ALTERNATIVE SOURCE DEMONSTRATION REPORT TEXAS STATE CCR RULE

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

Submitted to

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LIST OF ACRONYMS

ASD	Alternative Source Demonstration
BGS	Below Ground Surface
CCR	Coal Combustion Residuals
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Profile
SSL	Statistically Significant Level
TAC	Texas Administrative Code
TCEQ	Texas Commission on Environmental Quality
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
VAP	Vertical Aquifer Profiling
WBAP	West Bottom Ash Pond
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

This Alternative Source Demonstration (ASD) report has been prepared to address statistically significant levels (SSLs) for cobalt and lithium in the groundwater monitoring network at the H.W. Pirkey Plant East Bottom Ash Pond (EBAP), located in Hallsville, Texas, following the first semiannual assessment monitoring event of 2022. The H.W. Pirkey Plant has four coal combustion residuals (CCR) storage units regulated by the Texas Commission on Environmental Quality (TCEQ) under Registration No. CCR104, including the EBAP (**Figure 1**).

In June 2022, a semiannual assessment monitoring event was conducted at the EBAP in accordance with 30 TAC §352.951(a). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the unit (Geosyntec, 2020a) and the United States Environmental Protection Agency's (USEPA's) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of either the background concentration or, for constituents with a maximum contaminant level (MCL), the MCL. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were re-calculated for the Appendix IV parameters at the compliance wells to assess whether these parameters were present at an 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 (Geosyntec, 2022a):

- The LCLs for cobalt exceeded the GWPS of 0.00939 mg/L at AD-2 (0.0122 mg/L), AD-31 (0.00953 mg/L), and AD-32 (0.0323 mg/L).

- The LCL for lithium exceeded the GWPS of 0.0548 mg/L at AD-31 (0.0771 mg/L) and AD-32 (0.0785 mg/L).

No other SSLs were identified.

1.1 <u>CCR Rule Requirements</u>

TCEQ regulations regarding assessment monitoring programs for CCR landfills and surface impoundments (TCEQ, 2020a) provide owners and operators with the option to make an ASD when an SSL is identified (30 TAC §352.951(e)):

> *... In making a demonstration under this subsection, the owner or operator must, within 90 days of detecting a statistically significant level above the groundwater protection standard of any constituent listed in Appendix IV adopted by reference in §352.1431 of this title, submit a report prepared and certified in accordance with §352.4 of this title (relating to Engineering and Geoscientific Information) to the executive director, and any local pollution agency with jurisdiction that has requested to be notified, demonstrating that a source other than a CCR unit caused the exceedance or that the exceedance resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.*

Pursuant to 30 TAC §352.951(e), Geosyntec Consultants, Inc. (Geosyntec) has prepared this ASD report to document that the SSLs identified for cobalt and lithium in the groundwater monitoring network for the EBAP are from a source other than the EBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSLs 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 TCEQ CCR rules allow 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. Descriptions of the EBAP design and construction, regional geology and site hydrogeology, methodology used to evaluate the SSLs, and proposed alternative source are described below.

2.1 EBAP Design and Construction

The EBAP is a 31.5-acre CCR surface impoundment located at the north end of the Pirkey Plant, immediately east of the West Bottom Ash Pond (WBAP) (**Figure 1**). It was constructed while the Pirkey Plant was being developed in 1983 and 1984 and placed into operation in 1985 to receive bottom ash and economizer ash sluiced from the Plant boiler. Bottom ash and economizer ash are periodically excavated from the EBAP and removed via truck to either the on-site landfill or sold for offsite beneficial re-use.

The EBAP was developed by excavating part of its' perimeter into native soils to create an embankment height of approximately 4 feet, constructing compacted clay perimeter embankments, and constructing a compacted clay liner over the base of the pond (Arcadis, 2016). Multiple lithological borings advanced following installation of the clay liner confirm that at least 6 feet of clay is present below the base of the EBAP (Arcadis, 2016). The bottom elevation of the EBAP is approximately 347 feet above mean sea level, and the elevation of the top of the pond embankment is approximately 357 feet above mean sea level. The unit was designed to have a maximum storage capacity of 188 acre-feet.

2.2 Regional Geology/Site Hydrogeology

The EBAP is positioned on an outcrop of the Eocene-age Recklaw Formation, which consists predominantly of clay and fine-grained sand (Arcadis, 2016). The Recklaw Formation is underlain by the Carrizo Sand, which crops out in the topographically lower southern portion of the plant. The Carrizo Sand consists of fine to medium grained sand interbedded with silt and clay.

The EBAP monitoring well network monitors groundwater within the Uppermost Aquifer, which was defined by Arcadis (2016) as very fine to fine grained clayey and silty sand with an average thickness of approximately 15 feet. Geologic cross-section A-A' from the EBAP Groundwater Monitoring Well Network Report (Arcadis, 2016) shows the subsurface geometry of the Uppermost Aquifer (indicated on the figure as clayey silty sand, tan to gray) underlying the EBAP and the WBAP. This figure is provided as **Attachment A**. **Attachment A** demonstrates lateral continuity of the Uppermost Aquifer spanning the entire length of the EBAP.

Groundwater flow direction in the area of the EBAP is west-southwesterly (**Figure 1**). Seasonal variability in groundwater flow has not been observed since the monitoring well network was installed. Groundwater flow through the Uppermost Aquifer occurs at a hydraulic gradient of approximately 0.01 feet per foot. The EBAP monitoring well network consists of upgradient monitoring wells AD-4, AD-12, and AD-18, and compliance wells AD-2, AD-3, AD-31, and AD-32, all of which are screened within the Uppermost Aquifer.

2.3 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify alternative sources for cobalt and lithium due to Type I (sampling), Type II (laboratory), Type III (statistical evaluation), or Type V (anthropologic) issues. Groundwater sampling, laboratory analysis, and statistical evaluations were generally completed in accordance with 30 TAC §352.931 and the draft TCEQ guidance for groundwater monitoring (TCEQ, 2020b). As described below, the SSLs have been attributed to natural variation associated with the underlying geology, which is a Type IV (natural variation) issue.

2.3.1 Cobalt

Previous ASDs for cobalt at the EBAP provided evidence that cobalt is present in the aquifer geologic media at the site and that the observed cobalt concentrations in groundwater were due to natural variation of native geogenic sources (Geosyntec, 2019a; Geosyntec, 2019b; Geosyntec, 2020b; Geosyntec, 2020c; Geosyntec, 2021a; Geosyntec, 2021b; Geosyntec, 2022b). The previous ASDs demonstrated how the EBAP was not a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-846 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the most recent SPLP ash leachate sample, collected in 2019, above the reporting limit of 0.01 mg/L, which is lower than the average concentrations observed at the wells of interest (**Table 1**). No changes to material handling or plant operations have occurred which would change the anticipated cobalt concentrations in the pond since this sample was collected.

Cobalt was detected at a concentration of 0.00128 mg/L in a June 2022 surface water sample collected from the EBAP to characterize the total cobalt concentrations (**Table 1**). This concentration is lower than the reported cobalt concentrations for multiple in network wells from the June 2022 sampling event, including the upgradient monitoring wells AD-4 (0.0041 mg/L; **Figure 2**) and AD-12 (0.00135 mg/L; **Figure 2**). The EBAP sample was also found to be approximately an order of magnitude lower than the average concentration in groundwater at the wells of interest (**Table 1**). Thus, the EBAP is not the likely source of cobalt at AD-2, AD-31, and AD-32.

As noted in the previous ASDs, soil samples collected across the site, including from locations near the EBAP, identified cobalt in the aquifer solids at concentrations ranging from 0.59 – 23.5 milligrams per kilogram (mg/kg) with the highest value reported at AD-41, which is upgradient of the EBAP (**Figure 3**). SB-2 was advanced in the vicinity of AD-2 in April 2020 to re-log the geology at AD-2 and collect samples for laboratory analysis of total metals and mineralogy. The

SB-2 field boring log, which was generated by Auckland Consulting LLC, is provided as **Attachment B**. Cobalt was detected at SB-2 at concentrations of 9.45 mg/kg at 25-27 feet below ground surface (bgs) and 19.2 mg/kg at 31-33 feet bgs (**Table 2**). These cobalt concentrations are greater than the concentration of cobalt present in the bottom ash (6.1 mg/kg; **Table 1**). Both samples correlate to the depth of the monitoring well screen of AD-2 (20-40 feet bgs), indicating that naturally occurring cobalt is present in aquifer solids within the AD-2 screened interval.

In addition to the analysis of total cobalt, soil samples were submitted for mineralogical analysis to determine the mineral composition of soils near the EBAP. X-ray diffraction (XRD) analysis of soils from SB-2 identified pyrite (an iron sulfide) in samples collected at 25-27 feet bgs and 31-33 feet bgs at concentrations up to 7% by weight (**Figure 3**). Cobalt is known to undergo isomorphic substitution for iron in crystalline iron minerals such as pyrite due to their similar ionic radii of approximately 1.56 angstroms (Å) for iron vs. 1.52 Å for cobalt (Clementi and Raimondi, 1963; Krupka and Serne, 2002; Hitzman et al., 2017). The presence of iron-bearing minerals in soil near the EBAP constitutes a potential source of naturally occurring cobalt.

