ALTERNATIVE SOURCE DEMONSTRATION REPORT TEXAS STATE CCR RULE

H.W. Pirkey Power Plant West Bottom Ash Pond

Registration No. CCR104

Hallsville, Texas

Prepared for

American Electric Power
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Project CHA8495B

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LIST OF ACRONYMS

Å	angstrom
amsl	above mean sea level
ASD	alternative source demonstration
bgs	below ground surface
CCR	coal combustion residuals
EBAP	East Bottom Ash Pond
EDS	energy-dispersive spectroscopy
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	groundwater protection standard
LCL	lower confidence limit
MCL	maximum contaminant level
mg/kg	milligram per kilogram
mg/L	milligram per liter
SEM	scanning electron microscopy
SPLP	Synthetic Precipitation Leaching Procedure
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

1. INTRODUCTION AND SUMMARY

This Alternative Source Demonstration (ASD) report has been prepared to address a statistically significant level (SSL) for cobalt in the groundwater monitoring network at the H.W. Pirkey Plant West Bottom Ash Pond (WBAP), located in Hallsville, Texas, following the first semiannual assessment monitoring event of 2023. 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 WBAP (**Figure 1**).

In June 2023, a semiannual assessment monitoring event was conducted at the WBAP in accordance with 30 TAC §352.951(a). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis.

Confidence intervals were re-calculated for 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). An SSL was identified for cobalt at AD-28 at the WBAP, where the LCL of 0.0133 milligrams per liter (mg/L) exceeded the calculated GWPS of 0.00900 mg/L (Geosyntec, 2023a). No other SSLs were identified.

1.1 CCR Rule Requirements

TCEQ regulations regarding assessment monitoring programs for CCR landfills and surface impoundments provide owners and operators with the option to make an ASD when an SSL is identified:

> 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. (30 TAC §352.951(e))

Pursuant to 30 TAC §352.951(e), Geosyntec Consultants, Inc. (Geosyntec) has prepared this ASD report to document that the SSL identified for cobalt at AD-28 is from a source other than the WBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSLs could be attributed. Alternative sources were categorized into the following five types, based on methodology provided by the Electric Power Research Institute (EPRI 2017):

- ASD Type I: Sampling Causes
- ASD Type II: Laboratory Causes
- ASD Type III: Statistical Evaluation Causes
- ASD Type IV: Natural Variation
- 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.

2. SUMMARY OF SITE CONDITIONS

The WBAP design and construction, regional geology and site hydrogeology, and groundwater monitoring system and flow conditions are described below.

2.1 WBAP Design and Construction

The WBAP is a 30.9-acre CCR surface impoundment located at the north end of the Pirkey Plant, immediately west of the East Bottom Ash Pond (EBAP) (**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 (Arcadis 2016). The WBAP ceased receipt of CCR and non-CCR waste streams on March 30, 2022 (AEP 2022). At that time, the WBAP commenced closure by removal in accordance with the certified closure plan, with CCR material removal occurring from April to June of 2022. The final inspection for CCR material removal was completed on July 26, 2022. On May 5, 2023, the WBAP was certified closed by removal in accordance with 30 TAC §352.1221 and the most recent Written Closure Plan, and notification was placed in the Operating Record (AEP 2023a).

The WBAP was constructed with compacted clay embankments around the pond perimeter and a compacted clay liner over the pond base (Arcadis 2016). Multiple lithological borings advanced following installation of the clay liner confirmed that at least 6 feet of clay was present below the base of the EBAP (Arcadis 2016). The bottom elevation of the WBAP was approximately 347 feet above mean sea level (amsl), and the elevation of the top of the pond embankment was approximately 357 feet prior to pond closure. amsl

2.2 Regional Geology / Site Hydrogeology

The WBAP 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.

2.3 Groundwater Monitoring History and Flow Conditions

The WBAP 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 Arcadis (2016), provided as **Attachment A**, shows the subsurface structure of the uppermost aquifer (indicated on the figure as clayey silty sand, tan to gray) underlying the WBAP and the EBAP. Geologic cross-section A-A' demonstrates lateral continuity of the uppermost aquifer spanning the entire length of the WBAP.

Groundwater flow direction in the area of the WBAP 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 contains a hydraulic gradient of approximately 0.01 feet per foot. The WBAP monitoring well network consists of upgradient monitoring wells AD-3, AD-12, and AD-18, and compliance wells AD-17, AD-28, and AD-30, all of which are screened within the Uppermost Aquifer at depths ranging from 10 to 57 feet below ground surface (bgs) (301 to 348 ft amsl). Groundwater elevations at the unit have ranged from approximately 320 to 375 ft amsl (approximately 10 to 35 feet bgs depending on well location).

3. ALTERNATIVE SOURCE DEMONSTRATION

The ASD evaluation method and proposed alternative source of cobalt in AD-28 and the future groundwater sampling requirements are described below.

3.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance and quality control data did not identify alternative sources for cobalt 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 2020). As described below, the SSLs have been attributed to natural variation associated with the underlying geology, which is a Type IV (natural variation) issue.

Monitoring well AD-28 is located near the southwest corner of the WBAP, as shown in **Figure 1**. Previous ASDs for cobalt at the WBAP provided evidence that cobalt is present in the aquifer media at the site and that the observed cobalt concentrations in groundwater were due to natural variation (Geosyntec 2019a, Geosyntec 2019b, Geosyntec 2020b, Geosyntec 2020c, Geosyntec 2021b, Geosyntec 2022b, Geosyntec 2023b). The previous ASDs discussed how the WBAP 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, which is lower than the average concentration at AD-28 (**Table 1**).

Cobalt was detected at a concentration of 0.000501 mg/L in a surface water sample previously collected from the WBAP on November 4, 2020. Cobalt was detected in a surface water sample collected on June 24, 2022 from the EBAP at a concentration of 0.00128 mg/L (**Table 1**). The WBAP and EBAP have both been closed by removal since the samples were collected (AEP 2023a, AEP 2023b). The EBAP and WBAP historically received the same process water, with the use of each pond dependent on available freeboard and cleaning schedule; thus, there is a basis for the equivalency between these two surface water samples. These concentrations are lower than the reported cobalt concentrations for downgradient network wells from the most recent sampling event (**Figure 2).** Additionally, both pond surface water samples were over an order of magnitude lower than the average concentration observed at AD-28 (**Table 1**). Thus, the WBAP is not the likely source of cobalt at AD-28.

As noted in the previous ASDs, soil samples collected across the site, including from locations near the WBAP, identified cobalt in the aquifer solids at concentrations ranging from non-detect to 23.5 milligrams per kilogram (mg/kg) with the highest value reported at AD-41, which is upgradient of the WBAP and EBAP (**Figure 3**). SB-28 was advanced in the vicinity of AD-28 in April 2020 to re-log the geology at AD-28 and collect samples for laboratory analysis of total metals and mineralogy. The SB-28 field boring log, which was generated by Auckland Consulting

LLC, is provided as **Attachment B**. Cobalt was identified at SB-28 at concentrations of 4.53 mg/kg at 15.5-16 feet bgs and 8.70 mg/kg at 40-41 feet bgs (**Table 2**). The 15.5-16 feet bgs interval at SB-28 correlates to the depth of the monitoring well screen of AD-28 (15-35 feet bgs), indicating that cobalt is present in aquifer solids within the AD-28 screened interval.

In addition to total cobalt, soil samples were submitted for mineralogical analysis to evaluate the presence of cobalt-containing minerals. X-ray diffraction (XRD) analysis of soils from SB-28 identified pyrite (an iron sulfide mineral) in samples collected at 25-30 feet bgs and 40-41 feet bgs at concentrations up to 3% by weight (**Table 3**). Cobalt is known to undergo isomorphic substitution for iron in crystalline iron minerals such as pyrite due to their similar ionic radii of approximately 1.56 angstrom (Å) for iron vs. 1.52 Å for cobalt (Clementi and Raimondi 1963, Krupka and Serne 2002, Hitzman et al. 2017).

