Annual Groundwater Monitoring Report

Kentucky Power Company

Big Sandy Plant

Fly Ash Pond CCR Management Unit

Louisa, Kentucky

January 2020

Prepared by:

American Electric Power Service Corporation

1 Riverside Plaza

Columbus, Ohio 43215

KENTUCKY POWER

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BOUNDLESS ENERGY

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I. <u>Overview</u>

This *Annual Groundwater Monitoring Report* has been prepared to report the status of activities for the preceding year for an existing CCR unit at Kentucky Power Company's Big Sandy Power Plant. Kentucky Power Company is a wholly owned subsidiary of American Electric Power Company (AEP). 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.

In general, the following activities were completed:

- All monitoring wells that were installed and developed to establish a certified groundwater monitoring system around the CCR unit, in accordance with the requirements of 40 CFR 257.91 and documented in AEP's *Groundwater Monitoring Network Evaluation (Geosyntec, December 2016)* were sampled pursuant to 40 CFR 257.95(d)(1) on March 12, 2019 through March 14, 2019, pursuant to 40 CFR 257.95(b) on June 25, 2019 and June 27, 2019, and pursuant to 40 CFR 257.95(d)(1) on August 20, 2019 and August 21, 2019. All samples collected during the March 2019 sampling event were analyzed for all parameters in Appendix III of the CCR rules and for those Appendix IV constituents detected during a previous sampling pursuant to 40 CFR 257.95(b) on April 25, 2018 and April 26, 2018, following the establishment of an assessment monitoring program on April 13, 2018 and a subsequent sampling pursuant to 40 CFR 257.95(d)(1) ending on October 23, 2018. All samples collected during the June 2019 sampling event were analyzed for all parameters in Appendix IV of the CCR rules. All samples collected during the August 2019 sampling event were analyzed for all parameters in Appendix III of the CCR rules and for those Appendix IV constituents detected during the June 25, 2019 and June 27, 2019 sampling event. All sampling and analyses were in accordance with 40 CFR 257.94 *et seq.*, AEP's *Groundwater Sampling and Analysis Plan (AEP and EHS Support, October 2016), and AEP's Statistical Analysis Plan (Geosyntec, January 2017).* The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009);
- Groundwater detection monitoring data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Statistical analysis of the background and assessment monitoring data was conducted in accordance with *AEP's Statistical Analysis Plan (Geosyntec, January 2017)* to establish groundwater protection standards and to determine whether or not one or more Appendix IV constituents were detected at statistically significant levels (SSLs) above the corresponding groundwater protection standards in assessment monitoring samples collected during a sampling event ending in October 2018 and the March and August 2019 sampling events. The corresponding statistical analyses were completed in January 2019, July 2019, and January 2020;

- The statistical evaluations concluded that three to four Appendix IV constituents were detected at SSLs above the corresponding groundwater protection standard statistical limits at the same well during each of the three assessment monitoring sampling events, as discussed further in Section V of this report;
- Because Appendix IV constituents were found to be detected at SSLs above the corresponding groundwater protection standard statistical limits during the January 2019, July 2019, and January 2020 statistical evaluations, alternative source demonstration (ASD) studies were conducted resulting in February 2019, September 2019, and January 2020 ASD reports, as discussed further in Section VI of this report.

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

- A figure showing the CCR unit, 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 regarding the rationale for the installation/decommission;
- 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 required by the detection monitoring or assessment monitoring programs (attached as Appendixes 1 and 2);
- Results of the required statistical analysis of groundwater monitoring results;
- Results of alternate source demonstrations;
- A summary of any transition between monitoring programs or an alternate monitoring frequency;
- Other information required in the annual report such as an 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. <u>Groundwater Monitoring Well Locations and Identification Numbers</u>

A figure depicting the PE-certified groundwater monitoring network, with the monitoring well locations and their corresponding identification numbers, is in Appendix 2.

III. Monitoring Wells Installed or Decommissioned

There were no monitoring wells installed or decommissioned in 2019. The network design, as summarized in the *Groundwater Monitoring Network Evaluation* (*Geosyntec*, *December 2016*) and as posted at the CCR web site for Big Sandy Plant, did not change. That report, viewable on the publicly accessible AEP CCR Rule Compliance Data and Information Internet site at the following link: http://www.aep.com/about/codeofconduct/ccrrule/, discusses the facility location, the hydrogeological setting, the hydrostratigraphic units, the uppermost aquifer, downgradient monitoring well locations, and upgradient monitoring well locations.

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

Appendix 1 contains Table 1 showing the data analyzed from the samples collected during the first detection monitoring event and the samples collected for the two subsequent assessment monitoring events in 2018, including the number of samples collected per well, the sample collection dates, and the groundwater velocities for each sampling event. Table 1 also includes background data collected during the eight background sampling events and previous detection and assessment monitoring data. Static water elevation data and groundwater flow directions, in the form of potentiometric surface maps, from each monitoring event in 2019 are shown in Appendix 2.

V. Statistical Analysis of Groundwater Monitoring Data

Statistical analyses of data collected during the sampling event ending in October 2018, the March 2019 sampling event, and the August 2019 sampling event, for determination of SSLs detected above (or outside for pH) the corresponding groundwater protection standard statistical limits, were completed and documented in the January 8, 2019 *Statistical Analysis Summary (Geosyntec, January 2019)* for the sampling event ending in October 2018, in the July 12, 2019 *Statistical Analysis Summary (Geosyntec, July 2019)* for the March 2019 sampling event, and in the January 3, 2020 *Statistical Analysis Summary (Geosyntec, January 2020)* for the August 2019 sampling event. The three statistical analysis summaries contain full statistical evaluations in Attachment B of each summary and are provided in Appendix 3 of this report. SSLs of beryllium, cobalt, and lithium were identified above the corresponding groundwater protection standard statistical limits at one monitoring well, MW-1603, in all three statistical evaluations. Radium 226/228 was also identified above the corresponding groundwater protection standard statistical limit at MW-1603 in the January 2020 statistical evaluation.

VI. Alternative Source Demonstration

In an attempt to demonstrate that a source other than the CCR unit caused the SSLs detected in samples collected during the sampling event ending in October 2018, the March 2019 sampling event, and August 2019 sampling event, or that the SSLs resulted from errors in sampling, analysis, statistical evaluation, or natural variations in groundwater quality, alternative source evaluations including an assessment of site and regional geochemistry along with historical data for the CCR unit were conducted by EHS Support LLC (EHS Support). These evaluations resulted in the *Alternative Source Demonstration Report for Beryllium, Cobalt and Lithium (EHS Support, February 2019)*, the *Alternative Source Demonstration Report Addendum for Beryllium, Cobalt and Lithium (EHS Support, September 2019)*, and the *Alternative Source Demonstration Report Addendum for 2019 Monitoring Data (EHS Support, January 2020)*. The three alternative source demonstration reports are included in Appendix 4. All three reports concluded that the elevated concentrations of beryllium, cobalt, and lithium in the monitoring well are related to the dissolution of naturally occurring coal-seam-derived constituents within the shale layers of the monitored geologic formation, with the January 2020 report concluding the same for radium 226/228.

VII. Discussion about Transition between Monitoring Requirements or Alternate Monitoring Frequency

Because the alternative source demonstrations were successful in demonstrating that the Appendix IV SSLs detected in samples collected from Monitoring Well MW-1603 were not derived from the CCR constituents within the CCR unit, the assessment monitoring program was continued.

Regarding defining an alternate monitoring frequency, the groundwater velocity and monitoring well production are high enough at this facility that no modification to the semiannual assessment monitoring frequency is needed at this time.

VIII. Other Information Required

The CCR unit has progressed from detection monitoring to its current status in assessment monitoring. All required information has been included in this annual groundwater monitoring report. At the appropriate time, hydrogeological, geochemical, and statistical analyses of the groundwater assessment monitoring data will continue to attempt demonstrations of whether or not an alternative source or sources other than the CCR unit are causing the detection of SSLs above (or outside for pH) the corresponding groundwater protection standard statistical limits, or if the SSLs resulted from error in sampling, analysis, statistical evaluation or natural variation in groundwater quality. In those cases where an alternative source demonstration is made, the analyses and supporting information will be presented as well. This is likely to continue occurring at Monitoring Well MW-1603 because the well was screened across highly organic layers of rock with a coal-like texture that results in groundwater samples with a much lower pH than any other compliance well in the groundwater monitoring network. This well is expected to no longer be downgradient of the CCR unit at some point because the unit is being dewatered and closed in place. Once the groundwater elevations in the well are no longer higher than the elevation of surface water in the CCR unit, it is expected that the well will be removed from the groundwater monitoring network.

IX. Description of Any Problems Encountered in 2019 and Actions Taken

No significant problems were encountered. Through previous, proper construction of monitoring wells and use of low-flow purging and sampling methodology, samples representative of uppermost aquifer groundwater, with low turbidity, were obtained and the schedule to support preparation of this annual groundwater monitoring report was met. It is possible, however, that future necessary monitoring wells may not encounter earth materials with grain sizes coarse enough to produce low turbidity monitoring well samples no matter how carefully the monitoring wells are constructed and the groundwater samples are collected.

X. A Projection of Key Activities for the Upcoming Year

Key activities for 2020 include:

- Continued assessment monitoring sampling of CCR wells for all Appendix IV parameters annually pursuant to 40 CFR 257.95(b) and, pursuant to 40 CFR 257.95(d)(1), for all Appendix III parameters and those Appendix IV parameters detected during the previous sampling performed pursuant to 40 CFR 257.95(b);
- Continued establishment of groundwater protection standard statistical limits for all Appendix IV parameters and statistical comparison of Appendix IV concentrations in downgradient monitoring wells to those standards;
- If a groundwater protection standard is exceeded in a downgradient well that is not demonstrated to be due to a source other than the CCR unit or resulting from errors in sampling, analysis, statistical evaluation, or natural variations in groundwater quality by a successful alternative source demonstration, the following activities will be undertaken:
    - Prepare a notification identifying the constituents in Appendix IV that have exceeded the groundwater protection standard and place the notification in the facility's operating record;

  - Characterize the nature and extent of the potential release by installing additional monitoring wells as necessary, including at least one additional monitoring well at the facility boundary in the direction of potential contaminant migration;
  - Sample all wells in accordance with 40 CFR 257.95(d)(1) to characterize the nature and extent of the potential release.
  - Estimate the quantity of material potentially released including specific information on the Appendix IV constituents and the levels at which they are present in the material;
  - If contaminants have migrated off-site, notify all persons who own or reside on land that directly overlies any part of the plume of contamination and place the notification in the facility's operating record;
  - Initiate an assessment of corrective measures to prevent further releases, to remediate any releases, and to restore affected areas to original conditions;
- Respond to any new data received in light of what the CCR rule requires;
- Prepare a fourth annual groundwater monitoring report documenting activities that were undertaken in 2020.

APPENDIX 1—Tables

Tables follow showing the groundwater monitoring data collected, the rate of groundwater flow each time groundwater was sampled, the number of samples collected per monitoring well, dates that the samples were collected, and whether each sample was collected as part of a detection monitoring or an assessment monitoring program.

Table 1 - Groundwater Data Summary: MW-1011
Big Sandy - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
9/27/2016	Background	0.071	79.1	3.39	0.19	7.0	388	79.5
11/9/2016	Background	0.081	74.6	3.43	0.21	7.0	360	74.4
1/12/2017	Background	0.103	75.4	2.83	0.25	6.9	363	72.8
2/21/2017	Background	0.098	75.8	2.68	0.21	7.1	371	72.5
4/25/2017	Background	0.148	78.0	2.71	0.23	6.7	358	74.7
5/24/2017	Background	0.156	85.2	2.86	0.20	6.7	370	73.8
6/21/2017	Background	0.129	72.6	2.19	0.22	6.7	338	69.4
7/13/2017	Background	0.111	78.1	2.31	0.21	7.1	371	78.2
9/18/2017	Detection	0.146	80.1	2.85	0.18	6.9	372	78.0
4/26/2018	Assesment	0.139	105	4.71	0.2	6.3	456	106
9/20/2018	Assessment	0.165	72.7	3.43	0.28	7.0	386	76.3
3/13/2019	Assessment	0.101	80.5	5.22	0.24	6.5	411	84.2
6/27/2019	Assessment	0.119	75.3	4.2	0.27	7.0	386	75.2
8/21/2019	Assessment	0.117	86.2	4.41	0.26	7.1	385	76.2

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: MW-1011
Big Sandy - FAP
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
9/27/2016	Background	1.01	17.8	52.0	<0.005 U	0.02	0.5	2.85	2.56	0.19	0.214	0.011	<0.002 U	1.80	0.09 J	0.229
11/9/2016	Background	0.75	9.93	48.1	<0.005 U	0.02 J	0.744	1.12	3.56	0.21	0.297	0.017	<0.002 U	1.51	0.07 J	0.162
1/12/2017	Background	0.36	10.5	47.7	<0.005 U	0.01 J	0.369	1.47	5.24	0.25	0.026	0.009	<0.002 U	1.39	0.03 J	0.16
2/21/2017	Background	0.28	11.1	49.5	<0.005 U	0.008 J	0.189	1.09	3.43	0.21	0.024	0.016	<0.002 U	1.21	<0.03 U	0.153
4/25/2017	Background	0.26	11.9	53.0	<0.004 U	0.01 J	0.223	1.23	2.65	0.23	0.035	0.003	<0.002 U	1.23	<0.03 U	0.102
5/24/2017	Background	0.22	9.46	54.7	<0.004 U	0.008 J	0.318	1.15	2.566	0.20	0.02	0.005	<0.002 U	0.99	<0.03 U	0.134
6/21/2017	Background	0.24	5.57	45.7	<0.004 U	0.006 J	0.294	0.413	2.576	0.22	0.01 J	0.014	0.004 J	1.34	0.05 J	0.098
7/13/2017	Background	0.24	5.92	46.0	<0.004 U	0.01 J	0.223	0.444	2.353	0.21	0.054	0.01	<0.002 U	1.39	0.03 J	0.091
4/26/2018	Assessment	0.16	13.5	63.1	<0.004 U	<0.005 U	0.207	3.25	5.69	0.2	0.095	0.01	<0.002 U	0.82	<0.03 U	0.121
9/20/2018	Assessment	0.18	7.25	44.8	<0.02 U	< 0.01 U	0.588	0.683	2.56	0.28	0.08	0.009	- -	0.8	<0.03 U	< 0.1 U
10/23/2018	Assessment	- -	- -	- -	- -	- -	- -	- -	- -	--	- -	- -	<0.002 U	- -	- -	- -
3/13/2019	Assessment	0.15	7.53	49.2	<0.02 U	<0.01 U	0.576	0.709	2.425	0.24	0.217	0.02 J	<0.002 U	0.9 J	<0.03 U	<0.1 U
6/27/2019	Assessment	0.15	5.17	47.5	<0.02 U	<0.01 U	0.304	0.438	2.582	0.27	0.181	<0.009 U	<0.002 U	0.7 J	<0.03 U	<0.1 U
8/21/2019	Assessment	0.18	5.31	49.2	<0.02 U	0.01 J	0.341	0.421	2.54	0.26	0.1 J	0.00973	<0.002 U	0.7 J	<0.03 U	<0.1 U

Notes:
µg/L: micrograms per liter
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<: 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: MW-1012
Big Sandy - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
9/27/2016	Background	0.176	1.48	1.19	0.71	8.9	547	35.2
11/9/2016	Background	0.159	1.21	1.15	0.7	9.1	535	35.6
1/12/2017	Background	0.182	1.19	1.24	0.73	9.1	553	40.1
2/22/2017	Background	0.171	1.45	1.14	0.68	9.4	554	36.8
4/26/2017	Background	0.183	1.20	1.17	0.71	8.7	546	37.4
5/24/2017	Background	0.244	1.20	1.24	0.71	8.8	540	36.8
6/22/2017	Background	0.174	1.07	1.14	0.64	8.9	547	38.1
7/13/2017	Background	0.172	1.16	1.12	0.66	9.0	558	38.0
9/19/2017	Detection	0.205	1.11	1.1	0.67	9.1	546	38.5
4/26/2018	Assessment	0.227	1.13	1.34	0.82	9.0	541	36.6
9/20/2018	Assessment	0.236	1.11	1.27	0.75	9.1	561	36.6
3/13/2019	Assessment	0.189	1.15	1.26	0.73	8.8	572	35.6
6/25/2019	Assessment	0.169	1.1	1.19	0.74	9.3	559	35.9
8/21/2019	Assessment	0.176	1.38	1.26	0.79	9.4	583	36.8

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: MW-1012
Big Sandy - FAP
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
9/27/2016	Background	0.79	24.0	37.6	0.044	0.05	1.1	0.346	1.592	0.71	1.84	0.006	<0.002 U	3.25	0.2	0.03 J
11/9/2016	Background	1.20	28.9	24.4	0.027	0.04	0.903	0.113	0.548	0.7	0.872	0.014	0.002 J	1.68	0.05 J	0.02 J
1/12/2017	Background	0.79	24.7	23.8	0.01 J	0.04	0.395	0.066	0.542	0.73	0.439	0.008	<0.002 U	1.12	0.04 J	0.02 J
2/22/2017	Background	0.99	28.8	29.5	0.026	0.14	0.578	0.184	0.452	0.68	1.17	0.009	0.002 J	1.52	0.07 J	0.04 J
4/26/2017	Background	0.89	22.9	29.9	0.025	0.02	0.512	0.131	0.148	0.71	0.632	0.004	0.003 J	1.25	0.04 J	0.02 J
5/24/2017	Background	0.97	23.2	23.7	0.01 J	0.01 J	7.84	0.078	1.72	0.71	0.334	<0.0002 U	0.004 J	1.41	0.07 J	0.01 J
6/22/2017	Background	0.91	21.6	21.1	0.008 J	0.007 J	0.293	0.046	0.3575	0.64	0.261	0.018	<0.002 U	1.18	0.04 J	0.02 J
7/13/2017	Background	0.96	22.1	25.7	0.022	0.008 J	0.449	0.102	1.301	0.66	0.546	0.004	<0.002 U	1.43	0.09 J	0.02 J
4/26/2018	Assessment	0.65	15.8	24.1	0.01 J	0.006 J	0.262	0.062	1.135	0.82	0.287	0.006	0.003 J	0.89	0.05 J	0.02 J
9/20/2018	Assessment	0.62	14.0	24.2	0.02	<0.01 U	0.442	0.079	0.291	0.75	0.346	<0.009 U	0.013	0.8	0.08 J	< 0.1 U
3/13/2019	Assessment	0.60	15.2	27.2	0.03 J	<0.01 U	0.459	0.106	0.3959	0.73	0.354	0.01 J	<0.004 U	0.9 J	0.09 J	<0.1 U
6/25/2019	Assessment	0.67	13.4	28.0	0.03 J	<0.01 U	0.252	0.097	0.506	0.74	0.352	<0.009 U	<0.002 U	0.8 J	0.08 J	<0.1 U
8/21/2019	Assessment	0.77	19.0	41.9	0.06 J	<0.01 U	0.625	0.26	0.354	0.79	0.924	0.00536	<0.002 U	1 J	0.3	<0.1 U

Notes:
µg/L: micrograms 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
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: MW-1203
Big Sandy - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
9/26/2016	Background	0.097	60.5	5.72	0.15	7.8	261	28.4
11/9/2016	Background	0.088	56.8	5.35	0.13	6.9	273	26.5
1/12/2017	Background	0.11	59.9	5.69	0.13	7.0	278	33.4
2/21/2017	Background	0.092	55.8	5.23	0.12	7.0	248	30.2
4/26/2017	Background	0.122	55.6	5.18	0.12	6.6	265	29.0
5/23/2017	Background	0.16	55.6	5.08	0.12	6.5	279	29.6
6/21/2017	Background	0.137	62.3	4.74	0.11	6.7	264	28.0
7/13/2017	Background	0.089	56.7	5.05	0.10	6.7	261	33.0
9/18/2017	Detection	0.116	57.0	4.92	0.13	6.8	255	29.3
4/26/2018	Assessment	0.147	57.4	5.66	0.14	6.0	253	37.5
9/20/2018	Assessment	0.125	53.4	5.37	0.12	6.7	253	32.3
3/14/2019	Assessment	0.09 J	54.9	5.53	0.11	6.2	259	38.7
6/27/2019	Assessment	0.1 J	54.3	5.28	0.12	6.8	273	39.0
8/21/2019	Assessment	0.097	60.8	5.14	0.13	7.0	283	32.4

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: MW-1203
Big Sandy - FAP
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
9/26/2016	Background	0.02 J	0.26	95.3	0.022	<0.004 U	0.4	1.04	1.334	0.15	0.103	0.011	<0.002 U	0.21	0.04 J	0.01 J
11/9/2016	Background	0.03 J	0.43	110	0.126	0.009 J	1.5	1.04	1.473	0.13	1.28	0.017	<0.002 U	0.28	0.2	0.02 J
1/12/2017	Background	0.03 J	0.42	102	0.089	<0.004 U	0.718	1.15	1.657	0.13	0.748	0.014	<0.002 U	0.15	0.2	0.03 J
2/21/2017	Background	0.02 J	0.39	94.8	0.077	<0.004 U	0.365	0.989	2.509	0.12	0.509	0.017	<0.002 U	0.2	0.1	0.063
4/26/2017	Background	0.03 J	0.45	113	0.099	<0.005 U	0.648	1.05	1.293	0.12	0.697	0.009	<0.002 U	0.2	0.2	0.02 J
5/23/2017	Background	0.05 J	0.61	99.9	0.149	<0.005 U	0.96	1.07	3.44	0.12	1.22	0.020	0.002 J	0.15	0.3	0.02 J
6/21/2017	Background	0.04 J	0.63	101	0.116	<0.005 U	0.422	0.994	3.224	0.11	0.793	0.020	<0.002 U	0.62	0.3	0.03 J
7/13/2017	Background	0.02 J	0.44	93.8	0.062	<0.005 U	0.377	1.16	1.707	0.10	0.312	0.011	<0.002 U	0.59	0.05 J	0.01 J
4/26/2018	Assessment	0.03 J	0.30	89.1	0.033	<0.005 U	0.171	0.886	2.476	0.14	0.034	0.013	<0.002 U	0.12	<0.03 U	0.03 J
9/20/2018	Assessment	0.03 J	0.51	90.1	0.08	<0.01 U	0.240	0.916	1.252	0.12	0.05	0.01	- -	< 0.4 U	<0.03 U	< 0.1 U
10/22/2018	Assessment	- -	- -	- -	- -	- -	- -	- -	- -	--	- -	- -	<0.002 U	- -	- -	- -
3/14/2019	Assessment	0.03 J	0.23	88.0	0.02 J	<0.01 U	0.391	0.953	1.399	0.11	0.124	<0.009 U	<0.004 U	<0.4 U	<0.03 U	<0.1 U
6/27/2019	Assessment	<0.02 U	0.34	86.8	0.06 J	<0.01 U	0.1 J	0.909	1.341	0.12	0.1 J	0.01 J	<0.002 U	<0.4 U	<0.03 U	<0.1 U
8/21/2019	Assessment	<0.02 U	0.27	95.4	0.04 J	<0.01 U	0.304	0.774	1.471	0.13	0.06 J	0.0118	<0.002 U	<0.4 U	<0.03 U	<0.1 U

Notes:
µg/L: micrograms 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
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: MW-1601
Big Sandy - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
9/27/2016	Background	0.317	63.0	25.6	0.32	7.6	448	122
11/9/2016	Background	0.263	55.7	31.2	0.33	7.3	438	120
1/12/2017	Background	0.283	63.5	25.0	0.32	7.5	474	128
2/22/2017	Background	0.241	61.0	23.9	0.29	7.4	430	111
4/26/2017	Background	0.216	50.9	23.8	0.33	6.9	372	97.4
5/24/2017	Background	0.240	55.9	21.5	0.29	7.0	370	91.7
6/22/2017	Background	0.196	47.5	21.0	0.27	7.3	367	90.6
7/13/2017	Background	0.175	51.3	17.4	0.27	7.1	364	84.6
9/18/2017	Detection	0.183	51.5	15.8	0.29	7.2	362	82.7
1/31/2018	Detection	- -	- -	15.4	- -	7.5	- -	84.4
4/25/2018	Assessment	0.177	50.4	15.2	0.36	6.9	326	72.6
9/20/2018	Assessment	0.196	68.8	16.1	0.22	7.1	448	167
3/12/2019	Assessment	0.117	54.3	9.09	0.18	6.3	316	88.5
6/25/2019	Assessment	0.1 J	50.7	8.23	0.15	7.0	312	86.4
8/21/2019	Assessment	0.097	52.1	8.43	0.15	7.1	326	82.9

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: MW-1601
Big Sandy - FAP
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
9/27/2016	Background	0.13	5.03	81.7	0.026	0.009 J	0.7	1.96	1.22	0.32	0.143	0.04	<0.002 U	27.7	0.2	0.124
11/9/2016	Background	0.08	5.49	85.4	0.01 J	0.01 J	0.863	1.46	2.335	0.33	0.321	0.035	<0.002 U	20.5	0.2	0.02 J
1/12/2017	Background	0.05 J	5.24	79.1	0.009 J	0.01 J	0.39	1.78	1.695	0.32	0.05	0.038	<0.002 U	37.5	0.08 J	0.03 J
2/22/2017	Background	0.08	5.15	74	0.009 J	0.006 J	0.38	1.54	1.603	0.29	0.044	0.037	<0.002 U	31.5	0.1	0.02 J
4/26/2017	Background	0.17	5.48	80.4	0.009 J	0.006 J	0.411	1.23	1.3	0.33	0.034	0.025	<0.002 U	27.3	0.2	0.02 J
5/24/2017	Background	0.09	4.30	68.1	0.007 J	0.006 J	0.807	0.941	1.317	0.29	0.037	0.026	<0.002 U	27.0	0.09 J	0.01 J
6/22/2017	Background	0.08	4.19	60.1	<0.004 U	<0.005 U	0.247	0.926	0.802	0.27	0.02 J	0.037	<0.002 U	27.1	0.07 J	0.01 J
7/13/2017	Background	0.11	5.18	64.5	0.009 J	0.008 J	0.300	1.02	1.077	0.27	0.081	0.023	<0.002 U	28.3	0.07 J	0.01 J
4/25/2018	Assessment	0.17	4.58	56.4	0.005 J	<0.005 U	0.245	0.794	2.783	0.36	0.024	0.033	<0.002 U	20.6	0.1	0.02 J
9/20/2018	Assessment	0.29	3.54	75.9	< 0.02 U	< 0.01 U	0.378	1.21	0.698	0.22	0.04	0.031	- -	19.6	0.2	< 0.1 U
10/23/2018	Assessment	- -	- -	- -	- -	- -	- -	- -	- -	--	- -	- -	<0.002 U	- -	- -	- -
3/12/2019	Assessment	0.20	1.39	49.0	<0.02 U	<0.01 U	0.438	0.395	0.769	0.18	0.05 J	0.009 J	<0.002 U	7.00	0.2 J	<0.1 U
6/25/2019	Assessment	0.17	1.04	55.5	<0.02 U	<0.01 U	0.2 J	0.629	0.689	0.15	<0.02 U	<0.009 U	<0.002 U	4.89	0.2	<0.1 U
8/21/2019	Assessment	0.09 J	1.58	56.6	<0.02 U	0.02 J	0.351	0.831	0.855	0.15	<0.05 U	0.0172	<0.002 U	5.64	0.09 J	<0.1 U

Notes:
µg/L: micrograms 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
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: MW-1602
Big Sandy - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
9/27/2016	Background	0.054	72.5	10.6	0.19	7.7	400	106
11/9/2016	Background	0.037	63.1	8.77	0.18	7.5	360	86.1
1/12/2017	Background	0.039	65.4	7.2	0.17	7.8	362	81.6
2/22/2017	Background	0.041	69.4	8.13	0.14	7.7	399	96.3
4/26/2017	Background	0.052	73.8	7.74	0.13	6.8	382	83.6
5/24/2017	Background	0.074	74.7	9.9	0.12	6.9	394	103
6/22/2017	Background	0.062	70.4	10.7	0.11	7.5	416	106
7/13/2017	Background	0.052	81.9	12.1	0.09 J	7.0	484	132
10/19/2017	Detection	0.058	72.5	13.0	0.11	7.1	434	110
1/31/2018	Detection	- -	- -	15.3	- -	7.5	- -	128
4/26/2018	Assessment	0.143	75.2	13.9	0.14	8.0	416	106
9/20/2018	Assessment	0.07	72.1	15.2	0.11	7.0	492	150
3/13/2019	Assessment	0.07 J	79.4	12.6	0.1	6.9	444	133
6/25/2019	Assessment	0.06 J	69.8	12.2	0.11	7.5	436	111
8/20/2019	Assessment	0.04 J	74.5	13.2	0.1	7.5	434	117

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: MW-1602
Big Sandy - FAP
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
9/27/2016	Background	0.16	0.50	50.7	<0.005 U	0.005 J	0.8	0.06	1.233	0.19	0.067	0.008	0.002 J	3.41	2.0	0.02 J
11/9/2016	Background	0.13	0.42	51.1	<0.005 U	0.01 J	0.59	0.028	1.143	0.18	0.059	0.013	0.002 J	2.63	2.2	0.01 J
1/12/2017	Background	0.10	0.45	50.2	<0.005 U	0.01 J	0.666	0.043	1.545	0.17	0.03	0.004	<0.002 U	2.44	2.2	0.03 J
2/22/2017	Background	0.09	0.42	48.2	<0.005 U	0.009 J	0.547	0.02	0.712	0.14	0.02 J	0.008	<0.002 U	2.79	2.0	0.02 J
4/26/2017	Background	0.10	0.47	59.2	<0.004 U	0.01 J	0.692	0.024	0.534	0.13	0.026	0.006	0.002 J	1.88	2.2	0.03 J
5/24/2017	Background	0.08	0.37	54.6	<0.004 U	0.009 J	0.703	0.01 J	1.68	0.12	0.239	0.002	0.004 J	1.51	1.5	0.02 J
6/22/2017	Background	0.07	0.50	55	<0.004 U	0.01 J	0.566	0.205	0.812	0.11	0.047	0.021	0.002 J	2.12	1.3	0.02 J
7/13/2017	Background	0.07	0.71	57.6	<0.004 U	<0.005 U	0.482	0.85	1.138	0.09 J	0.031	0.005	0.003 J	2.29	1.0	0.01 J
4/26/2018	Assessment	0.05 J	3.15	60.9	<0.004 U	<0.005 U	0.29	0.552	1.754	0.14	0.049	0.008	0.003 J	1.64	0.4	0.01 J
9/20/2018	Assessment	0.03 J	3.92	55.1	<0.02 U	<0.01 U	0.328	0.312	1.044	0.11	0.03	< 0.009 U	<0.004 U	1	0.4	< 0.1 U
3/13/2019	Assessment	0.06 J	1.06	52.5	<0.02 U	<0.01 U	1.03	0.03 J	0.504	0.1	0.122	0.009 J	<0.002 U	2 J	1.6	<0.1 U
6/25/2019	Assessment	0.07 J	1.06	52.5	<0.02 U	<0.01 U	0.632	0.02 J	0.5359	0.11	0.05 J	<0.009 U	<0.002 U	1 J	1.4	<0.1 U
8/20/2019	Assessment	0.06 J	1.16	49.3	<0.02 U	0.01 J	1.15	0.08	0.543	0.1	0.1 J	0.00637	<0.002 U	1 J	1.1	<0.1 U

Notes:
µg/L: micrograms 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
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: MW-1603
Big Sandy - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
9/26/2016	Background	0.054	105	3.37	1.24	4.3	1060	801
11/9/2016	Background	0.053	94.7	3.22	1.1	5.6	1010	733
1/12/2017	Background	0.037	92.7	3.45	1.11	3.6	948	636
2/21/2017	Background	0.085	91.9	2.93	0.9	4.5	1020	720
4/26/2017	Background	0.052	90.5	3.28	1.04	3.3	994	678
5/24/2017	Background	0.096	93.9	3.34	0.98	3.3	936	646
6/22/2017	Background	0.051	90.6	3.10	0.98	3.0	1040	873
7/13/2017	Background	0.039	90.2	3.32	0.93	3.2	1000	694
10/19/2017	Detection	<0.002 U	91	3.24	0.93	3.5	962	784
1/31/2018	Detection	- -	82.2	- -	0.94	3.5	915	714
4/26/2018	Assessment	0.088	83.6	4.12	1.16	2.9	926	661
9/20/2018	Assessment	0.08	97.5	3.92	1.15	3.1	974	747
3/13/2019	Assessment	0.05 J	84.6	4.42	0.92	3.2	896	709
6/27/2019	Assessment	0.05 J	83.3	4.13	0.87	3.7	954	658
8/20/2019	Assessment	<0.1 U	95.8	3.93	0.84	3.5	1010	704

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: MW-1603
Big Sandy - FAP
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
9/26/2016	Background	0.01 J	1.51	13.4	18.6	0.84	1.1	101	6.04	1.24	9.75	0.242	<0.002 U	0.15	5.4	1.29
11/9/2016	Background	<0.01 U	1.19	15.4	18.3	0.93	1.12	94.4	6.6	1.1	8.18	0.237	<0.002 U	0.17	4.8	1.55
1/12/2017	Background	<0.01 U	1.4	11.4	17.1	0.79	0.731	89.6	5.86	1.11	6.11	0.225	<0.002 U	0.06 J	5.6	1.39
2/21/2017	Background	<0.01 U	1.26	10.3	18.9	0.75	0.771	93.2	4.03	0.9	6.3	0.208	<0.002 U	0.11	4.9	1.2
4/26/2017	Background	0.01 J	1.3	12.4	16.7	0.87	0.829	97.1	5.72	1.04	6.41	0.216	0.002 J	0.18	6.1	1.41
5/24/2017	Background	<0.01 U	1.34	11.5	16.4	0.77	0.62	85.3	6.4	0.98	4.96	0.221	<0.002 U	0.07 J	6.3	1.35
6/22/2017	Background	<0.01 U	1.29	11.4	16.4	0.86	0.821	92.4	6.00	0.98	6.47	0.263	<0.002 U	0.32	6.1	1.43
7/13/2017	Background	<0.01 U	0.89	11.3	18	0.8	0.485	92.5	6.36	0.93	3.72	0.217	<0.002 U	0.22	2.7	1.43
4/26/2018	Assessment	0.04 J	1.60	10.5	18.7	0.74	0.771	91.1	5.09	1.16	5.27	0.187	<0.002 U	0.03 J	8.1	1.39
9/20/2018	Assessment	< 0.02 U	1.40	11.4	19.6	0.83	0.713	93.8	6.75	1.15	4.39	0.255	- -	< 0.4 U	6.3	1.70
10/23/2018	Assessment	- -	- -	- -	- -	- -	- -	- -	- -	--	- -	- -	<0.002 U	- -	- -	- -
3/13/2019	Assessment	<0.20 U	1.26	12	24.4	0.78	1 J	87.9	4.8	0.92	4.28	0.209	<0.002 U	<4 U	4	1 J
6/27/2019	Assessment	<0.04 U	1.36	11	21.8	0.7	0.618	84.7	7.149	0.87	3.68	0.192	<0.002 U	<0.8 U	4.9	1.4
8/20/2019	Assessment	<0.10 U	1.39	13.6	25	0.89	0.8 J	96.6	10.92	0.84	4.17	0.226	<0.002 U	<2 U	5.6	2 J

Notes:
µg/L: micrograms 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
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: MW-1604
Big Sandy - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
9/27/2016	Background	0.031	6.48	6.20	0.27	7.5	182	16.6
11/8/2016	Background	0.03	4.26	6.22	0.29	3.4	180	9.1
1/11/2017	Background	0.016	3.27	4.07	0.23	6.2	186	5.9
2/21/2017	Background	0.04	3.21	2.60	0.12	6.5	102	5.7
4/25/2017	Background	0.01	3.15	1.71	0.08	5.9	78	8.6
5/23/2017	Background	0.038	2.93	1.56	0.06	5.8	68	8.2
6/21/2017	Background	0.017	2.88	1.41	0.03 J	5.6	49	10.5
7/12/2017	Background	0.054	3.06	1.84	0.06	5.5	85	9.8
9/18/2017	Detection	0.034	2.81	2.22	0.12	6.5	124	4.0
4/25/2018	Assessment	0.052	2.96	1.58	0.06	5.4	52	8.4
9/18/2018	Assessment	0.056	2.69	1.43	0.06 J	6.1	62	7.8
3/12/2019	Assessment	0.02 J	3.55	1.34	0.04 J	5.2	46	10
6/25/2019	Assessment	0.02 J	2.97	1.21	0.05 J	6.0	50	9.5
8/20/2019	Assessment	<0.02 U	3.42	1.17	0.03 J	5.4	50 J	10.5

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: MW-1604
Big Sandy - FAP
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
9/27/2016	Background	0.05 J	2.74	67.1	0.029	0.007 J	0.6	3.47	1.105	0.27	0.154	0.004	<0.002 U	3.48	0.2	0.01 J
11/8/2016	Background	0.04 J	3.61	59.0	0.048	0.008 J	0.583	1.55	1.277	0.29	0.265	0.005	<0.002 U	2.34	0.1	<0.01 U
1/11/2017	Background	0.08	4.28	54.8	0.027	0.06	0.551	2.02	0.707	0.23	0.188	0.005	<0.002 U	2.23	0.2	0.119
2/21/2017	Background	0.02 J	3.64	52.9	0.028	0.009 J	0.427	2.78	0.927	0.12	0.103	0.009	<0.002 U	1.51	0.1	0.175
4/25/2017	Background	0.03 J	3.54	65.1	0.034	0.006 J	0.365	5.59	0.478	0.08	0.01 J	<0.0002 U	<0.002 U	0.57	0.08 J	<0.01 U
5/23/2017	Background	0.02 J	2.24	54.8	0.04	0.03	0.401	4.18	6.707	0.06	0.062	<0.0002 U	<0.002 U	0.51	0.2	0.01 J
6/21/2017	Background	0.03 J	1.28	66.1	0.063	0.05	0.183	5.61	16.848	0.03 J	0.049	0.002	0.003 J	0.57	0.2	0.01 J
7/12/2017	Background	0.04 J	1.73	59.8	0.041	0.02	0.322	3.67	0.636	0.06	0.097	0.004	<0.002 U	15.9	0.1	<0.01 U
4/25/2018	Assessment	0.08	0.74	58.9	0.053	0.09	0.285	3.75	0.1535	0.06	0.263	0.01	<0.002 U	0.54	0.3	0.04 J
9/18/2018	Assessment	0.06	1.47	63.5	0.061	0.07	0.388	4.53	0.951	0.06 J	0.092	0.003	- -	0.86	0.2	0.04 J
10/22/2018	Assessment	- -	- -	- -	- -	- -	- -	- -	- -	--	- -	- -	<0.002 U	- -	- -	- -
3/12/2019	Assessment	0.03 J	0.16	66.8	0.06 J	0.08	0.547	0.844	0.458	0.04 J	0.04 J	<0.009 U	<0.002 U	<0.4 U	0.3	<0.1 U
6/25/2019	Assessment	0.03 J	0.12	68.3	0.07 J	0.09	0.231	0.503	0.799	0.05 J	0.03 J	<0.009 U	<0.002 U	<0.4 U	0.2	<0.1 U
8/20/2019	Assessment	<0.02 U	0.09 J	78.3	0.117	0.08	0.612	0.246	0.641	0.03 J	<0.05 U	0.00104	<0.002 U	<0.4 U	0.4	<0.1 U

Notes:
µg/L: micrograms 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
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: MW-1605
Big Sandy - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
9/27/2016	Background	0.008	1.00	0.43	<0.02 U	5.7	30 J	5.2
11/8/2016	Background	0.005	1.01	0.43	<0.02 U	2.3	40	4.2
1/11/2017	Background	<0.002 U	0.979	0.62	<0.02 U	4.6	35	5.7
2/21/2017	Background	0.061	1.37	1.49	<0.02 U	5.1	74	7.4
4/25/2017	Background	0.025	1.31	1.21	<0.02 U	4.9	30 J	6
5/23/2017	Background	0.063	1.21	1.00	<0.02 U	4.8	30 J	5.4
6/21/2017	Background	0.017	1.15	0.90	<0.02 U	4.9	25	5.8
7/12/2017	Background	0.075	1.11	1.32	<0.02 U	4.7	37	4.5
9/14/2017	Detection	0.102	1.01	1.72	<0.02 U	4.7	20 J	4.9
4/25/2018	Assessment	0.07	1.3	0.69	<0.02 U	4.6	37	6.5
9/18/2018	Assessment	0.036	0.93	0.62	<0.02 U	4.0	29	4.3
3/12/2019	Assessment	0.02 J	1.27	0.53	0.02 J	4.3	33	7.2
6/25/2019	Assessment	<0.02 U	1.2	0.43	<0.01 U	5.2	37	5.7
8/20/2019	Assessment	<0.02 U	1.01	0.46	0.01 J	5.5	30 J	5.5

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: MW-1605
Big Sandy - FAP
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
9/27/2016	Background	<0.01 U	0.04 J	30.3	0.091	0.06	2.7	0.897	0.679	<0.02 U	0.126	0.002	<0.002 U	0.08 J	0.2	0.01 J
11/8/2016	Background	0.01 J	0.08	30.5	0.121	0.06	2.5	0.917	1.986	<0.02 U	0.21	0.007	<0.002 U	0.05 J	0.2	0.01 J
1/11/2017	Background	0.01 J	0.07	32.2	0.111	0.07	2.53	1.64	0.1382	<0.02 U	0.19	0.008	<0.002 U	0.1 J	0.2	0.01 J
2/21/2017	Background	<0.01 U	0.03 J	42.6	0.138	0.09	2.61	1.45	0.904	<0.02 U	0.107	0.005	<0.002 U	0.1	0.2	0.03 J
4/25/2017	Background	0.01 J	0.06	39.1	0.119	0.09	2.57	0.991	0.2779	<0.02 U	0.121	<0.0002 U	<0.002 U	0.13	0.2	0.01 J
5/23/2017	Background	<0.01 U	0.03 J	35.0	0.114	0.07	2.39	0.667	6.077	<0.02 U	0.104	0.008	<0.002 U	0.07 J	0.2	0.01 J
6/21/2017	Background	<0.01 U	0.05 J	33.4	0.105	0.07	2.44	0.592	10.864	<0.02 U	0.11	0.002	<0.002 U	0.09 J	0.3	<0.01 U
7/12/2017	Background	<0.01 U	0.23	31.7	0.103	0.07	2.33	0.495	0.3796	<0.02 U	0.107	0.0003 J	<0.002 U	23.7	0.2	0.01 J
4/25/2018	Assessment	0.04 J	0.07	37.1	0.123	0.08	2.70	0.434	0.421	<0.02 U	0.193	0.009	<0.002 U	0.07 J	0.3	0.03 J
9/18/2018	Assessment	0.02 J	0.04 J	29.7	0.104	0.06	2.58	0.265	0.694	<0.02 U	0.092	0.002	- -	0.04 J	0.2	0.03 J
10/22/2018	Assessment	- -	- -	- -	- -	- -	- -	- -	- -	--	- -	- -	<0.002 U	- -	- -	- -
3/12/2019	Assessment	<0.02 U	0.17	36.6	0.131	0.08	2.91	0.483	0.2025	0.02 J	0.305	<0.009 U	0.003 J	<0.4 U	0.3	<0.1 U
6/25/2019	Assessment	<0.02 U	0.05 J	34.8	0.123	0.08	2.53	0.253	0.9023	<0.01 U	0.164	<0.009 U	<0.002 U	<0.4 U	0.2	<0.1 U
8/20/2019	Assessment	<0.02 U	0.03 J	29.1	0.09 J	0.06	2.41	0.215	0.268	0.01 J	0.09 J	0.000637	<0.002 U	<0.4 U	0.2	<0.1 U

Notes:
µg/L: micrograms 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
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: MW-1606
Big Sandy - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
9/27/2016	Background	1.92	78.6	31.3	0.17	7.4	362	54
11/8/2016	Background	1.8	75.9	31.5	0.19	7.2	400	54.5
1/12/2017	Background	1.77	75.1	31.2	0.21	7.3	396	58.8
2/22/2017	Background	1.63	76.7	30.4	0.18	7.2	358	53.9
4/26/2017	Background	1.78	73.8	31.7	0.19	6.7	380	56.1
5/23/2017	Background	1.87	78.1	31.7	0.19	6.8	360	56.2
6/21/2017	Background	1.89	78.1	31.1	0.17	6.7	369	55.3
7/12/2017	Background	1.79	75.7	31.4	0.17	6.5	382	57.0
9/18/2017	Detection	1.83	77.0	31.3	0.19	6.9	380	58.1
1/31/2018	Detection	1.63	- -	32.0	- -	7.2	- -	- -
4/25/2018	Assessment	1.81	73.7	31.3	0.26	6.6	350	56
9/19/2018	Assessment	1.82	71.8	31.1	0.24	6.6	380	56.9
3/13/2019	Assessment	1.93	74.2	31.7	0.22	6.9	389	58.8
6/25/2019	Assessment	1.84	74.5	30.8	0.23	7.1	384	58.7
8/20/2019	Assessment	1.74	75.1	31.4	0.21	7.0	385	58.3

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: MW-1606
Big Sandy - FAP
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
9/27/2016	Background	0.03 J	0.85	1030	0.064	0.009 J	1.7	0.814	2.76	0.17	1.19	0.006	<0.002 U	0.68	0.2	0.04 J
11/8/2016	Background	0.04 J	1.24	994	0.114	0.01 J	2.34	1.26	4.082	0.19	1.88	0.014	<0.002 U	0.51	0.3	0.03 J
1/12/2017	Background	0.07	1.19	883	0.058	0.06	1.52	0.919	3.35	0.21	1.02	0.01	<0.002 U	0.67	0.2	0.11
2/22/2017	Background	<0.01 U	0.97	875	0.025	<0.004 U	0.747	0.381	2.289	0.18	0.33	0.008	0.002 J	0.91	0.2	0.01 J
4/26/2017	Background	0.03 J	1.40	1080	0.053	0.007 J	1.33	0.951	2.398	0.19	0.862	0.003	<0.002 U	0.84	0.1	0.02 J
5/23/2017	Background	0.01 J	1.03	949	0.023	<0.005 U	0.79	0.411	3.37	0.19	0.341	0.006	0.002 J	0.54	0.09 J	<0.01 U
6/21/2017	Background	<0.01 U	0.98	884	0.01 J	<0.005 U	0.385	0.209	2.79	0.17	0.159	0.004	0.003 J	0.60	0.06 J	<0.01 U
7/12/2017	Background	0.01 J	1.14	773	0.01 J	<0.005 U	0.353	0.153	3.37	0.17	0.103	0.008	<0.002 U	7.56	0.06 J	<0.01 U
4/25/2018	Assessment	0.05	0.97	767	0.008 J	<0.005 U	0.301	0.101	3.71	0.26	0.077	0.014	<0.002 U	0.58	0.06 J	0.01 J
9/19/2018	Assessment	0.03 J	0.97	797	0.01 J	<0.005 U	0.366	0.155	3.28	0.24	0.126	0.001	- -	0.58	0.07 J	0.03 J
10/22/2018	Assessment	- -	- -	- -	- -	- -	- -	- -	- -		- -	- -	<0.002 U	- -	- -	- -
3/13/2019	Assessment	<0.02 U	1.22	764	<0.02 U	<0.01 U	0.535	0.208	2.63	0.22	0.123	<0.009 U	<0.002 U	2.6	0.05 J	<0.1 U
6/25/2019	Assessment	<0.02 U	0.94	843	<0.02 U	<0.01 U	0.1 J	0.055	2.366	0.23	0.05 J	<0.009 U	<0.002 U	0.6 J	0.06 J	<0.1 U
8/20/2019	Assessment	<0.02 U	0.85	768	<0.02 U	<0.01 U	0.304	0.05 J	3.12	0.21	<0.05 U	0.00301	<0.002 U	0.6 J	0.05 J	<0.1 U

Notes:
µg/L: micrograms 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
pCi/L: picocuries per liter

Table 1 - Groundwater Data Summary: MW-1607
Big Sandy - FAP
Appendix III Constituents

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
9/27/2016	Background	0.159	97.6	3.34	0.04 J	6.9	406	132
11/8/2016	Background	0.202	76.3	15.5	0.06	6.8	368	88.4
1/11/2017	Background	0.171	99.0	5.96	0.06	6.0	474	171
2/21/2017	Background	0.195	105	3.47	0.06	6.5	470	150
4/25/2017	Background	0.273	80.8	10.2	0.07	6.3	332	85.3
5/23/2017	Background	0.186	89.4	3.24	0.06 J	6.3	338	114
6/21/2017	Background	0.164	92.5	2.42	0.05 J	6.3	368	119
7/12/2017	Background	0.167	86.0	2.28	0.05 J	5.8	358	105
9/18/2017	Detection	0.155	90.7	2.73	0.07	6.4	398	125
1/31/2018	Detection	- -	110	- -	- -	6.6	- -	159
4/25/2018	Assessment	0.234	101	3.66	0.08	6.2	430	137
9/19/2018	Assessment	0.255	95.6	7.52	0.08	6.0	428	144
3/13/2019	Assessment	0.209	93.7	5.17	0.06	6.1	415	135
6/25/2019	Assessment	0.208	91.9	5.22	0.08	6.6	388	120
8/20/2019	Assessment	0.16	101	3.84	0.07	6.5	419	141

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: MW-1607
Big Sandy - FAP
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
9/27/2016	Background	0.02 J	7.36	34.3	0.01 J	<0.004 U	0.6	1.41	1.551	0.04 J	0.156	0.003	<0.002 U	0.52	0.1 J	0.03 J
11/8/2016	Background	0.02 J	11.6	42.3	0.025	0.007 J	0.619	1.45	1.683	0.06	0.376	0.002	<0.002 U	0.62	0.1	0.02 J
1/11/2017	Background	0.06	12.5	53.5	0.01 J	0.05	0.456	1.31	0.577	0.06	0.129	0.007	<0.002 U	0.83	0.1	0.119
2/21/2017	Background	0.01 J	8.71	34.3	0.01 J	<0.004 U	0.359	1.24	1.339	0.06	0.03	0.005	<0.002 U	0.54	0.05 J	0.055
4/25/2017	Background	0.03 J	15.4	38.1	0.028	0.006 J	0.682	1.34	1.08	0.07	0.416	0.003	<0.002 U	0.53	0.2	0.02 J
5/23/2017	Background	0.02 J	8.87	33.9	0.01 J	0.008 J	0.350	1.30	6.76	0.06 J	0.081	0.009	0.004 J	0.42	0.1	0.02 J
6/21/2017	Background	0.02 J	9.22	27.5	0.01 J	<0.005 U	0.324	1.39	1.274	0.05 J	0.123	0.004	<0.002 U	0.45	0.1	0.02 J
7/12/2017	Background	0.02 J	7.59	25.0	0.01 J	<0.005 U	0.293	1.13	0.33	0.05 J	0.07	0.004	<0.002 U	9.02	0.1	0.02 J
4/25/2018	Assessment	0.27	68.5	37.2	0.111	<0.005 U	0.851	1.57	3.217	0.08	0.799	0.012	<0.002 U	0.90	0.7	0.04 J
9/19/2018	Assessment	0.04 J	23.6	42.6	0.02 J	<0.005 U	0.423	1.59	0.611	0.08	0.159	0.001	- -	0.59	0.1	0.04 J
10/22/2018	Assessment	- -	- -	- -	- -	- -	- -	- -	- -		- -	- -	<0.002 U	- -	- -	- -
3/13/2019	Assessment	<0.02 U	7.67	31.6	<0.02 U	<0.01 U	0.424	1.43	0.18541	0.06	0.05 J	<0.009 U	<0.002 U	1 J	0.08 J	<0.1 U
6/25/2019	Assessment	0.02 J	19.3	38.1	<0.02 U	<0.01 U	0.250	1.39	0.501	0.08	0.09 J	<0.009 U	<0.002 U	0.7 J	0.1 J	<0.1 U
8/20/2019	Assessment	<0.02 U	14.4	29.1	<0.02 U	<0.01 U	0.347	1.19	0.685	0.07	<0.05 U	0.0001 J	<0.002 U	0.6 J	0.09 J	<0.1 U

Notes:
µg/L: micrograms 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
pCi/L: picocuries per liter

Table 1: Residence Time Calculation Summary
Big Sandy Fly Ash Pond

			2019-03		2019-06		2019-08	
CCR Management Unit	Monitoring Well	Well Diameter (inches)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
Fly Ash Pond	MW-1011 [1]	2.0	33.0	1.8	33.0	1.8	33.0	1.8
	MW-1012 [1]	2.0	33.0	1.8	33.0	1.8	33.0	1.8
	MW-1203 [1]	2.0	33.0	1.8	33.0	1.8	33.0	1.8
	MW-1601 [2]	4.0	33.0	3.7	33.0	3.7	33.0	3.7
	MW-1602 [2]	4.0	33.0	3.7	33.0	3.7	33.0	3.7
	MW-1603 [2]	4.0	33.0	3.7	33.0	3.7	33.0	3.7
	MW-1604 [1]	4.0	5.5	22.1	4.7	25.9	3.3	37.3
	MW-1605 [1]	4.0	5.5	22.1	4.7	25.9	3.3	37.3
	MW-1606 [2]	4.0	5.5	22.1	4.7	25.9	3.3	37.3
	MW-1607 [2]	4.0	5.5	22.1	4.7	25.9	3.3	37.3

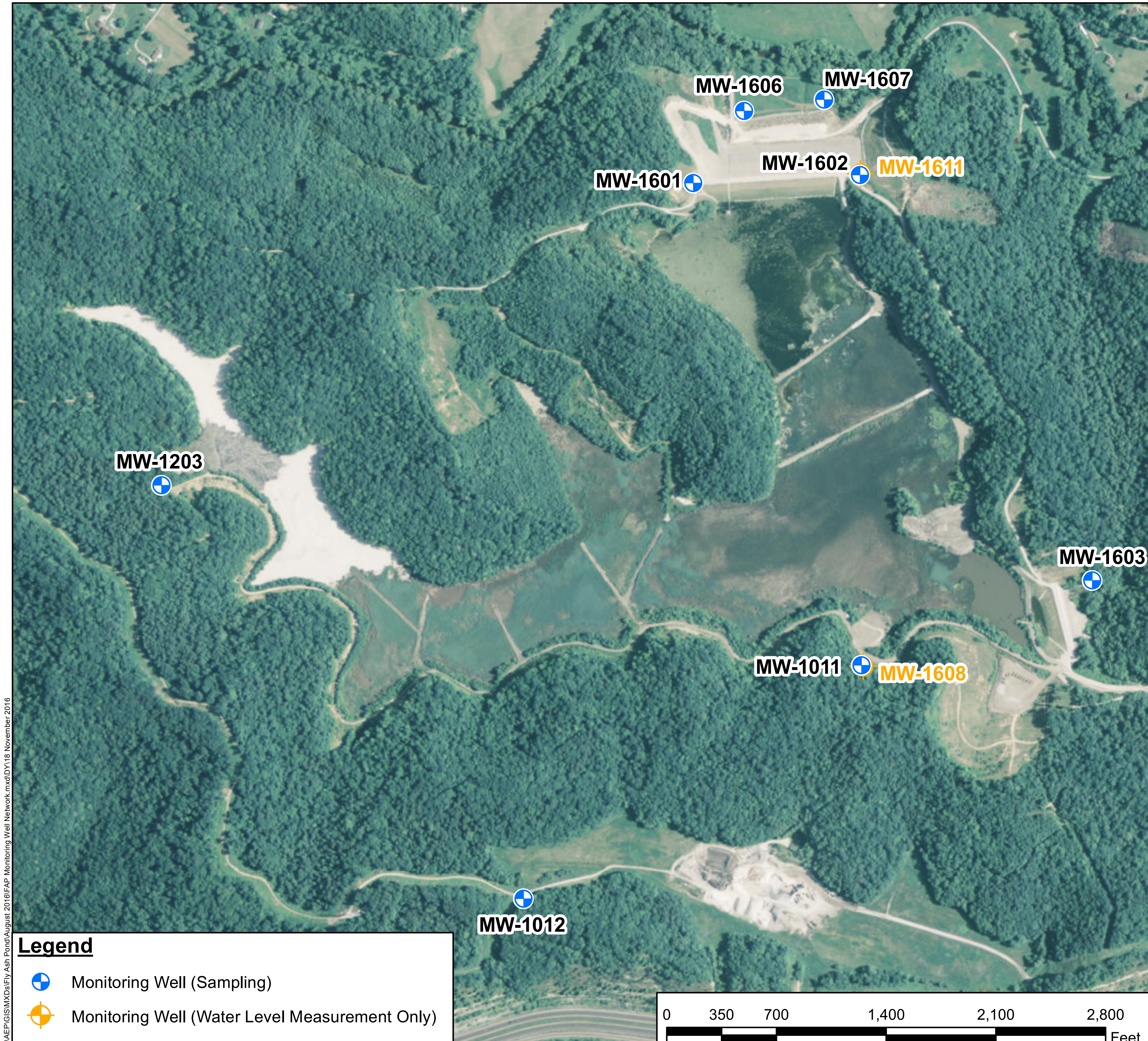
Notes:

[1] - Upgradient Well

[2] - Downgradient Well

APPENDIX 2—Figures

Figures follow showing the PE-certified groundwater monitoring network with the corresponding well identifications along with static water elevation data and groundwater flow directions each time groundwater was sampled in the form of annotated satellite images.



GROUNDWATER MONITORING WELL NETWORK

FLY ASH POND
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

Geosyntec consultants

AUSTIN, TX	DECEMBER 2016	FIGURE 1

N:\AEP\GIS\MXDs\Fly Ash Pond\August 2016\FAP Monitoring Well Network.mxd\DY\18 November 2016

Legend
- Groundwater Monitoring Well
- Inferred Groundwater Flow Direction

Notes
- Monitoring well coordinates and water level data (collected on March 11, 2019) provided by AEP.
- Site features based on information available in Groundwater Monitoring Network Evaluation - Big Sandy Fly Ash Pond (Geosyntec, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft amsl).

Potentiometric Surface Map - Uppermost Aquifer
March 2019
AEP Big Sandy Plant - Fly Ash Pond
Louisa, Kentucky

Geosyntec consultants

Columbus, Ohio	2019/12/31	Figure 2

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Legend
Groundwater Monitoring Well
Inferred Groundwater Flow Direction

Notes
- Monitoring well coordinates and water level data (collected on June 26, 2019) provided by AEP.
- Site features based on information available in Groundwater Monitoring Network Evaluation - Big Sandy Fly Ash Pond (Geosyntec, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft amsl).

750 375 0 750 Feet

Potentiometric Surface Map - Uppermost Aquifer
June 2019
AEP Big Sandy Plant - Fly Ash Pond
Louisa, Kentucky

Geosyntec consultants

Figure **3**

Columbus, Ohio | 2019/12/31

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Legend
- Groundwater Monitoring Well
- Inferred Groundwater Flow Direction

Notes
- Monitoring well coordinates and water level data (collected on August 19, 2019) provided by AEP.
- Site features based on information available in Groundwater Monitoring Network Evaluation - Big Sandy Fly Ash Pond (Geosyntec, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.

750 375 0 750 Feet

Potentiometric Surface Map - Uppermost Aquifer
August 2019
AEP Big Sandy Plant - Fly Ash Pond
Louisa, Kentucky

Geosyntec consultants

Columbus, Ohio | 2019/10/16

Figure **4**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Big Sandy\2019\AEP-BigSandy_FAP_GW_2019-08-August.mxd. hduff. 10/16/2019. CHA8423/05/08.

APPENDIX 3—Statistical Analysis Summaries

The January 2019, July 2019, and January 2020 statistical analysis summaries concluding that SSLs were identified at the CCR unit follow.

STATISTICAL ANALYSIS SUMMARY
FLY ASH POND
Big Sandy Plant
Louisa, Kentucky

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, Ohio 43221

January 8, 2019

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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
FAP	Fly 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 Fly Ash Pond (FAP), an existing CCR unit at the Big Sandy Power Plant located in Louisa, Kentucky.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, calcium, chloride, fluoride, total dissolved solids (TDS), and sulfate at the FAP. An alternate source was not identified at the time, so two assessment monitoring events were conducted at the FAP in 2018, in accordance with 40 CFR 257.95.

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 the usability of the data.

The monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were 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 beryllium, cobalt, and lithium. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (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

FLY 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) and 257.95(d)(1). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during assessment monitoring may be found 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.9.5 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 FAP 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 to meet the requirements of 40 CFR 257.95(b) and 257.95(d)(1) were screened for potential outliers. No outliers were identified. Outliers identified from the background and detection monitoring events conducted through January 2018 were summarized in a previous report (Geosyntec, 2018).

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 regional screening level (RSL) 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.

Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for antimony, arsenic, cadmium, chromium, fluoride, selenium, and thallium due to apparent non-normal distributions, for mercury due to a high non-detect frequency, and for beryllium due to both an apparent non-normal distribution and 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 Big Sandy FAP:

- The LCL for beryllium exceeded the GWPS of 0.004 mg/L at MW-1603 (0.0169 mg/L).
- The LCL for cobalt exceeded the GWPS of 0.006 mg/L at MW-1603 (0.0893 mg/L).
- The LCL for lithium exceeded the GWPS of 0.04 mg/L at MW-1603 (0.207 mg/L).

As a result, the Big Sandy FAP 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.

2.3 Conclusions

Two assessment monitoring events were conducted in 2018 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 2018 data. GWPSs were 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 beryllium, cobalt, and lithium.

Based on this evaluation, the Big Sandy FAP 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 – Big Sandy Plant. January 2017.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Fly Ash Pond, Big Sandy Plant, Louisa, Kentucky. January 15, 2018.

TABLES

Table 1 – Groundwater Data Summary
Big Sandy – Fly Ash Pond

Parameter	Unit	MW-1011			MW-1012		MW-1203			MW-1601			MW-1602		MW-1603			MW-1604		
		4/26/2018	9/20/2018	10/23/2018	4/26/2018	9/20/2018	4/26/2018	9/20/2018	10/22/2018	4/25/2018	9/20/2018	10/23/2018	4/26/2018	9/20/2018	4/26/2018	9/20/2018	10/23/2018	4/25/2018	9/18/2018	10/22/2018
Antimony	µg/L	0.16	0.18	-	0.65	0.62	0.03 J	0.03	-	0.17	0.29	-	0.05 J	0.03 J	0.04 J	0.020 J	-	0.08	0.06	-
Arsenic	µg/L	13.5	7.25	-	15.8	14	0.3	0.51	-	4.58	3.54	-	3.15	3.92	1.60	1.40	-	0.74	1.47	-
Barium	µg/L	63.1	44.8	-	24.1	24.2	89.1	90.1	-	56.4	75.9	-	60.9	55.1	10.5	11.4	-	58.9	63.5	-
Beryllium	µg/L	0.02 U	0.02 U	-	0.01 J	0.021	0.033	0.076	-	0.005 J	0.007 J	-	0.02 U	-	18.7	19.6	-	0.053	0.061	-
Boron	mg/L	0.139	0.165	-	0.227	0.236	0.147	0.125	-	0.177	0.196	-	0.143	0.07	0.088	0.0850	-	0.052	0.056	-
Cadmium	µg/L	0.02 U	0.009 J	-	0.006 J	0.02 U	0.02 U	0.02 U	-	0.02 U	0.005 J	-	0.02 U	0.02 U	0.74	0.830	-	0.09	0.07	-
Calcium	mg/L	105	72.7	-	1.13	1.11	57.4	53.4	-	50.4	68.8	-	75.2	72.1	83.6	97.5	-	2.96	2.69	-
Chloride	mg/L	4.71	3.43	-	1.34	1.27	5.66	5.37	-	15.2	16.1	-	13.9	15.2	4.12	3.92	-	1.58	1.43	-
Chromium	µg/L	0.207	0.588	-	0.262	0.442	0.171	0.24	-	0.245	0.378	-	0.29	0.328	0.771	0.713	-	0.285	0.388	-
Cobalt	µg/L	3.25	0.683	-	0.062	0.079	0.886	0.916	-	0.794	1.21	-	0.552	0.312	91.1	93.8	-	3.75	4.53	-
Combined Radium	pCi/L	5.69	2.56	-	1.14	0.291	2.48	1.25	-	2.783	0.698	-	1.75	1.04	5.09	6.75	-	0.154	0.951	-
Fluoride	mg/L	0.2	0.28	-	0.82	0.75	0.14	0.12	-	0.36	0.22	-	0.14	0.11	1.16	1.15	-	0.06	0.06 J	-
Lead	µg/L	0.095	0.083	-	0.287	0.346	0.034	0.049	-	0.024	0.041	-	0.049	0.025	5.27	4.39	-	0.263	0.092	-
Lithium	mg/L	0.01	0.009	-	0.006	0.006	0.013	0.013	-	0.033	0.031	-	0.008	0.008	0.187	0.255	-	0.01	0.003	-
Mercury	µg/L	0.007 U	-	0.005 U	0.003 J	0.013	0.007 U	-	0.005 U	0.007 U	-	0.005 U	0.003 J	0.01 U	0.007 U	-	0.005 U	0.005 U	-	0.005 U
Molybdenum	µg/L	0.82	0.82	-	0.89	0.82	0.12	0.11	-	20.6	19.6	-	1.64	1.27	0.03 J	0.04 J	-	0.54	0.86	-
Selenium	µg/L	0.1 U	0.1 U	-	0.05 J	0.08 J	0.1 U	0.1 U	-	0.1	0.2	-	0.4	0.4	8.10	6.30	-	0.3	0.2	-
Total Dissolved Solids	mg/L	456	386	-	541	561	253	253	-	326	448	-	416	492	926	974	-	52	62	-
Sulfate	mg/L	106	76.3	-	36.6	36.6	37.5	32.3	-	72.6	167	-	106	150	661	747	-	8.4	7.8	-
Thallium	µg/L	0.121	0.075	-	0.02 J	0.02 J	0.03 J	0.05 J	-	0.02 J	0.053	-	0.01 J	0.02 J	1.39	1.70	-	0.04 J	0.04 J	-
pH	SU	6.29	6.96	6.94	8.95	9.14	6.02	6.69	6.64	6.93	7.05	7.18	7.95	7.04	2.91	3.1	3.46	5.39	6.12	5.92

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Component was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Component was detected in concentrations below the reporting limit
-: Not sampled

Table 1 – Groundwater Data Summary
Big Sandy – Fly Ash Pond

Parameter	Unit	MW-1605			MW-1606			MW-1607		
		4/25/2018	9/18/2018	10/22/2018	4/25/2018	9/19/2018	10/22/2018	4/25/2018	9/19/2018	10/22/2018
Antimony	µg/L	0.04 J	0.02 J	-	0.05	0.03 J	-	0.27	0.04 J	-
Arsenic	µg/L	0.07	0.04 J	-	0.97	0.97	-	68.5	23.6	-
Barium	µg/L	37.1	29.7	-	767	797	-	37.2	42.6	-
Beryllium	µg/L	0.123	0.104	-	0.008 J	0.01 J	-	0.111	0.02 J	-
Boron	mg/L	0	0.036	-	1.81	1.82	-	0.234	0.255	-
Cadmium	µg/L	0.08	0.06	-	0.02 U	0.02 U	-	0.02 U	0.02 U	-
Calcium	mg/L	1.3	0.93	-	73.7	71.8	-	101	95.6	-
Chloride	mg/L	0.69	0.62	-	31.3	31.1	-	3.66	7.52	-
Chromium	µg/L	2.7	2.58	-	0.301	0.366	-	0.851	0.423	-
Cobalt	µg/L	0.434	0.265	-	0.101	0.155	-	1.57	1.59	-
Combined Radium	pCi/L	0.421	0.694	-	3.22	3.28	-	3.22	0.611	-
Fluoride	mg/L	0.06 U	0.06 U	-	0.26	0.24	-	0.08	0.08	-
Lead	µg/L	0.193	0.092	-	0.077	0.126	-	0.799	0.159	-
Lithium	mg/L	0.009	0.002	-	0.014	0.001	-	0.012	0.001	-
Mercury	µg/L	0.007 U	-	0.005 U	0.007 U	-	0.005 U	0.007 U	-	0.005 U
Molybdenum	µg/L	0.07 J	0.04 J	-	0.58	0.58	-	0.9	0.59	-
Selenium	µg/L	0.3	0.2	-	0.06 J	0.07 J	-	0.7	0.1	-
Total Dissolved Solids	mg/L	37	29	-	350	380	-	430	428	-
Sulfate	mg/L	6.5	4.3	-	56	56.9	-	137	144	-
Thallium	µg/L	0.03 J	0.03 J	-	0.01 J	0.03 J	-	0.04 J	0.04 J	-
pH	SU	4.57	4.01	4.7	6.59	6.59	7.06	6.15	6.04	6.47

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Component was not present in concentrations above method detection limit and is reported as the reporting limit
J: Estimated value. Component was detected in concentrations below the reporting limit
-: Not sampled

Table 2: Groundwater Protection Standards
Big Sandy Plant - Fly Ash Pond

Constituent Name	MCL	RSL	Background Limit
Antimony, Total (mg/L)	0.006		0.0012
Arsenic, Total (mg/L)	0.01		0.029
Barium, Total (mg/L)	2		0.12
Beryllium, Total (mg/L)	0.004		0.00015
Cadmium, Total (mg/L)	0.005		0.00014
Chromium, Total (mg/L)	0.1		0.0027
Cobalt, Total (mg/L)	n/a	0.006	0.0049
Combined Radium, Total (pCi/L)	5		6.57
Fluoride, Total (mg/L)	4		0.82
Lead, Total (mg/L)	n/a	0.015	0.0013
Lithium, Total (mg/L)	n/a	0.04	0.02
Mercury, Total (mg/L)	0.002		0.000013
Molybdenum, Total (mg/L)	n/a	0.1	0.011
Selenium, Total (mg/L)	0.05		0.0003
Thallium, Total (mg/L)	0.002		0.00023

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

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 Big Sandy Fly 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

STATE OF KENTUCKY
DAVID
ANTHONY
MILLER
33232
LICENSED
PROFESSIONAL ENGINEER

33232	KENTUCKY	01.08.19
License Number	Licensing State	Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS CONSULTING

November 11, 2018

Geosyntec Consultants
Attn: Ms. Allison Kreinberg
150 E. Wilson Bridge Rd., #232
Worthington, OH 43085

Re: Big Sandy Fly Ash Pond
Assessment Monitoring Event – September 2018

Dear Ms. Kreinberg,

Groundwater Stats Consulting (GSC), formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the evaluation of groundwater data for the September 2018 Assessment Monitoring event for American Electric Power Company's Big Sandy Bottom Ash Pond. 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 began at site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** MW-1011, MW-1012, MW-1203, MW-1604, and MW-1605; and
- **Downgradient wells:** MW-1601, MW-1602, MW-1603, MW-1606, and MW-1607.

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 CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and
- **Appendix IV** (Assessment Monitoring) **–** antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 + 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record. Values in background which have previously been flagged as outliers may be seen in a lighter font and disconnected symbol on the graphs. Additionally, a summary of flagged values follows this letter.

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, calcium, chloride, fluoride, sulfate and TDS; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for pH. In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. SSIs were noted for some of the Appendix III parameters and the results of those findings may be found in the Prediction Limit Summary tables following this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether data are statistically increasing, decreasing or stable. A few statistically significant decreasing trends were noted, but no statistically significant increasing trends were found. The Trend Test Summary Table follows this letter.

Evaluation of Appendix IV Parameters

Parametric tolerance limits were used to calculate background limits from pooled upgradient well data for Appendix IV parameters with a target of 95% confidence and 95% coverage to determine the Alternate Contaminant Level (ACL). The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and Regional Screening Levels (RSLs) in the Groundwater Protection Standards (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons.

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, RSL, or ACL as discussed above. Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No exceedances were noted except for the following well/constituent pairs: beryllium, cobalt, and lithium in well MW-1603. A summary of the confidence interval results follows this letter.

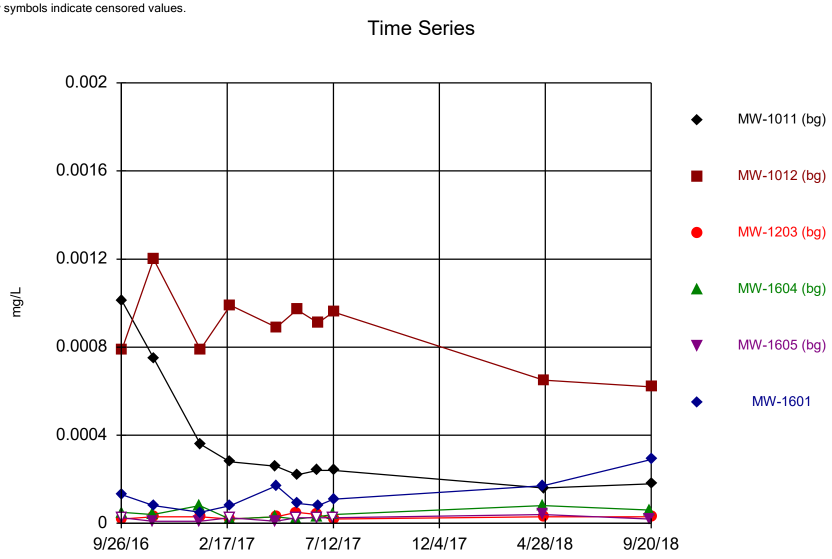
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for Big Sandy Fly Ash Pond. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



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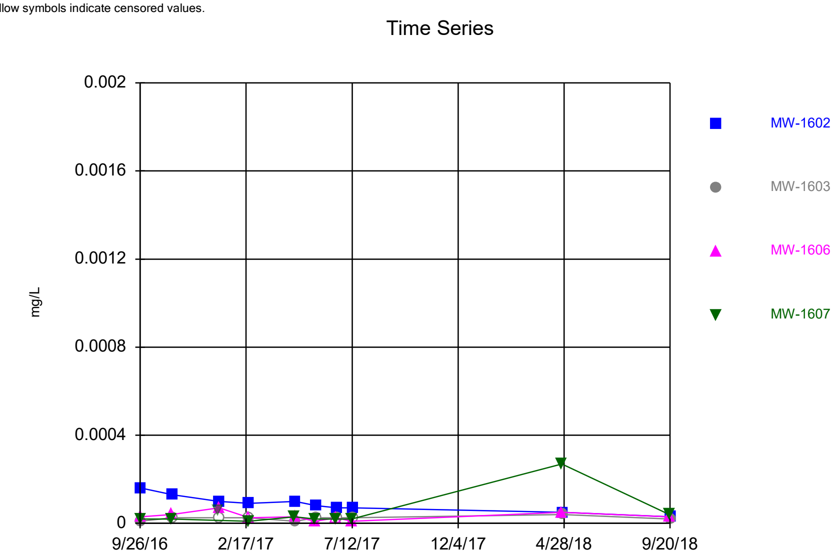
Hollow symbols indicate censored values.



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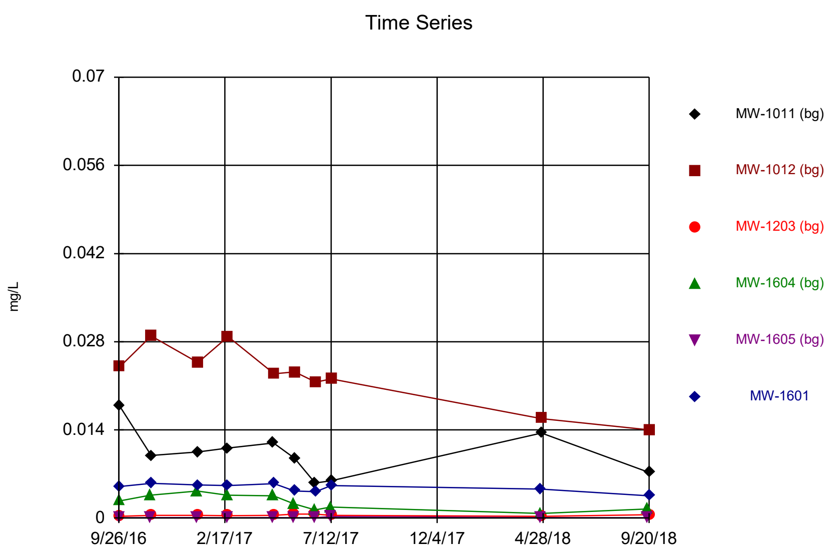

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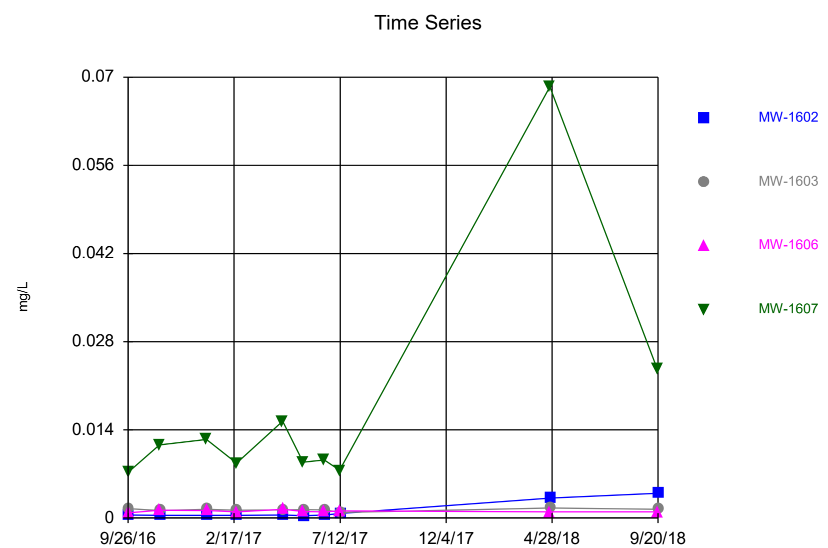

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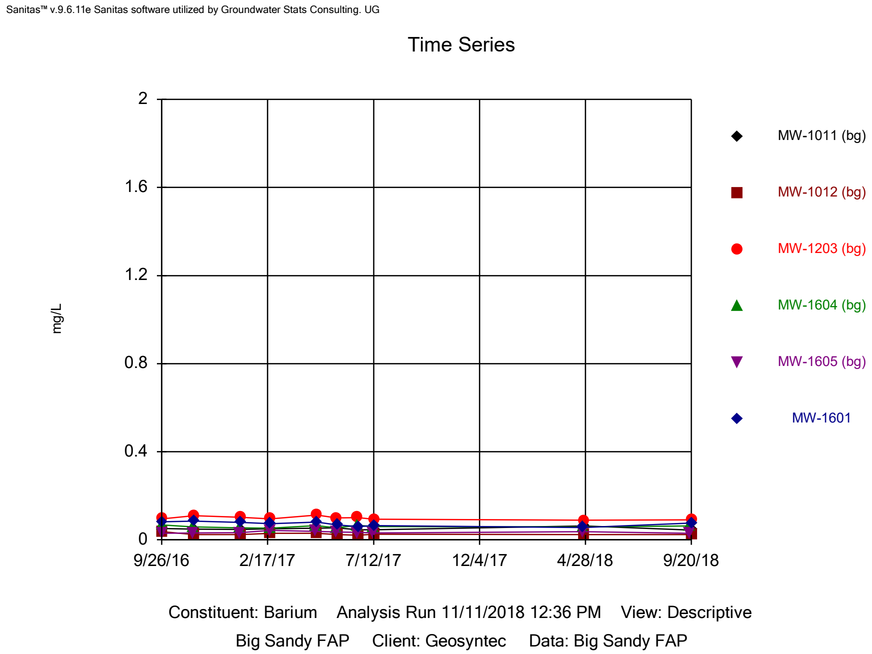
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Time Series
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1.6
1.2
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0
9/26/16
2/17/17
7/12/17
12/4/17
4/28/18
9/20/18
MW-1011 (bg)
MW-1012 (bg)
MW-1203 (bg)
MW-1604 (bg)
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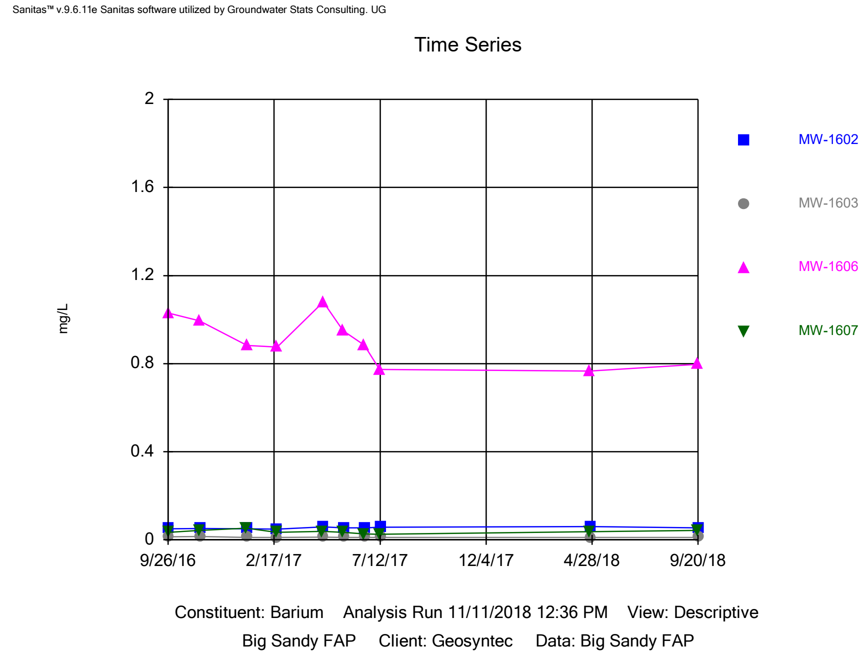
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Time Series
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1.6
1.2
0.8
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7/12/17
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4/28/18
9/20/18
MW-1602
MW-1603
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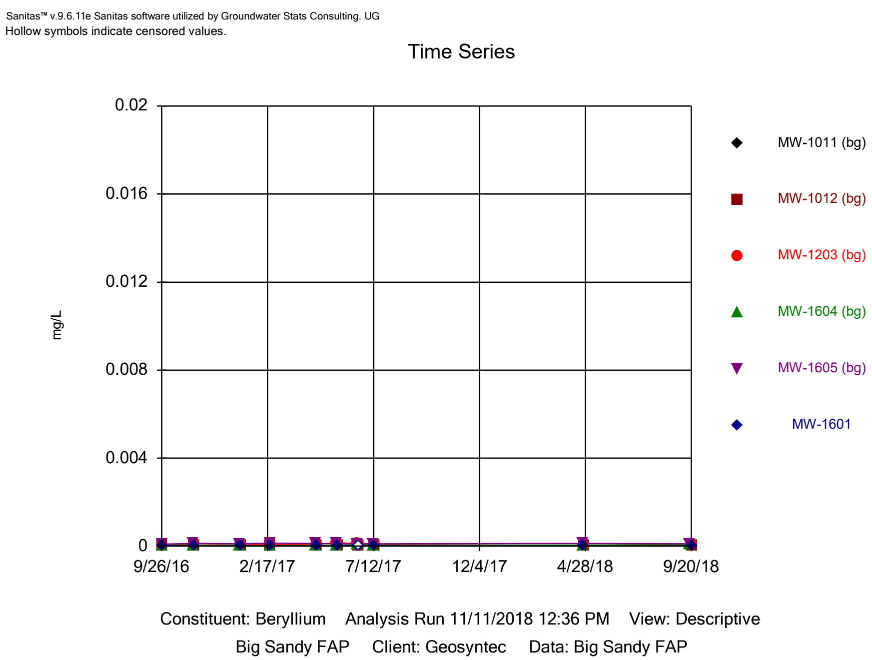
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Hollow symbols indicate censored values.
Time Series
mg/L
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0.012
0.008
0.004
0
9/26/16
2/17/17
7/12/17
12/4/17
4/28/18
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MW-1012 (bg)
MW-1203 (bg)
MW-1604 (bg)
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MW-1601
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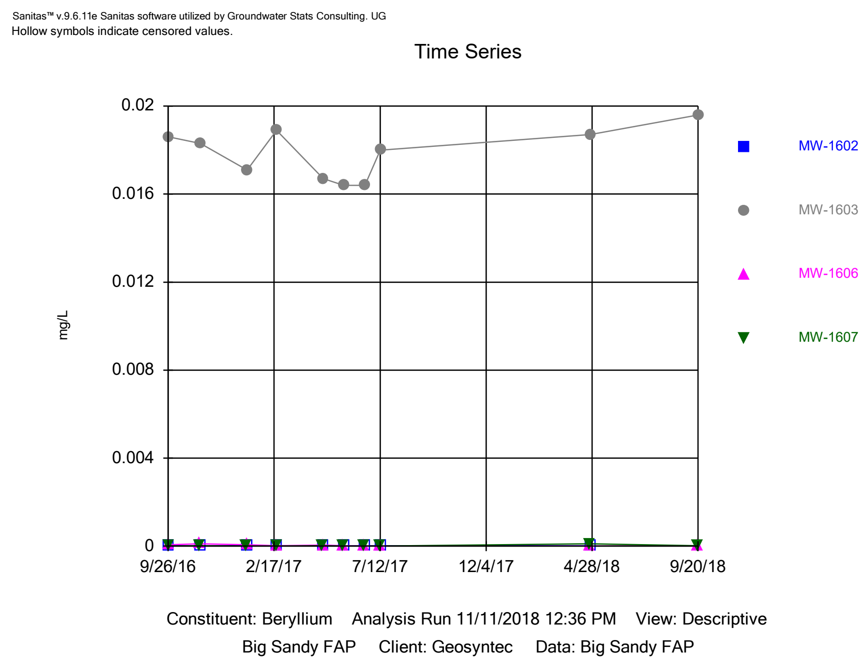
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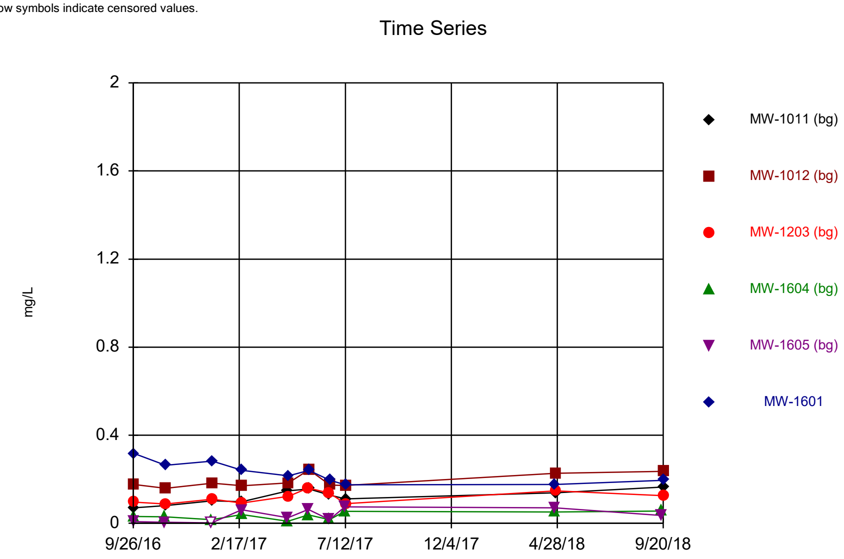
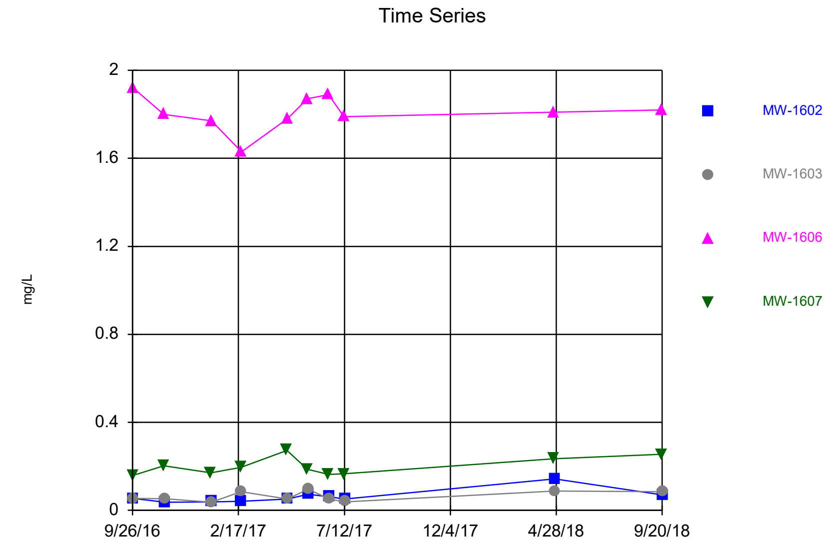
Hollow symbols indicate censored values.
Time Series
mg/L
0.02
0.016
0.012
0.008
0.004
0
9/26/16
2/17/17
7/12/17
12/4/17
4/28/18
9/20/18
MW-1602
MW-1603
MW-1606
MW-1607
Constituent: Beryllium Analysis Run 11/11/2018 12:36 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



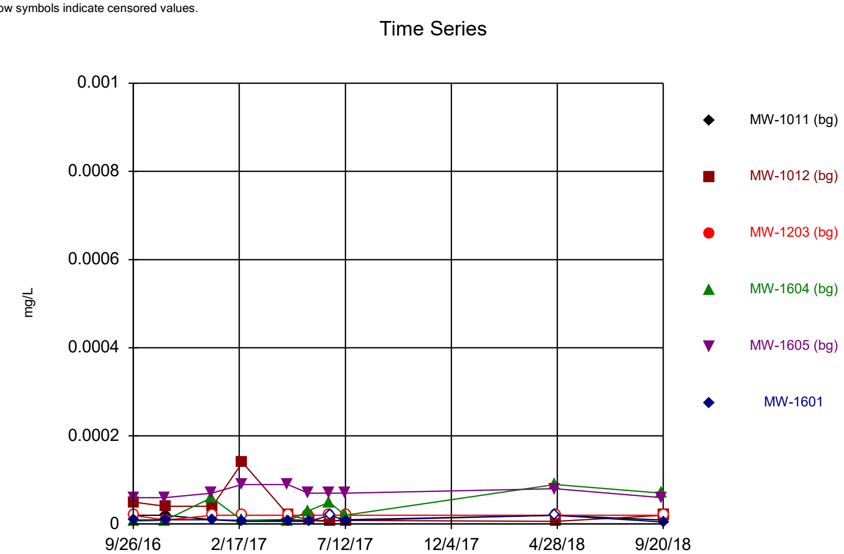
Constituent: Boron Analysis Run 11/11/2018 12:36 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



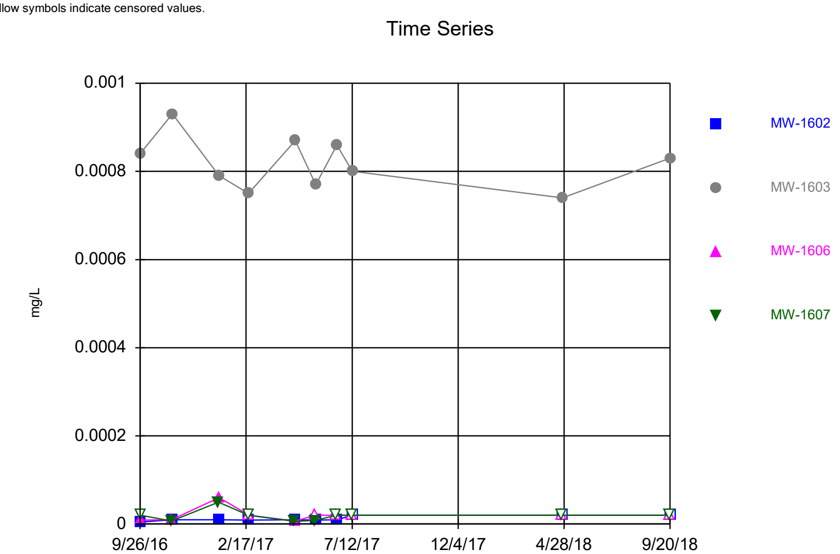
Constituent: Boron Analysis Run 11/11/2018 12:36 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



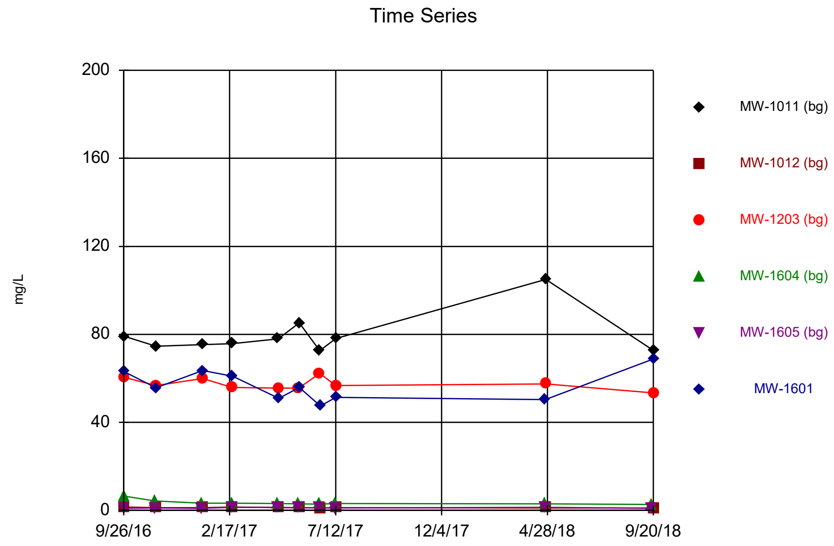
Constituent: Cadmium Analysis Run 11/11/2018 12:36 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



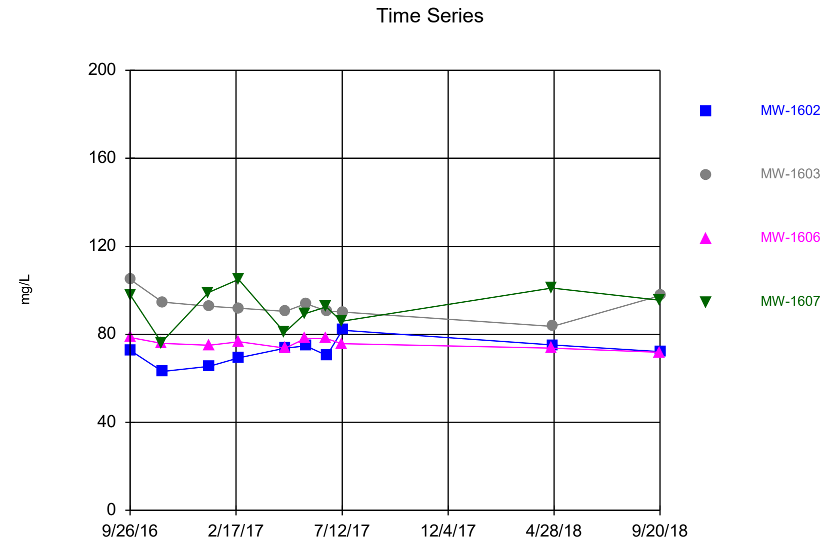
Constituent: Cadmium Analysis Run 11/11/2018 12:36 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



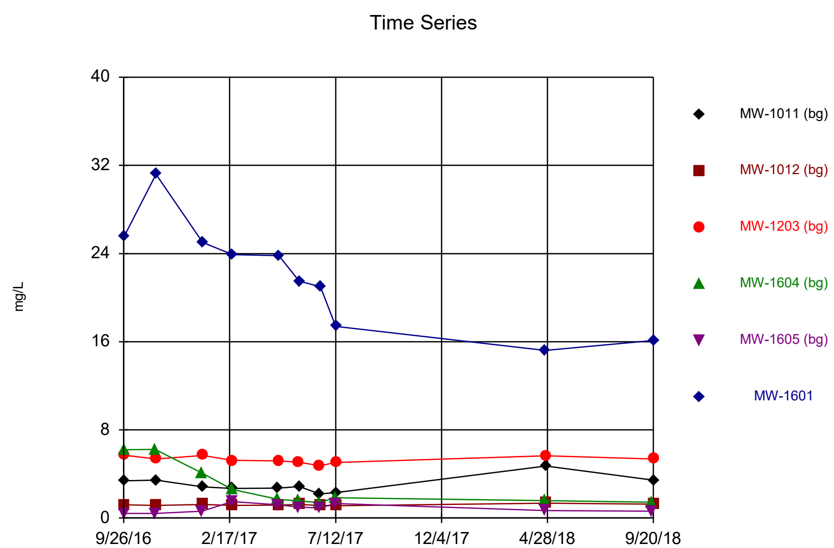
Constituent: Calcium Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



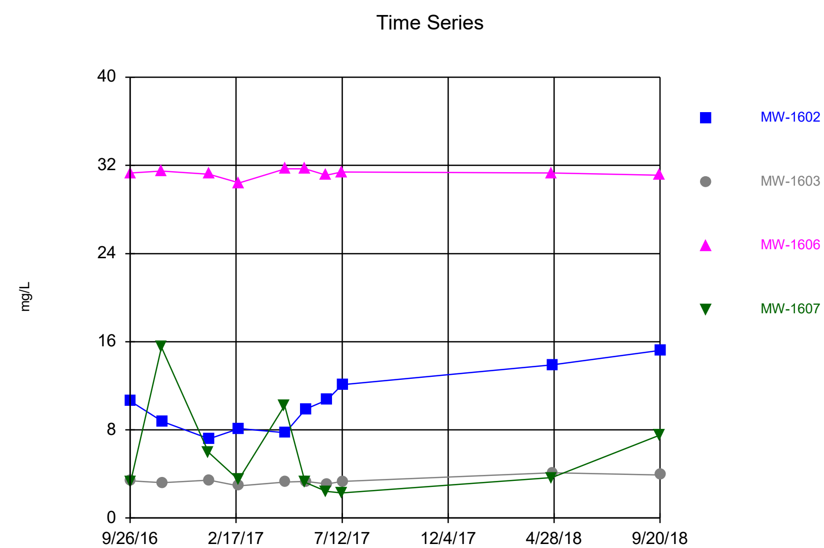
Constituent: Calcium Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



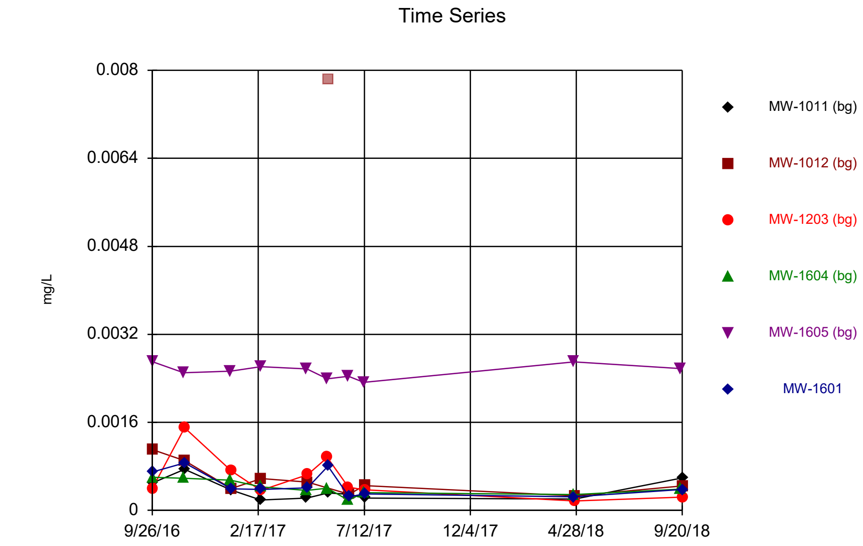
Constituent: Chloride Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



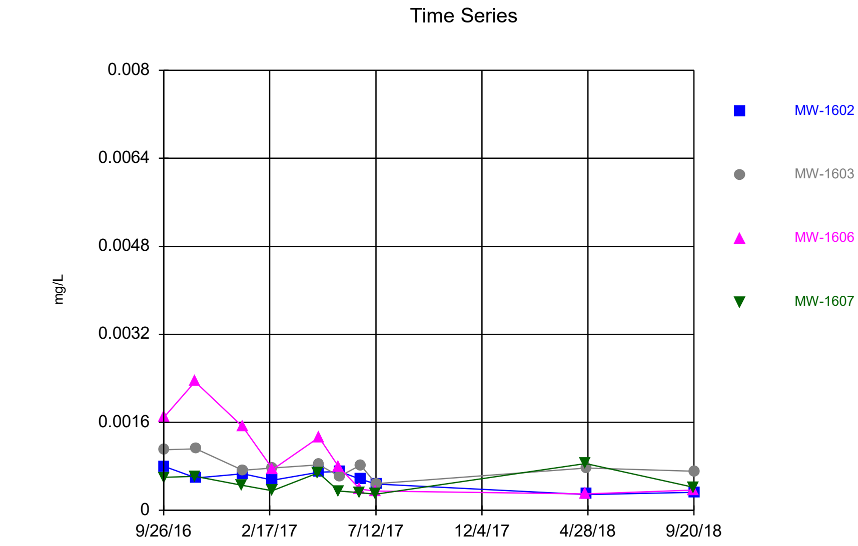
Constituent: Chloride Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



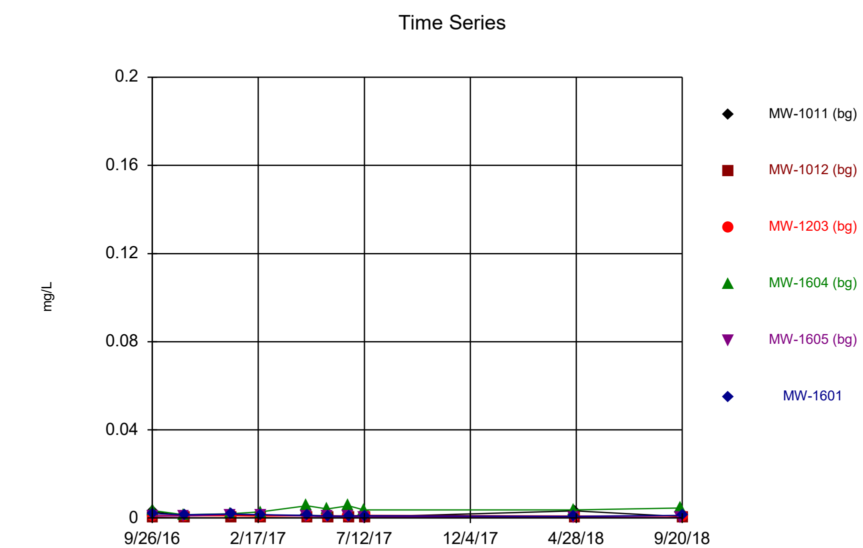
Constituent: Chromium Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



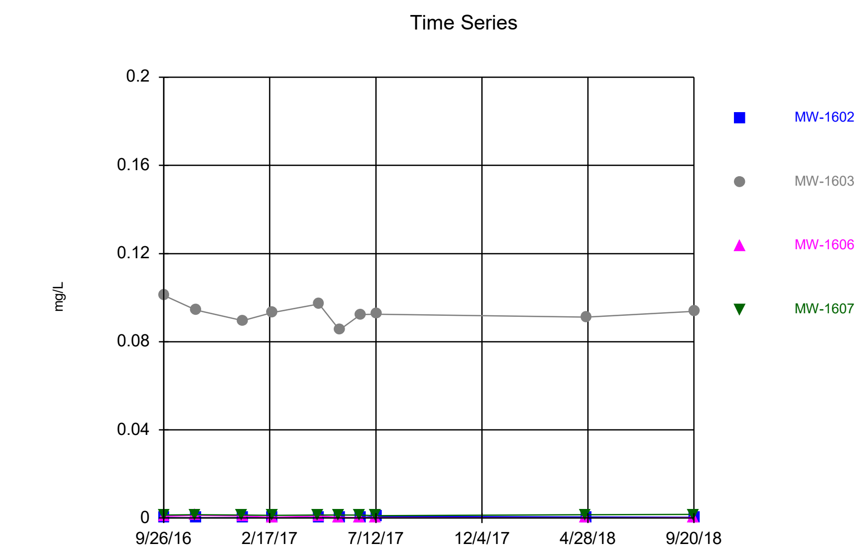
Constituent: Chromium Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



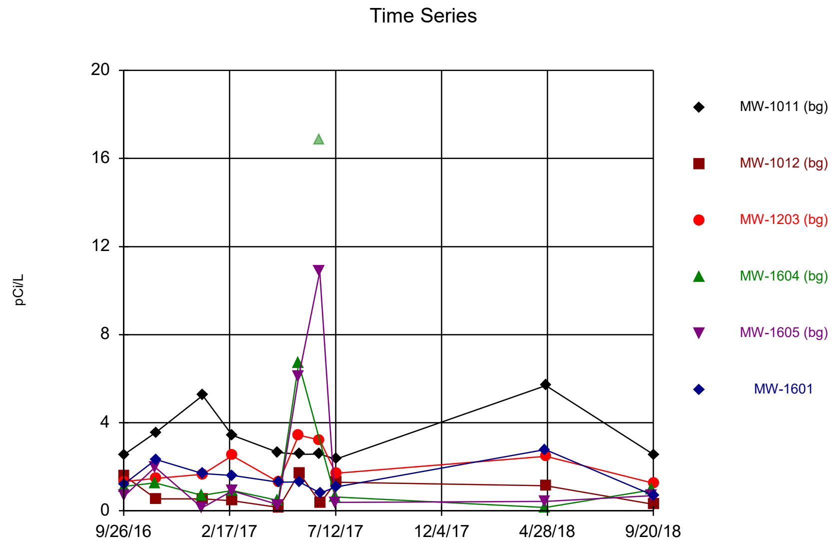
Constituent: Cobalt Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



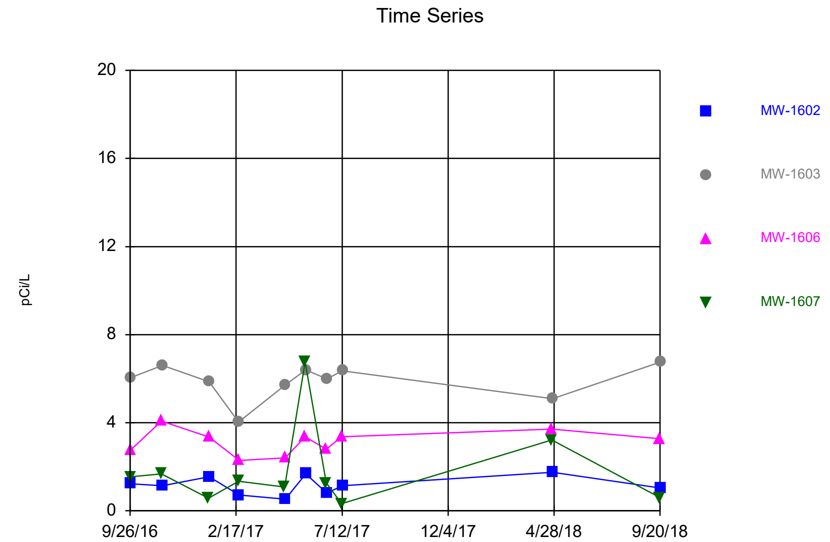
Constituent: Cobalt Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



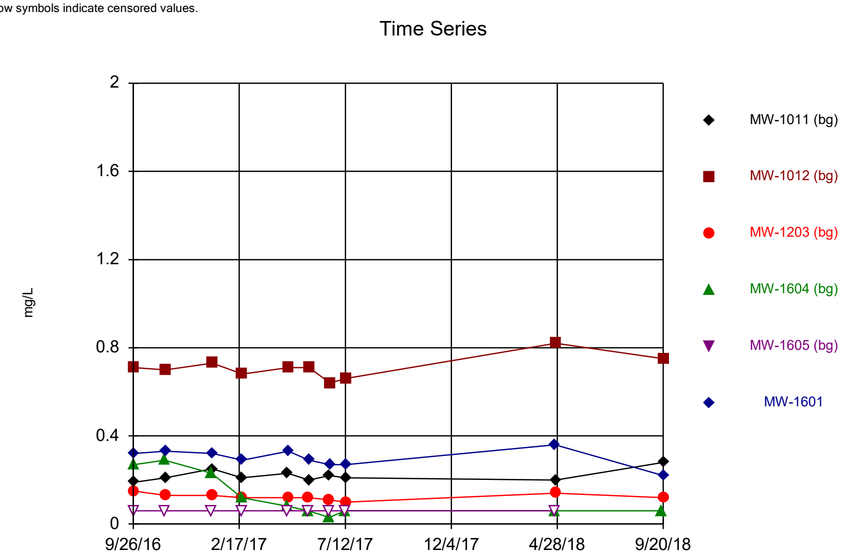
Constituent: Combined Radium 226 + 228 Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



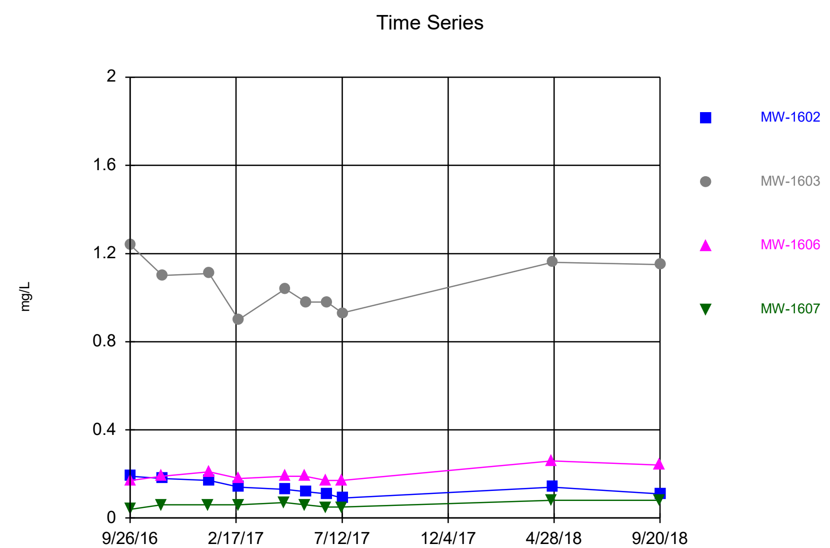
Constituent: Combined Radium 226 + 228 Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



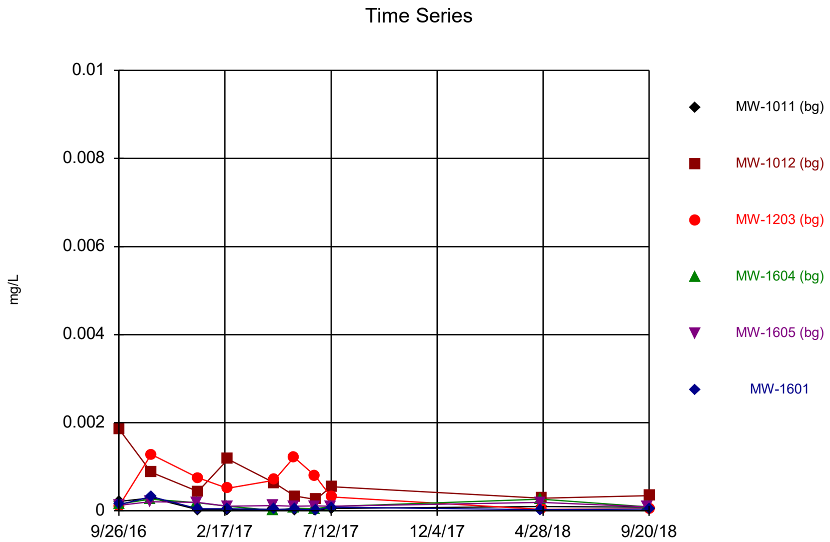
Constituent: Fluoride Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



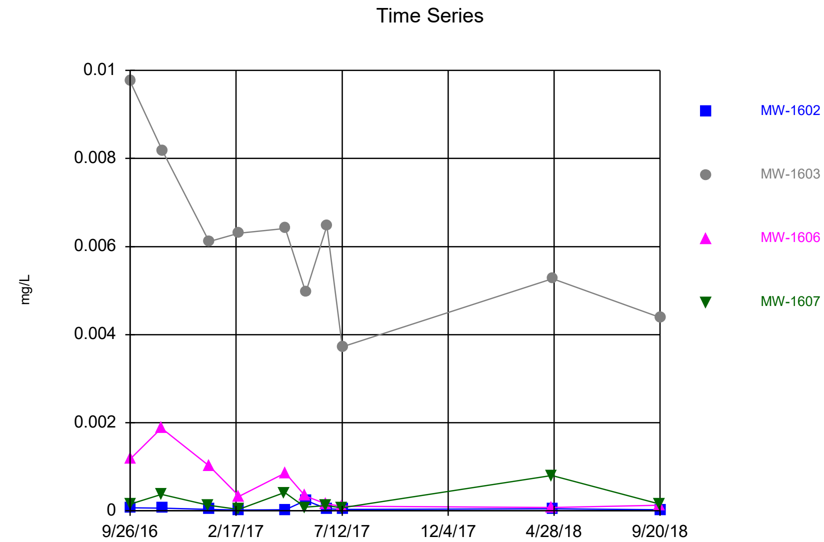
Constituent: Fluoride Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



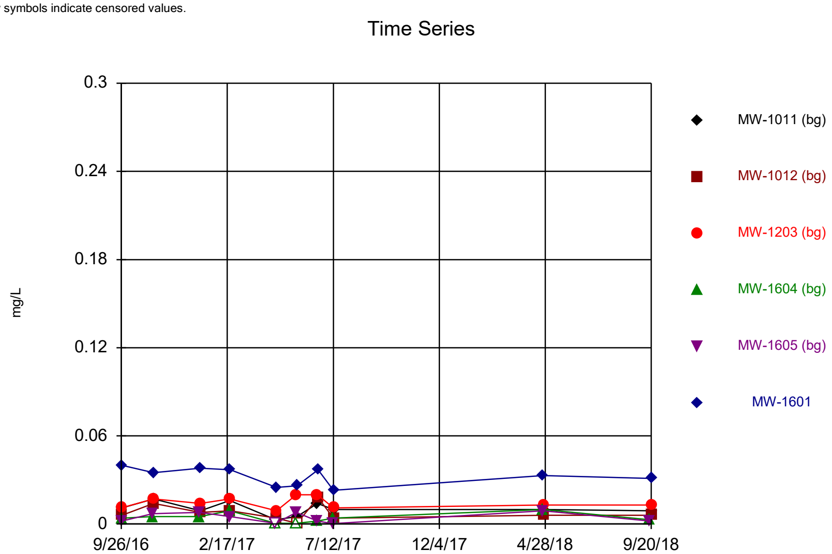
Constituent: Lead Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



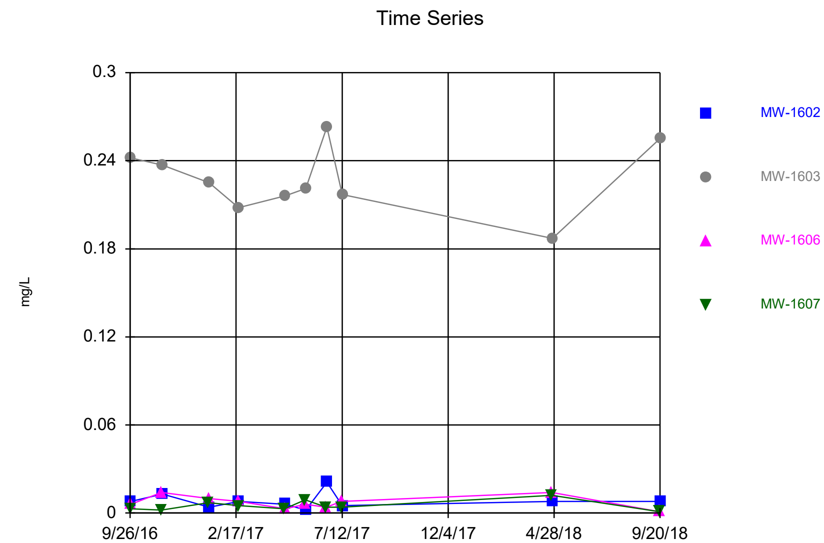
Constituent: Lead Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



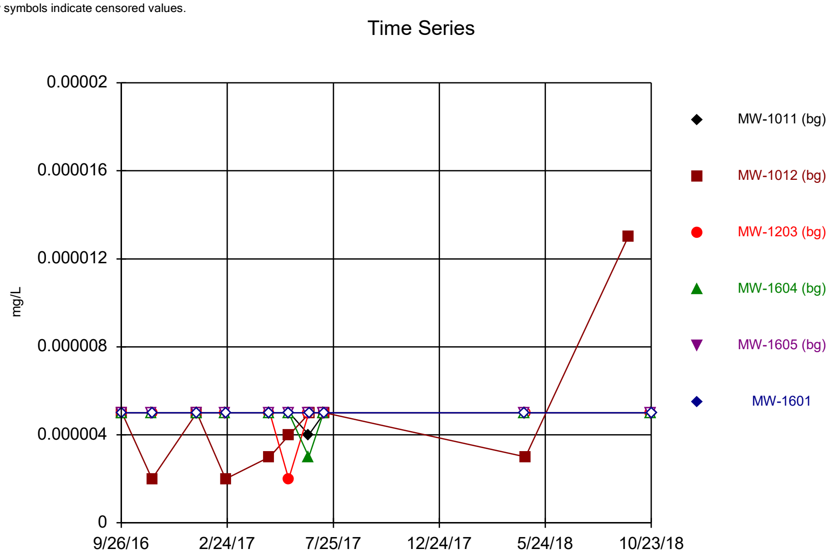
Constituent: Lithium Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



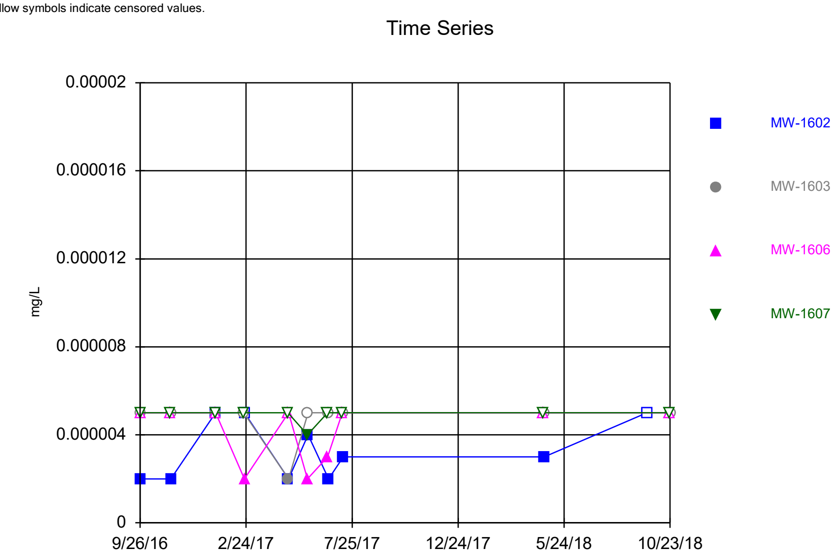
Constituent: Lithium Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



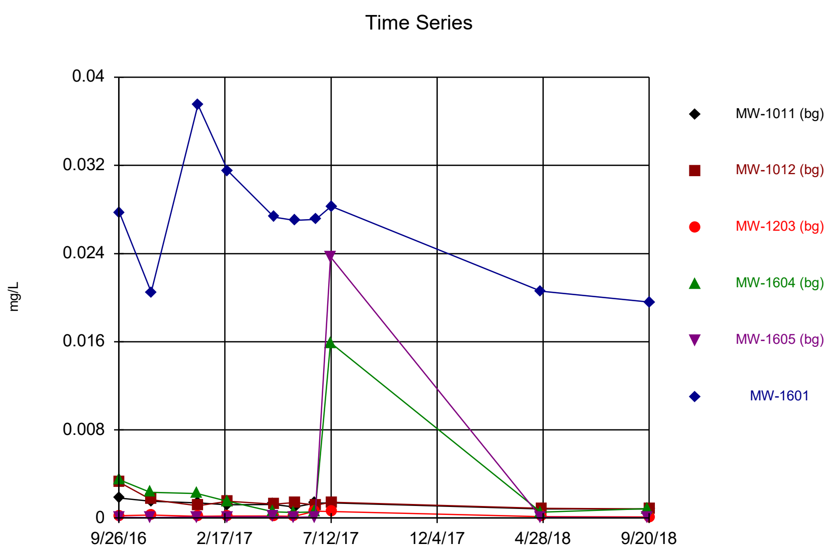
Constituent: Mercury Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



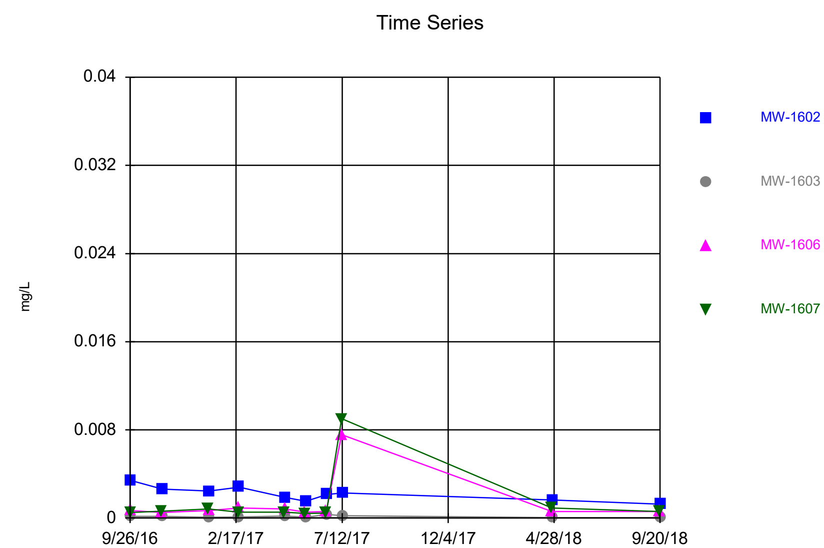
Constituent: Mercury Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



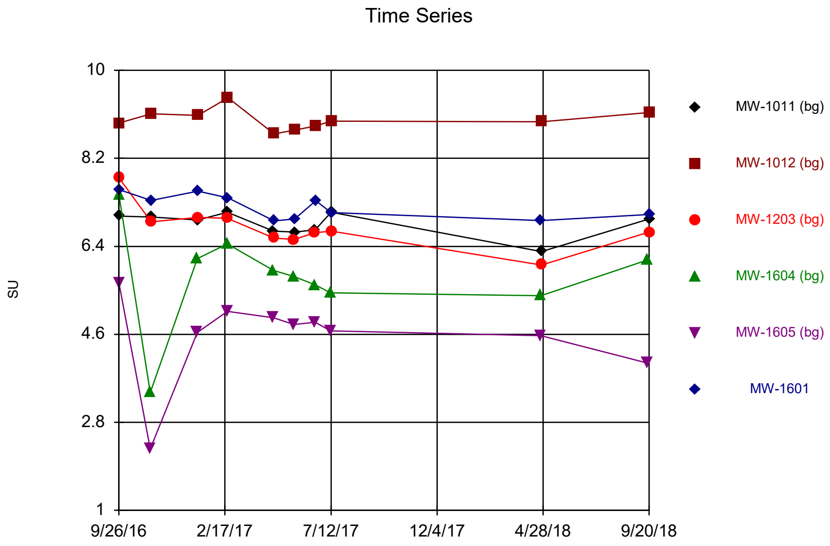
Constituent: Molybdenum Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



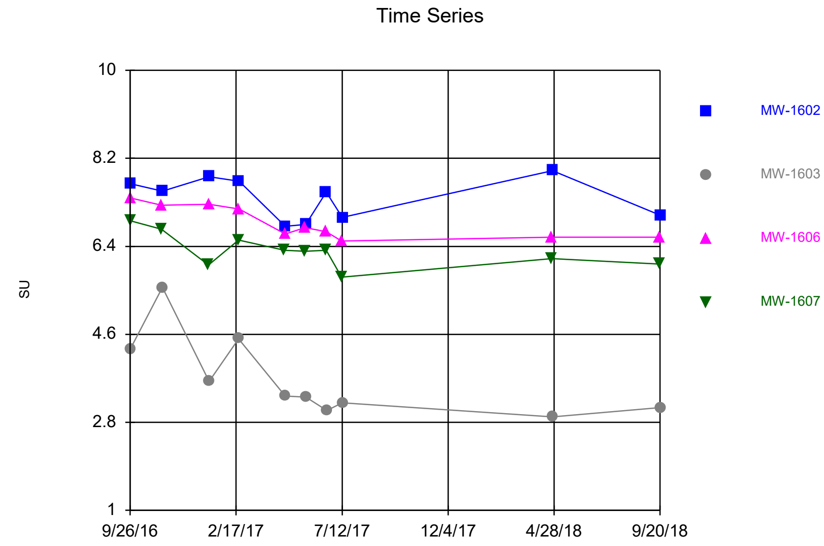
Constituent: Molybdenum Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



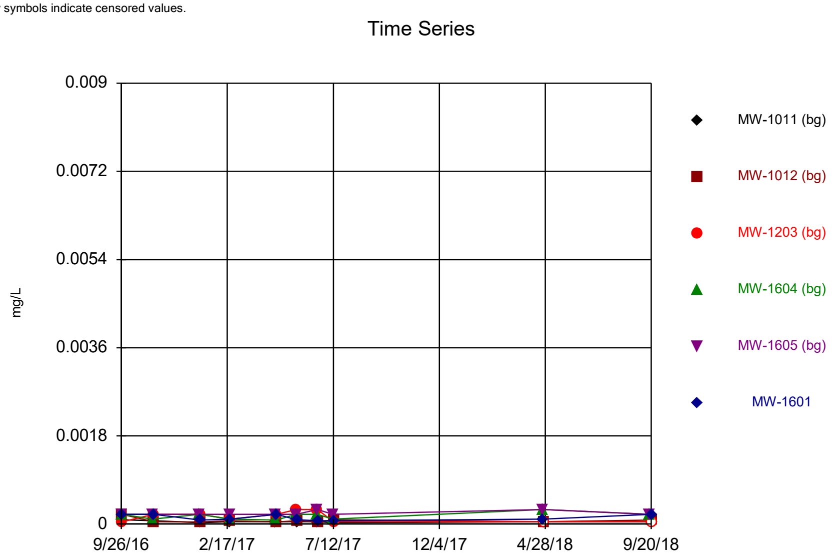
Constituent: pH Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



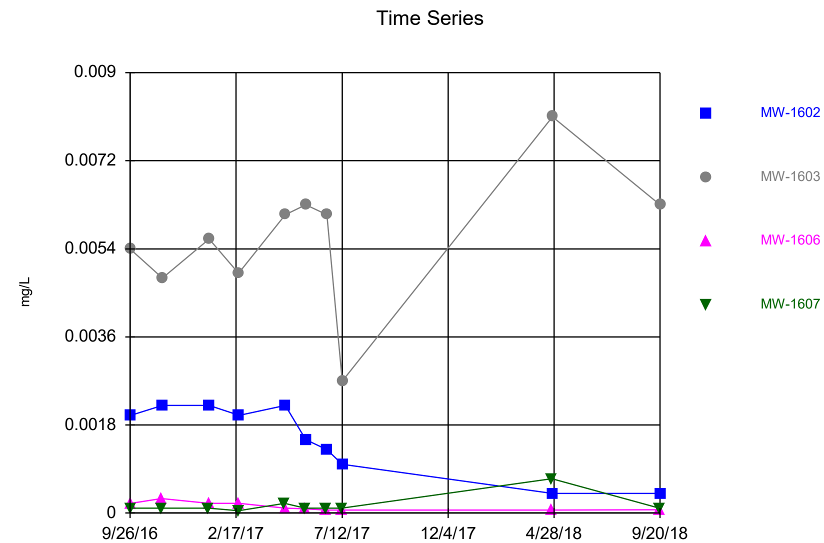
Constituent: pH Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



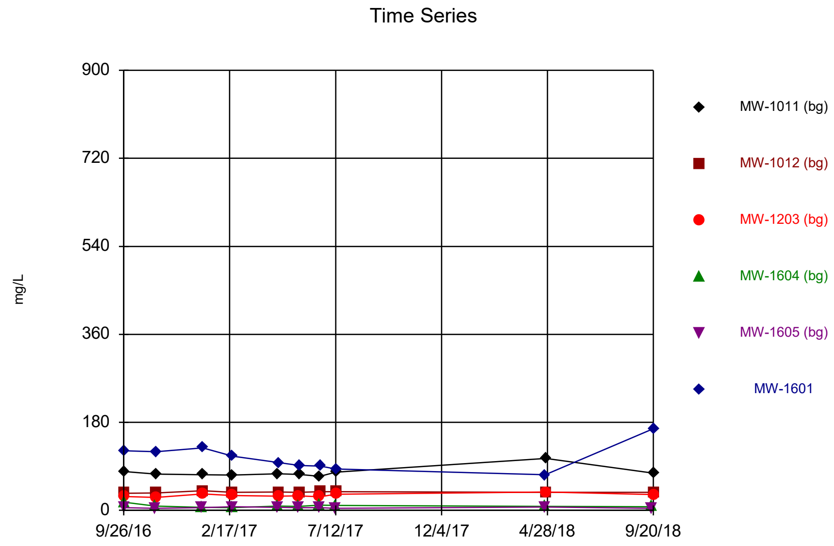
Constituent: Selenium Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



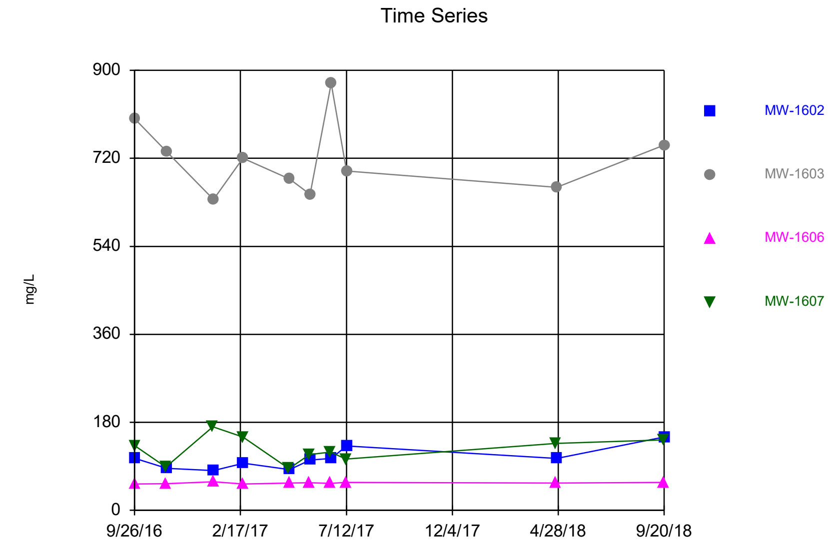
Constituent: Selenium Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



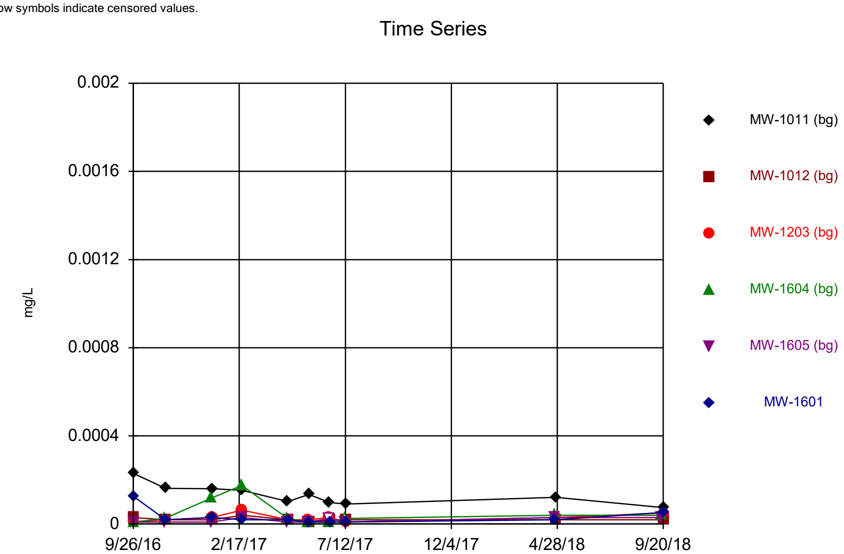
Constituent: Sulfate Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



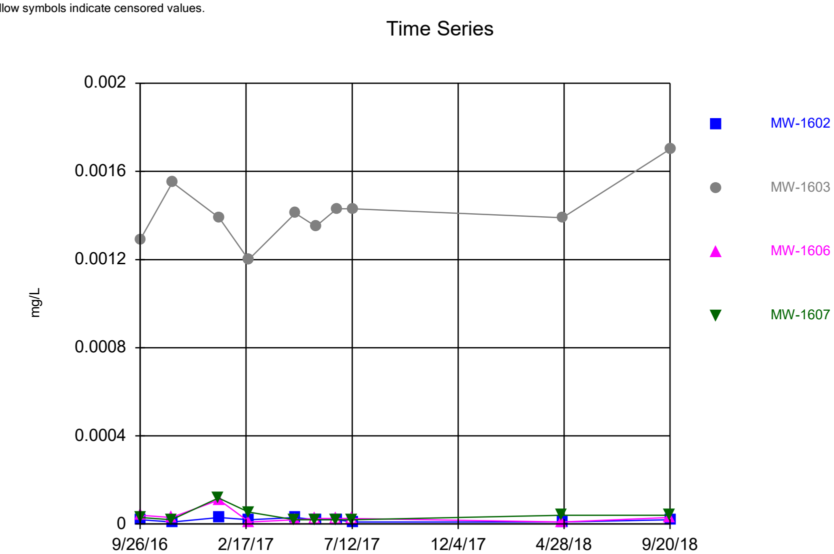
Constituent: Sulfate Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

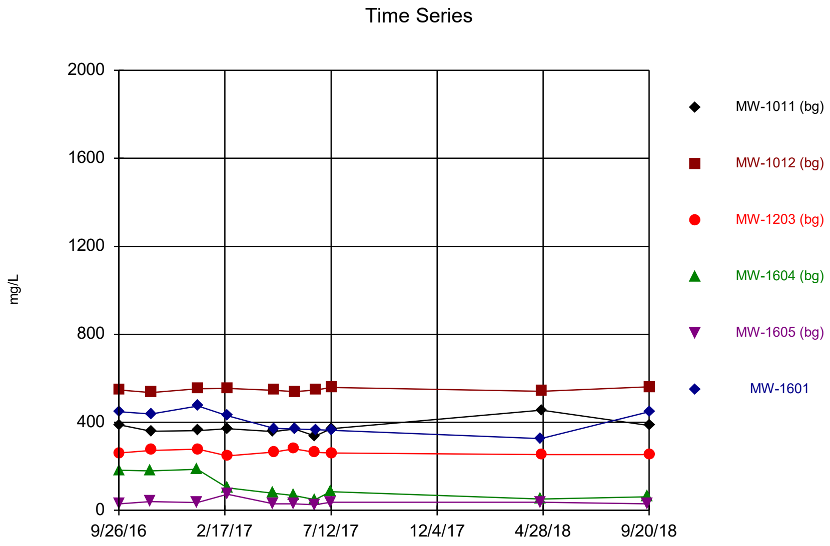


Constituent: Thallium Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

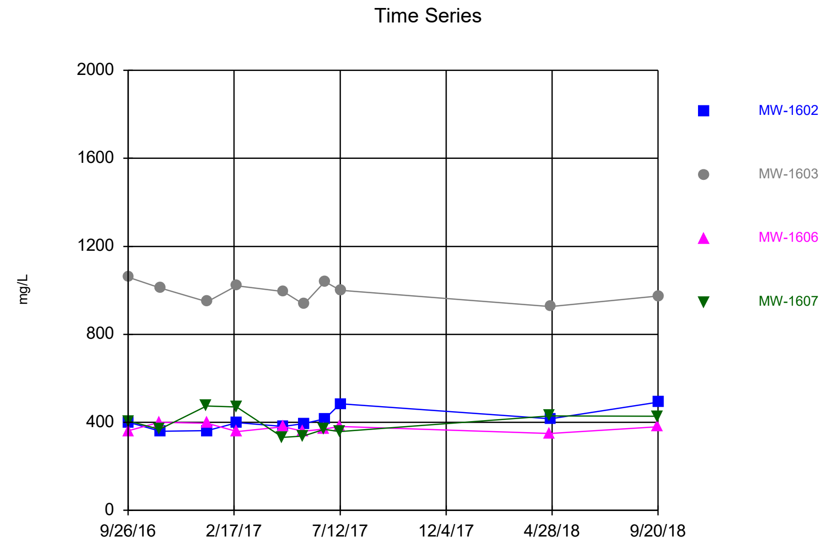


Constituent: Thallium Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Constituent: Total Dissolved Solids Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Total Dissolved Solids Analysis Run 11/11/2018 12:37 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Interwell Prediction Limit Summary Table - Significant Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 10/30/2018, 10:34 AM

Constituent	Well	Upper Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron (mg/L)	**MW-1606**	**0.2217**	**9/19/2018**	**1.82**	**Yes**	**50**	**0.09997**	**0.06539**	**2**	**None**	**No**	**0.001504**	**Param Inter 1 of 2**
Boron (mg/L)	**MW-1607**	**0.2217**	**9/19/2018**	**0.255**	**Yes**	**50**	**0.09997**	**0.06539**	**2**	**None**	**No**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	**MW-1601**	**7**	**9/20/2018**	**16.1**	**Yes**	**50**	**1.31**	**0.3238**	**0**	**None**	**x^(1/3)**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	**MW-1602**	**7**	**9/20/2018**	**15.2**	**Yes**	**50**	**1.31**	**0.3238**	**0**	**None**	**x^(1/3)**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	**MW-1606**	**7**	**9/19/2018**	**31.1**	**Yes**	**50**	**1.31**	**0.3238**	**0**	**None**	**x^(1/3)**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	**MW-1607**	**7**	**9/19/2018**	**7.52**	**Yes**	**50**	**1.31**	**0.3238**	**0**	**None**	**x^(1/3)**	**0.001504**	**Param Inter 1 of 2**
Fluoride (mg/L)	**MW-1603**	**0.82**	**9/20/2018**	**1.15**	**Yes**	**49**	**n/a**	**n/a**	**18.37**	**n/a**	**n/a**	**0.000782**	**NP Inter (normality) ...**
Sulfate (mg/L)	**MW-1601**	**106**	**9/20/2018**	**167**	**Yes**	**50**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0007428**	**NP Inter (normality) ...**
Sulfate (mg/L)	**MW-1602**	**106**	**9/20/2018**	**150**	**Yes**	**50**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0007428**	**NP Inter (normality) ...**
Sulfate (mg/L)	**MW-1603**	**106**	**9/20/2018**	**747**	**Yes**	**50**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0007428**	**NP Inter (normality) ...**
Sulfate (mg/L)	**MW-1607**	**106**	**9/19/2018**	**144**	**Yes**	**50**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0007428**	**NP Inter (normality) ...**
Total Dissolved Solids (mg/L)	**MW-1603**	**561**	**9/20/2018**	**974**	**Yes**	**50**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0007428**	**NP Inter (normality) ...**

Interwell Prediction Limit Summary Table - All Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 10/30/2018, 10:34 AM

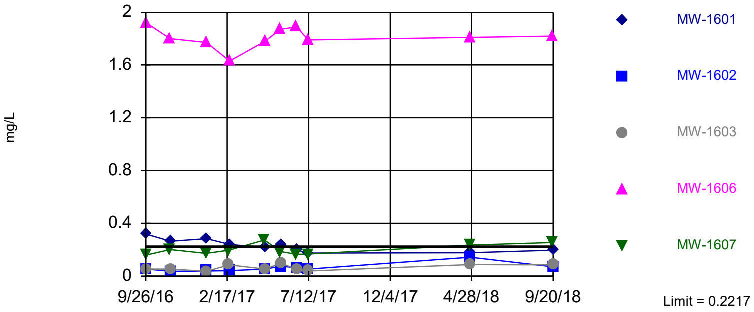
Constituent	Well	Upper Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron (mg/L)	MW-1601	0.2217	9/20/2018	0.196	No	50	0.09997	0.06539	2	None	No	0.001504	Param Inter 1 of 2
Boron (mg/L)	MW-1602	0.2217	9/20/2018	0.07	No	50	0.09997	0.06539	2	None	No	0.001504	Param Inter 1 of 2
Boron (mg/L)	MW-1603	0.2217	9/20/2018	0.085	No	50	0.09997	0.06539	2	None	No	0.001504	Param Inter 1 of 2
Boron (mg/L)	**MW-1606**	**0.2217**	**9/19/2018**	**1.82**	**Yes**	**50**	**0.09997**	**0.06539**	**2**	**None**	**No**	**0.001504**	**Param Inter 1 of 2**
Boron (mg/L)	**MW-1607**	**0.2217**	**9/19/2018**	**0.255**	**Yes**	**50**	**0.09997**	**0.06539**	**2**	**None**	**No**	**0.001504**	**Param Inter 1 of 2**
Calcium (mg/L)	MW-1601	105	9/20/2018	68.8	No	50	n/a	n/a	0	n/a	n/a	0.0007428	NP Inter (normality) ...
Calcium (mg/L)	MW-1602	105	9/20/2018	72.1	No	50	n/a	n/a	0	n/a	n/a	0.0007428	NP Inter (normality) ...
Calcium (mg/L)	MW-1603	105	9/20/2018	97.5	No	50	n/a	n/a	0	n/a	n/a	0.0007428	NP Inter (normality) ...
Calcium (mg/L)	MW-1606	105	9/19/2018	71.8	No	50	n/a	n/a	0	n/a	n/a	0.0007428	NP Inter (normality) ...
Calcium (mg/L)	MW-1607	105	9/19/2018	95.6	No	50	n/a	n/a	0	n/a	n/a	0.0007428	NP Inter (normality) ...
Chloride (mg/L)	**MW-1601**	**7**	**9/20/2018**	**16.1**	**Yes**	**50**	**1.31**	**0.3238**	**0**	**None**	**x^(1/3)**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	**MW-1602**	**7**	**9/20/2018**	**15.2**	**Yes**	**50**	**1.31**	**0.3238**	**0**	**None**	**x^(1/3)**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	MW-1603	7	9/20/2018	3.92	No	50	1.31	0.3238	0	None	x^(1/3)	0.001504	Param Inter 1 of 2
Chloride (mg/L)	**MW-1606**	**7**	**9/19/2018**	**31.1**	**Yes**	**50**	**1.31**	**0.3238**	**0**	**None**	**x^(1/3)**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	**MW-1607**	**7**	**9/19/2018**	**7.52**	**Yes**	**50**	**1.31**	**0.3238**	**0**	**None**	**x^(1/3)**	**0.001504**	**Param Inter 1 of 2**
Fluoride (mg/L)	MW-1601	0.82	9/20/2018	0.22	No	49	n/a	n/a	18.37	n/a	n/a	0.000782	NP Inter (normality) ...
Fluoride (mg/L)	MW-1602	0.82	9/20/2018	0.11	No	49	n/a	n/a	18.37	n/a	n/a	0.000782	NP Inter (normality) ...
Fluoride (mg/L)	**MW-1603**	**0.82**	**9/20/2018**	**1.15**	**Yes**	**49**	**n/a**	**n/a**	**18.37**	**n/a**	**n/a**	**0.000782**	**NP Inter (normality) ...**
Fluoride (mg/L)	MW-1606	0.82	9/19/2018	0.24	No	49	n/a	n/a	18.37	n/a	n/a	0.000782	NP Inter (normality) ...
Fluoride (mg/L)	MW-1607	0.82	9/19/2018	0.08	No	49	n/a	n/a	18.37	n/a	n/a	0.000782	NP Inter (normality) ...
Sulfate (mg/L)	**MW-1601**	**106**	**9/20/2018**	**167**	**Yes**	**50**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0007428**	**NP Inter (normality) ...**
Sulfate (mg/L)	**MW-1602**	**106**	**9/20/2018**	**150**	**Yes**	**50**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0007428**	**NP Inter (normality) ...**
Sulfate (mg/L)	**MW-1603**	**106**	**9/20/2018**	**747**	**Yes**	**50**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0007428**	**NP Inter (normality) ...**
Sulfate (mg/L)	MW-1606	106	9/19/2018	56.9	No	50	n/a	n/a	0	n/a	n/a	0.0007428	NP Inter (normality) ...
Sulfate (mg/L)	**MW-1607**	**106**	**9/19/2018**	**144**	**Yes**	**50**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0007428**	**NP Inter (normality) ...**
Total Dissolved Solids (mg/L)	MW-1601	561	9/20/2018	448	No	50	n/a	n/a	0	n/a	n/a	0.0007428	NP Inter (normality) ...
Total Dissolved Solids (mg/L)	MW-1602	561	9/20/2018	492	No	50	n/a	n/a	0	n/a	n/a	0.0007428	NP Inter (normality) ...
Total Dissolved Solids (mg/L)	**MW-1603**	**561**	**9/20/2018**	**974**	**Yes**	**50**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0007428**	**NP Inter (normality) ...**
Total Dissolved Solids (mg/L)	MW-1606	561	9/19/2018	380	No	50	n/a	n/a	0	n/a	n/a	0.0007428	NP Inter (normality) ...
Total Dissolved Solids (mg/L)	MW-1607	561	9/19/2018	428	No	50	n/a	n/a	0	n/a	n/a	0.0007428	NP Inter (normality) ...

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: MW-1606, MW-1607

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=0.09997, Std. Dev.=0.06539, n=50, 2% NDs. Normality test: Shapiro Francia @alpha = 0.01, calculated = 0.9708, critical = 0.935. Kappa = 1.862 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001504. Comparing 5 points to limit.

Constituent: Boron Analysis Run 10/30/2018 10:30 AM View: PL's - Interwell

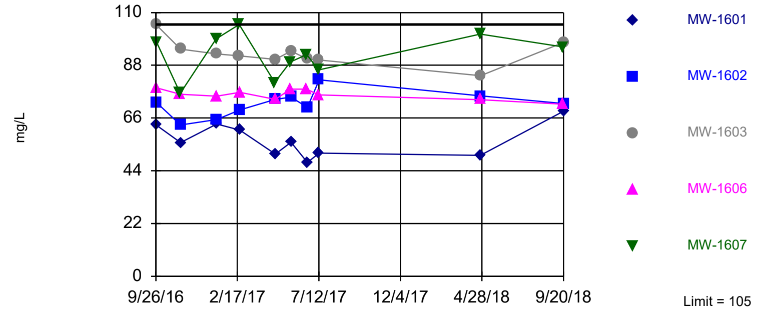
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 50 background values. Annual per-constituent alpha = 0.007403. Individual comparison alpha = 0.0007428 (1 of 2). Comparing 5 points to limit.

Constituent: Calcium Analysis Run 10/30/2018 10:30 AM View: PL's - Interwell

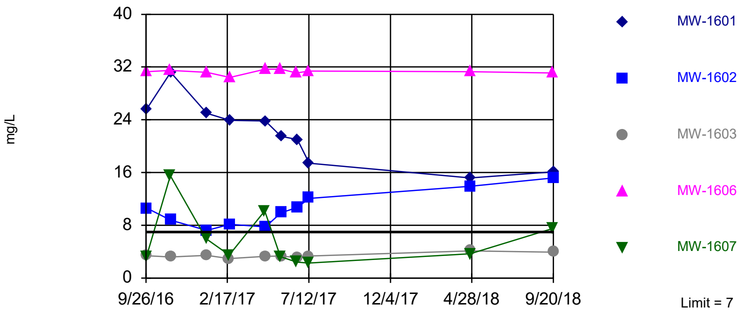
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: MW-1601, MW-1602, MW-1606, MW-1607

Prediction Limit

Interwell Parametric



Background Data Summary (based on cube root transformation): Mean=1.31, Std. Dev.=0.3238, n=50. Normality test: Shapiro Francia @alpha = 0.01, calculated = 0.9417, critical = 0.935. Kappa = 1.862 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001504. Comparing 5 points to limit.

Constituent: Chloride Analysis Run 10/30/2018 10:30 AM View: PL's - Interwell

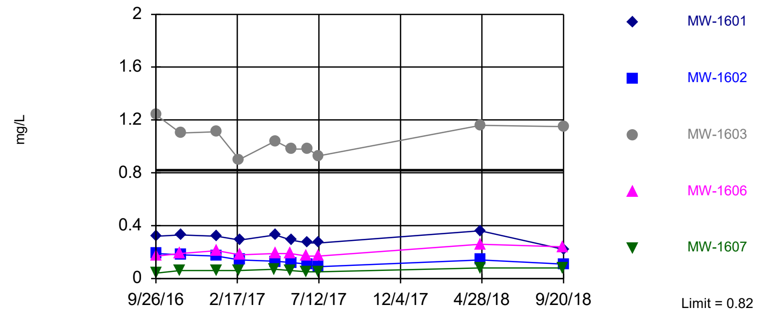
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: MW-1603

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 49 background values. 18.37% NDs. Annual per-constituent alpha = 0.007793. Individual comparison alpha = 0.000782 (1 of 2). Comparing 5 points to limit.

Constituent: Fluoride Analysis Run 10/30/2018 10:30 AM View: PL's - Interwell

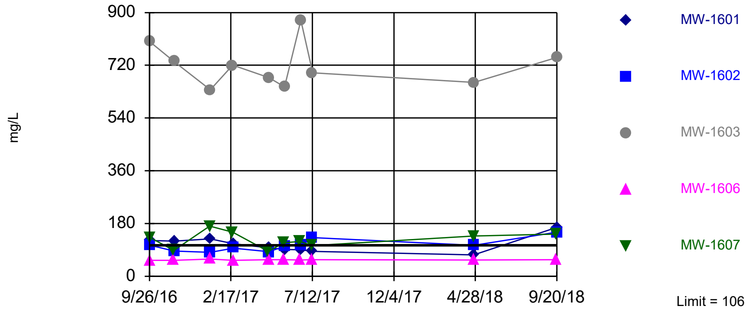
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: MW-1601, MW-1602, MW-1603, MW-1607

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 50 background values. Annual per-constituent alpha = 0.007403. Individual comparison alpha = 0.0007428 (1 of 2). Comparing 5 points to limit.

Constituent: Sulfate Analysis Run 10/30/2018 10:30 AM View: PL's - Interwell

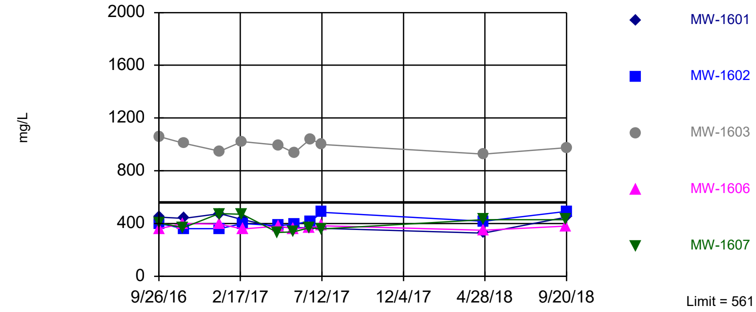
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: MW-1603

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 50 background values. Annual per-constituent alpha = 0.007403. Individual comparison alpha = 0.0007428 (1 of 2). Comparing 5 points to limit.

