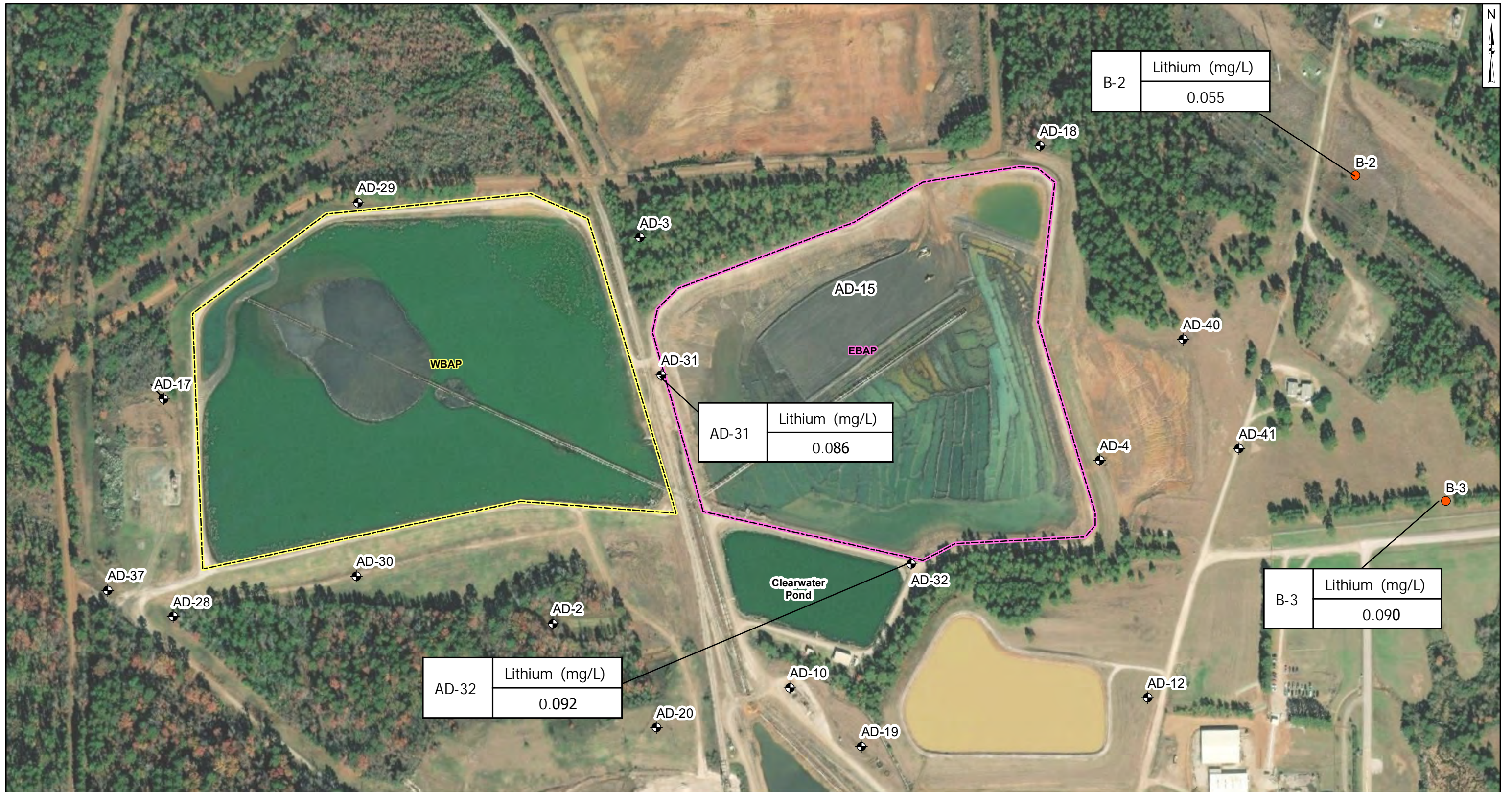
Geosyntec
consultants

Figure

4

CHA8462

September 2019



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.



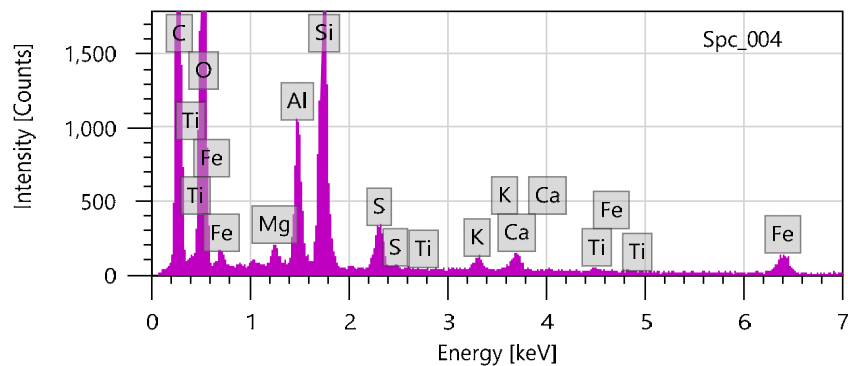
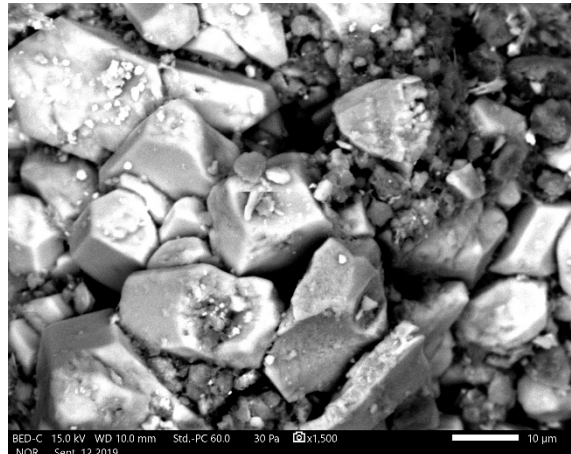
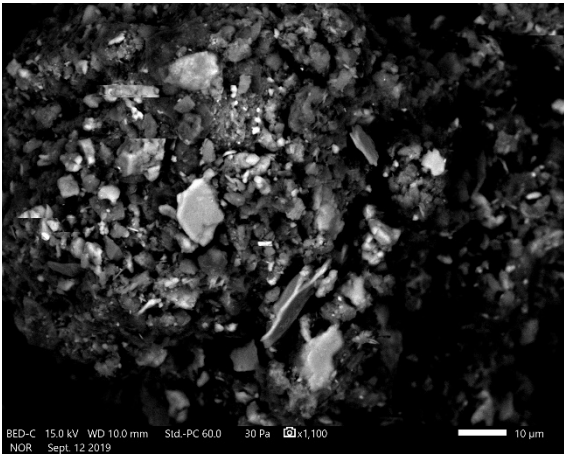
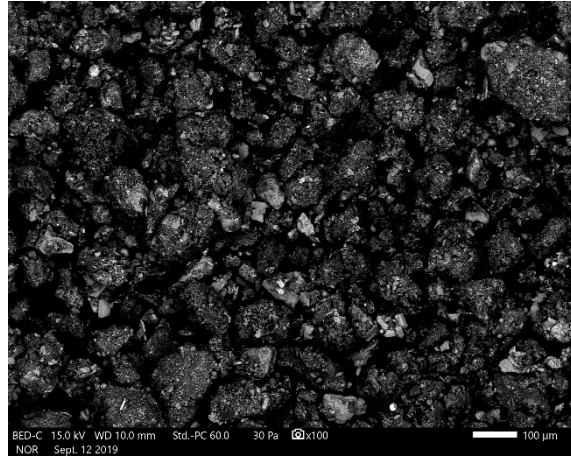
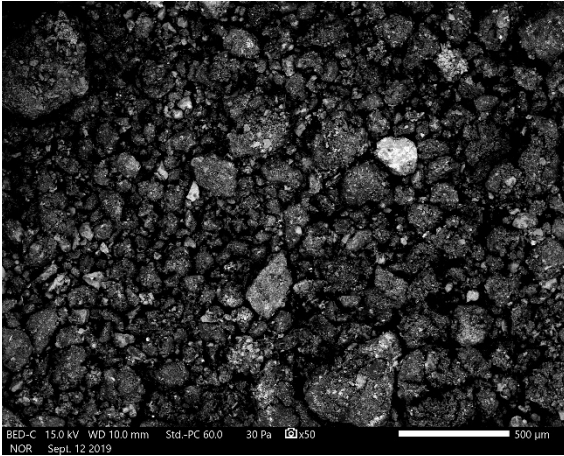
Lithium Distribution in Groundwater	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2019/09/18
Figure 5	

ATTACHMENT A
SEM/EDS Analysis

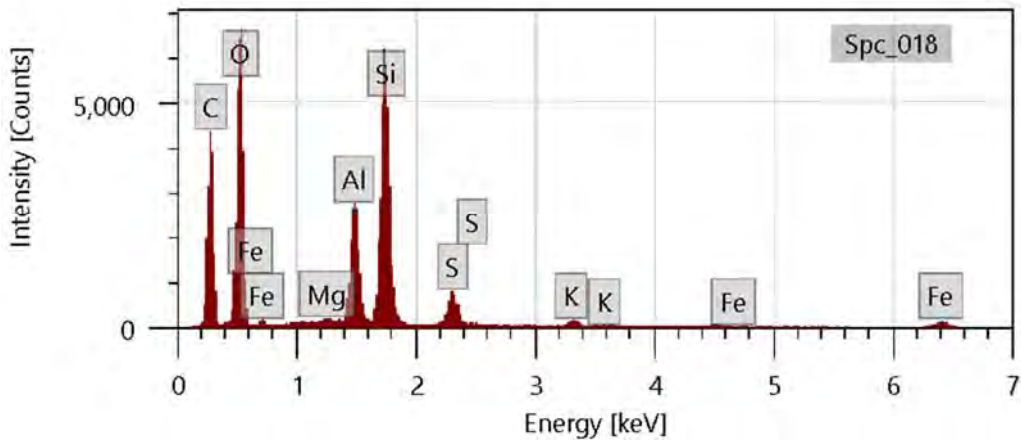
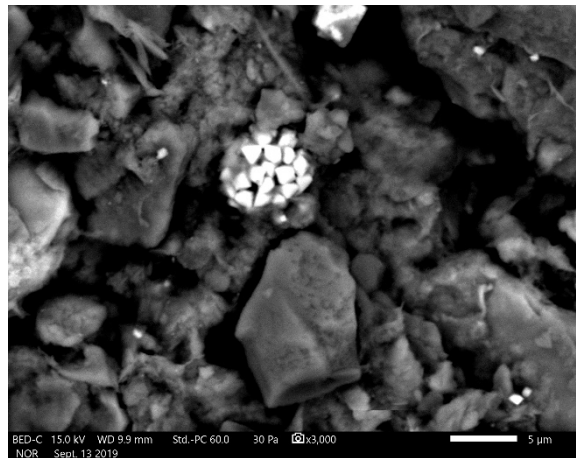
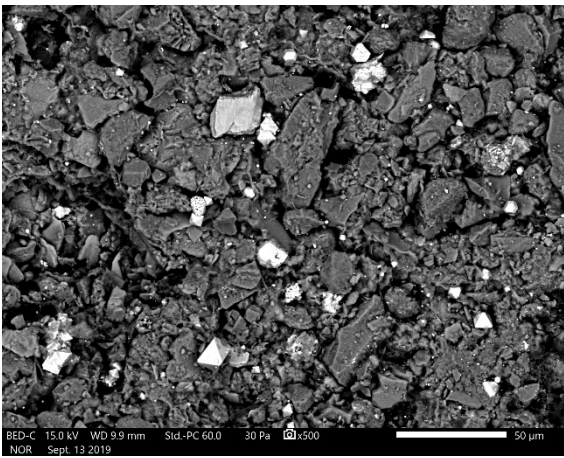
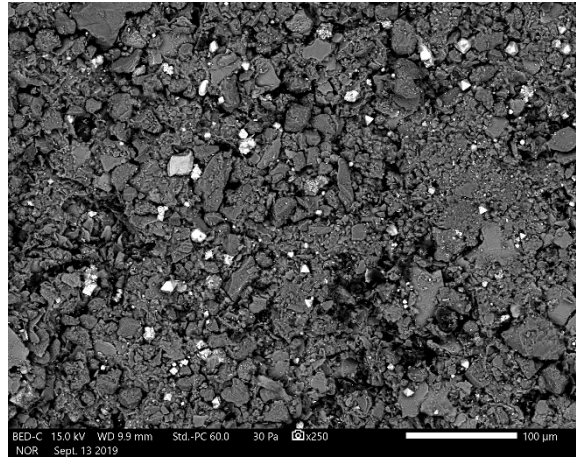
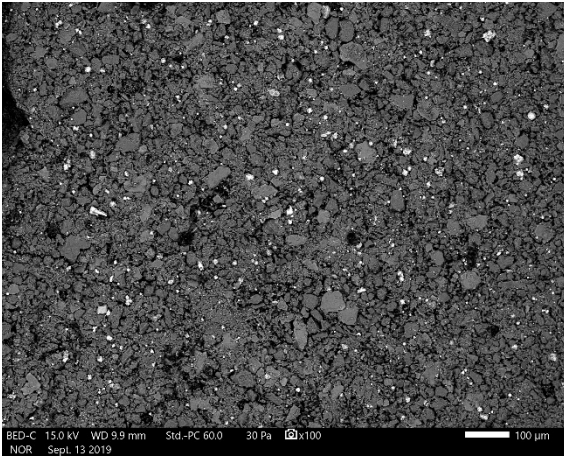
September 16, 2019

Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221

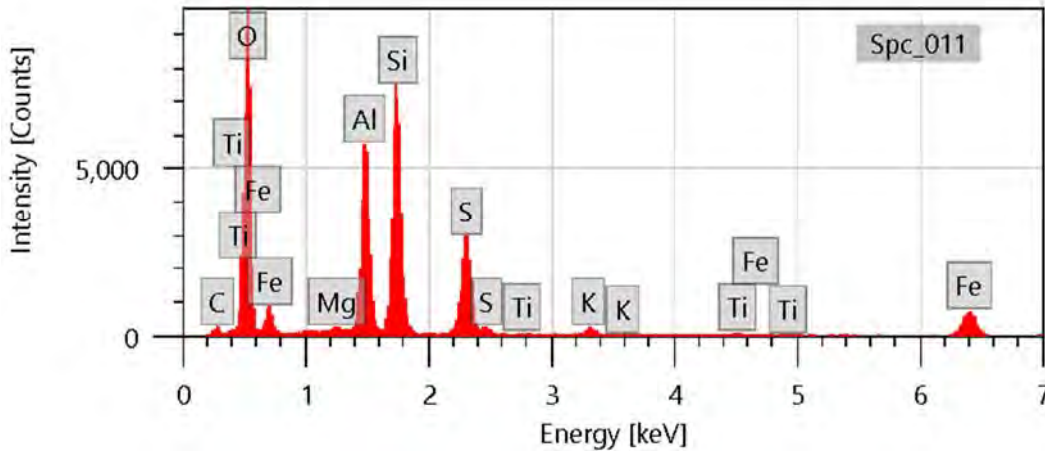
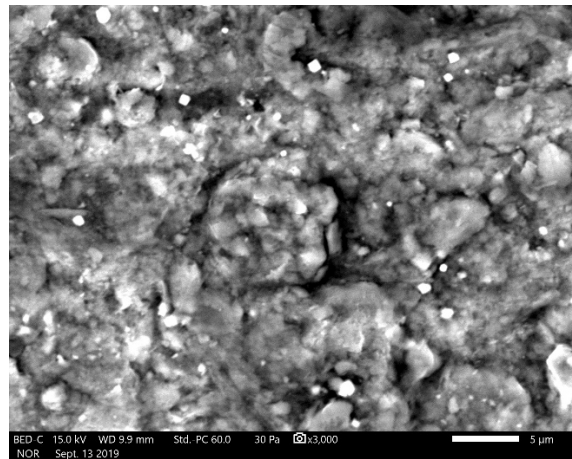
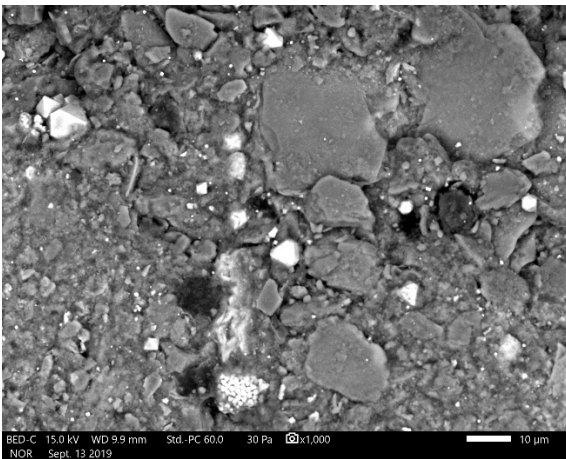
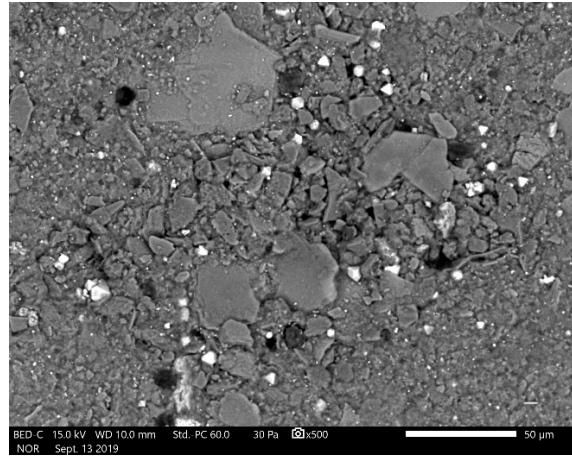
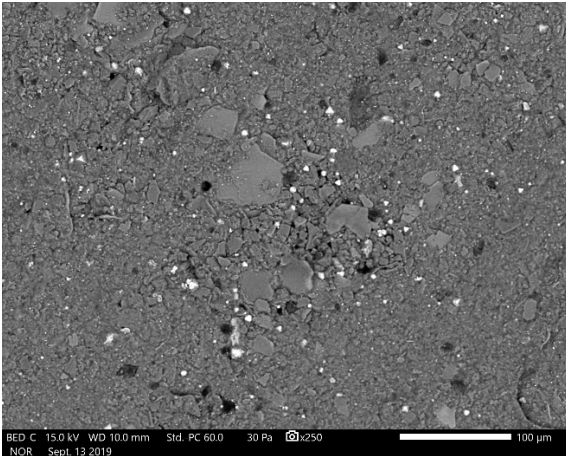
via Email: BSass@geosyntec.com



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



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	Latitude:	32° 26' 52.08" N
	LOCATED ON OWNERS PROPERTY	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	8.25	0	60

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	31	38	Bentonite 3 Bags/Sacks

Seal Method: **Tremie**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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**

	Top Depth (ft.)	Bottom Depth (ft.)
Plug Information:	50	60

Water Quality:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	Latitude:	32° 26' 52.08" N
	LOCATED ON OWNERS PROPERTY	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	Latitude:	32° 27' 56.32" N
	LOCATED ON OWNERS PROPERTY	Longitude:	094° 29' 41.78" 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**

	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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

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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	Latitude:	32° 27' 46.12" N
	LOCATED ON OWNERS PROPERTY	Longitude:	094° 29' 43.34" W
Well County:	Harrison	Elevation:	No Data
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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
2	Riser	New Plastic (PVC)	40	0	13
2	Screen	New Plastic (PVC)	40 0.1	13	18

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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 #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	Latitude:	32° 26' 52.05" N
	LOCATED ON OWNERS PROPERTY	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**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	8.25	0	12

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	1	CLAY
1	5	CLAY/SAND
5	9.5	CLAY
9.5	12	SAND/CLAY

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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 #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
Well County: Harrison	Longitude: 094° 29' 00.5" W
	Elevation: No Data
Type of Work: New Well	
Proposed Use: Monitor	

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	6.75	0	40

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Filter Material</i>	<i>Size</i>
Filter Pack Intervals:	27	40	Sand	16/30

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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 #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
Well County: Harrison	Longitude: 094° 29' 00.5" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **3/9/2019** Drilling End Date: **3/10/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	100

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	86	100	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 29' 50" W
	Elevation: No Data
<hr/>	
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:	6.75	0	22

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	8	22	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

Top (ft.)	Bottom (ft.)	Description
0	7	tan and brown sandy, silty clay
7	22	red and grey sand w/occ. lignite layers

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

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 #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
Well County: Harrison	Longitude: 094° 29' 50" W
	Elevation: No Data
Type of Work: New Well	
Proposed Use: Monitor	

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	80

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	56	80	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	25

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	12	25	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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
Well County: Harrison	Longitude: 094° 29' 53" W
	Elevation: No Data
<hr/>	
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:	6.75	0	70

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	45	70	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	Latitude:	32° 27' 30.34" N
	LOCAATED ON OWNERS PROPERTY	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**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	8.25	0	18

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
Annular Seal Data:	1	11	Bentonite 5 Bags/Sacks

Seal Method: **Tremie**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	10	CLAYS
10	18	SANDS AND CLAYS

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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 #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	Latitude:	32° 27' 30.28" N
	LOCATED ON OWNERS PROPERTY	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**

	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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**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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	45

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	32	45	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	45	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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 #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
Well County: Harrison	Longitude: 094° 30' 08" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	70

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	57	70	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

Top (ft.)	Bottom (ft.)	Description
0	70	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

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
Well Location: 2400 FM 3251 Hallsville, TX 75650	Latitude: 32° 27' 10" N
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	35

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	23	35	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	35	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	65

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	52	65	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	65	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	93

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	77	93	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	90	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)
90	93	gray clay (old pit base?)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 11" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **3/5/2019**

Drilling End Date: **3/5/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	30

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	17	30	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	0	12	Cement
	12	17	Bentonite 1 Bags/Sacks

Seal Method: **Gravity**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	30	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 11" W
	Elevation: No Data
Type of Work: New Well	
Proposed Use: Monitor	

Drilling Start Date: **3/4/2019** Drilling End Date: **3/4/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	60

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	48	60	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	60	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	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**

	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**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	18	tan and brown sandy, silty clay and occasional gravel

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	43

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	30	43	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	0	10	Cement
	10	30	Bentonite 5 Bags/Sacks

Seal Method: **Gravity**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	18	tan and brown sandy, silty clay and occasional gravel
18	43	red and grey sand w/occ. clay layers

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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 #525309

Owner: AEP Pirkey Power Plant	Owner Well #: B-2
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
Well County: Harrison	Longitude: 094° 28' 25.01" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **5/13/2019** Drilling End Date: **5/17/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	8.25	0	49

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	36	49	Sand	20/40

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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 #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
Well County:	Harrison	Longitude:	094° 28' 25.01" W
		Elevation:	No Data
Type of Work:	New Well	Proposed Use:	Monitor

Drilling Start Date: **5/15/2019** Drilling End Date: **5/15/2019**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	8	0	35

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Filter Material</i>	<i>Size</i>
Filter Pack Intervals:	26.9	35	Sand	20/40

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
Annular Seal Data:	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

Casing:
BLANK PIPE & WELL SCREEN DATA

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

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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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
Well Location: 2400 FM 3251 Hallsville, TX 75650	Latitude: 32° 27' 54.7" N
Well County: Harrison	Longitude: 094° 28' 25.01" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **5/20/2019** Drilling End Date: **5/20/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	4	0	40

Drilling Method: **Direct Push**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	27	40	Sand	20/40

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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

Casing:
BLANK PIPE & WELL SCREEN DATA

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

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
West Bottom Ash Pond CCR Management Unit
Hallsville, Texas
January 2020

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215



An **AEP** Company

BOUNDLESS ENERGY™

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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.

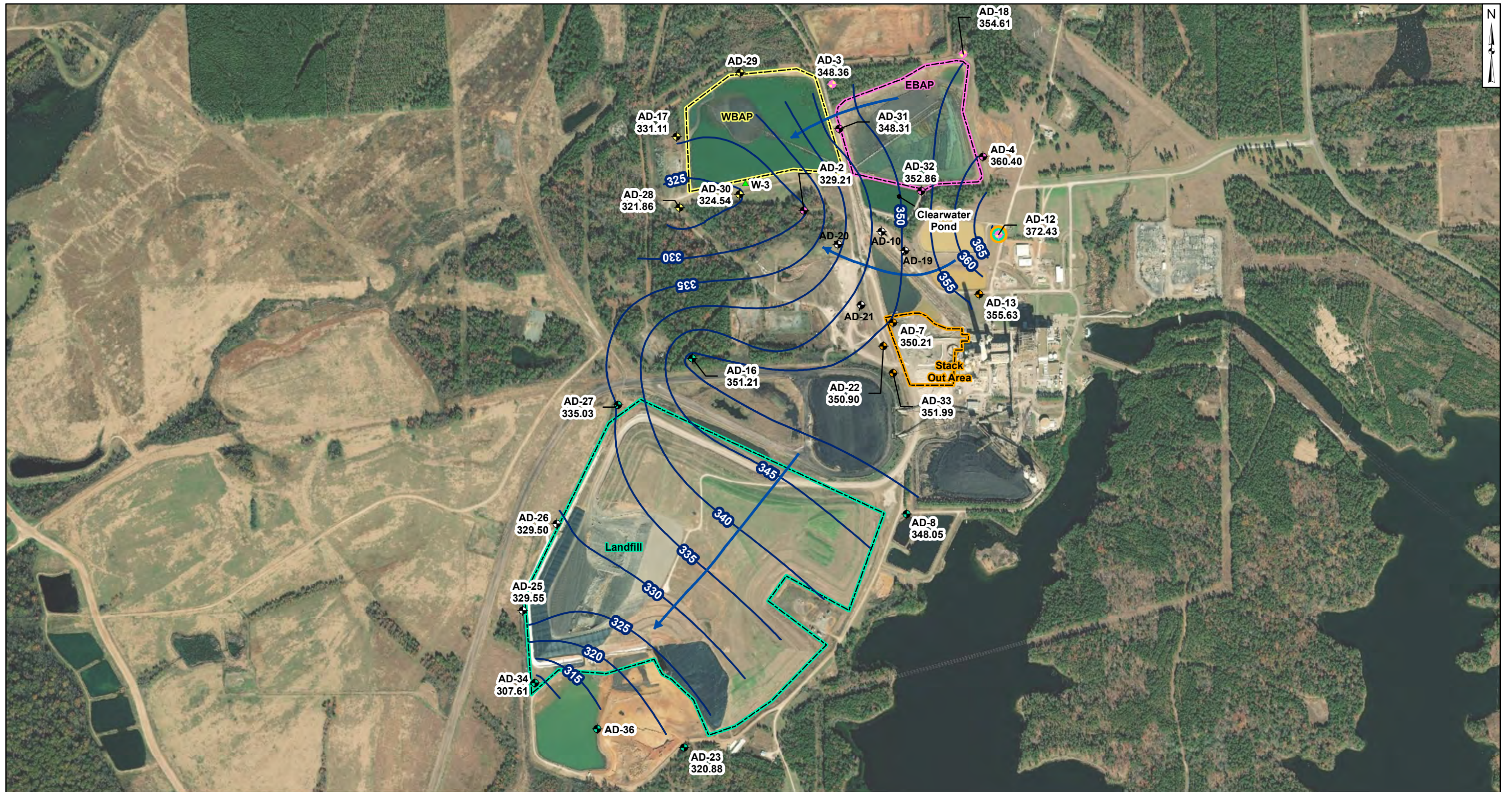
X. A Projection of Key Activities for the Upcoming Year

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

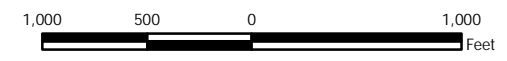
Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.



- 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.



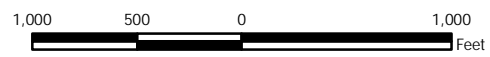
Potentiometric Contours - Uppermost Aquifer February 2019	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2020/01/16
Figure 1	



- 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

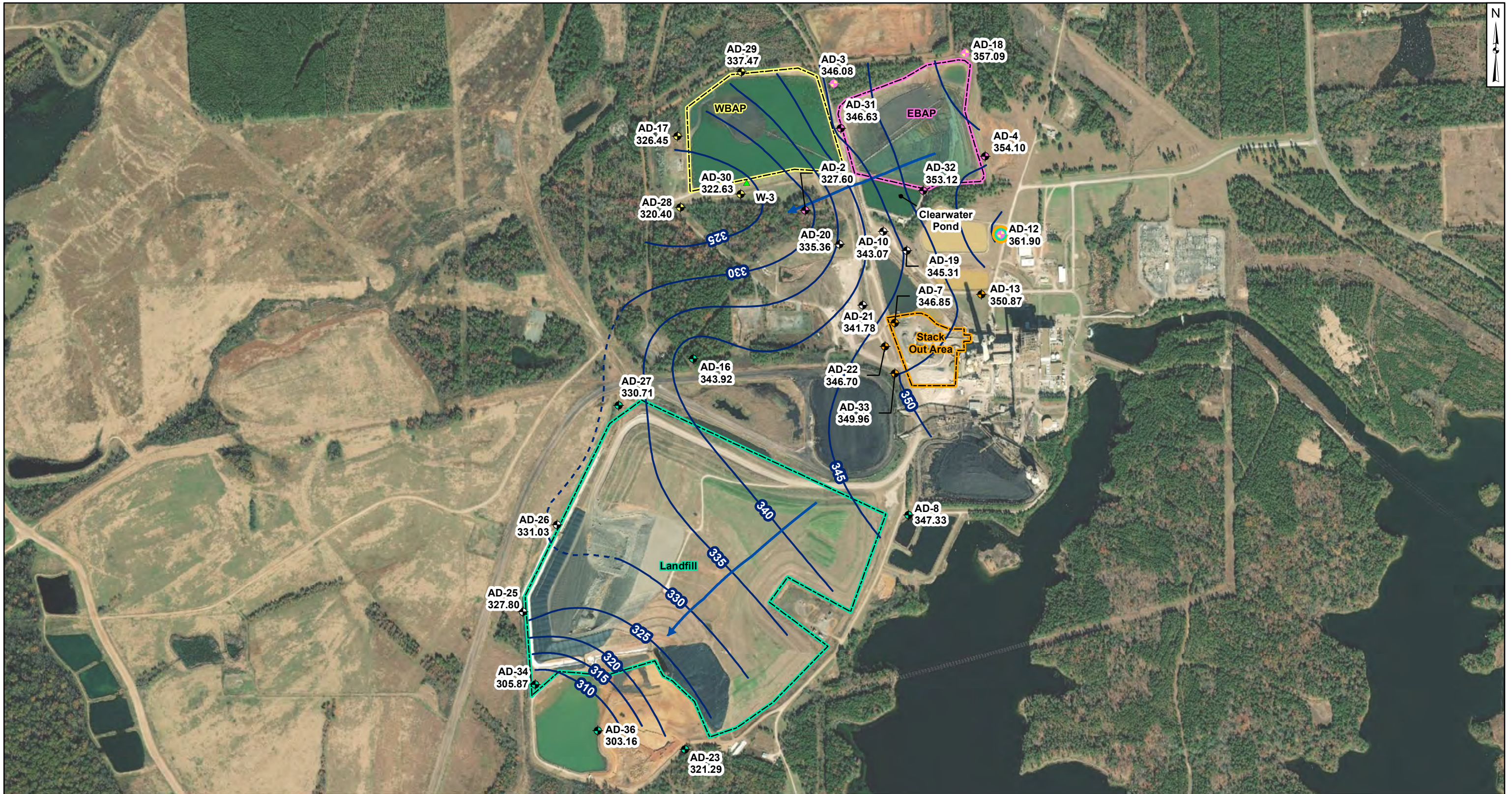
Geosyntec
consultants

Figure

2

Columbus, Ohio

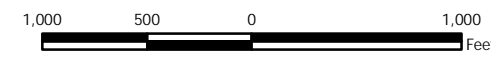
2020/01/16



- 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.



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 West Bottom Ash Pond**

Geosyntec Consultants, Inc.

CCR Management Unit	Monitoring Well	Well Diameter (inches)	2019-02		2019-05		2019-08	
			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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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

Geosyntec Consultants, Inc.

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	µg/L	pCi/L	mg/L	µg/L	mg/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



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Columbus, Ohio 43215-2372

Submitted by



engineers | scientists | innovators

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July 10, 2019

CHA8473

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LIST OF ATTACHMENTS

Attachment A	Certification by Qualified Professional Engineer
Attachment B	Statistical Analysis Output

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

112498

License Number

TEXAS

Licensing State

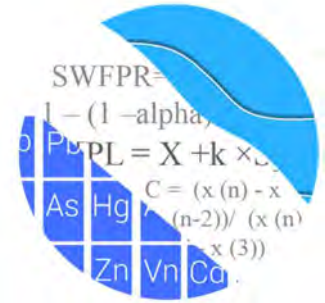
07.10.19

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.

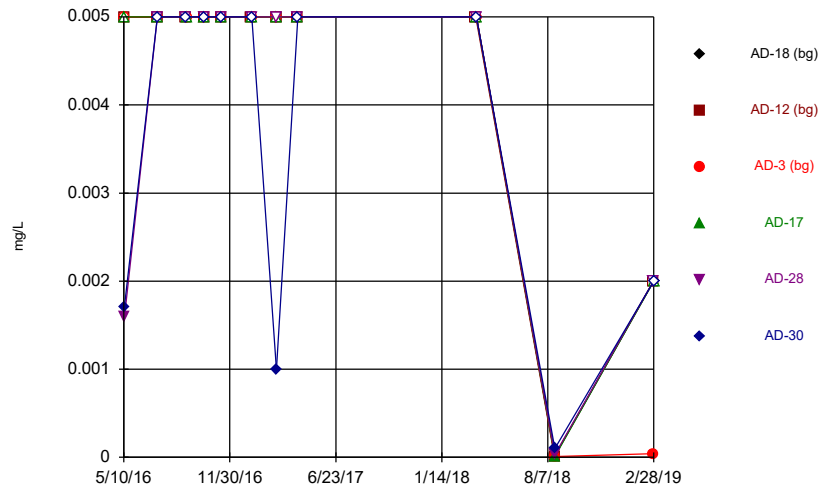
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey West Bottom Ash Pond. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

A handwritten signature in cursive script that reads "Kristina Rayner".

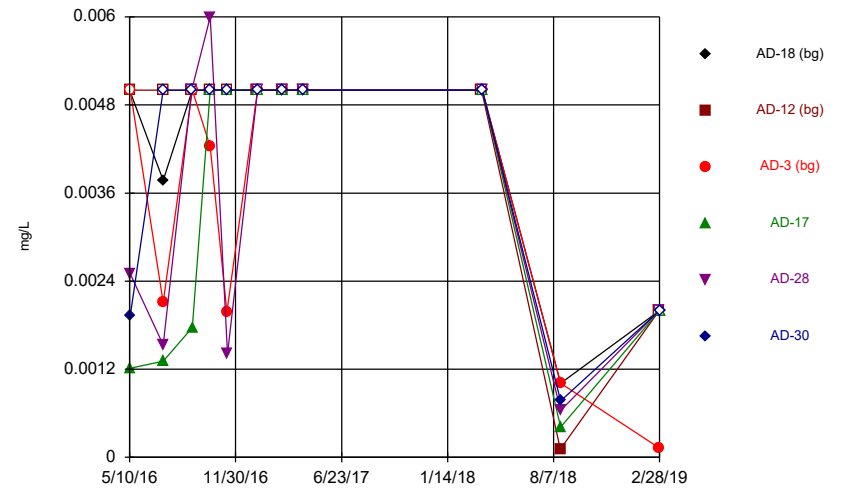
Kristina L. Rayner
Groundwater Statistician

Time Series



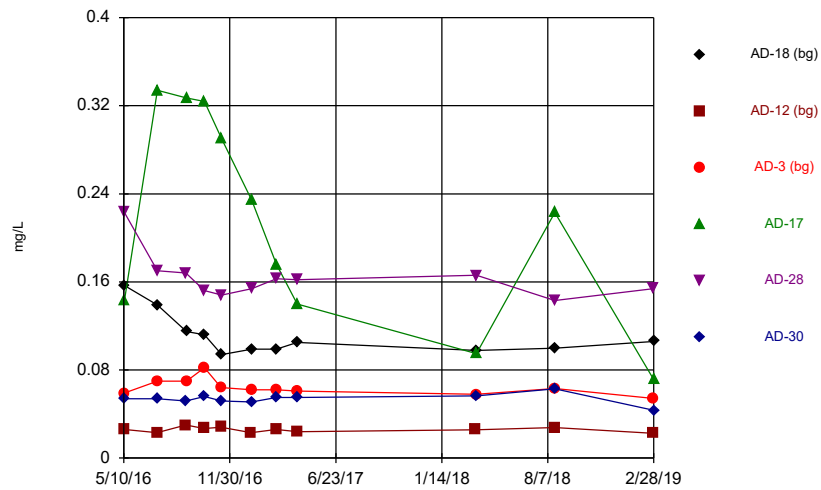
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Time Series



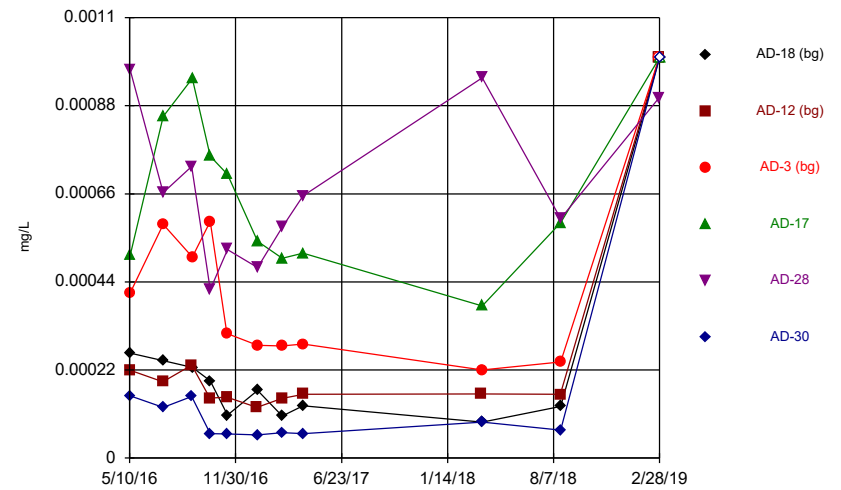
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Time Series



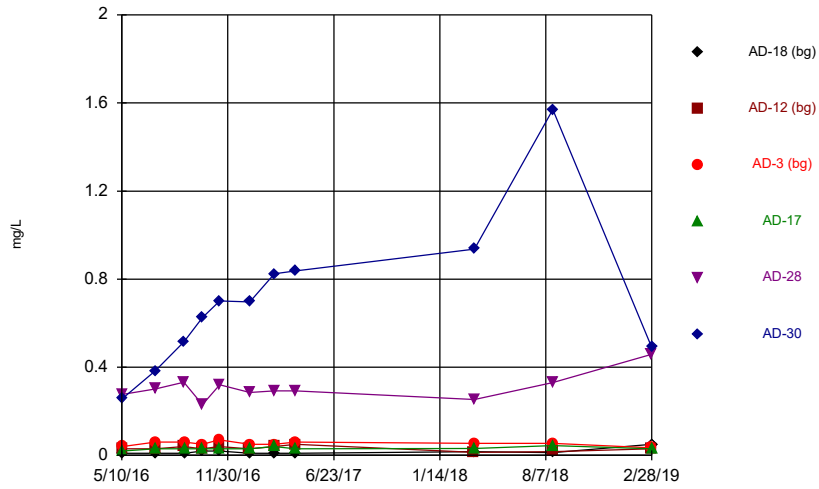
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Time Series



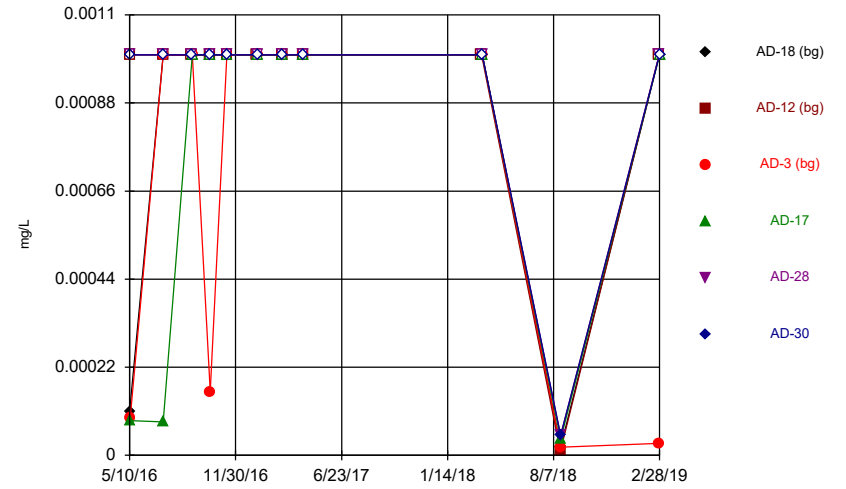
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Time Series



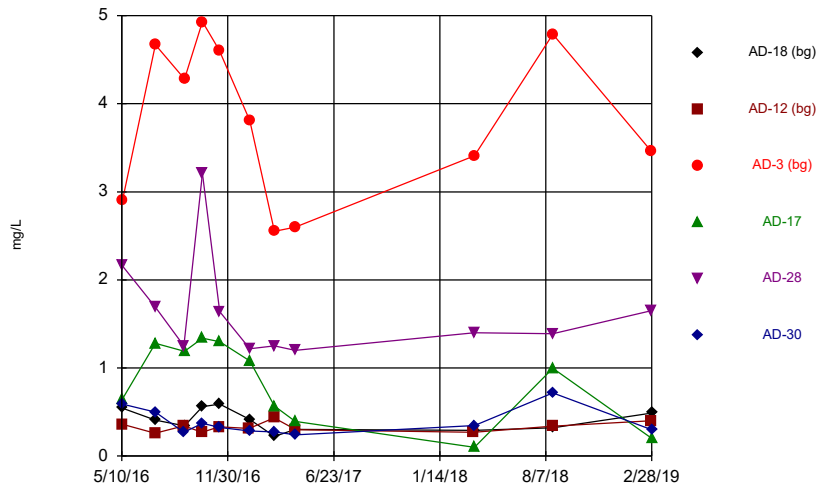
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Time Series



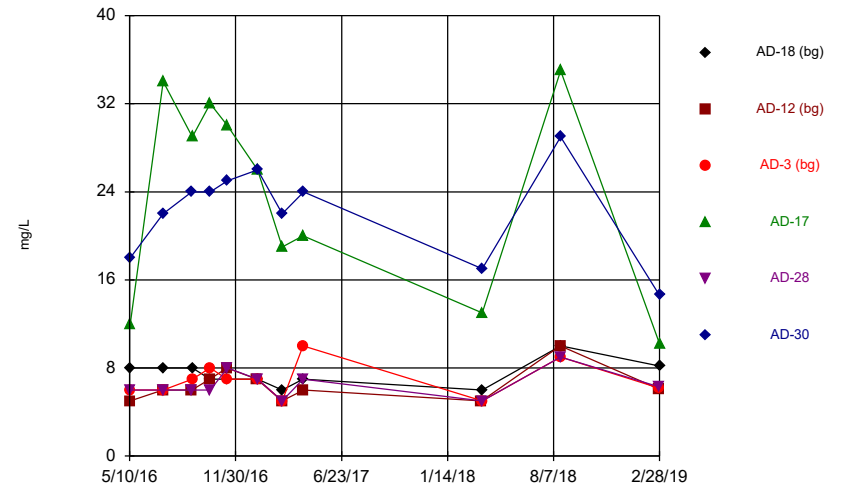
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Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Time Series



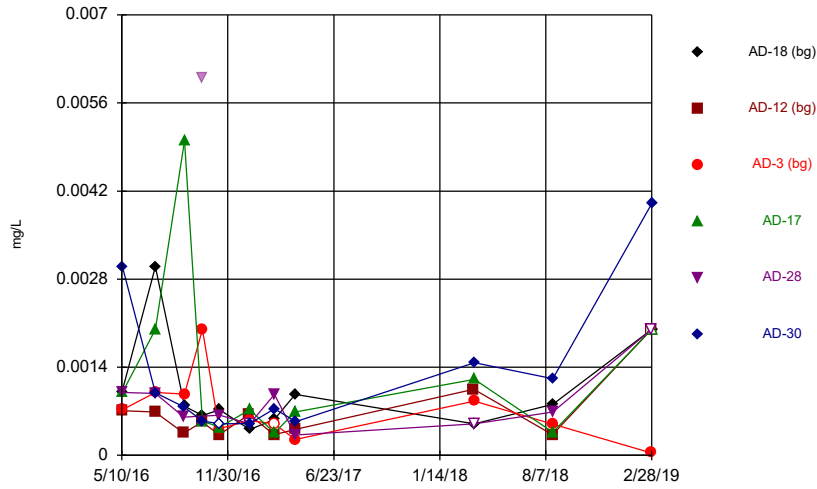
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Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Time Series



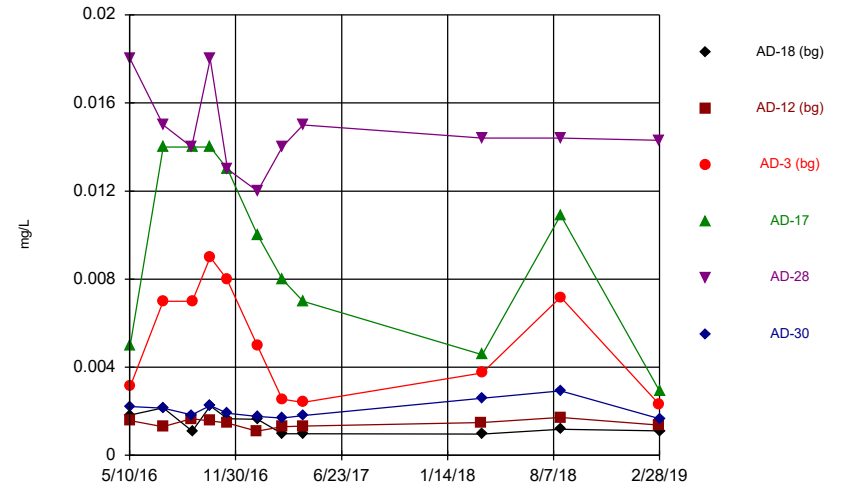
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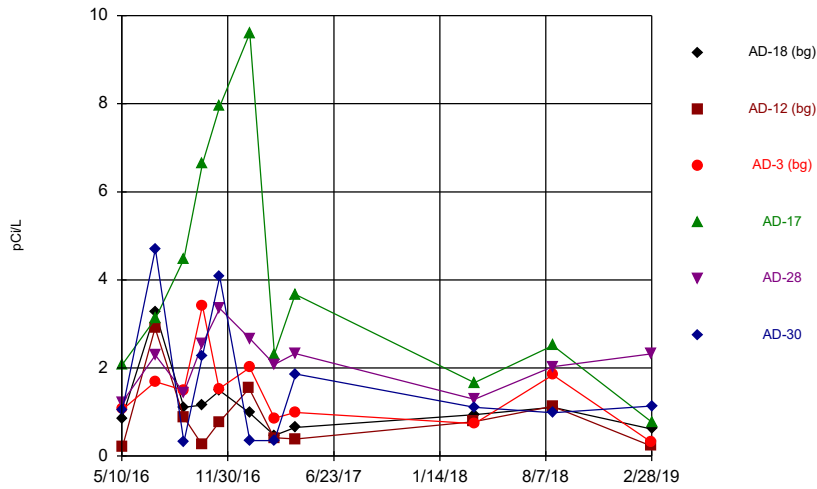
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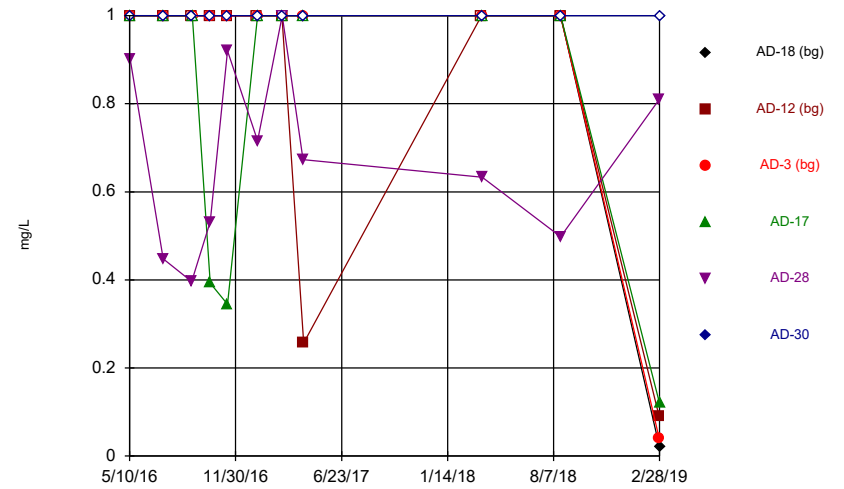
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Time Series



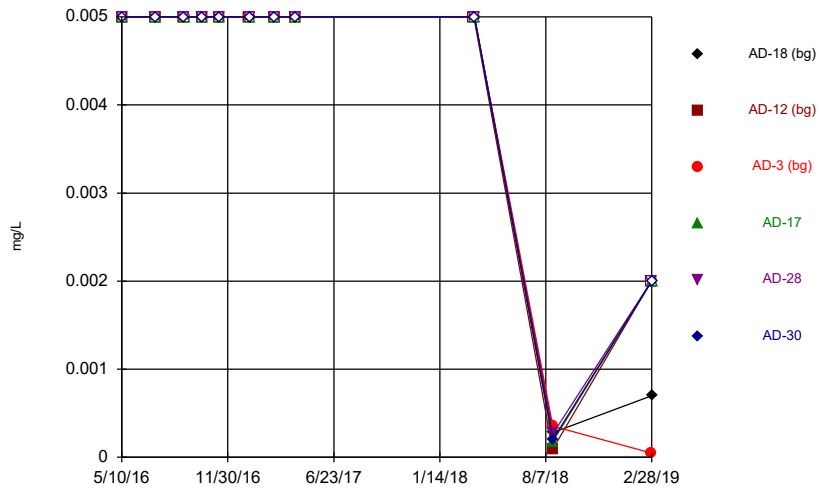
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Time Series



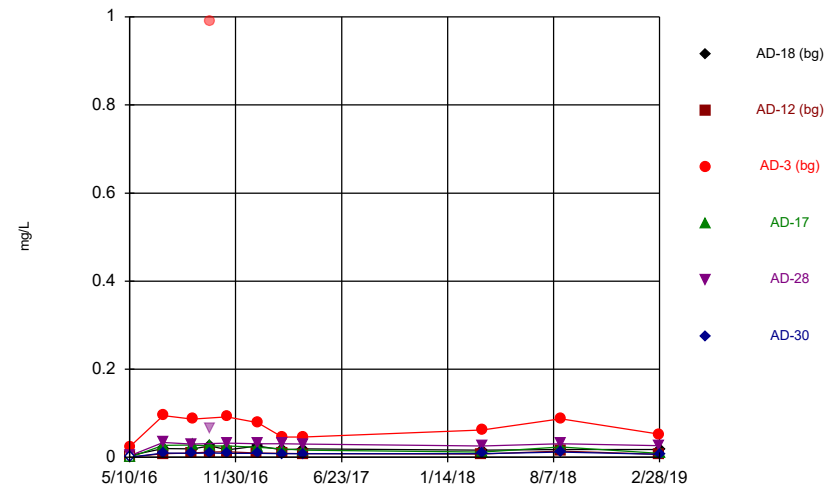
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Time Series



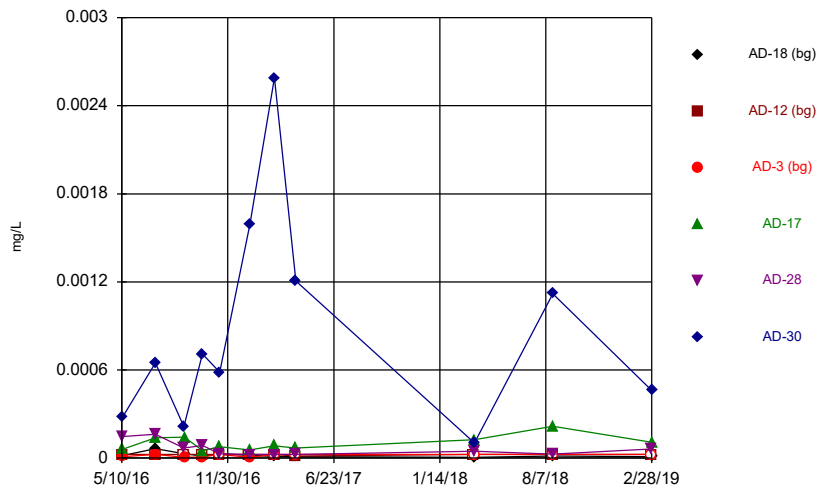
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Time Series



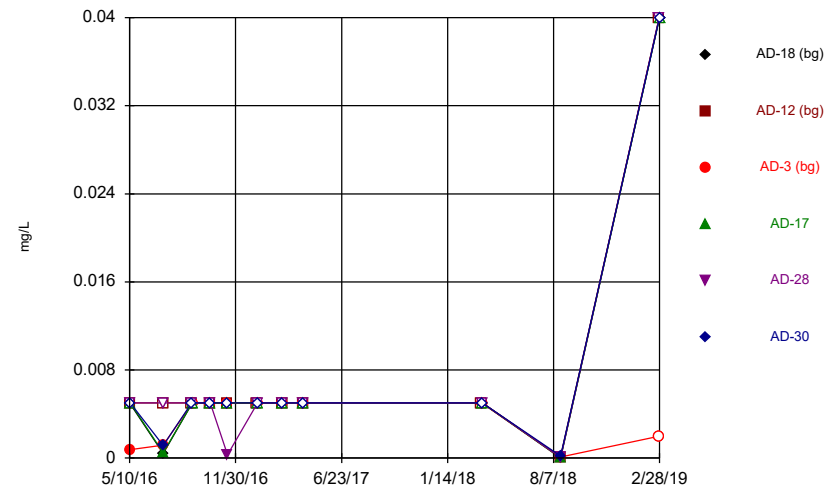
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Time Series



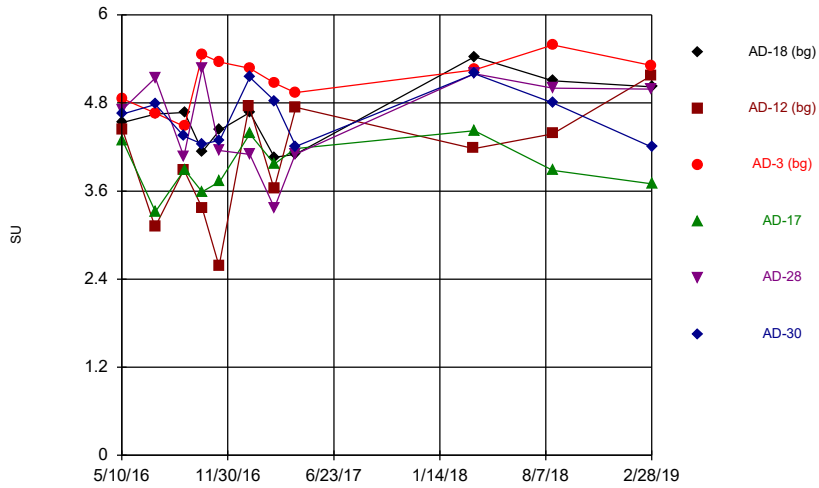
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Time Series



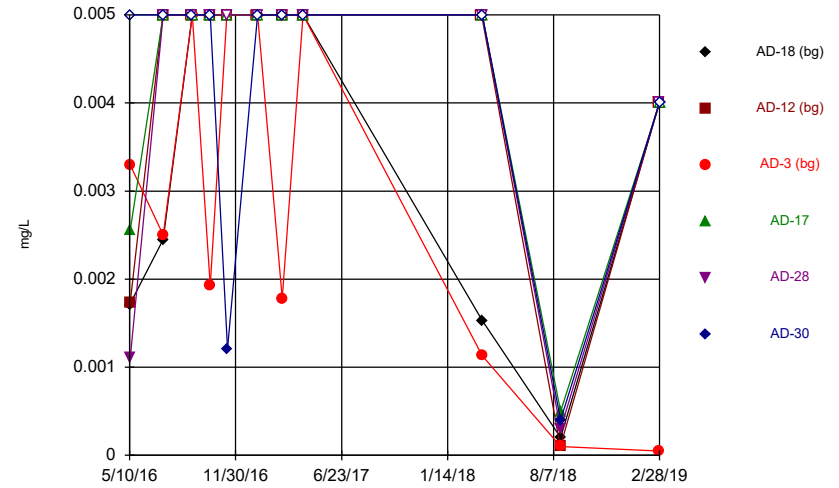
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Time Series



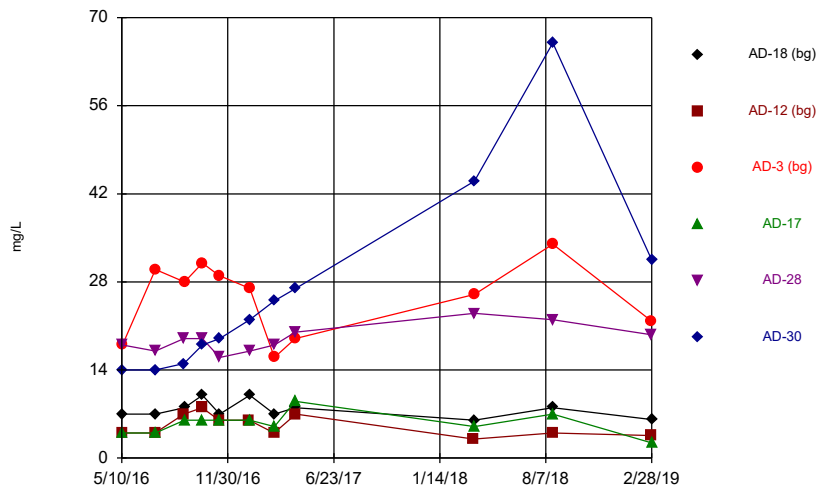
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Time Series



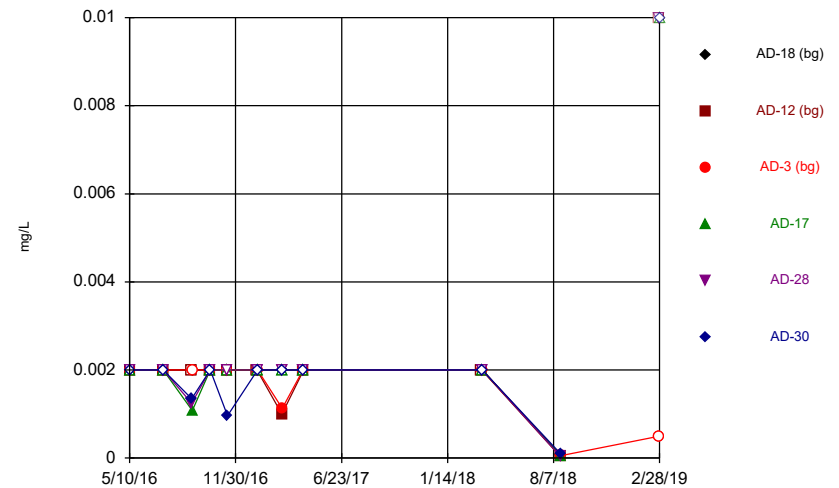
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Time Series



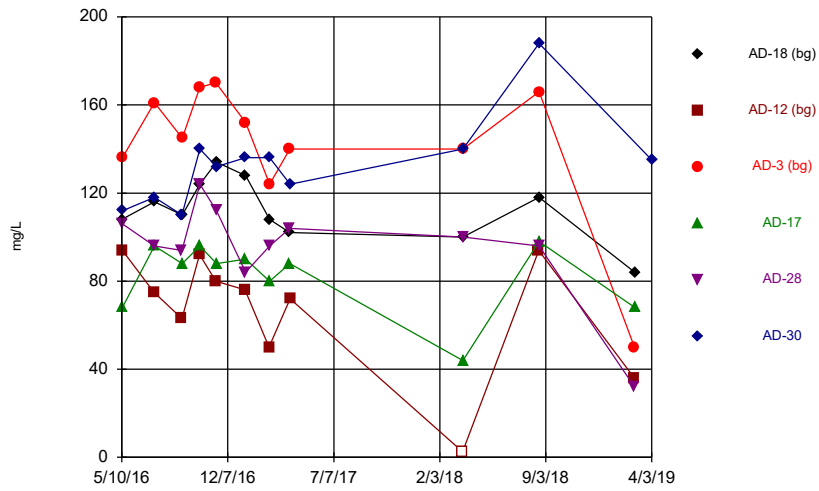
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Time Series



Constituent: Thallium, total Analysis Run 7/9/2019 1:51 PM View: Time Series
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Time Series



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

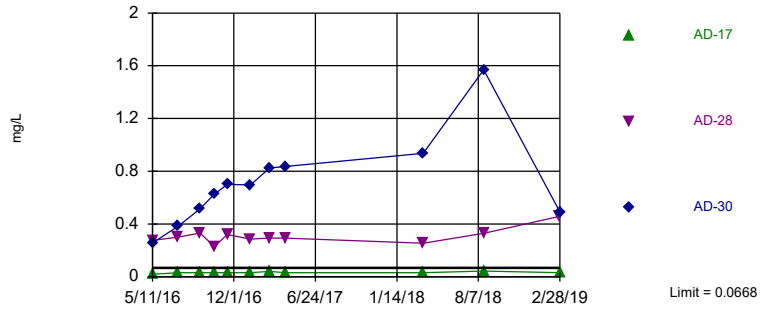
Interwell Prediction Limit Summary - All Results

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

Exceeds Limit: AD-28, AD-30

Prediction Limit
Interwell Parametric

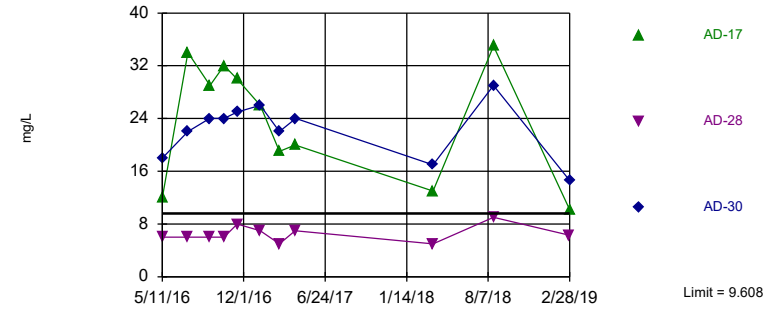


Background Data Summary: Mean=0.03374, Std. Dev.=0.01858, n=33, 3.03% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9114, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

Constituent: Boron, total Analysis Run 7/7/2019 8:00 PM View: PLs - Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Exceeds Limit: AD-17, AD-30

Prediction Limit
Interwell Parametric



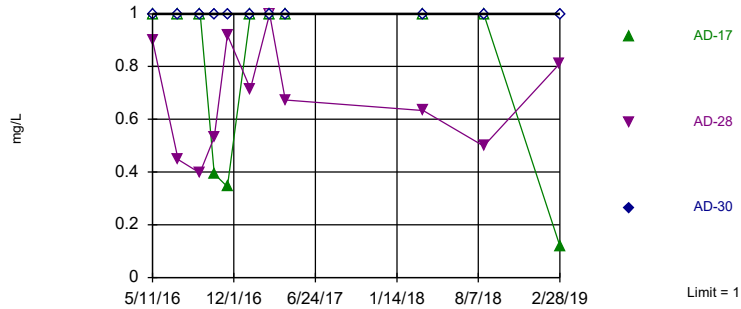
Background Data Summary (based on square root transformation): Mean=2.624, Std. Dev.=0.2676, n=33. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9176, critical = 0.906. Kappa = 1.78 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. 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

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.

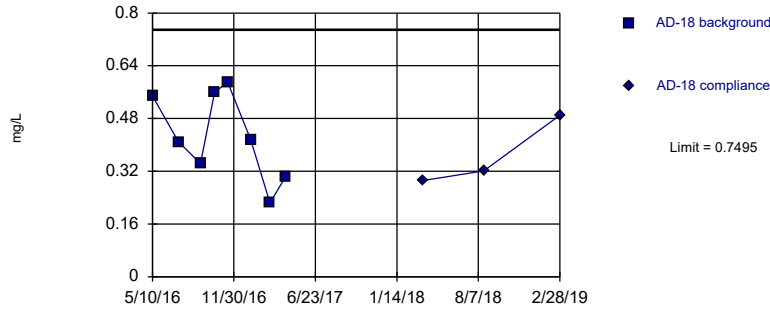
Constituent: Fluoride, total Analysis Run 7/7/2019 8:00 PM View: PLs - Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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

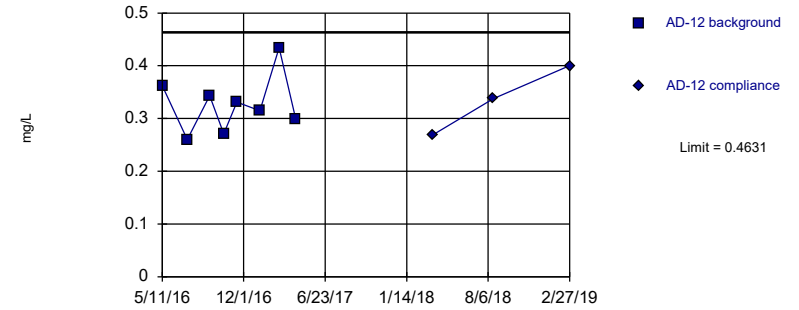
Within Limit Prediction Limit
Intrawell Parametric



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

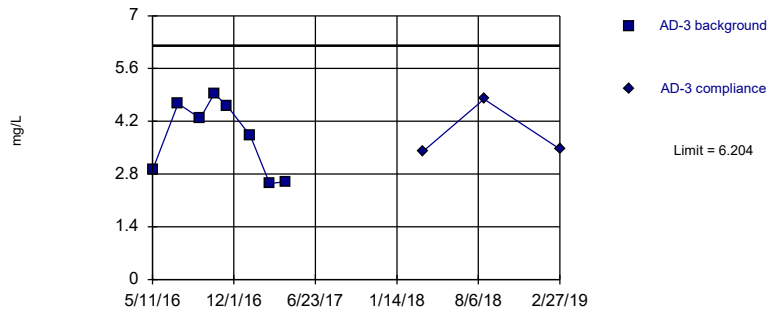
Within Limit Prediction Limit
Intrawell Parametric



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

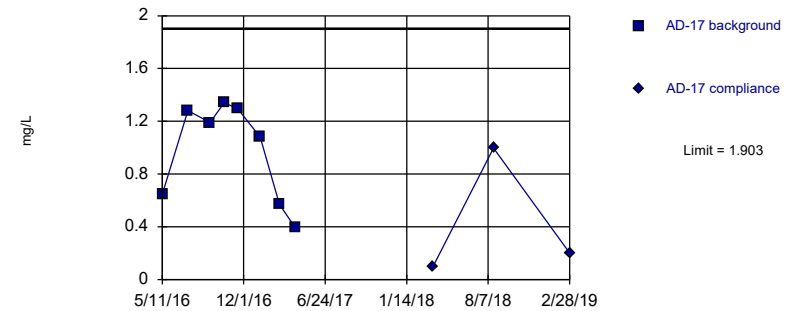
Within Limit Prediction Limit
Intrawell Parametric



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

Within Limit Prediction Limit
Intrawell Parametric

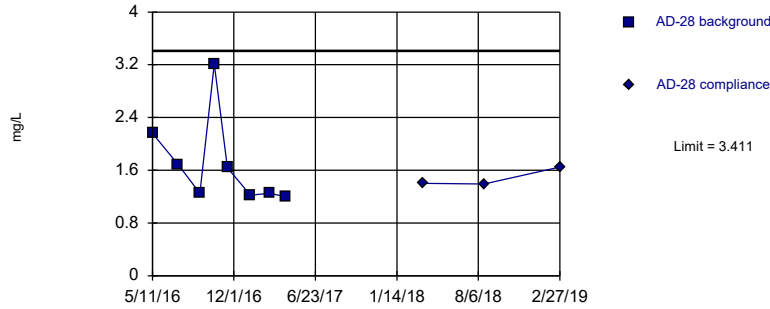


Background Data Summary: Mean=0.9754, Std. Dev.=0.3773, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8479, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit
Intrawell Parametric

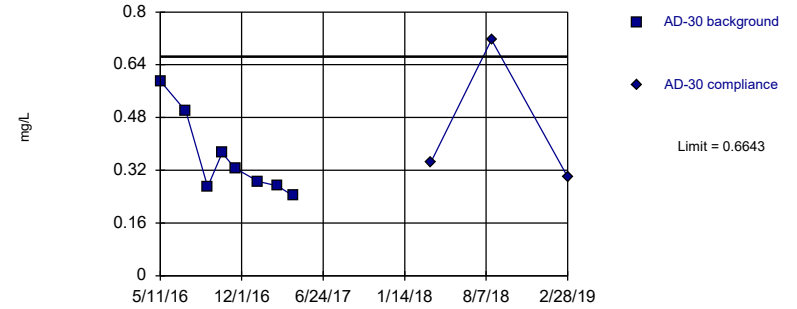


Background Data Summary: Mean=1.703, Std. Dev.=0.695, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.769, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit
Intrawell Parametric

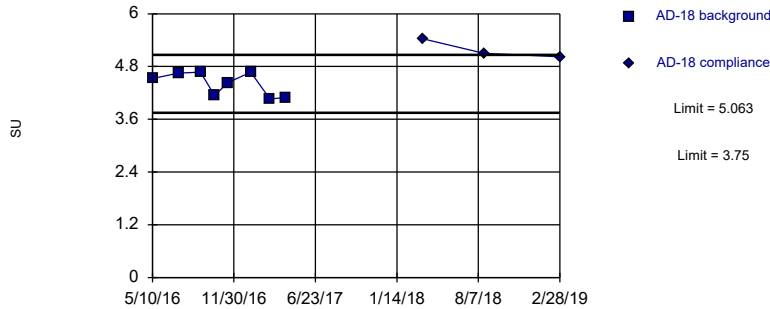


Background Data Summary: Mean=0.3575, Std. Dev.=0.1248, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.844, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limits

Prediction Limit
Intrawell Parametric

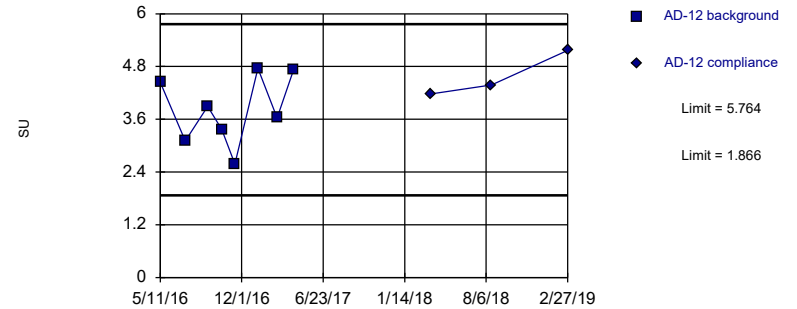


Background Data Summary: Mean=4.406, Std. Dev.=0.267, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8312, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limits

Prediction Limit
Intrawell Parametric

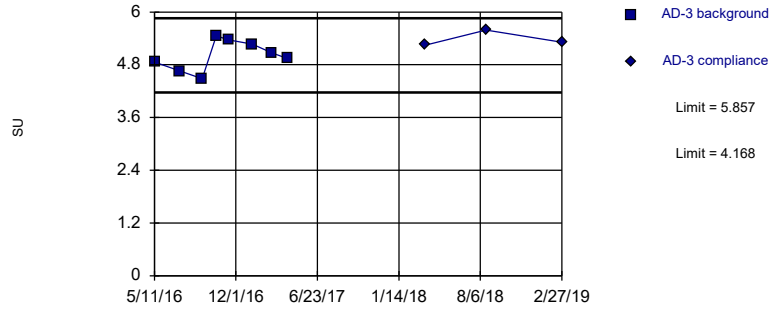


Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limits

Prediction Limit
Intrawell Parametric

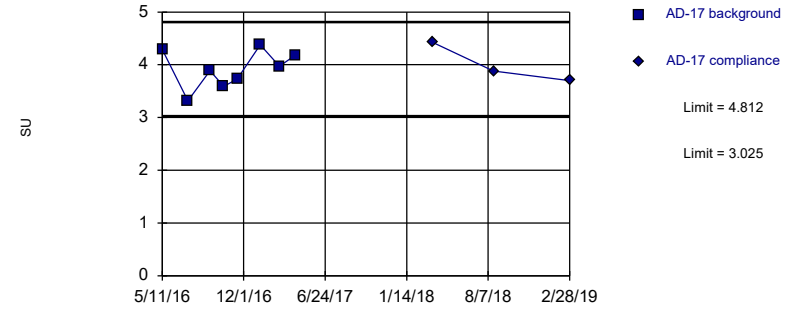


Background Data Summary: Mean=5.013, Std. Dev.=0.3437, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.965, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limits

Prediction Limit
Intrawell Parametric

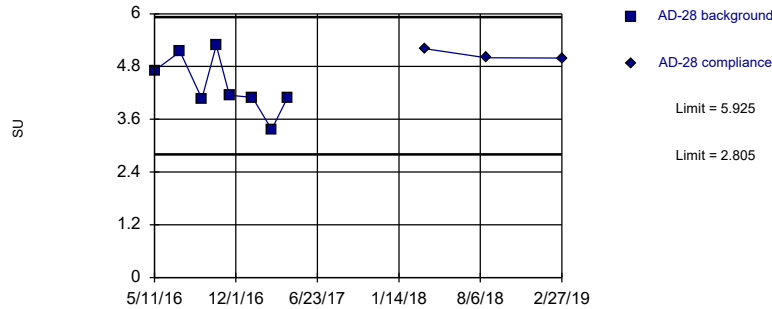


Background Data Summary: Mean=3.919, Std. Dev.=0.3634, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9678, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limits

Prediction Limit
Intrawell Parametric

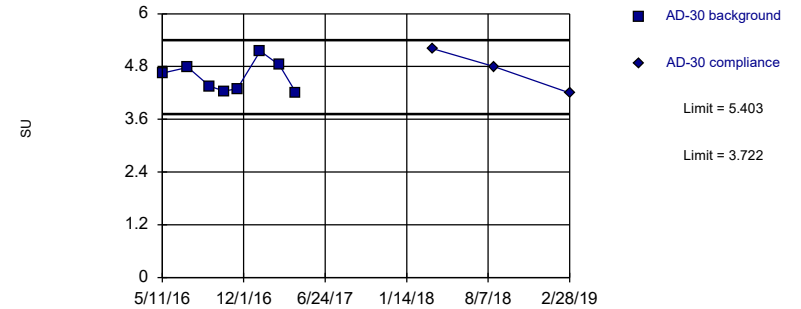


Background Data Summary: Mean=4.365, Std. Dev.=0.6348, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9117, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limits

Prediction Limit
Intrawell Parametric

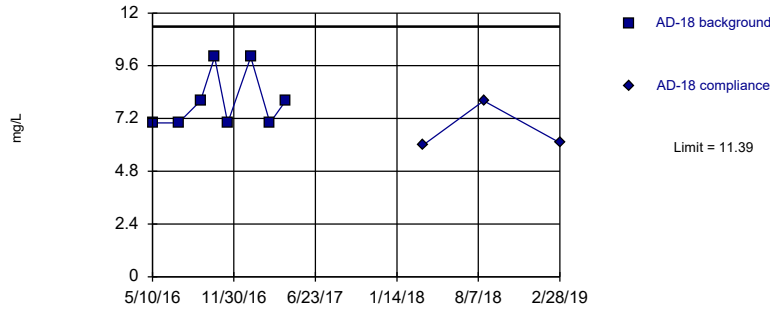


Background Data Summary: Mean=4.563, Std. Dev.=0.3421, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8981, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit Intrawell Parametric

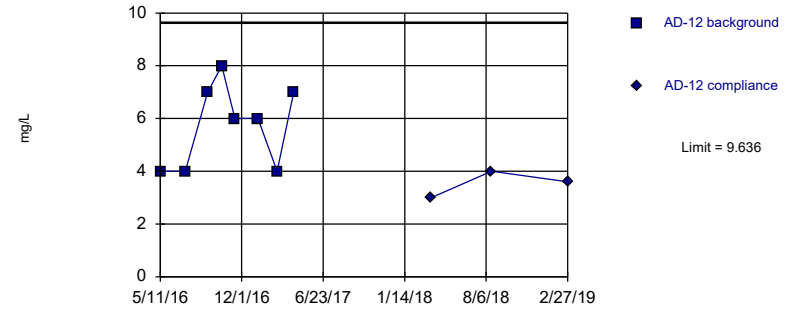


Background Data Summary (based on square root transformation): Mean=2.821, Std. Dev.=0.2255, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7543, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit Intrawell Parametric

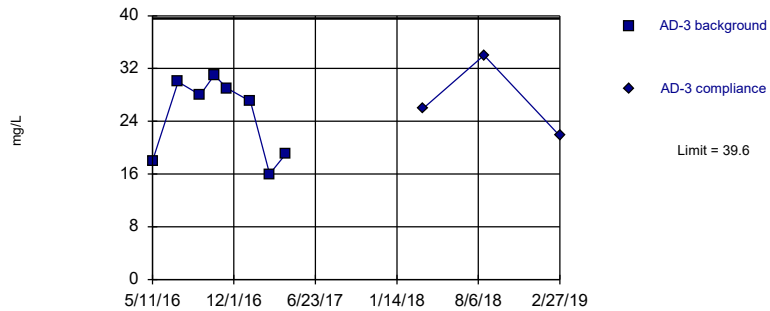


Background Data Summary: Mean=5.75, Std. Dev.=1.581, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.866, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit Intrawell Parametric

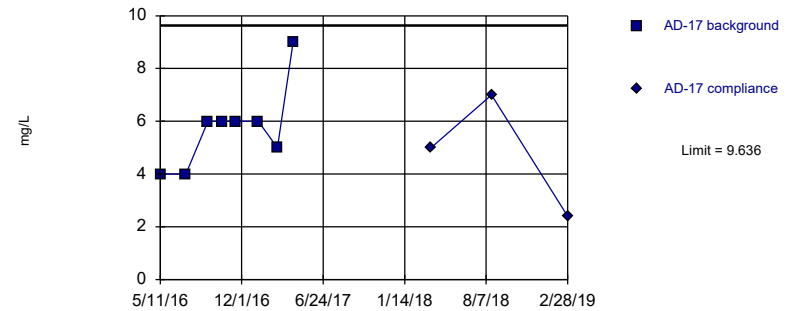


Background Data Summary: Mean=24.75, Std. Dev.=6.042, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8428, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Sulfate, total Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

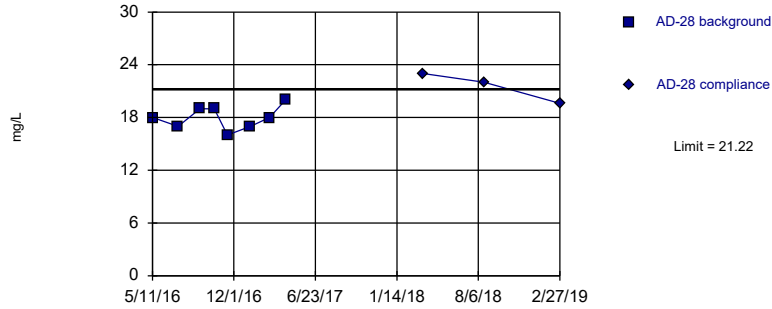
Prediction Limit Intrawell Parametric



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

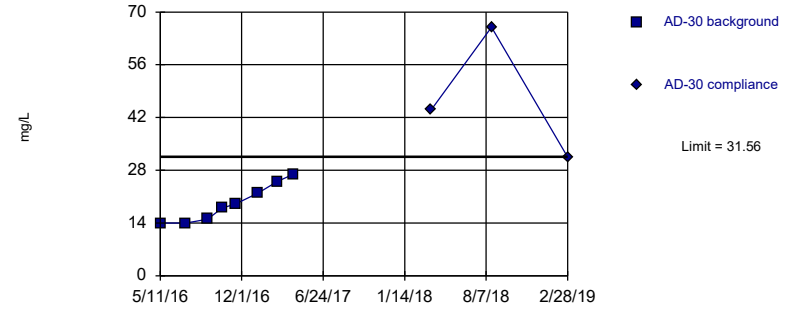
Within Limit Prediction Limit
Intrawell Parametric



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

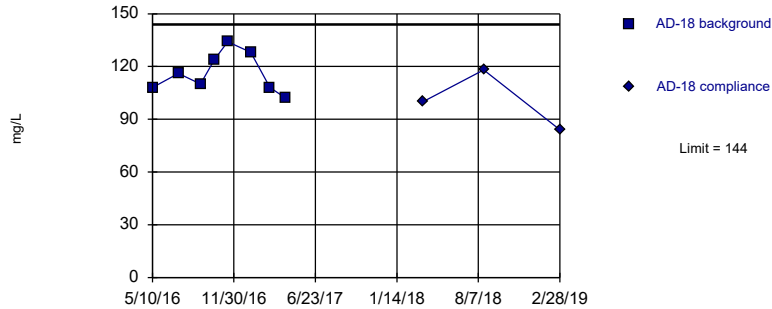
Within Limit Prediction Limit
Intrawell Parametric



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

Within Limit Prediction Limit
Intrawell Parametric

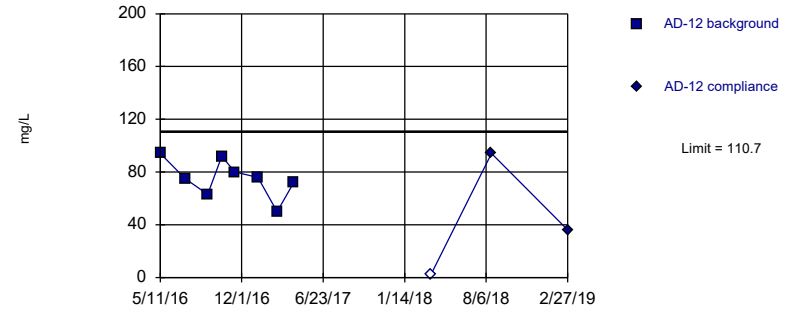


Background Data Summary: Mean=116.3, Std. Dev.=11.29, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9317, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Hollow symbols indicate censored values.

Within Limit Prediction Limit
Intrawell Parametric

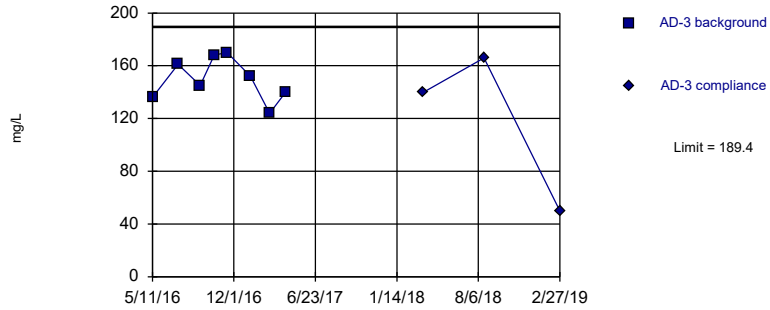


Background Data Summary: Mean=75.25, Std. Dev.=14.41, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9549, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit
Intrawell Parametric

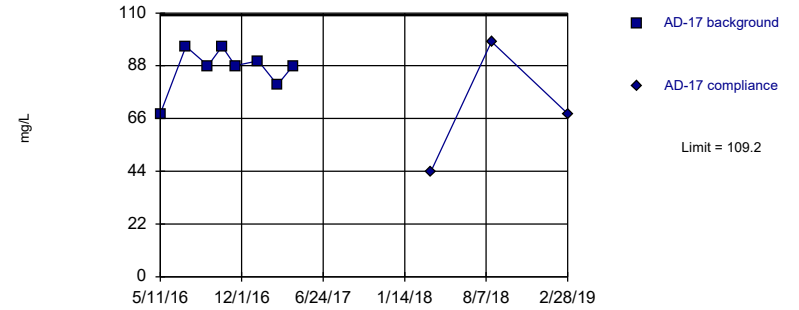


Background Data Summary: Mean=149.5, Std. Dev.=16.23, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9574, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit
Intrawell Parametric

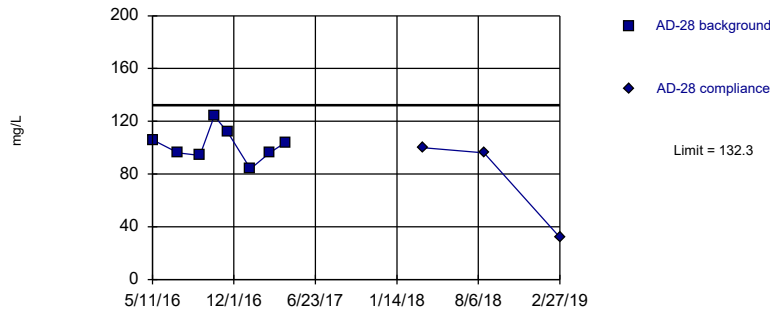


Background Data Summary: Mean=86.75, Std. Dev.=9.13, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8566, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Within Limit

Prediction Limit
Intrawell Parametric

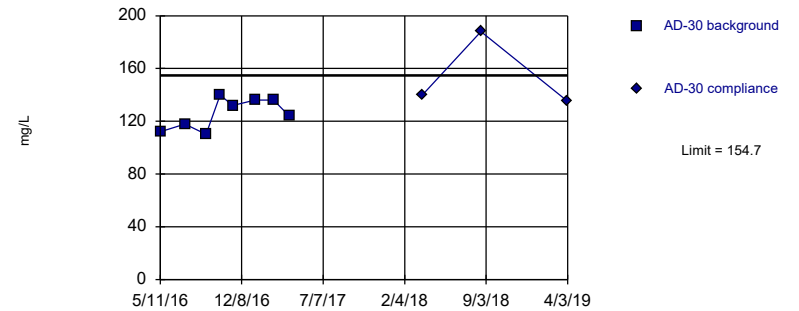


Background Data Summary: Mean=102, Std. Dev.=12.33, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9681, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/7/2019 8:02 PM View: PLs - Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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

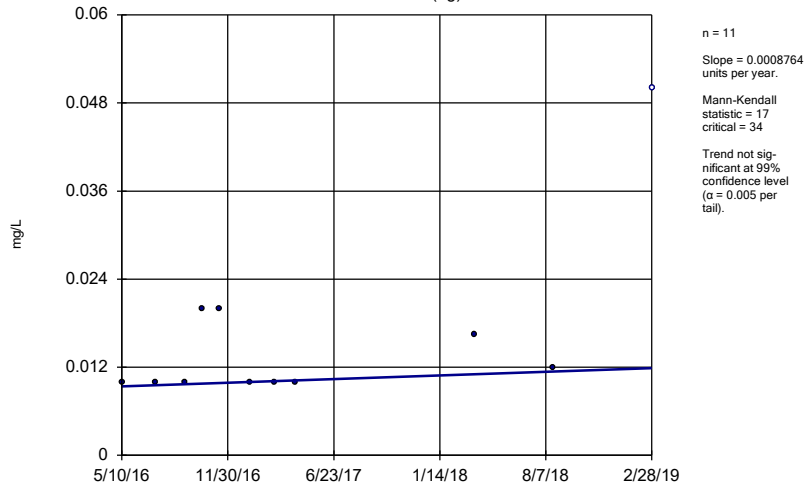
<u>Constituent</u>	<u>Well</u>	<u>Slope</u>	<u>Calc.</u>	<u>Critical</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Normality</u>	<u>Xform</u>	<u>Alpha</u>	<u>Method</u>
Boron, total (mg/L)	AD-30	0.5226	37	34	Yes	11	0	n/a	n/a	0.01	NP

Trend Test Summary Table - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 7/7/2019, 8:20 PM

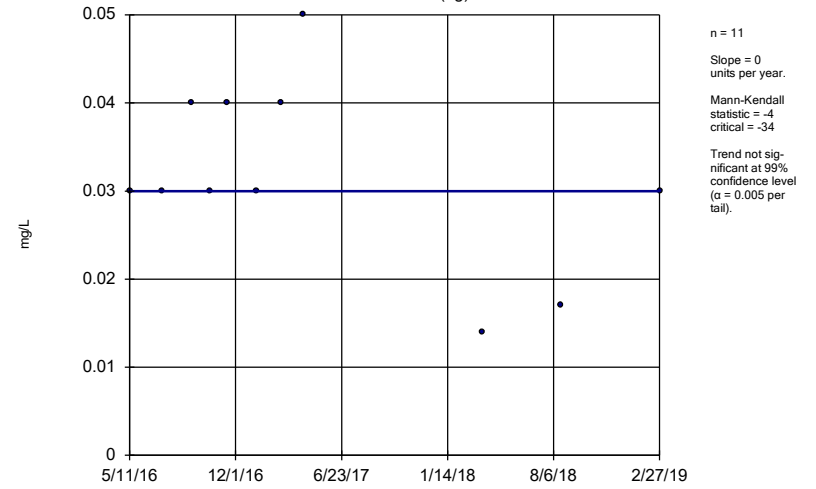
Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-18 (bg)	0.0008764	17	34	No	11	9.091	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-12 (bg)	0	-4	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-3 (bg)	-0.0002401	-7	-34	No	11	0	n/a	n/a	0.01	NP
Boron, total (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

Sen's Slope Estimator
 AD-18 (bg)



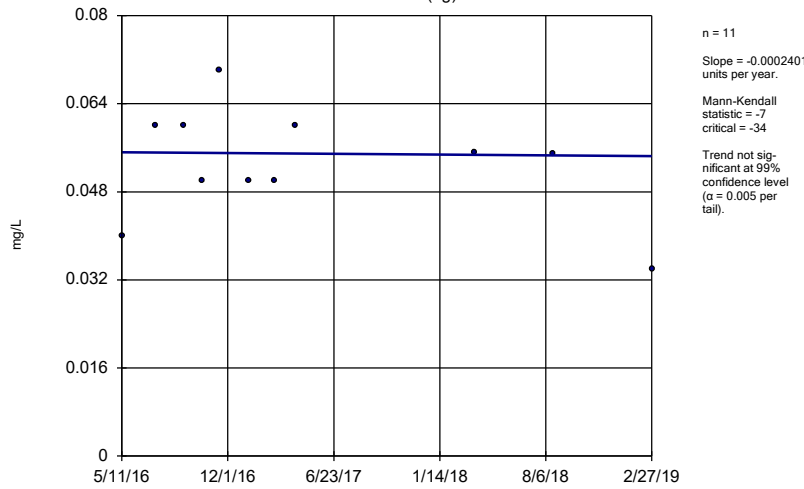
Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator
 AD-12 (bg)



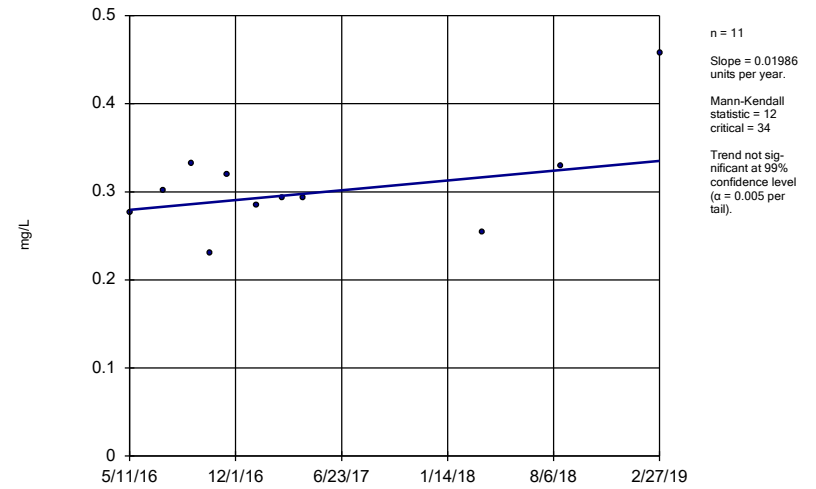
Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator
 AD-3 (bg)



Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

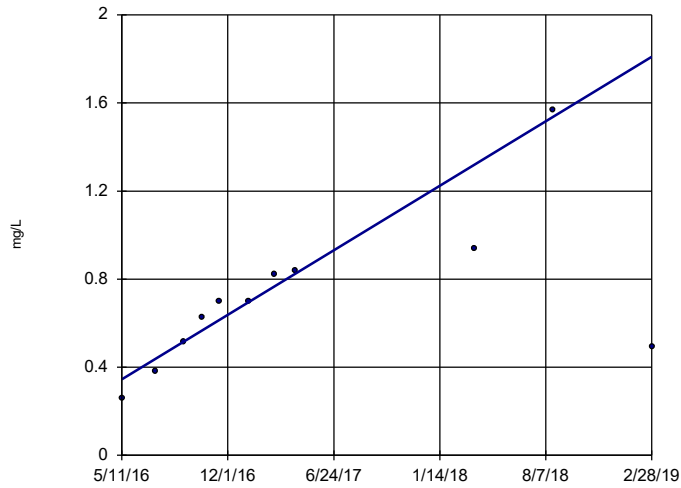
Sen's Slope Estimator
 AD-28



Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-30

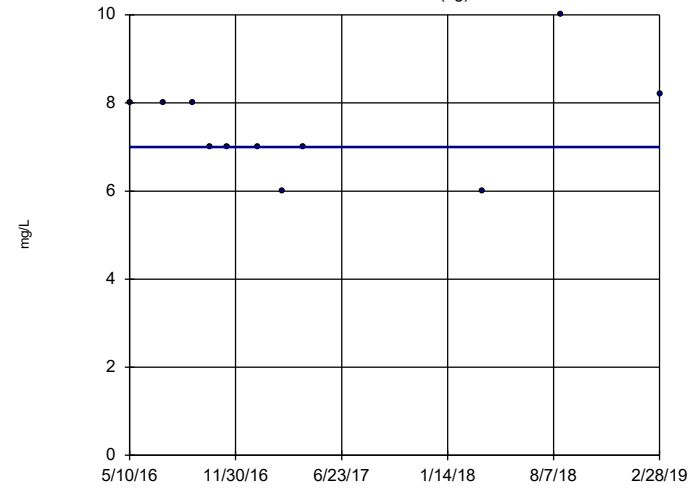


n = 11
 Slope = 0.5226 units per year.
 Mann-Kendall statistic = 37
 critical = 34
 Increasing trend significant at 99% confidence level (α = 0.005 per tail).

Constituent: Boron, total Analysis Run 7/7/2019 8:19 PM View: Trends
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-18 (bg)

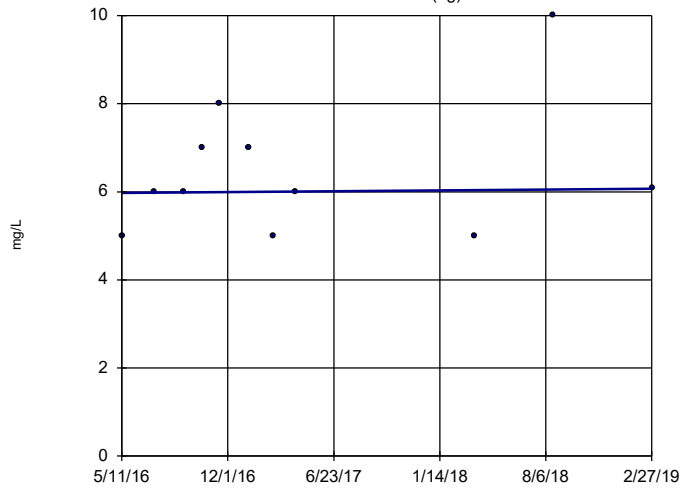


n = 11
 Slope = 0 units per year.
 Mann-Kendall statistic = -7
 critical = -34
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-12 (bg)

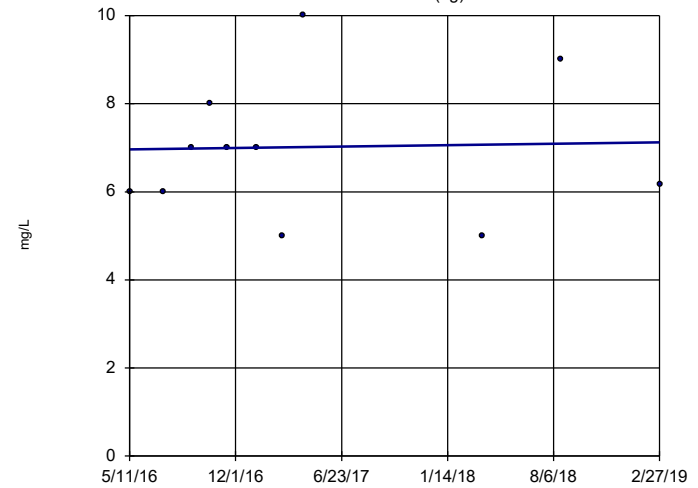


n = 11
 Slope = 0.03234 units per year.
 Mann-Kendall statistic = 10
 critical = 34
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-3 (bg)

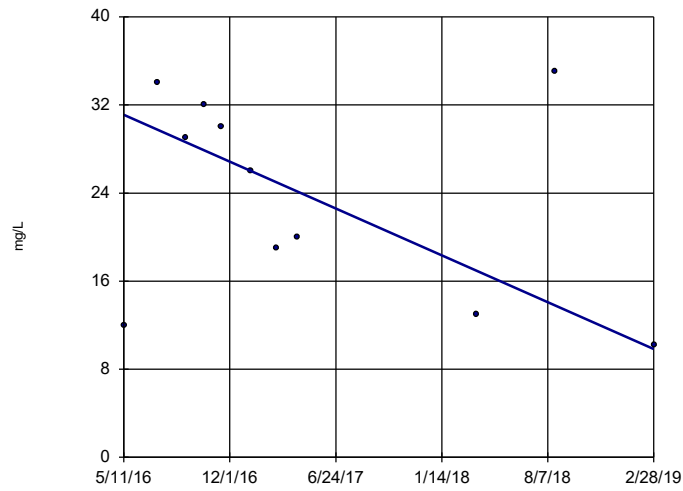


n = 11
 Slope = 0.05714 units per year.
 Mann-Kendall statistic = 6
 critical = 34
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-17

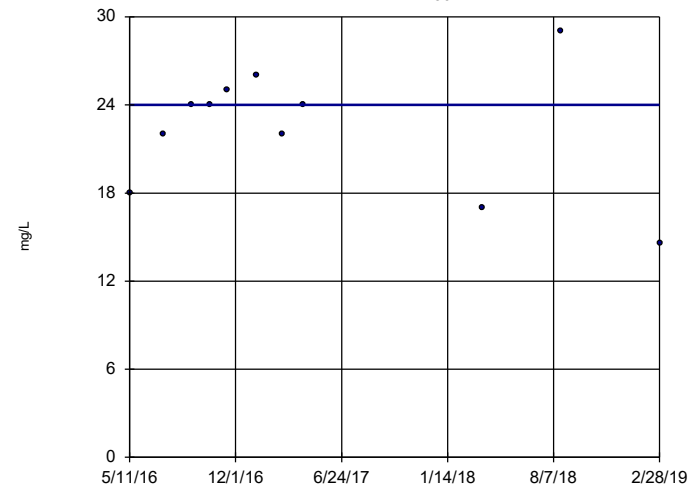


n = 11
Slope = -7.599
units per year.
Mann-Kendall
statistic = -15
critical = -34
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ per
tail).

Constituent: Chloride, total Analysis Run 7/7/2019 8:19 PM View: Trends
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-30



n = 11
Slope = 0
units per year.
Mann-Kendall
statistic = 3
critical = 34
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ 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

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Bg N</u>	<u>Bg Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
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

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Compliance</u>	<u>Lower Compl.</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
Cobalt, total (mg/L)	AD-28	0.01626	0.01321	0.009	n/a	Yes	11	0	No	0.01	Param.

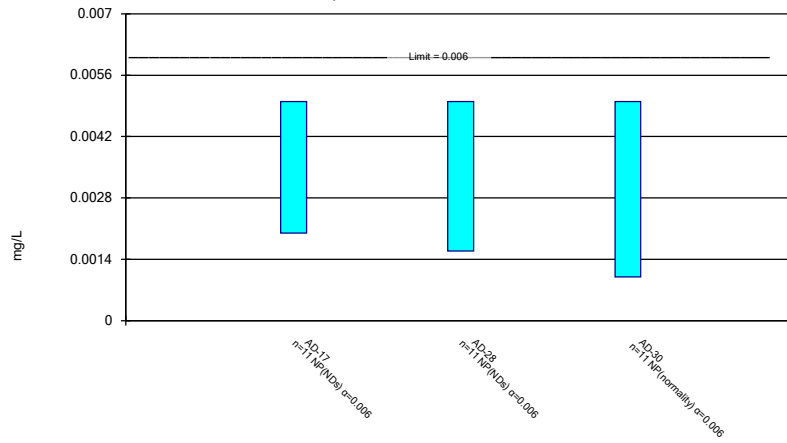
Confidence Interval Summary Table - All Results

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)

Non-Parametric Confidence Interval

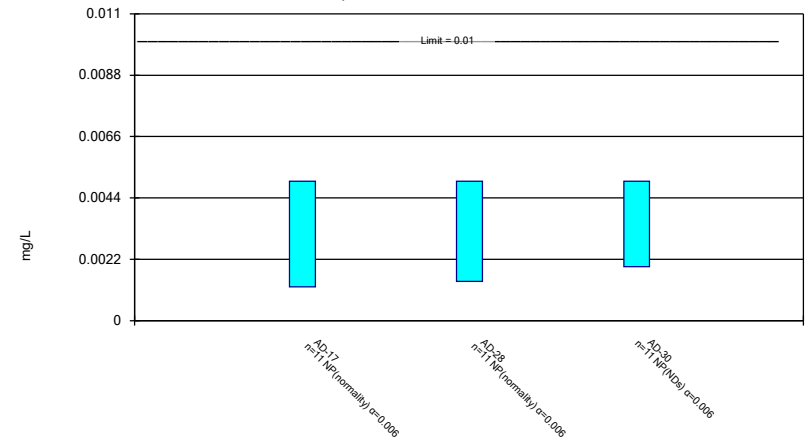
Compliance Limit is not exceeded.



Constituent: Antimony, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

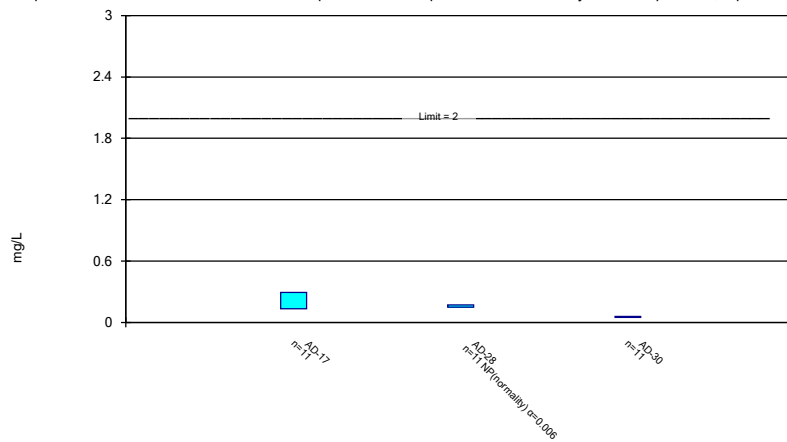
Compliance Limit is not exceeded.



Constituent: Arsenic, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

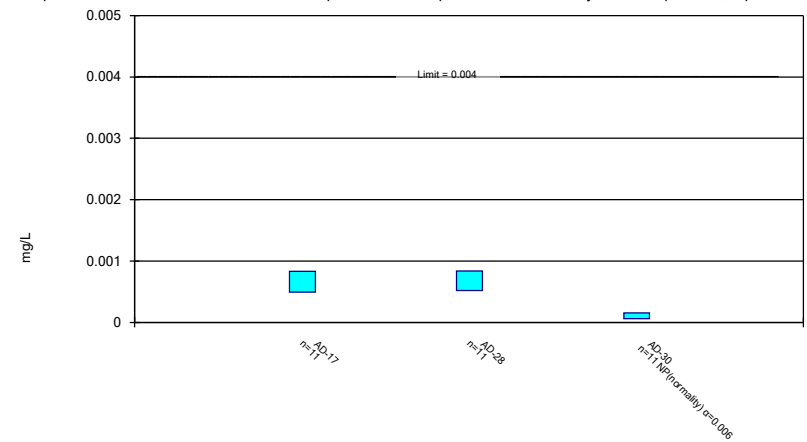
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Barium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

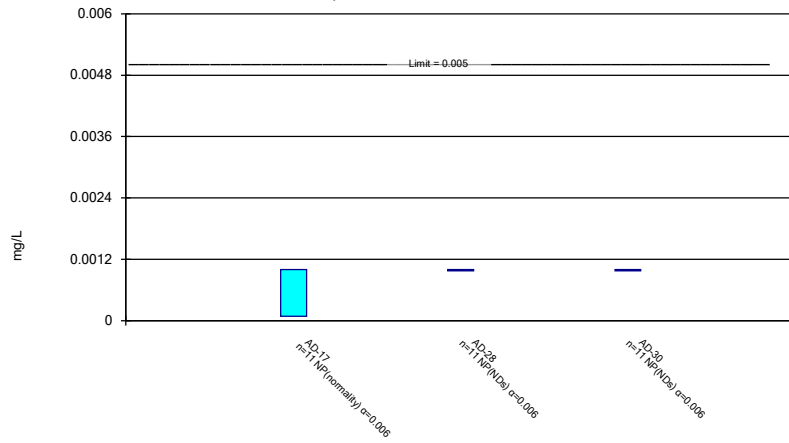
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

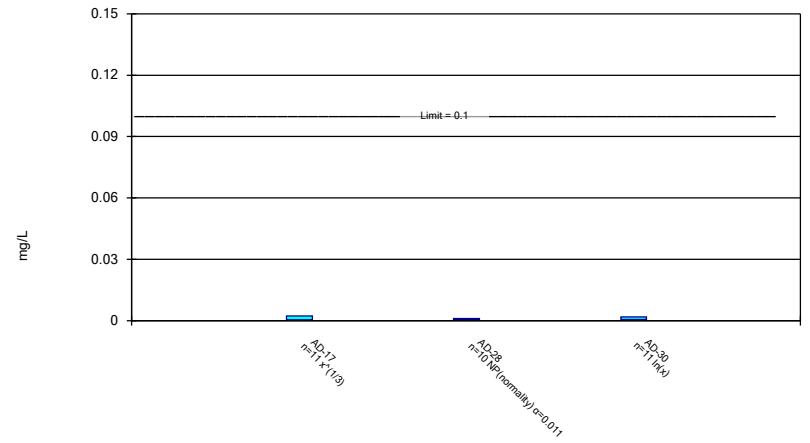
Compliance Limit is not exceeded.



Constituent: Cadmium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

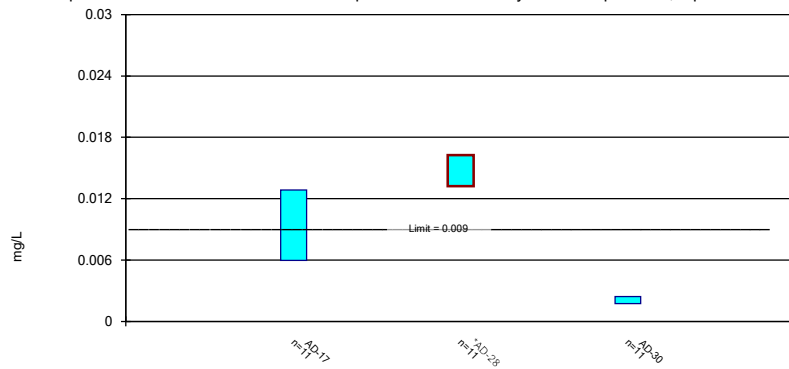
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chromium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

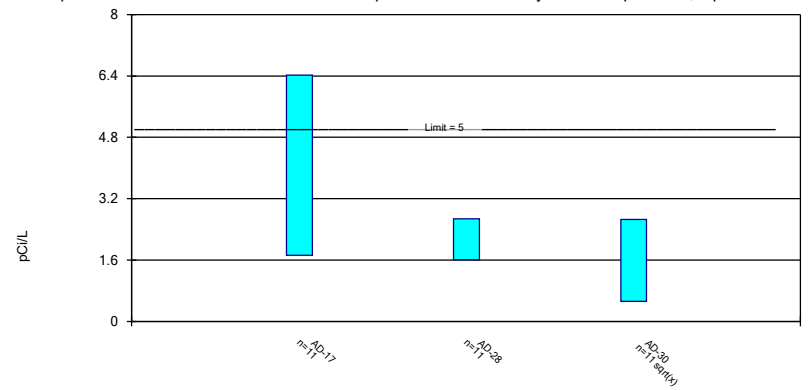
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cobalt, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

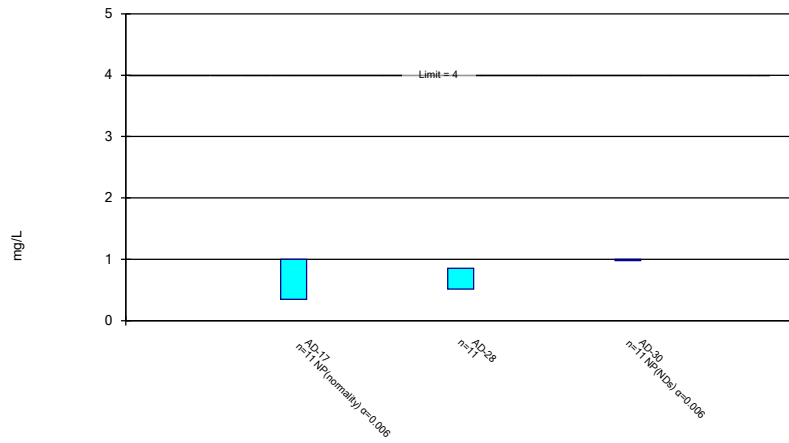
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals -
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

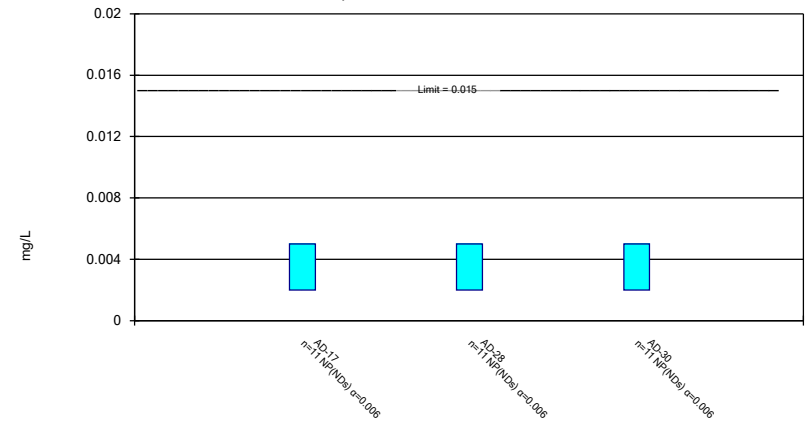
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Fluoride, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

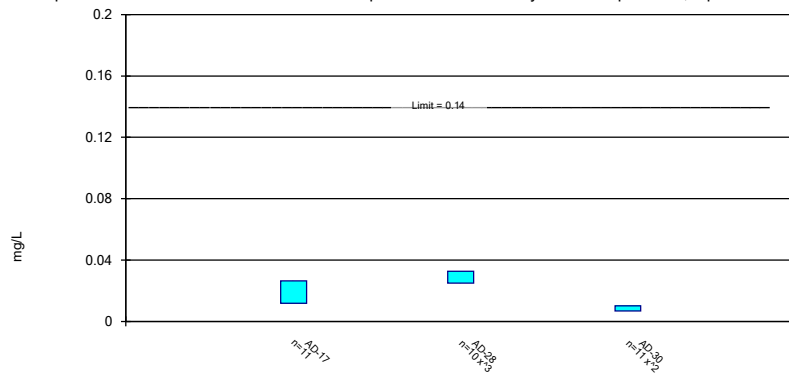
Compliance Limit is not exceeded.



Constituent: Lead, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

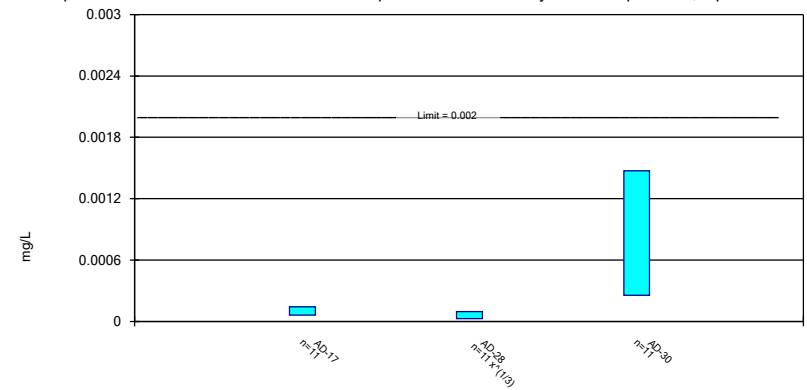
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Lithium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

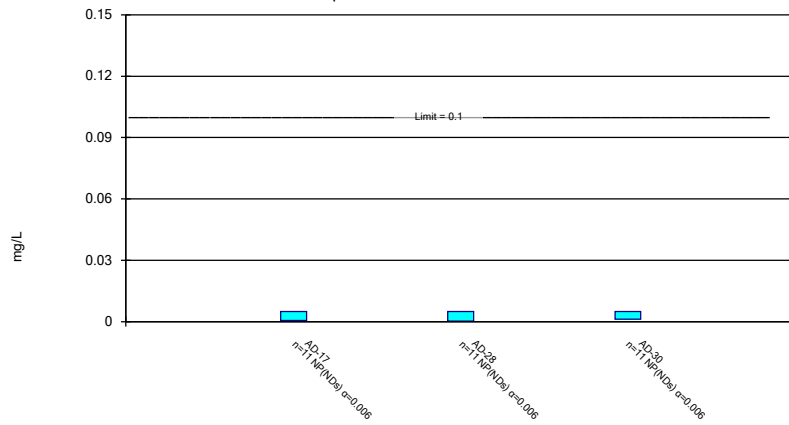
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Mercury, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

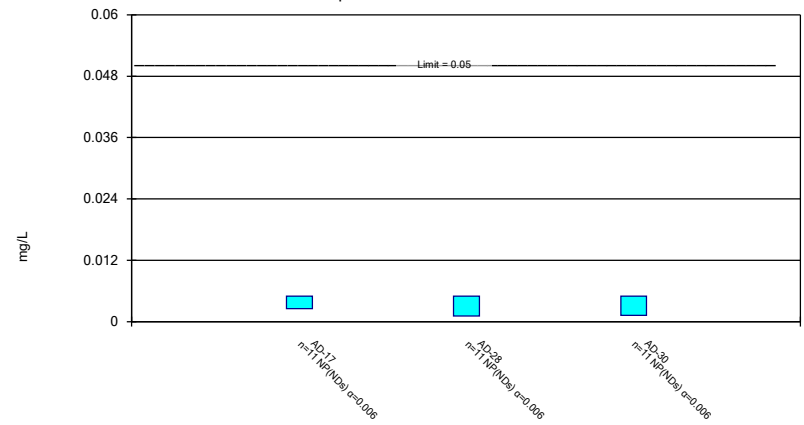
Compliance Limit is not exceeded.



Constituent: Molybdenum, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

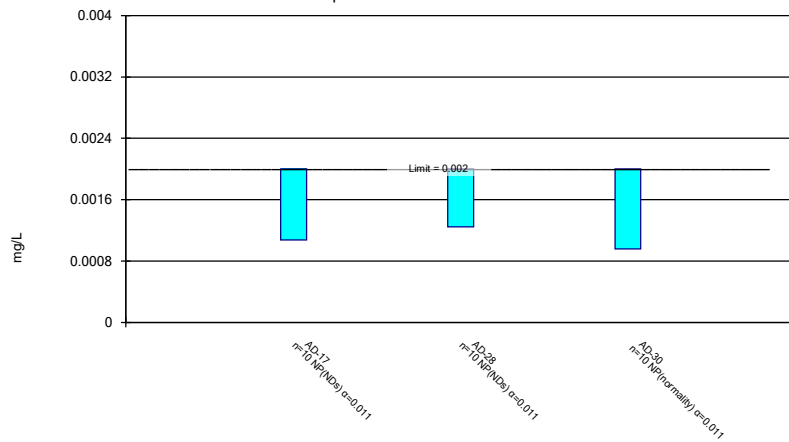
Compliance Limit is not exceeded.



Constituent: Selenium, total Analysis Run 7/9/2019 12:53 PM View: Confidence Intervals - App IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



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

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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
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-Francia 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

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 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).

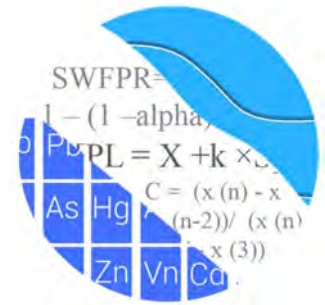
Sampling began at the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **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,

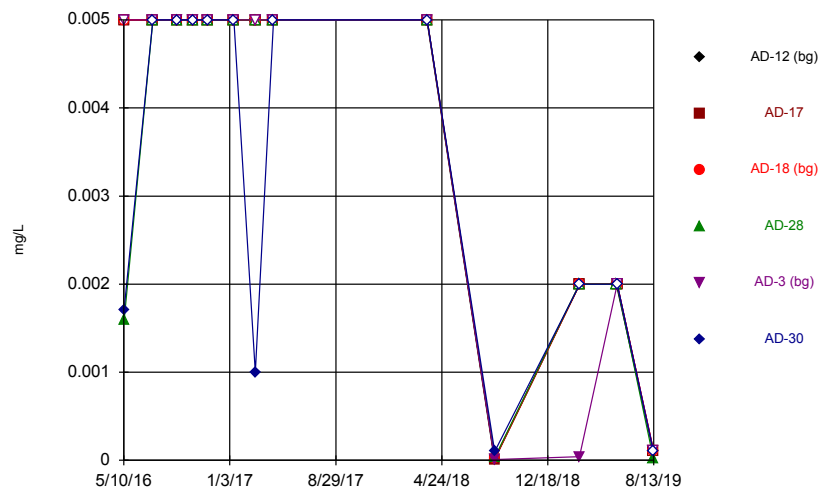
A handwritten signature in black ink that reads "A Collins". The signature is written in a cursive, slightly slanted style.

Andrew T. Collins
Groundwater Analyst

A handwritten signature in black ink that reads "Kristina Rayner". The signature is written in a cursive, slightly slanted style.