The aquifer solids at SB-28 are distinctly red in color at shallow depths, as illustrated in the photolog of soil cores provided in **Attachment C.** Red color in soils is often associated with the presence of oxidized iron-bearing minerals such as hematite and goethite. Goethite, an iron oxide mineral (FeOOH), was present at depths up to 16 ft bgs at SB-28 at up to 37% of the total aquifer solids (**Table 3**). The weathering of pyrite to goethite under oxidizing conditions is also a well-understood phenomenon, including in formations in east Texas (Senkayi et al. 1986, Dixon et al. 1982). It is likely that the pyrite weathering process is resulting in the release of isomorphically substituted cobalt from the pyrite crystal structure as it undergoes oxidative weathering to iron oxide minerals.

As described in an ASD previously generated for the WBAP, 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-30, one of the existing compliance wells within the WBAP groundwater monitoring network. Solid phase materials within these groundwater samples were separated and submitted for analysis of chemical composition and mineralogy. For the VAP samples, separation was completed using a centrifuge due to the high abundance of solids. For the groundwater sample at AD-30, the sample was filtered using a 1.5-micron filter. Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient VAP location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from permanent monitoring wells AD-30, B-2, and B-3 (**Table 2**). The concentrations of cobalt in the solid material retained after filtration were comparable to the bulk soil samples collected from the same locations.

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

The WBAP was not identified as the source of cobalt at wells in the WBAP monitoring well network based on the low concentrations of cobalt in the pond itself and the ubiquity of naturally occurring cobalt in the aquifer formation, especially in soil and groundwater samples upgradient from the WBAP. Cobalt in the WBAP network groundwater is believed to be a result of natural variability within the aquifer. Naturally occurring cobalt is known to substitute for iron in pyrite, which is then known to weather to iron oxides. The presence of pyrite and iron oxides has been confirmed at AD-28 and across the Site. The presence of these aquifer minerals suggests that weathering of pyritic minerals may be providing a source for aqueous cobalt in groundwater.

4. 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 SSL for cobalt identified at AD-28 during assessment monitoring in June 2023 was not due to a release from the WBAP. The identified SSL should instead be attributed to natural variation in the underlying geology, including the presence of pyrite and goethite in the solid aquifer material. Therefore, no further action is warranted, and the Pirkey WBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in **Attachment D**.

5. REFERENCES

Arcadis, 2016. West Bottom Ash Pond – CCR Groundwater Monitoring Well Network Evaluation. H.W. Pirkey Power Plant. May.

AEP, 2022. Annual Report-02 – Alternative Closure Requirements. East and West Bottom Ash Ponds. H.W. Pirkey Power Plant. November.

AEP, 2023a. Closure Completion Notification for Closure by Removal. Henry W. Pirkey Plant, West Bottom Ash Pond. May.

AEP, 2023b. Closure Completion Notification for Closure by Removal. Henry W. Pirkey Plant, East Bottom Ash Pond. October.

Clementi, E., and Raimdoni, D. L. 1963. Atomic screening constants from SCF functions. *J. Chem. Phys.,* 38, 2686.

Dixon, J.B., Hossner, L.R., Senkayi, A.L., and Egashira, K. 1982. Mineral properties of lignite overburden as they relate to mine spoil reclamation. In: J.A. Kittrick, D.S. Fanning, L. R. Hossner, editors, Acid Sulfate Weathering, *SSSA Spec. Publ. 10*. SSSA, Madison, WI. p. 169-191.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.

Geosyntec, 2019a. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant, West Bottom Ash Pond. Hallsville, Texas. March.

Geosyntec, 2019b. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant, West Bottom Ash Pond. Hallsville, Texas. September.

Geosyntec, 2020a. Statistical Analysis Plan – Revision 1. October.

Geosyntec, 2020b. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant, West Bottom Ash Pond. Hallsville, Texas. April.

Geosyntec, 2020c. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant, West Bottom Ash Pond. Hallsville, Texas. December.

Geosyntec, 2021a. Statistical Analysis Summary, West Bottom Ash Pond. H.W. Pirkey Power Plant. Hallsville, Texas. October.

Geosyntec, 2021b. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant, West Bottom Ash Pond. Hallsville, Texas. May.

Geosyntec, 2022a. Statistical Analysis Summary, West Bottom Ash Pond. H.W. Pirkey Power Plant. Hallsville, Texas. October.

Geosyntec, 2022b. Alternative Source Demonstration Report – Texas State CCR Rule. H.W. Pirkey Plant, West Bottom Ash Pond. Hallsville, Texas. June.

Geosyntec, 2023a. Statistical Analysis Summary, West Bottom Ash Pond. H.W. Pirkey Power Plant. Hallsville, Texas. October.

Geosyntec, 2023b. Alternative Source Demonstration Report – Texas State CCR Rule. H.W. Pirkey Plant, West Bottom Ash Pond. Hallsville, Texas. March.

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.

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.

Senkayi, A.L., Dixon, J.B., and Hossner, L.R. 1986. Todorokite, goethite, and hematite: alteration products of siderite in East Texas lignite overburden. *Soil Science*, 142, 36-43.

TCEQ, 2020a. Title 30, Part 1, Chapter 352: Coal Combustion Residuals Waste Management, May 22.

TCEQ, 2020b. Coal Combustion Residuals Groundwater Monitoring and Corrective Action Draft Technical Guideline No. 32. Topic: Coal Combustion Residuals (CCR) Groundwater Monitoring and Corrective Action. Waste Permits Division. May.

USEPA, 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.

TABLES

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

Sample	Sample Date	Unit	Cobalt Concentration
Bottom Ash (Solid Material)	2/11/2019	mg/kg	5.8
SPLP Leachate of Bottom Ash	2/11/2019	mg/L	<0.01
WBAP Pond Water	11/4/2020	mg/L	0.000501
EBAP Pond Water	6/24/2022	mg/L	0.00128
AD-28 - Average	May 2016 - June 2023	mg/L	0.0142

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 Data
West Bottom Ash Pond - H.W. Pirkey Plant

Location ID	Location	Sample Depth (ft bgs)	Cobalt (mg/kg)
Bulk Soil Samples			
AD-28	WBAP Network	6-6.5	< 2.38
		15.5-16	4.53
		25-30	< 2.50
		40-41	8.70
AD-30	WBAP Network	7	1.00
		23	15.0
B-2	Upgradient	10	2.36
		16	3.62
		71	10.30
		82	7.21
		87	3.11
B-3	Upgradient	10	1.30
		20	0.59
		97	1.11
AD-41	Upgradient	15	<1.0
		35	23.5
		95	1.90
Solid Material Retained After Filtration			
AD-30	WBAP Network	15-25	9.3 J
B-2	Upgradient	38-48	4.3 J
B-3	Upgradient	29-34	12.0
		VAP 40-45	18.0

Notes:

1. For AD-28 and AD-30, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation.

2. Samples at B-2, B-3, and AD-41 were collected from cores removed from the borehole during well lithology logging.

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

WBAP: West Bottom Ash Pond
mg/kg: milligram per kilogram
ft bgs: feet below ground surface
J: estimated value

Table 3: AD-28 Mineralogy Results
West Bottom Ash Pond - H. W. Pirkey Plant

Boring ID	**SB-28 (AD-28)**			
Sample Depth Interval	6-6.5	15.5-16	25-30	40-41
Sample Location	Above Screened Interval	Within Screened Interval		Below Screened Interval
Color	Red-brown to yellow-brown	Light gray, light red-brown	Brown, light red-brown	Gray to dark gray
Mineralogy				
Quartz	58%	46%	73%	34%
Pyrite	--	--	3%	3%
K-Feldspar	--	1%	1%	1%
Siderite	--	--	2%	52%
Goethite	37%	15%	--	--
Anhydrite	--	--	--	2%
Clay/Mica	5%	38%	21%	8%

Notes:
1. Sample depths are shown in feet below ground surface (bgs)
2. Well AD-28 is screened from 15-35 ft. below ground surface.
3. Mineralogical component results are shown in relative % abundance.

