Annual Groundwater Monitoring Report

Southwestern Electric Power Company

H. W. Pirkey Power Plant

East Bottom Ash Pond CCR Management Unit

Hallsville, Texas

January 2021

Prepared by:
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SOUTHWESTERN ELECTRIC POWER COMPANY℠

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I. Summary

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2021.

In general, the following activities were completed:

- Groundwater samples were collected for AD-2, AD-4, AD-12, AD-18, AD-31, and AD-32 in March, June, and November 2020 and analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in Assessment monitoring at the beginning and end of 2020;
- Statistical analysis report dated January 3, 2020 was included in last year's Annual Groundwater Monitoring Report. The following Appendix IV parameters exceeded established groundwater protection standards:
    - Lithium at AD-31 and AD-32
    - Cobalt at AD-2 and AD-32

  The following Appendix III parameters exceeded background:
    - Boron at AD-2 and AD-32
    - Calcium at AD-2, AD-31, and AD-32
    - Chloride at AD-2, AD-31 and AD-32
    - Sulfate at AD-2, AD-31, and AD-32
    - TDS concentrations at AD-2, AD-31, and AD-32
- An alternate source demonstration for the constituents above was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 2, 2020.
- Statistical analysis report dated October 2, 2020 is included in **Appendix II**. The following Appendix IV parameters exceeded established groundwater protection standards:
    - Lithium at AD-31 and AD-32
    - Cobalt at AD-2, AD-31, and AD-32

- Mercury at AD-32

The following Appendix III parameters exceeded background:

- Boron at AD-2 and AD-32
- Calcium at AD-32
- Chloride at AD-2, AD-31, and AD-32
- Sulfate at AD-2, AD-31, and AD-32
- TDS concentrations at AD-2, AD-31, and AD-32

- An alternate source demonstration for the constituents above was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on December 31, 2020.
- The November 2020 data are still undergoing statistical analysis
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

The major components of this annual report, to the extent applicable at this time, are presented in sections that follow:

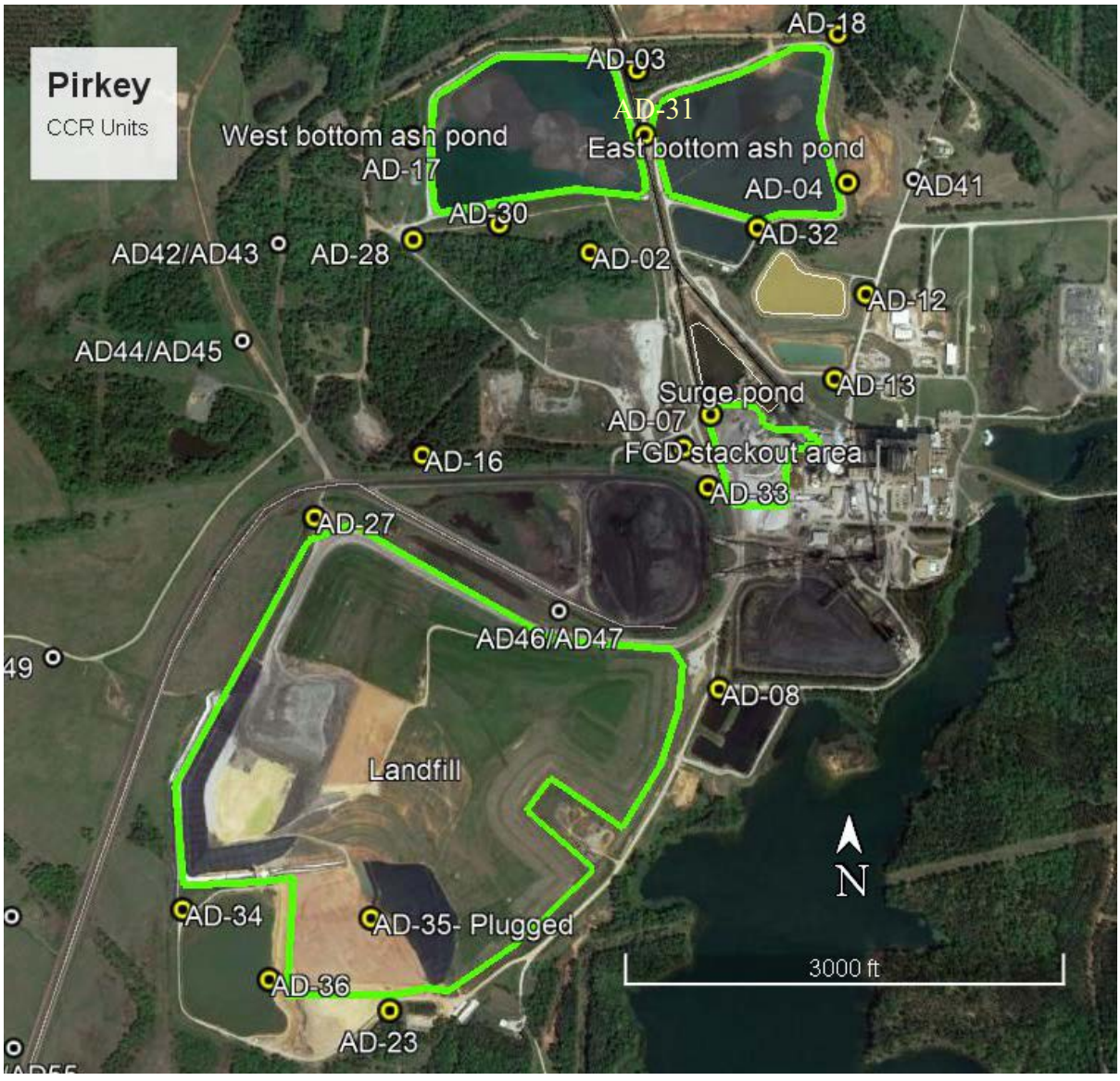
- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected per monitoring well, the dates the samples were collected and whether the sample was collected as part of detection monitoring or assessment monitoring programs is included in **Appendix I**;
- A summary of any transition between monitoring programs or an alternate monitoring frequency, for example the date and circumstances for transitioning from detection monitoring to assessment monitoring, in addition to identifying the constituents detected at a statistically significant increase over background concentrations.
- Other information required to be included in the annual report such as alternate source demonstration or assessment of corrective measures, if applicable.

In addition, this report summarizes key actions completed, and where applicable, describes any problems encountered and actions taken to resolve those problems. The report includes a projection of key activities for the upcoming year.

II. Groundwater Monitoring Well Locations and Identification Numbers

The figure that follows depicts the PE-certified groundwater monitoring network, the monitoring well locations and their corresponding identification numbers.

East BAP Monitoring Wells	
Up Gradient	Down Gradient
AD-4	AD-2
AD-12	AD-31
AD-18	AD-32



III. Monitoring Wells Installed or Decommissioned

One monitoring well (AD-7R) was installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry. The well installation reports can be found in **Appendix IV**.

IV. Groundwater Quality Data and Static Water Elevation Data, With Flow Rate and Direction and Discussion

Appendix I contains tables showing the groundwater quality. Static water elevation data from each monitoring event are presented in **Appendix I**, along with the groundwater velocity, groundwater flow direction and potentiometric maps developed after each sampling event.

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a March sampling event was conducted in accordance with 40 CFR 257.95(b). Two sampling events in June and November were conducted in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2021.

V. Statistical Evaluation of 2020 Events

Statistical analysis report dated January 3, 2020 was included in last year's Annual Groundwater Monitoring Report. The following Appendix IV parameters exceeded established groundwater protection standards:

- Lithium at AD-31 and AD-32
- Cobalt at AD-2 and AD-32

The following Appendix III parameters exceeded background:

- Boron at AD-2 and AD-32
- Calcium at AD-2, AD-31, and AD-32
- Chloride at AD-2, AD-31 and AD-32
- Sulfate at AD-2, AD-31, and AD-32
- TDS concentrations at AD-2, AD-31, and AD-32

Statistical analysis report dated October 2, 2020 is included in **Appendix II**. The following Appendix IV parameters exceeded established groundwater protection standards:

- Lithium at AD-31 and AD-32
- Cobalt at AD-2, AD-31, and AD-32
- Mercury at AD-32

The following Appendix III parameters exceeded background:

- Boron at AD-2 and AD-32
- Calcium at AD-32
- Chloride at AD-2, AD-31, and AD-32
- Sulfate at AD-2, AD-31, and AD-32
- TDS concentrations at AD-2, AD-31, and AD-32

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the east bottom ash pond SSLs above GWPSs.

SSLs above the GWPS were determined for cobalt and for lithium on January 3, 2020. An alternate source demonstration for the constituents above was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on April 2, 2020.

SSLs above the GWPS were determined for lithium, cobalt, and mercury on October 2, 2020. An alternate source demonstration for the constituents above was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on December 31, 2020.

The supporting information are found in **Appendix III**.

VII. Discussion About Transition Between Monitoring Requirements or Alternate Monitoring Frequency

Assessment monitoring will continue in 2021.

Regarding defining an alternate monitoring frequency, no modification to monitoring requirements is needed.

VIII. Other Information Required

On November 30, 2020, Pirkey Power Plant submitted a site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler by a date certain to US EPA. Pirkey Power Plant requested to allow the EBAP to continue to receive CCR and non-CR wastestreams after April 11, 2021.

Pirkey received TCEQ approval to extend the receipt of CCR waste and initiate closure activities April 11, 2021. Further extension can be obtained pending a successful demonstration to EPA under 40 CFR 257.103(f).

IX. Description of Any Problems Encountered in 2020 and Actions Taken

No problems were encountered this year.

X. A Projection of Key Activities for the Upcoming Year

Key activities for next year include:

- Assessment monitoring sampling will be conducted;
- Evaluation of the assessment monitoring results from a statistical analysis viewpoint, looking for any SSLs above GWPS;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the next annual groundwater report.

APPENDIX I

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

Table 1 - Groundwater Data Summary: AD-2
Pirkey - EBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	1.27	1.43	28	< 0.083 U	4.4	68	238
7/14/2016	Background	1.34	1.38	28	< 0.083 U	4.2	71	216
9/7/2016	Background	1.3	2.65	20	< 0.083 U	4.2	49	216
10/13/2016	Background	1.48	1.29	31	< 0.083 U	3.6	67	230
11/14/2016	Background	1.36	1.44	28	< 0.083 U	3.9	72	240
1/12/2017	Background	1.48	1.6	30	< 0.083 U	3.9	94	244
3/1/2017	Background	1.62	1.28	28	< 0.083 U	4.1	80	262
4/11/2017	Background	1.65	1.71	50	< 0.083 U	4.0	88	254
8/24/2017	Detection	1.46	2.06	24	< 0.083 U	4.3	64	200
12/21/2017	Detection	1.38	2.92	24	< 0.083 U	--	64	206
3/22/2018	Assessment	1.99	1.97	30	< 0.083 U	4.2	105	220
8/21/2018	Assessment	2.14	1.65	46	< 0.083 U	4.7	130	312
2/28/2019	Assessment	2.25	1.96	31.8	0.1 J	3.5	129	384
5/22/2019	Assessment	2.17	2.19	29.6	0.1 J	4.0	137	316
8/12/2019	Assessment	2.16	3.30	28.4	0.1 J	4.6	128	306
3/11/2020	Assessment	2.78	2.50	29.7	0.14	4.0	178	374
6/3/2020	Assessment	2.44	2.44	29.3	0.15	4.6	174	387
11/2/2020	Assessment	2.62	1.99	29.2	0.11	3.9	158	347

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-2
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	< 1.05 U	38	0.514594 J	< 0.07 U	< 0.23 U	10	1.446	< 0.083 U	< 0.68 U	< 0.00013 U	0.098	< 0.29 U	2.08256 J	< 0.86 U
7/14/2016	Background	< 0.93 U	< 1.05 U	38	0.46511 J	< 0.07 U	0.401928 J	11	0.723	< 0.083 U	< 0.68 U	0.051	0.068	0.862706 J	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	39	0.439699 J	< 0.07 U	0.493592 J	10	1.489	< 0.083 U	< 0.68 U	0.048	0.675	< 0.29 U	< 0.99 U	1.26444 J
10/13/2016	Background	< 0.93 U	< 1.05 U	39	0.40165 J	< 0.07 U	0.885421 J	11	2.65	< 0.083 U	< 0.68 U	0.052	0.048	< 0.29 U	1.3807 J	< 0.86 U
11/14/2016	Background	< 0.93 U	< 1.05 U	34	0.367353 J	< 0.07 U	< 0.23 U	10	2.121	< 0.083 U	< 0.68 U	0.048	0.154	< 0.29 U	1.23147 J	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	37	0.376129 J	< 0.07 U	< 0.23 U	10	1.656	< 0.083 U	< 0.68 U	0.052	0.093	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	37	0.413652 J	< 0.07 U	< 0.23 U	10	1.267	< 0.083 U	< 0.68 U	0.051	0.037	< 0.29 U	< 0.99 U	< 0.86 U
4/11/2017	Background	< 0.93 U	< 1.05 U	37	0.435396 J	< 0.07 U	0.243798 J	11	0.807	< 0.083 U	< 0.68 U	0.052	0.028	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	33.28	0.45 J	< 0.07 U	< 0.23 U	12.43	1.053	< 0.083 U	< 0.68 U	0.05379	0.042	< 0.29 U	1.61 J	< 0.86 U
8/21/2018	Assessment	< 0.01 U	0.52	29.0	0.428	0.06	0.406	13.6	1.059	< 0.083 U	0.338	0.0479	0.02 J	0.06 J	1.1	0.096
2/28/2019	Assessment	0.02 J	0.53	26.1	0.5 J	0.06	0.1 J	13.9	1.261	0.1 J	0.355	0.0591	0.027	< 0.4 U	1.5	< 0.1 U
5/22/2019	Assessment	< 0.4 U	< 0.6 U	25.6	< 0.4 U	< 0.2 U	< 0.8 U	15.5	0.832	0.1 J	< 0.4 U	0.0542	0.063	< 8 U	0.9 J	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.35	22.8	0.402	0.06	0.292	13.0	1.812	0.1 J	0.288	0.0560	0.044	< 0.4 U	0.8	0.1 J
3/11/2020	Assessment	< 0.02 U	0.52	21.9	0.499	0.08	0.247	17.7	0.1882	0.14	0.600	0.0476	0.056	4.37	1.5	0.1 J
6/3/2020	Assessment	< 0.02 U	0.45	19.7	0.474	0.07	0.243	16.5	1.412	0.15	0.389	0.0464	0.085	< 0.4 U	1.5	0.1 J
11/2/2020	Assessment	< 0.02 U	0.41	21.5	0.463	0.07	0.254	16.9	0.961	0.11	0.435	0.0490	0.037	< 0.4 U	1.3	0.1 J

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-4
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.02	1.63	4	< 0.083 U	5.4	23	148
7/14/2016	Background	0.02	2.32	4	< 0.083 U	4.9	20	157
9/8/2016	Background	0.02	2.37	5	< 0.083 U	4.9	20	136
10/13/2016	Background	0.03	2.87	6	< 0.083 U	4.1	19	164
11/15/2016	Background	0.04	2.71	5	< 0.083 U	4.3	19	152
1/12/2017	Background	0.03	2.94	5	< 0.083 U	4.8	18	148
3/1/2017	Background	0.03	2.86	4	< 0.083 U	4.7	18	148
4/10/2017	Background	0.04	1.91	5	< 0.083 U	4.4	21	140
8/24/2017	Detection	0.06229	2.04	5	< 0.083 U	4.6	20	94
3/22/2018	Assessment	0.0331	1.41	3	< 0.083 U	4.8	23	132
8/21/2018	Assessment	0.018	2.38	7	< 0.083 U	4.8	21	158
2/28/2019	Assessment	0.021	1.57	3.56	0.11	4.9	22.9	192
5/23/2019	Assessment	0.021	1.71	3.31	0.15	5.0	24.6	150
8/14/2019	Assessment	< 0.02 U	1.97	6.22	0.12	5.5	21.7	146
3/11/2020	Assessment	< 0.02 U	1.46	3.42	0.13	5.4	24.2	166
6/3/2020	Assessment	0.02 J	1.72	3.65	0.14	5.4	24.7	168
11/4/2020	Assessment	0.02 J	2.33	3.66	0.05 J	4.9	18.7	162

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-4
Pirkey - EBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	3.95918 J	75	1	0.133362 J	0.396808 J	8	0.729	< 0.083 U	< 0.68 U	0.013	0.00891 J	< 0.29 U	1.79183 J	< 0.86 U
7/14/2016	Background	< 0.93 U	8	127	1	< 0.07 U	3	9	4.271	< 0.083 U	< 0.68 U	0.041	0.037	< 0.29 U	1.73546 J	1.87362 J
9/8/2016	Background	< 0.93 U	5	123	1	0.111076 J	2	8	0.193	< 0.083 U	< 0.68 U	0.04	0.01151 J	< 0.29 U	< 0.99 U	< 0.86 U
10/13/2016	Background	< 0.93 U	11	183	0.830588 J	< 0.07 U	7	7	2.381	< 0.083 U	< 0.68 U	0.034	0.01005 J	< 0.29 U	1.60451 J	0.868603 J
11/15/2016	Background	< 0.93 U	< 1.05 U	114	0.53145 J	< 0.07 U	0.446412 J	6	1.072	< 0.083 U	< 0.68 U	0.035	0.01268 J	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	149	0.406228 J	< 0.07 U	0.305795 J	4.5062 J	2.599	< 0.083 U	< 0.68 U	0.03	0.01146 J	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	131	0.354085 J	< 0.07 U	< 0.23 U	4.45689 J	1.089	< 0.083 U	< 0.68 U	0.033	0.01224 J	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	94	0.915299 J	0.0796 J	0.240917 J	8	0.684	< 0.083 U	< 0.68 U	0.047	0.00554 J	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	66.74	1.15	0.26 J	< 0.23 U	9.39	1.283	< 0.083 U	< 0.68 U	0.05374	< 0.005 U	< 0.29 U	1.99 J	< 0.86 U
8/21/2018	Assessment	< 0.01 U	1.30	121	0.400	0.02 J	0.198	4.43	1.331	< 0.083 U	0.098	0.0294	0.005 J	< 0.02 U	0.04 J	0.096
2/28/2019	Assessment	< 0.02 U	0.26	70.5	0.9 J	0.01 J	0.1 J	6.92	0.818	0.11	0.106	0.0513	< 0.005 U	< 0.4 U	0.03 J	< 0.1 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	61.7	0.5 J	< 0.2 U	1 J	7.86	0.5173	0.15	< 0.4 U	0.0516	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U
8/14/2019	Assessment	< 0.02 U	0.17	73.5	1.04	< 0.01 U	0.08 J	6.52	0.833	0.12	0.06 J	0.0484	< 0.005 U	< 0.4 U	0.04 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	1.16	69.0	0.965	< 0.01 U	0.1 J	7.89	0.2327	0.13	0.06 J	0.0415	< 0.002 U	< 0.4 U	< 0.03 U	< 0.1 U
6/3/2020	Assessment	< 0.02 U	0.52	67.9	0.527	< 0.01 U	0.2 J	7.15	0.87	0.14	0.06 J	0.0380	< 0.002 U	< 0.4 U	< 0.03 U	< 0.1 U
11/4/2020	Assessment	0.03 J	5.30	124	0.922	0.03 J	0.433	4.40	1.45	0.05 J	0.402	0.0274	0.008	< 0.4 U	0.1 J	0.1 J

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-12
Pirkey - EBAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.03	0.362	5	< 0.083 U	4.4	4	94
7/13/2016	Background	0.03	0.26	6	< 0.083 U	3.1	4	75
9/7/2016	Background	0.04	0.343	6	< 0.083 U	3.9	7	63
10/12/2016	Background	0.03	0.271	7	1	3.4	8	92
11/14/2016	Background	0.04	0.331	8	< 0.083 U	2.6	6	80
1/11/2017	Background	0.03	0.315	7	< 0.083 U	4.8	6	76
2/28/2017	Background	0.04	0.434	5	< 0.083 U	3.6	4	50
4/11/2017	Background	0.05	0.299	6	0.2565 J	4.7	7	72
8/23/2017	Detection	0.0495	0.245	6	0.213 J	4.8	6	52
3/21/2018	Assessment	0.01397	0.269	5	< 0.083 U	4.2	3	< 2 U
8/20/2018	Assessment	0.017	0.338	10	< 0.083 U	4.4	4	94
2/27/2019	Assessment	0.03 J	0.4 J	6.08	0.09	5.2	3.6	36
5/21/2019	Assessment	0.020	0.3 J	6.30	0.09	4.1	4.0	80
8/12/2019	Assessment	< 0.02 U	0.278	7.24	0.06 J	4.9	2.6	90
3/10/2020	Assessment	0.02 J	0.3 J	6.08	0.10	4.9	3.7	62
6/2/2020	Assessment	< 0.02 U	0.2 J	5.63	0.10	4.0	3.9	91
11/2/2020	Assessment	0.03 J	0.3 J	4.65	0.08	4.3	3.3	74

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-12
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	< 1.05 U	26	0.219521 J	< 0.07 U	0.710981 J	1.58207 J	0.2073	< 0.083 U	< 0.68 U	< 0.00013 U	< 0.005 U	< 0.29 U	1.73953 J	< 0.86 U
7/13/2016	Background	< 0.93 U	< 1.05 U	23	0.190337 J	< 0.07 U	0.68835 J	1.29444 J	2.909	< 0.083 U	< 0.68 U	0.008	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
9/7/2016	Background	< 0.93 U	< 1.05 U	30	0.232192 J	< 0.07 U	0.353544 J	1.66591 J	0.881	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
10/12/2016	Background	< 0.93 U	< 1.05 U	27	0.149553 J	< 0.07 U	0.529033 J	1.56632 J	0.257	1	< 0.68 U	0.012	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
11/14/2016	Background	< 0.93 U	< 1.05 U	28	0.152375 J	< 0.07 U	0.32826 J	1.47282 J	0.767	< 0.083 U	< 0.68 U	0.013	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
1/11/2017	Background	< 0.93 U	< 1.05 U	23	0.126621 J	< 0.07 U	0.650158 J	1.09495 J	1.536	< 0.083 U	< 0.68 U	0.01	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
2/28/2017	Background	< 0.93 U	< 1.05 U	26	0.149219 J	< 0.07 U	0.325811 J	1.29984 J	0.416	< 0.083 U	< 0.68 U	0.009	< 0.005 U	< 0.29 U	< 0.99 U	0.994913 J
4/11/2017	Background	< 0.93 U	< 1.05 U	24	0.159412 J	< 0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	< 0.68 U	0.008	0.01364 J	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	< 1.05 U	25.82	0.16 J	< 0.07 U	1.05	1.49 J	0.784	< 0.083 U	< 0.68 U	0.00722	< 0.005 U	< 0.29 U	< 0.99 U	< 0.86 U
8/20/2018	Assessment	< 0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	< 0.083 U	0.089	0.0143	< 0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	< 0.4 U	< 0.6 U	22.5	< 0.4 U	< 0.2 U	< 0.8 U	1.37	0.225	0.09	< 0.4 U	0.00688	< 0.005 U	< 8 U	< 0.6 U	< 2 U
5/21/2019	Assessment	< 0.4 U	< 0.6 U	21.7	< 0.4 U	< 0.2 U	< 0.8 U	1.15	0.201	0.09	< 0.4 U	0.00576	< 0.005 U	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.07 J	23.8	0.154	< 0.01 U	0.204	1.30	0.237	0.06 J	0.08 J	0.00829	< 0.005 U	< 0.4 U	0.2 J	< 0.1 U
3/10/2020	Assessment	< 0.02 U	0.09 J	21.7	0.139	0.01 J	0.2 J	1.21	3.0706	0.10	0.09 J	0.00547	< 0.002 U	< 0.4 U	0.2	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.09 J	19.0	0.132	< 0.01 U	0.208	1.02	0.799	0.10	0.09 J	0.00505	< 0.002 U	< 0.4 U	0.3	< 0.1 U
11/2/2020	Assessment	0.05 J	0.09 J	18.9	0.122	< 0.01 U	0.204	1.04	0.929	0.08	0.09 J	0.00510	< 0.002 U	< 0.4 U	0.3	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-18
Pirkey - EBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/10/2016	Background	0.01	0.548	8	< 0.083 U	4.5	7	108
7/14/2016	Background	0.01	0.409	8	< 0.083 U	4.7	7	116
9/8/2016	Background	0.01	0.343	8	< 0.083 U	4.7	8	110
10/13/2016	Background	0.02	0.56	7	< 0.083 U	4.1	10	124
11/15/2016	Background	0.02	0.59	7	< 0.083 U	4.4	7	134
1/12/2017	Background	0.01	0.415	7	< 0.083 U	4.7	10	128
3/1/2017	Background	0.01	0.224	6	< 0.083 U	4.1	7	108
4/10/2017	Background	0.01	0.304	7	< 0.083 U	4.1	8	102
8/24/2017	Detection	0.0278	0.435	8	< 0.083 U	4.9	8	68
3/22/2018	Assessment	0.01642	0.292	6	< 0.083 U	5.4	6	100
8/21/2018	Assessment	0.012	0.321	10	< 0.083 U	5.1	8	118
2/28/2019	Assessment	< 0.02 U	0.490	8.19	0.02 J	5.0	6.1	84
5/23/2019	Assessment	0.013	0.684	8.82	0.02 J	5.2	10.6	104
8/13/2019	Assessment	< 0.02 U	0.647	8.49	0.01 J	5.2	6.6	90
3/11/2020	Assessment	< 0.02 U	0.3 J	7.34	0.02 J	4.4	6.1	90 J
6/3/2020	Assessment	< 0.02 U	0.2 J	8.30	0.03 J	4.5	6.3	119
11/4/2020	Assessment	< 0.02 U	0.2 J	6.30	0.02 J	4.4	6.3	100

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-18
Pirkey - EBAP
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/10/2016	Background	< 0.93 U	< 1.05 U	157	0.262755 J	0.109247 J	1	1.82932 J	0.847	< 0.083 U	< 0.68 U	0.004	0.01536 J	< 0.29 U	1.71074 J	< 0.86 U
7/14/2016	Background	< 0.93 U	3.77261 J	139	0.243326 J	< 0.07 U	3	2.16037 J	3.264	< 0.083 U	< 0.68 U	0.02	0.064	0.41347 J	2.45009 J	< 0.86 U
9/8/2016	Background	< 0.93 U	< 1.05 U	115	0.226343 J	< 0.07 U	0.779959 J	1.09947 J	1.105	< 0.083 U	< 0.68 U	0.019	0.03	< 0.29 U	< 0.99 U	< 0.86 U
10/13/2016	Background	< 0.93 U	< 1.05 U	112	0.192611 J	< 0.07 U	0.631027 J	2.24885 J	1.161	< 0.083 U	< 0.68 U	0.026	0.01416 J	< 0.29 U	< 0.99 U	< 0.86 U
11/15/2016	Background	< 0.93 U	< 1.05 U	94	0.107171 J	< 0.07 U	0.724569 J	1.66054 J	1.486	< 0.083 U	< 0.68 U	0.017	0.029	< 0.29 U	< 0.99 U	< 0.86 U
1/12/2017	Background	< 0.93 U	< 1.05 U	99	0.169196 J	< 0.07 U	0.411433 J	1.62881 J	0.976	< 0.083 U	< 0.68 U	0.026	0.01887 J	< 0.29 U	< 0.99 U	< 0.86 U
3/1/2017	Background	< 0.93 U	< 1.05 U	99	0.105337 J	< 0.07 U	0.572874 J	0.976724 J	0.468	< 0.083 U	< 0.68 U	0.017	0.01086 J	< 0.29 U	< 0.99 U	< 0.86 U
4/10/2017	Background	< 0.93 U	< 1.05 U	105	0.130316 J	< 0.07 U	0.967681 J	0.98157 J	0.648	< 0.083 U	< 0.68 U	0.019	0.0096 J	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	< 1.05 U	97.75	0.09 J	< 0.07 U	< 0.23 U	0.97 J	0.942	< 0.083 U	< 0.68 U	0.01647	0.006 J	< 0.29 U	1.53 J	< 0.86 U
8/21/2018	Assessment	0.02 J	1.01	99.8	0.129	0.02 J	0.809	1.18	1.108	< 0.083 U	0.280	0.0175	0.014 J	0.08 J	0.2	0.060
2/28/2019	Assessment	< 0.4 U	< 0.6 U	106	< 0.4 U	< 0.2 U	< 0.8 U	1.11	0.615	0.02 J	0.7 J	0.0177	0.009 J	< 8 U	< 0.6 U	< 2 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	131	< 0.4 U	< 0.2 U	< 0.8 U	1.47	0.492	0.02 J	< 0.4 U	0.0209	0.009 J	< 8 U	< 0.6 U	< 0.1 U
8/13/2019	Assessment	< 0.02 U	0.45	100	0.118	0.02 J	0.212	1.25	0.473	0.01 J	0.2 J	0.0183	0.023 J	< 0.4 U	0.09 J	< 0.1 U
3/11/2020	Assessment	< 0.02 U	0.09 J	97.1	0.09 J	0.01 J	0.1 J	0.948	4.813	0.02 J	< 0.05 U	0.0134	0.003 J	< 0.4 U	0.05 J	< 0.1 U
6/3/2020	Assessment	< 0.02 U	0.22	100	0.1 J	0.01 J	0.2 J	0.950	0.728	0.03 J	0.06 J	0.0132	0.007	< 0.4 U	0.09 J	< 0.1 U
11/4/2020	Assessment	< 0.02 U	0.29	89.3	0.08 J	0.01 J	0.1 J	0.917	1.169	0.02 J	0.06 J	0.0128	0.028	< 0.4 U	0.2 J	< 0.1 U

