

Purpose of Statistical Analysis Summary Report

During the initial phase of ground water monitoring, the CCR rule requires AEP to collect at least eight independent samples from at least one up-gradient and three downgradient wells for 21 substances listed in the CCR rule. The CCR rule also requires us to select a statistical method that will be used to evaluate the samples in the later phases of the ground water monitoring program. The Statistical Plan, which has been posted to AEP's CCR website, describes the methods selected by AEP. *See AEP's Statistical Analysis Plans.*

Each **Statistical Analysis Summary Report** is based on the results of the 8 independent samples that were collected by October 17, 2017, and reported in the Annual Groundwater Monitoring Report. Using the statistical methods chosen by AEP, the samples were evaluated to eliminate outliers, determine variability and general trends in the data, and establish background values for: boron, calcium chloride, fluoride, pH, sulfate, and total dissolved solids. Appendix IV substances were evaluated for purposes of identifying outliers and understanding data trends.

A subsequent sample taken during the first detection monitoring sampling event was also compared using the proper statistical methods to the background values that were established for these seven substances from the eight independent samples. A second or third re-sampling event occurred, and the results compared using the same methods. This work is reported in the memorandum included in attachment A. If confirmed, AEP will be required to enter the next phase of monitoring. The results of future sampling will be further analyzed to target any specific substances for which ongoing monitoring or potential corrective action is required.

STATISTICAL ANALYSIS SUMMARY BOTTOM ASH POND

**Cardinal Plant
Brilliant, Ohio**

Submitted to



1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec 
consultants

engineers | scientists | innovators

150 East Wilson Bridge Road
Suite 232
Worthington, Ohio 43085

January 11, 2018

CHA8423

TABLE OF CONTENTS

SECTION 1 Executive Summary	ES-1
SECTION 2 Bottom Ash Pond Evaluation.....	2-1
2.1 Data Validation & QA/QC	2-1
2.2 Statistical Analysis.....	2-1
2.2.1 Background Outlier Evaluation	2-2
2.2.2 Establishment of Background Levels	2-2
2.2.3 Certification by Qualified Professional Engineer.....	2-4
2.3 Conclusions.....	2-5
SECTION 3 References	3-1

LIST OF TABLES

Table 1	Groundwater Data Summary
Table 2	Outlier Analysis Summary
Table 3	Background Value Summary

LIST OF ATTACHMENTS

Attachment A	Evaluation of Detection Monitoring Data
Attachment B	Statistical Analysis Output

LIST OF ACRONYMS AND ABBREVIATIONS

AEP	American Electric Power
ANOVA	Analysis of Variance
BAP	Bottom Ash Pond
CCR	Coal Combustion Residuals
CCV	Continuing Calibration Value
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
LFB	Laboratory Fortified Blanks
LPL	Lower Prediction Limit
LRB	Laboratory Reagent Blanks
NELAP	National Environmental Laboratory Accreditation Program
PQL	Practical Quantitation Limit
QA	Quality Assurance
QC	Quality Control
SSI	Statistically Significant Increase
SWFPR	Site-Wide False-Positive Rate
TDS	Total Dissolved Solids
UPL	Upper Prediction Limit
USEPA	United States Environmental Protection Agency

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 Bottom Ash Pond (BAP), an existing CCR unit at the Cardinal Power Plant located in Brilliant, Ohio.

Eight monitoring events were completed prior to October 17, 2017 to establish background concentrations for Appendix III and Appendix IV parameters under the CCR rule. 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. The background data were reviewed for outliers, which were removed (when appropriate) prior to calculating upper prediction limits (UPLs) for each Appendix III parameter to represent background values. Oversight on the use of statistical calculations was provided by Dr. Kirk Cameron of MacStat Consulting, Ltd.

Following background monitoring, a detection monitoring event was completed on September 5, 2017 at the BAP. The results of the detection monitoring event are included in this report.

SECTION 2

BOTTOM ASH POND EVALUATION

2.1 Data Validation & QA/QC

During the background monitoring program, eight sets of samples were collected for analysis from each upgradient and compliance well. The data collected during the background and detection monitoring sampling events are provided 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.9.5.32 statistics software. The export 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

The background data used to conduct the statistical analyses and the detection monitoring data are summarized in Table 1. Statistical analyses for the BAP were conducted in accordance with the January 2017 *Statistical Analysis Plan* (AEP, 2017), except where noted below. Results for all completed statistical tests are provided in Attachment A. Throughout the statistical analysis provided in Attachment A, the well locations were identified via shorthand such that location ‘BAP-X’ represents results collected at ‘MW-BAP-X’ as described in the *Groundwater Monitoring Network Evaluation* (Geosyntec, 2016).

Time series plots of Appendix III and IV parameters are included in Attachment A. Mann-Kendall analyses ($\alpha = 0.01$) were conducted to evaluate trends in the background data. Barium and chromium were found to be significantly decreasing at compliance wells MW-BAP-1 and MW-BAP-3, respectively. Boron and chloride were found to be significantly increasing at compliance well MW-BAP-1, while sulfate was found to be significantly increasing at compliance well MW-BAP-3. No other significant increasing or decreasing trends were observed for other parameters or at other monitoring wells.

2.2.1 Background Outlier Evaluation

Potential outliers were identified using Tukey's outlier test; i.e., data points were considered potential outliers if they met one of the following criteria:

$$x_i < \tilde{x}_{0.25} - 3 \times IQR \quad (1)$$

or

$$x_i > \tilde{x}_{0.75} + 3 \times IQR \quad (2)$$

where:

$$\begin{aligned} x_i &= \text{individual data point} \\ \tilde{x}_{0.25} &= \text{first quartile} \\ \tilde{x}_{0.75} &= \text{third quartile} \\ IQR &= \text{the interquartile range} = \tilde{x}_{0.75} - \tilde{x}_{0.25} \end{aligned}$$

Data that were evaluated as potential outliers are summarized in Attachment A. Tukey's outlier test indicated three potential outliers, which are summarized in Table 2. Next, the data were reviewed to identify possible sources of errors or discrepancies, including data recording errors, unusual sampling conditions, laboratory quality, or inconsistent sample turbidity.

Three potential outliers were reported for mercury in select background August 10, 2016 and October 20, 2016 samples. However, two of these potential outlier values were estimated (J-flagged) trace concentrations and were not removed from the dataset. The remaining potential outlier, a reported value of 0.00007 mg/L at MW-BAP-4 on October 20, 2016 represented a detected value. Because the upgradient dataset contained many non-detect or estimated values for mercury, this detection likely represents aquifer conditions and was retained in the dataset.

2.2.2 Establishment of Background Levels

Analysis of Variance (ANOVA) was conducted to determine whether spatial variation was present among the two upgradient wells (Attachment A). ANOVA indicated no significant variation among the two upgradient wells for boron, calcium, and pH. Consequently, interwell tests were used for these parameters. Significant variation was observed for chloride, fluoride, sulfate, and total dissolved solids (TDS). Therefore, the appropriateness of using intrawell tests was evaluated for these parameters at the Cardinal Plant BAP.

Intrawell tests presume that the groundwater quality in the compliance wells was not initially impacted by the CCR unit. To test this presumption, the data from the upgradient wells were pooled and the data from each compliance well were compared to a pooled background value. Tolerance limits were calculated using the pooled background data for chloride, fluoride, sulfate, and TDS. Parametric tolerance limits with 99% confidence and 95% coverage were calculated for fluoride, sulfate, and pH; a non-parametric tolerance limit was calculated for chloride, given the

greater spatial variability observed for this parameter. Confidence intervals were calculated for each of these four parameters for each compliance monitoring well. If the lower confidence limit from a compliance well exceeded the upper tolerance limit for the pooled background data, it was concluded that compliance groundwater concentrations were above background concentrations. In these instances, intrawell tests would not be appropriate. However, the analyses indicated no significant exceedances for sulfate and TDS; elevated concentrations of chloride and fluoride were observed. (Non-parametric analyses also indicated no significant exceedances for sulfate and TDS and elevated compliance concentrations of chloride and fluoride.) Therefore, intrawell tests were used to evaluate potential statistically significant increases (SSIs) for sulfate and TDS. Interwell tests were used to evaluate potential SSIs for boron, calcium, chloride, fluoride, and pH.

After identified outliers were removed (where appropriate), 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-Francia 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 A.

Upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. To conduct the intrawell tests for sulfate and TDS, a separate UPL was calculated for each compliance well for each of these parameters. To conduct the interwell tests for boron, calcium, chloride, fluoride, and pH, a single prediction interval was calculated using pooled data from the two upgradient wells. The background data used for the UPL calculations are summarized in Table 1; the calculated UPLs are provided in Table 3.

Although a significant increasing trend in sulfate concentrations was observed at compliance well MW-BAP-1, the UPL was calculated as if no trend were present; i.e., the dataset was not limited to more recent data nor was the prediction interval constructed around a trendline. This was done because the change in sulfate concentrations at MW-BAP-1 is low relative to absolute sulfate concentrations at MW-BAP-1. Sulfate concentrations are also similar to sulfate concentrations at upgradient well MW-BAP-4. For these reasons, the increasing trend in sulfate concentrations at MW-BAP-1 is not currently considered indicative of a release from the BAP. The possibility of an ongoing increase and the need for truncating the background dataset for sulfate at MW-BAP-1 will be reevaluated after additional data are collected.

Significant increasing trend in boron and chloride concentrations were observed at compliance wells MW-BAP-1 and MW-BAP-3, respectively. However, the rates of change in boron and chloride concentrations are low relative to the absolute boron and chloride concentrations at MW-BAP-1 and MW-BAP-3. For this reason, the increasing trends in boron and chloride concentrations at MW-BAP-1 and MW-BAP-3, respectively, are not currently considered indicative of a release from the BAP CCR unit. If boron and chloride concentrations continue to increase at MW-BAP-1 and MW-BAP-3, respectively, an SSI will likely be concluded.

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 initial results did not exceed the UPL, a second sample was not collected. The one-of-two retesting procedure allowed achieving an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less. Power curves were constructed for the interwell and intrawell parametric tests and are compared with the EPA Reference Power Curve in Appendix A. The power curves associated with the statistical tests for the Cardinal Plant BAP exceed the EPA Reference Power Curve at 3 and 4 standard deviations; this is considered a “good” level of statistical power according to EPA’s *Unified Guidance* (USEPA, 2009).

2.2.3 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 Cardinal BAP CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID A. MILLER

Printed Name of Licensed Professional Engineer

David A. Miller

Signature

60659

License Number

OHIO

Licensing State

01.11.18

Date



2.3 Conclusions

Eight background monitoring events and one detection monitoring event were completed 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 three values, which were retained in the dataset due to extremely low concentrations. Prediction intervals were constructed based on the background data and a one-of-two retesting procedure. Interwell tests were selected for boron, calcium, chloride, fluoride, and pH, whereas parametric intrawell tests were selected for sulfate and TDS.

SECTION 3

REFERENCES

American Electric Power (AEP). 2017. Statistical Analysis Plan – Cardinal Plant. January 2017.

Geosyntec Consultants. 2016. Groundwater Monitoring Network Evaluation. Cardinal Site – Bottom Ash Pond. July 2016.

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
Cardinal Plant - Bottom Ash Pond

Parameter	Unit	MW-BAP-1								
		1/12/2017	10/20/2016	5/3/2017	5/31/2017	6/20/2017	6/28/2016	8/1/2017	8/10/2016	9/26/2017
		Background								
Antimony	µg/L	0.06	0.08	0.07	0.04J	0.04J	0.07	0.03J	0.08	-
Arsenic	µg/L	1.13	1.6	1.56	0.78	0.53	1.45	0.4	1.05	-
Barium	µg/L	86.5	107	85.3	72.6	63.6	93.6	61.5	107	-
Beryllium	µg/L	0.043	0.06	0.061	0.03	0.01J	0.072	0.01J	0.037	-
Boron	mg/L	1.95	1.73	2.27	2.11	2.4	1.71	2.69	1.83	2.7
Cadmium	µg/L	0.13	0.11	0.15	0.12	0.1	0.12	0.09	0.11	-
Calcium	mg/L	157	166	159	148	153	167	170	162	175
Chloride	mg/L	96.1	94.5	95.2	94.3	95.4	98.4	100	93.4	93.7
Chromium	µg/L	1.45	2	2.1	0.811	0.355	1.8	0.185	1.3	-
Cobalt	µg/L	1.1	1.29	1.3	0.951	0.74	1.49	0.665	1.2	-
Combined Radium	pCi/L	1.093	1.238	0.301	1.174	0.602	0.343	0.452	0.21	-
Fluoride	mg/L	0.34	0.35	0.33	0.3	0.3	0.38	0.41	0.33	0.33
Lead	µg/L	1.24	1.69	1.72	0.786	0.314	2.09	0.073	1.03	-
Lithium	mg/L	0.021	0.015	0.02	0.017	0.029	0.035	0.022	0.019	-
Mercury	µg/L	0.005U	0.007	0.006	0.004J	0.005U	0.01	0.003J	0.005U	-
Molybdenum	µg/L	26.4	28.6	26.8	27.4	29	19.6	29.2	27.5	-
Selenium	µg/L	0.2	0.4	0.3	0.1	0.06J	0.2	0.04J	0.2	-
Total Dissolved Solids	mg/L	918	942	948	952	957	953	926	916	977
Sulfate	mg/L	405	407	411	419	458	402	471	397	469
Thallium	µg/L	0.071	0.226	0.058	0.059	0.05J	0.05	0.05J	0.122	-
pH	SU	7.06	7.08	6.98	7.62	7.28	7.06	6.94	7.17	6.76

Notes:
mg/L: milligrams per liter
µg/L: micrograms 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
Cardinal Plant - Bottom Ash Pond

Geosyntec Consultants, Inc.

Parameter	Unit	MW-BAP-2								
		1/12/2017	10/20/2016	5/3/2017	5/31/2017	6/20/2017	6/28/2016	8/1/2017	8/10/2016	9/26/2017
		Background								Detection
Antimony	µg/L	0.03J	0.1	0.05J	0.03J	0.03J	0.07	0.03J	0.04J	-
Arsenic	µg/L	26	29.6	10.6	13.1	11.1	11.3	17.1	11.1	-
Barium	µg/L	104	123	104	106	91.5	94.3	93.8	89.5	-
Beryllium	µg/L	0.035	0.083	0.032	0.02J	0.01J	0.02J	0.02J	0.02J	-
Boron	mg/L	2.08	1.79	2.2	2.09	2.16	2.28	1.95	2.04	1.73
Cadmium	µg/L	0.05	0.09	0.04	0.04	0.02J	0.04	0.02	0.03	-
Calcium	mg/L	86.4	92.3	82.4	87.6	84.6	98.7	86	89.5	86.8
Chloride	mg/L	72.9	79.6	72	70.7	71.9	74.1	71.4	75.9	68.2
Chromium	µg/L	0.65	1.8	0.704	0.292	0.213	0.5	0.371	0.3	-
Cobalt	µg/L	1.59	2.17	1.61	1.37	1.21	1.52	1.2	1.36	-
Combined Radium	pCi/L	0.776	0.849	0.376	1.206	0.993	0.749	1.086	0.588	-
Fluoride	mg/L	0.62	0.79	0.42	0.33	0.34	0.35	0.46	0.33	0.33
Lead	µg/L	0.965	2.16	0.77	0.325	0.234	0.439	0.33	0.307	-
Lithium	mg/L	0.016	0.006	0.013	0.009	0.02	0.011	0.01	0.01	-
Mercury	µg/L	0.002J	0.004J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	-
Molybdenum	µg/L	26.2	31.9	42.1	46.6	49	37.6	46.1	38.4	-
Selenium	µg/L	0.1	0.4	0.2	0.09J	0.07J	0.09J	0.08J	0.08J	-
Total Dissolved Solids	mg/L	583	628	557	562	563	612	560	544	552
Sulfate	mg/L	176	190	213	222	234	239	218	228	230
Thallium	µg/L	0.03J	0.075	0.03J	0.02J	0.02J	0.03J	0.02J	0.03J	-
pH	SU	6.73	6.76	6.85	7.15	7.1	6.75	6.74	6.31	6.94

Notes:
mg/L: milligrams per liter
µg/L: micrograms 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
Cardinal Plant - Bottom Ash Pond

Parameter	Unit	MW-BAP-3								
		1/12/2017	10/20/2016	5/3/2017	5/31/2017	6/20/2017	6/28/2016	8/1/2017	8/11/2016	9/26/2017
		Background								
Antimony	µg/L	0.03J	0.02J	0.02J	0.02J	0.02J	0.03J	0.02J	0.04J	-
Arsenic	µg/L	0.99	0.69	0.39	0.36	0.32	0.42	0.31	0.75	-
Barium	µg/L	52.2	55.8	47.7	51.7	46.7	49.1	47.4	65.3	-
Beryllium	µg/L	0.009J	0.009J	0.006J	0.005J	0.02U	0.008J	0.005J	0.022	-
Boron	mg/L	1.77	1.8	1.87	1.91	2.05	1.92	2.12	2.03	2.03
Cadmium	µg/L	0.07	0.05	0.06	0.1	0.09	0.04	0.08	0.05	-
Calcium	mg/L	62.6	65.7	60.6	60.3	62.1	64.1	67	63	69.1
Chloride	mg/L	60.7	60.1	61.9	61.8	62.8	59.8	63.4	58.8	63.8
Chromium	µg/L	0.427	0.4	0.257	0.128	0.111	0.5	0.126	0.8	-
Cobalt	µg/L	0.779	0.759	0.721	0.675	0.591	0.759	0.579	0.962	-
Combined Radium	pCi/L	0.546	1.738	0.853	0.506	0.373	0.358	0.00513	0.76	-
Fluoride	mg/L	0.16	0.1J	0.16	0.1J	0.1J	0.17	0.1J	0.1J	0.1
Lead	µg/L	0.216	0.184	0.091	0.088	0.065	0.164	0.066	0.487	-
Lithium	mg/L	0.012	0.001U	0.003	0.001U	0.013	0.018	0.005	0.005	-
Mercury	µg/L	0.003J	0.002J	0.005U	0.005U	0.007	0.002J	0.005U	0.003J	-
Molybdenum	µg/L	2.7	2.45	3.57	2.51	2.21	2.13	1.87	5.63	-
Selenium	µg/L	0.03J	0.07J	0.06J	0.1U	0.1U	0.05J	0.1U	0.09J	-
Total Dissolved Solids	mg/L	390	396	402	410	421	418	424	400	421
Sulfate	mg/L	119	129	131	135	145	130	148	134	146
Thallium	µg/L	0.05J	0.059	0.04J	0.05J	0.05J	0.05J	0.05J	0.061	-
pH	SU	6.67	6.7	6.74	7.22	6.95	6.65	6.52	6.7	6.53

Notes:
mg/L: milligrams per liter
µg/L: micrograms 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
Cardinal Plant - Bottom Ash Pond

Parameter	Unit	MW-BAP-4								
		1/12/2017	10/20/2016	5/2/2017	5/31/2017	6/20/2017	6/30/2016	8/1/2017	8/10/2016	9/26/2017
		Background								
Antimony	µg/L	0.09	0.1	0.05J	0.04J	0.03J	0.06	0.05	0.07	-
Arsenic	µg/L	44.8	42.4	41.9	35.9	42.7	36.3	43.7	42.2	-
Barium	µg/L	59.9	69.8	44.9	51.7	41.9	54.9	49.9	54.7	-
Beryllium	µg/L	0.176	0.227	0.071	0.111	0.046	0.119	0.092	0.117	-
Boron	mg/L	0.02	0.064	0.16	0.024	0.038	0.115	0.034	0.062	0.033
Cadmium	µg/L	0.14	0.18	0.05	0.1	0.03	0.11	0.06	0.1	-
Calcium	mg/L	197	214	197	181	190	233	202	220	203
Chloride	mg/L	27.5	28.6	27.5	27.6	27.5	30	27.6	30.6	27.1
Chromium	µg/L	4.16	4.4	1.48	1.96	0.834	1.7	1.89	2.4	-
Cobalt	µg/L	20.3	19.8	19.2	20.2	18	18.7	19.9	18.2	-
Combined Radium	pCi/L	0.703	1.17	0.377	0.599	0.645	0.535	1.069	0.722	-
Fluoride	mg/L	0.1J	0.1J	0.1J	0.1J	0.1J	0.15	0.1J	0.16	0.1
Lead	µg/L	4.63	5.67	1.66	2.94	0.955	3.2	2.06	2.78	-
Lithium	mg/L	0.012	0.006	0.009	0.005	0.02	0.015	0.013	0.012	-
Mercury	µg/L	0.005	0.007	0.005U	0.004J	0.005U	0.005U	0.005U	0.004J	-
Molybdenum	µg/L	1.76	1.87	1.56	1	2.15	1.35	1.52	4.51	-
Selenium	µg/L	0.7	0.9	0.3	0.4	0.2	0.5	0.4	0.5	-
Total Dissolved Solids	mg/L	1200	1300	1250	1270	1280	1400	1330	1320	1250
Sulfate	mg/L	620	617	584	590	655	661	631	629	618
Thallium	µg/L	0.102	0.106	0.03J	0.03J	0.02J	0.03J	0.04J	0.063	-
pH	SU	6.37	6.72	6.45	6.63	6.81	6.37	6.27	6.28	6.36

Notes:
mg/L: milligrams per liter
µg/L: micrograms 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
Cardinal Plant - Bottom Ash Pond

Parameter	Unit	MW-BAP-5								
		1/12/2017	10/20/2016	5/2/2017	5/31/2017	6/20/2017	6/28/2016	8/1/2017	8/10/2016	9/26/2017
		Background								
Antimony	µg/L	0.06	0.12	0.07	0.05	0.03J	0.07	0.03J	0.09	-
Arsenic	µg/L	8.78	16.1	11.5	11.7	9.1	11.3	10.6	12.1	-
Barium	µg/L	87.9	118	88.2	95.3	77.7	92.7	83.1	102	-
Beryllium	µg/L	0.061	0.157	0.095	0.075	0.045	0.068	0.039	0.112	-
Boron	mg/L	0.043	0.058	0.116	0.073	0.05	0.072	0.043	0.043	0.059
Cadmium	µg/L	0.02	0.06	0.04	0.03	0.02J	0.03	0.01J	0.05	-
Calcium	mg/L	207	226	201	176	200	228	206	209	209
Chloride	mg/L	15.3	14.3	14.8	13.3	15.7	13.4	14.7	13.5	15.3
Chromium	µg/L	2.35	5.7	2.83	2.1	1.33	2	1.16	3.4	-
Cobalt	µg/L	1.34	3.06	1.92	1.47	0.966	1.28	0.855	2.03	-
Combined Radium	pCi/L	1.411	1.497	0.364	0.894	0.788	0.6516	0.686	1.026	-
Fluoride	mg/L	0.09J	0.08	0.1J	0.06J	0.08J	0.1J	0.08J	0.09J	0.09
Lead	µg/L	1.72	4.6	2.77	1.95	1.18	1.92	1.04	3.08	-
Lithium	mg/L	0.008	0.007	0.01	0.012	0.016	0.02	0.012	0.01	-
Mercury	µg/L	0.005U	0.003J	0.005U	0.005U	0.005U	0.005U	0.005U	0.003J	-
Molybdenum	µg/L	0.74	1.15	0.62	0.94	0.52	0.8	0.52	1.22	-
Selenium	µg/L	0.2	0.7	0.4	0.3	0.2	0.2	0.1	0.4	-
Total Dissolved Solids	mg/L	1050	1010	1010	955	1080	1050	1050	1060	1050
Sulfate	mg/L	474	433	418	404	472	449	448	456	442
Thallium	µg/L	0.058	0.114	0.059	0.04J	0.03J	0.03J	0.02J	0.059	-
pH	SU	6.6	6.59	6.6	7.07	6.94	6.6	6.55	6.7	6.72

Notes:
mg/L: milligrams per liter
µg/L: micrograms 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: Outlier Analysis Summary
Cardinal Bottom Ash Pond

Geosyntec Consultants, Inc.

Location	Well ID	Sample Date	Parameter	Reported Value	Units	Conclusions
Upgradient	MW-BAP-4	10/20/2016	Mercury	0.000007	mg/L	The pooled upgradient data for mercury had several non-detect values which were reported as the reporting limit. This detected value represents likely aquifer conditions and was not removed from the dataset.
Upgradient	MW-BAP-5	8/10/2016	Mercury	0.000003 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.
Upgradient	MW-BAP-5	10/20/2016	Mercury	0.000003 J	mg/L	This value was estimated (J-flagged) and was not removed from the dataset.

Table 3: Background Value Summary
Cardinal Plant - Bottom Ash Pond

Geosyntec Consultants, Inc.

Parameter	Unit	Description	MW-BAP-1	MW-BAP-2	MW-BAP-3
Boron	mg/L	Interwell Background Value (UPL)	0.1374		
Calcium	mg/L	Interwell Background Value (UPL)	237		
Chloride	mg/L	Interwell Background Value (UPL)	30.6		
Fluoride	mg/L	Interwell Background Value (UPL)	0.1523		
pH	SU	Interwell Background Value (UPL)	7.035		
	SU	Interwell Background Value (LPL)	6.159		
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	979.7	648.4	438.4
Sulfate	mg/L	Intrawell Background Value (UPL)	489.3	268.5	156.5

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

ATTACHMENT A

Evaluation of Detection Monitoring Data

Memorandum

Date: February 27, 2018

To: David Miller (AEP)

Copies to: Justin Jent (AEP)

From: Allison Kreinberg and Bruce Sass, Ph.D. (Geosyntec)

Subject: Evaluation of Detection Monitoring Data at
Cardinal Plant's Bottom Ash Pond (BAP)

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"), detection monitoring events were completed on September 26, 2017 and January 23, 2018 at the Bottom Ash Pond (BAP), an existing CCR unit at the Cardinal Power Plant located in Brilliant, Ohio.

Eight background monitoring events were conducted at the Cardinal BAP prior to these detection monitoring events, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated January 11, 2018.

To achieve an acceptably high statistical power while maintaining a site-wide false-positive rate (SWFPR) of 10% per year or less, prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is only concluded if both samples in a series of two exceeds the UPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed.

Detection monitoring results and the relevant background values are summarized in Table 1.

- Boron concentrations exceeded the interwell UPL of 0.137 mg/L in both the initial (2.7 mg/L) and second (2.91 mg/L) samples collected at MW-BAP-1, in both the initial (1.73 mg/L) and second (1.97 mg/L) samples collected at MW-BAP-2, and in both the initial

(2.03 mg/L) and second (1.91 mg/L) samples collected at MW-BAP-3. Therefore, an SSI over background is concluded for boron at MW-BAP-1, MW-BAP-2, and MW-BAP-3.

- Chloride concentrations exceeded the interwell UPL of 30.6 mg/L in both the initial (93.7 mg/L) and second (86.2 mg/L) samples collected at MW-BAP-1, in both the initial (68.2 mg/L) and second (61.1 mg/L) samples collected at MW-BAP-2, and in both the initial (63.8 mg/L) and second (64.1 mg/L) samples collected at MW-BAP-3. Therefore, an SSI over background is concluded for chloride at MW-BAP-1, MW-BAP-2, and MW-BAP-3.
- Fluoride concentrations exceeded the interwell UPL of 0.152 mg/L in both the initial (0.33 mg/L) and second (0.37 mg/L) samples collected at MW-BAP-1, and in both the initial (0.33 mg/L) and second (0.39 mg/L) samples collected at MW-BAP-2, Therefore, an SSI over background is concluded for fluoride at MW-BAP-1, and MW-BAP-2.

As a result, the Cardinal BAP CCR unit will conduct an alternate source demonstration.

No other exceedances of UPLs were observed during these detection monitoring events.

Figure E (“Analysis of Variance”) of Attachment A (“Statistical Analysis Output”) of Geosyntec’s *Statistical Analysis Summary* report was revised after the certification date of January 11, 2018 to correct a formatting error.

* * * * *

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

I certify that the selected statistical method, described above and in the January 11, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Cardinal BAP CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID A. MILLER

Printed Name of Licensed Professional Engineer

David A. Miller

Signature

E-60659

License Number

OHIO

Licensing State

02.27.18

Date

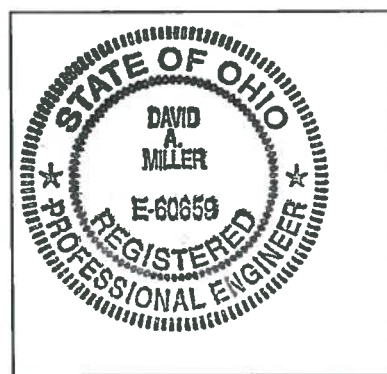


Table 1: Detection Monitoring Data Evaluation
Cardinal Plant - Bottom Ash Pond

Geosyntec Consultants, Inc.

Parameter	Unit	Description	MW-BAP-1		MW-BAP-2		MW-BAP-3	
			9/26/2017	1/23/2018	9/26/2017	1/23/2018	9/26/2017	1/23/2018
Boron	mg/L	Interwell Background Value (UPL)	0.137					
	mg/L	Detection Monitoring Result	2.7	2.91	1.73	1.97	2.03	1.91
Calcium	mg/L	Interwell Background Value (UPL)	237					
	mg/L	Detection Monitoring Result	175	-	86.8	-	69.1	-
Chloride	mg/L	Interwell Background Value (UPL)	30.6					
	mg/L	Detection Monitoring Result	93.7	86.2	68.2	61.1	63.8	64.1
Fluoride	mg/L	Interwell Background Value (UPL)	0.152					
	mg/L	Detection Monitoring Result	0.33	0.37	0.33	0.39	0.1	-
pH	SU	Interwell Background Value (UPL)	7.04					
	SU	Interwell Background Value (LPL)	6.16					
	SU	Detection Monitoring Result	6.76	-	6.94	-	6.53	-
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	979.7		648.4		438.4	
	mg/L	Detection Monitoring Result	977	-	552	-	421	-
Sulfate	mg/L	Intrawell Background Value (UPL)	489		269		157	
	mg/L	Detection Monitoring Result	469	-	230	-	146	-

Notes:

UPL: Upper prediction limit

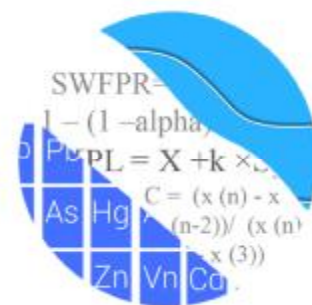
LPL: Lower prediction limit

Bold values exceed the background value.

Background values are shaded gray.

ATTACHMENT B
Statistical Analysis Output

GROUNDWATER STATS CONSULTING



November 4, 2017

Geosyntec Consultants
Attn: Mr. Bruce Sass
150 E. Wilson Bridge Rd., #232
Worthington, OH 43085

Dear Mr. Sass,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the screening and statistical analysis of background groundwater data for American Electric Power's Cardinal 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 Cardinal Bottom Ash Pond for the CCR program in 2016, and 8 background samples have been collected at each of the groundwater monitoring wells. The monitoring well network, as provided by Geosyntec Consultants, consists of the following: upgradient wells BAP-4 and BAP-5; and downgradient wells BAP-1, BAP-2, and BAP-3.

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis was reviewed by Dr. Kirk Cameron, PhD Statistician with MacStat Consulting, primary author of the USEPA Unified Guidance, and Senior Advisor to Groundwater Stats Consulting.

The following constituents were evaluated: Appendix III parameters – boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and Appendix IV parameters - 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 at all wells are provided for the purpose of screening data at these wells (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B). 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. It was noted that several variables exist in higher concentrations at upgradient wells, with a few exceptions where downgradient wells have higher concentrations.

Data at all wells were evaluated 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 are 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 sulfate and TDS;
- 2) Interwell prediction limits combined with a 1-of-2 resample plan for boron, calcium, chloride, fluoride, and pH.

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.

Background Screening

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 (Figure C).

Tukey's outlier test did not identify outliers in any of the downgradient wells as may be seen on the Outlier Summary Table and accompanying graphs. When values are identified as outliers, they are plotted in a lighter font on the time series graph. While the test identified a few outliers for mercury in upgradient wells, these values were not flagged as outliers because all concentrations are extremely low. 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.

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 (Figure D). 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 a few statistically significant increasing and decreasing trends, as may be seen on the Trend Test Summary Table that accompanies the trend tests. All of these trends are relatively low in magnitude when compared to average concentrations; therefore, no adjustments were made to the data sets.

Appendix III – Determination of Spatial Variation

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 (Figure E). 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 no variation for boron, calcium, and pH making these constituents suitable for interwell analyses. Variation was identified in groundwater upgradient of the site for chloride, fluoride, sulfate, and TDS. Therefore, these data were further evaluated as described for the appropriateness of intrawell testing to accommodate the groundwater quality. A summary table of the ANOVA results is 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 recommended for intrawell analyses (Figure F). 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 for chloride, fluoride, sulfate, and TDS (Figure G). 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 sulfate and TDS, while the confidence intervals for chloride and fluoride were above the background standards. Therefore, intrawell methods are recommended for sulfate and TDS at this time, and interwell methods are recommended for chloride and fluoride along with boron, calcium, and pH which did not exhibit spatial variation. As mentioned earlier, if a demonstration supports natural variation in groundwater, intrawell methods will be considered for all parameters.

All available data through August 2017 at each well were used to establish intrawell background limits based on a 1-of-2 resample plan that will be used for future comparisons (Figure H). Interwell prediction limits, combined with a 1-of-2 resample plan, were constructed from upgradient wells for the Appendix III parameters discussed above (Figure I). 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. As more data are collected, the resample plan will be re-evaluated for appropriateness of the 1-of-2 plan for intrawell analyses.

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. A summary table of the background prediction limits follows this letter.

Appendix IV – Assessment Monitoring Program

During an Assessment Monitoring program confidence intervals are constructed at all wells for detected Appendix IV parameters. A minimum of 4 samples is required to construct confidence intervals; however, 8 samples are generally recommended for better representation of the true average population. Established Maximum Contaminant Levels (MCLs) are used as the GWPS comparisons, unless background limits are higher as discussed below. Parametric confidence intervals are constructed with 99% confidence when data follow a normal or transformed-normal distribution. For all other cases, nonparametric confidence intervals are constructed, with the confidence level based on the number of samples available. The GWPS is exceeded only when the entire confidence interval exceeds its respective GWPS.

Background limits are established for the Appendix IV parameters using upper tolerance limits constructed with 95% confidence/95% coverage using pooled upgradient well data, for comparison against established MCLs. When background limits, or Alternate Contaminant Levels (ACLs), are higher than established MCLs, the CCR Rule recommends using these ACLs as the GWPS for the confidence interval comparisons. Additionally, tolerance limits are also recommended to establish ACLs for Appendix IV parameters, cobalt, lithium, and molybdenum, which do not have established MCLs. Since the scope of this project included screening and development of background limits for Appendix III Detection Monitoring statistics, comparison of the Appendix IV parameters with confidence intervals was not included in this report.

Recommendations

In summary, as a result of the background screening described in this letter, intrawell prediction limits combined with a 1-of-2 resample plan are recommended for sulfate and TDS. Interwell prediction limits combined with a 1-of-2 resample plan are recommended for boron, calcium, chloride, fluoride, and pH. The statistical analyses will be constructed according to the USEPA Unified Guidance, based on 7 Appendix III parameters and 3 downgradient wells.

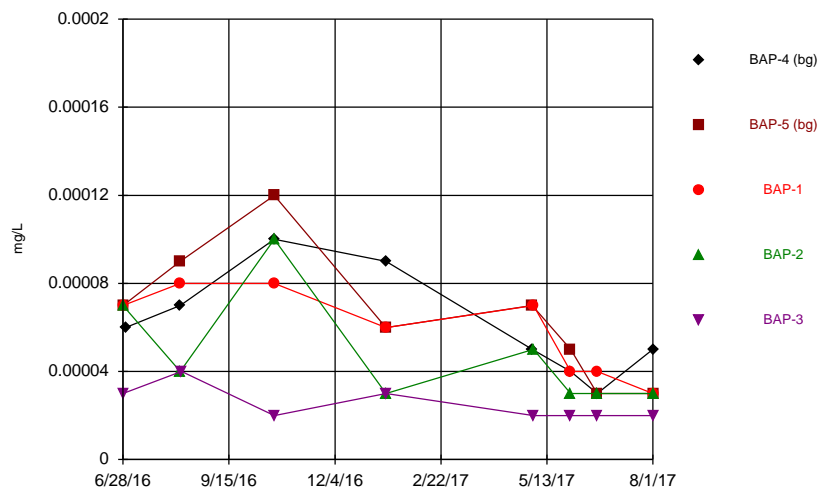
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Cardinal Bottom Ash Pond. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

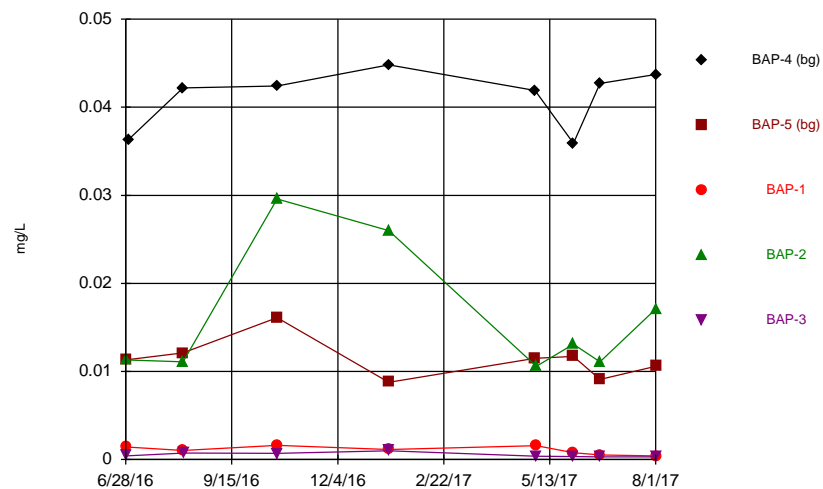
A handwritten signature in black ink, appearing to read 'Kristina L. Rayner'.

