

**Pirkey Power Plant
East Bottom Ash Pond
Alternate Source Demonstration**

The Pirkey East Bottom Ash Pond initiated an assessment monitoring program in accordance with 40 CFR 257.95 on April 3, 2018. Groundwater protection standards (GWPS) were set in accordance with 257.95(d)(2) and a statistical evaluation of the assessment monitoring data was conducted. The statistical evaluation revealed an exceedance of the cobalt and lithium GWPS on January 3, 2020. A successful alternate source demonstration (ASD) was completed per 257.95(g)(3), therefore, the Pirkey East Bottom Ash Pond will remain in assessment monitoring. An alternate source demonstration is documentation that shows a source other than the CCR unit was responsible for causing the statistics to exceed the GWPS. The ASD document will explain the alternate cause of the GWPS exceedance. The successful ASD is attached.

**ALTERNATIVE SOURCE
DEMONSTRATION REPORT
FEDERAL CCR RULE**

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

Submitted to



1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec 
consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

April 2, 2020

CHA8495

TABLE OF CONTENTS

SECTION 1 Introduction and Summary.....	1-1
1.1 CCR Rule Requirements.....	1-1
1.2 Demonstration of Alternative Sources.....	1-2
SECTION 2 Alternative Source Demonstration.....	2-1
2.1 Proposed Alternative Sources.....	2-1
2.1.1 Cobalt.....	2-1
2.1.2 Lithium.....	2-3
2.2 Sampling Requirements.....	2-4
SECTION 3 Conclusions and Recommendations	3-1
SECTION 4 References.....	4-1

TABLES

Table 1	Summary of Key Cobalt Analytical Data
Table 2	Soil Cobalt and Mineralogy Data
Table 3	X-Ray Diffraction Results
Table 4	Soil Lithium Data
Table 5	Calculated Site-Specific Partition Coefficients

FIGURES

Figure 1	Site Layout
Figure 2	Cobalt Distribution in Groundwater
Figure 3	Soil Chemical and Mineralogical Analysis Results
Figure 4	B-3 Visual Boring Log
Figure 5	Lithium Distribution in Groundwater

ATTACHMENTS

Attachment A	SEM/EDS Analysis
Attachment B	Certification by a Qualified Professional Engineer

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SPLP	Synthetic Precipitation Leaching Procedure
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency
VAP	Vertical Aquifer Profiling
XRD	X-Ray Diffraction

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the East Bottom Ash Pond (EBAP, Figure 1). In August 2019, a semi-annual assessment monitoring event was conducted at the EBAP in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were re-established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or, for constituents without an MCL, the risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were re-calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). The following SSLs were identified at the Pirkey EBAP:

- LCLs for cobalt exceeded the GWPS of 0.0094 mg/L at AD-2 (0.0100 mg/L), and AD-32 (0.0310 mg/L).
- LCLs for lithium exceeded the GWPS of 0.0616 mg/L at AD-31 (0.0859 mg/L) and AD-32 (0.0878 mg/L).

No other SSLs were identified (Geosyntec, 2020).

1.1 CCR Rule Requirements

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

Demonstrate that a source other than the CCR unit caused the contamination, or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Any such demonstration must be supported by a report that includes the factual or evidentiary basis for any conclusions and must be certified to be accurate by a qualified professional engineer or approval from the Participating State

Director or approval from EPA where EPA is the permitting authority. If a successful demonstration is made, the owner or operator must continue monitoring in accordance with the assessment monitoring program pursuant to this section....

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

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which the identified SSL could be attributed. Alternative sources were identified amongst five types, based on methodology provided by EPRI (2017):

- ASD Type I: Sampling Causes;
- ASD Type II: Laboratory Causes;
- ASD Type III: Statistical Evaluation Causes;
- ASD Type IV: Natural Variation; and
- ASD Type V: Alternative Sources.

A demonstration was conducted to show that the SSLs identified for cobalt and lithium were based on a Type IV cause and not by a release from the Pirkey EBAP.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The Federal CCR Rule allows the owner or operator 90 days from the determination of an SSL to demonstrate that a source other than the CCR unit caused the SSL. The methodology used to evaluate the SSLs identified for cobalt and lithium and the proposed alternative source are described below.

2.1 Proposed Alternative Sources

Initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify alternative sources due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSLs for cobalt and lithium have been attributed to natural variation associated with the underlying geology, which is a Type IV issue.

2.1.1 Cobalt

In previous ASDs for cobalt at the EBAP, evidence was provided to show that the observed cobalt concentrations were due to natural variation (Geosyntec, 2019a; Geosyntec, 2019b; Geosyntec, 2019c). The previous ASDs discussed that the EBAP itself did not appear to be a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-864 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP leachate above the reporting limit of 0.01 mg/L. Because cobalt mobility is affected by pH, the SPLP test results are likely even more conservative than actual pond conditions. SPLP is run at a pH of 5 SU, whereas the operational pH of the pond varies between approximately 5.8 and 7.0 SU. Cobalt mobility increases under more acidic conditions, although even at a pH of approximately 5, only 2% of cobalt in fly ash is mobile (Izquierdo and Querol, 2012).

Cobalt was detected at an estimated concentration of 0.0024 mg/L in a grab sample of the pond water. However, the reported concentration of cobalt in the pond water sample is significantly lower than the average concentration of cobalt observed at both wells where SSLs were identified (Table 1). Since the previous ASDs were prepared, there have been no notable changes in coal handling or sourcing at the plant that would have affected the composition of the ash or pond water.

Four additional permanent wells (B-2, B-3, AD-40, and AD-41) were installed upgradient of the EBAP in 2019. These upgradient locations were selected to represent conditions at the facility which are unimpacted by site operations. The most recent data available for select wells in the vicinity of the EBAP, as well as the upgradient locations, are shown in Figure 2. Groundwater cobalt concentrations at upgradient locations vary from 0.000799 mg/L to 0.0345 mg/L at AD-40 and B-3, respectively. This wide range in cobalt concentrations provides further evidence for the natural variation of cobalt at the Site, particularly as the concentration at B-3 exceeds the GWPS

for the EBAP. Additionally, the cobalt concentration at B-3 is comparable to the most recent sample results at AD-32 (0.0337 mg/L) and higher than the most recent cobalt concentration reported at AD-2 (0.013 mg/L), which are the two wells with exceedances.

As noted in the previous two ASDs, soil samples collected across the site, including from locations near the EBAP, identified cobalt in the aquifer solids at varying concentrations. While no additional soil samples were collected in support of this ASD, soil sampling data from select upgradient and downgradient locations from previous site investigations are summarized in Table 2 and Figure 3. Cobalt was identified in the aquifer solids at varying concentrations, with the highest value of 23.5 milligrams per kilogram (mg/kg) reported at AD-41, which is upgradient of the EBAP (Figure 3). Other testing included collection of aquifer solids to evaluate for the presence of cobalt-containing minerals. X-ray diffraction evidence identified pyrite and marcasite (both iron sulfides) at select locations at concentrations up to 3% by weight (Table 2). Cobalt is known to substitute for iron in crystalline iron minerals such as pyrite and marcasite due to their similar ionic radii (Krupka and Serne, 2002; Hitzman et al., 2017). While cobalt was identified in the aquifer solid samples collected from AD-32, soil analytical and mineralogical data are not available for AD-2. However, the wide distribution of cobalt and iron minerals across the site suggests that similar concentrations of cobalt are likely to be present in the aquifer solids at AD-2.