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-31
Pirkey - EBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.08	10.4	18	< 0.083 U	4.5	63	286
7/13/2016	Background	0.03	4.27	18	< 0.083 U	3.5	66	245
9/7/2016	Background	0.03	3.47	18	< 0.083 U	3.7	60	260
10/12/2016	Background	0.04	4.41	18	< 0.083 U	4.0	62	276
11/14/2016	Background	0.04	4.7	18	< 0.083 U	3.2	66	266
1/11/2017	Background	0.03	4.43	19	< 0.083 U	4.4	79	252
2/28/2017	Background	0.04	3.89	14	< 0.083 U	3.6	68	212
4/11/2017	Background	0.04	3.64	16	< 0.083 U	3.6	69	252
8/23/2017	Detection	0.01752	2.24	18	< 0.083 U	4.5	52	228
12/21/2017	Detection	--	--	20	< 0.083 U	--	58	224
3/22/2018	Assessment	0.04078	3.11	16	< 0.083 U	4.5	76	260
8/21/2018	Assessment	0.022	2.86	25	< 0.083 U	4.9	72	274
2/28/2019	Assessment	0.03 J	2.77	18.8	0.1 J	5.0	74.8	74
5/23/2019	Assessment	0.021	3.29	18.7	0.13	5.1	79.9	240
8/12/2019	Assessment	< 0.02 U	2.86	21.6	0.16	4.1	70.0	250
3/10/2020	Assessment	0.03 J	2.80	21.7	0.14	3.5	74.6	246
6/2/2020	Assessment	0.02 J	2.92	22.1	0.16	4.2	81.4	288
11/2/2020	Assessment	0.03 J	2.76	21.2	0.13	3.7	77.8	268

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-31
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	93	712	10	0.858875 J	212	50	7.32	< 0.083 U	57	0.077	1.797	0.893978 J	1.84045 J	< 0.86 U
7/13/2016	Background	< 0.93 U	3.41559 J	69	1	< 0.07 U	10	11	3.38	< 0.083 U	< 0.68 U	0.096	0.32	0.316083 J	1.11301 J	< 0.86 U
9/7/2016	Background	< 0.93 U	4.34007 J	88	2	< 0.07 U	15	11	2.345	< 0.083 U	< 0.68 U	0.094	0.284	< 0.29 U	< 0.99 U	< 0.86 U
10/12/2016	Background	< 0.93 U	6	76	1	< 0.07 U	14	11	3.88	< 0.083 U	1.54023 J	0.097	0.347	< 0.29 U	< 0.99 U	< 0.86 U
11/14/2016	Background	< 0.93 U	11	125	2	0.174662 J	30	14	3.202	< 0.083 U	3.93298 J	0.096	0.523	0.401556 J	1.03392 J	< 0.86 U
1/11/2017	Background	< 0.93 U	3.92088 J	77	1	< 0.07 U	12	10	2.725	< 0.083 U	< 0.68 U	0.093	0.384	< 0.29 U	< 0.99 U	1.01921 J
2/28/2017	Background	< 0.93 U	< 1.05 U	44	0.998308 J	< 0.07 U	3	9	2.684	< 0.083 U	< 0.68 U	0.09	0.138	< 0.29 U	< 0.99 U	< 0.86 U
4/11/2017	Background	< 0.93 U	3.31744 J	73	1	0.0944 J	12	11	3.521	< 0.083 U	< 0.68 U	0.097	0.333	< 0.29 U	< 0.99 U	< 0.86 U
3/22/2018	Assessment	< 0.93 U	3.32 J	70.83	1.24	0.12 J	9.62	11.12	2.955	< 0.083 U	< 0.68 U	0.09732	1.389	< 0.29 U	1.98 J	< 0.86 U
8/21/2018	Assessment	0.02 J	1.92	57.7	0.729	0.06	2.39	9.29	4.13	< 0.083 U	1.41	0.0556	1.112	0.24	2.5	0.113
2/28/2019	Assessment	< 0.4 U	< 0.6 U	33.1	1 J	< 0.2 U	< 0.8 U	9.38	3.156	0.1 J	< 0.4 U	0.0864	0.01 J	< 8 U	< 0.6 U	< 2 U
5/23/2019	Assessment	< 0.4 U	< 0.6 U	37.9	0.9 J	< 0.2 U	< 0.8 U	10.3	3.4	0.13	< 0.4 U	0.0928	0.057	< 8 U	< 0.6 U	< 0.1 U
8/12/2019	Assessment	< 0.02 U	0.53	35.0	0.850	0.06	0.365	8.69	2.196	0.16	0.325	0.0875	1.027	< 0.4 U	0.4	< 0.1 U
3/10/2020	Assessment	< 0.02 U	0.27	34.8	0.835	0.07	0.357	9.56	3.814	0.14	0.260	0.0669	0.183	< 0.4 U	0.4	< 0.1 U
6/2/2020	Assessment	< 0.02 U	0.21	32.7	0.868	0.06	0.292	9.62	2.656	0.16	0.2 J	0.0682	0.046	< 0.4 U	0.4	< 0.1 U
11/2/2020	Assessment	< 0.02 U	0.26	34.0	1.10	0.07	0.2 J	11.2	3.02	0.13	0.211	0.0895	0.144	< 0.4 U	0.3	0.1 J

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: AD-32
Pirkey - EBAP
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Sulfate	Total Dissolved Solids
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.708	7.41	12	< 0.083 U	4.3	124	206
7/13/2016	Background	5.23	33.9	32	0.67 J	3.3	461	835
9/7/2016	Background	5.78	37.4	35	< 0.083 U	3.1	479	884
10/12/2016	Background	4.26	27.1	29	0.8585 J	3.3	430	720
11/14/2016	Background	5.52	35.9	34	0.7468 J	3.0	621	922
1/11/2017	Background	5.05	40	35	< 0.083 U	3.9	683	894
2/28/2017	Background	2.73	18.4	19	< 0.083 U	3.1	285	490
4/11/2017	Background	1.46	11	15	0.4468 J	3.2	200	372
8/23/2017	Detection	0.716	7.15	14	1.962	4.3	115	288
12/21/2017	Detection	2.56	17.1	22	0.5932 J	--	324	504
3/21/2018	Assessment	0.628	6.32	15	< 0.083 U	4.1	113	288
8/21/2018	Assessment	2.45	17.8	28	< 0.083 U	3.9	321	548
2/28/2019	Assessment	0.679	6.62	17.5	0.40	3.2	121	222
5/21/2019	Assessment	0.555	5.35	18.6	0.31	3.2	105	292
8/16/2019	Assessment	1.92	14.6	26.1	0.83	4.0	273	522
3/10/2020	Assessment	0.656	6.84	20.5	0.39	3.7	117	286
6/2/2020	Assessment	0.557	5.75	24.1	0.41	3.9	93.6	327
11/2/2020	Assessment	4.04	34.3	36.2	1.40	3.4	690	1,070

Notes:
mg/L: milligrams per liter
SU: standard unit
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed

Table 1 - Groundwater Data Summary: AD-32
Pirkey - EBAP
Appendix IV Constituents

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	< 0.93 U	3.77019 J	35	3	0.293016 J	5	27	2.501	< 0.083 U	< 0.68 U	0.016	0.925	< 0.29 U	< 0.99 U	< 0.86 U
7/13/2016	Background	< 0.93 U	13	58	8	0.729634 J	18	74	6.41	0.67 J	< 0.68 U	0.119	13.916	0.76212 J	3.88793 J	< 0.86 U
9/7/2016	Background	< 0.93 U	3.25886 J	35	8	0.601583 J	6	70	4.846	< 0.083 U	< 0.68 U	0.111	1.68	< 0.29 U	< 0.99 U	1.09263 J
10/12/2016	Background	< 0.93 U	10	50	7	0.589066 J	15	65	17.32	0.8585 J	< 0.68 U	0.972	7.285	< 0.29 U	1.93488 J	< 0.86 U
11/14/2016	Background	< 0.93 U	6	37	9	0.78793 J	8	75	3.731	0.7468 J	< 0.68 U	0.114	3.624	< 0.29 U	< 0.99 U	1.078 J
1/11/2017	Background	< 0.93 U	6	37	7	0.602157 J	9	69	4.342	< 0.083 U	< 0.68 U	0.115	7.202	< 0.29 U	< 0.99 U	0.991051 J
2/28/2017	Background	< 0.93 U	4.56273 J	30	5	0.389491 J	5	45	4.001	< 0.083 U	< 0.68 U	0.095	7.927	< 0.29 U	2.53854 J	< 0.86 U
4/11/2017	Background	< 0.93 U	< 1.05 U	26	4	0.440252 J	3	35	4.32	0.4468 J	< 0.68 U	0.095	2.755	< 0.29 U	< 0.99 U	< 0.86 U
3/21/2018	Assessment	< 0.93 U	3.05 J	41.25	3.17	0.55 J	5.38	25.8	4.922	< 0.083 U	< 0.68 U	0.103	6.4	< 0.29 U	2.18 J	< 0.86 U
8/21/2018	Assessment	0.01 J	4.81	17.2	3.70	0.47	0.646	43.5	6.01	< 0.083 U	0.714	0.0689	2.649	0.04 J	15.0	0.238
2/28/2019	Assessment	< 0.4 U	2 J	28.9	3.34	0.2 J	2 J	25.0	4.67	0.40	< 0.4 U	0.0919	1.135	< 8 U	3 J	< 2 U
5/21/2019	Assessment	< 0.4 U	0.8 J	35.6	2.77	0.3 J	1 J	23.5	5.37	0.31	0.4 J	0.0897	1.371	< 8 U	1 J	0.2 J
8/16/2019	Assessment	< 0.1 U	3.43	38.5	4.88	0.46	1.70	40.4	5.7	0.83	0.996	0.103	4.127	< 2 U	7.8	0.2 J
3/10/2020	Assessment	< 0.02 U	0.88	28.7	2.51	0.30	0.379	23.9	5.741	0.39	0.343	0.0711	1.70	< 0.4 U	2.6	0.2 J
6/2/2020	Assessment	< 0.02 U	0.98	31.9	2.35	0.25	0.675	20.8	4.445	0.41	0.405	0.0696	3.97	< 0.4 U	2.3	0.2 J
11/2/2020	Assessment	0.02 J	6.29	22.0	8.90	0.79	1.17	74.0	8.88	1.40	1.23	0.0987	1.40	< 0.4 U	25.3	0.4 J

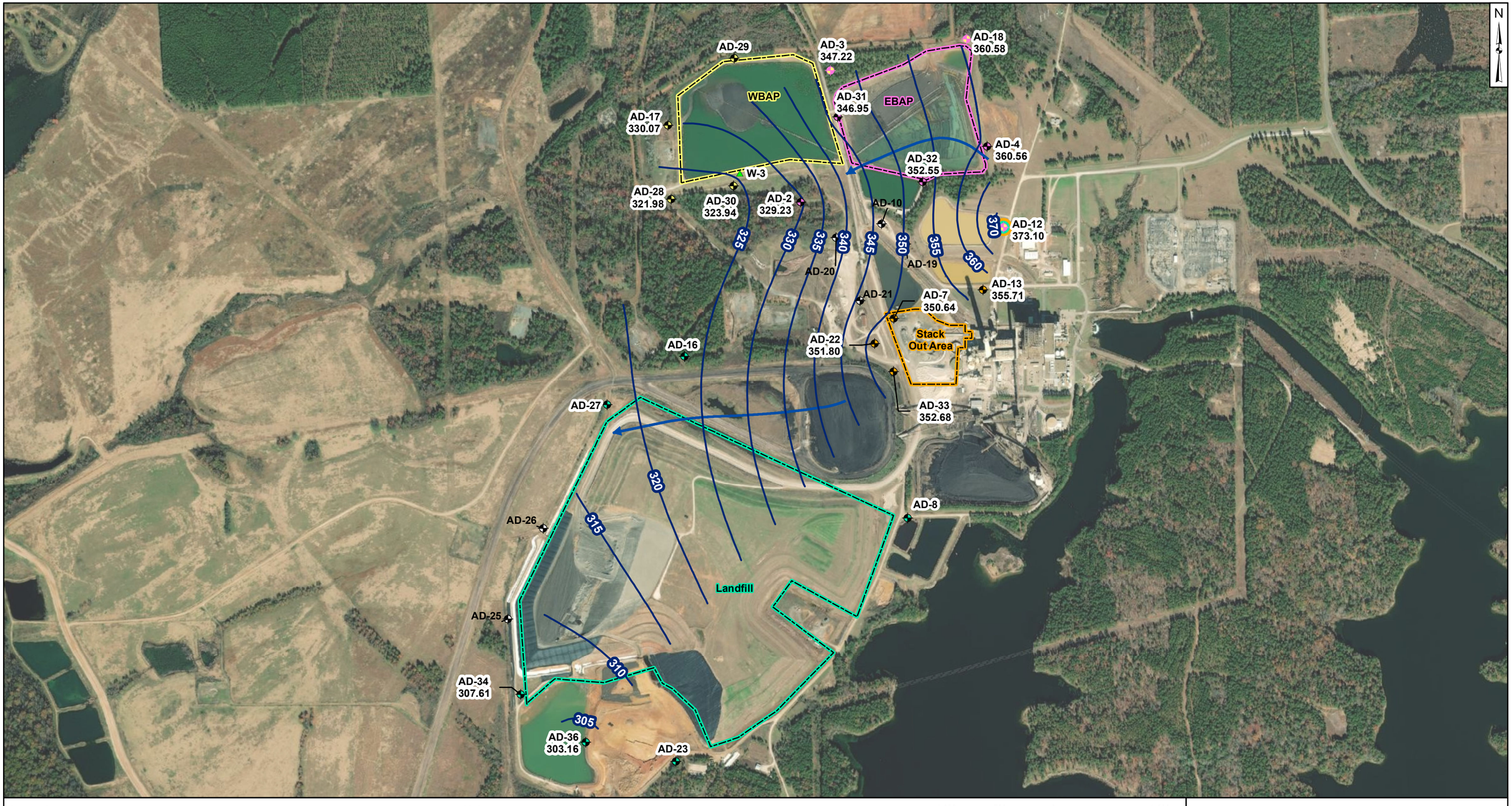
Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
<: Non-detect value. Parameters which were not detected are shown as less than the method detection limit (MDL) followed by a 'U' flag.
J: Estimated value. Parameter was detected at concentration below the reporting limit
- -: Not analyzed
pCi/L: picocuries per liter

Table 1: Residence Time Calculation Summary
Pirkey East Bottom Ash Pond

Geosyntec Consultants, Inc.

CCR Management Unit	Monitoring Well	Well Diameter (inches)	2020-03		2020-06		2020-11	
			Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
East Bottom Ash Pond	AD-2 [2]	4.0	32.0	3.8	26.9	4.5	24.6	5.0
	AD-4 [1]	4.0	7.2	16.9	10.4	11.7	4.9	24.8
	AD-12 [1]	4.0	35.1	3.5	20.1	6.0	26.9	4.5
	AD-18 [1]	2.0	9.2	6.6	10.1	6.0	10.8	5.6
	AD-31 [2]	2.0	24.3	2.5	26.6	2.3	23.5	2.6
	AD-32 [2]	2.0	21.7	2.8	21.0	2.9	13.8	4.4

Notes:
[1] - Background Well
[2] - Downgradient Well



Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction

Notes

- Monitoring well coordinates and water level data (collected on March 10-11, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-16, AD-27, and AD-29 were not gauged in March 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer March 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/06/12

Figure **1**

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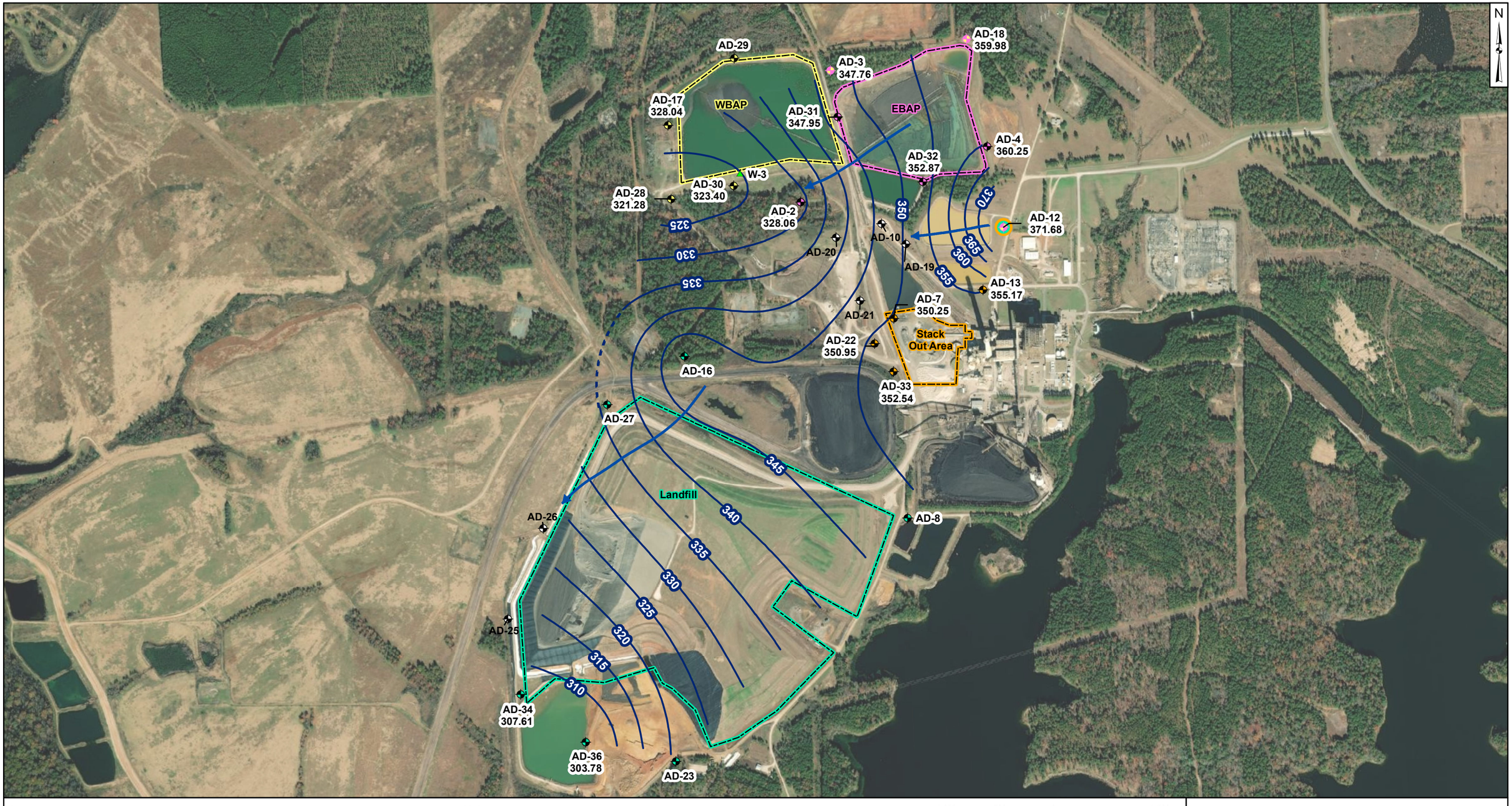

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on June 2 - 3, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3, AD-8, AD-16, AD-23, AD-27, and AD-29 were not gauged in June 2020.
- AD-34 is an artesian well.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer
June 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/11/13

Figure **2**

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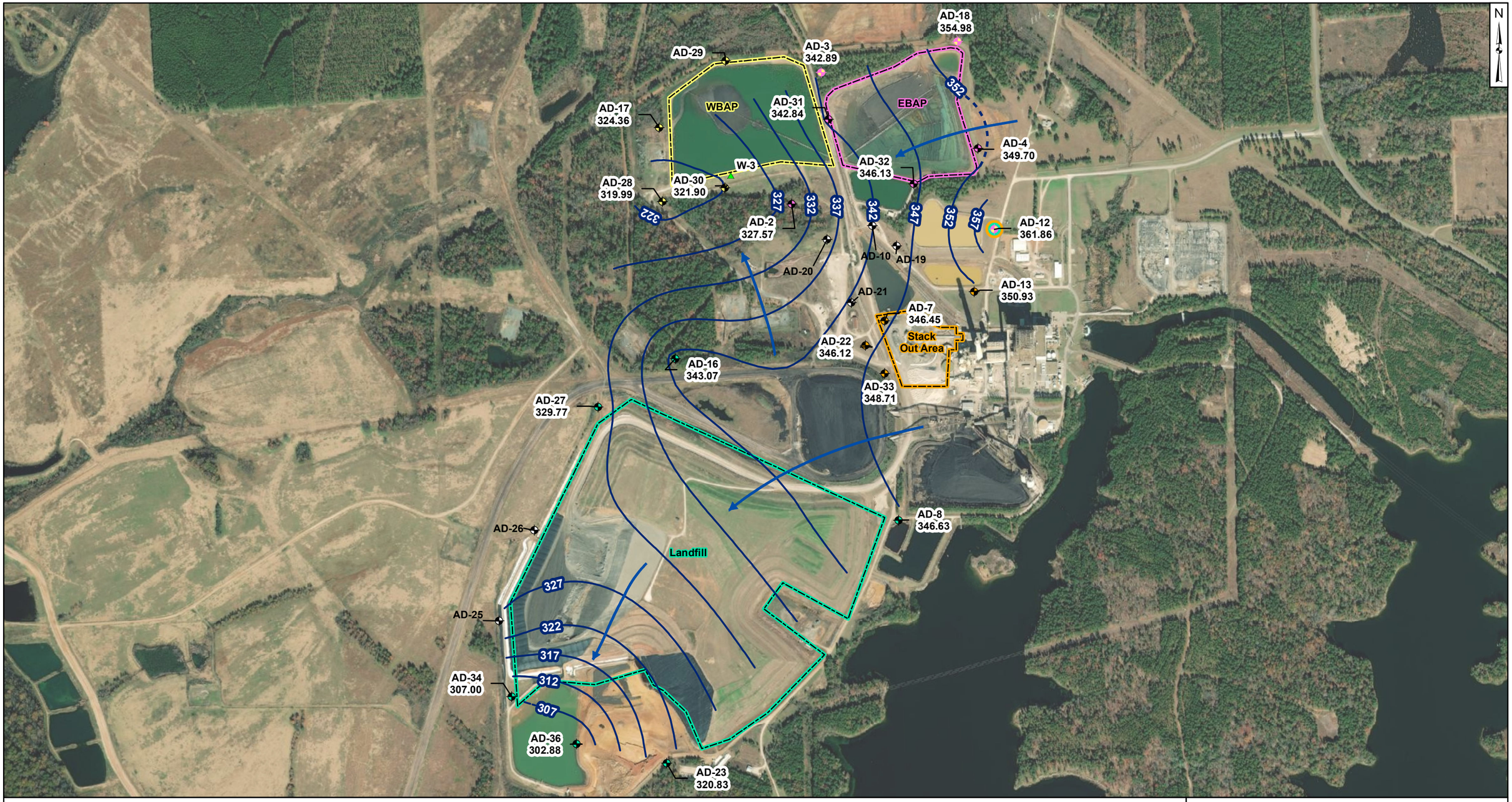

Legend

Groundwater Monitoring Wells

- Out of Network
- EBAP
- WBAP
- Landfill
- Stackout Area
- EBAP and WBAP

- All CCR Unit Networks
- Piezometer
- Approximate Groundwater Flow Direction
- Groundwater Elevation Contour
- Grondwater Elevation Contour (Inferred)

Notes

- Monitoring well coordinates and water level data (collected on November 2-4, 2020) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 and AD-29 were not gauged in November 2020.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer
November 2020

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2021/01/06

Figure **3**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2020\AEP-Pirkey_GW_2020-11November_new.mxd. HDuff. 1/6/2021. Project/Phase/Task.

APPENDIX II

Where applicable, show in this appendix the results from statistical analyses, and a description of the statistical analysis method chosen. These statistical analyses are to be conducted separately for each constituent in each monitoring well.

STATISTICAL ANALYSIS SUMMARY
EAST BOTTOM ASH POND
H.W. Pirkey Power Plant
Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

October 2, 2020

CHA8500

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LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
EBAP	East Bottom Ash Pond
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit

SECTION 1

EXECUTIVE SUMMARY

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), groundwater monitoring has been conducted at the East Bottom Ash Pond (EBAP), an existing CCR unit at the Pirkey Power Plant located in Hallsville, Texas.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, calcium, chloride, total dissolved solids (TDS), and sulfate at the EBAP. An alternative source was not identified at the time, so the EBAP has been in assessment monitoring since. During the most recent assessment monitoring event, completed in August 2019, SSLs were identified for cobalt and lithium (Geosyntec, 2019). An alternative source demonstration (ASD) was successfully completed per 40 CFR 257.95(g)(3); therefore, the EBAP remained in assessment monitoring. Two assessment monitoring events were conducted at the EBAP in March and June 2020 in accordance with 40 CFR 257.95. The results of these assessment events are documented in this report.

Groundwater data underwent several validation tests, including those for completeness, sample tracking accuracy, transcription errors, and consistent use of measurement units. No data quality issues were identified which would impact data usability.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. SSLs were identified for cobalt, lithium, and mercury. Thus, either the unit will move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

EAST BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (March 2020) and 257.95(d)(1) (June 2020). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events are presented in Table 1.

Chemical analysis was completed by an analytical laboratory certified by the National Environmental Laboratory Accreditation Program (NELAP). Quality assurance and quality control (QA/QC) samples completed by the analytical laboratory included the use of laboratory reagent blanks (LRBs), continuing calibration verification (CCV) samples, and laboratory fortified blanks (LFBs).

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.26 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

Statistical analyses for the EBAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Time series plots and results for all completed statistical tests are provided in Attachment B.

The data obtained in March and June 2020 were screened for potential outliers. No outliers were identified for these events.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Tolerance limits were calculated parametrically with 95% coverage and 95% confidence for chromium, combined radium, and lithium. Non-parametric tolerance limits were calculated

for barium, beryllium, cobalt, and mercury due to apparent non-normal distributions and for antimony, arsenic, cadmium, fluoride, lead, molybdenum, selenium, and thallium due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey EBAP:

- The LCL for cobalt exceeded the GWPS of 0.00939 mg/L at AD-2 (0.0100 mg/L), AD-31 (0.00942 mg/L), and AD-32 (0.0239 mg/L).
- The LCL for lithium exceeded the GWPS of 0.060 mg/L at AD-31 (0.0682 mg/L) and AD-32 (0.0770 mg/L).
- The LCL for mercury exceeded the GWPs of 0.00200 mg/L at AD-32 (0.00204 mg/L).

As a result, the Pirkey EBAP will either move to an assessment of corrective measures or an alternative source demonstration will be conducted to evaluate if the unit can remain in assessment monitoring.

2.2.3 Evaluation of Potential Appendix III SSIs

While SSLs were identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations.

Data collected during the June 2020 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0510 mg/L at AD-2 (2.44 mg/L) and AD-32 (0.557 mg/L).
- Calcium concentrations exceeded the interwell UPL of 2.94 mg/L at AD-32 (5.75 mg/L).
- Chloride concentrations exceeded the interwell UPL of 9.16 mg/L at AD-2 (29.3 mg/L), AD-31 (22.1 mg/L) and AD-32 (24.1 mg/L).

- Sulfate concentrations exceeded the interwell UPL of 23.0 mg/L at AD-2 (174 mg/L), AD-31 (81.4 mg/L), and AD-32 (93.6 mg/L).

- TDS concentrations exceeded the interwell UPL of 176 mg/L at AD-2 (387 mg/L), AD-31 (288 mg/L), and AD-32 (327 mg/L).

While the prediction limits were calculated for a one-of-two retesting procedure, SSIs were conservatively assumed if the June 2020 sample was above the UPL or below the LPL. Based on these results, concentrations of Appendix III constituents appear to be above background concentrations.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. A review of outliers identified no potential outliers in the March and June 2020 data. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. SSLs were identified for cobalt, lithium, and mercury. Appendix III parameters were compared to calculated prediction limits, with exceedances identified for boron, calcium, chloride, sulfate, and TDS.

Based on this evaluation, the Pirkey EBAP CCR unit will either move to an assessment of corrective measures or an ASD will be conducted to evaluate if the unit can remain in assessment monitoring.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – H.W. Pirkey Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2019. Statistical Analysis Summary – East Bottom Ash Pond, H.W. Pirkey Plant. December.