The aquifer solids at SB-2 are distinctly red in color at shallow depths, as illustrated in the photolog of soil cores provided in **Attachment C**. While shallow samples were not collected for mineralogical analysis, red color in soils is often associated with the presence of oxidized iron-bearing minerals such as hematite and goethite. The red color of the soil suggests the presence of iron oxide and hydroxide minerals within the shallow depth interval. The alteration of pyrite to these iron oxide and hydroxide minerals under oxidizing conditions is also a well-understood phenomenon, including in formations in east Texas (Senkayi et al., 1986; Dixon et al., 1982). It is likely that the pyrite weathering process is resulting in the release of isomorphically substituted cobalt from the pyrite crystal structure as it undergoes oxidative transformation to iron oxide/hydroxide minerals.

As described in the previous ASDs, vertical aquifer profiling (VAP) was used to collect groundwater samples from upgradient locations B-2 and B-3 during the soil boring and sample collection process (Geosyntec, 2019b). A groundwater sample was also collected from AD-32, one of the existing compliance-wells within the EBAP groundwater monitoring network where a cobalt SSL was identified. Solid phase materials within these groundwater samples were separated and submitted for analysis of chemical composition. For the VAP samples, separation was completed using a centrifuge due to the high abundance of suspended solids. For the groundwater sample at AD-32, the sample was filtered using a 1.5-micron filter. Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient VAP location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from permanent monitoring wells B-2 and B-3 (**Table 2**). The concentrations of cobalt in the solid material retained after filtration were comparable to the bulk soil samples collected from the same locations.

The solid sample [VAP-B3-(40-45)] was submitted for mineralogical analysis via XRD and scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS).

The XRD results identified pyrite as approximately 3% of the solid phase (**Table 3**). Pyrite was identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site. Logging completed while the VAP boring was advanced identified coal at several intervals, including 45 and 48 feet bgs (**Figure 4**). Furthermore, SEM/EDS of both centrifuged solid samples [VAP-B3-(40-45) and VAP-B3-(50-55)] identified pyrite in backscattered electron micrographs by the distinctive framboidal morphology (Harris et al., 1981; Sawlowicz, 2000). Major peaks representing iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (**Attachment D**). While cobalt was not identified in the EDS spectrum, it is likely present at concentrations below the detection limit.

The EBAP was not identified as the source of cobalt at wells in the EBAP network based on the low concentrations of cobalt in the pond itself and the ubiquity of naturally occurring cobalt, especially in soil and groundwater samples upgradient from the EBAP. Cobalt in the EBAP network groundwater is believed to be a result of natural variability within the aquifer. Naturally occurring cobalt is known to substitute for iron in iron-bearing minerals. The presence of iron sulfide (as pyrite) and iron oxides/hydroxides hematite and goethite have been confirmed at AD-2 and across the Site. The weathering of pyritic minerals to iron oxide/hydroxide minerals may be resulting in the release of cobalt into groundwater from the crystal structure of these aquifer minerals.

2.3.2 Lithium

Previous ASDs for lithium at the EBAP attributed the observed lithium exceedances to variations in lithium associated with the suspended native aquifer solids that likely originate from naturally occurring lignite present in these soils. These native lithium-containing aquifer solids are ubiquitous in the aquifer based on the presence of both solid-phase and dissolved lithium at upgradient locations (Geosyntec, 2019b; Geosyntec, 2020b; Geosyntec, 2020c; Geosyntec, 2021a; Geosyntec, 2021b; Geosyntec, 2022b). Data gathered in support of the prior ASDs and recent results provide additional evidence that the observed lithium groundwater concentrations at AD-31 and AD-32 are naturally occurring and are due to natural variation in the aquifer (Type IV ASD).

As discussed in Section 2.3.1, a surface water sample was collected directly from the EBAP in June 2022. Lithium was detected in the June 2022 EBAP sample at a concentration of 0.0463 mg/L (**Figure 5, Table 4**). The labile fraction identified in the bottom ash by SPLP from a February 2019 sample was even lower, with an estimated (J-flagged) lithium concentration of 0.011 mg/L. These concentrations are below the average lithium concentrations at AD-31 (0.0819 mg/L) and AD-32 (0.0859 mg/L) (**Table 4**). Thus, the EBAP is not the likely source of lithium at AD-31 and AD-32.

Groundwater samples collected from upgradient wells B-2 and B-3 in March 2022 had total lithium concentrations of 0.0574 mg/L and 0.0734 mg/L, respectively. The reported concentration at B-3 is greater than the GWPS of 0.0590 mg/L and only slightly lower than the concentrations of lithium observed at AD-31 and AD-32 (**Figure 5**). Because B-2 and B-3 were installed at locations upgradient to and unimpacted by site activities, these lithium concentrations suggest that dissolved lithium is naturally present at concentrations above the GWPS across the site at variable concentrations, and not limited to AD-31 and AD-32. It is noted that B-2 and B-3 are not part of the monitoring network for the EBAP, and as such the lithium concentrations in groundwater from these wells are not considered in calculating the GWPS for the CCR unit.

As described in Section 2.3.1, groundwater samples were collected from B-2, B-3, and AD-32 and filtered to separate solids. Groundwater was also collected from a VAP boring (VAP-B3-(40-45)) and centrifuged to separate solids. Lithium was detected in the solid material separated from these groundwater samples at concentrations comparable to bulk soil at all locations, providing evidence that the particulates captured during groundwater sampling contain lithium (**Table 5**).

2.3.2.1 Calculated Partition Coefficients

A previous ASD for lithium at the EBAP discussed lithium mobility in groundwater due to desorption from cation exchange complexes associated with clay minerals within naturally occurring lignite material. This mechanism was posited as the source of lithium in both upgradient and downgradient wells at the EBAP (Geosyntec, 2019b). Previously completed XRD analysis of centrifuged solid material samples (VAP-B3-(40-45)) found that clay minerals, including kaolinite, smectite, and illite/mica, made up at least 60% of the aquifer solid (**Table 3**). SEM/EDS analysis also identified the presence of silicon, aluminum, and oxygen, all of which are components of clay minerals (**Attachment D**). 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 clay minerals, particularly smectite and illite, are known to retain cations such as lithium via incorporation into the octahedral layer of the mineral structure and through cation exchange processes.

Mass measurements and total metal concentrations in the solid materials separated from the groundwater samples during filtration and the filtered groundwater concentrations were used to calculate partition coefficients values (K_d) for lithium, potassium, and sodium. Details about the K_d calculation are provided in the previous ASD (Geosyntec, 2019b). K_d values for groundwater and particulates collected from wells B-2, B-3, and AD-32 were comparable to literature K_d values reported for organic-rich media such as bogs and peat beds (Sheppard et al., 2009; Sheppard et al., 2011), providing further evidence that lithium mobility in site groundwater is similar to other sites with organic-rich soils (**Table 6**). Additionally, the calculated K_d values for Pirkey soils were consistent with the literature, with potassium having the highest K_d (greatest affinity for sorption) and sodium the lowest K_d (least affinity for sorption). Furthermore, the values are similar for groundwater from all three wells, suggesting a universal mechanism controlling lithium, sodium, and potassium mobility in groundwater.

These multiple lines of evidence show that elevated lithium concentrations at AD-31 and AD-32 are likely not due to a release from the EBAP, and instead can be attributed to natural variation

(Type IV ASD). This variation appears related to the distribution of clay fractions associated with lignite materials in the soil aquifer material.

2.4 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 semiannual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 30 TAC §352.951(e) and supports the position that the SSLs for cobalt and lithium identified during assessment monitoring in June 2022 were not due to a release from the EBAP. The identified SSLs should instead be attributed to natural variation in the underlying geology. Therefore, no further action is warranted, and the Pirkey EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in **Attachment E.**

SECTION 4

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TABLES

Table 1: Summary of Key Cobalt Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant

Sample	Sample Date	Unit	Cobalt Concentration
Bottom Ash (Solid Material)	2/11/2019	mg/kg	6.1
SPLP Leachate of Bottom Ash	2/11/2019	mg/L	<0.01
EBAP Pond Water	6/24/2022	mg/L	0.00128
AD-2 - Average	May 2016 - June 2022	mg/L	0.0140
AD-31 - Average	May 2016 - June 2022	mg/L	0.0123
AD-32 - Average	May 2016 - June 2022	mg/L	0.0431

Notes:
mg/kg - milligram per kilogram
mg/L - milligram per liter
SPLP - Synthetic Precipitation Leaching Procedure
Average values were calculated using all cobalt data collected under 40 CFR 257 Subpart D, excluding any identified outliers.

Table 2: Soil Cobalt Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Location	Sample Depth (ft bgs)	Cobalt (mg/kg)
Bulk Soil Samples			
AD-2	EBAP Network	25-27	9.45
		31-33	19.2
AD-18	EBAP Network	8	3.60
		22	2.90
AD-31	EBAP Network	12	1.90
		26	0.83
AD-32	EBAP Network	11	1.70
		20-25	9.10
AD-41	Upgradient	15	< 1.0
		35	23.5
		95	1.90
B-2	Upgradient	10	2.36
		16	3.62
		71	10.30
		82	7.21
		87	3.11
B-3	Upgradient	10	1.30
		20	0.59
		97	1.11
Solid Material Retained After Filtration			
AD-32	EBAP Network	13-33	5.4
B-2	Upgradient	38-48	4.3
B-3	Upgradient	29-34	12.0
		VAP 40-45	18.0

Notes:
mg/kg- milligram per kilogram
ft bgs - feet below ground surface

For AD-XX locations, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-2 and B-3 locations were collected from cores removed from the borehole during well lithology logging.

Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected.

Table 3: X-Ray Diffraction Results
East Bottom Ash Pond - H. W. Pirkey Plant

Constituent	VAP-B3-(40-45)
Quartz	15
Plagioclase Feldspar	0.5
Orthoclase	ND
Calcite	ND
Dolomite	ND
Siderite	0.5
Goethite	ND
Hematite	2
Pyrite	3
Kaolinite	42
Chlorite	4
Illite/Mica	6
Smectite	12
Amorphous	15

Notes:
Results given in units of relative % abundance
ND: Not detected
VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

Table 4: Summary of Key Lithium Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant

Sample	Sample Date	Unit	Lithium Concentration
Bottom Ash (Solid Material)	2/11/2019	mg/kg	0.82 J
SPLP Leachate of Bottom Ash	2/11/2019	mg/L	0.011 J
EBAP Pond Water	6/24/2022	mg/L	0.0463
AD-31 - Average	May 2016 - June 2022	mg/L	0.0819
AD-32 - Average	May 2016 - June 2022	mg/L	0.0859

Notes:
mg/kg - milligram per kilogram
mg/L - milligram per liter
Average lithium values for monitoring wells AD-31 and AD-32 were calculated using all lithium data collected under 40 CFR 257 Subpart D, excluding statistically identified outliers.
J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

Table 5: Soil Lithium Data
East Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Sample Depth (ft bgs)	Lithium (mg/kg)
Bulk Soil Sample		
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
* - AD-32 samples were collected from a seperate borehole advanced near monitoring well AD-32
Depths for samples collected after filtration represent the screened interval for the permanent well where the sample was collected
VAP - vertical aquifer profiling

Table 6: Calculated Site-Specific Partition Coefficients
Pirkey Plant - East Bottom Ash Pond

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).
* - AD-32 samples were collected from a separate borehole advanced near monitoring well AD-32

FIGURES

Legend

Groundwater Monitoring Wells

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

Notes

- Monitoring well coordinates and water level data (collected on June 20-22, 2022) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluation Update (Arcadis, 2022) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- AD-10, AD-19, AD-20, AD-21, AD-24, AD-29, AD-35, and W-3 were not gauged during the June 2022 event.
- AD-35 was abandoned on November 13, 2018.

1,000 500 0 1,000 Feet

STATE OF TEXAS
BETH ANN GROSS
79864
LICENSED
PROFESSIONAL ENGINEER

Beth Ann Gross

12/29/2022

Geosyntec Consultants, Inc.
Texas Firm
Registration No. 1182

Potentiometric Contours - Uppermost Aquifer
June 2022

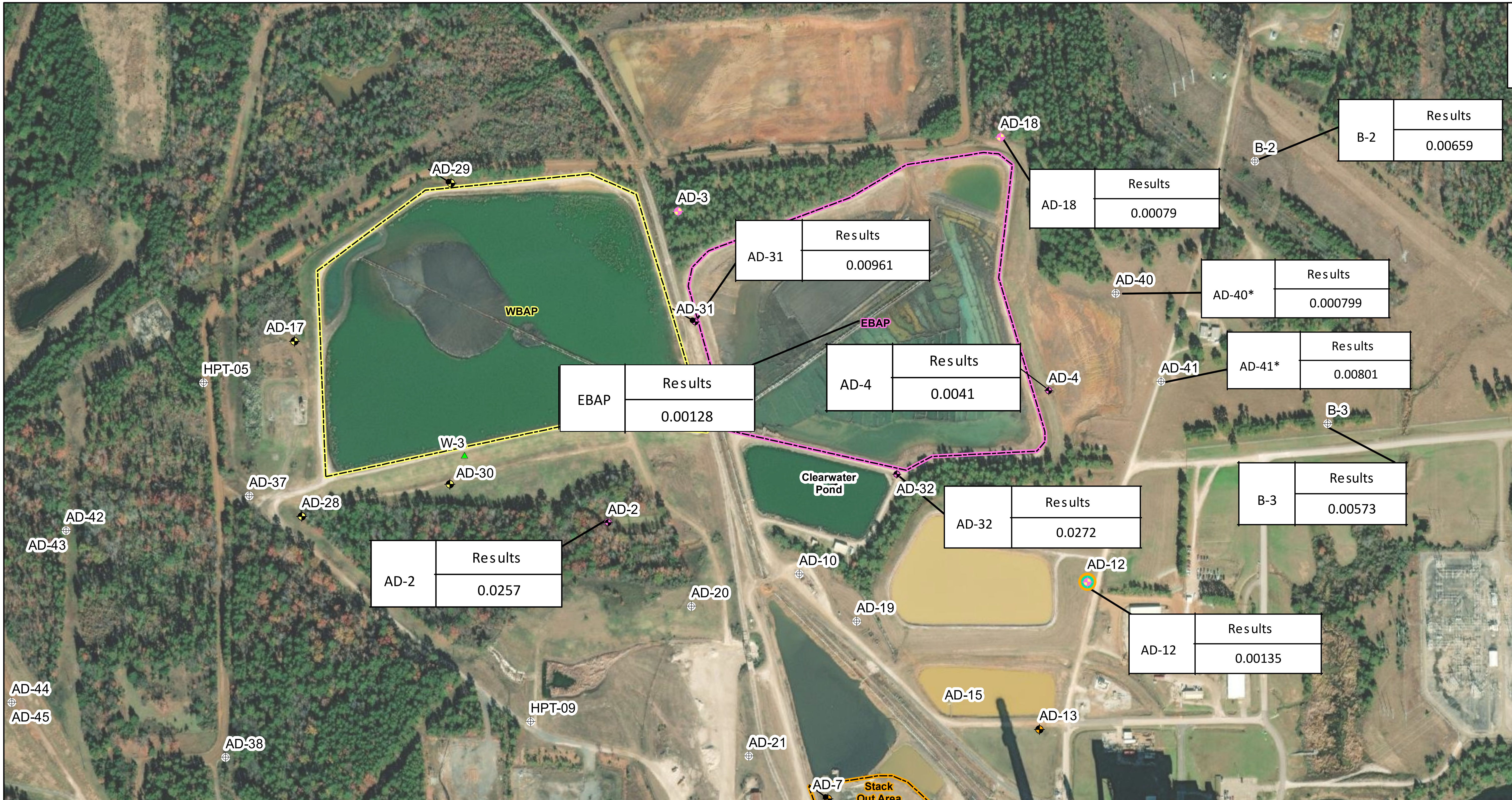
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Figure 1

Columbus, Ohio | 2022/12/21

W:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2022\AEP-Pirkey_GW_2022-06June.mxd. ASoltero. 12/21/2022. Project/Phase/Task.



Legend

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP
- All CCR Unit Networks
- Piezometer
- EBAP
- Stack Out Area
- WBAP

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- AD-15 location is approximated.
- Samples collected in June 2022.
- * - Well most recently sampled August 2019.
- Samples show in milligrams per liter