Groundwater samples were collected from upgradient location B-3 via vertical aquifer profiling (VAP), as described in an ASD previously generated for lithium exceedances at the EBAP (Geosyntec, 2019b). The VAP groundwater samples were centrifuged to separate solid and liquid phases, and the solid material was submitted for analysis of total metals and mineralogy by X-ray diffraction (XRD). The samples were also submitted for analysis of chemical composition and mineralogy by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS). Following installation of permanent monitoring wells at B-2 and B-3, groundwater samples were collected by purging groundwater through the filter pack using a submersible pump. An additional groundwater sample was collected at AD-32. These permanent well groundwater samples were filtered through a 1.5-micron filter and the solid material retained on the filter was submitted for analysis of total metals and by SEM/EDS.

Based on total metals analysis, cobalt was identified both in the centrifuged solid material collected from upgradient location B-3 [VAP-B3-(40-45)] and in the material retained on the filter after processing groundwater from B-2 and B-3 (Table 2). Cobalt was detected in the AD-32 solid material at 5.4 mg/kg, which is comparable to the concentration observed in bulk soil collected at the same location at the screened interval (9.1 mg/kg). These results provide further evidence that cobalt concentrations reported during groundwater sampling are naturally occurring and associated with the solid phase in the aquifer.

According to XRD results of the centrifuged solid sample [VAP-B3-(40-45)], pyrite was present as approximately 3% of the solid phase (Table 3). Logging completed while the VAP boring was advanced identified lignite at several intervals, including 45 and 48 ft bgs (Figure 4). Furthermore, SEM/EDS of both centrifuged solid samples [VAP-B3-(40-45) and VAP-B3-(50-55)] identified

pyrite in backscattered electron micrographs by the distinctive framboid pattern (Harris et al., 1981; Sawlowicz, 2000). Major peaks involving iron and sulfur were identified in the EDS spectrum, which further support the identification of pyrite (Attachment A). While cobalt was not identified in the EDS spectrum, it would likely be present at concentrations below the detection limit. Pyrite was also identified during SEM/EDS analysis of lignite which is mined immediately adjacent to the site.

In addition to pyrite, hematite (an iron(III) oxide) was present at 2% of the centrifuged solid sample collected from upgradient location VAP-B3 (Table 3). Weathering of pyrite to hematite is a known phenomenon in east Texas soils (Dixon, et al., 1982); the adsorption of cobalt to hematite is a documented mechanism which provides an additional pathway for cobalt to enter groundwater from the soil system (McLaren et al., 1986; Borggaard, 1987).

The wide distribution of iron minerals across the site provides evidence that naturally occurring cobalt, which may substitute for iron in pyrite or adsorb to hematite, may also be present in the aquifer solids near the EBAP. The presence of lignite in the area is well-documented, including at upgradient and downgradient locations relative to the EBAP (Broom and Myers, 1966; ETTL, 2010). Additionally, the pond was not identified as the source of cobalt at wells downgradient of the EBAP in previous ASDs based on the documented low mobility of cobalt under the pond conditions and lack of detectable cobalt in the pond itself.

2.1.2 Lithium

Two ASDs were previously generated for lithium exceedances at the EBAP which attributed the observed concentrations to variations in naturally suspended matter that likely originates from lignite and is ubiquitous in the aquifer (Geosyntec, 2019b; Geosyntec, 2019c). Data gathered in support of the prior ASDs provides additional evidence that the observed lithium concentrations at AD-31 and AD-32 are due to natural variation in the aquifer.

During the August 2019 sampling event, groundwater samples were collected at B-2, B-3, AD-31, and AD-32 using low-flow sampling techniques. Total lithium concentrations in permanent upgradient wells B-2 and B-3 were measured at 0.055 mg/l and 0.090 mg/l, respectively, both of which are above the GWPS of 0.0616 mg/L (Figure 5). Lithium was detected at AD-31 at 0.0875 mg/L and AD-32 at 0.103 mg/L, which are comparable to the observed concentration at B-3. Because B-2 and B-3 were installed at locations upgradient to and unimpacted by Site activities, they suggest that lithium concentrations above the GWPS are naturally present in the vicinity of the EBAP.

As described in Section 2.1.1, groundwater samples were collected from B-2, B-3, and AD-32 and filtered to separate captured solid material. Both the solid material and the filtered groundwater were submitted for total metals analysis. Lithium was detected in the solid material at concentrations comparable to bulk soil at all locations, providing evidence that the particulates captured during groundwater sampling contain lithium (Table 4).

A previous ASD generated for lithium at the EBAP developed a proposed mechanism for lithium mobility in groundwater which pointed to desorption from clay minerals associated with naturally occurring lignite material as the source of lithium in both up and downgradient wells at the EBAP (Geosyntec, 2019b). Previously completed XRD analysis of the centrifuged solid material samples [VAP-B3-(40-45) and VAP-B3-(50-55)] found that clay minerals, including kaolinite, smectite, and illite/mica, made up at least 60% of the aquifer solid (Table 3). These clay minerals, particularly smectite and illite, are known to retain metals such as lithium via cation exchange processes. SEM/EDS analysis identified the presence of silicon, aluminum and oxygen, all of which are indicative of clay minerals (Attachment A). The backscattered electron micrographs of these samples also identified clay particles by morphology. The largest clay particles ($> 5 \mu\text{m}$) are likely kaolinite, while smectite and illite dominate the smaller size fraction.

Total metal concentrations in the solid materials separated from the groundwater samples during filtration and the filtered groundwater concentrations were used to calculate partition coefficients values (K_d) for lithium, potassium, and sodium. Details about the K_d calculation are provided in the previous ASD (Geosyntec, 2019c). K_d values for groundwater and particulate collected from wells B-2, B-3, and AD-32 were comparable to literature K_d values reported for organic-rich media such as bogs and peat beds (Sheppard et al., 2009; 2011), providing further evidence that lithium mobility in Site groundwater is similar to other sites with organic-rich soils (Table 5). Additionally, the calculated K_d values for Pirkey soils were consistent with the literature, with potassium being the largest (most sorbable) and sodium the smallest (least sorbable). Furthermore, the values are similar for groundwater from all three wells, suggesting a universal mechanism is controlling the mobilities of lithium, sodium, and potassium in groundwater.

These multiple lines of evidence show that elevated lithium concentrations at AD-31 and AD-32 are not due to a release from the EBAP, and instead can be attributed to natural variation. This variation appears related to the distribution of clay fractions associated with lignite materials in the soil aquifer material.