TABLES

Table 1 - Groundwater Data Summary
Pirkey Plant - East Bottom Ash Pond

Parameter	Unit	AD-2		AD-4		AD-12		AD-18		AD-31		AD-32	
		3/11/2020	6/3/2020	3/11/2020	6/3/2020	3/10/2020	6/2/2020	3/11/2020	6/3/2020	3/10/2020	6/2/2020	3/10/2020	6/2/2020
Antimony	µg/L	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
Arsenic	µg/L	0.52	0.45	1.16	0.52	0.09 J	0.09 J	0.09 J	0.22	0.27	0.21	0.88	0.98
Barium	µg/L	21.9	19.7	69.0	67.9	21.7	19.0	97.1	100	34.8	32.7	28.7	31.9
Beryllium	µg/L	0.499	0.474	0.965	0.527	0.139	0.132	0.09 J	0.1 J	0.835	0.868	2.51	2.35
Boron	mg/L	2.78	2.44	0.05 U	0.02 J	0.02 J	0.05 U	0.05 U	0.05 U	0.03 J	0.02 J	0.656	0.557
Cadmium	µg/L	0.08	0.07	0.05 U	0.05 U	0.01 J	0.05 U	0.01 J	0.01 J	0.07	0.06	0.30	0.25
Calcium	mg/L	2.50	2.44	1.46	1.72	0.3 J	0.2 J	0.3 J	0.2 J	2.80	2.92	6.84	5.75
Chloride	mg/L	29.7	29.3	3.42	3.65	6.08	5.63	7.34	8.30	21.7	22.1	20.5	24.1
Chromium	µg/L	0.247	0.243	0.1 J	0.2 J	0.2 J	0.208	0.1 J	0.2 J	0.357	0.292	0.379	0.675
Cobalt	µg/L	17.7	16.5	7.89	7.15	1.21	1.02	0.948	0.950	9.56	9.62	23.9	20.8
Combined Radium	pCi/L	0.1882	1.412	0.2327	0.87	3.0706	0.799	4.813	0.728	3.814	2.656	5.741	4.445
Fluoride	mg/L	0.14	0.15	0.13	0.14	0.10	0.10	0.02 J	0.03 J	0.14	0.16	0.39	0.41
Lead	µg/L	0.600	0.389	0.06 J	0.06 J	0.09 J	0.09 J	0.2 U	0.06 J	0.260	0.2 J	0.343	0.405
Lithium	mg/L	0.0476	0.0464	0.0415	0.0380	0.00547	0.00505	0.0134	0.0132	0.0669	0.0682	0.0711	0.0696
Mercury	µg/L	0.056	0.085	0.005 U	0.005 U	0.005 U	0.005 U	0.003 J	0.007	0.183	0.046	1.70	3.97
Molybdenum	µg/L	4.37	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U	2 U
Selenium	µg/L	1.5	1.5	0.2 U	0.2 U	0.2	0.3	0.05 J	0.09 J	0.4	0.4	2.6	2.3
Sulfate	mg/L	178	174	24.2	24.7	3.7	3.9	6.1	6.3	74.6	81.4	117	93.6
Thallium	µg/L	0.1 J	0.1 J	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.2 J	0.2 J
Total Dissolved Solids	mg/L	374	387	166	168	62	91	90 J	119	246	288	286	327
pH	SU	4.0	4.6	5.4	5.4	4.9	4.0	4.4	4.5	3.5	4.2	3.7	3.9

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Non-detect value. For statistical analysis, parameters which were not detected were replaced with the reporting limit.
J: Estimated value. Parameter was detected in concentrations below the reporting limit.

Table 2: Groundwater Protection Standards
Pirkey Plant - East Bottom Ash Pond

Geosyntec Consultants, Inc.

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.0050
Arsenic, Total (mg/L)	0.01		0.011
Barium, Total (mg/L)	2		0.18
Beryllium, Total (mg/L)	0.004		0.0020
Cadmium, Total (mg/L)	0.005		0.0010
Chromium, Total (mg/L)	0.1		0.003
Cobalt, Total (mg/L)	n/a	0.006	0.0094
Combined Radium, Total (pCi/L)	5		4.60
Fluoride, Total (mg/L)	4		1.0
Lead, Total (mg/L)	0.015		0.0050
Lithium, Total (mg/L)	n/a	0.04	0.060
Mercury, Total (mg/L)	0.002		0.000064
Molybdenum, Total (mg/L)	n/a	0.1	0.040
Selenium, Total (mg/L)	0.05		0.0050
Thallium, Total (mg/L)	0.002		0.0020

Notes:
Grey cell indicates calculated UTL is higher than MCL or CCR Rule-specified value.
MCL = Maximum Contaminant Level
Calculated UTL (Upper Tolerance Limit) represents site-specific background values.
The higher of the calculated UTL or MCL/Rule-Specified Level is used as the GWPS.

Table 3 - Appendix III Data Summary
Pirkey Plant - East Bottom Ash Pond

Geosyntec Consultants, Inc.

Analyte	Unit	Description	AD-2	AD-31	AD-32
			6/3/2020	6/2/2020	6/2/2020
Boron	mg/L	Interwell Background Value (UPL)	0.0510		
		Analytical Result	**2.44**	0.02	**0.557**
Calcium	mg/L	Interwell Background Value (UPL)	2.94		
		Analytical Result	2.44	2.92	**5.75**
Chloride	mg/L	Interwell Background Value (UPL)	9.16		
		Analytical Result	**29.3**	**22.1**	**24.1**
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
		Analytical Result	0.15	0.16	0.41
pH	SU	Intrawell Background Value (UPL)	4.8	5.4	4.6
		Intrawell Background Value (LPL)	3.3	2.8	2.5
		Analytical Result	4.6	4.2	3.9
Sulfate	mg/L	Interwell Background Value (UPL)	23.0		
		Analytical Result	**174**	**81.4**	**93.6**
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	176		
		Analytical Result	**387**	**288**	**327**

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.

ATTACHMENT A
Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

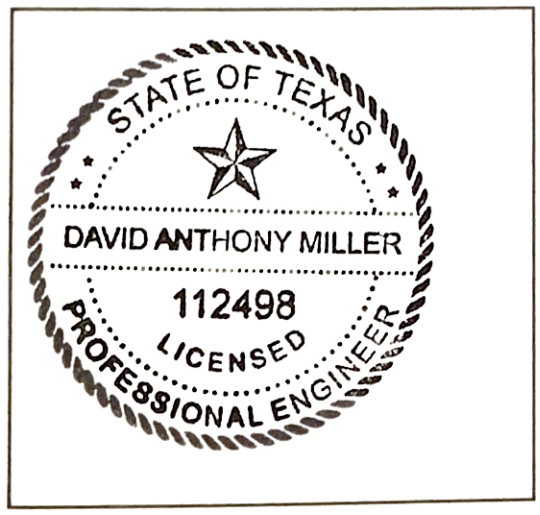
I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey East Bottom Ash Pond CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature



112498	TEXAS	10.02.2020
License Number	Licensing State	Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS CONSULTING

September 8, 2020

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
941 Chatham Lane, #103
Columbus, OH 43221

Re: Pirkey East Bottom Ash Pond
Assessment Monitoring Event – June 2020

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the evaluation of groundwater data from the Spring 2020 sample event for American Electric Power Company's Pirkey East Bottom Ash Pond (EBAP). The analysis complies with the federal rule for the Disposal of Coal Combustion Residuals from Electric Utilities (CCR Rule, 2015) as well as with the USEPA Unified Guidance (2009).

Sampling at each of the wells below began at Pirkey EBAP for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-4, AD-12, and AD-18
- **Downgradient wells:** AD-2, AD-31, and AD-32A

Data were sent electronically, and the statistical analysis was conducted according to the Statistical Analysis Plan and screening evaluation prepared by GSC and approved by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to GSC. The statistical analysis was reviewed Kristina Rayner, Groundwater Statistician and Founder of Groundwater Stats Consulting.

The CCR program consists of the following Assessment monitoring constituents:

- **Appendix IV –** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium

Time series plots and box plots for Appendix IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B).

Background Screening

Prior to constructing statistical limits, background data are screened through time series plots for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Values identified as outliers are flagged with (o) and displayed in a lighter font and disconnected symbol on the time series graphs. A summary of flagged outliers is included as Figure C.

For the current analysis, all data through June 2020 were screened, including data from downgradient wells. For the downgradient well data that are used to construct confidence intervals, a regulatory conservative approach is taken in that values that are marginally high relative to the rest of the data are retained unless there is particular justification for excluding them. Several outliers were flagged as a result of changes in reporting limits as follows.

A number of constituents in well AD-31 during the May 2016 event had higher reported concentrations compared to other reported values in this well for the same constituents, and therefore; these concentrations flagged as outliers. During the August 2019 event, a value of 0.015 mg/L was reported for selenium at well AD-32. That value was flagged as an outlier during this analysis since the reported value during the February 2019 event was significantly lower (0.003 mg/L) and similar to historical concentrations. The reporting limit during the February 2019 event for molybdenum at wells AD-12, AD-18, AD-31 and AD-32 was 0.04 mg/L, which is lower than the CCR Rule-Specified level of 0.1 mg/L. Therefore, these values were not considered outliers at this time. Wells AD-2 and AD-4 had a reporting limit of 0.002 mg/L during this event.

Summary of Statistical Methods

Assessment monitoring for Appendix IV parameters involves the comparison of a confidence interval for each parameter at each downgradient well against the corresponding Groundwater Protection Standard (GWPS). If, and only if, the entire confidence interval exceeds the GWPS, the well/constituent is considered to exceed its standard. The GWPS is determined for each parameter as the largest of the Maximum Contaminant Levels (MCLs), CCR Rule-Specified levels, or background limits determined from tolerance limits constructed from pooled upgradient well data.

Prior to computing tolerance limits on upgradient well data or confidence intervals on downgradient well data, the distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric tolerance limits and confidence intervals as appropriate, based on the following criteria.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, the reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory. There is no replacement of historical reporting limits with the most recent reporting limit. For several constituents, the most recent reporting limits are significantly lower than those reported historically. This is the most conservative approach for tolerance limits and confidence intervals at this site.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.
- Nonparametric tolerance limits are used on data containing greater than 50% nondetects.

Evaluation of Appendix IV Parameters

When data followed a normal or transformed-normal distribution, parametric tolerance limits were used to calculate background limits for Appendix IV parameters using pooled upgradient well data through June 2020 with a target of 95% confidence and 95% coverage (Figure D). Nonparametric tolerance limits are constructed when data do not follow a normal or transformed-normal distribution or when there are greater than 50% nondetects. The confidence and coverage levels for nonparametric tolerance limits are

dependent upon the number of background samples. These background limits were then compared to the Maximum Contaminant Levels (MCLs) and CCR Rule-Specified levels to determine the highest limit for use as the GWPS in the confidence interval comparisons (Figure E).

Confidence intervals were then constructed on downgradient wells with data through June 2020 for each of the Appendix IV parameters using either parametric or nonparametric intervals depending on the data distribution and percentage of nondetects, similar to the logic used to construct tolerance limits as discussed above (Figure F). Each confidence interval was compared with the corresponding GWPS from Figure E. Only when the entire confidence interval is above the GWPS is the well/constituent pair considered to exceed its respective standard. Both a tabular summary and graphical presentation of the confidence interval results follow this letter. Exceedances were noted for the following well/constituent pairs:

- Cobalt: AD-2, AD-31, and AD-32
- Lithium: AD-31 and AD-32
- Mercury: AD-32

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

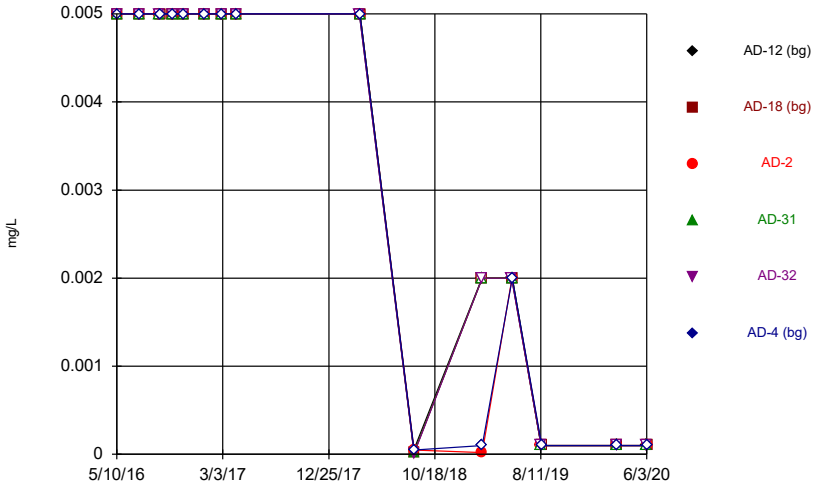
For Groundwater Stats Consulting,

Easton Rayner
Groundwater Analyst

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

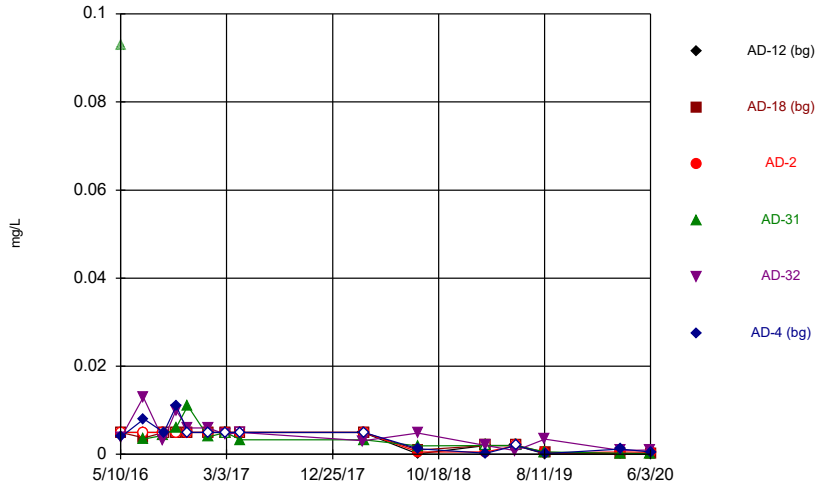
Time Series



Constituent: Antimony, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

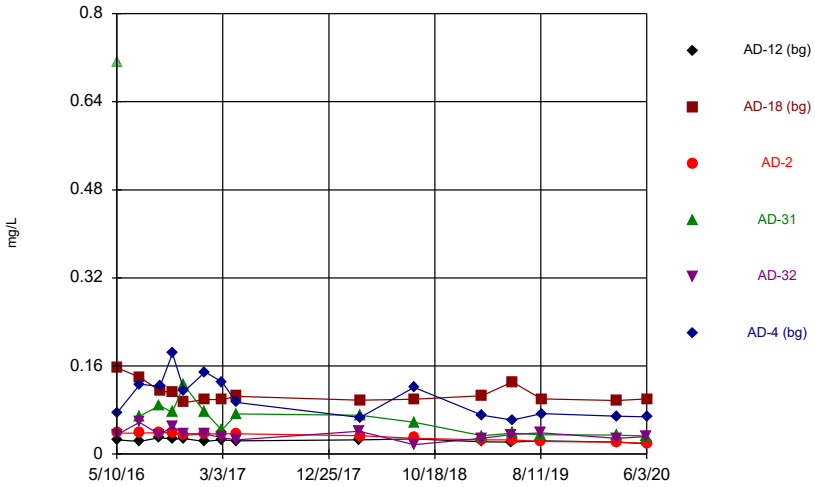
Time Series



Constituent: Arsenic, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

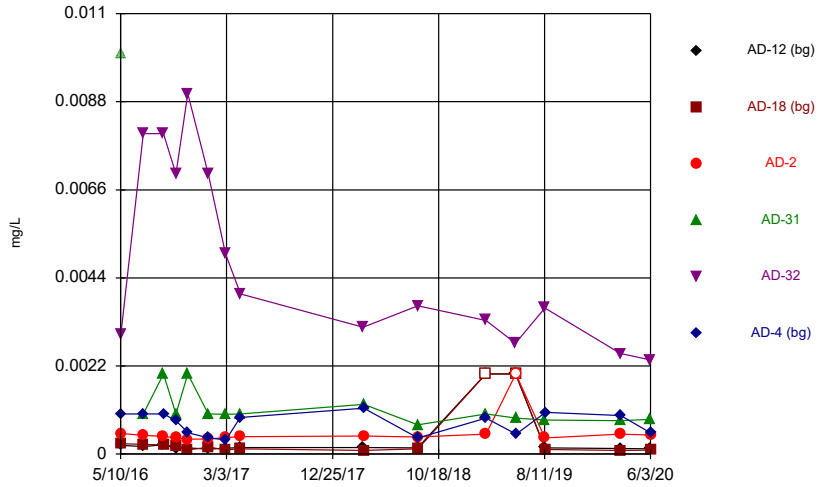
Time Series



Constituent: Barium, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Beryllium, total Analysis Run 9/8/2020 8:23 AM
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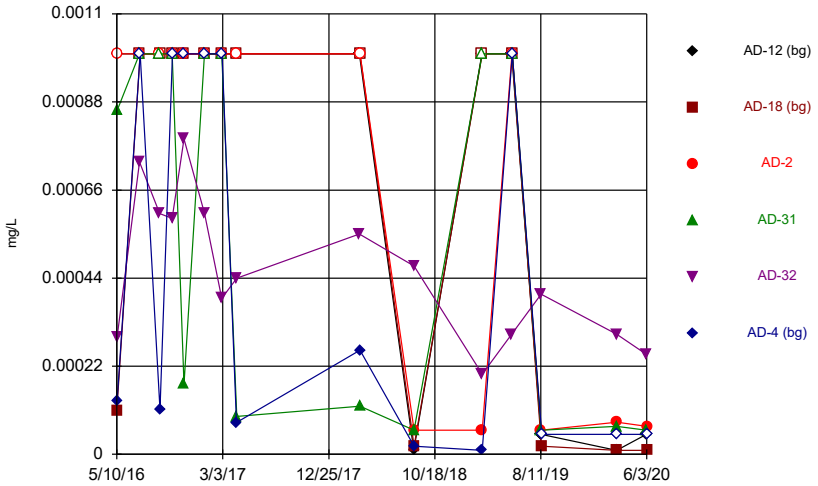
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Cadmium, total Analysis Run 9/8/2020 8:23 AM
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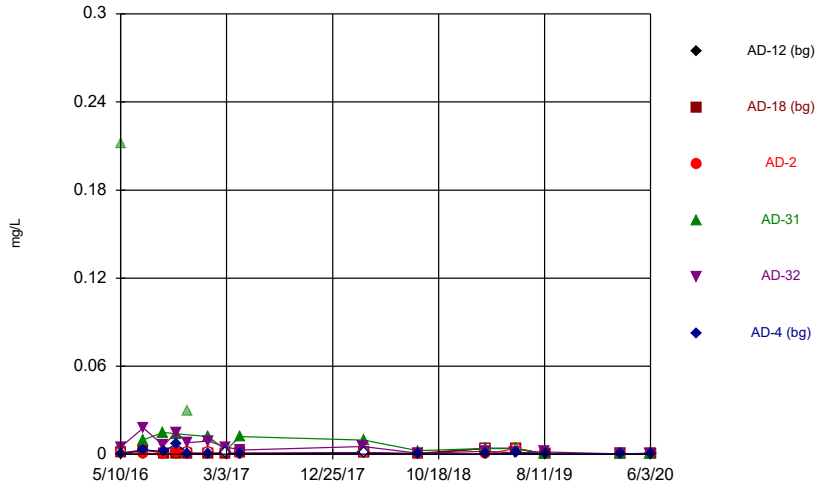
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

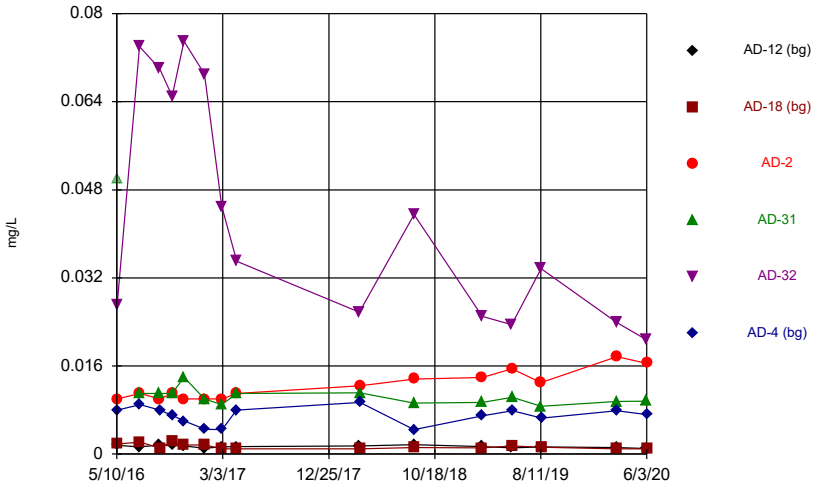
Time Series



Constituent: Chromium, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Time Series



Constituent: Cobalt, total Analysis Run 9/8/2020 8:23 AM
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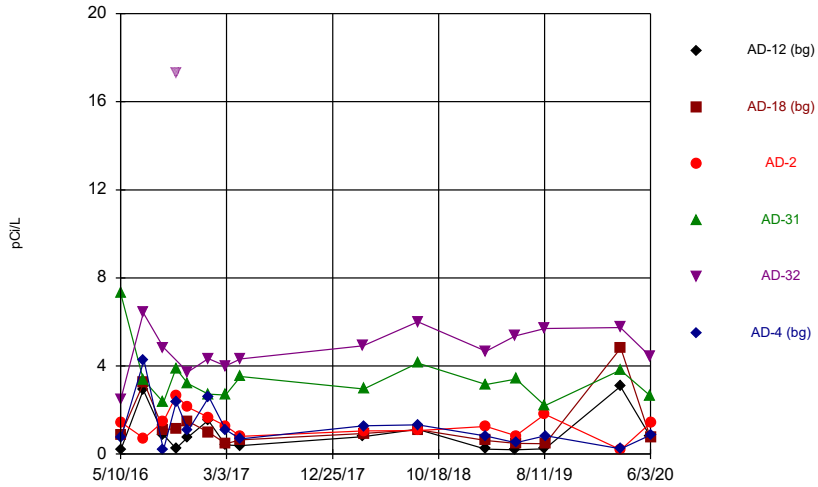
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

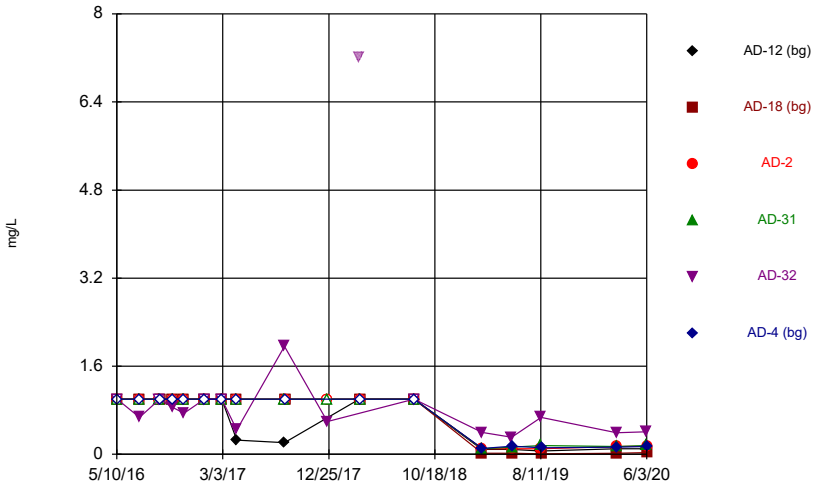
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

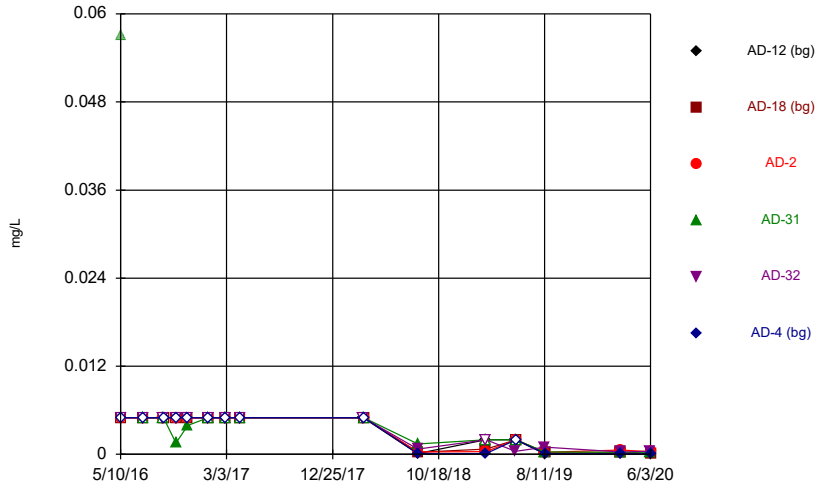
Time Series



Constituent: Fluoride, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Lead, total Analysis Run 9/8/2020 8:23 AM
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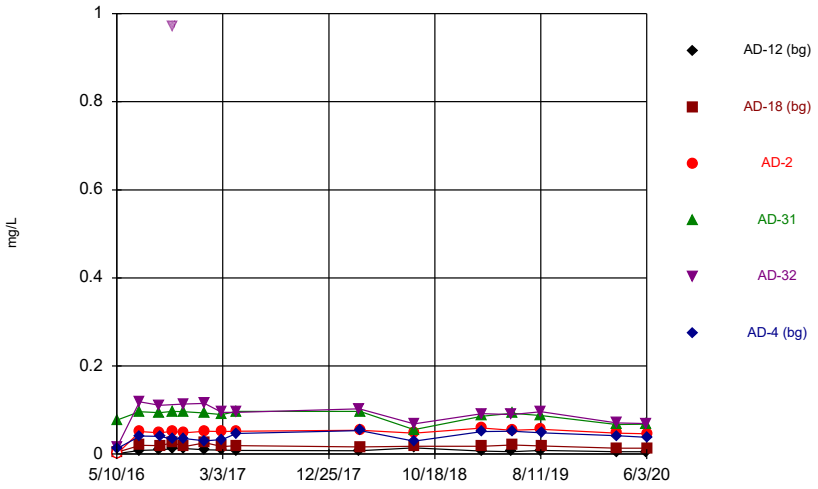
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Lithium, total Analysis Run 9/8/2020 8:23 AM
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Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

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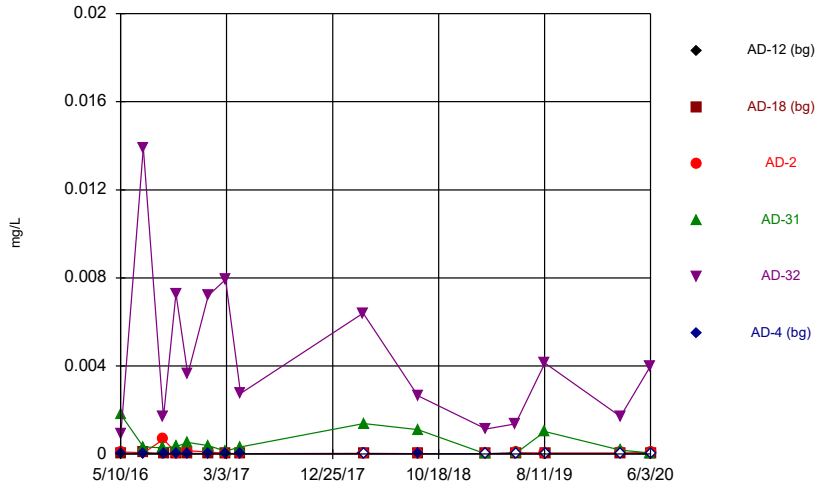
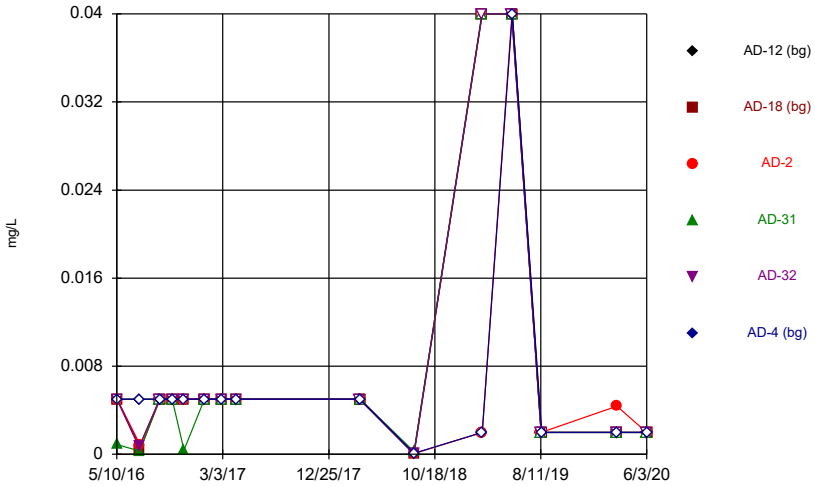


Constituent: Mercury, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

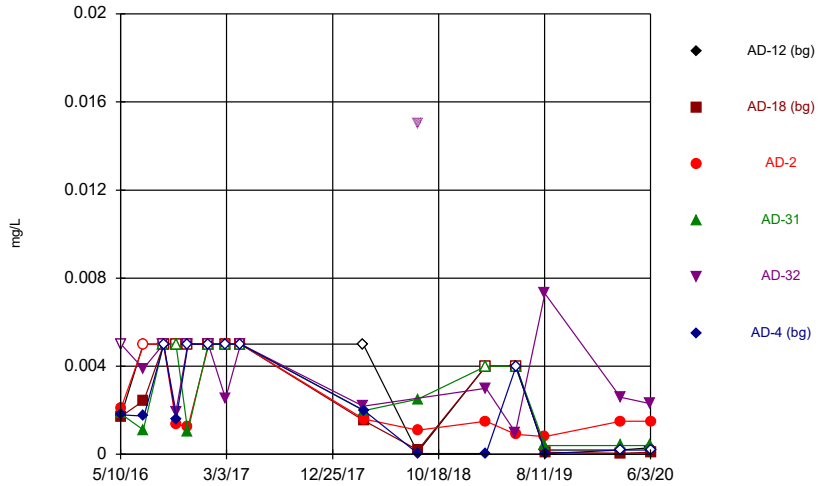
Time Series



Constituent: Molybdenum, total Analysis Run 9/8/2020 8:23 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Selenium, total Analysis Run 9/8/2020 8:23 AM
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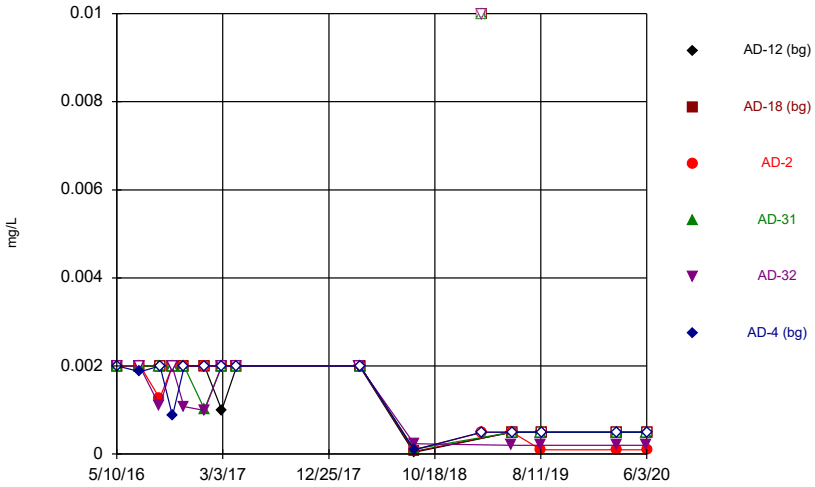
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