400 200 0 400 Feet

Aqueous Cobalt Distribution

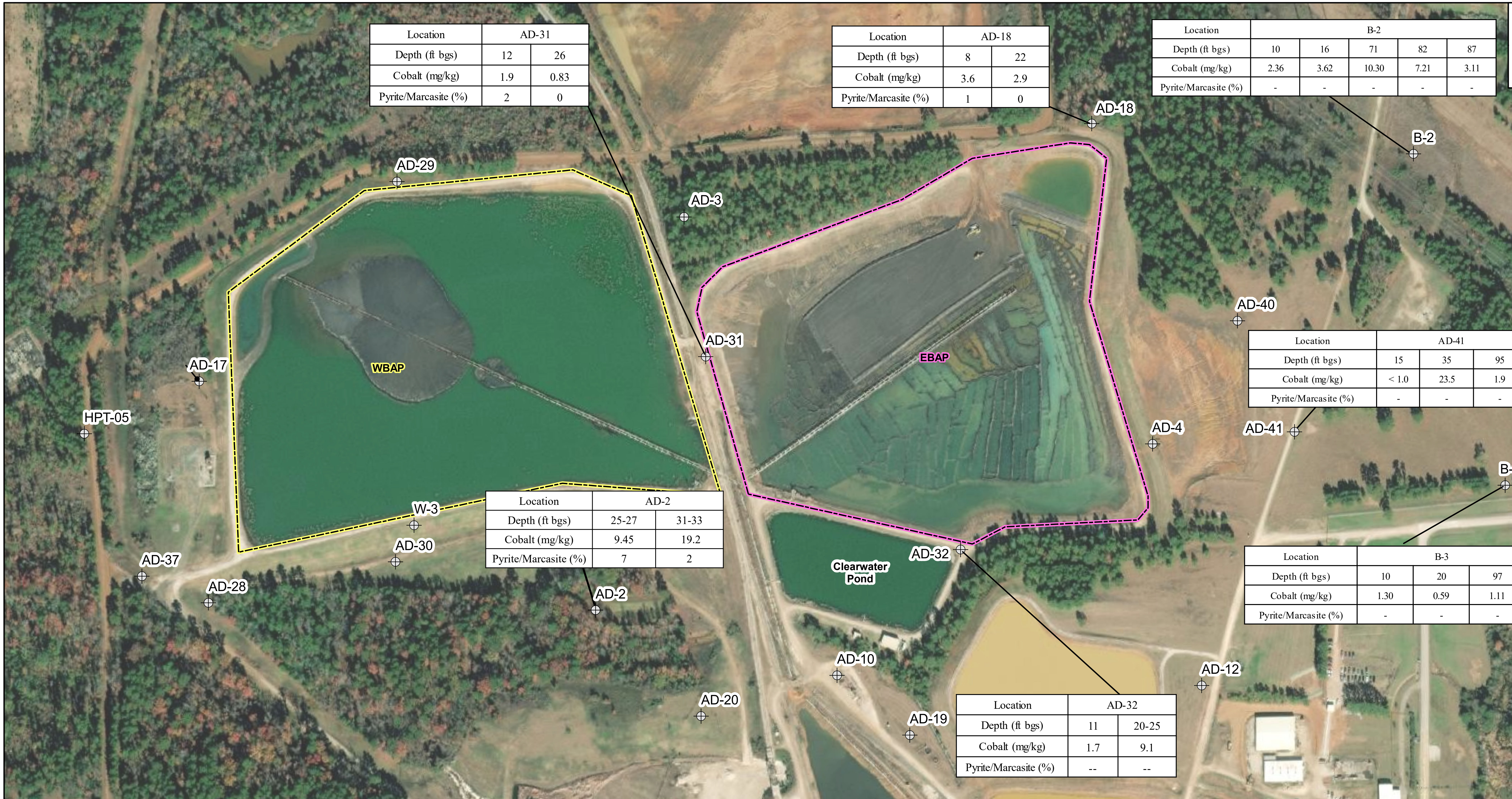
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2022/12/19

Figure 2

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2021\AEP_Pirkey_Cobalt_GW_20210429.mxd. HDuff. 4/29/2021. Project/Phase/Task.



Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

Location	AD-18	
Depth (ft bgs)	8	22
Cobalt (mg/kg)	3.6	2.9
Pyrite/Marcasite (%)	1	0

Location	B-2				
Depth (ft bgs)	10	16	71	82	87
Cobalt (mg/kg)	2.36	3.62	10.30	7.21	3.11
Pyrite/Marcasite (%)	-	-	-	-	-

Location	AD-41		
Depth (ft bgs)	15	35	95
Cobalt (mg/kg)	< 1.0	23.5	1.9
Pyrite/Marcasite (%)	-	-	-

Location	AD-2	
Depth (ft bgs)	25-27	31-33
Cobalt (mg/kg)	9.45	19.2
Pyrite/Marcasite (%)	7	2

Location	B-3		
Depth (ft bgs)	10	20	97
Cobalt (mg/kg)	1.30	0.59	1.11
Pyrite/Marcasite (%)	-	-	-

Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Legend

- Monitoring Wells
- EBAP
- WBAP

Notes

- Monitoring well coordinates provided by AEP.
- AD-2 sample collected on April 20, 2020
- All other data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.

300 150 0 300 Feet

Cobalt Distribution in Soil

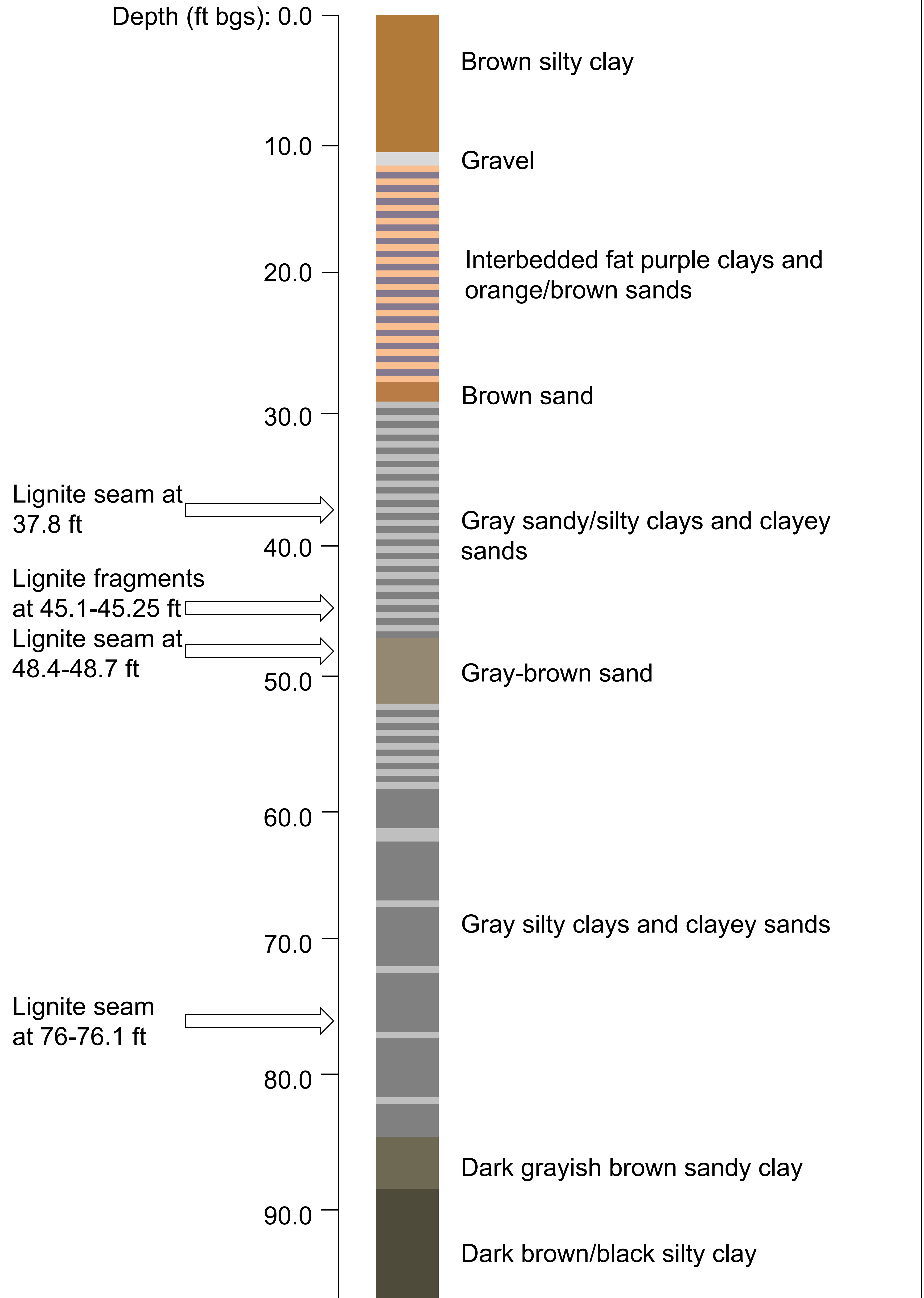
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/12/22

Figure **3**

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\20201218 Pirkey_SoilChem_minerals_March2019_new.mxd. CChristenson. 12/22/2020. Project/Phase/Task.



Notes:
- Ft = feet
- Bgs = below ground surface
- Boring completed May 2019
- Total depth of 97.5 ft bgs
- Well installed in offset boring screened at 29-34 ft bgs