Constituent: Total Dissolved Solids Analysis Run 10/30/2018 10:30 AM View: PL's - Interwell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Intrawell Prediction Limit Summary Table - All Results (No Significant Results)

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 10/30/2018, 10:41 AM

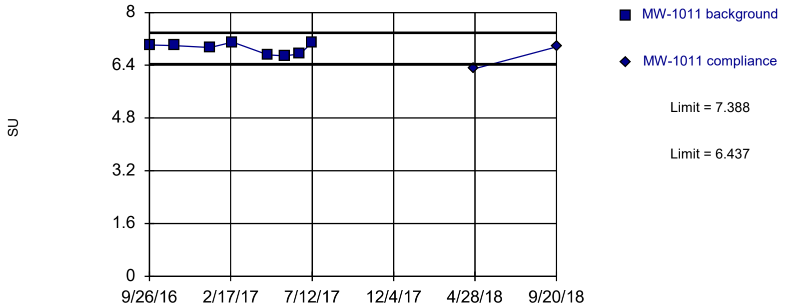
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH (SU)	MW-1011	7.388	6.437	9/20/2018	6.96	No	8	6.913	0.1734	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1012	9.616	8.347	9/20/2018	9.14	No	8	8.981	0.2315	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1203	8.004	5.786	9/20/2018	6.69	No	8	6.895	0.4046	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1604	8.915	2.64	9/18/2018	6.12	No	8	5.778	1.145	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1605	6.564	1.095	9/18/2018	4.01	No	8	22.14	7.644	0	None	x^2	0.000752	Param 1 of 2
pH (SU)	MW-1601	7.94	6.59	9/20/2018	7.05	No	8	7.265	0.2465	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1602	8.5	6.23	9/20/2018	7.04	No	8	7.365	0.4143	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1603	6.228	1.497	9/20/2018	3.1	No	8	3.863	0.8632	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1606	7.883	6.04	9/19/2018	6.59	No	8	6.961	0.3363	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1607	7.383	5.349	9/19/2018	6.04	No	8	6.366	0.3713	0	None	No	0.000752	Param 1 of 2

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.913, Std. Dev.=0.1734, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8526, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 10/30/2018 10:39 AM View: PL's - Intrawell

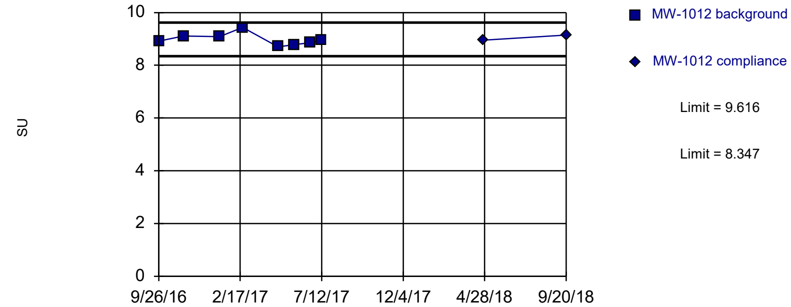
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=8.981, Std. Dev.=0.2315, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9365, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 10/30/2018 10:39 AM View: PL's - Intrawell

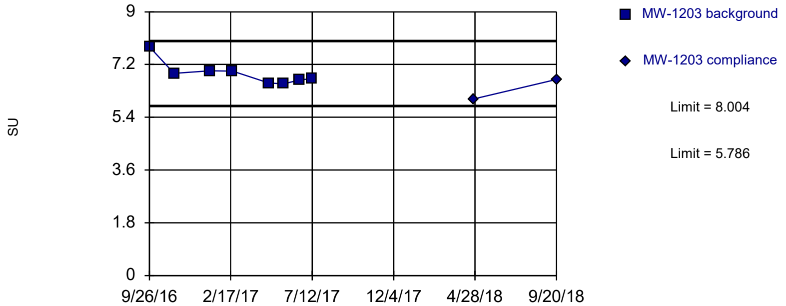
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.895, Std. Dev.=0.4046, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7987, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 10/30/2018 10:39 AM View: PL's - Intrawell

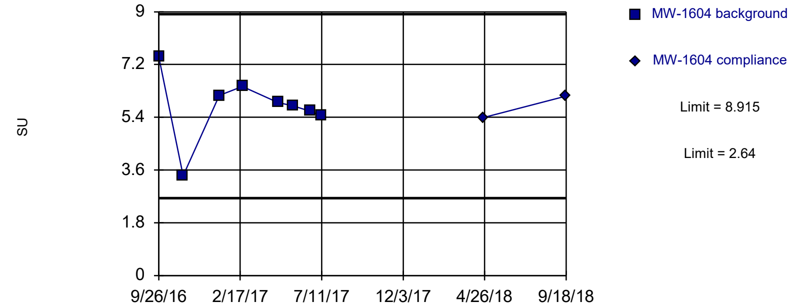
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.778, Std. Dev.=1.145, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8966, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 10/30/2018 10:39 AM View: PL's - Intrawell

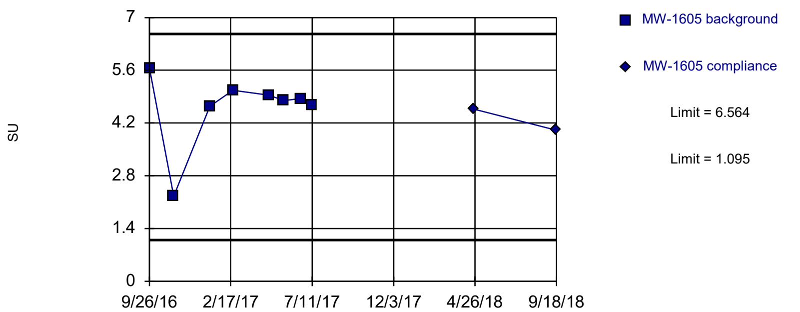
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square transformation): Mean=22.14, Std. Dev.=7.644, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8006, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 10/30/2018 10:39 AM View: PL's - Intrawell

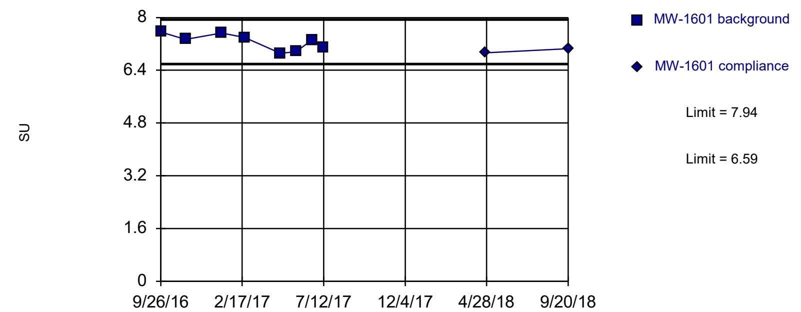
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=7.265, Std. Dev.=0.2465, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9052, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 10/30/2018 10:39 AM View: PL's - Intrawell

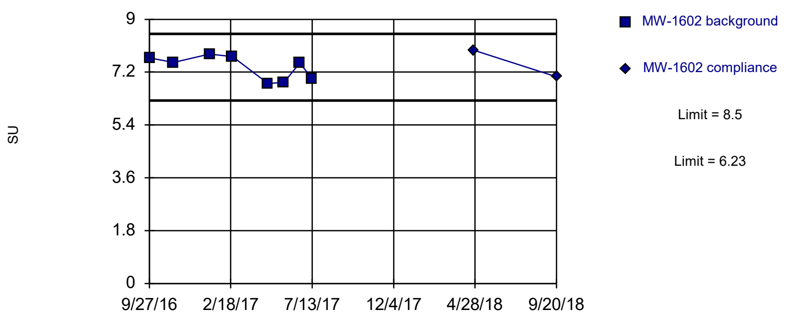
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=7.365, Std. Dev.=0.4143, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8508, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 10/30/2018 10:39 AM View: PL's - Intrawell

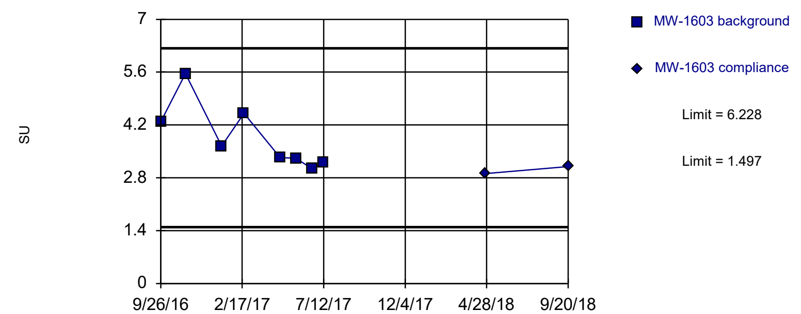
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.863, Std. Dev.=0.8632, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8662, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

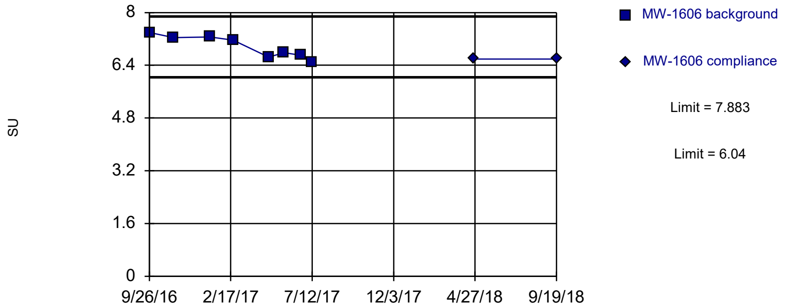
Constituent: pH Analysis Run 10/30/2018 10:39 AM View: PL's - Intrawell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.961, Std. Dev.=0.3363, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8932, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

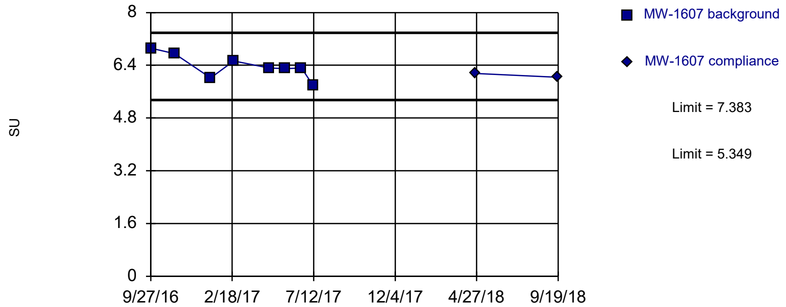
Constituent: pH Analysis Run 10/30/2018 10:39 AM View: PL's - Intrawell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.366, Std. Dev.=0.3713, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9693, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 10/30/2018 10:39 AM View: PL's - Intrawell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Trend Test Summary Table - Significant Results

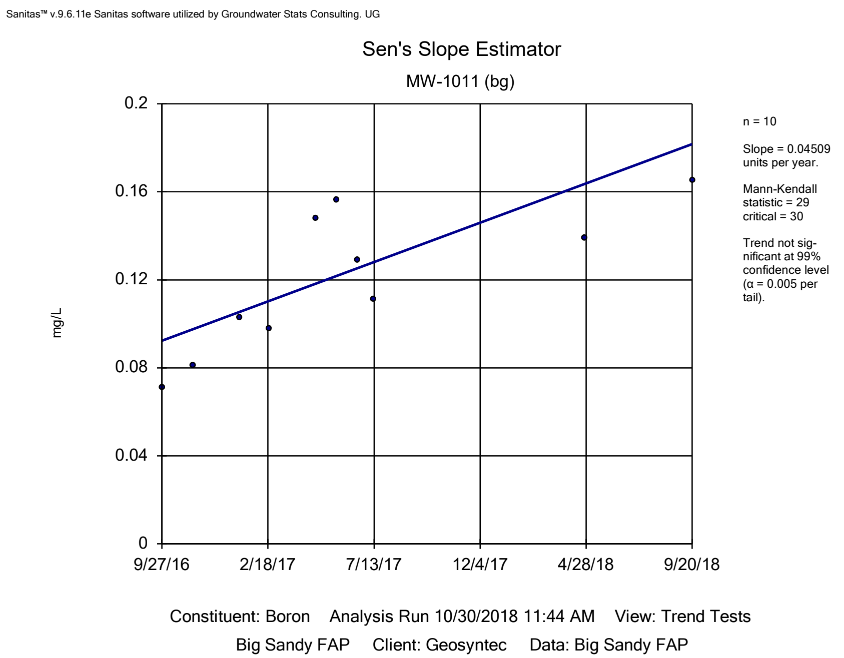
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 10/30/2018, 11:46 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Chloride (mg/L)	**MW-1604 (bg)**	**-2.575**	**-31**	**-30**	**Yes**	**10**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride (mg/L)	**MW-1601**	**-7.643**	**-41**	**-30**	**Yes**	**10**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Fluoride (mg/L)	**MW-1604 (bg)**	**-0.1575**	**-31**	**-30**	**Yes**	**10**	**0**	**n/a**	**n/a**	**0.01**	**NP**

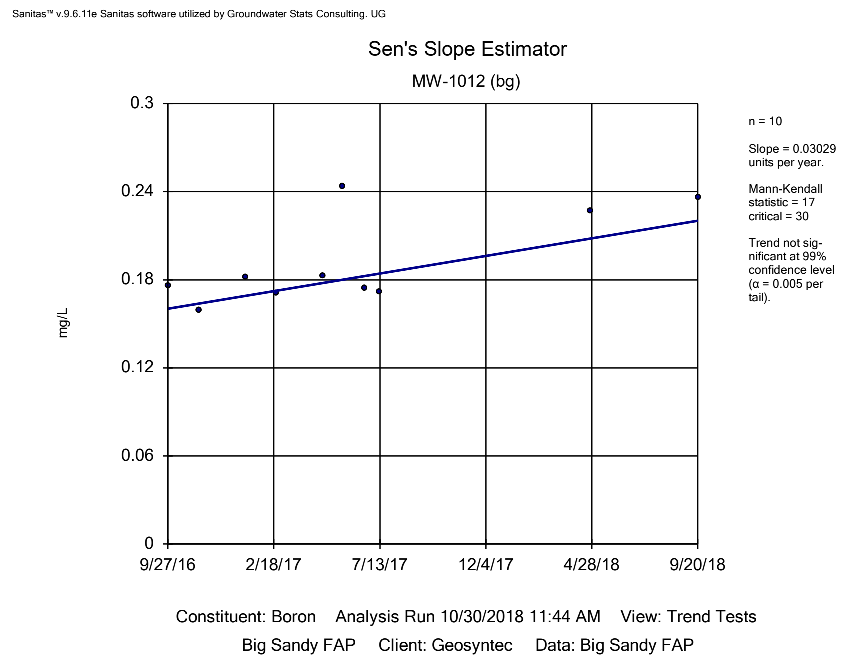
Trend Test Summary Table - All Results

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 10/30/2018, 11:46 AM

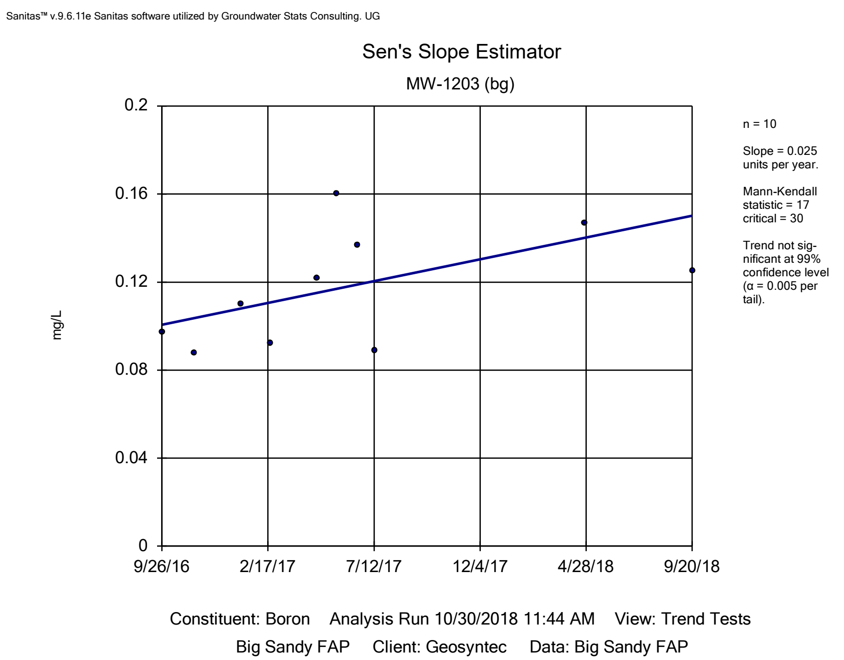
Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron (mg/L)	MW-1011 (bg)	0.04509	29	30	No	10	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1012 (bg)	0.03029	17	30	No	10	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1203 (bg)	0.025	17	30	No	10	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1604 (bg)	0.01398	19	30	No	10	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1605 (bg)	0.02955	21	30	No	10	10	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1606	0.02483	5	30	No	10	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1607	0.03809	11	30	No	10	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1011 (bg)	-0.4252	-2	-30	No	10	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1012 (bg)	0.02262	5	30	No	10	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1203 (bg)	-0.4212	-17	-30	No	10	0	n/a	n/a	0.01	NP
Chloride (mg/L)	**MW-1604 (bg)**	**-2.575**	**-31**	**-30**	**Yes**	**10**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride (mg/L)	MW-1605 (bg)	0.1021	7	30	No	10	0	n/a	n/a	0.01	NP
Chloride (mg/L)	**MW-1601**	**-7.643**	**-41**	**-30**	**Yes**	**10**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride (mg/L)	MW-1602	3.792	27	30	No	10	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1606	-0.1011	-6	-30	No	10	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1607	-1.79	-9	-30	No	10	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	MW-1011 (bg)	0.01527	7	30	No	10	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	MW-1012 (bg)	0.01185	4	30	No	10	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	MW-1203 (bg)	-0.02786	-20	-30	No	10	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	**MW-1604 (bg)**	**-0.1575**	**-31**	**-30**	**Yes**	**10**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Fluoride (mg/L)	MW-1605 (bg)	0	0	25	No	9	100	n/a	n/a	0.01	NP
Fluoride (mg/L)	MW-1603	-0.05061	-6	-30	No	10	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1011 (bg)	1.138	5	30	No	10	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1012 (bg)	0.6848	5	30	No	10	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1203 (bg)	3.113	15	30	No	10	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1604 (bg)	-0.5714	-7	-30	No	10	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1605 (bg)	0.05376	1	30	No	10	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1601	-42.55	-23	-30	No	10	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1602	31.47	24	30	No	10	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1603	-27.22	-3	-30	No	10	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1607	6.066	3	30	No	10	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1011 (bg)	12.62	8	30	No	10	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1012 (bg)	6.404	12	30	No	10	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1203 (bg)	-8.805	-13	-30	No	10	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1604 (bg)	-87.65	-29	-30	No	10	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1605 (bg)	-0.7557	-9	-30	No	10	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1603	-33.18	-17	-30	No	10	0	n/a	n/a	0.01	NP



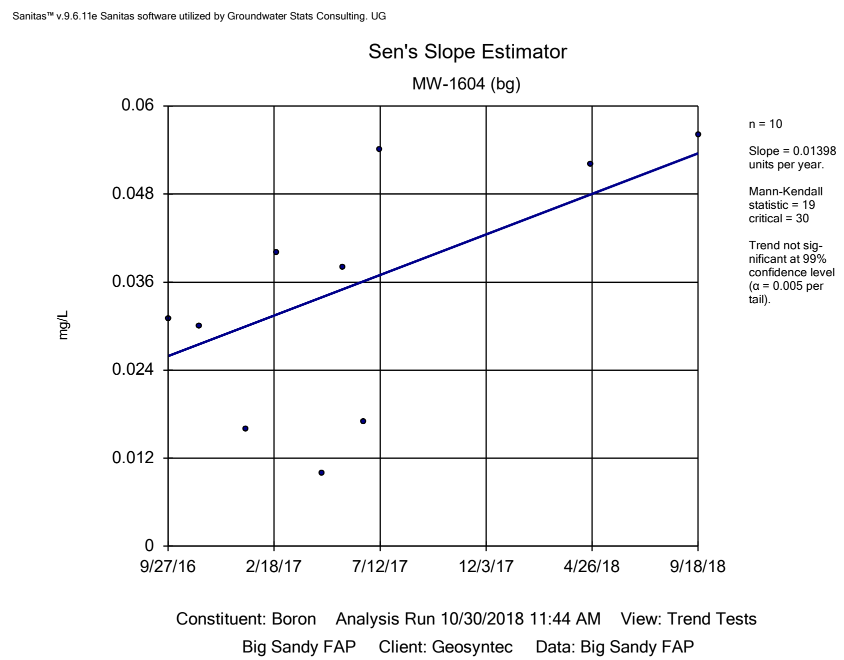
Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1011 (bg)
mg/L
0.2
0.16
0.12
0.08
0.04
0
9/27/16
2/18/17
7/13/17
12/4/17
4/28/18
9/20/18
n = 10
Slope = 0.04509 units per year.
Mann-Kendall statistic = 29 critical = 30
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Boron Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1012 (bg)
mg/L
0.3
0.24
0.18
0.12
0.06
0
9/27/16
2/18/17
7/13/17
12/4/17
4/28/18
9/20/18
n = 10
Slope = 0.03029 units per year.
Mann-Kendall statistic = 17 critical = 30
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Boron Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1203 (bg)
mg/L
0.2
0.16
0.12
0.08
0.04
0
9/26/16
2/17/17
7/12/17
12/4/17
4/28/18
9/20/18
n = 10
Slope = 0.025 units per year.
Mann-Kendall statistic = 17 critical = 30
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Boron Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

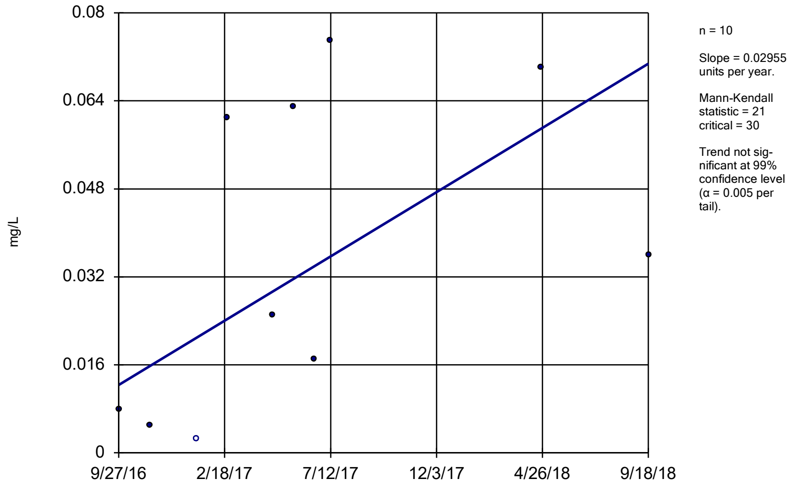


Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1604 (bg)
mg/L
0.06
0.048
0.036
0.024
0.012
0
9/27/16
2/18/17
7/12/17
12/3/17
4/26/18
9/18/18
n = 10
Slope = 0.01398 units per year.
Mann-Kendall statistic = 19 critical = 30
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Boron Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

MW-1605 (bg)

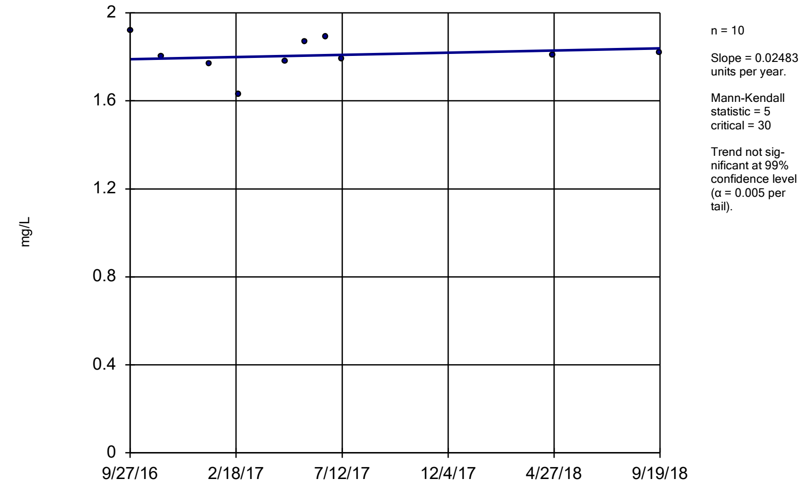


Constituent: Boron Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

MW-1606

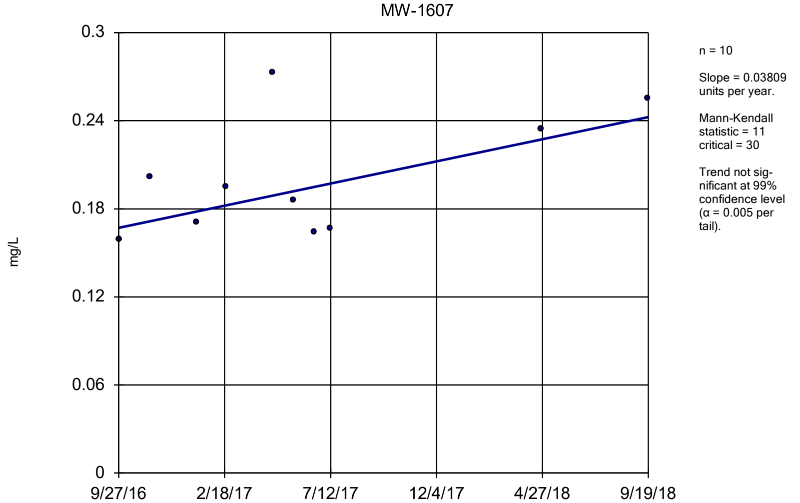


Constituent: Boron Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

MW-1607

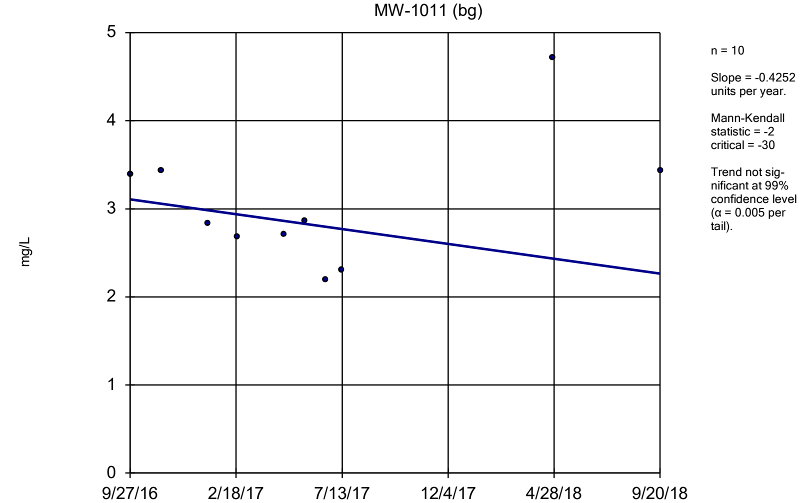


Constituent: Boron Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

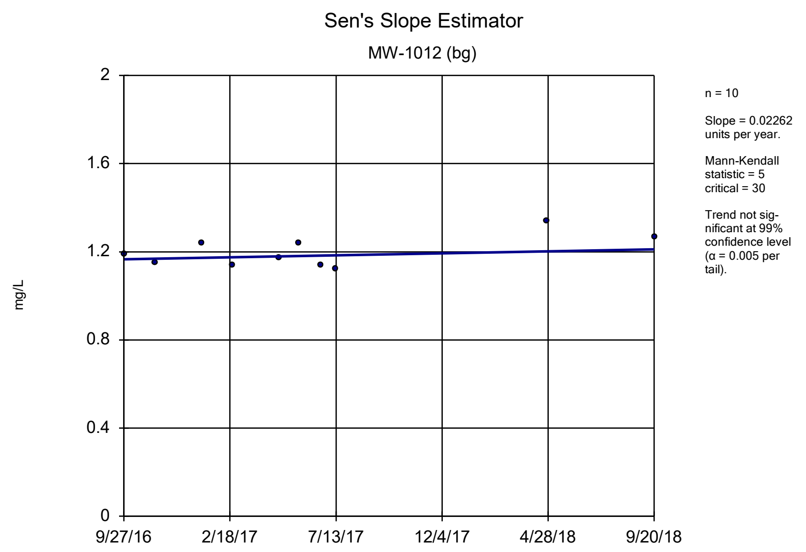
Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

MW-1011 (bg)

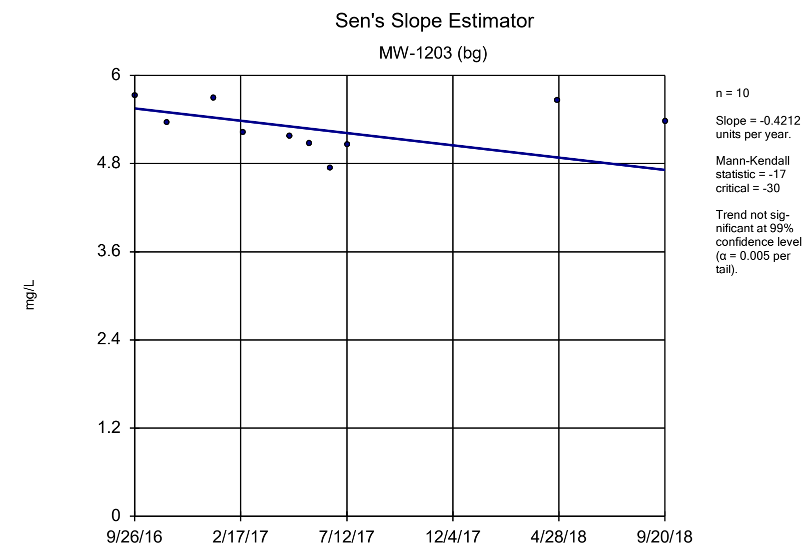


Constituent: Chloride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



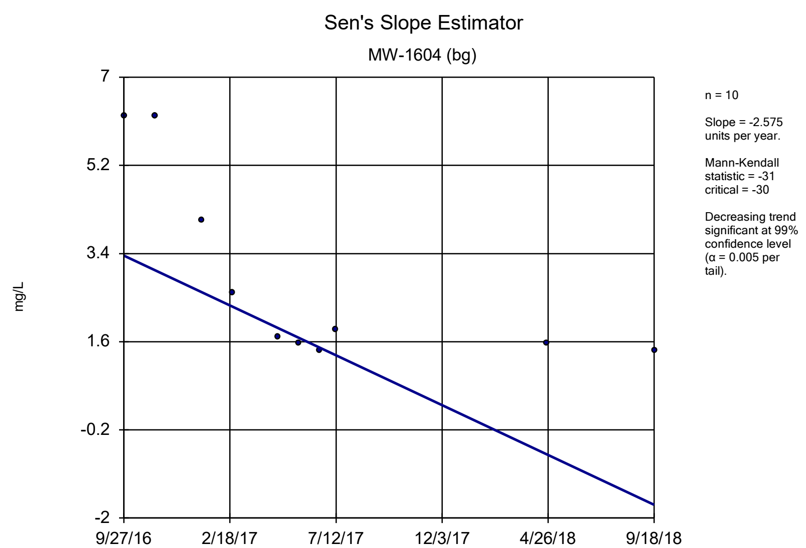
Constituent: Chloride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



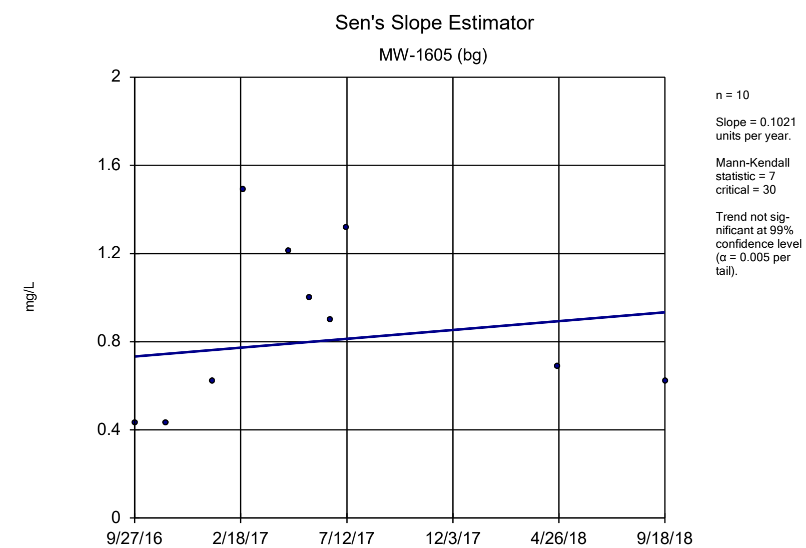
Constituent: Chloride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

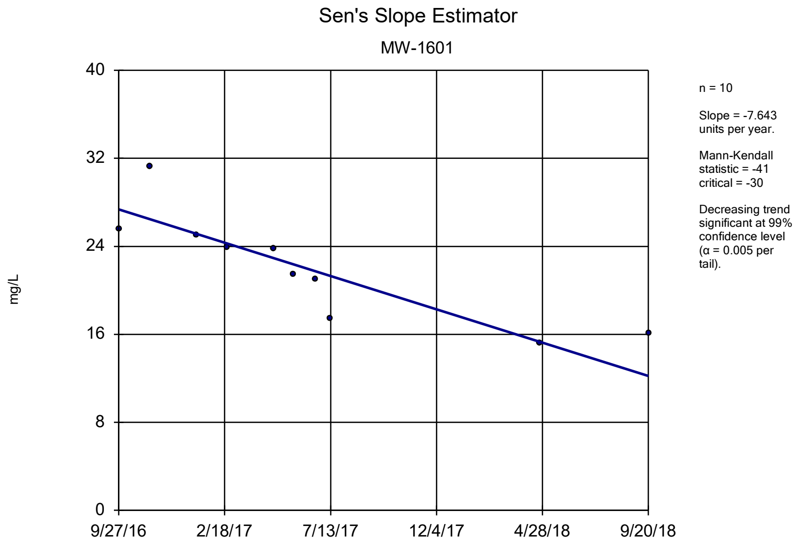


Constituent: Chloride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

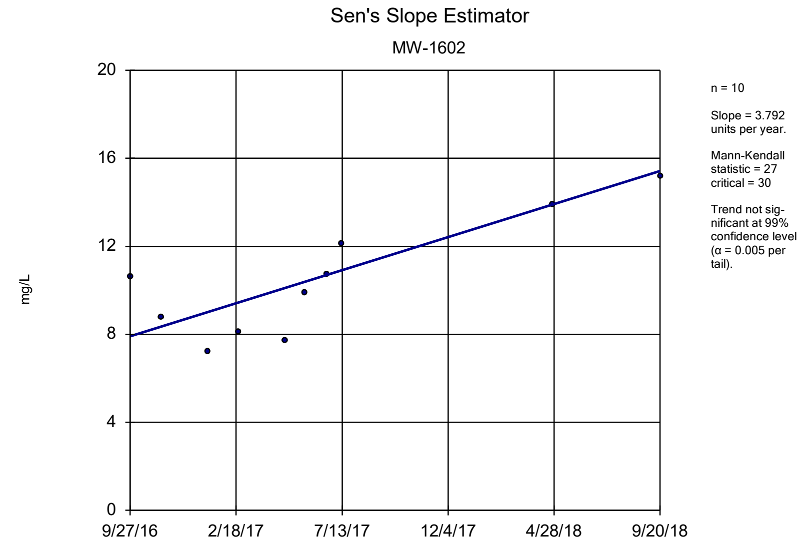


Constituent: Chloride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



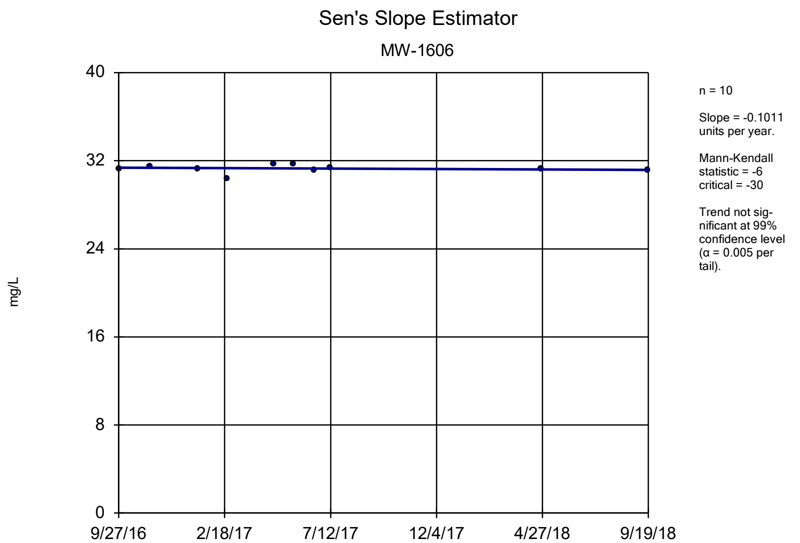
Constituent: Chloride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



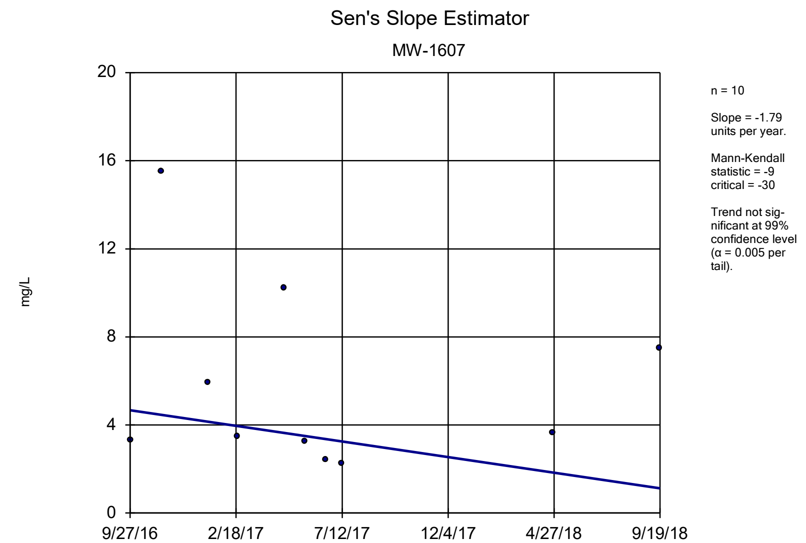
Constituent: Chloride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



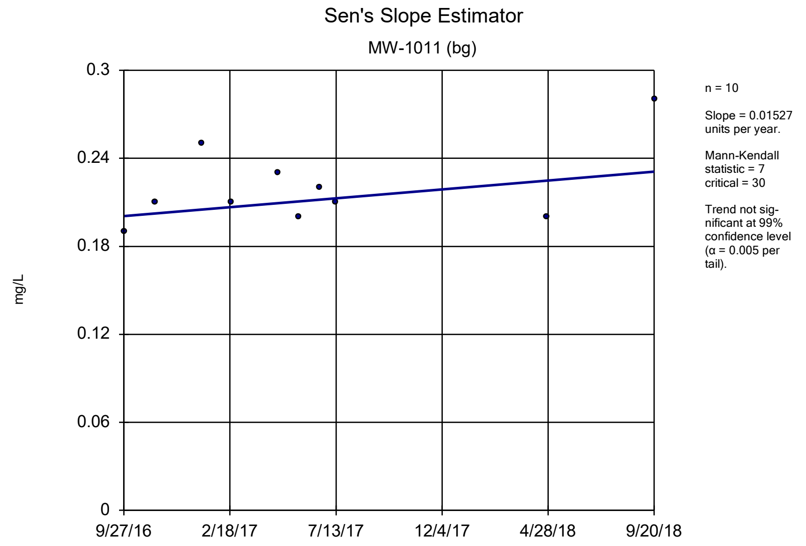
Constituent: Chloride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



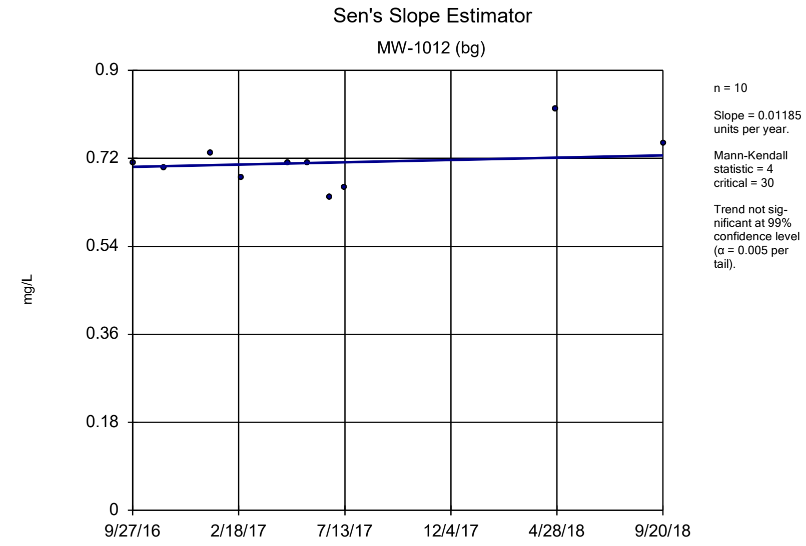
Constituent: Chloride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



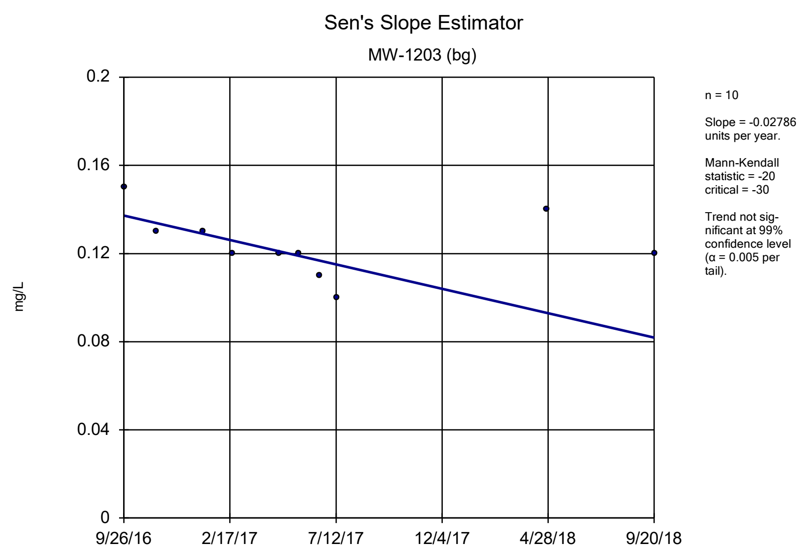
Constituent: Fluoride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



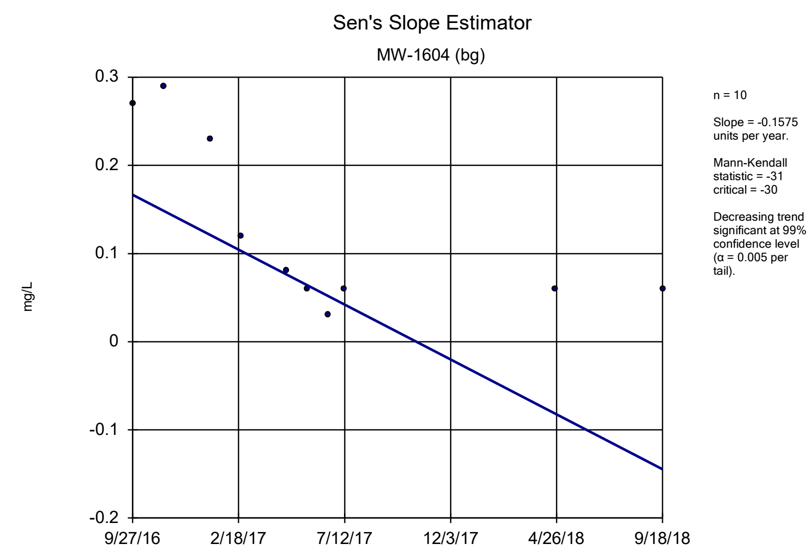
Constituent: Fluoride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



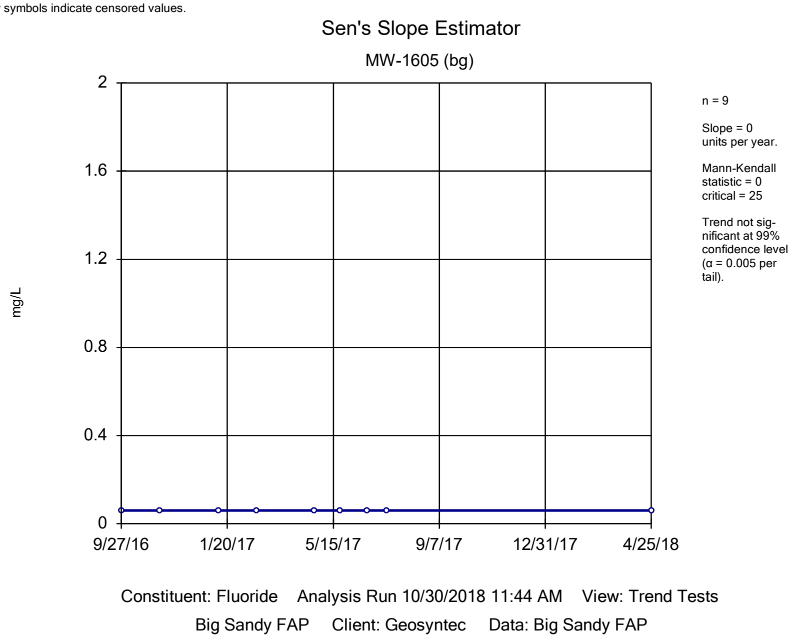
Constituent: Fluoride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

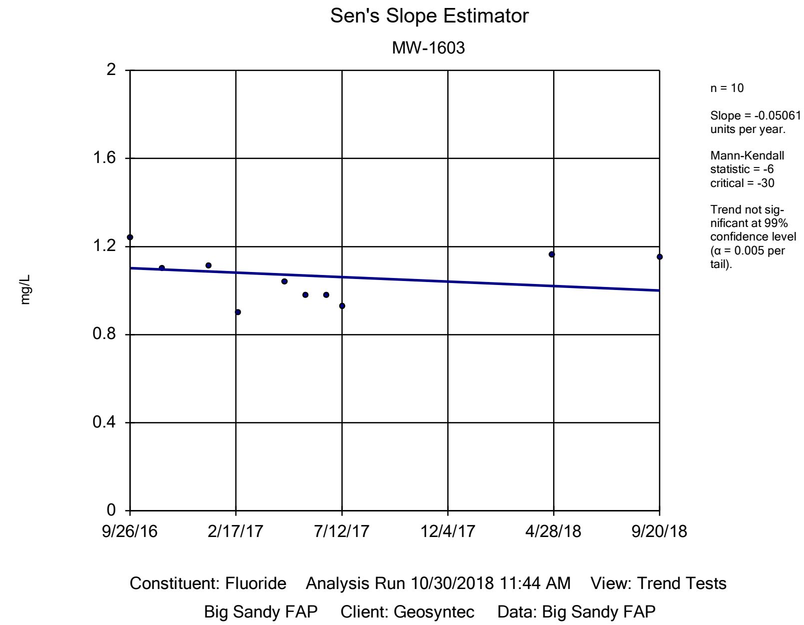


Constituent: Fluoride Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

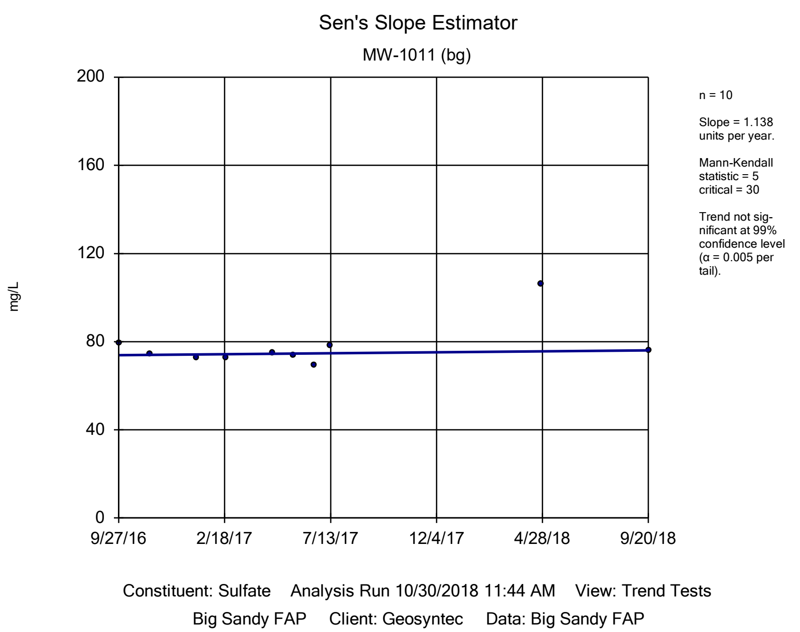
Hollow symbols indicate censored values.



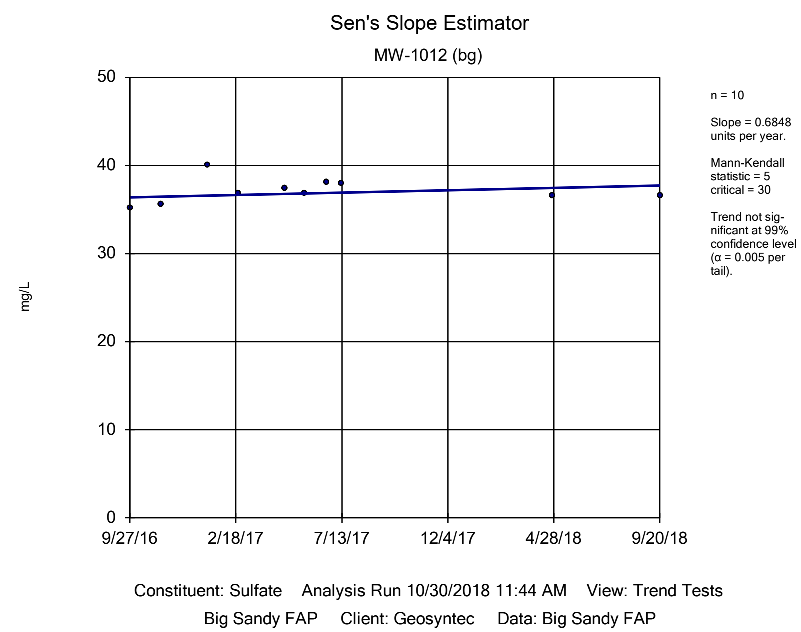
Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



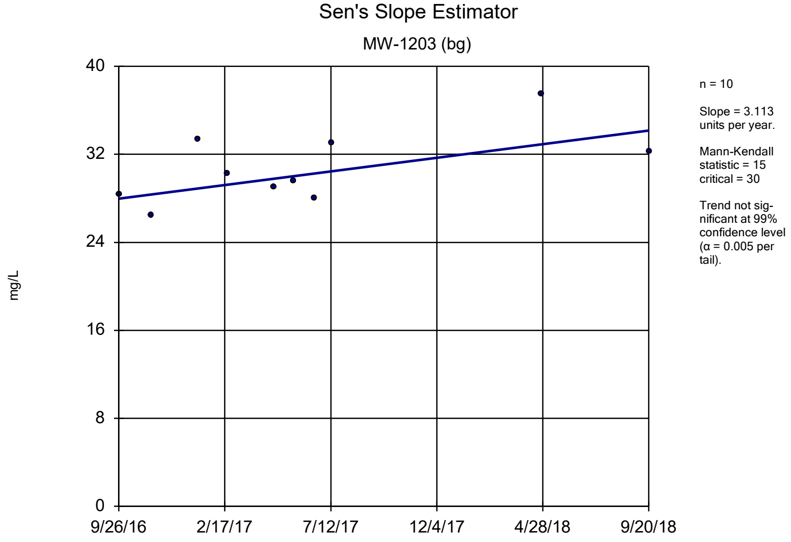
Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

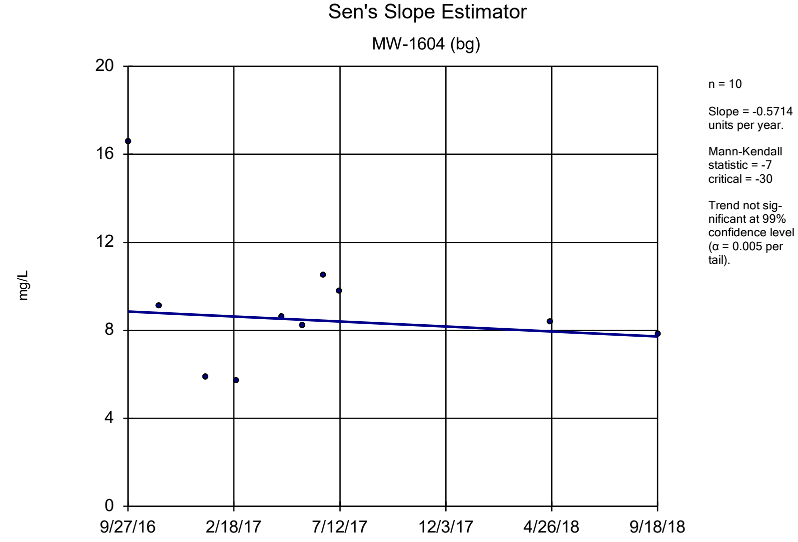


Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



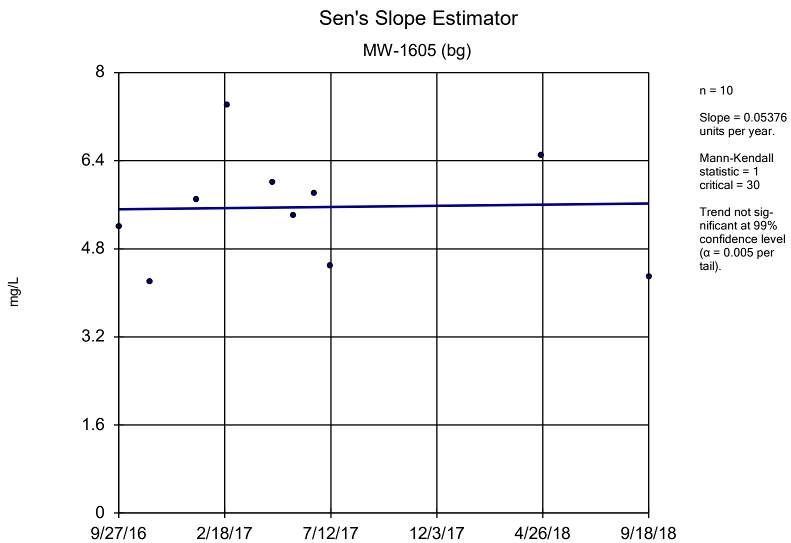
Constituent: Sulfate Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



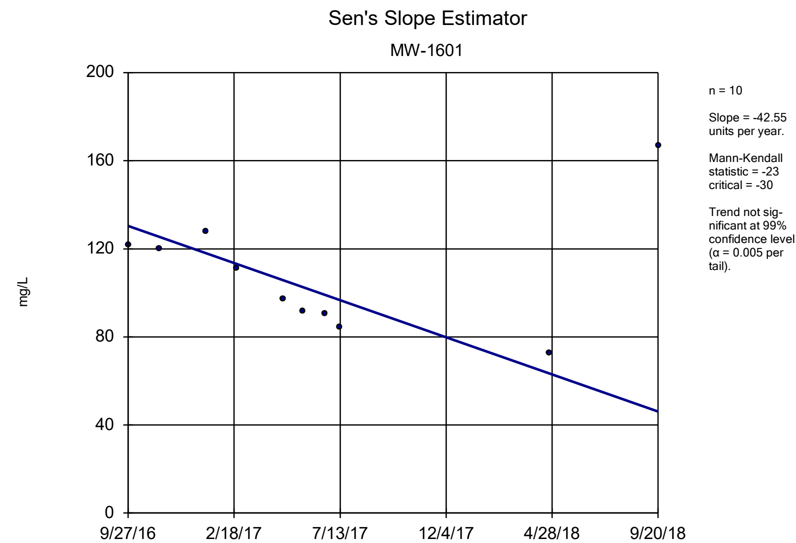
Constituent: Sulfate Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Sulfate Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

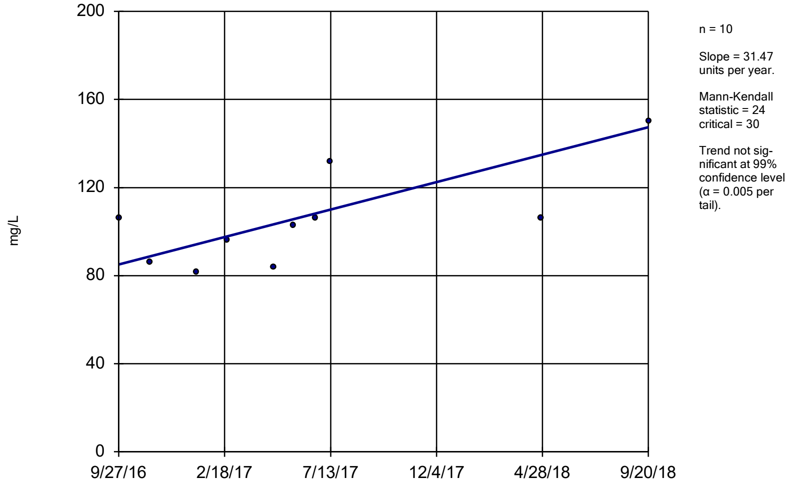


Constituent: Sulfate Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

MW-1602



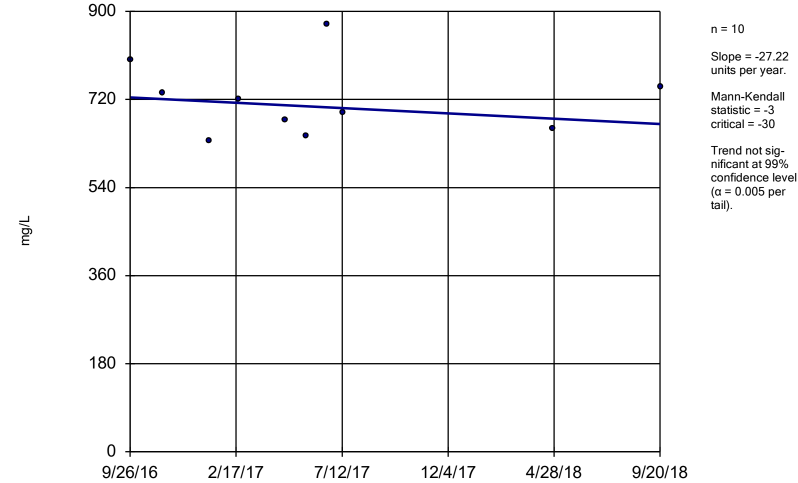
Constituent: Sulfate Analysis Run 10/30/2018 11:44 AM View: Trend Tests

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

MW-1603



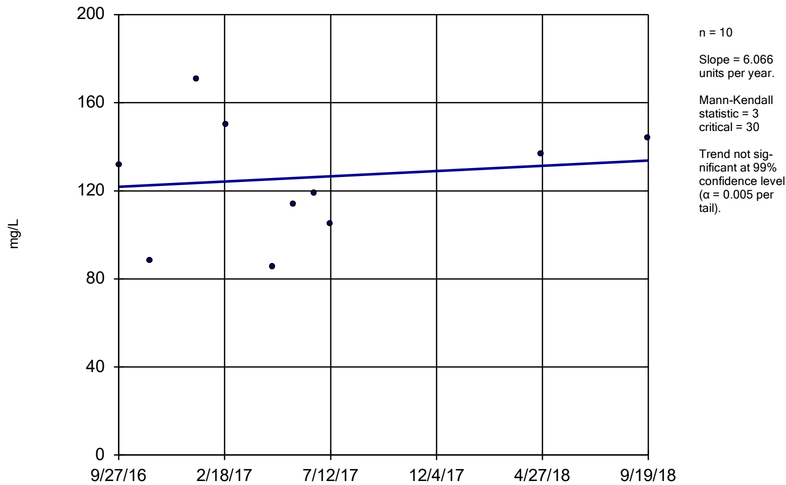
Constituent: Sulfate Analysis Run 10/30/2018 11:44 AM View: Trend Tests

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

MW-1607



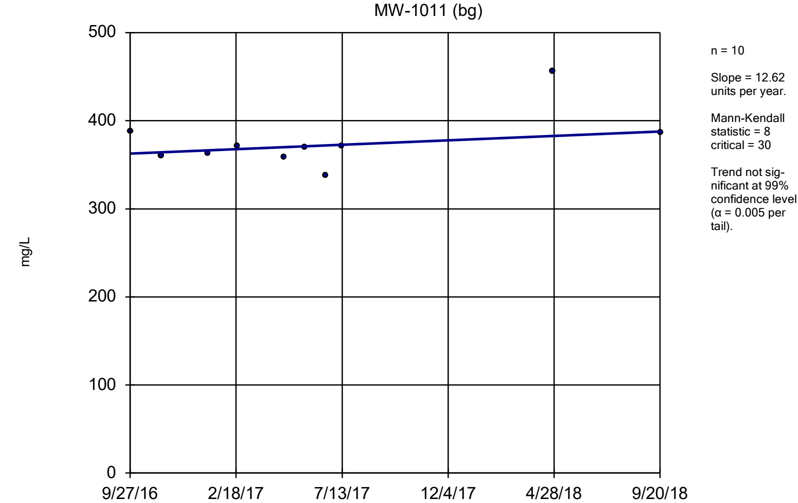
Constituent: Sulfate Analysis Run 10/30/2018 11:44 AM View: Trend Tests

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

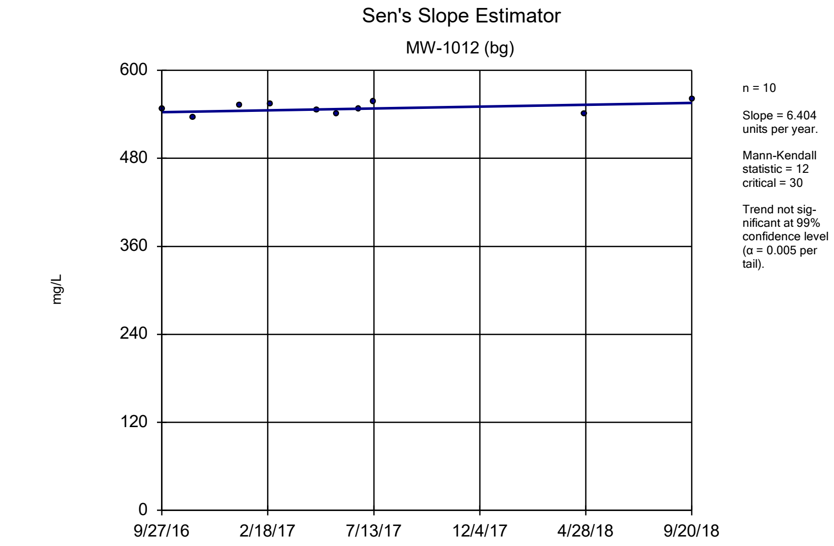
Sen's Slope Estimator

MW-1011 (bg)



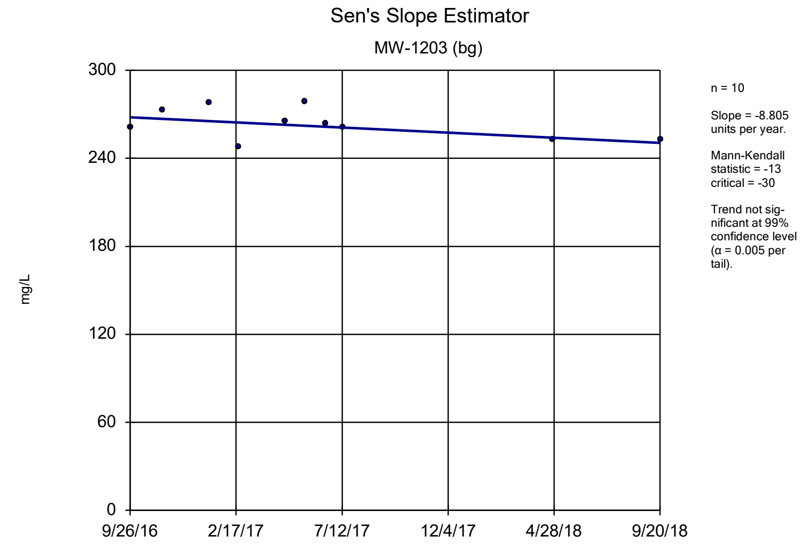
Constituent: Total Dissolved Solids Analysis Run 10/30/2018 11:44 AM View: Trend Tests

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



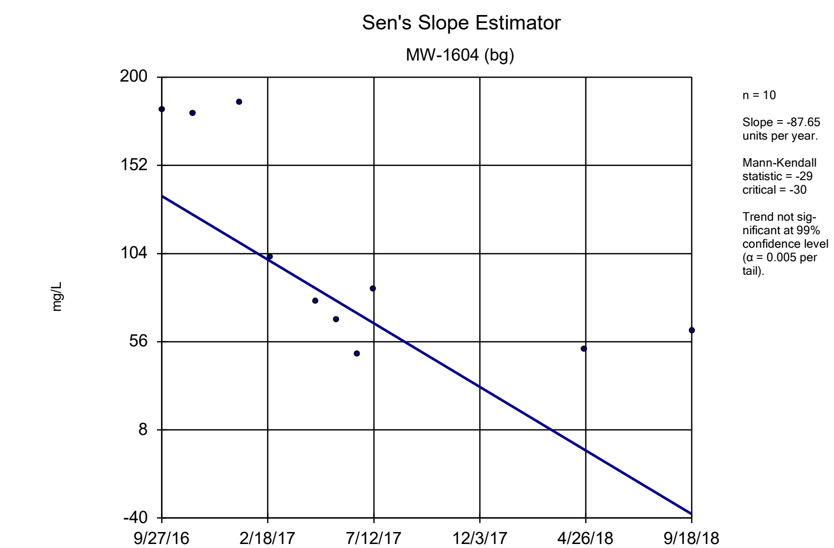
Constituent: Total Dissolved Solids Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



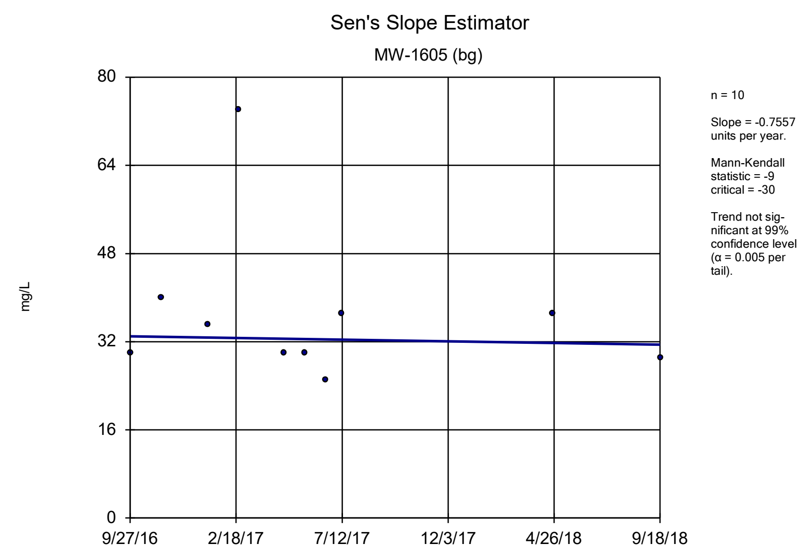
Constituent: Total Dissolved Solids Analysis Run 10/30/2018 11:44 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



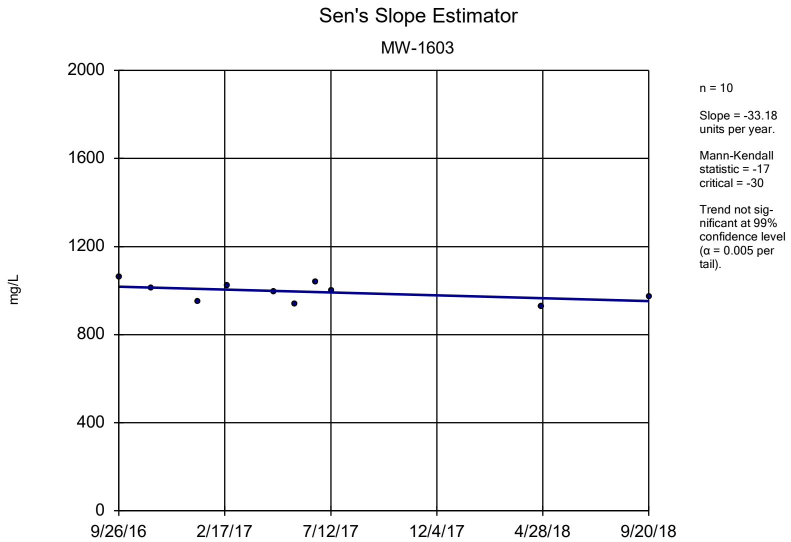
Constituent: Total Dissolved Solids Analysis Run 10/30/2018 11:45 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Total Dissolved Solids Analysis Run 10/30/2018 11:45 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Total Dissolved Solids Analysis Run 10/30/2018 11:45 AM View: Trend Tests

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Upper Tolerance Limits

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/11/2018, 12:22 PM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony (mg/L)	n/a	0.0012	50	n/a	n/a	10	n/a	n/a	0.07694	NP Inter(normality)
Arsenic (mg/L)	n/a	0.0289	50	n/a	n/a	0	n/a	n/a	0.07694	NP Inter
Barium (mg/L)	n/a	0.1149	50	0.226	0.05467	0	None	sqrt(x)	0.05	Inter
Beryllium (mg/L)	n/a	0.000149	50	n/a	n/a	20	n/a	n/a	0.07694	NP Inter(Cohens/xform)
Cadmium (mg/L)	n/a	0.00014	50	n/a	n/a	22	n/a	n/a	0.07694	NP Inter(normality)
Chromium (mg/L)	n/a	0.0027	49	n/a	n/a	0	n/a	n/a	0.08099	NP Inter(normality)
Cobalt (mg/L)	n/a	0.004934	50	0.03313	0.01797	0	None	sqrt(x)	0.05	Inter
Combined Radium 226 + 228 (pCi/L)	n/a	6.573	49	1.262	0.6288	0	None	sqrt(x)	0.05	Inter
Fluoride (mg/L)	n/a	0.82	49	n/a	n/a	18.37	n/a	n/a	0.08099	NP Inter(normality)
Lead (mg/L)	n/a	0.001301	50	0.0593	0.02414	0	None	x^(1/3)	0.05	Inter
Lithium (mg/L)	n/a	0.0196	50	0.008226	0.005508	8	None	No	0.05	Inter
Mercury (mg/L)	n/a	0.000013	50	n/a	n/a	82	n/a	n/a	0.07694	NP Inter(NDs)
Molybdenum (mg/L)	n/a	0.01087	50	-7.441	1.414	0	None	ln(x)	0.05	Inter
Selenium (mg/L)	n/a	0.0003	50	n/a	n/a	14	n/a	n/a	0.07694	NP Inter(normality)
Thallium (mg/L)	n/a	0.000229	50	n/a	n/a	8	n/a	n/a	0.07694	NP Inter(normality)

Confidence Interval - Significant Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/11/2018, 12:33 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Beryllium (mg/L)	**MW-1603**	**0.01889**	**0.01685**	**0.004**	**Yes**	**10**	**0**	**No**	**0.01**	**Param.**
Cobalt (mg/L)	**MW-1603**	**0.09678**	**0.0893**	**0.006**	**Yes**	**10**	**0**	**No**	**0.01**	**Param.**
Lithium (mg/L)	**MW-1603**	**0.2473**	**0.2069**	**0.04**	**Yes**	**10**	**0**	**No**	**0.01**	**Param.**

Confidence Interval - All Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/11/2018, 12:33 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Antimony (mg/L)	MW-1601	0.0001877	0.0000623	0.006	No	10	0	No	0.01	Param.
Antimony (mg/L)	MW-1602	0.0001216	0.0000544	0.006	No	10	0	No	0.01	Param.
Antimony (mg/L)	MW-1603	0.000025	0.00001	0.006	No	10	60	No	0.011	NP (normality)
Antimony (mg/L)	MW-1606	0.00005984	0.00002	0.006	No	10	20	No	0.01	Param.
Antimony (mg/L)	MW-1607	0.00027	0.00001	0.006	No	9	0	No	0.002	NP (normality)
Arsenic (mg/L)	MW-1601	0.005391	0.004245	0.029	No	10	0	No	0.01	Param.
Arsenic (mg/L)	MW-1602	0.00315	0.00037	0.029	No	10	0	No	0.011	NP (normality)
Arsenic (mg/L)	MW-1603	0.00149	0.001146	0.029	No	10	0	No	0.01	Param.
Arsenic (mg/L)	MW-1606	0.001221	0.0009268	0.029	No	10	0	No	0.01	Param.
Arsenic (mg/L)	MW-1607	0.0236	0.00736	0.029	No	10	0	No	0.011	NP (normality)
Barium (mg/L)	MW-1601	0.08132	0.0638	2	No	10	0	No	0.01	Param.
Barium (mg/L)	MW-1602	0.05799	0.05053	2	No	10	0	No	0.01	Param.
Barium (mg/L)	MW-1603	0.0132	0.01059	2	No	10	0	sqrt(x)	0.01	Param.
Barium (mg/L)	MW-1606	1	0.8064	2	No	10	0	No	0.01	Param.
Barium (mg/L)	MW-1607	0.0441	0.02964	2	No	10	0	No	0.01	Param.
Beryllium (mg/L)	MW-1601	0.00001	0.000005	0.004	No	10	10	No	0.011	NP (normality)
Beryllium (mg/L)	MW-1602	0.00001	0.00001	0.004	No	9	100	No	0.002	NP (NDs)
Beryllium (mg/L)	**MW-1603**	**0.01889**	**0.01685**	**0.004**	**Yes**	**10**	**0**	**No**	**0.01**	**Param.**
Beryllium (mg/L)	MW-1606	0.00006344	0.00001006	0.004	No	10	0	sqrt(x)	0.01	Param.
Beryllium (mg/L)	MW-1607	0.000028	0.00001	0.004	No	10	0	No	0.011	NP (normality)
Cadmium (mg/L)	MW-1601	0.00001	0.000005	0.005	No	10	20	No	0.011	NP (normality)
Cadmium (mg/L)	MW-1602	0.00001	0.000005	0.005	No	10	30	No	0.011	NP (normality)
Cadmium (mg/L)	MW-1603	0.000871	0.000765	0.005	No	10	0	No	0.01	Param.
Cadmium (mg/L)	MW-1606	0.00001	0.000007	0.005	No	10	60	No	0.011	NP (normality)
Cadmium (mg/L)	MW-1607	0.00001	0.000006	0.005	No	10	60	No	0.011	NP (normality)
Chromium (mg/L)	MW-1601	0.0006611	0.0002777	0.1	No	10	0	sqrt(x)	0.01	Param.
Chromium (mg/L)	MW-1602	0.0007122	0.0004206	0.1	No	10	0	No	0.01	Param.
Chromium (mg/L)	MW-1603	0.0009693	0.0006229	0.1	No	10	0	No	0.01	Param.
Chromium (mg/L)	MW-1606	0.001611	0.0003553	0.1	No	10	0	No	0.01	Param.
Chromium (mg/L)	MW-1607	0.0006598	0.0003316	0.1	No	10	0	No	0.01	Param.
Cobalt (mg/L)	MW-1601	0.001633	0.0009388	0.006	No	10	0	No	0.01	Param.
Cobalt (mg/L)	MW-1602	0.0003909	0.00001283	0.006	No	10	0	sqrt(x)	0.01	Param.
Cobalt (mg/L)	**MW-1603**	**0.09678**	**0.0893**	**0.006**	**Yes**	**10**	**0**	**No**	**0.01**	**Param.**
Cobalt (mg/L)	MW-1606	0.0009054	0.0001654	0.006	No	10	0	No	0.01	Param.
Cobalt (mg/L)	MW-1607	0.001499	0.001247	0.006	No	10	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1601	2.066	0.8997	6.57	No	10	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1602	1.523	0.7943	6.57	No	10	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1603	6.607	5.163	6.57	No	10	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1606	3.648	2.631	6.57	No	10	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1607	3.104	0.5096	6.57	No	10	0	sqrt(x)	0.01	Param.
Fluoride (mg/L)	MW-1601	0.3359	0.2641	4	No	10	0	No	0.01	Param.
Fluoride (mg/L)	MW-1602	0.1674	0.1086	4	No	10	0	No	0.01	Param.
Fluoride (mg/L)	MW-1603	1.158	0.9602	4	No	10	0	No	0.01	Param.
Fluoride (mg/L)	MW-1606	0.2232	0.1705	4	No	10	0	x^(1/3)	0.01	Param.
Fluoride (mg/L)	MW-1607	0.07248	0.04952	4	No	10	0	No	0.01	Param.
Lead (mg/L)	MW-1601	0.0001142	0.00002532	0.015	No	10	0	ln(x)	0.01	Param.
Lead (mg/L)	MW-1602	0.00008316	0.00002313	0.015	No	10	0	ln(x)	0.01	Param.
Lead (mg/L)	MW-1603	0.007743	0.004569	0.015	No	10	0	No	0.01	Param.
Lead (mg/L)	MW-1606	0.00115	0.00006768	0.015	No	10	0	No	0.01	Param.
Lead (mg/L)	MW-1607	0.0003982	0.0000598	0.015	No	10	0	sqrt(x)	0.01	Param.
Lithium (mg/L)	MW-1601	0.03786	0.02714	0.04	No	10	0	No	0.01	Param.
Lithium (mg/L)	MW-1602	0.01308	0.003522	0.04	No	10	0	No	0.01	Param.
Lithium (mg/L)	**MW-1603**	**0.2473**	**0.2069**	**0.04**	**Yes**	**10**	**0**	**No**	**0.01**	**Param.**
Lithium (mg/L)	MW-1606	0.01128	0.003518	0.04	No	10	0	No	0.01	Param.
Lithium (mg/L)	MW-1607	0.008033	0.001967	0.04	No	10	0	No	0.01	Param.

Confidence Interval - All Results

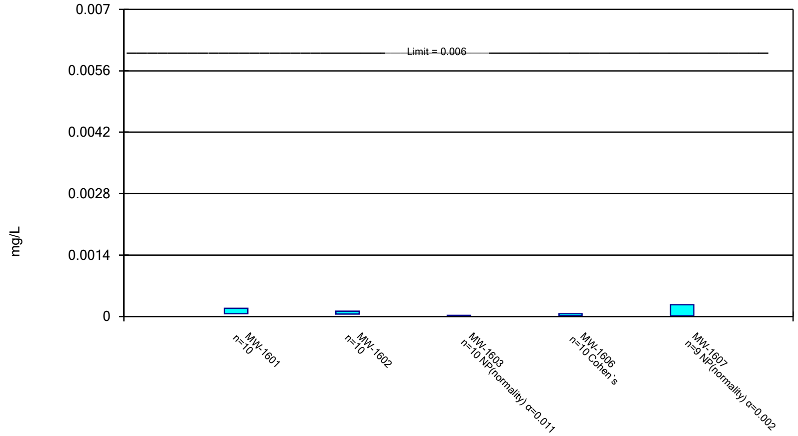
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/11/2018, 12:33 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Mercury (mg/L)	MW-1601	0.0000025	0.0000025	0.002	No	10	100	No	0.011	NP (NDs)
Mercury (mg/L)	MW-1602	0.000003	0.000002	0.002	No	10	30	No	0.011	NP (Cohens/xfrm)
Mercury (mg/L)	MW-1603	0.0000025	0.000002	0.002	No	10	90	No	0.011	NP (NDs)
Mercury (mg/L)	MW-1606	0.0000025	0.000002	0.002	No	10	70	No	0.011	NP (normality)
Mercury (mg/L)	MW-1607	0.0000025	0.0000025	0.002	No	10	90	No	0.011	NP (NDs)
Molybdenum (mg/L)	MW-1601	0.0316	0.02182	0.1	No	10	0	No	0.01	Param.
Molybdenum (mg/L)	MW-1602	0.00278	0.001616	0.1	No	10	0	No	0.01	Param.
Molybdenum (mg/L)	MW-1603	0.0002167	0.00005331	0.1	No	10	0	No	0.01	Param.
Molybdenum (mg/L)	MW-1606	0.00091	0.00051	0.1	No	10	0	No	0.011	NP (normality)
Molybdenum (mg/L)	MW-1607	0.0009	0.00042	0.1	No	10	0	No	0.011	NP (normality)
Selenium (mg/L)	MW-1601	0.0002	0.00007	0.05	No	10	0	No	0.011	NP (normality)
Selenium (mg/L)	MW-1602	0.002163	0.0008769	0.05	No	10	0	No	0.01	Param.
Selenium (mg/L)	MW-1603	0.006867	0.004393	0.05	No	10	0	No	0.01	Param.
Selenium (mg/L)	MW-1606	0.0002023	0.0000631	0.05	No	10	0	sqrt(x)	0.01	Param.
Selenium (mg/L)	MW-1607	0.0002	0.00005	0.05	No	10	0	No	0.011	NP (normality)
Thallium (mg/L)	MW-1601	0.00004569	0.00001096	0.002	No	10	0	ln(x)	0.01	Param.
Thallium (mg/L)	MW-1602	0.00003	0.00001	0.002	No	10	0	No	0.011	NP (normality)
Thallium (mg/L)	MW-1603	0.001536	0.001292	0.002	No	10	0	No	0.01	Param.
Thallium (mg/L)	MW-1606	0.00004	0.00001	0.002	No	10	30	No	0.011	NP (Cohens/xfrm)
Thallium (mg/L)	MW-1607	0.000055	0.00002	0.002	No	10	0	No	0.011	NP (normality)

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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

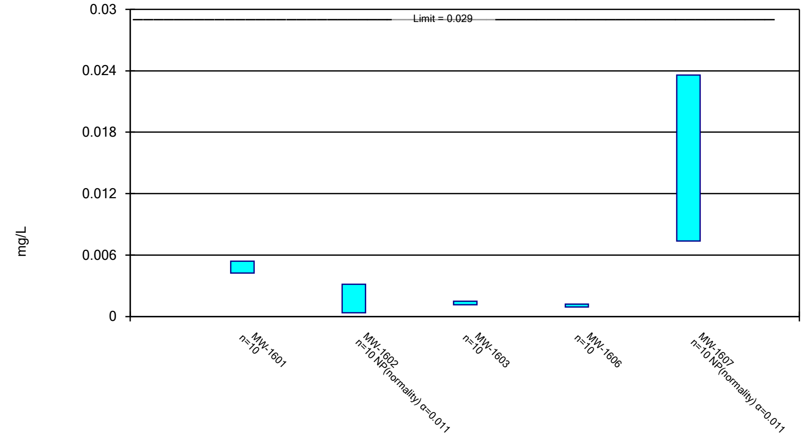


Constituent: Antimony   Analysis Run 11/11/2018 12:31 PM   View: Confidence Intervals - App IV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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

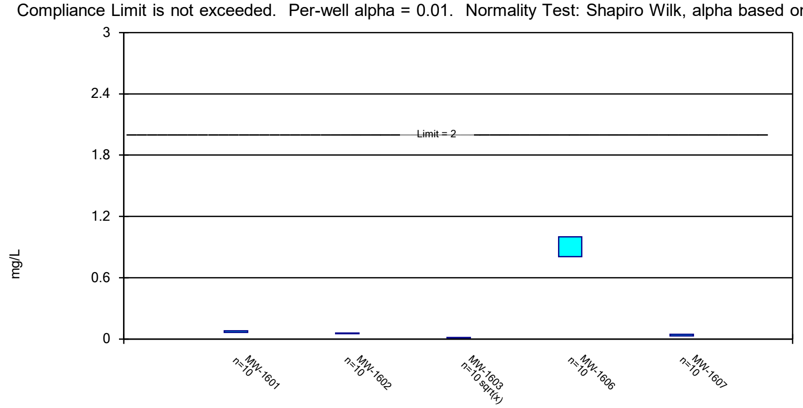


Constituent: Arsenic   Analysis Run 11/11/2018 12:31 PM   View: Confidence Intervals - App IV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

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

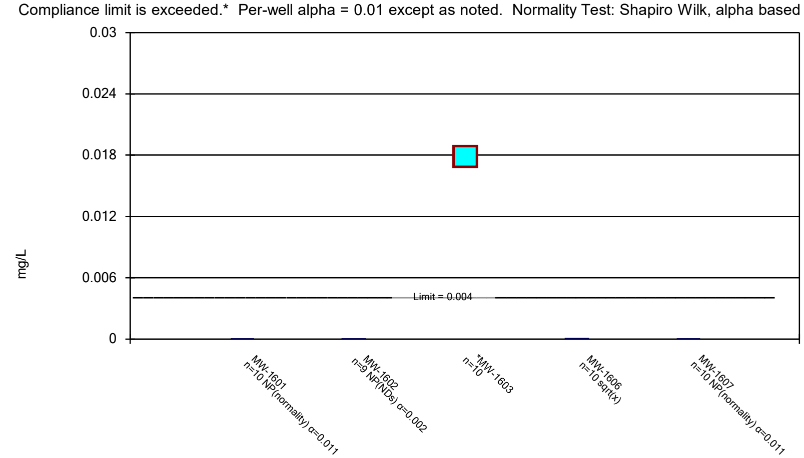


Constituent: Barium   Analysis Run 11/11/2018 12:31 PM   View: Confidence Intervals - App IV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

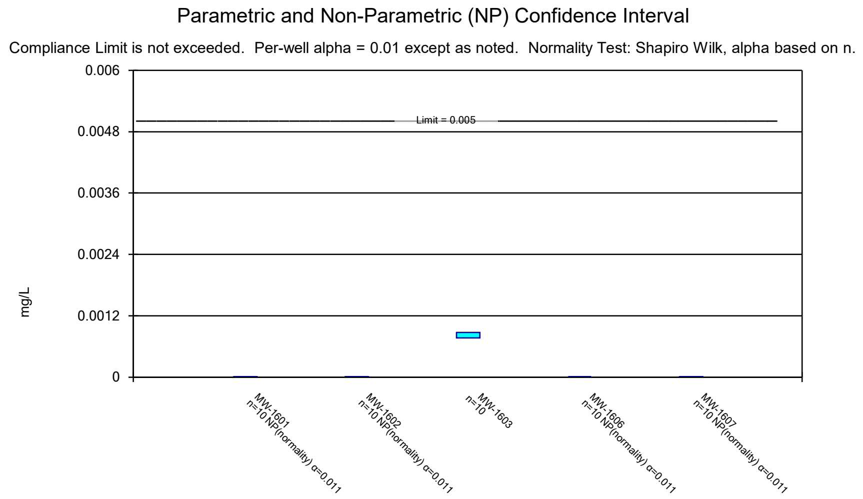
Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



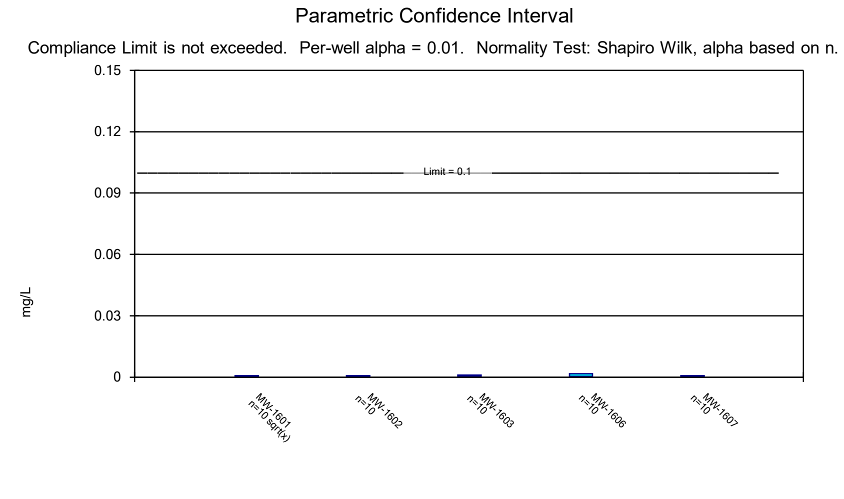
Constituent: Beryllium   Analysis Run 11/11/2018 12:31 PM   View: Confidence Intervals - App IV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



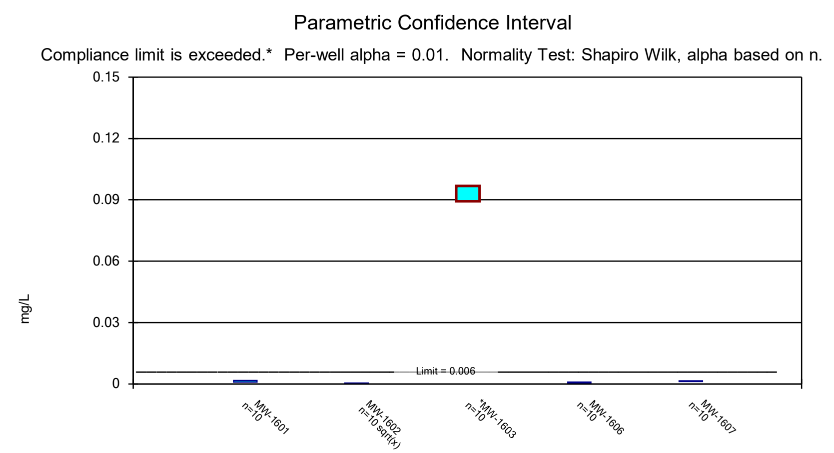
Constituent: Cadmium Analysis Run 11/11/2018 12:31 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



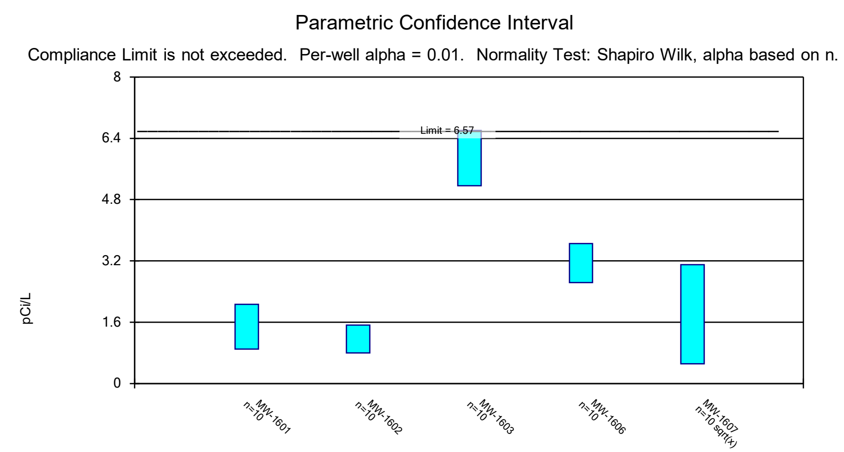
Constituent: Chromium Analysis Run 11/11/2018 12:31 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Cobalt Analysis Run 11/11/2018 12:31 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

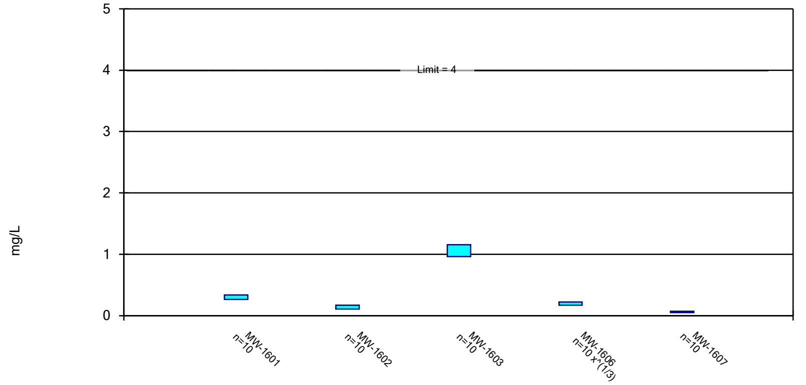


Constituent: Combined Radium 226 + 228 Analysis Run 11/11/2018 12:31 PM View: Confidence Intervals
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

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

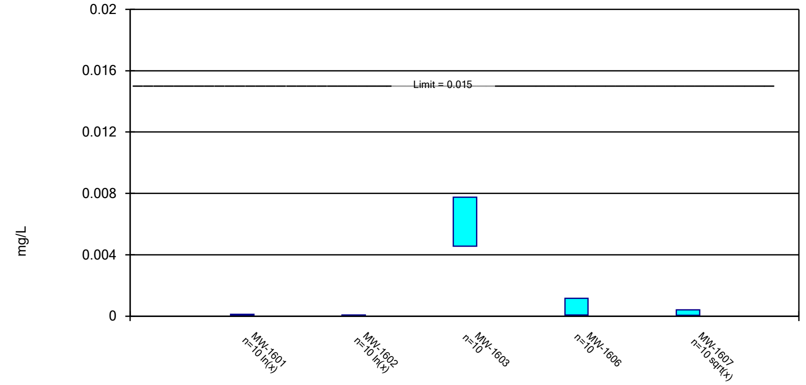


Constituent: Fluoride Analysis Run 11/11/2018 12:31 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

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

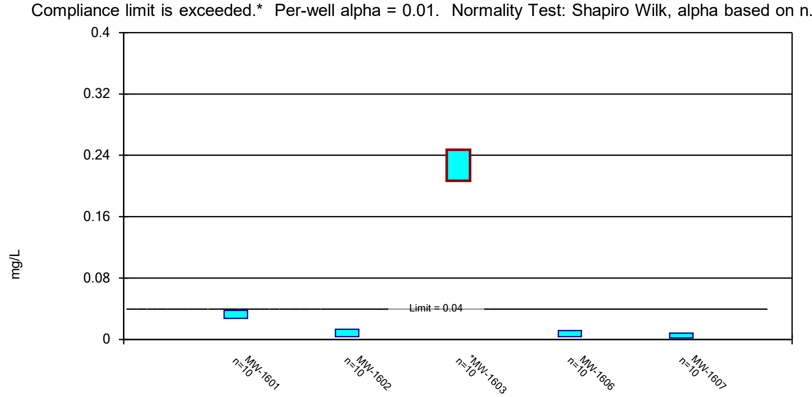


Constituent: Lead Analysis Run 11/11/2018 12:31 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

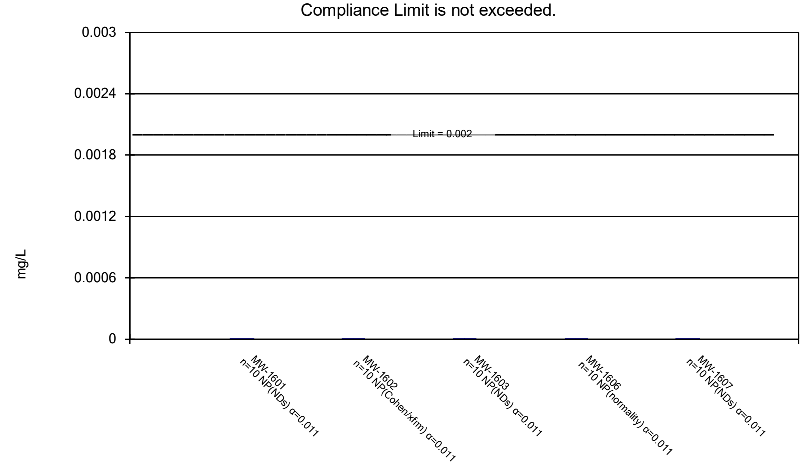


Constituent: Lithium Analysis Run 11/11/2018 12:31 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

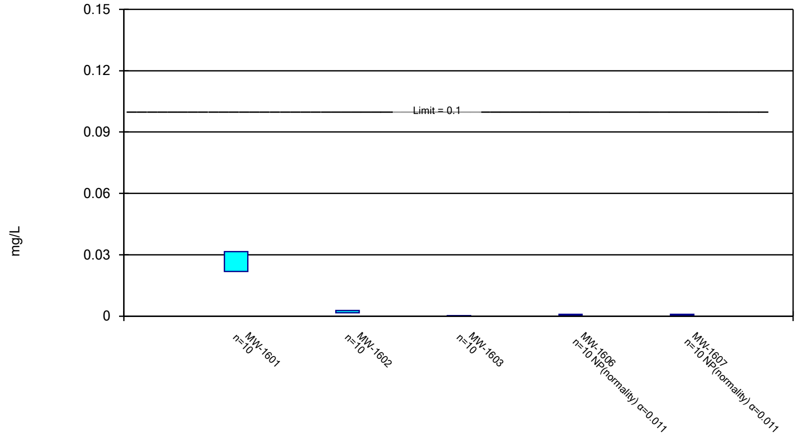


Constituent: Mercury Analysis Run 11/11/2018 12:31 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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

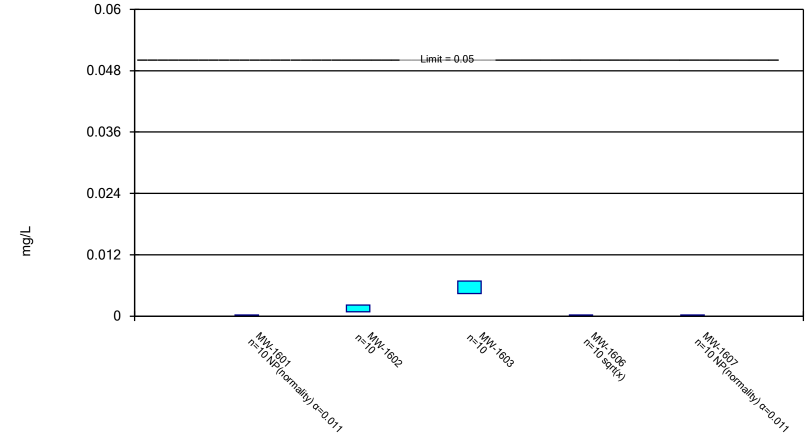


Constituent: Molybdenum Analysis Run 11/11/2018 12:31 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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

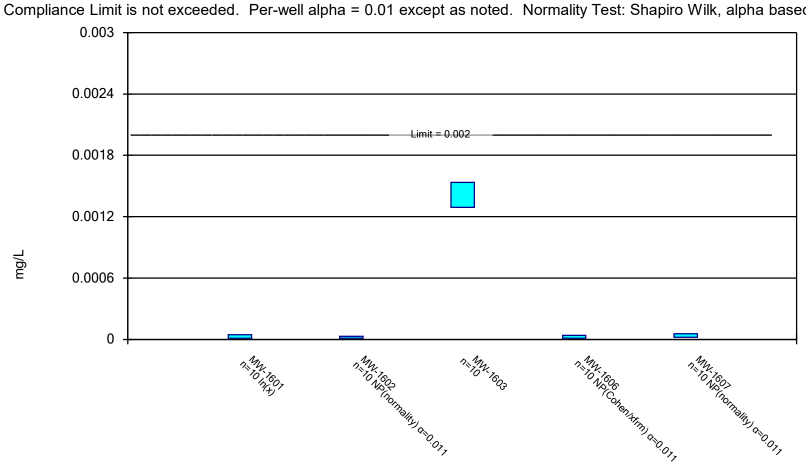


Constituent: Selenium Analysis Run 11/11/2018 12:31 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.11e Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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



Constituent: Thallium Analysis Run 11/11/2018 12:32 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

STATISTICAL ANALYSIS SUMMARY
FLY ASH POND
Big Sandy Plant
Louisa, Kentucky

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, Ohio 43221

July 12, 2019

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

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
FAP	Fly 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 Fly Ash Pond (FAP), an existing CCR unit at the Big Sandy Power Plant located in Louisa, Kentucky.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, calcium, chloride, fluoride, total dissolved solids (TDS), and sulfate at the FAP. An alternative source was not identified at the time, so two assessment monitoring events were conducted at the FAP in 2018, in accordance with 40 CFR 257.95. SSLs for beryllium, cobalt, and lithium were identified at well MW-1603. An ASD was successfully completed (EHS, 2019); thus, the unit remained in assessment monitoring. A semi-annual assessment monitoring event was also completed in March 2019, with the results of the March 2019 event 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 the usability of the data.

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 beryllium, cobalt, and lithium. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (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

FLY ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, one set of samples was collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(d)(1). Samples from the March 2019 semi-annual sampling event were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during this assessment monitoring event may be found 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.9.6.14 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 FAP 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 to meet the requirements of 40 CFR 257.95(d)(1) were screened for potential outliers. No outliers were identified.

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. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for antimony, arsenic, beryllium, cadmium, chromium, molybdenum, selenium, and thallium due to apparent non-normal distributions, for mercury due to a high non-detect frequency, and for fluoride due to both an apparent non-normal distribution and 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 Big Sandy FAP:

- The LCL for beryllium exceeded the GWPS of 0.004 mg/L at MW-1603 (0.0164 mg/L).
- The LCL for cobalt exceeded the GWPS of 0.006 mg/L at MW-1603 (0.0890 mg/L).
- The LCL for lithium exceeded the GWPS of 0.04 mg/L at MW-1603 (0.207 mg/L).

As a result, the Big Sandy FAP 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. Prediction limits were calculated for the Appendix III parameters to represent background values. As described in the January 2018 *Statistical Analysis Summary* report (Geosyntec, 2018), intrawell tests were used to evaluate potential SSIs for pH, whereas interwell tests were used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS.

Prediction limits for the interwell tests were recalculated using data collected during the March 2019 assessment monitoring event. Five data points (i.e., one sample from five background wells) were added to the background dataset for each interwell test. New data were tested for outliers prior to being added to the background dataset. The updated prediction limits were calculated for a one-of-two retesting procedure, as during detection monitoring. The values of the updated prediction limits were similar to the values of the prediction limits calculated during detection monitoring. The revised interwell prediction limits were used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS.

For the intrawell tests, limited data made it possible to add only one data point (i.e., one sample from each compliance well) to each background dataset. Because one sample result is insufficient to compare against the existing background dataset, the prediction limits were not updated for the intrawell tests at this time. The intrawell prediction limits calculated during detection monitoring were used to evaluate potential SSIs for pH.

Data collected during March 2019 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:

- Chloride concentrations exceeded the interwell UPL of 8.49 mg/L at MW-1601 (9.09 mg/L) and MW-1606 (31.7 mg/L).

- Fluoride concentration exceeded the interwell UPL of 0.884 mg/L at MW-1603 (0.92 mg/L).

- Sulfate concentrations exceeded the interwell UPL of 106 at MW-1602 (133 mg/L), MW-1603 (709 mg/L) and MW-1607 (135 mg/L).

- TDS concentrations exceeded the interwell UPL of 572 mg/L at MW-1603 (896 mg/L).

While the prediction limits were calculated assuming a one-of-two testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Big Sandy FAP during assessment monitoring.

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 2019 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 beryllium, cobalt, and lithium. Appendix III parameters were also evaluated, with exceedances identified for chloride, fluoride, sulfate, and TDS.

Based on this evaluation, the Big Sandy FAP 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 – Big Sandy Plant. January 2017.

EHS Support LLC. 2019. Alternative Source Demonstration for Beryllium, Cobalt, and Lithium. Big Sandy Fly Ash Pond. February 2019.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Fly Ash Pond, Big Sandy Plant, Louisa, Kentucky. January 15, 2018.

United States Environmental Protection Agency (USEPA). 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance. EPA 530/R-09-007. March 2009.

TABLES

Table 1 - Groundwater Data Summary
Big Sandy - Fly Ash Pond

Geosyntec Consultants

Parameter	Unit	MW-1011	MW-1012	MW-1203	MW-1601	MW-1602	MW-1603	MW-1604	MW-1605	MW-1606	MW-1607
		3/13/2019	3/13/2019	3/14/2019	3/12/2019	3/13/2019	3/13/2019	3/12/2019	3/12/2019	3/13/2019	3/13/2019
Antimony	µg/L	0.150	0.600	0.0300 J	0.200	0.0600 J	1.00 U	0.0300 J	0.100 U	0.100 U	0.100 U
Arsenic	µg/L	7.53	15.2	0.230	1.39	1.06	1.26	0.160	0.170	1.22	7.67
Barium	µg/L	49.2	27.2	88.0	49.0	52.5	12.0	66.8	36.6	764	31.6
Beryllium	µg/L	0.100 U	0.0300 J	0.0200 J	0.100 U	0.100 U	24.4	0.0600 J	0.131	0.100 U	0.100 U
Boron	mg/L	0.101	0.189	0.0900 J	0.117	0.0700 J	0.0500 J	0.0200 J	0.0200 J	1.93	0.209
Cadmium	µg/L	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.0500 U	0.780	0.0800	0.0800	0.0500 U	0.0500 U
Calcium	mg/L	80.5	1.15	54.9	54.3	79.4	84.6	3.55	1.27	74.2	93.7
Chloride	mg/L	5.22	1.26	5.53	9.09	12.6	4.42	1.34	0.530	31.7	5.17
Chromium	µg/L	0.576	0.459	0.391	0.438	1.03	1.00 J	0.547	2.91	0.535	0.424
Cobalt	µg/L	0.709	0.106	0.953	0.395	0.0300 J	87.9	0.844	0.483	0.208	1.43
Combined Radium	pCi/L	2.43	0.396	1.40	0.769	0.504	4.80	0.458	0.203	2.63	0.185
Fluoride	mg/L	0.240	0.730	0.110	0.180	0.100	0.920	0.0400 J	0.0200 J	0.220	0.0600
Lead	µg/L	0.217	0.354	0.124	0.0500 J	0.122	4.28	0.0400 J	0.305	0.123	0.0500 J
Lithium	mg/L	0.0200 J	0.0100 J	0.0300 U	0.00900 J	0.00900 J	0.209	0.0300 U	0.0300 U	0.0300 U	0.0300 U
Mercury	µg/L	0.00500 U	0.0100 U	0.0100 U	0.00500 U	0.00500 U	0.00500 U	0.00500 U	0.00300 J	0.00500 U	0.00500 U
Molybdenum	µg/L	0.900 J	0.900 J	2.00 U	7.00	2.00 J	20.0 U	2.00 U	2.00 U	2.60	1.00 J
Selenium	µg/L	0.200 U	0.0900 J	0.200 U	0.200 J	1.60	4.00	0.300	0.300	0.0500 J	0.0800 J
Total Dissolved Solids	mg/L	411	572	259	316	444	896	46.0	33.0	389	415
Sulfate	mg/L	84.2	35.6	38.7	88.5	133	709	10.0	7.20	58.8	135
Thallium	µg/L	0.500 U	0.500 U	0.500 U	0.500 U	0.500 U	1.00 J	0.500 U	0.500 U	0.500 U	0.500 U
pH	Sµ	6.46	8.75	6.20	6.25	6.94	3.19	5.15	4.30	6.93	6.07

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
Big Sandy Plant - Fly Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.0012
Arsenic, Total (mg/L)	0.01		0.029
Barium, Total (mg/L)	2		0.11
Beryllium, Total (mg/L)	0.004		0.00015
Cadmium, Total (mg/L)	0.005		0.00014
Chromium, Total (mg/L)	0.1		0.0029
Cobalt, Total (mg/L)	n/a	0.006	0.0051
Combined Radium, Total (pCi/L)	5		6.69
Fluoride, Total (mg/L)	4		0.82
Lead, Total (mg/L)	n/a	0.015	0.0012
Lithium, Total (mg/L)	n/a	0.04	0.02
Mercury, Total (mg/L)	0.002		0.000013
Molybdenum, Total (mg/L)	n/a	0.1	0.024
Selenium, Total (mg/L)	0.05		0.0003
Thallium, Total (mg/L)	0.002		0.0005

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

Table 3: Appendix III Data Summary
Big Sandy Plant - Fly Ash Pond

Parameter	Units	Description	MW-1601	MW-1602	MW-1603	MW-1606	MW-1607
			3/12/2019	3/13/2019	3/13/2019	3/13/2019	3/13/2019
Boron	mg/L	Interwell Background Value (UPL)	0.219				
		Detection Monitoring Result	0.117	0.070	0.050	1.93	0.209
Calcium	mg/L	Interwell Background Value (UPL)	105				
		Detection Monitoring Result	54.3	79.4	84.6	74.2	93.7
Chloride	mg/L	Interwell Background Value (UPL)	8.49				
		Detection Monitoring Result	**9.09**	12.6	4.42	**31.7**	5.17
Fluoride	mg/L	Interwell Background Value (UPL)	0.884				
		Detection Monitoring Result	0.180	0.100	**0.920**	0.220	0.060
pH	SU	Intrawell Background Value (UPL)	7.9	8.5	6.2	7.9	7.4
		Intrawell Background Value (LPL)	6.6	6.2	1.5	6.0	5.3
		Detection Monitoring Result	6.3	6.9	3.2	6.9	6.1
Sulfate	mg/L	Interwell Background Value (UPL)	106				
		Detection Monitoring Result	88.5	**133**	**709**	58.8	**135**
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	572				
		Detection Monitoring Result	316	444	**896**	389	415

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

Bold values exceed the background value.

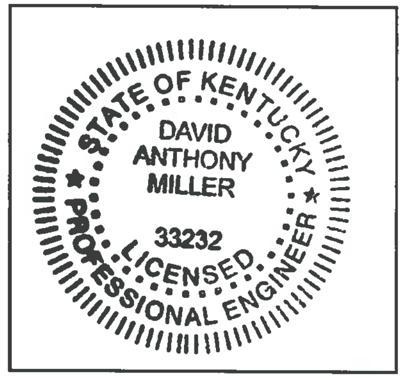
Background values are shaded gray.

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 Big Sandy Fly 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

33232
License Number

KENTUCKY
Licensing State

07.12.19
Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS
CONSULTING

July 3, 2019

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

Re: Big Sandy Fly Ash Pond
Assessment Monitoring Event – March 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting (GSC), formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the evaluation of groundwater data for the March 2019 Assessment Monitoring event for American Electric Power Company's Big Sandy Bottom Ash Pond. 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 began at site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** MW-1011, MW-1012, MW-1203, MW-1604, and MW-1605; and
- **Downgradient wells:** MW-1601, MW-1602, MW-1603, MW-1606, and MW-1607.

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 CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) **-** boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and

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

Time series plots for Appendix III and IV parameters are provided for all wells and constituents; and are used to evaluate concentrations over the entire record (Figure A). Values in background which have previously been flagged as outliers may be seen in a lighter font and disconnected symbol on the graphs. Additionally, a summary of flagged values follows this letter (Figure B).

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, calcium, chloride, fluoride, sulfate and TDS; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for pH (Figures C and D, respectively). In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary.

Prediction limit exceedances were noted for boron in well MW-1606; chloride in wells MW-1601, MW-1602, and MW-1606; fluoride in well MW-1603; pH in well MW-1601; sulfate in wells MW-1602, MW-1603 and well MW-1607; and total dissolved solids in well MW-1603. The results of those findings may be found in the Prediction Limit Summary tables following this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen’s Slope/Mann Kendall trend test to determine whether data are statistically increasing, decreasing or stable (Figure E). No statistically significant increasing trends were found. Statistically significant decreasing trends were noted for chloride in upgradient well MW-1603 and in downgradient well MW-1601; and fluoride and total dissolved solids in upgradient well MW-1604. The Trend Test Summary Table follows this letter.

Evaluation of Appendix IV Parameters

Parametric tolerance limits were used to calculate background limits from pooled upgradient well data for Appendix IV parameters with a target of 95% confidence and 95% coverage to determine the Alternate Contaminant Level (ACL) (Figure F). The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standards (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure G).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, CCR-Rule specified level or ACL as discussed above (Figure H). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No exceedances were noted except for the following well/constituent pairs: beryllium, cobalt, and lithium in well MW-1603. A summary of the confidence interval results follows this letter.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for Big Sandy Fly Ash Pond. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina L. Rayner
Groundwater Statistician

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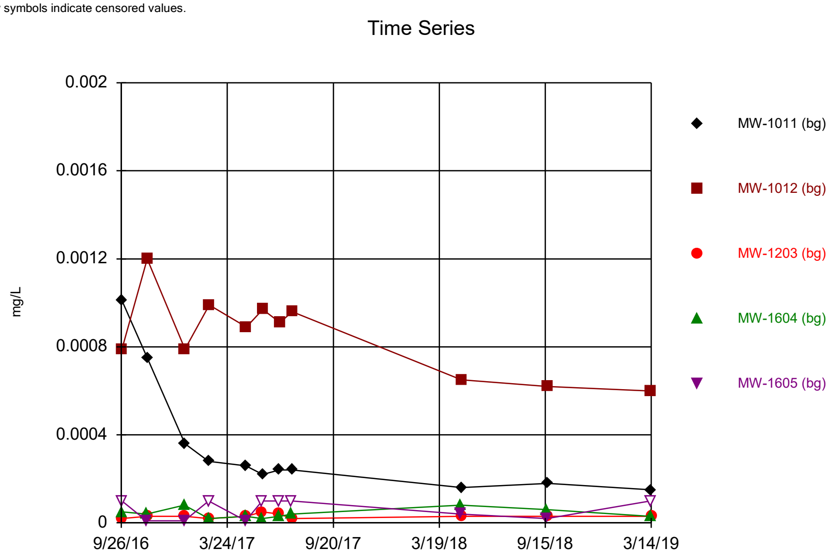
Hollow symbols indicate censored values.



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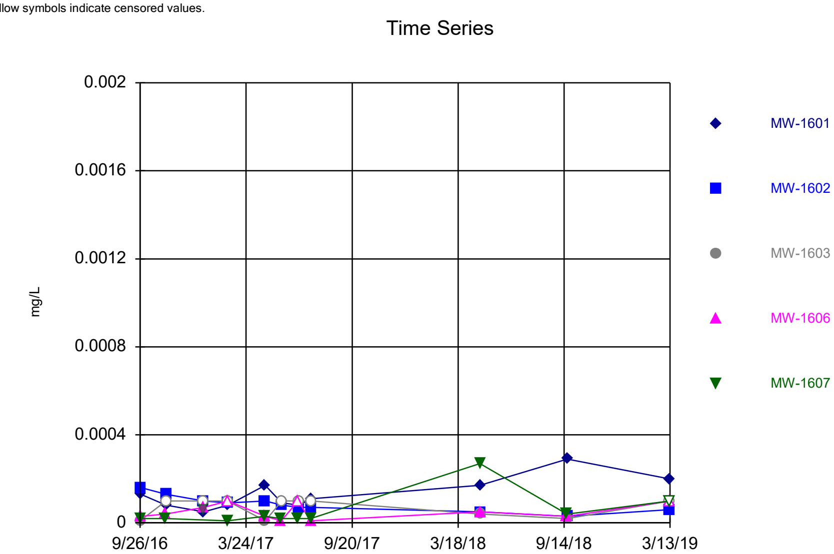

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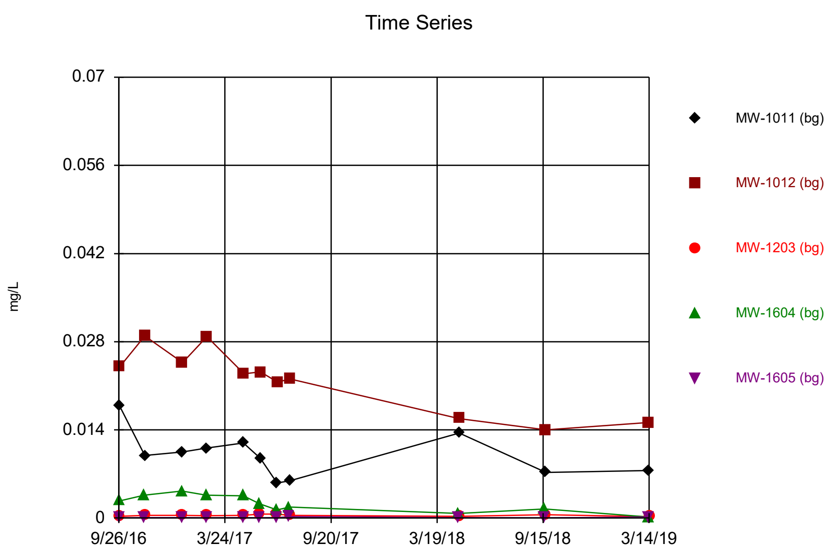

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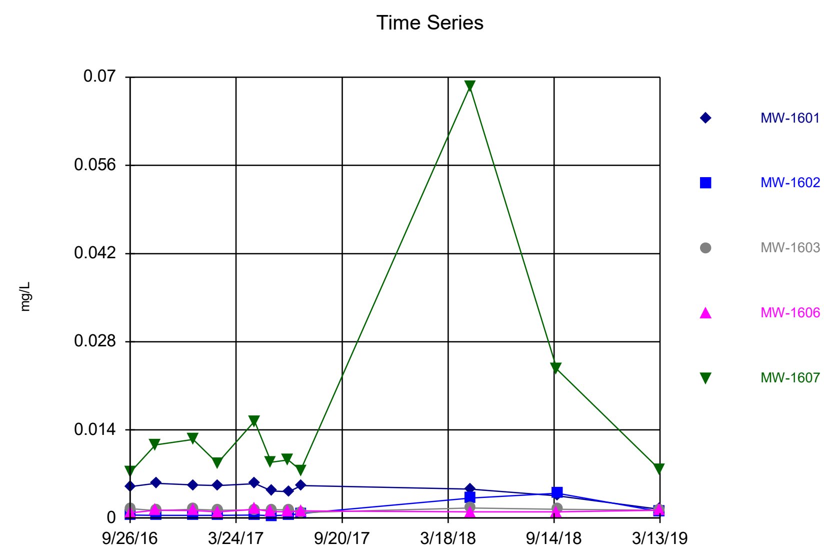

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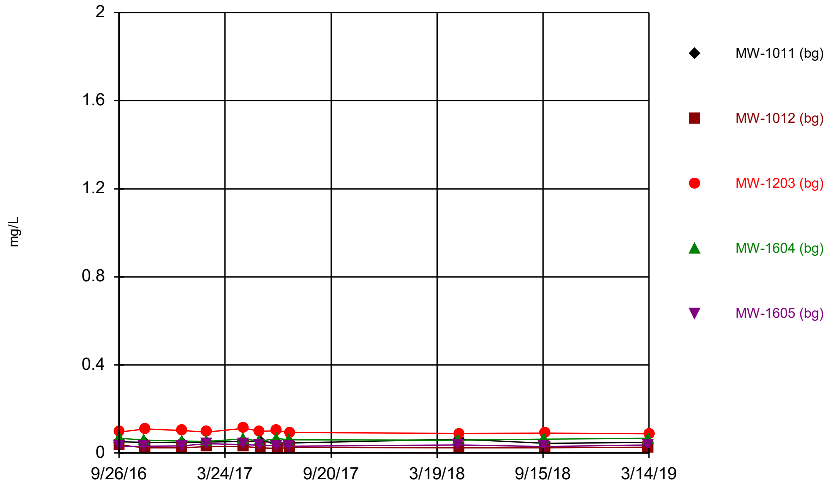
Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



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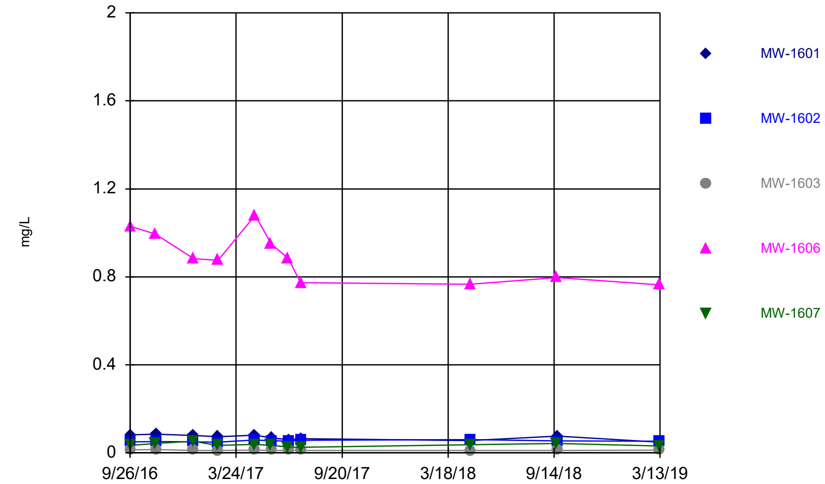
Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG

Time Series



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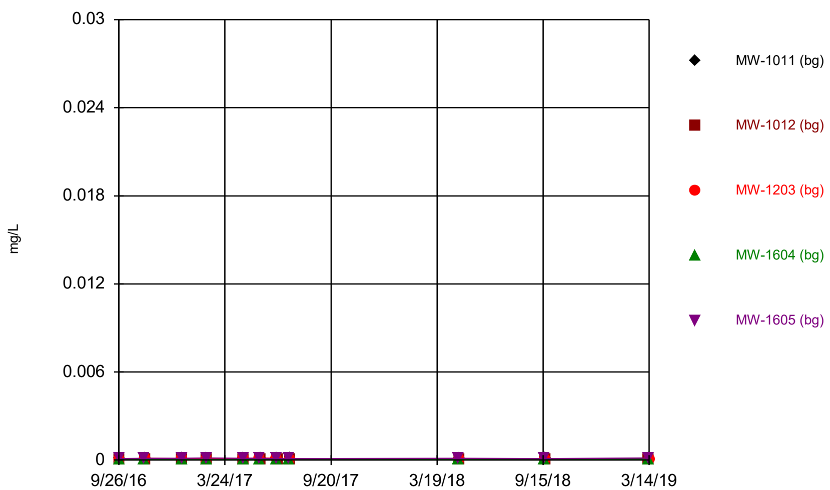
Time Series



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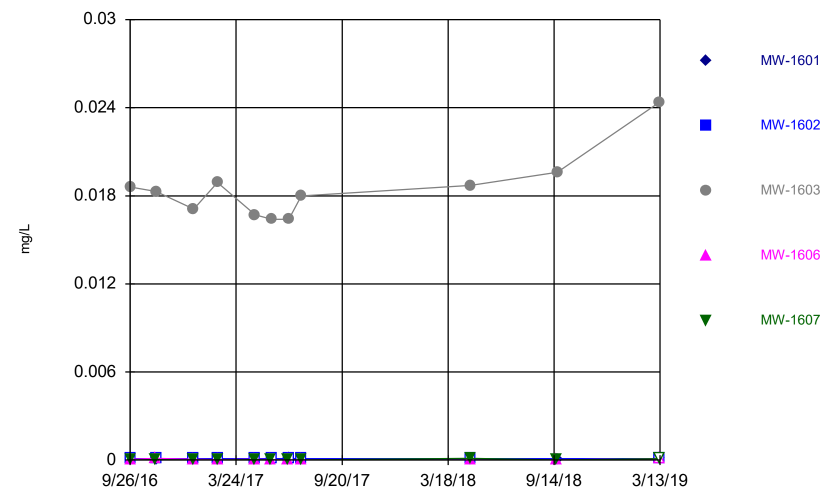
Hollow symbols indicate censored values.

Time Series



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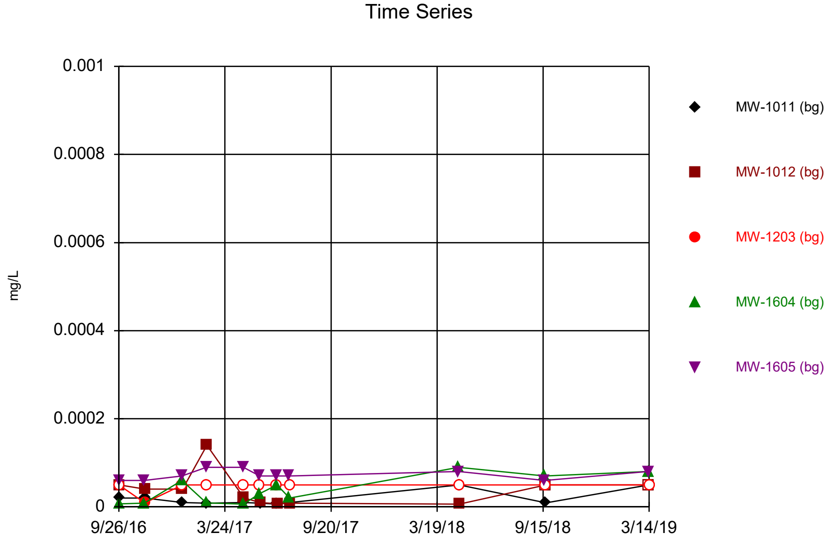

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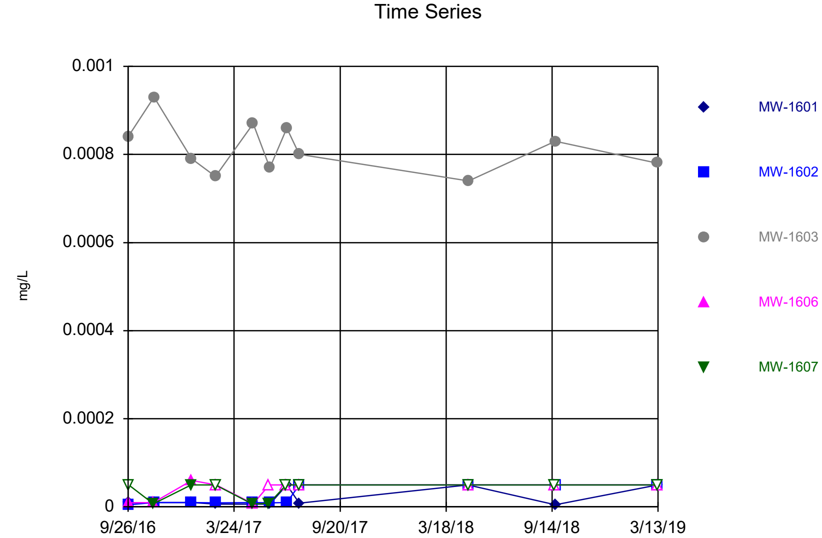
Hollow symbols indicate censored values.



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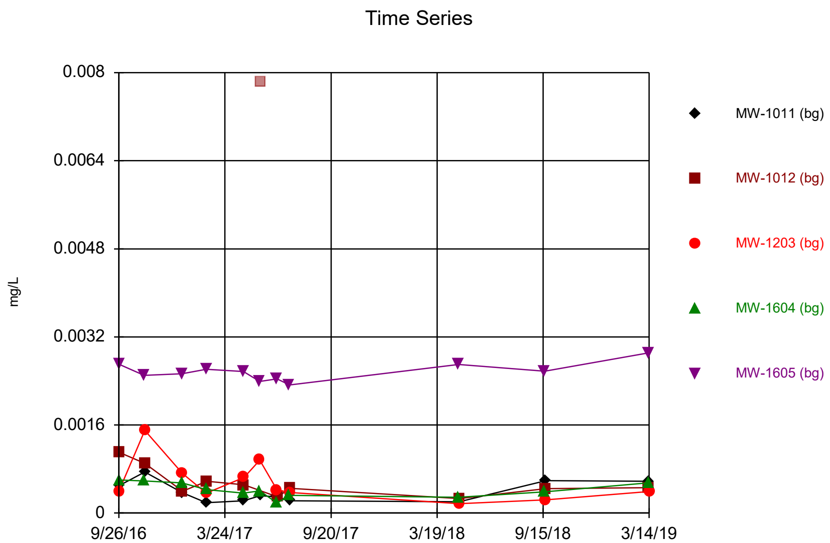

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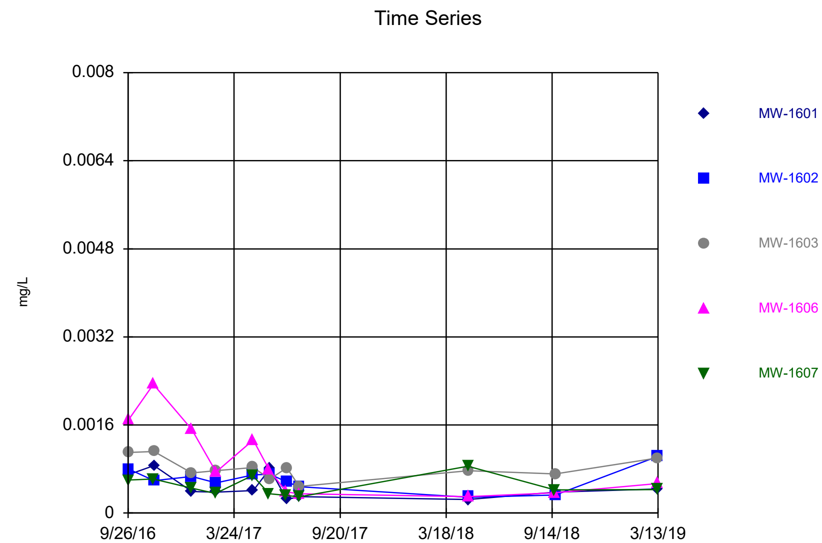

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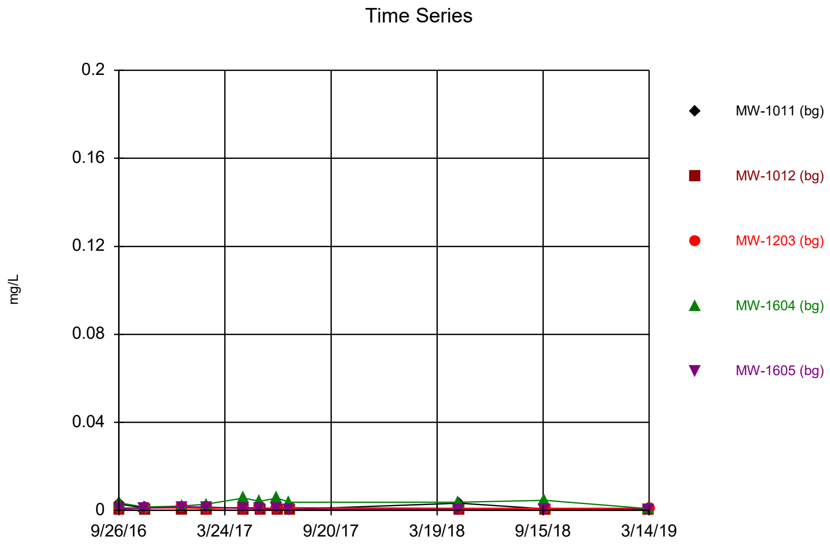

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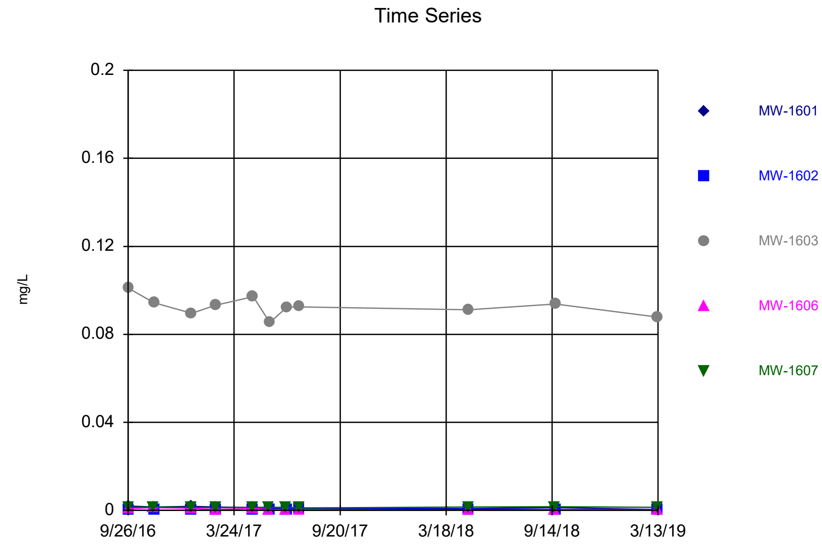

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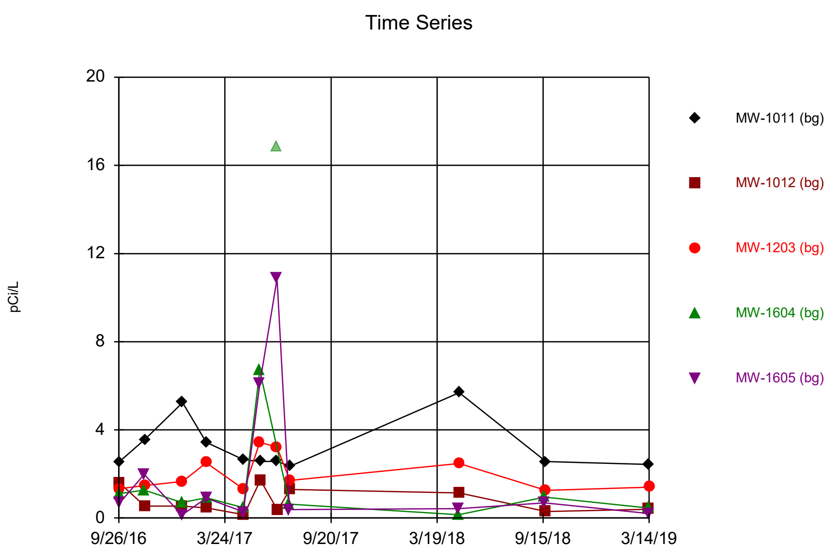
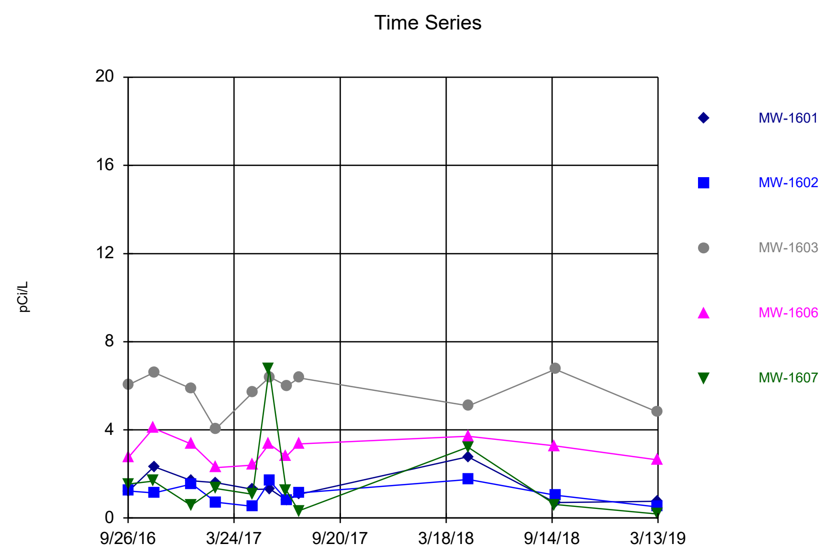
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Combined Radium 226 + 228 Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals -
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

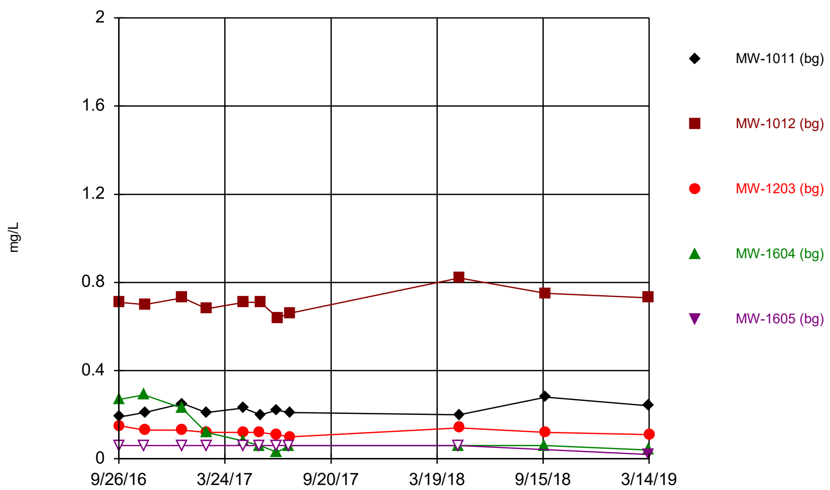
Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Combined Radium 226 + 228 Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals -
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

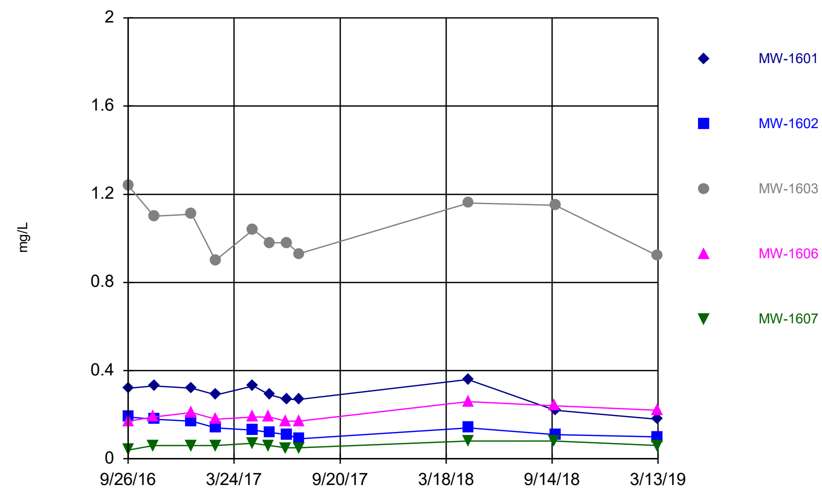
Time Series



Constituent: Fluoride Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG

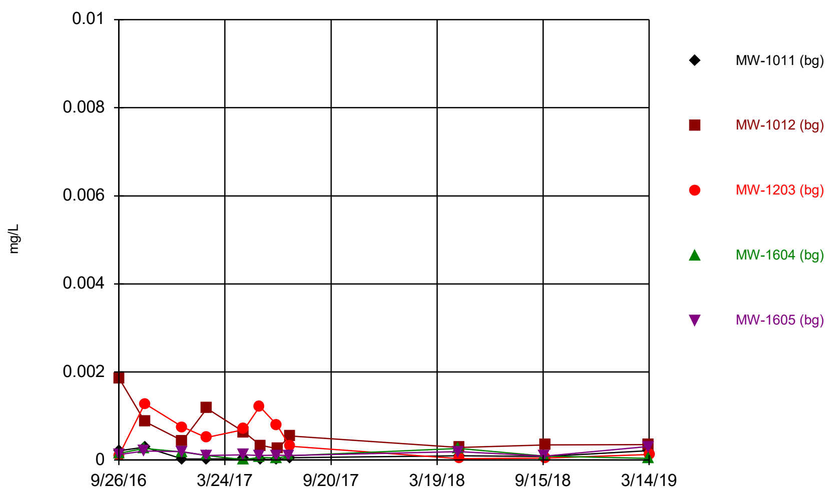
Time Series



Constituent: Fluoride Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG

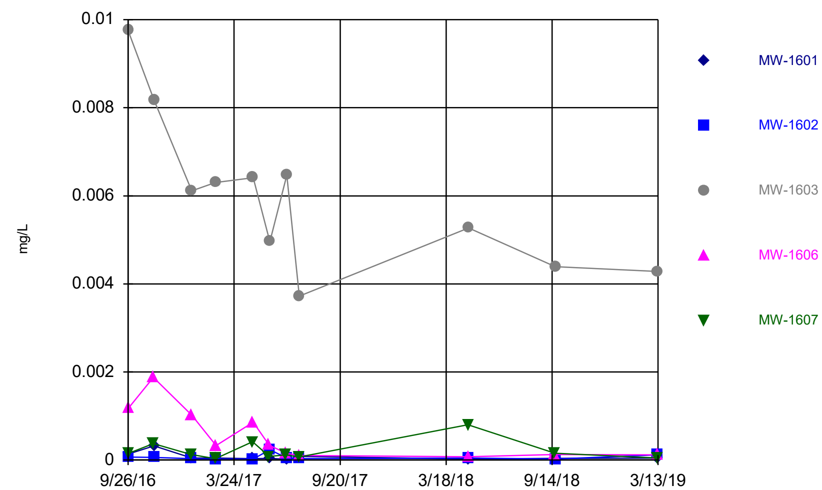
Time Series



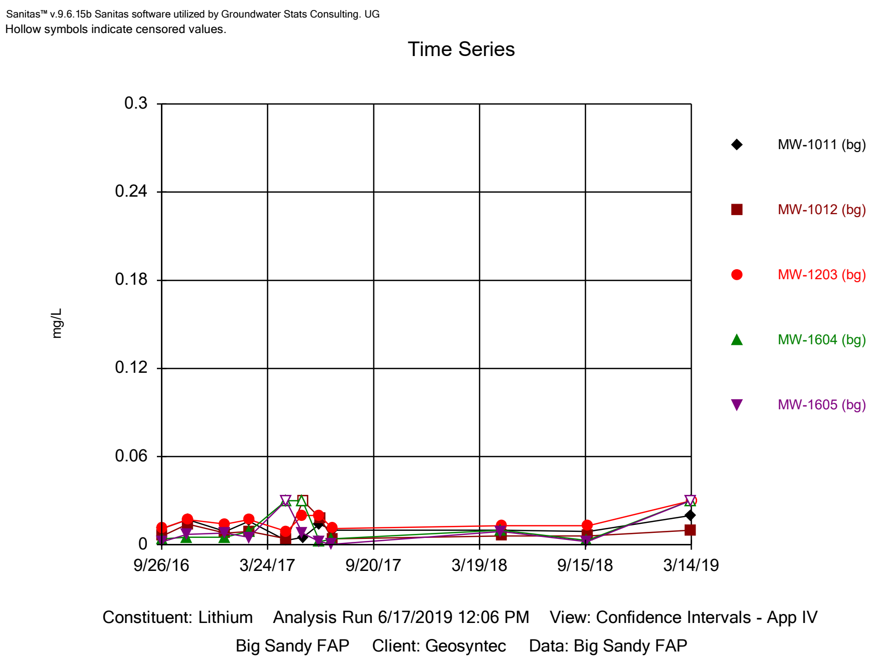
Constituent: Lead Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

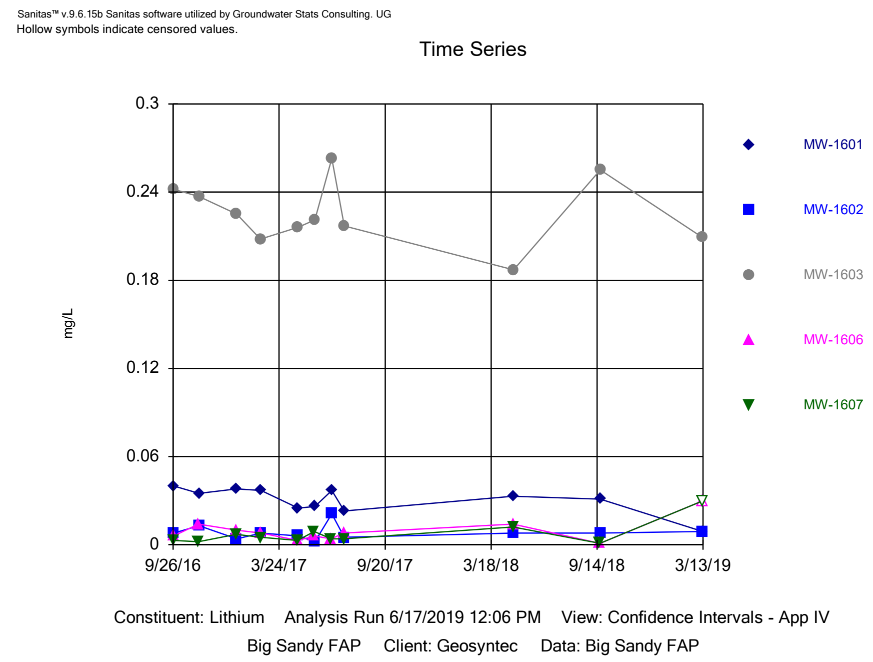
Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG

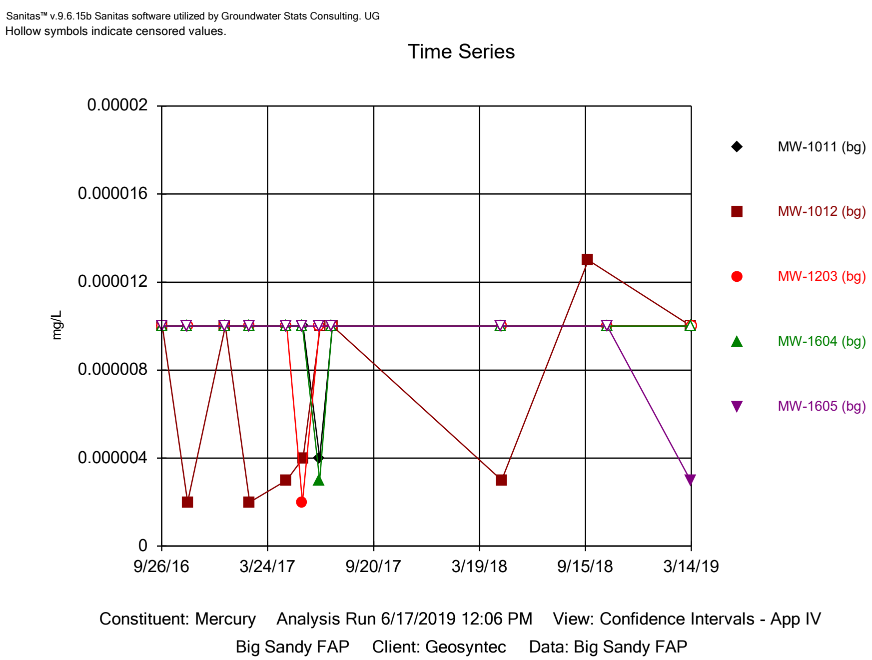
Time Series

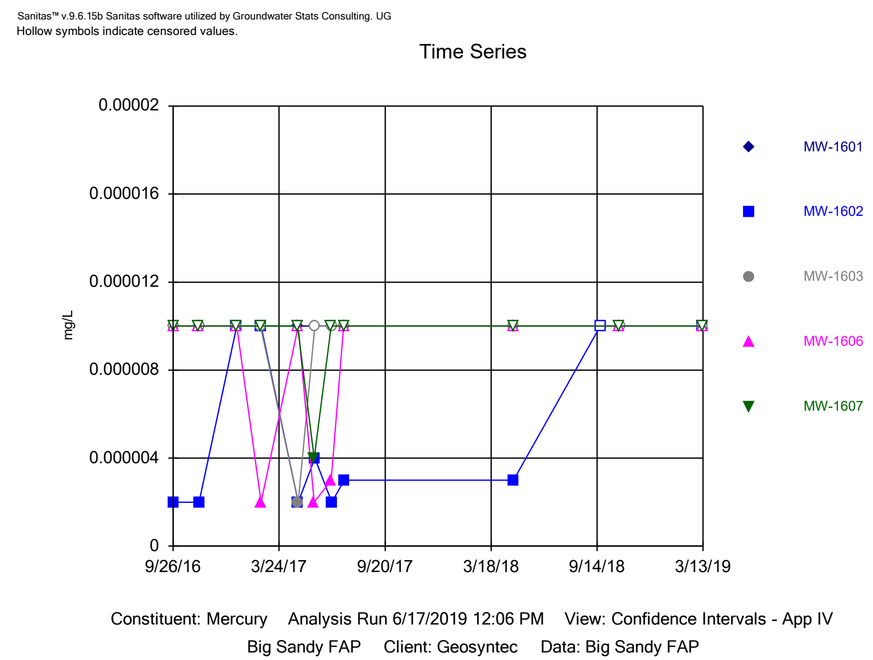


Constituent: Lead Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

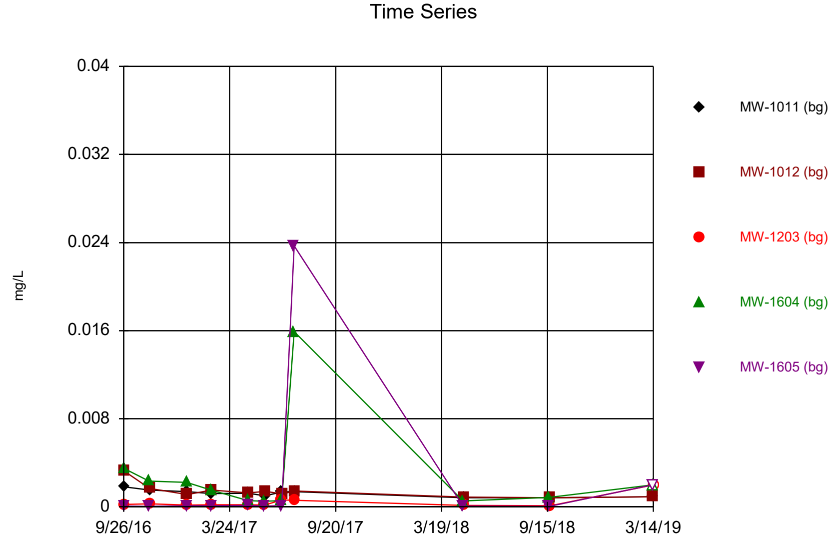

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.
Time Series
mg/L
0.3
0.24
0.18
0.12
0.06
0
9/26/16
3/24/17
9/20/17
3/19/18
9/15/18
3/14/19
MW-1011 (bg)
MW-1012 (bg)
MW-1203 (bg)
MW-1604 (bg)
MW-1605 (bg)
Constituent: Lithium Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.
Time Series
mg/L
0.3
0.24
0.18
0.12
0.06
0
9/26/16
3/24/17
9/20/17
3/18/18
9/14/18
3/13/19
MW-1601
MW-1602
MW-1603
MW-1606
MW-1607
Constituent: Lithium Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.
Time Series
mg/L
0.00002
0.000016
0.000012
0.000008
0.000004
0
9/26/16
3/24/17
9/20/17
3/19/18
9/15/18
3/14/19
MW-1011 (bg)
MW-1012 (bg)
MW-1203 (bg)
MW-1604 (bg)
MW-1605 (bg)
Constituent: Mercury Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

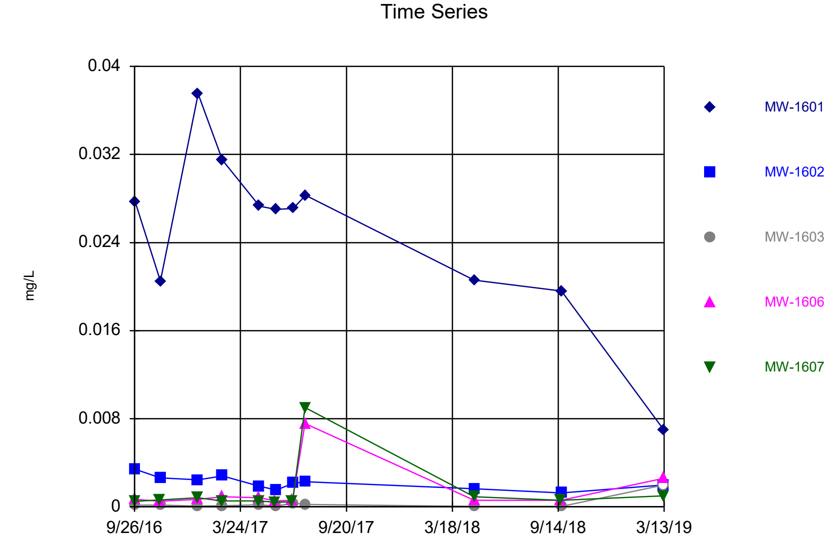

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.
Time Series
mg/L
0.00002
0.000016
0.000012
0.000008
0.000004
0
9/26/16
3/24/17
9/20/17
3/18/18
9/14/18
3/13/19
MW-1601
MW-1602
MW-1603
MW-1606
MW-1607
Constituent: Mercury Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



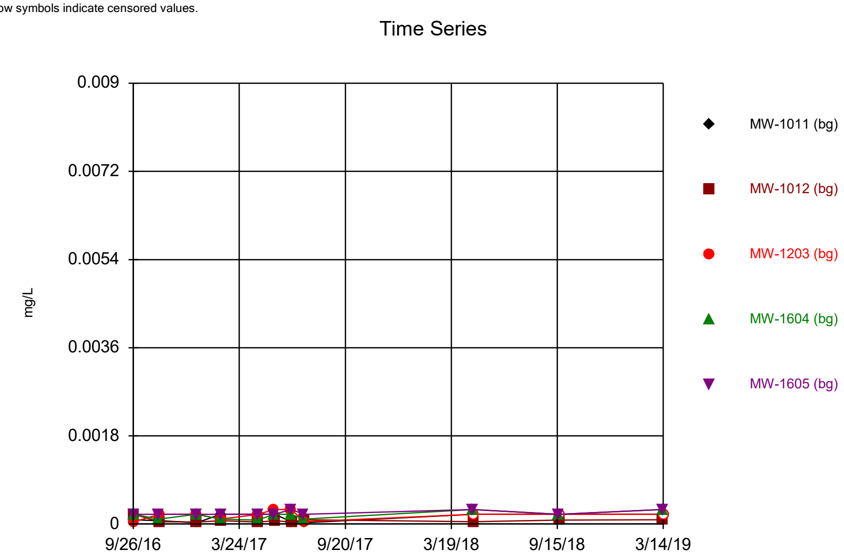
Constituent: Molybdenum Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



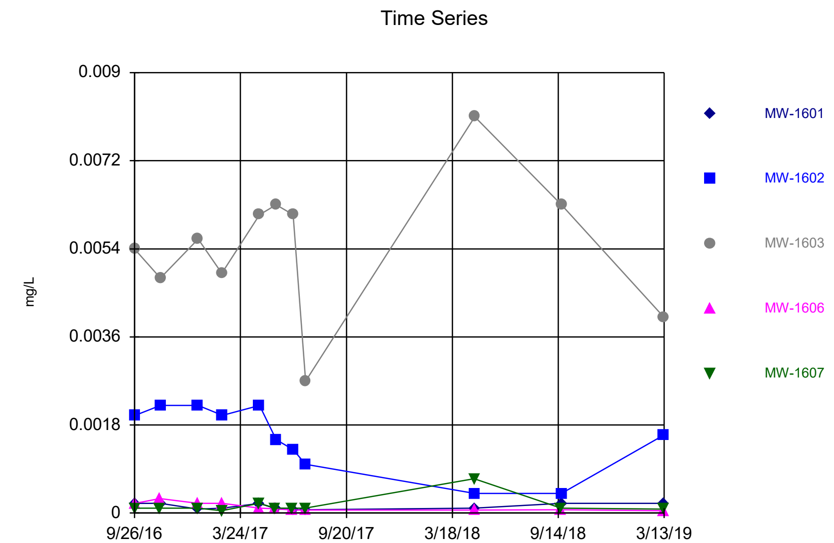
Constituent: Molybdenum Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



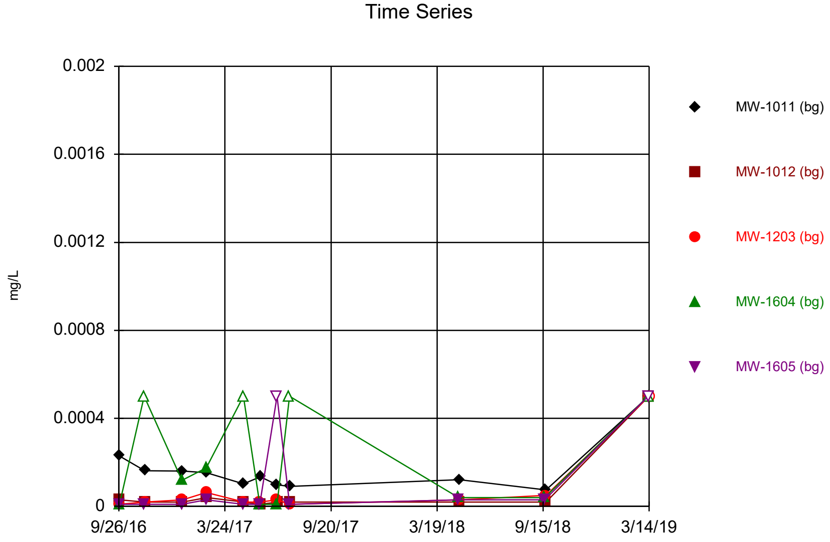
Constituent: Selenium Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG



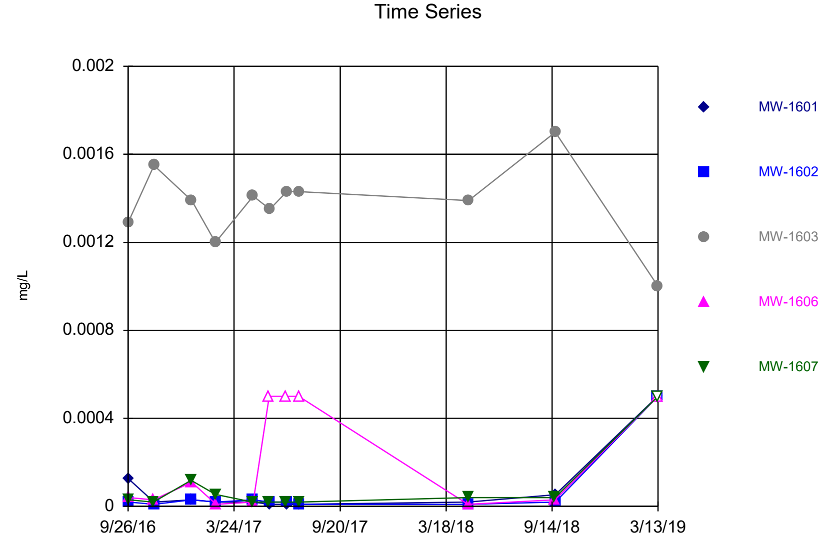
Constituent: Selenium Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Thallium Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.15b Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



Constituent: Thallium Analysis Run 6/17/2019 12:06 PM View: Confidence Intervals - App IV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Outlier Summary

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 7/3/2019, 9:31 AM

	MW-1607 Antimony (mg/L)	MW-1012 Chromium (mg/L)	MW-1604 Combined Radium 226 + 228 (pCi/L)
1/11/2017	6E-05 (o)		
5/24/2017		0.00784 (o)	
6/21/2017			16.848 (o)

Interwell Prediction Limit Summary - Significant Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 6/30/2019, 6:22 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron (mg/L)	**MW-1606**	**0.2194**	**n/a**	**3/13/2019**	**1.93**	**Yes**	**55**	**0.09856**	**0.06523**	**1.818**	**None**	**No**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	**MW-1601**	**8.492**	**n/a**	**3/12/2019**	**9.09**	**Yes**	**55**	**0.7122**	**0.7705**	**0**	**None**	**ln(x)**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	**MW-1602**	**8.492**	**n/a**	**3/13/2019**	**12.6**	**Yes**	**55**	**0.7122**	**0.7705**	**0**	**None**	**ln(x)**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	**MW-1606**	**8.492**	**n/a**	**3/13/2019**	**31.7**	**Yes**	**55**	**0.7122**	**0.7705**	**0**	**None**	**ln(x)**	**0.001504**	**Param Inter 1 of 2**
Fluoride (mg/L)	**MW-1603**	**0.8843**	**n/a**	**3/13/2019**	**0.92**	**Yes**	**54**	**-2.368**	**1.211**	**16.67**	**Kaplan-Meier**	**ln(x)**	**0.001504**	**Param Inter 1 of 2**
Sulfate (mg/L)	**MW-1602**	**106**	**n/a**	**3/13/2019**	**133**	**Yes**	**55**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0006329**	**NP Inter (normality) 1 of 2**
Sulfate (mg/L)	**MW-1603**	**106**	**n/a**	**3/13/2019**	**709**	**Yes**	**55**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0006329**	**NP Inter (normality) 1 of 2**
Sulfate (mg/L)	**MW-1607**	**106**	**n/a**	**3/13/2019**	**135**	**Yes**	**55**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0006329**	**NP Inter (normality) 1 of 2**
Total Dissolved Solids (mg/L)	**MW-1603**	**572**	**n/a**	**3/13/2019**	**896**	**Yes**	**55**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0006329**	**NP Inter (normality) 1 of 2**

Interwell Prediction Limit Summary - All Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 6/30/2019, 6:22 PM

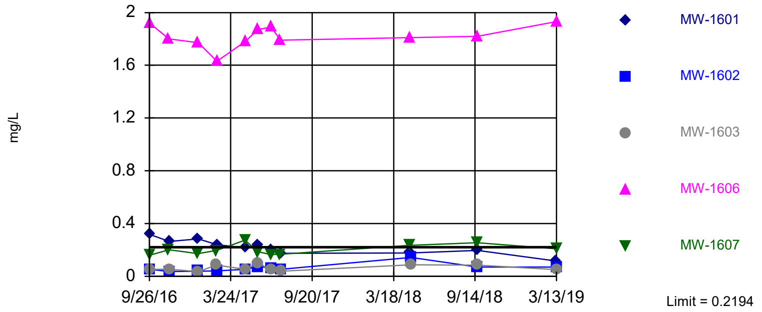
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron (mg/L)	MW-1601	0.2194	n/a	3/12/2019	0.117	No	55	0.09856	0.06523	1.818	None	No	0.001504	Param Inter 1 of 2
Boron (mg/L)	MW-1602	0.2194	n/a	3/13/2019	0.07	No	55	0.09856	0.06523	1.818	None	No	0.001504	Param Inter 1 of 2
Boron (mg/L)	MW-1603	0.2194	n/a	3/13/2019	0.05	No	55	0.09856	0.06523	1.818	None	No	0.001504	Param Inter 1 of 2
Boron (mg/L)	**MW-1606**	**0.2194**	**n/a**	**3/13/2019**	**1.93**	**Yes**	**55**	**0.09856**	**0.06523**	**1.818**	**None**	**No**	**0.001504**	**Param Inter 1 of 2**
Boron (mg/L)	MW-1607	0.2194	n/a	3/13/2019	0.209	No	55	0.09856	0.06523	1.818	None	No	0.001504	Param Inter 1 of 2
Calcium (mg/L)	MW-1601	105	n/a	3/12/2019	54.3	No	55	n/a	n/a	0	n/a	n/a	0.0006329	NP Inter (normality) 1 of 2
Calcium (mg/L)	MW-1602	105	n/a	3/13/2019	79.4	No	55	n/a	n/a	0	n/a	n/a	0.0006329	NP Inter (normality) 1 of 2
Calcium (mg/L)	MW-1603	105	n/a	3/13/2019	84.6	No	55	n/a	n/a	0	n/a	n/a	0.0006329	NP Inter (normality) 1 of 2
Calcium (mg/L)	MW-1606	105	n/a	3/13/2019	74.2	No	55	n/a	n/a	0	n/a	n/a	0.0006329	NP Inter (normality) 1 of 2
Calcium (mg/L)	MW-1607	105	n/a	3/13/2019	93.7	No	55	n/a	n/a	0	n/a	n/a	0.0006329	NP Inter (normality) 1 of 2
Chloride (mg/L)	**MW-1601**	**8.492**	**n/a**	**3/12/2019**	**9.09**	**Yes**	**55**	**0.7122**	**0.7705**	**0**	**None**	**ln(x)**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	**MW-1602**	**8.492**	**n/a**	**3/13/2019**	**12.6**	**Yes**	**55**	**0.7122**	**0.7705**	**0**	**None**	**ln(x)**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	MW-1603	8.492	n/a	3/13/2019	4.42	No	55	0.7122	0.7705	0	None	ln(x)	0.001504	Param Inter 1 of 2
Chloride (mg/L)	**MW-1606**	**8.492**	**n/a**	**3/13/2019**	**31.7**	**Yes**	**55**	**0.7122**	**0.7705**	**0**	**None**	**ln(x)**	**0.001504**	**Param Inter 1 of 2**
Chloride (mg/L)	MW-1607	8.492	n/a	3/13/2019	5.17	No	55	0.7122	0.7705	0	None	ln(x)	0.001504	Param Inter 1 of 2
Fluoride (mg/L)	MW-1601	0.8843	n/a	3/12/2019	0.18	No	54	-2.368	1.211	16.67	Kaplan-Meier	ln(x)	0.001504	Param Inter 1 of 2
Fluoride (mg/L)	MW-1602	0.8843	n/a	3/13/2019	0.1	No	54	-2.368	1.211	16.67	Kaplan-Meier	ln(x)	0.001504	Param Inter 1 of 2
Fluoride (mg/L)	**MW-1603**	**0.8843**	**n/a**	**3/13/2019**	**0.92**	**Yes**	**54**	**-2.368**	**1.211**	**16.67**	**Kaplan-Meier**	**ln(x)**	**0.001504**	**Param Inter 1 of 2**
Fluoride (mg/L)	MW-1606	0.8843	n/a	3/13/2019	0.22	No	54	-2.368	1.211	16.67	Kaplan-Meier	ln(x)	0.001504	Param Inter 1 of 2
Fluoride (mg/L)	MW-1607	0.8843	n/a	3/13/2019	0.06	No	54	-2.368	1.211	16.67	Kaplan-Meier	ln(x)	0.001504	Param Inter 1 of 2
Sulfate (mg/L)	MW-1601	106	n/a	3/12/2019	88.5	No	55	n/a	n/a	0	n/a	n/a	0.0006329	NP Inter (normality) 1 of 2
Sulfate (mg/L)	**MW-1602**	**106**	**n/a**	**3/13/2019**	**133**	**Yes**	**55**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0006329**	**NP Inter (normality) 1 of 2**
Sulfate (mg/L)	**MW-1603**	**106**	**n/a**	**3/13/2019**	**709**	**Yes**	**55**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0006329**	**NP Inter (normality) 1 of 2**
Sulfate (mg/L)	MW-1606	106	n/a	3/13/2019	58.8	No	55	n/a	n/a	0	n/a	n/a	0.0006329	NP Inter (normality) 1 of 2
Sulfate (mg/L)	**MW-1607**	**106**	**n/a**	**3/13/2019**	**135**	**Yes**	**55**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0006329**	**NP Inter (normality) 1 of 2**
Total Dissolved Solids (mg/L)	MW-1601	572	n/a	3/13/2019	316	No	55	n/a	n/a	0	n/a	n/a	0.0006329	NP Inter (normality) 1 of 2
Total Dissolved Solids (mg/L)	MW-1602	572	n/a	3/13/2019	444	No	55	n/a	n/a	0	n/a	n/a	0.0006329	NP Inter (normality) 1 of 2
Total Dissolved Solids (mg/L)	**MW-1603**	**572**	**n/a**	**3/13/2019**	**896**	**Yes**	**55**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.0006329**	**NP Inter (normality) 1 of 2**
Total Dissolved Solids (mg/L)	MW-1606	572	n/a	3/13/2019	389	No	55	n/a	n/a	0	n/a	n/a	0.0006329	NP Inter (normality) 1 of 2
Total Dissolved Solids (mg/L)	MW-1607	572	n/a	3/13/2019	415	No	55	n/a	n/a	0	n/a	n/a	0.0006329	NP Inter (normality) 1 of 2

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: MW-1606

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=0.09856, Std. Dev.=0.06523, n=55, 1.818% NDs. Normality test: Shapiro Francia @alpha = 0.01, calculated = 0.9667, critical = 0.94. Kappa = 1.852 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001504. Comparing 5 points to limit.

Constituent: Boron Analysis Run 6/30/2019 6:18 PM View: PL's - Interwell

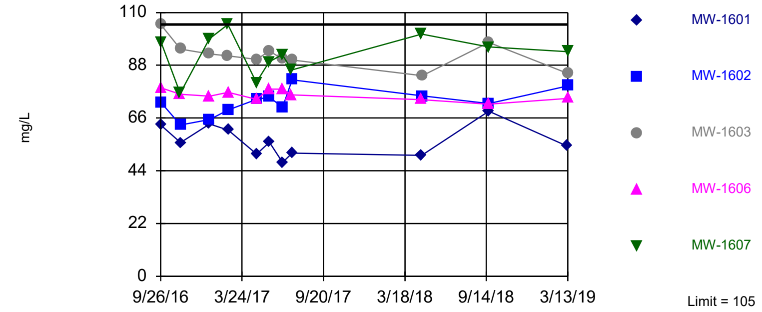
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limit

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 55 background values. Annual per-constituent alpha = 0.006311. Individual comparison alpha = 0.0006329 (1 of 2). Comparing 5 points to limit.

Constituent: Calcium Analysis Run 6/30/2019 6:18 PM View: PL's - Interwell

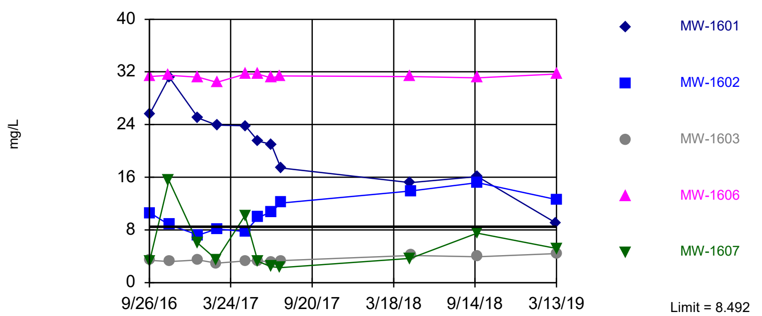
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: MW-1601, MW-1602, MW-1606

Prediction Limit

Interwell Parametric



Background Data Summary (based on natural log transformation): Mean=0.7122, Std. Dev.=0.7705, n=55. Normality test: Shapiro Francia @alpha = 0.01, calculated = 0.945, critical = 0.94. Kappa = 1.852 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001504. Comparing 5 points to limit.

Constituent: Chloride Analysis Run 6/30/2019 6:18 PM View: PL's - Interwell

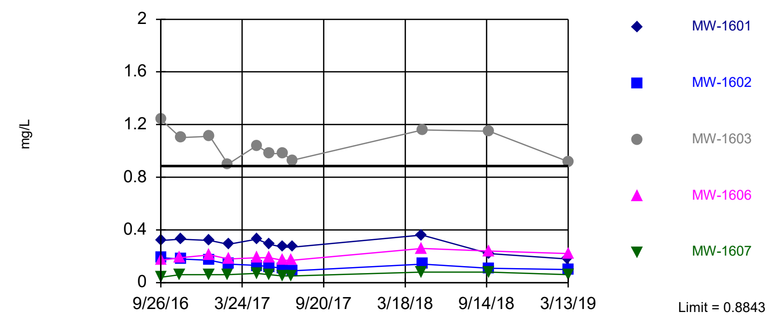
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limit: MW-1603

Prediction Limit

Interwell Parametric



Background Data Summary (based on natural log transformation) (after Kaplan-Meier Adjustment): Mean=-2.368, Std. Dev.=1.211, n=54, 16.67% NDs. Normality test: Shapiro Francia @alpha = 0.01, calculated = 0.9419, critical = 0.939. Kappa = 1.854 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.001504. Comparing 5 points to limit.

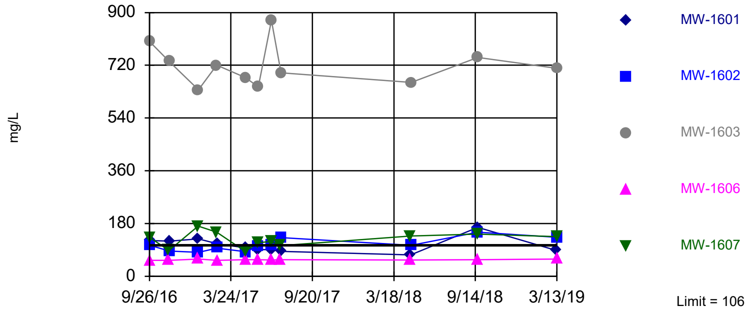
Constituent: Fluoride Analysis Run 6/30/2019 6:18 PM View: PL's - Interwell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Exceeds Limit: MW-1602, MW-1603, MW-1607

Prediction Limit

Interwell Non-parametric



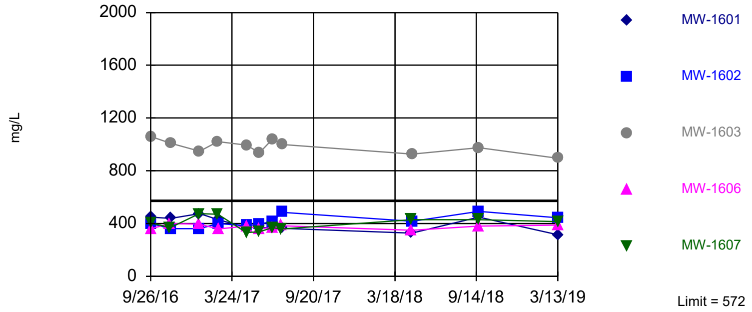
Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 55 background values. Annual per-constituent alpha = 0.006311. Individual comparison alpha = 0.0006329 (1 of 2). Comparing 5 points to limit.

Constituent: Sulfate Analysis Run 6/30/2019 6:18 PM View: PL's - Interwell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Exceeds Limit: MW-1603

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Francia normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 55 background values. Annual per-constituent alpha = 0.006311. Individual comparison alpha = 0.0006329 (1 of 2). Comparing 5 points to limit.

Constituent: Total Dissolved Solids Analysis Run 6/30/2019 6:18 PM View: PL's - Interwell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Intrawell Prediction Limit Summary - Significant Results

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 6/30/2019, 6:25 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH (SU)	**MW-1601**	**7.94**	**6.59**	**3/12/2019**	**6.25**	**Yes**	**8**	**7.265**	**0.2465**	**0**	**None**	**No**	**0.000752**	Param 1 of 2

Intrawell Prediction Limit Summary - All Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 6/30/2019, 6:25 PM

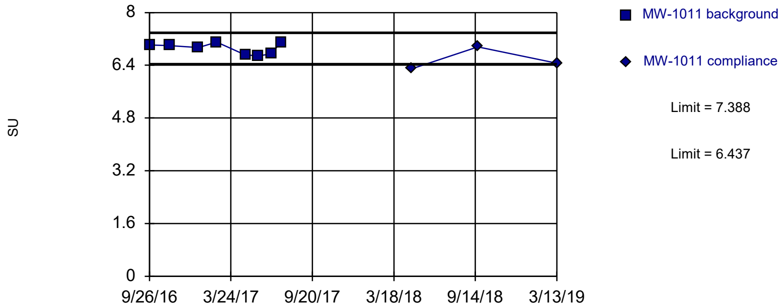
Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH (SU)	MW-1011	7.388	6.437	3/13/2019	6.46	No	8	6.913	0.1734	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1012	9.616	8.347	3/13/2019	8.75	No	8	8.981	0.2315	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1203	8.004	5.786	3/14/2019	6.2	No	8	6.895	0.4046	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1604	8.915	2.64	3/12/2019	5.15	No	8	5.778	1.145	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1605	6.564	1.095	3/12/2019	4.3	No	8	22.14	7.644	0	None	x^2	0.000752	Param 1 of 2
pH (SU)	**MW-1601**	**7.94**	**6.59**	**3/12/2019**	**6.25**	**Yes**	**8**	**7.265**	**0.2465**	**0**	**None**	**No**	**0.000752**	Param 1 of 2
pH (SU)	MW-1602	8.5	6.23	3/13/2019	6.94	No	8	7.365	0.4143	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1603	6.228	1.497	3/13/2019	3.19	No	8	3.863	0.8632	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1606	7.883	6.04	3/13/2019	6.93	No	8	6.961	0.3363	0	None	No	0.000752	Param 1 of 2
pH (SU)	MW-1607	7.383	5.349	3/13/2019	6.07	No	8	6.366	0.3713	0	None	No	0.000752	Param 1 of 2

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.913, Std. Dev.=0.1734, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8526, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 6/30/2019 6:23 PM View: PL's - Intrawell

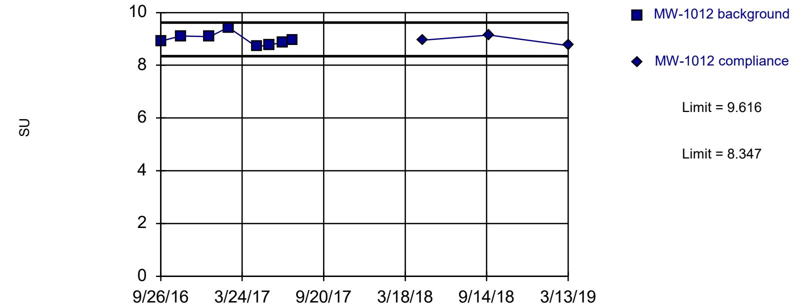
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=8.981, Std. Dev.=0.2315, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9365, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 6/30/2019 6:23 PM View: PL's - Intrawell

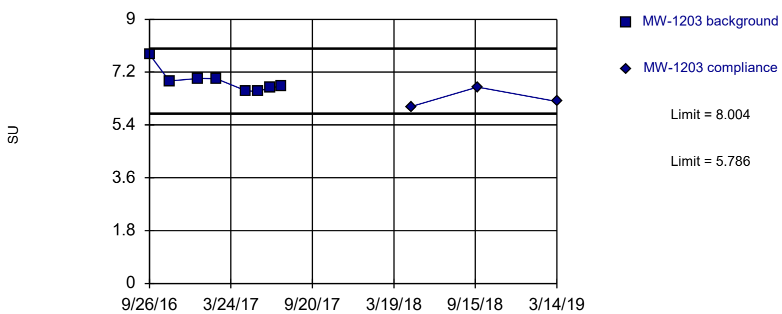
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.895, Std. Dev.=0.4046, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7987, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 6/30/2019 6:23 PM View: PL's - Intrawell

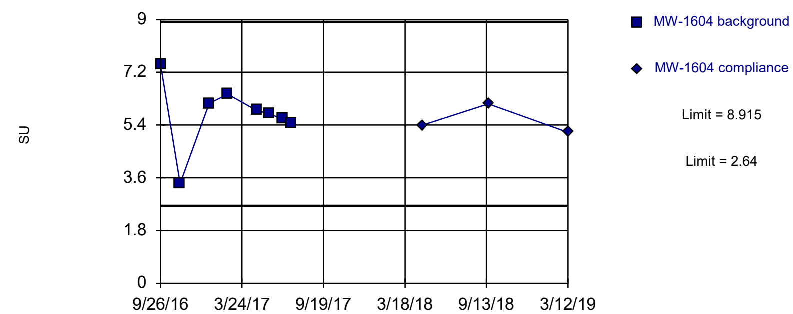
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=5.778, Std. Dev.=1.145, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8966, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 6/30/2019 6:23 PM View: PL's - Intrawell

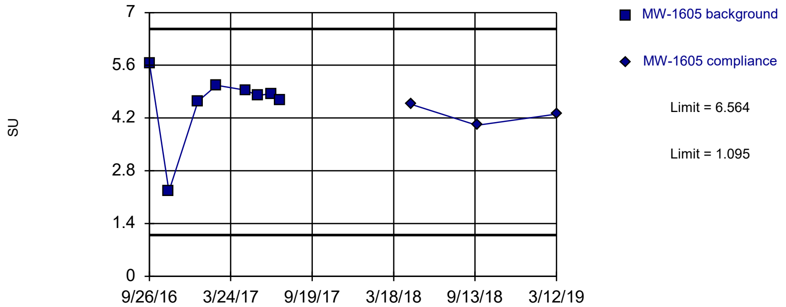
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary (based on square transformation): Mean=22.14, Std. Dev.=7.644, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8006, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 6/30/2019 6:23 PM View: PL's - Intrawell

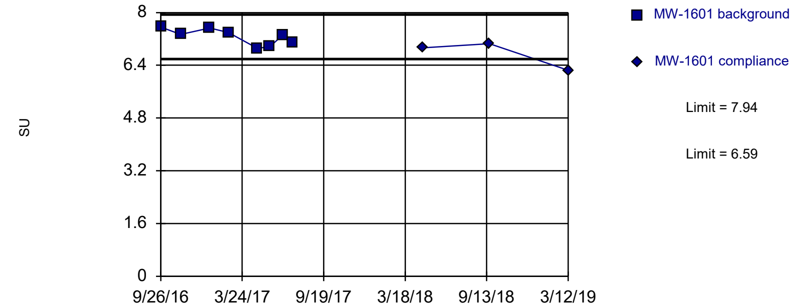
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Exceeds Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=7.265, Std. Dev.=0.2465, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9052, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 6/30/2019 6:23 PM View: PL's - Intrawell

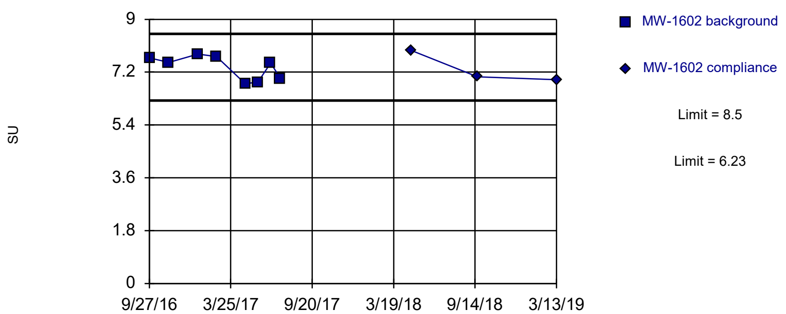
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=7.365, Std. Dev.=0.4143, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8508, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 6/30/2019 6:23 PM View: PL's - Intrawell

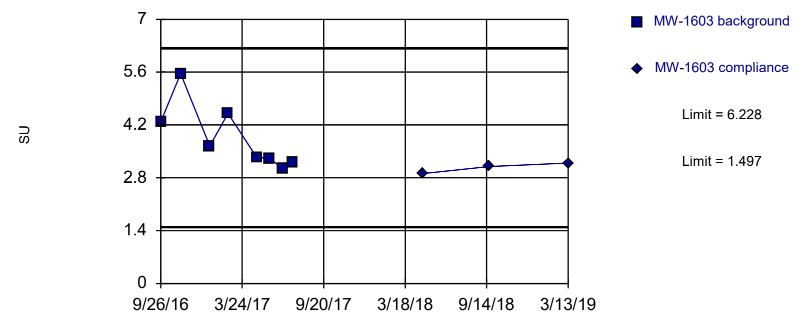
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.863, Std. Dev.=0.8632, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8662, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 6/30/2019 6:23 PM View: PL's - Intrawell

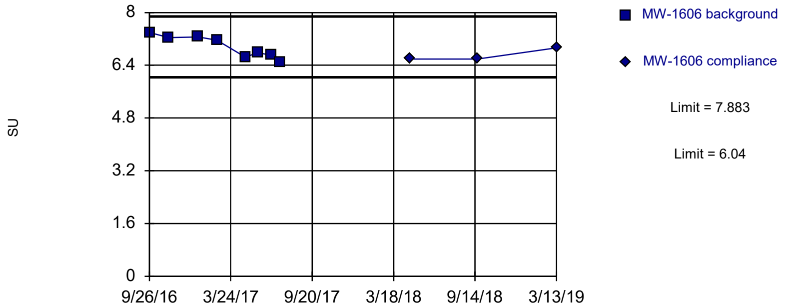
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.961, Std. Dev.=0.3363, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8932, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

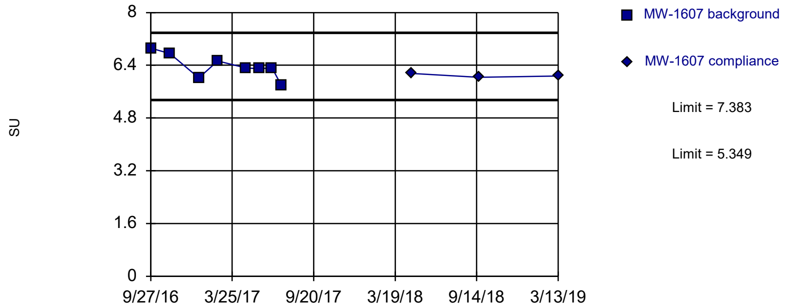
Constituent: pH Analysis Run 6/30/2019 6:23 PM View: PL's - Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=6.366, Std. Dev.=0.3713, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9693, critical = 0.749. Kappa = 2.74 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504.