2.2 Sampling Requirements

As the ASD presented above supports the position that the identified SSLs are not due to a release from the Pirkey EBAP, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and provides evidence that the SSLs for cobalt at AD-2 and AD-32 and for lithium at AD-31 and AD-32 identified during assessment monitoring in August 2019 were not due to a release from the EBAP. The identified SSLs were, instead, attributed to natural variation in the underlying geology. Therefore, no further action for cobalt or lithium is warranted, and the Pirkey EBAP will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

REFERENCES

- AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.
- Broom, M.E. and Myers, B.N., 1966. Ground-Water Resources of Harrison County, Texas. Texas Water Development Board Report 27. August.
- EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. 3002010920. October.
- ETTL, 2010. Pirkey Power Station, Existing Ash, Surge, Lignite and Limestone Runoff, and Landfill Stormwater Ponds Embankment Investigation, Hallsville, Texas, Geotechnical Investigation. October.
- Geosyntec Consultants, 2020. Statistical Analysis Summary – East Bottom Ash Pond. H.W. Pirkey Plant. Hallsville, Texas. January.
- Geosyntec Consultants, 2019a. Alternative Source Demonstration – Federal CCR Rule. H.W. Pirkey Power Plant. East Bottom Ash Pond. Hallsville, Texas. April.
- Geosyntec Consultants, 2019b. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant, East Bottom Ash Pond. Hallsville, Texas. July.
- Geosyntec Consultants, 2019c. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant, East Bottom Ash Pond. Hallsville, Texas. September.
- Harris, L.A, Kenik, E.A., and Yust, C.S. 1981. Reactions in pyrite framboids induced by electron beam heating in a HVEM. *Scanning Electron Microscopy*, 1, web.
- Hitzman, M.W., Bookstrom, A.A., Slack, J.F., and Zientek, M.L., 2017. Cobalt – Styles of Deposits and the Search for Primary Deposits. USGS Open File Report 2017-1155.
- Izquierdo, M. and Querol, X., 2012. Leaching Behaviour of Elements from Coal Combustion Fly Ash: An Overview. *International Journal of Coal Geology*, 94, 54-66.
- Krupka, K.M. and Serne, R.J., 2002. Geochemical Factors Affecting the Behavior of Antimony, Cobalt, Europium, Technetium, and Uranium in Vadose Sediments. Pacific Northwest National Lab, PNNL-14126. December.
- Sawlowicz, Z. 2000. *Framboids: From Their Origin to Application*. Pr. Mineral. (Mineralogical Transactions), 88, web.

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

Sheppard, S., Sohlenius, G., Omberg, L.G., Borgiel, M., Grolander, S., and Nordén, S. 2011. Solid/Liquid Partition Coefficients (K_d) and Plant/Soil Concentration Ratios (CR) for Selected Soil, Tills, and Sediments at Forsmark. R-11-24. Swedish Nuclear Fuel and Waste Management Co. R-11-24. November.

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

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

TABLES

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

Sample	Unit	Cobalt Concentration
Bottom Ash (Solid Material)	mg/kg	6.1
SPLP Leachate of Bottom Ash	mg/L	<0.01
EBAP Pond Water	mg/L	0.0024 J
AD-2 - Average	mg/L	0.0113
AD-32 - Average	mg/L	0.0544

Notes:

mg/kg - milligram per kilogram

mg/L - milligram per liter

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

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

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

Geosyntec Consultants, Inc.

Location ID	Sample Depth (ft bgs)	Cobalt (mg/kg)	Pyrite/Marcasite (%)
Bulk Soil Samples			
AD-17	7	3.10	2
	15	1.50	0
AD-18	8	3.60	1
	22	2.90	0
AD-30	7	1.00	3
	23	15.0	1
AD-31	12	1.90	2
	26	0.83	0
AD-32	11	1.70	--
	20-25	9.10	--
AD-41	15	< 1.0	--
	35	23.5	---
	95	1.90	---
B-2	10	2.36	---
	16	3.62	---
	71	10.30	---
	82	7.21	---
	87	3.11	---
B-3	10	1.30	---
	20	0.59	---
	97	1.11	---
Solid Material Retained After Filtration			
AD-32	13-33	5.4	--
B-2	38-48	4.3	--
B-3	29-34	12.0	--
	VAP 40-45	18.0	3

Notes:

'--' - analysis not completed

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

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

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

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

Geosyntec Consultants, Inc.

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

Notes:

ND: Not detected

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

Table 4: Soil Lithium Data
East Bottom Ash Pond - H.W. Pirkey Plant

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

Notes:

J - estimated value

mg/kg- milligram per kilogram

ft bgs - feet below ground surface

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

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

VAP - vertical aquifer profiling

**Table 5: Calculated Site-Specific Partition Coefficients
East Bottom Ash Pond - H. W. Pirkey Plant**

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

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

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

Notes:

mg/L: milligrams per liter

mg/kg: milligrams per kilogram

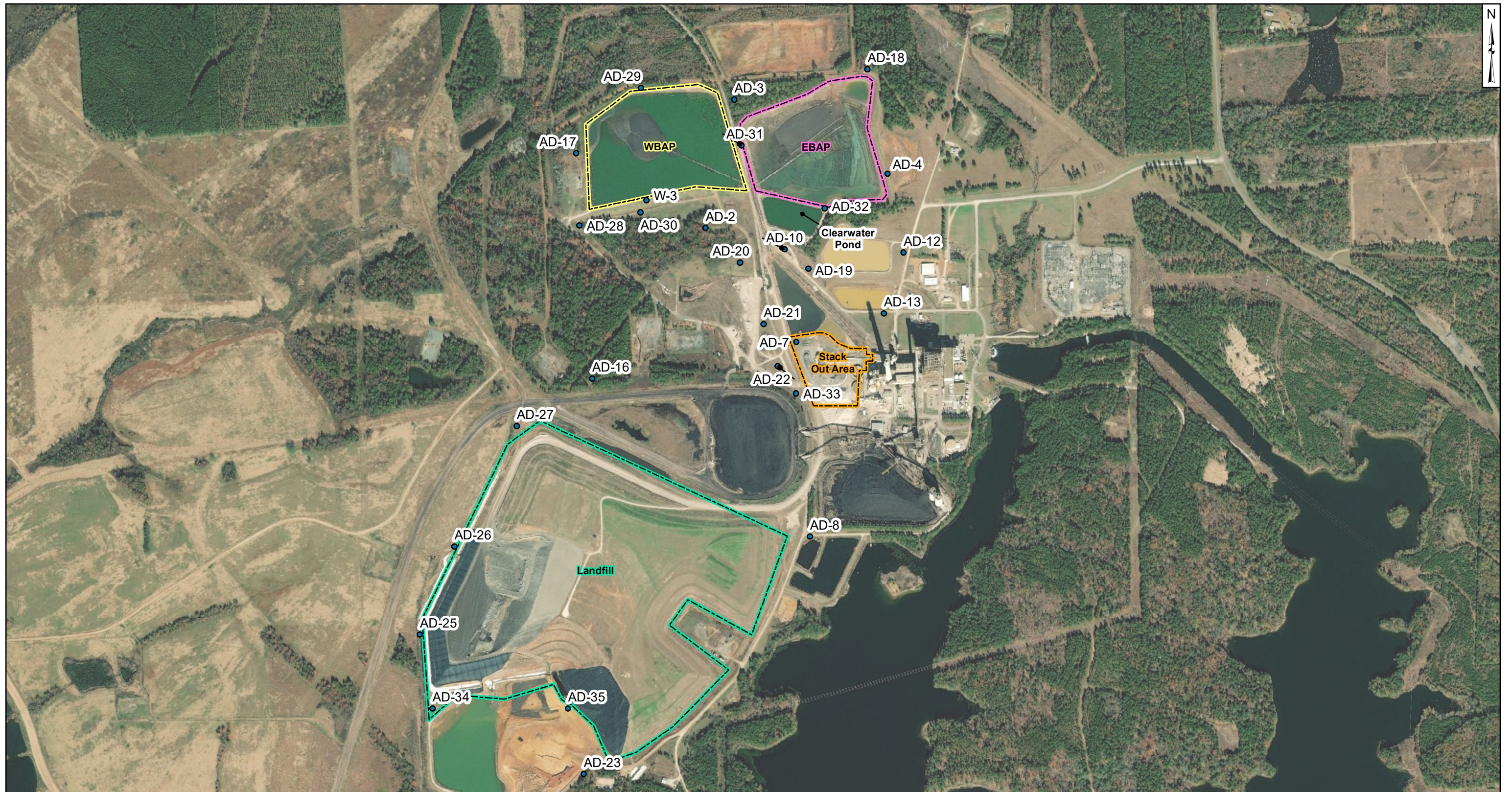
L/kg: liters per kilogram

Kd: partition coefficient

Adsorbed values are total metals concentrations reported by USEPA Method 6010B.

Literature values represent maximum and minimum values for the parameter as reported in Sheppard et al, 2009 (Table 4-1, all sites) and Sheppard et al, 2011 (Table 3-3 cultivated peat and wetland peat only).

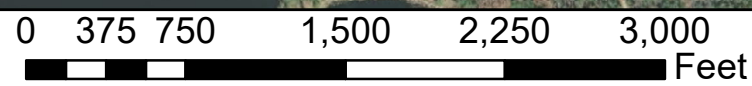
FIGURES



Legend

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

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



Site Layout

AEP Pirkey Power Plant
 Hallsville, Texas

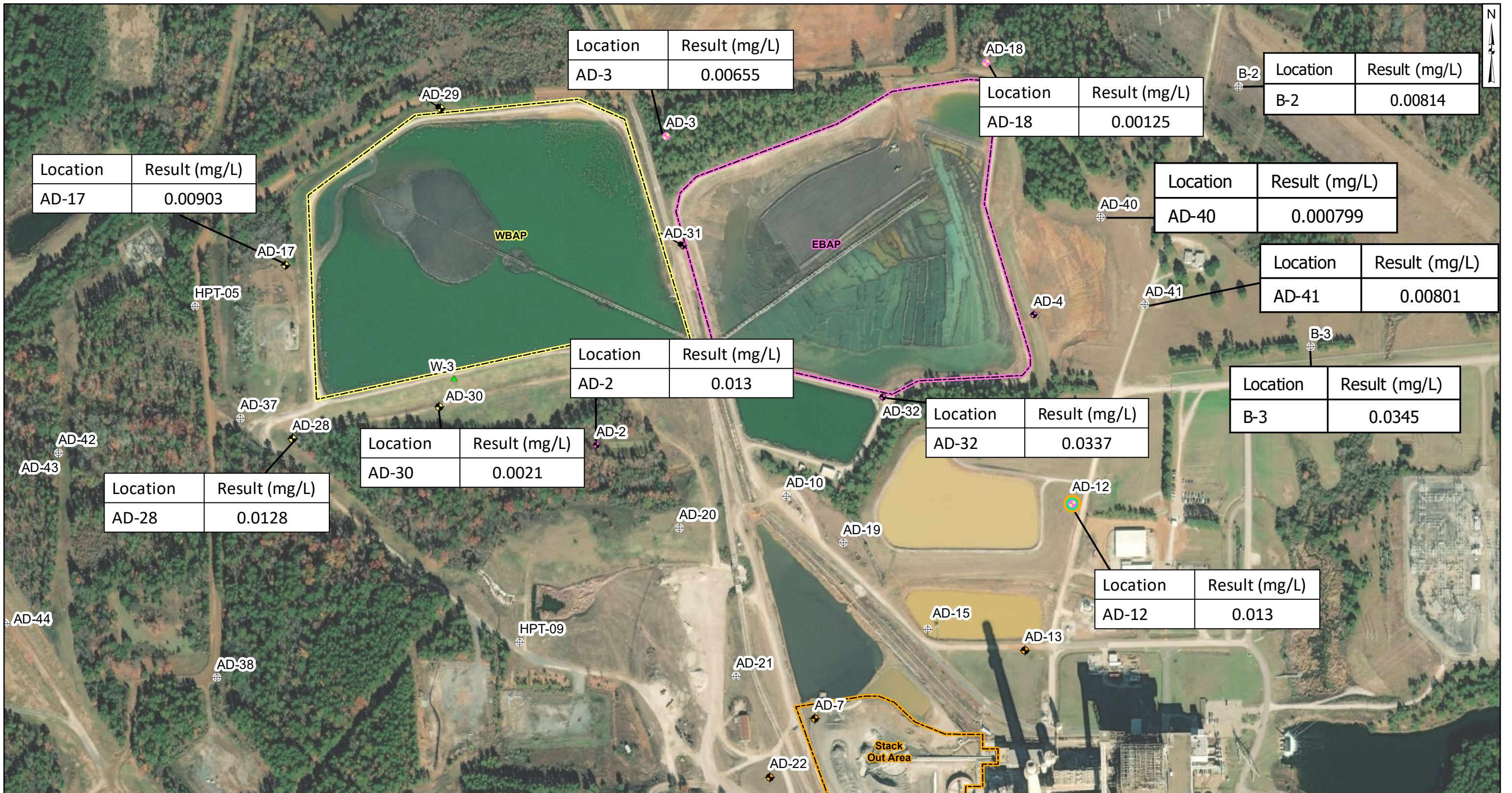
Geosyntec
 consultants

Columbus, Ohio

2020/03/24

Figure

1



Location	Result (mg/L)
AD-3	0.00655

Location	Result (mg/L)
AD-18	0.00125

Location	Result (mg/L)
B-2	0.00814

Location	Result (mg/L)
AD-17	0.00903

Location	Result (mg/L)
AD-40	0.000799

Location	Result (mg/L)
AD-41	0.00801

Location	Result (mg/L)
AD-2	0.013

Location	Result (mg/L)
AD-32	0.0337

Location	Result (mg/L)
B-3	0.0345

Location	Result (mg/L)
AD-28	0.0128

Location	Result (mg/L)
AD-30	0.0021

Location	Result (mg/L)
AD-12	0.013

Legend

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

Notes

- Monitoring well coordinates, site features, and data provided by AEP
- AD-15 location is approximated
- Samples collected in August 2019
- AD-29 included in the well network for water level measurements only