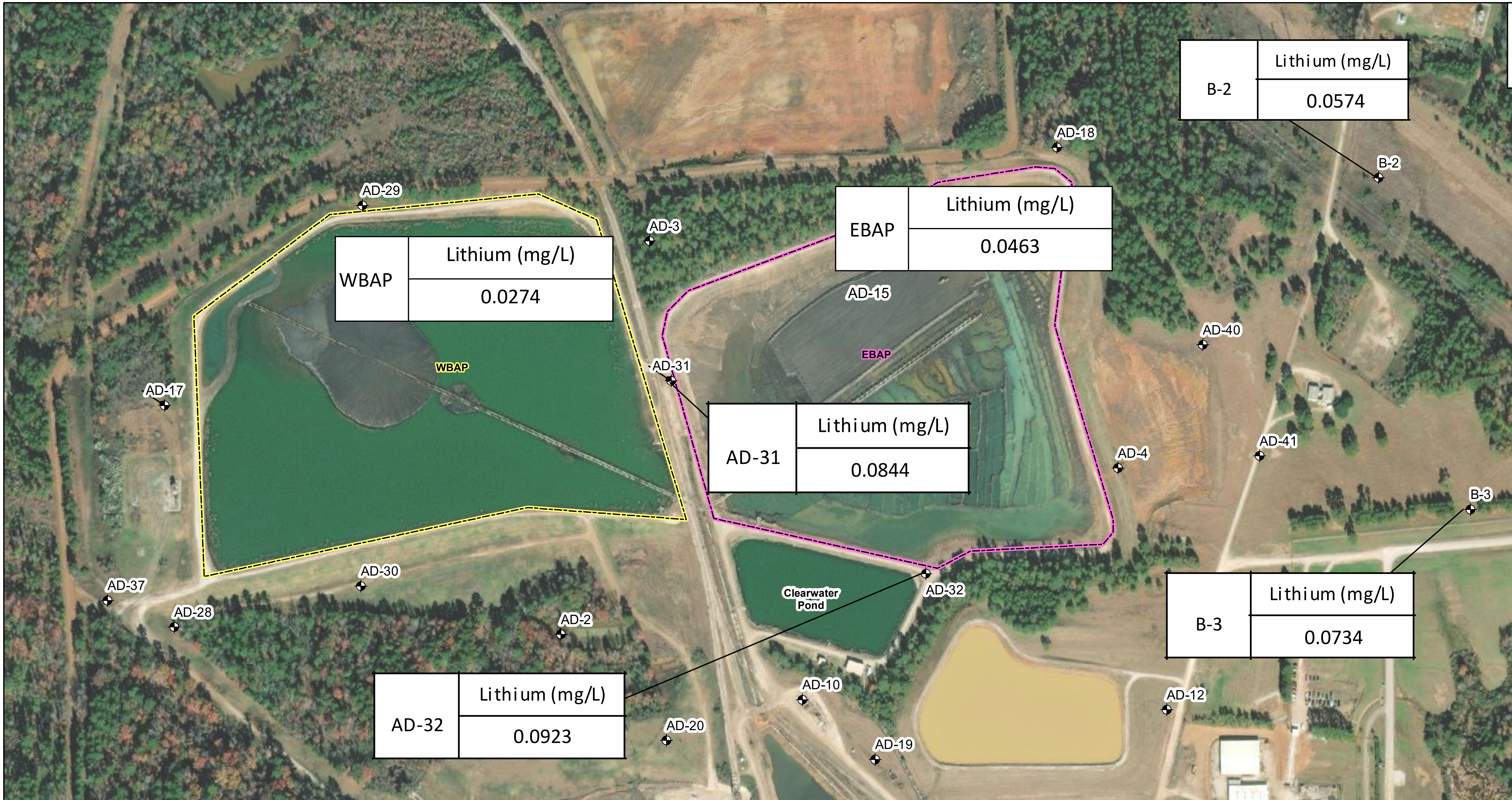
B-3 Visual Boring Log

AEP Pirkey Powerplant
Hallsville, TX

Geosyntec consultants

CHA8462	March 2020	Figure 4

\\annarbor-01\data\Projects\AEP\Legal Department - ASD Review\Pirkey\2019-05 Field Investigation\Field Forms\Compiled Boring Logs\Visual boring logs



Legend

- Monitoring Well
- EBAP
- Landfill
- Stack Out Area
- WBAP

Notes

- Lithium concentrations in milligrams per liter mg/L.
- Monitoring well coordinates, site features, and data provided by AEP.
- Groundwater samples were collected in June 2022.
- Porewater sample from East Bottom Ash Pond (EBAP) was collected in 2022.

300 150 0 300
Feet

Aqueous Lithium Distribution

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Figure **5**

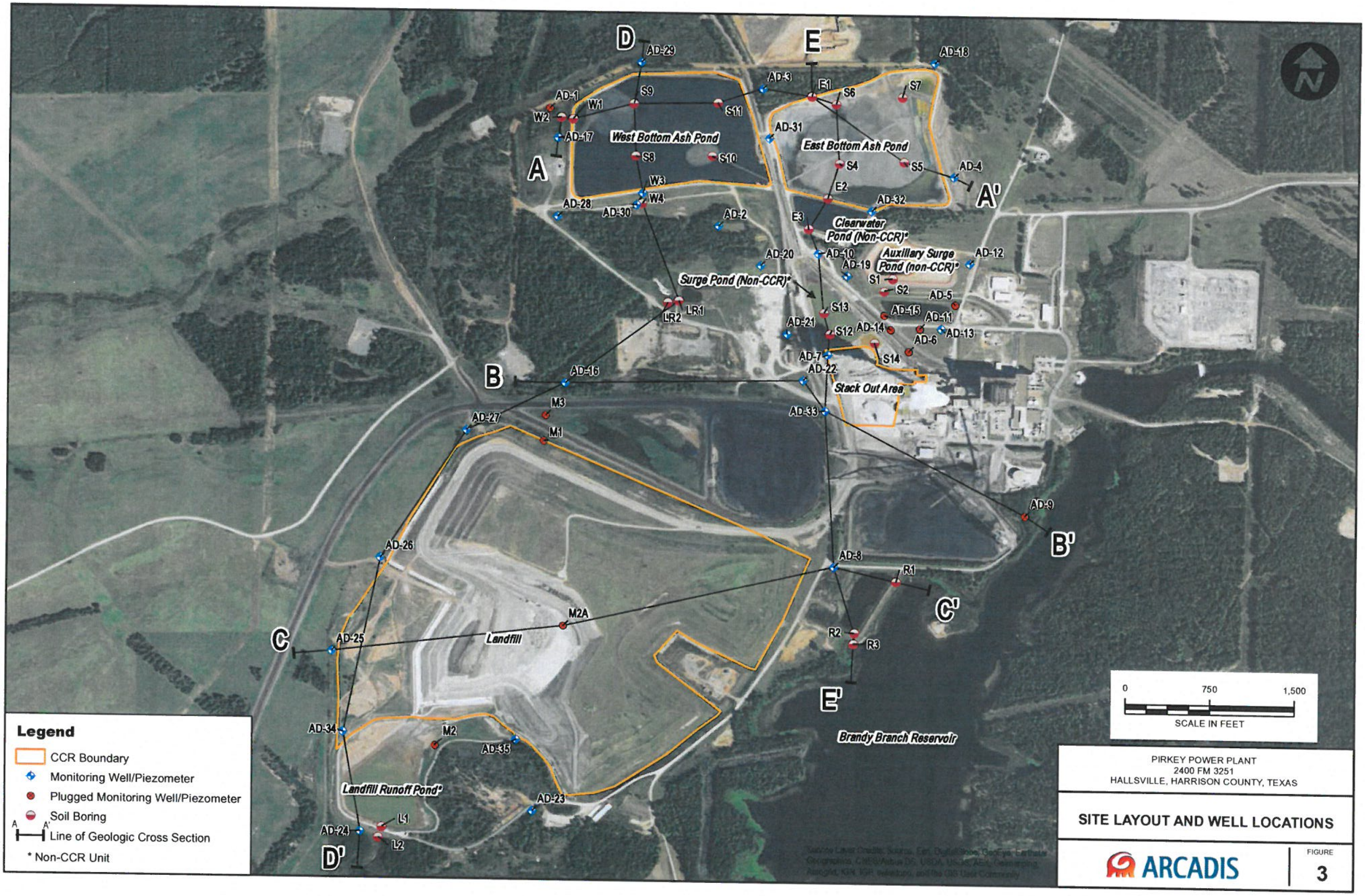
Columbus, Ohio | 2022/12/19

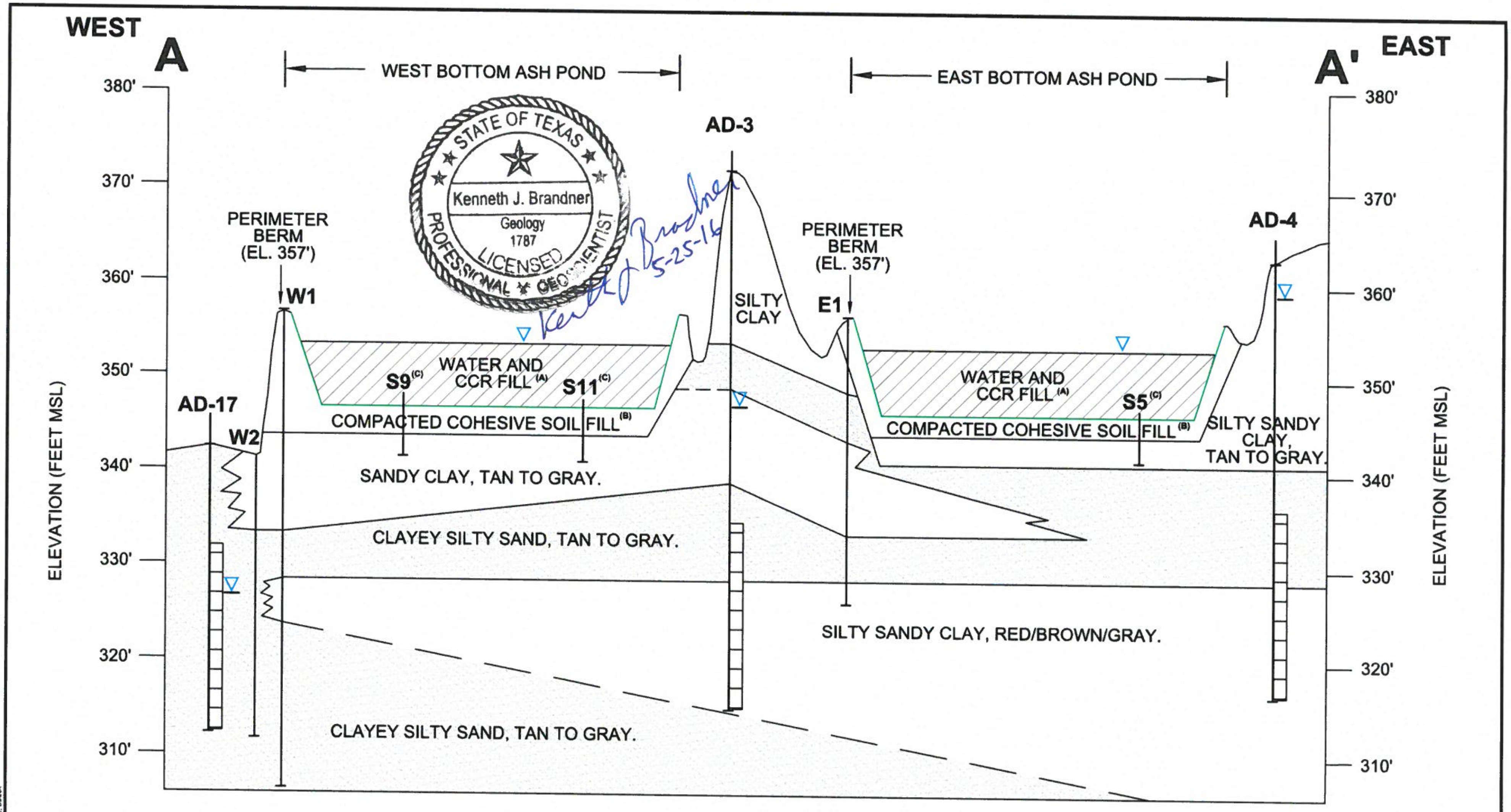
P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2021\AEP-Pirkey_ASD_Li_20220601.mxd. BAres. 6/1/2022. CHA8462/12/02.