Kristina L. Rayner
Groundwater Statistician

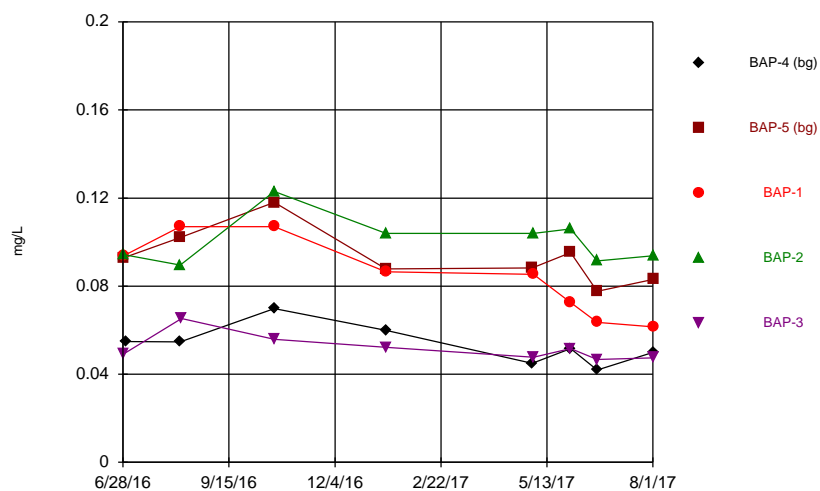
Time Series



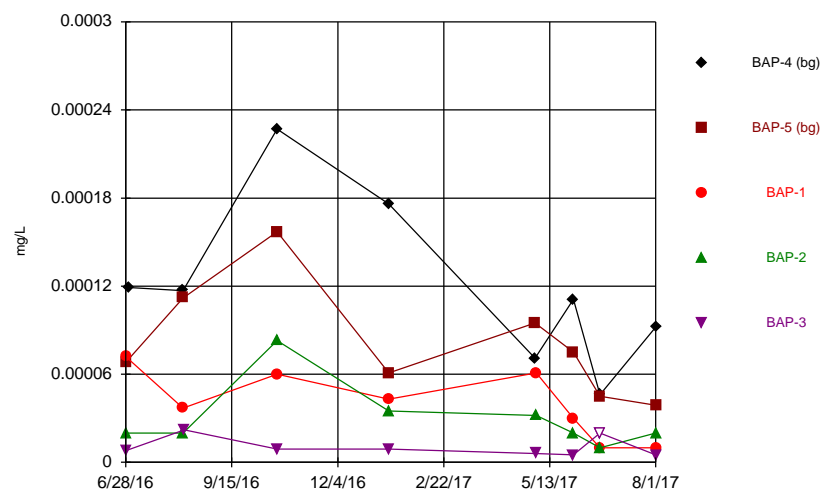
Time Series



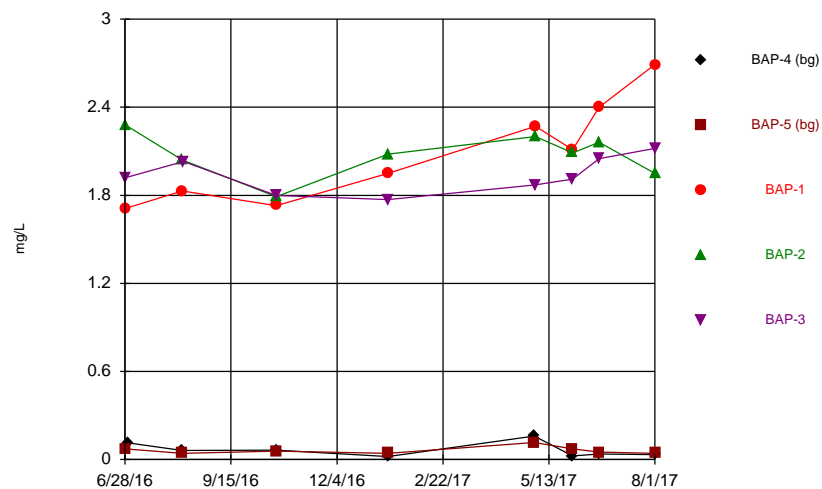
Time Series



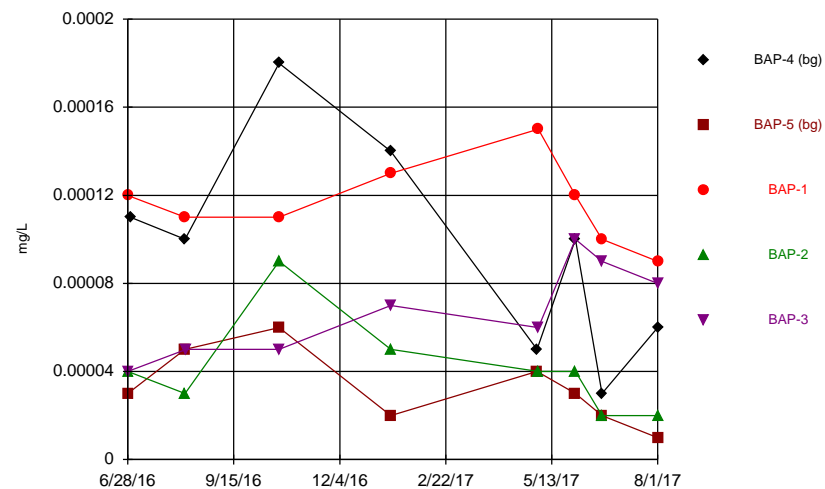
Time Series



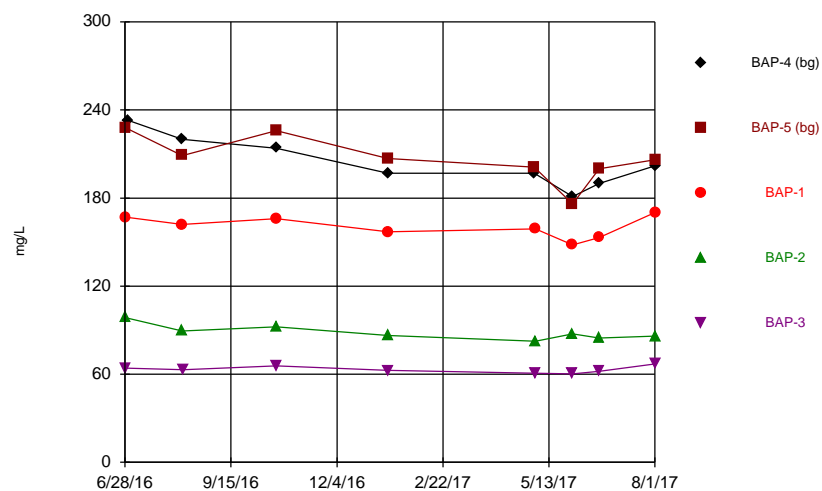
Time Series



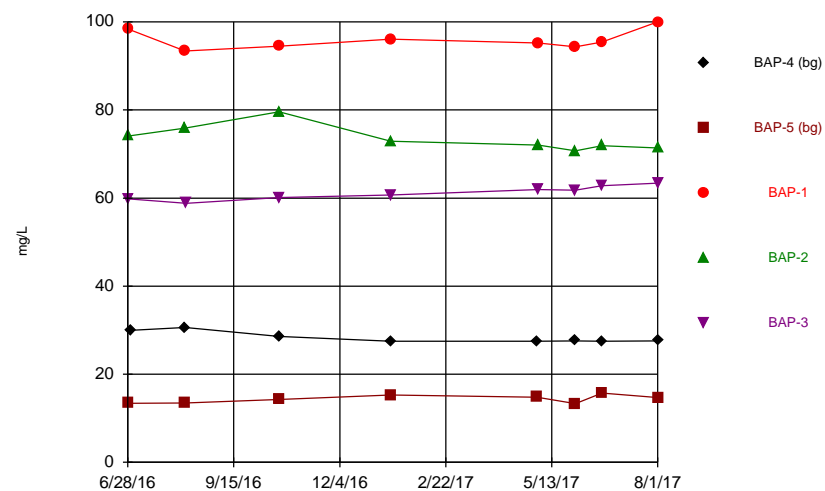
Time Series



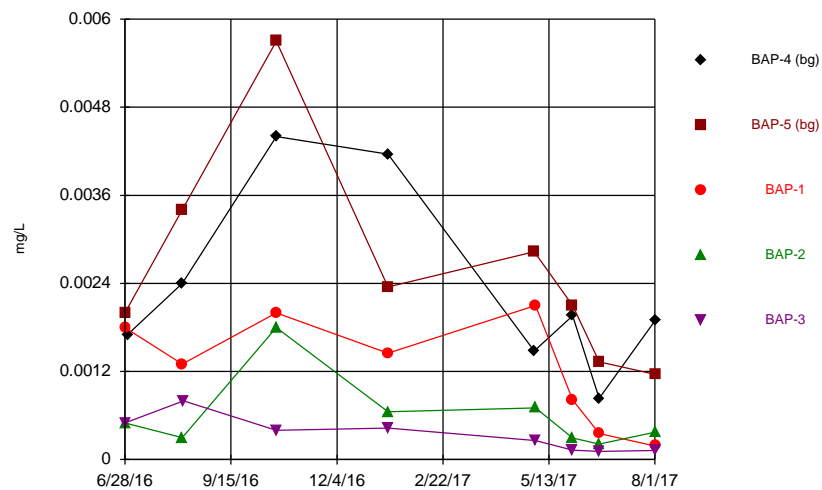
Time Series



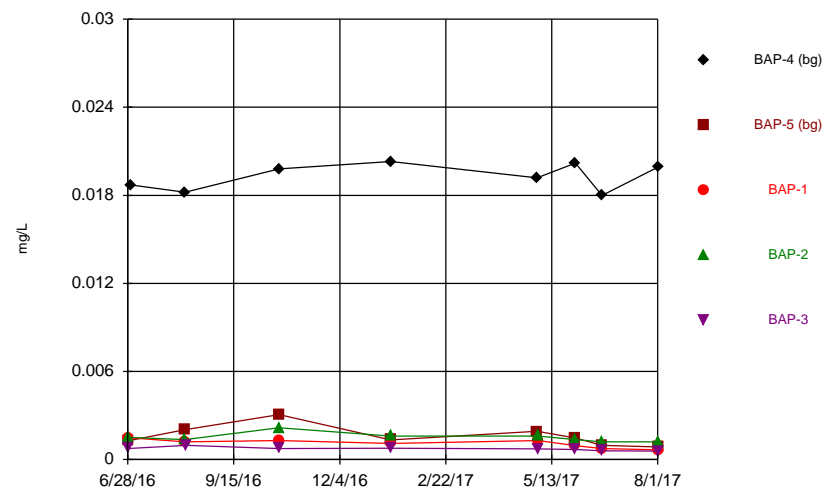
Time Series



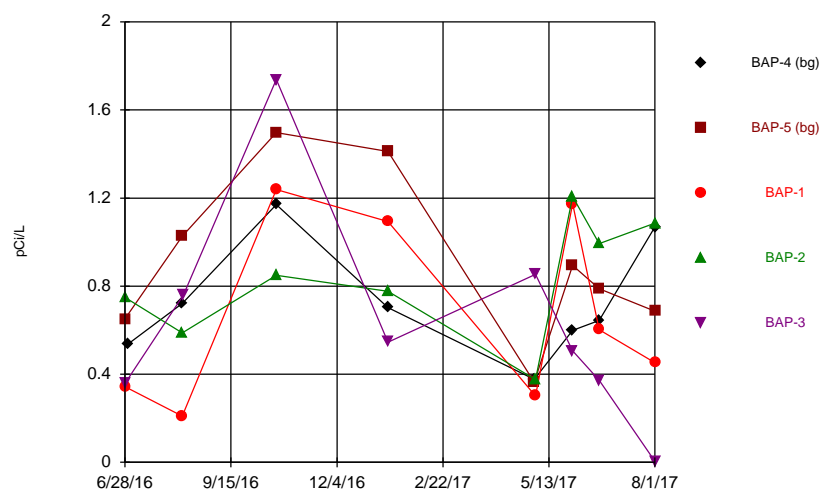
Time Series



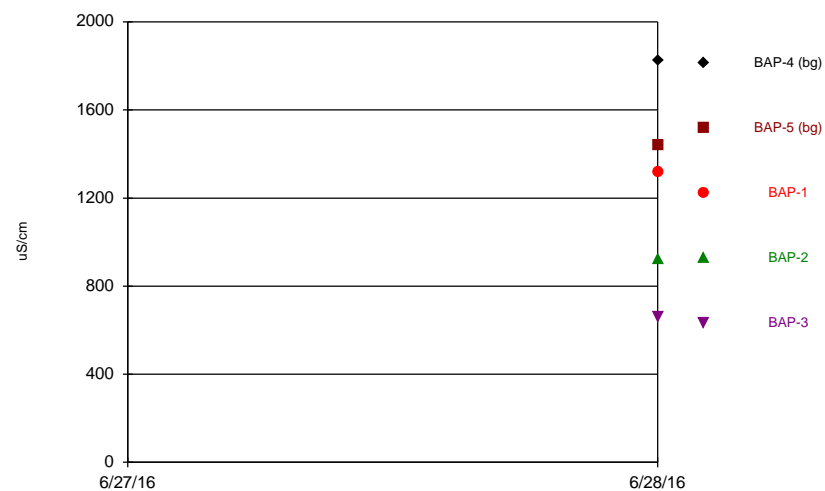
Time Series

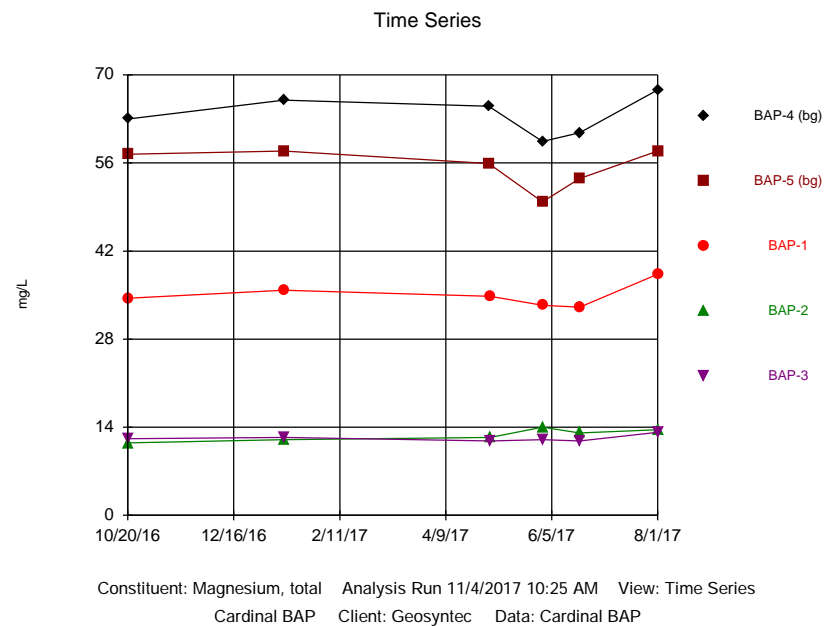
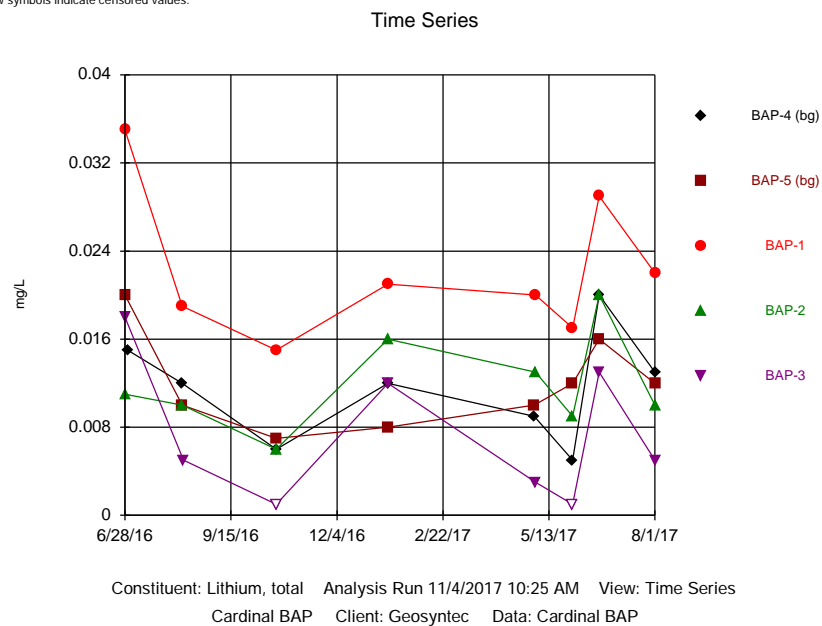
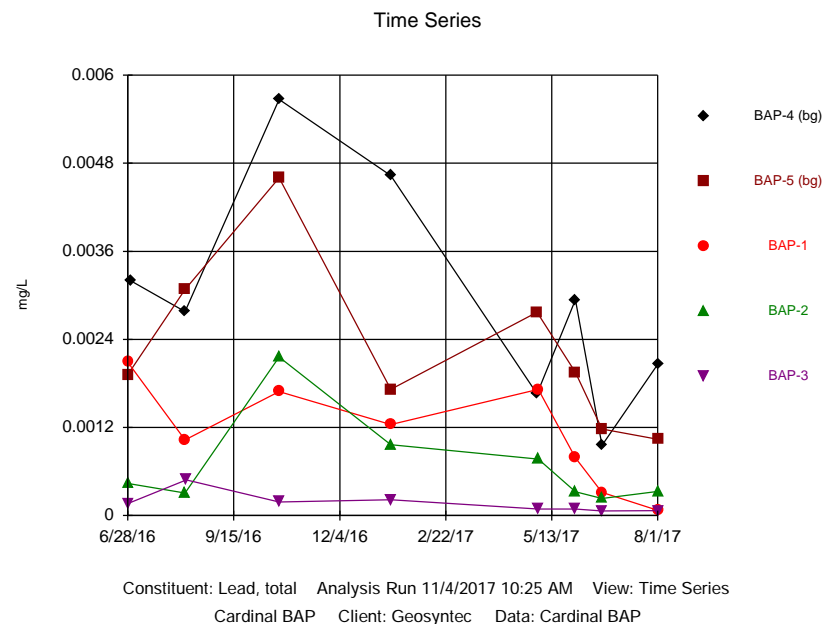
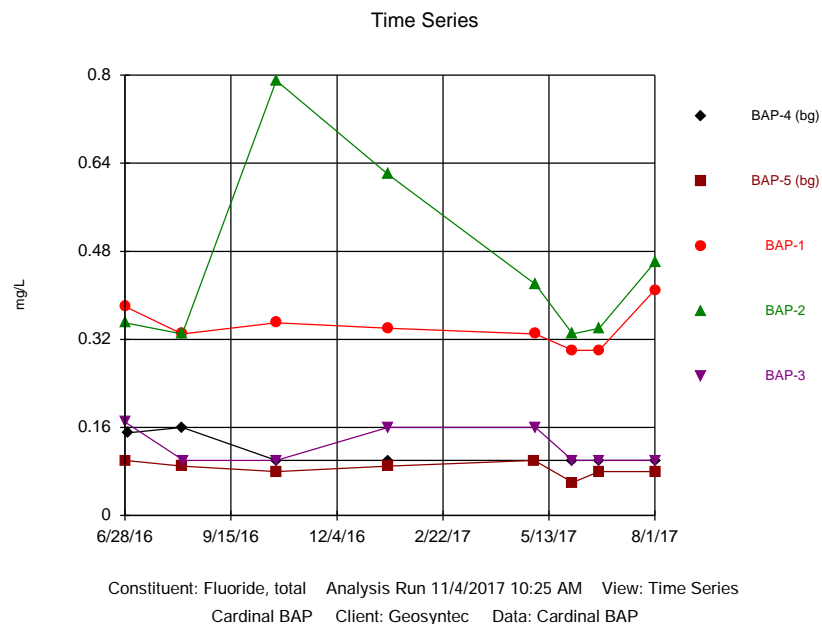


Time Series

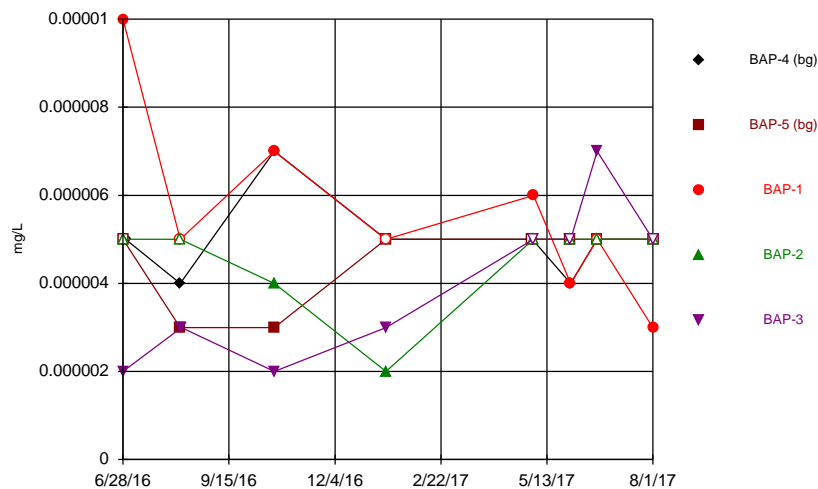


Time Series



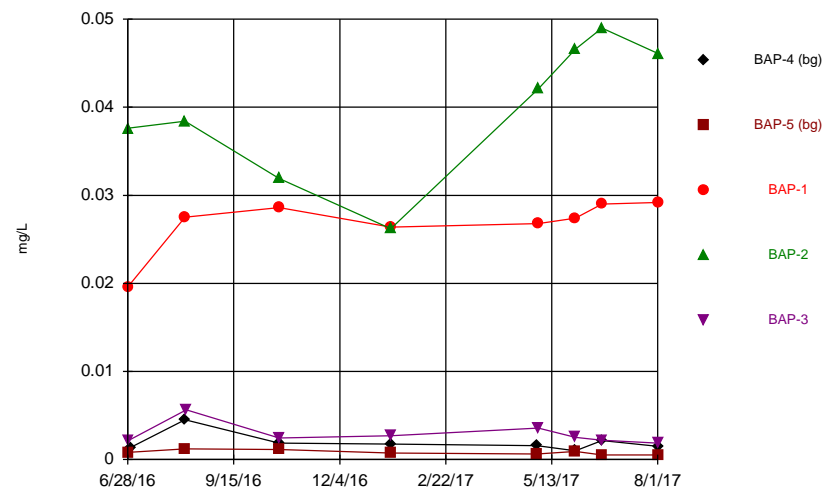


Time Series



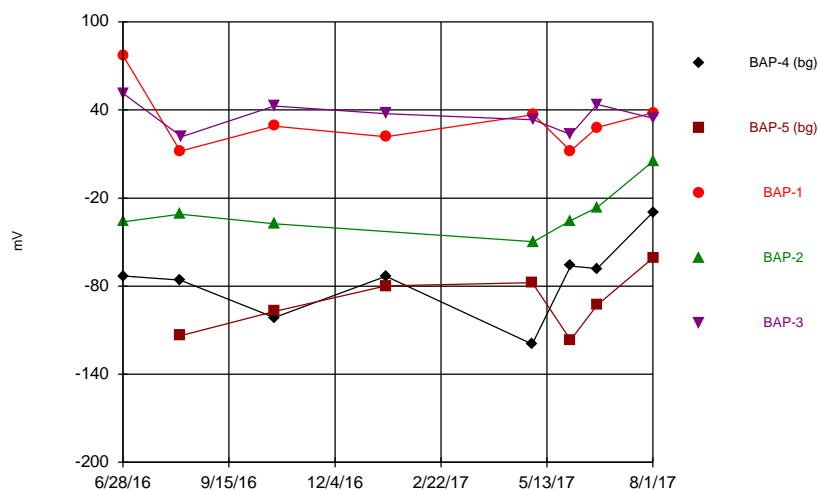
Constituent: Mercury, total Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Time Series



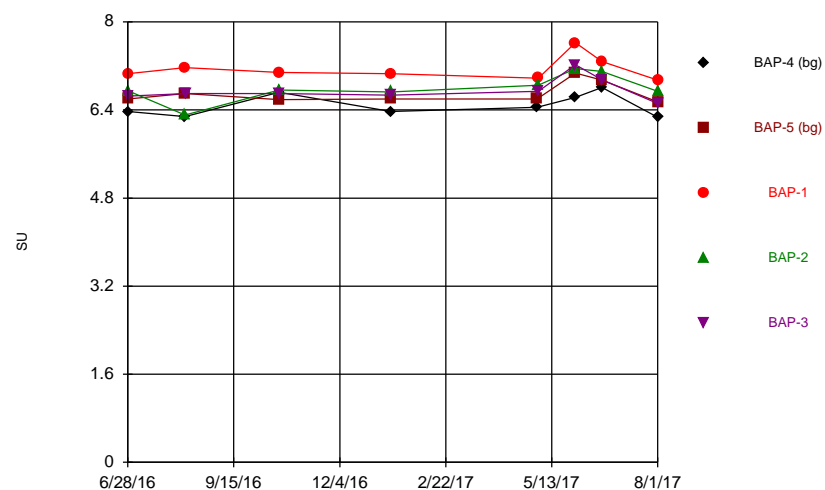
Constituent: Molybdenum, total Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Time Series



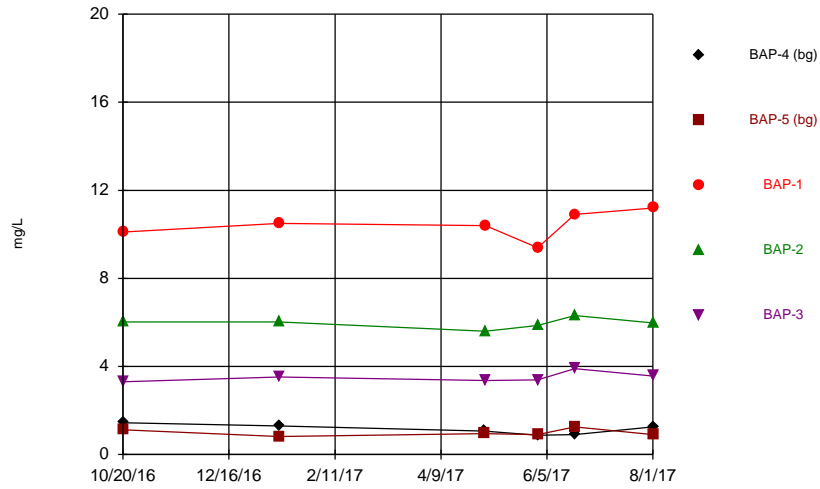
Constituent: ORP Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Time Series



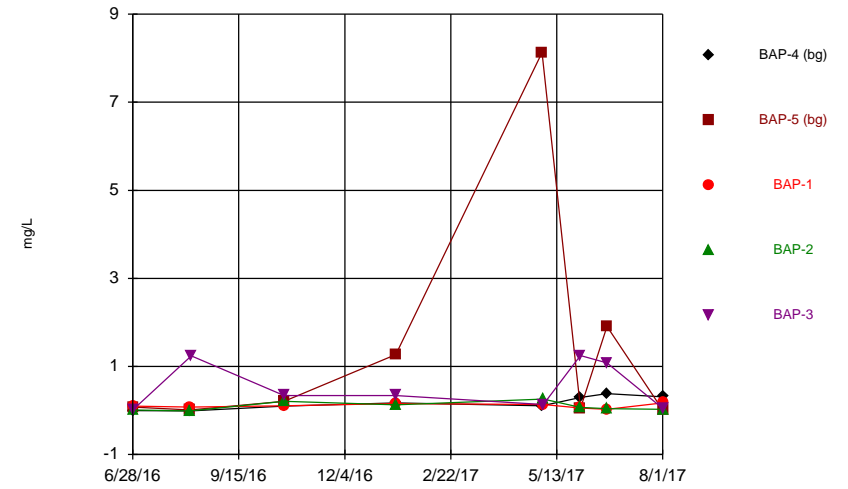
Constituent: pH, field Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Time Series



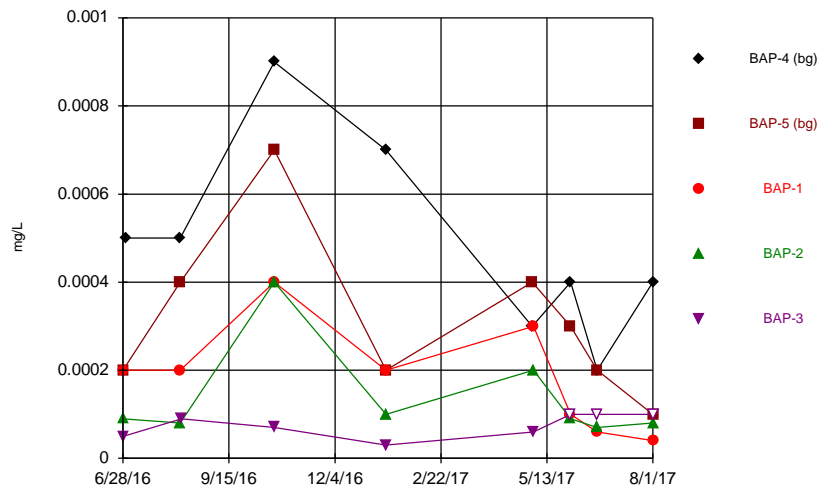
Constituent: Potassium, total Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Time Series



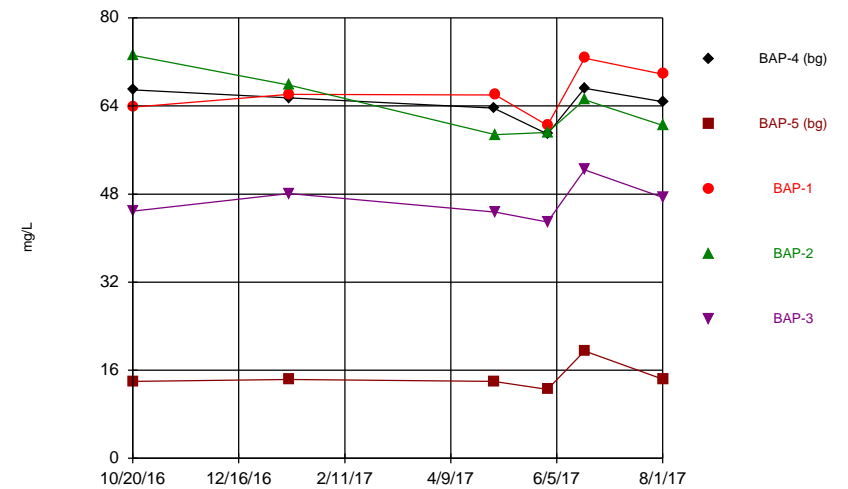
Constituent: RDO Concentration Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Time Series

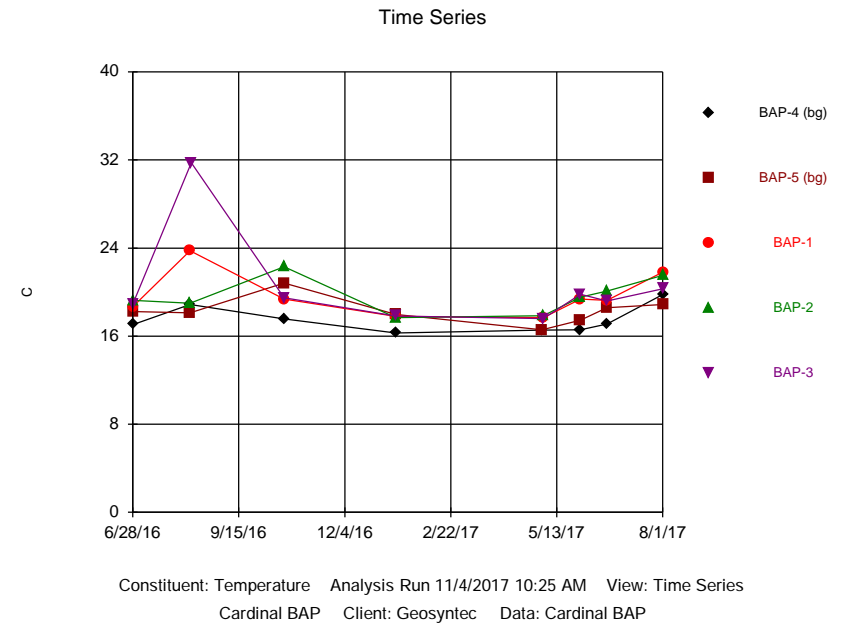
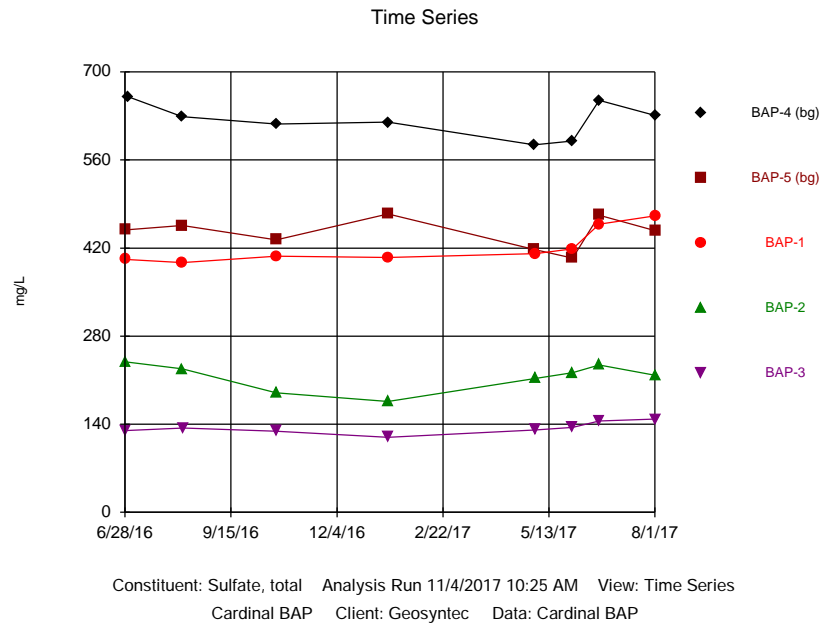
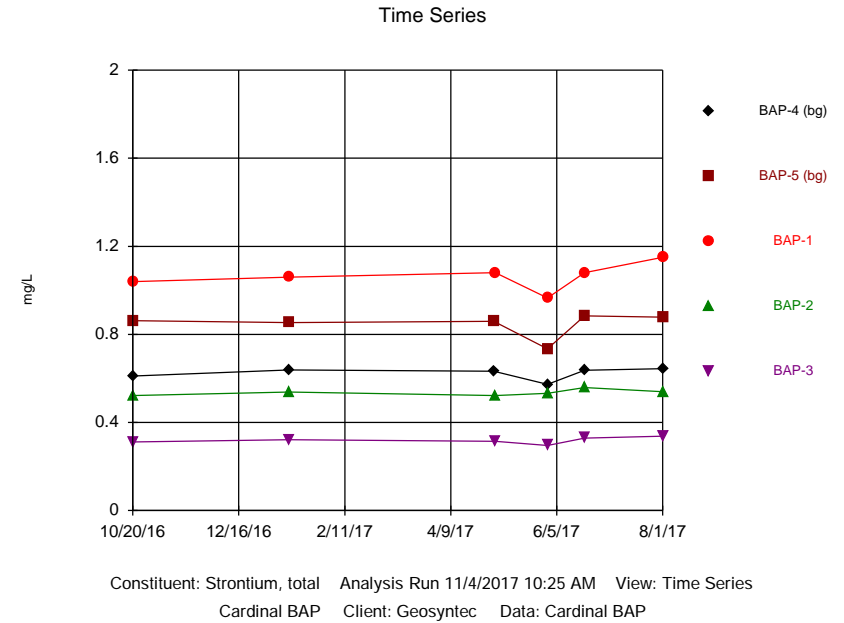
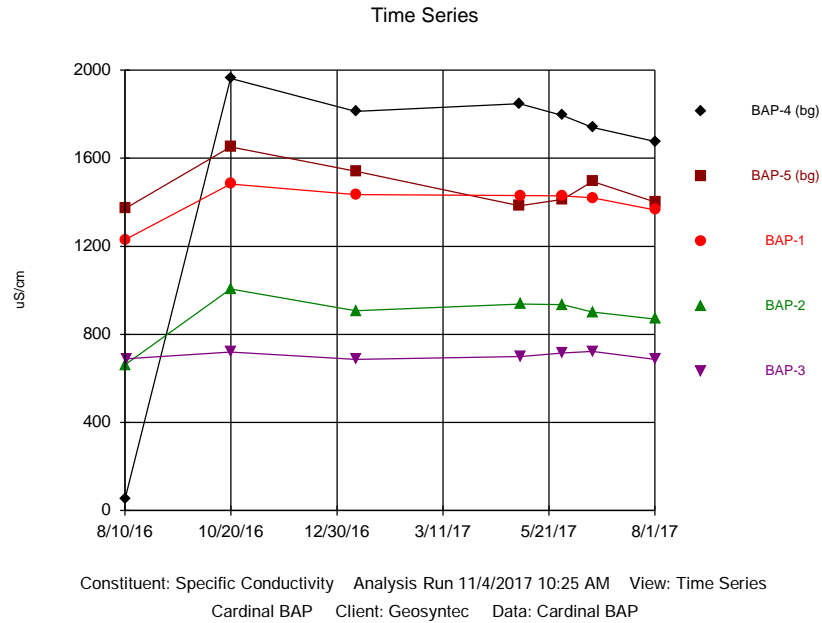