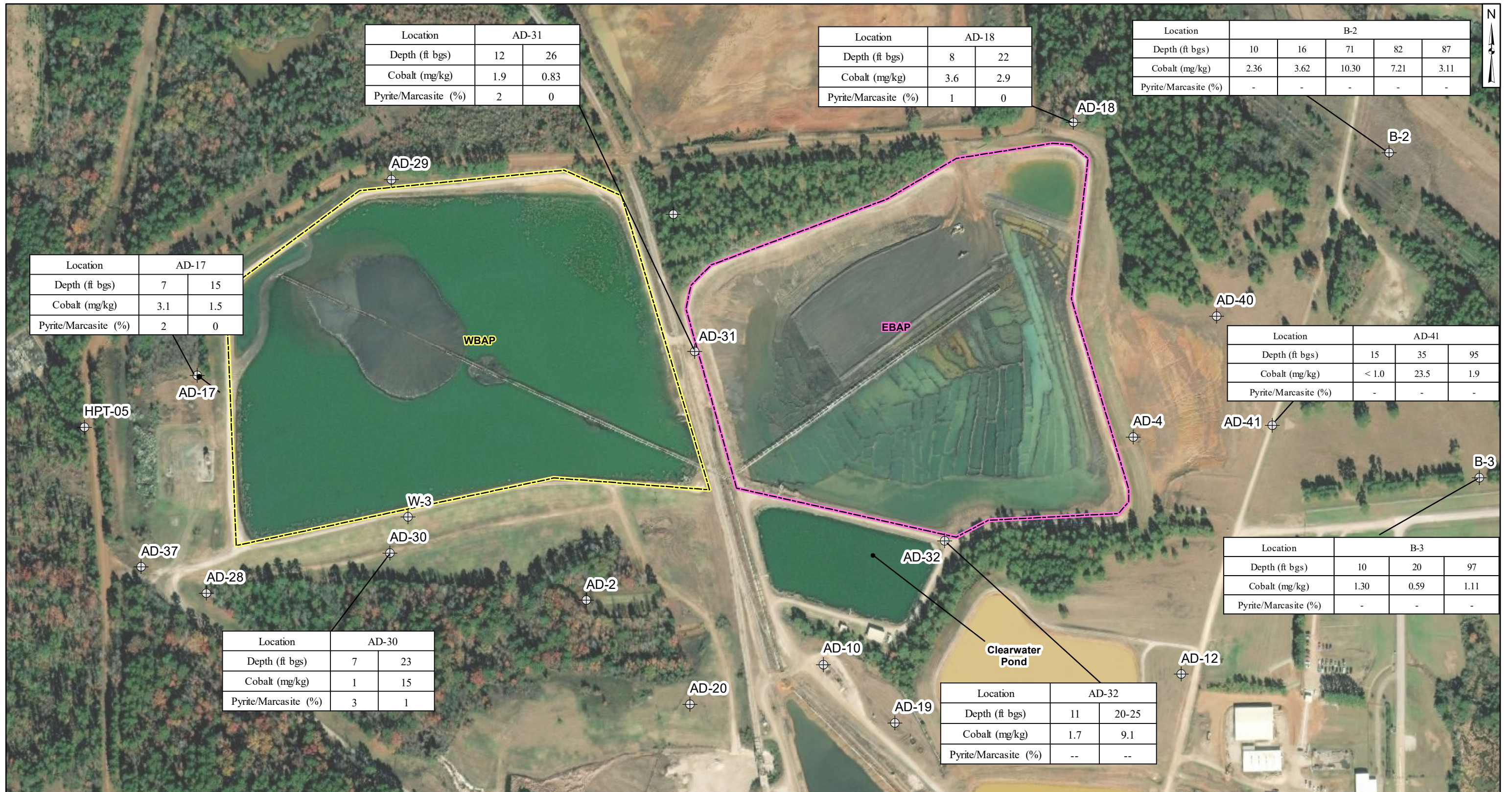
Cobalt Distribution in Groundwater August 2019

AEP Pirkey Power Plant
Hallsville, Texas



Figure
2

Columbus, Ohio 2020/04/01



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

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

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

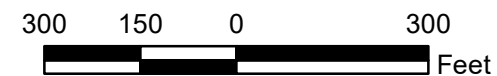
Location	AD-32	
Depth (ft bgs)	11	20-25
Cobalt (mg/kg)	1.7	9.1
Pyrite/Marcasite (%)	--	--

Legend

- Monitoring Wells
- EBAP
- WBAP

Notes

- Monitoring well coordinates provided by AEP.
- Data provided by AEP, 2019.
- ft bgs: feet below ground surface.
- mg/kg: milligrams per kilogram.
- -- not analyzed.



Soil Chemical and Mineralogical Analysis Results

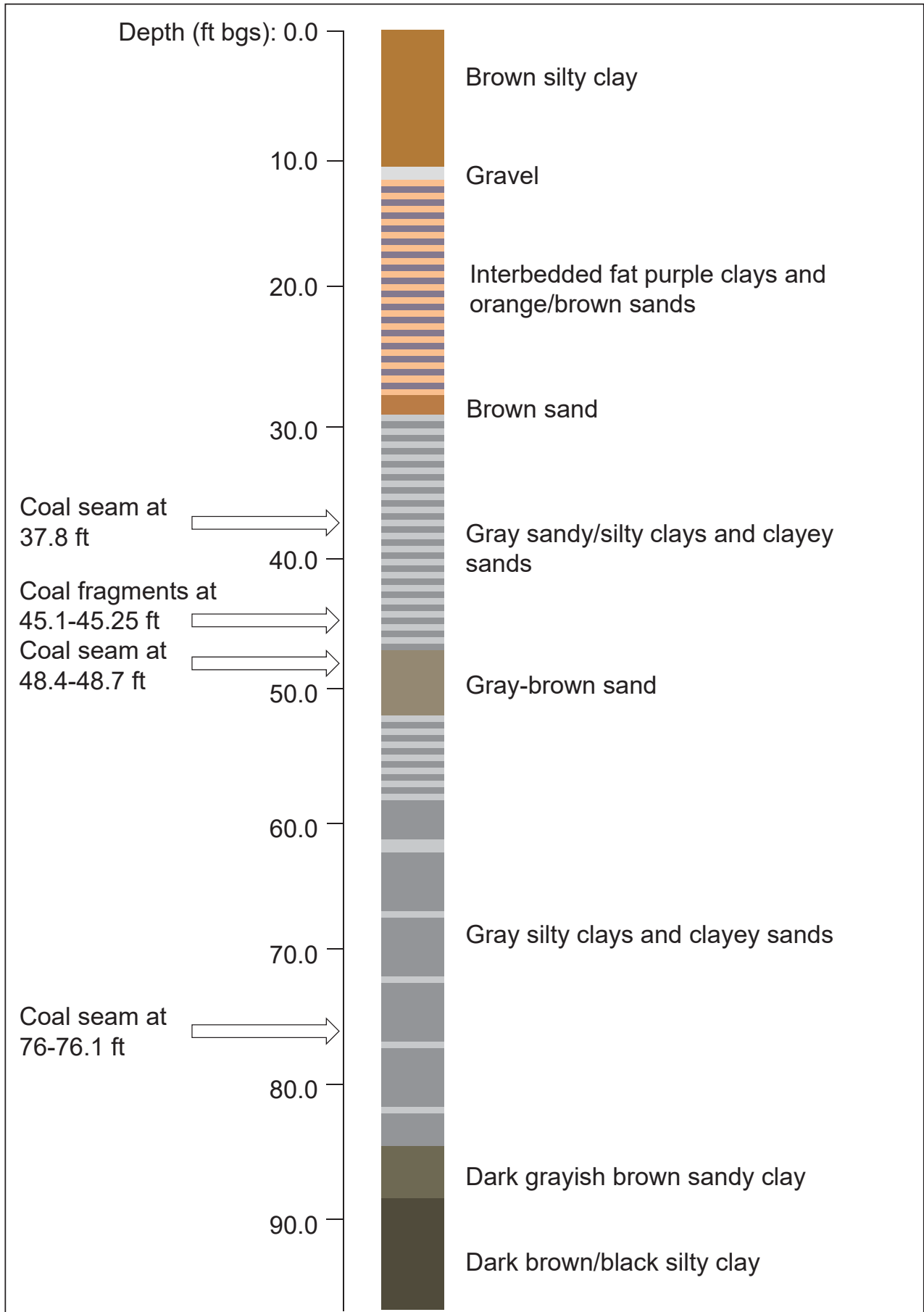
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec
consultants

