ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

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

Submitted to

AMERICAN
ELECTRIC
POWER

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LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Profile
SSL	Statistically Significant Level
TCEQ	Texas Commission on Environmental Quality
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
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 second semi-annual assessment monitoring event of 2020. The EBAP is registered as a surface impoundment under Texas Commission on Environmental Quality (TCEQ) Industrial and Hazardous Waste Solid Waste Registration No. 33240.

The H.W. Pirkey Plant has four regulated coal combustion residuals (CCR) storage units, including the EBAP (**Figure 1**). In November 2020, a semi-annual assessment monitoring event was conducted at the EBAP in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the unit (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 the background concentration and the maximum contaminant level (MCL) or, for parameters without an MCL, the risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were re-calculated for each Appendix IV parameter at the compliance wells to assess whether these 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 (Geosyntec, 2021):

- The LCLs for cobalt exceeded the GWPS of 0.00940 mg/L at AD-2 (0.0100 mg/L), AD-31 (0.00953 mg/L), and AD-32 (0.0239 mg/L).
- The LCL for lithium exceeded the GWPS of 0.0590 mg/L at AD-31 (0.0835 mg/L) and AD-32 (0.0838 mg/L).

No other SSLs were identified.

1.1 CCR Rule Requirements

USEPA regulations regarding assessment monitoring programs for CCR landfills and surface impoundments provide owners and operators with the option to make an alternative source demonstration when an SSL is identified (40 CFR 257.95(g)(3)(ii)). An owner or operator may:

> *Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section…*

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this ASD report to document that the SSLs identified for cobalt and lithium are from a source other than the EBAP.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified 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 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 sources are described below.

2.1 Proposed Alternative Source

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

2.1.1 Cobalt

Previous ASDs for cobalt at the EBAP provided evidence that cobalt is present in the aquifer media at the site and that the observed cobalt concentrations were due to natural variation (Geosyntec, 2019a; Geosyntec, 2019b; Geosyntec, 2020b; Geosyntec, 2020c). The previous ASDs discussed how the EBAP 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-846 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP ash leachate above the reporting limit of 0.01 mg/L, which is lower than the average concentrations observed at the wells of interest (**Table 1**).

A surface water sample was collected directly from the WBAP on November 4, 2020 as a surrogate for an EBAP sample. A sample could not be collected from the EBAP, as all ponded water had been removed at the time of sampling. However, the EBAP and WBAP receive the same process water, with the use of each pond dependent on available freeboard and cleaning schedule; thus, there is a basis for the equivalency between these two surface water samples. Cobalt was detected at a concentration of 0.000501 mg/L in the WBAP sample (**Table 1**). Cobalt was detected in a surface water sample previously collected (December 15, 2018) from the EBAP at an estimated concentration of 0.0024 mg/L (**Table 1**). These concentrations are lower than all reported cobalt concentrations for in network wells from the most recent sampling event (excluding upgradient well AD-18), and over an order of magnitude lower than the average concentration in groundwater at the wells of interest (**Table 1; Figure 2**). Thus, the EBAP is not the likely source of cobalt at AD-2, AD-31, and AD-32.

As noted in the previous ASDs, soil samples collected across the site, including from locations near the EBAP, identified cobalt in the aquifer solids at varying concentrations. SB-2 was advanced in the vicinity of AD-2 in April 2020 to re-log the geology at AD-2 and collect samples for laboratory analysis of total metals and mineralogy. The SB-2 field boring log, which was generated by Auckland Consulting LLC, is provided as **Attachment A**. Cobalt was identified at SB-2 at concentrations of 9.45 milligrams per kilogram (mg/kg) at 25-27 feet below ground surface (bgs) and 19.2 mg/kg at 31-33 feet bgs (**Table 2**). These cobalt concentrations are greater than the concentration of cobalt present in the bottom ash (**Table 1**). Both samples correlate to the depth of the monitoring well screen of AD-2 (20-40 feet bgs), indicating that cobalt is present in aquifer solids within the AD-2 screened interval. Cobalt was also identified in the aquifer solids at varying concentrations at other locations throughout the site, with the highest value of 23.5 mg/kg reported at AD-41, which is upgradient of the EBAP (**Figure 3**).

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

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

As described in 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, an existing well within the EBAP groundwater monitoring network. Solid phases within these groundwater samples were separated and submitted for analysis of chemical composition. For the VAP samples, separation was completed using a centrifuge due to the high abundance of solids. For the groundwater sample at AD-32, the sample was filtered using a 1.5-micron filter. Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient VAP location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from permanent monitoring wells B-2 and B-3 (**Table 2**). The concentrations of cobalt in the solid material retained after filtration were comparable to the bulk soil samples collected from the same locations.

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

Naturally occurring cobalt is known to substitute for iron in pyrite, which is then known to weather to iron oxides. The presence of pyrite has been confirmed at AD-2 and across the Site. This suggests that pyrite may be providing a source for aqueous cobalt in groundwater. Additionally, the pond was not identified as the source of cobalt at wells in the EBAP network based on the low concentrations of cobalt in the pond itself.

2.1.2 Lithium

Previous ASDs for lithium at the EBAP attributed the observed lithium exceedances to variations in naturally suspended aquifer solids that likely originate from naturally occurring lignite and are ubiquitous in the aquifer based on the presence of lithium at upgradient locations and in the solid phase (Geosyntec, 2019b; Geosyntec, 2020b; Geosyntec, 2020c). Data gathered in support of the prior ASDs and recent results provide additional evidence that the observed lithium concentrations at AD-31 and AD-32 are due to natural variation in the aquifer.

As discussed in Section 2.1.1, a surface water sample was collected directly from the WBAP on November 4, 2020, as a surrogate for an EBAP sample. Lithium was detected in the WBAP sample at a concentration of 0.0274 mg/L, which is comparable to the estimated concentration of 0.023 mg/L reported for the EBAP water in 2018 (**Table 4**). The mobile fraction identified in the bottom ash by SPLP was even lower, with an estimated lithium concentration of 0.011 mg/L. These concentrations are lower than the average lithium concentrations at AD-31 and AD-32 (**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 2021 had total lithium concentrations of 0.0610 mg/L and 0.0686 mg/L, respectively, both of which were above the GWPS of 0.0590 mg/L (**Figure 5**). Because B-2 and B-3 were installed at locations upgradient to and unimpacted by site activities, their lithium concentrations suggest that lithium is naturally present at concentrations above the GWPS in the vicinity of the EBAP. 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 2.1.1, groundwater samples were collected from B-2, B-3, and AD-32 and filtered to separate solids. Groundwater was also collected from a VAP boring (VAP-B3-(40-45)) and centrifuged to separate solids. Lithium was detected in the solid material separated from these groundwater samples at concentrations comparable to bulk soil at all locations, providing evidence that the particulates captured during groundwater sampling contain lithium (**Table 5**).