Constituent: Selenium, total Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

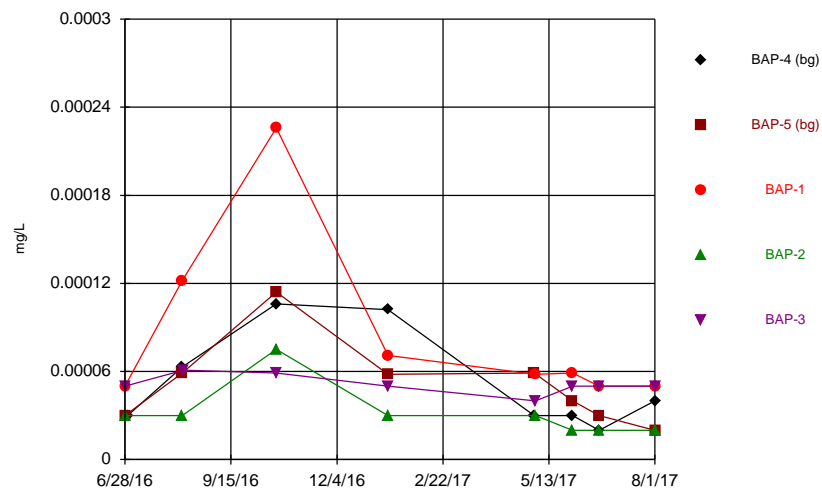
Time Series



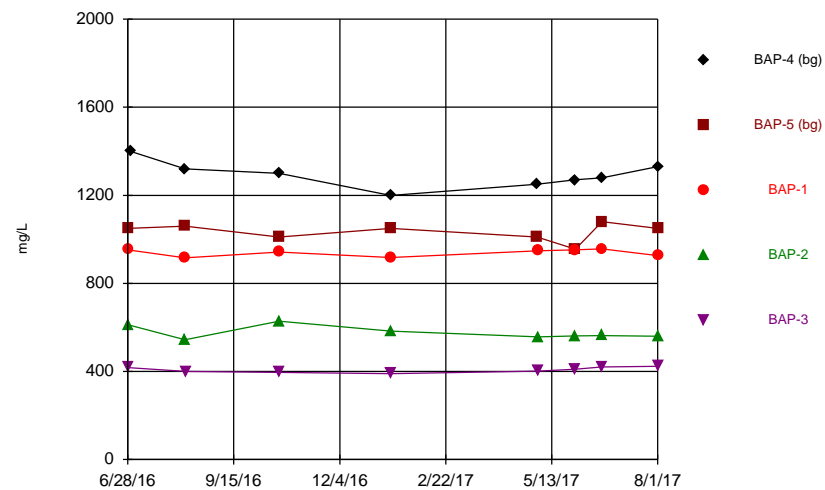
Constituent: Sodium, total Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



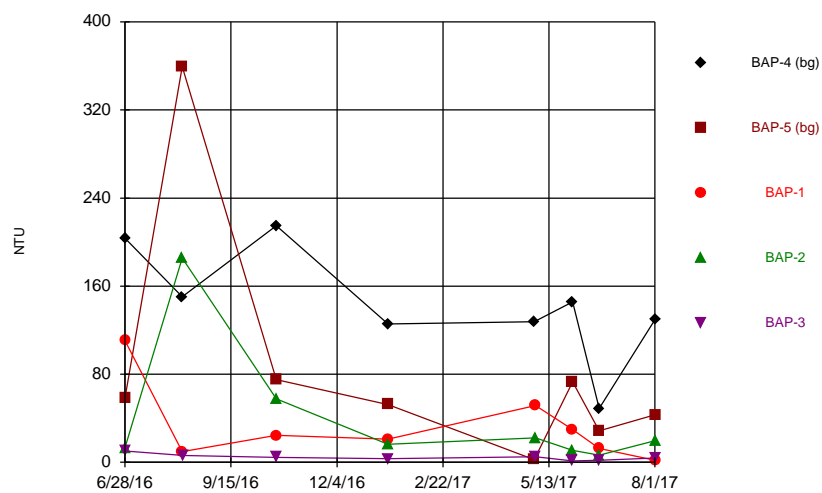
Time Series



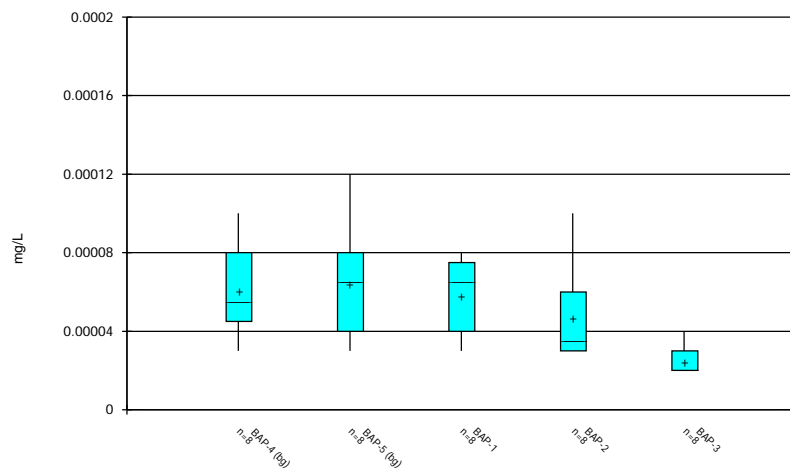
Time Series



Time Series

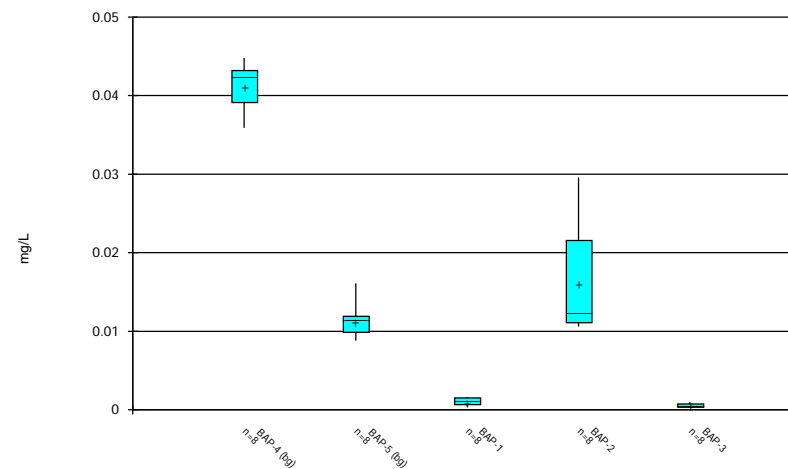


Box & Whiskers Plot



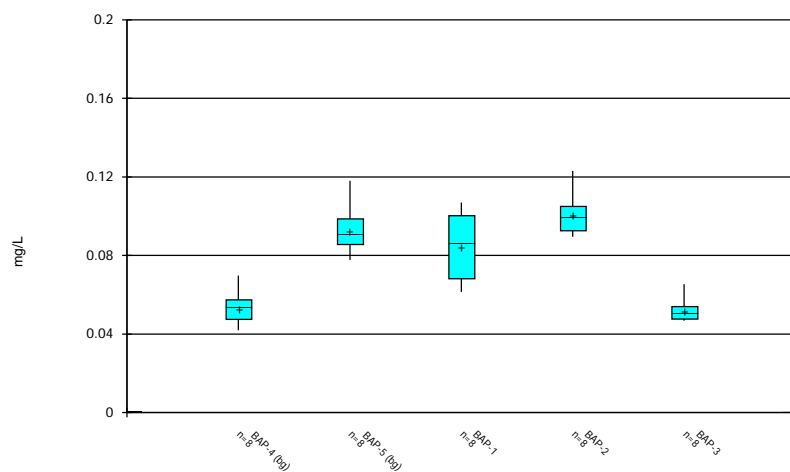
Constituent: Antimony, total Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



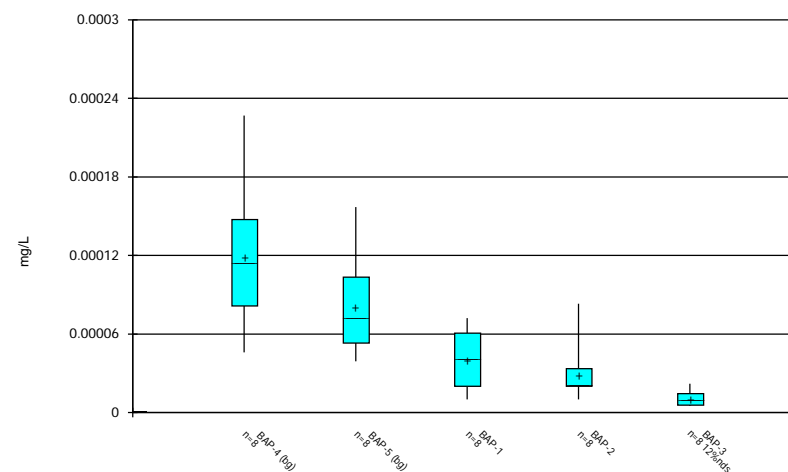
Constituent: Arsenic, total Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



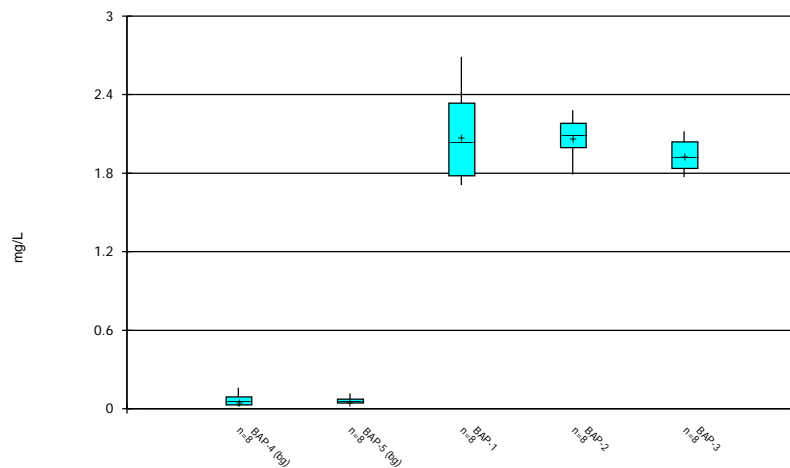
Constituent: Barium, total Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



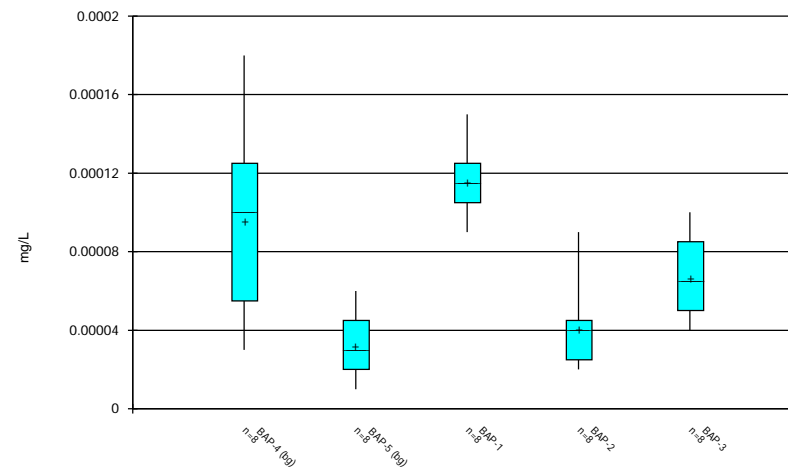
Constituent: Beryllium, total Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



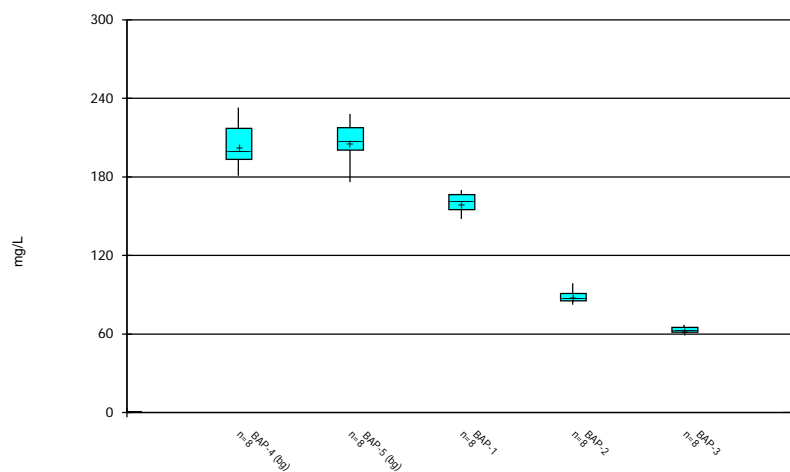
Constituent: Boron, total Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



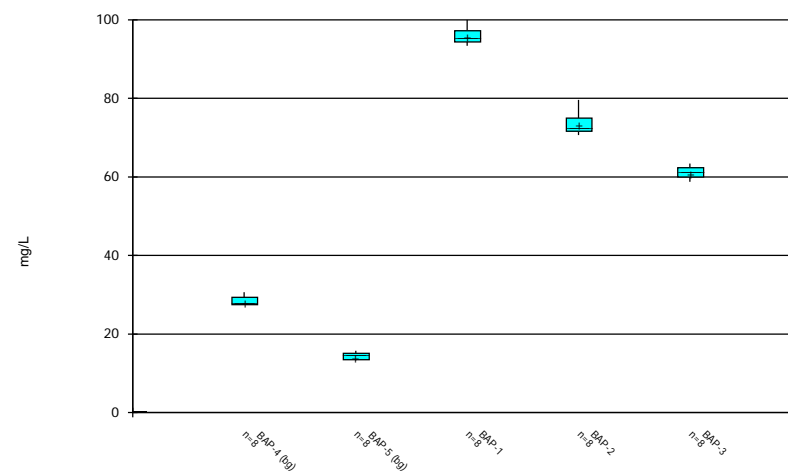
Constituent: Cadmium, total Analysis Run 11/4/2017 10:25 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



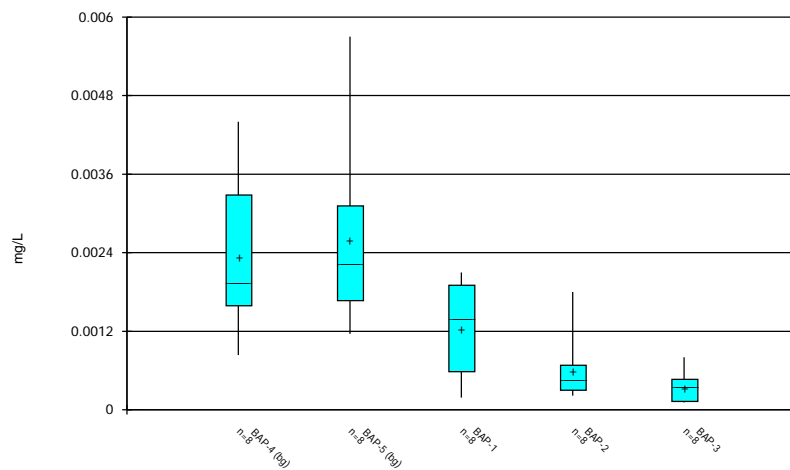
Constituent: Calcium, total Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



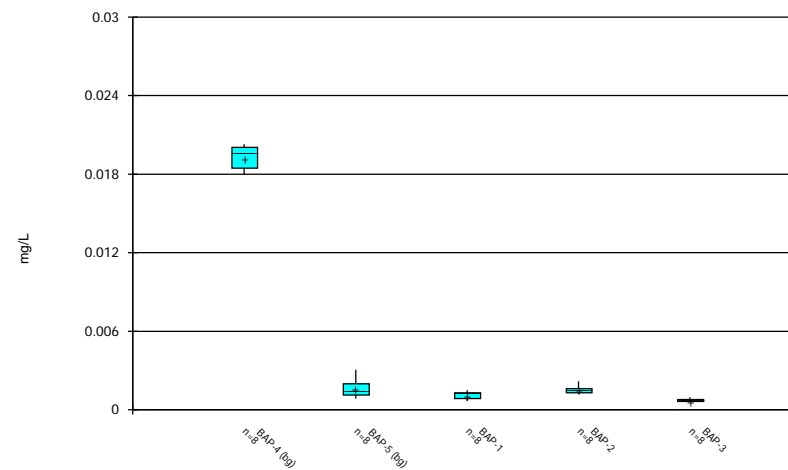
Constituent: Chloride, total Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



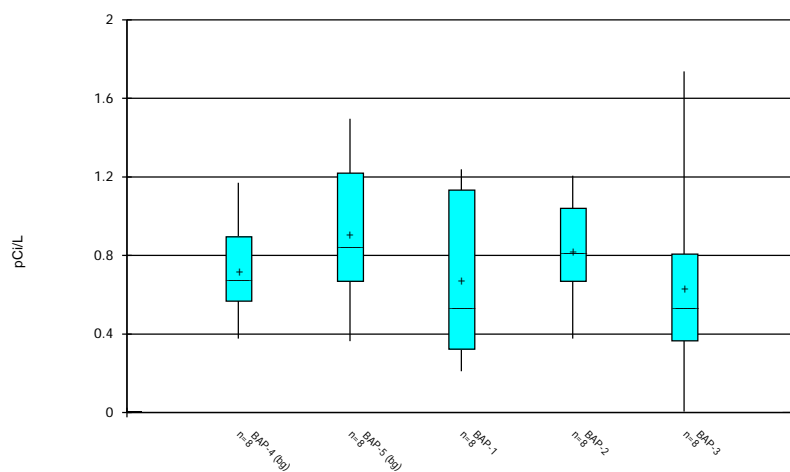
Constituent: Chromium, total Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



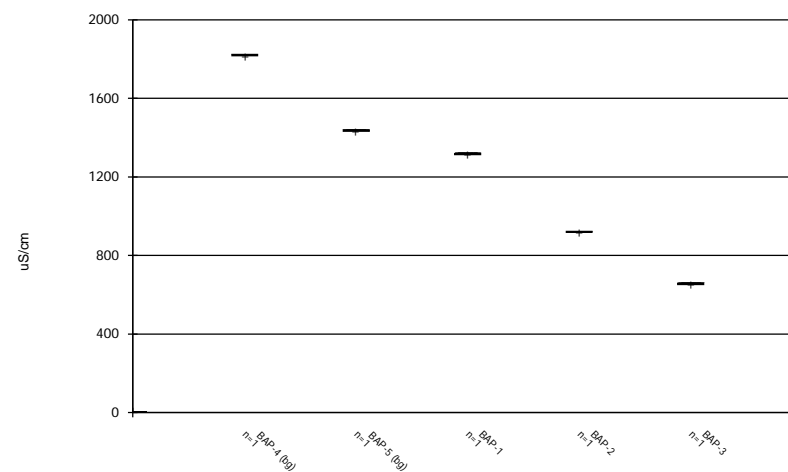
Constituent: Cobalt, total Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



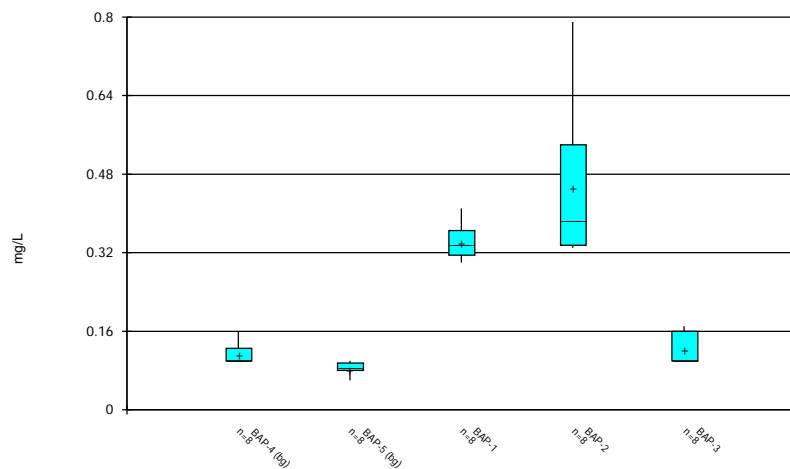
Constituent: Combined Radium 226 + 228 Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



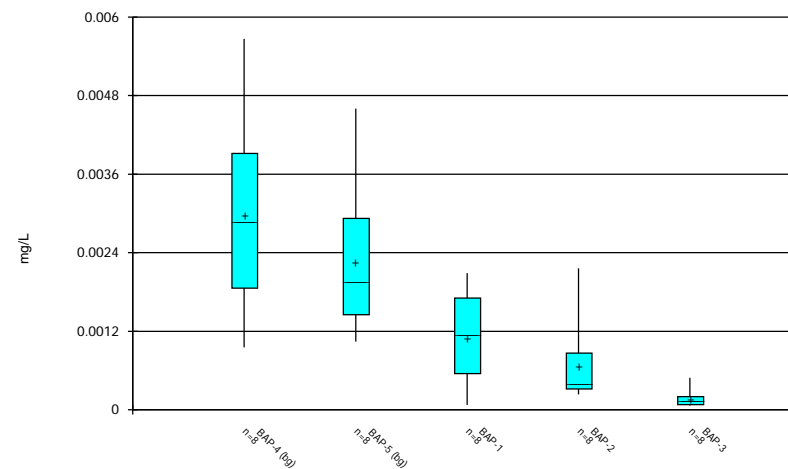
Constituent: Conductivity Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



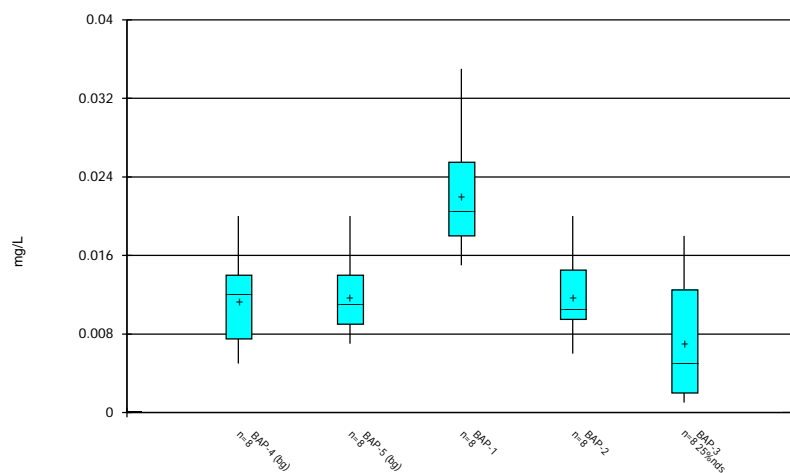
Constituent: Fluoride, total Analysis Run 11/4/2017 10:26 AM View: Time Series
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



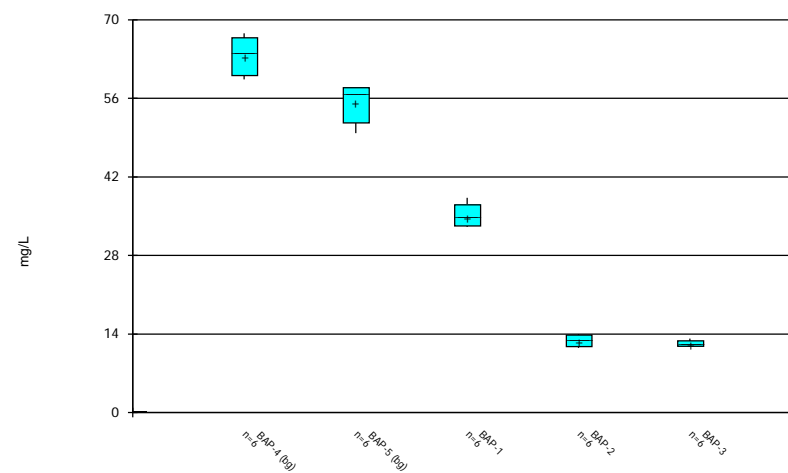
Constituent: Lead, total Analysis Run 11/4/2017 10:26 AM View: Time Series
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



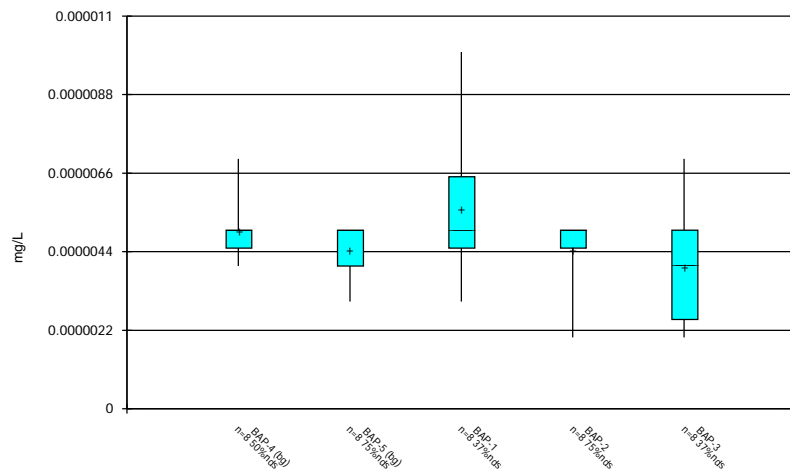
Constituent: Lithium, total Analysis Run 11/4/2017 10:26 AM View: Time Series
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



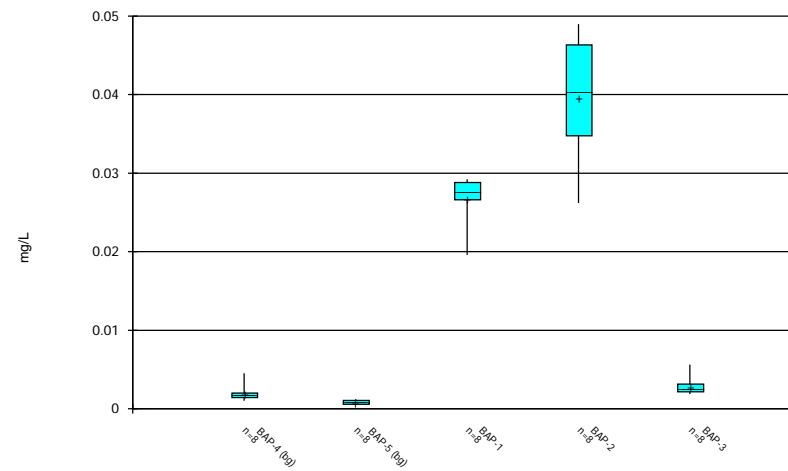
Constituent: Magnesium, total Analysis Run 11/4/2017 10:26 AM View: Time Series
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



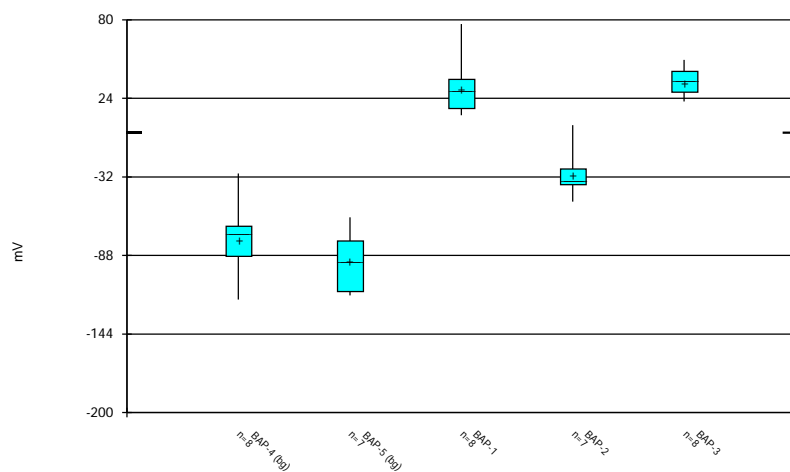
Constituent: Mercury, total Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



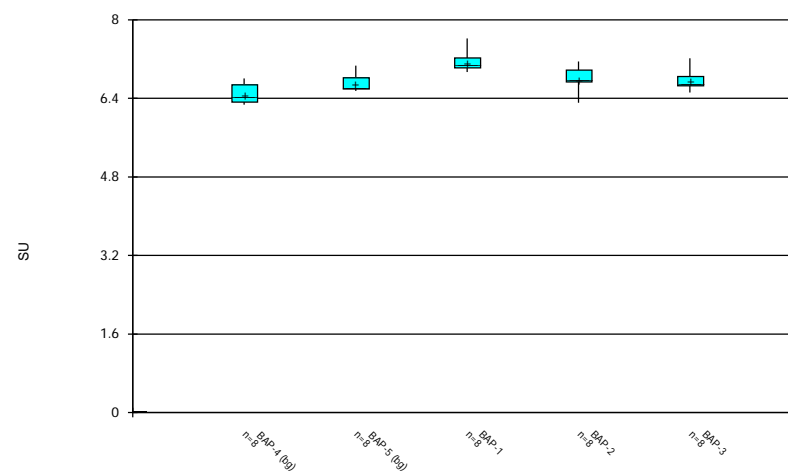
Constituent: Molybdenum, total Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



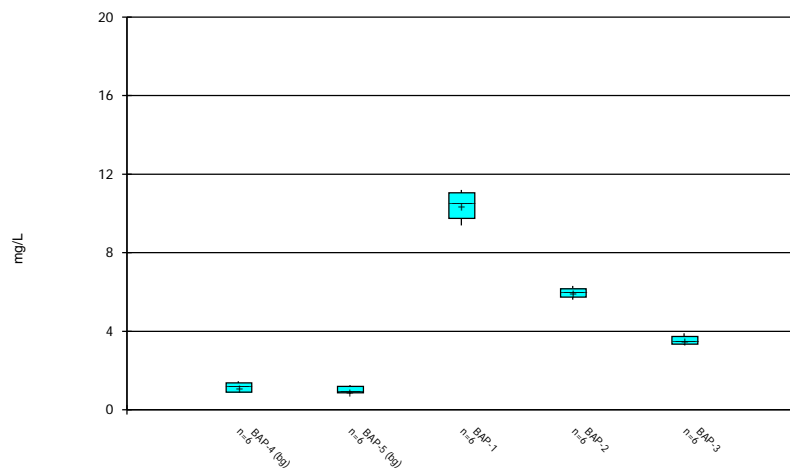
Constituent: ORP Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



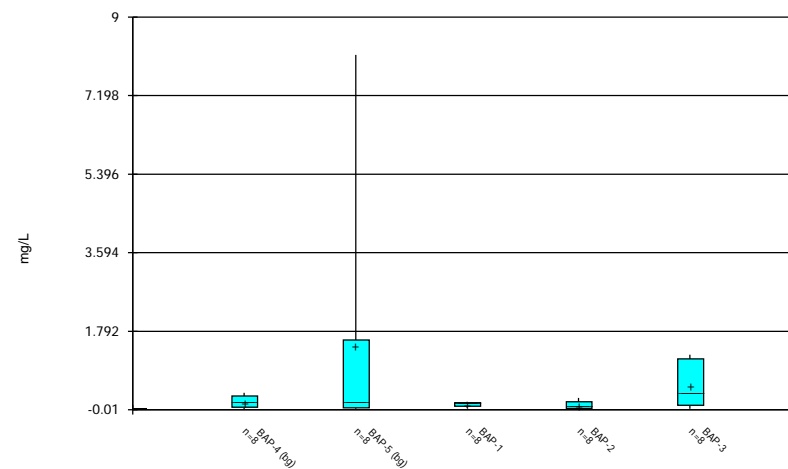
Constituent: pH, field Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



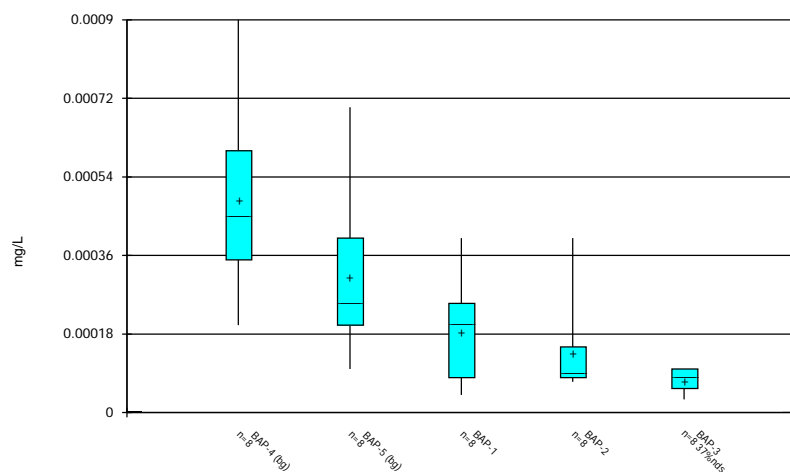
Constituent: Potassium, total
Cardinal BAP
Analysis Run 11/4/2017 10:26 AM
Client: Geosyntec
Data: Cardinal BAP
View: Time Series

Box & Whiskers Plot



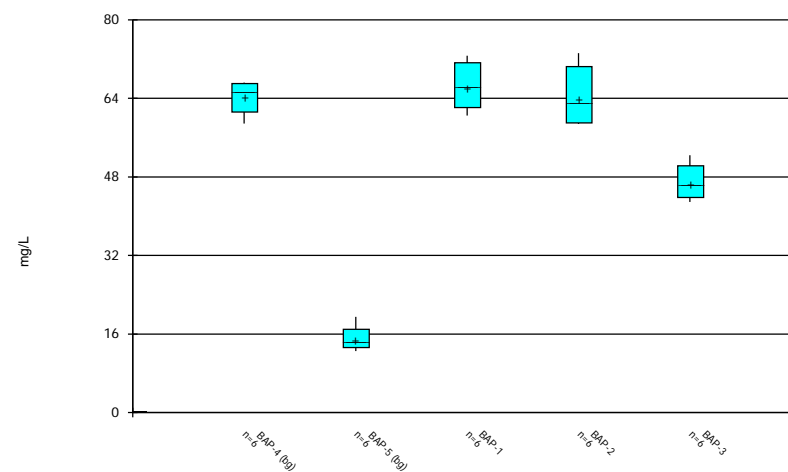
Constituent: RDO Concentration
Cardinal BAP
Analysis Run 11/4/2017 10:26 AM
Client: Geosyntec
Data: Cardinal BAP
View: Time Series