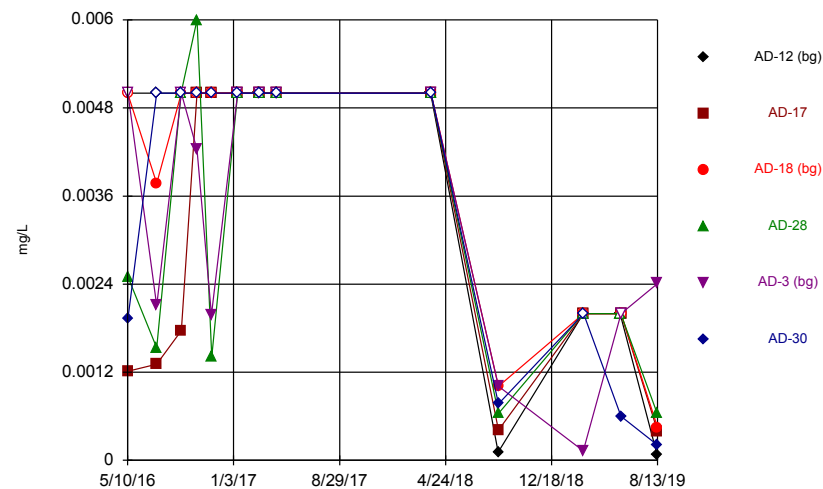
Kristina L. Rayner
Groundwater Statistician

Time Series



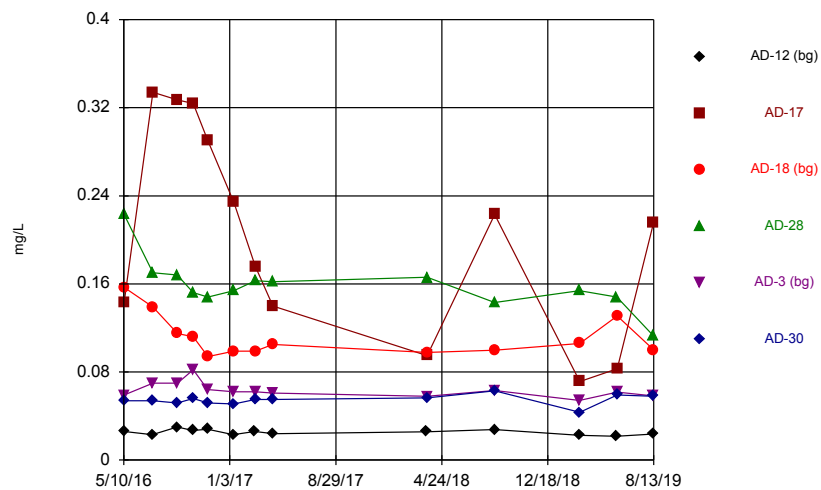
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Time Series



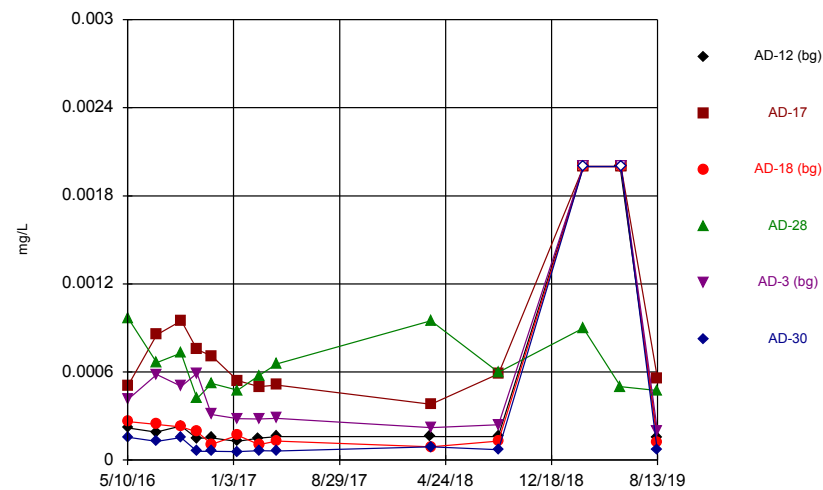
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Time Series



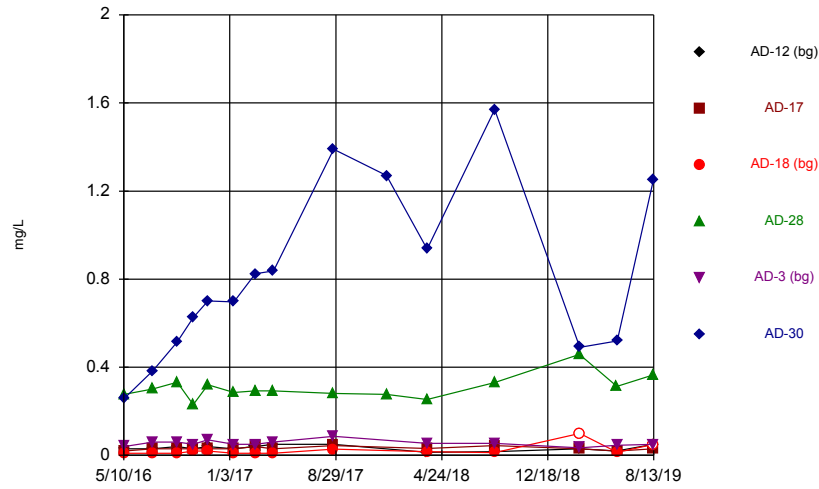
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Time Series



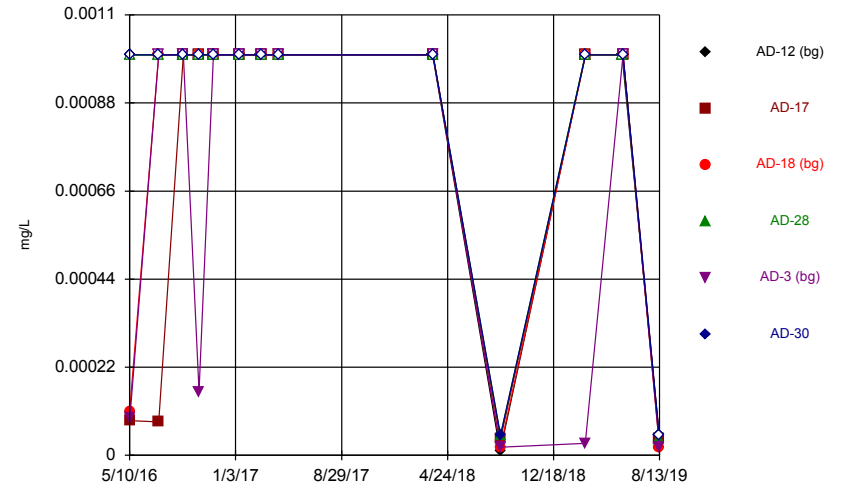
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Time Series



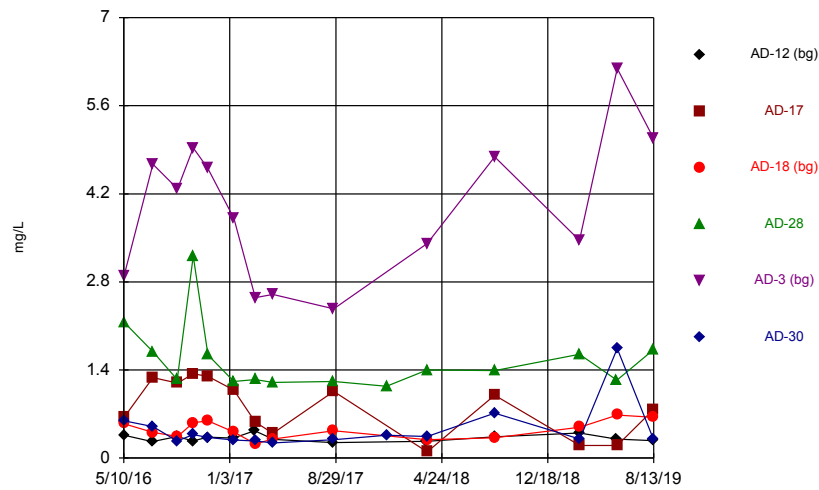
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Time Series



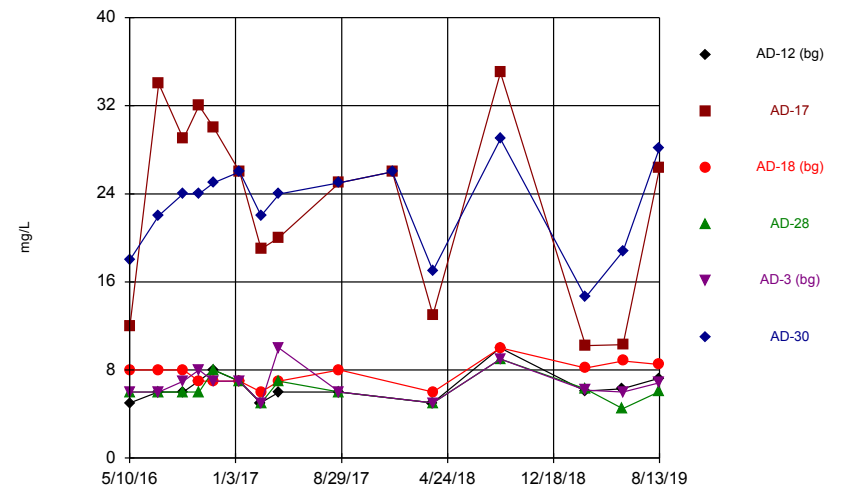
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Time Series



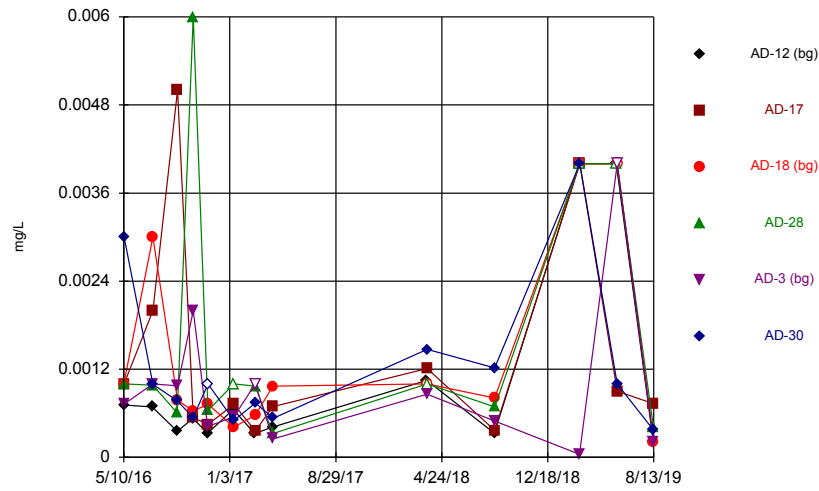
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Time Series



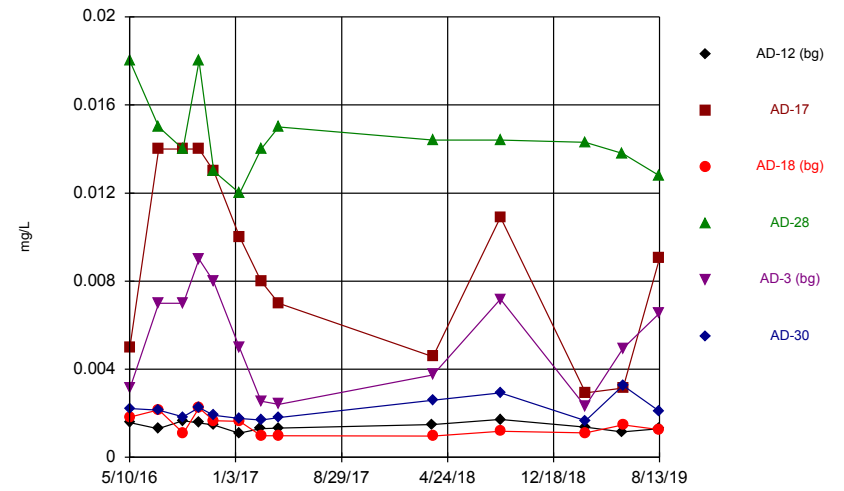
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Time Series



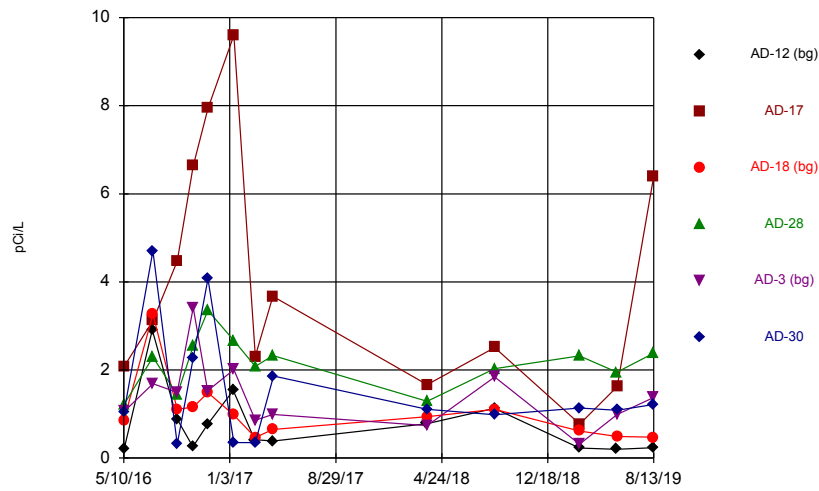
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Time Series



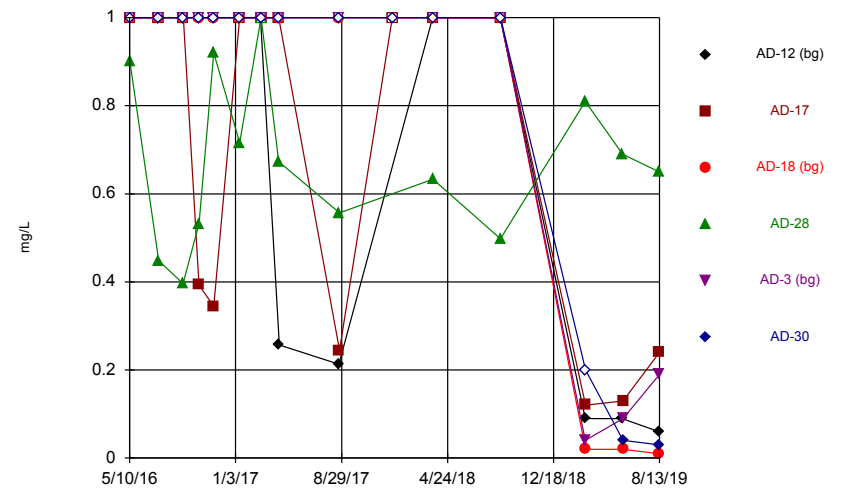
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Time Series



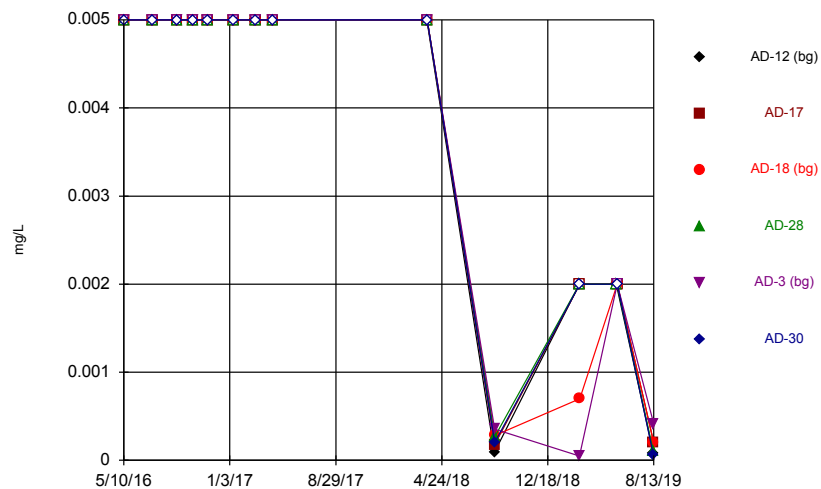
Constituent: Combined Radium 226 + 228 Analysis Run 12/6/2019 8:34 AM
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Time Series



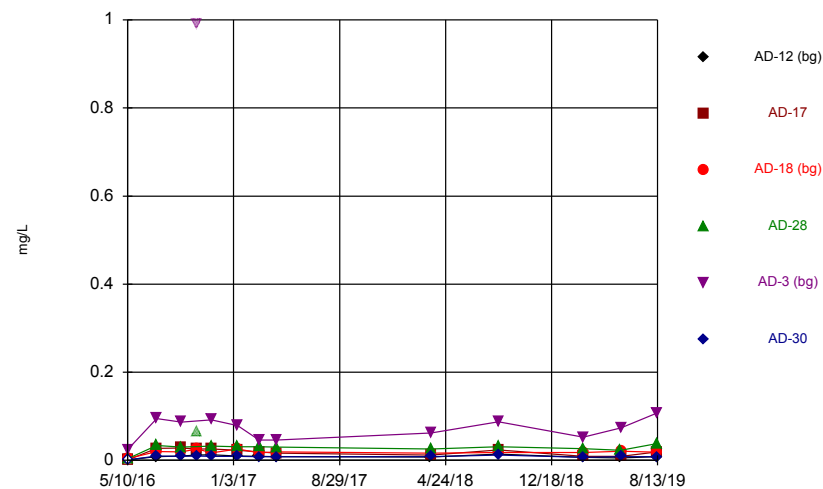
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Time Series



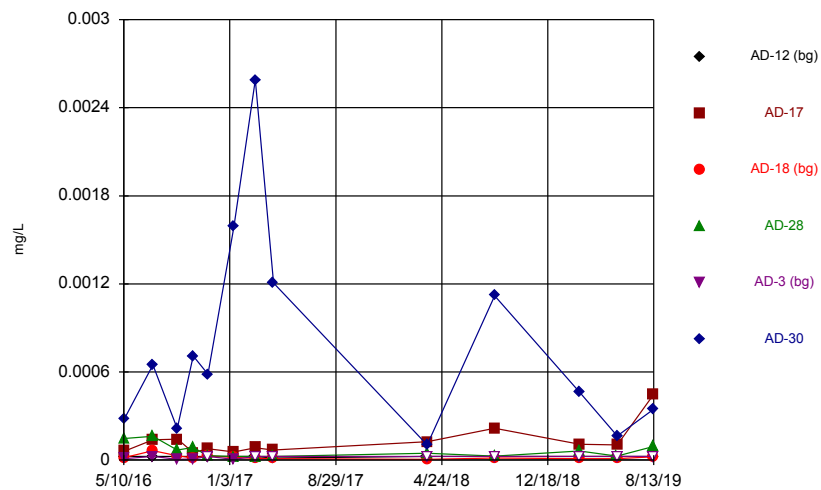
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Time Series



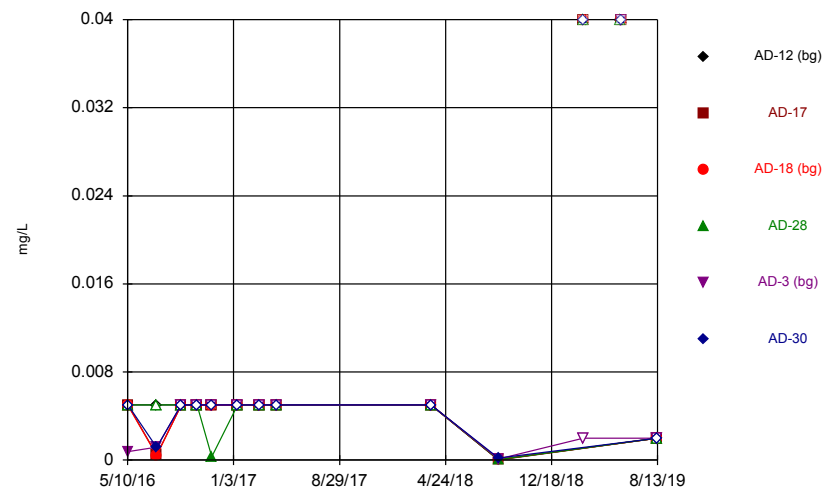
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Time Series



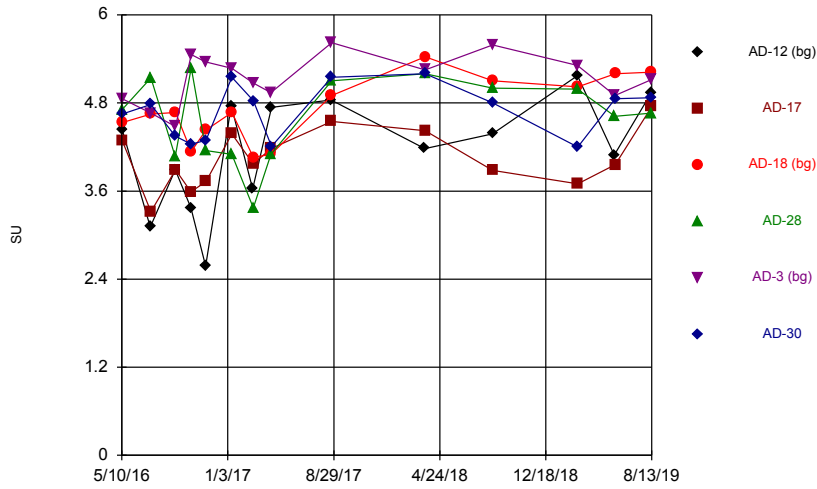
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Time Series



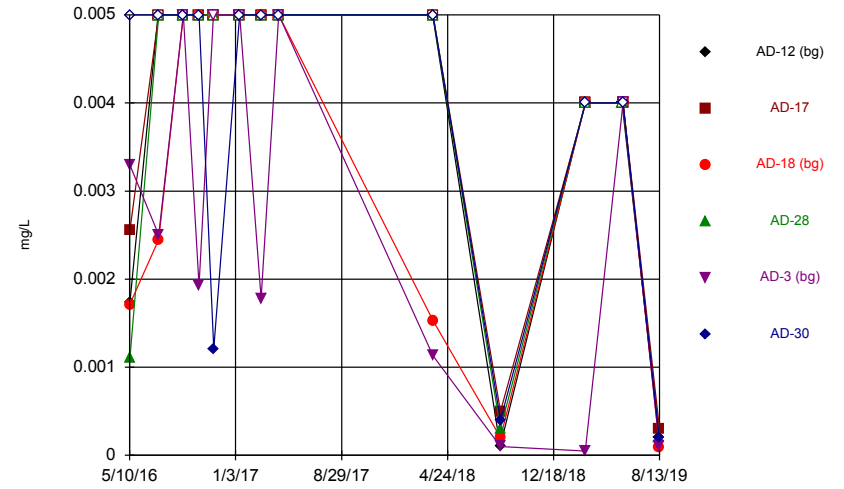
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Time Series



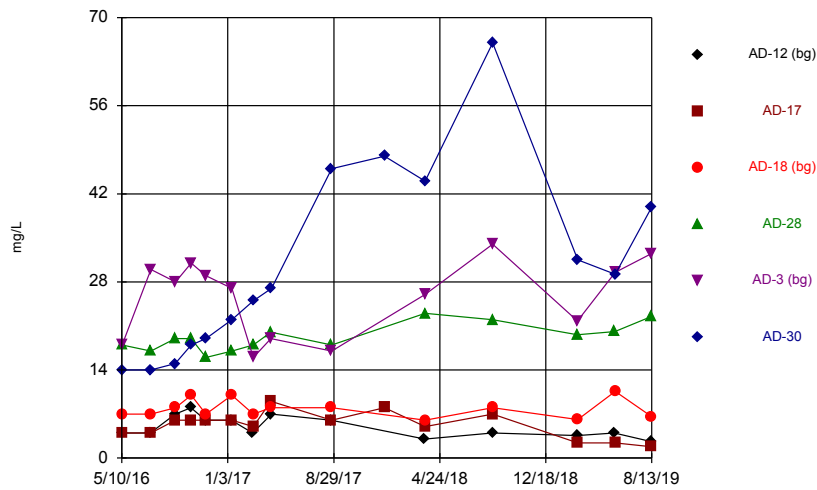
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Time Series



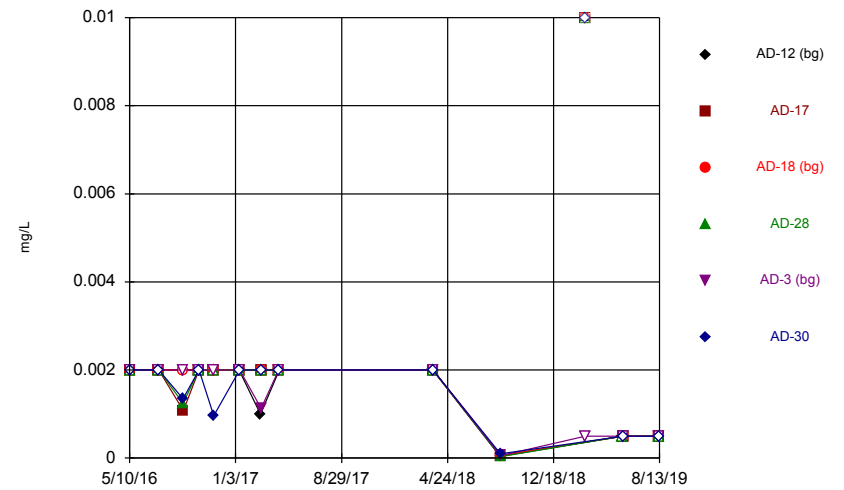
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Time Series



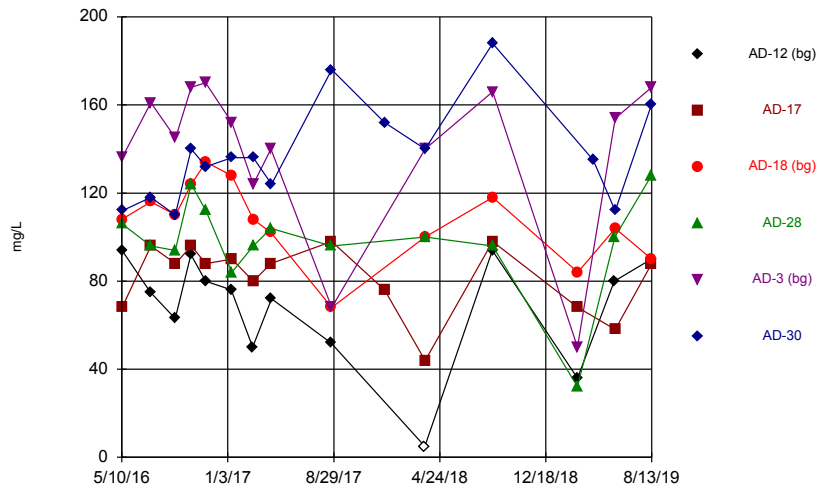
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Time Series



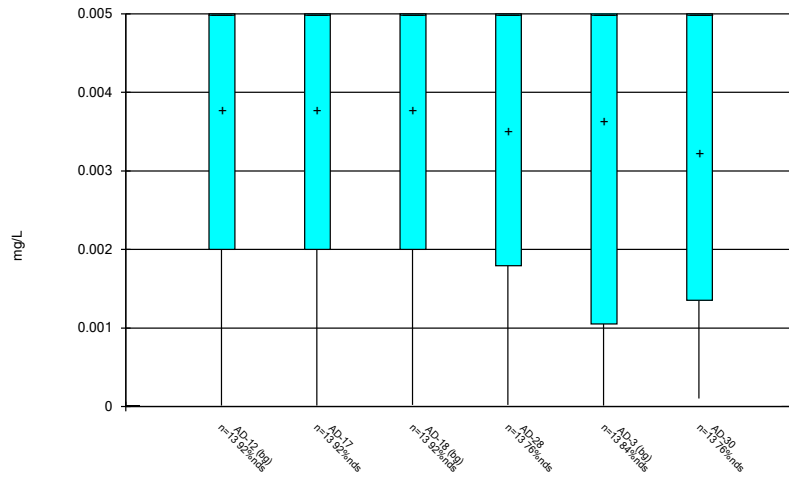
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Time Series



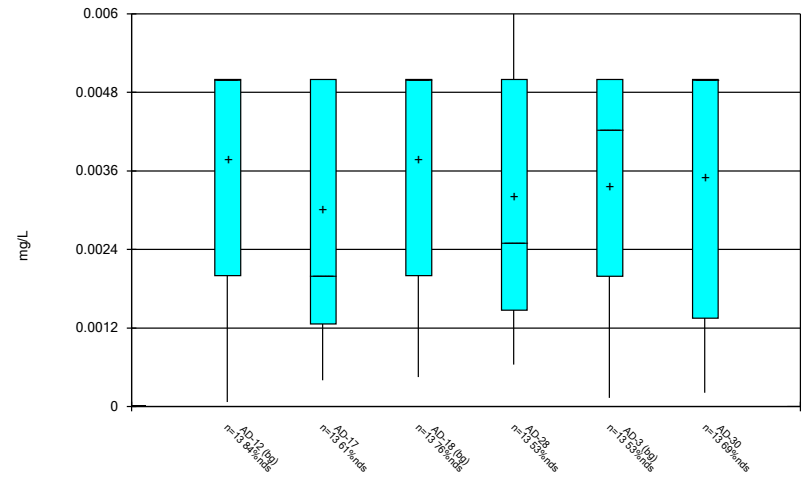
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Box & Whiskers Plot



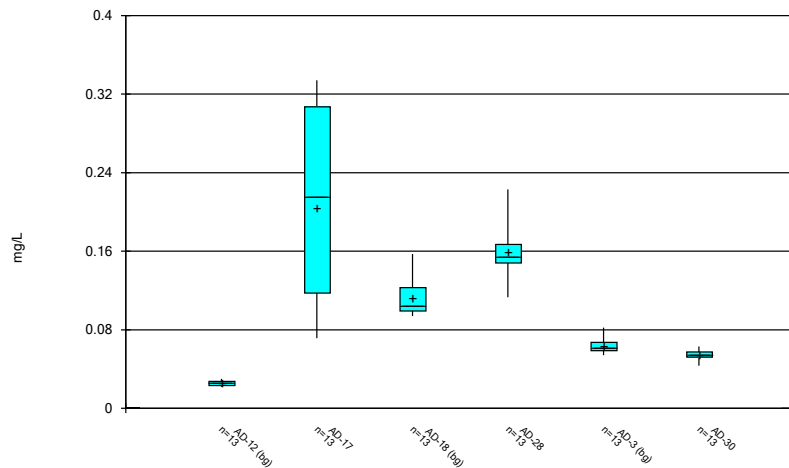
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Box & Whiskers Plot



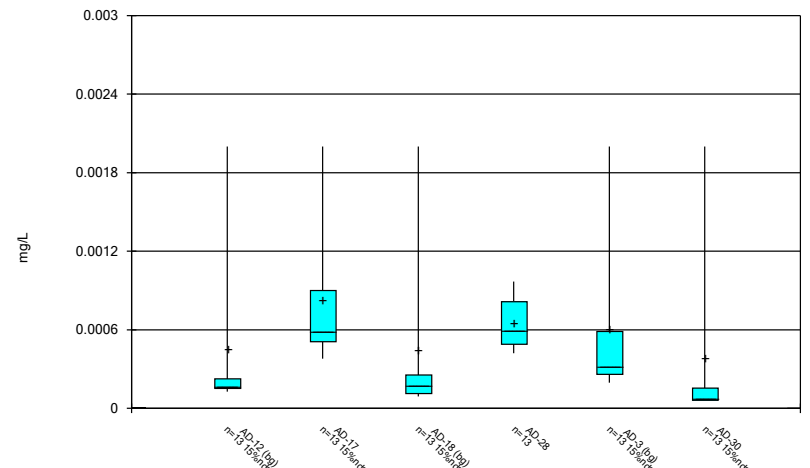
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Box & Whiskers Plot



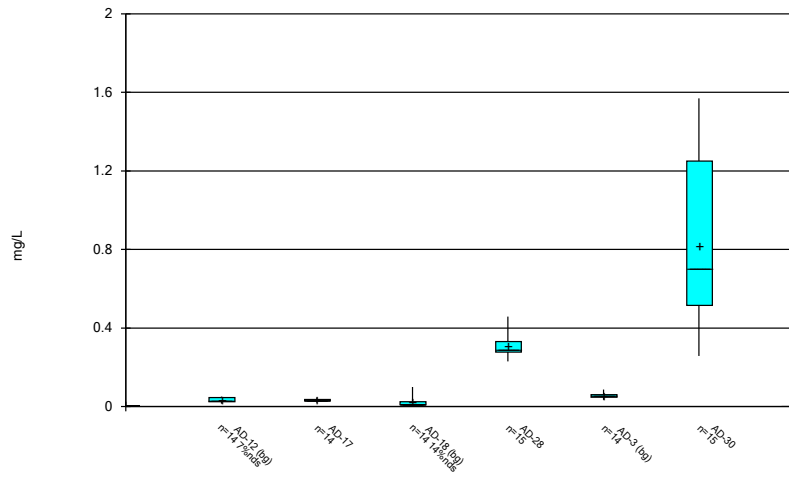
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Box & Whiskers Plot



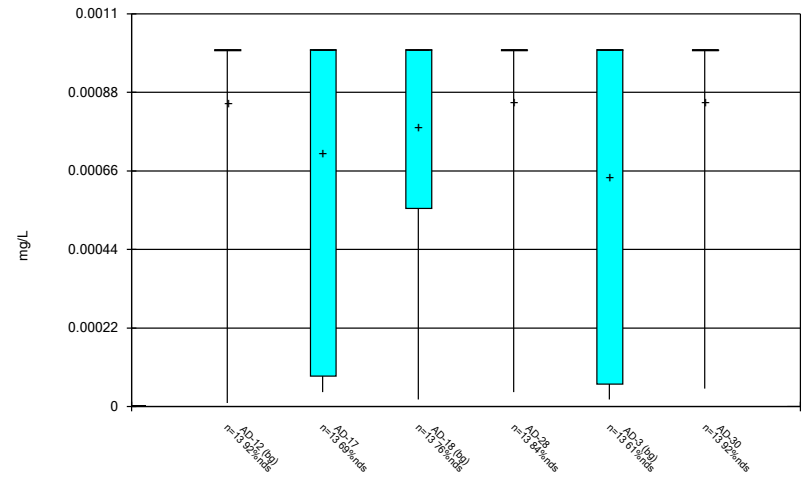
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Box & Whiskers Plot



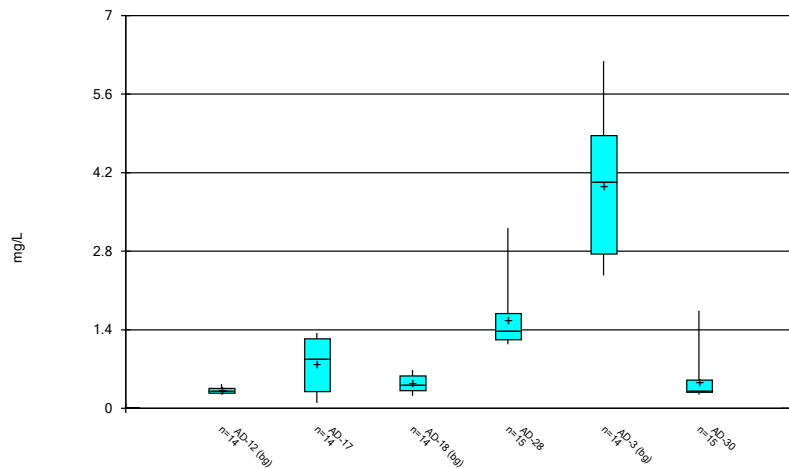
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Box & Whiskers Plot



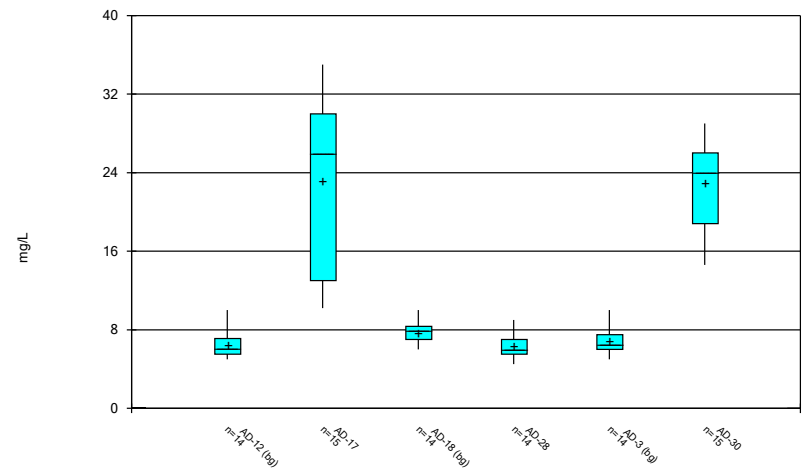
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Box & Whiskers Plot



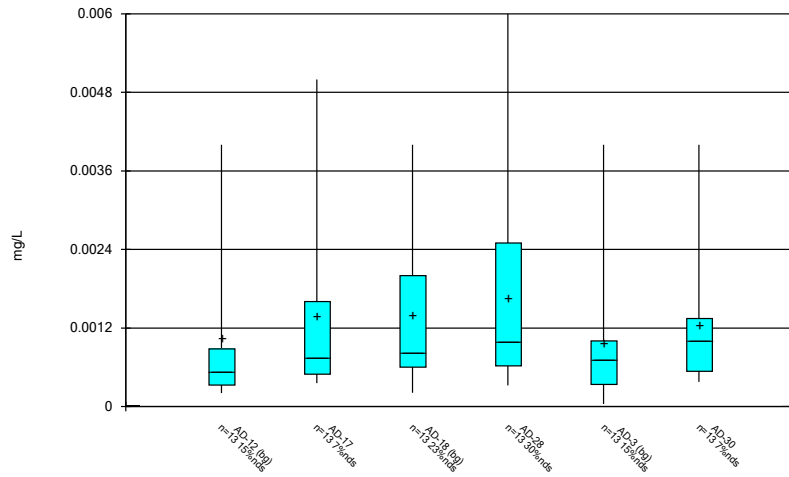
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Box & Whiskers Plot



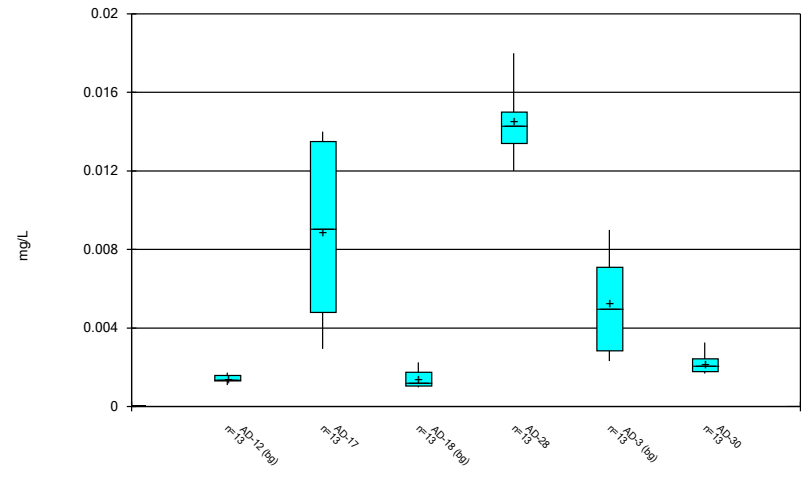
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 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



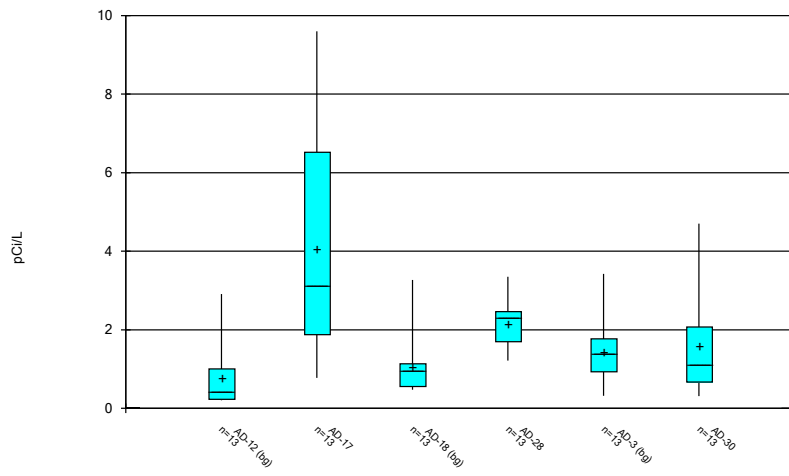
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 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



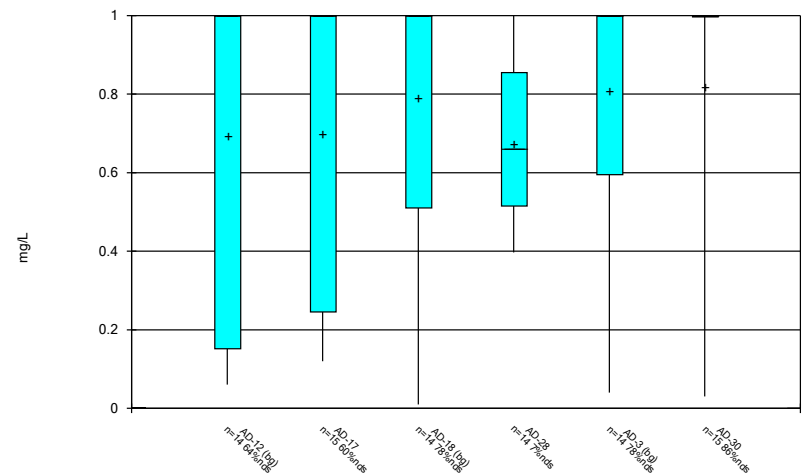
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Box & Whiskers Plot



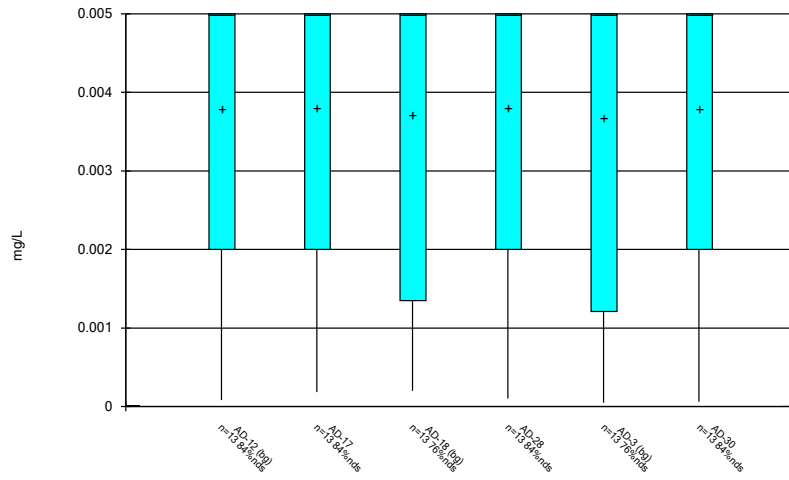
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Box & Whiskers Plot



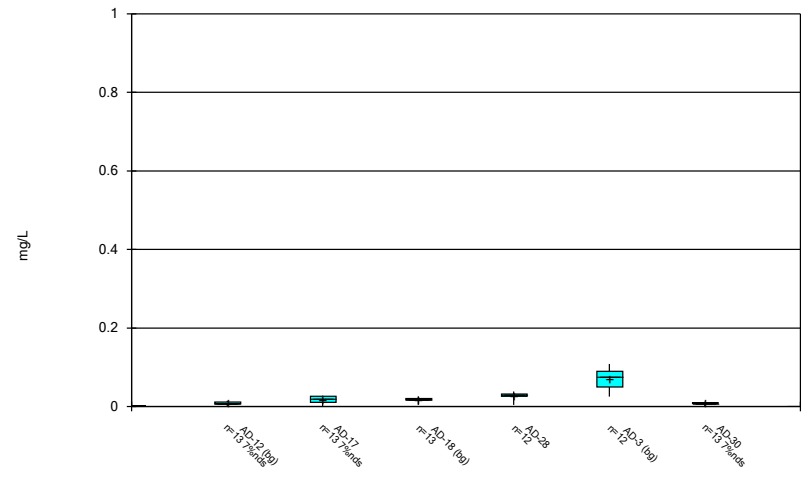
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Box & Whiskers Plot



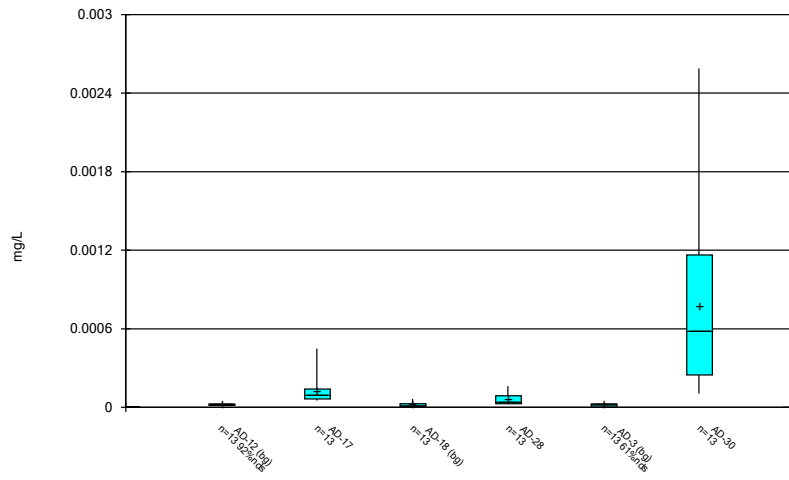
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 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



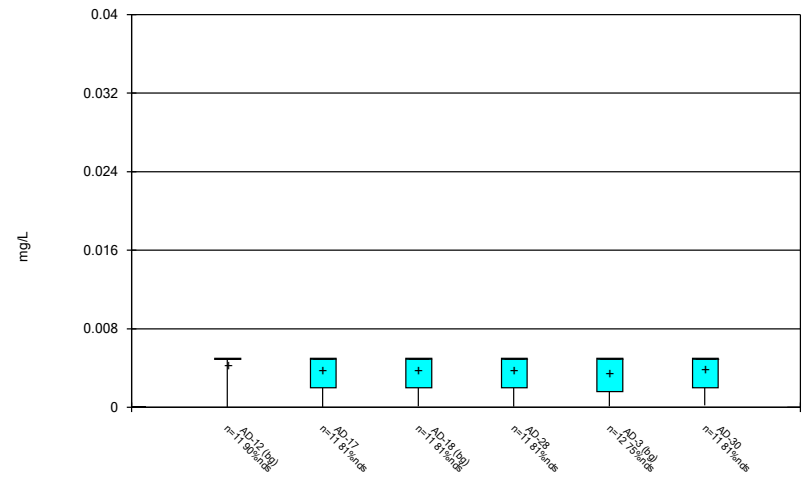
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Box & Whiskers Plot



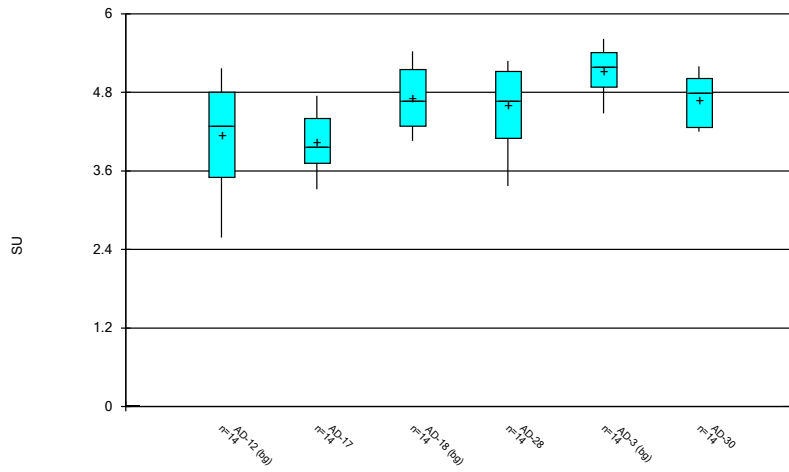
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 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



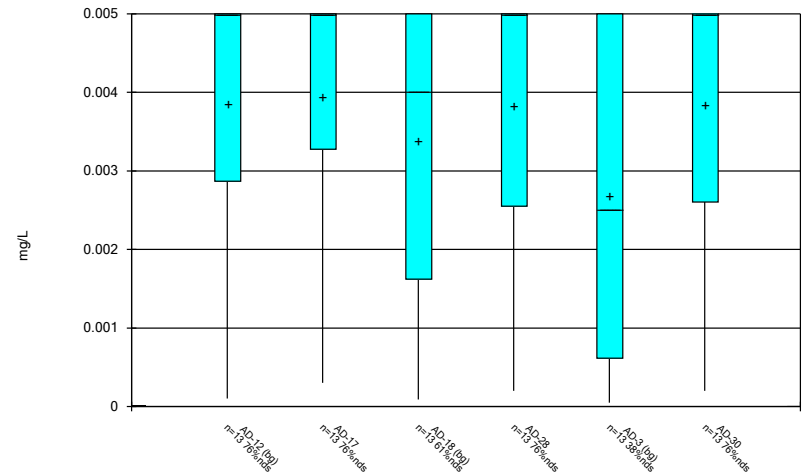
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 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



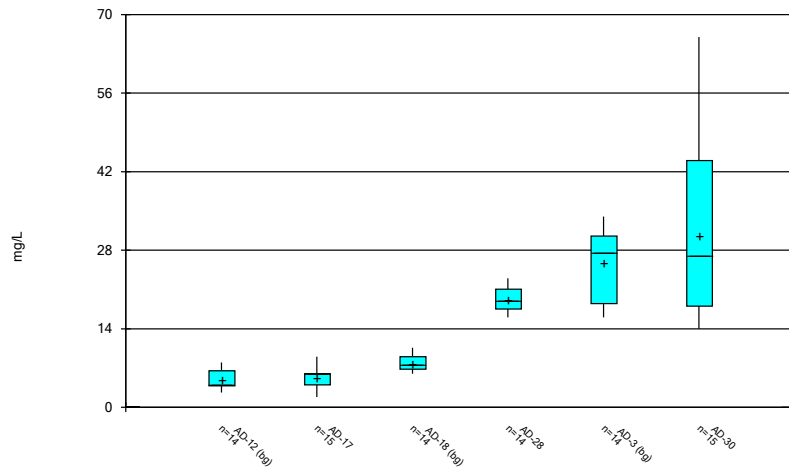
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 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Box & Whiskers Plot



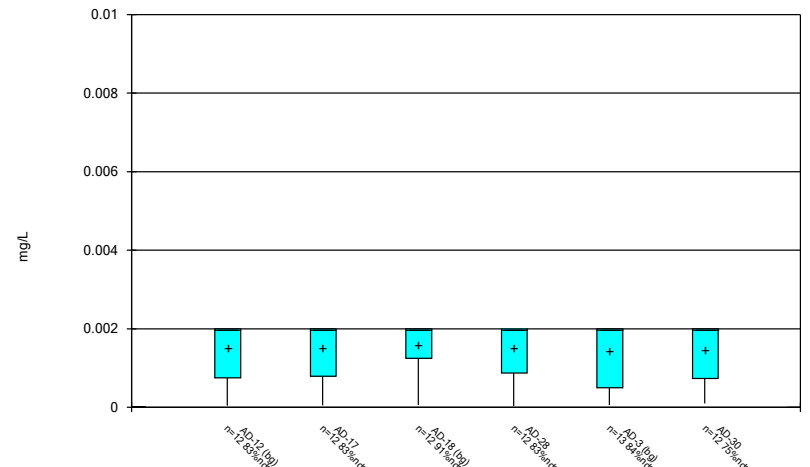
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Box & Whiskers Plot



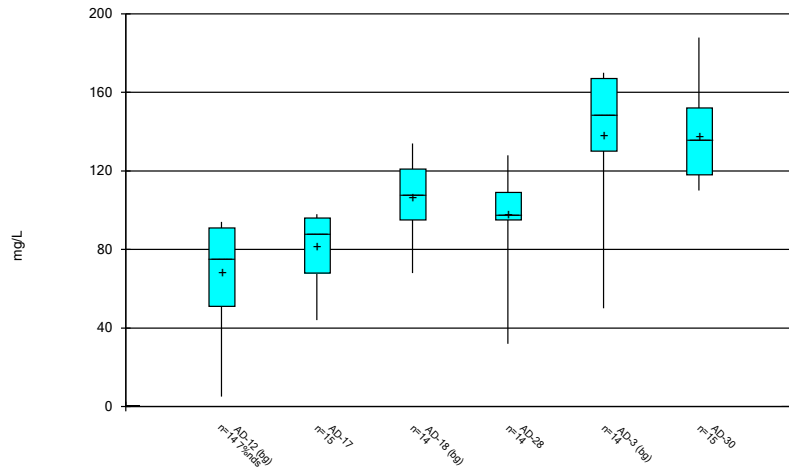
Constituent: Sulfate, total Analysis Run 12/6/2019 8:36 AM
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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

<u>Constituent</u>	<u>Well</u>	<u>Calc.</u>	<u>0.01</u>	<u>Method</u>
pH, field (SU)	AD-18 (bg)	2.637	Yes	Mann-W
Sulfate, total (mg/L)	AD-30	2.858	Yes	Mann-W

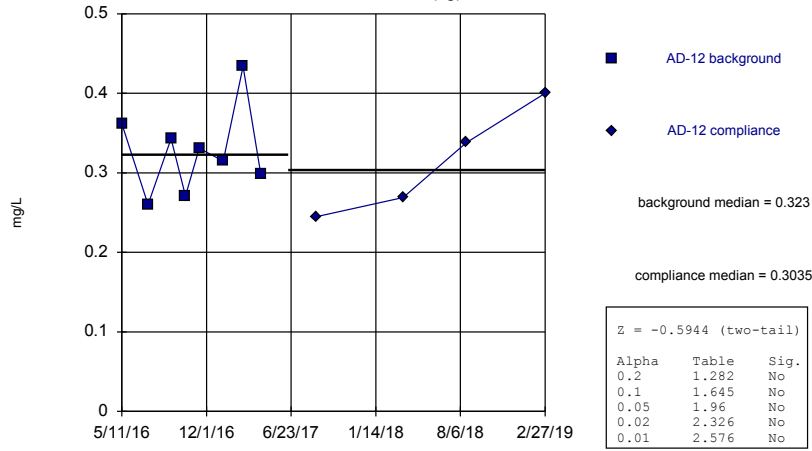
Welch's t-test/Mann-Whitney - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 12/9/2019, 7:40 AM

<u>Constituent</u>	<u>Well</u>	<u>Calc.</u>	<u>0.01</u>	<u>Method</u>
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

Mann-Whitney (Wilcoxon Rank Sum)

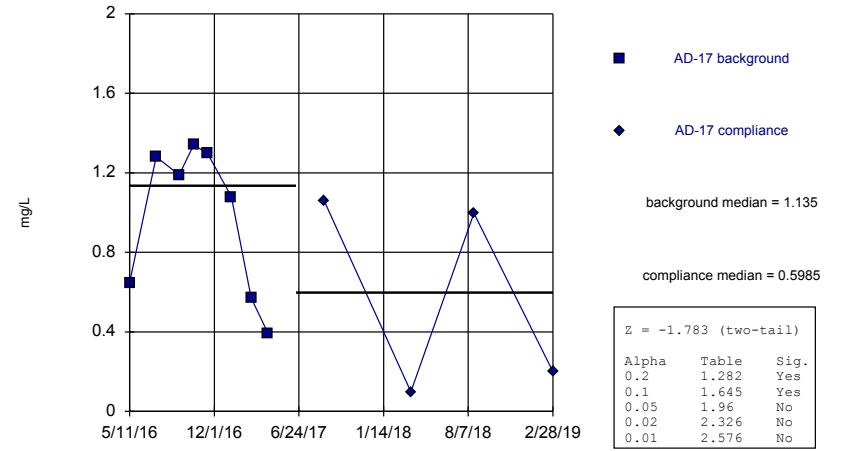
AD-12 (bg)



Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

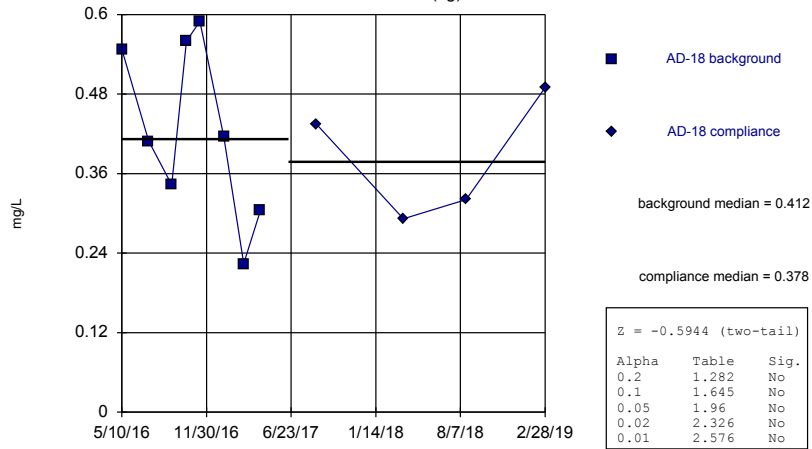
AD-17



Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

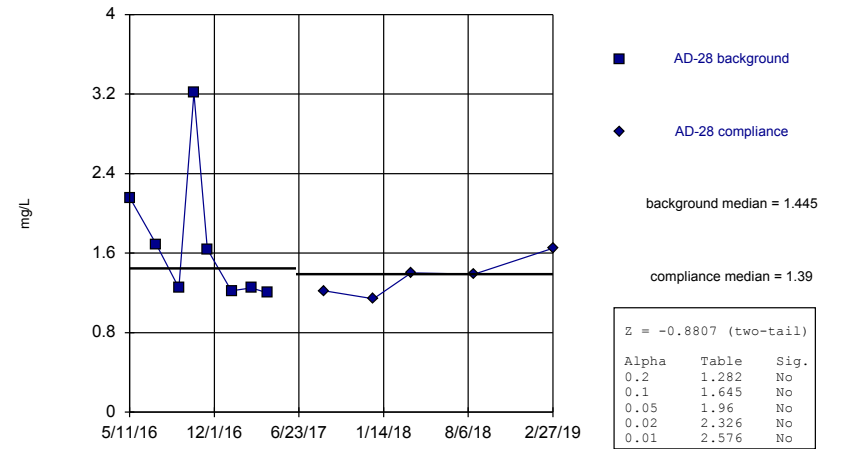
AD-18 (bg)



Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

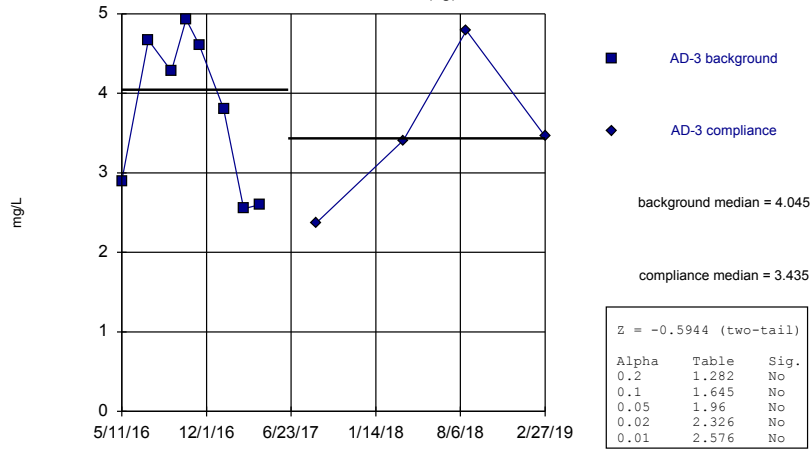
AD-28



Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

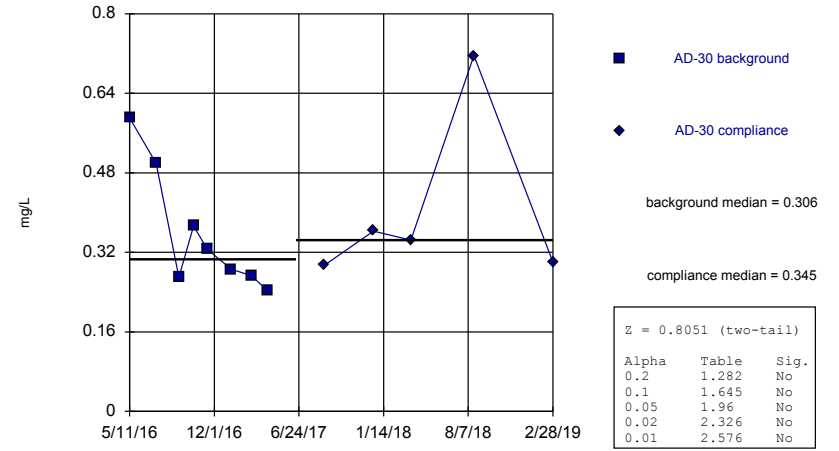
AD-3 (bg)



Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

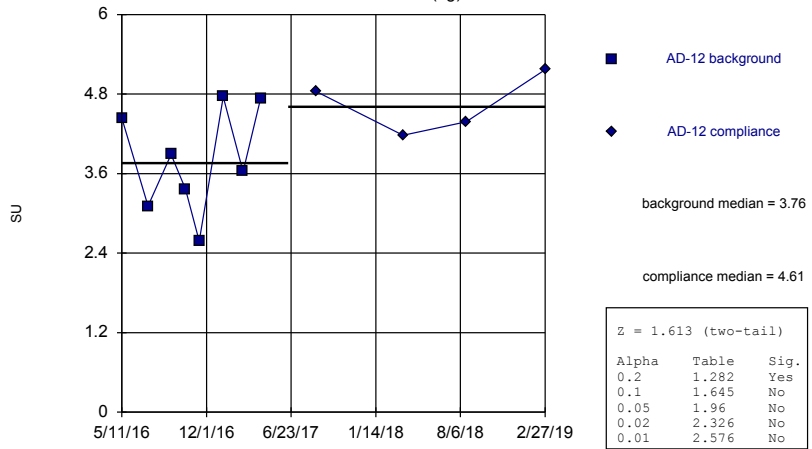
AD-30



Constituent: Calcium, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

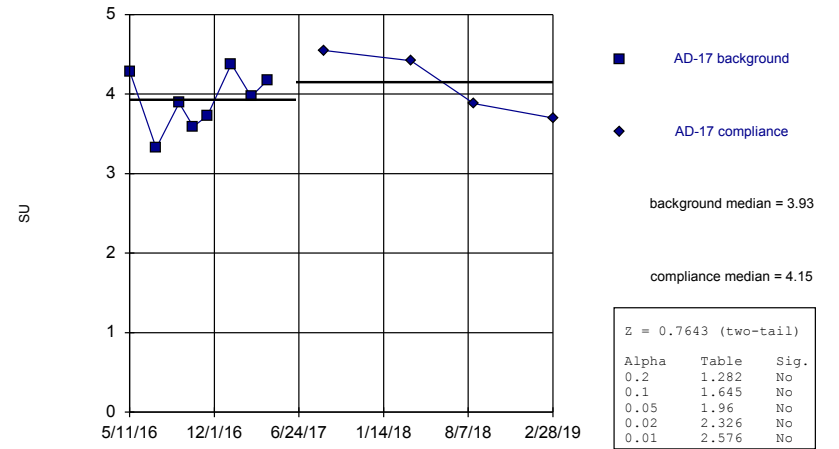
AD-12 (bg)



Constituent: pH, field Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

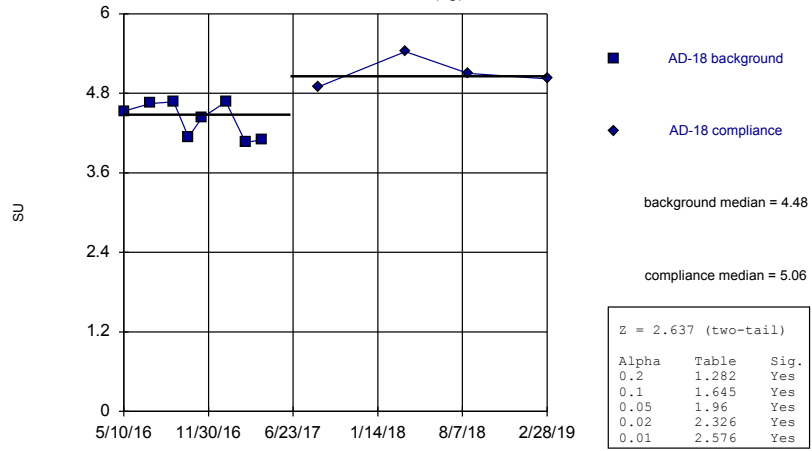
Mann-Whitney (Wilcoxon Rank Sum)

AD-17



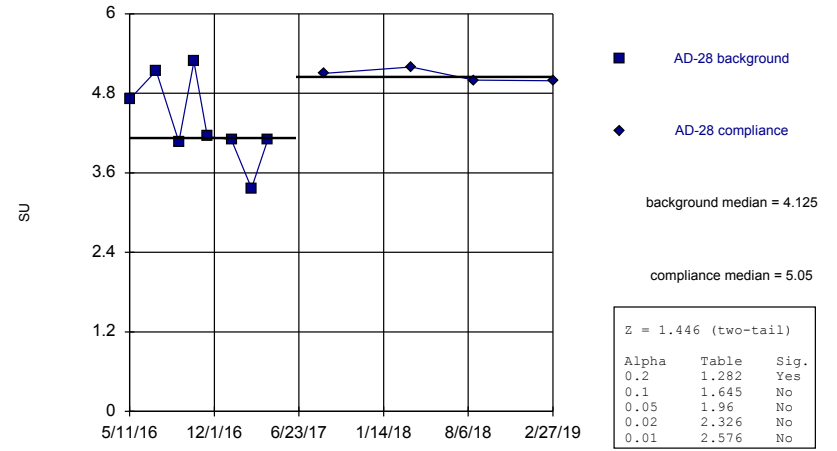
Constituent: pH, field Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)
AD-18 (bg)



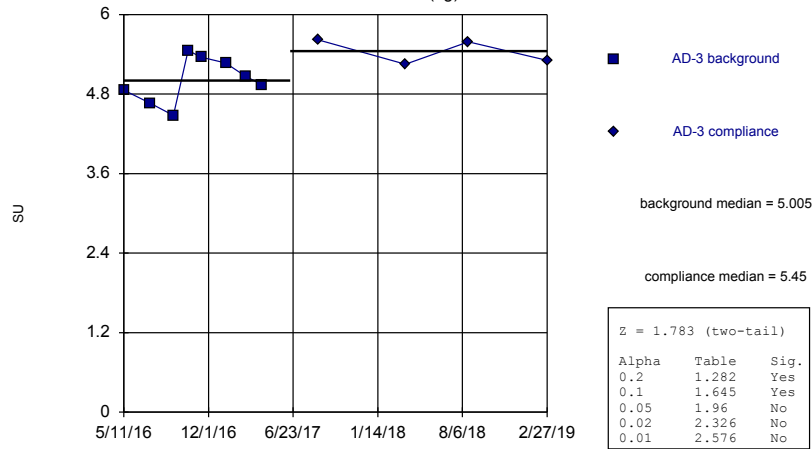
Constituent: pH, field Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)
AD-28



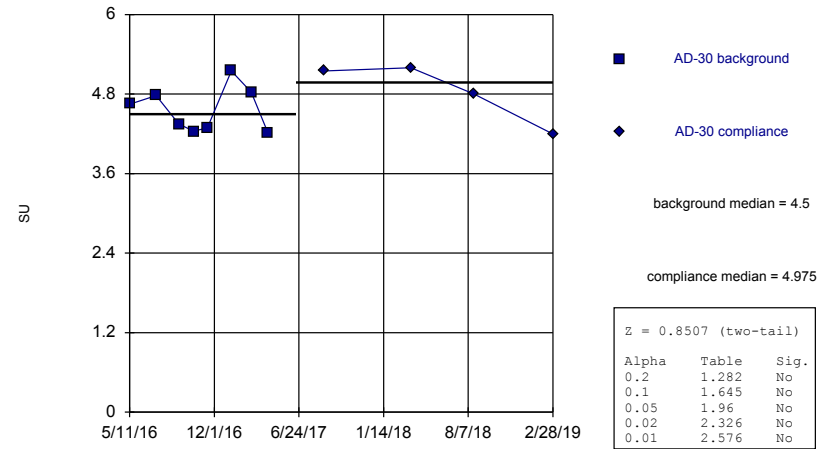
Constituent: pH, field Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)
AD-3 (bg)



Constituent: pH, field Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

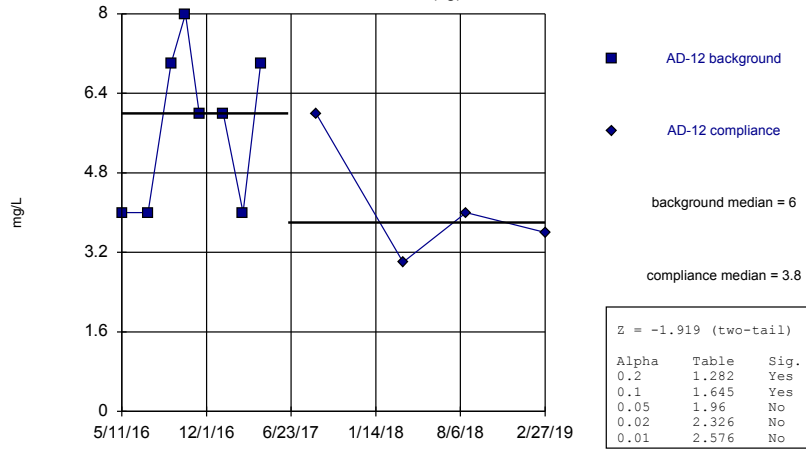
Mann-Whitney (Wilcoxon Rank Sum)
AD-30



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)

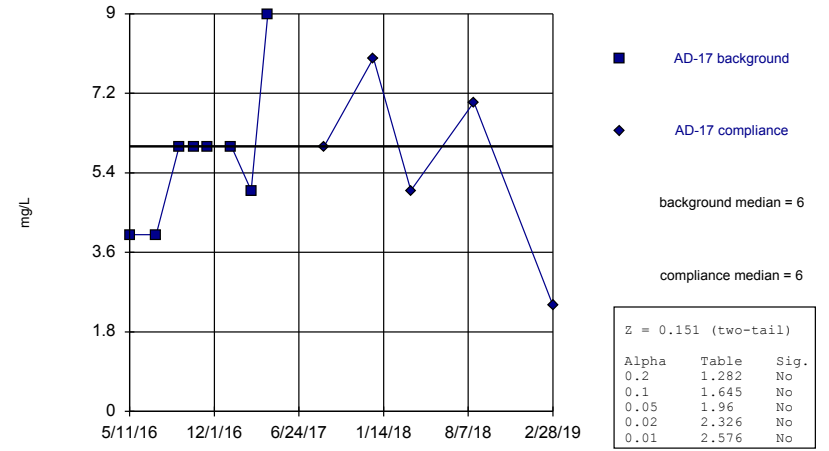
AD-12 (bg)



Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

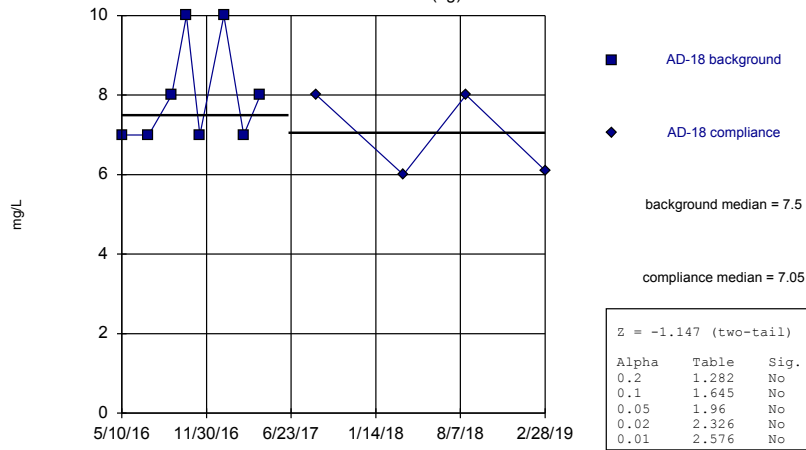
AD-17



Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

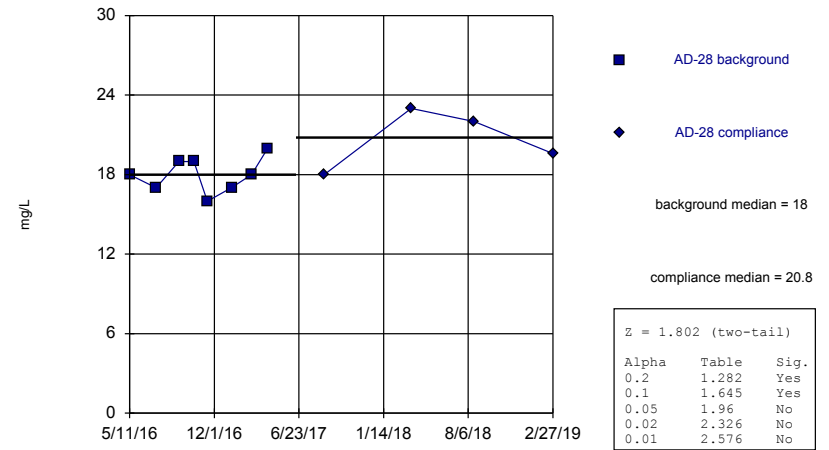
AD-18 (bg)



Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

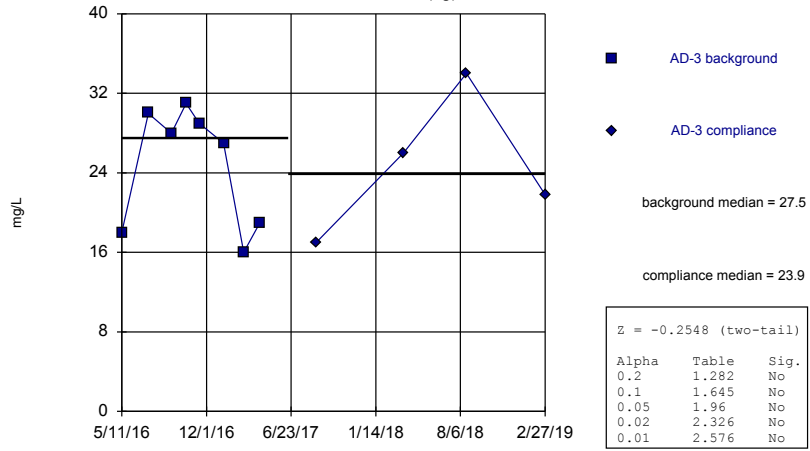
AD-28



Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

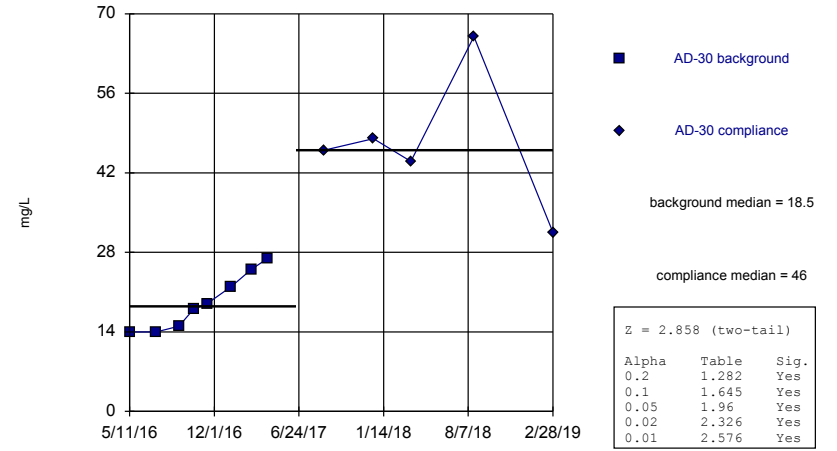
AD-3 (bg)



Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

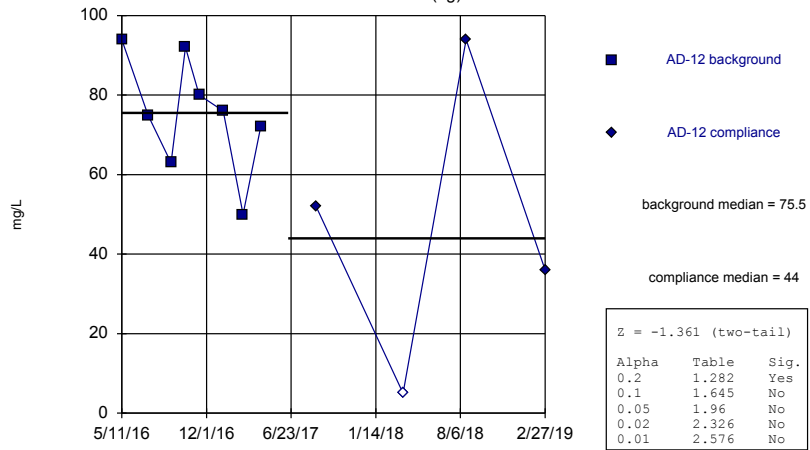
AD-30



Constituent: Sulfate, total Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)

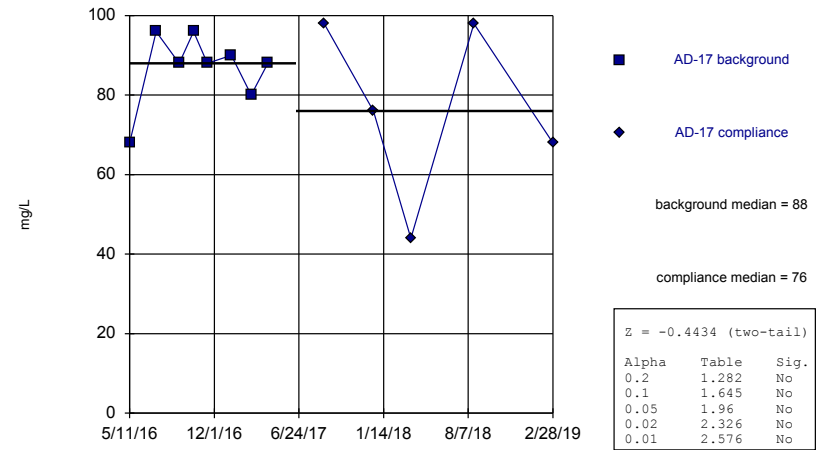
AD-12 (bg)



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

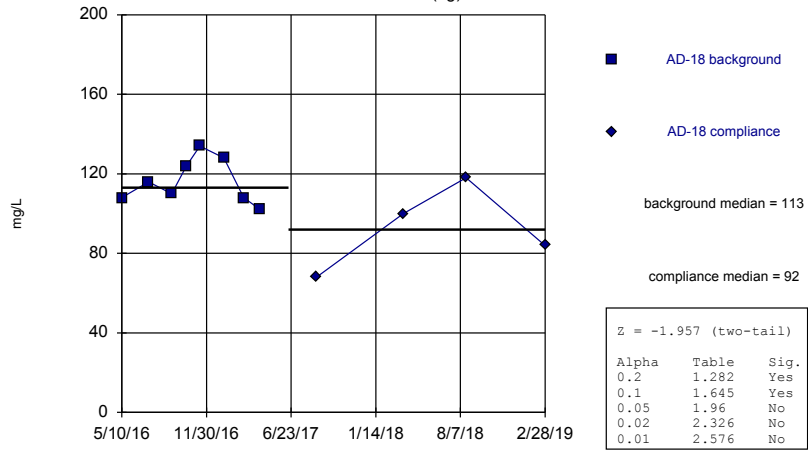
Mann-Whitney (Wilcoxon Rank Sum)

AD-17



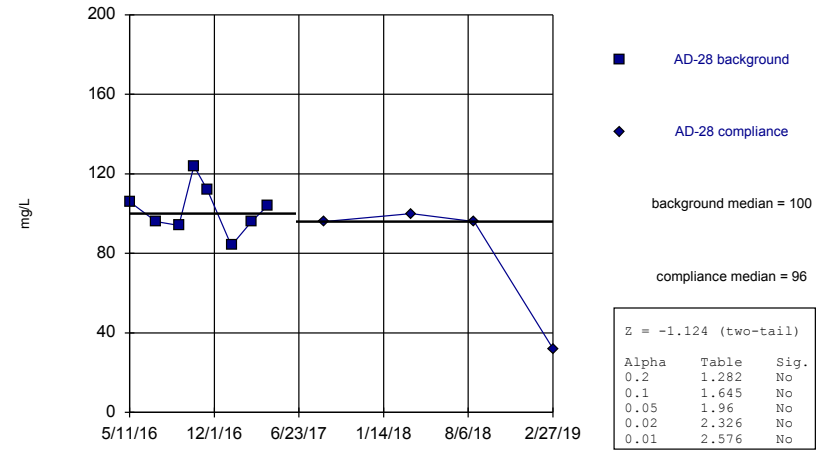
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)
AD-18 (bg)



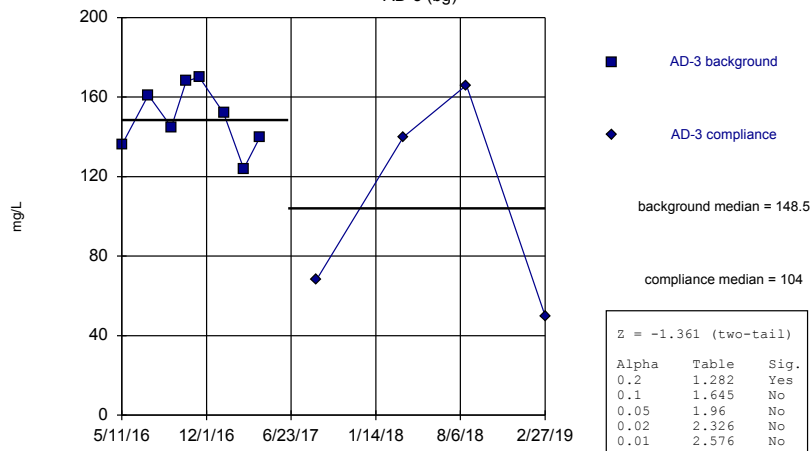
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)
AD-28



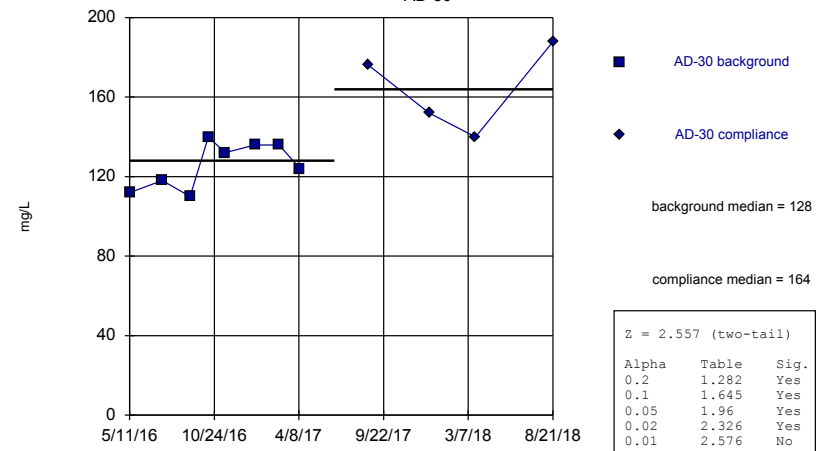
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)
AD-3 (bg)



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:39 AM View: Intrawell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Mann-Whitney (Wilcoxon Rank Sum)
AD-30



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

pH, field (SU)

AD-18 background: 11/15/2016-2/28/2019

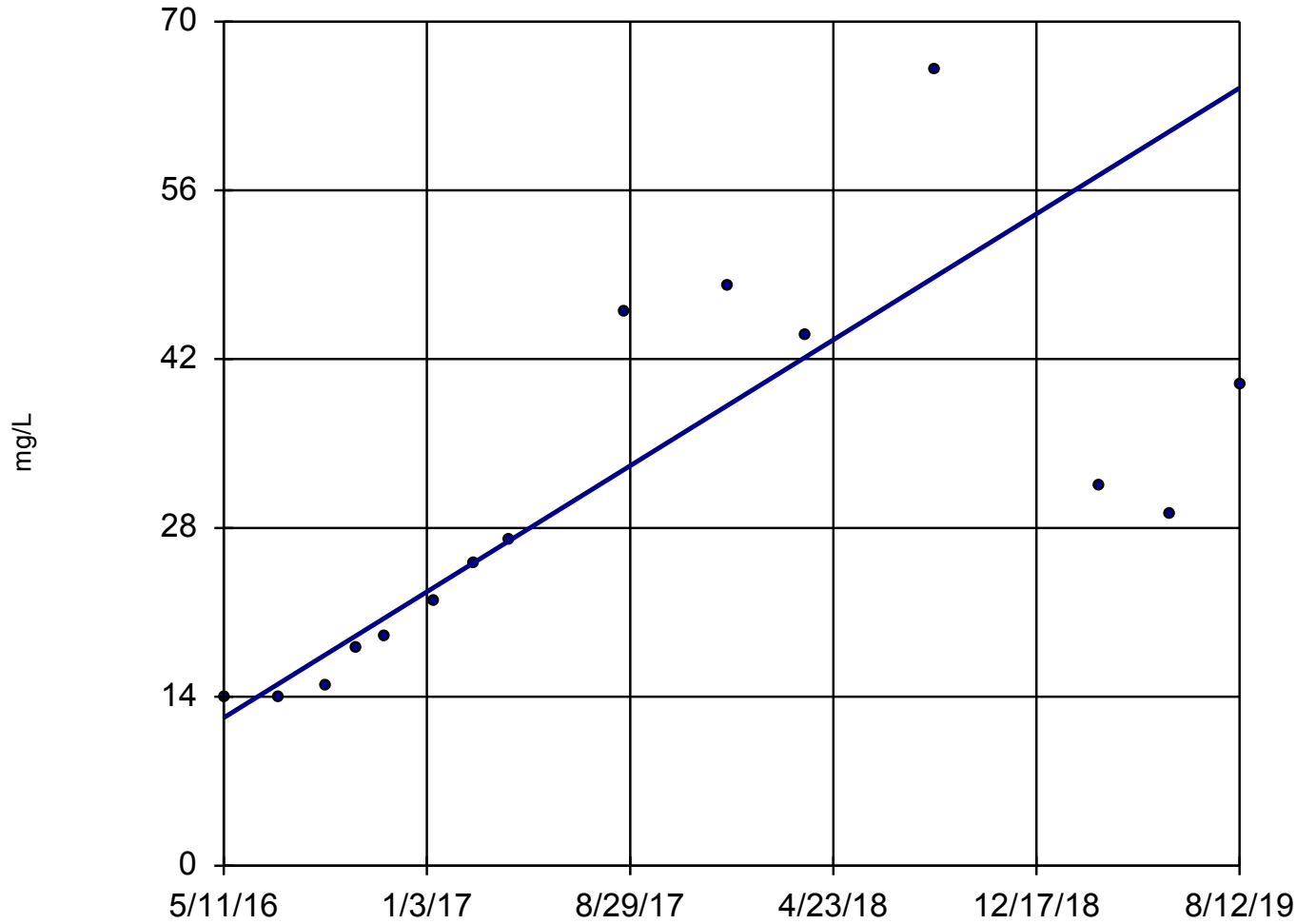
Trend Tests Summary Table - All Results

Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP Printed 11/25/2019, 6:30 PM

<u>Constituent</u>	<u>Well</u>	<u>Slope</u>	<u>Calc.</u>	<u>Critical</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Normality</u>	<u>Xform</u>	<u>Alpha</u>	<u>Method</u>
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
($\alpha = 0.005$ per
tail).

Constituent: Sulfate, total Analysis Run 11/25/2019 6:29 PM View: Intrawell Trend Tests

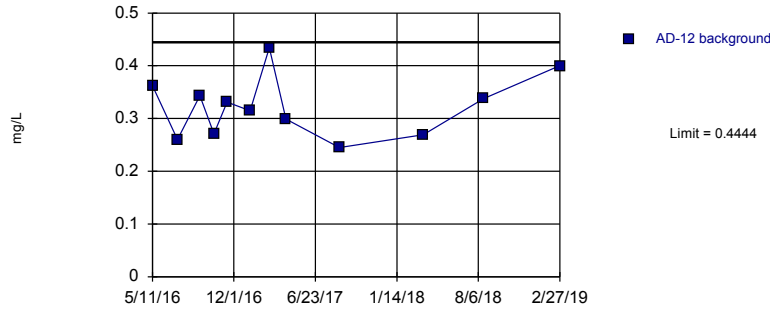
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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	NBg	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	

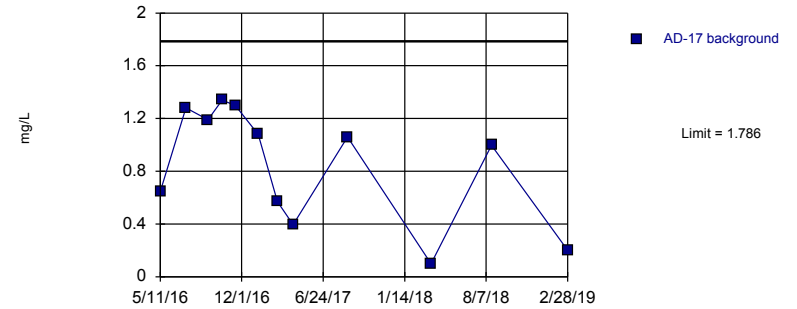
Prediction Limit
Intrawell Parametric, AD-12 (bg)



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

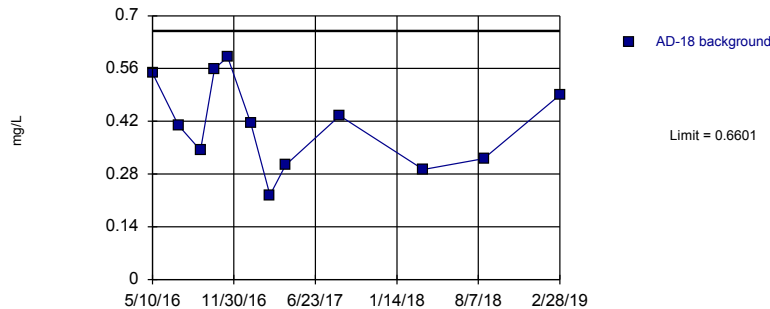
Prediction Limit
Intrawell Parametric, AD-17



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

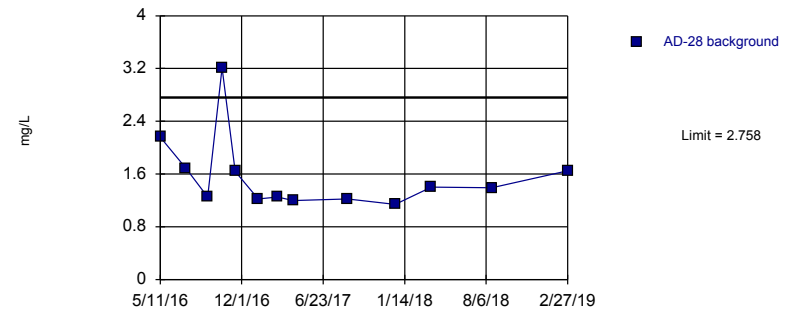
Prediction Limit
Intrawell Parametric, AD-18 (bg)



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

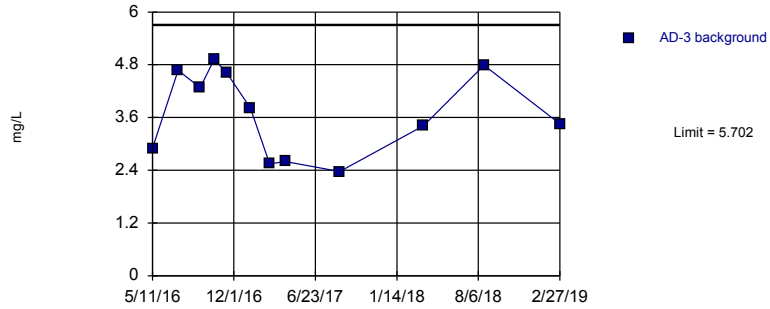
Prediction Limit
Intrawell Parametric, AD-28



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

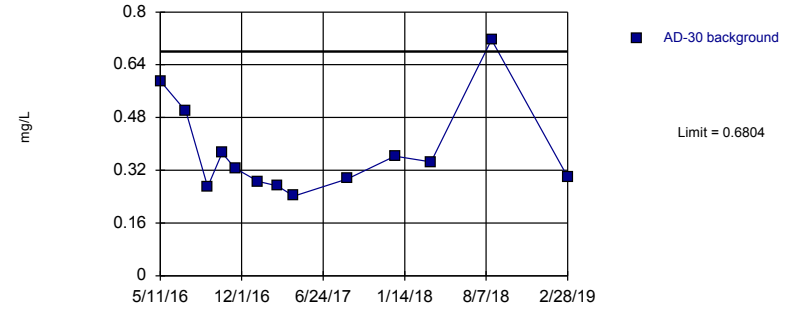
Prediction Limit
Intrawell Parametric, AD-3 (bg)



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

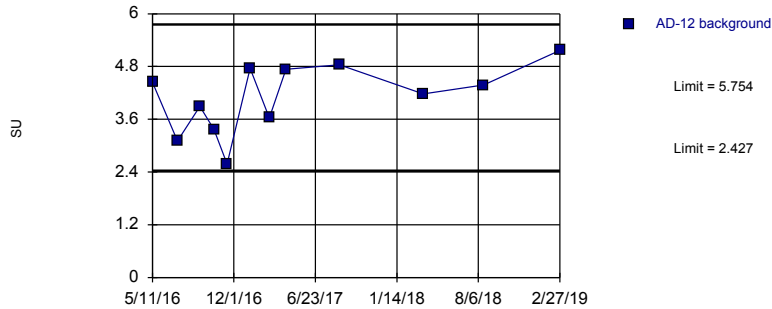
Prediction Limit
Intrawell Parametric, AD-30



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

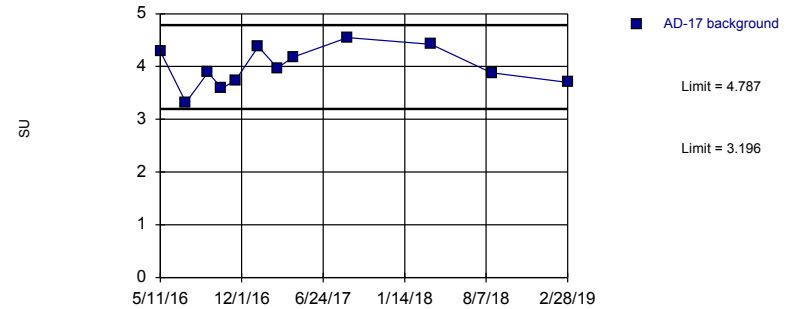
Prediction Limit
Intrawell Parametric, AD-12 (bg)



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

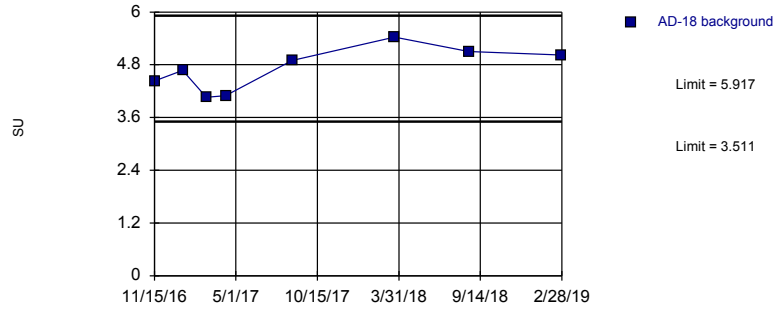
Prediction Limit
Intrawell Parametric, AD-17



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

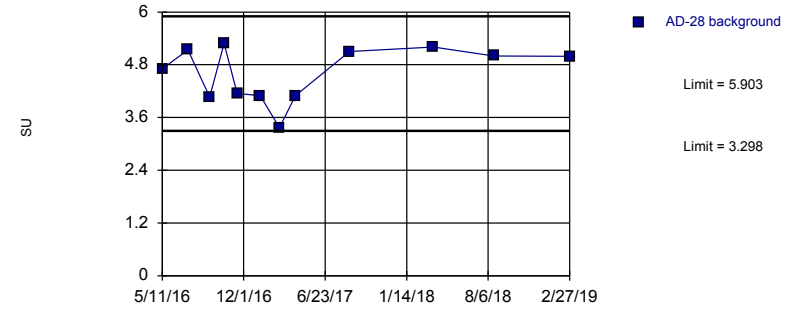
Prediction Limit
Intrawell Parametric, AD-18 (bg)



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

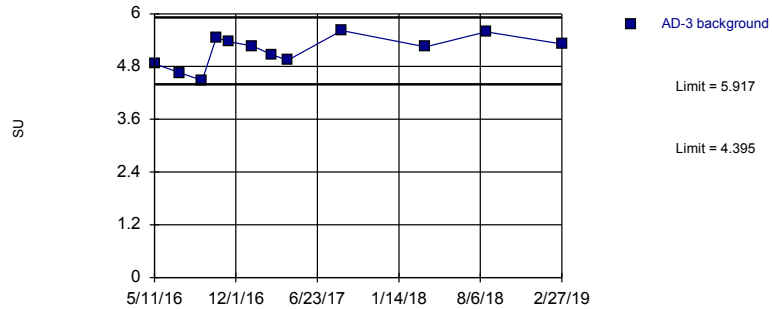
Prediction Limit
Intrawell Parametric, AD-28



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

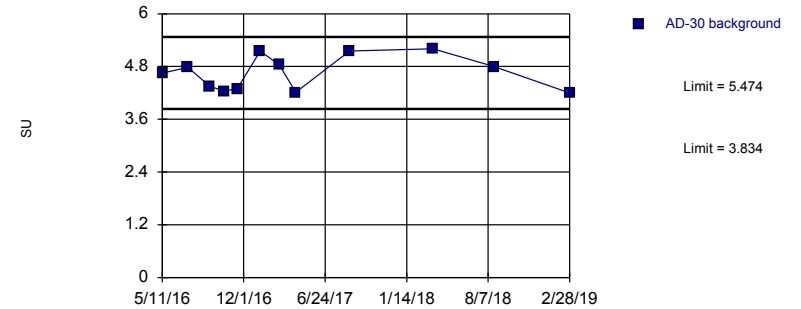
Prediction Limit
Intrawell Parametric, AD-3 (bg)



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

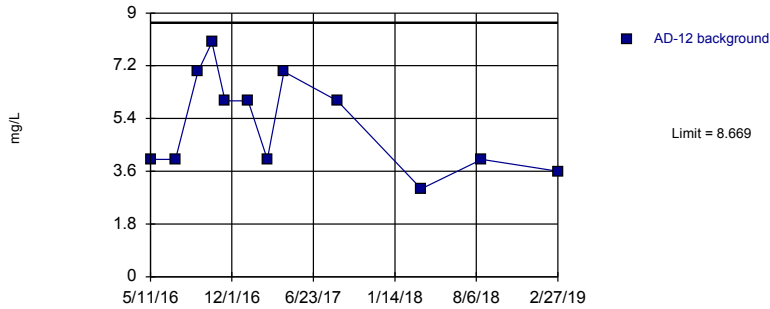
Prediction Limit
Intrawell Parametric, AD-30



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

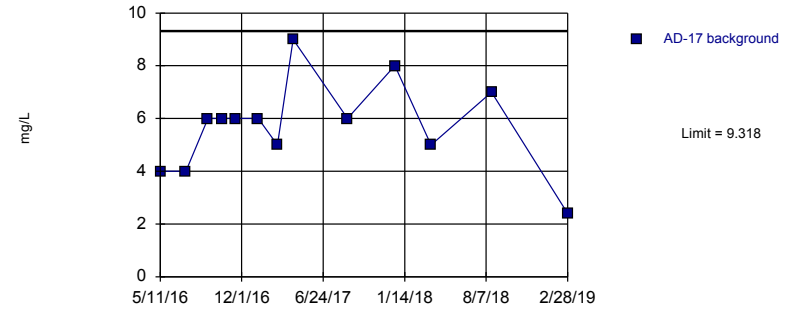
Prediction Limit Intrawell Parametric, AD-12 (bg)



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

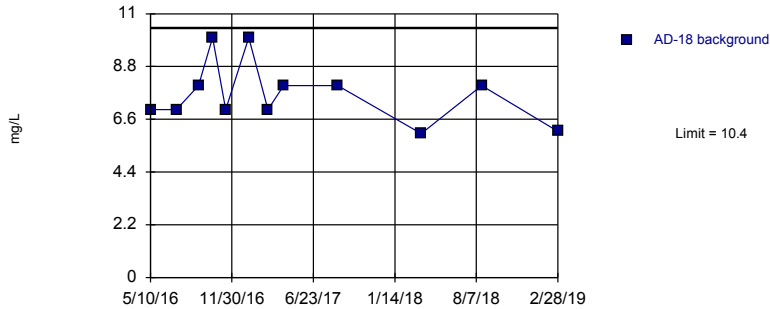
Prediction Limit Intrawell Parametric, AD-17



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

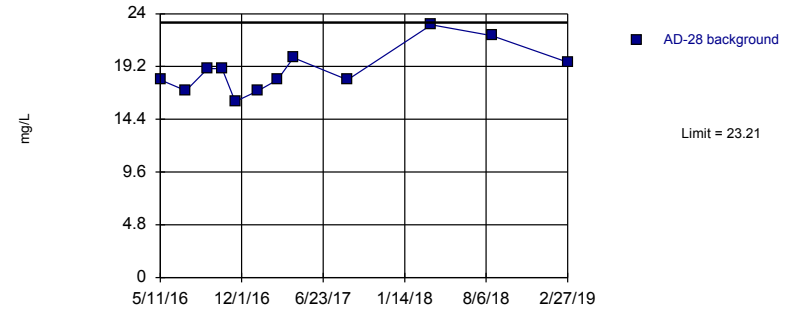
Prediction Limit Intrawell Parametric, AD-18 (bg)



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

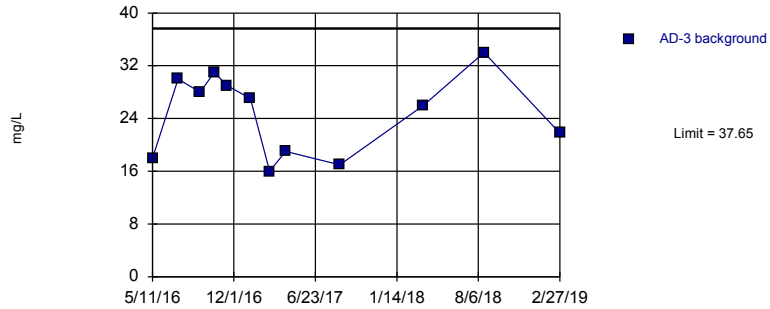
Prediction Limit Intrawell Parametric, AD-28



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

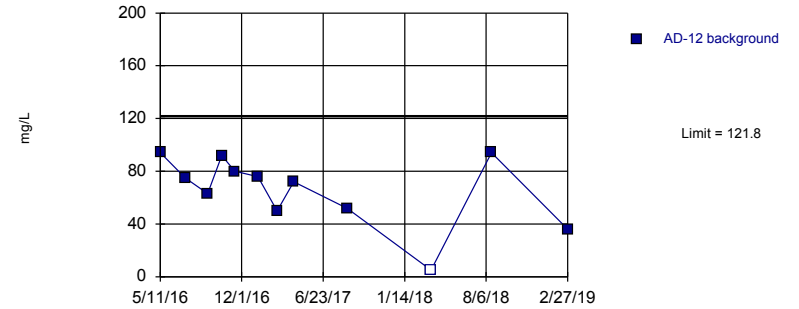
Prediction Limit
Intrawell Parametric, AD-3 (bg)



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

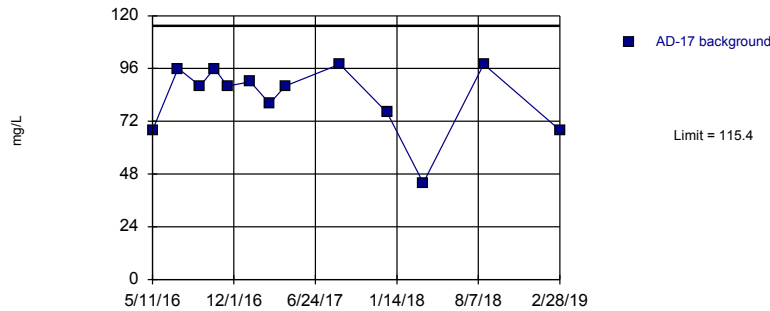
Prediction Limit
Intrawell Parametric, AD-12 (bg)



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

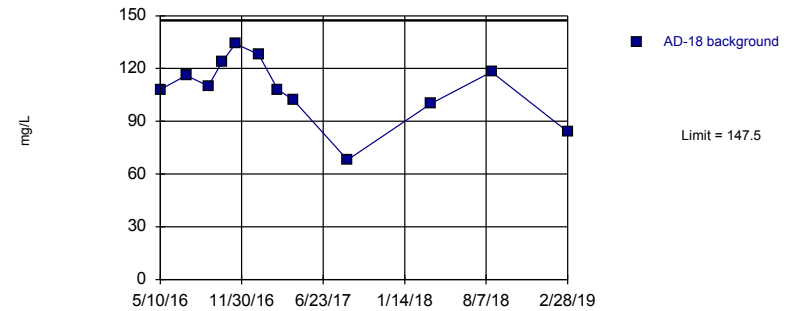
Prediction Limit
Intrawell Parametric, AD-17



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

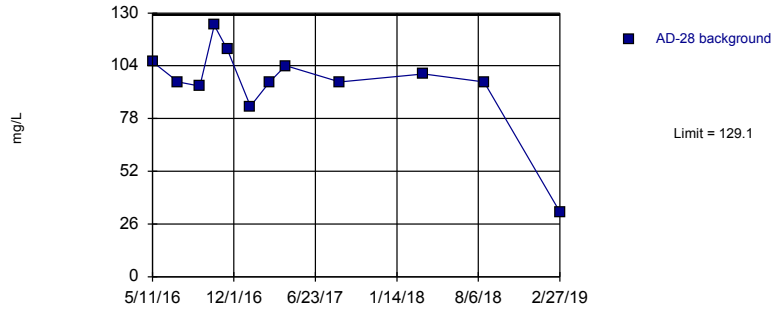
Prediction Limit
Intrawell Parametric, AD-18 (bg)



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

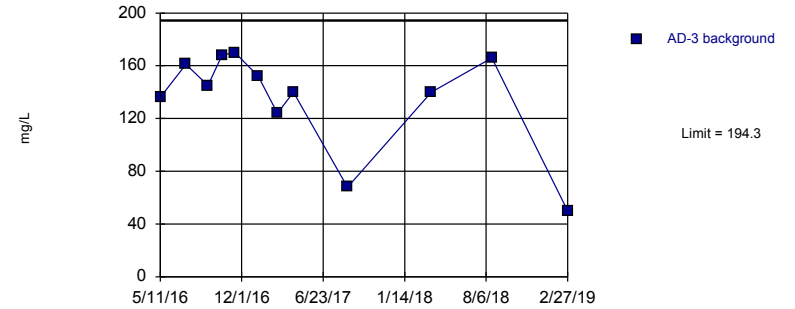
Prediction Limit
Intrawell Parametric, AD-28



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

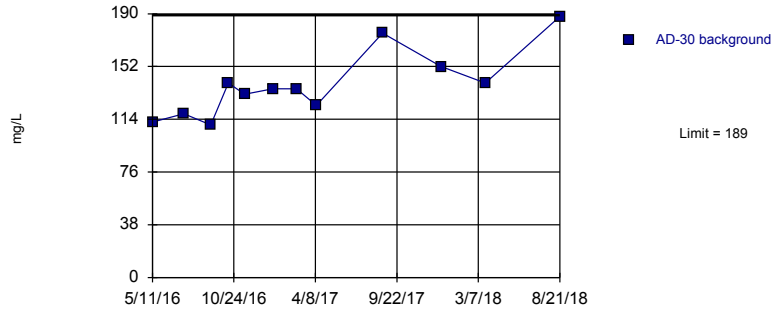
Prediction Limit
Intrawell Parametric, AD-3 (bg)



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

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

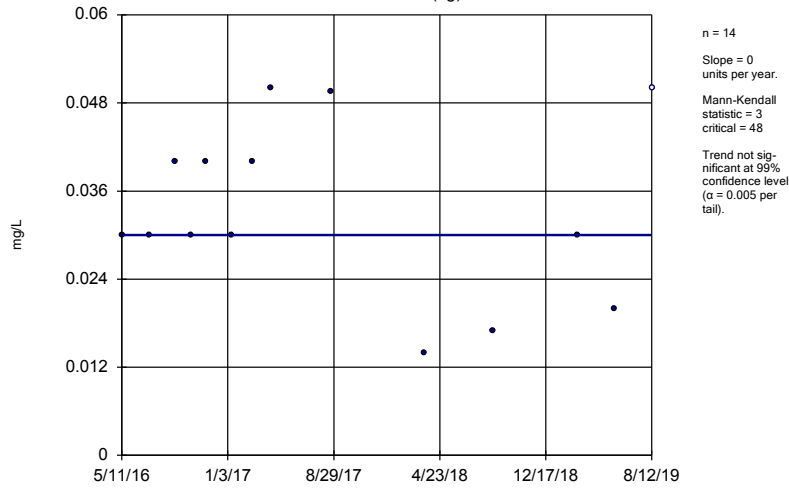
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg	NBq	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	n/a	0.07675	n/a	n/a	3 future	n/a	36	0.03686	0.02259	2.778	None		No	0.002505	Param Inter 1 of 2
Chloride, total (mg/L)	n/a	9.495	n/a	n/a	3 future	n/a	36	2.62	0.2615	0	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

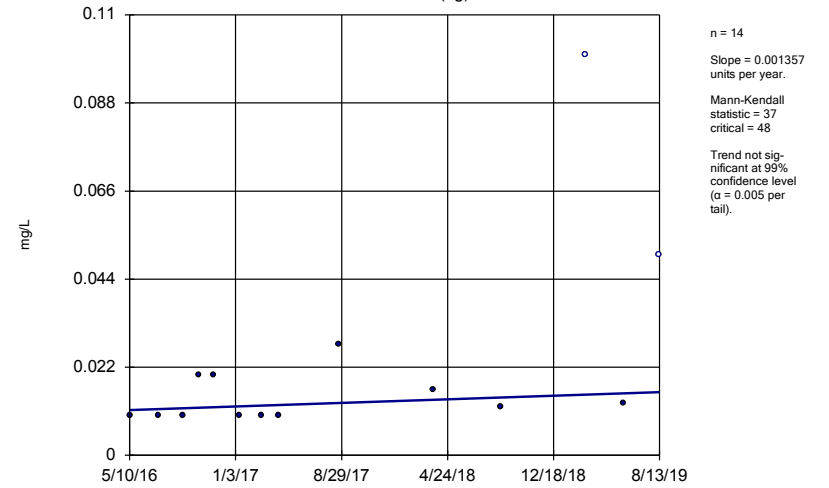
<u>Constituent</u>	<u>Well</u>	<u>Slope</u>	<u>Calc.</u>	<u>Critical</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Normality</u>	<u>Xform</u>	<u>Alpha</u>	<u>Method</u>
Boron, total (mg/L)	AD-12 (bg)	0	3	48	No	14	7.143	n/a	n/a	0.01	NP
Boron, total (mg/L)	AD-18 (bg)	0.001357	37	48	No	14	14.29	n/a	n/a	0.01	NP
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

Sen's Slope Estimator AD-12 (bg)



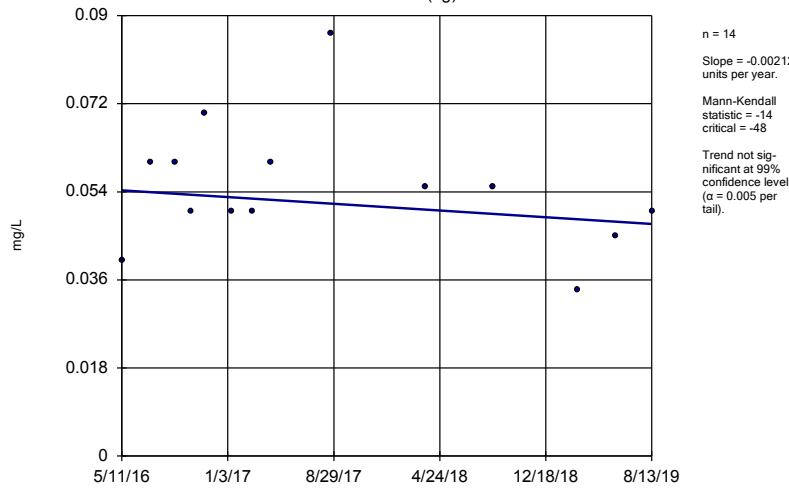
Constituent: Boron, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator AD-18 (bg)



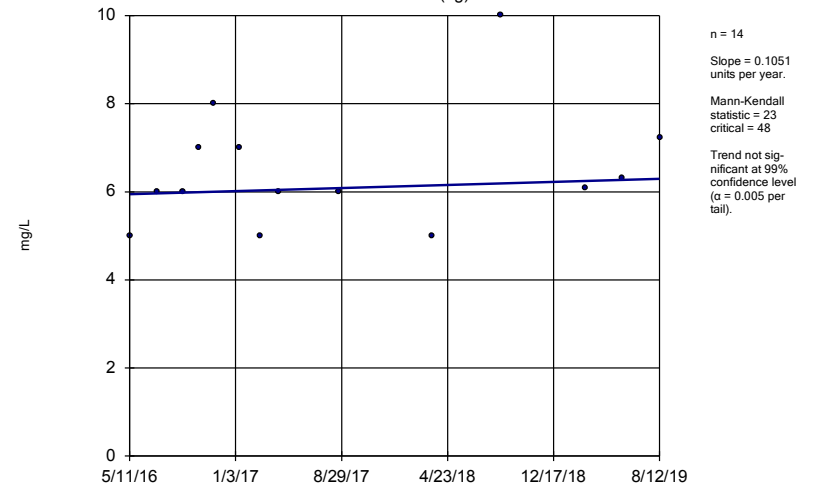
Constituent: Boron, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator AD-3 (bg)



Constituent: Boron, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

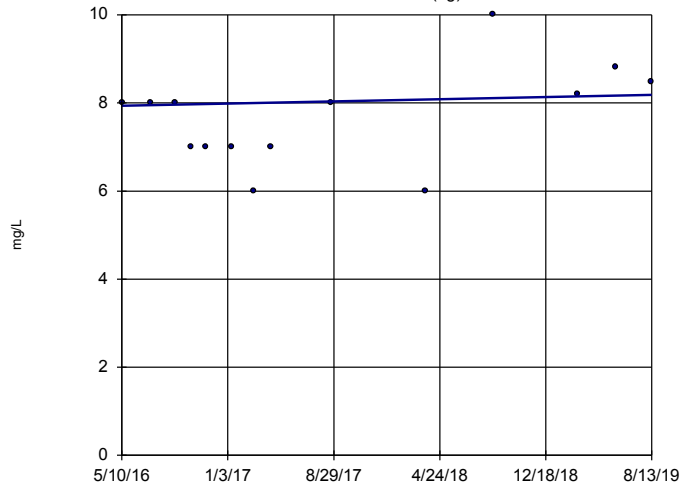
Sen's Slope Estimator AD-12 (bg)



Constituent: Chloride, total Analysis Run 12/6/2019 9:01 AM View: Interwell
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-18 (bg)

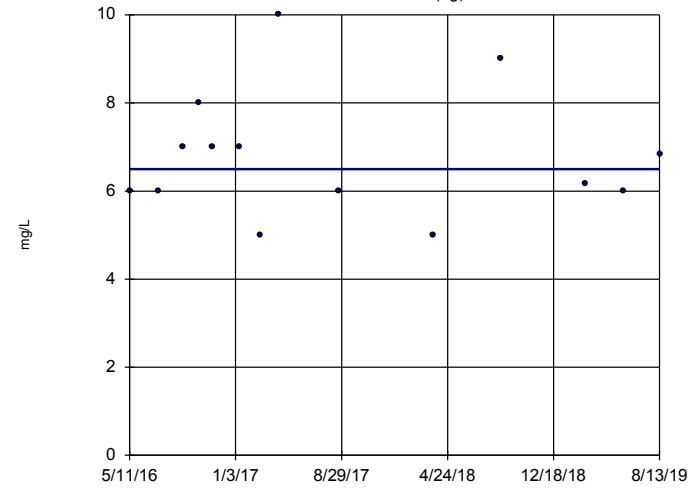


n = 14
 Slope = 0.0768
 units per year.
 Mann-Kendall
 statistic = 18
 critical = 48
 Trend not sig-
 nificant at 99%
 confidence level
 (α = 0.005 per
 tail).

Constituent: Chloride, total Analysis Run 12/6/2019 9:02 AM View: Interwell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-3 (bg)

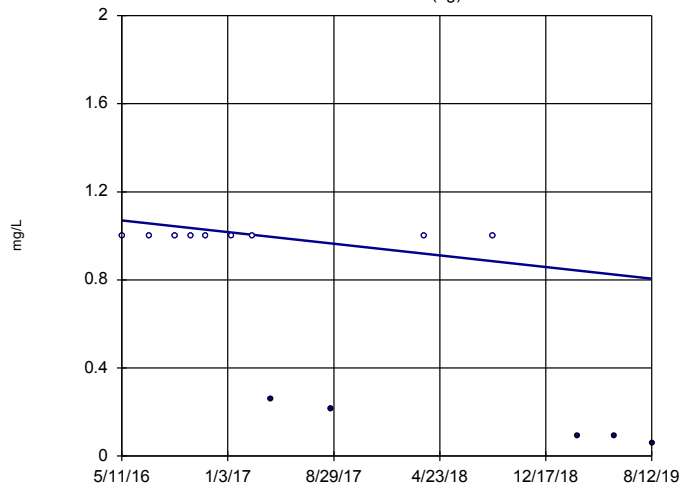


n = 14
 Slope = 0
 units per year.
 Mann-Kendall
 statistic = -4
 critical = -48
 Trend not sig-
 nificant at 99%
 confidence level
 (α = 0.005 per
 tail).

Constituent: Chloride, total Analysis Run 12/6/2019 9:02 AM View: Interwell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-12 (bg)

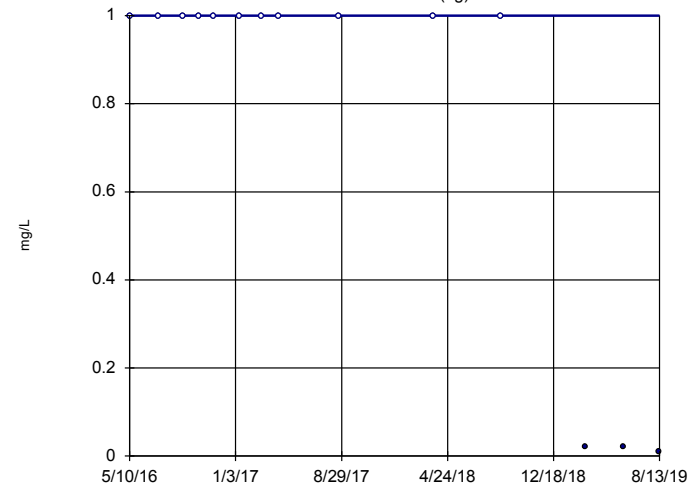


n = 14
 Slope = -0.08118
 units per year.
 Mann-Kendall
 statistic = -46
 critical = -48
 Trend not sig-
 nificant at 99%
 confidence level
 (α = 0.005 per
 tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 9:02 AM View: Interwell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-18 (bg)

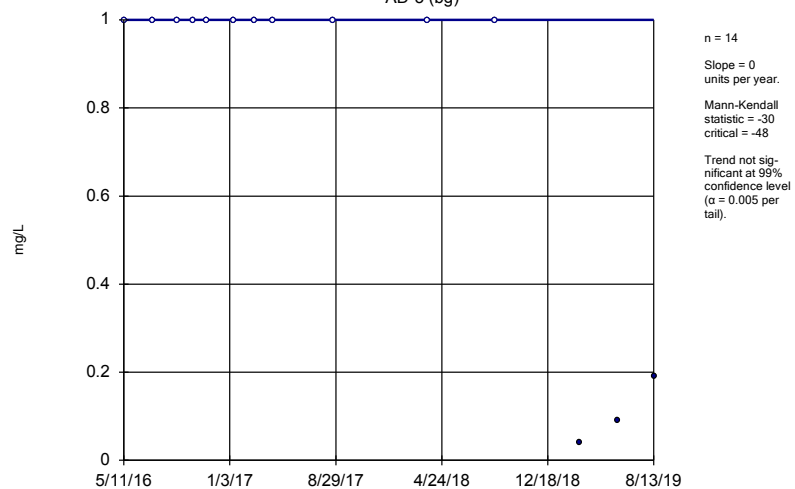


n = 14
 Slope = 0
 units per year.
 Mann-Kendall
 statistic = -35
 critical = -48
 Trend not sig-
 nificant at 99%
 confidence level
 (α = 0.005 per
 tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 9:02 AM View: Interwell
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Sen's Slope Estimator

AD-3 (bg)



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

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Compliance</u>	<u>Sig. N</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>TransformAlpha</u>	<u>Method</u>
Cobalt, total (mg/L)	AD-28	0.01583	0.0132	0.009	Yes 13	0.01452	0.001766	0	None	No	0.01 Param.

