Annual Groundwater Monitoring Report

Southwestern Electric Power Company

H. W. Pirkey Power Plant

FGD Stackout Area CCR Management Unit

Hallsville, Texas

January 2020

Prepared by:
American Electric Power Service Corporation
1 Riverside Plaza
Columbus, Ohio 43215

SOUTHWESTERN ELECTRIC POWER COMPANY℠

An AEP Company

BOUNDLESS ENERGY℠

Page

Table of Contents

I. Summary

This *Annual Groundwater Monitoring Report* (Report) has been prepared to report the status of activities for the preceding year for an existing CCR unit at Southwestern Electric Power Company's, a wholly-owned subsidiary of American Electric Power Company (AEP), Pirkey Power Plant. The USEPA's CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2020.

In general, the following activities were completed:

- Groundwater samples were collected for AD-7, AD-12, AD-13, AD-22, and AD-33 in February, May, and August 2019 analyzed for Appendix III and Appendix IV constituents, as specified in 40 CFR 257.94 or 95 *et seq.* and AEP's *Groundwater Sampling and Analysis Plan (2016)*;
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Assessment Monitoring sampling was initiated on April 3, 2018;
- The unit was in Assessment monitoring at the beginning and the end of 2019;
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for mercury at wells AD-22 on December 26, 2018. An alternate source for cobalt was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on February 14, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-22 on July 11, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on October 3, 2019.
- Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-7 and AD-22 and cobalt at AD-22 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 40 CFR 257.93. The statistical process was guided by USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance* ("Unified Guidance", USEPA, 2009).

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

- A map, aerial photograph or a drawing showing the CCR management unit(s), all groundwater monitoring wells and monitoring well identification numbers;

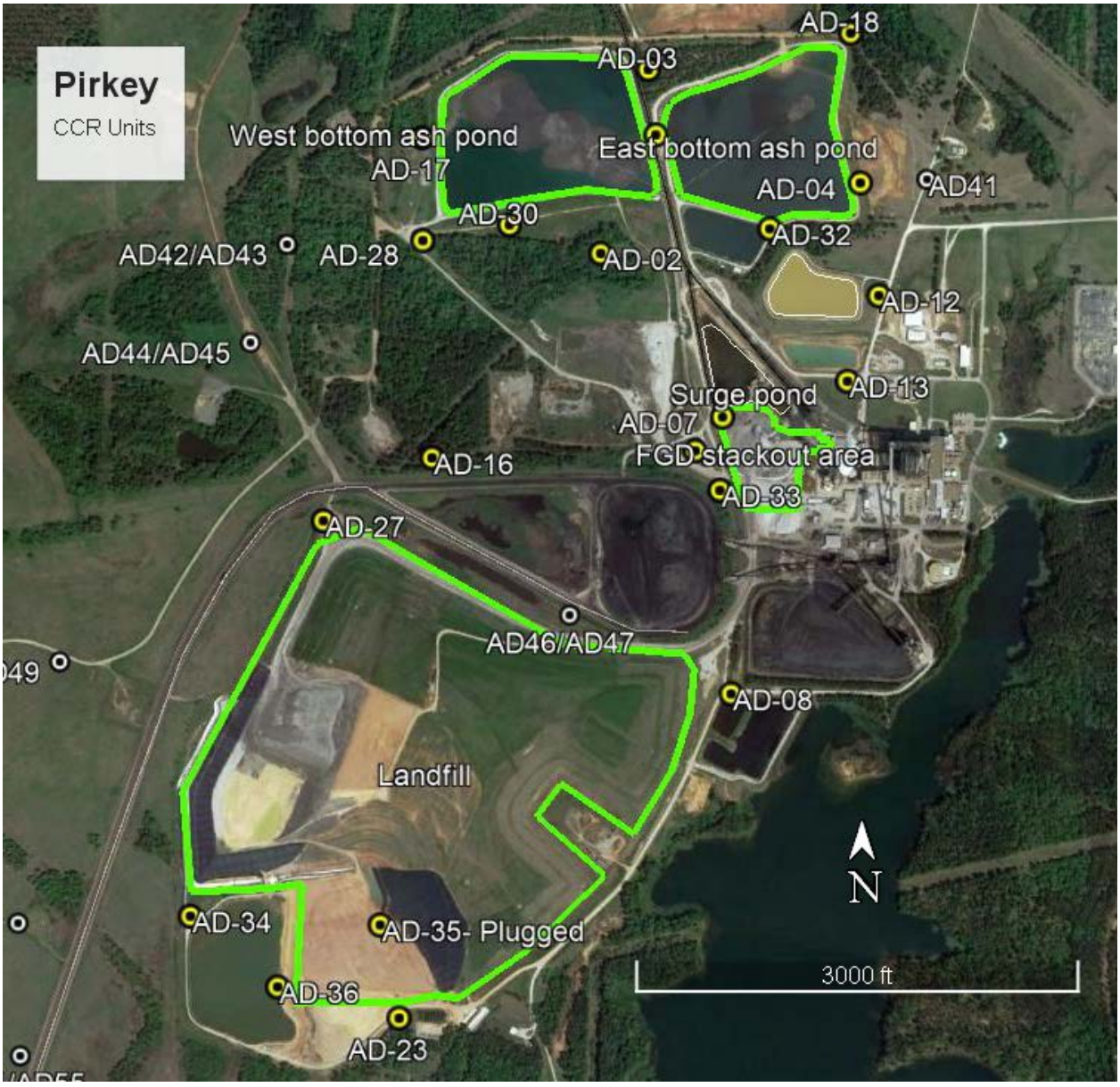
- Identification of any monitoring wells that were installed or decommissioned during the preceding year, along with a statement as to why that happened;
- All of the monitoring data collected, including the rate and direction of groundwater flow, plus a summary showing the number of samples collected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

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

II. Groundwater Monitoring Well Locations and Identification Numbers

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

FGD Stackout Area Monitoring Wells	
Up Gradient	Down Gradient
AD-12	AD-7
AD-13	AD-22
	AD-33



III. Monitoring Wells Installed or Decommissioned

Several monitoring wells were installed to better understand spatial variability of constituents across the site, groundwater flow, and groundwater chemistry in mine spoils. Please see the list below. Well installation reports can be found in Appendix V.

Soil Boring ID	Monitor Well ID
	AD-37
	AD-38
	AD-39
	AD-40
SB-01A	AD-41
SB-04	AD-42
SB-04	AD-43
SB-05	AD-44
SB-05	AD-45
SB-06	AD-46
SB-06	AD-47
SB-07	AD-48
SB-07	AD-49
SB-08	AD-50
SB-08	AD-52
SB-08	AD-53
SB-09	AD-54
SB-09	AD-55
SB-11	AD-56
SB-11	AD-57

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

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

As required by the assessment monitoring rules, 40 CFR 257.95 et seq., a one round of sampling in February in accordance with 40 CFR 257.95(d)(1). A May sampling event was conducted in accordance with 40 CFR 257.95(b) including all Appendix III parameters and those Appendix IV constituents parameters followed by an August round of sampling in accordance with 40 CFR 257.95(d)(1). Assessment monitoring will continue in 2020.

V. Statistical Evaluation of 2019 Events

The two statistical analysis reports are included in Appendix II.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-22 on July 11, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on October 3, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-7 and AD-22 and cobalt at AD-22 on January 3, 2020. An investigation will be conducted to see if an alternate source can be identified in a report.

VI. Alternate Source Demonstration

An alternate source investigation was conducted for the SSLs above GWPSs. SSLs above the GWPS at AD-22 were determined for mercury on December 26, 2018. An alternate source for mercury was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on February 14, 2019.

SSLs above the GWPS were determined for beryllium at wells AD-22 on July 10, 2019. An alternate source was identified in a report (*Alternative Source Demonstration Report Federal CCR Rule*) on October 3, 2019.

Statistically significant level (SSLs) above the groundwater protection standard (GWPS) were determined for beryllium at wells AD-7 and AD-22 and cobalt at well AD-22 on January 3, 2020. An alternate source investigation will be conducted for these SSLs.

The supporting information are found in Appendix III.

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

The unit transitioned from detection monitoring to assessment monitoring transition on April 3, 2018.

Assessment monitoring will continue in 2020.

Regarding defining an alternate monitoring frequency, no modification of the twice-per-year detection monitoring effort is needed.

VIII. Other Information Required

No other information applies at this time.

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

No significant problems were encountered.

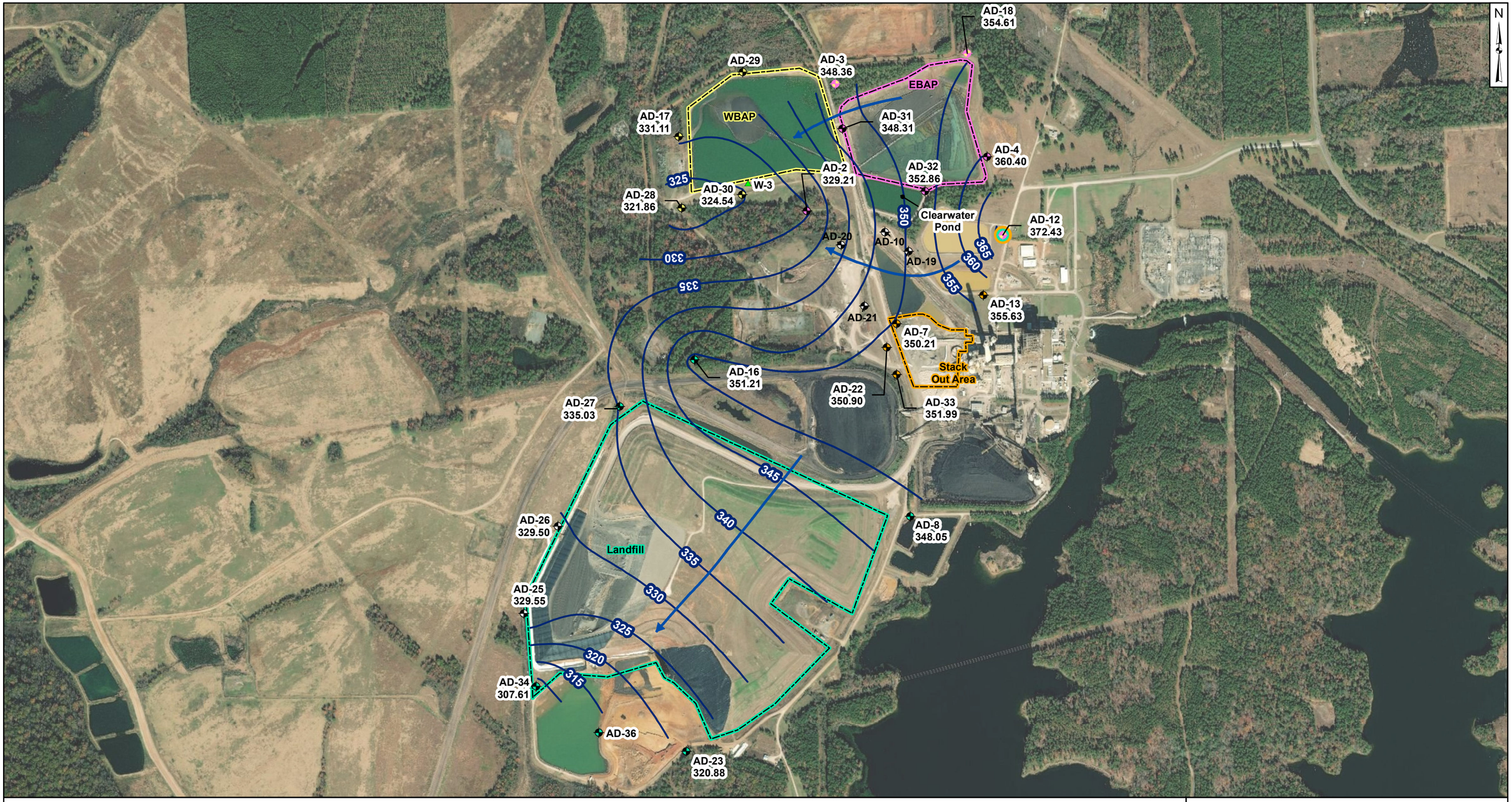
X. A Projection of Key Activities for the Upcoming Year

Key activities for 2020 include:

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

APPENDIX I

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



Legend

Groundwater Monitoring Wells

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

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

Notes

- Monitoring well coordinates and water level data (collected on February 23-28, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in February 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer
February 2019

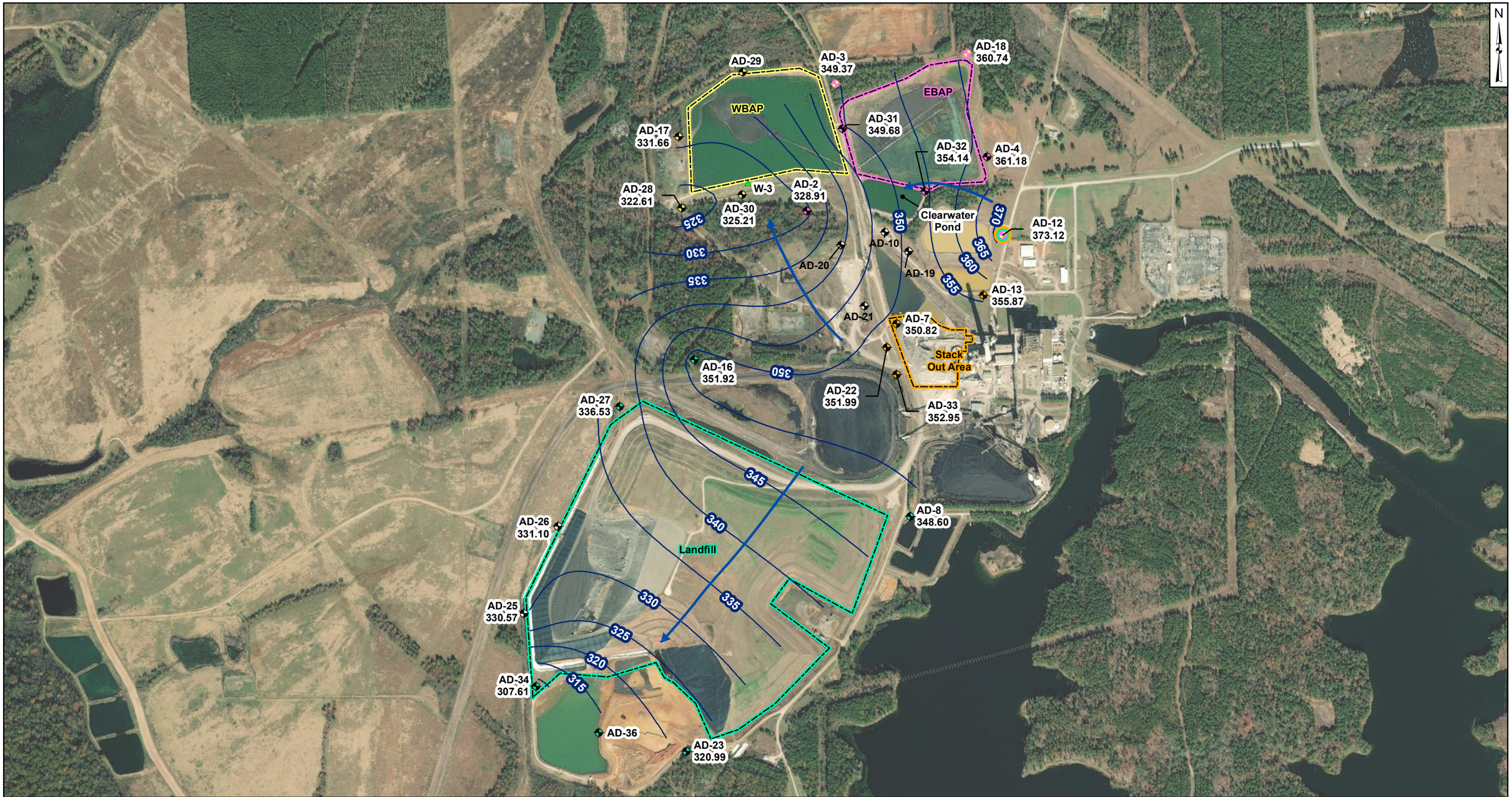
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure **1**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201902-February.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

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

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

Notes

- Monitoring well coordinates and water level data (collected on May 21-23, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in May 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer May 2019

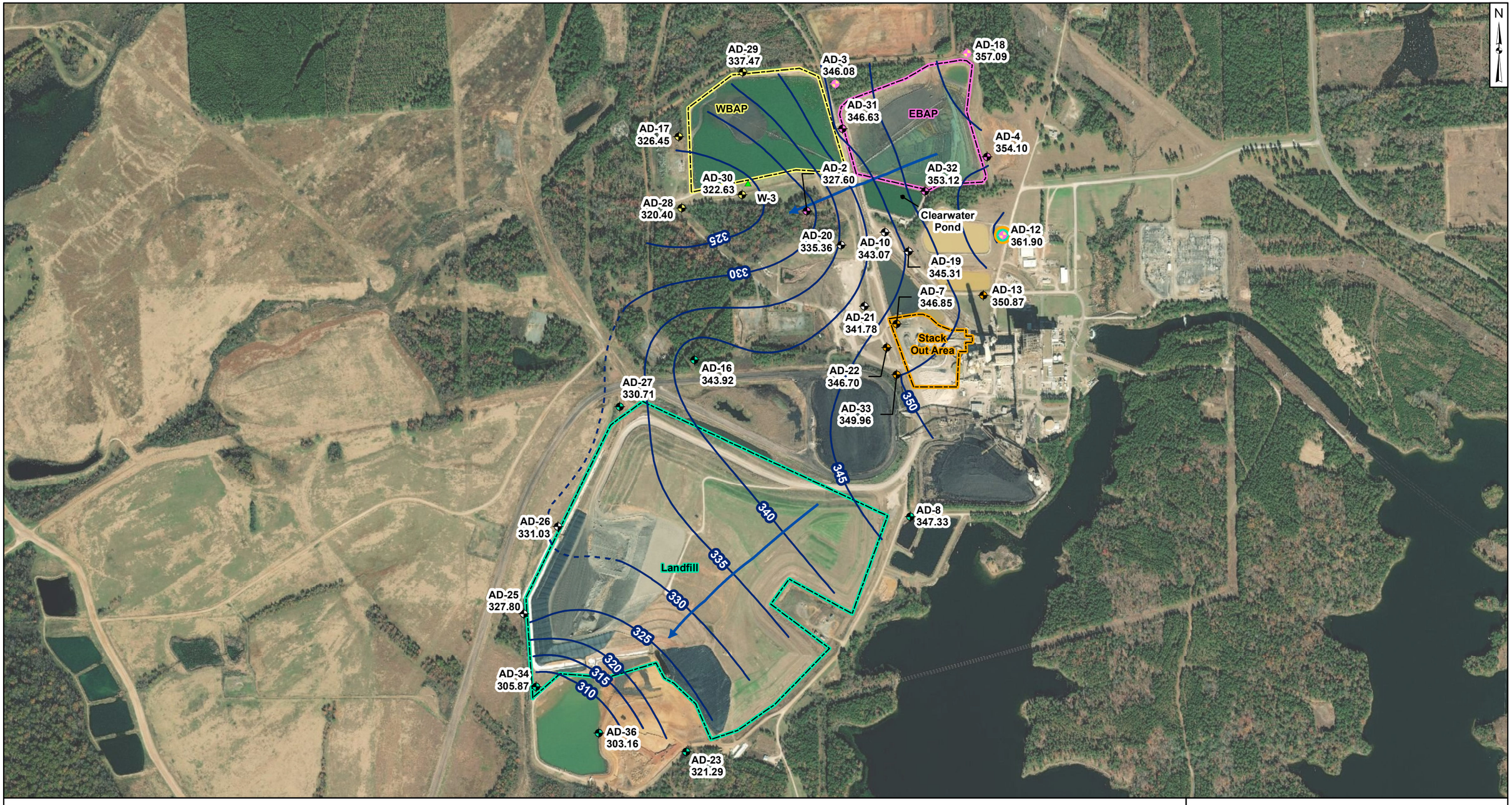
AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure **2**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_20190S-May.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.



Legend

Groundwater Monitoring Wells

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

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

Notes

- Monitoring well coordinates and water level data (collected on August 12-16, 2019) provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.
- Groundwater elevation units are feet above mean sea level.
- East and West Bottom Ash Ponds have compacted cohesive soil from elevation 344 to 347 ft. msl (Sargent and Lundy, 1984; AMEC, 2011).
- Clearwater pond base elevation is 344 ft. msl (Sargent and Lundy, 1983).
- W-3 was not gauged in August 2019.
- AD-35 was abandoned November 13, 2018. AD-36 was installed April 24, 2019.

1,000 500 0 1,000 Feet

Potentiometric Contours - Uppermost Aquifer August 2019

AEP Pirkey Power Plant
Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2020/01/16

Figure **3**

P:\Projects\AEP\Groundwater Statistical Evaluation - CHA8423\Groundwater Mapping\GIS Files\MXD\Pirkey\2019\AEP-Pirkey_GW_201908-August.mxd. ARevezzo. 1/16/2020. Project/Phase/Task.

Table 1: Residence Time Calculation Summary
Pirkey Plant Stackout Area

Geosyntec Consultants, Inc.

CCR Management Unit	Monitoring Well	Well Diameter (inches)	2019-02		2019-05		2019-08	
			Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)	Groundwater Velocity (ft/year)	Groundwater Residence Time (days)
Stack Out Area	AD-7 [2]	4.0	11.2	10.8	7.1	17.1	13.8	8.8
	AD-12 [1]	4.0	34.2	3.6	35.0	3.5	21.4	5.7
	AD-13 [1]	4.0	28.6	4.2	14.8	8.2	19.4	6.3
	AD-22 [2]	2.0	6.9	8.8	9.6	6.3	9.1	6.7
	AD-33 [2]	2.0	5.3	11.5	6.9	8.9	12.2	5.0

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

Table 1 - Groundwater Data Summary: AD-7
Pirkey - Stackout
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	2.39	6.58	28	0.6493 J	4.0	302	92
7/13/2016	Background	0.716	2.97	16	<0.083 U	3.6	204	40
9/7/2016	Background	0.978	3.15	18	<0.083 U	4.1	208	42
10/13/2016	Background	0.67	2.81	17	<0.083 U	3.8	212	38
11/14/2016	Background	0.682	2.63	16	<0.083 U	4.0	216	38
1/11/2017	Background	1.39	3.92	19	<0.083 U	3.5	204	46
2/28/2017	Background	1.51	4.78	20	<0.083 U	3.7	240	46
4/10/2017	Background	3.24	5.06	28	0.4117 J	3.6	322	65
8/24/2017	Detection	0.943	2.99	18	2.994	3.7	176	51
12/21/2017	Detection	0.718	3.26	19	<0.083 U	- -	176	39
3/21/2018	Assessment	2.47	5.37	20	<0.083 U	3.6	266	90
8/20/2018	Assessment	1.36	3.76	33	<0.083 U	4.3	180	54
2/27/2019	Assessment	2.10	5.2	29.9	0.50	2.9	268	69.1
5/22/2019	Assessment	0.195	5.77	28.0	0.58	3.4	334	91.6
8/12/2019	Assessment	3.54	4.20	36.7	0.30	4.0	266	59.6

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

Table 1 - Groundwater Data Summary: AD-7
Pirkey - Stackout
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	1.38216 J	37	8	0.87394 J	0.766043 J	52	4.344	0.6493 J	<0.68 U	0.044	0.309	<0.29 U	1.04661 J	<0.86 U
7/13/2016	Background	<0.93 U	1.18444 J	50	3	0.66774 J	1	24	0.942	<0.083 U	<0.68 U	0.099	0.261	<0.29 U	<0.99 U	1.03212 J
9/7/2016	Background	<0.93 U	<1.05 U	50	4	0.730872 J	0.316008 J	27	3.132	<0.083 U	<0.68 U	0.099	0.059	<0.29 U	<0.99 U	<0.86 U
10/13/2016	Background	<0.93 U	1.08028 J	61	4	0.858417 J	1	23	3.81	<0.083 U	<0.68 U	0.101	0.154	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	60	4	1	<0.23 U	22	3.538	<0.083 U	<0.68 U	0.099	0.039	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	58	5	0.756968 J	<0.23 U	31	3.77	<0.083 U	<0.68 U	0.101	0.02275 J	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	53	5	0.838869 J	<0.23 U	34	3.92	<0.083 U	<0.68 U	0.101	0.185	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	51	7	0.723565 J	0.295188 J	44	4.35	0.4117 J	<0.68 U	0.111	0.191	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	40.31	6.81	0.82 J	<0.23 U	45.34	3.99	<0.083 U	<0.68 U	0.108	0.117	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	0.01 J	0.47	51.6	2.07	0.68	0.075	25.6	0.787	<0.083 U	0.362	0.0877	0.006 J	<0.02 U	1.0	0.179
2/27/2019	Assessment	<0.4 U	2.12	42.9	7.01	0.73	0.225	41.0	4.75	0.50	1 J	0.106	0.201	<0.4 U	7.1	<2 U
5/22/2019	Assessment	<0.4 U	2 J	37.8	6.47	0.6 J	<0.8 U	46.0	4.72	0.58	0.8 J	0.0975	0.26	<8 U	3 J	<0.1 U
8/12/2019	Assessment	<0.02 U	0.64	41.9	3.24	0.75	0.1 J	29.7	3.278	0.30	0.529	0.102	0.09	<0.4 U	1.7	0.2 J

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

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

Geosyntec Consultants, Inc.

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

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

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

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	<1.05 U	26	0.219521 J	<0.07 U	0.710981 J	1.58207 J	0.2073	<0.083 U	<0.68 U	<0.00013 U	<0.005 U	<0.29 U	1.73953 J	<0.86 U
7/13/2016	Background	<0.93 U	<1.05 U	23	0.190337 J	<0.07 U	0.68835 J	1.29444 J	2.909	<0.083 U	<0.68 U	0.008	<0.005 U	<0.29 U	<0.99 U	<0.86 U
9/7/2016	Background	<0.93 U	<1.05 U	30	0.232192 J	<0.07 U	0.353544 J	1.66591 J	0.881	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
10/12/2016	Background	<0.93 U	<1.05 U	27	0.149553 J	<0.07 U	0.529033 J	1.56632 J	0.257	< 1 U	<0.68 U	0.012	<0.005 U	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	<1.05 U	28	0.152375 J	<0.07 U	0.32826 J	1.47282 J	0.767	<0.083 U	<0.68 U	0.013	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	<1.05 U	23	0.126621 J	<0.07 U	0.650158 J	1.09495 J	1.536	<0.083 U	<0.68 U	0.01	<0.005 U	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	<1.05 U	26	0.149219 J	<0.07 U	0.325811 J	1.29984 J	0.416	<0.083 U	<0.68 U	0.009	<0.005 U	<0.29 U	<0.99 U	0.994913 J
4/11/2017	Background	<0.93 U	<1.05 U	24	0.159412 J	<0.07 U	0.416007 J	1.33344 J	0.3895	0.2565 J	<0.68 U	0.008	0.01364 J	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	<1.05 U	25.82	0.16 J	<0.07 U	1.05	1.49 J	0.784	<0.083 U	<0.68 U	0.00722	<0.005 U	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	<0.01 U	0.11	27.8	0.159	0.01 J	0.330	1.72	1.128	<0.083 U	0.089	0.0143	<0.005 U	0.04 J	0.1	0.04 J
2/27/2019	Assessment	<0.4 U	<0.6 U	22.5	<0.4 U	<0.2 U	<0.8 U	1.37	0.225	0.09	<0.4 U	0.00688	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	<0.6 U	21.7	<0.4 U	<0.2 U	<0.8 U	1.15	0.201	0.09	<0.4 U	0.00576	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	0.07 J	23.8	0.154	<0.01 U	0.204	1.3	0.237	0.06 J	0.08 J	0.00829	<0.005 U	<0.4 U	0.2 J	<0.1 U

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

Table 1 - Groundwater Data Summary: AD-13
Pirkey - Stackout
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.06	8.77	28	0.748 J	5.6	236	52
7/13/2016	Background	0.06	9.08	32	0.3474 J	5.6	192	59
9/7/2016	Background	0.05	8.48	23	<0.083 U	5.2	228	41
10/13/2016	Background	0.06	7.53	26	0.6297 J	5.8	236	47
11/14/2016	Background	0.06	7.21	26	0.3114 J	6.1	250	47
1/11/2017	Background	0.04	6.14	22	<0.083 U	5.8	188	37
2/28/2017	Background	0.07	7.88	28	<0.083 U	5.9	172	56
4/11/2017	Background	0.08	9.11	32	0.4278 J	5.2	200	58
8/23/2017	Detection	0.07408	9.5	21	0.344 J	6.0	160	38
3/21/2018	Assessment	0.07169	10.3	25	<0.083 U	5.9	176	48
8/20/2018	Assessment	0.065	8.40	39	0.0845 J	5.9	210	66
2/27/2019	Assessment	0.08 J	11.0	40.8	0.25	5.2	176	80.8
5/21/2019	Assessment	0.061	10.1	34.8	0.40	5.3	190	69.5
8/12/2019	Assessment	0.064	8.68	42.3	0.39	5.9	310	73.6

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

Table 1 - Groundwater Data Summary: AD-13
Pirkey - Stackout
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	4.25914 J	38	0.586539 J	0.293832 J	<0.23 U	42	0.989	0.748 J	<0.68 U	0.081	0.00969 J	<0.29 U	<0.99 U	1.11268 J
7/13/2016	Background	<0.93 U	9	44	2	0.0875208 J	<0.23 U	47	2.332	0.3474 J	<0.68 U	0.158	0.01928 J	<0.29 U	3.63671 J	0.928756 J
9/7/2016	Background	<0.93 U	<1.05 U	47	0.631177 J	0.219799 J	<0.23 U	38	1.219	<0.083 U	<0.68 U	0.139	<0.005 U	<0.29 U	<0.99 U	1.44332 J
10/13/2016	Background	<0.93 U	7	43	0.963478 J	<0.07 U	<0.23 U	42	2.422	0.6297 J	<0.68 U	0.142	<0.005 U	<0.29 U	2.59885 J	<0.86 U
11/14/2016	Background	<0.93 U	2.07189 J	39	0.717704 J	0.310257 J	<0.23 U	42	1.723	0.3114 J	<0.68 U	0.136	<0.005 U	<0.29 U	<0.99 U	<0.86 U
1/11/2017	Background	<0.93 U	2.73936 J	39	0.302907 J	0.11238 J	<0.23 U	32	1.844	<0.083 U	<0.68 U	0.133	0.00732 J	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	1.64435 J	34	0.290018 J	<0.07 U	<0.23 U	44	1.728	<0.083 U	<0.68 U	0.153	<0.005 U	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	4.43115 J	45	0.736525 J	2	<0.23 U	56	1.309	0.4278 J	<0.68 U	0.156	<0.005 U	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	3.23 J	42.23	0.46 J	0.86 J	<0.23 U	39.91	2.093	<0.083 U	<0.68 U	0.145	<0.005 U	<0.29 U	3.86 J	<0.86 U
8/20/2018	Assessment	0.01 J	5.79	40.9	0.648	<0.005 U	0.103	48.8	1.735	0.0845 J	0.01 J	0.146	<0.005 U	<0.02 U	0.2	0.03 J
2/27/2019	Assessment	<0.4 U	2.17	38.5	<0.4 U	<0.2 U	<0.8 U	48.7	0.909	0.25	<0.4 U	0.165	<0.005 U	<8 U	<0.6 U	<2 U
5/21/2019	Assessment	<0.4 U	2 J	35.0	<0.4 U	<0.2 U	<0.8 U	44.7	0.875	0.40	<0.4 U	0.153	<0.005 U	<8 U	<0.6 U	<0.1 U
8/12/2019	Assessment	<0.02 U	1.64	35.0	0.235	<0.01 U	0.06 J	44.5	1.642	0.39	<0.05 U	0.139	<0.005 U	<0.4 U	<0.03 U	<0.1 U