Box & Whiskers Plot



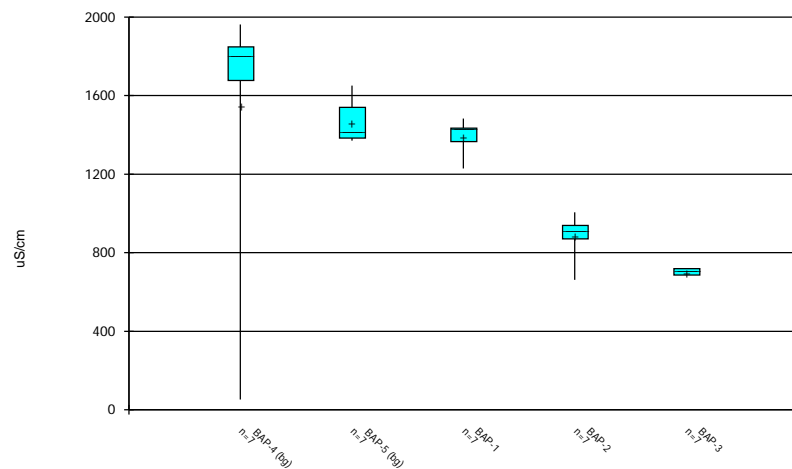
Constituent: Selenium, total
Cardinal BAP
Analysis Run 11/4/2017 10:26 AM
Client: Geosyntec
Data: Cardinal BAP
View: Time Series

Box & Whiskers Plot



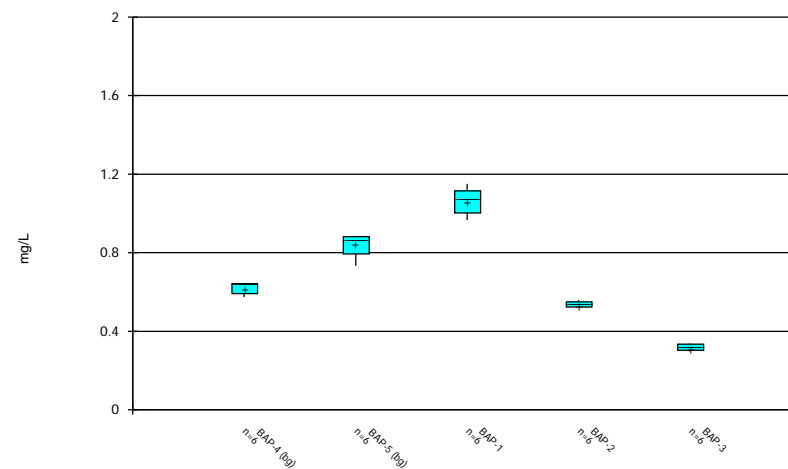
Constituent: Sodium, total
Cardinal BAP
Analysis Run 11/4/2017 10:26 AM
Client: Geosyntec
Data: Cardinal BAP
View: Time Series

Box & Whiskers Plot



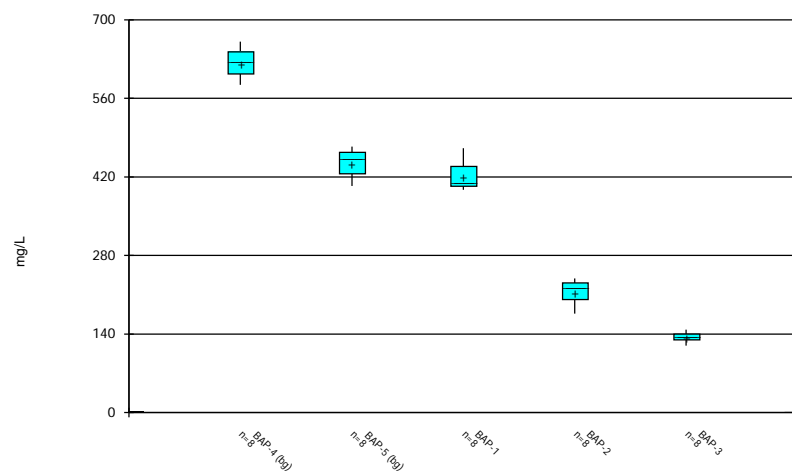
Constituent: Specific Conductivity Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



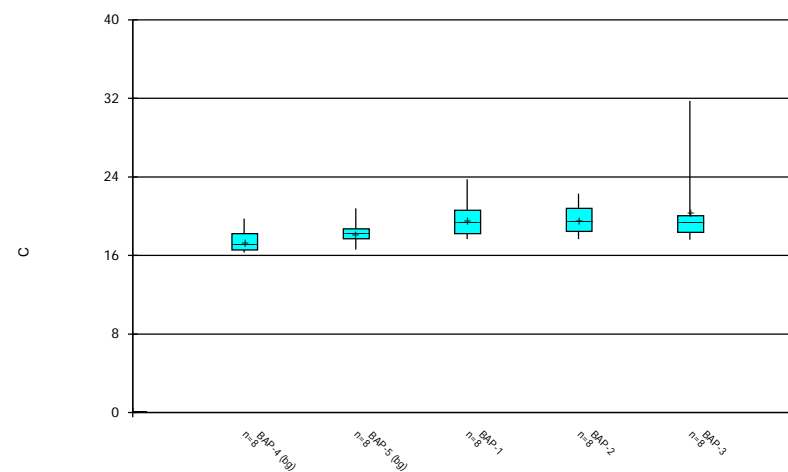
Constituent: Strontium, total Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



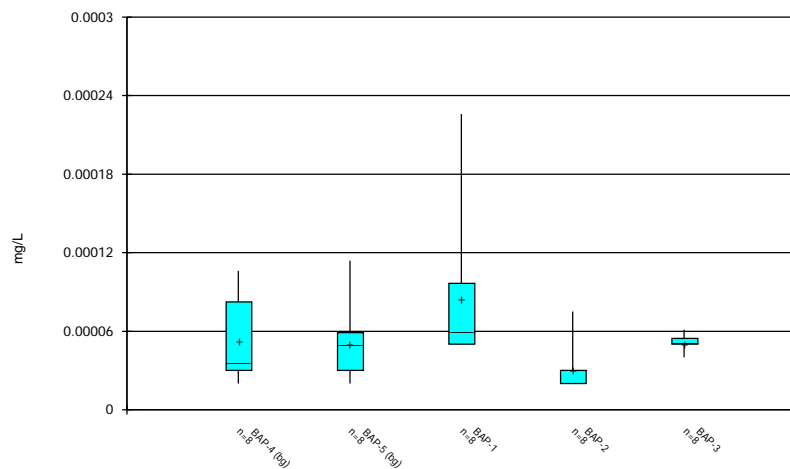
Constituent: Sulfate, total Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



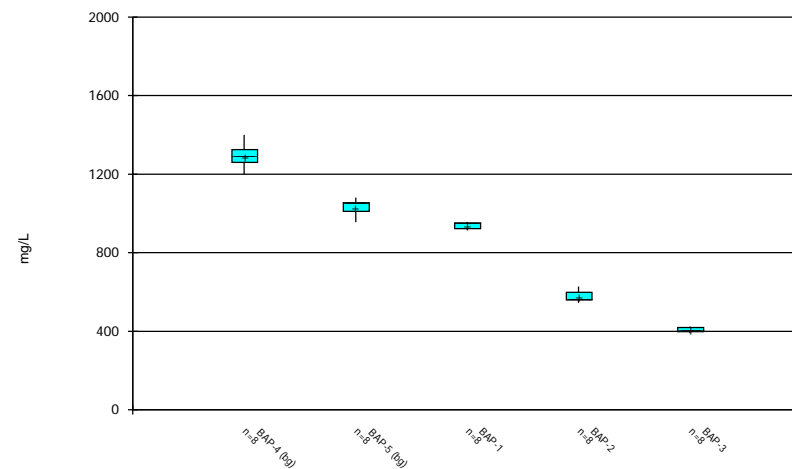
Constituent: Temperature Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



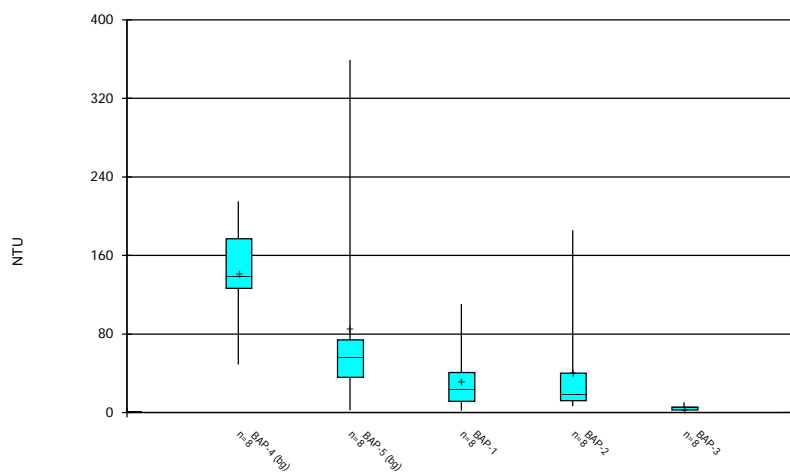
Constituent: Thallium, total Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



Constituent: Total Dissolved Solids [TDS] Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Box & Whiskers Plot



Constituent: Turbidity Analysis Run 11/4/2017 10:26 AM View: Time Series
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

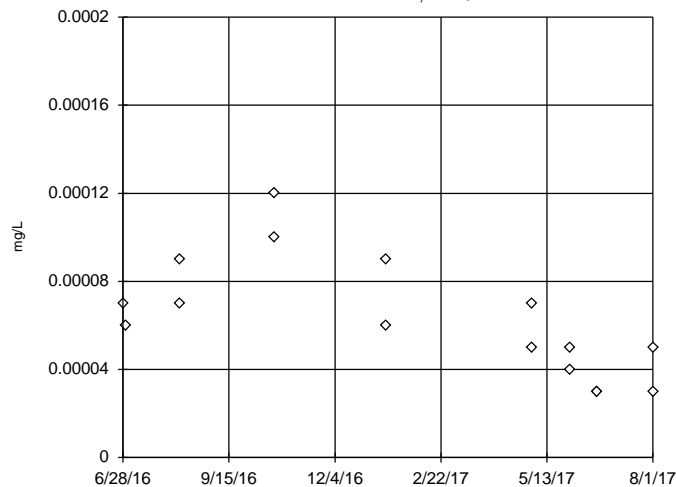
Outlier Analysis - All Upgradient Wells

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 11/4/2017, 10:08 AM

Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	0.00006313	0.00002651	sqrt(x)	ShapiroWilk
Arsenic, total (mg/L)	BAP-4,BAP-5	No	n/a	NP (nrm)	16	0.02632	0.01565	unknown	ShapiroWilk
Barium, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	0.07329	0.02297	sqrt(x)	ShapiroWilk
Beryllium, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	0.0001007	0.00005153	ln(x)	ShapiroWilk
Boron, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	0.06344	0.03771	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	0.00006438	0.00004844	ln(x)	ShapiroWilk
Calcium, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	205.4	16.12	normal	ShapiroWilk
Chloride, total (mg/L)	BAP-4,BAP-5	No	n/a	NP (nrm)	16	21.37	7.301	unknown	ShapiroWilk
Chromium, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	0.002481	0.001323	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	BAP-4,BAP-5	No	n/a	NP (nrm)	16	0.01045	0.00916	unknown	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	BAP-4,BAP-5	No	n/a	NP	16	0.8211	0.3342	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	BAP-4,BAP-5	No	n/a	NP (nrm)	16	0.09938	0.02462	unknown	ShapiroWilk
Lead, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	0.002635	0.001373	ln(x)	ShapiroWilk
Lithium, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	0.01169	0.004438	x^(1/3)	ShapiroWilk
Mercury, total (mg/L)	BAP-4,BAP-5	Yes	0.000007,0.000003	NP (nrm)	16	0.00000475	9.3e-7	unknown	ShapiroWilk
Molybdenum, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	0.001389	0.0009676	ln(x)	ShapiroWilk
pH, field (SU)	BAP-4,BAP-5	No	n/a	NP	16	6.597	0.2233	ln(x)	ShapiroWilk
Selenium, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	0.0004	0.0002191	x^(1/3)	ShapiroWilk
Sulfate, total (mg/L)	BAP-4,BAP-5	No	n/a	NP (nrm)	16	533.8	95.86	unknown	ShapiroWilk
Thallium, total (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	0.00005194	0.00003084	ln(x)	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	BAP-4,BAP-5	No	n/a	NP	16	1163	143.2	ln(x)	ShapiroWilk

Tukey's Outlier Screening, Pooled Background

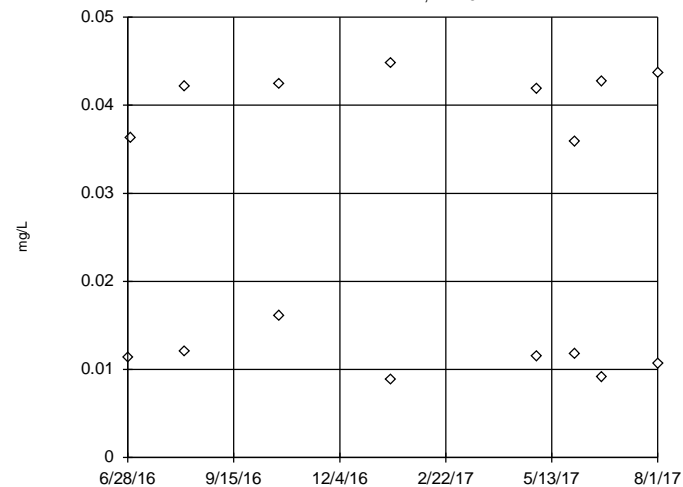
BAP-4,BAP-5



Constituent: Antimony, total Analysis Run 11/4/2017 10:07 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening, Pooled Background

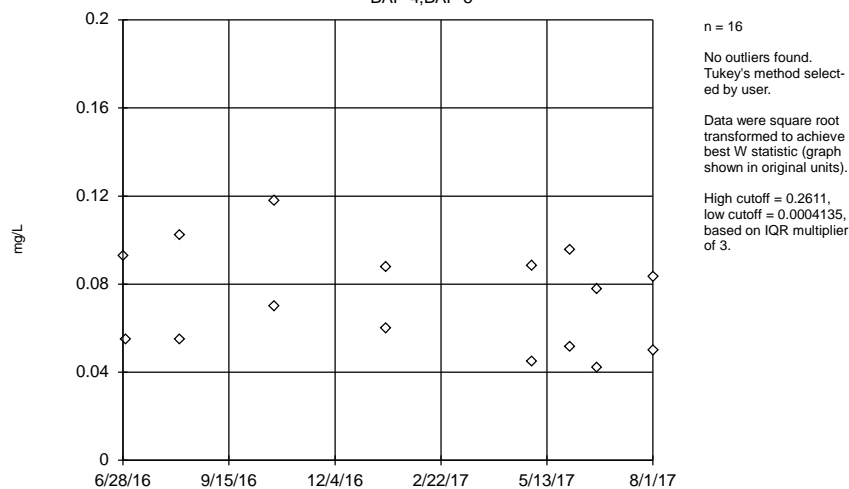
BAP-4,BAP-5



Constituent: Arsenic, total Analysis Run 11/4/2017 10:07 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening, Pooled Background

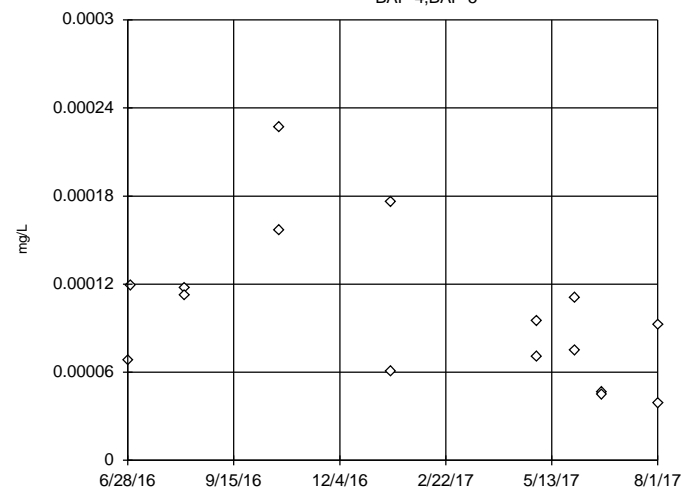
BAP-4,BAP-5



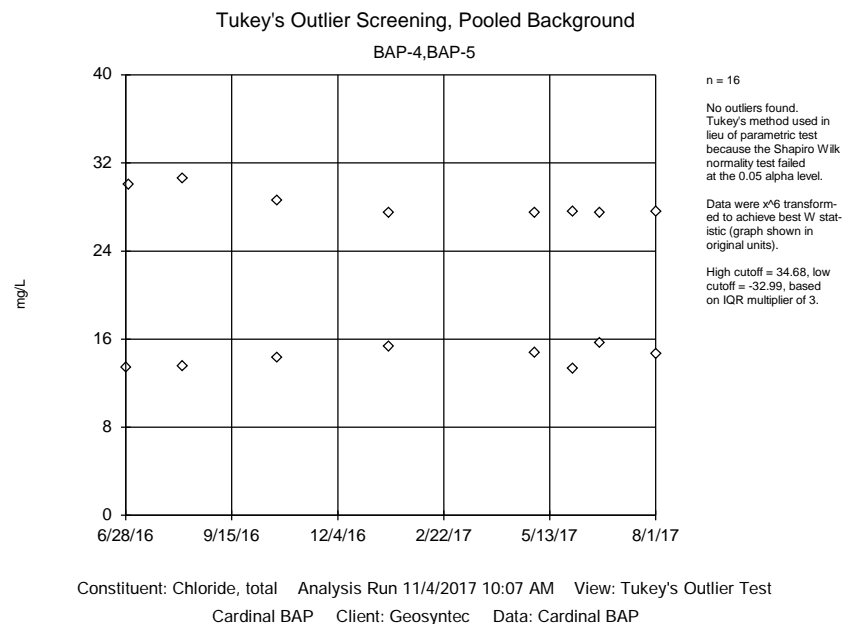
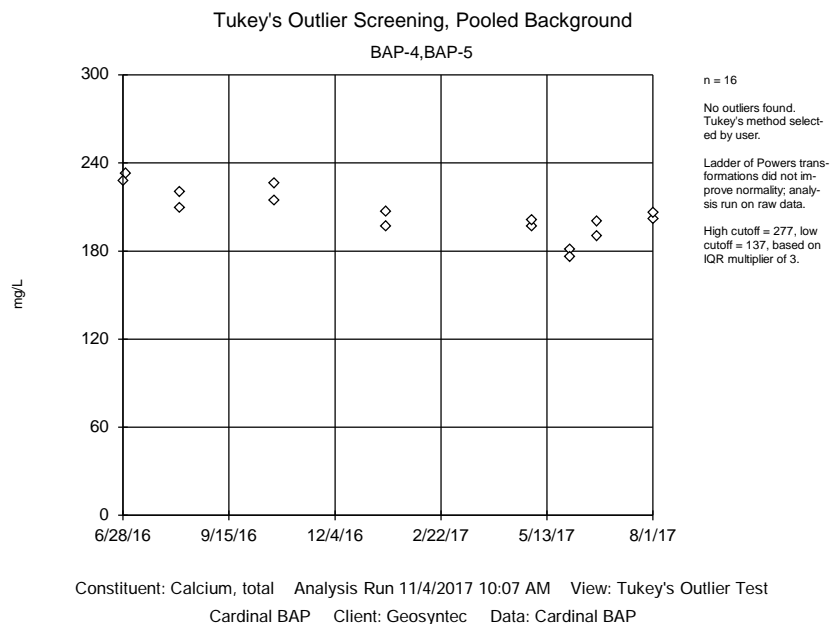
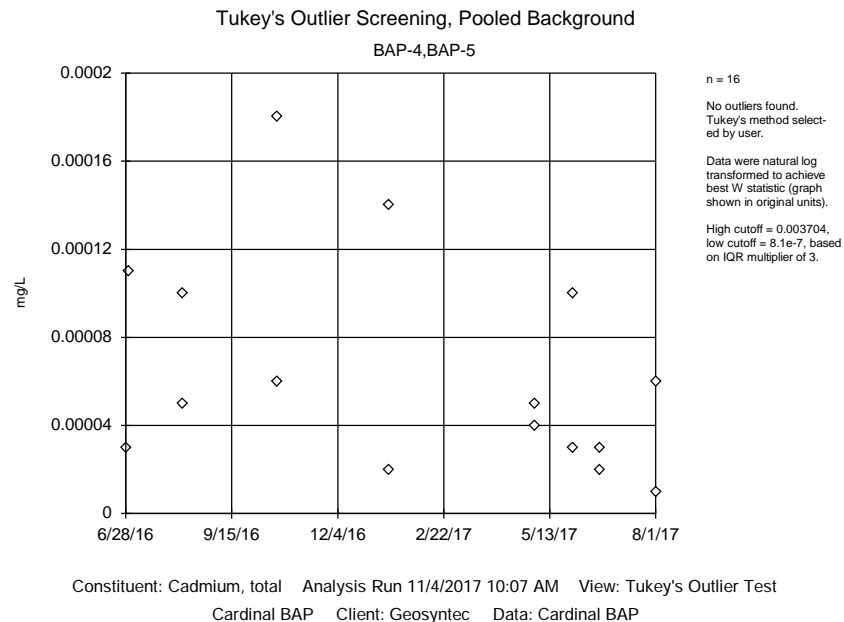
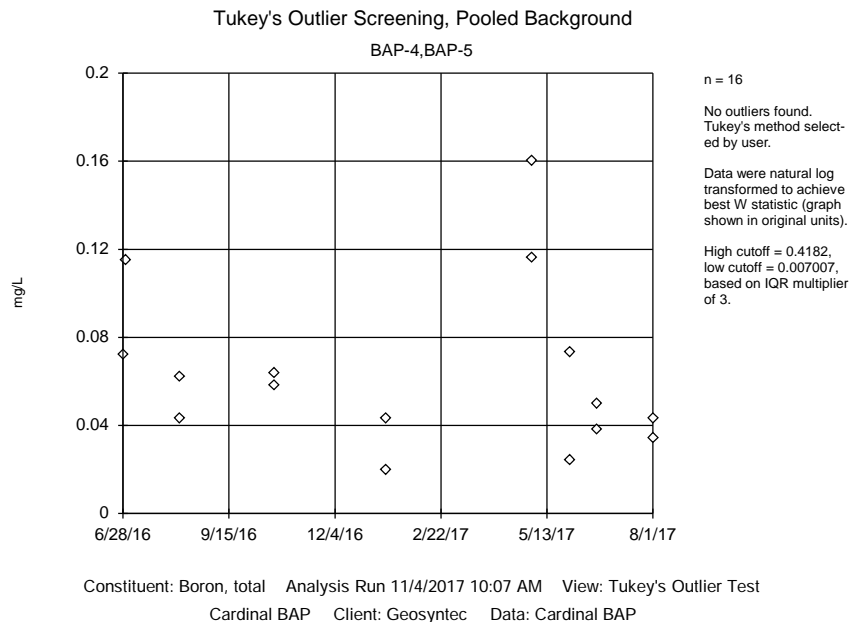
Constituent: Barium, total Analysis Run 11/4/2017 10:07 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

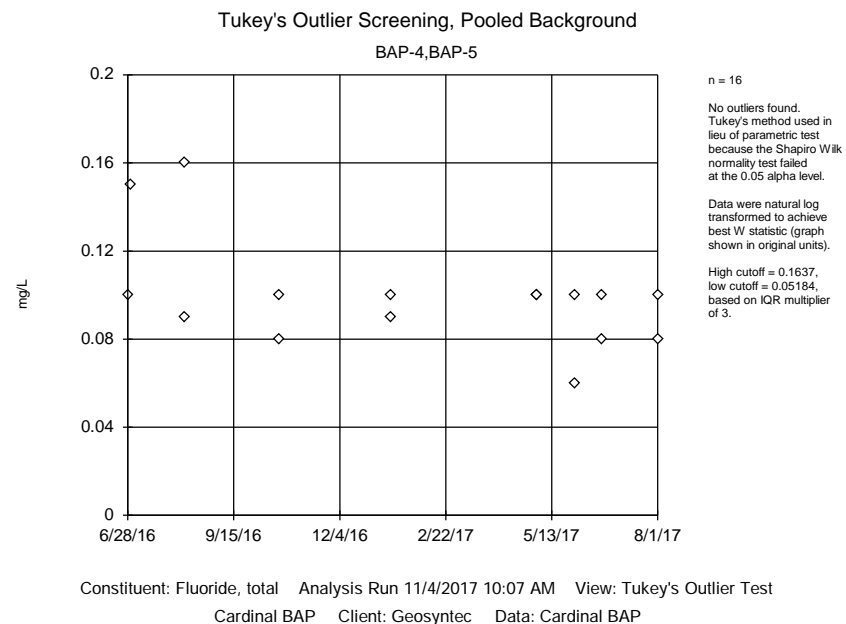
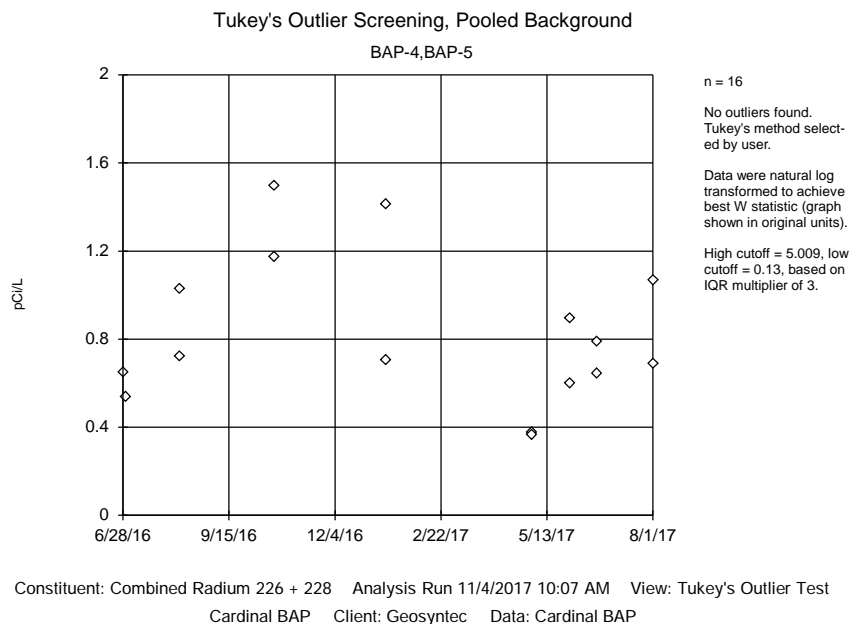
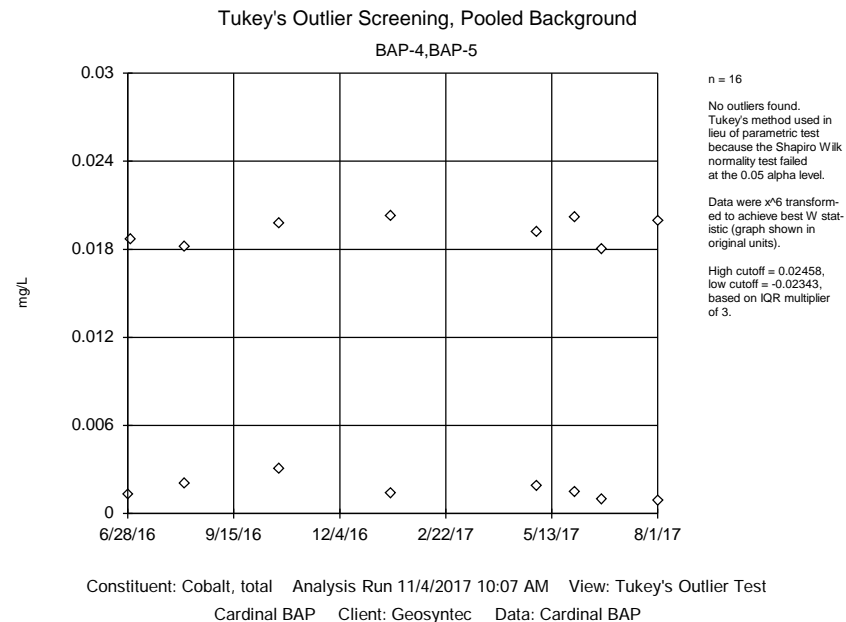
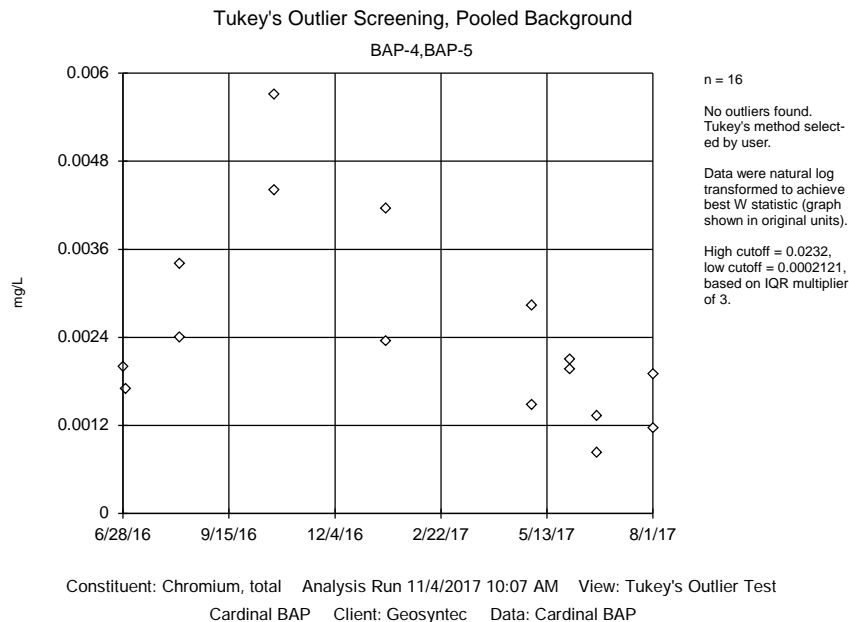
Tukey's Outlier Screening, Pooled Background

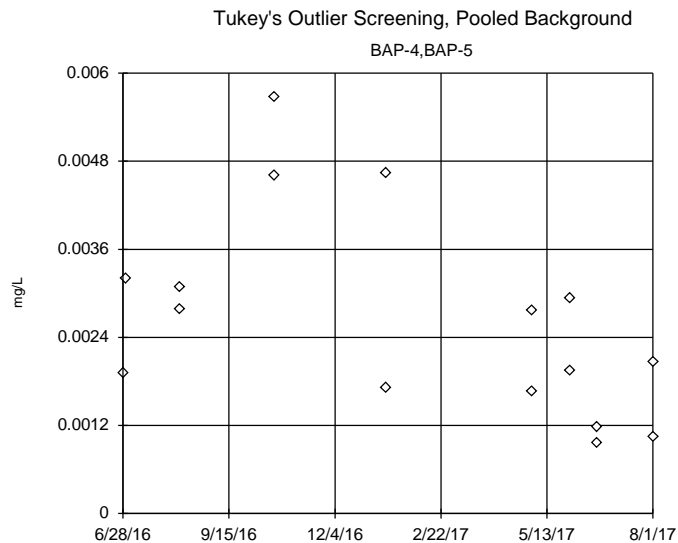
BAP-4,BAP-5



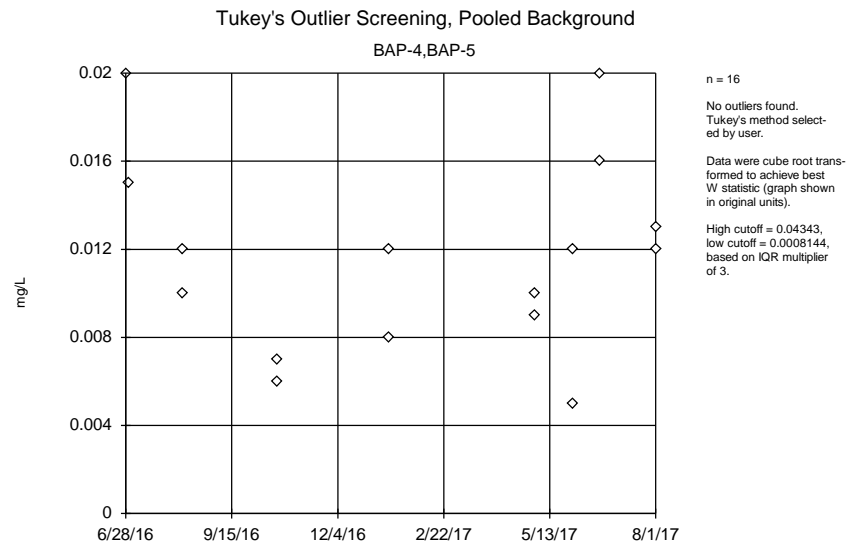
Constituent: Beryllium, total Analysis Run 11/4/2017 10:07 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



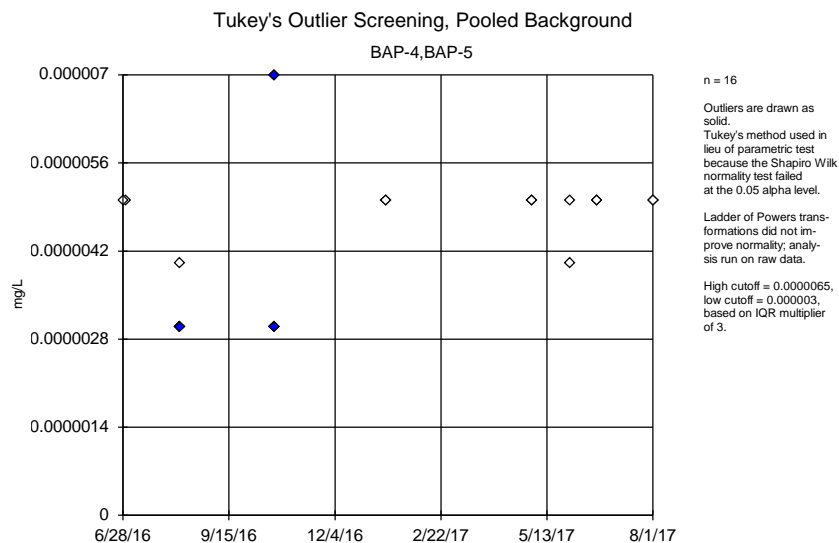




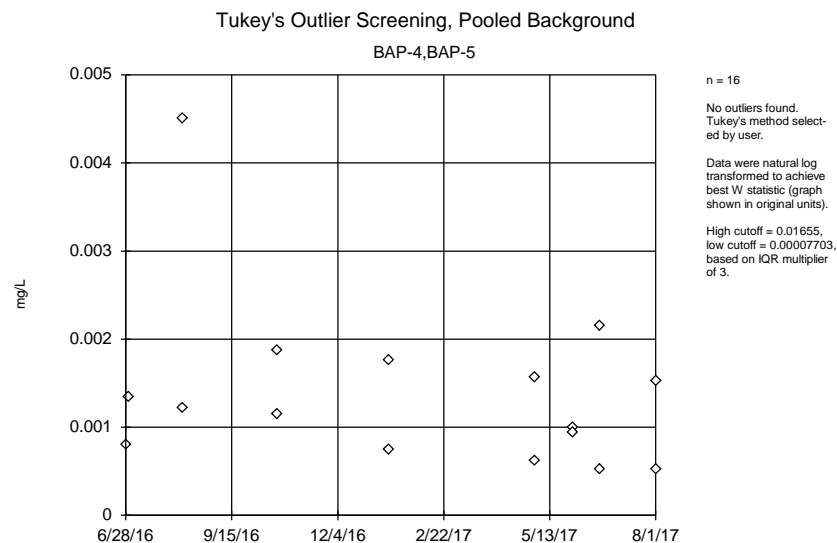
Constituent: Lead, total Analysis Run 11/4/2017 10:07 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