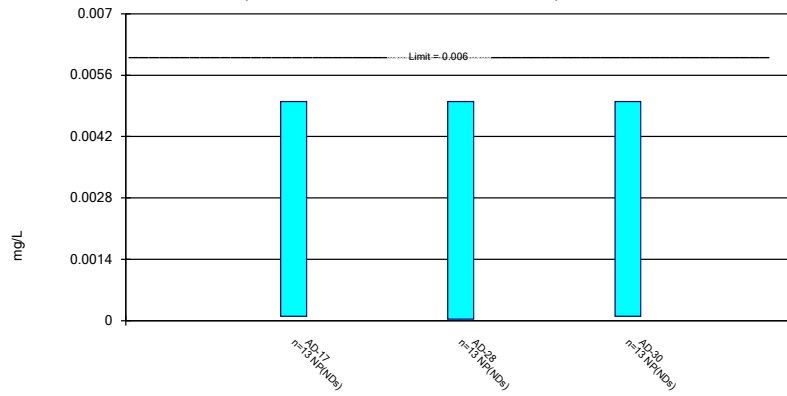
Confidence Intervals - All Results

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.	TransformAlpha	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)

Non-Parametric Confidence Interval

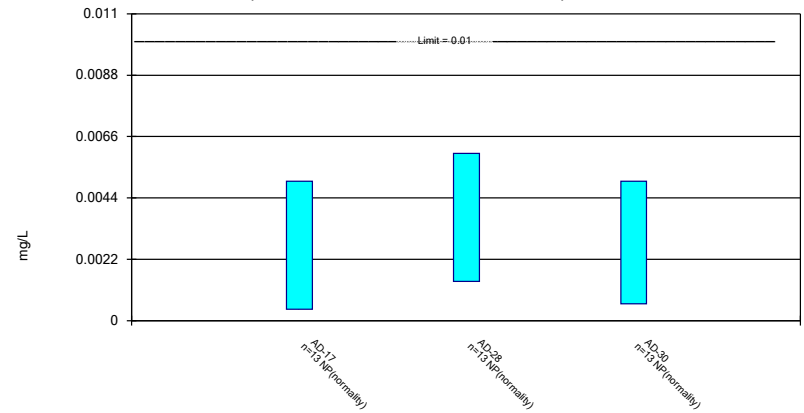
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Antimony, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

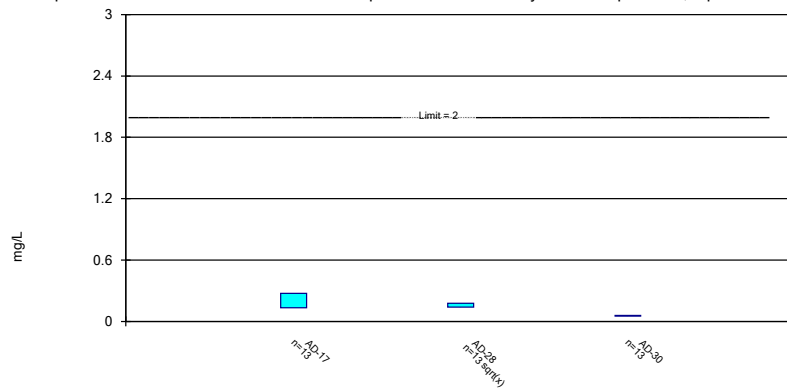
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Arsenic, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

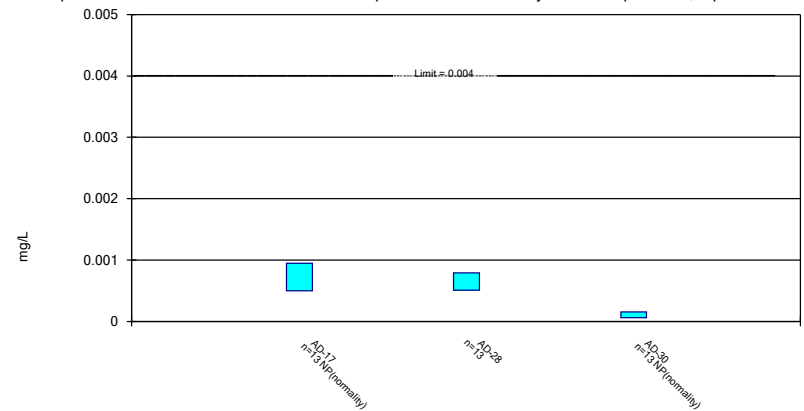
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Constituent: Barium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

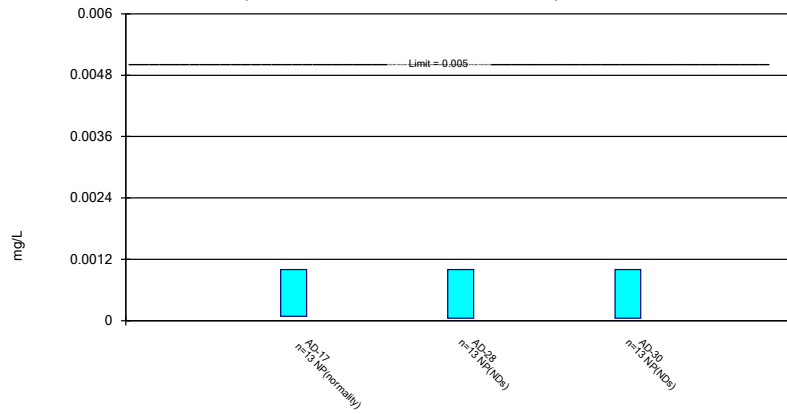
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

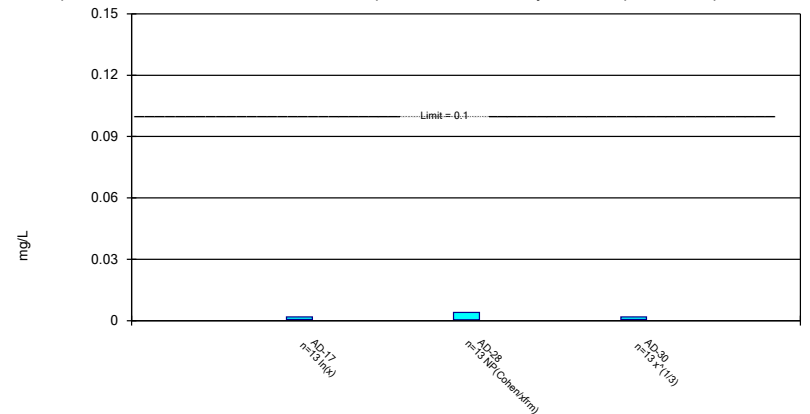
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Cadmium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

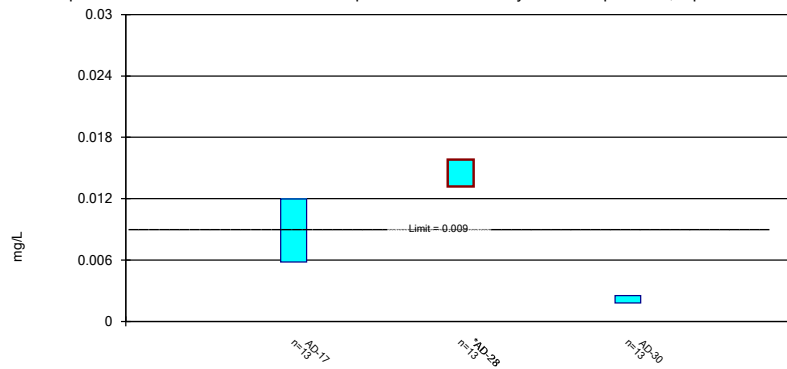
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chromium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

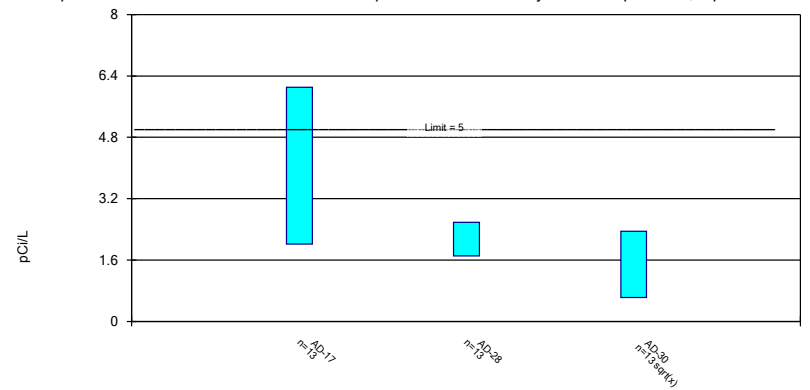
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Constituent: Cobalt, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

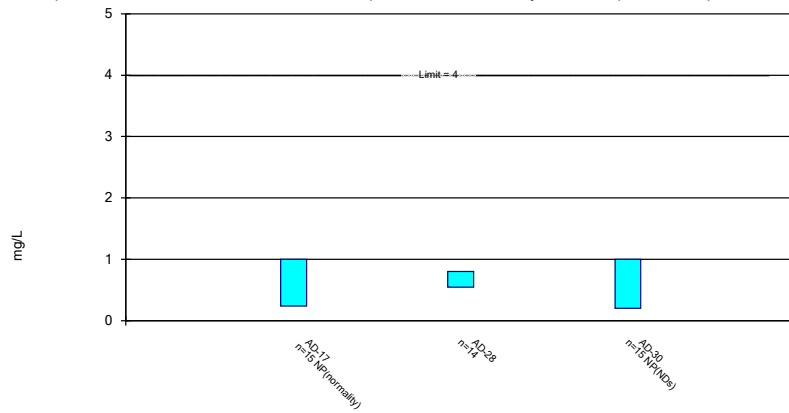
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Constituent: Combined Radium 226 + 228 Analysis Run 12/6/2019 9:10 AM View: Appendix IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric and Non-Parametric (NP) Confidence Interval

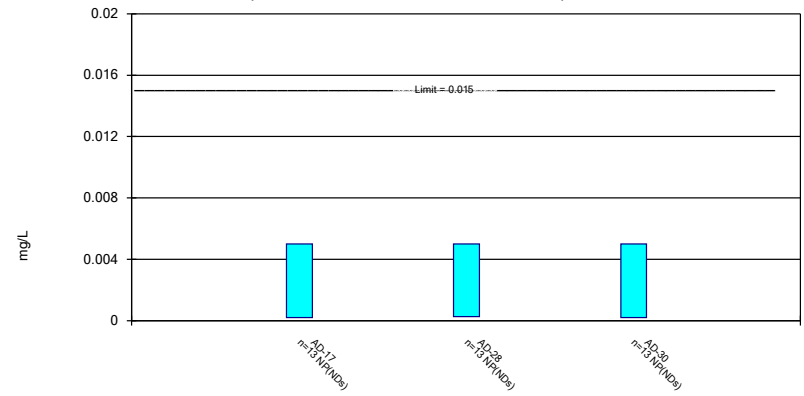
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Constituent: Fluoride, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

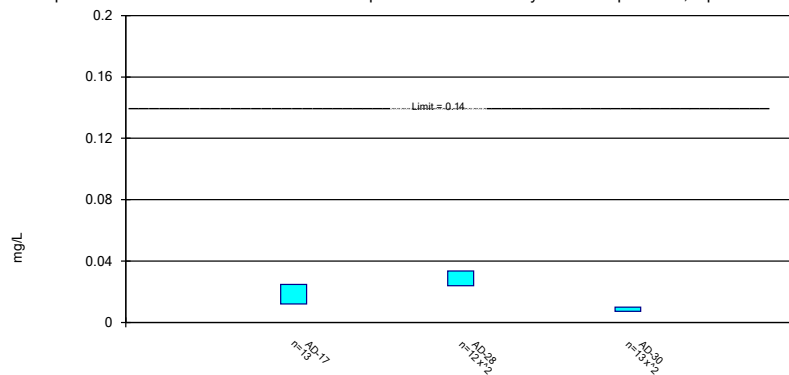
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Lead, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

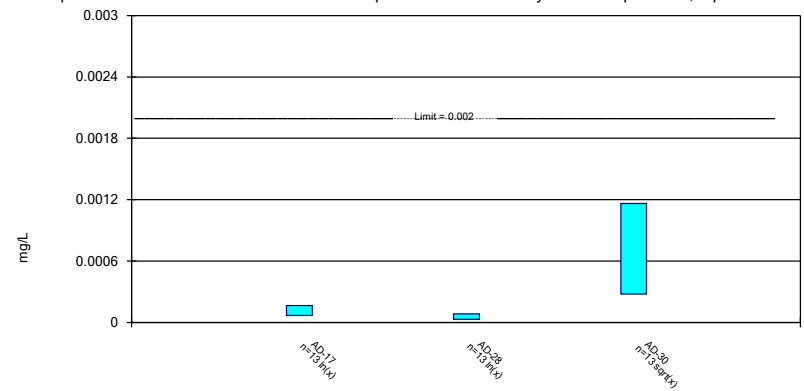
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Constituent: Lithium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Parametric Confidence Interval

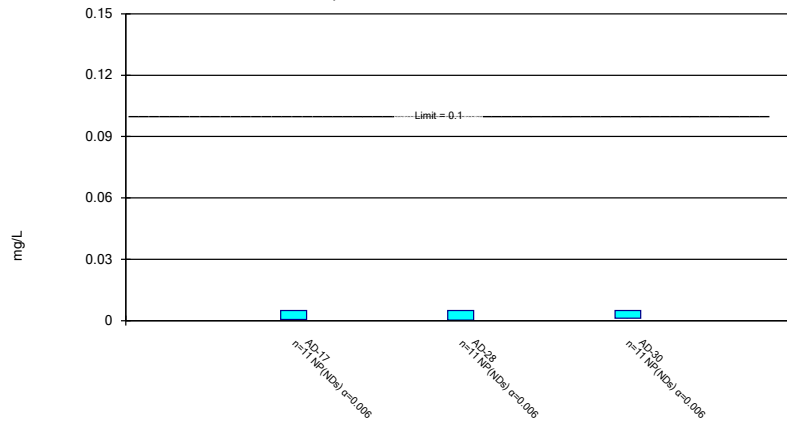
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Mercury, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

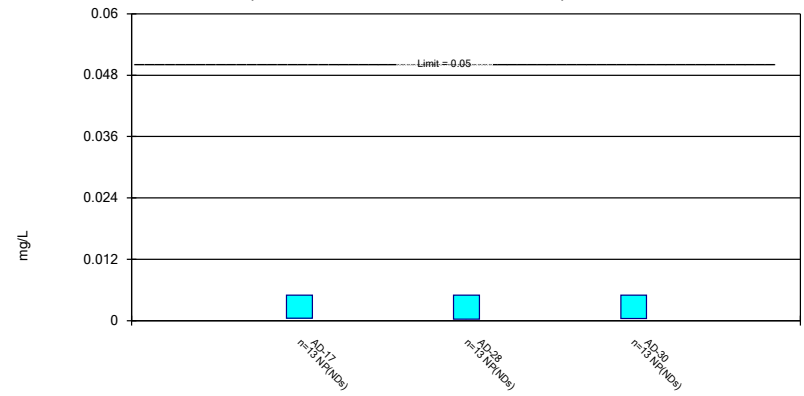
Compliance Limit is not exceeded.



Constituent: Molybdenum, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

Non-Parametric Confidence Interval

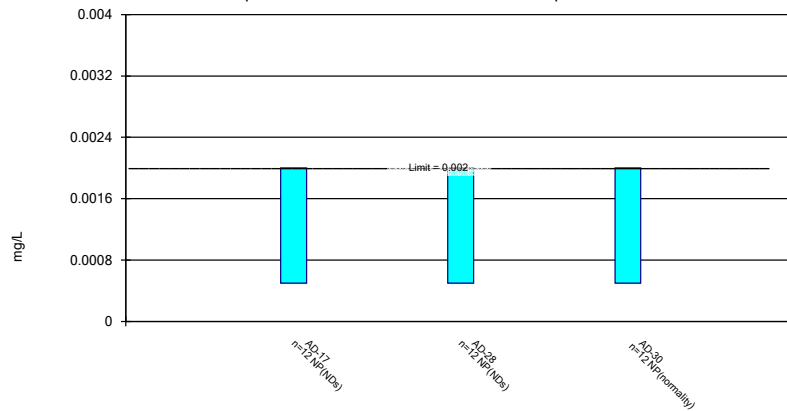
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Selenium, total Analysis Run 12/6/2019 9:10 AM View: Appendix IV
 Pirkey WBAP Client: Geosyntec Data: Pirkey WBAP

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



1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec 
consultants

engineers | scientists | innovators

941 Chatham Lane
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March 26, 2019

CHA8462

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ATTACHMENTS

Attachment A Bottom Ash and Bottom Ash SPLP Laboratory Analytical Data
Attachment B Bottom Ash Pond Water Laboratory Analytical Data
Attachment C Certification by a Qualified Professional Engineer

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; E TTL, 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 FeS₂) and marcasite (orthorhombic FeS₂) 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

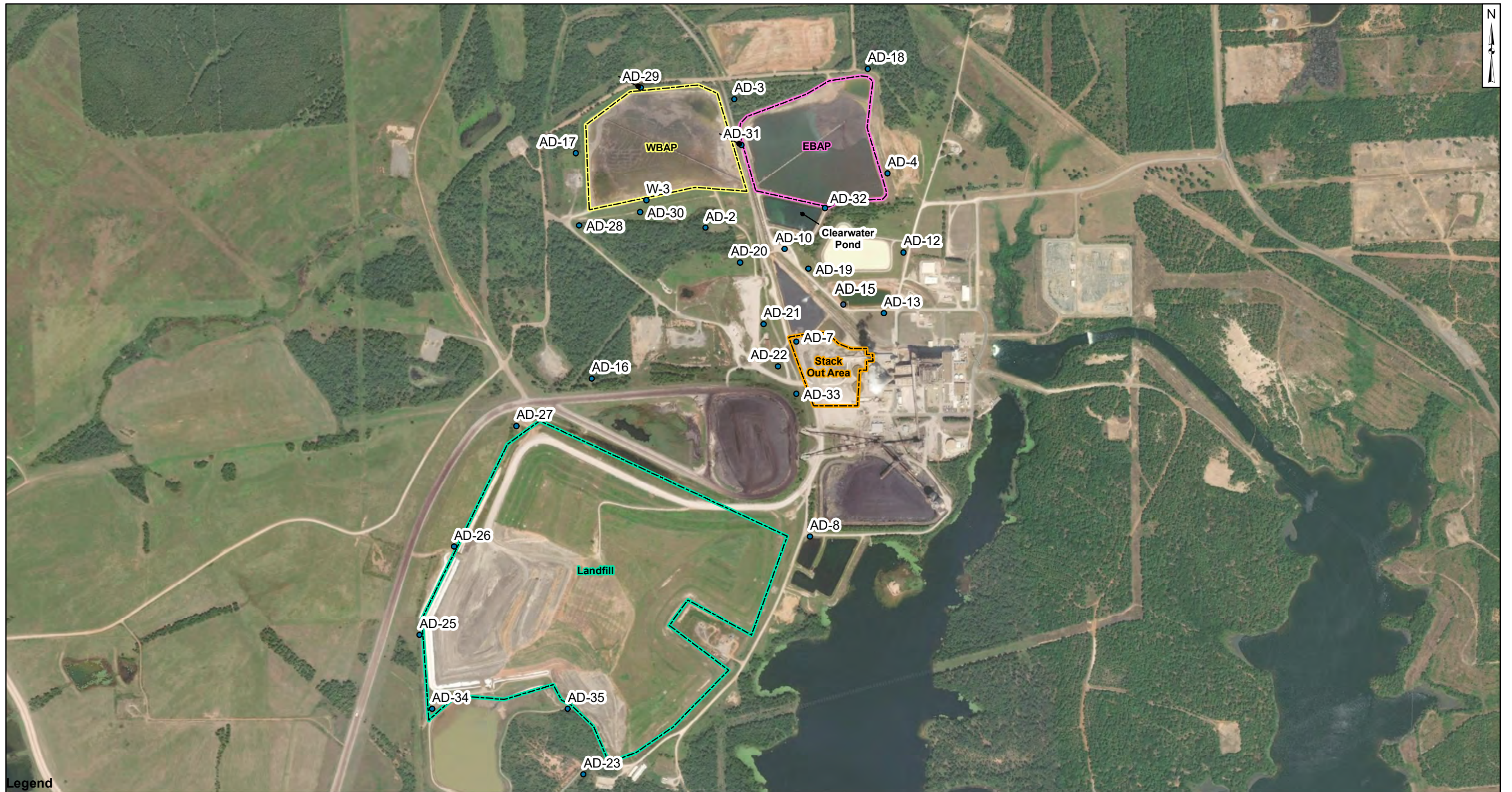
The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of cobalt for AD-28 identified during assessment monitoring in 2018 was not due to a release from the WBAP. The identified SSL was, instead, attributed to natural variation 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

REFERENCES

- AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.
- Arcadis, 2016. West Bottom Ash Pond – CCR Groundwater Monitoring Well Network Evaluation. H.W. Pirkey Power Plant. May.
- Broom, M.E. and Myers, B.N., 1966. Ground-Water Resources of Harrison County, Texas. Texas Water Development Board Report 27. August.
- EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.
- ETTL, 2010. Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas, Geotechnical Investigation. October.
- Geosyntec Consultants, 2018. Statistical Analysis Summary, West Bottom Pond. H.W. Pirkey Power Plant. Hallsville, Texas. December.
- Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.
- Izquierdo, M. and Querol, X., 2012. Leaching Behaviour of Elements from Coal Combustion Fly Ash: An Overview. *International Journal of Coal Geology*, 94, 54-66.
- Krupka, K. M. and Serne, R. J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.
- United States Environmental Protection Agency (USEPA), 1994. Method 1312 – Synthetic Precipitation Leaching Procedure, Revision 0, September 1994, Final Update to the Third Edition of the Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846.
- USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

FIGURES



Legend

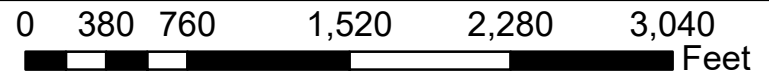
- AD-15
- Monitoring Wells

Location Boundaries

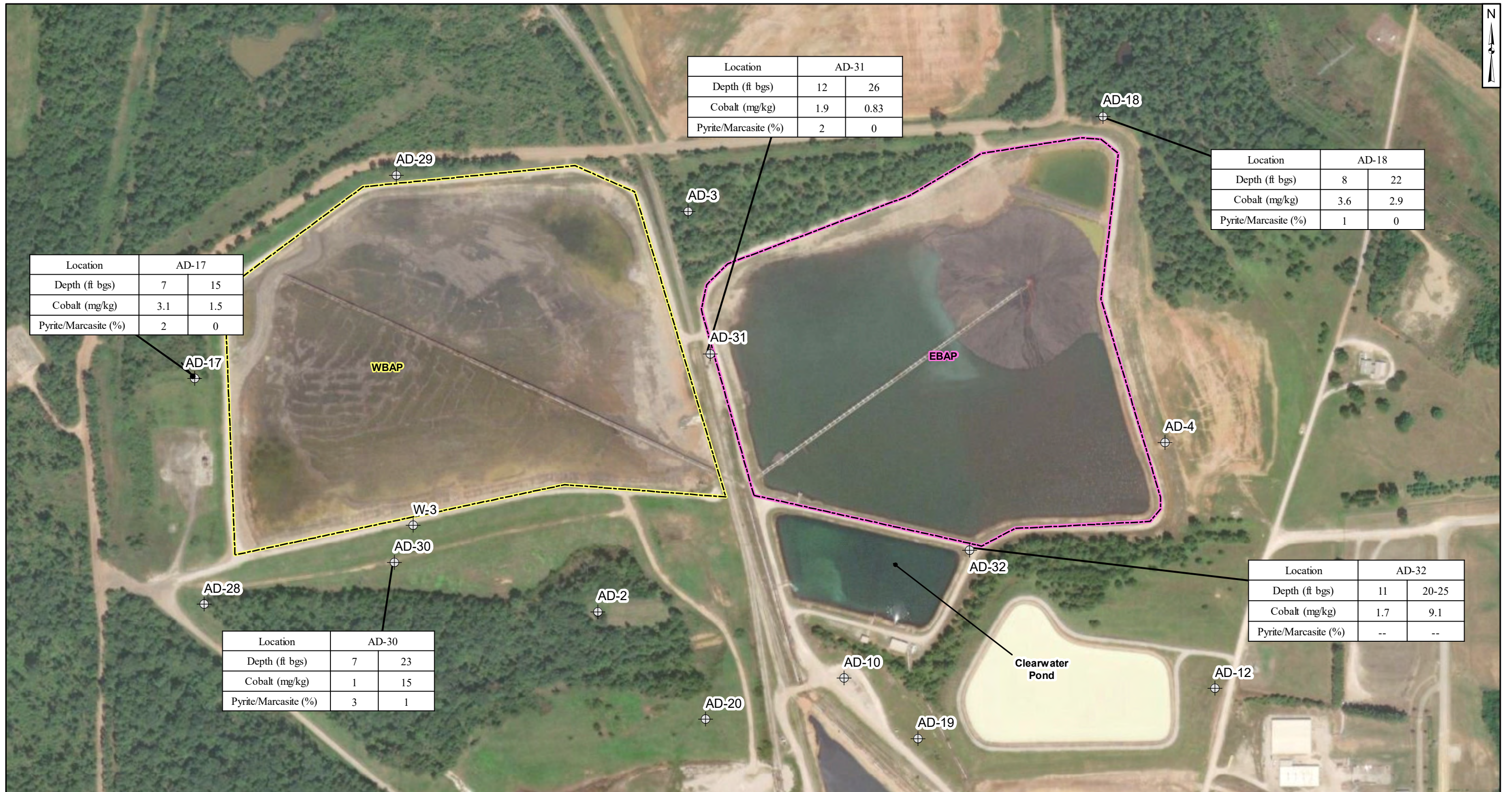
- CCR Units**
- EBAP
 - Landfill
 - Stack Out Area
 - WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.



Site Layout	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2019/03/25
Figure 1	



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-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

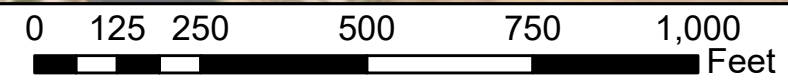
Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Legend

⊕ Monitoring Wells

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- ft bgs: feet below ground surface
- mg/kg: milligrams per kilogram



Soil Chemical and Mineralogical Analysis Results

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure

2

Columbus, Ohio

2019/03/25

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: 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

Matrix: Solid

Date Received: 02/13/19 09:40

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

Matrix: Solid

Date Received: 02/13/19 09:40

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: Burns & McDonnell
Project/Site: CSM Refinement

TestAmerica Job ID: 490-165222-1
SDG: AEP Pirkey plant

Client Sample ID: SW-WBAP-1

Lab Sample ID: 490-165222-5

Date Collected: 12/15/18 14:15

Matrix: Water

Date Received: 12/18/18 10:30

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

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 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



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Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

3/26/2019
Date

**ALTERNATIVE SOURCE
DEMONSTRATION REPORT
FEDERAL CCR RULE**

**H.W. Pirkey Power Plant
West Bottom Ash Pond
Hallsville, Texas**

Submitted to



1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec 
consultants

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September 23, 2019

CHA8462

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ATTACHMENTS

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Attachment B Certification by a Qualified Professional Engineer

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

REFERENCES

- AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.
- Broom, M.E. and Myers, B.N., 1966. Ground-Water Resources of Harrison County, Texas. Texas Water Development Board Report 27. August.
- EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.
- ETTL, 2010. Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas, Geotechnical Investigation. October.
- Geosyntec Consultants, 2019a. Statistical Analysis Summary, West Bottom Ash Pond. H.W. Pirkey Power Plant. Hallsville, Texas. July.
- Geosyntec, 2019b. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, West Bottom Ash Pond. Hallsville, Texas. March.
- Geosyntec, 2019c. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. Hallsville, Texas. July.
- Harris, L. A, Kenik, E. A., and Yust, C. S. 1981. Reactions in pyrite frambooids induced by electron beam heating in a HVEM. *Scanning Electron Microscopy*, 1, web.
- Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.
- Izquierdo, M. and Querol, X., 2012. Leaching Behaviour of Elements from Coal Combustion Fly Ash: An Overview. *International Journal of Coal Geology*, 94, 54-66.
- Krupka, K. M. and Serne, R. J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.
- Sawlowicz, Z. 2000. *Frambooids: From Their Origin to Application*. Pr. Mineral. (Mineralogical Transactions), 88, web.
- United States Environmental Protection Agency (USEPA), 1994. Method 1312 – Synthetic Precipitation Leaching Procedure, Revision 0, September 1994, Final Update to the Third

Edition of the Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846.

USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

TABLES

**Table 1: Summary of Key Analytical Data
West Bottom Ash Pond - H.W. Pirkey Plant**

Geosyntec Consultants, Inc.

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**

Geosyntec Consultants, Inc.

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

Geosyntec Consultants, Inc.

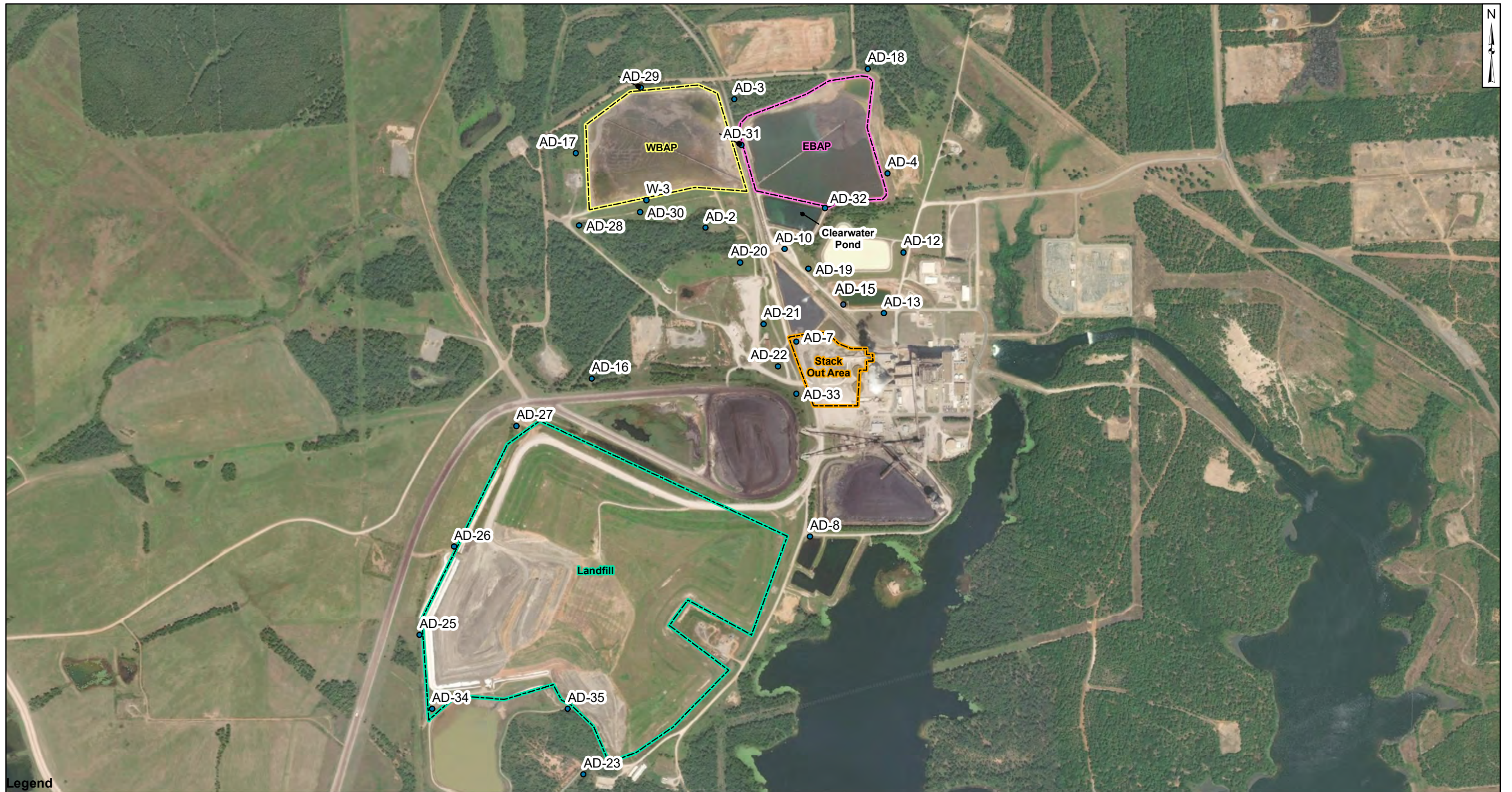
Constituent	VAP-B3-(40-45)
Quartz	15
Plagioclase Feldspar	0.5
Orthoclase	ND
Calcite	ND
Dolomite	ND
Siderite	0.5
Goethite	ND
Hematite	2
Pyrite	3
Kaolinite	42
Chlorite	4
Illite/Mica	6
Smectite	12
Amorphous	15

Notes:

ND: Not detected

VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

FIGURES



Legend

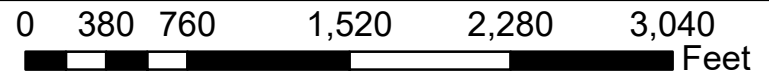
- AD-15
- Monitoring Wells

Location Boundaries

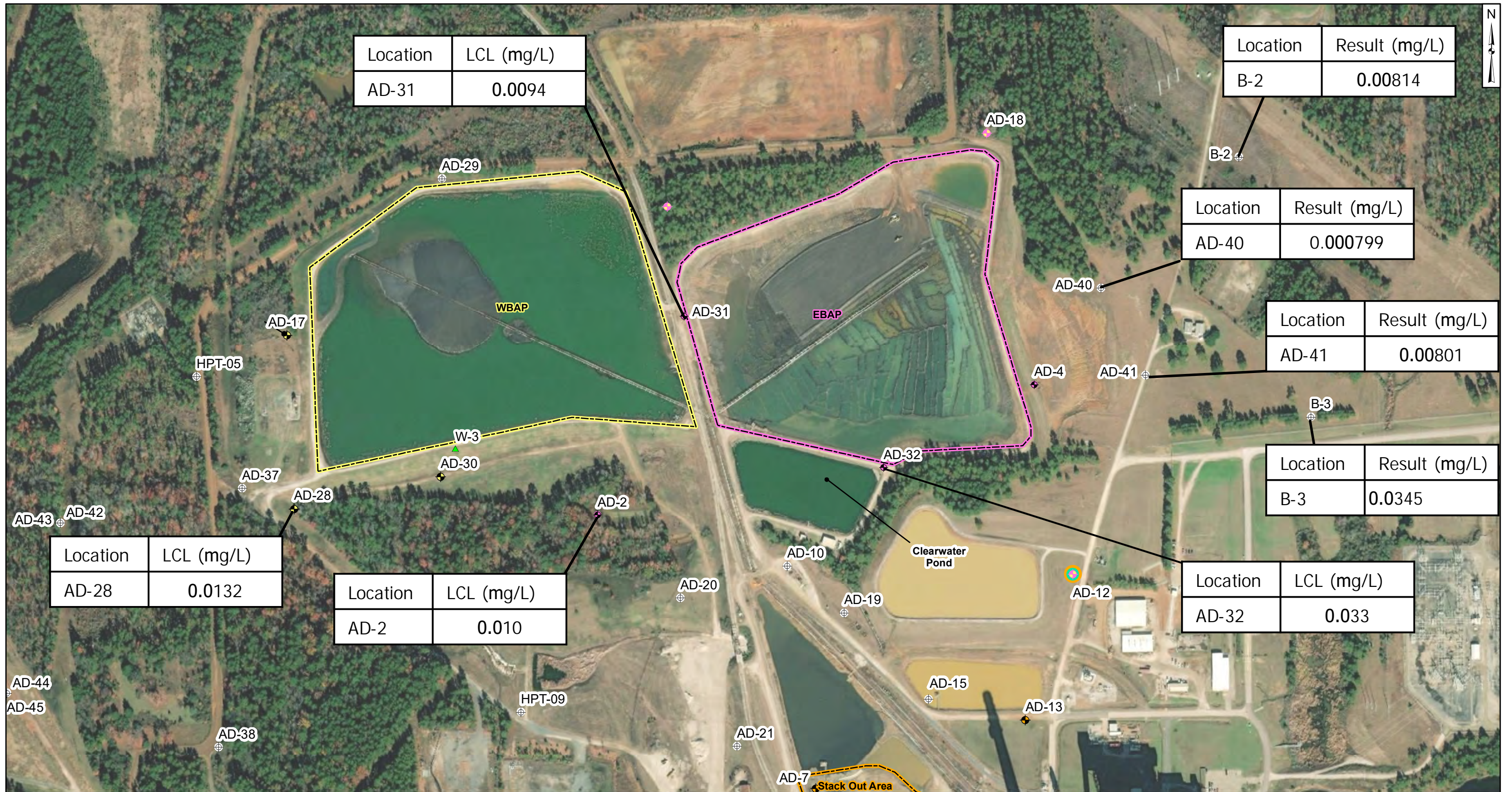
- CCR Units**
- EBAP
 - Landfill
 - Stack Out Area
 - WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019
- AD-15 location is approximate.



<p>Site Layout</p> <p>AEP Pirkey Power Plant Hallsville, Texas</p>		<p>Figure 1</p>
<p>Geosyntec consultants</p>		
<p>Columbus, Ohio</p>	<p>2019/03/25</p>	



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

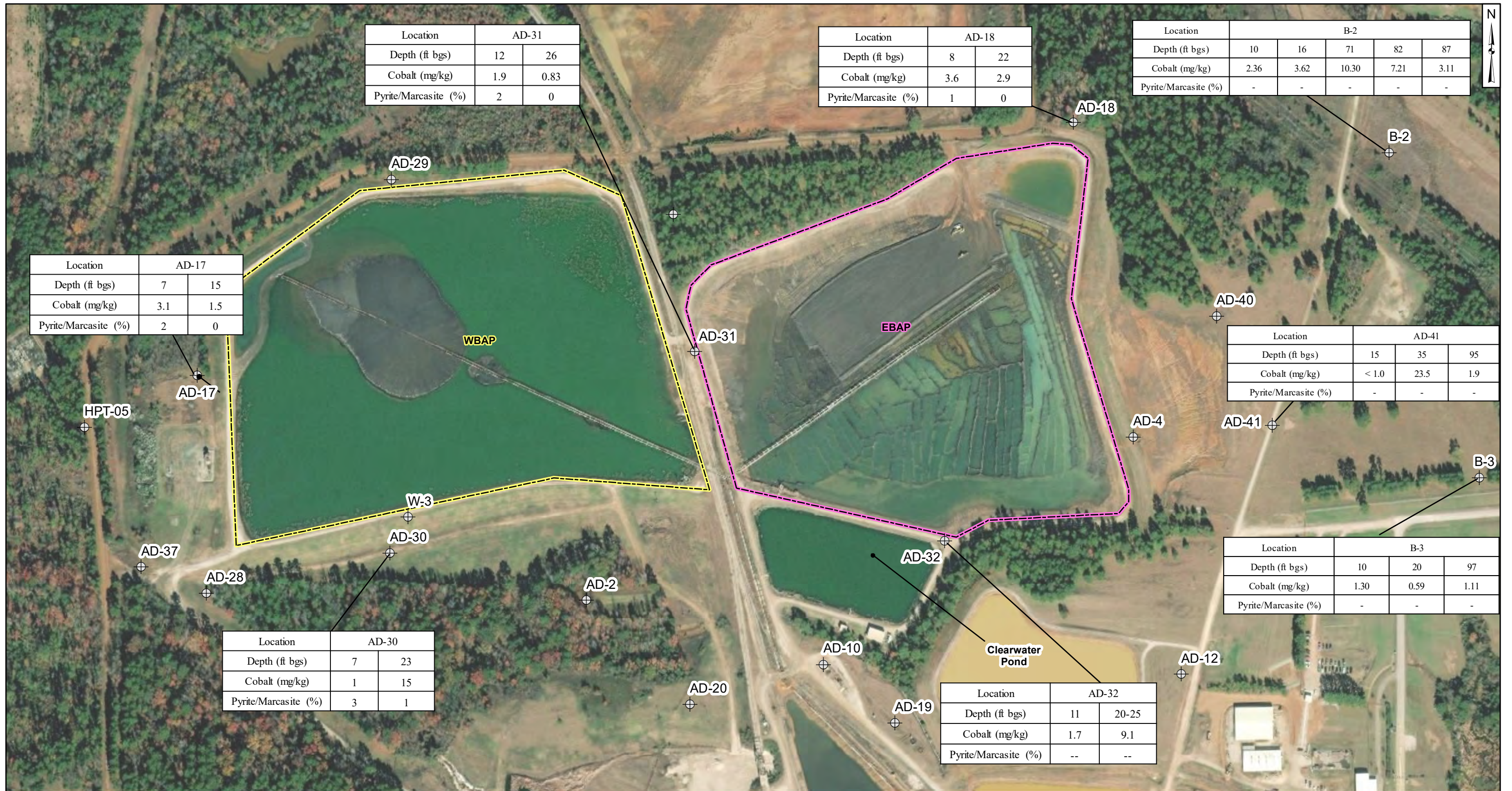
Cobalt Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas




Geosyntec
consultants

Figure
2

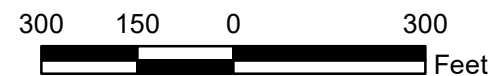
Columbus, Ohio 2019/09/17



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.



Soil Chemical and Mineralogical Analysis Results

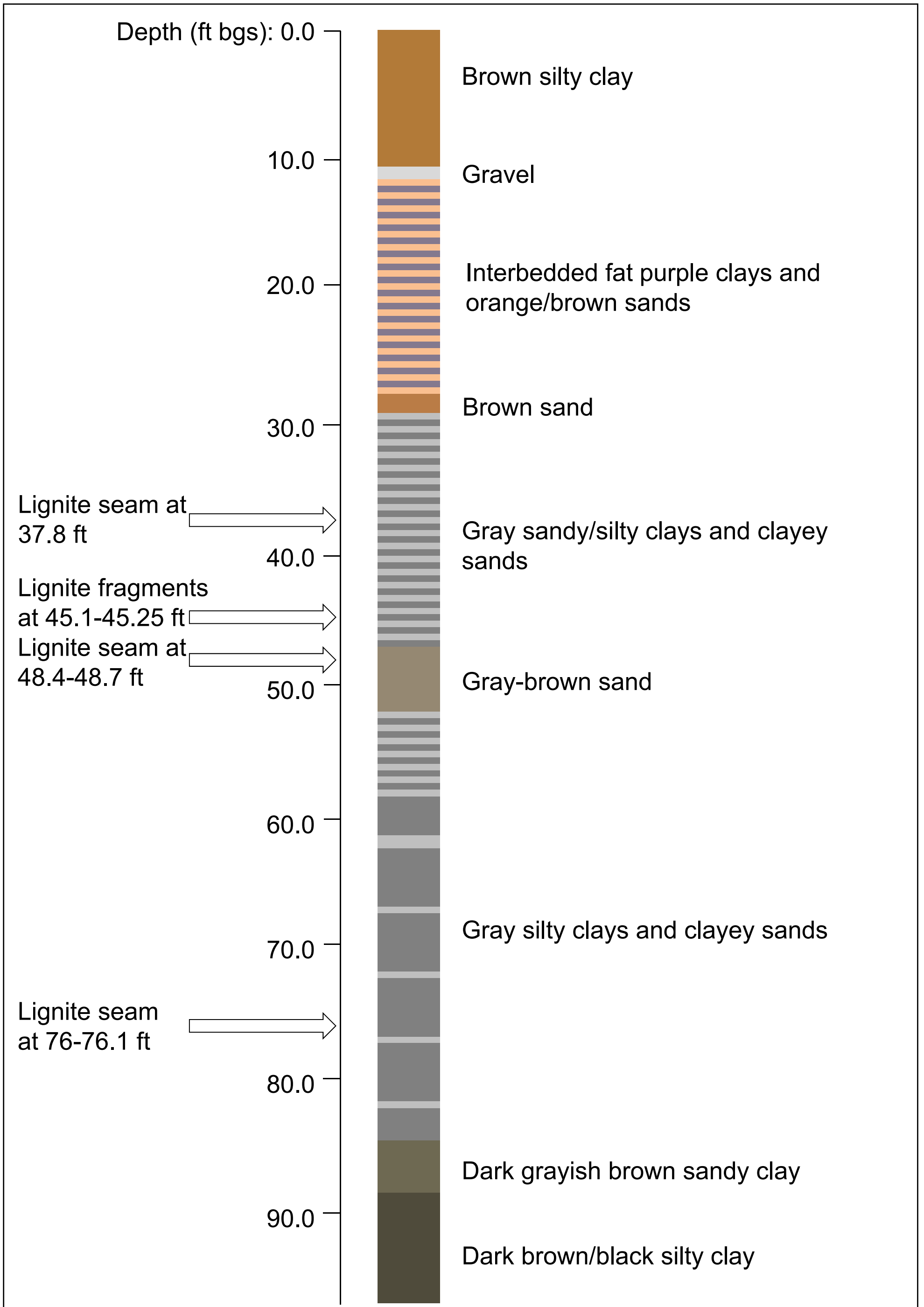
AEP Pirkey Power Plant
 Hallsville, Texas

Geosyntec
 consultants

Figure
3

Columbus, Ohio

2019/09/18



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

Figure

4

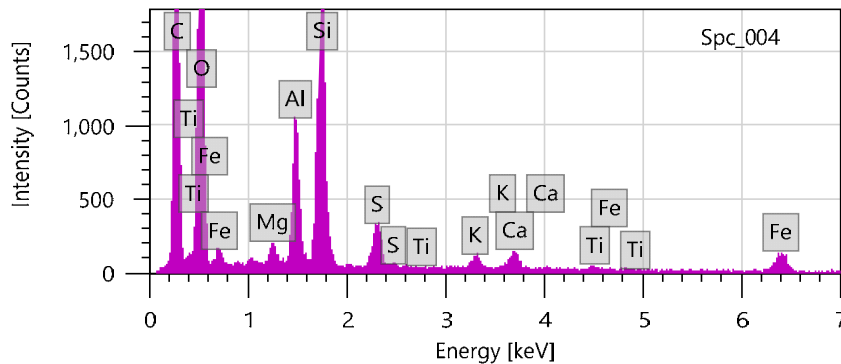
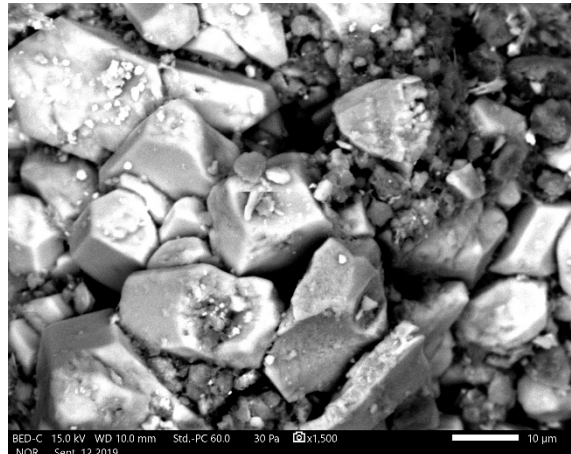
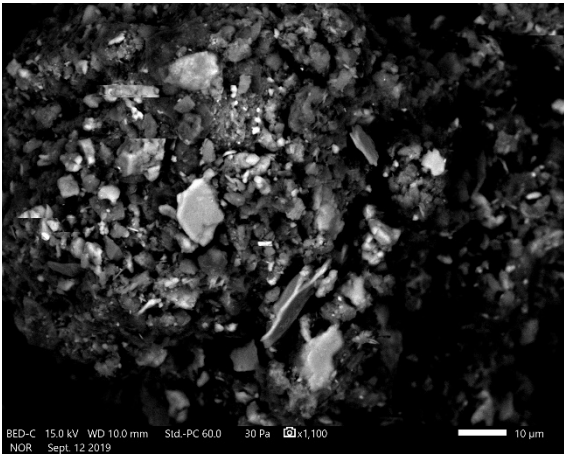
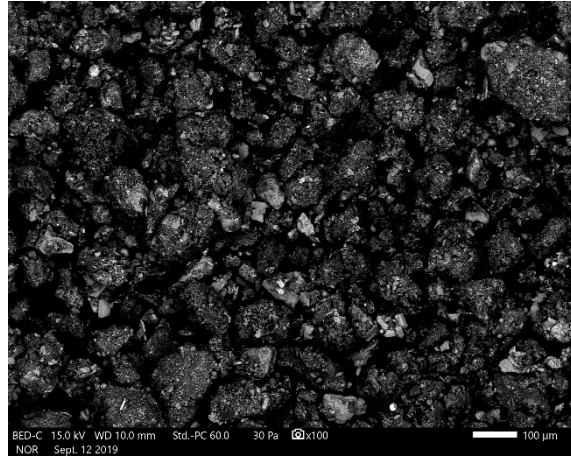
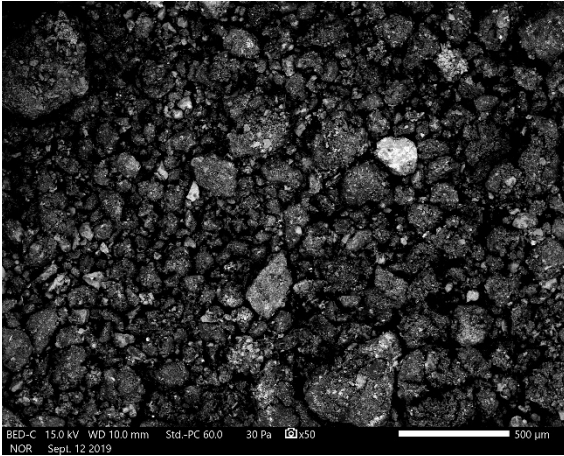
CHA8462

September 2019

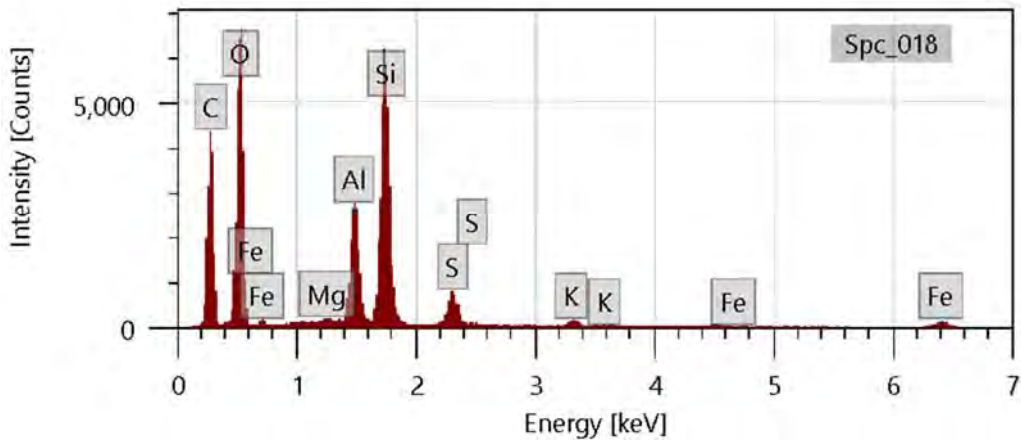
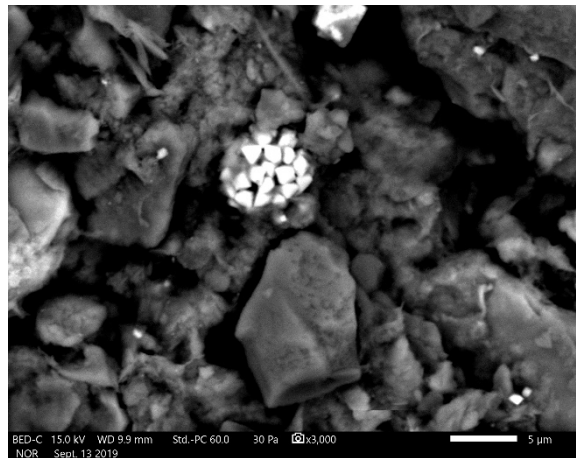
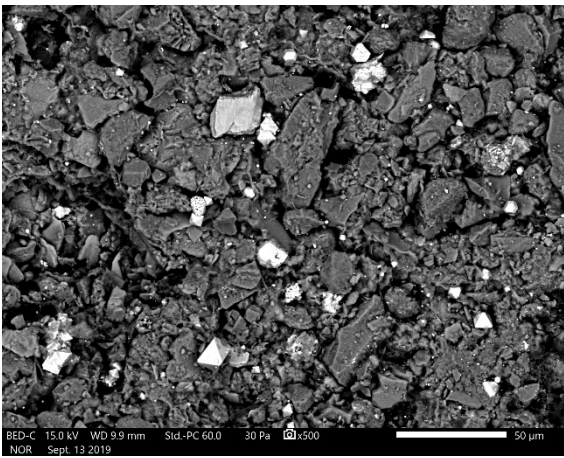
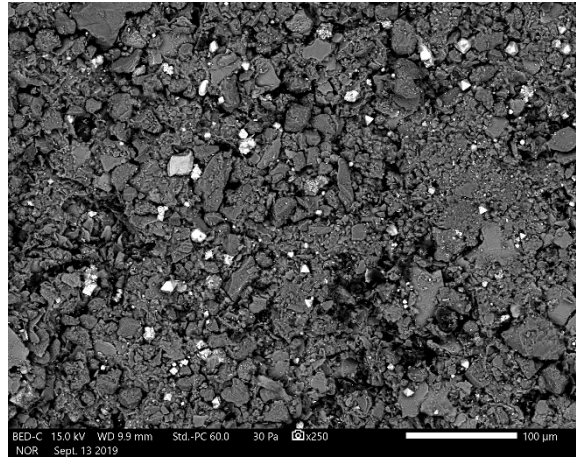
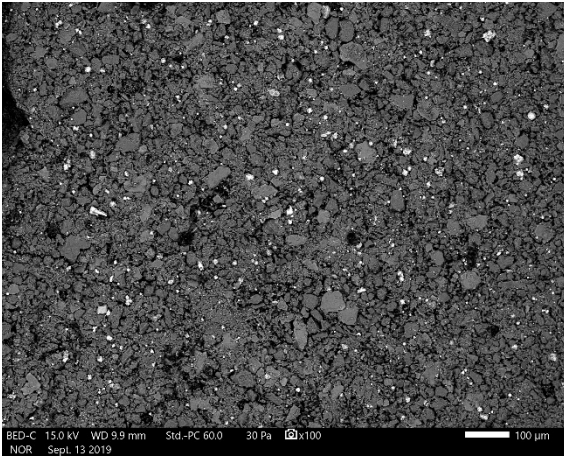
ATTACHMENT A
SEM/EDS Analysis

Dr. Bruce Sass
 941 Chatham Lane, Suite 103, Columbus, OH 43221

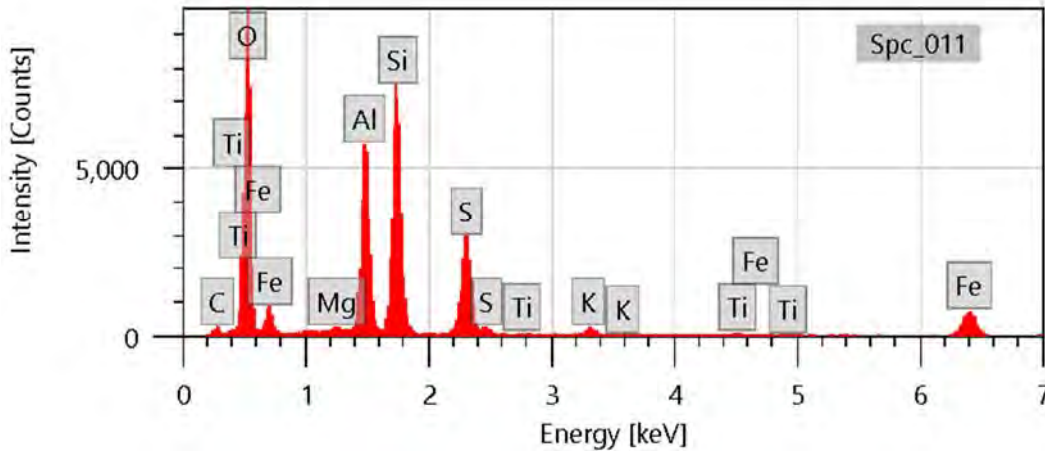
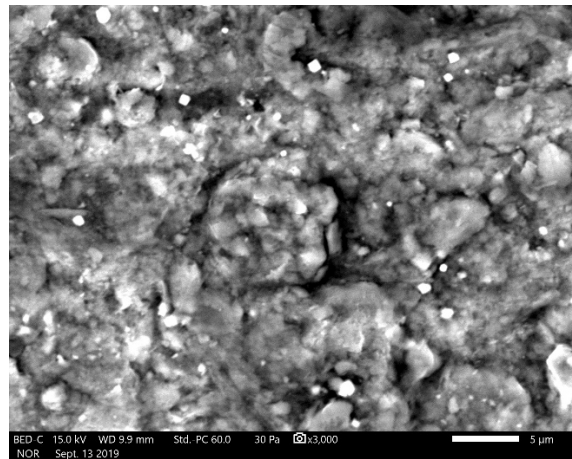
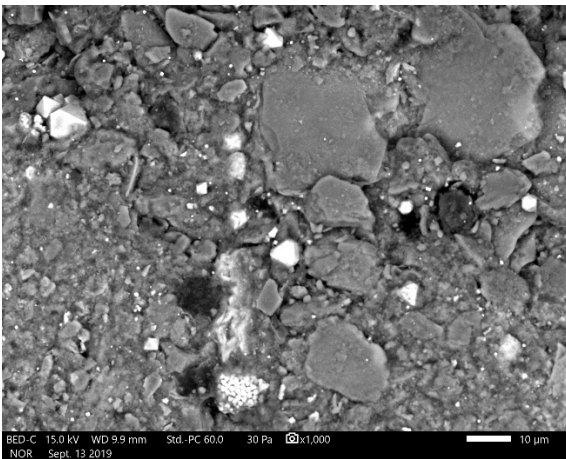
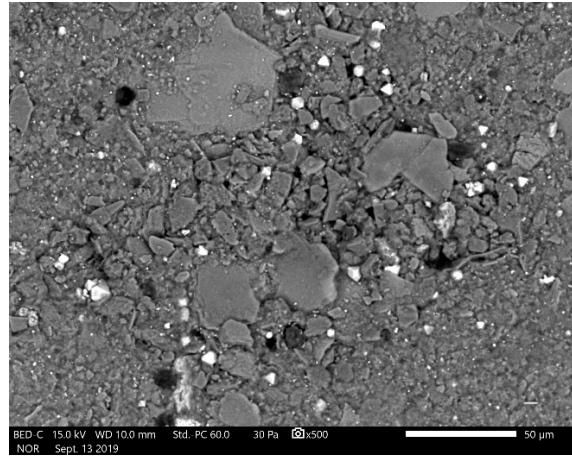
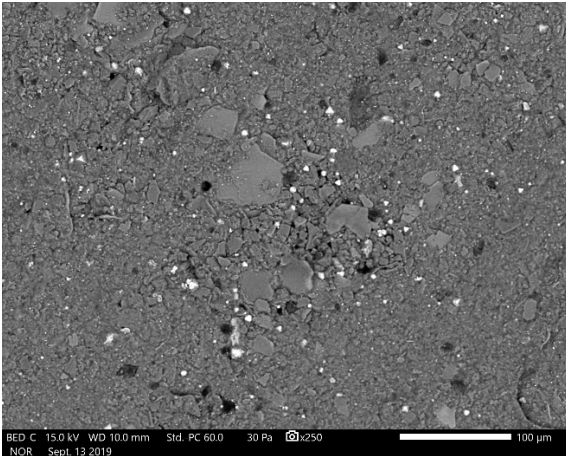
via Email: BSass@geosyntec.com



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



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	Latitude: 32° 26' 52.08" N
LOCATED ON OWNERS PROPERTY	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**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	8.25	0	60

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
Annular Seal Data:	31	38	Bentonite 3 Bags/Sacks

Seal Method: **Tremie**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Plug Information:	50	60

Water Quality:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	Latitude: 32° 26' 52.08" N
LOCATED ON OWNERS PROPERTY	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	Latitude: 32° 27' 56.32" N
LOCATED ON OWNERS PROPERTY	Longitude: 094° 29' 41.78" 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**

	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	Latitude:	32° 27' 46.12" N
	LOCATED ON OWNERS PROPERTY	Longitude:	094° 29' 43.34" W
Well County:	Harrison	Elevation:	No Data
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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	Latitude:	32° 26' 52.05" N
	LOCATED ON OWNERS PROPERTY	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**

	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	1	CLAY
1	5	CLAY/SAND
5	9.5	CLAY
9.5	12	SAND/CLAY

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 29' 00.5" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	40

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	27	40	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
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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
Well County: Harrison	Longitude: 094° 29' 00.5" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **3/9/2019** Drilling End Date: **3/10/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	100

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	86	100	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
2	Riser	New Plastic (PVC)	40	0	90
2	Screen	New Plastic (PVC)	40 0.010	90	100

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Texas Department of Licensing and Regulation
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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
Well County: Harrison	Longitude: 094° 29' 50" W
	Elevation: No Data
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:	6.75	0	22

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	8	22	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	7	tan and brown sandy, silty clay
7	22	red and grey sand w/occ. lignite layers

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
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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
Well County: Harrison	Longitude: 094° 29' 50" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	80

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	56	80	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
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(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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	25

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	12	25	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

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

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
Well County: Harrison	Longitude: 094° 29' 53" W
	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:	6.75	0	70

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	45	70	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
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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	Latitude: 32° 27' 30.34" N
LOCAATED ON OWNERS PROPERTY	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	10	CLAYS
10	18	SANDS AND CLAYS

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
2	Riser	New Plastic (PVC)	40	0	13
2	Screen	New Plastic (PVC)	40 0.1	13	18

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(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	Latitude:	32° 27' 30.28" N
	LOCATED ON OWNERS PROPERTY	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**

	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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

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 #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
Well County: Harrison	Longitude: 094° 30' 08" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **3/3/2019** Drilling End Date: **3/3/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	45

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	32	45	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	45	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 08" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	70

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	57	70	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	70	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	35

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	23	35	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	0	12	Cement
	12	23	Bentonite 4 Bags/Sacks

Seal Method: **Gravity**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	35	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	65

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	52	65	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	65	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	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
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	93

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	77	93	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	90	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)
90	93	gray clay (old pit base?)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 11" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **3/5/2019**

Drilling End Date: **3/5/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	30

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	17	30	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	0	12	Cement
	12	17	Bentonite 1 Bags/Sacks

Seal Method: **Gravity**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	30	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 11" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **3/4/2019** Drilling End Date: **3/4/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	60

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	48	60	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	60	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	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**

	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**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	18	tan and brown sandy, silty clay and occasional gravel

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	43

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	30	43	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	0	10	Cement
	10	30	Bentonite 5 Bags/Sacks

Seal Method: **Gravity**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	18	tan and brown sandy, silty clay and occasional gravel
18	43	red and grey sand w/occ. clay layers

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well Location: 2400 FM 3251 Hallsville, TX 75650	Latitude: 32° 27' 54.7" N
Well County: Harrison	Longitude: 094° 28' 25.01" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **5/13/2019** Drilling End Date: **5/17/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	8.25	0	49

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	36	49	Sand	20/40

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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 #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
Well County: Harrison	Longitude: 094° 28' 25.01" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **5/15/2019** Drilling End Date: **5/15/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	8	0	35

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	26.9	35	Sand	20/40

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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

Casing:
BLANK PIPE & WELL SCREEN DATA

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

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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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
Well Location: 2400 FM 3251 Hallsville, TX 75650	Latitude: 32° 27' 54.7" N
Well County: Harrison	Longitude: 094° 28' 25.01" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **5/20/2019** Drilling End Date: **5/20/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	4	0	40

Drilling Method: **Direct Push**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	27	40	Sand	20/40

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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

Casing:
BLANK PIPE & WELL SCREEN DATA

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

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



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 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.

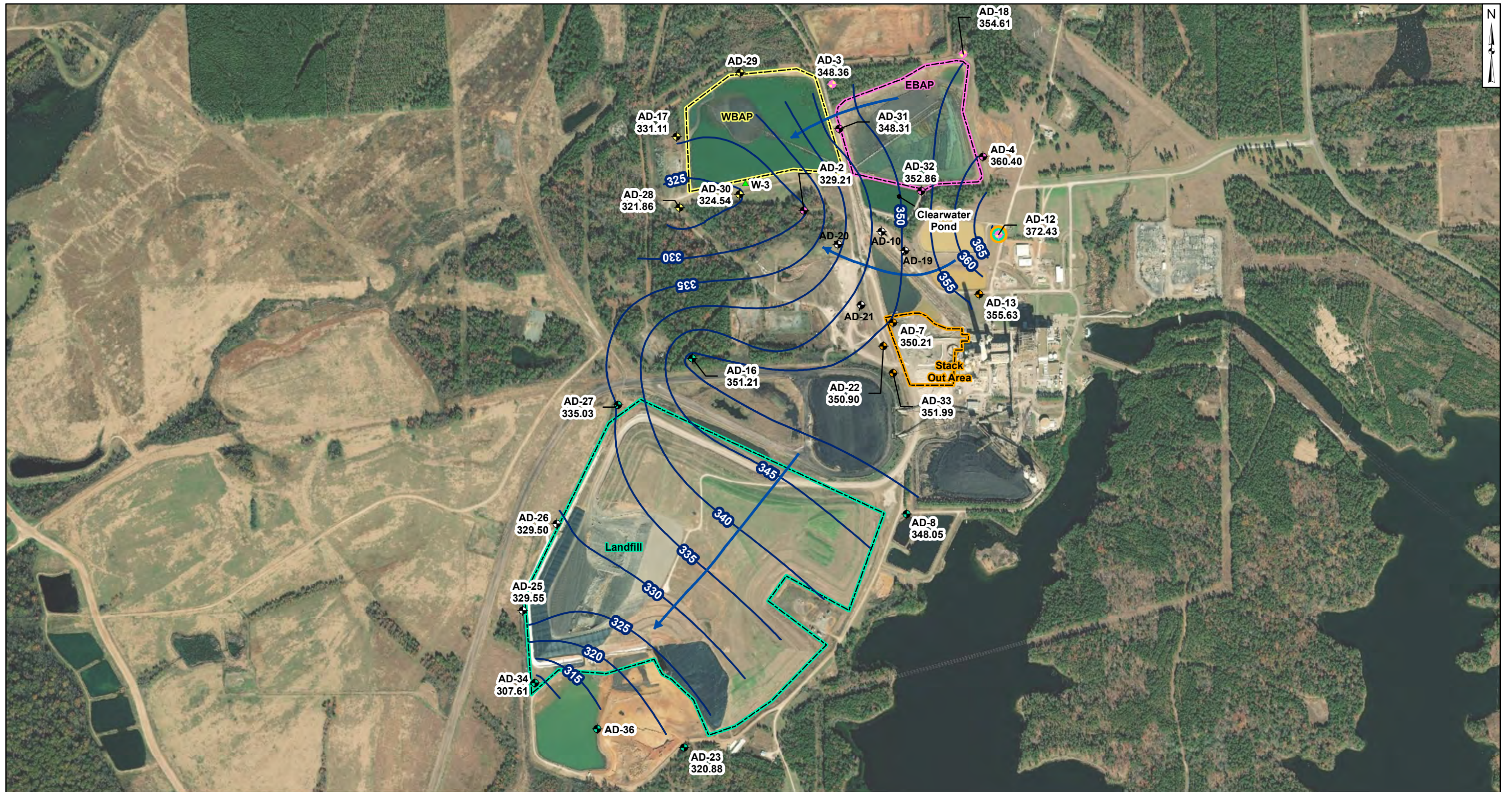
X. A Projection of Key Activities for the Upcoming Year

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

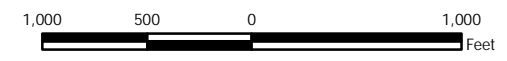
Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.



- 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.



Potentiometric Contours - Uppermost Aquifer
February 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Columbus, Ohio

2020/01/16

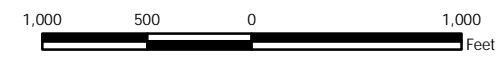
Figure
1



- 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

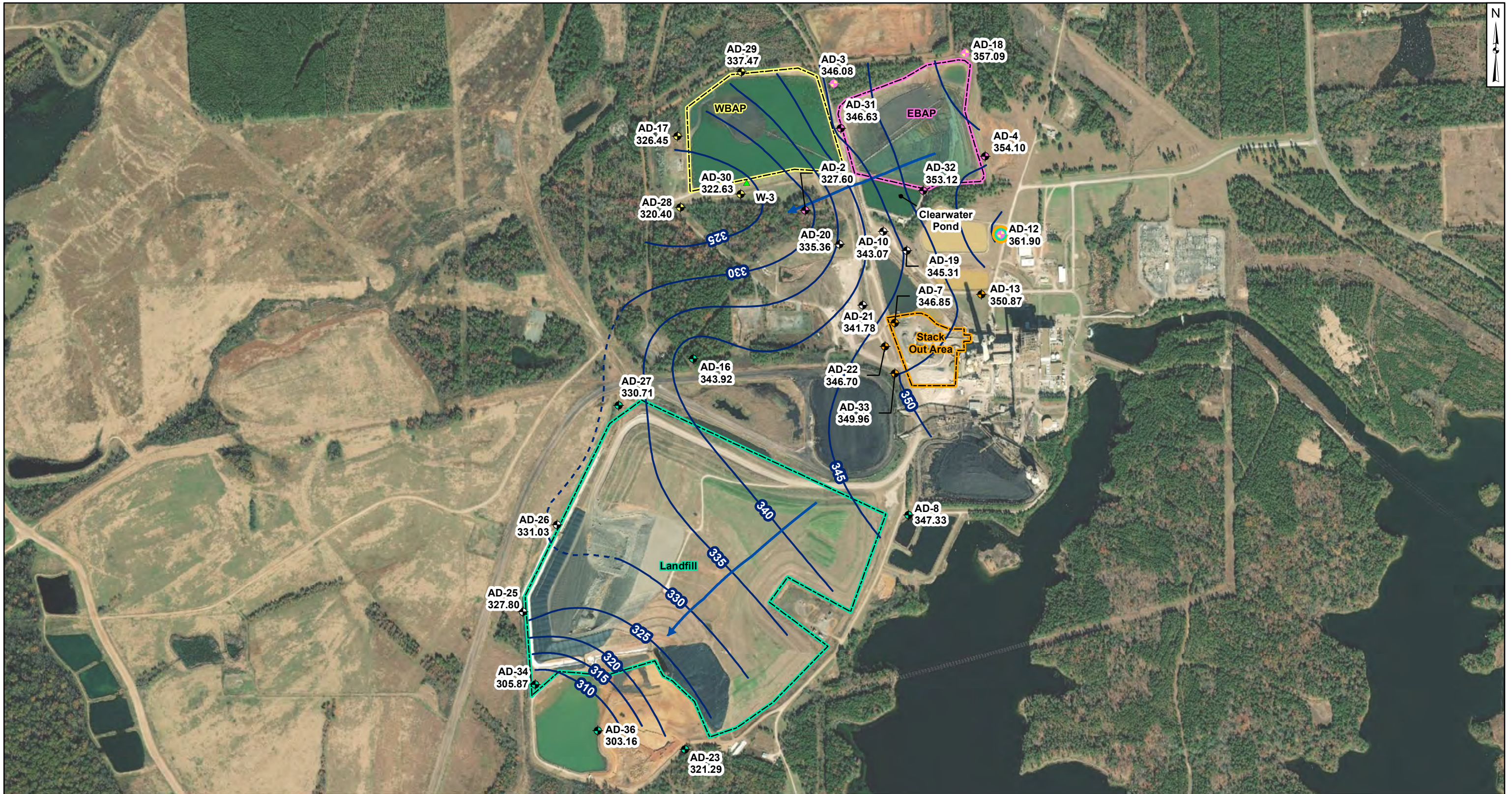
Geosyntec
consultants

Figure

2

Columbus, Ohio

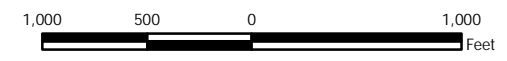
2020/01/16



- 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.



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**

Geosyntec Consultants, Inc.

CCR Management Unit	Monitoring Well	Well Diameter (inches)	2019-02		2019-05		2019-08	
			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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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 DESULFURIZATION (FGD)
STACKOUT AREA
H.W. Pirkey Plant
Hallsville, Texas**

Submitted to



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CHA8473

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LIST OF ATTACHMENTS

Attachment A	Certification by Qualified Professional Engineer
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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

112498

License Number

TEXAS

Licensing State

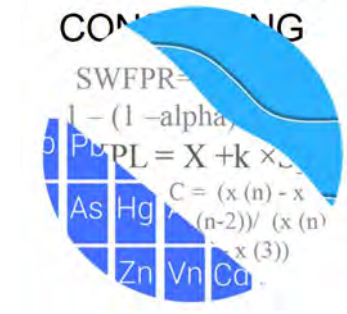
07.11.19

Date



ATTACHMENT B
Statistical Analysis Output

GROUNDWATER STATS



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.

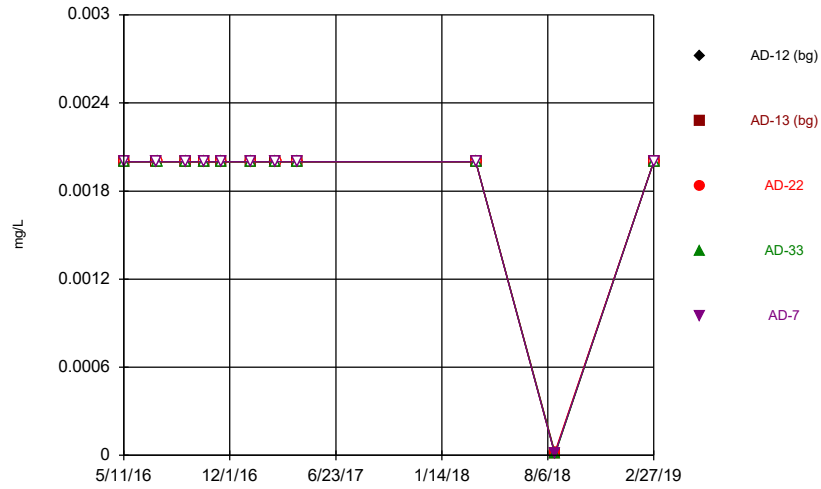
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Stackout. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

A handwritten signature in cursive script that reads "Kristina Rayner". The signature is written in black ink and is positioned above the typed name.

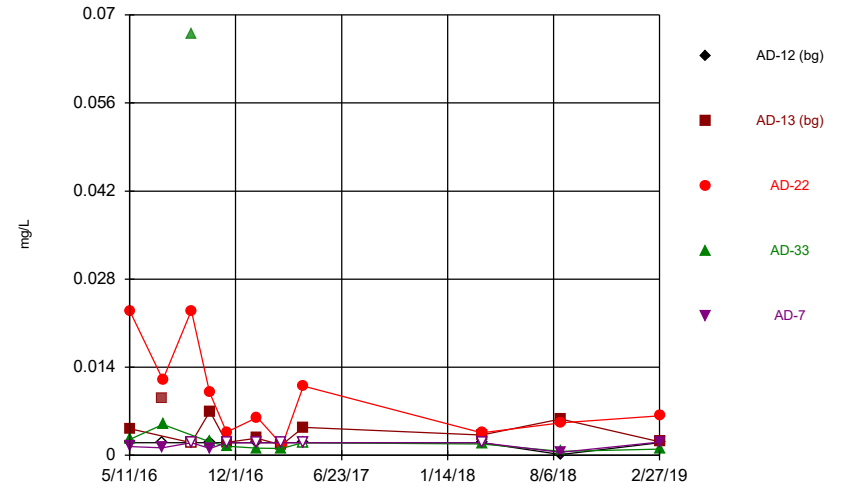
Kristina L. Rayner
Groundwater Statistician

Time Series



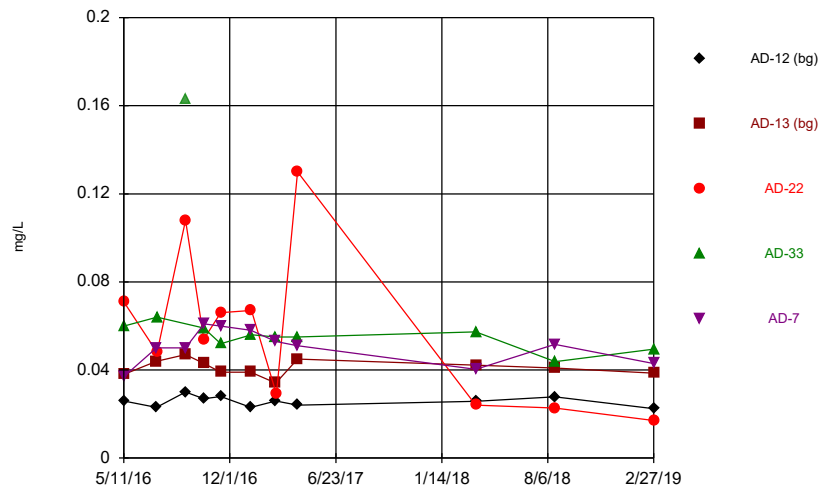
Constituent: Antimony, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



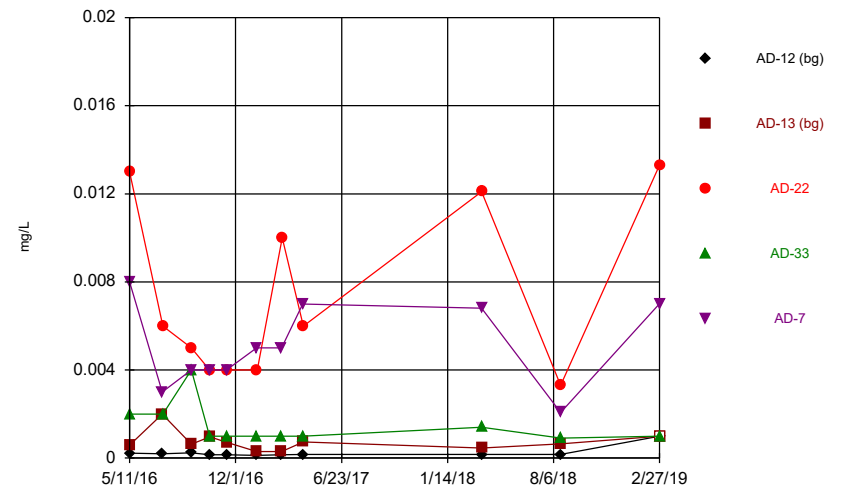
Constituent: Arsenic, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



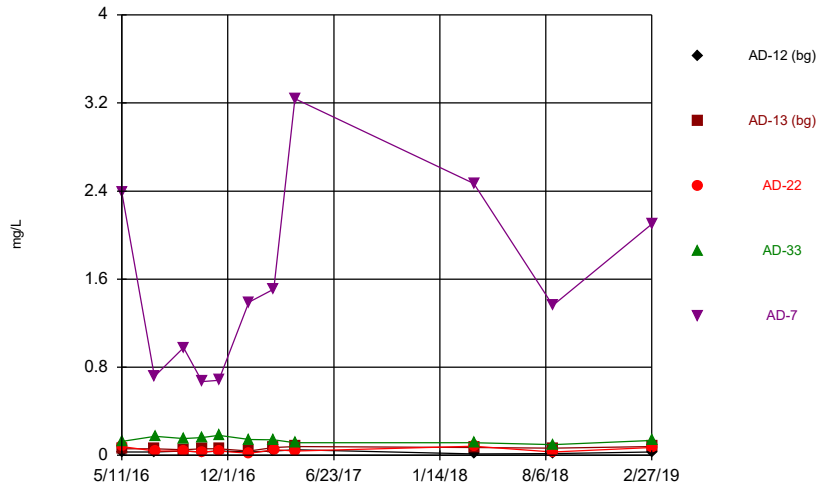
Constituent: Barium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



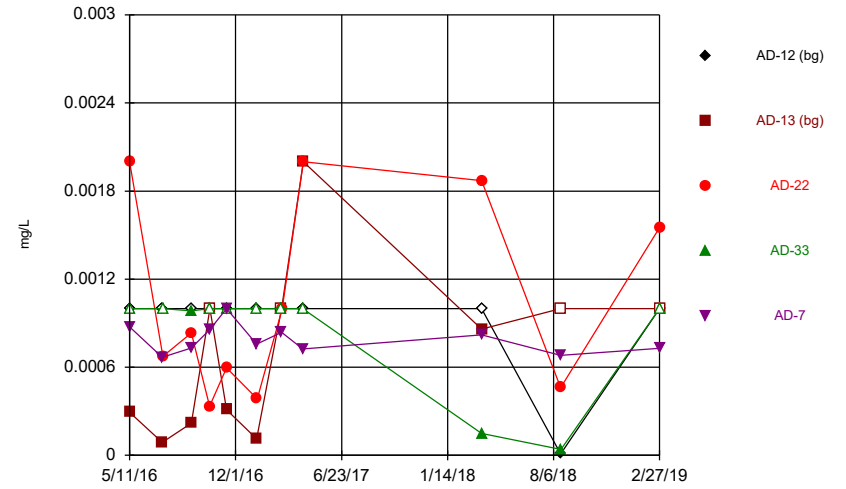
Constituent: Beryllium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
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Time Series



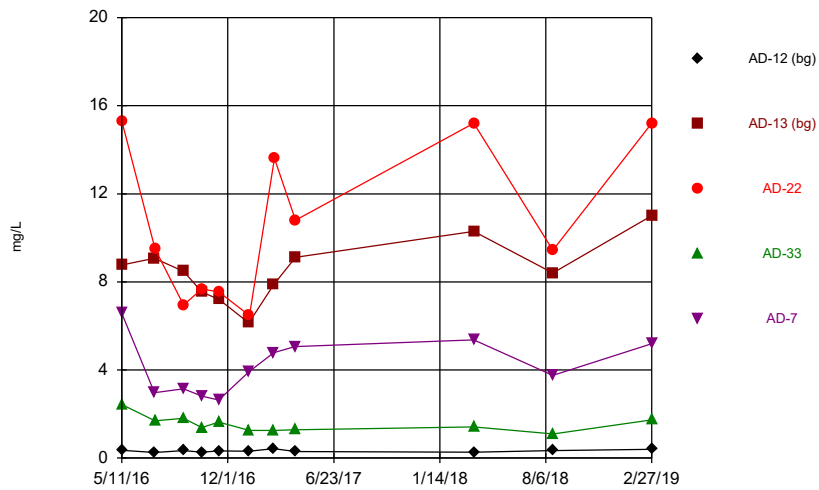
Constituent: Boron, total Analysis Run 7/8/2019 9:16 AM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



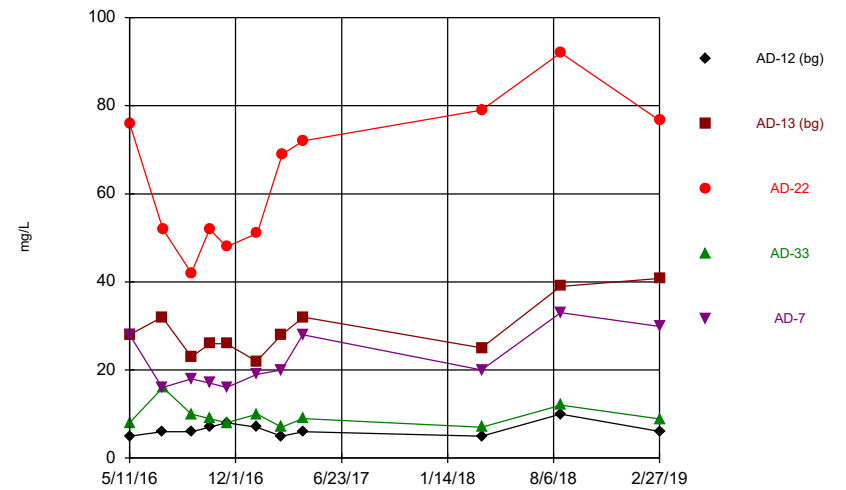
Constituent: Cadmium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



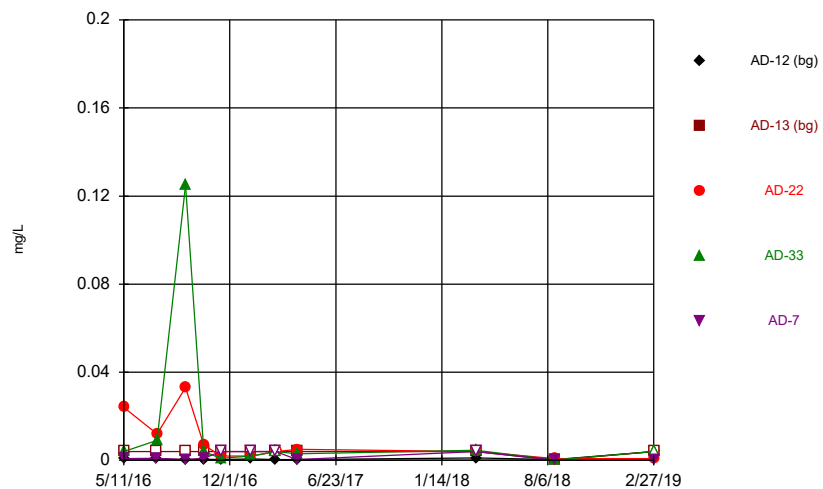
Constituent: Calcium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



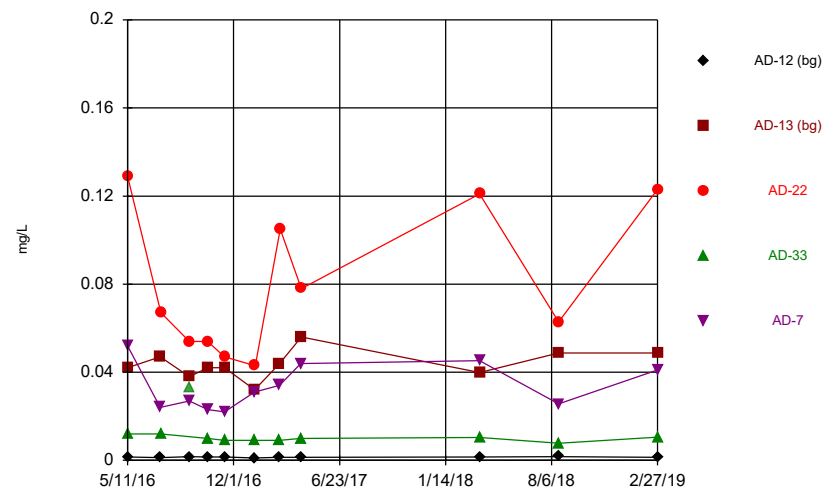
Constituent: Chloride, total Analysis Run 7/8/2019 9:16 AM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



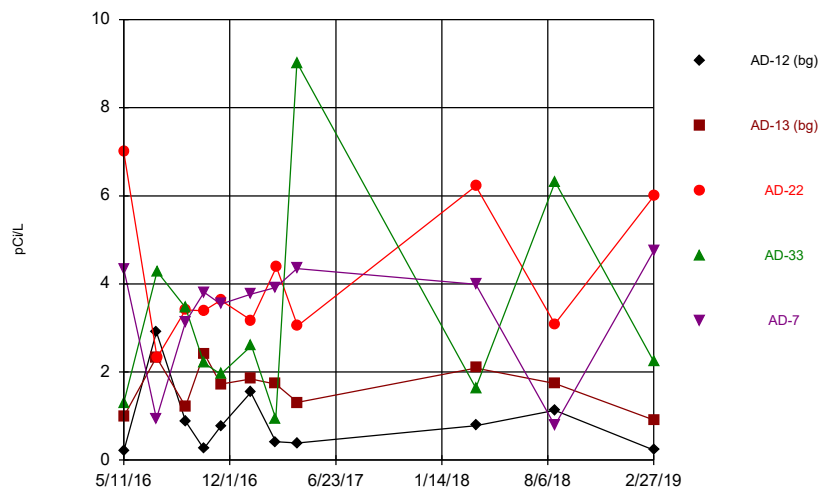
Constituent: Chromium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



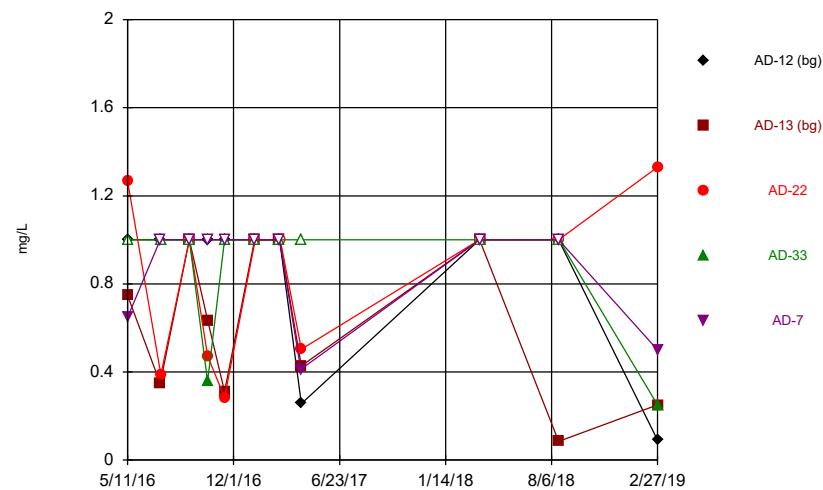
Constituent: Cobalt, total Analysis Run 7/8/2019 9:16 AM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



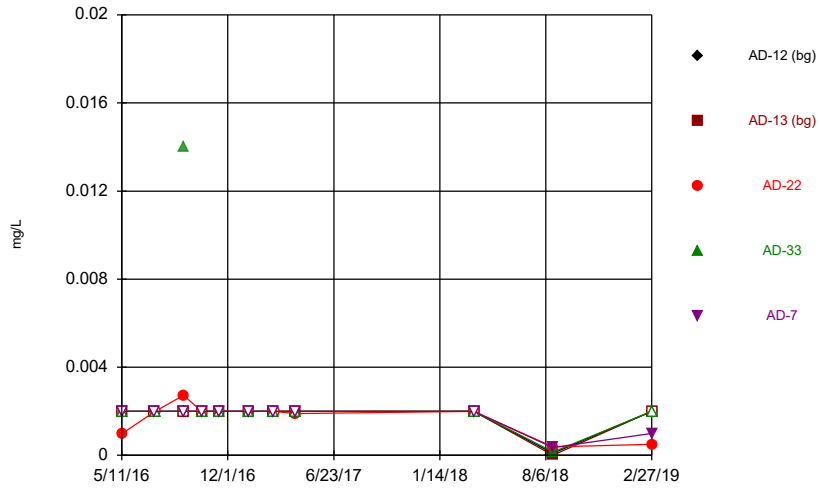
Constituent: Combined Radium 226 + 228 Analysis Run 7/8/2019 9:16 AM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



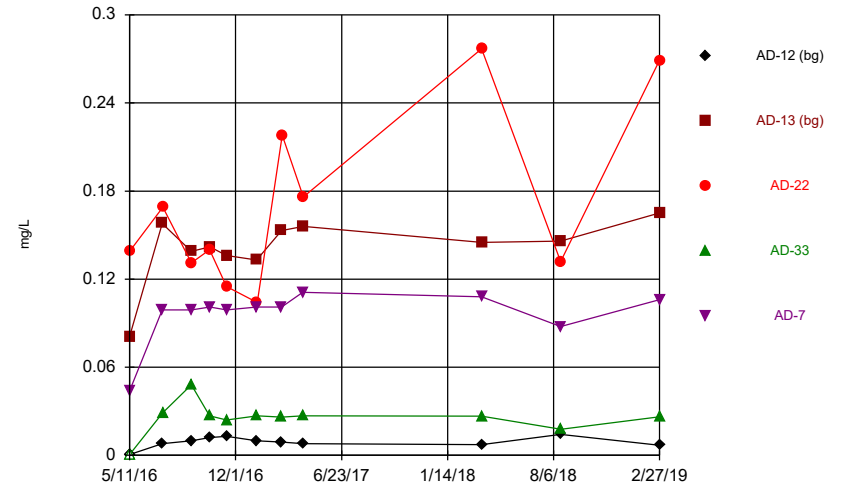
Constituent: Fluoride, total Analysis Run 7/8/2019 9:16 AM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



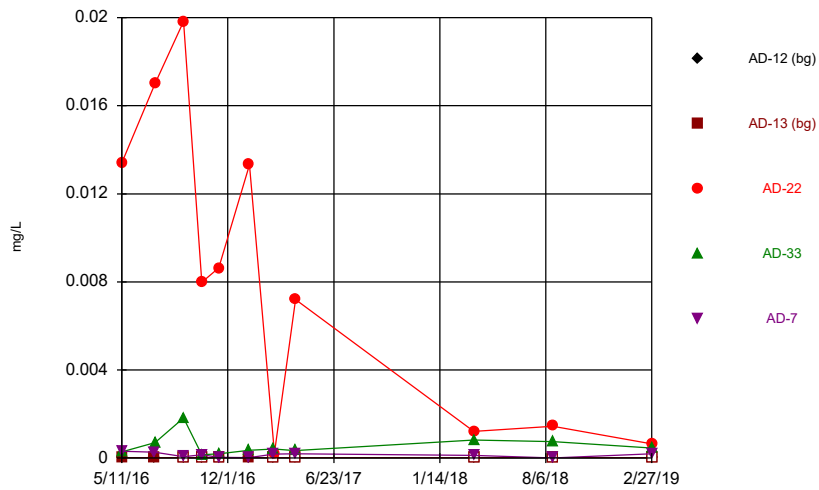
Constituent: Lead, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



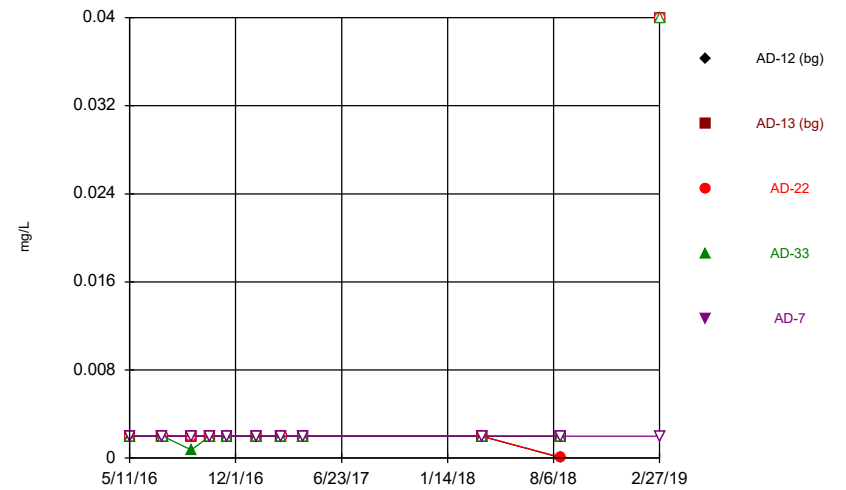
Constituent: Lithium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



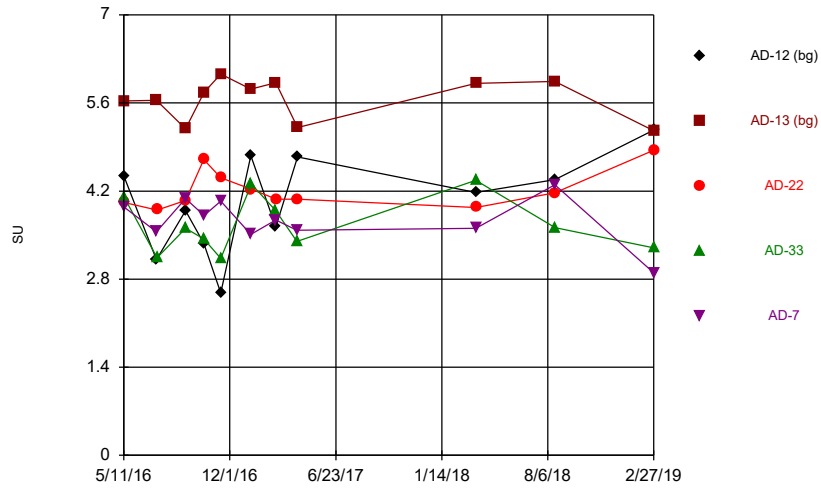
Constituent: Mercury, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



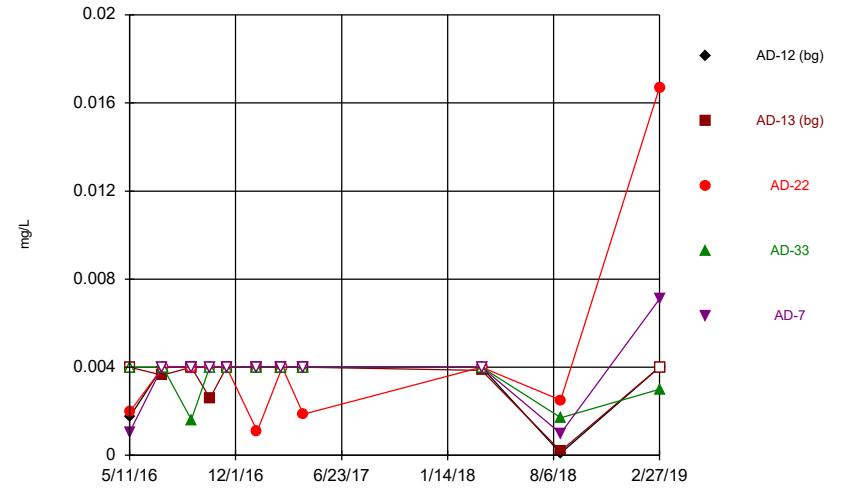
Constituent: Molybdenum, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



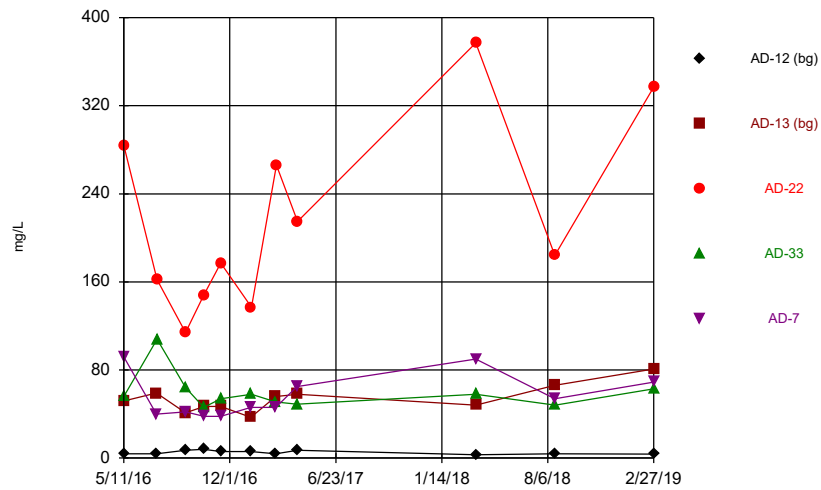
Constituent: pH, field Analysis Run 7/8/2019 9:17 AM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



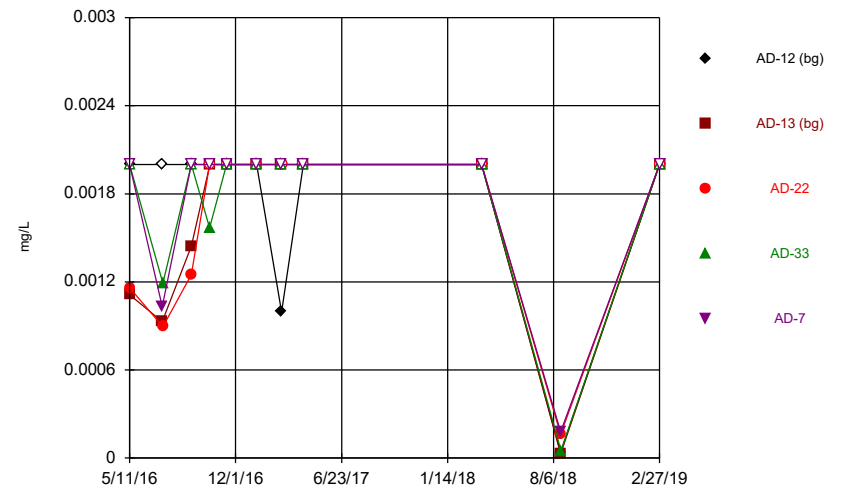
Constituent: Selenium, total Analysis Run 7/8/2019 9:17 AM View: Time Series
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Time Series



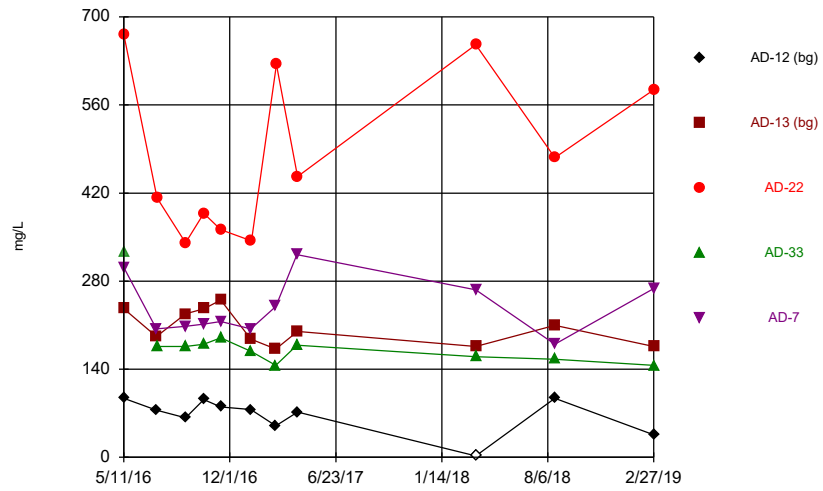
Constituent: Sulfate, total Analysis Run 7/8/2019 9:17 AM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



Constituent: Thallium, total Analysis Run 7/8/2019 9:17 AM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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.	Bq 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

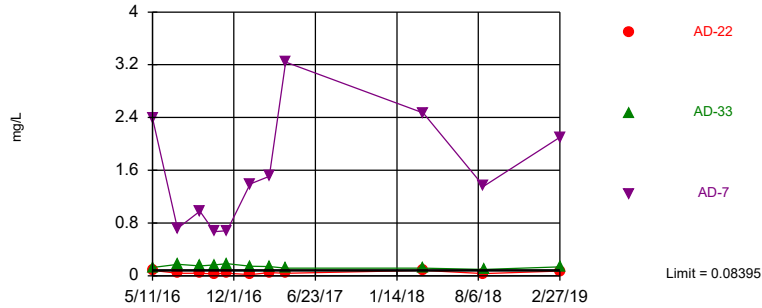
Interwell Prediction Limit Summary - All Results

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

Exceeds Limit: AD-33, AD-7

Prediction Limit
Interwell Parametric

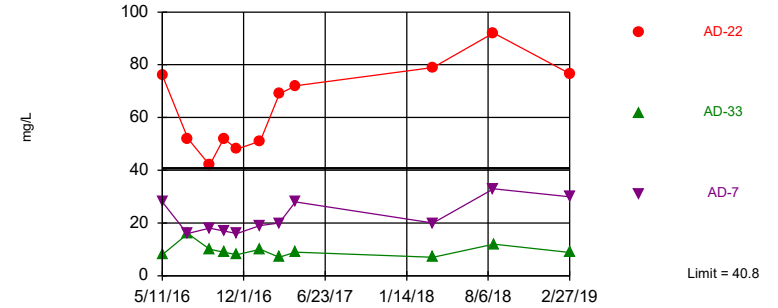


Background Data Summary: Mean=0.04762, Std. Dev.=0.01946, n=22. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9482, critical = 0.878. Kappa = 1.866 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

Constituent: Boron, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Exceeds Limit: AD-22

Prediction Limit
Interwell Non-parametric

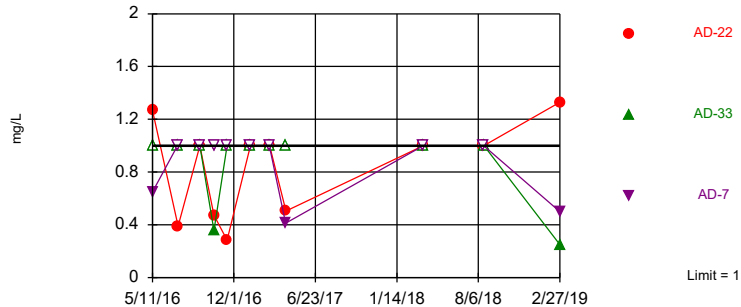


Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 22 background values. Annual per-constituent alpha = 0.02133. Individual comparison alpha = 0.003586 (1 of 2). Comparing 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

Exceeds Limit: AD-22

Prediction Limit
Interwell Non-parametric

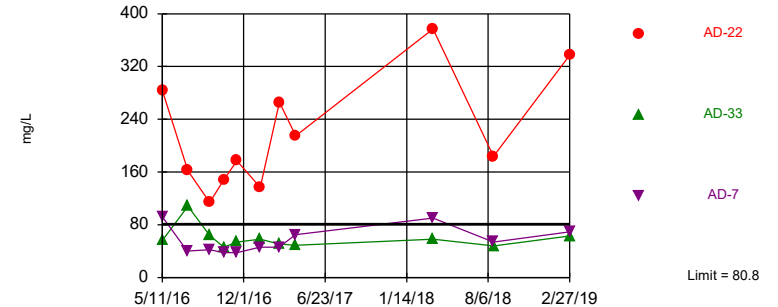


Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 22 background values. 59.09% NDs. Annual per-constituent alpha = 0.02133. Individual comparison alpha = 0.003586 (1 of 2). Comparing 3 points to limit.

Constituent: Fluoride, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

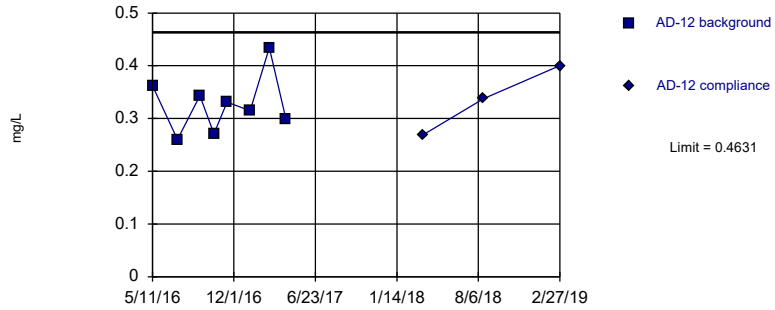
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-13	10.58	n/a	2/27/2019	11	Yes	8	8.025	1.038	0	None	No	0.002505	Param 1 of 2
pH, field (SU)	AD-22	4.819	3.544	2/27/2019	4.85	Yes	8	4.181	0.2594	0	None	No	0.001253	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

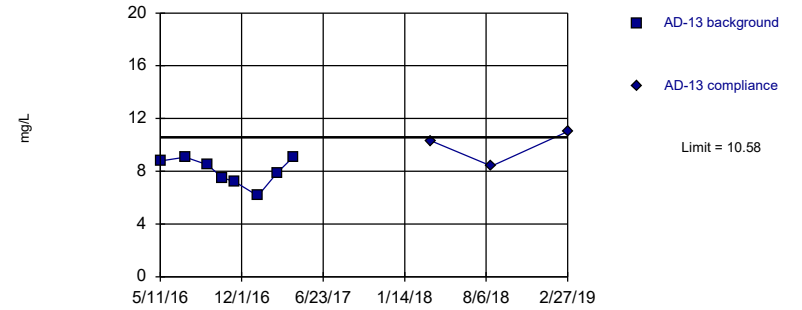
Within Limit Prediction Limit
Intrawell Parametric



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

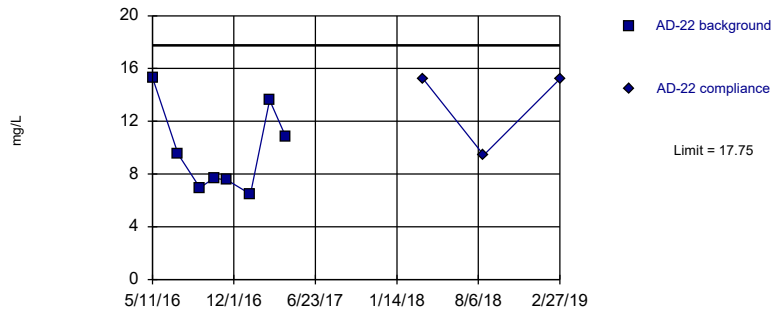
Exceeds Limit Prediction Limit
Intrawell Parametric



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

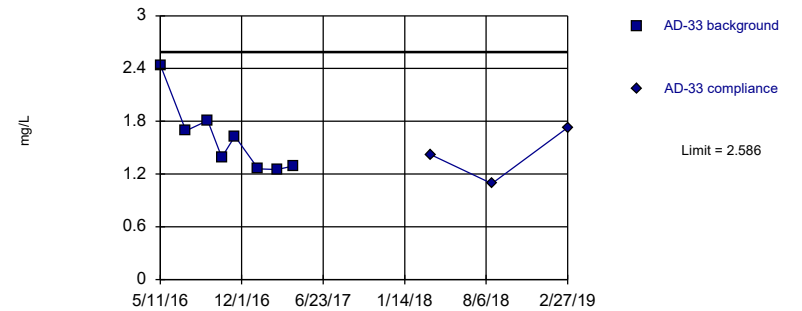
Within Limit Prediction Limit
Intrawell Parametric



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

Within Limit Prediction Limit
Intrawell Parametric

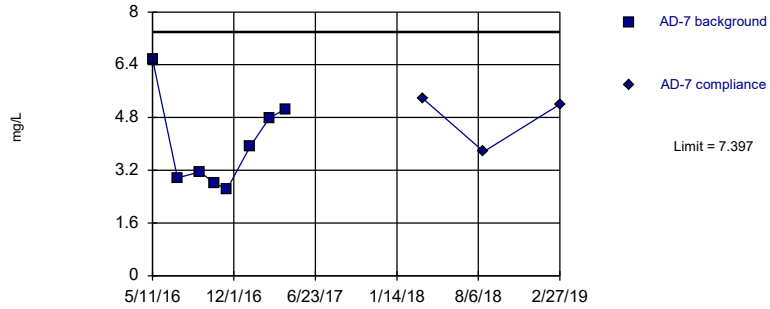


Background Data Summary: Mean=1.595, Std. Dev.=0.403, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8403, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit
Intrawell Parametric

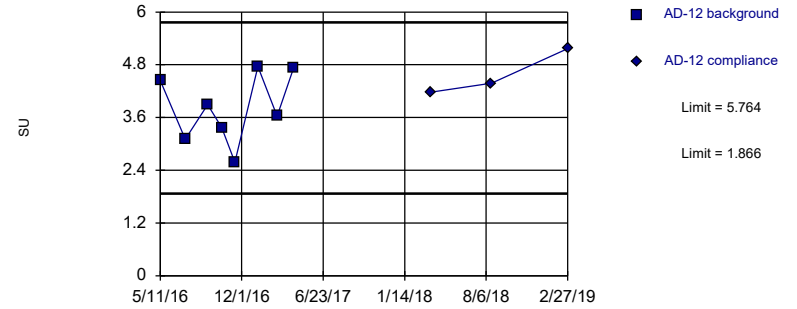


Background Data Summary: Mean=3.988, Std. Dev.=1.387, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8893, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limits

Prediction Limit
Intrawell Parametric

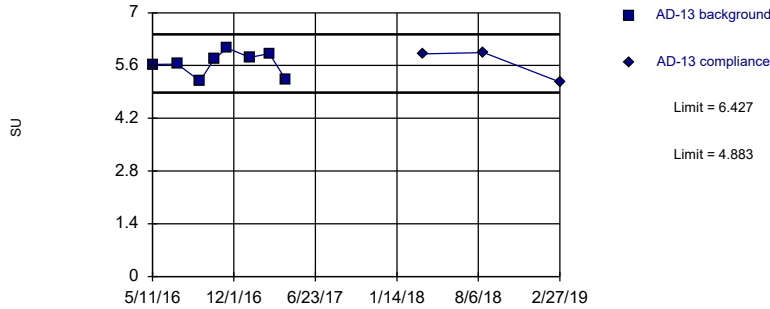


Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limits

Prediction Limit
Intrawell Parametric

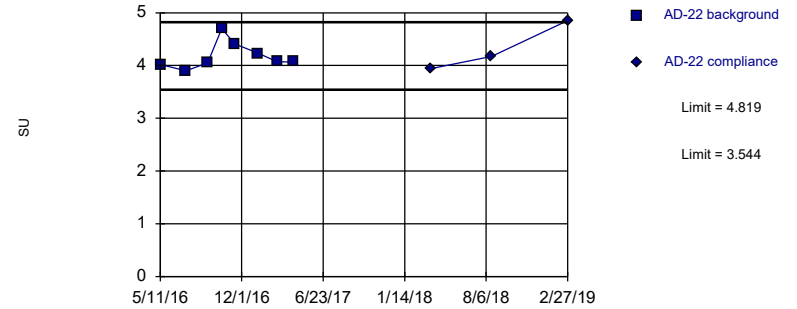


Background Data Summary: Mean=5.655, Std. Dev.=0.3139, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9084, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Exceeds Limits

Prediction Limit
Intrawell Parametric

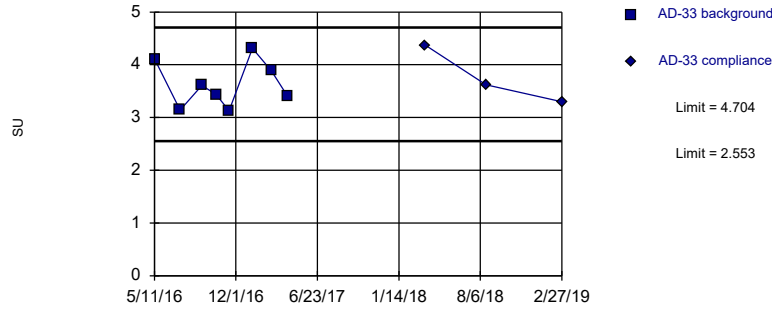


Background Data Summary: Mean=4.181, Std. Dev.=0.2594, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8669, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limits

Prediction Limit
Intrawell Parametric

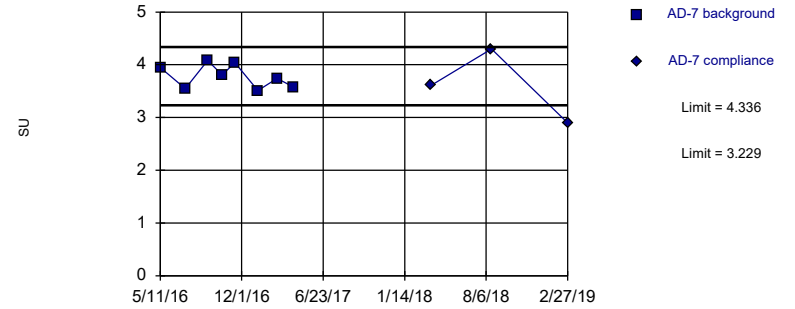


Background Data Summary: Mean=3.629, Std. Dev.=0.4375, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9295, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Exceeds Limits

Prediction Limit
Intrawell Parametric

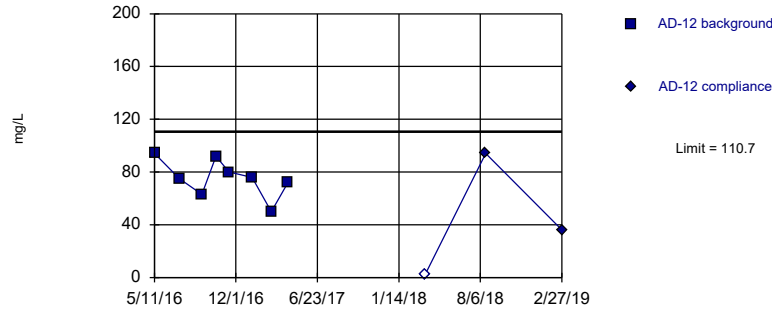


Background Data Summary: Mean=3.783, Std. Dev.=0.2251, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9108, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit
Intrawell Parametric

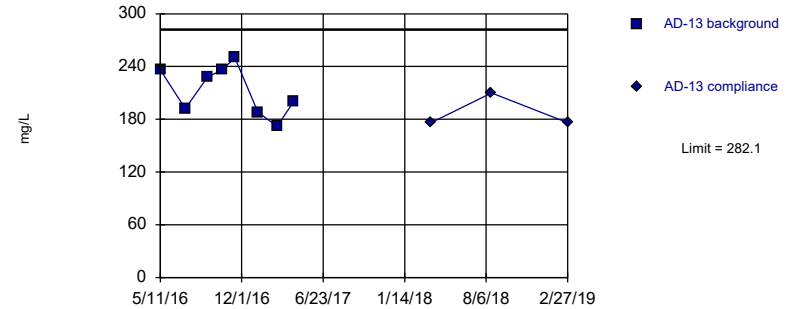


Background Data Summary: Mean=75.25, Std. Dev.=14.41, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9549, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit
Intrawell Parametric

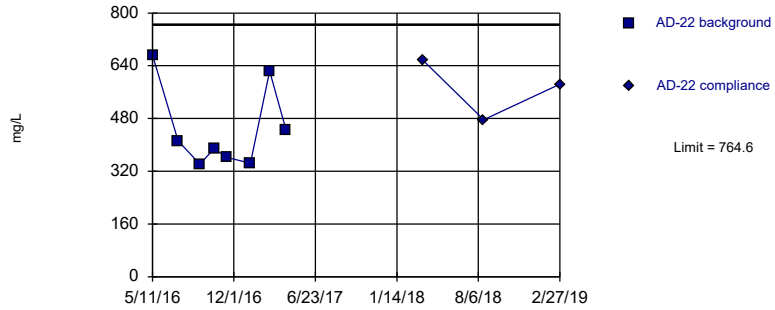


Background Data Summary: Mean=212.8, Std. Dev.=28.2, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9216, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit
Intrawell Parametric

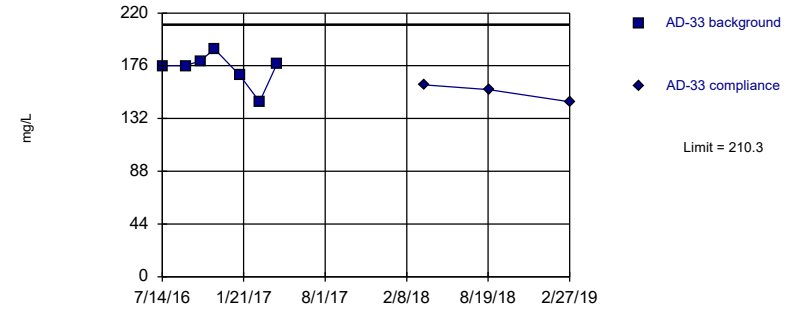


Background Data Summary: Mean=448.6, Std. Dev.=128.6, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8034, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit
Intrawell Parametric

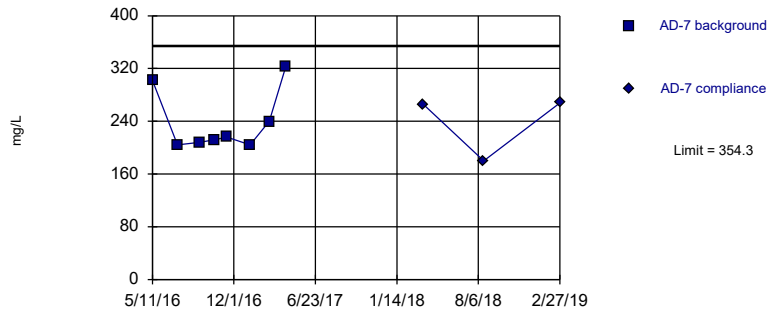


Background Data Summary: Mean=173.4, Std. Dev.=13.75, n=7. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8665, critical = 0.73. Kappa = 2.685 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

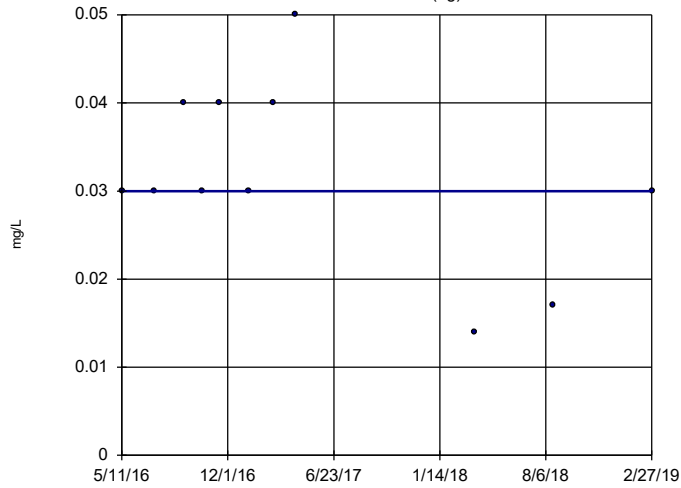
Trend Test Summary Table - All Results (No Significant)

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 3:15 PM

<u>Constituent</u>	<u>Well</u>	<u>Slope</u>	<u>Calc.</u>	<u>Critical</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Normality</u>	<u>Xform</u>	<u>Alpha</u>	<u>Method</u>
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

Sen's Slope Estimator

AD-12 (bg)

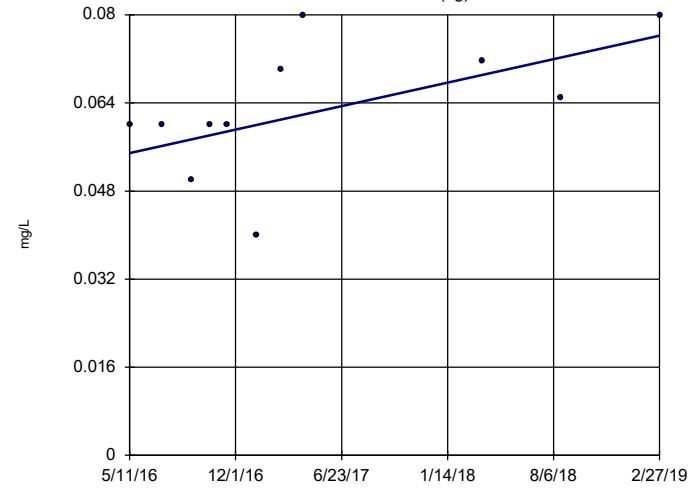


n = 11
 Slope = 0
 units per year.
 Mann-Kendall
 statistic = -4
 critical = -31
 Trend not sig-
 nificant at 98%
 confidence level
 ($\alpha = 0.01$ per
 tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-13 (bg)

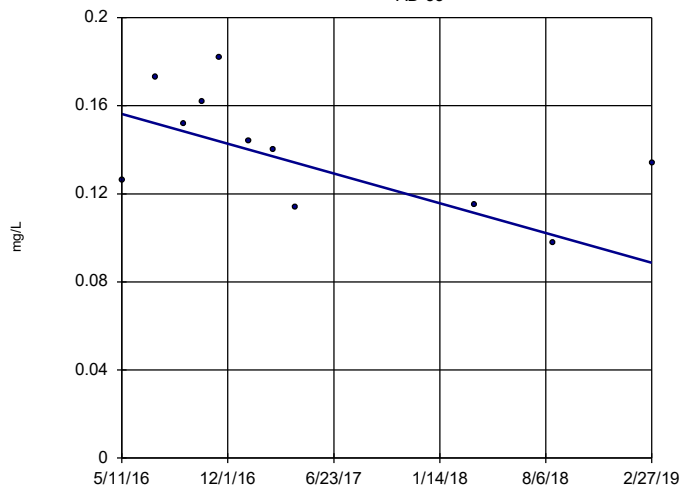


n = 11
 Slope = 0.007612
 units per year.
 Mann-Kendall
 statistic = 26
 critical = 31
 Trend not sig-
 nificant at 98%
 confidence level
 ($\alpha = 0.01$ per
 tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-33

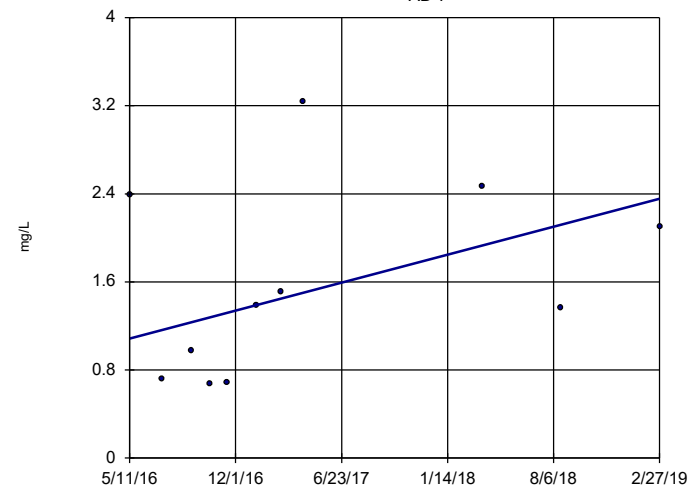


n = 11
 Slope = -0.02412
 units per year.
 Mann-Kendall
 statistic = -25
 critical = -31
 Trend not sig-
 nificant at 98%
 confidence level
 ($\alpha = 0.01$ per
 tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-7

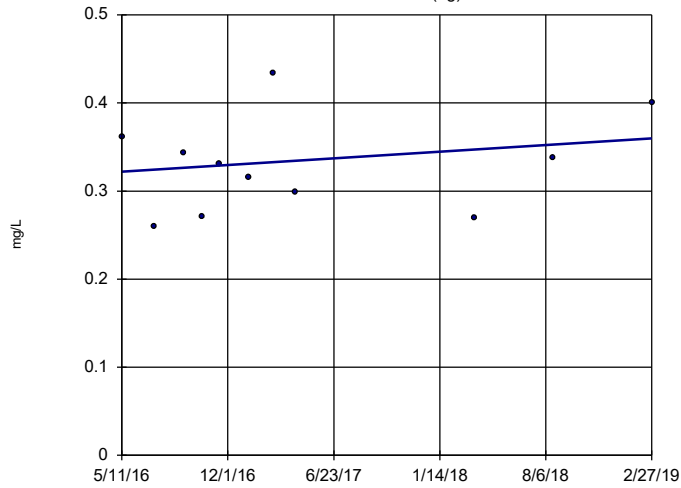


n = 11
 Slope = 0.4535
 units per year.
 Mann-Kendall
 statistic = 17
 critical = 31
 Trend not sig-
 nificant at 98%
 confidence level
 ($\alpha = 0.01$ per
 tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-12 (bg)

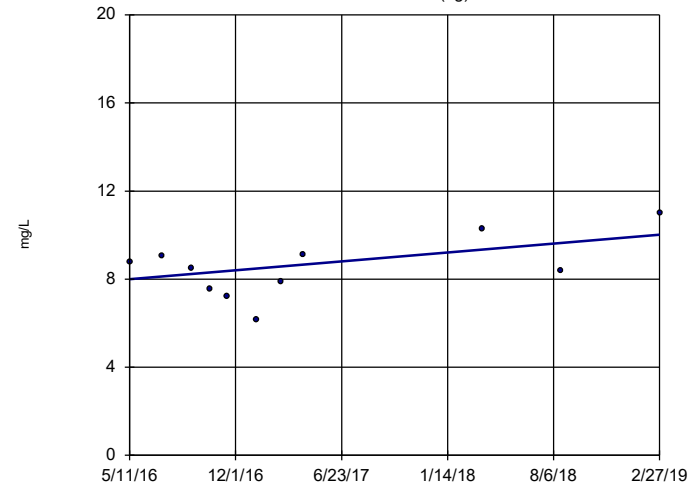


n = 11
 Slope = 0.01357
 units per year.
 Mann-Kendall
 statistic = 5
 critical = 31
 Trend not sig-
 nificant at 98%
 confidence level
 (α = 0.01 per
 tail).

Constituent: Calcium, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-13 (bg)

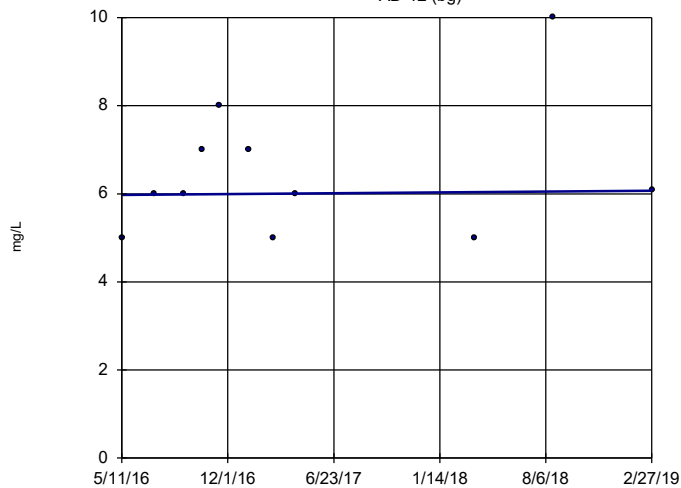


n = 11
 Slope = 0.7229
 units per year.
 Mann-Kendall
 statistic = 11
 critical = 31
 Trend not sig-
 nificant at 98%
 confidence level
 (α = 0.01 per
 tail).