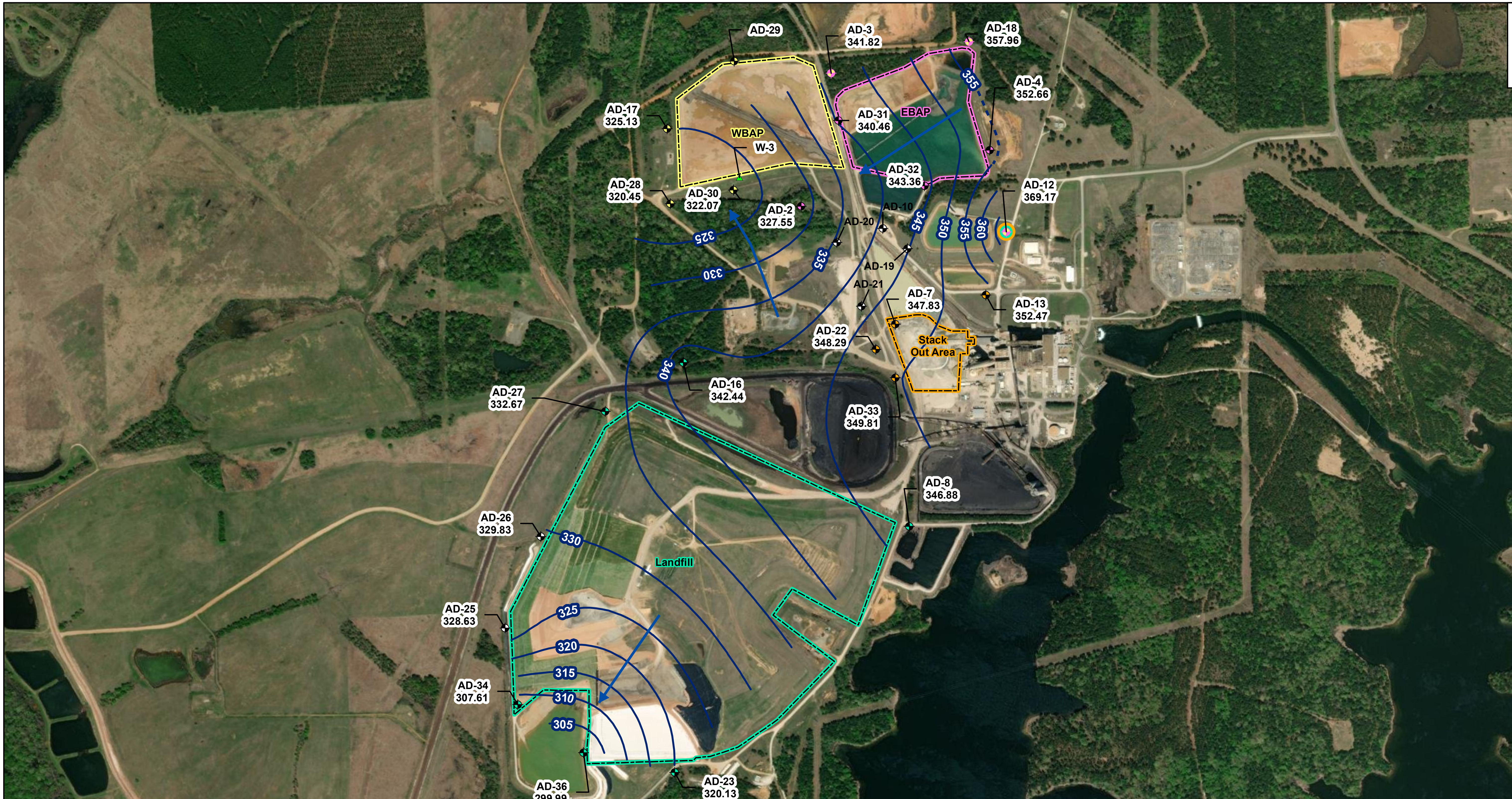
Table 4: B-3 X-Ray Diffraction Results
West Bottom Ash Pond - H. W. Pirkey Plant

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

Notes:
1. Results given in units of relative % abundance VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

ND: Not detected

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

1. Monitoring well coordinates and water level data (collected on June 26 and 27, 2023) provided by American Electric Power (AEP).
2. Site features based on information available in coal combustion residuals (CCR) Groundwater Monitoring Well Network Evaluation Update (Arcadis 2022) provided by AEP.
3. Groundwater elevation units are feet above mean sea level.
4. AD-10, AD-19, AD-20, AD-21, AD-29, and W-3 were not gauged during the June 2023 event.
5. AD-35 was abandoned on November 13, 2018.
6. Removal of CCR plus one foot of material was completed on July 26, 2022 for the West Bottom Ash Pond (WBAP).

EBAP: East Bottom Ash Pond.

1,000 500 0 1,000 Feet

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November 9, 2023

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Potentiometric Contours: Uppermost Aquifer June 2023

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio	2023/10/06	Figure 1

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 2023.
- * - Well most recently sampled August 2019.
- AD-29 included in the well network for water level measurements only.
- WBAP surface water results shown for November 2020 sample. EBAP surface water results shown for June 2022 sample.