Constituent: pH Analysis Run 6/30/2019 6:23 PM View: PL's - Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Trend Test Summary Table - Significant Results

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 7/3/2019, 9:39 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Chloride (mg/L)	**MW-1604 (bg)**	**-1.955**	**-41**	**-34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride (mg/L)	**MW-1601**	**-7.36**	**-51**	**-34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Fluoride (mg/L)	**MW-1604 (bg)**	**-0.1236**	**-39**	**-34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Total Dissolved Solids (mg/L)	**MW-1604 (bg)**	**-60.75**	**-39**	**-34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**

Trend Test Summary Table - All Results

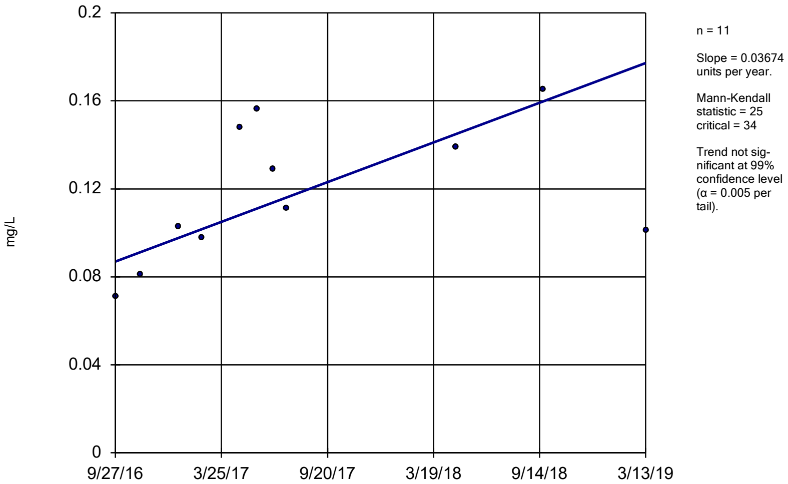
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 7/3/2019, 9:39 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron (mg/L)	MW-1011 (bg)	0.03674	25	34	No	11	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1012 (bg)	0.01282	21	34	No	11	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1203 (bg)	0.01181	11	34	No	11	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1604 (bg)	0.01023	15	34	No	11	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1605 (bg)	0.01417	20	34	No	11	9.091	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1606	0.02857	15	34	No	11	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1011 (bg)	0.3395	8	34	No	11	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1012 (bg)	0.02848	11	34	No	11	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1203 (bg)	-0.1765	-13	-34	No	11	0	n/a	n/a	0.01	NP
Chloride (mg/L)	**MW-1604 (bg)**	**-1.955**	**-41**	**-34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride (mg/L)	MW-1605 (bg)	0	1	34	No	11	0	n/a	n/a	0.01	NP
Chloride (mg/L)	**MW-1601**	**-7.36**	**-51**	**-34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride (mg/L)	MW-1602	3.131	33	34	No	11	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1606	0	2	34	No	11	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	MW-1011 (bg)	0.0146	13	34	No	11	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	MW-1012 (bg)	0.01109	9	34	No	11	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	MW-1203 (bg)	-0.01624	-27	-34	No	11	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	**MW-1604 (bg)**	**-0.1236**	**-39**	**-34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Fluoride (mg/L)	MW-1605 (bg)	0	-9	-30	No	10	90	n/a	n/a	0.01	NP
Fluoride (mg/L)	MW-1603	-0.06385	-14	-34	No	11	0	n/a	n/a	0.01	NP
pH (SU)	MW-1011 (bg)	-0.2276	-20	-34	No	11	0	n/a	n/a	0.01	NP
pH (SU)	MW-1012 (bg)	-0.06383	-5	-34	No	11	0	n/a	n/a	0.01	NP
pH (SU)	MW-1203 (bg)	-0.55	-31	-34	No	11	0	n/a	n/a	0.01	NP
pH (SU)	MW-1604 (bg)	-0.5915	-25	-34	No	11	0	n/a	n/a	0.01	NP
pH (SU)	MW-1605 (bg)	-0.3739	-23	-34	No	11	0	n/a	n/a	0.01	NP
pH (SU)	MW-1601	-0.3944	-33	-34	No	11	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1011 (bg)	2.408	13	34	No	11	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1012 (bg)	0	-2	-34	No	11	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1203 (bg)	3.442	25	34	No	11	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1604 (bg)	-0.2	-1	-34	No	11	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1605 (bg)	0.5	9	34	No	11	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1602	23.75	32	34	No	11	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1603	-10.26	-3	-34	No	11	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1607	6.066	5	34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1011 (bg)	16.04	16	34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1012 (bg)	8.902	22	34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1203 (bg)	-6.518	-17	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	**MW-1604 (bg)**	**-60.75**	**-39**	**-34**	**Yes**	**11**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Total Dissolved Solids (mg/L)	MW-1605 (bg)	-0.7557	-9	-34	No	11	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1603	-43.36	-27	-34	No	11	0	n/a	n/a	0.01	NP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

MW-1011 (bg)



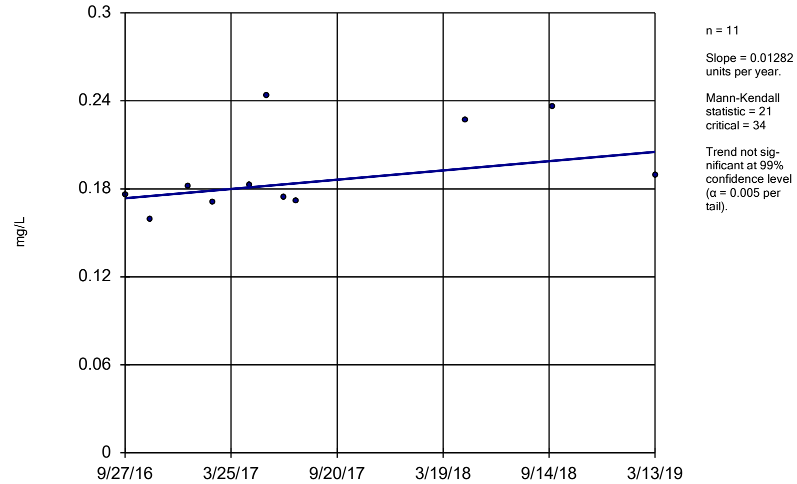
Constituent: Boron Analysis Run 7/3/2019 9:36 AM View: Trend Tests

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

MW-1012 (bg)



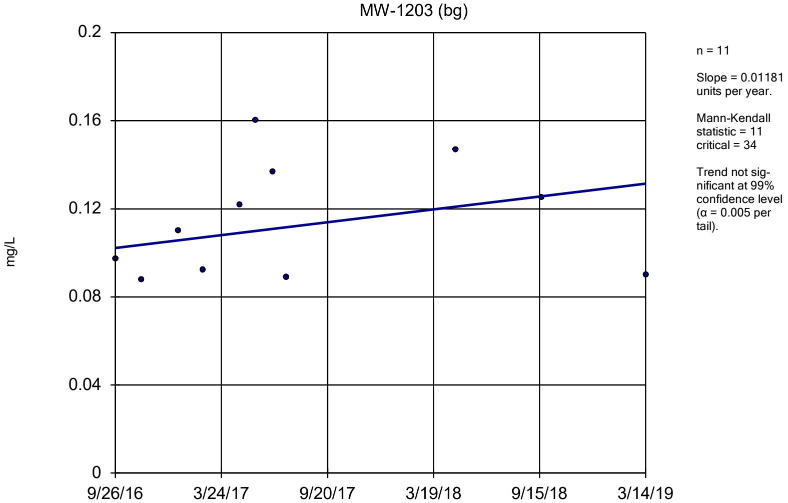
Constituent: Boron Analysis Run 7/3/2019 9:36 AM View: Trend Tests

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

MW-1203 (bg)



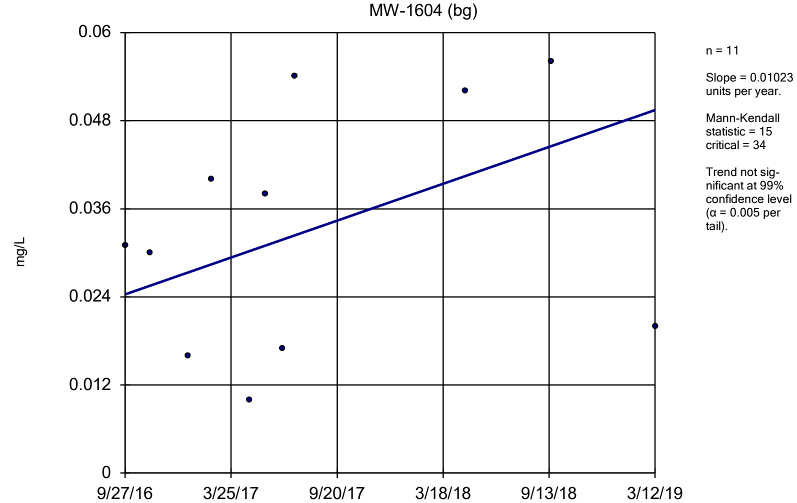
Constituent: Boron Analysis Run 7/3/2019 9:36 AM View: Trend Tests

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Sen's Slope Estimator

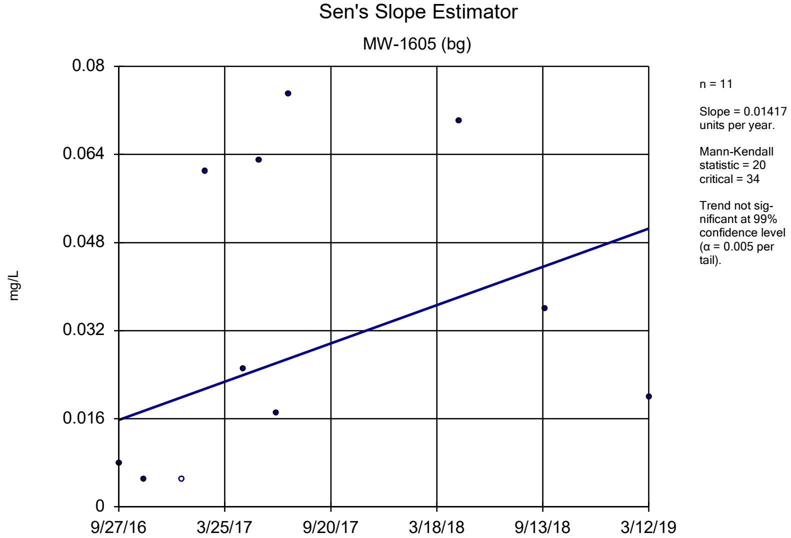
MW-1604 (bg)



Constituent: Boron Analysis Run 7/3/2019 9:36 AM View: Trend Tests

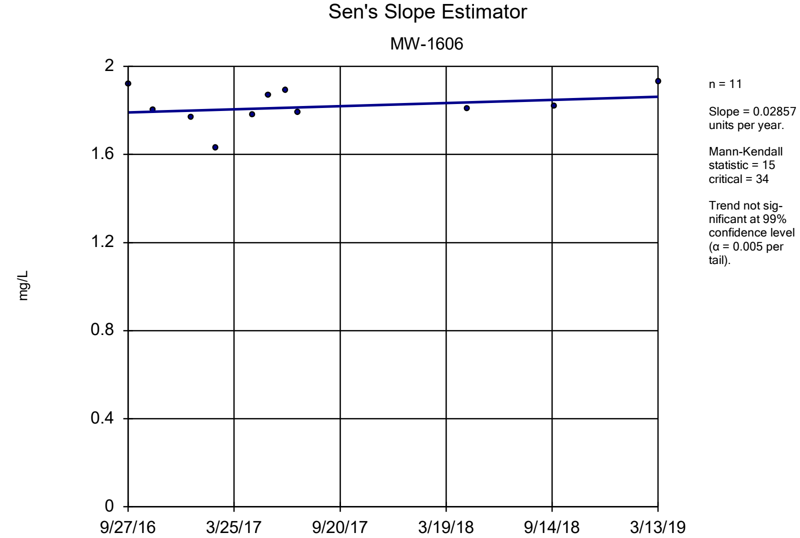
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



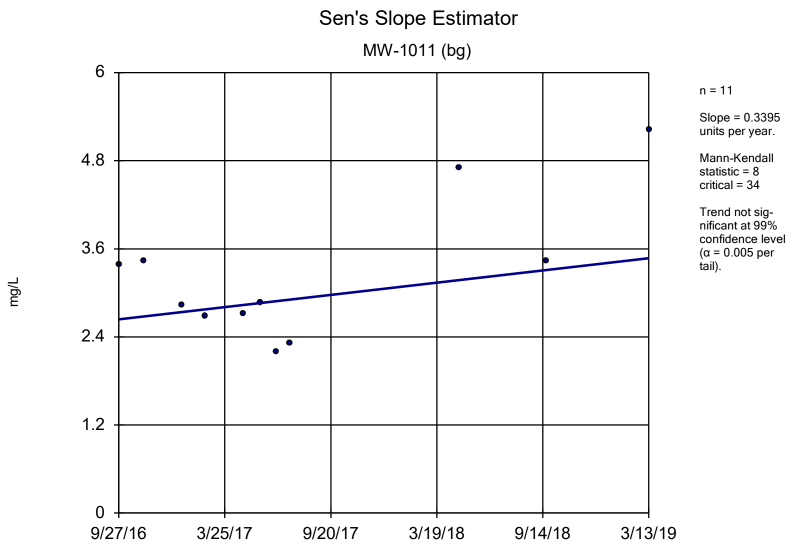
Constituent: Boron Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



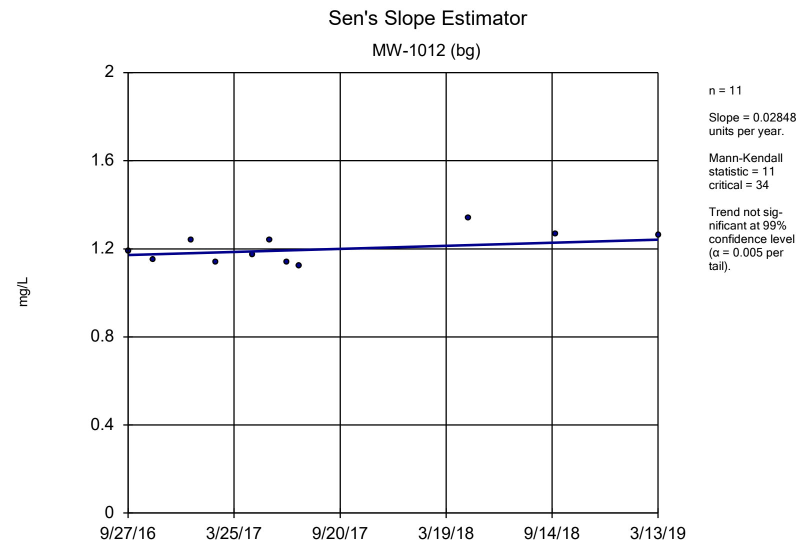
Constituent: Boron Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

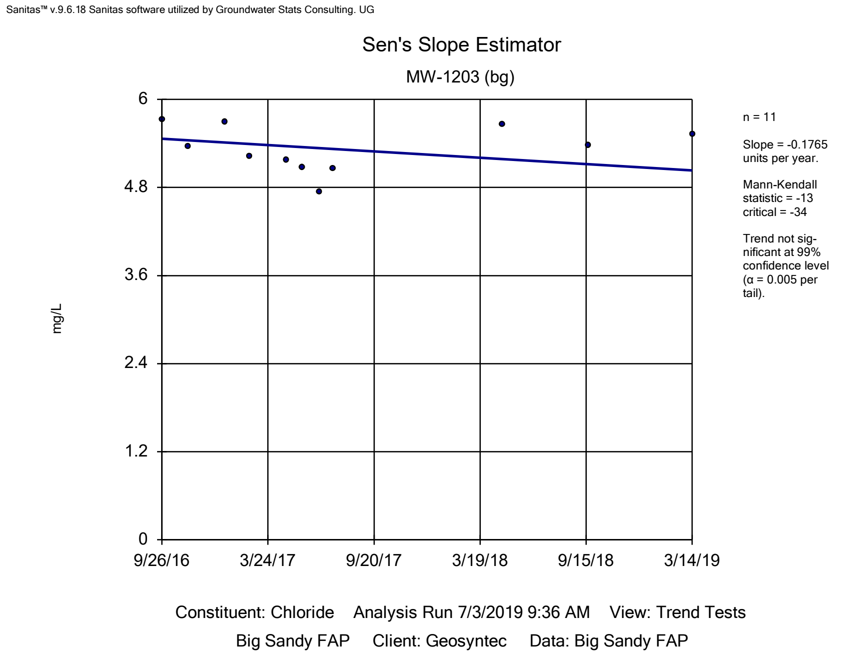


Constituent: Chloride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

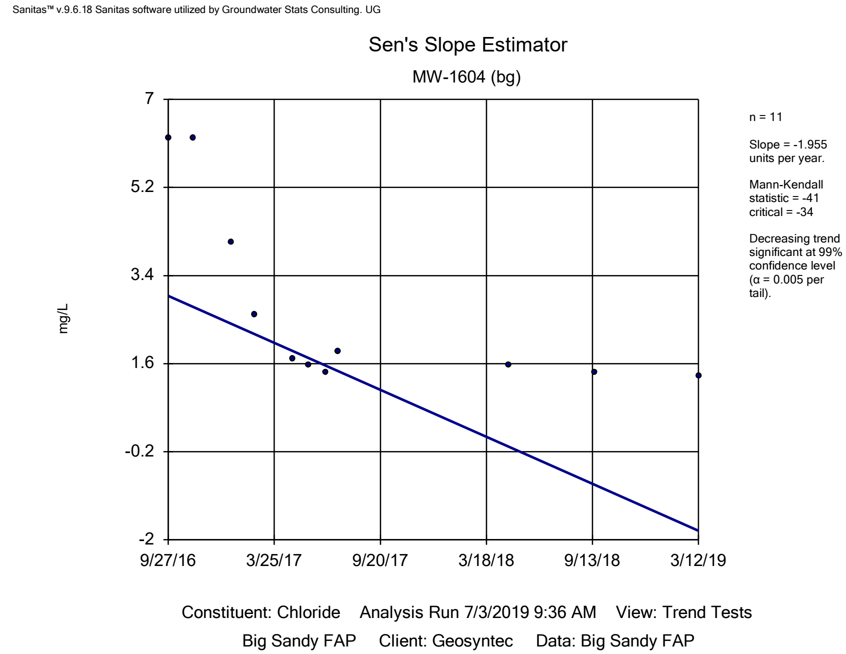
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



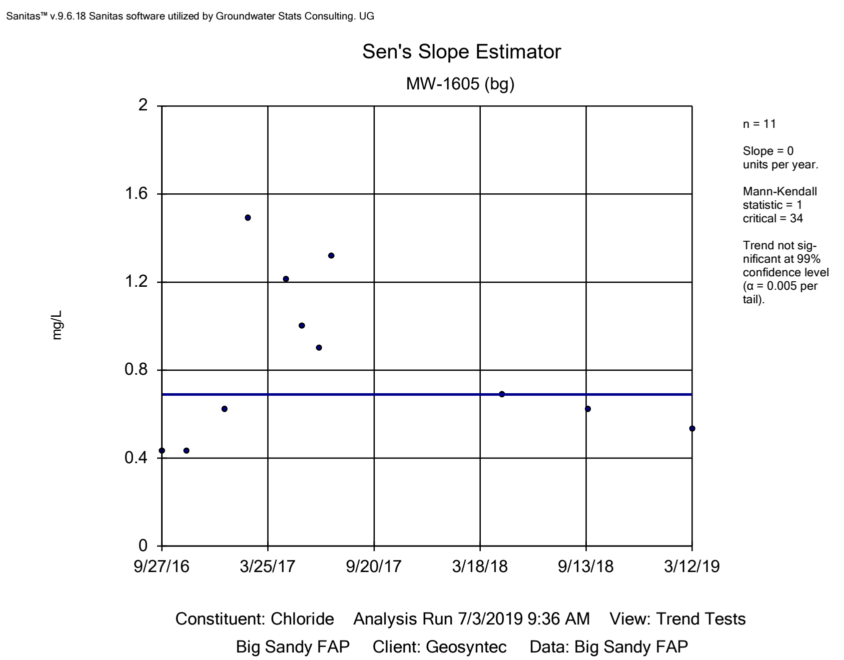
Constituent: Chloride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



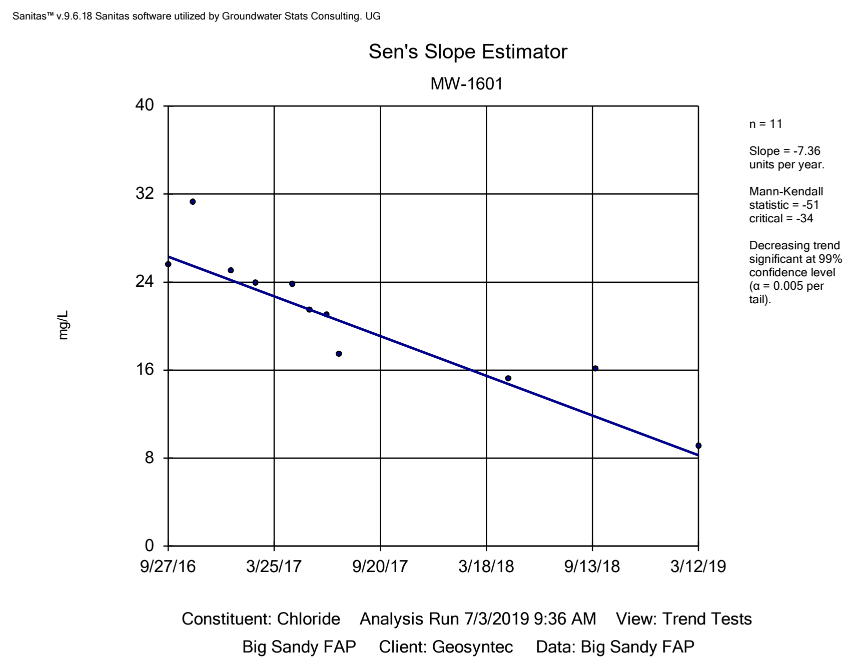
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1203 (bg)
mg/L
6
4.8
3.6
2.4
1.2
0
9/26/16
3/24/17
9/20/17
3/19/18
9/15/18
3/14/19
n = 11
Slope = -0.1765 units per year.
Mann-Kendall statistic = -13 critical = -34
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Chloride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1604 (bg)
mg/L
7
5.2
3.4
1.6
-0.2
-2
9/27/16
3/25/17
9/20/17
3/18/18
9/13/18
3/12/19
n = 11
Slope = -1.955 units per year.
Mann-Kendall statistic = -41 critical = -34
Decreasing trend significant at 99% confidence level (α = 0.005 per tail).
Constituent: Chloride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

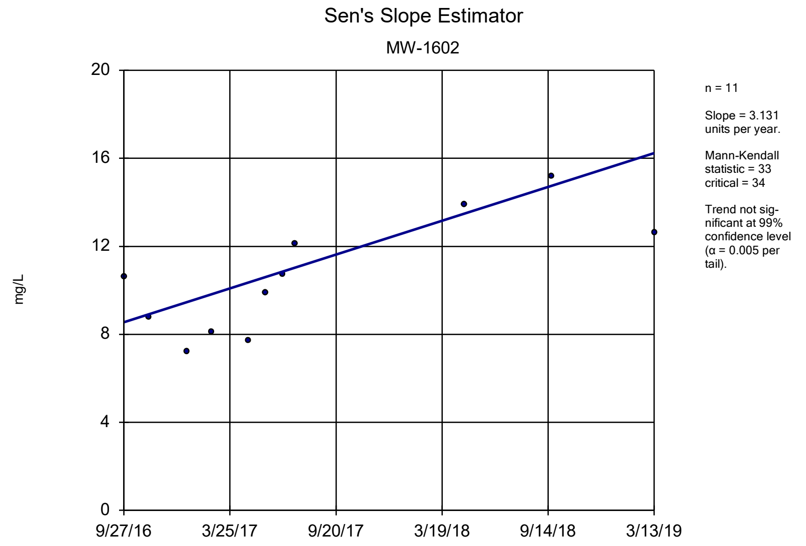


Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1605 (bg)
mg/L
2
1.6
1.2
0.8
0.4
0
9/27/16
3/25/17
9/20/17
3/18/18
9/13/18
3/12/19
n = 11
Slope = 0 units per year.
Mann-Kendall statistic = 1 critical = 34
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Chloride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



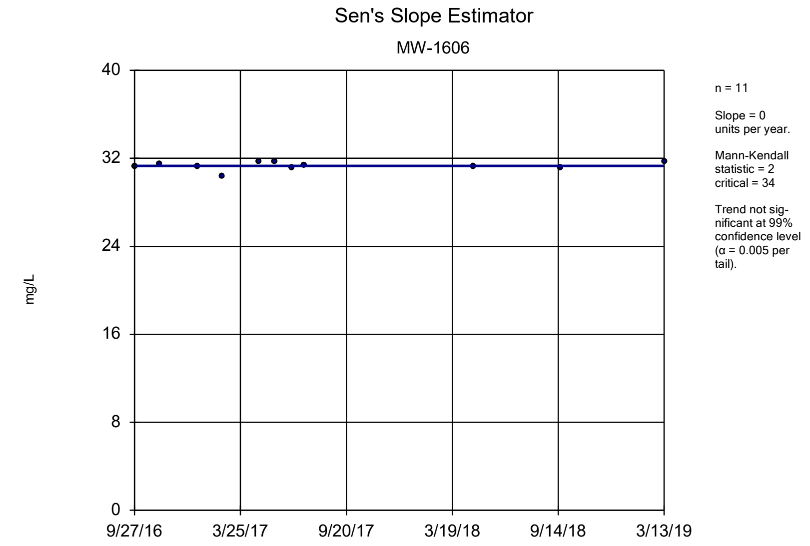
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1601
mg/L
40
32
24
16
8
0
9/27/16
3/25/17
9/20/17
3/18/18
9/13/18
3/12/19
n = 11
Slope = -7.36 units per year.
Mann-Kendall statistic = -51 critical = -34
Decreasing trend significant at 99% confidence level (α = 0.005 per tail).
Constituent: Chloride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



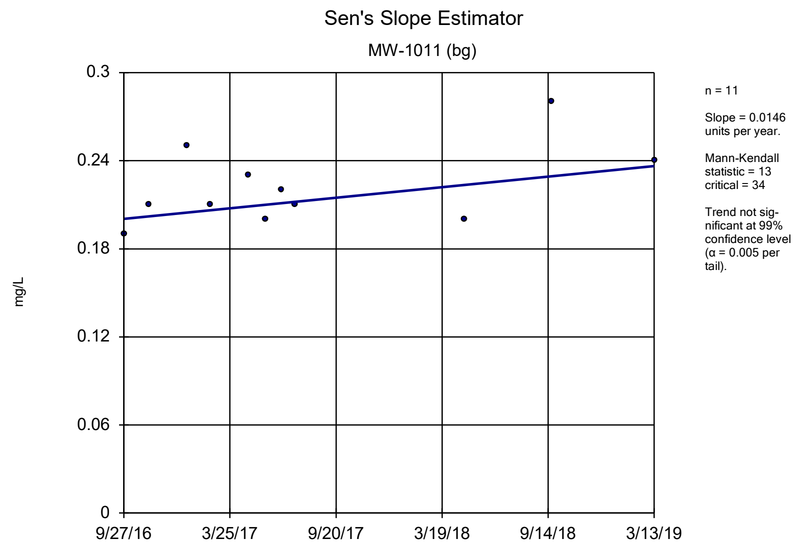
Constituent: Chloride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



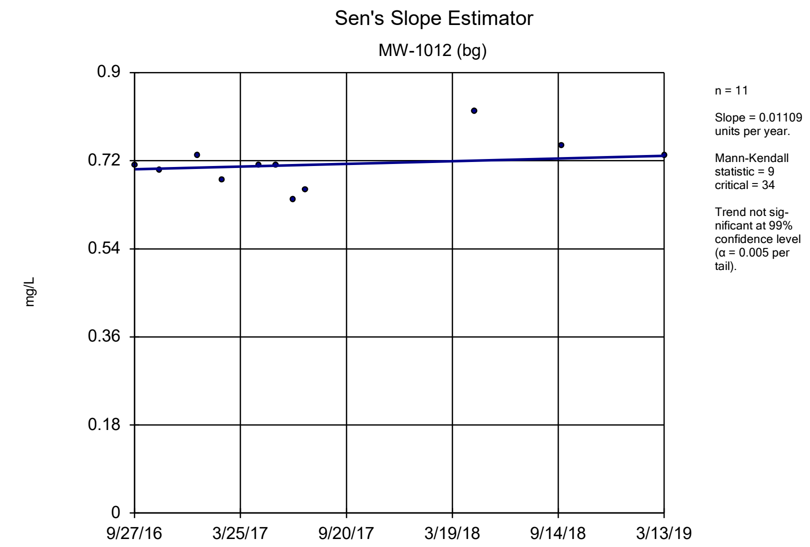
Constituent: Chloride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



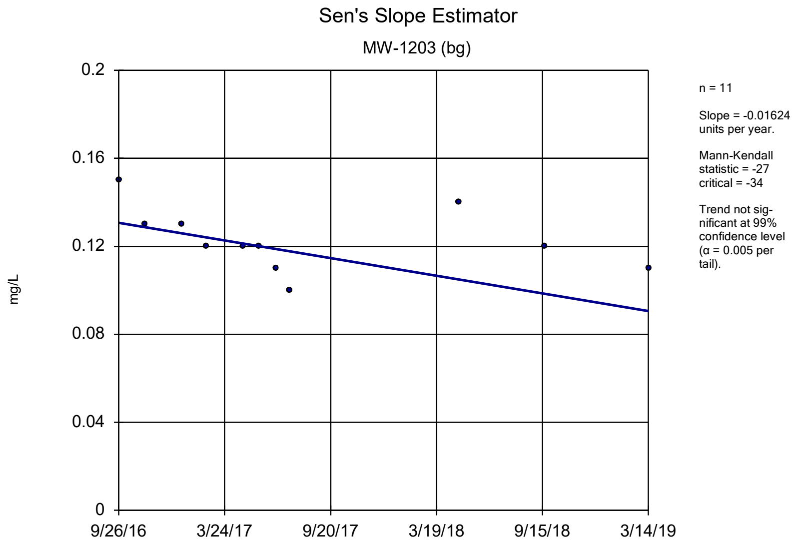
Constituent: Fluoride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



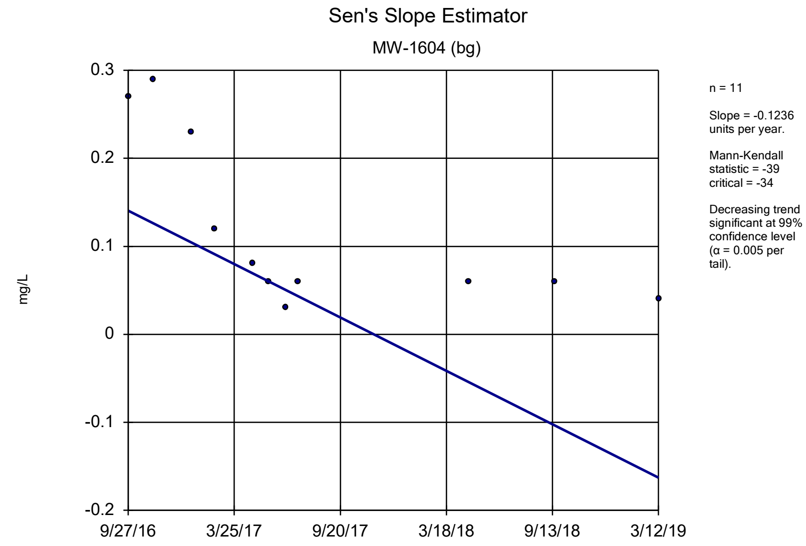
Constituent: Fluoride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



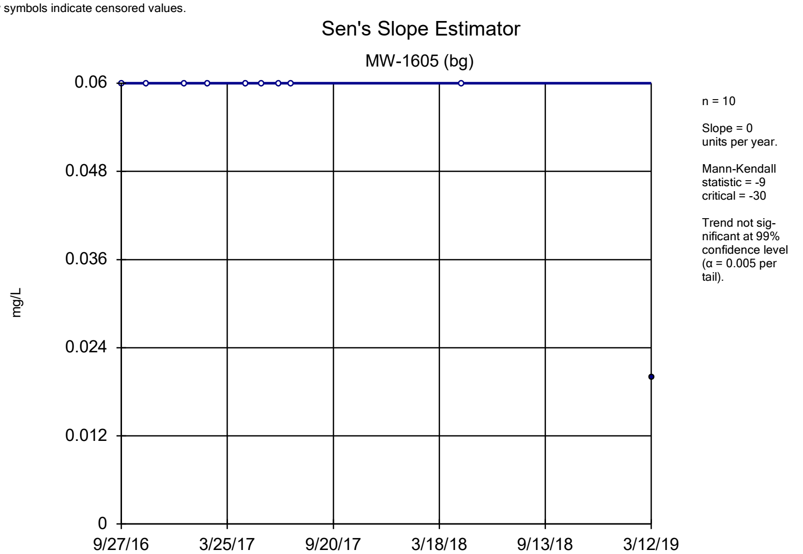
Constituent: Fluoride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



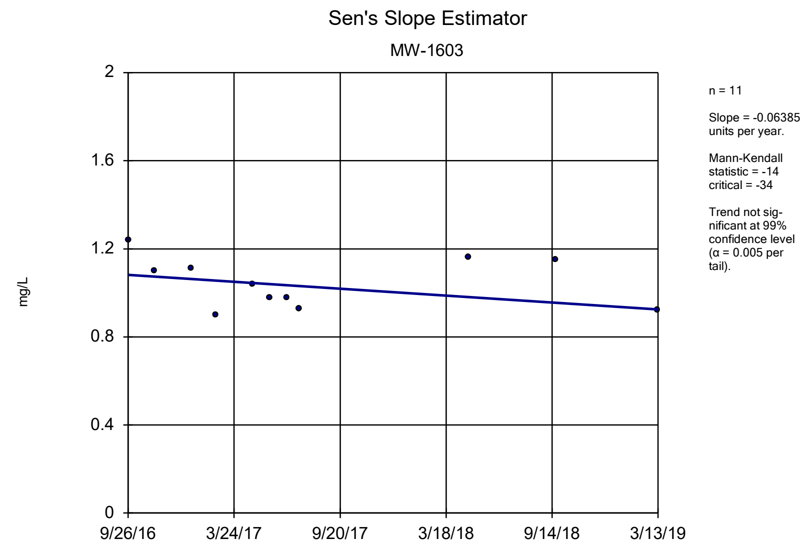
Constituent: Fluoride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

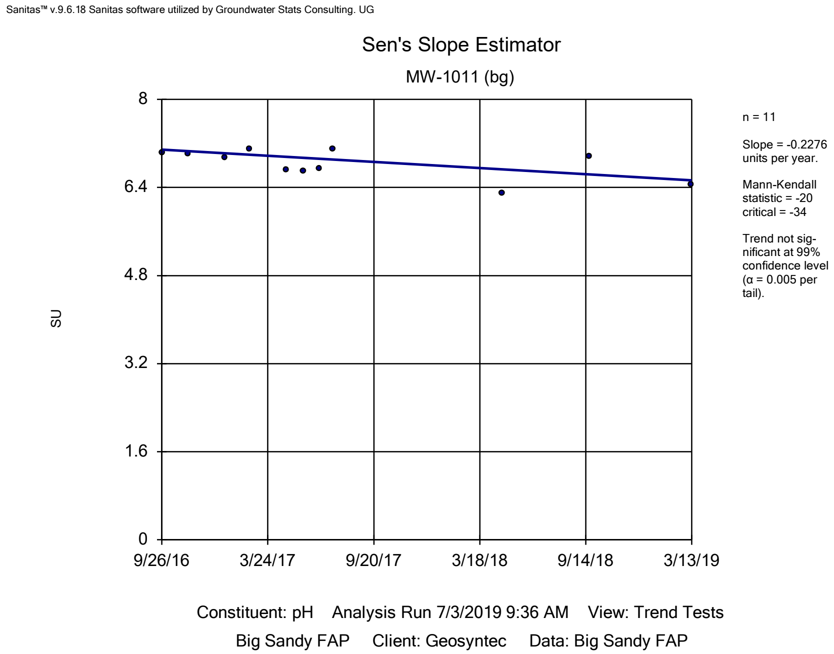


Constituent: Fluoride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

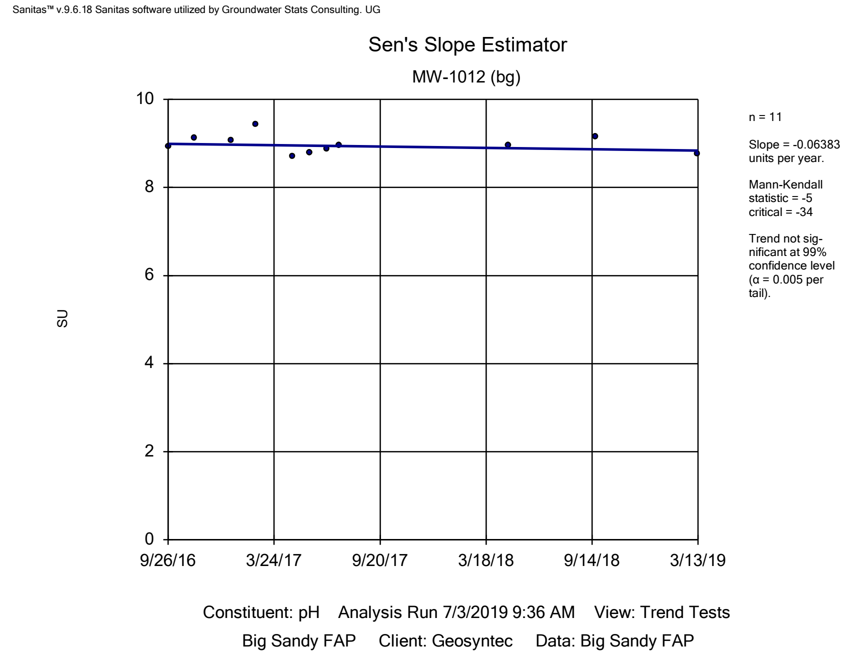
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



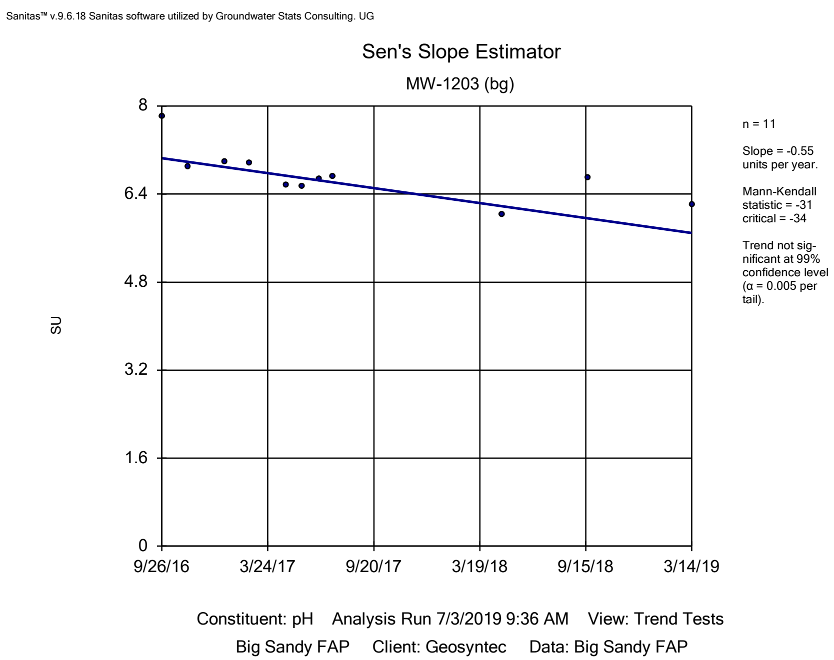
Constituent: Fluoride Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



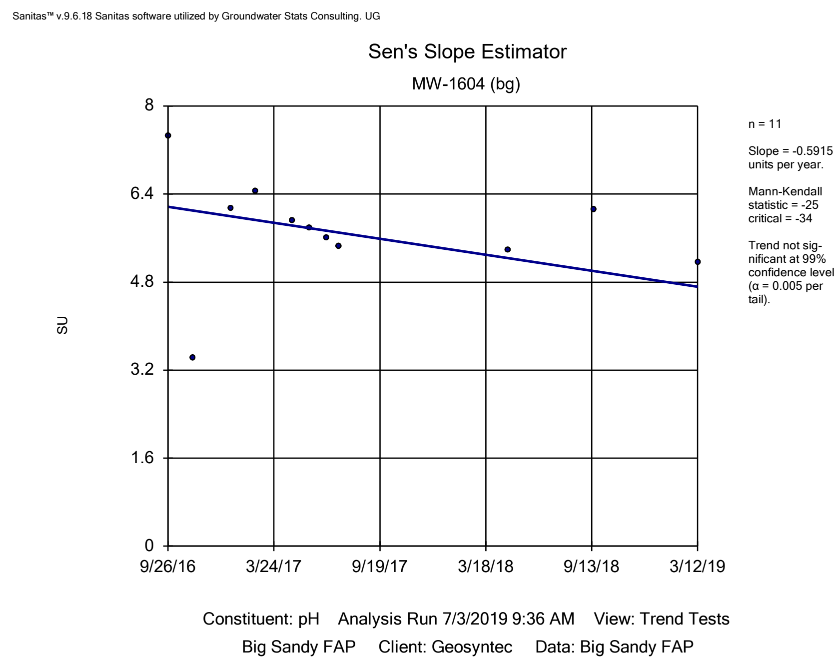
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1011 (bg)
SU
8
6.4
4.8
3.2
1.6
0
9/26/16
3/24/17
9/20/17
3/18/18
9/14/18
3/13/19
n = 11
Slope = -0.2276 units per year.
Mann-Kendall statistic = -20 critical = -34
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: pH Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



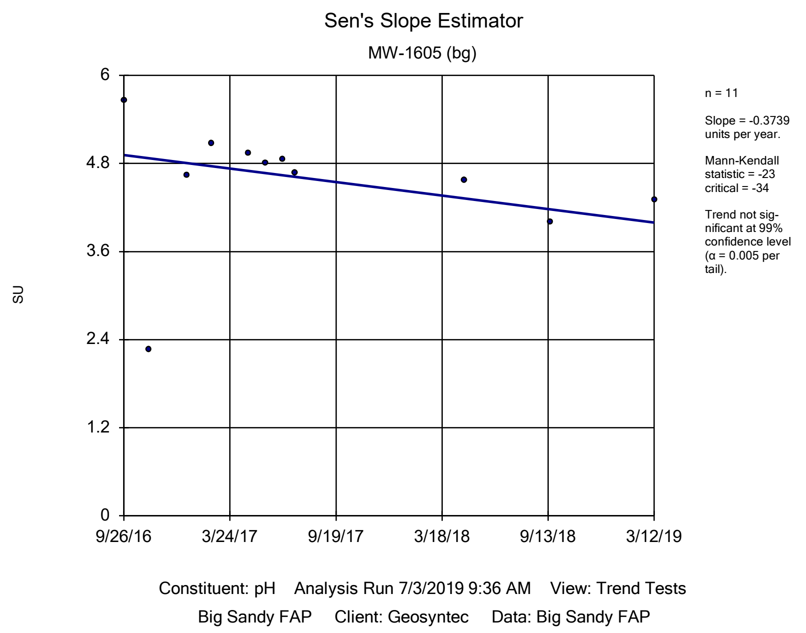
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1012 (bg)
SU
10
8
6
4
2
0
9/26/16
3/24/17
9/20/17
3/18/18
9/14/18
3/13/19
n = 11
Slope = -0.06383 units per year.
Mann-Kendall statistic = -5 critical = -34
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: pH Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



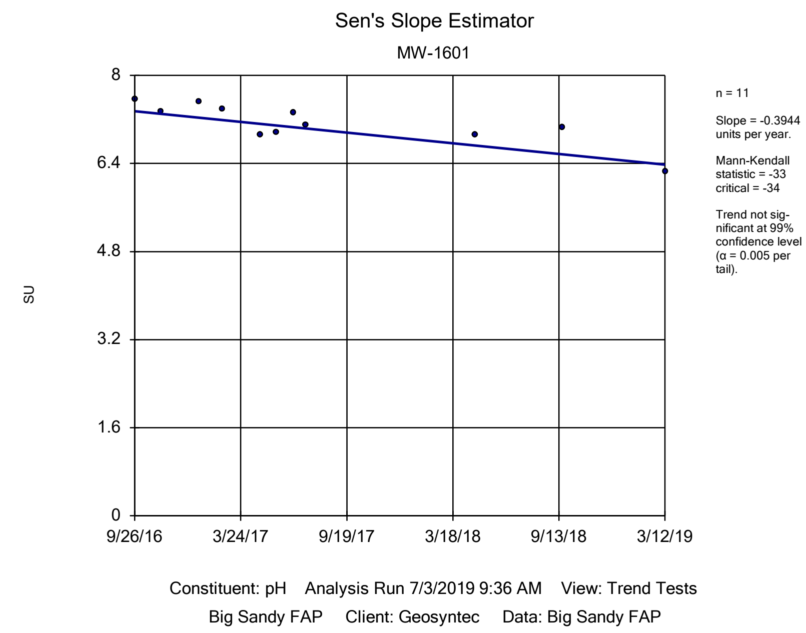
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1203 (bg)
SU
8
6.4
4.8
3.2
1.6
0
9/26/16
3/24/17
9/20/17
3/19/18
9/15/18
3/14/19
n = 11
Slope = -0.55 units per year.
Mann-Kendall statistic = -31 critical = -34
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: pH Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



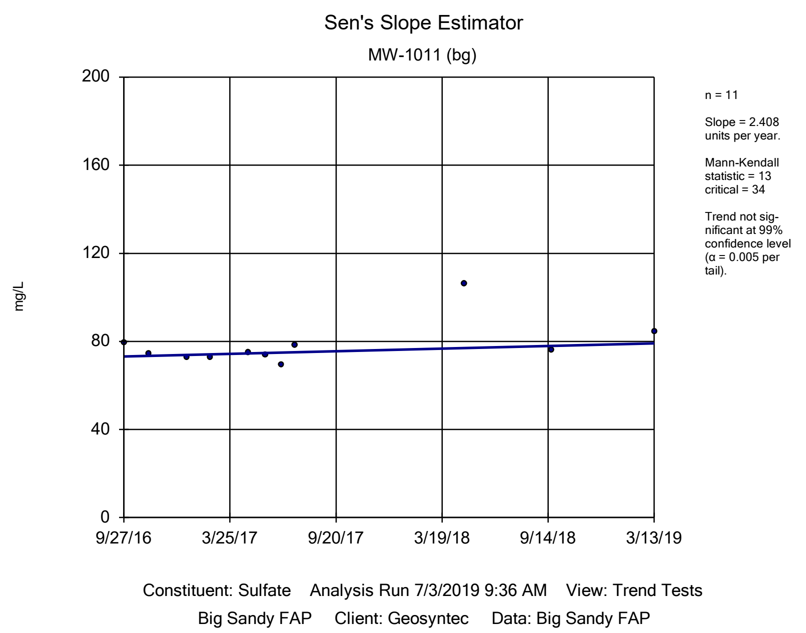
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1604 (bg)
SU
8
6.4
4.8
3.2
1.6
0
9/26/16
3/24/17
9/19/17
3/18/18
9/13/18
3/12/19
n = 11
Slope = -0.5915 units per year.
Mann-Kendall statistic = -25 critical = -34
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: pH Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



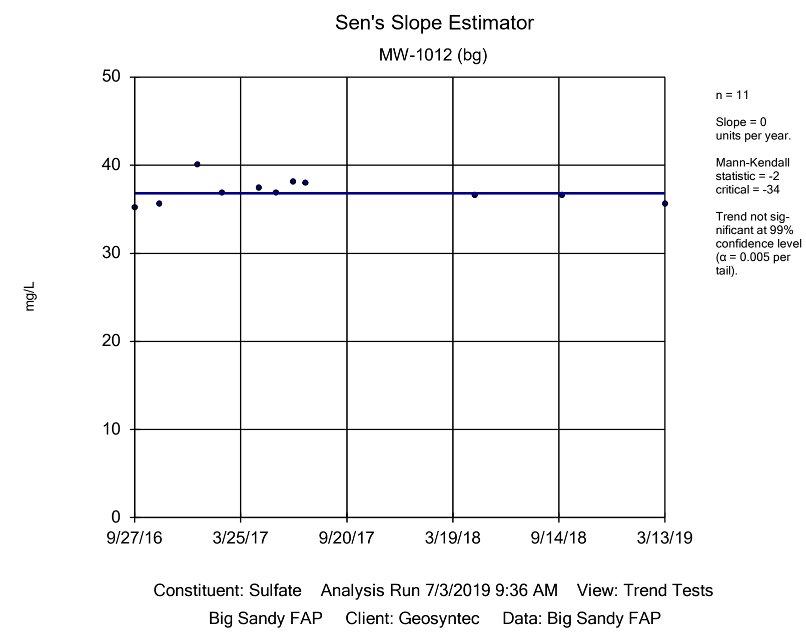
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

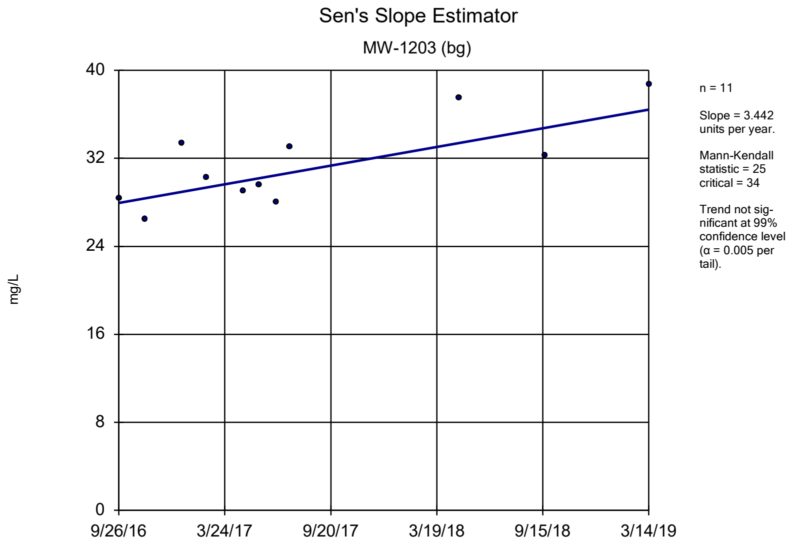


Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



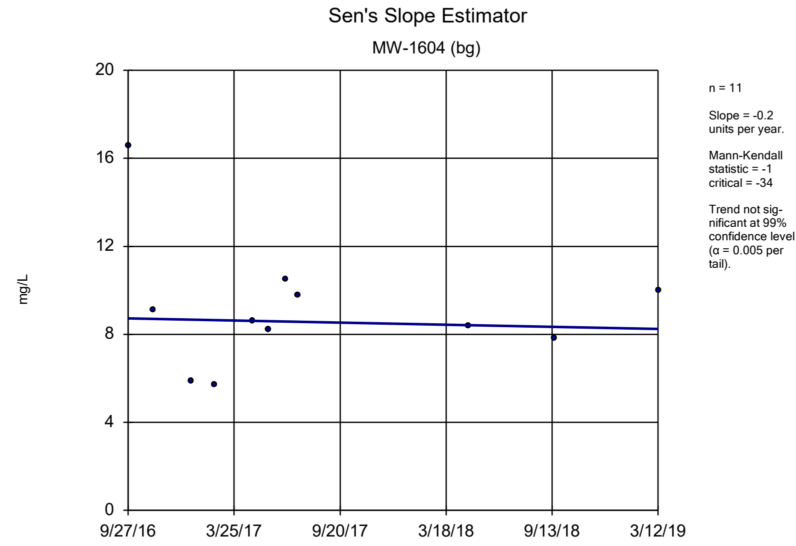
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG





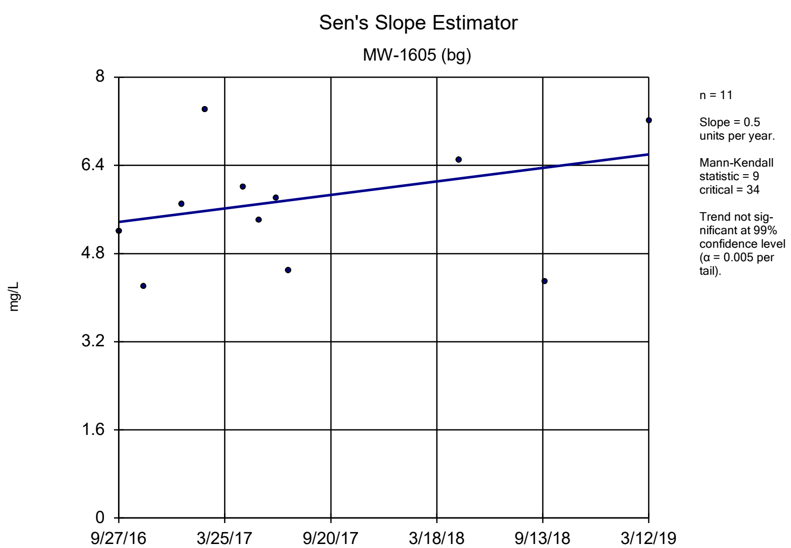
Constituent: Sulfate Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



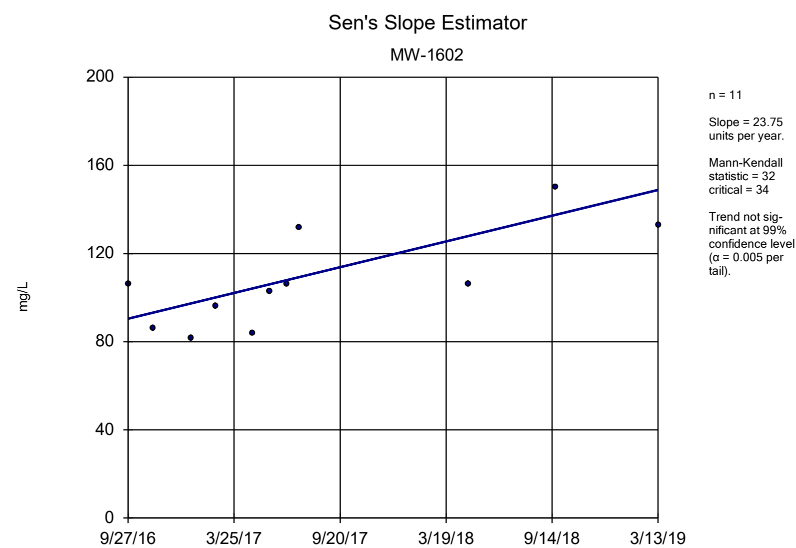
Constituent: Sulfate Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

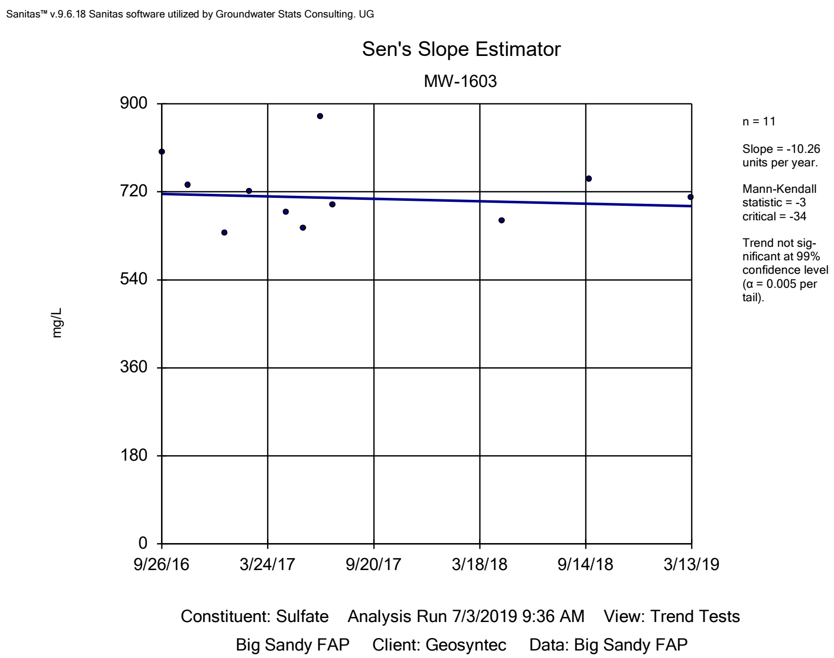


Constituent: Sulfate Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

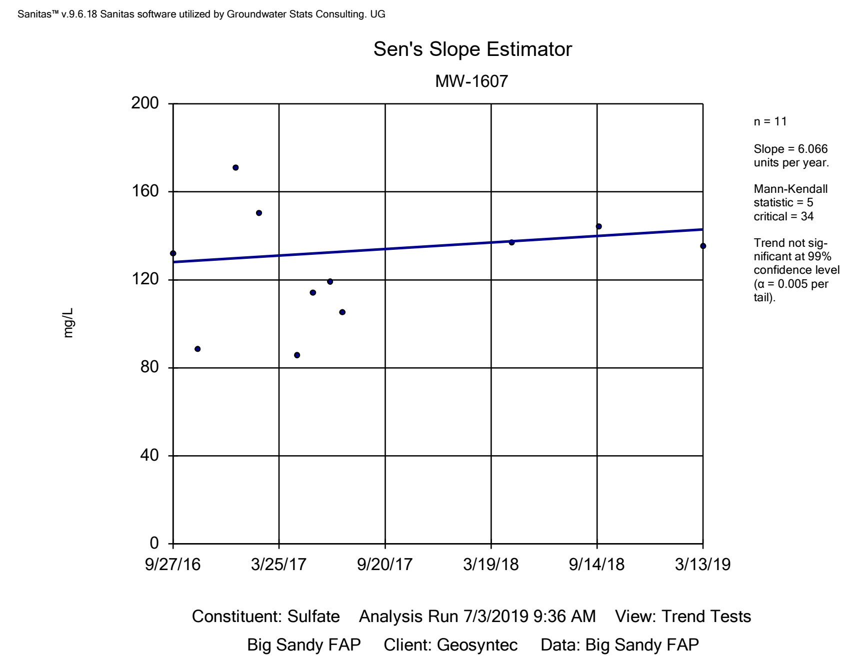
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



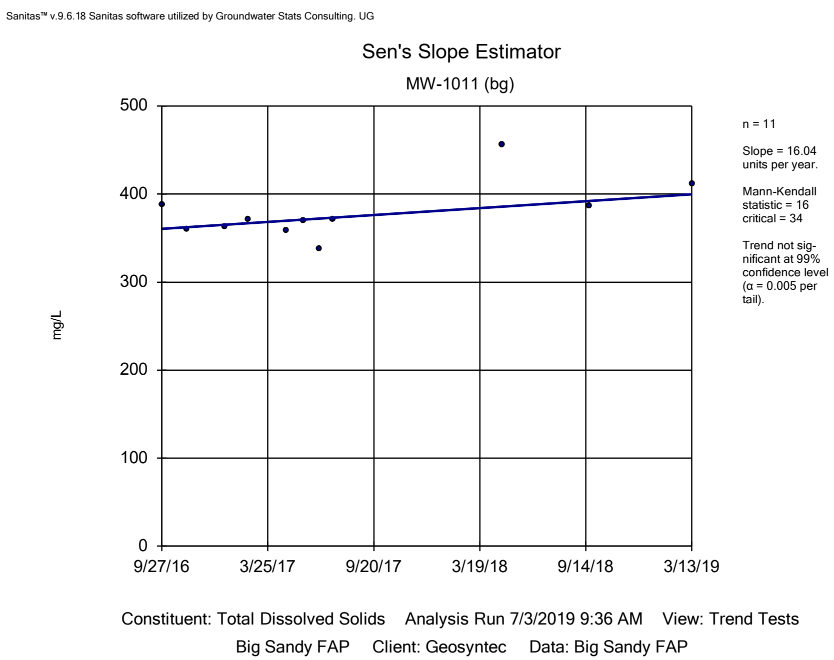
Constituent: Sulfate Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



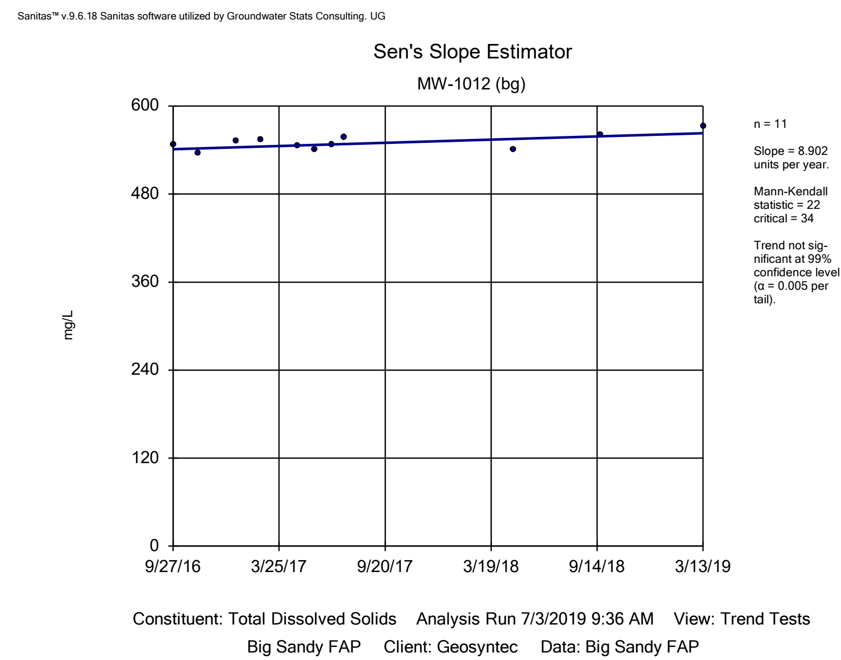
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1603
mg/L
900
720
540
360
180
0
9/26/16
3/24/17
9/20/17
3/18/18
9/14/18
3/13/19
n = 11
Slope = -10.26 units per year.
Mann-Kendall statistic = -3 critical = -34
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Sulfate   Analysis Run 7/3/2019 9:36 AM   View: Trend Tests
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP



Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1607
mg/L
200
160
120
80
40
0
9/27/16
3/25/17
9/20/17
3/19/18
9/14/18
3/13/19
n = 11
Slope = 6.066 units per year.
Mann-Kendall statistic = 5 critical = 34
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Sulfate   Analysis Run 7/3/2019 9:36 AM   View: Trend Tests
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

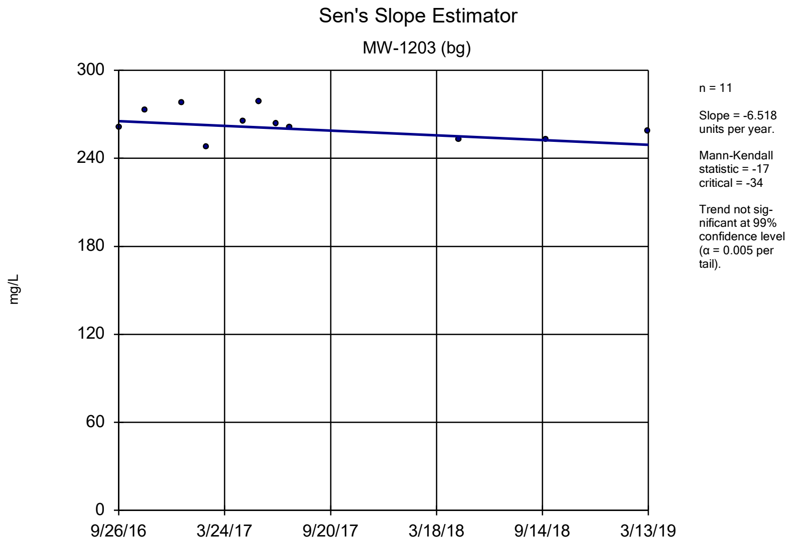


Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1011 (bg)
mg/L
500
400
300
200
100
0
9/27/16
3/25/17
9/20/17
3/19/18
9/14/18
3/13/19
n = 11
Slope = 16.04 units per year.
Mann-Kendall statistic = 16 critical = 34
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Total Dissolved Solids   Analysis Run 7/3/2019 9:36 AM   View: Trend Tests
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP



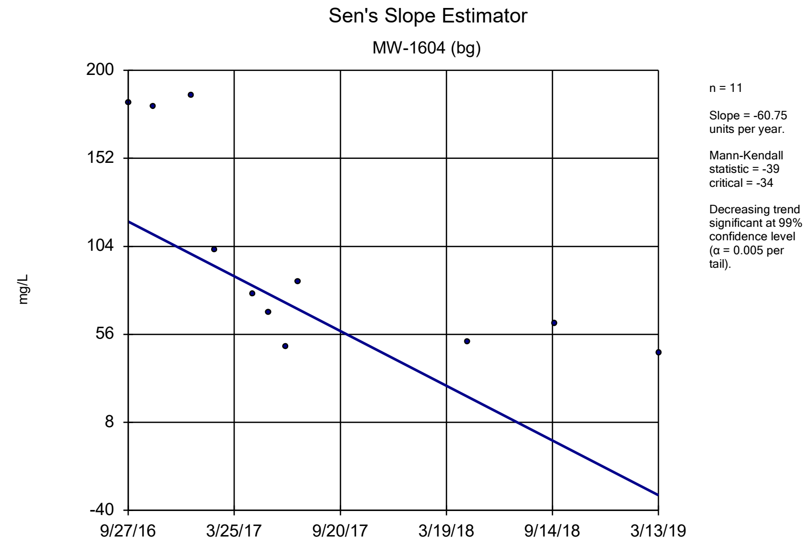
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG
Sen's Slope Estimator
MW-1012 (bg)
mg/L
600
480
360
240
120
0
9/27/16
3/25/17
9/20/17
3/19/18
9/14/18
3/13/19
n = 11
Slope = 8.902 units per year.
Mann-Kendall statistic = 22 critical = 34
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Total Dissolved Solids   Analysis Run 7/3/2019 9:36 AM   View: Trend Tests
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



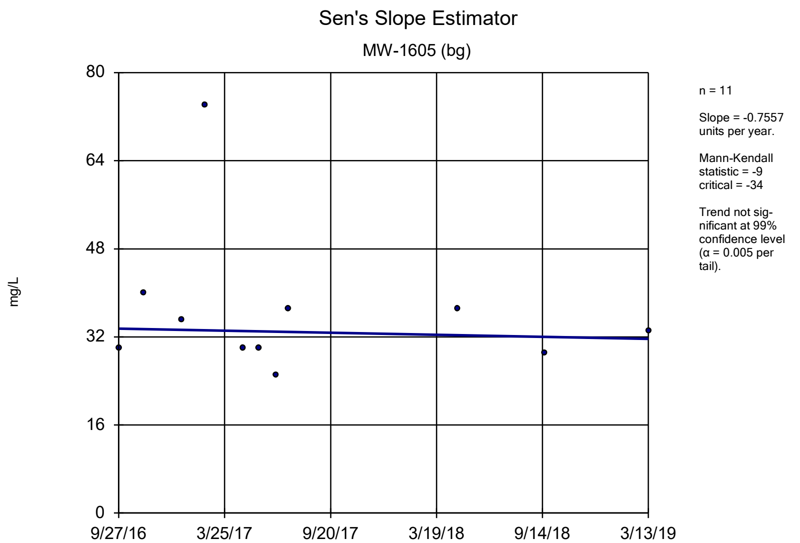
Constituent: Total Dissolved Solids Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



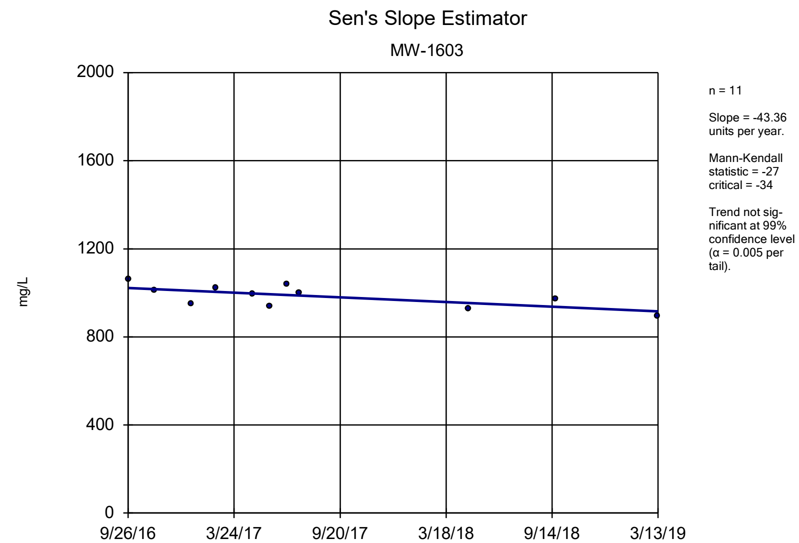
Constituent: Total Dissolved Solids Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Total Dissolved Solids Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Total Dissolved Solids Analysis Run 7/3/2019 9:36 AM View: Trend Tests
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Upper Tolerance Limits

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 6/12/2019, 2:28 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Wells	%NDs	Transform	Alpha	Method
Antimony (mg/L)	n/a	0.0012	n/a	n/a	n/a	n/a	55	MW-1011,MW...	10.91	n/a	0.05954	NP Inter(normality)
Arsenic (mg/L)	n/a	0.0289	n/a	n/a	n/a	n/a	55	MW-1011,MW...	0	n/a	0.05954	NP Inter(normality)
Barium (mg/L)	n/a	0.1129	n/a	n/a	n/a	n/a	55	MW-1011,MW...	0	sqrt(x)	0.05	Inter
Beryllium (mg/L)	n/a	0.000149	n/a	n/a	n/a	n/a	55	MW-1011,MW...	20	n/a	0.05954	NP Inter(normality)
Cadmium (mg/L)	n/a	0.00014	n/a	n/a	n/a	n/a	55	MW-1011,MW...	25.45	n/a	0.05954	NP Inter(normality)
Chromium (mg/L)	n/a	0.00291	n/a	n/a	n/a	n/a	54	MW-1011,MW...	0	n/a	0.06267	NP Inter(normality)
Cobalt (mg/L)	n/a	0.005125	n/a	n/a	n/a	n/a	55	MW-1011,MW...	0	x^(1/3)	0.05	Inter
Combined Radium 226 + 228 (pCi/L)	n/a	6.692	n/a	n/a	n/a	n/a	54	MW-1011,MW...	0	x^(1/3)	0.05	Inter
Fluoride (mg/L)	n/a	0.82	n/a	n/a	n/a	n/a	54	MW-1011,MW...	16.67	n/a	0.06267	NP Inter(Cohens/x...
Lead (mg/L)	n/a	0.001212	n/a	n/a	n/a	n/a	55	MW-1011,MW...	0	x^(1/3)	0.05	Inter
Lithium (mg/L)	n/a	0.02083	n/a	n/a	n/a	n/a	55	MW-1011,MW...	12.73	No	0.05	Inter
Mercury (mg/L)	n/a	0.000013	n/a	n/a	n/a	n/a	55	MW-1011,MW...	81.82	n/a	0.05954	NP Inter(NDs)
Molybdenum (mg/L)	n/a	0.0237	n/a	n/a	n/a	n/a	55	MW-1011,MW...	5.455	n/a	0.05954	NP Inter(normality)
Selenium (mg/L)	n/a	0.0003	n/a	n/a	n/a	n/a	55	MW-1011,MW...	16.36	n/a	0.05954	NP Inter(normality)
Thallium (mg/L)	n/a	0.0005	n/a	n/a	n/a	n/a	55	MW-1011,MW...	16.36	n/a	0.05954	NP Inter(normality)

Confidence Interval - Significant Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 6/12/2019, 2:47 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Beryllium (mg/L)	**MW-1603**	**0.0196**	**0.0164**	**0.004**	**n/a**	**Yes**	**11**	**0**	**No**	**0.006**	**NP (normality)**
Cobalt (mg/L)	**MW-1603**	**0.09613**	**0.08901**	**0.006**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Lithium (mg/L)	**MW-1603**	**0.2439**	**0.207**	**0.04**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**

Confidence Interval - All Results

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 6/12/2019, 2:47 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Antimony (mg/L)	MW-1601	0.0001905	0.00007315	0.006	n/a	No	11	0	No	0.01	Param.
Antimony (mg/L)	MW-1602	0.000116	0.00005487	0.006	n/a	No	11	0	No	0.01	Param.
Antimony (mg/L)	MW-1603	0.0001	0.00001	0.006	n/a	No	11	63.64	No	0.006	NP (normality)
Antimony (mg/L)	MW-1606	0.00009619	0.0000209	0.006	n/a	No	11	27.27	No	0.01	Param.
Antimony (mg/L)	MW-1607	0.0001	0.00001	0.006	n/a	No	10	10	No	0.011	NP (normality)
Arsenic (mg/L)	MW-1601	0.005365	0.003802	0.0289	n/a	No	11	0	x^2	0.01	Param.
Arsenic (mg/L)	MW-1602	0.00315	0.00037	0.0289	n/a	No	11	0	No	0.006	NP (normality)
Arsenic (mg/L)	MW-1603	0.001466	0.00116	0.0289	n/a	No	11	0	No	0.01	Param.
Arsenic (mg/L)	MW-1606	0.001223	0.0009518	0.0289	n/a	No	11	0	No	0.01	Param.
Arsenic (mg/L)	MW-1607	0.0236	0.00736	0.0289	n/a	No	11	0	No	0.006	NP (normality)
Barium (mg/L)	MW-1601	0.08018	0.06066	2	n/a	No	11	0	No	0.01	Param.
Barium (mg/L)	MW-1602	0.05743	0.05077	2	n/a	No	11	0	No	0.01	Param.
Barium (mg/L)	MW-1603	0.01305	0.01075	2	n/a	No	11	0	sqrt(x)	0.01	Param.
Barium (mg/L)	MW-1606	0.9832	0.7979	2	n/a	No	11	0	No	0.01	Param.
Barium (mg/L)	MW-1607	0.04293	0.02985	2	n/a	No	11	0	No	0.01	Param.
Beryllium (mg/L)	MW-1601	0.0001	0.000005	0.004	n/a	No	11	18.18	No	0.006	NP (normality)
Beryllium (mg/L)	MW-1602	0.0001	0.0001	0.004	n/a	No	10	100	No	0.011	NP (NDs)
Beryllium (mg/L)	**MW-1603**	**0.0196**	**0.0164**	**0.004**	**n/a**	**Yes**	**11**	**0**	**No**	**0.006**	**NP (normality)**
Beryllium (mg/L)	MW-1606	0.00007466	0.0000117	0.004	n/a	No	11	9.091	No	0.01	Param.
Beryllium (mg/L)	MW-1607	0.0001	0.00001	0.004	n/a	No	11	9.091	No	0.006	NP (normality)
Cadmium (mg/L)	MW-1601	0.00005	0.000005	0.005	n/a	No	11	27.27	No	0.006	NP (normality)
Cadmium (mg/L)	MW-1602	0.00005	0.000005	0.005	n/a	No	11	36.36	No	0.006	NP (normality)
Cadmium (mg/L)	MW-1603	0.0008625	0.0007666	0.005	n/a	No	11	0	No	0.01	Param.
Cadmium (mg/L)	MW-1606	0.00005	0.000007	0.005	n/a	No	11	63.64	No	0.006	NP (normality)
Cadmium (mg/L)	MW-1607	0.00005	0.000006	0.005	n/a	No	11	63.64	No	0.006	NP (normality)
Chromium (mg/L)	MW-1601	0.0006337	0.0002944	0.1	n/a	No	11	0	sqrt(x)	0.01	Param.
Chromium (mg/L)	MW-1602	0.0007825	0.0004346	0.1	n/a	No	11	0	No	0.01	Param.
Chromium (mg/L)	MW-1603	0.0009764	0.0006528	0.1	n/a	No	11	0	No	0.01	Param.
Chromium (mg/L)	MW-1606	0.00151	0.0003748	0.1	n/a	No	11	0	No	0.01	Param.
Chromium (mg/L)	MW-1607	0.0006357	0.0003427	0.1	n/a	No	11	0	No	0.01	Param.
Cobalt (mg/L)	MW-1601	0.001586	0.0008246	0.006	n/a	No	11	0	No	0.01	Param.
Cobalt (mg/L)	MW-1602	0.0003103	0.00001807	0.006	n/a	No	11	0	x^(1/3)	0.01	Param.
Cobalt (mg/L)	**MW-1603**	**0.09613**	**0.08901**	**0.006**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Cobalt (mg/L)	MW-1606	0.0008437	0.0001676	0.006	n/a	No	11	0	No	0.01	Param.
Cobalt (mg/L)	MW-1607	0.001491	0.001265	0.006	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1601	1.965	0.871	6.692	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1602	1.462	0.7369	6.692	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1603	6.481	5.091	6.692	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1606	3.562	2.625	6.692	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1607	2.792	0.4326	6.692	n/a	No	11	0	sqrt(x)	0.01	Param.
Fluoride (mg/L)	MW-1601	0.3329	0.2452	4	n/a	No	11	0	No	0.01	Param.
Fluoride (mg/L)	MW-1602	0.1623	0.1068	4	n/a	No	11	0	No	0.01	Param.
Fluoride (mg/L)	MW-1603	1.141	0.9521	4	n/a	No	11	0	No	0.01	Param.
Fluoride (mg/L)	MW-1606	0.2242	0.174	4	n/a	No	11	0	No	0.01	Param.
Fluoride (mg/L)	MW-1607	0.07108	0.05073	4	n/a	No	11	0	No	0.01	Param.
Lead (mg/L)	MW-1601	0.0001042	0.0000274	0.015	n/a	No	11	0	ln(x)	0.01	Param.
Lead (mg/L)	MW-1602	0.0000897	0.00002582	0.015	n/a	No	11	0	ln(x)	0.01	Param.
Lead (mg/L)	MW-1603	0.007468	0.004503	0.015	n/a	No	11	0	No	0.01	Param.
Lead (mg/L)	MW-1606	0.0009484	0.00012	0.015	n/a	No	11	0	sqrt(x)	0.01	Param.
Lead (mg/L)	MW-1607	0.0003574	0.00005704	0.015	n/a	No	11	0	sqrt(x)	0.01	Param.
Lithium (mg/L)	MW-1601	0.03794	0.02279	0.04	n/a	No	11	0	No	0.01	Param.
Lithium (mg/L)	MW-1602	0.01206	0.004374	0.04	n/a	No	11	0	sqrt(x)	0.01	Param.
Lithium (mg/L)	**MW-1603**	**0.2439**	**0.207**	**0.04**	**n/a**	**Yes**	**11**	**0**	**No**	**0.01**	**Param.**
Lithium (mg/L)	MW-1606	0.01203	0.004157	0.04	n/a	No	11	9.091	No	0.01	Param.
Lithium (mg/L)	MW-1607	0.009588	0.00223	0.04	n/a	No	11	9.091	No	0.01	Param.

Confidence Interval - All Results

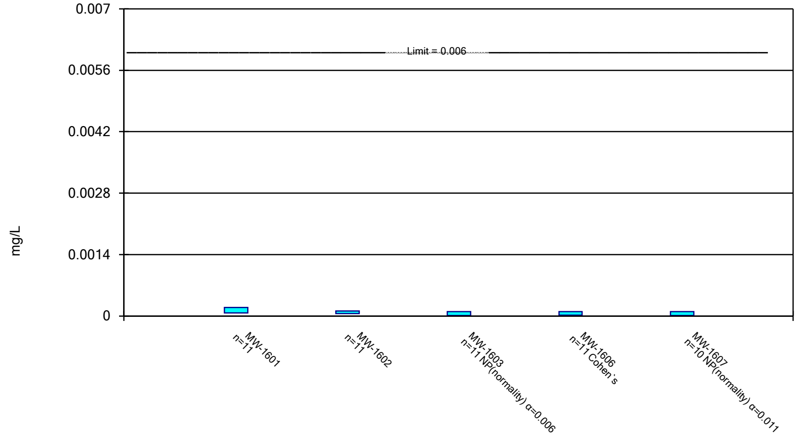
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 6/12/2019, 2:47 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Mercury (mg/L)	MW-1601	0.000005	0.000005	0.002	n/a	No	11	100	No	0.006	NP (NDs)
Mercury (mg/L)	MW-1602	0.000005	0.000002	0.002	n/a	No	11	36.36	No	0.006	NP (normality)
Mercury (mg/L)	MW-1603	0.000005	0.000002	0.002	n/a	No	11	90.91	No	0.006	NP (NDs)
Mercury (mg/L)	MW-1606	0.000005	0.000002	0.002	n/a	No	11	72.73	No	0.006	NP (normality)
Mercury (mg/L)	MW-1607	0.000005	0.000004	0.002	n/a	No	11	90.91	No	0.006	NP (NDs)
Molybdenum (mg/L)	MW-1601	0.0315	0.01834	0.1	n/a	No	11	0	No	0.01	Param.
Molybdenum (mg/L)	MW-1602	0.002698	0.001662	0.1	n/a	No	11	0	No	0.01	Param.
Molybdenum (mg/L)	MW-1603	0.00032	0.00003	0.1	n/a	No	11	9.091	No	0.006	NP (normality)
Molybdenum (mg/L)	MW-1606	0.0026	0.00051	0.1	n/a	No	11	0	No	0.006	NP (normality)
Molybdenum (mg/L)	MW-1607	0.001	0.00042	0.1	n/a	No	11	0	No	0.006	NP (normality)
Selenium (mg/L)	MW-1601	0.0002	0.00007	0.05	n/a	No	11	0	No	0.006	NP (normality)
Selenium (mg/L)	MW-1602	0.002097	0.0009571	0.05	n/a	No	11	0	No	0.01	Param.
Selenium (mg/L)	MW-1603	0.006652	0.004312	0.05	n/a	No	11	0	No	0.01	Param.
Selenium (mg/L)	MW-1606	0.0001839	0.00006086	0.05	n/a	No	11	0	x^(1/3)	0.01	Param.
Selenium (mg/L)	MW-1607	0.0002	0.00005	0.05	n/a	No	11	0	No	0.006	NP (normality)
Thallium (mg/L)	MW-1601	0.00006693	0.00001161	0.002	n/a	No	11	9.091	ln(x)	0.01	Param.
Thallium (mg/L)	MW-1602	0.00003	0.00001	0.002	n/a	No	11	9.091	No	0.006	NP (normality)
Thallium (mg/L)	MW-1603	0.001526	0.001227	0.002	n/a	No	11	0	No	0.01	Param.
Thallium (mg/L)	MW-1606	0.00025	0.00001	0.002	n/a	No	11	36.36	No	0.006	NP (Cohens/xfrm)
Thallium (mg/L)	MW-1607	0.000119	0.00002	0.002	n/a	No	11	9.091	No	0.006	NP (normality)

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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



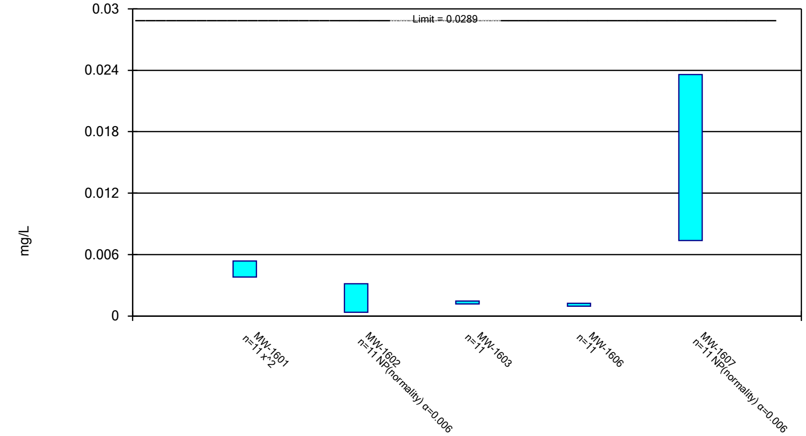
Constituent: Antimony Analysis Run 6/12/2019 2:44 PM View: Confidence Intervals

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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



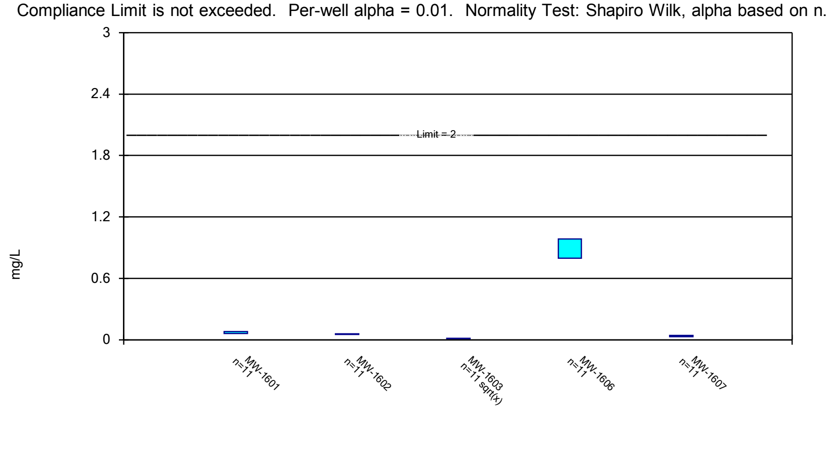
Constituent: Arsenic Analysis Run 6/12/2019 2:44 PM View: Confidence Intervals

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric Confidence Interval

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



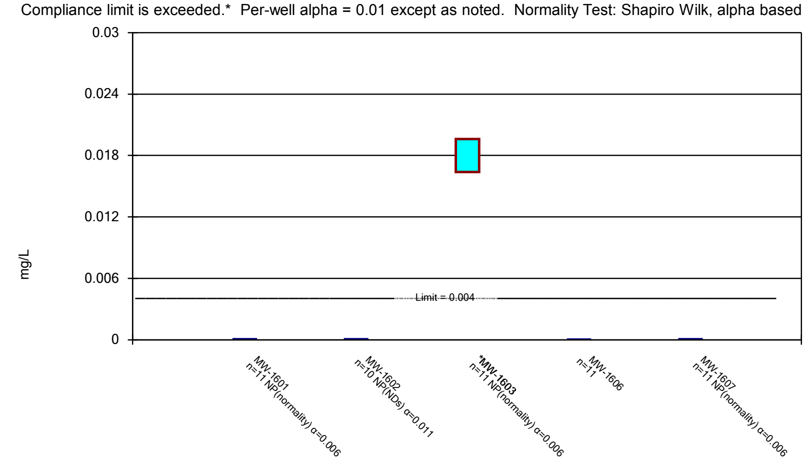
Constituent: Barium Analysis Run 6/12/2019 2:44 PM View: Confidence Intervals

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



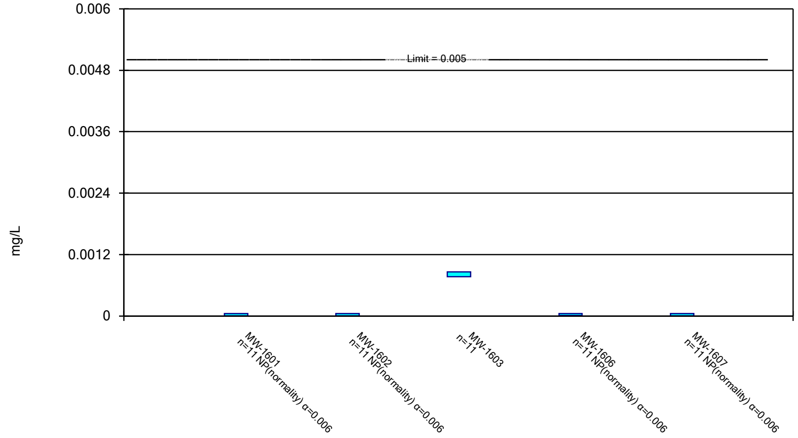
Constituent: Beryllium Analysis Run 6/12/2019 2:44 PM View: Confidence Intervals

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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

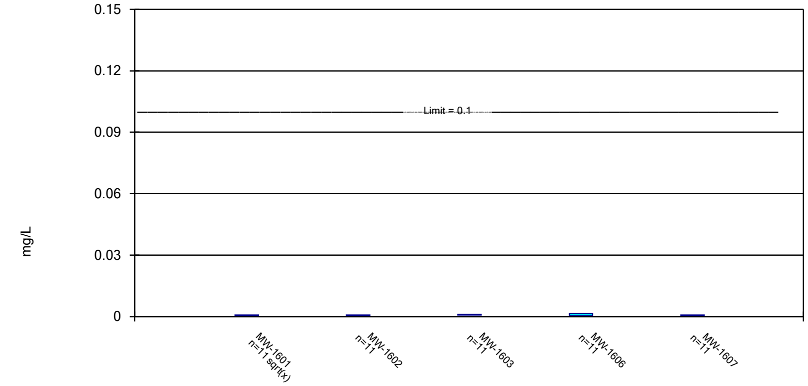


Constituent: Cadmium Analysis Run 6/12/2019 2:44 PM View: Confidence Intervals
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric Confidence Interval

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

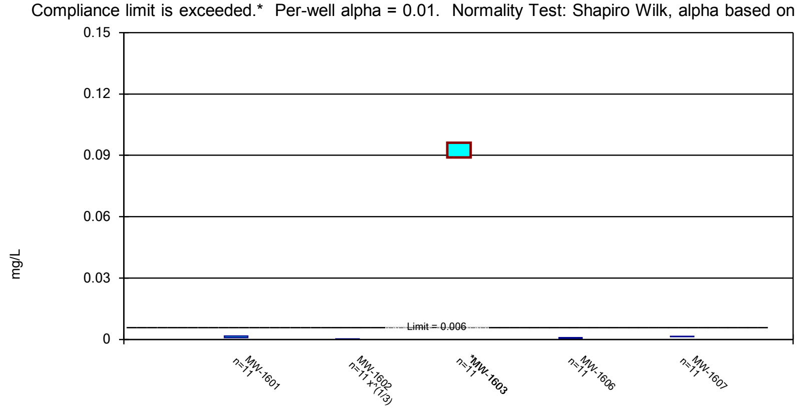


Constituent: Chromium Analysis Run 6/12/2019 2:44 PM View: Confidence Intervals
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

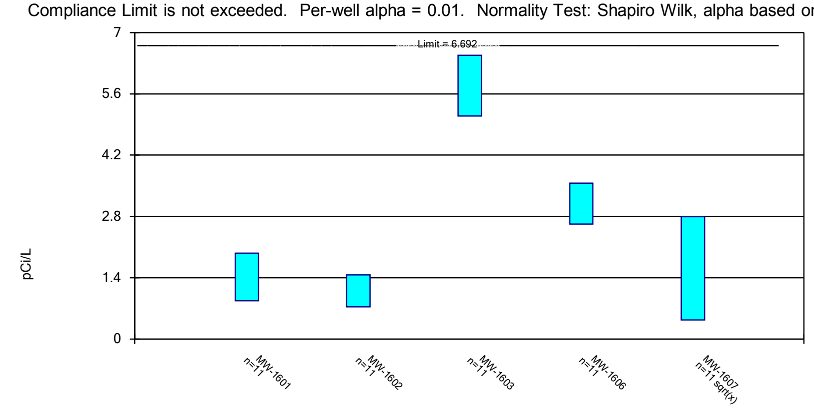


Constituent: Cobalt Analysis Run 6/12/2019 2:44 PM View: Confidence Intervals
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric Confidence Interval

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

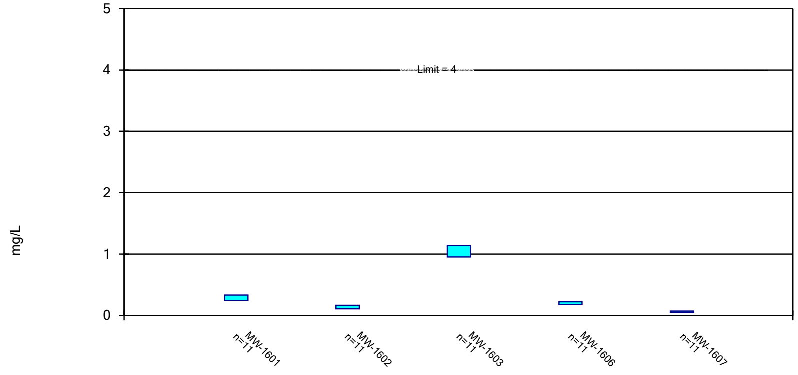


Constituent: Combined Radium 226 + 228 Analysis Run 6/12/2019 2:44 PM View: Confidence Intervals
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric Confidence Interval

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



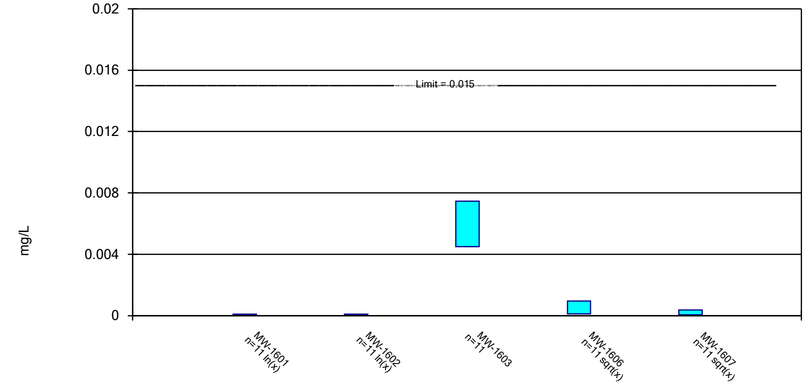
Constituent: Fluoride   Analysis Run 6/12/2019 2:44 PM   View: Confidence Intervals

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric Confidence Interval

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



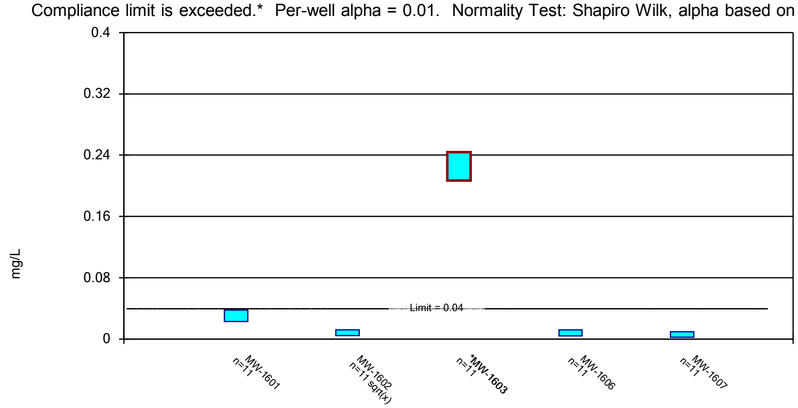
Constituent: Lead   Analysis Run 6/12/2019 2:44 PM   View: Confidence Intervals

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



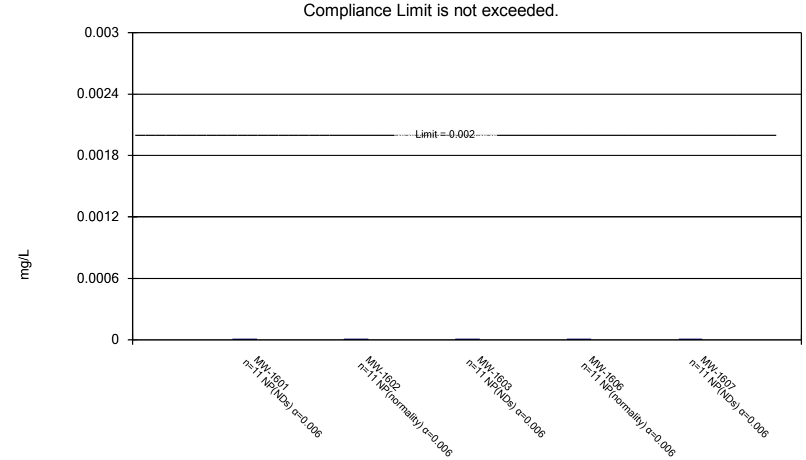
Constituent: Lithium   Analysis Run 6/12/2019 2:44 PM   View: Confidence Intervals

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



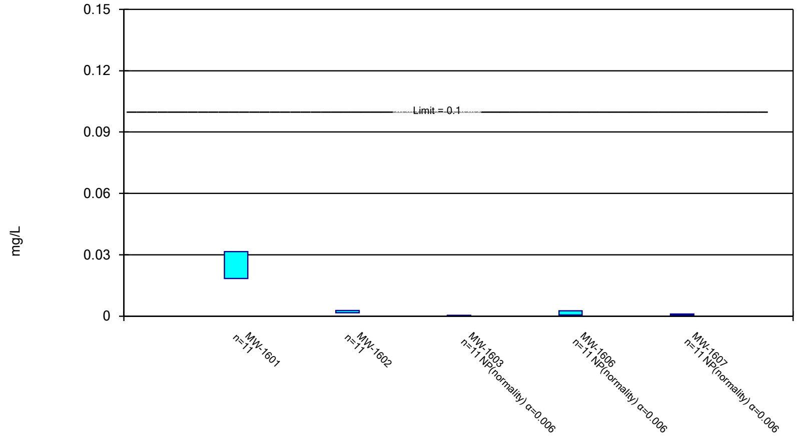
Constituent: Mercury   Analysis Run 6/12/2019 2:44 PM   View: Confidence Intervals

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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

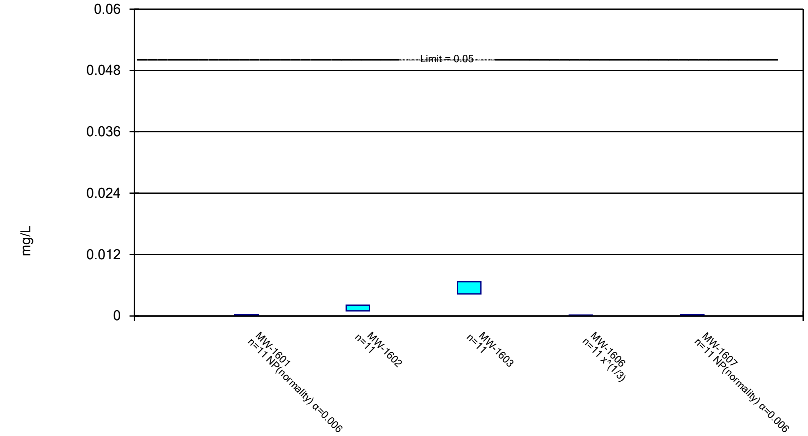


Constituent: Molybdenum Analysis Run 6/12/2019 2:44 PM View: Confidence Intervals
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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

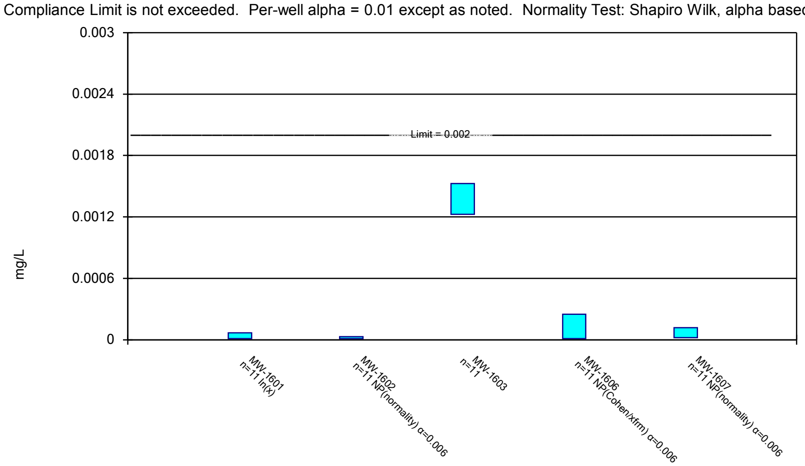


Constituent: Selenium Analysis Run 6/12/2019 2:44 PM View: Confidence Intervals
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.14 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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



Constituent: Thallium Analysis Run 6/12/2019 2:44 PM View: Confidence Intervals
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

STATISTICAL ANALYSIS SUMMARY
FLY ASH POND
Big Sandy Plant
Louisa, Kentucky

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, Ohio 43221

January 3, 2020

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

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
FAP	Fly Ash Pond
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
LFB	Laboratory Fortified Blanks
LPL	Lower Prediction Limit
LRB	Laboratory Reagent Blanks
MCL	Maximum Contaminant Level
NELAP	National Environmental Laboratory Accreditation Program
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SSL	Statistically Significant Level
SU	Standard Units
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 Fly Ash Pond (FAP), an existing CCR unit at the Big Sandy Power Plant located in Louisa, Kentucky.

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, calcium, chloride, fluoride, total dissolved solids (TDS), and sulfate at the FAP. An alternative source was not identified at the time, so the FAP has been in assessment monitoring. During the most recent assessment monitoring event, completed in March 2019, statistically significant levels (SSLs) were identified for beryllium, cobalt, and lithium at MW-1603. An alternative source demonstration (ASD) was successfully completed (EHS, 2019); thus, the unit remained in assessment monitoring. Two assessment monitoring events were conducted at the FAP in June and August 2019, in accordance with 40 CFR 257.95. The results of these 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 the usability of the data.

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 an SSL above the GWPS. SSLs were identified for beryllium, cobalt, combined radium, and lithium. 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

FLY 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) (June 2019) and 257.95(d)(1) (August 2019). 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 may be found 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.9.6.23 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 FAP 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 June and August 2019 were screened for potential outliers. No outliers were identified.

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. Where possible, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for arsenic, beryllium, cadmium, chromium, fluoride, selenium, and thallium due to apparent non-normal distributions, for mercury due to a high non-detect frequency, and for antimony and lithium due to both an apparent non-normal distribution and 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 Big Sandy FAP:

- The LCL for beryllium exceeded the GWPS of 0.004 mg/L at MW-1603 (0.0172 mg/L).
- The LCL for cobalt exceeded the GWPS of 0.006 mg/L at MW-1603 (0.0888 mg/L).
- The LCL for combined radium exceeded the GWPS of 5.00 pCi/L at MW-1603 (5.13 pCi/L).
- The LCL for lithium exceeded the GWPS of 0.040 mg/L at MW-1603 (0.206 mg/L).

As a result, the Big Sandy FAP 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.

2.2.3 Establishment of Appendix III Prediction Limits

Upper prediction limits (UPLs) were previously established for all Appendix III parameters following the background monitoring period (Geosyntec, 2018). Intrawell tests were used to evaluate potential SSIs for pH, whereas interwell tests were used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS. While interwell prediction limits have been updated periodically during the assessment monitoring period as sufficient data became available, this represents the first update to the background dataset for parameters evaluated using intrawell tests.

Mann-Whitney (Wilcoxon rank-sum) tests were performed to determine whether the newer data are affected by a release from the FAP. Because the interwell Appendix III limits and the Appendix IV GWPSs are based on data from upgradient wells which we would not expect to have been impacted by a release, these tests were used for intrawell Appendix III tests only. Mann-Whitney tests were used to compare the medians of historical data (September 2016 - July 2017) to the new compliance samples (September 2017 – March 2019) for pH. Results were evaluated to determine if the medians of the two groups were similar at the 99% confidence level. Where no significant difference was found, the new compliance data were added to the background dataset. Where a statistically significant difference was found between the medians of the two groups, the data were reviewed to evaluate the cause of the difference and to determine if adding newer data to the background dataset, replacing the background dataset with the newer data, or continuing to use the existing background dataset was most appropriate. If the differences appeared to have been caused by a release, then the previous background dataset would have continued to be used. The complete Mann-Whitney test results and a summary of the significant findings can be found in Attachment B. No significant differences were found between the two groups.

After the revised background set was established, a parametric or non-parametric analysis was selected based on the distribution of the data and the frequency of non-detect data. Estimated results less than the practical quantitation limit (PQL) – i.e., "J-flagged" data – were considered detections and the estimated results were used in the statistical analyses. Non-parametric analyses were selected for datasets with at least 50% non-detect data or datasets that could not be normalized. Parametric analyses were selected for datasets (either transformed or untransformed) that passed the Shapiro-Wilk / Shapiro-Francía test for normality. The Kaplan-Meier non-detect adjustment was applied to datasets with between 15% and 50% non-detect data. For datasets with fewer than 15% non-detect data, non-detect data were replaced with one half of the PQL. The selected analysis (i.e., parametric or non-parametric) and transformation (where applicable) for each background dataset are shown in Attachment B.

UPLs were updated using all the historical data through March 2019 to represent background values. Lower prediction limits (LPLs) were also updated for pH. The updated prediction limits are summarized in Table 3. Intrawell tests continued to be used to evaluate potential SSIs for pH, whereas interwell tests continued to be used to evaluate potential SSIs for boron, calcium, chloride, fluoride, sulfate, and TDS. The intrawell UPLs were calculated for a one-of-two retesting procedure; i.e., if at least one sample in a series of two does not exceed the UPL, then it can be concluded that an SSI has not occurred. In practice, where the initial result did not exceed the UPL, a second sample was not collected. The retesting procedures allowed achieving an acceptably high statistical power to detect changes at downgradient wells for constituents evaluated using both interwell and intrawell prediction limits.

2.2.4 Evaluation of Potential Appendix III SSIs

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

Data collected during the June and August 2019 assessment monitoring events from each compliance well were compared to the prediction limits to evaluate results above background values. The results from these events and the prediction limits are summarized in Table 4. The following exceedances of the UPLs were noted:

- Boron concentrations exceeded the interwell UPL of 0.220 mg/L at MW-1606 (1.84 mg/L and 1.74 mg/L).

- Chloride concentrations exceeded the interwell UPL of 8.21 mg/L at MW-1601 (8.23 mg/L and 8.43 mg/L), MW-1602 (12.2 mg/L and 13.2 mg/L), and MW-1606 (30.8 mg/L and 31.4 mg/L).

- Fluoride concentrations exceeded the interwell UPL of 0.820 mg/L at MW-1603 (0.870 mg/L and 0.840 mg/L).

- Sulfate concentrations exceeded the interwell UPL of 106 mg/L at MW-1602 (111 mg/L and 117 mg/L), MW-1603 (658 mg/L and 704 mg/L), and MW-1607 (120 mg/L and 141 mg/L).

- TDS concentrations exceeded the interwell UPL of 561 mg/L at MW-1603 (954 mg/L and 1010 mg/L).

Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Big Sandy FAP during assessment monitoring.

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 June and August 2019 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 beryllium, cobalt, combined radium, and lithium. Appendix III parameters were compared to recalculated prediction limits, with exceedances identified for boron, chloride, fluoride, sulfate, and TDS.

Based on this evaluation, the Big Sandy FAP 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 – Big Sandy Plant. January 2017.

EHS Support. 2019. Alternative Source Demonstration Addendum Report for Beryllium, Cobalt and Lithium. Big Sandy Fly Ash Pond. September 2019.

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Fly Ash Pond, Big Sandy Plant, Louisa, Kentucky. January 15, 2018.

TABLES

Table 1 - Groundwater Data Summary
Big Sandy - Fly Ash Pond

Component	Unit	MW-1011		MW-1012		MW-1203		MW-1601		MW-1602	
		6/27/2019	8/21/2019	6/25/2019	8/21/2019	6/27/2019	8/21/2019	6/25/2019	8/21/2019	6/25/2019	8/20/2019
Antimony	µg/L	0.15	0.18	0.67	0.77	0.1 U	0.1 U	0.17	0.09 J	0.07 J	0.06 J
Arsenic	µg/L	5.17	5.31	13.4	19.0	0.34	0.27	1.04	1.58	1.06	1.16
Barium	µg/L	47.5	49.2	28.0	41.9	86.8	95.4	55.5	56.6	52.5	49.3
Beryllium	µg/L	0.1 U	0.1 U	0.03 J	0.06 J	0.06 J	0.04 J	0.1 U	0.1 U	0.1 U	0.1 U
Boron	mg/L	0.119	0.117	0.169	0.176	0.1 J	0.097	0.1 J	0.097	0.06 J	0.04 J
Cadmium	µg/L	0.05 U	0.01 J	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.02 J	0.05 U	0.01 J
Calcium	mg/L	75.3	86.2	1.10	1.38	54.3	60.8	50.7	52.1	69.8	74.5
Chloride	mg/L	4.20	4.41	1.19	1.26	5.28	5.14	8.23	8.43	12.2	13.2
Chromium	µg/L	0.304	0.341	0.252	0.625	0.1 J	0.304	0.2 J	0.351	0.632	1.15
Cobalt	µg/L	0.438	0.421	0.097	0.260	0.909	0.774	0.629	0.831	0.02 J	0.080
Combined Radium	pCi/L	2.58	2.54	0.506	0.354	1.34	1.47	0.689	0.855	0.536	0.543
Fluoride	mg/L	0.27	0.26	0.74	0.79	0.12	0.13	0.15	0.15	0.11	0.1
Lead	µg/L	0.181	0.1 J	0.352	0.924	0.1 J	0.06 J	0.1 U	0.2 U	0.05 J	0.1 J
Lithium	mg/L	0.03 U	0.00973	0.03 U	0.00536	0.01 J	0.0118	0.03 U	0.0172	0.03 U	0.00637
Mercury	µg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Molybdenum	µg/L	0.7 J	0.7 J	0.8 J	1 J	2 U	2 U	4.89	5.64	1 J	1 J
Selenium	µg/L	0.2 U	0.2 U	0.08 J	0.3	0.2 U	0.2 U	0.2	0.09 J	1.4	1.1
Total Dissolved Solids	mg/L	386	385	559	583	273	283	312	326	436	434
Sulfate	mg/L	75.2	76.2	35.9	36.8	39.0	32.4	86.4	82.9	111	117
Thallium	µg/L	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
pH	SU	6.97	7.10	9.32	9.39	6.82	6.99	6.96	7.13	7.46	7.47

Notes:
µg/L: micrograms per liter
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations at or above the method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit

Table 1 - Groundwater Data Summary
Big Sandy - Fly Ash Pond

Component	Unit	MW-1603		MW-1604		MW-1605		MW-1606		MW-1607	
		6/27/2019	8/20/2019	6/25/2019	8/20/2019	6/25/2019	8/20/2019	6/25/2019	8/20/2019	6/25/2019	8/20/2019
Antimony	µg/L	0.2 U	0.5 U	0.03 J	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.02 J	0.1 U
Arsenic	µg/L	1.36	1.39	0.12	0.09 J	0.05 J	0.03 J	0.94	0.85	19.3	14.4
Barium	µg/L	11.0	13.6	68.3	78.3	34.8	29.1	843	768	38.1	29.1
Beryllium	µg/L	21.8	25.0	0.07 J	0.117	0.123	0.09 J	0.1 U	0.1 U	0.1 U	0.1 U
Boron	mg/L	0.05 J	0.2 U	0.02 J	0.05 U	0.1 U	0.05 U	1.84	1.74	0.208	0.160
Cadmium	µg/L	0.7	0.89	0.09	0.08	0.08	0.06	0.05 U	0.05 U	0.05 U	0.05 U
Calcium	mg/L	83.3	95.8	2.97	3.42	1.2	1.01	74.5	75.1	91.9	101
Chloride	mg/L	4.13	3.93	1.21	1.17	0.43	0.46	30.8	31.4	5.22	3.84
Chromium	µg/L	0.618	0.8 J	0.231	0.612	2.53	2.41	0.1 J	0.304	0.250	0.347
Cobalt	µg/L	84.7	96.6	0.503	0.246	0.253	0.215	0.055	0.05 J	1.39	1.19
Combined Radium	pCi/L	7.15	10.9	0.799	0.641	0.902	0.268	2.37	3.12	0.501	0.685
Fluoride	mg/L	0.87	0.84	0.05 J	0.03 J	0.06 U	0.01 J	0.23	0.21	0.08	0.07
Lead	µg/L	3.68	4.17	0.03 J	0.2 U	0.164	0.09 J	0.05 J	0.2 U	0.09 J	0.2 U
Lithium	mg/L	0.192	0.226	0.03 U	0.00104	0.03 U	0.000637	0.03 U	0.00301	0.03 U	0.0001 J
Mercury	µg/L	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Molybdenum	µg/L	4 U	10 U	2 U	2 U	2 U	2 U	0.6 J	0.6 J	0.7 J	0.6 J
Selenium	µg/L	4.9	5.6	0.2	0.4	0.2	0.2	0.06 J	0.05 J	0.1 J	0.09 J
Total Dissolved Solids	mg/L	954	1010	50	50 J	37	30 J	384	385	388	419
Sulfate	mg/L	658	704	9.5	10.5	5.7	5.5	58.7	58.3	120	141
Thallium	µg/L	1.40	2 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
pH	SU	3.73	3.54	5.95	5.39	5.22	5.48	7.08	7.02	6.62	6.54

Notes:

µg/L: micrograms per liter

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

U: Parameter was not present in concentrations at or above the method detection limit and is reported as the reporting limit

J: Estimated value. Parameter was detected in concentrations below the reporting limit

Table 2: Groundwater Protection Standards
Big Sandy Plant - Fly Ash Pond

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.0012
Arsenic, Total (mg/L)	0.01		0.029
Barium, Total (mg/L)	2		0.11
Beryllium, Total (mg/L)	0.004		0.00015
Cadmium, Total (mg/L)	0.005		0.00014
Chromium, Total (mg/L)	0.1		0.0029
Cobalt, Total (mg/L)	n/a	0.006	0.0045
Combined Radium, Total (pCi/L)	5		4.33
Fluoride, Total (mg/L)	4		0.82
Lead, Total (mg/L)	n/a	0.015	0.0016
Lithium, Total (mg/L)	n/a	0.04	0.03
Mercury, Total (mg/L)	0.002		0.000013
Molybdenum, Total (mg/L)	n/a	0.1	0.0027
Selenium, Total (mg/L)	0.05		0.0004
Thallium, Total (mg/L)	0.002		0.0005

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

Table 3: Revised Prediction Limits
Big Sandy Plant - Fly Ash Pond

Parameter	Unit	Description	MW-1601	MW-1602	MW-1603	MW-1606	MW-1607
Boron	mg/L	Interwell Background Value (UPL)	0.220				
Calcium	mg/L	Interwell Background Value (UPL)	105				
Chloride	mg/L	Interwell Background Value (UPL)	8.21				
Fluoride	mg/L	Interwell Background Value (UPL)	0.820				
pH	SU	Intrawell Background Value (UPL)	8.0	8.2	5.4	7.6	7.1
		Intrawell Background Value (LPL)	6.3	6.4	2.2	6.2	5.6
Sulfate	mg/L	Interwell Background Value (UPL)	106				
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	561				

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit

Table 4: Appendix III Data Summary
Big Sandy Plant - Fly Ash Pond

Parameter	Unit	Description	MW-1601		MW-1602		MW-1603		MW-1606		MW-1607	
			6/25/2019	8/21/2019	6/25/2019	8/20/2019	6/27/2019	8/20/2019	6/25/2019	8/20/2019	6/25/2019	8/20/2019
Boron	mg/L	Interwell Background Value (UPL)	0.220									
		Detection Monitoring Result	0.1 J	0.097	0.06 J	0.04 J	0.05 J	0.2 U	**1.84**	**1.74**	0.208	0.160
Calcium	mg/L	Interwell Background Value (UPL)	105									
		Detection Monitoring Result	50.7	52.1	69.8	74.5	83.3	95.8	74.5	75.1	91.9	101
Chloride	mg/L	Interwell Background Value (UPL)	8.21									
		Detection Monitoring Result	**8.23**	**8.43**	**12.2**	**13.2**	4.13	3.93	**30.8**	**31.4**	5.22	3.84
Fluoride	mg/L	Interwell Background Value (UPL)	0.820									
		Detection Monitoring Result	0.15	0.15	0.11	0.10	**0.87**	**0.84**	0.23	0.21	0.08	0.07
pH	SU	Intrawell Background Value (UPL)	8.0		8.2		5.4		7.6		7.1	
		Intrawell Background Value (LPL)	6.3		6.4		2.2		6.2		5.6	
		Detection Monitoring Result	7.0	7.1	7.5	7.5	3.7	3.5	7.1	7.0	6.6	6.5
Sulfate	mg/L	Interwell Background Value (UPL)	106									
		Detection Monitoring Result	86.4	82.9	**111**	**117**	**658**	**704**	58.7	58.3	**120**	**141**
Total Dissolved Solids	mg/L	Interwell Background Value (UPL)	561									
		Detection Monitoring Result	312	326	436	434	**954**	**1010**	384	385	388	419

Notes:
UPL: Upper prediction limit
LPL: Lower prediction limit
Bold values exceed the background value.
Background values are shaded gray.
U: Parameter was not present in concentrations at or above the method detection limit and is reported as the reporting limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit

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 Big Sandy Fly 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

STATE OF KENTUCKY
DAVID
ANTHONY
MILLER
33232
LICENSED
PROFESSIONAL ENGINEER

33232	KENTUCKY	01.03.20
License Number	Licensing State	Date

ATTACHMENT B

Statistical Analysis Output

December 8, 2019

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

Re: Big Sandy Fly Ash Pond – Assessment Monitoring & Background Update - 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting (GSC), formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the background update and analysis of groundwater data for American Electric Power Company's Big Sandy Bottom Ash Pond. 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 began at site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** MW-1011, MW-1012, MW-1203, MW-1604, and MW-1605; and
- **Downgradient wells:** MW-1601, MW-1602, MW-1603, MW-1606, and MW-1607.

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 CCR program consists of the following constituents:

- **Appendix III** (Detection Monitoring) - boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and

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

Time series plots for Appendix III and 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). Values in background which have been flagged as outliers may be seen in a lighter font and as a disconnected symbol on the graph. A summary of these values follows this letter. The time series plots are used to initially screen for suspected outliers and trends, while the box plots provide visual representation of variation within individual wells and between all wells.

Data at all wells were evaluated during the initial background screening conducted in December 2017 for the following: 1) outliers; 2) trends; 3) most appropriate statistical method for Appendix III parameters based on site characteristics of groundwater data upgradient of the facility; and 4) eligibility of downgradient wells when intrawell statistical methods are recommended. Power curves were provided to demonstrate that the selected statistical methods for Appendix III parameters comply with the USEPA Unified Guidance recommendations as discussed below.

Summary of Statistical Method:

1) Intrawell prediction limits, combined with a 1-of-2 resample plan for ph; and
2) Interwell prediction limits combined with a 1-of-2 resample plan for boron, calcium, chloride, fluoride, sulfate and TDS.

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. 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 prediction limits.

- 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, simple substitution of one-half the reporting limit is utilized in the statistical analysis. The reporting limit

utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory.
- 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 prediction limits are used on data containing greater than 50% nondetects.

Summary of Background Screening Conducted in December 2017

Outlier Evaluation

Time series plots are used to identify suspected outliers, or extreme values that would result in limits that are not conservative from a regulatory perspective, in proposed background data. Suspected outliers at all wells for Appendix III and Appendix IV parameters were formally tested using Tukey's box plot method and, when identified, flagged in the computer database with "o" and deselected prior to construction of statistical limits.

Tukey's outlier test did not note any outliers for each of the Appendix III parameters, with a couple exceptions. Well MW-1607 had a couple outliers identified for antimony, but only the highest concentration of 0.06 mg/L was flagged as an outlier. No values were flagged for cadmium in well MW-1602 as all values were trace values estimated between the Method Detection Limit and the Practical Quantitation Limit, with one value reported as a nondetect. The outliers identified for molybdenum in wells MW-1606 and MW-1607 were not flagged as outliers because the concentrations are the most recent reported value and could indicate a change in the population. If it is determined that these values were incorrectly recorded in the database, they will either be flagged as outliers or they will be corrected if possible. A substitution of the most recent reporting limit was applied when varying detection limits existed in data.

No true seasonal patterns were observed on the time series plots for any of the detected data; therefore, no deseasonalizing adjustments were made to the data. When seasonal patterns are observed, data may be deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release. It was noted that for each constituent evaluated, the highest concentrations are reported in the upgradient wells.

While trends may be visual, a quantification of the trend and its significance is needed. The Sen's Slope/Mann Kendall trend test was used to evaluate all data at each well to identify statistically significant increasing or decreasing trends. In the absence of suspected contamination, significant trending data are typically not included as part of the background data used for construction of prediction limits. This step serves to eliminate the trend and, thus, reduce variation in background. When statistically significant decreasing trends are present, earlier data are evaluated to determine whether earlier concentration levels are significantly different than current reported concentrations and will be deselected as necessary. When the historical records of data are truncated for the reasons above, a summary report will be provided to show the date ranges used in construction of the statistical limits.

The results of the trend analyses showed several statistically significant decreasing trends, as may be seen on the Trend Test Summary table. These trends were similar in magnitude to the average reported concentrations. One exception is fluoride in upgradient well MW-1604 which appears to be developing a pattern of lower concentrations than previously reported. If future concentrations continue at these lower levels, earlier data will be deselected prior to construction of statistical limits so that resulting limits are more conservative from a regulatory perspective. No other adjustments were required for any other data sets.

<u>Appendix III – Determination of Spatial Variation</u>

The Analysis of Variance (ANOVA) was used to statistically evaluate differences in average concentrations among upgradient wells, which assists in identifying the most appropriate statistical approach. Interwell tests, which compare downgradient well data to statistical limits constructed from pooled upgradient well data, are appropriate when average concentrations are similar across upgradient wells. Intrawell tests, which compare compliance data from a single well to screened historical data within the same well, are appropriate when upgradient wells exhibit spatial variation; when statistical limits constructed from upgradient wells would not be conservative from a regulatory perspective; and when downgradient water quality is unimpacted compared to upgradient water quality for the same parameter.

The ANOVA identified variation for all Appendix III parameters. Therefore, all parameters were further evaluated as described for the appropriateness of intrawell testing to accommodate the groundwater quality. A summary table of the ANOVA results was included with the reports.

Appendix III - Statistical Limits

Intrawell limits constructed from carefully screened background data from within each well serve to provide statistical limits that are conservative (i.e. lower) from a regulatory perspective, and that will rapidly identify a change in more recent compliance data from within a given well. This statistical method removes the element of variation from across wells and eliminates the chance of mistaking natural spatial variation for a release from the facility. Prior to performing intrawell prediction limits, several steps are required to reasonably demonstrate downgradient water quality does not have existing impacts from the practices of the facility.

Exploratory data analysis was used as a general comparison of concentrations in downgradient wells for all Appendix III parameters recommended for intrawell analyses to concentrations reported in upgradient wells. Upper tolerance limits are used in conjunction with confidence intervals to determine whether the estimated averages in downgradient wells are higher than observed levels upgradient of the facility. The upper tolerance limits were constructed to represent the extreme upper range of possible background levels at the site.

In cases where downgradient average concentrations are higher than observed concentrations upgradient for a given constituent, an independent study and hydrogeological investigation would be required to identify local geochemical conditions and expected groundwater quality for the region to justify an intrawell approach. Such an assessment is beyond the scope of services provided by Groundwater Stats Consulting. When there is not an obvious explanation for observed concentration differences in downgradient wells relative to reported concentrations in upgradient wells, interwell prediction limits will initially be selected for the statistical method until further evidence shows that concentrations are due to natural variation rather than a result of the facility.

Parametric tolerance limits were constructed with a target of 99% confidence and 95% coverage using pooled upgradient well data for each of the Appendix III parameters. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. As more data are collected, the background population is better represented and the confidence and coverage levels increase.

Confidence intervals were constructed on downgradient wells for each of the Appendix III parameters, using the tolerance limits discussed above, to determine intrawell eligibility. When the entire confidence interval is above a background standard for a given parameter, interwell methods are initially recommended as the statistical method.

Therefore, only parameters with confidence intervals which did not exceed background standards are eligible for intrawell prediction limits.

Confidence intervals for the above parameters were found to be within their respective background limit for pH, but at least one well was above background limits all other Appendix III parameters. Therefore, intrawell methods are recommended for pH; and interwell methods are initially recommended for boron, calcium, chloride, fluoride, sulfate, and TDS. As mentioned earlier, if a demonstration supports natural variation in groundwater, intrawell methods will be considered for all parameters.

All available data through July 2017 at each well were used to establish intrawell background limits for pH based on a 1-of-2 resample plan that will be used for future comparisons. Interwell prediction limits, combined with a 1-of-2 resample plan, were constructed from upgradient wells for all other Appendix III parameters. Downgradient measurements will be compared to these background limits during each subsequent semi-annual sampling event.

Natural systems continuously evolve due to physical changes made to the environment. Examples include capping a landfill, paving areas near a well, or lining a drainage channel to prevent erosion. Periodic updating of background statistical limits will be necessary to accommodate these types of changes In the interwell case, newer data will be included in background when a minimum of 2 new samples are available. In the intrawell case, data for all wells and constituents are re-evaluated when a minimum of 4 new data points are available to determine whether earlier concentrations are representative of present-day groundwater quality. In some cases, the earlier portion of data are deselected prior to construction of limits in order to provide sensitive limits that will rapidly detect changes in groundwater quality. Even though the data are excluded from the calculation, the values will continue to be reported and shown in tables and graphs.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of an additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered to be a false positive result and, therefore, no further action is necessary. All analyses were submitted with the background screening report.

November 2019 - Background Update

Data were re-evaluated using Tukey's outlier test and visual screening with the March 2019 samples. All Appendix III parameters are tested using interwell prediction limits; therefore, only upgradient wells were tested for outliers for these constituents (Figure C). Tukey's outlier test was used to evaluate all wells for pH, which is tested using intrawell prediction limits, and for all Appendix IV parameters (Figure C). Outliers were identified by Tukey's for combined radium in well MW-1604, molybdenum in wells MW-1606 and MW-1607, and selenium in well MW-1607. These values were flagged in the database as outliers. While the test identified a few outliers for selenium in well MW-1607, only the highest value was flagged and deselected in the data base as the other measurements were similar to the other reported values within this record. Additional values were flagged as outliers for combined radium in wells MW-1604 and MW-1605, as well as molybdenum in well MW-1604 and MW-1605 after observing all additional wells for these constituents. Although Tukey's did not identify these values as outliers, the data did not appear to represent the population for these well/constituent pairs.

For constituents requiring intrawell prediction limits, the Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through June 2017 to the new compliance samples at each well through March 2019 to evaluate whether the groups are statistically similar at the 99% confidence level, in which case background data may be updated with compliance data (Figure D). No statistically significant differences were found between the two groups for pH in any of the wells.

When the test concludes that the medians of the two groups are significantly different, particularly in the downgradient wells, the background may not updated to include the newer data but will be reconsidered in the future. A summary of these results follows this letter and the test results are included with the Mann Whitney test section at the end of this report.

Intrawell prediction limits using all historical data through March 2019 combined with a 1-of-2 resample plan, were constructed for pH and a summary of the updated limits follows this letter (Figure E).

The Sen's Slope/Mann Kendall trend test was used to evaluate data at upgradient wells for boron, calcium, chloride, fluoride, sulfate and TDS to identify statistically significant increasing or decreasing trends (Figure F). The results of the trend analyses showed no statistically significant increasing trends. Statistically significant decreasing trends were noted for chloride, fluoride and TDS in upgradient well MW-1604. However, the magnitudes of the trends are low relative to average concentrations within this well and reported measurements are consistent with those reported at one or more neighboring upgradient wells. Therefore, no adjustments were made to the records at this time. All records will be re-evaluated during the next background update and, if earlier measurements are no longer representative of present-day conditions, the historical portion of the records will be deselected prior to construction of statistical limits.

Interwell prediction limits, combined with a 1-of-2 resample plan, were updated using all available data from upgradient wells for the same time period for boron, calcium, chloride, fluoride, sulfate and TDS (Figure G). Interwell prediction limits pool upgradient well data to establish a background limit for an individual constituent. A summary table of the updated limits may be found following this letter in the Prediction Limit Summary Tables.

Evaluation of Appendix IV Parameters

Parametric tolerance limits were used to calculate background limits from pooled upgradient well data for Appendix IV parameters with a target of 95% confidence and 95% coverage to determine the Alternate Contaminant Level (ACL) (Figure H). The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standards (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure I).

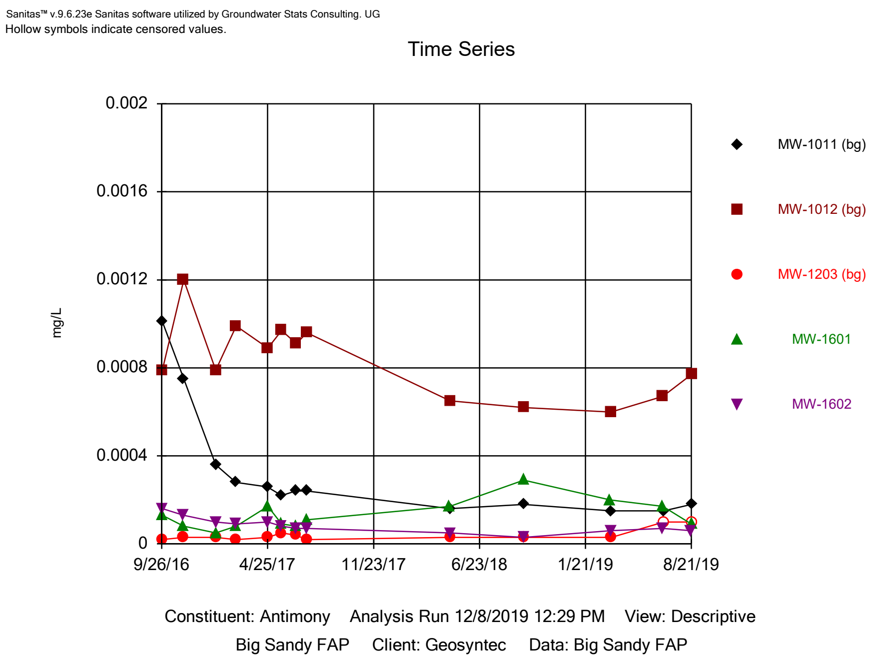
Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, CCR-Rule specified level or ACL as discussed above (Figure H). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. The following confidence intervals exceeded their respective GWPS: beryllium, cobalt, combined radium and lithium in well MW-1603. A summary of the confidence interval results follows this letter.

Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for Big Sandy Fly Ash Pond. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina Rayner

Kristina L. Rayner
Groundwater Statistician



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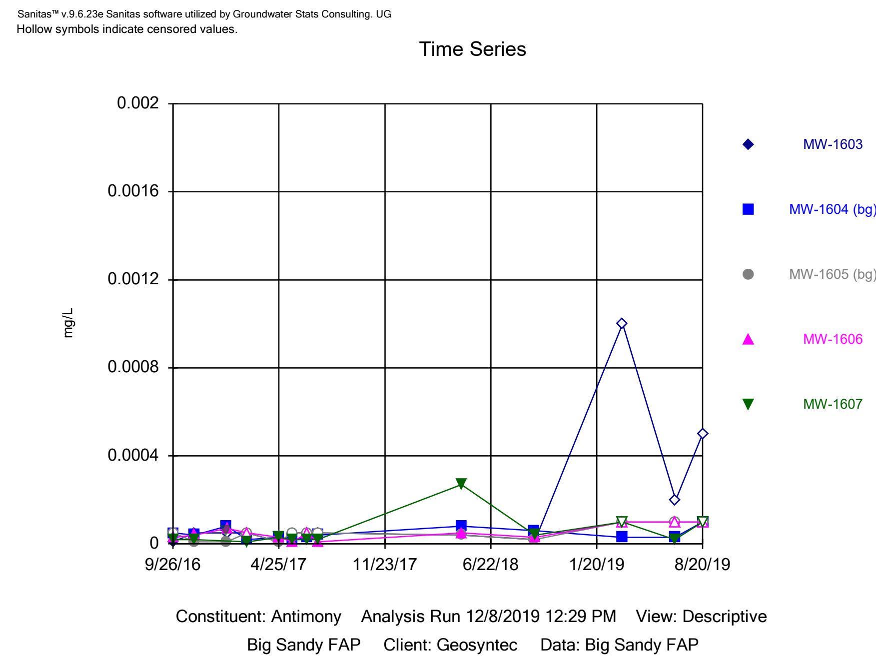

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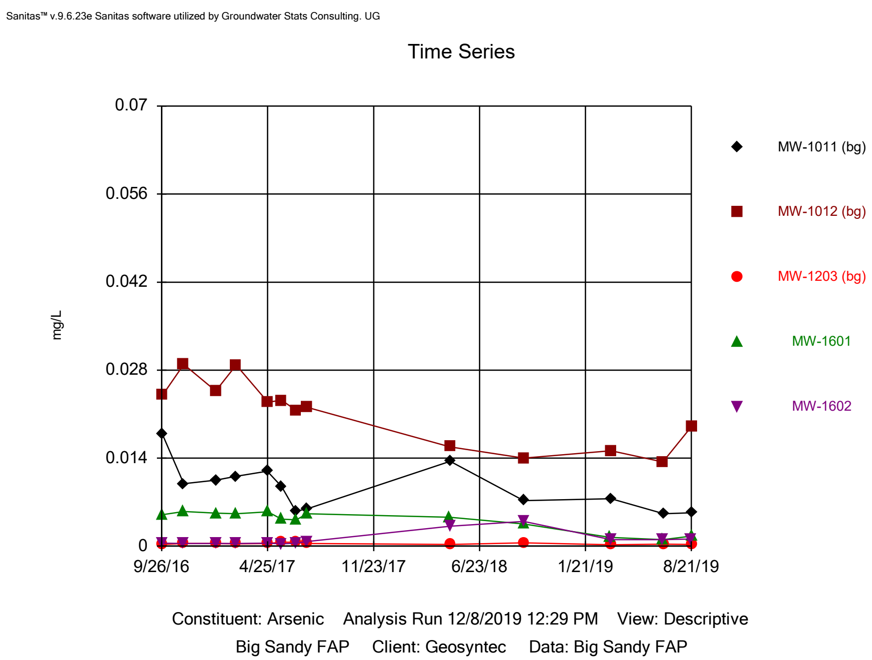

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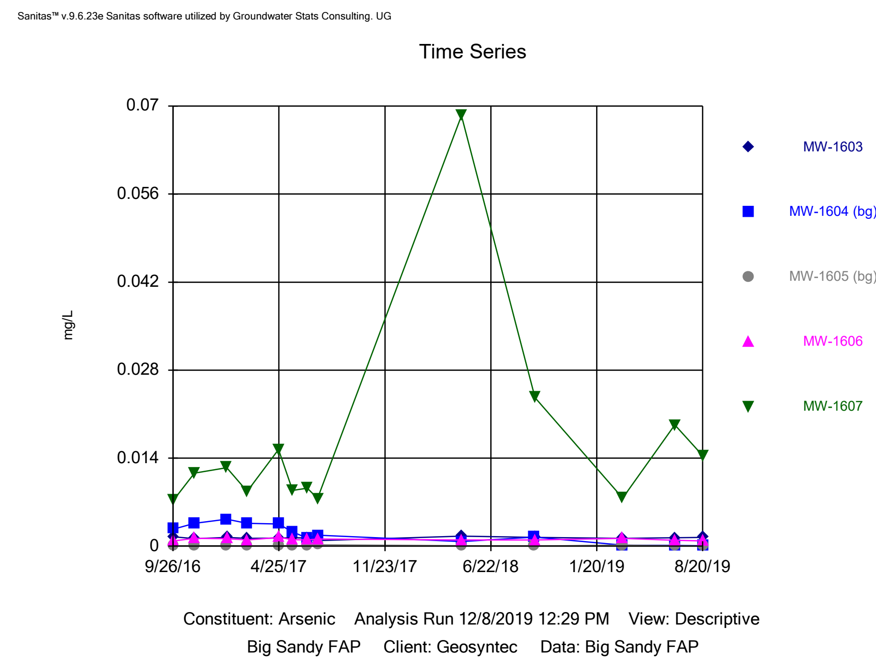

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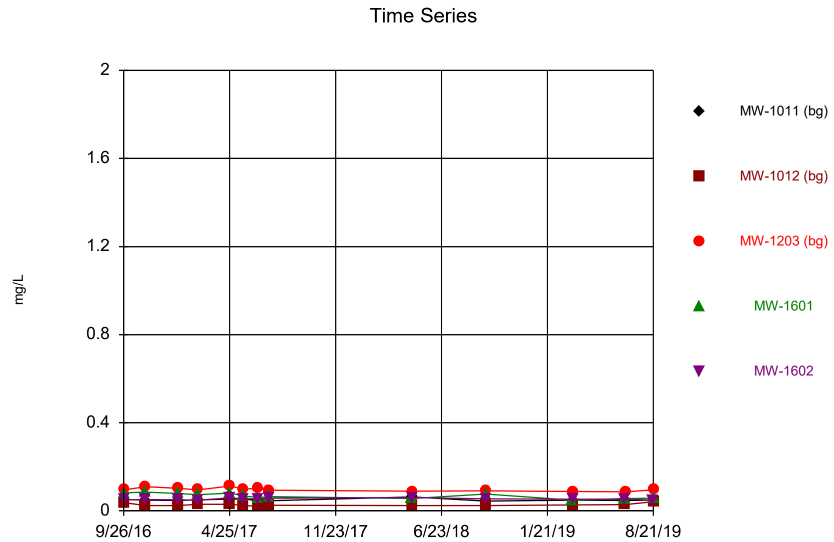

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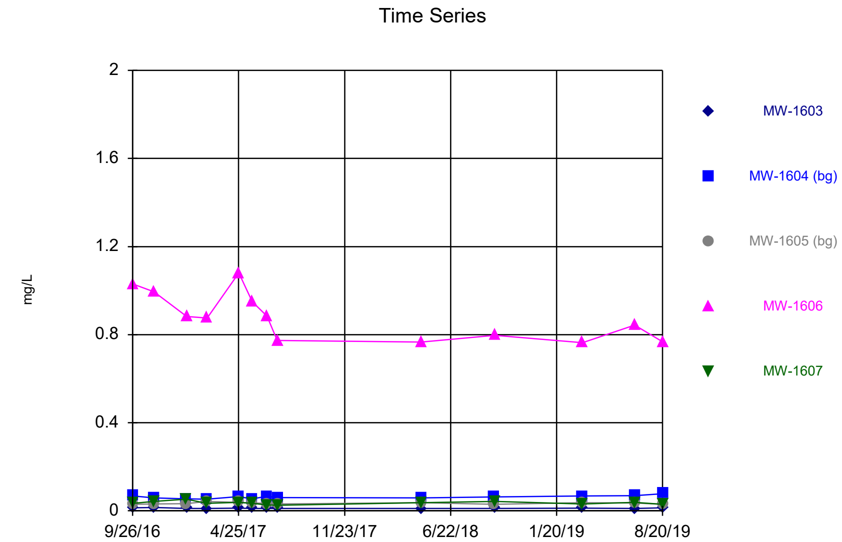

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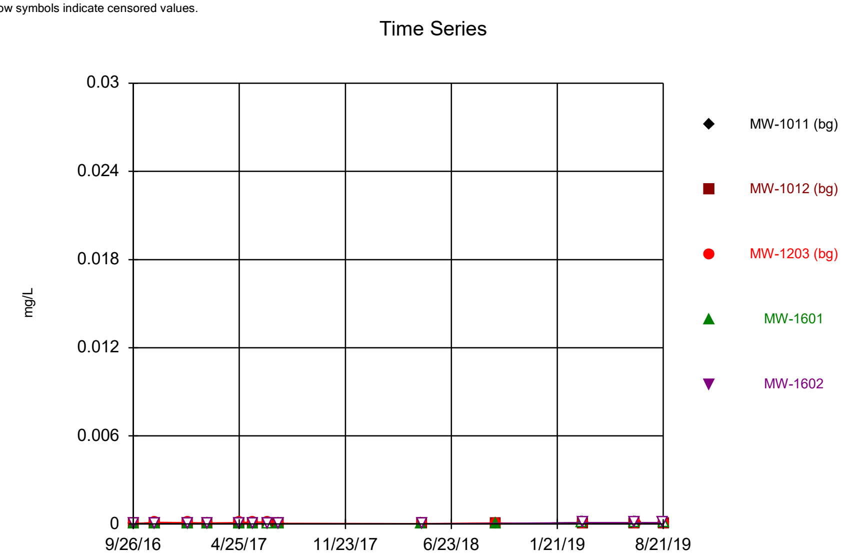

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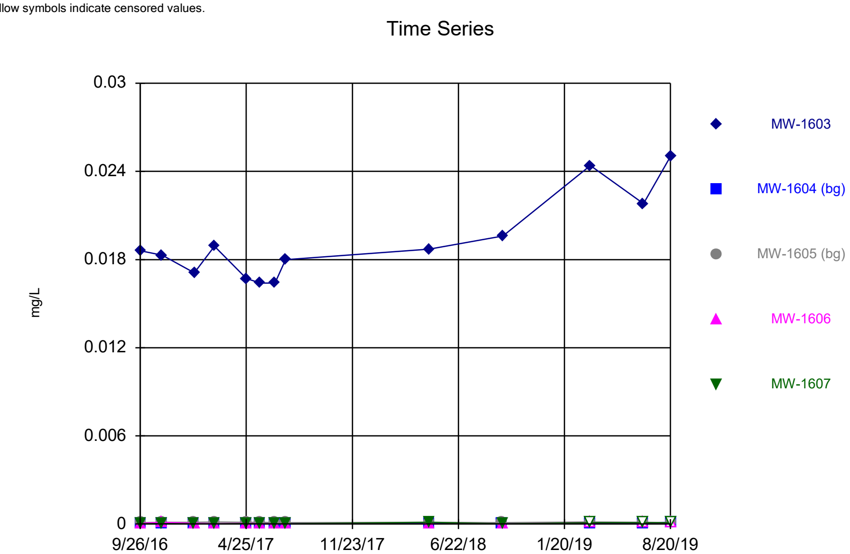

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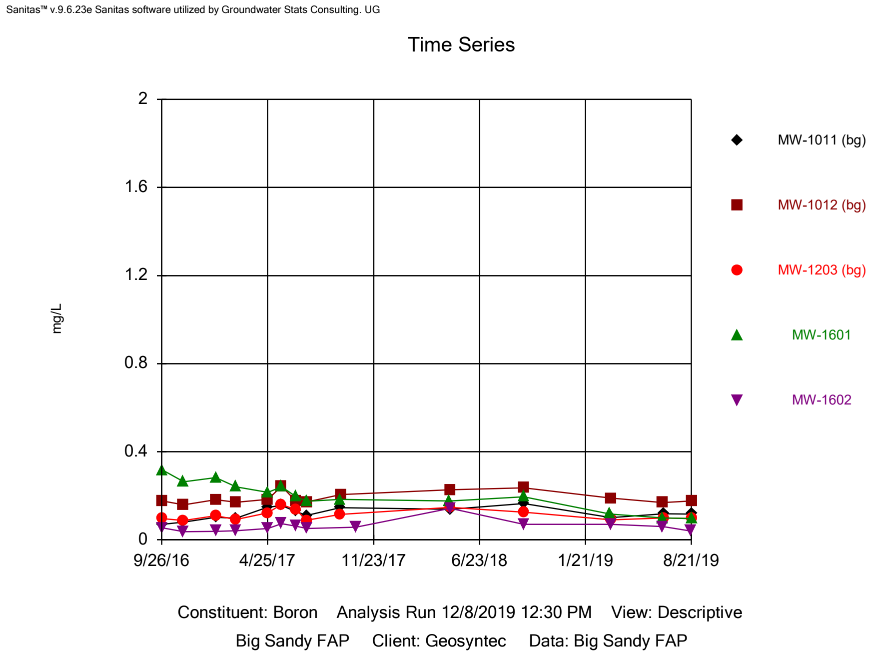

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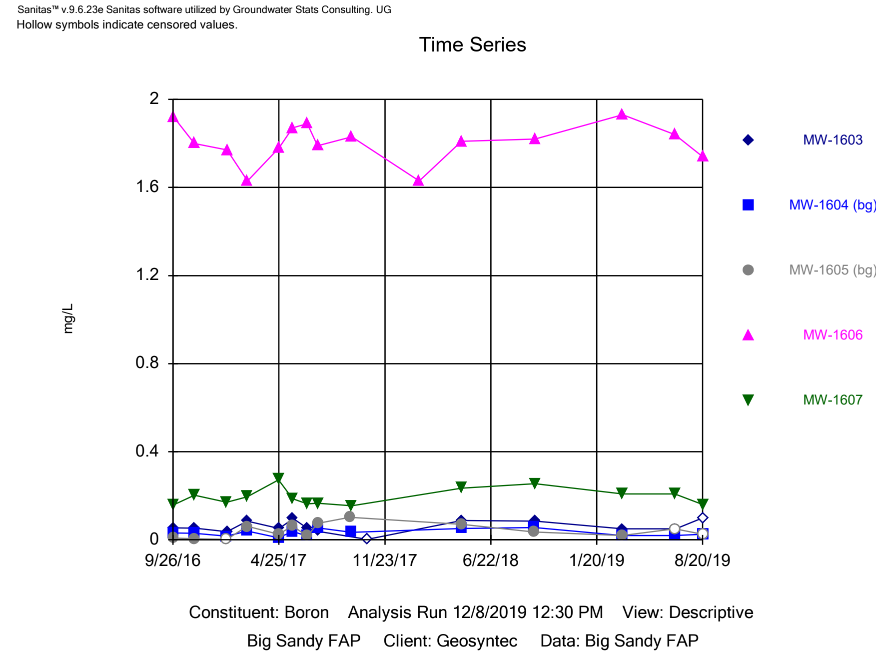

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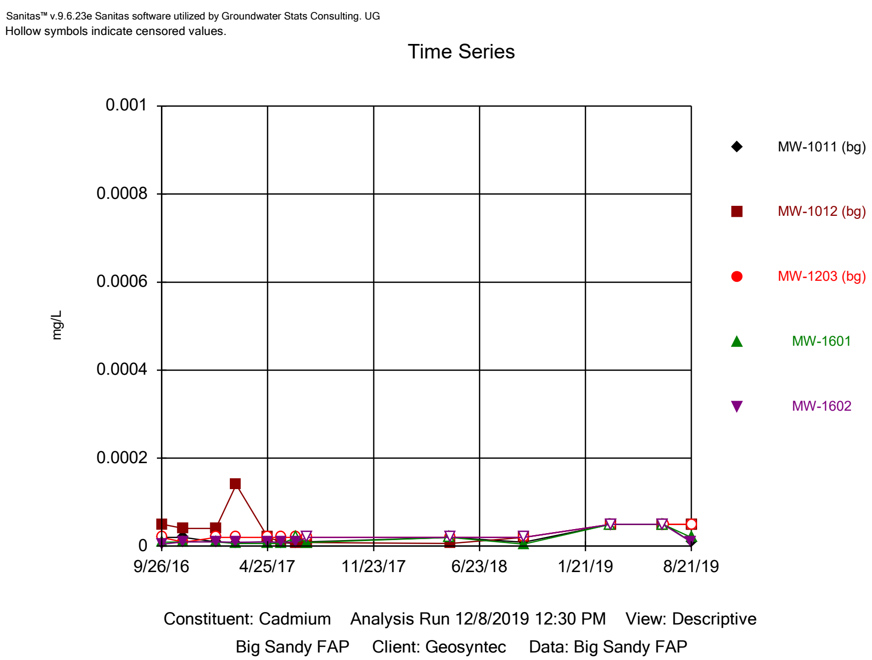

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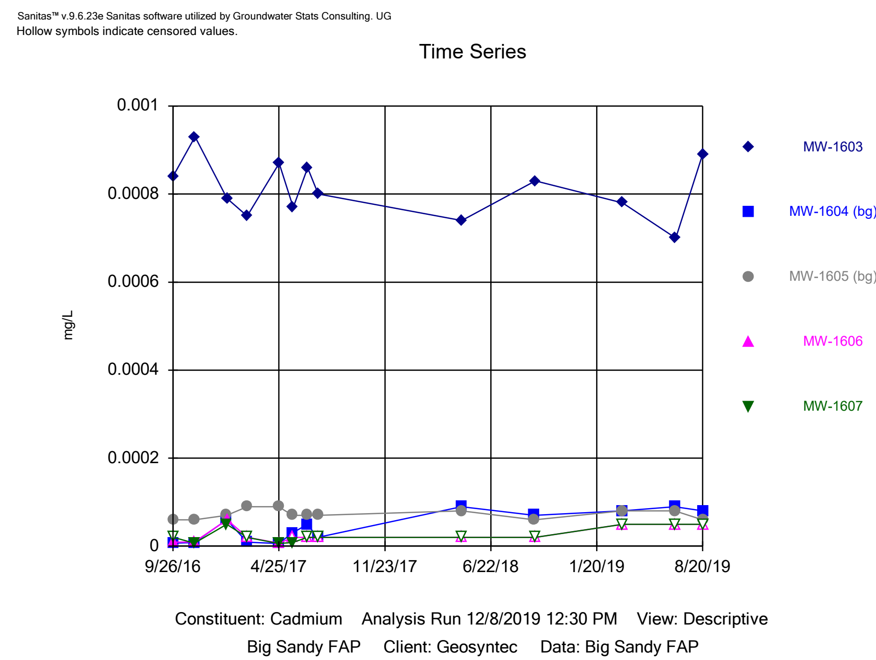

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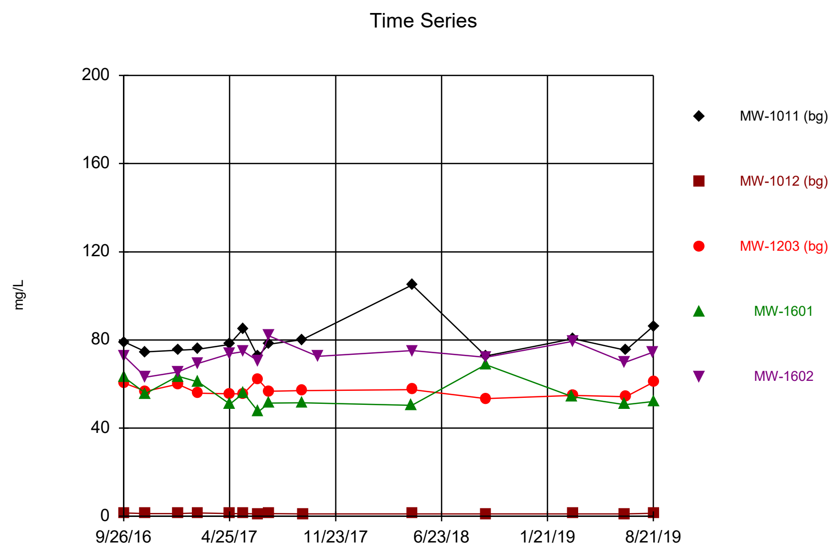

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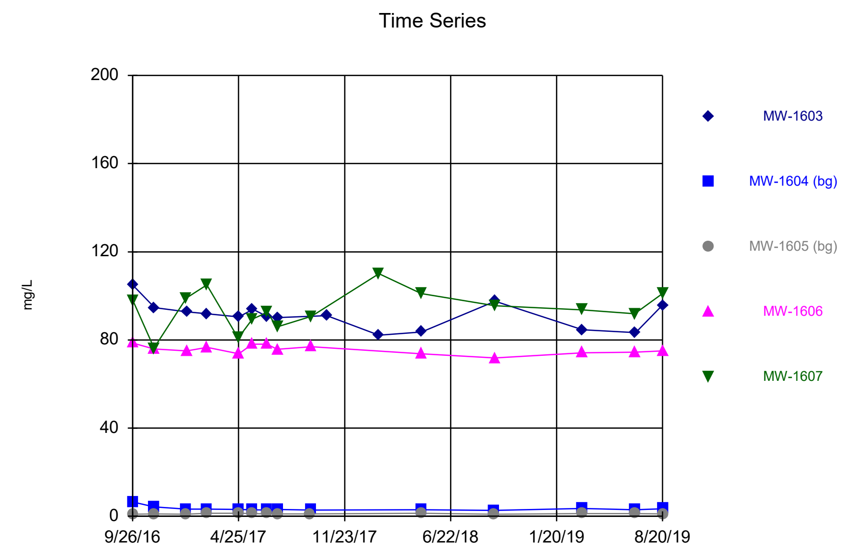

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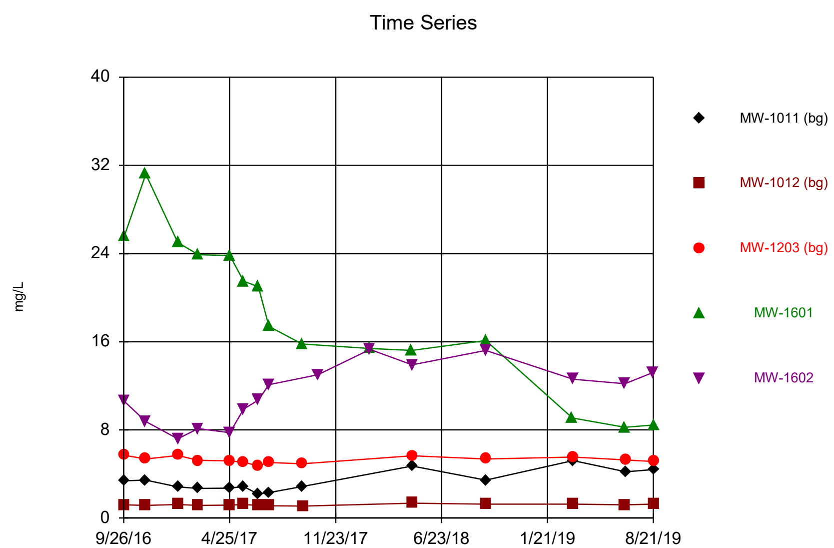

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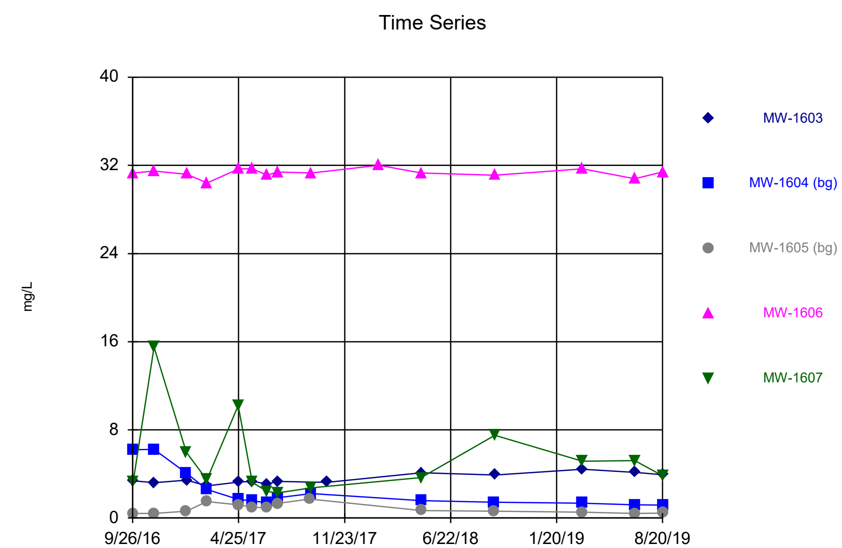

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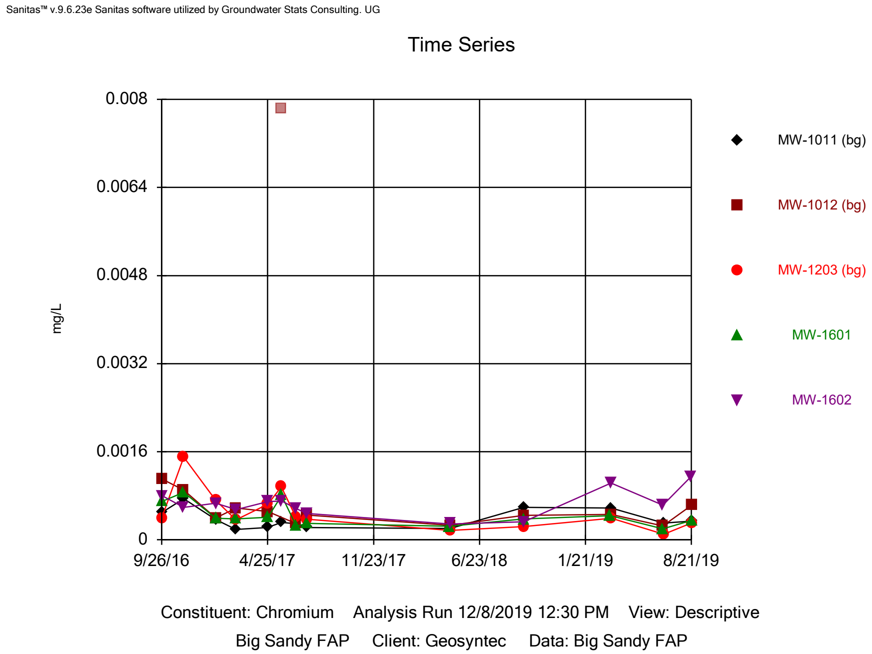

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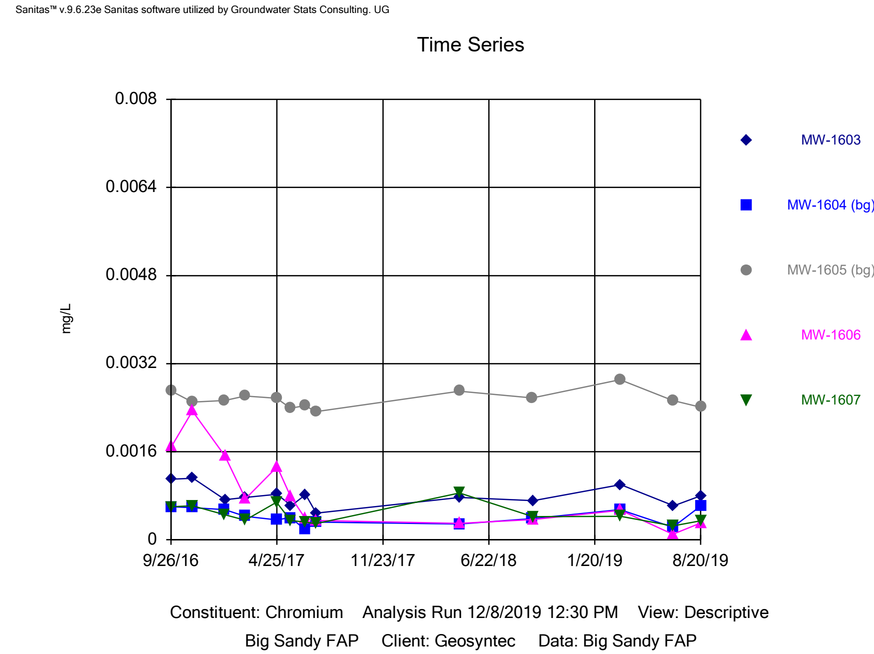

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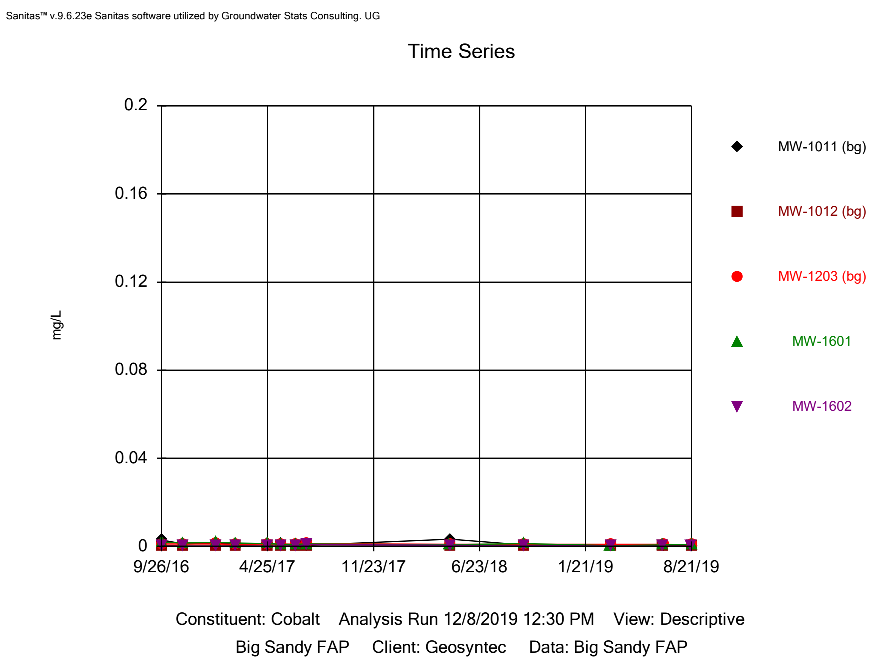

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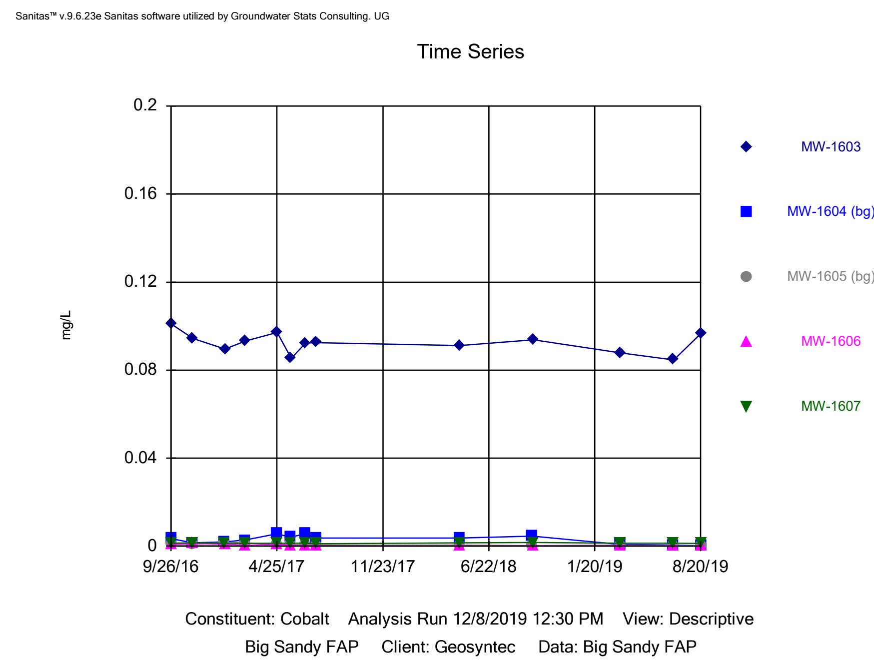

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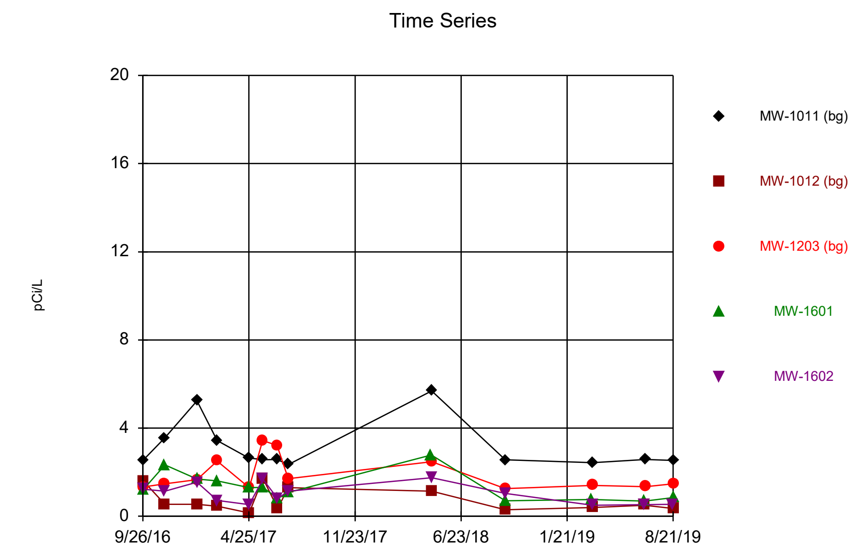

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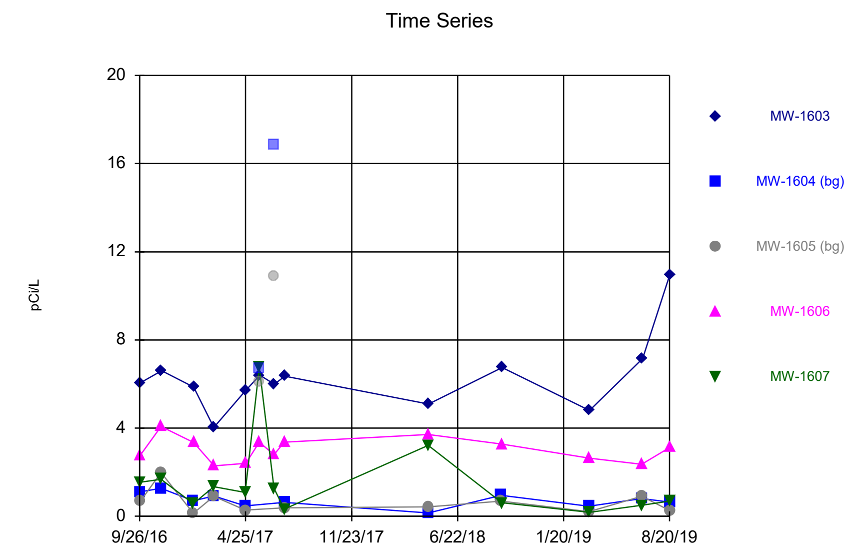
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG



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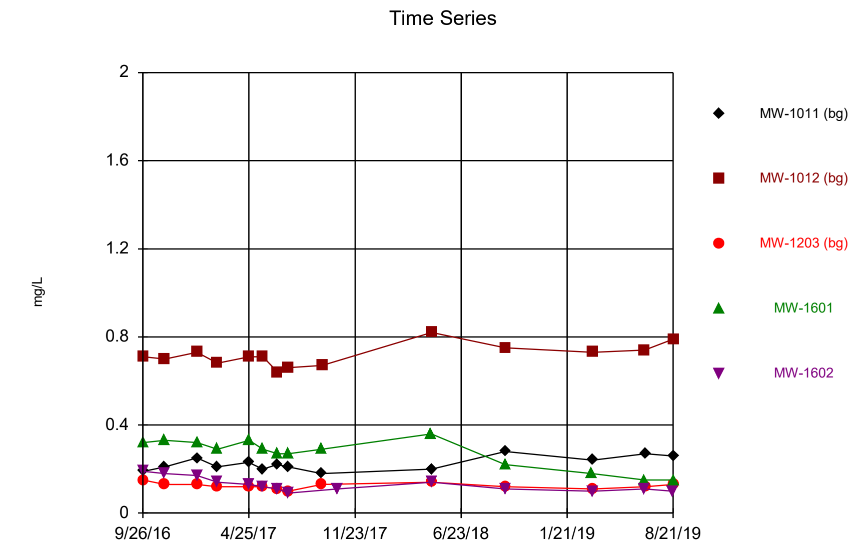
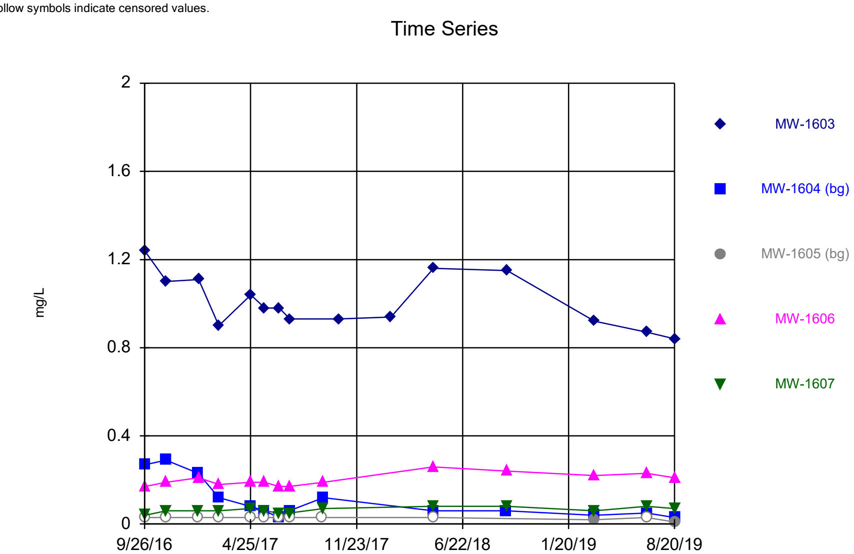
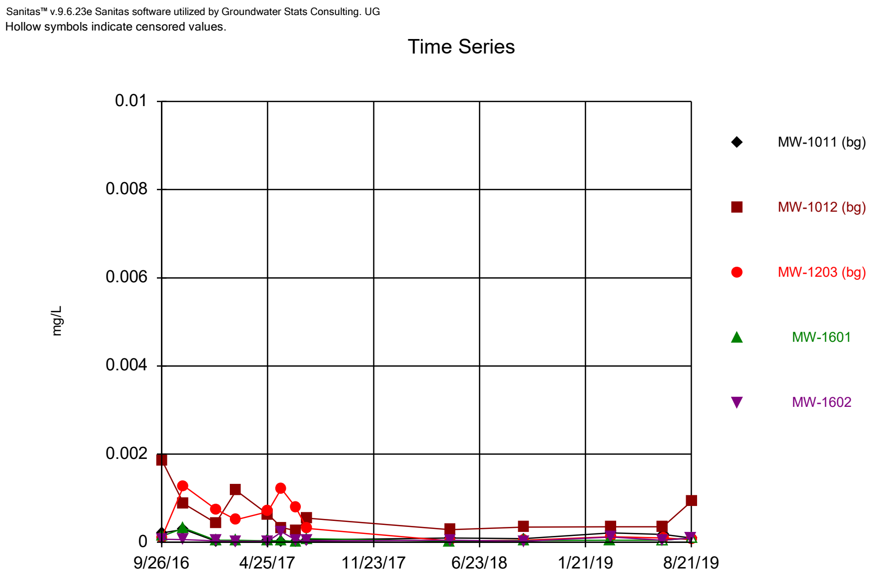


Constituent: Fluoride Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

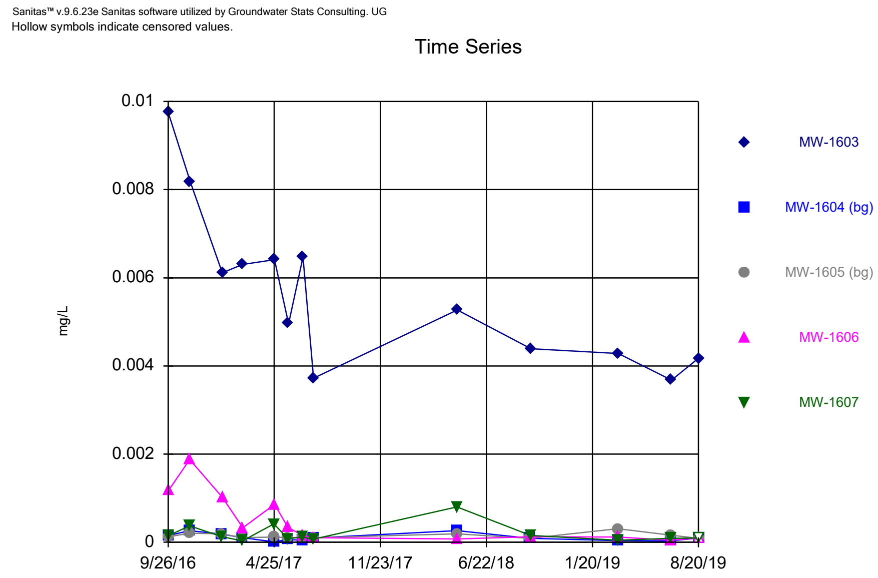
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.