Constituent: Calcium, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-12 (bg)

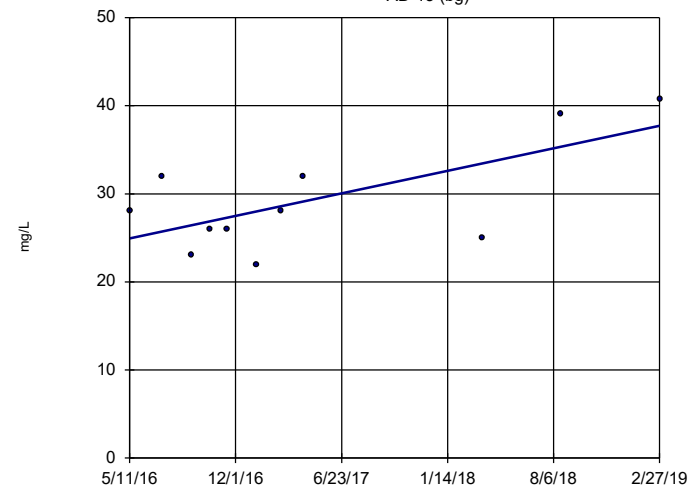


n = 11
 Slope = 0.03234
 units per year.
 Mann-Kendall
 statistic = 10
 critical = 31
 Trend not sig-
 nificant at 98%
 confidence level
 (α = 0.01 per
 tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-13 (bg)

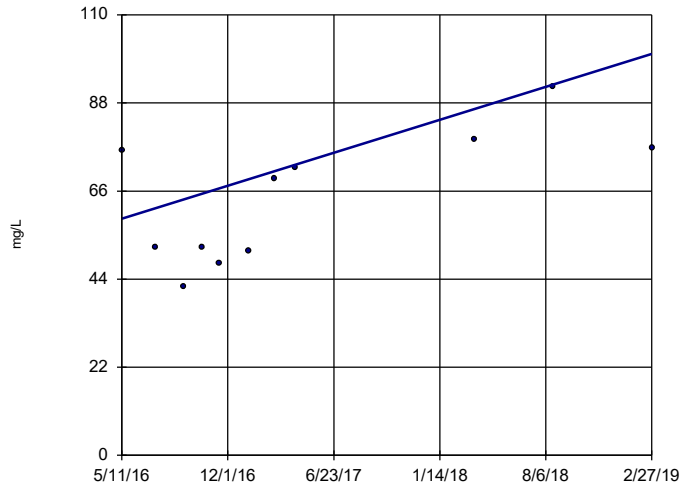


n = 11
 Slope = 4.571
 units per year.
 Mann-Kendall
 statistic = 16
 critical = 31
 Trend not sig-
 nificant at 98%
 confidence level
 (α = 0.01 per
 tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-22

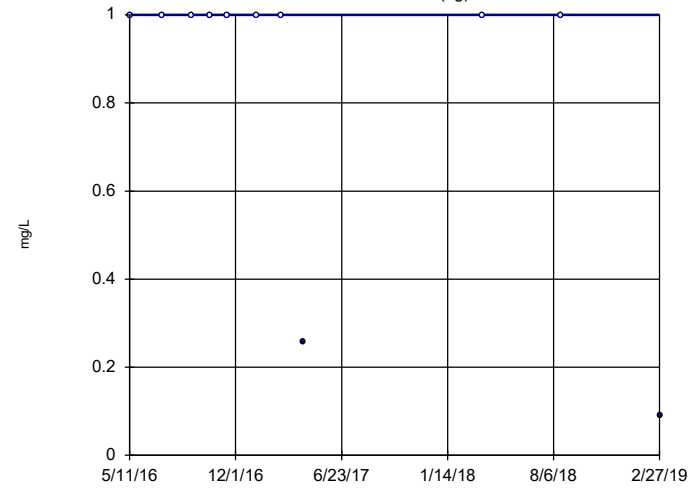


n = 11
Slope = 14.72 units per year.
Mann-Kendall statistic = 26
critical = 31
Trend not significant at 98% confidence level ($\alpha = 0.01$ per tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-12 (bg)

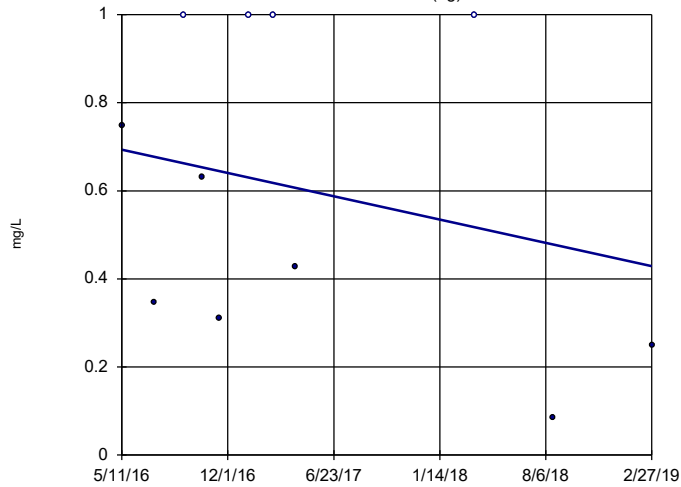


n = 11
Slope = 0 units per year.
Mann-Kendall statistic = -15
critical = -31
Trend not significant at 98% confidence level ($\alpha = 0.01$ per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-13 (bg)

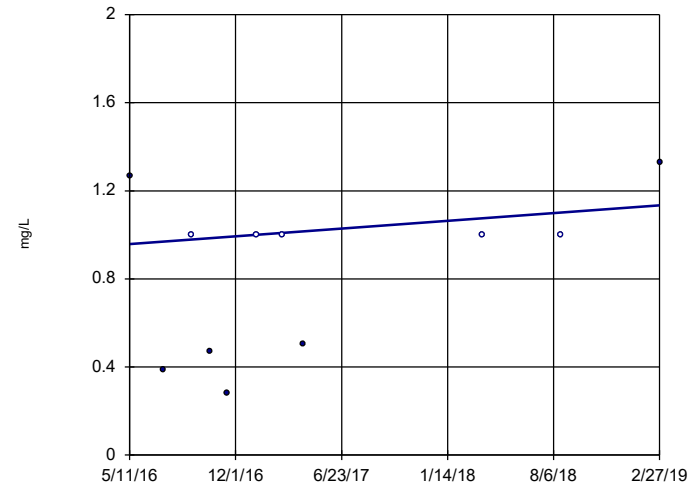


n = 11
Slope = -0.09446 units per year.
Mann-Kendall statistic = -11
critical = -31
Trend not significant at 98% confidence level ($\alpha = 0.01$ per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-22

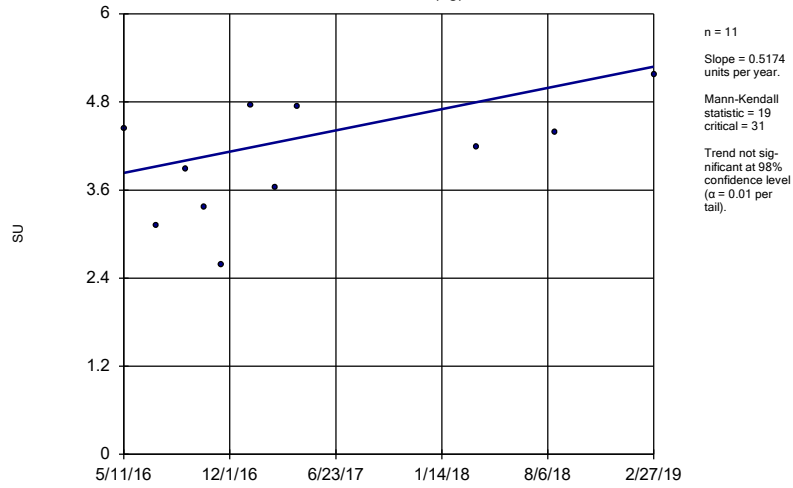


n = 11
Slope = 0.06272 units per year.
Mann-Kendall statistic = 13
critical = 31
Trend not significant at 98% confidence level ($\alpha = 0.01$ per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

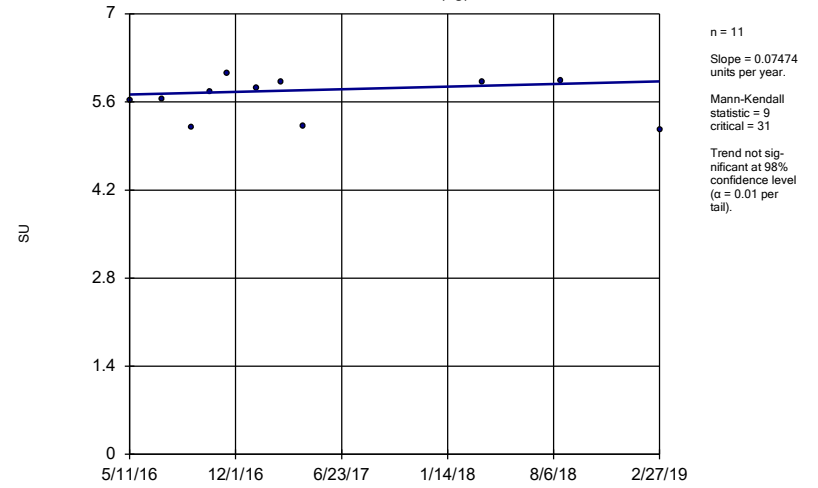
AD-12 (bg)



Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

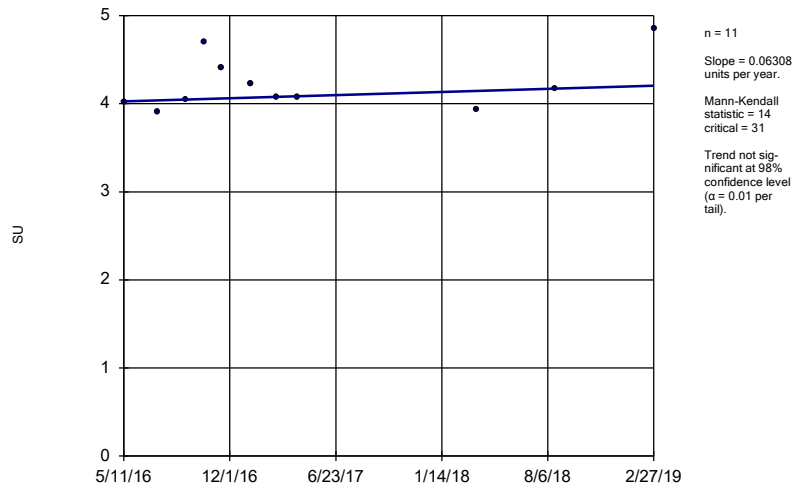
AD-13 (bg)



Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

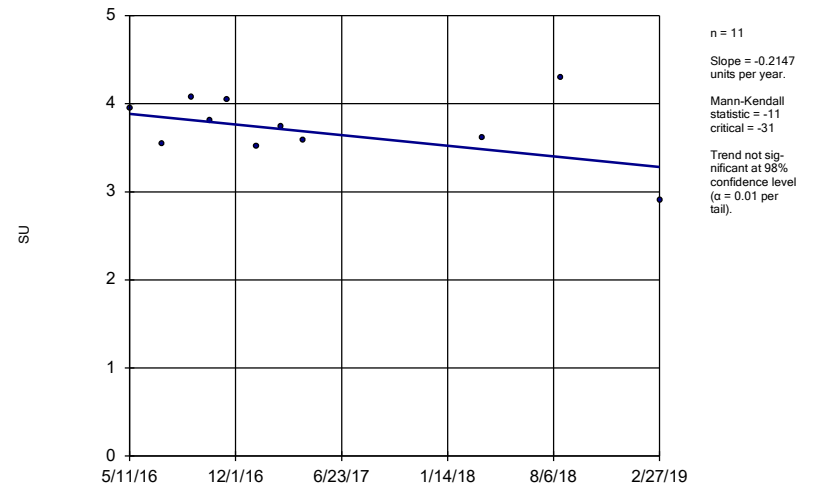
AD-22



Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

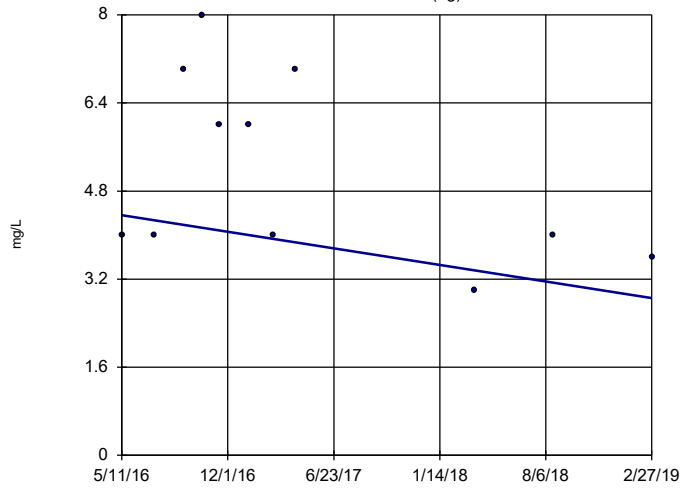
AD-7



Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-12 (bg)

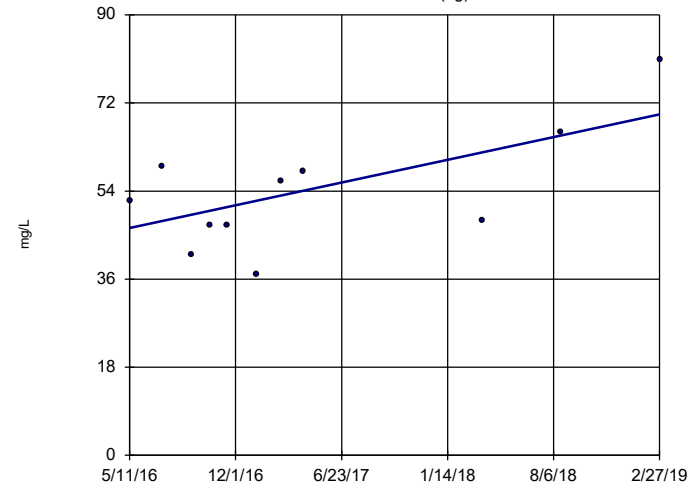


n = 11
 Slope = -0.5376
 units per year.
 Mann-Kendall
 statistic = -15
 critical = -31
 Trend not sig-
 nificant at 98%
 confidence level
 (α = 0.01 per
 tail).

Constituent: Sulfate, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-13 (bg)

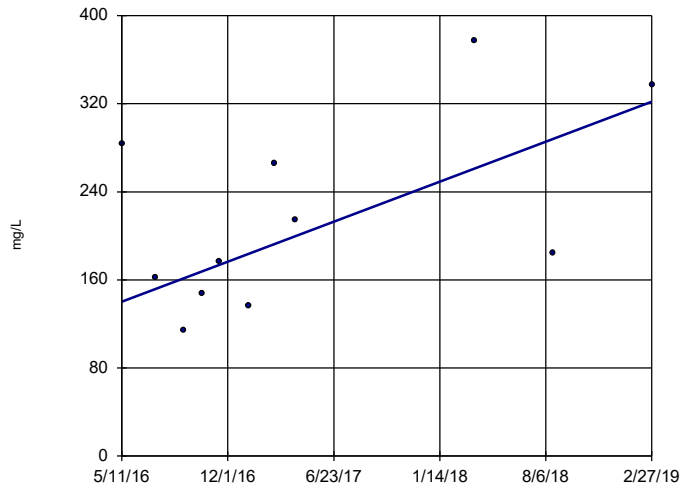


n = 11
 Slope = 8.297
 units per year.
 Mann-Kendall
 statistic = 20
 critical = 31
 Trend not sig-
 nificant at 98%
 confidence level
 (α = 0.01 per
 tail).

Constituent: Sulfate, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-22



n = 11
 Slope = 64.82
 units per year.
 Mann-Kendall
 statistic = 19
 critical = 31
 Trend not sig-
 nificant at 98%
 confidence level
 (α = 0.01 per
 tail).

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

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Bg N</u>	<u>Bg Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
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

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Compliance</u>	<u>Lower Compl.</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
Beryllium, total (mg/L)	AD-22	0.01023	0.004131	0.004	n/a	Yes	11	0	x^(1/3)	0.01	Param.

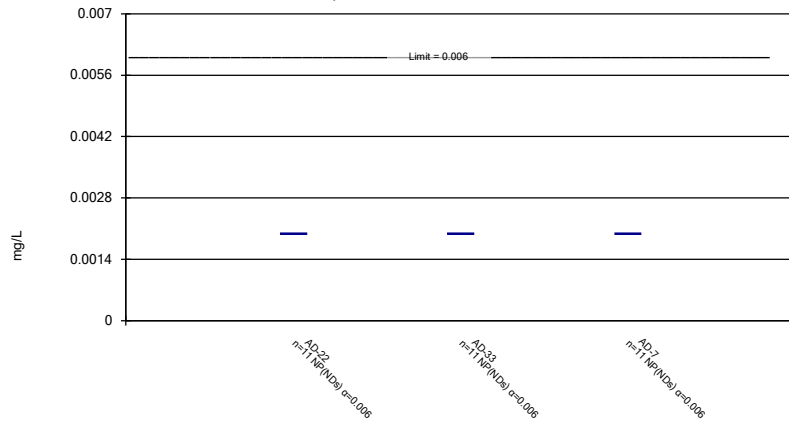
Confidence Interval Summary Table - All Results

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)

Non-Parametric Confidence Interval

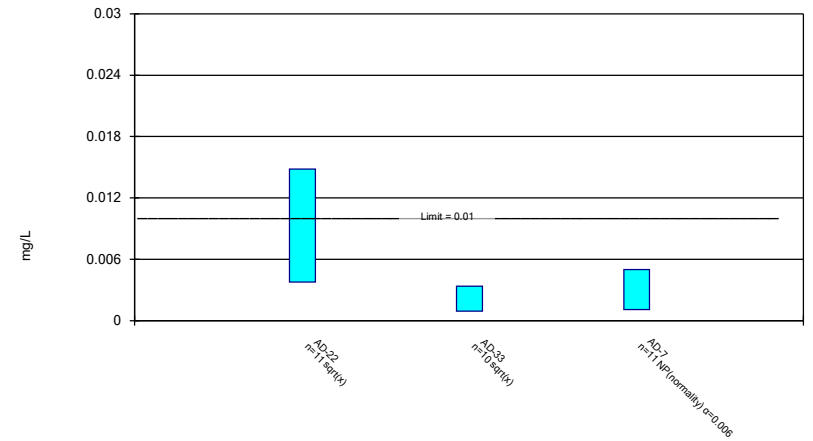
Compliance Limit is not exceeded.



Constituent: Antimony, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

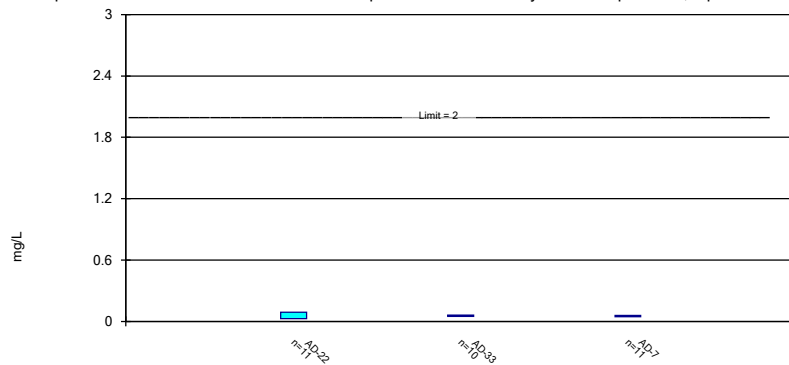
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Arsenic, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

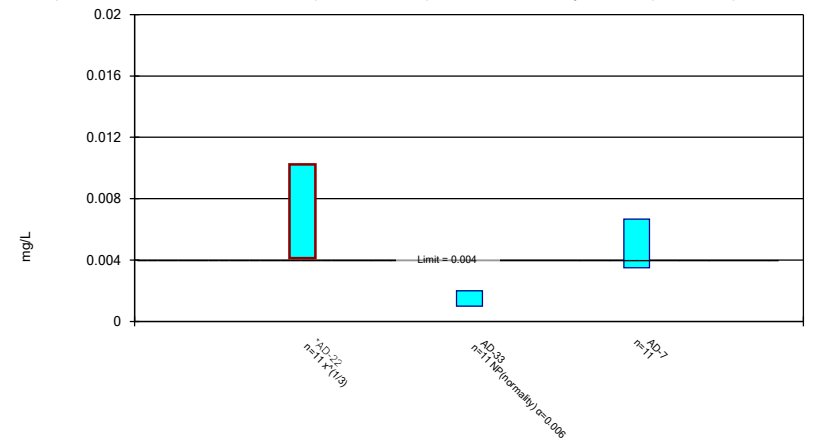
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Constituent: Barium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

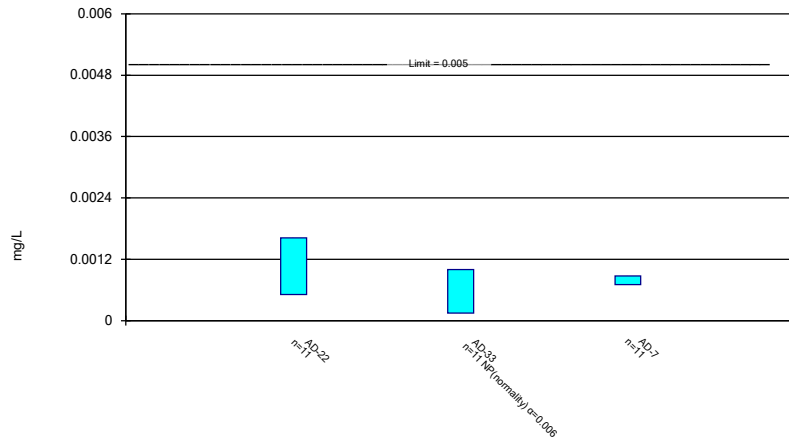
Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

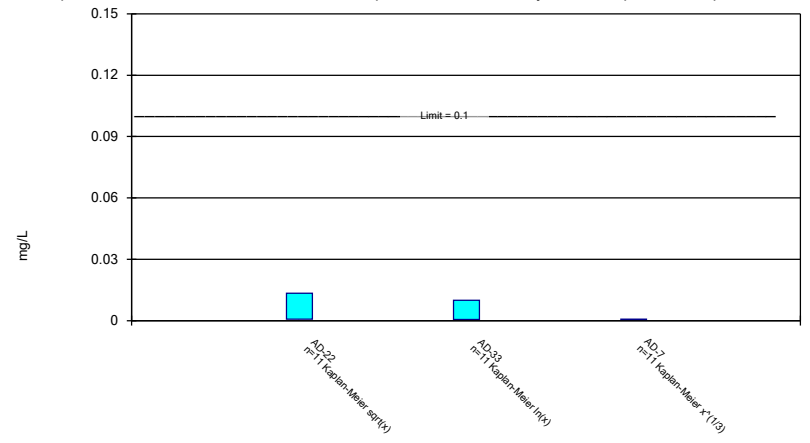
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cadmium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

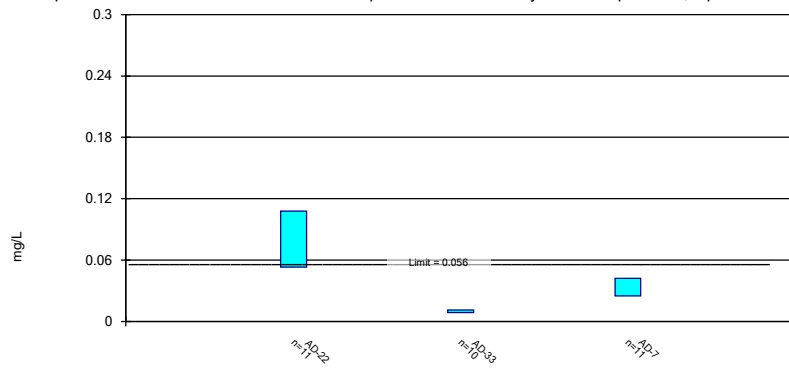
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chromium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

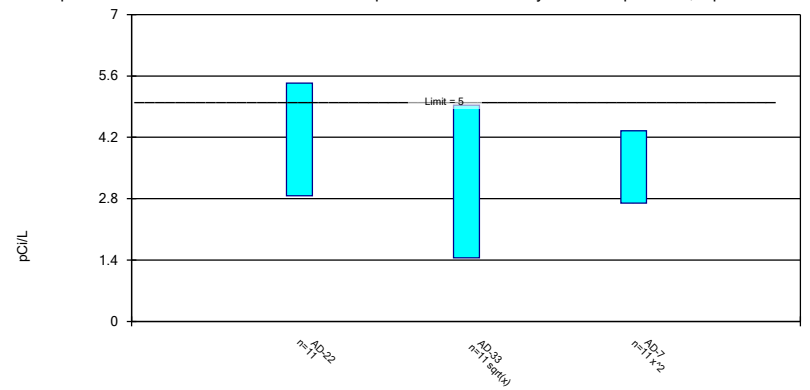
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cobalt, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

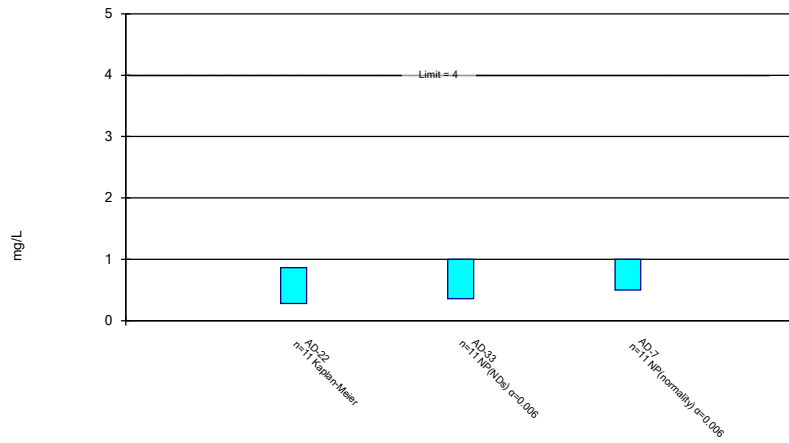
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

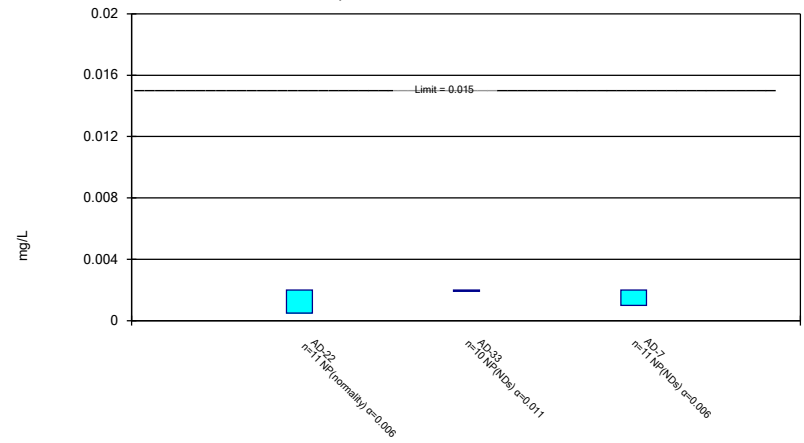
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Constituent: Fluoride, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

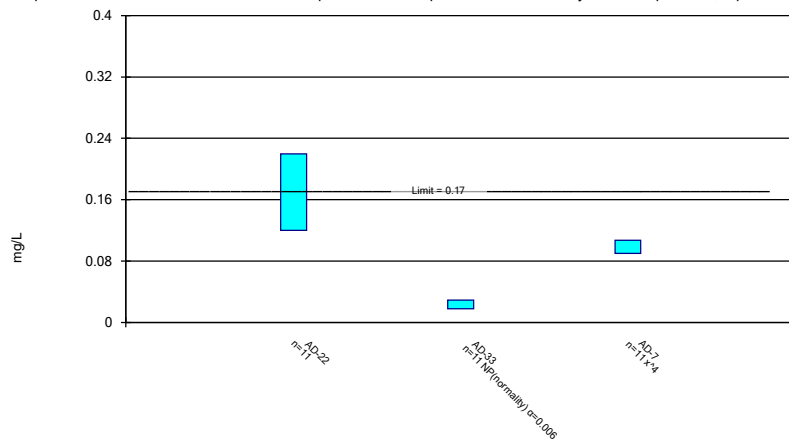
Compliance Limit is not exceeded.



Constituent: Lead, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

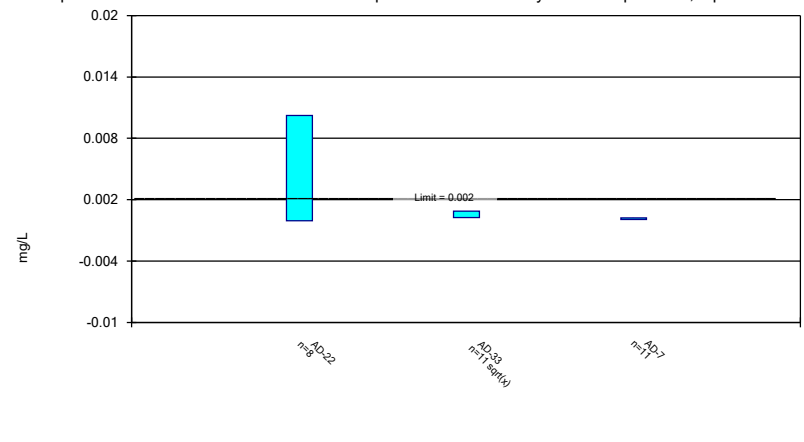
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Lithium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

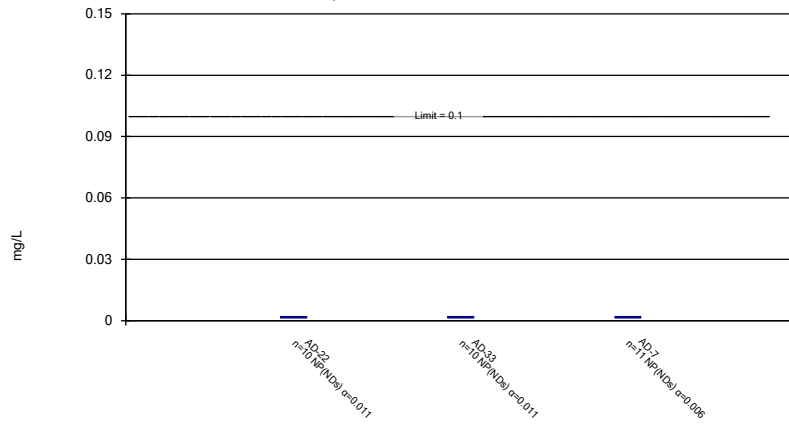
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Mercury, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

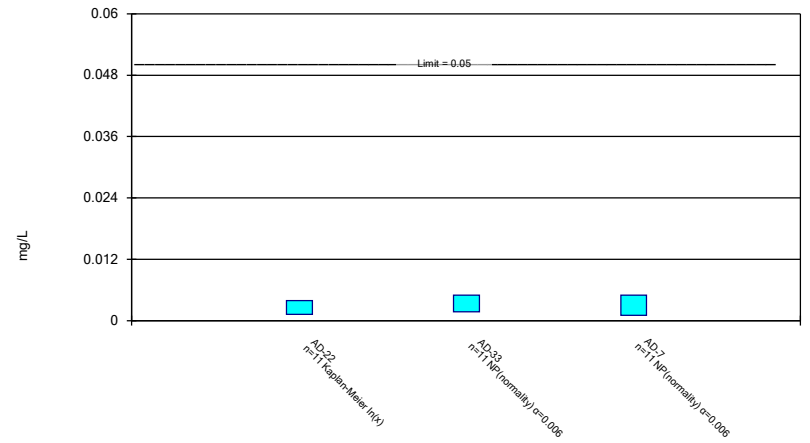
Compliance Limit is not exceeded.



Constituent: Molybdenum, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

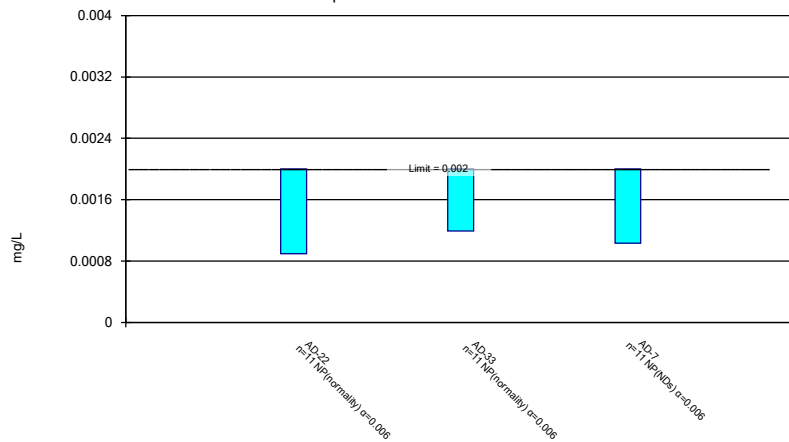
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Selenium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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



1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by



engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

January 2, 2020

CHA8473

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LIST OF ATTACHMENTS

Attachment A	Certification by Qualified Professional Engineer
Attachment B	Statistical Analysis Output

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 – February 2019) 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-Francia 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

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature



112498

License Number

TEXAS

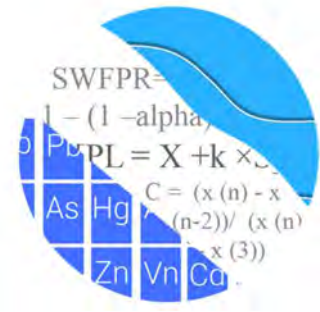
Licensing State

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,

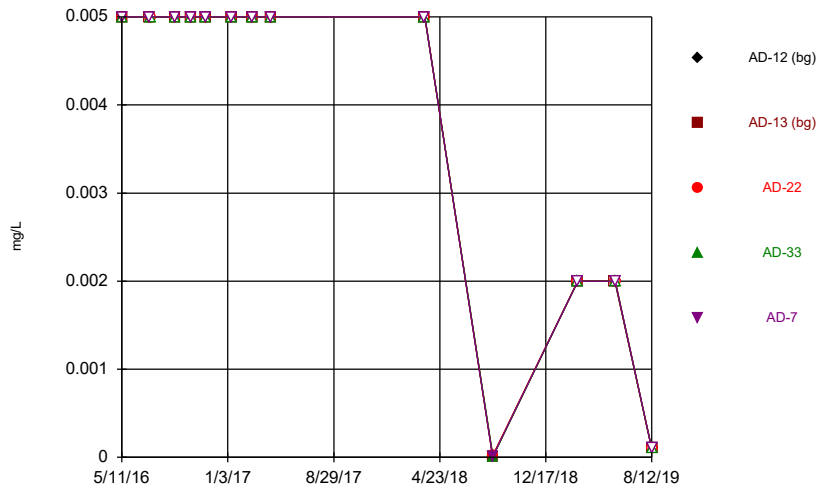


Andrew T. Collins
Groundwater Analyst



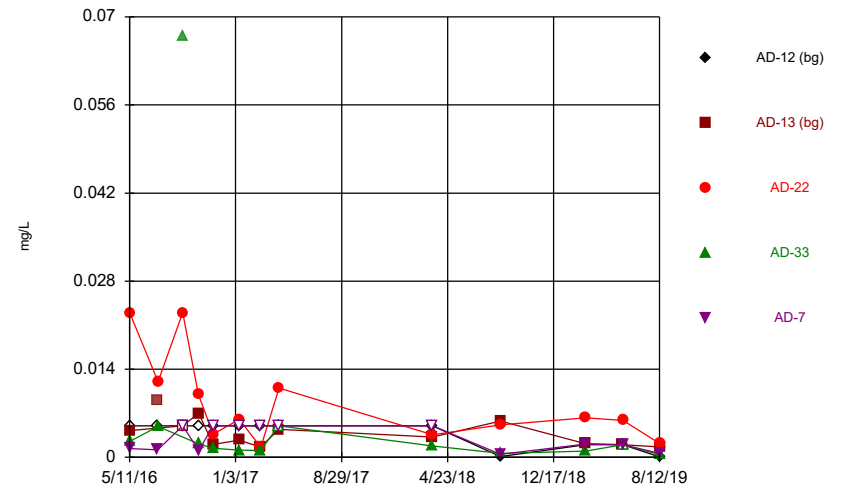
Kristina L. Rayner
Groundwater Statistician

Time Series



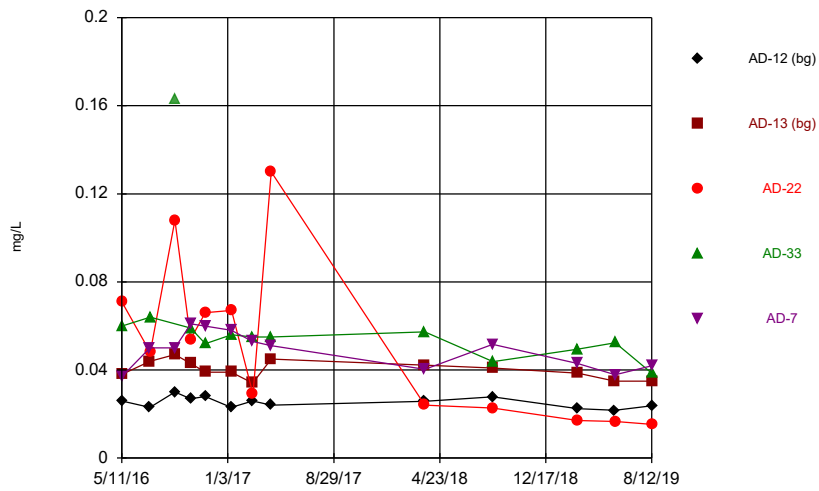
Constituent: Antimony, total Analysis Run 12/10/2019 12:28 PM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



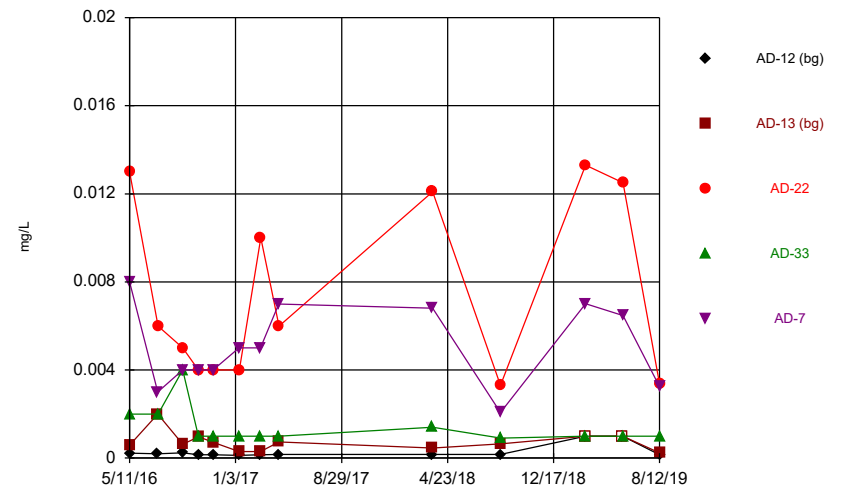
Constituent: Arsenic, total Analysis Run 12/10/2019 12:28 PM View: Time Series
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Time Series



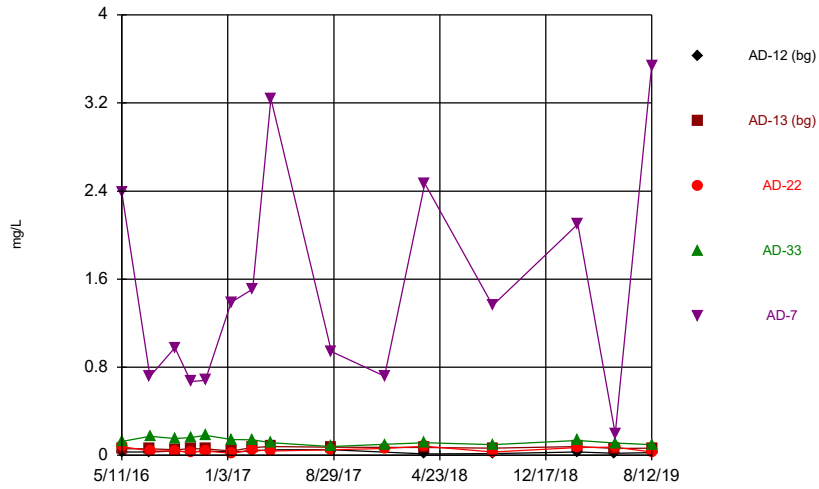
Constituent: Barium, total Analysis Run 12/10/2019 12:28 PM View: Time Series
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Time Series



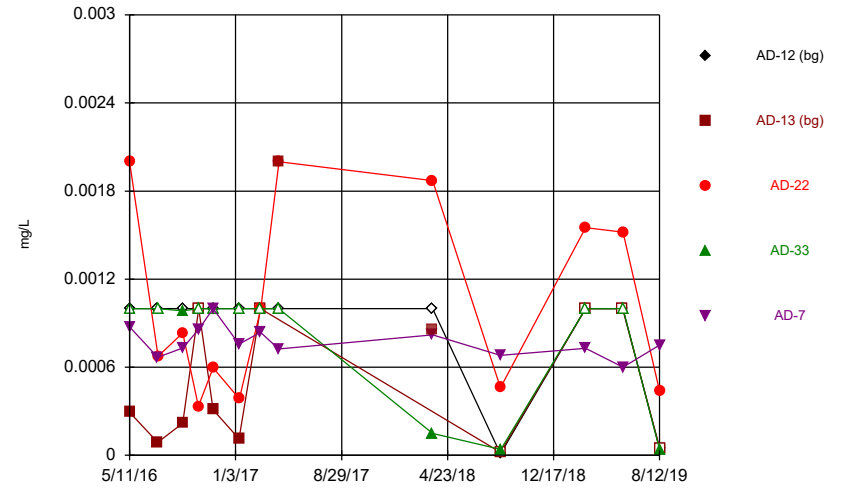
Constituent: Beryllium, total Analysis Run 12/10/2019 12:28 PM View: Time Series
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Time Series



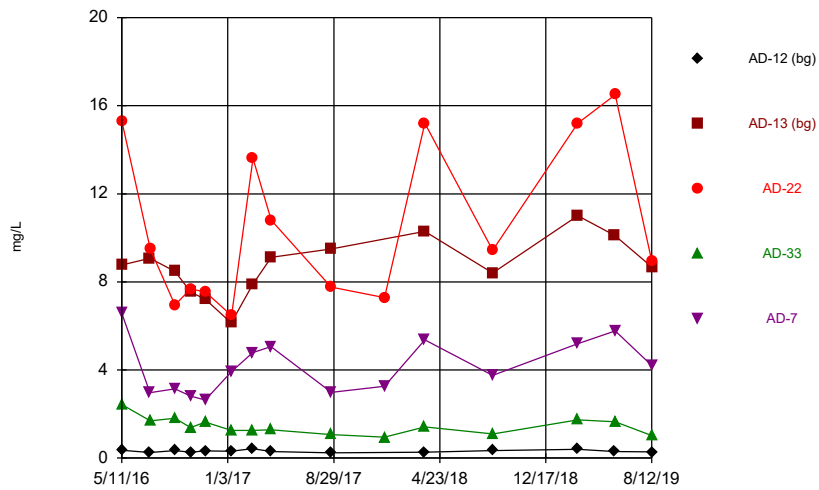
Constituent: Boron, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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Time Series



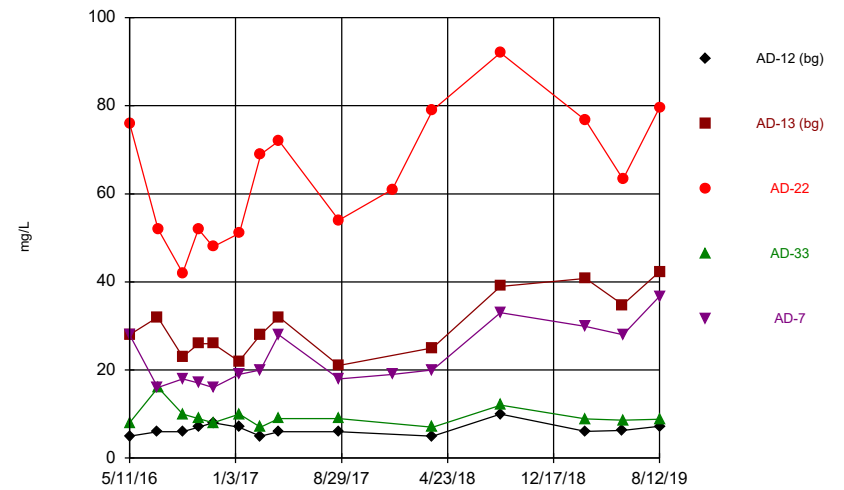
Constituent: Cadmium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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Time Series



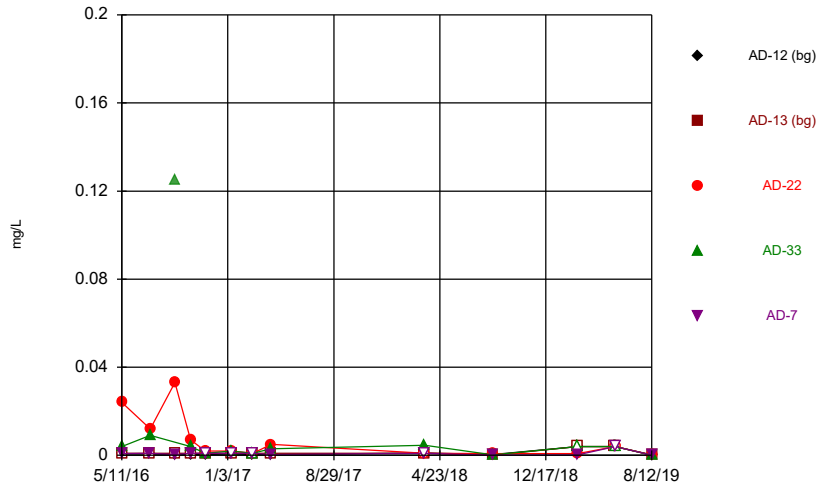
Constituent: Calcium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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Time Series



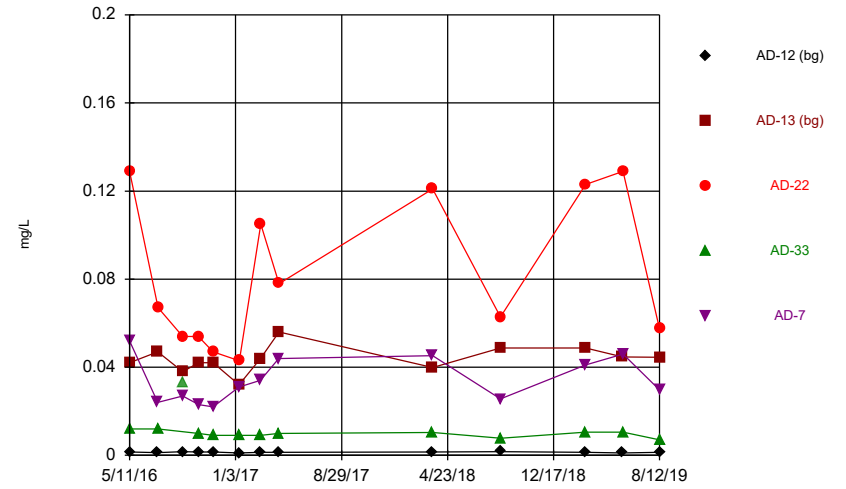
Constituent: Chloride, total Analysis Run 12/10/2019 12:29 PM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



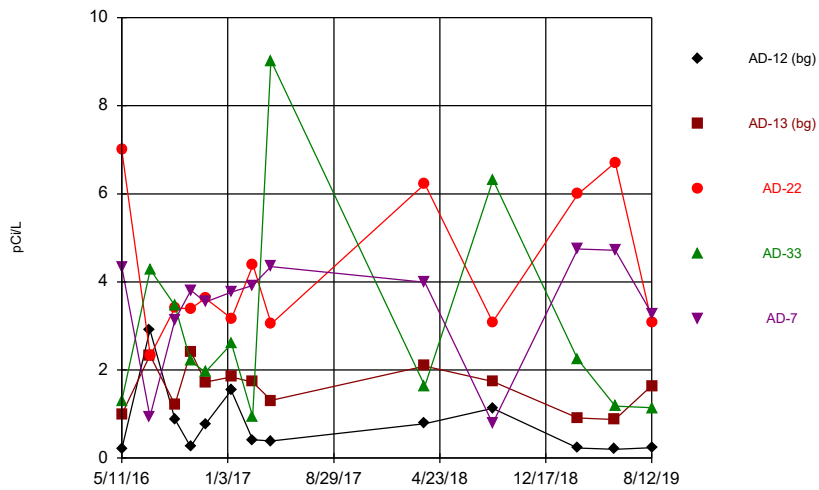
Constituent: Chromium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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Time Series



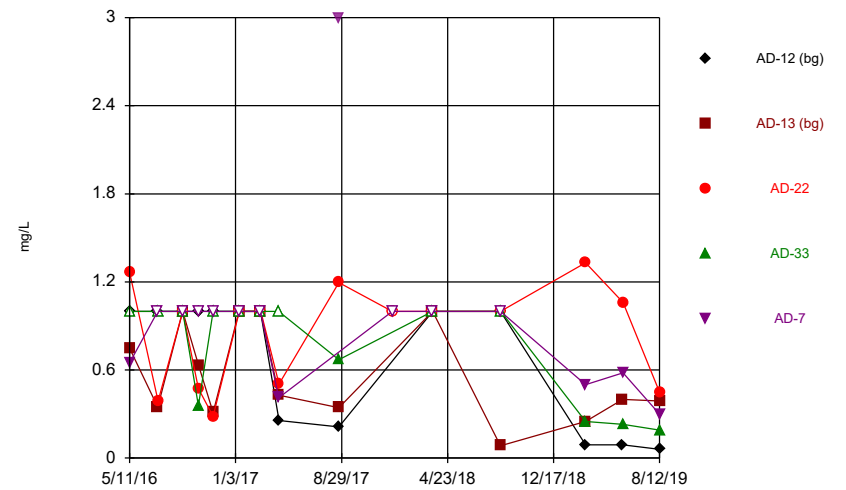
Constituent: Cobalt, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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Time Series



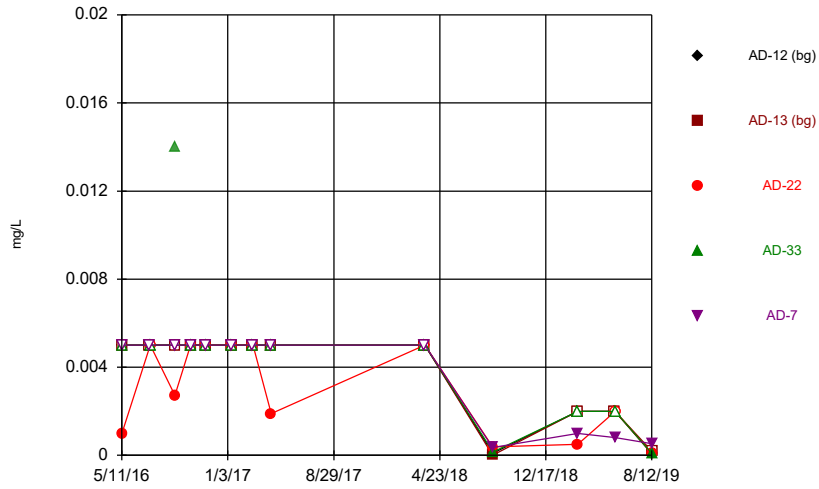
Constituent: Combined Radium 226 + 228 Analysis Run 12/10/2019 12:29 PM View: Time Series
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Time Series



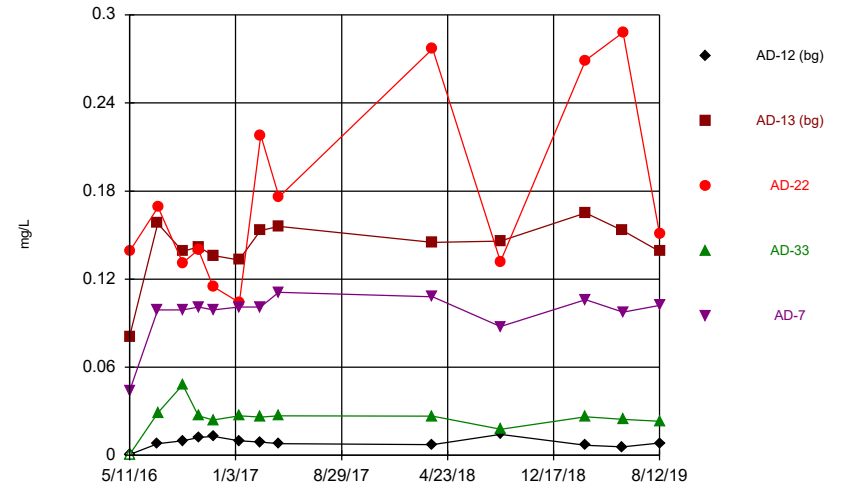
Constituent: Fluoride, total Analysis Run 12/10/2019 12:29 PM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



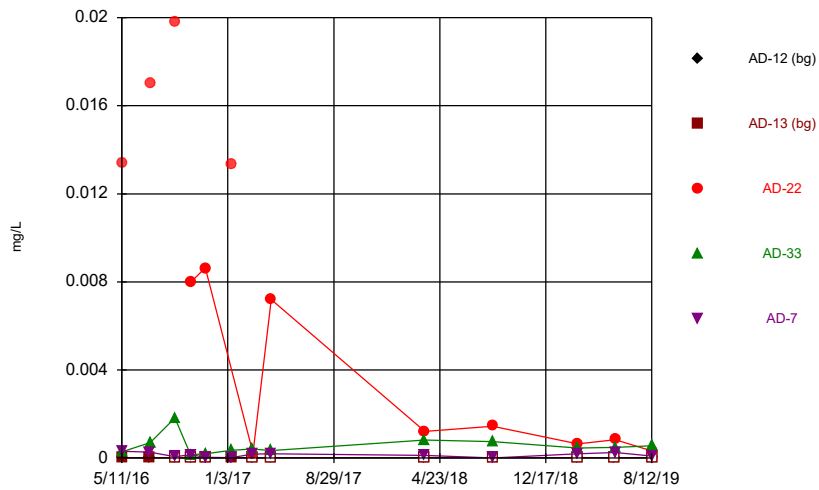
Constituent: Lead, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



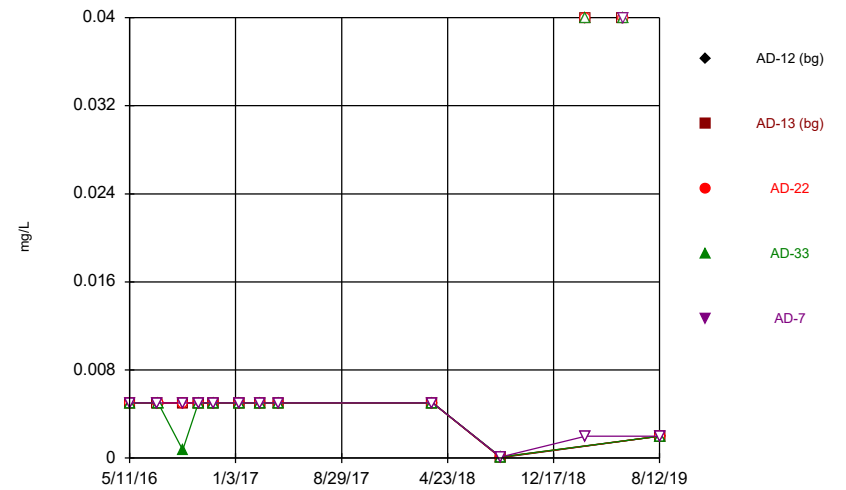
Constituent: Lithium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



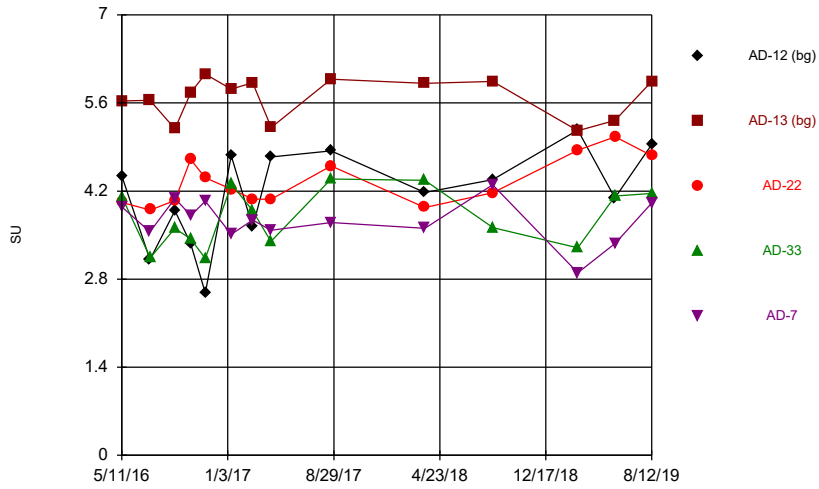
Constituent: Mercury, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



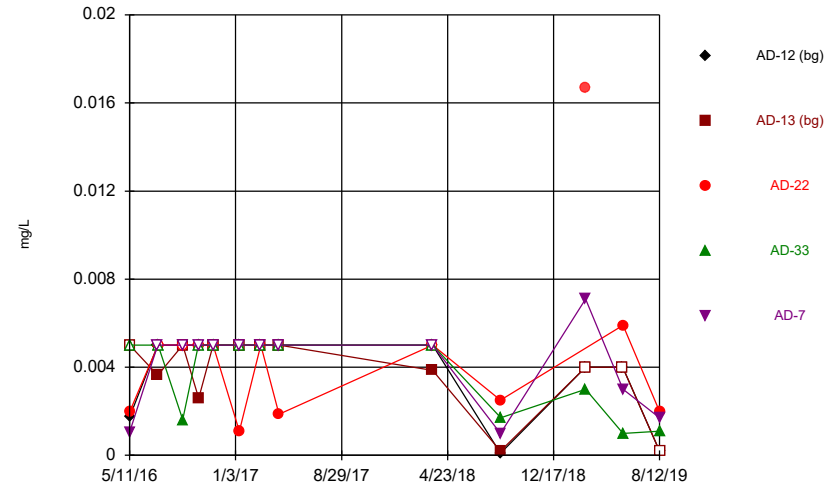
Constituent: Molybdenum, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



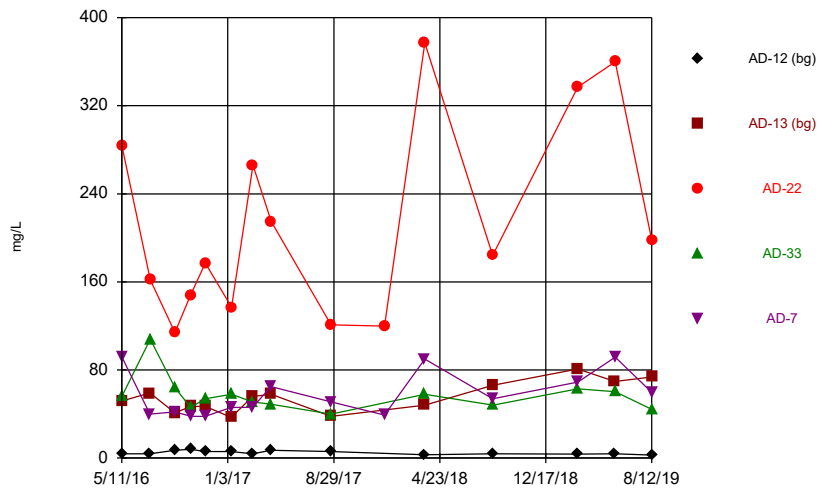
Constituent: pH, field Analysis Run 12/10/2019 12:29 PM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



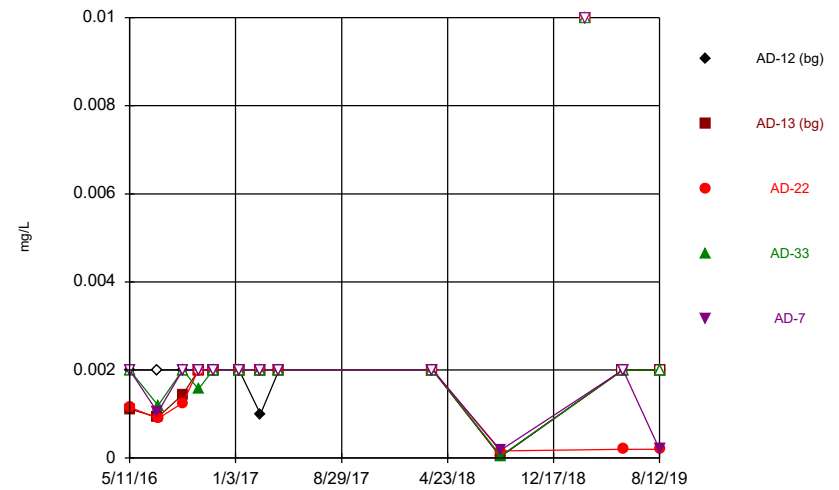
Constituent: Selenium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
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Time Series



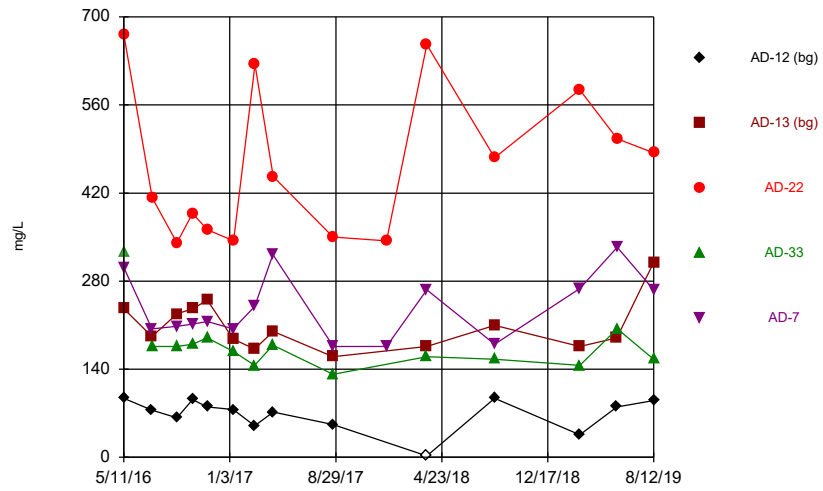
Constituent: Sulfate, total Analysis Run 12/10/2019 12:29 PM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



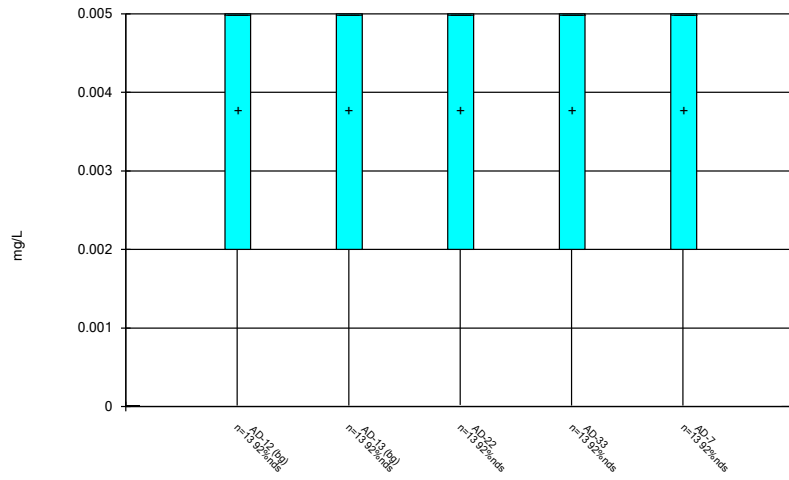
Constituent: Thallium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Time Series



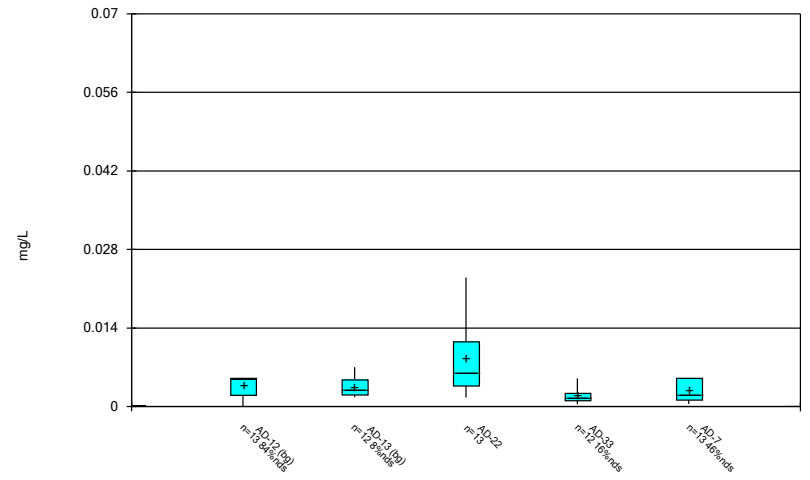
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



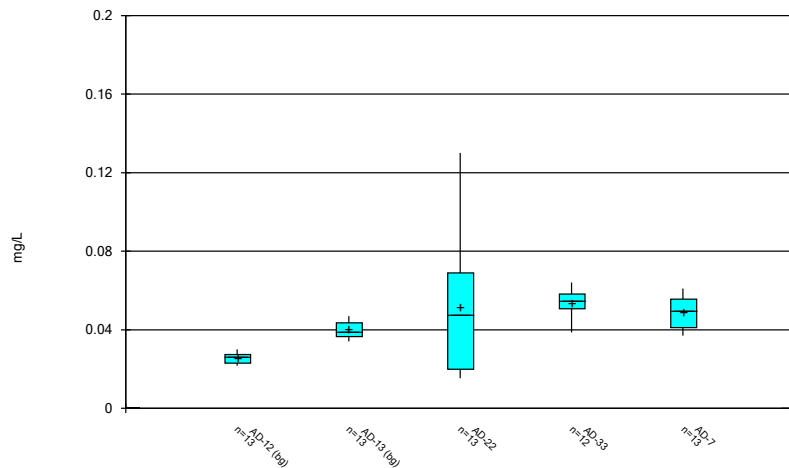
Constituent: Antimony, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



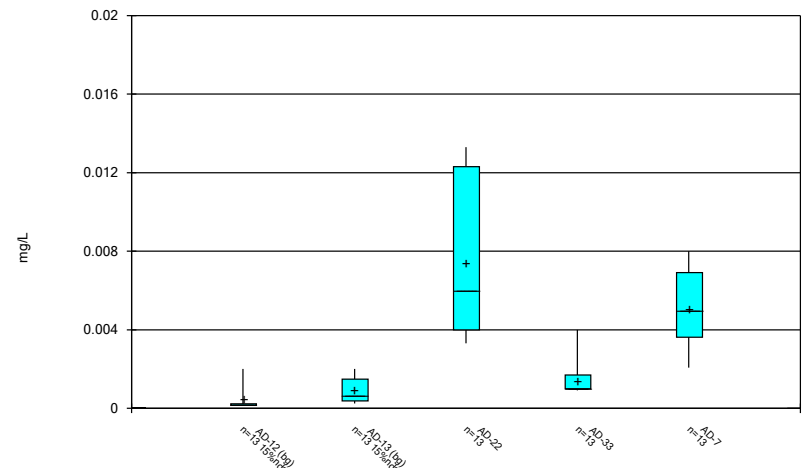
Constituent: Arsenic, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



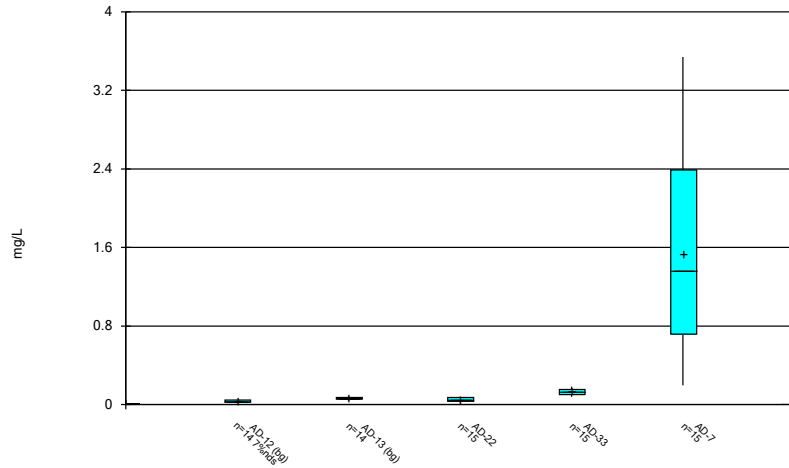
Constituent: Barium, total Analysis Run 12/6/2019 11:13 AM
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Box & Whiskers Plot



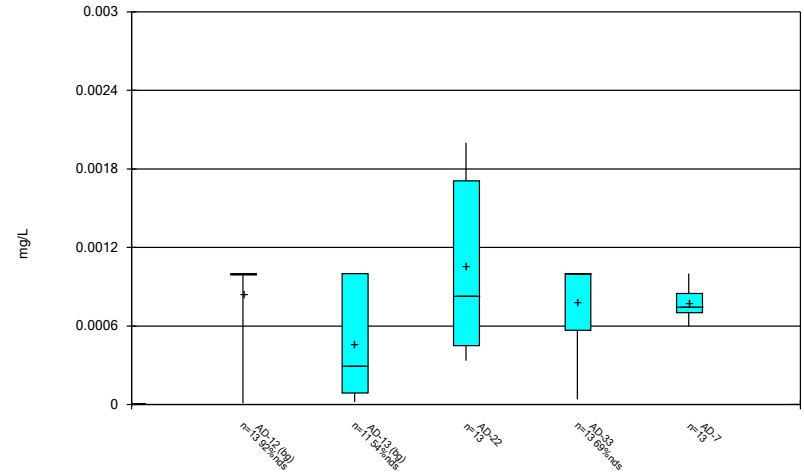
Constituent: Beryllium, total Analysis Run 12/6/2019 11:13 AM
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Box & Whiskers Plot



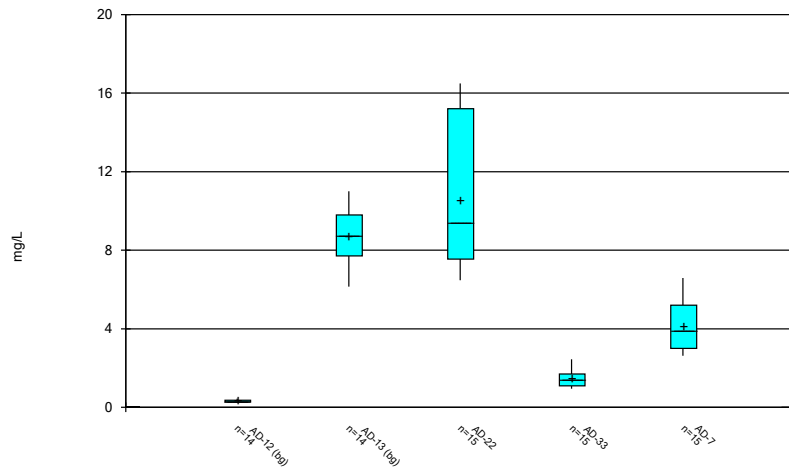
Constituent: Boron, total Analysis Run 12/6/2019 11:13 AM
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



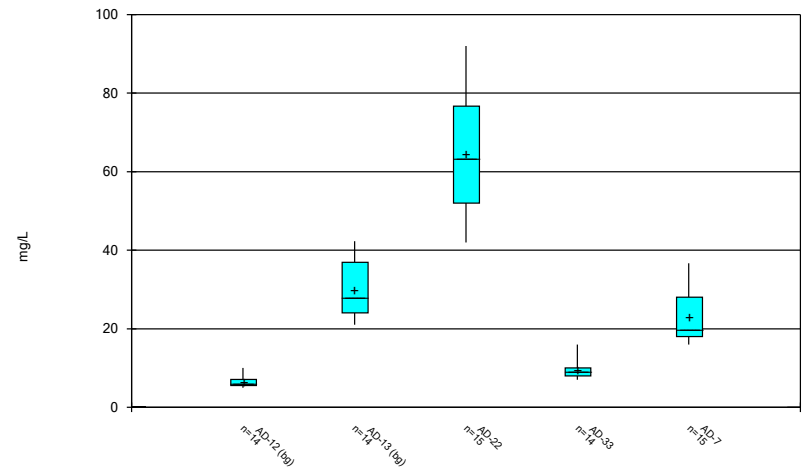
Constituent: Cadmium, total Analysis Run 12/6/2019 11:13 AM
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



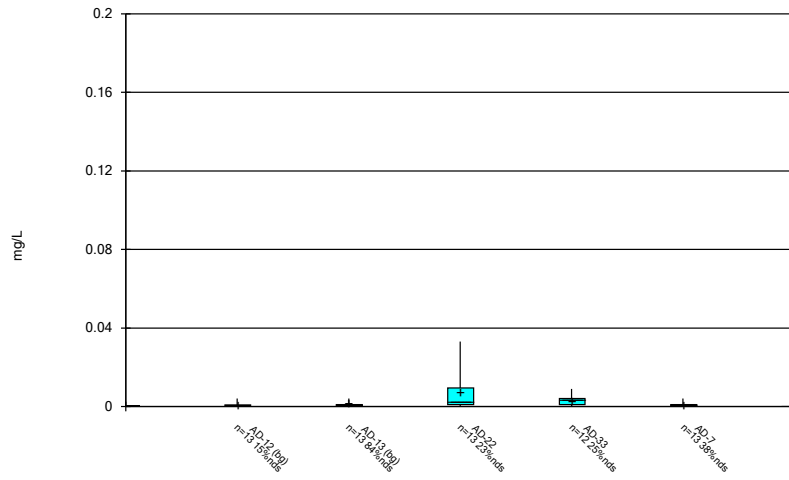
Constituent: Calcium, total Analysis Run 12/6/2019 11:13 AM
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



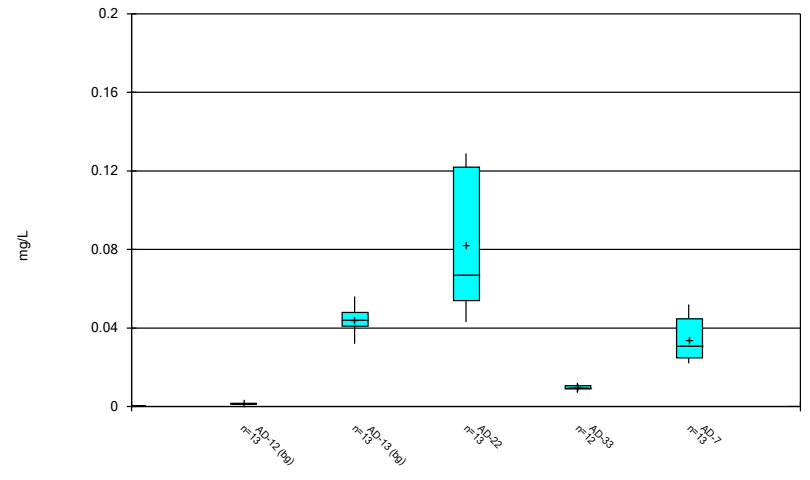
Constituent: Chloride, total Analysis Run 12/6/2019 11:13 AM
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



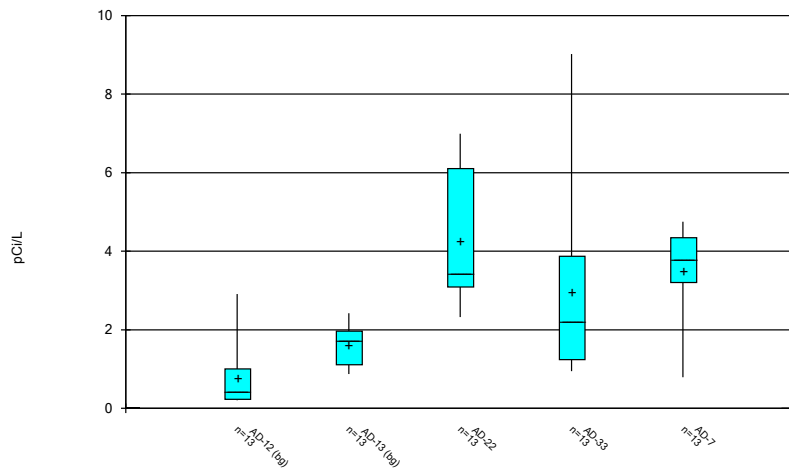
Constituent: Chromium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



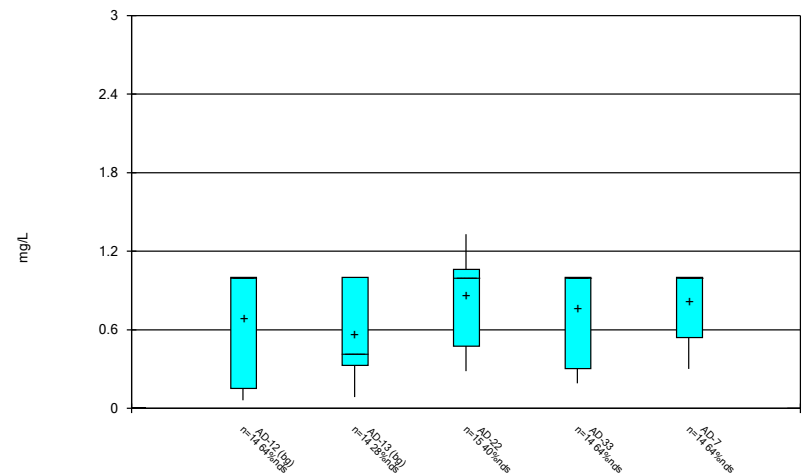
Constituent: Cobalt, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



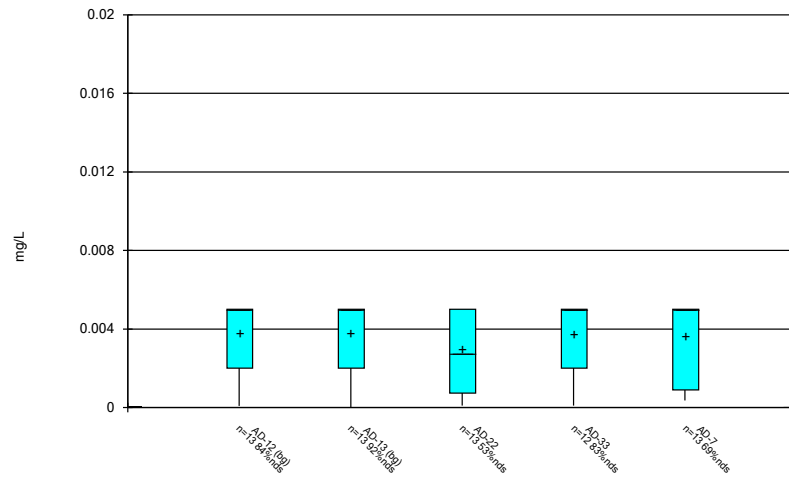
Constituent: Combined Radium 226 + 228 Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



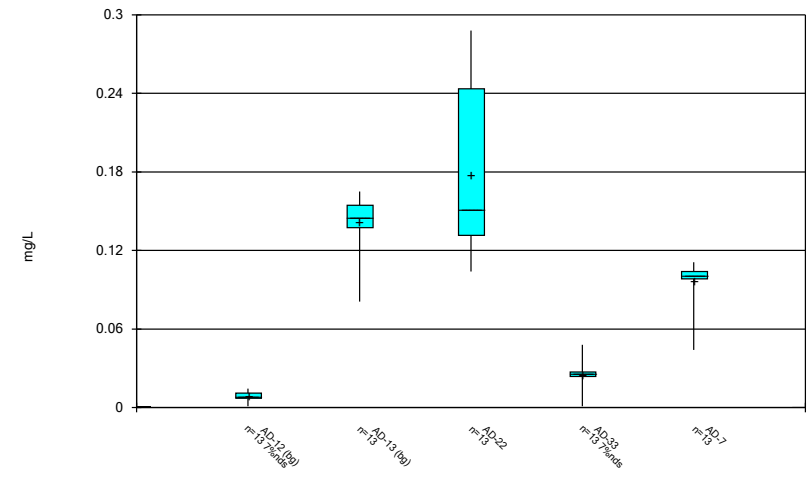
Constituent: Fluoride, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



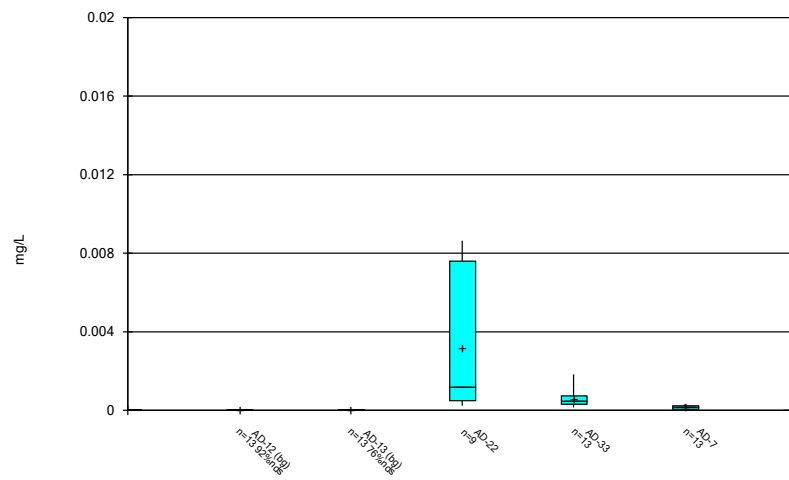
Constituent: Lead, total Analysis Run 12/6/2019 11:13 AM
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



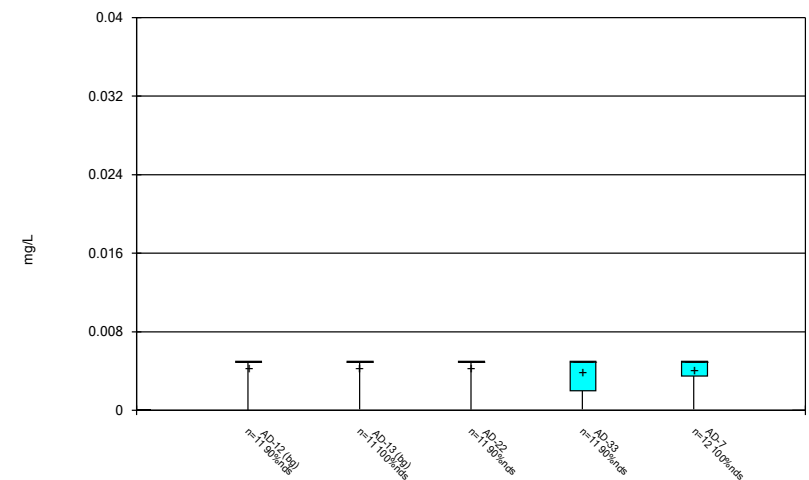
Constituent: Lithium, total Analysis Run 12/6/2019 11:13 AM
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



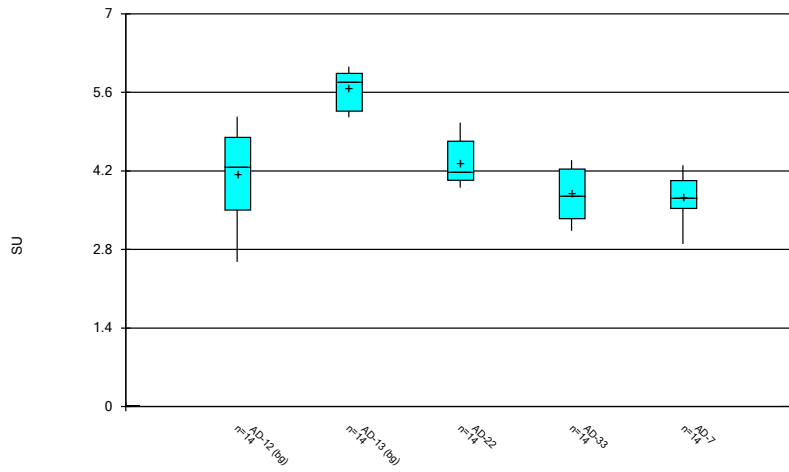
Constituent: Mercury, total Analysis Run 12/6/2019 11:13 AM
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Box & Whiskers Plot



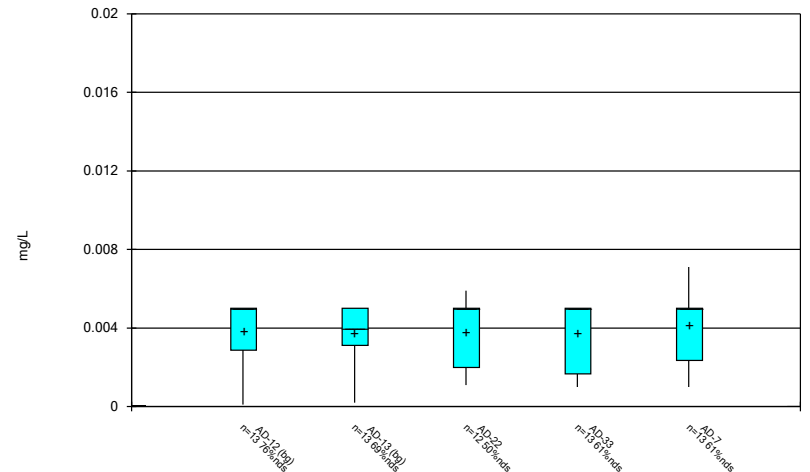
Constituent: Molybdenum, total Analysis Run 12/6/2019 11:13 AM
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



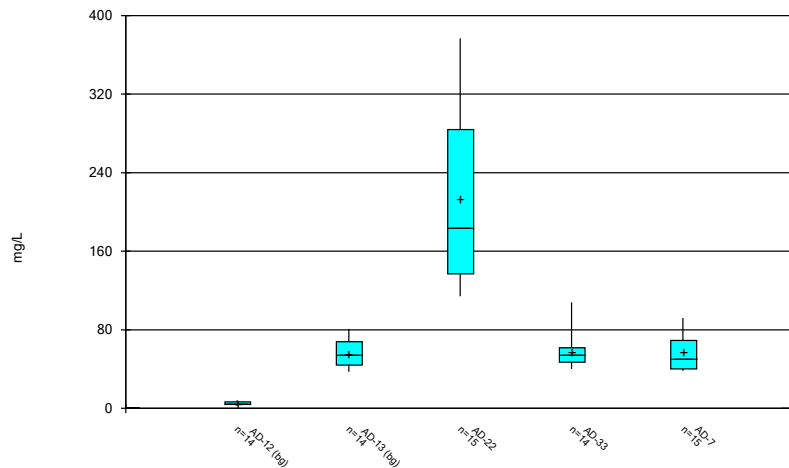
Constituent: pH, field Analysis Run 12/6/2019 11:14 AM
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



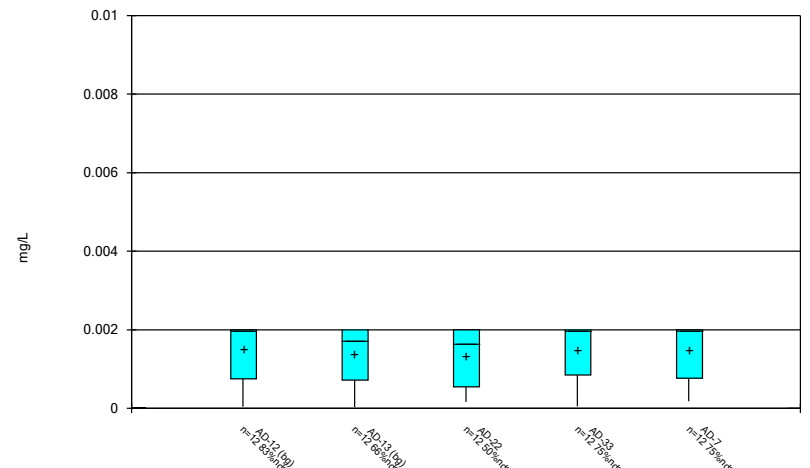
Constituent: Selenium, total Analysis Run 12/6/2019 11:14 AM
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



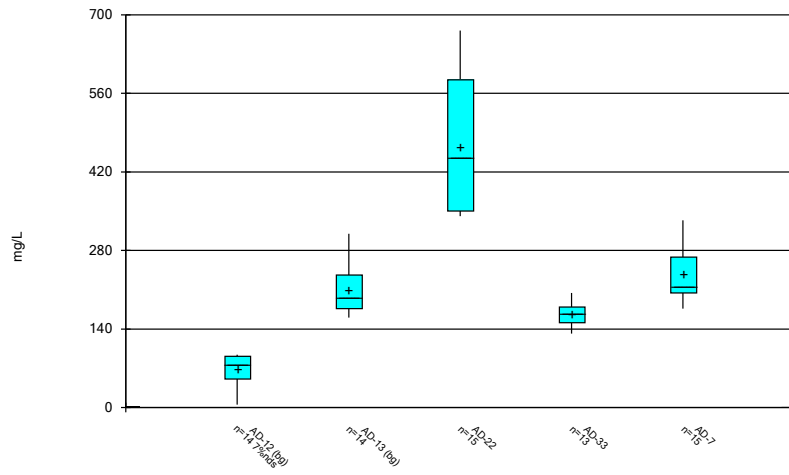
Constituent: Sulfate, total Analysis Run 12/6/2019 11:14 AM
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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	

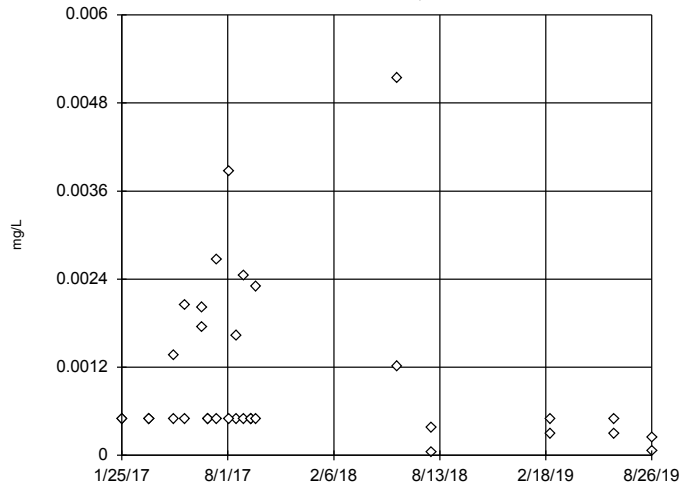
Upgradient Outlier Analysis - All Results

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	0.00009233	$x^{(1/3)}$	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

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

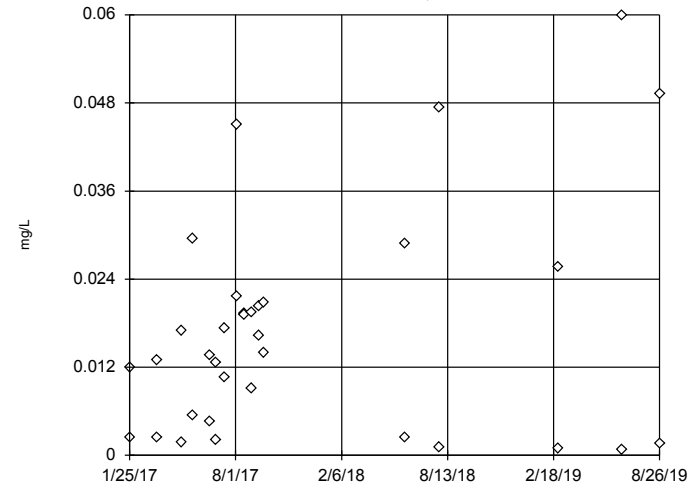


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.06435, low cutoff = 0.00001309, based on IQR multiplier of 3.

Constituent: Antimony Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

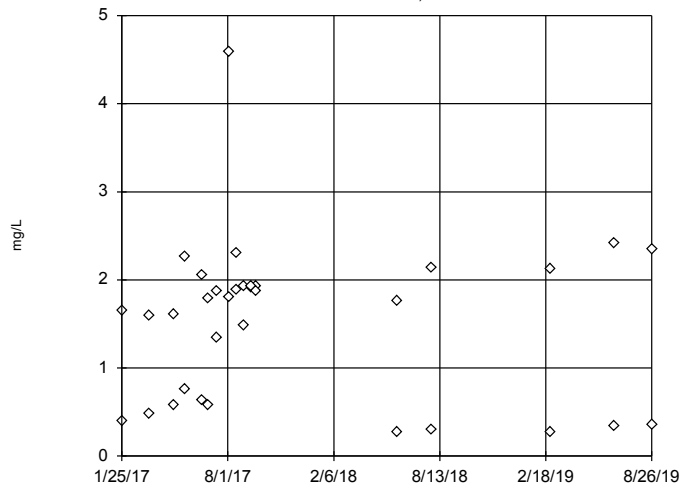


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were cube root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.3424, low cutoff = -0.02368, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

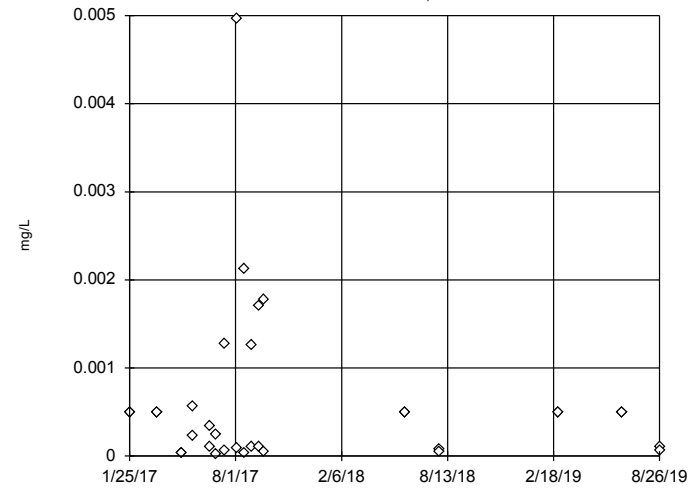


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were square root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 11.31, low cutoff = -1.424, based on IQR multiplier of 3.

Constituent: Barium Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

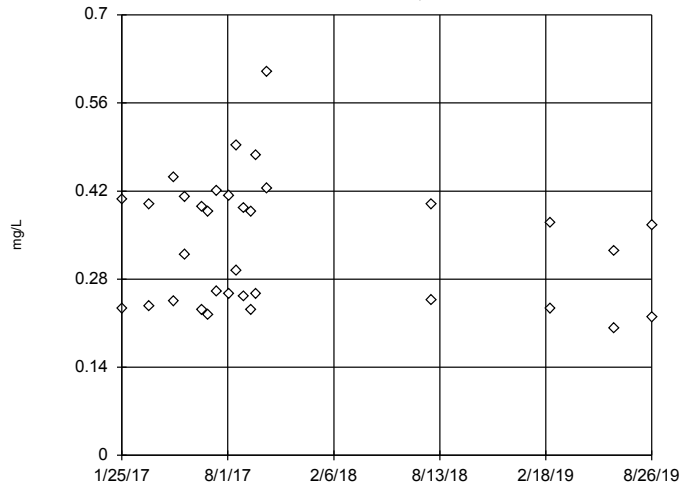


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.1952, low cutoff = 1.8e-7, based on IQR multiplier of 3.

Constituent: Beryllium Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

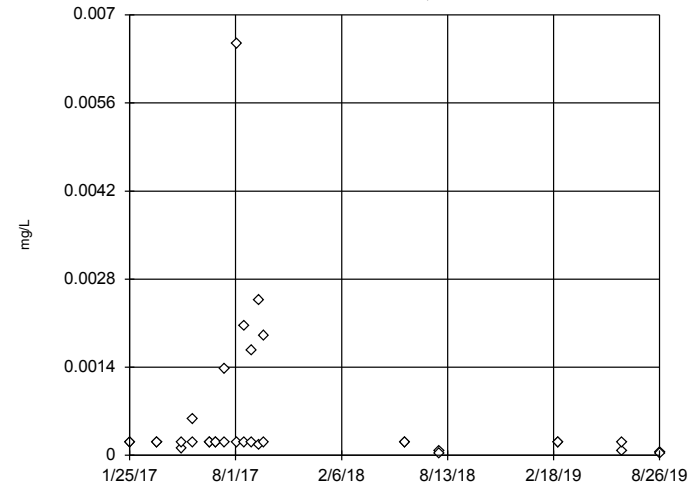


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were cube root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 1.34, low cutoff = 0.01787, based on IQR multiplier of 3.

Constituent: Boron Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

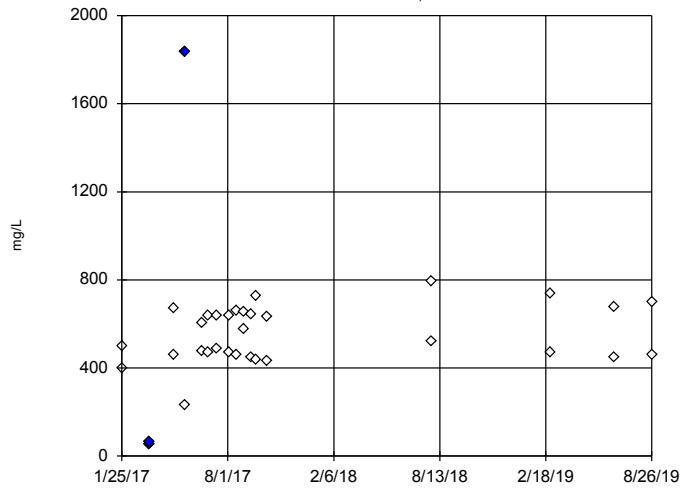


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Cadmium Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

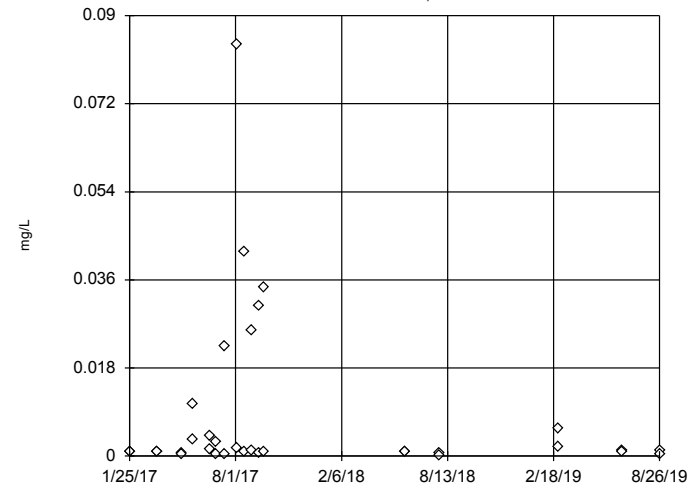


n = 34
 Outliers are drawn as solid.
 Tukey's method selected by user.
 Data were square root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 1487, low cutoff = 69.92, based on IQR multiplier of 3.

Constituent: Chloride Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

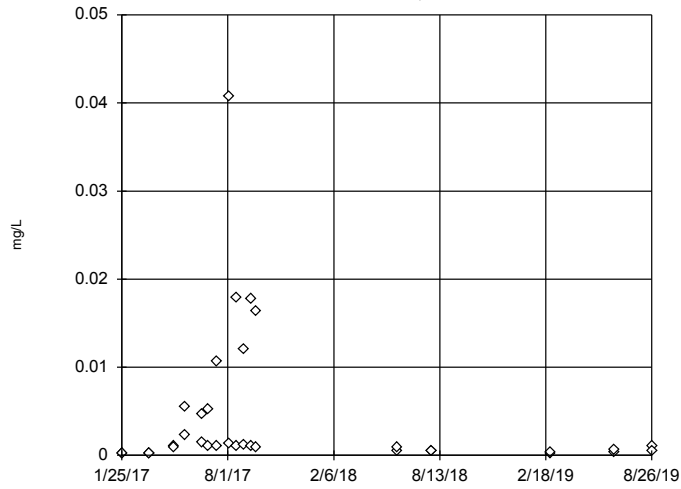


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 1.453, low cutoff = 0.000002366, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

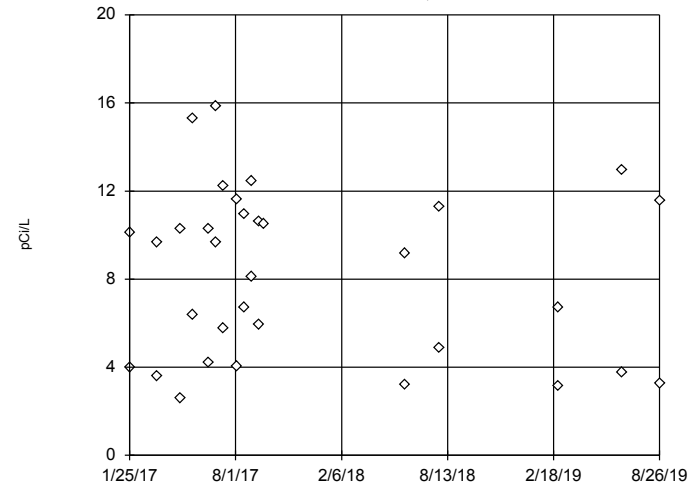


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 5.308, low cutoff = 4.5e-7, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

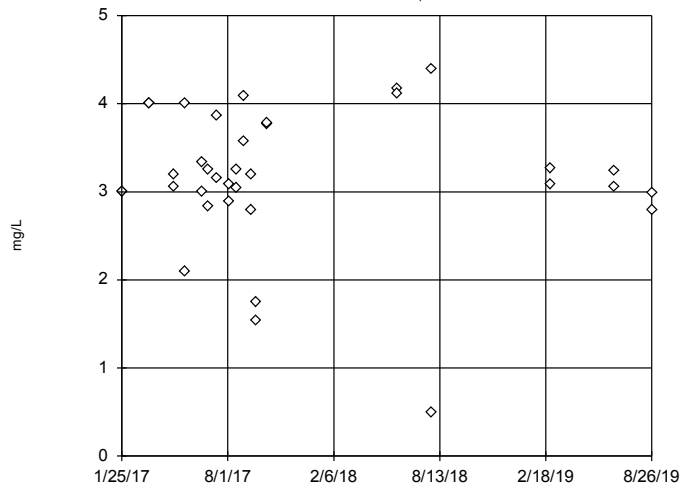


n = 33
 No outliers found.
 Tukey's method selected by user.
 Ladder of Powers transformations did not improve normality; analysis run on raw data.
 High cutoff = 32.17, low cutoff = -16.94, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

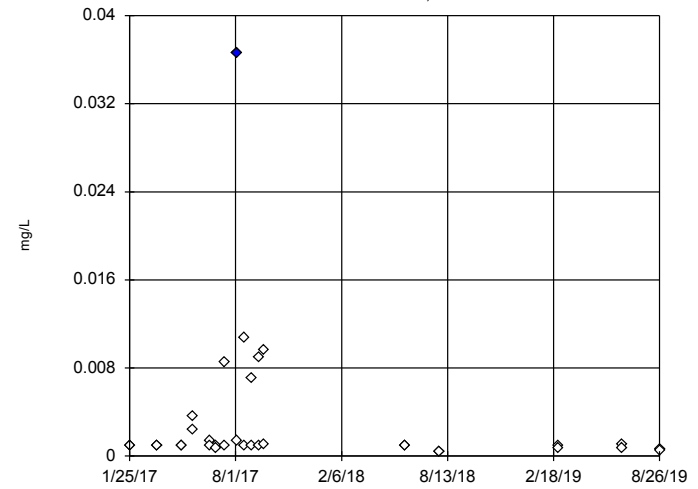


n = 36
 No outliers found.
 Tukey's method selected by user.
 Data were square transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 5.492, low cutoff = -2.631, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

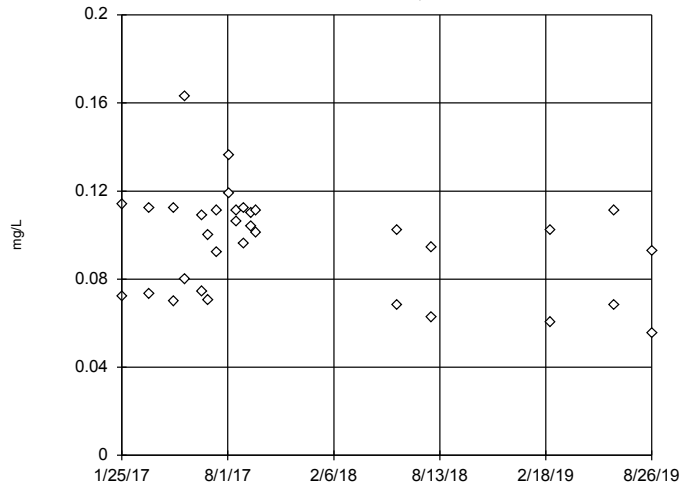


n = 34
 Outlier is drawn as solid.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.01438, low cutoff = 0.0001192, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

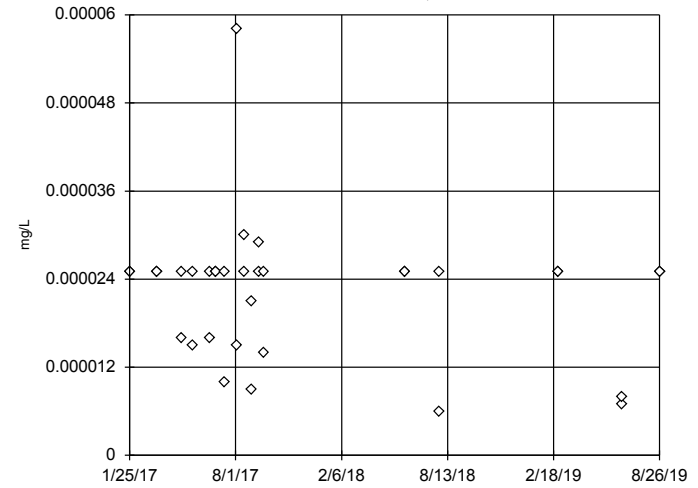


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were square root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.2755,
 low cutoff = 0.00601,
 based on IQR multiplier of 3.

Constituent: Lithium Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

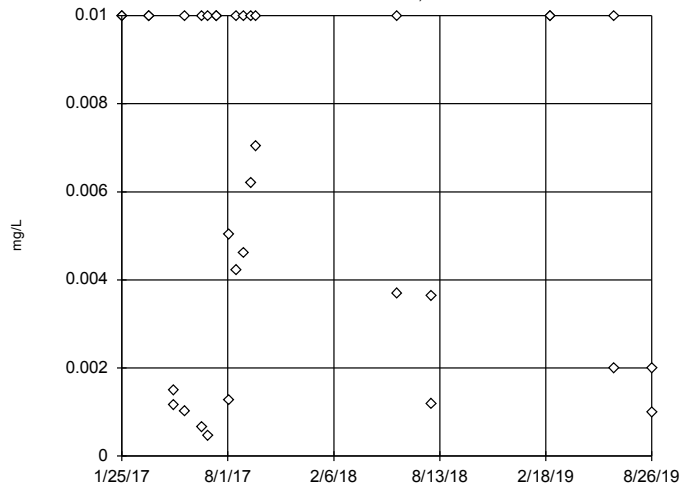


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were cube root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.00007499,
 low cutoff = 0.000001728,
 based on IQR multiplier of 3.

Constituent: Mercury Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

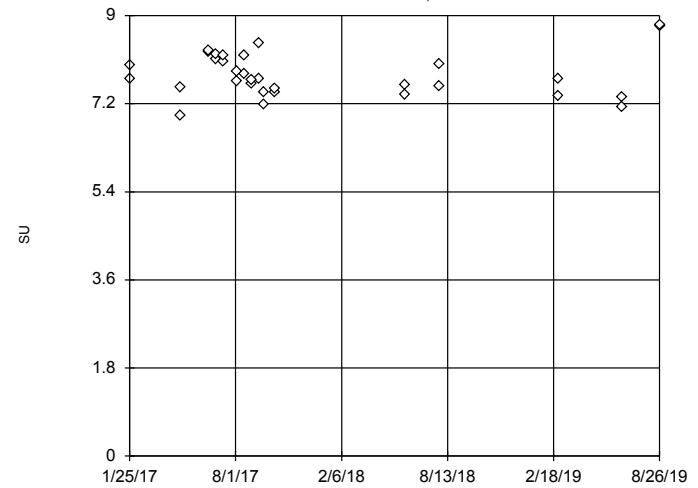


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were cube root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.1258,
 low cutoff = -0.004525,
 based on IQR multiplier of 3.

Constituent: Molybdenum Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

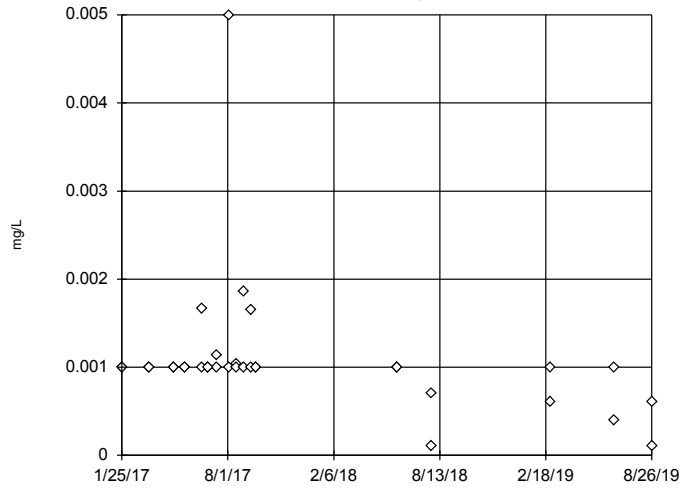


n = 32
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 10.49,
 low cutoff = 5.804,
 based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

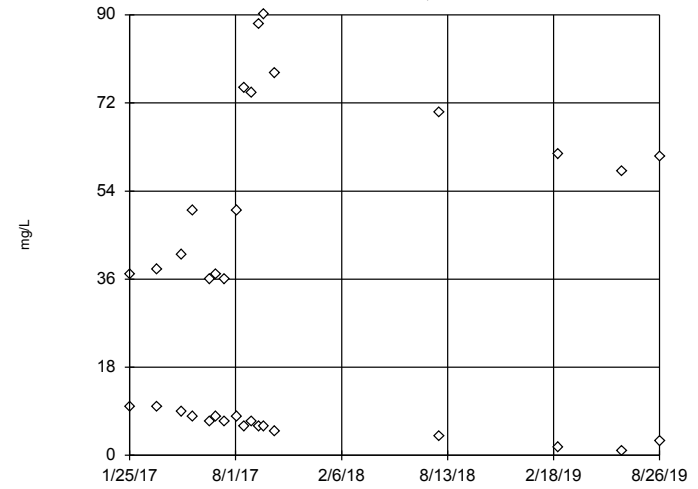


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were cube root transformed to achieve best W statistic (graph shown in original units).
 The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Selenium Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

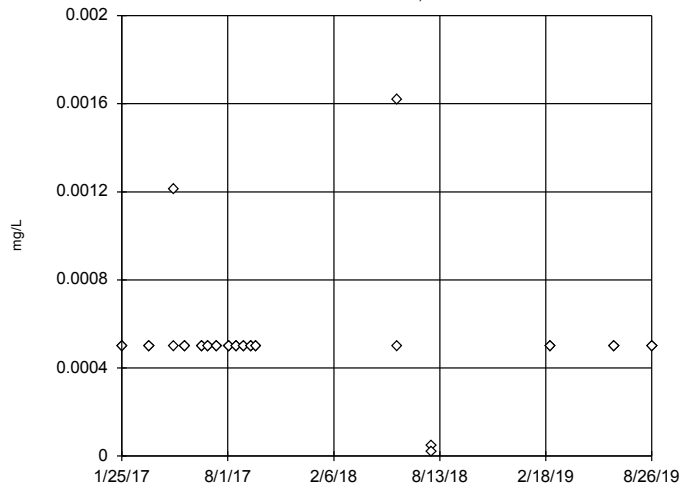


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 45988, low cutoff = 0.008382, based on IQR multiplier of 3.

Constituent: Sulfate Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5

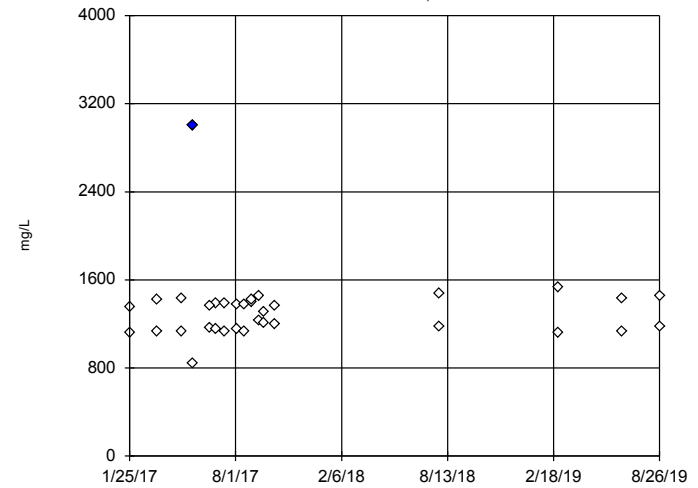


n = 34
 No outliers found.
 Tukey's method selected by user.
 Data were square root transformed to achieve best W statistic (graph shown in original units).
 The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium Analysis Run 12/5/2019 7:05 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

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

<u>Constituent</u>	<u>Well</u>	<u>Outlier</u>	<u>Value(s)</u>	<u>Method</u>	<u>Alpha</u>	<u>N</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Distribution</u>	<u>Normality Test</u>
Combined Radium 226 + 228 (pCi/L)	SP-1	Yes	14.29	NP	NaN	16	4.103	2.814	In(x)	ShapiroWilk

Outlier Analysis - All Results

Northeastern BAP Client: Geosyntec Data: Northeastern BAP Printed 12/5/2019, 7:09 PM

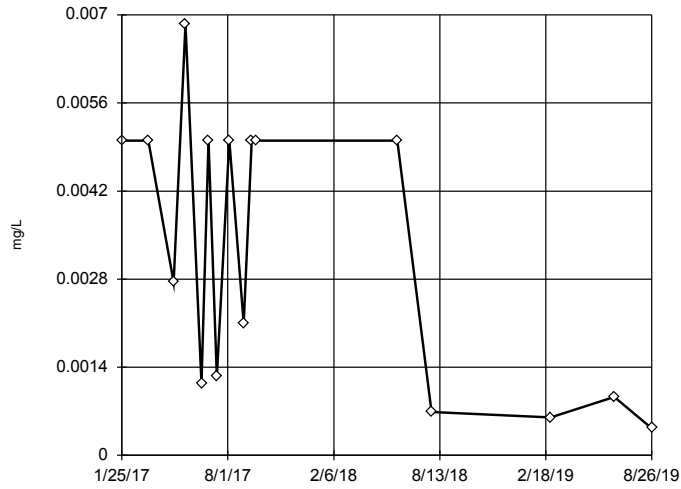
Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony (mg/L)	SP-1	No	n/a	NP	NaN	16	0.003233	0.002181	x^(1/3)	ShapiroWilk
Antimony (mg/L)	SP-10	No	n/a	NP	NaN	13	0.002672	0.001941	ln(x)	ShapiroWilk
Antimony (mg/L)	SP-11	No	n/a	NP	NaN	13	0.003377	0.003125	x^(1/3)	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

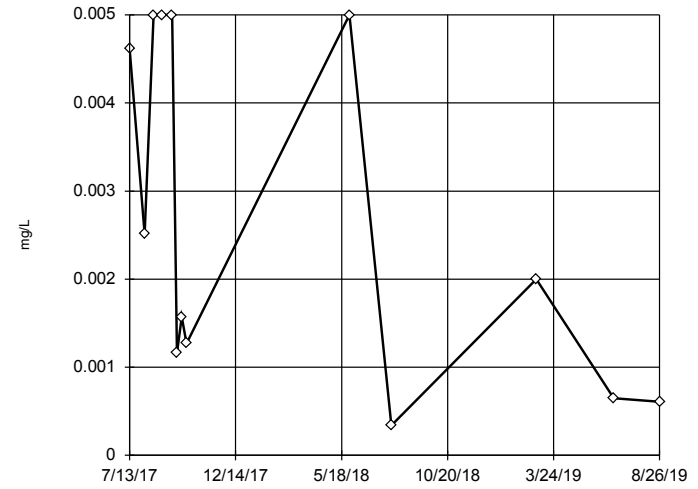
Tukey's Outlier Screening
SP-1



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

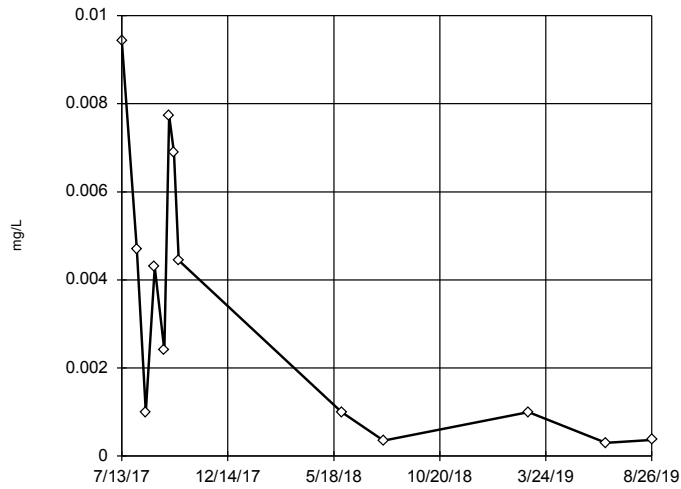
Tukey's Outlier Screening
SP-10



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 = 0.00004548, based on IQR multiplier of 3.

Constituent: Antimony Analysis Run 12/5/2019 7:07 PM
Northeastern BAP Client: Geosyntec Data: Northeastern BAP

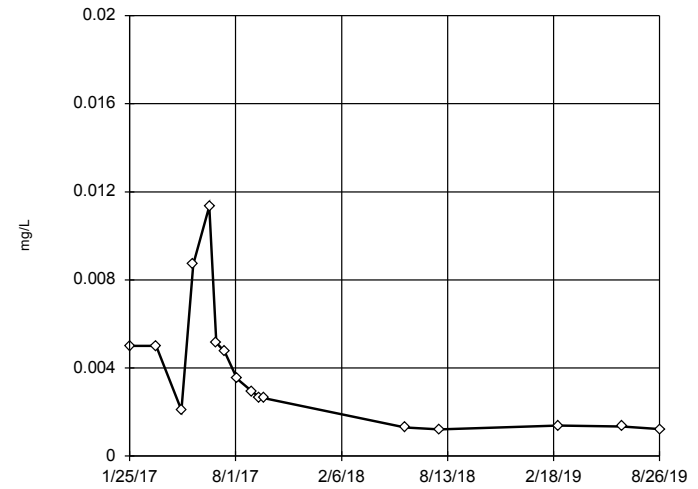
Tukey's Outlier Screening
SP-11



n = 13
No outliers found. Tukey's method selected by user.
Data were 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

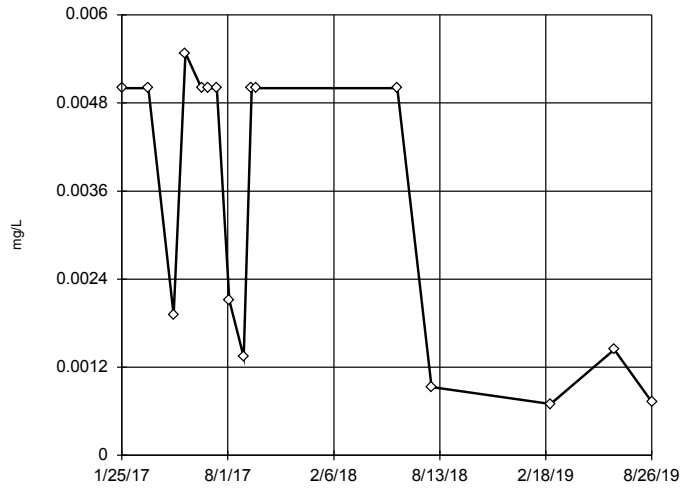
Tukey's Outlier Screening
SP-2



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

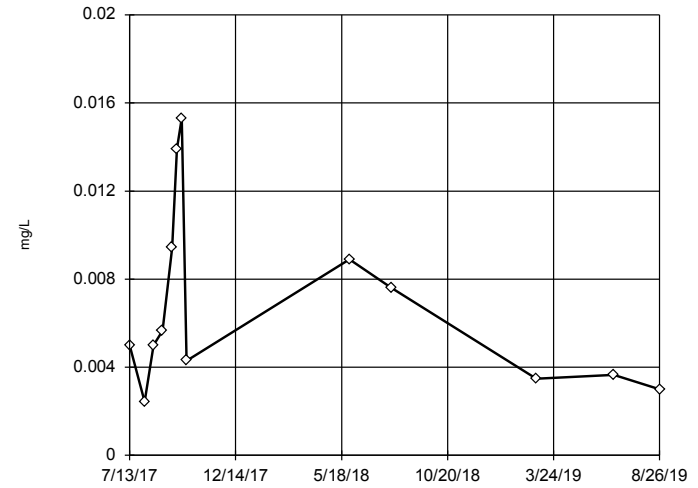
Tukey's Outlier Screening
SP-1



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 = 0.0002979, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM
Northeastern BAP Client: Geosyntec Data: Northeastern BAP

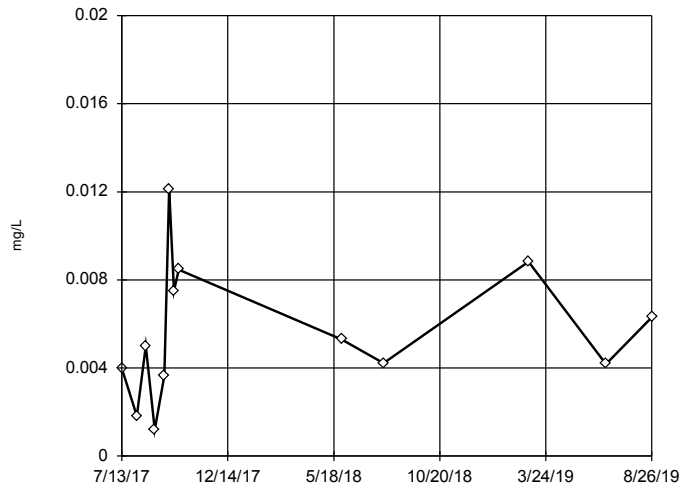
Tukey's Outlier Screening
SP-10



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 = 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

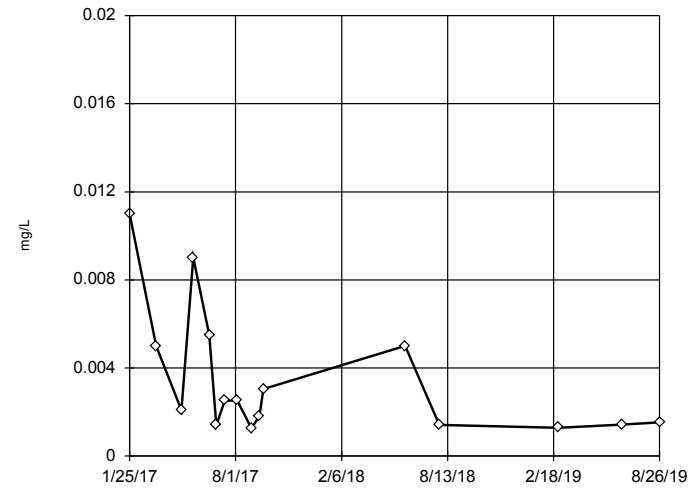
Tukey's Outlier Screening
SP-11



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

Tukey's Outlier Screening
SP-2

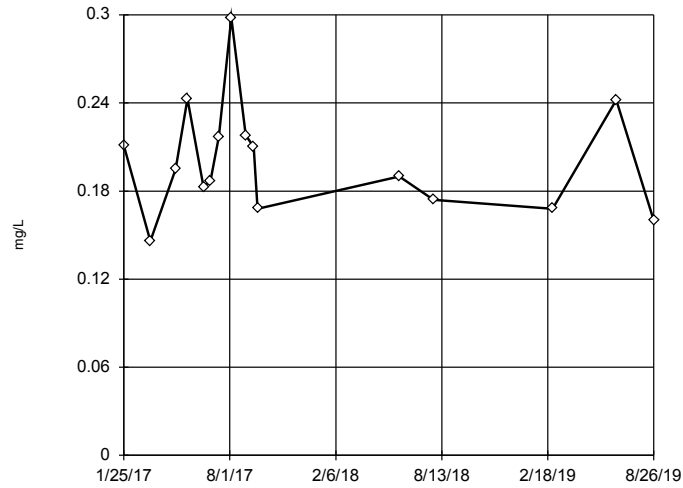


n = 16
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.216, low cutoff = 0.0003299, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM
Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1

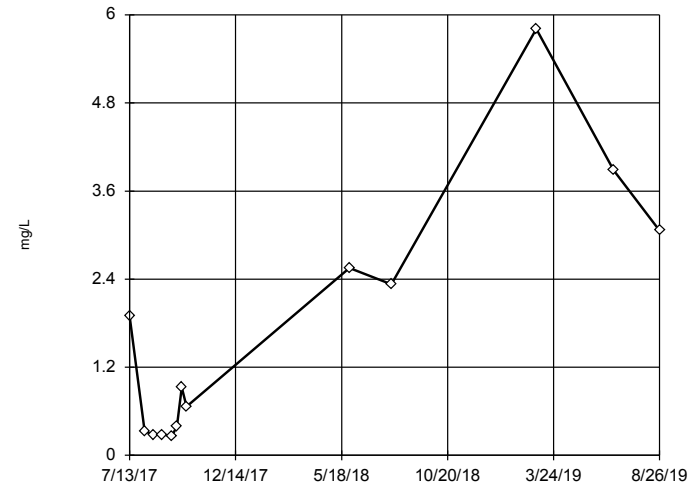


n = 16
No outliers found.
Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.4478, low cutoff = 0.08305, based on IQR multiplier of 3.