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

Table 1 - Groundwater Data Summary: AD-22
Pirkey - Stackout
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.08	15.3	76	1.266	4.0	672	284
7/14/2016	Background	0.04	9.5	52	0.3891 J	3.9	412	162
9/7/2016	Background	0.04	6.95	42	<0.083 U	4.1	341	114
10/12/2016	Background	0.03	7.68	52	0.473 J	4.7	388	148
11/14/2016	Background	0.04	7.55	48	0.2834 J	4.4	362	177
1/12/2017	Background	0.02	6.47	51	<0.083 U	4.2	344	137
3/1/2017	Background	0.05	13.6	69	<0.083 U	4.1	624	266
4/11/2017	Background	0.04	10.8	72	0.5041 J	4.1	446	215
8/23/2017	Detection	0.05075	7.77	54	1.196	4.6	350	121
12/21/2017	Detection	0.06278	7.29	61	<0.083 U	- -	344	120
3/21/2018	Assessment	0.0818	15.2	79	<0.083 U	3.9	656	377
8/20/2018	Assessment	0.031	9.43	92	<0.083 U	4.2	476	184
2/27/2019	Assessment	0.07 J	15.2	76.7	1.33	4.9	584	337
5/22/2019	Assessment	0.073	16.5	63.3	1.06	5.1	506	360
8/12/2019	Assessment	0.03 J	8.96	79.6	0.45	4.8	484	198

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

Table 1 - Groundwater Data Summary: AD-22
Pirkey - Stackout
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	23	71	13	2	24	129	6.994	1.266	0.97266 J	0.139	13.41	<0.29 U	1.97127 J	1.16089 J
7/14/2016	Background	<0.93 U	12	48	6	0.674427 J	12	67	2.325	0.3891 J	<0.68 U	0.169	17	<0.29 U	<0.99 U	0.895409 J
9/7/2016	Background	<0.93 U	23	108	5	0.833408 J	33	54	3.412	<0.083 U	2.72959 J	0.131	19.829	<0.29 U	<0.99 U	1.25036 J
10/12/2016	Background	<0.93 U	10	54	4	0.333745 J	7	54	3.39	0.473 J	<0.68 U	0.14	7.984	<0.29 U	<0.99 U	<0.86 U
11/14/2016	Background	<0.93 U	3.69822 J	66	4	0.596378 J	2	47	3.63	0.2834 J	<0.68 U	0.115	8.634	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	6	67	4	0.385609 J	2	43	3.173	<0.083 U	<0.68 U	0.104	13.32	<0.29 U	1.09664 J	<0.86 U
3/1/2017	Background	<0.93 U	1.61319 J	29	10	1	<0.23 U	105	4.385	<0.083 U	<0.68 U	0.218	0.22	<0.29 U	<0.99 U	<0.86 U
4/11/2017	Background	<0.93 U	11	130	6	2	5	78	3.045	0.5041 J	1.89388 J	0.176	7.201	<0.29 U	1.86563 J	<0.86 U
3/21/2018	Assessment	<0.93 U	3.56 J	24.13	12.1	1.87	<0.23 U	121	6.22	<0.083 U	<0.68 U	0.277	1.206	<0.29 U	<0.99 U	<0.86 U
8/20/2018	Assessment	0.02 J	5.18	22.7	3.30	0.46	0.829	62.9	3.088	<0.083 U	0.386	0.132	1.448	0.07 J	2.5	0.162
2/27/2019	Assessment	<0.4 U	6.3	17.0	13.3	1.55	0.8 J	123	5.99	1.33	0.5 J	0.269	0.642	<8 U	16.7	<2 U
5/22/2019	Assessment	<0.4 U	5.89	16.7	12.5	1.52	<0.8 U	129	6.71	1.06	<0.4 U	0.288	0.837	<8 U	5.9	0.2 J
8/12/2019	Assessment	<0.02 U	2.19	15.3	3.38	0.44	0.2 J	57.5	3.088	0.45	0.1 J	0.151	0.325	<0.4 U	2.0	0.2 J

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

Table 1 - Groundwater Data Summary: AD-33
Pirkey - Stackout
Appendix III Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Boron	Calcium	Chloride	Fluoride	pH	Total Dissolved Solids	Sulfate
		mg/L	mg/L	mg/L	mg/L	SU	mg/L	mg/L
5/11/2016	Background	0.126	2.44	8	<0.083 U	4.1	326	56
7/14/2016	Background	0.173	1.69	16	<0.083 U	3.1	176	108
9/7/2016	Background	0.152	1.81	10	<0.083 U	3.6	176	64
10/12/2016	Background	0.162	1.39	9	0.357 J	3.4	180	46
11/14/2016	Background	0.182	1.63	8	<0.083 U	3.1	190	54
1/12/2017	Background	0.144	1.26	10	<0.083 U	4.3	168	58
2/28/2017	Background	0.14	1.25	7	<0.083 U	3.9	146	51
4/10/2017	Background	0.114	1.29	9	<0.083 U	3.4	178	49
8/23/2017	Detection	0.07952	1.06	9	0.670 J	4.4	132	40
12/21/2017	Detection	0.09993	0.946	- -	- -	- -	- -	- -
3/21/2018	Assessment	0.115	1.42	7	<0.083 U	4.4	160	58
8/21/2018	Assessment	0.098	1.09	12	<0.083 U	3.6	156	48
2/27/2019	Assessment	0.134	1.73	8.89	0.25	3.3	146	62.8
5/22/2019	Assessment	0.111	1.65	8.57	0.23	4.1	204	60.4
8/12/2019	Assessment	0.097	1.03	8.85	0.19	4.2	156	44.3

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

Table 1 - Groundwater Data Summary: AD-33
Pirkey - Stackout
Appendix IV Constituents

Geosyntec Consultants, Inc.

Collection Date	Monitoring Program	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Combined Radium	Fluoride	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	pCi/L	mg/L	µg/L	mg/L	µg/L	µg/L	µg/L	µg/L
5/11/2016	Background	<0.93 U	2.53645 J	60	2	<0.07 U	4	12	1.303	<0.083 U	<0.68 U	<0.00013 U	0.288	<0.29 U	<0.99 U	<0.86 U
7/14/2016	Background	<0.93 U	4.91616 J	64	2	<0.07 U	9	12	4.28	<0.083 U	<0.68 U	0.029	0.707	<0.29 U	<0.99 U	1.19199 J
9/7/2016	Background	<0.93 U	67	163	4	0.984692 J	125	33	3.461	<0.083 U	14	0.048	1.826	0.736517 J	1.61343 J	<0.86 U
10/12/2016	Background	<0.93 U	2.15866 J	59	1	<0.07 U	4	10	2.208	0.357 J	<0.68 U	0.027	0.145	<0.29 U	<0.99 U	1.56738 J
11/14/2016	Background	<0.93 U	1.46353 J	52	1	<0.07 U	1	9	1.953	<0.083 U	<0.68 U	0.024	0.197	<0.29 U	<0.99 U	<0.86 U
1/12/2017	Background	<0.93 U	1.12979 J	56	1	<0.07 U	2	9	2.596	<0.083 U	<0.68 U	0.027	0.36	<0.29 U	<0.99 U	<0.86 U
2/28/2017	Background	<0.93 U	1.069 J	55	1	<0.07 U	<0.23 U	9	0.942	<0.083 U	<0.68 U	0.026	0.41	<0.29 U	<0.99 U	<0.86 U
4/10/2017	Background	<0.93 U	<1.05 U	55	1	<0.07 U	3	10	9.024	<0.083 U	<0.68 U	0.027	0.341	<0.29 U	<0.99 U	<0.86 U
3/21/2018	Assessment	<0.93 U	1.78 J	57.26	1.4	0.15 J	4.64	10.42	1.643	<0.083 U	<0.68 U	0.02669	0.825	<0.29 U	<0.99 U	<0.86 U
8/21/2018	Assessment	0.01 J	0.65	43.8	0.905	0.04	0.147	7.72	6.32	<0.083 U	0.151	0.0178	0.745	<0.02 U	1.7	0.05 J
2/27/2019	Assessment	<0.4 U	1 J	49.5	1 J	<0.2 U	<0.8 U	10.5	2.235	0.25	<0.4 U	0.0262	0.464	<8 U	3 J	<2 U
5/22/2019	Assessment	<0.4 U	<0.6 U	52.4	1 J	<0.2 U	<0.8 U	10.5	1.178	0.23	<0.4 U	0.0245	0.481	<8 U	1 J	<0.1 U
8/12/2019	Assessment	<0.02 U	0.41	38.6	1.00	0.04 J	0.1 J	7.02	1.141	0.19	0.1 J	0.0233	0.564	<0.4 U	1.1	<0.1 U

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

APPENDIX II

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

STATISTICAL ANALYSIS SUMMARY
FLUE GAS DESULFERIZATION (FGD)
STACKOUT AREA
H.W. Pirkey Plant
Hallsville, Texas

Submitted to

AMERICAN ELECTRIC POWER℠

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

July 11, 2019

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

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

SECTION 1

EXECUTIVE SUMMARY

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

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, and sulfate at the FGD Stackout Area. An alternative source was not identified at the time, so two assessment monitoring events were conducted at the FGD Stackout Area in 2018, in accordance with 40 CFR 257.95. An SSL was identified for mercury at well AD-22. An ASD was successfully completed which resulted in a revision to the dataset for mercury at well AD-22 (Geosyntec, 2019). Thus, the unit remained in assessment monitoring.

A semi-annual assessment monitoring event was also completed in February 2019, with the results of the February 2019 event documented in this report. The 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 February 2019 monitoring data were submitted to Groundwater Stats Consulting, LLC for statistical analysis. Groundwater protection standards (GWPSs) were re-established for the Appendix IV parameters. Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPS. An SSL was identified for beryllium. Thus, either the unit will move to an assessment of corrective measures or an alternative source demonstration (ASD) will be conducted to evaluate if the unit can remain in assessment monitoring. Certification of the selected statistical methods by a qualified professional engineer is documented in Attachment A.

SECTION 2

FGD STACKOUT AREA EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, one set of samples was collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(d)(1). Although antimony, fluoride, lead, molybdenum, and thallium were not detected at any locations during the March 2018 screening event, samples from the February 2019 semi-annual sampling event were analyzed for all Appendix III and Appendix IV parameters. A summary of data collected during this assessment monitoring event may be found in Table 1.

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

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.14 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

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

The data obtained to meet the requirements of 40 CFR 257.95(d)(1) were screened for potential outliers. Non-detect values for molybdenum at AD-12, AD-13, AD-22, and AD-33 were flagged as outliers because the reporting limit during the February 2019 sampling event for these wells 0.04 mg/L compared to a historical reporting limit of 0.002 mg/L. Well AD-7 had a reporting limit of 0.002 mg/L during this event. The removal of these values as outliers did not affect the statistical evaluation of this event, as molybdenum was not detected during the March 2018 screening event.

2.2.1 Establishment of GWPSs

A GWPS was established for each Appendix IV parameter in accordance with 40 CFR 257.95(h) and the *Statistical Analysis Plan* (AEP, 2017). The established GWPS was determined to be the greater value of the background concentration and the maximum contaminant level (MCL) or risk-

based level specified in 40 CFR 257.95(h)(2) for each Appendix IV parameter. To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for arsenic, cadmium, chromium, cobalt, fluoride, lithium, selenium, and thallium due to apparent non-normal distributions and for antimony, lead, mercury, and molybdenum due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

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

The following SSL was identified at the Pirkey FGD Stackout Area:

- The LCL for beryllium exceeded the GWPS of 0.004 mg/L at AD-22 (0.00413).

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

2.2.3 Evaluation of Potential Appendix III SSIs

While an SSLs was identified, a review of the Appendix III results were also completed to assess whether concentrations of Appendix III parameters at the compliance wells exceeded background concentrations. Prediction limits were calculated for the Appendix III parameters to represent background values. As described in the January 2018 *Statistical Analysis Summary* report (Geosyntec, 2018), intrawell tests were used to evaluate potential SSIs for calcium, pH, and TDS, whereas interwell tests were used to evaluate potential SSIs for boron, chloride, fluoride, and sulfate.

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

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

Data collected during the February 2019 assessment monitoring event from each compliance well were compared to the prediction limits to evaluate results above background values. The results from this event and the prediction limits are summarized in Table 3. The following exceedances of the upper prediction limits (UPLs) were noted:

- Boron concentrations exceeded the interwell UPL of 0.0840 mg/L at AD-33 (0.134 mg/L) and AD-7 (2.1 mg/L).
- The chloride concentration exceeded the interwell UPL of 40.8 mg/L at AD-22 (76.7 mg/L).
- The fluoride concentration exceeded the interwell UPL or 1.0 mg/L at AD-22 (1.33 mg/L).
- The reported pH values exceeded the intrawell UPL of 4.8 SU at AD-22 (4.9 SU) and were below the intrawell lower prediction limit (LPL) of 3.2 SU at AD-7 (2.9 SU).
- The sulfate concentration exceeded the interwell UPL of 80.8 mg/L at AD-22 (337 mg/L).

While the prediction limits were calculated assuming a 1-of-2 testing procedure, it was conservatively assumed that an SSI was identified if the initial sample exceeded either the UPL based on previous results. Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey FGD Stackout Area during assessment monitoring.

2.3 Conclusions

A semi-annual assessment monitoring event was conducted in accordance with the CCR Rule. The laboratory and field data were reviewed prior to statistical analysis, with no QA/QC issues identified that impacted data usability. Following a review of outliers in the February 2019 data the non-detect molybdenum results from AD-12, AD-13, AD-22, and AD-33, which were replaced with the reporting limit, were removed as outliers. GWPSs were re-established for the Appendix IV parameters. A confidence interval was constructed at each compliance well for each Appendix IV parameter; SSLs were concluded if the entire confidence interval exceeded the GWPS. An SSLs was identified for beryllium. Appendix III parameters were also evaluated, with exceedances identified for boron, chloride, fluoride, pH, and sulfate.

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

SECTION 3

REFERENCES

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

Geosyntec Consultants (Geosyntec). 2018. Statistical Analysis Summary – Flue Gas Desulfurization Stackout Area, H.W. Pirkey Power Plant, Hallsville, Texas. January 3, 2018.

Geosyntec. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H.W. Pirkey Plant Flue Gas Desulfurization (FGD) Stackout Area. February 13, 2019.

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
Pirkey - Stackout

Geosyntec Consultants

Parameter	Unit	AD-7	AD-12	AD-13	AD-22	AD-33
		2/27/2019	2/27/2019	2/27/2019	2/27/2019	2/27/2019
Antimony	µg/L	2.00 U	2.00 U	2.00 U	2.00 U	2.00 U
Arsenic	µg/L	2.12	2.00 U	2.17	6.30	1.00 J
Barium	µg/L	42.9	22.5	38.5	17.0	49.5
Beryllium	µg/L	7.01	2.00 U	2.00 U	13.3	1.00 J
Boron	mg/L	2.10	0.0300 J	0.0800 J	0.0700 J	0.134
Cadmium	µg/L	0.730	1.00 U	1.00 U	1.55	1.00 U
Calcium	mg/L	5.20	0.400 J	11.0	15.2	1.73
Chloride	mg/L	29.9	6.08	40.8	76.7	8.89
Chromium	µg/L	0.225	4.00 U	4.00 U	0.800 J	4.00 U
Cobalt	µg/L	41.0	1.37	48.7	123	10.5
Combined Radium	pCi/L	4.75	0.225	0.909	5.99	2.24
Fluoride	mg/L	0.500	0.0900	0.250	1.33	0.250
Lead	µg/L	1.00 J	2.00 U	2.00 U	0.500 J	2.00 U
Lithium	mg/L	0.106	0.00688	0.165	0.269	0.0262
Mercury	mg/L	0.000201	0.0000250 U	0.0000250 U	0.000642	0.000464
Molybdenum	µg/L	2.00 U	40.0 U	40.0 U	40.0 U	40.0 U
Selenium	µg/L	7.10	4.00 U	4.00 U	16.7	3.00 J
Total Dissolved Solids	mg/L	268	36.0	176	584	146
Sulfate	mg/L	69.1	3.60	80.8	337	62.8
Thallium	µg/L	10.0 U	10.0 U	10.0 U	10.0 U	10.0 U
pH	SU	2.90	5.17	5.16	4.85	3.30

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

Table 2: Groundwater Protection Standards
Pirkey Plant - Stackout

Geosyntec Consultants, Inc.

Constituent Name	MCL	CCR Rule-Specified	Background Limit
Antimony, Total (mg/L)	0.006		0.002
Arsenic, Total (mg/L)	0.01		0.007
Barium, Total (mg/L)	2		0.053
Beryllium, Total (mg/L)	0.004		0.0019
Cadmium, Total (mg/L)	0.005		0.002
Chromium, Total (mg/L)	0.1		0.004
Cobalt, Total (mg/L)	n/a	0.006	0.056
Combined Radium, Total (pCi/L)	5		3.18
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.002
Lithium, Total (mg/L)	n/a	0.04	0.17
Mercury, Total (mg/L)	0.002		0.000025
Molybdenum, Total (mg/L)	n/a	0.1	0.002
Selenium, Total (mg/L)	0.05		0.004
Thallium, Total (mg/L)	0.002		0.002

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

Table 3: Appendix III Data Summary
Pirkey Plant - FGD Stackout Area

Geosyntec Consultants, Inc.

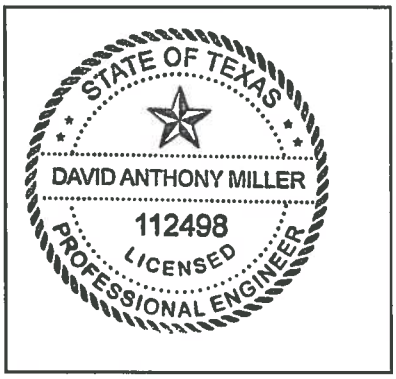
Parameter	Units	Description	AD-22	AD-33	AD-7
			2/27/2019	2/27/2019	2/27/2019
Boron	mg/L	Interwell Background Value (UPL)	0.0840		
		Detection Monitoring Result	0.07	**0.134**	**2.1**
Calcium	mg/L	Intrawell Background Value (UPL)	17.75	2.59	7.40
		Detection Monitoring Result	15.2	1.73	5.20
Chloride	mg/L	Interwell Background Value (UPL)	40.8		
		Detection Monitoring Result	**76.7**	8.89	29.9
Fluoride	mg/L	Interwell Background Value (UPL)	1.0		
		Detection Monitoring Result	**1.33**	0.25	0.5
pH	SU	Intrawell Background Value (UPL)	4.8	4.7	4.3
		Intrawell Background Value (LPL)	3.5	2.6	3.2
		Detection Monitoring Result	**4.9**	3.3	**2.9**
Sulfate	mg/L	Interwell Background Value (UPL)	80.8		
		Detection Monitoring Result	**337**	62.8	69.1
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	765	210	354
		Detection Monitoring Result	584	146	268

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

ATTACHMENT A
Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

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



DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

112498	TEXAS	07.11.19
License Number	Licensing State	Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS CONSULTING

July 10, 2019

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

Re: Pirkey Stackout
Assessment Monitoring Event – February 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the statistical analysis of the groundwater data for the February 2019 sample event for American Electric Power Inc.'s Pirkey Stackout. 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 the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-12 and AD-13; and
- **Downgradient wells:** AD-22, AD-33, and AD-7.

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

The CCR program consists of the following constituents:

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

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

Evaluation of Appendix III Parameters

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, chloride, fluoride, and sulfate; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, pH and TDS (Figures C & D, respectively). The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data are screened for any newly suspected outliers or obvious trending patterns using time series plots. All values flagged as outliers may be seen on the Outlier Summary report following this letter. No obvious trending patterns were observed in the upgradient wells.

Intrawell prediction limits utilize the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the background data set will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is

considered a false positive result and, therefore, no further action is necessary. Prediction limit exceedances were noted for boron in wells AD-33 and AD-7; calcium in well AD-13; chloride, fluoride and sulfate in well AD-22; and pH in wells AD-22 and AD-7. The results of those findings may be found in the Prediction Limit Summary tables following this letter.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable (Figure E). Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site which is an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances.

Evaluation of Appendix IV Parameters

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure F). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Any flagged values may be seen on the Outlier Summary following this letter.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure G).

Note that the reporting limit during the February 2019 event for molybdenum at wells AD-12, AD-13, AD-22 and AD-33 was 0.04 mg/L compared to a historical reporting limit of 0.002 mg/L. Well AD-7, however, had a reporting limit of 0.002 mg/L during this event. The resulting nondetects reported at 0.04 mg/L are censored at much higher levels than the rest of the data; therefore, contain little or no useful information and are flagged as outliers.

The reporting limit (or practical quantitation limit) for this event for thallium also increased from the historical reporting limit of 0.002 mg/L to 0.01 mg/L for all wells. However, since no detections were present above the method detection limit of 0.002

mg/L for this event, the historical reporting limit of 0.002 mg/L was substituted for these nondetects.

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of either the MCL, CCR-Rule specified levels, or ACL as discussed above (Figure H). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No confidence interval exceedances were noted except for beryllium in well AD-22. The lower confidence interval of 0.0041 mg/L is slightly higher than the MCL of 0.004 mg/L. A summary of the confidence interval results follows this letter.

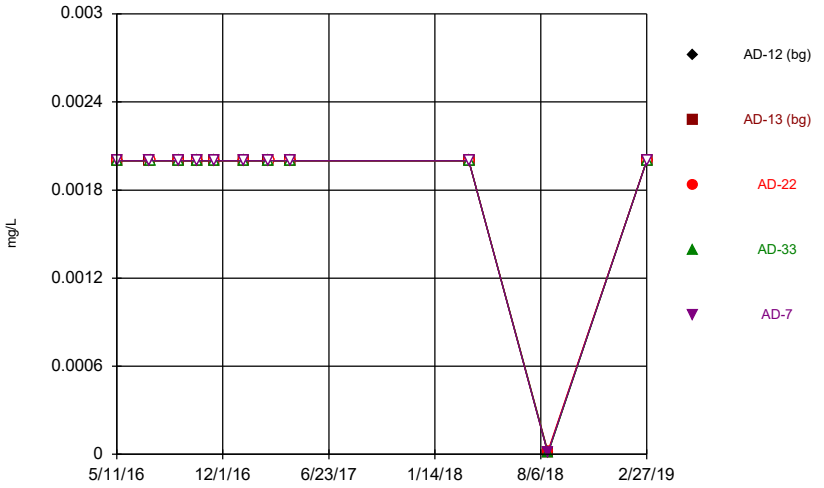
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Pirkey Stackout. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