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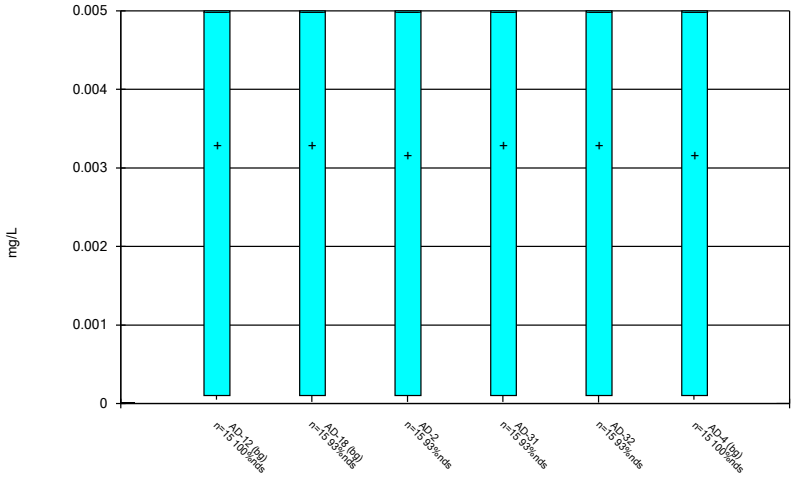
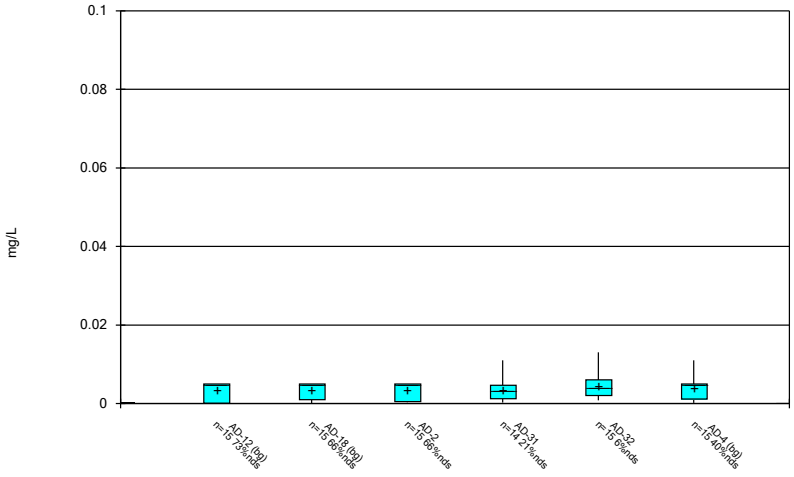
Box & Whiskers Plot



Constituent: Antimony, total Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot



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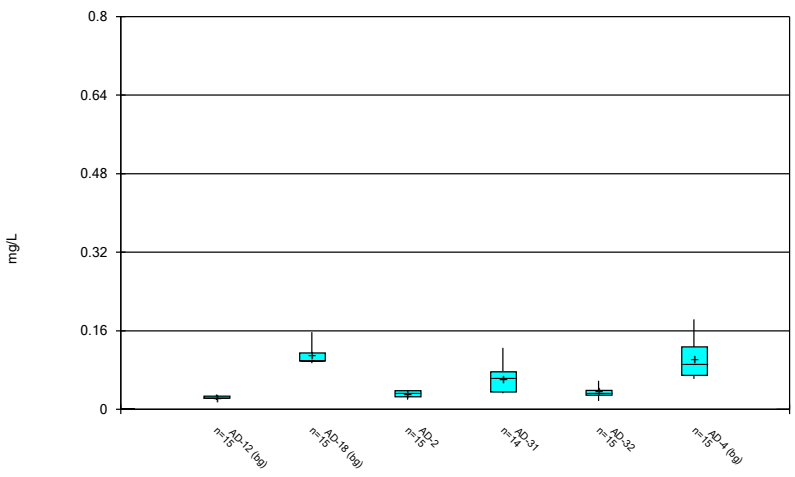
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

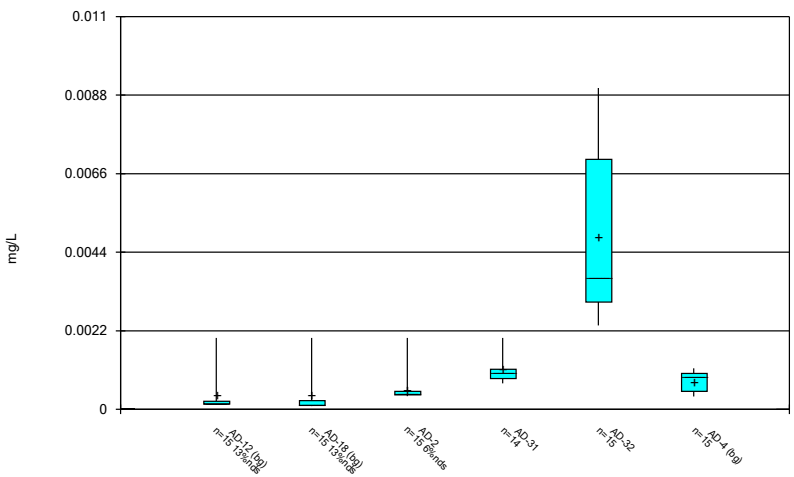
Box & Whiskers Plot



Constituent: Barium, total Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Beryllium, total Analysis Run 9/8/2020 8:24 AM
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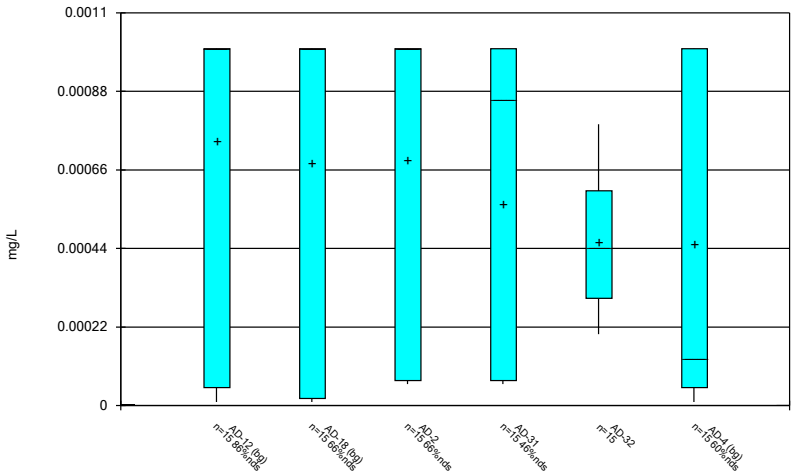
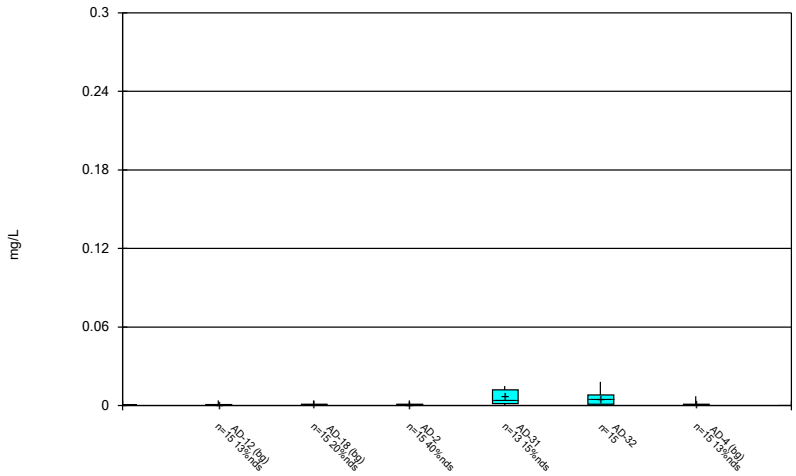
Box & Whiskers Plot



Constituent: Cadmium, total Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Chromium, total Analysis Run 9/8/2020 8:24 AM
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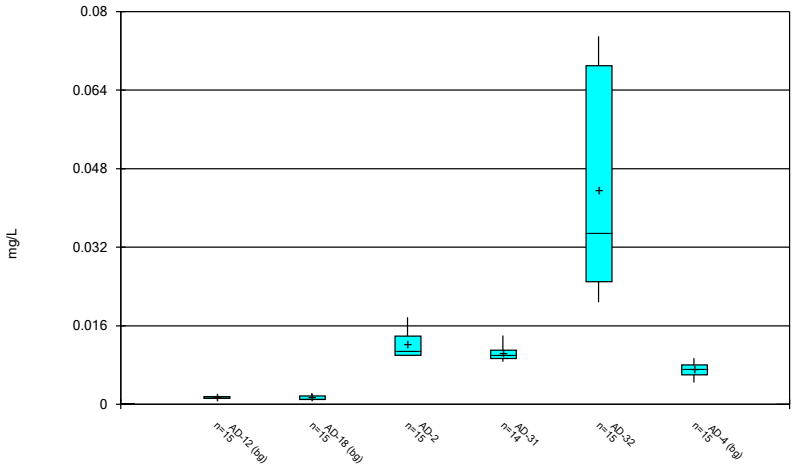
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

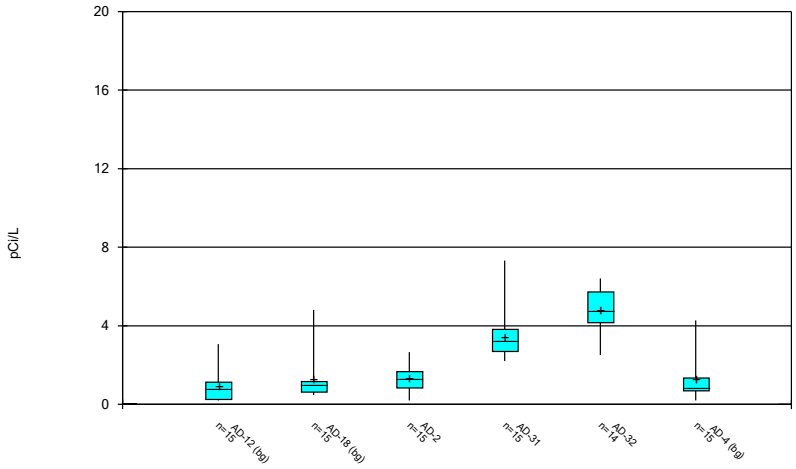
Box & Whiskers Plot



Constituent: Cobalt, total Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

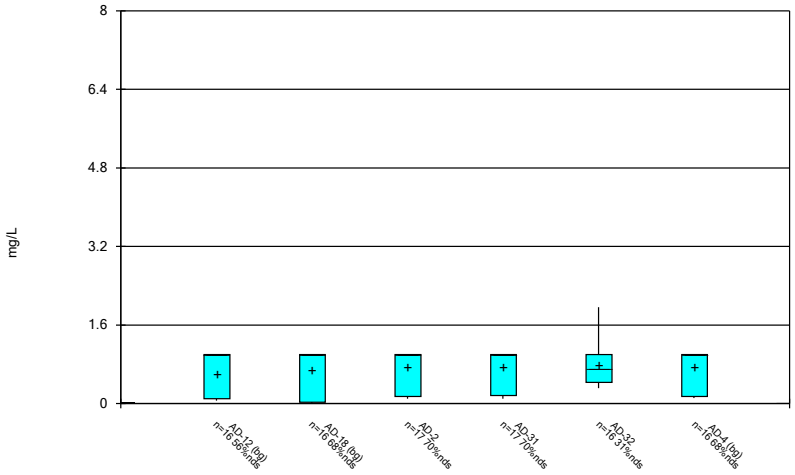
Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot



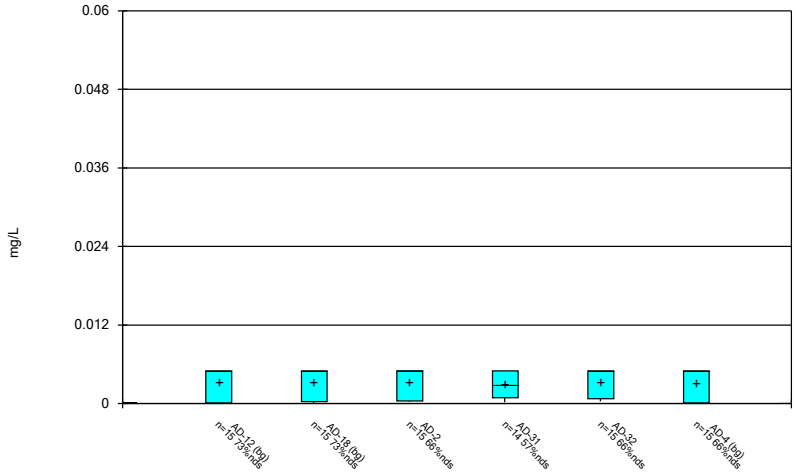
Constituent: Combined Radium 226 + 228 Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



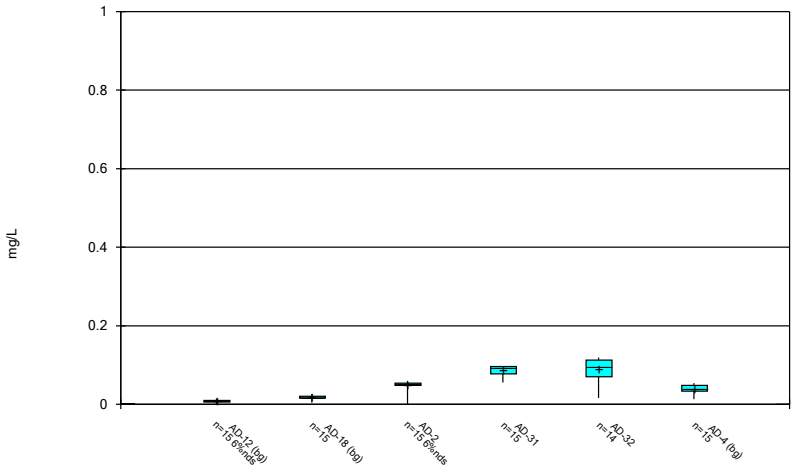
Constituent: Fluoride, total Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



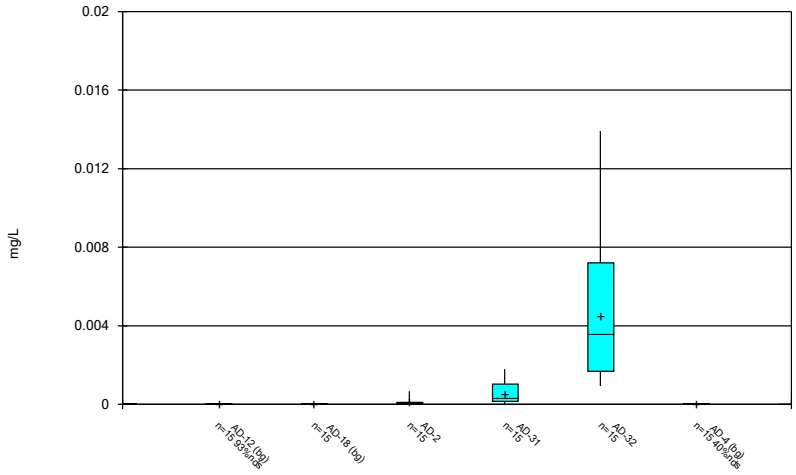
Constituent: Lead, total Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



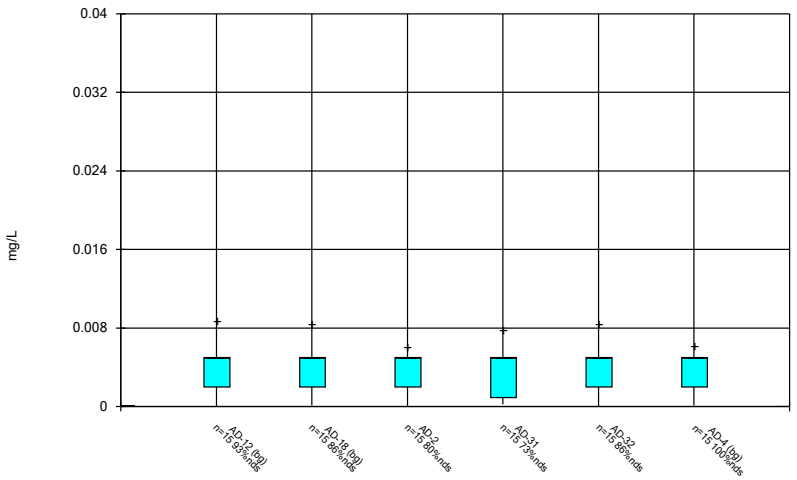
Constituent: Lithium, total Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Box & Whiskers Plot



Constituent: Mercury, total Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

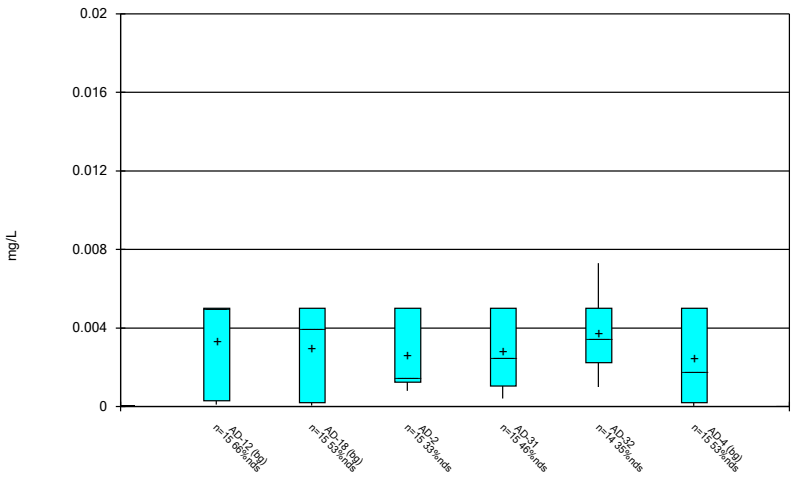
Box & Whiskers Plot



Constituent: Molybdenum, total Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

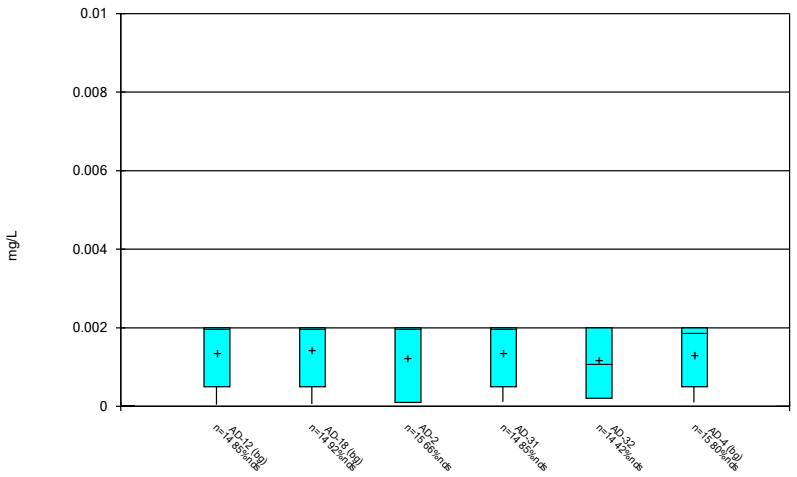
Box & Whiskers Plot



Constituent: Selenium, total Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Thallium, total Analysis Run 9/8/2020 8:24 AM
Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Outlier Summary

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 9/4/2020, 3:47 PM

	AD-31 Arsenic, total (mg/L)	AD-31 Barium, total (mg/L)	AD-31 Beryllium, total (mg/L)	AD-31 Chromium, total (mg/L)	AD-31 Cobalt, total (mg/L)	AD-32 Combined Radium 226 + 228 (pCi/L)	AD-32 Fluoride, total (mg/L)	AD-31 Lead, total (mg/L)	AD-32 Lithium, total (mg/L)	AD-32 Selenium, total (mg/L)
5/11/2016	0.093 (o)	0.712 (o)	0.01 (o)	0.212 (o)	0.05 (o)			0.057 (o)		
10/12/2016						17.32 (o)			0.972 (o)	
11/14/2016				0.03 (o)						
3/21/2018							7.2 (o)			
8/21/2018										0.015 (o)
2/27/2019										
2/28/2019										

	AD-12 Thallium, total (mg/L)	AD-18 Thallium, total (mg/L)	AD-31 Thallium, total (mg/L)	AD-32 Thallium, total (mg/L)
5/11/2016				
10/12/2016				
11/14/2016				
3/21/2018				
8/21/2018				
2/27/2019	<0.01 (o)			
2/28/2019		<0.01 (o)	<0.01 (o)	<0.01 (o)

Tolerance Limit Summary Table

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 9/8/2020, 8:48 AM

Constituent	Upper Lim.	Lower Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.0050	n/a	n/a	45	n/a	n/a	97.78	n/a	n/a	0.09944	NP Inter(NDs)
Arsenic, total (mg/L)	0.011	n/a	n/a	45	n/a	n/a	60	n/a	n/a	0.09944	NP Inter(NDs)
Barium, total (mg/L)	0.18	n/a	n/a	45	n/a	n/a	0	n/a	n/a	0.09944	NP Inter(normality)
Beryllium, total (mg/L)	0.0020	n/a	n/a	45	n/a	n/a	8.889	n/a	n/a	0.09944	NP Inter(normality)
Cadmium, total (mg/L)	0.0010	n/a	n/a	45	n/a	n/a	71.11	n/a	n/a	0.09944	NP Inter(NDs)
Chromium, total (mg/L)	0.003	n/a	n/a	45	-7.851	0.9761	15.56	Kaplan-Meier	ln(x)	0.05	Inter
Cobalt, total (mg/L)	0.0094	n/a	n/a	45	n/a	n/a	0	n/a	n/a	0.09944	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	4.6	n/a	n/a	45	-0.1917	0.8228	0	None	ln(x)	0.05	Inter
Fluoride, total (mg/L)	1.0	n/a	n/a	48	n/a	n/a	64.58	n/a	n/a	0.08526	NP Inter(NDs)
Lead, total (mg/L)	0.0050	n/a	n/a	45	n/a	n/a	71.11	n/a	n/a	0.09944	NP Inter(NDs)
Lithium, total (mg/L)	0.06	n/a	n/a	45	0.1385	0.05078	2.222	None	sqrt(x)	0.05	Inter
Mercury, total (mg/L)	0.000064	n/a	n/a	45	n/a	n/a	44.44	n/a	n/a	0.09944	NP Inter(normality)
Molybdenum, total (mg/L)	0.040	n/a	n/a	45	n/a	n/a	93.33	n/a	n/a	0.09944	NP Inter(NDs)
Selenium, total (mg/L)	0.0050	n/a	n/a	45	n/a	n/a	57.78	n/a	n/a	0.09944	NP Inter(NDs)
Thallium, total (mg/L)	0.0020	n/a	n/a	43	n/a	n/a	86.05	n/a	n/a	0.1102	NP Inter(NDs)

PIRKEY EBAP GWPS				
Constituent Name	**MCL**	**CCR Rule-Specified**	**Background Limit**	**GWPS**
Antimony, Total (mg/L)	0.006		0.005	0.006
Arsenic, Total (mg/L)	0.01		0.011	0.011
Barium, Total (mg/L)	2		0.18	2
Beryllium, Total (mg/L)	0.004		0.002	0.004
Cadmium, Total (mg/L)	0.005		0.001	0.005
Chromium, Total (mg/L)	0.1		0.003	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.0094	0.0094
Combined Radium, Total (pCi/L)	5		4.6	5
Fluoride, Total (mg/L)	4		1	4
Lead, Total (mg/L)	0.015		0.005	0.015
Lithium, Total (mg/L)	n/a	0.04	0.06	0.06
Mercury, Total (mg/L)	0.002		0.000064	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.04	0.1
Selenium, Total (mg/L)	0.05		0.005	0.05
Thallium, Total (mg/L)	0.002		0.002	0.002

**Grey cell indicates Background Limit is higher than MCL or CCR Rule -Specified Level*

**MCL = Maximum Contaminant Level*

**CCR = Coal Combustion Risidual*

**GWPS = Groundwater Protection Standard*

Confidence Intervals Summary Table - Significant Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 9/8/2020, 8:52 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Cobalt, total (mg/L)	**AD-2**	**0.0155**	**0.01**	**0.0094**	**Yes**	**15**	**0.01237**	**0.002581**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Cobalt, total (mg/L)	**AD-31**	**0.01126**	**0.009415**	**0.0094**	**Yes**	**14**	**0.01035**	**0.001344**	**0**	**None**	**sqrt(x)**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-32**	**0.07**	**0.0239**	**0.0094**	**Yes**	**15**	**0.04375**	**0.02093**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Lithium, total (mg/L)	**AD-31**	**0.097**	**0.0682**	**0.06**	**Yes**	**15**	**0.08631**	**0.01318**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Lithium, total (mg/L)	**AD-32**	**0.1073**	**0.07699**	**0.06**	**Yes**	**14**	**0.08969**	**0.02695**	**0**	**None**	**x^2**	**0.01**	**Param.**
Mercury, total (mg/L)	**AD-32**	**0.006254**	**0.002042**	**0.002**	**Yes**	**15**	**0.004445**	**0.003549**	**0**	**None**	**sqrt(x)**	**0.01**	**Param.**

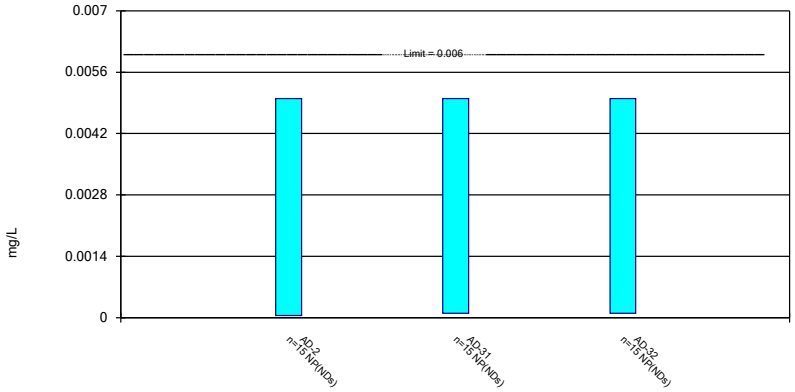
Confidence Intervals Summary Table - All Results