Constituent: Barium Analysis Run 12/5/2019 7:07 PM
Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-10

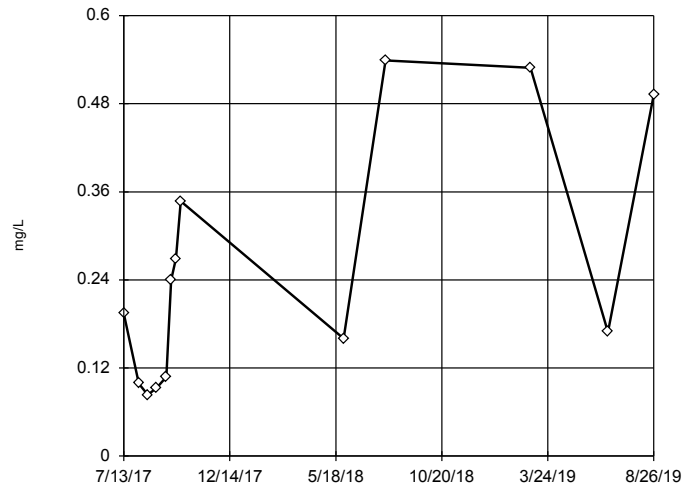


n = 13
No outliers found.
Tukey's method selected by user.
Data were cube root transformed to achieve best W statistic (graph shown in original units).
High cutoff = 47.27, low cutoff = -3.605, based on IQR multiplier of 3.

Constituent: Barium Analysis Run 12/5/2019 7:07 PM
Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11

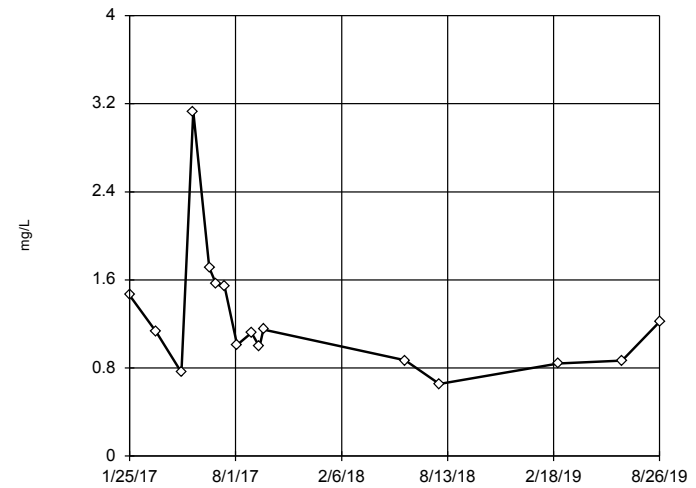


n = 13
No outliers found.
Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 26.47, low cutoff = 0.001612, based on IQR multiplier of 3.

Constituent: Barium Analysis Run 12/5/2019 7:07 PM
Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

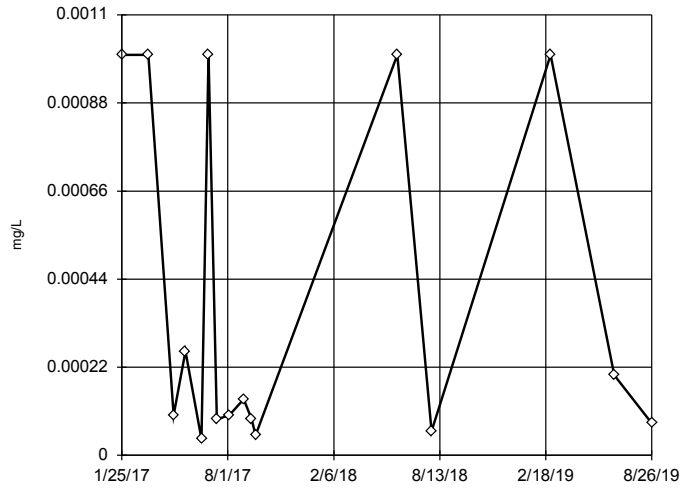
SP-2



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 = 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

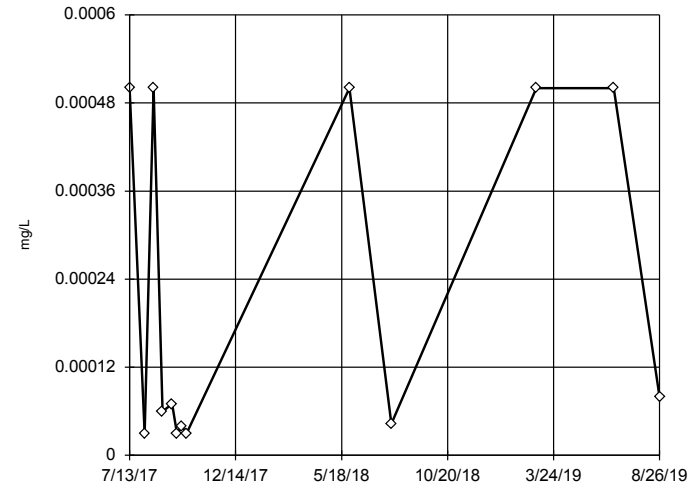
Tukey's Outlier Screening SP-1



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

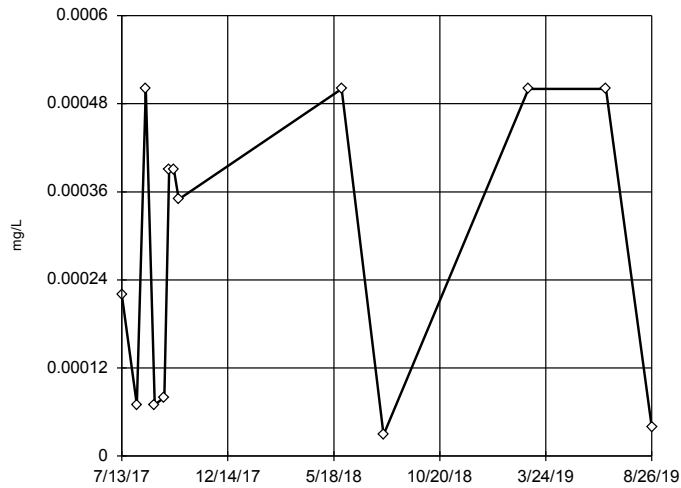
Tukey's Outlier Screening SP-10



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

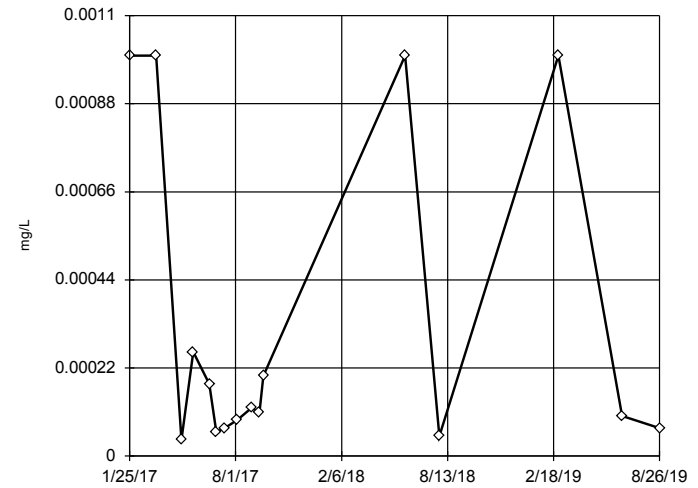
Tukey's Outlier Screening SP-11



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

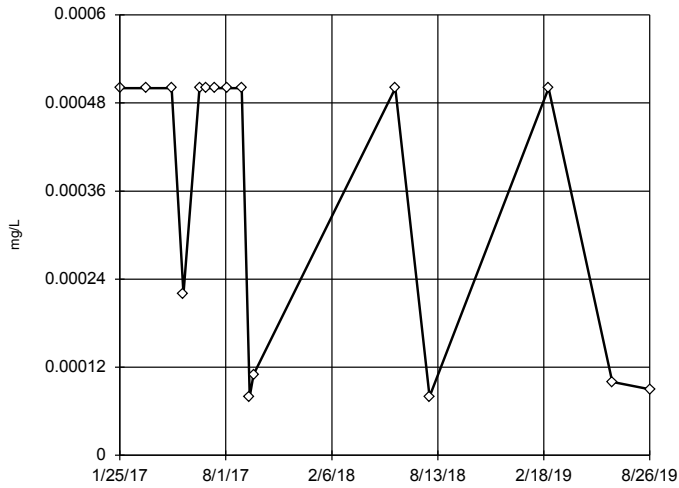
Tukey's Outlier Screening SP-2



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

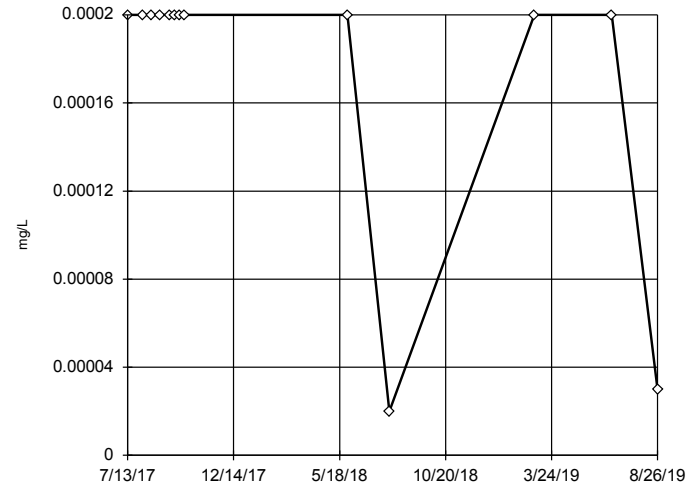
Tukey's Outlier Screening
SP-1



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

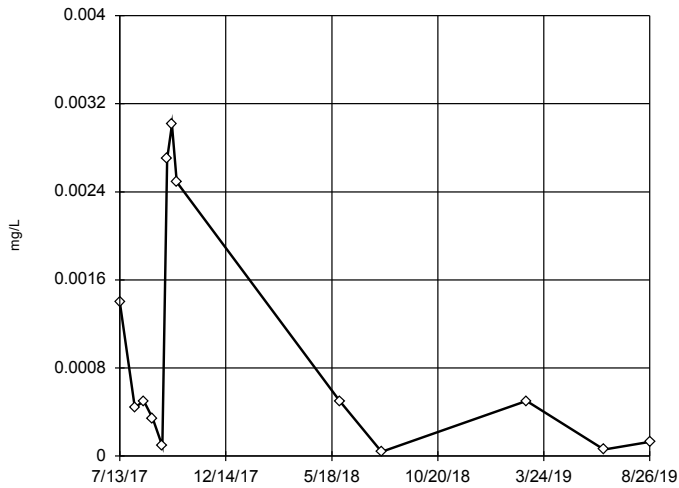
Tukey's Outlier Screening
SP-10



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

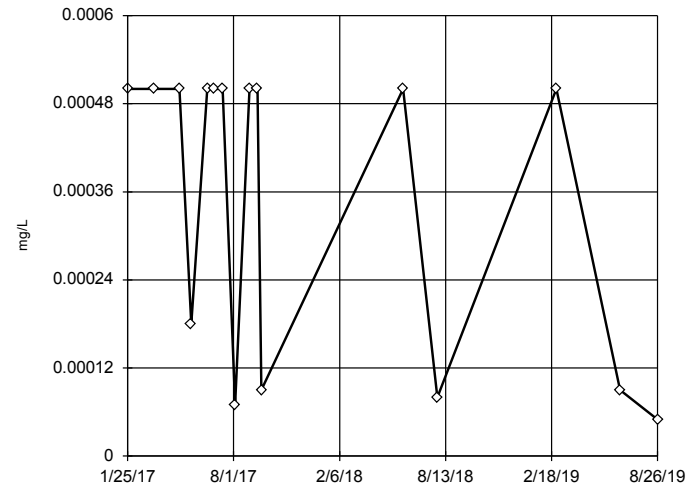
Tukey's Outlier Screening
SP-11



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

Tukey's Outlier Screening
SP-2

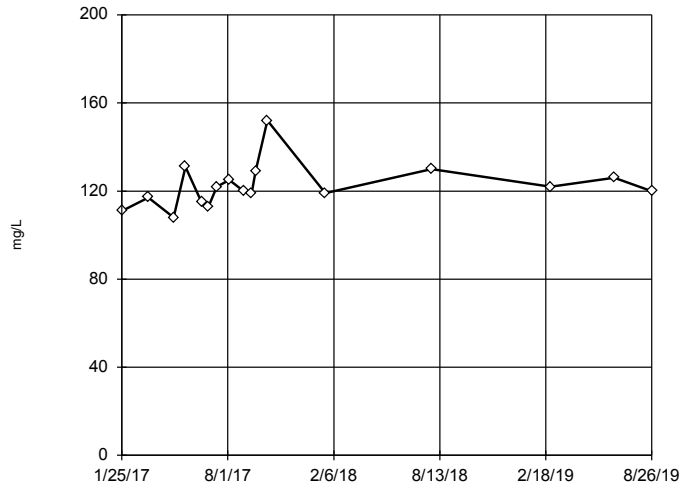


n = 16
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.08573, low cutoff = 5.2e-7, based on IQR multiplier of 3.

Constituent: Cadmium Analysis Run 12/5/2019 7:07 PM
Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1

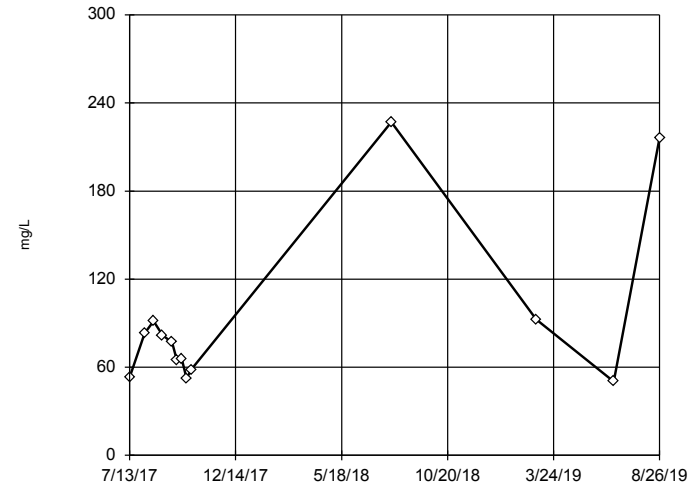


n = 17
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 169.3, low cutoff = 87.36, based on IQR multiplier of 3.

Constituent: Calcium Analysis Run 12/5/2019 7:07 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-10

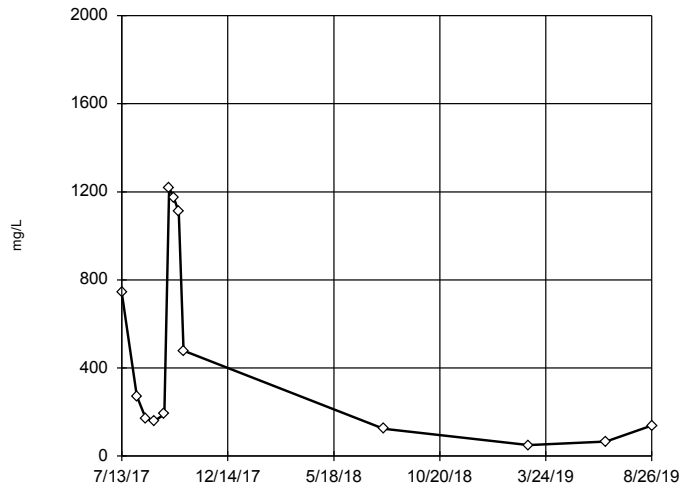


n = 13
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 416, low cutoff = 12.3, based on IQR multiplier of 3.

Constituent: Calcium Analysis Run 12/5/2019 7:07 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11

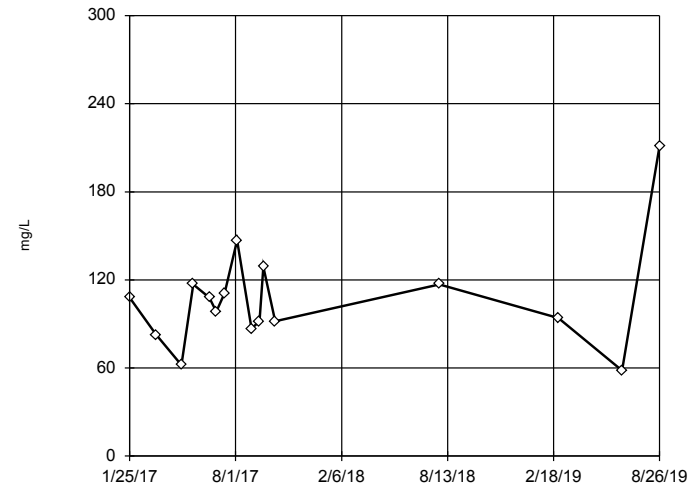


n = 13
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 299778, low cutoff = 0.3975, based on IQR multiplier of 3.

Constituent: Calcium Analysis Run 12/5/2019 7:07 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

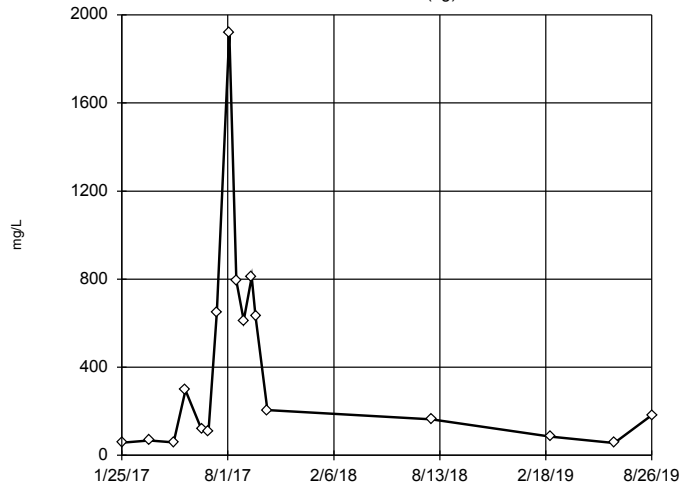
SP-2



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

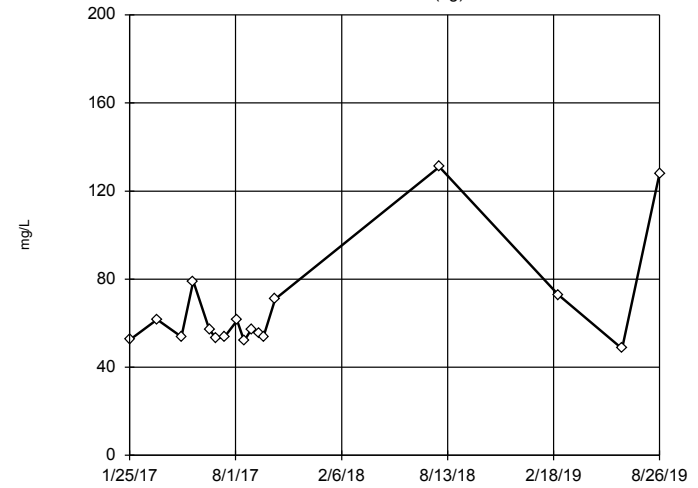
Tukey's Outlier Screening
SP-4 (bg)



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

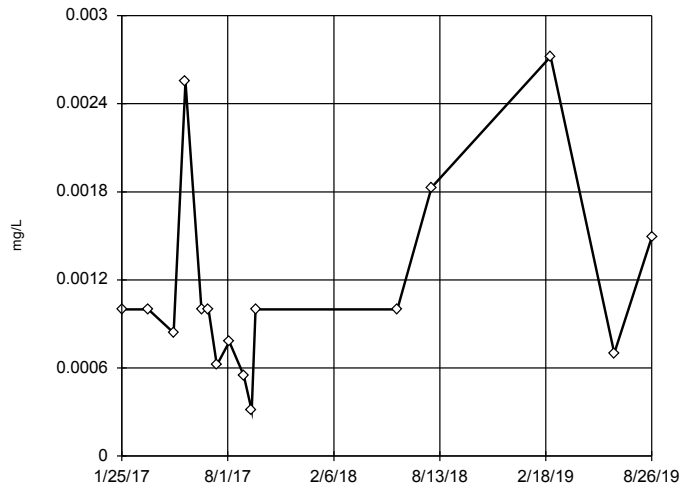
Tukey's Outlier Screening
SP-5 (bg)



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

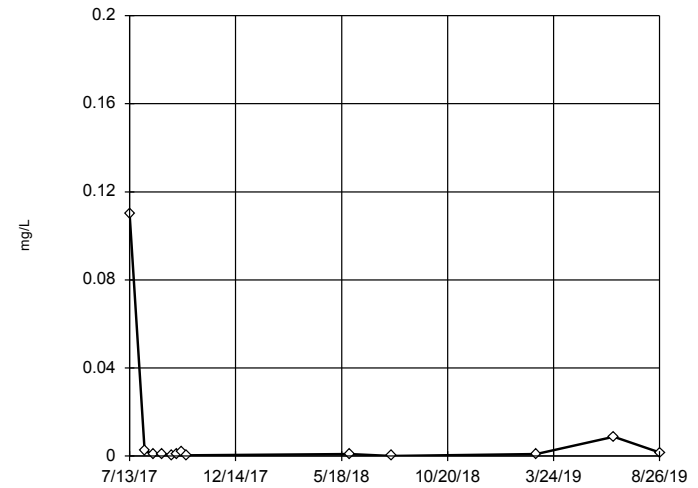
Tukey's Outlier Screening
SP-1



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

Tukey's Outlier Screening
SP-10

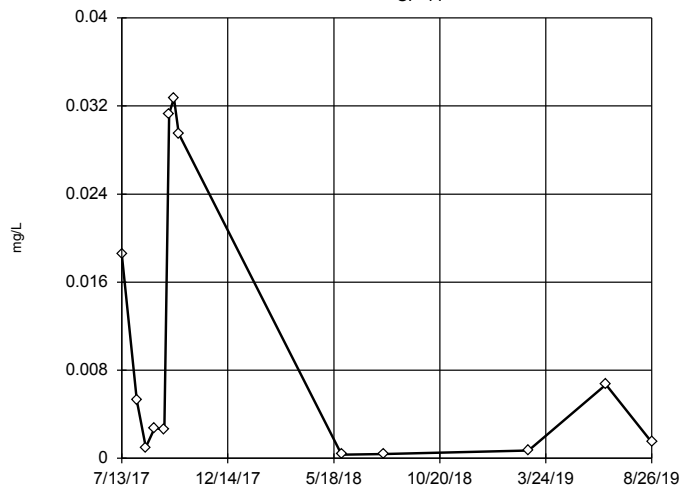


n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.1338, low cutoff = 0.000009664, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 12/5/2019 7:07 PM
Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11

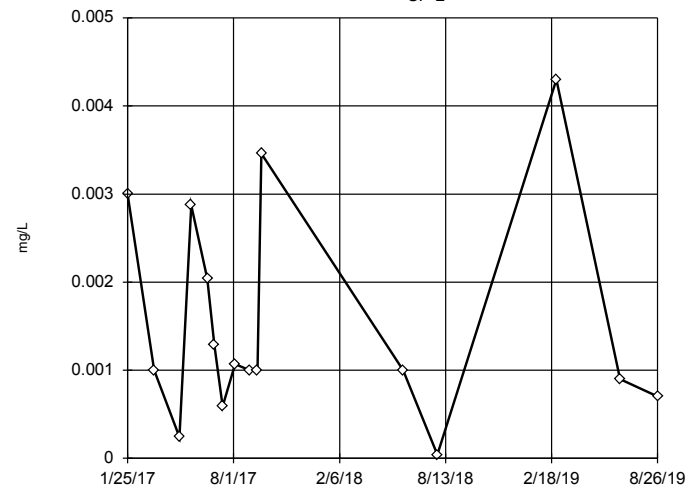


n = 13
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 509.3, low cutoff = 3.8e-8, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 12/5/2019 7:07 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-2

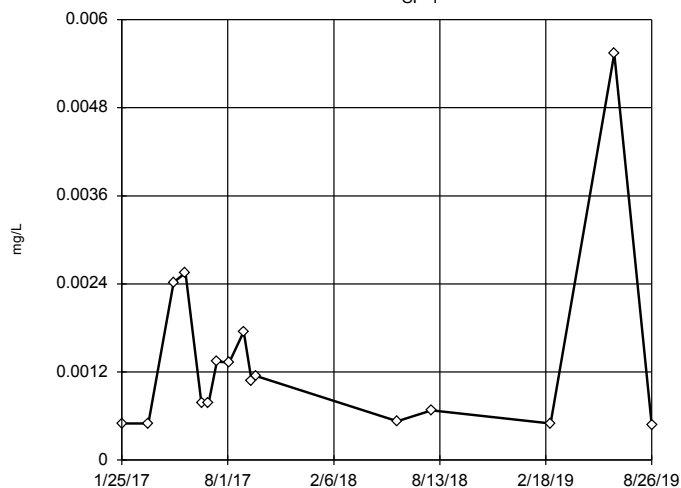


n = 16
 No outliers found.
 Tukey's method selected by user.
 Data were cube root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.01754, low cutoff = -0.0003478, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 12/5/2019 7:07 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1

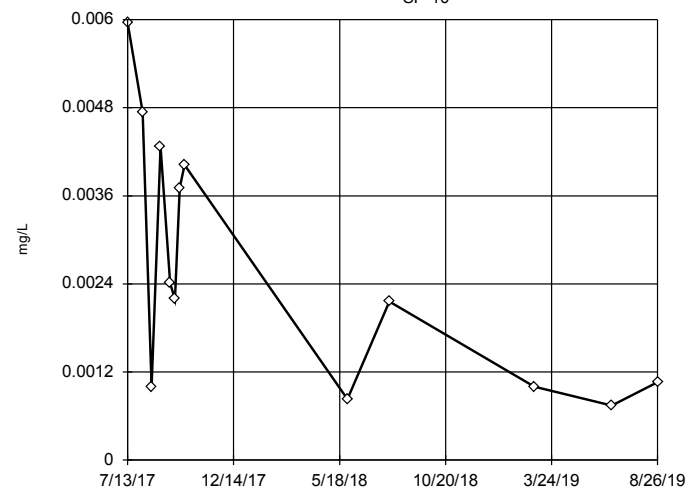


n = 16
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.04031, low cutoff = 0.00001956, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

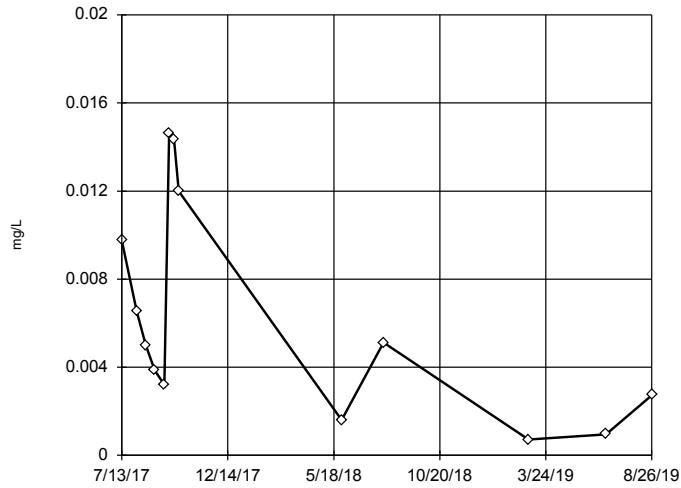
Tukey's Outlier Screening

SP-10



Tukey's Outlier Screening

SP-11

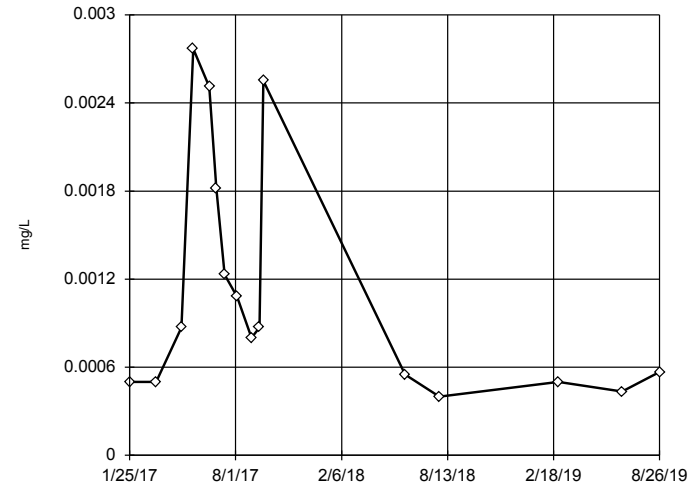


n = 13
 No outliers found.
 Tukey's method selected by user.
 Data were cube root transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.1248, low cutoff = -0.003371, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-2

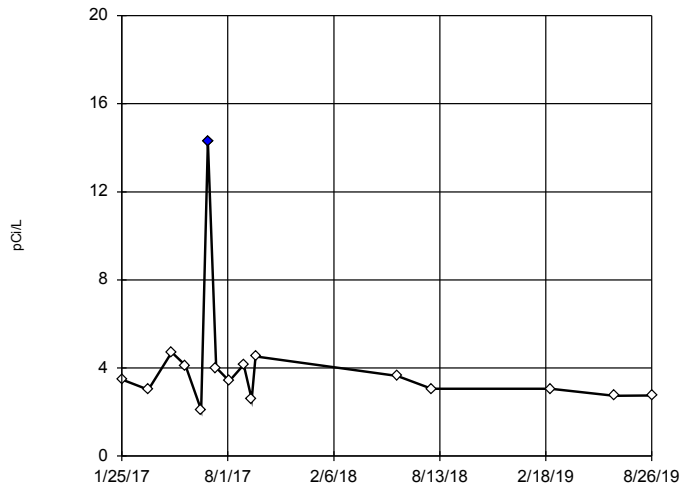


n = 16
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.04009, low cutoff = 0.00001866, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1

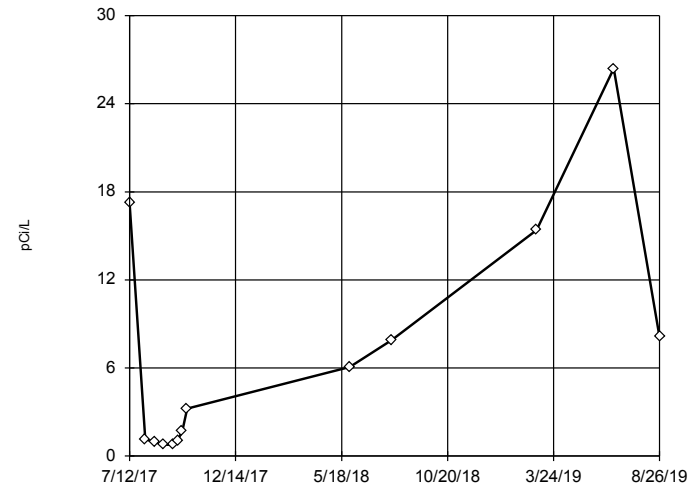


n = 16
 Outlier is drawn as solid.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 12.25, low cutoff = 0.9717, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:07 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

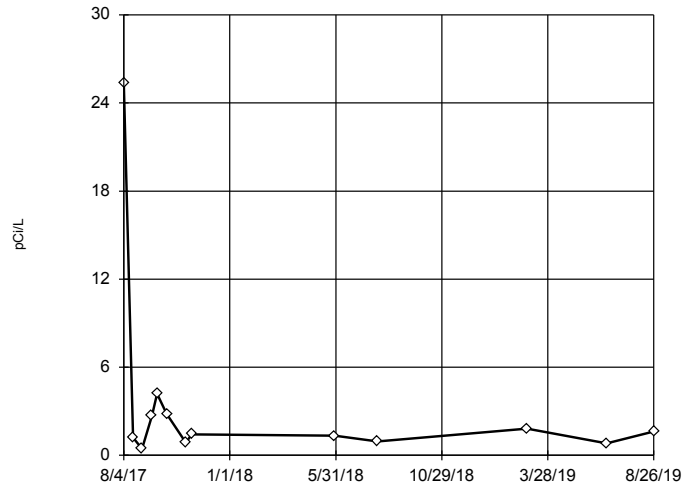
SP-10



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

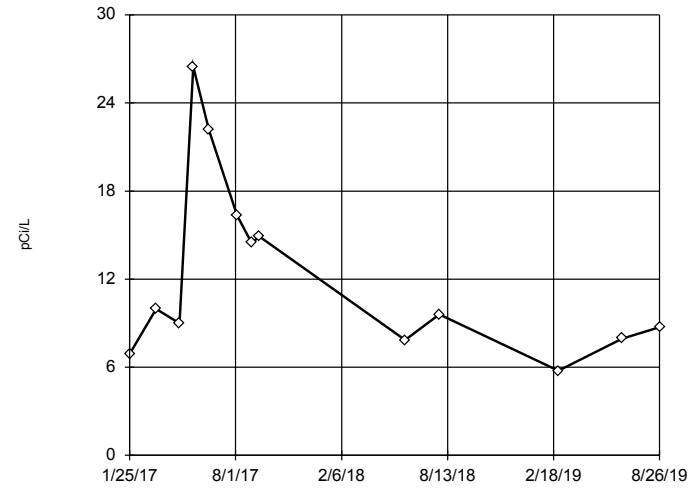
Tukey's Outlier Screening SP-11



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

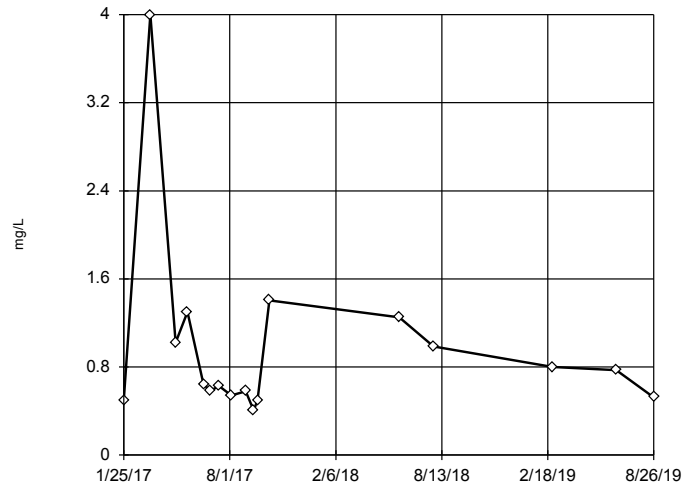
Tukey's Outlier Screening SP-2



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

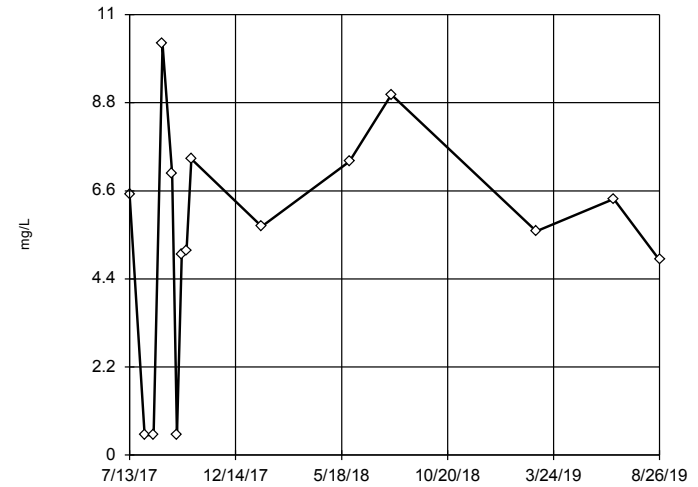
Tukey's Outlier Screening SP-1



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

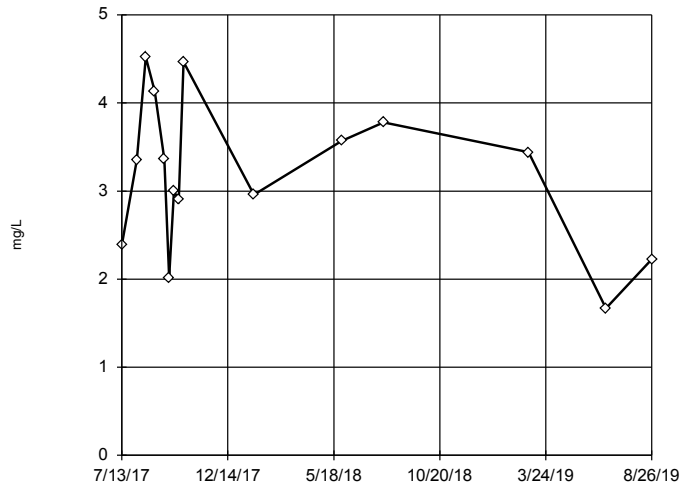
Tukey's Outlier Screening SP-10



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

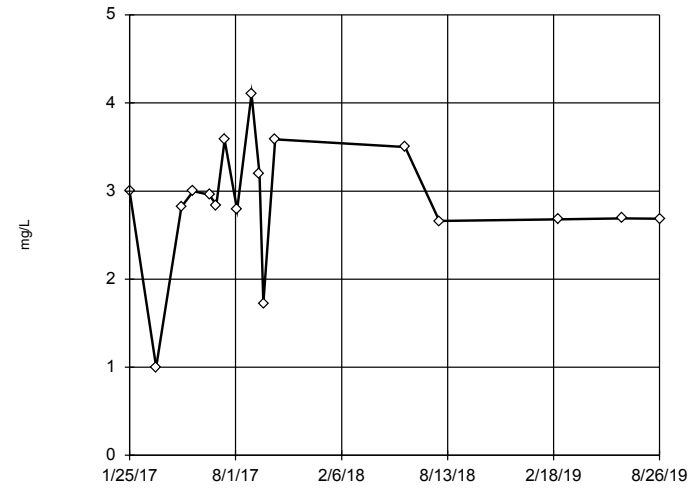
Tukey's Outlier Screening
SP-11



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

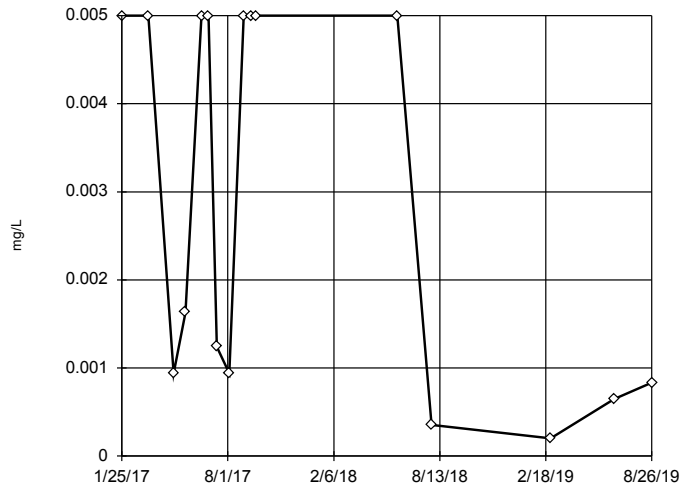
Tukey's Outlier Screening
SP-2



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

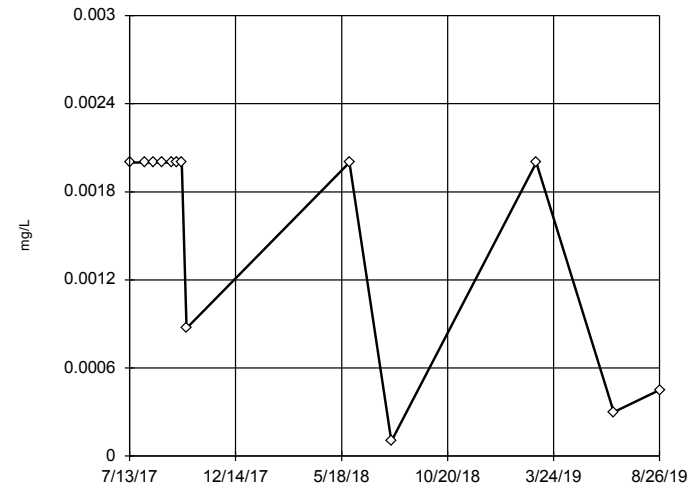
Tukey's Outlier Screening
SP-1



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

Tukey's Outlier Screening
SP-10

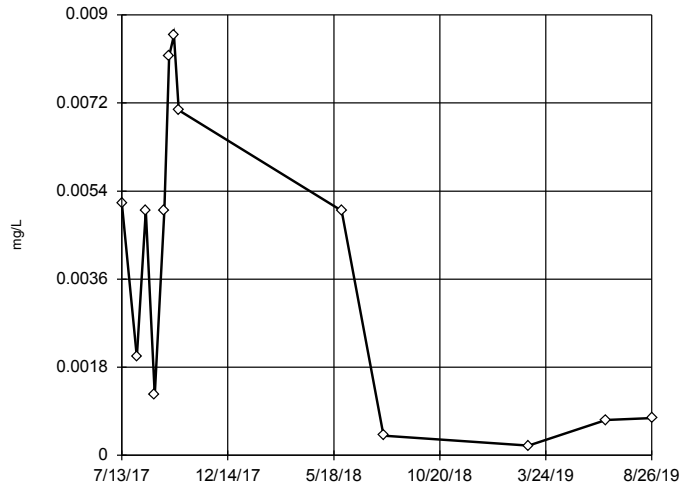


n = 13
No outliers found. Tukey's method selected by user.
Data were cube root transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.01487, low cutoff = -0.00003896, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 12/5/2019 7:07 PM
Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

No outliers found.
Tukey's method selected by user.

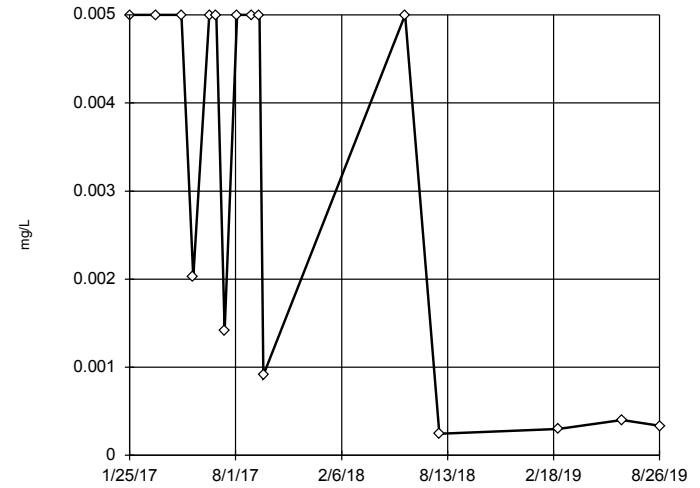
Data were square root transformed to achieve best W statistic (graph shown in original units).

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

Tukey's Outlier Screening

SP-2



n = 16

No outliers found.
Tukey's method selected by user.

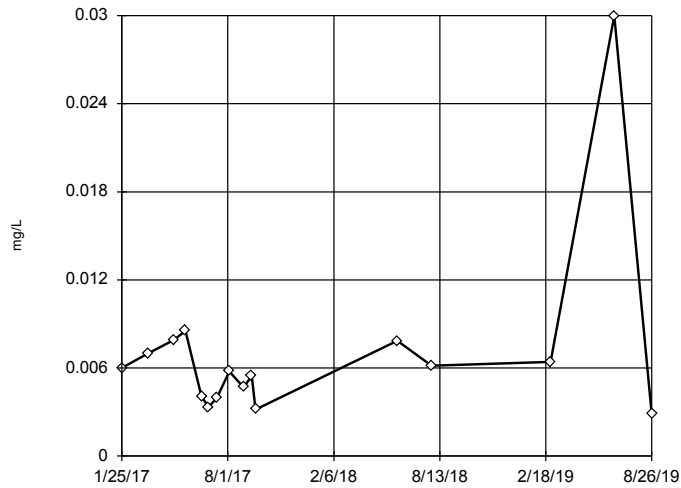
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.846, low cutoff = 0.0000106, based on IQR multiplier of 3.

Constituent: Lead 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.

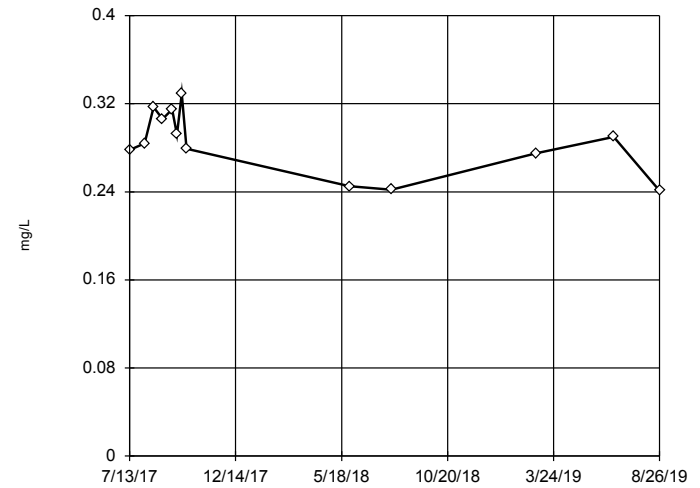
Data were natural log transformed to achieve best W statistic (graph shown in original units).

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

Tukey's Outlier Screening

SP-10



n = 13

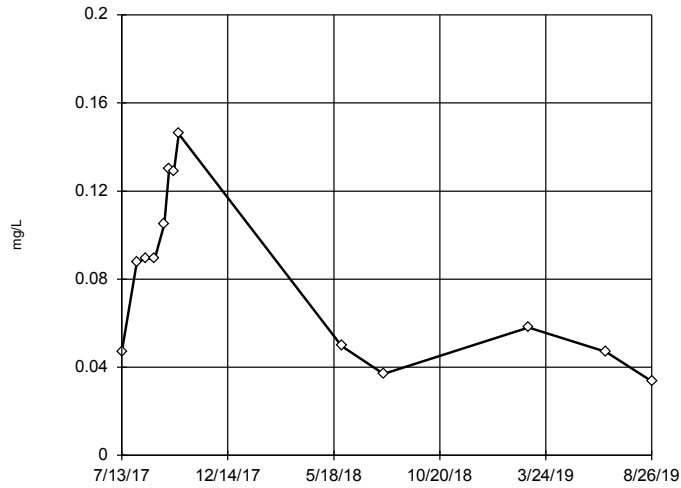
No outliers found.
Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.4053,
low cutoff = -0.2652,
based on IQR multiplier of 3.

Constituent: Lithium Analysis Run 12/5/2019 7:08 PM
Northeastern BAP Client: Geosyntec Data: Northeastern BAP

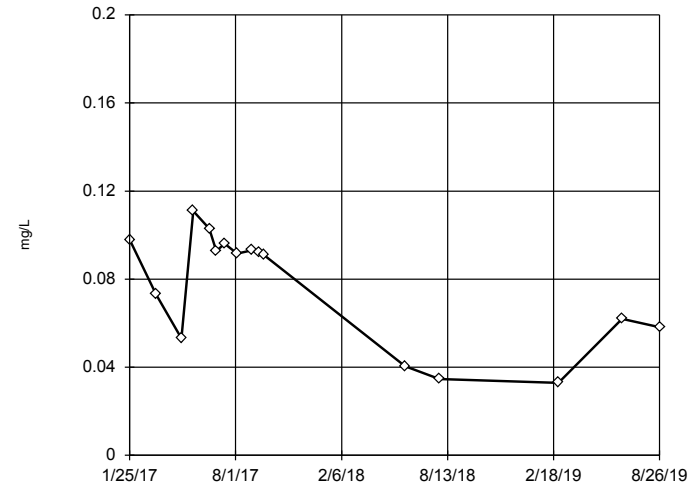
Tukey's Outlier Screening SP-11



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 = 0.662, low cutoff = -0.0001086, based on IQR multiplier of 3.

Constituent: Lithium Analysis Run 12/5/2019 7:08 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

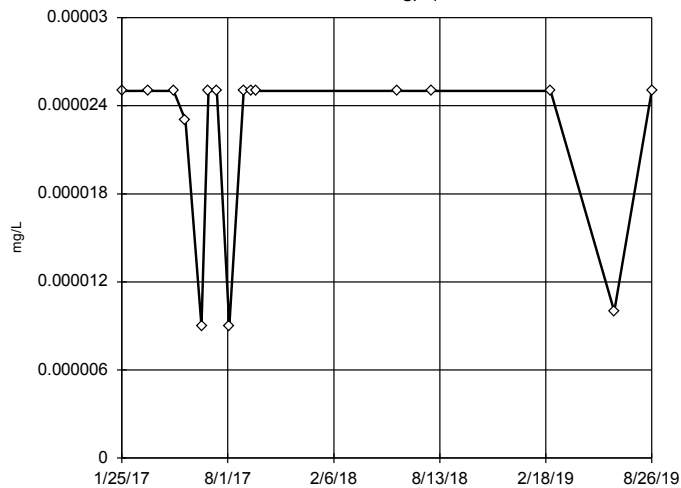
Tukey's Outlier Screening SP-2



n = 16
 No outliers found.
 Tukey's method selected by user.
 Data were 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

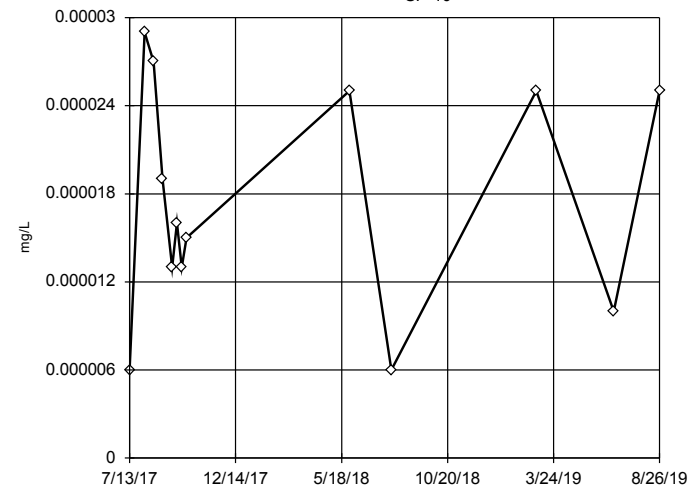
Tukey's Outlier Screening SP-1



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

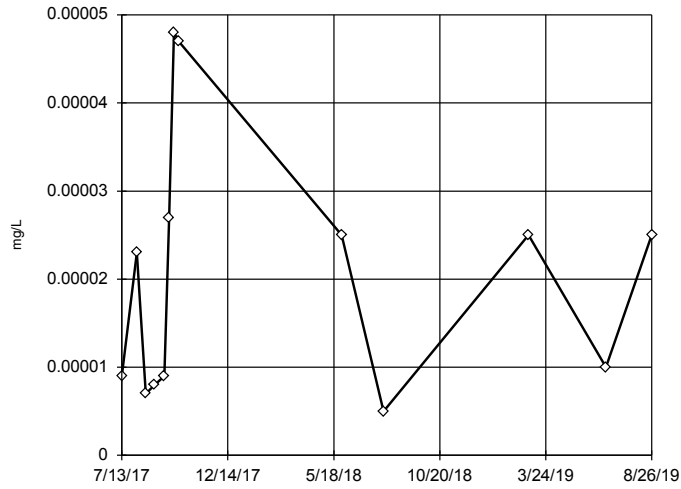
Tukey's Outlier Screening SP-10



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

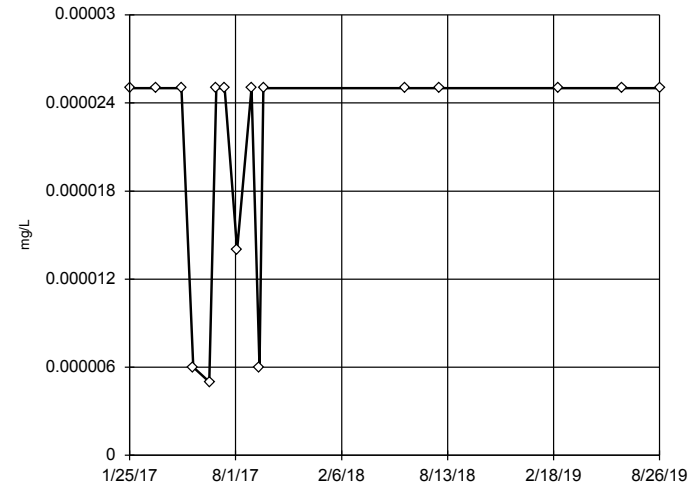
Tukey's Outlier Screening
SP-11



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

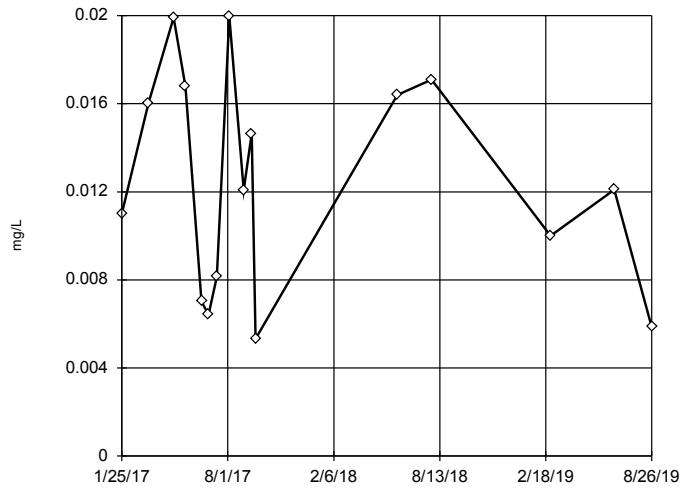
Tukey's Outlier Screening
SP-2



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

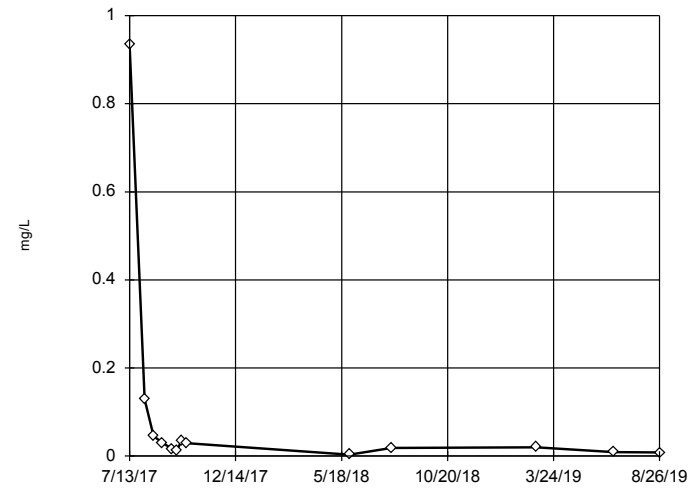
Tukey's Outlier Screening
SP-1



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

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

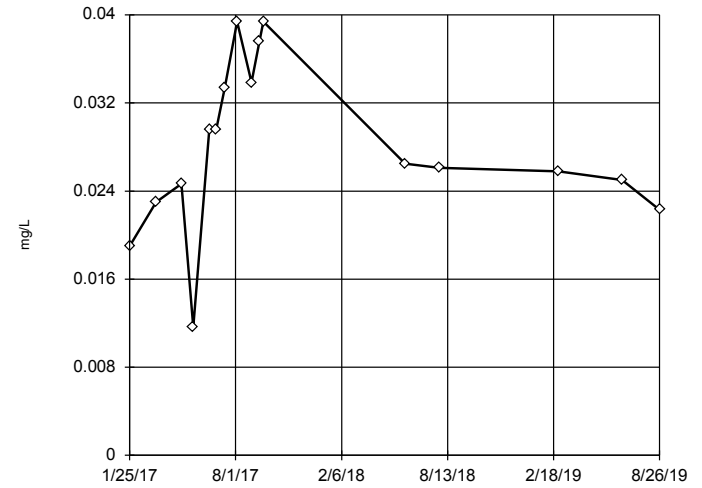
Tukey's Outlier Screening SP-11



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

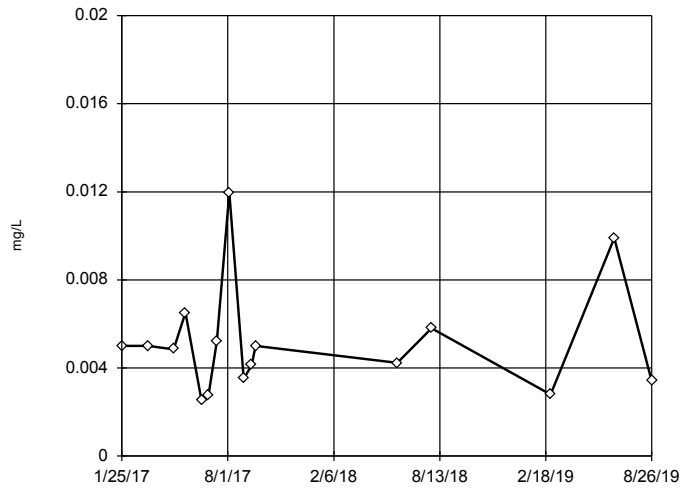
Tukey's Outlier Screening SP-2



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

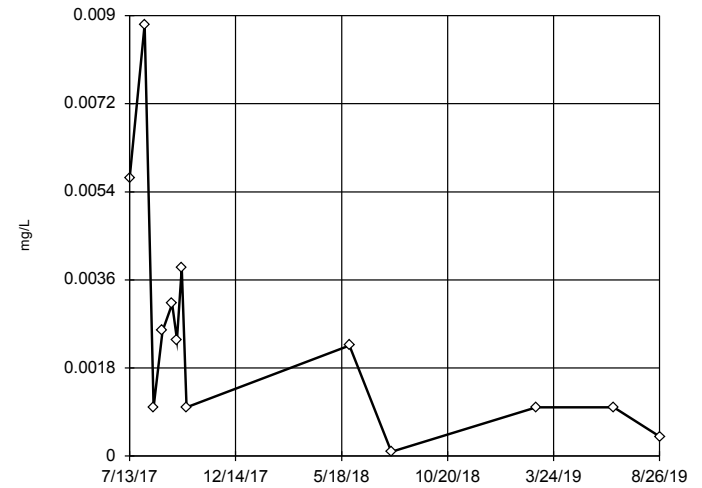
Tukey's Outlier Screening SP-1



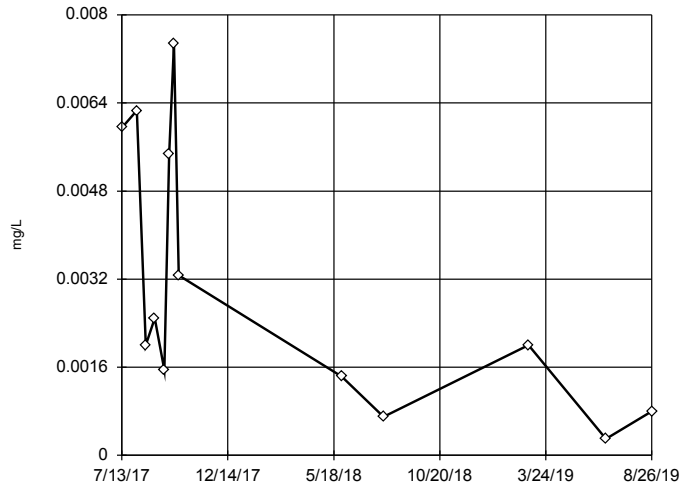
n = 16
 No outliers found.
 Tukey's method selected by user.
 Data were natural log transformed to achieve best W statistic (graph shown in original units).
 High cutoff = 0.02215,
 low cutoff = 0.0008574,
 based on IQR multiplier of 3.

Constituent: Selenium Analysis Run 12/5/2019 7:08 PM
 Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening SP-10



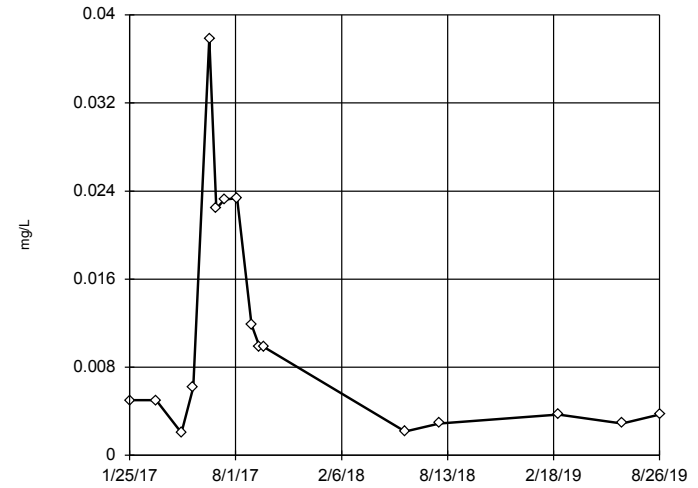
Tukey's Outlier Screening
SP-11



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

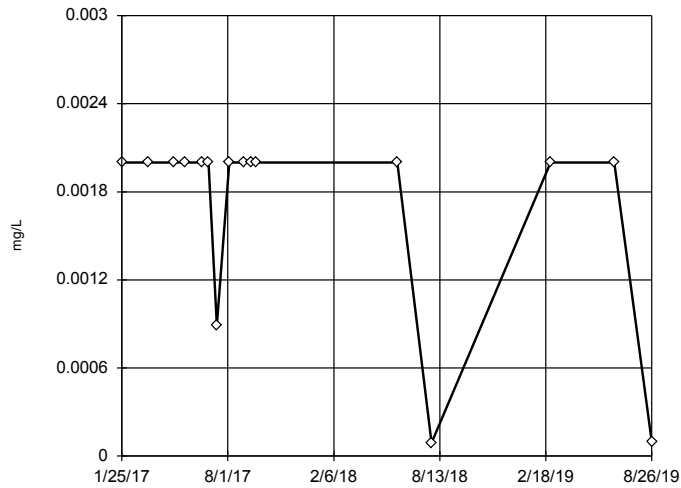
Tukey's Outlier Screening
SP-2



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

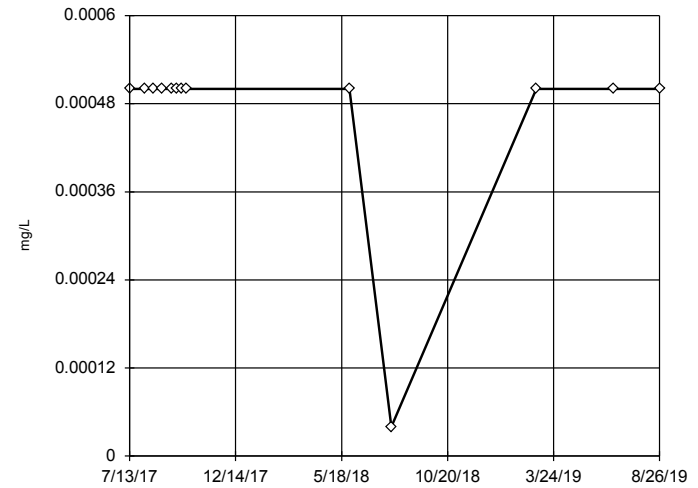
Tukey's Outlier Screening
SP-1



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

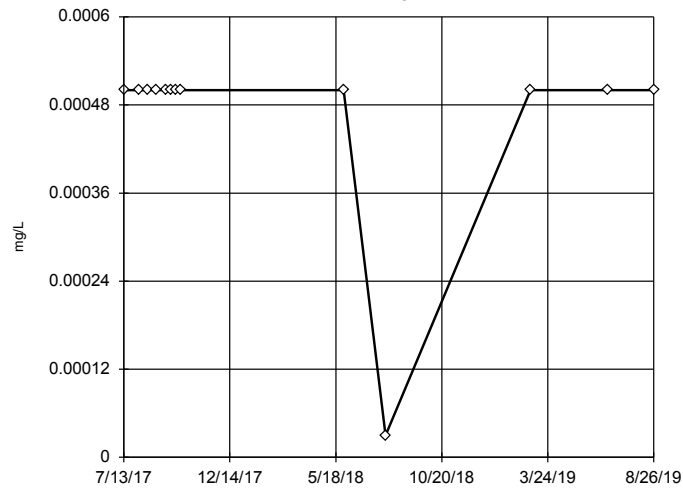
Tukey's Outlier Screening
SP-10



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

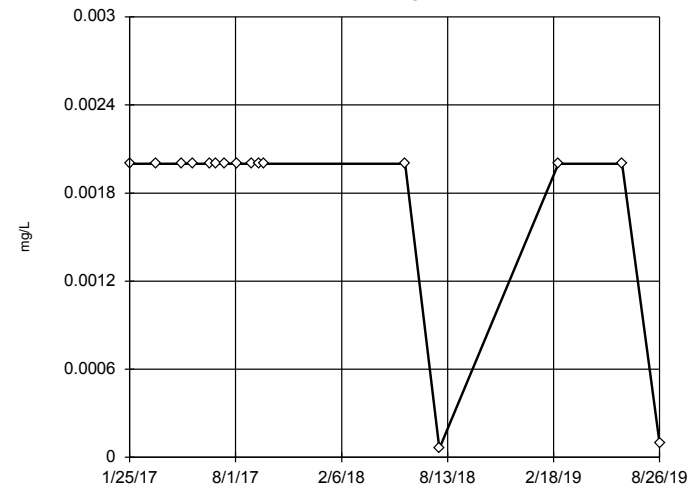
Tukey's Outlier Screening SP-11



n = 13
No outliers found.
Tukey's method selected by user.
Data were x⁴ 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.

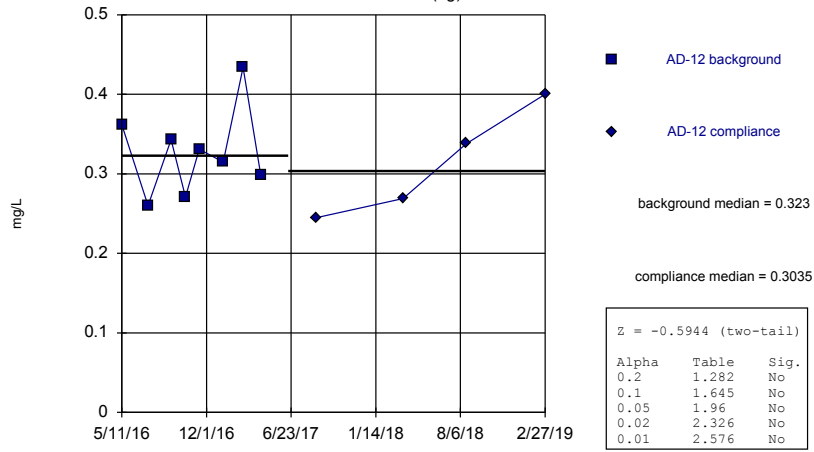
Constituent: Thallium Analysis Run 12/5/2019 7:08 PM
Northeastern BAP Client: Geosyntec Data: Northeastern BAP

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

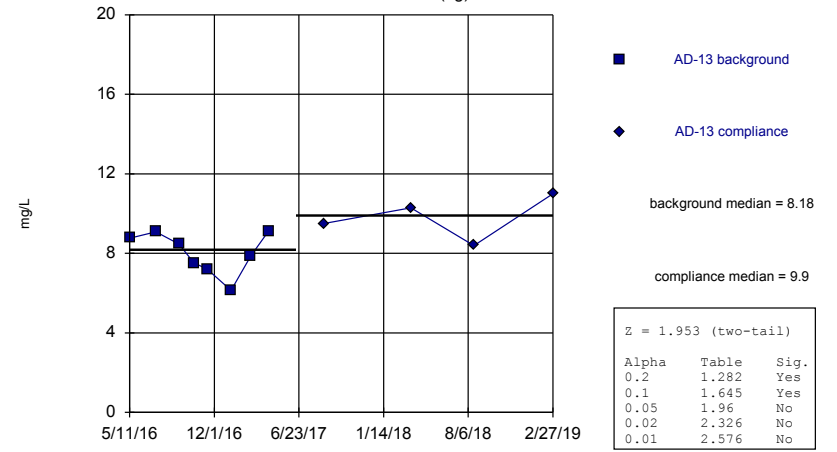
<u>Constituent</u>	<u>Well</u>	<u>Calc.</u>	<u>0.01</u>	<u>Method</u>
Calcium, total (mg/L)	AD-12 (bg)	-0.5944	No	Mann-W
Calcium, total (mg/L)	AD-13 (bg)	1.953	No	Mann-W
Calcium, total (mg/L)	AD-22	0.5131	No	Mann-W
Calcium, total (mg/L)	AD-33	-1.537	No	Mann-W
Calcium, total (mg/L)	AD-7	0.6587	No	Mann-W
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

Mann-Whitney (Wilcoxon Rank Sum)
AD-12 (bg)



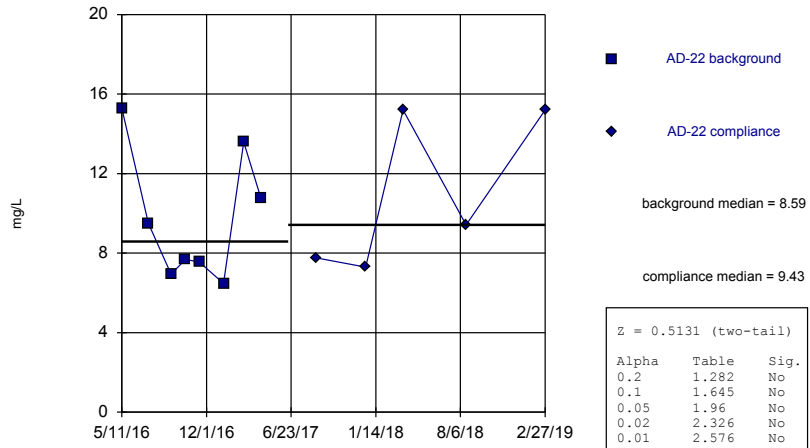
Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)
AD-13 (bg)



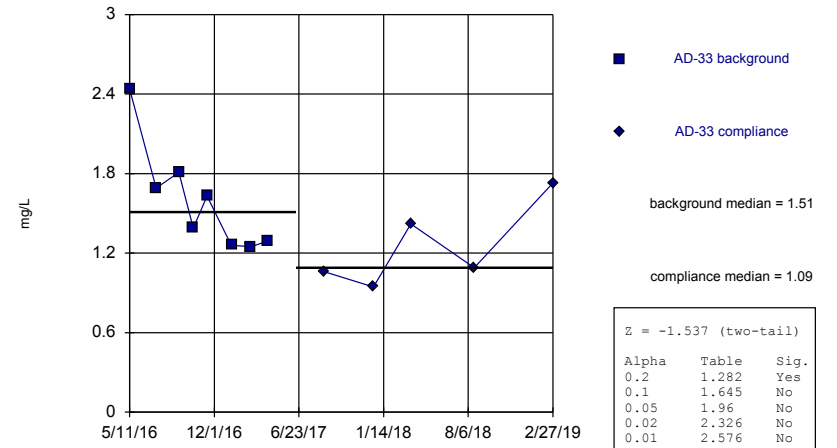
Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)
AD-22



Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

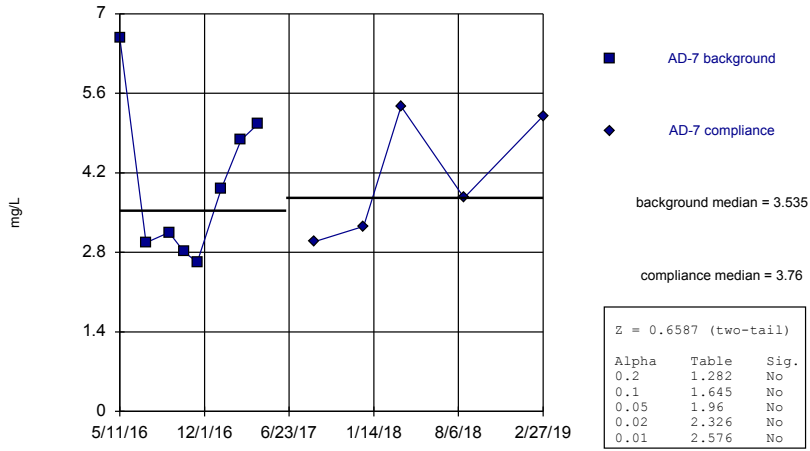
Mann-Whitney (Wilcoxon Rank Sum)
AD-33



Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

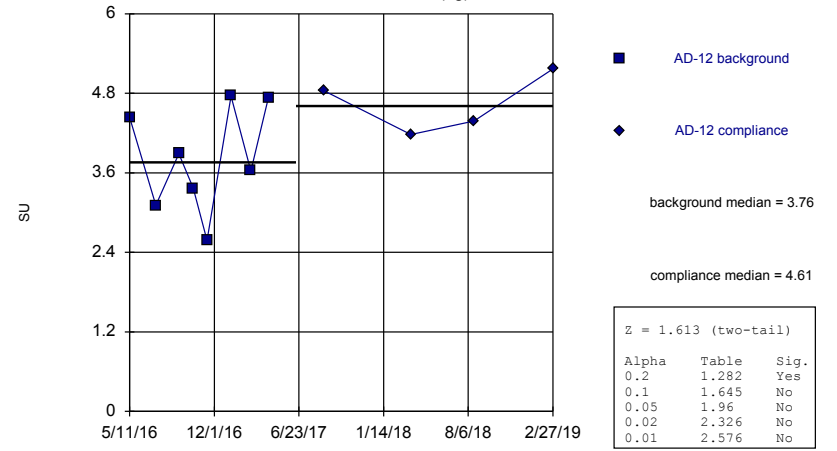
AD-7



Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

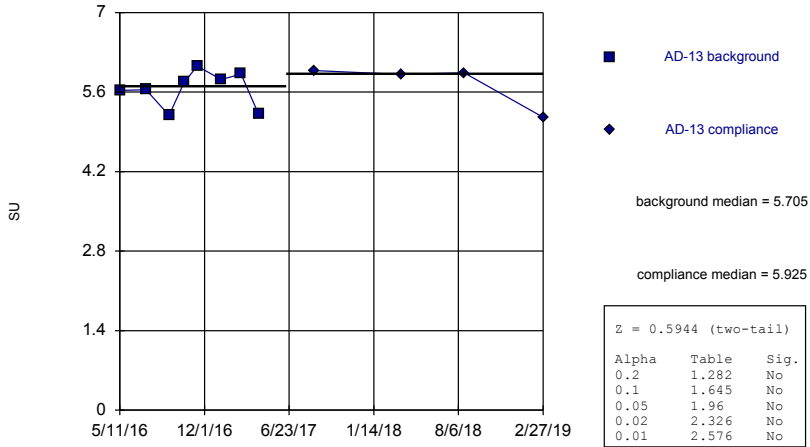
AD-12 (bg)



Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

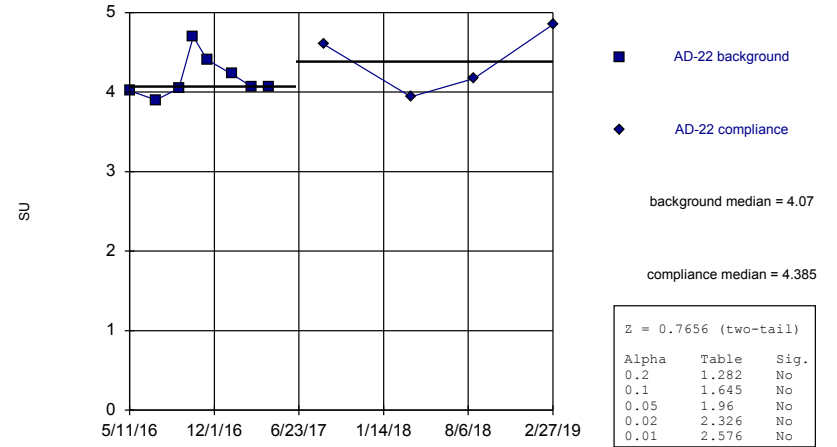
AD-13 (bg)



Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

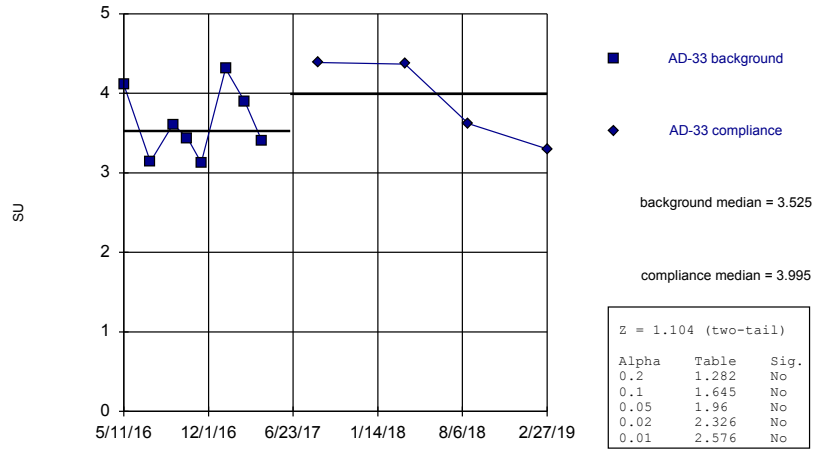
AD-22



Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

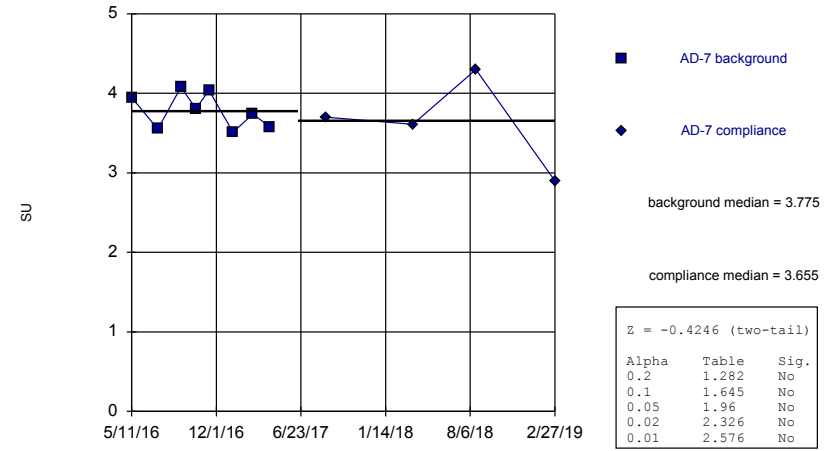
AD-33



Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

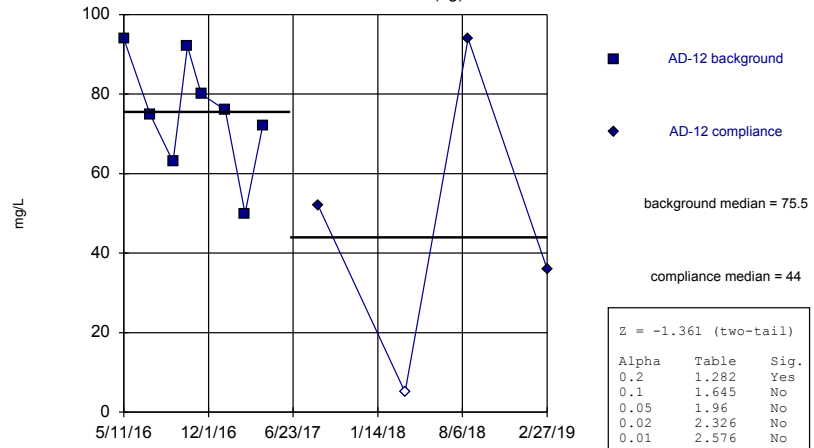
AD-7



Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

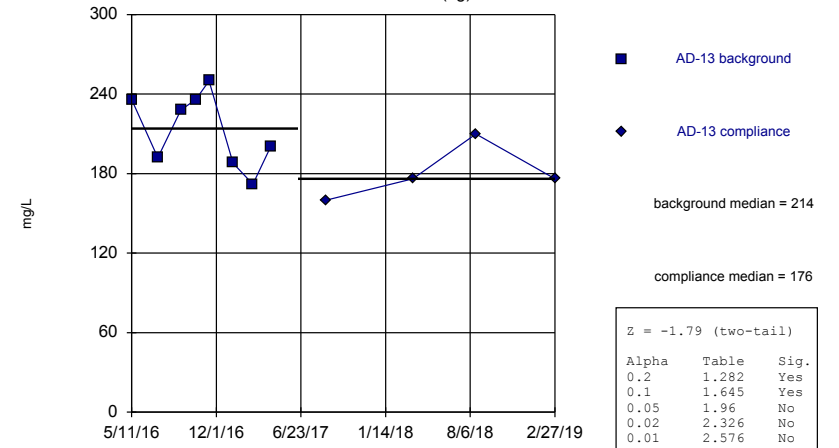
AD-12 (bg)



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

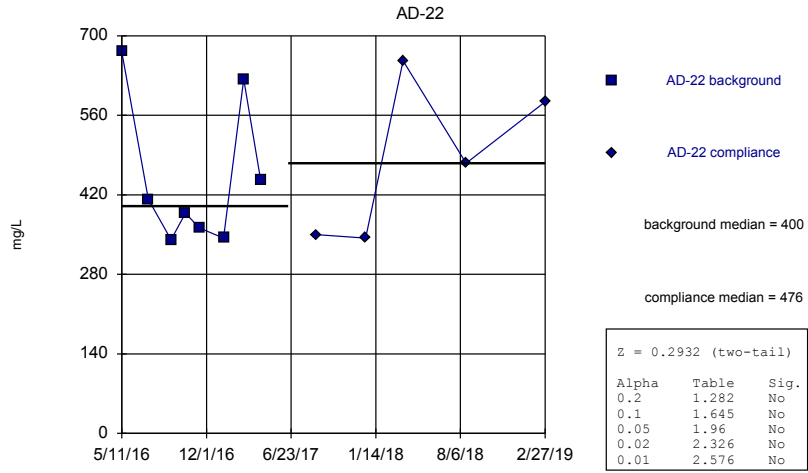
Mann-Whitney (Wilcoxon Rank Sum)

AD-13 (bg)



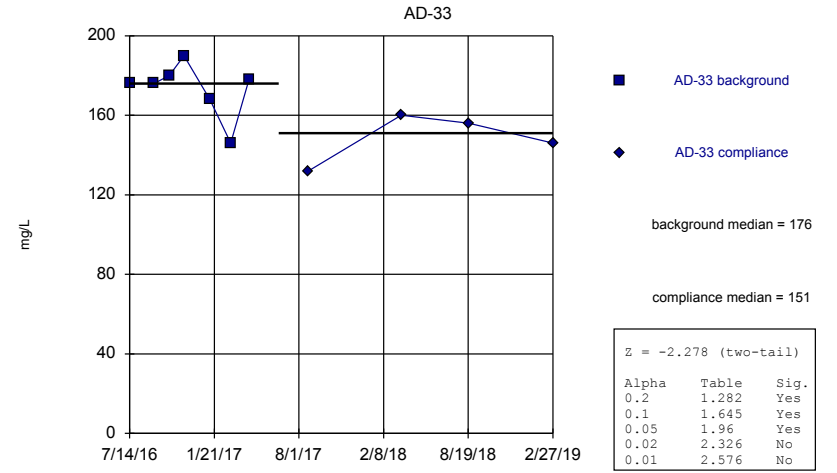
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)



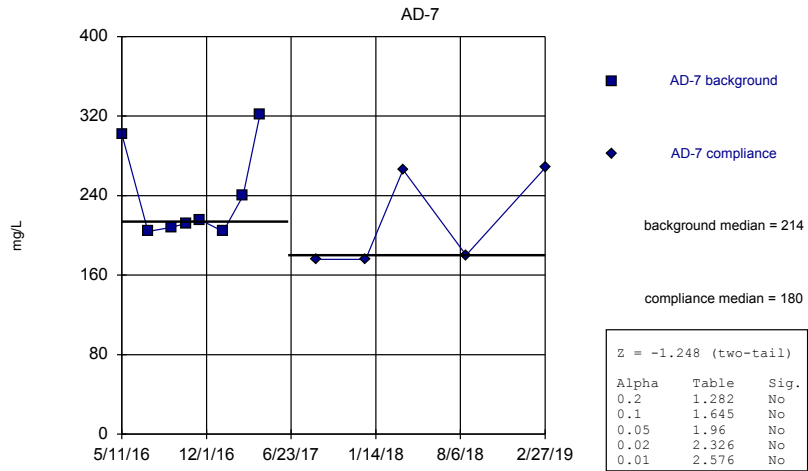
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)



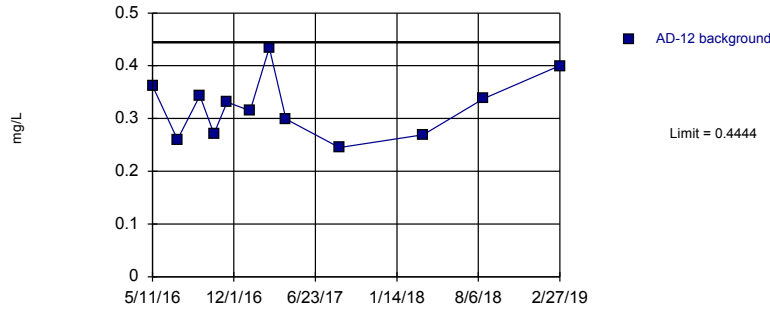
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Intrawell Prediction Limit Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 8:00 AM

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Date</u>	<u>Observ.</u>	<u>Sig.</u>	<u>Bg</u>	<u>NBq</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
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	

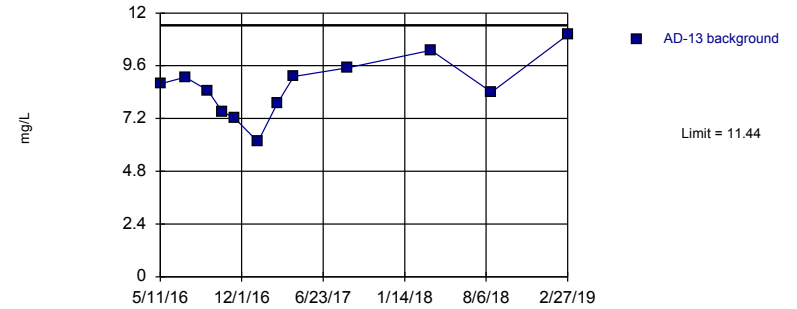
Prediction Limit
Intrawell Parametric, AD-12 (bg)



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

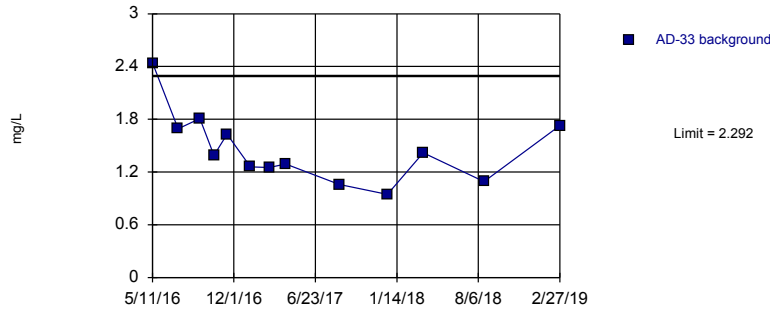
Prediction Limit
Intrawell Parametric, AD-13 (bg)



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

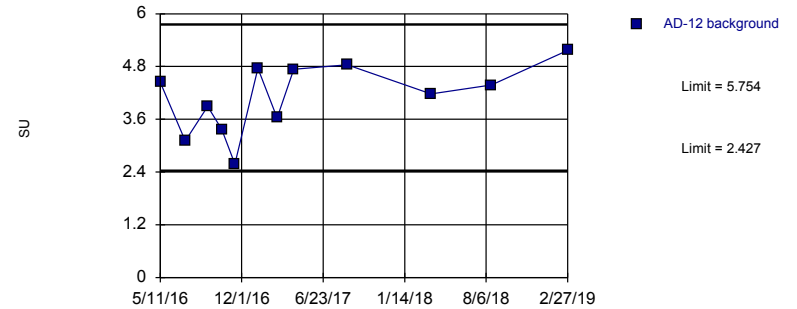
Prediction Limit
Intrawell Parametric, AD-33



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

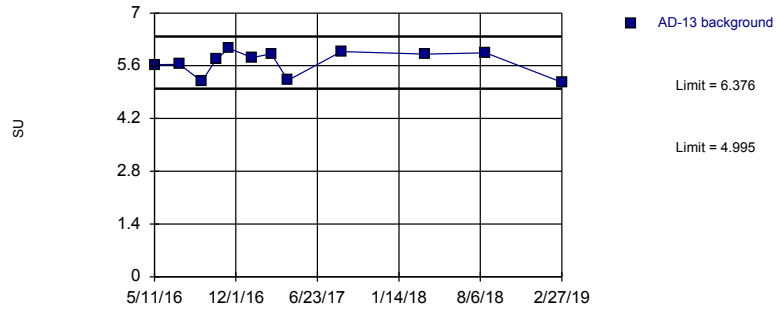
Prediction Limit
Intrawell Parametric, AD-12 (bg)



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

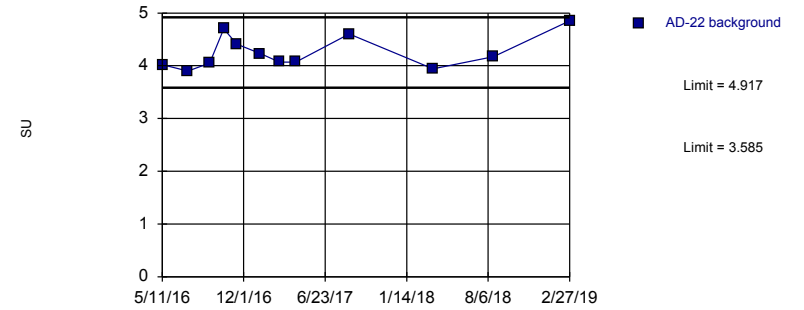
Prediction Limit
Intrawell Parametric, AD-13 (bg)



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

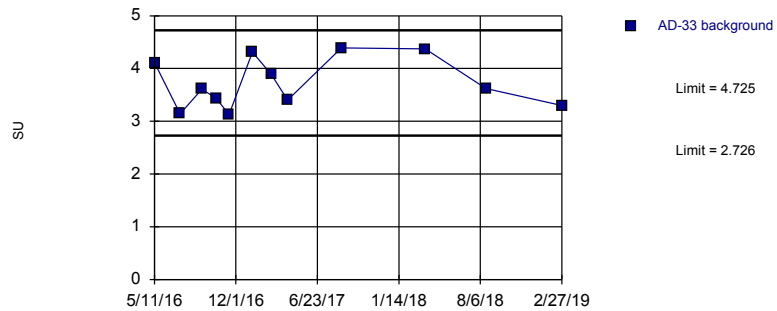
Prediction Limit
Intrawell Parametric, AD-22



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

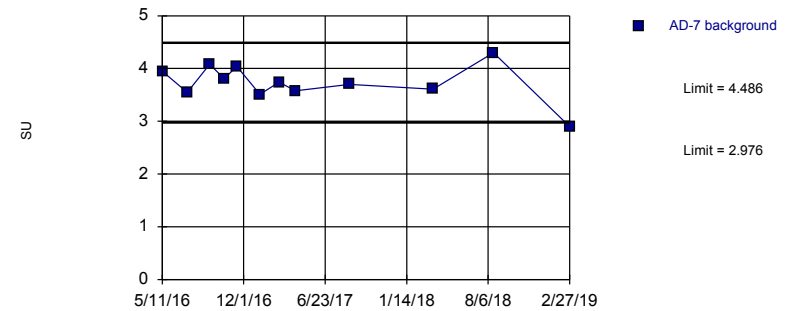
Prediction Limit
Intrawell Parametric, AD-33



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

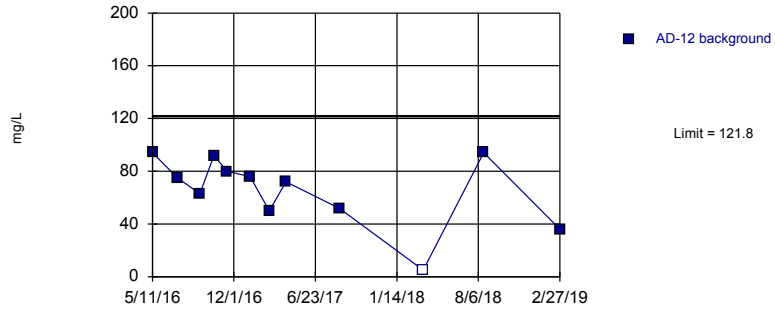
Prediction Limit
Intrawell Parametric, AD-7



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

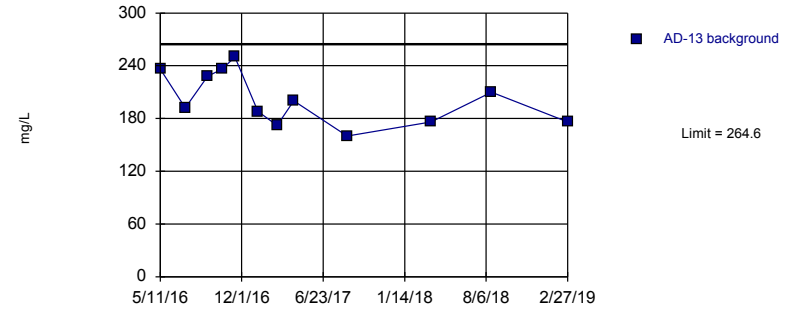
Prediction Limit
Intrawell Parametric, AD-12 (bg)



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

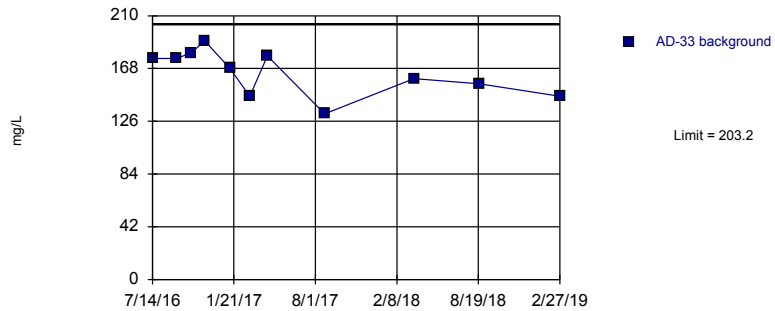
Prediction Limit
Intrawell Parametric, AD-13 (bg)



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

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.

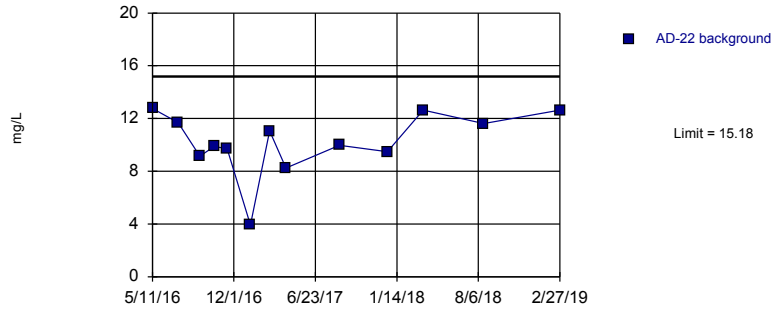
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Deseasonalized Intrawell Prediction Limit Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 8:06 AM

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Date</u>	<u>Observ.</u>	<u>Sig.</u>	<u>Bg</u>	<u>NBq</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
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	

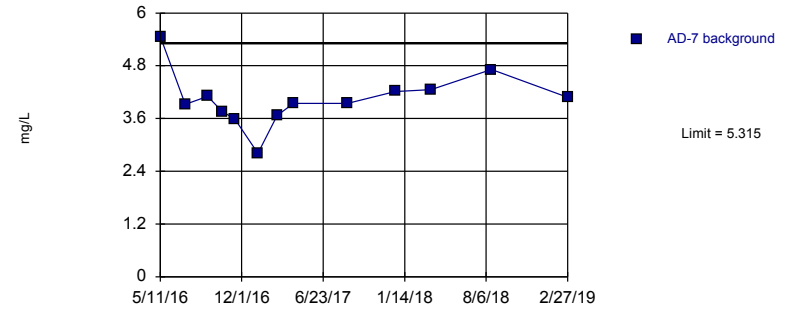
Prediction Limit
Intrawell Parametric, AD-22



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

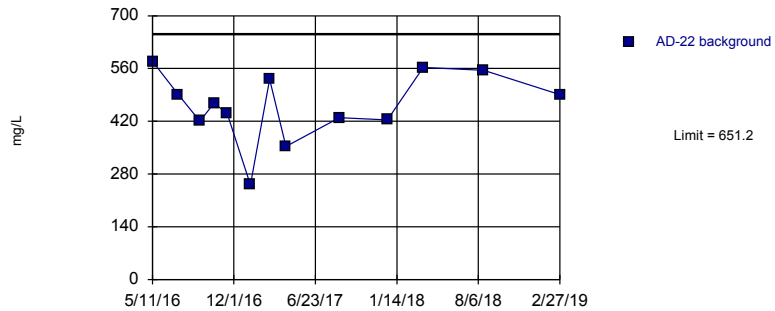
Prediction Limit
Intrawell Parametric, AD-7



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

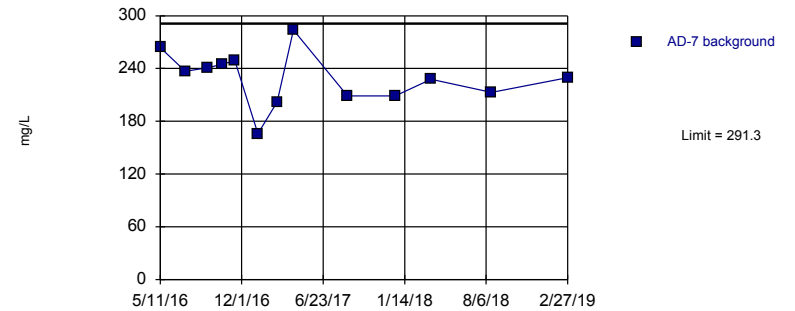
Prediction Limit
Intrawell Parametric, AD-22



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

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.

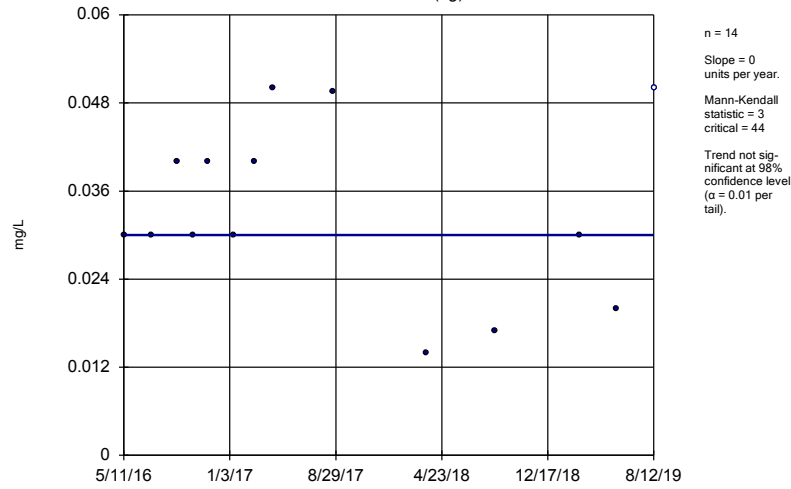
Constituent: Total Dissolved Solids [TDS], Alt. Values Analysis Run 12/9/2019 8:06 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Trend Tests Summary Table - Upgradient Wells

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/6/2019, 11:26 AM

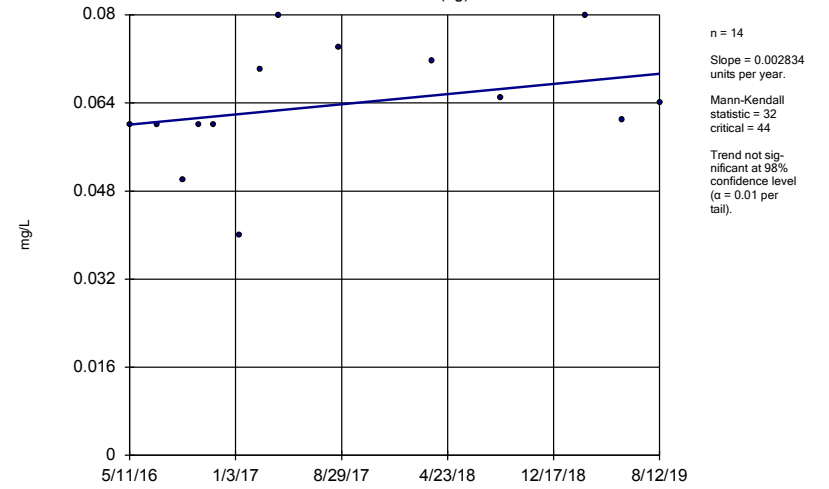
Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-12 (bg)	0	3	44	No	14	7.143	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-13 (bg)	0.002834	32	44	No	14	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-12 (bg)	0.1051	23	44	No	14	0	n/a	n/a	0.02	NP
Chloride, total (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

Sen's Slope Estimator AD-12 (bg)



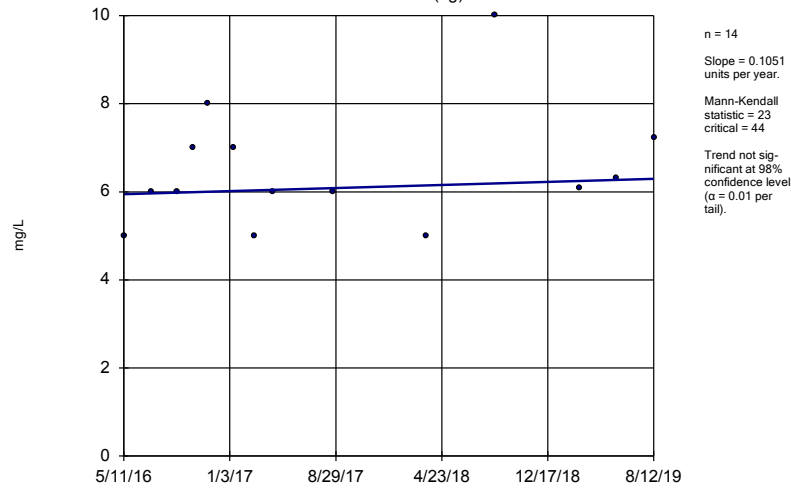
Constituent: Boron, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator AD-13 (bg)



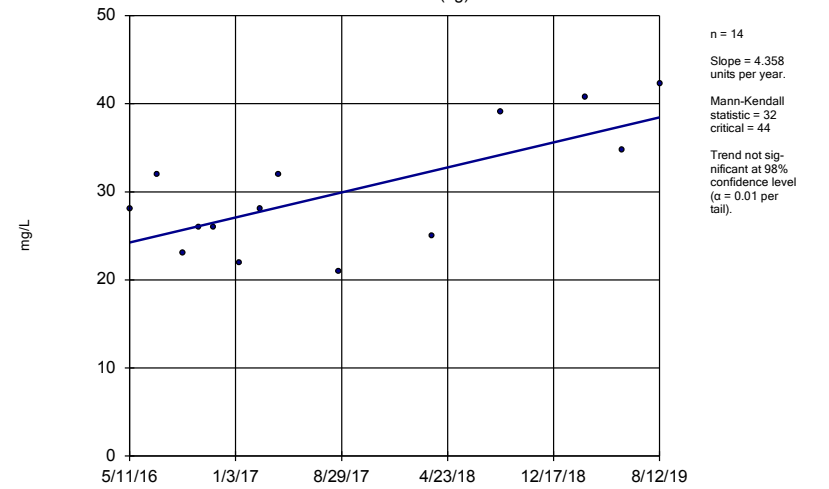
Constituent: Boron, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator AD-12 (bg)



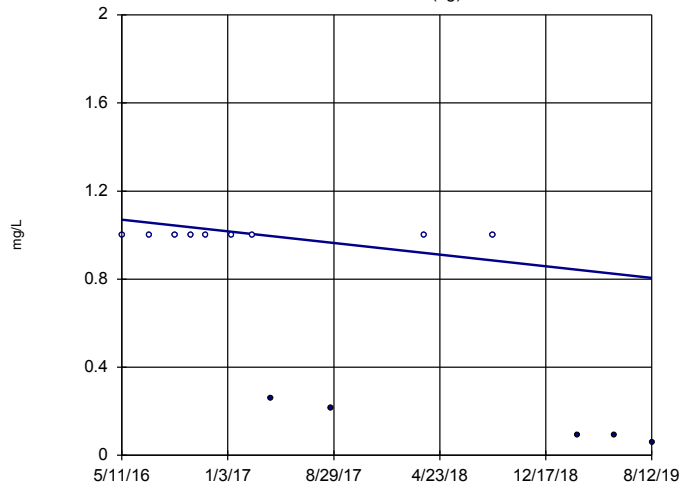
Constituent: Chloride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator AD-13 (bg)



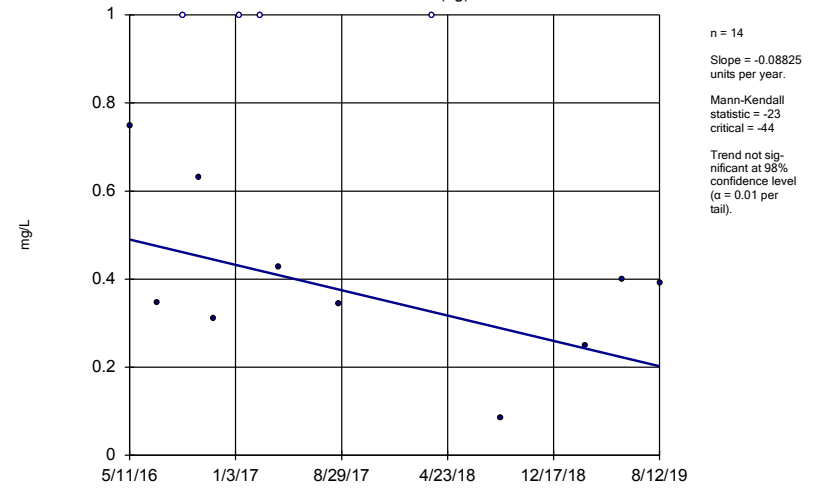
Constituent: Chloride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator AD-12 (bg)



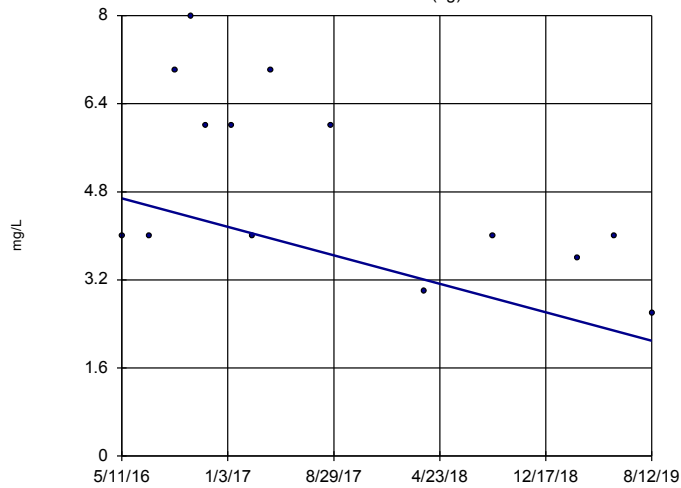
Constituent: Fluoride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator AD-13 (bg)



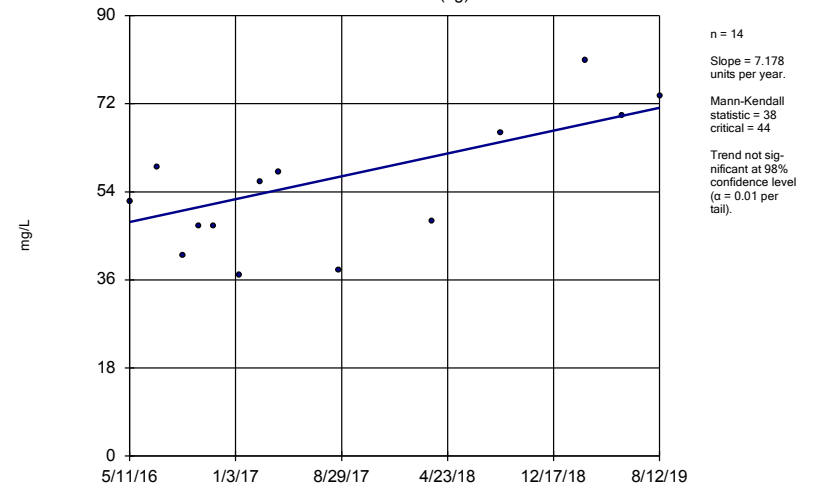
Constituent: Fluoride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator AD-12 (bg)



Constituent: Sulfate, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator AD-13 (bg)



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	NBq	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

<u>Constituent</u>	<u>Upper Lim.</u>	<u>Bg N</u>	<u>Bg Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
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)

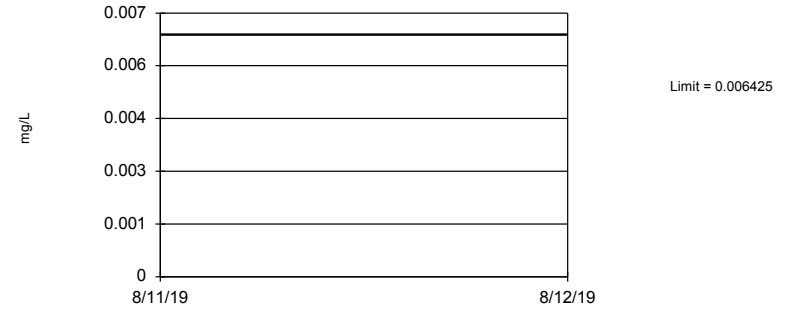
Tolerance Limit
Interwell Non-parametric



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

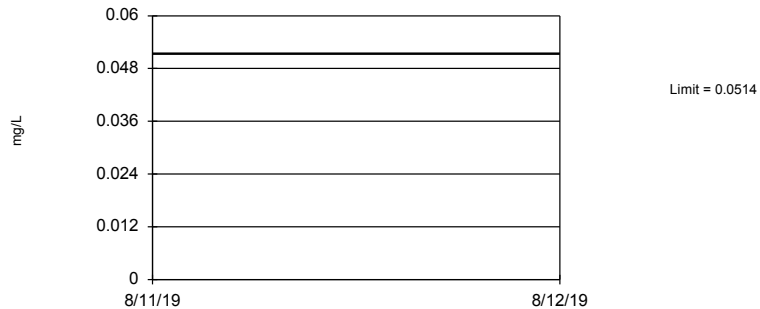
Tolerance Limit
Interwell Parametric



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

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

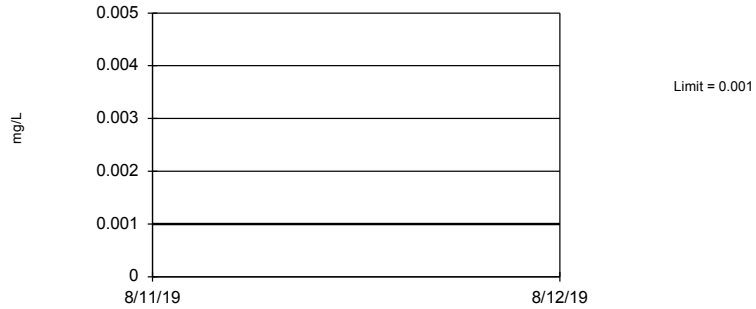
Tolerance Limit
Interwell Non-parametric



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

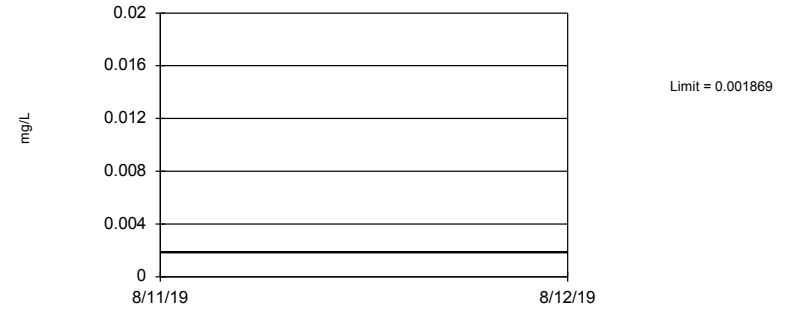
Tolerance Limit
Interwell Non-parametric



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

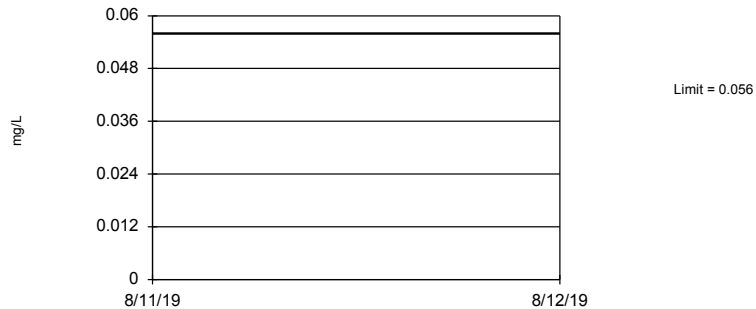
Tolerance Limit
Interwell Parametric



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

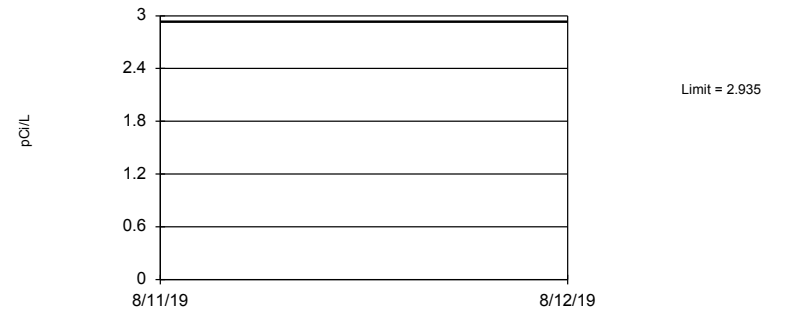
Tolerance Limit
Interwell Non-parametric



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

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

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

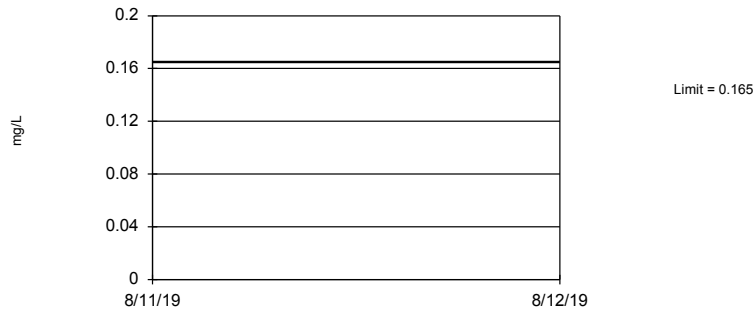
Tolerance Limit
Interwell Non-parametric



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

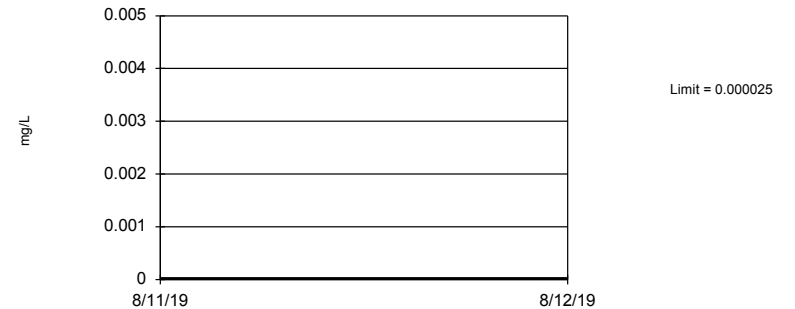
Tolerance Limit
Interwell Non-parametric



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

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

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

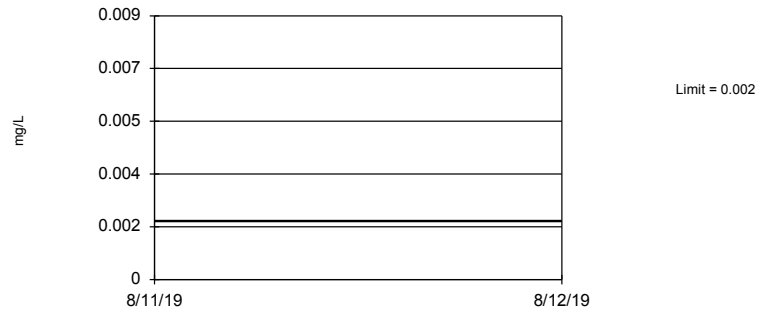
Tolerance Limit Interwell Non-parametric



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

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*

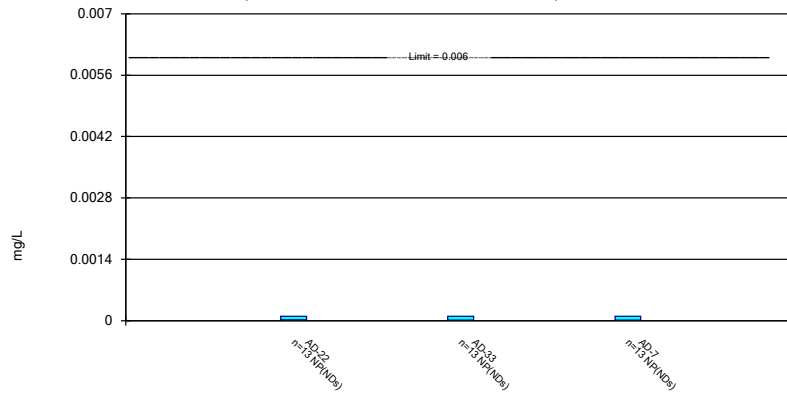
Confidence Intervals - All Results (No Significant Results)

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.	TransformAlpha	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)

Non-Parametric Confidence Interval

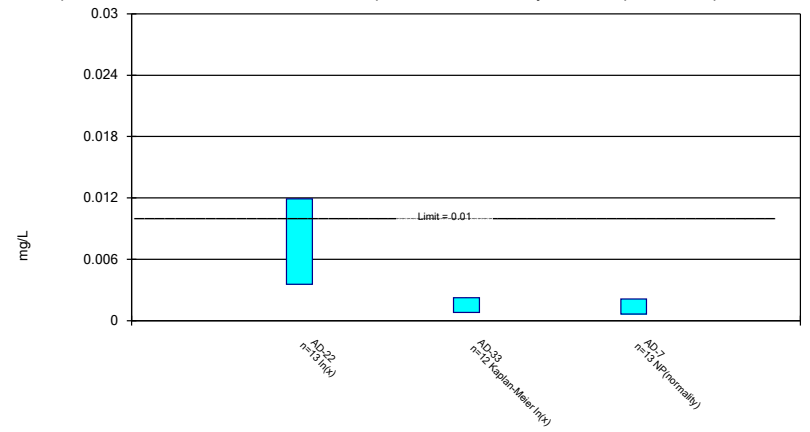
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Antimony, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

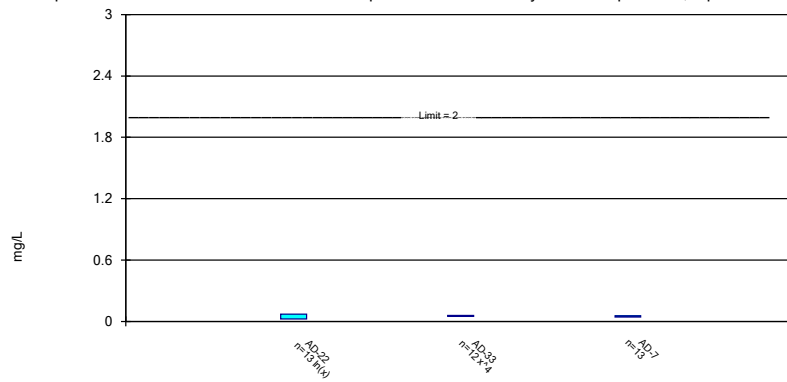
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Arsenic, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

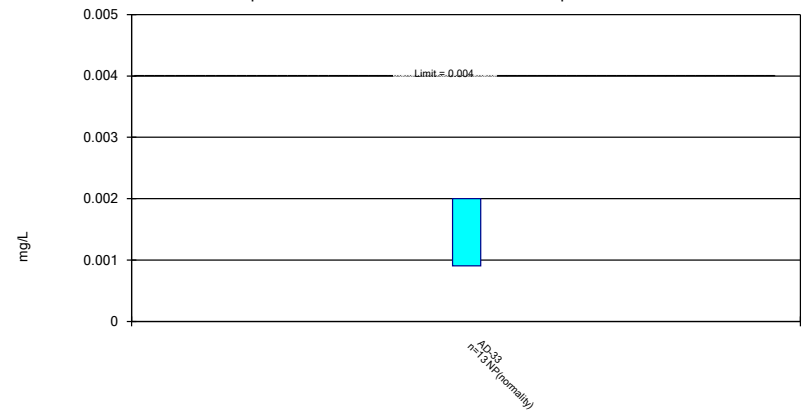
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Barium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

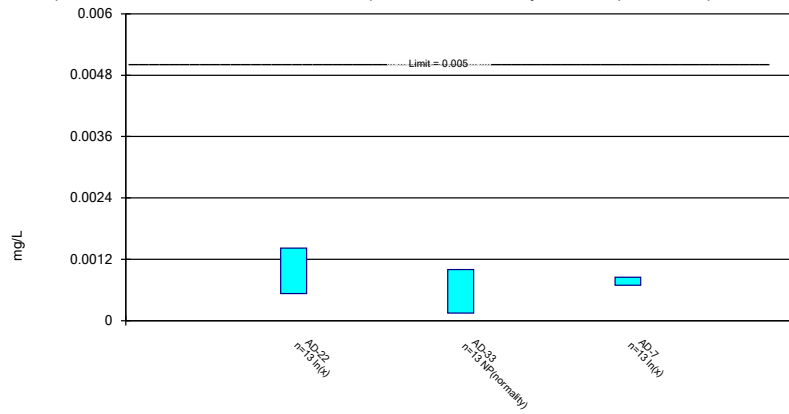
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Beryllium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

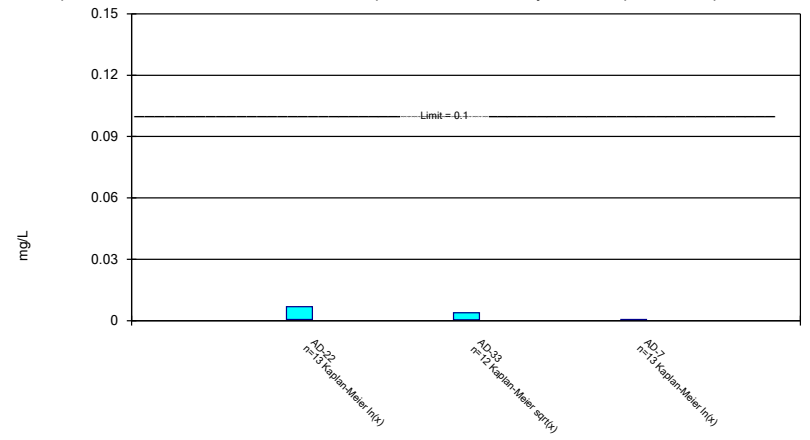
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cadmium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

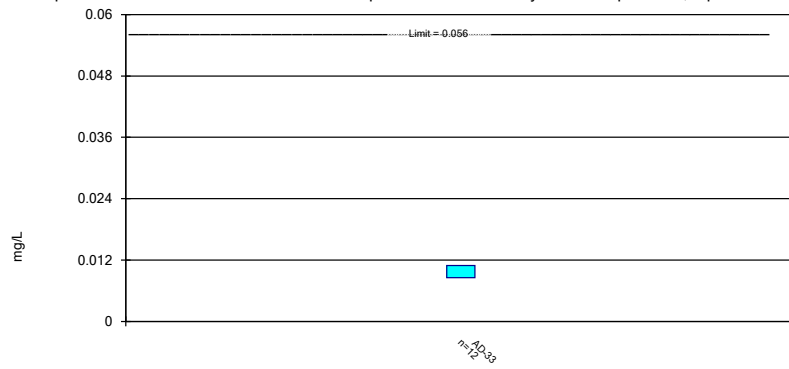
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chromium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

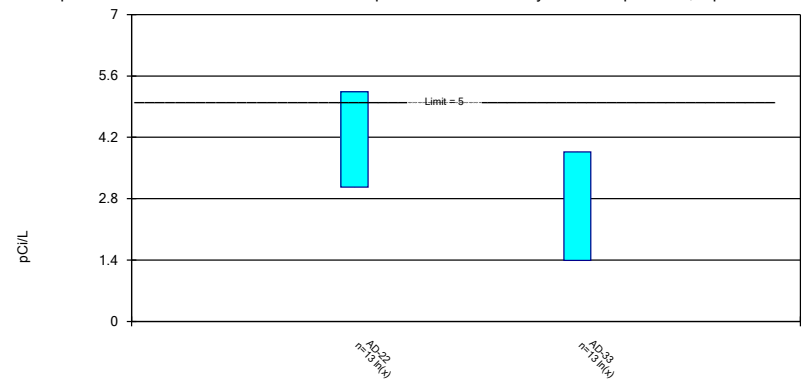
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cobalt, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

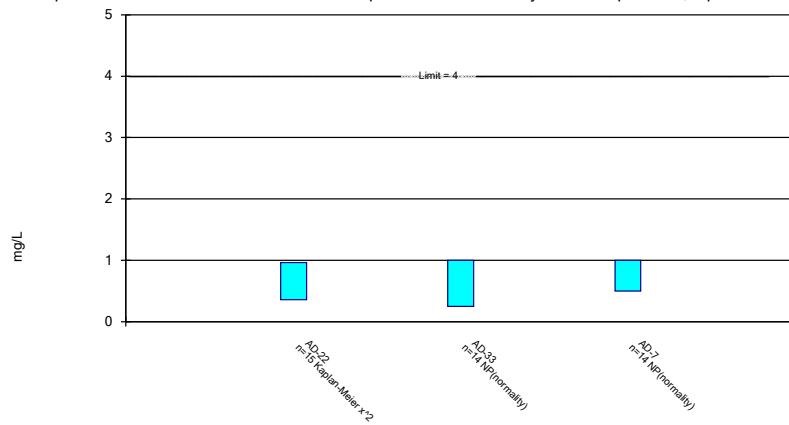
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

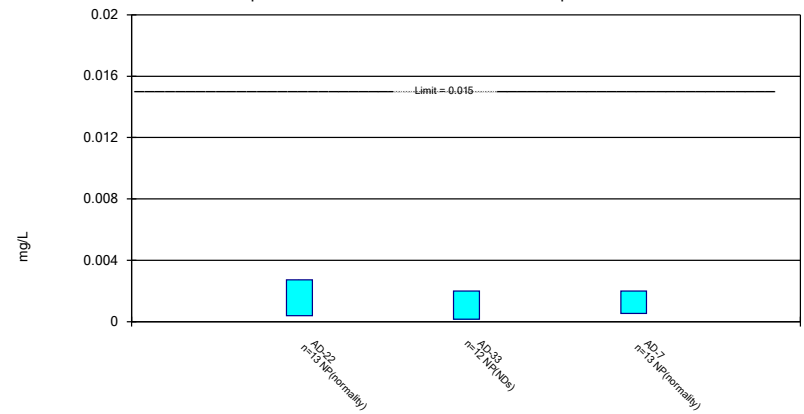
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Fluoride, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

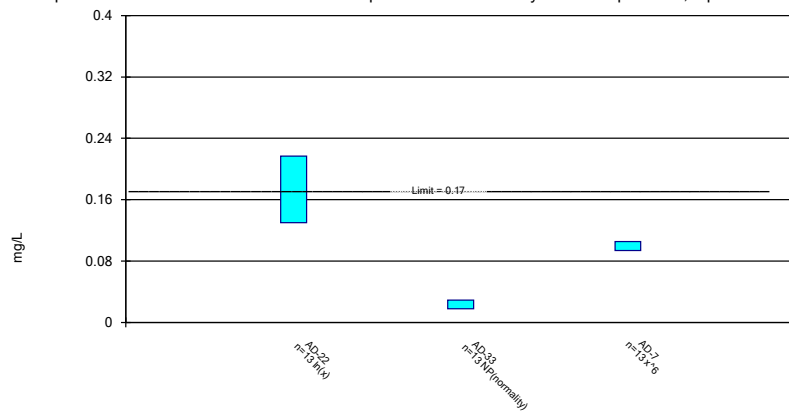
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Lead, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

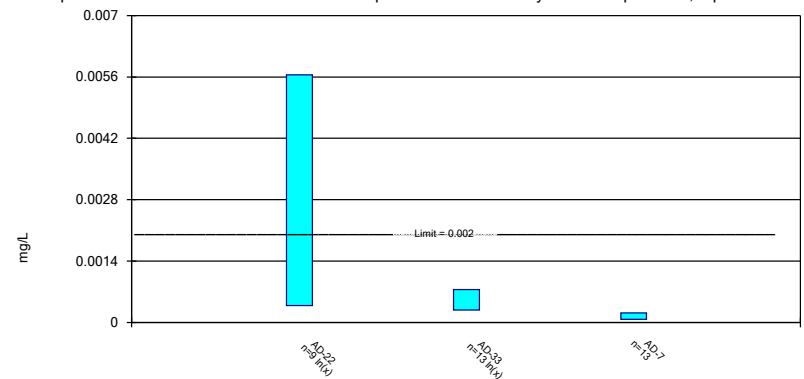
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Lithium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

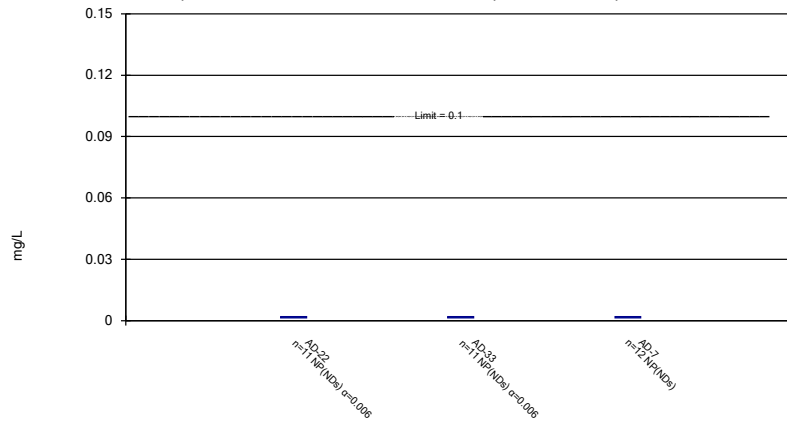
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Mercury, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

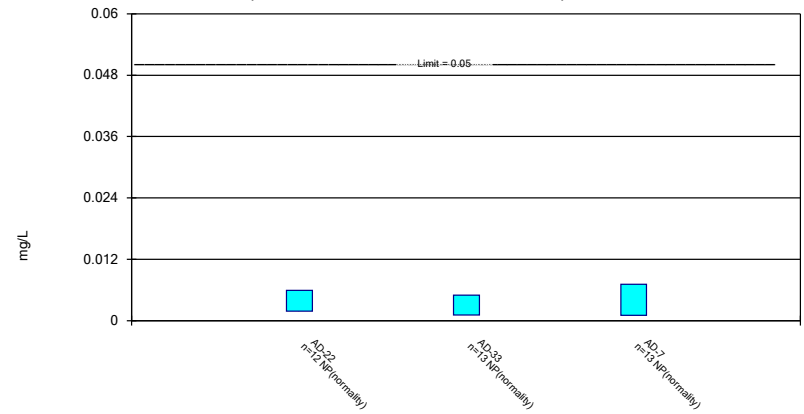
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted.