ATTACHMENT A

Geologic Cross-Section A-A'

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





LEGEND

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

0 300'
HORIZONTAL SCALE

NOTES:

A) TOP OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND PERIMETER BERM ELEVATION IS 357', OPERATING ELEVATION IS 354'(JOHNSON & PACE, MAY 2011). BASE ELEVATION OF WEST BOTTOM ASH POND AND EAST BOTTOM ASH POND IS 347' (SARGENT & LUNDY, JANUARY 1983).
B) COMPACTED COHESIVE SOIL FROM ELEVATION 344' TO 347' (SARGENT & LUNDY, SEPTEMBER 1984;AMEC, AUGUST 2011).
C) SOIL BORING INSTALLED BY SOUTHWESTERN LABORATORIES DURING ASH POND CONSTRUCTION IN 1983.

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

CROSS SECTION A - A'

ARCADIS

FIGURE
4

ATTACHMENT B

SB-2 Boring Log

PROJECT NO. ____________ PROJ. ____________ BOR. NO. SB-2

LOCATION AD-2/MW-2 - Pittsburg Power Plant ELEV. ____________ DATE 4/20/20

SILTS & SANDS		COHESIVE SOILS - CLAYS			COLORS	MATERIALS	SAND ADJ.	CHARACTERTICS
CONDITION		CONSISTENCY	PENETROMETER	N - VALUE				
VLo ...... Very Loose	0- 4	Vso.. Very Soft	0 - 0.25	<2	Li .... Light .....Br ....Brown	Cl ..... Clay, Clayer	F.......Fine	Calc ..... Calcareous
Lo .... Loose	4-10	So.... Soft	0.25 - 0.5	2 - 4	Dk ... Dark .....Bk ....Black	Si ..... Silt, Silty	M ....Medium	Lig .... Lignite
MDe ..... Med. Dense	10-30	Mst.. Stiff	0.5 - 1.0	4 - 8	G ..... Grey ....Bl ....Blue	Sa ..... Sand, Sandy	Co....Coarse	Org .... Organic
De .... Dense	30-50	St..... Stiff	1.0 - 2.0	8 - 15	T ...... Tan ....Gr .....Grenn	Ls .... Limestone	Si.....Silty	Lam ...... Laminate
VDe ...... Very Dense	>50	VSt.. Very Stiff	2.0 - 4.0	15 - 30	R ...... Red ......Y ......Yellow	Gr .... Gravel		Sls .... Slickensided
		H..... Hard	> 4.0	>30	Rdish.Reddish.Wh ...White	SiS ... Siltstone		SL .... Slightly
						SS .... Sandstone		Sm(s) ... Seam (s)
						Sh..... Shale, Shaley		Nod ...... Nodules

	Sample Interval (~~TEST ASSIGNMENT~~)	~~SAMPLE NO.~~ Recovery	DEPTH FT.	SAMPLES	STRATUM DESCRIPTION: CONDITION OR CONSISTENCY	COLOR	MINOR MATERIALS OR ADJECTIVES	PREDOMINATE MATERIAL	CHARACTERISTICS OR MODIFICATIONS	STANDARD PENETROMETER: SEAT - 6"	1st - 6"	2nd - 6"	UNIFIED SOIL CLASSIFICATION	N - VALUE OR HAND PENETROMETER
SM	0-5	2' Rec	0		0-8'	Br, Lt. Rd Br	Si	Sa	Silty Sand - trace clay,					
									trace root hairs, moist.				moist	(0-5)
	5-10	2.5' Rec				Lt. Rd Br			- thin lenses (less than 1/4")				moist	(5-10)
8'									at 7.5', trace, iron staining					
Cl	10-15	4' Rec	8		8-14.5'	Lt. Rd Br, Rd Br, Gray	Sa, Si	Cl	Clay - some silty sand and silty				moist	(10-15')
									clayey sand in interbeds					
14.5'									to 14.5', trace iron ore gravel					
									in sand seams @ 10.5, 12', 12.5'					
	15-20	2' Rec	14.5		14.5-39'	Rd Br, Yllw. Br, Gray	Si, Cl	Sa	silty clayey sand - some sandy clay;				v. moist to	
									iron cemented sand @ 16.5'				moist	(15-20)
									and ironstone → (~1.5")					
	20-25'	* No Rec.							(?) - cemented sand seams in silty				v. moist	(20-25?)
SC									sand @ 20-25'					
	25-30	2.5' Rec				Gray - Dk Gray Dk. Br			- gravel & cemented sand seam @ 25' (6")				sat. @	25'-25.5'
									- cemented and partially cemented @					
						(25-39')			clayey silty sand @ 25.5				moist	25.5-27
									- dark gray silty sat. sand seam (2")				sat. @	27.0 (2")
									@ 27"					
	30-35	3' Rec							- sat. silty sand seam @ 30.5 (1")				sat. @	30.5 (1")
									- sat. silty sand seam @ 32' (3")					32.0 (3")
39'									* some v.f. gypsum crystals in clayey sand					
									between sat. sand seams (25-40')				v. moist	(to 39')
ML	35-40	4' Rec	39		39-40	Lt. Gray, Gray (39-40)	Cl, Sa	Si	Clayey sandy silt,					
									- interbedded silt & clay @ 39' to 40'				moist	(39-40')
									B.T. @ 40'					
									* 25-27' collected @ 1015					
									* 31-33' collected @ 1035					

Type Boring HSA — Dry Auger ☒ Rotary Wash ☐

SEEPAGE @ 25' FT. WHILE DRILLING, W.L. @ ____ FT. ON COMPL. (OR) BAILED TO ____ FT. UPON COMPLETION. W.L. @ ____ FT AND CAVED TO ____ FT. ON ________.

* GPS: 32.46522, -94.49032 (12' E, 3.5' N of AD-2/MW-2)

ATTACHMENT C

SB-2 Boring Photographic Log

GEOSYNTEC CONSULTANTS
Photographic Record

Client: AEP | **Project Number: CHA8495**

Site Name: Pirkey East Bottom Ash Pond | **Site Location: Hallsville, Texas**

Photograph 1

Date: 4/21/2020

Direction: N/A

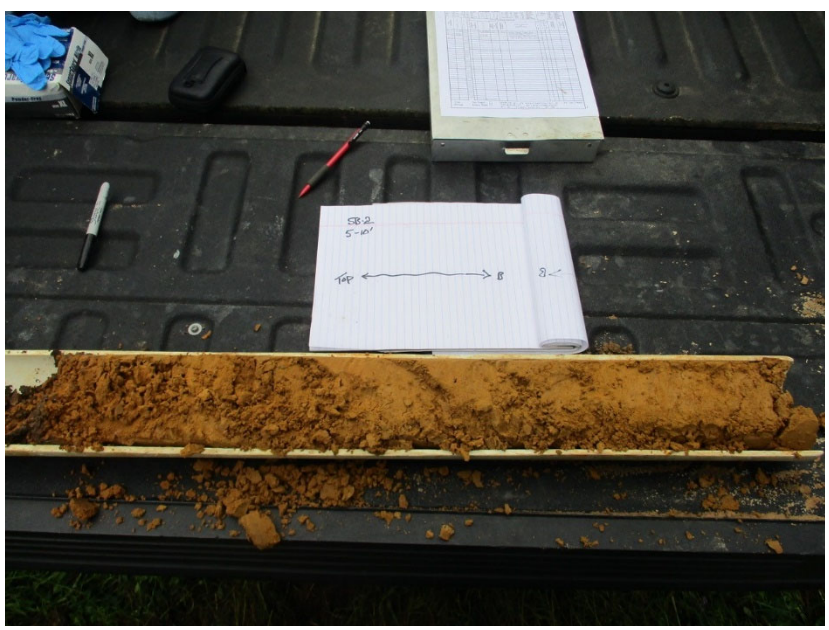
Comments:
0-5 foot interval of SB-2.