Figure
3

Columbus, Ohio

2020/03/20



- 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

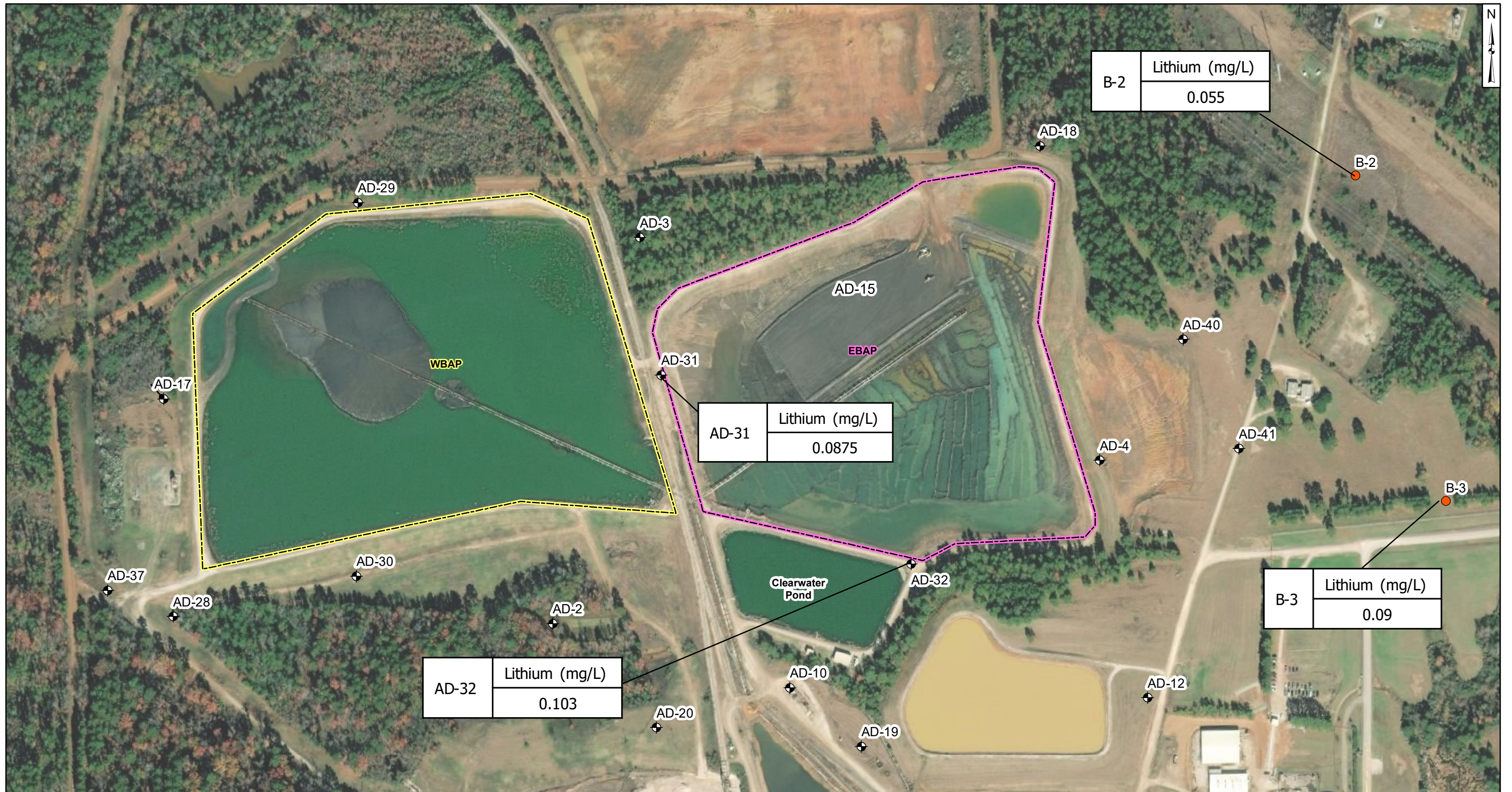
Geosyntec
consultants

Figure

4

CHA8495

March 2020



Legend

- Borehole
- ◆ Monitoring Well

Location Boundaries

- ▭ EBAP
- ▭ WBAP

Notes

- Lithium concentrations in micrograms per liter ug/L
- Monitoring well coordinates, site features, and data provided by AEP.
- Groundwater samples collected August 2019.