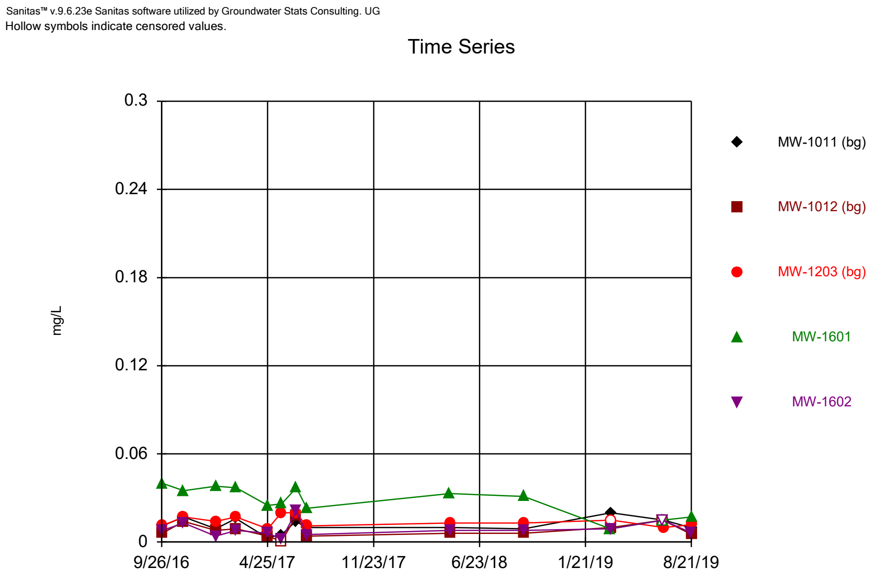
Constituent: Fluoride Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



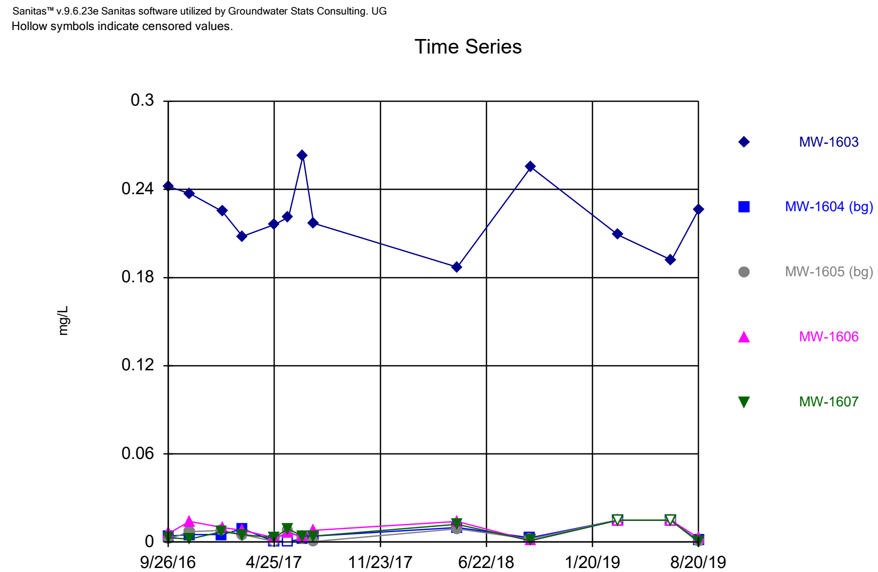
Constituent: Lead Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Constituent: Lead Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



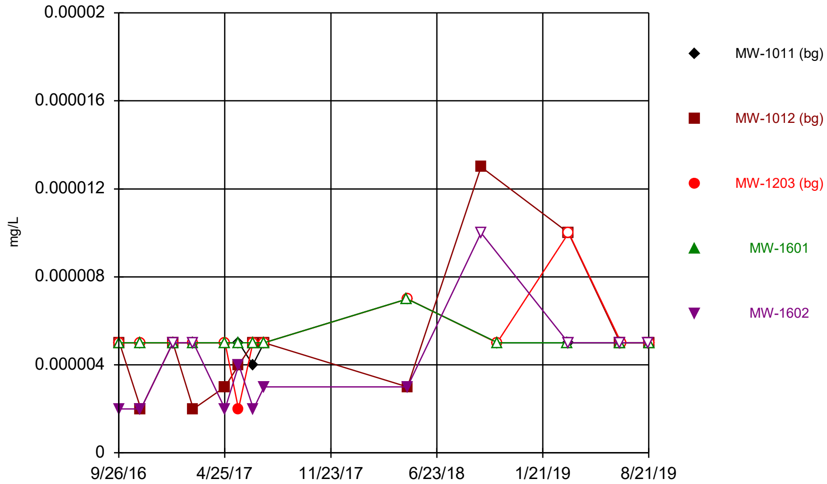
Constituent: Lithium Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Constituent: Lithium Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

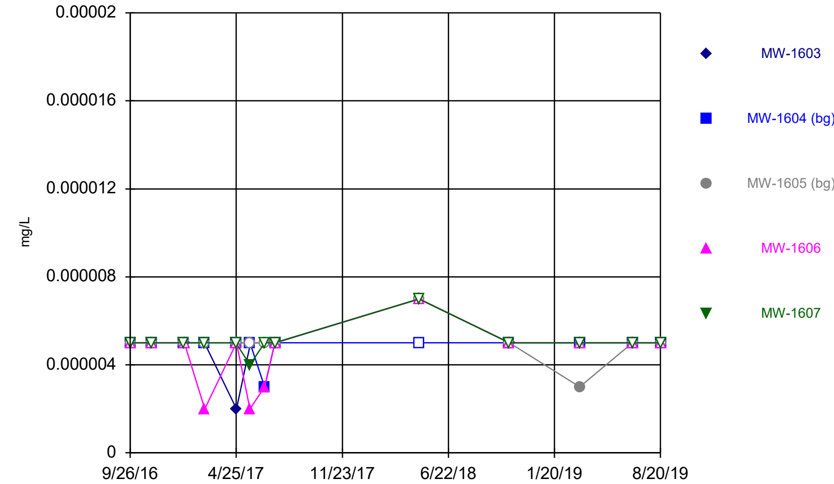
Time Series



Constituent: Mercury Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

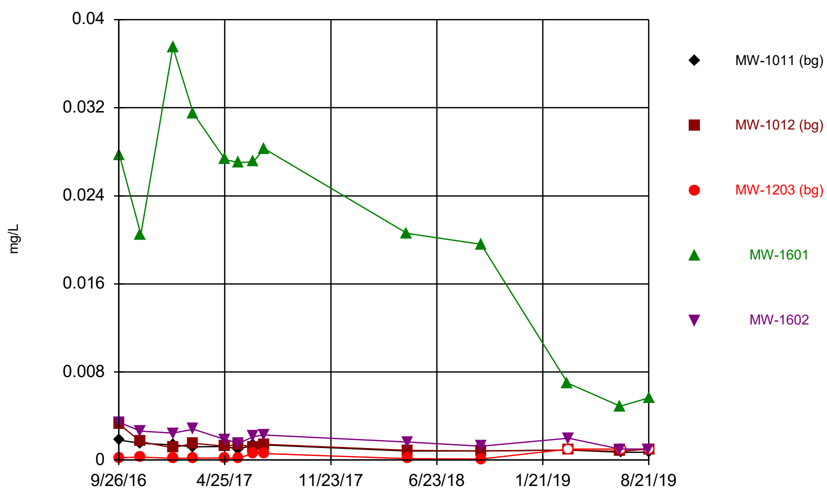
Time Series



Constituent: Mercury Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

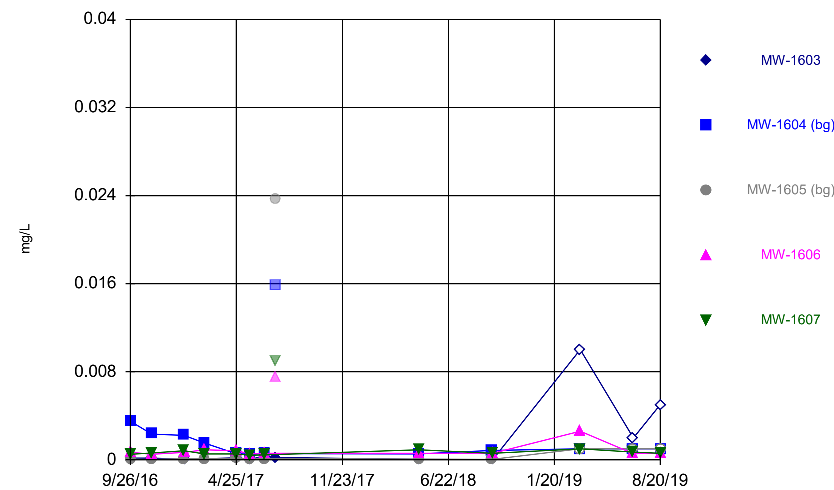
Time Series



Constituent: Molybdenum Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

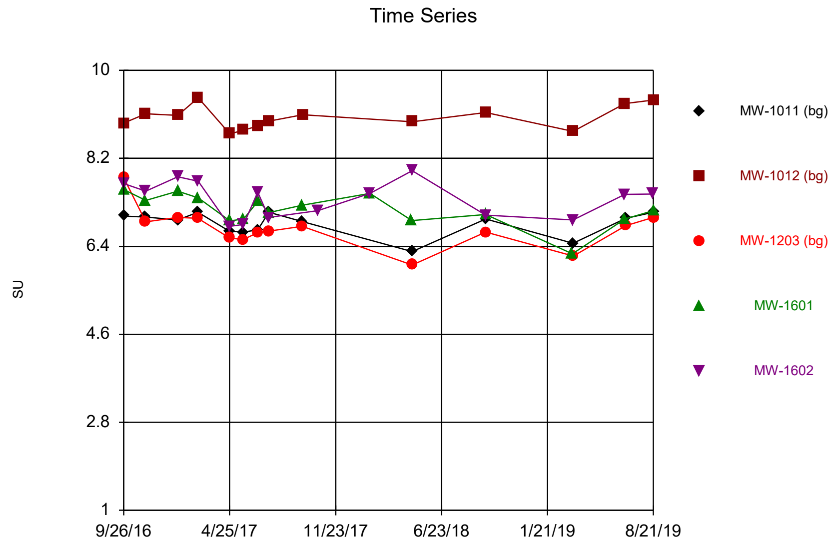
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



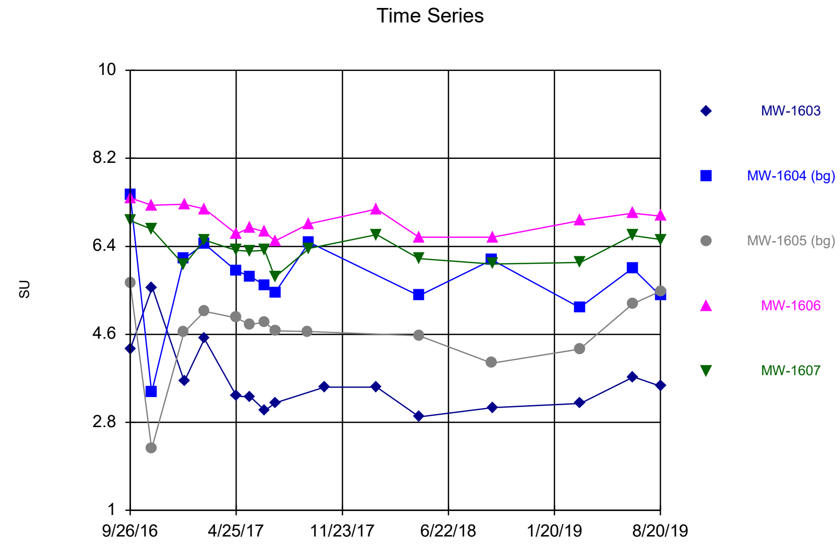
Constituent: Molybdenum Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG



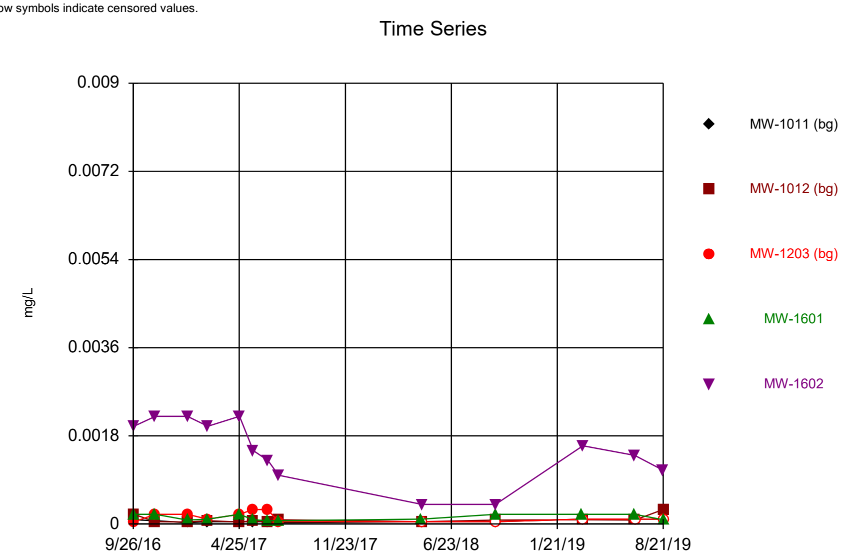
Constituent: pH Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG



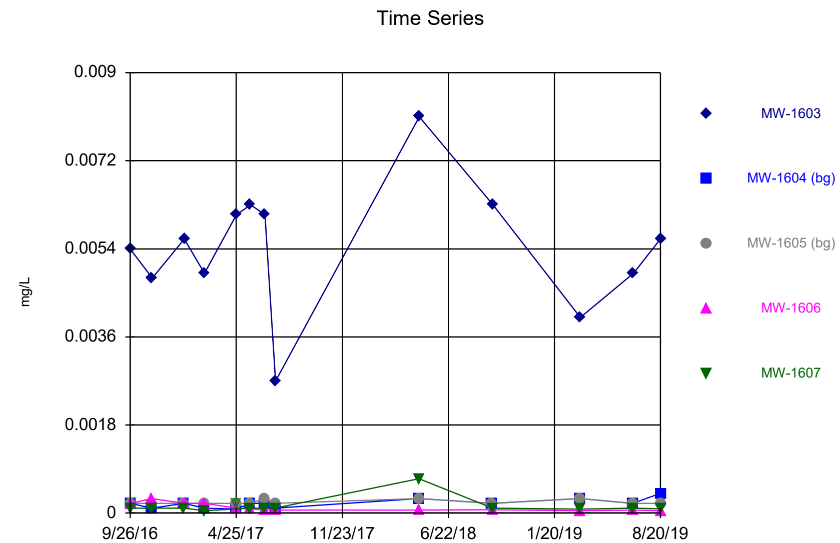
Constituent: pH Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

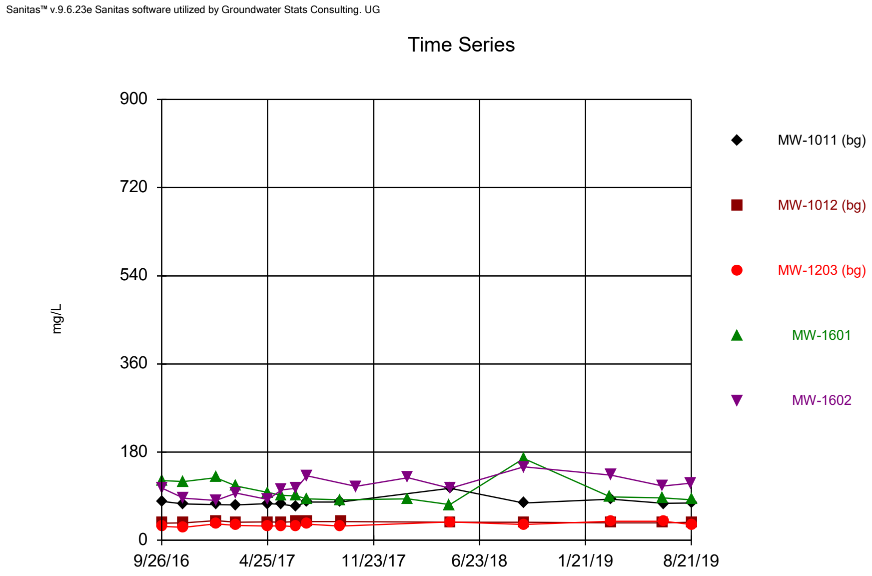


Constituent: Selenium Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

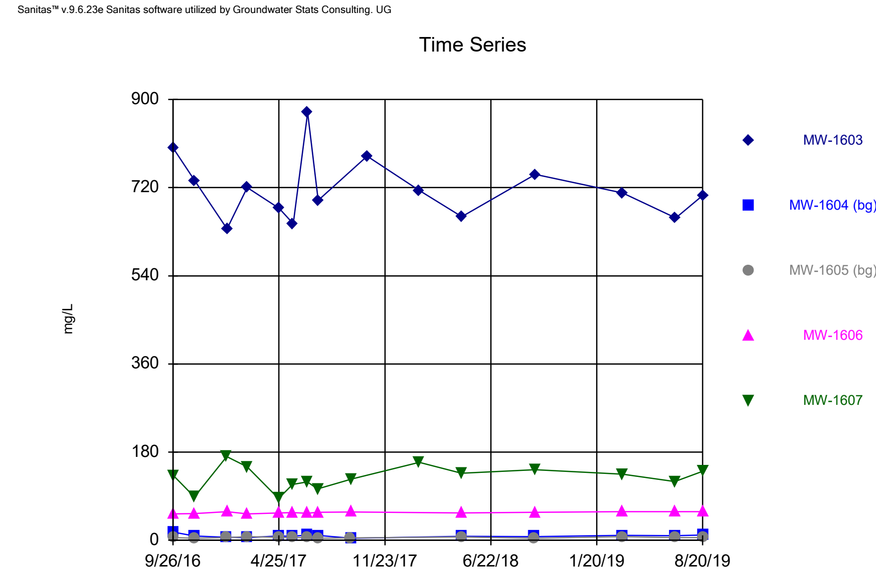
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG



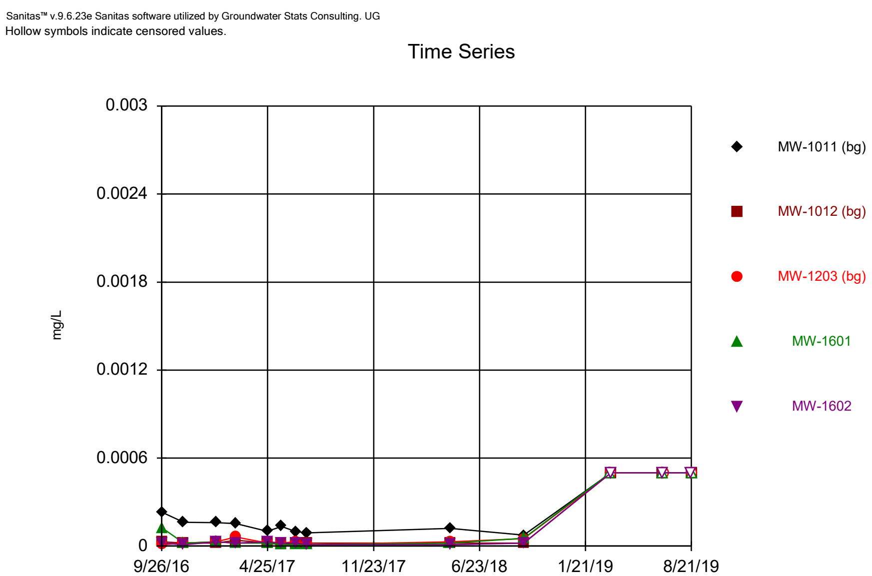
Constituent: Selenium Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



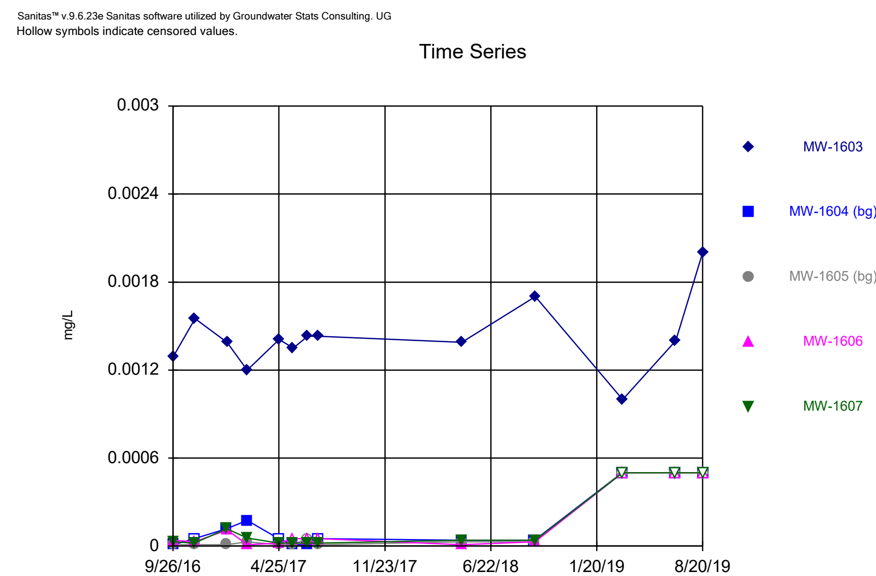
Constituent: Sulfate Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



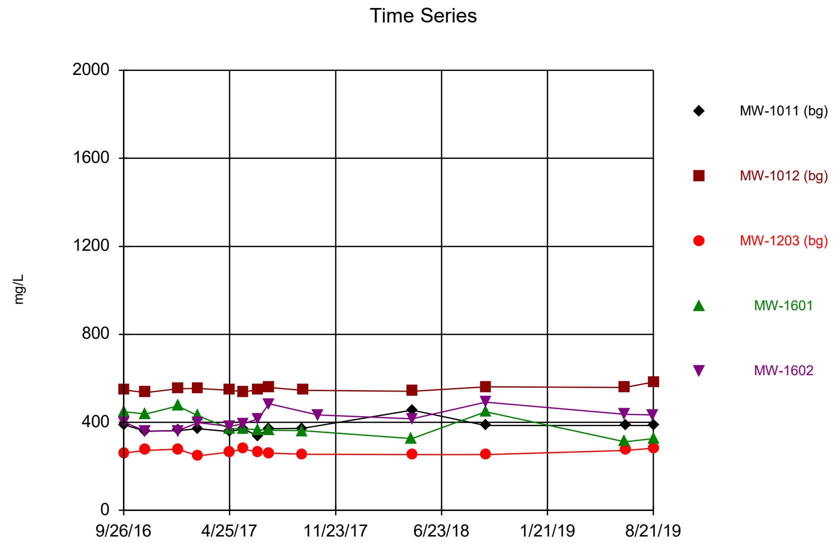
Constituent: Sulfate Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Constituent: Thallium Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

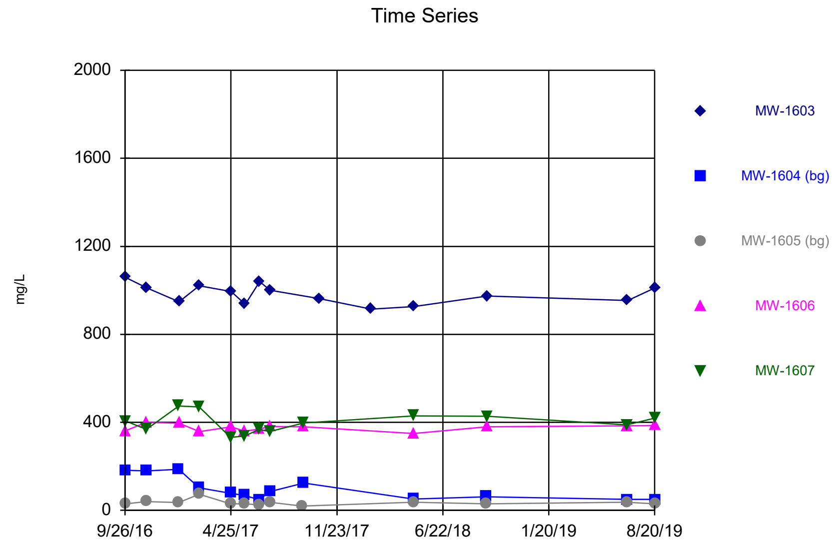


Constituent: Thallium Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Constituent: Total Dissolved Solids Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

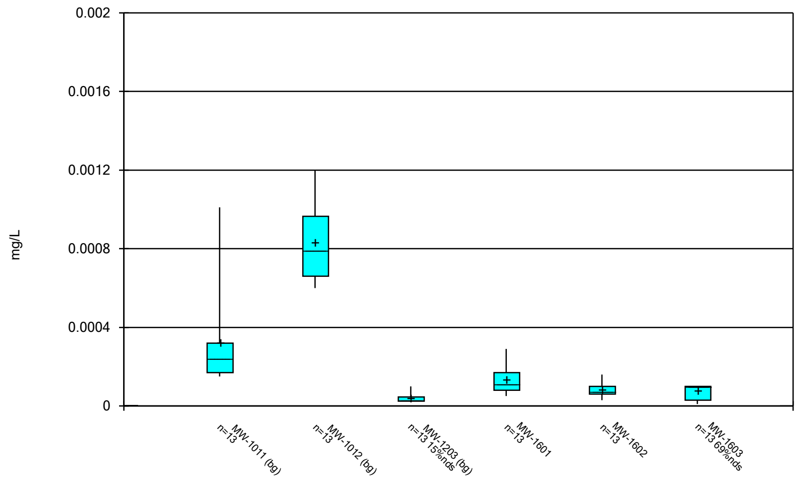
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG



Constituent: Total Dissolved Solids Analysis Run 12/8/2019 12:30 PM View: Descriptive
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

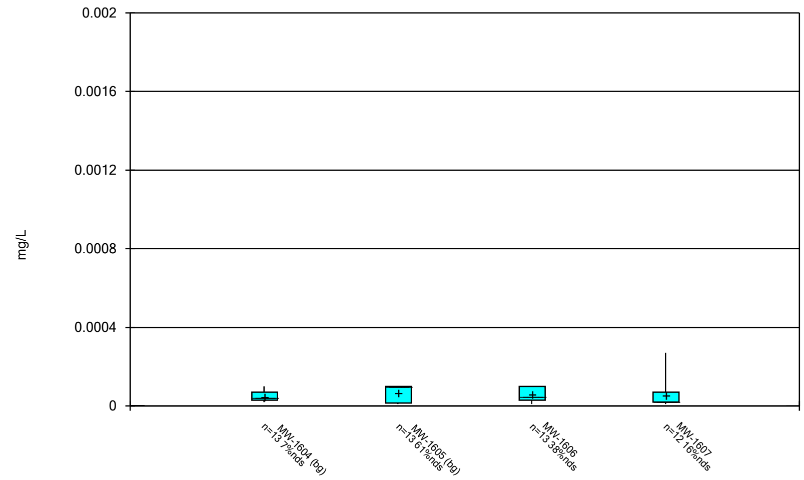
Box & Whiskers Plot



Constituent: Antimony Analysis Run 11/13/2019 5:04 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

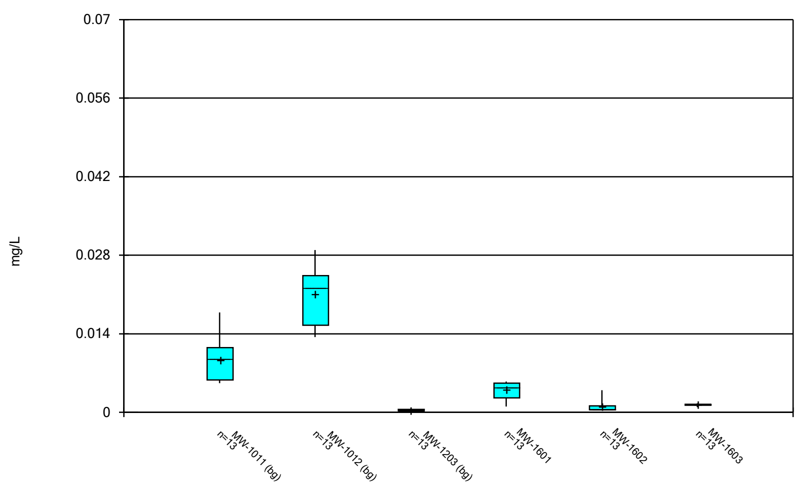
Box & Whiskers Plot



Constituent: Antimony Analysis Run 11/13/2019 5:04 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

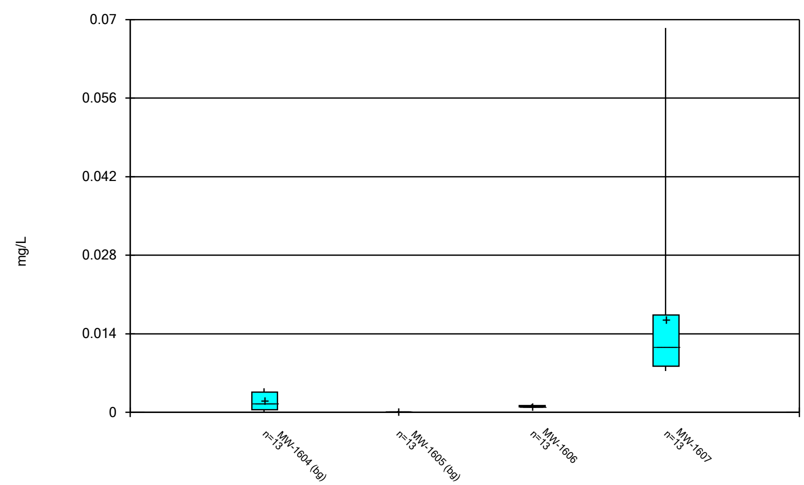
Box & Whiskers Plot



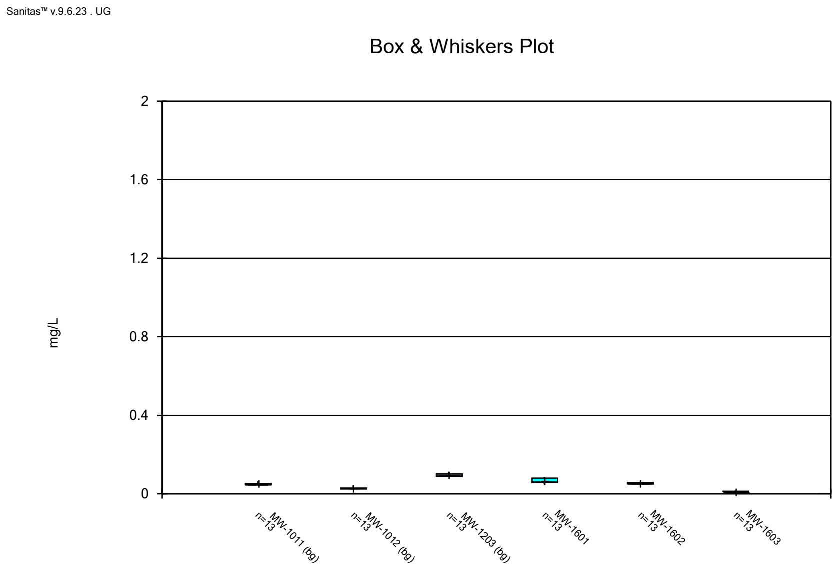
Constituent: Arsenic Analysis Run 11/13/2019 5:04 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

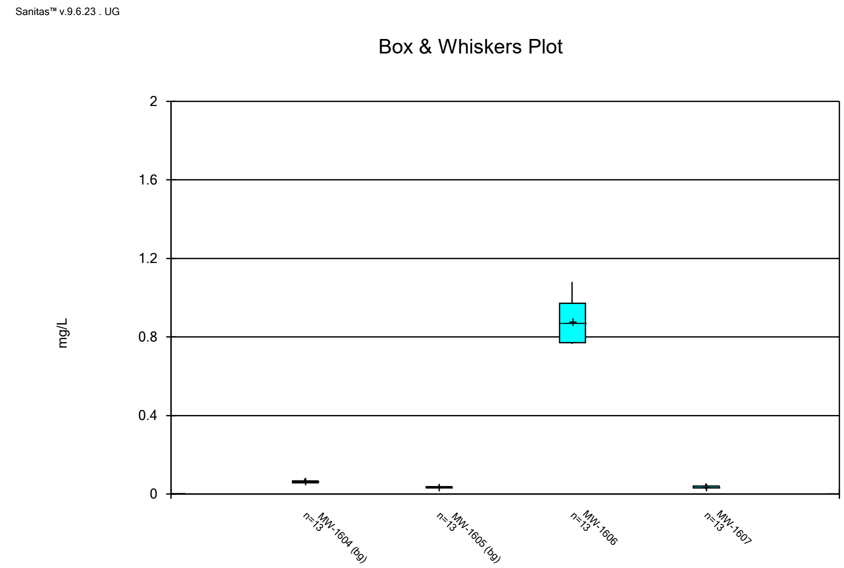
Box & Whiskers Plot



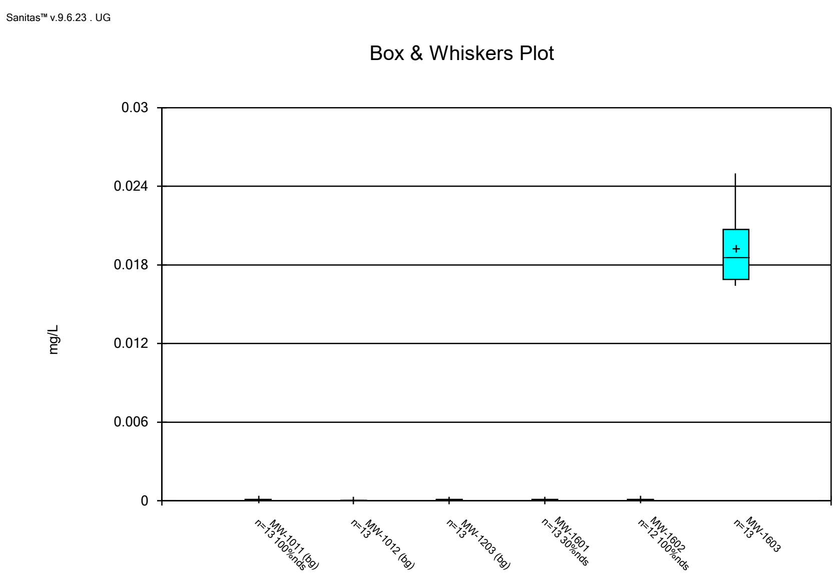
Constituent: Arsenic Analysis Run 11/13/2019 5:04 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



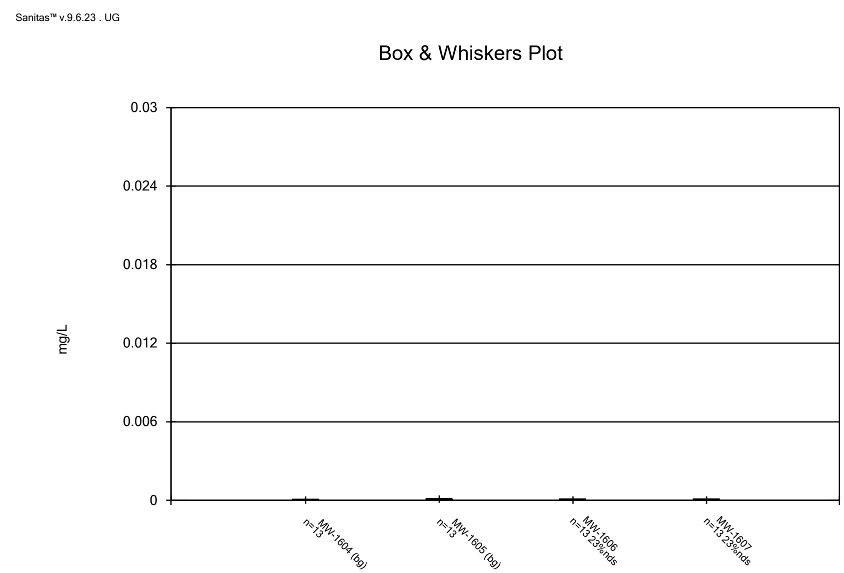
Constituent: Barium Analysis Run 11/13/2019 5:04 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Constituent: Barium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



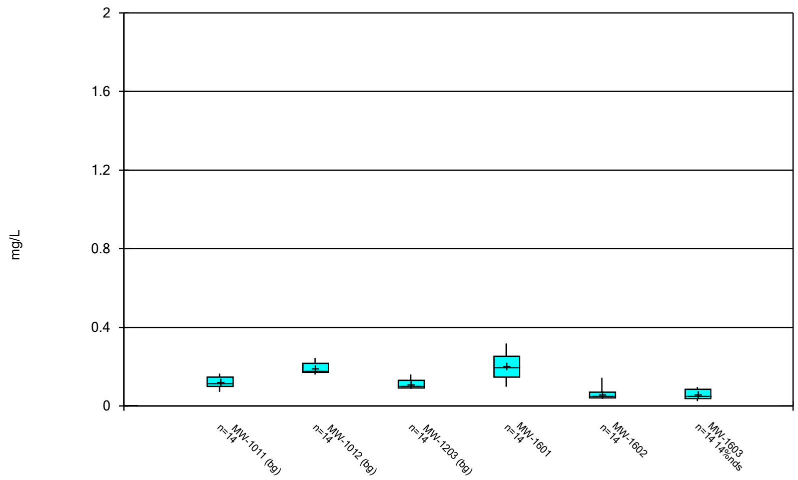
Constituent: Beryllium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Constituent: Beryllium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

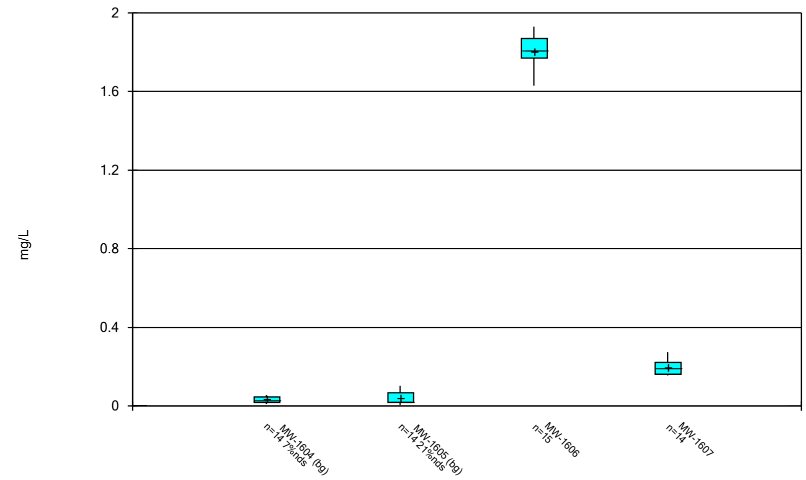
Box & Whiskers Plot



Constituent: Boron Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

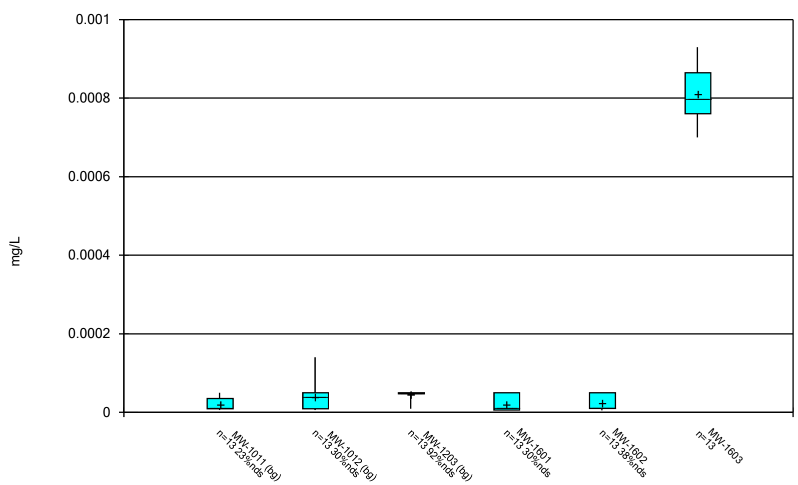
Box & Whiskers Plot



Constituent: Boron Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

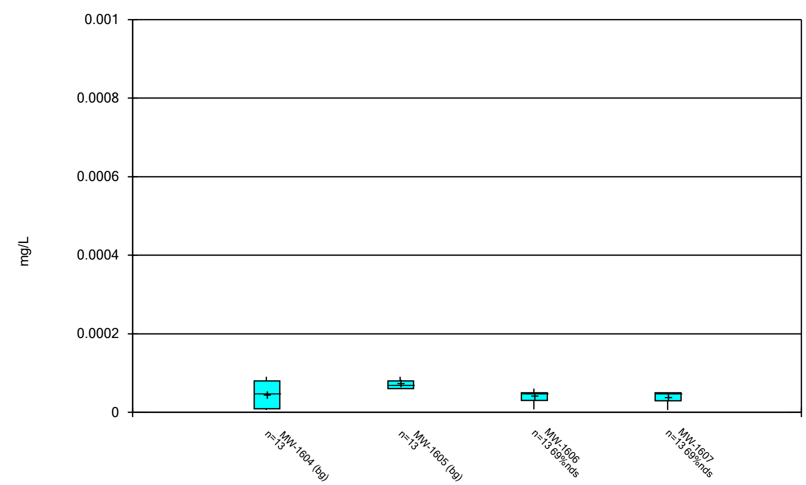
Box & Whiskers Plot



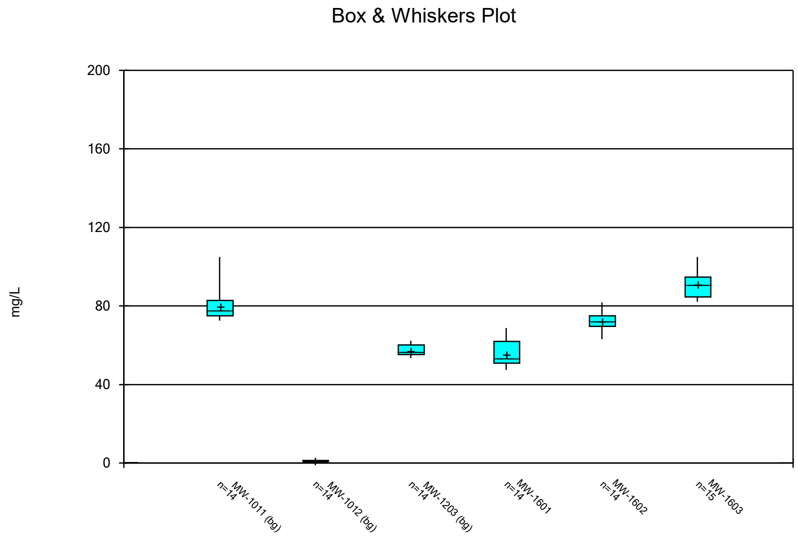
Constituent: Cadmium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot

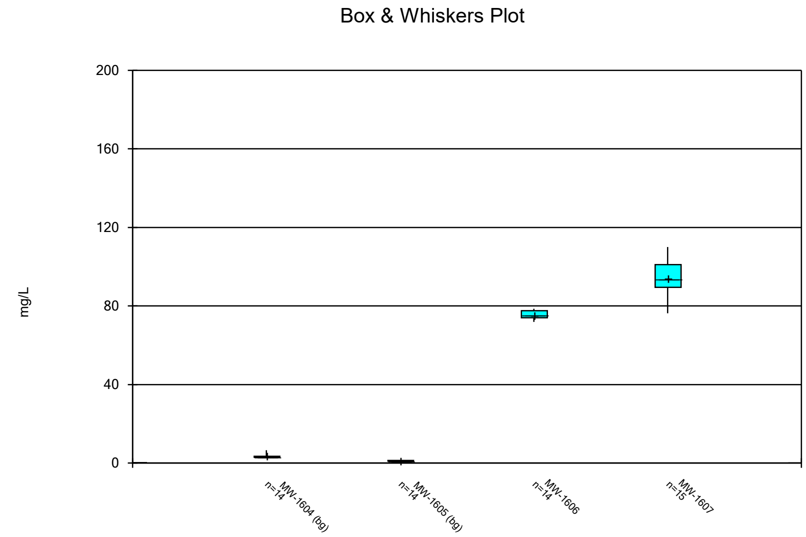


Constituent: Cadmium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



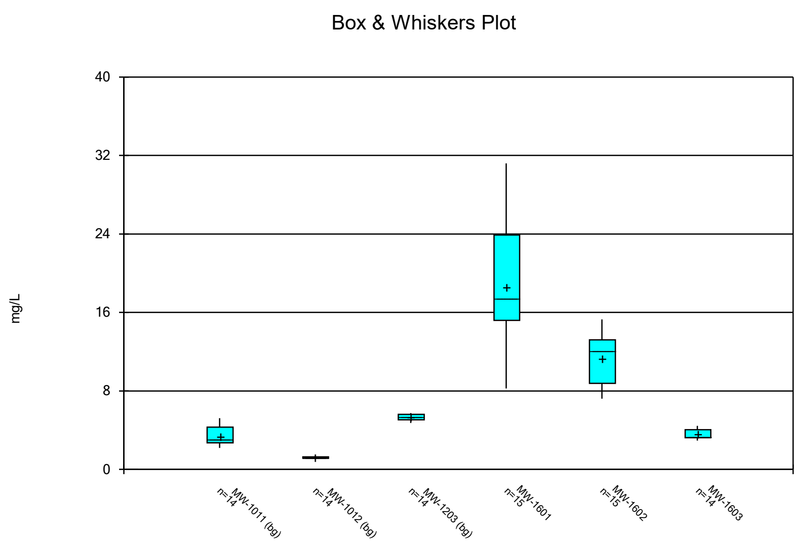
Constituent: Calcium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



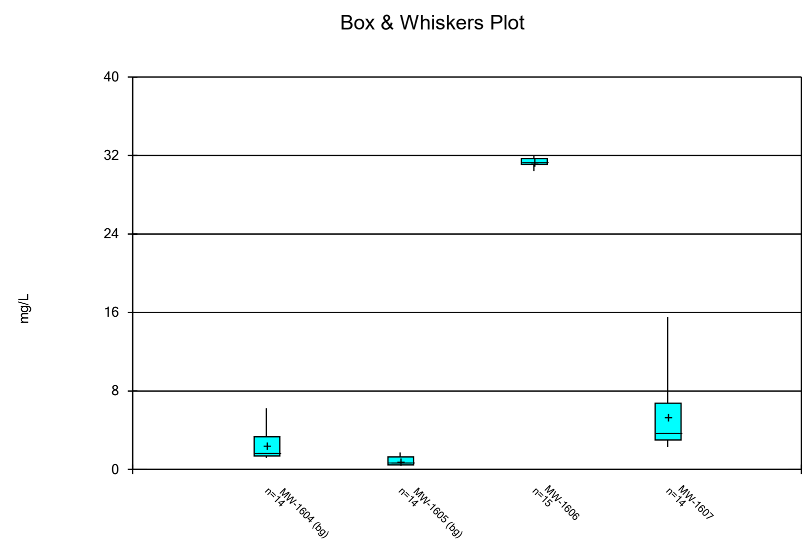
Constituent: Calcium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

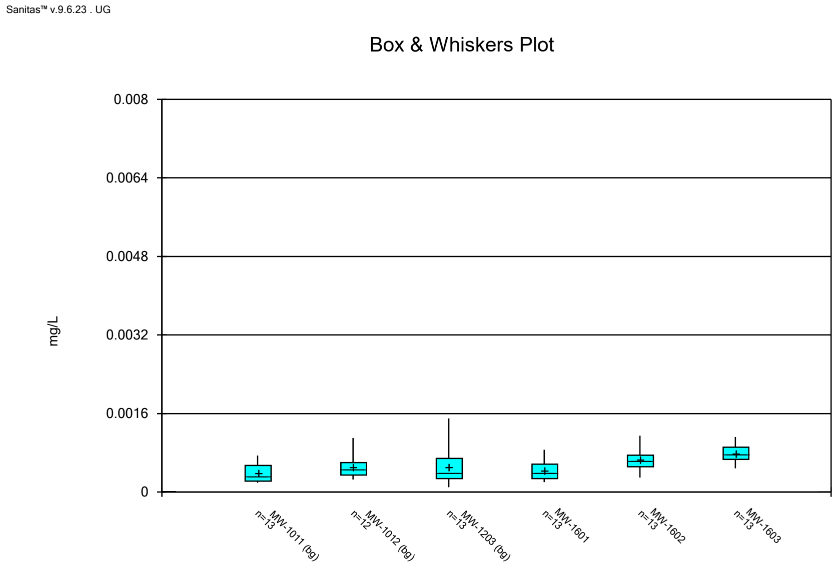


Constituent: Chloride Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

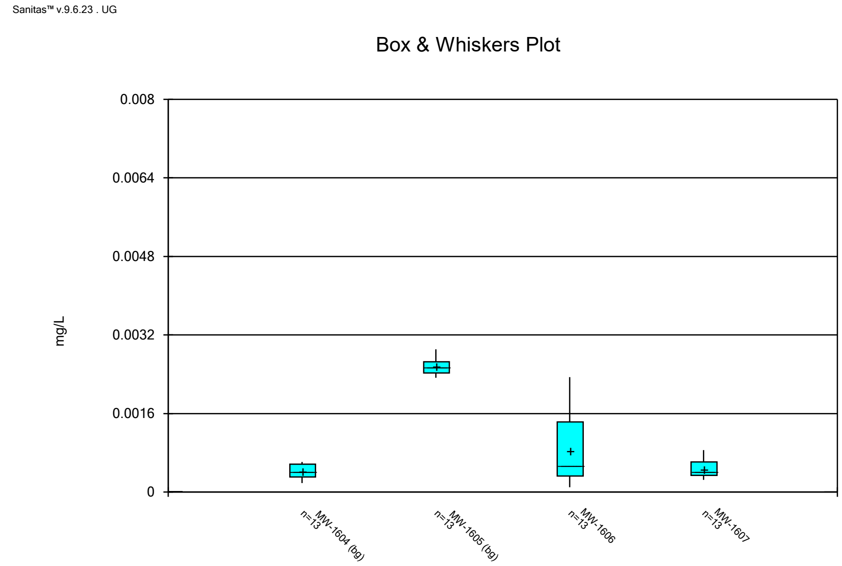
Sanitas™ v.9.6.23 . UG



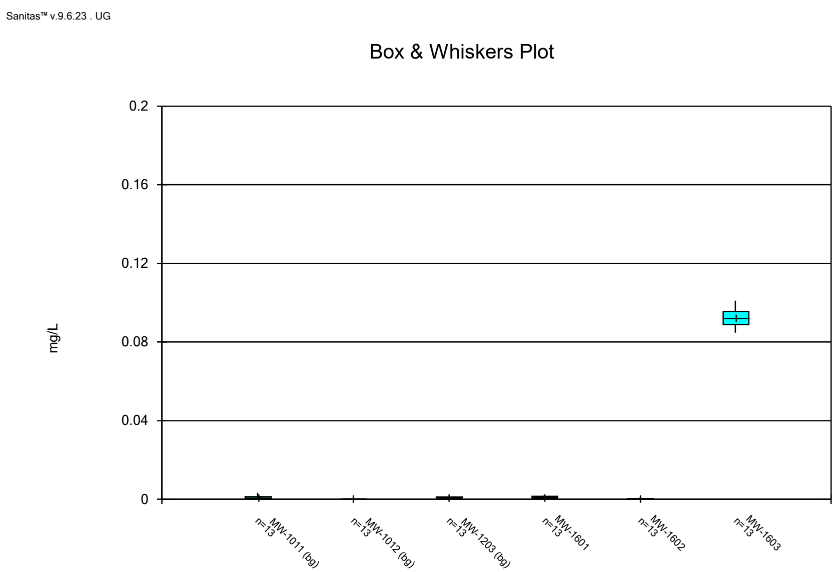
Constituent: Chloride Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



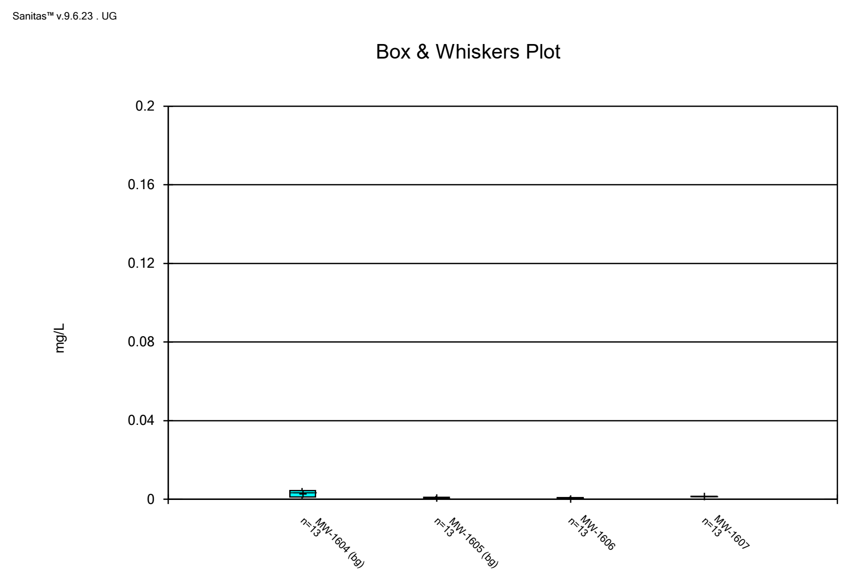
Constituent: Chromium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Constituent: Chromium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



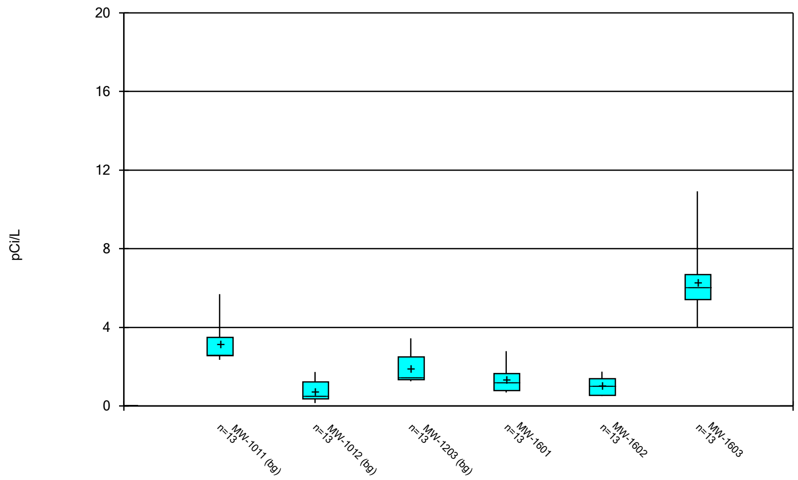
Constituent: Cobalt Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Constituent: Cobalt Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot

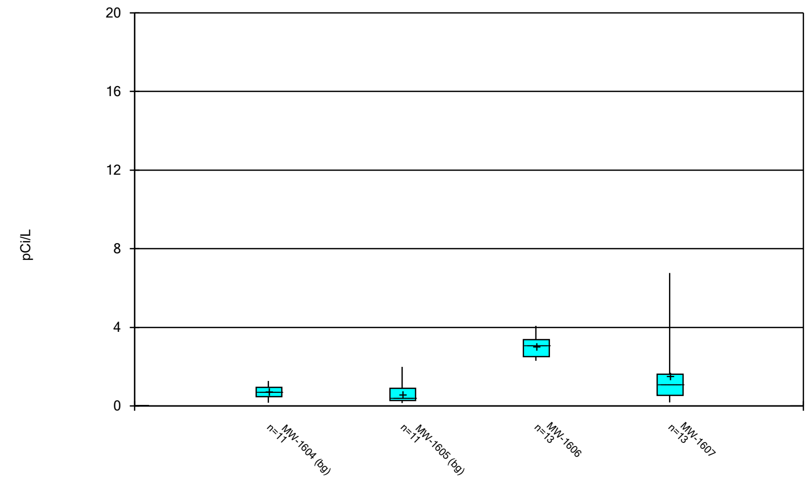


Constituent: Combined Radium 226 + 228   Analysis Run 11/13/2019 5:05 PM   View: Interwell and Intrawell

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot

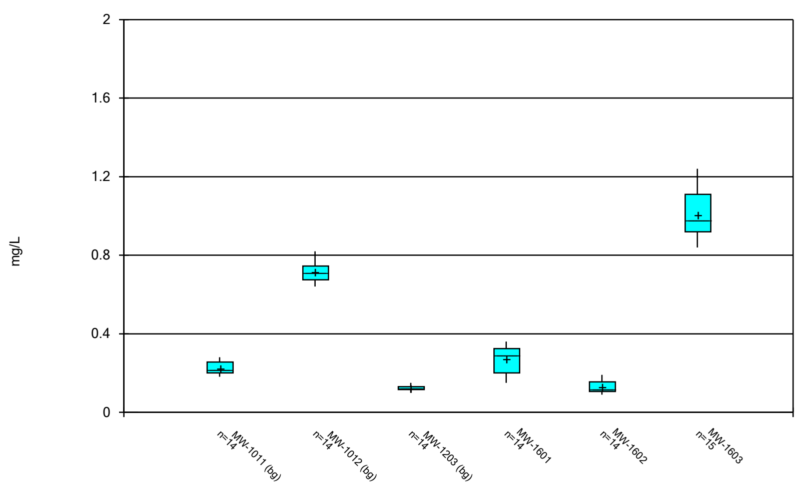


Constituent: Combined Radium 226 + 228   Analysis Run 11/13/2019 5:05 PM   View: Interwell and Intrawell

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot

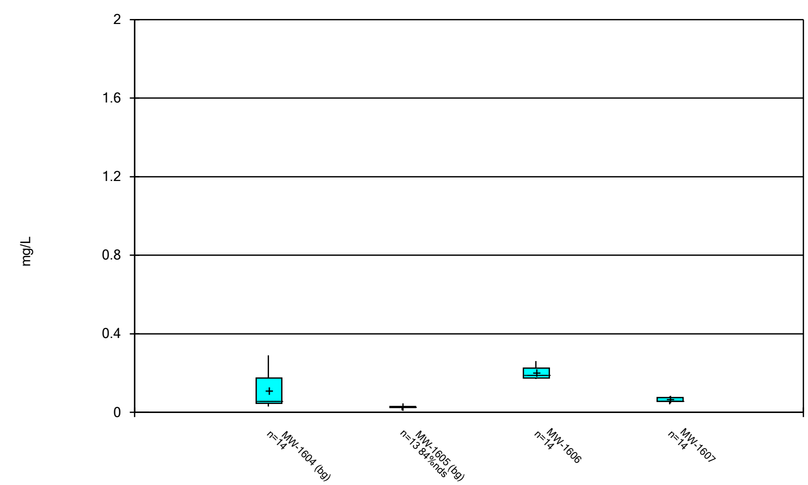


Constituent: Fluoride   Analysis Run 11/13/2019 5:05 PM   View: Interwell and Intrawell

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot

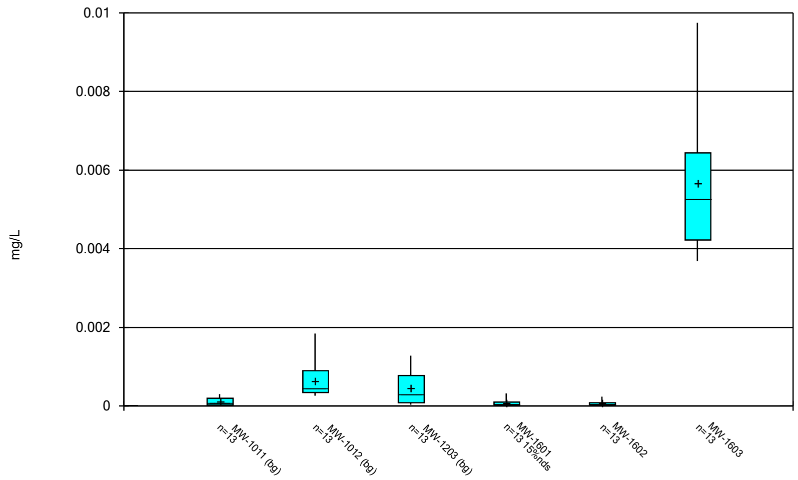


Constituent: Fluoride   Analysis Run 11/13/2019 5:05 PM   View: Interwell and Intrawell

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

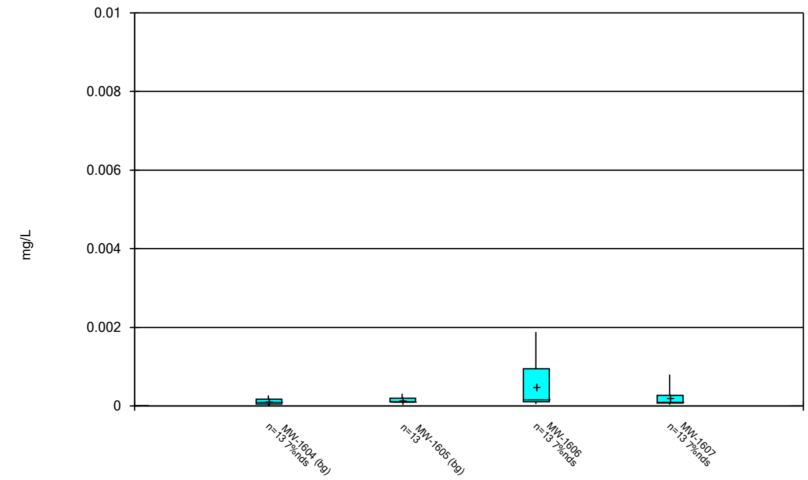
Box & Whiskers Plot



Constituent: Lead Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

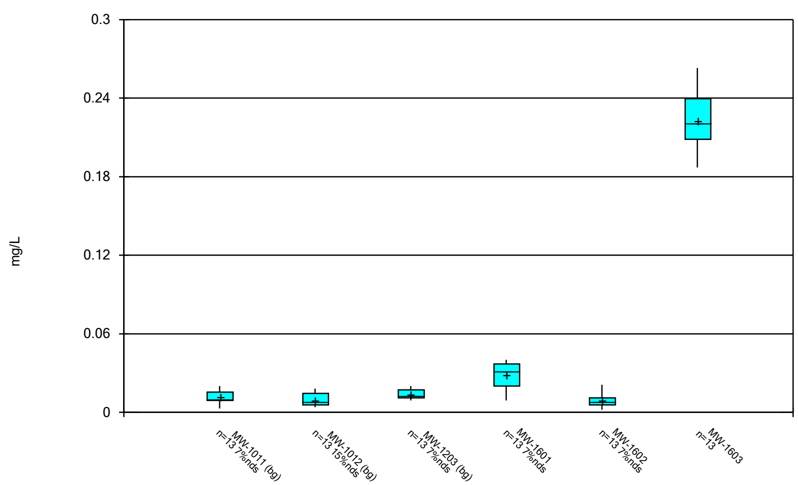
Box & Whiskers Plot



Constituent: Lead Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

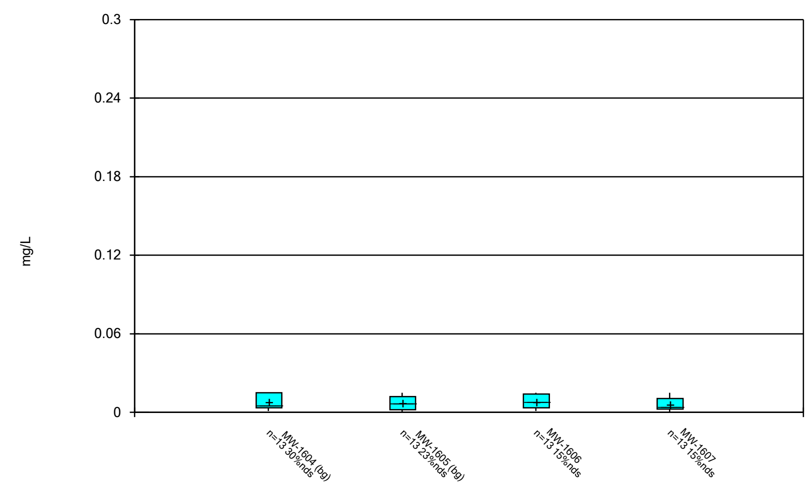
Box & Whiskers Plot



Constituent: Lithium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

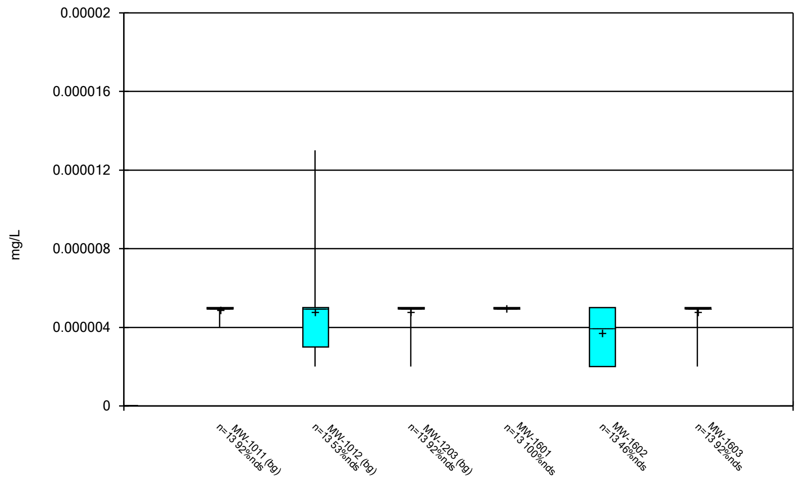
Box & Whiskers Plot



Constituent: Lithium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

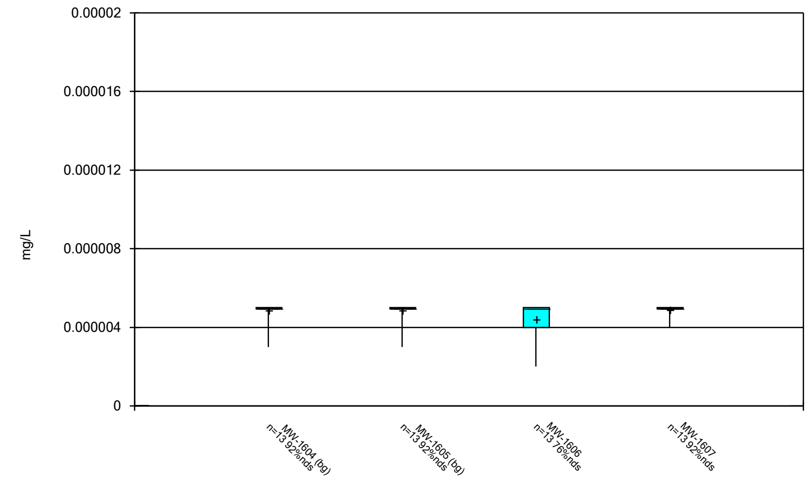
Box & Whiskers Plot



Constituent: Mercury Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

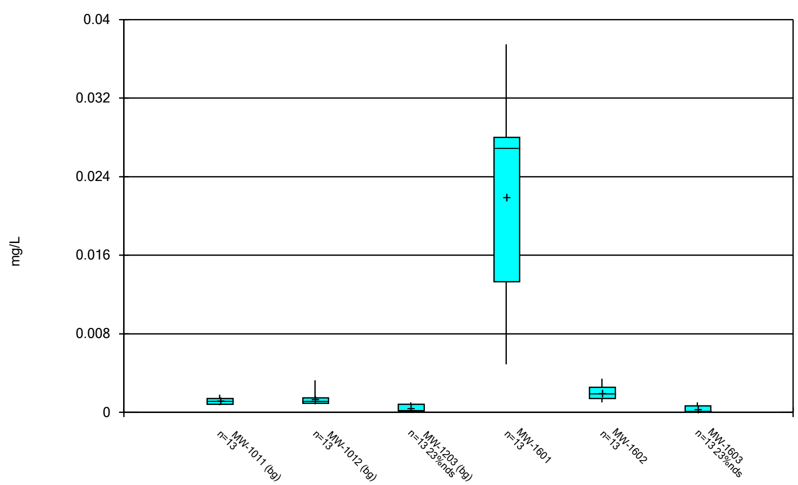
Box & Whiskers Plot



Constituent: Mercury Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

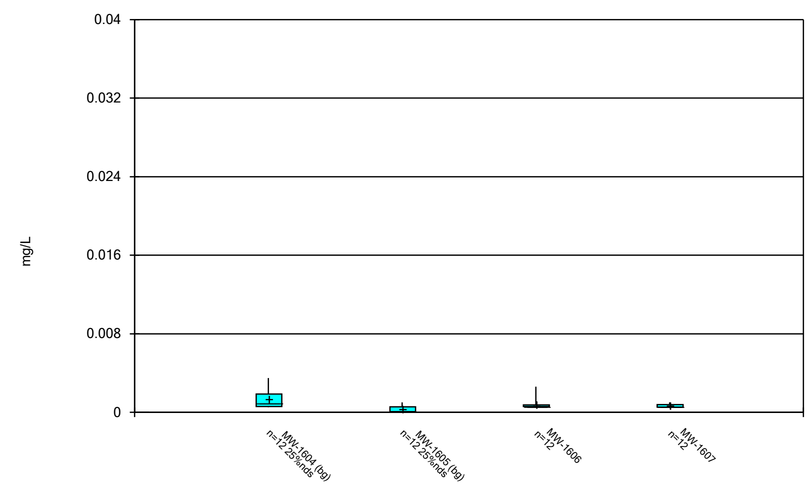
Box & Whiskers Plot



Constituent: Molybdenum Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

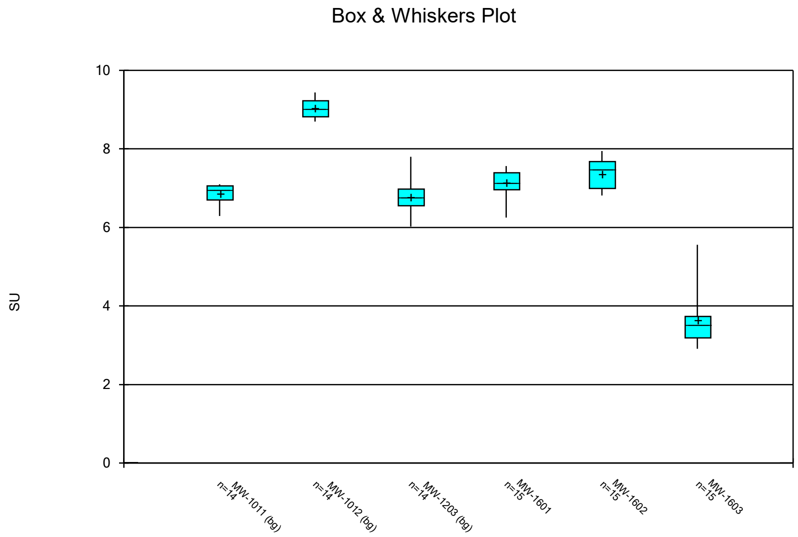
Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot



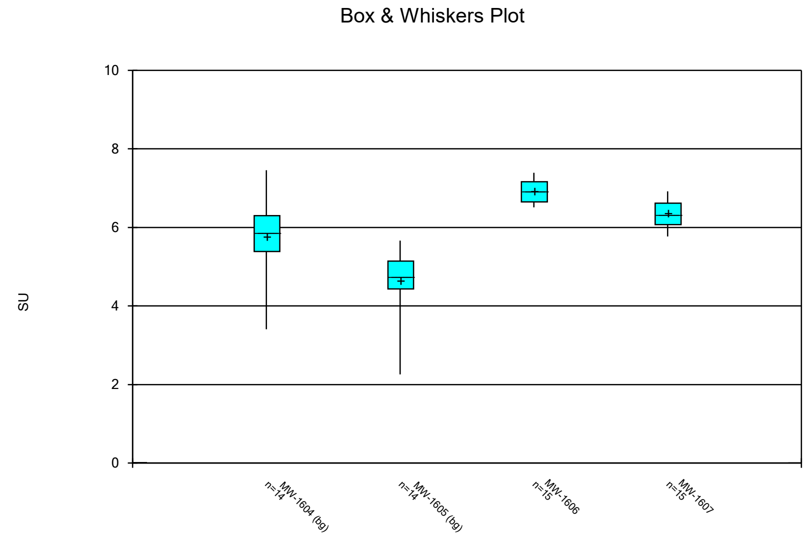
Constituent: Molybdenum Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



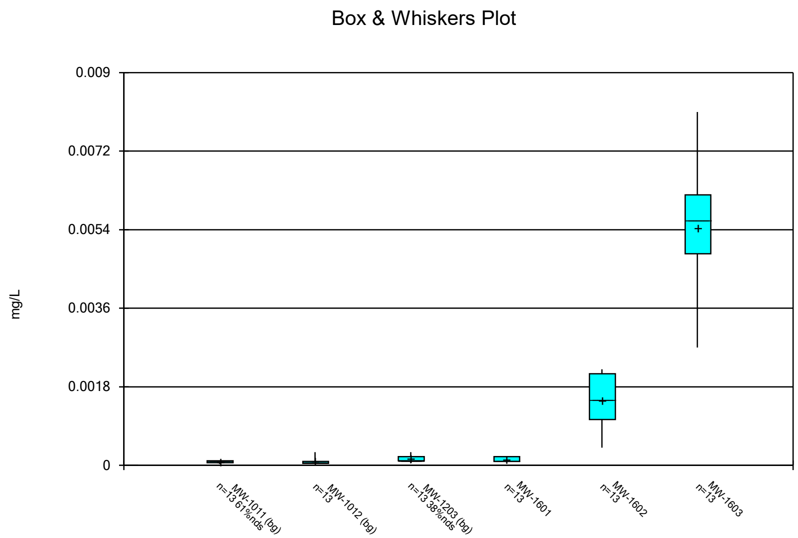
Constituent: pH Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



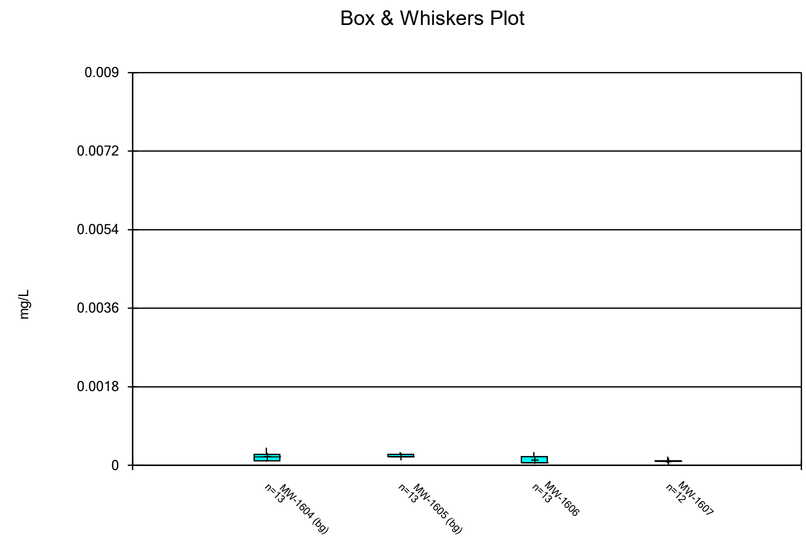
Constituent: pH Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



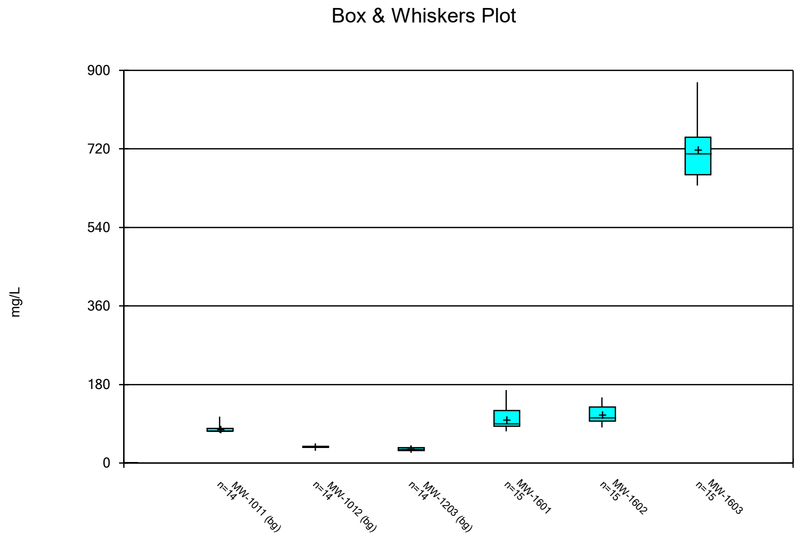
Constituent: Selenium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



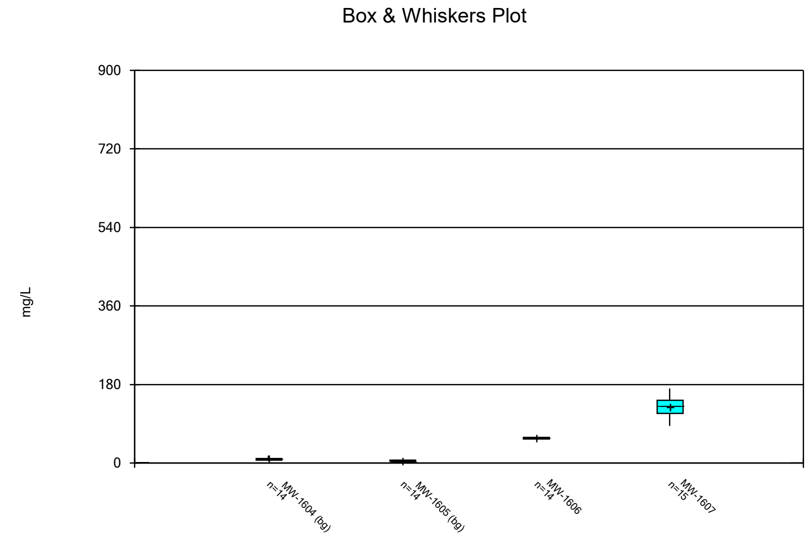
Constituent: Selenium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



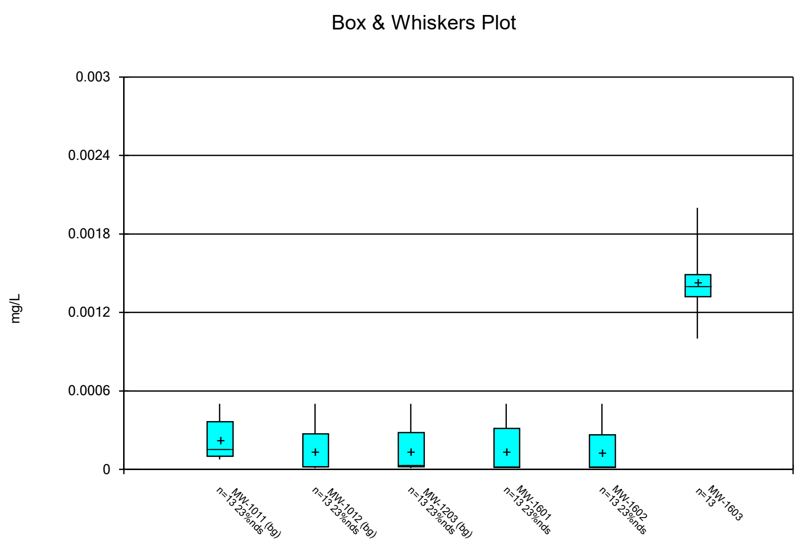
Constituent: Sulfate Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



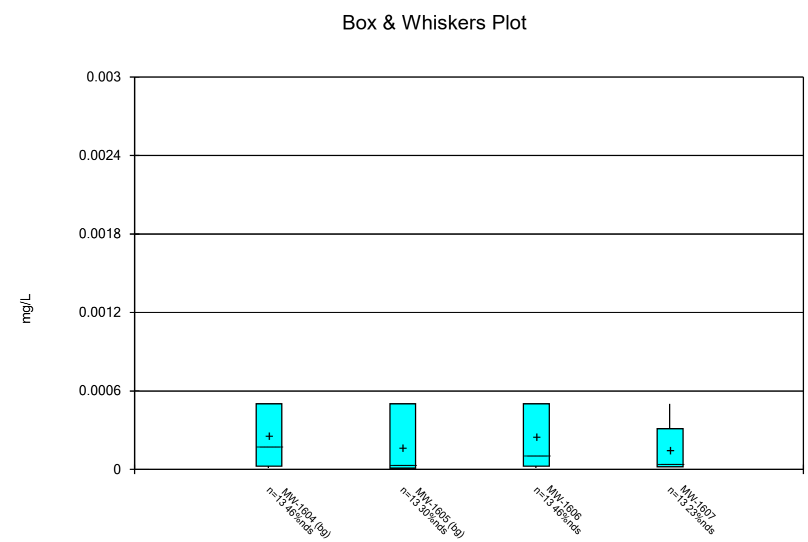
Constituent: Sulfate Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



Constituent: Thallium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

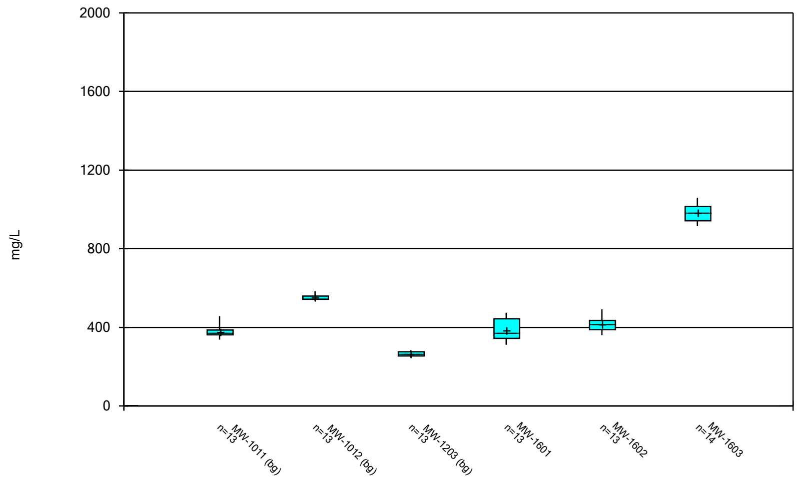
Sanitas™ v.9.6.23 . UG



Constituent: Thallium Analysis Run 11/13/2019 5:05 PM View: Interwell and Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

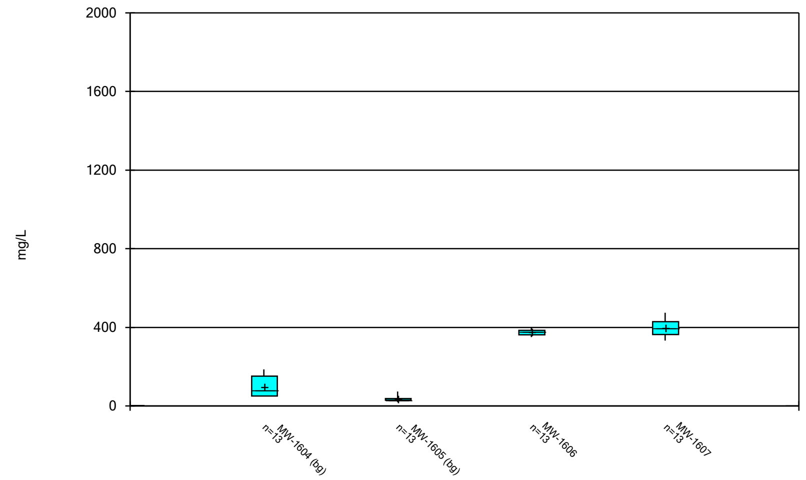
Box & Whiskers Plot



Constituent: Total Dissolved Solids   Analysis Run 11/13/2019 5:05 PM   View: Interwell and Intrawell
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Box & Whiskers Plot



Constituent: Total Dissolved Solids   Analysis Run 11/13/2019 5:05 PM   View: Interwell and Intrawell
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Outlier Summary

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/13/2019, 10:46 PM

	MW-1607 Antimony (mg/L)	MW-1012 Chromium (mg/L)	MW-1604 Combined Radium 226 + 228 (pCi/L)	MW-1605 Combined Radium 226 + 228 (pCi/L)	MW-1604 Molybdenum (mg/L)	MW-1605 Molybdenum (mg/L)	MW-1606 Molybdenum (mg/L)	MW-1607 Molybdenum (mg/L)	MW-1607 Selenium (mg/L)
1/11/2017	6E-05 (o)								
5/23/2017			6.707 (o)	6.077 (o)					
5/24/2017		0.00784 (o)							
6/21/2017			16.848 (o)	10.864 (o)					
7/12/2017					0.0159 (o)	0.0237 (o)	0.00756 (o)	0.00902 (o)	
4/25/2018									0.0007 (o)

Interwell Appendix III Outlier Analysis - All Results (No Significant)

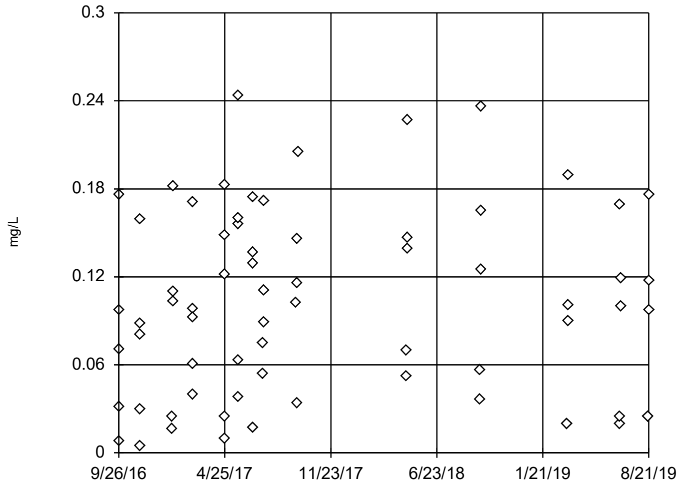
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 11/13/2019, 4:35 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Boron (mg/L)	MW-1011,M...	No	n/a	n/a w/com...	NP	NaN	70	0.09881	0.06354	sqrt(x)	ShapiroFrancia
Calcium (mg/L)	MW-1011,M...	No	n/a	n/a w/com...	NP	NaN	70	28.57	33.89	ln(x)	ShapiroFrancia
Chloride (mg/L)	MW-1011,M...	No	n/a	n/a w/com...	NP	NaN	70	2.634	1.844	ln(x)	ShapiroFrancia
Fluoride (mg/L)	MW-1011,M...	No	n/a	n/a w/com...	NP	NaN	69	0.248	0.2494	ln(x)	ShapiroFrancia
Sulfate (mg/L)	MW-1011,M...	No	n/a	n/a w/com...	NP	NaN	70	32.28	26.51	x^(1/3)	ShapiroFrancia
Total Dissolved Solids (mg/L)	MW-1011,M...	No	n/a	n/a w/com...	NP	NaN	65	265.3	190.9	sqrt(x)	ShapiroFrancia

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

MW-1011,MW-1012,MW-1203,MW-1604,MW-16...



n = 70

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.9963, low cutoff = -0.1775, based on IQR multiplier of 3.

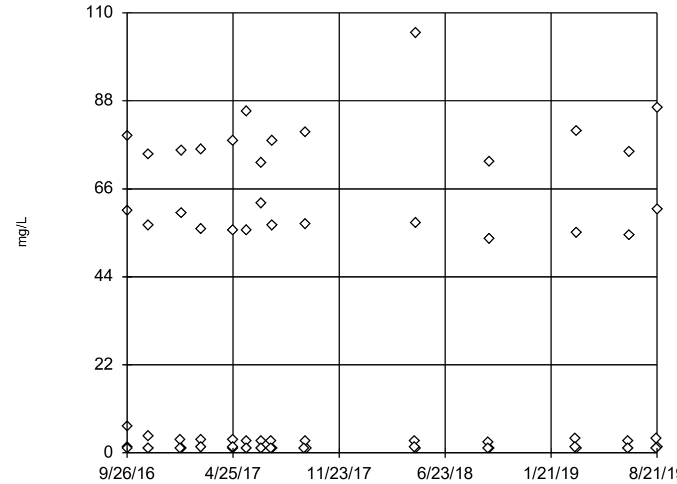
Constituent: Boron   Analysis Run 11/13/2019 4:34 PM   View: Interwell AIII

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

MW-1011,MW-1012,MW-1203,MW-1604,MW-16...



n = 70

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 7600124, low cutoff = 0.000009505, based on IQR multiplier of 3.

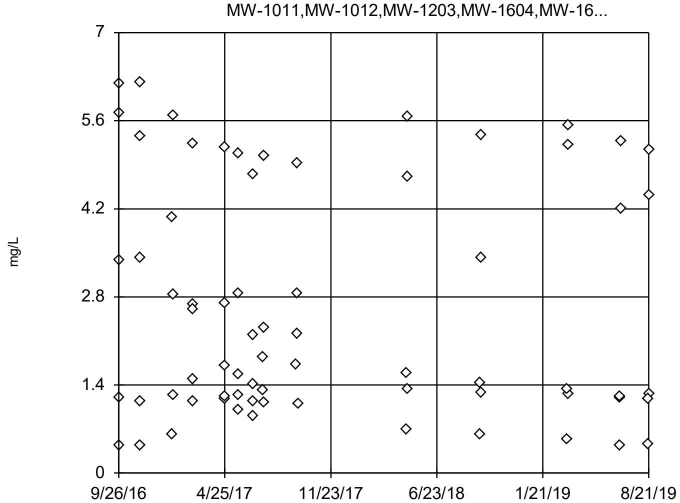
Constituent: Calcium   Analysis Run 11/13/2019 4:34 PM   View: Interwell AIII

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

MW-1011,MW-1012,MW-1203,MW-1604,MW-16...



n = 70

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 303.4, low cutoff = 0.01838, based on IQR multiplier of 3.

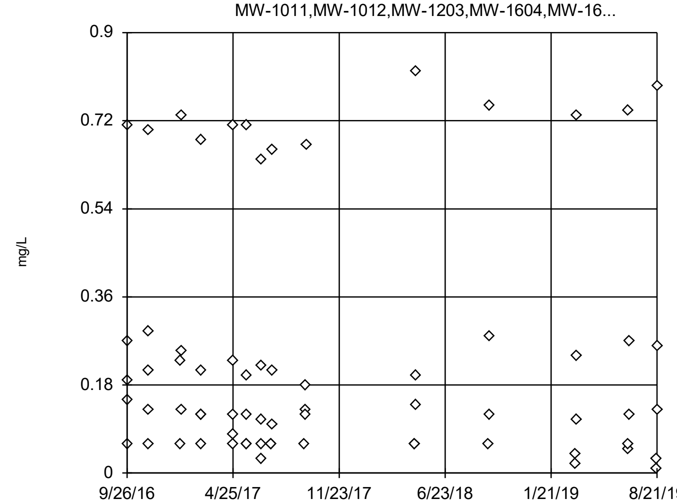
Constituent: Chloride   Analysis Run 11/13/2019 4:34 PM   View: Interwell AIII

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

MW-1011,MW-1012,MW-1203,MW-1604,MW-16...



n = 69

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 24.6, low cutoff = 0.0006584, based on IQR multiplier of 3.

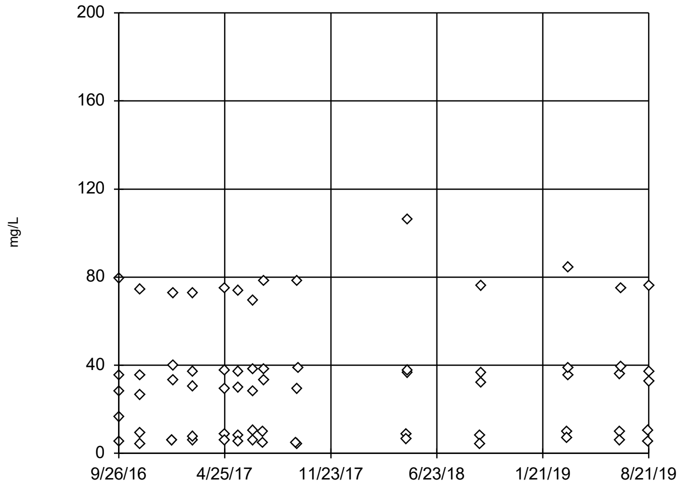
Constituent: Fluoride   Analysis Run 11/13/2019 4:34 PM   View: Interwell AIII

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

MW-1011,MW-1012,MW-1203,MW-1604,MW-16...



n = 70

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 442.5, low cutoff = -11.77, based on IQR multiplier of 3.

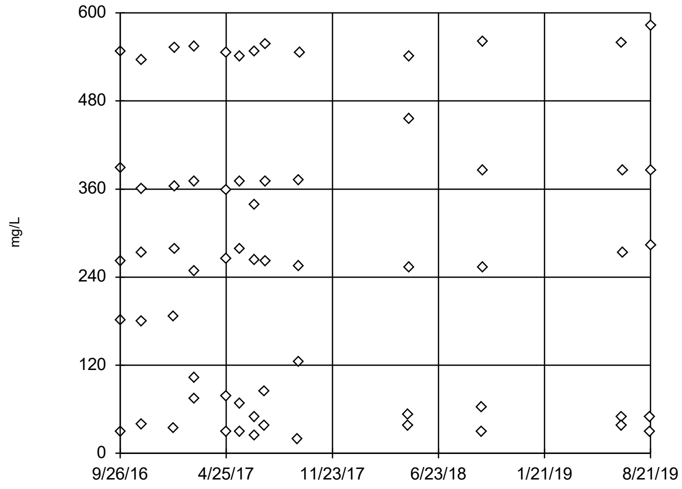
Constituent: Sulfate   Analysis Run 11/13/2019 4:34 PM   View: Interwell AIII

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening, Pooled Background

MW-1011,MW-1012,MW-1203,MW-1604,MW-16...



n = 65

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 3132, low cutoff = -827.7, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids   Analysis Run 11/13/2019 4:34 PM   View: Interwell AIII

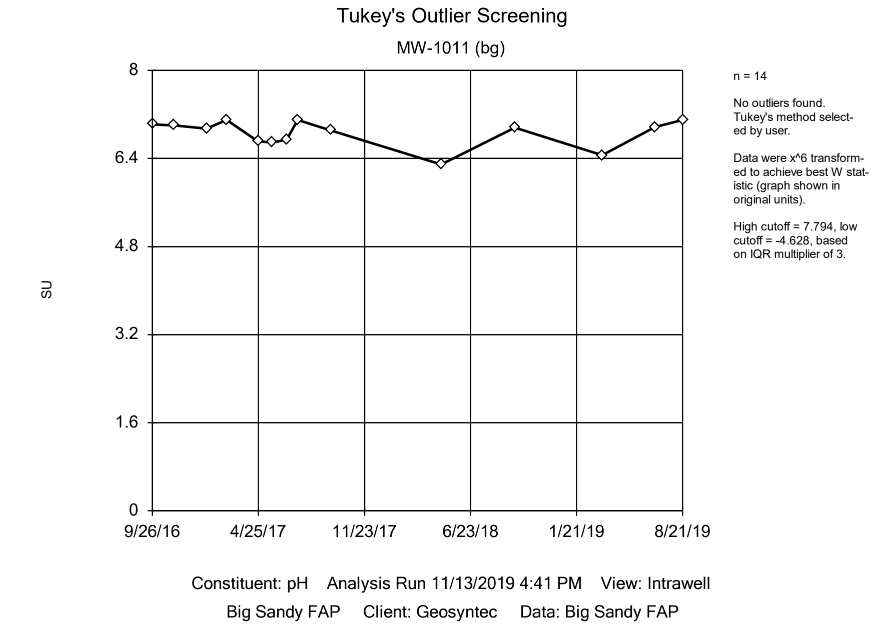
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Intrawell Outlier Analysis - All Results (No Significant)

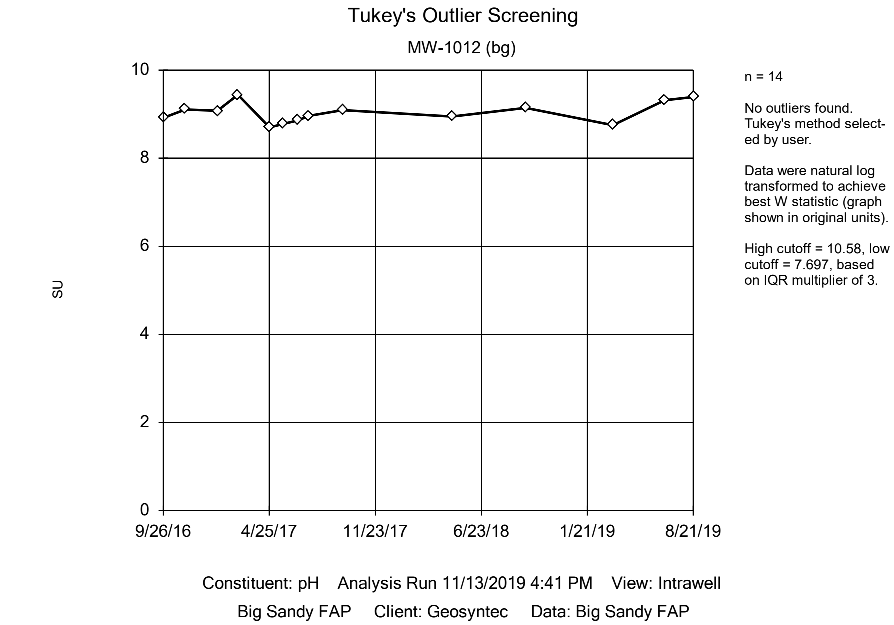
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/13/2019, 4:42 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
pH (SU)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	14	6.856	0.248	x^6	ShapiroWilk
pH (SU)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	14	9.035	0.2334	ln(x)	ShapiroWilk
pH (SU)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	14	6.764	0.4129	ln(x)	ShapiroWilk
pH (SU)	MW-1601	No	n/a	n/a	NP	NaN	15	7.144	0.333	x^6	ShapiroWilk
pH (SU)	MW-1602	No	n/a	n/a	NP	NaN	15	7.359	0.3701	x^5	ShapiroWilk
pH (SU)	MW-1603	No	n/a	n/a	NP	NaN	15	3.627	0.6909	ln(x)	ShapiroWilk
pH (SU)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	14	5.764	0.8992	x^2	ShapiroWilk
pH (SU)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	14	4.652	0.8137	x^4	ShapiroWilk
pH (SU)	MW-1606	No	n/a	n/a	NP	NaN	15	6.928	0.2827	x^2	ShapiroWilk
pH (SU)	MW-1607	No	n/a	n/a	NP	NaN	15	6.357	0.3133	normal	ShapiroWilk

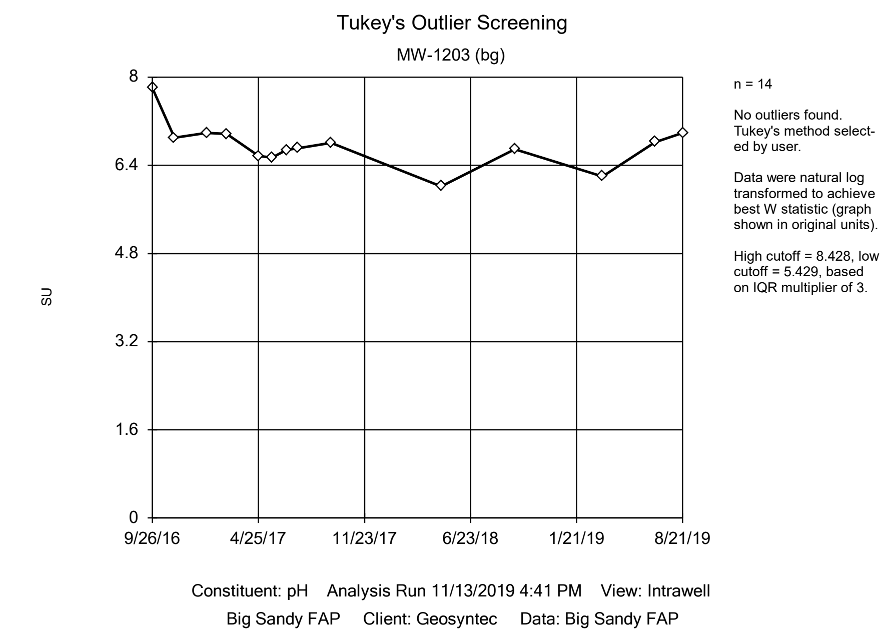
Sanitas™ v.9.6.23 . UG



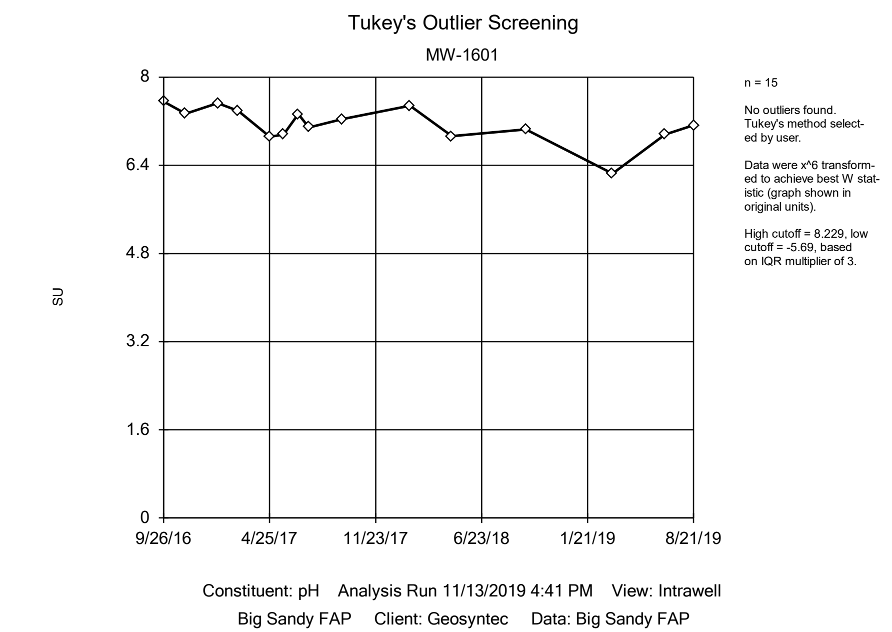
Sanitas™ v.9.6.23 . UG

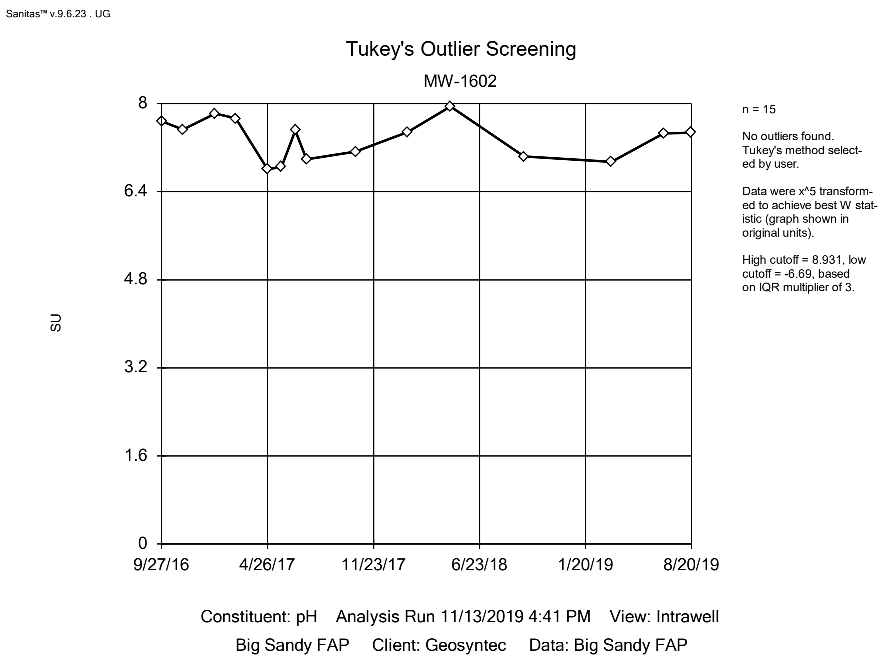


Sanitas™ v.9.6.23 . UG

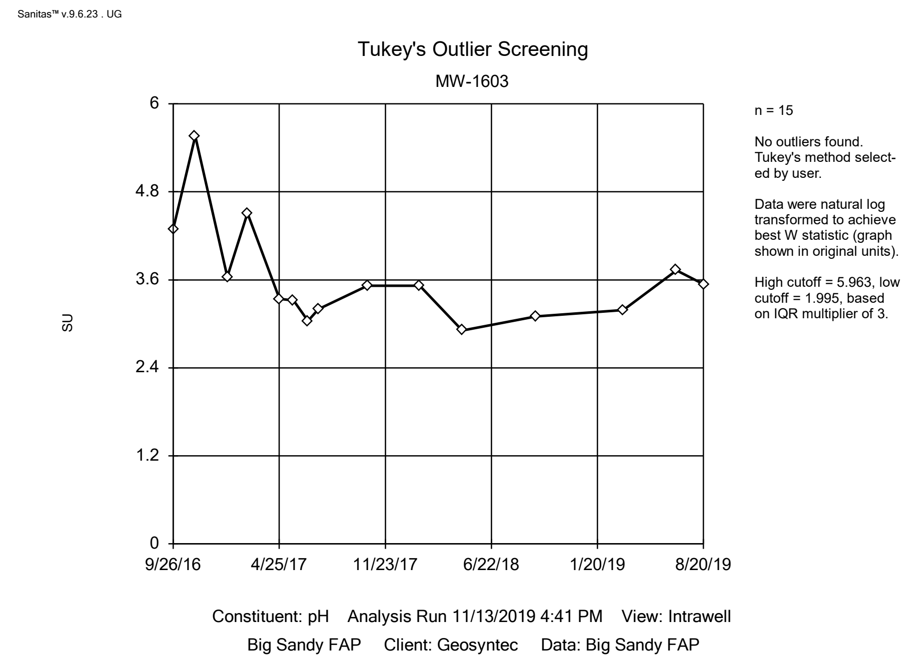


Sanitas™ v.9.6.23 . UG

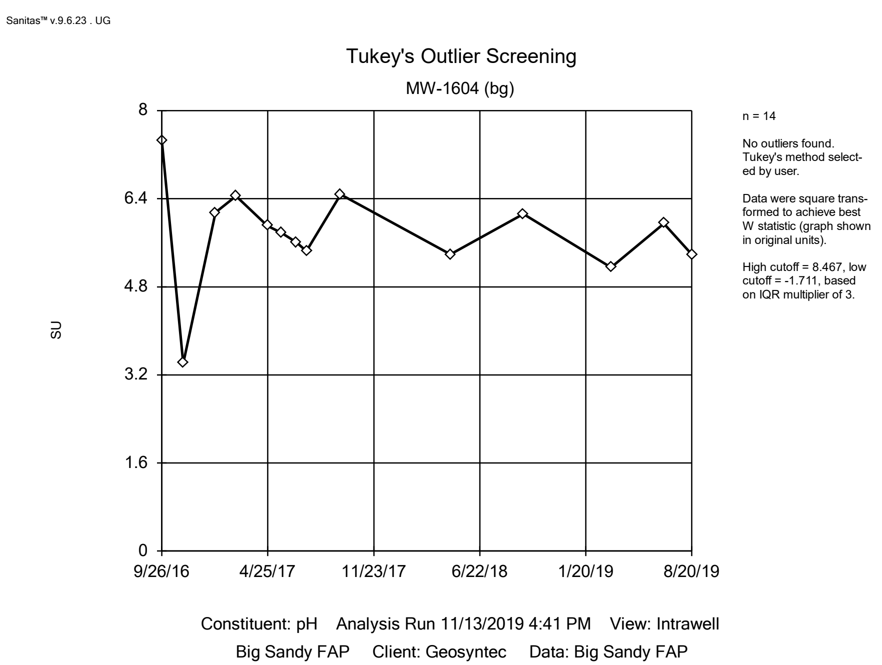




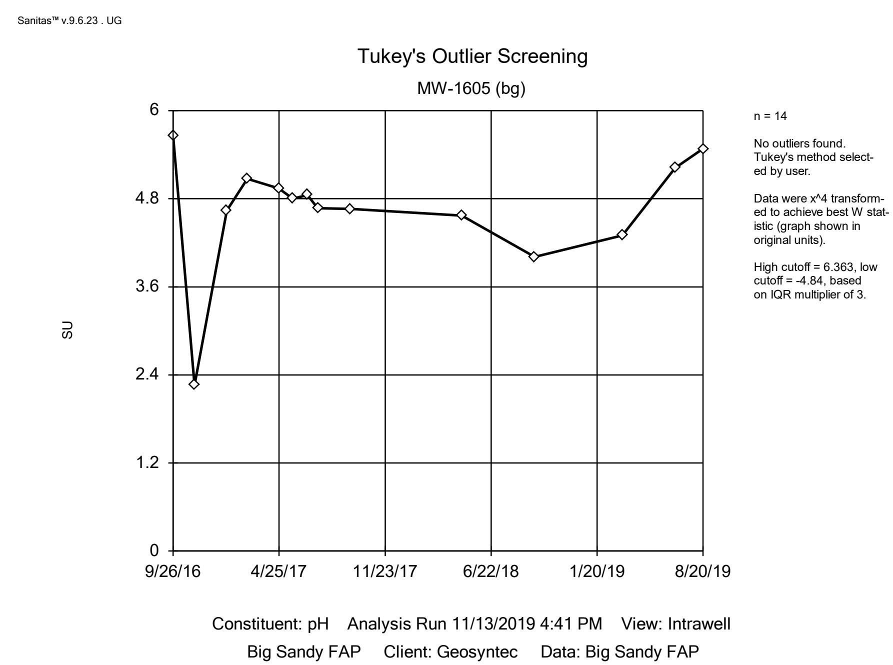
Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1602
SU
8
6.4
4.8
3.2
1.6
0
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 15
No outliers found. Tukey's method selected by user.
Data were x^5 transformed to achieve best W statistic (graph shown in original units).
High cutoff = 8.931, low cutoff = -6.69, based on IQR multiplier of 3.
Constituent: pH Analysis Run 11/13/2019 4:41 PM View: Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



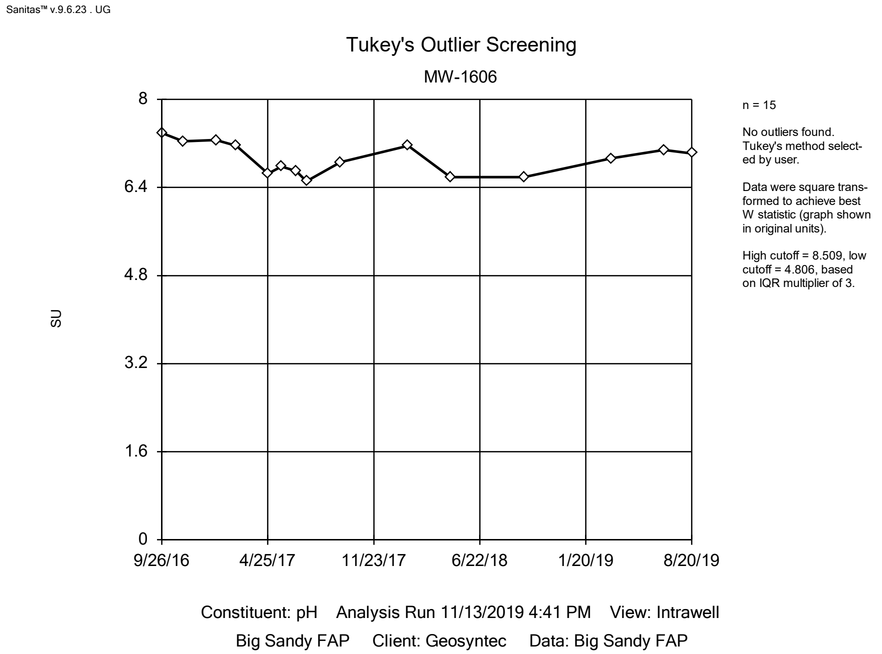
Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1603
SU
6
4.8
3.6
2.4
1.2
0
9/26/16
4/25/17
11/23/17
6/22/18
1/20/19
8/20/19
n = 15
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 5.963, low cutoff = 1.995, based on IQR multiplier of 3.
Constituent: pH Analysis Run 11/13/2019 4:41 PM View: Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

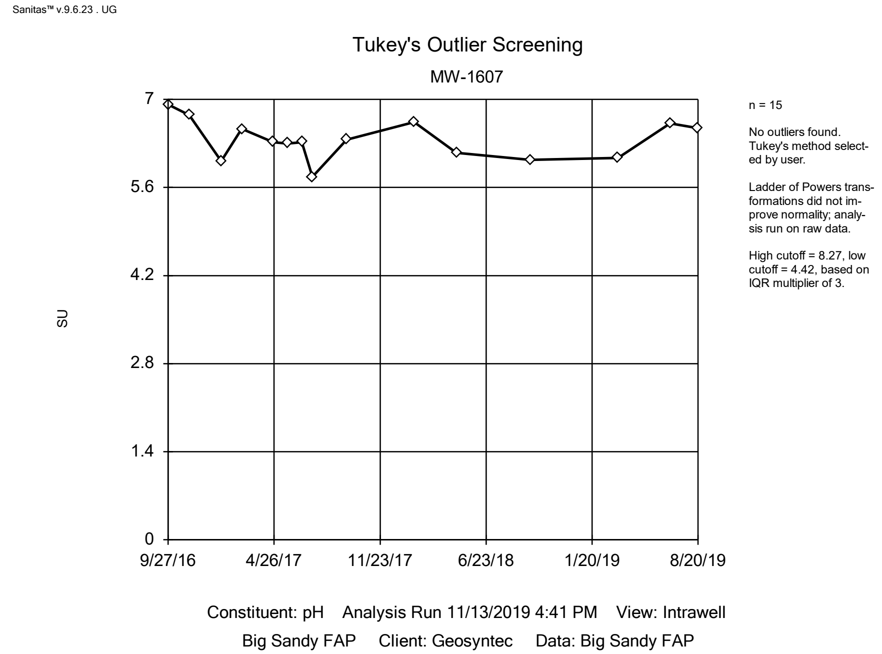


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1604 (bg)
SU
8
6.4
4.8
3.2
1.6
0
9/26/16
4/25/17
11/23/17
6/22/18
1/20/19
8/20/19
n = 14
No outliers found. Tukey's method selected by user.
Data were square transformed to achieve best W statistic (graph shown in original units).
High cutoff = 8.467, low cutoff = -1.711, based on IQR multiplier of 3.
Constituent: pH Analysis Run 11/13/2019 4:41 PM View: Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1605 (bg)
SU
6
4.8
3.6
2.4
1.2
0
9/26/16
4/25/17
11/23/17
6/22/18
1/20/19
8/20/19
n = 14
No outliers found. Tukey's method selected by user.
Data were x^4 transformed to achieve best W statistic (graph shown in original units).
High cutoff = 6.363, low cutoff = -4.84, based on IQR multiplier of 3.
Constituent: pH Analysis Run 11/13/2019 4:41 PM View: Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1606
8
6.4
4.8
3.2
1.6
0
SU
9/26/16
4/25/17
11/23/17
6/22/18
1/20/19
8/20/19
n = 15
No outliers found. Tukey's method selected by user.
Data were square transformed to achieve best W statistic (graph shown in original units).
High cutoff = 8.509, low cutoff = 4.806, based on IQR multiplier of 3.
Constituent: pH   Analysis Run 11/13/2019 4:41 PM   View: Intrawell
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1607
7
5.6
4.2
2.8
1.4
0
SU
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 15
No outliers found. Tukey's method selected by user.
Ladder of Powers transformations did not improve normality; analysis run on raw data.
High cutoff = 8.27, low cutoff = 4.42, based on IQR multiplier of 3.
Constituent: pH   Analysis Run 11/13/2019 4:41 PM   View: Intrawell
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Appendix IV Outlier Analysis - Significant Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/13/2019, 4:40 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Combined Radium 226 + 228 (pCi/L)	**MW-1604 (bg)**	**Yes**	**6.707**	**5/23/2017**	**NP**	**NaN**	**12**	**1.237**	**1.749**	**ln(x)**	**ShapiroWilk**
Molybdenum (mg/L)	**MW-1606**	**Yes**	**0.00756**	**7/12/2017**	**NP**	**NaN**	**13**	**0.001328**	**0.001952**	**ln(x)**	**ShapiroWilk**
Molybdenum (mg/L)	**MW-1607**	**Yes**	**0.00902**	**7/12/2017**	**NP**	**NaN**	**13**	**0.001286**	**0.00233**	**ln(x)**	**ShapiroWilk**
Selenium (mg/L)	**MW-1607**	**Yes**	**0.00005,0...**	**2/21/2017...**	**NP**	**NaN**	**13**	**0.000...**	**0.0001692**	**ln(x)**	**ShapiroWilk**

Appendix IV Outlier Analysis - All Results

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 11/13/2019, 4:40 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony (mg/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0002603	ln(x)	ShapiroWilk
Antimony (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0001758	ln(x)	ShapiroWilk
Antimony (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Antimony (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Antimony (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	x^(1/3)	ShapiroWilk
Antimony (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.000...	0.0002307	ln(x)	ShapiroWilk
Antimony (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Antimony (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000422	x^(1/3)	ShapiroWilk
Antimony (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	x^(1/3)	ShapiroWilk
Antimony (mg/L)	MW-1607	No	n/a	n/a	NP	NaN	12	0.000...	0.0000...	ln(x)	ShapiroWilk
Arsenic (mg/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	13	0.009303	0.003735	ln(x)	ShapiroWilk
Arsenic (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.02105	0.005223	normal	ShapiroWilk
Arsenic (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0001269	x^(1/3)	ShapiroWilk
Arsenic (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.004015	0.001629	x^4	ShapiroWilk
Arsenic (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.001092	0.00113	ln(x)	ShapiroWilk
Arsenic (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.001322	0.0001694	x^3	ShapiroWilk
Arsenic (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.001972	0.001485	normal	ShapiroWilk
Arsenic (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Arsenic (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	13	0.001058	0.0001661	ln(x)	ShapiroWilk
Arsenic (mg/L)	MW-1607	No	n/a	n/a	NP	NaN	13	0.01652	0.01638	ln(x)	ShapiroWilk
Barium (mg/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	13	0.05004	0.004872	ln(x)	ShapiroWilk
Barium (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.02778	0.005936	ln(x)	ShapiroWilk
Barium (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	0.09686	0.008112	ln(x)	ShapiroWilk
Barium (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.06821	0.01198	normal	ShapiroWilk
Barium (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.05361	0.003896	ln(x)	ShapiroWilk
Barium (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.01197	0.00142	ln(x)	ShapiroWilk
Barium (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.06272	0.00699	ln(x)	ShapiroWilk
Barium (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.03401	0.004034	ln(x)	ShapiroWilk
Barium (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	13	0.8775	0.1075	ln(x)	ShapiroWilk
Barium (mg/L)	MW-1607	No	n/a	n/a	NP	NaN	13	0.03596	0.007473	ln(x)	ShapiroWilk
Beryllium (mg/L)	MW-1011 (bg)	n/a	n/a	n/a	NP	NaN	13	0.0001	0	unknown	ShapiroWilk
Beryllium (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000148	x^(1/3)	ShapiroWilk
Beryllium (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	sqrt(x)	ShapiroWilk
Beryllium (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Beryllium (mg/L)	MW-1602	n/a	n/a	n/a	NP	NaN	12	0.0001	0	unknown	ShapiroWilk
Beryllium (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.01922	0.002841	ln(x)	ShapiroWilk
Beryllium (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Beryllium (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	x^2	ShapiroWilk
Beryllium (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	sqrt(x)	ShapiroWilk
Beryllium (mg/L)	MW-1607	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Cadmium (mg/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Cadmium (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	x^(1/3)	ShapiroWilk
Cadmium (mg/L)	MW-1203 (bg)	n/a	n/a	n/a	NP	NaN	13	0.000...	0.0000...	unknown	ShapiroWilk
Cadmium (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.000...	0.0000201	ln(x)	ShapiroWilk
Cadmium (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Cadmium (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Cadmium (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	normal	ShapiroWilk
Cadmium (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	x^(1/3)	ShapiroWilk
Cadmium (mg/L)	MW-1606	n/a	n/a	n/a	NP	NaN	13	0.000...	0.0000...	unknown	ShapiroWilk
Cadmium (mg/L)	MW-1607	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Chromium (mg/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0001738	ln(x)	ShapiroWilk
Chromium (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	12	0.000...	0.0002555	ln(x)	ShapiroWilk
Chromium (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0003781	ln(x)	ShapiroWilk
Chromium (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.000...	0.0002146	ln(x)	ShapiroWilk
Chromium (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.000652	0.0002423	x^(1/3)	ShapiroWilk
Chromium (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.000...	0.0001854	ln(x)	ShapiroWilk
Chromium (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0001453	sqrt(x)	ShapiroWilk
Chromium (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.002554	0.000155	ln(x)	ShapiroWilk
Chromium (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	13	0.000...	0.0006824	ln(x)	ShapiroWilk
Chromium (mg/L)	MW-1607	No	n/a	n/a	NP	NaN	13	0.000...	0.0001768	ln(x)	ShapiroWilk
Cobalt (mg/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	13	0.001174	0.0009082	ln(x)	ShapiroWilk
Cobalt (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Cobalt (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0001081	x^2	ShapiroWilk
Cobalt (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.001132	0.0004553	sqrt(x)	ShapiroWilk
Cobalt (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.000...	0.0002578	ln(x)	ShapiroWilk
Cobalt (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.09228	0.004651	x^2	ShapiroWilk
Cobalt (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.00298	0.001827	normal	ShapiroWilk
Cobalt (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0004482	ln(x)	ShapiroWilk

Appendix IV Outlier Analysis - All Results

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 11/13/2019, 4:40 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Cobalt (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	13	0.000...	0.0004075	ln(x)	ShapiroWilk
Cobalt (mg/L)	MW-1607	No	n/a	n/a	NP	NaN	13	0.001365	0.0001344	sqrt(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	13	3.134	1.1	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.719	0.5272	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	1.891	0.762	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-1601	No	n/a	n/a	NP	NaN	13	1.318	0.6471	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-1602	No	n/a	n/a	NP	NaN	13	1.013	0.4491	sqrt(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-1603	No	n/a	n/a	NP	NaN	13	6.286	1.631	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	**MW-1604 (bg)**	**Yes**	**6.707**	**5/23/2017**	**NP**	**NaN**	**12**	**1.237**	**1.749**	**ln(x)**	**ShapiroWilk**
Combined Radium 226 + 228 (pCi/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	1.83	3.142	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-1606	No	n/a	n/a	NP	NaN	13	3.04	0.5517	sqrt(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	MW-1607	No	n/a	n/a	NP	NaN	13	1.523	1.763	ln(x)	ShapiroWilk
Fluoride (mg/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	14	0.225	0.03082	ln(x)	ShapiroWilk
Fluoride (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	14	0.7171	0.0489	ln(x)	ShapiroWilk
Fluoride (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	14	0.1236	0.01277	x^(1/3)	ShapiroWilk
Fluoride (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	14	0.2693	0.06844	x^3	ShapiroWilk
Fluoride (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	14	0.1286	0.03159	ln(x)	ShapiroWilk
Fluoride (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	15	1.006	0.1201	ln(x)	ShapiroWilk
Fluoride (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	14	0.1071	0.08974	ln(x)	ShapiroWilk
Fluoride (mg/L)	MW-1605 (bg)	n/a	n/a	n/a	NP	NaN	13	0.02769	0.005991	unknown	ShapiroWilk
Fluoride (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	14	0.2014	0.02797	ln(x)	ShapiroWilk
Fluoride (mg/L)	MW-1607	No	n/a	n/a	NP	NaN	14	0.06357	0.01216	normal	ShapiroWilk
Lead (mg/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Lead (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.000458	ln(x)	ShapiroWilk
Lead (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0004476	ln(x)	ShapiroWilk
Lead (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Lead (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Lead (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.005668	0.001802	ln(x)	ShapiroWilk
Lead (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	x^(1/3)	ShapiroWilk
Lead (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Lead (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	13	0.000...	0.0005724	ln(x)	ShapiroWilk
Lead (mg/L)	MW-1607	No	n/a	n/a	NP	NaN	13	0.000...	0.0002152	ln(x)	ShapiroWilk
Lithium (mg/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	13	0.01144	0.004797	normal	ShapiroWilk
Lithium (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.009258	0.004738	ln(x)	ShapiroWilk
Lithium (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	0.01398	0.003615	ln(x)	ShapiroWilk
Lithium (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.02817	0.009888	x^2	ShapiroWilk
Lithium (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.008721	0.005041	x^(1/3)	ShapiroWilk
Lithium (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.2229	0.02229	ln(x)	ShapiroWilk
Lithium (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.007926	0.00548	ln(x)	ShapiroWilk
Lithium (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.006841	0.005493	x^(1/3)	ShapiroWilk
Lithium (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	13	0.008232	0.004968	sqrt(x)	ShapiroWilk
Lithium (mg/L)	MW-1607	No	n/a	n/a	NP	NaN	13	0.006162	0.005087	sqrt(x)	ShapiroWilk
Mercury (mg/L)	MW-1011 (bg)	n/a	n/a	n/a	NP	NaN	13	0.000...	2.8e-7	unknown	ShapiroWilk
Mercury (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Mercury (mg/L)	MW-1203 (bg)	n/a	n/a	n/a	NP	NaN	13	0.000...	8.3e-7	unknown	ShapiroWilk
Mercury (mg/L)	MW-1601	n/a	n/a	n/a	NP	NaN	13	0.000005	0	unknown	ShapiroWilk
Mercury (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	sqrt(x)	ShapiroWilk
Mercury (mg/L)	MW-1603	n/a	n/a	n/a	NP	NaN	13	0.000...	8.3e-7	unknown	ShapiroWilk
Mercury (mg/L)	MW-1604 (bg)	n/a	n/a	n/a	NP	NaN	13	0.000...	5.5e-7	unknown	ShapiroWilk
Mercury (mg/L)	MW-1605 (bg)	n/a	n/a	n/a	NP	NaN	13	0.000...	5.5e-7	unknown	ShapiroWilk
Mercury (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	normal	ShapiroWilk
Mercury (mg/L)	MW-1607	n/a	n/a	n/a	NP	NaN	13	0.000...	2.8e-7	unknown	ShapiroWilk
Molybdenum (mg/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	13	0.001138	0.0003443	sqrt(x)	ShapiroWilk
Molybdenum (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.001327	0.0006431	ln(x)	ShapiroWilk
Molybdenum (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0003615	ln(x)	ShapiroWilk
Molybdenum (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.02189	0.01032	x^2	ShapiroWilk
Molybdenum (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.001998	0.0007198	sqrt(x)	ShapiroWilk
Molybdenum (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.001258	0.002135	ln(x)	ShapiroWilk
Molybdenum (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.002424	0.004145	ln(x)	ShapiroWilk
Molybdenum (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.00211	0.006499	ln(x)	ShapiroWilk
Molybdenum (mg/L)	**MW-1606**	**Yes**	**0.00756**	**7/12/2017**	**NP**	**NaN**	**13**	**0.001328**	**0.001952**	**ln(x)**	**ShapiroWilk**
Molybdenum (mg/L)	**MW-1607**	**Yes**	**0.00902**	**7/12/2017**	**NP**	**NaN**	**13**	**0.001286**	**0.00233**	**ln(x)**	**ShapiroWilk**
Selenium (mg/L)	MW-1011 (bg)	n/a	n/a	n/a	NP	NaN	13	0.000...	0.0000...	unknown	ShapiroWilk
Selenium (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Selenium (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Selenium (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	ln(x)	ShapiroWilk
Selenium (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.001485	0.0006362	normal	ShapiroWilk
Selenium (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.005446	0.001293	normal	ShapiroWilk

Appendix IV Outlier Analysis - All Results

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 11/13/2019, 4:40 PM

Constituent	Well	Outlier	Value(s)	Date(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Selenium (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	sqrt(x)	ShapiroWilk
Selenium (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0000...	x^5	ShapiroWilk
Selenium (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	13	0.000...	0.0000813	ln(x)	ShapiroWilk
Selenium (mg/L)	**MW-1607**	**Yes**	**0.00005,0...**	**2/21/2017...**	**NP**	**NaN**	**13**	**0.000...**	**0.0001692**	**ln(x)**	**ShapiroWilk**
Thallium (mg/L)	MW-1011 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0001659	ln(x)	ShapiroWilk
Thallium (mg/L)	MW-1012 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0002097	ln(x)	ShapiroWilk
Thallium (mg/L)	MW-1203 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0002074	ln(x)	ShapiroWilk
Thallium (mg/L)	MW-1601	No	n/a	n/a	NP	NaN	13	0.000...	0.0002076	ln(x)	ShapiroWilk
Thallium (mg/L)	MW-1602	No	n/a	n/a	NP	NaN	13	0.00013	0.000211	ln(x)	ShapiroWilk
Thallium (mg/L)	MW-1603	No	n/a	n/a	NP	NaN	13	0.001426	0.0002381	ln(x)	ShapiroWilk
Thallium (mg/L)	MW-1604 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.000234	ln(x)	ShapiroWilk
Thallium (mg/L)	MW-1605 (bg)	No	n/a	n/a	NP	NaN	13	0.000...	0.0002323	ln(x)	ShapiroWilk
Thallium (mg/L)	MW-1606	No	n/a	n/a	NP	NaN	13	0.00025	0.0002421	ln(x)	ShapiroWilk
Thallium (mg/L)	MW-1607	No	n/a	n/a	NP	NaN	13	0.000...	0.0002042	ln(x)	ShapiroWilk

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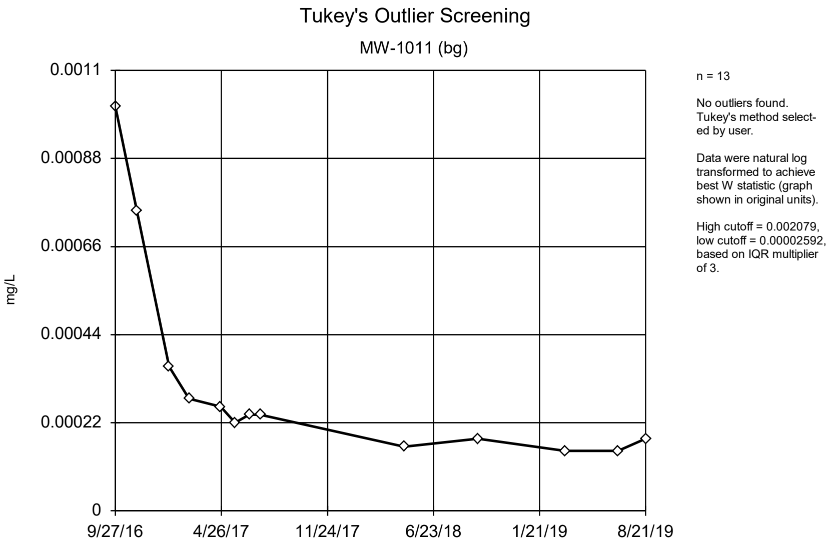

Constituent: Antimony Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

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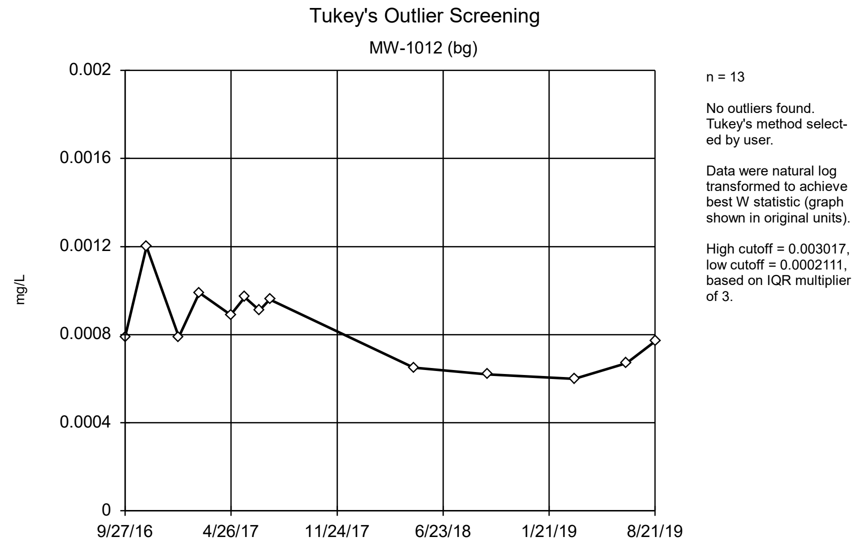
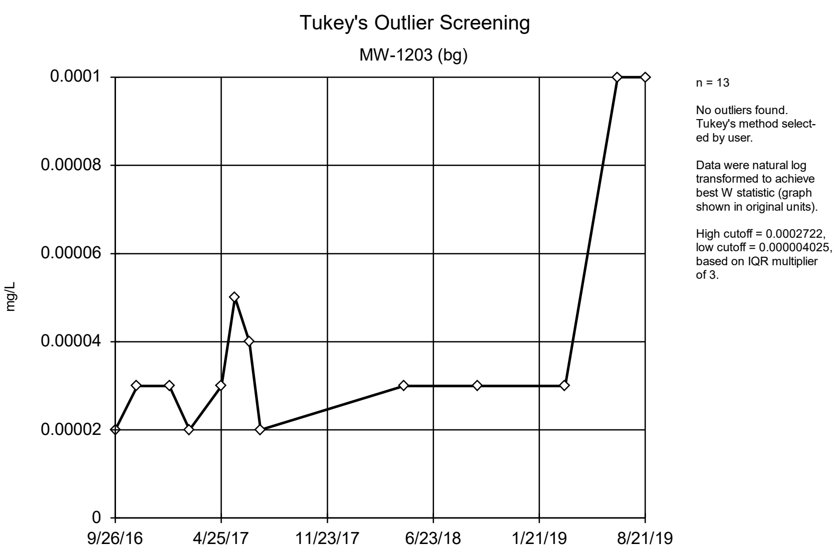


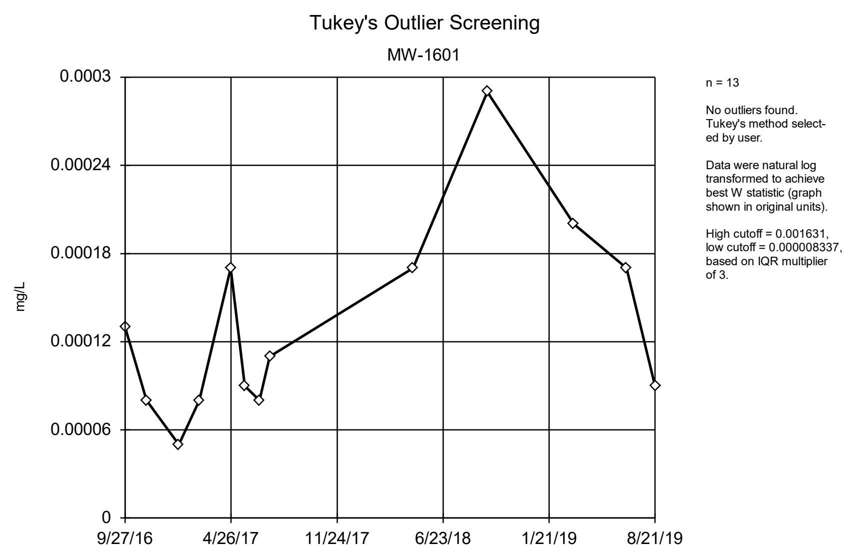
Constituent: Antimony Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



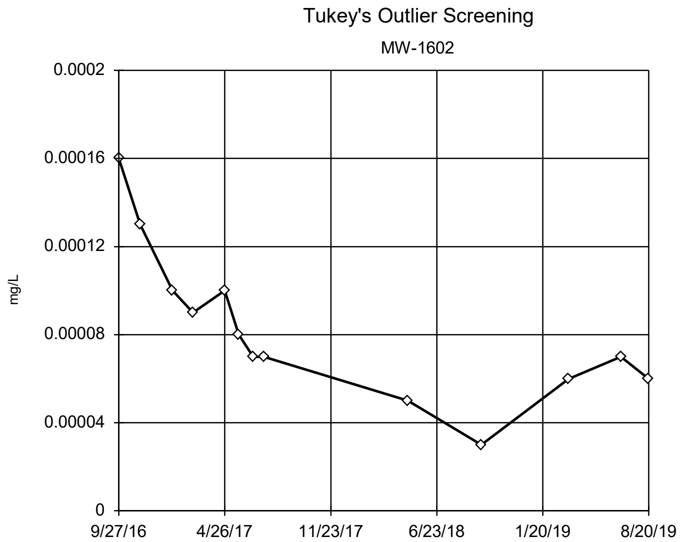
Constituent: Antimony Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



Constituent: Antimony Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

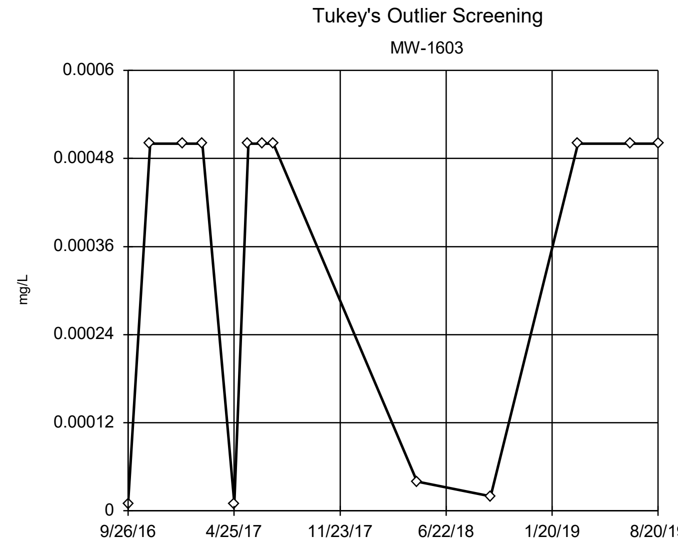
No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0003175, low cutoff = 0.00000522, based on IQR multiplier of 3.

Constituent: Antimony Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

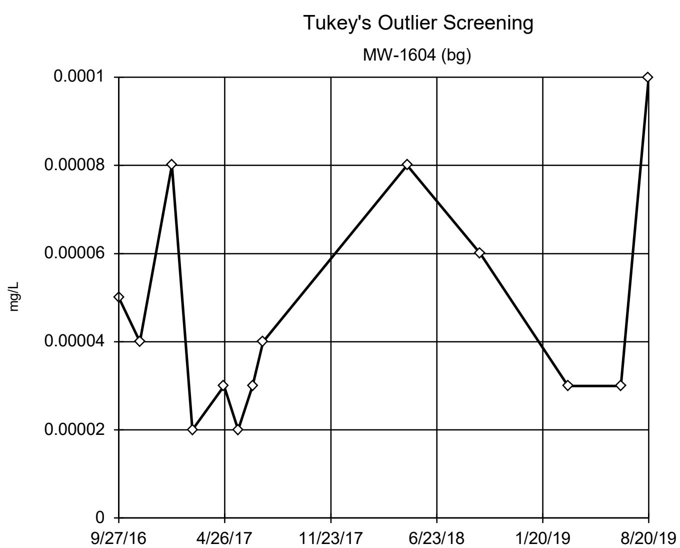
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.762, low cutoff = 5.1e-9, based on IQR multiplier of 3.

Constituent: Antimony Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

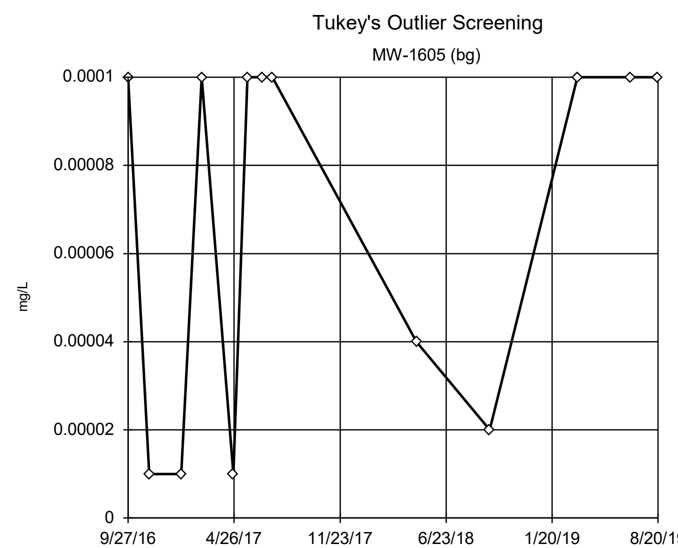
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0008533, low cutoff = 0.000002436, based on IQR multiplier of 3.

Constituent: Antimony Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

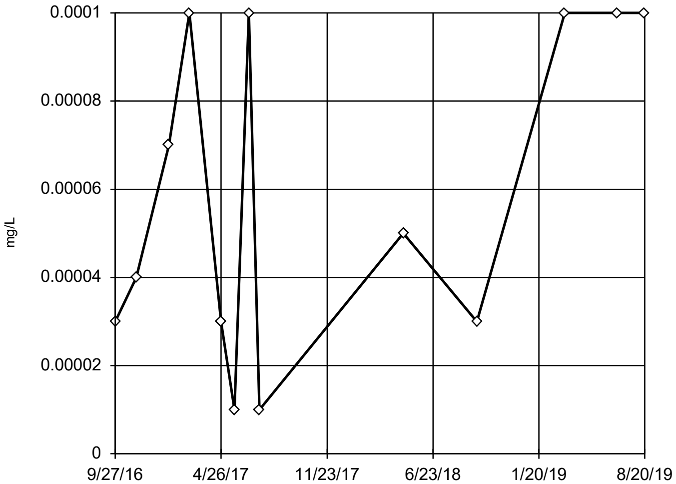
High cutoff = 0.001429, low cutoff = -0.00007341, based on IQR multiplier of 3.

Constituent: Antimony Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1606



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

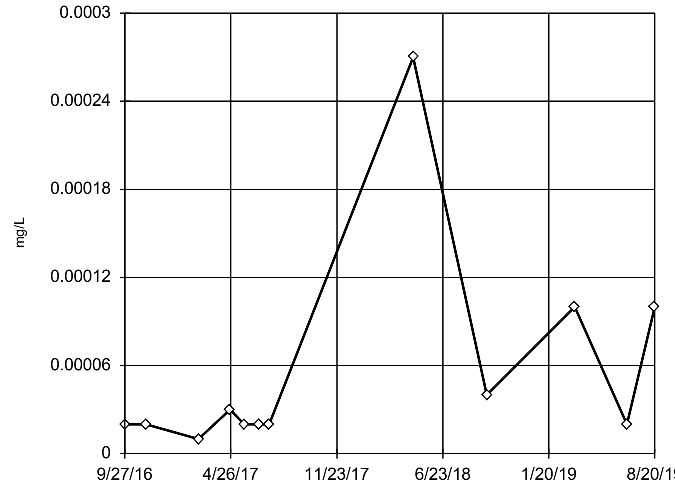
High cutoff = 0.0007901, low cutoff = -0.000003347, based on IQR multiplier of 3.

Constituent: Antimony Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1607



n = 12

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

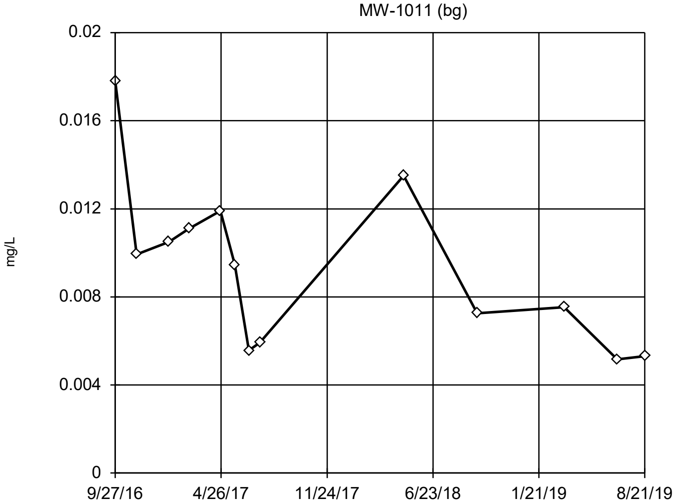
High cutoff = 0.002, low cutoff = 6.3e-7, based on IQR multiplier of 3.

Constituent: Antimony Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1011 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

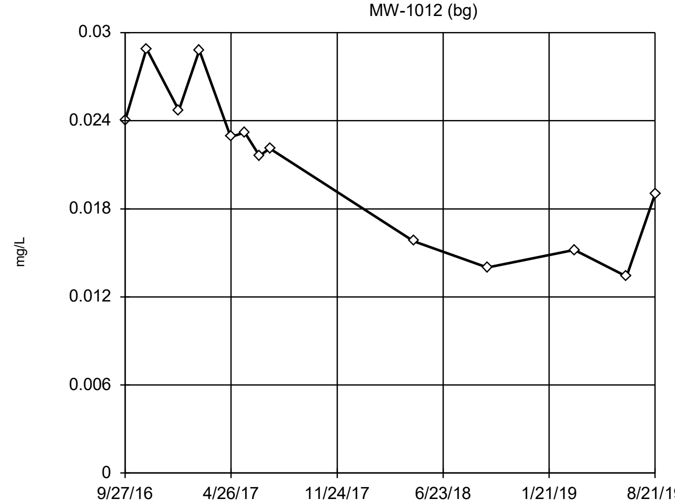
High cutoff = 0.09215, low cutoff = 0.0007162, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1012 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

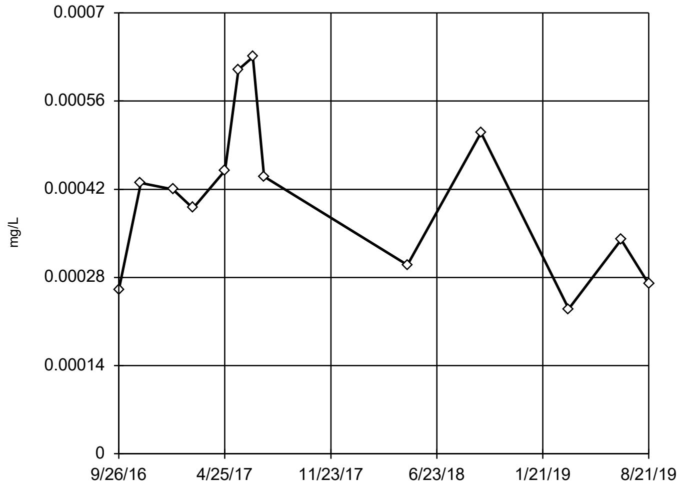
High cutoff = 0.0509, low cutoff = -0.01105, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1203 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

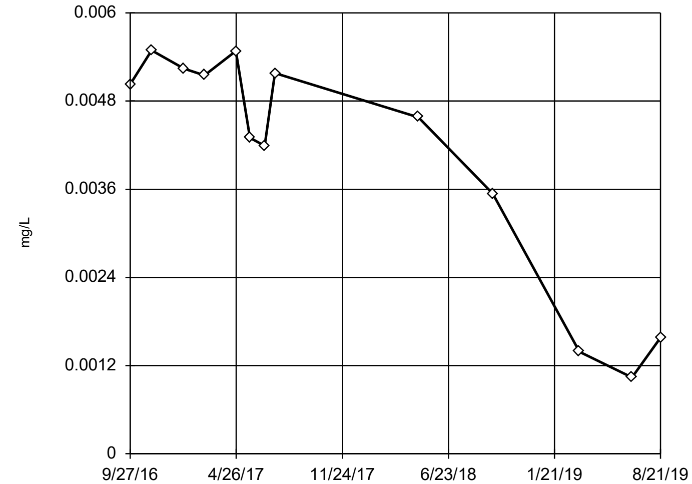
High cutoff = 0.001548, low cutoff = 0.00002282, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1601



n = 13

No outliers found. Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

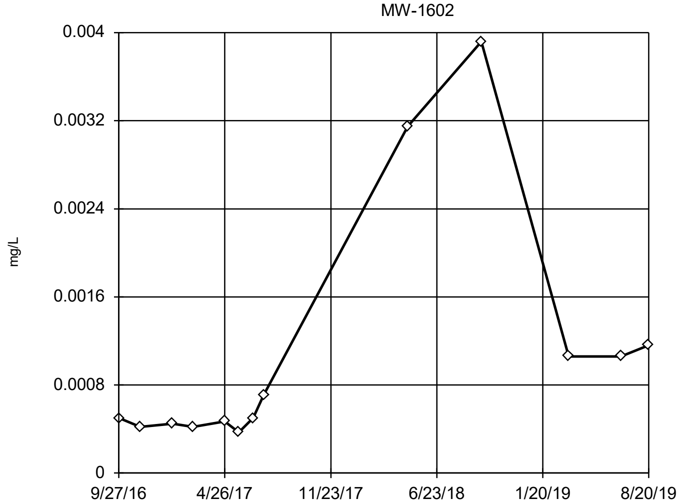
High cutoff = 0.00721, low cutoff = -0.006589, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1602



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

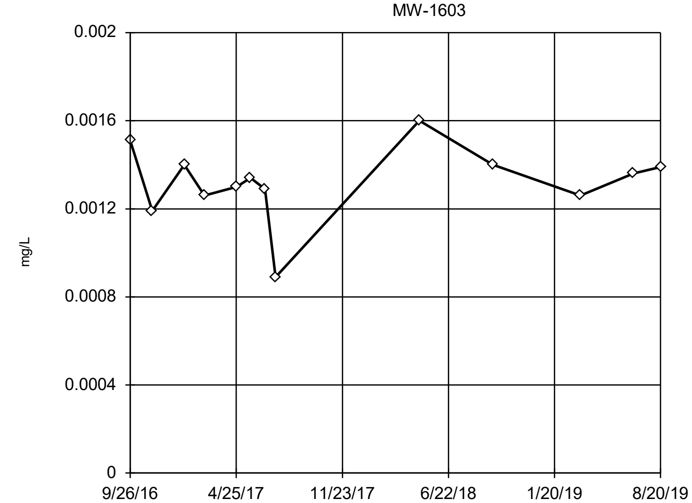
High cutoff = 0.0184, low cutoff = 0.0000262, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1603



n = 13

No outliers found. Tukey's method selected by user.

Data were cube transformed to achieve best W statistic (graph shown in original units).

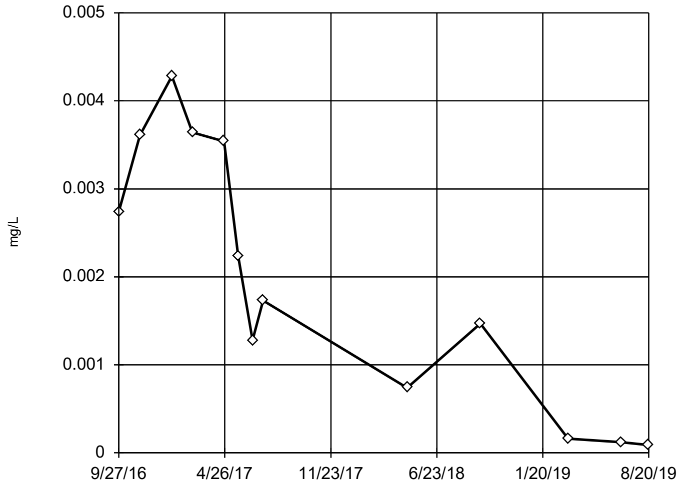
High cutoff = 0.001707, low cutoff = -0.0006131, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1604 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

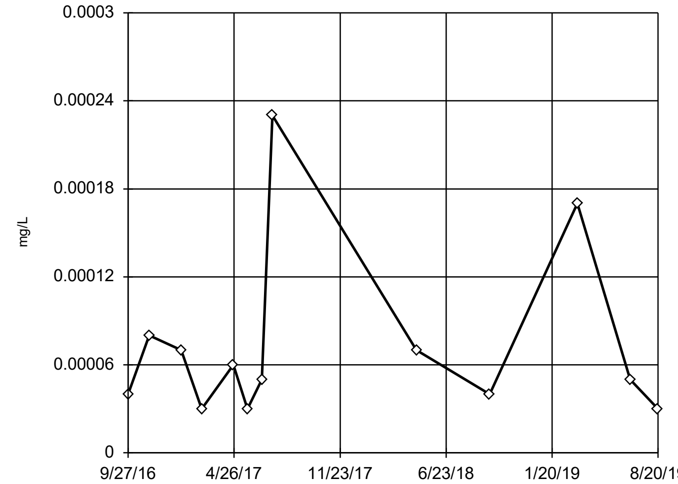
High cutoff = 0.01295, low cutoff = -0.008925, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1605 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

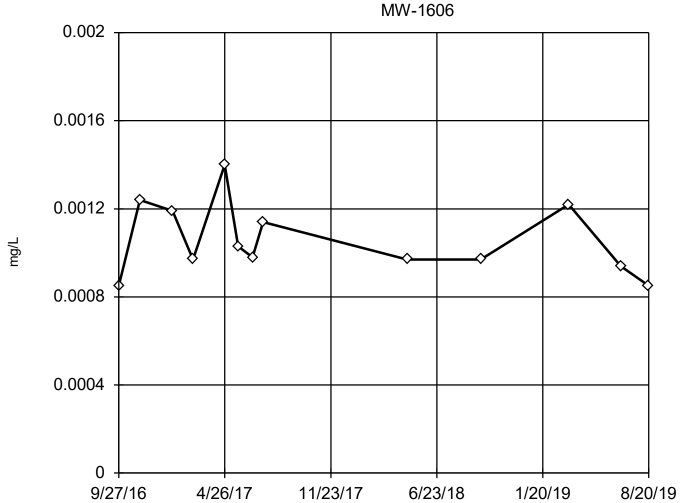
High cutoff = 0.0007544, low cutoff = 0.000003436, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1606



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

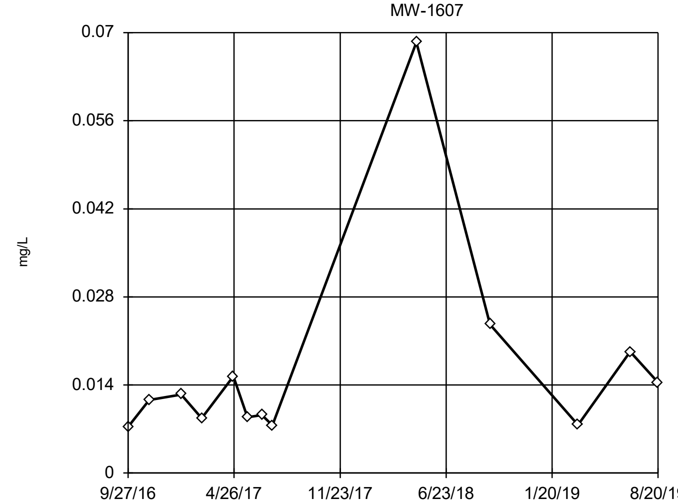
High cutoff = 0.002421, low cutoff = 0.0004753, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1607



n = 13

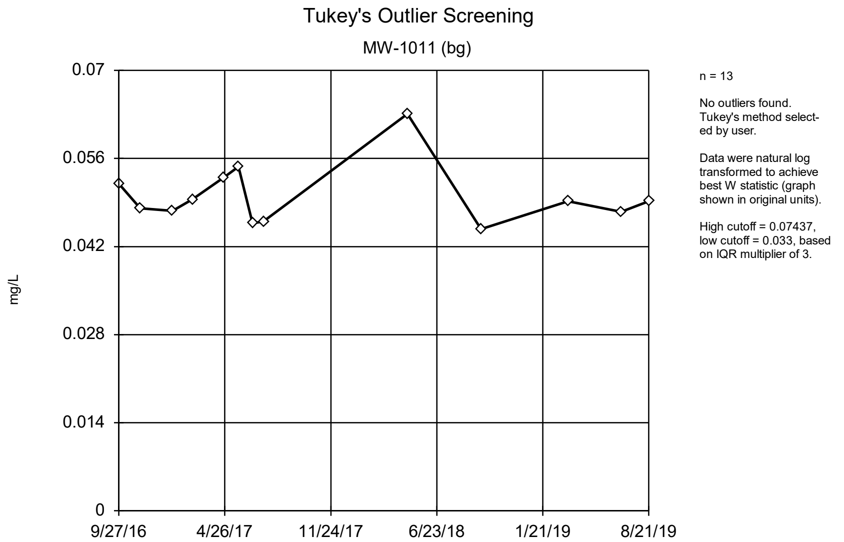
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1618, low cutoff = 0.000871, based on IQR multiplier of 3.

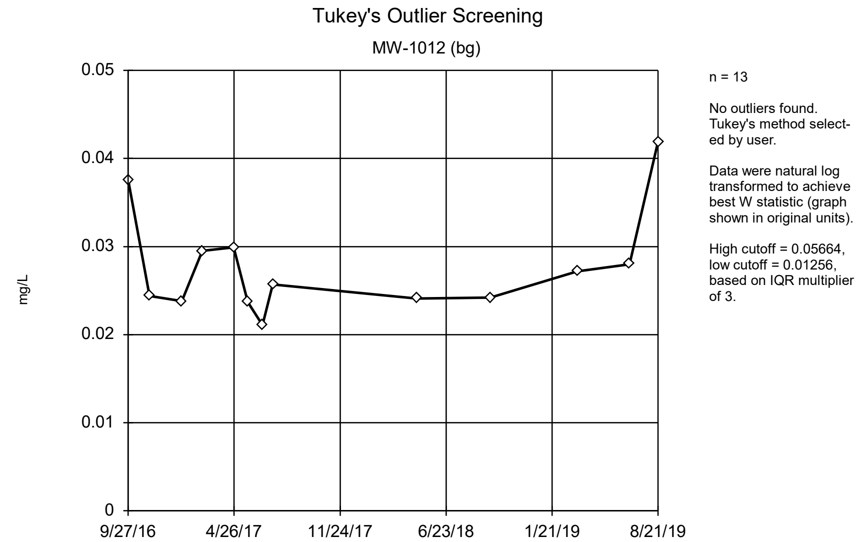
Constituent: Arsenic Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



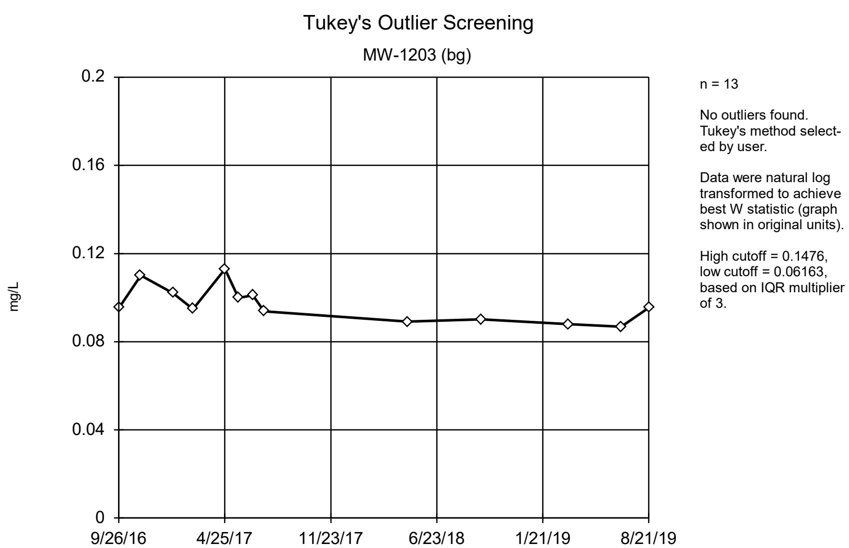
Constituent: Barium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



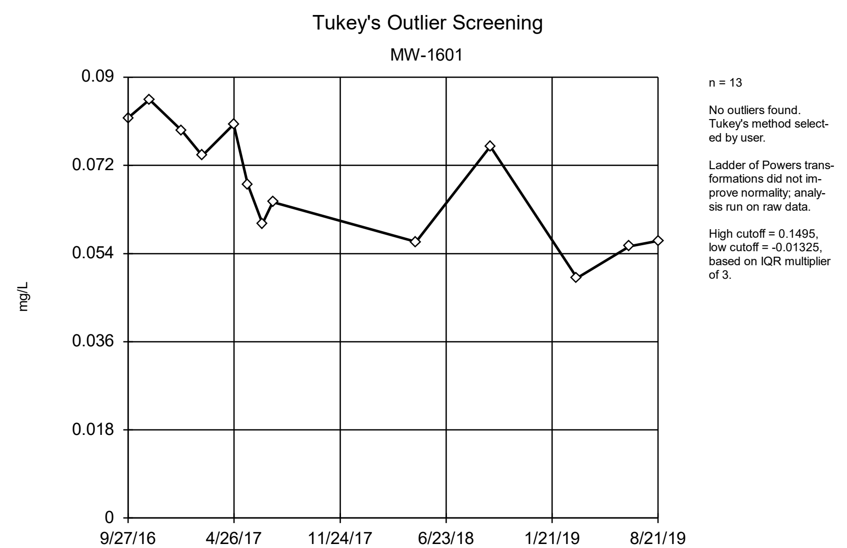
Constituent: Barium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



Constituent: Barium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

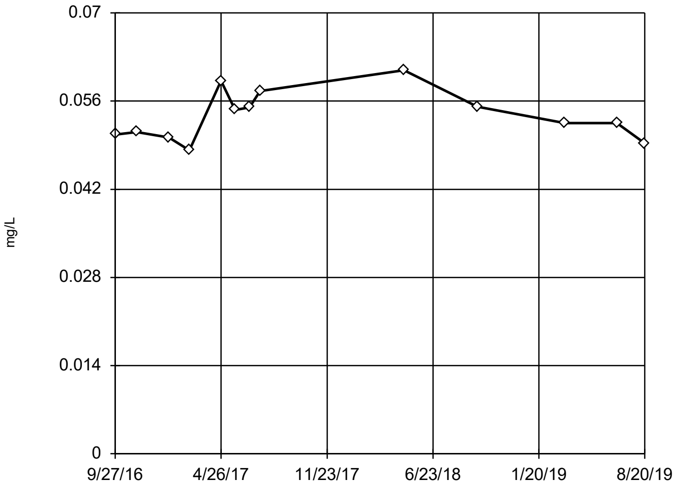


Constituent: Barium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1602



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

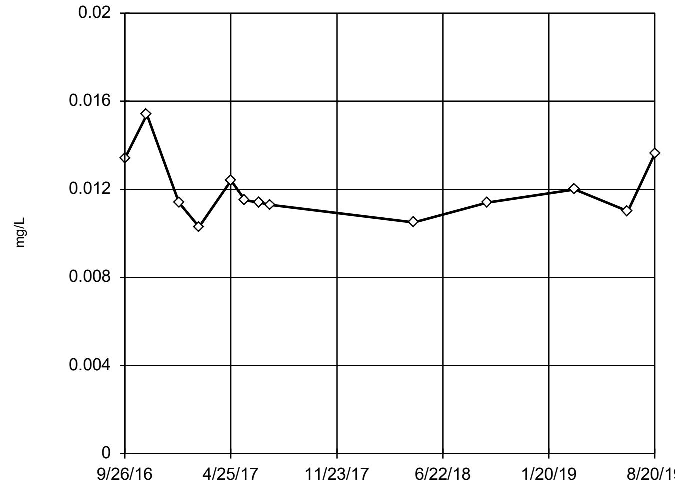
High cutoff = 0.07845, low cutoff = 0.03623, based on IQR multiplier of 3.

Constituent: Barium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1603



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

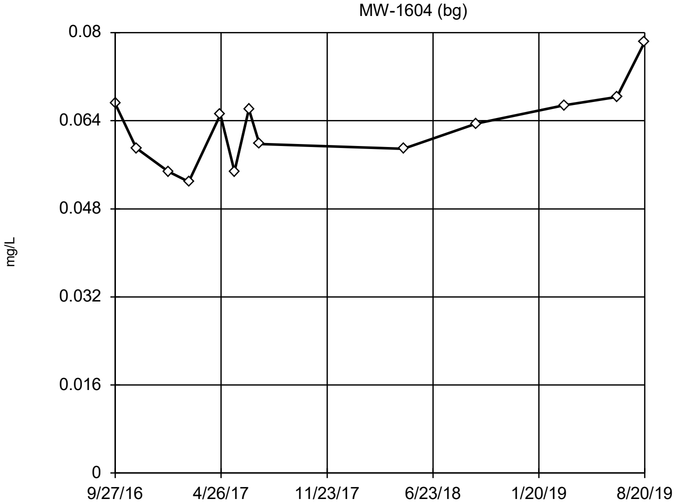
High cutoff = 0.01992, low cutoff = 0.007214, based on IQR multiplier of 3.

Constituent: Barium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1604 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

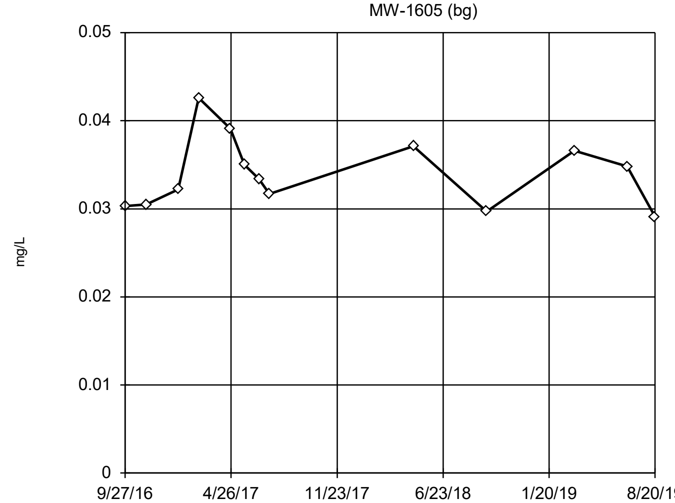
High cutoff = 0.1096, low cutoff = 0.03472, based on IQR multiplier of 3.

Constituent: Barium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1605 (bg)



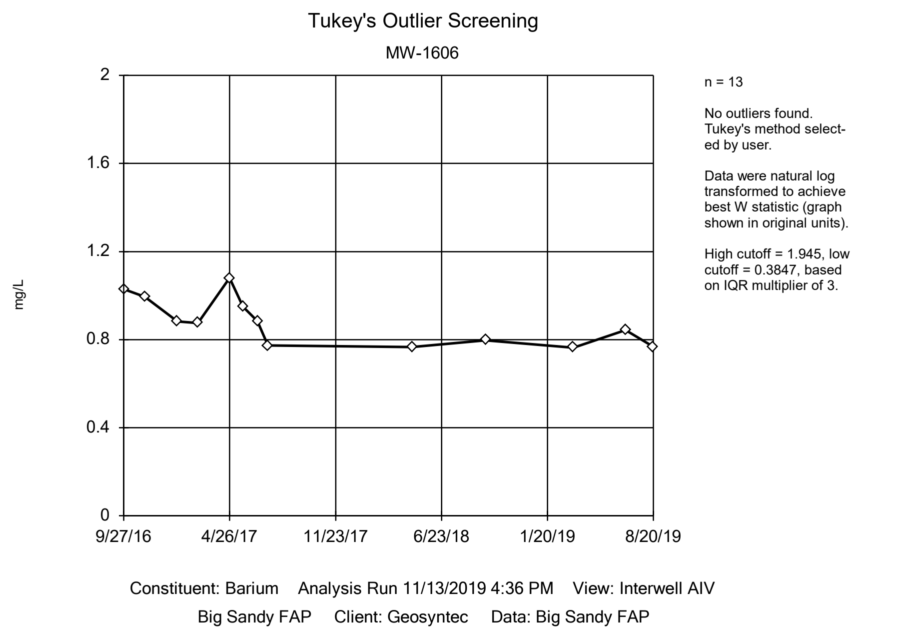
n = 13

No outliers found. Tukey's method selected by user.

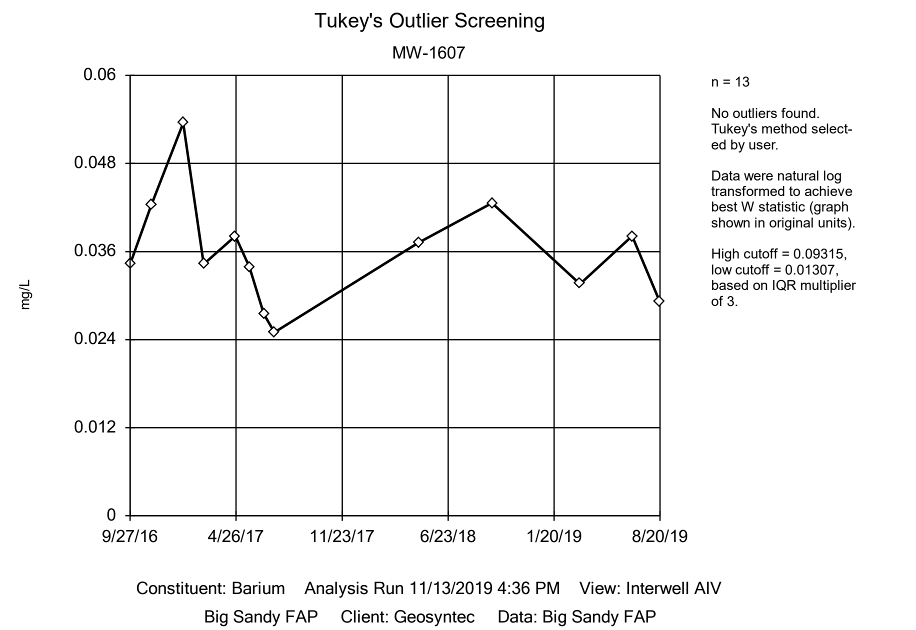
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.06563, low cutoff = 0.01707, based on IQR multiplier of 3.

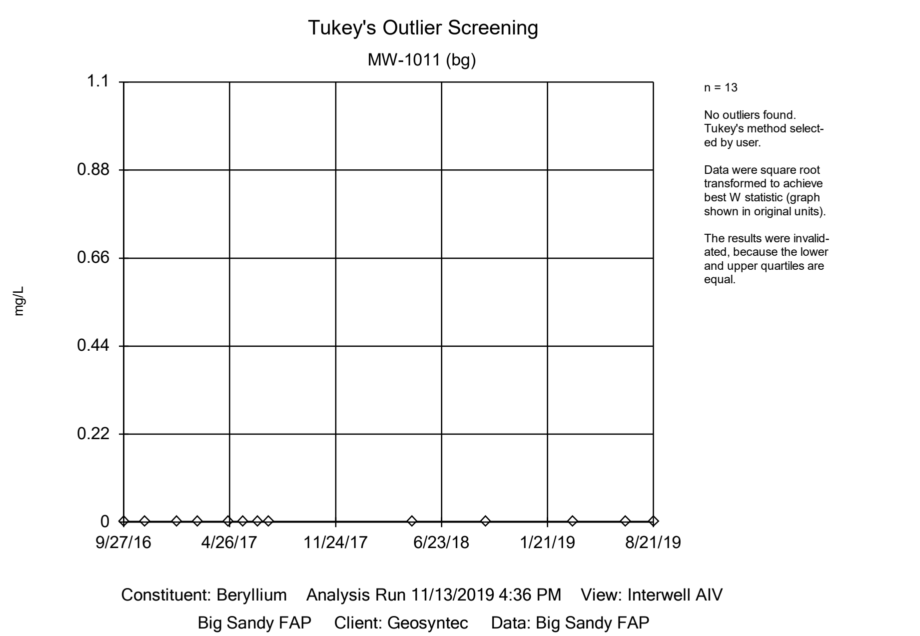
Constituent: Barium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP



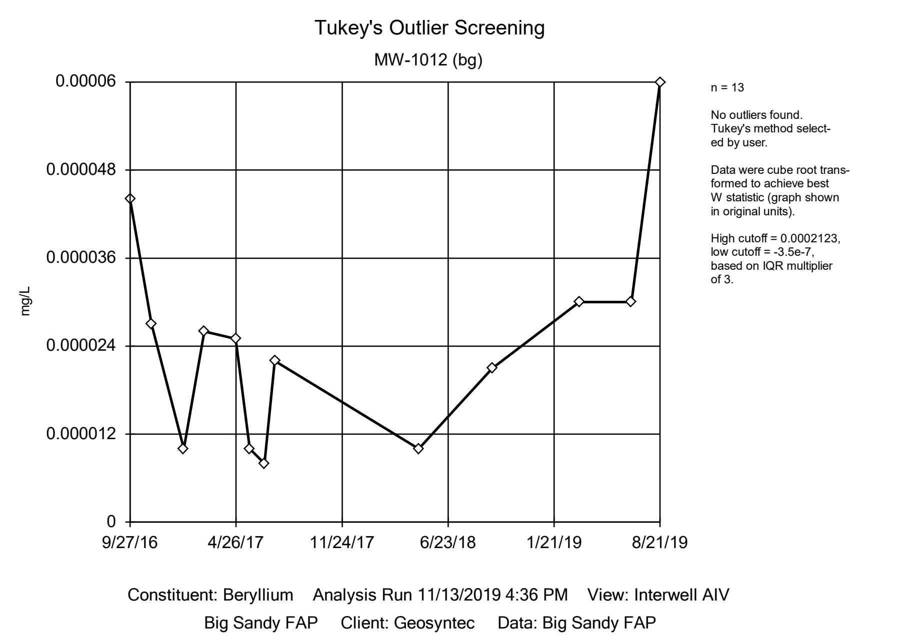
Sanitas™ v.9.6.23 . UG



Sanitas™ v.9.6.23 . UG



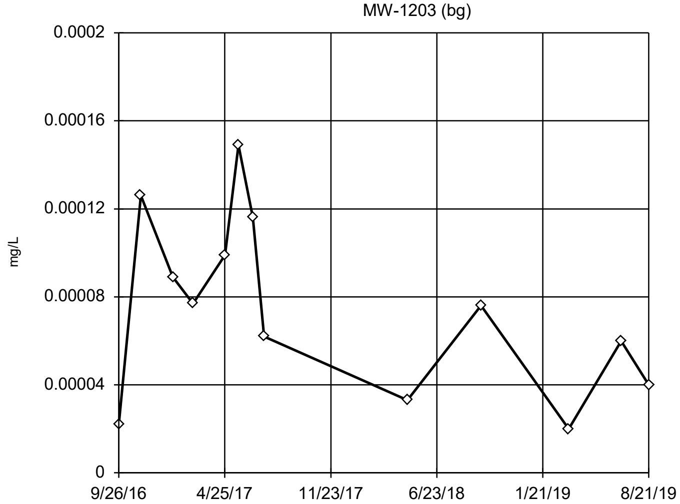
Sanitas™ v.9.6.23 . UG



Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1203 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

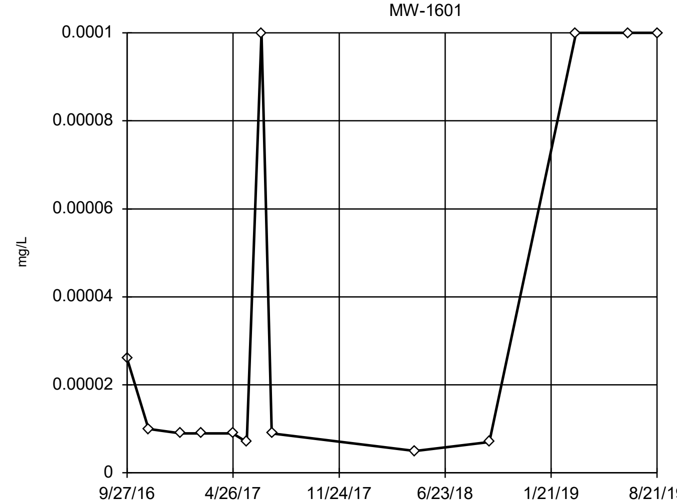
High cutoff = 0.0005446, low cutoff = -0.00004819, based on IQR multiplier of 3.

Constituent: Beryllium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1601



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

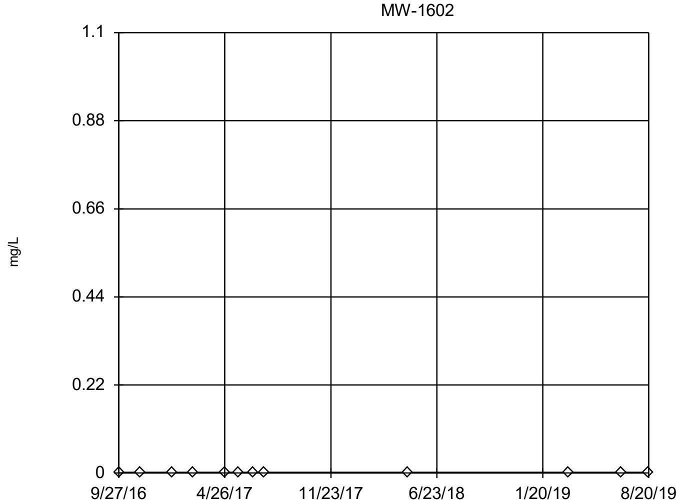
High cutoff = 0.2, low cutoff = 4.0e-9, based on IQR multiplier of 3.

Constituent: Beryllium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1602



n = 12

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

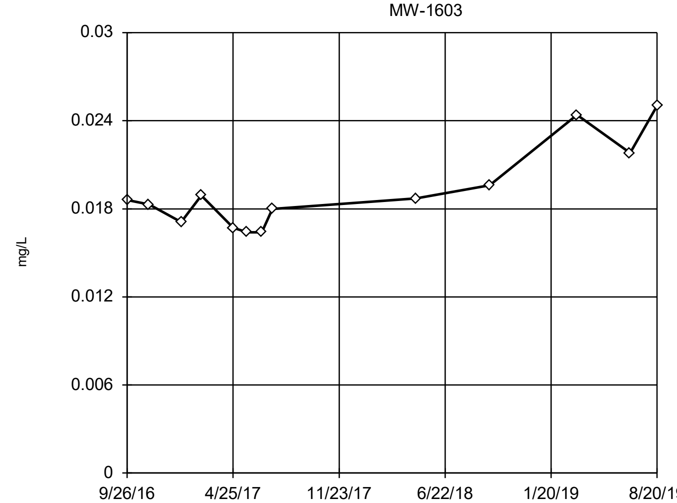
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Beryllium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1603



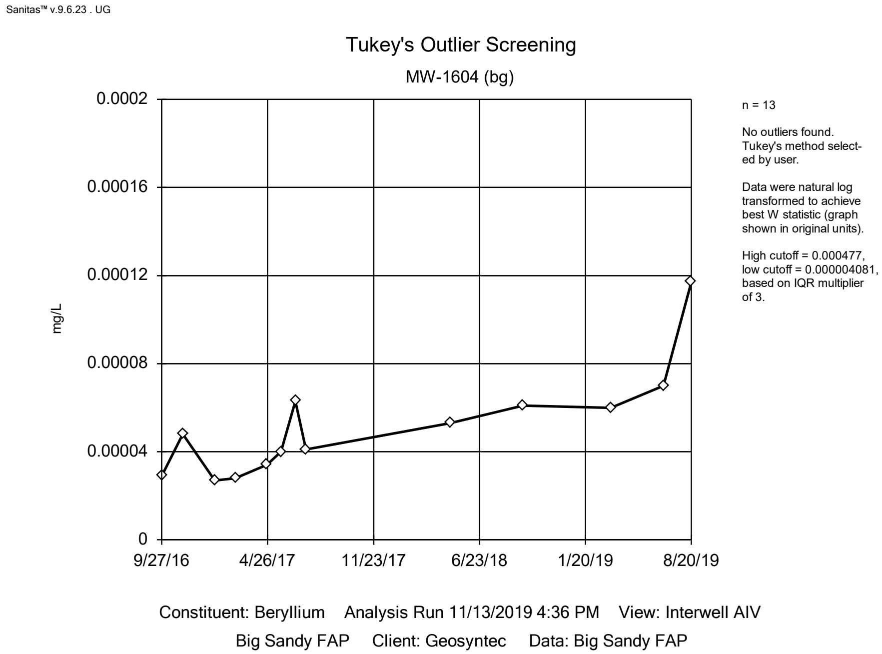
n = 13

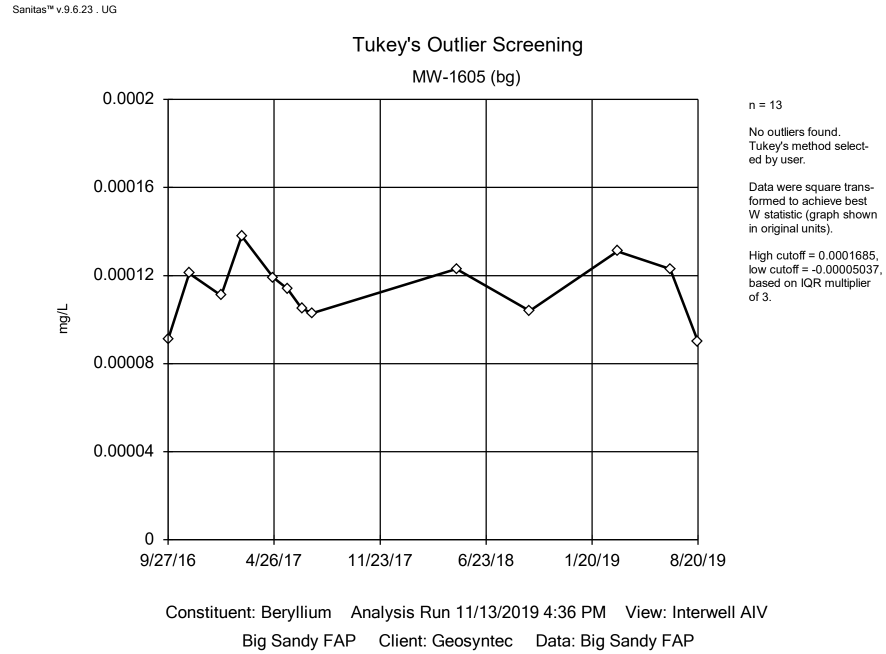
No outliers found. Tukey's method selected by user.