Constituent: Molybdenum, total Analysis Run 12/9/2019 4:00 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

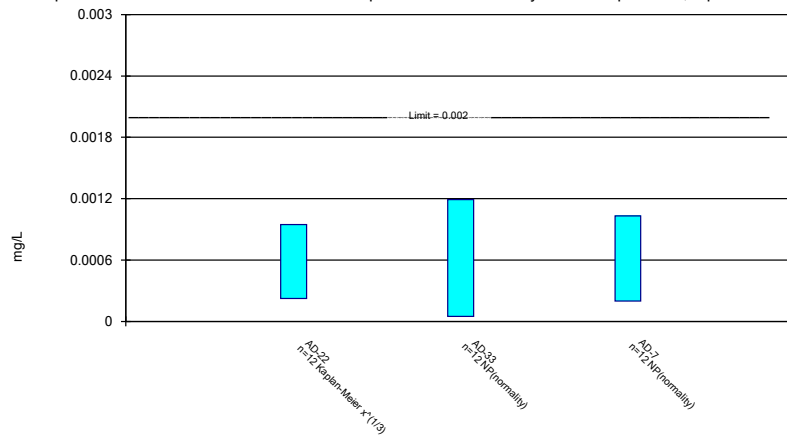
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Selenium, total Analysis Run 12/9/2019 4:00 PM View: Appendix IV
 Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Compliance</u>	<u>Sig. N</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>TransformAlpha</u>	<u>Method</u>	
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.

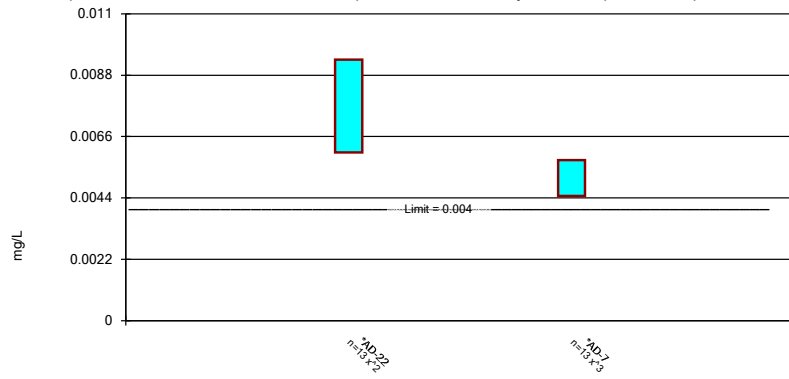
Deseasonalized Confidence Intervals - All Results

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.	TransformAlpha	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

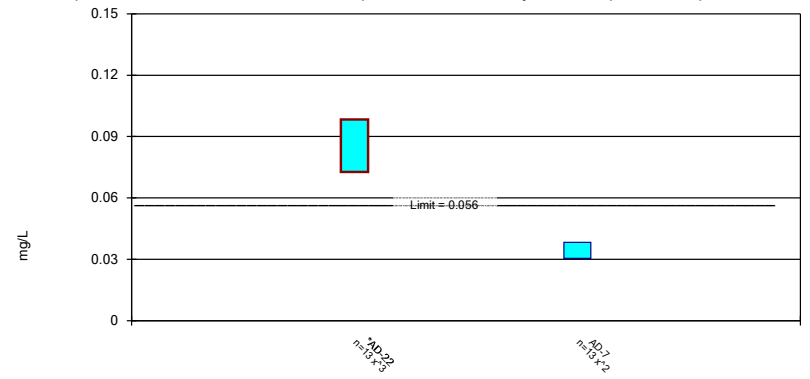
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



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

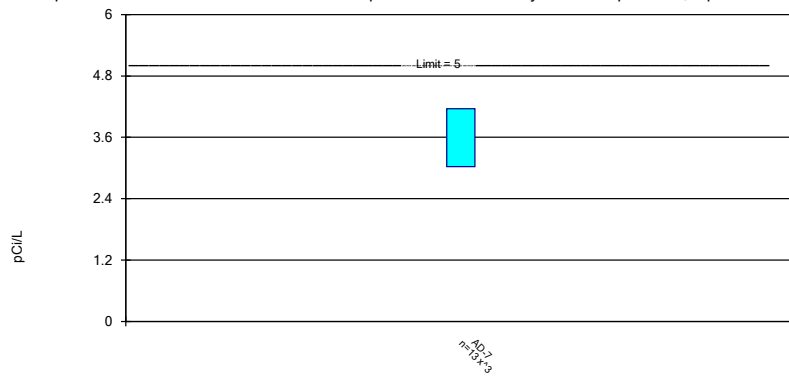
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



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



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

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FIGURES

Figure 1 Mercury Time Series Graph for AD-22

ATTACHMENTS

Attachment A Statistical Analysis Results
Attachment B Certification by a Qualified Professional Engineer

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 $\mu\text{g/L}$ ($\alpha = 0.008$), which is below the GWPS for mercury of 2 $\mu\text{g/L}$. 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

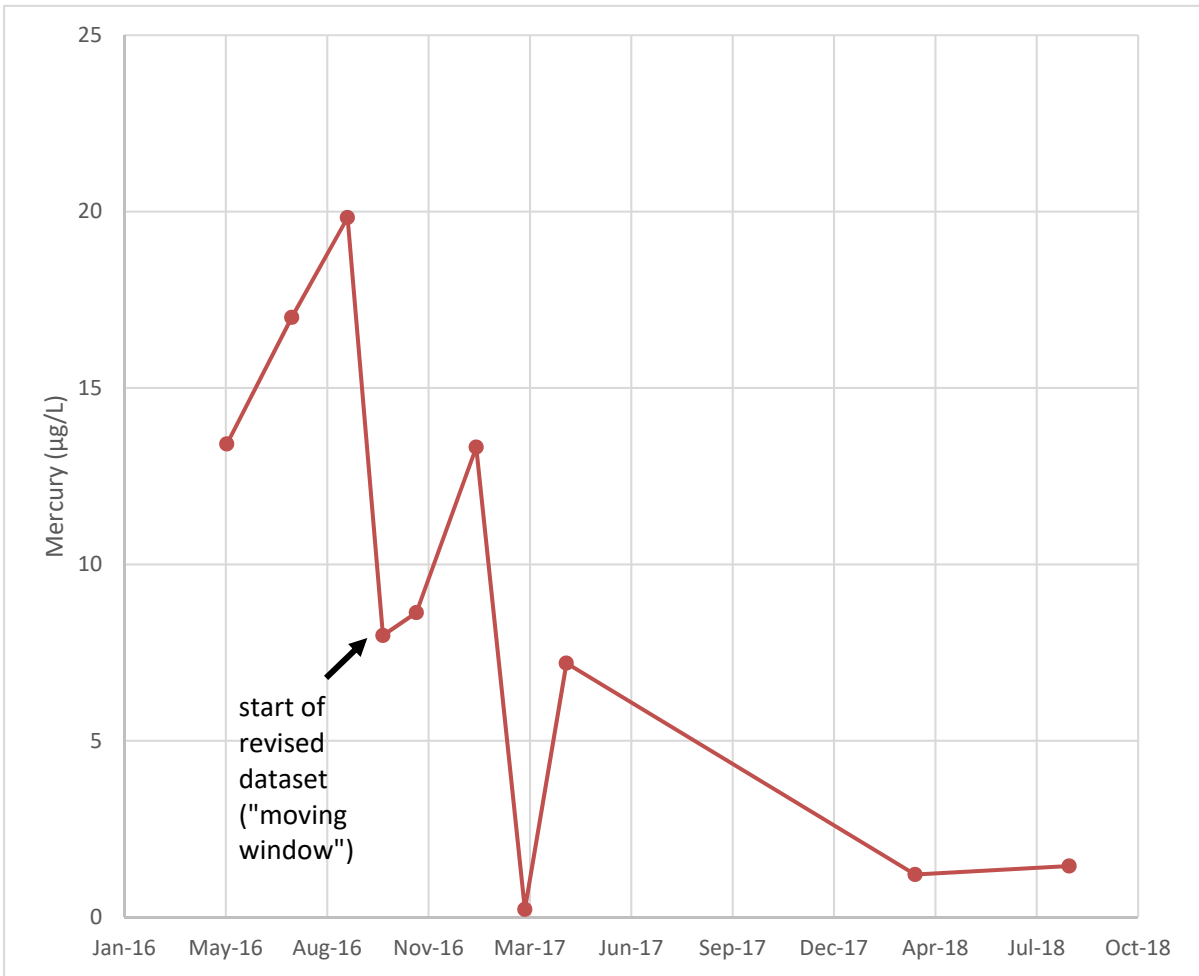
REFERENCES

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



Figure

1

Columbus, Ohio

14-Feb-2019

ATTACHMENT A
Statistical Analysis Output

Trend Test Summary Table

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 2/5/2019, 8:16 AM

<u>Constituent</u>	<u>Well</u>	<u>Slope</u>	<u>Calc.</u>	<u>Critical</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Normality</u>	<u>Xform</u>	<u>Alpha</u>	<u>Method</u>
Mercury, total (mg/L)	AD-22	-0.00738	-25	-27	No	10	0	n/a	n/a	0.02	NP

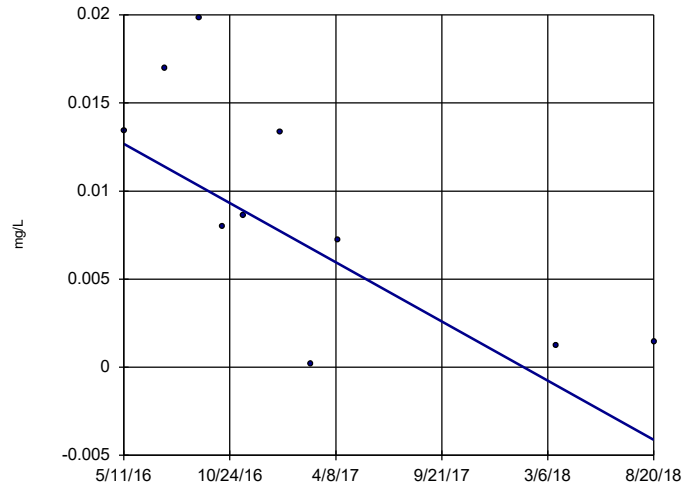
Confidence Interval Summary Table

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 2/5/2019, 8:16 AM

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Compliance</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
Mercury, total (mg/L)	AD-22	0.01332	0.00022	0.002	No	7	0	No	0.008	NP (selected)

Sen's Slope Estimator

AD-22

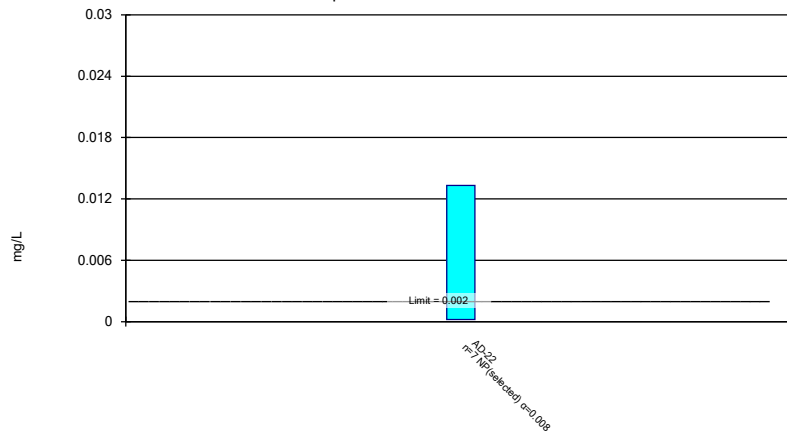


n = 10
Slope = -0.00738
units per year.
Mann-Kendall
statistic = -25
critical = -27
Trend not sig-
nificant at 98%
confidence level
($\alpha = 0.01$ per
tail).

Constituent: Mercury, total Analysis Run 2/5/2019 12:58 PM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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



Geosyntec Consultants
8217 Shoal Creek Blvd, Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No F-1182

79864
License Number

Texas
Licensing State

February 18, 2019
Date

**ALTERNATIVE SOURCE
DEMONSTRATION REPORT
FEDERAL CCR RULE**

**H.W. Pirkey Power Plant
Flue Gas Desulfurization
(FGD) Stackout Area
Hallsville, Texas**

Submitted to



1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec 
consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

October 3, 2019

CHA8462

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Figure 2	Beryllium v. Groundwater Elevation
Figure 3	AD-22 Schoeller Diagram
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ATTACHMENTS

Attachment A	Statistical Evaluation – Seasonality at AD-22
Attachment B	AD-22 Boring Log
Attachment C	SEM/EDS Analysis
Attachment D	Certification by a Qualified Professional Engineer

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

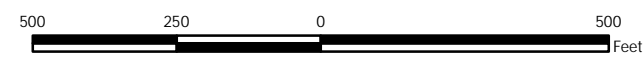


Monitoring Well Network

- Downgradient Sampling Location
- Upgradient Sampling Location
- 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.



Site Layout
FGD Stackout Area

AEP Pirkey Power Plant Hallsville, Texas

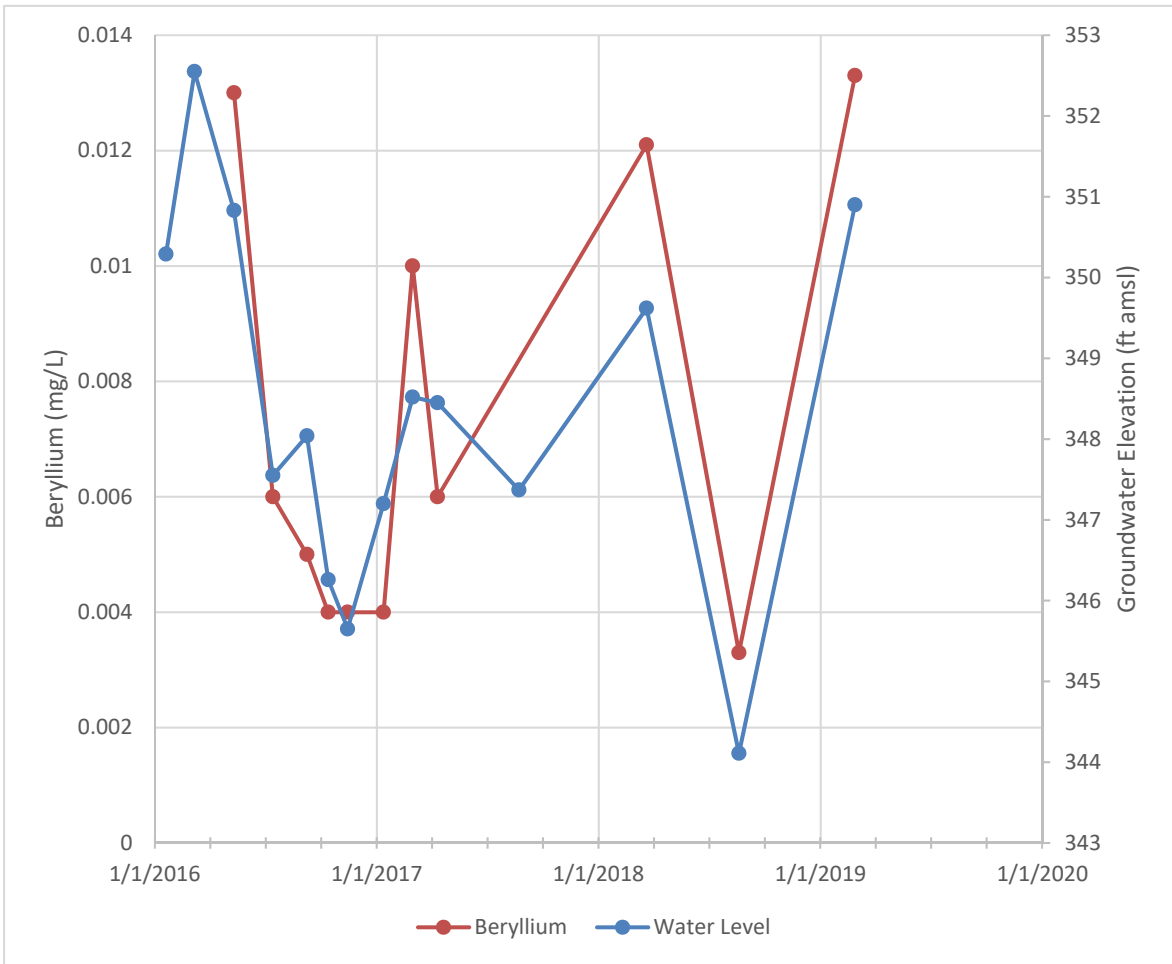
Geosyntec
consultants

Figure

1

Columbus, Ohio

2018/01/26



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

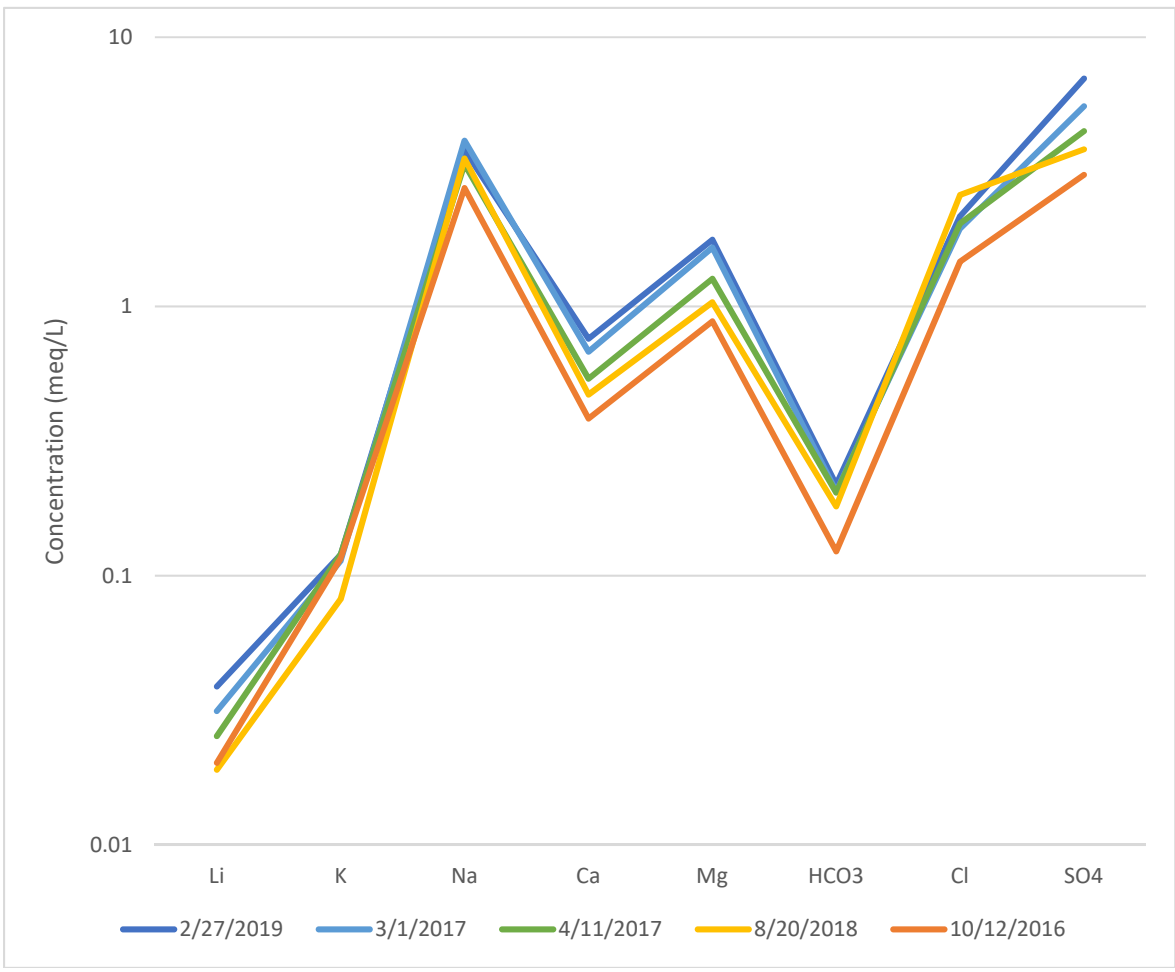


Columbus, Ohio

23-Sep-2019

Figure

2



Notes: Concentrations are shown in milliequivalents per liter (meq/L).

AD-22 Schoeller Diagram
Pirkey FGD Stackout Pad

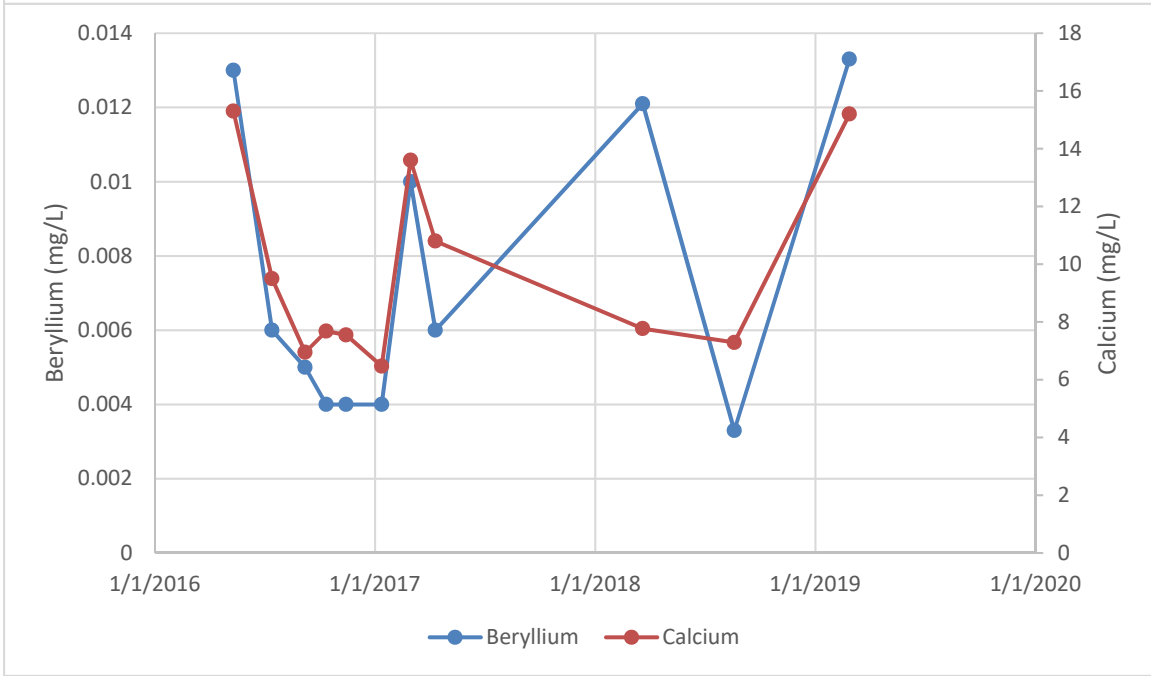
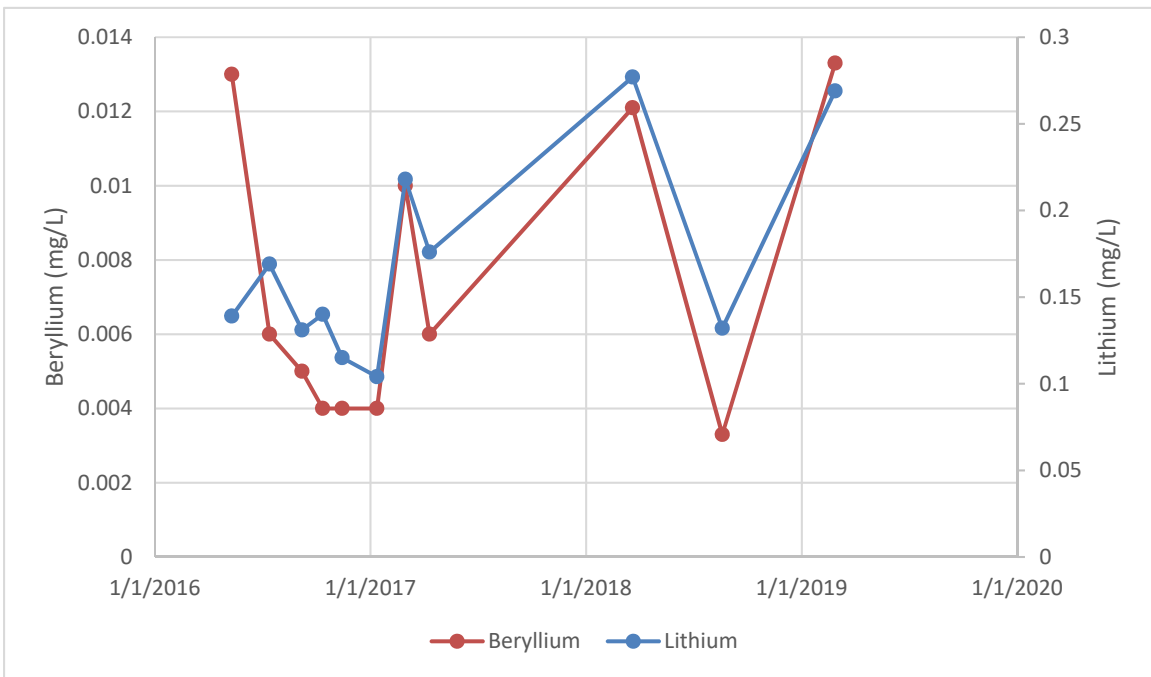


Figure

3

Columbus, Ohio

23-Sep-2019



Notes: Beryllium, lithium, and calcium concentrations are shown in milligrams per liter (mg/L).

Beryllium v. Cations
Pirkey FGD Stackout Pad



Columbus, Ohio

23-Sep-2019

Figure

4

ATTACHMENT A
Statistical Evaluation - Seasonality at AD-22

Seasonality: AD-22

For the selected data, the Kruskal-Wallis test indicates SEASONALITY at 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.

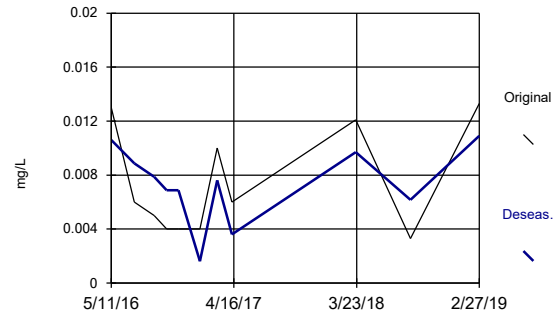
Calculated Kruskal-Wallis statistic = 4.511

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


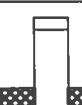



Constituent: Beryllium, total Analysis Run 9/22/2019 7:11 AM

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
 LATITUDE: 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				0.5-12	CL	Lean clay, light brown mottled with light gray	None	Slightly Moist
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13				12-20	SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained	None	Slightly Wet
14								
15								
16								
17								
18								
19								
20								
21				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
22								
23								
24								
25								
26				25-30	SM	Sand, greenish brown (1') grading to orangish brown, silty, very fine grained	None	Wet
27								
28								
29								
30								
31								
32								
33								
34								
35								
36								
37								
38								
39								
40								

 Cement  Bentonite  Filter Sand  Water Level



Total Depth: 30 feet Riser Interval: +3 (ags)-10'
 Filter Sand (Size/Interval): 8-30' Screen Interval: 10-30'
 Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8' Water level: 12.5'
 Surface Completion Flush Above Ground 3'

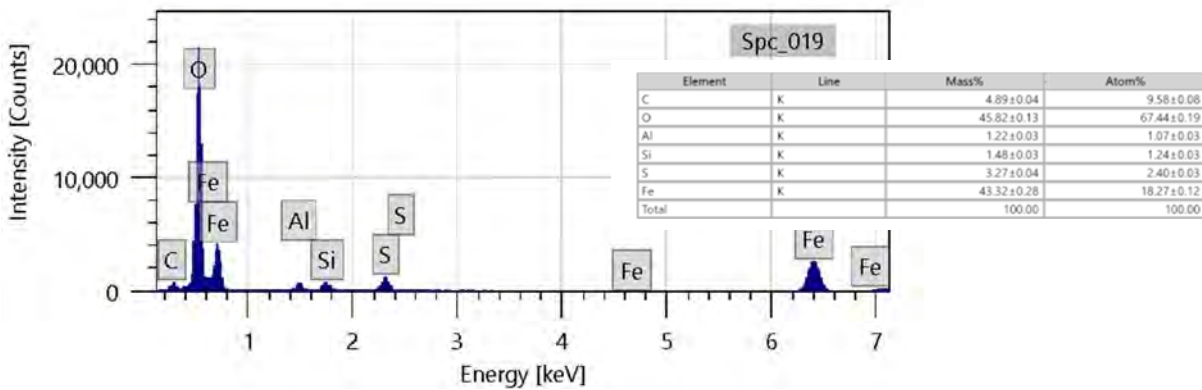
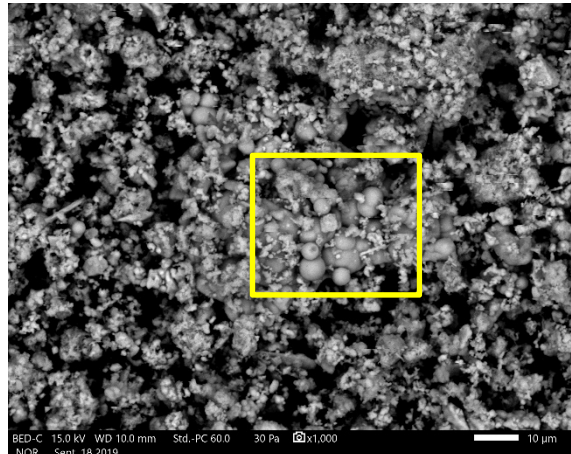
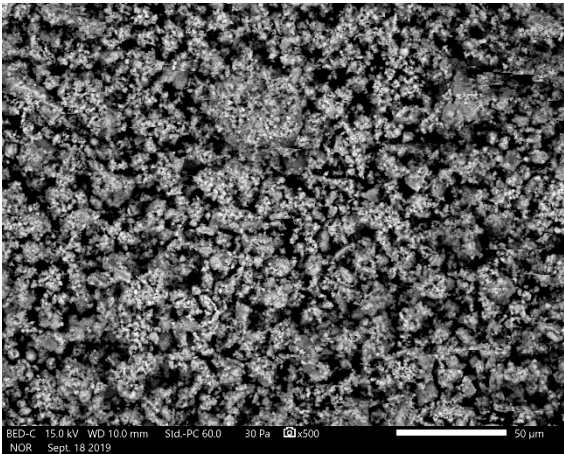
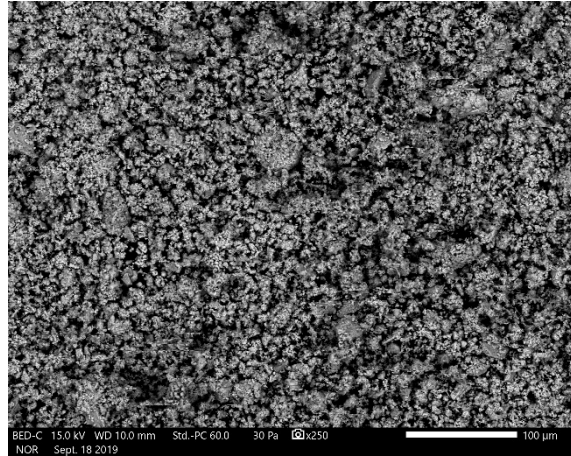
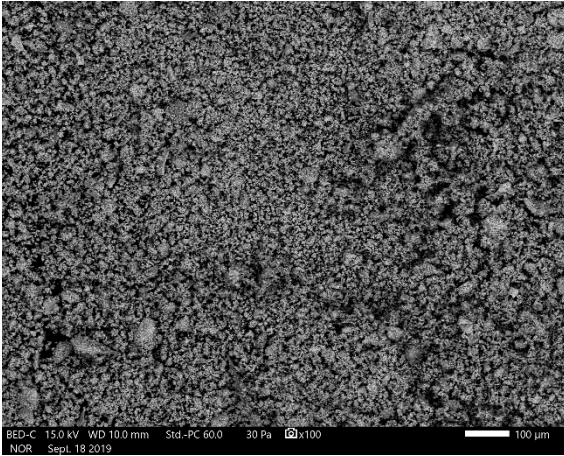
Note: This log is not to be used separate from this report.
 Boring Logs_110-089, AD-22

ATTACHMENT C
SEM/EDS Analysis

September 22, 2019

Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221

via Email: BSass@geosyntec.com



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



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	Latitude:	32° 26' 52.08" N
	LOCATED ON OWNERS PROPERTY	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	8.25	0	60

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	31	38	Bentonite 3 Bags/Sacks

Seal Method: **Tremie**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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**

	Description (number of sacks & material)	Top Depth (ft.)	Bottom Depth (ft.)
Plug Information:	SAND	50	60

Water Quality:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	Latitude: 32° 26' 52.08" N
LOCATED ON OWNERS PROPERTY	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
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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	Latitude:	32° 27' 56.32" N
	LOCATED ON OWNERS PROPERTY	Longitude:	094° 29' 41.78" 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**

	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	Latitude:	32° 27' 46.12" N
	LOCATED ON OWNERS PROPERTY	Longitude:	094° 29' 43.34" W
Well County:	Harrison	Elevation:	No Data
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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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 #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	Latitude: 32° 26' 52.05" N
LOCATED ON OWNERS PROPERTY	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**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	8.25	0	12

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
Annular Seal Data:	1	5	Bentonite 3 Bags/Sacks

Seal Method: **Tremie**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	1	CLAY
1	5	CLAY/SAND
5	9.5	CLAY
9.5	12	SAND/CLAY

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 29' 00.5" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	40

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	27	40	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 29' 00.5" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **3/9/2019** Drilling End Date: **3/10/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	100

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	86	100	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
2	Riser	New Plastic (PVC)	40	0	90
2	Screen	New Plastic (PVC)	40 0.010	90	100

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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
Well County: Harrison	Longitude: 094° 29' 50" W
	Elevation: No Data
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:	6.75	0	22

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	8	22	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	7	tan and brown sandy, silty clay
7	22	red and grey sand w/occ. lignite layers

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 29' 50" W
	Elevation: No Data
Type of Work: New Well	
Proposed Use: Monitor	

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	80

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	56	80	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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 #508712

Owner: **AEP Pirkey Power Plant** Owner Well #: **SB-5 shallow (MW)**
Address: **2400 FM 3251** Grid #: **35-37-1**
Hallsville, TX 75650
Well Location: **2400 FM 3251** Latitude: **32° 27' 48" N**
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**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	6.75	0	25

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Filter Material</i>	<i>Size</i>
Filter Pack Intervals:	12	25	Sand	16/30

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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
Well County: Harrison	Longitude: 094° 29' 53" W
	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:	6.75	0	70

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	45	70	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	Latitude:	32° 27' 30.34" N
	LOCAATED ON OWNERS PROPERTY	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**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	10	CLAYS
10	18	SANDS AND CLAYS

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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 #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	Latitude:	32° 27' 30.28" N
	LOCATED ON OWNERS PROPERTY	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**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	8.25	0	65

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	45

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	32	45	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	45	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 08" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	70

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	57	70	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	70	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County:	Harrison	Longitude:	094° 30' 12" W
		Elevation:	No Data
Type of Work: New Well		Proposed Use: Monitor	

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	35

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	23	35	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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
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Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	35	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	65

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	52	65	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	65	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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 #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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	93

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	77	93	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	90	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)
90	93	gray clay (old pit base?)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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

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
Well County: Harrison	Longitude: 094° 30' 11" W
	Elevation: No Data
Type of Work: New Well	
Proposed Use: Monitor	

Drilling Start Date: **3/5/2019**

Drilling End Date: **3/5/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	30

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	17	30	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	0	12	Cement
	12	17	Bentonite 1 Bags/Sacks

Seal Method: **Gravity**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	30	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 11" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **3/4/2019**

Drilling End Date: **3/4/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	60

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	48	60	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	0	12	Cement
	12	48	Bentonite 10 Bags/Sacks

Seal Method: **Gravity**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	60	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	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**

	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	18	tan and brown sandy, silty clay and occasional gravel

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	43

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	30	43	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	0	10	Cement
	10	30	Bentonite 5 Bags/Sacks

Seal Method: **Gravity**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	18	tan and brown sandy, silty clay and occasional gravel
18	43	red and grey sand w/occ. clay layers

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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



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.

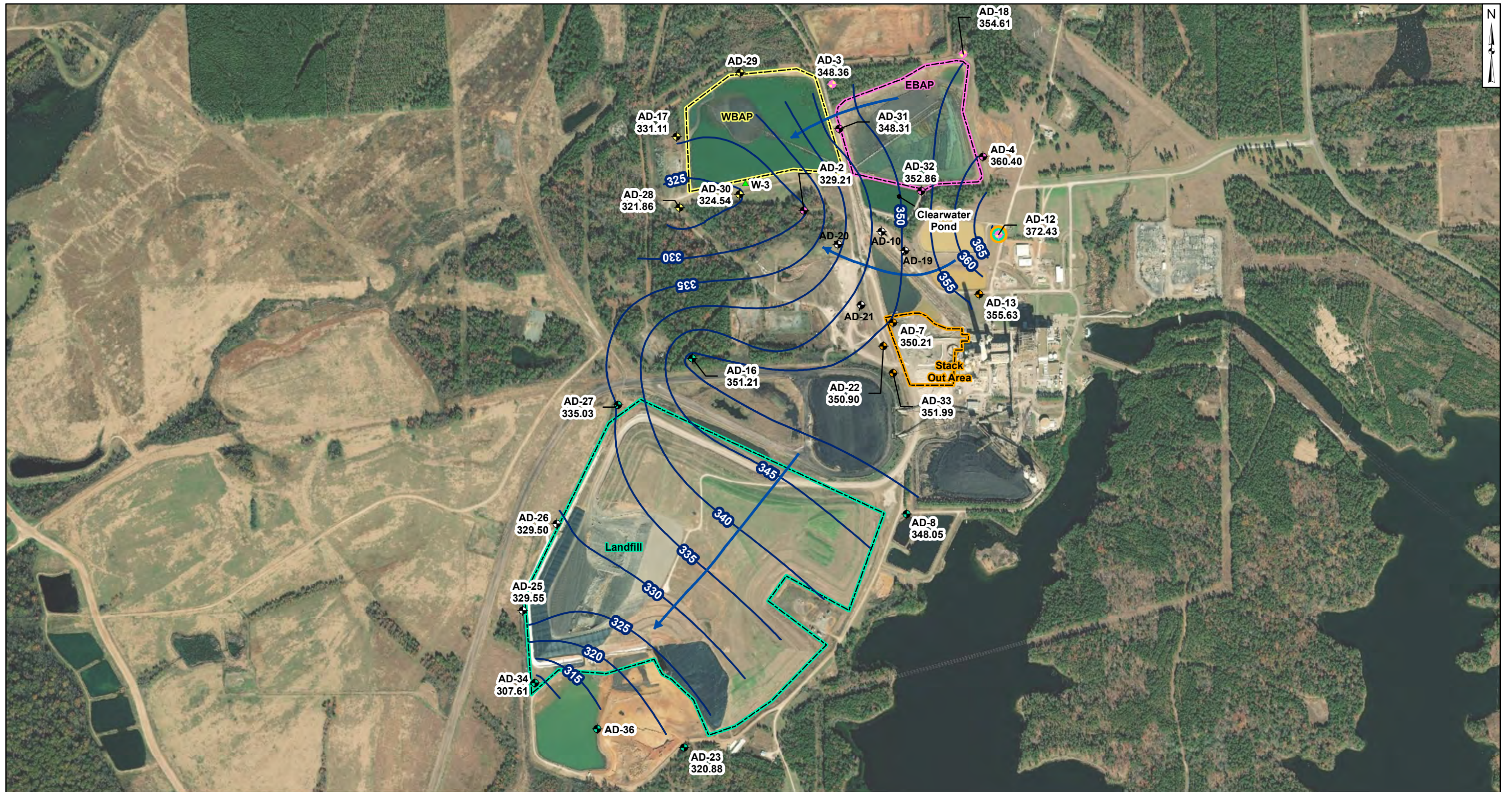
X. A Projection of Key Activities for the Upcoming Year

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

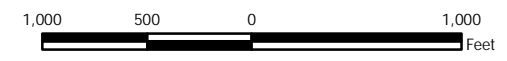
Tables follow, showing the groundwater monitoring data collected, the rate and direction of groundwater flow, and a summary showing the number of samples collected per monitoring well. The dates that the samples were collected also is shown.



- 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.



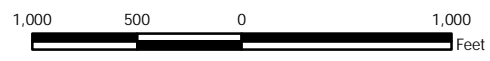
Potentiometric Contours - Uppermost Aquifer February 2019	
AEP Pirkey Power Plant Hallsville, Texas	
Columbus, Ohio	2020/01/16
Figure 1	



- 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

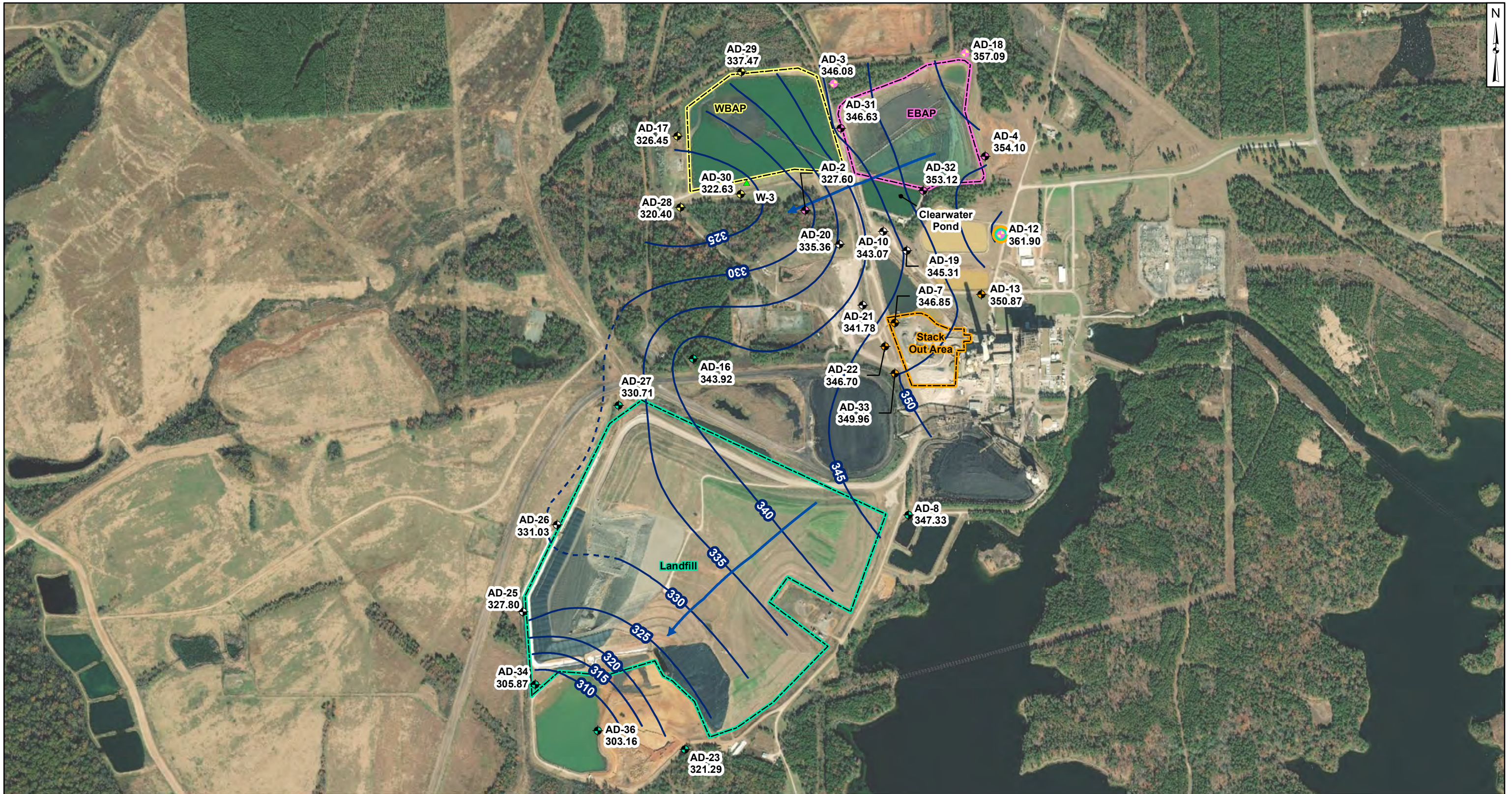
Geosyntec
consultants

Figure

2

Columbus, Ohio

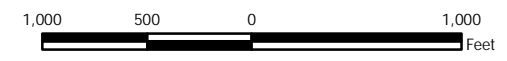
2020/01/16



- 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.



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 Landfill**

Geosyntec Consultants, Inc.

CCR Management Unit	Monitoring Well	Well Diameter (inches)	2019-02		2019-05		2019-08	
			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	NC	34.4

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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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

Geosyntec Consultants, Inc.

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	µg/L	pCi/L	mg/L	µg/L	mg/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

Geosyntec Consultants, Inc.

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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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	µg/L	pCi/L	mg/L	µg/L	mg/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



1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by



engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

July 11, 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
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

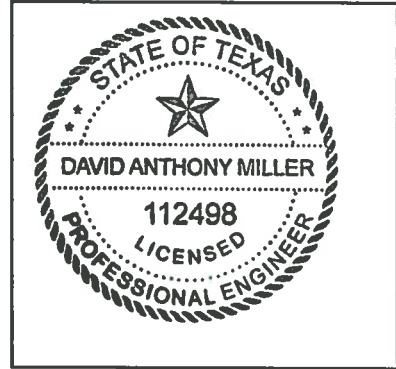
I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey Landfill CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature



112498

License Number

TEXAS

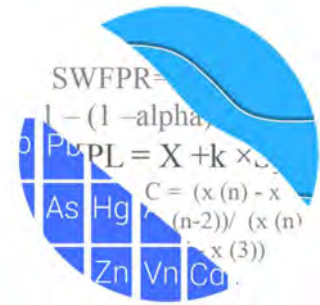
Licensing State

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.

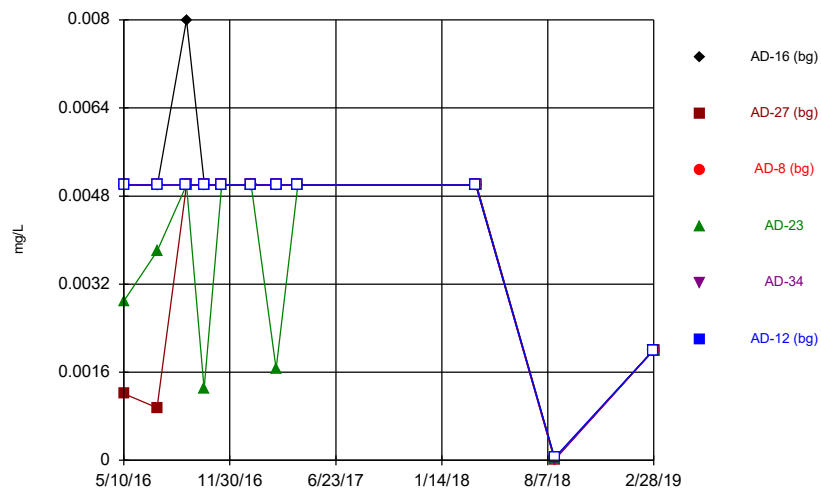
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Landfill. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

A handwritten signature in black ink that reads "Kristina Rayner". The signature is written in a cursive, flowing style.

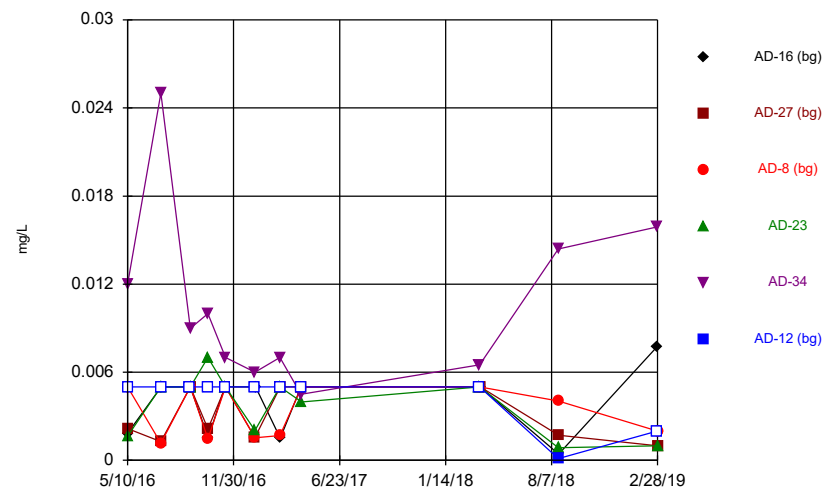
Kristina L. Rayner
Groundwater Statistician

Time Series



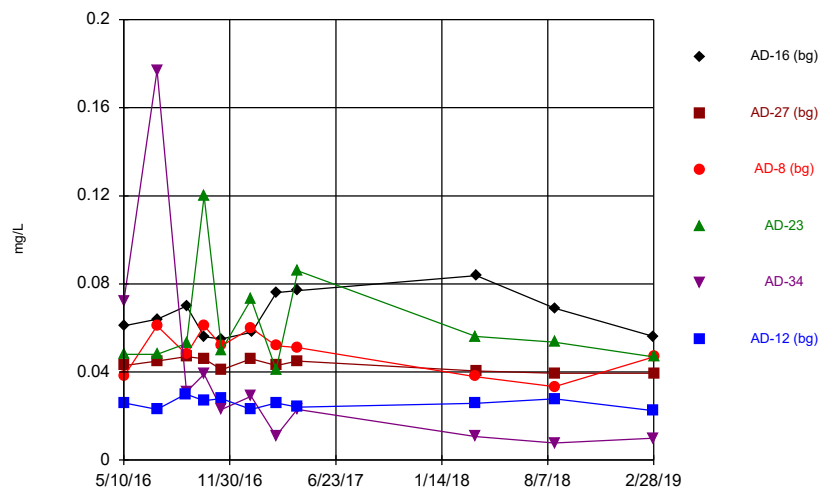
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Time Series



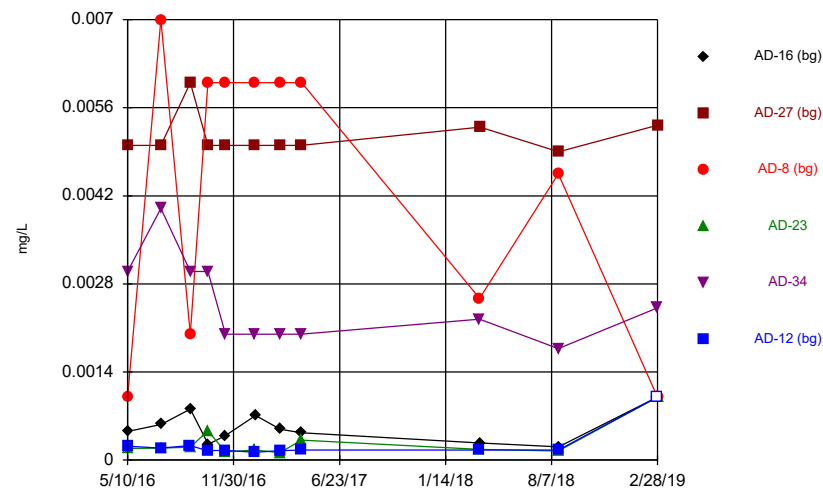
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Time Series



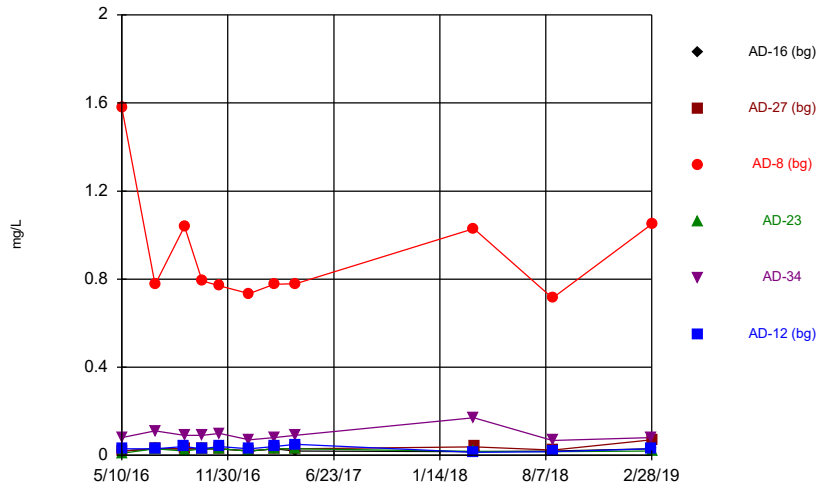
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Time Series



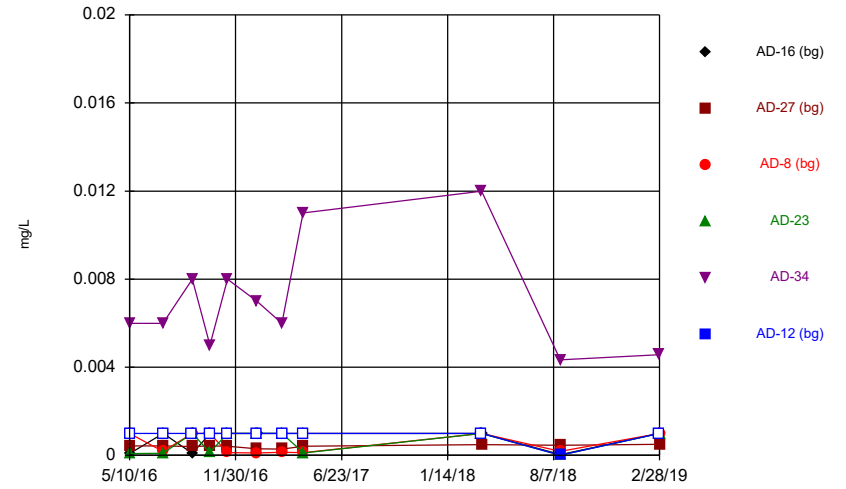
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Time Series



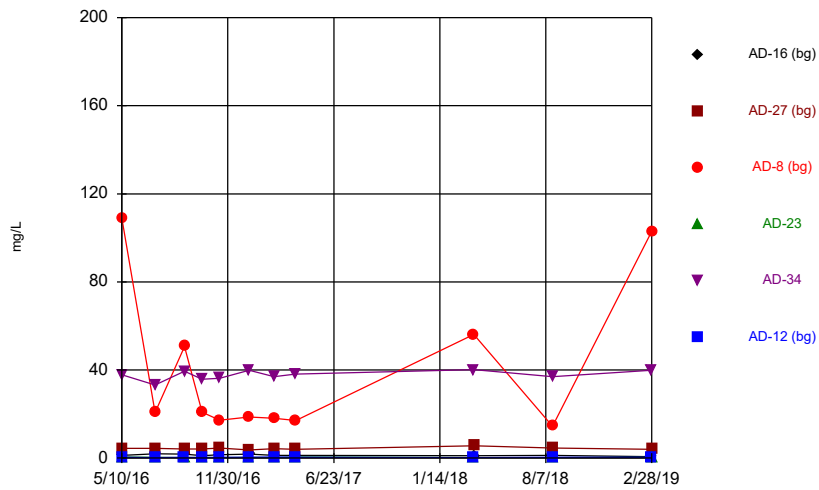
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Time Series



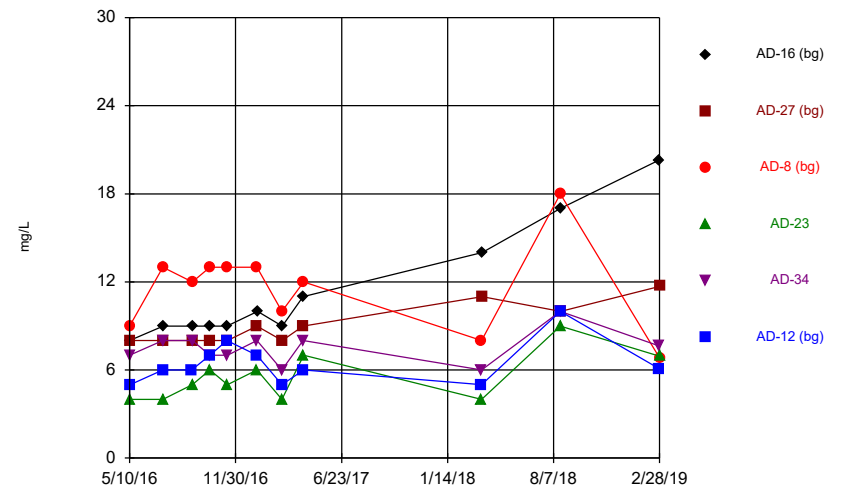
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 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



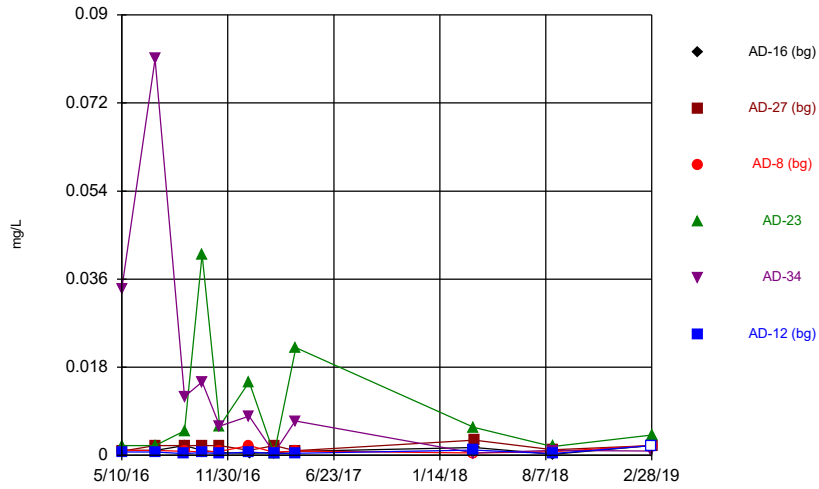
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Time Series



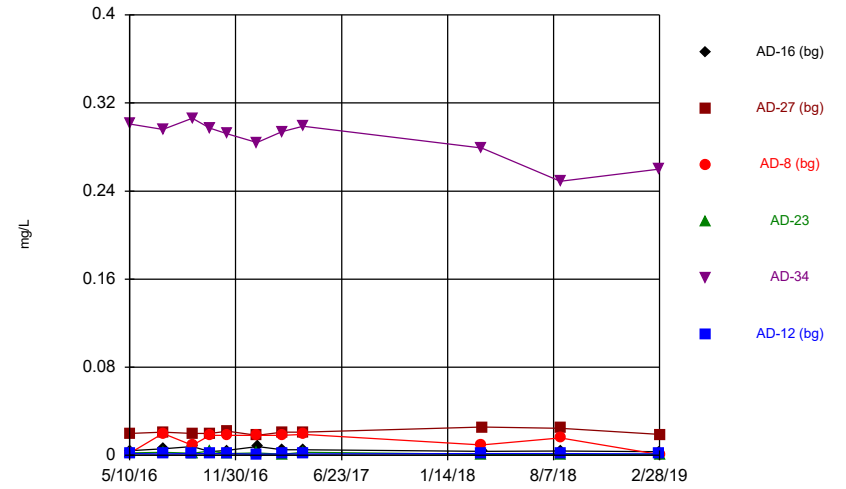
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Time Series



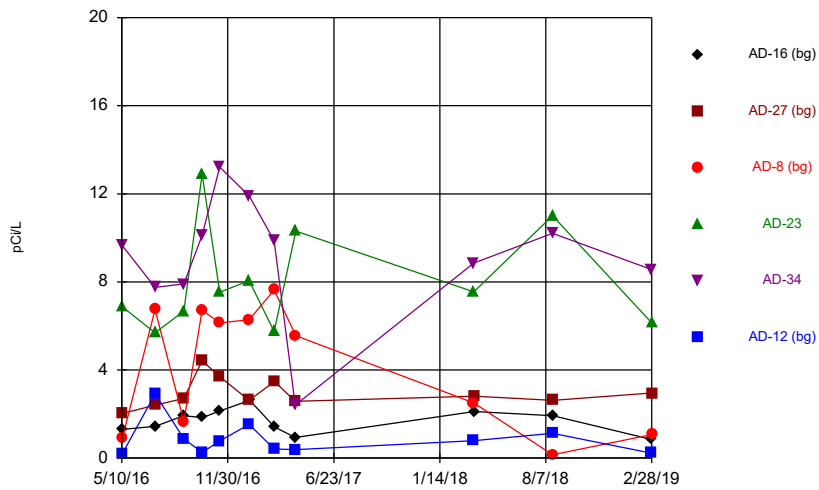
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Time Series



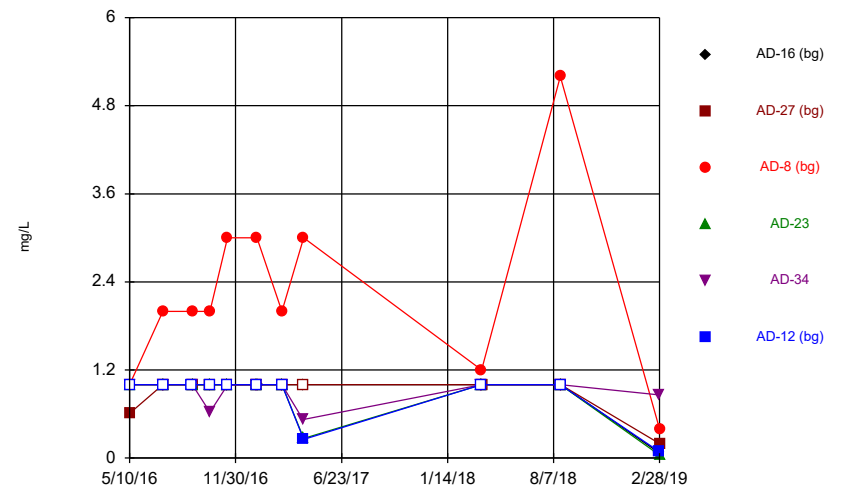
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Time Series



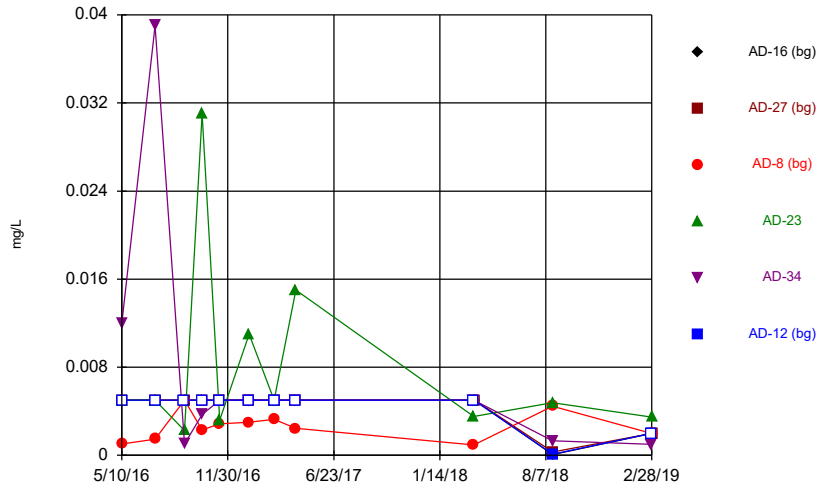
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 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



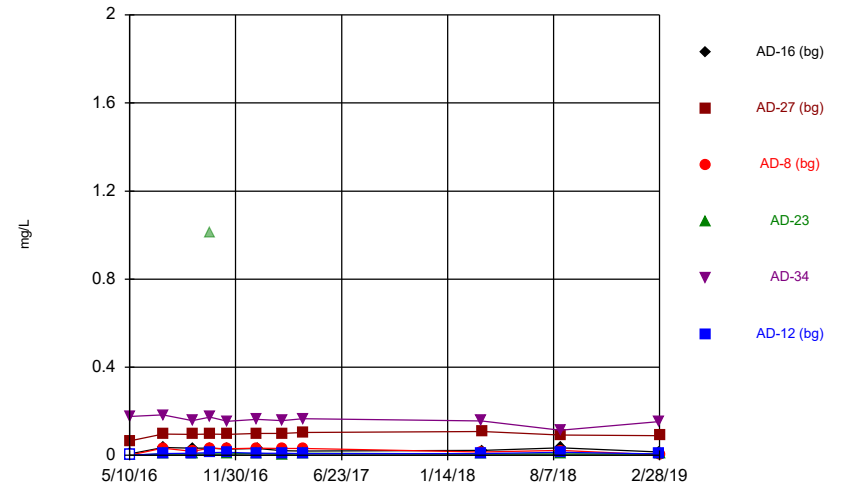
Constituent: Fluoride, total Analysis Run 7/11/2019 1:49 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



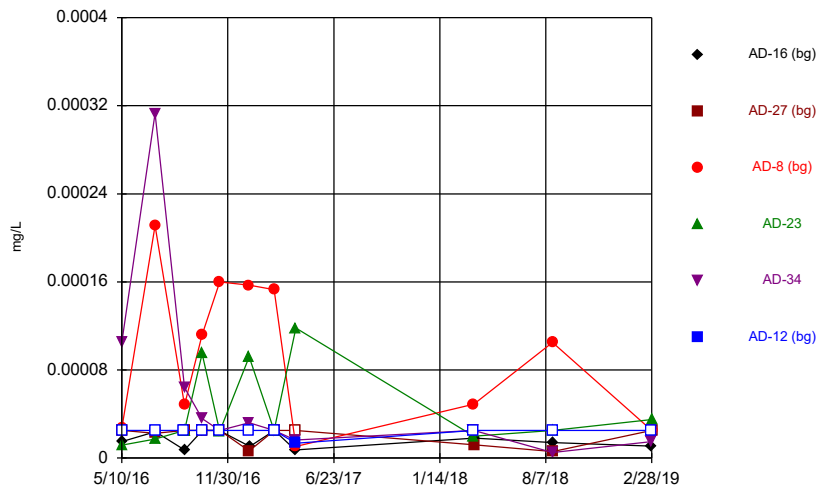
Constituent: Lead, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



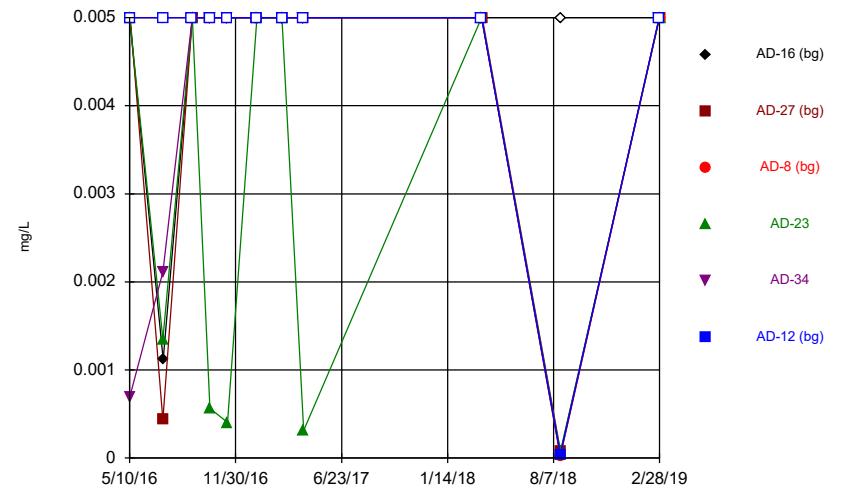
Constituent: Lithium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



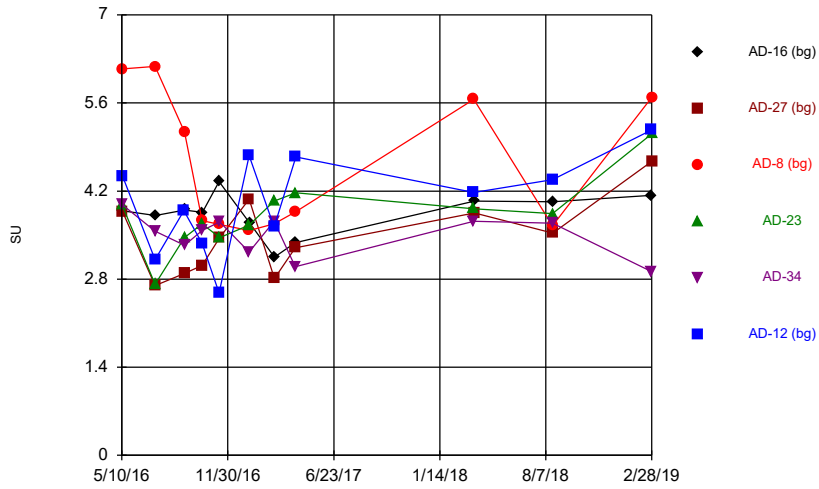
Constituent: Mercury, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



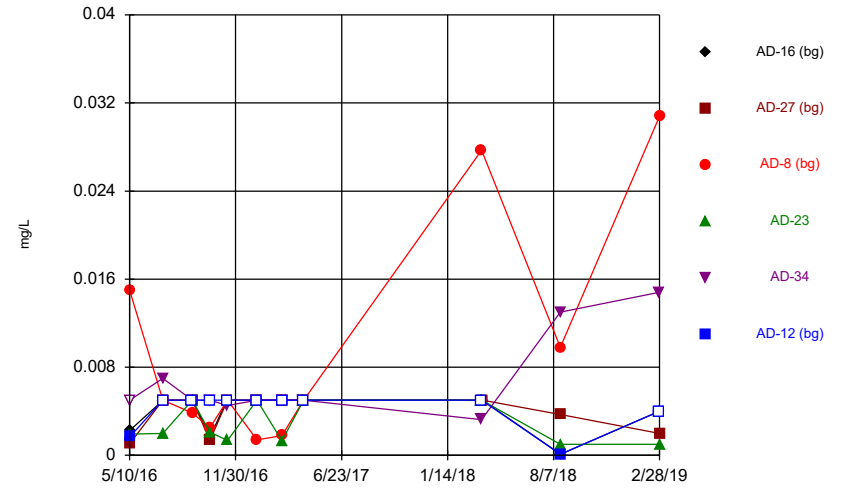
Constituent: Molybdenum, total Analysis Run 7/11/2019 1:49 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



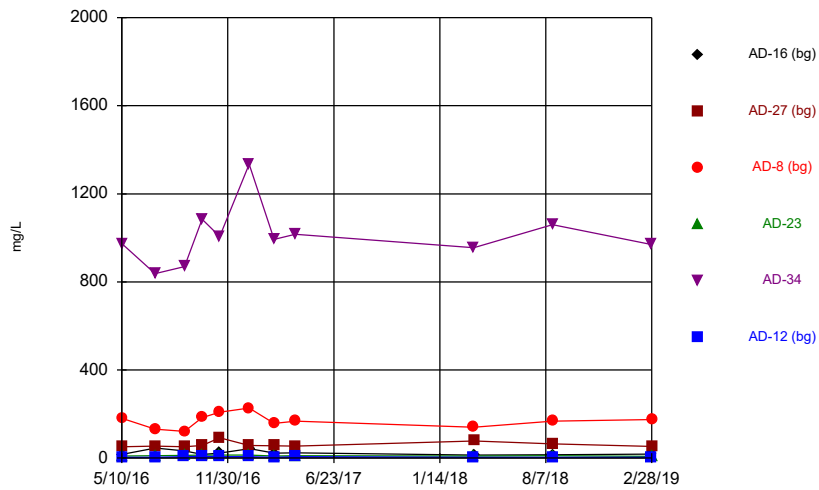
Constituent: pH, field Analysis Run 7/11/2019 1:49 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



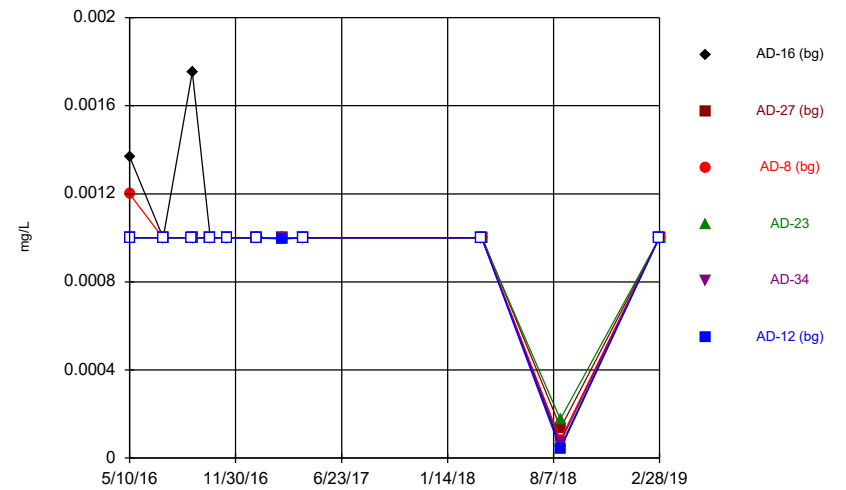
Constituent: Selenium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



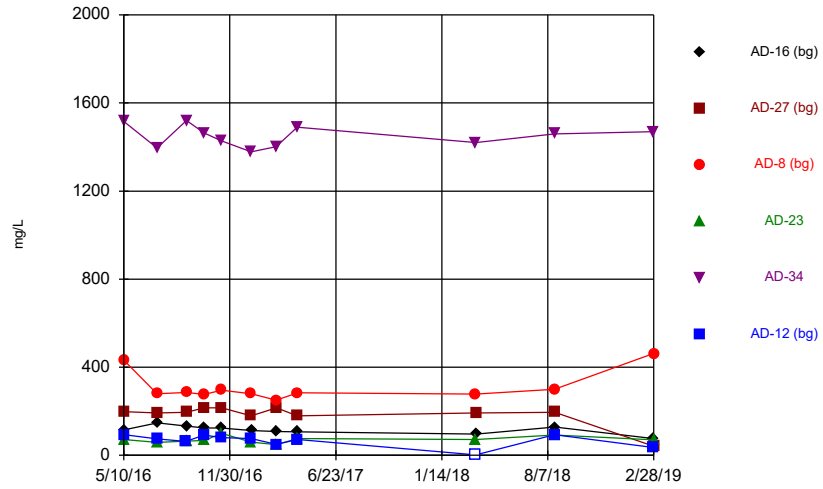
Constituent: Sulfate, total Analysis Run 7/11/2019 1:49 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



Constituent: Thallium, total Analysis Run 7/11/2019 1:49 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



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

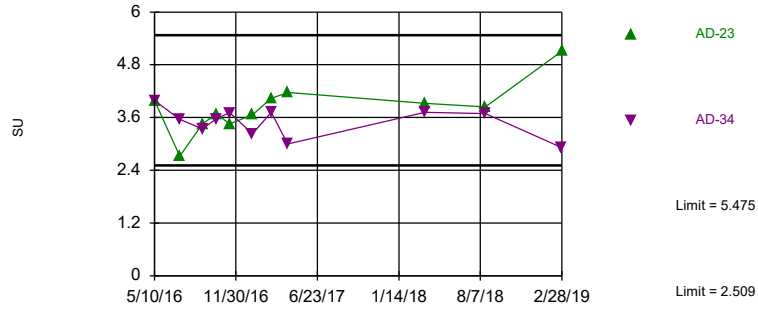
Interwell Prediction Limit Summary - All Results

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

Within Limits

Prediction Limit
Interwell Parametric

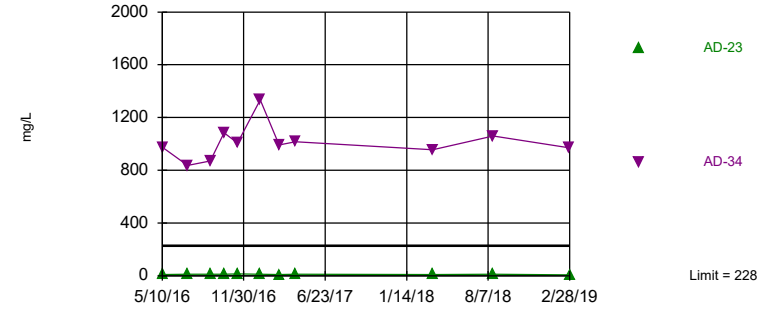


Background Data Summary: Mean=3.992, Std. Dev.=0.8529, n=44. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9258, critical = 0.924. Kappa = 1.739 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001253. Comparing 2 points to limit. Assumes 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

Exceeds Limit: AD-34

Prediction Limit
Interwell Non-parametric

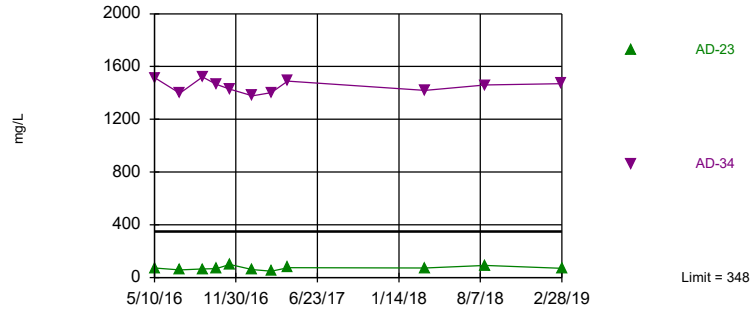


Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 44 background values. Annual per-constituent alpha = 0.005902. Individual comparison alpha = 0.0009861 (1 of 2). Comparing 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

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

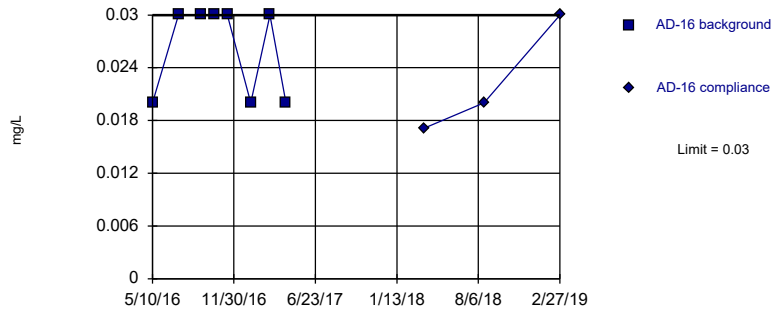
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg. N	Bg. Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Chloride, total (mg/L)	AD-16	11.43	n/a	2/27/2019	20.3	Yes	8	9.25	0.8864	0	None	No	0.002505	Param Intra 1 of 2
Chloride, total (mg/L)	AD-27	9	n/a	2/28/2019	11.7	Yes	8	n/a	n/a	0	n/a	n/a	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	n/a	0.02144	NP Intra (NDs) 1 of 2

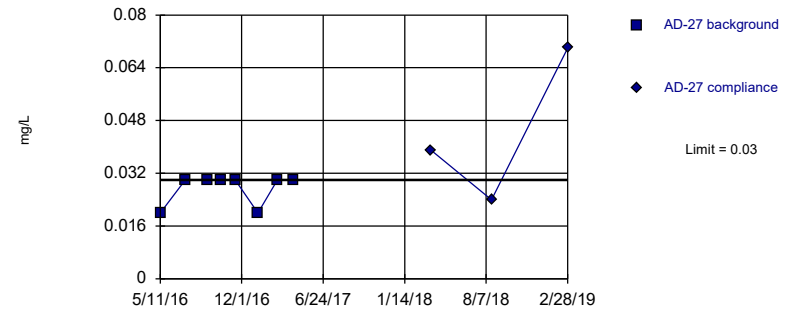
Within Limit Prediction Limit
Intrawell Non-parametric



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

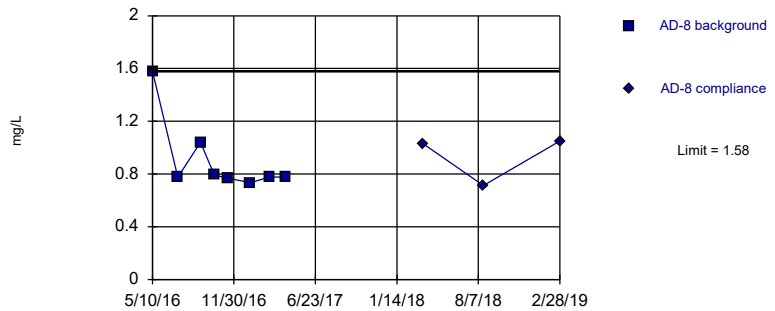
Within Limit Prediction Limit
Intrawell Non-parametric



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

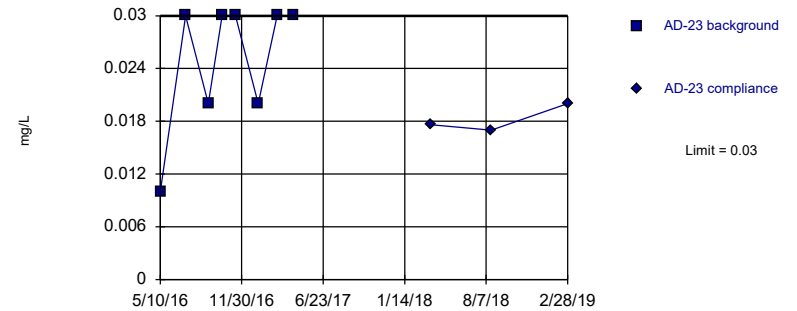
Within Limit Prediction Limit
Intrawell Non-parametric



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

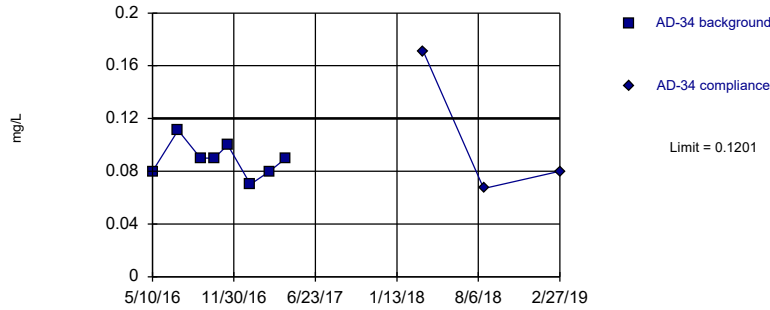
Within Limit Prediction Limit
Intrawell Non-parametric



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

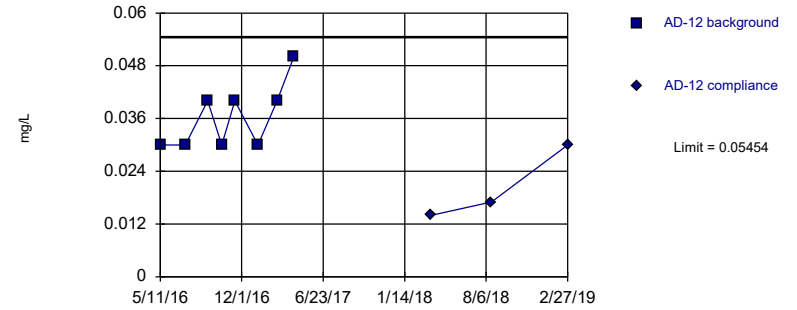
Within Limit Prediction Limit
Intrawell Parametric



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

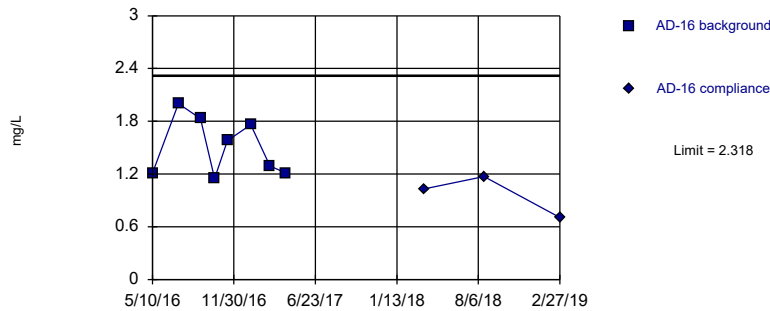
Within Limit Prediction Limit
Intrawell Parametric



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

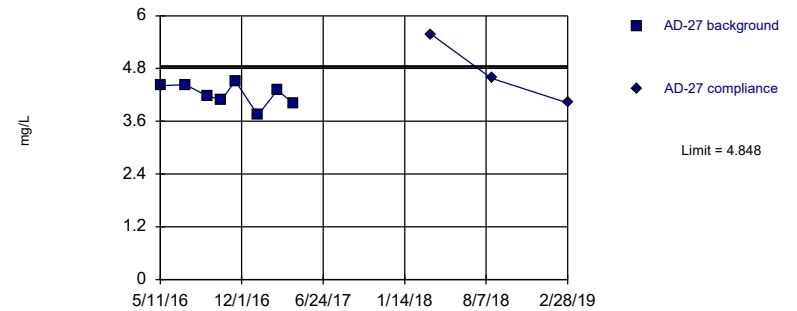
Within Limit Prediction Limit
Intrawell Parametric



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

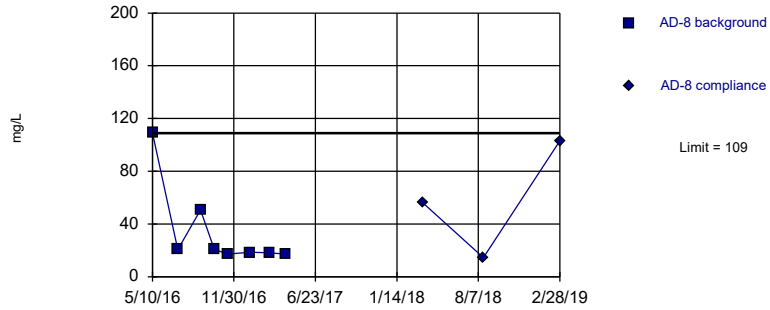
Within Limit Prediction Limit
Intrawell Parametric



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

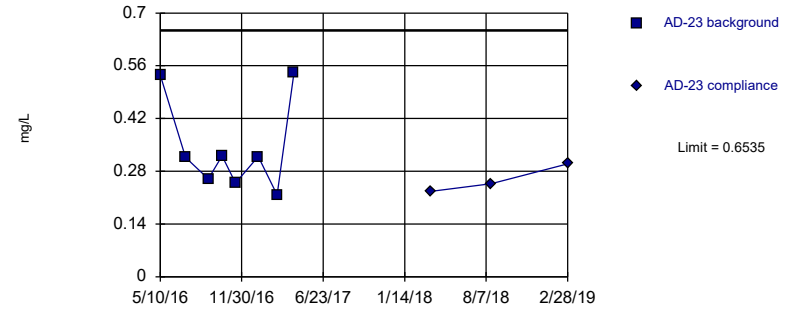
Within Limit Prediction Limit
Intrawell Non-parametric



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

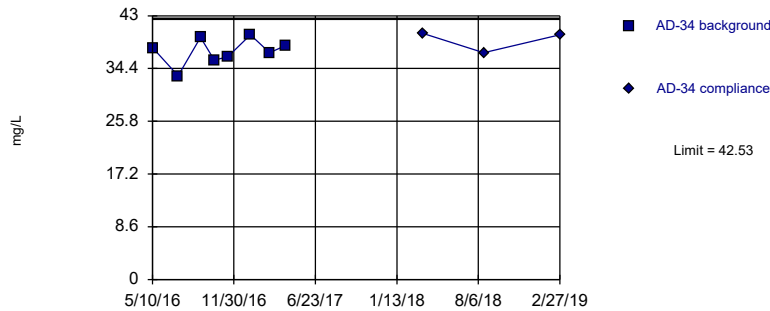
Within Limit Prediction Limit
Intrawell Parametric



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

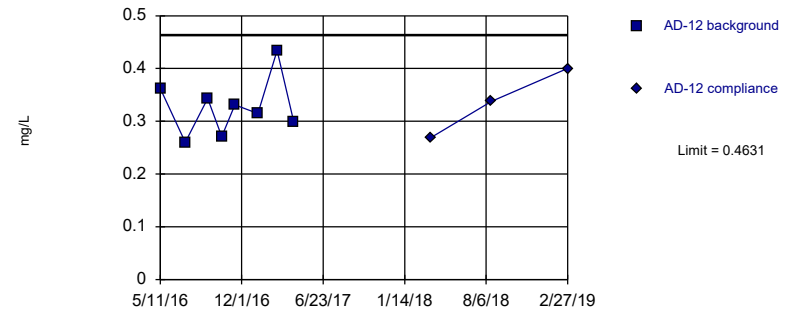
Within Limit Prediction Limit
Intrawell Parametric



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

Within Limit Prediction Limit
Intrawell Parametric

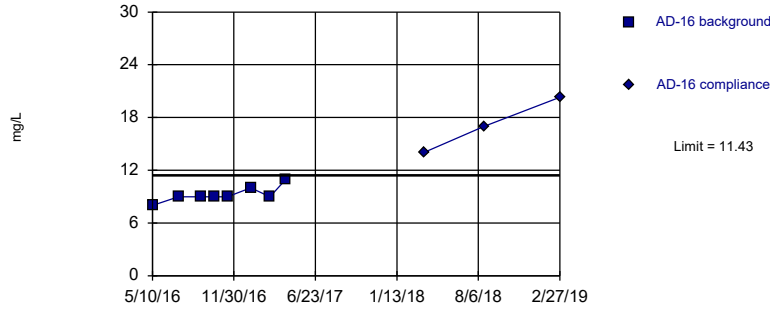


Background Data Summary: Mean=0.3269, Std. Dev.=0.05542, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9467, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Exceeds Limit

Prediction Limit
Intrawell Parametric

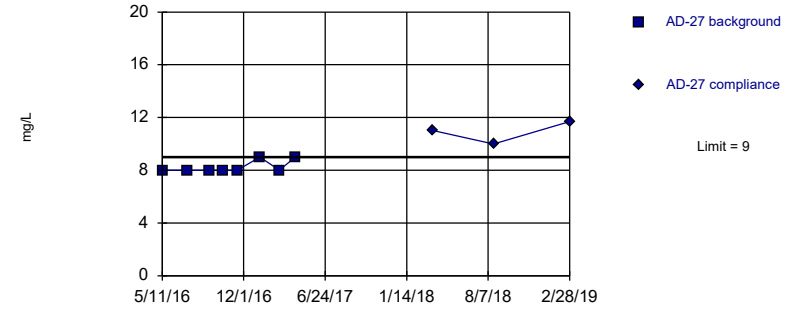


Background Data Summary: Mean=9.25, Std. Dev.=0.8864, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8264, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Exceeds Limit

Prediction Limit
Intrawell Non-parametric

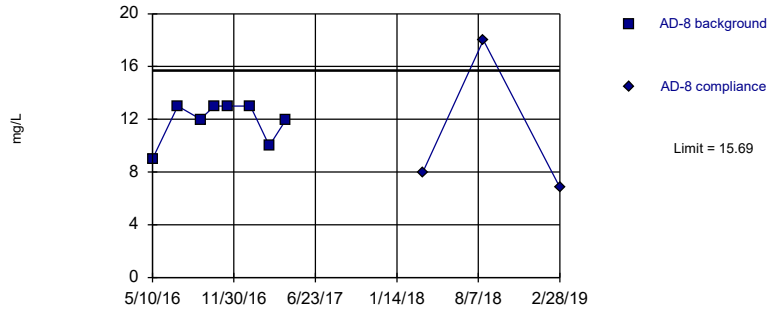


Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
Intrawell Parametric

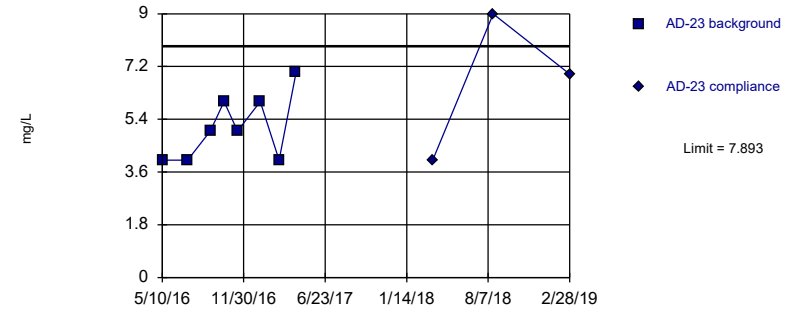


Background Data Summary: Mean=11.88, Std. Dev.=1.553, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7682, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
Intrawell Parametric

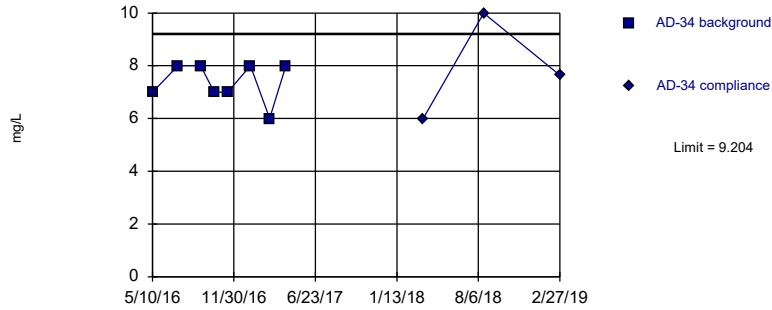


Background Data Summary: Mean=5.125, Std. Dev.=1.126, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8815, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
Intrawell Parametric

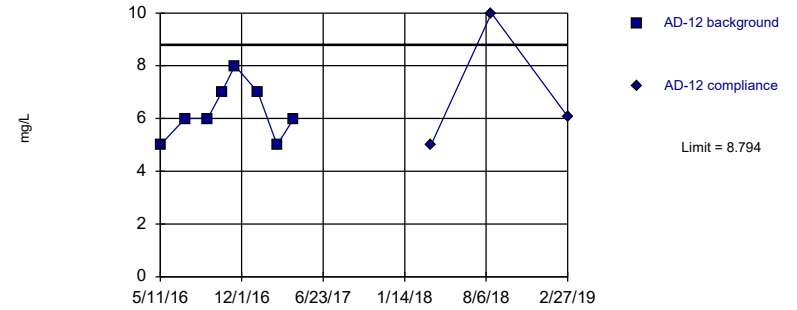


Background Data Summary: Mean=7.375, Std. Dev.=0.744, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7968, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
Intrawell Parametric



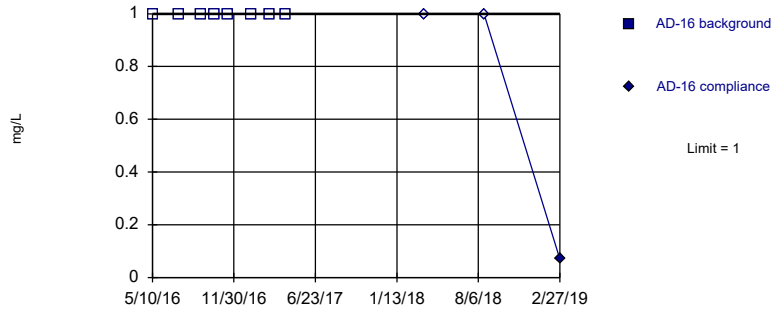
Background Data Summary: Mean=6.25, Std. Dev.=1.035, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9171, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Hollow symbols indicate censored values.

Within Limit

Prediction Limit
Intrawell Non-parametric



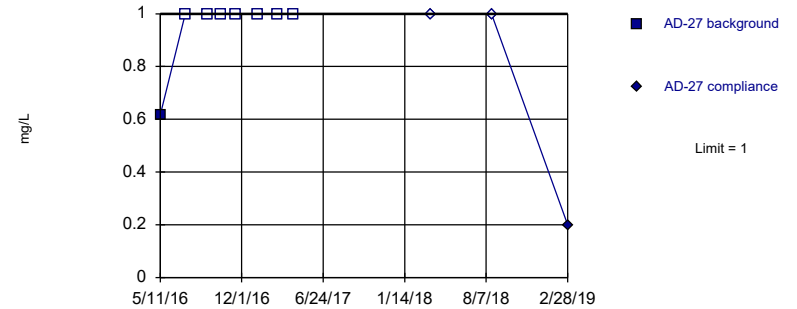
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 8) were censored; limit is most recent reporting limit. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Hollow symbols indicate censored values.

Within Limit

Prediction Limit
Intrawell Non-parametric

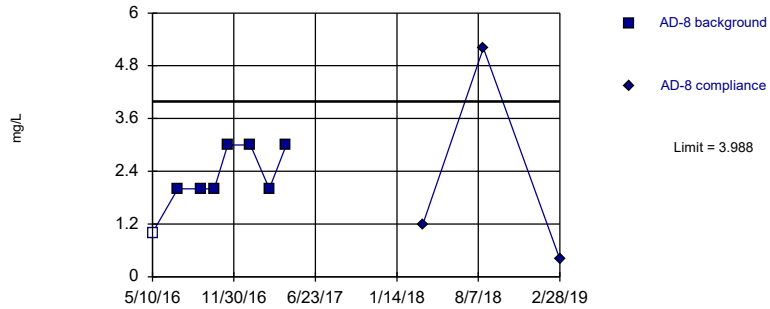


Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
Intrawell Parametric

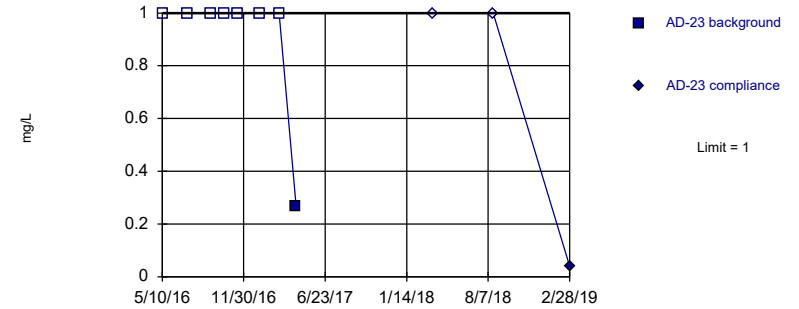


Background Data Summary: Mean=2.25, Std. Dev.=0.7071, n=8, 12.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8268, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
Intrawell Non-parametric

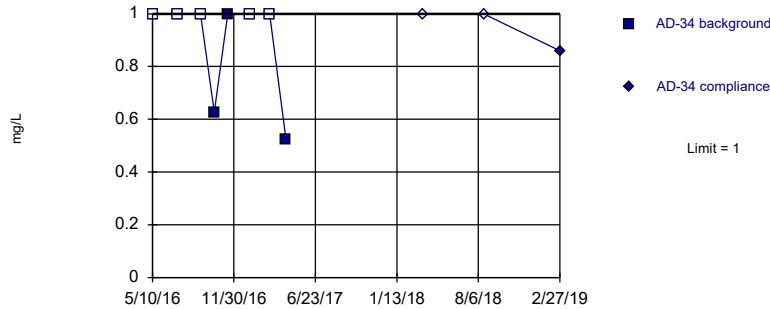


Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
Intrawell Non-parametric

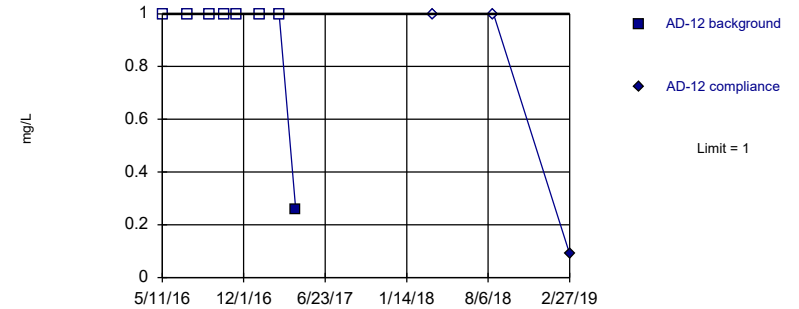


Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 62.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 7/11/2019 1:39 PM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

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

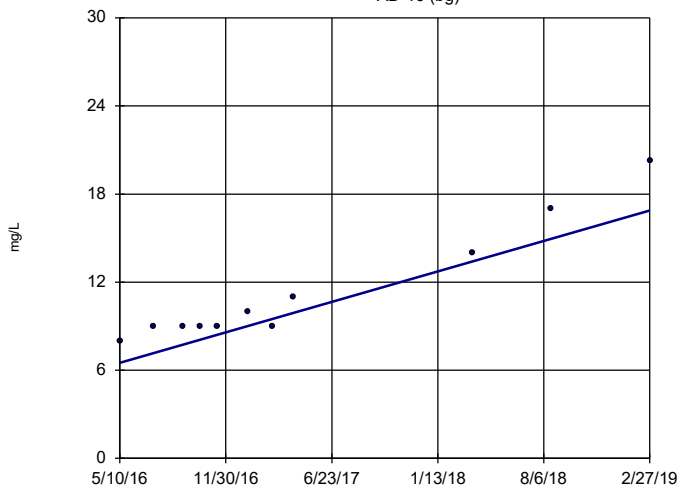
Trend Test Summary Table - All Results

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

Sen's Slope Estimator

AD-16 (bg)

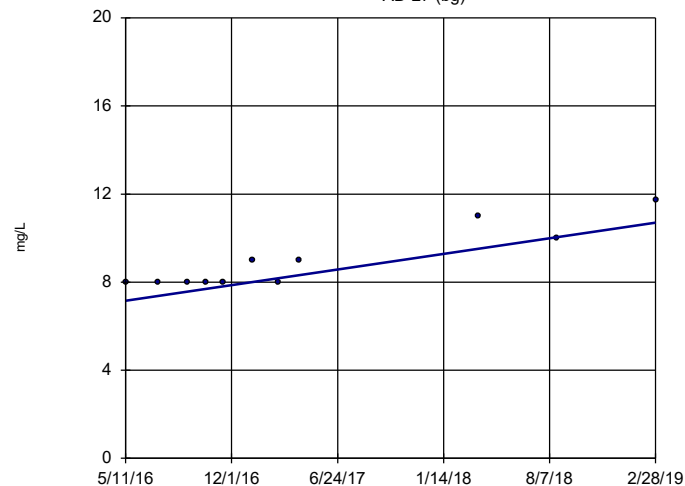


n = 11
 Slope = 3.702
 units per year.
 Mann-Kendall
 statistic = 43
 critical = 34
 Increasing trend
 significant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-27 (bg)

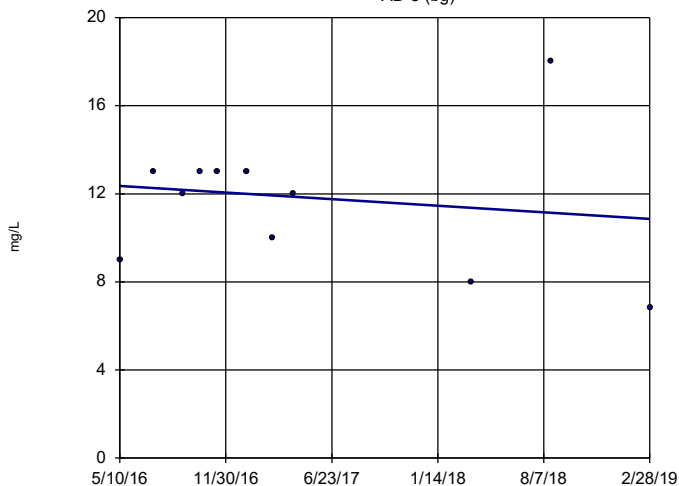


n = 11
 Slope = 1.267
 units per year.
 Mann-Kendall
 statistic = 35
 critical = 34
 Increasing trend
 significant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-8 (bg)

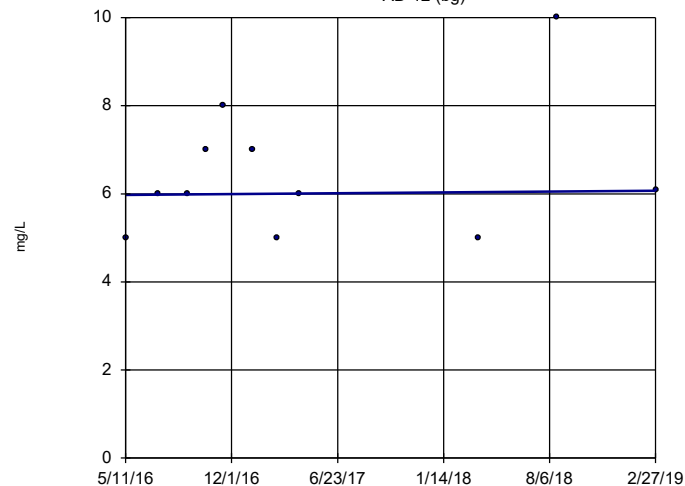


n = 11
 Slope = -0.5368
 units per year.
 Mann-Kendall
 statistic = -8
 critical = -34
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-12 (bg)

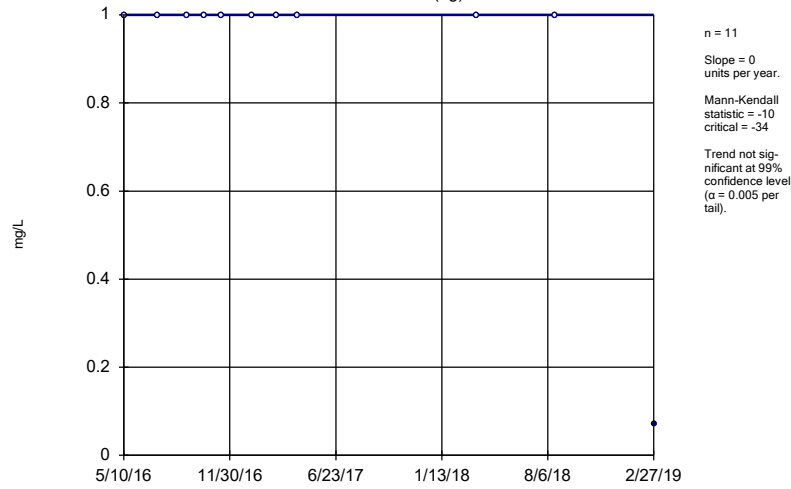


n = 11
 Slope = 0.03234
 units per year.
 Mann-Kendall
 statistic = 10
 critical = 34
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

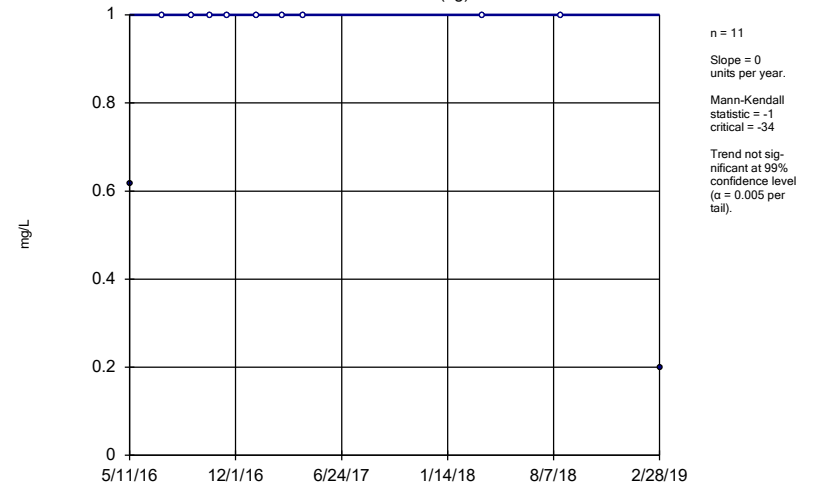
AD-16 (bg)



Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

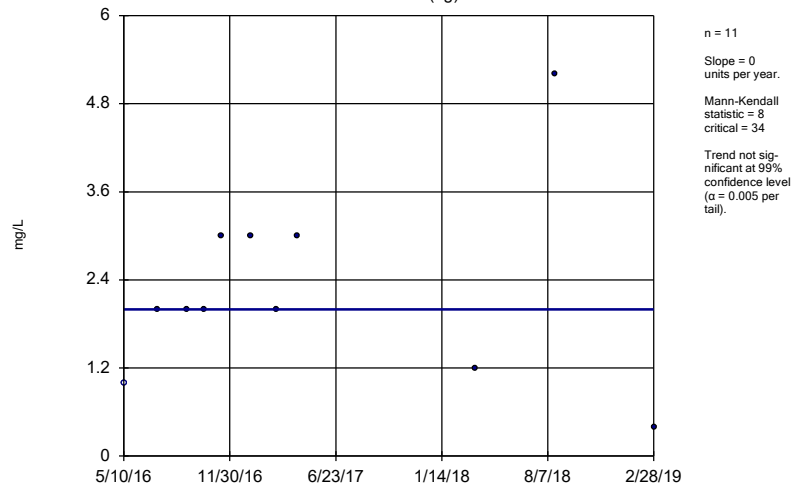
AD-27 (bg)



Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

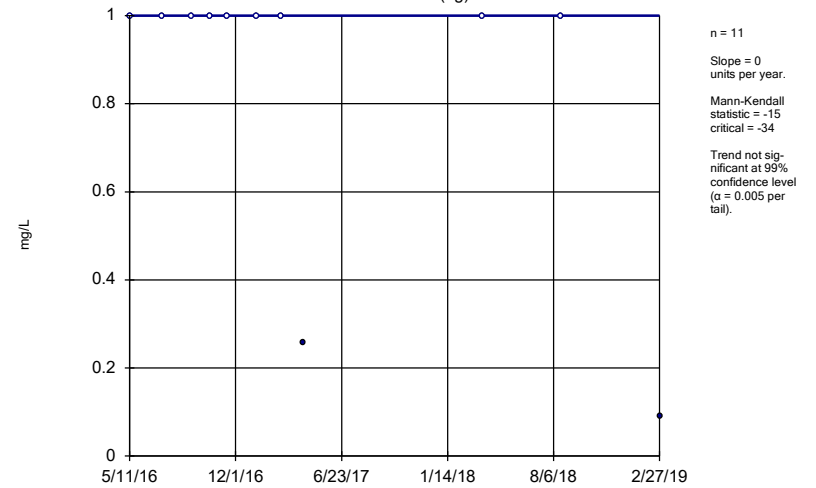
AD-8 (bg)



Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

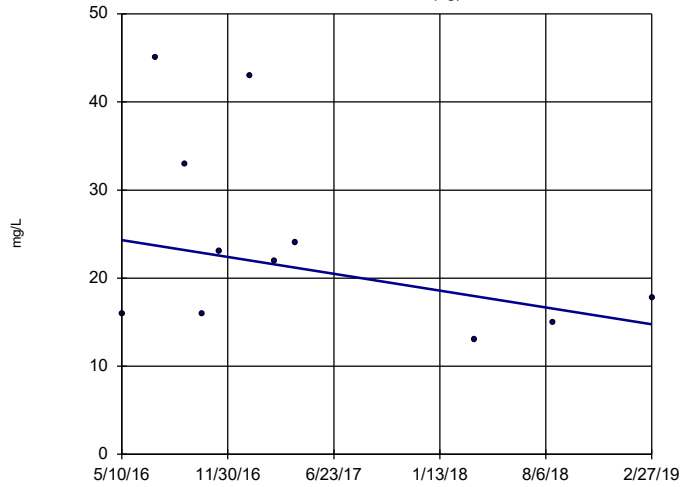
AD-12 (bg)



Constituent: Fluoride, total Analysis Run 7/11/2019 1:50 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-16 (bg)

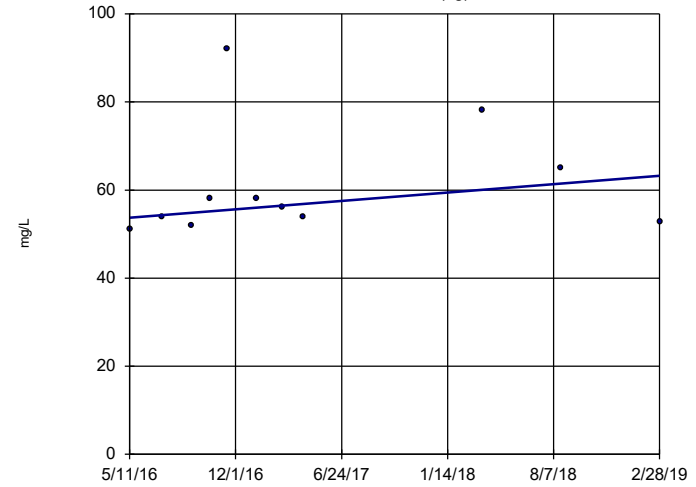


n = 11
 Slope = -3.411 units per year.
 Mann-Kendall statistic = -16
 critical = -34
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-27 (bg)

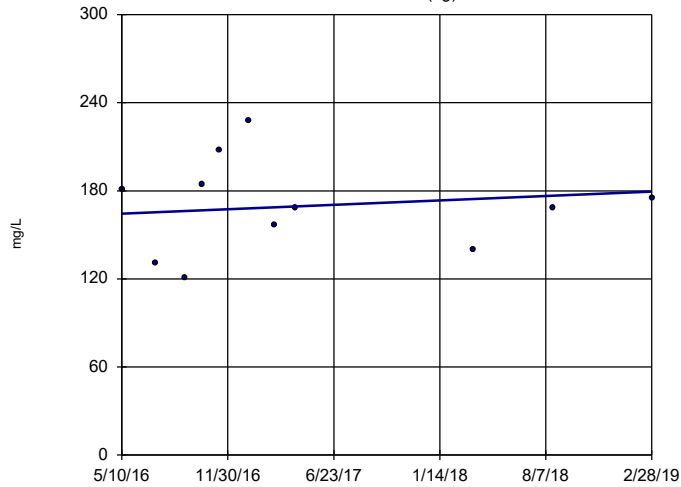


n = 11
 Slope = 3.411 units per year.
 Mann-Kendall statistic = 13
 critical = 34
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-8 (bg)

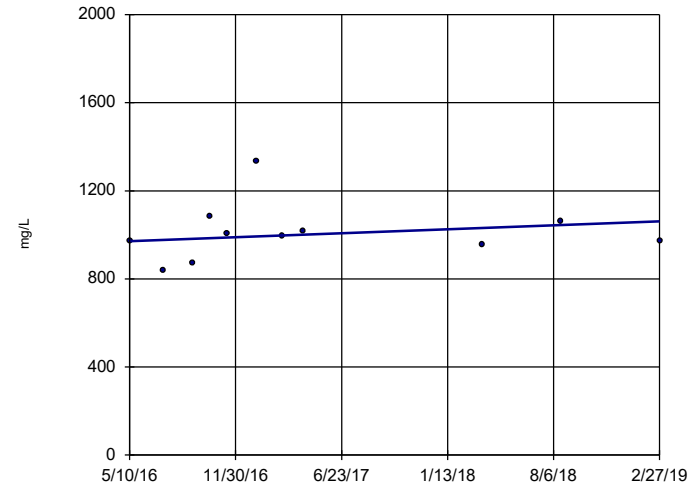


n = 11
 Slope = 5.333 units per year.
 Mann-Kendall statistic = 4
 critical = 34
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-34

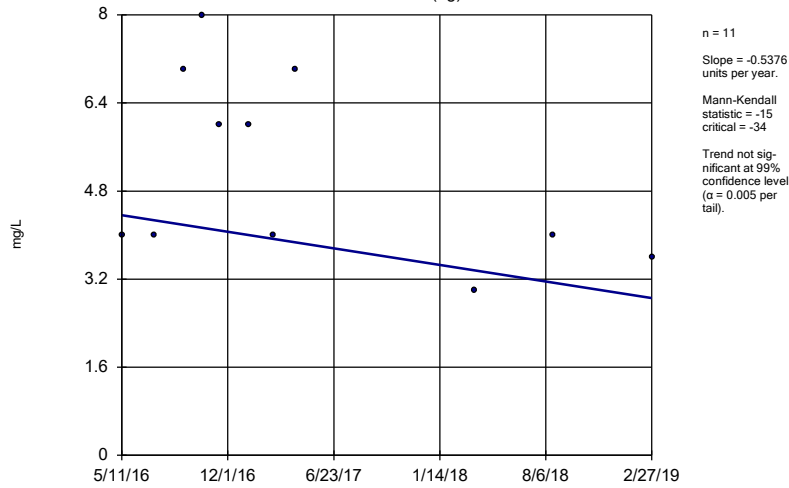


n = 11
 Slope = 32.31 units per year.
 Mann-Kendall statistic = 9
 critical = 34
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

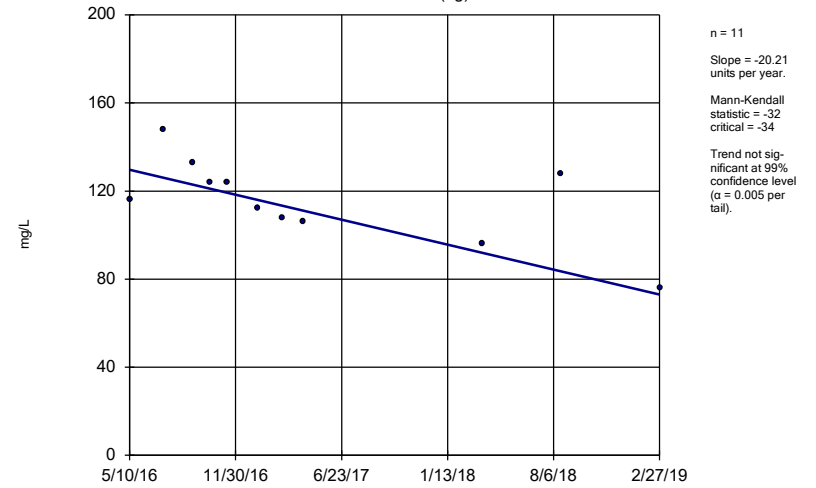
AD-12 (bg)



Constituent: Sulfate, total Analysis Run 7/11/2019 1:51 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

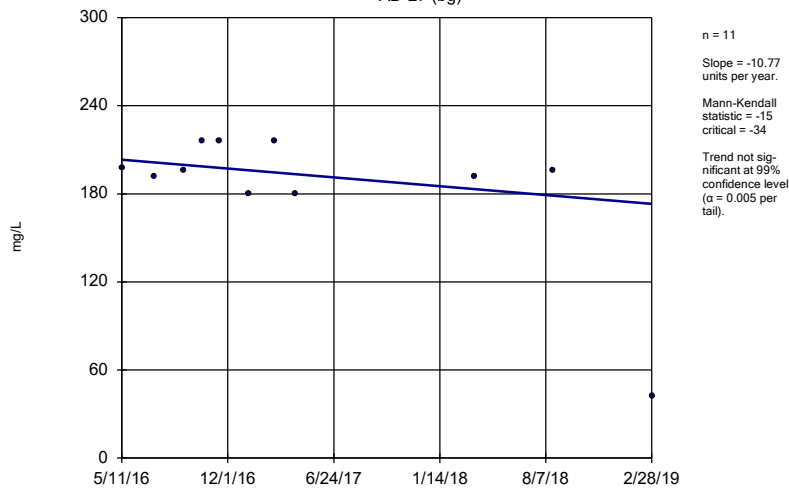
AD-16 (bg)



Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

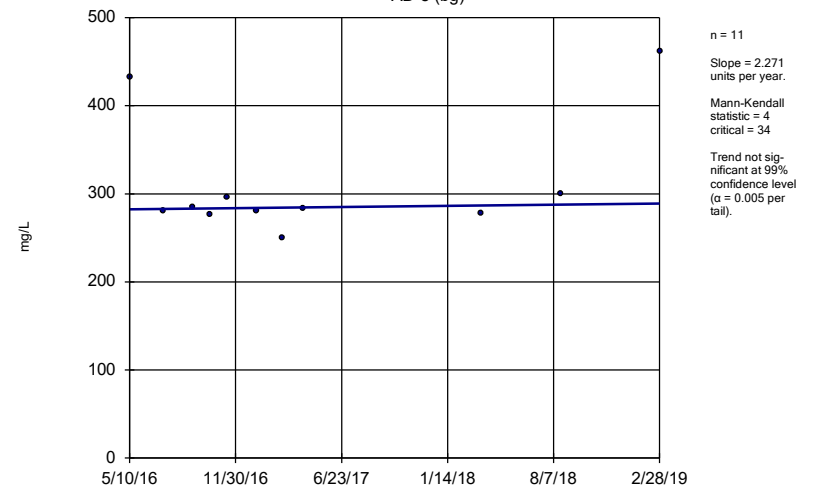
AD-27 (bg)



Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

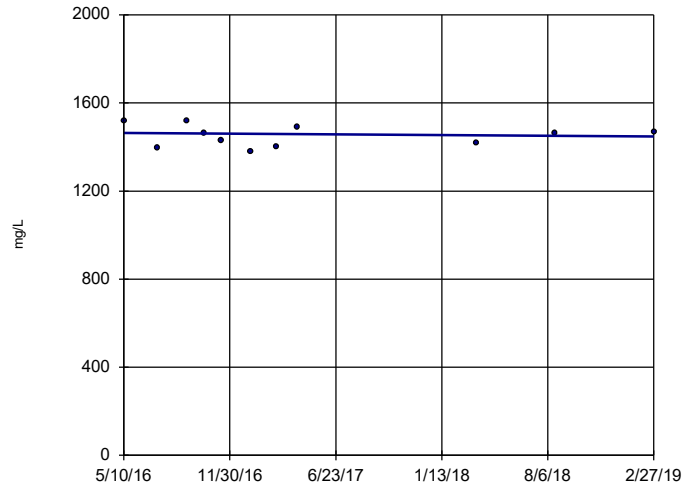
AD-8 (bg)



Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-34

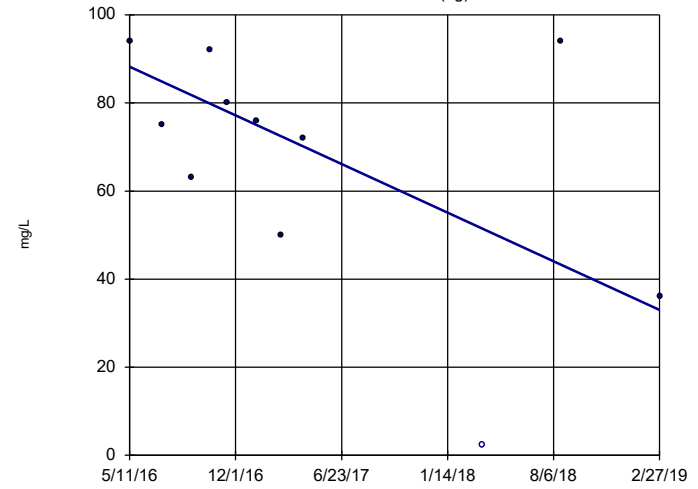


n = 11
Slope = -5.947
units per year.
Mann-Kendall
statistic = -3
critical = -34
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ per
tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/11/2019 1:51 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-12 (bg)



n = 11
Slope = -19.73
units per year.
Mann-Kendall
statistic = -20
critical = -34
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ 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

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Bg N</u>	<u>Bg Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
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

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Compliance</u>	<u>Lower Compl.</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
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.