400 200 0 400
Feet

Aqueous Cobalt Distribution

AEP Pirkey Power Plant
Hallsville, Texas

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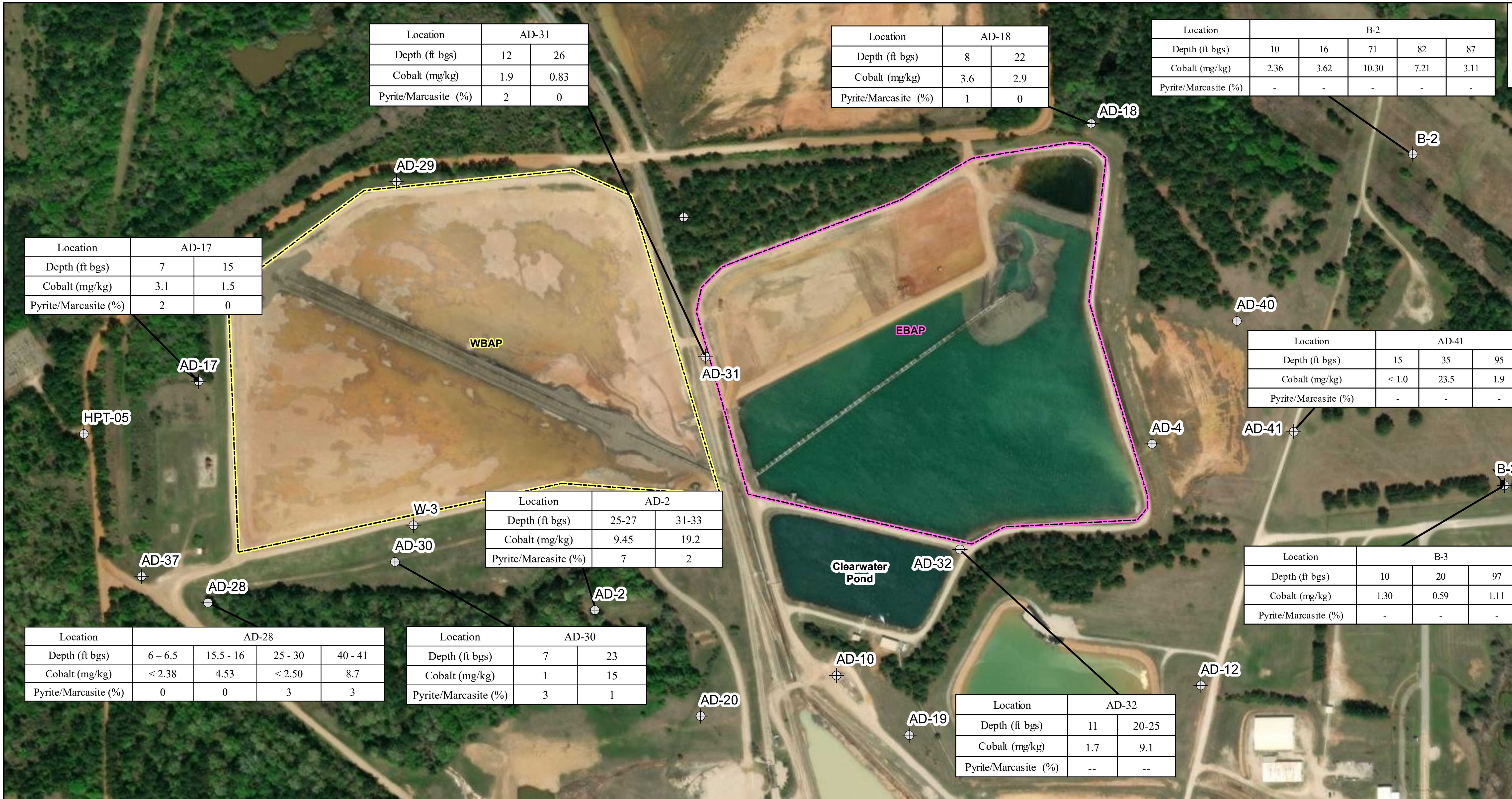
Figure **2**

\\annarbor-01\Data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2023\20240116_AEP_WBAP_Pirkey_Cobalt.mxd. ASoltero. 1/16/2024. Project/Phase/Task.



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

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

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

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

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

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

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

Location	AD-28			
Depth (ft bgs)	6 – 6.5	15.5 - 16	25 - 30	40 - 41
Cobalt (mg/kg)	< 2.38	4.53	< 2.50	8.7
Pyrite/Marcasite (%)	0	0	3	3

Location	AD-30	
Depth (ft bgs)	7	23
Cobalt (mg/kg)	1	15
Pyrite/Marcasite (%)	3	1

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

Legend

- Monitoring Wells
- EBAP
- WBAP

Notes

- Monitoring well coordinates provided by AEP.
- AD-2 and AD-28 samples collected on April 20, 2020
- All other data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.

300 150 0 300 Feet

Cobalt Distribution in Soil

AEP Pirkey Power Plant
Hallsville, Texas

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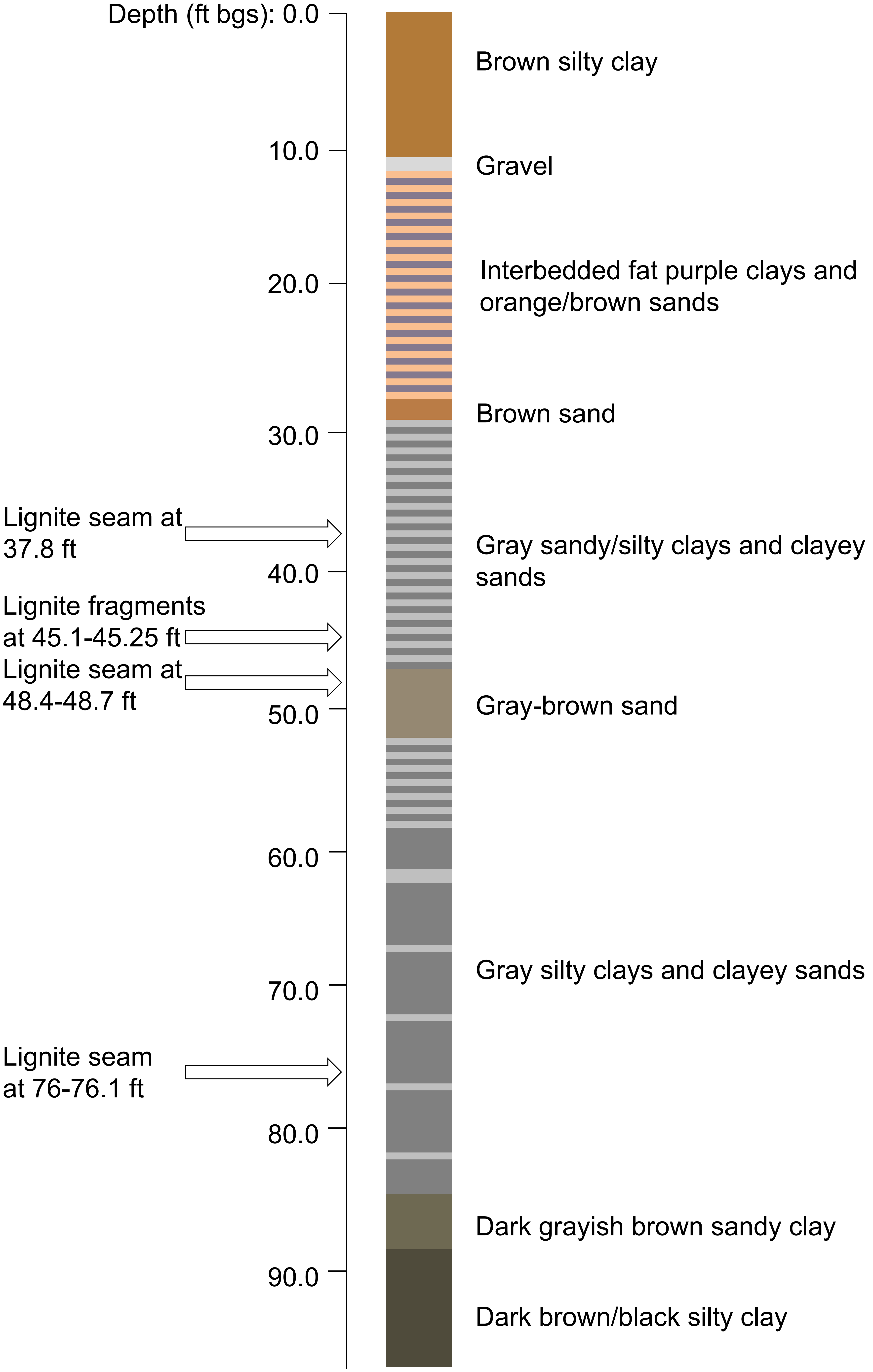
Figure 3

\\annarbor-01\Data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2023\20240116 Pirkey_SoilChem_minerals.mxd. ASoltero. 1/16/2024. 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