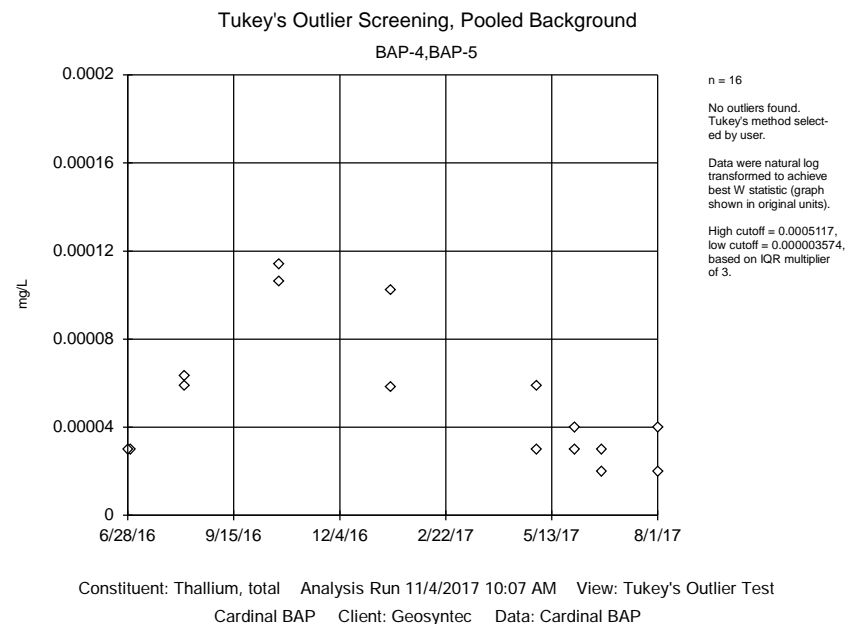
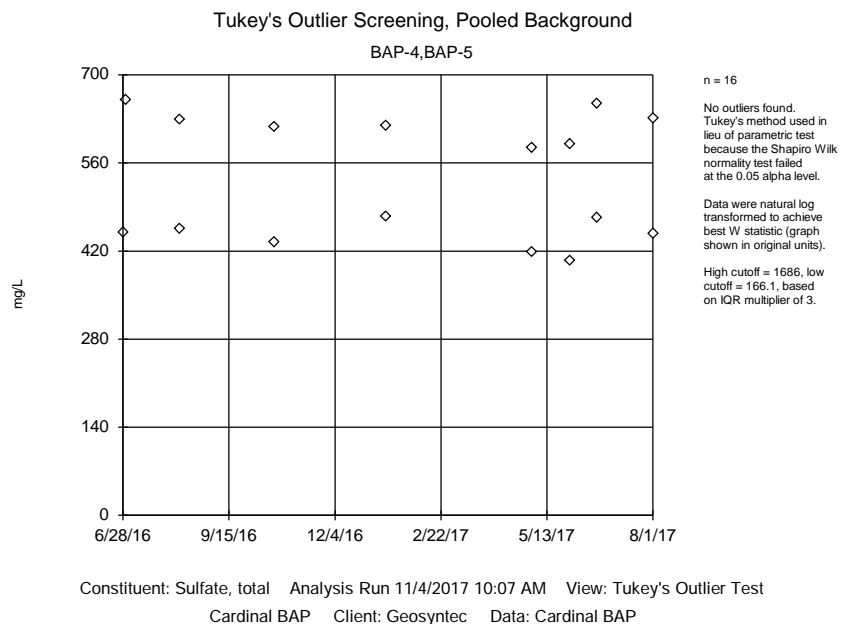
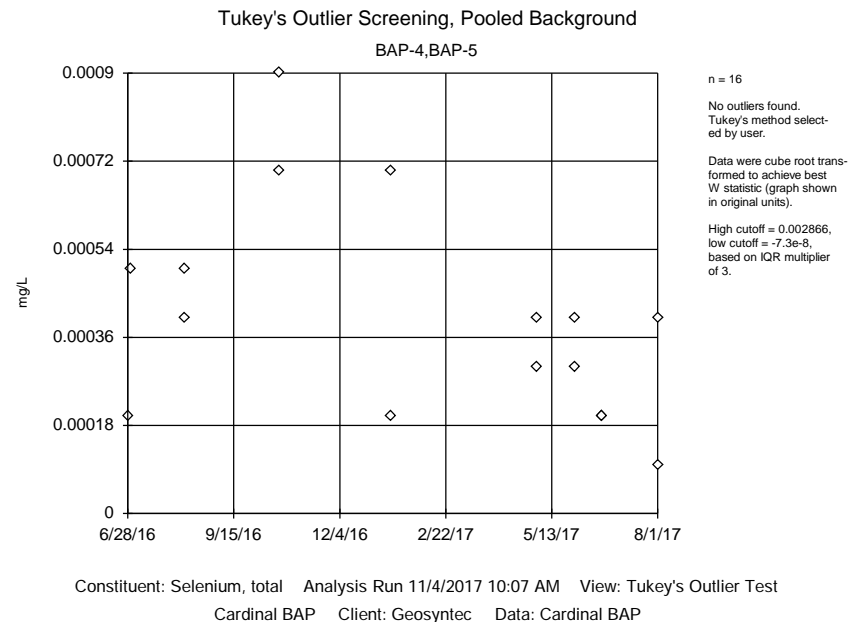
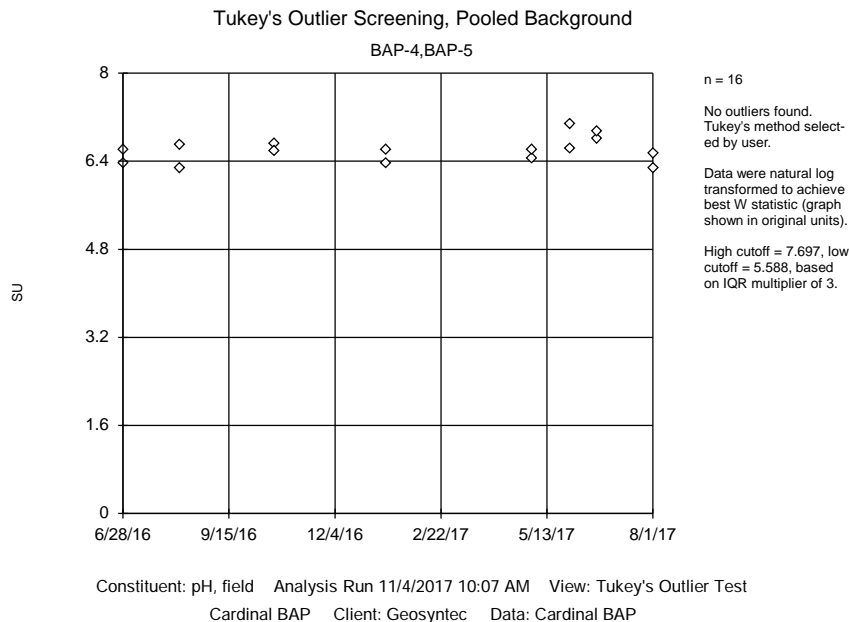
Constituent: Lithium, total Analysis Run 11/4/2017 10:07 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



Constituent: Mercury, total Analysis Run 11/4/2017 10:07 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

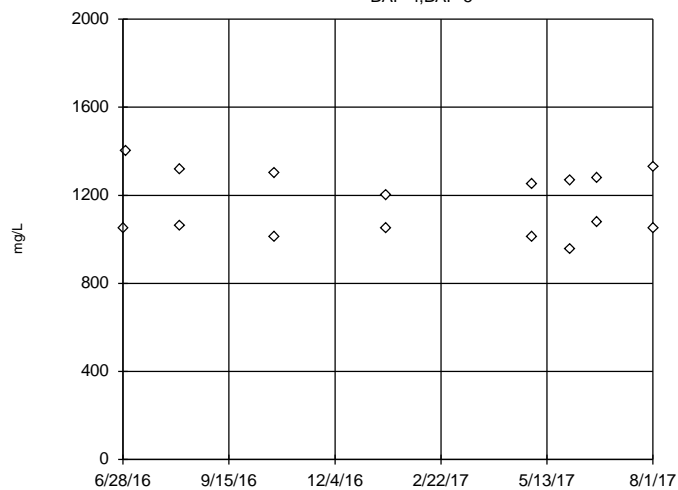


Constituent: Molybdenum, total Analysis Run 11/4/2017 10:07 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



Tukey's Outlier Screening, Pooled Background

BAP-4,BAP-5



n = 16

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 = 2392, low cutoff = 566.3, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 11/4/2017 10:07 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Outlier Analysis - All Downgradient Wells

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 11/4/2017, 10:11 AM

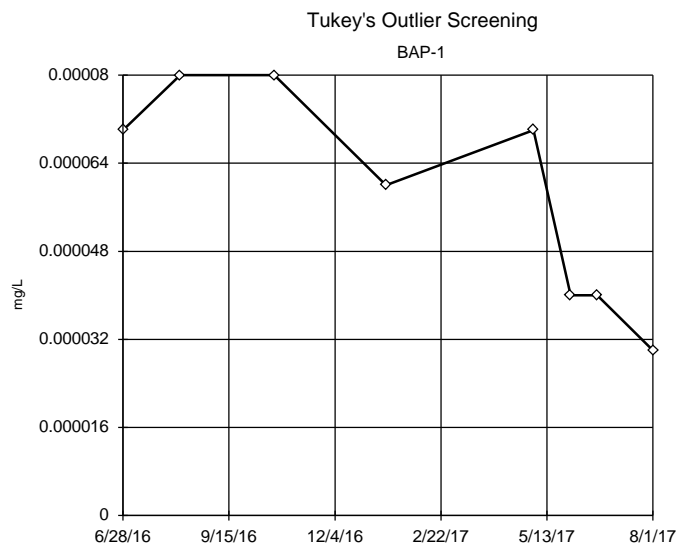
Constituent	Well	Outlier	Value(s)	Method	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony, total (mg/L)	BAP-1	No	n/a	NP	8	0.00005875	0.00001959	x^2	ShapiroWilk
Antimony, total (mg/L)	BAP-2	No	n/a	NP (nrm)	8	0.0000475	0.0000255	unknown	ShapiroWilk
Antimony, total (mg/L)	BAP-3	No	n/a	NP (nrm)	8	0.000025	0.000007559	unknown	ShapiroWilk
Arsenic, total (mg/L)	BAP-1	No	n/a	NP	8	0.001063	0.0004619	normal	ShapiroWilk
Arsenic, total (mg/L)	BAP-2	No	n/a	NP (nrm)	8	0.01624	0.007497	unknown	ShapiroWilk
Arsenic, total (mg/L)	BAP-3	No	n/a	NP	8	0.0005288	0.0002503	ln(x)	ShapiroWilk
Barium, total (mg/L)	BAP-1	No	n/a	NP	8	0.08464	0.01776	normal	ShapiroWilk
Barium, total (mg/L)	BAP-2	No	n/a	NP	8	0.1008	0.01099	ln(x)	ShapiroWilk
Barium, total (mg/L)	BAP-3	No	n/a	NP	8	0.05199	0.006183	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	BAP-1	No	n/a	NP	8	0.00004038	0.00002324	normal	ShapiroWilk
Beryllium, total (mg/L)	BAP-2	No	n/a	NP	8	0.00003	0.0000228	ln(x)	ShapiroWilk
Beryllium, total (mg/L)	BAP-3	No	n/a	NP	8	0.0000105	0.000006698	ln(x)	ShapiroWilk
Boron, total (mg/L)	BAP-1	No	n/a	NP	8	2.086	0.3485	ln(x)	ShapiroWilk
Boron, total (mg/L)	BAP-2	No	n/a	NP	8	2.074	0.1527	x^5	ShapiroWilk
Boron, total (mg/L)	BAP-3	No	n/a	NP	8	1.934	0.1236	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	BAP-1	No	n/a	NP	8	0.0001163	0.00001847	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	BAP-2	No	n/a	NP	8	0.00004125	0.00002232	ln(x)	ShapiroWilk
Cadmium, total (mg/L)	BAP-3	No	n/a	NP	8	0.0000675	0.00002121	ln(x)	ShapiroWilk
Calcium, total (mg/L)	BAP-1	No	n/a	NP	8	160.3	7.479	x^5	ShapiroWilk
Calcium, total (mg/L)	BAP-2	No	n/a	NP	8	88.44	5.118	ln(x)	ShapiroWilk
Calcium, total (mg/L)	BAP-3	No	n/a	NP	8	63.18	2.338	ln(x)	ShapiroWilk
Chloride, total (mg/L)	BAP-1	No	n/a	NP	8	95.91	2.224	ln(x)	ShapiroWilk
Chloride, total (mg/L)	BAP-2	No	n/a	NP	8	73.56	2.945	ln(x)	ShapiroWilk
Chloride, total (mg/L)	BAP-3	No	n/a	NP	8	61.16	1.577	normal	ShapiroWilk
Chromium, total (mg/L)	BAP-1	No	n/a	NP	8	0.00125	0.0007327	normal	ShapiroWilk
Chromium, total (mg/L)	BAP-2	No	n/a	NP	8	0.0006038	0.0005141	ln(x)	ShapiroWilk
Chromium, total (mg/L)	BAP-3	No	n/a	NP	8	0.0003436	0.0002385	x^(1/3)	ShapiroWilk
Cobalt, total (mg/L)	BAP-1	No	n/a	NP	8	0.001092	0.0002875	x^2	ShapiroWilk
Cobalt, total (mg/L)	BAP-2	No	n/a	NP	8	0.001504	0.0003117	ln(x)	ShapiroWilk
Cobalt, total (mg/L)	BAP-3	No	n/a	NP	8	0.0007281	0.0001214	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	BAP-1	No	n/a	NP	8	0.6766	0.4246	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	BAP-2	No	n/a	NP	8	0.8279	0.2694	normal	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	BAP-3	No	n/a	NP	8	0.6424	0.5135	sqrt(x)	ShapiroWilk
Fluoride, total (mg/L)	BAP-1	No	n/a	NP	8	0.3425	0.0377	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	BAP-2	No	n/a	NP	8	0.455	0.1674	ln(x)	ShapiroWilk
Fluoride, total (mg/L)	BAP-3	No	n/a	NP (nrm)	8	0.1238	0.03292	unknown	ShapiroWilk
Lead, total (mg/L)	BAP-1	No	n/a	NP	8	0.001118	0.0007077	normal	ShapiroWilk
Lead, total (mg/L)	BAP-2	No	n/a	NP	8	0.0006913	0.0006462	ln(x)	ShapiroWilk
Lead, total (mg/L)	BAP-3	No	n/a	NP	8	0.0001701	0.0001402	ln(x)	ShapiroWilk
Lithium, total (mg/L)	BAP-1	No	n/a	NP	8	0.02225	0.006606	ln(x)	ShapiroWilk
Lithium, total (mg/L)	BAP-2	No	n/a	NP	8	0.01188	0.00439	ln(x)	ShapiroWilk
Lithium, total (mg/L)	BAP-3	No	n/a	NP	8	0.00725	0.006296	x^(1/3)	ShapiroWilk
Mercury, total (mg/L)	BAP-1	No	n/a	NP	8	0.000005625	0.000002134	ln(x)	ShapiroWilk
Mercury, total (mg/L)	BAP-2	No	n/a	NP (nrm)	8	0.0000045	0.000001069	unknown	ShapiroWilk
Mercury, total (mg/L)	BAP-3	No	n/a	NP	8	0.000004	0.000001773	sqrt(x)	ShapiroWilk
Molybdenum, total (mg/L)	BAP-1	No	n/a	NP	8	0.02681	0.003087	x^6	ShapiroWilk
Molybdenum, total (mg/L)	BAP-2	No	n/a	NP	8	0.03974	0.007838	x^3	ShapiroWilk
Molybdenum, total (mg/L)	BAP-3	No	n/a	NP	8	0.002884	0.00122	ln(x)	ShapiroWilk
pH, field (SU)	BAP-1	No	n/a	NP	8	7.149	0.2179	ln(x)	ShapiroWilk
pH, field (SU)	BAP-2	No	n/a	NP	8	6.799	0.2585	x^5	ShapiroWilk
pH, field (SU)	BAP-3	No	n/a	NP	8	6.769	0.2179	ln(x)	ShapiroWilk
Selenium, total (mg/L)	BAP-1	No	n/a	NP	8	0.0001875	0.0001219	sqrt(x)	ShapiroWilk
Selenium, total (mg/L)	BAP-2	No	n/a	NP	8	0.0001388	0.0001133	ln(x)	ShapiroWilk
Selenium, total (mg/L)	BAP-3	No	n/a	NP	8	0.000075	0.00002673	normal	ShapiroWilk
Sulfate, total (mg/L)	BAP-1	No	n/a	NP (nrm)	8	421.3	27.68	unknown	ShapiroWilk

Outlier Analysis - All Downgradient Wells

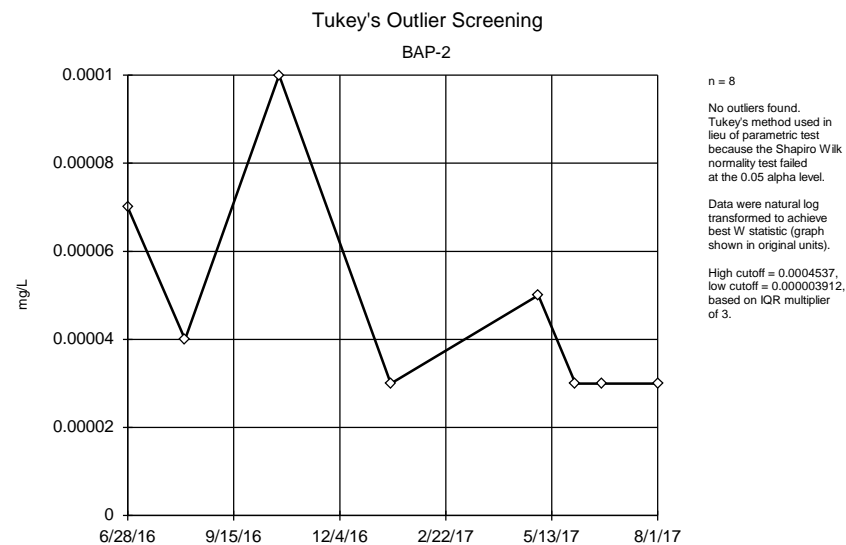
Page 2

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 11/4/2017, 10:11 AM

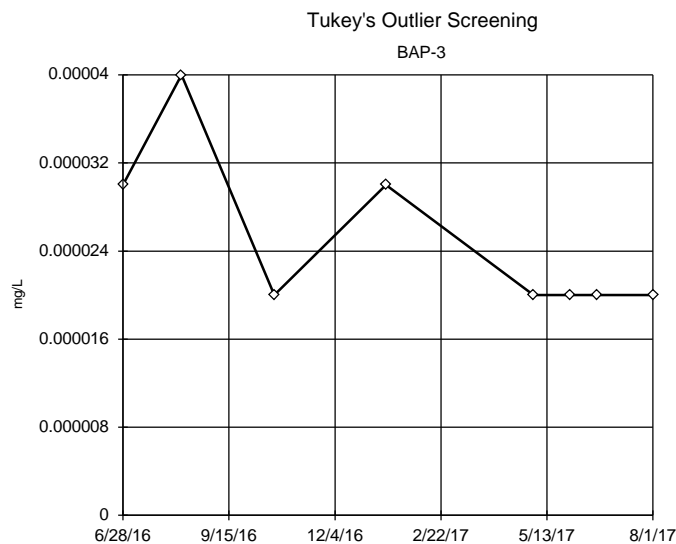
<u>Constituent</u>	<u>Well</u>	<u>Outlier</u>	<u>Value(s)</u>	<u>Method</u>	<u>N</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>Distribution</u>	<u>Normality Test</u>
Sulfate, total (mg/L)	BAP-2	No	n/a	NP	8	215	21.76	x^6	ShapiroWilk
Sulfate, total (mg/L)	BAP-3	No	n/a	NP	8	133.9	9.203	ln(x)	ShapiroWilk
Thallium, total (mg/L)	BAP-1	No	n/a	NP	8	0.00008575	0.00006155	ln(x)	ShapiroWilk
Thallium, total (mg/L)	BAP-2	No	n/a	NP (nrm)	8	0.00003188	0.00001811	unknown	ShapiroWilk
Thallium, total (mg/L)	BAP-3	No	n/a	NP	8	0.00005125	0.000006431	normal	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	BAP-1	No	n/a	NP	8	939	16.55	x^6	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	BAP-2	No	n/a	NP	8	576.1	29.41	ln(x)	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	BAP-3	No	n/a	NP	8	407.6	12.51	ln(x)	ShapiroWilk



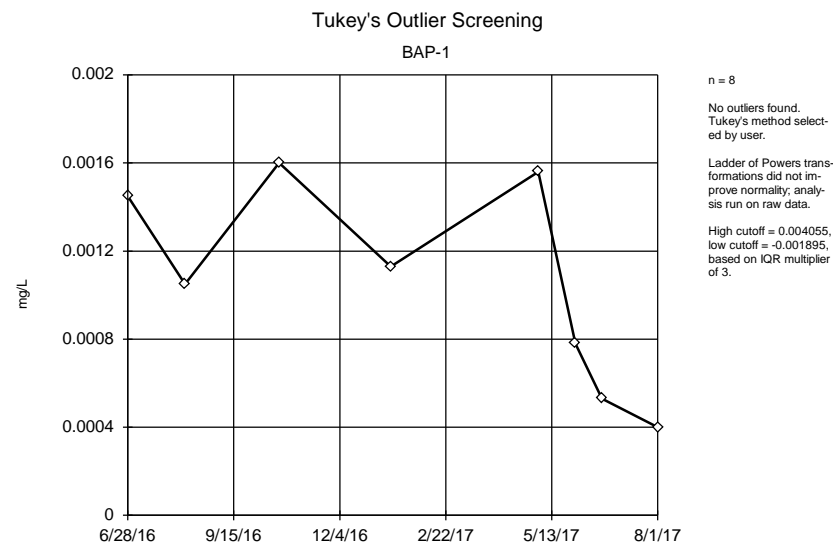
Constituent: Antimony, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



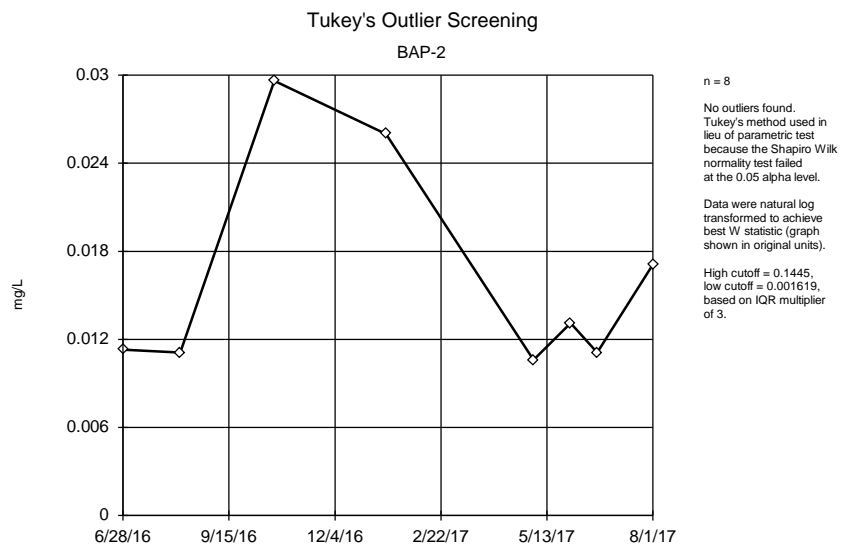
Constituent: Antimony, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



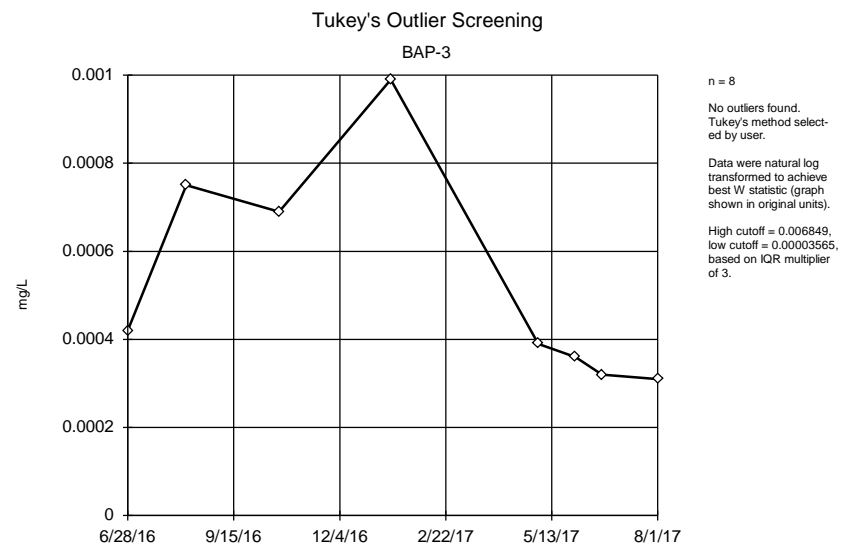
Constituent: Antimony, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



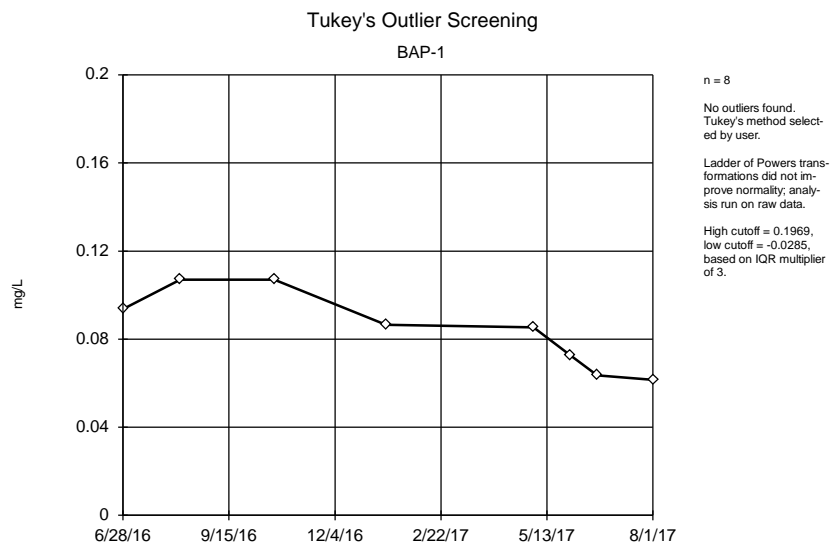
Constituent: Arsenic, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



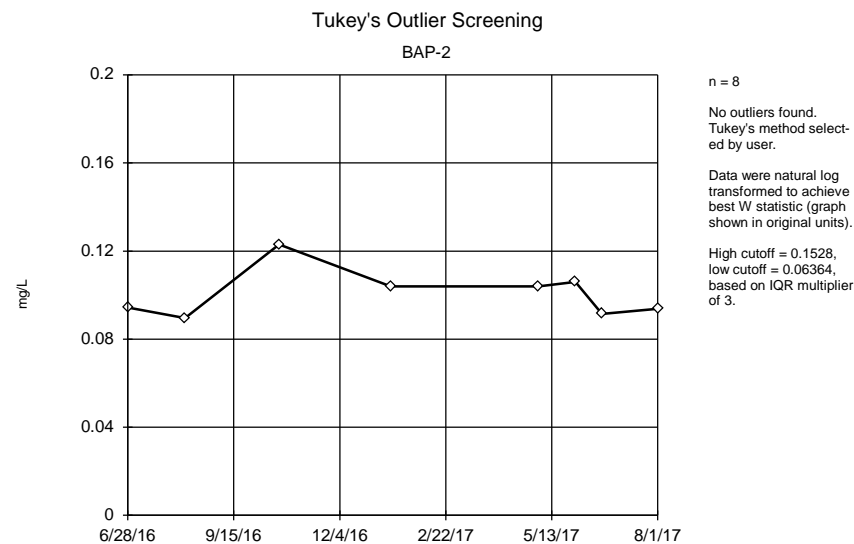
Constituent: Arsenic, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



Constituent: Arsenic, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



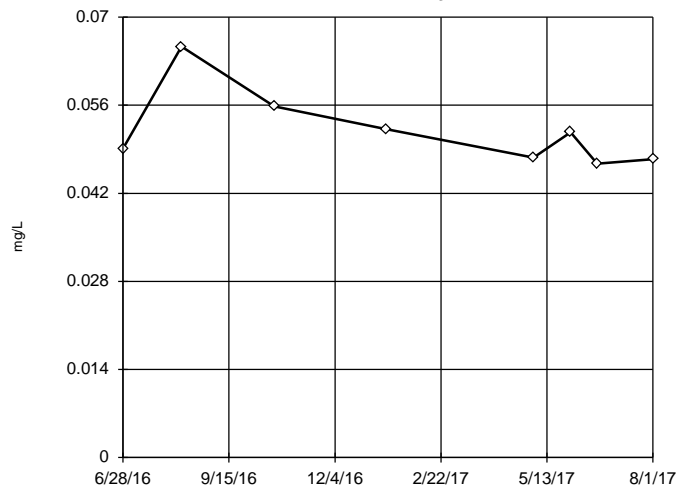
Constituent: Barium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



Constituent: Barium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-3



n = 8

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

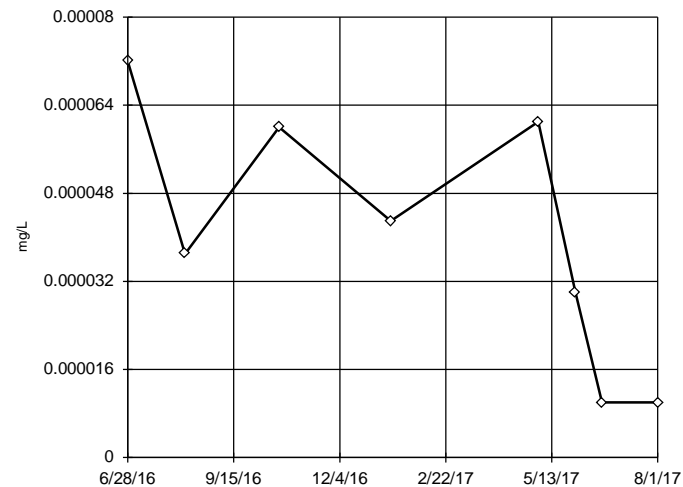
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.07892,
low cutoff = 0.03252,
based on IQR multiplier of 3.

Constituent: Barium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-1



n = 8

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

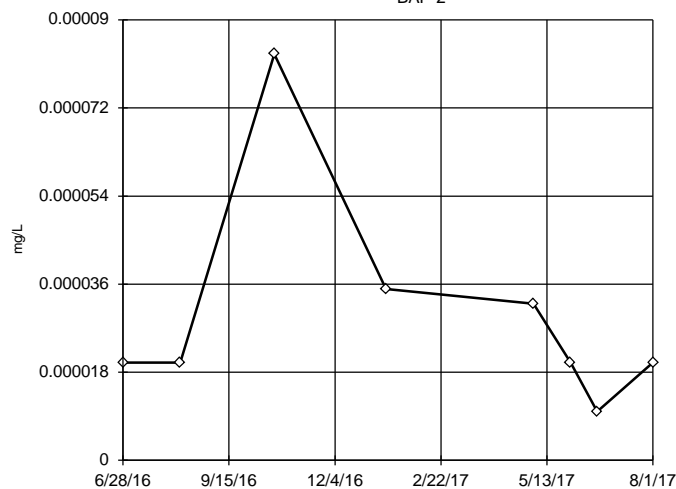
Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.000182,
low cutoff = -0.0001015,
based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-2



n = 8

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

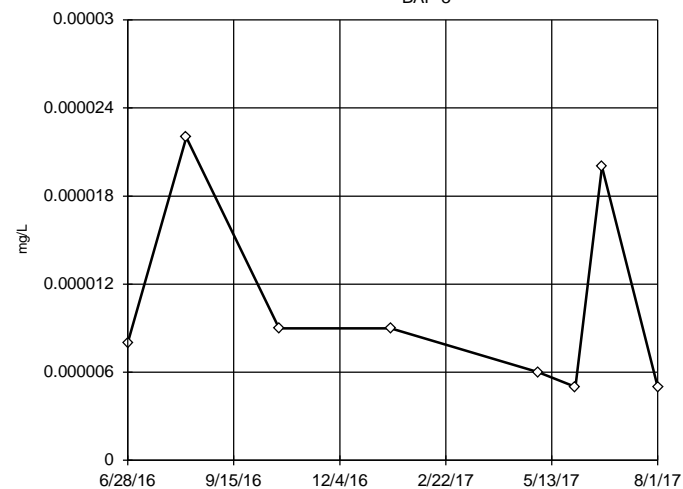
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0001568,
low cutoff = 0.000004269,
based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-3



n = 8

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

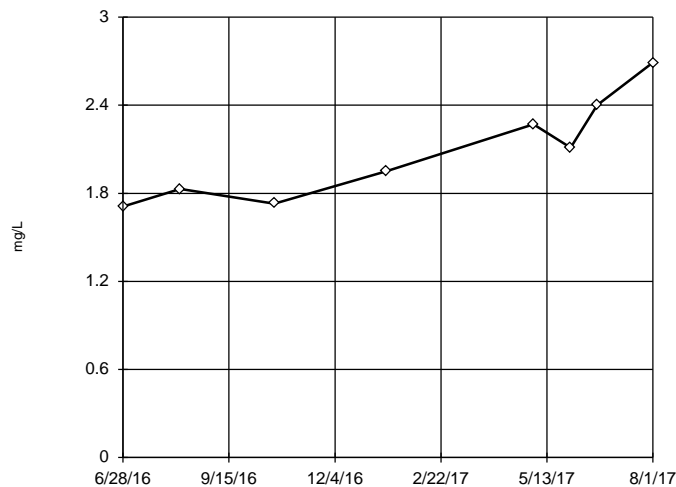
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0001972,
low cutoff = 3.7e-7, based on IQR multiplier of 3.

Constituent: Beryllium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-1



n = 8

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

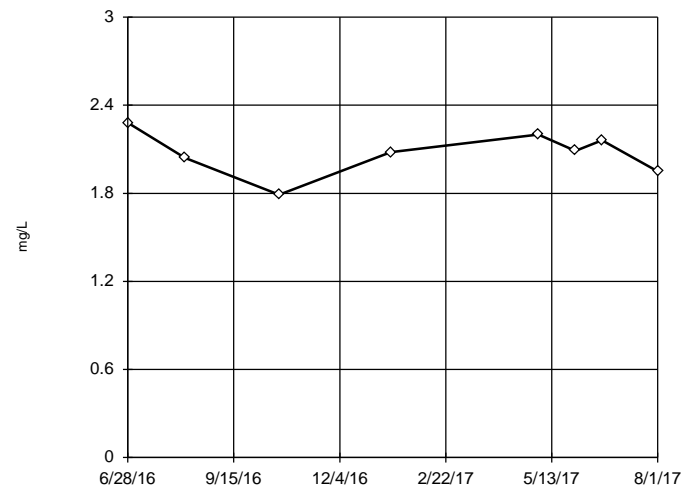
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 5.269, low cutoff = 0.7882, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-2



n = 8

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

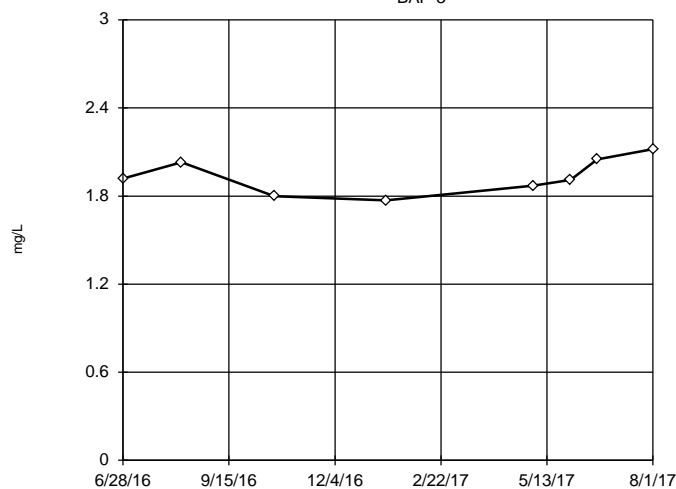
Data were x*5 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.521, low cutoff = -1.835, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-3



n = 8

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

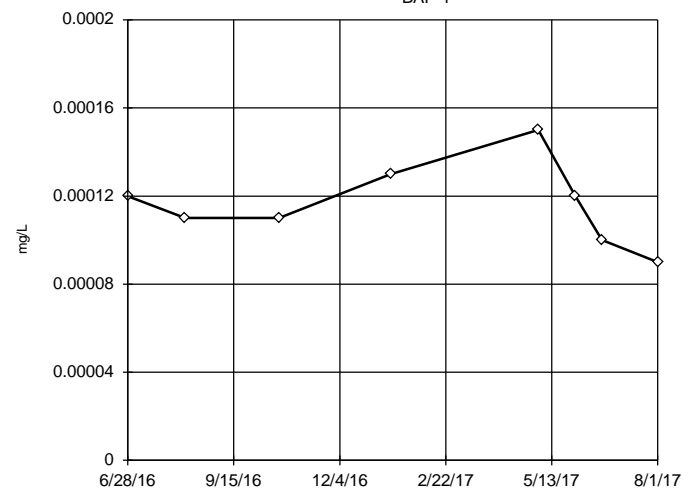
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 2.804, low cutoff = 1.335, based on IQR multiplier of 3.