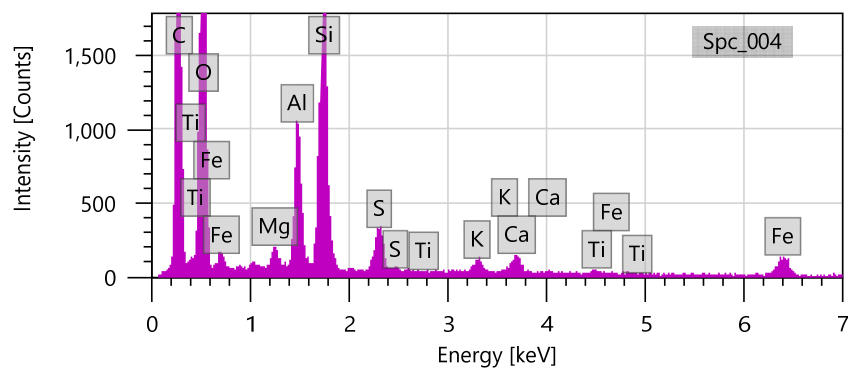
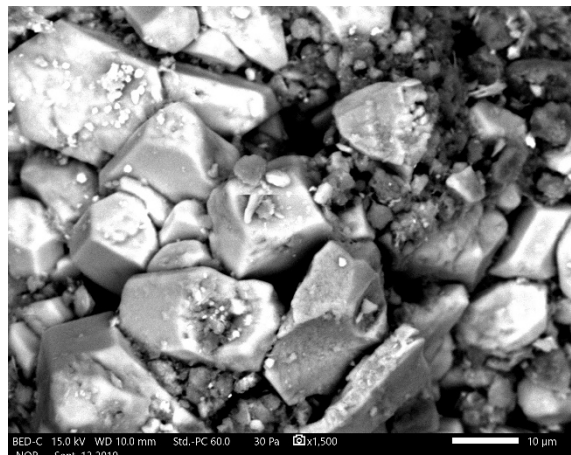
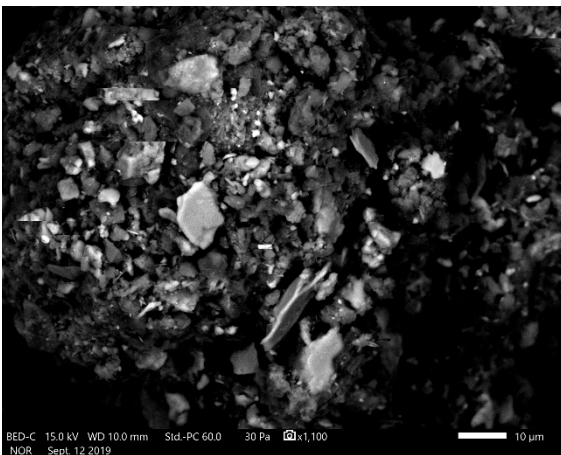
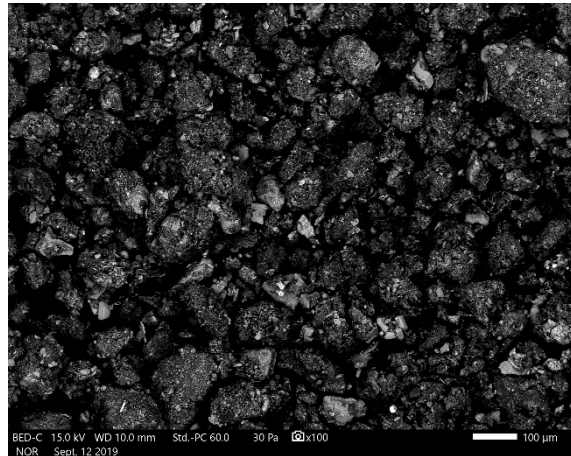
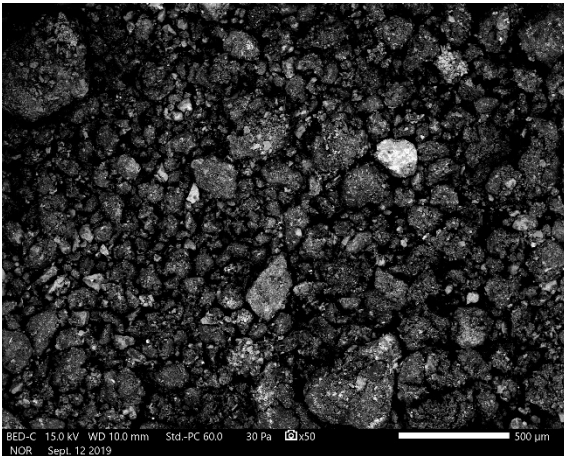
Lithium Distribution in Groundwater	
AEP Pirkey Power Plant Hallsville, Texas	
Geosyntec consultants	
Columbus, Ohio	2020/03/20
Figure 5	

ATTACHMENT A
SEM/EDS Analysis

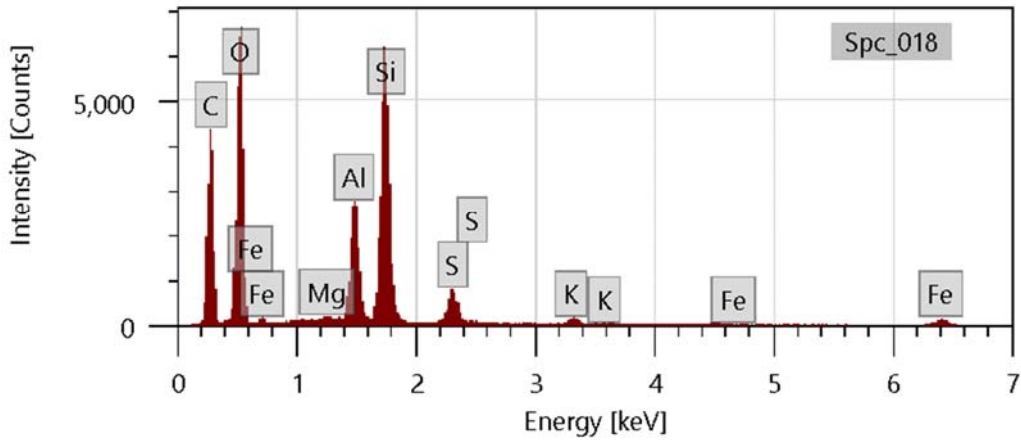
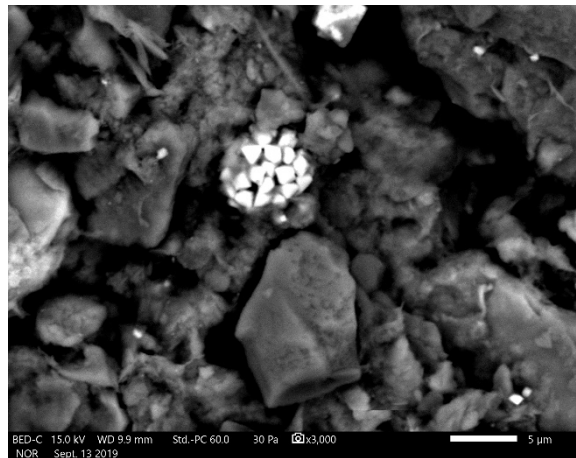
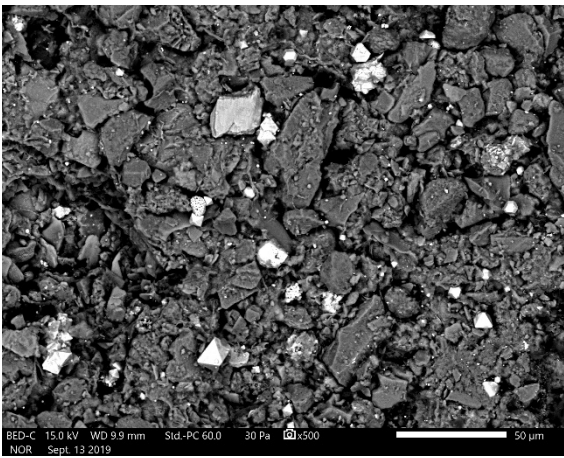
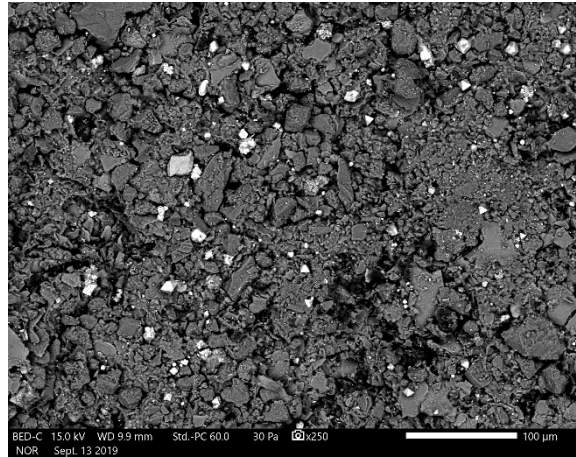
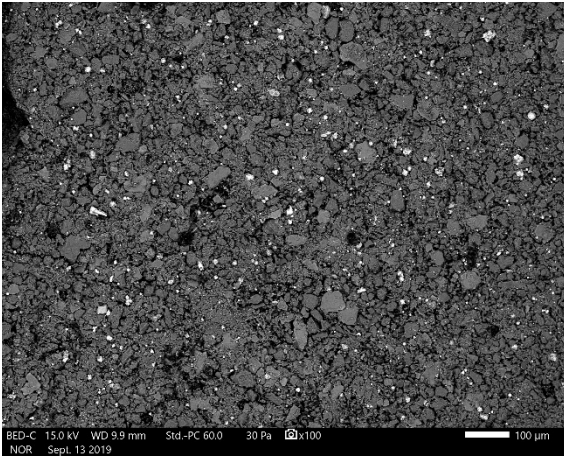
September 16, 2019