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP Printed 9/8/2020, 8:52 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	AD-2	0.005	0.00005	0.006	No	15	0.003158	0.002382	93.33	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-31	0.005	0.0001	0.006	No	15	0.003288	0.00225	93.33	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-32	0.005	0.0001	0.006	No	15	0.003287	0.002251	93.33	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-2	0.005	0.00052	0.011	No	15	0.003291	0.002198	66.67	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-31	0.004418	0.0008715	0.011	No	14	0.003375	0.002809	21.43	Kaplan-Meier	sqrt(x)	0.01	Param.
Arsenic, total (mg/L)	AD-32	0.006294	0.00215	0.011	No	15	0.004503	0.003361	6.667	None	sqrt(x)	0.01	Param.
Barium, total (mg/L)	AD-2	0.038	0.0228	2	No	15	0.03183	0.006933	0	None	No	0.01	NP (normality)
Barium, total (mg/L)	AD-31	0.08003	0.04197	2	No	14	0.061	0.02687	0	None	No	0.01	Param.
Barium, total (mg/L)	AD-32	0.04192	0.02876	2	No	15	0.03534	0.009717	0	None	No	0.01	Param.
Beryllium, total (mg/L)	AD-2	0.0005	0.0004017	0.004	No	15	0.0005444	0.0004051	6.667	None	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-31	0.00124	0.00085	0.004	No	14	0.001101	0.0003985	0	None	No	0.01	NP (normality)
Beryllium, total (mg/L)	AD-32	0.006116	0.003218	0.004	No	15	0.004833	0.002305	0	None	x^(1/3)	0.01	Param.
Cadmium, total (mg/L)	AD-2	0.001	0.00006	0.005	No	15	0.0006887	0.0004558	66.67	None	No	0.01	NP (NDs)
Cadmium, total (mg/L)	AD-31	0.001	0.00006	0.005	No	15	0.0005665	0.0004624	46.67	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-32	0.000581	0.0003394	0.005	No	15	0.0004602	0.0001783	0	None	No	0.01	Param.
Chromium, total (mg/L)	AD-2	0.0004629	0.0002143	0.1	No	15	0.0008208	0.0009457	40	Kaplan-Meier	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-31	0.009696	0.001498	0.1	No	13	0.006694	0.005523	15.38	Kaplan-Meier	No	0.01	Param.
Chromium, total (mg/L)	AD-32	0.007896	0.001708	0.1	No	15	0.005385	0.00529	0	None	sqrt(x)	0.01	Param.
Cobalt, total (mg/L)	**AD-2**	**0.0155**	**0.01**	**0.0094**	**Yes**	**15**	**0.01237**	**0.002581**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Cobalt, total (mg/L)	**AD-31**	**0.01126**	**0.009415**	**0.0094**	**Yes**	**14**	**0.01035**	**0.001344**	**0**	**None**	**sqrt(x)**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-32**	**0.07**	**0.0239**	**0.0094**	**Yes**	**15**	**0.04375**	**0.02093**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Combined Radium 226 + 228 (pCi/L)	AD-2	1.727	0.9091	5	No	15	1.318	0.6038	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-31	3.984	2.697	5	No	15	3.425	1.215	0	None	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-32	5.514	4.058	5	No	14	4.786	1.028	0	None	No	0.01	Param.
Fluoride, total (mg/L)	AD-2	1	0.14	4	No	17	0.7406	0.4144	70.59	None	No	0.01	NP (NDs)
Fluoride, total (mg/L)	AD-31	1	0.14	4	No	17	0.7465	0.405	70.59	None	No	0.01	NP (NDs)
Fluoride, total (mg/L)	AD-32	0.7898	0.3933	4	No	16	0.7786	0.4059	31.25	Kaplan-Meier	sqrt(x)	0.01	Param.
Lead, total (mg/L)	AD-2	0.005	0.000355	0.015	No	15	0.003265	0.002235	66.67	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-31	0.005	0.000325	0.015	No	14	0.002976	0.002039	57.14	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-32	0.005	0.000405	0.015	No	15	0.003324	0.002158	66.67	None	No	0.01	NP (NDs)
Lithium, total (mg/L)	AD-2	0.05405	0.04685	0.06	No	15	0.048	0.01346	6.667	None	x^4	0.01	Param.
Lithium, total (mg/L)	**AD-31**	**0.097**	**0.0682**	**0.06**	**Yes**	**15**	**0.08631**	**0.01318**	**0**	**None**	**No**	**0.01**	**NP (normality)**
Lithium, total (mg/L)	**AD-32**	**0.1073**	**0.07699**	**0.06**	**Yes**	**14**	**0.08969**	**0.02695**	**0**	**None**	**x^2**	**0.01**	**Param.**
Mercury, total (mg/L)	AD-2	0.0001123	0.00003526	0.002	No	15	0.0001025	0.0001622	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-31	0.000782	0.000151	0.002	No	15	0.0005299	0.0005431	0	None	sqrt(x)	0.01	Param.
Mercury, total (mg/L)	**AD-32**	**0.006254**	**0.002042**	**0.002**	**Yes**	**15**	**0.004445**	**0.003549**	**0**	**None**	**sqrt(x)**	**0.01**	**Param.**
Molybdenum, total (mg/L)	AD-2	0.04	0.0008627	0.1	No	15	0.006086	0.009548	80	None	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-31	0.04	0.0004016	0.1	No	15	0.007857	0.01319	73.33	None	No	0.01	NP (NDs)
Molybdenum, total (mg/L)	AD-32	0.04	0.0007621	0.1	No	15	0.008453	0.01293	86.67	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-2	0.005	0.0011	0.05	No	15	0.002574	0.001801	33.33	None	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-31	0.005	0.0004	0.05	No	15	0.002844	0.001927	46.67	None	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-32	0.003814	0.001743	0.05	No	14	0.003696	0.001736	35.71	Kaplan-Meier	No	0.01	Param.
Thallium, total (mg/L)	AD-2	0.002	0.0001	0.002	No	15	0.001244	0.0008833	66.67	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-31	0.002	0.0005	0.002	No	14	0.001367	0.0007798	85.71	None	No	0.01	NP (NDs)
Thallium, total (mg/L)	AD-32	0.002	0.0002	0.002	No	14	0.001157	0.0008232	42.86	None	No	0.01	NP (normality)

Non-Parametric Confidence Interval

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

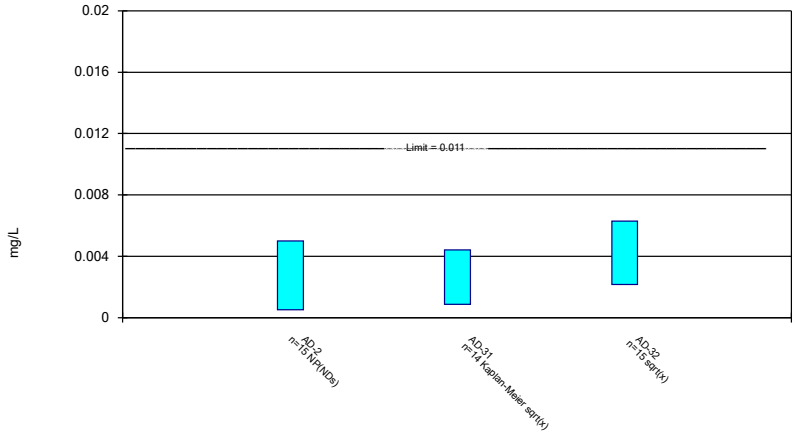


Constituent: Antimony, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

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

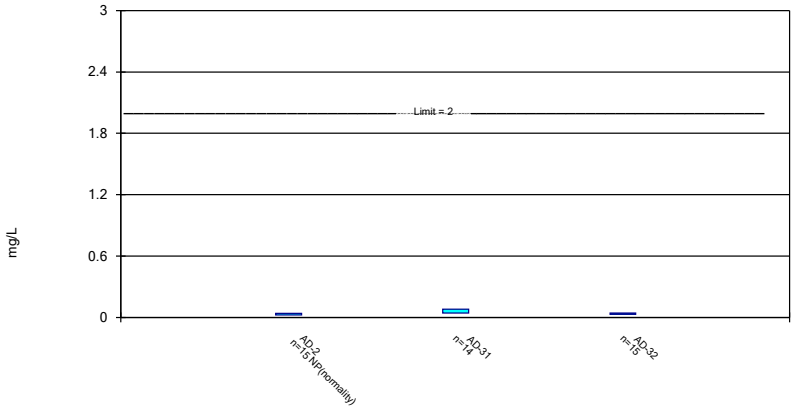


Constituent: Arsenic, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

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



Constituent: Barium, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

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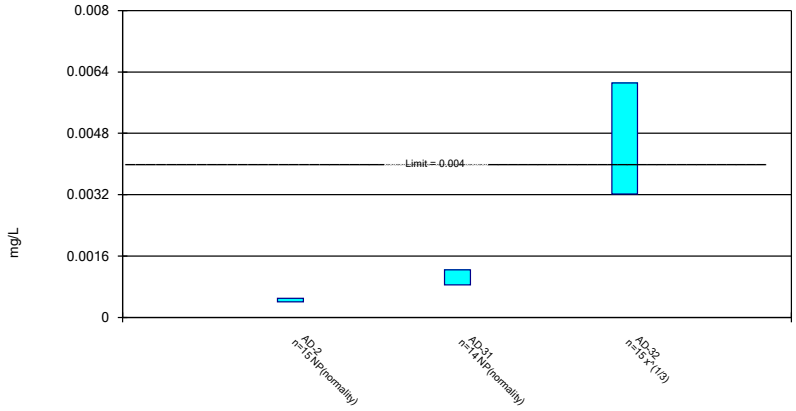
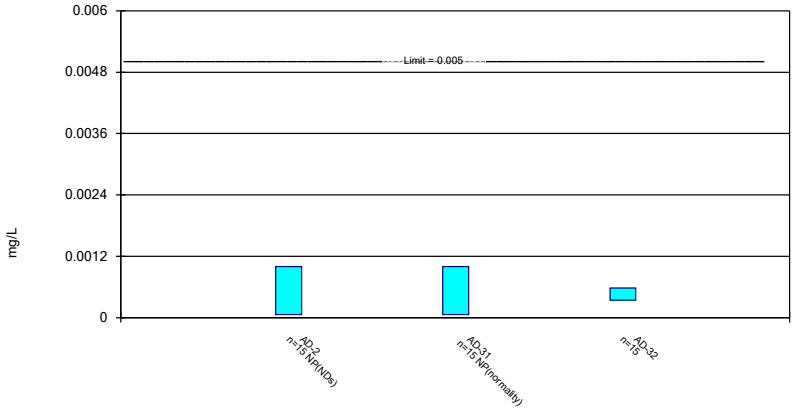


Constituent: Beryllium, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

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

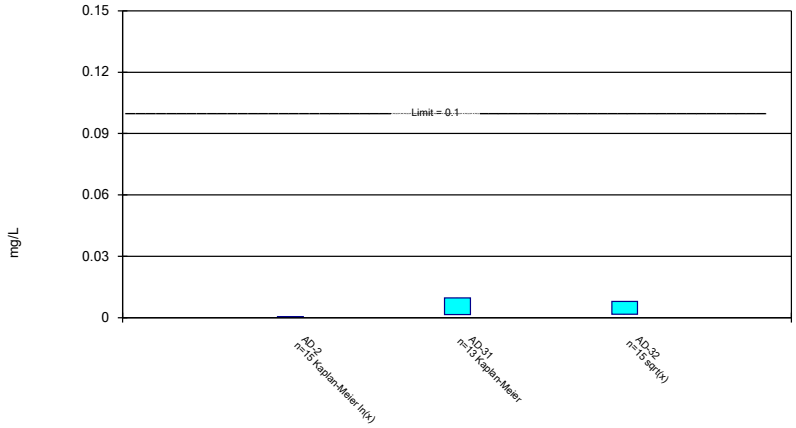


Constituent: Cadmium, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric Confidence Interval

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



Constituent: Chromium, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

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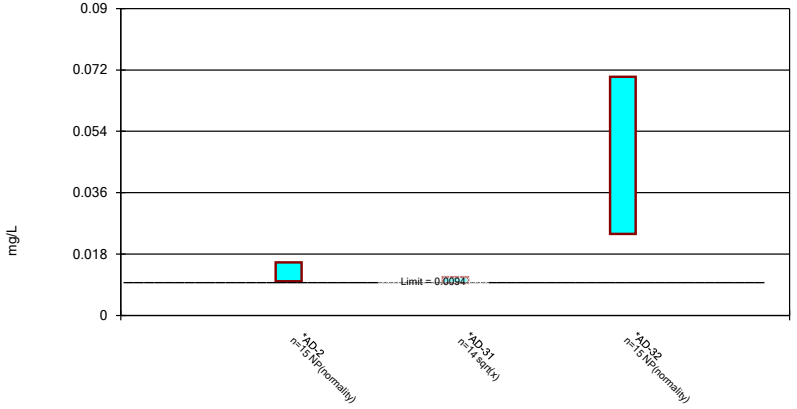
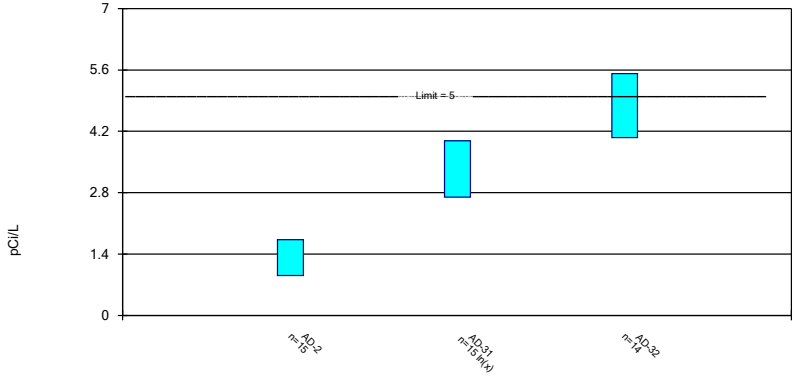


Constituent: Cobalt, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric Confidence Interval

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

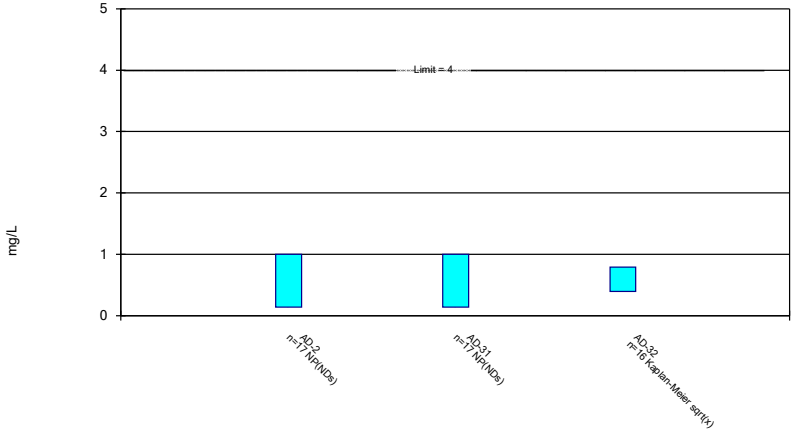


Constituent: Combined Radium 226 + 228 Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

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

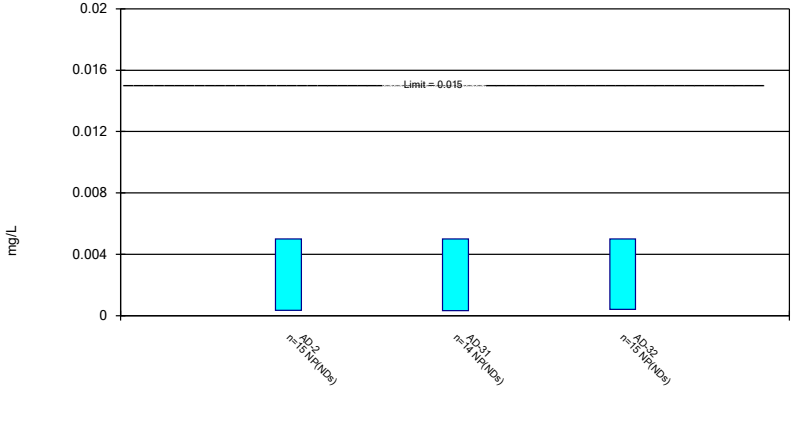


Constituent: Fluoride, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Non-Parametric Confidence Interval

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



Constituent: Lead, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric and Non-Parametric (NP) Confidence Interval

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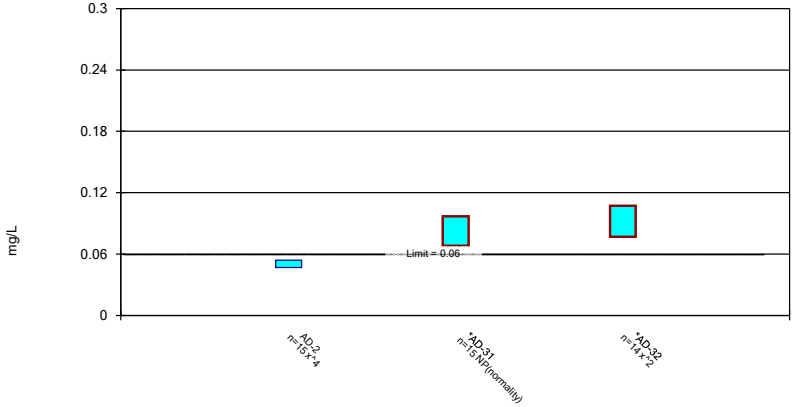

Constituent: Lithium, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Parametric Confidence Interval

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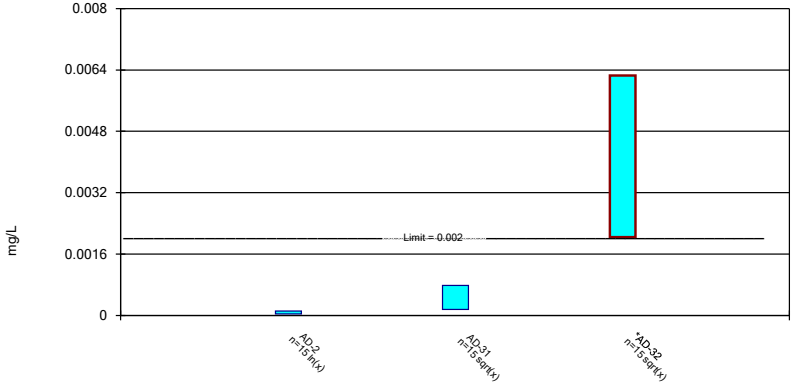


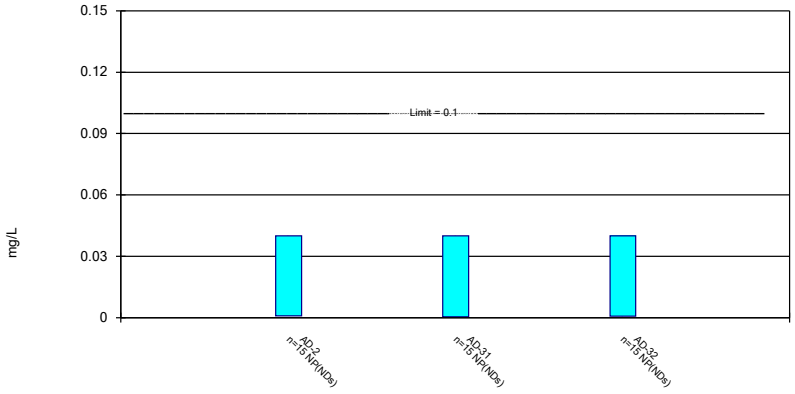
Constituent: Mercury, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

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



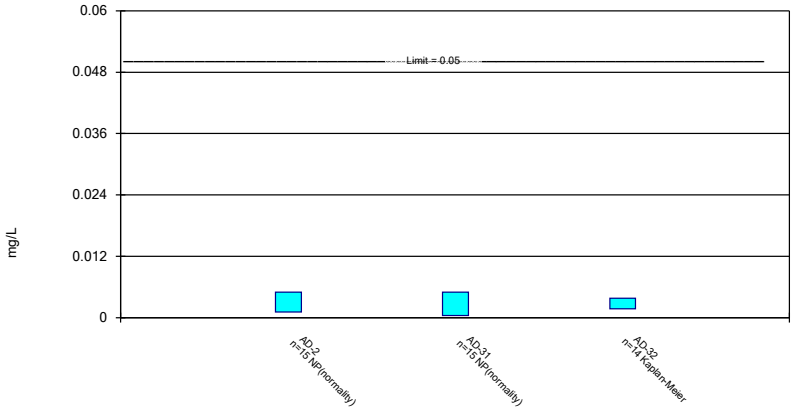
Constituent: Molybdenum, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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



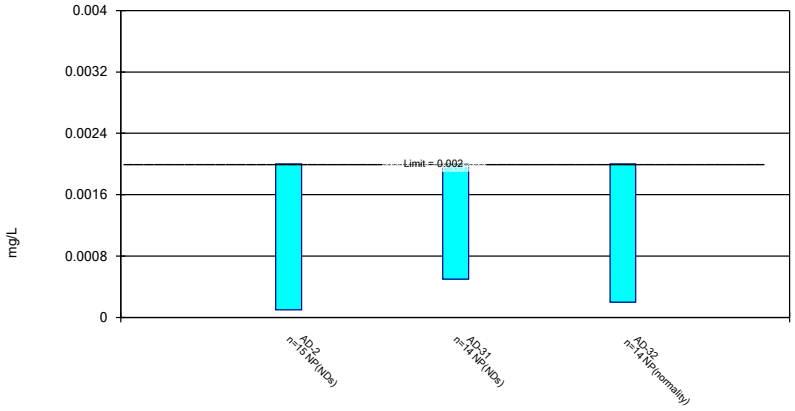
Constituent: Selenium, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

Sanitas™ v.9.6.27 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

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



Constituent: Thallium, total Analysis Run 9/8/2020 8:50 AM

Pirkey EBAP Client: Geosyntec Data: Pirkey EBAP

APPENDIX III

Alternate source demonstrations are included in this appendix. Alternate sources are sources or reasons that explain that statistically significant increases over background or statistically significant levels above the groundwater protection standard are not attributable to the CCR unit.

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

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

Submitted to

AMERICAN ELECTRIC POWER

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

TABLES

FIGURES

ATTACHMENTS

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 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 calculated 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

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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

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

Geosyntec Consultants, Inc.

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

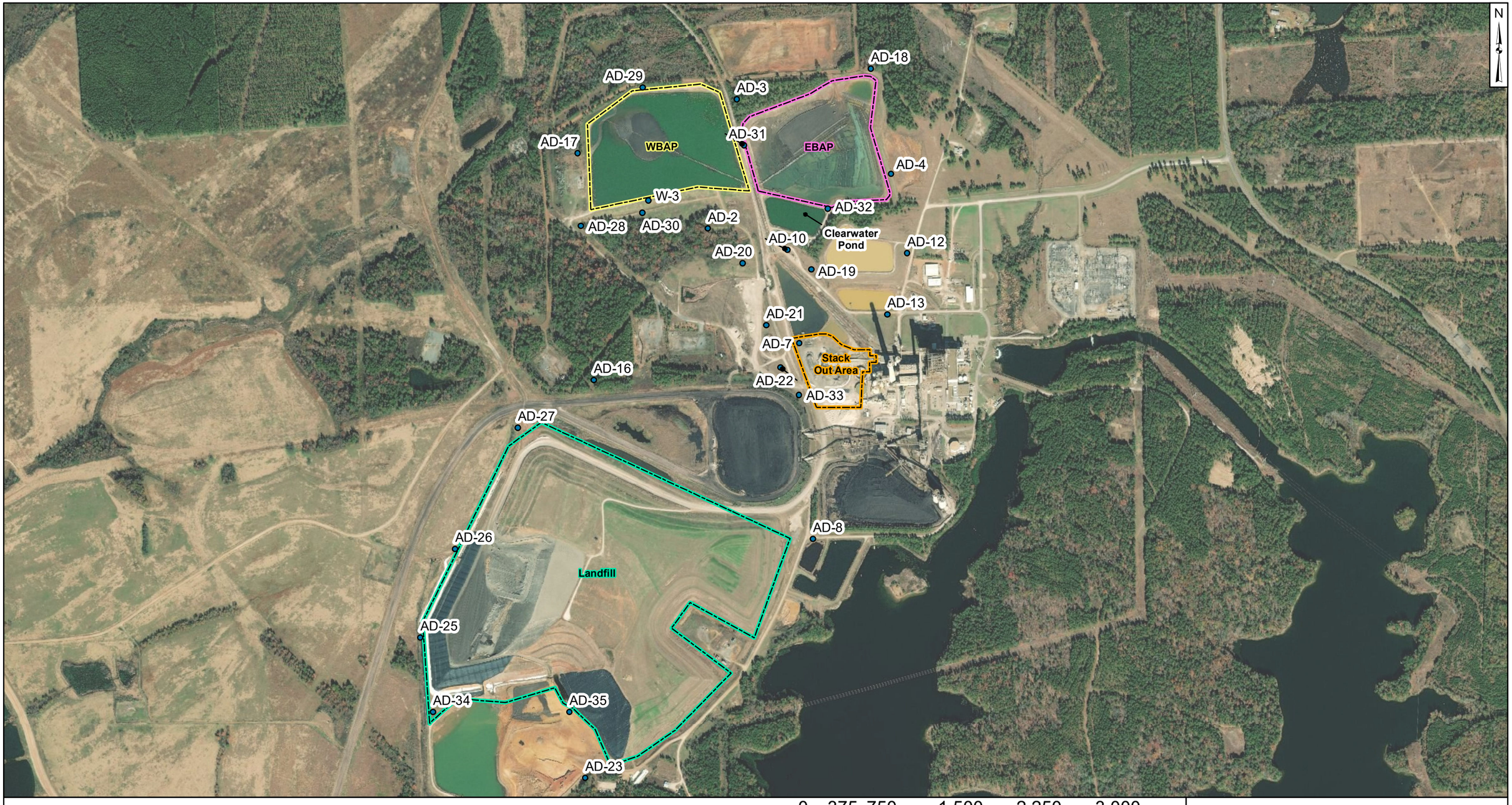
Source	B-2			Literature Value
Unit	mg/L	mg/kg	L/kg	L/kg
Element	**Aqueous Phase**	**Adsorbed**	**Kd**	**Kd**
Li	0.081	6.5	80	43-370
K	2.6	1100	423	42-1200
Na	14	130	9	5.2-82

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

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

Site Layout

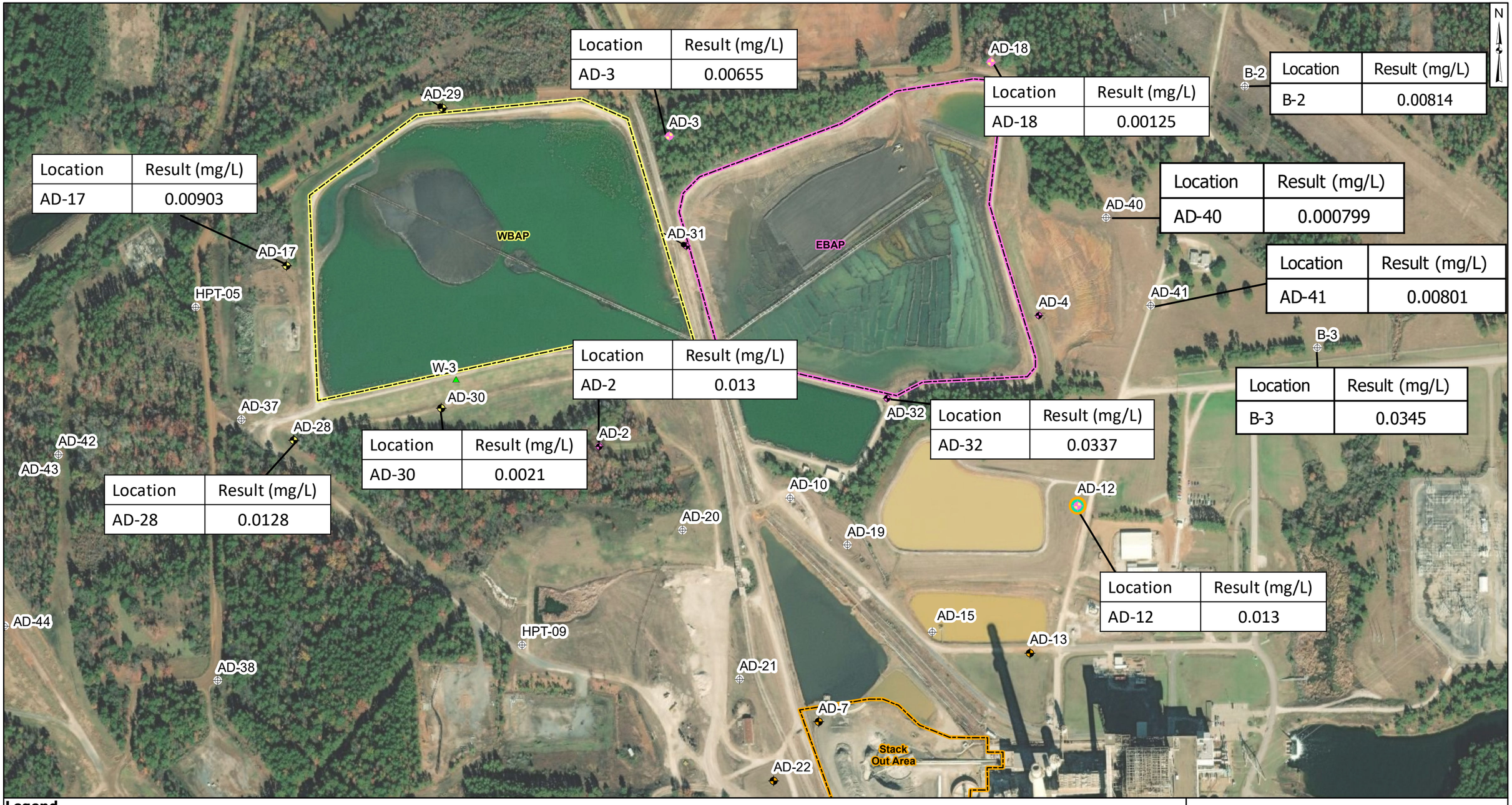
AEP Pirkey Power Plant
Hallsville, Texas

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
- Samples collected in August 2019
- AD-29 included in the well network for water level measurements only

400 200 0 400 Feet

Cobalt Distribution in Groundwater
August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/04/01

Figure **2**

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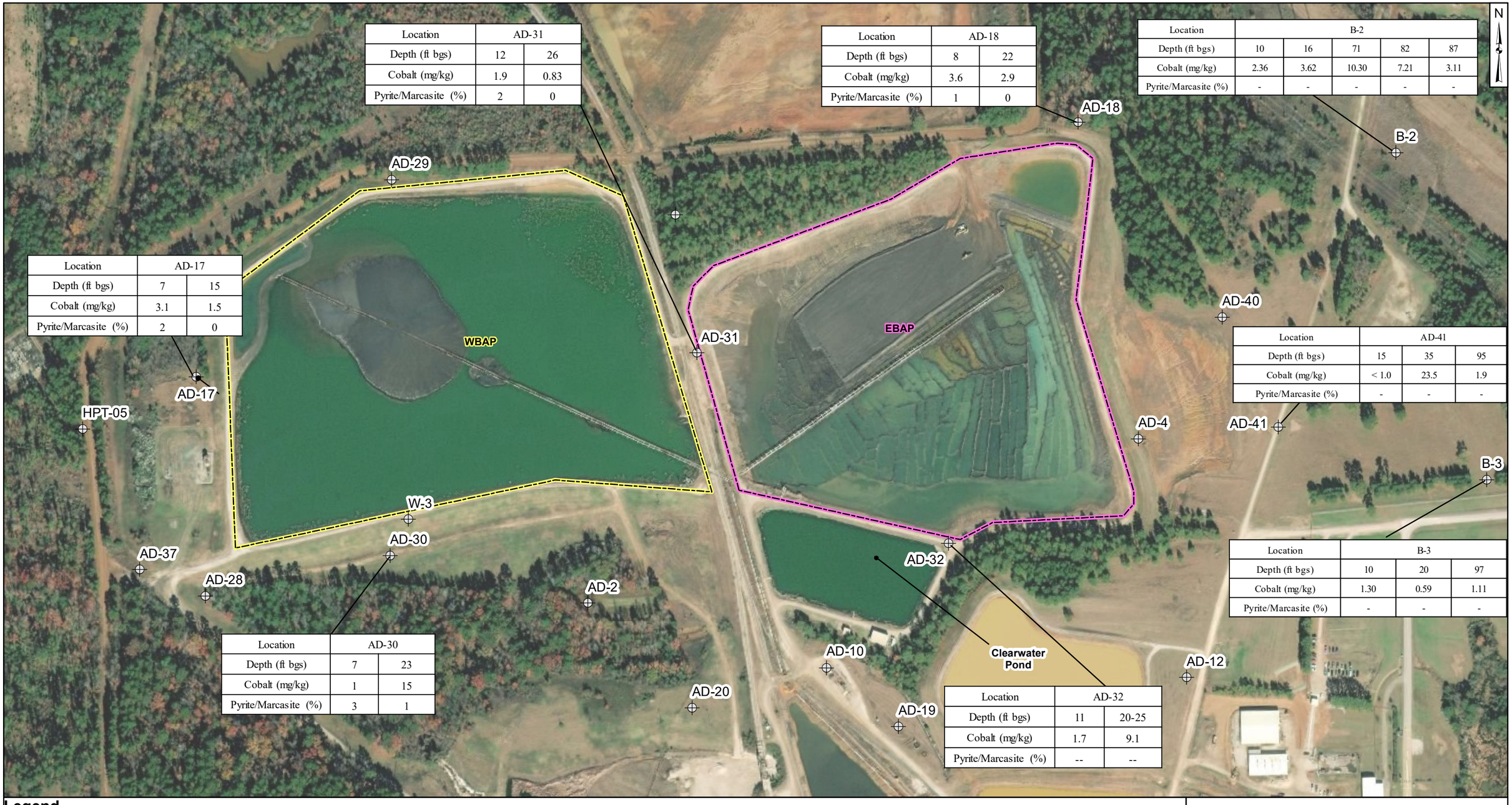


Location	AD-31	
Depth (ft bgs)	12	26
Cobalt (mg/kg)	1.9	0.83
Pyrite/Marcasite (%)	2	0

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	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.