2.1.2.1 Calculated Partition Coefficients

A previous ASD for lithium at the EBAP developed a proposed lithium mobility in groundwater due to desorption from clay minerals associated with naturally occurring lignite material. This mechanism was posited as the source of lithium in both upgradient and downgradient wells at the EBAP (Geosyntec, 2019b). Previously completed XRD analysis of centrifuged solid material samples (VAP-B3-(40-45)) found that clay minerals, including kaolinite, smectite, and illite/mica, made up at least 60% of the aquifer solid (**Table 3**). These clay minerals, particularly smectite and illite, are known to retain positively charged ions such as lithium via cation exchange processes. SEM/EDS analysis identified the presence of silicon, aluminum and oxygen, all of which are indicative of clay minerals (**Attachment A**). The backscattered electron micrographs of these samples also identified clay particles by morphology. The largest clay particles (> 5 µm) are likely kaolinite, while smectite and illite dominate the smaller size fraction.

Total metal concentrations in the solid materials separated from the groundwater samples during filtration and the filtered groundwater concentrations were used to calculate partition coefficients values (K_d) for lithium, potassium, and sodium. Details about the K_d calculation are provided in the previous ASD (Geosyntec, 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. Since the site-specific Kd values were calculated, lithium concentrations at the wells of interest have remained consistent, suggesting that this cation exchange mechanism is still controlling lithium groundwater concentrations (**Figure 6**).

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 semiannual 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 identified during assessment monitoring in November 2020 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 is warranted, and the Pirkey EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in **Attachment E.**

SECTION 4

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TABLES

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

Sample	Sample Date	Unit	Cobalt Concentration
Bottom Ash (Solid Material)	2/11/2019	mg/kg	6.1
SPLP Leachate of Bottom Ash	2/11/2019	mg/L	<0.01
EBAP Pond Water	12/15/2018	mg/L	0.0024 J
WBAP Pond Water	11/4/2020	mg/L	0.000501
AD-2 - Average	May 2016 - November 2020	mg/L	0.0132
AD-31 - Average	May 2016 - November 2020	mg/L	0.0127
AD-32 - Average	May 2016 - November 2020	mg/L	0.0441

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.

A sample was collected from the WBAP on 11/4/2020 as a surrogate for the EBAP, as the EBAP did not contain free water. The same process water is stored in both the WBAP or EBAP.

Average values were calculated using all cobalt data collected under 40 CFR 257 Subpart D, excluding any identified outliers.

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

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

Notes:

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

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

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

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

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

Notes:

ND: Not detected

VAP-B3-(40-45) is the centrifuged solid material from the groundwater sample collected at that interval.

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

Sample	Sample Date	Unit	Lithium Concentration
Bottom Ash (Solid Material)	2/11/2019	mg/kg	0.82 J
SPLP Leachate of Bottom Ash	2/11/2019	mg/L	0.011 J
EBAP Pond Water	12/15/2018	mg/L	0.023 J
WBAP Pond Water	11/4/2020	mg/L	0.0274
AD-31 - Average	May 2016 - November 2020	mg/L	0.0855
AD-32 - Average	May 2016 - November 2020	mg/L	0.139

Notes:
mg/kg - milligram per kilogram
mg/L - milligram per liter
J - Estimated value. Result is less than the reporting limit but greater than or equal to the method detection limit.
A sample was collected from the WBAP on 11/4/2020 as a surrogate for the EBAP, as the EBAP did not contain free water. The same process water is stored in both the WBAP or EBAP.
Average values were calculated using all lithium data collected under 40 CFR 257 Subpart D, excluding any identified outliers.

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

Location ID	**Sample Depth (ft bgs)**	**Lithium (mg/kg)**
Bulk Soil Samples		
AD-32	11	0.53
	20-25	1.60
B-2	10	5.30
	16	3.97
	71	7.42
	87	13.10
B-3	10	3.64
	20	2.59
	97	11.10
Lignite	N/A	2.9 J
Solid Material Retained After Filtration		
AD-32	13-33	9.8 J
B-2	38-48	6.5 J
B-3	29-34	7.8 J
	VAP 40-45	13.0

Notes:

J - estimated value

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

For AD-32, samples were collected from additional boreholes advanced in the immediate area of the location identified by the well ID. Samples were not collected from the cuttings of the borings advanced for well installation. Samples for B-X locations were collected from cores removed from the borehole during well lithology logging.

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

VAP - vertical aquifer profiling

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

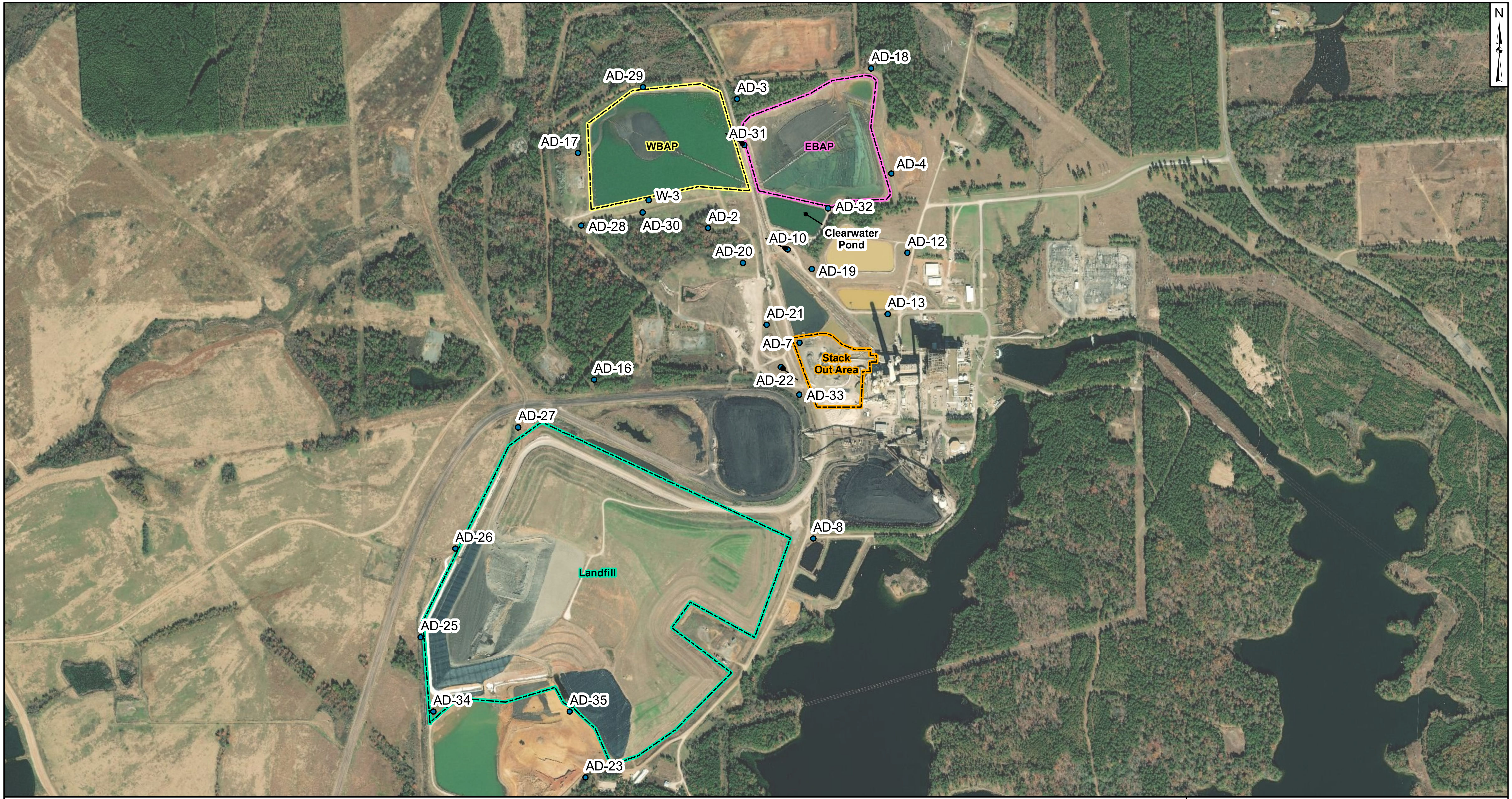
Source	B-2			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.081	6.5	80	43-370
K	2.6	1100	423	42-1200
Na	14	130	9	5.2-82