Kristina L. Rayner
Groundwater Statistician

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

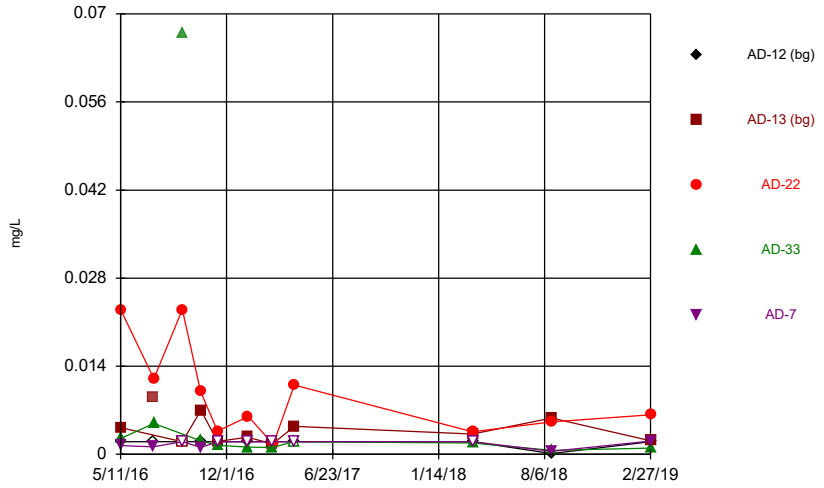
Time Series



Constituent: Antimony, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

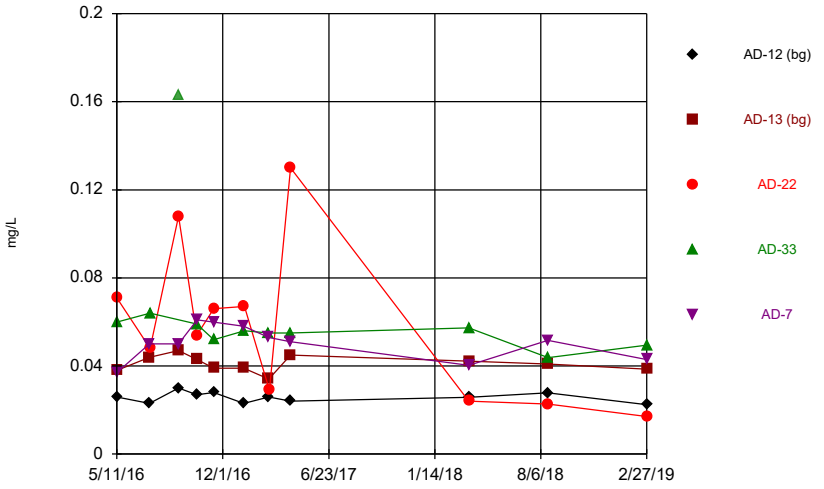
Time Series



Constituent: Arsenic, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

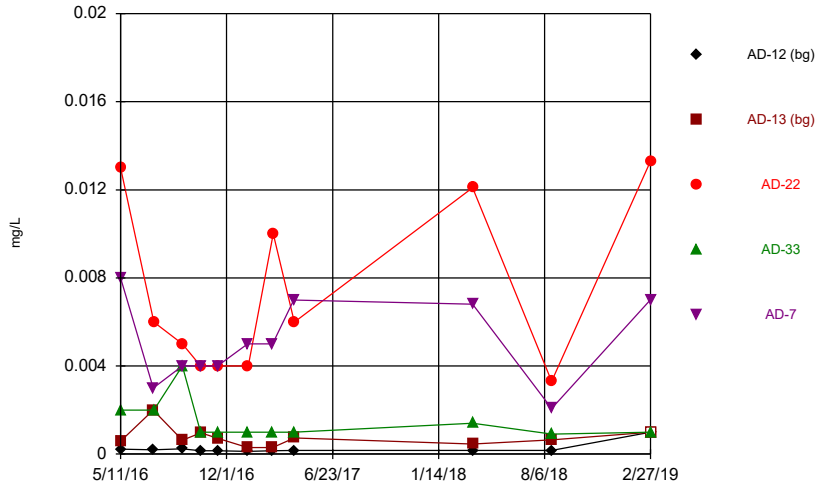
Time Series



Constituent: Barium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

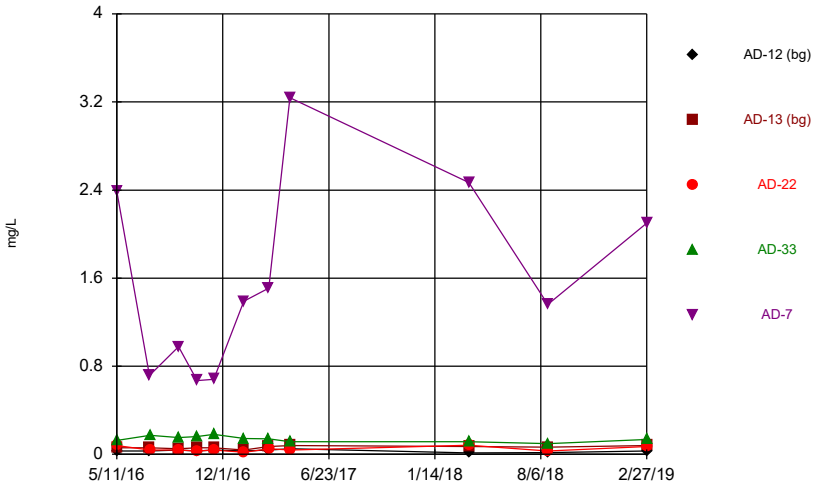
Time Series



Constituent: Beryllium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

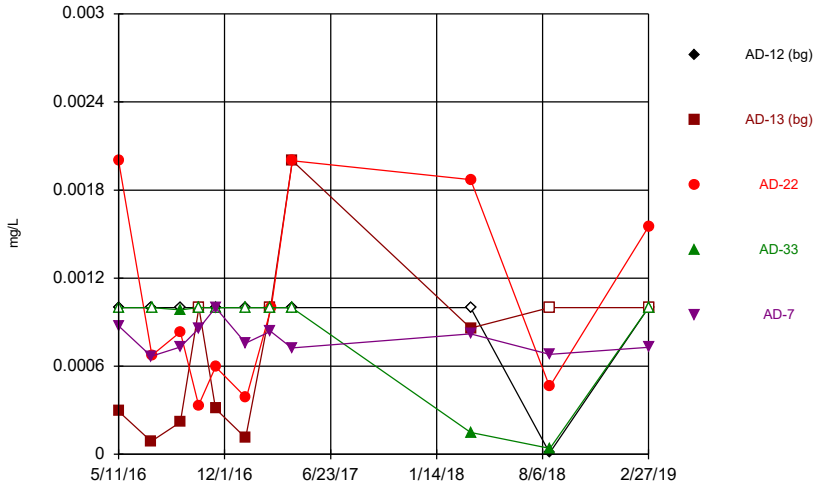
Time Series



Constituent: Boron, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

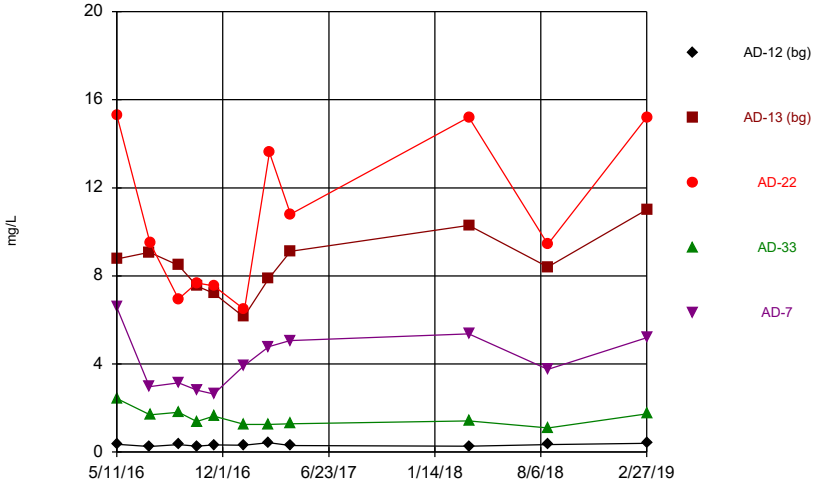
Time Series



Constituent: Cadmium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

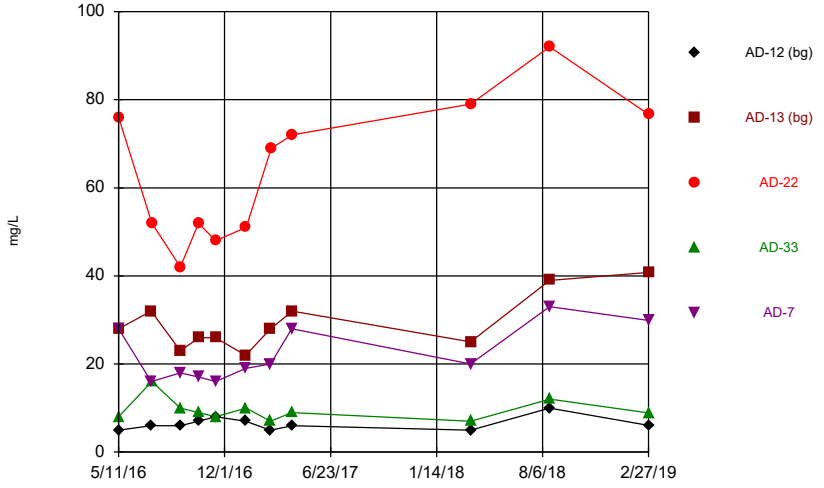
Time Series



Constituent: Calcium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

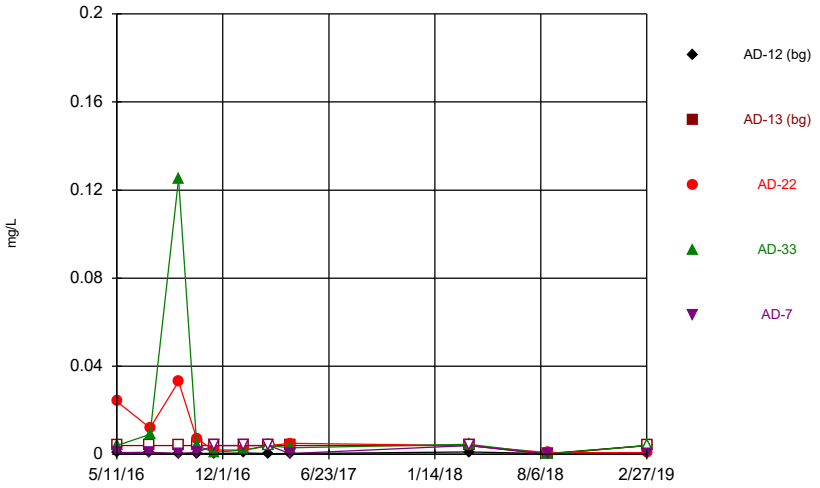
Time Series



Constituent: Chloride, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

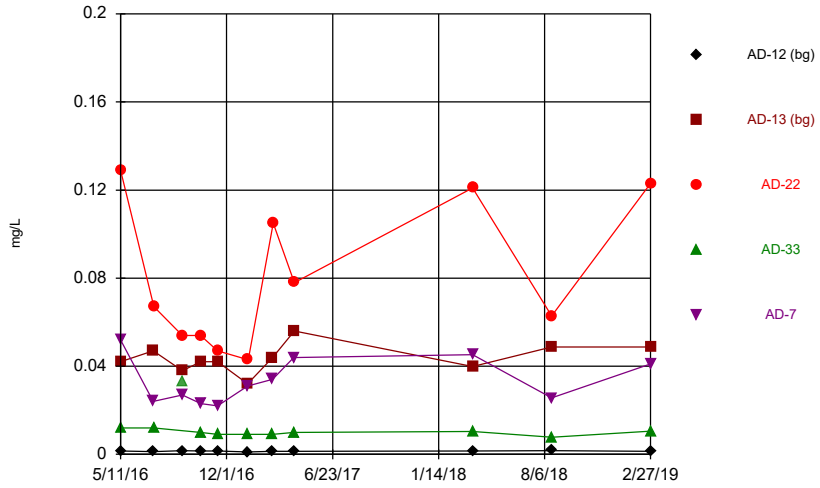
Time Series



Constituent: Chromium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

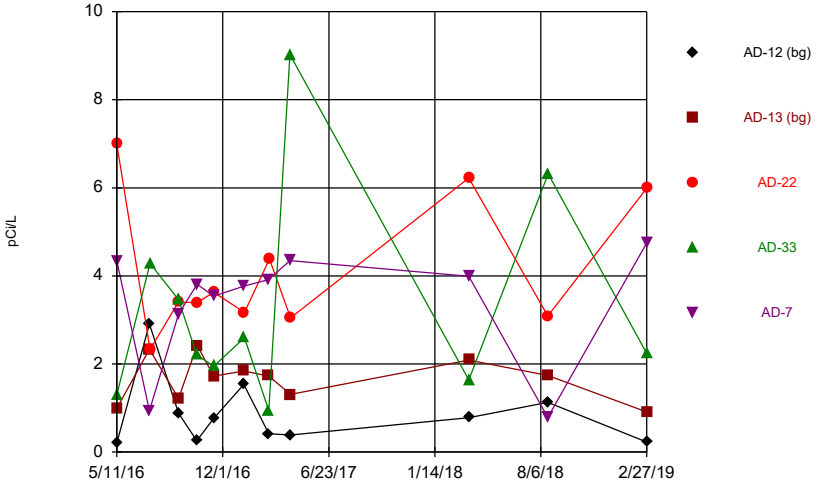
Time Series



Constituent: Cobalt, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

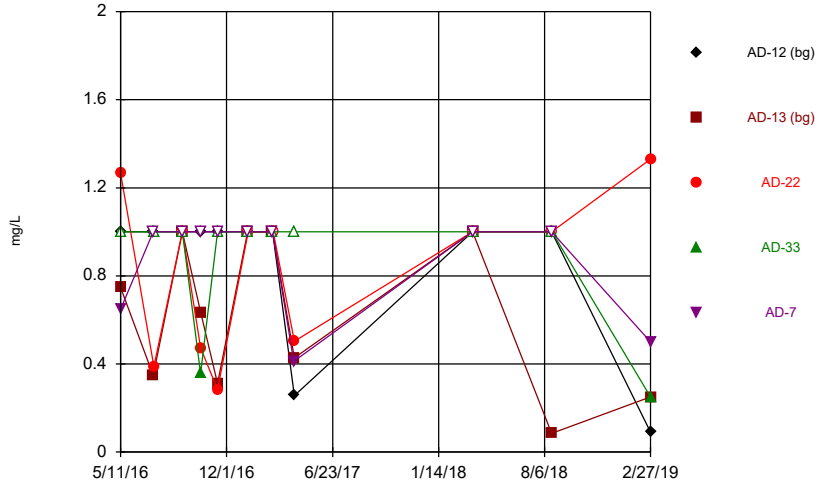
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

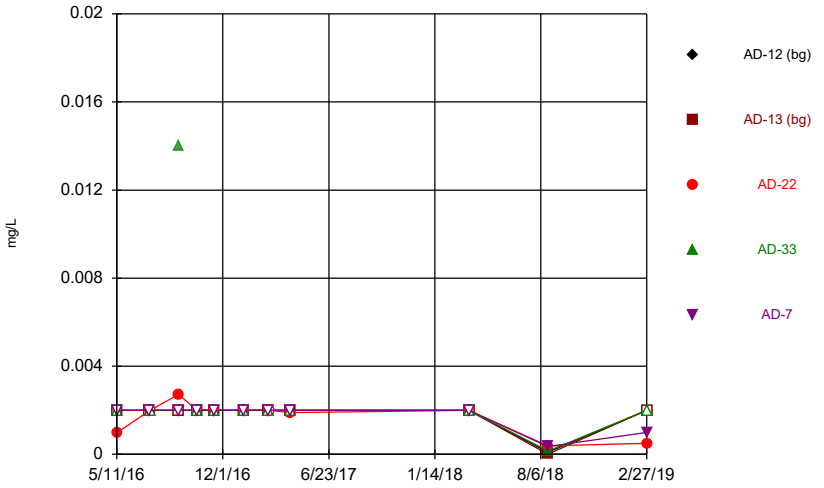
Time Series



Constituent: Fluoride, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

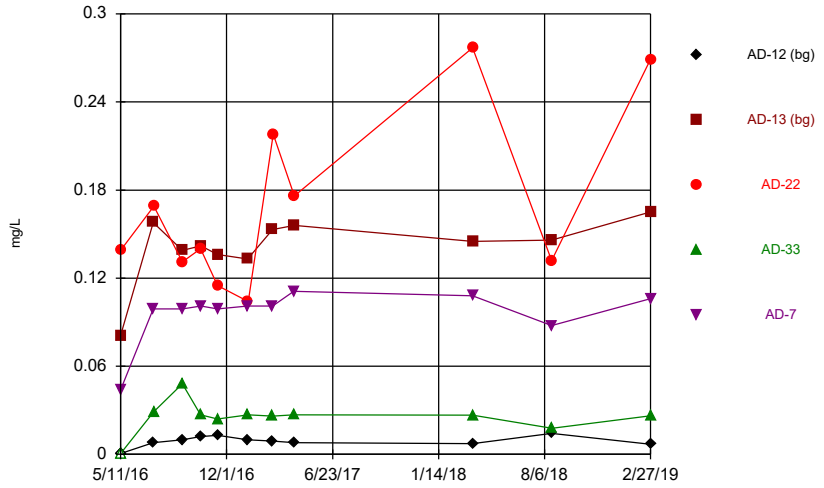
Time Series



Constituent: Lead, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

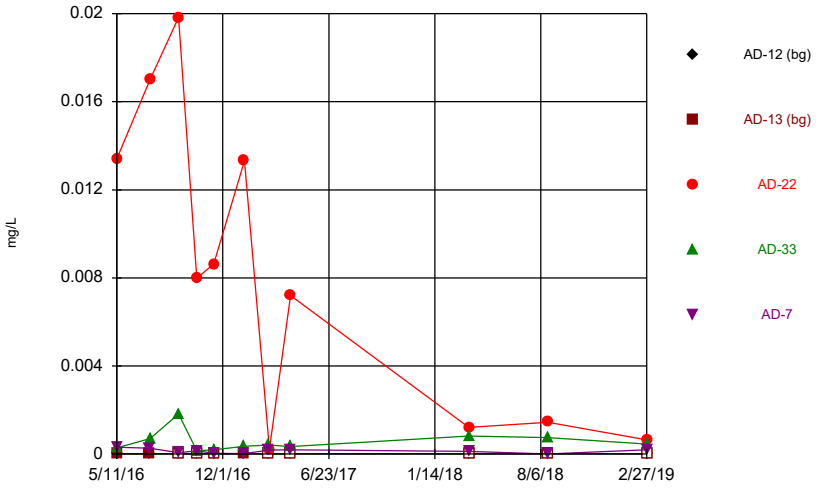
Time Series



Constituent: Lithium, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

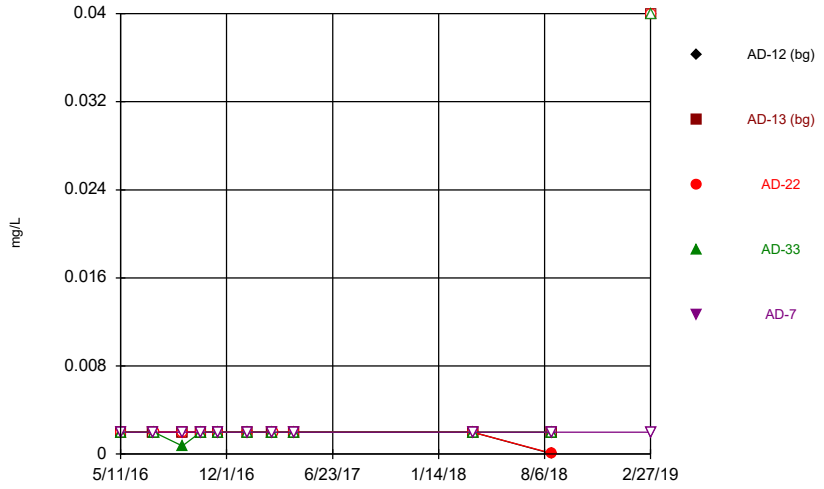
Time Series



Constituent: Mercury, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

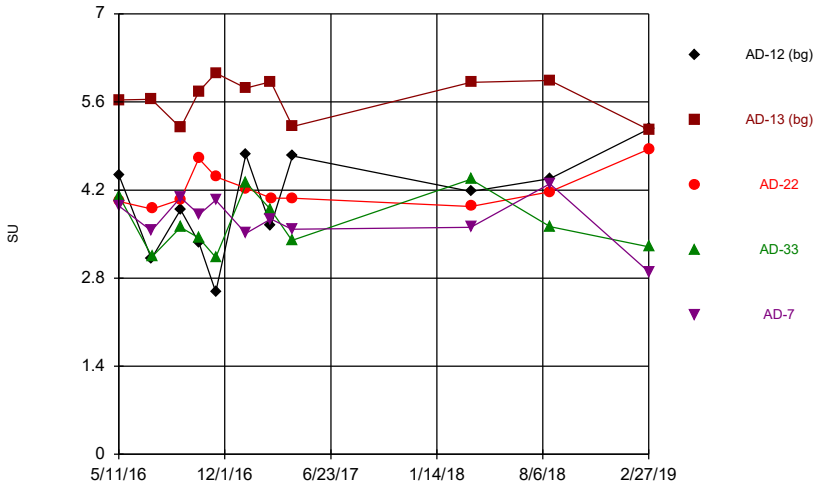
Time Series



Constituent: Molybdenum, total Analysis Run 7/8/2019 9:16 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

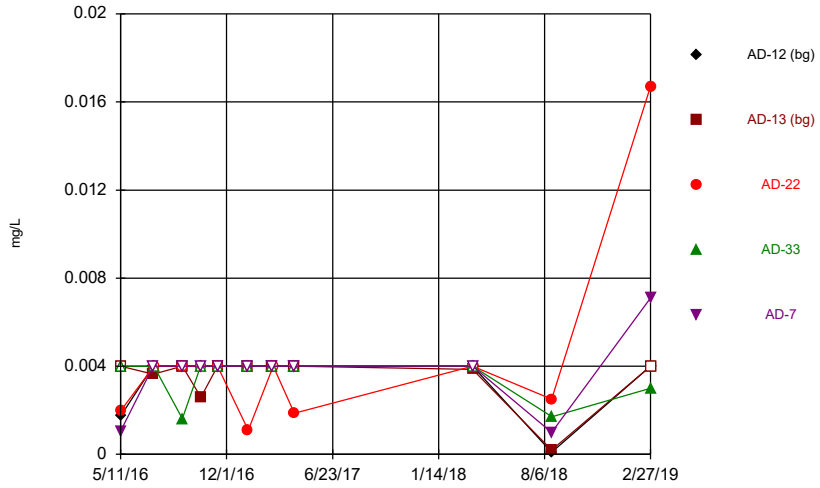
Time Series



Constituent: pH, field Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

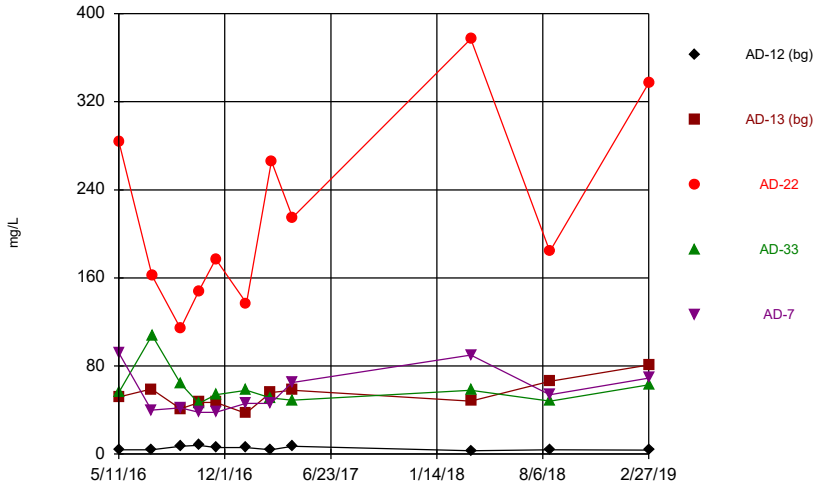
Time Series



Constituent: Selenium, total Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

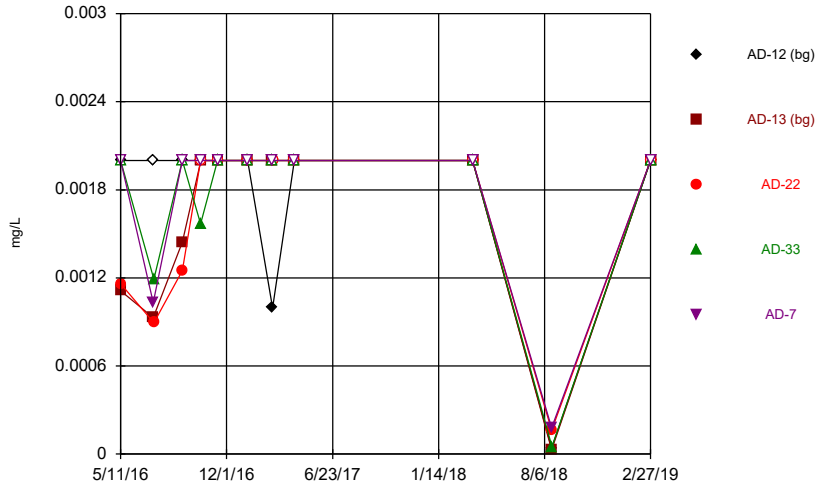
Time Series



Constituent: Sulfate, total Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

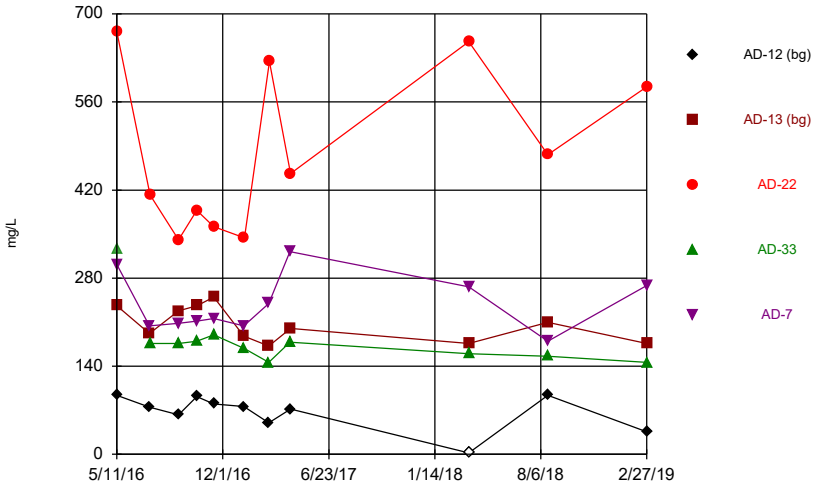
Time Series



Constituent: Thallium, total Analysis Run 7/8/2019 9:17 AM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Hollow symbols indicate censored values.

Time Series



Constituent: Total Dissolved Solids [TDS] Analysis Run 7/8/2019 9:17 AM View: Time Series

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Outlier Summary

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/8/2019, 9:14 AM

	AD-13 Arsenic, total (mg/L)	AD-33 Arsenic, total (mg/L)	AD-33 Barium, total (mg/L)	AD-33 Cobalt, total (mg/L)	AD-33 Lead, total (mg/L)	AD-12 Molybdenum, total (mg/L)	AD-13 Molybdenum, total (mg/L)	AD-22 Molybdenum, total (mg/L)	AD-33 Molybdenum, total (mg/L)	AD-33 Total Dissolved Solids [TDS] (mg/L)
5/11/2016										326 (o)
7/13/2016	0.009 (o)									
9/7/2016		0.067 (o)	0.163 (o)	0.033 (o)	0.014 (o)					
2/27/2019						<0.04 (o)	<0.04 (o)	<0.04 (o)	<0.04 (o)	

Interwell Prediction Limit Summary - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 2:49 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	**AD-33**	**0.08395**	**n/a**	**2/27/2019**	**0.134**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-7**	**0.08395**	**n/a**	**2/27/2019**	**2.1**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-22**	**40.8**	**n/a**	**2/27/2019**	**76.7**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**
Fluoride, total (mg/L)	**AD-22**	**1**	**n/a**	**2/27/2019**	**1.33**	**Yes**	**22**	**n/a**	**n/a**	**59.09**	**n/a**	**n/a**	**0.003586**	**NP Inter (NDs) 1 of 2**
Sulfate, total (mg/L)	**AD-22**	**80.8**	**n/a**	**2/27/2019**	**337**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**

Interwell Prediction Limit Summary - All Results

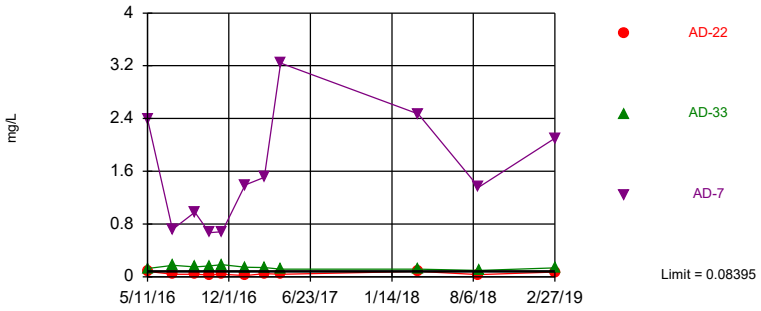
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 2:49 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	AD-22	0.08395	n/a	2/27/2019	0.07	No	22	0.04762	0.01946	0	None	No	0.002505	Param Inter 1 of 2
Boron, total (mg/L)	**AD-33**	**0.08395**	**n/a**	**2/27/2019**	**0.134**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Boron, total (mg/L)	**AD-7**	**0.08395**	**n/a**	**2/27/2019**	**2.1**	**Yes**	**22**	**0.04762**	**0.01946**	**0**	**None**	**No**	**0.002505**	**Param Inter 1 of 2**
Chloride, total (mg/L)	**AD-22**	**40.8**	**n/a**	**2/27/2019**	**76.7**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**
Chloride, total (mg/L)	AD-33	40.8	n/a	2/27/2019	8.89	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2
Chloride, total (mg/L)	AD-7	40.8	n/a	2/27/2019	29.9	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2
Fluoride, total (mg/L)	**AD-22**	**1**	**n/a**	**2/27/2019**	**1.33**	**Yes**	**22**	**n/a**	**n/a**	**59.09**	**n/a**	**n/a**	**0.003586**	**NP Inter (NDs) 1 of 2**
Fluoride, total (mg/L)	AD-33	1	n/a	2/27/2019	0.25	No	22	n/a	n/a	59.09	n/a	n/a	0.003586	NP Inter (NDs) 1 of 2
Fluoride, total (mg/L)	AD-7	1	n/a	2/27/2019	0.5	No	22	n/a	n/a	59.09	n/a	n/a	0.003586	NP Inter (NDs) 1 of 2
Sulfate, total (mg/L)	**AD-22**	**80.8**	**n/a**	**2/27/2019**	**337**	**Yes**	**22**	**n/a**	**n/a**	**0**	**n/a**	**n/a**	**0.003586**	**NP Inter (normality) 1 of 2**
Sulfate, total (mg/L)	AD-33	80.8	n/a	2/27/2019	62.8	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2
Sulfate, total (mg/L)	AD-7	80.8	n/a	2/27/2019	69.1	No	22	n/a	n/a	0	n/a	n/a	0.003586	NP Inter (normality) 1 of 2

Exceeds Limit: AD-33, AD-7

Prediction Limit

Interwell Parametric



Background Data Summary: Mean=0.04762, Std. Dev.=0.01946, n=22. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9482, critical = 0.878. Kappa = 1.866 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.007498. Individual comparison alpha = 0.002505. Comparing 3 points to limit.

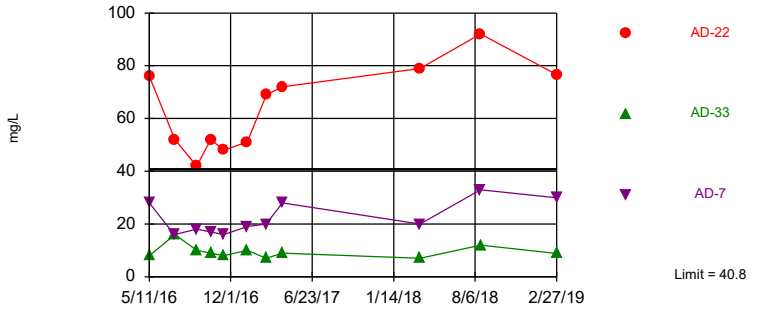
Constituent: Boron, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Exceeds Limit: AD-22

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 22 background values. Annual per-constituent alpha = 0.02133. Individual comparison alpha = 0.003586 (1 of 2). Comparing 3 points to limit.

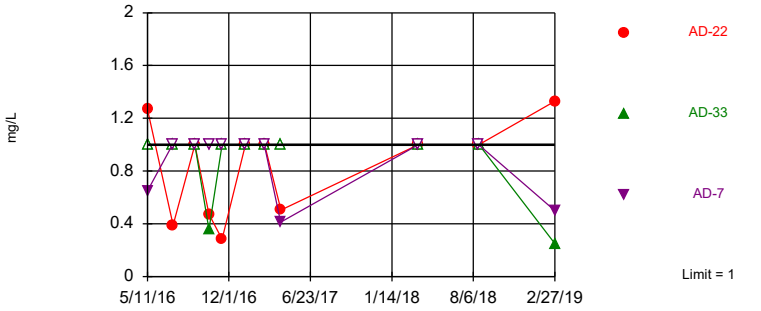
Constituent: Chloride, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Exceeds Limit: AD-22

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because censored data exceeded 50%. Limit is highest of 22 background values. 59.09% NDs. Annual per-constituent alpha = 0.02133. Individual comparison alpha = 0.003586 (1 of 2). Comparing 3 points to limit.

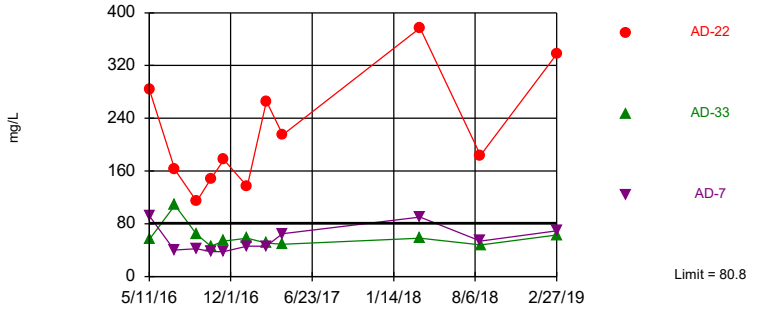
Constituent: Fluoride, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Exceeds Limit: AD-22

Prediction Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric prediction limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 22 background values. Annual per-constituent alpha = 0.02133. Individual comparison alpha = 0.003586 (1 of 2). Comparing 3 points to limit.