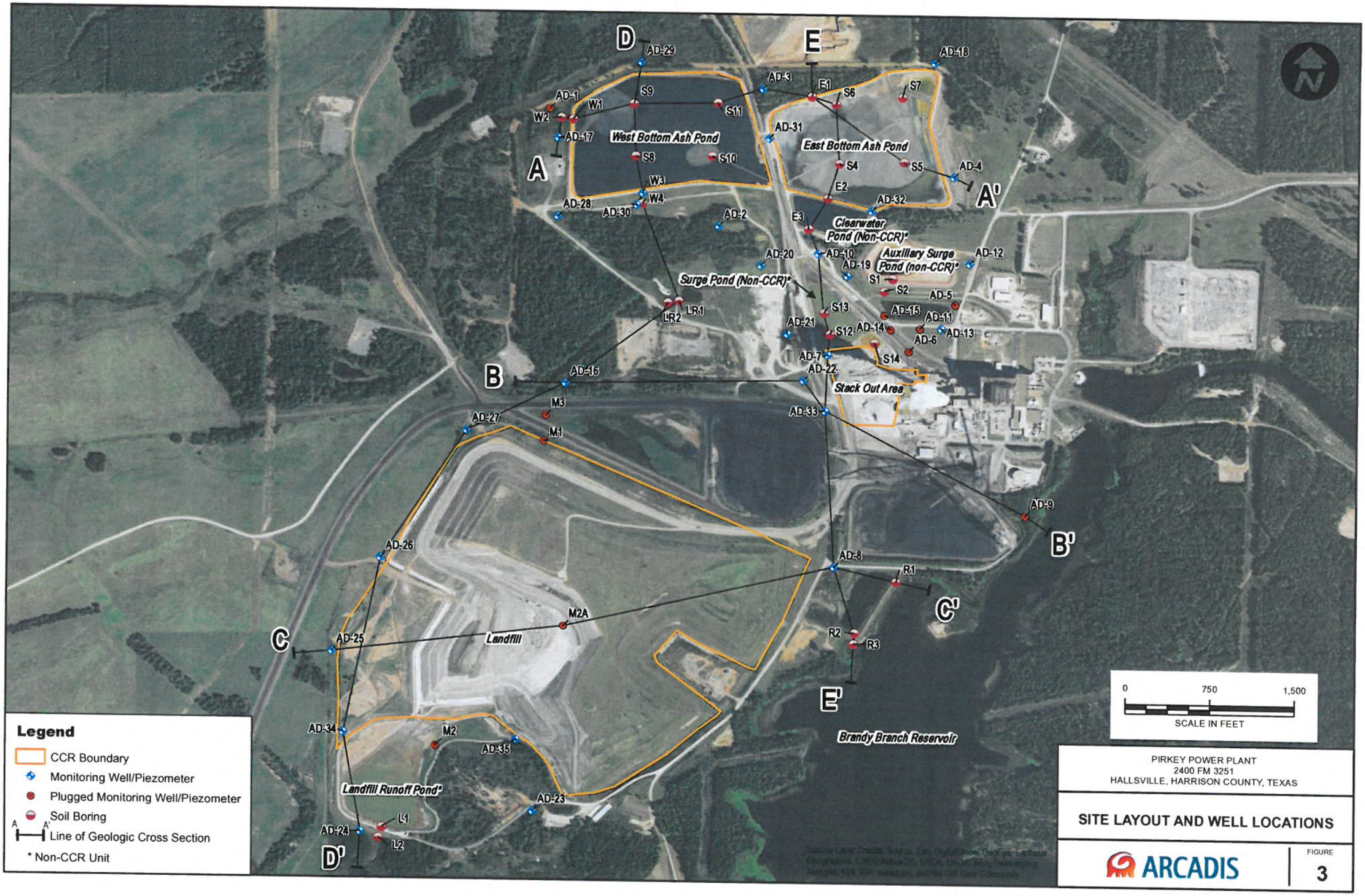
B-3 Visual Boring Log

AEP Pirkey Powerplant
Hallsville, TX

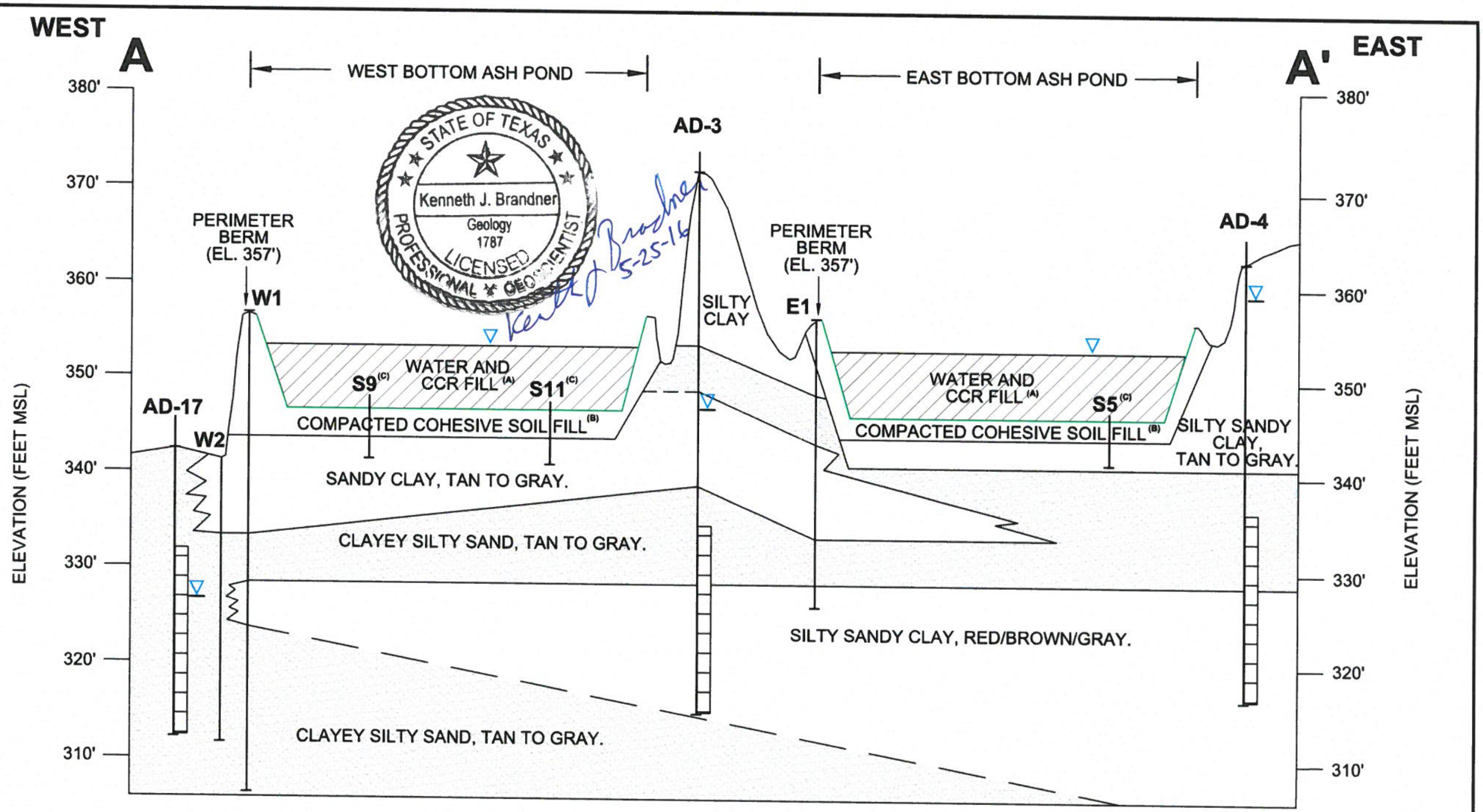
Geosyntec consultants

CHA8462	March 2020	**Figure 4**

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-28 Boring Log

PROJECT NO. ______ PROJ. ______ BOR. NO. SB-28

LOCATION AD-28/MW-28 - Pirkey Power Plant ELEV. ______ DATE 4/20/20

SILTS & SANDS		
CONDITION		
VLo ...... Very Loose		0-4
Lo .... Loose		4-10
MDe ..... Med. Dense		10-30
De .... Dense		30-50
VDe ...... Very Dense		>50