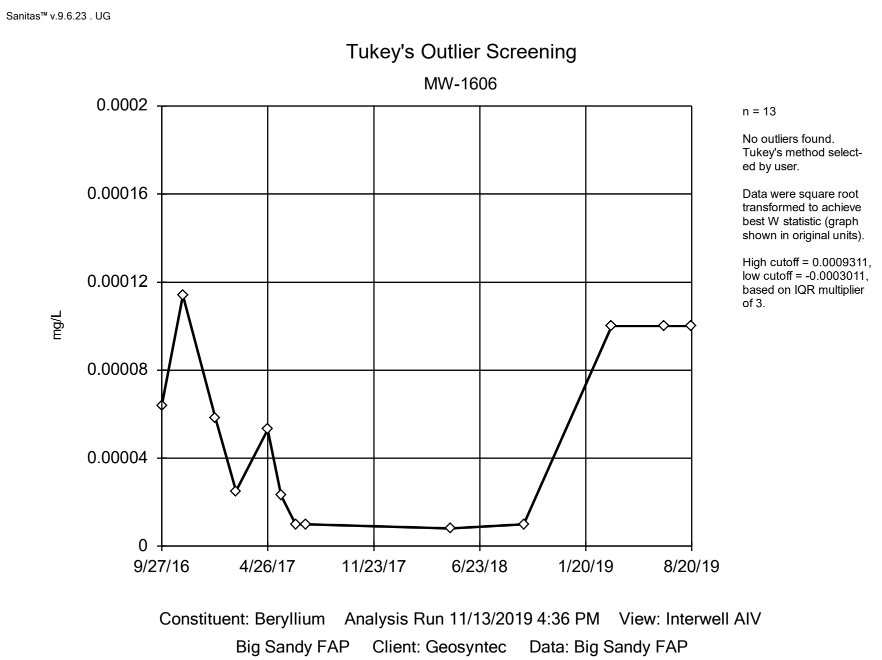
Data were natural log transformed to achieve best W statistic (graph shown in original units).

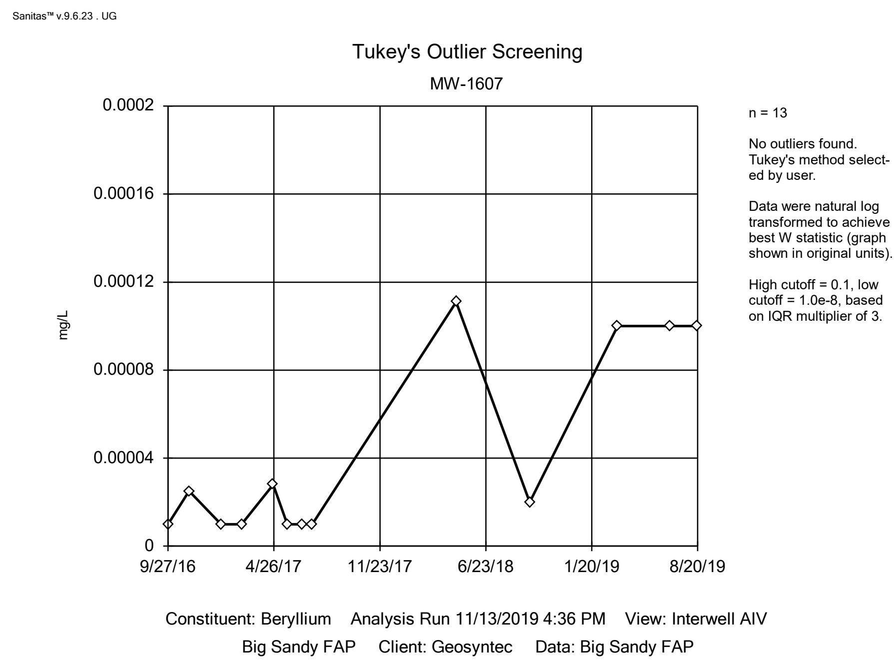
High cutoff = 0.03783, low cutoff = 0.009233, based on IQR multiplier of 3.

Constituent: Beryllium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

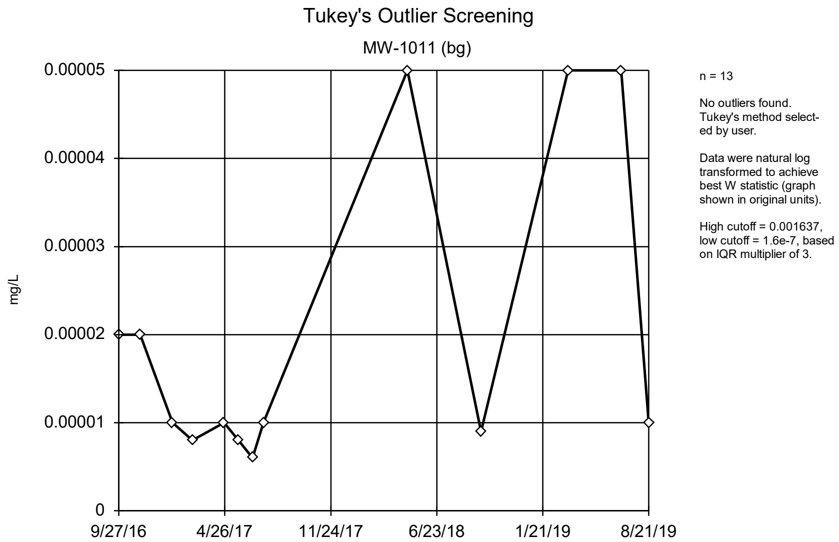

Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1604 (bg)
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.000477, low cutoff = 0.000004081, based on IQR multiplier of 3.
mg/L
0.0002
0.00016
0.00012
0.00008
0.00004
0
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
Constituent: Beryllium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1605 (bg)
n = 13
No outliers found. Tukey's method selected by user.
Data were square transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.0001685, low cutoff = -0.00005037, based on IQR multiplier of 3.
mg/L
0.0002
0.00016
0.00012
0.00008
0.00004
0
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
Constituent: Beryllium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1606
n = 13
No outliers found. Tukey's method selected by user.
Data were square root transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.0009311, low cutoff = -0.0003011, based on IQR multiplier of 3.
mg/L
0.0002
0.00016
0.00012
0.00008
0.00004
0
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
Constituent: Beryllium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

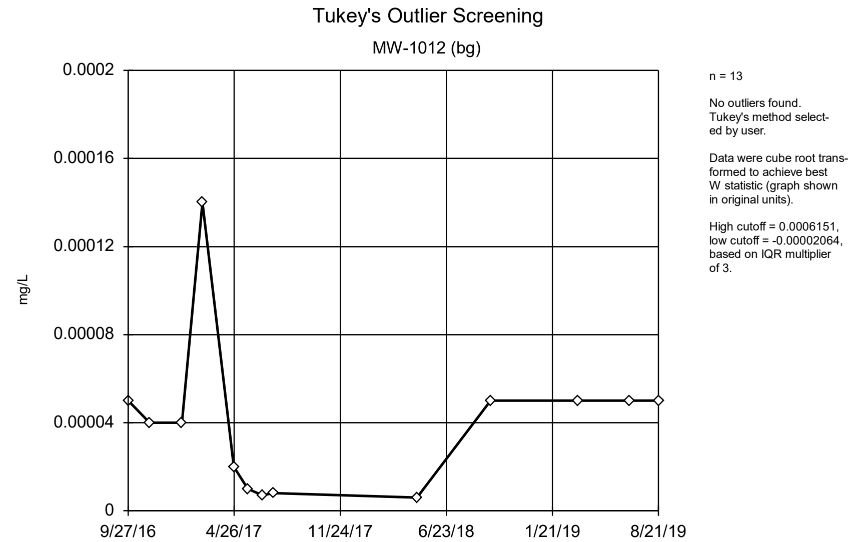

Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1607
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.1, low cutoff = 1.0e-8, based on IQR multiplier of 3.
mg/L
0.0002
0.00016
0.00012
0.00008
0.00004
0
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
Constituent: Beryllium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



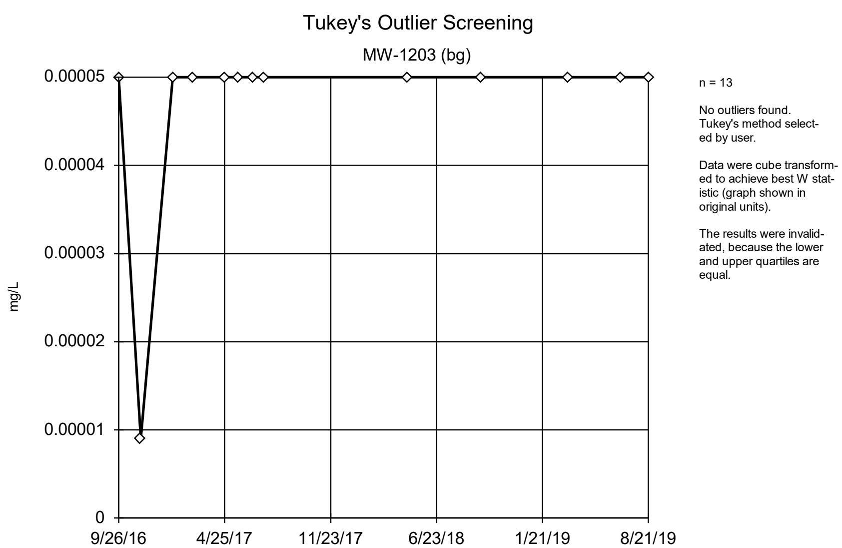
Constituent: Cadmium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



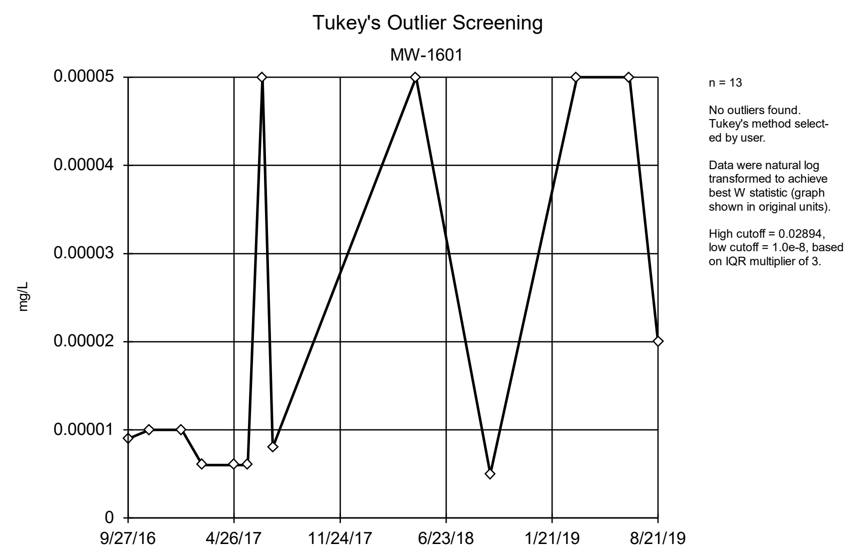
Constituent: Cadmium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



Constituent: Cadmium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

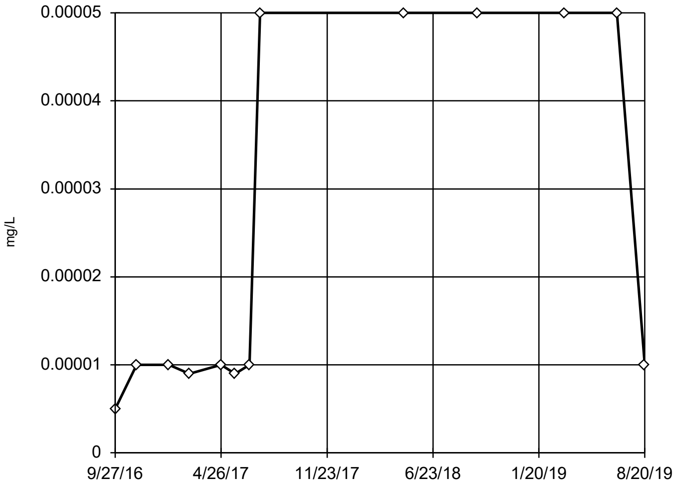


Constituent: Cadmium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1602



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

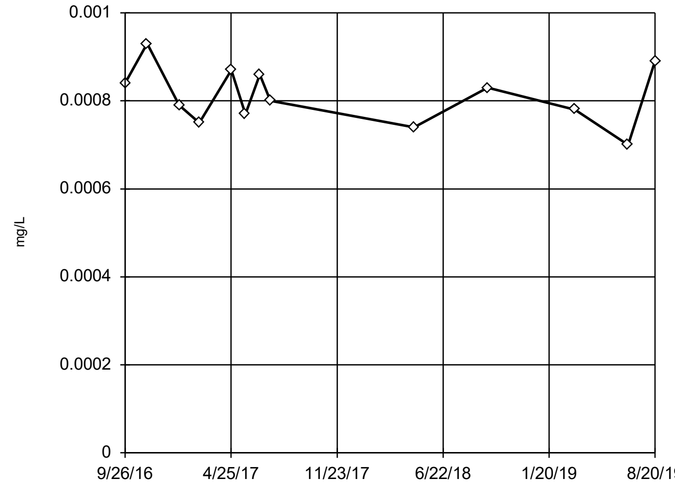
High cutoff = 0.00732, low cutoff = 6.5e-8, based on IQR multiplier of 3.

Constituent: Cadmium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1603



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

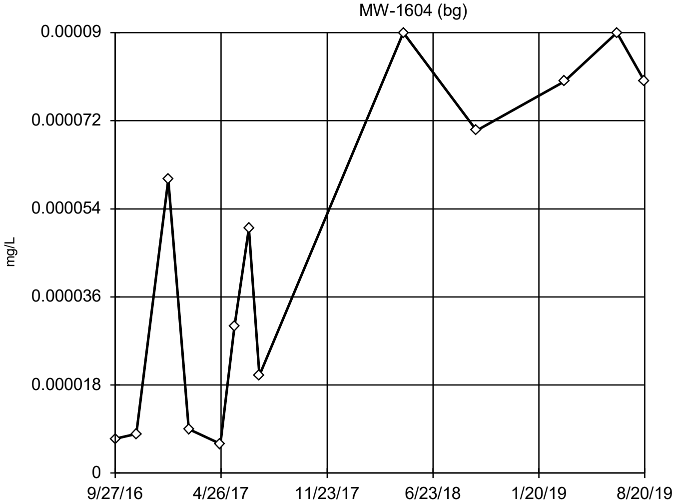
High cutoff = 0.001276, low cutoff = 0.0005153, based on IQR multiplier of 3.

Constituent: Cadmium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1604 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

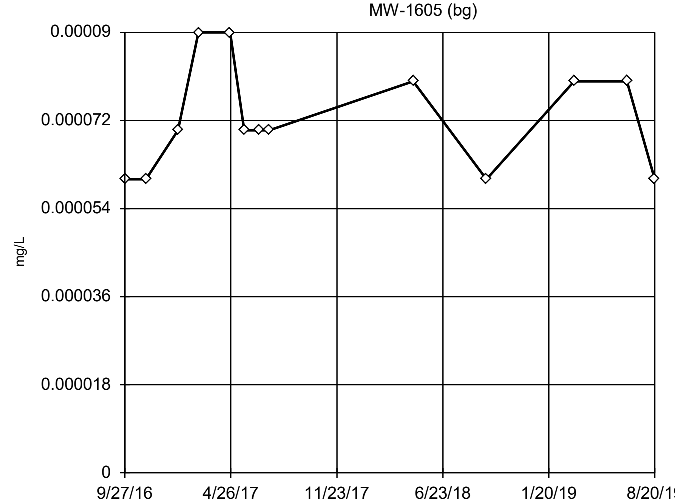
High cutoff = 0.0002945, low cutoff = -0.000206, based on IQR multiplier of 3.

Constituent: Cadmium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1605 (bg)



n = 13

No outliers found. Tukey's method selected by user.

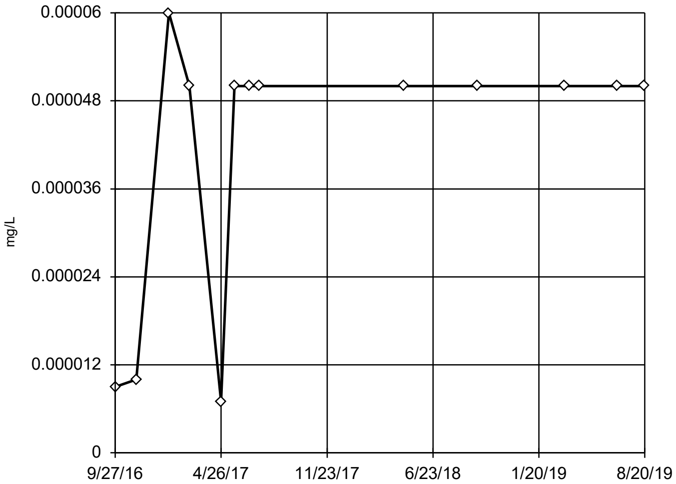
Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0001655, low cutoff = 0.00002041, based on IQR multiplier of 3.

Constituent: Cadmium   Analysis Run 11/13/2019 4:36 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Tukey's Outlier Screening

MW-1606



n = 13

No outliers found. Tukey's method selected by user.

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

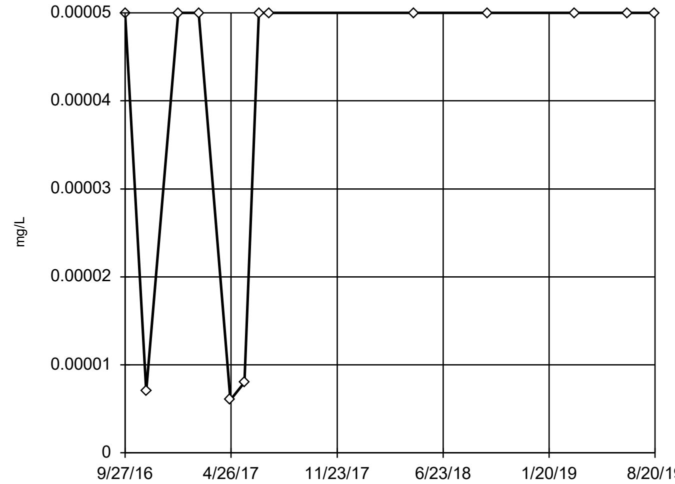
The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Cadmium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1607



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

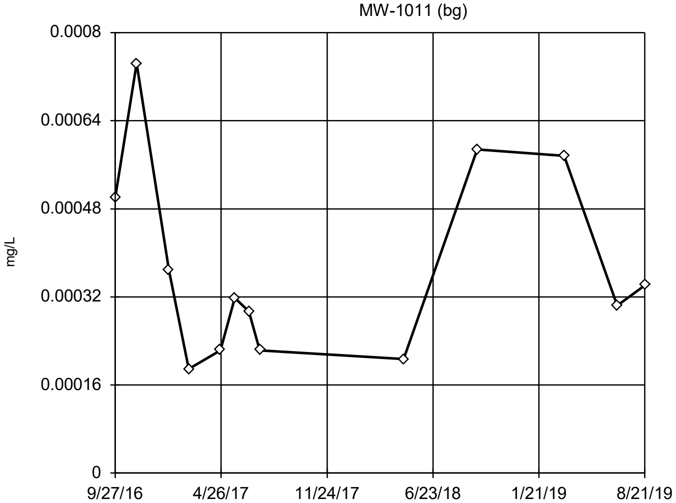
High cutoff = 0.0007812, low cutoff = 0.00000128, based on IQR multiplier of 3.

Constituent: Cadmium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1011 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

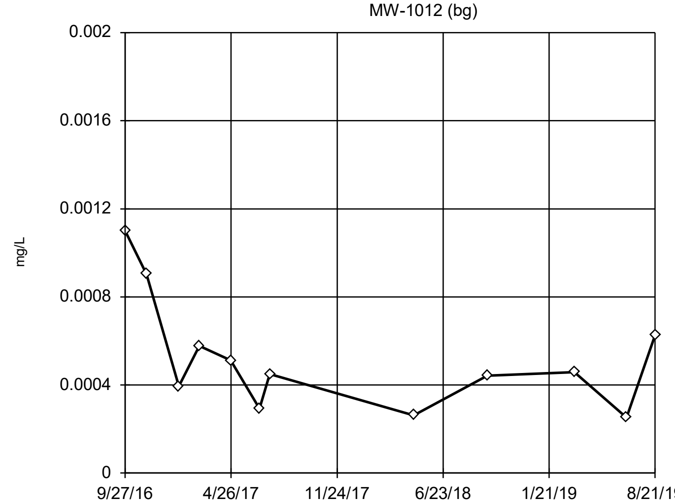
High cutoff = 0.007479, low cutoff = 0.000016, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1012 (bg)



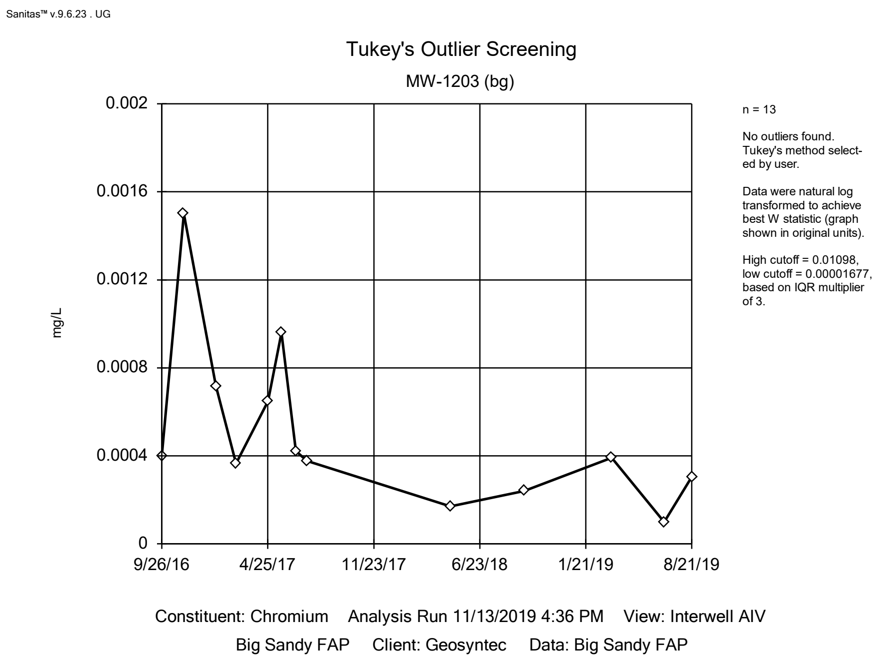
n = 12

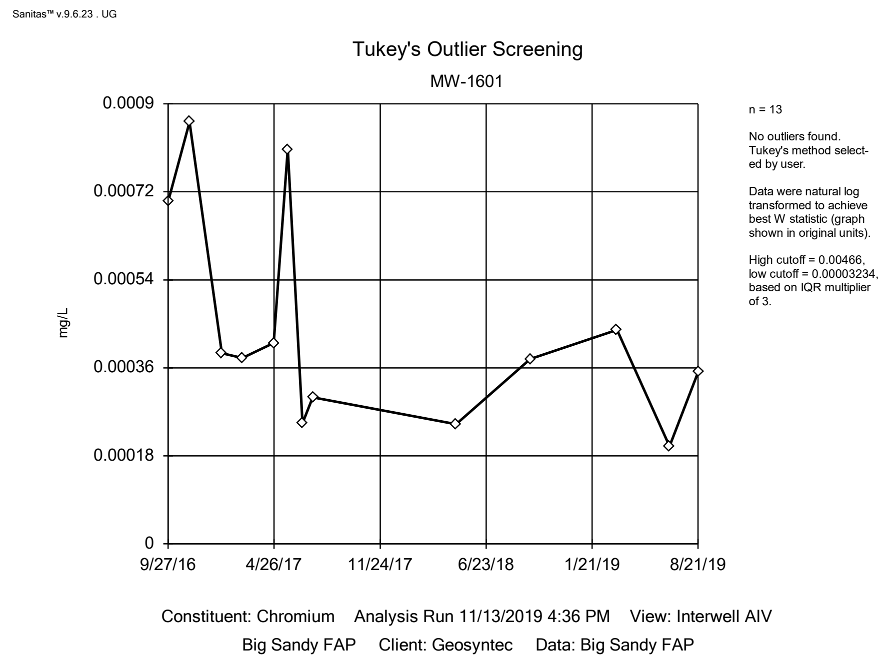
No outliers found. Tukey's method selected by user.

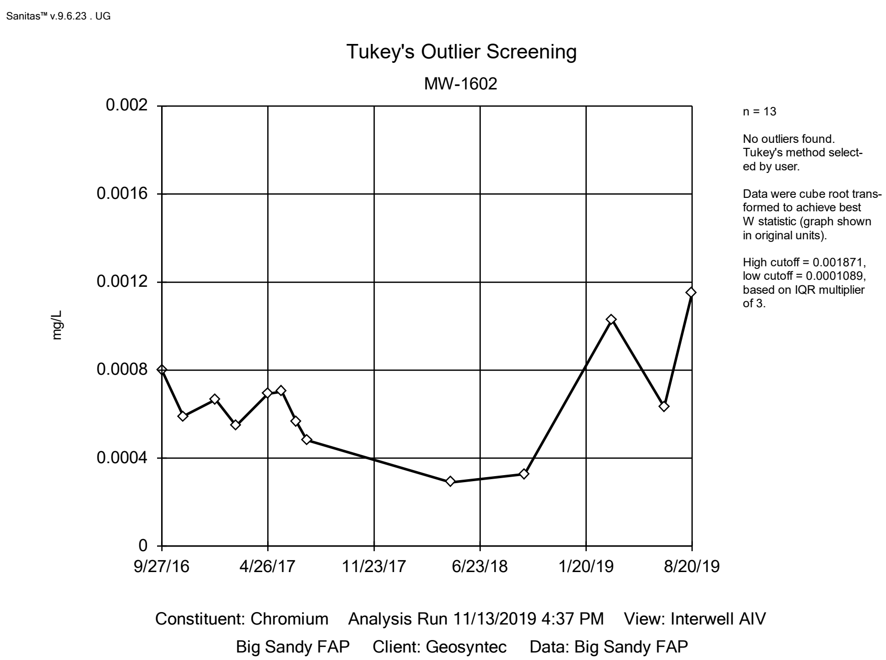
Data were natural log transformed to achieve best W statistic (graph shown in original units).

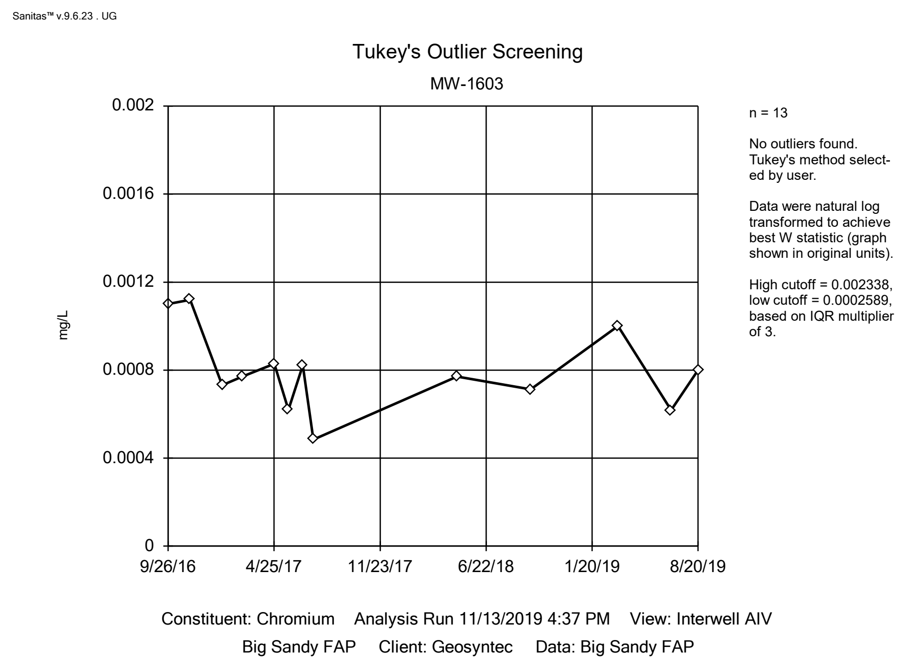
High cutoff = 0.003315, low cutoff = 0.00006169, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

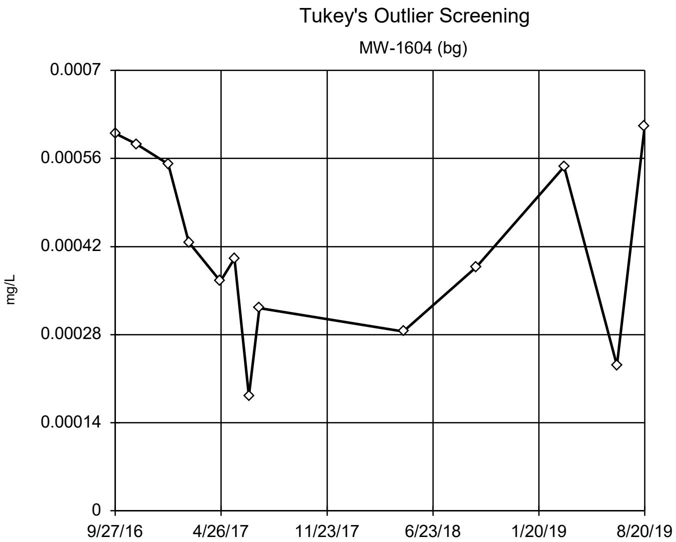

Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1203 (bg)
mg/L
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.01098, low cutoff = 0.00001677, based on IQR multiplier of 3.
Constituent: Chromium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1601
mg/L
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.00466, low cutoff = 0.00003234, based on IQR multiplier of 3.
Constituent: Chromium Analysis Run 11/13/2019 4:36 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1602
mg/L
n = 13
No outliers found. Tukey's method selected by user.
Data were cube root transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.001871, low cutoff = 0.0001089, based on IQR multiplier of 3.
Constituent: Chromium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1603
mg/L
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.002338, low cutoff = 0.0002589, based on IQR multiplier of 3.
Constituent: Chromium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

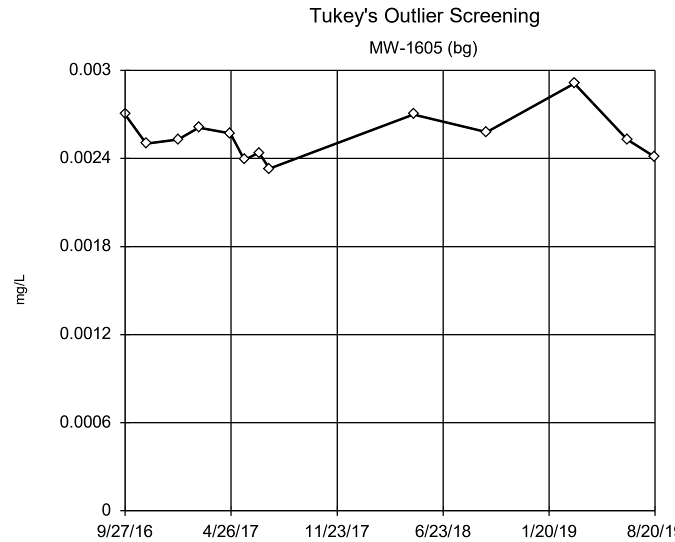
No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.001849, low cutoff = -0.000003153, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

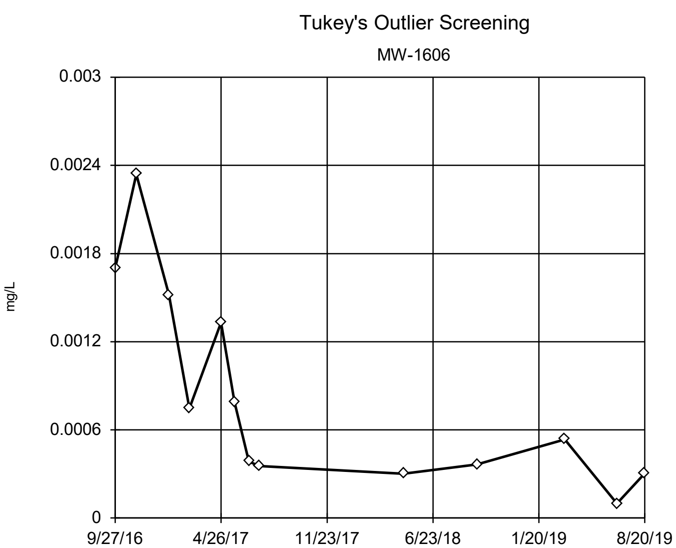
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.003483, low cutoff = 0.001848, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

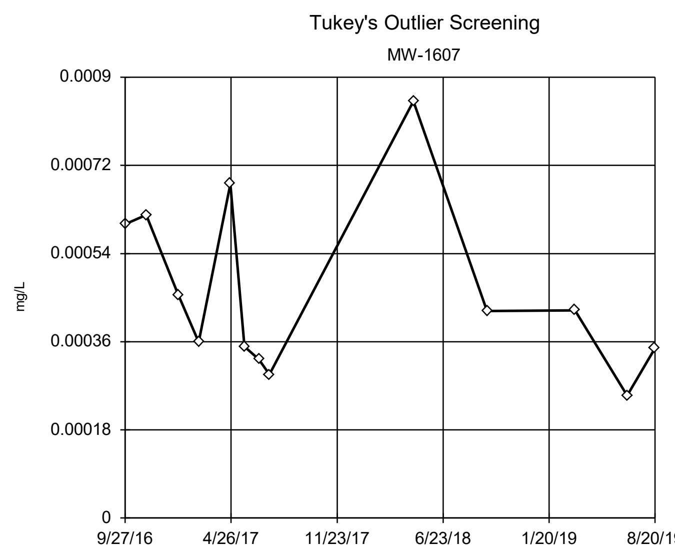
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1163, low cutoff = 0.000004006, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

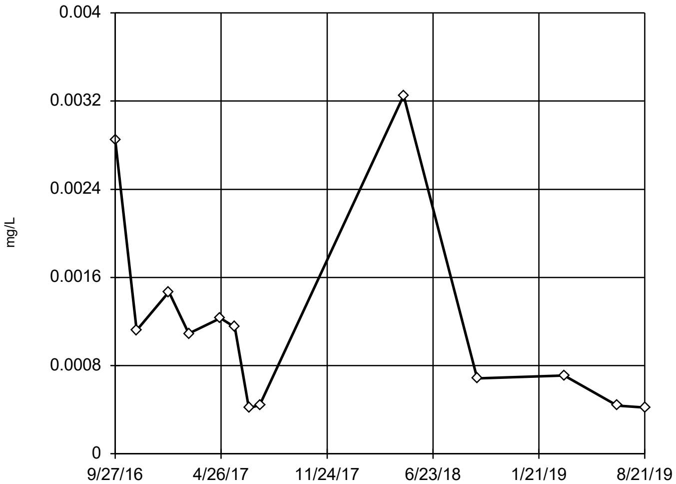
High cutoff = 0.003659, low cutoff = 0.00005585, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1011 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

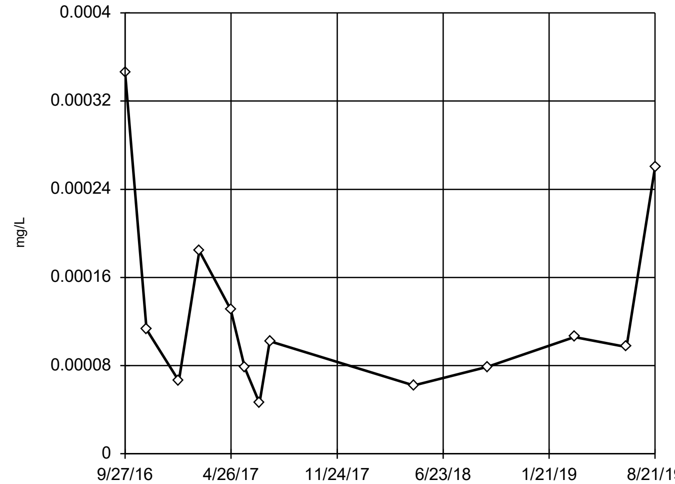
High cutoff = 0.03812, low cutoff = 0.00001556, based on IQR multiplier of 3.

Constituent: Cobalt   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1012 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

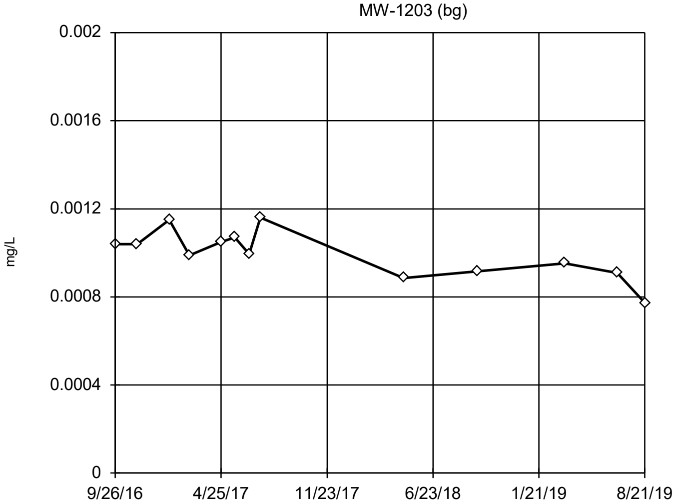
High cutoff = 0.001573, low cutoff = 0.000007082, based on IQR multiplier of 3.

Constituent: Cobalt   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1203 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

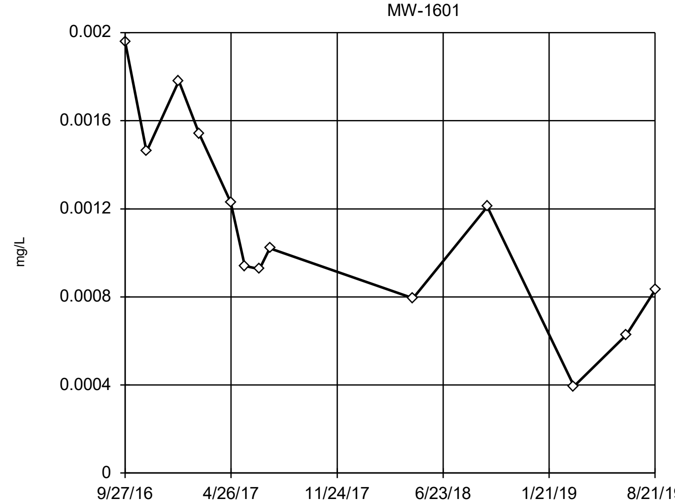
High cutoff = 0.001413, low cutoff = -0.0002011, based on IQR multiplier of 3.

Constituent: Cobalt   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1601



n = 13

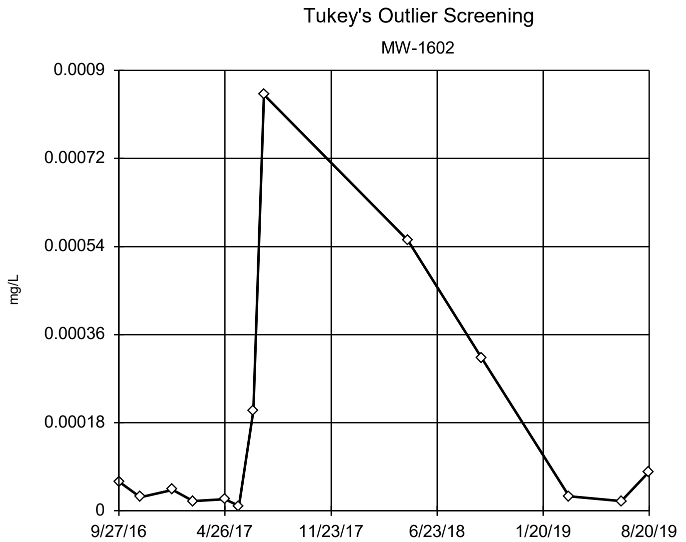
No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.004816, low cutoff = -0.000004705, based on IQR multiplier of 3.

Constituent: Cobalt   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

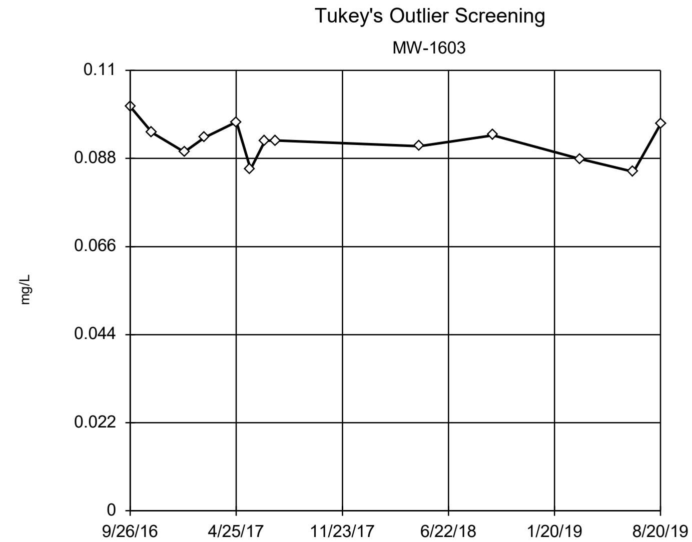
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.389, low cutoff = 1.4e-8, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

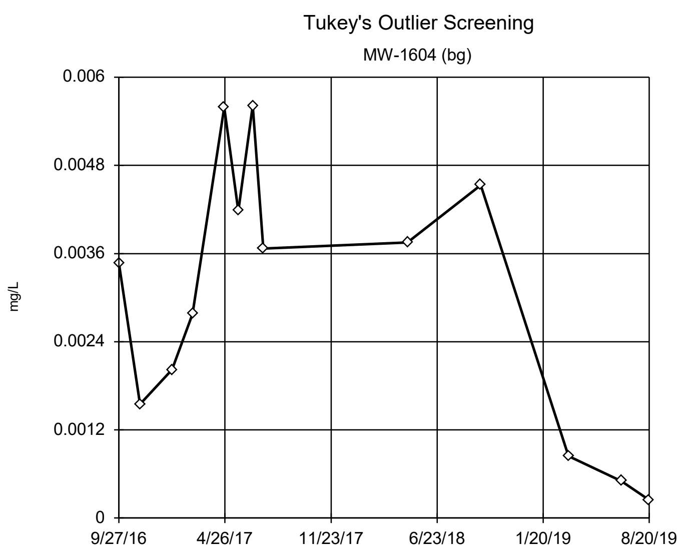
No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1134, low cutoff = 0.06438, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

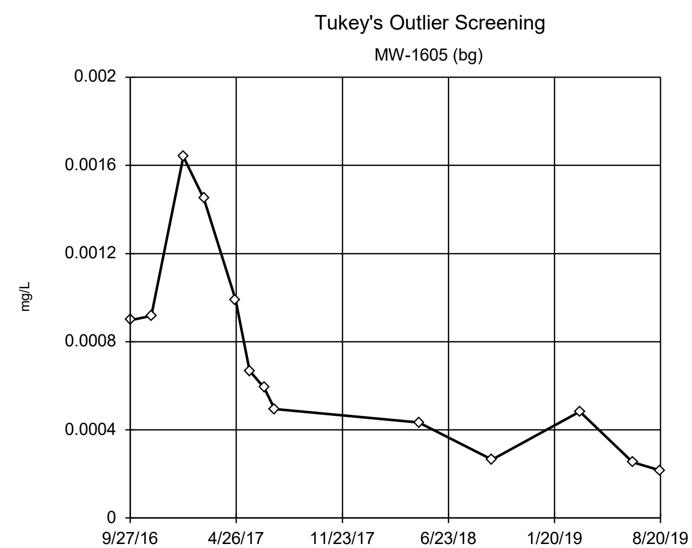
No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.01383, low cutoff = -0.008277, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

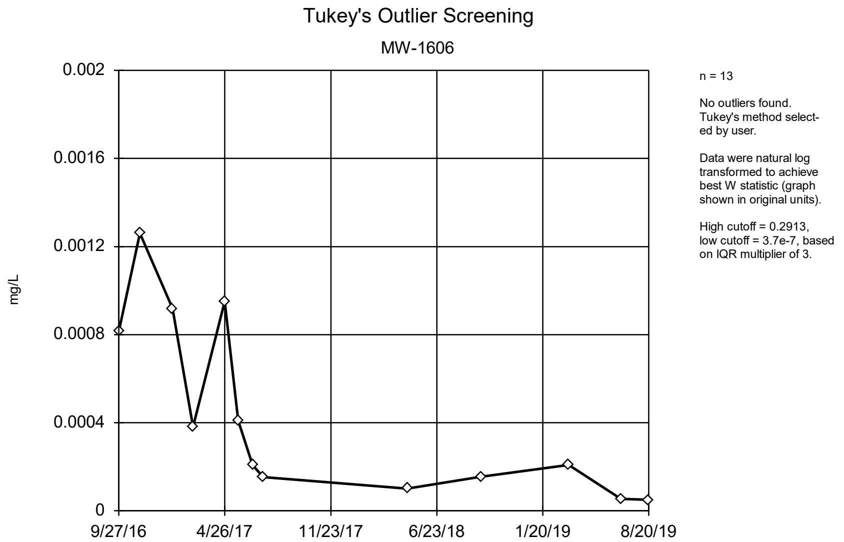
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.02117, low cutoff = 0.00001527, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

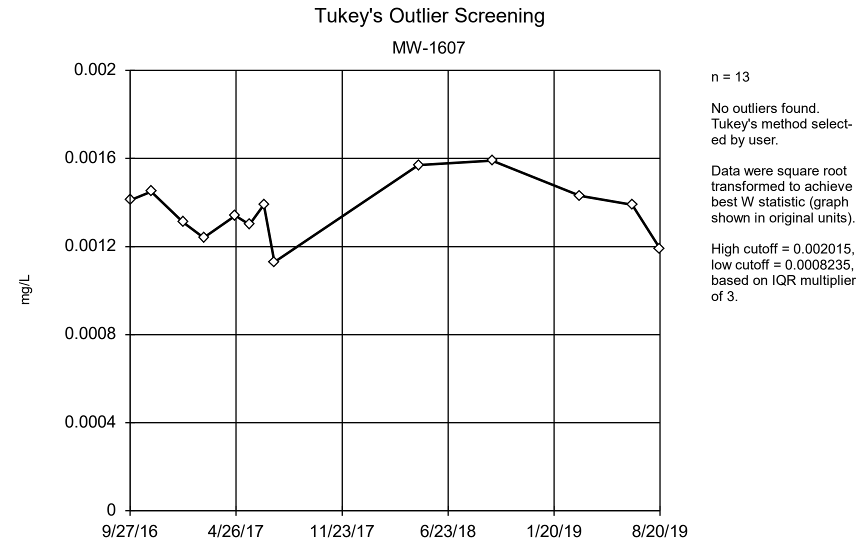
Sanitas™ v.9.6.23 . UG



Constituent: Cobalt   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

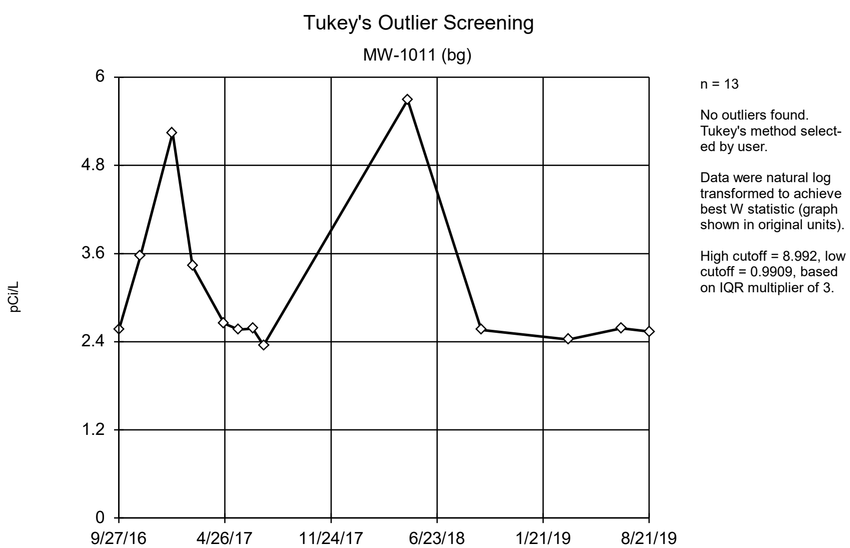
Sanitas™ v.9.6.23 . UG



Constituent: Cobalt   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

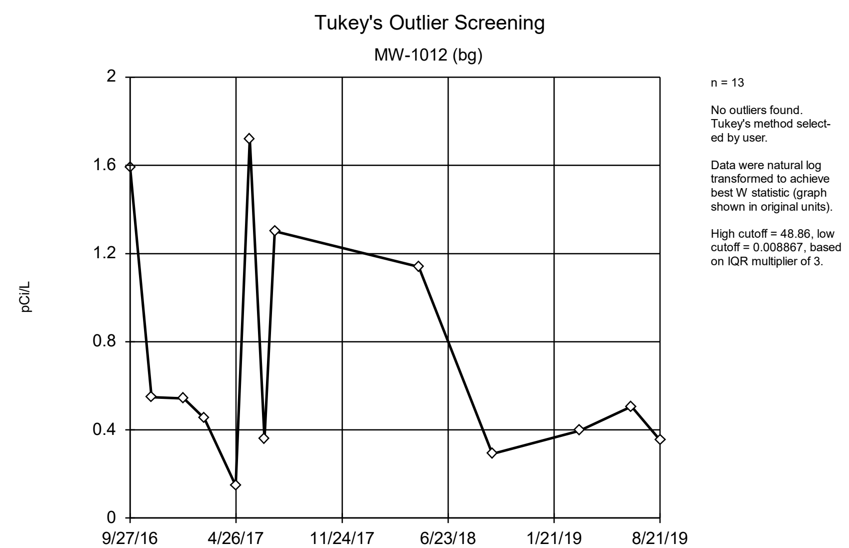
Sanitas™ v.9.6.23 . UG



Constituent: Combined Radium 226 + 228   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

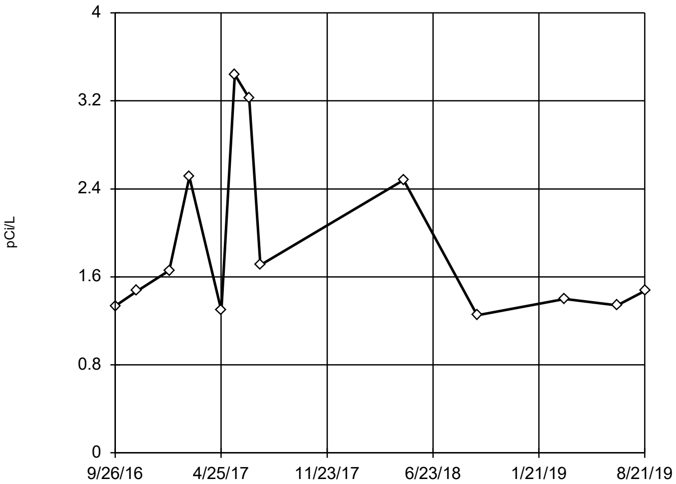


Constituent: Combined Radium 226 + 228   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Tukey's Outlier Screening

MW-1203 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

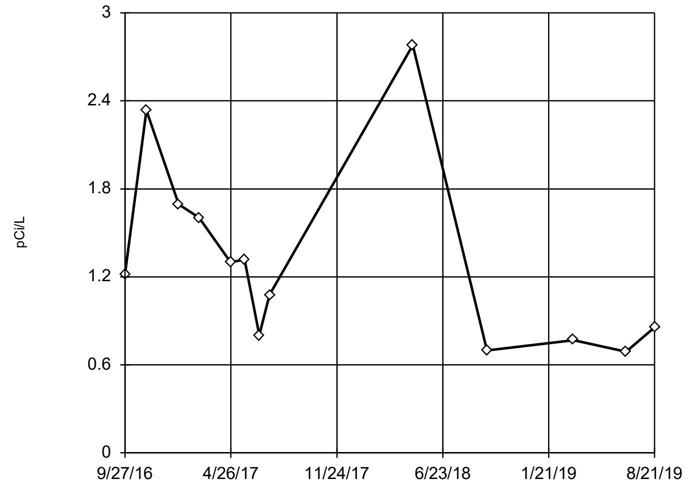
High cutoff = 16.18, low cutoff = 0.2062, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/13/2019 4:37 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Tukey's Outlier Screening

MW-1601



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

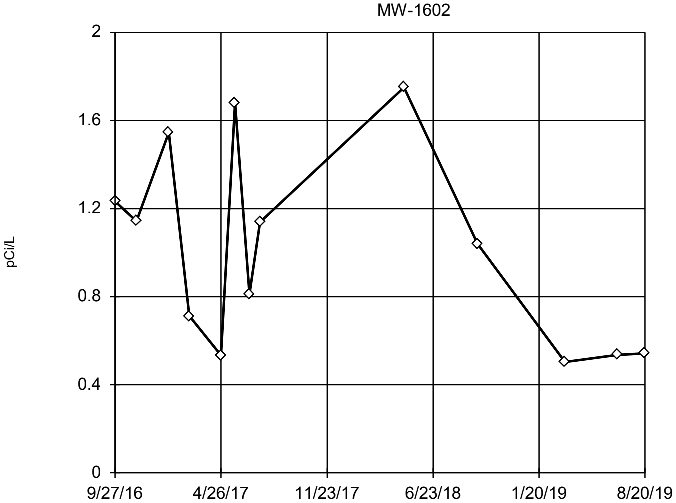
High cutoff = 15.24, low cutoff = 0.08493, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/13/2019 4:37 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Tukey's Outlier Screening

MW-1602



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

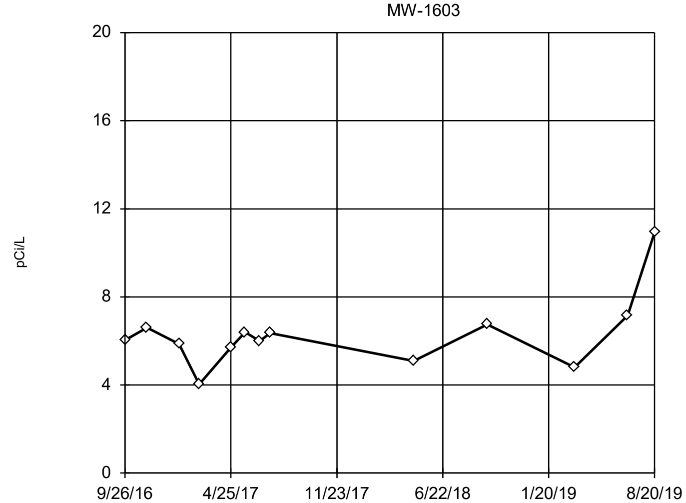
High cutoff = 6.267, low cutoff = -0.3507, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/13/2019 4:37 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Tukey's Outlier Screening

MW-1603



n = 13

No outliers found. Tukey's method selected by user.

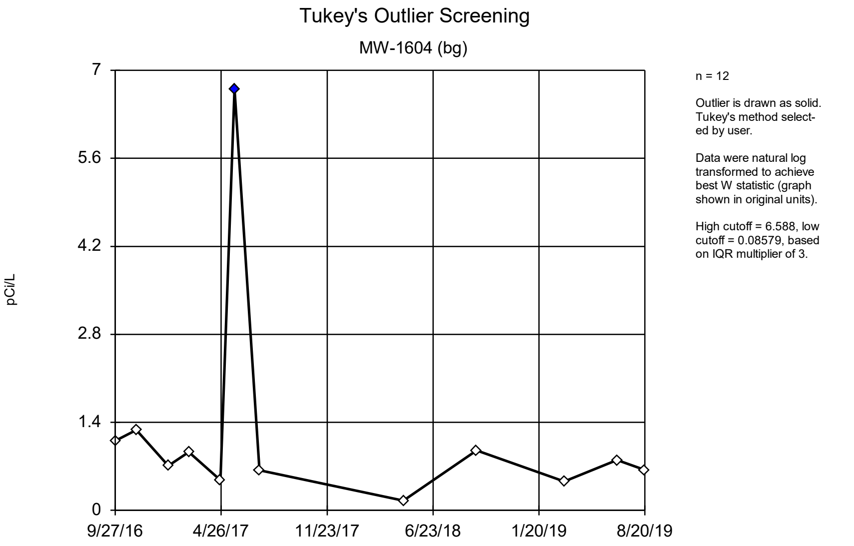
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 12.63, low cutoff = 2.851, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 11/13/2019 4:37 PM View: Interwell AIV

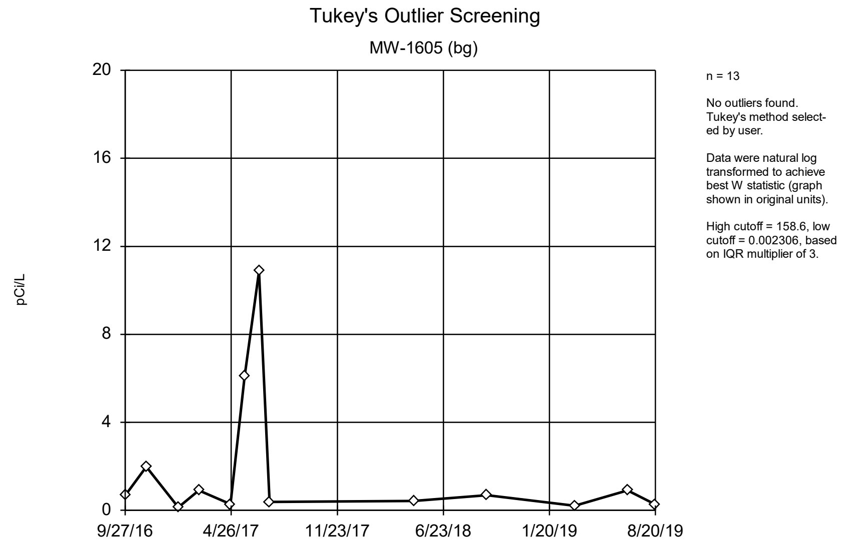
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



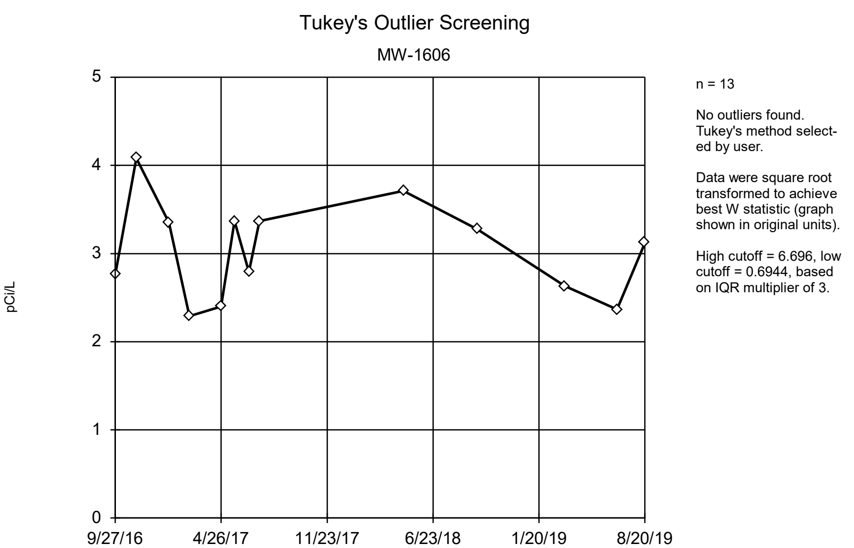
Constituent: Combined Radium 226 + 228 Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



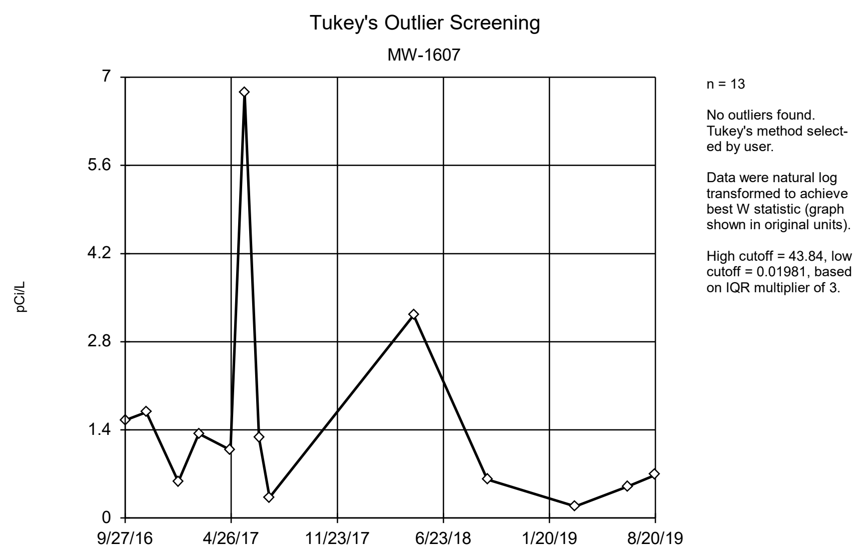
Constituent: Combined Radium 226 + 228 Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



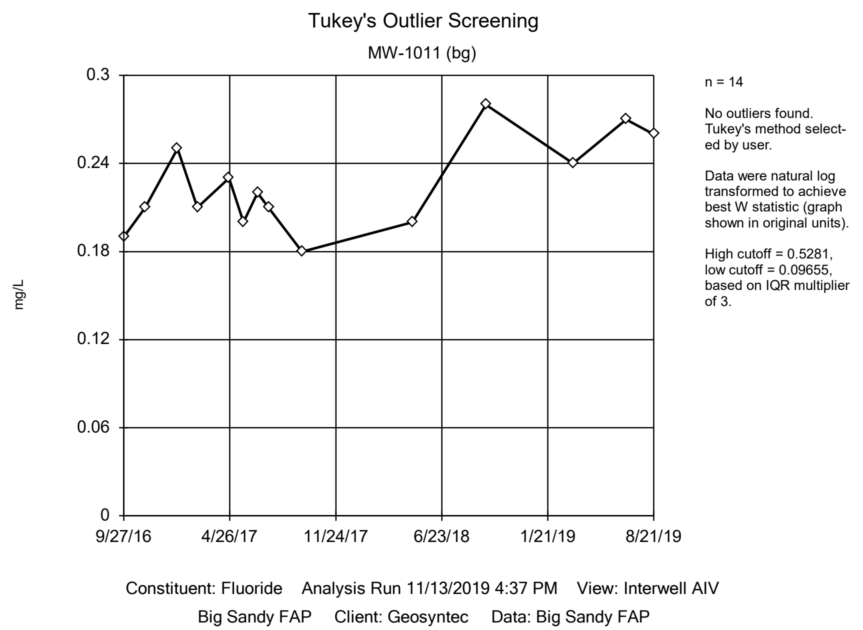
Constituent: Combined Radium 226 + 228 Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

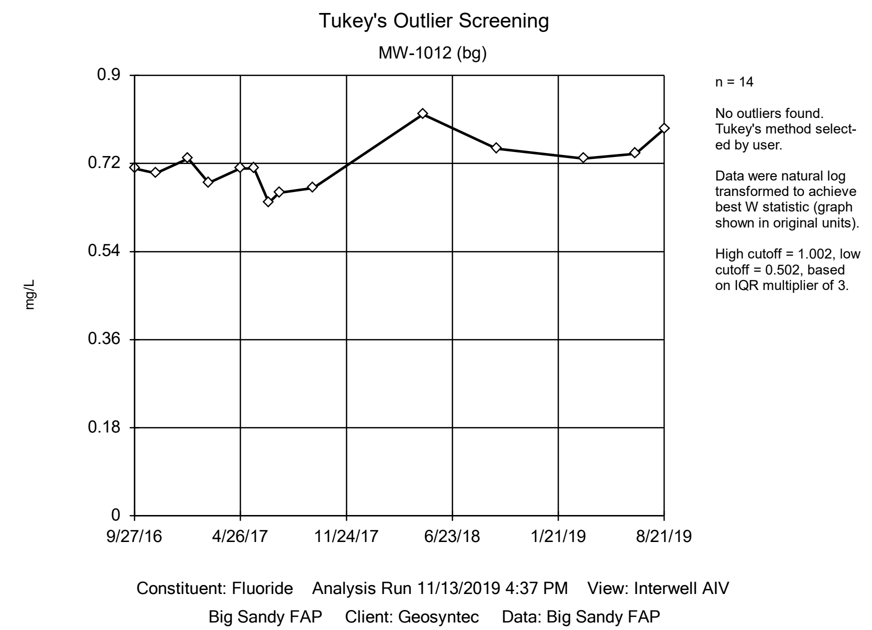


Constituent: Combined Radium 226 + 228 Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

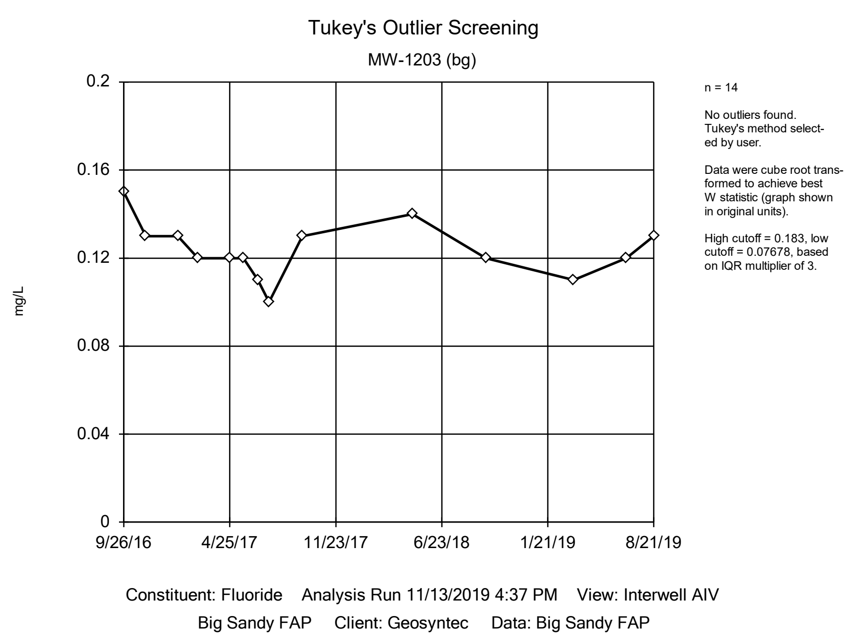
Sanitas™ v.9.6.23 . UG



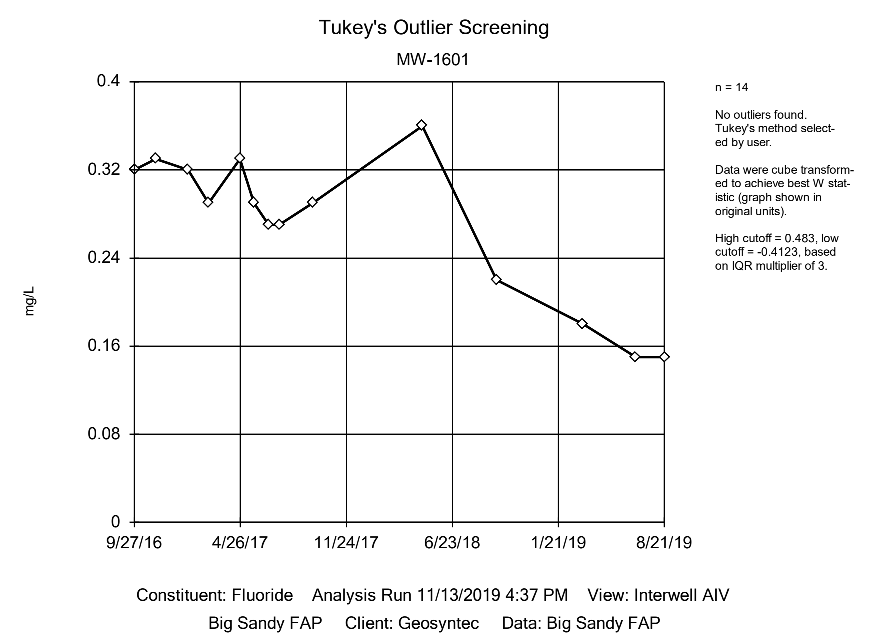
Sanitas™ v.9.6.23 . UG



Sanitas™ v.9.6.23 . UG



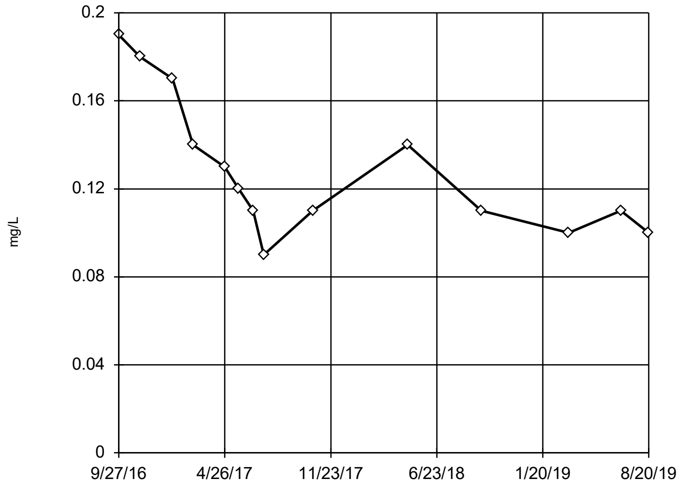
Sanitas™ v.9.6.23 . UG



Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1602



n = 14

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

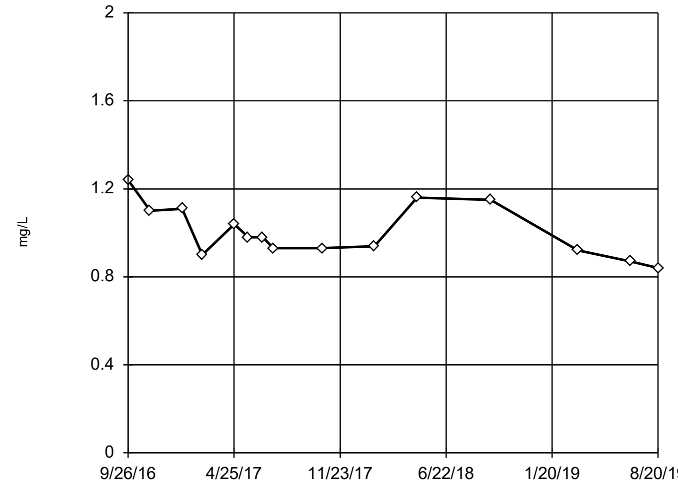
High cutoff = 0.491, low cutoff = 0.03295, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1603



n = 15

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

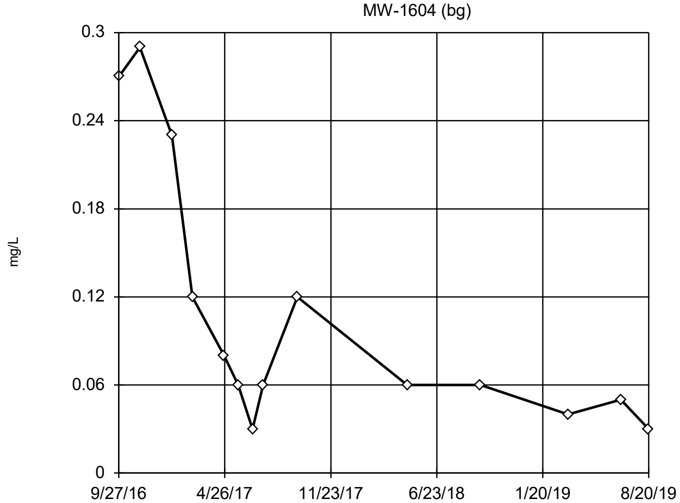
High cutoff = 1.95, low cutoff = 0.5238, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1604 (bg)



n = 14

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

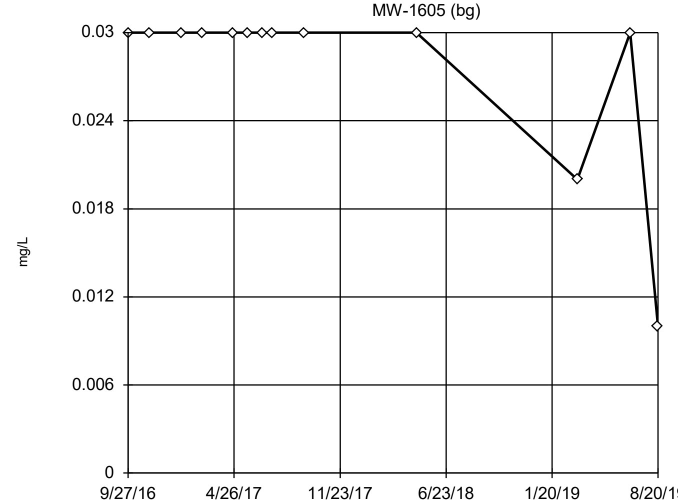
High cutoff = 8.517, low cutoff = 0.0008724, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1605 (bg)



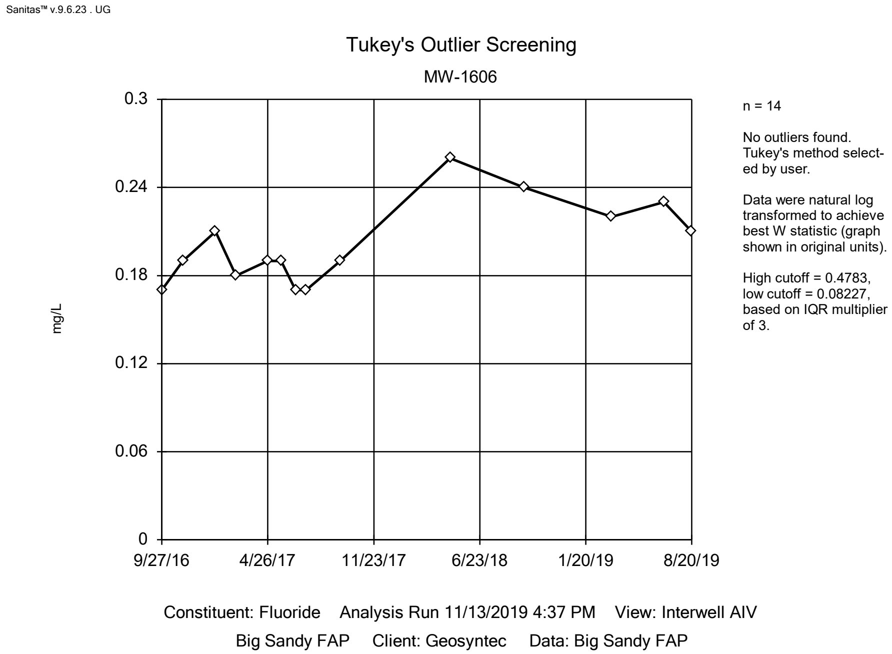
n = 13

No outliers found. Tukey's method selected by user.

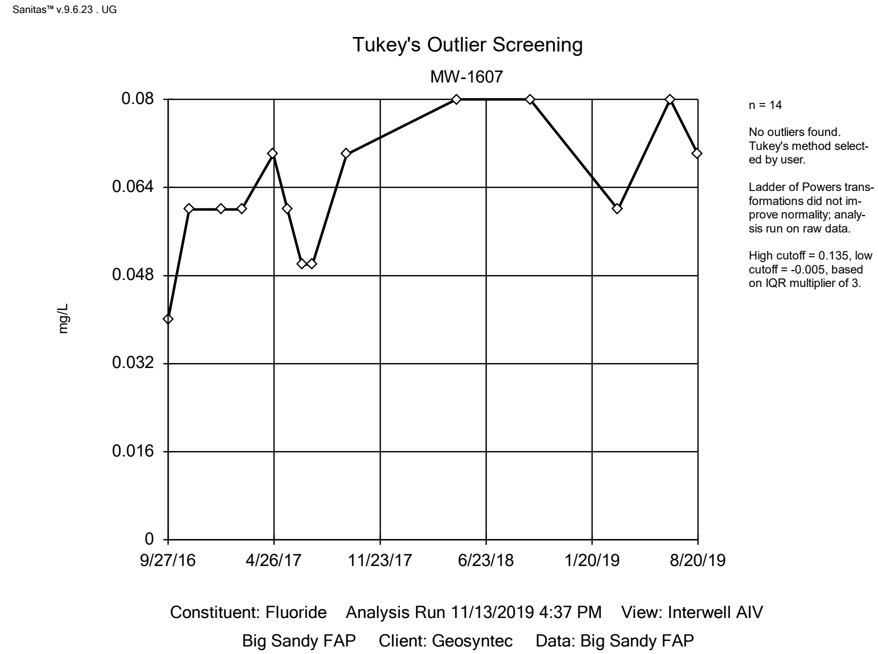
Data were square transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

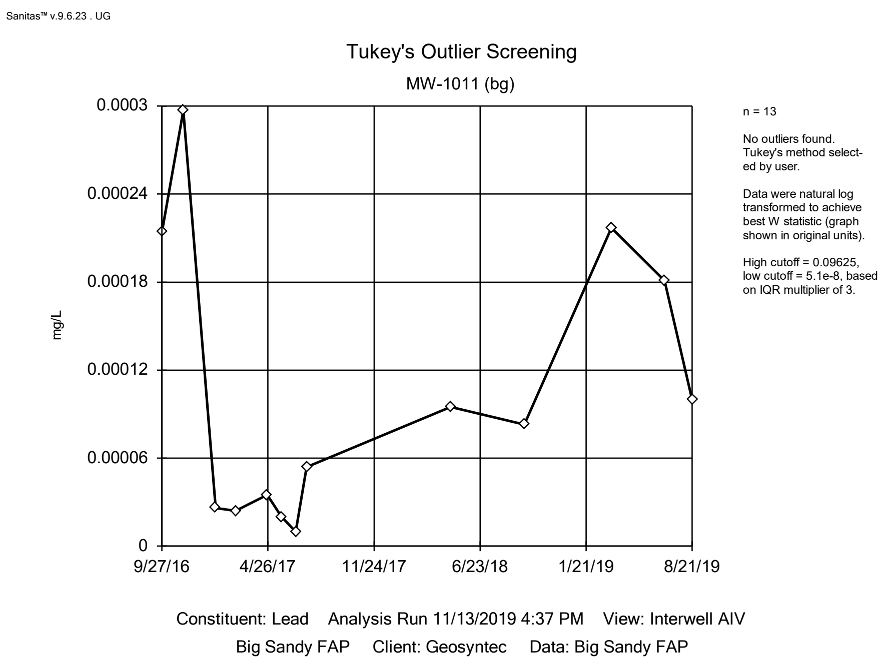
Constituent: Fluoride Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



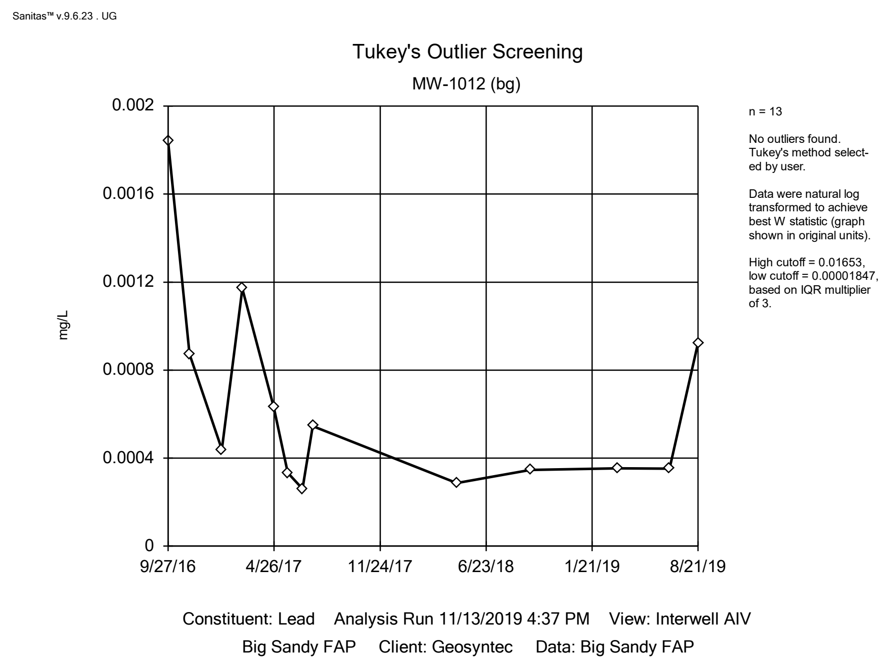
Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1606
0.3
0.24
0.18
0.12
0.06
0
mg/L
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 14
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.4783, low cutoff = 0.08227, based on IQR multiplier of 3.
Constituent: Fluoride Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1607
0.08
0.064
0.048
0.032
0.016
0
mg/L
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 14
No outliers found. Tukey's method selected by user.
Ladder of Powers transformations did not improve normality; analysis run on raw data.
High cutoff = 0.135, low cutoff = -0.005, based on IQR multiplier of 3.
Constituent: Fluoride Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1011 (bg)
0.0003
0.00024
0.00018
0.00012
0.00006
0
mg/L
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.09625, low cutoff = 5.1e-8, based on IQR multiplier of 3.
Constituent: Lead Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

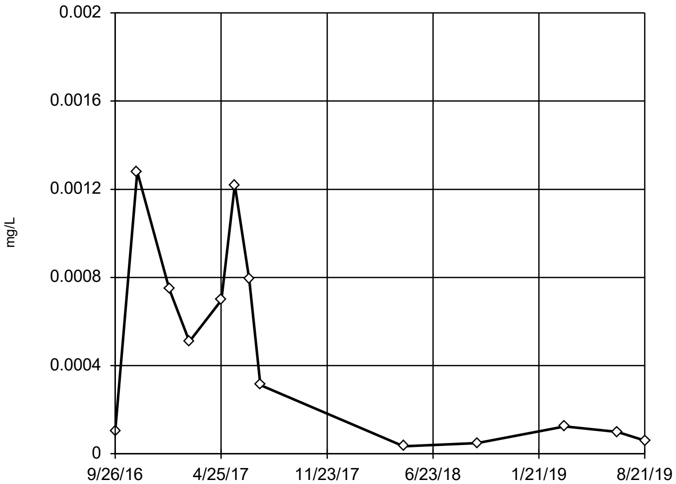


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1012 (bg)
0.002
0.0016
0.0012
0.0008
0.0004
0
mg/L
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.01653, low cutoff = 0.00001847, based on IQR multiplier of 3.
Constituent: Lead Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1203 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

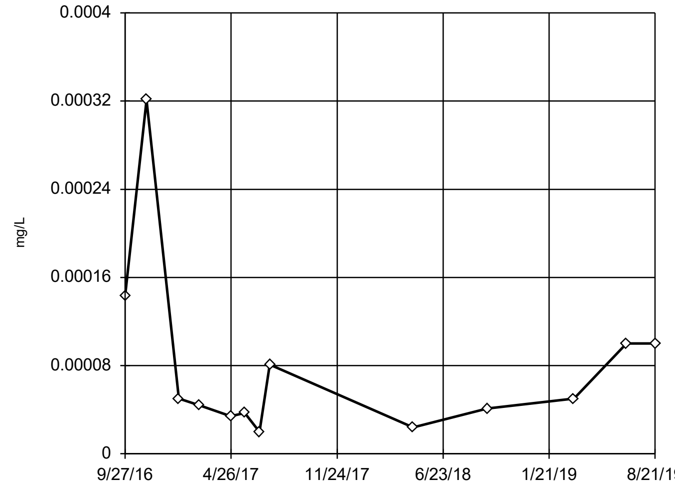
High cutoff = 0.757, low cutoff = 7.9e-8, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1601



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

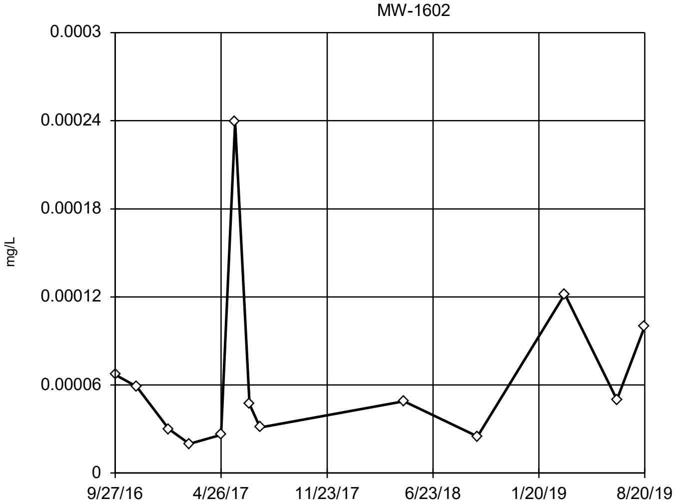
High cutoff = 0.002241, low cutoff = 0.000001583, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1602



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

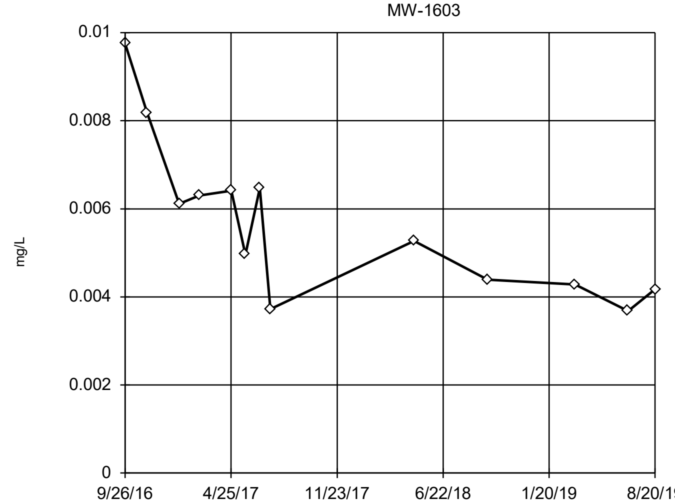
High cutoff = 0.002061, low cutoff = 0.000001109, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1603



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

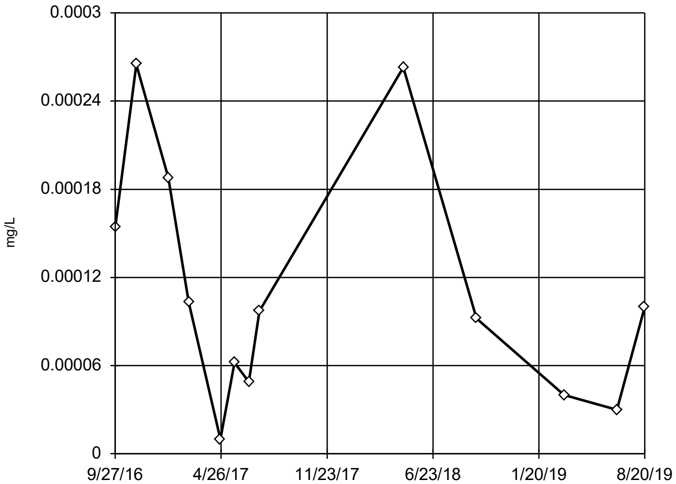
High cutoff = 0.02281, low cutoff = 0.001193, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1604 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

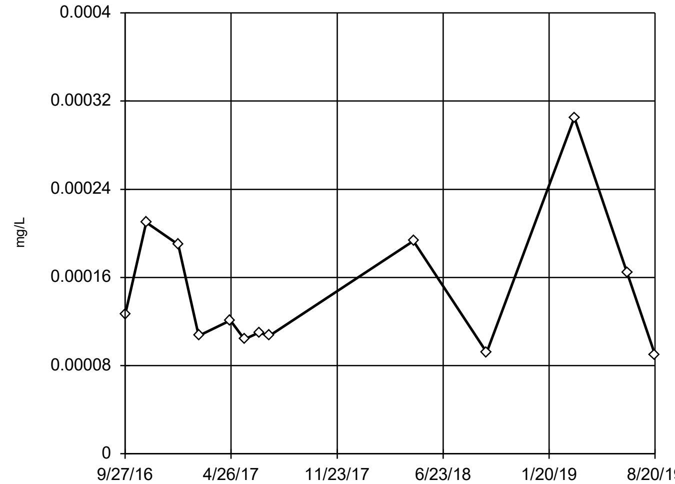
High cutoff = 0.001544, low cutoff = -0.00001515, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1605 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

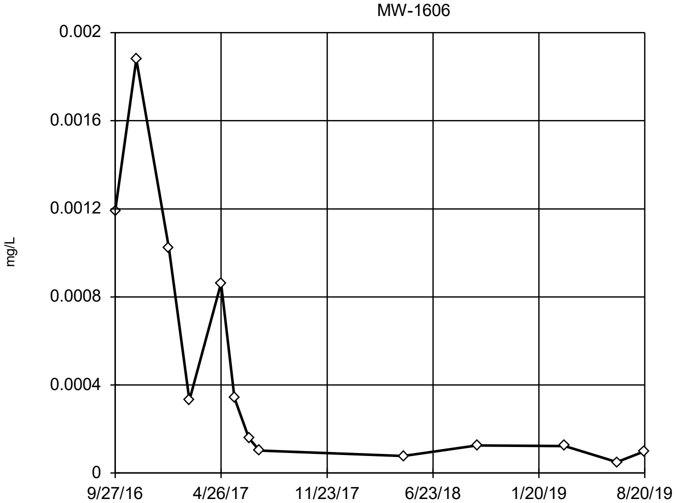
High cutoff = 0.001146, low cutoff = 0.00001763, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1606



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

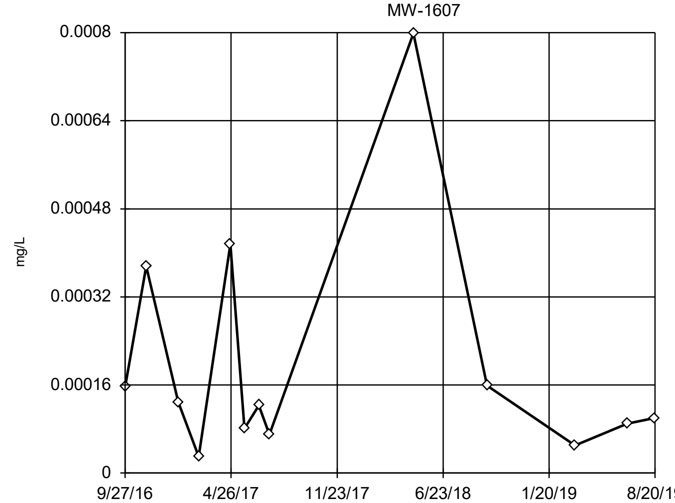
High cutoff = 0.7395, low cutoff = 1.3e-7, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1607



n = 13

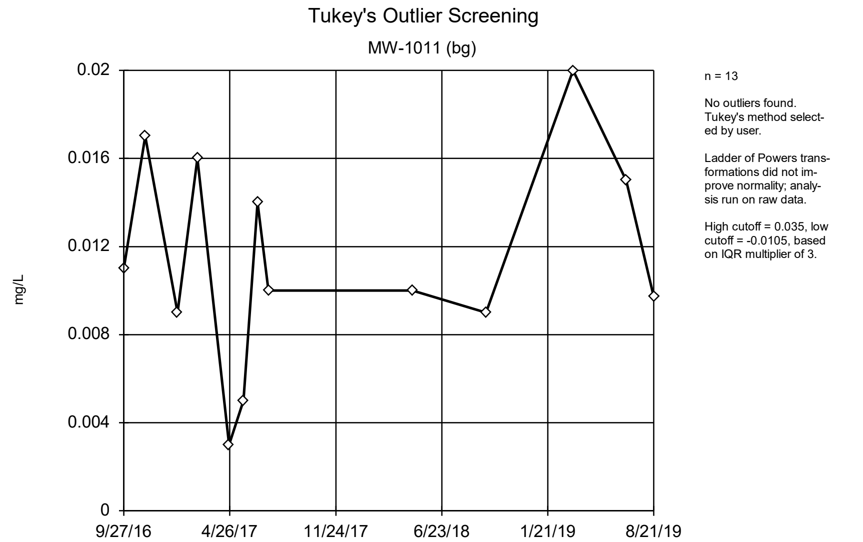
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.008371, low cutoff = 0.000002199, based on IQR multiplier of 3.

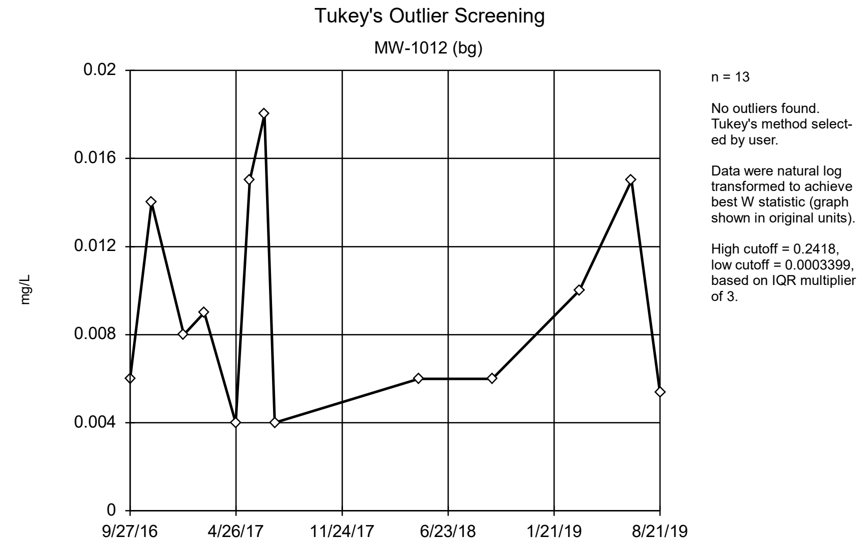
Constituent: Lead Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



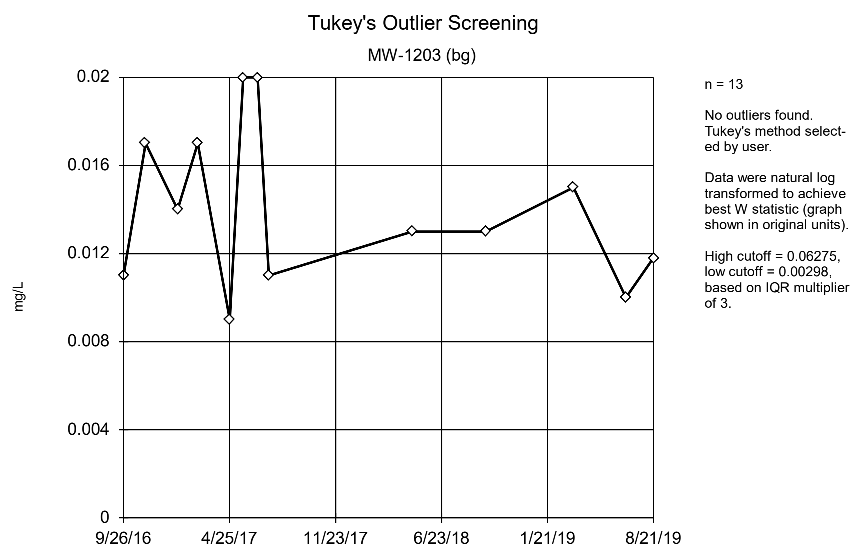
Constituent: Lithium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



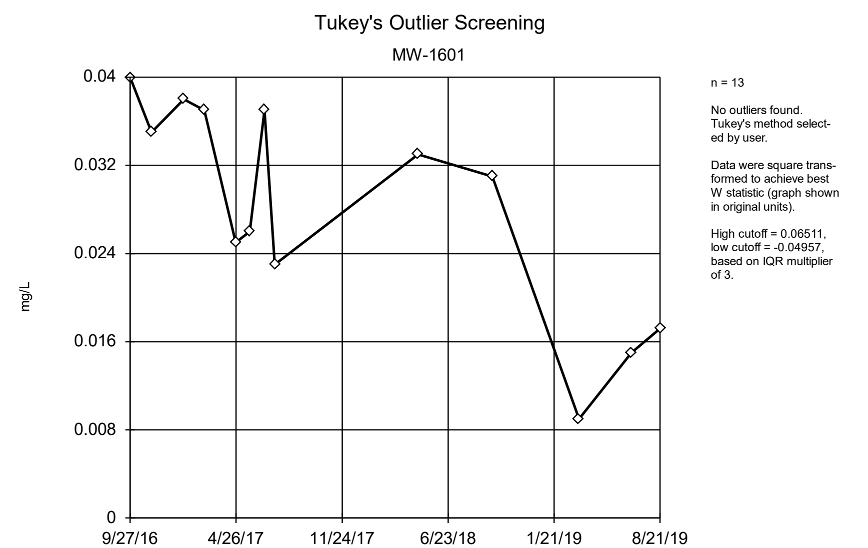
Constituent: Lithium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

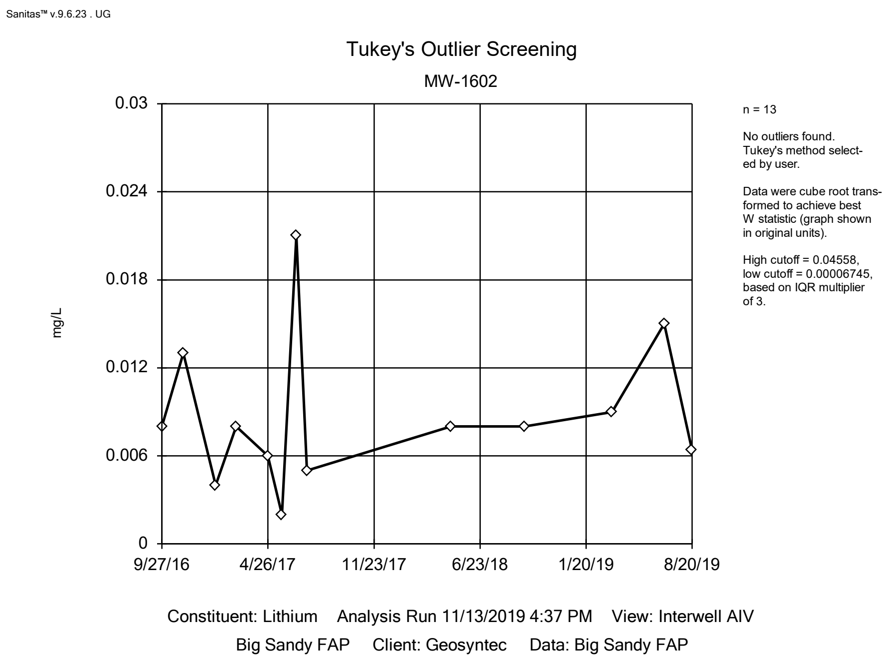


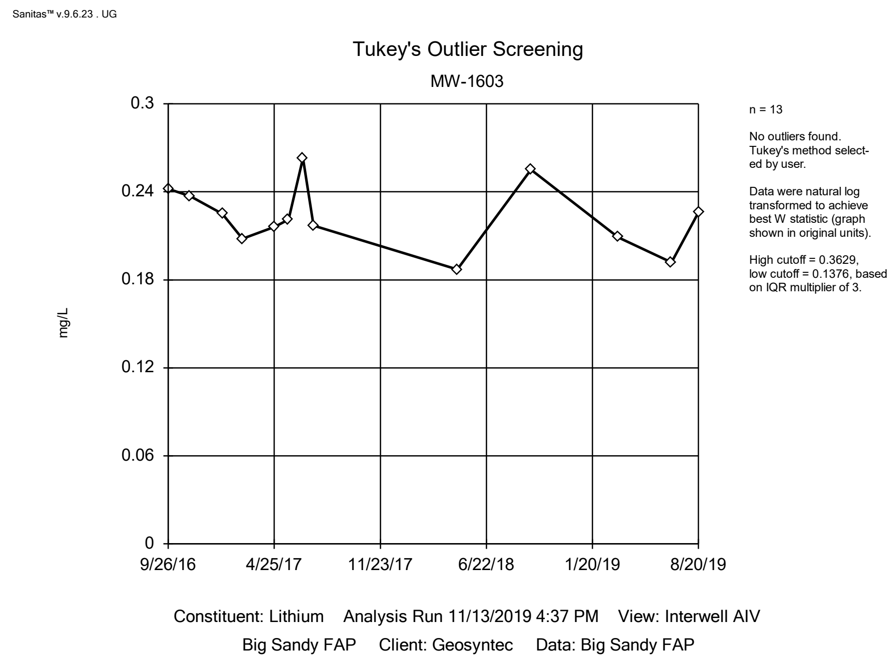
Constituent: Lithium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

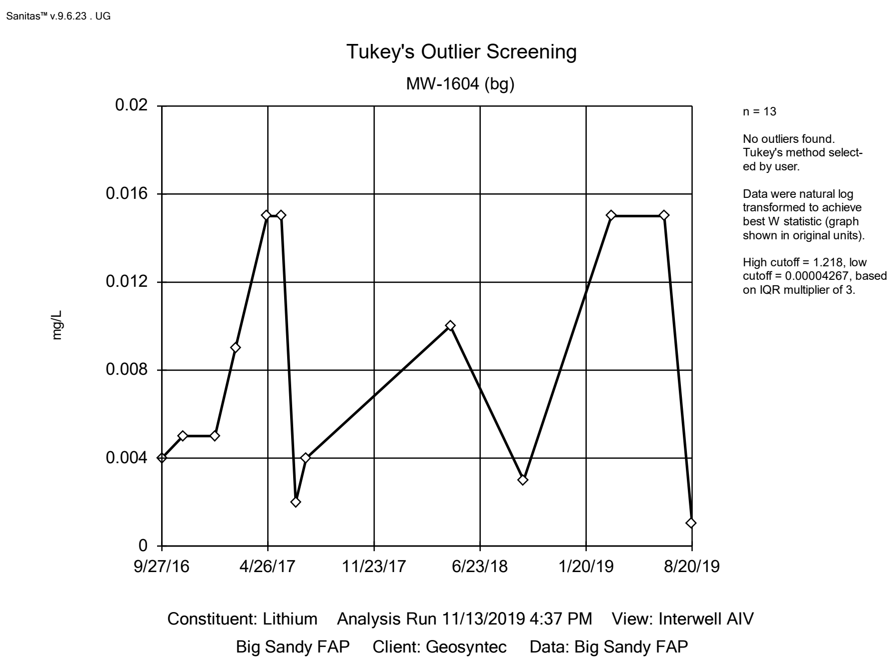
Sanitas™ v.9.6.23 . UG

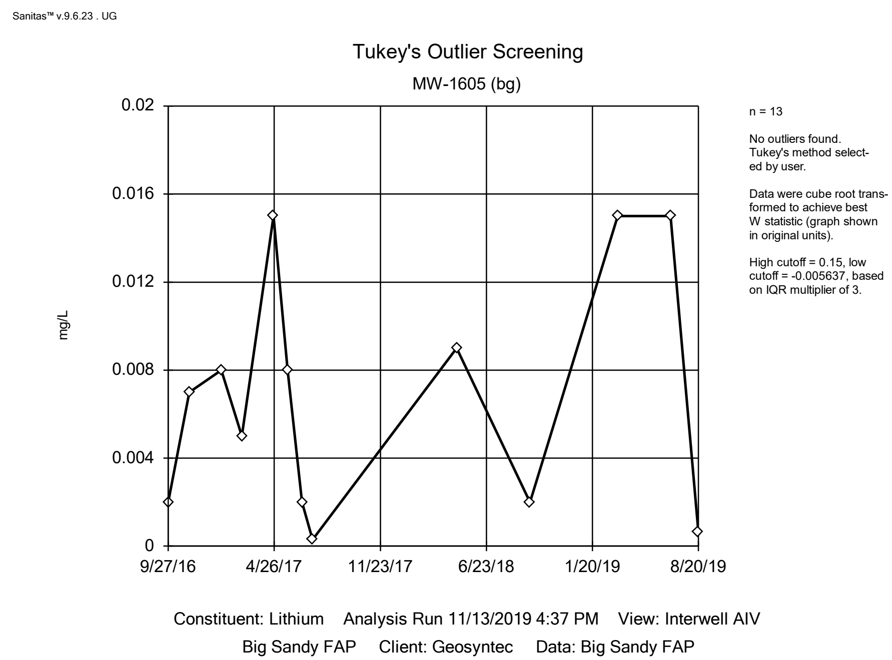


Constituent: Lithium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1602
0.03
0.024
0.018
0.012
0.006
0
mg/L
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 13
No outliers found. Tukey's method selected by user.
Data were cube root transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.04558, low cutoff = 0.00006745, based on IQR multiplier of 3.
Constituent: Lithium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1603
0.3
0.24
0.18
0.12
0.06
0
mg/L
9/26/16
4/25/17
11/23/17
6/22/18
1/20/19
8/20/19
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.3629, low cutoff = 0.1376, based on IQR multiplier of 3.
Constituent: Lithium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

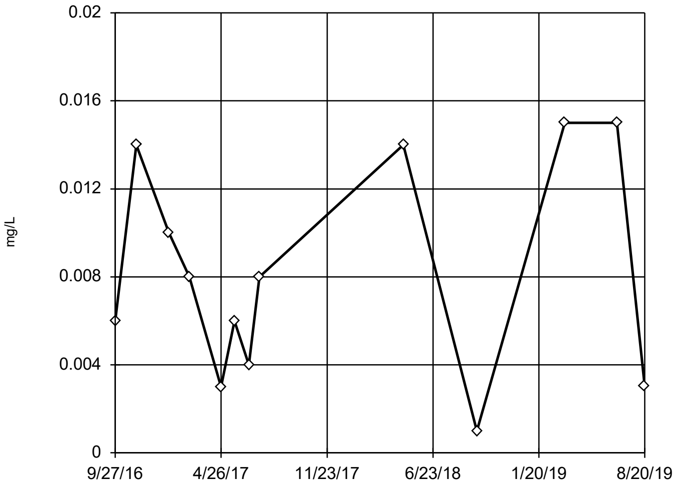

Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1604 (bg)
0.02
0.016
0.012
0.008
0.004
0
mg/L
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 1.218, low cutoff = 0.00004267, based on IQR multiplier of 3.
Constituent: Lithium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1605 (bg)
0.02
0.016
0.012
0.008
0.004
0
mg/L
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 13
No outliers found. Tukey's method selected by user.
Data were cube root transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.15, low cutoff = -0.005637, based on IQR multiplier of 3.
Constituent: Lithium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1606



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.08769, low cutoff = -0.0141, based on IQR multiplier of 3.

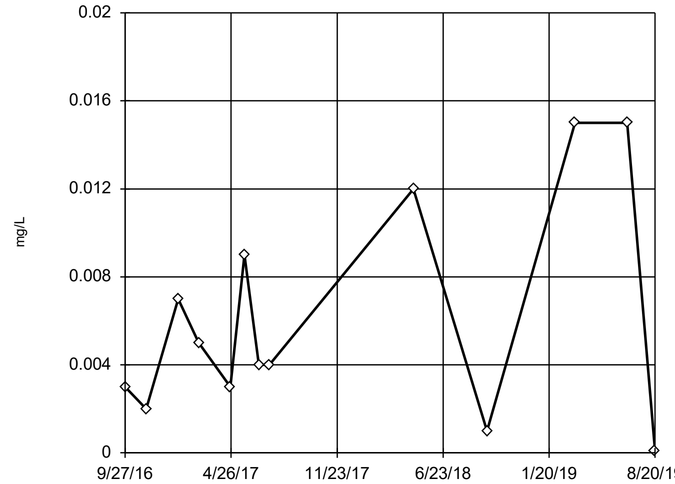
Constituent: Lithium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1607



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.06738, low cutoff = -0.01158, based on IQR multiplier of 3.

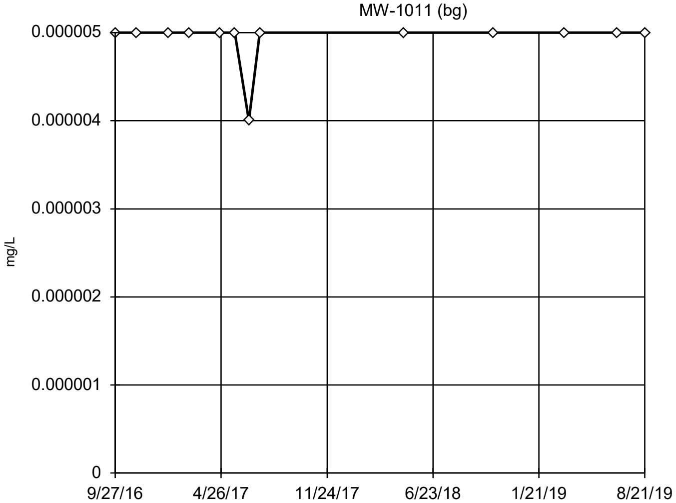
Constituent: Lithium Analysis Run 11/13/2019 4:37 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1011 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were square transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

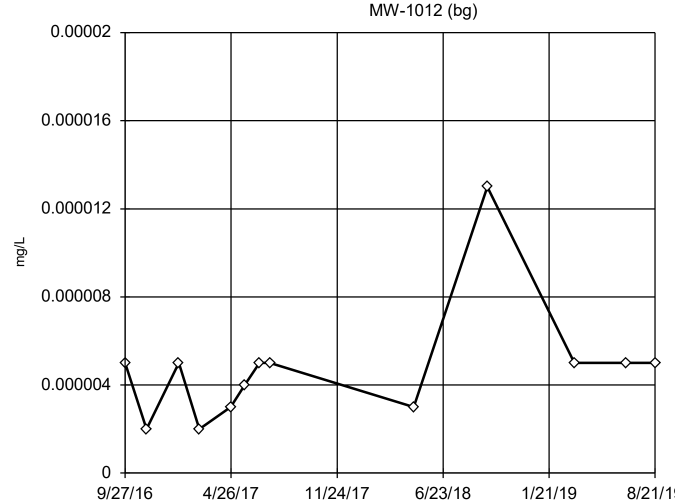
Constituent: Mercury Analysis Run 11/13/2019 4:37 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1012 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.00002315, low cutoff = 6.5e-7, based on IQR multiplier of 3.

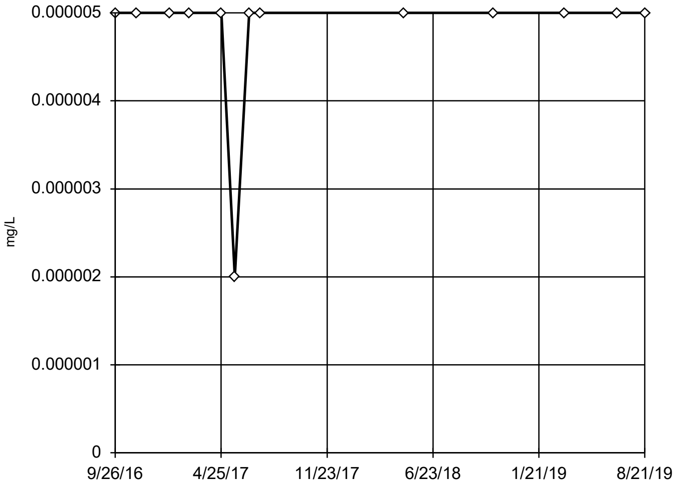
Constituent: Mercury Analysis Run 11/13/2019 4:37 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1203 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were cube root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

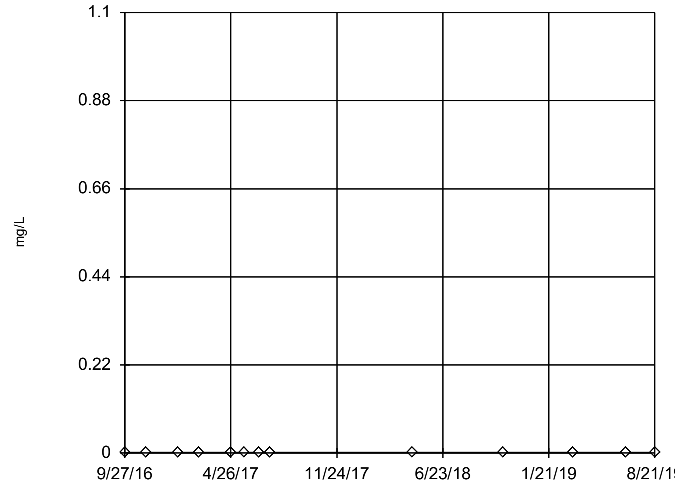
Constituent: Mercury   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1601



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

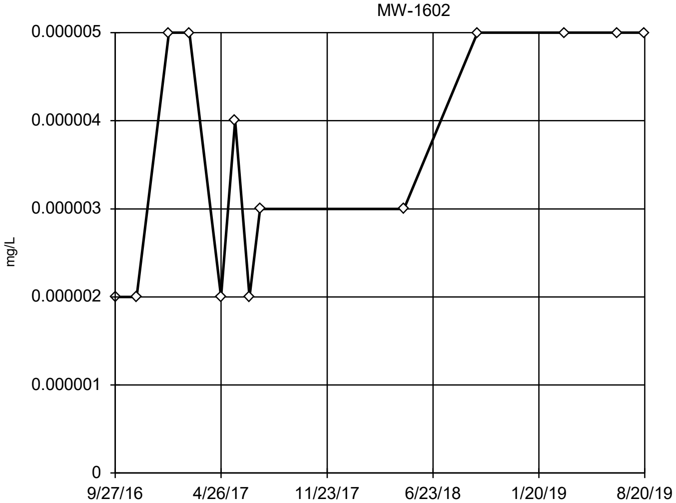
Constituent: Mercury   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1602



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.00002211, low cutoff = -0.000001105, based on IQR multiplier of 3.

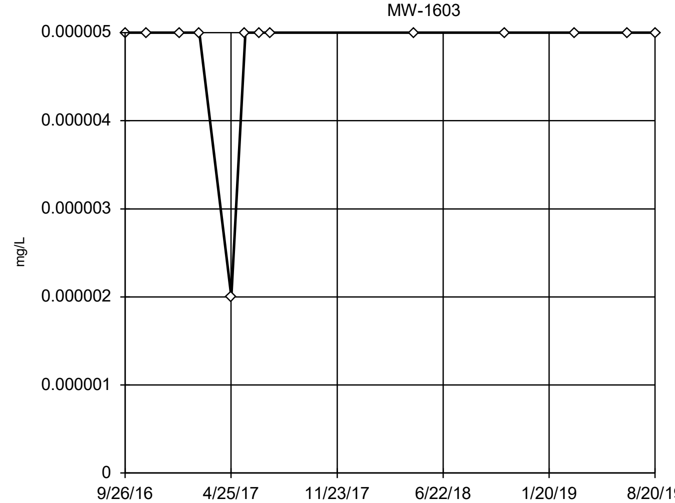
Constituent: Mercury   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1603



n = 13

No outliers found. Tukey's method selected by user.

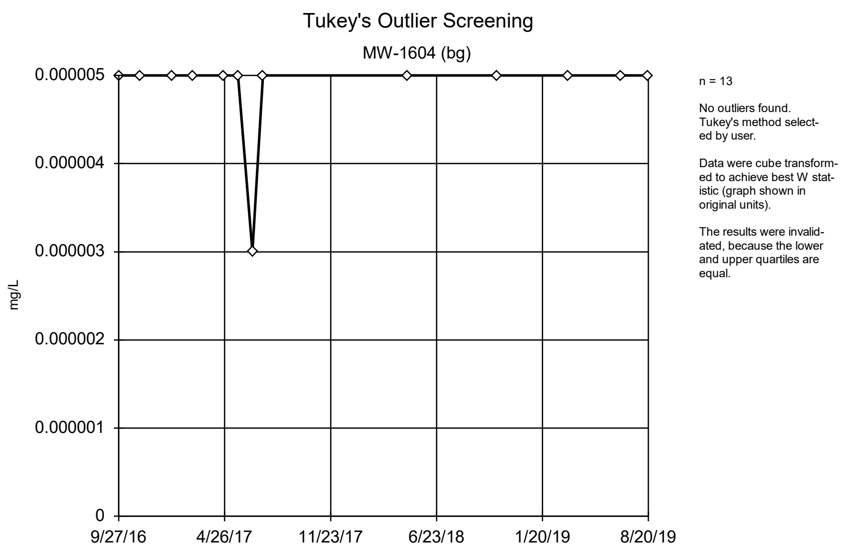
Data were cube root transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Mercury   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV

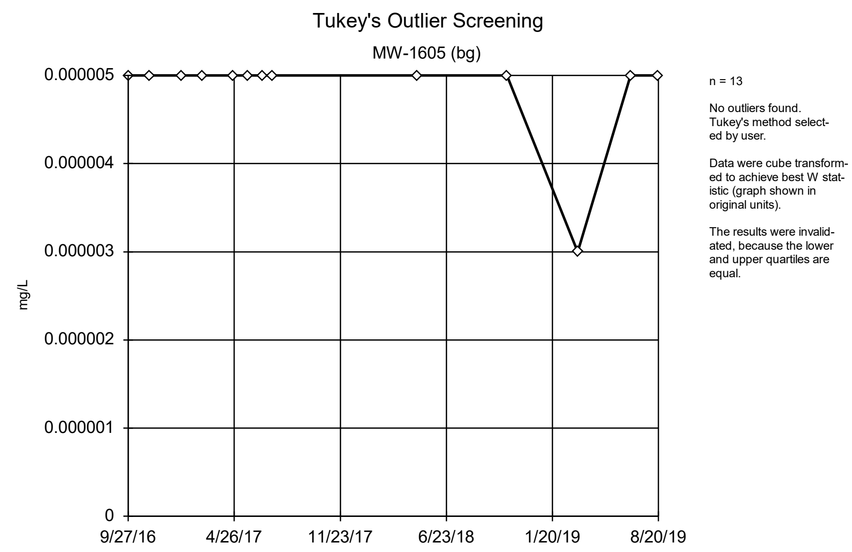
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



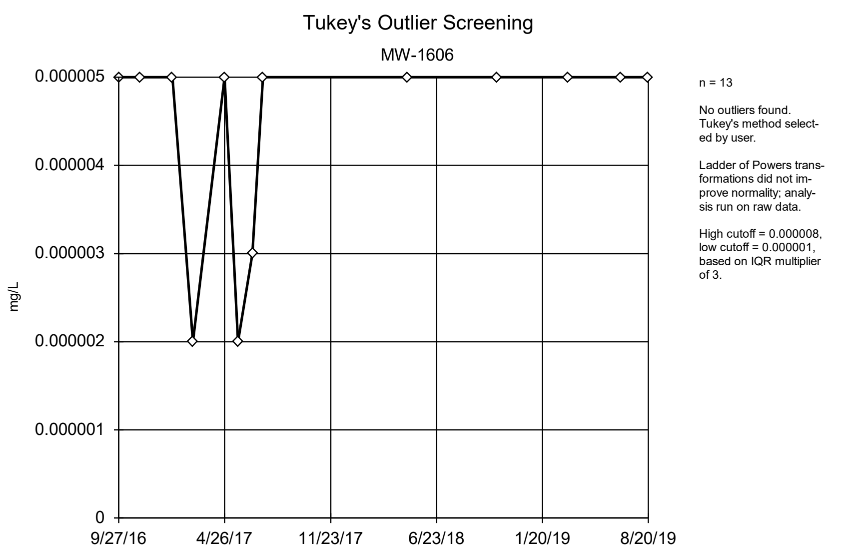
Constituent: Mercury Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



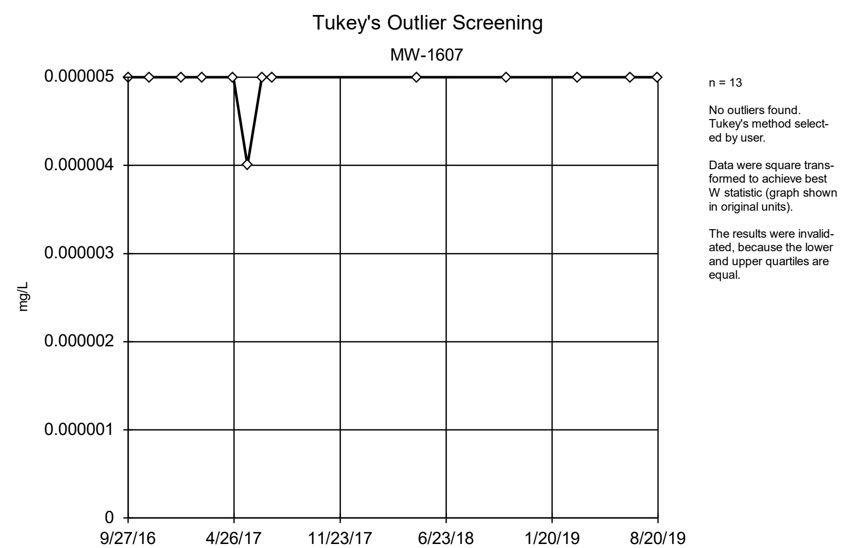
Constituent: Mercury Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

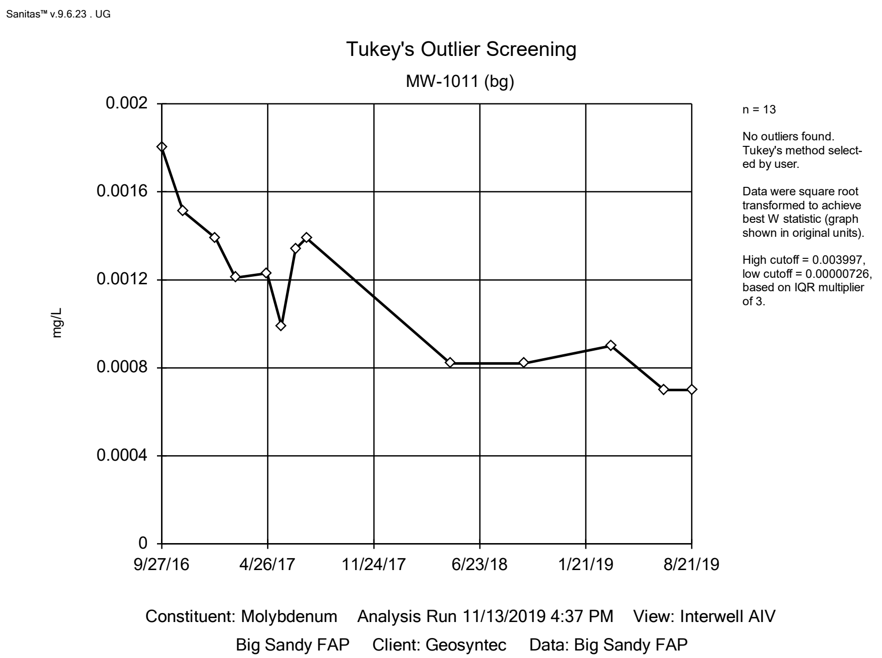


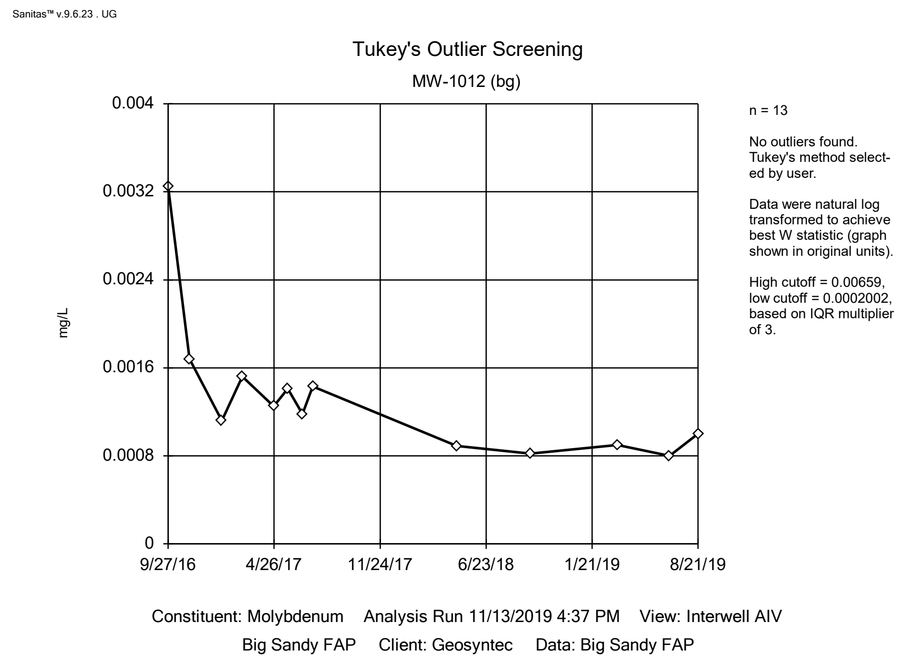
Constituent: Mercury Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

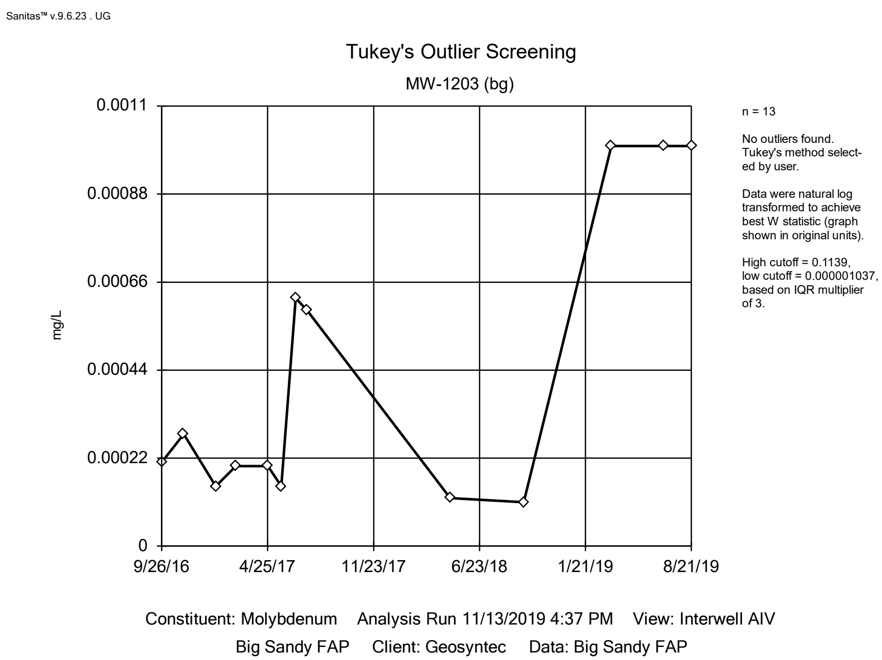
Sanitas™ v.9.6.23 . UG

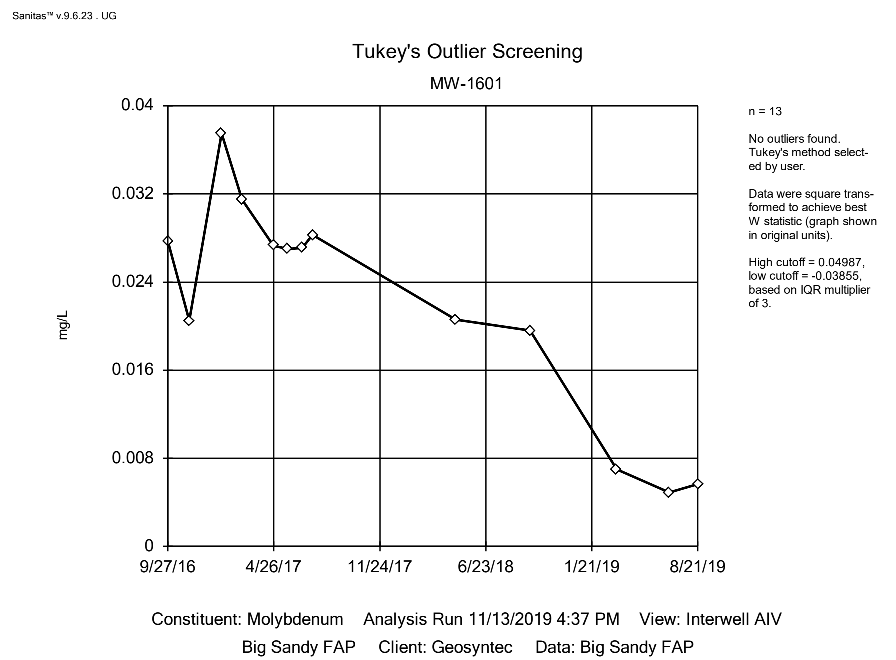


Constituent: Mercury Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1011 (bg)
n = 13
No outliers found. Tukey's method selected by user.
Data were square root transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.003997, low cutoff = 0.00000726, based on IQR multiplier of 3.
mg/L
0.002
0.0016
0.0012
0.0008
0.0004
0
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
Constituent: Molybdenum Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1012 (bg)
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.00659, low cutoff = 0.0002002, based on IQR multiplier of 3.
mg/L
0.004
0.0032
0.0024
0.0016
0.0008
0
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
Constituent: Molybdenum Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

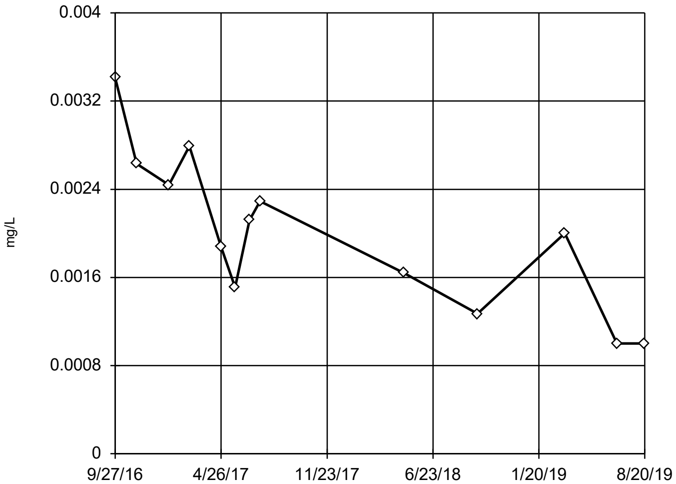

Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1203 (bg)
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.1139, low cutoff = 0.000001037, based on IQR multiplier of 3.
mg/L
0.0011
0.00088
0.00066
0.00044
0.00022
0
9/26/16
4/25/17
11/23/17
6/23/18
1/21/19
8/21/19
Constituent: Molybdenum Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1601
n = 13
No outliers found. Tukey's method selected by user.
Data were square transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.04987, low cutoff = -0.03855, based on IQR multiplier of 3.
mg/L
0.04
0.032
0.024
0.016
0.008
0
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
Constituent: Molybdenum Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1602



n = 13

No outliers found. Tukey's method selected by user.

Data were square root transformed to achieve best W statistic (graph shown in original units).

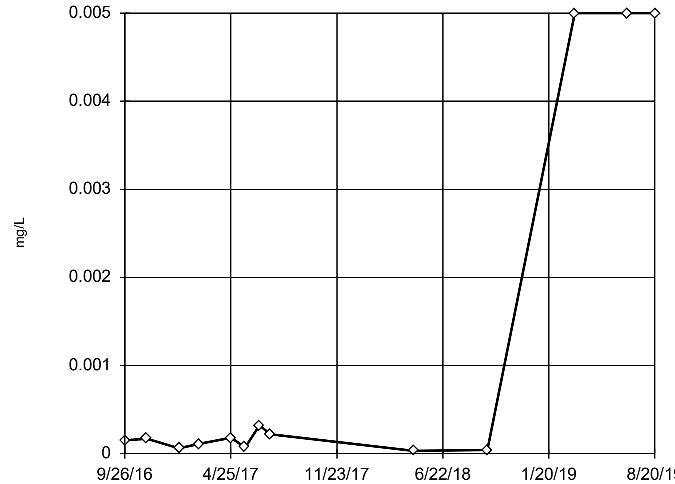
High cutoff = 0.008031, low cutoff = -0.000004114, based on IQR multiplier of 3.

Constituent: Molybdenum Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1603



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

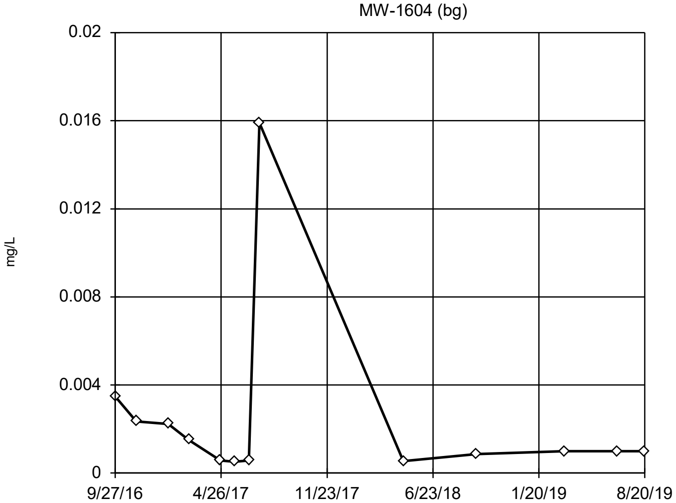
High cutoff = 9.405, low cutoff = 8.7e-9, based on IQR multiplier of 3.

Constituent: Molybdenum Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1604 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

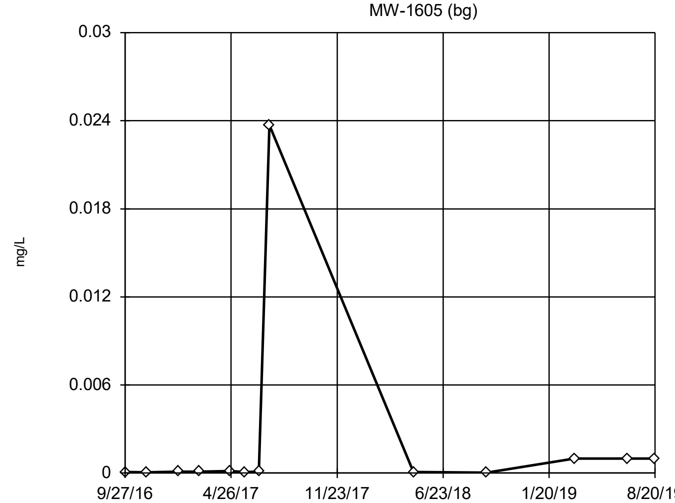
High cutoff = 0.147, low cutoff = 0.000008856, based on IQR multiplier of 3.

Constituent: Molybdenum Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1605 (bg)



n = 13

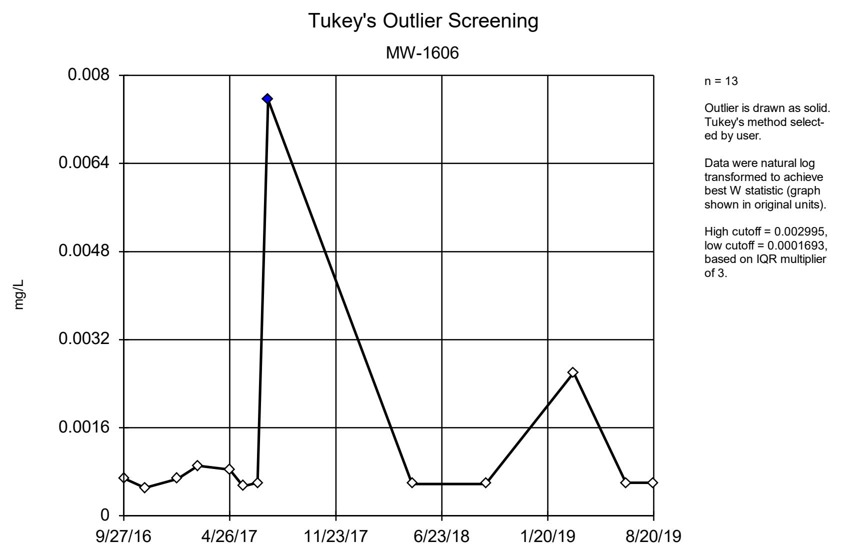
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.915, low cutoff = 2.4e-8, based on IQR multiplier of 3.

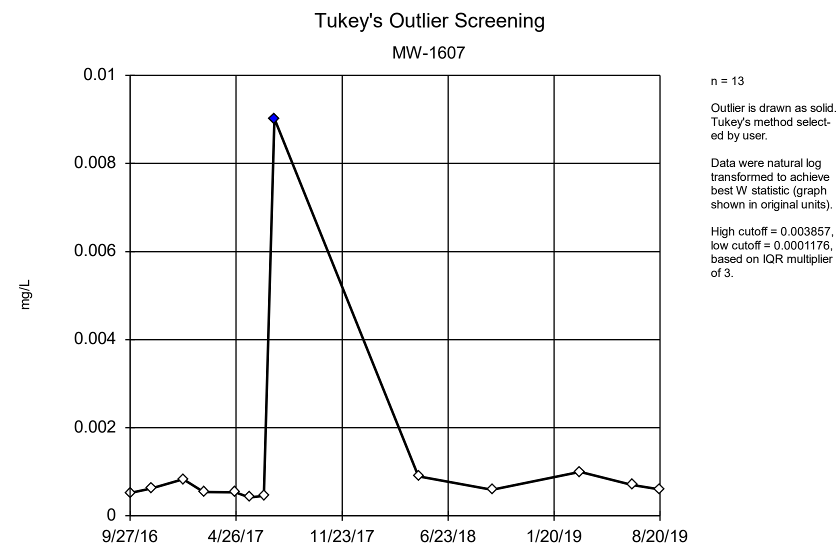
Constituent: Molybdenum Analysis Run 11/13/2019 4:37 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



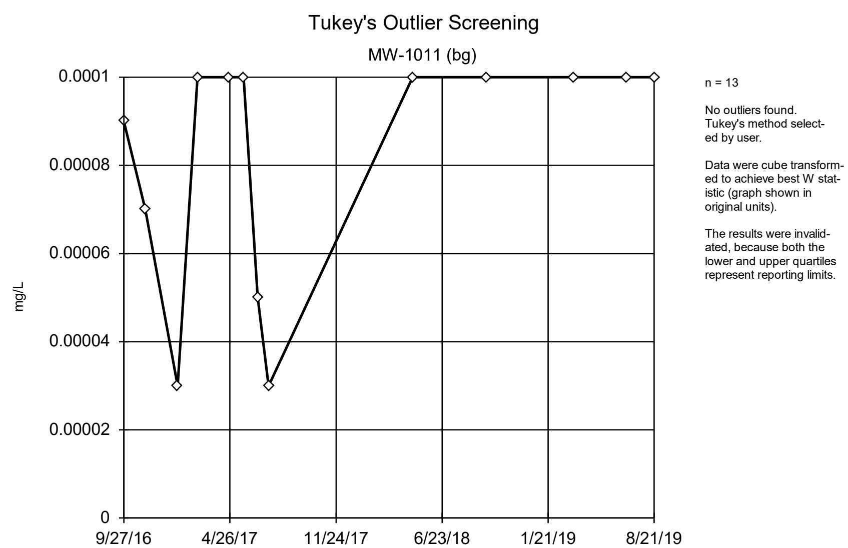
Constituent: Molybdenum   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



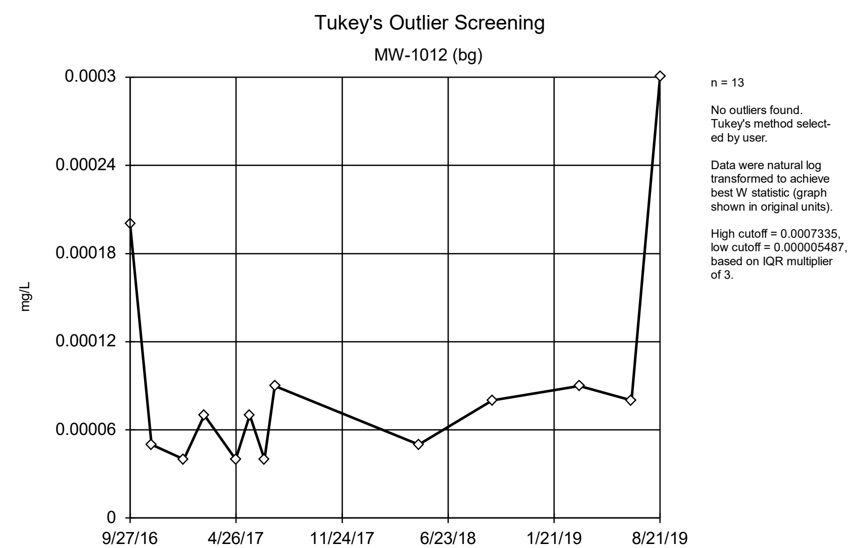
Constituent: Molybdenum   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



Constituent: Selenium   Analysis Run 11/13/2019 4:37 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

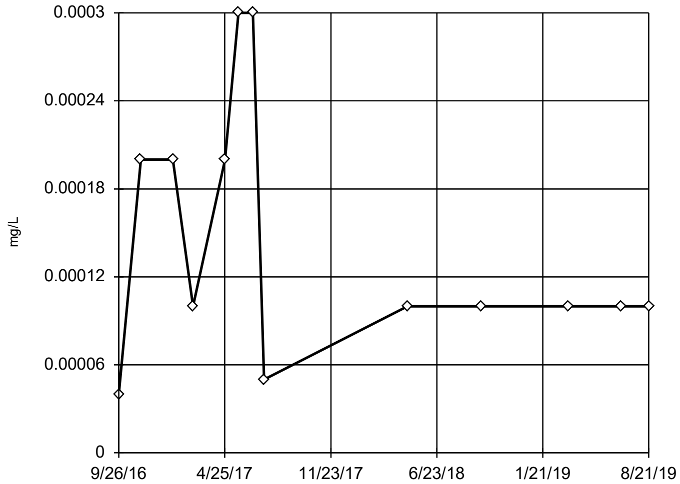


Constituent: Selenium   Analysis Run 11/13/2019 4:38 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1203 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

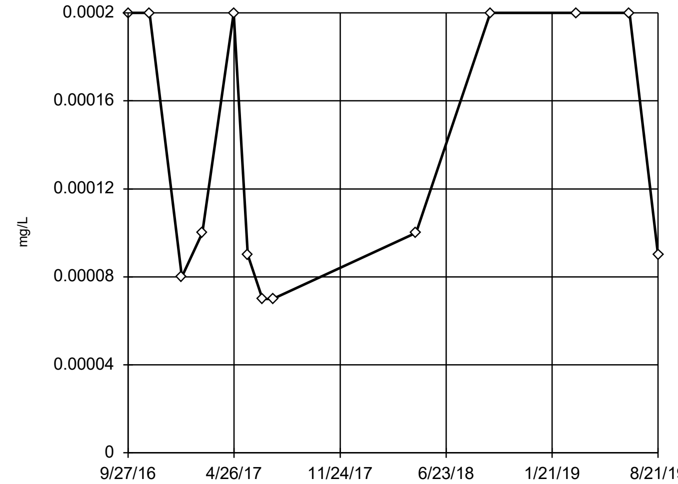
High cutoff = 0.0016, low cutoff = 0.0000125, based on IQR multiplier of 3.

Constituent: Selenium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1601



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

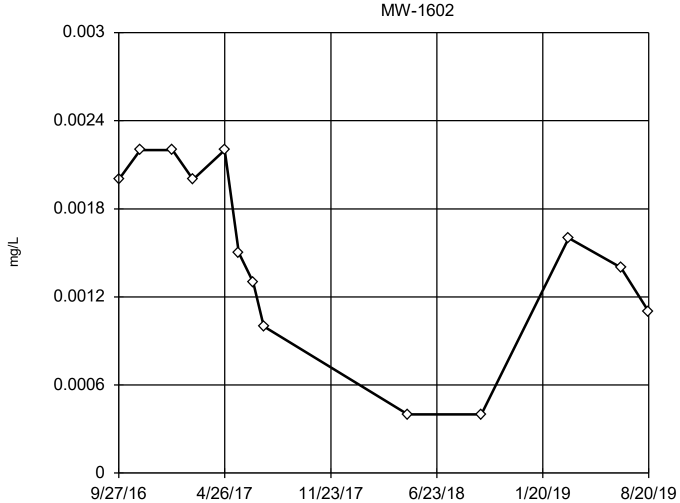
High cutoff = 0.002619, low cutoff = 0.00000648, based on IQR multiplier of 3.

Constituent: Selenium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1602



n = 13

No outliers found. Tukey's method selected by user.

Ladder of Powers transformations did not improve normality; analysis run on raw data.

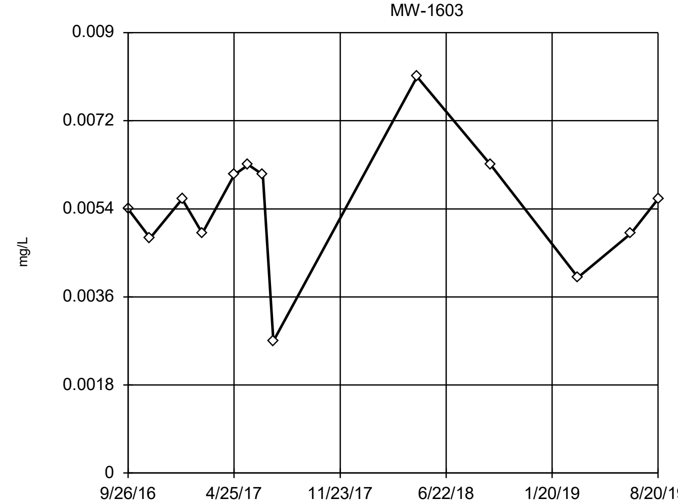
High cutoff = 0.00525, low cutoff = -0.0021, based on IQR multiplier of 3.

Constituent: Selenium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1603



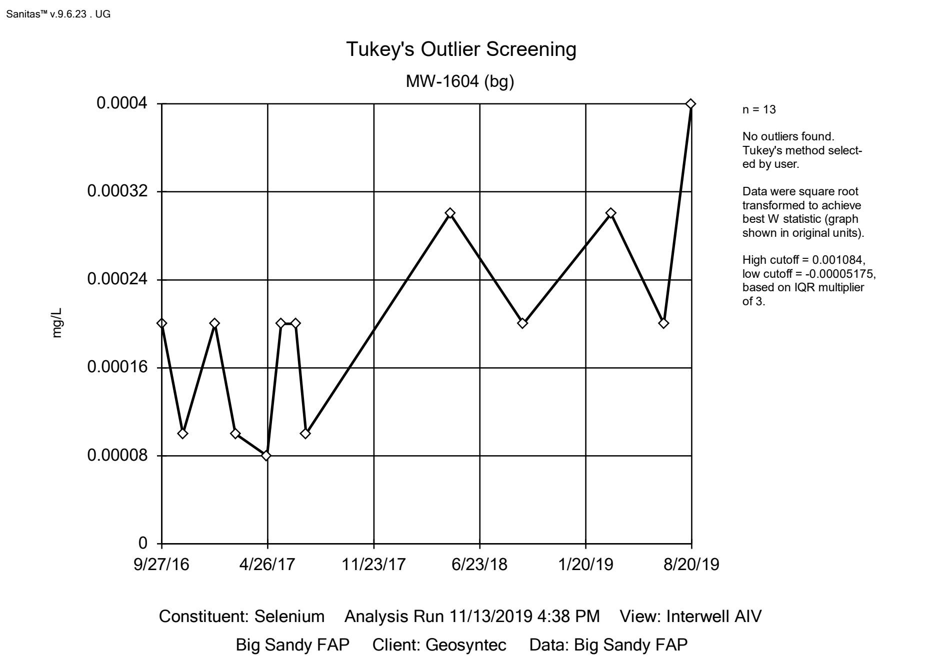
n = 13

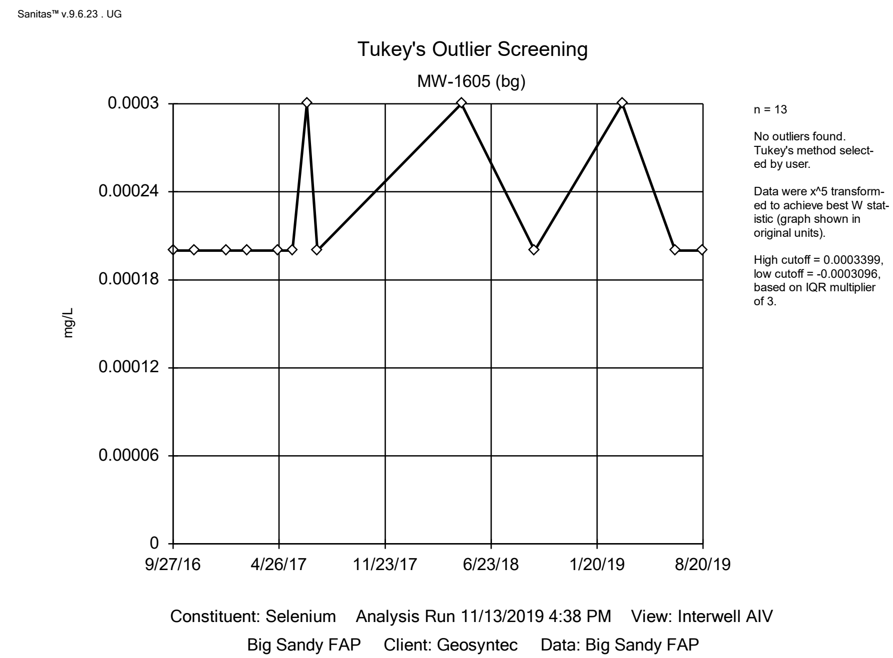
No outliers found. Tukey's method selected by user.

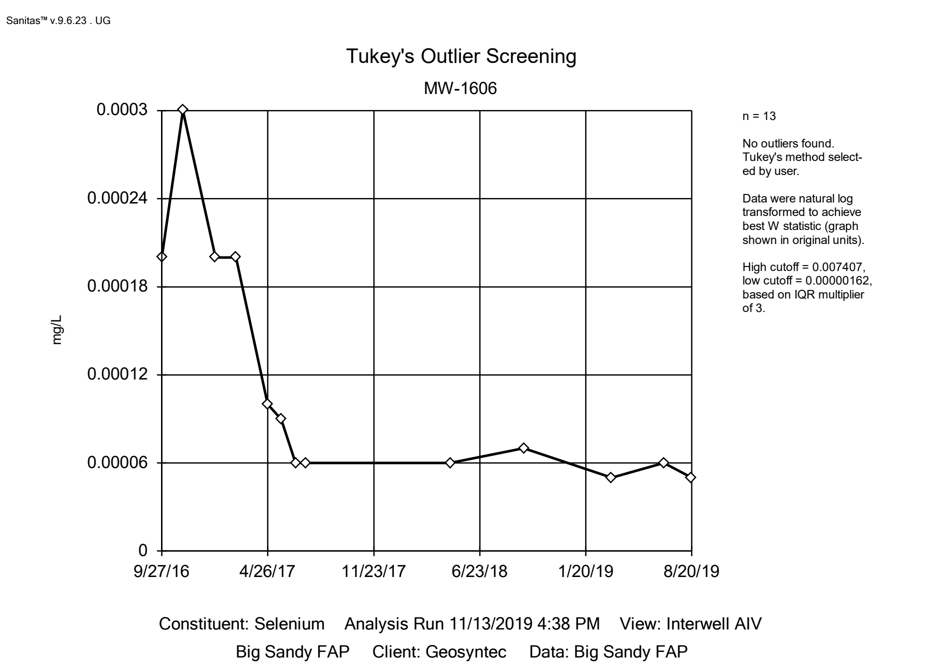
Ladder of Powers transformations did not improve normality; analysis run on raw data.

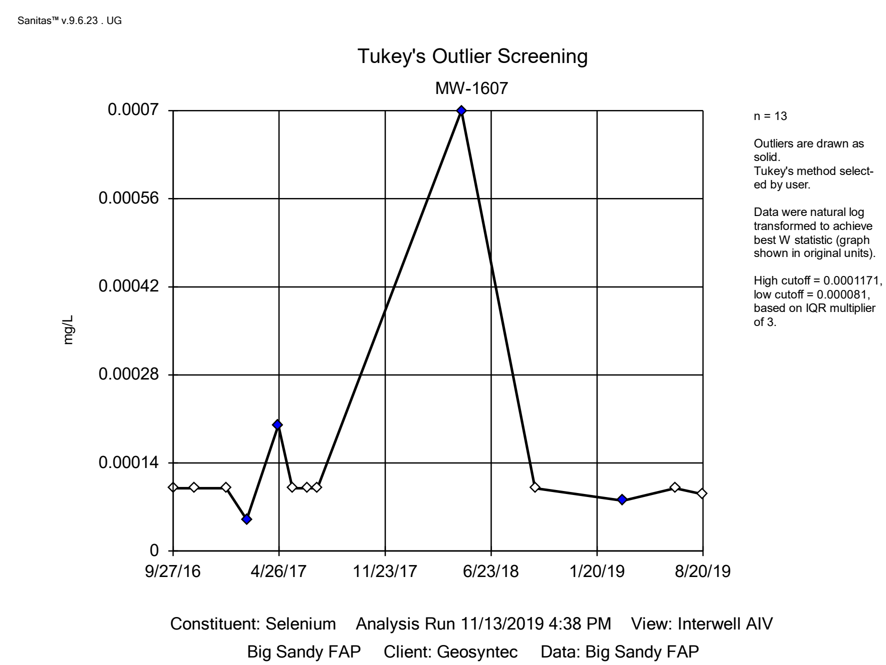
High cutoff = 0.01025, low cutoff = 0.0008, based on IQR multiplier of 3.

Constituent: Selenium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

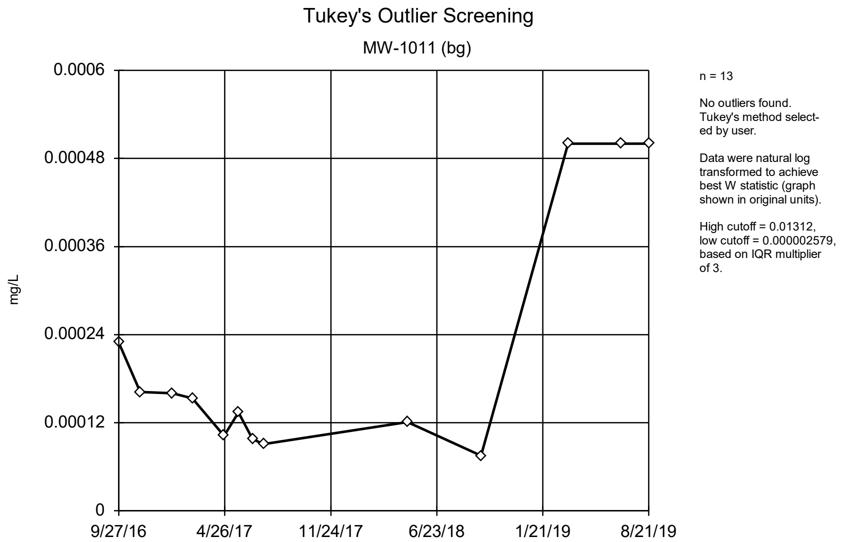

Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1604 (bg)
0.0004
0.00032
0.00024
0.00016
0.00008
0
mg/L
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 13
No outliers found. Tukey's method selected by user.
Data were square root transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.001084, low cutoff = -0.00005175, based on IQR multiplier of 3.
Constituent: Selenium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1605 (bg)
0.0003
0.00024
0.00018
0.00012
0.00006
0
mg/L
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 13
No outliers found. Tukey's method selected by user.
Data were x^5 transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.0003399, low cutoff = -0.0003096, based on IQR multiplier of 3.
Constituent: Selenium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1606
0.0003
0.00024
0.00018
0.00012
0.00006
0
mg/L
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 13
No outliers found. Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.007407, low cutoff = 0.00000162, based on IQR multiplier of 3.
Constituent: Selenium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

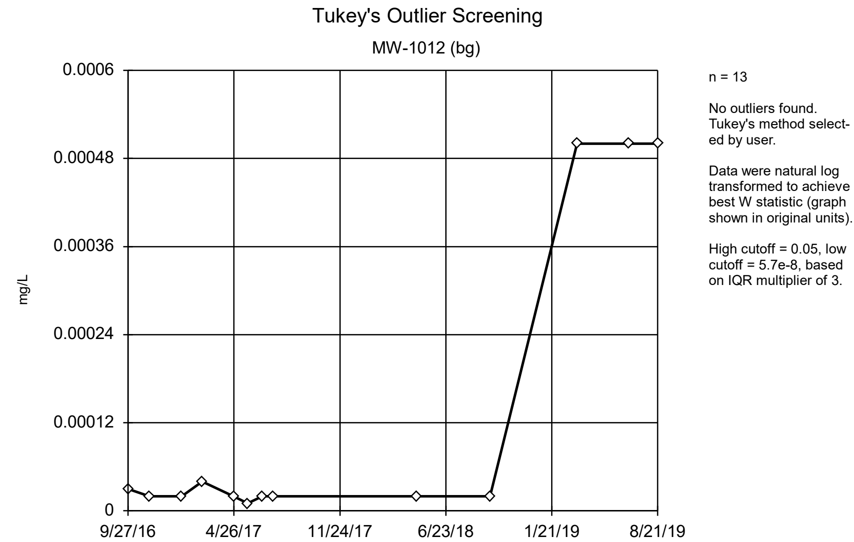

Sanitas™ v.9.6.23 . UG
Tukey's Outlier Screening
MW-1607
0.0007
0.00056
0.00042
0.00028
0.00014
0
mg/L
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 13
Outliers are drawn as solid.
Tukey's method selected by user.
Data were natural log transformed to achieve best W statistic (graph shown in original units).
High cutoff = 0.0001171, low cutoff = 0.000081, based on IQR multiplier of 3.
Constituent: Selenium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



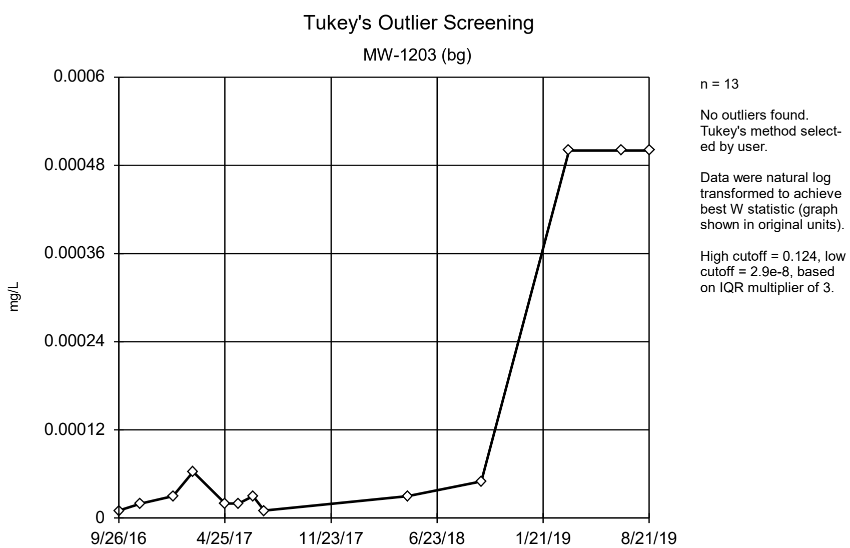
Constituent: Thallium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



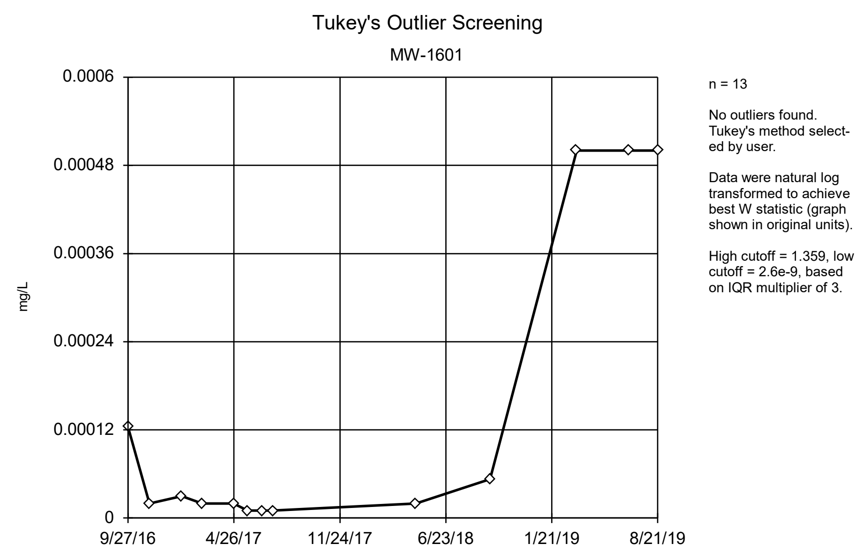
Constituent: Thallium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



Constituent: Thallium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

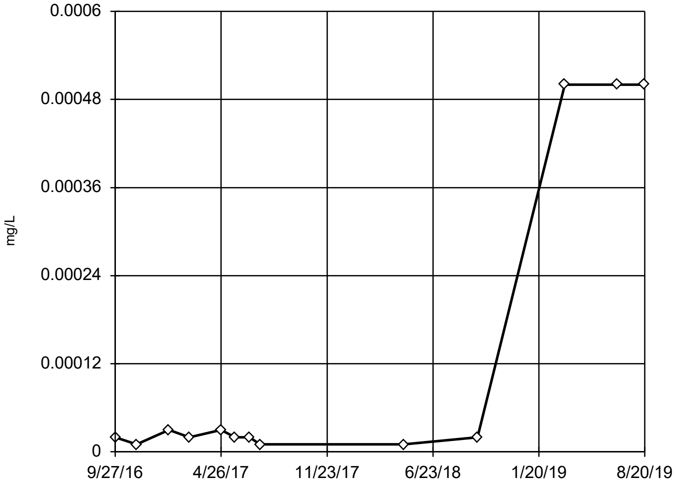


Constituent: Thallium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1602



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

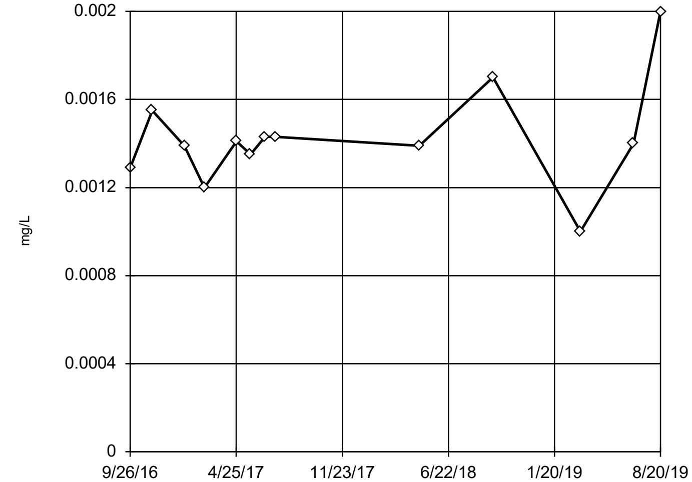
High cutoff = 0.07955, low cutoff = 2.2e-8, based on IQR multiplier of 3.

Constituent: Thallium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1603



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

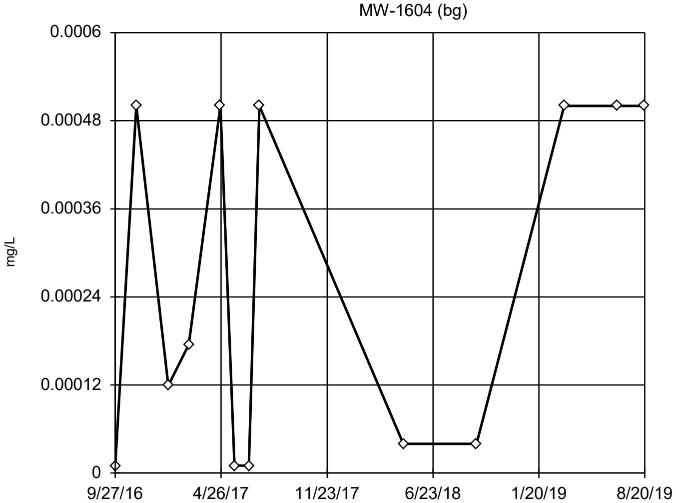
High cutoff = 0.002138, low cutoff = 0.0009191, based on IQR multiplier of 3.

Constituent: Thallium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1604 (bg)



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

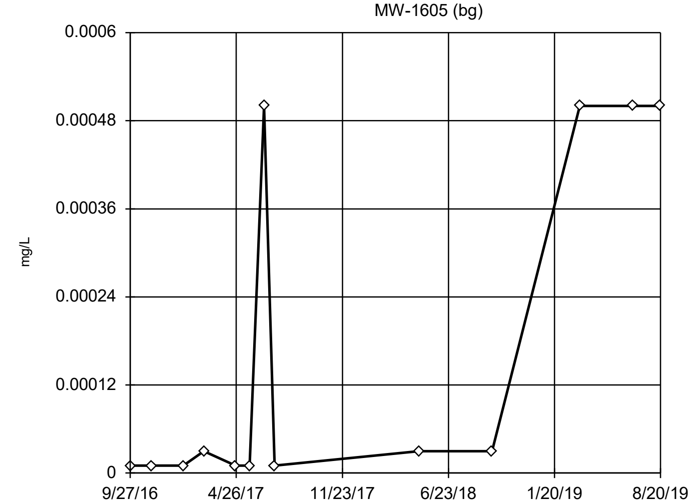
High cutoff = 7.813, low cutoff = 1.3e-9, based on IQR multiplier of 3.

Constituent: Thallium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Tukey's Outlier Screening

MW-1605 (bg)



n = 13

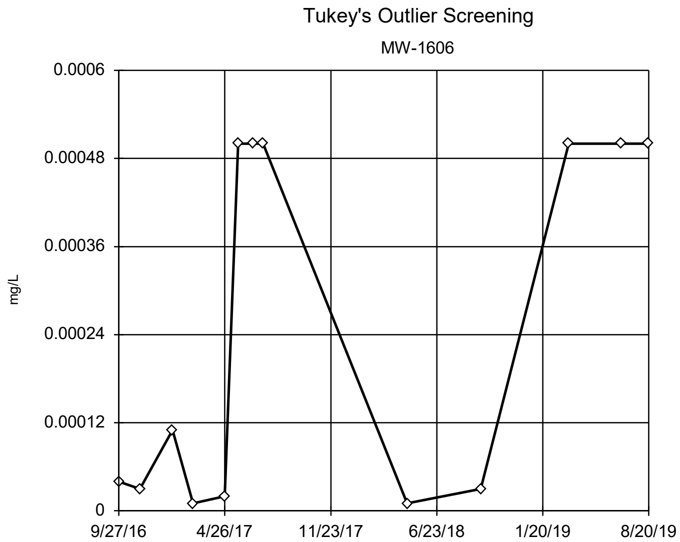
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 62.5, low cutoff = 8.0e-11, based on IQR multiplier of 3.

Constituent: Thallium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

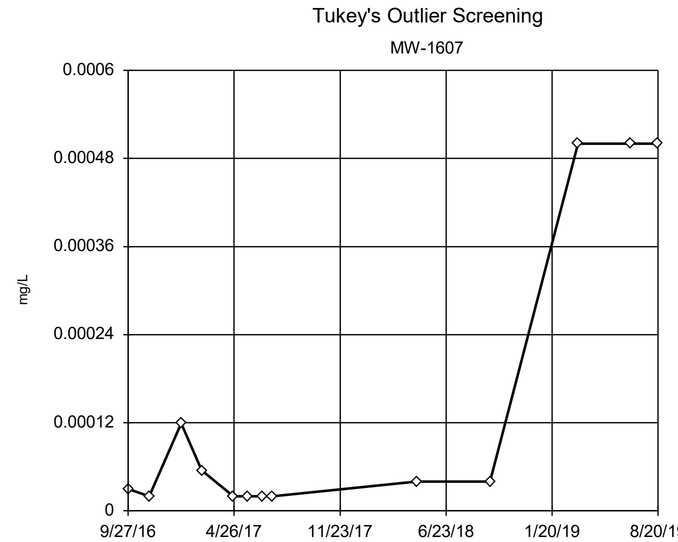
No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 4.253, low cutoff = 2.9e-9, based on IQR multiplier of 3.

Constituent: Thallium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



n = 13

No outliers found. Tukey's method selected by user.

Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.4425, low cutoff = 1.1e-8, based on IQR multiplier of 3.

Constituent: Thallium Analysis Run 11/13/2019 4:38 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Mann-Whitney - All Results (No Significant)

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 12/8/2019, 12:33 PM

Constituent	Well	Calc.	0.01	Sig.	Method
pH (SU)	MW-1011 (bg)	-1.616	No	No	Mann-W
pH (SU)	MW-1012 (bg)	0.2548	No	No	Mann-W
pH (SU)	MW-1203 (bg)	-1.613	No	No	Mann-W
pH (SU)	MW-1601	-1.244	No	No	Mann-W
pH (SU)	MW-1602	-0.2196	No	No	Mann-W
pH (SU)	MW-1603	-1.539	No	No	Mann-W
pH (SU)	MW-1604 (bg)	-0.4246	No	No	Mann-W
pH (SU)	MW-1605 (bg)	-1.953	No	No	Mann-W
pH (SU)	MW-1606	-0.8807	No	No	Mann-W
pH (SU)	MW-1607	-0.5131	No	No	Mann-W

Intrawell Prediction Limit Summary

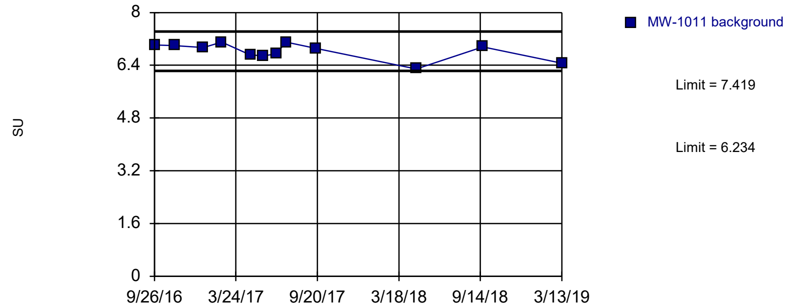
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 12/8/2019, 12:35 PM

Constituent	Well	Upper Lim.	Lower Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
pH (SU)	MW-1011	7.419	6.234	12	6.827	0.2552	0	None	No	0.000752	Param Intra 1 of 2
pH (SU)	MW-1012	9.46	8.503	12	8.982	0.206	0	None	No	0.000752	Param Intra 1 of 2
pH (SU)	MW-1203	7.768	5.712	12	6.74	0.4427	0	None	No	0.000752	Param Intra 1 of 2
pH (SU)	MW-1601	7.969	6.349	13	7.159	0.3554	0	None	No	0.000752	Param Intra 1 of 2
pH (SU)	MW-1602	8.248	6.438	13	7.343	0.3971	0	None	No	0.000752	Param Intra 1 of 2
pH (SU)	MW-1603	5.366	2.177	13	1.896	0.1845	0	None	sqrt(x)	0.000752	Param Intra 1 of 2
pH (SU)	MW-1604	8.031	3.529	12	5.78	0.9693	0	None	No	0.000752	Param Intra 1 of 2
pH (SU)	MW-1605	6.004	2.518	12	21.19	6.397	0	None	x^2	0.000752	Param Intra 1 of 2
pH (SU)	MW-1606	7.594	6.225	13	6.909	0.3004	0	None	No	0.000752	Param Intra 1 of 2
pH (SU)	MW-1607	7.06	5.585	13	6.322	0.3235	0	None	No	0.000752	Param Intra 1 of 2

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, MW-1011 (bg)



Background Data Summary: Mean=6.827, Std. Dev.=0.2552, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8951, critical = 0.805. Kappa = 2.322 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504. Assumes 1 future value.