Constituent: Sulfate, total Analysis Run 7/5/2019 2:47 PM View: PLs - Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Intrawell Prediction Limit Summary - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 2:56 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	**AD-13**	**10.58**	**n/a**	**2/27/2019**	**11**	**Yes**	**8**	**8.025**	**1.038**	**0**	**None**	**No**	**0.002505**	Param 1 of 2
pH, field (SU)	**AD-22**	**4.819**	**3.544**	**2/27/2019**	**4.85**	**Yes**	**8**	**4.181**	**0.2594**	**0**	**None**	**No**	**0.001253**	Param 1 of 2
pH, field (SU)	**AD-7**	**4.336**	**3.229**	**2/27/2019**	**2.9**	**Yes**	**8**	**3.783**	**0.2251**	**0**	**None**	**No**	**0.001253**	Param 1 of 2

Intrawell Prediction Limit Summary - All Results

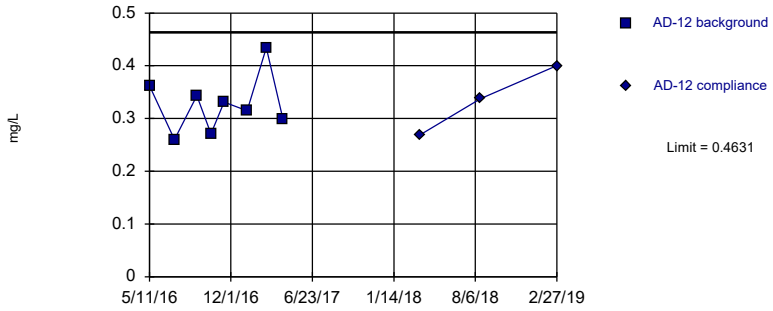
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 2:56 PM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-12	0.4631	n/a	2/27/2019	0.4	No	8	0.3269	0.05542	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	**AD-13**	**10.58**	**n/a**	**2/27/2019**	**11**	**Yes**	**8**	**8.025**	**1.038**	**0**	**None**	**No**	**0.002505**	Param 1 of 2
Calcium, total (mg/L)	AD-22	17.75	n/a	2/27/2019	15.2	No	8	9.731	3.263	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-33	2.586	n/a	2/27/2019	1.73	No	8	1.595	0.403	0	None	No	0.002505	Param 1 of 2
Calcium, total (mg/L)	AD-7	7.397	n/a	2/27/2019	5.2	No	8	3.988	1.387	0	None	No	0.002505	Param 1 of 2
pH, field (SU)	AD-12	5.764	1.866	2/27/2019	5.17	No	8	3.815	0.7928	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	AD-13	6.427	4.883	2/27/2019	5.16	No	8	5.655	0.3139	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	**AD-22**	**4.819**	**3.544**	**2/27/2019**	**4.85**	**Yes**	**8**	**4.181**	**0.2594**	**0**	**None**	**No**	**0.001253**	Param 1 of 2
pH, field (SU)	AD-33	4.704	2.553	2/27/2019	3.3	No	8	3.629	0.4375	0	None	No	0.001253	Param 1 of 2
pH, field (SU)	**AD-7**	**4.336**	**3.229**	**2/27/2019**	**2.9**	**Yes**	**8**	**3.783**	**0.2251**	**0**	**None**	**No**	**0.001253**	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	110.7	n/a	2/27/2019	36	No	8	75.25	14.41	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-13	282.1	n/a	2/27/2019	176	No	8	212.8	28.2	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-22	764.6	n/a	2/27/2019	584	No	8	448.6	128.6	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-33	210.3	n/a	2/27/2019	146	No	7	173.4	13.75	0	None	No	0.002505	Param 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-7	354.3	n/a	2/27/2019	268	No	8	238.5	47.1	0	None	No	0.002505	Param 1 of 2

Within Limit

Prediction Limit

Intrawell Parametric



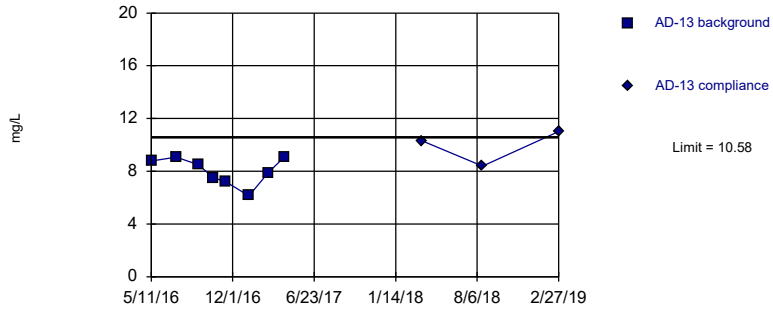
Background Data Summary: Mean=0.3269, Std. Dev.=0.05542, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9467, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Exceeds Limit

Prediction Limit

Intrawell Parametric



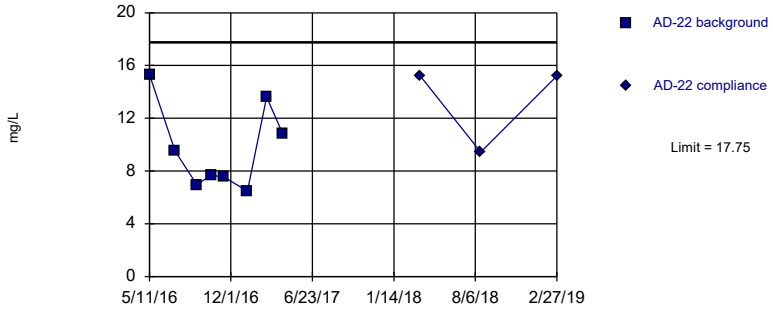
Background Data Summary: Mean=8.025, Std. Dev.=1.038, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9241, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit

Intrawell Parametric



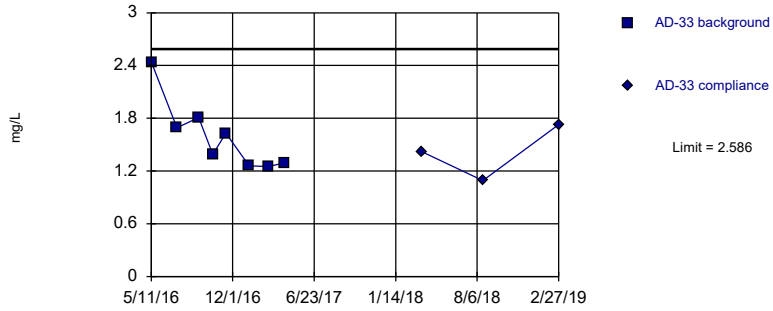
Background Data Summary: Mean=9.731, Std. Dev.=3.263, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8841, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit

Intrawell Parametric



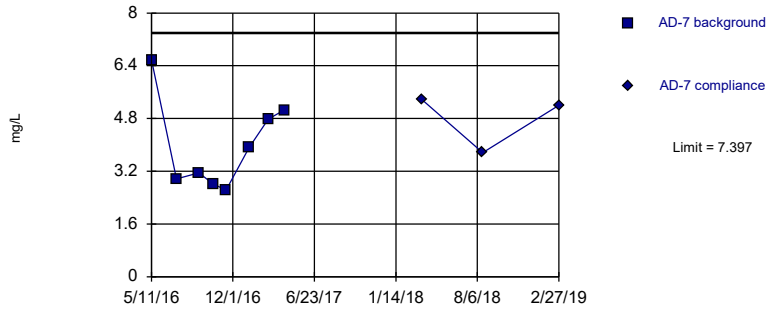
Background Data Summary: Mean=1.595, Std. Dev.=0.403, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8403, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit

Intrawell Parametric



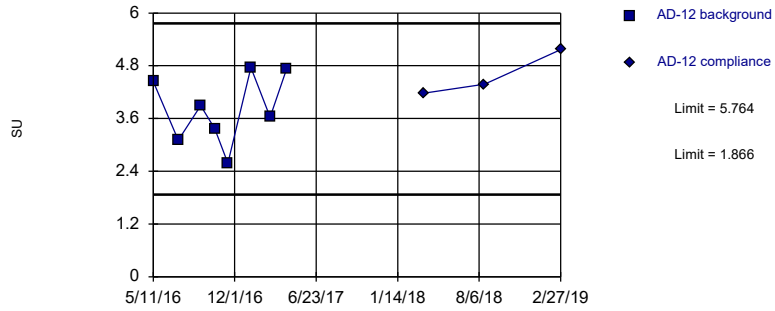
Background Data Summary: Mean=3.988, Std. Dev.=1.387, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8893, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Calcium, total Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limits

Prediction Limit

Intrawell Parametric



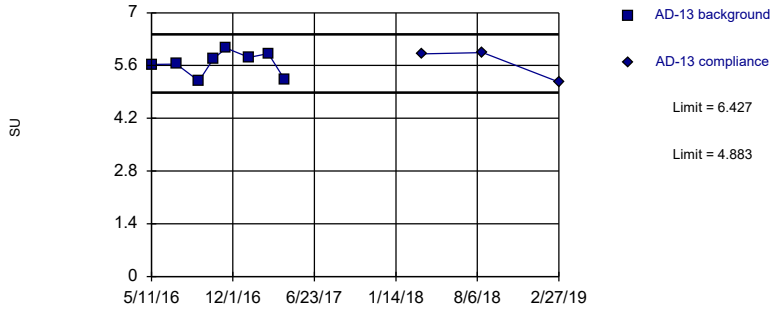
Background Data Summary: Mean=3.815, Std. Dev.=0.7928, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9424, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limits

Prediction Limit

Intrawell Parametric



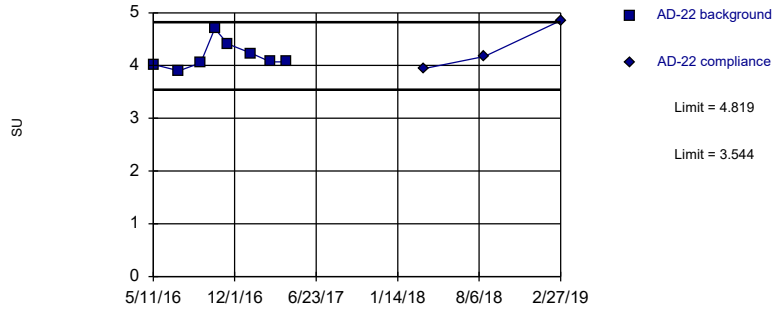
Background Data Summary: Mean=5.655, Std. Dev.=0.3139, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9084, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Exceeds Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=4.181, Std. Dev.=0.2594, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8669, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

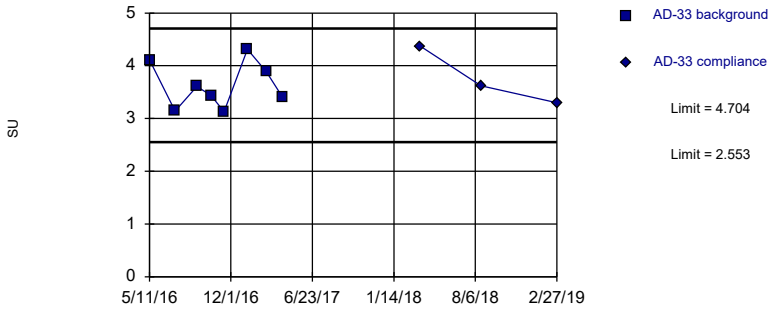
Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Within Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.629, Std. Dev.=0.4375, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9295, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

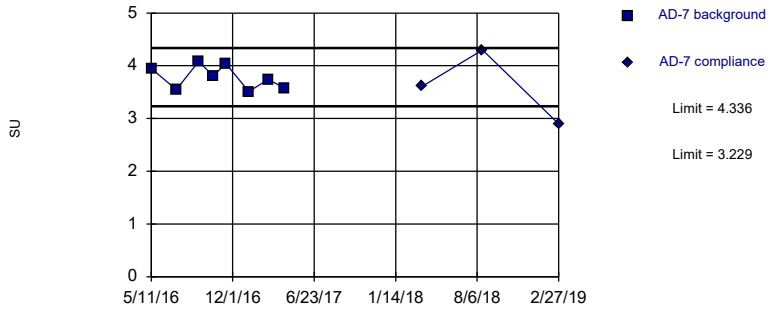
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Exceeds Limits

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=3.783, Std. Dev.=0.2251, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9108, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: pH, field Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

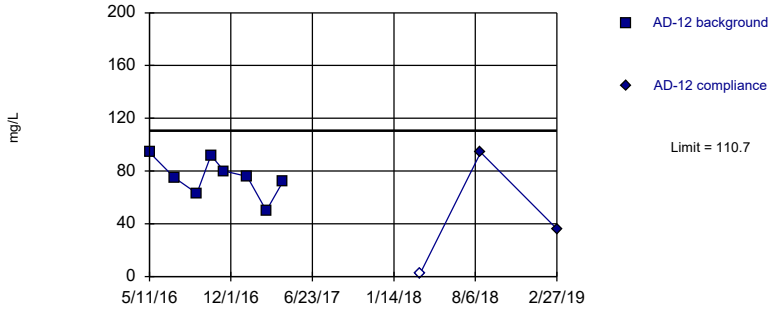
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=75.25, Std. Dev.=14.41, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9549, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

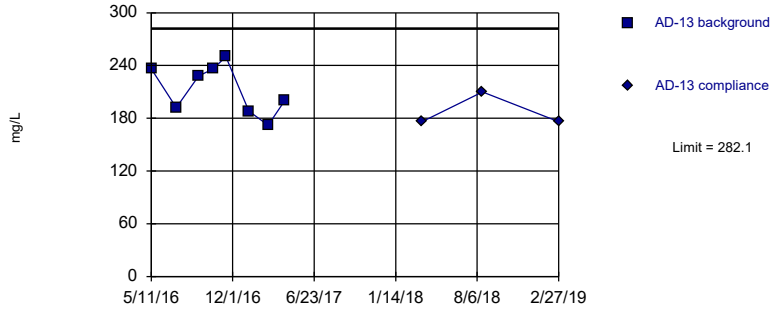
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=212.8, Std. Dev.=28.2, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9216, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

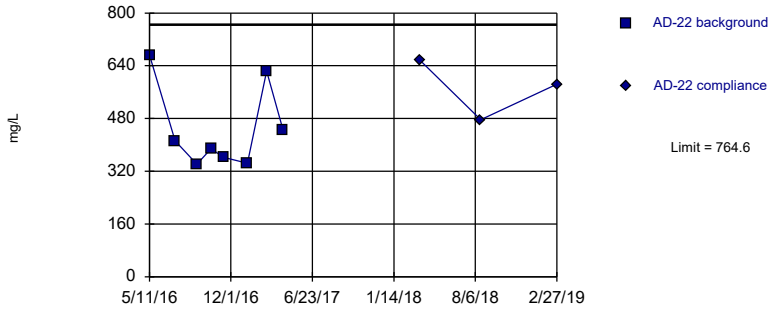
Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=448.6, Std. Dev.=128.6, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8034, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

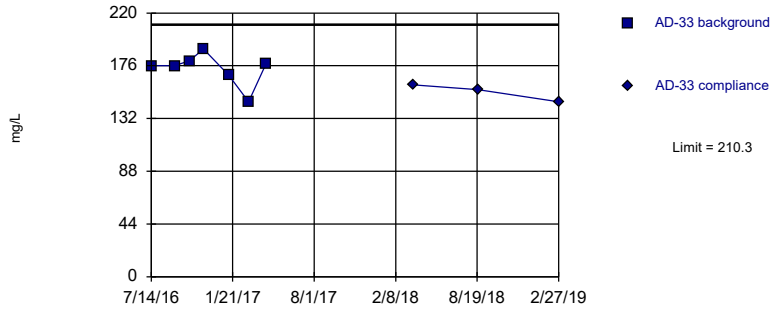
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=173.4, Std. Dev.=13.75, n=7. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8665, critical = 0.73. Kappa = 2.685 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

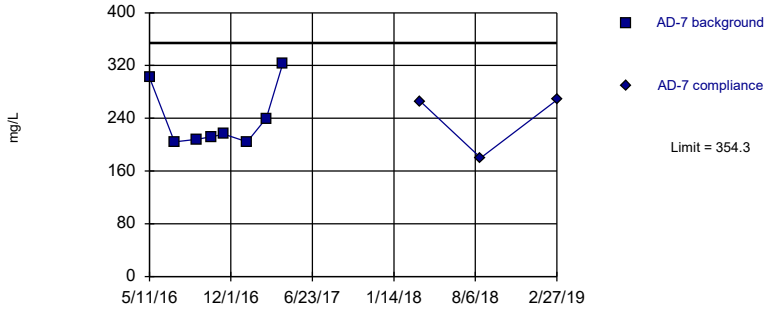
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Within Limit

Prediction Limit

Intrawell Parametric



Background Data Summary: Mean=238.5, Std. Dev.=47.1, n=8. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.7544, critical = 0.749. Kappa = 2.458 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505.

Constituent: Total Dissolved Solids [TDS] Analysis Run 7/5/2019 2:50 PM View: PLs - Intrawell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

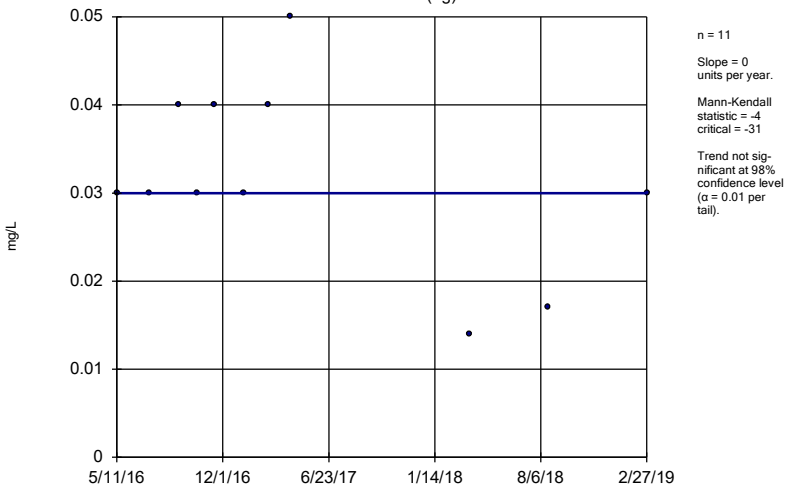
Trend Test Summary Table - All Results (No Significant)

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 3:15 PM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-12 (bg)	0	-4	-31	No	11	0	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-13 (bg)	0.007612	26	31	No	11	0	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-33	-0.02412	-25	-31	No	11	0	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-7	0.4535	17	31	No	11	0	n/a	n/a	0.02	NP
Calcium, total (mg/L)	AD-12 (bg)	0.01357	5	31	No	11	0	n/a	n/a	0.02	NP
Calcium, total (mg/L)	AD-13 (bg)	0.7229	11	31	No	11	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-12 (bg)	0.03234	10	31	No	11	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-13 (bg)	4.571	16	31	No	11	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-22	14.72	26	31	No	11	0	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	AD-12 (bg)	0	-15	-31	No	11	81.82	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	AD-13 (bg)	-0.09446	-11	-31	No	11	36.36	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	AD-22	0.06272	13	31	No	11	45.45	n/a	n/a	0.02	NP
pH, field (SU)	AD-12 (bg)	0.5174	19	31	No	11	0	n/a	n/a	0.02	NP
pH, field (SU)	AD-13 (bg)	0.07474	9	31	No	11	0	n/a	n/a	0.02	NP
pH, field (SU)	AD-22	0.06308	14	31	No	11	0	n/a	n/a	0.02	NP
pH, field (SU)	AD-7	-0.2147	-11	-31	No	11	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.5376	-15	-31	No	11	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-13 (bg)	8.297	20	31	No	11	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-22	64.82	19	31	No	11	0	n/a	n/a	0.02	NP

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -4 critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

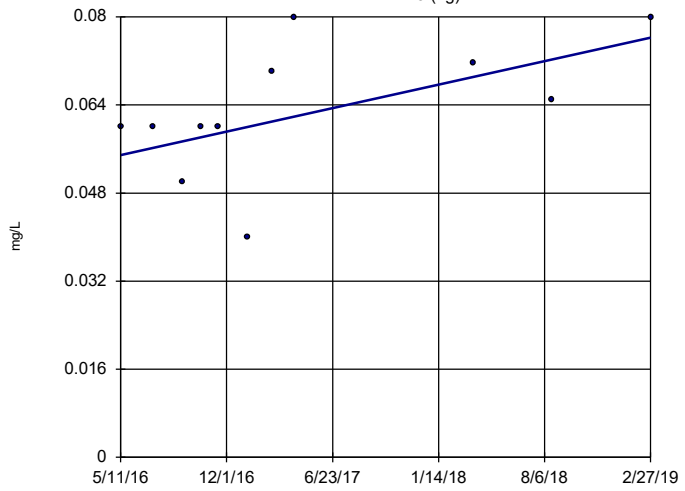
Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = 0.007612 units per year.

Mann-Kendall statistic = 26 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

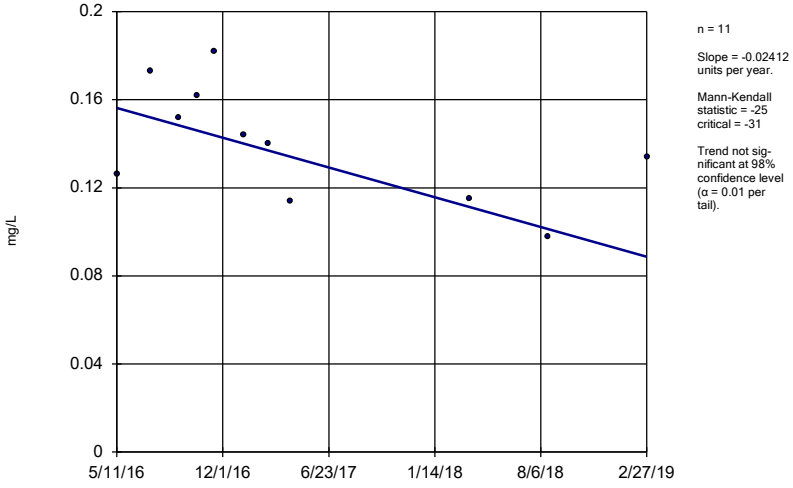
Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-33



n = 11

Slope = -0.02412 units per year.

Mann-Kendall statistic = -25 critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

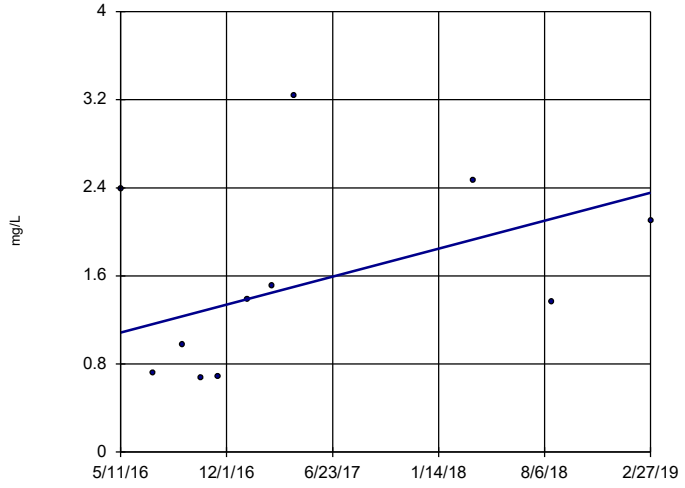
Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-7



n = 11

Slope = 0.4535 units per year.

Mann-Kendall statistic = 17 critical = 31

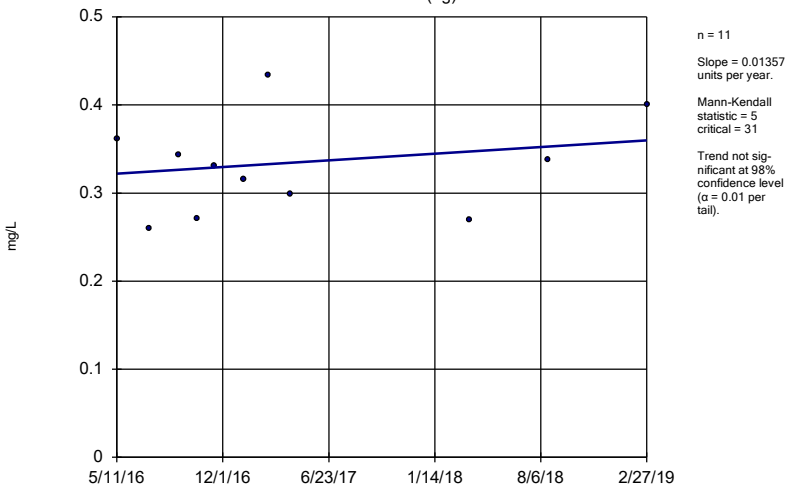
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Boron, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.01357 units per year.

Mann-Kendall statistic = 5
critical = 31

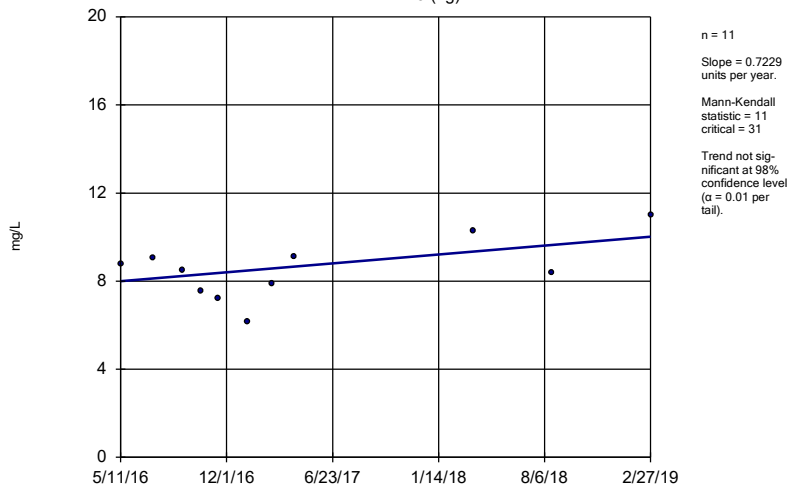
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Calcium, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = 0.7229 units per year.

Mann-Kendall statistic = 11
critical = 31

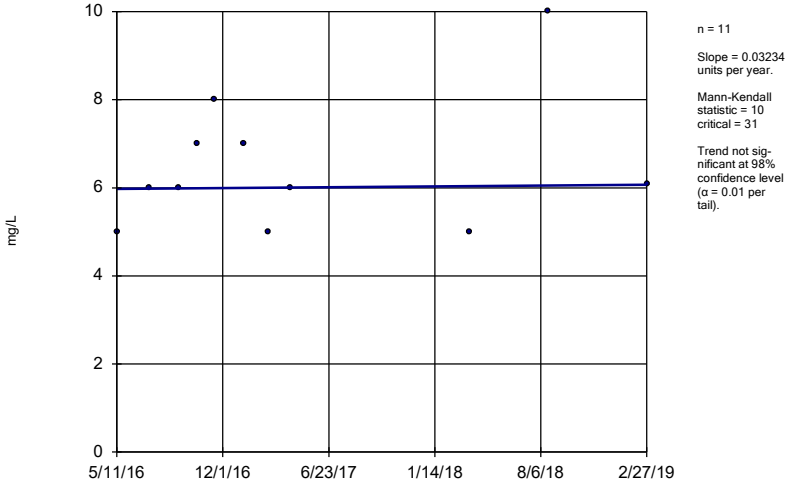
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Calcium, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.03234 units per year.

Mann-Kendall statistic = 10
critical = 31

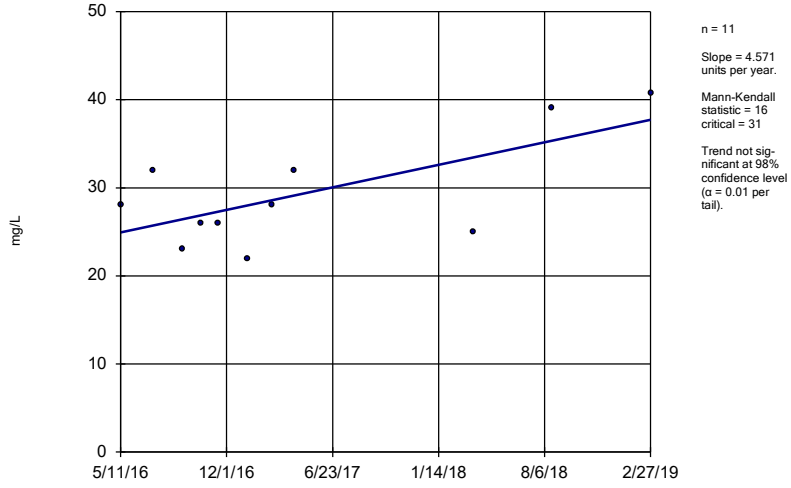
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = 4.571 units per year.

Mann-Kendall statistic = 16
critical = 31

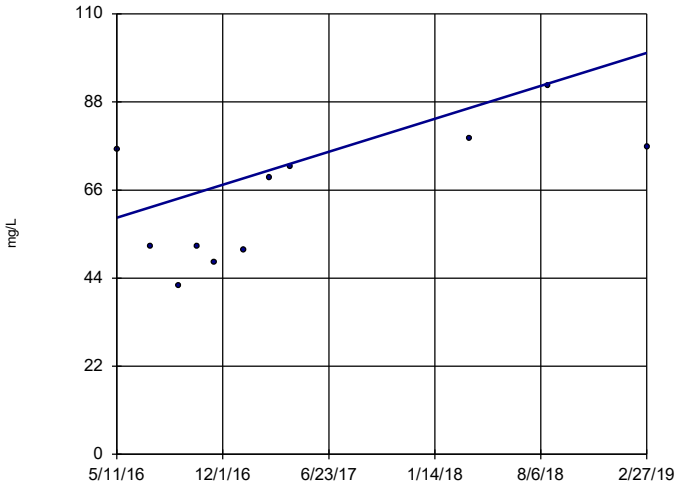
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-22



n = 11

Slope = 14.72 units per year.

Mann-Kendall statistic = 26 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Chloride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

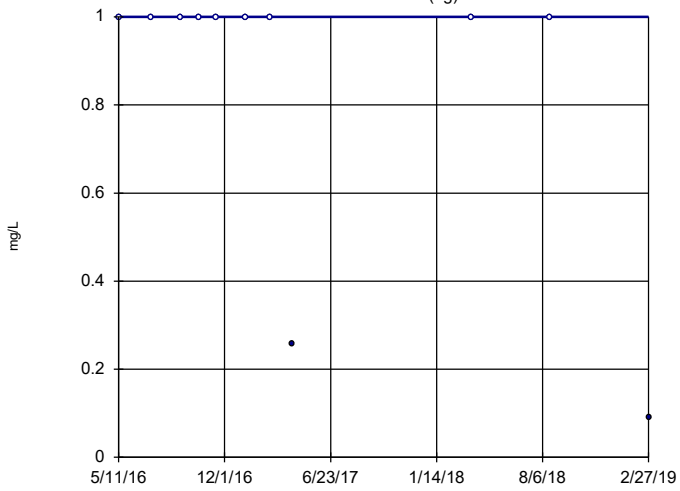
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0 units per year.

Mann-Kendall statistic = -15 critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

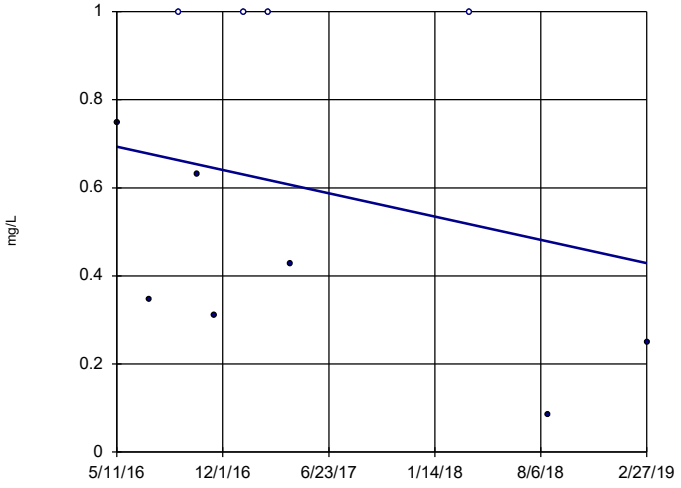
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = -0.09446 units per year.

Mann-Kendall statistic = -11 critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

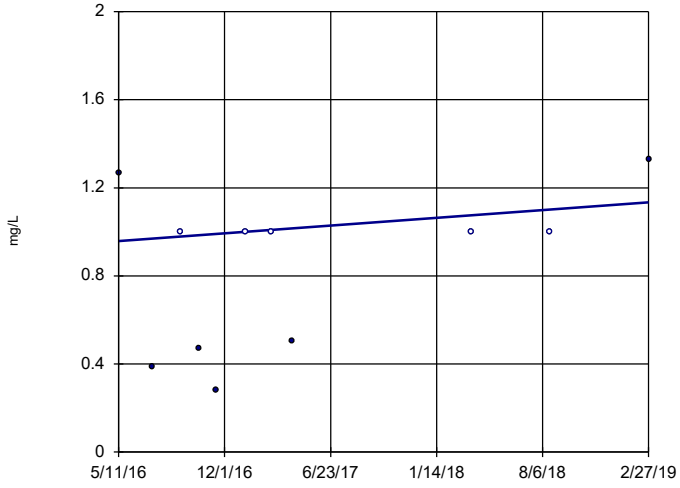
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-22



n = 11

Slope = 0.06272 units per year.

Mann-Kendall statistic = 13 critical = 31

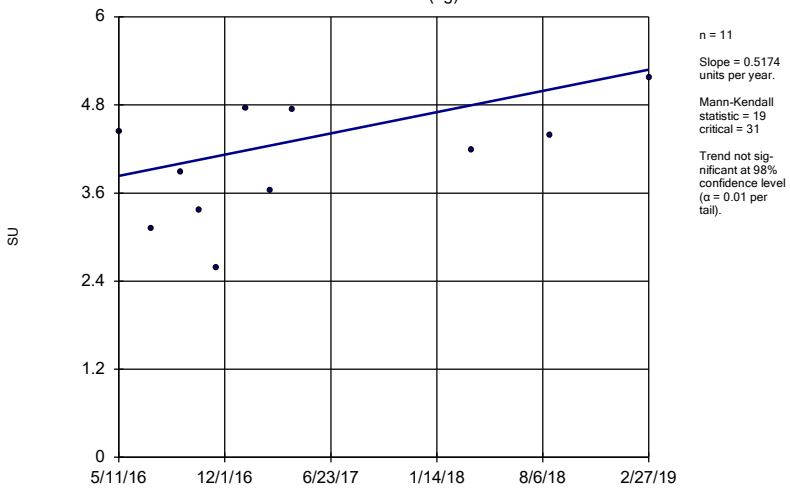
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = 0.5174 units per year.

Mann-Kendall statistic = 19 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

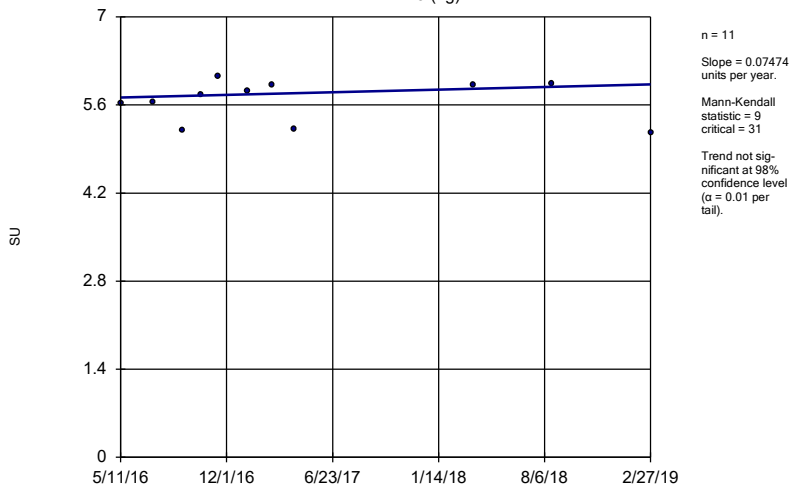
Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = 0.07474 units per year.