Source	B-3			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.097	7.8	80	43-370
K	2.9	1100	379	42-1200
Na	32	240	8	5.2-82

Source	AD-32			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.11	9.8	89	43-370
K	3.9	1800	462	42-1200
Na	57	220	4	5.2-82

Notes:
mg/L: milligrams per liter
mg/kg: milligrams per kilogram
L/kg: liters per kilogram
Kd: partition coefficient
Adsorbed values are total metals concentrations reported by USEPA Method 6010B.
Literature values represent maximum and minimum values for the parameter as reported in Sheppard et al, 2009 (Table 4-1, all sites) and Sheppard et al, 2011 (Table 3-3 cultivated peat and wetland peat only).

FIGURES



Legend

- ● Monitoring Wells
- ▭ EBAP
- ▭ Landfill
- ▭ Stack Out Area
- ▭ WBAP

Notes
- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019

0 375 750 1,500 2,250 3,000 Feet

Site Layout

AEP Pirkey Power Plant
Hallsville, Texas

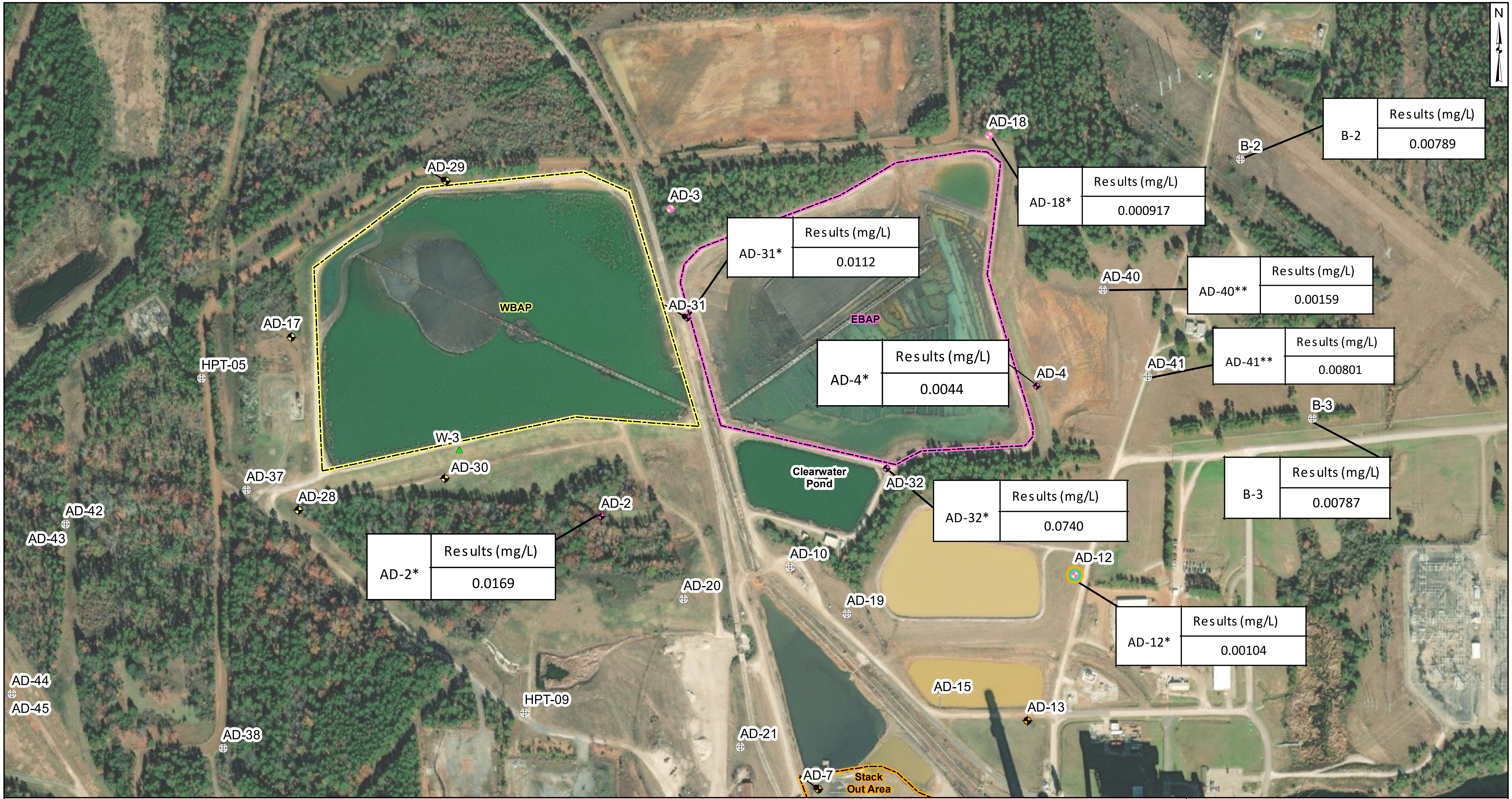
Geosyntec consultants

Columbus, Ohio

2020/03/24

Figure
1

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\Site_Layout_2020324.mxd. hduff. 3/24/2020. Project/Phase/Task.



Legend

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

Notes

- Monitoring well coordinates, site features, and data provided by AEP.
- AD-15 location is approximated
  - B2 and B3 samples collected in March 2021
- * - Well most recently sampled November 2020
- ** - Well most recently sampled August 2019