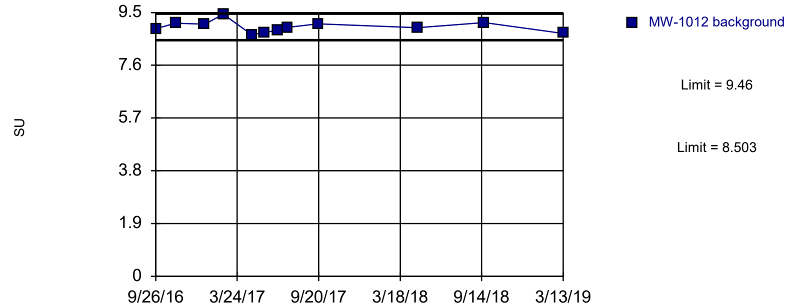
Constituent: pH Analysis Run 12/8/2019 12:34 PM View: PL's - Intrawell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, MW-1012 (bg)



Background Data Summary: Mean=8.982, Std. Dev.=0.206, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.944, critical = 0.805. Kappa = 2.322 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504. Assumes 1 future value.

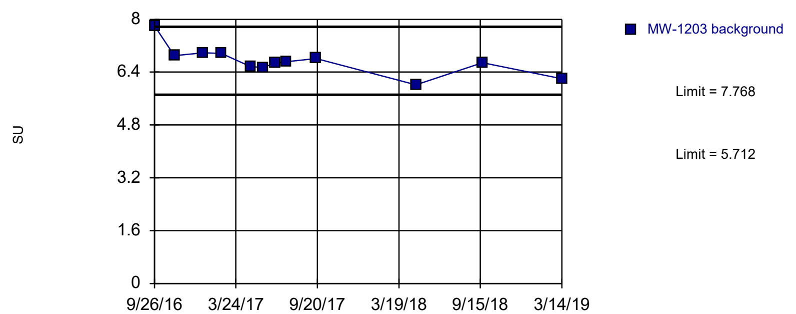
Constituent: pH Analysis Run 12/8/2019 12:34 PM View: PL's - Intrawell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, MW-1203 (bg)



Background Data Summary: Mean=6.74, Std. Dev.=0.4427, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9133, critical = 0.805. Kappa = 2.322 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504. Assumes 1 future value.

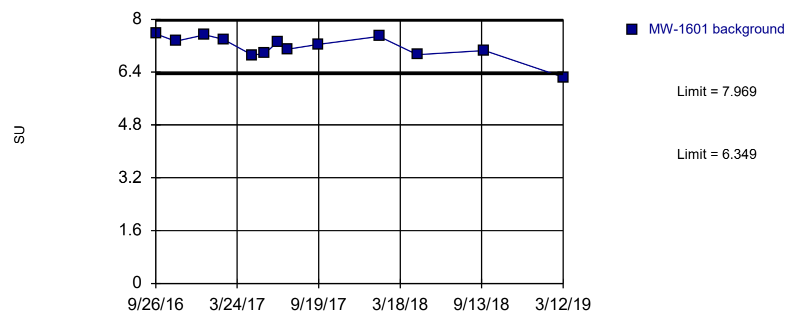
Constituent: pH Analysis Run 12/8/2019 12:34 PM View: PL's - Intrawell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, MW-1601



Background Data Summary: Mean=7.159, Std. Dev.=0.3554, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8814, critical = 0.814. Kappa = 2.279 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504. Assumes 1 future value.

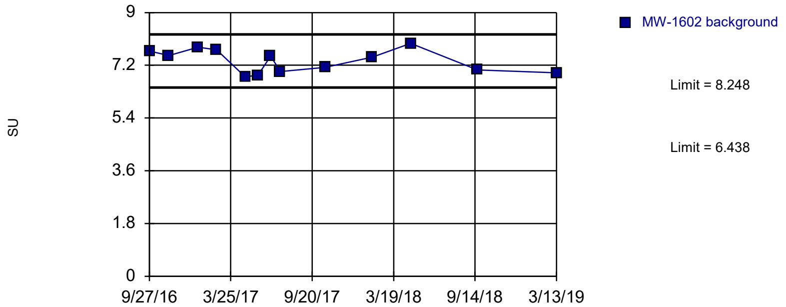
Constituent: pH Analysis Run 12/8/2019 12:34 PM View: PL's - Intrawell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, MW-1602



Background Data Summary: Mean=7.343, Std. Dev.=0.3971, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9154, critical = 0.814. Kappa = 2.279 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504. Assumes 1 future value.

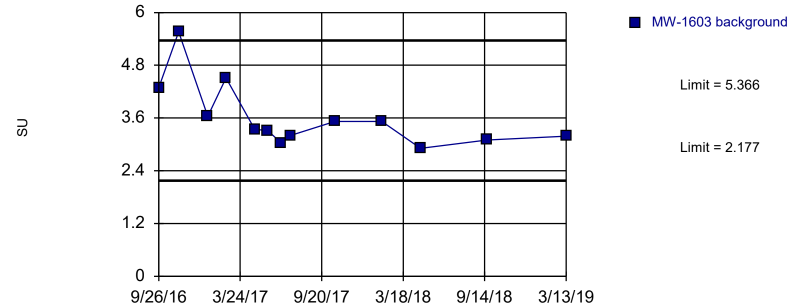
Constituent: pH Analysis Run 12/8/2019 12:34 PM View: PL's - Intrawell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, MW-1603



Background Data Summary (based on square root transformation): Mean=1.896, Std. Dev.=0.1845, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8355, critical = 0.814. Kappa = 2.279 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504. Assumes 1 future value.

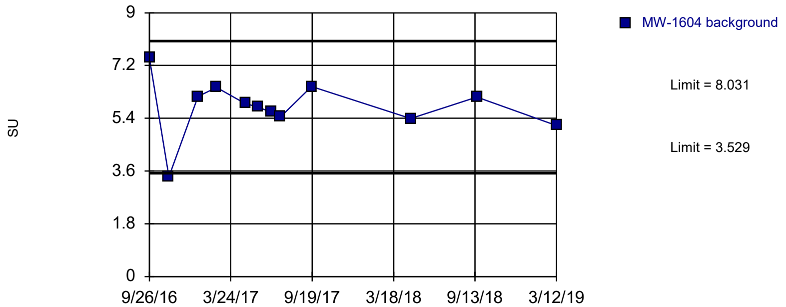
Constituent: pH Analysis Run 12/8/2019 12:34 PM View: PL's - Intrawell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, MW-1604 (bg)



Background Data Summary: Mean=5.78, Std. Dev.=0.9693, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9122, critical = 0.805. Kappa = 2.322 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504. Assumes 1 future value.

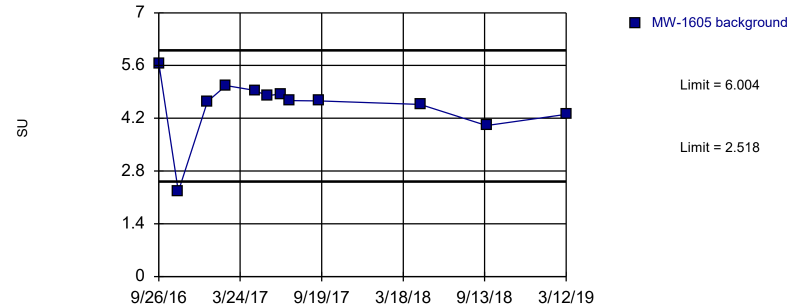
Constituent: pH Analysis Run 12/8/2019 12:34 PM View: PL's - Intrawell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, MW-1605 (bg)



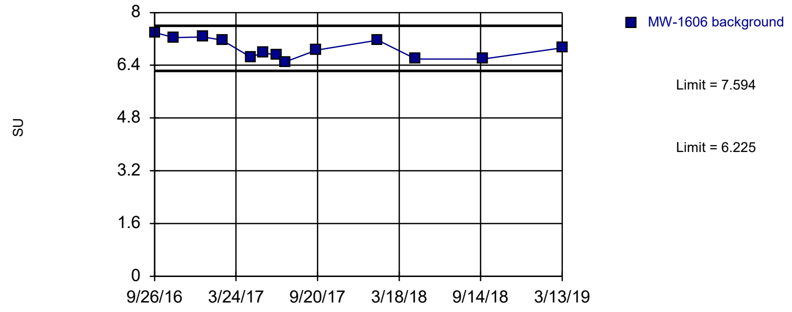
Background Data Summary (based on square transformation): Mean=21.19, Std. Dev.=6.397, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8791, critical = 0.805. Kappa = 2.322 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504. Assumes 1 future value.

Constituent: pH Analysis Run 12/8/2019 12:34 PM View: PL's - Intrawell

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Prediction Limit

Intrawell Parametric, MW-1606



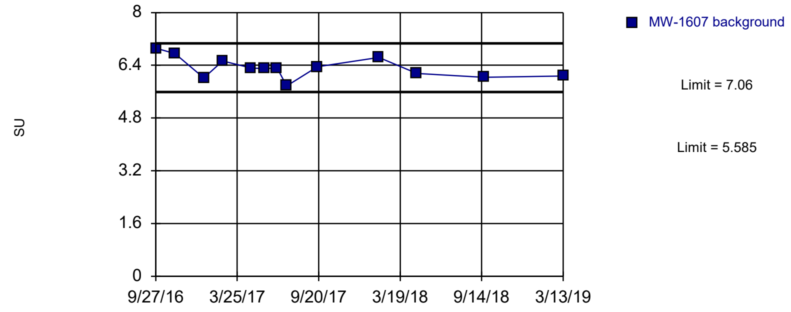
Background Data Summary: Mean=6.909, Std. Dev.=0.3004, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9175, critical = 0.814. Kappa = 2.279 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504. Assumes 1 future value.

Constituent: pH Analysis Run 12/8/2019 12:34 PM View: PL's - Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, MW-1607



Background Data Summary: Mean=6.322, Std. Dev.=0.3235, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9749, critical = 0.814. Kappa = 2.279 (c=7, w=5, 1 of 2, event alpha = 0.05132). Report alpha = 0.001504. Assumes 1 future value.

Constituent: pH Analysis Run 12/8/2019 12:34 PM View: PL's - Intrawell
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Trend Test Summary Table - Significant Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/13/2019, 4:54 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Chloride (mg/L)	**MW-1604 (bg)**	**-0.744**	**-69**	**-48**	**Yes**	**14**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Fluoride (mg/L)	**MW-1604 (bg)**	**-0.06**	**-61**	**-48**	**Yes**	**14**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Total Dissolved Solids (mg/L)	**MW-1604 (bg)**	**-43.32**	**-47**	**-43**	**Yes**	**13**	**0**	**n/a**	**n/a**	**0.01**	**NP**

Trend Test Summary Table - All Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/13/2019, 4:54 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron (mg/L)	MW-1011 (bg)	0.01445	27	48	No	14	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1012 (bg)	0.00381	16	48	No	14	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1203 (bg)	0.001484	8	48	No	14	0	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1604 (bg)	0.001848	10	48	No	14	7.143	n/a	n/a	0.01	NP
Boron (mg/L)	MW-1605 (bg)	0.006411	19	48	No	14	21.43	n/a	n/a	0.01	NP
Calcium (mg/L)	MW-1011 (bg)	2.356	23	48	No	14	0	n/a	n/a	0.01	NP
Calcium (mg/L)	MW-1012 (bg)	-0.0467	-39	-48	No	14	0	n/a	n/a	0.01	NP
Calcium (mg/L)	MW-1203 (bg)	-0.8111	-20	-48	No	14	0	n/a	n/a	0.01	NP
Calcium (mg/L)	MW-1604 (bg)	-0.3286	-33	-48	No	14	0	n/a	n/a	0.01	NP
Calcium (mg/L)	MW-1605 (bg)	0	-2	-48	No	14	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1011 (bg)	0.5123	30	48	No	14	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1012 (bg)	0.01524	15	48	No	14	0	n/a	n/a	0.01	NP
Chloride (mg/L)	MW-1203 (bg)	-0.1474	-21	-48	No	14	0	n/a	n/a	0.01	NP
Chloride (mg/L)	**MW-1604 (bg)**	**-0.744**	**-69**	**-48**	**Yes**	**14**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Chloride (mg/L)	MW-1605 (bg)	-0.1587	-11	-48	No	14	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	MW-1011 (bg)	0.01798	27	48	No	14	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	MW-1012 (bg)	0.02019	27	48	No	14	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	MW-1203 (bg)	-0.00...	-20	-48	No	14	0	n/a	n/a	0.01	NP
Fluoride (mg/L)	**MW-1604 (bg)**	**-0.06**	**-61**	**-48**	**Yes**	**14**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Fluoride (mg/L)	MW-1605 (bg)	0	-21	-43	No	13	84.62	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1011 (bg)	1.138	19	48	No	14	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1012 (bg)	0	-4	-48	No	14	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1203 (bg)	2.446	43	48	No	14	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1604 (bg)	0.3322	8	48	No	14	0	n/a	n/a	0.01	NP
Sulfate (mg/L)	MW-1605 (bg)	0.1036	6	48	No	14	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1011 (bg)	8.171	26	43	No	13	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1012 (bg)	8.135	30	43	No	13	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	MW-1203 (bg)	-0.9946	-3	-43	No	13	0	n/a	n/a	0.01	NP
Total Dissolved Solids (mg/L)	**MW-1604 (bg)**	**-43.32**	**-47**	**-43**	**Yes**	**13**	**0**	**n/a**	**n/a**	**0.01**	**NP**
Total Dissolved Solids (mg/L)	MW-1605 (bg)	-0.735	-13	-43	No	13	0	n/a	n/a	0.01	NP

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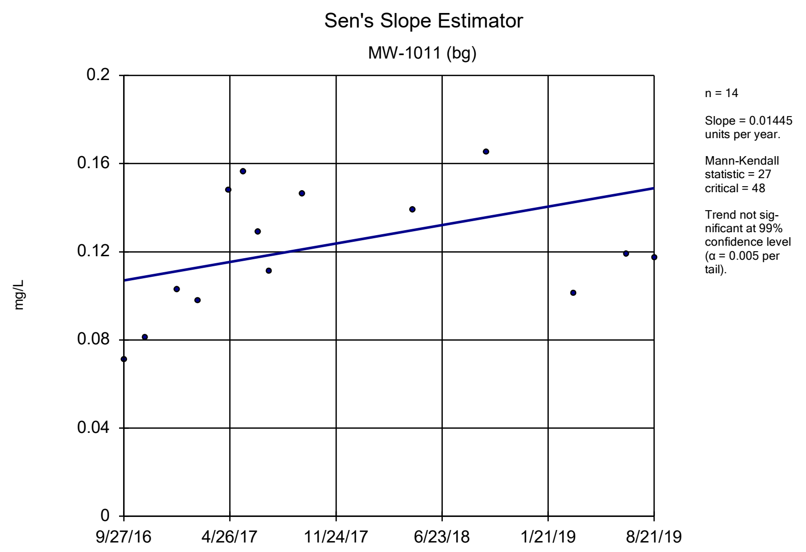
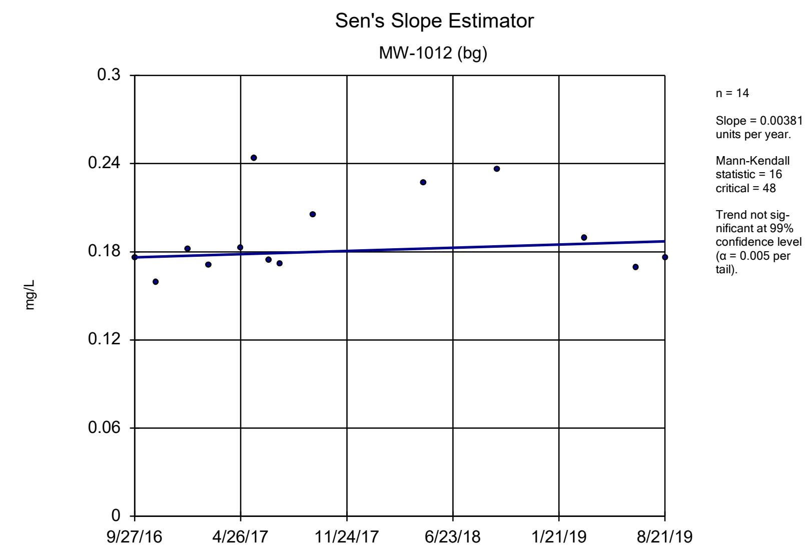


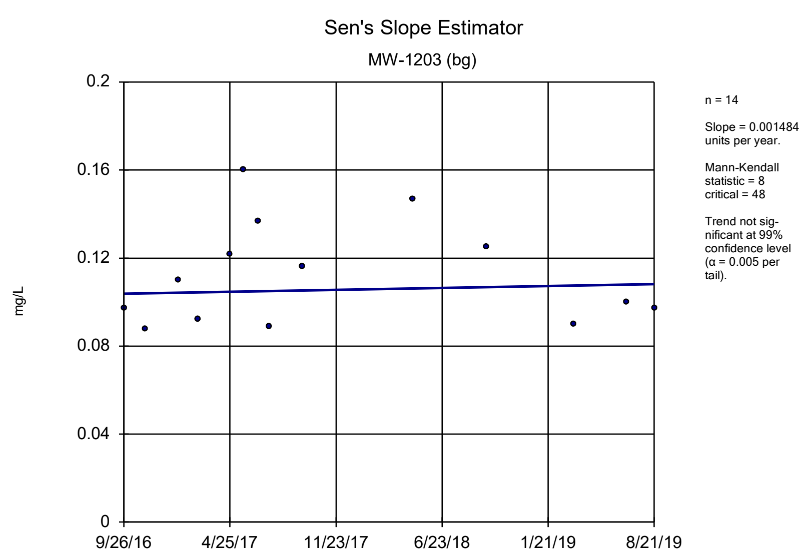
Constituent: Boron Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



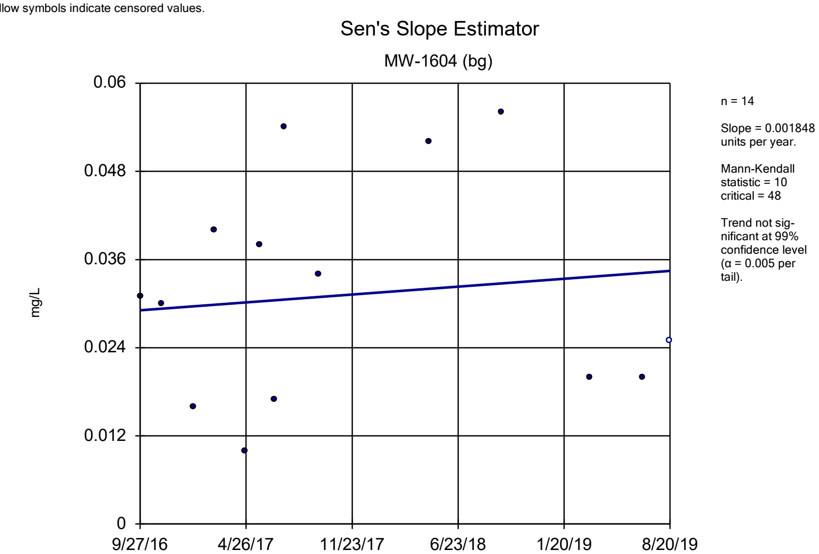
Constituent: Boron Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



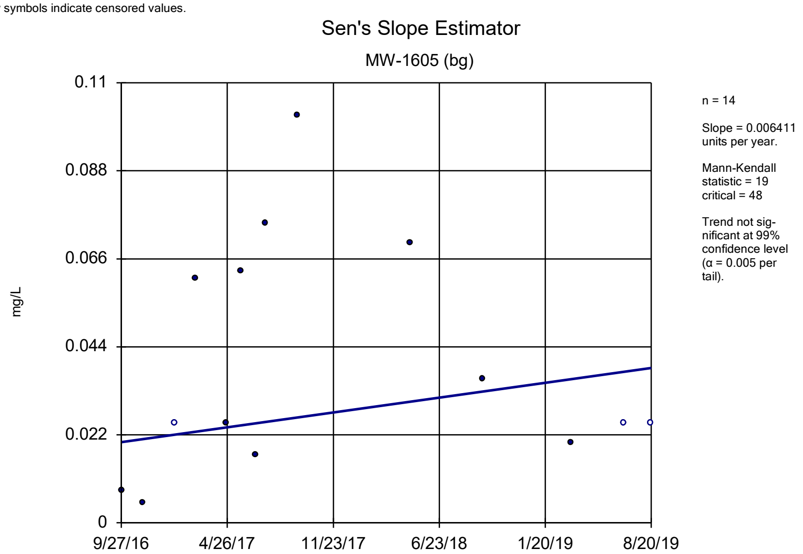
Constituent: Boron Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.



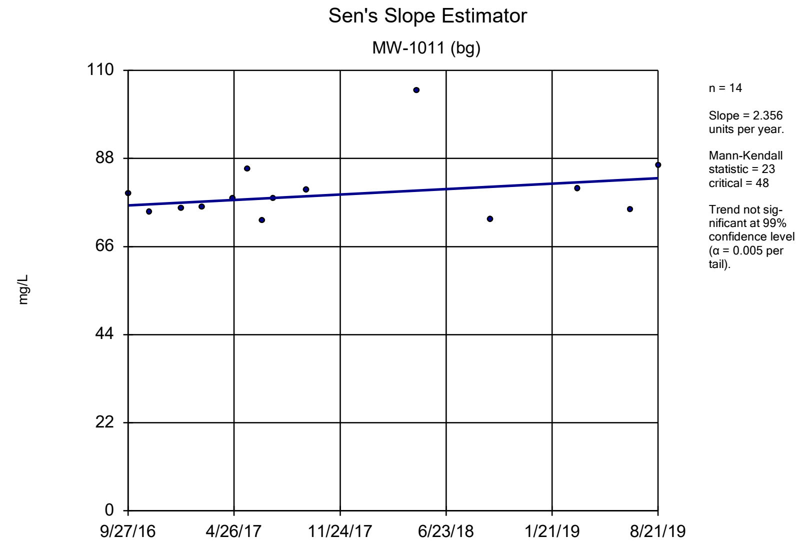
Constituent: Boron Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.



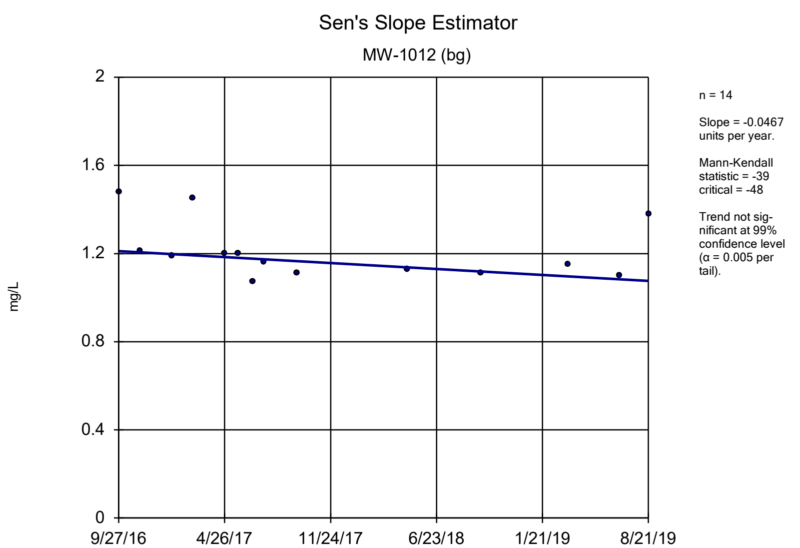
Constituent: Boron Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



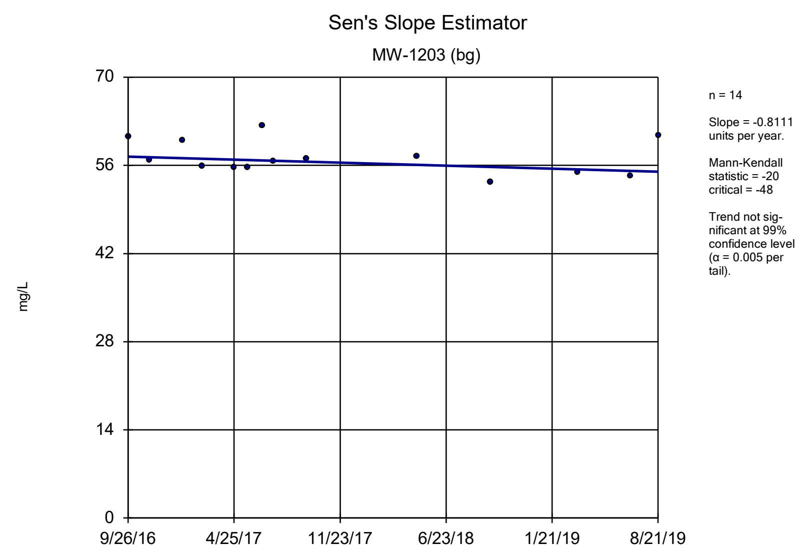
Constituent: Calcium Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

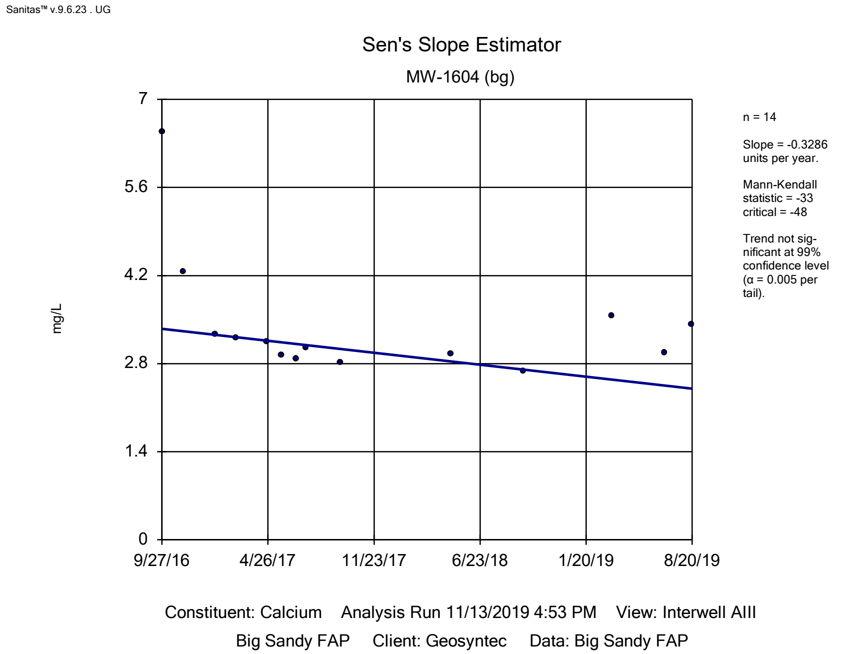


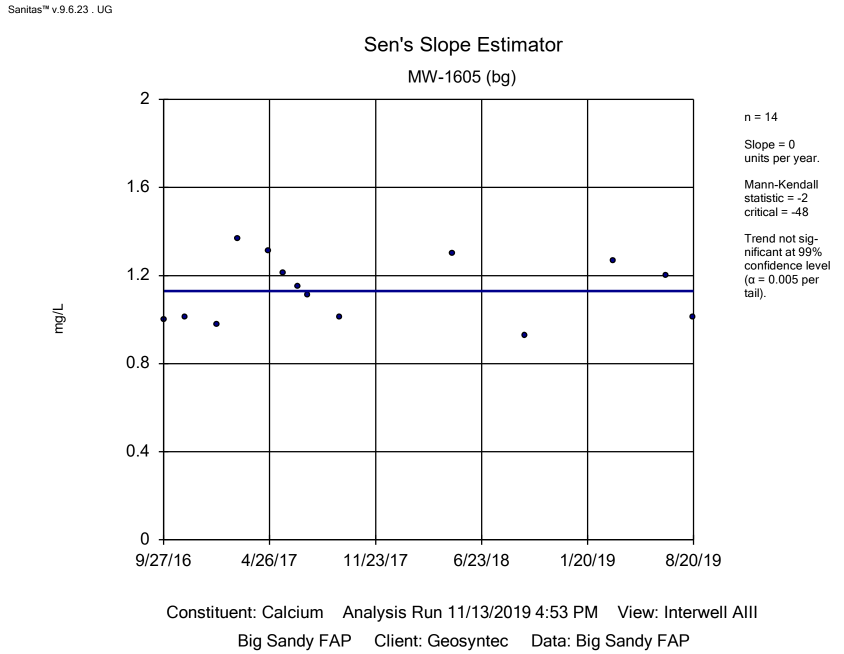
Constituent: Calcium Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

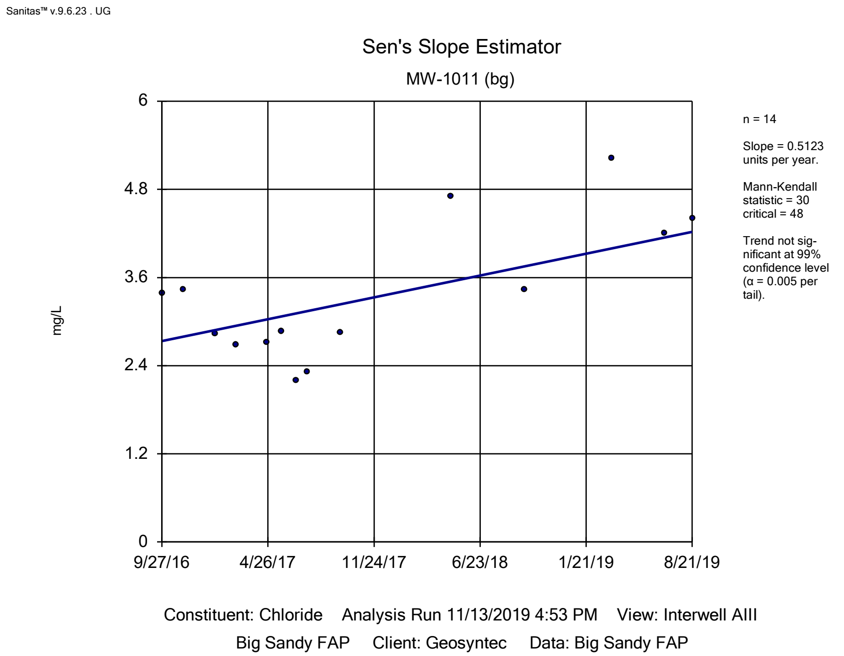
Sanitas™ v.9.6.23 . UG

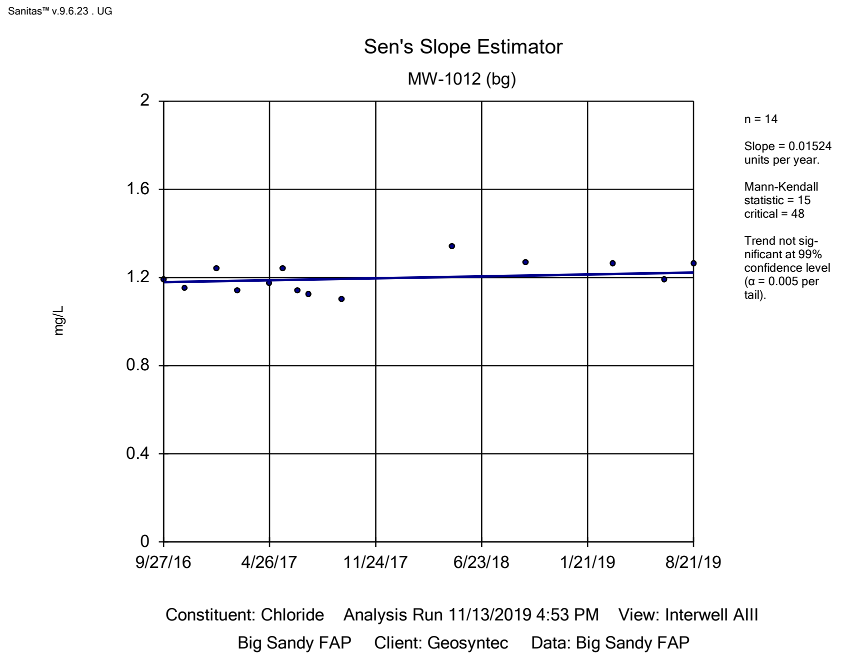


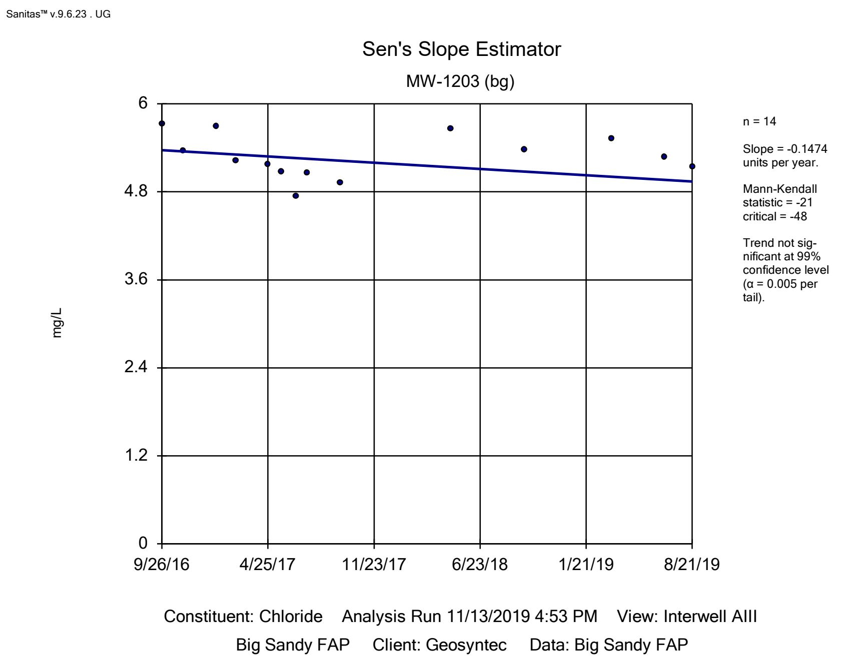
Constituent: Calcium Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1604 (bg)
7
5.6
4.2
2.8
1.4
0
mg/L
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 14
Slope = -0.3286
units per year.
Mann-Kendall
statistic = -33
critical = -48
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).
Constituent: Calcium Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

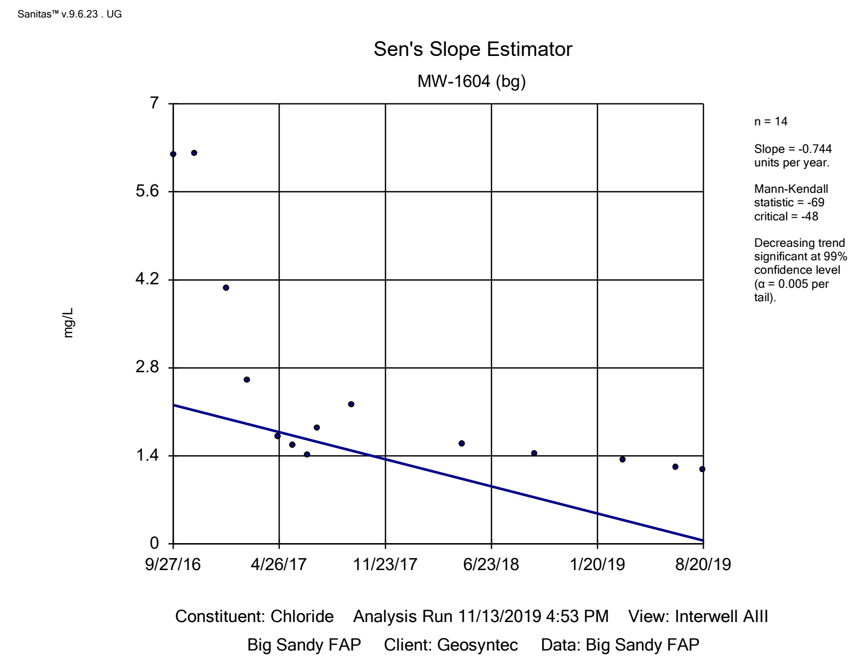

Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1605 (bg)
2
1.6
1.2
0.8
0.4
0
mg/L
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 14
Slope = 0
units per year.
Mann-Kendall
statistic = -2
critical = -48
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).
Constituent: Calcium Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1011 (bg)
6
4.8
3.6
2.4
1.2
0
mg/L
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
n = 14
Slope = 0.5123
units per year.
Mann-Kendall
statistic = 30
critical = 48
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).
Constituent: Chloride Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

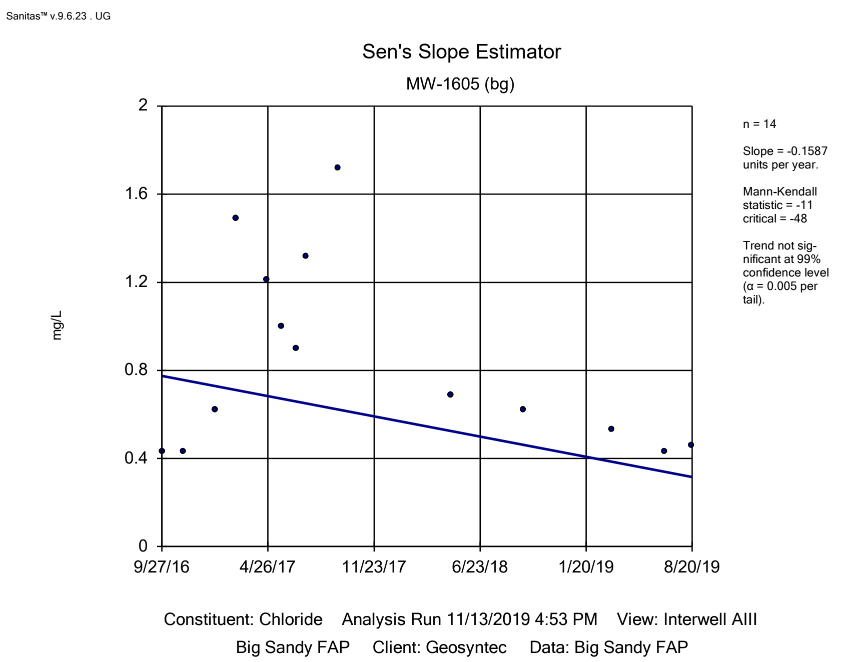

Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1012 (bg)
2
1.6
1.2
0.8
0.4
0
mg/L
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
n = 14
Slope = 0.01524
units per year.
Mann-Kendall
statistic = 15
critical = 48
Trend not sig-
nificant at 99%
confidence level
(α = 0.005 per
tail).
Constituent: Chloride Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



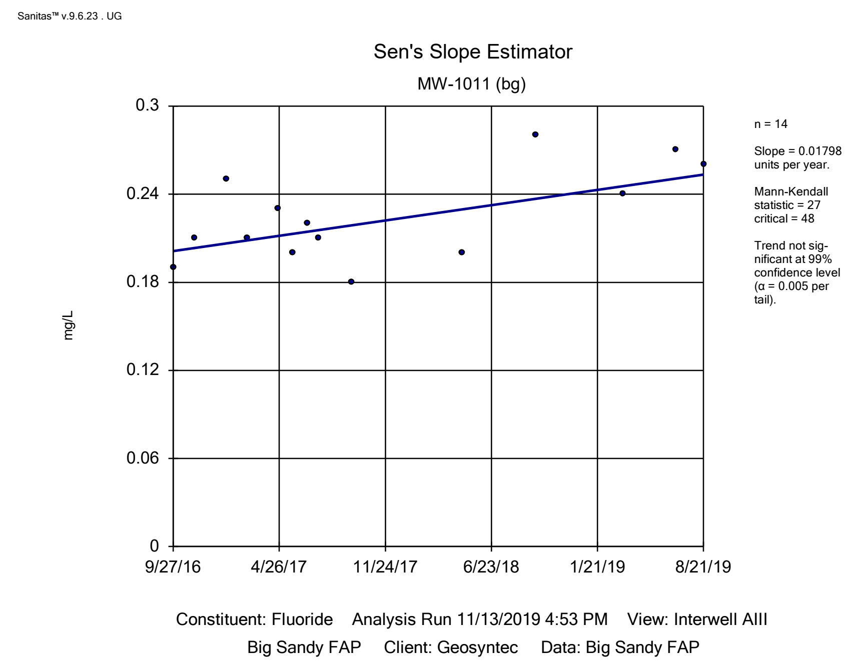
Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1203 (bg)
mg/L
6
4.8
3.6
2.4
1.2
0
9/26/16
4/25/17
11/23/17
6/23/18
1/21/19
8/21/19
n = 14
Slope = -0.1474 units per year.
Mann-Kendall statistic = -21 critical = -48
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Chloride Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1604 (bg)
mg/L
7
5.6
4.2
2.8
1.4
0
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 14
Slope = -0.744 units per year.
Mann-Kendall statistic = -69 critical = -48
Decreasing trend significant at 99% confidence level (α = 0.005 per tail).
Constituent: Chloride Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

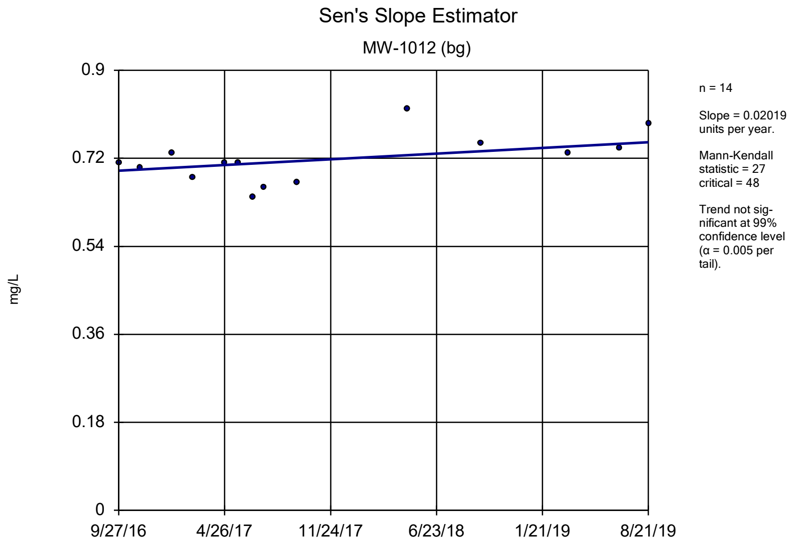


Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1605 (bg)
mg/L
2
1.6
1.2
0.8
0.4
0
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 14
Slope = -0.1587 units per year.
Mann-Kendall statistic = -11 critical = -48
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Chloride Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



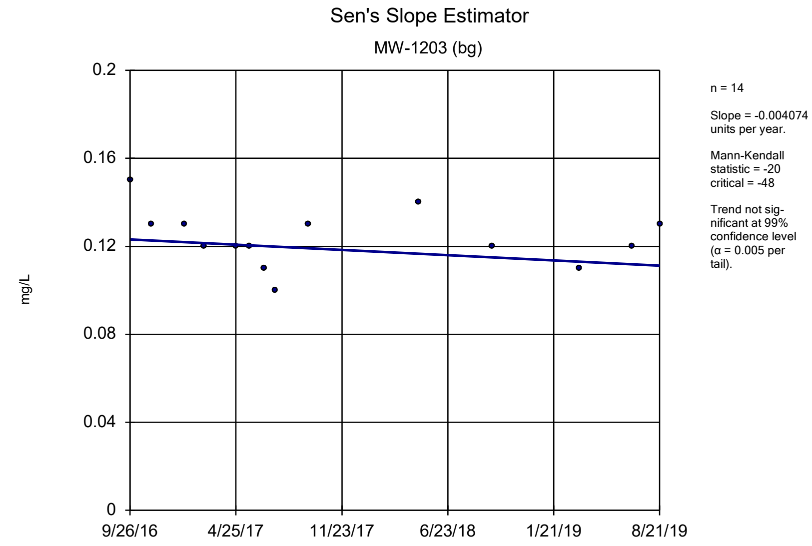
Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1011 (bg)
mg/L
0.3
0.24
0.18
0.12
0.06
0
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
n = 14
Slope = 0.01798 units per year.
Mann-Kendall statistic = 27 critical = 48
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Fluoride Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



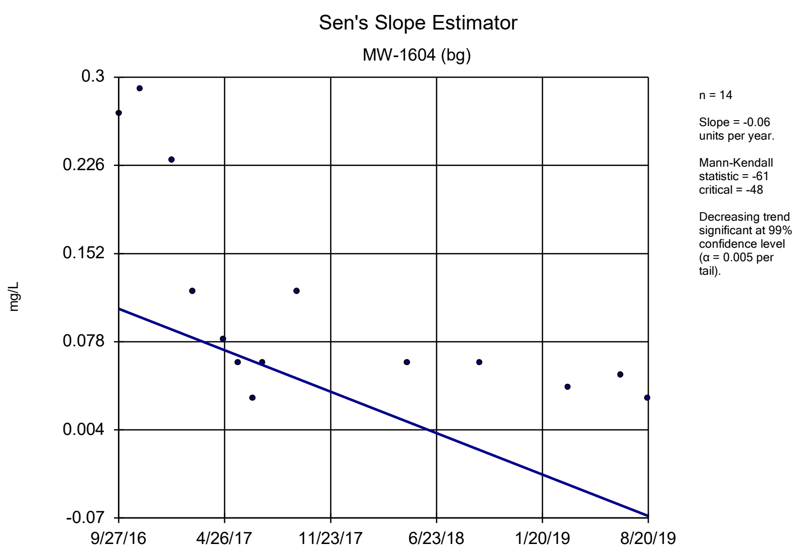
Constituent: Fluoride Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



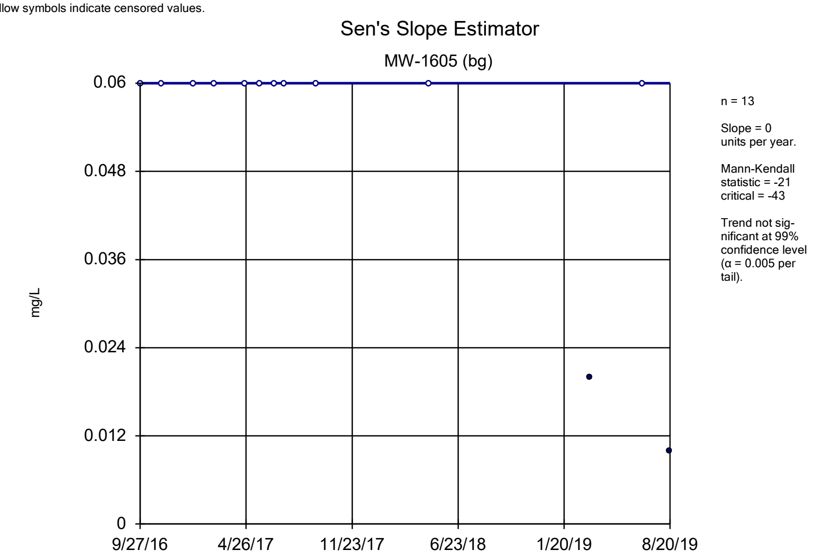
Constituent: Fluoride Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

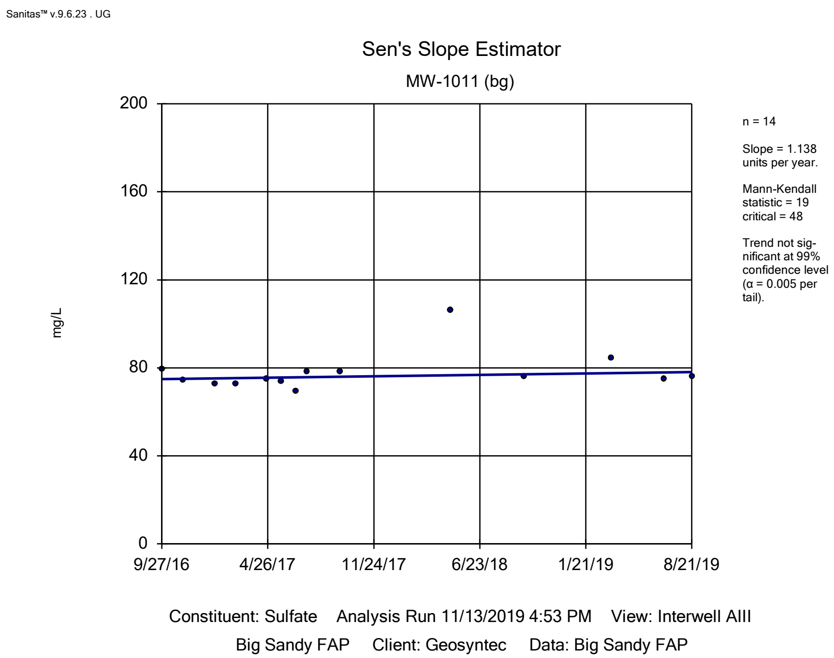


Constituent: Fluoride Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

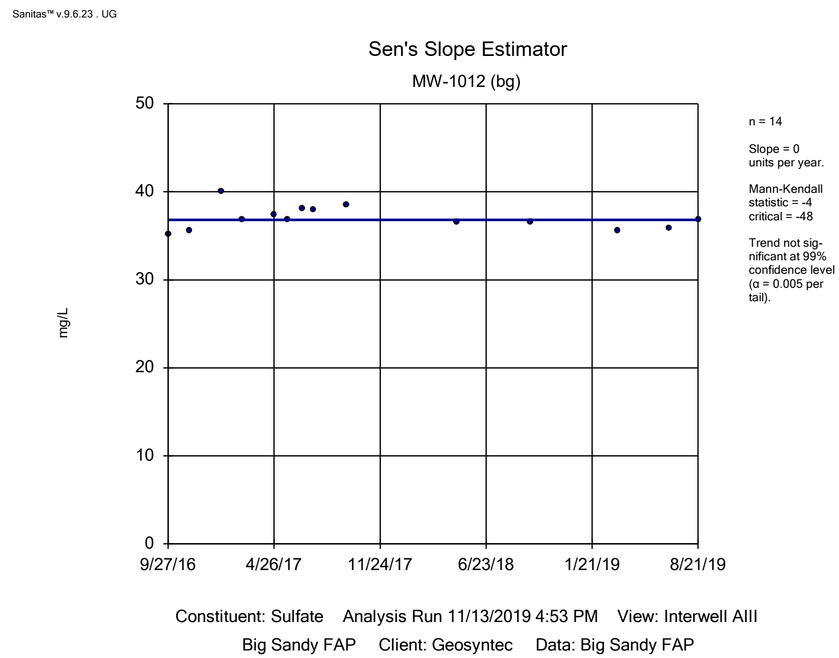
Sanitas™ v.9.6.23 . UG
Hollow symbols indicate censored values.



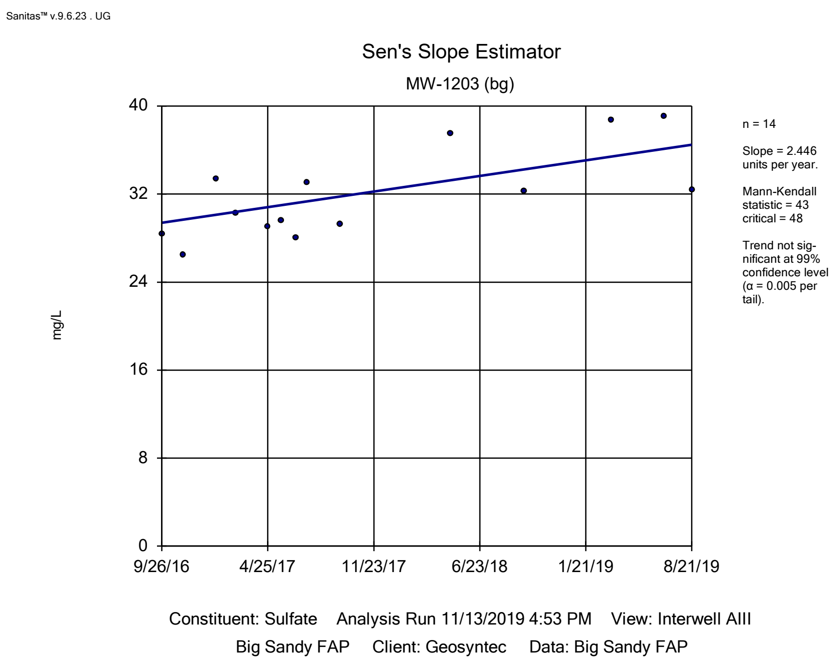
Constituent: Fluoride Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



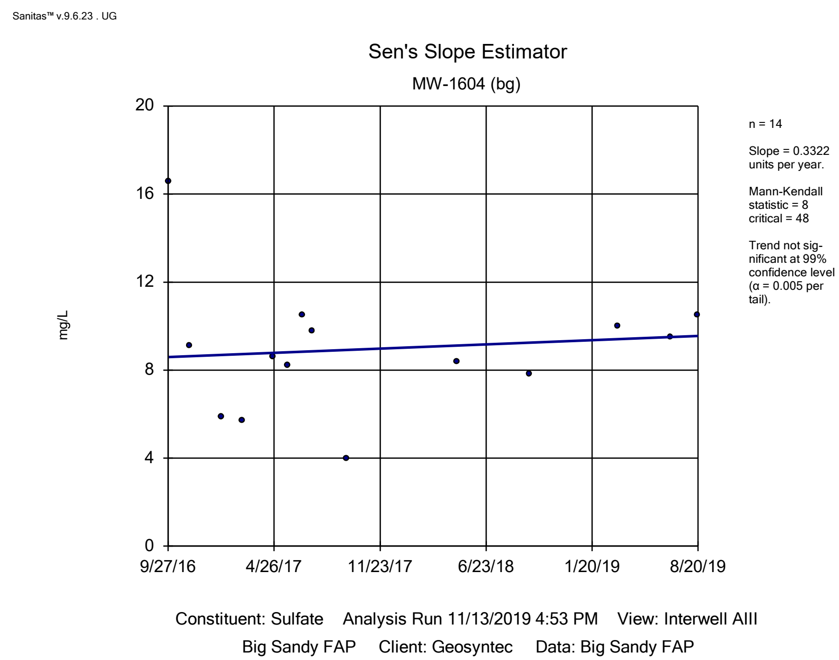
Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1011 (bg)
mg/L
200
160
120
80
40
0
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
n = 14
Slope = 1.138 units per year.
Mann-Kendall statistic = 19 critical = 48
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Sulfate Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



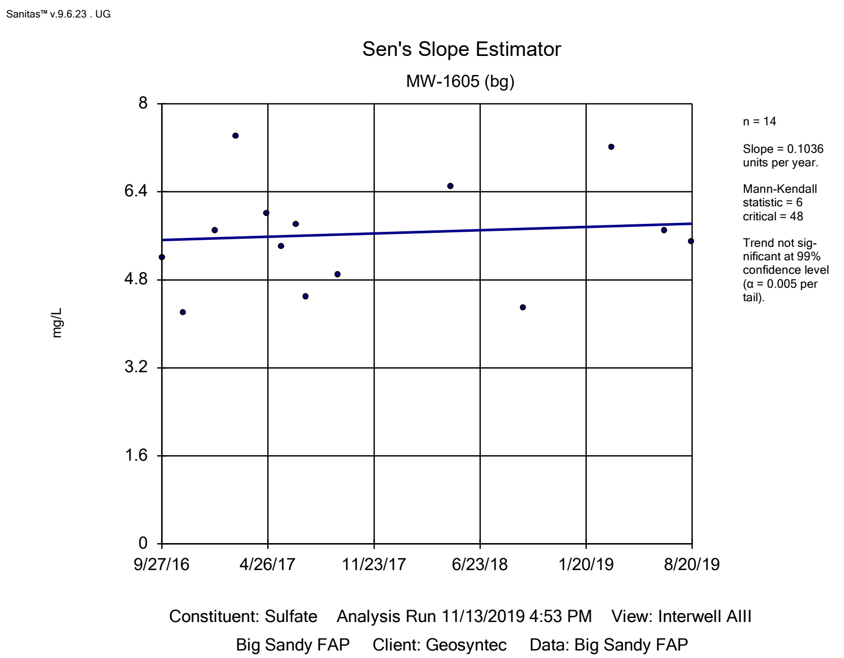
Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1012 (bg)
mg/L
50
40
30
20
10
0
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
n = 14
Slope = 0 units per year.
Mann-Kendall statistic = -4 critical = -48
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Sulfate Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

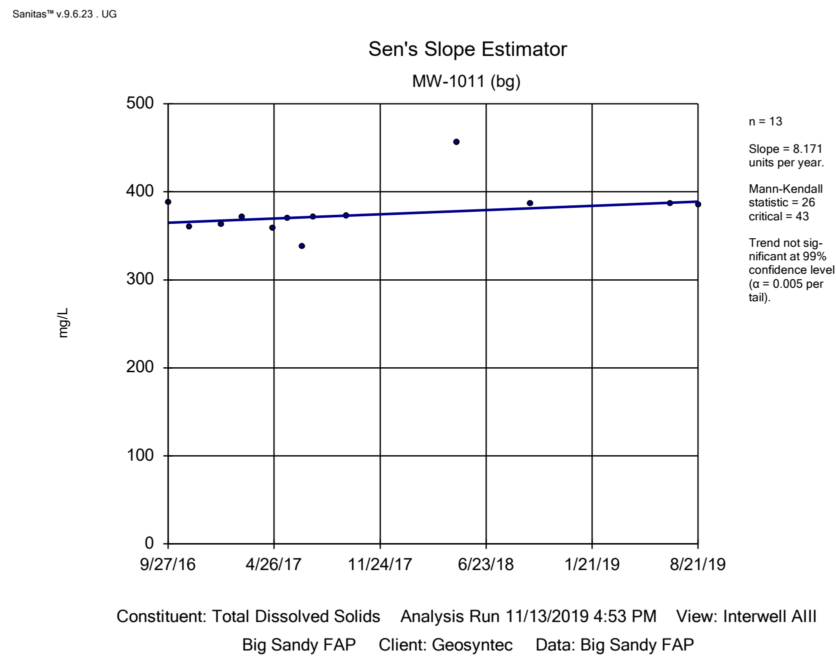


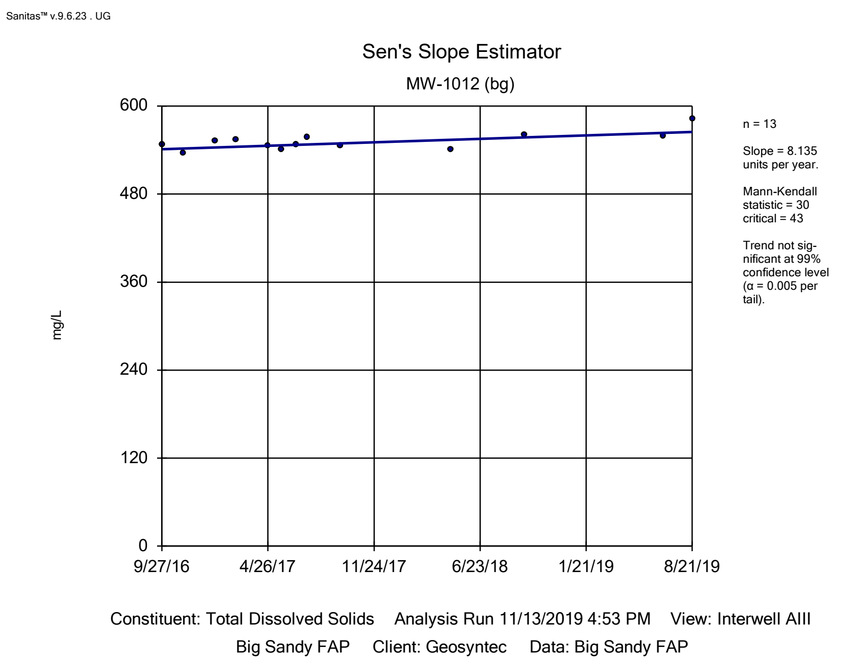
Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1203 (bg)
mg/L
40
32
24
16
8
0
9/26/16
4/25/17
11/23/17
6/23/18
1/21/19
8/21/19
n = 14
Slope = 2.446 units per year.
Mann-Kendall statistic = 43 critical = 48
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Sulfate Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

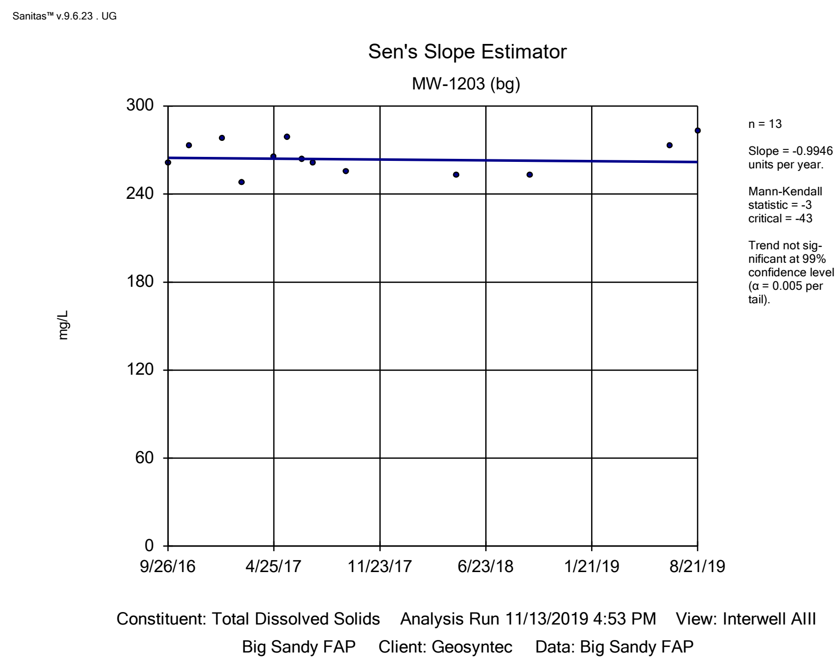


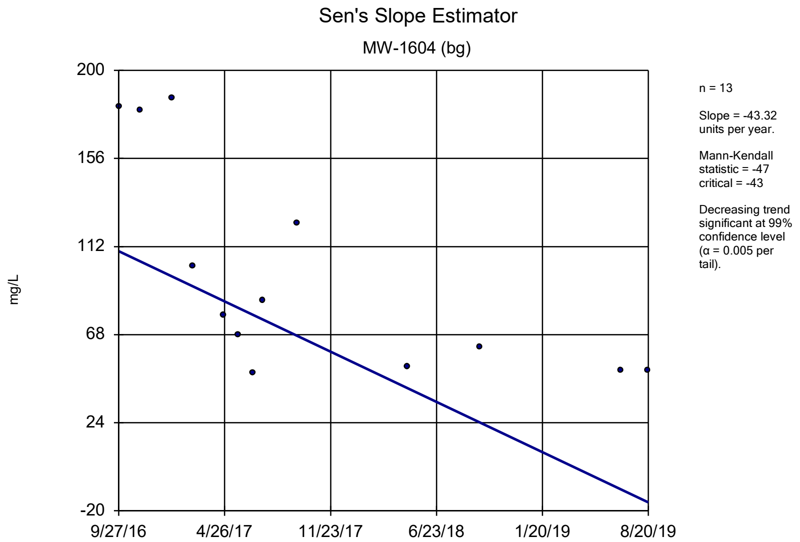
Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1604 (bg)
mg/L
20
16
12
8
4
0
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 14
Slope = 0.3322 units per year.
Mann-Kendall statistic = 8 critical = 48
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Sulfate Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1605 (bg)
mg/L
8
6.4
4.8
3.2
1.6
0
9/27/16
4/26/17
11/23/17
6/23/18
1/20/19
8/20/19
n = 14
Slope = 0.1036 units per year.
Mann-Kendall statistic = 6 critical = 48
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Sulfate Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1011 (bg)
mg/L
500
400
300
200
100
0
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
n = 13
Slope = 8.171 units per year.
Mann-Kendall statistic = 26 critical = 43
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Total Dissolved Solids Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

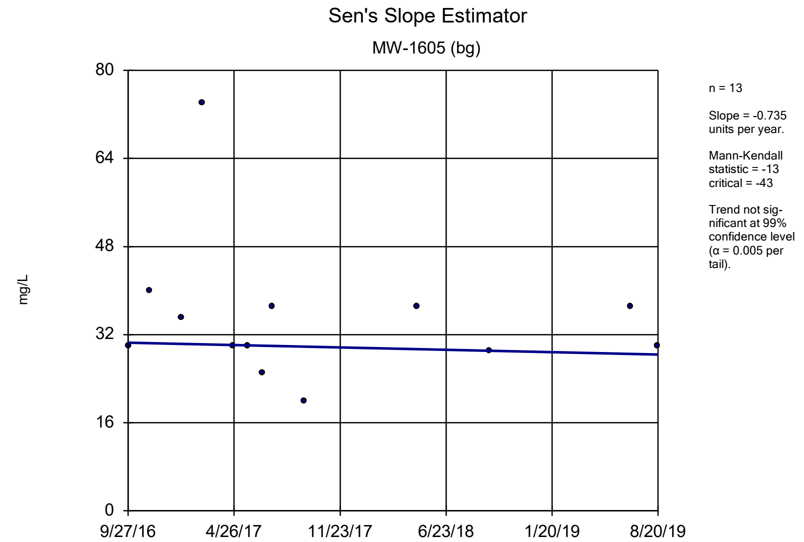

Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1012 (bg)
mg/L
600
480
360
240
120
0
9/27/16
4/26/17
11/24/17
6/23/18
1/21/19
8/21/19
n = 13
Slope = 8.135 units per year.
Mann-Kendall statistic = 30 critical = 43
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Total Dissolved Solids Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP


Sanitas™ v.9.6.23 . UG
Sen's Slope Estimator
MW-1203 (bg)
mg/L
300
240
180
120
60
0
9/26/16
4/25/17
11/23/17
6/23/18
1/21/19
8/21/19
n = 13
Slope = -0.9946 units per year.
Mann-Kendall statistic = -3 critical = -43
Trend not significant at 99% confidence level (α = 0.005 per tail).
Constituent: Total Dissolved Solids Analysis Run 11/13/2019 4:53 PM View: Interwell AIII
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP



Constituent: Total Dissolved Solids   Analysis Run 11/13/2019 4:53 PM   View: Interwell AIII
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG



Constituent: Total Dissolved Solids   Analysis Run 11/13/2019 4:53 PM   View: Interwell AIII
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Interwell Prediction Limit Summary

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP Printed 12/8/2019, 12:37 PM

Constituent	Well	Upper Lim.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron (mg/L)	n/a	0.2198	n/a	60	0.1004	0.06485	1.667	None	No	0.001504	Param 1 of 2
Calcium (mg/L)	n/a	105	n/a	60	n/a	n/a	0	n/a	n/a	0.0005231	NP (normality) 1 of 2
Chloride (mg/L)	n/a	8.214	n/a	60	0.7208	0.7519	0	None	ln(x)	0.001504	Param 1 of 2
Fluoride (mg/L)	n/a	0.82	n/a	59	n/a	n/a	16.95	n/a	n/a	0.0005451	NP (normality) 1 of 2
Sulfate (mg/L)	n/a	106	n/a	60	n/a	n/a	0	n/a	n/a	0.0005231	NP (normality) 1 of 2
Total Dissolved Solids (mg/L)	n/a	561	n/a	55	n/a	n/a	0	n/a	n/a	0.0006329	NP (normality) 1 of 2

Tolerance Limit Summary Table

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 12/8/2019, 12:39 PM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony (mg/L)	n/a	0.0012	65	n/a	n/a	16.92	n/a	n/a	0.03565	NP Inter(normality)
Arsenic (mg/L)	n/a	0.0289	65	n/a	n/a	0	n/a	n/a	0.03565	NP Inter(normality)
Barium (mg/L)	n/a	0.1112	65	0.2269	0.05328	0	None	sqrt(x)	0.05	Inter
Beryllium (mg/L)	n/a	0.000149	65	n/a	n/a	20	n/a	n/a	0.03565	NP Inter(normality)
Cadmium (mg/L)	n/a	0.00014	65	n/a	n/a	29.23	n/a	n/a	0.03565	NP Inter(normality)
Chromium (mg/L)	n/a	0.00291	64	n/a	n/a	0	n/a	n/a	0.03752	NP Inter(normality)
Cobalt (mg/L)	n/a	0.004471	65	0.09396	0.03539	0	None	x^(1/3)	0.05	Inter
Combined Radium 226 + 228 (pCi/L)	n/a	4.329	61	1.115	0.4795	0	None	sqrt(x)	0.05	Inter
Fluoride (mg/L)	n/a	0.82	69	n/a	n/a	15.94	n/a	n/a	0.02904	NP Inter(normality)
Lead (mg/L)	n/a	0.001644	65	-8.754	1.172	1.538	None	ln(x)	0.05	Inter
Lithium (mg/L)	n/a	0.03	65	n/a	n/a	16.92	n/a	n/a	0.03565	NP Inter(Cohens/xform)
Mercury (mg/L)	n/a	0.000013	65	n/a	n/a	84.62	n/a	n/a	0.03565	NP Inter(NDs)
Molybdenum (mg/L)	n/a	0.002717	63	0.02751	0.01226	14.29	None	sqrt(x)	0.05	Inter
Selenium (mg/L)	n/a	0.0004	65	n/a	n/a	20	n/a	n/a	0.03565	NP Inter(normality)
Thallium (mg/L)	n/a	0.0005	65	n/a	n/a	29.23	n/a	n/a	0.03565	NP Inter(normality)

BIG SANDY FAP GWPS				
Constituent Name	**MCL**	**CCR-Rule**	**Background**	**GWPS**
Antimony, Total (mg/L)	0.006		0.0012	0.006
Arsenic, Total (mg/L)	0.01		0.029	0.029
Barium, Total (mg/L)	2		0.11	2
Beryllium, Total (mg/L)	0.004		0.00015	0.004
Cadmium, Total (mg/L)	0.005		0.00014	0.005
Chromium, Total (mg/L)	0.1		0.0029	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.0045	0.006
Combined Radium, Total (pCi/L)	5		4.33	5
Fluoride, Total (mg/L)	4		0.82	4
Lead, Total (mg/L)	0.015		0.0016	0.015
Lithium, Total (mg/L)	n/a	0.04	0.03	0.04
Mercury, Total (mg/L)	0.002		0.000013	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.0027	0.1
Selenium, Total (mg/L)	0.05		0.0004	0.05
Thallium, Total (mg/L)	0.002		0.0005	0.002

**Grey cell indicates Background is higher than MCL.*

**MCL = Maximum Contaminant Level*

Confidence Interval Summary Table - Significant Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/13/2019, 5:04 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Beryllium (mg/L)	**MW-1603**	**0.02113**	**0.01717**	**0.004**	**Yes**	**13**	**0**	**ln(x)**	**0.01**	**Param.**
Cobalt (mg/L)	**MW-1603**	**0.09574**	**0.08882**	**0.006**	**Yes**	**13**	**0**	**No**	**0.01**	**Param.**
Combined Radium 226 + 228 (pCi/L)	**MW-1603**	**7.379**	**5.125**	**5**	**Yes**	**13**	**0**	**sqrt(x)**	**0.01**	**Param.**
Lithium (mg/L)	**MW-1603**	**0.2395**	**0.2064**	**0.04**	**Yes**	**13**	**0**	**No**	**0.01**	**Param.**

Confidence Interval Summary Table - All Results

Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/13/2019, 5:04 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Antimony (mg/L)	MW-1601	0.0001808	0.00008223	0.006	No	13	0	No	0.01	Param.
Antimony (mg/L)	MW-1602	0.0001079	0.0000567	0.006	No	13	0	No	0.01	Param.
Antimony (mg/L)	MW-1603	0.0001	0.00002	0.006	No	13	69.23	No	0.01	NP (normality)
Antimony (mg/L)	MW-1606	0.0001	0.00001	0.006	No	13	38.46	No	0.01	NP (normality)
Antimony (mg/L)	MW-1607	0.0001	0.00001	0.006	No	12	16.67	No	0.01	NP (normality)
Arsenic (mg/L)	MW-1601	0.005148	0.003552	0.029	No	13	0	x^3	0.01	Param.
Arsenic (mg/L)	MW-1602	0.00315	0.00042	0.029	No	13	0	No	0.01	NP (normality)
Arsenic (mg/L)	MW-1603	0.001448	0.001196	0.029	No	13	0	No	0.01	Param.
Arsenic (mg/L)	MW-1606	0.001181	0.0009342	0.029	No	13	0	No	0.01	Param.
Arsenic (mg/L)	MW-1607	0.0236	0.00759	0.029	No	13	0	No	0.01	NP (normality)
Barium (mg/L)	MW-1601	0.07711	0.0593	2	No	13	0	No	0.01	Param.
Barium (mg/L)	MW-1602	0.0565	0.05071	2	No	13	0	No	0.01	Param.
Barium (mg/L)	MW-1603	0.01302	0.01091	2	No	13	0	No	0.01	Param.
Barium (mg/L)	MW-1606	0.9574	0.7975	2	No	13	0	No	0.01	Param.
Barium (mg/L)	MW-1607	0.04152	0.0304	2	No	13	0	No	0.01	Param.
Beryllium (mg/L)	MW-1601	0.0001	0.000007	0.004	No	13	30.77	No	0.01	NP (normality)
Beryllium (mg/L)	MW-1602	0.0001	0.0001	0.004	No	12	100	No	0.01	NP (NDs)
Beryllium (mg/L)	**MW-1603**	**0.02113**	**0.01717**	**0.004**	**Yes**	**13**	**0**	**ln(x)**	**0.01**	**Param.**
Beryllium (mg/L)	MW-1606	0.0001	0.00001	0.004	No	13	23.08	No	0.01	NP (Cohens/xfrm)
Beryllium (mg/L)	MW-1607	0.0001	0.00001	0.004	No	13	23.08	No	0.01	NP (normality)
Cadmium (mg/L)	MW-1601	0.00005	0.000006	0.005	No	13	30.77	No	0.01	NP (normality)
Cadmium (mg/L)	MW-1602	0.00005	0.000009	0.005	No	13	38.46	No	0.01	NP (normality)
Cadmium (mg/L)	MW-1603	0.0008604	0.0007627	0.005	No	13	0	No	0.01	Param.
Cadmium (mg/L)	MW-1606	0.00006	0.000009	0.005	No	13	69.23	No	0.01	NP (normality)
Cadmium (mg/L)	MW-1607	0.00005	0.000007	0.005	No	13	69.23	No	0.01	NP (normality)
Chromium (mg/L)	MW-1601	0.0005774	0.0002839	0.1	No	13	0	sqrt(x)	0.01	Param.
Chromium (mg/L)	MW-1602	0.0008322	0.0004718	0.1	No	13	0	No	0.01	Param.
Chromium (mg/L)	MW-1603	0.0009362	0.0006605	0.1	No	13	0	No	0.01	Param.
Chromium (mg/L)	MW-1606	0.001232	0.0003284	0.1	No	13	0	sqrt(x)	0.01	Param.
Chromium (mg/L)	MW-1607	0.0005913	0.0003283	0.1	No	13	0	No	0.01	Param.
Cobalt (mg/L)	MW-1601	0.001471	0.0007934	0.006	No	13	0	No	0.01	Param.
Cobalt (mg/L)	MW-1602	0.0001894	0.00002336	0.006	No	13	0	ln(x)	0.01	Param.
Cobalt (mg/L)	**MW-1603**	**0.09574**	**0.08882**	**0.006**	**Yes**	**13**	**0**	**No**	**0.01**	**Param.**
Cobalt (mg/L)	MW-1606	0.0006699	0.000133	0.006	No	13	0	sqrt(x)	0.01	Param.
Cobalt (mg/L)	MW-1607	0.001465	0.001265	0.006	No	13	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1601	1.8	0.8373	5	No	13	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1602	1.347	0.6791	5	No	13	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	**MW-1603**	**7.379**	**5.125**	**5**	**Yes**	**13**	**0**	**sqrt(x)**	**0.01**	**Param.**
Combined Radium 226 + 228 (pCi/L)	MW-1606	3.45	2.629	5	No	13	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	MW-1607	2.205	0.4784	5	No	13	0	x^(1/3)	0.01	Param.
Fluoride (mg/L)	MW-1601	0.3178	0.2208	4	No	14	0	No	0.01	Param.
Fluoride (mg/L)	MW-1602	0.1509	0.1062	4	No	14	0	No	0.01	Param.
Fluoride (mg/L)	MW-1603	1.087	0.9246	4	No	15	0	No	0.01	Param.
Fluoride (mg/L)	MW-1606	0.2212	0.1816	4	No	14	0	No	0.01	Param.
Fluoride (mg/L)	MW-1607	0.07218	0.05496	4	No	14	0	No	0.01	Param.
Lead (mg/L)	MW-1601	0.000143	0.000024	0.015	No	13	15.38	No	0.01	NP (Cohens/xfrm)
Lead (mg/L)	MW-1602	0.0000937	0.00002931	0.015	No	13	0	x^(1/3)	0.01	Param.
Lead (mg/L)	MW-1603	0.007008	0.004328	0.015	No	13	0	No	0.01	Param.
Lead (mg/L)	MW-1606	0.0007209	0.0001065	0.015	No	13	7.692	x^(1/3)	0.01	Param.
Lead (mg/L)	MW-1607	0.0002867	0.00006618	0.015	No	13	7.692	x^(1/3)	0.01	Param.
Lithium (mg/L)	MW-1601	0.03552	0.02082	0.04	No	13	7.692	No	0.01	Param.
Lithium (mg/L)	MW-1602	0.01247	0.004973	0.04	No	13	7.692	No	0.01	Param.
Lithium (mg/L)	**MW-1603**	**0.2395**	**0.2064**	**0.04**	**Yes**	**13**	**0**	**No**	**0.01**	**Param.**
Lithium (mg/L)	MW-1606	0.01922	0.003217	0.04	No	13	15.38	No	0.01	Param.
Lithium (mg/L)	MW-1607	0.01767	0.0006933	0.04	No	13	15.38	No	0.01	Param.
Mercury (mg/L)	MW-1601	0.000005	0.000005	0.002	No	13	100	No	0.01	NP (NDs)
Mercury (mg/L)	MW-1602	0.000005	0.000002	0.002	No	13	46.15	No	0.01	NP (normality)
Mercury (mg/L)	MW-1603	0.000005	0.000002	0.002	No	13	92.31	No	0.01	NP (NDs)
Mercury (mg/L)	MW-1606	0.000005	0.000003	0.002	No	13	76.92	No	0.01	NP (NDs)
Mercury (mg/L)	MW-1607	0.000005	0.000004	0.002	No	13	92.31	No	0.01	NP (NDs)
Molybdenum (mg/L)	MW-1601	0.02957	0.01422	0.1	No	13	0	No	0.01	Param.
Molybdenum (mg/L)	MW-1602	0.002534	0.001463	0.1	No	13	0	No	0.01	Param.
Molybdenum (mg/L)	MW-1603	0.005	0.00004	0.1	No	13	23.08	No	0.01	NP (normality)
Molybdenum (mg/L)	MW-1606	0.00091	0.00054	0.1	No	12	0	No	0.01	NP (normality)
Molybdenum (mg/L)	MW-1607	0.0007841	0.0004993	0.1	No	12	0	No	0.01	Param.
Selenium (mg/L)	MW-1601	0.0002	0.00008	0.05	No	13	0	No	0.01	NP (normality)
Selenium (mg/L)	MW-1602	0.001958	0.001012	0.05	No	13	0	No	0.01	Param.
Selenium (mg/L)	MW-1603	0.006407	0.004485	0.05	No	13	0	No	0.01	Param.

Confidence Interval Summary Table - All Results

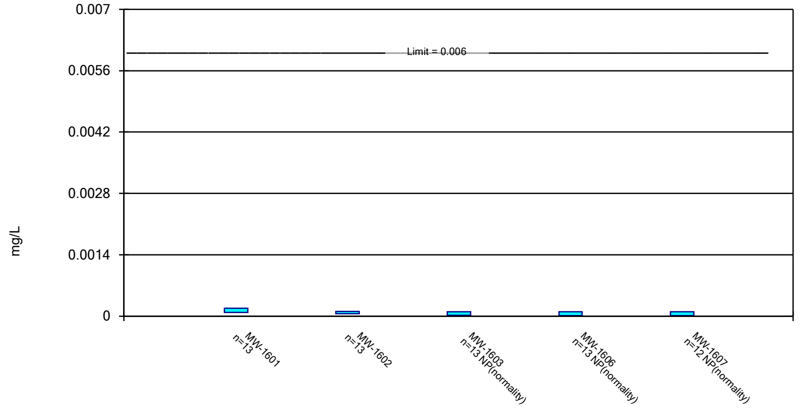
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP   Printed 11/13/2019, 5:04 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Selenium (mg/L)	MW-1606	0.0002	0.00005	0.05	No	13	0	No	0.01	NP (normality)
Selenium (mg/L)	MW-1607	0.0002	0.00008	0.05	No	12	0	No	0.01	NP (normality)
Thallium (mg/L)	MW-1601	0.0005	0.00001	0.002	No	13	23.08	No	0.01	NP (normality)
Thallium (mg/L)	MW-1602	0.0005	0.00001	0.002	No	13	23.08	No	0.01	NP (normality)
Thallium (mg/L)	MW-1603	0.001603	0.001249	0.002	No	13	0	No	0.01	Param.
Thallium (mg/L)	MW-1606	0.0005	0.00002	0.002	No	13	46.15	No	0.01	NP (normality)
Thallium (mg/L)	MW-1607	0.0005	0.00002	0.002	No	13	23.08	No	0.01	NP (normality)

Sanitas™ v.9.6.23 . 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.

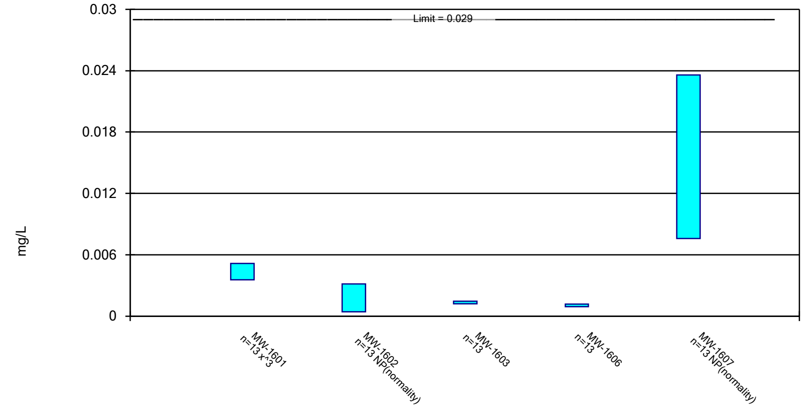


Constituent: Antimony   Analysis Run 11/13/2019 5:02 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . 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.

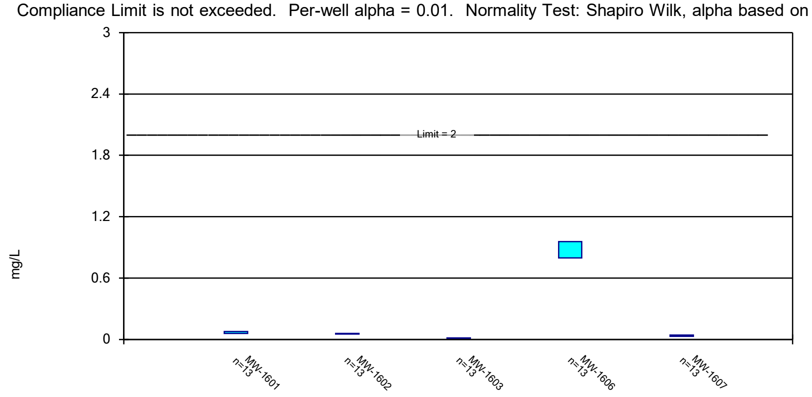


Constituent: Arsenic   Analysis Run 11/13/2019 5:02 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Parametric Confidence Interval

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

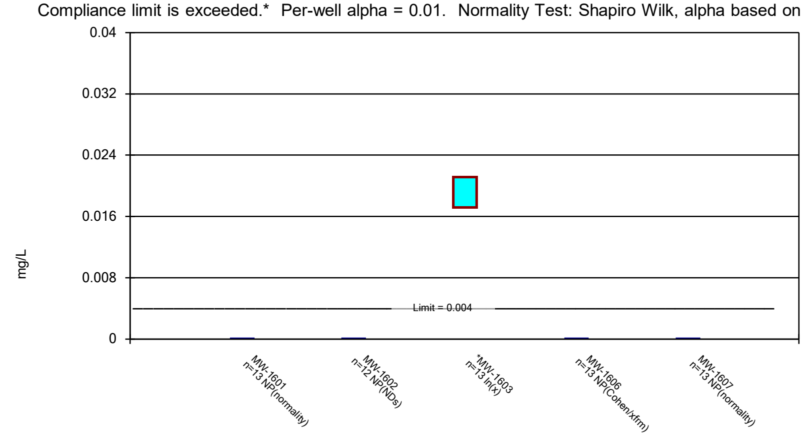


Constituent: Barium   Analysis Run 11/13/2019 5:02 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Parametric and Non-Parametric (NP) Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

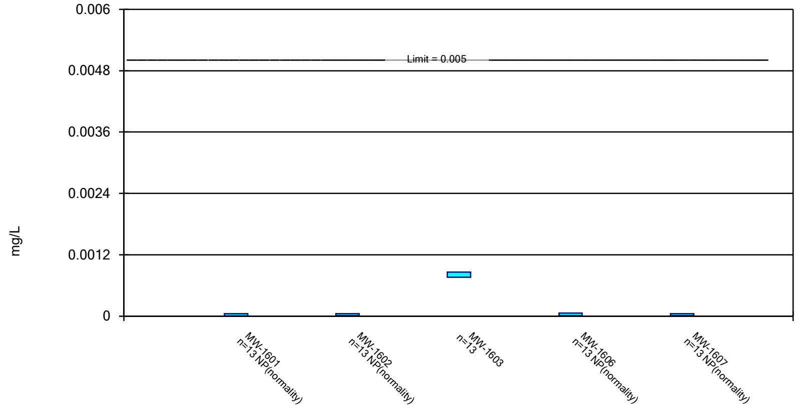


Constituent: Beryllium   Analysis Run 11/13/2019 5:02 PM   View: Interwell AIV
Big Sandy FAP   Client: Geosyntec   Data: Big Sandy FAP

Sanitas™ v.9.6.23 . 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.



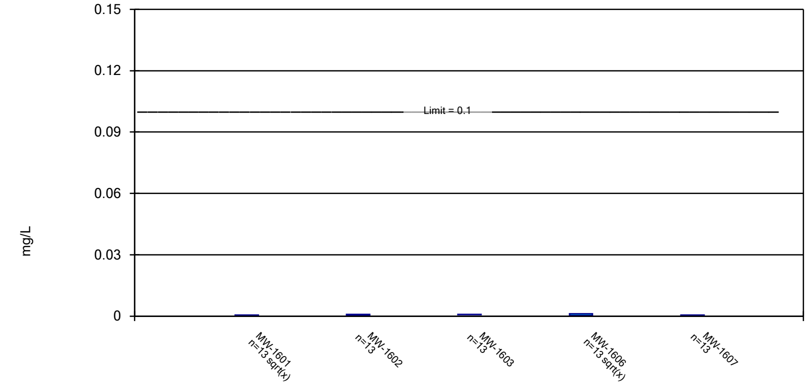
Constituent: Cadmium Analysis Run 11/13/2019 5:02 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Parametric Confidence Interval

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



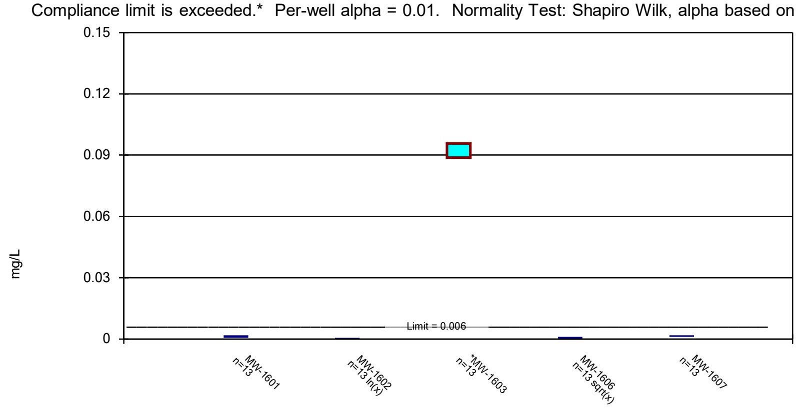
Constituent: Chromium Analysis Run 11/13/2019 5:02 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



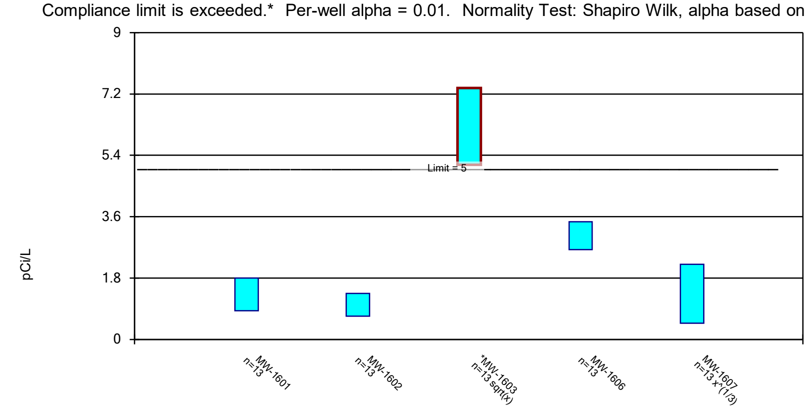
Constituent: Cobalt Analysis Run 11/13/2019 5:02 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



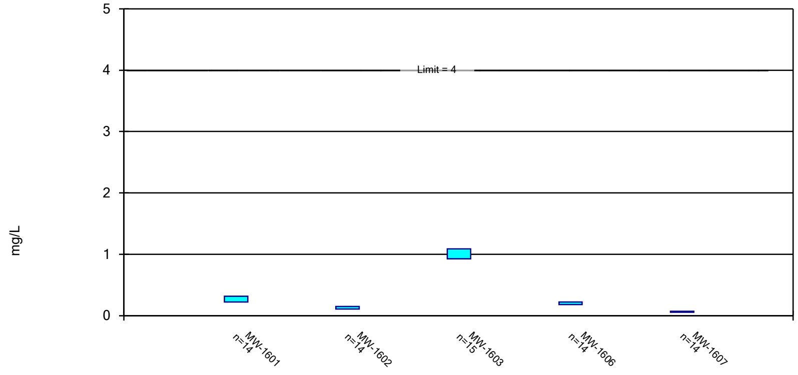
Constituent: Combined Radium 226 + 228 Analysis Run 11/13/2019 5:03 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Parametric Confidence Interval

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

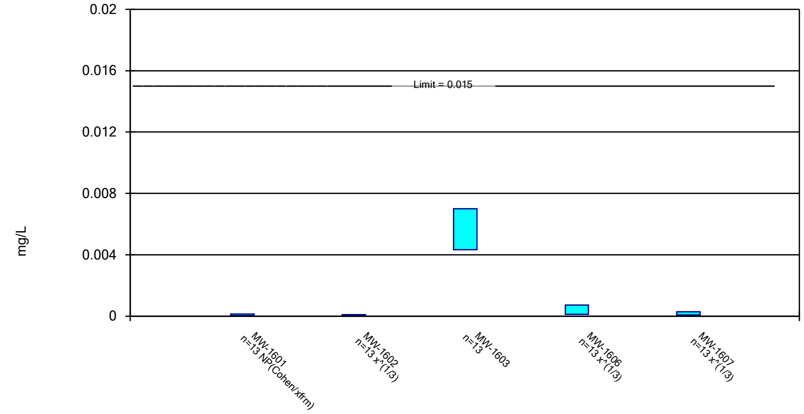


Constituent: Fluoride Analysis Run 11/13/2019 5:03 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . 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.

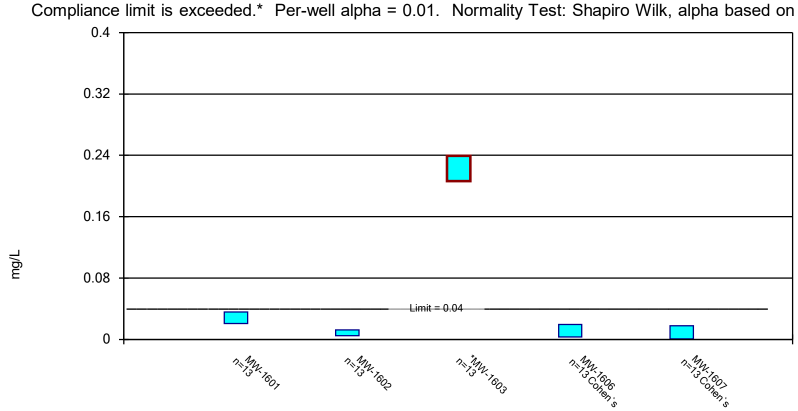


Constituent: Lead Analysis Run 11/13/2019 5:03 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Parametric Confidence Interval

Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.

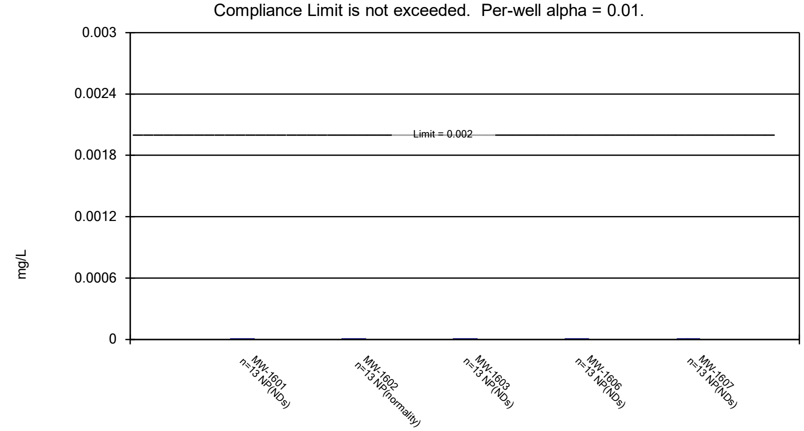


Constituent: Lithium Analysis Run 11/13/2019 5:03 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . UG

Non-Parametric Confidence Interval

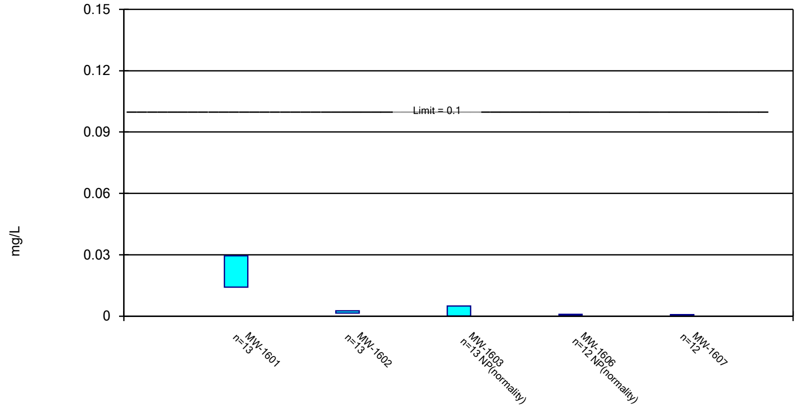
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Mercury Analysis Run 11/13/2019 5:03 PM View: Interwell AIV
Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

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.



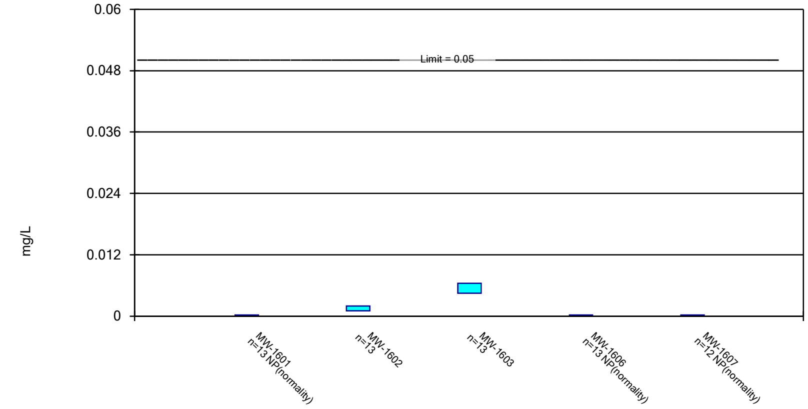
Constituent: Molybdenum Analysis Run 11/13/2019 5:03 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . 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.



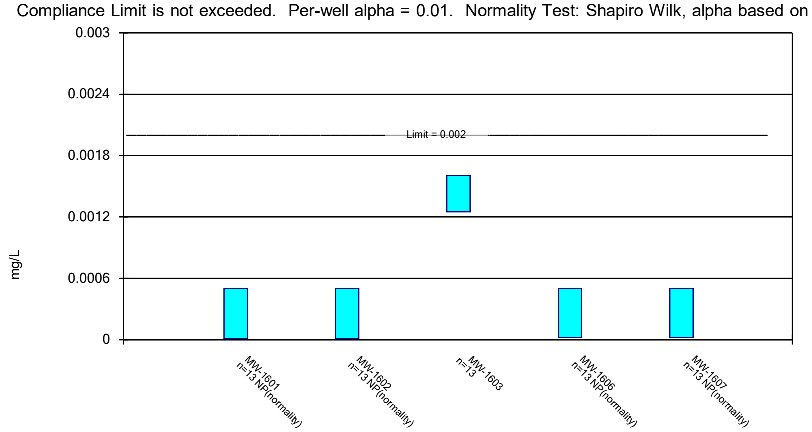
Constituent: Selenium Analysis Run 11/13/2019 5:03 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

Sanitas™ v.9.6.23 . 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: Thallium Analysis Run 11/13/2019 5:03 PM View: Interwell AIV

Big Sandy FAP Client: Geosyntec Data: Big Sandy FAP

APPENDIX 4—Alternative Source Demonstration Reports

The February 2019, September 2019, and January 2020 alternative source demonstration reports concluding that an alternative source for the SSLs observed during 2019 assessment monitoring at the CCR unit was identified follow.

Alternative Source Demonstration Report for Beryllium, Cobalt and Lithium

Big Sandy Fly Ash Pond
Louisa, Kentucky

Prepared for:

American Electric Power

Prepared by:

EHS Support

February 2019

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Acronyms

AEP	American Electric Power, Kentucky Power Company
ASD	alternative source demonstration
BSFAP	Big Sandy Fly Ash Pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
ft bgs	feet below ground surface
KGS	Kentucky Geological Survey
Ma	Million-Year-Old
mg/L	milligrams per liter
MSL	mean sea level
SSI	statistically significant increases
SSL	statistically significant levels
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

Certification by Qualified Professional Engineer

I certify that the alternative source demonstration (ASD) conducted and presented within this report is accurate and appropriate for evaluating the groundwater monitoring data for the Big Sandy Fly Ash Pond Coal Combustion Residual (CCR) management area associated with the Big Sandy Power Plant located in Louisa, Kentucky. This ASD meets the requirements of the United States Environmental Protection Agency CCR Rule defined at 40 Code of Federal Regulations 257.95(g)(3)(ii).

Jonathan Patrick Waddell

Printed Name of Licensed Professional Engineer

STATE OF KENTUCKY
JONATHAN
PATRICK
WADDELL
31526
LICENSED
PROFESSIONAL ENGINEER

Signature

31526	KY	02/06/2019
License Number	Licensing State	Date

1 Introduction

EHS Support LLC ("EHS Support") was retained by American Electric Power, Kentucky Power Company ("AEP") to conduct an alternative source demonstration (ASD) investigation at the Big Sandy Fly Ash Pond (BSFAP) associated with the Big Sandy Power Plant located in Louisa, Kentucky (**Figure 1**). This ASD has been prepared per the requirements of the United States Environmental Protection Agency (USEPA) Coal Combustion Residual (CCR) Rule (40 Code of Federal Regulations [CFR] 257.95).

1.1 Objectives

AEP's objective for this ASD investigation is to assess groundwater monitoring data collected in compliance with the CCR Rule as allowed under paragraph 40 CFR 257.95(g)(3)(ii) of the CCR Rule. This part of the rule allows AEP to determine whether the source(s) for statistically significant exceedances of beryllium, cobalt, and lithium reported from groundwater monitoring well MW-1603 are associated with the CCR unit, or if the statistically significant increases (SSIs) resulted from an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

1.2 Lines of Evidence

This ASD for the BSFAP has been conducted to evaluate potential alternate sources or reasons for the statistically significant exceedances of beryllium, cobalt, and lithium within monitoring well MW-1603. A potential alternate source is evident, based on the following lines of evidence:

- Lack of exceedances and increasing trends of primary indicators of CCR
- BSFAP water concentrations are lower than those of the corresponding constituent observed in groundwater
- Major ion chemistry does not indicate mixing between BSFAP water and groundwater

For the purposes of this ASD investigation, constituents were identified that would serve as a primary indicator for coal ash leachate. A primary indicator must meet **both** of the following criteria:

- Constituent that typically has high concentration in leachate, relative to background, such that it is expected to have elevated concentration in the event of a release.
- Constituent is not reactive and has high mobility in groundwater such that it is expected to be at the leading edge of the plume, meaning that it will have elevated concentrations relative to background across the entire area of the plume.

As boron and sulfate are primary indicators for coal ash leachate (Electric Power Research Institute [EPRI], 2012) they were evaluated in this ASD investigation. Other potential indicators that were evaluated in this ASD investigation include chloride, potassium, sodium, fluoride, molybdenum, and bromide.

2 Project Background

AEP has complied with the CCR Rule requirements relative to investigation, assessment, and monitoring of the BSFAP, as discussed in the following sections.

2.1 Site Location and History

The Big Sandy Power Plant is located along the Kentucky side of the Big Sandy River that forms the border with West Virginia (**Appendix A**, **Figure A1**). The CCRs formerly generated by the Big Sandy Plant were disposed in a nearby existing surface impoundment or BSFAP (**Figure A1** and **Figure 1**). The BSFAP is located approximately 1.3 miles northwest of the Big Sandy Power Plant. The BSFAP formerly received wet-sluiced fly ash from the coal burning process as well as bottom ash that was periodically transferred from the Bottom Ash Ponds next to the main plant area. AEP permanently ceased burning coal at the Big Sandy Power Plant in November 2015 and transitioned to a 278-megawatt natural-gas-fired unit. As a result, CCR wastes are no longer being generated and operation of the BSFAP for disposal of CCR waste has ceased. The BSFAP was formed by constructing a dam across the valley of Horseford Creek and is contained by a dam called the Main Dam, located at the north end of the Horseford Creek valley (**Appendix A**, **Figure A1**).

2.2 Site Geology

The topography of the Louisa (Lawrence County), Kentucky area is dependent on the subsurface geology. Harder bedrock formations of marine limestone and shales of the Conemaugh Formation make up the hills while the creek and river bottoms cut through the weaker bedrock of sandstones, siltstones, and coal seams of the upper portion of the Breathitt Group. The creek and river bottoms consist of clays, silts, sands and gravels of alluvial and lacustrine deposits. As shown on **Figure A1 (Appendix A)**, the BSFAP now fills one of these creek bottoms that contains Horseford Creek, which is a tributary of Blaine Creek.

The bedrock around the site consists of Pennsylvanian-aged (Carboniferous) fluvial deposits that were deposited in the Central Appalachian Basin. Both the Kentucky Geological Survey (KGS) and the United States Geological Survey (USGS) have painstakingly mapped the coal deposits associated with the 300-million-year-old (Ma) stream deposits to understand the extent and thicknesses for mining in both Kentucky and West Virginia. This section provides a summary of the more extensive literature of the bedrock found in the referenced sources.

The Central Appalachian Basin is a part of an extensive foreland basin formed behind the Appalachian Orogenic Belt that received eroded sediments from those mountains within the larger fluvial systems. The regional stratigraphic framework is provided on **Figure A2 (Appendix A)**. The sediments in this portion of the basin received sediments in the Devonian period (~400 Ma) to the Permian period (~275 Ma). Over geologic time, the Permian-aged sediments and most of the Pennsylvanian-aged sediments that were formed into hard-rock were removed through erosion. The bedrock in the area, currently exposed, is middle to upper Pennsylvanian as shown on the KGS geological map (**Figure A2** of **Appendix A)**. The oldest formation exposed is the upper portions of the Breathitt Group. The Breathitt Group consists of several different formations as provided on **Figure A2 (Appendix A)**. Only the uppermost formation, the Princess Formation, is exposed at the surface in this area around Louisa.

The upper 200 feet of the Princess Formation consist primarily of yellowish- to dark-gray, ripple-bedded siltstone with some interbedded light-yellowish to yellowish-gray, fine to medium-grained, cross-bedded sandstone and medium to dark-gray, finely-bedded shale (Ward, 1978). This sequence has a series of interbedded coal beds that have been numbered within the Princess Formation by the KGS and USGS, as shown on **Figure A3 (Appendix A)** and summarized by Rice and Hiett (1994). The KGS has documented and photographed the uppermost of these coal beds (Princess Number 7 and Princess Number 8) along Highway 23 as shown on **Figure A4 (Appendix A).** Along Highway 23, the Princess Number 8 was documented to be an elevation of 650 feet, 660 feet, 632 feet, and 670 feet mean sea level (MSL). These elevations are shown on **Figure A4 (Appendix A).** One of the marker beds associated with the Princess Formation at the Princess Number 5 coal seam is the Vanport Limestone (Ward, 1978) or also called the Kilgore Flint Member (Ruppert et al., 2010). This 3-foot brownish-gray, very fossiliferous, limestone is also a source of sideritic ironstone.

The USGS has analyzed the Princess Number 9 coal in other states for geochemistry at over 3,700 locations (Ruppert et al., 2000). In Pennsylvania and West Virginia, the Princess Number 9 coal is identified as the Upper Freeport Coal Bed. The thickness of this coal bed is not usually mineable in Northeastern Kentucky. The coal is medium-sulfur bituminous coal that has relatively high sulfur concentrations in relation to the surrounding rock. USGS reports in Ruppert et al., (2000) that the coal itself has metal concentrations including beryllium, cadmium, cobalt, lead, nickel, arsenic, and selenium. Maps of the beryllium, cobalt and lead concentrations from the coal are provided on **Figure A5-A** and **A5-B (Appendix A).**

The uppermost coal bed, Princess Number 9, has been designated as the top of the Breathitt Group's Princess formation and the bottom of the overlying Conemaugh Formation. The bottom 100 feet of the formation that is exposed in the hills in the area is a yellowish- to yellowish-gray, calcareous, lenticular, siltstone with some light yellowish-gray, fine-grained to coarse grained, massive, cross-bedded sandstone (Ward, 1978).

The Brush Creek Limestone Member, another marker bed used by the KGS and USGS, is at the top of this 100-foot thick sequence of the Conemaugh Formation. This 2-foot-thick olive- to yellowish-gray, not very fossiliferous, marine limestone is used to determine the "structure" of these Upper Pennsylvanian-aged sediments. The KGS has mapped this marker bed due to the presence of coal at the top of the limestone in the region (**Figure A4, Appendix A**). Using the elevation of the Brush Creek Limestone Member (structural contours) as shown on **Figure A6** (**Appendix A**), the limestone is dipping towards the north as are the rest of the strata of the Conemaugh Formation and Breathitt Group into a very large regional syncline system called the Allegheny Synclinorium (or the Parkersburg Syncline in West Virginia) as shown on **Figure A6** (**Appendix A**) from Chesnut (1992). The Conemaugh Formation above the Brush Creek Limestone Member, that makes up the top of the hills in the area, is primarily a yellowish-gray to dusky-yellow and maroon shale with some interbedded yellowish-gray to dusky-yellow, slightly calcareous, siltstones and sandstones (Ward, 1978).

The stream and river valleys of Blaine Creek, Big Sandy River, and the smaller tributary valleys contain Quaternary-aged alluvium that are largely floodplain deposits consisting of silts, sands, gravels, and clays (Ward, 1978). Per the recent work of Erjavec (2018), the hillsides of the valleys were inundated by lake water from pro-glacial Lake Tight when the pre-glacial Teays River was blocked by advancing early Wisconsian-aged glaciers (**Figure A7**, **Appendix A**). This lake lasted approximately 10,000 years and reached an elevation of 900 feet MSL (Bailey et al., 2014). As shown on **Figure A7** (**Appendix A**), only the very top of the hills in the area are over 900 feet so they were islands in this lake the size of present-day Lake Erie. Lake Tight deposited varved (rhythmites) lacustrine gray and black silts and clays called the Minford Clay Member of the Teays Formation. The Minford Clay has been studied extensively in Ohio and nearby in West Virginia by Bonnett et al. (1991). Bonnett et al. (1991) discussed in length the amount of iron oxides like hematite and chlorite and weathered products like kaolinite, limonite, and goethite in these varved sediments.

2.3 Groundwater Monitoring Network Evaluation

On behalf of AEP, Geosyntec Consultants, Inc. ("Geosyntec") conducted an assessment of the groundwater monitoring network in the uppermost aquifer associated with the BSFAP (Geosyntec, 2016). Geosyntec determined that the hydrostratigraphy in the vicinity of the BSFAP is characterized by an interconnected water-bearing system comprised of Pennsylvanian-aged bedrocks of the Breathitt Group and the Quaternary alluvium. The Conemaugh Formation and Breathitt Group consists of sandstones, siltstones, shale, and coal that may grade laterally and vertically into one another. The Quaternary alluvium deposits include sandy lean clay to silty sand and gravel at the bottom of the Horseford Creek valley and the floodplain of the Blaine Creek. Based on these hydrogeologic conditions, Geosyntec defined the interconnected water-bearing system of the fractured bedrock and alluvium as the uppermost aquifer for the BSFAP CCR unit. This determination was based on the presence of groundwater in numerous monitoring wells screened in the water- bearing units, the recovery of these wells during pumping and development, and a potentiometric surface generally consistent with site topography and surface water elevations.

To assess the upper water-bearing aquifer, Geosyntec identified the groundwater monitoring network as consisting of 10 groundwater monitoring wells to provide detection monitoring in the uppermost aquifer (fractured bedrock and alluvium) (Geosyntec, 2016). Of these 10 wells, six (MW-1011, MW-1012, MW-1203, MW-1601, MW-1602, and MW-1603) are screened in fractured sandstone and shale layers of the Breathitt formation. The remaining four monitoring wells (MW-1604 through MW-1607) are screened in the alluvium. The location of each groundwater monitoring well within the uppermost aquifer is shown in **Figure 2**.

Three of the monitoring wells (MW-1011, MW-1012, and MW-1203) screened in bedrock were installed on the hillside slopes upgradient of the BSFAP to support background monitoring. Three monitoring wells (MW-1601, MW-1602, and MW-1603) installed in bedrock are located downgradient of the BSFAP and used for compliance monitoring. Two monitoring wells (MW-1604 and MW-1605) screened in alluvium are used for background monitoring; while two other monitoring wells (MW-1606 and MW-1607), screened in alluvium and located below the Main Dam are used for compliance monitoring.

The monitoring well network is monitoring different portions of the Pennsylvanian-aged sequence of sandstones, siltstones, and coals as shown in **Table 2-1**.

As bedrock monitoring well MW-1603 is the focus of this ASD, the boring log provided in **Appendix B** shows the boring containing alternating sequences of yellowish-brown sandstones and bluish-gray to black shales (beginning at 13 feet below ground surface [ft bgs] and extending to the bottom of the boring at 39.5 ft bgs) that are indicative of the upper portion of the Princess Formation discussed in the previous section. Within the screened interval (22 to 32 ft bgs), a description of the shale at a depth of

24 to 25 ft bgs was “intensely fractured, black, wet, nearly all organic matter; slight coaly texture.” This elevation corresponds with the measurements by the KGS of the elevation of the Princess Number 8 coal discussed in **Section 2.2**. A coal or “organic material” also was logged in three other monitoring wells (MW-1608, MW-1609, MW-1610) in the network (shown on **Table 2-1**) at the same approximate elevation between 630 and 650 feet that matches the KGS measurements. Three monitoring wells did not document any coal in this section (MW-1601, MW-1602, MW-1611) and four wells were installed below this coal layer in the sedimentary sequence (MW-1604, MW-1605, MW-1606, MW-1607).

Table 2-1 Screened Interval of Monitoring Wells

Well/Boring	Surface Elevation (feet MSL)	Screened Interval (feet MSL)	Coal or “Organics” Description at 632-650 feet?
MW-1601	713.8	646.8-636.8	No coal logged
MW-1602	711.6	632.1-622.1	No coal logged
MW-1603	673.2	651.2-641.2	Yes at a depth of ~25 feet (Elevation of 648 feet)
MW-1604	553.1	513.1-503.1	---
MW-1605	554.4	538.9-528.9	---
MW-1606	551	513.1-503.1	---
MW-1607	542.2	518.7-508.7	---
MW-1608	716.2	606.6-596.6	Yes at depths of ~74 feet (Elevation of 642 feet), ~ 75.3 to 76.6 feet (Elevation of 641 to 640 feet) and ~ 83.5 to 84 feet (Elevation of 633 to 632 feet)
MW-1609	~728	---	Yes at a depth of ~79 feet (Elevation of 649 feet)
MW-1610	~716	---	Yes at a depth of ~81 feet (Elevation of 635 feet)
MW-1611	~711	606-596	No coal logged

--- = Boring advanced below the coal interval
Not logged = Boring log has no description of coal or “organics” in the interval between 632 to 650 MSL
~ = Approximate
MSL = mean sea level

Geosyntec determined that the groundwater monitoring well network described above meets the requirements of 40 CFR §257.91, as it consists of a sufficient number of wells installed at the appropriate locations and depths to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater and groundwater passing the waste boundary of the BSFAP.

2.4 Groundwater Monitoring

AEP has conducted groundwater monitoring of the uppermost aquifer to meet the requirements of the CCR Rules. These monitoring activities generally included the following activities:

- Collection of groundwater samples and analysis for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan* (AEP and EHS Support, October 2016)
- Completion of validation tests for groundwater data, including tests for completeness, valid values, transcription errors, and consistent units
- Establishment of background data for each Appendix III and Appendix IV constituent
- Initiation of detection monitoring sampling and analysis
- Evaluation of the groundwater data using a statistical process in accordance with 40 CFR 257.93, which was prepared, certified, and posted to AEP's CCR website in April 2017 in AEP's *Statistical Analysis Plan* (Geosyntec, January 2017). The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).
- Initiation of assessment monitoring sampling and analysis
- Completion of statistical data evaluation and determination of groundwater protection standards

3 Alternative Source Demonstration Requirements

3.1 CCR Rule Applicability

Per the CCR Rule at 40 CFR 257.94(e)(2), "The owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The owner or operator must complete the written demonstration within 90 days of detecting a statistically significant increase over background levels to include obtaining a certification from a qualified professional engineer verifying the accuracy of the information in the report."

3.2 Alternative Source Demonstration

Potential causes that may support the ASD may include, but are not limited to, sampling causes (ASD Type I), laboratory causes (ASD Type II), statistical evaluation causes (TYPE III) and/or natural variation causes (Type IV). This ASD for the BSFAP will be focused on assessing whether Type IV natural variations in groundwater could be the cause of statistically significant exceedances of beryllium, cobalt, and lithium reported from groundwater monitoring well MW-1603.

3.3 Water Monitoring Results

The constituents discussed below will typically provide the information required:

- The constituents listed in **Table 1** are analyzed in groundwater to identify primary indicators for potential leachate and to assess potential effects from the BSFAP leachate.
- Major ion concentrations (alkalinity, chloride, sulfate, calcium, magnesium, potassium, and sodium) in leachate and groundwater are used to evaluate whether downgradient groundwater chemistry remains representative of background groundwater chemistry. Major ion chemistry can also be used to evaluate natural variability due to seasonal changes or other causes.
- Field turbidity in groundwater is an indicator of the presence of suspended solids that may contribute to elevated concentrations of constituents monitored in unfiltered samples under the CCR Rule.
- pH in leachate and groundwater provides information on chemical reactions and mobility in groundwater.
- Dissolved oxygen, oxidation reduction potential (ORP), and iron and manganese in groundwater are all indicators of redox conditions. Changes in redox can affect the chemical state and solubility of sulfate in addition to trace elements including arsenic and selenium. For example, under strongly reduced conditions (ORP less than –200 mV at pH 7), sulfate can be reduced to form hydrogen sulfide or it can precipitate as iron sulfide, arsenic reduces to the more mobile arsenite species, and selenium reduces to the low-mobility selenite species.

Groundwater monitored at a CCR unit for compliance with the CCR Rule is a compilation of the history of all sources of water comingling at that particular monitoring well. Different sources may contribute some of the same constituents, making source identification challenging. The identification and use of water quality “signatures” can be used as a tool for deciphering the similarity between potential sources and the water quality at a specific monitoring point.

4 Alternative Source Demonstration Assessment

As stated within **Section 1.2**, the primary indicators for CCR (coal ash leachate) impacts in groundwater are boron and sulfate. In addition to these two constituents, chloride will also be a primary indicator for this ASD. Other potential indicators that may be evaluated include potassium, sodium, fluoride, molybdenum, and bromide.

As identified in **Section 1.1**, elevated concentrations of beryllium, cobalt, and lithium have been reported in groundwater samples from monitoring well MW-1603. The water quality signatures for MW-1603 will be discussed within **Section 4.3** and compared to the water quality of the BSFAP.

EPRI (2012) describes three tiers of investigation for evaluation of water quality signatures to determine if elevated concentrations represent a release from a CCR facility. Conversely, these tools can also be used to evaluate whether or not sources other than CCR are contributing to groundwater quality degradation. The three tiers defined by EPRI (2012) are:

- Tier I: Trend Analysis and Statistics
- Tier II: Advanced Geochemical Evaluation Methods
- Tier III: Isotopic Analyses

The CCR Rule requires statistical analysis under detection monitoring and under assessment monitoring for the determination of SSIs or statistically significant levels (SSLs). Many of the primary and potential indicator constituents listed for coal ash (EPRI, 2017) are included in AEP's constituent list for the BSFAP groundwater monitoring programs, including the primary constituents boron and sulfate. If there is an SSI/SSL without a corresponding increase in a primary indicator constituent (boron and usually sulfate for coal ash), then this is a key line of evidence for an ASD.

4.1 Groundwater Data Analysis

4.1.1 Primary Indicators

Temporal plots for primary indicators boron, sulfate, and chloride reported in groundwater monitoring well MW-1603 are provided in **Figure 4-1** to **Figure 4-3**, respectively, with data for the BSFAP water presented for comparison.

The BSFAP water signature is plotted as a constant concentration in **Figure 4-1** to **Figure 4-12**. This sample was collected on October 19, 2017. As the BSFAP accepted fly ash prior to 1970, it is probable that BSFAP water quality has historically varied over time. However, since the BSFAP ceased accepting fly ash by 2016, the water quality is anticipated to be more stable; therefore, this October 2017 data provides a reasonable representation of current BSFAP conditions.

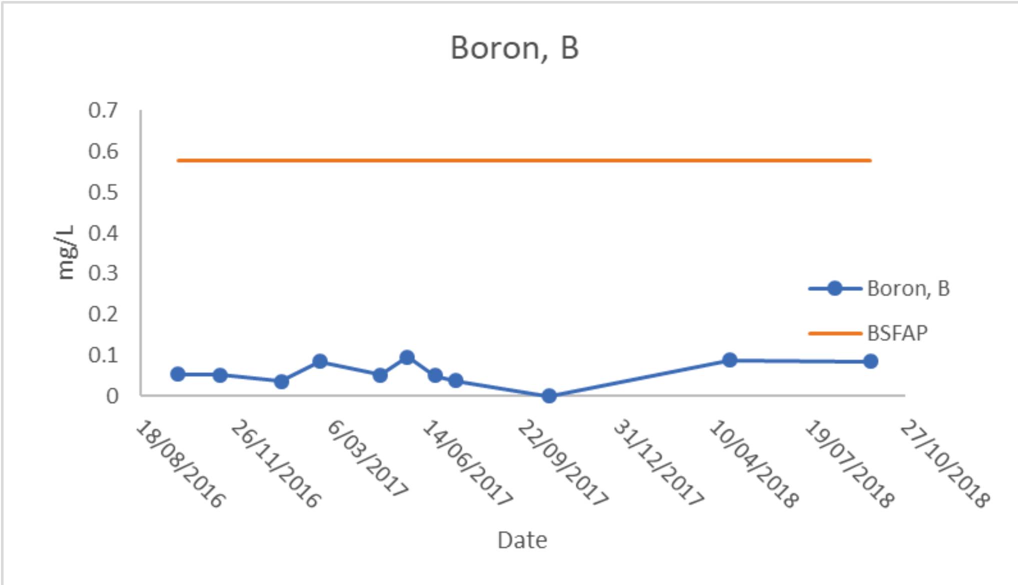


Figure 4-1 MW-1603 Boron concentrations

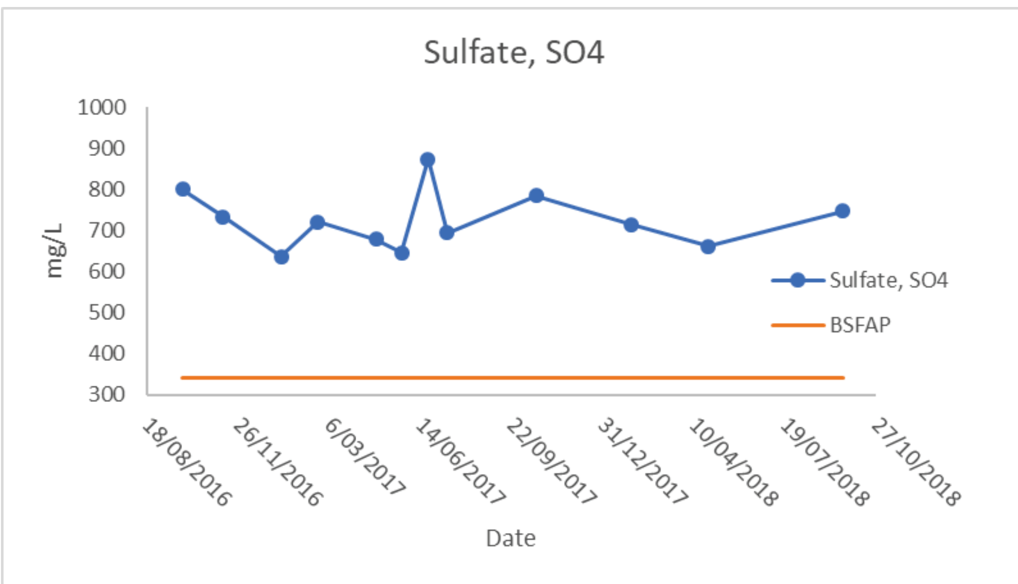


Figure 4-2 MW-1603 Sulfate

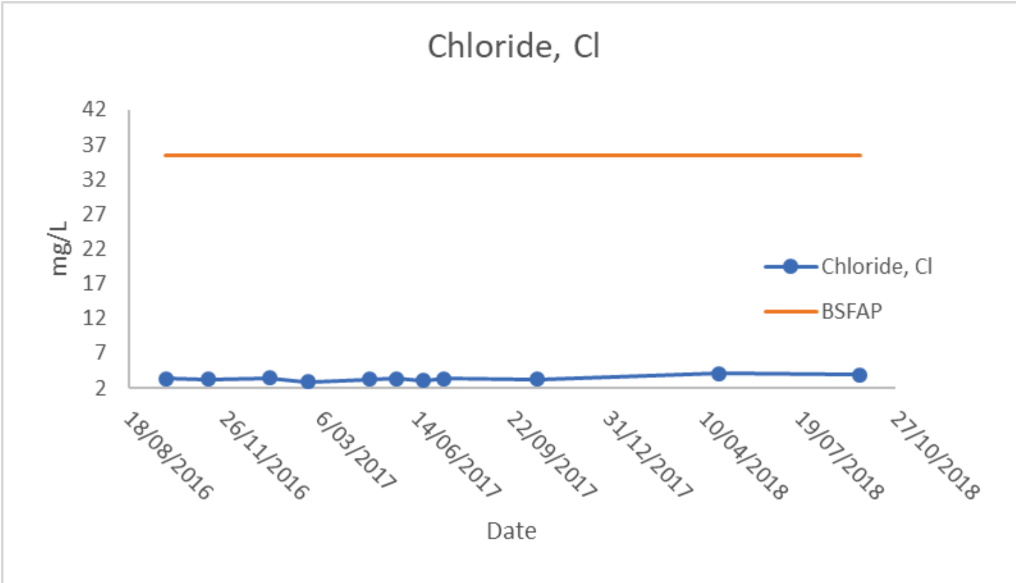


Figure 4-3 MW-1603 Chloride

Boron concentrations in MW-1603 have remained relatively constant, with some variability and only a slight increase from 0.054 milligrams per liter (mg/L) to 0.085 mg/L over the monitoring period (August 2016 through September 2018). Sulfate was initially reported as 801 mg/L and 747 mg/L in September 2016 and has shown a very slight decreasing trend during the monitoring period. Chloride concentrations in MW-1603 have also remained relatively constant, with some variability and only a slight increase over the monitoring period from an initial concentration of 3.37 mg/L (September 2016) to 3.92 mg/L (January 2018). Comparing the concentrations in groundwater to the BSFAP, boron and chloride are present at higher concentrations in the BSFAP than in groundwater, while sulfate is present at higher concentrations in groundwater than in the BSFAP.

4.1.2 Potential Indicators

Temporal plots for potential indicators bromide, fluoride, molybdenum, potassium and sodium reported in groundwater monitoring well MW-1603 are provided in **Figure 4-4** to **Figure 4-8**, respectively, with data for the BSFAP water presented for comparison.

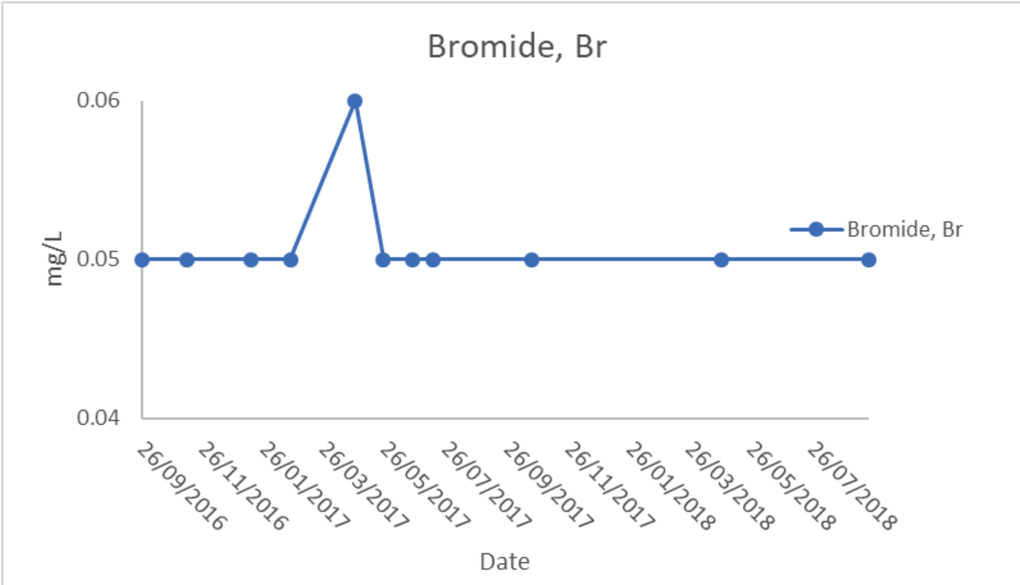


Figure 4-4 MW-1603 Bromide Concentrations[1]

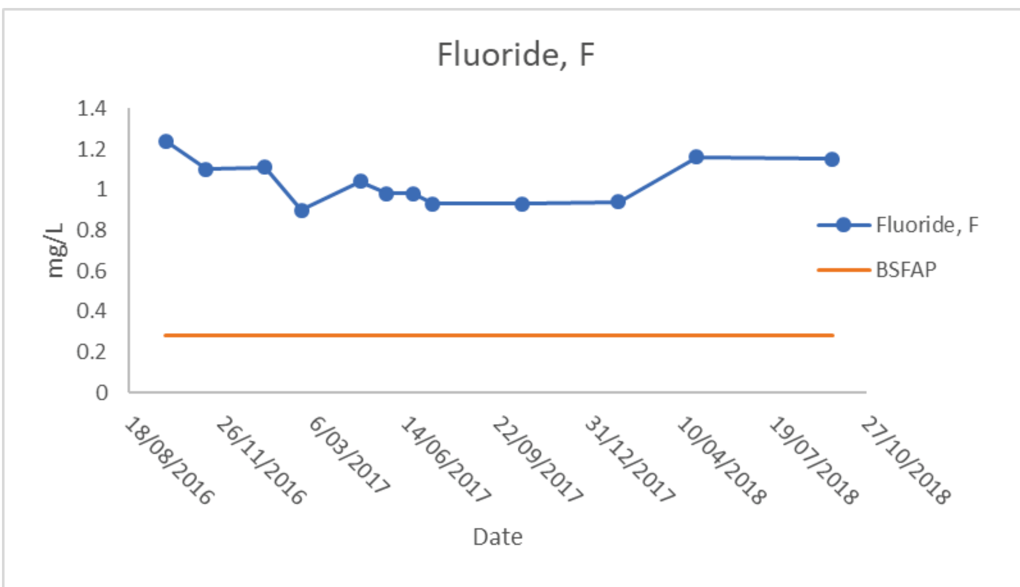


Figure 4-5 MW-1603 Fluoride Concentrations

[1] Bromide is below the level of reporting for the BSFAP water, with a detection level of <0.05 milligrams per liter.

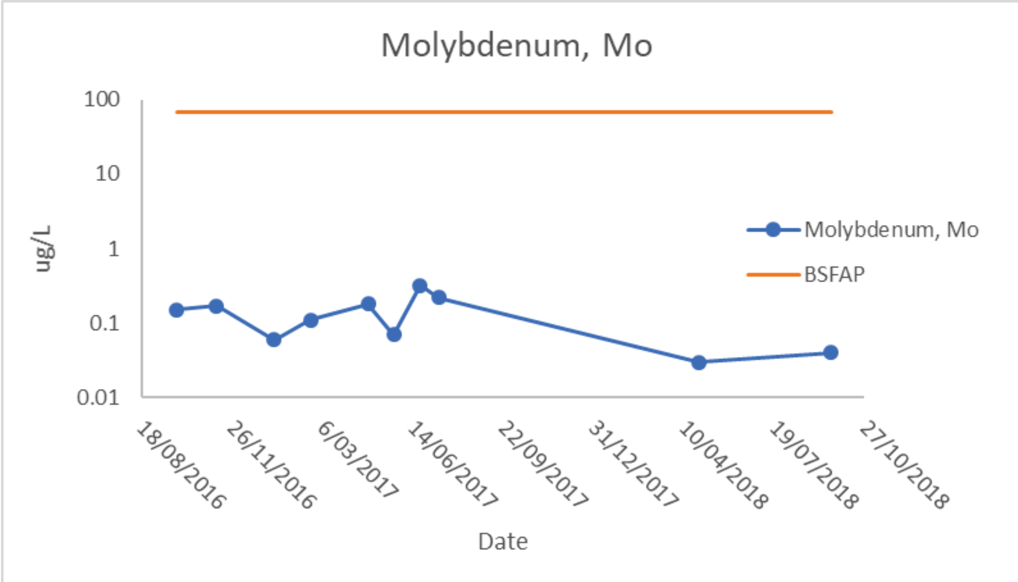


Figure 4-6 MW-1603 Molybdenum Concentrations

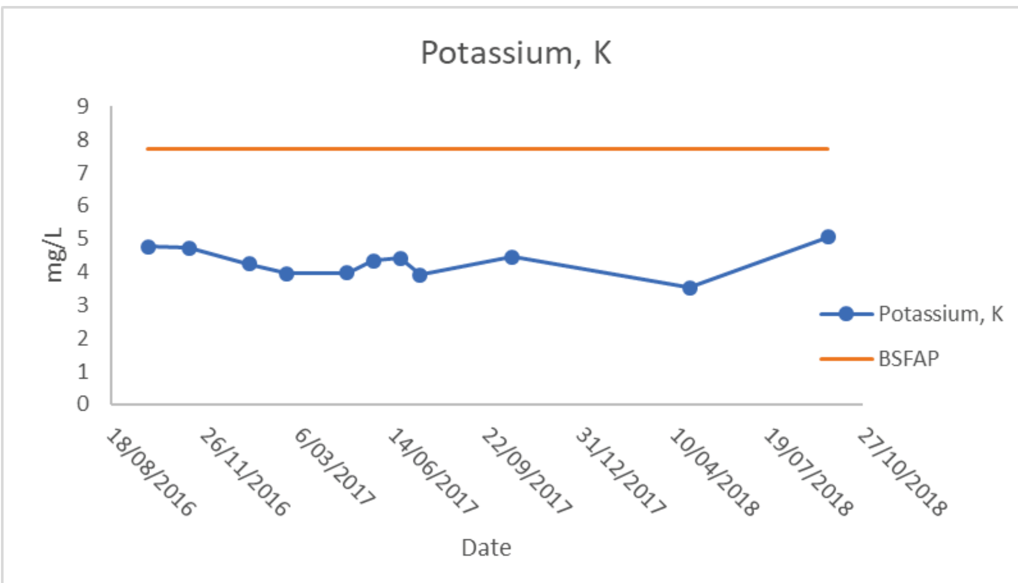


Figure 4-7 MW-1603 Potassium Concentrations

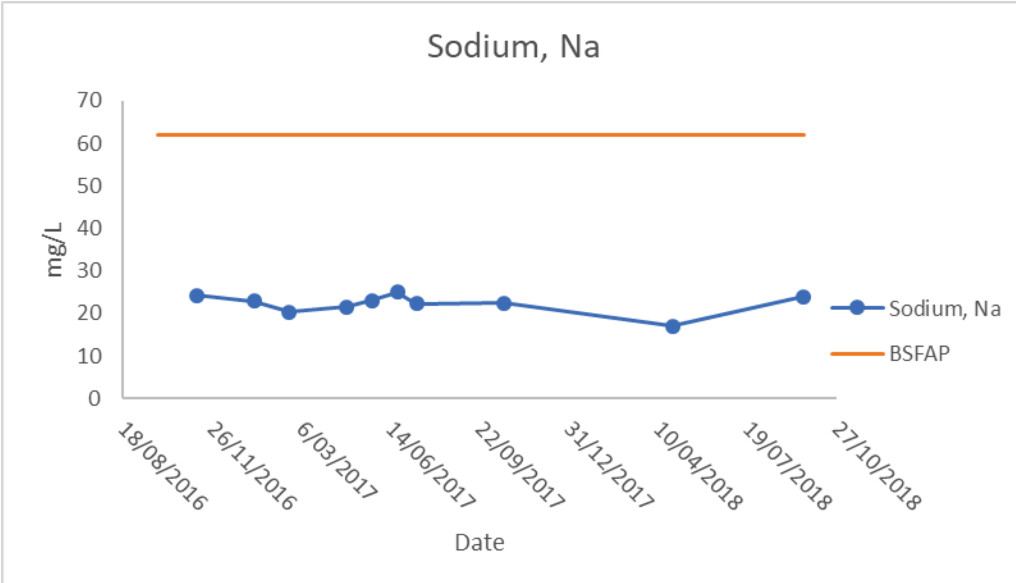


Figure 4-8 MW-1603 Sodium Concentrations

Molybdenum, potassium and sodium are present in groundwater at concentrations below the concentration within the BSFAP. Fluoride and bromide groundwater concentrations are more elevated than those within the BSFAP.

The comparison of pH between the BSFAP and MW-1603 is provided in **Figure 4-9** below. This illustrates the significant difference in pH between the pond water and groundwater, between approximately 3 to 5 standard units.

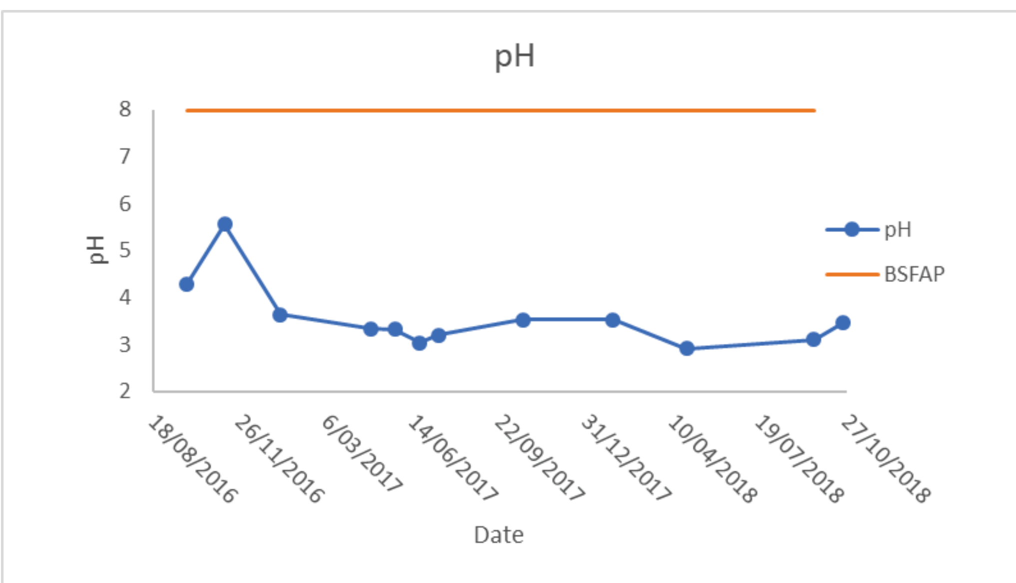


Figure 4-9 MW-1603 pH values

4.1.3 ASD Constituent Trends

Temporal plots for the elevated ASD constituents, beryllium, cobalt and lithium reported in groundwater monitoring well MW-1603, are provided in **Figure 4-10** to **Figure 4-12** below, with data for the BSFAP water presented for comparison.

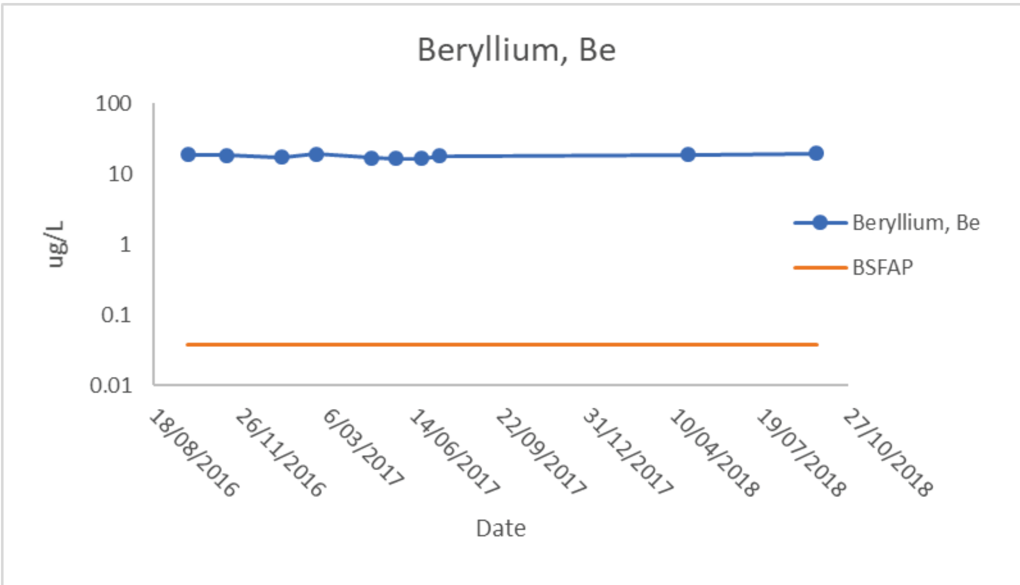


Figure 4-10 MW-1603 Beryllium Concentrations

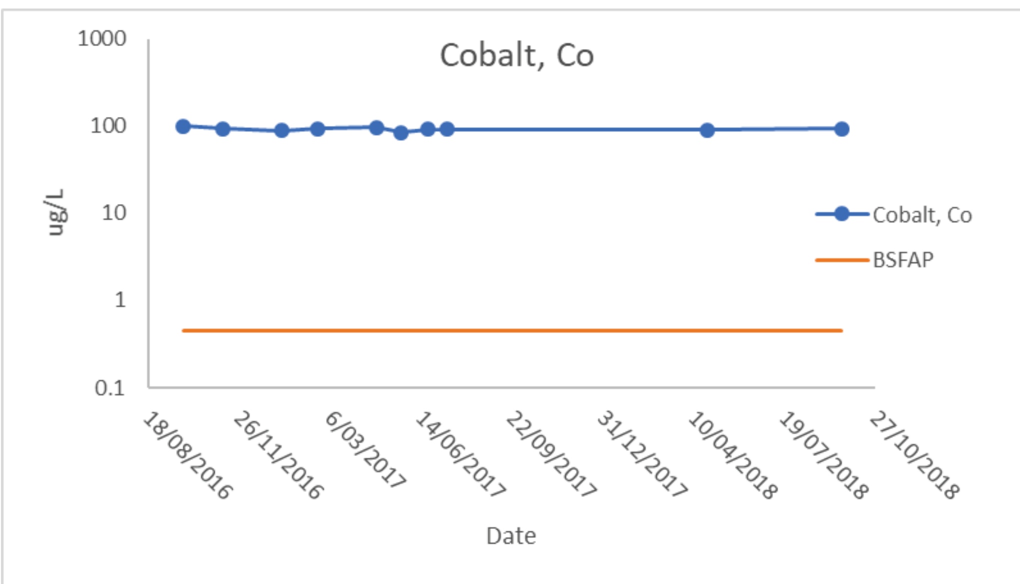


Figure 4-11 MW-1603 Cobalt Concentrations

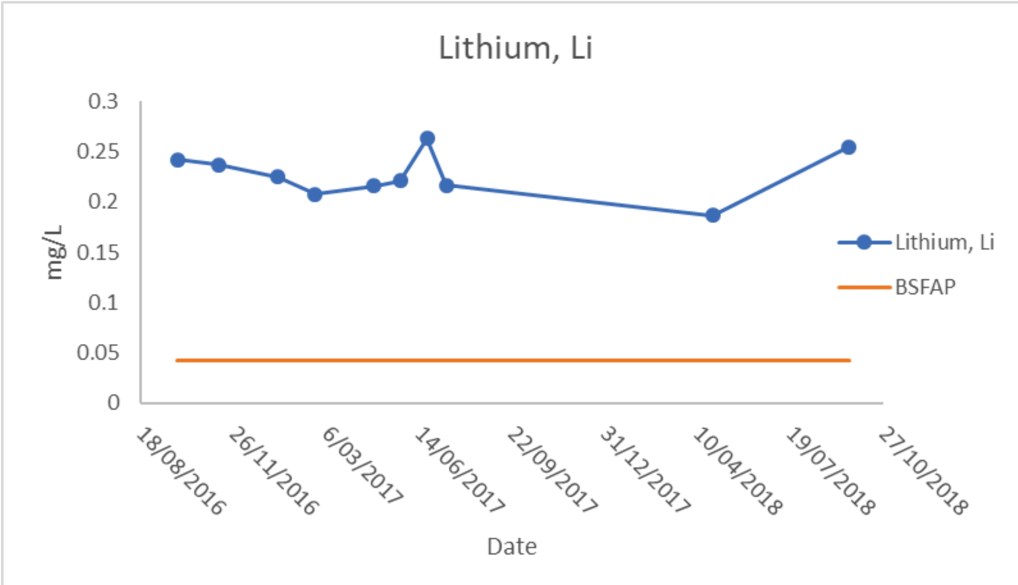


Figure 4-12 MW-1603 Lithium Concentrations

Beryllium, cobalt and lithium are more elevated in groundwater in comparison to BSFAP water indicating the source is not likely associated with the BSFAP.

4.1.4 Indicator Analysis Findings

Based on the temporal plots for primary indicators, potential indicators, and ASD constituents, it is considered unlikely that CCR constituents from the BSFAP are influencing water chemistry in surrounding groundwater. This is based on the primary indicator sulfate, potential indicators fluoride and bromide, and the ASD constituents beryllium, cobalt and lithium all being present at higher concentrations in groundwater compared to the BSFAP water. As the concentrations of these constituents in groundwater are higher, it is unlikely that there is a concentration gradient extending from the BSFAP into groundwater. It is more likely that an alternate source in groundwater is contributing to the higher concentrations observed in groundwater.

There are no consistently increasing trends within MW-1603 that suggest CCR constituents are migrating from the BSFAP into groundwater based on the analyses presented above.

4.2 Statistical Evaluation

A statistical evaluation of analytes was conducted graphically using box plots of the data (**Appendix C**). The box plots show that MW-1603 is statistically the same as the USGS reported regional background (Ruppert et al., 2000) in regards to arsenic, boron, calcium, chloride, chromium, fluoride, molybdenum, potassium, sodium, and strontium. The box plots also show a difference between MW-1603, BSFAP water and/or the regional background for pH, alkalinity, barium, cobalt, lead, lithium, magnesium, selenium, and sulfate. For beryllium, chromium, lead, lithium, molybdenum, and selenium no background values were provided by the USGS. It is likely that the acidic pH conditions, low alkalinity and high sulfate conditions at MW-1603 relative to regional background are driving dissolution of metals. These geochemical conditions within MW-1603, which are similar to acid mine drainage, are due to the presence of the Princess Coal Seams discussed in **Section 2.2** being intersected by the screened interval of this monitoring well. The combination of the well installation and sampling is allowing the saturated conditions within the coal seams to become aerobic which results in a lowering of pH and increase in metal solubility.

4.3 Tier II Evaluation - Geochemical Evaluation

A simple analysis of primary and potential indicator constituents (as performed in **Section 4.1**) may not provide the lines of evidence required for a robust ASD. It is recognized that naturally occurring indicator constituents and upgradient sources may have an additional influence on groundwater quality. Spatially across a site, groundwater quality may be observed to change due to chemical interactions with the aquifer matrix. EPRI (2012) recommended more sophisticated methods that can be used for multiple parameters over multiple locations. These include ion ratios and Piper plots.

Development of ion ratios involves first selecting two non-competing, non-sorbing constituents. The ratios of these constituents are then compared spatially across the site and a judgment is made as to whether the hydraulically downgradient groundwater is similar to the background groundwater quality.

The median concentrations of boron, chloride, and sulfate are provided in **Table 4-1**. These three constituents were selected based on the recommended indicator species in EPRI (2017). Bromide was not included within the assessment, as bromide was non-detect in the BSFAP water indicating its presence in groundwater was either naturally derived or from an off-site source.

One of the downgradient groundwater monitoring wells (MW-1606) reports similar chloride concentrations to the BSFAP and higher boron concentrations. As the boron concentrations are significantly higher (by a factor of 3) it is considered unlikely that boron in groundwater in the vicinity of this well is related to the BSFAP. Concentrations of boron, chloride, and sulfate reported from MW-1601 are elevated in comparison to other downgradient groundwater monitoring wells. In addition, as discussed above the groundwater quality reported from MW-1603 is unlikely to be influenced by the BSFAP.

Table 4-1 Median Concentrations of Boron, Chloride, and Sulfate

		Median Concentrations 2016 to 2018		
	Location ID	**Boron**	**Chloride**	**Sulfate**
Location	**Units**	**mg/L**	**mg/L**	**mg/L**
Source	**Fly Ash Pond**	0.58	35.4	342
Background	**MW-1011**	0.13 ±0.03	3 ±1	75 ±10
Background	**MW-1012**	0.18 ±0.03	1 ±0.1	37 ±1
Background	**MW-1203**	0.12 ±0.02	5 ±0.3	30 ±3
Downgradient	**MW-1601**	0.22 ±0.05	22 ±5	97 ±27
Downgradient	**MW-1602**	0.05 ±0.03	11 ±3	106 ±21
Downgradient	**MW-1603**	0.05 ±0.03	3 ±0.4	707 ±74

		Median Concentrations 2016 to 2018		
	Location ID	**Boron**	**Chloride**	**Sulfate**
Location	**Units**	**mg/L**	**mg/L**	**mg/L**
Background	**MW-1604**	0.04 ±0.02	2 ±2[2]	8 ±2
Background	**MW-1605**	0.06 ±0.03	1 ±0.4	5 ±1
Downgradient	**MW-1606**	1.81 ±0.07	31 ±0.2	56 ±2
Downgradient	**MW-1607**	0.19 ±0.04	4 ±4[3]	122 ±27

mg/L = milligrams per liter

Ion ratios have been calculated using boron, chloride, and sulfate as recommended in EPRI (2017) and are provided in **Table 4-2**.

Table 4-2 Ion Ratios

		Median Concentrations 2016 to 2018		
Location	**Location ID**	**Boron/Sulfate (x1000)**	**Boron/Chloride**	**Chloride/Sulfate**
Source	**Fly Ash Pond**	1.68	0.002	0.10
Background	**MW-1011**	1.42 ±0.43	0.05 ±0.01	0.04 ±0.01
Background	**MW-1012**	4.89 ±0.83	0.15 ±0.02	0.03 ±0.00
Background	**MW-1203**	3.87 ±0.8	0.02 ±0.01	0.17 ±0.02
Downgradient	**MW-1601**	2.21 ±0.38	0.01 ±0.00	0.21 ±0.04
Downgradient	**MW-1602**	0.51 ±0.27	0.01 ±0.00	0.10 ±0.01
Downgradient	**MW-1603**	0.07 ±0.03	0.02 ±0.01	0.01 ±0.00
Background	**MW-1604**	5.07 ±2.51	0.02 ±0.01	0.19 ±0.22
Background	**MW-1605**	8.37 ±6.41	0.06 ±0.03	0.17 ±0.09
Downgradient	**MW-1606**	31.86 ±1.29	0.06 ±0.00	0.56 ±0.01
Downgradient	**MW-1607**	1.61 ±0.63	0.06 ±0.02	0.03 ±0.05

Using the ion ratios of boron/sulfate, boron/chloride, and chloride/sulfate and comparing the values between the BSFAP, downgradient, and background groundwater monitoring wells, does not appear to show a conclusive outcome using all three ratios. Specifically, the ratios of the BSFAP are not consistently different from the groundwater ratios. MW-1603 ratios do show a difference by at least an order of magnitude, with the exception of the boron to chloride ratio. Therefore, based on this ion ratio analysis, it does not appear likely that MW-1603 has been impacted by CCR constituents from the BSFAP.

[2] Initial analysis concentrations are elevated in September and November 2016 which skews the dataset
[3] Initial analysis concentrations are elevated in September and November 2016 which skews the dataset

Piper plots are used to classify groundwater types based on the major ion ratios of calcium, magnesium, sodium (and potassium), alkalinity, chloride, and sulfate. They can be used to visually illustrate ion exchange and mixing between different water chemistries. Piper plots for individual wells are depicted in **Figure 3**.

Figure 4-13 illustrates the relationship between BSFAP and groundwater (background and downgradient). Most groundwaters are a bicarbonate water type (calcium and sodium) and the BSFAP is a calcium sulfate water type. This means: the predominant major ions in groundwater are calcium, sodium and bicarbonate; and calcium and sulfate are dominant in the BSFAP. Background groundwater monitoring well MW-1605 is mostly a sodium sulfate groundwater and downgradient wells MW-1603 and MW-1607 are calcium sulfate water types. It is unlikely that background well MW-1605 water quality is being influenced by CCR constituents as it is not in a downgradient receiving catchment. MW-1603 reports higher concentrations of sulfate than the BSFAP water and MW1607 does have a similar boron/sulfate ion ratio to the BSFAP water but boron/chloride and chloride/sulfate are not comparable. The groundwater water types suggest that mixing and ion exchange are occurring. This suggests that the varying lithologies within the screened sections of the individual monitoring wells are contributing to differing groundwater qualities identified in individual wells. When these coal seams are intersected and mixing of the waters occur, ion exchange occurs between the cations (sodium magnesium and calcium), as does possible dilution and precipitation of anions (alkalinity, chloride and sulfate).

It should be noted that MW-1601, MW-1602, and MW-1603 are bedrock wells which are screened within the Breathitt Group. MW-1604, MW-1605, MW-1606, and MW-1607 are alluvium wells that are screened within either the Horseford Creek or Blaine Creek Quaternary floodplain deposits.

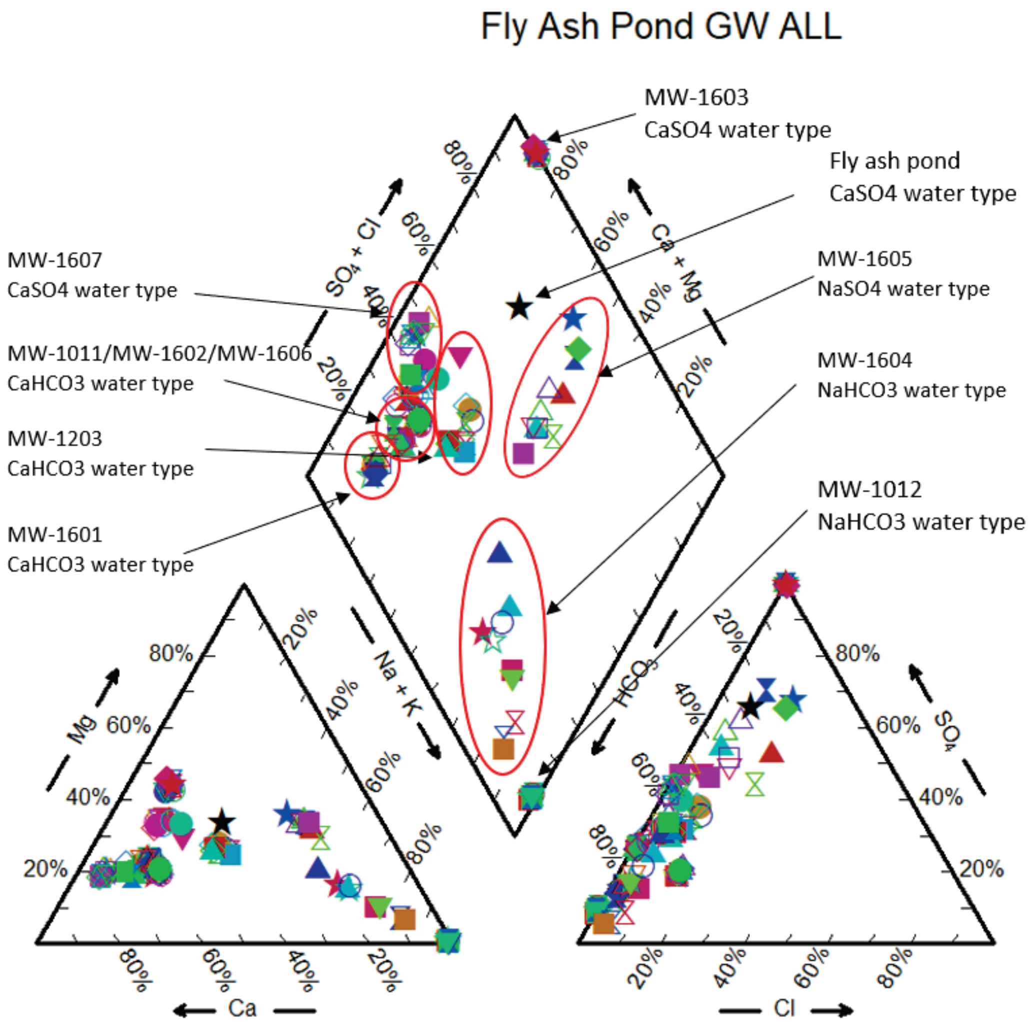


Figure 4-13 BSFAP and Groundwater Piper Plot

Stiff plots can also be used to illustrate major ion relationships. As discussed in EPRI (2017), coal ash leachates display characteristic Stiff plots (**Figure 4-14**). The Stiff plots for the groundwater samples appear to be representative of natural waters with the exception of MW-1603 (**Figure 4-15**). The Stiff plot for this location is very similar to the bituminous coal ash leachate in Figure 3-5 of the EPRI (2017) guidance (replicated below as **Figure 4-14**). This similarity is supported by the boring log for this well location, which reports the presence of, '…intensely fractured, black, wet, nearly all organic matter; slight coaly texture' horizon at the same elevation of the well screen (Geosyntec, 2016). The pH recorded from MW-1603 ranges from pH 2.91 to 5.56, with an average of 3.58, which is also indicative of potential influence from a coal matrix (Bigham and Cravotta, 2006).

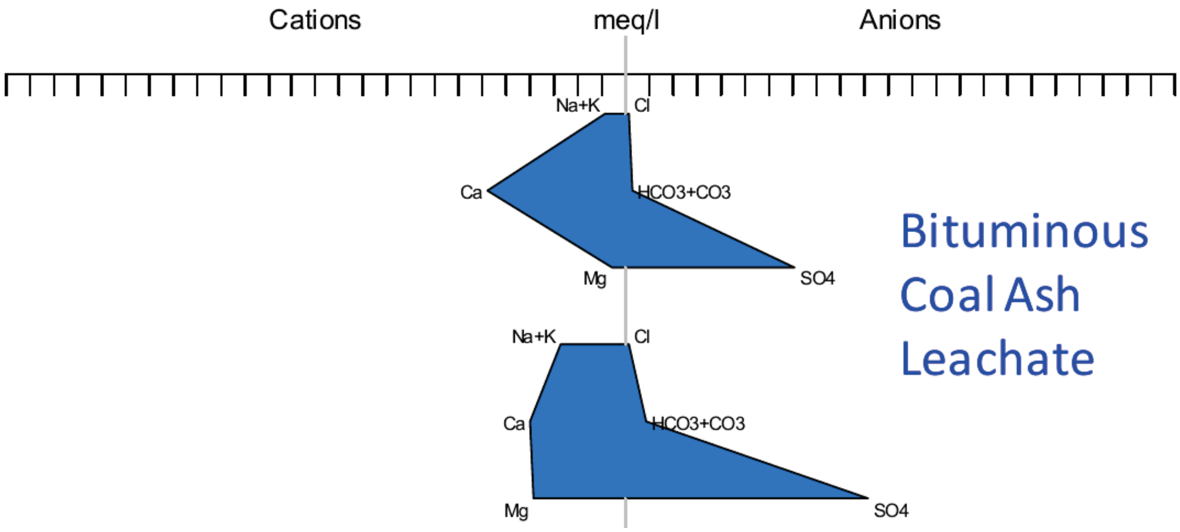


Figure 4-14 Bituminous Coal Ash Leachate Stiff Plot (EPRI, 2017)

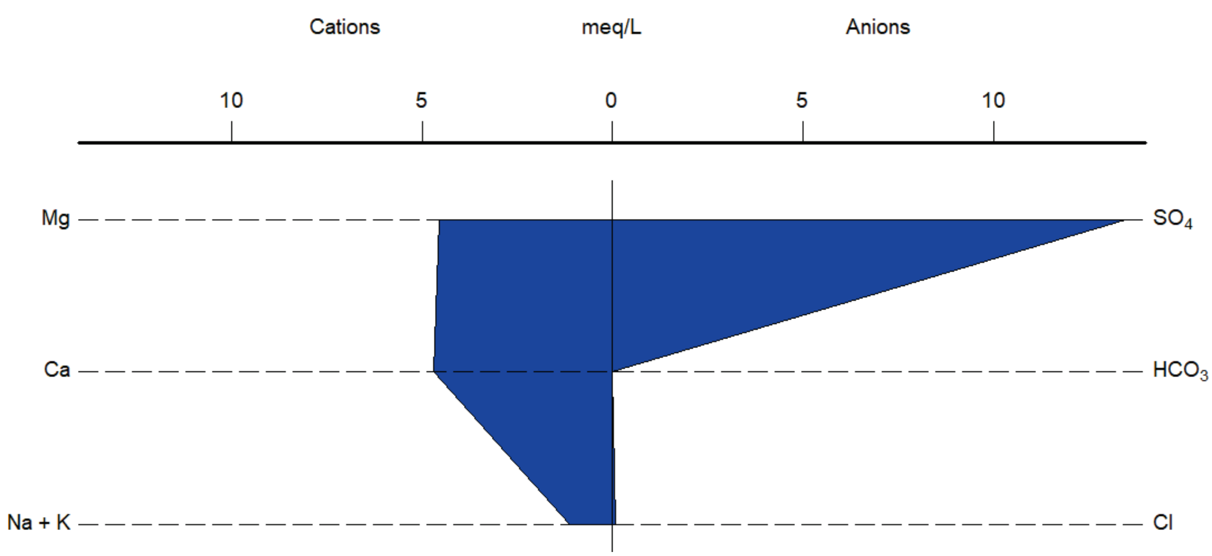


Figure 4-15 Stiff Plot for MW-1603 24th May 2017

In summary, based on the geochemical evaluation there is insufficient evidence to support the presence of CCR constituents, as derived from the BSFAP, in groundwater sampled in the vicinity of MW-1603. The Piper plots do not support mixing between groundwater and BSFAP water at any of the groundwater monitoring locations. The BSFAP water type is calcium sulfate. Only two other groundwater locations report this water type – MW-1603 and MW-1607; however, the magnitude of the calcium and sulfate is considerably different to that expressed in the BSFAP. Cobalt concentrations are approximately 3 times higher in MW-1607 in comparison to the BSFAP water, therefore it is highly unlikely the source of cobalt is from the BSFAP and is more likely to be a characteristic of the lithologies in which these two monitoring locations are screened across.

5 Summary and Conclusions

Using the EPRI (2017) guidance for ASD, the conclusions that are based on the lines of evidence presented and discussed within **Sections 3** and **4** indicate that groundwater in the vicinity of the BSFAP is not being impacted by CCR constituents from the BSFAP. The elevated beryllium, cobalt, and lithium concentrations that triggered the ASD assessment are due to the oxidation of coal seams that have been intersected by well location MW-1603. This is supported by the visual evidence during the logging of core characteristics at this location, the low pH reported in groundwater, and the subsequent likely dissolution and mobility of metalliferous species (beryllium, cobalt, and lithium) by the elevated acidity. The elevated pH in the BSFAP water and the corresponding lower concentrations of minor ions in BSFAP also support the unlikely influence of the BSFAP on groundwater. Therefore, it is concluded that the elevated signatures of beryllium, cobalt, and lithium are related to the dissolution of naturally-occurring coal-seam derived constituents within the shale layers of the Breathitt Group, as supported by the discussion of local and regional geology in **Section 2.2**.

6 References

AEP and EHS Support. (2016). Groundwater Sampling and Analysis Plan for the AEP Big Sandy Plant. October 28.

Bailey, T., Bishop, Z, and Shoemaker, K. (2014). Two Distinct Shorelines of Pleistocene Lake Tight in South-Central Ohio. Geological Society of America Abstracts with Programs. Volume 46, Number 3, Page 96.

Bigham, J. M., & Cravotta, C. A. (2006). Acid mine drainage. Encyclopedia of soil science. CRC Press, Boca Raton Google Scholar.

Bonnett, R., Noltimier, H., and Sanderson, D. (1991). A paleomagnetic study of the early Pleistocene Minford Silt Member, Teays Formation, West Virginia, in Melhorn, W. and Kempton, J., Geology and Hydrogeology of the Teays-Mahomet Bedrock Valley System, Geological Society of America Special Paper 258, 10 pages.

Chesnut, D. (1992). Stratigraphic and Structural Framework of Carboniferous Rocks in the Central Appalachian Basin in Kentucky, Kentucky Geological Survey Bulletin 3, Series XI, 49 pages.

EPRI. (2012). Groundwater Quality Signatures for Assessing Potential Impacts from Coal Combustion Product Leachate. EPRI, Palo Alto, CA. 1017923.

EPRI. (2017). Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. EPRI, Palo Alto, CA. 3002010920.

Erjavec, J. (2018). A New Map of Pleistocene Proglacial Lake Tight Based on GIS Modeling and Analysis. Ohio Journal of Science, Volume 118, Number 2, Pages 57-65.

Geosyntec Consultants, Inc. (2016). Groundwater Monitoring Well Installation Report – Fly Ash Pond. October.

Hansen, M. (1995). The Teays River, Ohio Department of Natural Resources Division of Geological Survey. GeoFacts No. 10. 2 pages.

Rice, C. and Hiett, J. (1994). Revised Correlation Chart of the Coal Beds, Coal Zones, and Key Stratigraphic Units in the Pennsylvanian Rocks of Eastern Kentucky, USGS Miscellaneous Field Studies Map MF-2275.

Ruppert, L., Tewalt, S., Wallack, R., Bragg, L., Brezinski, D., Carlton, R., Butler, D., and Calef, F. (2000). A Digital Resource Model of the Middle Pennsylvanian Upper Freeport Coal Bed Allegheny Group, Northern Appalachian Basin Coal Region. USGS Professional Paper 1625-C. 101 pages.

Ruppert, L., Trippi, M., and Slucher, E. (2010). Correlation Chart of Pennsylvanian Rocks in Alabama, Tennessee, Kentucky, Virginia, West Virginia, Ohio, Maryland, Pennsylvania Showing Position of Coal Beds, Coal Zones, and Key Stratigraphic Units. USGS Scientific Investigations Report 2010-5152. 3 plates.

USEPA. (2009). Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance.

Ward, D. (1978). Geological Map of the Adams Quadrangle, Lawrence County, Kentucky, USGS Geological Quadrangle Map GQ-1489. 1 plate.