COHESIVE SOILS - CLAYS		
CONSISTENCY	PENETROMETER	N - VALUE
Vso.. Very Soft	0 - 0.25	<2
So.... Soft	0.25 - 0.5	2 - 4
Mst.. Stiff	0.5 - 1.0	4 - 8
St.... Stiff	1.0 - 2.0	8 - 15
VSt.. Very Stiff	2.0 - 4.0	15 - 30
H..... Hard	> 4.0	>30

COLORS	MATERIALS	SAND ADJ.	CHARACTERTICS
Li .... Light .....Br ....Brown	Cl ..... Clay, Clayer	F.......Fine	Calc ..... Calcareous
Dk ... Dark .....Bk ....Black	Si ..... Silt, Silty	M ....Medium	Lig .... Lignite
G ..... Grey ....Bl ....Blue	Sa .... Sand, Sandy	Co....Coarse	Org .... Organic
T ...... Tan ....Gr ....Grenn	Ls .... Limestone	Si.....Silty	Lam ...... Laminate
R ...... Red ......Y ......Yellow	Gr .... Gravel		Sls .... Slickensided
Rdish.Reddish.Wh ...White	SiS ... Siltstone		SL .... Slightly
	SS .... Sandstone		Sm(s) ... Seam (s)
	Sh..... Shale, Shaley		Nod ...... Nodules

	~~TEST ASSIGNMENT~~ Sample Interval	~~SAMPLE NO.~~ Recovery	DEPTH FT.	SAMPLES	CONDITION OR CONSISTENCY	COLOR	MINOR MATERIALS OR ADJECTIVES	PREDOMINATE MATERIAL	CHARACTERISTICS OR MODIFICATIONS	SEAT - 6"	1st - 6"	2nd - 6"	UNIFIED SOIL CLASSIFICATION	N - VALUE OR HAND PENETROMETER
0	0-5	4'			0-2	Br, Lt. Br, Lt. Rd Br	Si	Sa	Silty sand, trace clay & roots, trace fine iron ore gravel,				moist	(0-2)
SM 2'			2										moist	(2-5)
					2-10'	Rd Br, Yllw Br	Si, Gr	Cl	Clay - some silt, trace v.f. sand, trace coarse iron ore concretions,				moist	(5-10)
CL	5-10	1.5'							- some v.f. sand, ironstone layer @ 6-6.5'					
10'			10											
SC-SM	10-15	1'			10'-16-	Rd Br, Lt. Br	Si Cl	Sa	Clayey vf to f Silty Sand with clay in thin lences, trace cemented clayey sand				v. moist	(10-15)
	15-20	1.5'				Lt. Gr and Lt. Rd Br			- clay lense @ 15' (6") - ironstone layer @ 15.5' & cemented sand to 16'-				v. moist	(15-16)
16' SM	20-25	3"			16-40	Br, Lt. Rd Br, Gray	Si	Sa	Silty Sand - some ironstone - gray @ 20' & some cemented clayey sand (only recovery @ 25-30')				Saturated @ 16' to 40'	
	25-30	3'												
	30-35	NR												
	35-40	NR							B.T. @ 40'					
40'									*Split Spoon Driven from 40-41'					
SC	40-41	1'			40-41	Gray, Dk Gray	Cl	Sa	Clayey sand w/ lenses of cemented sand @ 41.5-41.75 trace v.f. gypsum crystals @ 40-41'				v. moist	40-41
									*6-6.5' collected @ 1140					
									*15.5-16' collected @ 1215					
									*25-30' collected @ 1230					
									*40-41 collected @ 1300					

Type Boring HSA Dry Auger ☒ Rotary Wash ☐

SEEPAGE @ 16 FT. WHILE DRILLING, W.L. @ ___ FT. ON COMPL. (OR) BAILED TO ___ FT. UPON COMPLETION. W.L. @ ___ FT AND CAVED TO ___ FT. ON ______.

*GPS: 32.46544°, -94.49432 (18' W-NW of AD-28/MW-28)

ATTACHMENT C
SB-28 Boring Photographic Log

GEOSYNTEC CONSULTANTS
Photographic Record

Client: American Electric Power	**Project Number: CHA8495/12A/02**
Site Name: H.W. Pirkey Plant WBAP	**Site Location: Hallsville, Texas**

Photograph 1

Date: 4/21/2020

Direction: N/A

Comments:
Multiple sections of core from soil boring SB-28 advanced near downgradient monitoring well AD-28 within the Western Bottom Ash Pond (WBAP) CCR unit. 5-foot pushes were used. Note the reddish color indicating the presence of oxidized iron-bearing minerals.

Photograph 2

Date: 4/21/2020

Direction: N/A

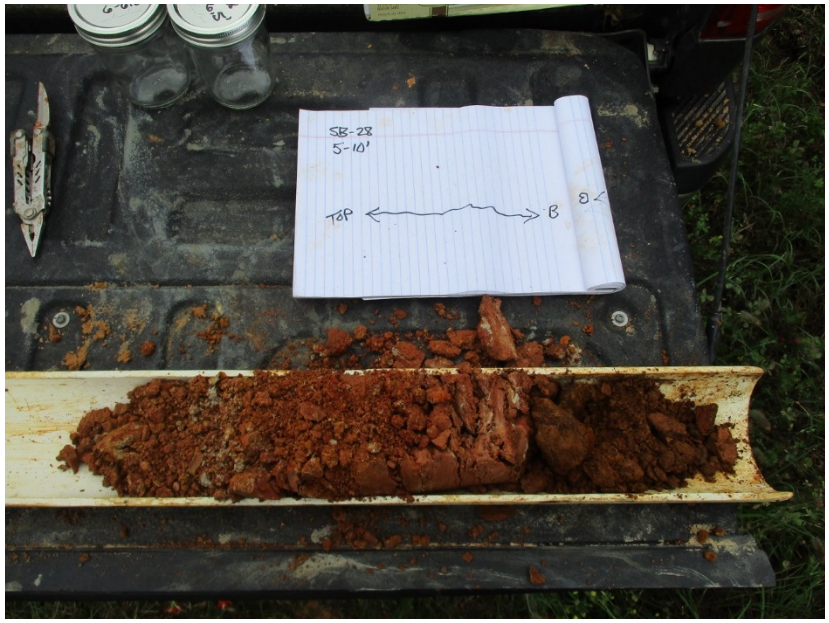
Comments:
0-5 foot interval of SB-28.

Photograph 3

Date: 4/21/2020

Direction: N/A

Comments:
5-10 foot interval of SB-28. Recovery of this interval was limited. A sample was collected from this interval from 6-6.5 ft. below ground surface (bgs).

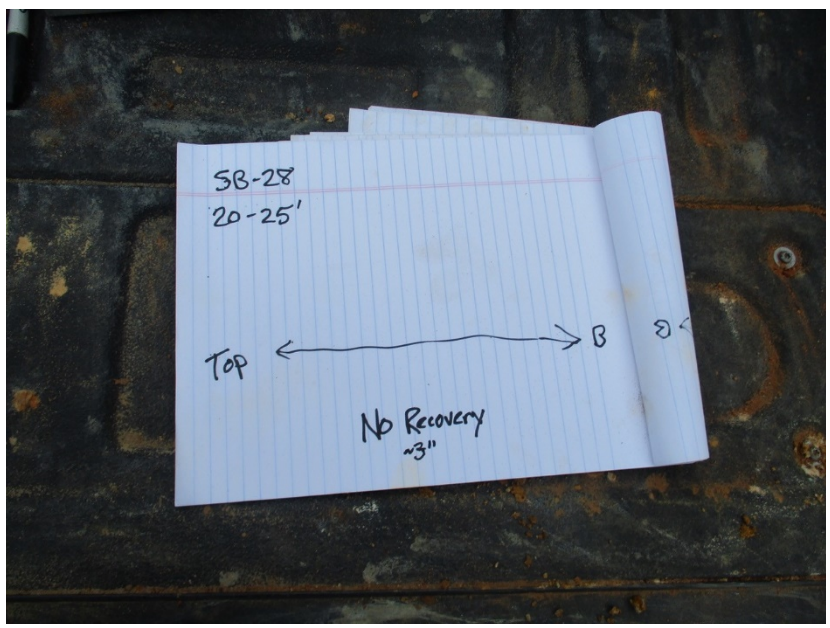


Photograph 4

Date: 4/21/2020

Direction: N/A

Comments:
10-15 foot interval of SB-28. Recovery of this interval was limited.