400 200 0 400
Feet

Cobalt Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2021/04/29

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

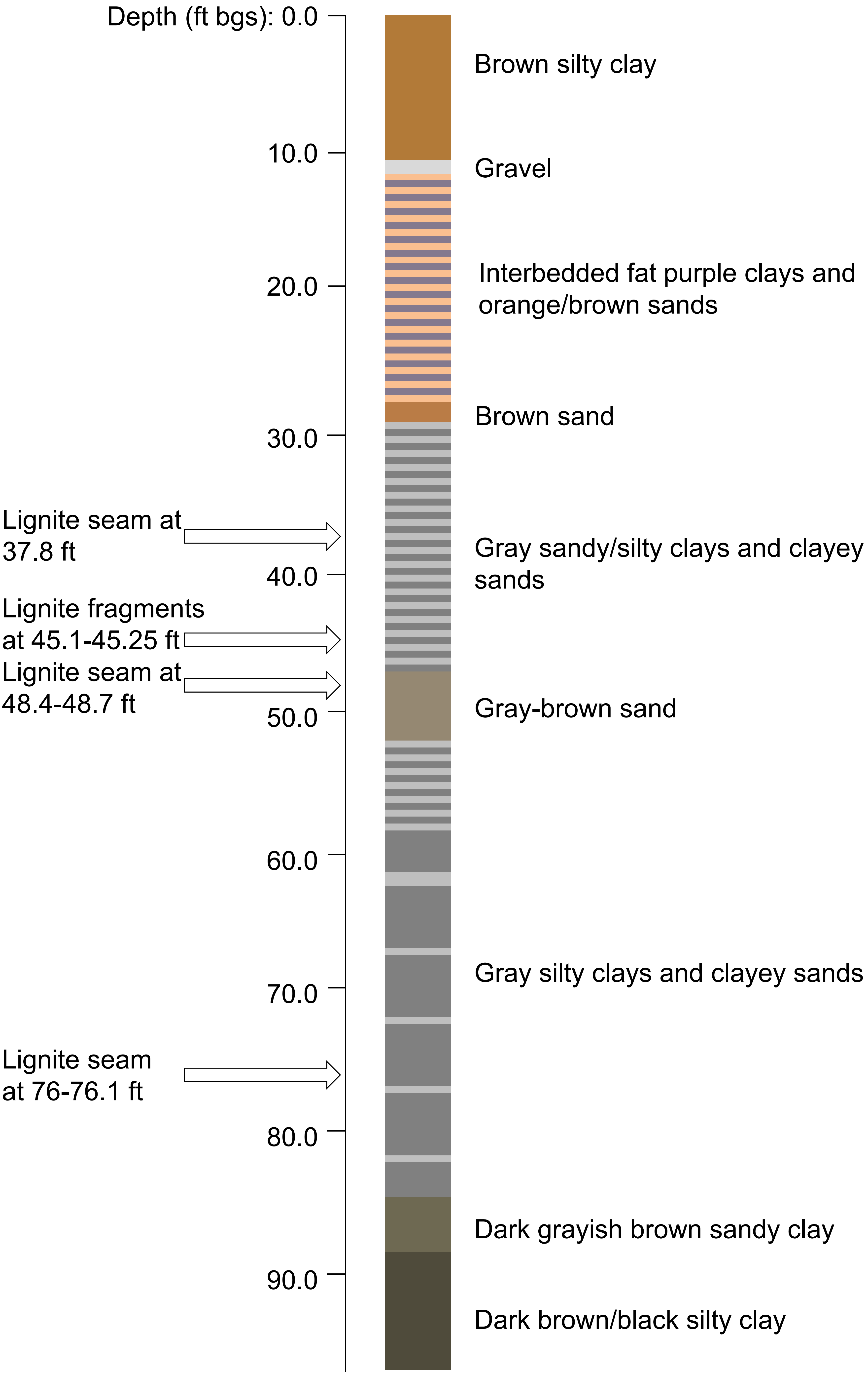
AEP Pirkey Power Plant
Hallsville, Texas

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

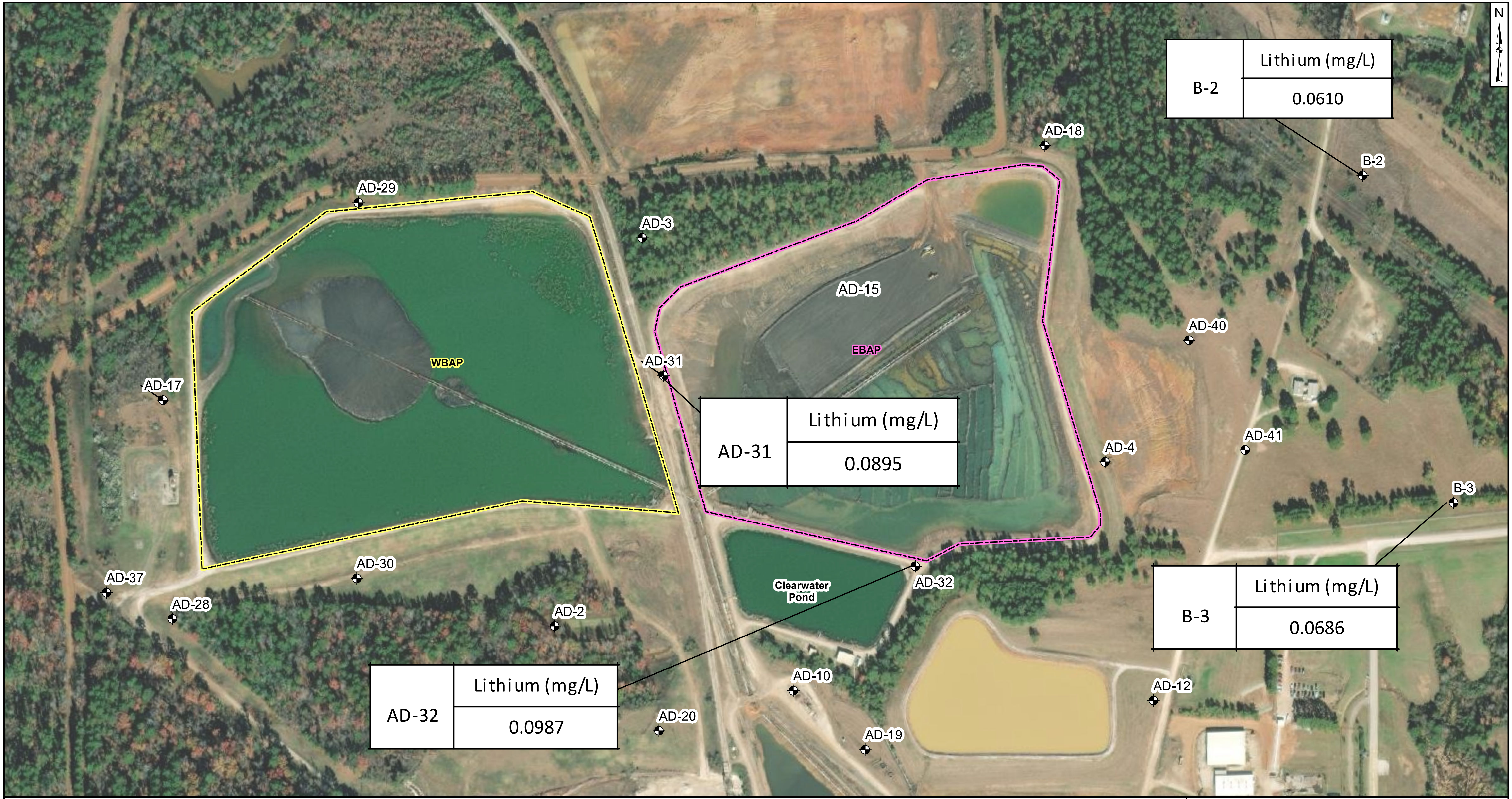
AEP Pirkey Powerplant
Hallsville, TX

Geosyntec
consultants

CHA8462 | March 2020

Figure

4



	Lithium (mg/L)
B-2	0.0610

	Lithium (mg/L)
AD-31	0.0895

	Lithium (mg/L)
B-3	0.0686

	Lithium (mg/L)
AD-32	0.0987

Legend

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

Notes
- Lithium concentrations in micrograms per liter ug/L
- Monitoring well coordinates, site features, and data provided by AEP
- Groundwater samples were collected from B-2 and B-3 in March 2021
- Groundwater samples were collected from AD-31 and AD-32 in November 2020