Tables

Table 1 Analytical Suite for Water Sampling

	Field Measured	Laboratory Analyzed
Parameter	Turbidity	Alkalinity, as $CaCO_3$
	pH	Antimony, Sb
	Electrical Conductivity	Arsenic, As
	Temperature	Barium, Ba
	Oxidation Reducing Potential	Beryllium, Be
	Dissolved Oxygen	Boron, B
		Bromide, Br
		Cadmium, Cd
		Calcium, Ca
		Chloride, Cl
		Chromium, Cr
		Cobalt, Co
		Fluoride, F
		Lead, Pb
		Lithium, Li
		Magnesium, Mg
		Mercury, Hg
		Molybdenum, Mo
		Potassium, K
		Selenium, Se
		Sodium, Na
		Strontium, Sr
		Sulfate, SO4
		Thallium, Tl
		TDS, Residue, Filterable

Figures

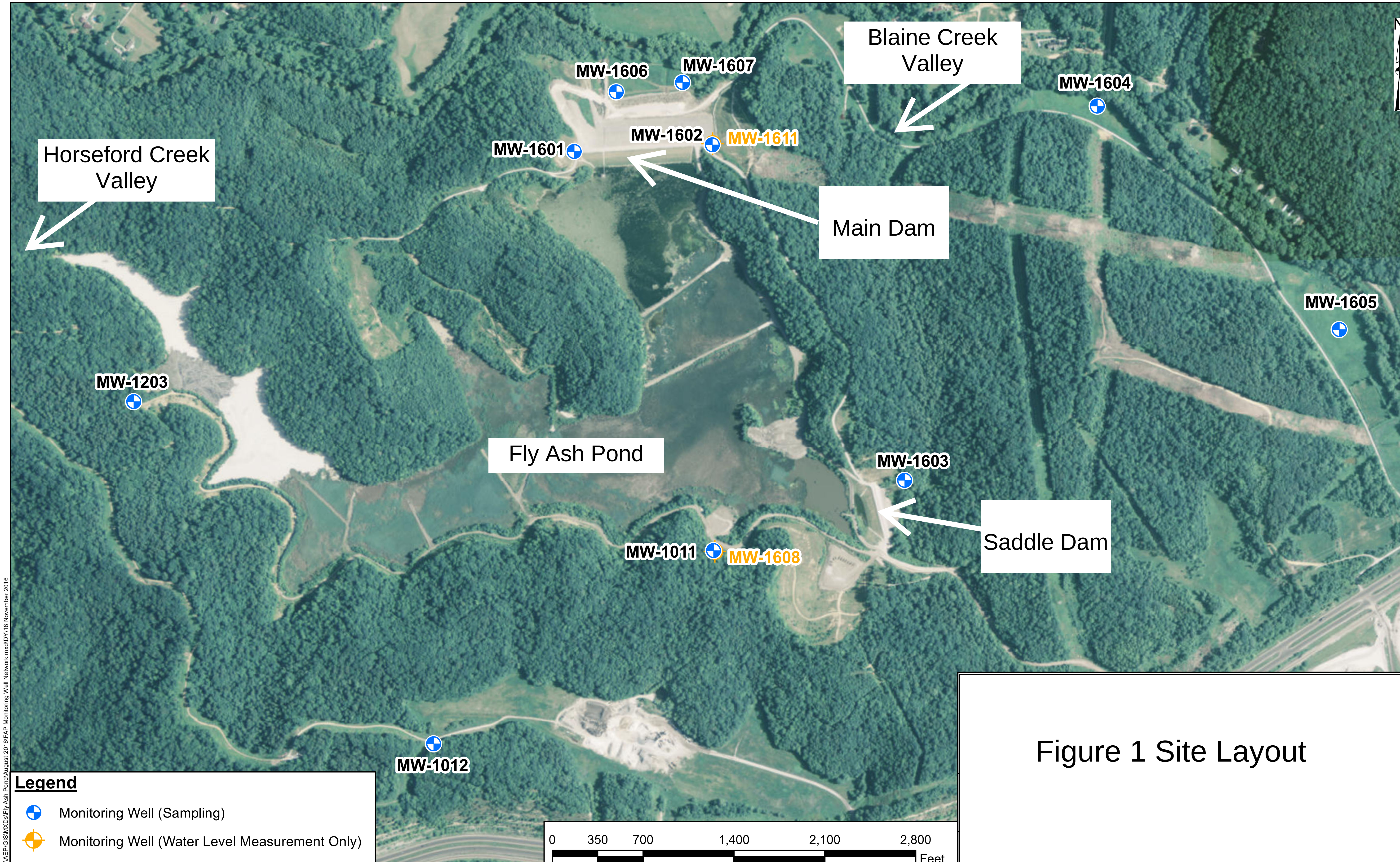


Figure 1 Site Layout

N:\AEP\GIS\MXDs\Fly Ash Pond\August 2016\FAP Monitoring Well Network.mxd\DY\18 November 2016

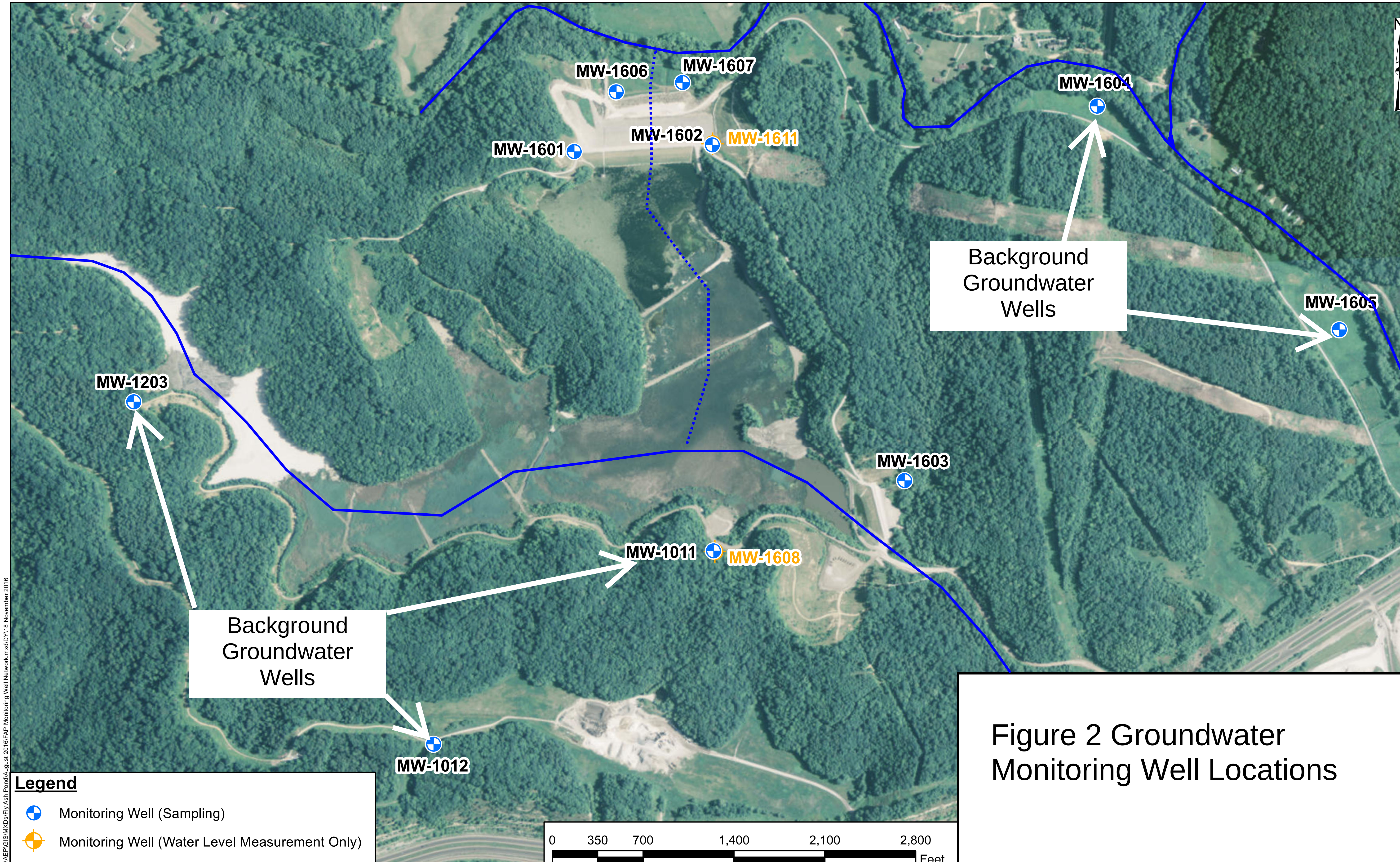
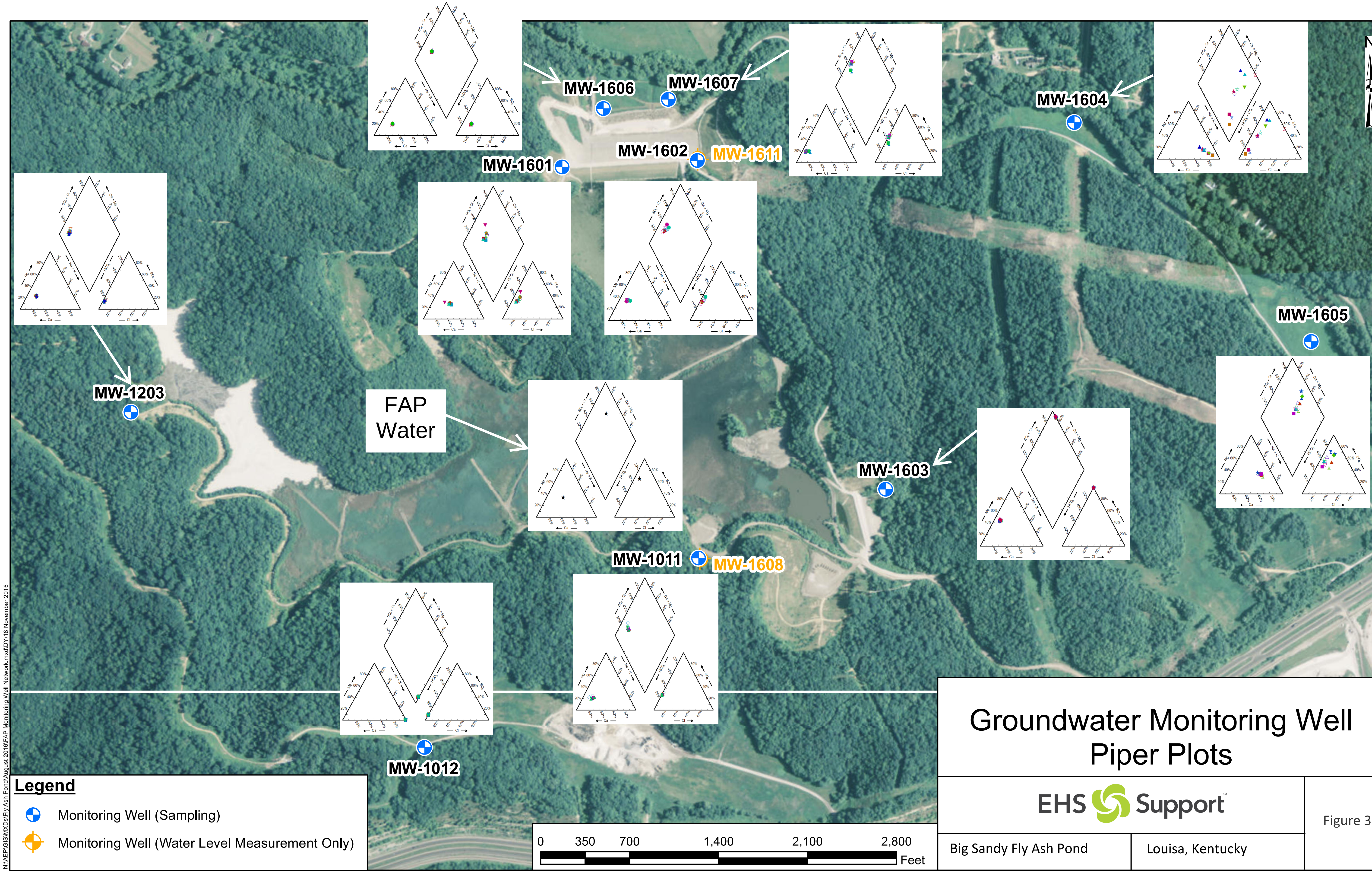


Figure 2 Groundwater Monitoring Well Locations

N:\AEP\GIS\MXDs\Fly Ash Pond\August 2016\FAP Monitoring Well Network.mxd\DY\18 November 2016



Groundwater Monitoring Well Piper Plots

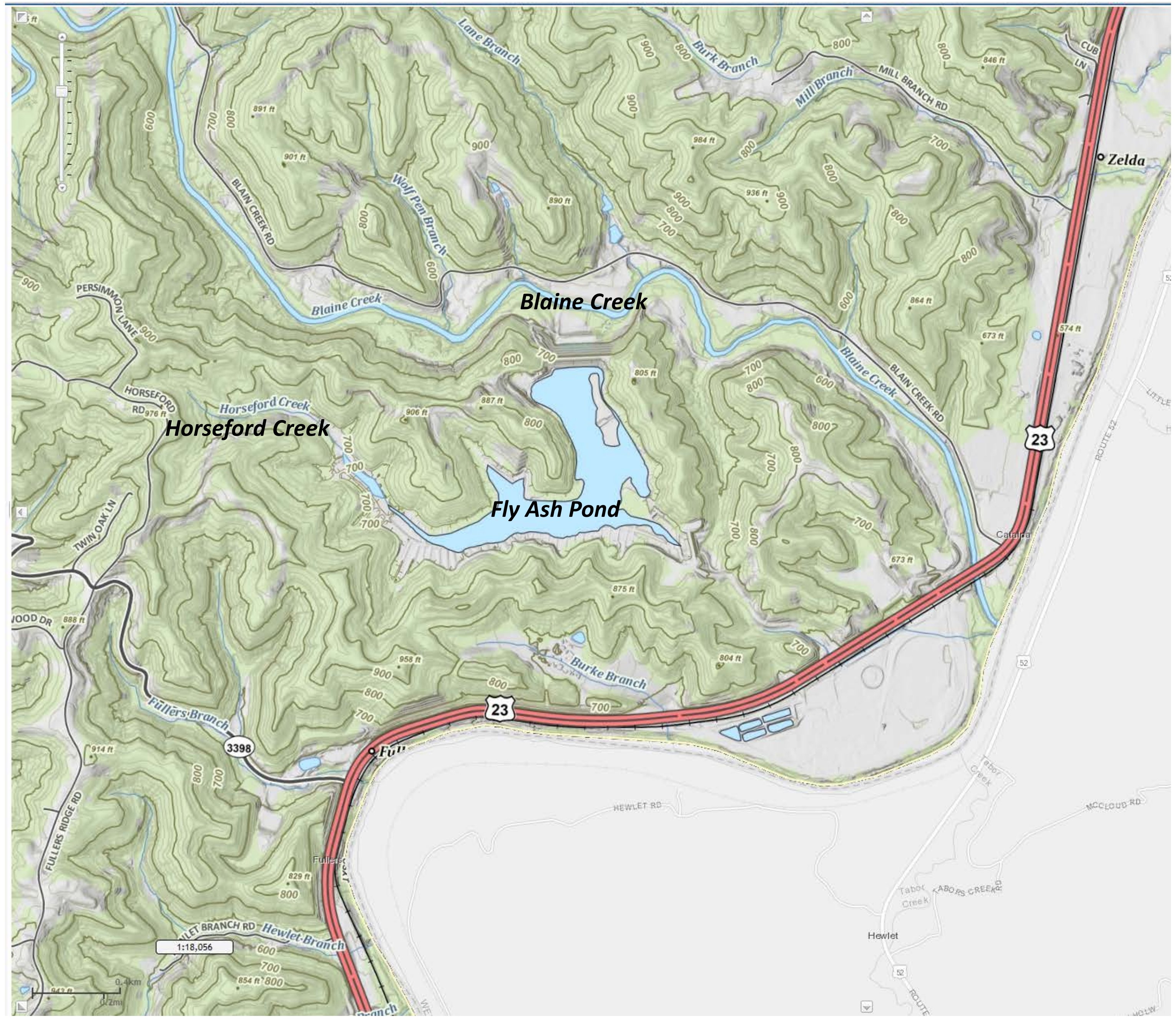
EHS Support

Big Sandy Fly Ash Pond | Louisa, Kentucky

Figure 3

Appendix A Geologic Figures

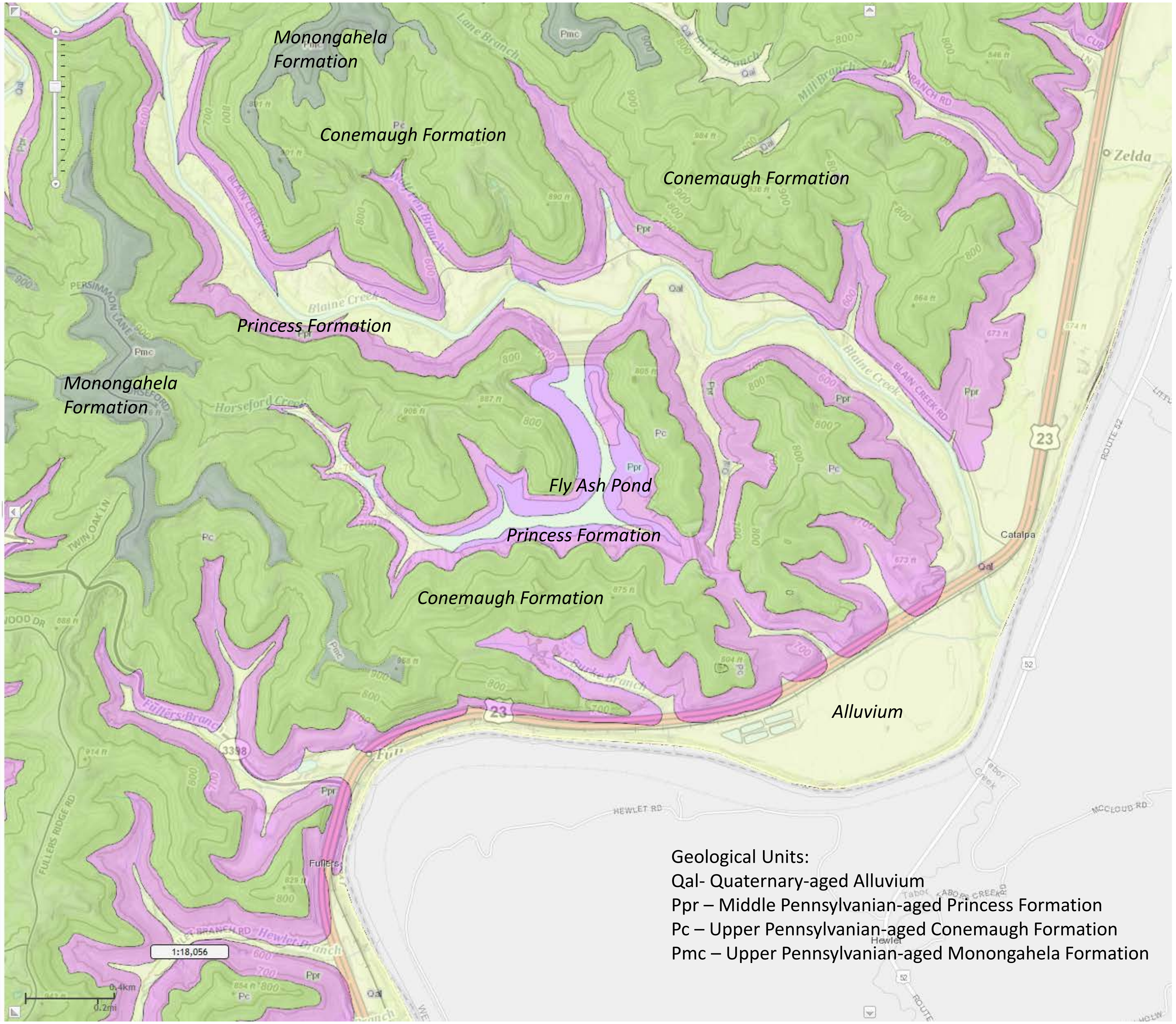
Topographical Map for Area



Aerial Photograph for Area

Taken from Kentucky Geologic Map Information Service
https://bit.ly/2QN0Fby

EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**TOPOGRAPHICAL AND AERIAL PHOTO FOR SITE**	**FIGURE A1**



Taken from Kentucky Geologic Map Information Service
https://bit.ly/2Aaahm4

Regional Stratigraphical Framework

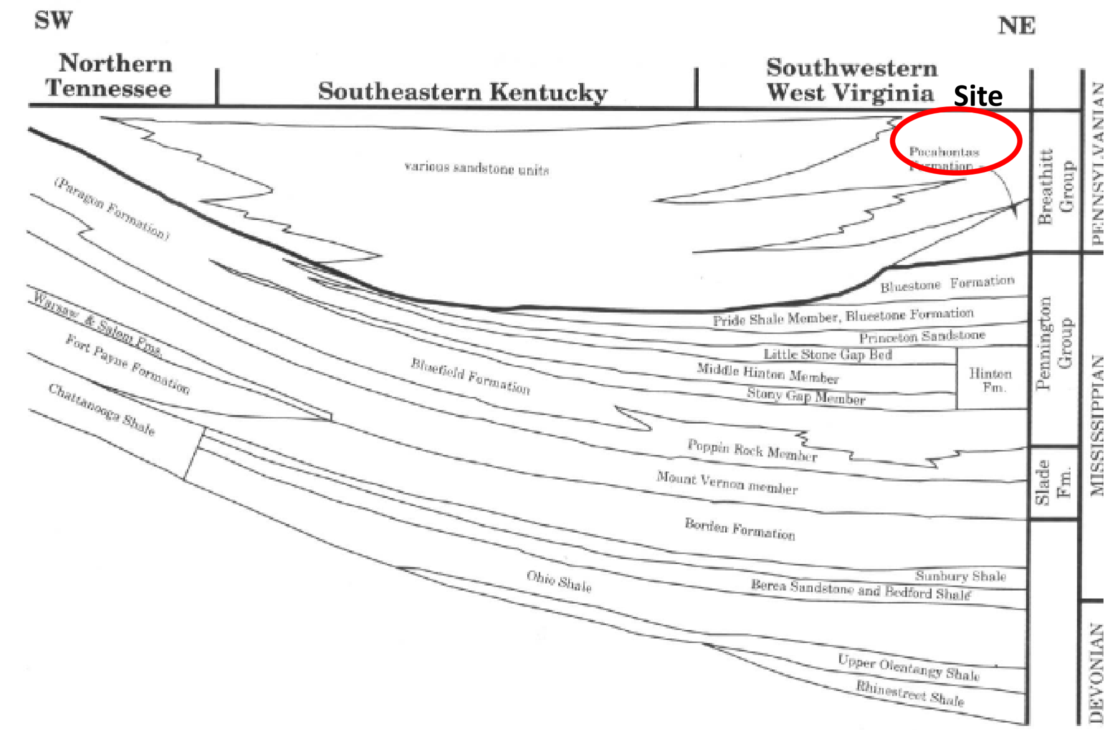


Figure 4. Stratigraphic framework of Mississippian rocks in the Central Appalachian Basin. Pennsylvanian and Devonian units are also shown.

Regional Stratigraphy Column of the Breathitt Group

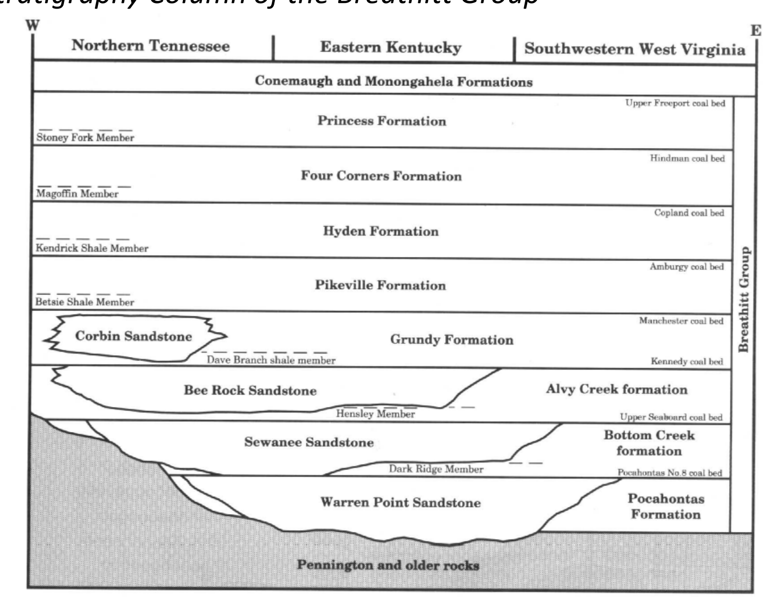
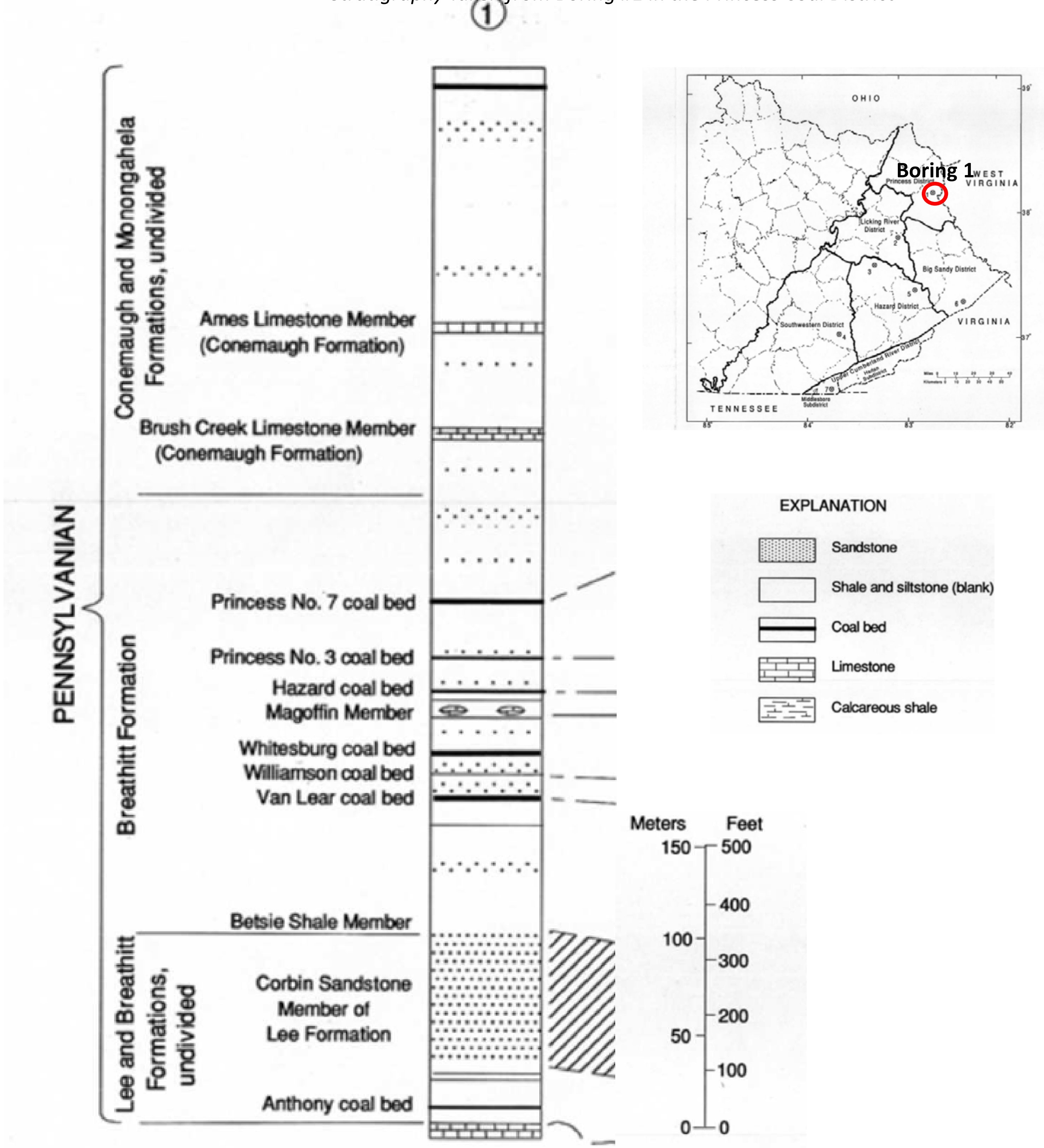


Figure 5. Stratigraphic framework of Pennsylvanian rocks in the Central Appalachian Basin.

Taken from Chesnut (1992)

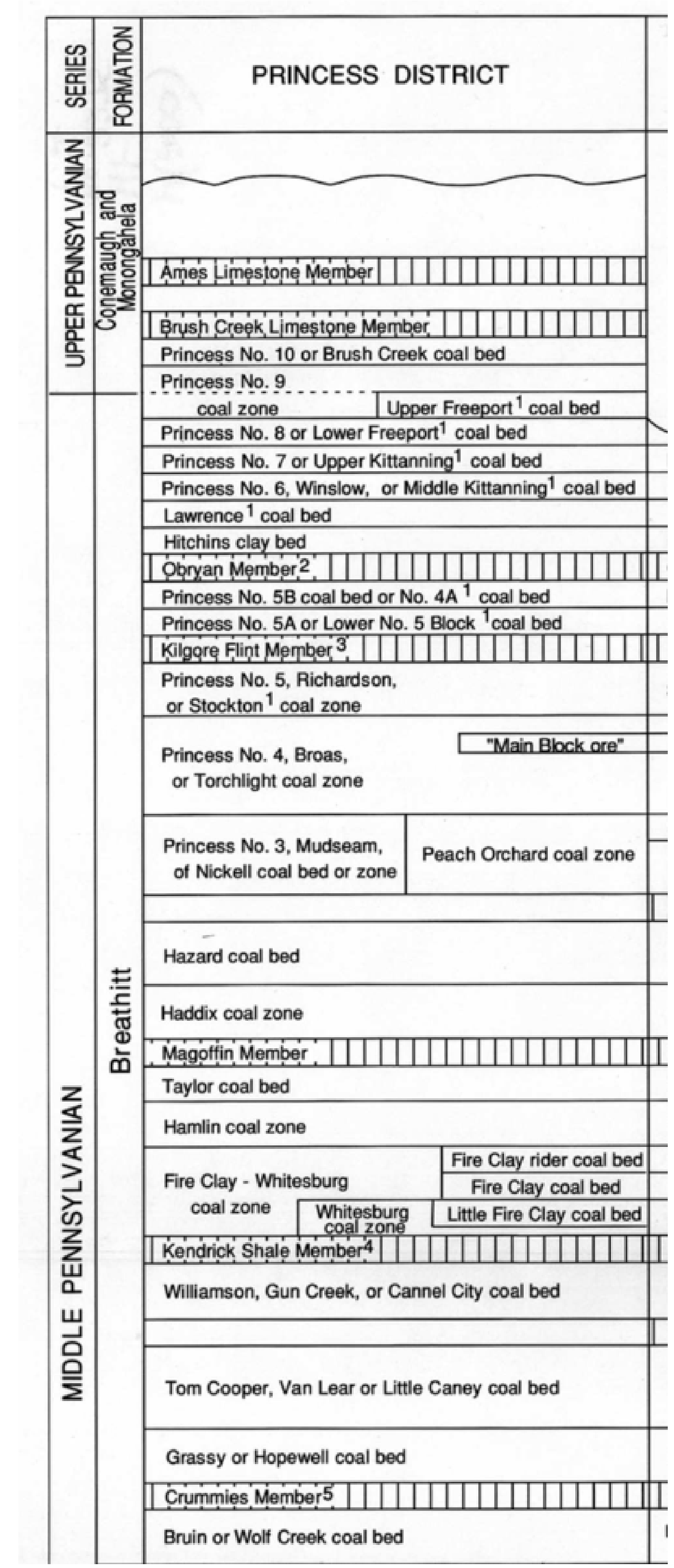
EHS Support	AMERICAN ELECTRIC POWER AEP BIG SANDY PLANT LOUISA, KENTUCKY	GEOLOGICAL MAP FROM THE KENTUCKY GEOLOGICAL SURVEY	FIGURE A2

Stratigraphy Taken from Boring #1 in the Princess Coal District



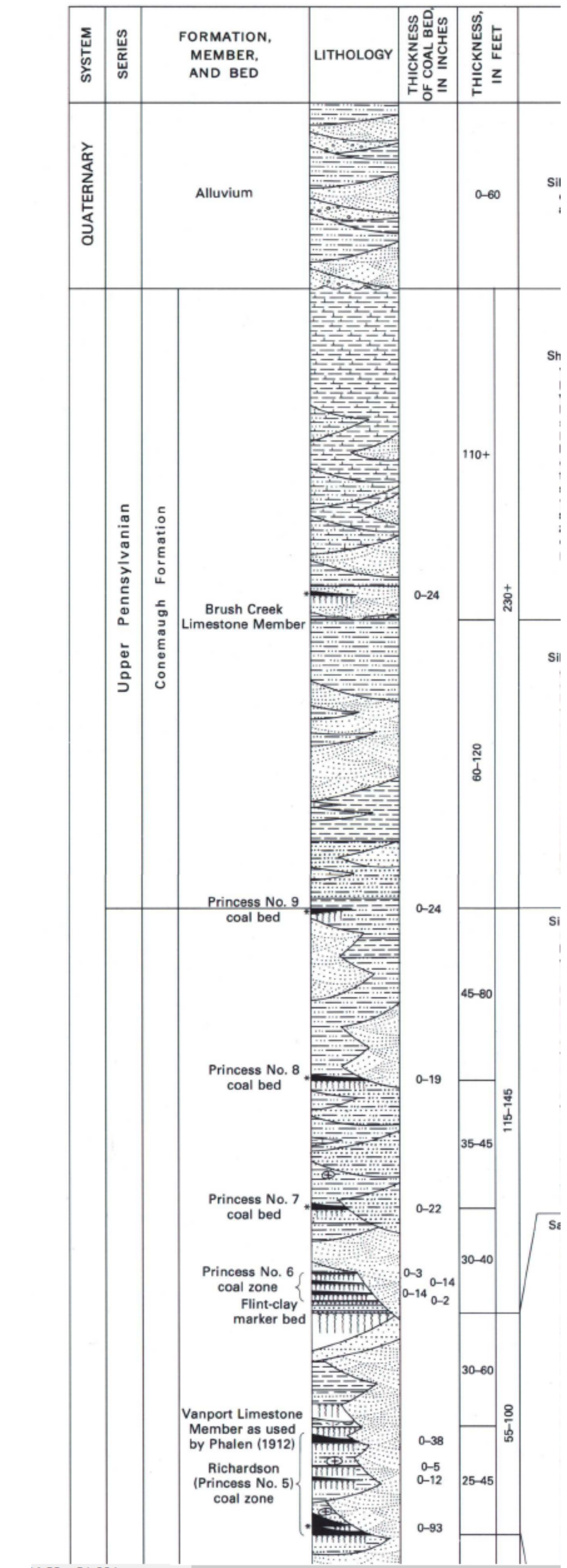
Taken from Rice and Hiett (1994)

Stratigraphy Column of the Princess Coal District



Taken from Rice and Hiett (1994)

Stratigraphy Column for Adams Quadrangle



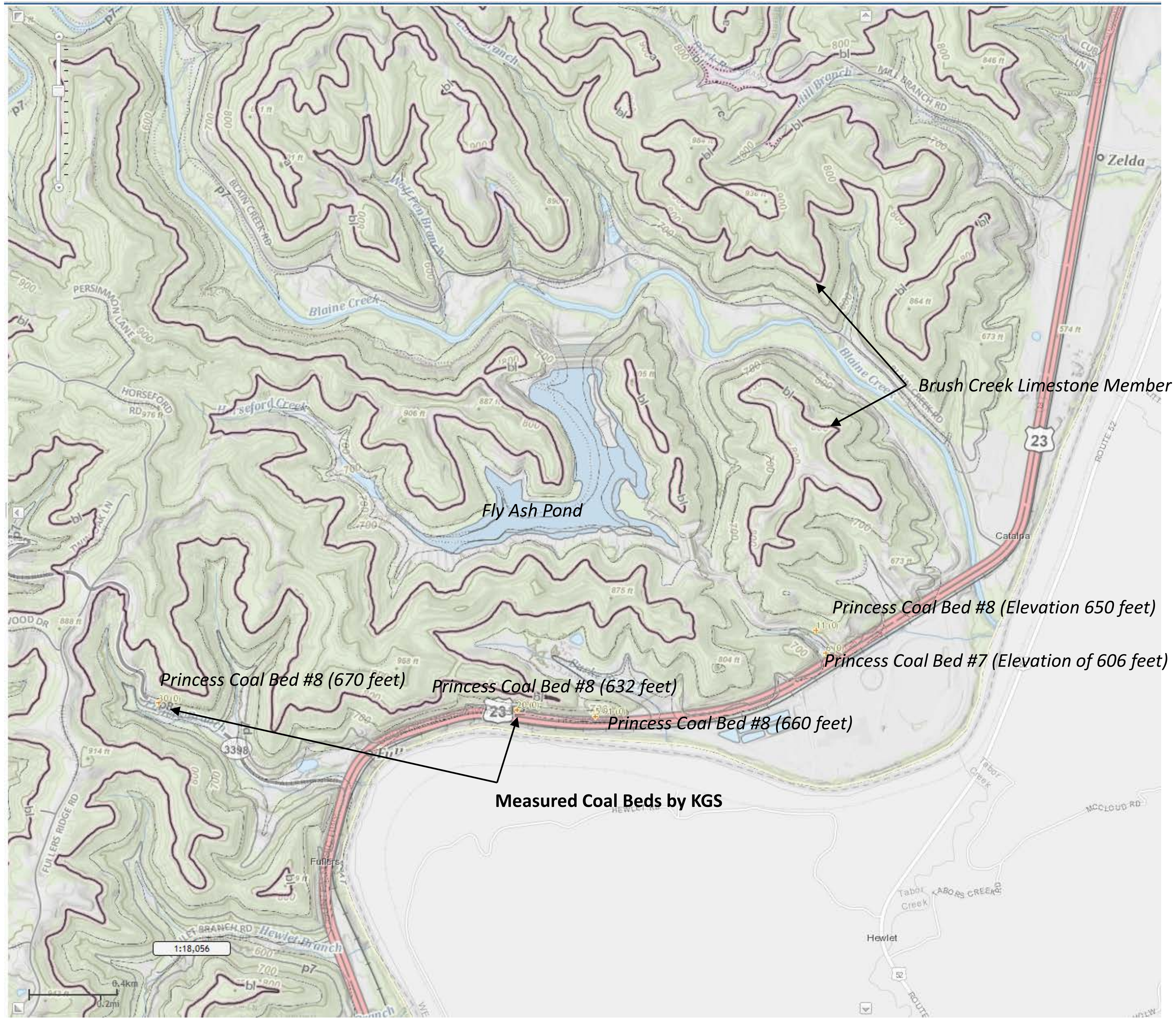
Taken from Ward (1978)

EHS Support

AMERICAN ELECTRIC POWER
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

STRATIGRAPHY OF THE PRINCESS COAL DISTRICT

FIGURE A3



Taken from Kentucky Geologic Map Information Service
https://bit.ly/2Aaahm4

EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**IDENTIFIED COAL BEDS FROM THE KENTUCKY GEOLOGICAL SURVEY**	**FIGURE A4**

Beryllium Content of the Upper Freeport Coal/Princess Number 9

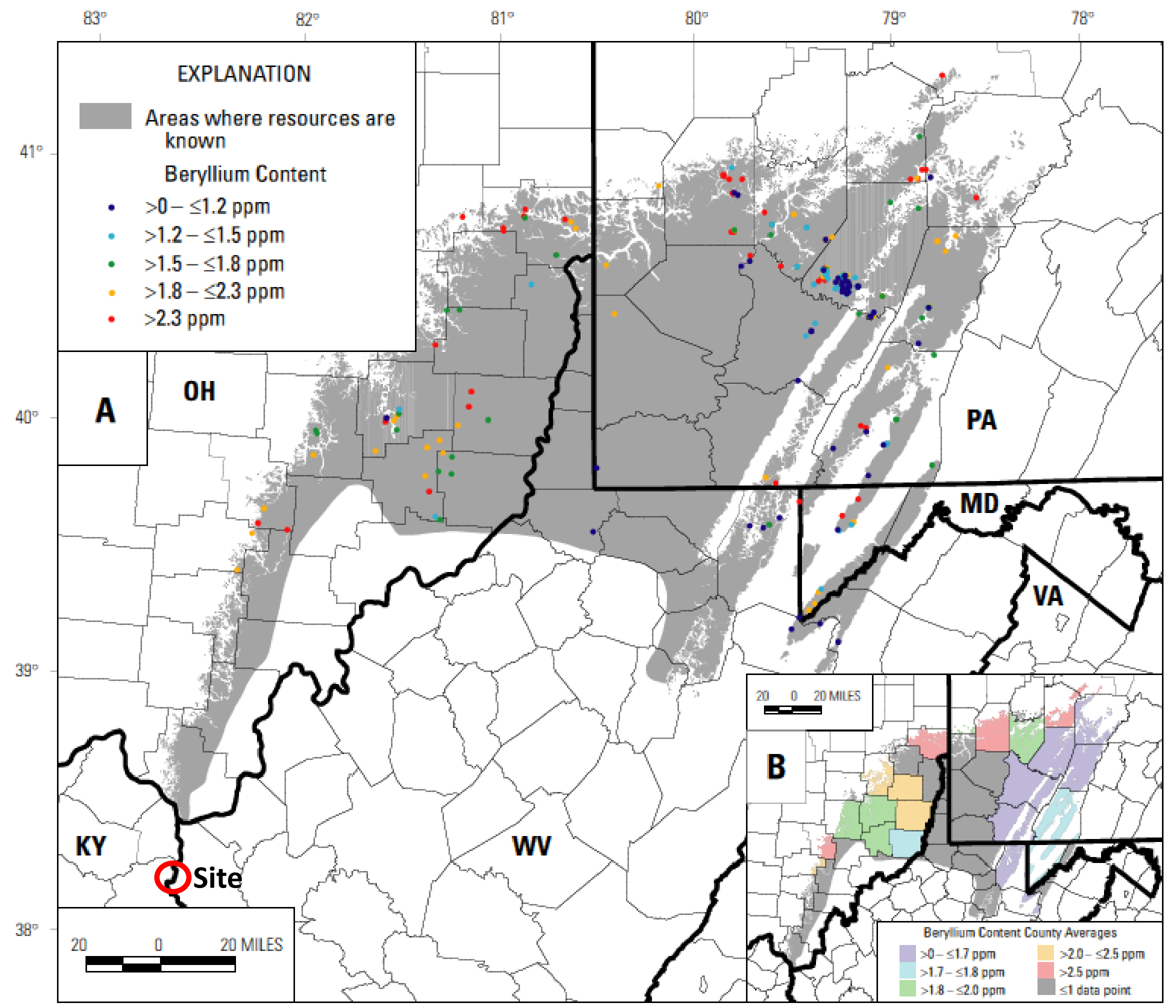


Figure 38. Maps showing beryllium content (parts per million (ppm), as-received whole-coal basis) of the Upper Freeport coal bed in Pennsylvania, West Virginia, Ohio, and Maryland. Map A shows beryllium contents of 226 samples for which geochemical records are publicly available and located by latitude and longitude (Appendix 8). Map B shows county averages for beryllium contents using 257 records in the geochemical database, including those that are located only to a county level; beryllium contents range from 0.21 to 5.0 ppm with a mean value of 1.8±0.81 (table 8). The values are classified into five categories, each representing 20 percent of the data values. See figure 3 for county names.

Cobalt Content of the Upper Freeport Coal/Princess Number 9

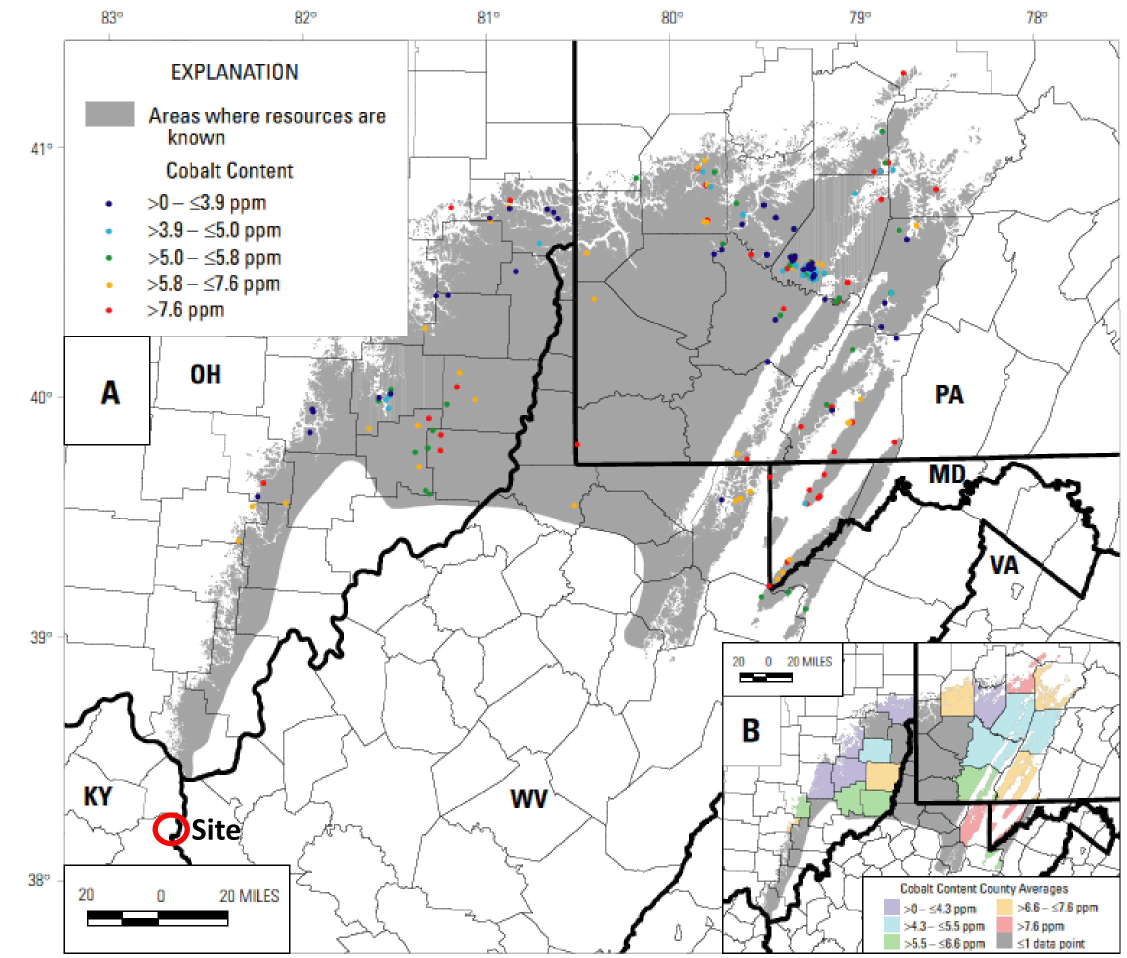


Figure 42. Maps showing cobalt content (parts per million (ppm), as-received whole-coal basis) of the Upper Freeport coal bed in Pennsylvania, West Virginia, Ohio, and Maryland. Map A shows cobalt contents of 225 samples for which geochemical records are publicly available and located by latitude and longitude (Appendix 8). Map B shows county averages for cobalt contents using all 254 records in the geochemical database, including those that are located only to a county level; cobalt contents range from 0.76 to 20 ppm with a mean value of 6.1±3.1 ppm (table 12). The values are classified into five categories, each representing 20 percent of the data values. See figure 3 for county names.

Taken from Ruppert et al. 2000

EHS Support	AMERICAN ELECTRIC POWER AEP BIG SANDY PLANT LOUISA, KENTUCKY	GEOCHEMISTRY OF COAL	FIGURE A5-A

Lead Content of the Upper Freeport Coal/Princess Number 9

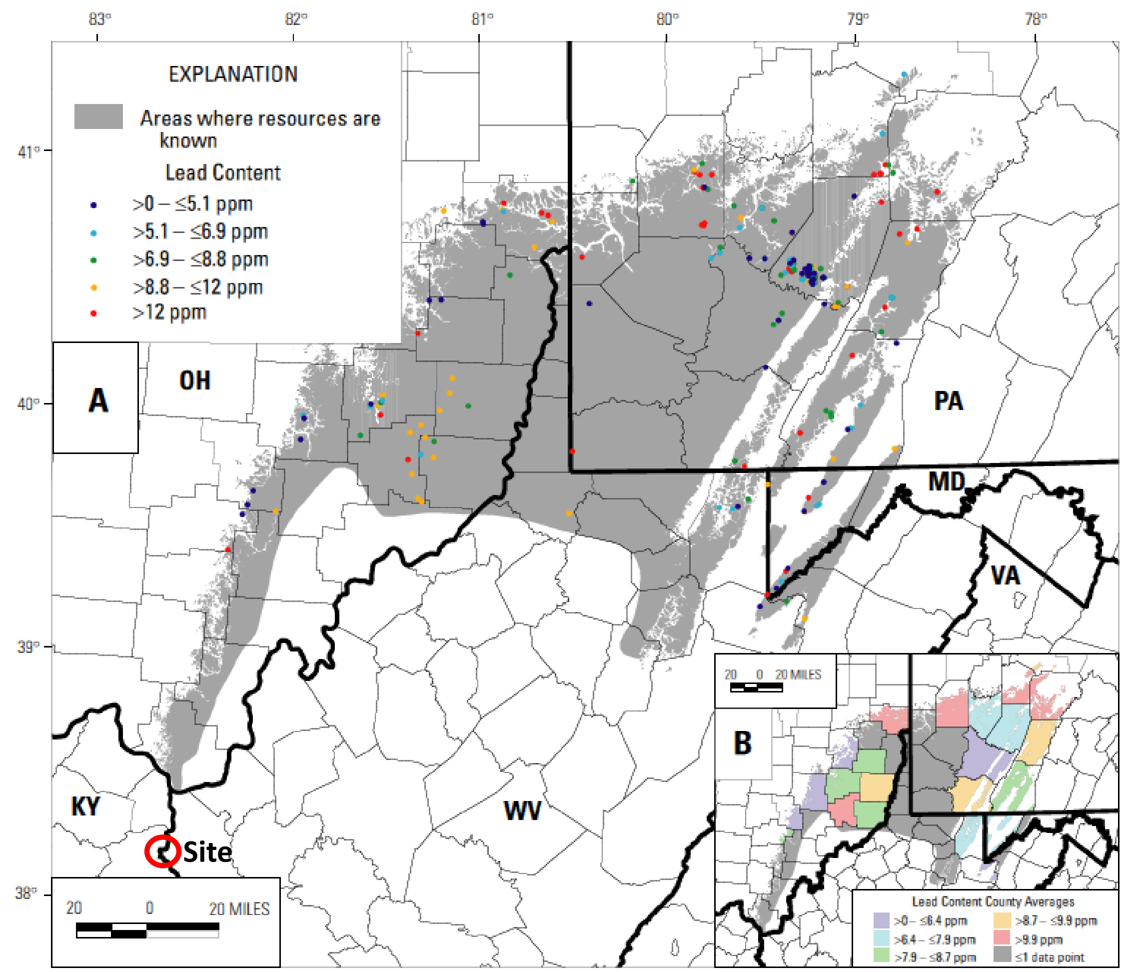


Figure 43. Maps showing lead content (parts per million (ppm), as-received whole-coal basis) of the Upper Freeport coal bed in Pennsylvania, West Virginia, Ohio, and Maryland. Map A shows lead contents of 225 samples for which geochemical records are publicly available and located by latitude and longitude (Appendix 8). Map B shows county averages for lead contents using all 254 records in the geochemical database, including those that are locat ed only to a county level; lead contents range from 1.3 to 27 ppn with a mean value of 8.6±4.4 ppm (table 13). The values are clas sified into five categories, each representing 20 percent of the dat: values. See figure 3 for county names.

Cobalt Content of the Upper Freeport Coal/Princess Number 9

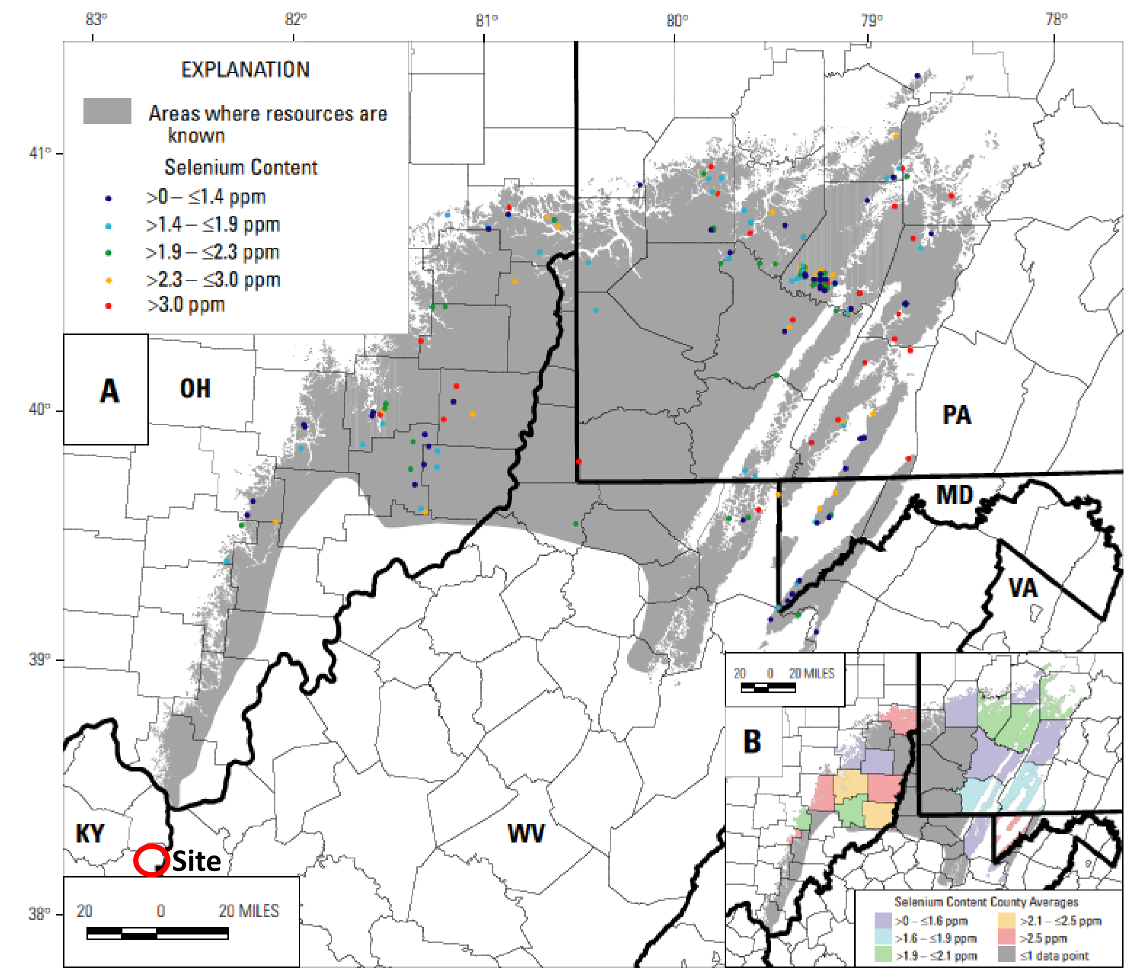
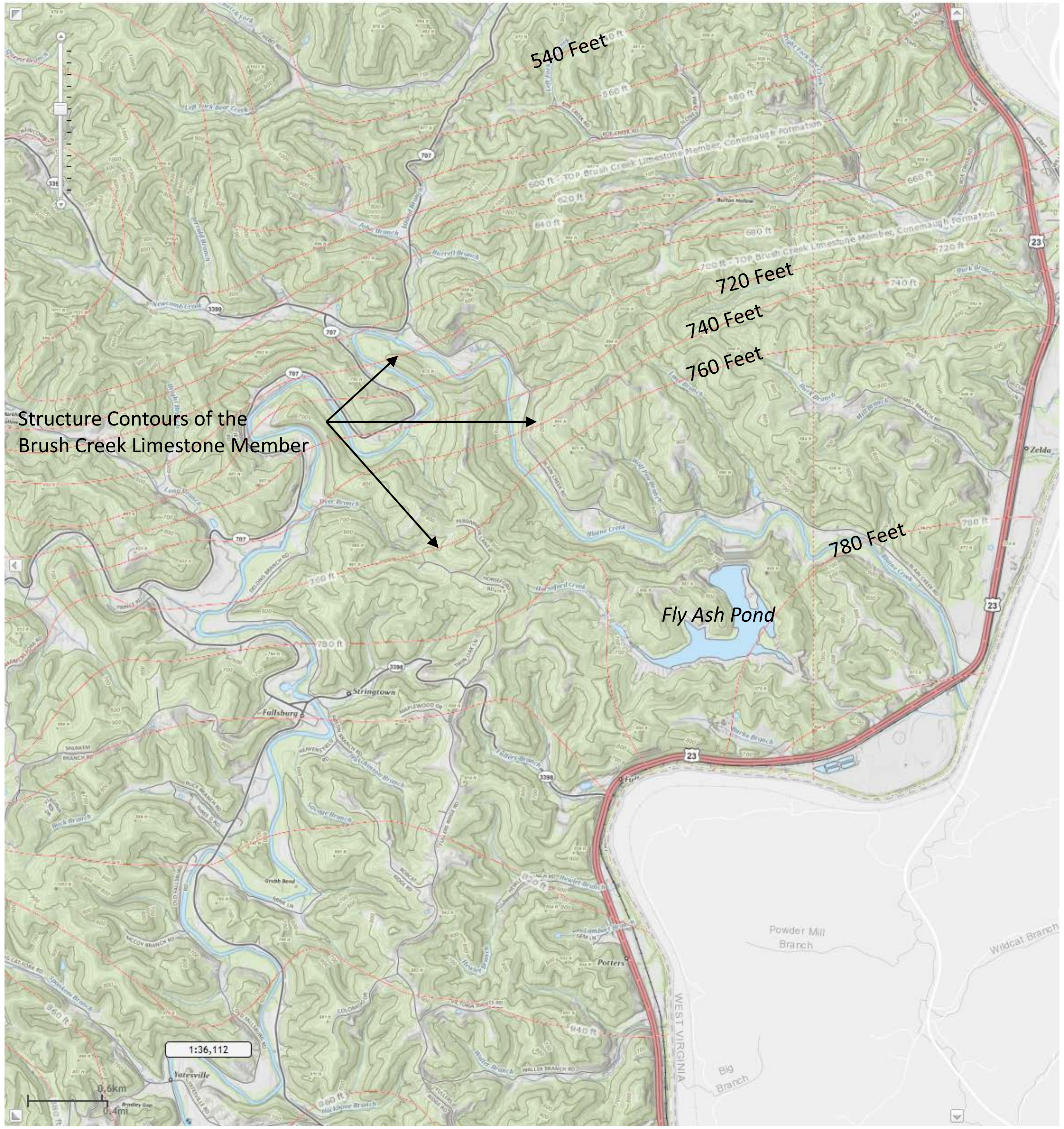


Figure 46. Maps showing selenium content (parts per million (ppm), as-received whole-coal basis) of the Upper Freeport coal bed in Pennsylvania, West Virginia, Ohio, and Maryland. Map A shows selenium contents of 224 samples for which geochemical records are publicly available and located by latitude and longitude (Appendix 8). Map B shows county averages for selenium contents using all 250 records in the geochemical database, including those located only to a county level; selenium contents range from 0.098 to 6.0 ppm with a mean value of 2.0±1.1 ppm (table 16). The values are classified into five categories, each representing 20 percent of the data values. See figure 3 for county names.

Taken from Ruppert et al. 2000

EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**GEOCHEMISTRY OF COAL**	**FIGURE A5-B**

Structural Contour Map



Taken from Kentucky Geologic Map Information Service
https://bit.ly/2Cqv1HN

Regional Geological Structural Map

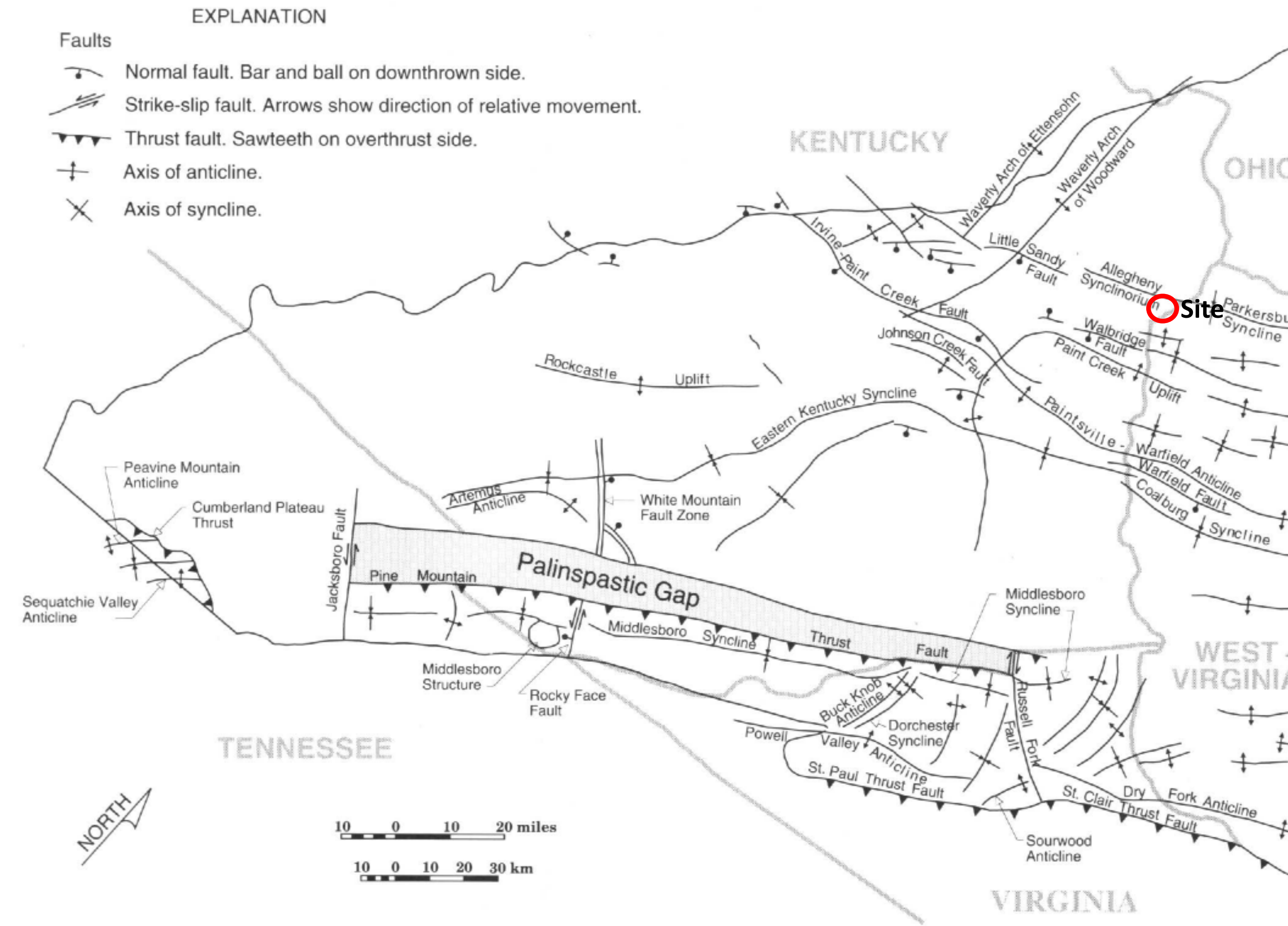


Figure 14. Near–surface structural features of part of the Central Appalachian Basin, compiled from maps prepared by Stearns (1954), Woodward (1961), Huddle and others (1963), Miller (1974), Ettensohn (1975), and Arkle and others (1979). Base map has been reconstructed to show original position of Pine Mountain Thrust Fault.

Taken from Chesnut (1992)

EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**STRUCTURAL TOP OF BRUSH CREEK LIMESTONE MEMBER OF THE CONEMAUGH FORMATION AND REGIONAL GEOLOGICAL STRUCTURAL MAP**	**FIGURE A6**

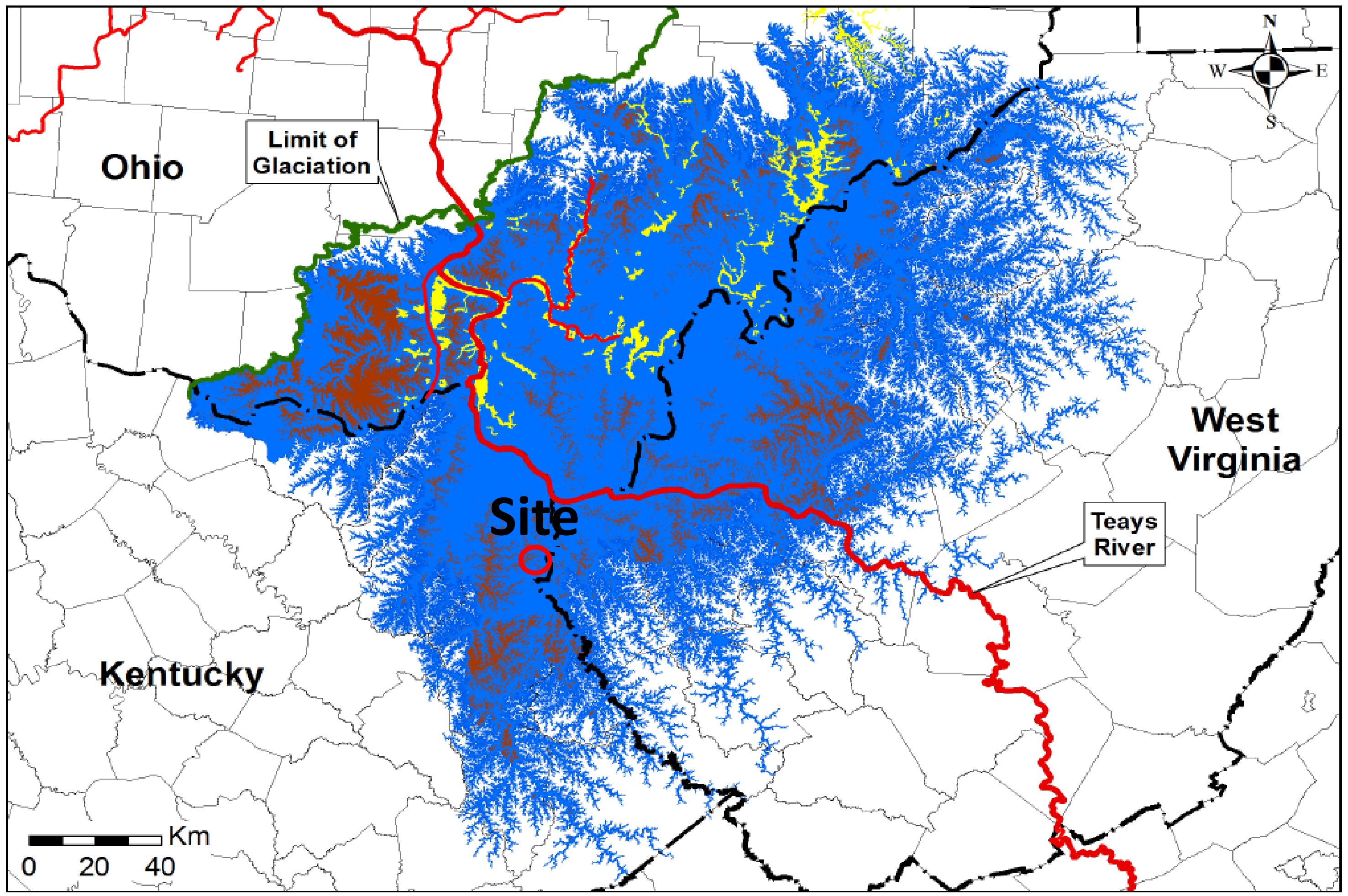
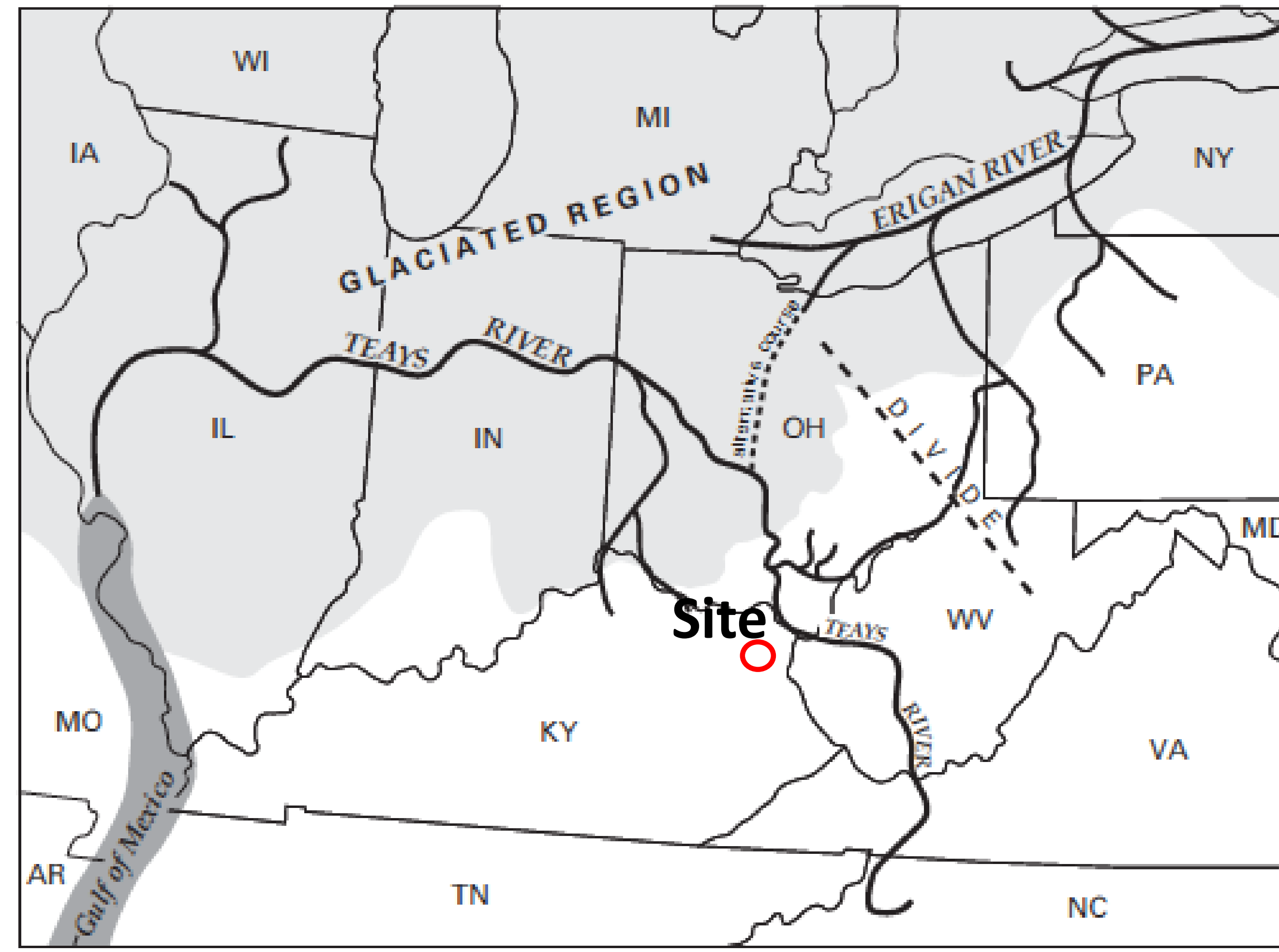


FIGURE 3. GIS model of Proglacial Lake Tight in blue. Islands in dark brown. Mapped exposures of lacustrine sediments (mostly Minford Clay) are in yellow (from Pavey et al. 1999). Boundaries within the states are county outlines.



Classic interpretation of the preglacial Teays River and an alternative course (dashed line) favored by some geologists. The entire extent of the Teays and its tributaries north of the glacial border is buried beneath thick glacial drift. Northern Ohio was drained by the Erigan River, which followed the axis of what is now Lake Erie, and flowed into the ancestral St. Lawrence River. Neither the Great Lakes nor the Ohio River existed at this time.

Taken from Erjavec, 2018

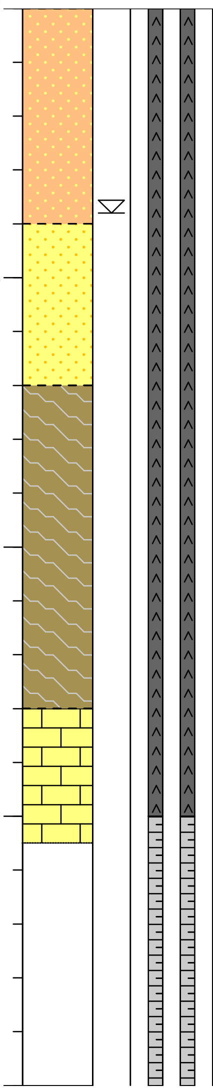
Taken from Hansen, 1995

EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**PROGLACIAL LAKE TIGHT AND PREGLACIAL TEAYS RIVER**	**FIGURE A7**

Appendix B MW-1603 Boring Log

Geosyntec consultants engineers | scientists | innovators	Client: American Electric Power Project: Big Sandy Plant Address: 23000 US-23, Louisa, KY	**WELL LOG** **Well No. MW-1603** **Page: 1 of 2**

Drilling Start Date:	**04/25/2016**	Boring Depth (ft):	**40**	Well Depth (ft):	**32**
Drilling End Date:	**06/01/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & Core Barrel**	Screen Slot (in):	**0.010**
Drilling Method:	**HSA/Rock Coring**	DTW During Drilling (ft):	**3.8**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**SCR-13**	DTW After Drilling (ft):	**21.8**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Keith Fehrman**	Top of Casing Elev. (ft msl):	**675.75**	Seal Material(s):	**Bentonite Pellets**
Logged By:	**N. Tilahun/J. Ivanowski**	Location (X,Y):	**2107344.43, 251596.53***	Filter Pack:	**Global Filter Pack #5**



DEPTH (ft)	Sample Type	Date & Time	Blow Counts	Recovery (ft)	N Value RQD (%)	SOIL/ROCK VISUAL DESCRIPTION	REMARKS	ELEV. (ft msl)
0						(0.0') Well-graded SAND with silt (SW-SM); mostly fine-coarse grained sand, few fine-coarse gravel, little silt, little clay, loose, dry, light brown, 7.5YR/7/4, FILL.		673.24
	SS	04/25 13:54	10 12 14 10	2.0	26			670
5	SS	04/25 14:13	6 8 8 9	1.5	16	(4') Well-graded SAND (SW); mostly medium grained sand, few coarse gravel, few silt, dense, moist, light brown, 7.5YR/5/8.		
	SS	04/25 15:50	4 4 5 5	2.0	9	(7') Fat CLAY with sand (CH); trace coarse gravel, some medium-coarse sand, some silt, mostly clay, high plasticity, stiff, moist, dark gray, GLEY2/4/10B, abundant roots, reduced (decomposed) soil odor.		
	SS	04/25 16:00	5 5 5 5	1.5	10			665
10	SS	04/25 16:07	6 7 7 8	1.0	14			
	SS	04/25 16:10	6 6 7 7	2.0	13	(13') SED ROCK (SANDSTONE); medium sand, massive, intensely weathered, very hard, light brown, moist, 7.5YR/7/3.		660
15	CO			0.0	108	(15.5') No Recovery. 06/01/2016 - removed hollow-stem auger and advanced borehole using rotasonic drilling. 06/01/2016 - advanced borehole using wireline rock coring inside of hollow stem auger (surface to 15 ft bgs).		655
20								

NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.51 ft above ground surface. Ground surface elevation is 673.24 ft MSL.

WELL LOG

Geosyntec consultants
engineers | scientists | innovators

Client: American Electric Power
Project: Big Sandy Plant
Address: 23000 US-23, Louisa, KY

Well No. MW-1603

Drilling Start Date:	**04/25/2016**	Boring Depth (ft):	**40**	Well Depth (ft):	**32**
Drilling End Date:	**06/01/2016**	Boring Diameter (in):	**8**	Well Diameter (in):	**4**
Drilling Company:	**Layne**	Sampling Method(s):	**SS & Core Barrel**	Screen Slot (in):	**0.010**
Drilling Method:	**HSA/Rock Coring**	DTW During Drilling (ft):	**3.8**	Riser Material:	**Sch 40 PVC**
Drilling Equipment:	**SCR-13**	DTW After Drilling (ft):	**21.8**	Screen Material:	**Sch 40 PVC Slotted**
Driller:	**Keith Fehrman**	Top of Casing Elev. (ft msl):	**675.75**	Seal Material(s):	**Bentonite Pellets**
Logged By:	**N. Tilahun/J. Ivanowski**	Location (X,Y):	**2107344.43, 251596.53***	Filter Pack:	**Global Filter Pack #5**

DEPTH (ft) | LITHOLOGY | WATER LEVEL | WELL COMPLETION | COLLECT | SOIL/ROCK VISUAL DESCRIPTION | REMARKS | ELEV. (ft msl)

DEPTH (ft)	Sample Type	Date & Time	Blow Counts	Recovery (ft)	N Value / RQD (%)
20	CO	06/01 18:16		5.0	20
25	CO			4.5	24
30	CO			4.6	70
35	CO			5.0	90

Depth scale: 20, 25, 30, 35, 40. Elevation scale: 650, 645, 640, 635.

SOIL/ROCK VISUAL DESCRIPTION

(20') Well-graded SAND (SW); mostly fine grained sand, loose, saturated, light yellowish-brown.

(22') SED ROCK (SANDSTONE); fine sand, massive, slightly weathered, hard, unfractured, light yellowish-brown, wet.

(23') SED ROCK (SHALE); silt, laminated, decomposed, soft, intensely fractured, dark gray, wet, iron oxide staining; organic matter.

(24') SED ROCK (SHALE); silt, laminated, decomposed, very soft, intensely fractured, black, wet, nearly all organic matter; slight coaly texture.

(25') SED ROCK (CLAYSTONE); clay, moderately bedded, intensely weathered, moderately soft, slightly fractured, pale bluish-gray, wet.

(29') SED ROCK (SANDSTONE); very fine sand, very thinly bedded, intensely weathered, moderately hard, very intensely fractured, light reddish-brown, wet.

(30') SED ROCK (SANDSTONE); very fine sand, laminated, slightly weathered, very hard, moderately fractured, dark bluish-gray, wet, some micaceous minerals.

(32') SED ROCK (SANDSTONE); very fine sand, laminated, fresh, very hard, unfractured, dark bluish-gray, moist.

(35.5') Fractured zone; slight iron-oxide staining on surface.

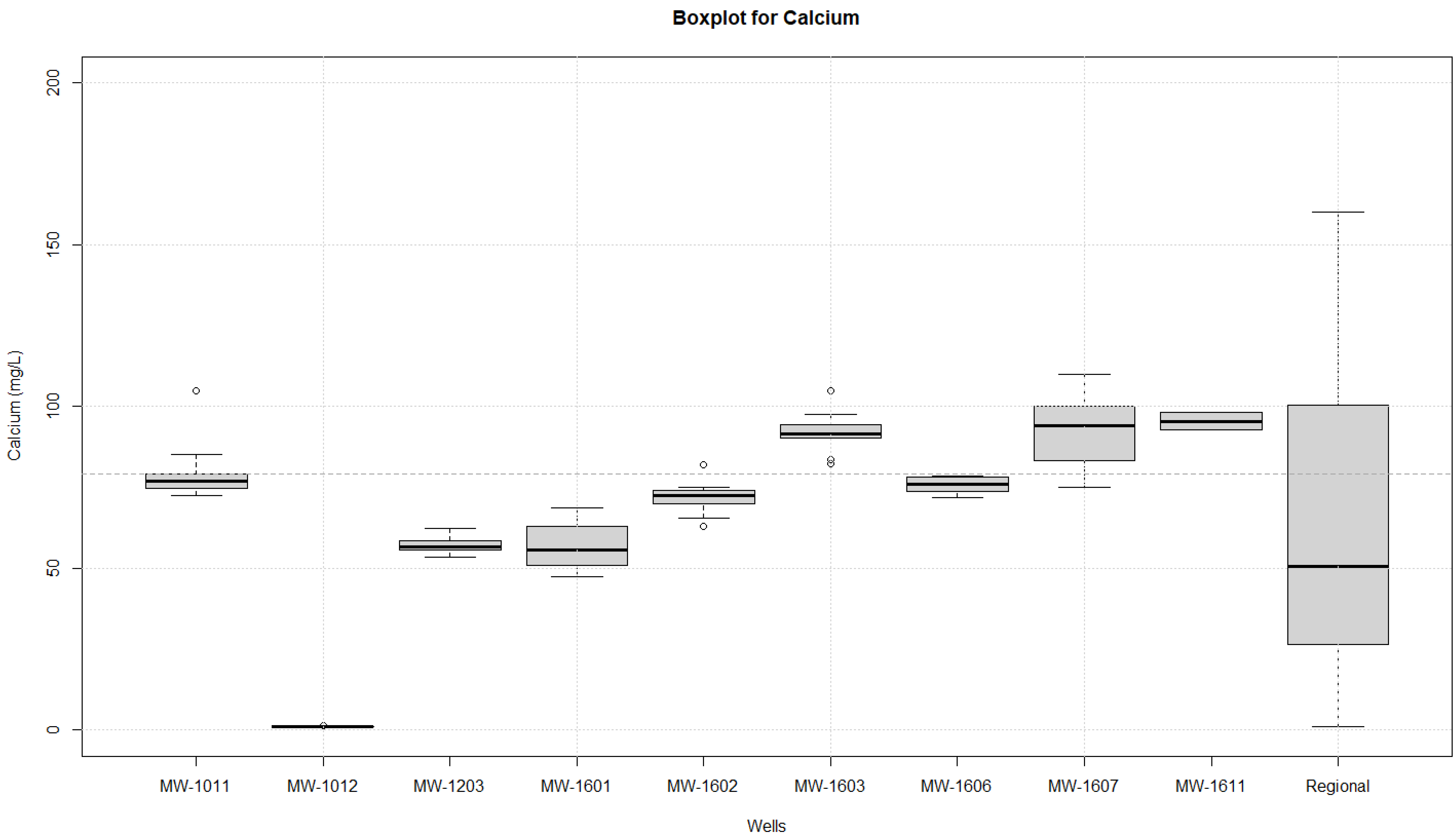
(39.5') As Above.
End of Boring.

REMARKS

(31') Bedding Joint: 5°-10° Dip, Open; Surface (Slightly Rough, Planar); Filling (Clay).

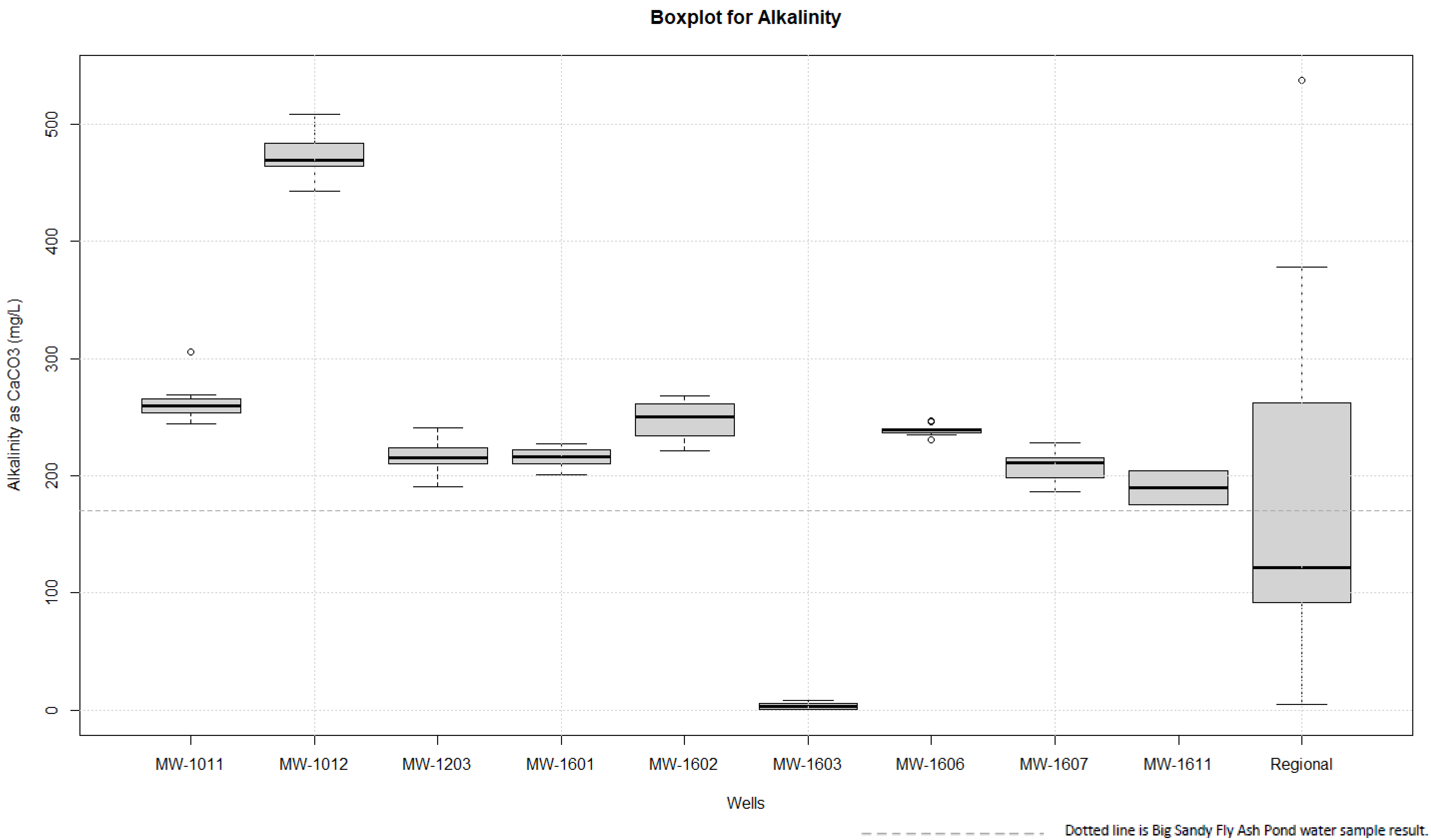
NOTES: *Northing and easting are in NAD83 Kentucky North. Elevation is in ft MSL NAVD88.
Top of casing (TOC) is 2.51 ft above ground surface. Ground surface elevation is 673.24 ft MSL.

Appendix C Box Plots



Dotted line is Big Sandy Fly Ash Pond water sample result.

EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**BOXPLOT FOR CALCIUM**	**FIGURE C1**

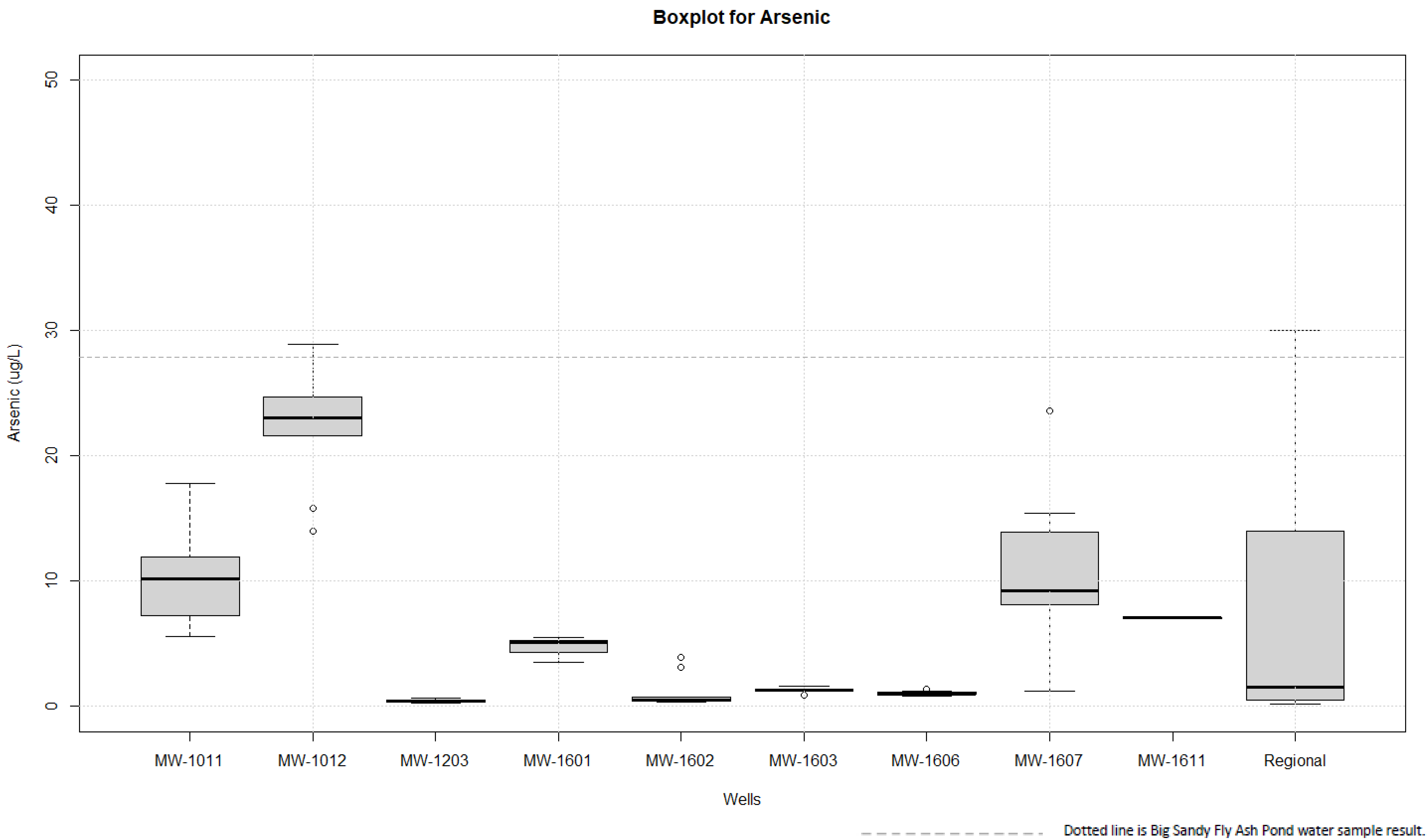


EHS Support

AMERICAN ELECTRIC POWER
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

BOXPLOT FOR ALKALINITY

FIGURE C2

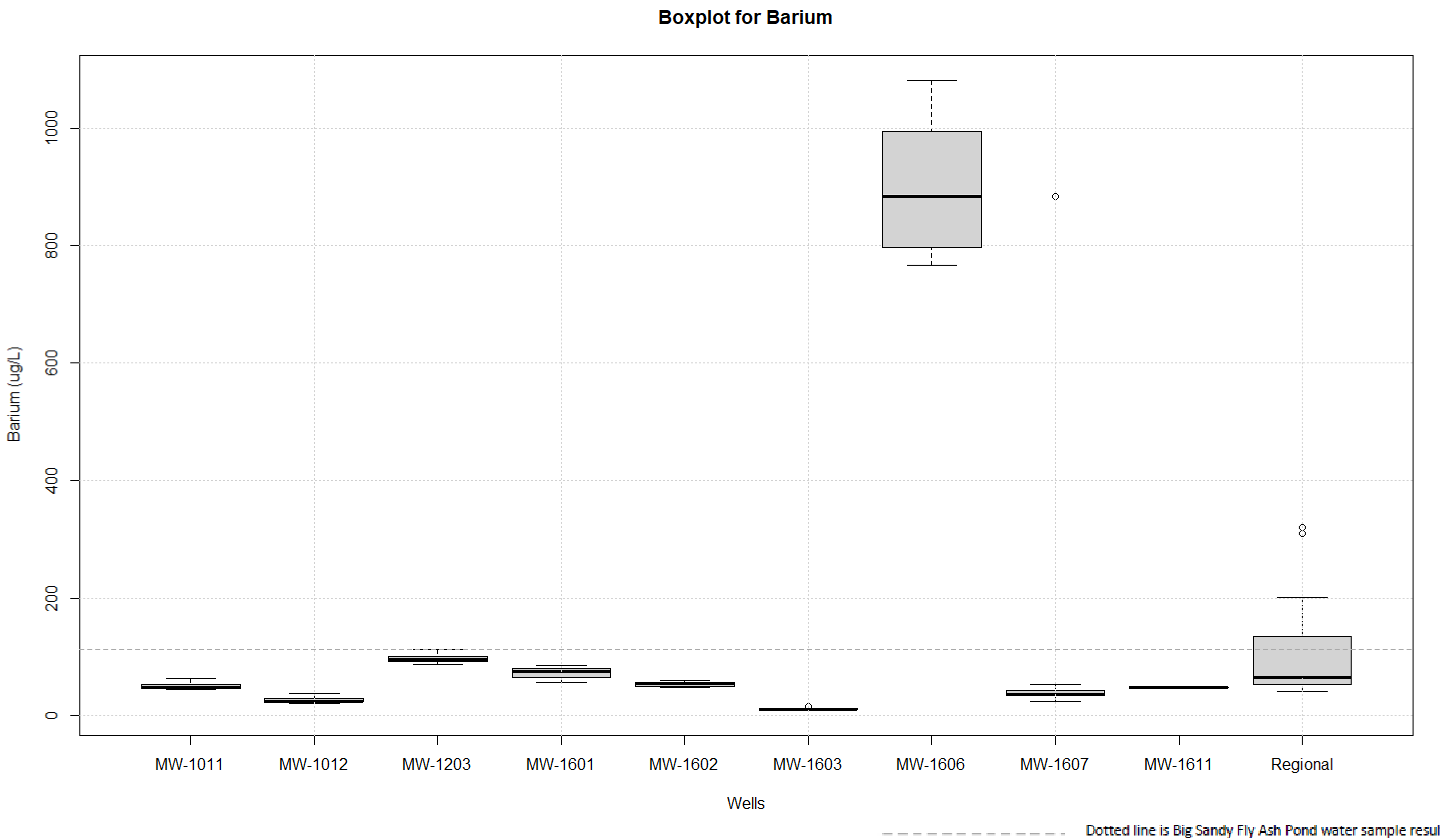


EHS Support

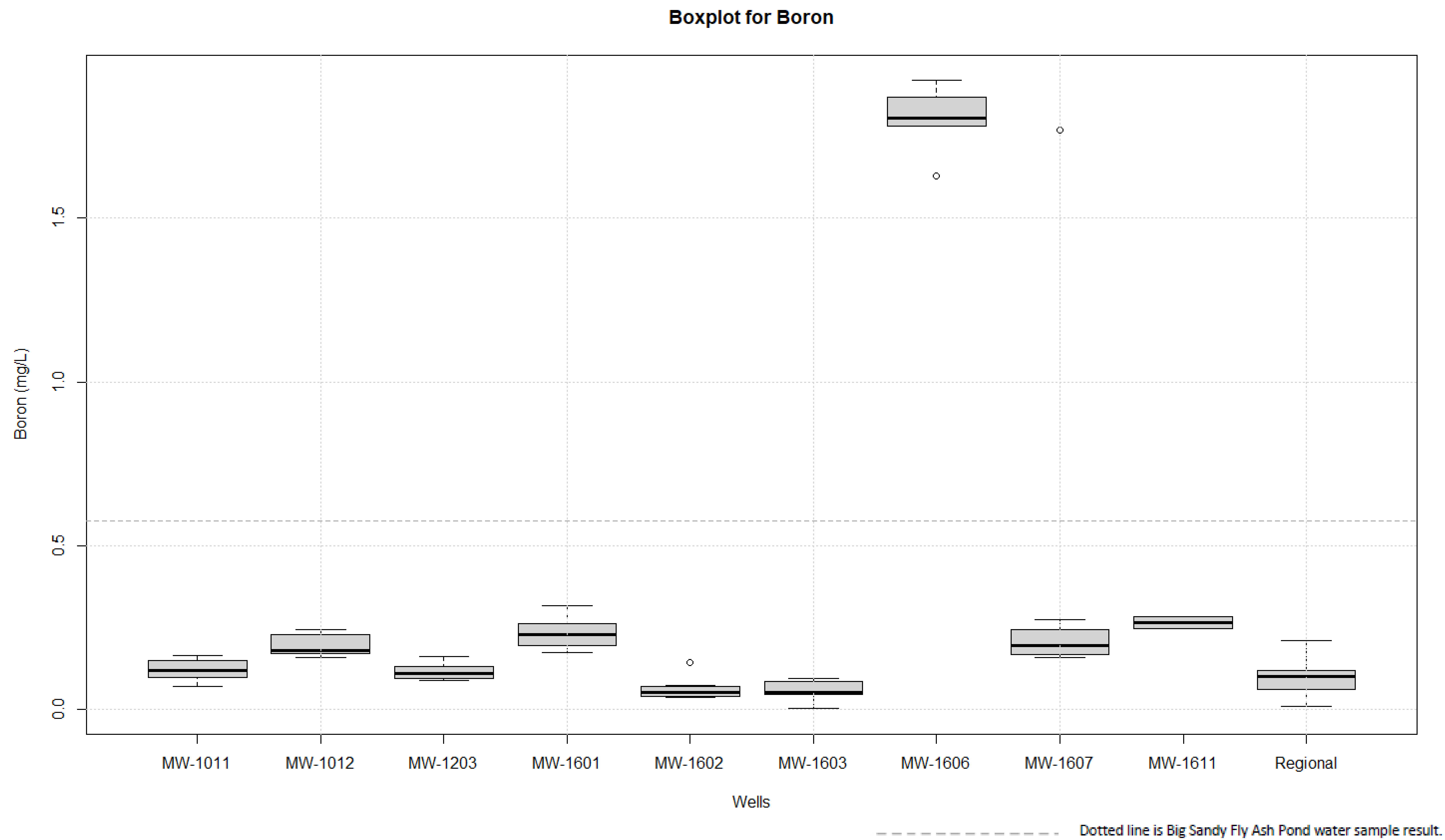
AMERICAN ELECTRIC POWER
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

BOXPLOT FOR ARSENIC

FIGURE C3



EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**BOXPLOT FOR BARIUM**	**FIGURE C4**

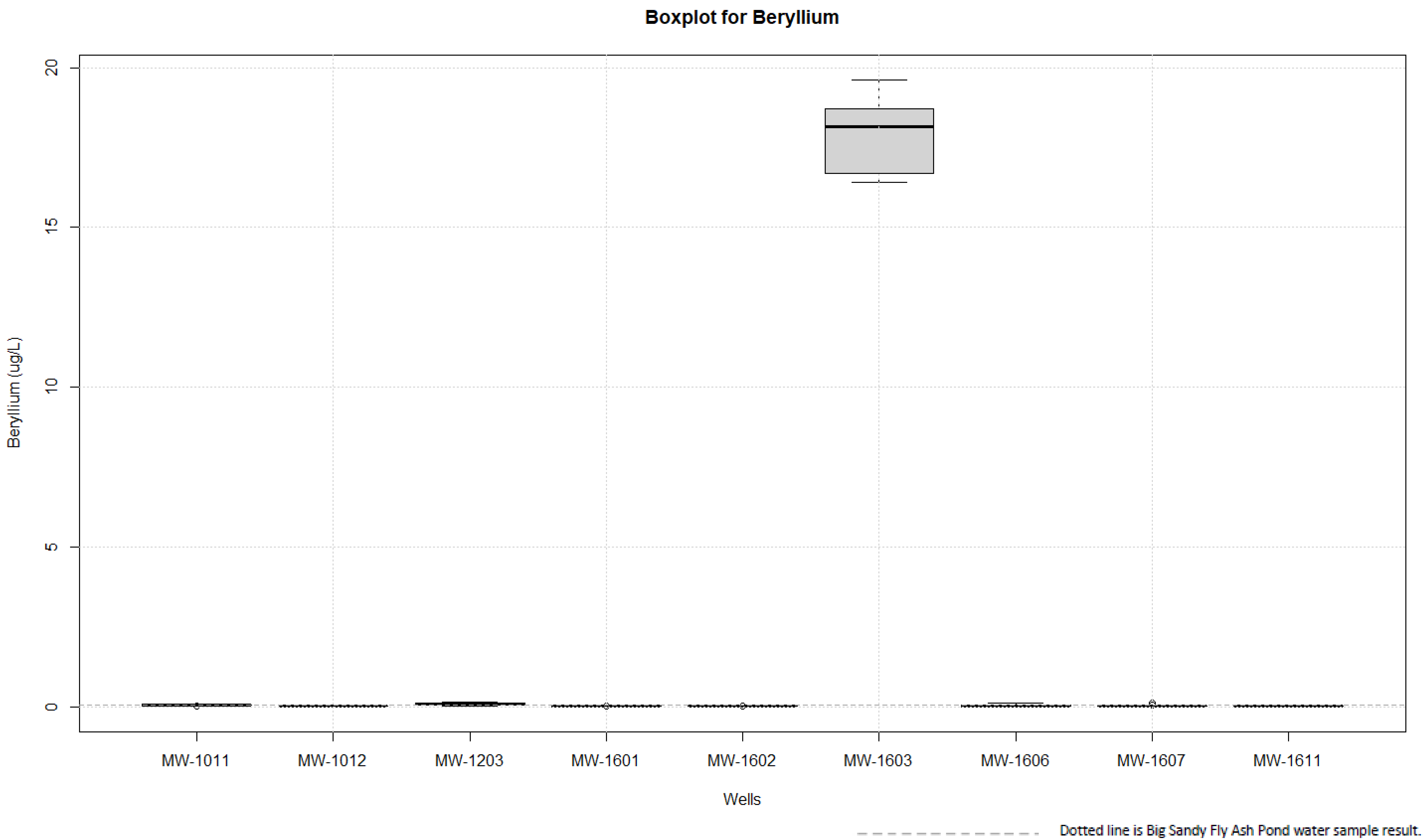


EHS Support

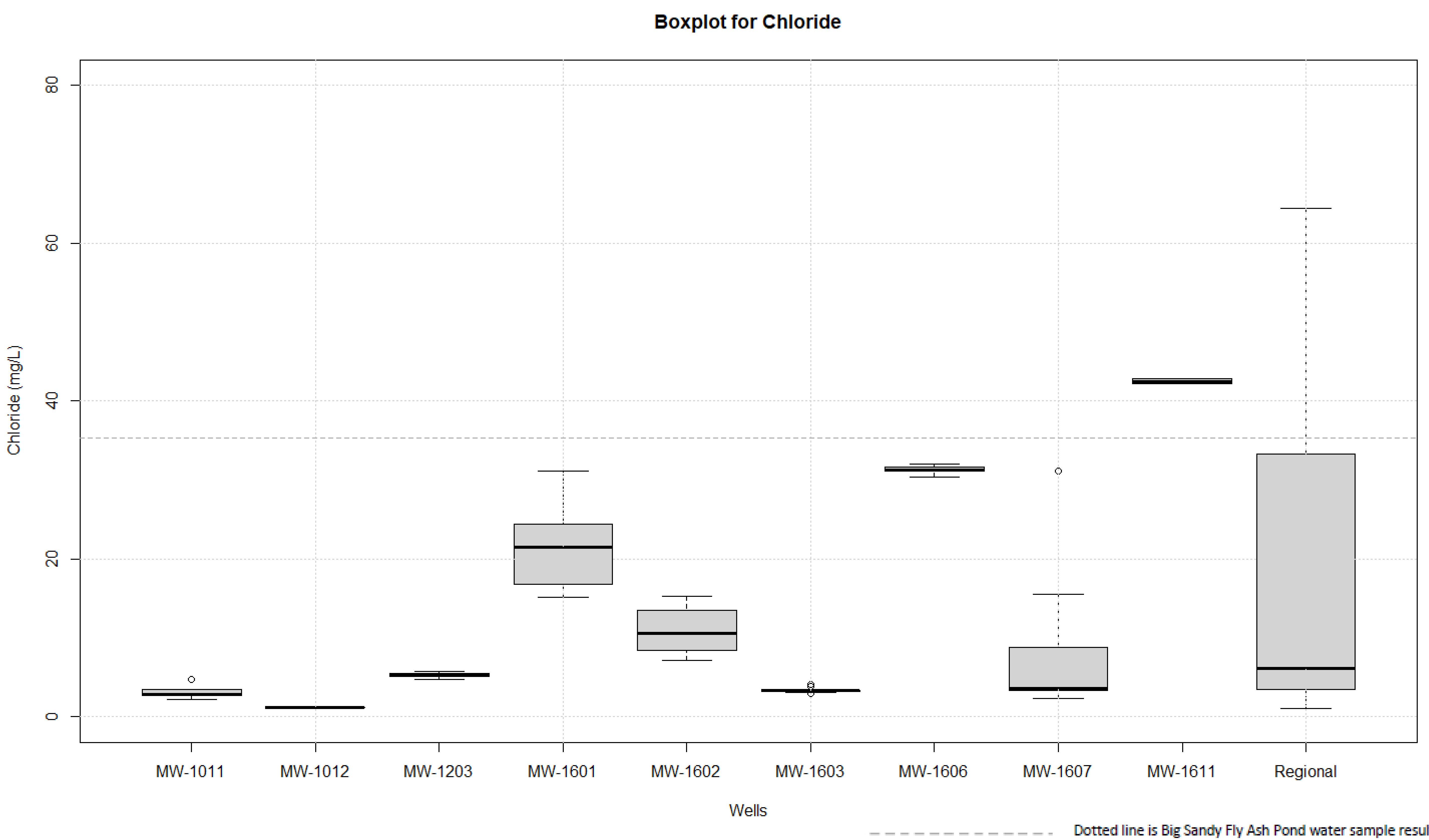
AMERICAN ELECTRIC POWER
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

BOXPLOT FOR BORON

FIGURE C5



EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**BOXPLOT FOR BERYLLIUM**	**FIGURE C6**

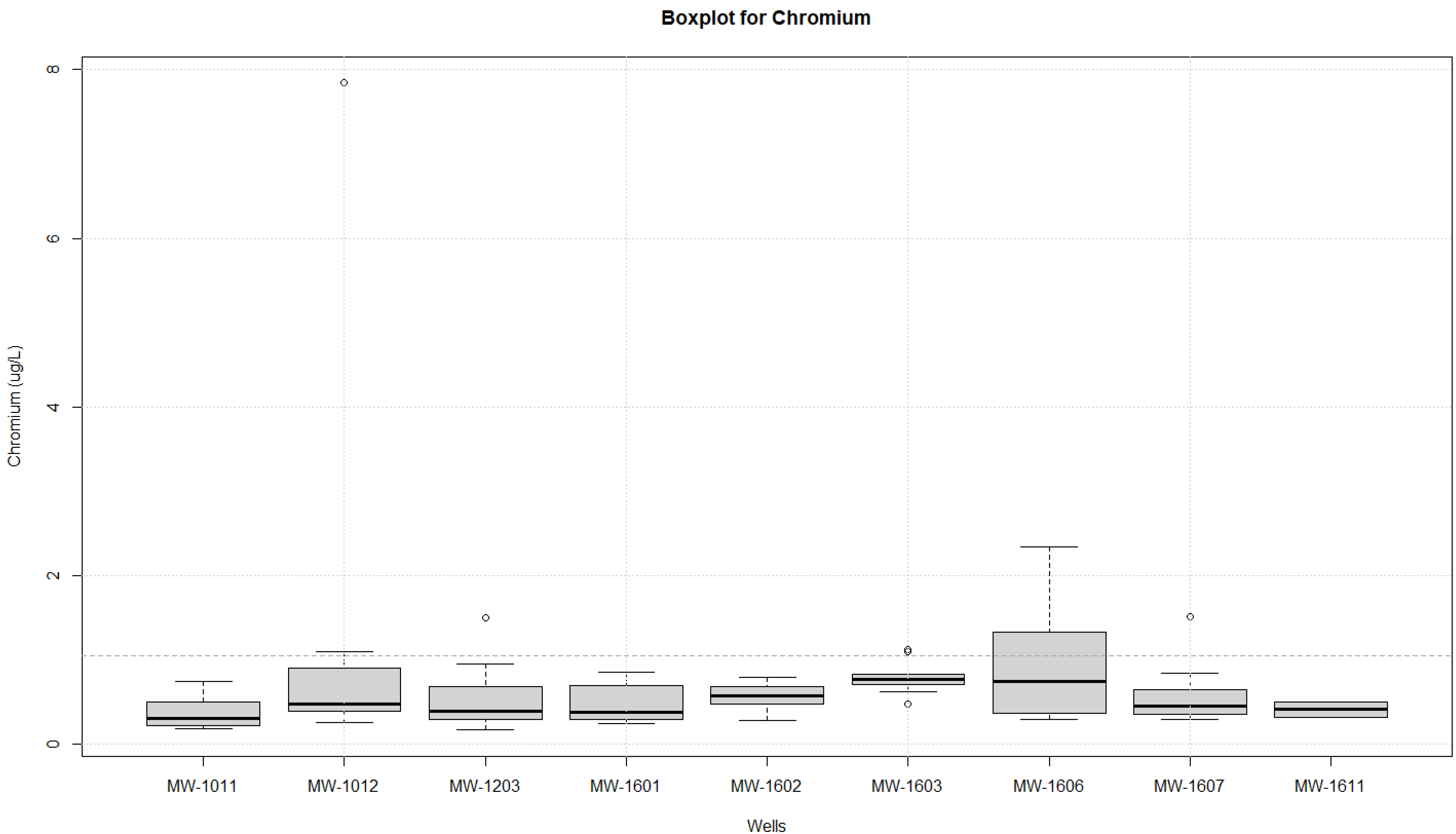


EHS Support

AMERICAN ELECTRIC POWER
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

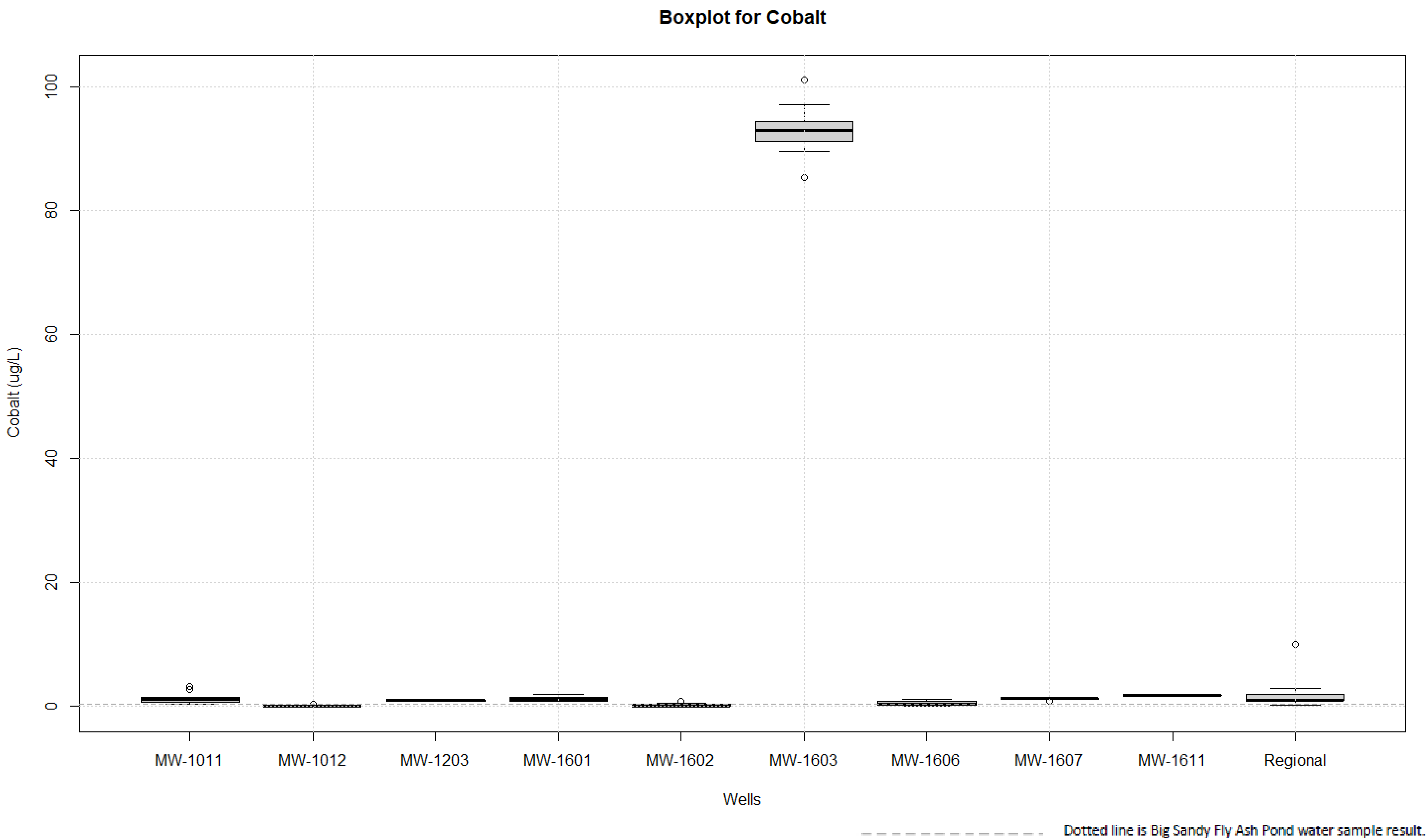
BOXPLOT FOR CHLORIDE

FIGURE C7



Dotted line is Big Sandy Fly Ash Pond water sample result.

EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**BOXPLOT FOR CHROMIUM**	**FIGURE C8**

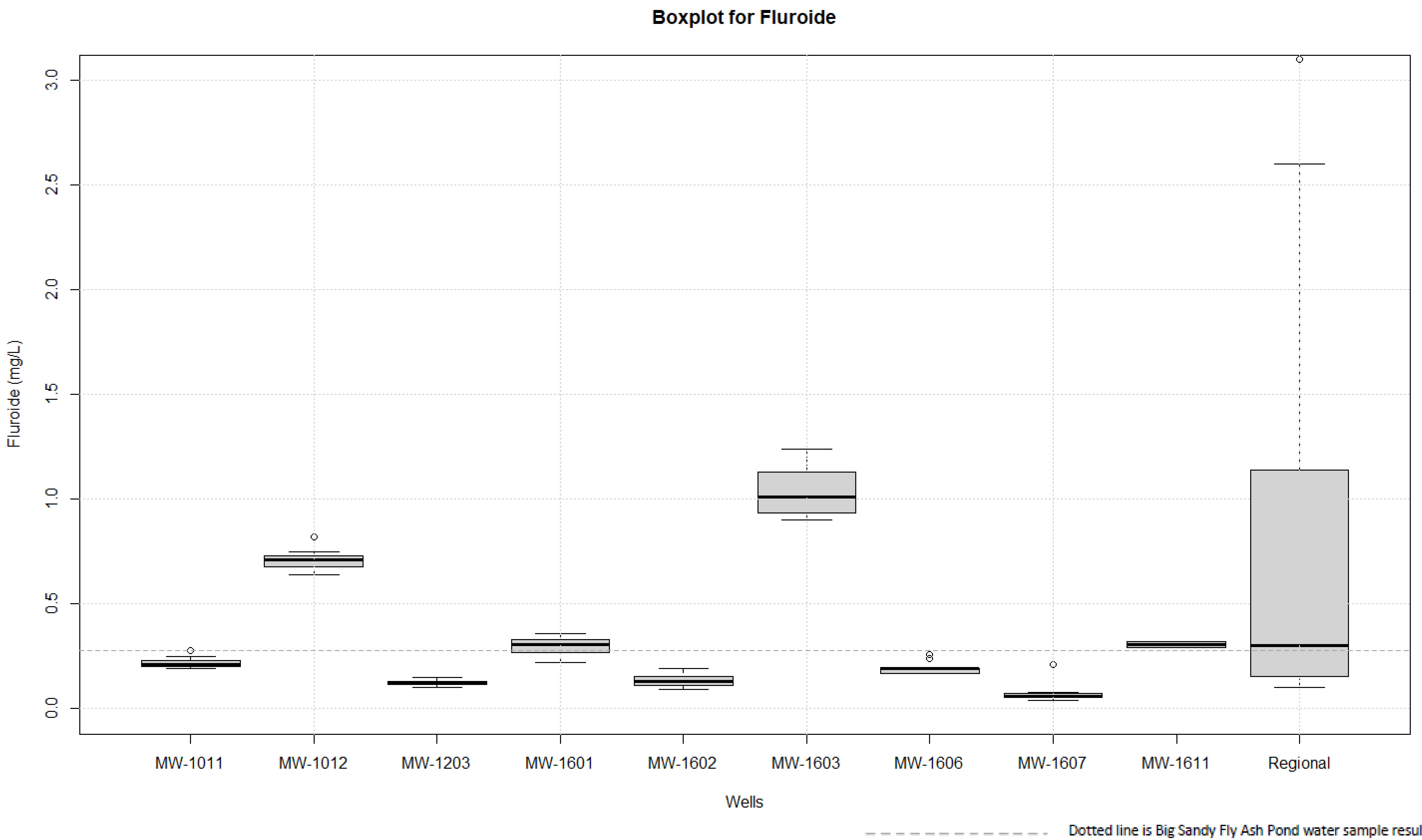


EHS Support

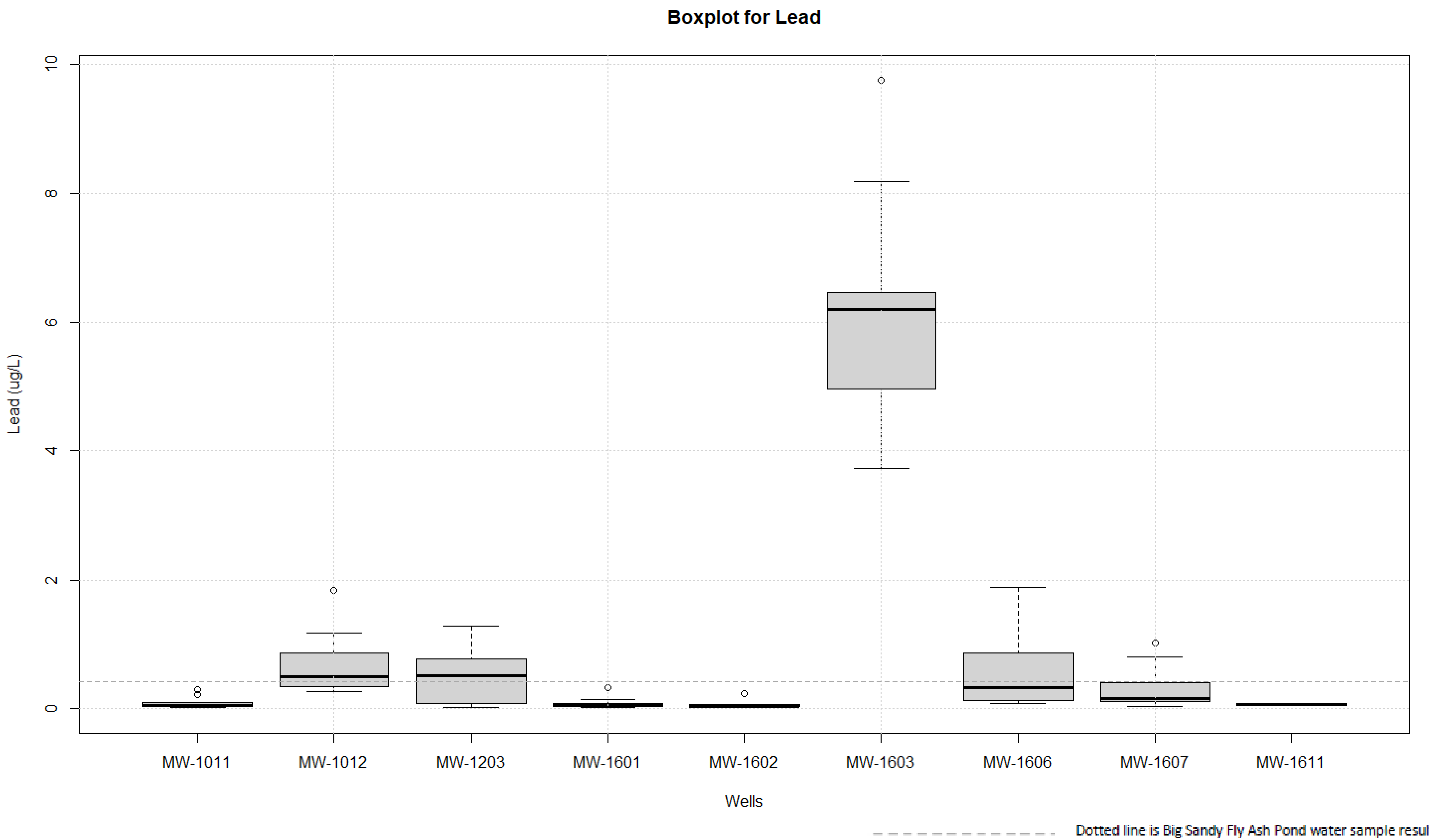
AMERICAN ELECTRIC POWER
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

BOXPLOT FOR COBALT

FIGURE C9



EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**BOXPLOT FOR FLUROIDE**	**FIGURE C10**

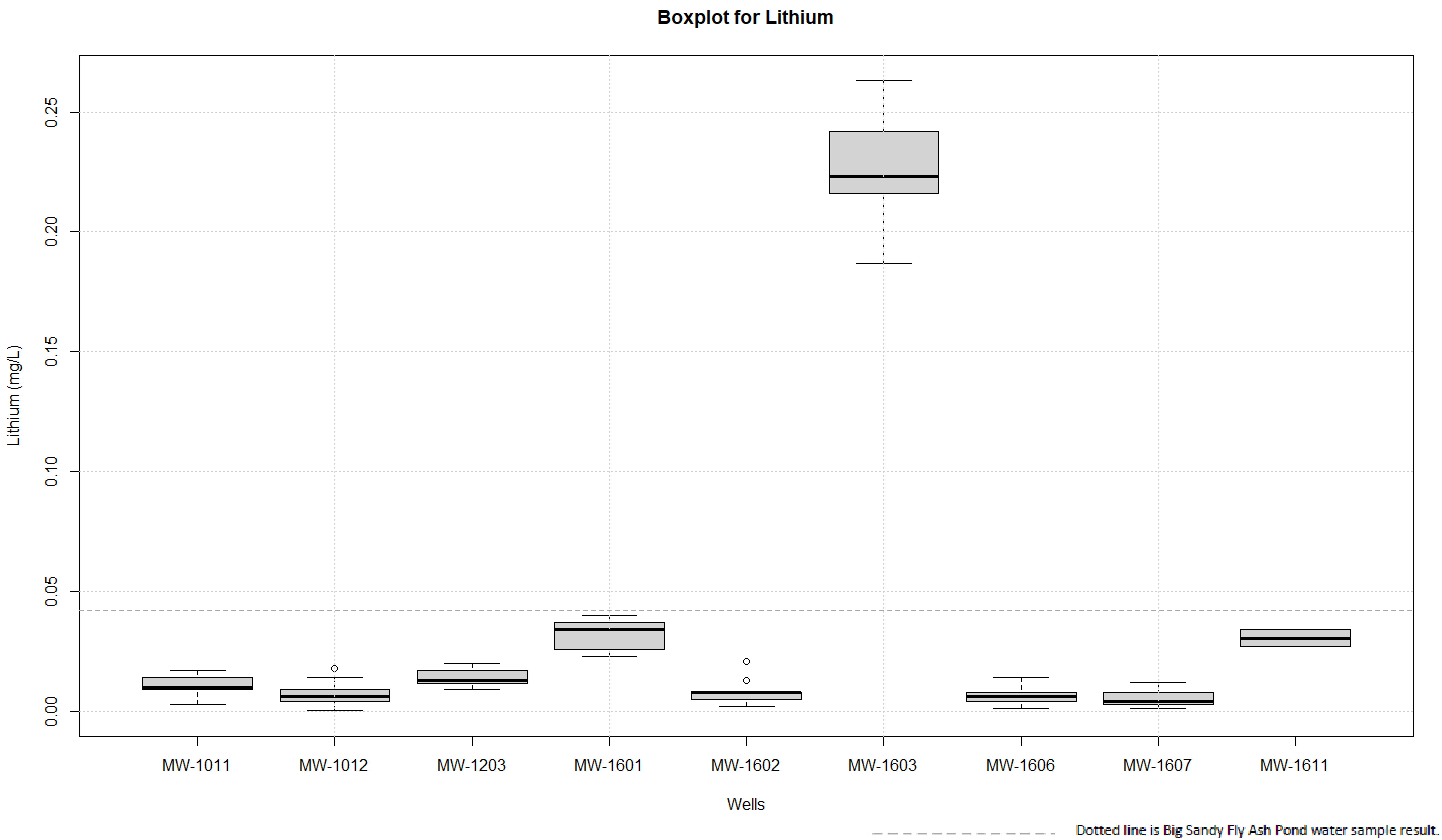


EHS Support

AMERICAN ELECTRIC POWER
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

BOXPLOT FOR LEAD

FIGURE C11

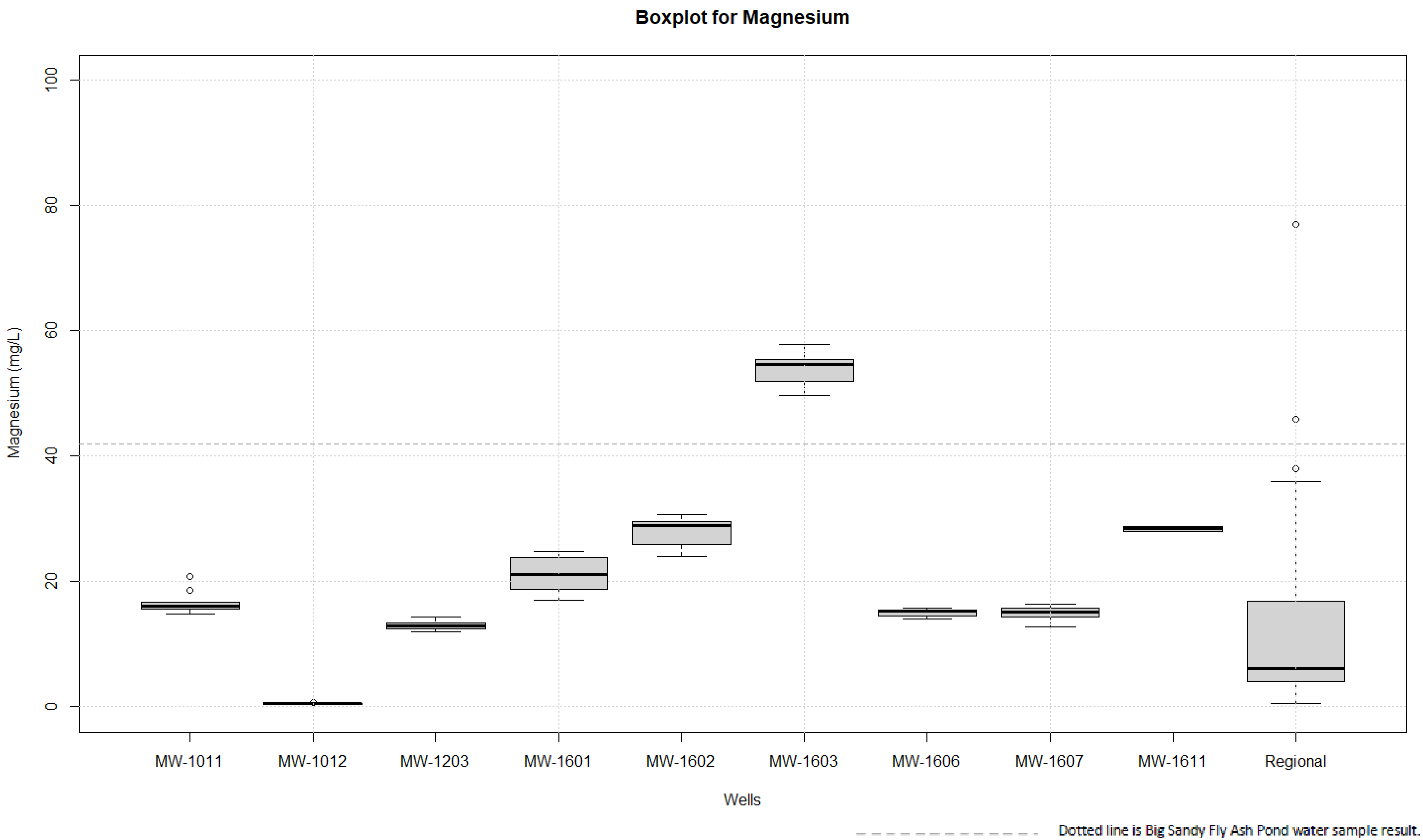


EHS Support

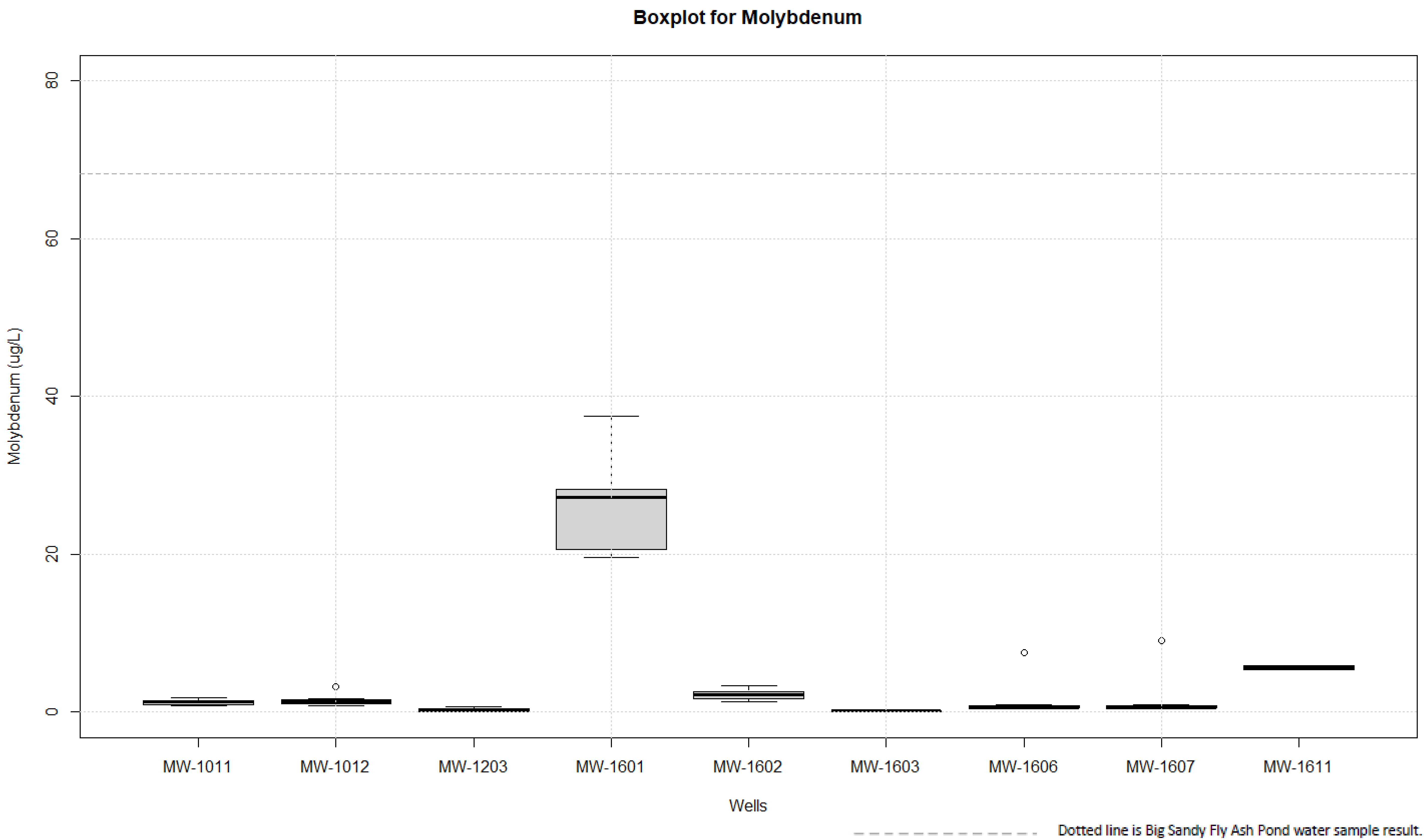
AMERICAN ELECTRIC POWER
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

BOXPLOT FOR LITHIUM

FIGURE C12



EHS Support	AMERICAN ELECTRIC POWER AEP BIG SANDY PLANT LOUISA, KENTUCKY	BOXPLOT FOR MAGNESIUM	FIGURE C13

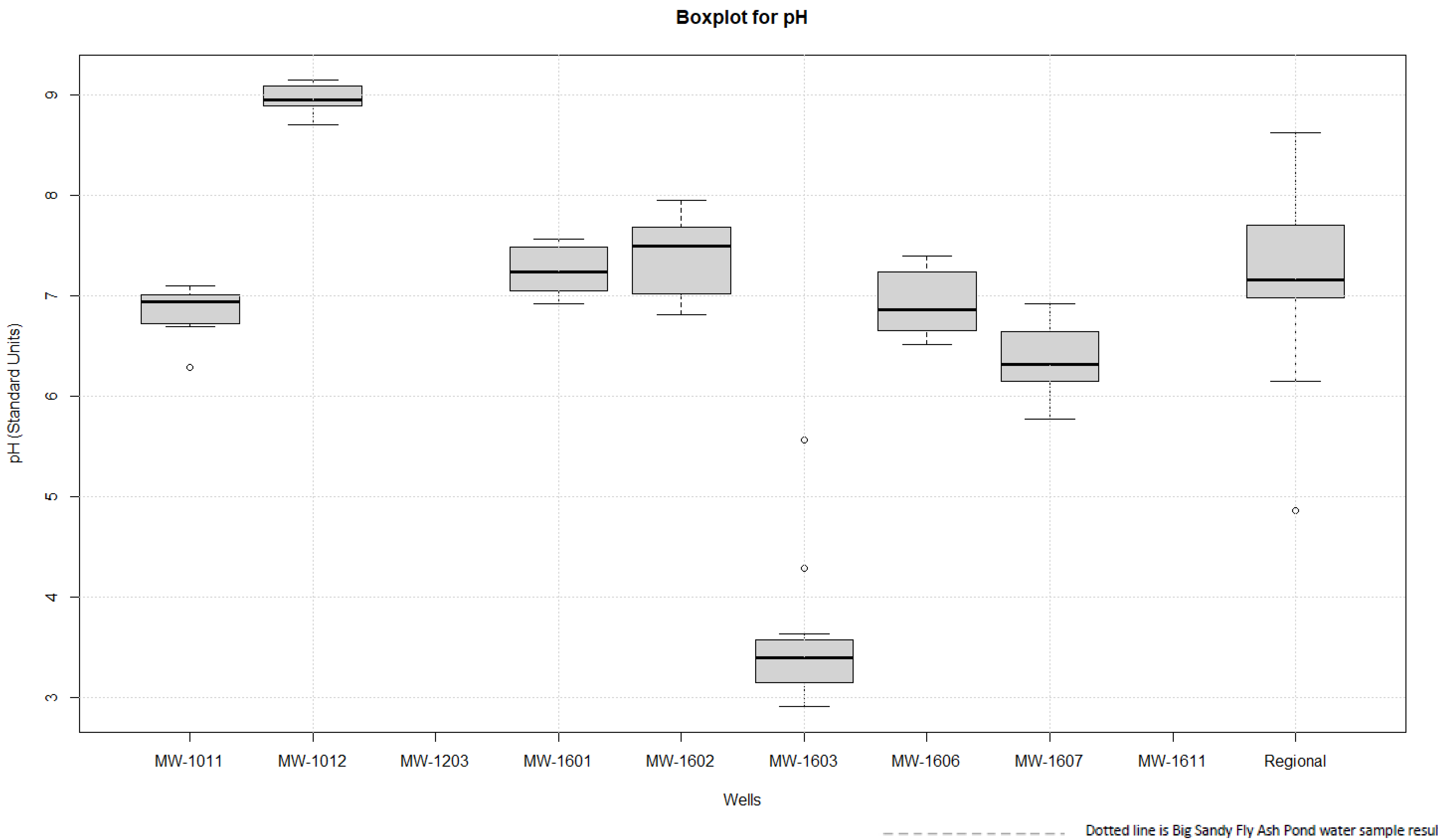


EHS Support

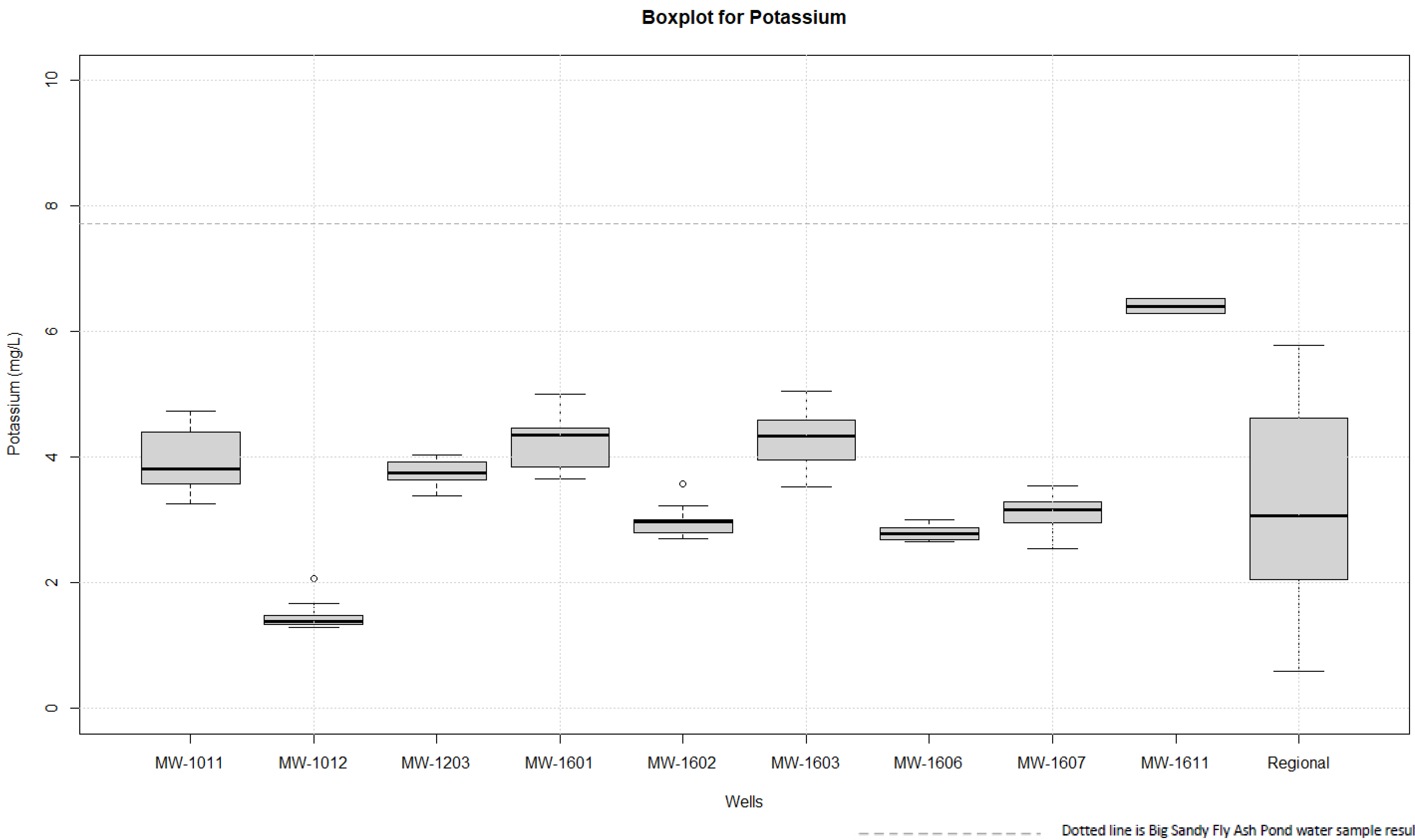
AMERICAN ELECTRIC POWER
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

BOXPLOT FOR MOLYBDENUM

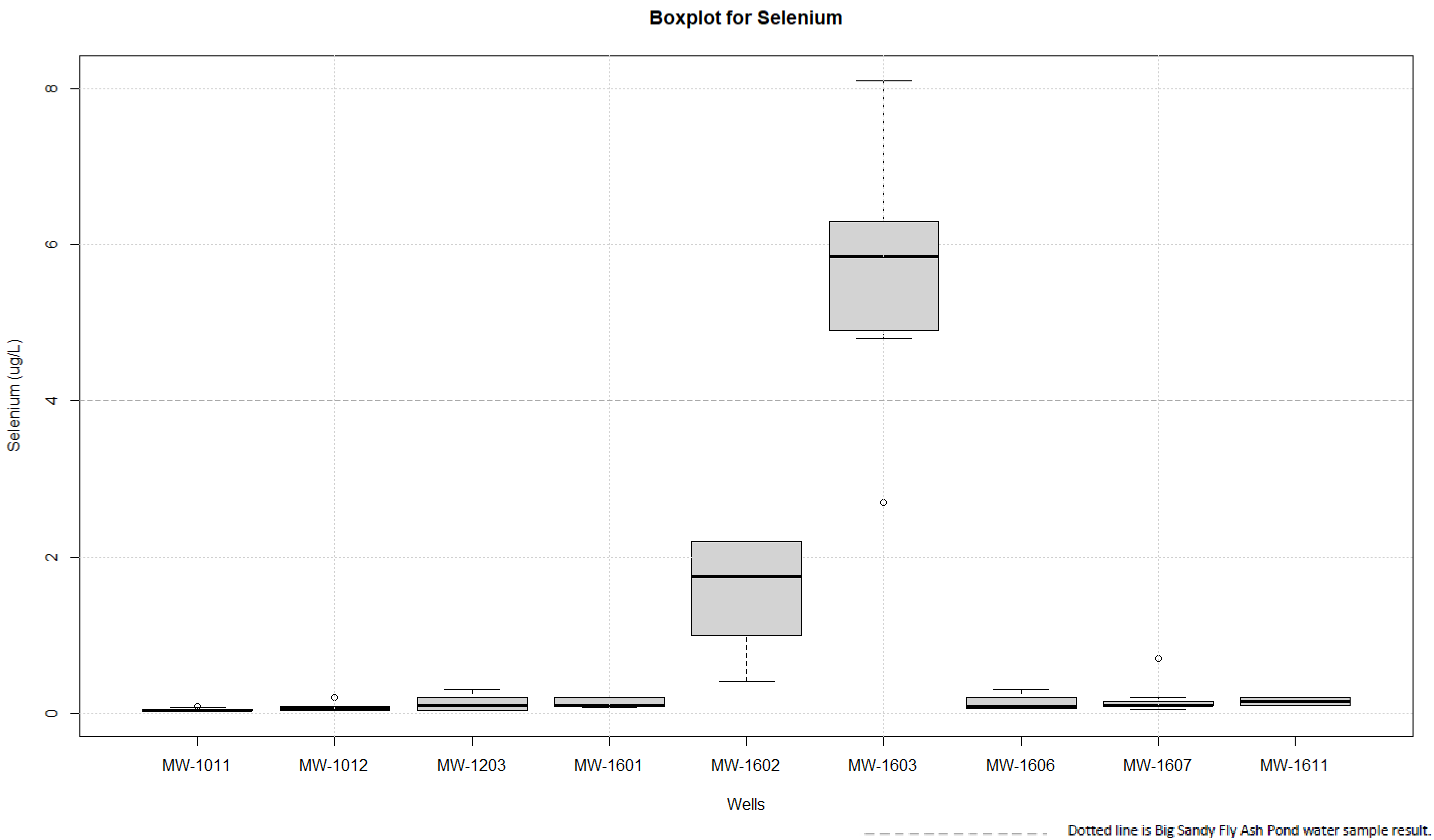
FIGURE C14



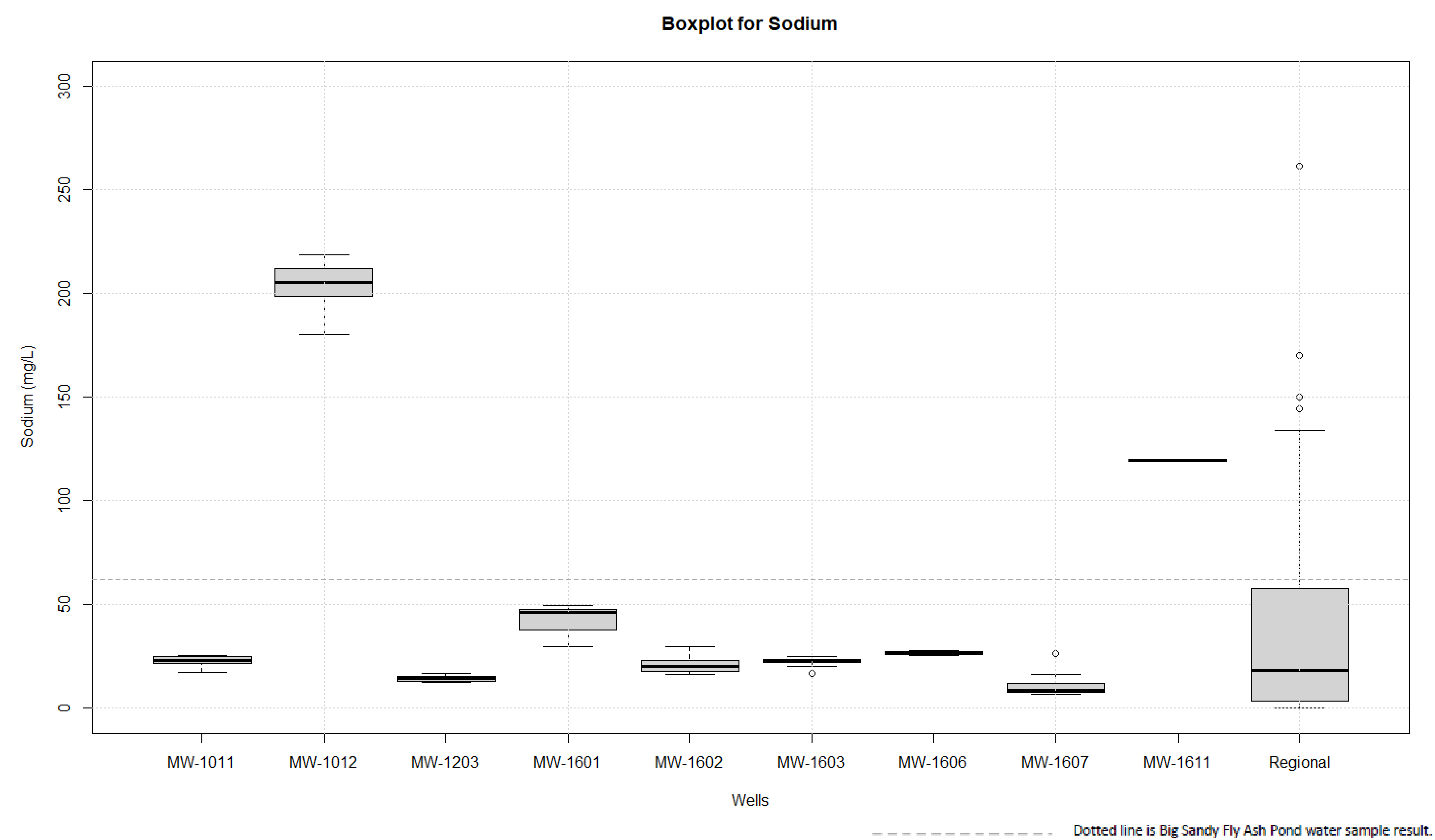
EHS Support	AMERICAN ELECTRIC POWER AEP BIG SANDY PLANT LOUISA, KENTUCKY	BOXPLOT FOR PH	FIGURE C15



EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**BOXPLOT FOR POTASSIUM**	**FIGURE C16**



EHS Support	**AMERICAN ELECTRIC POWER** AEP BIG SANDY PLANT LOUISA, KENTUCKY	**BOXPLOT FOR SELENIUM**	**FIGURE C17**

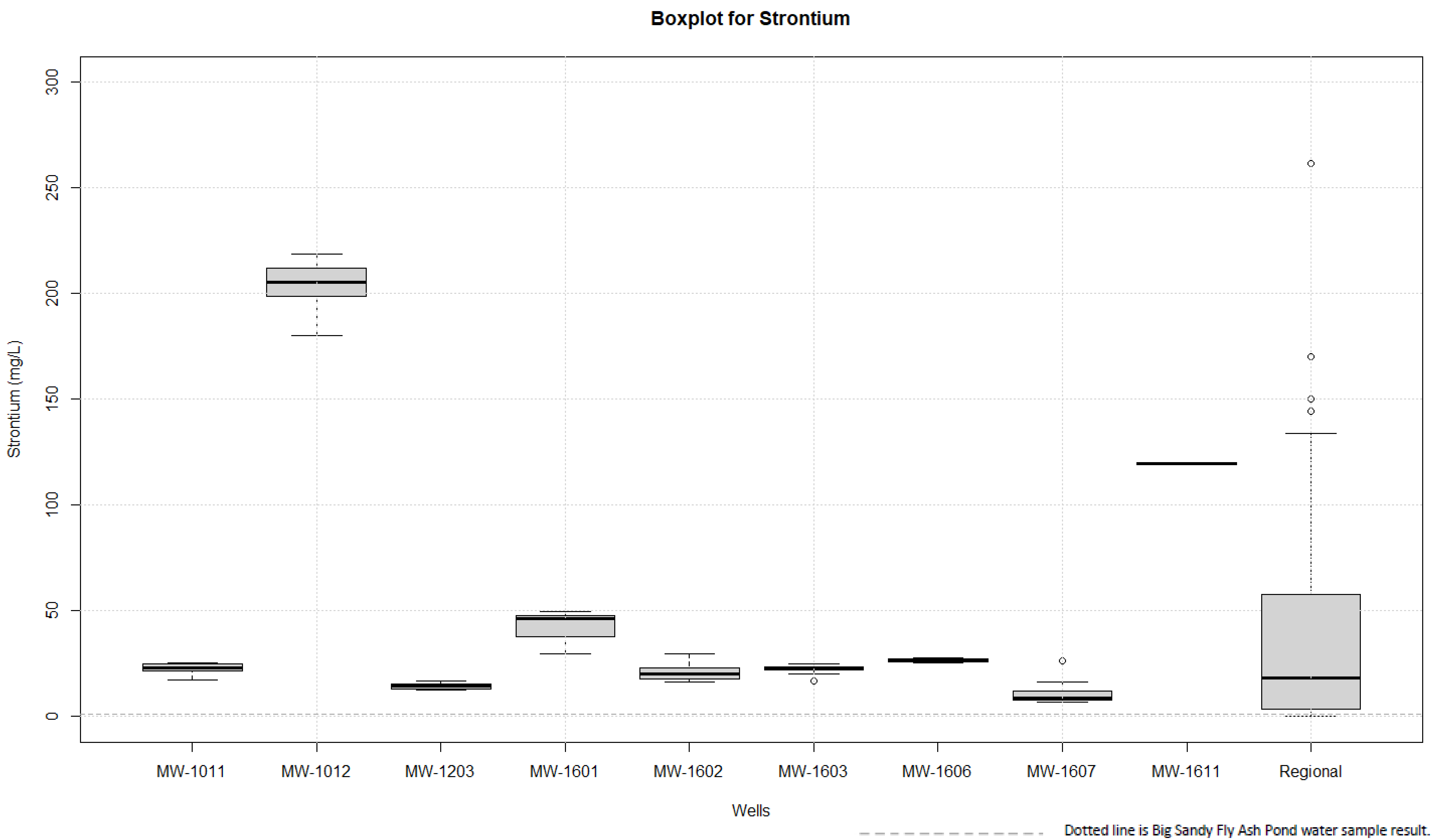


EHS Support

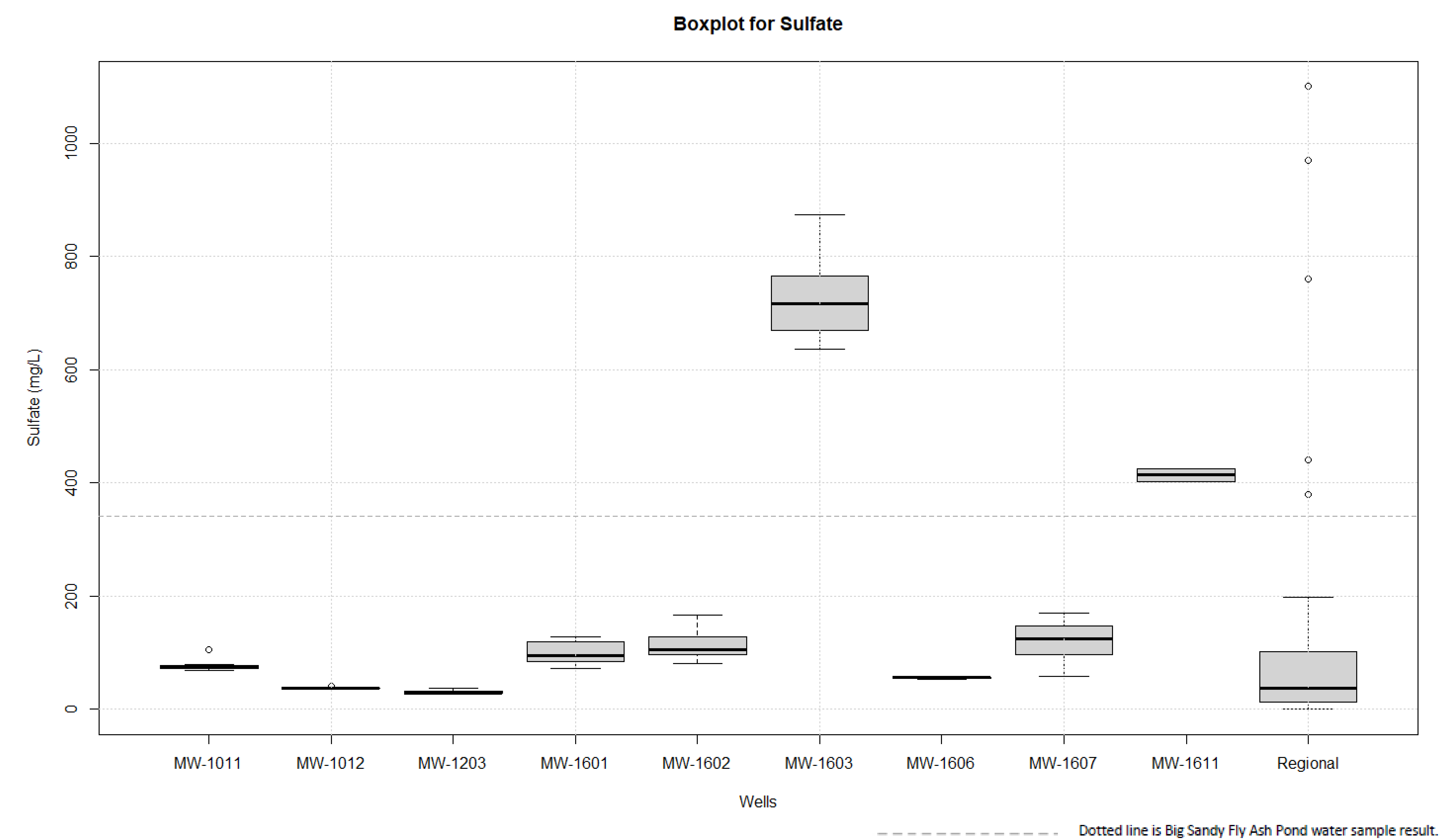
AMERICAN ELECTRIC POWER
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

BOXPLOT FOR SODIUM

FIGURE C18



EHS Support	AMERICAN ELECTRIC POWER AEP BIG SANDY PLANT LOUISA, KENTUCKY	BOXPLOT FOR STRONTIUM	FIGURE C19



EHS Support

AMERICAN ELECTRIC POWER
AEP BIG SANDY PLANT
LOUISA, KENTUCKY

BOXPLOT FOR SULFATE

FIGURE C20

Alternative Source Demonstration Addendum Report for Beryllium, Cobalt and Lithium

Big Sandy Fly Ash Pond
Louisa, Kentucky

Prepared for:

American Electric Power

Prepared by:

EHS Support

September 2019

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Acronyms

<	less than
µg/L	micrograms per liter
ASD	alternative source demonstration
bgs	below ground surface
BSFAP	Big Sandy Fly Ash Pond
CCR	Coal Combustion Residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
ft	foot/feet
J	estimated concentration below the reporting level and greater than equal to the method detection limit
KGS	Kentucky Geological Survey
mg/L	milligrams per liter
msl	mean sea level
MDL	Method Detection Limit
mV	millivolts
MW	monitoring well
ORP	oxidation reduction potential
SSL	statistically significant levels
S.U.	standard units (pH)
U	not detected
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

Certification by Qualified Professional Engineer

I certify that the alternative source demonstration (ASD) conducted and presented within this report is accurate and appropriate for evaluating the groundwater monitoring data for the Big Sandy Fly Ash Pond Coal Combustion Residual (CCR) management area associated with the Big Sandy Power Plant located in Louisa, Kentucky. This ASD meets the requirements of the United States Environmental Protection Agency CCR Rule defined at 40 Code of Federal Regulations 257.95(g)(3)(ii).

Jonathan Patrick Waddell

Printed Name of Licensed Professional Engineer

Signature

31526

License Number

KY

Licensing State

9/19/2019

Date

1 Introduction

EHS Support LLC ("EHS Support") was retained by American Electric Power, Kentucky Power Company ("AEP") in December 2018 to conduct an alternative source demonstration (ASD) investigation for beryllium, cobalt and lithium at the Big Sandy Fly Ash Pond (BSFAP) associated with the Big Sandy Power Plant located in Louisa, Kentucky (**Figure 1,** attached) (EHS Support, 2019). The ASD determined that groundwater in the vicinity of the BSFAP is not being impacted by coal combustion residual (CCR) constituents from the BSFAP, but rather the elevated beryllium, cobalt, and lithium concentrations that triggered the ASD assessment are due to the oxidation of coal seams that have been intersected by well location MW-1603.

Since the initial ASD was completed (incorporating data from September 2016 to October 2018), statistically significant levels (SSLs) of beryllium, cobalt, and lithium exceeding the groundwater protection standards have persisted through the subsequent March 2019 sampling event in one groundwater monitoring location, MW-1603. All other March 2019 groundwater quality results were below the level of statistical significance.

This ASD addendum for beryllium, cobalt and lithium in MW-1603 groundwater has been prepared per the requirements of the United States Environmental Protection Agency (USEPA) CCR Rule (40 Code of Federal Regulations [CFR] §257.95).

1.1 Objectives

The ASD investigation objective is to assess groundwater monitoring data collected in compliance with the CCR Rule as allowed under paragraph 40 CFR §257.95(g)(3)(ii) of the CCR Rule. This part of the rule allows AEP to determine whether the source(s) for SSLs of beryllium, cobalt, and lithium exceeding the groundwater protection standards reported from groundwater monitoring well MW-1603 are associated with the CCR unit, or if the SSL resulted from an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

1.2 Lines of Evidence

This ASD addendum for the BSFAP has been conducted to further evaluate potential alternate sources or reasons for the continuing SSLs of beryllium, cobalt, and lithium within monitoring well MW-1603.

A potential alternate source was previously established as evident in (EHS Support, 2019), based on the following lines of evidence:

- Lack of exceedances and increasing trends of primary indicators of CCR
- BSFAP water concentrations are lower than those of the corresponding constituent observed in groundwater
- Major ion chemistry does not indicate mixing between BSFAP water and groundwater.

For the purposes of this ASD investigation, constituents were identified that would serve as a primary indicator for coal ash leachate. A primary indicator must meet **both** of the following criteria:

1. Constituent that typically has high concentration in leachate, relative to background, such that it is expected to have elevated concentration in the event of a release
2. Constituent that is not reactive and has high mobility in groundwater such that it is expected to be at the leading edge of the plume, meaning that it will have elevated concentrations relative to background across the entire area of the plume.

As boron and sulfate are primary indicators for coal ash leachate (Electric Power Research Institute [“EPRI”], 2012) and have previously been evaluated, they have been re-evaluated herein as primary indicators for this ASD investigation. Other potential indicators that were evaluated in this ASD investigation include: chloride, potassium, sodium, fluoride, molybdenum, and bromide.

2 Project Background

A detailed description of site location, history, and geology was previously provided in the *Alternative Source Demonstration Report for Beryllium, Cobalt and Lithium, Big Sandy Fly Ash Pond, Louisa, Kentucky* (EHS Support, 2019). Attached **Figures 1** and **2** show the site layout and groundwater monitoring network.

To support this ASD, the following sections on the groundwater monitoring network and groundwater monitoring are included to provide context to the ASD investigation.

2.1 Groundwater Monitoring Network Evaluation

On behalf of AEP, Geosyntec Consultants, Inc. ("Geosyntec") conducted an assessment of the groundwater monitoring network in the uppermost aquifer associated with the BSFAP (Geosyntec, 2016). Geosyntec determined that the hydrostratigraphy in the vicinity of the BSFAP is characterized by an interconnected water-bearing system comprised of Pennsylvanian-aged bedrock of the Breathitt Group and the Quaternary alluvium. The Conemaugh Formation and Breathitt Group consists of sandstones, siltstones, shale, and coal that may grade laterally and vertically into one another. The overlying Quaternary alluvium deposits include sandy lean clay to silty sand and gravel at the bottom of the Horseford Creek valley and the floodplain of the Blaine Creek. Based on these hydrogeologic conditions, Geosyntec defined the interconnected water-bearing system of the fractured bedrock and alluvium as the uppermost aquifer for the BSFAP CCR unit. This determination was based on the presence of groundwater in numerous monitoring wells screened in the water- bearing units, the recovery of these wells during pumping and development, and a potentiometric surface generally consistent with site topography and surface water elevations.

To assess the upper water-bearing aquifer, Geosyntec identified the groundwater monitoring network as consisting of 10 groundwater monitoring wells to provide detection monitoring in the uppermost aquifer (fractured bedrock and alluvium) (Geosyntec, 2016). Of these, six monitoring wells (MW-1011, MW-1012, MW-1203, MW-1601, MW-1602, and MW-1603) are screened in fractured sandstone and shale layers of the Breathitt formation. The remaining four monitoring wells (MW-1604 through MW-1607) are screened in the alluvium. The location of each groundwater monitoring well within the uppermost aquifer is shown in **Figure 2**.

Three of the monitoring wells (MW-1011, MW-1012, and MW-1203) screened in bedrock were installed on the hillside slopes upgradient of the BSFAP to support background monitoring. The remaining three monitoring wells (MW-1601, MW-1602, and MW-1603) installed in bedrock are located downgradient of the BSFAP and used for compliance monitoring. Two monitoring wells (MW-1604 and MW-1605) screened in alluvium are used for background monitoring; while two other monitoring wells (MW-1606 and MW-1607), screened in alluvium and located below the Main Dam, are used for compliance monitoring.

As bedrock monitoring well MW-1603 is the focus of this ASD, the boring log (EHS Support, 2019) exhibits alternating sequences of yellowish-brown sandstones and bluish-gray to black shales (beginning at 13 feet below ground surface [ft bgs] and extending to the bottom of the boring at 39.5 ft bgs) that are indicative of the upper portion of the Princess Formation (uppermost formation in the Breathitt

Group [Rice, C. and Hiett, J., 1994]). Within the screened interval (22 to 32 ft bgs), a description of the shale at a depth of 24 to 25 ft bgs was “intensely fractured, black, wet, nearly all organic matter; slight coaly texture.” This elevation corresponds with the measurements by the Kentucky Geologic Society (KGS) of the elevation of the Princess Number 8 coal (EHS Support, 2019). A coal or “organic material” also was logged in three other monitoring wells (MW-1608, MW-1609, and MW-1610) in the network (**Table 2-1**) at the same approximate elevation between 630 and 650 feet that matches the KGS measurements. Three monitoring wells did not document any coal in this section (MW-1601, MW-1602, and MW-1611) and four monitoring wells were installed below this coal layer in the sedimentary sequence (MW-1604, MW-1605, MW-1606, and MW-1607).

Table 2-1 Screened Interval of Monitoring Wells

Well/Boring	Surface Elevation (ft msl)	Screened Interval (ft msl)	Coal or “Organics” Description at 632-650 ft?
MW-1601	713.8	646.8-636.8	No coal logged
MW-1602	711.6	632.1-622.1	No coal logged
MW-1603	673.2	651.2-641.2	Yes, at a depth of ~25 ft (Elevation of 648 ft)
MW-1604	553.1	513.1-503.1	---
MW-1605	554.4	538.9-528.9	---
MW-1606	551	513.1-503.1	---
MW-1607	542.2	518.7-508.7	---
MW-1608	716.2	606.6-596.6	Yes, at depths of ~74 ft (Elevation of 642 ft), ~ 75.3 to 76.6 ft (Elevation of 641 to 640 ft) and ~ 83.5 to 84 ft (Elevation of 633 to 632 ft)
MW-1609	~728	---	Yes, at a depth of ~79 ft (Elevation of 649 ft)
MW-1610	~716	---	Yes, at a depth of ~81 ft (Elevation of 635 ft)
MW-1611	~711	606-596	No coal logged

--- = Boring advanced below the coal interval
Not logged = Boring log has no description of coal or “organics” in the interval between 632 to 650 ft msl
~ = Approximate
ft = feet
msl = mean sea level

Geosyntec determined that the groundwater monitoring well network described above meets the requirements of 40 CFR §257.91, as it consists of a sufficient number of wells installed at the appropriate locations and depths to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater and groundwater passing the waste boundary of the BSFAP.

2.2 Groundwater Monitoring

AEP has conducted groundwater monitoring of the uppermost aquifer to meet the requirements of the CCR Rules. Groundwater monitoring generally included the following activities:

- Collection of groundwater samples and analysis for Appendix III and Appendix IV constituents, as specified in 40 CFR §257.94 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan* (AEP and EHS Support, October 2016)
- Completion of validation tests for groundwater data, including tests for completeness, valid values, transcription errors, and consistent units
- Establishment of background data for each Appendix III and Appendix IV constituent.
- Initiation of detection monitoring sampling and analysis
- Evaluation of the groundwater data using a statistical process in accordance with 40 CFR §257.93, which was prepared, certified, and posted to AEP's CCR website in April 2017 in AEP's *Statistical Analysis Plan* (Geosyntec, January 2017). The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009)
- Initiation of assessment monitoring sampling and analysis
- Completion of statistical data evaluation and determination of groundwater protection standards

Assessment monitoring for the BSFAP has been conducted on a semi-annual basis since April 2018. The groundwater data up until and including the March 2019 monitoring event has been used for this review. Specifically, beryllium, cobalt and lithium in well MW-1603 that were identified as continuing to exhibit a SSLs. Assessment monitoring data for well MW-1603 is provided in **Table 2-2** below.

Table 2-2 MW-1603 March 2019 Groundwater Quality

Analyte	Unit	Value
Antimony	µg/L	<0.2
Arsenic	µg/L	1.26
Barium	µg/L	12
Beryllium	µg/L	24.4
Boron	mg/L	0.05
Cadmium	µg/L	0.78
Calcium	mg/L	84.6
Chloride	mg/L	4.42
Chromium	µg/L	1
Cobalt	µg/L	87.9
Fluoride	mg/L	0.92
Lead	µg/L	4.28
Lithium	mg/L	0.209

Analyte	Unit	Value
Mercury	µg/L	<0.002
Molybdenum	µg/L	<4
pH	Std. Units	3.19
Residue, Filterable, TDS	mg/L	896
Selenium	µg/L	4
Sulfate	mg/L	709

< = less than
µg/L = micrograms per liter
J = estimated concentration
mg = milligrams per liter
TDS = total dissolved solids

3 Alternative Source Demonstration Requirements

3.1 Alternative Source Demonstration

Potential causes that may support the ASD may include, but are not limited to, sampling causes (ASD Type I), laboratory causes (ASD Type II), statistical evaluation causes (ASD Type III) and/or natural variation causes (ASD Type IV). This ASD for the BSFAP will be focused on assessing whether Type IV natural variations in groundwater could be the cause of statistically significant exceedances of beryllium, cobalt and lithium reported from groundwater monitoring well MW-1603.

Historical groundwater monitoring data for MW-1603 is provided as **Table 1**.

3.2 Water Monitoring Results

The following constituents will typically provide the information required for a complete ASD:

- Primary indicators (boron and sulfate) for potential BSFAP leachate impacts.
- Major ion concentrations (alkalinity, chloride, sulfate, calcium, magnesium, potassium, and sodium) in leachate and groundwater which are used to evaluate whether downgradient groundwater chemistry remains representative of background groundwater chemistry. Major ion chemistry can also be used to evaluate natural variability due to seasonal changes or other causes.
- Field turbidity in groundwater is an indicator of the presence of suspended solids that may contribute to elevated concentrations of constituents monitored in unfiltered samples under the CCR Rule.
- pH in leachate and groundwater provides information on chemical reactions and potential mobility of constituents in groundwater.
- Dissolved oxygen, oxidation reduction potential (ORP), iron, and manganese in groundwater are all indicators of redox conditions. Changes in redox can affect the chemical state and solubility of sulfate in addition to trace elements including arsenic and selenium. For example, under strongly reduced conditions (ORP less than –200 millivolts [mV] at pH 7), sulfate can be reduced to form hydrogen sulfide or it can precipitate as iron sulfide, arsenic reduces to the more mobile arsenite species, and selenium reduces to the low-mobility selenite species.

Groundwater monitored at a CCR unit for compliance with the CCR Rule is a compilation of the history of all sources of water comingling at that particular monitoring well. Different sources may contribute some of the same constituents, making source identification challenging. The identification and use of water quality “signatures” can be used as a tool for deciphering the similarity between potential sources and the water quality at a specific monitoring point.

4 Alternative Source Demonstration Assessment

As stated within **Section 1.2**, the primary indicators for CCR (coal ash) leachate affects in groundwater are boron and sulfate. In addition to these two constituents, chloride will also be a primary indicator for this ASD. Other potential indicators that have been evaluated include potassium, sodium, fluoride, molybdenum, and bromide.

As identified in **Section 1.1**, SSLs of beryllium, cobalt, and lithium have been reported in groundwater samples from monitoring well MW-1603. The water quality signatures for well MW-1603 will be discussed within **Section 4.3** and compared to the water quality of the BSFAP.

EPRI (2012) describes three tiers of investigation for evaluation of water quality signatures to determine if elevated concentrations represent a release from a CCR facility. Conversely, these tools can also be used to evaluate whether or not sources other than CCR are contributing to groundwater quality degradation. The three tiers defined by EPRI (2012) are:

- Tier I: Trend Analysis and Statistics
- Tier II: Advanced Geochemical Evaluation Methods
- Tier III: Isotopic Analyses

The CCR Rule requires statistical analysis under detection monitoring and under assessment monitoring for the determination of SSLs. Many of the primary and potential indicator constituents listed for coal ash (EPRI, 2017) are included in AEP's constituent list for the BSFAP groundwater monitoring programs, including the primary constituent's boron and sulfate. If there is a SSL without a corresponding increase in a primary indicator constituent (boron and usually sulfate for coal ash), then this is a key line of evidence for an ASD.

4.1 Groundwater Data Analysis

4.1.1 Primary Indicators

Temporal plots for primary indicators boron, sulfate, and chloride reported in groundwater monitoring well MW-1603 are provided in **Figure 4-1** to **Figure 4-3**, respectively, with data for the BSFAP water presented for comparison. All temporal plots have used the following color-coding system:

- Red – to indicate a concentration reported above the reporting limit
- Orange – to indicate a concentration reported below the reporting limit but above the method detection limit (denoted as estimated "J" values)
- Green – to indicate a concentration below the method detection limit (denoted as "U"); results below the method detection limit (MDL) were conservatively plotted as the MDL.

The BSFAP water signature is plotted as a constant concentration in **Figure 4-1** to **Figure 4-12**. This sample was collected on October 19, 2017. As the BSFAP accepted fly ash prior to 1970, it is probable that BSFAP water quality has historically varied over time. However, since the BSFAP ceased accepting fly ash prior to 2016, the water quality is anticipated to be more stable; therefore, this October 2017 data provides a reasonable representation of current BSFAP conditions.

Groundwater quality for well MW-1603 is plotted on the primary y-axis and BSFAP water quality is plotted on the secondary y-axis, due to the differences in concentration between the groundwater quality in the vicinity of MW-1603 and the BSFAP water, as labelled in **Figure 4-1** to **Figure 4-12** below.