Mann-Kendall statistic = 9 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

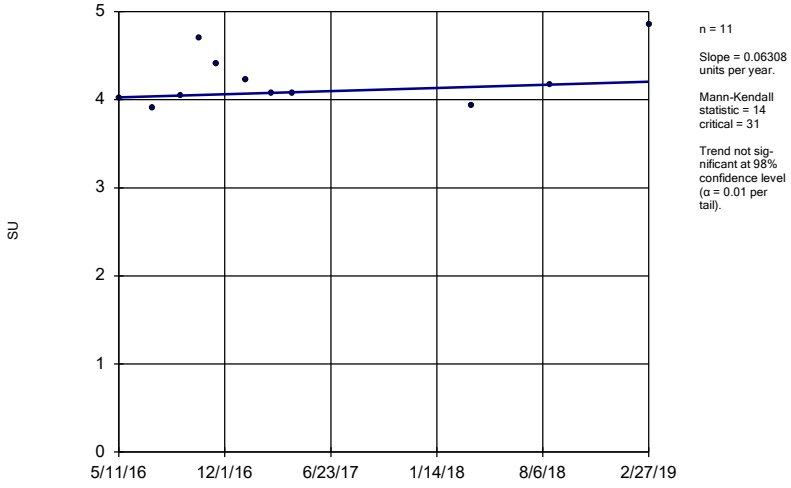
Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-22



n = 11

Slope = 0.06308 units per year.

Mann-Kendall statistic = 14 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

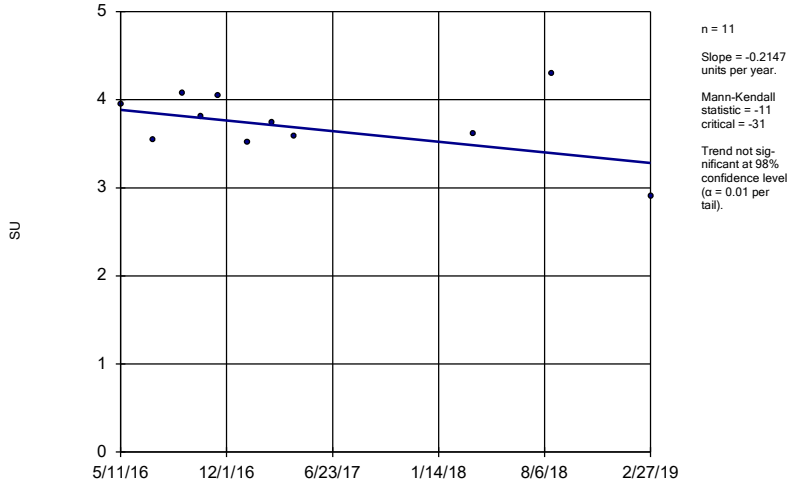
Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-7



n = 11

Slope = -0.2147 units per year.

Mann-Kendall statistic = -11 critical = -31

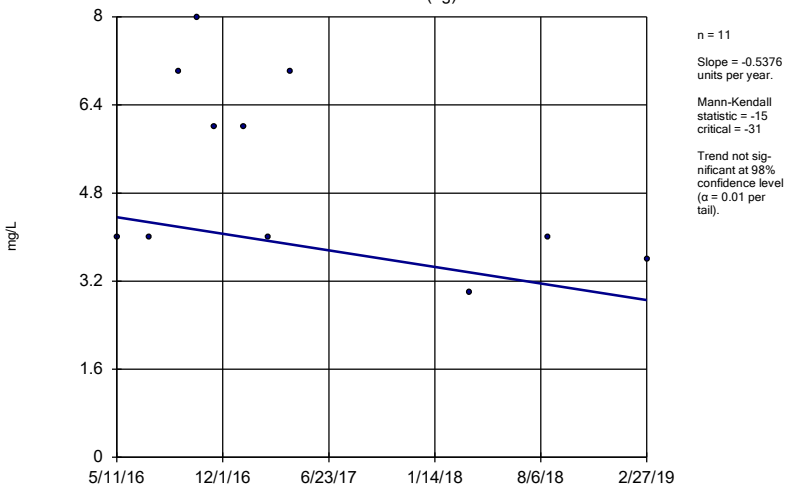
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: pH, field Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sen's Slope Estimator

AD-12 (bg)



n = 11

Slope = -0.5376 units per year.

Mann-Kendall statistic = -15 critical = -31

Trend not significant at 98% confidence level (α = 0.01 per tail).

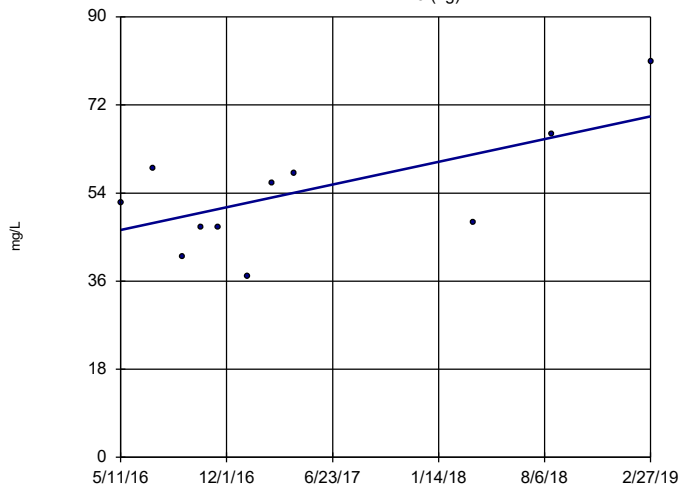
Constituent: Sulfate, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-13 (bg)



n = 11

Slope = 8.297 units per year.

Mann-Kendall statistic = 20 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

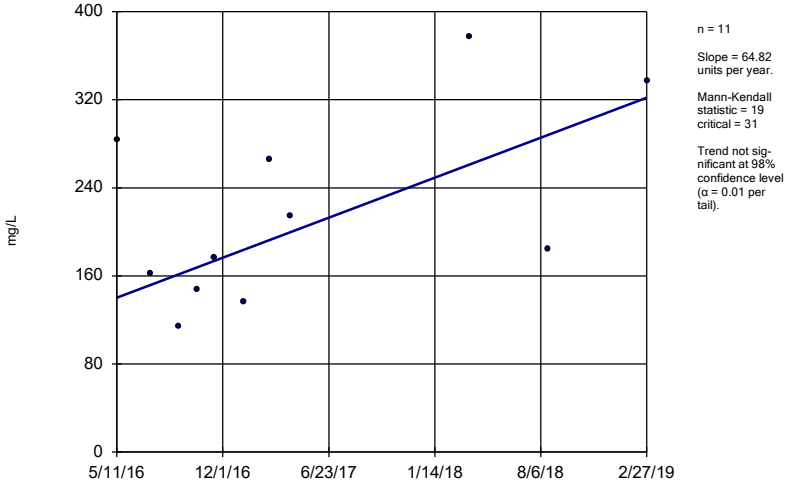
Constituent: Sulfate, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Sen's Slope Estimator

AD-22



n = 11

Slope = 64.82 units per year.

Mann-Kendall statistic = 19 critical = 31

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Sulfate, total Analysis Run 7/5/2019 3:14 PM View: Trend Tests

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit Summary Table - Appendix IV Parameters

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/5/2019, 3:07 PM

Constituent	Well	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	n/a	0.002	22	n/a	n/a	90.91	n/a	n/a	0.3235	NP Inter(NDs)
Arsenic, total (mg/L)	n/a	0.007	21	n/a	n/a	52.38	n/a	n/a	0.3406	NP Inter(normality)
Barium, total (mg/L)	n/a	0.05302	22	0.03335	0.008372	0	None	No	0.05	Inter
Beryllium, total (mg/L)	n/a	0.001876	22	0.07377	0.02109	9.091	None	x^(1/3)	0.05	Inter
Cadmium, total (mg/L)	n/a	0.002	22	n/a	n/a	63.64	n/a	n/a	0.3235	NP Inter(normality)
Chromium, total (mg/L)	n/a	0.004	22	n/a	n/a	50	n/a	n/a	0.3235	NP Inter(normality)
Cobalt, total (mg/L)	n/a	0.056	22	n/a	n/a	0	n/a	n/a	0.3235	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	n/a	3.075	22	1.264	0.7707	0	None	No	0.05	Inter
Fluoride, total (mg/L)	n/a	1	22	n/a	n/a	59.09	n/a	n/a	0.3235	NP Inter(normality)
Lead, total (mg/L)	n/a	0.002	22	n/a	n/a	90.91	n/a	n/a	0.3235	NP Inter(NDs)
Lithium, total (mg/L)	n/a	0.165	22	n/a	n/a	4.545	n/a	n/a	0.3235	NP Inter(normality)
Mercury, total (mg/L)	n/a	0.000025	22	n/a	n/a	81.82	n/a	n/a	0.3235	NP Inter(NDs)
Molybdenum, total (mg/L)	n/a	0.002	22	n/a	n/a	95.45	n/a	n/a	0.3235	NP Inter(NDs)
Selenium, total (mg/L)	n/a	0.004	22	n/a	n/a	72.73	n/a	n/a	0.3235	NP Inter(normality)
Thallium, total (mg/L)	n/a	0.002	22	n/a	n/a	72.73	n/a	n/a	0.3235	NP Inter(normality)

Confidence Interval Summary Table - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/9/2019, 9:05 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.01023**	**0.004131**	**0.004**	**n/a**	**Yes**	**11**	**0**	**x^(1/3)**	**0.01**	**Param.**

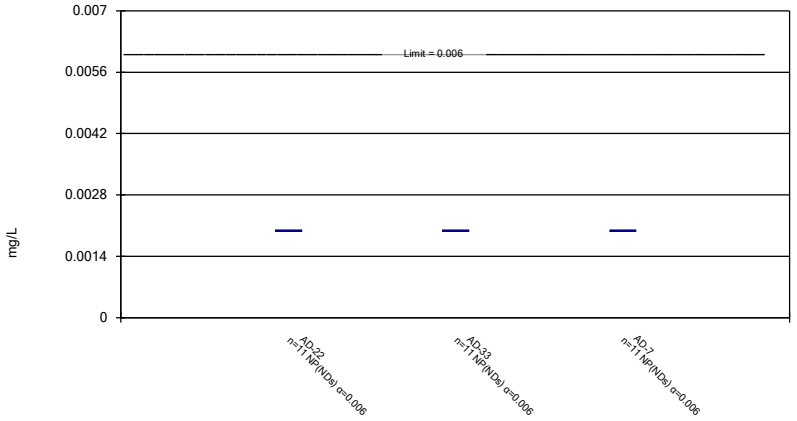
Confidence Interval Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 7/9/2019, 9:05 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Lower Compl.	Sig.	N	%NDs	Transform	Alpha	Method
Antimony, total (mg/L)	AD-22	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-33	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Antimony, total (mg/L)	AD-7	0.002	0.002	0.006	n/a	No	11	90.91	No	0.006	NP (NDs)
Arsenic, total (mg/L)	AD-22	0.01483	0.003766	0.01	n/a	No	11	0	sqrt(x)	0.01	Param.
Arsenic, total (mg/L)	AD-33	0.003379	0.0009104	0.01	n/a	No	10	10	sqrt(x)	0.01	Param.
Arsenic, total (mg/L)	AD-7	0.005	0.00108	0.01	n/a	No	11	54.55	No	0.006	NP (normality)
Barium, total (mg/L)	AD-22	0.08797	0.02781	2	n/a	No	11	0	No	0.01	Param.
Barium, total (mg/L)	AD-33	0.06025	0.05007	2	n/a	No	10	0	No	0.01	Param.
Barium, total (mg/L)	AD-7	0.05694	0.04393	2	n/a	No	11	0	No	0.01	Param.
Beryllium, total (mg/L)	**AD-22**	**0.01023**	**0.004131**	**0.004**	**n/a**	**Yes**	**11**	**0**	**x^(1/3)**	**0.01**	**Param.**
Beryllium, total (mg/L)	AD-33	0.002	0.001	0.004	n/a	No	11	0	No	0.006	NP (normality)
Beryllium, total (mg/L)	AD-7	0.006658	0.003504	0.004	n/a	No	11	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-22	0.001618	0.0005097	0.005	n/a	No	11	0	No	0.01	Param.
Cadmium, total (mg/L)	AD-33	0.001	0.00015	0.005	n/a	No	11	72.73	No	0.006	NP (normality)
Cadmium, total (mg/L)	AD-7	0.0008719	0.0007063	0.005	n/a	No	11	0	No	0.01	Param.
Chromium, total (mg/L)	AD-22	0.01336	0.0007646	0.1	n/a	No	11	18.18	sqrt(x)	0.01	Param.
Chromium, total (mg/L)	AD-33	0.009869	0.000489	0.1	n/a	No	11	18.18	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-7	0.0006464	0.0001661	0.1	n/a	No	11	36.36	x^(1/3)	0.01	Param.
Cobalt, total (mg/L)	AD-22	0.1078	0.05293	0.056	n/a	No	11	0	No	0.01	Param.
Cobalt, total (mg/L)	AD-33	0.01117	0.00875	0.056	n/a	No	10	0	No	0.01	Param.
Cobalt, total (mg/L)	AD-7	0.04224	0.02483	0.056	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-22	5.437	2.864	5	n/a	No	11	0	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-33	4.932	1.447	5	n/a	No	11	0	sqrt(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-7	4.352	2.698	5	n/a	No	11	0	x^2	0.01	Param.
Fluoride, total (mg/L)	AD-22	0.8655	0.2814	4	n/a	No	11	45.45	No	0.01	Param.
Fluoride, total (mg/L)	AD-33	1	0.357	4	n/a	No	11	81.82	No	0.006	NP (NDs)
Fluoride, total (mg/L)	AD-7	1	0.5	4	n/a	No	11	72.73	No	0.006	NP (normality)
Lead, total (mg/L)	AD-22	0.002	0.0005	0.015	n/a	No	11	54.55	No	0.006	NP (normality)
Lead, total (mg/L)	AD-33	0.002	0.002	0.015	n/a	No	10	90	No	0.011	NP (NDs)
Lead, total (mg/L)	AD-7	0.002	0.001	0.015	n/a	No	11	81.82	No	0.006	NP (NDs)
Lithium, total (mg/L)	AD-22	0.2199	0.1201	0.17	n/a	No	11	0	No	0.01	Param.
Lithium, total (mg/L)	AD-33	0.029	0.0178	0.17	n/a	No	11	9.091	No	0.006	NP (normality)
Lithium, total (mg/L)	AD-7	0.107	0.08978	0.17	n/a	No	11	0	x^4	0.01	Param.
Mercury, total (mg/L)	AD-22	0.01023	-0.00006233	0.002	n/a	No	8	0	No	0.01	Param.
Mercury, total (mg/L)	AD-33	0.0008791	0.0002363	0.002	n/a	No	11	0	sqrt(x)	0.01	Param.
Mercury, total (mg/L)	AD-7	0.0002241	0.00005679	0.002	n/a	No	11	0	No	0.01	Param.
Molybdenum, total (mg/L)	AD-22	0.002	0.002	0.1	n/a	No	10	90	No	0.011	NP (NDs)
Molybdenum, total (mg/L)	AD-33	0.002	0.002	0.1	n/a	No	10	90	No	0.011	NP (NDs)
Molybdenum, total (mg/L)	AD-7	0.002	0.002	0.1	n/a	No	11	100	No	0.006	NP (NDs)
Selenium, total (mg/L)	AD-22	0.003928	0.001214	0.05	n/a	No	11	54.55	ln(x)	0.01	Param.
Selenium, total (mg/L)	AD-33	0.005	0.0017	0.05	n/a	No	11	72.73	No	0.006	NP (normality)
Selenium, total (mg/L)	AD-7	0.005	0.001047	0.05	n/a	No	11	72.73	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-22	0.002	0.0008954	0.002	n/a	No	11	63.64	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-33	0.002	0.001192	0.002	n/a	No	11	72.73	No	0.006	NP (normality)
Thallium, total (mg/L)	AD-7	0.002	0.001032	0.002	n/a	No	11	81.82	No	0.006	NP (NDs)

Non-Parametric Confidence Interval

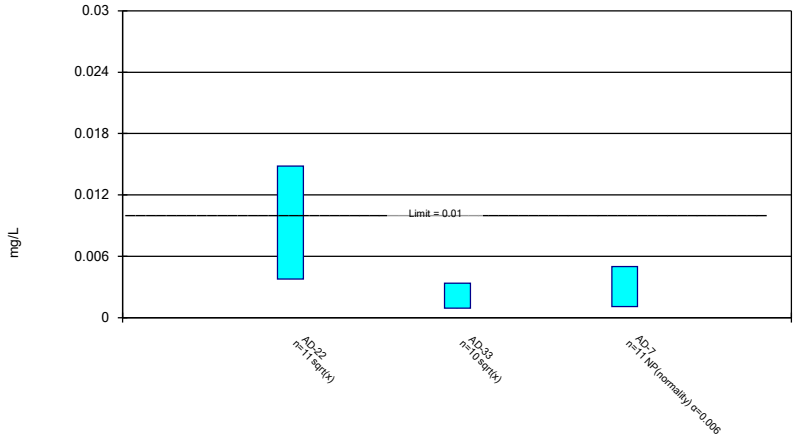
Compliance Limit is not exceeded.



Constituent: Antimony, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

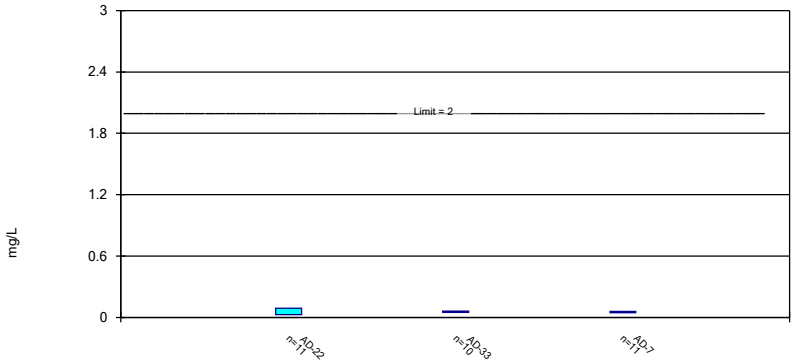
Compliance Limit is not exceeded. Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Arsenic, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

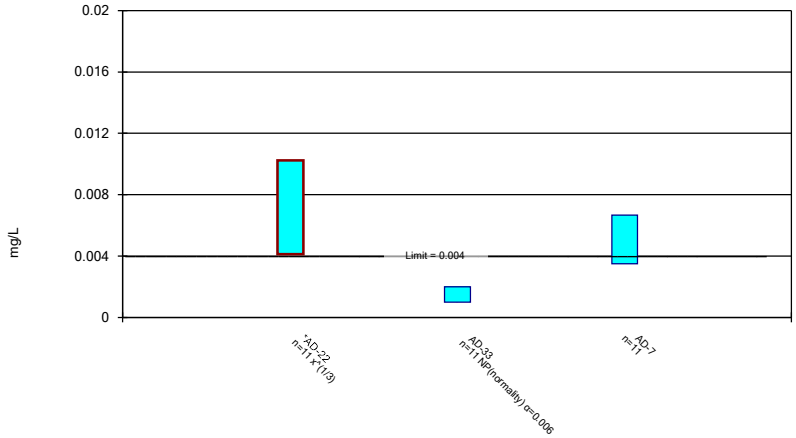
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Barium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

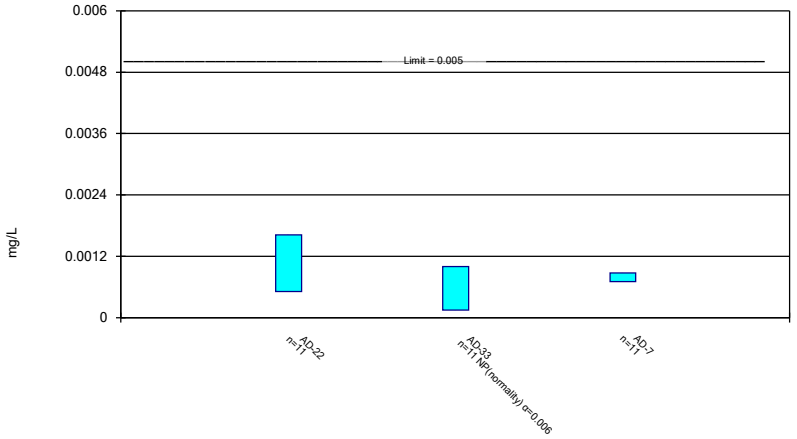
Compliance limit is exceeded.* Per-well alpha = 0.01 except as noted. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Beryllium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

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

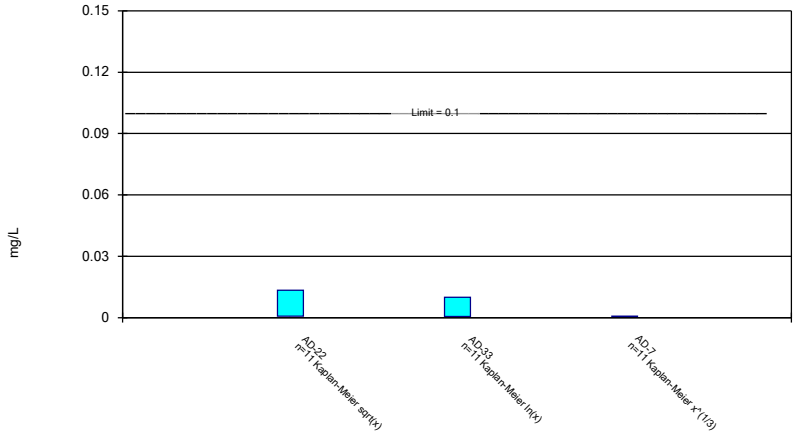


Constituent: Cadmium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Parametric Confidence Interval

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

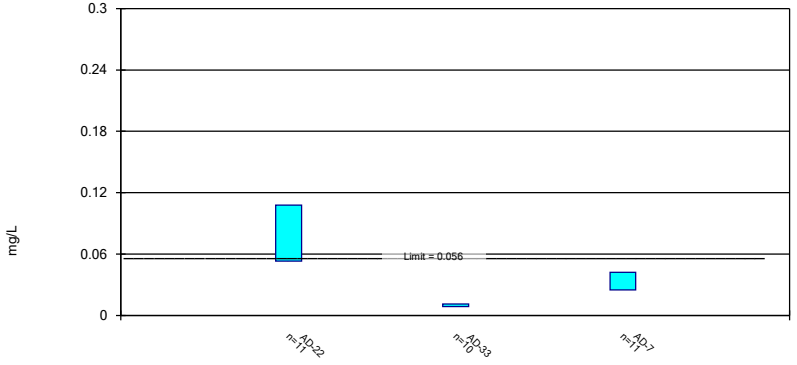


Constituent: Chromium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Parametric Confidence Interval

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

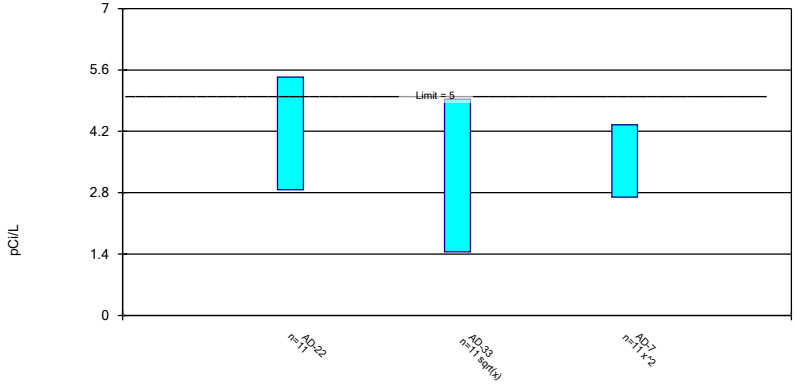


Constituent: Cobalt, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Parametric Confidence Interval

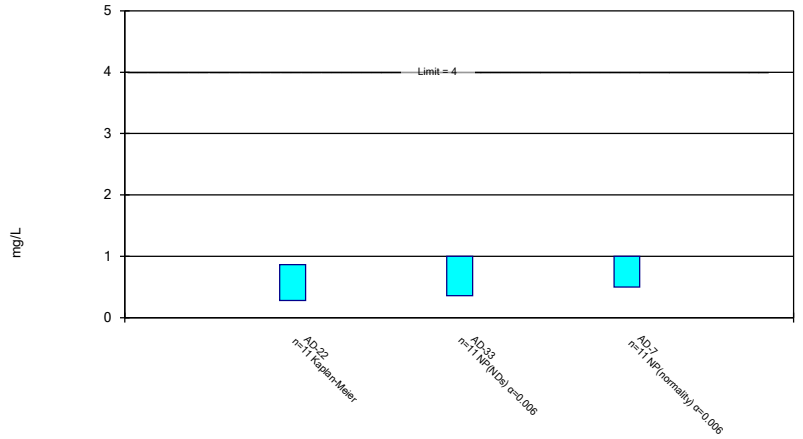
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - A
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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.

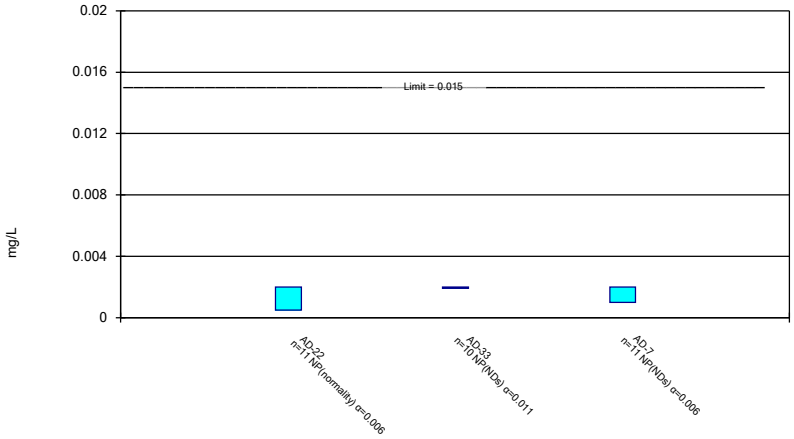


Constituent: Fluoride, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.

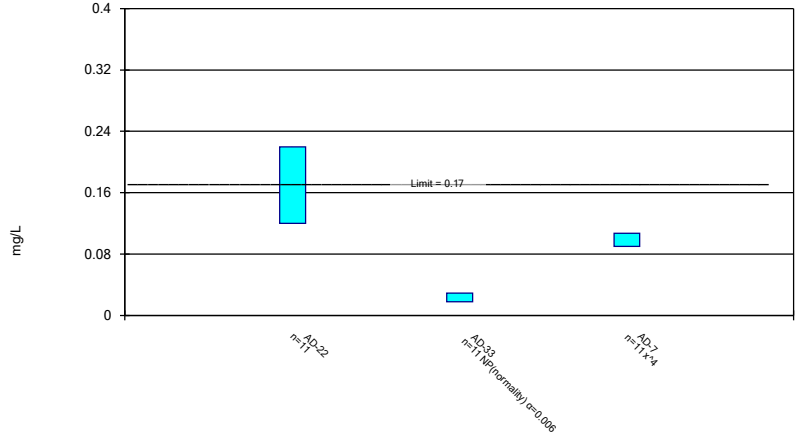


Constituent: Lead, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

Parametric and Non-Parametric (NP) Confidence Interval

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

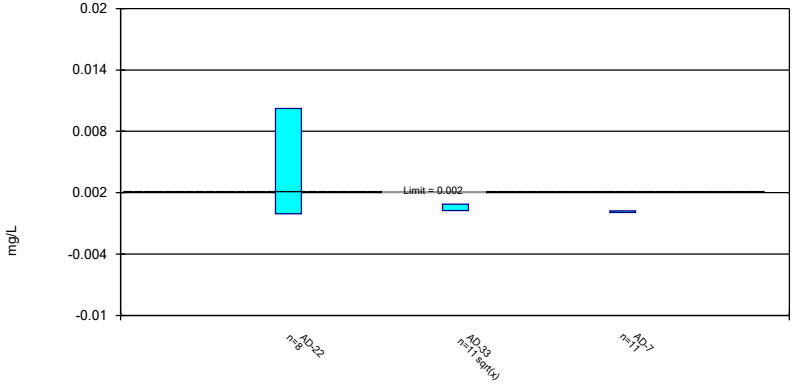


Constituent: Lithium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

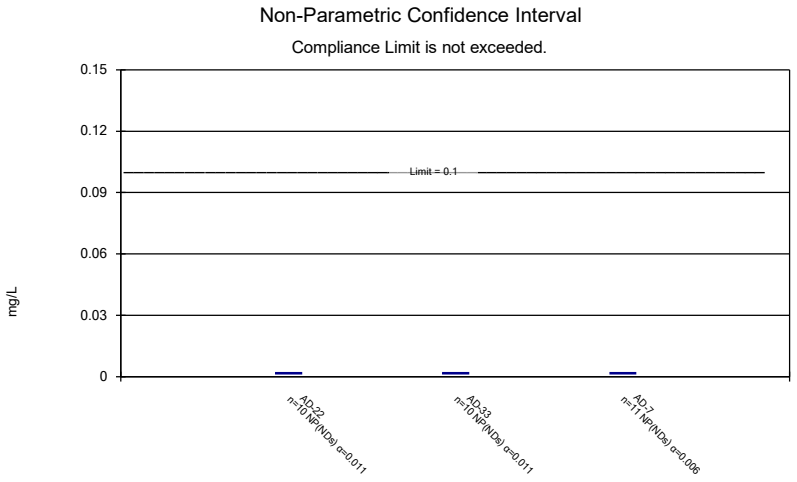
Sanitas™ v.9.6.18 Sanitas software utilized by Groundwater Stats Consulting. UG

Parametric Confidence Interval

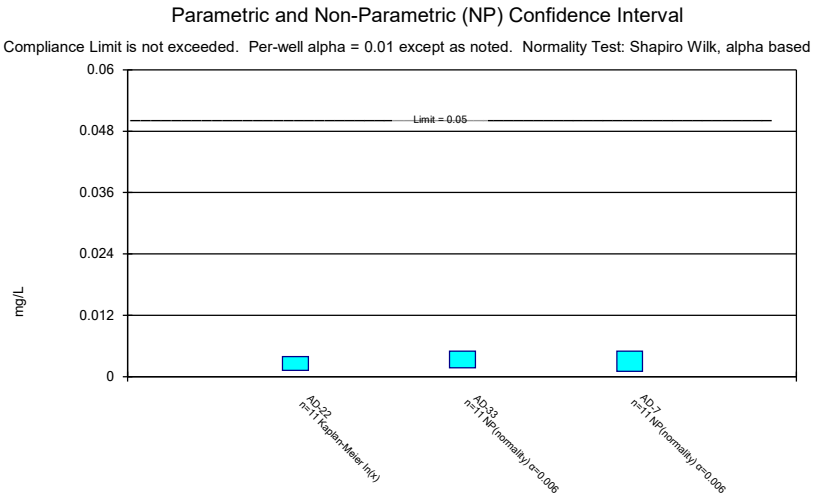
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



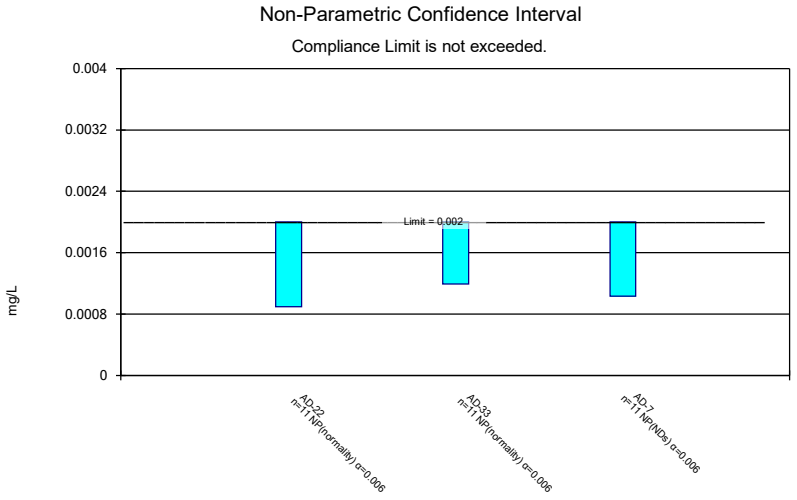
Constituent: Mercury, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout



Constituent: Molybdenum, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout



Constituent: Selenium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout



Constituent: Thallium, total Analysis Run 7/9/2019 9:03 AM View: Confidence Intervals - App IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

STATISTICAL ANALYSIS SUMMARY
FLUE GAS DESULFURIZATION (FGD) STACKOUT AREA
H.W. Pirkey Plant
Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, Ohio 43221

January 2, 2020

CHA8473

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS AND ABBREVIATIONS

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

SECTION 1

EXECUTIVE SUMMARY

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

Based on detection monitoring conducted in 2017 and 2018, statistically significant increases (SSIs) over background were concluded for boron, chloride, and sulfate at the FGD Stackout Area. An alternative source was not identified at the time, so the FGD Stackout Area has been in assessment monitoring since. During the most recent assessment monitoring event, completed in February 2019, an SSL for beryllium was identified at AD-22. An ASD was successfully prepared for beryllium (Geosyntec, 2019); thus, the unit remained in assessment monitoring. Two assessment monitoring events were conducted at the FGD Stackout Area in May and August 2019, in accordance with 40 CFR 257.95. The results of these events are documented in this report.