Constituent: Boron, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-1



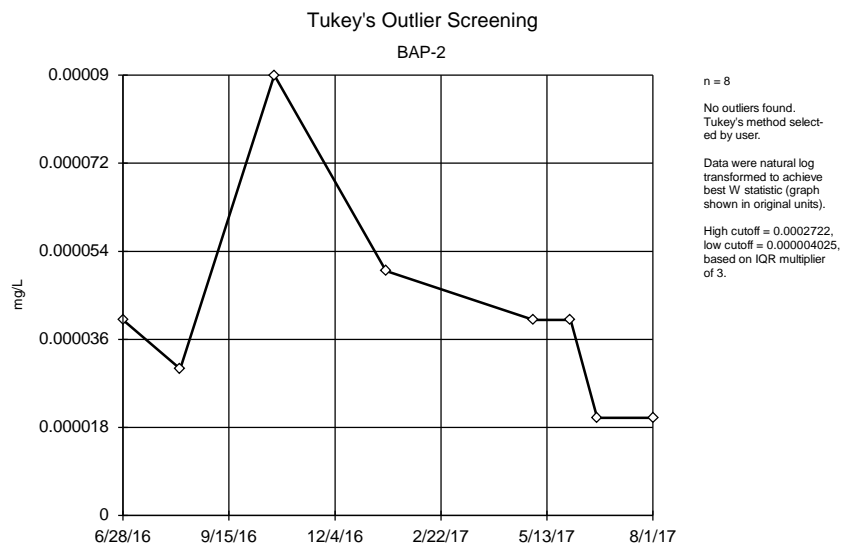
n = 8

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

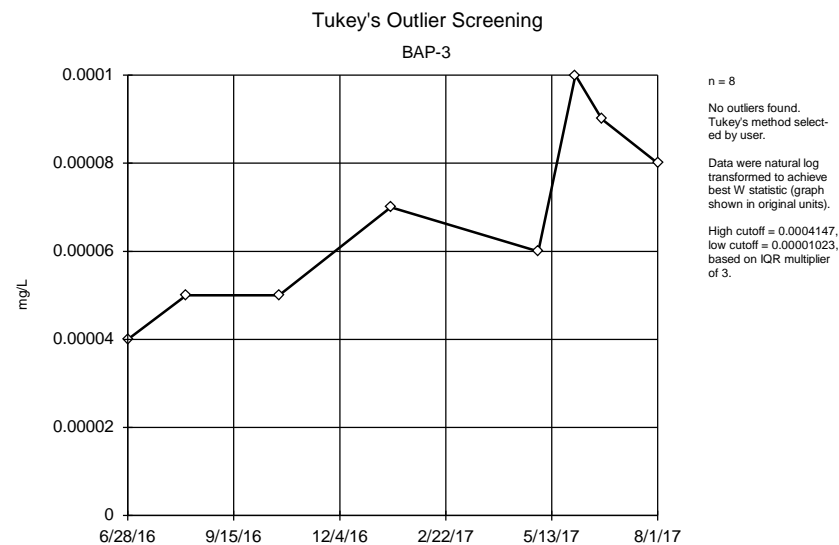
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0002109, low cutoff = 0.0000621, based on IQR multiplier of 3.

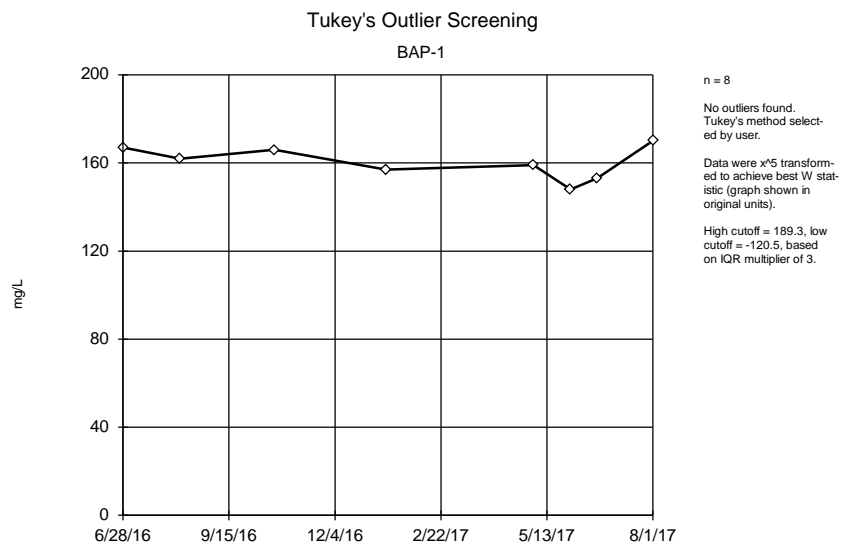
Constituent: Cadmium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



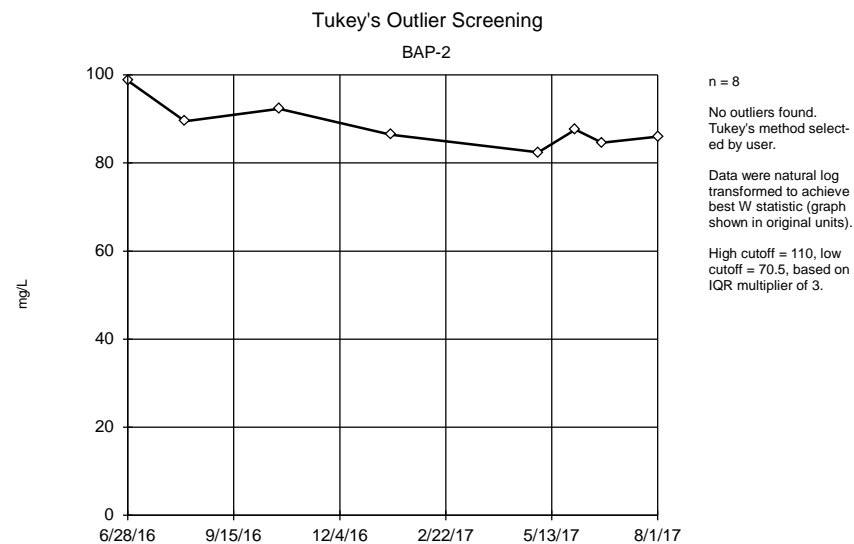
Constituent: Cadmium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



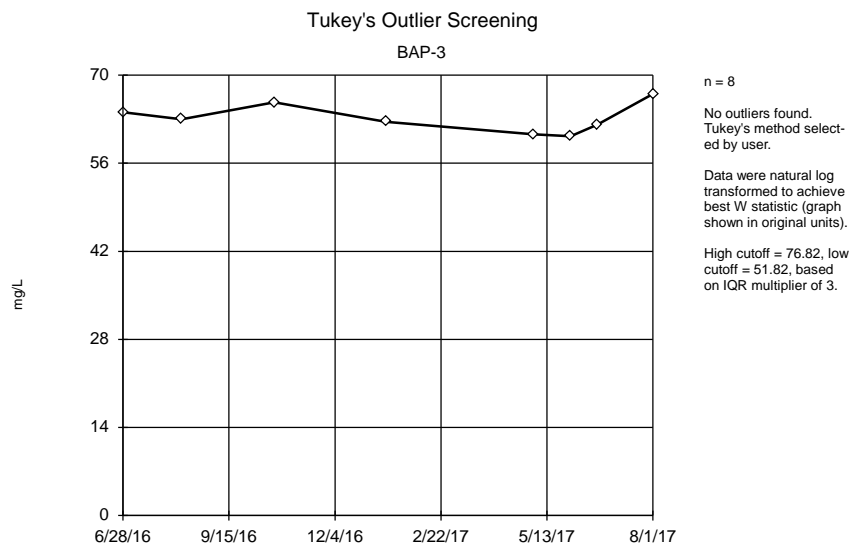
Constituent: Cadmium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



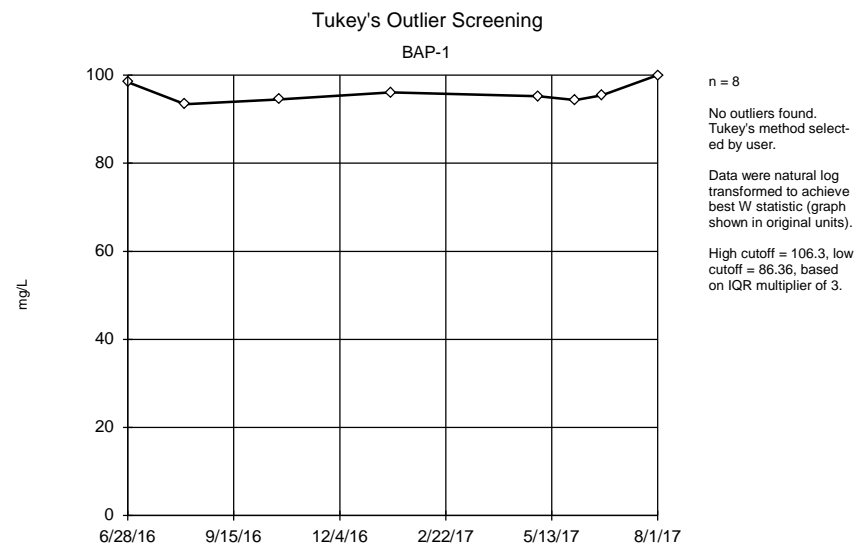
Constituent: Calcium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



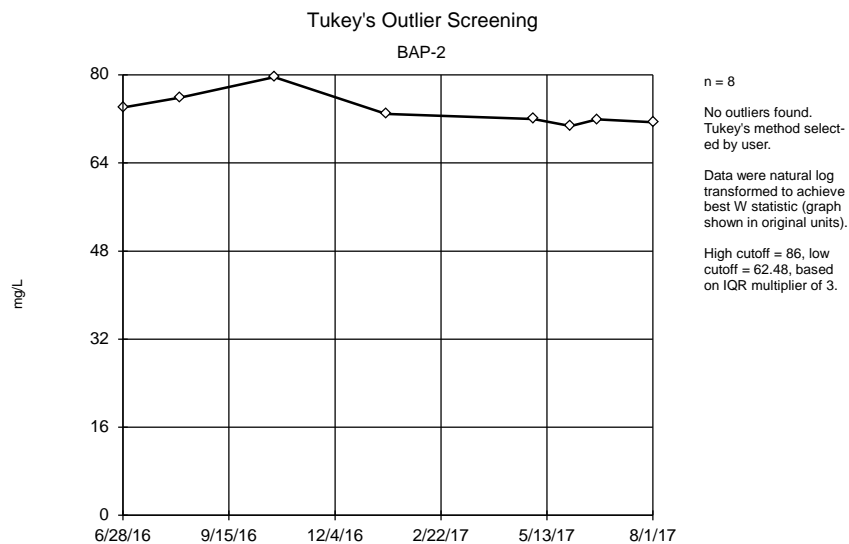
Constituent: Calcium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



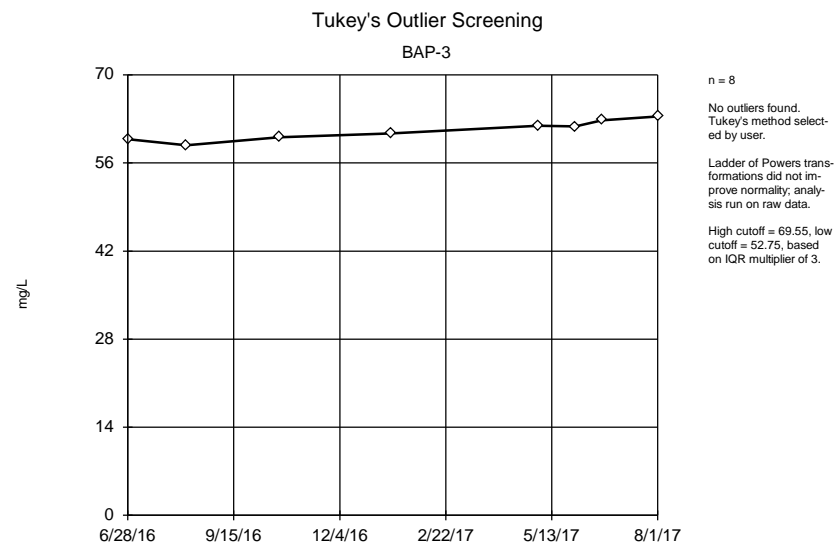
Constituent: Calcium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



Constituent: Chloride, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



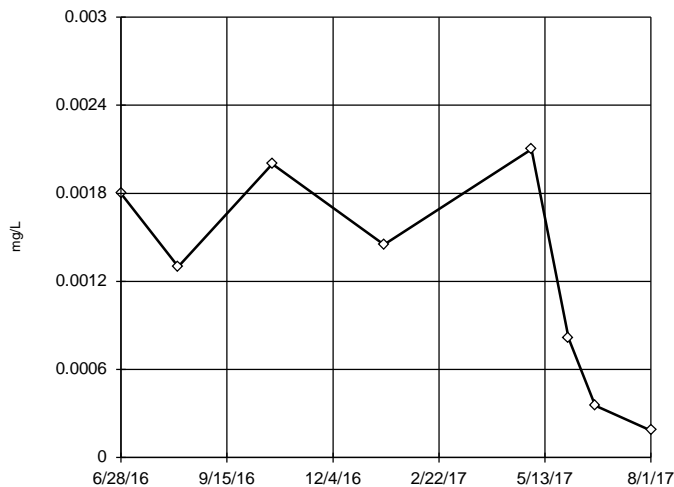
Constituent: Chloride, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



Constituent: Chloride, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-1



n = 8

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

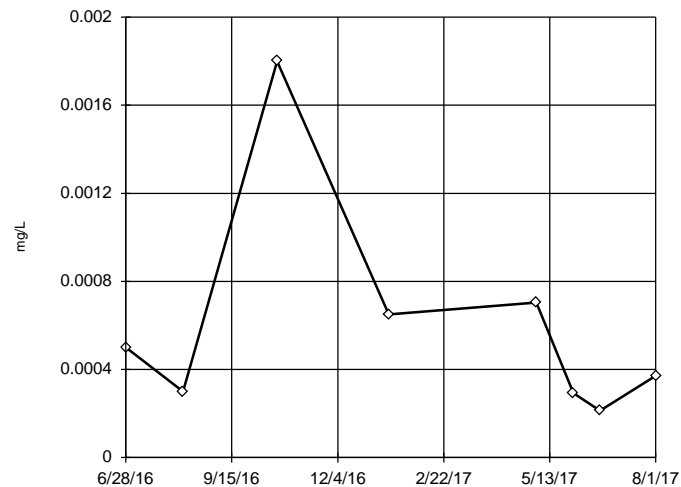
Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.005851,
low cutoff = -0.003368,
based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-2



n = 8

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

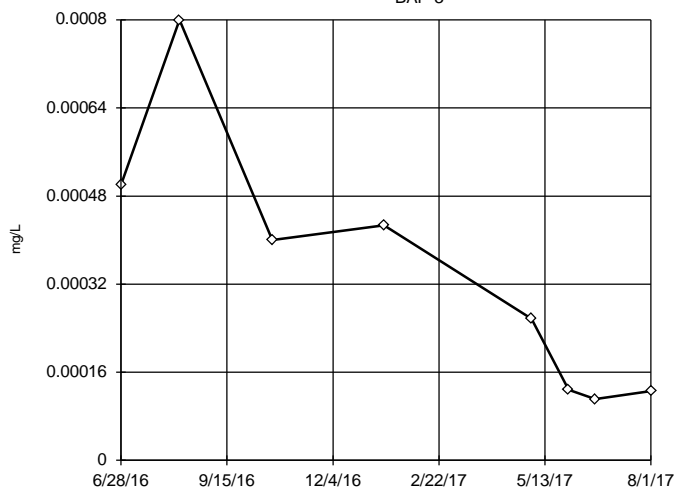
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.008076,
low cutoff = 0.00002479,
based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-3



n = 8

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

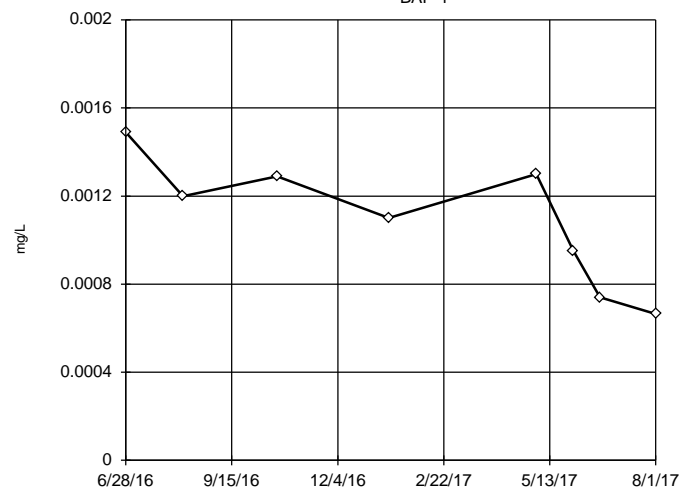
Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.003986,
low cutoff = -0.00002964,
based on IQR multiplier of 3.

Constituent: Chromium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-1



n = 8

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

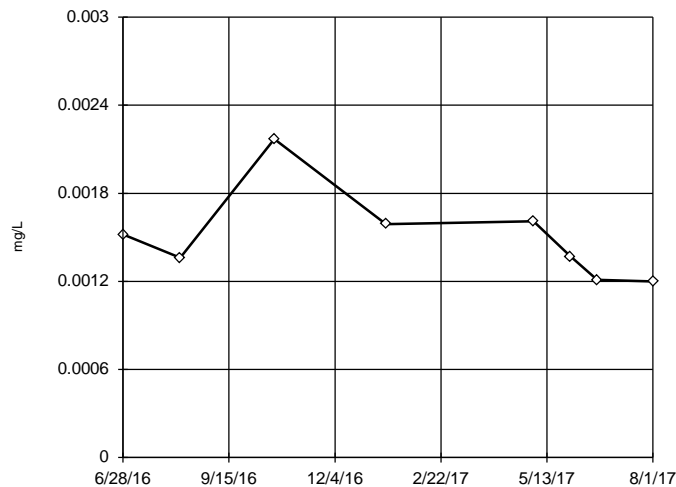
Data were square transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.002128,
low cutoff = -0.001458,
based on IQR multiplier of 3.

Constituent: Cobalt, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

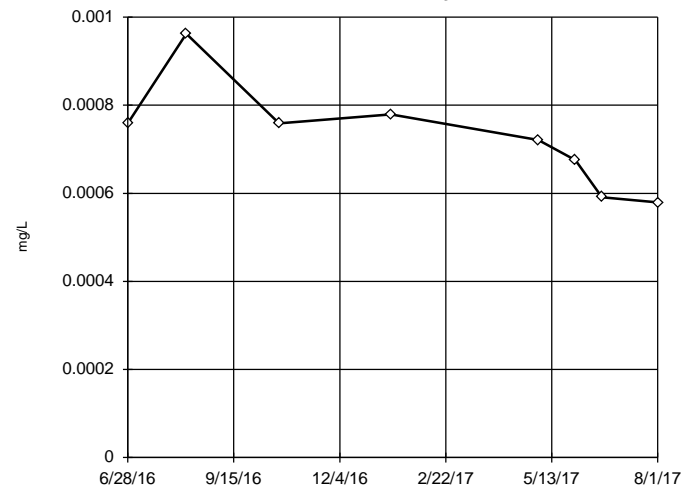
BAP-2



Constituent: Cobalt, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

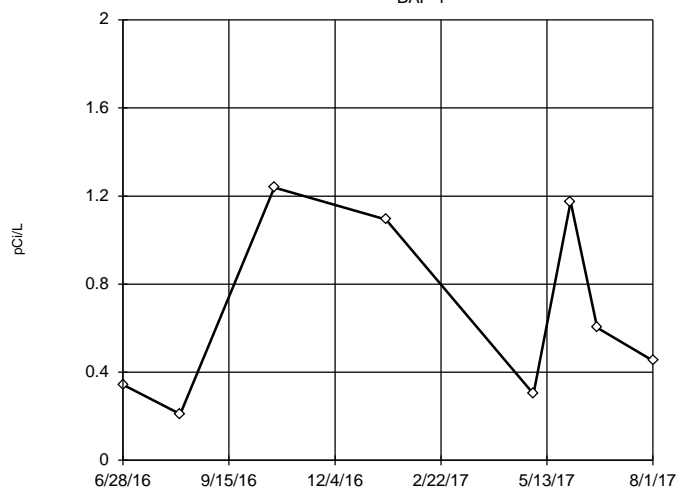
BAP-3



Constituent: Cobalt, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

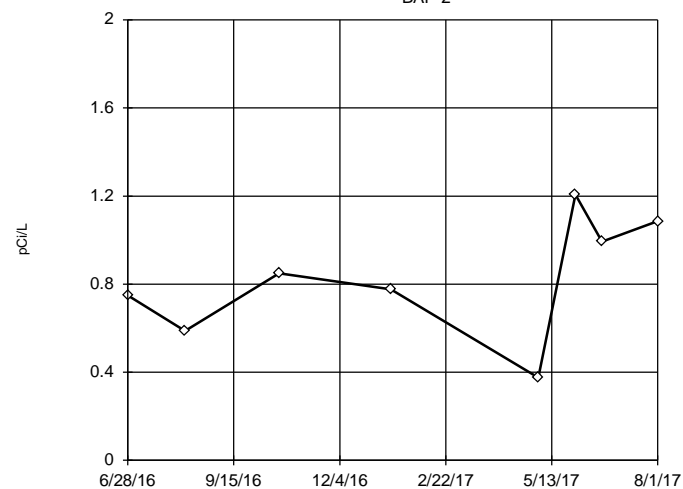
BAP-1



Constituent: Combined Radium 226 + 228 Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

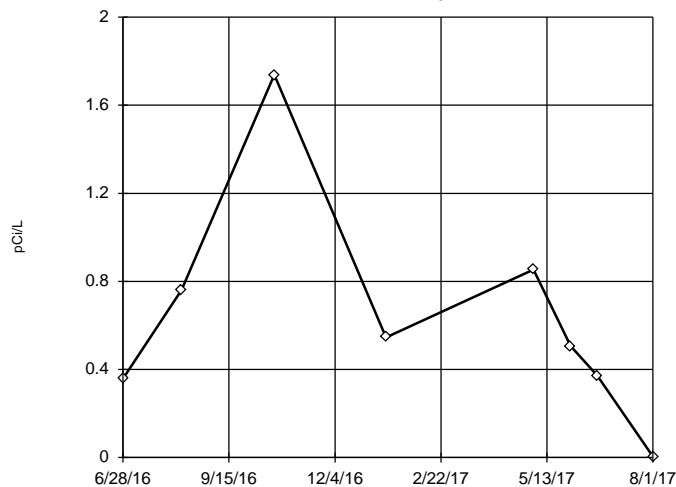
BAP-2



Constituent: Combined Radium 226 + 228 Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

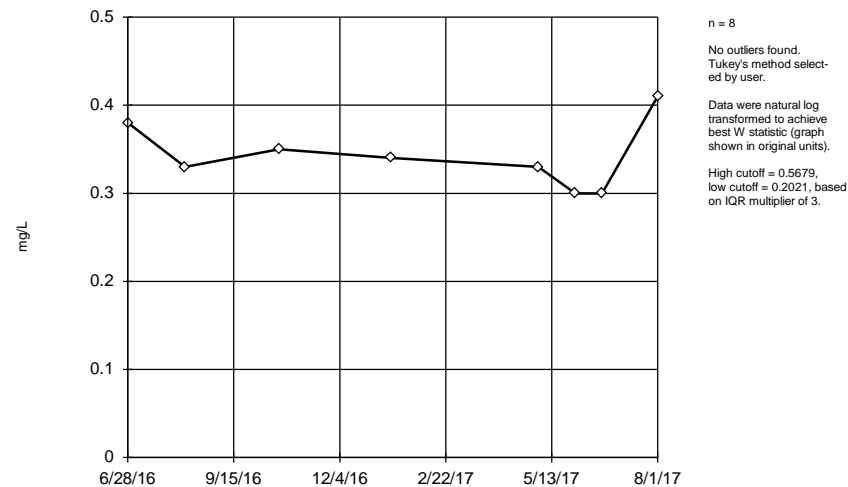
BAP-3



Constituent: Combined Radium 226 + 228 Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

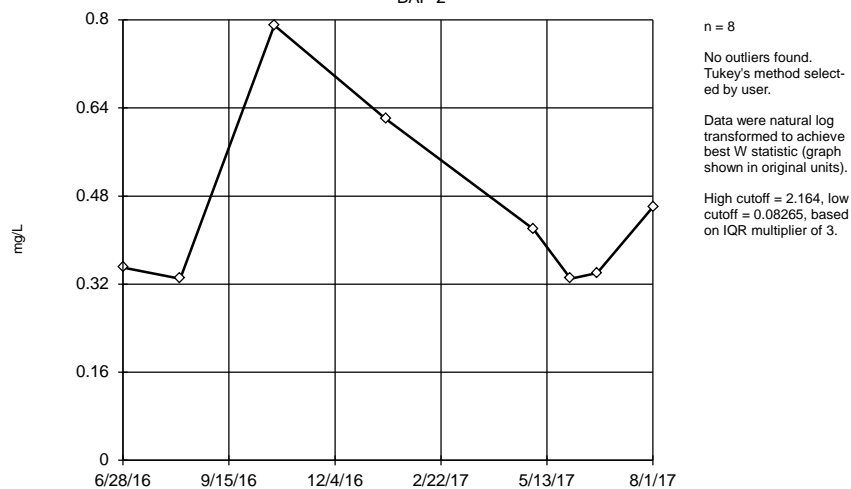
BAP-1



Constituent: Fluoride, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

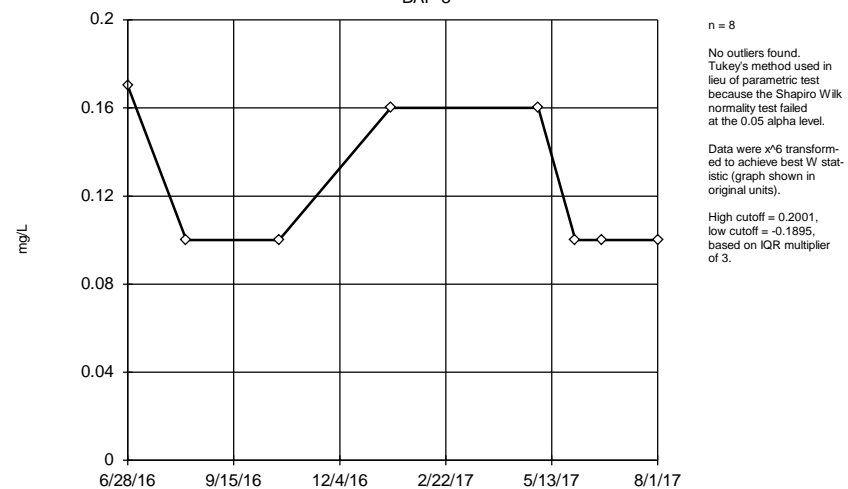
BAP-2



Constituent: Fluoride, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

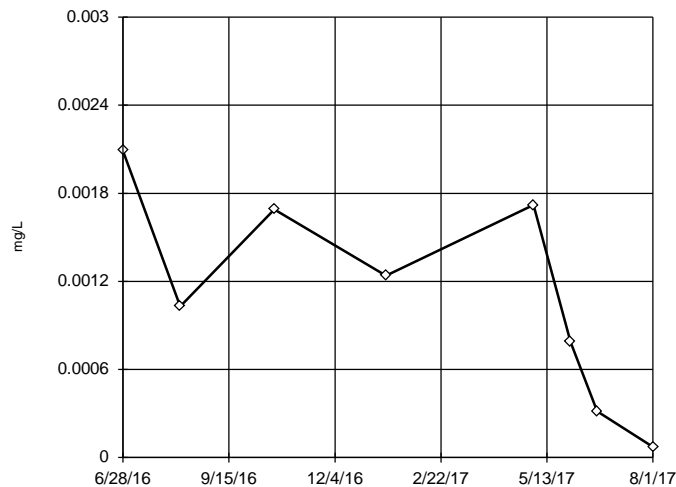
BAP-3



Constituent: Fluoride, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-1



n = 8

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

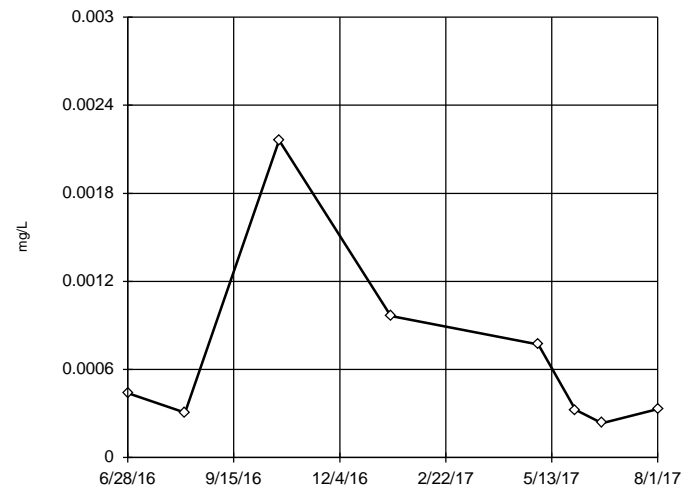
Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.00517,
low cutoff = -0.002915,
based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-2



n = 8

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

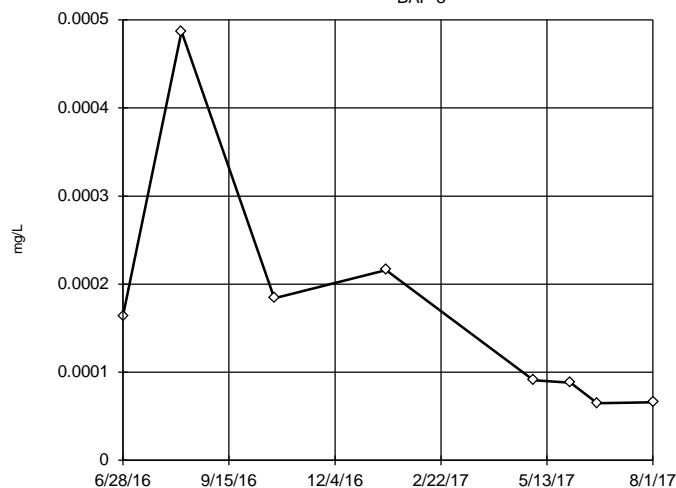
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.01752,
low cutoff = 0.00001554,
based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-3



n = 8

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

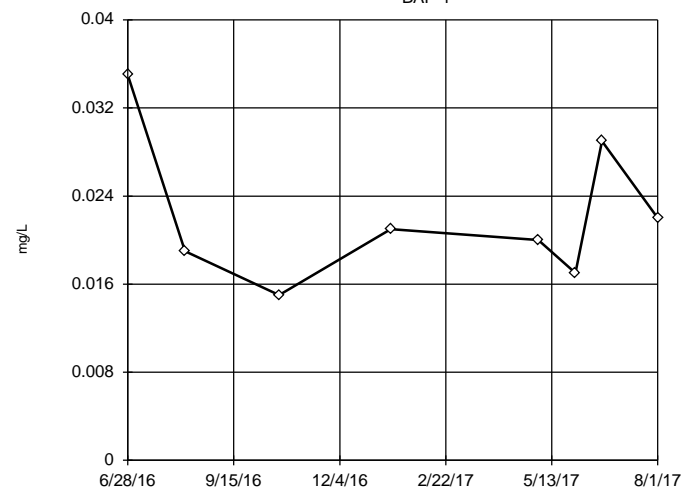
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.003569,
low cutoff = 0.000004257,
based on IQR multiplier of 3.

Constituent: Lead, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-1



n = 8

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

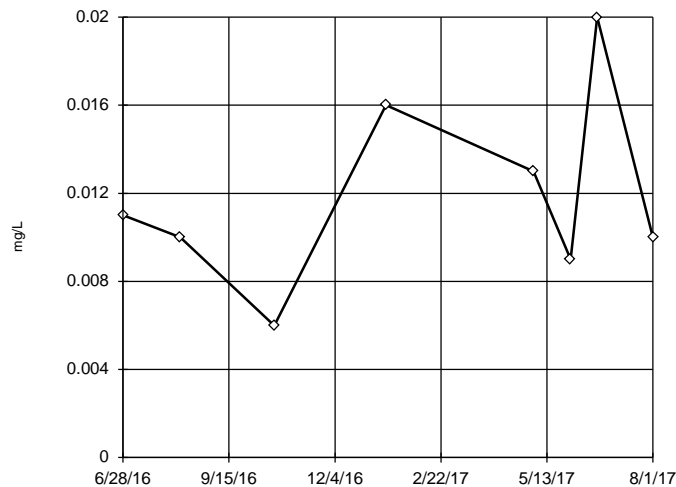
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.07012,
low cutoff = 0.006474,
based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-2



n = 8

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

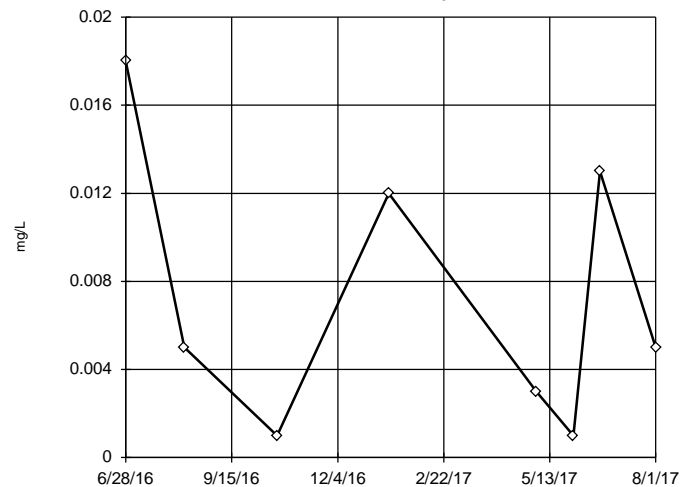
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.05067,
low cutoff = 0.0027, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-3



n = 8

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

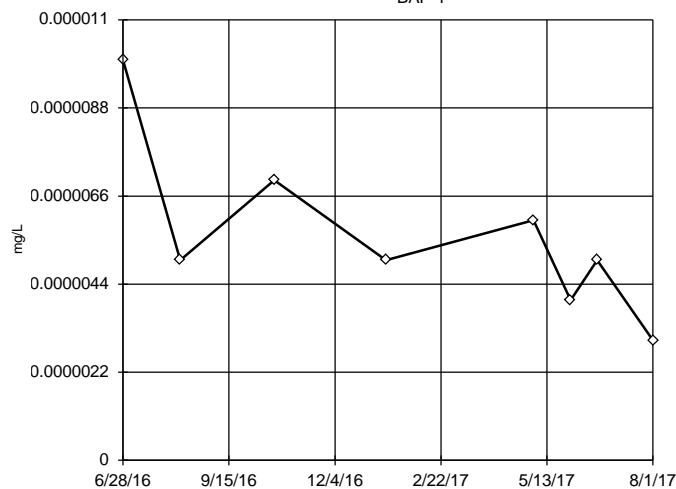
Data were cube root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.1773,
low cutoff = -0.008955, based on IQR multiplier of 3.

Constituent: Lithium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-1



n = 8

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

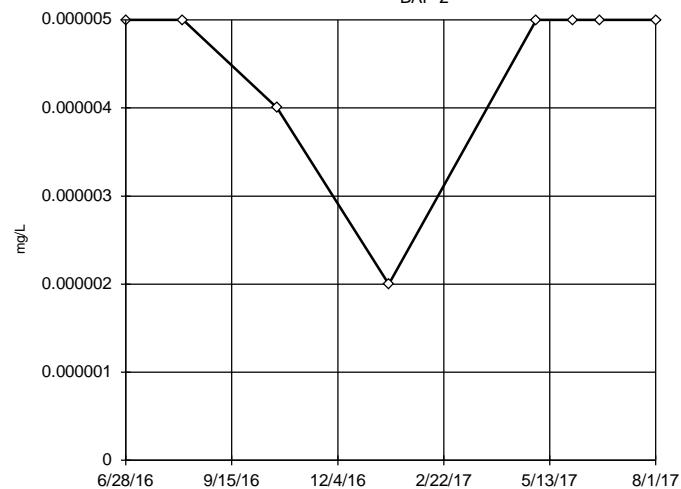
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.00001972,
low cutoff = 0.00000147, based on IQR multiplier of 3.

Constituent: Mercury, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-2



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

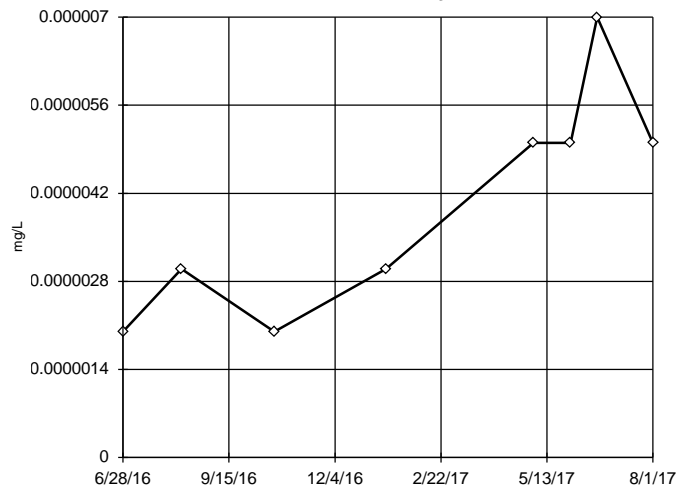
Data were cube transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because both the lower and upper quartiles represent reporting limits.