300 150 0 300
Feet

Lithium Distribution in Groundwater

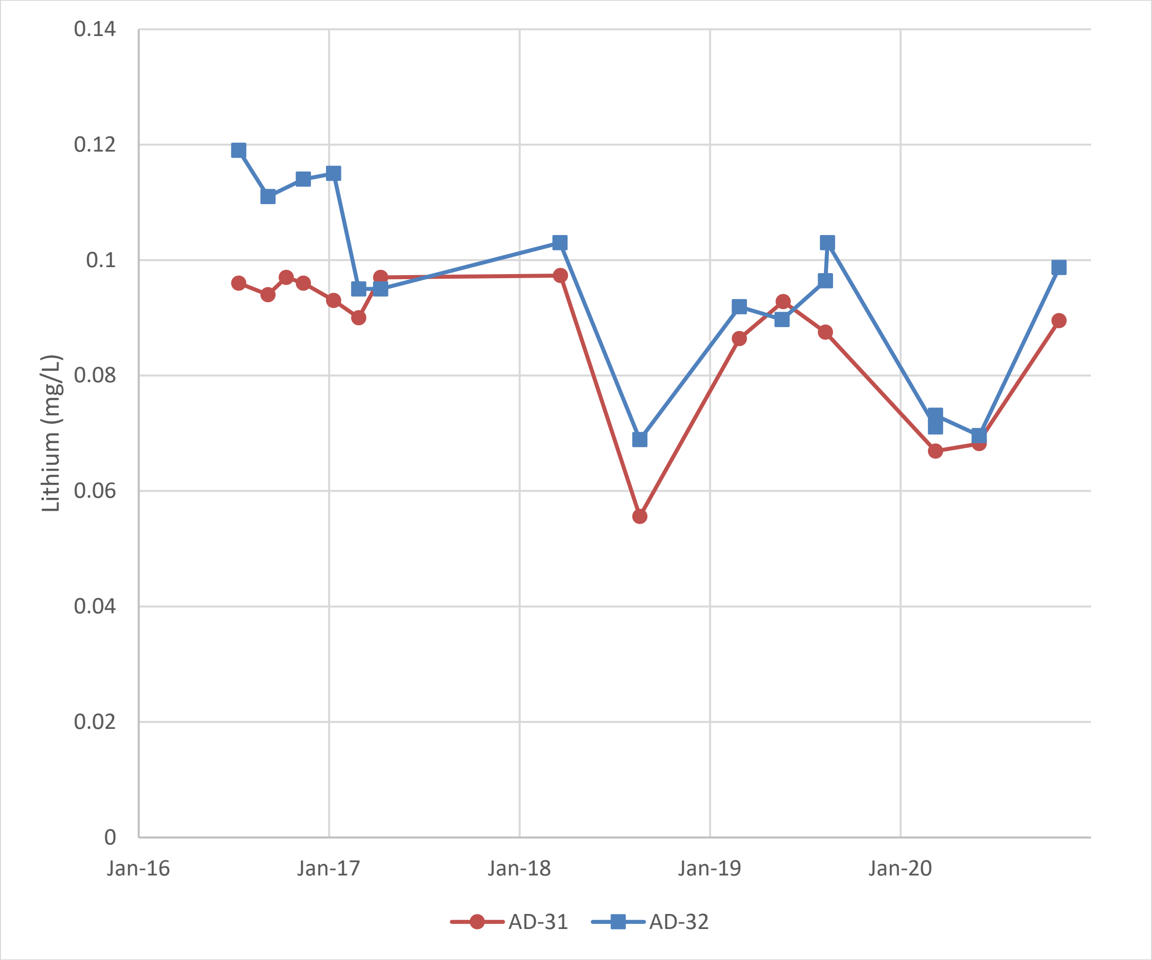
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio
2021/04/29

Figure
5

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2021\AEP-Pirkey_Li_20210429.mxd. HDuff. 4/29/2021. CHA8462/12/02.



Notes: Lithium concentrations are shown in milligrams per liter (mg/L). An outlier lithium value reported for AD-32 on 10/12/16 was excluded from the time series graph.

Lithium Time Series Graph

Pirkey East Bottom Ash Pond

Geosyntec consultants

AMERICAN ELECTRIC POWER

Columbus, Ohio

27-May-2021

Figure

6

ATTACHMENT A

SB-2 Boring Log

PROJECT NO. ____________ PROJ. ________________________ BOR. NO. SB-2
LOCATION AD-2/MW-2 - Pirkey Power Plant ELEV. ____________ DATE 4/20/20

SILTS & SANDS		COHESIVE SOILS - CLAYS			COLORS	MATERIALS	SAND ADJ.	CHARACTERTICS
CONDITION		CONSISTENCY	PENETROMETER	N - VALUE				
VLo ...... Very Loose	0- 4	Vso.. Very Soft	0 - 0.25	<2	Li .... Light .....Br ....Brown	Cl ..... Clay, Clayer	F.......Fine	Calc ..... Calcareous
Lo .... Loose	4-10	So.... Soft	0.25 - 0. 5	2 - 4	Dk ... Dark .....Bk ....Black	Si ..... Silt, Silty	M ....Medium	Lig .... Lignite
MDe ..... Med. Dense	10-30	Mst.. Stiff	0.5 - 1.0	4 - 8	G ..... Grey ....Bl ....Blue	Sa .... Sand, Sandy	Co....Coarse	Org .... Organic
De .... Dense	30-50	St..... Stiff	1.0 - 2.0	8 - 15	T ...... Tan ....Gr .....Grenn	Ls .... Limestone	Si.....Silty	Lam ...... Laminate
VDe ...... Very Dense	>50	VSt.. Very Stiff	2.0 - 4.0	15 - 30	R ...... Red ......Y ......Yellow	Gr .... Gravel		Sls .... Slickensided
		H..... Hard	> 4.0	>30	Rdish.Reddish.Wh ...White	SiS .... Siltstone		SL .... Slightly
						SS .... Sandstone		Sm(s) ... Seam (s)
						Sh..... Shale, Shaley		Nod ...... Nodules