Photograph 2

Date: 4/21/2020

Direction: N/A

Comments:
5-10 foot interval of SB-2.



GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

Client: AEP	**Project Number: CHA8495**
Site Name: Pirkey East Bottom Ash Pond	**Site Location: Hallsville, Texas**

Photograph 3

Date: 4/21/2020

Direction: N/A

Comments:
10-15 foot interval of SB-2.

Photograph 4

Date: 4/21/2020

Direction: N/A

Comments:
15-20 foot interval of SB-2. Recovery of this interval was limited.

GEOSYNTEC CONSULTANTS
Photographic Record

Client: AEP	**Project Number: CHA8495**
Site Name: Pirkey East Bottom Ash Pond	**Site Location: Hallsville, Texas**

Photograph 5

Date: 4/21/2020

Direction: N/A

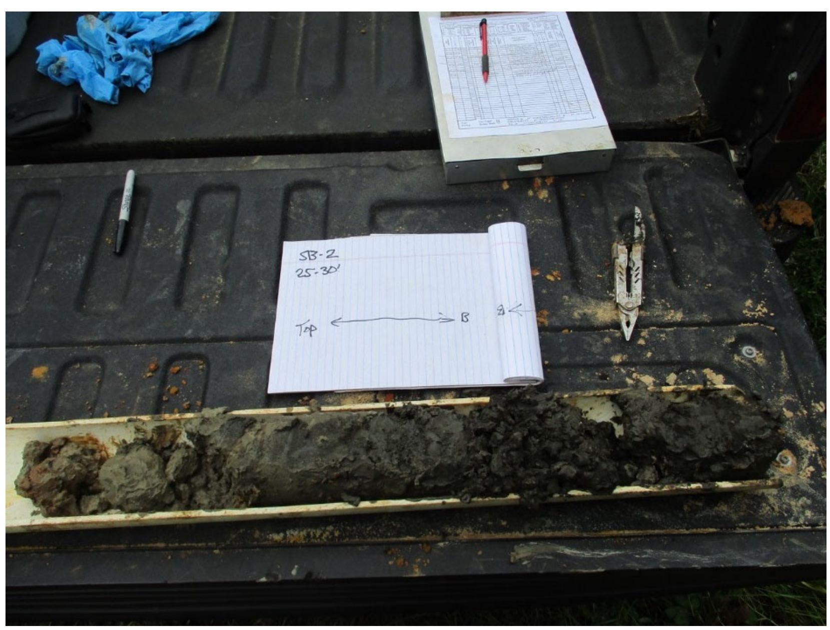
Comments:
20-25 foot interval of SB-2. Recovery of this interval was limited.

Photograph 6

Date: 4/21/2020

Direction: N/A

Comments:
25-30 foot interval of SB-2. Very little of this interval was recovered. A color change was observed from red to dark brown/black. A sample was collected from this interval.



GEOSYNTEC CONSULTANTS
Photographic Record

Client: AEP	**Project Number: CHA8495**
Site Name: Pirkey East Bottom Ash Pond	**Site Location: Hallsville, Texas**

Photograph 9

Date: 4/21/2020

Direction: N/A

Comments:
30-35 foot interval of SB-2. Very little of this interval was recovered.. A sample was collected from this interval.

Photograph 10

Date: 4/21/2020

Direction: N/A

Comments:
35-40 foot interval of SB-2

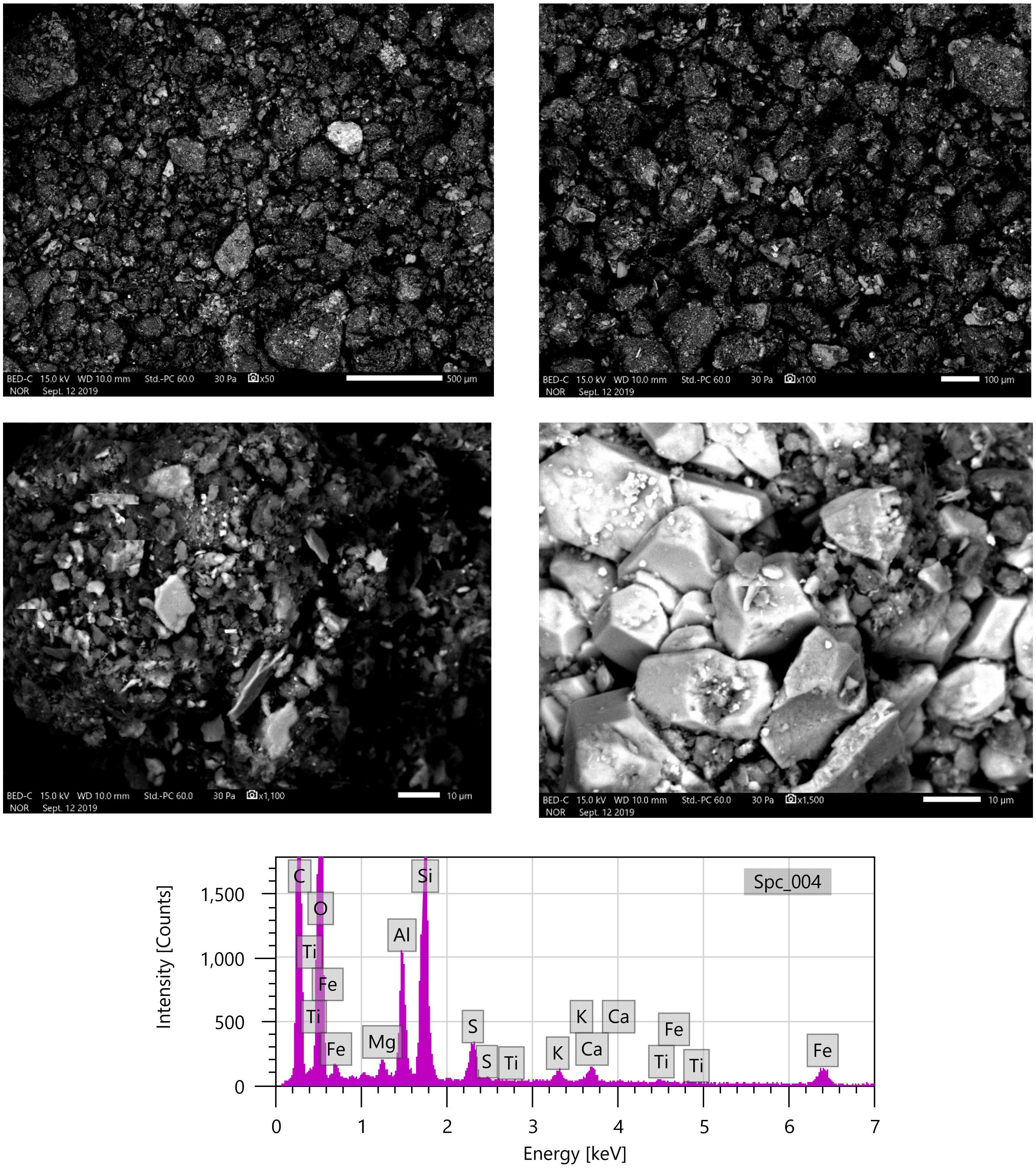
ATTACHMENT D

SEM/EDS Analysis

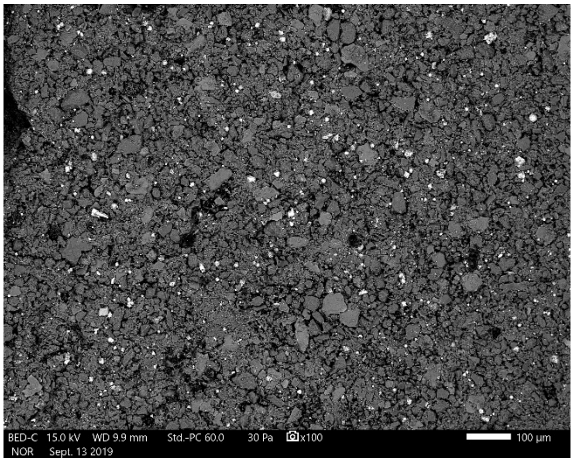
September 16, 2019

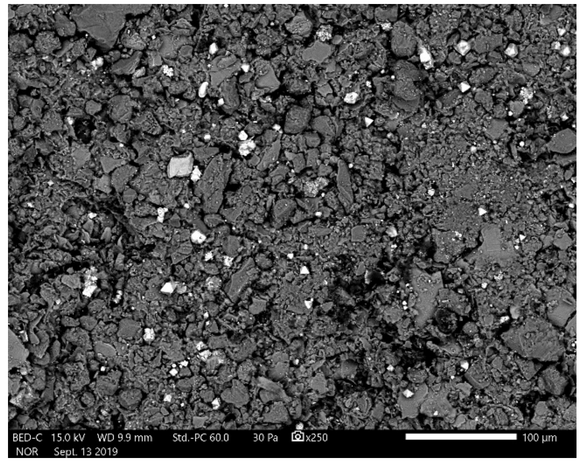
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221