300 150 0 300 Feet

Soil Chemical and Mineralogical Analysis Results

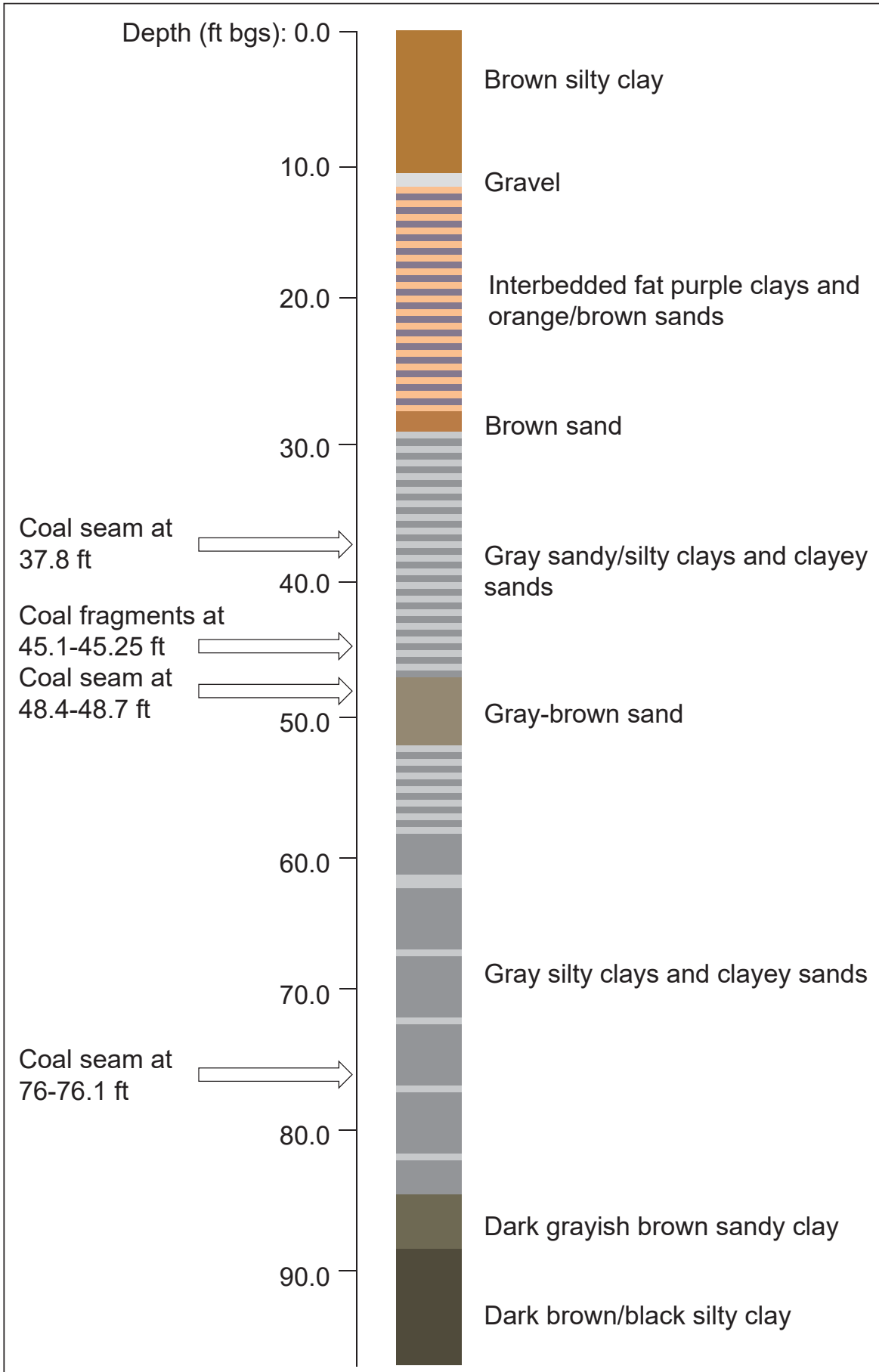
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/03/20

Figure **3**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\Pirkey_SoilChem_minerals_March2019.mxd. hduff. 9/18/2019. 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

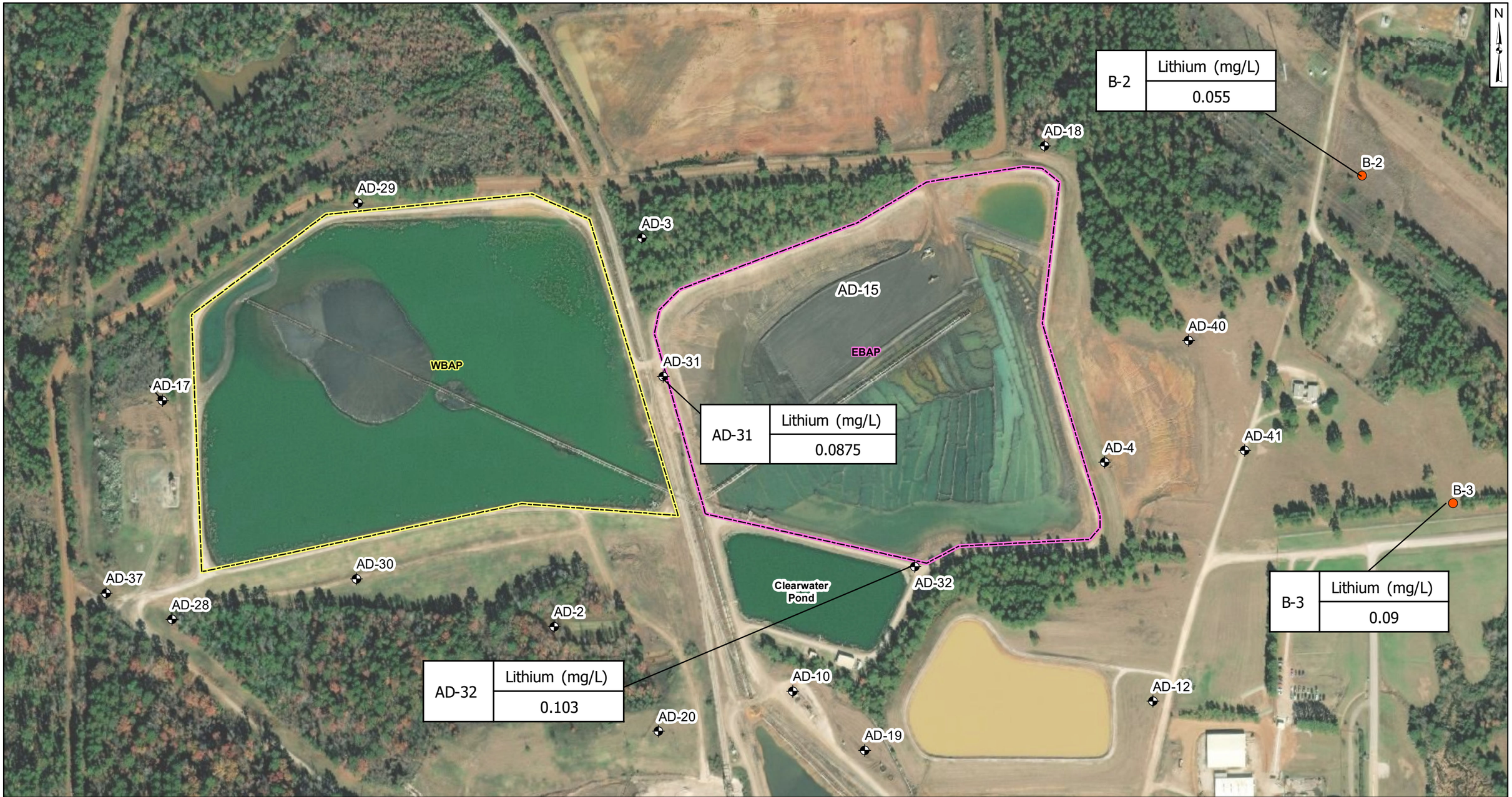
AEP Pirkey Powerplant
Hallsville, TX

Geosyntec consultants

CHA8495 | March 2020

Figure 4

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



Legend

- 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.

300 150 0 300
Feet

Lithium Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/03/20

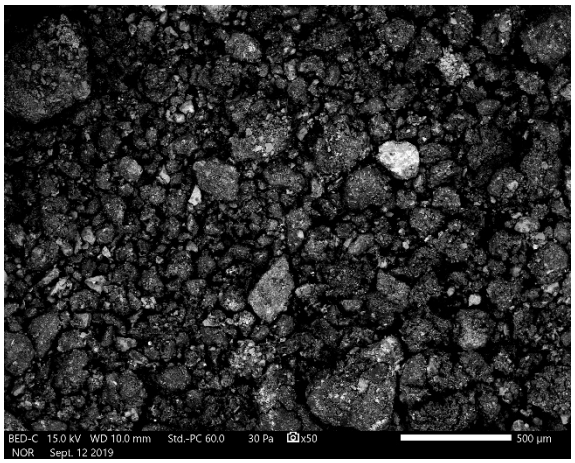
Figure **5**

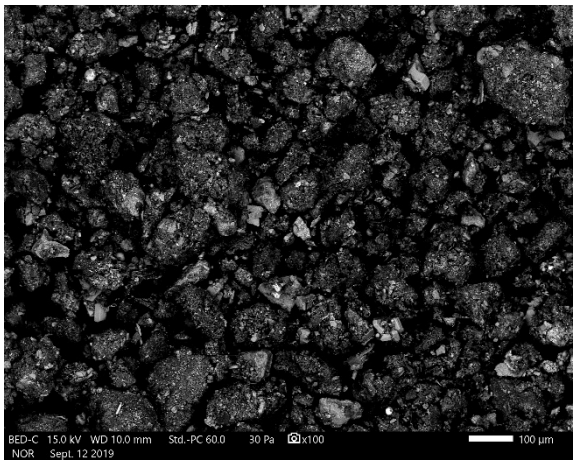
P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_Li_201909.mxd. hduff. 9/18/2019. CHA8462/12/02.

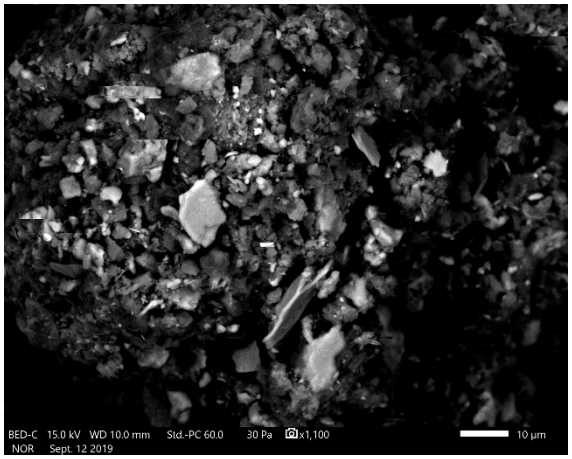
ATTACHMENT A
SEM/EDS Analysis

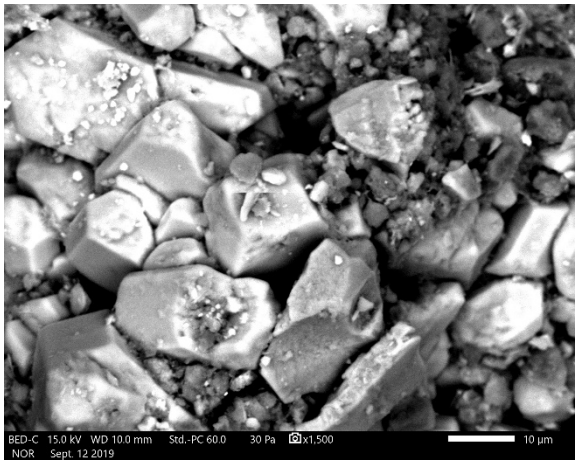
September 16, 2019

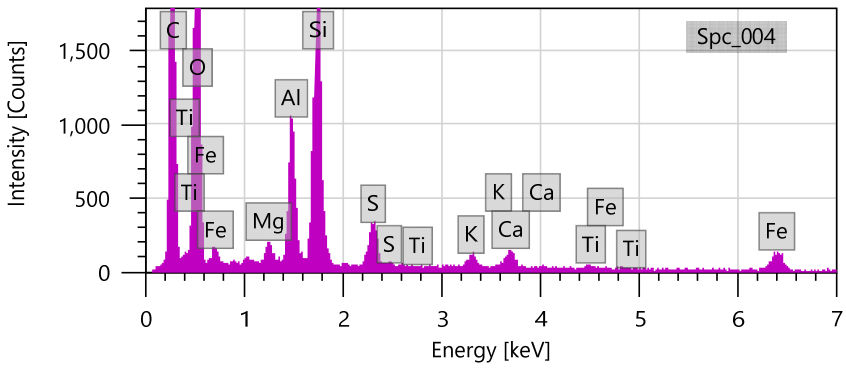
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221
via Email: BSass@geosyntec.com



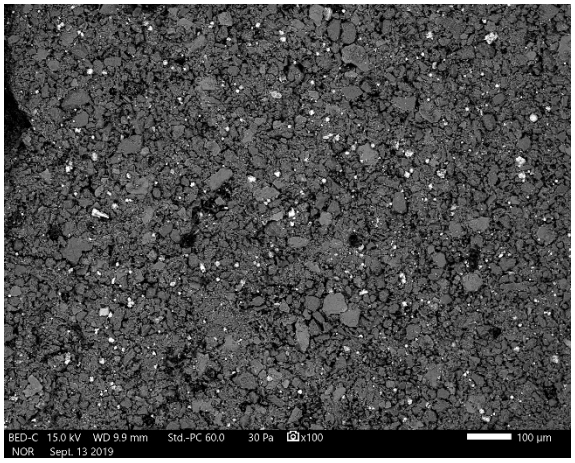


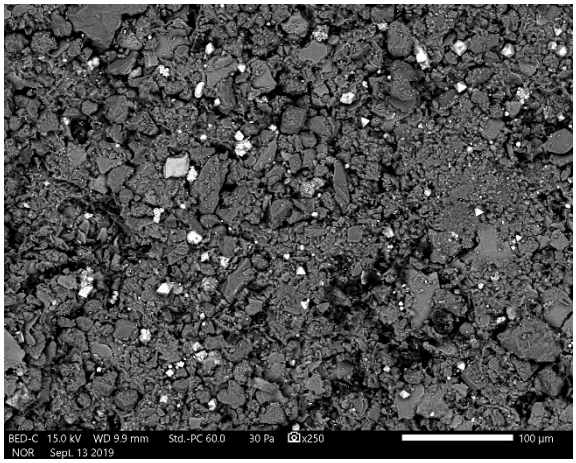


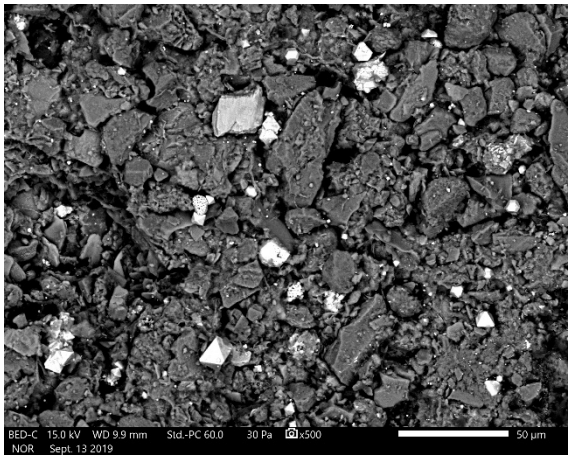


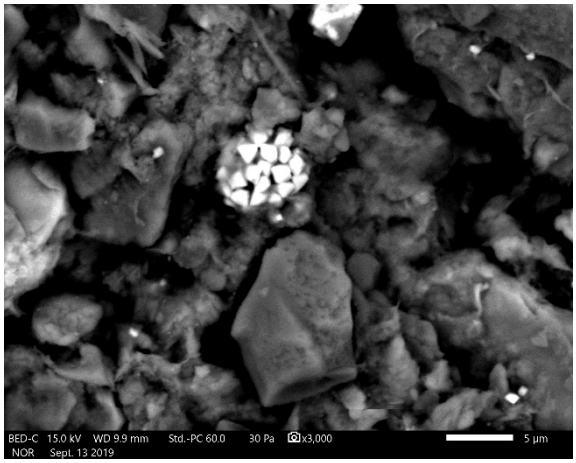


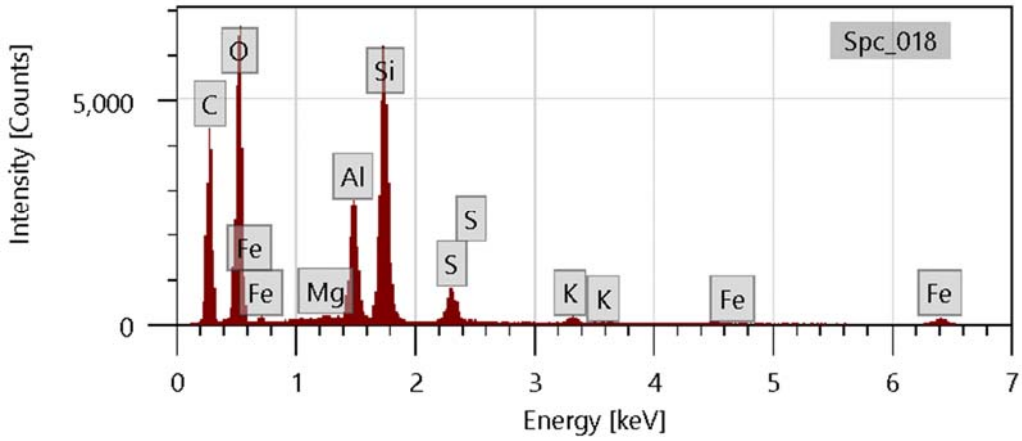
Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





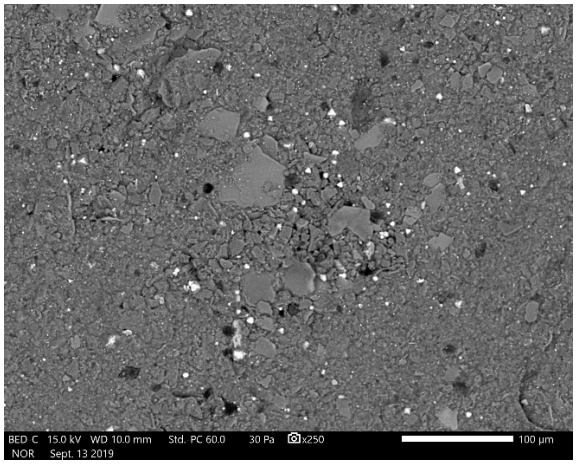


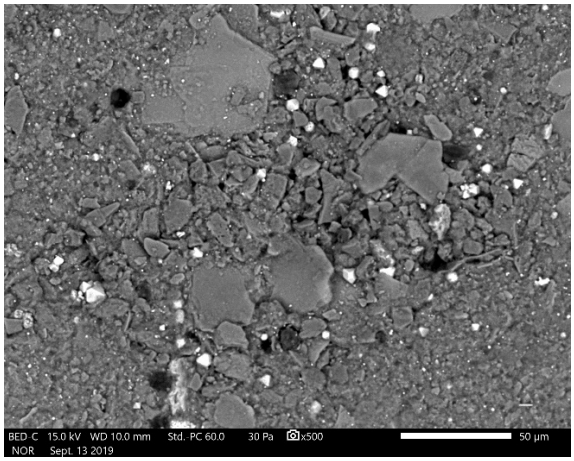


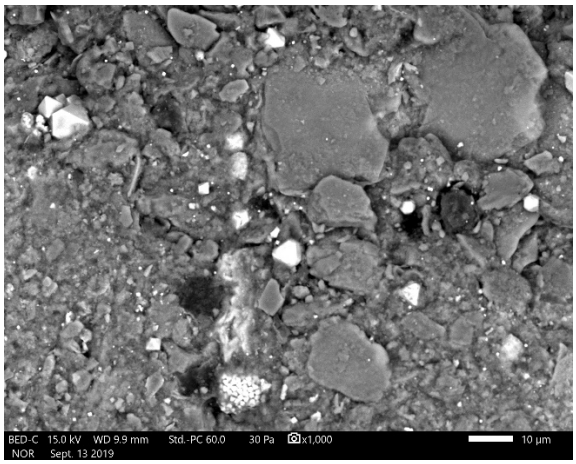


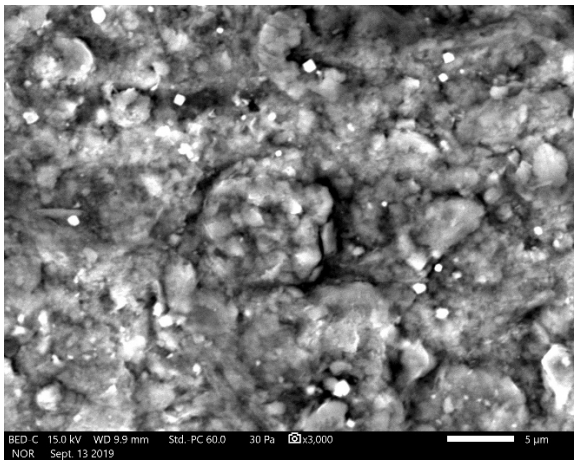
Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest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

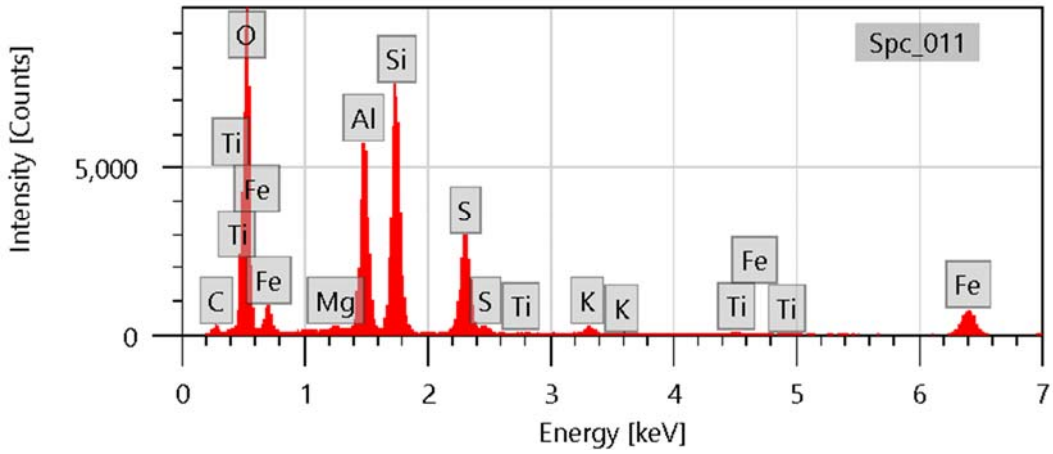
Geosyntec
CTLGroup 150350











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

ATTACHMENT 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	Texas	4/2/2020
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

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

Submitted to

AMERICAN ELECTRIC POWER

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

December 2020

CHA8495

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHMENTS

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
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, lithium, and mercury in the groundwater monitoring network at the H.W. Pirkey Plant East Bottom Ash Pond (EBAP) following the first semiannual 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, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the EBAP (**Figure 1**). In June 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 (AEP, 2017) 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 parameter were present at a statistically significant level (SSL) above the GWPS. 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:

- The LCL for cobalt exceeded the GWPS of 0.00939 mg/L at AD-2 (0.0100 mg/L), AD-31 (0.00942 mg/L), and AD-32 (0.0239 mg/L);
- The LCL for lithium exceeded the GWPS of 0.060 mg/L at AD-31 (0.0682 mg/L) and AD-32 (0.0770 mg/L); and
- The LCL for mercury exceeded the GWPS of 0.00200 mg/L at AD-32 (0.00204 mg/L).

No other SSLs were identified (Geosyntec, 2020a).

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, lithium, and mercury 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, lithium, and mercury 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, lithium, and mercury 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 ASDs 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 seasonal effects, 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). The previous ASDs demonstrated that the EBAP is not a source for cobalt in downgradient groundwater, based on observed concentrations of cobalt both in the ash material and in leachate from Synthetic Precipitation Leaching Procedure (SPLP) analysis (SW-846 Test Method 1312, [USEPA, 1994]) of the ash material. Cobalt was not detected in the SPLP ash leachate above the reporting limit of 0.01 mg/L.

To support this ASD determination, 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 groundwater cobalt concentrations for in-network wells from the most recent sampling event, and approximately two orders of magnitude lower than recent groundwater samples 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.

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 on **Figure 2**. Groundwater cobalt concentrations at upgradient locations varied from 0.000799 mg/L (at AD-40) to 0.0108 mg/L (at B-3). This wide range in cobalt concentrations provides further evidence for the natural variation of cobalt at the Site, particularly as the concentration at upgradient location B-3 exceeds the GWPS for the EBAP.

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 a previous ASD, 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, 2019c). 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 at the EBAP in 2018 (**Table 4**). These concentrations are lower than the average lithium concentrations at AD-2 and AD-32 (**Table 4**). The mobile fraction identified by SPLP was even lower, with an estimated lithium concentration of 0.011 mg/L. Thus, the EBAP is not the likely source of lithium at AD-2 and AD-32.

Groundwater samples collected from upgradient wells B-2 and B-3 in November 2020 had total lithium concentrations of 0.063 mg/L and 0.103 mg/L, respectively, both of which were above the GWPS of 0.060 mg/L (**Figure 5**). Lithium was detected at AD-31 at 0.0682 mg/L, and AD-32 at 0.0696 mg/L, which were comparable to the observed concentration at B-2 and less than the observed concentration at B-3. 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.

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, 2019c). K_d values for groundwater and particulates collected from wells B-2, B-3, and AD-32 were comparable to literature K_d values reported for organic-rich media such as bogs and peat beds (Sheppard et al., 2009; Sheppard et al., 2011), providing further evidence that lithium mobility in site groundwater is similar to other sites with organic-rich soils (**Table 6**). Additionally, the calculated K_d values for Pirkey soils were consistent with the literature, with potassium having the highest K_d (greatest affinity for sorption) and sodium the lowest K_d (least affinity for sorption). Furthermore, the values are similar for groundwater from all three wells, suggesting a universal mechanism controlling lithium, sodium, and potassium mobility in groundwater.

These multiple lines of evidence show that elevated lithium concentrations at AD-31 and AD-32 are 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.