	Sample Interval ~~TEST~~ ASSIGNMENT	~~S A M P L E N O.~~ Recovery	D E P T H F T.	S A M P L E S	STRATUM DESCRIPTION: CONDITION OR CONSISTENCY	COLOR	MINOR MATERIALS OR ADJECTIVES	PREDOMINATE MATERIAL	CHARACTERISTICS OR MODIFICATIONS	STANDARD PENETROMETER: SEAT - 6"	1st - 6"	2nd - 6"	UNIFIED SOIL CLASSIFICATION	N - VALUE OR HAND PENETROMETER
	0-5	2' Rec	0		0-8'	Br, Lt. Rd Br	Si	Sa	Silty Sand- trace clay,					
SM									trace root hairs, moist.				moist	(0-5')
	5-10	2.5' Rec				Lt. Rd Br			- thin lenses (less than 1/4")				moist	(5-10')
8'									at 7.5', trace iron staining					
	10-15	4' Rec			8-14.5	Lt. Rd Br, Rd	Sa, Si	Cl	Clay - some silty sand and silty				moist	(10-15')
Cl			8			Br, Gray			clayey sand in interbeds					
									to 14.5', trace iron ore gravel					
14.5'									in sand seams @ 10.5, 12', 12.5'					
	15-20	2' Rec	14.5		14.5-	Rd Br, Yllw.	Si, Cl	Sa	silty clayey sand - some sandy clay;				v. moist to	
					39'	Br, Gray			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			- gravel & cemented sand seams @ 25' (6")				sat. @ 25'-25.5'	
						Dk. Br			- cemented and partially cemented @					
						(25-39')			clayey silty sand @ 25.5				moist	25.5-27
									- dark gray silty sat. sand seam (2")				sat. @ 27.0	(2")
									@ 27"					
	30-35	3' Rec							- sat. silty sand seam @ 30.5 (1")				sat. @ 30.5	(1")
									- sat. silty sand seam @ 32' (3")				32.0'	(3")
39'									* some v.f. gypsum crystals in clayey sand					
									between sat. sand seams (25-40')				v. moist	(to 39')
ML	35-40	4' Rec	39		39-40	Lt. Gray, Gray	Cl, Sa	Si	Clayey sandy silt,					
						(39-40)			- interbedded silt & clay @ 39' to 40'				moist	(39-40')
									B.T. @ 40'					
									* 25-27' collected @ 1015					
									* 31-33' collected @ 1035					

Type Boring HSA Dry Auger ☒ Rotary Wash ☐

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

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

ATTACHMENT B

SB-2 Boring Photographic Log

GEOSYNTEC CONSULTANTS
Photographic Record

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

Photograph 1

Date: 4/21/2020

Direction: N/A

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

Photograph 2

Date: 4/21/2020

Direction: N/A

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

GEOSYNTEC CONSULTANTS
Photographic Record

Client: AEP **Project Number: CHA8495**

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

Photograph 3

Date: 4/21/2020

Direction: N/A

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

Photograph 4

Date: 4/21/2020

Direction: N/A

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

GEOSYNTEC CONSULTANTS
Photographic Record

Client: AEP **Project Number:** CHA8495

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

Photograph 5

Date: 4/21/2020

Direction: N/A

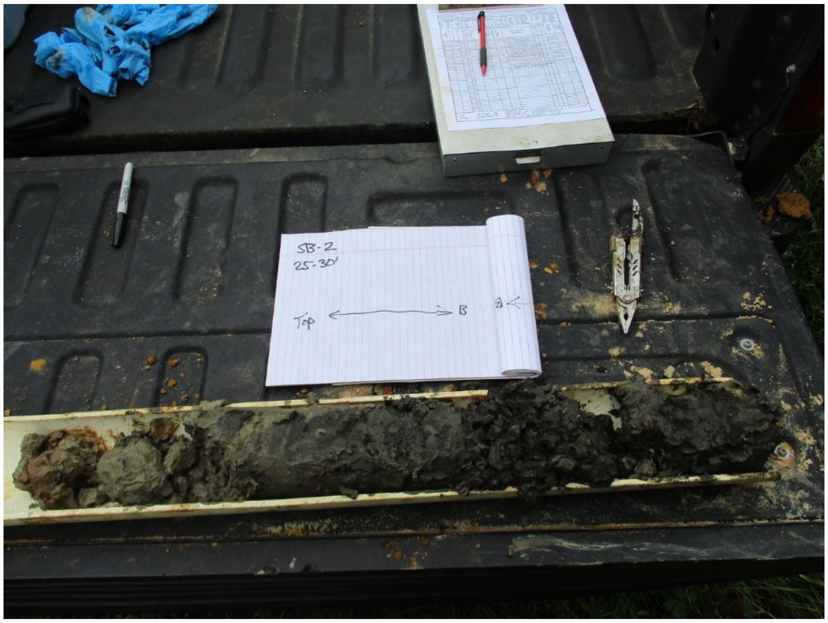
Comments:
20-25 foot interval of SB-2. Recovery of this interval was limited.