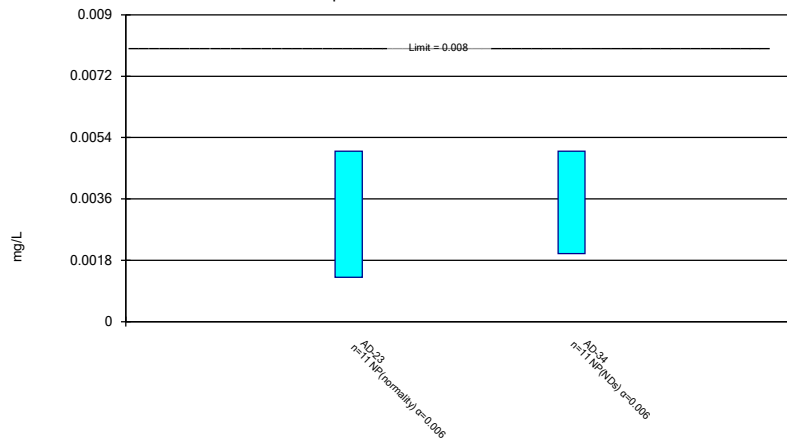
Confidence Interval Summary Table - All Results

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)

Non-Parametric Confidence Interval

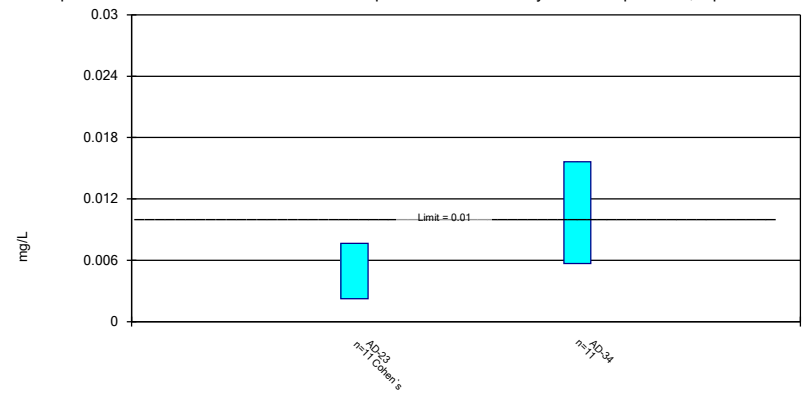
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Constituent: Antimony, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Parametric Confidence Interval

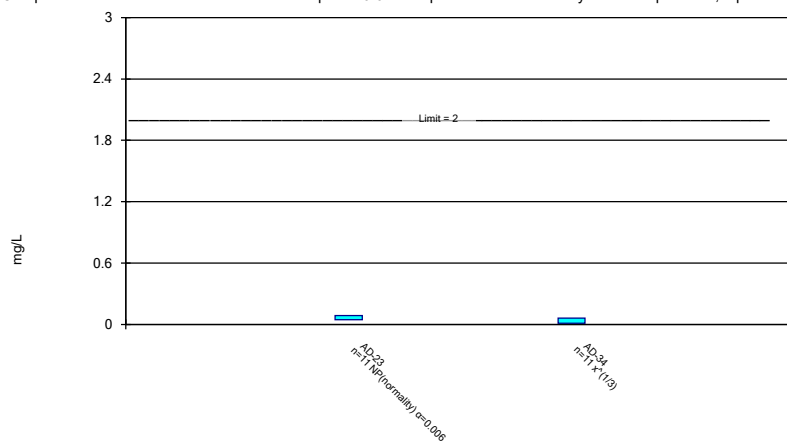
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Constituent: Arsenic, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Parametric and Non-Parametric (NP) Confidence Interval

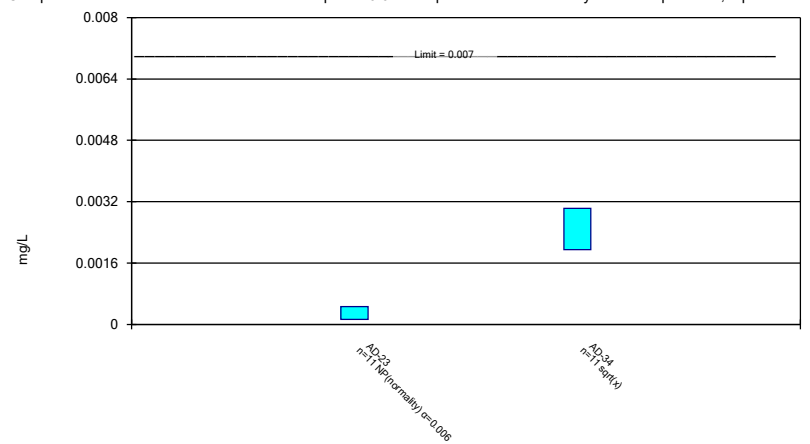
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Constituent: Barium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Parametric and Non-Parametric (NP) Confidence Interval

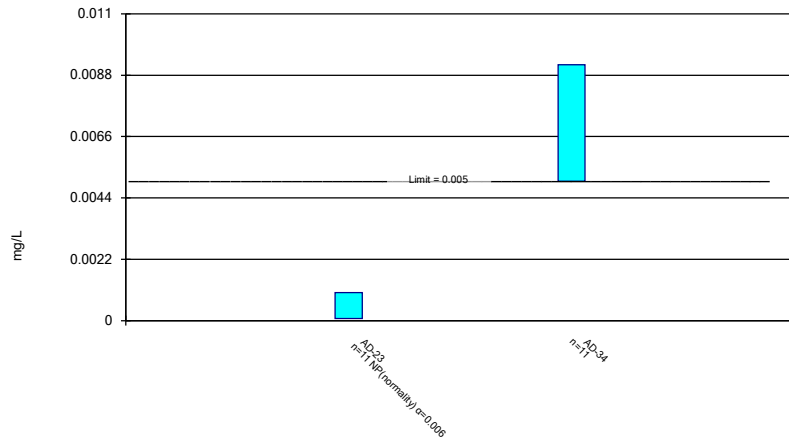
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Constituent: Beryllium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
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Parametric and Non-Parametric (NP) Confidence Interval

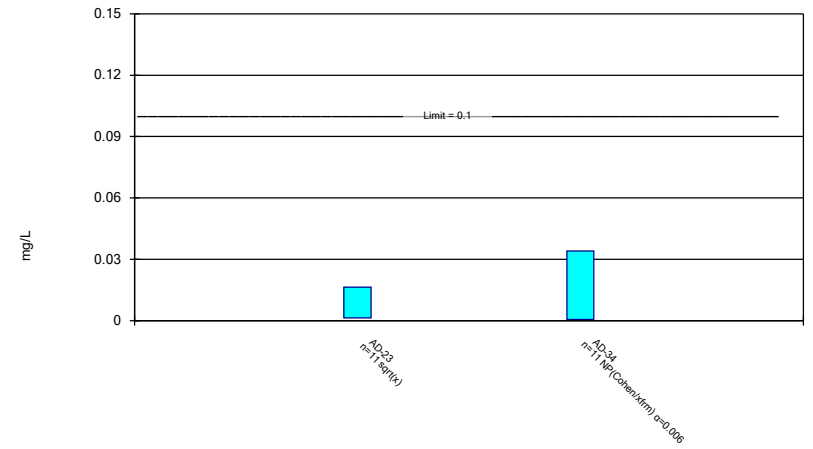
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Constituent: Cadmium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Parametric and Non-Parametric (NP) Confidence Interval

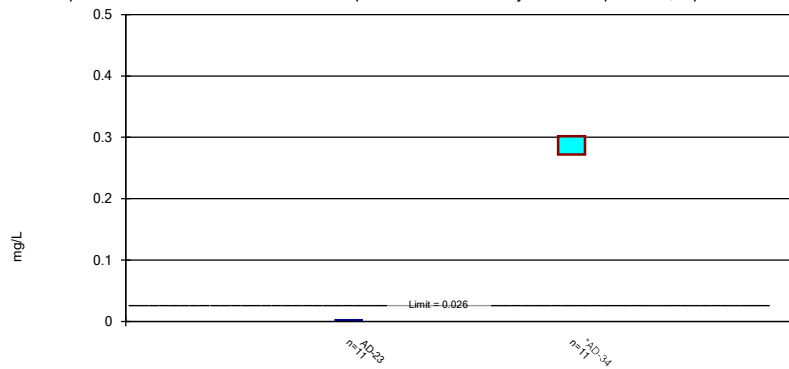
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Constituent: Chromium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Parametric Confidence Interval

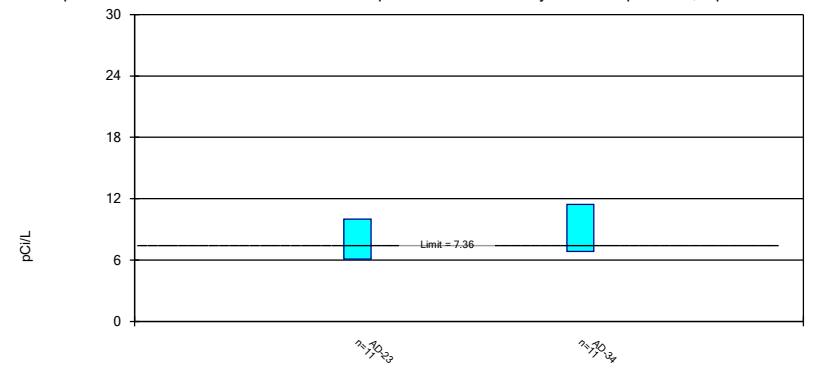
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cobalt, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Parametric Confidence Interval

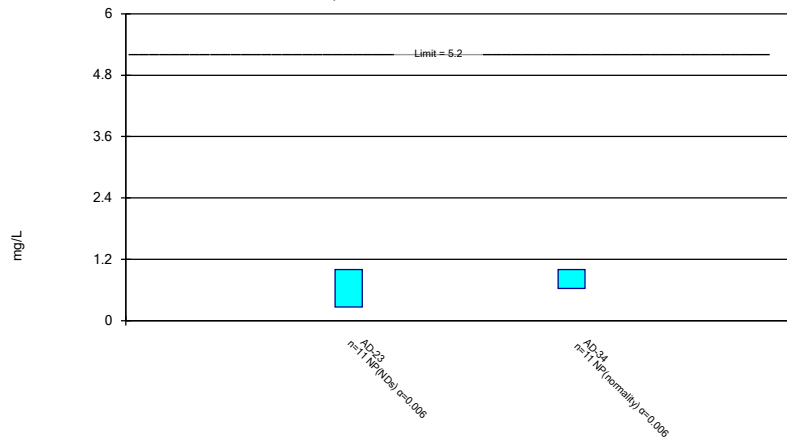
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Constituent: Combined Radium 226 + 228 Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals -
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Non-Parametric Confidence Interval

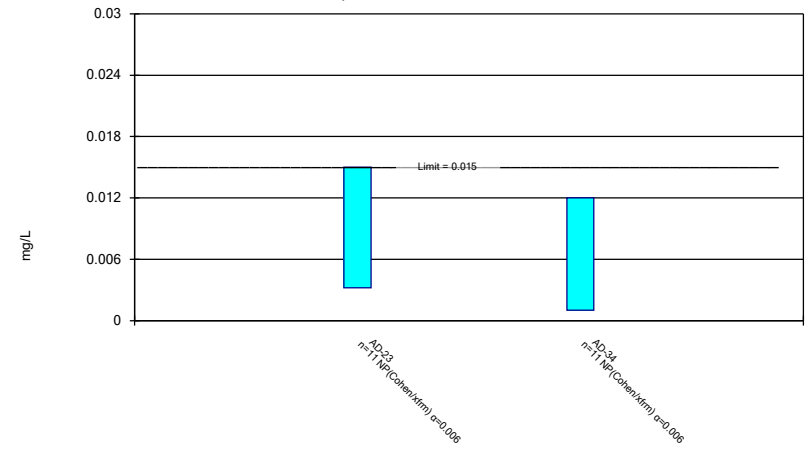
Compliance Limit is not exceeded.



Constituent: Fluoride, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Non-Parametric Confidence Interval

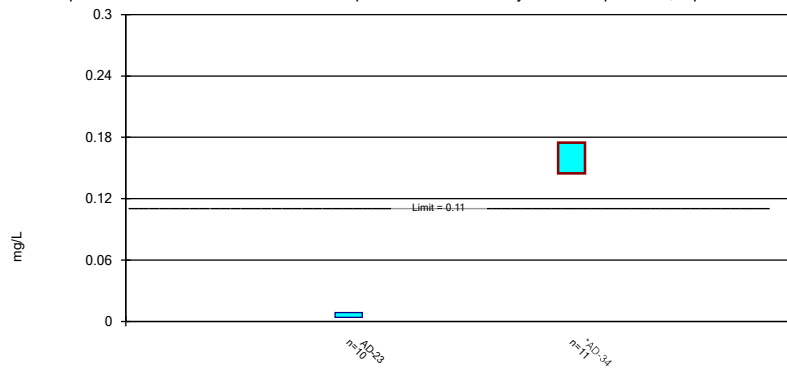
Compliance Limit is not exceeded.



Constituent: Lead, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Parametric Confidence Interval

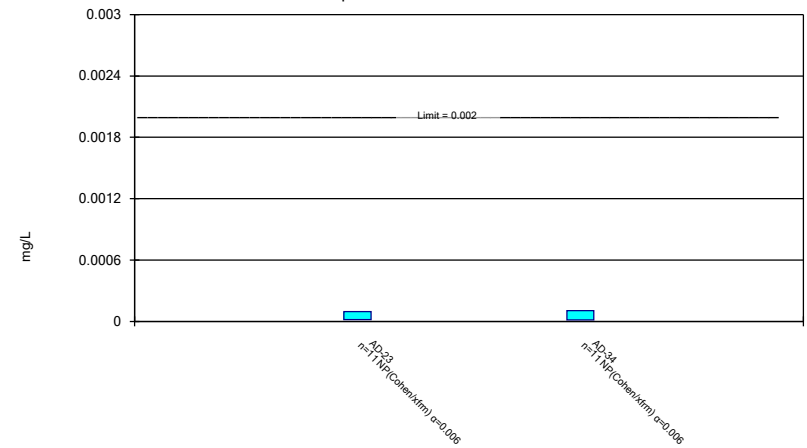
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Constituent: Lithium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Non-Parametric Confidence Interval

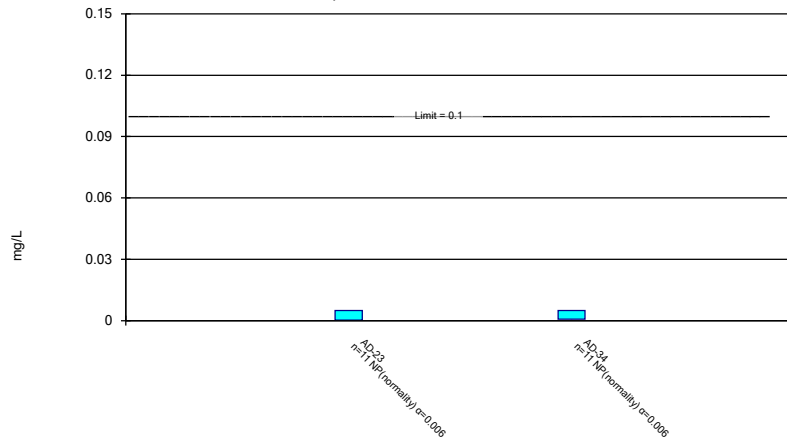
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Constituent: Mercury, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
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Non-Parametric Confidence Interval

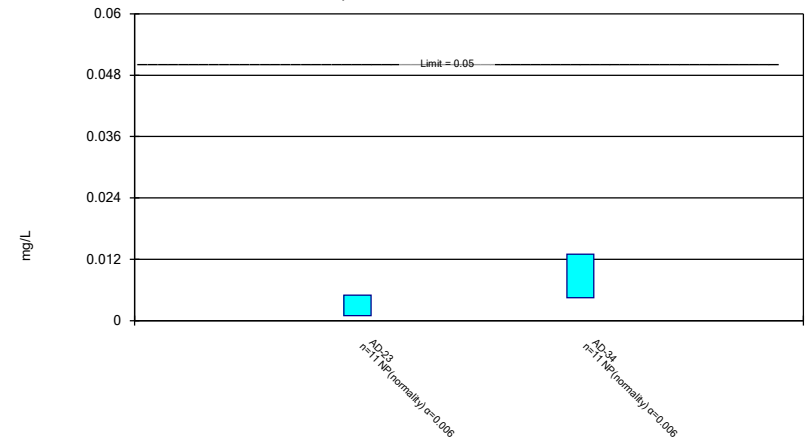
Compliance Limit is not exceeded.



Constituent: Molybdenum, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Non-Parametric Confidence Interval

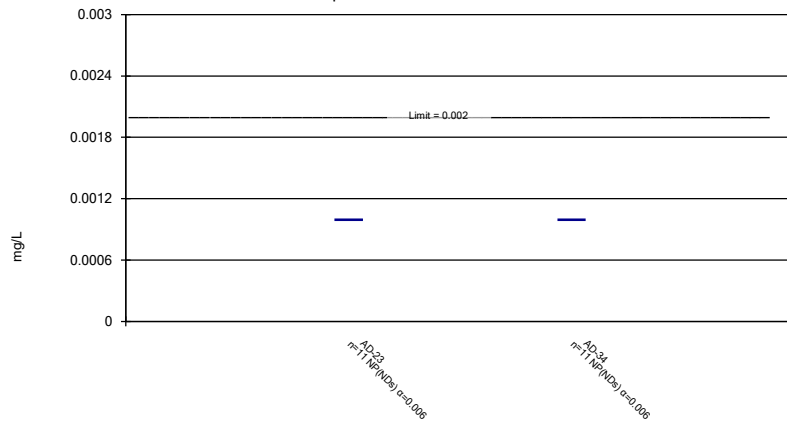
Compliance Limit is not exceeded.



Constituent: Selenium, total Analysis Run 7/11/2019 1:56 PM View: Confidence Intervals - App IV
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



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

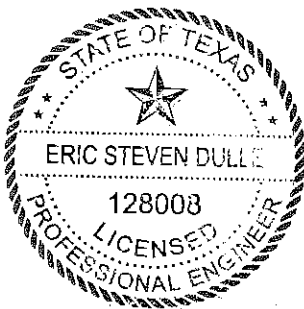
American Electric Power Alternate Source Demonstration Evaluation Report Project No. 112112

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4	Summary and Conclusions	3
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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 Dulle
4-22-19

Eric Dulle
Eric Dulle, P.E. (Texas 128008)

Date: 4/22/2019

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LIST OF ABBREVIATIONS

<u>Abbreviation</u>	<u>Term/Phrase/Name</u>
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

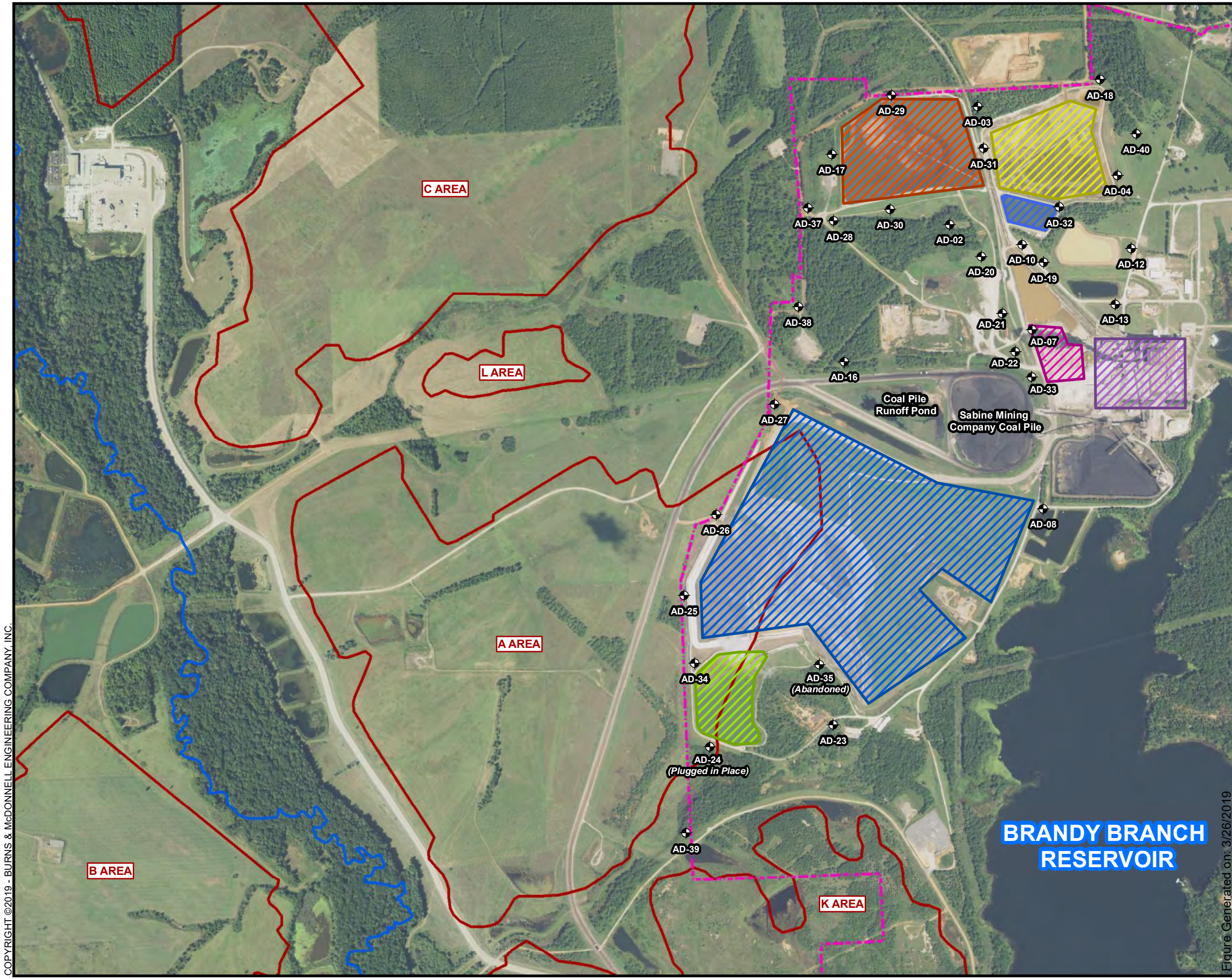
The purpose of this evaluation is to determine if concentrations of certain CCR constituents measured in groundwater samples collected from Site groundwater monitoring wells at SSLs above GWPSs established for the Landfill in accordance with 40 CFR 257.95(h) resulted from a source other than the Landfill 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.

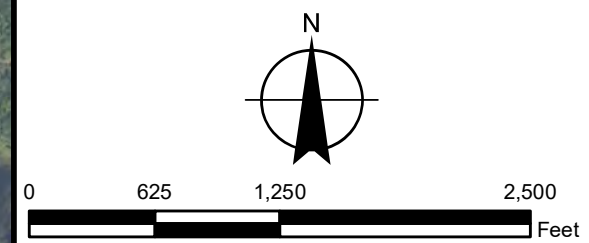


LEGEND

- 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.



BRANDY BRANCH RESERVOIR

FIGURE 1-1
 SITE LAYOUT MAP
 AEP PIRKEY POWER PLANT
 HALLSVILLE, TEXAS

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Figure Generated on: 3/26/2019

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.

BRANDY BRANCH RESERVOIR

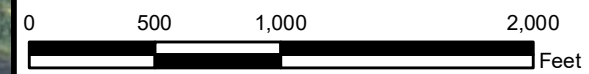
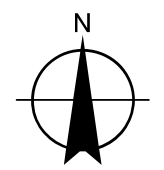
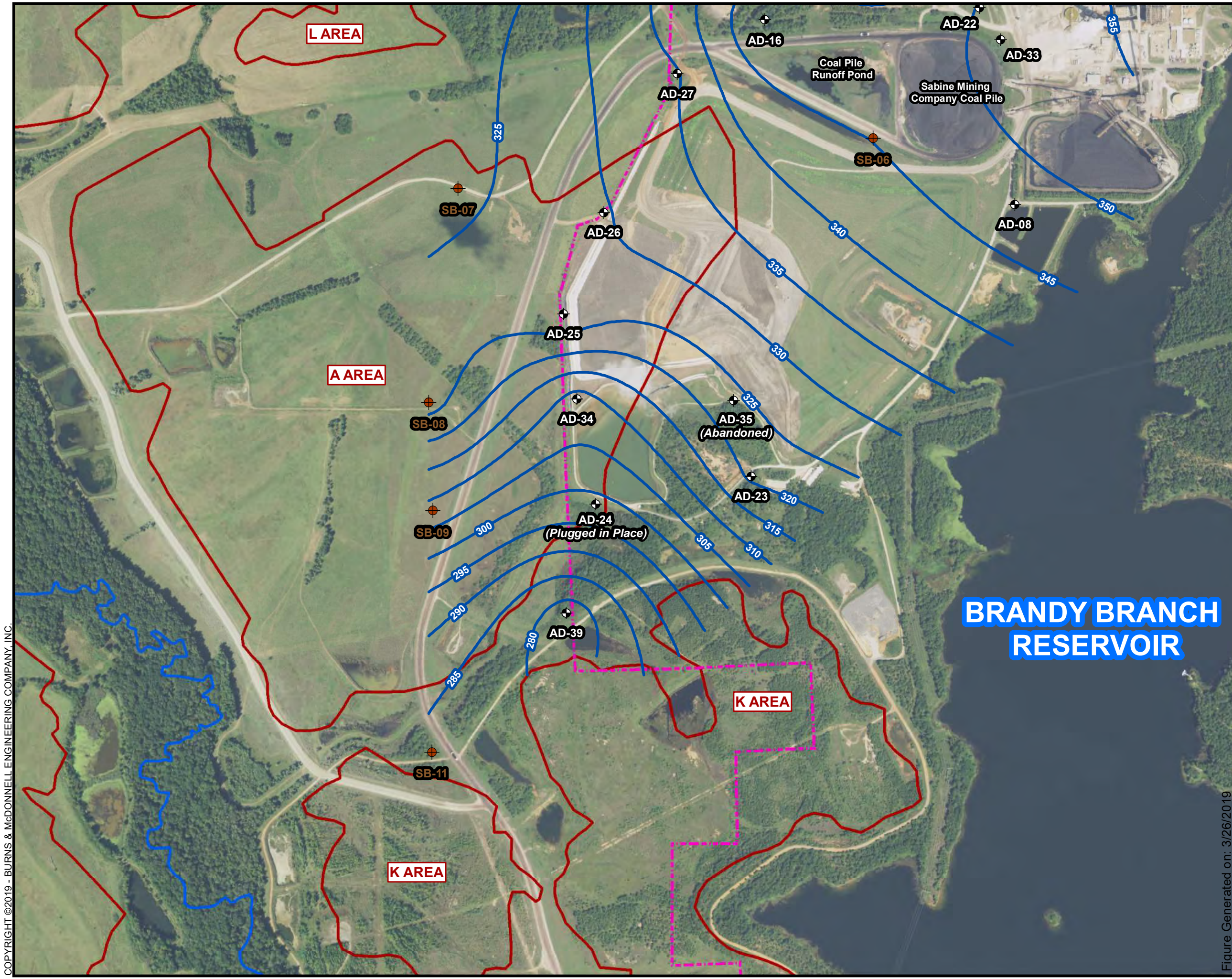


FIGURE 2-1
SAMPLE LOCATION MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

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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

BRANDY BRANCH RESERVOIR

N

0 500 1,000 2,000
Feet

FIGURE 2-2
POTENTIOMETRIC SURFACE MAP
AEP PIRKEY POWER PLANT
HALLSVILLE, TEXAS

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Figure Generated on: 3/26/2019

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

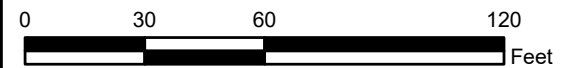
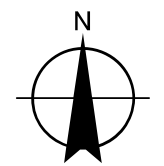


Figure Generated On: 4/19/2019

FIGURE 3-1
 HISTORICAL COAL MINE
 DRAINAGE MAP
 AEP PIRKEY POWER PLANT
 HALLSVILLE, TEXAS

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

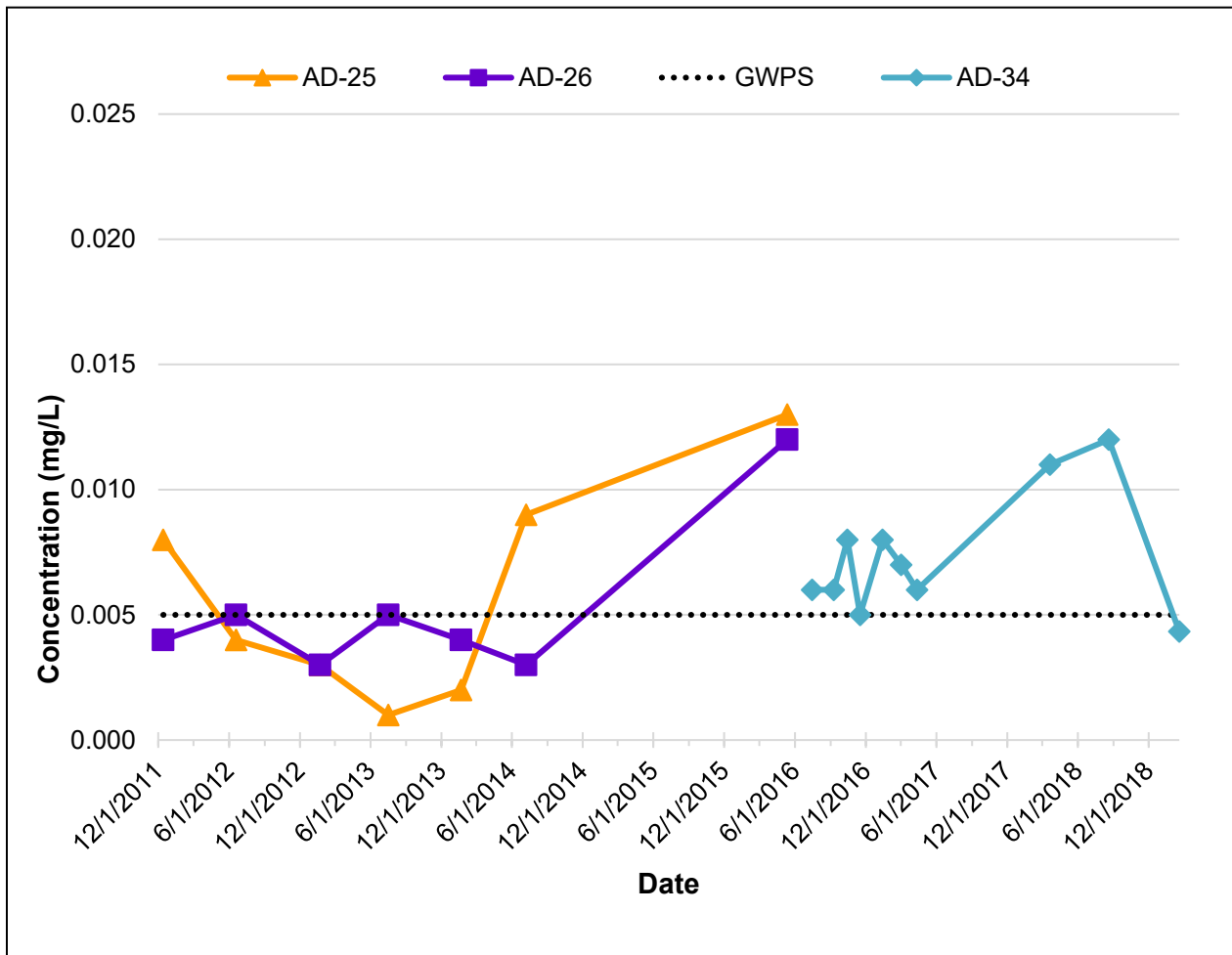
Well Location	Sample Date	Cadmium (mg/L)
AD-34	5/10/2016	0.006
	7/13/2016	0.006
	9/8/2016	0.008
	10/12/2016	0.005
	11/15/2016	0.008
	1/11/2017	0.007
	2/28/2017	0.006
	4/10/2017	0.011
	3/21/2018	0.012
	8/20/2018	0.00434

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

- AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.
- Arcadis, 2016. Landfill – CCR Groundwater Monitoring Well Network Evaluation. Prepared for American Electric Power Service Corporation. May.
- Arcadis, 2018. 2018 Landfill Lateral Expansion – CCR Location Restriction Evaluation, October.
- Cravotta III, C.A. 2008. *Dissolved metals and associated constituents in abandoned coal-mine discharges, Pennsylvania, USA. Part 2: Geochemical controls on constituent concentrations*, Applied Geochemistry 23 (2008), pp 203–226
- Flawn, P.T., 1965. Geologic Atlas of Texas, Tyler Sheet. University of Texas at Austin, Bureau of Economic Geology. March.
- Hyman, D.M. and Watzlaf, G.R., 1997. *Metals and Other Components of Coal Mine Drainage as Related to Aquatic Life Standards*, Proceedings America Society of Mining and Reclamation, 1997 pp 531-545.
- Geosyntec Consultants, 2018. Statistical Analysis Summary – H.W. Pirkey Power Plant. Hallsville, Texas. January 3.
- U. S. Environmental Protection Agency (USEPA), 1982. Development Document for Effluent Limitations Guidelines and Standards for the Coal Mining. EPA 440/1-82/057.
- U. S. Environmental Protection Agency (USEPA), 1993. Solid Waste Disposal Facility Criteria Technical Manual, Subpart E. EPA530-R-93-017.
- U. S. Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007.

APPENDIX A - DATA SUMMARY TABLES

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 concentration.

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	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	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 Detection 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 Detection 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	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	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
Arsenic	mg/kg	23	18	2.0
Barium	mg/kg	6.4 J	7.6 J	14.5
Boron	mg/kg	23 U	24 U	11.4 U
Beryllium	mg/kg	0.044 J	0.082 J	0.57 U
Cadmium	mg/kg	0.13 J	0.11 J	0.57 U
Chromium	mg/kg	15	21	10.9
Cobalt	mg/kg	5.7 U	5.9 U	1.1 U
Fluoride	mg/kg	1.2 U	1.2 U	24.0 U M1
Lead	mg/kg	5.3	5.6	4.8
Lithium	mg/kg	5.7 U	1.1 J	5.2
Mercury	mg/kg	0.025 J	0.020 J	0.048 U
Molybdenum	mg/kg	0.77 J	1.1 J	5.7 U
Selenium	mg/kg	1.1 U	1.5	1.1 U
Thallium	mg/kg	2.3 U	2.4 U	1.1 U
Combined Ra 226/228	pCi/L	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.



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**ALTERNATIVE SOURCE
DEMONSTRATION REPORT
FEDERAL CCR RULE**

H.W. Pirkey Power Plant

Landfill

Hallsville, Texas

Submitted to



1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec 
consultants

engineers | scientists | innovators

941 Chatham Lane
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Columbus, OH 43221

September 24, 2019

CHA8462

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Attachment B	Scanning Electron Microscopy Results
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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
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 calculate 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:

$$K_d = \frac{mg \text{ adsorbed}/kg \text{ soil}}{mg/L \text{ solution}}$$

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.

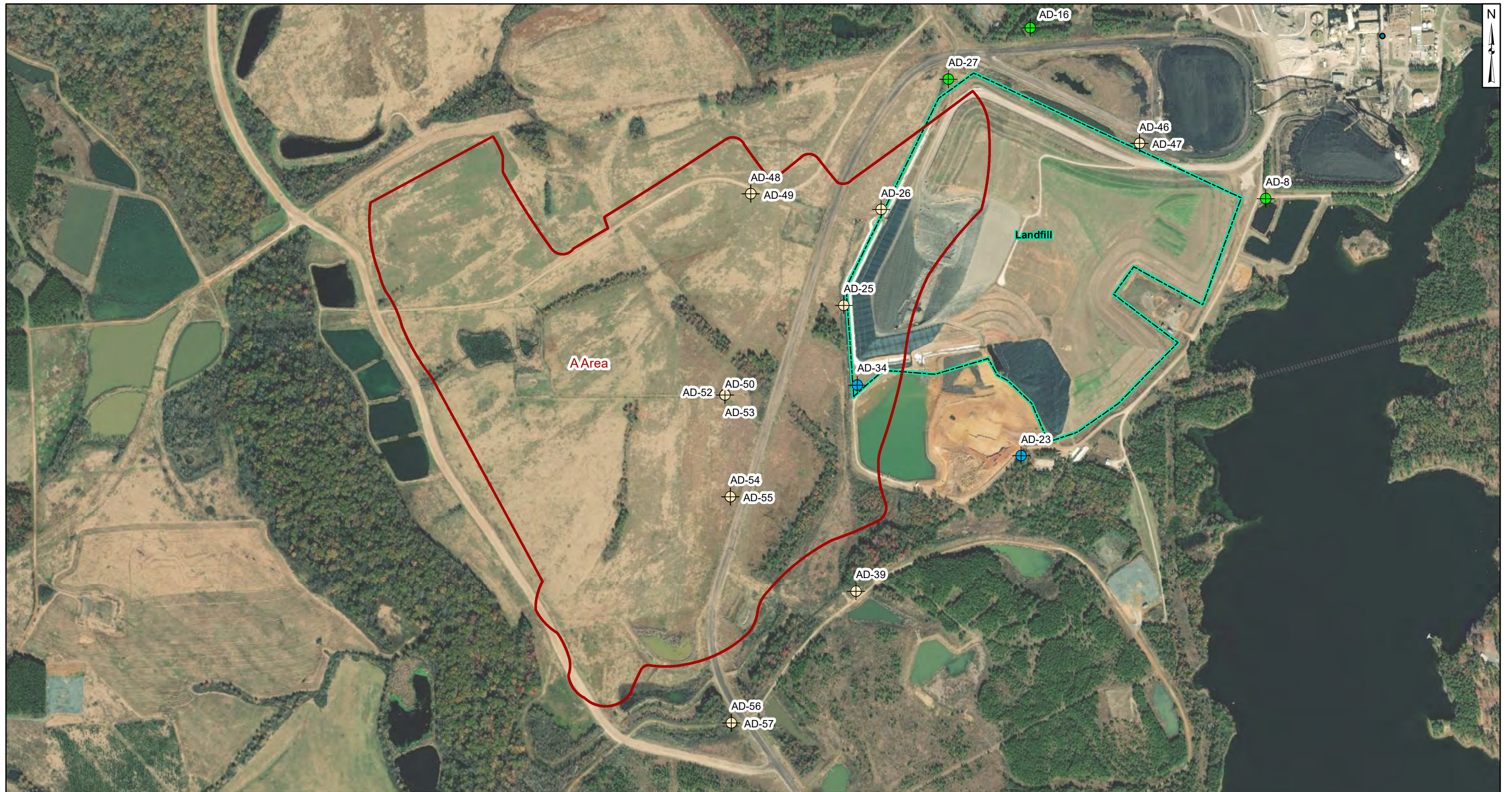
SECTION 4

REFERENCES

- AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.
- Burns & McDonnell Engineering Company, Inc. 2019. Alternate Source Demonstration Evaluation Report. H. W. Pirkey Plant. Landfill CCR Management Unit. April.
- EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.
- Geosyntec Consultants. 2018. Statistical Analysis Summary – Landfill. H.W. Pirkey Power Plant. Hallsville, Texas. December.
- Geosyntec Consultants, 2019a. Statistical Analysis Summary – Landfill. H.W. Pirkey Power Plant. Hallsville, Texas. July.
- Geosyntec Consultants, 2019b. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. Hallsville, Texas. July.
- Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.
- Johnson, D. B. 2003. Chemical and Microbiological Characteristics of Mineral Spoils and Drainage Waters at Abandoned Coal and Metal Mines. *Water, Air, & Soil Pollution: Focus*, 3, 47-66.
- Krupka, K. M. and Serne, R. J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.
- Izquierdo, M. and Querol, X., 2012. Leaching Behaviour of Elements from Coal Combustion Fly Ash: An Overview. *International Journal of Coal Geology*, 94, 54-66.
- Sheppard, S., Sohlenius, G., Omberg, L.G., Borgiel, M., Grolander, S. Nordén, S. 2011. Solid/Liquid Partition Coefficients (K_d) and Plant/Soil Concentration Ratios (CR) for Selected Soil, Tills, and Sediments at Forsmark. R-11-24. Swedish Nuclear Fuel and Waste Management Co. R-11-24. November.
- Sheppard, S., Long, J., Sanipelli, B., Sohlenius, G. 2009. Solid/Liquid Partition Coefficients (K_d) for Selected Soil and Sediments at Forsmark and Laxemar-Simpevarp. R-09-27. Swedish Nuclear Fuel and Waste Management Co. March.

United States Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

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.



Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

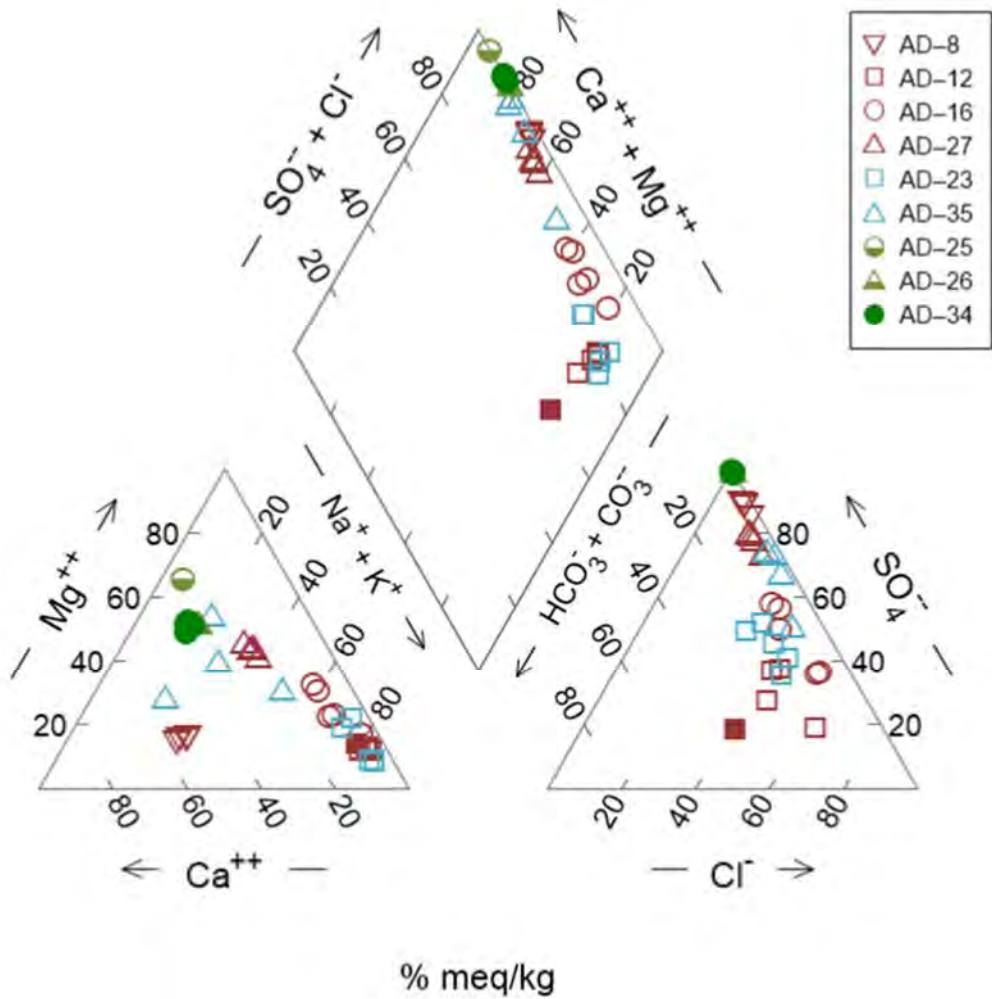
Geosyntec
consultants

Columbus, Ohio

2019/09/19

Figure

1



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

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 consultants

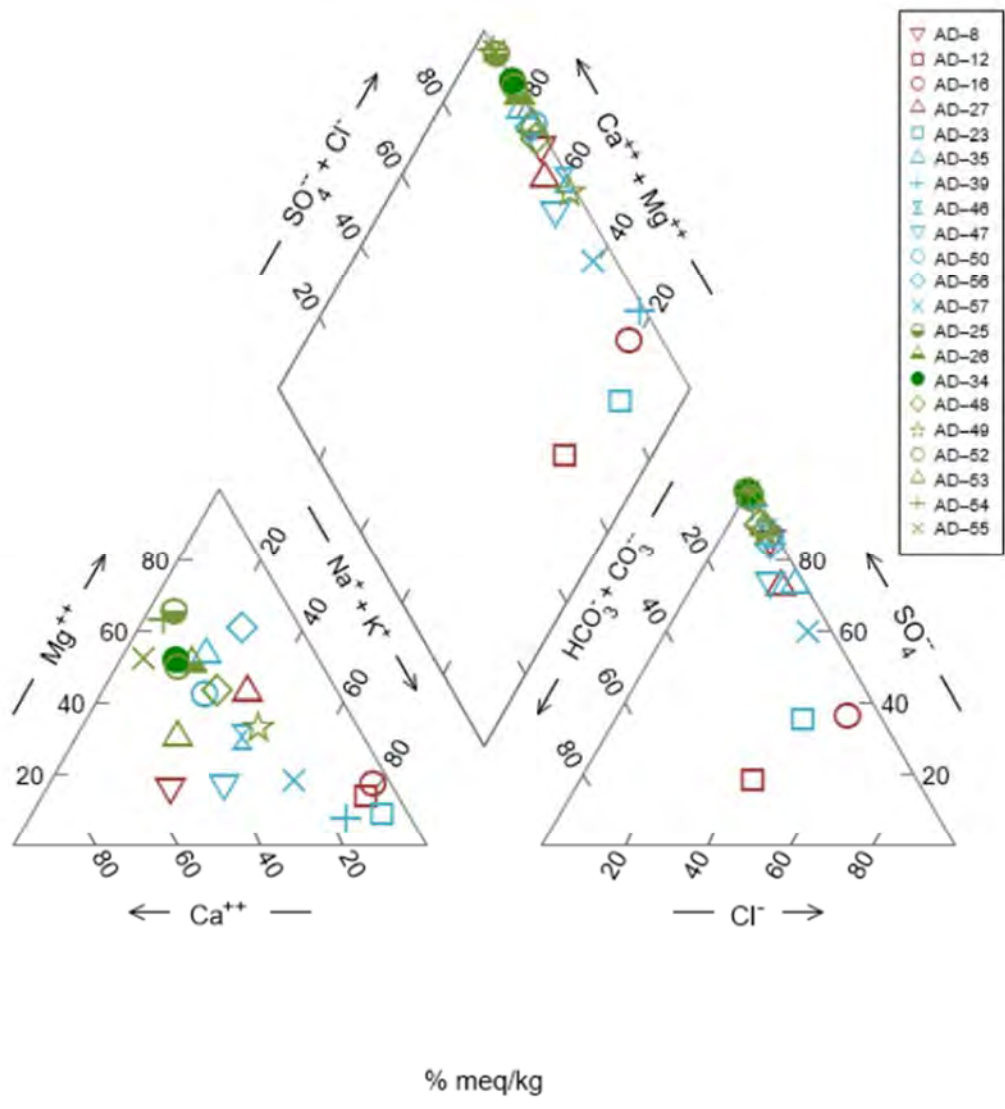


Columbus, Ohio

19-Sep-2019

Figure

2



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.

Piper Diagram – Landfill Area Wells
 Pirkey Landfill

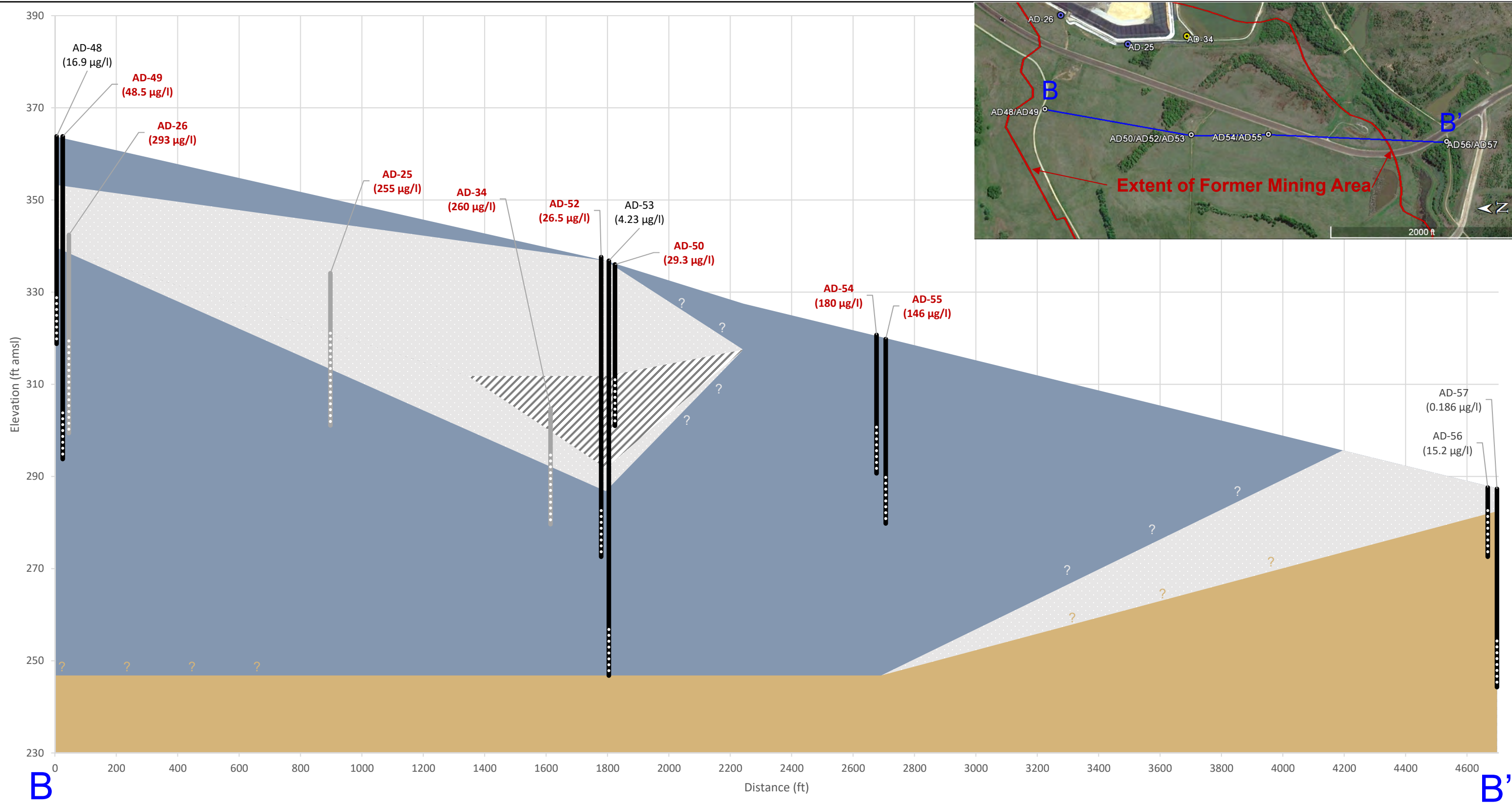


Columbus, Ohio

19-Sep-2019

Figure
3

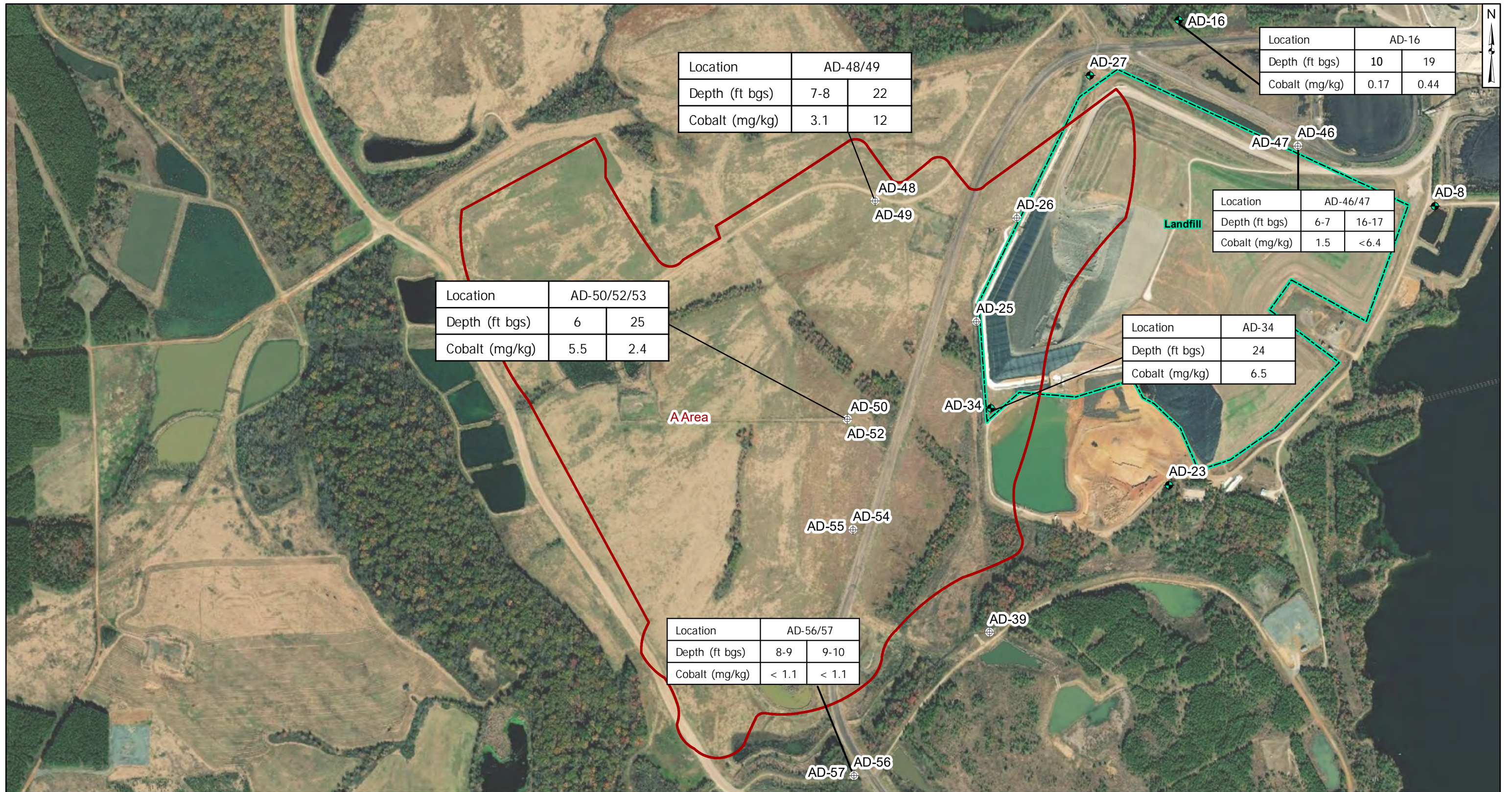
internal info. path. date. revised. author



- 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	
	Figure 4
CHA8462	September 2019



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.



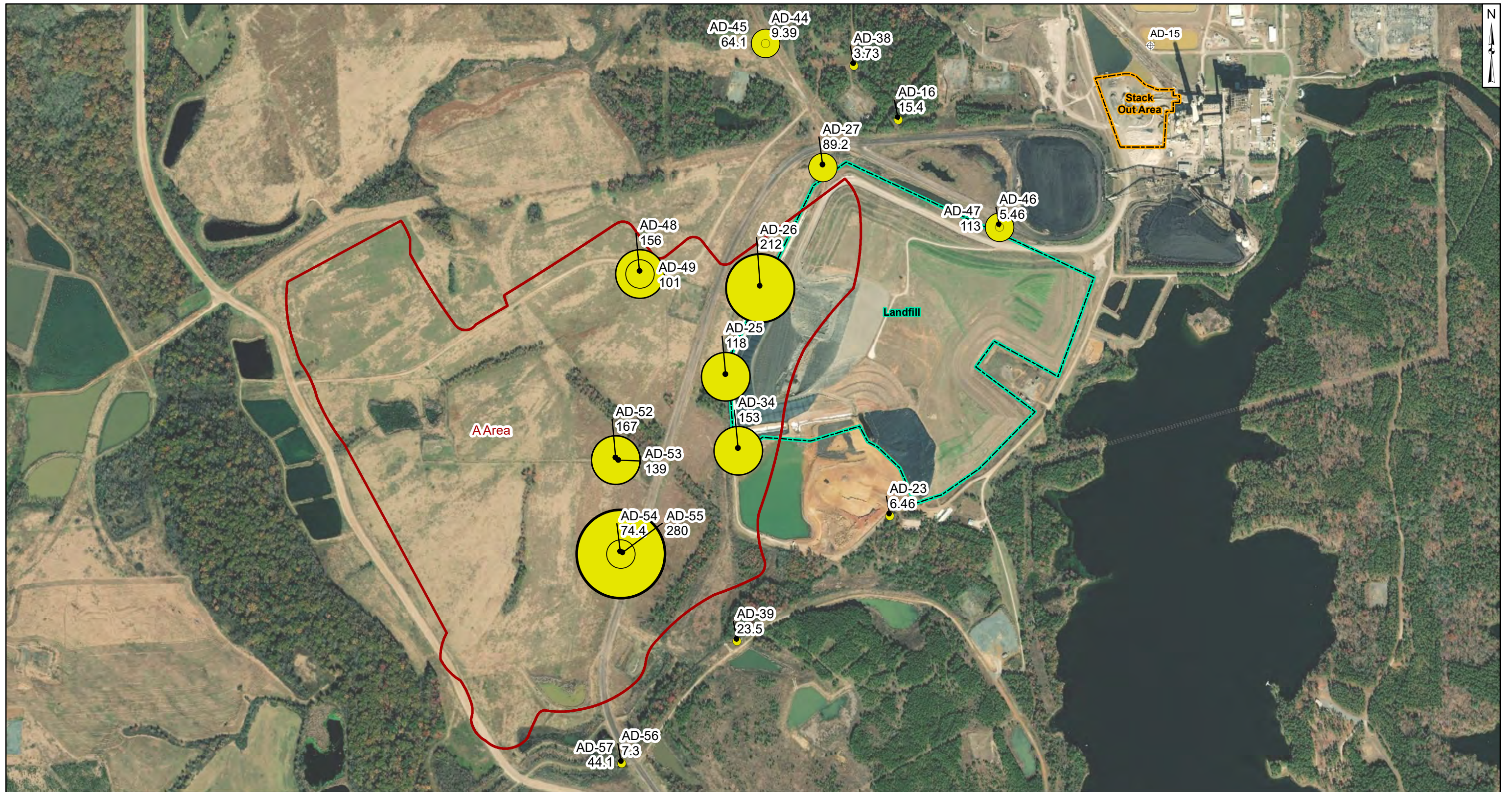
Cobalt Soil Values - Landfill Area
August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
5

Columbus, Ohio 2019/09/23



- 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 represented with data from the February 2019 sampling event.
- Area A is a former lignite (reclaimed) mine.



Spatial Distribution of Lithium in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

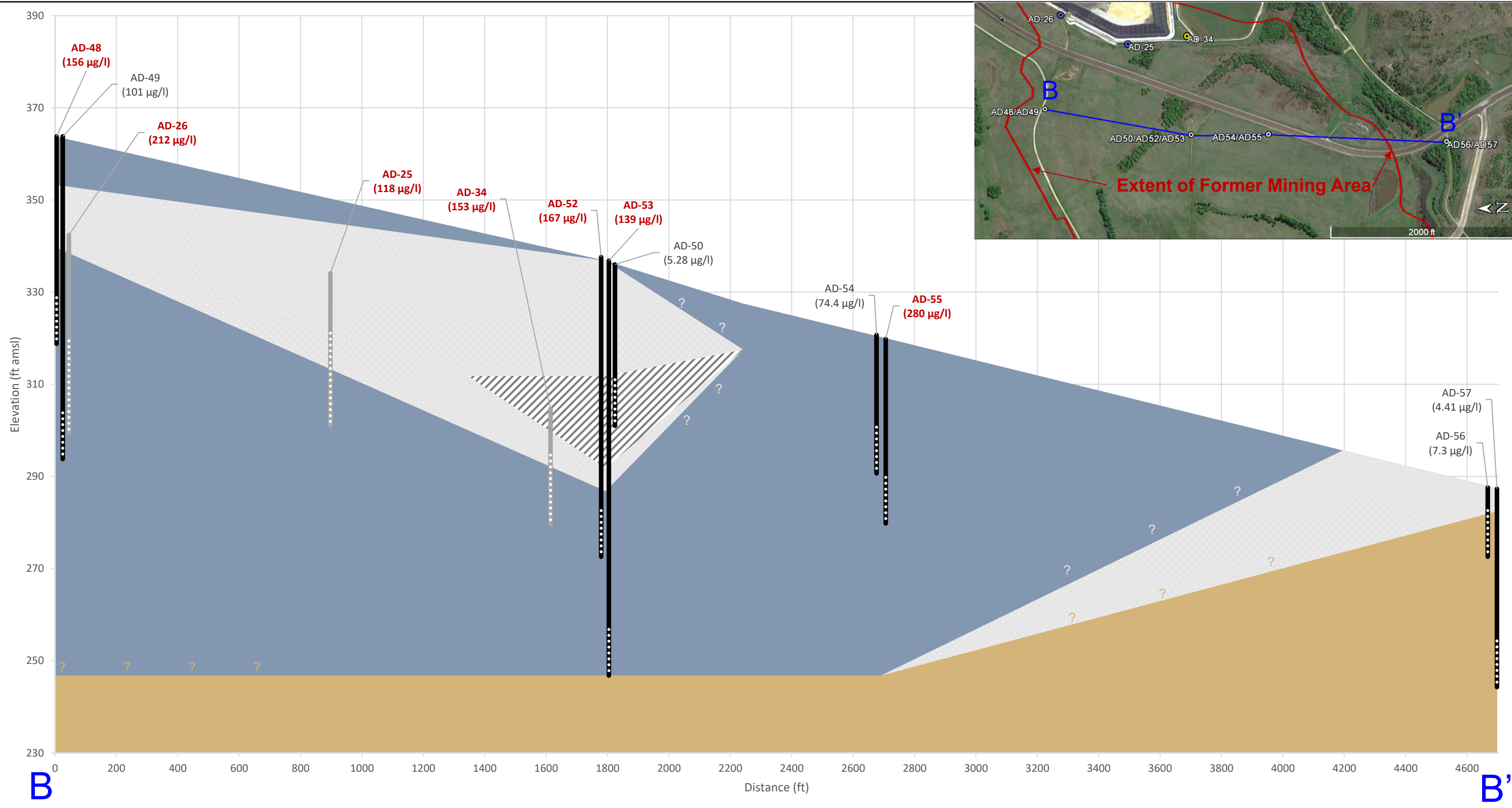
Geosyntec
consultants

Figure

6

Columbus, Ohio

2019/09/17



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.
 Lithium concentrations in micrograms per liter ($\mu\text{g/l}$)
 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 $110 \mu\text{g/L}$

Landfill Area Cross Section with Lithium Concentrations AEP Pirkey Power Plant Hallsville, Texas	
CHA8462	September 2019
Figure 7	

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**

Geosyntec Consultants, Inc.

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

Geosyntec Consultants, Inc.

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

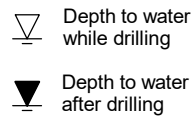
	Project Name AEP Pirkey CSM		Project No. 111173	Boring/Monitoring Well Number SB-07
	Coordinates N 6872868 E 3201272.9		Ground Elevation 363.80	Page 1 of 5
	Total Depth (feet) 70	Hole Size (inches) 6.75"	Driller J. Smith	

Drilling Rig Ardco 4x4	Drilling Company MHC X-Ploration
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Date 2/28/2019	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)	Remarks
363	1	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.	[Cross-hatch pattern]	NA	NA	NA	NA	NA	NA	NA	Log cuttings from 0'-5.0'.
362	2	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.	[Cross-hatch pattern]								
361	3		[Cross-hatch pattern]								
360	4	- with clay below 4.0'	[Cross-hatch pattern]								
359	5		[Cross-hatch pattern]								Sampled SB-7/7'-8' (1045)
358	6	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.	[Cross-hatch pattern]								
357	7	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.	[Cross-hatch pattern]	MC	1		NA	2.9/5	NA	NA	
356	8		[Cross-hatch pattern]								No free water observed
355	9	- thin very fine grained sand seam, some to little clay, moist at 8.9'	[Cross-hatch pattern]								
354	10		[Cross-hatch pattern]								
353	11	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.	[Dotted pattern]								
352	12	SAND, Gray (10YR 5/1), with silt, trace clay, few to trace inclusions (lignite, coal, and sandstone), damp, medium density; SP.	[Dotted pattern]	MC	2		NA	4.5/5	NA	NA	
351	13	SAND and GRAVEL, Gray (10YR 5/1), very fine grained sand, poorly sorted, little to some silt, damp, trace to few lignite clasts;	[Dotted pattern]								
350			[Dotted pattern]								

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19




Drilling Log, continued

	Boring/Monitoring Well Number SB-07	
	Project Name AEP Pirkey CSM	Page 2 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
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 sandstone 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. - moist, trace clay below 18.5'		MC	3		NA	4.3/5	NA	NA	
346	18										
345	19										
344	20										
343	21	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. SAND, Gray (10YR 5/1), very fine grained, poorly graded, some silte, few muscovite flakes, moist to wet; SP.		MC	4		NA	2.5/5	NA	NA	Sampled SB-7/22'-23'
342	22										
341	23	- trace to few inclusions (lignite, coal, ironstone, sandstone, and gravel) below 23.0'									
340	24										
339	25	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. 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											

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19


Drilling Log, continued

			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.	X	NA	NA	NA	NA	NA	NA	NA	
333	31		X								
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.	X								
331	33		X								
330	34		X								
329	35		X								
328	36		X								
327	37		X								
326	38		X								
325	39		X								
324	40		X								
323	41		X								
322	42		X								
321	43		X								
320			X								

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19


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
319 318 317 316 315 314 313 312 311 310 309 308 307 306 305	45 46 47 48 49 50 51 52 53 54 55 56 57 58	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	

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19

Drilling Log, continued

			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
304 303 302 301 300 299 298 297 296 295 294	60 61 62 63 64 65 66 67 68 69 70	<p>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'</p> <p>- trace to few red clay clasts below 65.0'</p>		NA	NA	NA	NA	NA	NA	NA	
	71 72 73	Boring terminated at 70 feet bgs.									Temporary Piezometer Installed on 2/28/2019

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

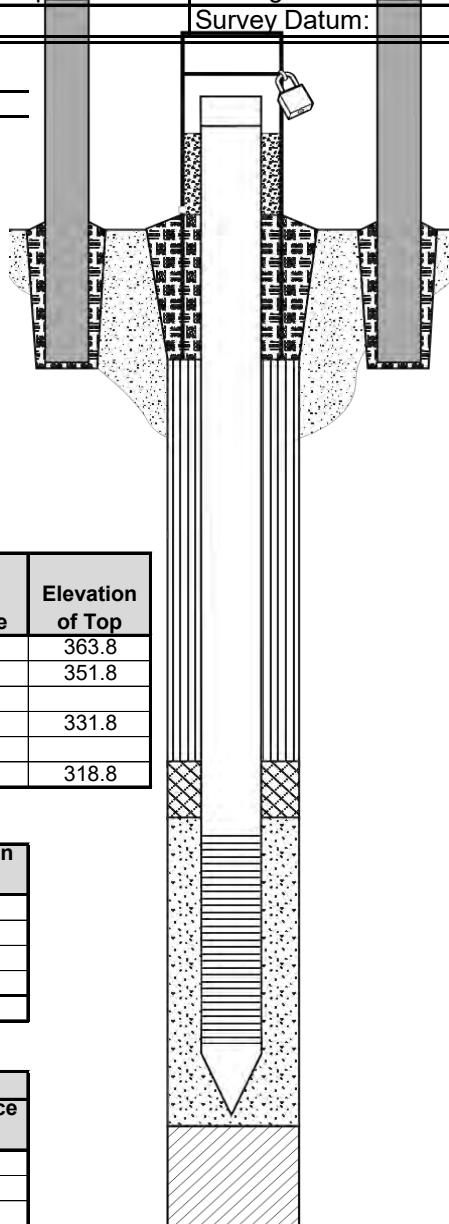
Elevations	
Top of Casing (TOC)	366.4
Ground Surface (GS)	363.8
Reference Point (RP)	ground surface

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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	45

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	32	45	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	45	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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

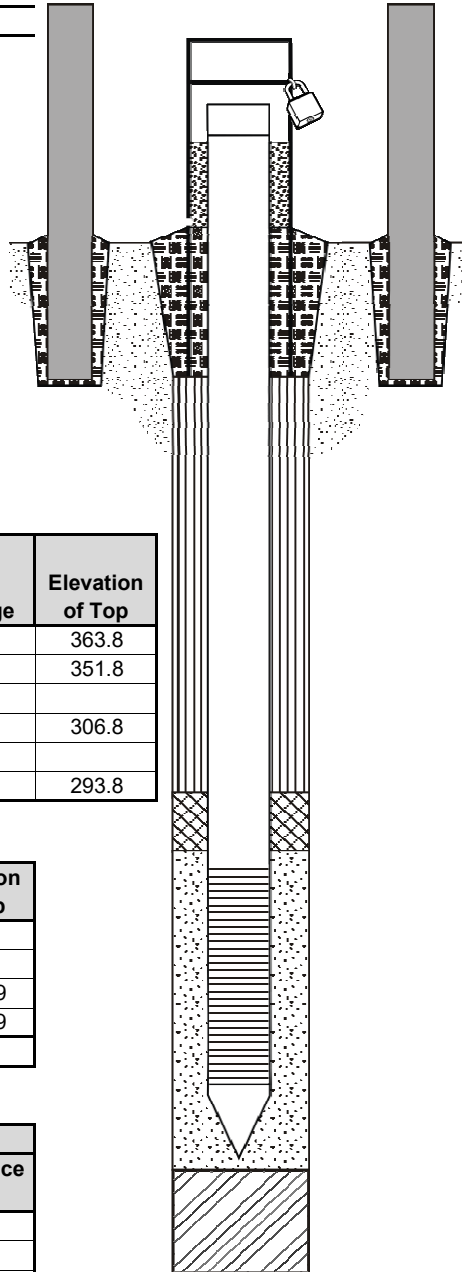
Elevations	
Top of Casing (TOC)	366.5
Ground Surface (GS)	363.8
Reference Point (RP)	ground surface

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
Well County: Harrison	Longitude: 094° 30' 08" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	70

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	57	70	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

Top (ft.)	Bottom (ft.)	Description
0	70	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

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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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-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
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Date 2/24/2019 to 2/26/2019	Logged By: C. Hoglund	Reviewed by:	Approved by:
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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
336	1	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 consistency; FILL.									
335	2			HA	1		NA	5/5			Hand dig from 0.0'-5.0'
334	3	- with very fine grained sand below 4.0'									
333	4										
332	5	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.									
331	6	- with silt to very fine sand lenses - few to little iron staining lenses, few ironstone inclusions									
330	7	- trace to few very fine grained sandstone inclusions, little to some lignite and rock fragments below 7.0'		MC	1		NA	4/5	NA	NA	
329	8	- increased very fine grained sand and inclusions below 8.0'									
328	9										
327	10										
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.									No free water observed
325	12	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.		MC	2		NA	3.2/5	NA	NA	
324	13										
323											

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19


Drilling Log, continued

			Boring/Monitoring Well Number	SB-08
	Project Name	AEP Pirkey CSM	Page	2 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
322	15	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'		MC	2		NA	3.2/5	NA	NA	
321	16			MC	3		NA	2.1/5	NA	NA	
320	17			MC	4		NA	0.6/5	NA	NA	
319	18			MC	5		NA	0/5	NA	NA	
318	19			MC	6		NA	0/5	NA	NA	
317	20		MC	7		NA	0/5	NA	NA		
316	21		MC	8		NA	0/5	NA	NA		
315	22		MC	9		NA	0/5	NA	NA		
314	23		MC	10		NA	0/5	NA	NA		
313	24		MC	11		NA	0/5	NA	NA		
312	25	No Recovery from 25.0'-45.0'.	NR								
311	26		MC	12		NA	0/5	NA	NA		
310	27		MC	13		NA	0/5	NA	NA		
309	28		MC	14		NA	0/5	NA	NA		
308	29		MC	15		NA	0/5	NA	NA		

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19


Drilling Log, continued


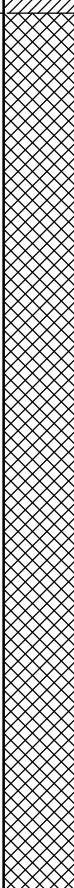
			Boring/Monitoring Well Number	SB-08
	Project Name	AEP Pirkey CSM	Page	3 of 7
	Project Number	111173	Date	2/24/2019 to 2/26/2019

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	
307	30	No Recovery from 25.0'-45.0'.	NR	MC	5		NA	0/5	NA	NA		
306	31			MC	6		NA	0/5	NA	NA		
305	32											
304	33											
303	34											
302	35											
301	36											
300	37											
299	38			MC	7		NA	0/5	NA	NA		
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												

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19


Drilling Log, continued


			Boring/Monitoring Well Number	SB-08
	Project Name	AEP Pirkey CSM	Page	4 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	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'									
286	51	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.									
285	52										
284	53										
283	54										
282	55										
281	56										
280	57										
279	58										
278											

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19


Drilling Log, continued

			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
277 276 275 274 273 272 271 270 269 268 267 266 265 264 263	60 61 62 63 64 65 66 67 68 69 70 71 72 73	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	

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19


Drilling Log, continued

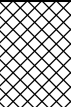

			Boring/Monitoring Well Number	SB-08
	Project Name	AEP Pirkey CSM	Page	6 of 7
	Project Number	111173	Date	2/24/2019 to 2/26/2019

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
262	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.	X	NA	NA	NA	NA	NA	NA	NA	
	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										

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19

Drilling Log, continued

			Boring/Monitoring Well Number	SB-08
	Project Name	AEP Pirkey CSM	Page	7 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
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.								
	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

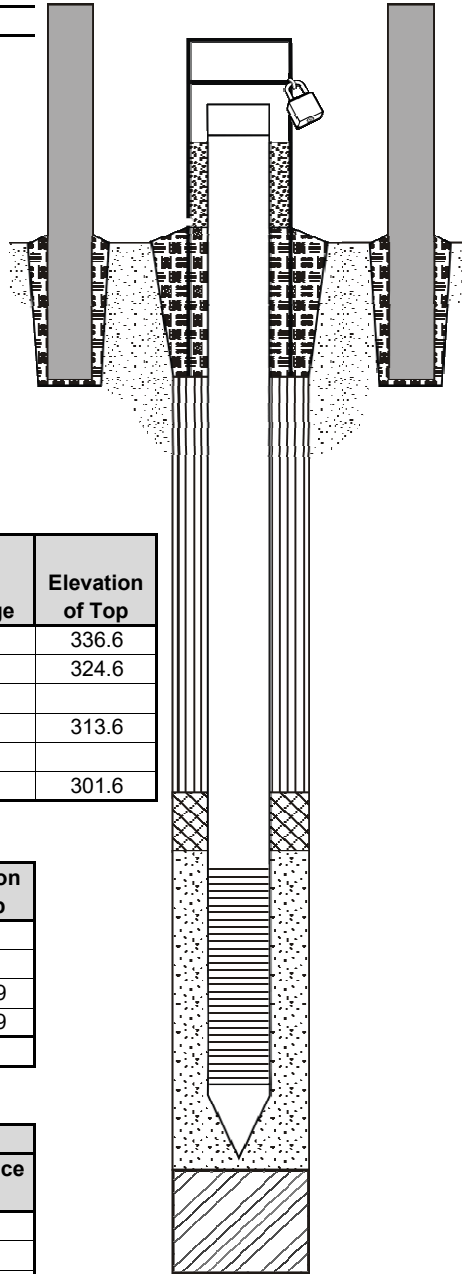
Elevations	
Top of Casing (TOC)	339.0
Ground Surface (GS)	336.6
Reference Point (RP)	ground surface

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
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	35

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	23	35	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	35	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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

Monitoring Well Construction Diagram

Project Number: 111173	Well Number: AD-52 (SB-81)
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

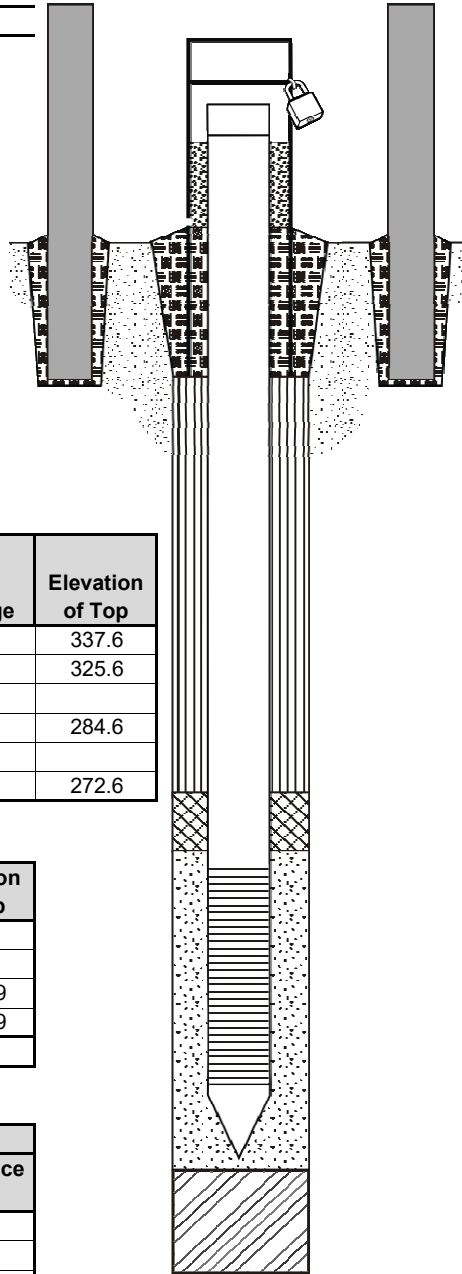
Elevations	
Top of Casing (TOC)	340.7
Ground Surface (GS)	337.6
Reference Point (RP)	ground surface

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
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
Type of Work: New Well	
Proposed Use: Monitor	

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	65

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	52	65	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	65	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
2	Riser	New Plastic (PVC)	40	0	55
2	Screen	New Plastic (PVC)	40 0.010	55	65

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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-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

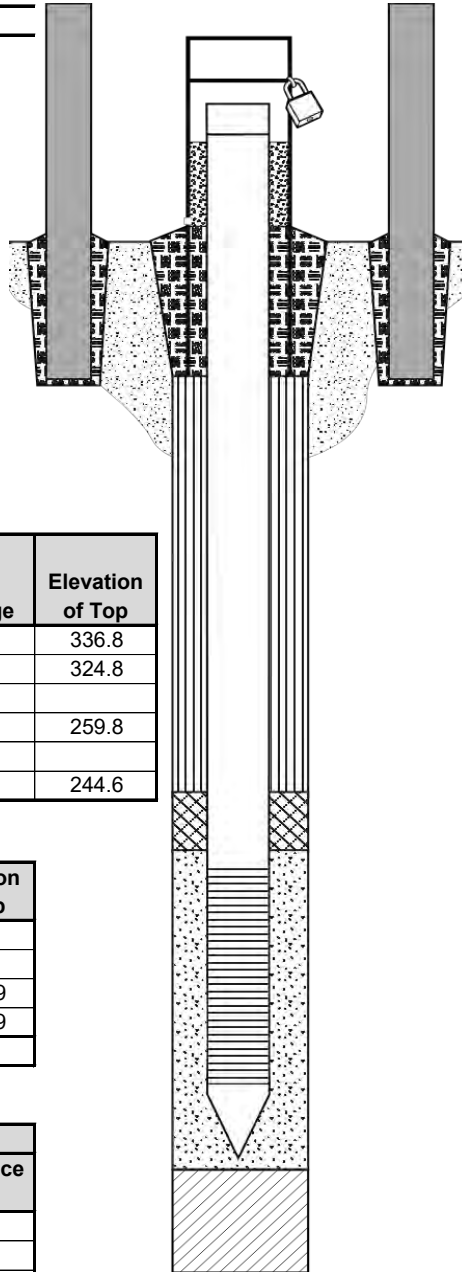
Elevations	
Top of Casing (TOC)	339.4
Ground Surface (GS)	336.8
Reference Point (RP)	ground surface

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
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	93

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	77	93	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	90	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)
90	93	gray clay (old pit base?)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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-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:
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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
319	1	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.	X	NA	NA	NA	NA	NA	NA	NA	Log from soil cuttings from 0'-5'.
318	2		X								
317	3		X								Sampled SB-09 5'-6'
316	4		X								
315	5	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.	X	NA	NA	NA	NA	NA	NA	NA	
314	6	3 Feet of slough (Based on driller's feel).									No free water observed
313	7							0.5/5			
312	8										No free water observed
311	9	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.	X	NA	NA	NA	NA	NA	NA	NA	
310	10	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	X	NA	NA	NA	NA	NA	NA	NA	
309	11		X								No free water observed
308	12		X					0.5/5			
307	13		X								
306			X								

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19


Drilling Log, continued

			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	15	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	0.5/5	NA	NA	Log from soil cuttings below 20.0'. Sampled SB-09 20'-21'
304	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	18	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			
301	19										
300	20	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	
299	21										
298	22										
297	23										
296	24										
295	25	SILT and SAND and CLAY, reddish Yellow (7.5YR 6/6); FILL. Mine Reclaim.									
294	26										
293	27										
292	28										
291											

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19


Drilling Log, continued


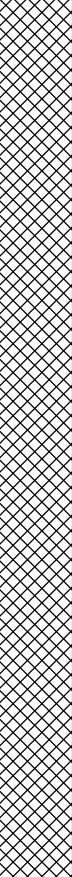
	Project Name AEP Pirkey CSM		Boring/Monitoring Well Number SB-09
	Project Number 111173		Page 3 of 5
			Date 3/4/2019

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
290	30	SILT and SAND and CLAY, reddish Yellow (7.5YR 6/6); FILL. Mine Reclaim.	[Cross-hatched pattern]	NA	NA	NA	NA	NA	NA	NA	
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.	[Cross-hatched pattern]								
279	41										
278	42										
277	43										
276											

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19


Drilling Log, continued


			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
275	45	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	
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.		NA	NA	NA	NA	NA	NA		
269	51										
268	52										
267	53										
266	54										
265	55										
264	56										
263	57										
262	58										
261	59										

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19

Drilling Log, continued

			Boring/Monitoring Well Number	SB-09
	Project Name	AEP Pirkey CSM	Page	5 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
260	60	Boring terminated at 60 feet bgs.		NA	NA	NA	NA	NA	NA	NA	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

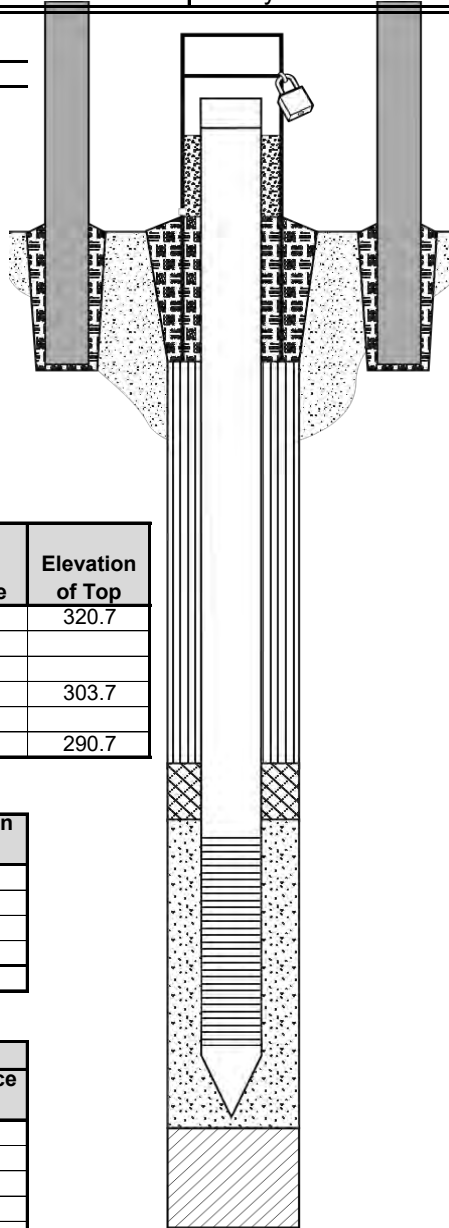
Elevations	
Top of Casing (TOC)	323.7
Ground Surface (GS)	320.7
Reference Point (RP)	ground surface

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
Gauge 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
Well County: Harrison	Longitude: 094° 30' 11" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **3/5/2019**

Drilling End Date: **3/5/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	30

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	17	30	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	0	12	Cement
	12	17	Bentonite 1 Bags/Sacks

Seal Method: **Gravity**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	30	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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

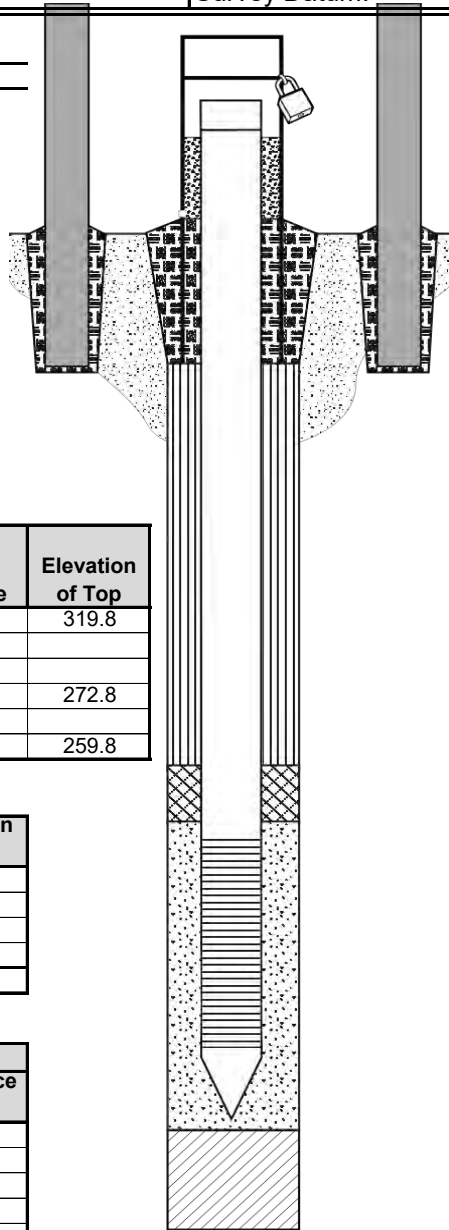
Elevations	
Top of Casing (TOC)	321.9
Ground Surface (GS)	319.8
Reference Point (RP)	ground surface

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
Well County: Harrison	Longitude: 094° 30' 11" W
	Elevation: No Data
Type of Work: New Well	
Proposed Use: Monitor	

Drilling Start Date: **3/4/2019** Drilling End Date: **3/4/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	60

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	48	60	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	60	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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

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
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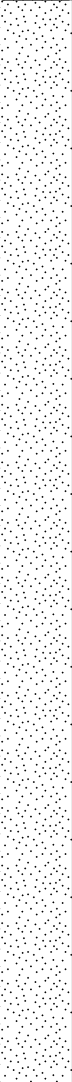
Date 3/7/2019	Logged By: J.Hermanson	Reviewed by:	Approved by:
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Elevation (MSL)	Depth (feet bgs)	Description	Graphic Log	Sample Type	Sample Number	Blow Count	N Value	Sample Recovery/Length (feet)	Penetrometer (tsf)	PID Reading (ppm)	Remarks
	1	SILT, Brown (7.5YR 4/2), with very fine grained sand, damp, low to medium, low to medium plasticity; FILL.	[Cross-hatch pattern]								
	2	clayey GRAVEL, gravel-sand-clay mixture, strong Brown (7.5YR 5/6), coarse grained gravel, fine grained sand, wet, trace to medium plasticity; FILL.	[Cross-hatch pattern]	MC	1		NA	4/5	NA	NA	
	5	CLAY, dark yellowish Brown (10YR 4/6), some sand, damp to moist, medium plasticity; CL.	[Diagonal lines pattern]								
	8	SAND, light Gray (7.5YR 7/1), fine grained, trace clay, damp, medium density; SP.	[Dotted pattern]	MC	2		NA	3/5	NA	NA	
	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.	[Diagonal lines pattern]								
	10	SAND, pinkish Gray (7.5YR 7/2), fine grained, trace clay, wet, medium density; SP.	[Dotted pattern]								▽
	11										Free water observed at approximately 10.0'
	12	CLAY, light reddish Gray (2.5YR 7/1), trace sand, damp, medium density, medium plasticity; CL.	[Diagonal lines pattern]	MC	3		NA	3/5	NA	NA	
	13										


AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19

Drilling Log, continued

			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
	15	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	
	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	SAND, Gray (7.5YR 5/1), very fine grained, with clay laminations, trace iron ore laminations, dry, dense; SP.									
	24	- iron ore laminations grade out, increased sand content below 24.0'									
	22			MC	5		NA	4/5	NA	NA	
	27			MC	6		NA	5/10	NA	NA	

Drilling Log, continued

			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
	30	SAND, Gray (7.5YR 5/1), very fine grained, with clay laminations, trace iron ore laminations, dry, dense; SP.	[Dotted Pattern]	MC	6		NA	5/10	NA	NA	
	31										
	32										
	33										
	34										
	35										
	36										
	37										
	38										
	39										
	40	SAND, dark Gray (7.5YR 4/1), very fine grained, trace clay, moist, medium density; SP.	[Dotted Pattern]	MC	7		NA	8/8	NA	NA	
	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

AEP_PIRKEY_SOILBORINGLOGS.GPJ 5/9/19

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

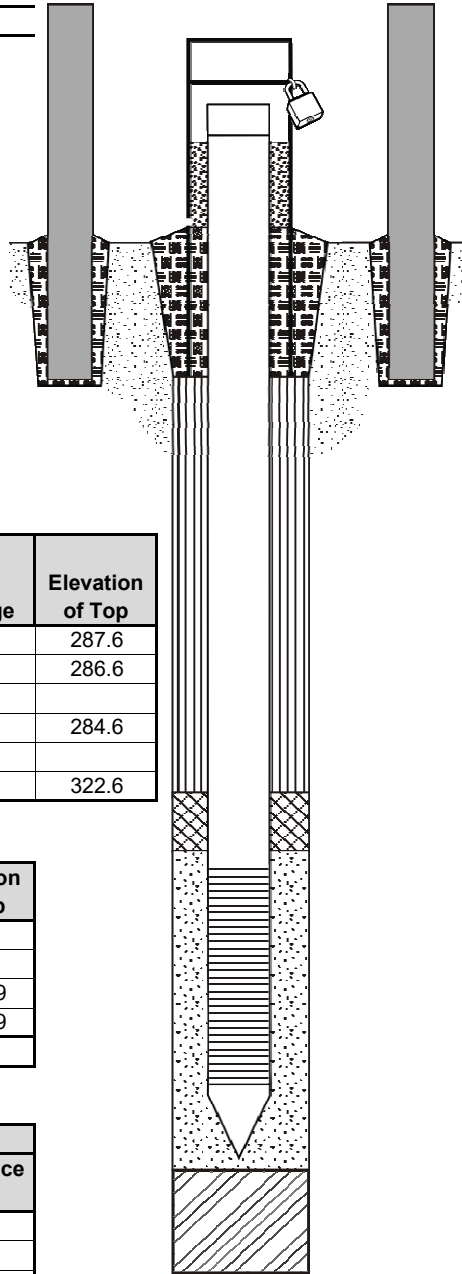
Elevations	
Top of Casing (TOC)	290.0
Ground Surface (GS)	287.6
Reference Point (RP)	ground surface

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
Well County: Harrison	Longitude: 094° 30' 11" W
	Elevation: No Data
<hr/>	
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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	18	tan and brown sandy, silty clay and occasional gravel

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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

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

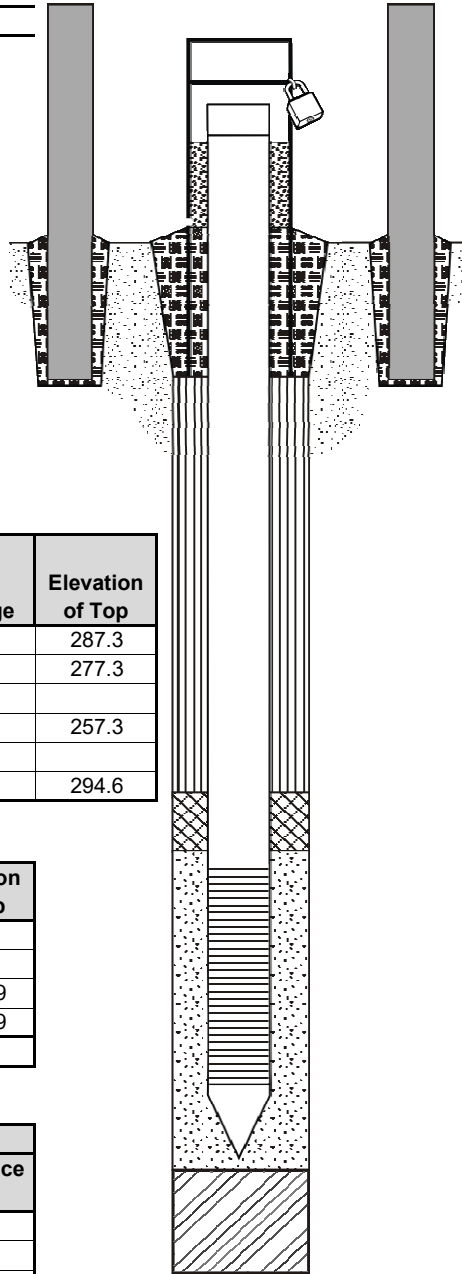
Elevations	
Top of Casing (TOC)	290.0
Ground Surface (GS)	287.3
Reference Point (RP)	ground surface

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

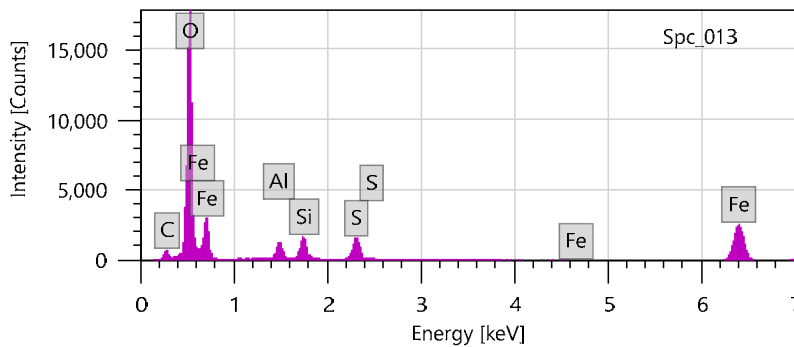
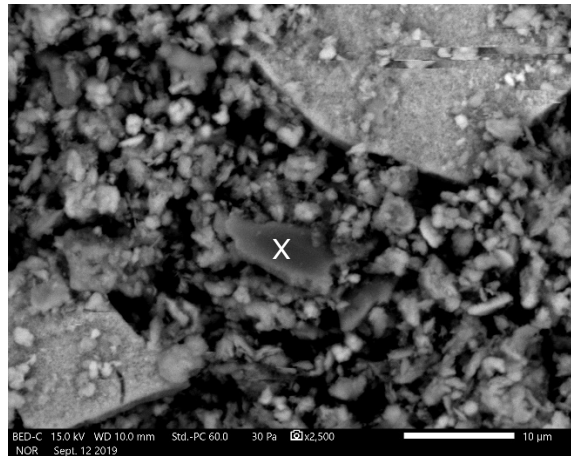
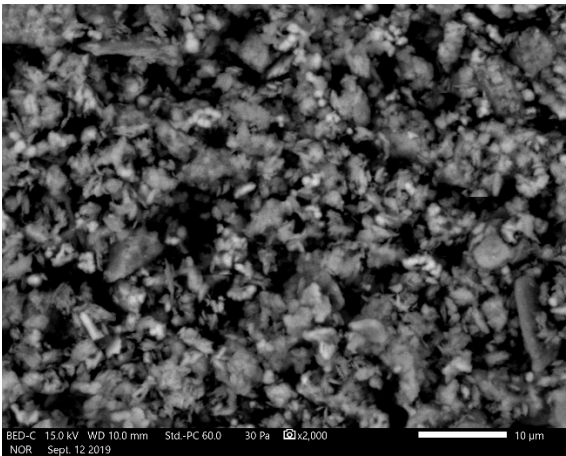
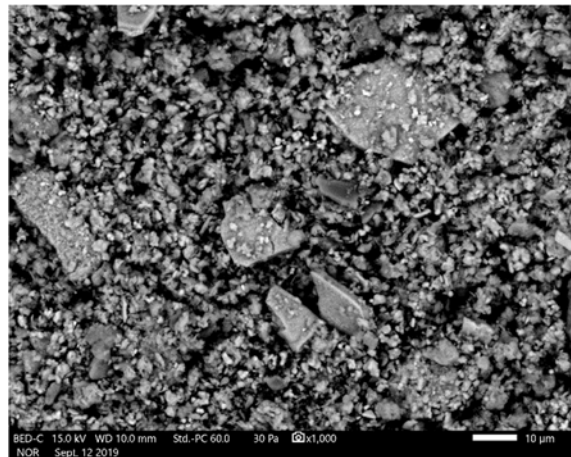
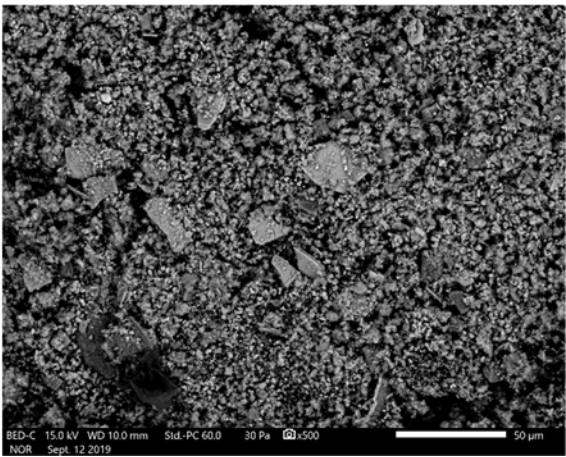
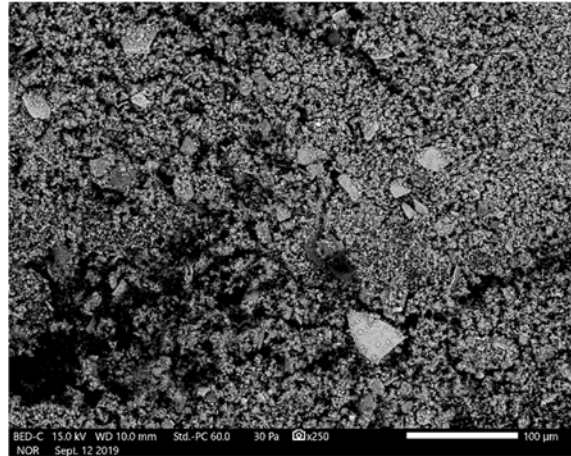
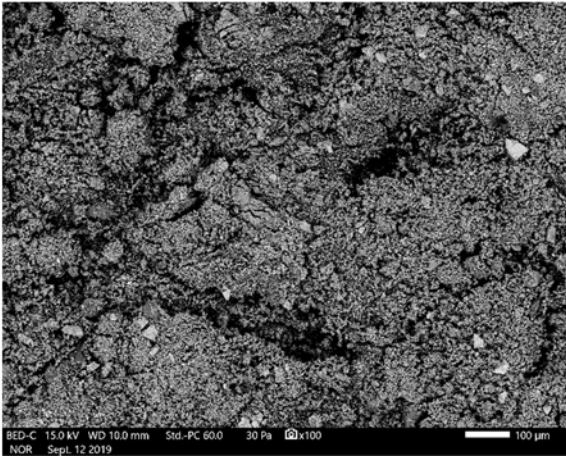
Casing Materials Measurements	Total Footage	Elevation of Top
Total Riser Installed	33.00	NA
Total Riser Cutoff	0.69	NA
Screen	10.00	308.39
Bottom Cap	0.28	298.39
Total Depth from TOC	42.59	

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

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



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

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Figure 1	Site Layout
Figure 2	Piper Diagram – Landfill Area Wells
Figure 3	Landfill Area Sulfate Values
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Figure 5	AD-34 Appendix III Time Series Graphs
Figure 6	AD-23 Boron Time Series Graph
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TABLES

Table 1	Initial Detection Monitoring Data Evaluation
Table 2	2016-2017 Background Groundwater Data
Table 3	Detection Monitoring Data Evaluation - Updated Background Prediction Limits

ATTACHMENTS

Attachment A	Revised Statistical Output
Attachment B	Certification by a Qualified Professional Engineer

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

- AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.
- AEP, 2019. Annual Groundwater Monitoring Report. Southwestern Electric Power Company – H.W. Pirkey Plant Landfill CCR Management Unit. January.
- Burns & McDonnell Engineering Company, Inc. 2019. Alternate Source Demonstration Evaluation Report. H. W. Pirkey Plant. Landfill CCR Management Unit. April.
- Cunningham, W.L. and Jones. R. L. 1990. Long-Term Effects of Surface Coal Mining on Groundwater Levels and Quality in Two Small Watersheds in Eastern Ohio. USGS Water-Resources Investigations Report 90-4136.
- Geosyntec Consultants. 2018a. Statistical Analysis Summary – Landfill. H.W. Pirkey Power Plant. Hallsville, Texas. January.
- Geosyntec Consultants. 2018b. Statistical Analysis Summary – Landfill. H.W. Pirkey Power Plant. Hallsville, Texas. December.
- Geosyntec Consultants. 2019a. Statistical Analysis Summary – Landfill. H.W. Pirkey Power Plant. Hallsville, Texas. July.
- Geosyntec Consultants, 2019b. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Plant, East Bottom Ash Pond. Hallsville, Texas. September.
- Skousen, J. and Zipper, C.E., 2014. Post-mining policies and practices in the Eastern USA coal region. International Journal of Coal Science & Technology, 1, pp.135-151.
- United States Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09/007. March.

FIGURES



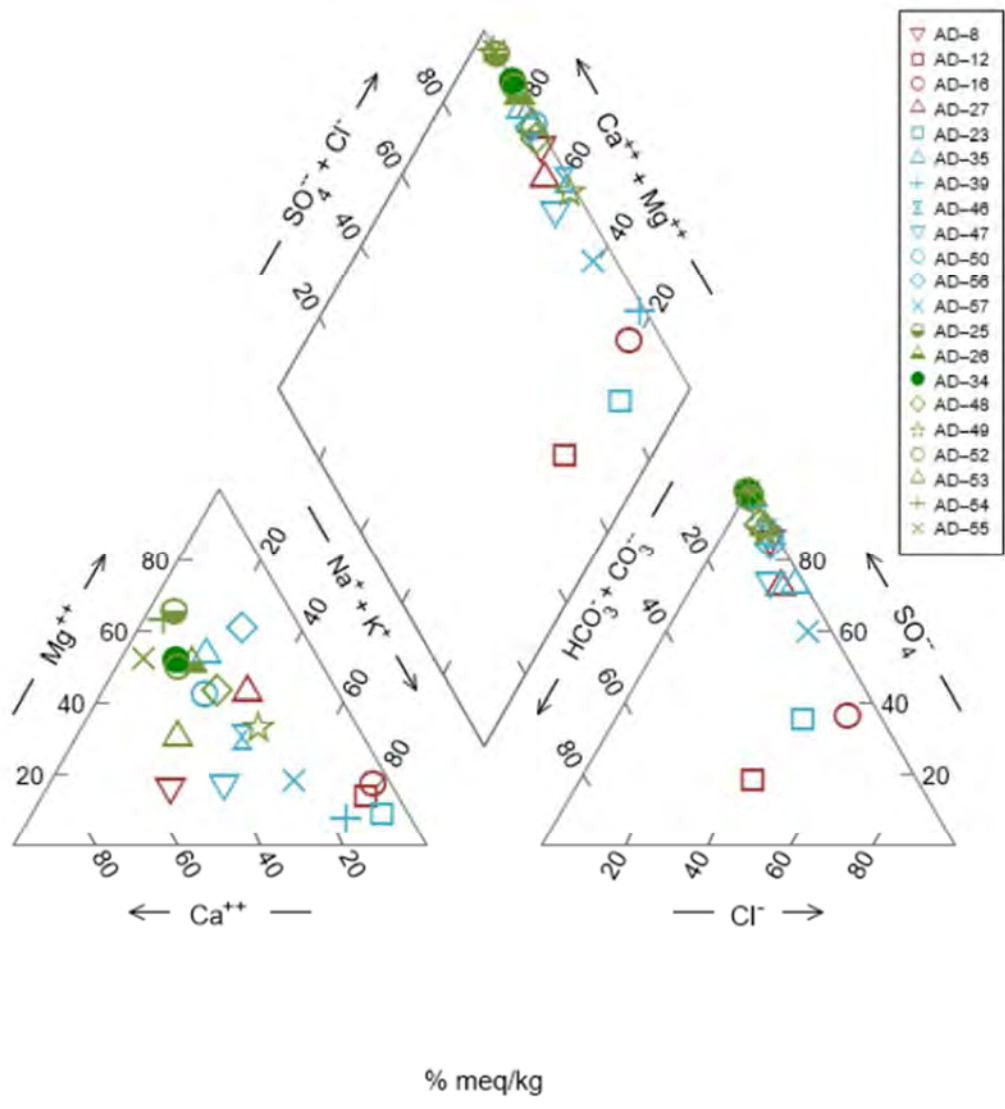
- Legend**
- Upgradient Well
 - Downgradient Well
 - Out of Network Well
 - Abandoned Well
 - A Area
 - Landfill

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.



<p>Site Layout</p> <p>AEP Pirkey Power Plant Hallsville, Texas</p>		<p>Figure 1</p>
Columbus, Ohio	2020/01/06	



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

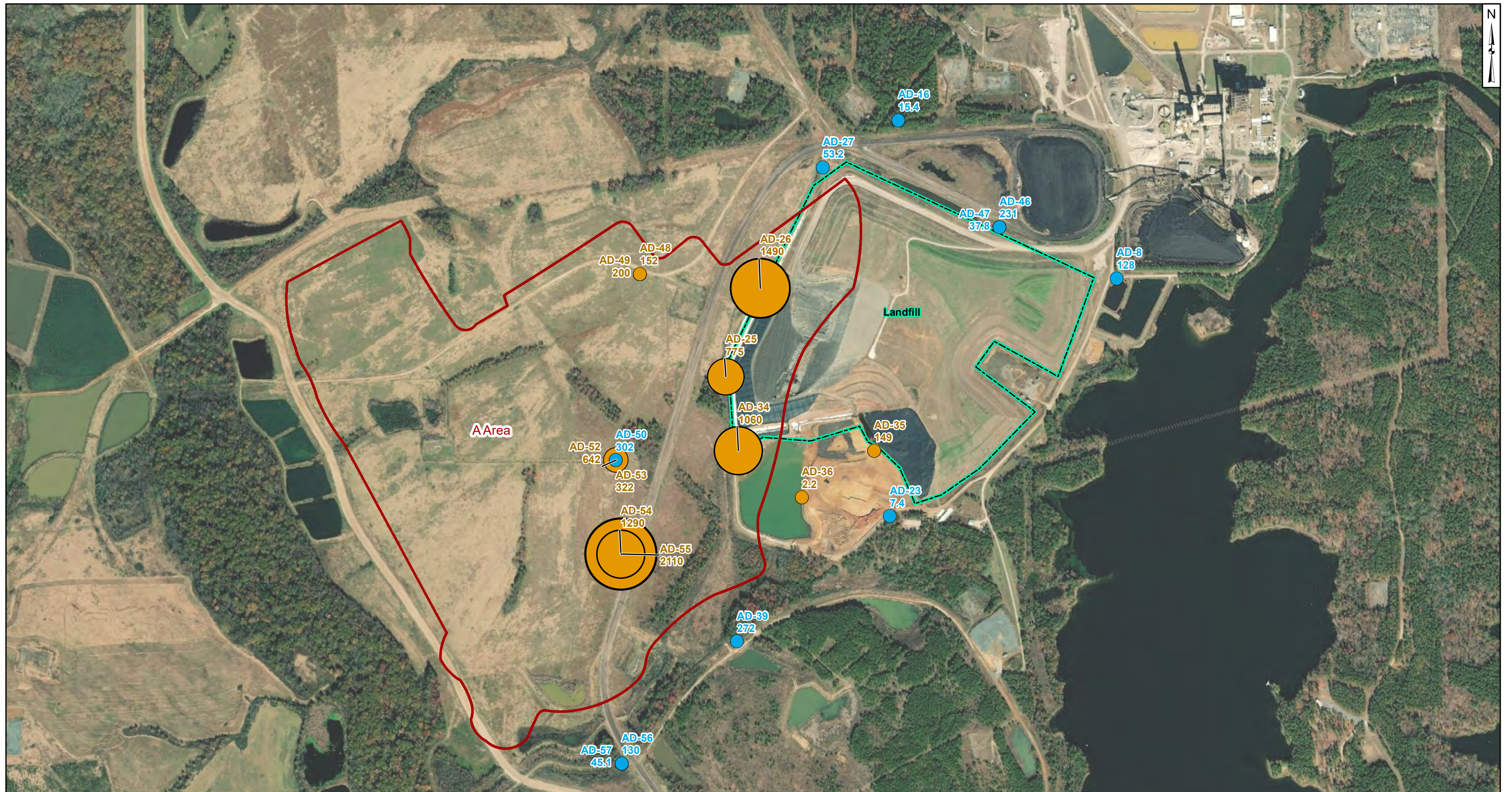


Columbus, Ohio

19-Sep-2019

Figure
2

internal info. path. date. revised. author



- 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.



Landfill Area Sulfate Values

AEP Pirkey Power Plant
Hallsville, Texas

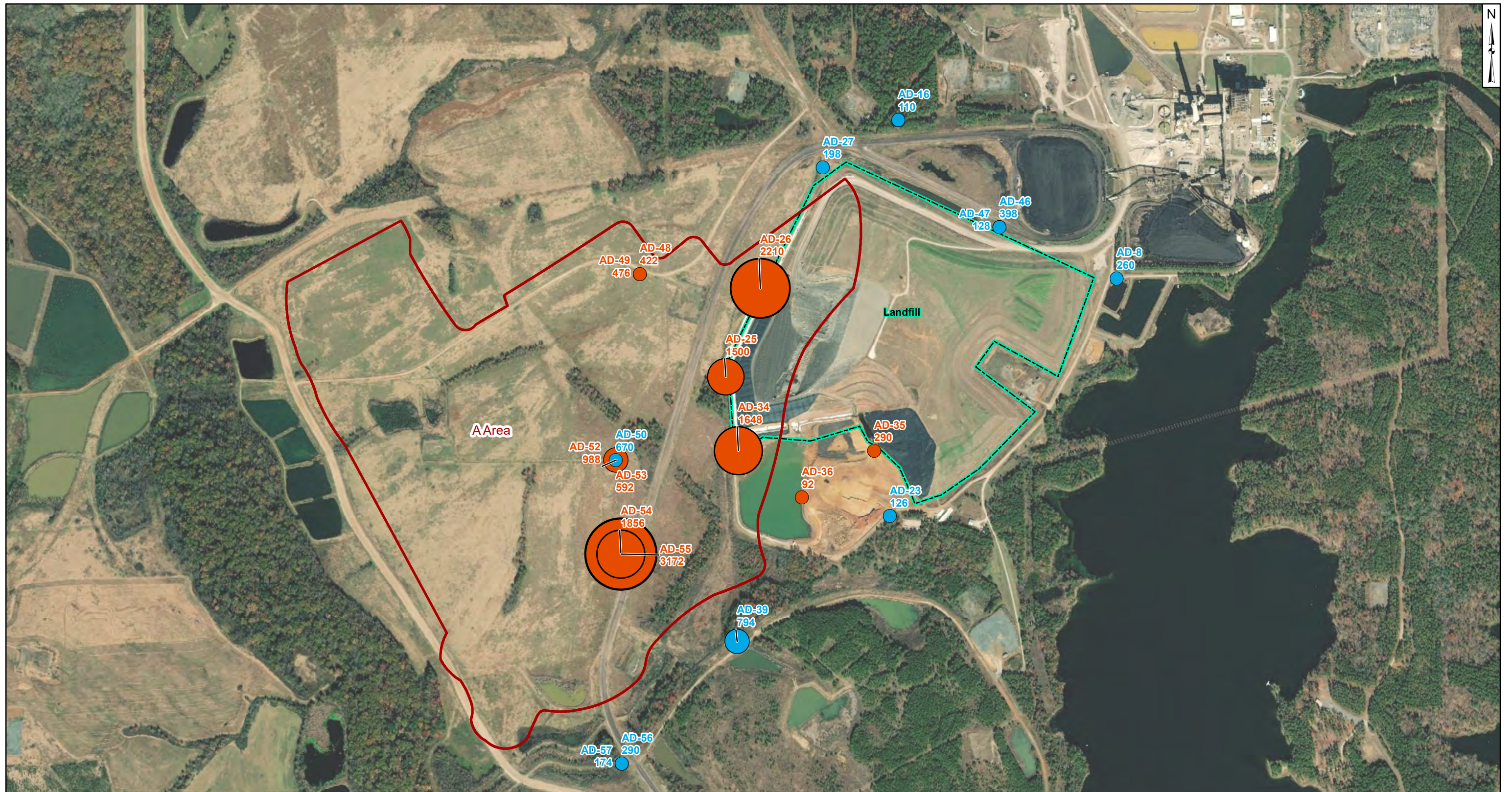
Geosyntec
consultants

Figure

3

Columbus, Ohio

2020/01/06



Legend

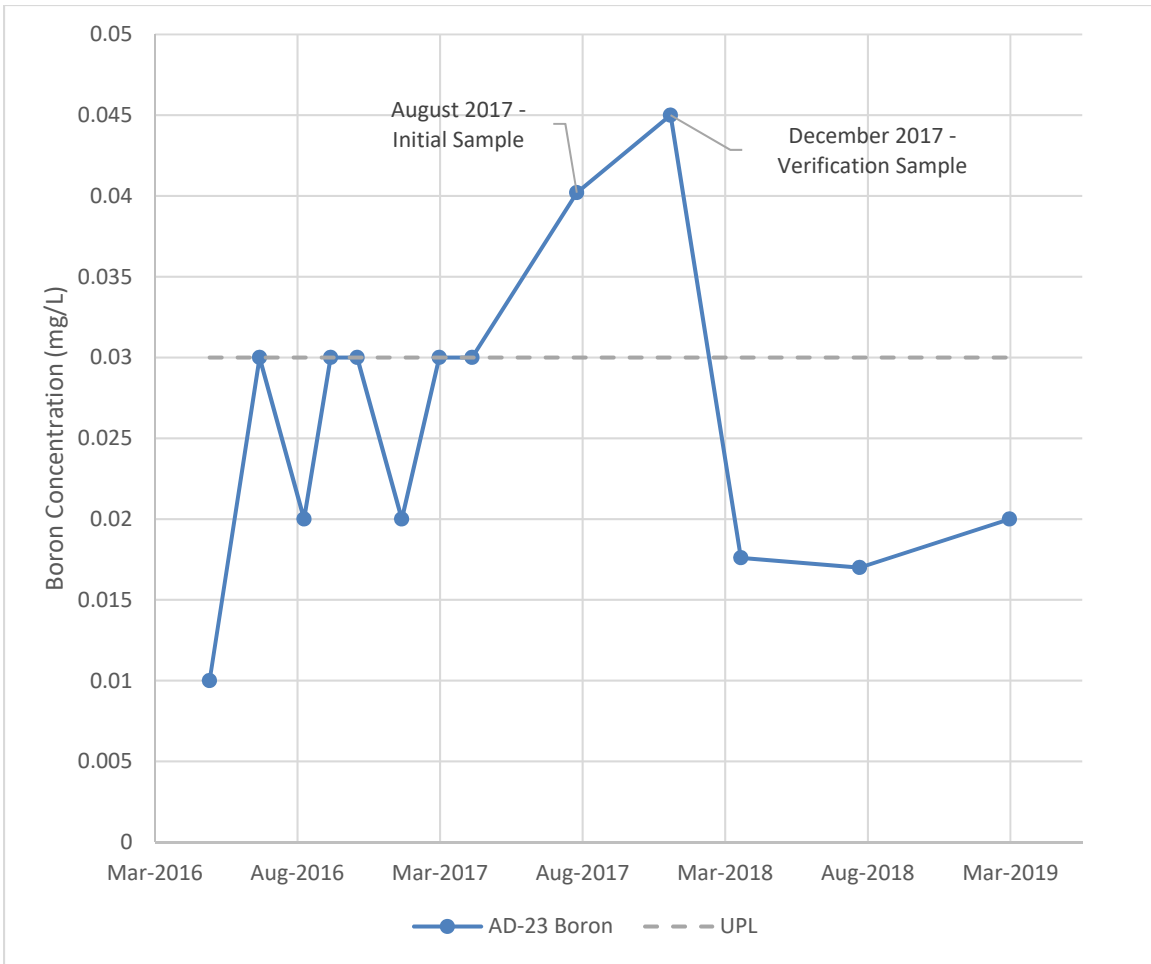
- Wells not screened in mine spoil
- Wells screened in mine spoil
- A Area
- Landfill

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 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.