Photograph 5	
Date: 4/21/2020	
Direction: N/A	
Comments: 15-20 foot interval of SB-28. Recovery of this interval was limited. A sample was collected from this interval from 15.5-16 ft. bgs.	
Photograph 6	
Date: 4/21/2020	
Direction: N/A	
Comments: Field geologist's note indicating that very little of the 20-25 foot interval of SB-28 was recovered.	

Photograph 7

Date: 4/21/2020

Direction: N/A

Comments:
25-30 foot interval of SB-28. Very little of this interval was recovered. Note the color change of the soil from red to dark brown/black. A sample was collected from this interval.

Photograph 8

Date: 4/21/2020

Direction: N/A

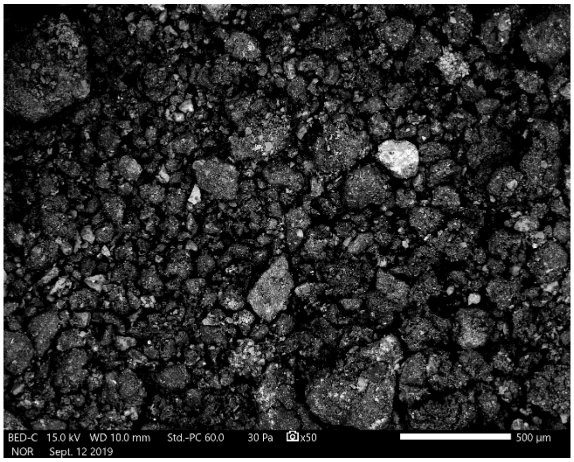
Comments:
Bottom of SB-28. The boring log indicates no recovery of soil from the 30-40 foot interval. A sample was collected from this interval.

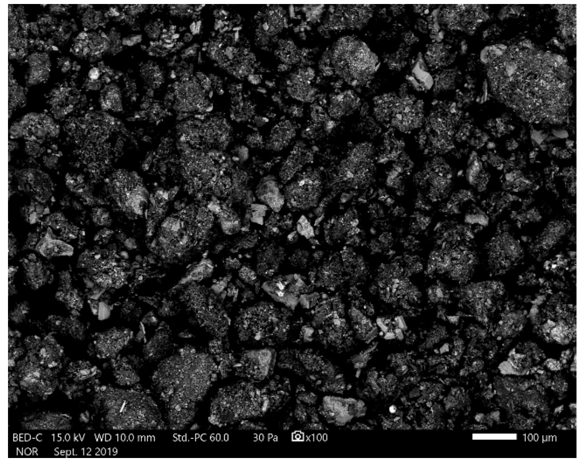
ATTACHMENT D
SEM/EDS Analysis

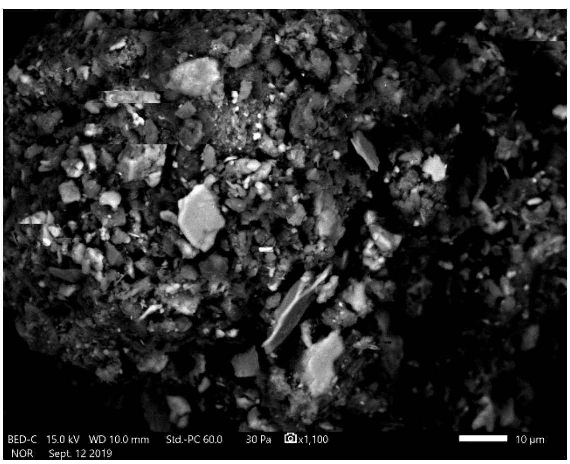
September 16, 2019

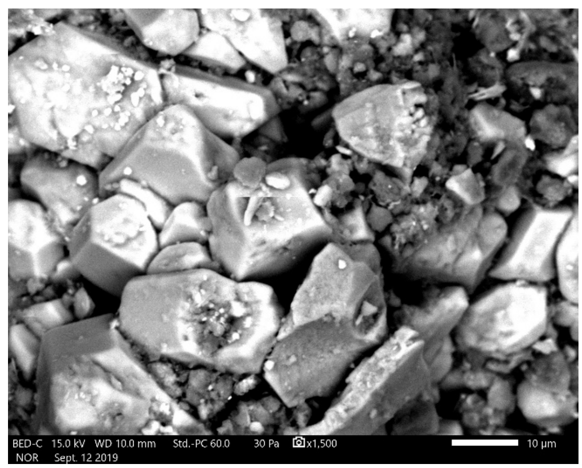
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221