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

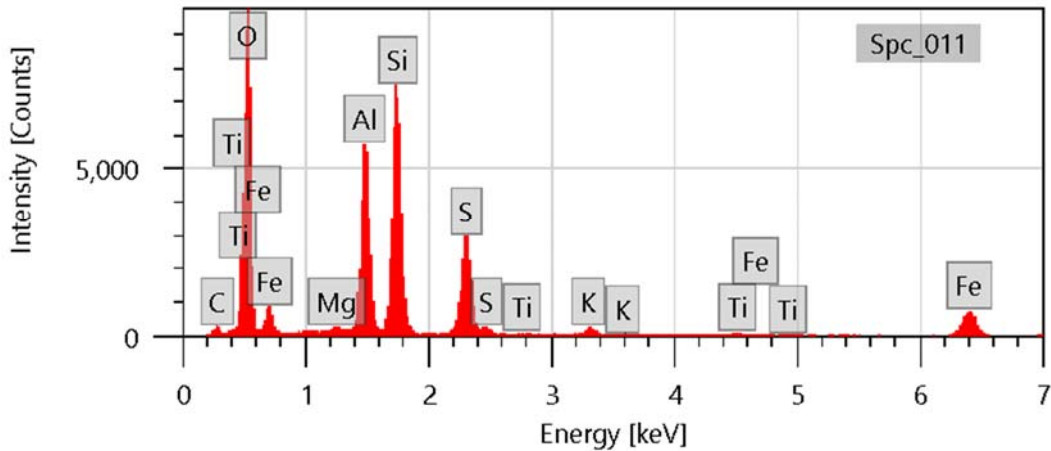
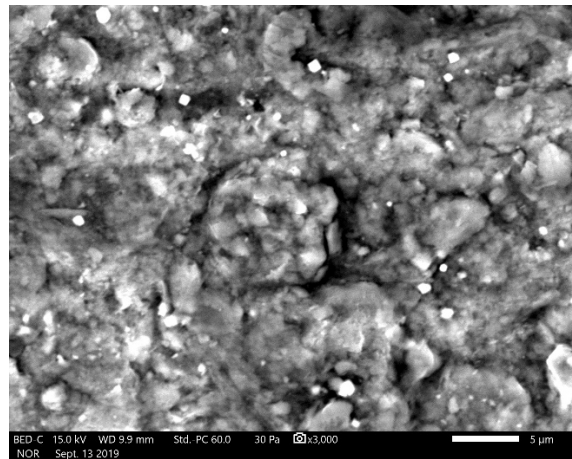
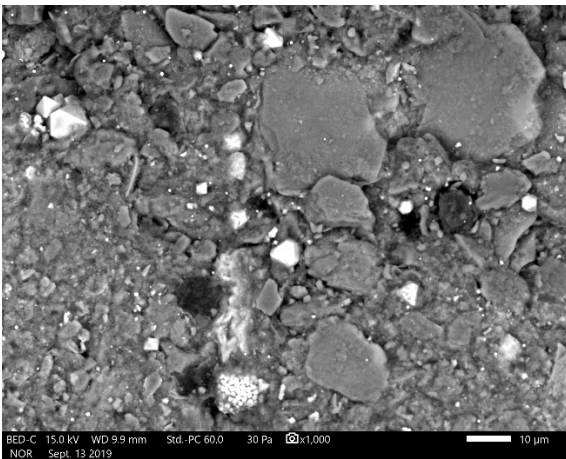
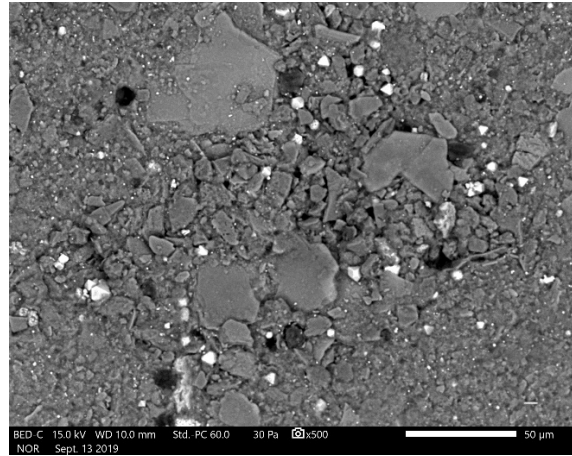
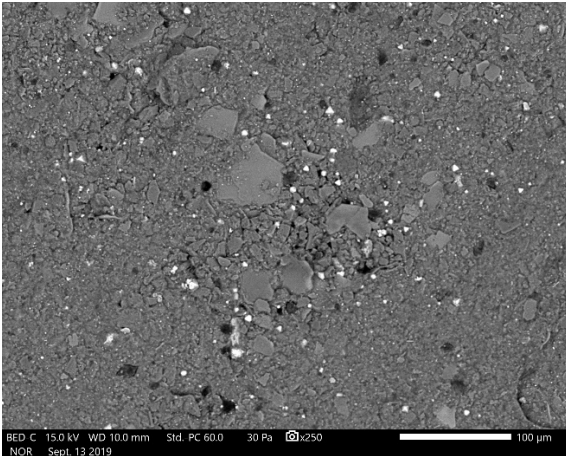
via Email: BSass@geosyntec.com



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



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



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

ATTACHMENT B

Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

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

Beth Ann Gross

Printed Name of Licensed Professional Engineer

Beth Ann Gross

Signature



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

Texas Registered Engineering Firm
No. F-1182

79864
License Number

Texas
Licensing State

4/2/2020
Date