Landfill Area Total Dissolved Solids Values	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2020/01/06
Figure 4	



Notes:
 mg/L: milligrams per liter
 UPL: Upper prediction limit

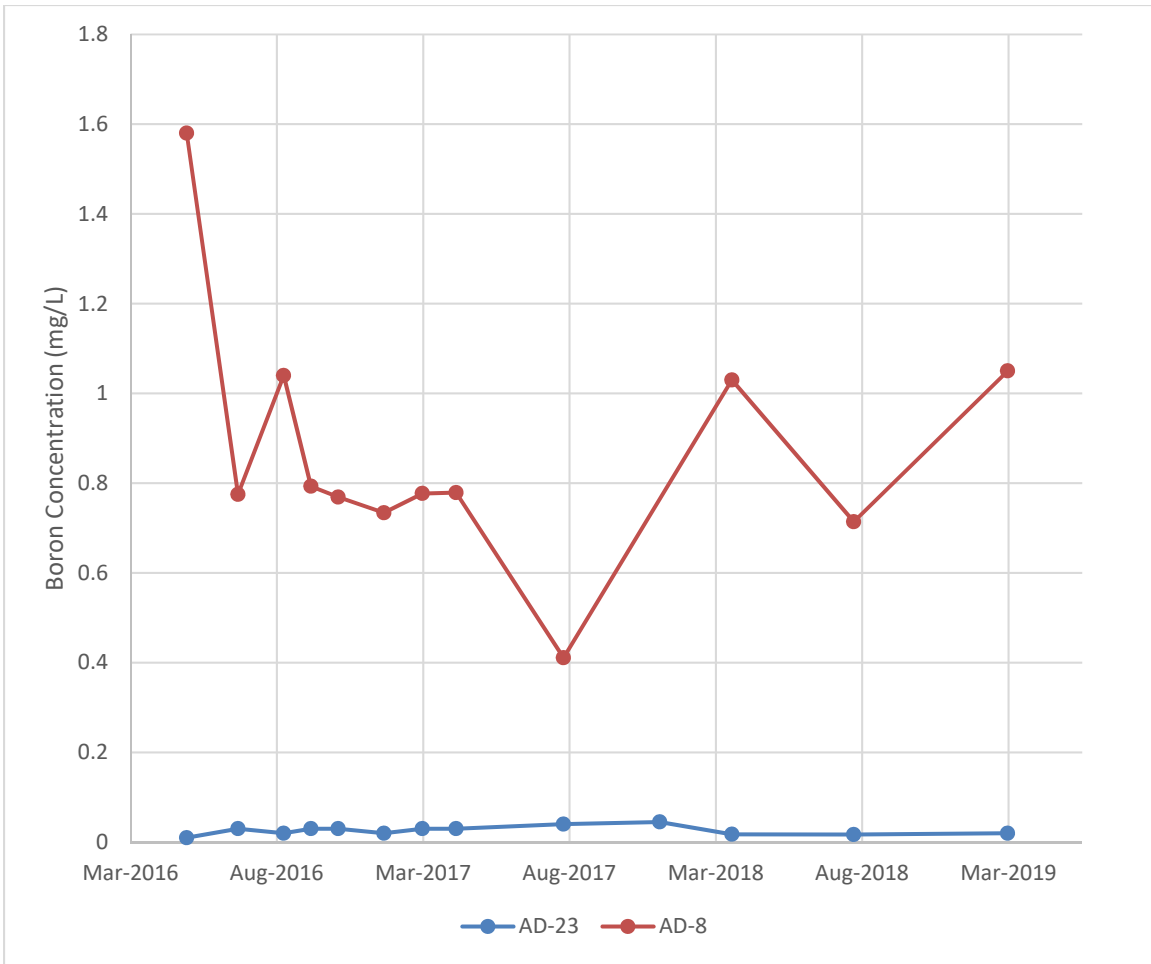
AD-23 Boron Time Series Graph
 Pirkey Landfill



Columbus, Ohio

12-Dec-2019

Figure
6



Notes:
 mg/L: milligrams per liter
 AD-8 is an upgradient well in the Pirkey LF monitoring network.

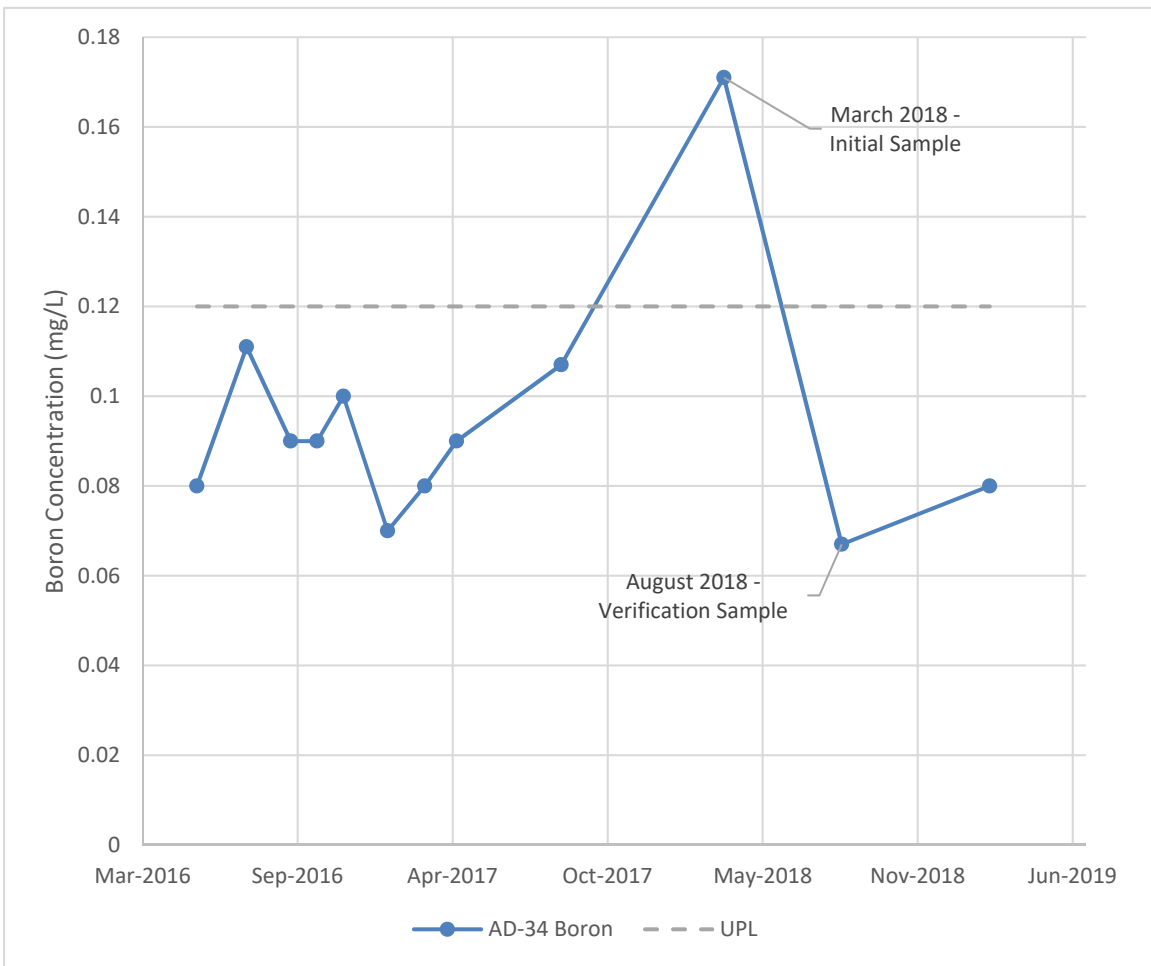
AD-23 and AD-8 Boron Time Series Graphs
 Pirkey Landfill



Figure
 7

Columbus, Ohio

12-Dec-2019



Notes:
 mg/L: milligrams per liter
 UPL: Upper prediction limit

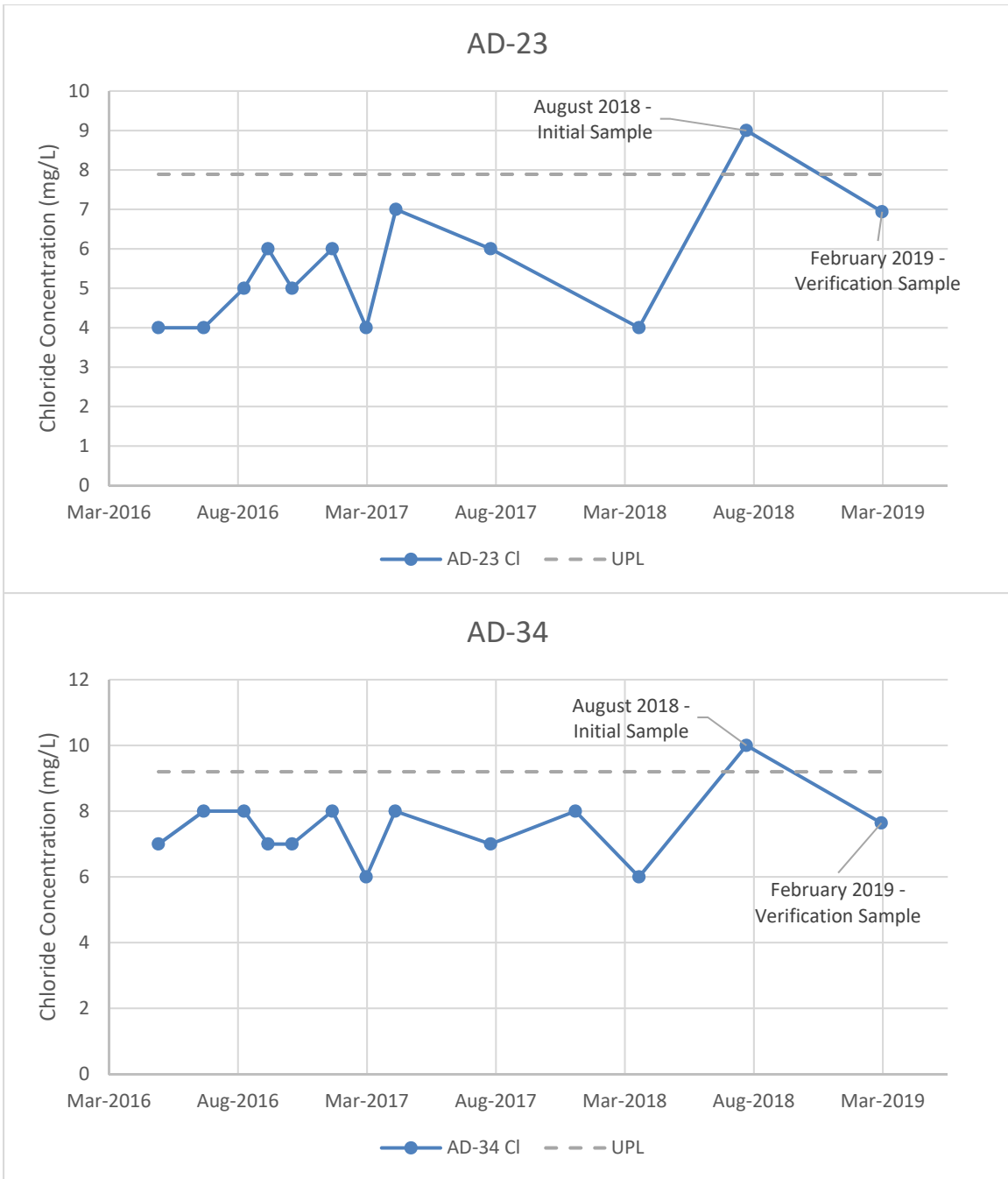
AD-34 Boron Time Series Graph
 Pirkey Landfill



Columbus, Ohio

12-Dec-2019

Figure
8



Notes:
 mg/L: milligrams per liter
 UPL: Upper prediction limit

AD-23 and AD-34
Chloride Time Series Graphs
 Pirkey Landfill



Figure
9

Columbus, Ohio

12-Dec-2019

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**

Geosyntec Consultants, Inc.

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**

Geosyntec Consultants, Inc.

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**

Geosyntec Consultants, Inc.

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**

Geosyntec Consultants, Inc.

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**

Geosyntec Consultants, Inc.

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**

Geosyntec Consultants, Inc.

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**

Geosyntec Consultants, Inc.

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
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
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
Chloride	mg/L	Intrawell Background Value (UPL)	7.89					9.2				
		Detection Monitoring Result	6	--	4	9	6.94	--	7	8	6	10
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
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
Sulfate	mg/L	Intrawell Background Value (UPL)	15.8					1388				
		Detection Monitoring Result	11	--	10	11	7.2	--	1231	1020	956	1060
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

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 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.

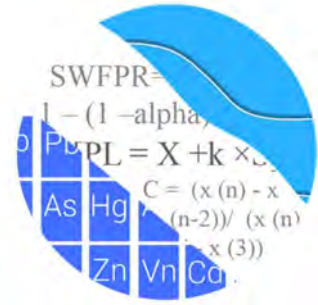
Based on a revised understanding of the site, the Appendix III prediction limits were recalculated for intrawell tests using the background dataset.

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.

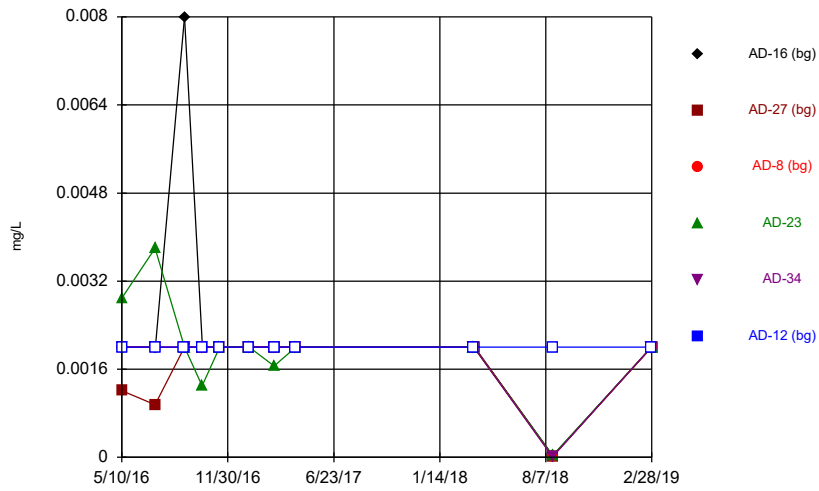
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Landfill. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

A handwritten signature in black ink that reads "Kristina Rayner". The signature is written in a cursive, flowing style.

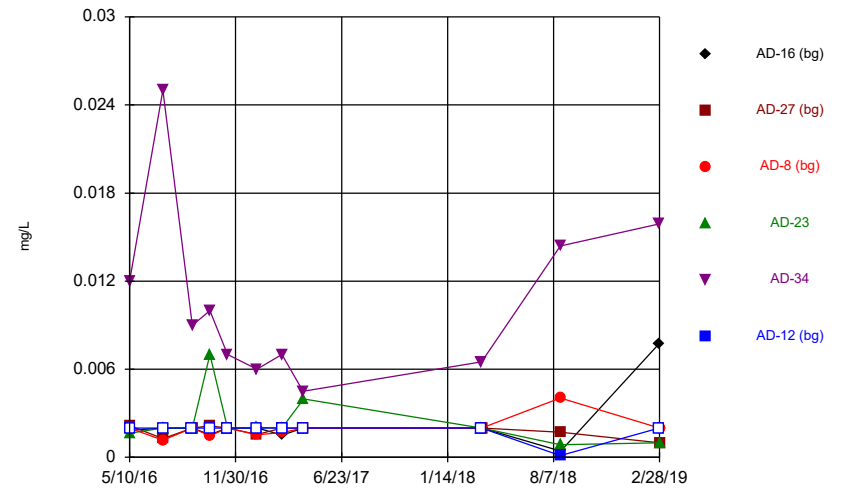
Kristina L. Rayner
Groundwater Statistician

Time Series



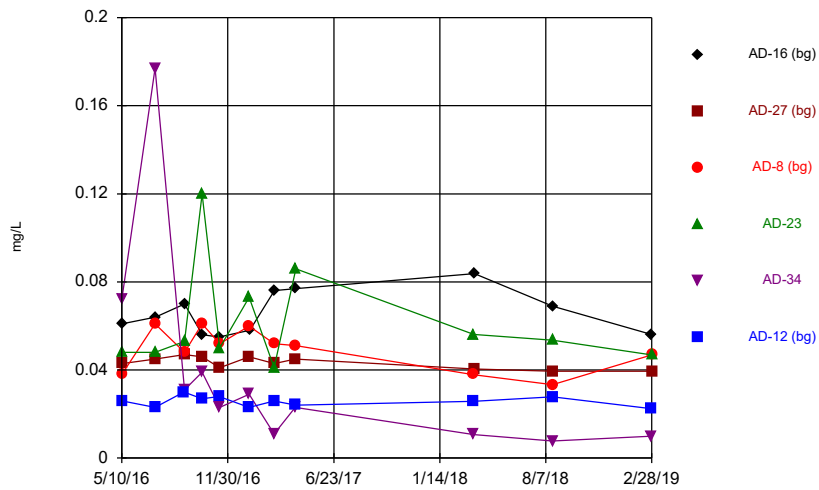
Constituent: Antimony, total Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



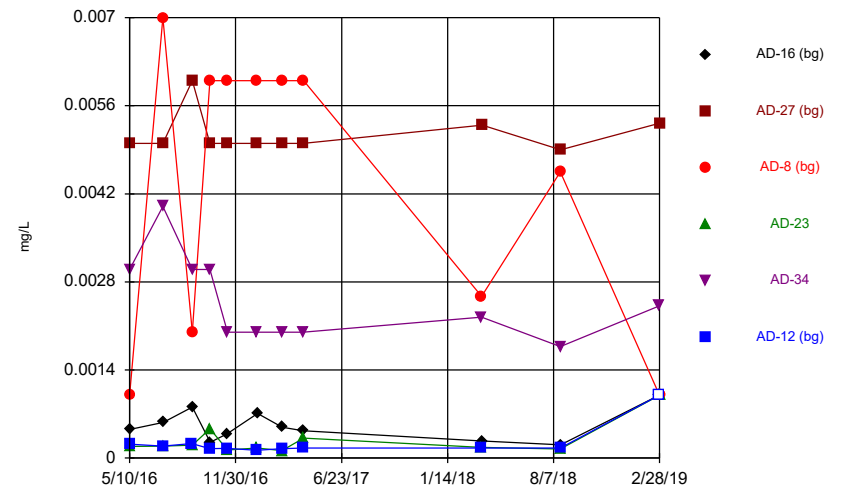
Constituent: Arsenic, total Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



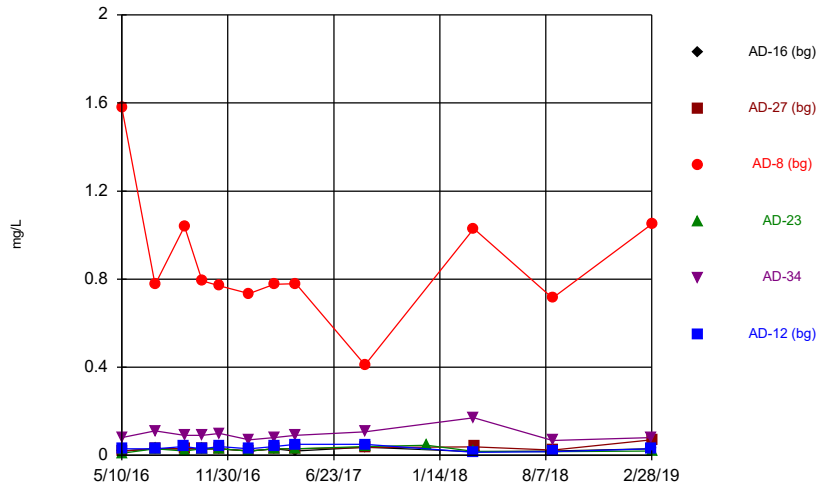
Constituent: Barium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



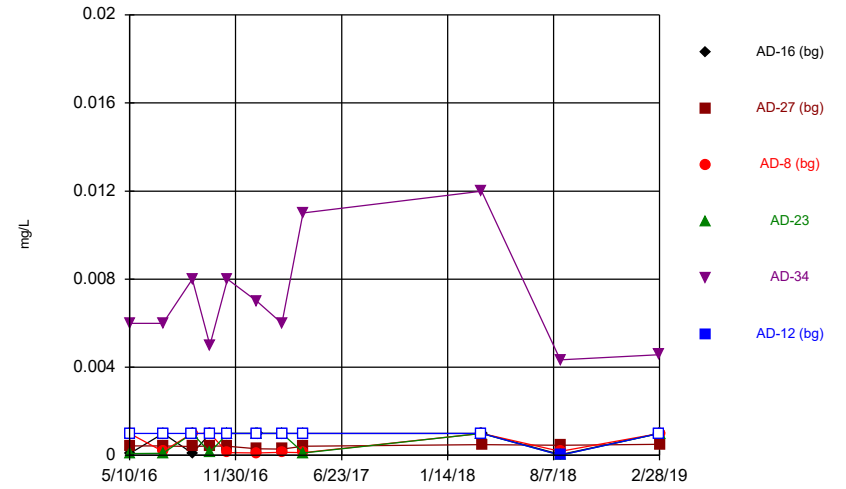
Constituent: Beryllium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



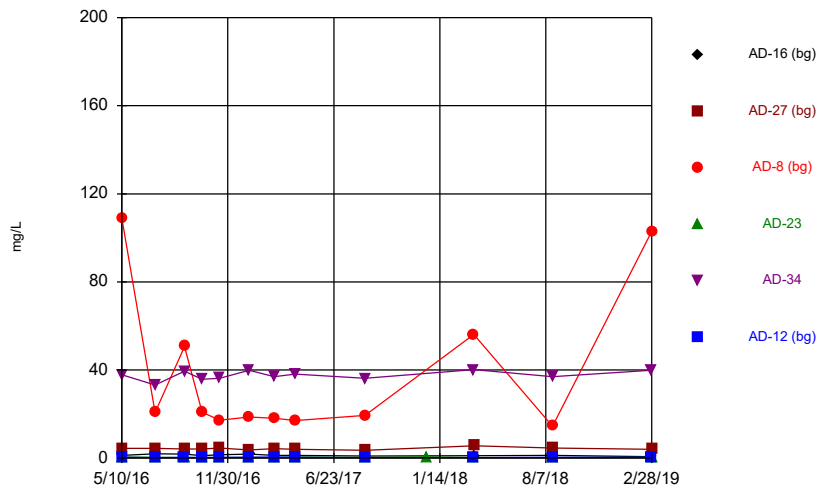
Constituent: Boron, total Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



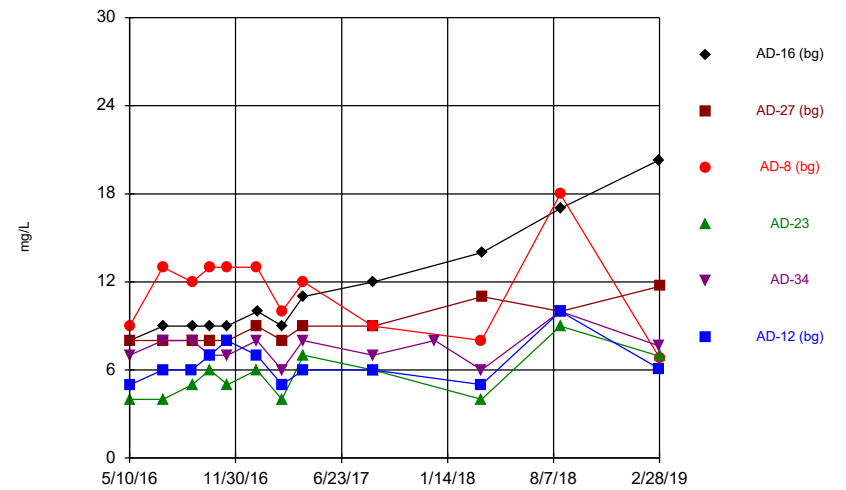
Constituent: Cadmium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



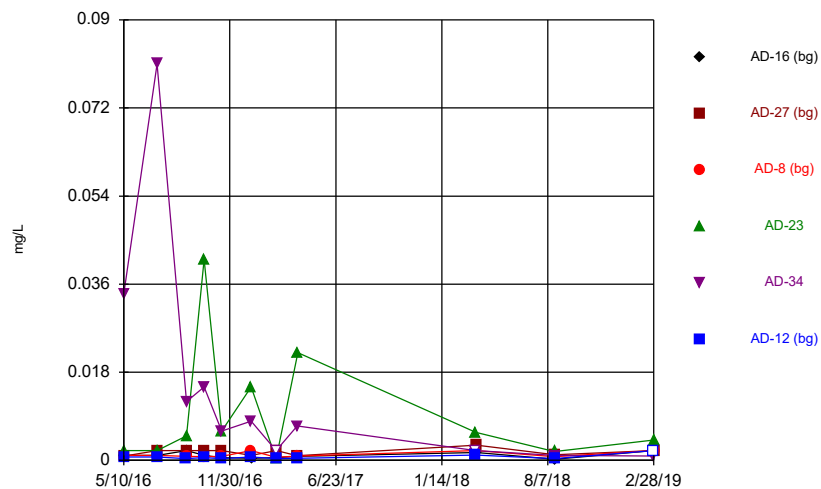
Constituent: Calcium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



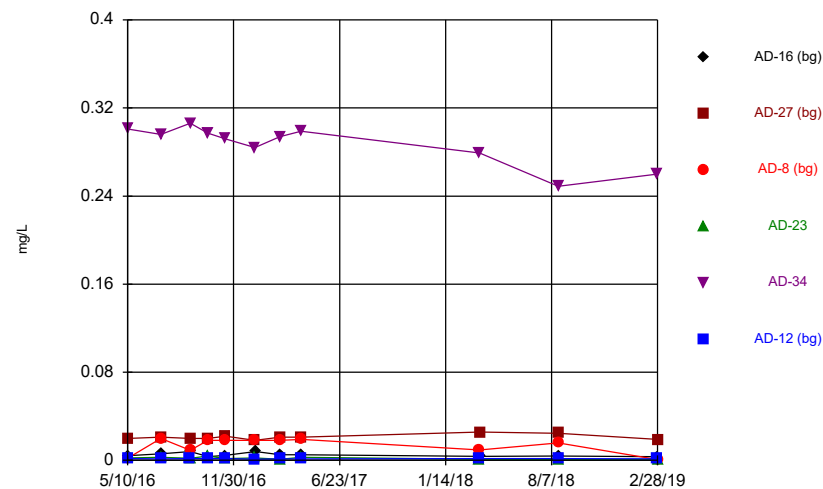
Constituent: Chloride, total Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



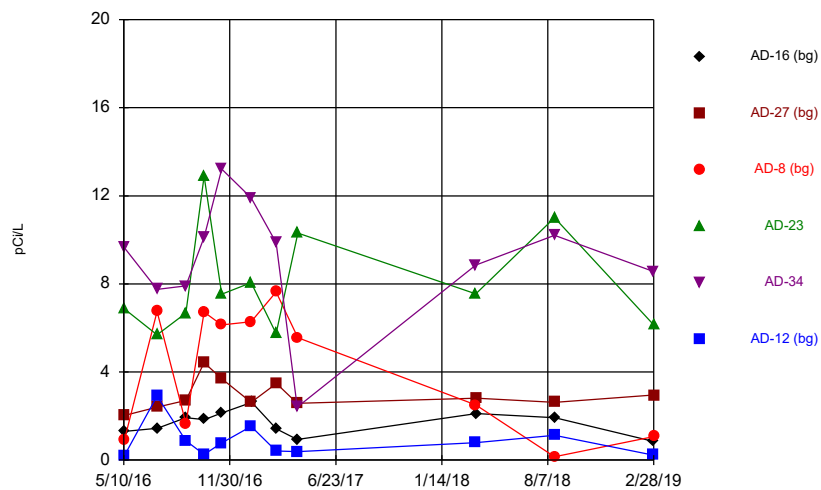
Constituent: Chromium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



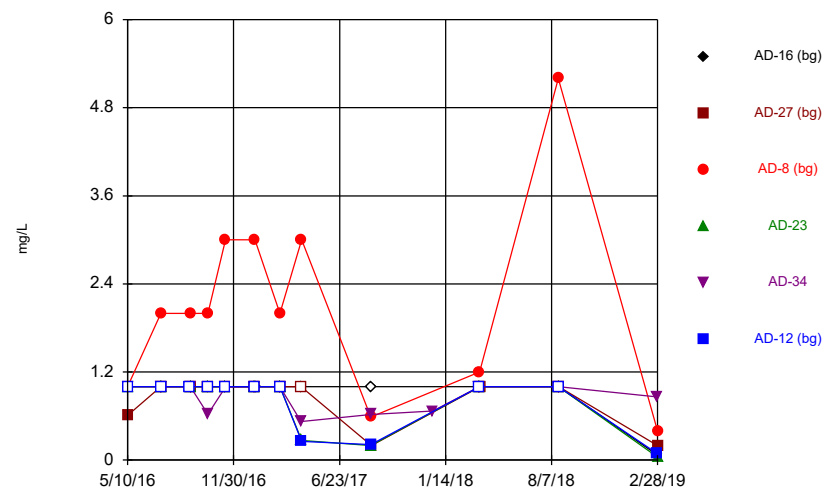
Constituent: Cobalt, total Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



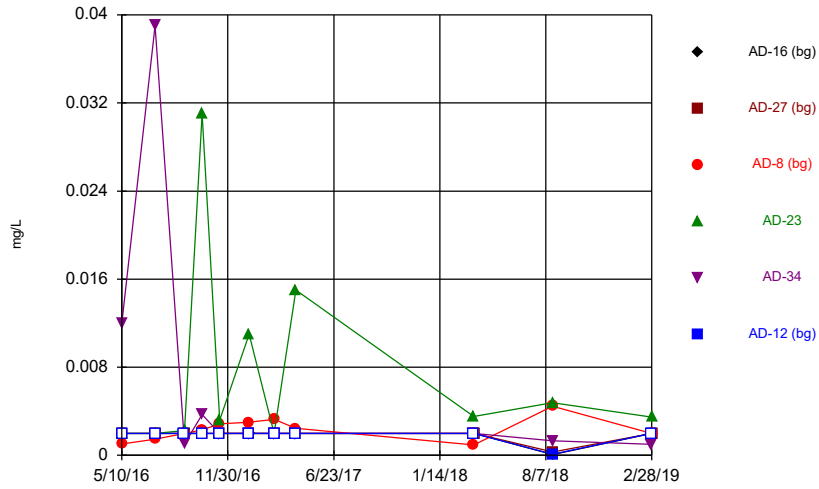
Constituent: Combined Radium 226 + 228 Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



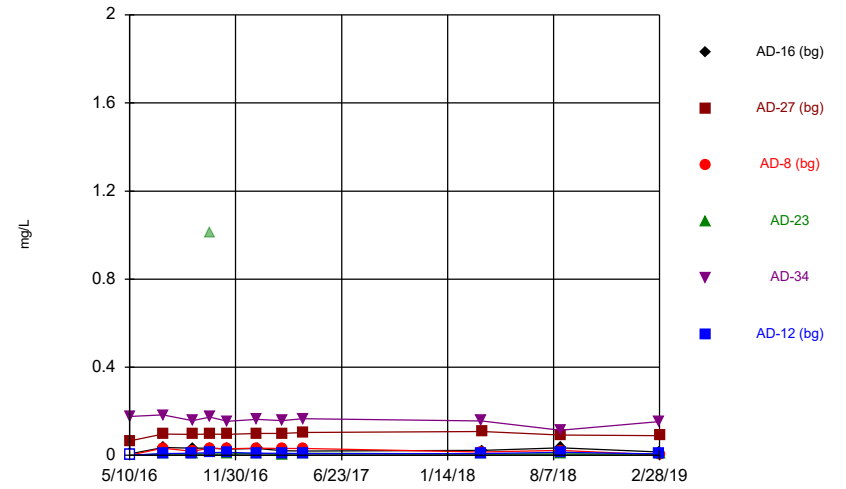
Constituent: Fluoride, total Analysis Run 9/5/2019 1:36 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



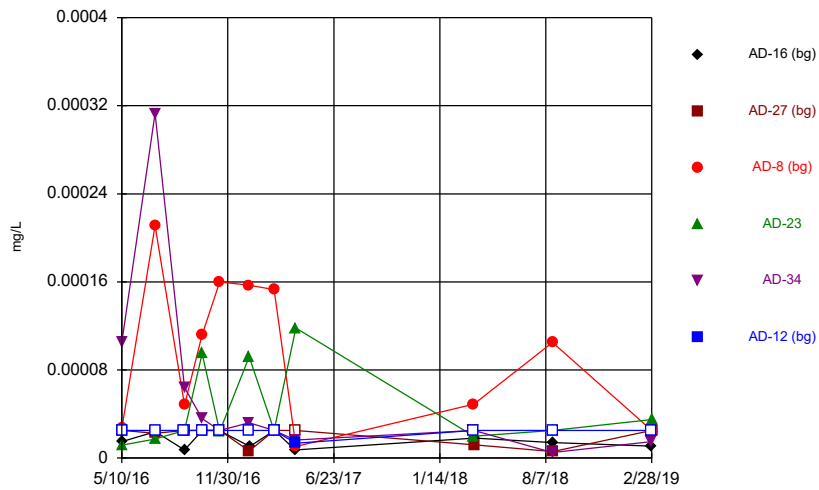
Constituent: Lead, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



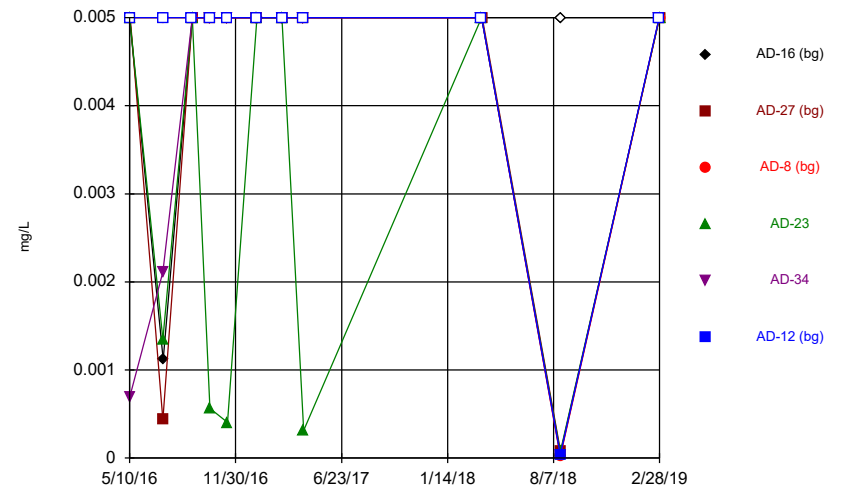
Constituent: Lithium, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



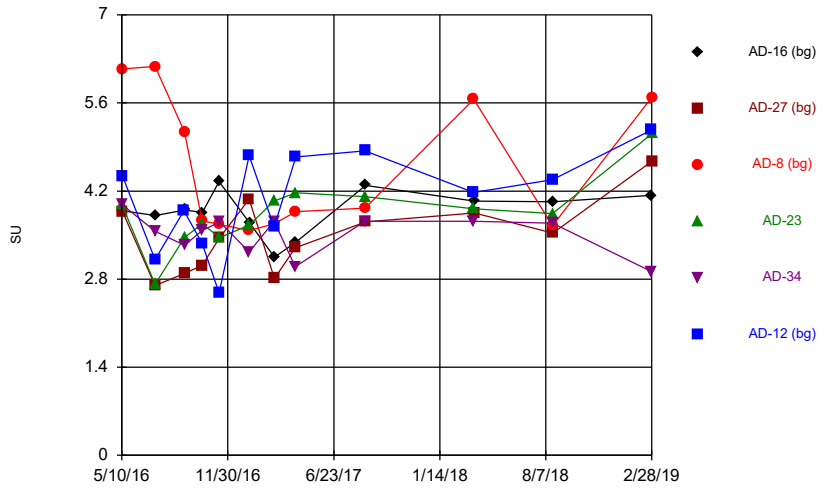
Constituent: Mercury, total Analysis Run 9/5/2019 1:36 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



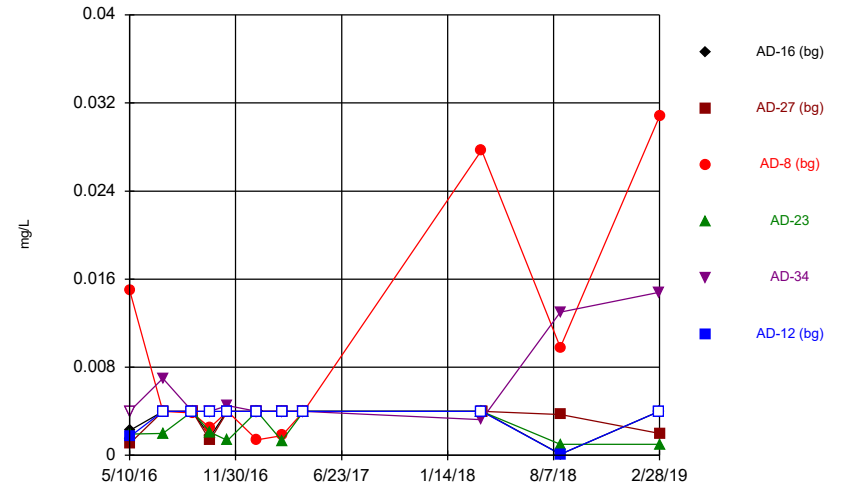
Constituent: Molybdenum, total Analysis Run 9/5/2019 1:37 PM View: Time Series
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



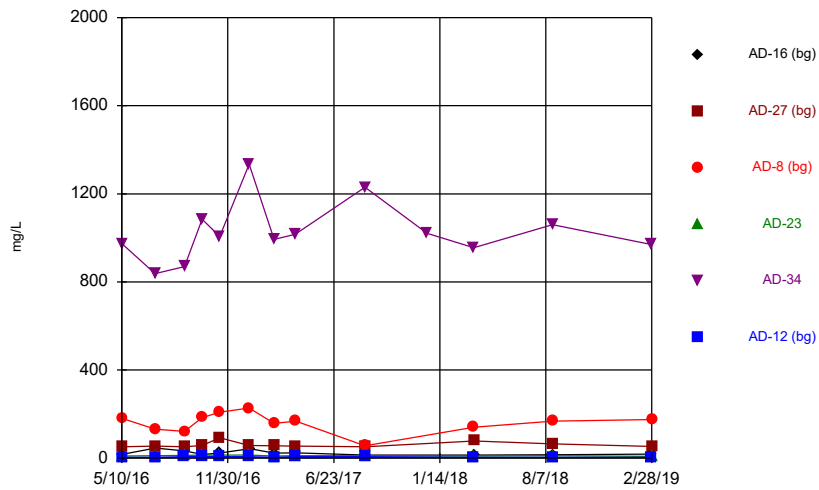
Constituent: pH, field Analysis Run 9/5/2019 1:37 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



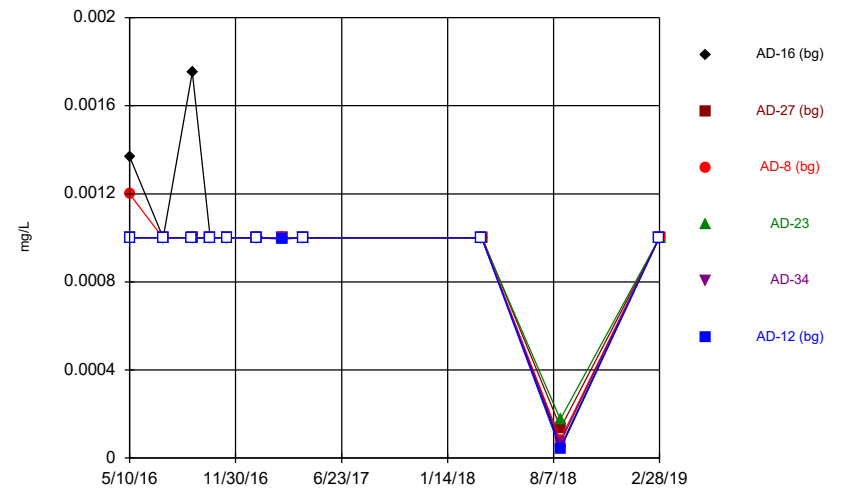
Constituent: Selenium, total Analysis Run 9/5/2019 1:37 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



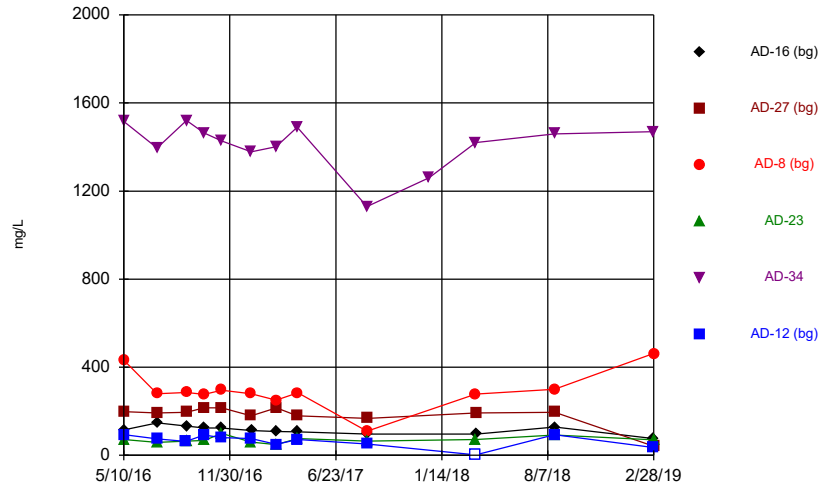
Constituent: Sulfate, total Analysis Run 9/5/2019 1:37 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



Constituent: Thallium, total Analysis Run 9/5/2019 1:37 PM View: Time Series
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Time Series



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)

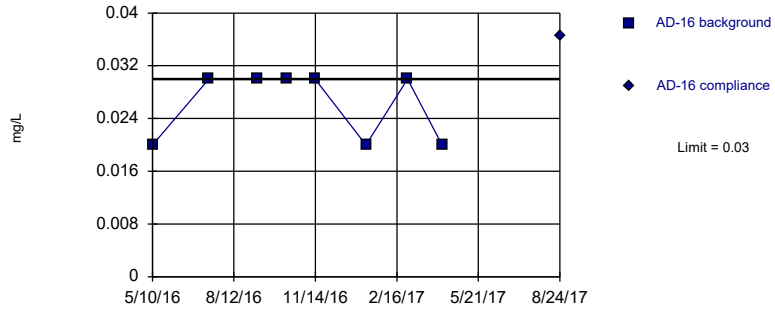
Intrawell Prediction Limit Summary - All Results

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	15.89	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

Exceeds Limit

Prediction Limit
Intrawell Non-parametric

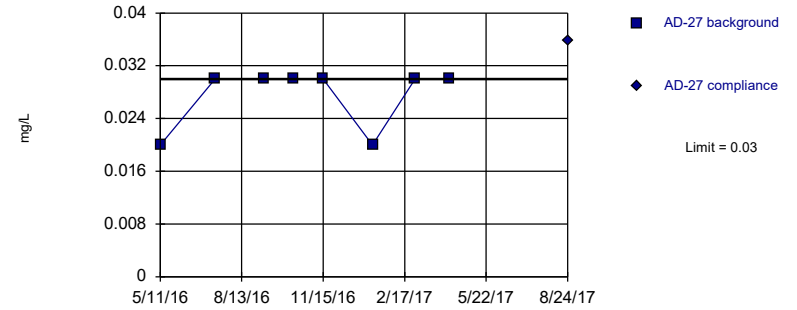


Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Exceeds Limit

Prediction Limit
Intrawell Non-parametric

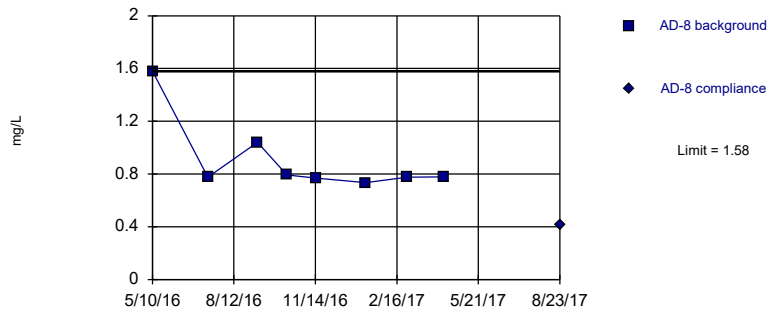


Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
Intrawell Non-parametric

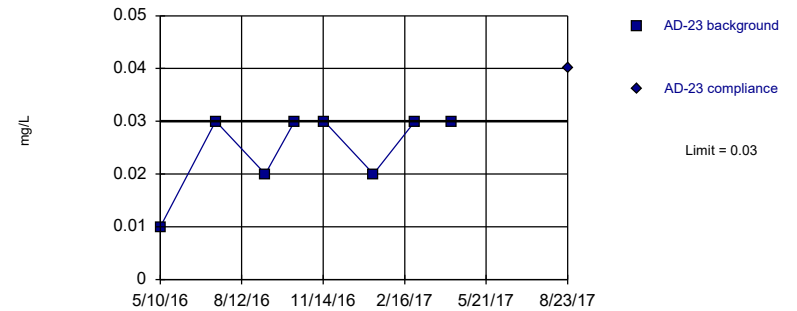


Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 8 background values. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Boron, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Exceeds Limit

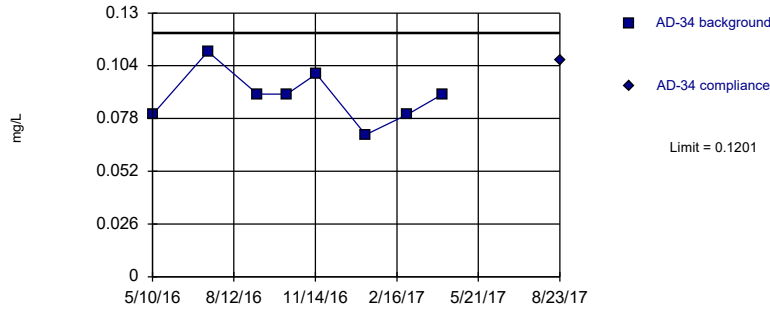
Prediction Limit
Intrawell Non-parametric



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

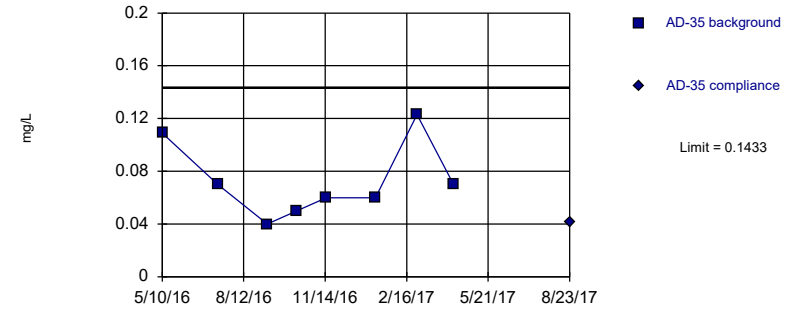
Within Limit Prediction Limit
Intrawell Parametric



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

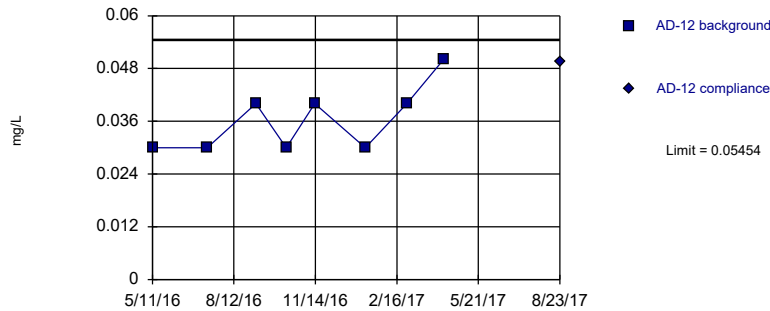
Within Limit Prediction Limit
Intrawell Parametric



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

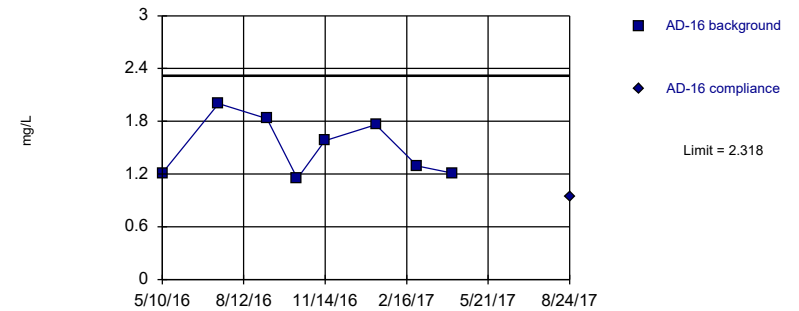
Within Limit Prediction Limit
Intrawell Parametric



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

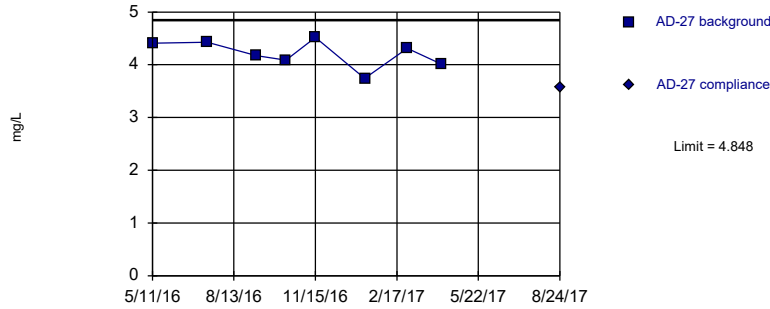
Within Limit Prediction Limit
Intrawell Parametric



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

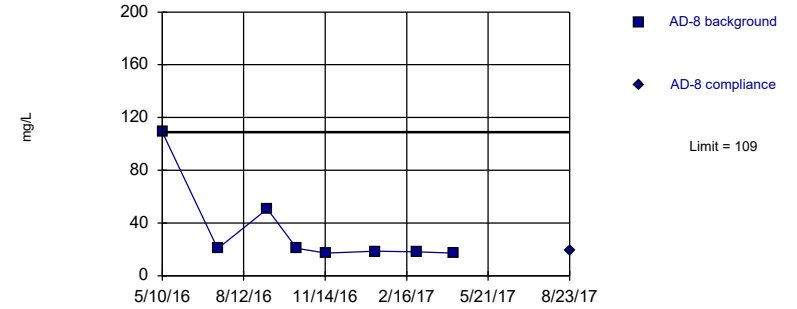
Within Limit Prediction Limit
Intrawell Parametric



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

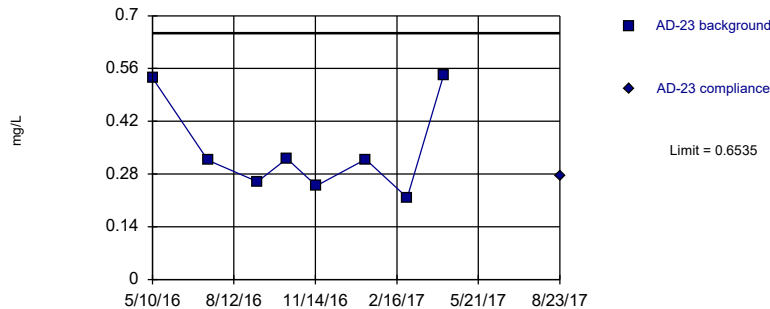
Within Limit Prediction Limit
Intrawell Non-parametric



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

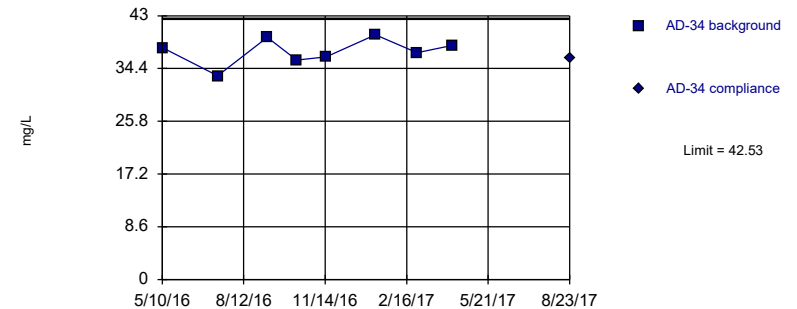
Within Limit Prediction Limit
Intrawell Parametric



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

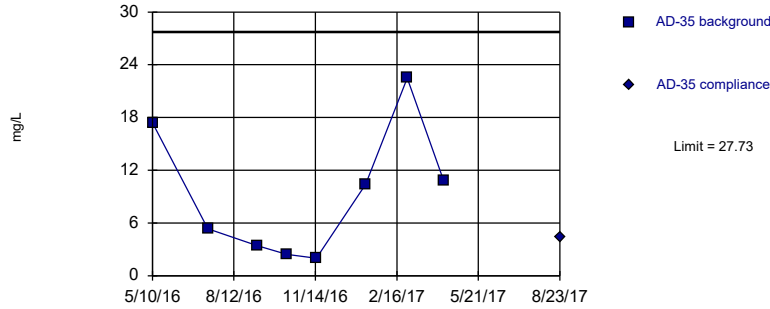
Within Limit Prediction Limit
Intrawell Parametric



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

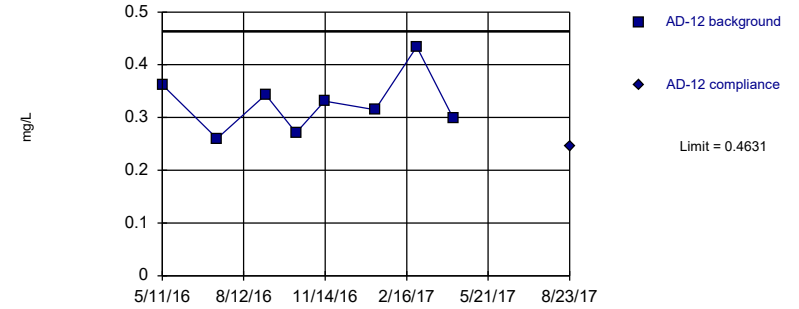
Within Limit Prediction Limit
Intrawell Parametric



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

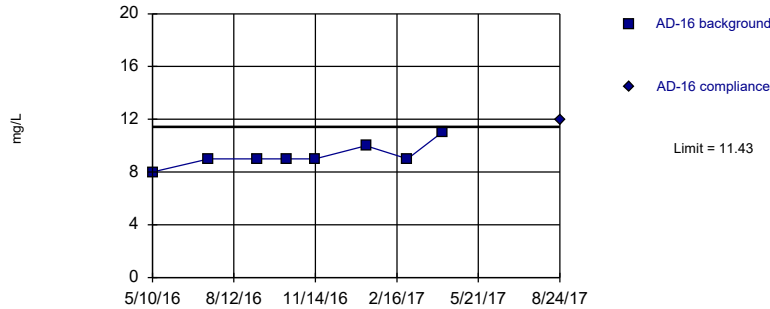
Within Limit Prediction Limit
Intrawell Parametric



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

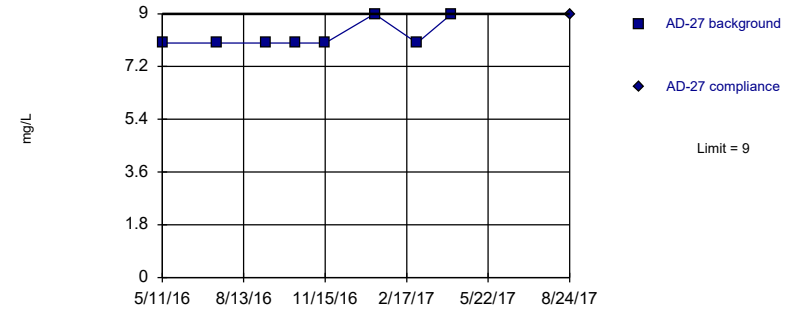
Exceeds Limit Prediction Limit
Intrawell Parametric



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

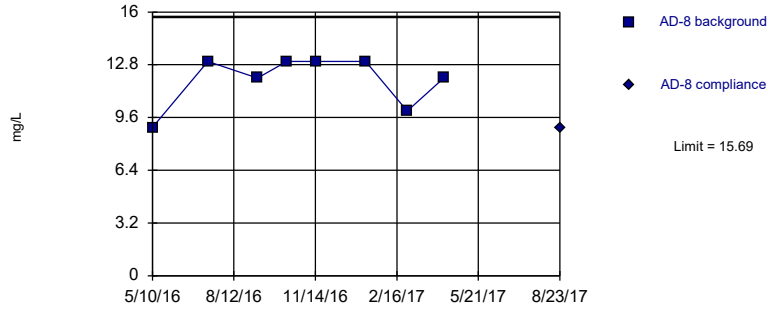
Within Limit Prediction Limit
Intrawell Non-parametric



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

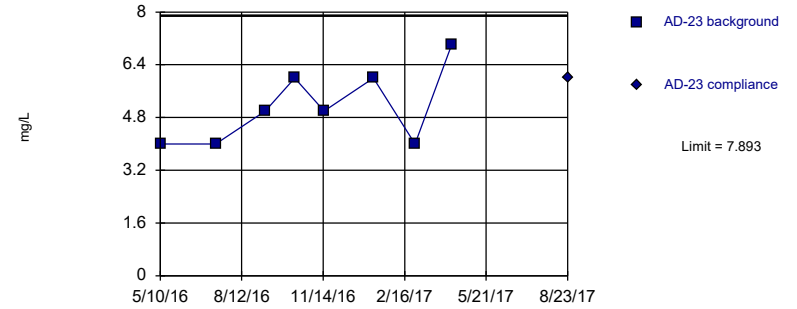
Within Limit Prediction Limit
Intrawell Parametric



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

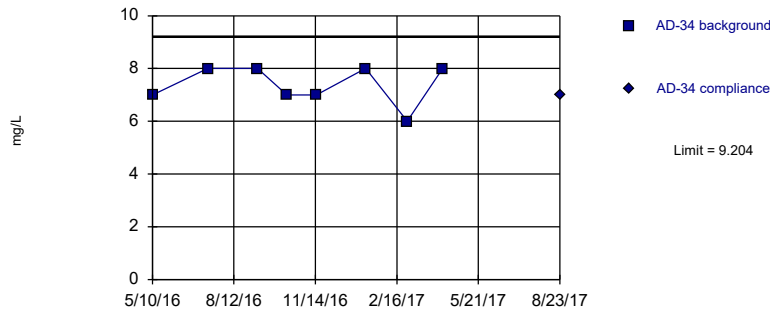
Within Limit Prediction Limit
Intrawell Parametric



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

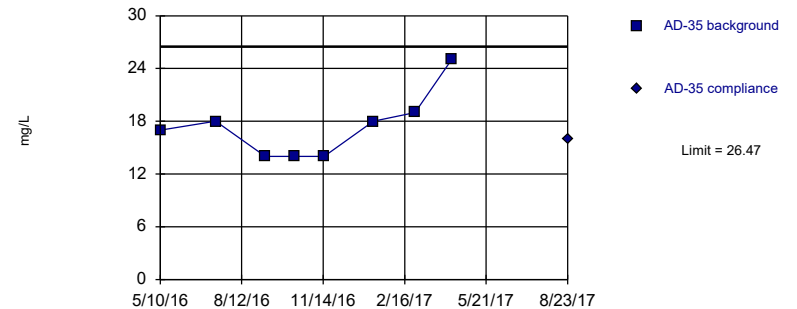
Within Limit Prediction Limit
Intrawell Parametric



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

Within Limit Prediction Limit
Intrawell Parametric

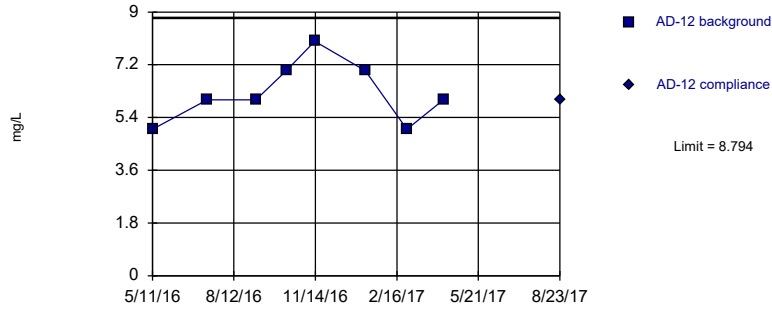


Background Data Summary: Mean=17.38, Std. Dev.=3.701, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8434, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
Intrawell Parametric

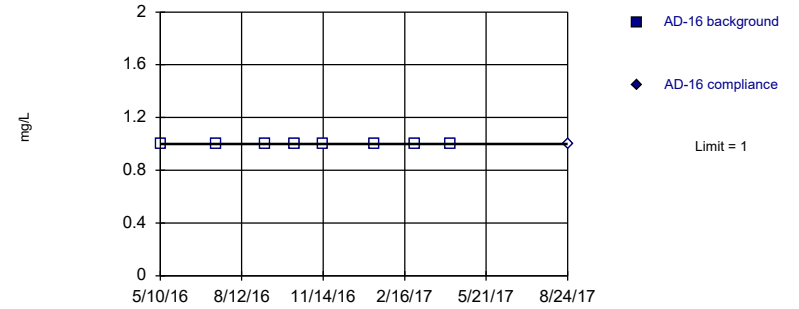


Background Data Summary: Mean=6.25, Std. Dev.=1.035, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9171, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Chloride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
Intrawell Non-parametric



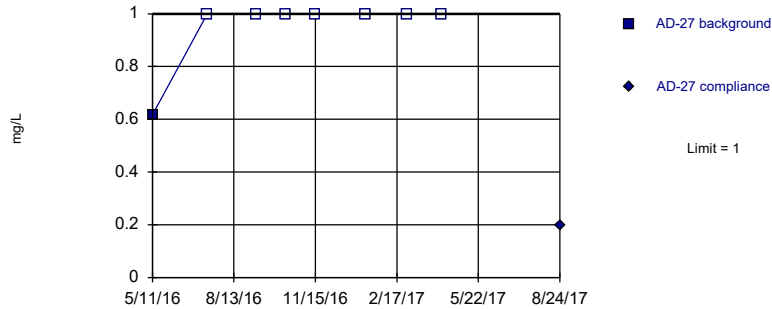
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. All background values (n = 8) were censored; limit is most recent reporting limit. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Hollow symbols indicate censored values.

Within Limit

Prediction Limit
Intrawell Non-parametric



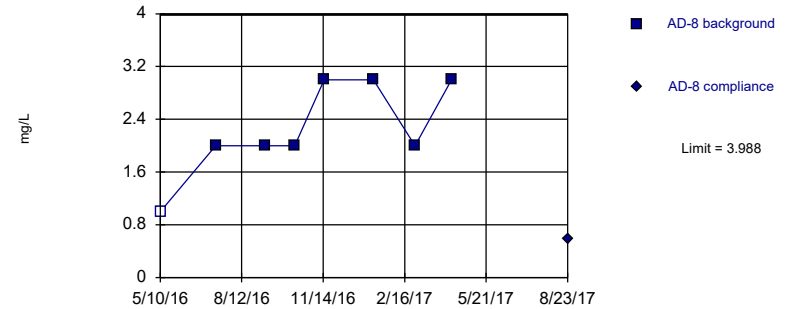
Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Hollow symbols indicate censored values.

Within Limit

Prediction Limit
Intrawell Parametric

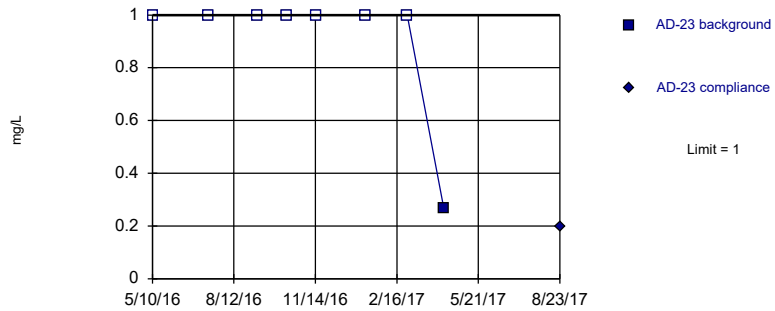


Background Data Summary: Mean=2.25, Std. Dev.=0.7071, n=8, 12.5% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8268, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
 Intrawell Non-parametric

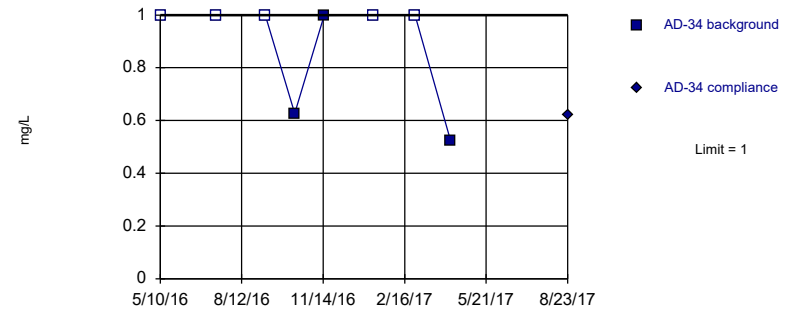


Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
 Intrawell Non-parametric

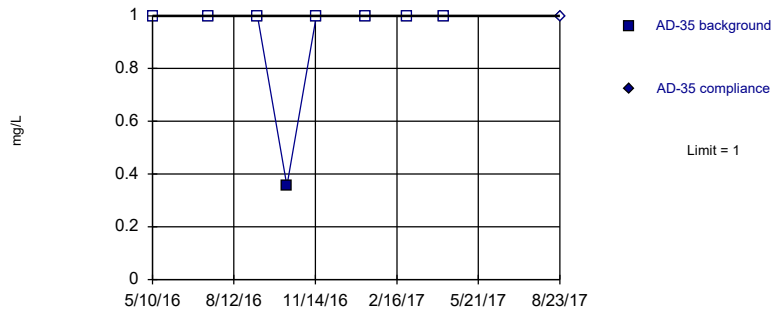


Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 62.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 11/26/2019 8:02 AM View: PL's - Intrawell
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
 Intrawell Non-parametric

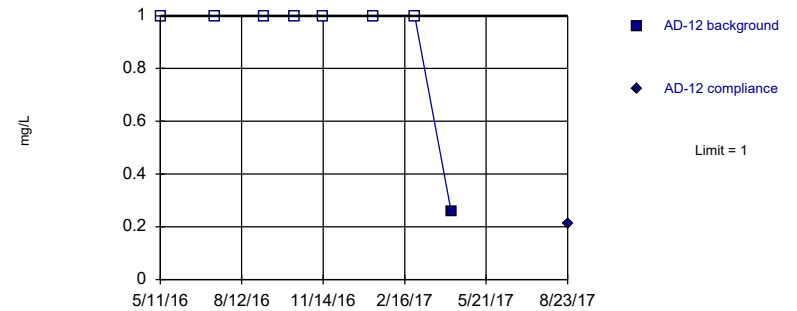


Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limit

Prediction Limit
 Intrawell Non-parametric

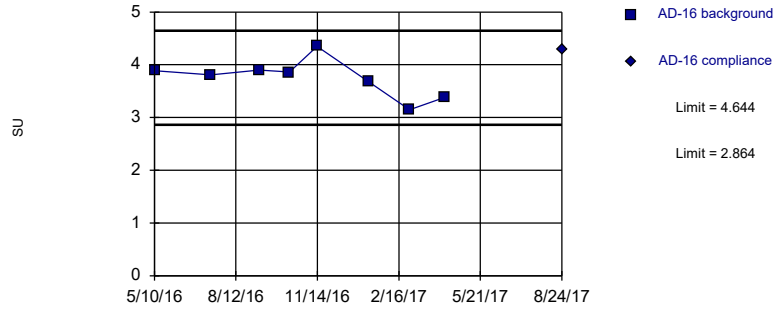


Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 8 background values. 87.5% NDs. Well-constituent pair annual alpha = 0.04242. Individual comparison alpha = 0.02144 (1 of 2).

Constituent: Fluoride, total Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limits

Prediction Limit
Intrawell Parametric

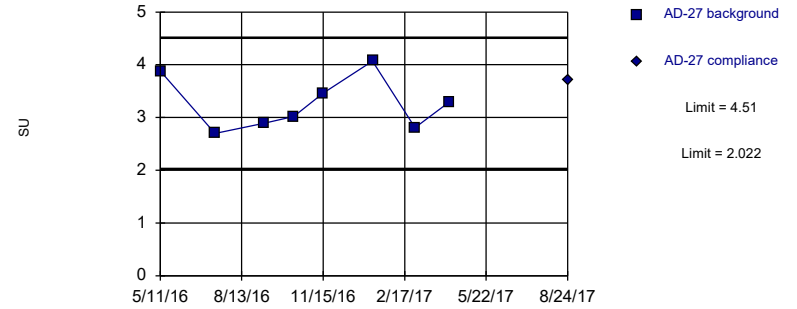


Background Data Summary: Mean=3.754, Std. Dev.=0.3622, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9388, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limits

Prediction Limit
Intrawell Parametric

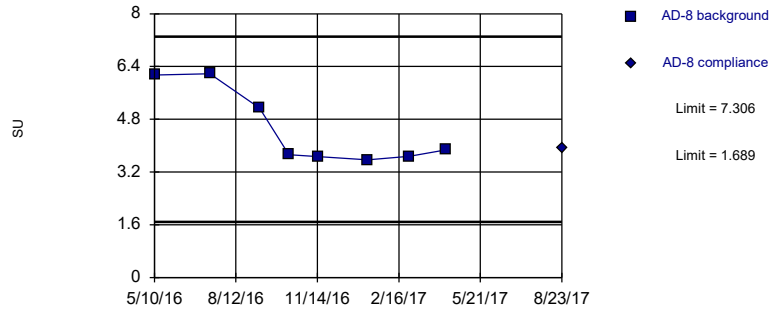


Background Data Summary: Mean=3.266, Std. Dev.=0.506, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.918, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limits

Prediction Limit
Intrawell Parametric

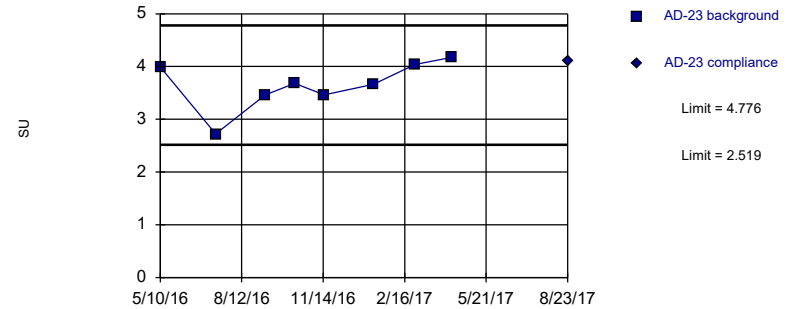


Background Data Summary: Mean=4.498, Std. Dev.=1.143, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7532, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limits

Prediction Limit
Intrawell Parametric

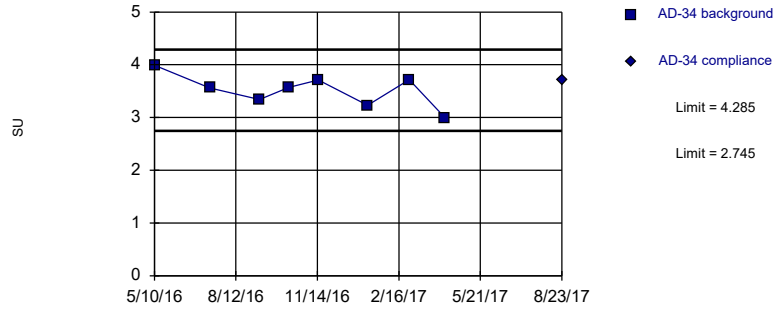


Background Data Summary: Mean=3.648, Std. Dev.=0.4592, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.903, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limits

Prediction Limit
Intrawell Parametric

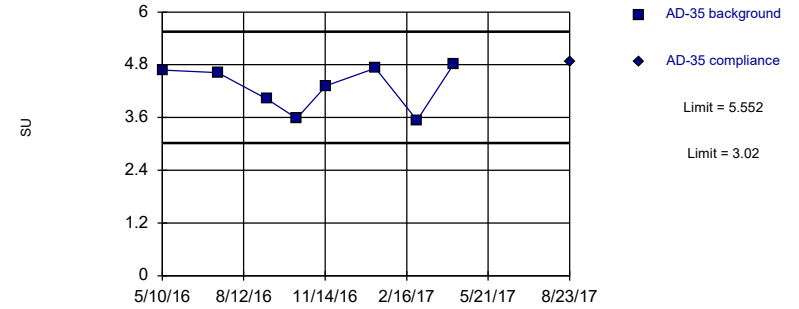


Background Data Summary: Mean=3.515, Std. Dev.=0.3135, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9758, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limits

Prediction Limit
Intrawell Parametric

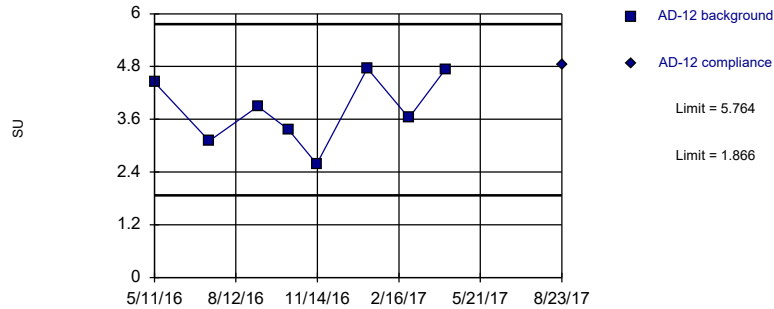


Background Data Summary: Mean=4.286, Std. Dev.=0.515, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8567, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limits

Prediction Limit
Intrawell Parametric

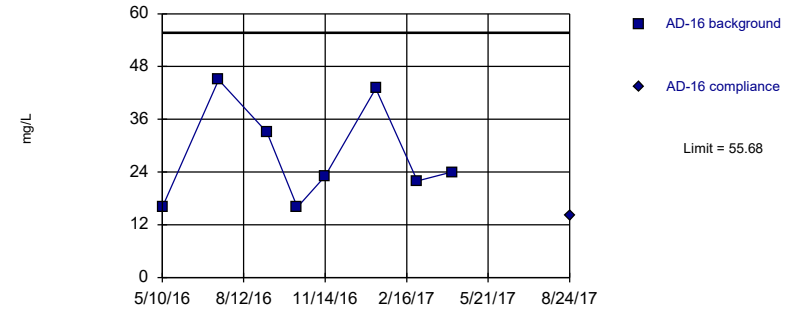


Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 11/26/2019 8:03 AM View: PL's - Intrawell
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Within Limits

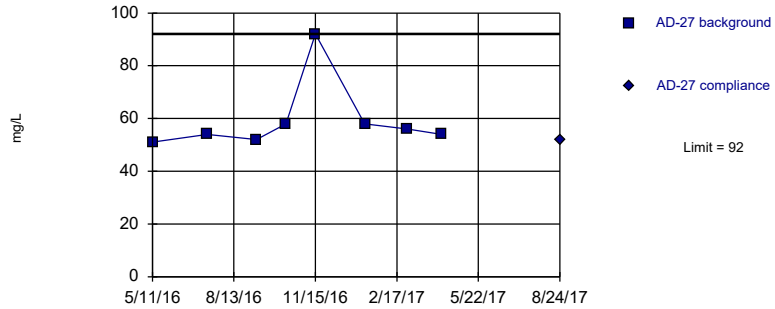
Prediction Limit
Intrawell Parametric



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

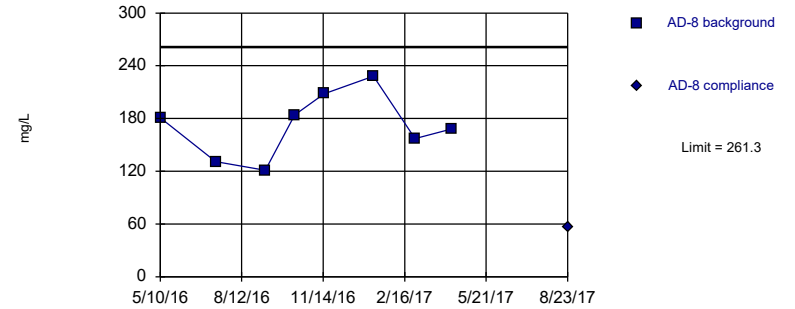
Within Limit Prediction Limit
Intrawell Non-parametric



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

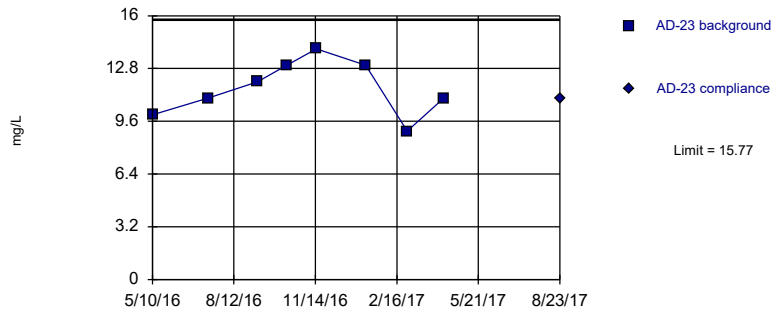
Within Limit Prediction Limit
Intrawell Parametric



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

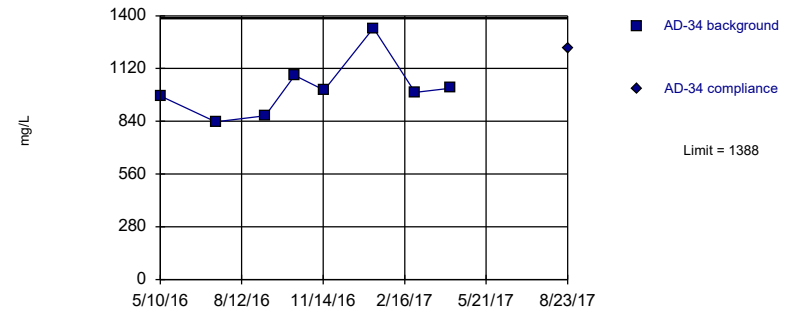
Within Limit Prediction Limit
Intrawell Parametric



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

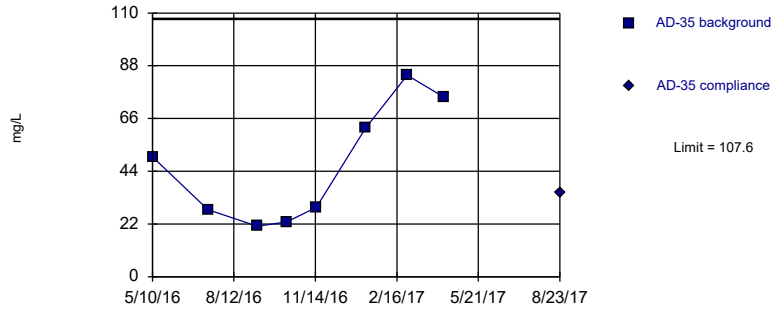
Within Limit Prediction Limit
Intrawell Parametric



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

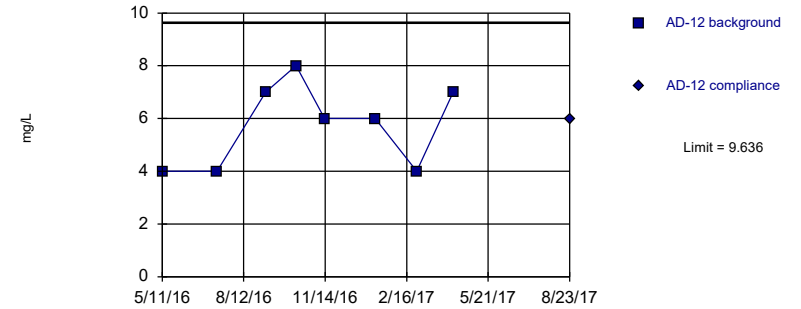
Within Limit Prediction Limit
Intrawell Parametric



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

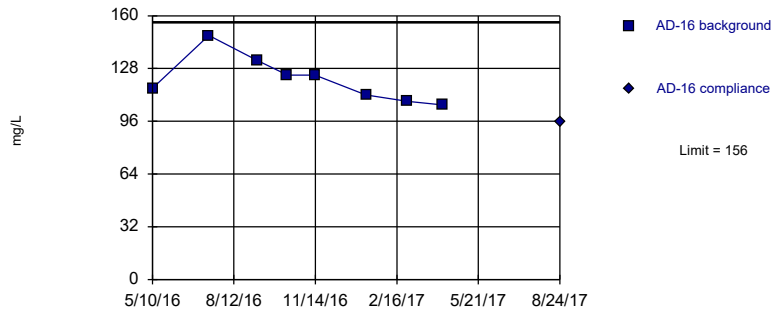
Within Limit Prediction Limit
Intrawell Parametric



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

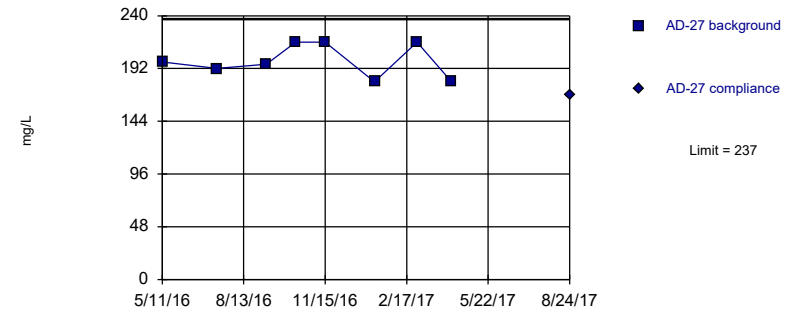
Within Limit Prediction Limit
Intrawell Parametric



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

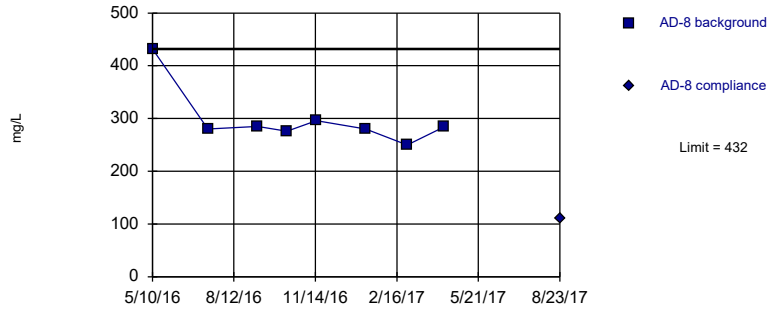
Within Limit Prediction Limit
Intrawell Parametric



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

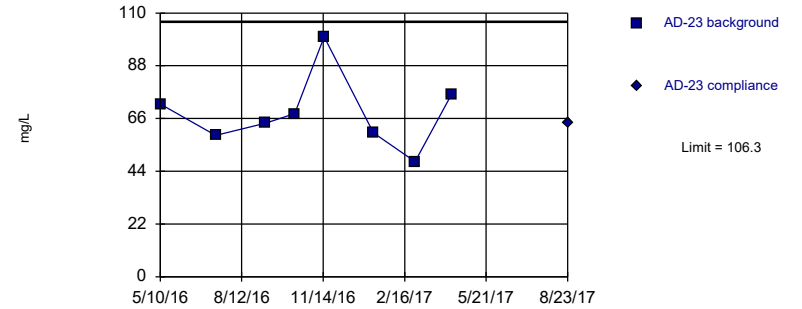
Within Limit Prediction Limit
Intrawell Non-parametric



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

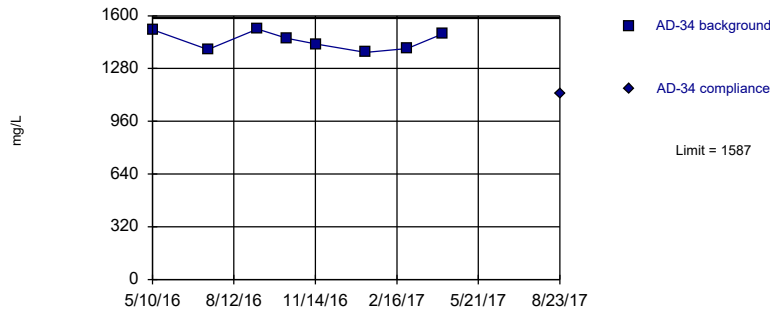
Within Limit Prediction Limit
Intrawell Parametric



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

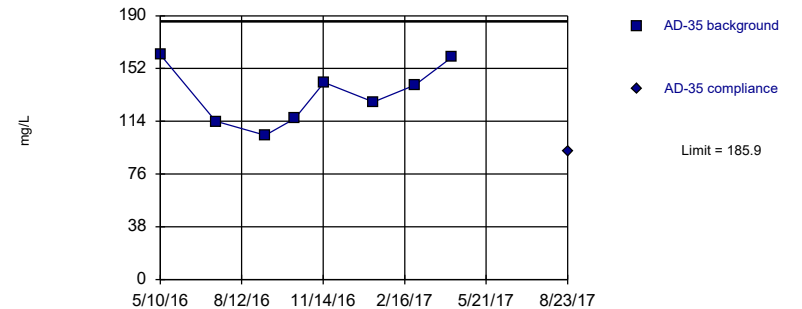
Within Limit Prediction Limit
Intrawell Parametric



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

Within Limit Prediction Limit
Intrawell Parametric

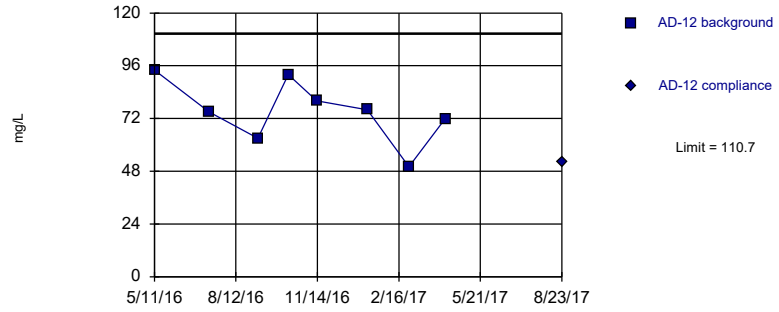


Background Data Summary: Mean=133.3, Std. Dev.=21.43, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.936, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

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 - Significant Results

Pirkey LF Client: Geosyntec Data: Pirkey Landfill Printed 9/5/2019, 1:43 PM

<u>Constituent</u>	<u>Well</u>	<u>Slope</u>	<u>Calc.</u>	<u>Critical</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Normality</u>	<u>Xform</u>	<u>Alpha</u>	<u>Method</u>
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

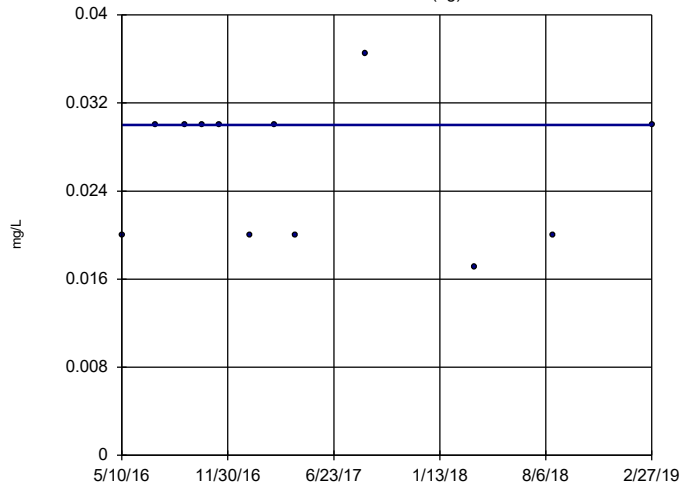
Trend Test Summary Table - All Results

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

Sen's Slope Estimator

AD-16 (bg)

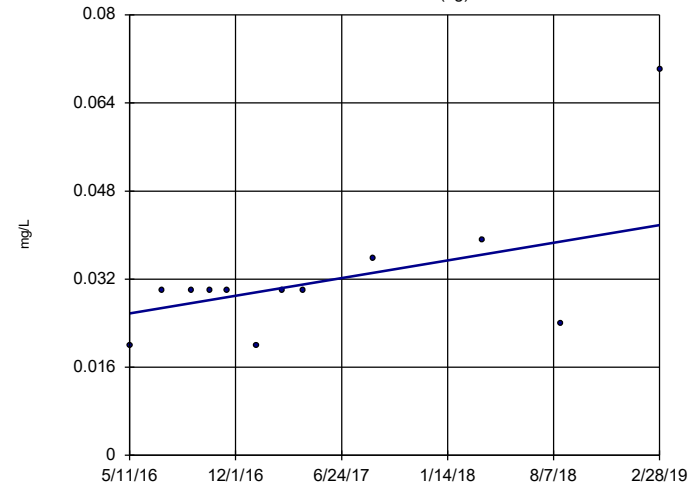


n = 12
 Slope = 0
 units per year.
 Mann-Kendall
 statistic = -5
 critical = -38
 Trend not sig-
 nificant at 99%
 confidence level
 (α = 0.005 per
 tail).

Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-27 (bg)

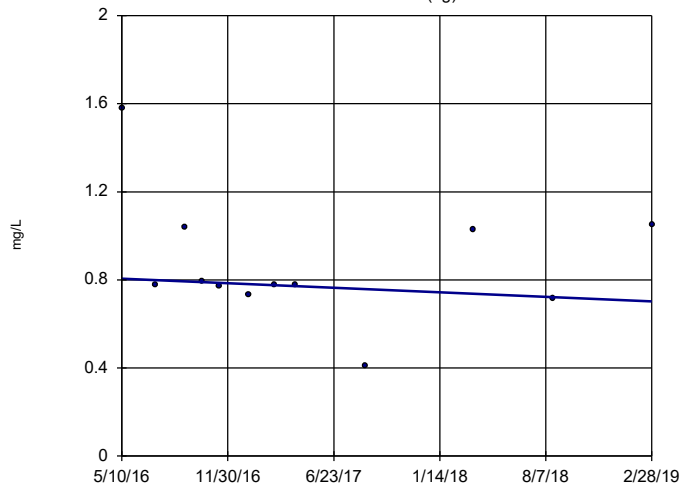


n = 12
 Slope = 0.005714
 units per year.
 Mann-Kendall
 statistic = 26
 critical = 38
 Trend not sig-
 nificant at 99%
 confidence level
 (α = 0.005 per
 tail).

Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-8 (bg)

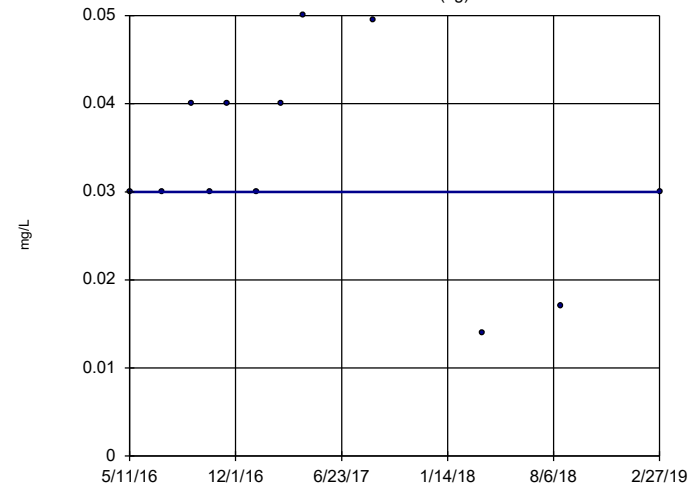


n = 12
 Slope = -0.03662
 units per year.
 Mann-Kendall
 statistic = -12
 critical = -38
 Trend not sig-
 nificant at 99%
 confidence level
 (α = 0.005 per
 tail).

Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-12 (bg)

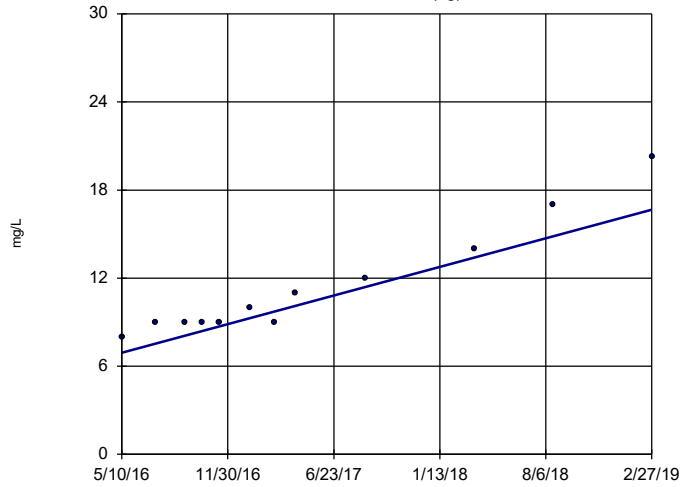


n = 12
 Slope = 0
 units per year.
 Mann-Kendall
 statistic = -1
 critical = -38
 Trend not sig-
 nificant at 99%
 confidence level
 (α = 0.005 per
 tail).

Constituent: Boron, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-16 (bg)

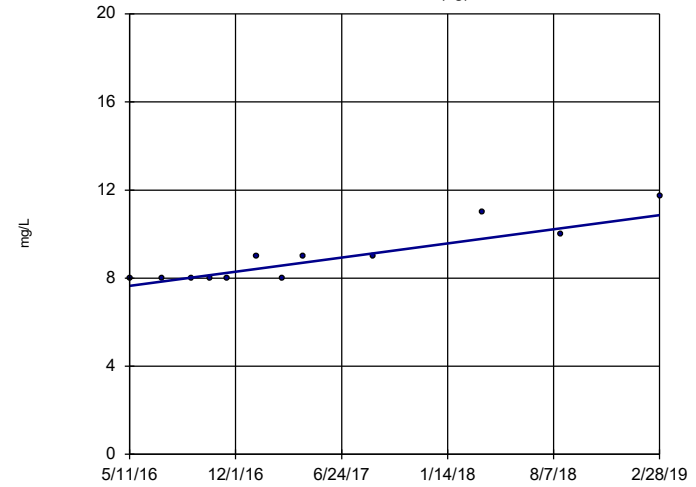


n = 12
 Slope = 3.476
 units per year.
 Mann-Kendall
 statistic = 54
 critical = 38
 Increasing trend
 significant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-27 (bg)

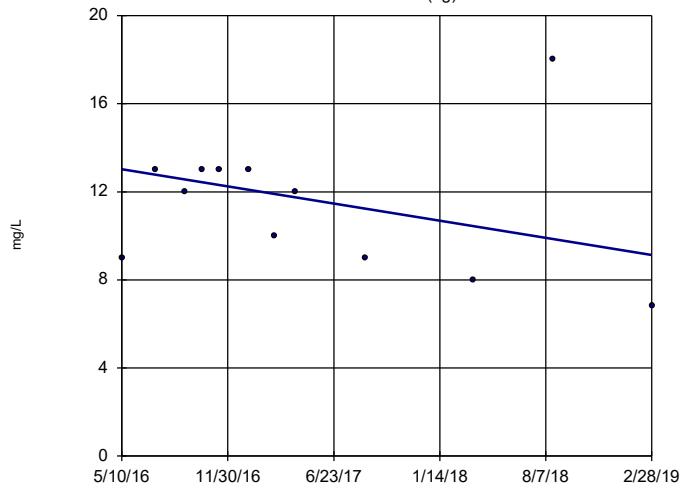


n = 12
 Slope = 1.144
 units per year.
 Mann-Kendall
 statistic = 44
 critical = 38
 Increasing trend
 significant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-8 (bg)

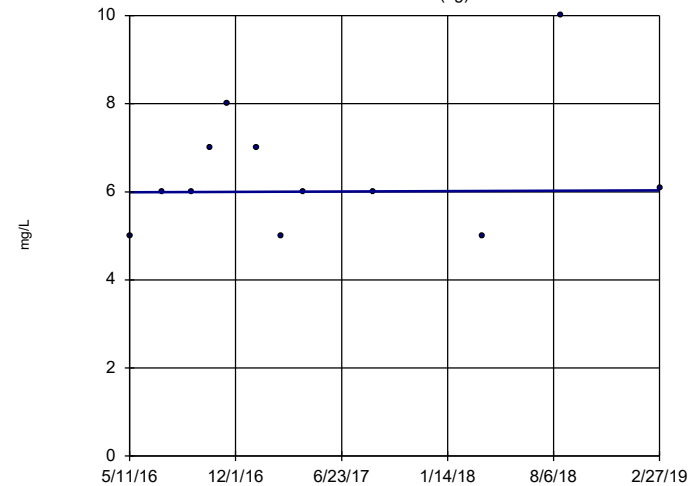


n = 12
 Slope = -1.386
 units per year.
 Mann-Kendall
 statistic = -16
 critical = -38
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-12 (bg)

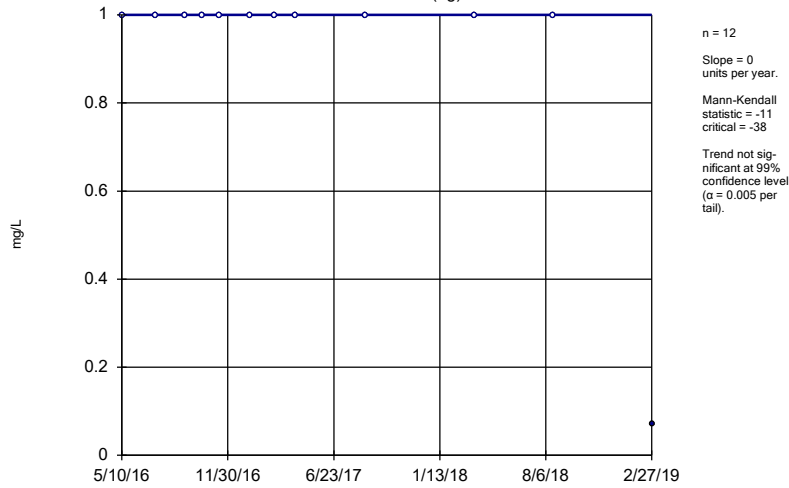


n = 12
 Slope = 0.01522
 units per year.
 Mann-Kendall
 statistic = 10
 critical = 38
 Trend not sig-
 nificant at 99%
 confidence level
 ($\alpha = 0.005$ per
 tail).

Constituent: Chloride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

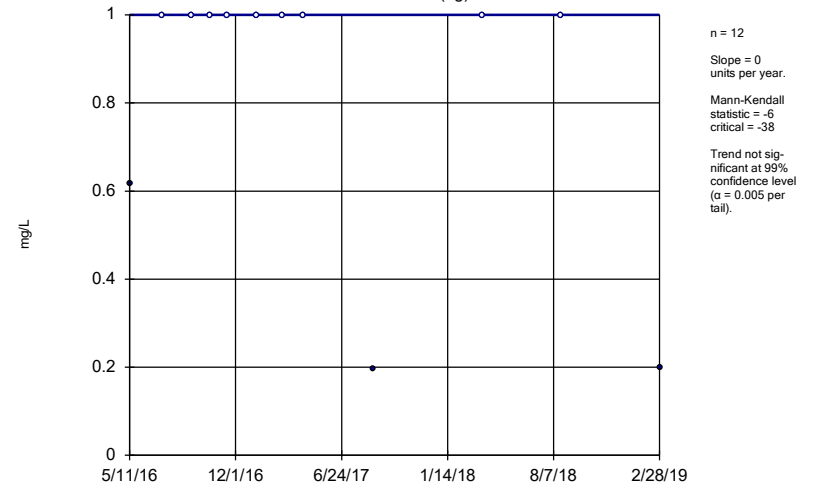
AD-16 (bg)



Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

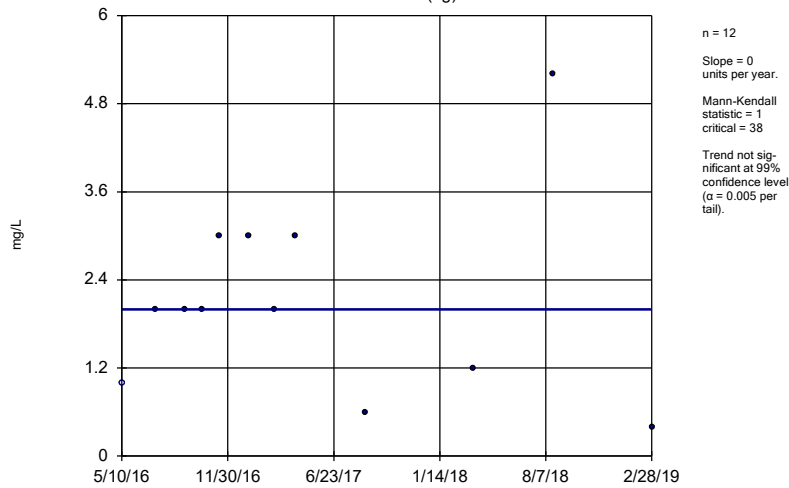
AD-27 (bg)



Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

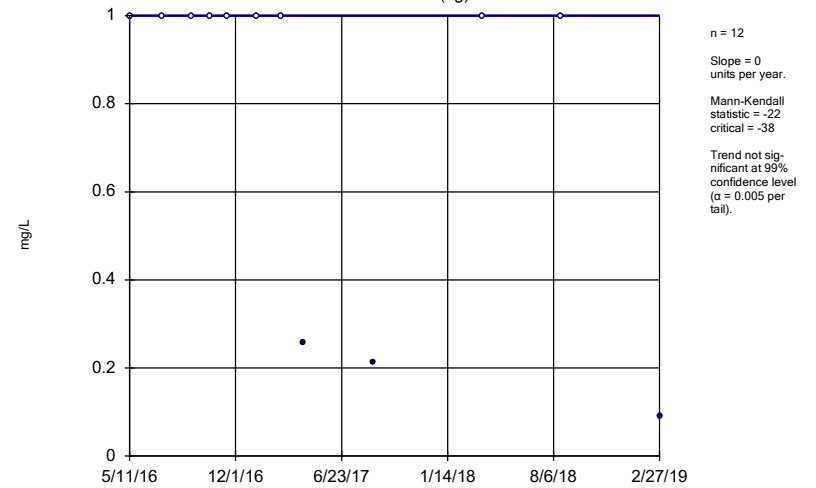
AD-8 (bg)



Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

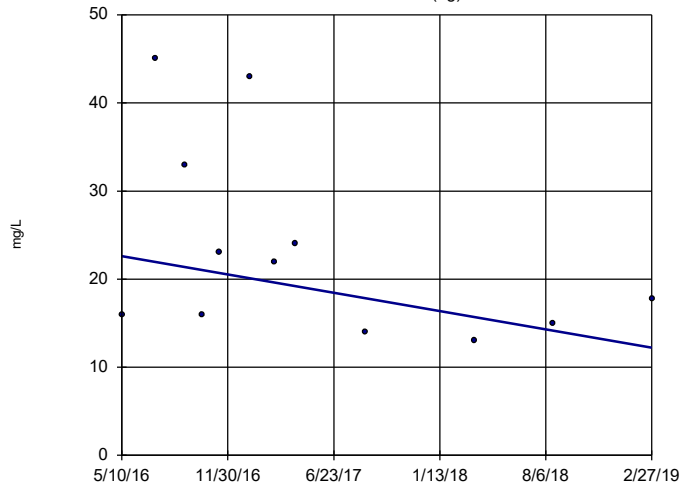
AD-12 (bg)



Constituent: Fluoride, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-16 (bg)

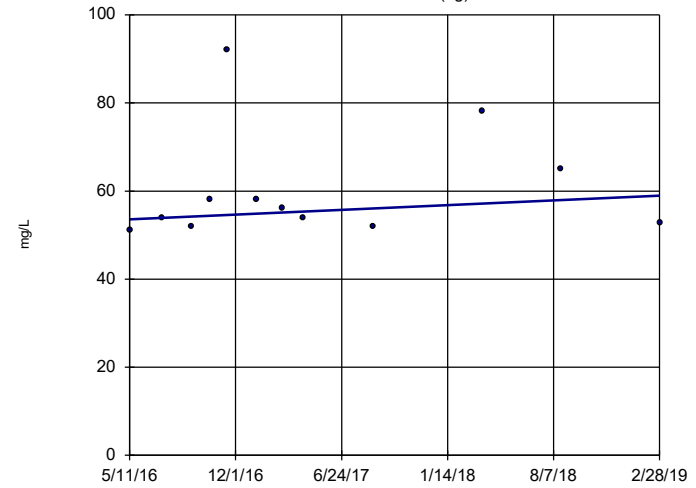


n = 12
 Slope = -3.711 units per year.
 Mann-Kendall statistic = -23
 critical = -38
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-27 (bg)

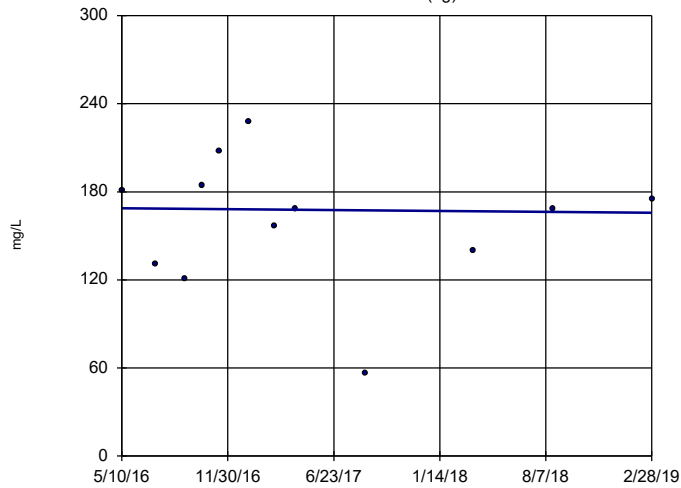


n = 12
 Slope = 1.909 units per year.
 Mann-Kendall statistic = 11
 critical = 38
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-8 (bg)

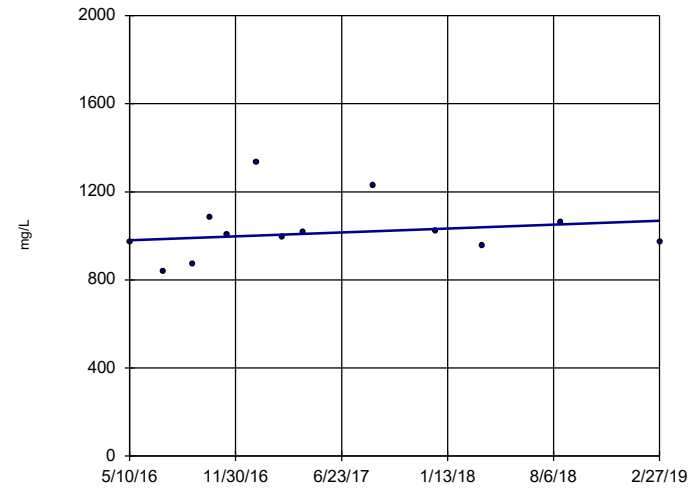


n = 12
 Slope = -1.069 units per year.
 Mann-Kendall statistic = -1
 critical = -38
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-34

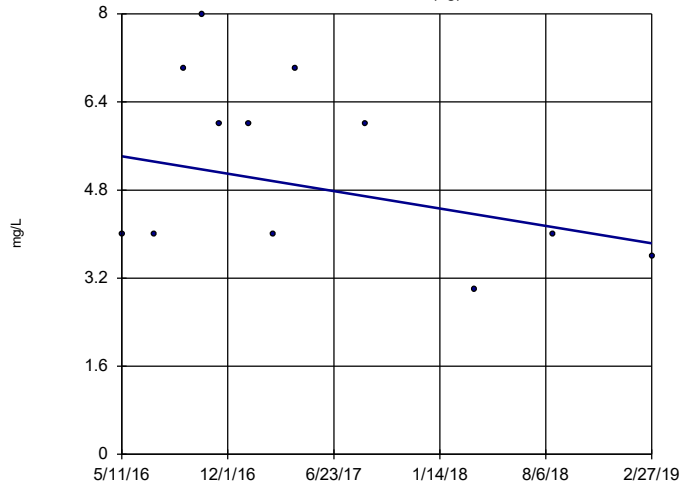


n = 13
 Slope = 31.48 units per year.
 Mann-Kendall statistic = 14
 critical = 43
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-12 (bg)

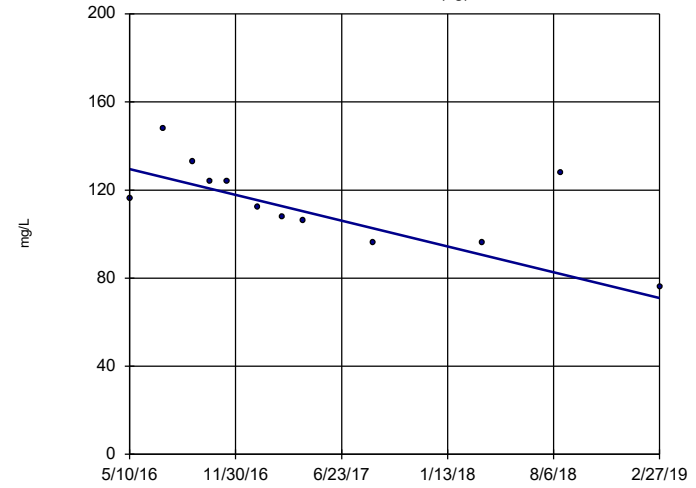


n = 12
 Slope = -0.565 units per year.
 Mann-Kendall statistic = -18
 critical = -38
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Sulfate, total Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-16 (bg)

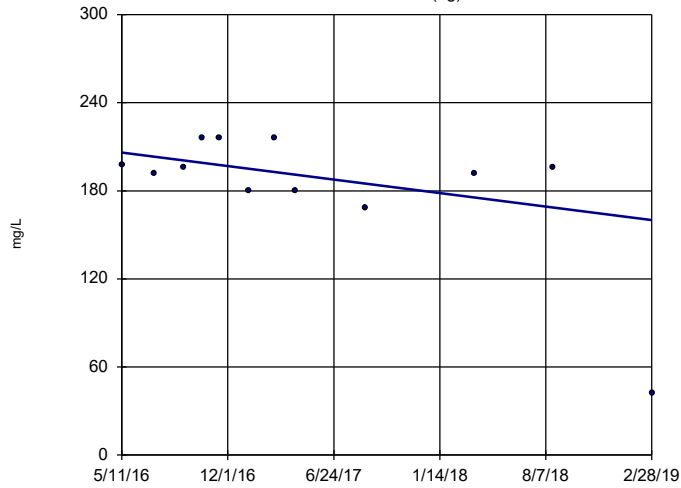


n = 12
 Slope = -20.86 units per year.
 Mann-Kendall statistic = -40
 critical = -38
 Decreasing trend significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-27 (bg)

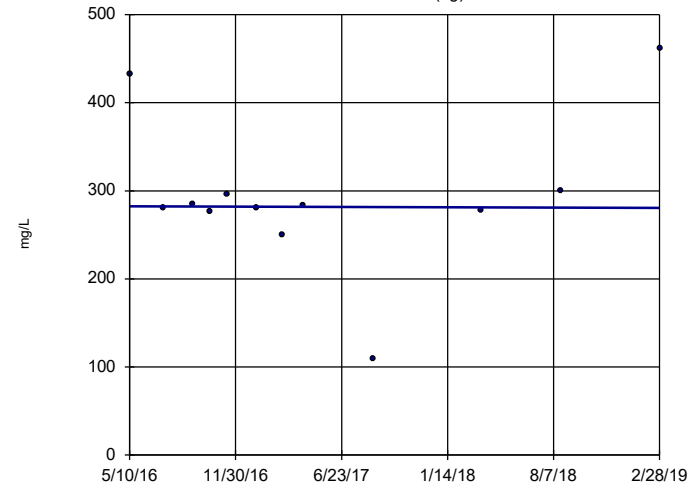


n = 12
 Slope = -16.41 units per year.
 Mann-Kendall statistic = -22
 critical = -38
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-8 (bg)

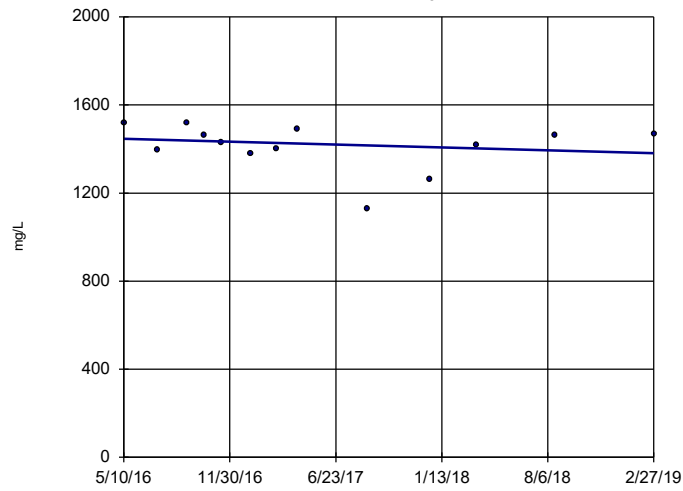


n = 12
 Slope = -0.5925 units per year.
 Mann-Kendall statistic = -1
 critical = -38
 Trend not significant at 99% confidence level (α = 0.005 per tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests
 Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-34

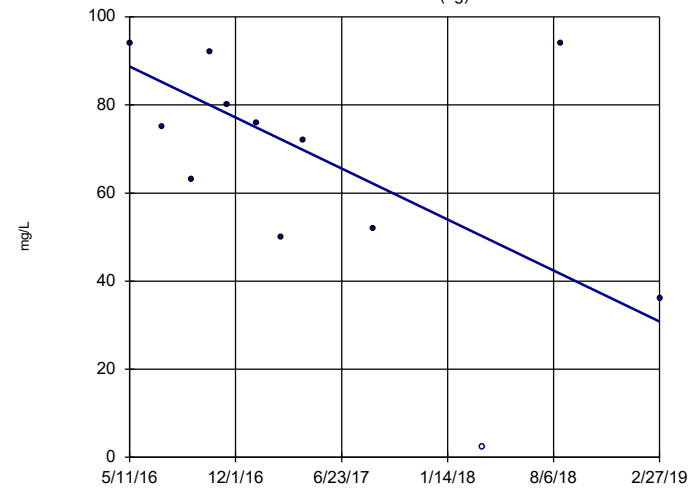


n = 13
Slope = -23.3
units per year.
Mann-Kendall
statistic = -12
critical = -43
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ per
tail).

Constituent: Total Dissolved Solids [TDS] Analysis Run 9/5/2019 1:42 PM View: Trend Tests
Pirkey LF Client: Geosyntec Data: Pirkey Landfill

Sen's Slope Estimator

AD-12 (bg)



n = 12
Slope = -20.7
units per year.
Mann-Kendall
statistic = -27
critical = -38
Trend not sig-
nificant at 99%
confidence level
($\alpha = 0.005$ 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

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

License Number

Texas

Licensing State

1/7/2020

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
Well County:	Harrison	Longitude:	094° 29' 50.99" W
		Elevation:	No Data
Type of Work:	New Well	Proposed Use:	Monitor

Drilling Start Date: **4/24/2019** Drilling End Date: **4/24/2019**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	8.25	0	15

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Filter Material</i>	<i>Size</i>
Filter Pack Intervals:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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 #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	Latitude: 32° 26' 52.08" N
LOCATED ON OWNERS PROPERTY	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	8.25	0	60

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	31	38	Bentonite 3 Bags/Sacks

Seal Method: **Tremie**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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**

	Description (number of sacks & material)	Top Depth (ft.)	Bottom Depth (ft.)
Plug Information:	SAND	50	60

Water Quality:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	Latitude: 32° 26' 52.08" N
LOCATED ON OWNERS PROPERTY	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
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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	Latitude:	32° 27' 56.32" N
	LOCATED ON OWNERS PROPERTY	Longitude:	094° 29' 41.78" 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**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	8.25	0	17

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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	Latitude: 32° 27' 46.12" N
LOCATED ON OWNERS PROPERTY	Longitude: 094° 29' 43.34" W
Well County: Harrison	Elevation: No Data
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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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 #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	Latitude:	32° 26' 52.05" N
	LOCATED ON OWNERS PROPERTY	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**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	8.25	0	12

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	1	CLAY
1	5	CLAY/SAND
5	9.5	CLAY
9.5	12	SAND/CLAY

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 29' 00.5" W
	Elevation: No Data
Type of Work: New Well	
	Proposed Use: Monitor

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	40

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	27	40	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 29' 00.5" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **3/9/2019** Drilling End Date: **3/10/2019**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	6.75	0	100

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Filter Material</i>	<i>Size</i>
Filter Pack Intervals:	86	100	Sand	16/30

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
2	Riser	New Plastic (PVC)	40	0	90
2	Screen	New Plastic (PVC)	40 0.010	90	100

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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 #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
Well County: Harrison	Longitude: 094° 29' 50" W
	Elevation: No Data
<hr/>	
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:	6.75	0	22

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	8	22	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	7	tan and brown sandy, silty clay
7	22	red and grey sand w/occ. lignite layers

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 29' 50" W
	Elevation: No Data
Type of Work: New Well	
Proposed Use: Monitor	

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	6.75	0	80

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Filter Material</i>	<i>Size</i>
Filter Pack Intervals:	56	80	Sand	16/30

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	25

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	12	25	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

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

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
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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** Grid #: **35-37-1**
Hallsville, TX 75650
Well Location: **2400 FM 3251** Latitude: **32° 27' 48" N**
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: **2/23/2019** Drilling End Date: **2/23/2019**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	6.75	0	70

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Filter Material</i>	<i>Size</i>
Filter Pack Intervals:	45	70	Sand	16/30

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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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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	Latitude: 32° 27' 30.34" N
LOCAATED ON OWNERS PROPERTY	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	10	CLAYS
10	18	SANDS AND CLAYS

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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

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.

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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** Grid #: **35-37-1**
HALLSVILLE, TX 75650
Well Location: **2400 FM 3251** Latitude: **32° 27' 30.28" N**
HALLSVILLE, TX 75650 Longitude: **094° 29' 27.75" W**
LOCATED ON OWNERS PROPERTY 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**

	<i>Diameter (in.)</i>	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>
Borehole:	8.25	0	65

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	<i>Top Depth (ft.)</i>	<i>Bottom Depth (ft.)</i>	<i>Description (number of sacks & material)</i>
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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
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

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 08" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **3/3/2019** Drilling End Date: **3/3/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	45

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	32	45	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	45	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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

Water Quality:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	70	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well Location: 2400 FM 3251 Hallsville, TX 75650	Latitude: 32° 27' 10" N
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	35

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	23	35	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	35	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
Type of Work: New Well	
Proposed Use: Monitor	

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	65

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	52	65	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	65	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
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(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
Well County: Harrison	Longitude: 094° 30' 12" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	93

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	77	93	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	90	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)
90	93	gray clay (old pit base?)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 11" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **3/5/2019**

Drilling End Date: **3/5/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	30

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	17	30	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	0	12	Cement
	12	17	Bentonite 1 Bags/Sacks

Seal Method: **Gravity**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	30	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	Longitude: 094° 30' 11" W
	Elevation: No Data
<hr/>	
Type of Work: New Well	Proposed Use: Monitor

Drilling Start Date: **3/4/2019** Drilling End Date: **3/4/2019**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	60

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	48	60	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	60	tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	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**

	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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	18	tan and brown sandy, silty clay and occasional gravel

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
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
Well County: Harrison	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**

	Diameter (in.)	Top Depth (ft.)	Bottom Depth (ft.)
Borehole:	6.75	0	43

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	Bottom Depth (ft.)	Filter Material	Size
Filter Pack Intervals:	30	43	Sand	16/30

	Top Depth (ft.)	Bottom Depth (ft.)	Description (number of sacks & material)
Annular Seal Data:	0	10	Cement
	10	30	Bentonite 5 Bags/Sacks

Seal Method: **Gravity**

Distance to Property Line (ft.): **No Data**

Sealed By: **Driller**

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:	<i>Strata Depth (ft.)</i>	<i>Water Type</i>
	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

Casing:
 BLANK PIPE & WELL SCREEN DATA

<i>Top (ft.)</i>	<i>Bottom (ft.)</i>	<i>Description</i>
0	18	tan and brown sandy, silty clay and occasional gravel
18	43	red and grey sand w/occ. clay layers

<i>Dia (in.)</i>	<i>Type</i>	<i>Material</i>	<i>Sch./Gage</i>	<i>Top (ft.)</i>	<i>Bottom (ft.)</i>
2	Riser	New Plastic (PVC)	40	0	33
2	Screen	New Plastic (PVC)	40 0.010	33	43

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