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

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

SECTION 2

FLUE GAS DESULFURIZATION (FGD) STACKOUT AREA EVALUATION

2.1 Data Validation & QA/QC

During the assessment monitoring program, two sets of samples were collected for analysis from each upgradient and downgradient well to meet the requirements of 40 CFR 257.95(b) (May 2019) and 257.95(d)(1) (August 2019). Samples from both sampling events were analyzed for the Appendix III and Appendix IV parameters. A summary of data collected during these assessment monitoring events may be found in Table 1.

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

The analytical data were imported into a Microsoft Access database, where checks were completed to assess the accuracy of sample location identification and analyte identification. Where necessary, unit conversions were applied to standardize reported units across all sampling events. Exported data files were created for use with the Sanitas™ v.9.6.23 statistics software. The export file was checked against the analytical data for transcription errors and completeness. No QA/QC issues were noted which would impact data usability.

2.2 Statistical Analysis

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

The data obtained in May and August 2019 were screened for potential outliers. Outliers were identified for molybdenum at AD-7, AD-12, AD-13, AD-22, and AD-33. At these locations, molybdenum was not detected and was replaced with the reporting limit of 0.04 mg/L, which is higher than previous reporting limits.

2.2.1 Establishment of GWPSs

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

events. Generally, tolerance limits were calculated parametrically with 95% coverage and 95% confidence. Non-parametric tolerance limits were calculated for beryllium, cadmium, cobalt, fluoride, lithium, selenium, and thallium due to apparent non-normal distributions and for antimony, mercury, and molybdenum due to a high non-detect frequency. Tolerance limits and the final GWPSs are summarized in Table 2.

2.2.2 Evaluation of Potential Appendix IV SSLs

A confidence interval was constructed for each Appendix IV parameter at each compliance well. Confidence limits were generally calculated parametrically ($\alpha = 0.01$); however, non-parametric confidence limits were calculated in some cases (e.g., when the data did not appear to be normally distributed or when the non-detect frequency was too high). Seasonal patterns were observed for beryllium and cobalt at AD-7 and AD-22 and for combined radium at AD-7. The data for these well/parameter pairs was deseasonalized so that the resulting confidence limits correctly account for seasonality as a predictable pattern rather than random variation or a release.

An SSL was concluded if the lower confidence limit (LCL) exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). Calculated confidence limits are shown in Attachment B.

The following SSLs were identified at the Pirkey FGD Stackout Area:

- The deseasonalized LCL for beryllium exceeded the GWPS of 0.00400 mg/L at AD-7 (0.00603 mg/L) and AD-22 (0.00447 mg/L).
- The deseasonalized LCL for cobalt exceeded the GWPS of 0.0560 mg/L at AD-22 (0.0727 mg/L).

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

2.2.3 Establishment of Appendix III Prediction Limits

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

Mann-Whitney (Wilcoxon rank-sum) tests were performed to determine whether the newer data are affected by a release from the FGD Stackout Area. Because the interwell Appendix III limits and the Appendix IV GWPSs are based on data from upgradient wells which we would not expect

to have been impacted by a release, these tests were used for intrawell Appendix III tests only. Mann-Whitney tests were used to compare the medians of historical data (May 2016 - April 2017) to the new compliance samples (August 2017 – February2019) for calcium, pH, and TDS. Results were evaluated to determine if the medians of the two groups were similar at the 99% confidence level. Where no significant difference was found, the new compliance data were added to the background dataset. Where a statistically significant difference was found between the medians of the two groups, the data were reviewed to evaluate the cause of the difference and to determine if adding newer data to the background dataset, replacing the background dataset with the newer data, or continuing to use the existing background dataset was most appropriate. If the differences appeared to have been caused by a release, then the previous background dataset continued to be used.

The complete Mann-Whitney test results and a summary of the significant findings can be found in Attachment B. No significant differences were found between the two groups for calcium, pH, or TDS.

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

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

2.2.4 Evaluation of Potential Appendix III SSIs

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

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

- Boron concentrations exceeded the interwell UPL of 0.0845 mg/L at AD-33 (0.111 mg/L and 0.0970 mg/L) and AD-7 (0.195 mg/L and 3.54 mg/L).
- Calcium concentrations exceeded the intrawell UPL of 15.2 mg/L at AD-22 (16.5 mg/L) and the intrawell UPL of 5.32 mg/L at AD-7 (5.77 mg/L).
- Chloride concentrations exceeded the interwell UPL of 40.8 mg/L AD-22 (63.3 mg/L and 79.6 mg/L).
- The fluoride concentration exceeded the interwell UPL of 1.00 mg/L at AD-22 (1.06 mg/L).
- The May 2019 pH measurement at AD-22 (5.1 SU) exceeded the GWPS of 4.9 SU.
- Sulfate concentrations exceeded the interwell UPL of 80.8 mg/L at AD-22 (360 mg/L and 198 mg/L) and AD-7 (91.6 mg/L).
- TDS concentrations exceeded the intrawell UPL of 203 mg/L at AD-33 (204 mg/L) and the intrawell UPL of 291 mg/L at AD-7 (334 mg/L).

Based on these results, concentrations of Appendix III parameters exceeded background levels at compliance wells at the Pirkey FGD Stackout Area during assessment monitoring.

2.3 Conclusions

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

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

SECTION 3

REFERENCES

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

Geosyntec Consultants. 2018. Statistical Analysis Summary – Flue Gas Desulfurization (FGD) Stackout Area, H.W. Pirkey Plant, Hallsville, Texas. January.

Geosyntec Consultants. 2019. Alternative Source Demonstration Report – Federal CCR Rule. H. W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area, Hallsville, Texas. October.

TABLES

Table 1 - Groundwater Data Summary
Pirkey - Stackout Pad

Component	Unit	AD-7		AD-12		AD-13		AD-22		AD-33	
		5/22/2019	8/12/2019	5/21/2019	8/12/2019	5/21/2019	8/12/2019	5/22/2019	8/12/2019	5/22/2019	8/12/2019
Antimony	µg/L	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U	2.00 U	0.100 U
Arsenic	µg/L	2.00 J	0.640	2.00 U	0.0700 J	2.00 J	1.64	5.89	2.19	2.00 U	0.410
Barium	µg/L	37.8	41.9	21.7	23.8	35.0	35.0	16.7	15.3	52.4	38.6
Beryllium	µg/L	6.47	3.24	2.00 U	0.154	2.00 U	0.235	12.5	3.38	1.00 J	1.00
Boron	mg/L	0.195	3.54	0.0200	0.0500 U	0.0610	0.0640	0.0730	0.0300 J	0.111	0.0970
Cadmium	µg/L	0.600 J	0.750	1.00 U	0.0500 U	1.00 U	0.0500 U	1.52	0.440	1.00 U	0.0400 J
Calcium	mg/L	5.77	4.20	0.300 J	0.278	10.1	8.68	16.5	8.96	1.65	1.03
Chloride	mg/L	28.0	36.7	6.30	7.24	34.8	42.3	63.3	79.6	8.57	8.85
Chromium	µg/L	4.00 U	0.100 J	4.00 U	0.204	4.00 U	0.0600 J	4.00 U	0.200 J	4.00 U	0.100 J
Cobalt	µg/L	46.0	29.7	1.15	1.30	44.7	44.5	129	57.5	10.5	7.02
Combined Radium	pCi/L	4.72	3.28	0.201	0.237	0.875	1.64	6.71	3.09	1.18	1.14
Fluoride	mg/L	0.580	0.300	0.0900	0.0600 J	0.400	0.390	1.06	0.450	0.230	0.190
Lead	µg/L	0.800 J	0.529	2.00 U	0.0800 J	2.00 U	0.200 U	2.00 U	0.100 J	2.00 U	0.100 J
Lithium	mg/L	0.0975	0.102	0.00576	0.00829	0.153	0.139	0.288	0.151	0.0245	0.0233
Mercury	mg/L	0.000260	0.0000900	0.0000250 U	0.0000250 U	0.0000250 U	0.0000250 U	0.000837	0.000325	0.000481	0.000564
Molybdenum	µg/L	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U	40.0 U	2.00 U
Selenium	µg/L	3.00 J	1.70	4.00 U	0.200 J	4.00 U	0.200 U	5.90	2.00	1.00 J	1.10
Total Dissolved Solids	mg/L	334	266	80.0	90.0	190	310	506	484	204	156
Sulfate	mg/L	91.6	59.6	4.00	2.60	69.5	73.6	360	198	60.4	44.3
Thallium	µg/L	0.500 U	0.200 J	0.500 U	0.500 U	0.500 U	0.500 U	0.200 J	0.200 J	0.500 U	0.500 U
pH	SU	3.37	4.01	4.09	4.94	5.32	5.94	5.06	4.76	4.12	4.16

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

Table 2: Groundwater Protection Standards
Pirkey Plant - Stackout

Geosyntec Consultants, Inc.

Constituent Name	MCL	CCR Rule-Specified	Calculated UTL
Antimony, Total (mg/L)	0.006		0.005
Arsenic, Total (mg/L)	0.01		0.006
Barium, Total (mg/L)	2		0.051
Beryllium, Total (mg/L)	0.004		0.002
Cadmium, Total (mg/L)	0.005		0.001
Chromium, Total (mg/L)	0.1		0.002
Cobalt, Total (mg/L)	n/a	0.006	0.056
Combined Radium, Total (pCi/L)	5		2.94
Fluoride, Total (mg/L)	4		1
Lead, Total (mg/L)	n/a	0.015	0.005
Lithium, Total (mg/L)	n/a	0.04	0.17
Mercury, Total (mg/L)	0.002		0.000025
Molybdenum, Total (mg/L)	n/a	0.1	0.005
Selenium, Total (mg/L)	0.05		0.005
Thallium, Total (mg/L)	0.002		0.002

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

Table 3: Revised Prediction Limits
Pirkey Plant - Stackout Pad

Parameter	Unit	Description	AD-22	AD-33	AD-7
Boron	mg/L	Interwell Background Value (UPL)	0.0845		
Calcium	mg/L	Intrawell Background Value (UPL)	15.2	2.29	5.32
Chloride	mg/L	Interwell Background Value (UPL)	40.8		
Fluoride	mg/L	Interwell Background Value (UPL)	1.00		
pH	SU	Intrawell Background Value (UPL)	4.9	4.7	4.5
		Intrawell Background Value (LPL)	3.6	2.7	3.0
Sulfate	mg/L	Interwell Background Value (UPL)	80.8		
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	651	203	291

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

Table 4: Appendix III Data Summary
Pirkey Plant - Stackout Pad

Geosyntec Consultants, Inc.

Parameter	Unit	Description	AD-22		AD-33		AD-7	
			5/22/2019	8/12/2019	5/22/2019	8/12/2019	5/22/2019	8/12/2019
Boron	mg/L	Interwell Background Value (UPL)	0.0845					
		Detection Monitoring Result	0.0730	0.0300	**0.111**	**0.0970**	**0.195**	**3.54**
Calcium	mg/L	Intrawell Background Value (UPL)	15.2		2.29		5.32	
		Detection Monitoring Result	**16.5**	8.96	1.65	1.03	**5.77**	4.20
Chloride	mg/L	Interwell Background Value (UPL)	40.8					
		Detection Monitoring Result	**63.3**	**79.6**	8.57	8.85	28.0	36.7
Fluoride	mg/L	Interwell Background Value (UPL)	1.00					
		Detection Monitoring Result	**1.06**	0.450	0.230	0.190	0.580	0.300
pH	SU	Intrawell Background Value (UPL)	4.9		4.7		4.5	
		Intrawell Background Value (LPL)	3.6		2.7		3.0	
		Detection Monitoring Result	**5.1**	4.8	4.1	4.2	3.4	4.0
Sulfate	mg/L	Interwell Background Value (UPL)	80.8					
		Detection Monitoring Result	**360**	**198**	60.4	44.3	**91.6**	59.6
Total Dissolved Solids	mg/L	Intrawell Background Value (UPL)	651		203		291	
		Detection Monitoring Result	506	484	**204**	156	**334**	266

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

ATTACHMENT A
Certification by Qualified Professional Engineer

Certification by Qualified Professional Engineer

I certify that the selected and above described statistical method is appropriate for evaluating the groundwater monitoring data for the Pirkey Flue Gas Desulfurization (FGD) Stackout Area CCR management area and that the requirements of 40 CFR 257.93(f) have been met.

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

112498	TEXAS	01.03.20
License Number	Licensing State	Date

ATTACHMENT B

Statistical Analysis Output

GROUNDWATER STATS CONSULTING

December 10, 2019

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

Re: Pirkey Stackout
Statistical Analysis & Background Update – 2019

Dear Ms. Kreinberg,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the background update of groundwater data for American Electric Power Inc.'s Pirkey Stackout. 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 the site for the CCR program in 2016. The monitoring well network, as provided by Geosyntec Consultants, consists of the following:

- **Upgradient wells:** AD-12 and AD-13; and
- **Downgradient wells:** AD-22, AD-33, and AD-7.

Data were sent electronically to Groundwater Stats Consulting, and the statistical analysis report 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 analysis was prepared according to the background screening conducted in December 2017 that was approved by Dr. Cameron.

The CCR program consists of the following constituents:

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

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

Summary of Statistical Method:

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

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, the reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory. There is no replacement of historical reporting limits with the most recent reporting limit. It was noted that the most recent RL are significantly lower than those reported historically.
- 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.

Historical Summary - Evaluation of Appendix III Parameters – December 2017

Outlier Evaluation

Time series plots were 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 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.

During the previous background screening, a high value was flagged as an outlier for TDS in downgradient well AD-33. The current assumption is that changes in concentrations are reflective of natural variation upgradient of the facility; however, a separate study and hydrogeological investigation would be required to fully understand the geochemical conditions and expected groundwater quality for the region. That study and assessment is beyond the scope of services provided by Groundwater Stats Consulting.

Statistical Limits

Interwell prediction limits combined with a 1-of-2 verification strategy were constructed for boron, chloride, fluoride, and sulfate; and intrawell prediction limits combined with a 1-of-2 verification strategy were constructed for calcium, pH and TDS. The statistical method selected for each parameter was determined based on the results of the evaluation performed in December 2017; and all proposed background data were screened for outliers and trends at that time. The findings of those reports were submitted with that analysis.

Interwell prediction limits utilize all upgradient well data for construction of statistical limits. During each sample event, upgradient well data were screened for any newly suspected outliers or obvious trending patterns using time series plots. Intrawell prediction limits utilized the background data set that was originally screened in 2017. As recommended in the EPA Unified Guidance (2009), the set background data will be tested for the purpose of updating statistical limits using the Mann-Whitney two-sample test when an additional four to eight measurements are available.

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. When the resample confirms the initial exceedance, a statistically significant increase (SSI) is identified and further research would be required to identify the cause of the exceedance (i.e. impact from the site, natural variation, or an off-site source). If the resample falls within the statistical limit, the initial exceedance is considered a false positive result and, therefore, no further action is necessary. Prediction limit exceedances were noted for boron in wells AD-33 and AD-7; calcium in well AD-13; chloride, fluoride and sulfate in well AD-22; and pH in wells AD-22 and AD-7. The results of those findings were included in the previous screening and may be found in the Prediction Limit Summary tables.

When a statistically significant increase is identified, the data are further evaluated using the Sen's Slope/Mann Kendall trend test to determine whether concentrations are statistically increasing, decreasing or stable. Upgradient wells are included in the trend analyses to identify whether similar patterns exist upgradient of the site which is an indication of natural variability in groundwater unrelated to practices at the site.

No statistically significant increasing or decreasing trends were found for any of the downgradient well/parameter pairs with prediction limit exceedances.

Appendix III Background Update – November 2019

Prior to updating background data, samples are re-evaluated for all wells for intrawell parameters and all upgradient wells for interwell parameters using Tukey's outlier test and visual screening with the May and August 2019 samples. Additionally, samples during August and December 2017 that were previously absent were incorporated into this analysis. No values were flagged for Appendix III parameters except for fluoride in downgradient well AD-7, and the previously flagged outlier for TDS in well AD-33 was also flagged for this background screening. As mentioned above, any flagged data are displayed in a lighter font and as a disconnected symbol on the time series reports, as well as in a lighter font on the accompanying data pages. An updated summary of Tukey's test results and flagged outliers follows this letter (Figure C).

For constituents requiring intrawell prediction limits, the Mann-Whitney (Wilcoxon Rank Sum) test was used to compare the medians of historical data through April 2017 to the new compliance samples at each well through February 2019 to evaluate whether the groups are statistically different at the 99% confidence level, in which case background data may be updated with compliance data.

No statistically significant differences were found between the two groups for any well/parameter pairs. Typically, when the test concludes that the medians of the two groups are significantly different, particularly in the downgradient wells, the background are not updated to include the newer data but will be reconsidered in the future. A summary of these results follows this letter and the test results are included with the Mann Whitney test section at the end of this report (Figure D).

Intrawell prediction limits using all historical data through February 2019 combined with a 1-of-2 resample plan, were constructed for a majority of the well/constituent pairs and a summary of the updated limits follows this letter (Figure E). Seasonal trends appeared to be present for calcium and TDS in wells AD-22 and AD-7 and, therefore, prediction limits were constructed using de-seasonalized values (Figure F).

For parameters tested using interwell analyses, the Sen's Slope/Mann-Kendall trend test was used on upgradient wells to determine whether concentrations are statistically increasing, decreasing or stable (Figure G). No statistically significant increasing or decreasing trends were noted with the exception of fluoride in upgradient well AD-12. The magnitude of this trend, however, is low relative to the average concentrations in these wells. Therefore, no adjustments were required at this time. A summary of these results is included with the trend tests.

Interwell prediction limits, combined with a 1-of-2 resample plan, were updated using all available data from upgradient wells through February 2019 for boron, chloride, fluoride, and sulfate (Figure H). Interwell prediction limits pool upgradient well data to establish a background limit for an individual constituent. A summary table of the updated limits may be found following this letter in the Prediction Limit Summary Tables.

Evaluation of Appendix IV Parameters – November 2019

Interwell Tolerance limits were used to calculate background limits from all available pooled upgradient well data for Appendix IV parameters to determine the Alternate Contaminant Level (ACL) for each constituent (Figure I). Background data are screened for outliers and extreme trending patterns that would lead to artificially elevated statistical limits. Tukey's test did identify several outliers that were flagged in the database.

Note that the reporting limit during the February 2019 event for molybdenum at wells AD-12, AD-13, AD-22 and AD-33 was 0.04 mg/L compared to a historical reporting limit of 0.002 mg/L. Well AD-7, however, had a reporting limit of 0.002 mg/L during this

event. The resulting nondetects reported at 0.04 mg/L are censored at much higher levels than the rest of the data and, therefore, are flagged as outliers.

The reporting limit (or practical quantitation limit) for the February 2019 event for thallium also increased from the historical reporting limit of 0.002 mg/L to 0.01 mg/L for all wells. However, since no detections were present above the method detection limit of 0.002 mg/L for this event, the historical reporting limit of 0.002 mg/L was used for historic nondetects and the nondetects with a reporting limit of 0.01 mg/L were flagged as outliers.

Parametric limits use a target of 95% confidence and 95% coverage. The confidence and coverage levels for nonparametric tolerance limits are dependent upon the number of background samples. These limits were compared to the Maximum Contaminant Levels (MCLs) and CCR-Rule specified levels in the Groundwater Protection Standard (GWPS) table following this letter to determine the highest limit for use as the GWPS in the Confidence Interval comparisons (Figure J).

Confidence intervals were then constructed on downgradient wells for each of the Appendix IV parameters using the highest limit of the MCL, CCR-Rule specified levels, or ACL as discussed above (Figure K). Only when the entire confidence interval is above a GWPS is the well/constituent pair considered to exceed its respective standard. No confidence interval exceedances were noted; however, seasonal patterns were noted in some wells and additional confidence intervals were constructed using deseasonalized data as discussed below. A summary of the confidence interval results follows this letter.

Seasonal patterns were observed on the time series plots for beryllium and cobalt in wells AD-22 and AD-7, and combined radium 226 + 228 in well AD-7. When seasonal patterns are observed, data are deseasonalized so that the resulting limits will correctly account for the seasonality as a predictable pattern rather than random variation or a release. It was noted that cadmium in well AD-22 may also be exhibiting some seasonal influence; however, all reported measurements are well below the GWPS and, therefore, this record did not require additional adjustments. Confidence intervals were constructed with deseasonalized values for those wells and constituents mentioned above and the results follow this letter (Figure L). The GWPS was exceeded by wells AD-22 and AD-7 for beryllium, and by well AD-22 for cobalt.

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

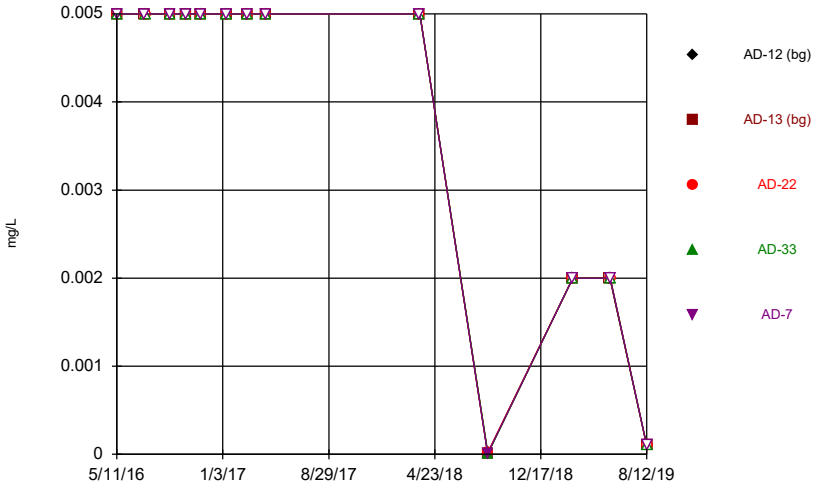
For Groundwater Stats Consulting,

Andrew T. Collins
Groundwater Analyst

Kristina L. Rayner
Groundwater Statistician

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

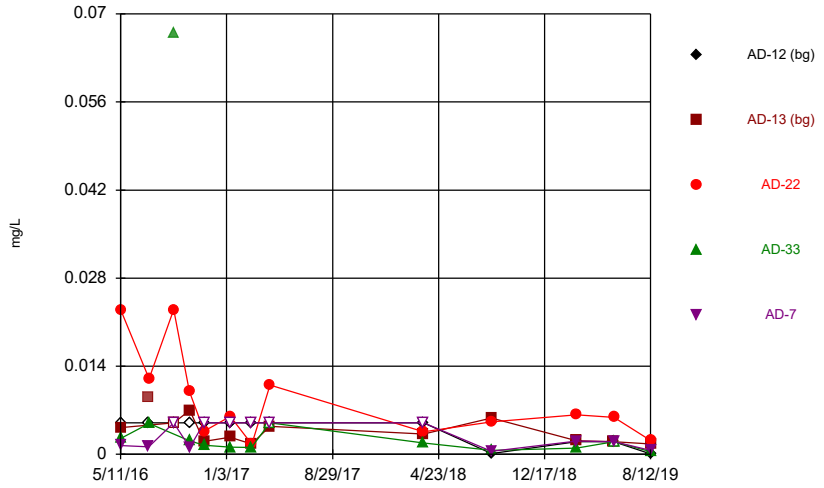
Time Series



Constituent: Antimony, total Analysis Run 12/10/2019 12:28 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

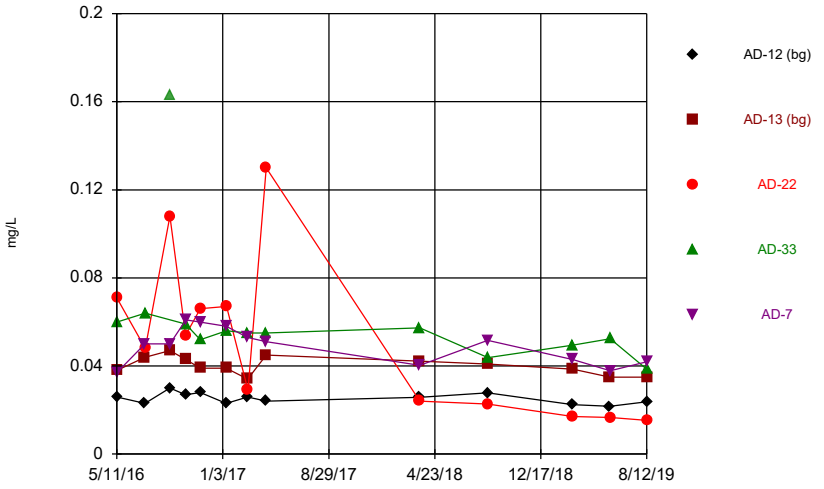
Time Series



Constituent: Arsenic, total Analysis Run 12/10/2019 12:28 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

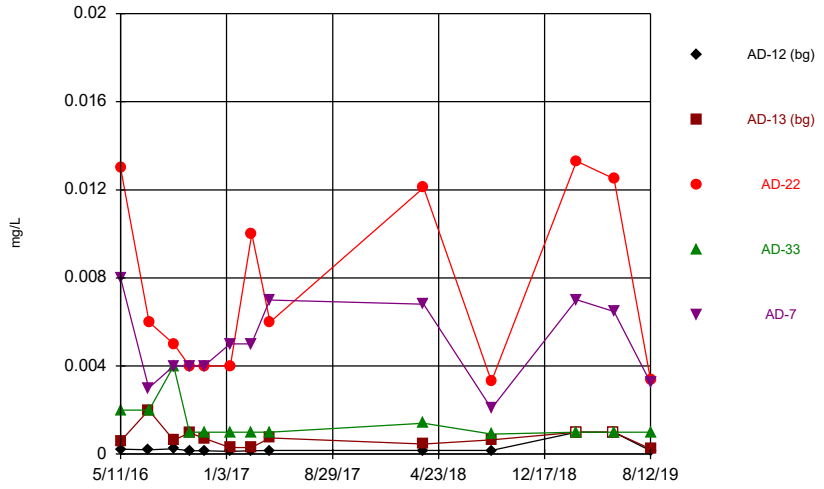
Time Series



Constituent: Barium, total Analysis Run 12/10/2019 12:28 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

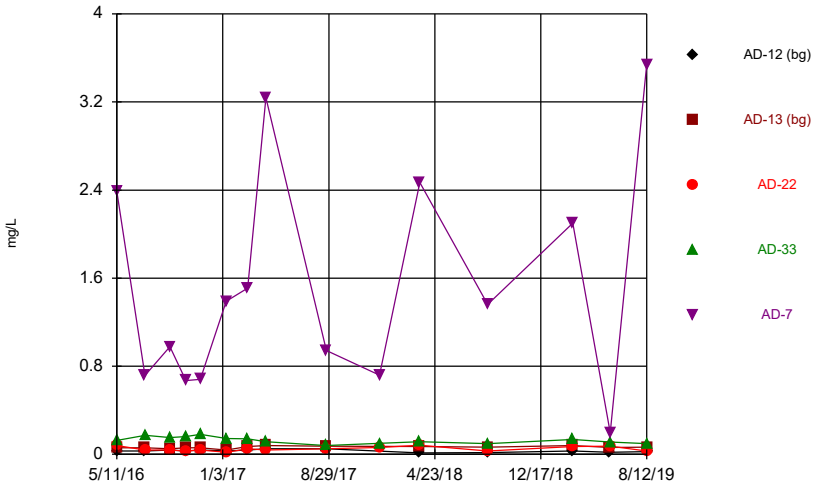
Time Series



Constituent: Beryllium, total Analysis Run 12/10/2019 12:28 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