Constituent: Mercury, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

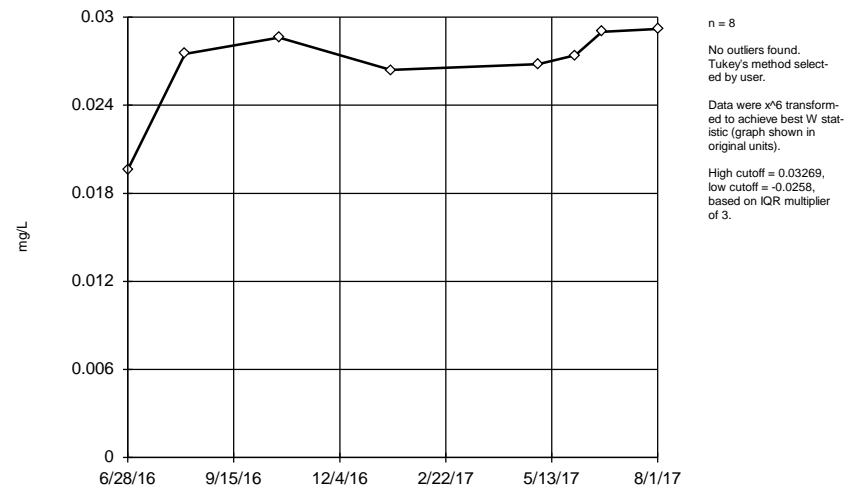
BAP-3



Constituent: Mercury, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

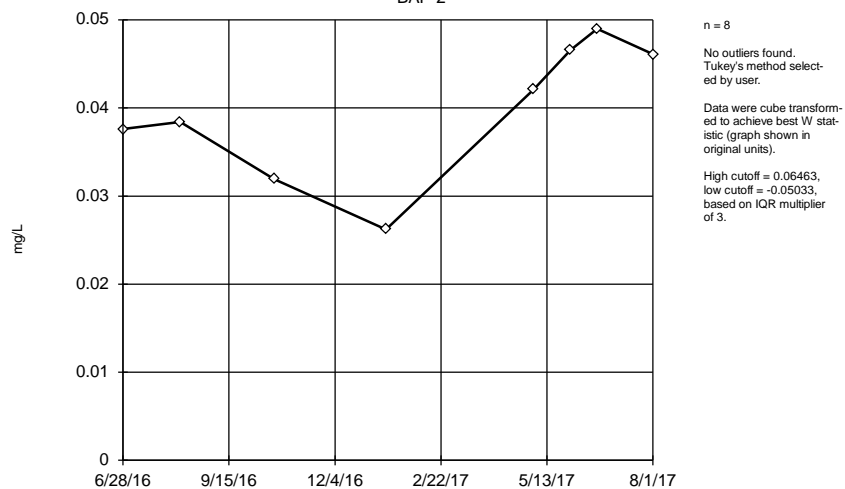
BAP-1



Constituent: Molybdenum, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

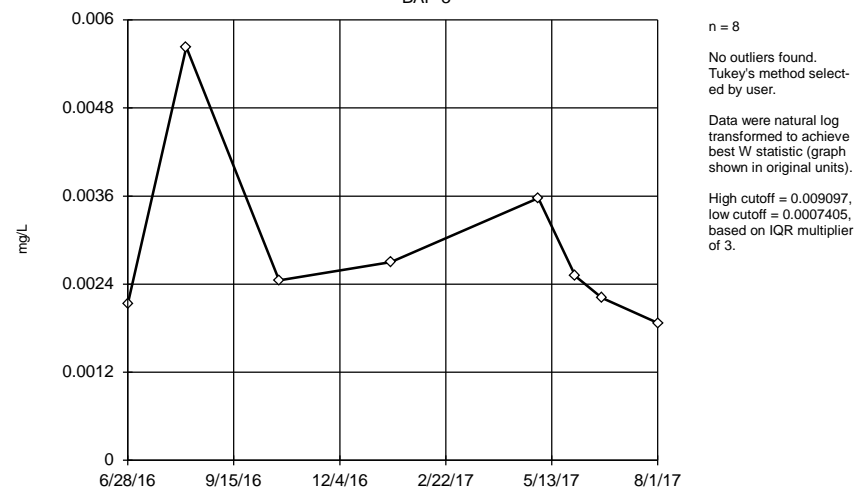
BAP-2



Constituent: Molybdenum, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

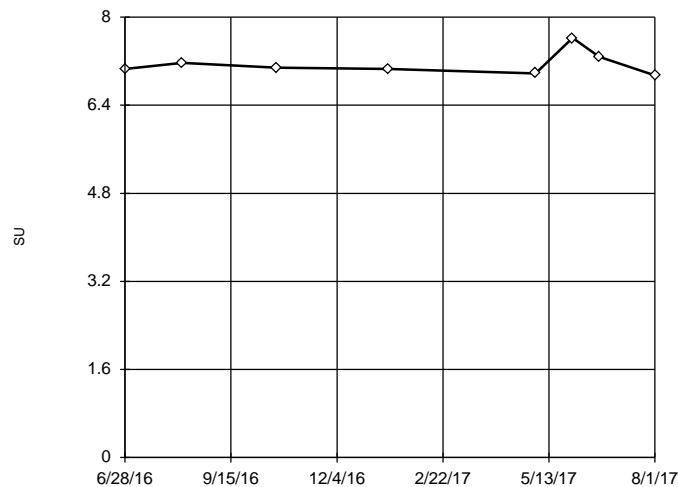
BAP-3



Constituent: Molybdenum, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-1



n = 8

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

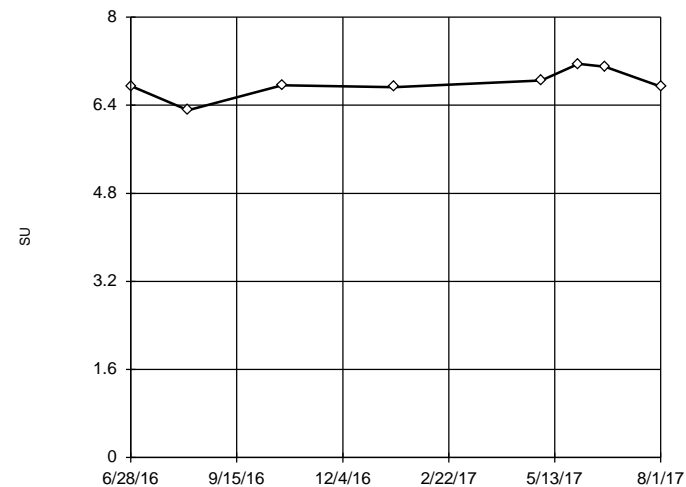
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 7.876, low cutoff = 6.439, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-2



n = 8

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

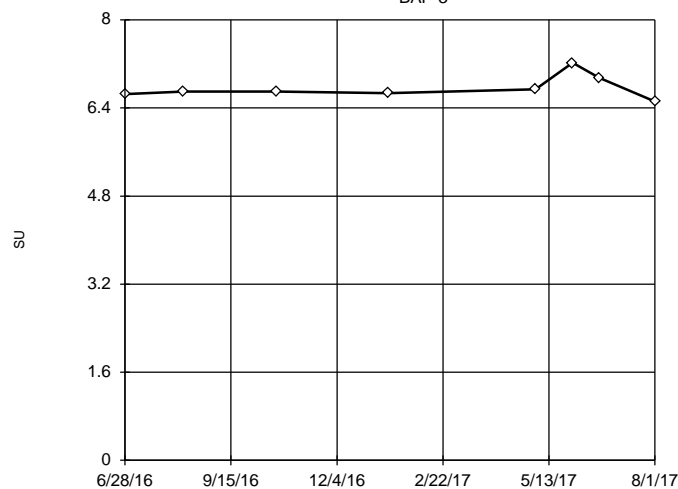
Data were x*5 transformed to achieve best W statistic (graph shown in original units).

High cutoff = 7.559, low cutoff = 5.647, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-3



n = 8

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

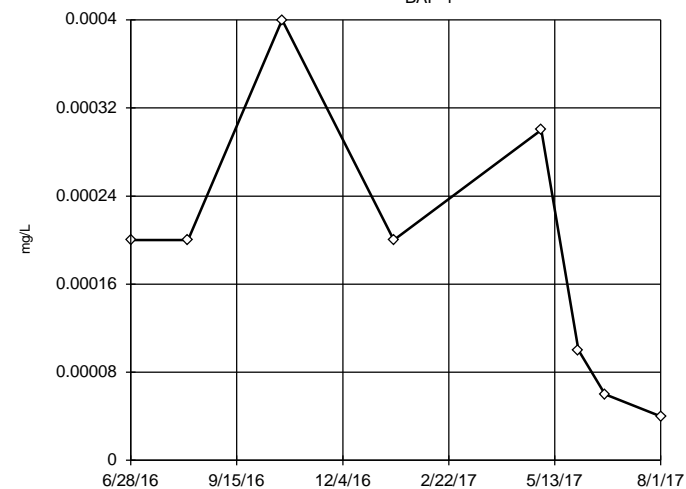
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 7.428, low cutoff = 6.137, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-1



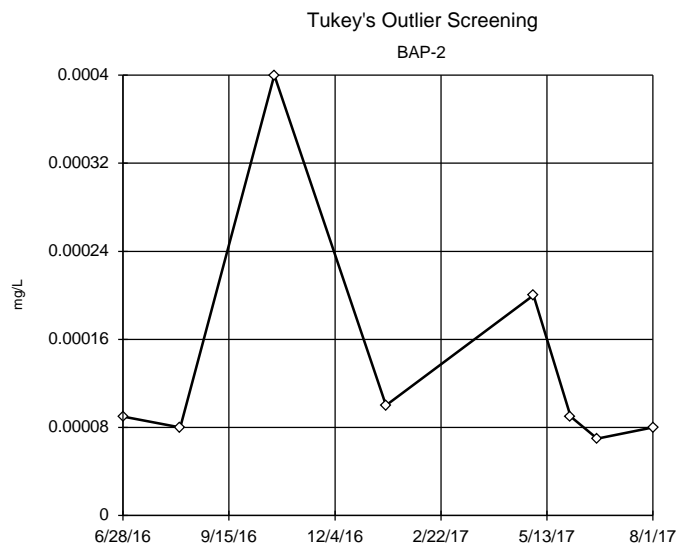
n = 8

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

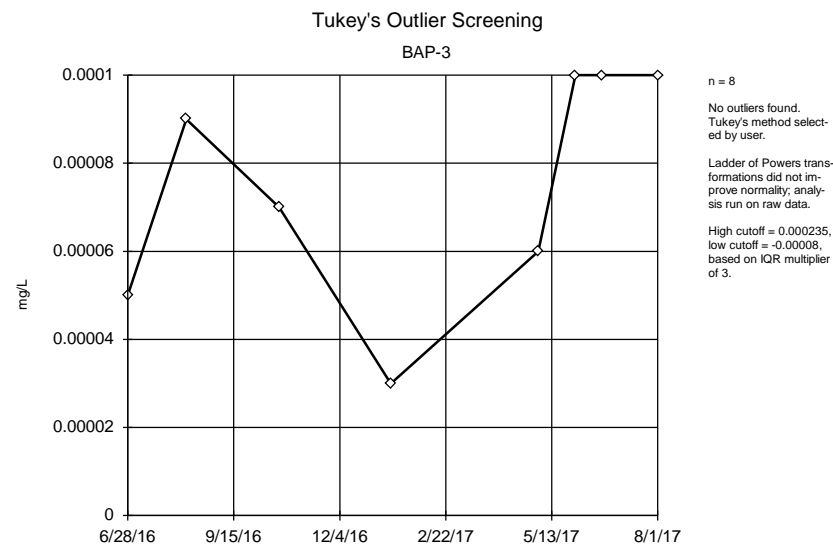
Data were square root transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.001318, low cutoff = -0.0001369, based on IQR multiplier of 3.

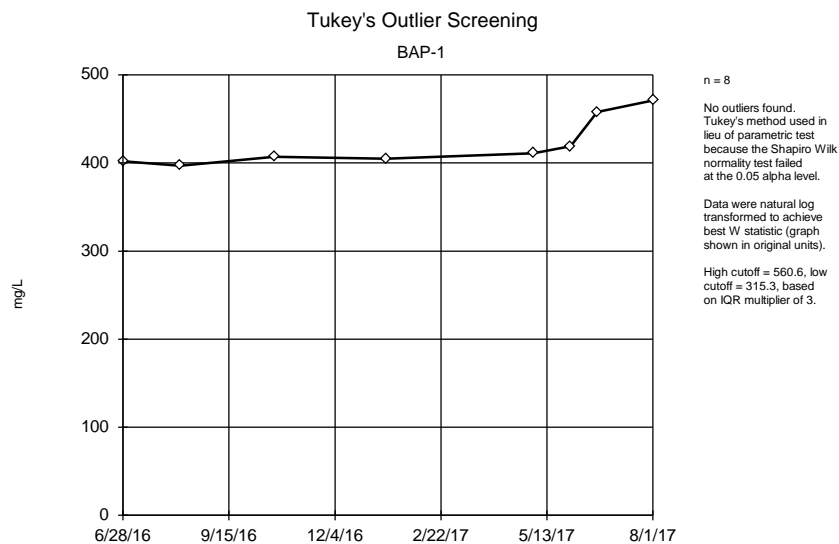
Constituent: Selenium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



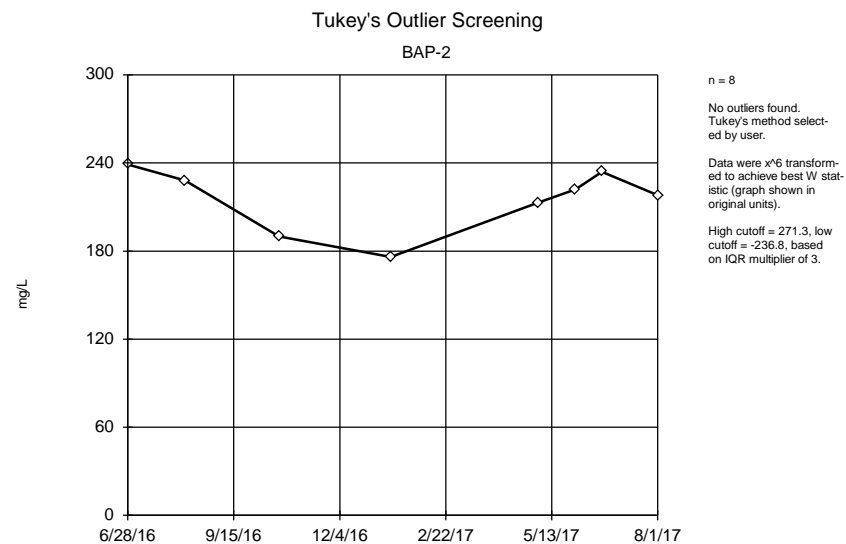
Constituent: Selenium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



Constituent: Selenium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



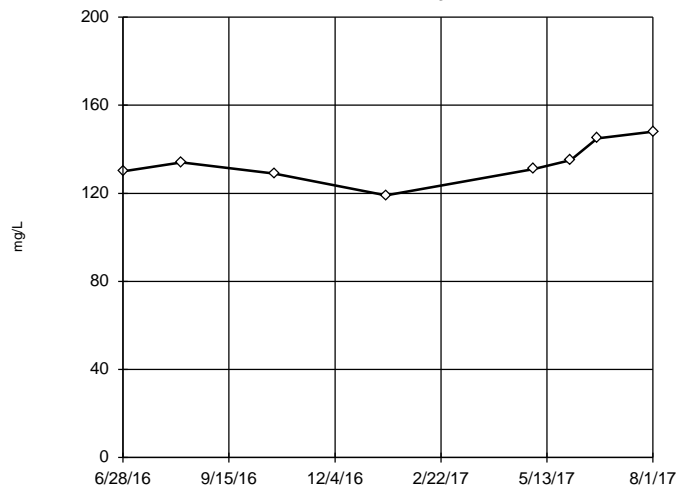
Constituent: Sulfate, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



Constituent: Sulfate, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-3



n = 8

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

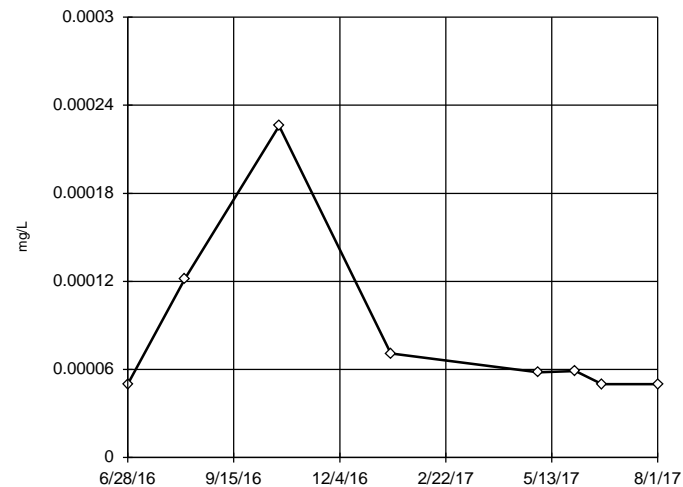
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 176.4, low cutoff = 102.7, based on IQR multiplier of 3.

Constituent: Sulfate, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-1



n = 8

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

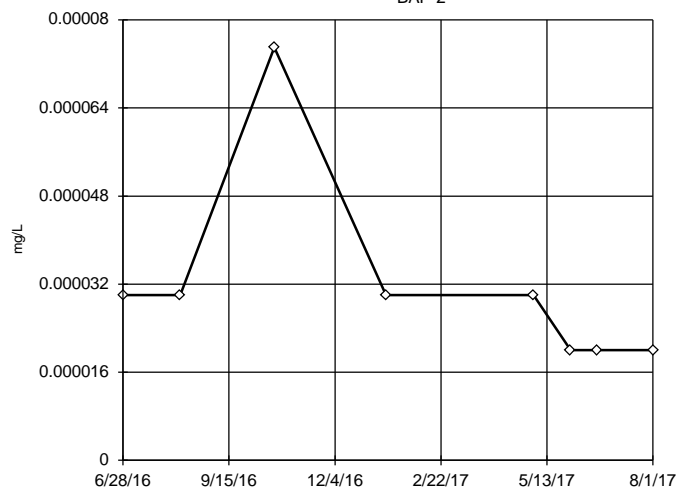
Data were natural log transformed to achieve best W statistic (graph shown in original units).

High cutoff = 0.0006002, low cutoff = 0.00007753, based on IQR multiplier of 3.

Constituent: Thallium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-2



n = 8

No outliers found.
Tukey's method used in lieu of parametric test because the Shapiro Wilk normality test failed at the 0.05 alpha level.

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

High cutoff = 0.0001013, low cutoff = 0.000005926, based on IQR multiplier of 3.

Constituent: Thallium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Tukey's Outlier Screening

BAP-3



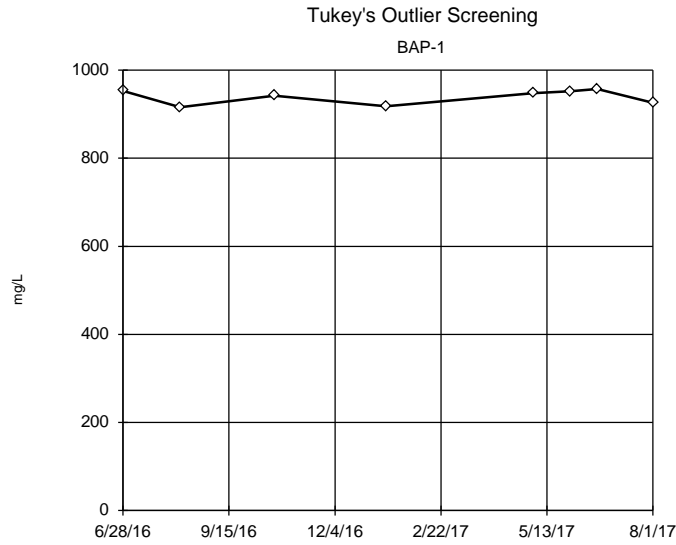
n = 8

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

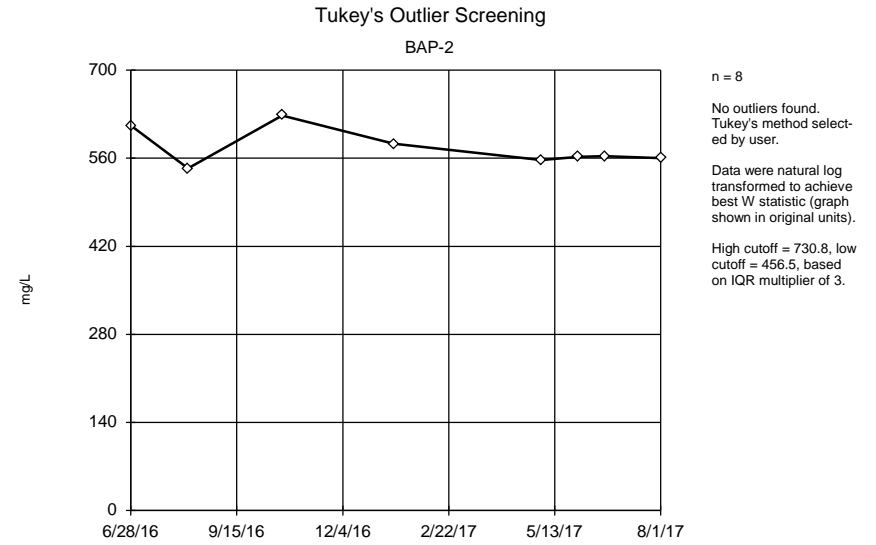
Ladder of Powers transformations did not improve normality; analysis run on raw data.

High cutoff = 0.000068, low cutoff = 0.0000365, based on IQR multiplier of 3.

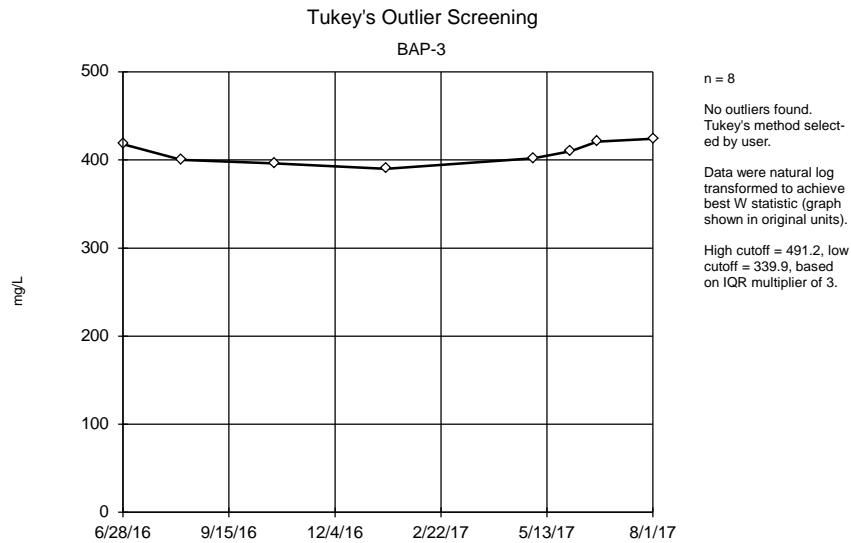
Constituent: Thallium, total Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



Constituent: Total Dissolved Solids [TDS] Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



Constituent: Total Dissolved Solids [TDS] Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP



Constituent: Total Dissolved Solids [TDS] Analysis Run 11/4/2017 10:09 AM View: Tukey's Outlier Test
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Trend Tests Summary Table - Significant Results

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 10/25/2017, 1:11 PM

<u>Constituent</u>	<u>Well</u>	<u>Slope</u>	<u>Calc.</u>	<u>Critical</u>	<u>Sig.</u>	<u>N</u>	<u>%NDs</u>	<u>Normality</u>	<u>Xform</u>	<u>Alpha</u>	<u>Method</u>
Barium, total (mg/L)	BAP-1	-0.04405	-23	-21	Yes	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	BAP-1	0.8891	24	21	Yes	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	BAP-3	4.001	24	21	Yes	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	BAP-3	-0.0004396	-22	-21	Yes	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	BAP-1	54.33	24	21	Yes	8	0	n/a	n/a	0.01	NP

Trend Tests Summary Table - All Results

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 10/25/2017, 1:11 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Antimony, total (mg/L)	BAP-4 (bg)	-0.00003404	-13	-21	No	8	0	n/a	n/a	0.01	NP
Antimony, total (mg/L)	BAP-5 (bg)	-0.000058	-18	-21	No	8	0	n/a	n/a	0.01	NP
Antimony, total (mg/L)	BAP-1	-0.0000468	-19	-21	No	8	0	n/a	n/a	0.01	NP
Antimony, total (mg/L)	BAP-2	-0.00002359	-14	-21	No	8	0	n/a	n/a	0.01	NP
Antimony, total (mg/L)	BAP-3	-0.000009686	-13	-21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	BAP-4 (bg)	0.001601	8	21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	BAP-5 (bg)	-0.001182	-6	-21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	BAP-1	-0.0009506	-16	-21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	BAP-2	-0.0001022	-1	-21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	BAP-3	-0.0004217	-18	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	BAP-4 (bg)	-0.01265	-14	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	BAP-5 (bg)	-0.01717	-12	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	BAP-1	-0.04405	-23	-21	Yes	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	BAP-2	-0.0002287	-1	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	BAP-3	-0.009737	-16	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	BAP-4 (bg)	-0.00006921	-14	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	BAP-5 (bg)	-0.00004904	-14	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	BAP-1	-0.00005128	-17	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	BAP-2	-0.00001004	-8	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	BAP-3	-0.000003652	-10	-21	No	8	12.5	n/a	n/a	0.01	NP
Boron, total (mg/L)	BAP-4 (bg)	-0.03874	-8	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	BAP-5 (bg)	-0.006008	-3	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	BAP-1	0.8891	24	21	Yes	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	BAP-2	-0.09339	-2	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	BAP-3	0.1815	10	21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	BAP-4 (bg)	-0.00008181	-13	-21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	BAP-5 (bg)	-0.00002985	-14	-21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	BAP-1	-0.00002048	-8	-21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	BAP-2	-0.00002335	-12	-21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	BAP-3	0.00004628	19	21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	BAP-4 (bg)	-35.46	-17	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	BAP-5 (bg)	-20.02	-18	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	BAP-1	-9.956	-8	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	BAP-2	-8.744	-16	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	BAP-3	-1.596	-6	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	BAP-4 (bg)	-1.947	-12	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	BAP-5 (bg)	1.21	10	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	BAP-1	1.408	6	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	BAP-2	-3.321	-18	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	BAP-3	4.001	24	21	Yes	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	BAP-4 (bg)	-0.0007183	-8	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	BAP-5 (bg)	-0.002229	-14	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	BAP-1	-0.001477	-14	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	BAP-2	-0.0002594	-8	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	BAP-3	-0.0004396	-22	-21	Yes	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	BAP-4 (bg)	0.0006256	4	21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	BAP-5 (bg)	-0.0009227	-12	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	BAP-1	-0.0006854	-20	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	BAP-2	-0.0004473	-12	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	BAP-3	-0.0002627	-21	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	BAP-4 (bg)	0.09141	2	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	BAP-5 (bg)	-0.3447	-6	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	BAP-1	0.1123	2	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	BAP-2	0.3814	12	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	BAP-3	-0.4793	-10	-21	No	8	0	n/a	n/a	0.01	NP

Trend Tests Summary Table - All Results

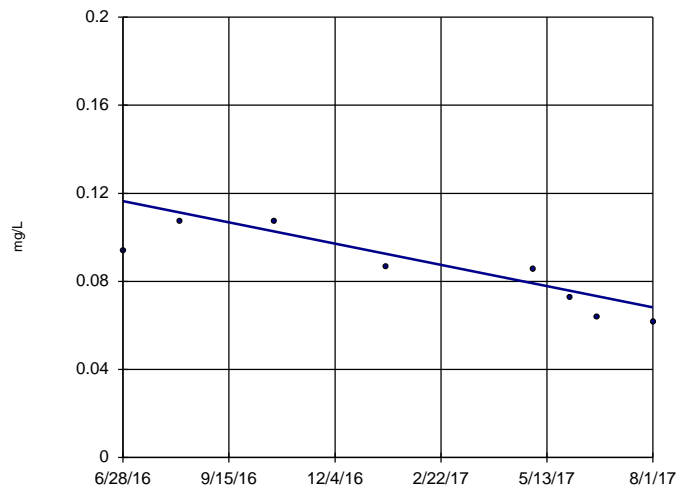
Page 2

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 10/25/2017, 1:11 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Fluoride, total (mg/L)	BAP-4 (bg)	0	0	14	No	6	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	BAP-5 (bg)	-0.01823	-11	-21	No	8	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	BAP-1	-0.03734	-8	-21	No	8	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	BAP-2	-0.005112	-1	-21	No	8	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	BAP-3	0	-9	-21	No	8	0	n/a	n/a	0.01	NP
Lead, total (mg/L)	BAP-4 (bg)	-0.002215	-12	-21	No	8	0	n/a	n/a	0.01	NP
Lead, total (mg/L)	BAP-5 (bg)	-0.001321	-14	-21	No	8	0	n/a	n/a	0.01	NP
Lead, total (mg/L)	BAP-1	-0.001691	-18	-21	No	8	0	n/a	n/a	0.01	NP
Lead, total (mg/L)	BAP-2	-0.0004254	-8	-21	No	8	0	n/a	n/a	0.01	NP
Lead, total (mg/L)	BAP-3	-0.0001656	-18	-21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	BAP-4 (bg)	-0.0008184	-1	-21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	BAP-5 (bg)	0.003414	6	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	BAP-1	0.001594	2	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	BAP-2	0.00324	3	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	BAP-3	-0.003869	-4	-21	No	8	25	n/a	n/a	0.01	NP
Mercury, total (mg/L)	BAP-4 (bg)	0	2	18	No	7	57.14	n/a	n/a	0.01	NP
Mercury, total (mg/L)	BAP-5 (bg)	0	8	21	No	8	75	n/a	n/a	0.01	NP
Mercury, total (mg/L)	BAP-1	-0.000004818	-17	-21	No	8	37.5	n/a	n/a	0.01	NP
Mercury, total (mg/L)	BAP-2	0	3	21	No	8	75	n/a	n/a	0.01	NP
Mercury, total (mg/L)	BAP-3	0.000003588	19	21	No	8	37.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	BAP-4 (bg)	-0.0001604	-1	-18	No	7	0	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	BAP-5 (bg)	-0.0003988	-17	-21	No	8	0	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	BAP-1	0.00537	16	21	No	8	0	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	BAP-2	0.01092	14	21	No	8	0	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	BAP-3	-0.0009338	-8	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	BAP-4 (bg)	0.1736	5	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	BAP-5 (bg)	0	1	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	BAP-1	-0.0907	-3	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	BAP-2	0.3762	10	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	BAP-3	0.09059	7	21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	BAP-4 (bg)	-0.000257	-12	-21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	BAP-5 (bg)	-0.000207	-10	-21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	BAP-1	-0.0001689	-15	-21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	BAP-2	-0.00002335	-8	-21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	BAP-3	0.00004174	13	21	No	8	37.5	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	BAP-4 (bg)	-24.39	-4	-21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	BAP-5 (bg)	-6.397	-4	-21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	BAP-1	54.33	24	21	Yes	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	BAP-2	-6.281	-2	-21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	BAP-3	15.9	16	21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	BAP-4 (bg)	-0.00002048	-7	-21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	BAP-5 (bg)	-0.00004363	-12	-21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	BAP-1	-0.00004548	-11	-21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	BAP-2	-0.00001054	-15	-21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	BAP-3	0	-8	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	BAP-4 (bg)	-47.8	-4	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	BAP-5 (bg)	0	-2	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	BAP-1	10.74	6	21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	BAP-2	-43.84	-6	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	BAP-3	23.7	12	21	No	8	0	n/a	n/a	0.01	NP

Sen's Slope Estimator

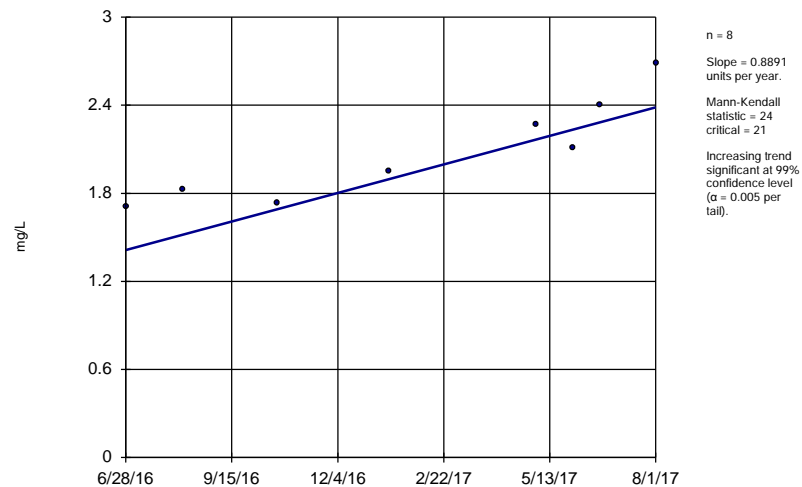
BAP-1



Constituent: Barium, total Analysis Run 10/25/2017 1:07 PM View: Trend Tests
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Sen's Slope Estimator

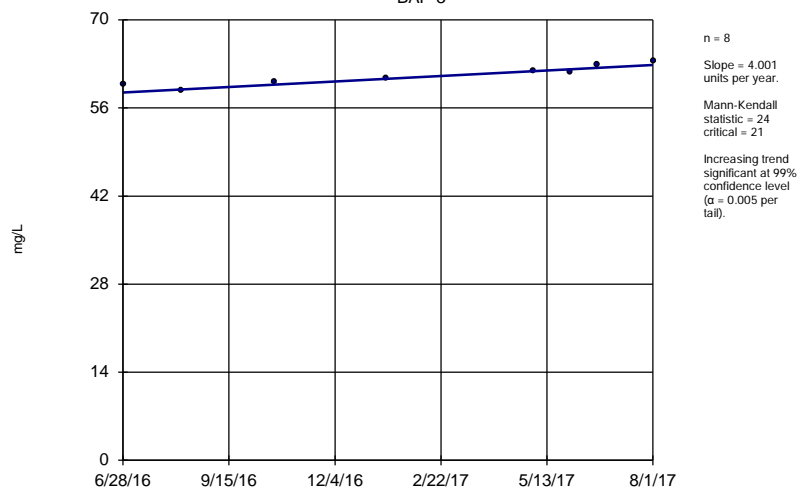
BAP-1



Constituent: Boron, total Analysis Run 10/25/2017 1:07 PM View: Trend Tests
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Sen's Slope Estimator

BAP-3



Constituent: Chloride, total Analysis Run 10/25/2017 1:07 PM View: Trend Tests
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Sen's Slope Estimator

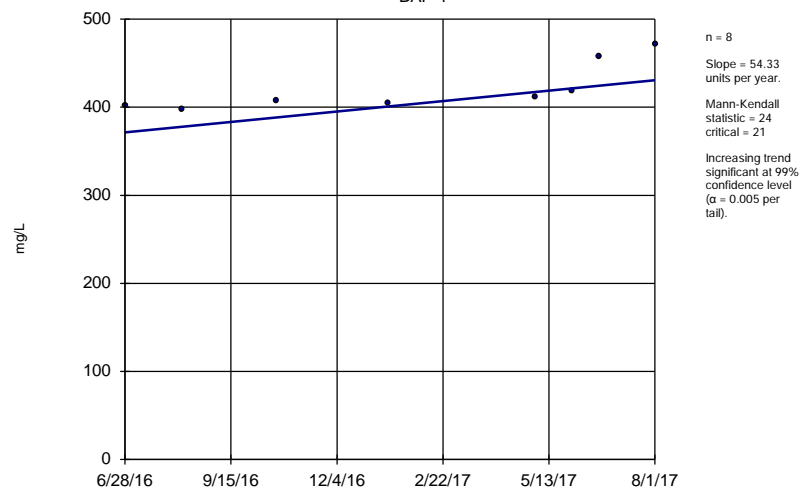
BAP-3



Constituent: Chromium, total Analysis Run 10/25/2017 1:08 PM View: Trend Tests
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Sen's Slope Estimator