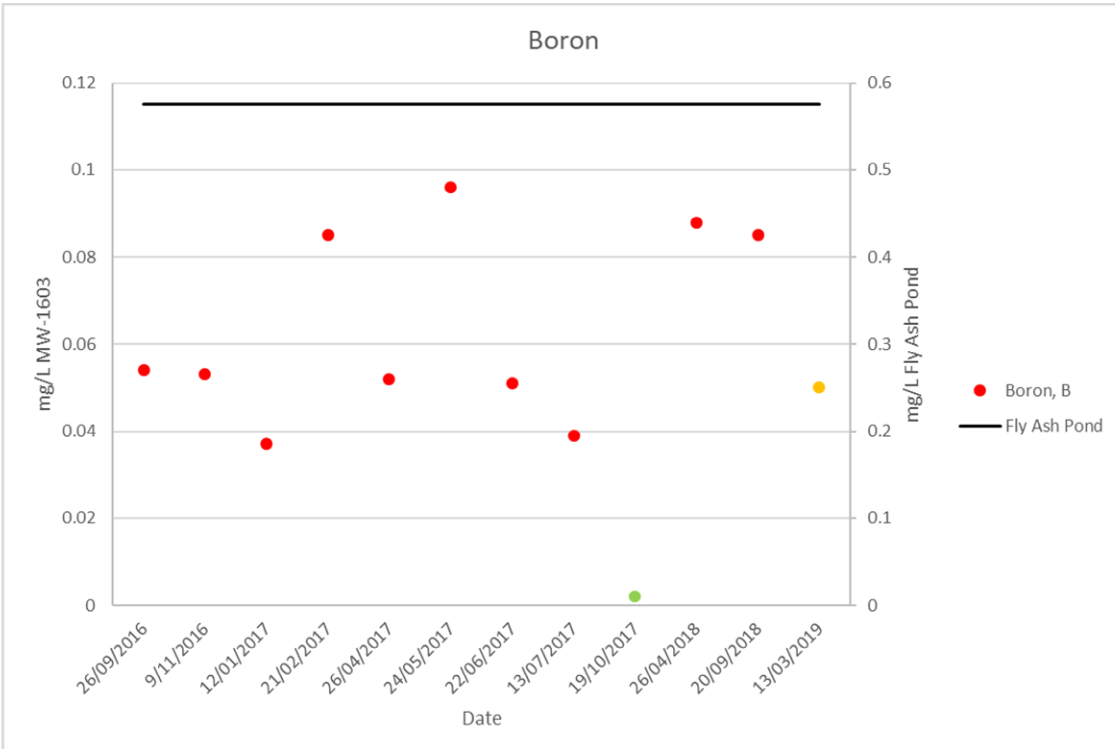

Figure 4-1 MW-1603 Boron concentrations

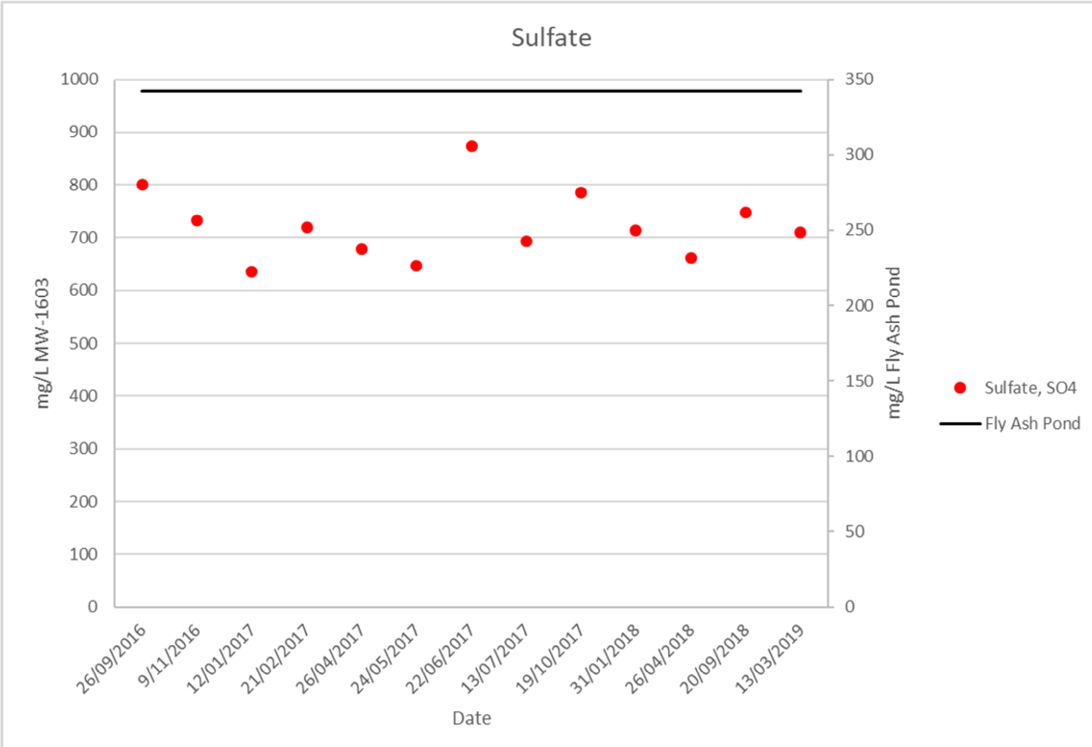

Figure 4-2 MW-1603 Sulfate

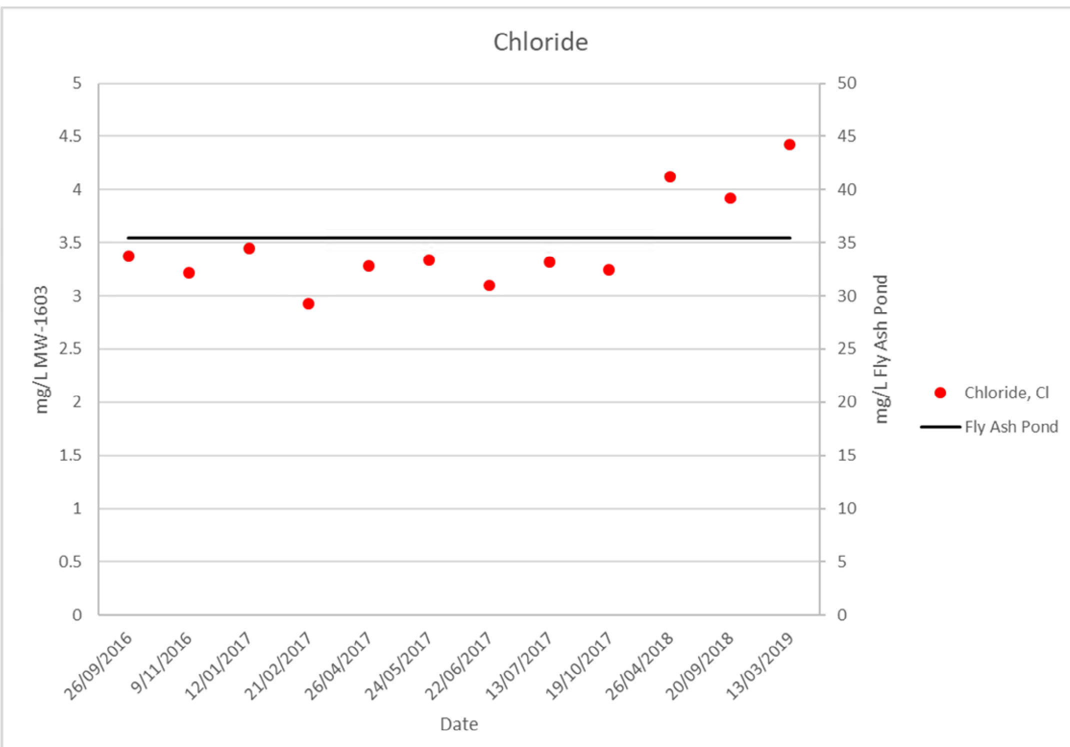

Figure 4-3 MW-1603 Chloride

Boron concentrations in MW-1603 have remained relatively constant, with some variability over the monitoring period (September 2016 through March 2019). Sulfate was initially reported as 801 mg/L in September 2016 and has shown a very slight decreasing trend during the monitoring period. Chloride concentrations in MW-1603 also remained relatively constant until April 2018, after which a slight increase is observed. Comparing the concentrations in groundwater to the BSFAP, boron and chloride are present at higher concentrations in the BSFAP than in groundwater, while sulfate is present at higher concentrations in groundwater than in the BSFAP.

In summary, there has been no observable changes in primary indicator concentrations since the last review in February 2019.

4.1.2 Potential Indicators

Temporal plots for potential indicators bromide, fluoride, molybdenum, potassium, and sodium reported in groundwater monitoring well MW-1603 are provided in **Figure 4-4** to **Figure 4-8**, respectively, with data for the BSFAP water presented for comparison.

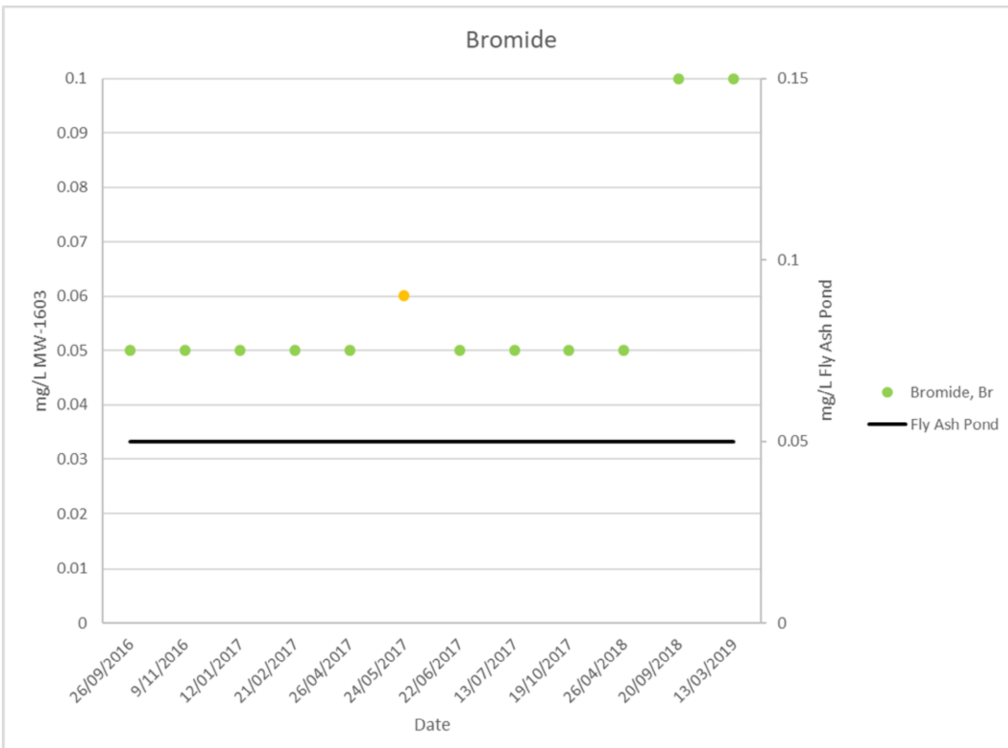

Figure 4-4 MW-1603 Bromide Concentrations[1]

[1] Bromide is below the level of reporting for the BSFAP water, with a detection level of <0.05 mg/L.

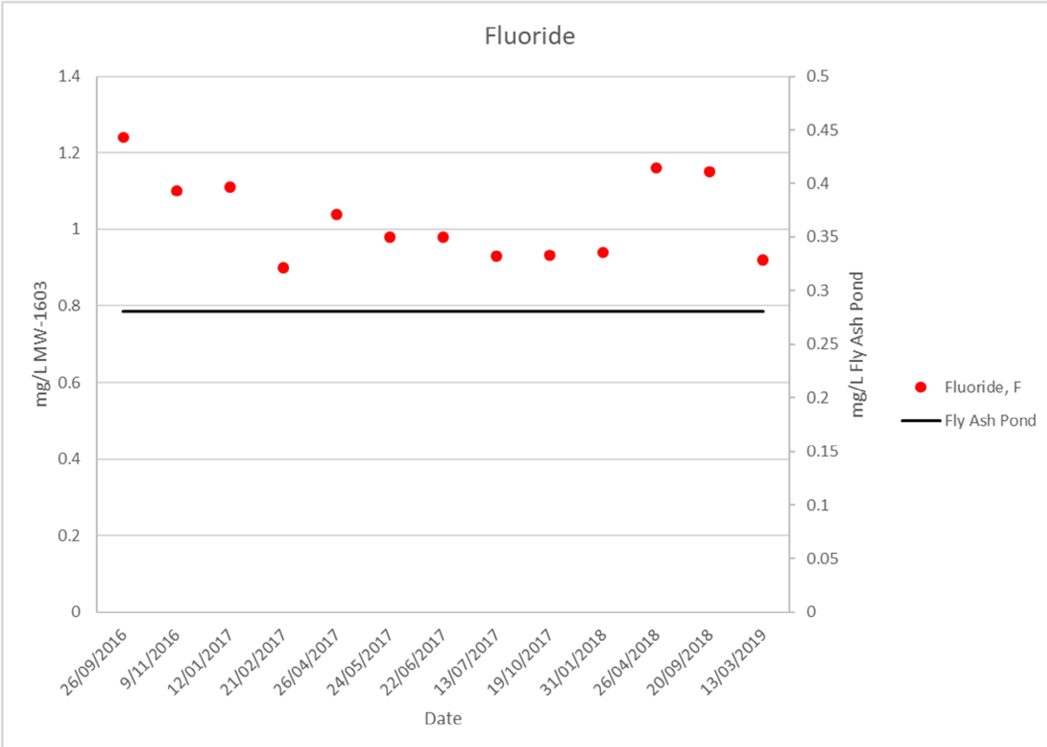

Figure 4-5 MW-1603 Fluoride Concentrations

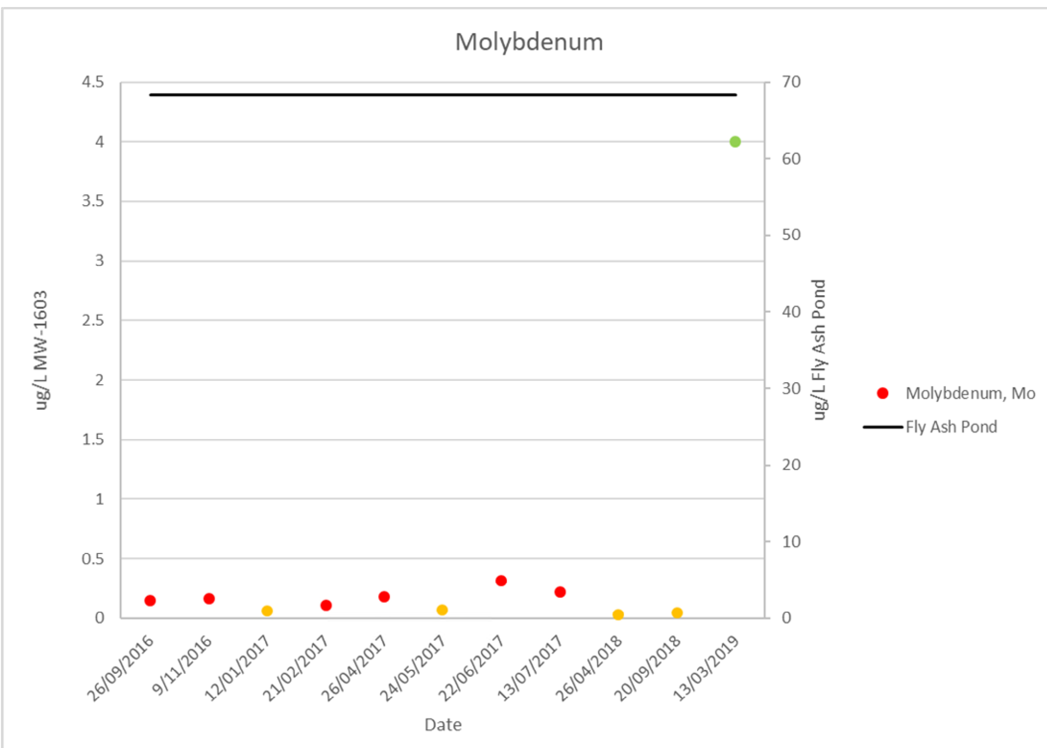

Figure 4-6 MW-1603 Molybdenum Concentrations

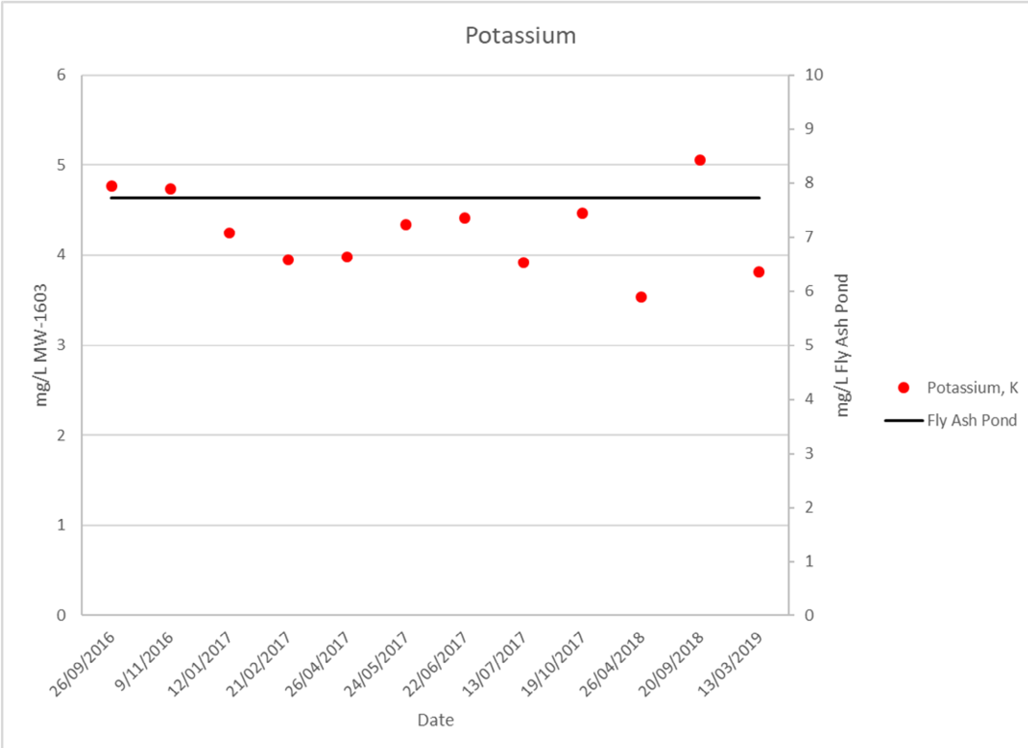

Figure 4-7 MW-1603 Potassium Concentrations

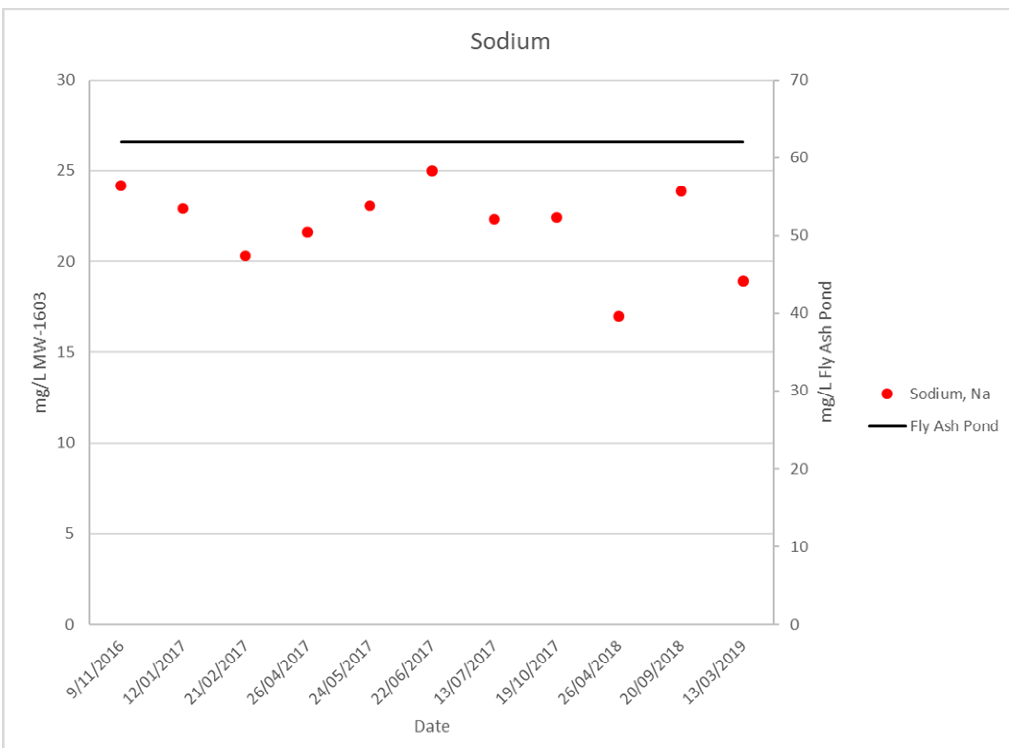

Figure 4-8 MW-1603 Sodium Concentrations

Molybdenum, potassium, and sodium are present in the groundwater in the vicinity of MW-1603 at concentrations below the concentrations reported within the BSFAP. Fluoride and bromide groundwater concentrations are more elevated than those within the BSFAP.

The comparison of pH between the BSFAP and MW-1603 is provided in **Figure 4-9** below. This illustrates the significant difference in pH between the pond water and groundwater, between approximately three to five standard units. This is using the standard pH scale which is logarithmic and converts to a difference of 1,000 to 100,000 units on an arithmetic scale.

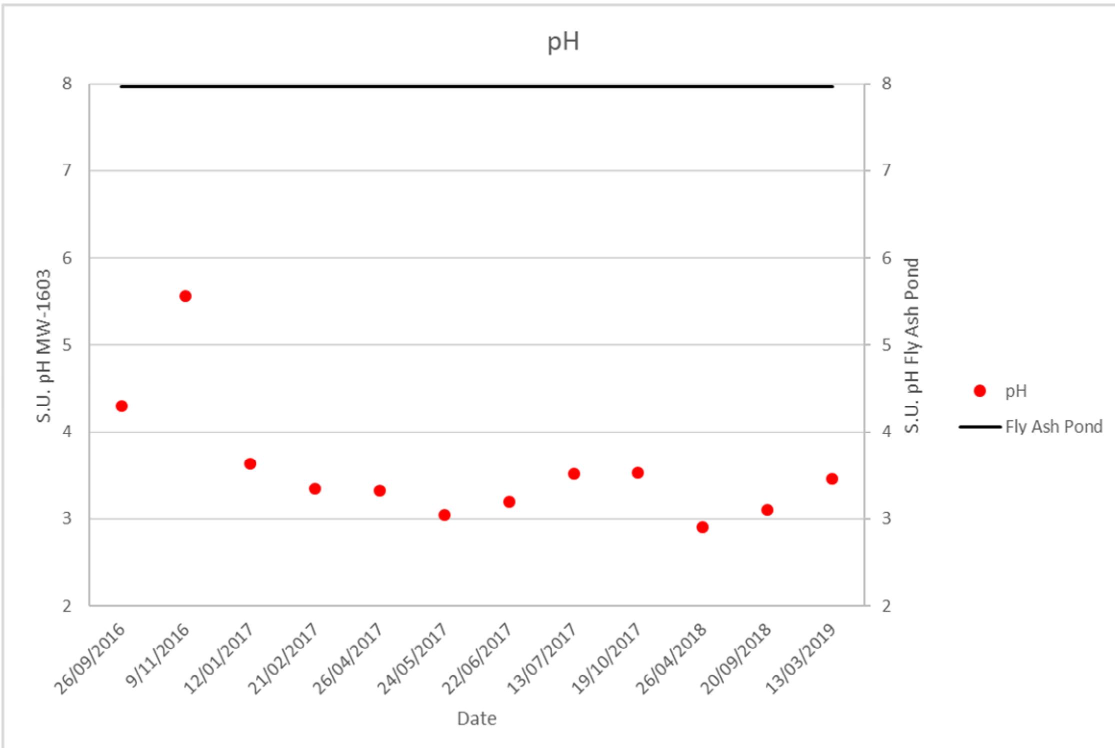

Figure 4-9 MW-1603 pH values

In summary, there has been no observable changes in primary indicator concentrations since the last review in February 2019.

4.1.3 ASD Constituent Trends

Temporal plots for the ASD constituents, beryllium, cobalt, and lithium reported in groundwater monitoring well MW-1603, are provided in **Figure 4-10** to **Figure 4-12** below, with data for the BSFAP water presented for comparison.

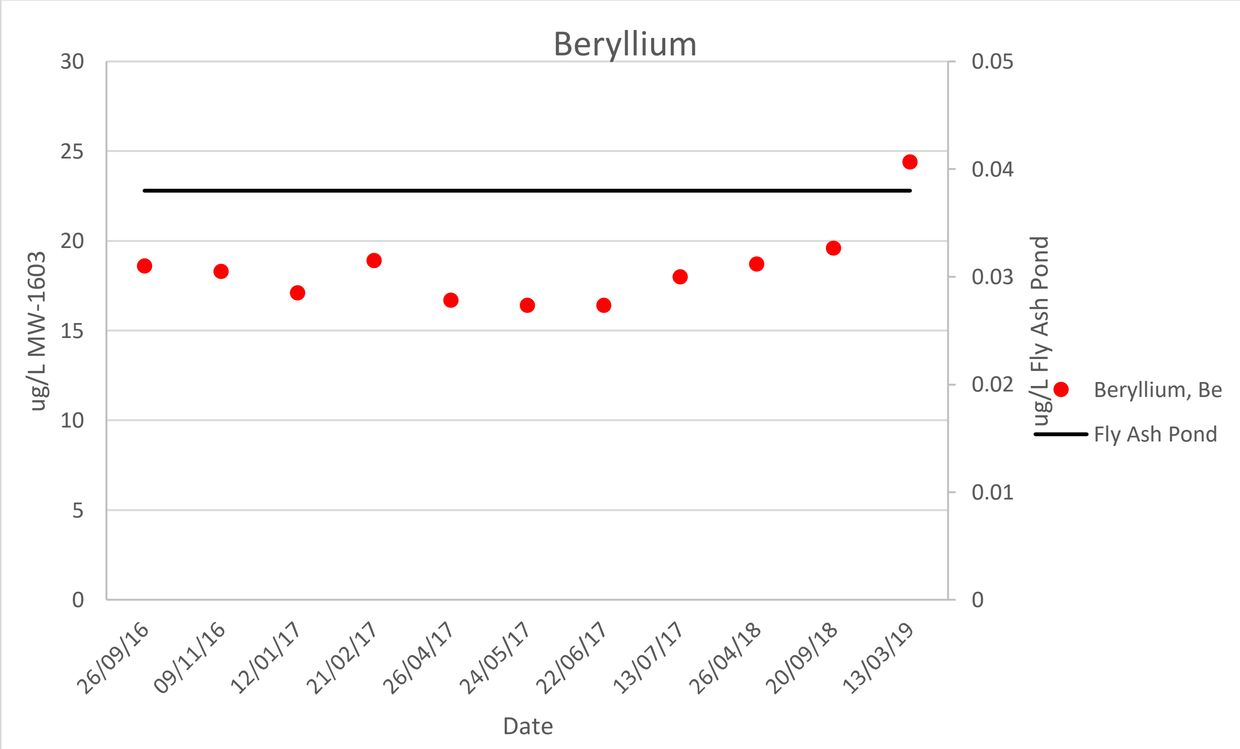

Figure 4-10 MW-1603 Beryllium Concentrations

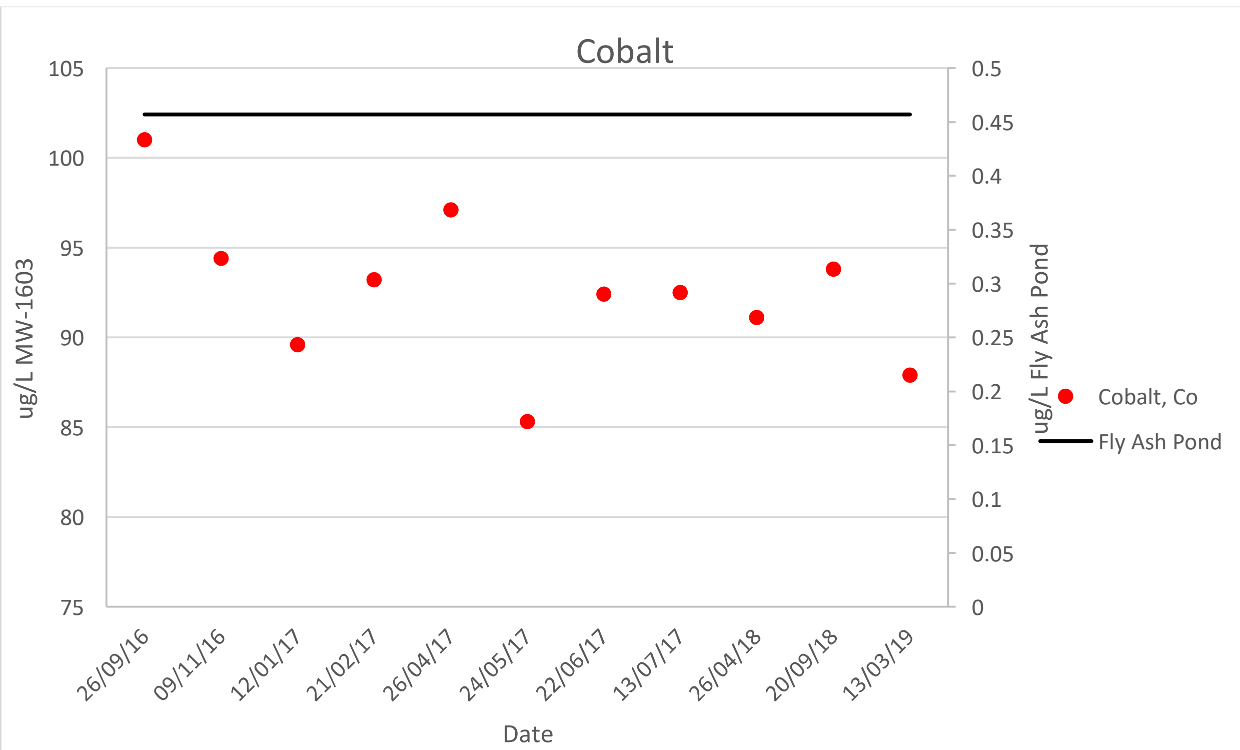

Figure 4-11 MW-1603 Cobalt Concentrations

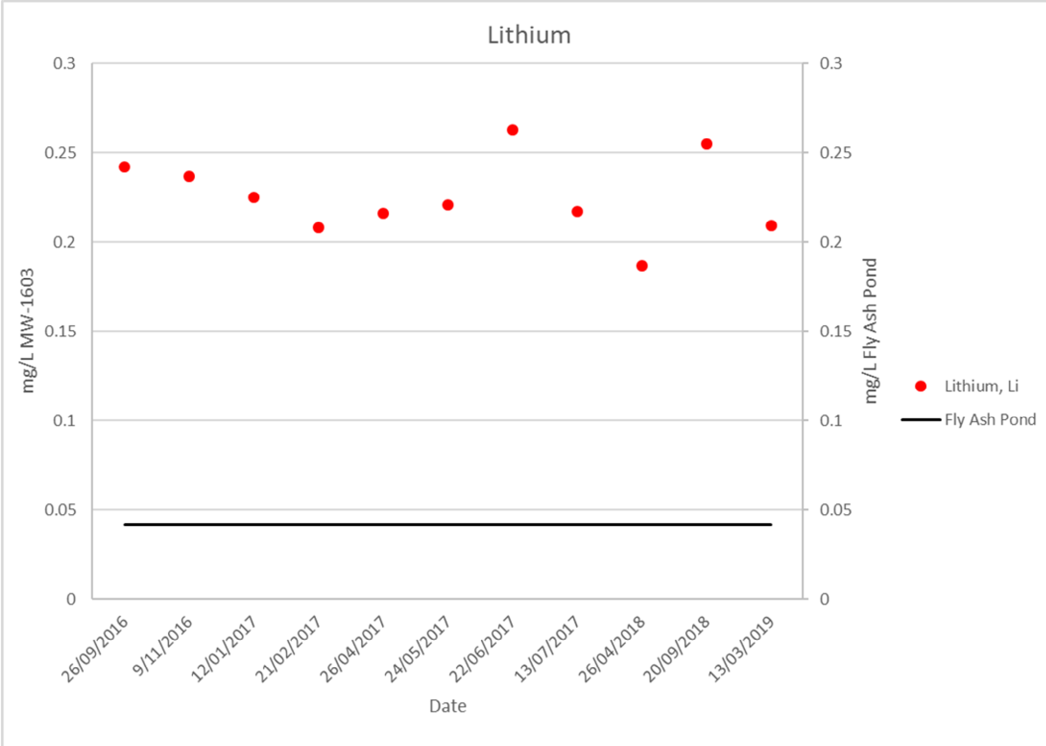

Figure 4-12 MW-1603 Lithium Concentrations

Beryllium, cobalt, and lithium are more elevated in MW-1603 groundwater in comparison to BSFAP water indicating the source of beryllium, cobalt, and lithium is not likely associated with the BSFAP.

4.1.4 Indicator Analysis Findings

Based on the temporal plots for primary indicators, potential indicators, and ASD constituents, it is considered unlikely that CCR constituents from the BSFAP are influencing water chemistry in surrounding groundwater. This is based on the primary indicator sulfate, potential indicators fluoride and bromide, and the ASD constituent's beryllium, cobalt, and lithium all being present at higher concentrations in groundwater compared to the BSFAP water. As the concentrations of these constituents in groundwater are higher, it is unlikely that there is a concentration gradient extending from the BSFAP into groundwater. It is more likely that an alternate source in groundwater is contributing to the higher concentrations observed in groundwater.

In summary, there are no trends within MW-1603 groundwater data to suggest CCR constituents are migrating from the BSFAP into groundwater based on the analyses presented above.

4.2 Tier I Evaluation - Statistical Evaluation

A statistical evaluation of analytes has been conducted previously (EHS Support, 2019). The evaluation concluded that groundwater in the vicinity of MW-1603 is statistically the same as the United States Geologic Survey (USGS) reported regional background (Ruppert et al., 2000) in regard to arsenic, boron, calcium, chloride, chromium, fluoride, molybdenum, potassium, sodium, and strontium. The box plots from the earlier ASD investigation also show a difference between well MW-1603, BSFAP water and/or the regional background for pH, alkalinity, barium, cobalt, lead, lithium, magnesium, selenium, and sulfate. For beryllium, chromium, lead, lithium, molybdenum, and selenium no background values were provided by the USGS.

Updated box and whisker plots for constituents reported in MW-1603 groundwater are provided in **Appendix AFigures A-1 through A-11**. Plots for molybdenum, sodium, beryllium, and pH exhibit outliers which are calculated to be outside the range of distribution. A summary of data distribution statistics for MW-1603 is provided in **Appendix B - Table B-1**.

It is likely that the acidic pH conditions, low alkalinity and high sulfate conditions at MW-1603 relative to regional background are driving dissolution of metals. These geochemical conditions within well MW-1603, which are similar to acid mine drainage, are due to the presence of the Princess Coal Seams (discussed in EHS Support, 2019) being intersected by the screened interval of this monitoring well. The combination of the well installation and sampling is allowing the saturated conditions within the coal seams to become aerobic which results in a lowering of pH and increase in metal solubility.

4.3 Tier II Evaluation - Geochemical Evaluation

A simple analysis of primary and potential indicator constituents (as performed in **Section 4.1**) may not provide the lines of evidence required for a robust ASD. It is recognized that naturally occurring indicator constituents and upgradient sources may have an additional influence on groundwater quality. Spatially across a site, groundwater quality may be observed to change due to chemical interactions with the aquifer matrix. EPRI (2012) recommended more sophisticated methods that can be used for multiple parameters over multiple locations. These include ion ratios and ternary plots.

Development of ion ratios involves first selecting two non-competing, non-sorbing constituents (boron and chloride). The ratios of these constituents are then compared spatially across the site and a judgment is made as to whether the hydraulically downgradient groundwater is similar to the background groundwater quality.

The median concentrations of boron, chloride, and sulfate are provided in **Table 4-1**. These three constituents were selected based on the recommended indicator species in EPRI (2017). Bromide was not included within the assessment, as bromide was non-detect in the BSFAP water indicating its presence in groundwater was either naturally derived or from an off-site source. The median concentration for sulfate indicates a minor increase, and median concentrations for boron and chloride show no change since January 2019.

As discussed above, the groundwater quality reported from well MW-1603 is unlikely to be influenced by the BSFAP.

Table 4-1 Median Concentrations of Boron, Chloride, and Sulfate

		Median Concentrations 2016 to 2019		
	Location ID	**Boron**	**Chloride**	**Sulfate**
Location	**Units**	**mg/L**	**mg/L**	**mg/L**
Source	**Fly Ash Pond**	0.58	35.4	342
Downgradient	**MW-1603**	0.05 ±0.02	3 ±0.4	714 ±67

mg/L = milligrams per liter

Ion ratios have been calculated using boron, chloride, and sulfate as recommended in EPRI (2017) and are provided in **Table 4-2**. The ion ratios show no change since the last evaluation in February 2019.

Table 4-2 Ion Ratios

		Median Concentrations 2016 to 2019		
Location	**Location ID**	**Boron/Sulfate (x1000)**	**Boron/Chloride**	**Chloride/Sulfate**
Source	**Fly Ash Pond**	1.68	0.002	0.10
Downgradient	**MW-1603**	0.07 ±0.03	0.02 ±0.01	0.005 ±0.001

Based on the previous evaluation of ion ratio analysis, the conclusion that it does not appear likely that MW-1603 has been impacted by CCR constituents from the BSFAP is unchanged.

Ternary plots can be used to identify changes in major or minor ion distributions over time. A ternary plot using calcium, chloride, and sulfate measured in the vicinity of MW-1603 is provided in **Figure 4-13**.

The ternary plot shows that the major ion groundwater ratios have not changed during the period of groundwater quality monitoring at well MW-1603, as all the event ratios are grouped closely together.

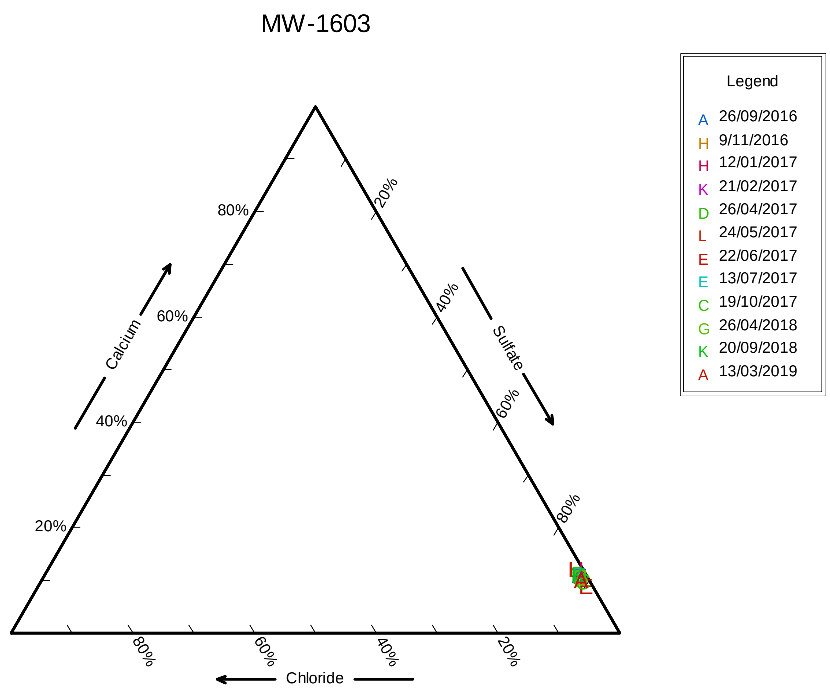

Figure 4-13 Ternary Plot MW-1603

In summary, based on the previous geochemical evaluation and the updated review presented in this ASD addendum there is insufficient evidence to support the presence of CCR constituents (principally beryllium, cobalt and lithium), as derived from the BSFAP, in groundwater sampled at MW-1603. The ternary plot does not support temporal changes of MW-1603 groundwater quality. The ion ratios of boron, chloride, and sulfate remain unchanged since February 2019. Therefore, it is highly unlikely that beryllium, cobalt, and lithium detected within MW-1603 groundwater is sourced from the BSFAP. It is much more likely that beryllium, cobalt, and lithium are characteristic of the lithologies in which this monitoring well is screened across, which includes the Princess Coal Seams.

5 Summary and Conclusions

Using the EPRI (2017) guidance for ASD, the conclusions that are based on the lines of evidence presented and discussed within **Sections 3** and **4** indicate that groundwater in the vicinity of the BSFAP is not being impacted by CCR constituents from the BSFAP. The elevated beryllium, cobalt, and lithium concentrations that triggered the ASD assessment are due to the oxidation of coal seams that have been intersected by well location MW-1603. This is supported by the visual evidence during the logging of core characteristics at this location (refer to EHS Support, 2019), the low pH reported in groundwater, and the subsequent likely dissolution and mobility of metalliferous species (beryllium, cobalt, and lithium) by the elevated acidity.

The elevated pH in the BSFAP water and the corresponding lower concentrations of minor ions in BSFAP also support the unlikely influence of the BSFAP on groundwater. Therefore, it is concluded that the elevated signatures of beryllium, cobalt, and lithium in MW-1603 are related to the dissolution of naturally-occurring coal-seam derived constituents within the shale layers of the Breathitt Group, as supported by the discussion of local and regional geology in **Section 2.1** and EHS Support (2019).

6 References

AEP and EHS Support. (2016). Groundwater Sampling and Analysis Plan. October.

EHS Support. (2019). Alternative Source Demonstration Report for Beryllium, Cobalt and Lithium, Big Sandy Fly Ash Pond, Louisa, Kentucky. February.

EPRI. (2012). Groundwater Quality Signatures for Assessing Potential Impacts from Coal Combustion Product Leachate. EPRI, Palo Alto, CA. 1017923.

EPRI. (2017). Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. EPRI, Palo Alto, CA. 3002010920.

Geosyntec Consultants, Inc. (2017). Statistical Analysis Plan. January.

Geosyntec Consultants, Inc. (2016). Groundwater Monitoring Well Installation Report – Fly Ash Pond. October.

Rice, C. and Hiett, J. (1994). Revised Correlation Chart of the Coal Beds, Coal Zones, and Key Stratigraphic Units in the Pennsylvanian Rocks of Eastern Kentucky, USGS Miscellaneous Field Studies Map MF-2275.

Ruppert, L., Tewalt, S., Wallack, R., Bragg, L., Brezinski, D., Carlton, R., Butler, D., and Calef, F. (2000). A Digital Resource Model of the Middle Pennsylvanian Upper Freeport Coal Bed Allegheny Group, Northern Appalachian Basin Coal Region. USGS Professional Paper 1625-C. 101 pages.

USEPA. (2009). Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. March.

Figures

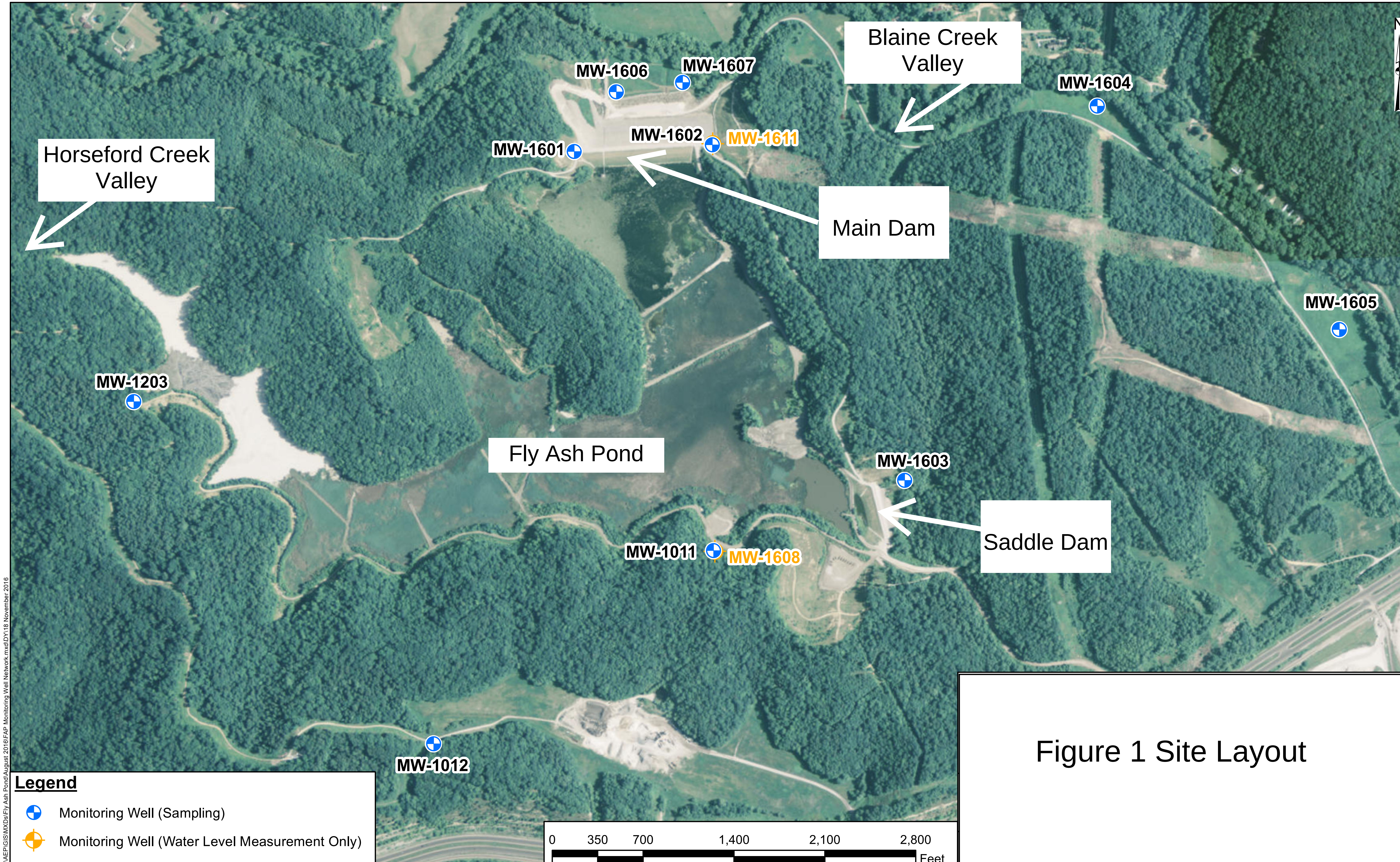

Figure 1 Site Layout

N:\AEP\GIS\MXDs\Fly Ash Pond\August 2016\FAP Monitoring Well Network.mxd\DY\18 November 2016

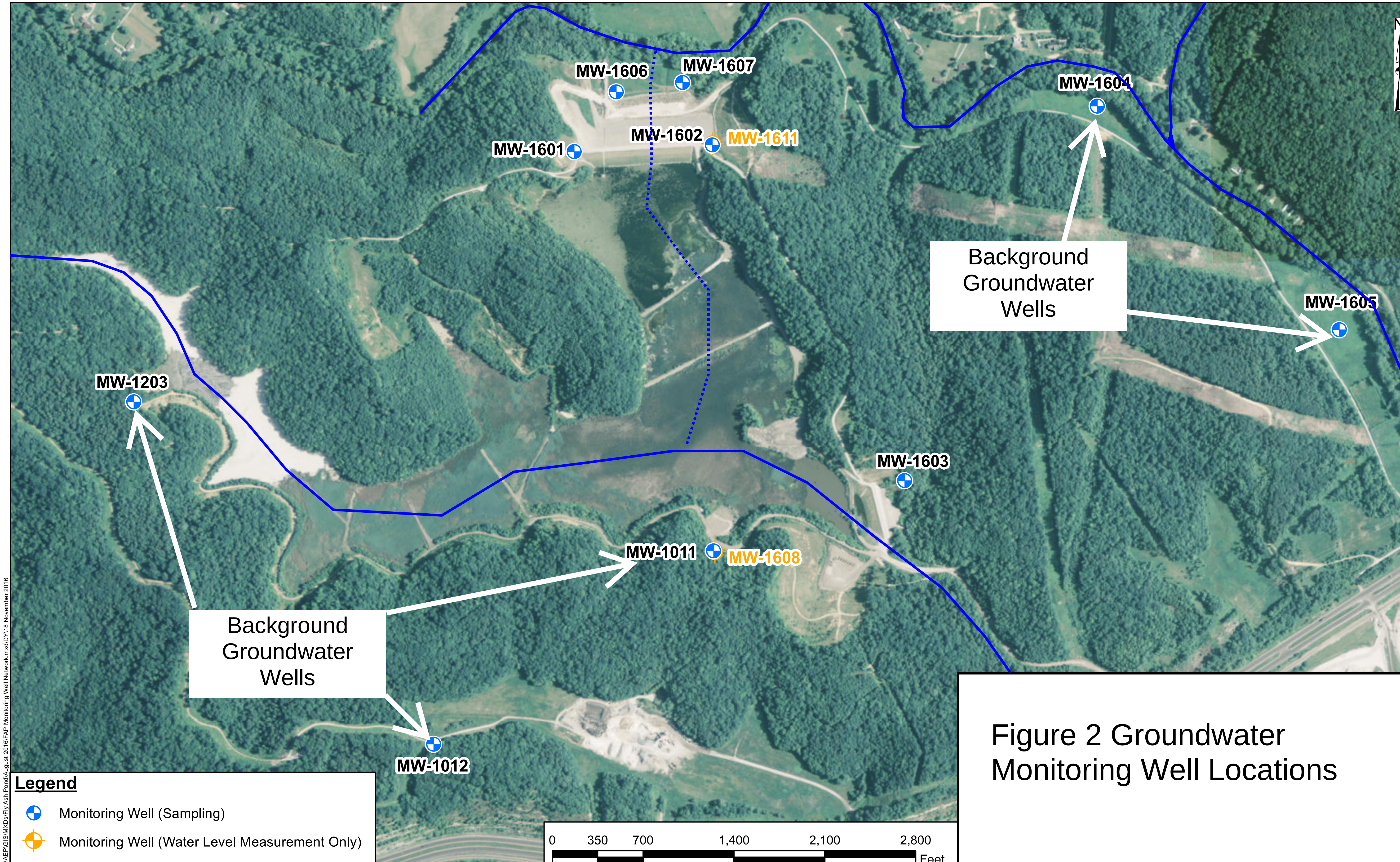

Figure 2 Groundwater Monitoring Well Locations

Tables

Table 1
MW-1603 Historical Groundwater Data 2016 to 2019
Big Sandy Fly Ash Pond Groundwater Monitoring,
American Electric Power, Kentucky Power Company, Louisa, Kentucky

Analytes	Units	9/26/2016	11/9/2016	1/12/2017	2/21/2017	4/26/2017	5/24/2017	6/22/2017	7/13/2017	10/19/2017	1/31/2018	4/26/2018	9/20/2018	10/23/2018	3/13/2019
Antimony, Sb	ug/L	0.01 J	< 0.01	< 0.01	< 0.01	0.01 J	< 0.01	< 0.01	< 0.01	NA	NA	0.04 J	0.02 J	NA	< 0.2
Arsenic, As	ug/L	1.51	1.19	1.4	1.26	1.3	1.34	1.29	0.89	NA	NA	1.6	1.4	NA	1.26
Barium, Ba	ug/L	13.4	15.4	11.4	10.3	12.4	11.5	11.4	11.3	NA	NA	10.5	11.4	NA	12
Beryllium, Be	ug/L	18.6	18.3	17.1	18.9	16.7	16.4	16.4	18	NA	NA	18.7	19.6	NA	24.4
Boron, B	mg/L	0.054	0.053	0.037	0.085	0.052	0.096	0.051	0.039	< 0.002	NA	0.088	0.085	NA	0.05 J
Cadmium, Cd	ug/L	0.84	0.93	0.79	0.75	0.87	0.77	0.86	0.8	NA	NA	0.74	0.83	NA	0.78
Calcium, Ca	mg/L	105	94.7	92.7	91.9	90.5	93.9	90.6	90.2	91	82.2	83.6	97.5	NA	84.6
Chloride, Cl	mg/L	3.37	3.22	3.45	2.93	3.28	3.34	3.1	3.32	3.24	NA	4.12	3.92	NA	4.42
Chromium, Cr	ug/L	1.1	1.12	0.731	0.771	0.829	0.62	0.821	0.485	NA	NA	0.771	0.713	NA	1 J
Cobalt, Co	ug/L	101	94.4	89.6	93.2	97.1	85.3	92.4	92.5	NA	NA	91.1	93.8	NA	87.9
Comb. Radium 226/228	pCi/L	6.04	6.6	5.86	4.03	5.72	6.4	6	6.36	NA	NA	5.09	6.75	NA	4.8
Fluoride, F	mg/L	1.24	1.1	1.11	0.9	1.04	0.98	0.98	0.93	0.93	0.94	1.16	1.15	NA	0.92
Lead, Pb	ug/L	9.75	8.18	6.11	6.3	6.41	4.96	6.47	3.72	NA	NA	5.27	4.39	NA	4.28
Lithium, Li	mg/L	0.242	0.237	0.225	0.208	0.216	0.221	0.263	0.217	NA	NA	0.187	0.255	NA	0.209
Mercury, Hg	ug/L	< 0.002	< 0.002	< 0.002	< 0.002	0.002 J	< 0.002	< 0.002	< 0.002	NA	NA	< 0.002	NA	< 0.002	< 0.002
Molybdenum, Mo	ug/L	0.15	0.17	0.06 J	0.11	0.18	0.07 J	0.32	0.22	NA	NA	0.03 J	0.04 J	NA	< 4
pH	S.U.	4.29	5.56	3.64	3.34	3.32	3.04	3.20	3.52	NA	3.52	2.91	3.10	3.46	3.19
Residue, Filterable, TDS	mg/L	1060	1010	948	1020	994	936	1040	1000	962	915	926	974	NA	896
Selenium, Se	ug/L	5.4	4.8	5.6	4.9	6.1	6.3	6.1	2.7	NA	NA	8.1	6.3	NA	4
Sulfate, SO4	mg/L	801	733	636	720	678	646	873	694	784	714	661	747	NA	709
Thallium, Tl	ug/L	1.29	1.55	1.39	1.2	1.41	1.35	1.43	1.43	NA	NA	1.39	1.7	NA	1 J

Notes:

J - Estimated value. Analyte detected at a level less than the reporting limit and greater than or equal to the method detection limit.

< - not detected at or above the method detection limit

S.U. – Standard Units

TDS – Total Dissolved Solids

ug/L – Micrograms per liter

mg/L – Milligrams per liter

pCi/L – Picocuries per liter

NA – Not analyzed

Appendix A Box Plots

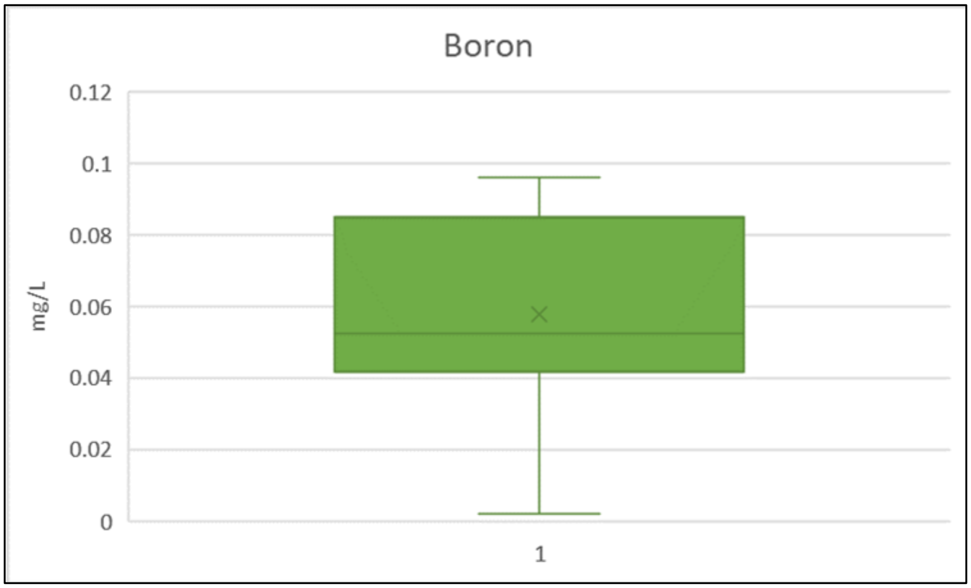

Figure A-1 Boron Box Plot

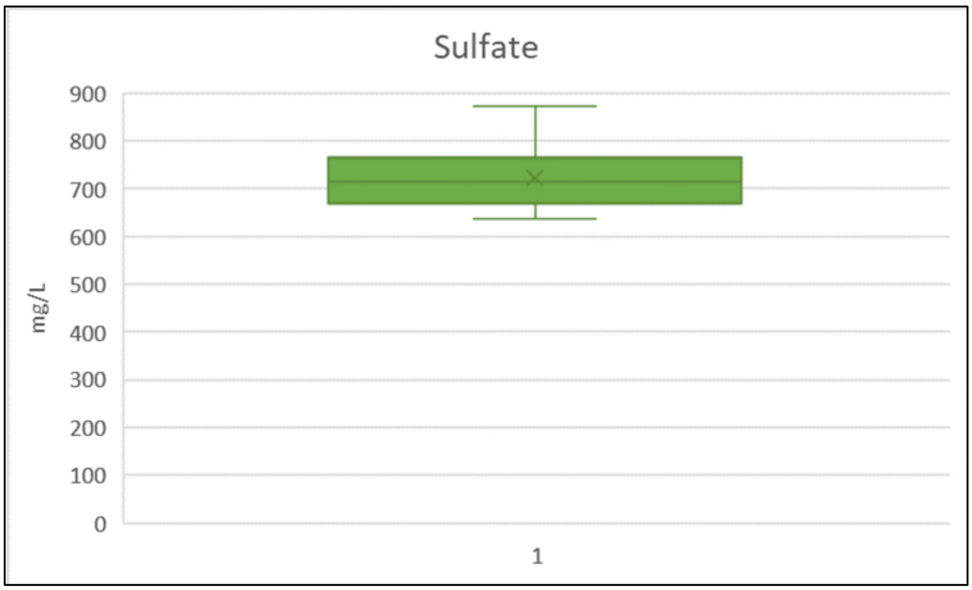

Figure A-2 Sulfate Box Plot

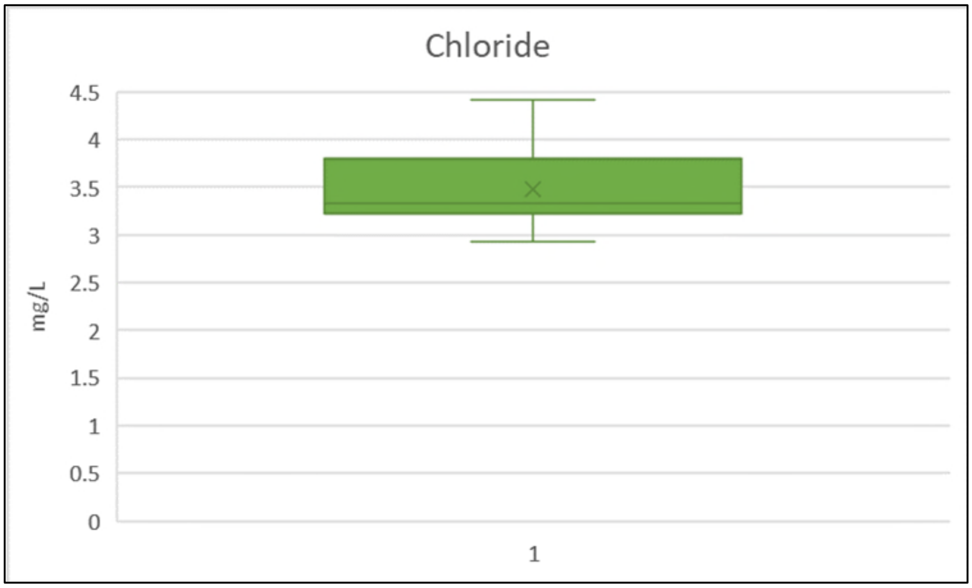

Figure A-3 Chloride Box Plot

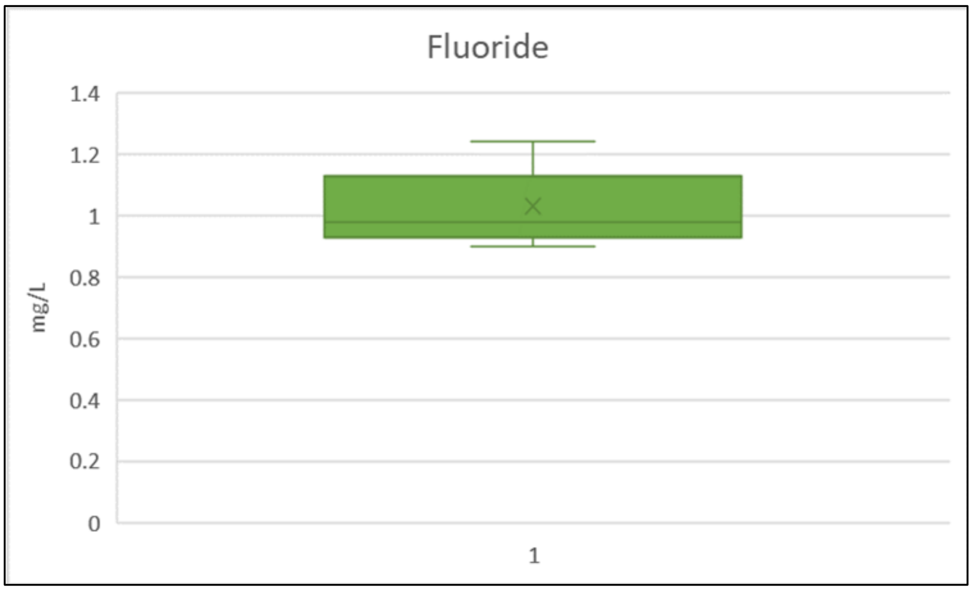

Figure A-4 Fluoride Box Plot

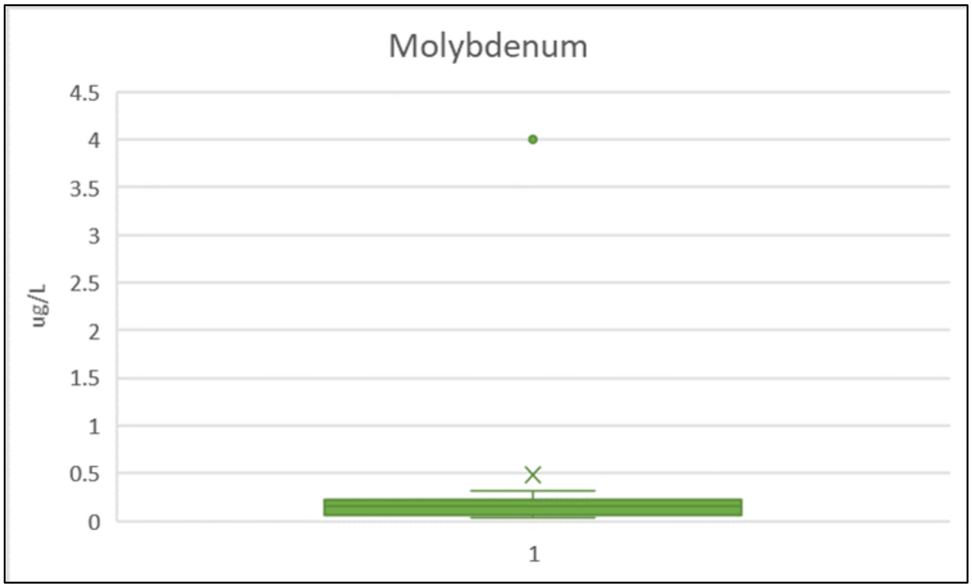

Figure A-5 Molybdenum Box Plot

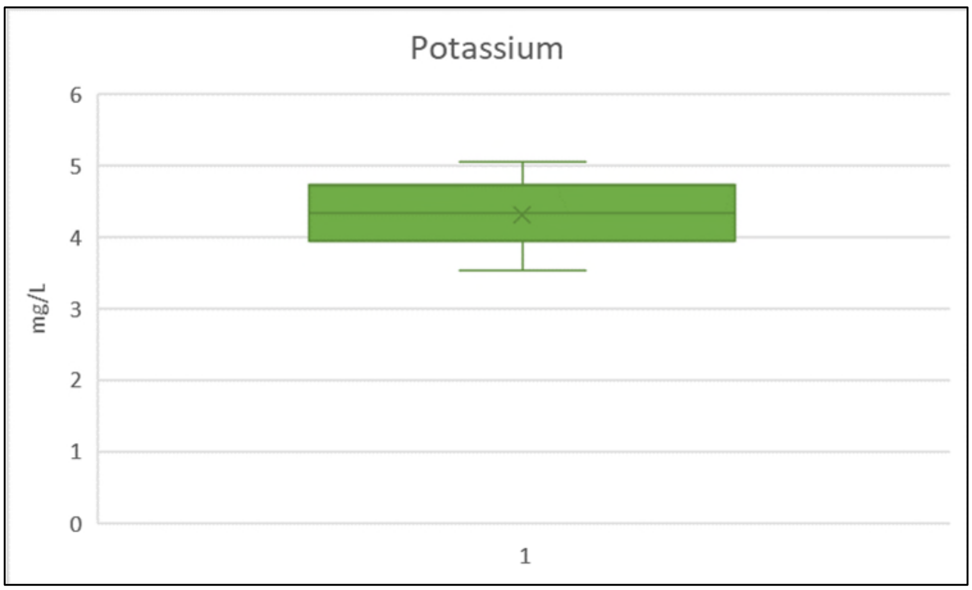

Figure A-6 Potassium Box Plot

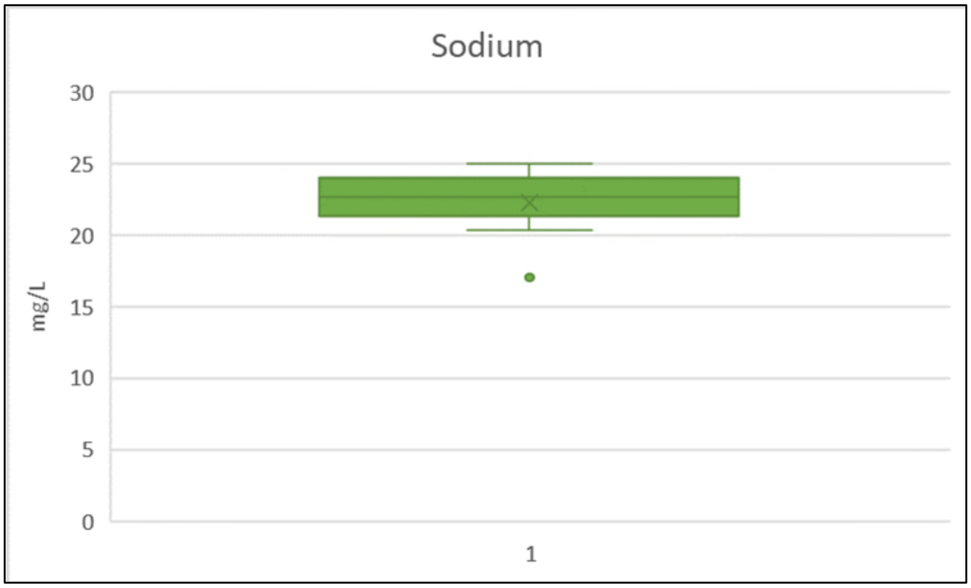

Figure A-7 Sodium Box Plot

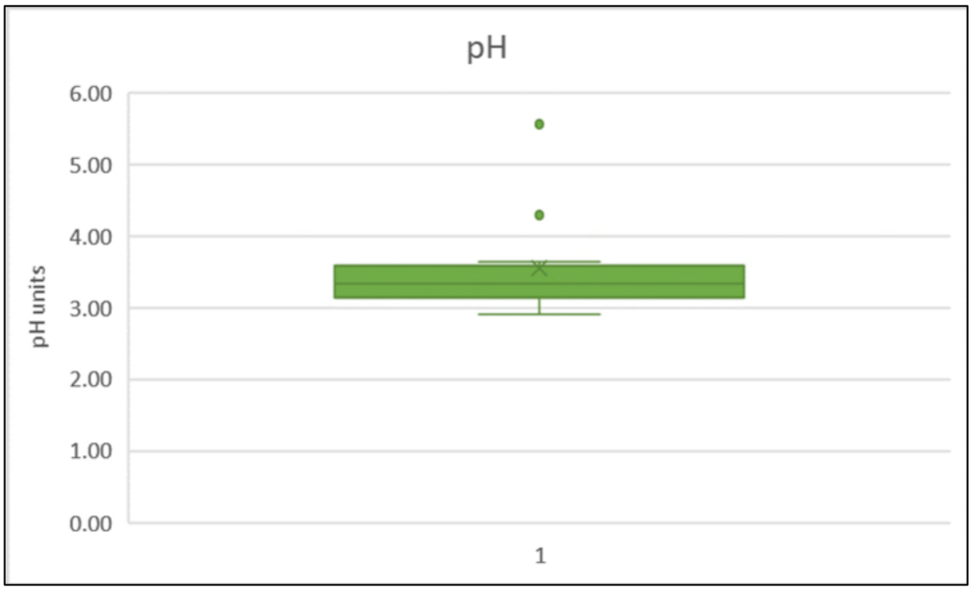

Figure A-8 pH Box Plot

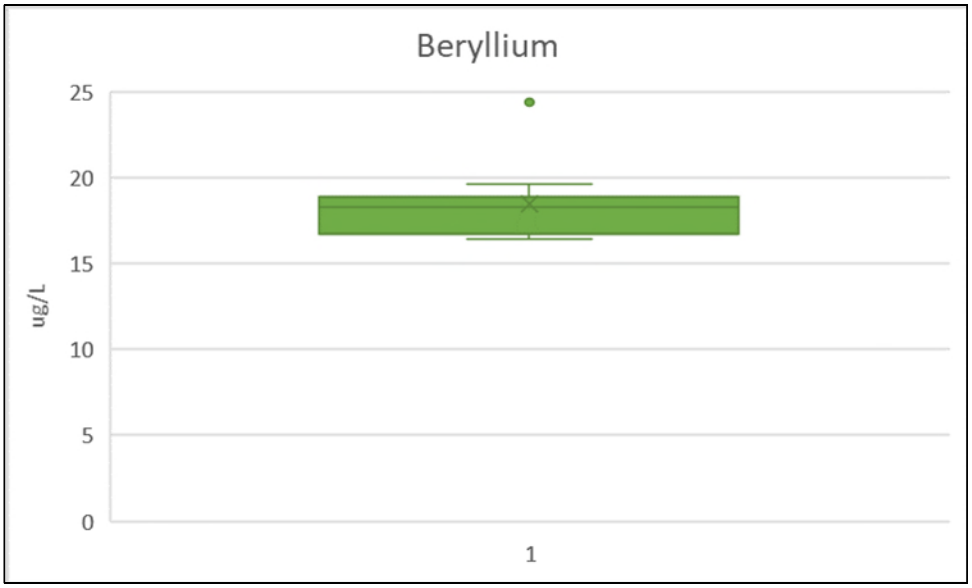

Figure A-9 Beryllium Box Plot

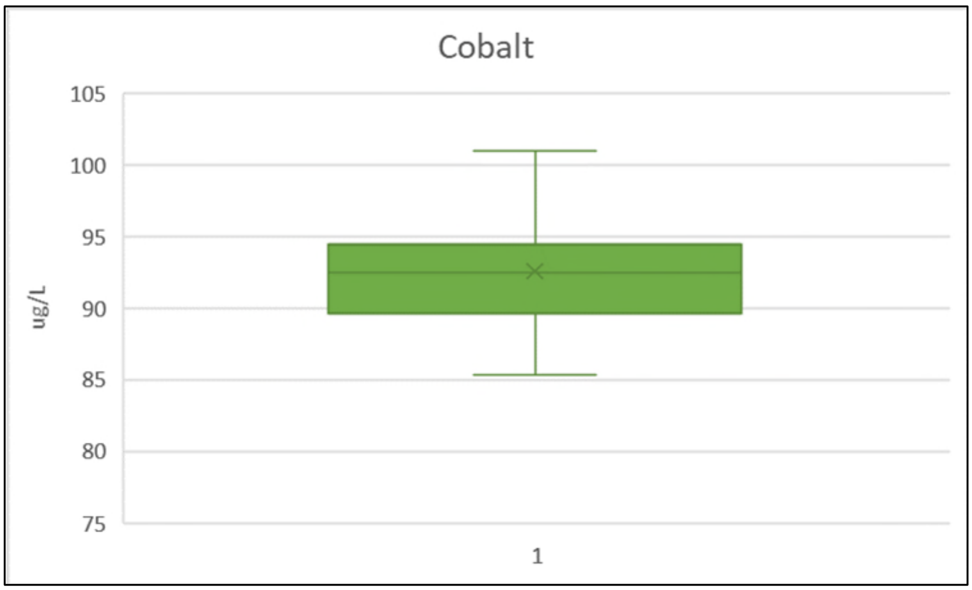

Figure A-10 Cobalt Box Plot

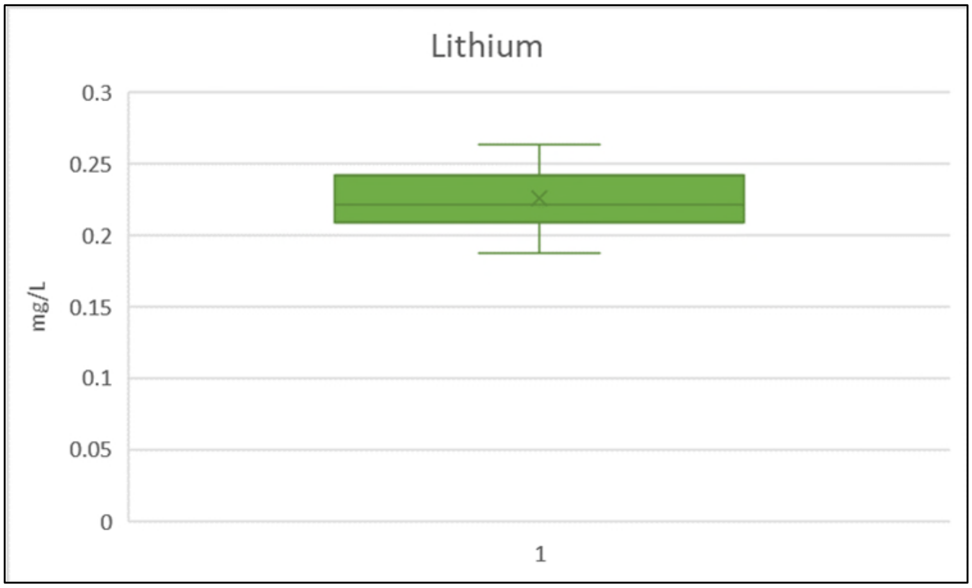

Figure A-11 Lithium Box Plot

Appendix B Data Distribution Summary

Table B-1 Data distribution Summary MW-1603

Parameter	Boron	Sulfate	Chloride	Fluoride	Molybdenum	Potassium	Sodium	pH	Beryllium	Cobalt	Lithium
	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	S.U.	µg/L	µg/L	mg/L
1st quartile	0.042	670	3.23	0.93	0.06	3.95	21.28	3.15	16.7	89.6	0.209
2nd quartile	0.053	714	3.33	0.98	0.15	4.34	22.65	3.34	18.3	92.5	0.221
3rd quartile	0.085	766	3.80	1.13	0.22	4.73	23.98	3.58	18.9	94.4	0.242
Median	0.053	714	3.33	0.98	0.15	4.34	22.65	3.34	18.3	92.5	0.221
Mean	0.058	723	3.48	1.03	0.49	4.31	22.27	4.50	18.5	92.6	0.225
Standard deviation	0.027	67	0.44	0.11	1.17	0.44	2.29	0.70	2.2	4.3	0.022
Minimum	0.002	636	2.93	0.90	0.03	3.53	17.00	2.91	16.4	85.3	0.187
Maximum	0.096	873	4.42	1.24	4.00	5.05	25.00	5.56	24.4	101.0	0.263

µg/L = micrograms per liter
mg/L = milligrams per liter

Alternative Source Demonstration Addendum Report for 2019 Monitoring Data

Big Sandy Fly Ash Pond
Louisa, Kentucky

Prepared for:

American Electric Power

Prepared by:

EHS Support

January 2020

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Acronyms

<	less than
µg/L	micrograms per liter
ASD	alternative source demonstration
bgs	below ground surface
BSFAP	Big Sandy Fly Ash Pond
CCR	coal combustion residual
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
ft	foot/feet
GWPS	Groundwater Protection Standards
J	estimated concentration below the reporting level and greater than equal to the method detection limit
KGS	Kentucky Geological Survey
mg/L	milligrams per liter
msl	mean sea level
MDL	method detection limit
NORM	naturally occurring radioactive material
ORP	oxidation reduction potential
pCi/L	picocuries per liter
SSL	statistically significant level
S.U.	standard units (pH)
TDS	total dissolved solids
U	Below the method detection limit
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

Certification by Qualified Professional Engineer

I certify that the alternative source demonstration (ASD) conducted and presented within this report is accurate and appropriate for evaluating the groundwater monitoring data for the Big Sandy Fly Ash Pond Coal Combustion Residual (CCR) management area associated with the Big Sandy Power Plant located in Louisa, Kentucky. This ASD meets the requirements of the United States Environmental Protection Agency CCR Rule defined at 40 Code of Federal Regulations 257.95(g)(3)(ii).

Jonathan Patrick Waddell
Printed Name of Licensed Professional Engineer

Signature

STATE OF KENTUCKY
JONATHAN PATRICK WADDELL
31526
LICENSED PROFESSIONAL ENGINEER

31526	KY	01/16/2020
License Number	Licensing State	Date

1 Introduction

EHS Support LLC ("EHS Support") was retained by American Electric Power, Kentucky Power Company ("AEP") in December 2018 to conduct an alternative source demonstration (ASD) investigation for coal combustion residual (CCR) constituents at the Big Sandy Fly Ash Pond (BSFAP) associated with the Big Sandy Power Plant located in Louisa, Kentucky (EHS Support, 2019a). The ASD determined that groundwater in the vicinity of the BSFAP is not being impacted by CCR constituents from the BSFAP, but rather the statistically significant levels (SSLs) of beryllium, cobalt, and lithium concentrations present in excess of the Groundwater Protection Standards (GWPS) that triggered the ASD investigation were due to the oxidation of coal seams that have been intersected by well location MW-1603.

Since the initial ASD investigation was completed (incorporating data from September 2016 to October 2018), a second ASD investigation was conducted after the March 2019 groundwater monitoring data showed SSLs of beryllium, cobalt, and lithium exceeding the GWPS at the same groundwater monitoring location, MW-1603 (EHS Support, 2019b). The presence of these three CCR constituents at SSLs above the GWPS has persisted in MW-1603 through the August 2019 sampling event. In addition, the August 2019 sampling event reported a SSL of radium 226/228 (combined) above its GWPS for the first time, in MW-1603.

The results for the broader list of CCR constituents from the groundwater monitoring events have been used within plots presented within this Alternative Source Demonstration Addendum Report (ASD addendum), even though all but beryllium, cobalt, lithium, and radium 226/228 were reported below the level of statistical significance.

This ASD addendum for beryllium, cobalt, lithium, and radium 226/228 in MW-1603 groundwater has been prepared per the requirements of the United States Environmental Protection Agency (USEPA) CCR Rule (40 Code of Federal Regulations [CFR] §257.95).

1.1 Objectives

The ASD investigation objective is to assess groundwater monitoring data collected in compliance with the CCR Rule as allowed under paragraph 40 CFR §257.95(g)(3)(ii) of the CCR Rule. This part of the rule allows AEP to determine whether the source(s) for SSLs of beryllium, cobalt, lithium, and radium 226/228 exceeding the groundwater protection standards reported from groundwater monitoring well MW-1603 are associated with the CCR unit, or if the SSL resulted from an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

1.2 Lines of Evidence

This third ASD investigation for the BSFAP has been conducted to further evaluate potential alternate sources or reasons for the continuing SSLs of beryllium, cobalt, and lithium, and the first time SSL for radium 226/228, within monitoring well MW-1603.

A potential alternate source was previously established as evident in the prior two ASD investigations (EHS Support, 2019a and 2019b), based on the following lines of evidence:

- There are a lack of exceedances and increasing trends of primary indicators of CCR.
- BSFAP water concentrations are lower than those of the corresponding constituent observed in groundwater.
- Major ion chemistry does not indicate mixing between BSFAP water and groundwater.

For the purposes of this ASD investigation, constituents were identified that would serve as a primary indicator for coal ash leachate. A primary indicator must meet **both** of the following criteria:

1. Constituent that typically has a high concentration in leachate, relative to background, such that it is expected to have elevated concentration in the event of a release
2. Constituent that is not reactive and has high mobility in groundwater such that it is expected to be at the leading edge of the plume, meaning that it will have elevated concentrations relative to background across the entire area of the plume

As boron and sulfate are primary indicators for coal ash leachate (Electric Power Research Institute [EPRI], 2012) and have previously been evaluated, they have been re-evaluated herein as primary indicators for this ASD investigation. Other potential indicators that were evaluated in this ASD investigation include: chloride, potassium, sodium, fluoride, molybdenum, and bromide.

2 Project Background

A detailed description of site location, history, and geology was previously provided in the *Alternative Source Demonstration Report for Beryllium, Cobalt and Lithium, Big Sandy Fly Ash Pond, Louisa, Kentucky* (EHS Support, 2019a). Attached **Figures 1** and **2** show the site layout and groundwater monitoring network.

To support this ASD addendum, the following sections on the groundwater monitoring network and groundwater monitoring are included to provide context to the ASD investigation.

2.1 Groundwater Monitoring Network Evaluation

On behalf of AEP, Geosyntec Consultants, Inc. ("Geosyntec") conducted an assessment of the groundwater monitoring network in the uppermost aquifer associated with the BSFAP (Geosyntec, 2016). Geosyntec determined that the hydrostratigraphy in the vicinity of the BSFAP is characterized by an interconnected water-bearing system comprised of Pennsylvanian-aged bedrock of the Breathitt Group and the Quaternary alluvium. The Conemaugh Formation and Breathitt Group consists of sandstones, siltstones, shale, and coal that may grade laterally and vertically into one another. The overlying Quaternary alluvium deposits include sandy lean clay to silty sand and gravel at the bottom of the Horseford Creek valley and the floodplain of the Blaine Creek. Based on these hydrogeologic conditions, Geosyntec defined the interconnected water-bearing system of the fractured bedrock and alluvium as the uppermost aquifer for the BSFAP CCR unit. This determination was based on the presence of groundwater in numerous monitoring wells screened in the water-bearing units, the recovery of these wells during pumping and development, and a potentiometric surface generally consistent with site topography and surface water elevations.

To assess the upper water-bearing aquifer, Geosyntec identified the groundwater monitoring network as consisting of 10 groundwater monitoring wells to provide detection monitoring in the uppermost aquifer (fractured bedrock and alluvium) (Geosyntec, 2016). Of these, six monitoring wells (MW-1011, MW-1012, MW-1203, MW-1601, MW-1602, and MW-1603) are screened in fractured sandstone and shale layers of the Breathitt formation. The remaining four monitoring wells (MW-1604 through MW-1607) are screened in the alluvium. The location of each groundwater monitoring well within the uppermost aquifer is shown in **Figure 2**.

Three of the monitoring wells (MW-1011, MW-1012, and MW-1203) screened in bedrock were installed on the hillside slopes upgradient of the BSFAP to support background monitoring. The remaining three monitoring wells (MW-1601, MW-1602, and MW-1603) installed in bedrock are located downgradient of the BSFAP and used for compliance monitoring. Two monitoring wells (MW-1604 and MW-1605) screened in alluvium are used for background monitoring; while two other monitoring wells (MW-1606 and MW-1607), screened in alluvium and located below the Main Dam, are used for compliance monitoring.

As bedrock monitoring well MW-1603 is the focus of this ASD, the boring log (EHS Support, 2019a) exhibits alternating sequences of yellowish-brown sandstones and bluish-gray to black shales (beginning at 13 feet below ground surface [ft bgs] and extending to the bottom of the boring at 39.5 ft bgs) that are indicative of the upper portion of the Princess Formation (uppermost formation in the Breathitt

Group [Rice, C. and Hiett, J., 1994]). Within the screened interval (22 to 32 ft bgs), a description of the shale at a depth of 24 to 25 ft bgs was "intensely fractured, black, wet, nearly all organic matter; slight coaly texture." This elevation corresponds with the measurements by the Kentucky Geological Survey (KGS) of the elevation of the Princess Number 8 coal (EHS Support, 2019a). A coal or "organic material" also was logged in three other monitoring wells (MW-1608, MW-1609, and MW-1610) in the network (**Table 2-1**) at the same approximate elevation between 630 and 650 feet that matches the KGS measurements. Three monitoring wells did not document any coal in this section (MW-1601, MW-1602, and MW-1611) and four monitoring wells were installed below this coal layer in the sedimentary sequence (MW-1604, MW-1605, MW-1606, and MW-1607).

Table 2-1 Screened Interval of Monitoring Wells

Well/Boring	Surface Elevation (ft msl)	Screened Interval (ft msl)	Coal or "Organics" Description at 632-650 ft?
MW-1601	713.8	646.8-636.8	No coal logged
MW-1602	711.6	632.1-622.1	No coal logged
MW-1603	673.2	651.2-641.2	Yes, at a depth of ~25 ft (Elevation of 648 ft)
MW-1604	553.1	513.1-503.1	---
MW-1605	554.4	538.9-528.9	---
MW-1606	551	513.1-503.1	---
MW-1607	542.2	518.7-508.7	---
MW-1608	716.2	606.6-596.6	Yes, at depths of ~74 ft (Elevation of 642 ft), ~ 75.3 to 76.6 ft (Elevation of 641 to 640 ft) and ~ 83.5 to 84 ft (Elevation of 633 to 632 ft)
MW-1609	~728	---	Yes, at a depth of ~79 ft (Elevation of 649 ft)
MW-1610	~716	---	Yes, at a depth of ~81 ft (Elevation of 635 ft)
MW-1611	~711	606-596	No coal logged

--- = Boring advanced below the coal interval
~ = Approximate
ft = feet
msl = mean sea level

Geosyntec determined that the groundwater monitoring well network described above meets the requirements of 40 CFR §257.91, as it consists of a sufficient number of wells installed at the appropriate locations and depths to yield groundwater samples from the uppermost aquifer that accurately represent the quality of background groundwater and groundwater passing the waste boundary of the BSFAP.

2.2 Groundwater Monitoring

AEP has conducted groundwater monitoring of the uppermost aquifer to meet the requirements of the CCR Rules. Groundwater monitoring generally included the following activities:

- Collection of groundwater samples and analysis for Appendix III and Appendix IV constituents, as specified in 40 CFR §257.94 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan* (AEP and EHS Support, October 2016)
- Completion of validation tests for groundwater data, including tests for completeness, valid values, transcription errors, and consistent units
- Establishment of background data for each Appendix III and Appendix IV constituent.
- Initiation of detection monitoring sampling and analysis
- Evaluation of the groundwater data using a statistical process in accordance with 40 CFR §257.93, which was prepared, certified, and posted to AEP's CCR website in April 2017 in AEP's *Statistical Analysis Plan* (Geosyntec, 2017). The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance"; USEPA, 2009)
- Initiation of assessment monitoring sampling and analysis
- Completion of statistical data evaluation and determination of groundwater protection standards

Assessment monitoring for the BSFAP has been conducted on a semi-annual basis since April 2018. The groundwater data collected up until and including the August 2019 monitoring event has been used for this ASD investigation. Specifically, beryllium, cobalt, and lithium in well MW-1603, which were identified as continuing to exhibit an SSL, and radium 226/228, which exhibited an SSL for the first time in August 2019. Assessment monitoring data for well MW-1603 is provided in **Table 2-2**.

Table 2-2 MW-1603 August 2019 Groundwater Quality

Analyte	Unit	Value
Antimony	µg/L	<0.1
Arsenic	µg/L	1.39
Barium	µg/L	13.6
Beryllium	µg/L	25
Boron	mg/L	<0.1
Cadmium	µg/L	0.89
Calcium	mg/L	95.8
Chloride	mg/L	3.93
Chromium	µg/L	0.8
Cobalt	µg/L	96.6
Fluoride	mg/L	0.84
Lead	µg/L	4.17
Lithium	mg/L	0.226

Analyte	Unit	Value
Mercury	µg/L	<0.002
Molybdenum	µg/L	<2
pH	S.U.	3.54
Radium 226/228	pCi/L	10.92
Residue, Filterable, TDS	mg/L	1,010
Selenium	µg/L	5.6
Sulfate	mg/L	704

< = less than
µg/L = micrograms per liter
mg/L = milligrams per liter
pCi/L = picocuries per liter
S.U. = standard units
TDS = total dissolved solids

3 Alternative Source Demonstration Requirements

3.1 Alternative Source Demonstration

Potential causes that may support the ASD may include, but are not limited to, sampling causes (ASD Type I), laboratory causes (ASD Type II), statistical evaluation causes (ASD Type III), and/or natural variation causes (ASD Type IV). This ASD for the BSFAP will focus on assessing whether Type IV natural variations in groundwater could be the cause of SSLs of beryllium, cobalt, lithium, and radium 226/228 reported from groundwater monitoring well MW-1603.

Historical groundwater monitoring data for MW-1603 is provided as **Table 1** (attached).

3.2 Water Monitoring Results

The following constituents will typically provide the information required for a complete ASD:

- Primary indicators (boron and sulfate) for potential BSFAP leachate impacts.
- Major ion concentrations (alkalinity, chloride, sulfate, calcium, magnesium, potassium, and sodium) in leachate and groundwater that are used to evaluate whether downgradient groundwater chemistry remains representative of background groundwater chemistry. Major ion chemistry can also be used to evaluate natural variability due to seasonal changes or other causes.
- Field turbidity in groundwater is an indicator of the presence of suspended solids that may contribute to elevated concentrations of constituents monitored in unfiltered samples under the CCR Rule.
- pH in leachate and groundwater provides information on chemical reactions and potential mobility of constituents in groundwater.
- Dissolved oxygen, oxidation reduction potential (ORP), iron, and manganese in groundwater are all indicators of redox conditions. Changes in redox can affect the chemical state and solubility of sulfate in addition to trace elements including arsenic and selenium. For example, under strongly reduced conditions (ORP less than –200 millivolts at pH 7), sulfate can be reduced to form hydrogen sulfide or it can precipitate as iron sulfide, arsenic reduces to the more mobile arsenite species, and selenium reduces to the low-mobility selenite species.

Groundwater monitored at a CCR unit for compliance with the CCR Rule is a compilation of the history of all sources of water comingling at that particular monitoring well. Different sources may contribute some of the same constituents, making source identification challenging. The identification and use of water quality “signatures” can be used as a tool for deciphering the similarity between potential sources and the water quality at a specific monitoring point.

4 Alternative Source Demonstration Assessment

As stated within **Section 1.2**, the primary indicators for CCR (coal ash) leachate affects in groundwater are boron and sulfate. In addition to these two constituents, chloride will also be a primary indicator for this ASD. Other potential indicators that have been evaluated include potassium, sodium, fluoride, molybdenum, and bromide.

As identified in **Section 1.1**, SSLs of beryllium, cobalt, lithium, and radium 226/228 have been reported in groundwater samples above the GWPS from monitoring well MW-1603 in August 2019. The water quality signatures for well MW-1603 will be discussed within **Section 4.3** and compared to the water quality of the BSFAP.

EPRI (2012) describes three tiers of investigation for evaluation of water quality signatures to determine if elevated concentrations represent a release from a CCR facility. Conversely, these tools can also be used to evaluate whether or not sources other than CCR are contributing to groundwater quality degradation. The three tiers defined by EPRI (2012) are:

- Tier I: Trend Analysis and Statistics
- Tier II: Advanced Geochemical Evaluation Methods
- Tier III: Isotopic Analyses

The CCR Rule requires statistical analysis under detection monitoring and under assessment monitoring for the determination of SSLs above the GWPS. Many of the primary and potential indicator constituents listed for coal ash (EPRI, 2017) are included in AEP's constituent list for the BSFAP groundwater monitoring programs, including the primary constituent's boron and sulfate. If there is an SSL without a corresponding increase in a primary indicator constituent (boron and usually sulfate for coal ash), then this is a key line of evidence for an ASD.

4.1 Groundwater Data Analysis

4.1.1 Primary Indicators

Temporal plots for primary indicators boron, sulfate, and chloride reported in groundwater monitoring well MW-1603 are provided in **Figure 4-1** to **Figure 4-3**, respectively, with data for the BSFAP water presented for comparison. All temporal plots use the following color-coding system:

- Red – indicates a concentration reported above the reporting limit.
- Orange – indicates a concentration reported below the reporting limit but above the method detection limit (denoted as estimated "J" values).
- Green – indicates a concentration below the method detection limit (MDL) (denoted as "U"); results below the MDL were conservatively plotted as the MDL.

The BSFAP water signature is plotted as a constant concentration in **Figure 4-1** to **Figure 4-12**. This sample was collected on October 19, 2017. As the BSFAP accepted fly ash prior to 1970, it is probable that BSFAP water quality has historically varied over time. However, since the BSFAP ceased accepting fly ash prior to 2016, the water quality is anticipated to be more stable; therefore, this October 2017 data provides a reasonable representation of current BSFAP conditions.

Groundwater quality for well MW-1603 is plotted on the primary y-axis and BSFAP water quality is plotted on the secondary y-axis, due to the differences in concentration between the groundwater quality in the vicinity of MW-1603 and the BSFAP water, as labelled in **Figure 4-1** to Figure 4-13.

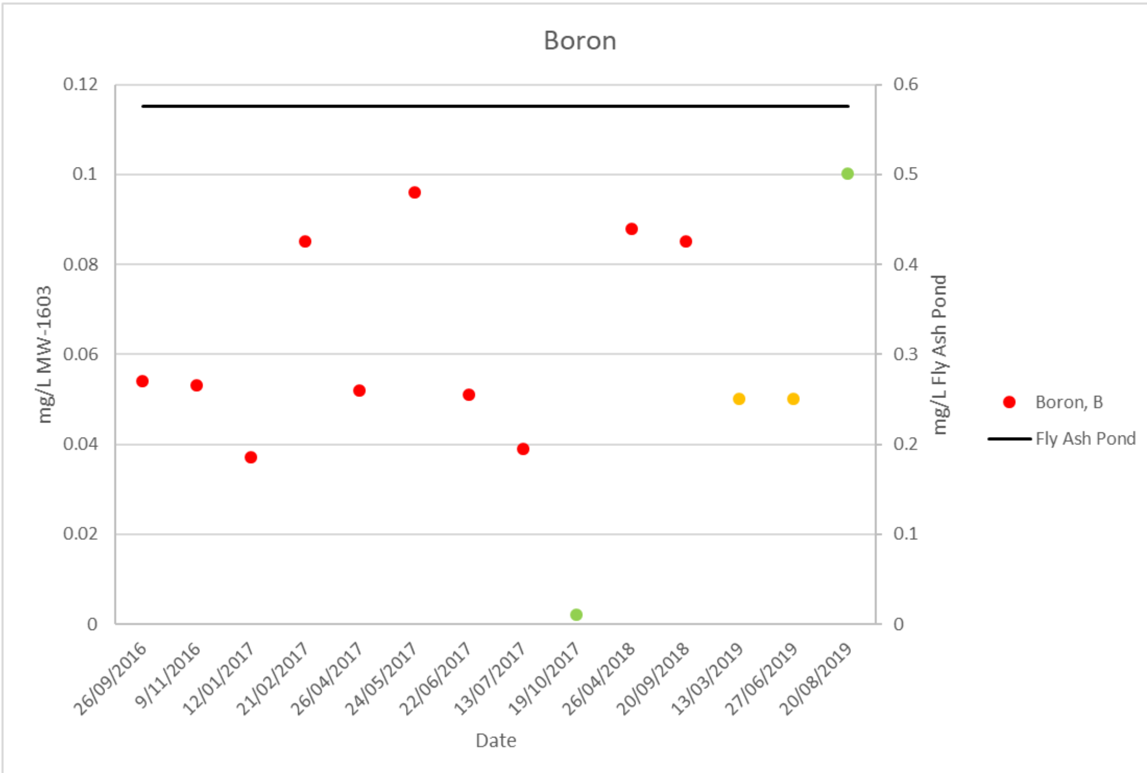

Figure 4-1 MW-1603 Boron Concentrations

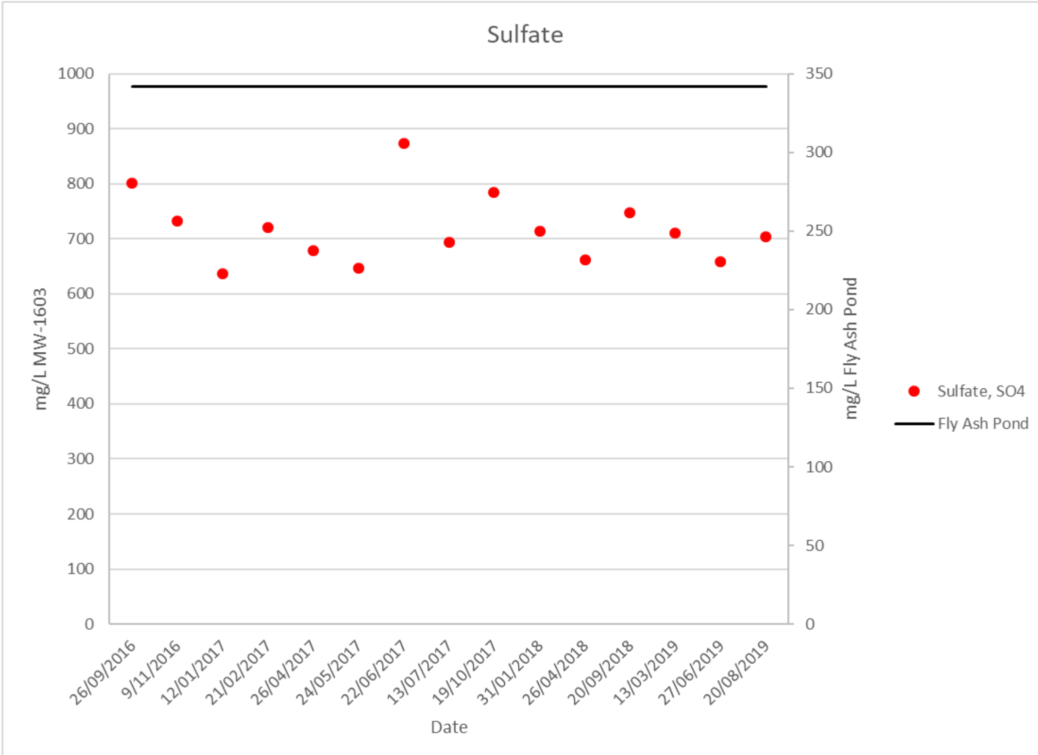

Figure 4-2 MW-1603 Sulfate Concentrations

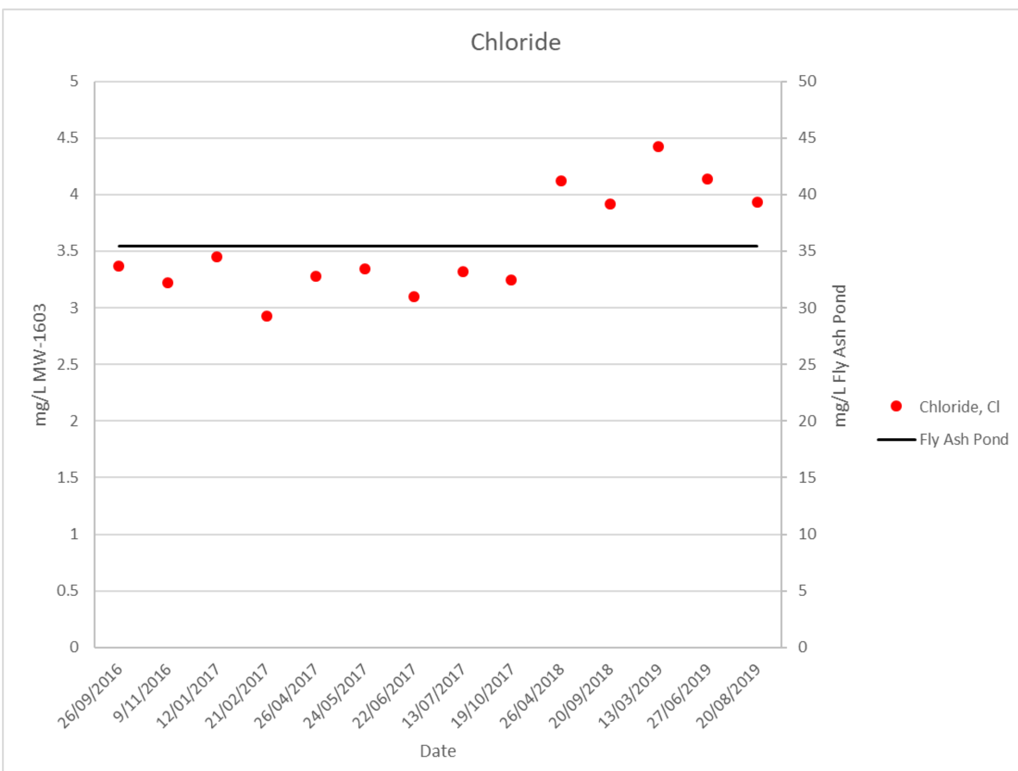

Figure 4-3 MW-1603 Chloride Concentrations

Boron concentrations in MW-1603 have remained relatively constant, with some variability over the monitoring period (September 2016 through August 2019). Sulfate was initially reported as 801 mg/L in September 2016 and has shown a very slight decreasing trend during the monitoring period. Chloride concentrations in MW-1603 also remained relatively constant until April 2018, after which a slight increase is observed until March 2019 when concentrations decrease. Comparing the concentrations in groundwater to the BSFAP, boron and chloride are present at higher concentrations in the BSFAP than in groundwater, while sulfate is present at higher concentrations in groundwater than in the BSFAP.

In summary, there has been no observable changes in primary indicator concentrations since the last review in September 2019.

4.1.2 Potential Indicators

Temporal plots for potential indicators bromide, fluoride, molybdenum, potassium, and sodium reported in groundwater monitoring well MW-1603 are provided in **Figure 4-4** to **Figure 4-8**, respectively, with data for the BSFAP water presented for comparison.

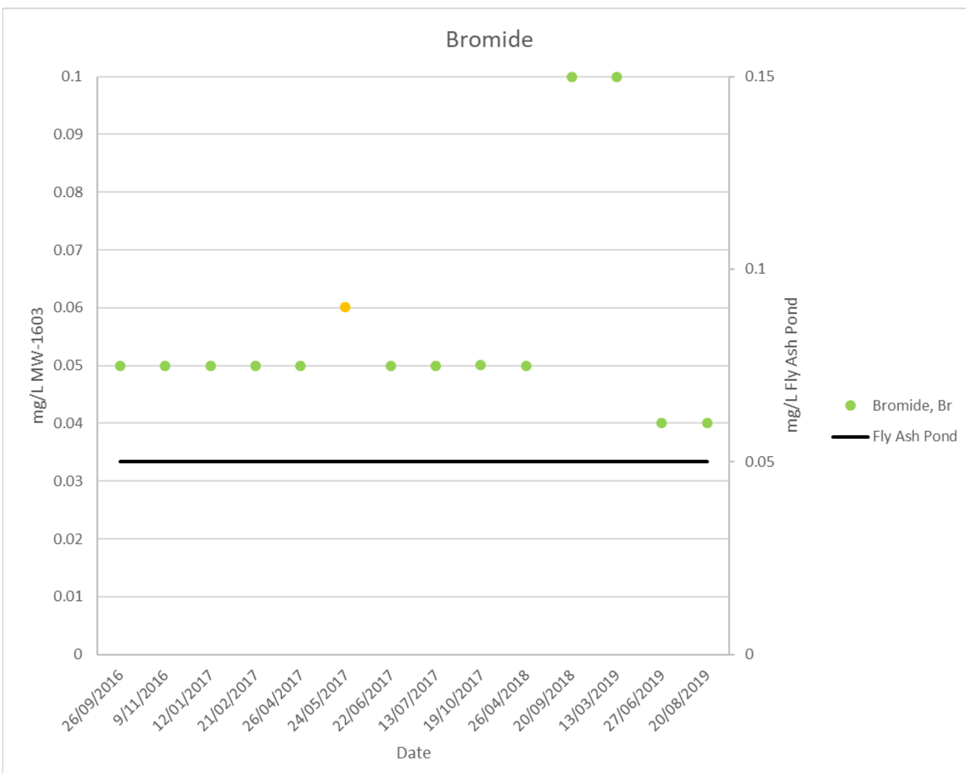

Figure 4-4 MW-1603 Bromide Concentrations[1]

[1] Bromide is below the level of reporting for the BSFAP water, with a detection level of <0.05 mg/L for this sample result.

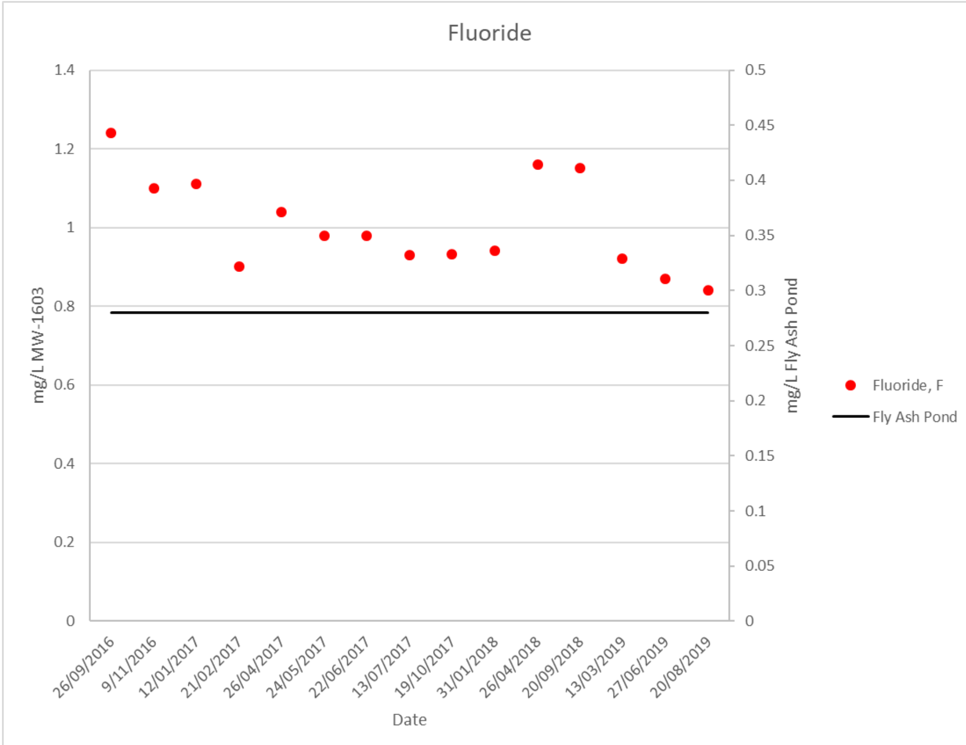

Figure 4-5 MW-1603 Fluoride Concentrations

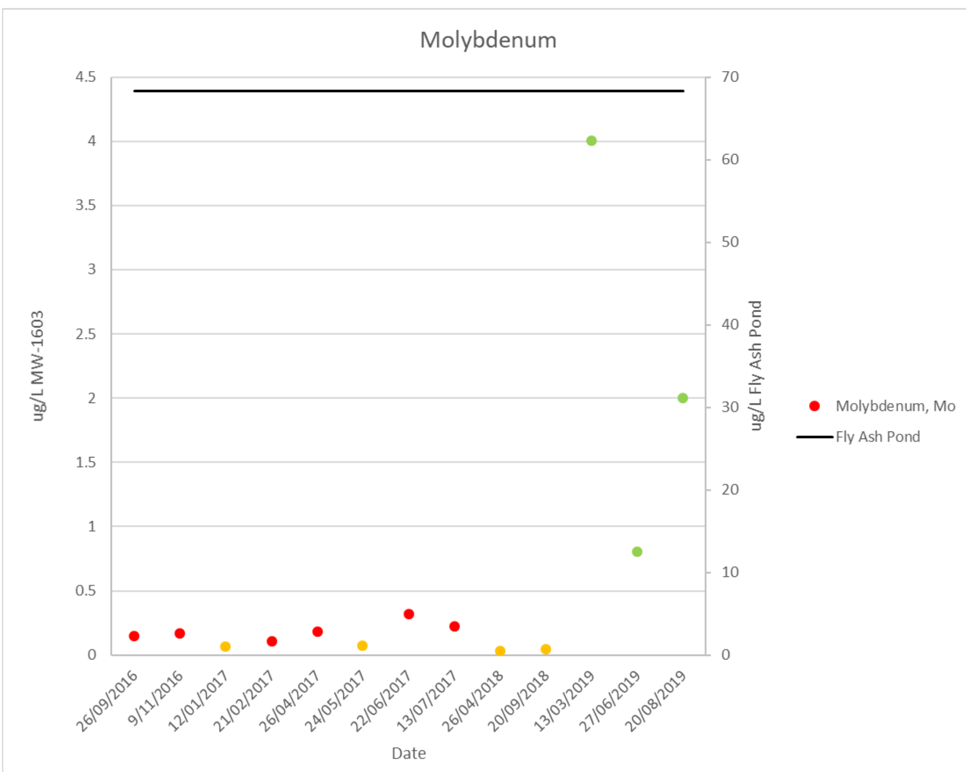

Figure 4-6 MW-1603 Molybdenum Concentrations

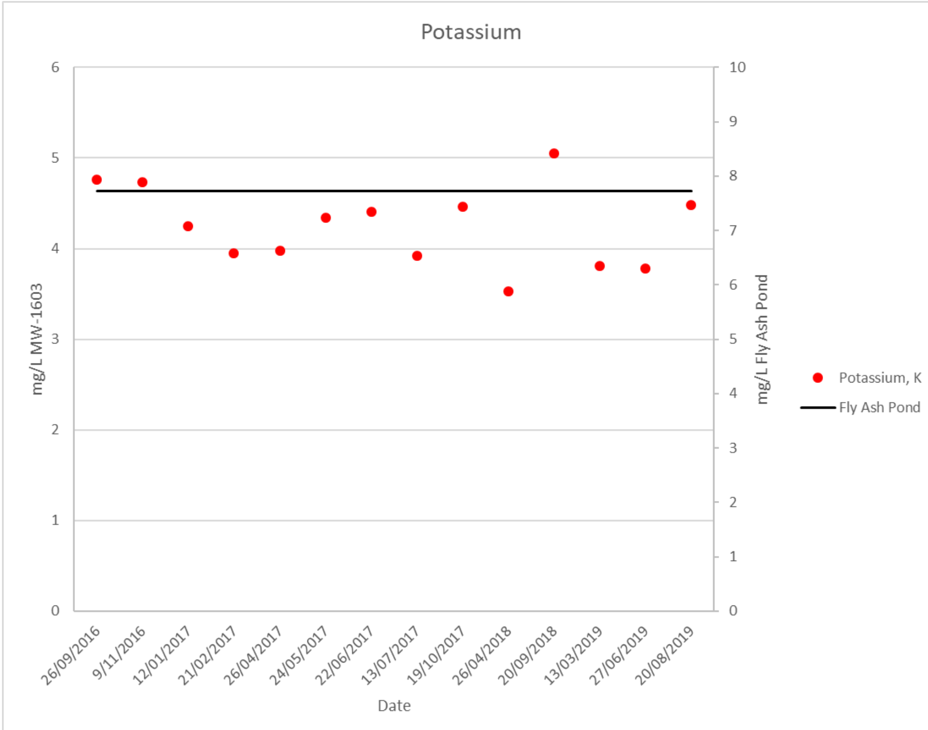

Figure 4-7 MW-1603 Potassium Concentrations

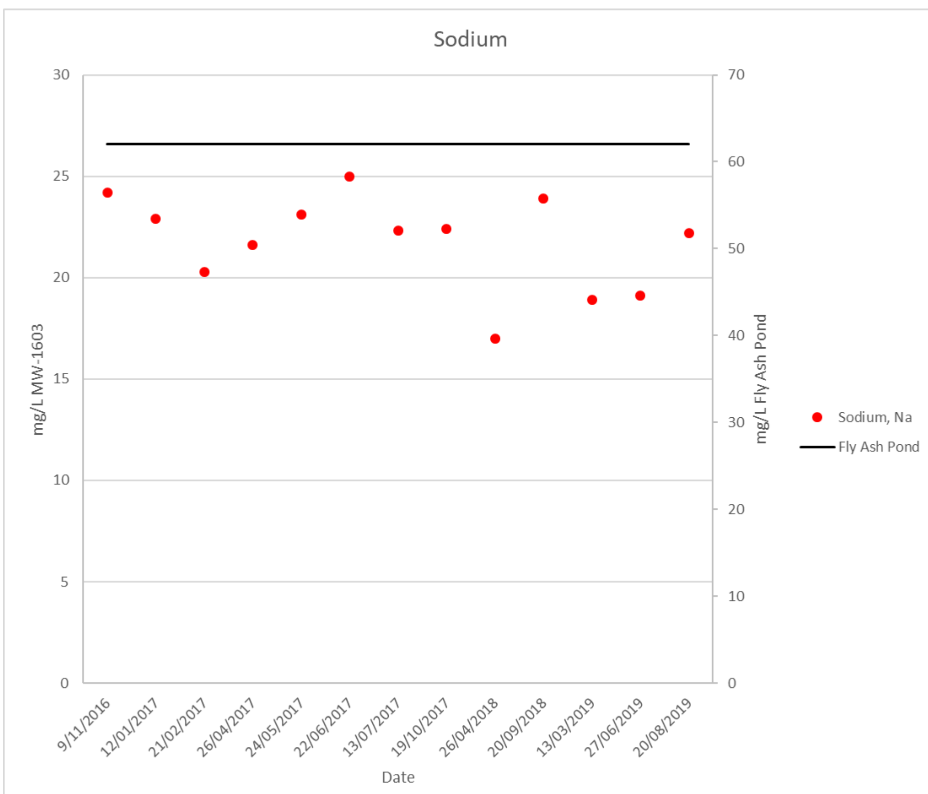

Figure 4-8 MW-1603 Sodium Concentrations

Molybdenum, potassium, and sodium are present in the groundwater in the vicinity of MW-1603 at concentrations below the concentrations reported within the BSFAP. Fluoride groundwater concentrations are more elevated than those within the BSFAP. Bromide concentrations in groundwater have been mostly below the method of detection. Where bromide has been detected (May 2017) it was 0.06 mg/L, or slightly above the <0.05 mg/L reported in BSFAP water in May 2017.

The comparison of pH between the BSFAP and MW-1603 is provided in **Figure 4-9**. This illustrates the significant difference in pH between the pond water and groundwater, between approximately three to five standard units. This is using the standard pH scale which is logarithmic and converts to a difference of 1,000 to 100,000 units on an arithmetic scale.

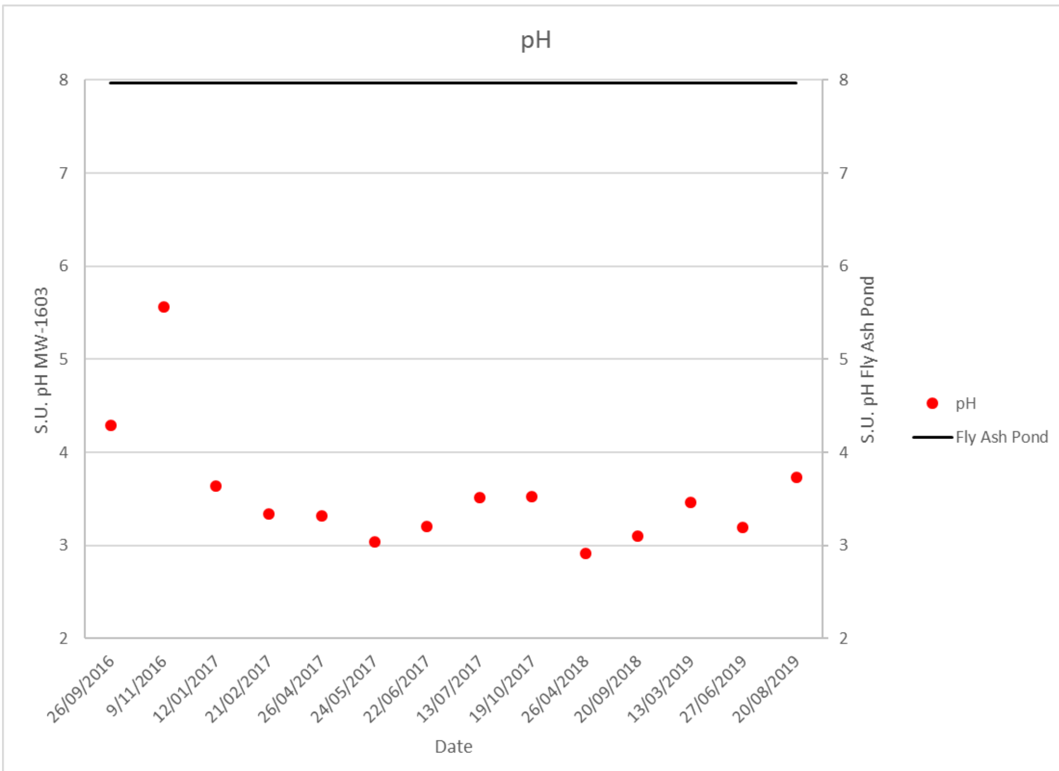

Figure 4-9 MW-1603 pH Values

In summary, there has been no observable changes in primary indicator concentrations since the last review in September 2019.

4.1.3 ASD Constituent Trends

Temporal plots for the ASD constituents, beryllium, cobalt, lithium, and radium 226/228 reported in groundwater monitoring well MW-1603, are provided in **Figure 4-10** to **Figure 4-13**, respectively, with data for the BSFAP water presented for comparison.

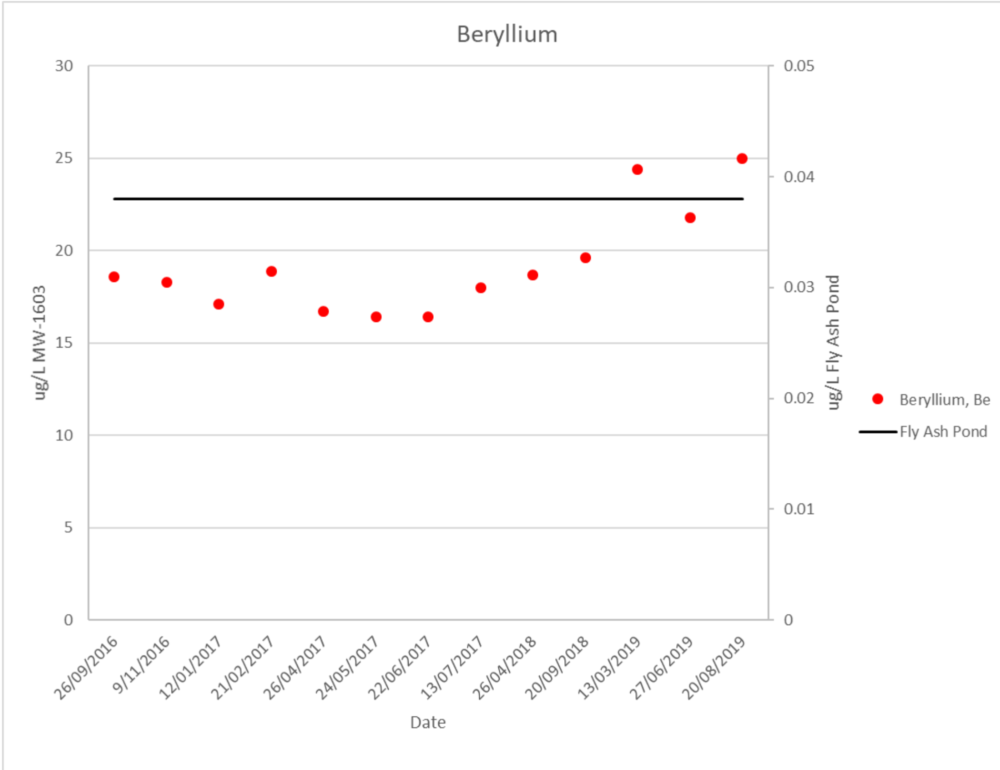

Figure 4-10 MW-1603 Beryllium Concentrations

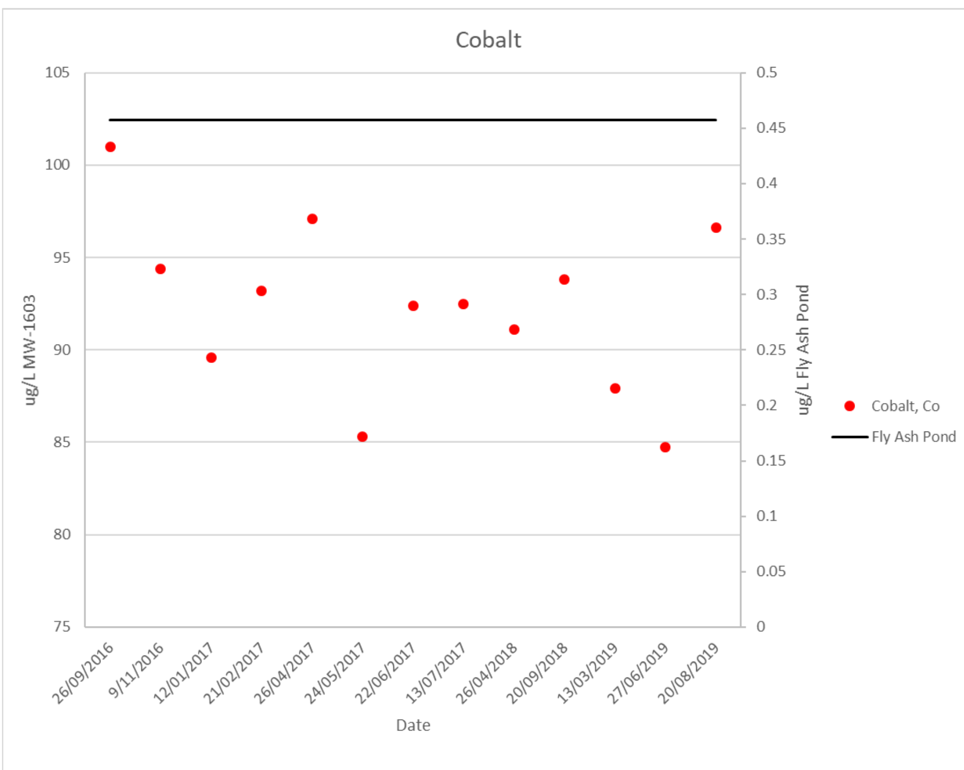

Figure 4-11 MW-1603 Cobalt Concentrations

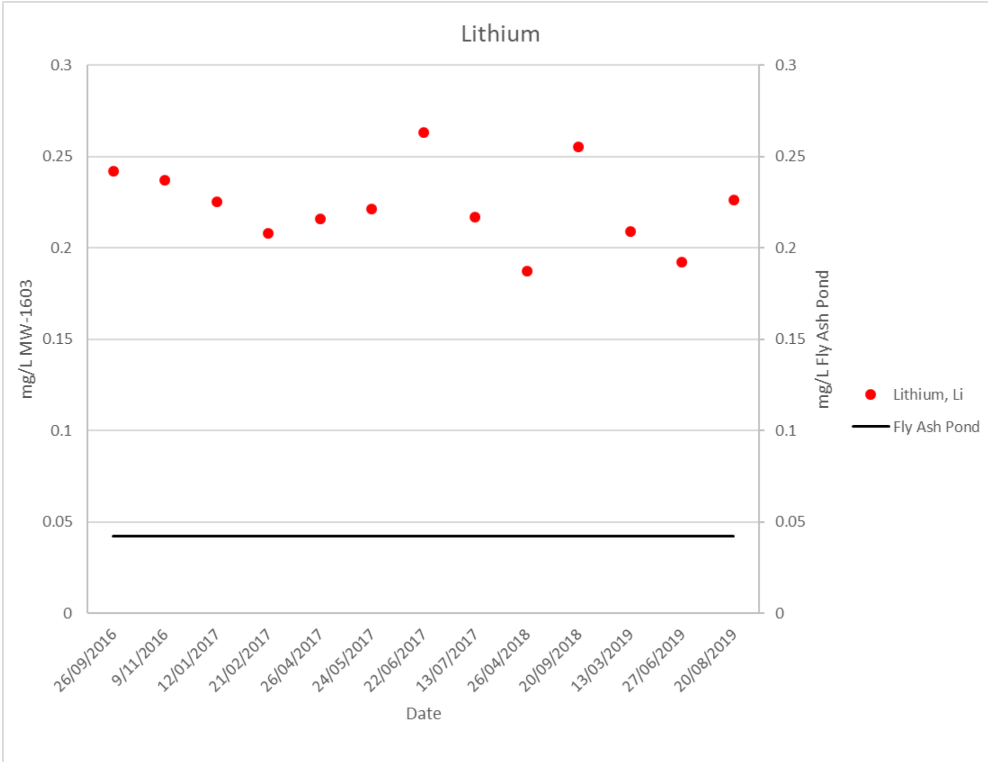

Figure 4-12 MW-1603 Lithium Concentrations

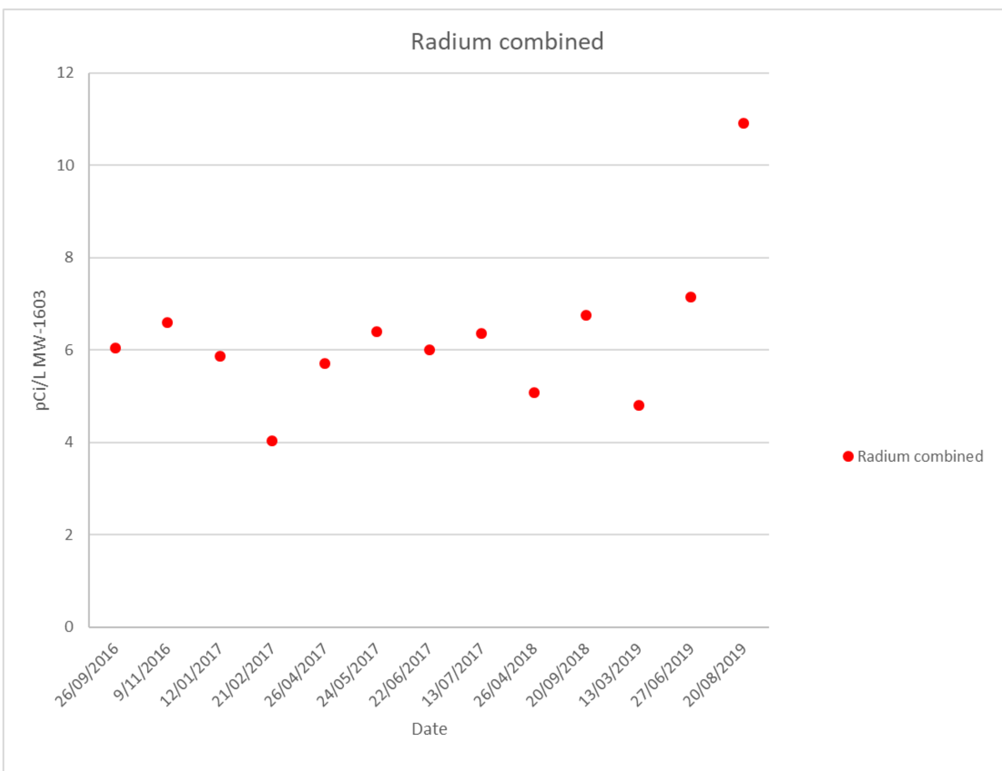

Figure 4-13 MW-1603 Radium 226/228 Concentrations

Beryllium, cobalt, and lithium are more elevated in MW-1603 groundwater in comparison to BSFAP water indicating the source of beryllium, cobalt, and lithium is not likely associated with the BSFAP.

Radium 226/228 concentrations in the BSFAP water are unknown and a comparison between the BSFAP water and MW-1603 groundwater has not been made. Radium 226/228 concentrations in MW-1603 appear to be stable across the majority of the dataset, with August 2019 elevated in comparison to the earlier measurements. More data points for MW-1603 are required to ascertain whether the August 2019 concentration of radium (combined) is considered to be an outlier relative to the other monitoring wells being used to assess potential influence from the BSFAP.

4.1.4 Indicator Analysis Findings

Based on the temporal plots for primary indicators, potential indicators, and ASD constituents, it is considered unlikely that CCR constituents from the BSFAP are influencing water chemistry in surrounding groundwater. This is based on the primary indicator sulfate, potential indicators fluoride and bromide, and the ASD constituent's beryllium, cobalt, and lithium all being present at higher concentrations in groundwater compared to the BSFAP water. As the concentrations of these constituents in groundwater are higher, it is unlikely that there is a concentration gradient extending from the BSFAP into groundwater. It is more likely that an alternate source in groundwater is contributing to the higher concentrations observed in groundwater.

In summary, there are no trends within MW-1603 groundwater data to suggest CCR constituents are migrating from the BSFAP into groundwater based on the analyses presented above.

4.2 Tier I Evaluation - Statistical Evaluation

A statistical evaluation of analytes has been conducted previously (EHS Support, 2019a and 2019b). The evaluation concluded that groundwater in the vicinity of MW-1603 is statistically the same as the United States Geologic Survey (USGS) reported for regional background (Ruppert et al., 2000) in regard to arsenic, boron, calcium, chloride, chromium, fluoride, molybdenum, potassium, sodium, and strontium. The box plots from the earlier ASD investigations (EHS Support, 2019a and 2019b) also show a difference between well MW-1603, BSFAP water, and/or the regional background for pH, alkalinity, barium, cobalt, lead, lithium, magnesium, selenium, and sulfate. For beryllium, chromium, lead, lithium, molybdenum, and selenium no background values were provided by the USGS.

Updated box and whisker plots for constituents reported in MW-1603 groundwater are provided in **Appendix A - Figures A-1 through A-11**. Plots for radium 226/228 and pH exhibit outliers which are calculated to be outside the range of distribution (refer to Appendix A Figure A-12 and Figure A-8, respectively). A summary of data distribution statistics for MW-1603 is provided in **Appendix B – Table B-1**.

It is likely that the acidic pH conditions, low alkalinity, and high sulfate conditions at MW-1603 relative to regional background are driving dissolution of metals. These geochemical conditions within well MW-1603, which are similar to acid mine drainage, are due to the presence of the Princess Coal Seams (discussed in EHS Support, 2019a) being intersected by the screened interval of this monitoring well. The combination of the well installation and sampling is allowing the saturated conditions within the coal seams to become aerobic which results in a lowering of pH and increase in metal solubility. Trace amounts of uranium are also known to be present within coal deposits (Gabbard, 1993). When uranium decays it forms radium. If the coal seam intersected by MW-1603 contains trace amounts of uranium, it could also be a source of the radium 226/228 detected in MW-1603.

4.3 Tier II Evaluation - Geochemical Evaluation

A simple analysis of primary and potential indicator constituents (as performed in **Section 4.1**) may not provide the lines of evidence required for a robust ASD investigation. It is recognized that naturally occurring indicator constituents and upgradient sources may have an additional influence on groundwater quality. Spatially across a site, groundwater quality may be observed to change due to chemical interactions with the aquifer matrix. EPRI (2012) recommended more sophisticated methods that can be used for multiple parameters over multiple locations. These include ion ratios and ternary plots.

Development of ion ratios involves first selecting two non-competing, non-sorbing constituents (boron and chloride). The ratios of these constituents are then compared spatially across the site and a judgment is made as to whether the hydraulically downgradient groundwater is similar to the background groundwater quality.

The median concentrations of boron, chloride, and sulfate are provided in **Table 4-1**. These three constituents were selected based on the EPRI recommended indicator species (2017). Bromide was not included within the assessment, as bromide was non-detect in the BSFAP water indicating its presence in groundwater was either naturally derived or from an off-site source. The median concentration for sulfate indicates a minor decrease, and median concentrations for boron and chloride show no change since January 2019.

As discussed above, the groundwater quality reported from well MW-1603 is unlikely to be influenced by the BSFAP.

Table 4-1 Median Concentrations of Boron, Chloride, and Sulfate

		Median Concentrations 2016 to 2019		
	Location ID	**Boron**	**Chloride**	**Sulfate**
Location	**Units**	**mg/L**	**mg/L**	**mg/L**
Source	**Fly Ash Pond**	0.58	35.4	342
Downgradient	**MW-1603**	0.05 ±0.02	3 ±0.4	709 ±64

mg/L = milligrams per liter

Ion ratios have been calculated using boron, chloride, and sulfate as recommended in EPRI (2017) and are provided in **Table 4-2**. The ion ratios show no change since the last evaluation in September 2019.

Table 4-2 Ion Ratios

		Median Concentrations 2016 to 2019		
Location	**Location ID**	**Boron/Sulfate (x1000)**	**Boron/Chloride**	**Chloride/Sulfate**
Source	**Fly Ash Pond**	1.68	0.002	0.10
Downgradient	**MW-1603**	0.07 ±0.03	0.02 ±0.01	0.005 ±0.001

Based on the previous evaluation of ion ratio analysis, the conclusion that it does not appear likely that MW-1603 has been impacted by CCR constituents from the BSFAP is unchanged.

Ternary plots can be used to identify changes in major or minor ion distributions over time. A ternary plot using calcium, chloride, and sulfate measured in the vicinity of MW-1603 is provided in **Figure 4-14**. The ternary plot shows that the major ion groundwater ratios have not changed during the 3-year period of groundwater quality monitoring at well MW-1603, as all the event ratios are grouped closely together.

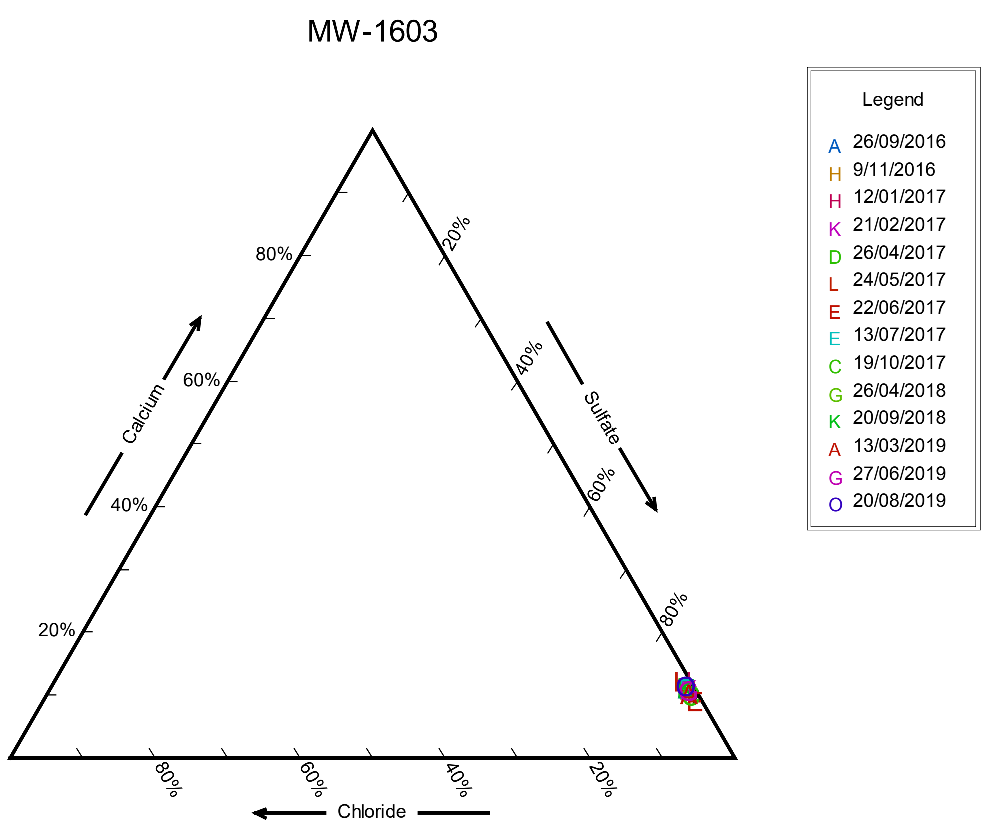

Figure 4-14 Ternary Plot MW-1603

In summary, based on the previous geochemical evaluation and the updated review presented in this ASD investigation, there is insufficient evidence to support the presence of CCR constituents (principally beryllium, cobalt, and lithium), as derived from the BSFAP, in groundwater sampled at MW-1603. The ternary plot does not support temporal changes of MW-1603 groundwater quality. The ion ratios of boron, chloride, and sulfate remain unchanged since September 2019. Therefore, it is highly unlikely that beryllium, cobalt, lithium, and radium 226/228 detected within MW-1603 groundwater are sourced from the BSFAP. It is much more likely that beryllium, cobalt, lithium, and radium 226/228 are characteristic of the lithologies in which this monitoring well is screened across, which includes the Princess Coal Seams.

5 Summary and Conclusions

Using the EPRI (2017) guidance for ASD investigations, the conclusions that are based on the lines of evidence presented and discussed within **Sections 3** and **4** indicate that groundwater in the vicinity of the BSFAP is not being impacted by CCR constituents from the BSFAP. The elevated beryllium, cobalt, and lithium concentrations that triggered the ASD investigation are due to the oxidation of coal seams that have been intersected by well location MW-1603. This is supported by the visual evidence during the logging of core characteristics at this location (refer to EHS Support, 2019a), the low pH reported in groundwater, and the subsequent likely dissolution and mobility of metalliferous species (beryllium, cobalt, and lithium) by the elevated acidity.

In addition, radium 226/228 concentrations have been reported in MW-1603 at an SSL in the August 2019 groundwater monitoring data. Radium isotopes are naturally occurring radioactive materials (NORMs) found in coal measures as decay products of uranium. Therefore, the presence of radium 226/228 is likely due to the oxidation of coal seams that have been intersected by well location MW-1603. As a result of the installation, screening, and extraction of groundwater from MW-1603, radium 226/228 is now likely to be a technologically enhanced NORM.

The elevated pH in the BSFAP water and the corresponding lower concentrations of minor ions in the BSFAP also support the unlikely influence of the BSFAP on groundwater. Therefore, it is concluded that the elevated signatures of beryllium, cobalt, lithium, and radium 226/228 in MW-1603 noted in the August 2019 groundwater monitoring data are related to the dissolution of naturally-occurring coal seam-derived constituents within the shale layers of the Breathitt Group, as supported by the discussion of local and regional geology in **Section 2.1** and EHS Support (2019a).

6 References

AEP and EHS Support. (2016). Groundwater Sampling and Analysis Plan. October.

EHS Support. (2019a). Alternative Source Demonstration Report for Beryllium, Cobalt and Lithium, Big Sandy Fly Ash Pond, Louisa, Kentucky. February.

EHS Support. (2019b). Alternative Source Demonstration Addendum Report for Beryllium, Cobalt and Lithium, Big Sandy Fly Ash Pond, Louisa, Kentucky. September.

EPRI. (2012). Groundwater Quality Signatures for Assessing Potential Impacts from Coal Combustion Product Leachate. EPRI, Palo Alto, CA. 1017923.

EPRI. (2017). Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Sites. EPRI, Palo Alto, CA. 3002010920.

Gabbard, A. (1993) Coal Combustion: Nuclear Resource or Danger. Oak Ridge National Laboratory Review v.26, no. 3&4

Geosyntec Consultants, Inc. (2017). Statistical Analysis Plan. January.

Geosyntec Consultants, Inc. (2016). Groundwater Monitoring Well Installation Report – Fly Ash Pond. October.

Rice, C. and Hiett, J. (1994). Revised Correlation Chart of the Coal Beds, Coal Zones, and Key Stratigraphic Units in the Pennsylvanian Rocks of Eastern Kentucky, USGS Miscellaneous Field Studies Map MF-2275.

Ruppert, L., Tewalt, S., Wallack, R., Bragg, L., Brezinski, D., Carlton, R., Butler, D., and Calef, F. (2000). A Digital Resource Model of the Middle Pennsylvanian Upper Freeport Coal Bed Allegheny Group, Northern Appalachian Basin Coal Region. USGS Professional Paper 1625-C. 101 pages.

USEPA. (2009). Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance. March.

Figures

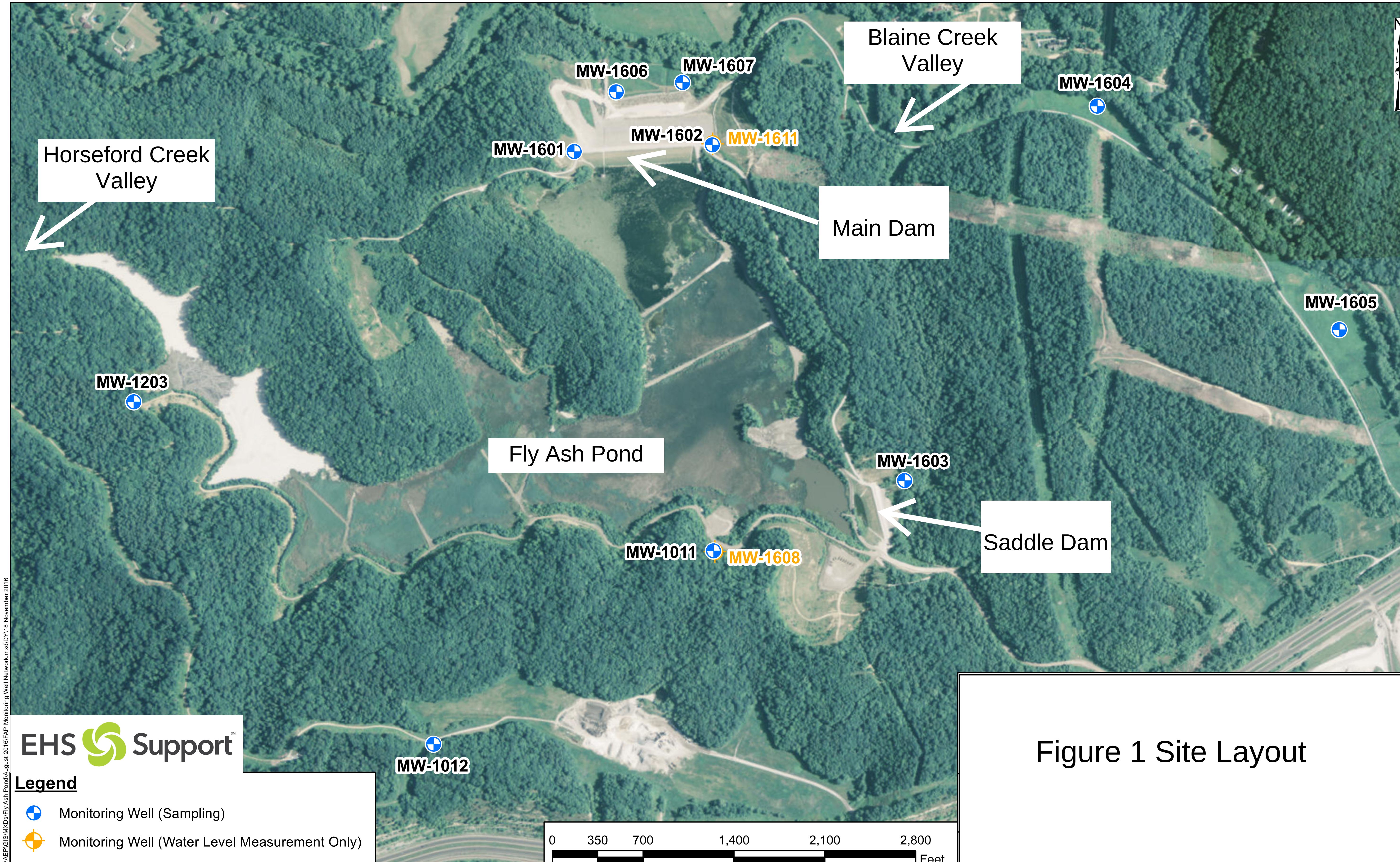

Figure 1 Site Layout

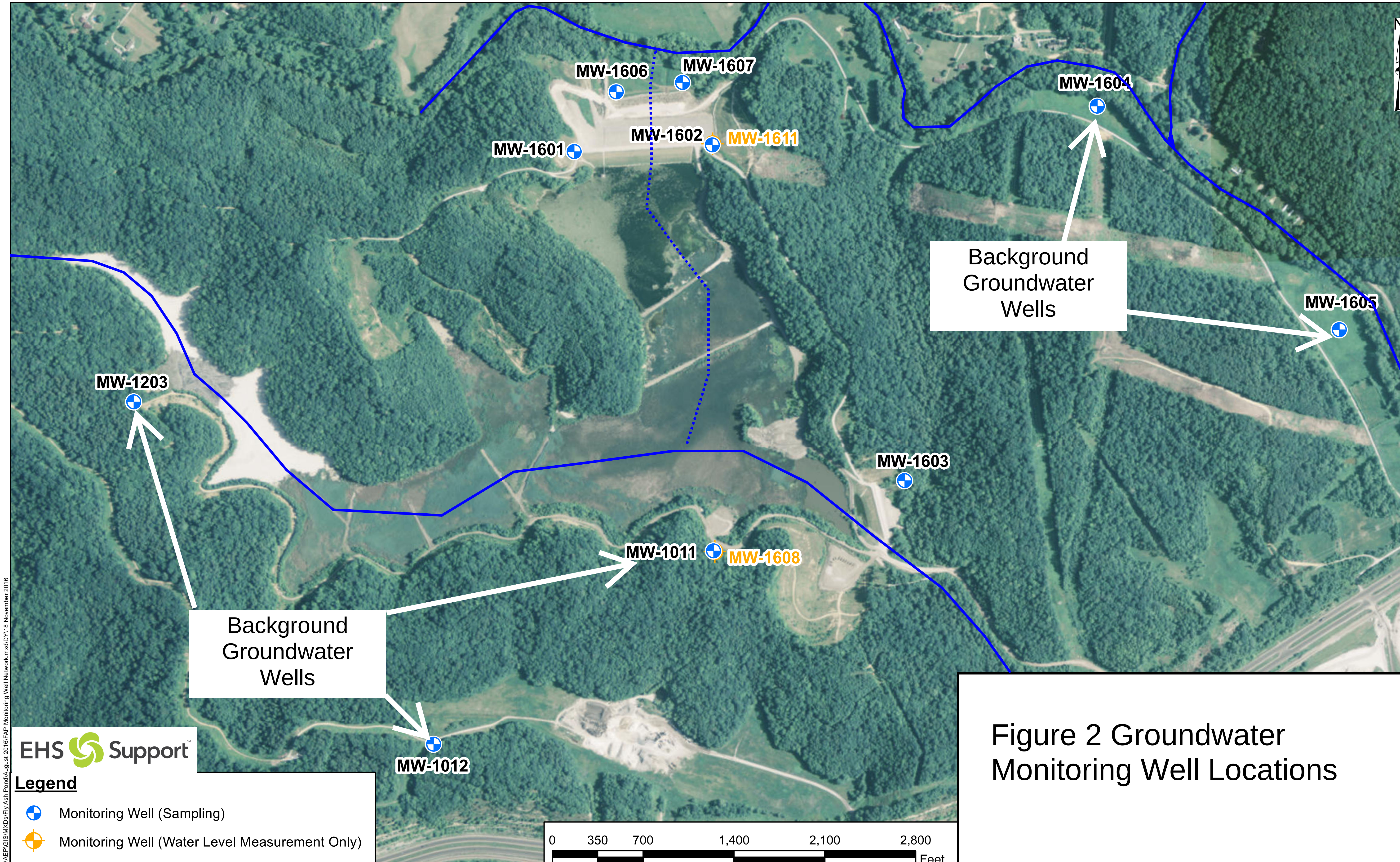

Figure 2 Groundwater Monitoring Well Locations

N:\AEP\GIS\MXDs\Fly Ash Pond\August 2016\FAP Monitoring Well Network.mxd\DY\18 November 2016

Tables

Table 1
MW-1603 Historical Groundwater Data 2016 to 2019
Big Sandy Fly Ash Pond Groundwater Monitoring,
American Electric Power, Kentucky Power Company, Louisa, Kentucky

Analytes	Units	26/09/2016	9/11/2016	12/01/2017	21/02/2017	26/04/2017	24/05/2017	22/06/2017	13/07/2017	19/10/2017	31/01/2018	26/04/2018	20/09/2018	23/10/2018	13/03/2019	27/06/2019	20/08/2019
Antimony, Sb	µg/L	0.01 J	< 0.01	< 0.01	< 0.01	0.01 J	< 0.01	< 0.01	< 0.01	NA	NA	0.04 J	0.02 J	NA	< 0.2	< 0.04	< 0.1
Arsenic, As	µg/L	1.51	1.19	1.4	1.26	1.3	1.34	1.29	0.89	NA	NA	1.6	1.4	NA	1.26	1.36	1.39
Barium, Ba	µg/L	13.4	15.4	11.4	10.3	12.4	11.5	11.4	11.3	NA	NA	10.5	11.4	NA	12	11	13.6
Beryllium, Be	µg/L	18.6	18.3	17.1	18.9	16.7	16.4	16.4	18	NA	NA	18.7	19.6	NA	24.4	21.8	25
Boron, B	mg/L	0.054	0.053	0.037	0.085	0.052	0.096	0.051	0.039	< 0.002	NA	0.088	0.085	NA	0.05 J	0.05 J	< 0.1
Cadmium, Cd	µg/L	0.84	0.93	0.79	0.75	0.87	0.77	0.86	0.8	NA	NA	0.74	0.83	NA	0.78	0.7	0.89
Calcium, Ca	mg/L	105	94.7	92.7	91.9	90.5	93.9	90.6	90.2	91	82.2	83.6	97.5	NA	84.6	83.3	95.8
Chloride, Cl	mg/L	3.37	3.22	3.45	2.93	3.28	3.34	3.1	3.32	3.24	NA	4.12	3.92	NA	4.42	4.13	3.93
Chromium, Cr	µg/L	1.1	1.12	0.731	0.771	0.829	0.62	0.821	0.485	NA	NA	0.771	0.713	NA	1 J	0.618	0.8
Cobalt, Co	µg/L	101	94.4	89.6	93.2	97.1	85.3	92.4	92.5	NA	NA	91.1	93.8	NA	87.9	84.7	96.6
Comb. Radium 226/228	pCi/L	6.04	6.6	5.86	4.03	5.72	6.4	6	6.36	NA	NA	5.09	6.75	NA	4.8	7.149	10.92
Fluoride, F	mg/L	1.24	1.1	1.11	0.9	1.04	0.98	0.98	0.93	0.93	0.94	1.16	1.15	NA	0.92	0.87	0.84
Lead, Pb	µg/L	9.75	8.18	6.11	6.3	6.41	4.96	6.47	3.72	NA	NA	5.27	4.39	NA	4.28	3.68	4.17
Lithium, Li	mg/L	0.242	0.237	0.225	0.208	0.216	0.221	0.263	0.217	NA	NA	0.187	0.255	NA	0.209	0.192	0.226
Mercury, Hg	µg/L	< 0.002	< 0.002	< 0.002	< 0.002	0.002 J	< 0.002	< 0.002	< 0.002	NA	NA	< 0.002	NA	< 0.002	< 0.002	< 0.002	< 0.002
Molybdenum, Mo	µg/L	0.15	0.17	0.06 J	0.11	0.18	0.07 J	0.32	0.22	NA	NA	0.03 J	0.04 J	NA	< 4	< 0.8	< 2
pH	S.U.	4.29	5.56	3.64	3.34	3.32	3.04	3.20	3.52	NA	3.52	2.91	3.10	3.46	3.19	3.73	3.54
Residue, Filterable, TDS	mg/L	1060	1010	948	1020	994	936	1040	1000	962	915	926	974	NA	896	954	1010
Selenium, Se	µg/L	5.4	4.8	5.6	4.9	6.1	6.3	6.1	2.7	NA	NA	8.1	6.3	NA	4	4.9	5.6
Sulfate, SO4	mg/L	801	733	636	720	678	646	873	694	784	714	661	747	NA	709	658	704
Thallium, Tl	µg/L	1.29	1.55	1.39	1.2	1.41	1.35	1.43	1.43	NA	NA	1.39	1.7	NA	1 J	1.4	2 J

Notes:
< - not detected at or above the method detection limit
J - Estimated value. Analyte detected at a level less than the reporting limit and greater than or equal to the method detection limit.
mg/L – Milligrams per liter
NA – Not analyzed
pCi/L – Picocuries per liter
S.U. – Standard Units
TDS – Total Dissolved Solids
µg/L – Micrograms per liter

Appendix A Box Plots

Figure A-1 Boron Box Plot

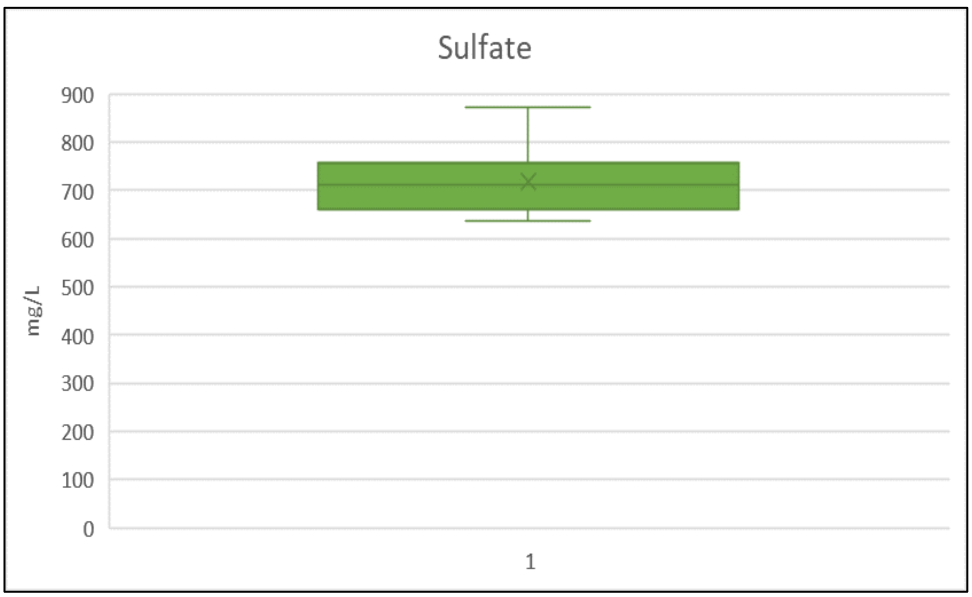

Figure A-2 Sulfate Box Plot

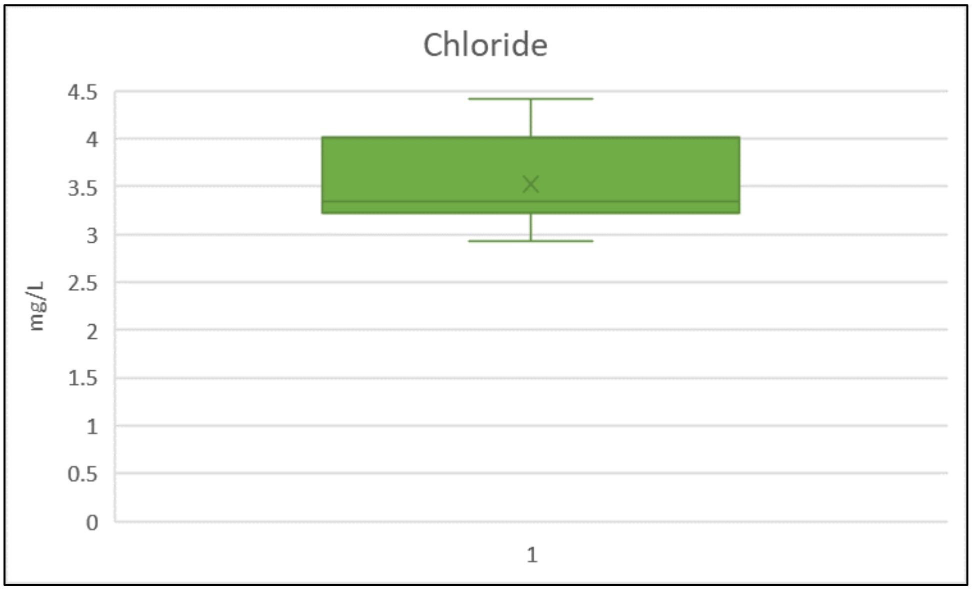

Figure A-3 Chloride Box Plot

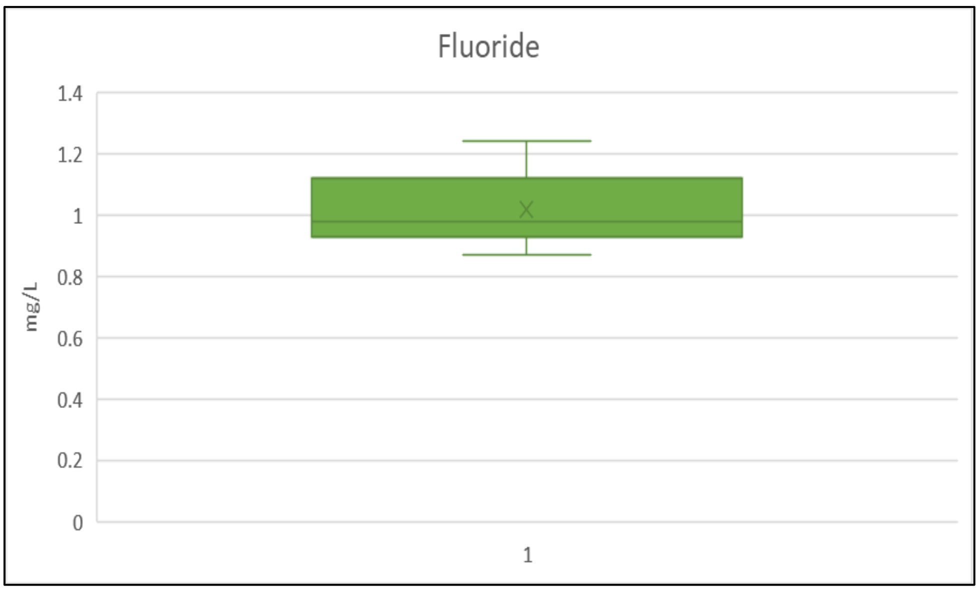

Figure A-4 Fluoride Box Plot

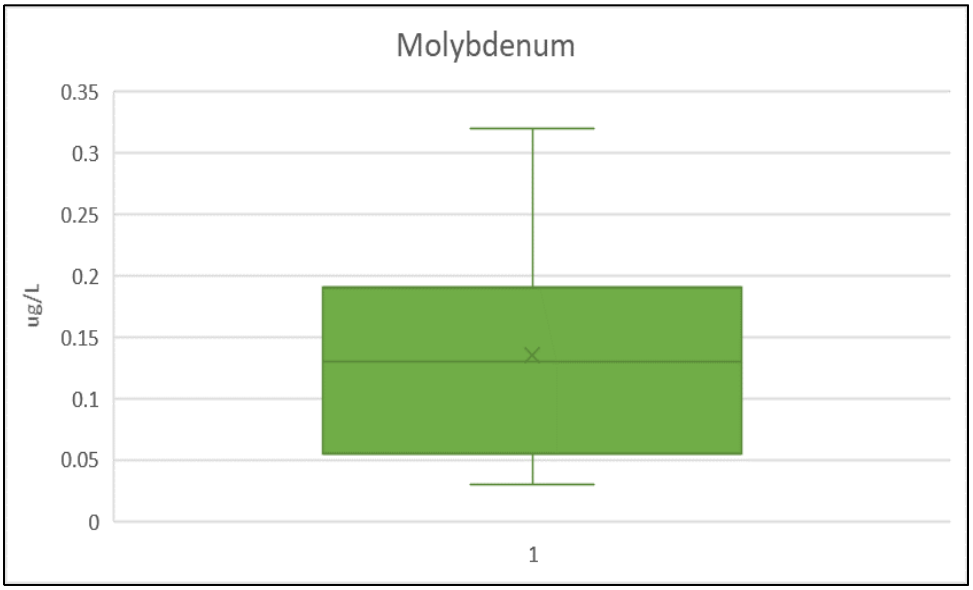

Figure A-5 Molybdenum Box Plot

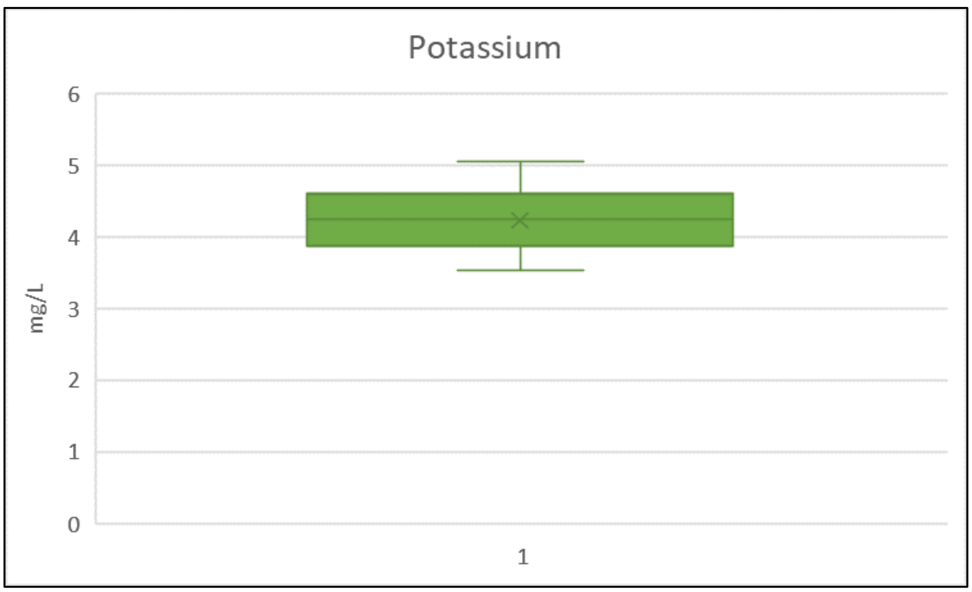

Figure A-6 Potassium Box Plot

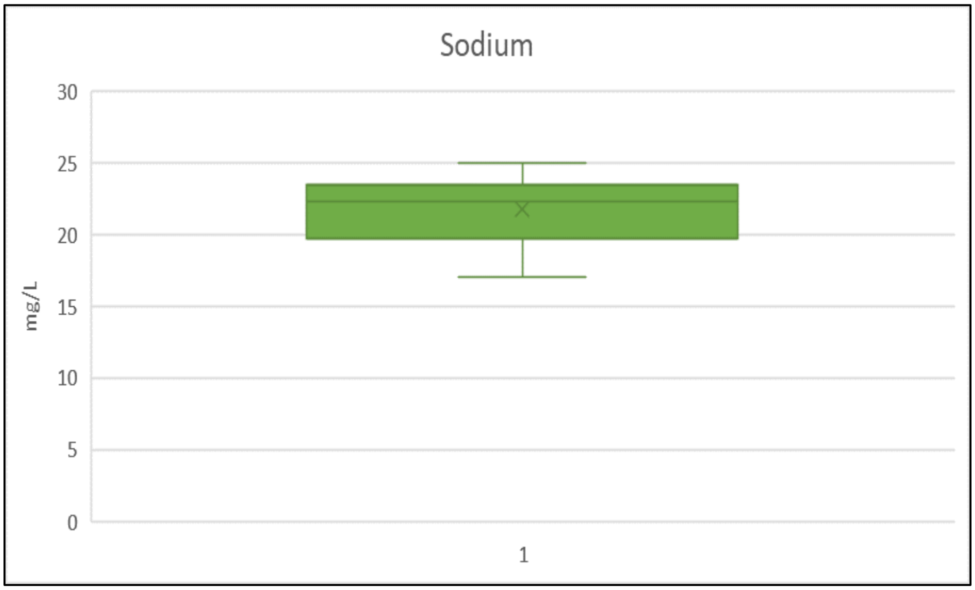

Figure A-7 Sodium Box Plot

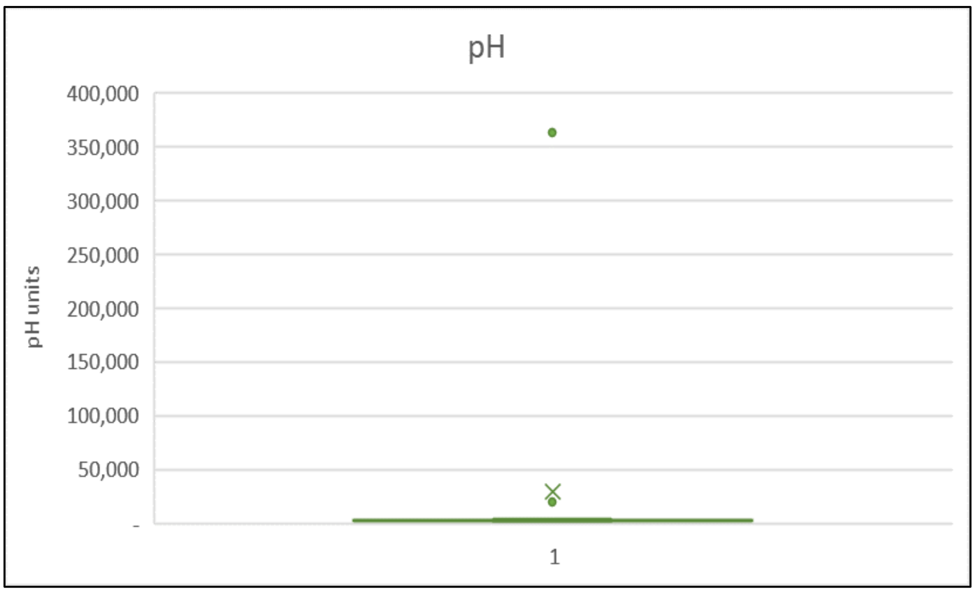

Figure A-8 pH Box Plot

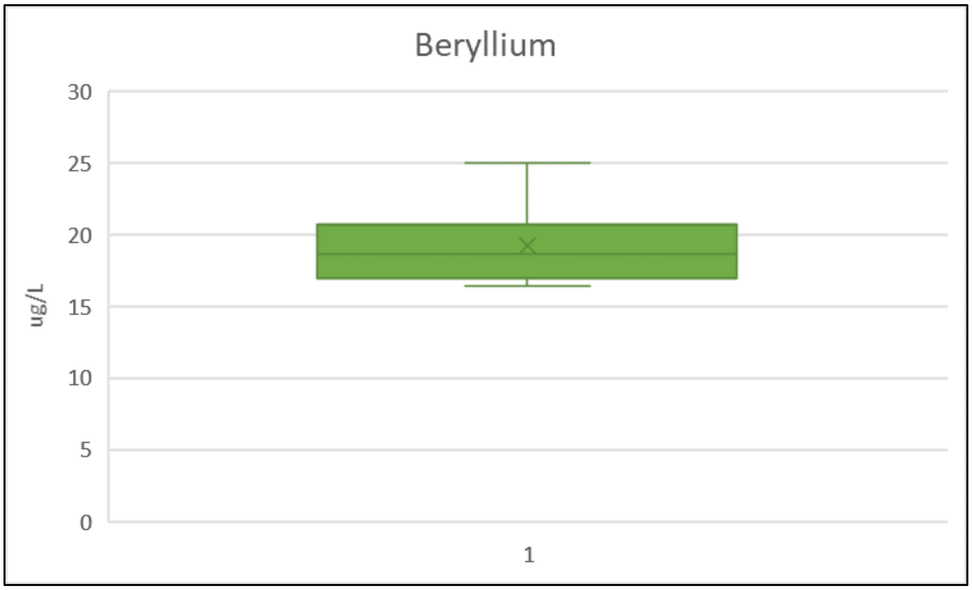

Figure A-9 Beryllium Box Plot

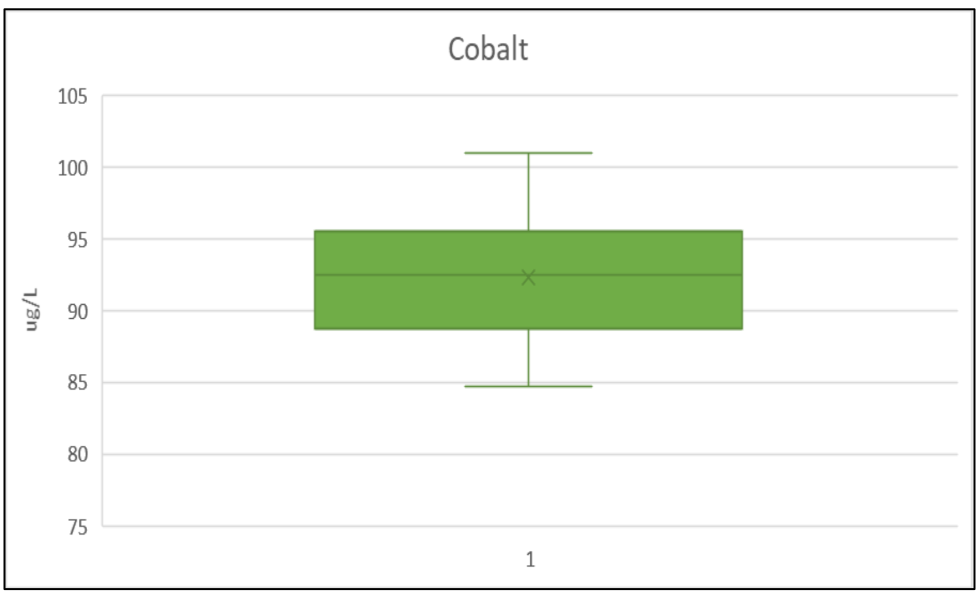

Figure A-10 Cobalt Box Plot

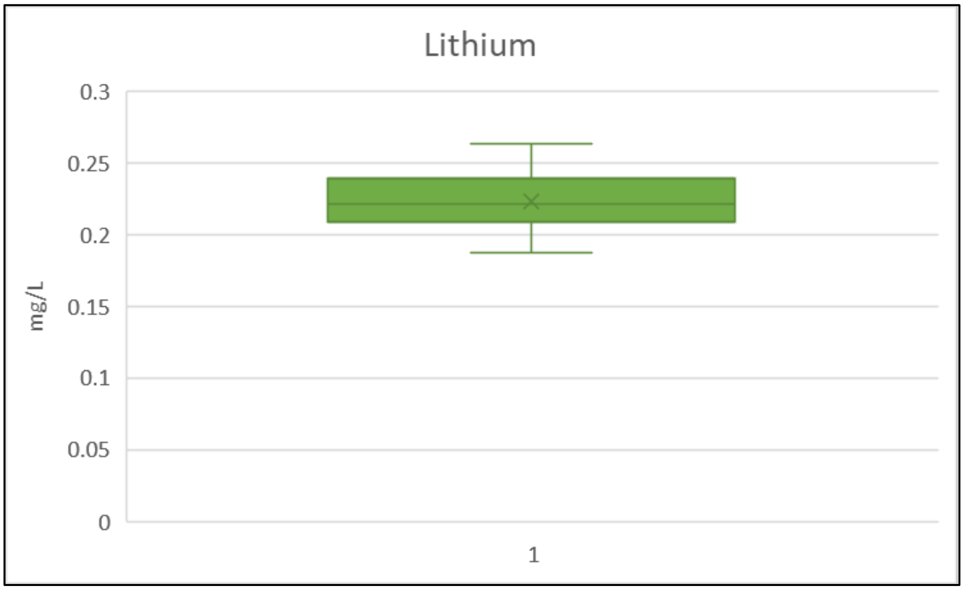

Figure A-11 Lithium Box Plot

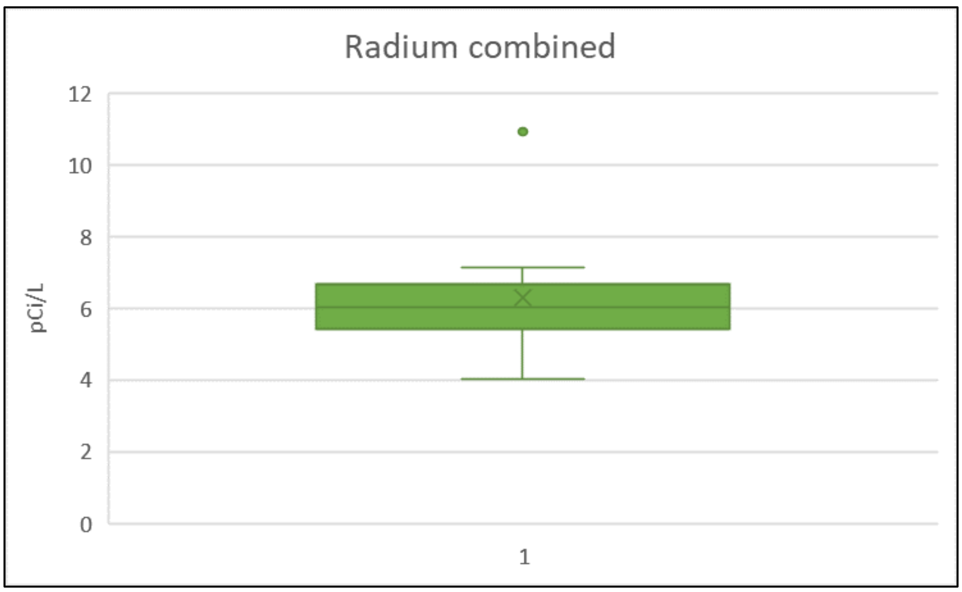

Figure A-12 Radium 226/228 Box Plot

Appendix B Data Distribution Summary

Table B-1 Data Distribution Summary MW-1603

Parameter	Boron	Sulfate	Chloride	Fluoride	Molybdenum	Potassium	Sodium	pH	Beryllium	Cobalt	Lithium	Radium combined
	mg/L	mg/L	mg/L	mg/L	µg/L	mg/L	mg/L	S.U.	µg/L	µg/L	mg/L	pCi/L
1st quartile	0.045	661	3.24	0.92	0.06	3.89	19.70	3.19	16.9	88.8	0.209	5.405
2nd quartile	0.052	709	3.36	0.98	0.13	4.30	22.30	3.46	18.6	92.5	0.221	6.04
3rd quartile	0.085	747	3.98	1.11	0.19	4.54	23.50	4.29	20.7	95.5	0.2395	6.675
Median	0.052	709	3.36	0.98	0.13	4.30	22.30	3.46	18.6	92.5	0.221	6.04
Mean	0.057	717	3.56	1.01	0.14	4.25	21.76	3.79	19.2	92.3	0.223	6.286
Standard deviation	0.026	64	0.46	0.12	0.09	0.44	2.33	0.91	2.8	4.7	0.022	1.631
Minimum	0.002	636	2.93	0.84	0.03	3.53	17	2.91	16.4	84.7	0.187	4.03
Maximum	0.096	873	4.42	1.24	0.32	5.05	25	5.56	2	101	0.263	10.92

µg/L = micrograms per liter
mg/L = milligrams per liter
pCi/L = picocuries per liter
S.U. = standard units