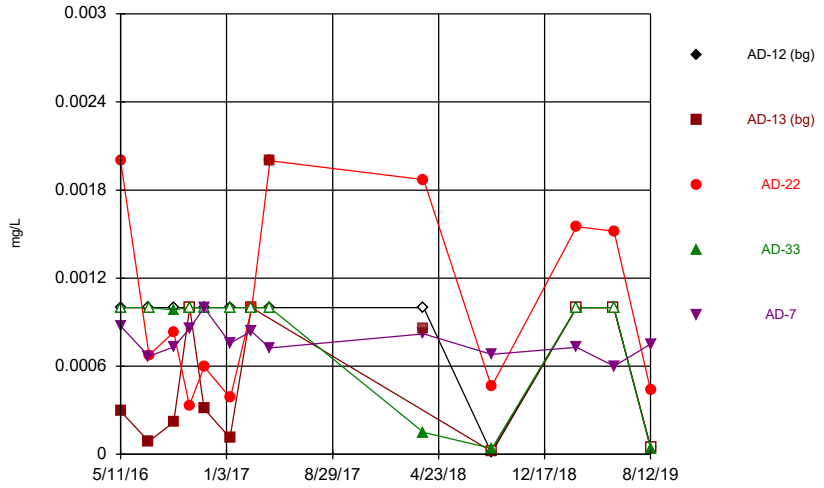
Time Series



Constituent: Boron, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

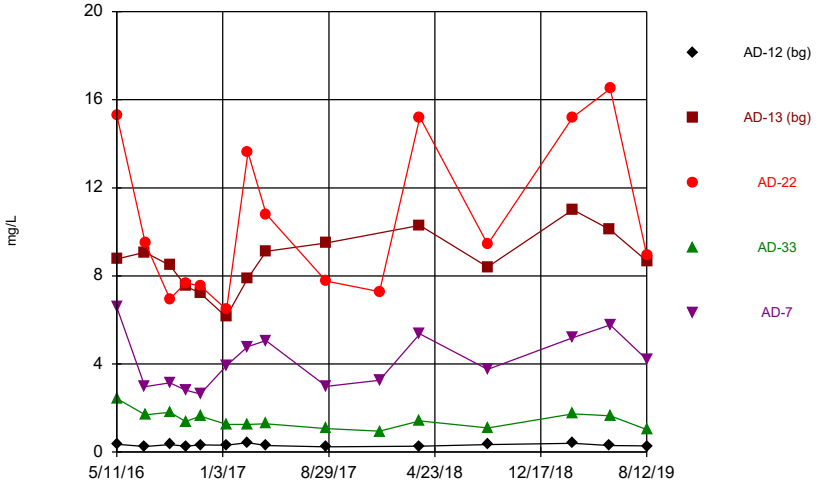
Time Series



Constituent: Cadmium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

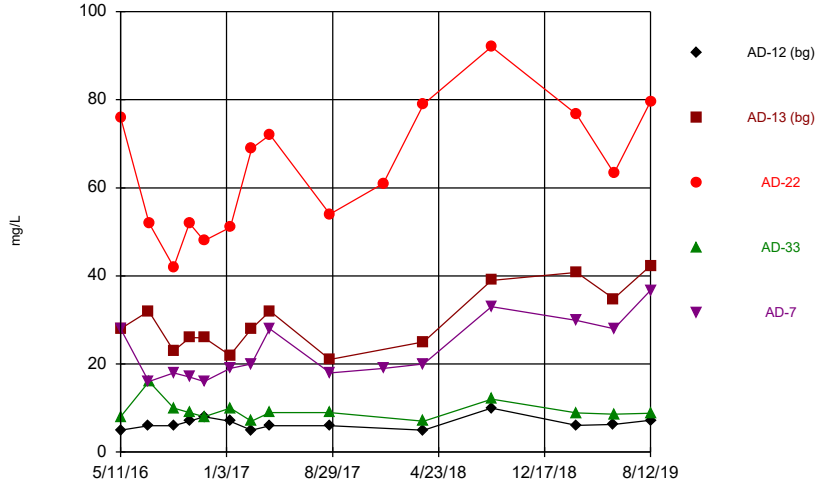
Time Series



Constituent: Calcium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

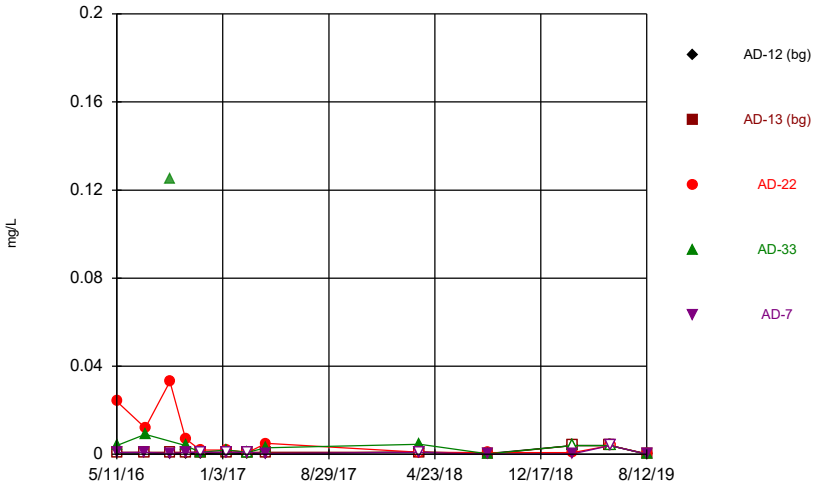
Time Series



Constituent: Chloride, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

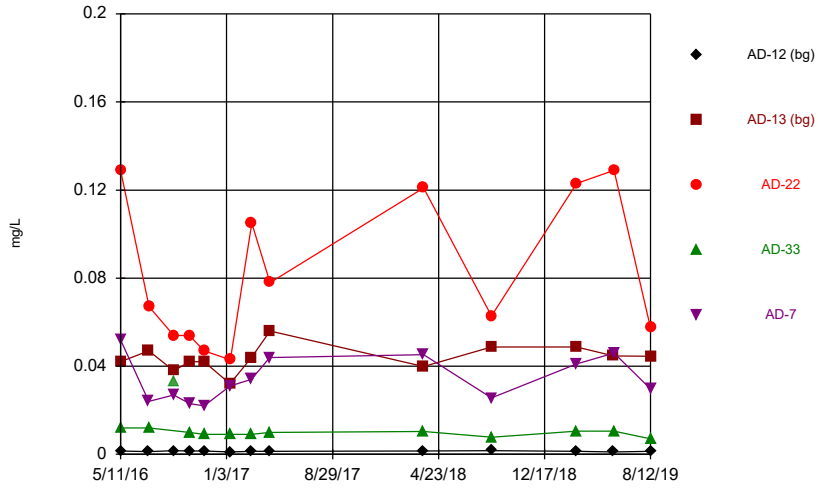
Time Series



Constituent: Chromium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

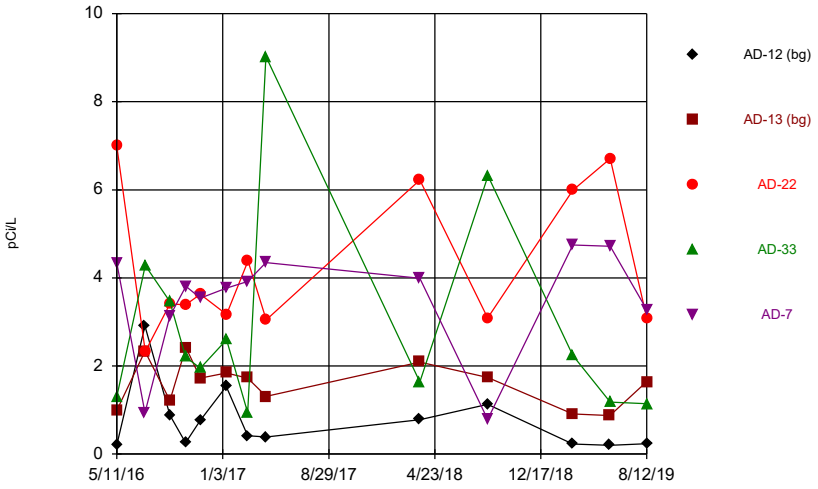
Time Series



Constituent: Cobalt, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

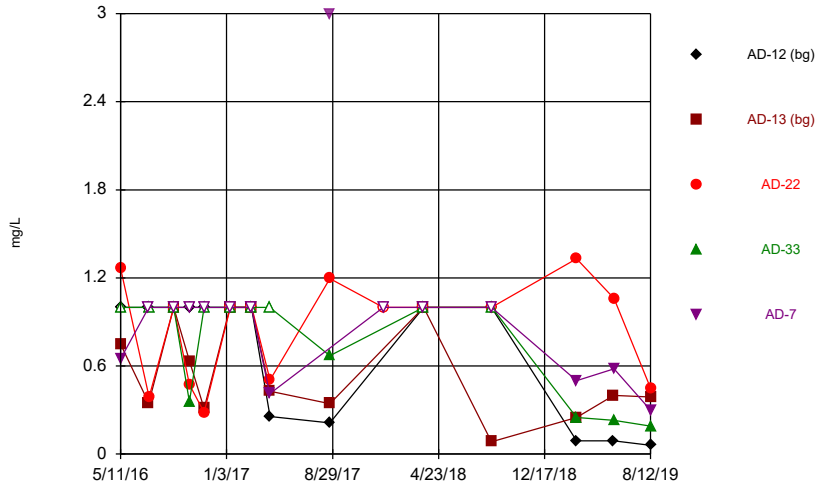
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

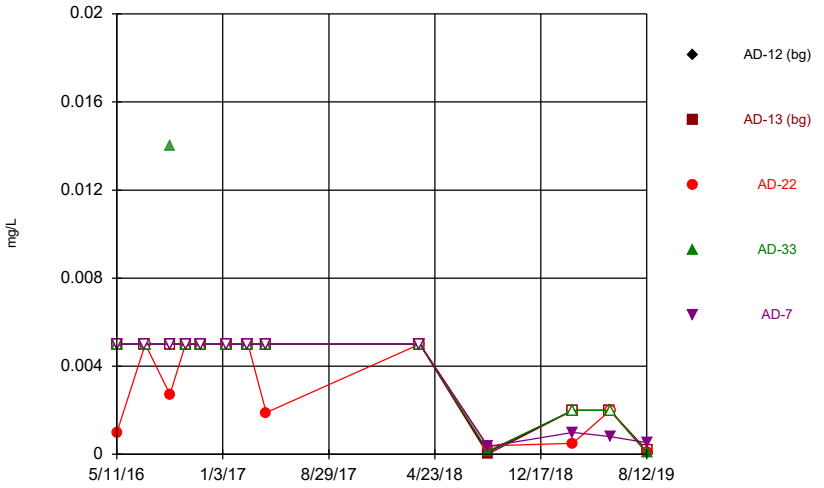
Time Series



Constituent: Fluoride, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

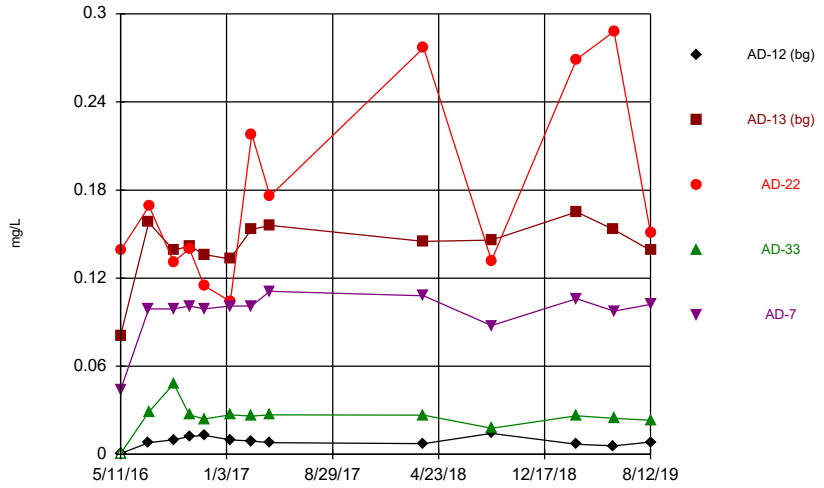
Time Series



Constituent: Lead, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

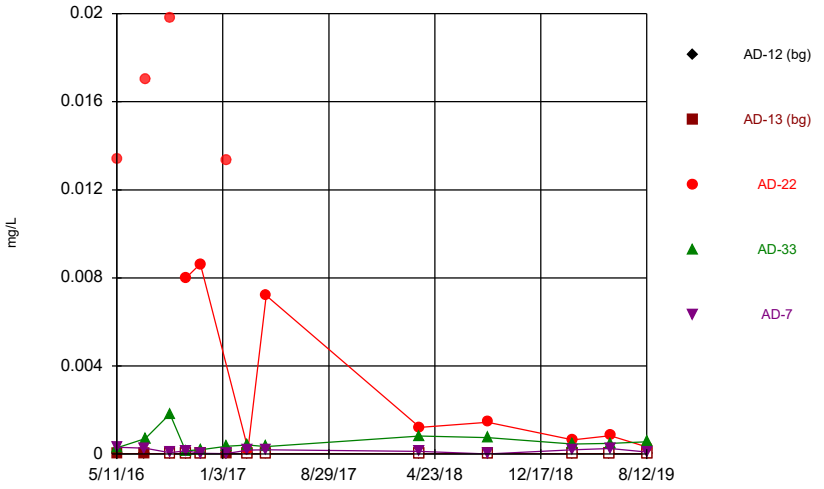
Time Series



Constituent: Lithium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

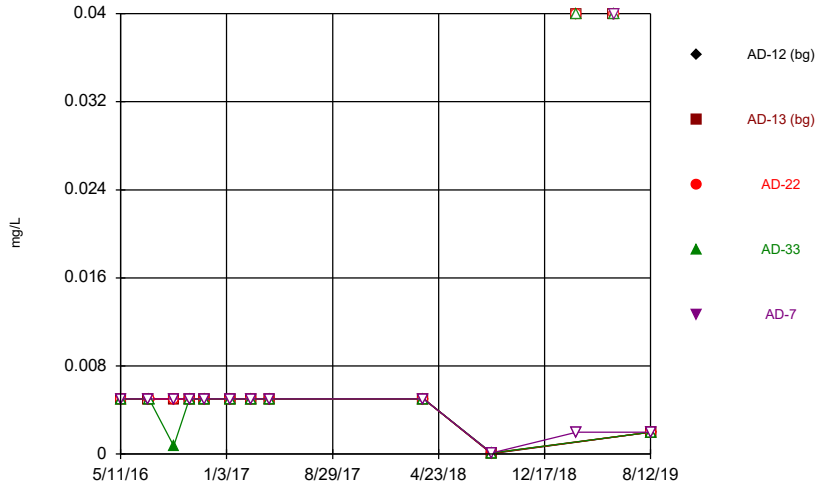
Time Series



Constituent: Mercury, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

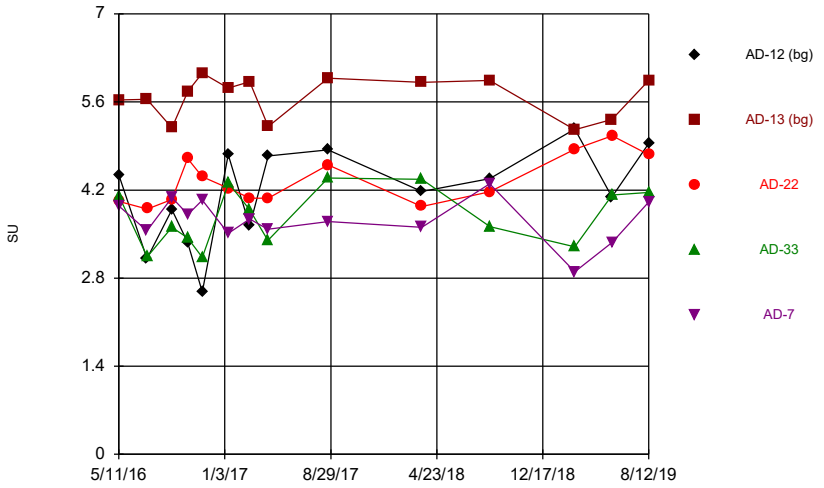
Time Series



Constituent: Molybdenum, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

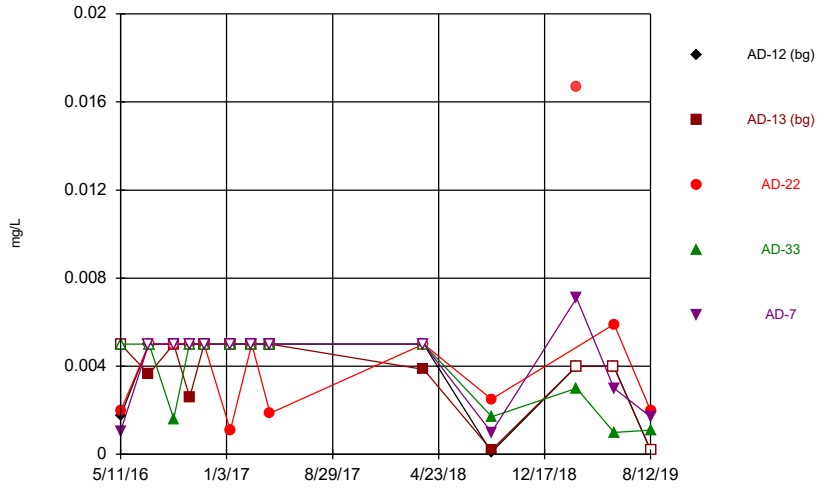
Time Series



Constituent: pH, field Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

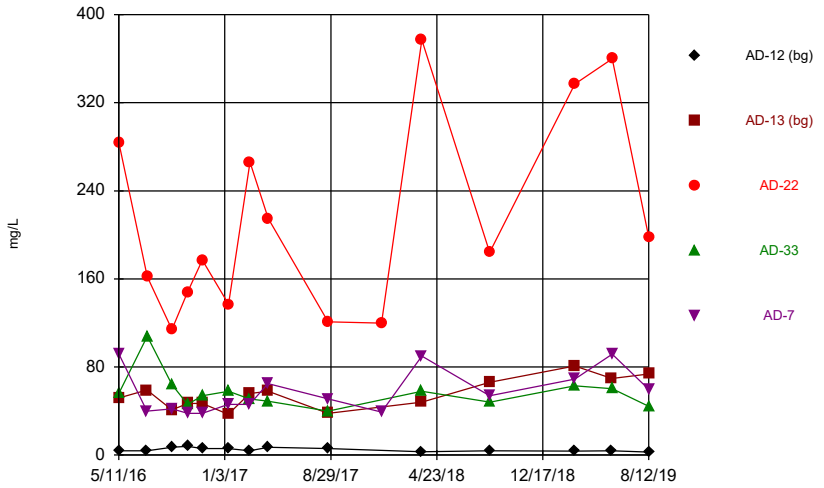
Time Series



Constituent: Selenium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

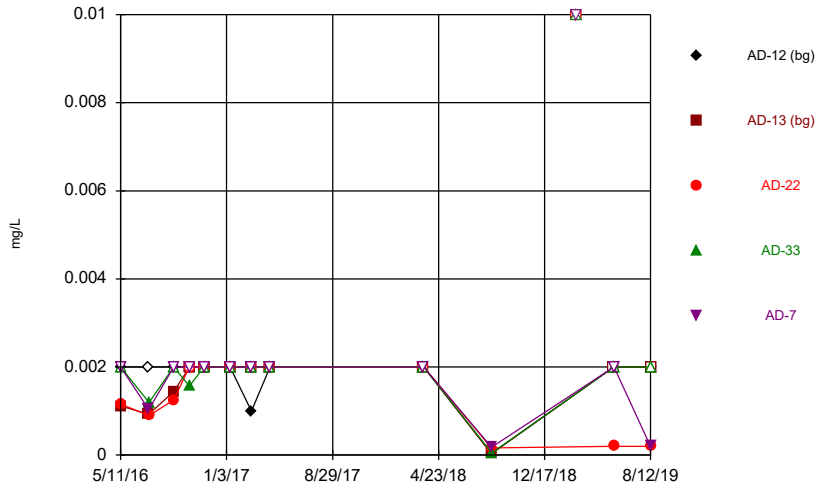
Time Series



Constituent: Sulfate, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

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

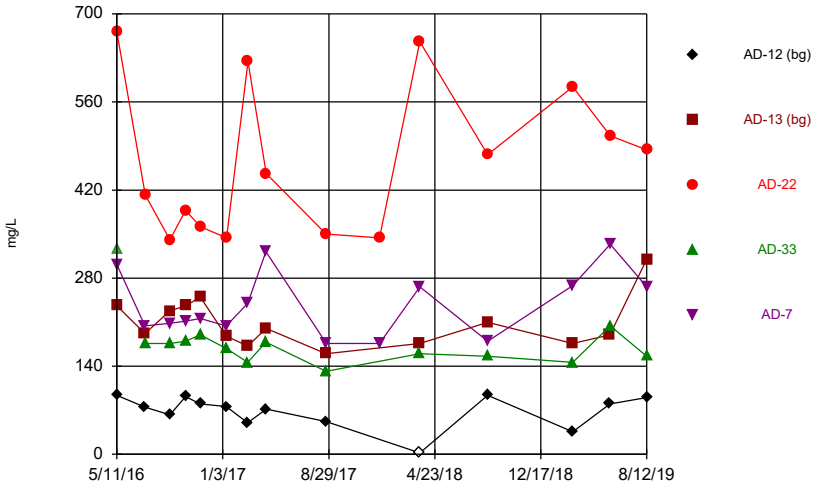
Time Series



Constituent: Thallium, total Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

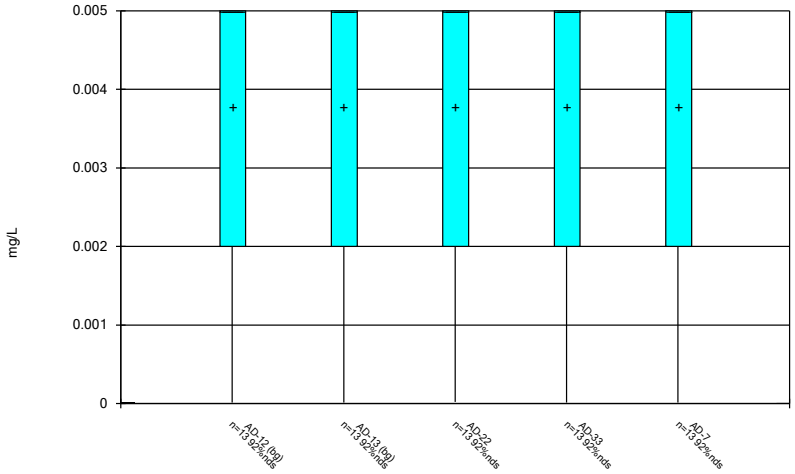
Sanitas™ v.9.6.23e Sanitas software utilized by Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Time Series



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/10/2019 12:29 PM View: Time Series
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

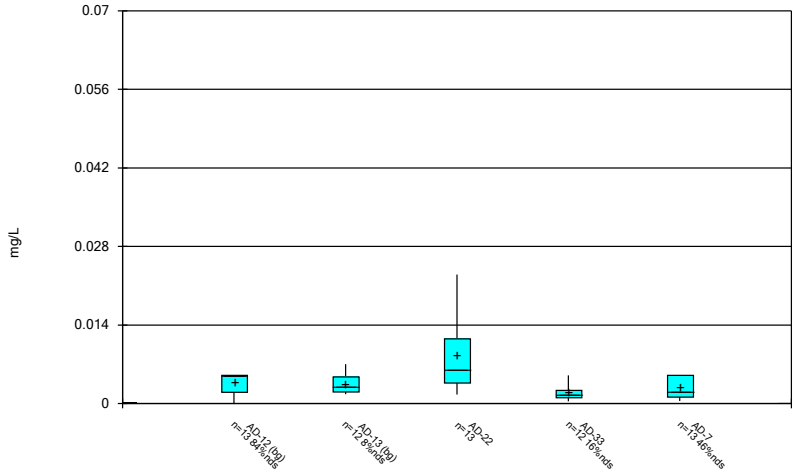
Box & Whiskers Plot



Constituent: Antimony, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

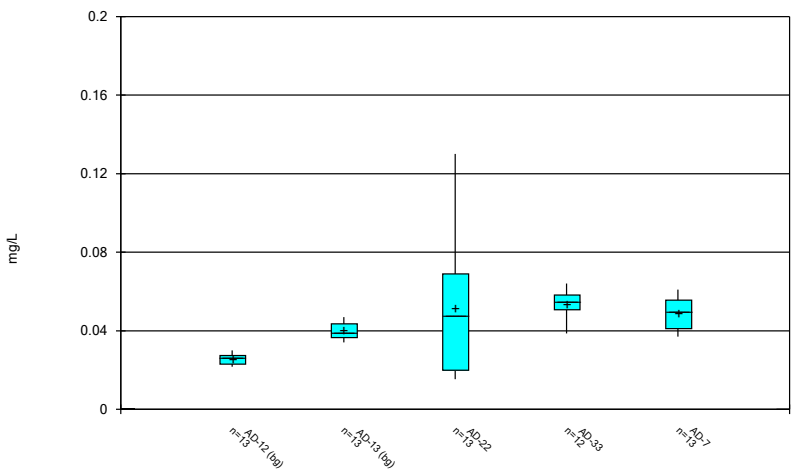
Box & Whiskers Plot



Constituent: Arsenic, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

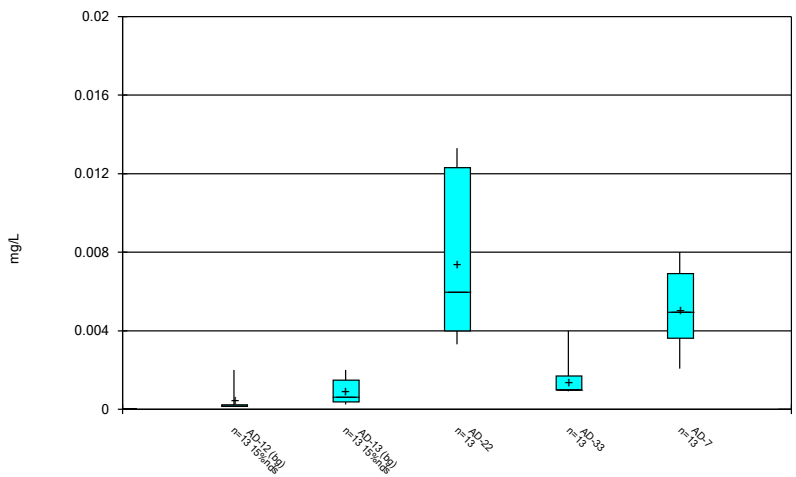
Box & Whiskers Plot



Constituent: Barium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

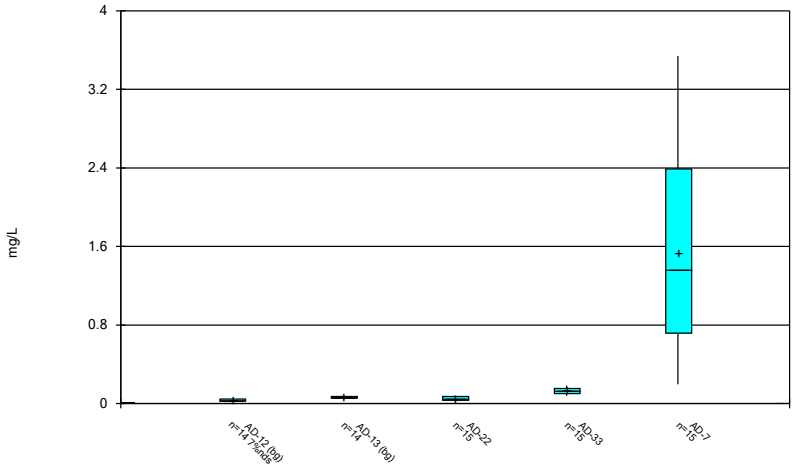
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot



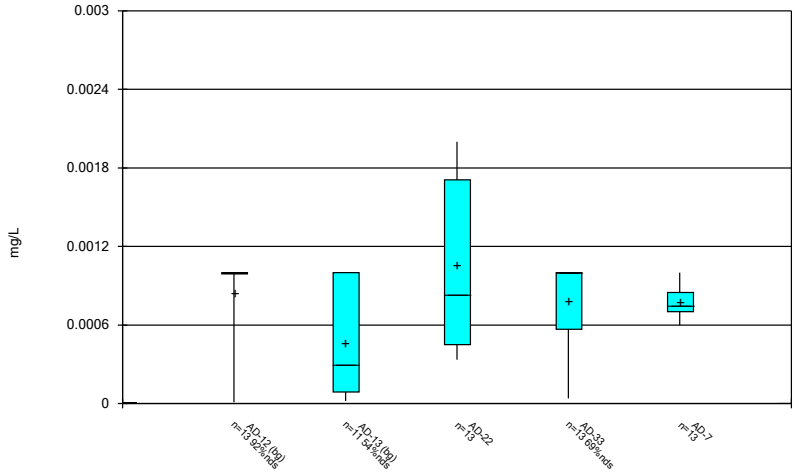
Constituent: Beryllium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



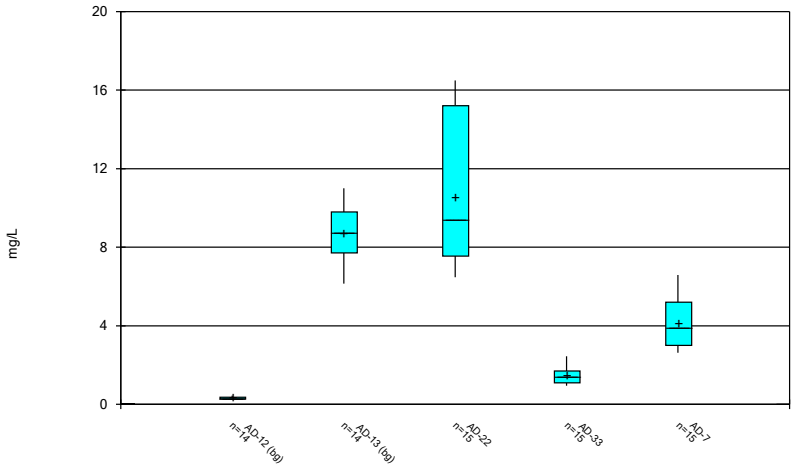
Constituent: Boron, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



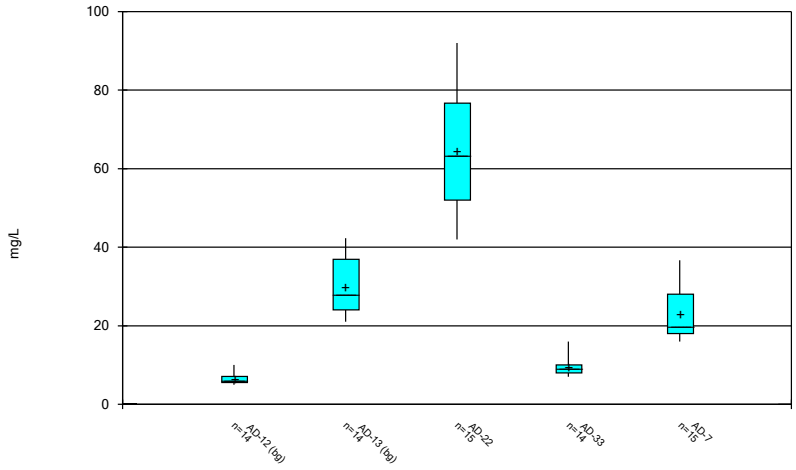
Constituent: Cadmium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



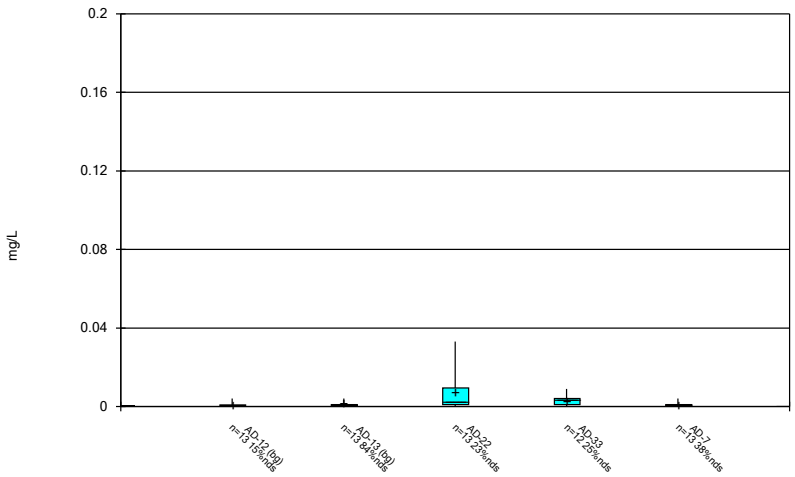
Constituent: Calcium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