BAP-1



Constituent: Sulfate, total Analysis Run 10/25/2017 1:08 PM View: Trend Tests
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Trend Tests Summary Table - All Results

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 10/25/2017, 1:11 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Antimony, total (mg/L)	BAP-4 (bg)	-0.00003404	-13	-21	No	8	0	n/a	n/a	0.01	NP
Antimony, total (mg/L)	BAP-5 (bg)	-0.000058	-18	-21	No	8	0	n/a	n/a	0.01	NP
Antimony, total (mg/L)	BAP-1	-0.0000468	-19	-21	No	8	0	n/a	n/a	0.01	NP
Antimony, total (mg/L)	BAP-2	-0.00002359	-14	-21	No	8	0	n/a	n/a	0.01	NP
Antimony, total (mg/L)	BAP-3	-0.000009686	-13	-21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	BAP-4 (bg)	0.001601	8	21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	BAP-5 (bg)	-0.001182	-6	-21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	BAP-1	-0.0009506	-16	-21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	BAP-2	-0.0001022	-1	-21	No	8	0	n/a	n/a	0.01	NP
Arsenic, total (mg/L)	BAP-3	-0.0004217	-18	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	BAP-4 (bg)	-0.01265	-14	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	BAP-5 (bg)	-0.01717	-12	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	BAP-1	-0.04405	-23	-21	Yes	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	BAP-2	-0.0002287	-1	-21	No	8	0	n/a	n/a	0.01	NP
Barium, total (mg/L)	BAP-3	-0.009737	-16	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	BAP-4 (bg)	-0.00006921	-14	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	BAP-5 (bg)	-0.00004904	-14	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	BAP-1	-0.00005128	-17	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	BAP-2	-0.00001004	-8	-21	No	8	0	n/a	n/a	0.01	NP
Beryllium, total (mg/L)	BAP-3	-0.000003652	-10	-21	No	8	12.5	n/a	n/a	0.01	NP
Boron, total (mg/L)	BAP-4 (bg)	-0.03874	-8	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	BAP-5 (bg)	-0.006008	-3	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	BAP-1	0.8891	24	21	Yes	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	BAP-2	-0.09339	-2	-21	No	8	0	n/a	n/a	0.01	NP
Boron, total (mg/L)	BAP-3	0.1815	10	21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	BAP-4 (bg)	-0.00008181	-13	-21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	BAP-5 (bg)	-0.00002985	-14	-21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	BAP-1	-0.00002048	-8	-21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	BAP-2	-0.00002335	-12	-21	No	8	0	n/a	n/a	0.01	NP
Cadmium, total (mg/L)	BAP-3	0.00004628	19	21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	BAP-4 (bg)	-35.46	-17	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	BAP-5 (bg)	-20.02	-18	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	BAP-1	-9.956	-8	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	BAP-2	-8.744	-16	-21	No	8	0	n/a	n/a	0.01	NP
Calcium, total (mg/L)	BAP-3	-1.596	-6	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	BAP-4 (bg)	-1.947	-12	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	BAP-5 (bg)	1.21	10	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	BAP-1	1.408	6	21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	BAP-2	-3.321	-18	-21	No	8	0	n/a	n/a	0.01	NP
Chloride, total (mg/L)	BAP-3	4.001	24	21	Yes	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	BAP-4 (bg)	-0.0007183	-8	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	BAP-5 (bg)	-0.002229	-14	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	BAP-1	-0.001477	-14	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	BAP-2	-0.0002594	-8	-21	No	8	0	n/a	n/a	0.01	NP
Chromium, total (mg/L)	BAP-3	-0.0004396	-22	-21	Yes	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	BAP-4 (bg)	0.0006256	4	21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	BAP-5 (bg)	-0.0009227	-12	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	BAP-1	-0.0006854	-20	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	BAP-2	-0.0004473	-12	-21	No	8	0	n/a	n/a	0.01	NP
Cobalt, total (mg/L)	BAP-3	-0.0002627	-21	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	BAP-4 (bg)	0.09141	2	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	BAP-5 (bg)	-0.3447	-6	-21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	BAP-1	0.1123	2	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	BAP-2	0.3814	12	21	No	8	0	n/a	n/a	0.01	NP
Combined Radium 226 + 228 (pCi/L)	BAP-3	-0.4793	-10	-21	No	8	0	n/a	n/a	0.01	NP

Trend Tests Summary Table - All Results

Page 2

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 10/25/2017, 1:11 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Fluoride, total (mg/L)	BAP-4 (bg)	0	0	14	No	6	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	BAP-5 (bg)	-0.01823	-11	-21	No	8	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	BAP-1	-0.03734	-8	-21	No	8	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	BAP-2	-0.005112	-1	-21	No	8	0	n/a	n/a	0.01	NP
Fluoride, total (mg/L)	BAP-3	0	-9	-21	No	8	0	n/a	n/a	0.01	NP
Lead, total (mg/L)	BAP-4 (bg)	-0.002215	-12	-21	No	8	0	n/a	n/a	0.01	NP
Lead, total (mg/L)	BAP-5 (bg)	-0.001321	-14	-21	No	8	0	n/a	n/a	0.01	NP
Lead, total (mg/L)	BAP-1	-0.001691	-18	-21	No	8	0	n/a	n/a	0.01	NP
Lead, total (mg/L)	BAP-2	-0.0004254	-8	-21	No	8	0	n/a	n/a	0.01	NP
Lead, total (mg/L)	BAP-3	-0.0001656	-18	-21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	BAP-4 (bg)	-0.0008184	-1	-21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	BAP-5 (bg)	0.003414	6	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	BAP-1	0.001594	2	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	BAP-2	0.00324	3	21	No	8	0	n/a	n/a	0.01	NP
Lithium, total (mg/L)	BAP-3	-0.003869	-4	-21	No	8	25	n/a	n/a	0.01	NP
Mercury, total (mg/L)	BAP-4 (bg)	0	2	18	No	7	57.14	n/a	n/a	0.01	NP
Mercury, total (mg/L)	BAP-5 (bg)	0	8	21	No	8	75	n/a	n/a	0.01	NP
Mercury, total (mg/L)	BAP-1	-0.000004818	-17	-21	No	8	37.5	n/a	n/a	0.01	NP
Mercury, total (mg/L)	BAP-2	0	3	21	No	8	75	n/a	n/a	0.01	NP
Mercury, total (mg/L)	BAP-3	0.000003588	19	21	No	8	37.5	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	BAP-4 (bg)	-0.0001604	-1	-18	No	7	0	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	BAP-5 (bg)	-0.0003988	-17	-21	No	8	0	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	BAP-1	0.00537	16	21	No	8	0	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	BAP-2	0.01092	14	21	No	8	0	n/a	n/a	0.01	NP
Molybdenum, total (mg/L)	BAP-3	-0.0009338	-8	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	BAP-4 (bg)	0.1736	5	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	BAP-5 (bg)	0	1	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	BAP-1	-0.0907	-3	-21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	BAP-2	0.3762	10	21	No	8	0	n/a	n/a	0.01	NP
pH, field (SU)	BAP-3	0.09059	7	21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	BAP-4 (bg)	-0.000257	-12	-21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	BAP-5 (bg)	-0.000207	-10	-21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	BAP-1	-0.0001689	-15	-21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	BAP-2	-0.00002335	-8	-21	No	8	0	n/a	n/a	0.01	NP
Selenium, total (mg/L)	BAP-3	0.00004174	13	21	No	8	37.5	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	BAP-4 (bg)	-24.39	-4	-21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	BAP-5 (bg)	-6.397	-4	-21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	BAP-1	54.33	24	21	Yes	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	BAP-2	-6.281	-2	-21	No	8	0	n/a	n/a	0.01	NP
Sulfate, total (mg/L)	BAP-3	15.9	16	21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	BAP-4 (bg)	-0.00002048	-7	-21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	BAP-5 (bg)	-0.00004363	-12	-21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	BAP-1	-0.00004548	-11	-21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	BAP-2	-0.00001054	-15	-21	No	8	0	n/a	n/a	0.01	NP
Thallium, total (mg/L)	BAP-3	0	-8	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	BAP-4 (bg)	-47.8	-4	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	BAP-5 (bg)	0	-2	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	BAP-1	10.74	6	21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	BAP-2	-43.84	-6	-21	No	8	0	n/a	n/a	0.01	NP
Total Dissolved Solids [TDS] (mg/L)	BAP-3	23.7	12	21	No	8	0	n/a	n/a	0.01	NP

Analysis of Variance

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 1/15/2018, 5:20 PM

<u>Constituent</u>	<u>Crit.</u>	<u>Sig.</u>	<u>Alpha</u>	<u>Transform</u>	<u>ANOVA Sig.</u>	<u>Calc.</u>	<u>Alpha</u>	<u>Method</u>
Boron, total (mg/L)	n/a	n/a	n/a	sqrt(x)	No	0.02871	0.05	Param.
Calcium, total (mg/L)	n/a	n/a	n/a	No	No	0.08151	0.05	Param.
Chloride, total (mg/L)	n/a	n/a	n/a	sqrt(x)	Yes	670.8	0.05	Param.
Fluoride, total (mg/L)	n/a	n/a	n/a	sqrt(x)	Yes	8.779	0.05	Param.
pH, field (SU)	n/a	n/a	n/a	No	No	2.5	0.05	NP (normality)
Sulfate, total (mg/L)	n/a	n/a	n/a	No	Yes	189.4	0.05	Param.
Total Dissolved Solids [TDS] (mg/L)	n/a	n/a	n/a	No	Yes	106.4	0.05	Param.

Parametric ANOVA

Constituent: Boron, total Analysis Run 1/15/2018 5:18 PM View: ANOVA
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

For observations made between 6/28/2016 and 8/1/2017 the parametric analysis of variance test (after square root transformation) indicates NO VARIATION at the 5% significance level. Because the calculated F statistic is less than or equal to the tabulated F statistic, the hypothesis of a single homogeneous population is accepted.

Calculated F statistic = 0.02871

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.0001493	1	0.0001493	0.02871
Error Within Groups	0.07279	14	0.005199	
Total	0.07294	15		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.05, calculated = 0.9271, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 3.048, tabulated = 4.6.

Parametric ANOVA

Constituent: Calcium, total Analysis Run 1/15/2018 5:19 PM View: ANOVA
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

For observations made between 6/28/2016 and 8/1/2017 the parametric analysis of variance test indicates NO VARIATION at the 5% significance level. Because the calculated F statistic is less than or equal to the tabulated F statistic, the hypothesis of a single homogeneous population is accepted.

Calculated F statistic = 0.08151

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	22.56	1	22.56	0.08151
Error Within Groups	3875	14	276.8	
Total	3898	15		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9725, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 0.2775, tabulated = 4.6.

Parametric ANOVA

Constituent: Chloride, total Analysis Run 1/15/2018 5:19 PM View: ANOVA
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

For observations made between 6/28/2016 and 8/1/2017 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 670.8

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	9.422	1	9.422	670.8
Error Within Groups	0.1966	14	0.01405	
Total	9.618	15		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.05, calculated = 0.9073, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 0.01228, tabulated = 4.6.

Parametric ANOVA

Constituent: Fluoride, total Analysis Run 1/15/2018 5:19 PM View: ANOVA
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

For observations made between 6/28/2016 and 8/1/2017 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 8.779

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	0.008043	1	0.008043	8.779
Error Within Groups	0.01283	14	0.0009162	
Total	0.02087	15		

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.05, calculated = 0.8893, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 2.075, tabulated = 4.6.

Non-Parametric ANOVA

Constituent: pH, field Analysis Run 1/15/2018 5:19 PM View: ANOVA
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

For observations made between 6/28/2016 and 8/1/2017, the non-parametric analysis of variance test indicates NO DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is less than or equal to the Chi-squared value, we conclude that no group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 2.5

Tabulated Chi-Squared value = 3.841 with 1 degree of freedom at the 5% significance level.

There were 2 groups of ties in the data, consequently the Kruskal-Wallis statistic (H) was adjusted. The adjusted statistic (H') was utilized to determine if the medians were equal.

Kruskal-Wallis statistic (H) = 2.482

Adjusted Kruskal-Wallis statistic (H') = 2.5

Parametric ANOVA

Constituent: Sulfate, total Analysis Run 1/15/2018 5:20 PM View: ANOVA
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

For observations made between 6/28/2016 and 8/1/2017 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 189.4

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	128343	1	128343	189.4
Error Within Groups	9487	14	677.7	
Total	137830	15		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9394, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 0.02579, tabulated = 4.6.

Parametric ANOVA

Constituent: Total Dissolved Solids [TDS] Analysis Run 1/15/2018 5:20 PM View: ANOVA
Cardinal BAP Client: Geosyntec Data: Cardinal BAP

For observations made between 6/28/2016 and 8/1/2017 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 106.4

Tabulated F statistic = 4.6 with 1 and 14 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between Groups	271702	1	271702	106.4
Error Within Groups	35734	14	2552	
Total	307436	15		

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.05, calculated = 0.9621, critical = 0.887. Levene's Equality of Variance test passed. Calculated = 0.707, tabulated = 4.6.

Tolerance Limits - Appendix III

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 11/4/2017, 10:33 AM

<u>Constituent</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Bg N</u>	<u>Bg Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
Boron, total (mg/L)	0.1776	n/a	16	0.06344	0.03771	0	None	No	0.01	Inter
Calcium, total (mg/L)	254.2	n/a	16	205.4	16.12	0	None	No	0.01	Inter
Chloride, total (mg/L)	30.6	n/a	16	n/a	n/a	0	n/a	n/a	0.4401	NP Inter(normality)
Fluoride, total (mg/L)	0.195	n/a	16	-2.335	0.2311	0	None	ln(x)	0.01	Inter
pH, field (SU)	7.361	5.833	16	6.597	0.2233	0	None	No	0.01	Inter
Sulfate, total (mg/L)	824.1	n/a	16	533.8	95.86	0	None	No	0.01	Inter
Total Dissolved Solids [TDS] (mg/L)	1597	n/a	16	1163	143.2	0	None	No	0.01	Inter

Confidence Interval Summary Table - Significant Results Appendix III

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 11/4/2017, 10:36 AM

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Compliance</u>	<u>Sig. N</u>	<u>Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
Boron, total (mg/L)	BAP-1	2.456	1.717	0.18	Yes 8	2.086	0.3485	0	None	No	0.01	Param.
Boron, total (mg/L)	BAP-2	2.236	1.912	0.18	Yes 8	2.074	0.1527	0	None	No	0.01	Param.
Boron, total (mg/L)	BAP-3	2.065	1.803	0.18	Yes 8	1.934	0.1236	0	None	No	0.01	Param.
Chloride, total (mg/L)	BAP-1	98.27	93.56	30.6	Yes 8	95.91	2.224	0	None	No	0.01	Param.
Chloride, total (mg/L)	BAP-2	76.68	70.44	30.6	Yes 8	73.56	2.945	0	None	No	0.01	Param.
Chloride, total (mg/L)	BAP-3	62.83	59.49	30.6	Yes 8	61.16	1.577	0	None	No	0.01	Param.
Fluoride, total (mg/L)	BAP-1	0.3825	0.3025	0.2	Yes 8	0.3425	0.0377	0	None	No	0.01	Param.
Fluoride, total (mg/L)	BAP-2	0.79	0.33	0.2	Yes 8	0.455	0.1674	0	None	No	0.004	NP (normality)

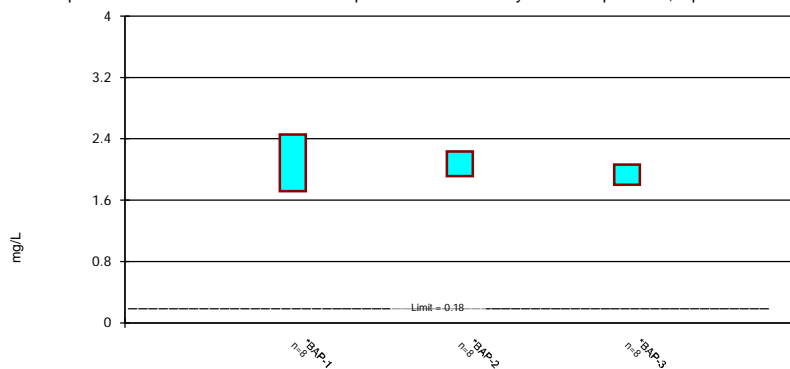
Confidence Interval Summary Table - All Results Appendix III

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 11/4/2017, 10:37 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig. N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	BAP-1	2.456	1.717	0.18	Yes 8	2.086	0.3485	0	None	No	0.01	Param.
Boron, total (mg/L)	BAP-2	2.236	1.912	0.18	Yes 8	2.074	0.1527	0	None	No	0.01	Param.
Boron, total (mg/L)	BAP-3	2.065	1.803	0.18	Yes 8	1.934	0.1236	0	None	No	0.01	Param.
Calcium, total (mg/L)	BAP-1	168.2	152.3	254.2	No 8	160.3	7.479	0	None	No	0.01	Param.
Calcium, total (mg/L)	BAP-2	93.86	83.01	254.2	No 8	88.44	5.118	0	None	No	0.01	Param.
Calcium, total (mg/L)	BAP-3	65.65	60.7	254.2	No 8	63.18	2.338	0	None	No	0.01	Param.
Chloride, total (mg/L)	BAP-1	98.27	93.56	30.6	Yes 8	95.91	2.224	0	None	No	0.01	Param.
Chloride, total (mg/L)	BAP-2	76.68	70.44	30.6	Yes 8	73.56	2.945	0	None	No	0.01	Param.
Chloride, total (mg/L)	BAP-3	62.83	59.49	30.6	Yes 8	61.16	1.577	0	None	No	0.01	Param.
Fluoride, total (mg/L)	BAP-1	0.3825	0.3025	0.2	Yes 8	0.3425	0.0377	0	None	No	0.01	Param.
Fluoride, total (mg/L)	BAP-2	0.79	0.33	0.2	Yes 8	0.455	0.1674	0	None	No	0.004	NP (normality)
Fluoride, total (mg/L)	BAP-3	0.17	0.1	0.2	No 8	0.1238	0.03292	0	None	No	0.004	NP (normality)
pH, field (SU)	BAP-1	7.62	6.94	7.4	No 8	7.149	0.2179	0	None	No	0.004	NP (normality)
pH, field (SU)	BAP-2	7.119	6.479	7.4	No 8	6.799	0.2585	0	None	No	0.005	Param.
pH, field (SU)	BAP-3	7.037	6.503	7.4	No 8	6.769	0.2179	0	None	sqrt(x)	0.005	Param.
Sulfate, total (mg/L)	BAP-1	471	397	824.1	No 8	421.3	27.68	0	None	No	0.004	NP (normality)
Sulfate, total (mg/L)	BAP-2	238.1	191.9	824.1	No 8	215	21.76	0	None	No	0.01	Param.
Sulfate, total (mg/L)	BAP-3	143.6	124.1	824.1	No 8	133.9	9.203	0	None	No	0.01	Param.
Total Dissolved Solids [TDS] (mg/L)	BAP-1	956.5	921.5	1597	No 8	939	16.55	0	None	No	0.01	Param.
Total Dissolved Solids [TDS] (mg/L)	BAP-2	607.3	545	1597	No 8	576.1	29.41	0	None	No	0.01	Param.
Total Dissolved Solids [TDS] (mg/L)	BAP-3	420.9	394.4	1597	No 8	407.6	12.51	0	None	No	0.01	Param.

Parametric Confidence Interval

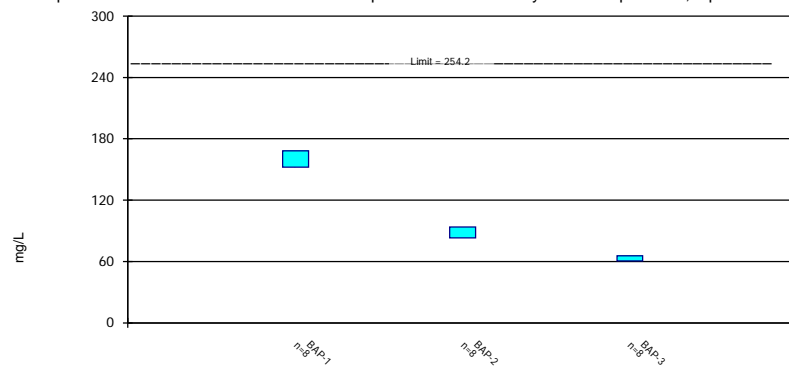
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Boron, total Analysis Run 11/4/2017 10:35 AM View: Confidence Intervals
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Parametric Confidence Interval

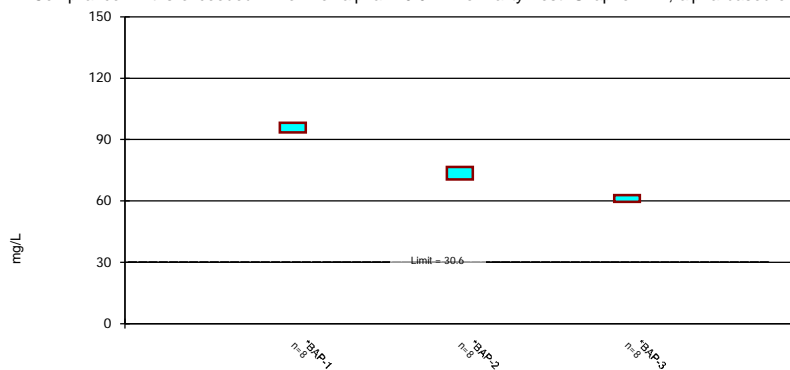
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Calcium, total Analysis Run 11/4/2017 10:35 AM View: Confidence Intervals
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Parametric Confidence Interval

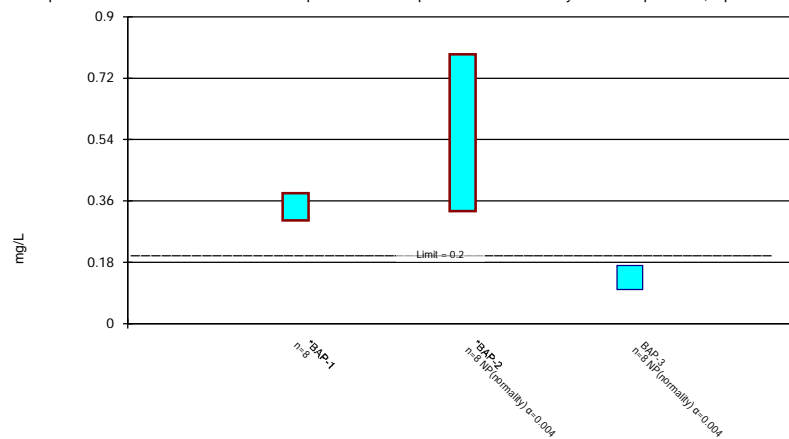
Compliance limit is exceeded.* Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chloride, total Analysis Run 11/4/2017 10:35 AM View: Confidence Intervals
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Parametric and Non-Parametric (NP) Confidence Interval

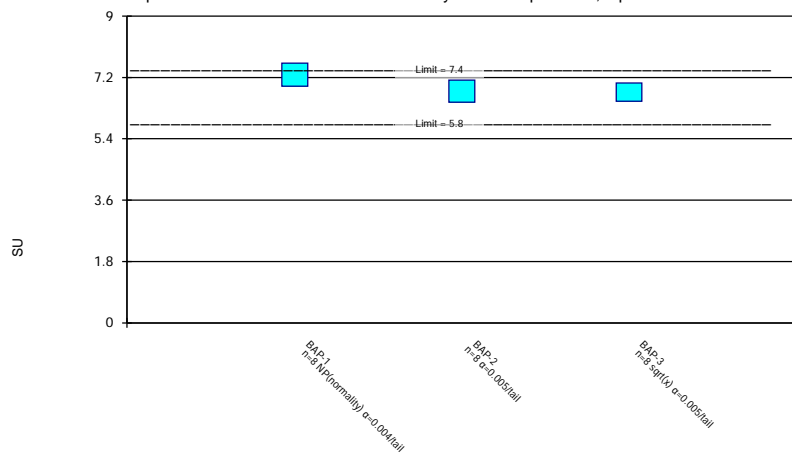
Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Fluoride, total Analysis Run 11/4/2017 10:35 AM View: Confidence Intervals
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Parametric and Non-Parametric (NP) Confidence Interval

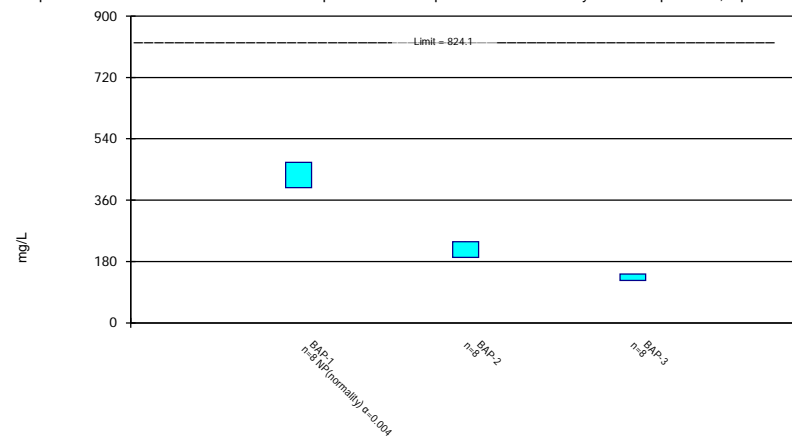
Compliance Limit is not exceeded. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: pH, field Analysis Run 11/4/2017 10:35 AM View: Confidence Intervals
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Parametric and Non-Parametric (NP) Confidence Interval

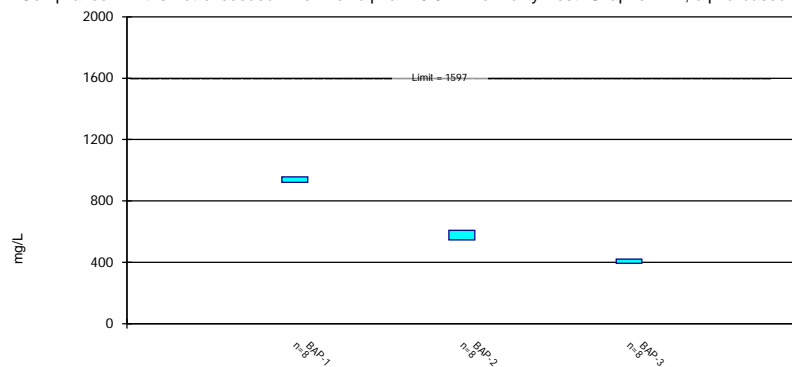
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Sulfate, total Analysis Run 11/4/2017 10:35 AM View: Confidence Intervals
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Parametric Confidence Interval

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



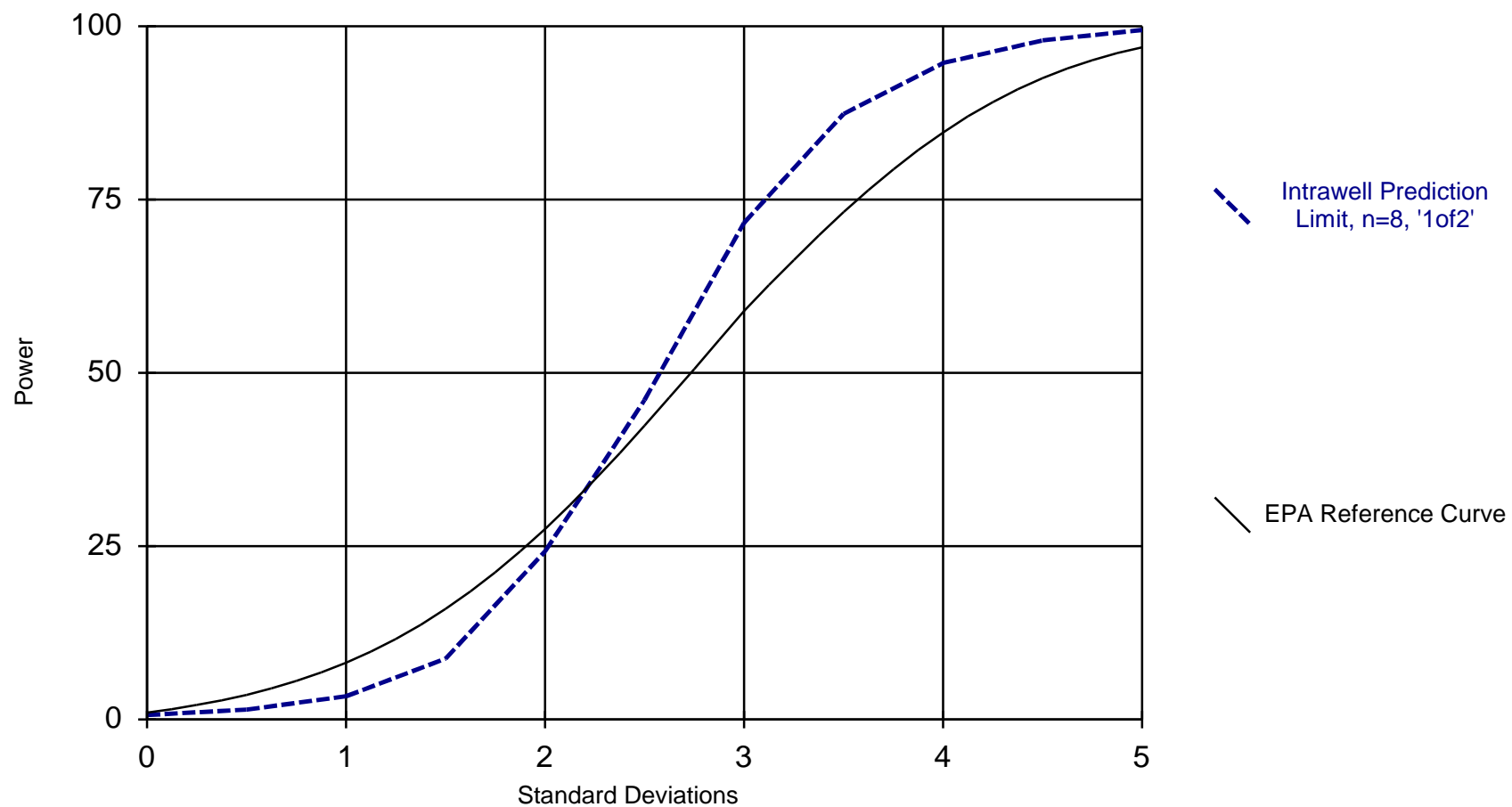
Constituent: Total Dissolved Solids [TDS] Analysis Run 11/4/2017 10:35 AM View: Confidence Intervals
 Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Intrawell Prediction Limit Summary Table

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 11/4/2017, 10:44 AM

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Bg N</u>	<u>Bg Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
Sulfate, total (mg/L)	BAP-4	690.5	n/a	8	623.4	27.31	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	BAP-5	504.9	n/a	8	444.3	24.69	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	BAP-1	489.3	n/a	8	421.3	27.68	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	BAP-2	268.5	n/a	8	215	21.76	0	None	No	0.002505	Param Intra 1 of 2
Sulfate, total (mg/L)	BAP-3	156.5	n/a	8	133.9	9.203	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	BAP-4	1440	n/a	8	1294	59.51	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	BAP-5	1130	n/a	8	1033	39.55	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	BAP-1	979.7	n/a	8	939	16.55	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	BAP-2	648.4	n/a	8	576.1	29.41	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	BAP-3	438.4	n/a	8	407.6	12.51	0	None	No	0.002505	Param Intra 1 of 2

Power Curve



Kappa = 2.458, based on 3 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

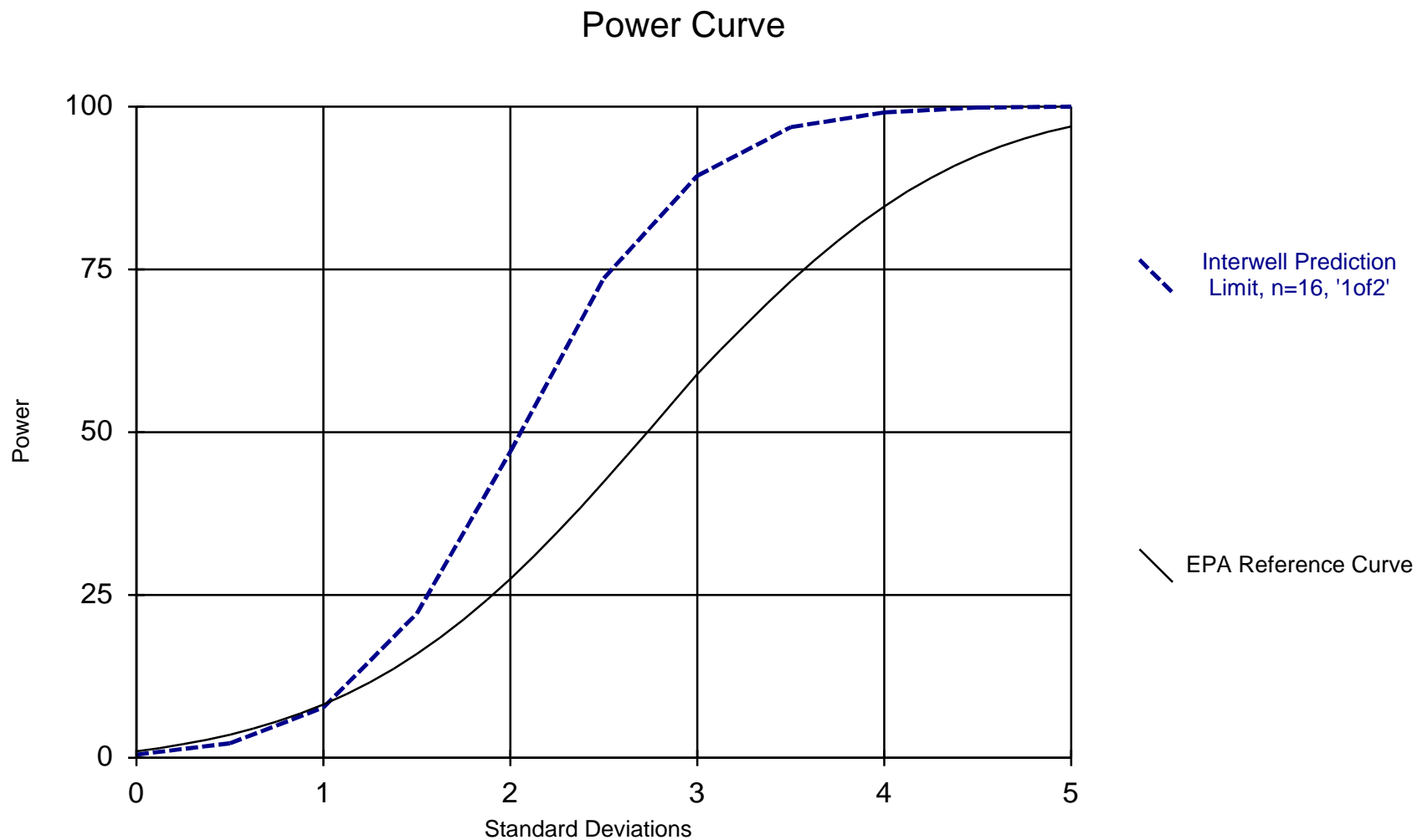
Analysis Run 10/25/2017 1:24 PM View: Confidence Intervals

Cardinal BAP Client: Geosyntec Data: Cardinal BAP

Interwell Prediction Limit Summary Table

Cardinal BAP Client: Geosyntec Data: Cardinal BAP Printed 11/4/2017, 11:05 AM

<u>Constituent</u>	<u>Well</u>	<u>Upper Lim.</u>	<u>Lower Lim.</u>	<u>Bg N</u>	<u>Bg Mean</u>	<u>Std. Dev.</u>	<u>%NDs</u>	<u>ND Adj.</u>	<u>Transform</u>	<u>Alpha</u>	<u>Method</u>
Boron, total (mg/L)	n/a	0.1374	n/a	16	0.06344	0.03771	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	n/a	237	n/a	16	205.4	16.12	0	None	No	0.002505	Param 1 of 2
Chloride, total (mg/L)	n/a	30.6	n/a	16	n/a	n/a	0	n/a	n/a	0.006129	NP (normality) 1 of 2
Fluoride, total (mg/L)	n/a	0.1523	n/a	16	-2.335	0.2311	0	None	ln(x)	0.002505	Param 1 of 2
pH, field (SU)	n/a	7.035	6.159	16	6.597	0.2233	0	None	No	0.001253	Param 1 of 2



Kappa = 1.96, based on 3 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

Analysis Run 10/25/2017 1:25 PM View: Confidence Intervals

Cardinal BAP Client: Geosyntec Data: Cardinal BAP