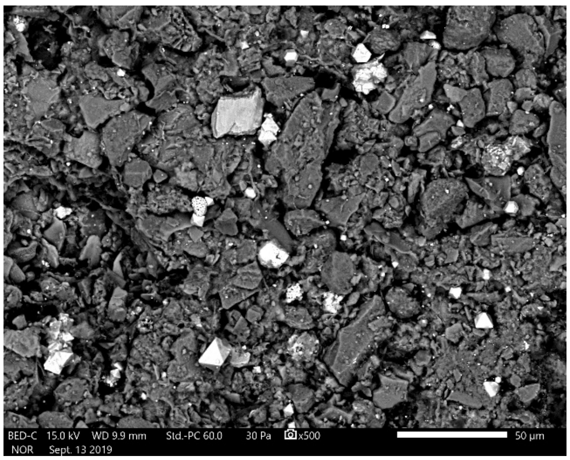
via Email: BSass@geosyntec.com

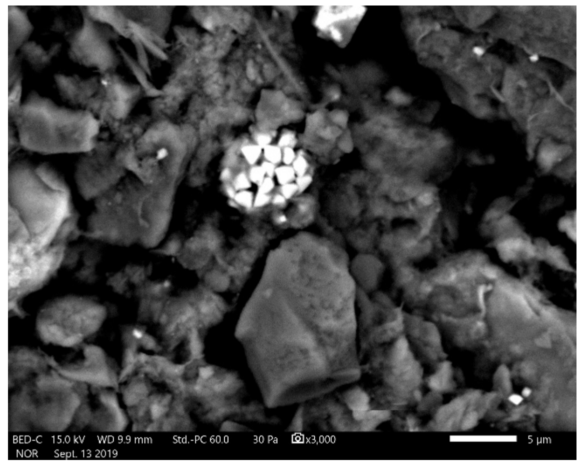


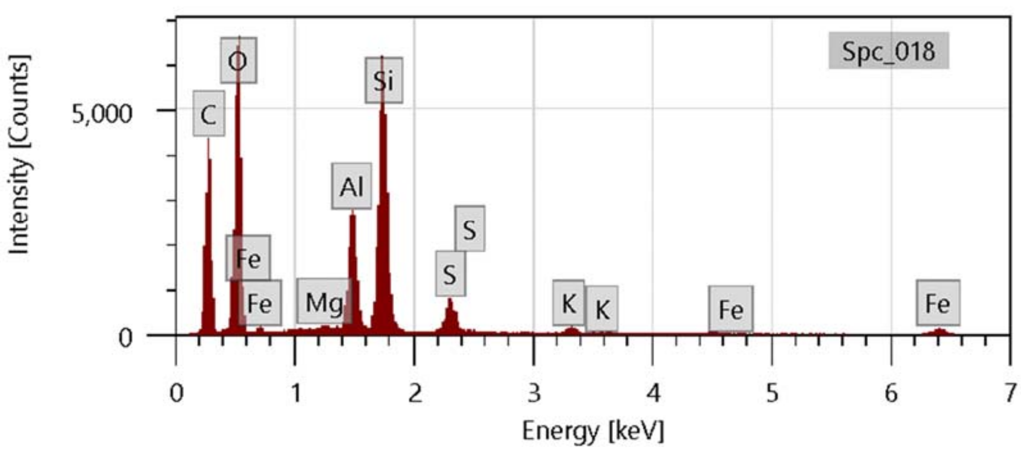
Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





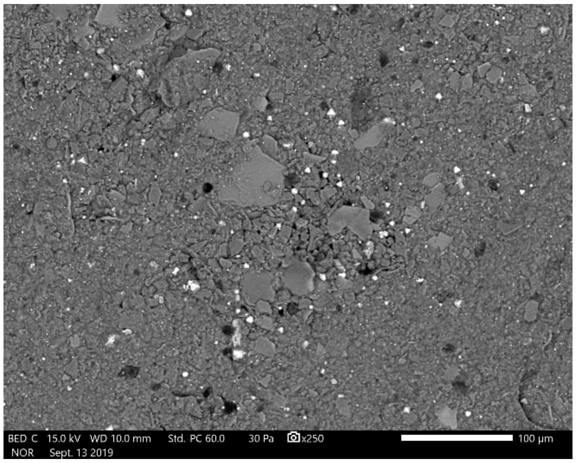


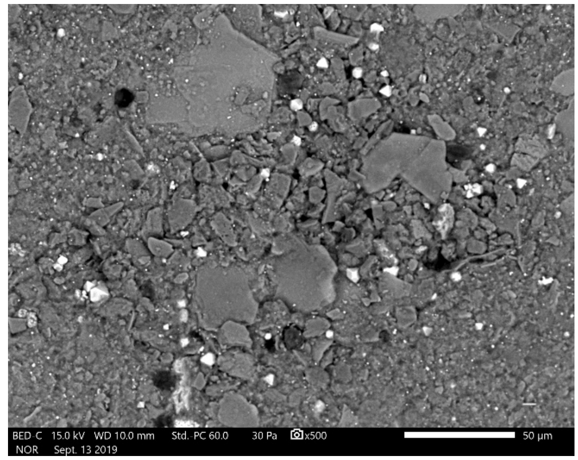


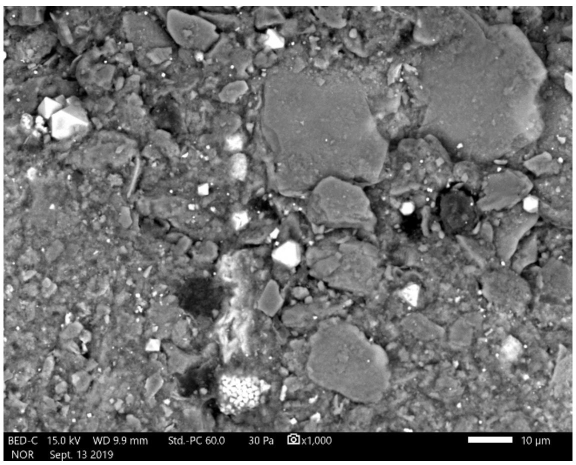


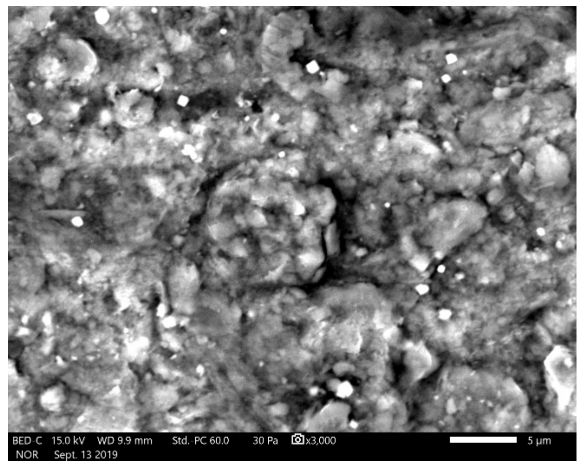
Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.

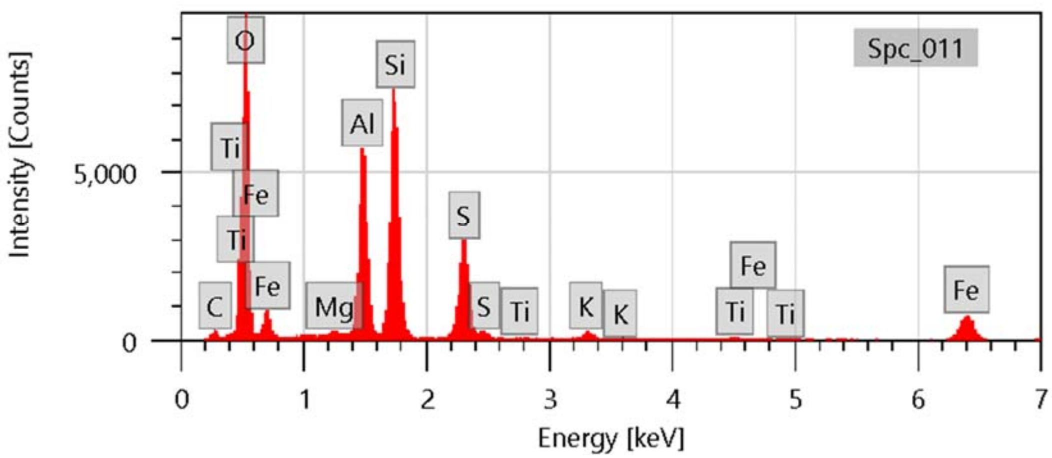
Geosyntec
CTLGroup 150350











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 E

Certification by a Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the 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 30 TAC § 352.951(e) have been met.

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Digitally signed by Beth Gross,
Date: 2023.01.25 16:50:32 -05'00'

Signature

Geosyntec Consultants
2039 Centre Pointe Blvd, Suite 103
Tallahassee, Florida 32308

Texas Registered Engineering Firm
No. F-1182

79864	Texas	January 25, 2023
License Number	Licensing State	Date