2.1.3 Mercury

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. Mercury was not detected in the WBAP sample or a surface water sample previously collected from the EBAP (**Table 7**), with the reporting limits for these samples approximately one and three orders of magnitude lower than the average mercury concentration at AD-32 (**Table 7**). Thus, the EBAP is not the likely source of mercury at AD-32.

Dissolved concentrations of mercury at AD-32 are consistently lower than the reported total values (**Figure 6**), with no dissolved concentrations detected above the MCL of 0.002 mg/L. The recorded turbidity at the time of sampling was often elevated, with values ranging from approximately 45 to 450 nephelometric turbidity units (NTUs; **Figure 7**). The inclusion of suspended particles (including colloids) in samples with elevated turbidity is likely to result in an overestimation of metals due to the mobilization of metals from the colloidal or solid to aqueous phase following acid preservation during sample collection. Thus, the completion of low-flow purging of the well until field water quality parameters have stabilized is necessary to ensure the collected sample is representative of actual groundwater concentrations (USEPA, 1996). While low-flow purging was completed, a review of sample logs found multiple instances where turbidity did not stabilize within 10% for three consecutive readings, as recommended by TCEQ (TCEQ, 2020; **Attachment D**).

The difference between the total and dissolved mercury concentrations suggests that mercury is associated with the colloidal fraction that is captured in samples collected with elevated turbidity. Mercury 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. 1.71 Å for mercury (Clementi and Raimondi, 1963; Manceau et. al, 2018). As documented in Section 2.1.1., pyrite was identified in aquifer solids in the vicinity of the EBAP, including from samples collected adjacent to AD-32 (**Figure 3**). Mercury was identified in the centrifuged solid material collected from upgradient VAP location B-3[VAP-B3-(40-45)] at 1.1 mg/kg (**Table 7**); pyrite was detected in this same sample at 3% (**Table 3**).

The abundance of pyrite across the site, including upgradient locations, and the likely association of mercury with pyrite suggests that the pond is not the likely source of mercury at AD-32. The currently calculated LCL of 0.00204 mg/L is negligibly above the MCL of 0.002.

2.2 Sampling Requirements

As the ASD described 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 supports the position that the SSLs for cobalt, lithium, and mercury during assessment monitoring in June 2020 were not due to a release from the EBAP. The identified SSLs were instead attributed to natural variation. 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

Geosyntec Consultants, Inc.

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 - June 2020	mg/L	0.0134
AD-31 - Average	May 2016 - June 2020	mg/L	0.0136
AD-32 - Average	May 2016 - June 2020	mg/L	0.0450

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 *Geosyntec Consultants, Inc.*
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

Geosyntec Consultants, Inc.

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-2 - Average	May 2016 - June 2020	mg/L	0.0547
AD-32 - Average	May 2016 - June 2020	mg/L	0.150

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

Geosyntec Consultants, Inc.

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).

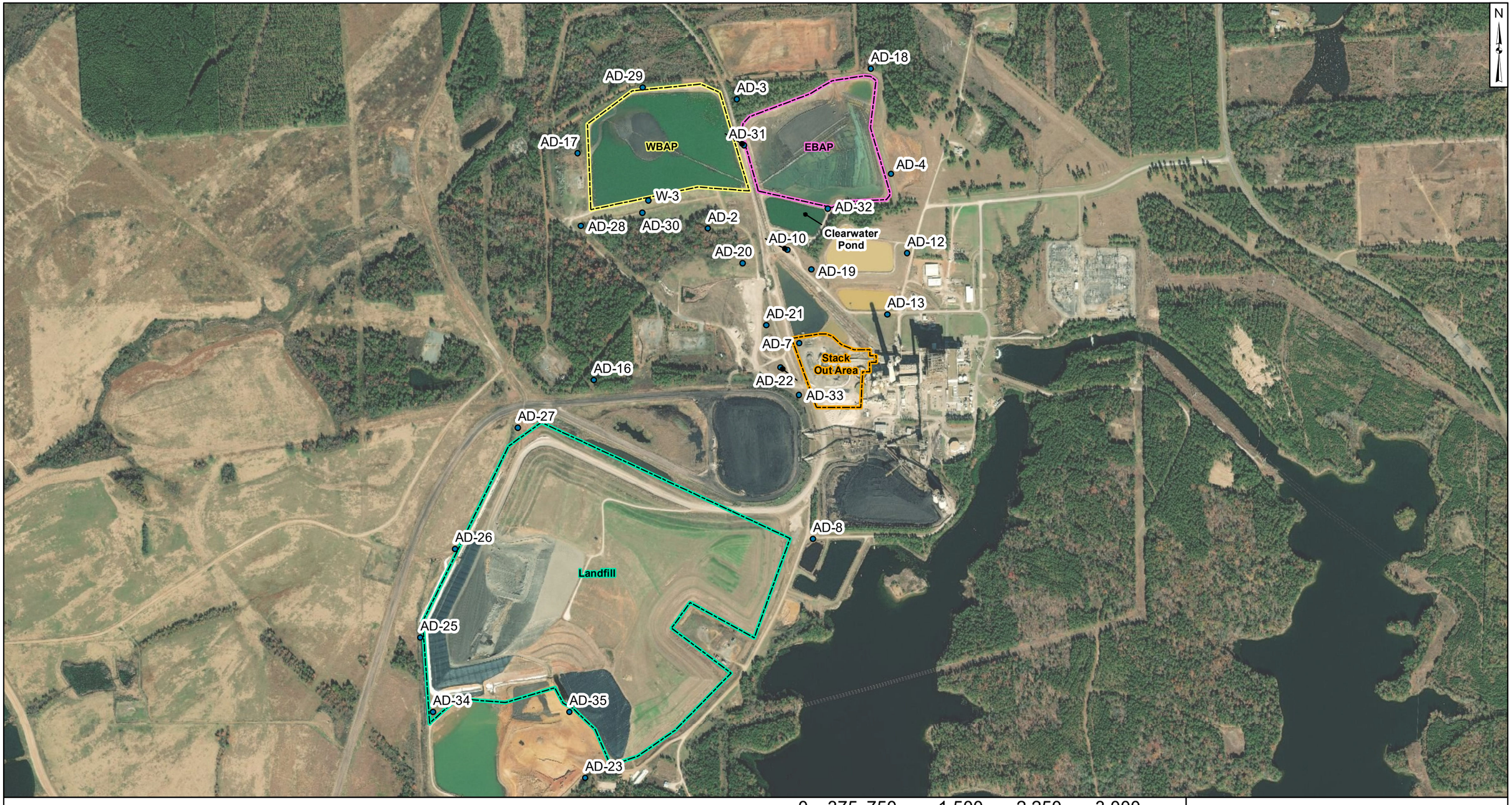
Table 7: Summary of Key Mercury Analytical Data
East Bottom Ash Pond - H.W. Pirkey Plant

Geosyntec Consultants, Inc.

Sample	Sample Date	Unit	Mercury Concentration
VAP-B3-(40-45)	6/19/2019	mg/kg	1.1
Bottom Ash (Solid Material)	2/11/2019	mg/kg	<0.13
SPLP Leachate of Bottom Ash	2/11/2019	µg/L	<0.20
EBAP Pond Water	12/15/2018	µg/L	<0.2
WBAP Pond Water	11/4/2020	µg/L	<0.002
AD-32 - Average	May 2016 - June 2020	µg/L	4.56

Notes:
mg/kg - milligram per kilogram
µg/L - microgram per liter
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 mercury data collected under 40 CFR 257 Subpart D, excluding any identified outliers.
VAP-B3-(40-45) represents the solid phase that was separated via centrifugation from an aqueous sample at boring B-3.

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

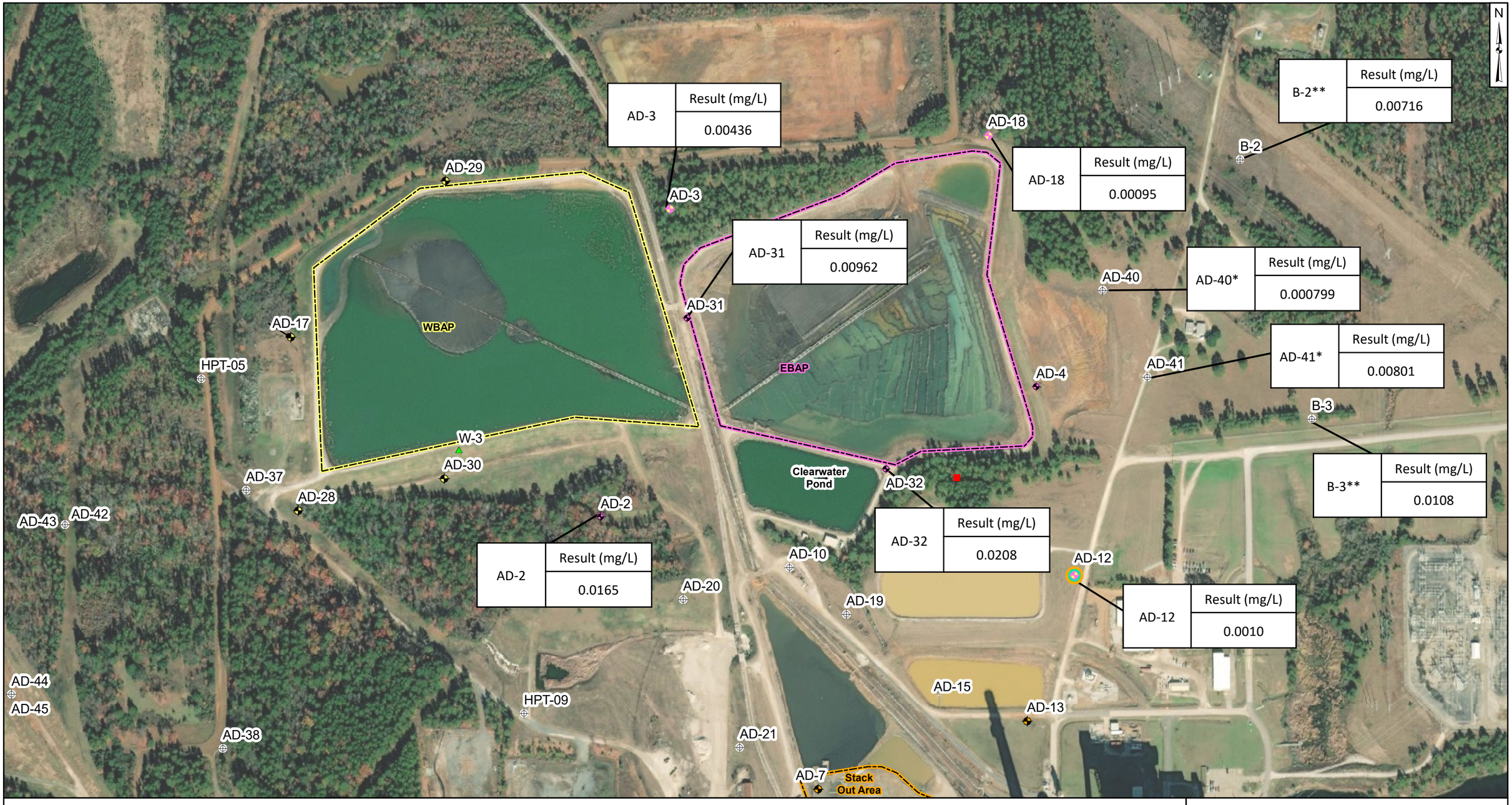
AEP Pirkey Power Plant
Hallsville, Texas

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
- Samples collected in June 2020
- * - Well most recently sampled August 2019
- ** - Well most recently sampled November 2020
- AD-29 included in the well network for water level measurements only

400 200 0 400 Feet

Cobalt Distribution in Groundwater

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/12/22

Figure **2**

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP_Pirkey_Cobalt_20201222.mxd. CChristenson. 12/22/2020. 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 (%)	--	--

AD-29, AD-31, AD-18, B-2, AD-40, AD-17, HPT-05, AD-4, AD-41, B-3, W-3, AD-30, AD-37, AD-28, AD-2, Clearwater Pond, AD-32, AD-10, AD-12, AD-20, AD-19

WBAP

EBAP

N

Legend

- Monitoring Wells
- EBAP
- WBAP

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

300 150 0 300 Feet

Cobalt Distribution in Soil

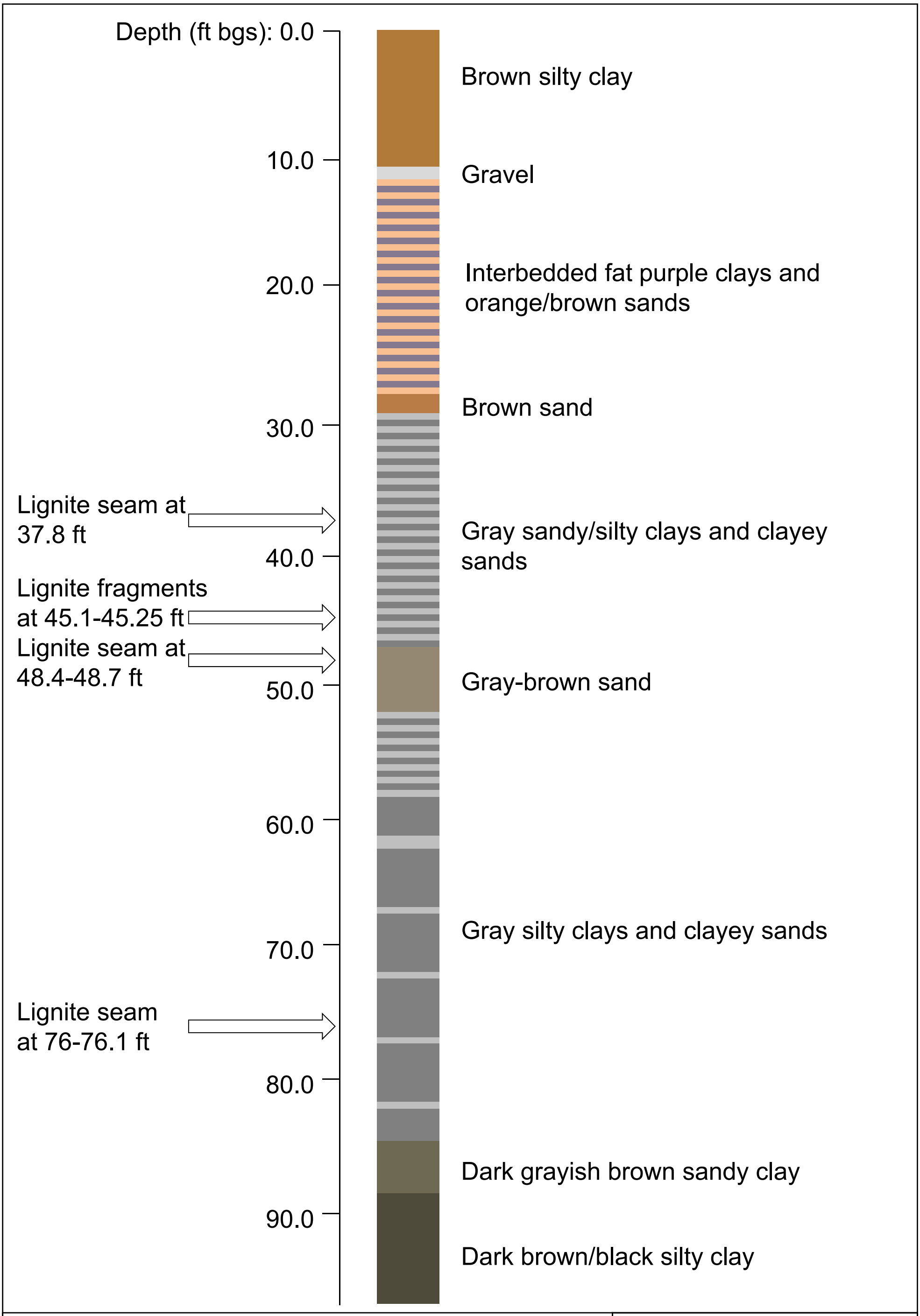
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/12/22

Figure 3

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



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

B-3 Visual Boring Log

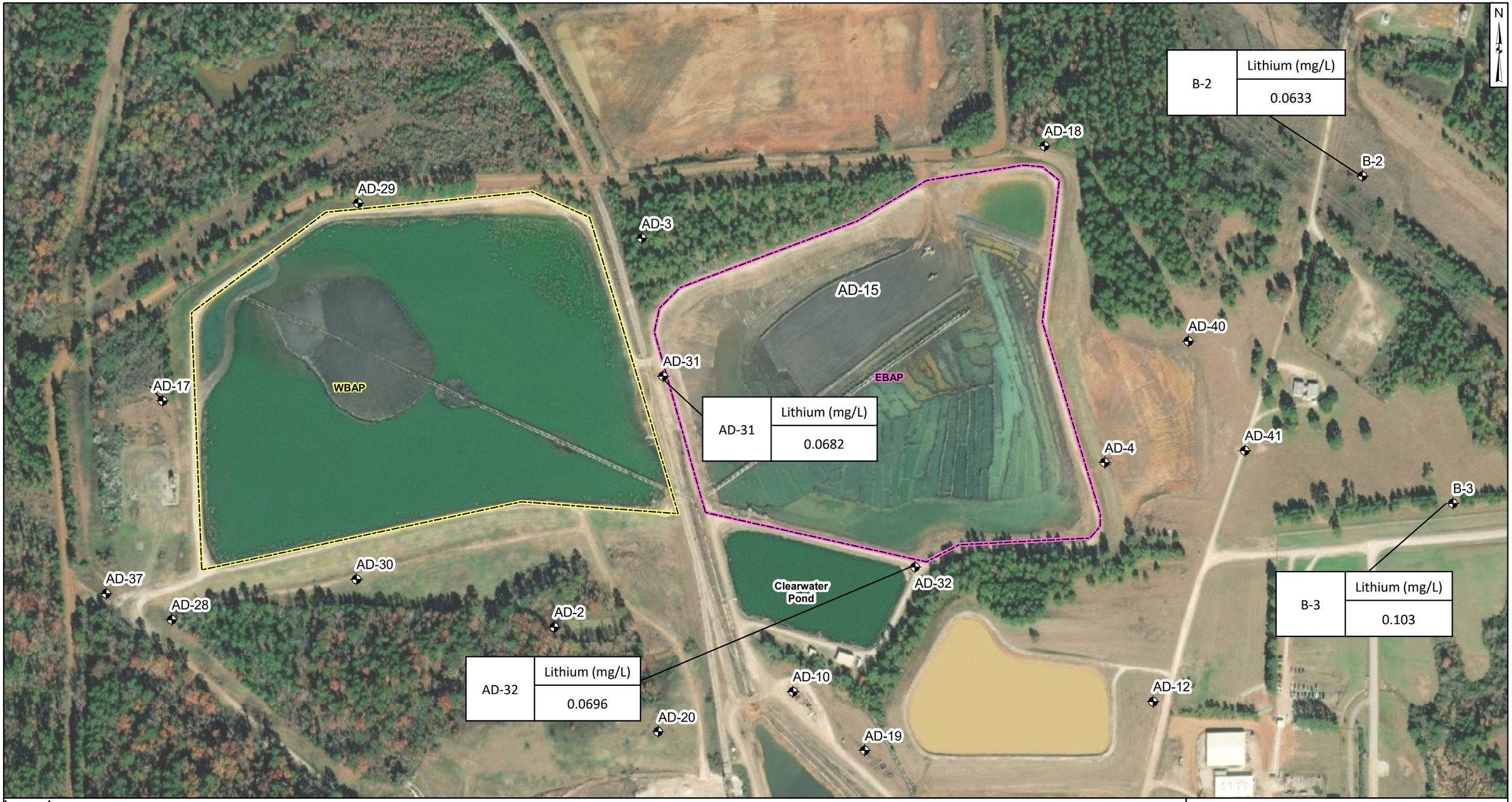
AEP Pirkey Powerplant
Hallsville, TX

Geosyntec consultants

CHA8462 | March 2020

Figure 4

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



Legend

- 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 were collected from AD-31 and AD-32 in June 2020
- Groundwater samples were collected from B-2 and B-3 in November 2020

300 150 0 300 Feet

Lithium Distribution in Groundwater

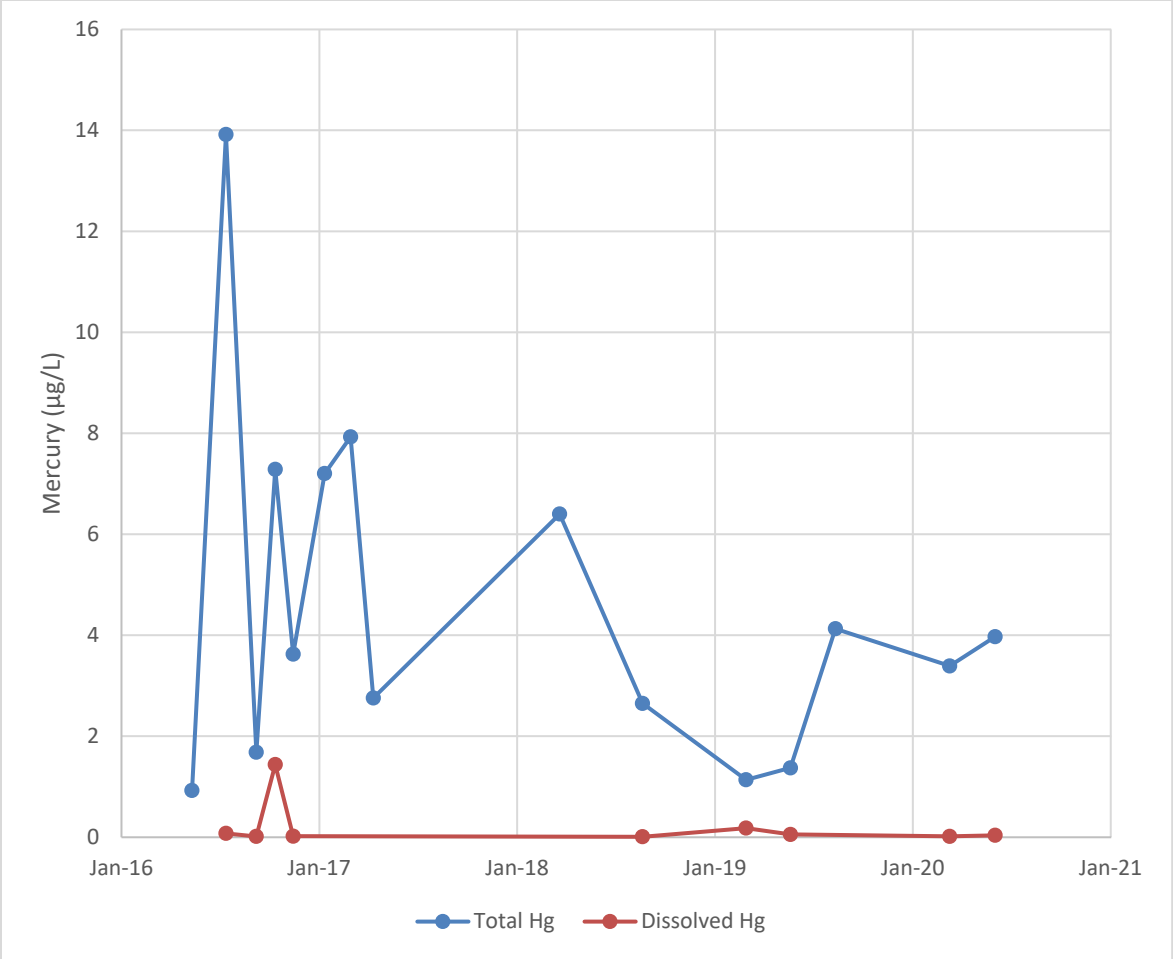
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/12/22

Figure **5**

\\annarbor-01\data\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_Li_20201222.mxd. CChristenson. 12/22/2020. CHA8462/12/02.

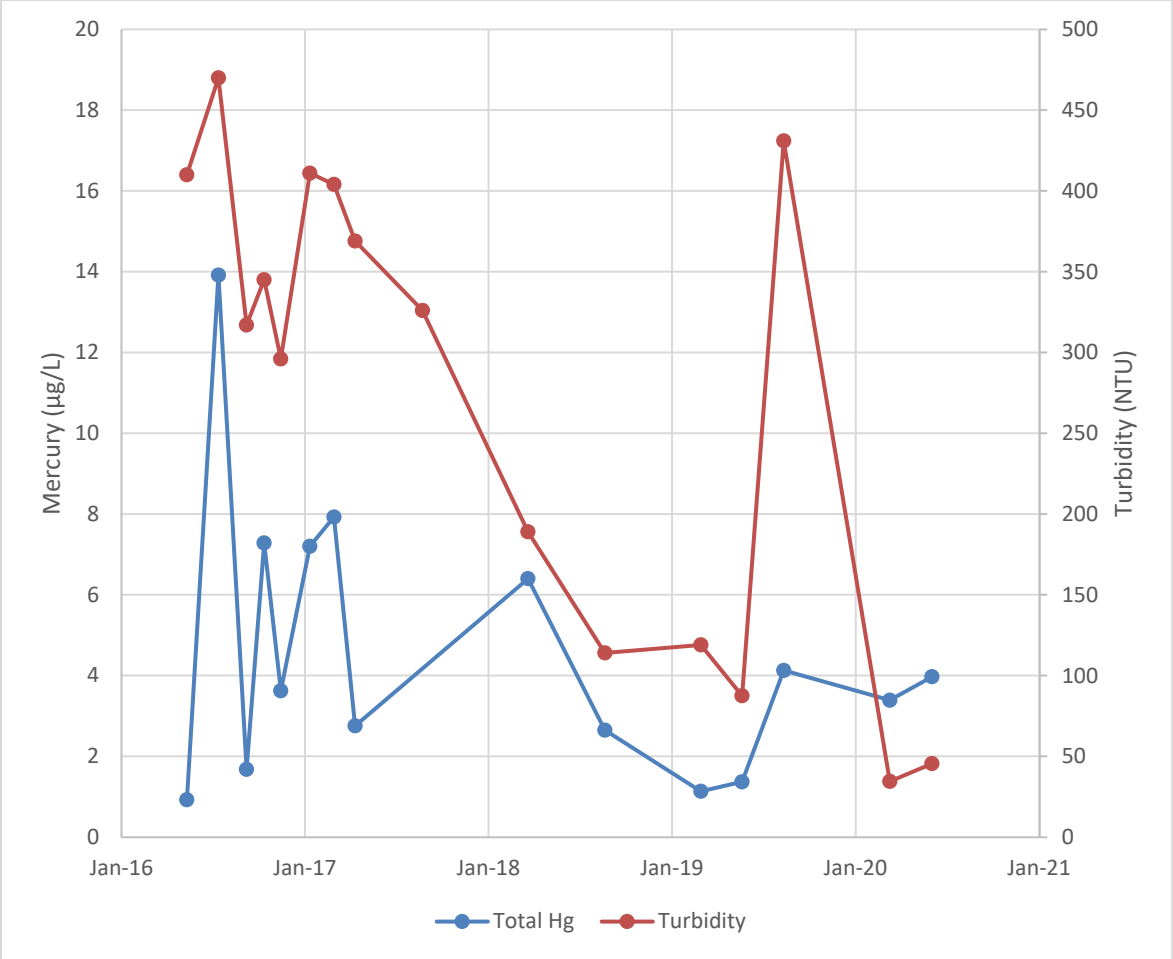


Notes: Total and dissolved mercury results at AD-32 are shown. Concentrations are shown in micrograms per liter (µg/L).

Total and Dissolved Mercury Concentrations
East Bottom Ash Pond – H.W. Pirkey Plant

Geosyntec consultants | AMERICAN ELECTRIC POWER | Figure 6

Columbus, Ohio | 22-December-2020



Notes: Total mercury results and field turbidity measurements at AD-32 are shown. Mercury concentrations are shown in micrograms per liter (µg/L). Turbidity is shown as as nephelometric turbidity units (NTU).