Photograph 6

Date: 4/21/2020

Direction: N/A

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



GEOSYNTEC CONSULTANTS
Photographic Record

Client: AEP

Project Number: CHA8495

Site Name: Pirkey East Bottom Ash Pond

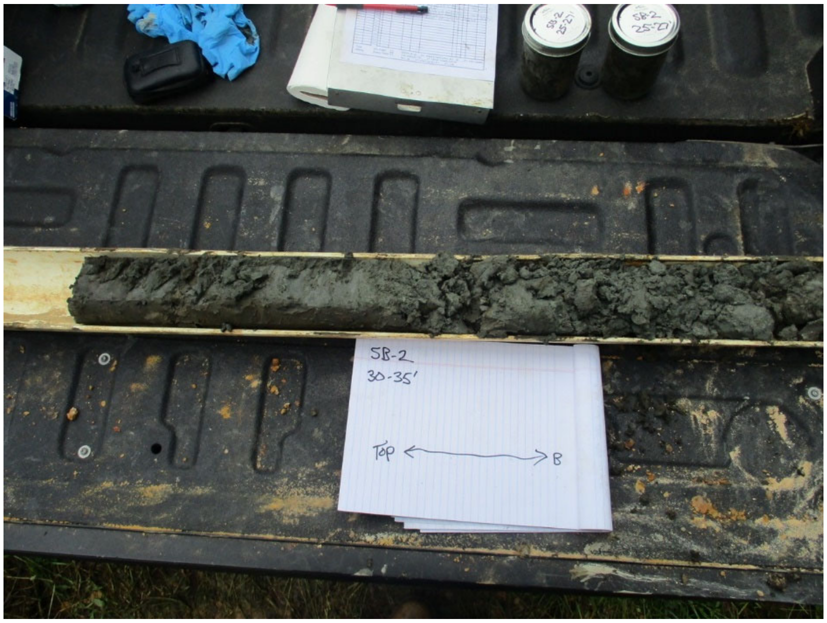
Site Location: Hallsville, Texas

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

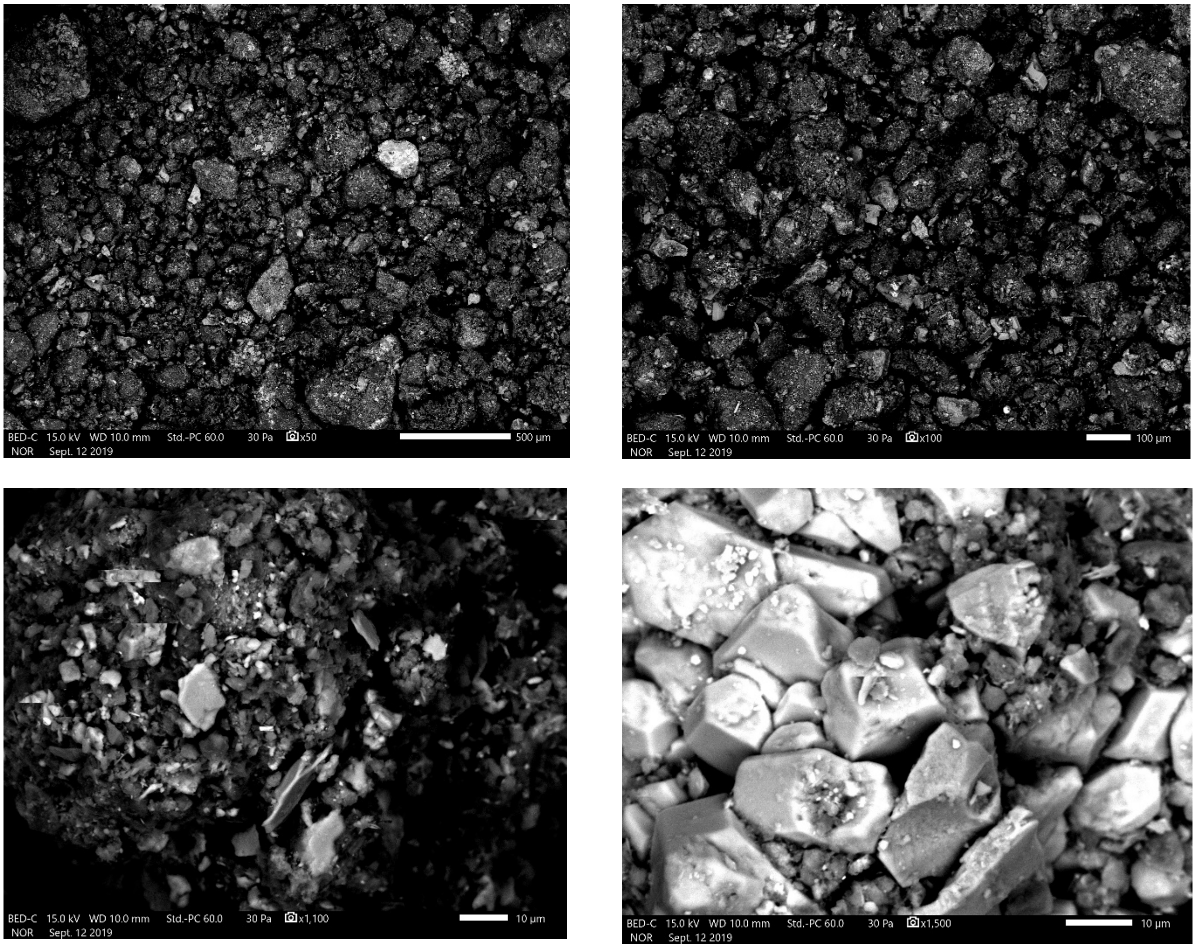
Comments:
35-40 foot interval of SB-2

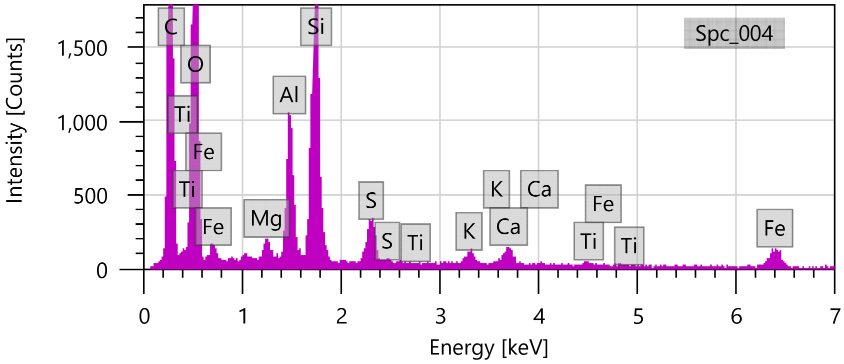
ATTACHMENT C

SEM/EDS Analysis

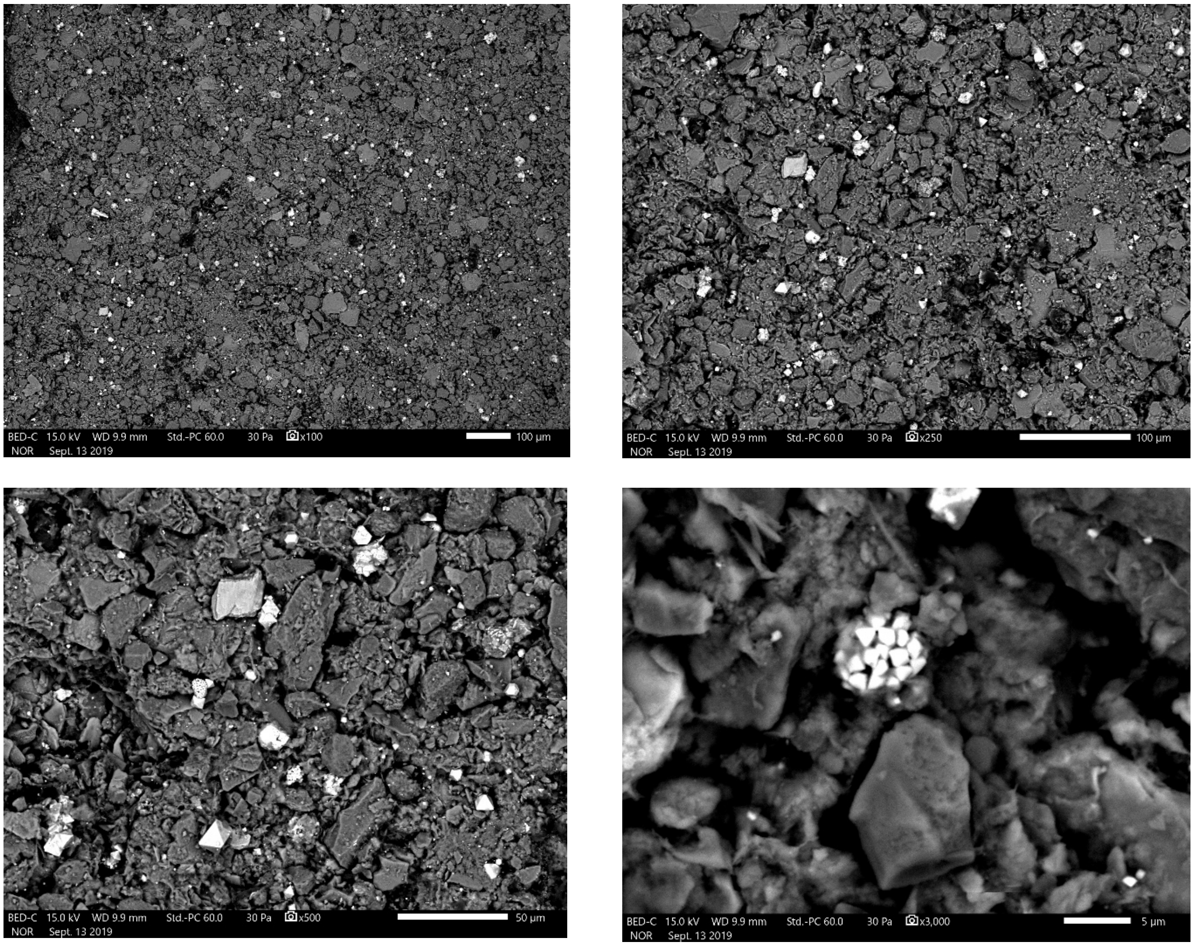
September 16, 2019

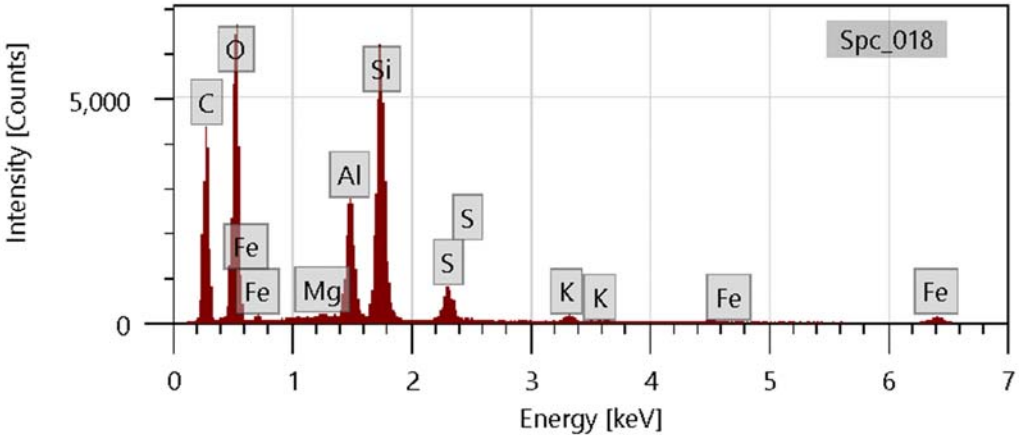
Dr. Bruce Sass via Email: BSass@geosyntec.com
941 Chatham Lane, Suite 103, Columbus, OH 43221



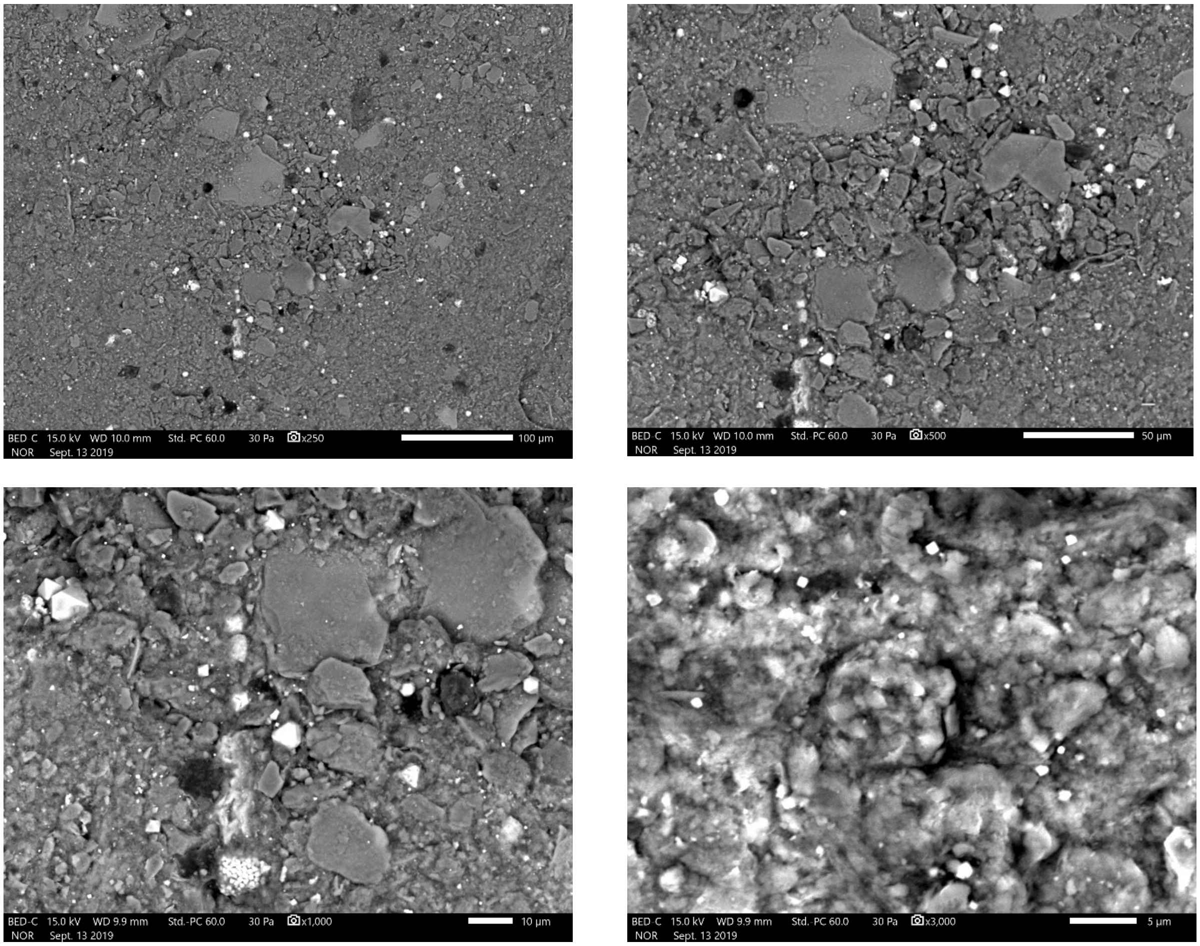


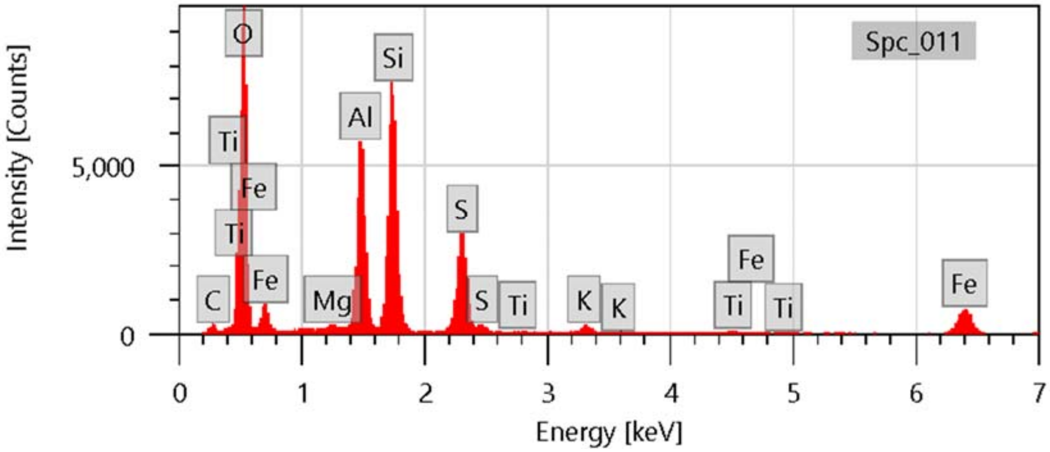
Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





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





Sample VAP B3 50-55. Backscattered electron micrographs show the sample at 250X, 500X, 1000X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 3000X. Bright particles are mostly pyrite (framboid in bottom left micrograph); occasional particles of Fe-Ti oxide are detected. Major peaks for oxygen, silicon, and aluminum suggest clay. Large blocky particles are mostly quartz, feldspar, and clay.

ATTACHMENT D

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.95(g)(3)(ii) have been met.

BETH ANN GROSS
79864

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

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

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

5/28/2021
Date