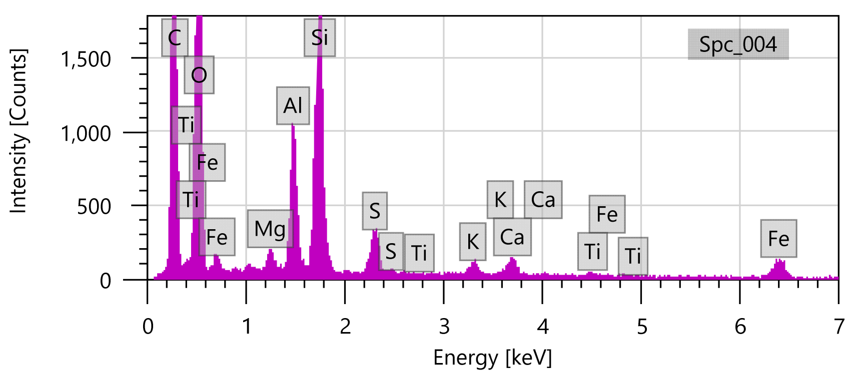
via Email: BSass@geosyntec.com





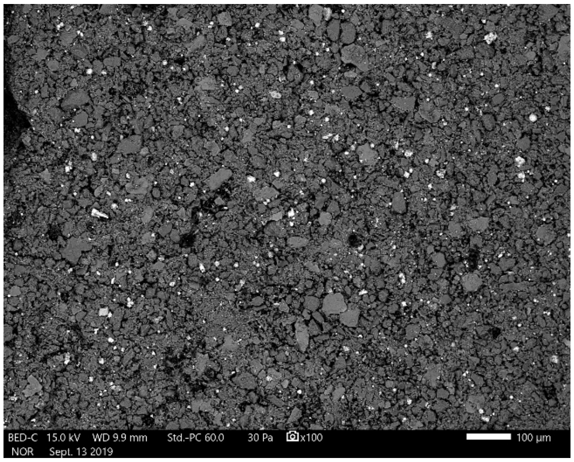


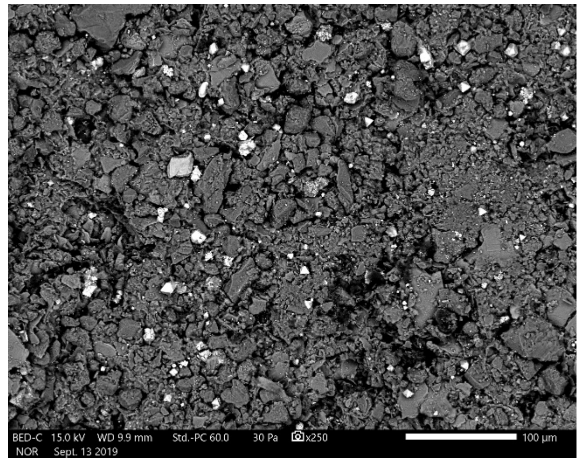


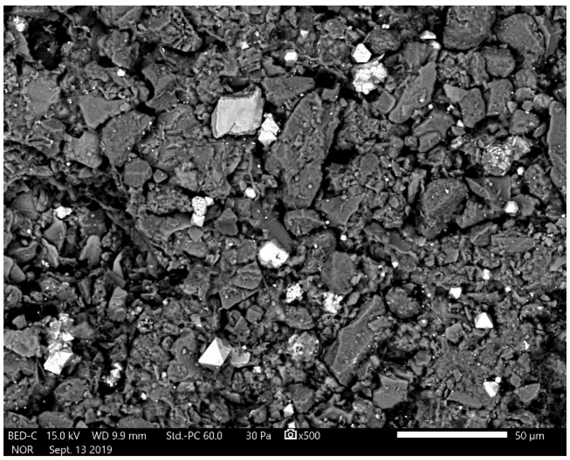


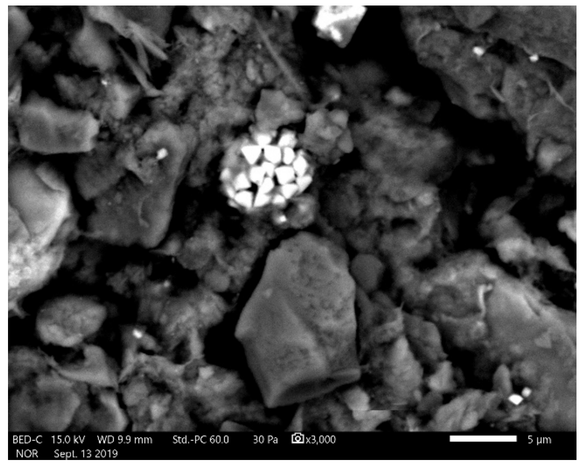
Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.

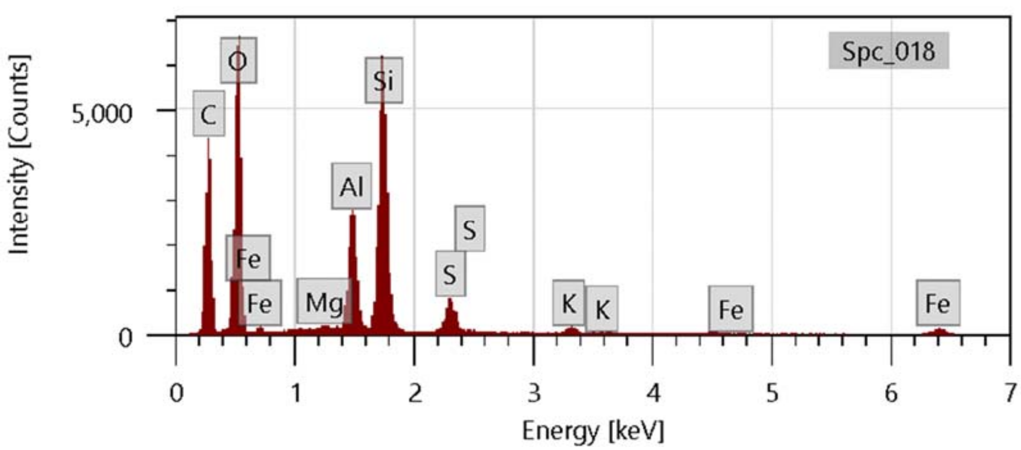
Geosyntec
CTLGroup 150350



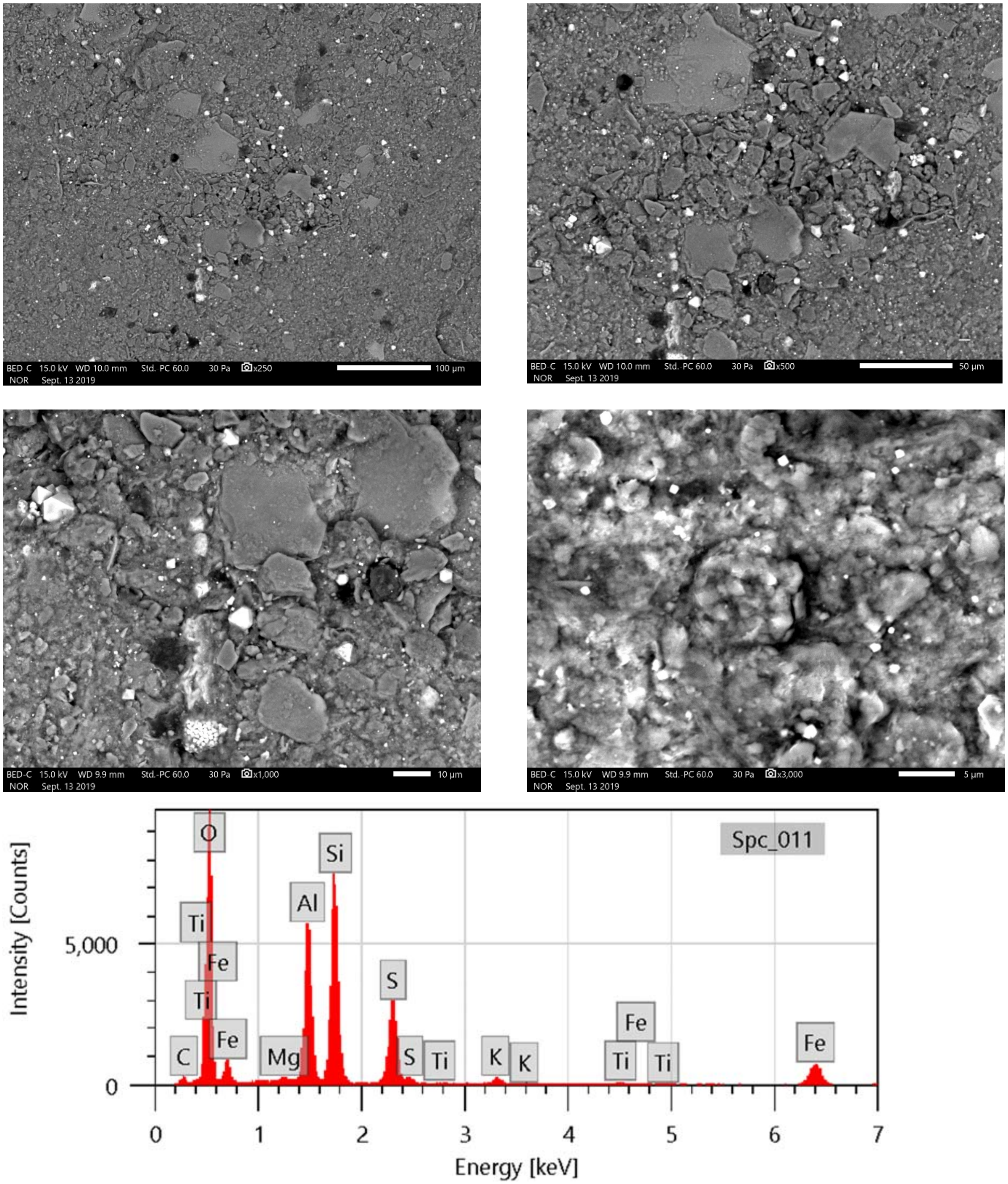








Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest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

Signature

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

Texas Registered Engineering Firm
No. F-1182

79864	Texas	January 29, 2024
License Number	Licensing State	Date