Mercury and Turbidity Time Series Graph
East Bottom Ash Pond – H.W. Pirkey Plant

Geosyntec consultants | AMERICAN ELECTRIC POWER | Figure 7

Columbus, Ohio | 22-December-2020

internal info: path, date revised, author

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

Sample Interval TEST ASSIGNMENT	SAMPLE NO. Recovery	DEPTH FT.	SAMPLES	STRATUM DESCRIPTION: CONDITION OR CONSISTENCY	COLOR	MINOR MATERIALS OR ADJECTIVES	PREDOMINATE MATERIAL	CHARACTERISTICS OR MODIFICATIONS	STANDARD PENETROMETER: SEAT - 6"	1st - 6"	2nd - 6"	UNIFIED SOIL CLASSIFICATION	N - VALUE OR HAND PENETROMETER
SM	0-5 2' Rec	0		0-8'	Br, Lt. Rd Br	Si	Sa	Silty Sand - trace clay, trace root hairs, moist.					
												moist	(0-5')
8'	5-10 2.5' Rec				Lt. Rd Br			- thin lenses (less than 1/4")				moist	(5-10')
								at 7.5', trace iron staining					
Cl	10-15 4' Rec	8		8-14.5	Lt. Rd Br, Rd Br, Gray	Sa, Si	Cl	Clay - some silty sand and silty clayey sand in interbeds to 14.5', trace iron ore gravel in sand seams @ 10.5', 12', 12.5'				moist	(10-15')
14.5'													
	15-20 2' Rec	14.5		14.5-39'	Rd Br, Yllw. Br, Gray	Si, Cl	Sa	silty/clayey Sand - some sandy clay, iron cemented sand @ 16.5' and ironstone (1.5")				v. moist to moist	(15-20')
	20-25' * No Rec.							- cemented sand seams in silty sand @ 20-25'				v. moist	(20-25')
SC	25-30' 2.5' Rec				Gray - DK Gray DK. Br			- gravel & cemented sand seam @ 25'	(6")			sat. @ 25'-25.5'	
								- cemented sand, partially cemented					
					(25-39')			clayey silty sand @ 25.5'				moist	25.5-27
								- dark gray silty sat sand seam @ 27'	(2")			sat. @ 27.0'	(2")
	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, dry stalk in clayey sand between sat. sand seams (25-40')				v. moist (to 39')	
ML	35-40 4' Rec	39		39-46	Lt. Gray, Gray (39-46')	Cl, Si	Si	Clayey sandy silt, - interbedded silt & clay @ 39' to 40'				moist	(39-40')
								B.T. @ 40'					
								* 25-27' collected @ 1015					
								* 31-33' collected @ 1035					

Type Boring HSA Dry Auger ☒ Rotary Wash ☐

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

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

ATTACHMENT B

SB-2 Boring Photographic Log

GEOSYNTEC CONSULTANTS
Photographic Record

Geosyntec consultants

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

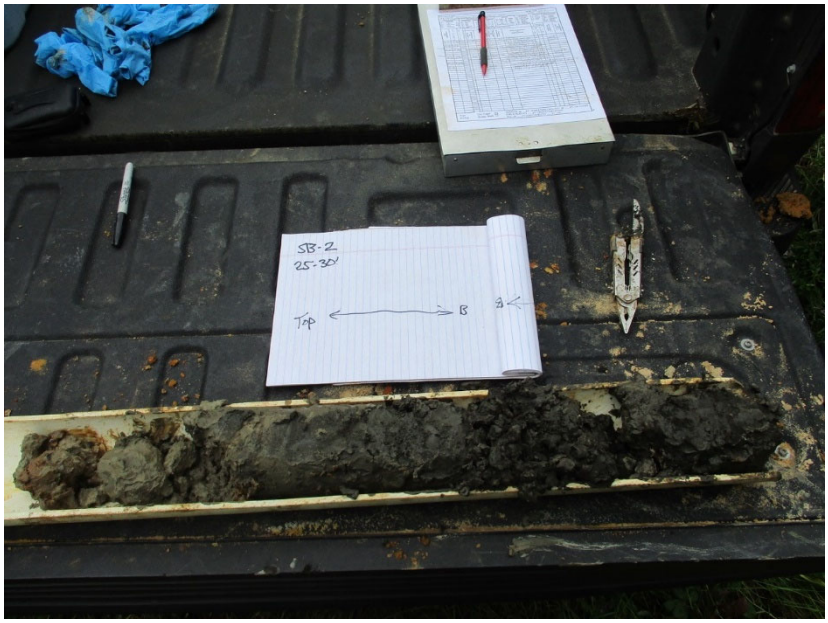
Photograph 1 **Date: 4/21/2020** **Direction: N/A** **Comments:** 0-5 foot interval of SB-2.	

Photograph 2 **Date: 4/21/2020** **Direction: N/A** **Comments:** 5-10 foot interval of SB-2.	

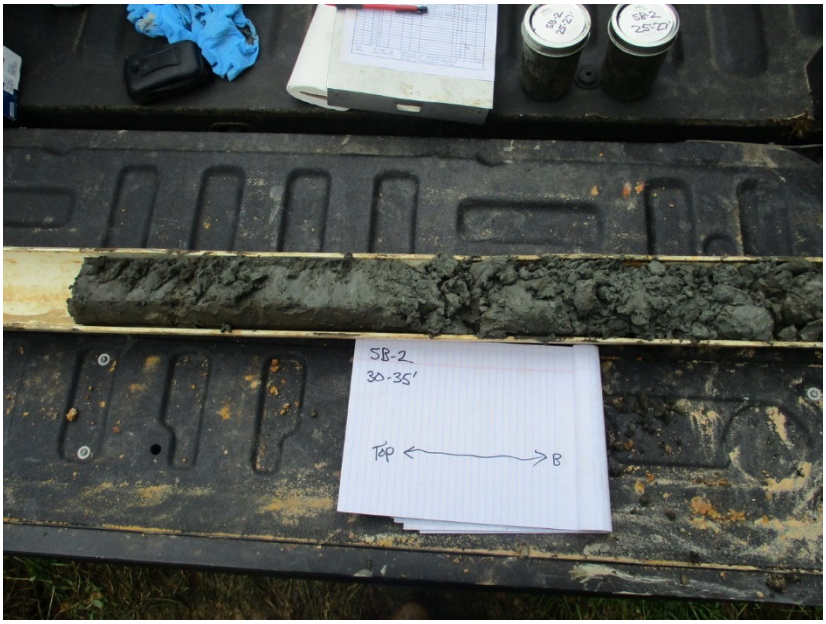
GEOSYNTEC CONSULTANTS Photographic Record	Geosyntec consultants
Client: AEP	**Project Number: CHA8495**
Site Name: Pirkey East Bottom Ash Pond	**Site Location: Hallsville, Texas**

Photograph 3 **Date: 4/21/2020** **Direction: N/A** **Comments:** 10-15 foot interval of SB-2.	
Photograph 4 **Date: 4/21/2020** **Direction: N/A** **Comments:** 15-20 foot interval of SB-2. Recovery of this interval was limited.	

GEOSYNTEC CONSULTANTS Photographic Record	Geosyntec consultants
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.	

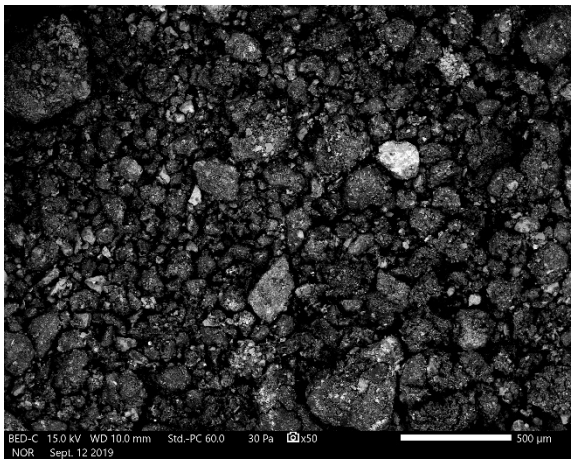
GEOSYNTEC CONSULTANTS Photographic Record	Geosyntec consultants
Client: AEP	**Project Number: CHA8495**
Site Name: Pirkey East Bottom Ash Pond	**Site Location: Hallsville, Texas**

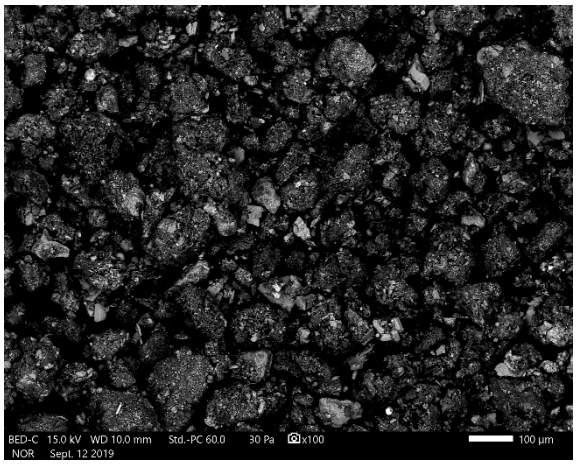
Photograph 9 **Date: 4/21/2020** **Direction: N/A** **Comments:** 30-35 foot interval of SB-2. Very little of this interval was recovered.. A sample was collected from this interval.	
Photograph 10 **Date: 4/21/2020** **Direction: N/A** **Comments:** 35-40 foot interval of SB-2	

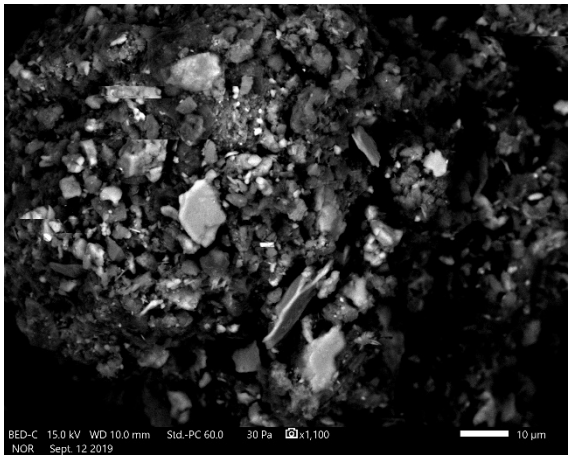
ATTACHMENT C
SEM/EDS Analysis

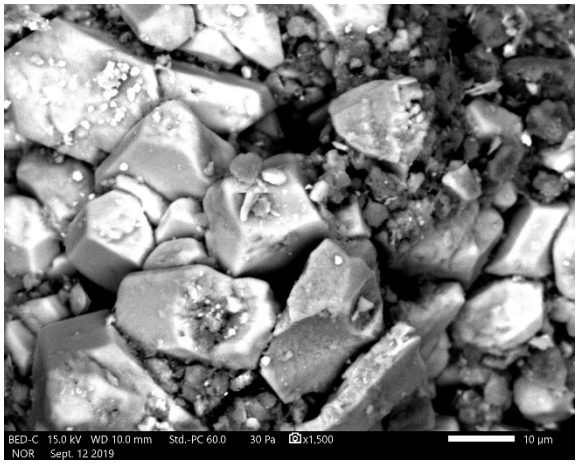
September 16, 2019

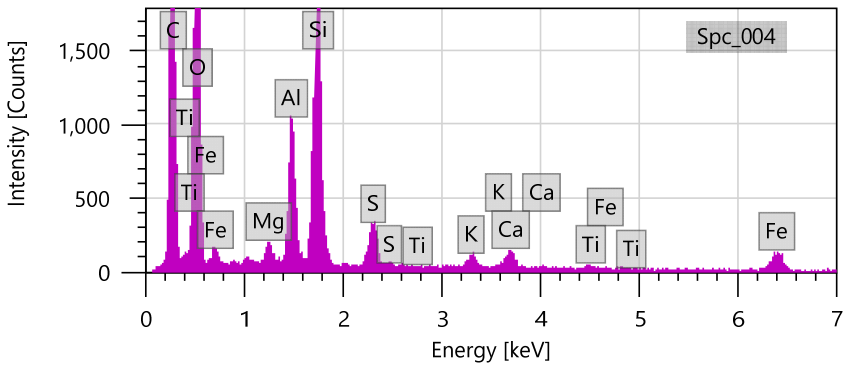
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221
via Email: BSass@geosyntec.com



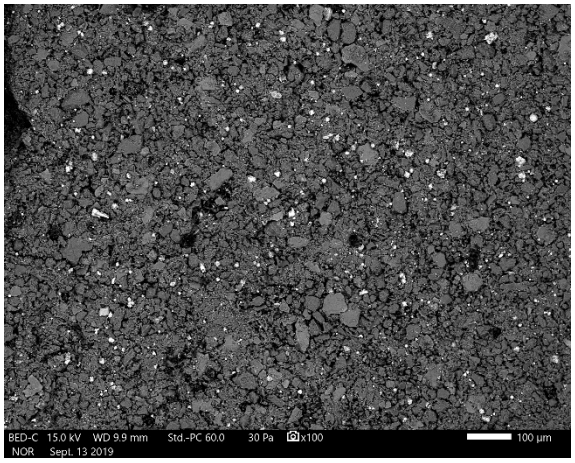


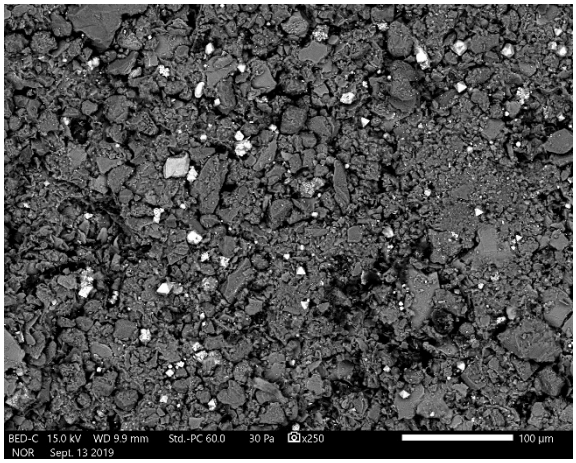


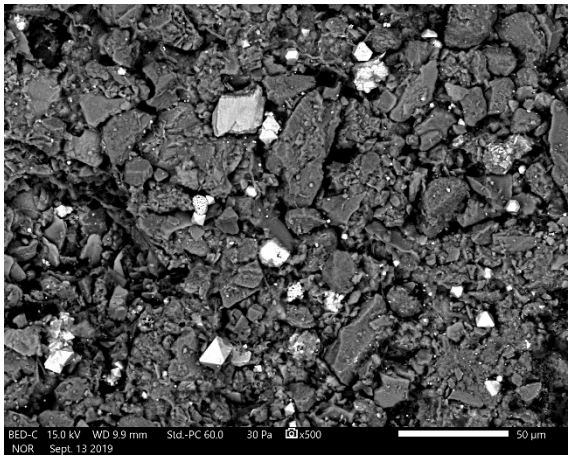


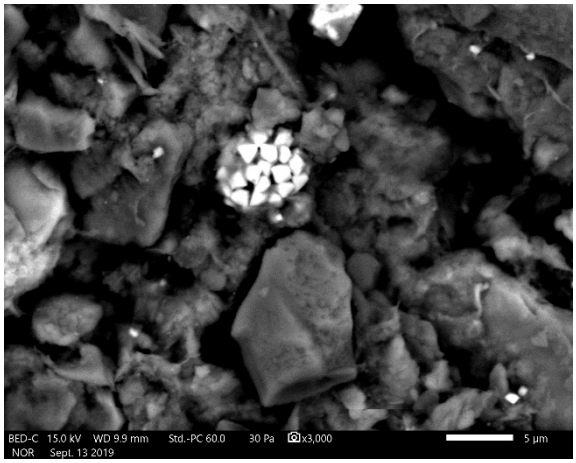


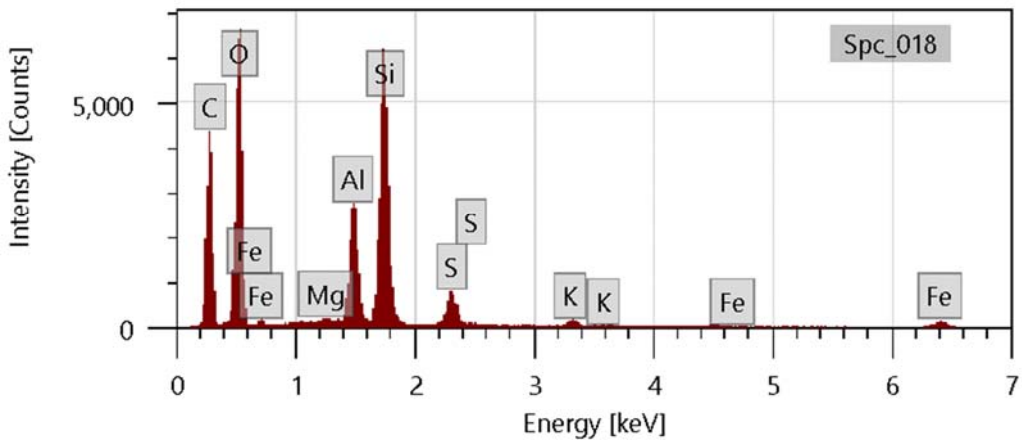
Lignite. Backscattered electron micrographs show the sample at 100X, 1,100X, and 1,500X. EDS spectrum at bottom is an area scan of the region shown in top right micrograph. Bright particles are mostly quartz and feldspar. Major peaks for carbon, oxygen, silicon, and aluminum suggest coal and clay.





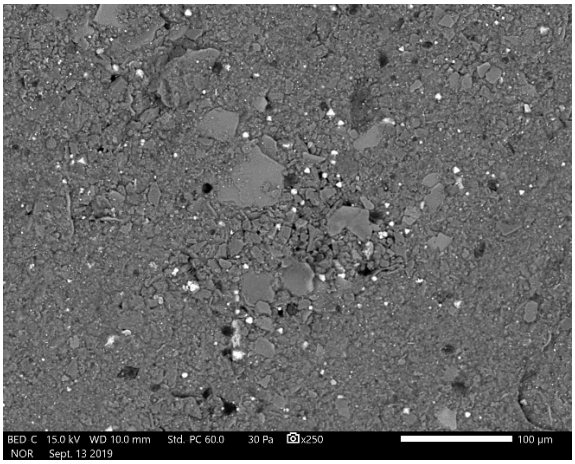


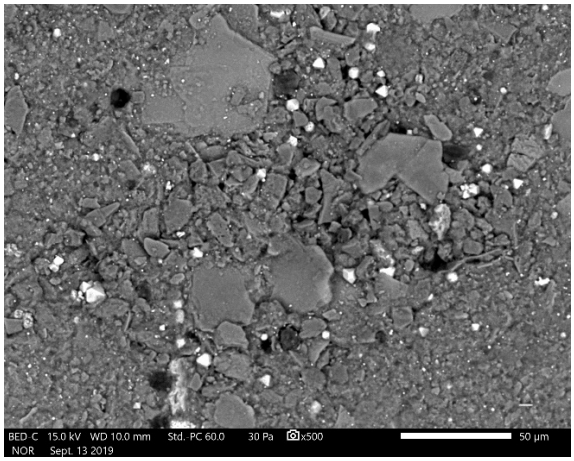


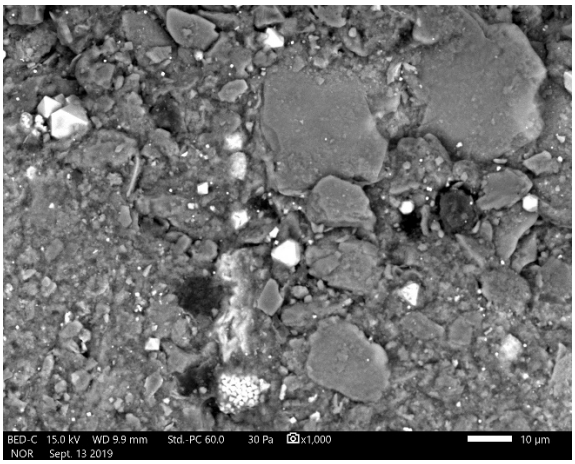


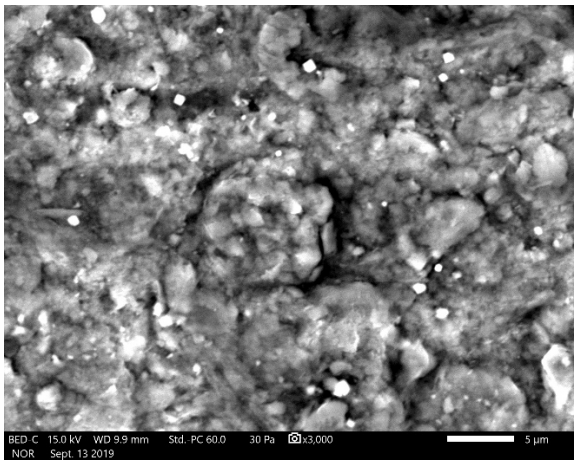
Sample VAP B3 40-45. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 3000X. EDS spectrum at bottom is an area scan of the region shown at 500X. Bright particles are pyrite (framboid in bottom right micrograph). Major peaks for carbon, oxygen, silicon, and aluminum suggest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

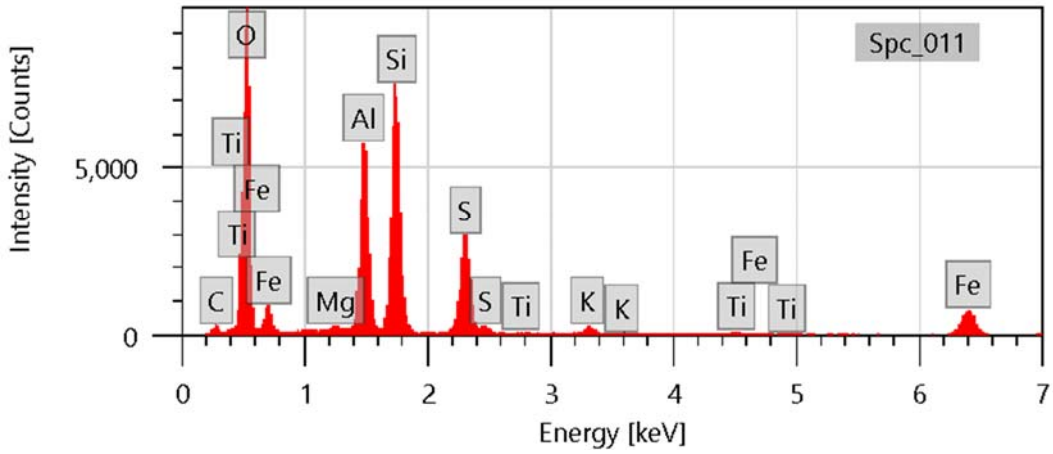
Geosyntec
CTLGroup 150350











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

ATTACHMENT D
AD-32 Low-Flow Purge Logs

Facility Name	Pixley
Sampled by	Matt / Hamilton

Sample Location ID	AD-32

Depth to water, feet(TOC)	6.44
Measured Total Depth, feet(TOC)	34.69

Depth to water Date	

Purge Stabilization Data

Time	Water Depth	Flow Rate	pH	Spec Cond	Turbidity	D.O.	ORP	Temp, deg C		
905	6.33	380	4.69	302	408	3.42	258	22.49		
910	6.37	"	4.50	305	630	.98	243	22.24		
915	6.45	"	4.45	304	655	.71	238	22.21		
920	6.41	"	4.41	302	655	.95	235	22.19		
925	6.42	"	4.41	299	425	.81	234	22.17		
930	6.42	"	4.34	299	410	.80	242	22.17		

Total volume purged	2,280 mL
Sample appearance	Opaque
Sample time	~~0946~~ 932
Sample date	5/11/16

Facility Name	Pixley
Sample by	Matt / Hamilton

Depth to water, feet (TOC)	7.76
Measured Total Depth, feet (TOC)	34.69

Sample Location ID	AD-32
Depth to water date	3-21-18

Purge Stabilization Data

Time	Water Depth (from TOC)	Flow Rate (mL/min)	pH (S.U.)	Spec Cond (µS/cm)	Turbidity (N.T.U)	D.O. (mg/L)	ORP (mV)	Temperature (°C)		
1200	7.76	300	4.14	340	277	1.87	324	21.76		
1205	7.86	"	4.16	349	165	2.31	318	21.29		
1210	7.88	"	4.16	350	154	3.65	316	21.20		

Total volume purged	
Sample appearance	~~clear~~ turbid / brown
Sample time	1212
Sample date	3-21-18

RA-Dup-1

Facility Name	AEP Pirkey PP
Sample by	Matt Hamilton

Sample Location ID	AD-32

Depth to water, feet (TOC)	5.04
Measured Total Depth, feet (TOC)	34.69

Depth to water date	5/21/2019

Purge Stabilization Data

Time	Water Depth (from TOC)	Flow Rate (mL/min)	pH (S.U.)	Spec Cond (µS/cm)	Turbidity (N.T.U)	D.O. (mg/L)	ORP (mV)	Temperature (°C)		
1245	5.01	240	3.38	292	200	5.25	370	30.27		
1250	5.06	240	3.21	316	101	1.08	388	26.36		
1255	5.07	240	3.21	315	84	0.85	386	25.43		
1300	5.08	240	3.21	315	87.5	0.70	386	25.65		

Total volume purged	
Sample appearance	Clear
Sample time	1302
Sample date	5/21/2019

Facility Name	Pinkerton
Sample by	Mott/Hamilton

Depth to water, feet (TOC)	6.63
Measured Total Depth, feet (TOC)	34.65

Sample Location ID	AP-32
Depth to water date	3-10-20

Purge Stabilization Data

Time	Water Depth (from TOC)	Flow Rate (mL/min)	pH (S.U.)	Spec Cond (µS/cm)	Turbidity (N.T.U)	D.O. (mg/L)	ORP (mV)	Temperature (°C)		
1153	6.83	220	4.02	342	133	2.61	316	23.50		
1158	6.85	"	3.93	347	105	1.37	265	23.91		
1203	6.89	"	3.84	357	1.2	1.05	254	24.28		
1208	6.92	"	3.74	362	45	1.02	254	24.10		
1213	6.94	"	3.75	363	36.6	0.64	261	23.51		
1218	6.95	"	3.73	364	34.5	0.96	270	23.99		

Total volume purged	
Sample appearance	clear
Sample time	1220
Sample date	3-10-20

Dup-1

Facility Name	Pinkney
Sample by	M. Hamilton

Depth to water, feet (TOC)	6.31
Measured Total Depth, feet (TOC)	34.69

Sample Location ID	AD-32
Depth to water date	6-2-26

Purge Stabilization Data

Time	Water Depth (from TOC)	Flow Rate (mL/min)	pH (S.U.)	Spec Cond (µS/cm)	Turbidity (N.T.U)	D.O. (mg/L)	ORP (mV)	Temperature (°C)		
959	6.62	220	3.67	332	71.1	2.59	471	25.46		
1004	6.68	"	3.80	378	141	0.44	448	23.42		
1009	6.72	"	3.83	381	125	0.85	436	23.41		
1014	6.73	"	3.86	380	83.2	0.76	425	24.25		
1019	6.75	"	3.89	360	46.6	0.73	418	24.37		
1024	6.76	"	3.91	380	45.5	0.70	415	24.43		

Total volume purged	
Sample appearance	clear
Sample time	1026
Sample date	6-2-26

Facility Name	Pixley
Sample by	Matt Hamilton

Depth to water, feet (TOC)	13.05
Measured Total Depth, feet (TOC)	34.69

Sample Location ID	AD-32
Depth to water date	11-2-20

Purge Stabilization Data

Time	Water Depth (from TOC)	Flow Rate (mL/min)	pH (S.U.)	Spec Cond (µS/cm)	Turbidity (N.T.U)	D.O. (mg/L)	ORP (mV)	Temperature (°C)		
954	13.39	220	3.47	1,430	47.6	50	458	19.71		
959	13.44	220	3.44	1,510	61.3	50	441	20.71		
1004	13.41	220	3.46	1,540	43.6	0.47	441	20.97		
1009	13.49	220	3.44	1,550	26.1	0.75	437	21.15		
1014	13.50	220	3.43	1,540	19.0	0.79	433	21.31		
1019	13.51	220	3.43	1,530	18.6	0.87	430	21.35		

Total volume purged	
Sample appearance	clear
Sample time	1021
Sample date	11-2-20

ATTACHMENT E

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 Gross
Signature

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

Texas Registered Engineering Firm
No. F-1182

79864	Texas	12/31/2020
License Number	Licensing State	Date

APPENDIX IV

Reports documenting monitoring well plugging and abandonment or well installation are included in the appendix.

STATE OF TEXAS WELL REPORT for Tracking #540556

Owner:	**American Electric Power Company**	Owner Well #:	**AD-7R**
Address:	**502 N. Allen Street Shreveport, LA 71101**	Grid #:	**35-37-1**
		Latitude:	**32° 27' 43.7" N**
Well Location:	**2400 Farm Road 3251 Hallsville, TX 75650**	Longitude:	**094° 29' 18.3" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/3/2020** Drilling End Date: **3/3/2020**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**31.5**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Filter Packed**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
Filter Pack Intervals:	**18**	**31.5**	**Sand**	**20/40**

Annular Seal Data: **No Data**

Seal Method: **Poured**

Sealed By: **Driller**

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

Distance to Septic Field or other concentrated contamination (ft.): **No Data**

Distance to Septic Tank (ft.): **No Data**

Method of Verification: **No Data**

Surface Completion: **Surface Slab Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

Strata Depth (ft.)	Water Type
No Data	**No Data**

Chemical Analysis Made: **No**

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

Certification Data: The driller certified that the driller drilled this well (or the well was drilled under the driller's direct supervision) and that each and all of the statements herein are true and correct. The driller understood that failure to complete the required items will result in the report(s) being returned for completion and resubmittal.

Company Information: **C&S Lease**

1873 FM 1252 E
Kilgore, TX 75663

Driller Name: **Buford E. Collier** License Number: **50089**

Apprentice Name: **David Diduch** Apprentice Number: **60297**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1.5**	**Top soil, vegetation, black silt, gravel, light gray/red/brown clayey silt**
1.5	**10**	**Red/light gray clay, low plasticity, high stiffness, iron ore present, trace silt,**
10	**15**	**Maroon/light gray clay, high stiffness, low plasticity, iron ore, wet**
15	**20**	**Black silty clay, low-moderate plasticity, wet, Maroon/orange clayey silt, wet, good cohesion, iron ore, gray/orange clayey silt, iron ore present, wet, good cohesion**
20	**24.6**	**Black clayey silt, Dark gray fine grained sand, trace clay, wet, black silty clay, low-moderate plasticity, moderate to low stiffness**
24.6	**31.5**	**Dark gray fine grained sand, wet, well sorted, orange fine grained sand, wet, well sorted, tan fine grained sand, wet, well sorted, iron present**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**20**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**20**	**30**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

TEX. OCC. CODE Title 12, Chapter 1901.251, authorizes the owner (owner or the person for whom the well was drilled) to keep information in Well Reports confidential. The Department shall hold the contents of the well log confidential and not a matter of public record if it receives, by certified mail, a written request to do so from the owner.

Please include the report's Tracking Number on your written request.

Texas Department of Licensing and Regulation
P.O. Box 12157
Austin, TX 78711
(512) 334-5540