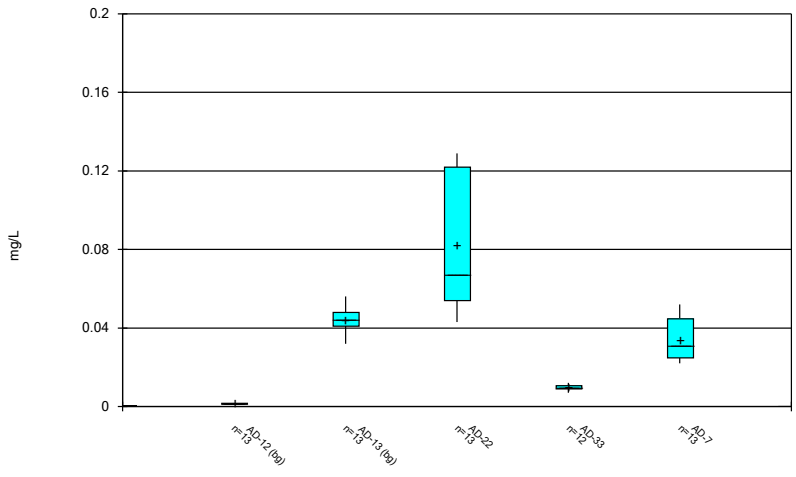
Constituent: Chloride, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



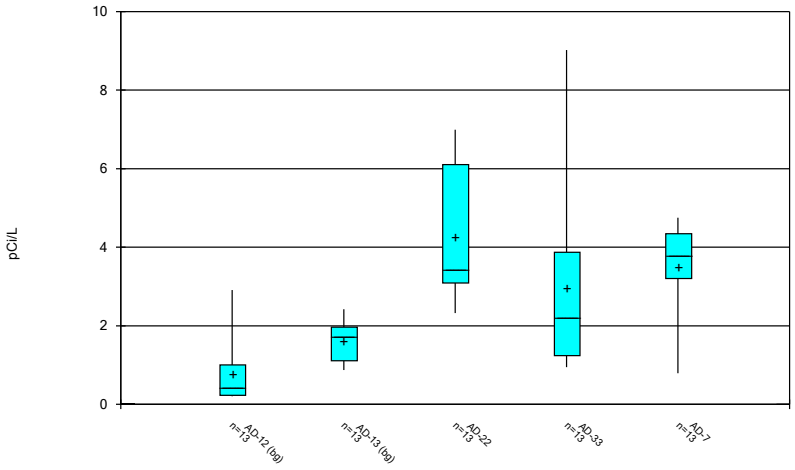
Constituent: Chromium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



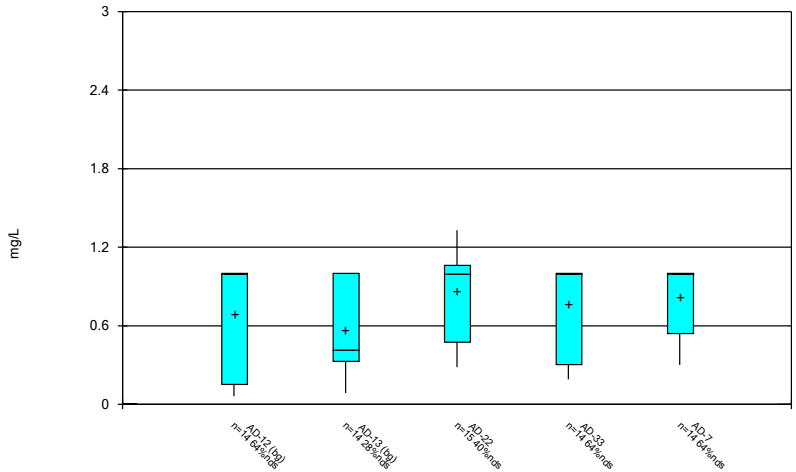
Constituent: Cobalt, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



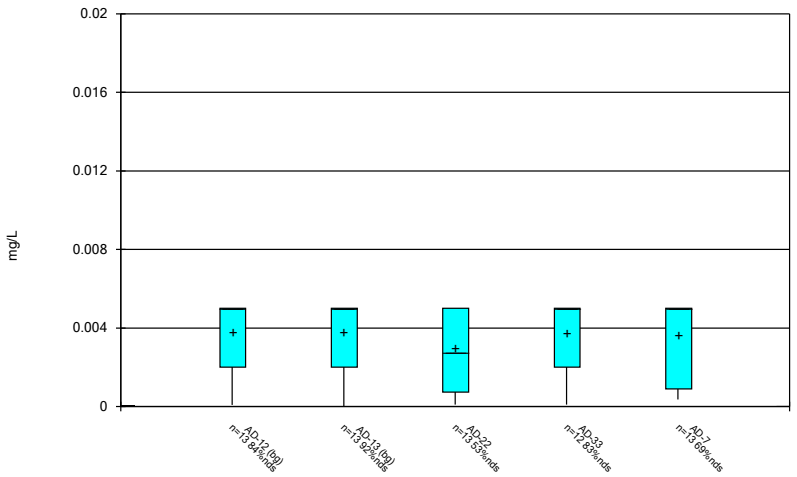
Constituent: Combined Radium 226 + 228 Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



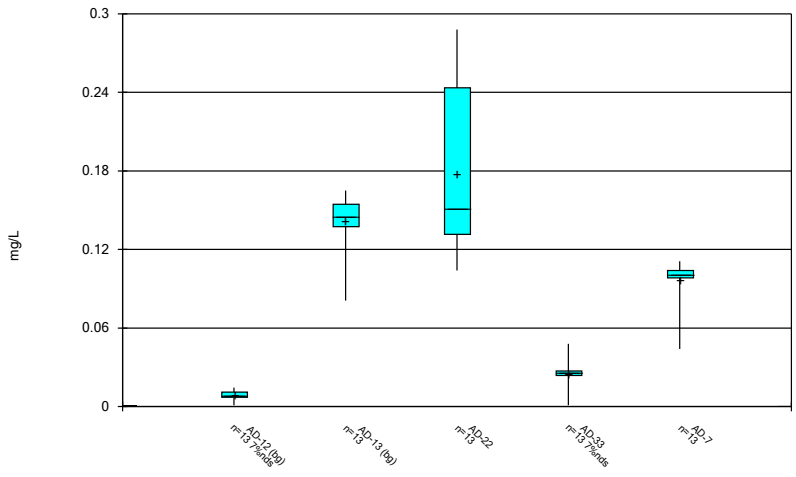
Constituent: Fluoride, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



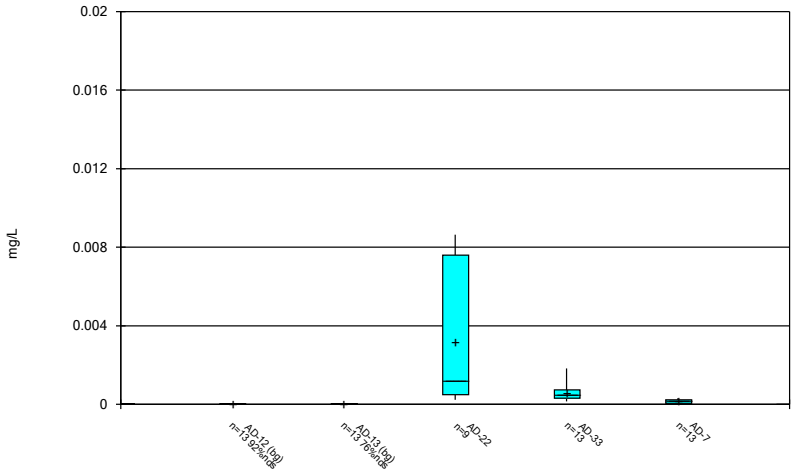
Constituent: Lead, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



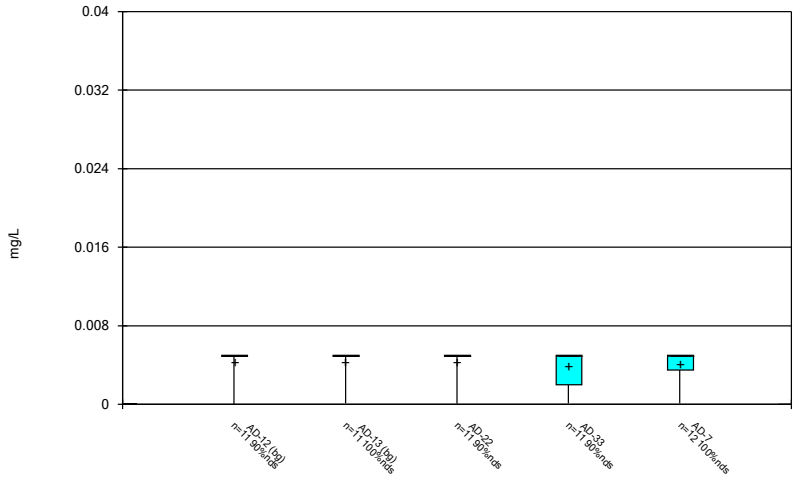
Constituent: Lithium, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



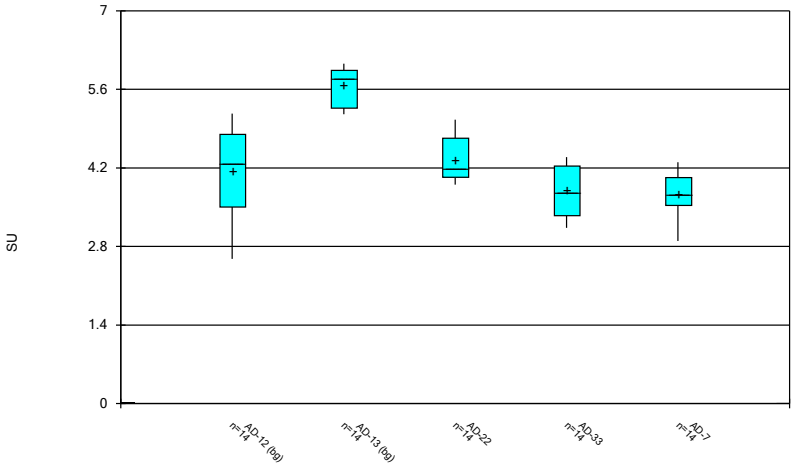
Constituent: Mercury, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



Constituent: Molybdenum, total Analysis Run 12/6/2019 11:13 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

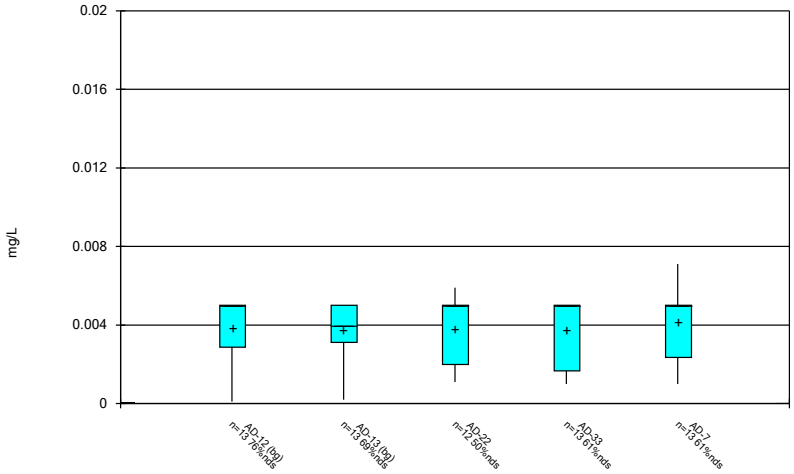
Box & Whiskers Plot



Constituent: pH, field Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

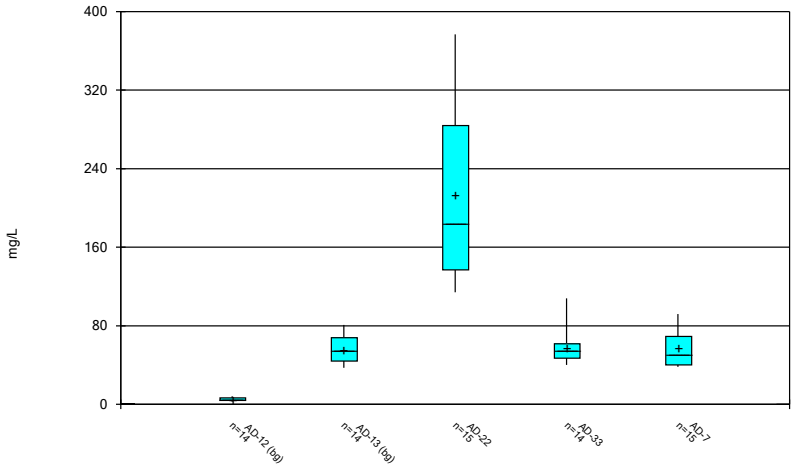
Box & Whiskers Plot



Constituent: Selenium, total Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

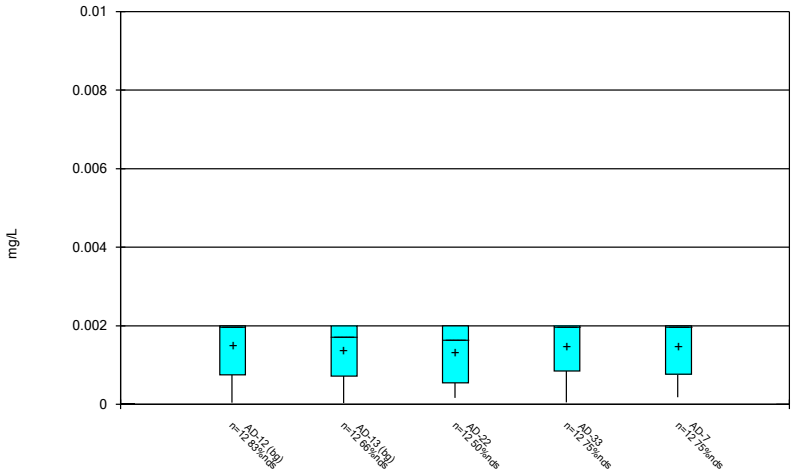
Box & Whiskers Plot



Constituent: Sulfate, total Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

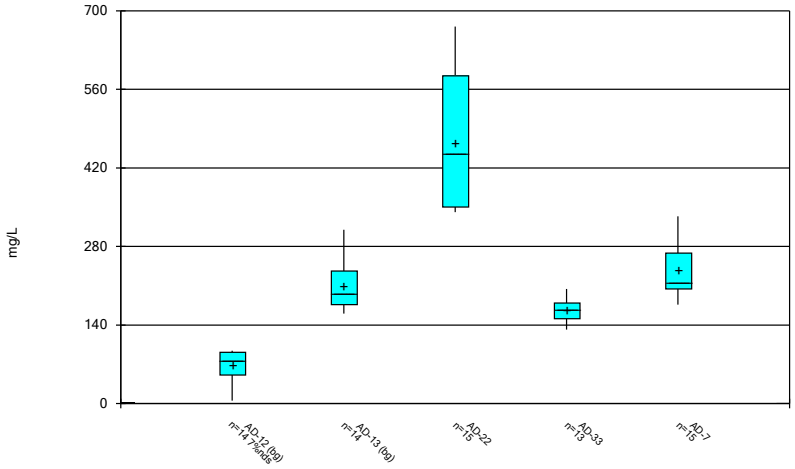
Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Box & Whiskers Plot



Constituent: Thallium, total Analysis Run 12/6/2019 11:14 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Box & Whiskers Plot



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/6/2019 11:14 AM

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Outlier Summary

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/10/2019, 12:26 PM

	AD-13 Arsenic, total (mg/L)	AD-33 Arsenic, total (mg/L)	AD-33 Barium, total (mg/L)	AD-13 Cadmium, total (mg/L)	AD-33 Chromium, total (mg/L)	AD-33 Cobalt, total (mg/L)	AD-7 Fluoride, total (mg/L)	AD-33 Lead, total (mg/L)	AD-22 Mercury, total (mg/L)	AD-12 Molybdenum, total (mg/L)
5/11/2016									0.01341 (o)	
7/13/2016	0.009 (o)									
7/14/2016									0.017 (o)	
9/7/2016		0.067 (o)	0.163 (o)		0.125 (o)	0.033 (o)		0.014 (o)	0.019829 (o)	
1/12/2017									0.01332 (o)	
4/11/2017				0.002 (o)						
8/24/2017							2.994 (o)			
3/21/2018				0.00086 (Jo)						
2/27/2019										<0.04 (o)
5/21/2019										<0.04 (o)
5/22/2019										

	AD-13 Molybdenum, total (mg/L)	AD-22 Molybdenum, total (mg/L)	AD-33 Molybdenum, total (mg/L)	AD-7 Molybdenum, total (mg/L)	AD-22 Selenium, total (mg/L)	AD-12 Thallium, total (mg/L)	AD-13 Thallium, total (mg/L)	AD-22 Thallium, total (mg/L)	AD-33 Thallium, total (mg/L)	AD-7 Thallium, total (mg/L)
5/11/2016										
7/13/2016										
7/14/2016										
9/7/2016										
1/12/2017										
4/11/2017										
8/24/2017										
3/21/2018										
2/27/2019	<0.04 (o)	<0.04 (o)	<0.04 (o)		0.0167 (o)	<0.002 (o)	<0.002 (o)	<0.002 (o)	<0.002 (o)	<0.002 (o)
5/21/2019	<0.04 (o)									
5/22/2019		<0.04 (o)	<0.04 (o)	<0.04 (o)						

	AD-33 Total Dissolved Solids [TDS] (mg/L)
5/11/2016	326 (o)
7/13/2016	
7/14/2016	
9/7/2016	
1/12/2017	
4/11/2017	
8/24/2017	
3/21/2018	
2/27/2019	
5/21/2019	
5/22/2019	

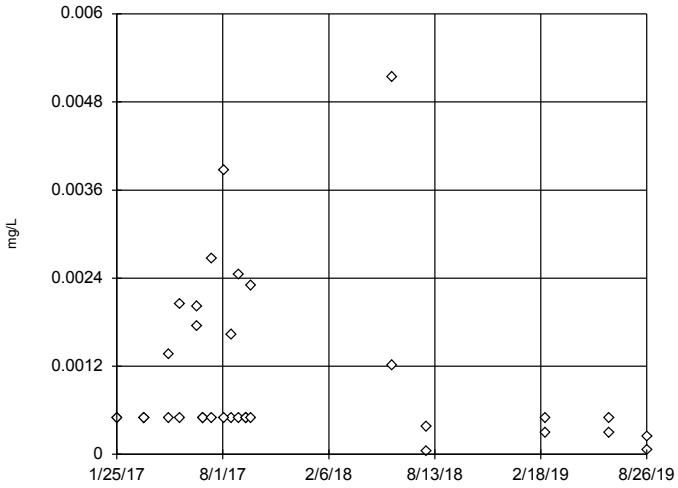
Upgradient Outlier Analysis - All Results

Northeastern BAP Client: Geosyntec Data: Northeastern BAP Printed 12/5/2019, 7:06 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.001066	0.001141	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.0167	0.01515	x^(1/3)	ShapiroWilk
Barium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	1.517	0.909	sqrt(x)	ShapiroWilk
Beryllium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.0006003	0.0009429	ln(x)	ShapiroWilk
Boron (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.3369	0.09923	x^(1/3)	ShapiroWilk
Cadmium (mg/L)	SP-4,SP-5	n/a	n/a	NP	NaN	34	0.0006194	0.001226	unknown	ShapiroWilk
Chloride (mg/L)	**SP-4,SP-5**	**Yes**	**52,62,1834**	**NP**	**NaN**	**34**	**562.2**	**280.7**	**sqrt(x)**	**ShapiroWilk**
Chromium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.008442	0.01735	ln(x)	ShapiroWilk
Cobalt (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.004423	0.008256	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	SP-4,SP-5	No	n/a	NP	NaN	33	8.197	3.807	normal	ShapiroWilk
Fluoride (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	36	3.171	0.7808	x^2	ShapiroWilk
Lead (mg/L)	**SP-4,SP-5**	**Yes**	**0.03663**	**NP**	**NaN**	**34**	**0.003275**	**0.006578**	**ln(x)**	**ShapiroWilk**
Lithium (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.09636	0.02338	sqrt(x)	ShapiroWilk
Mercury (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.00002218	0.000009233	x^(1/3)	ShapiroWilk
Molybdenum (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	0.006372	0.003953	x^(1/3)	ShapiroWilk
pH, field (SU)	SP-4,SP-5	No	n/a	NP	NaN	32	7.796	0.449	ln(x)	ShapiroWilk
Selenium (mg/L)	SP-4,SP-5	n/a	n/a	NP	NaN	34	0.001084	0.0007727	unknown	ShapiroWilk
Sulfate (mg/L)	SP-4,SP-5	No	n/a	NP	NaN	34	31.97	29.27	ln(x)	ShapiroWilk
Thallium (mg/L)	SP-4,SP-5	n/a	n/a	NP	NaN	34	0.0005265	0.0002563	unknown	ShapiroWilk
Total Dissolved Solids [TDS] (mg/L)	**SP-4,SP-5**	**Yes**	**3008**	**NP**	**NaN**	**34**	**1328**	**333.4**	**ln(x)**	**ShapiroWilk**

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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 = 0.06435, low cutoff = 0.00001309, based on IQR multiplier of 3.

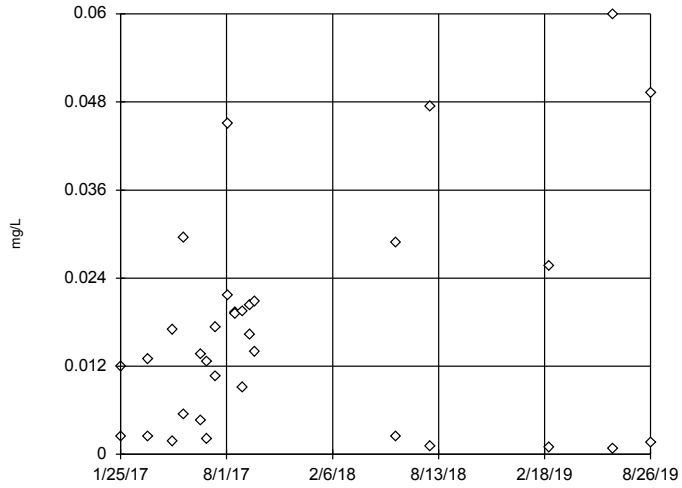
Constituent: Antimony Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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 = 0.3424, low cutoff = -0.02368, based on IQR multiplier of 3.

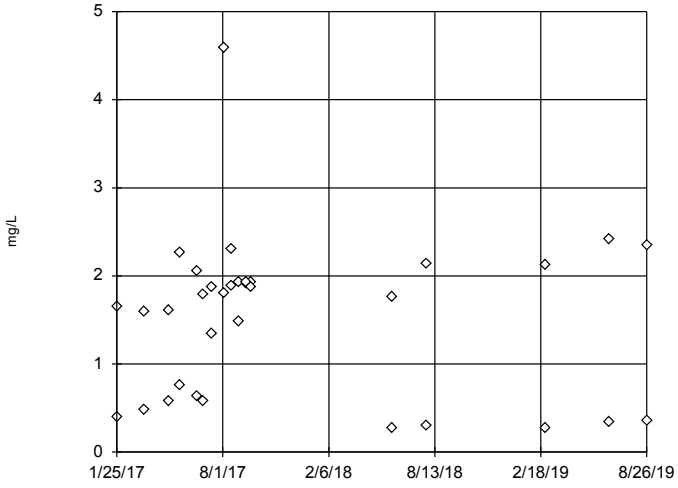
Constituent: Arsenic Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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 = 11.31, low cutoff = -1.424, based on IQR multiplier of 3.

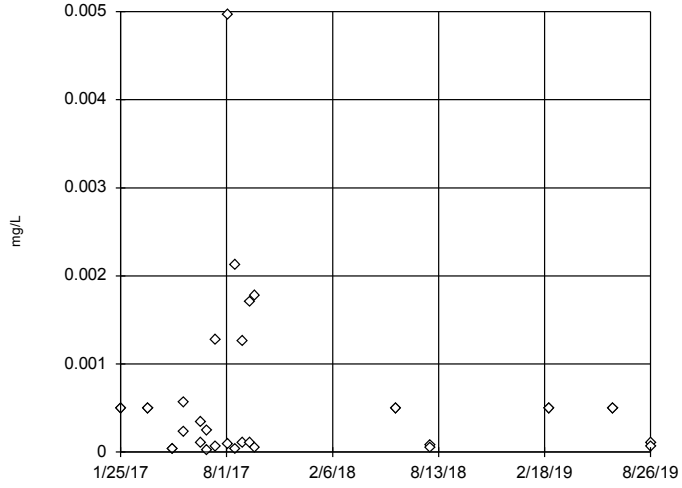
Constituent: Barium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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

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

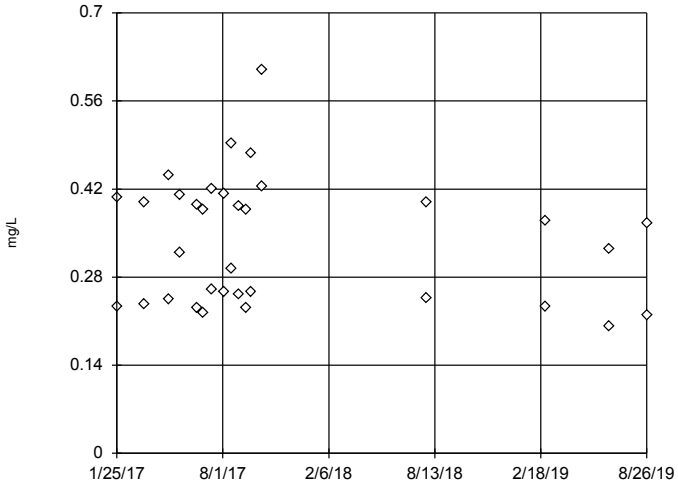
High cutoff = 0.1952, low cutoff = 1.8e-7, based on IQR multiplier of 3.

Constituent: Beryllium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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 = 1.34, low cutoff = 0.01787, based on IQR multiplier of 3.

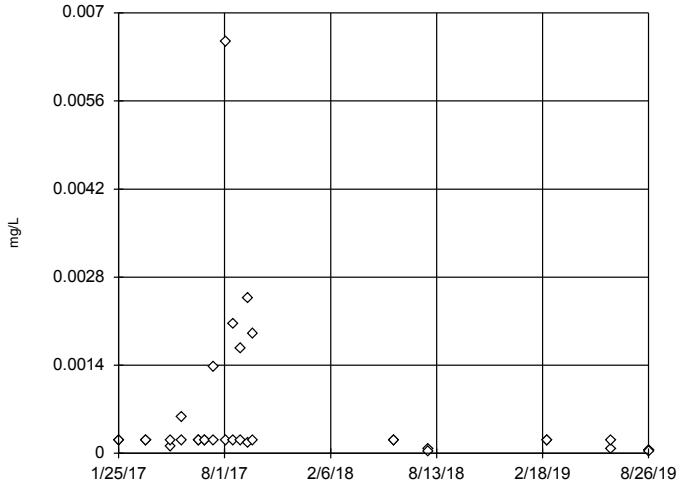
Constituent: Boron Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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

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

The results were invalidated, because the lower and upper quartiles are equal.

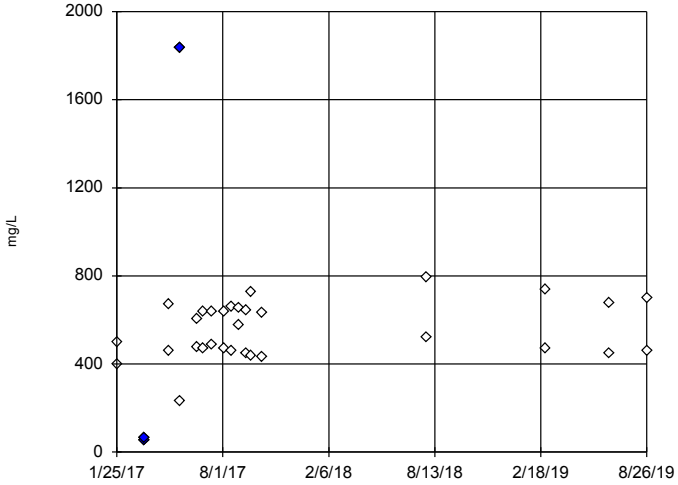
Constituent: Cadmium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

Outliers are drawn as solid.
Tukey's method selected by user.

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

High cutoff = 1487, low cutoff = 69.92, based on IQR multiplier of 3.

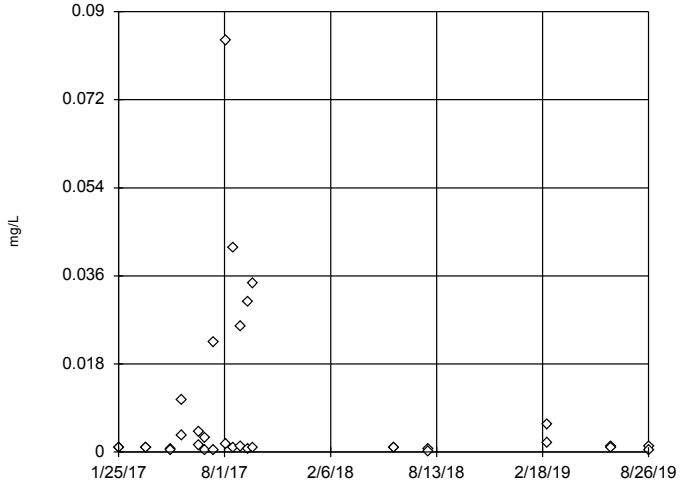
Constituent: Chloride Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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

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

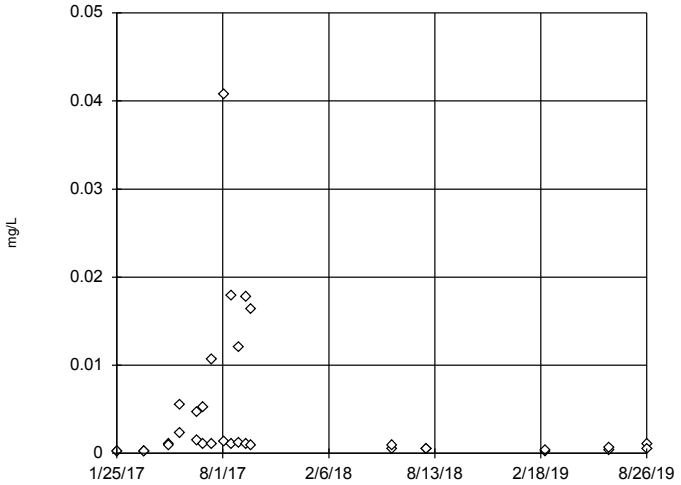
High cutoff = 1.453, low cutoff = 0.000002366, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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 = 5.308, low cutoff = 4.5e-7, based on IQR multiplier of 3.

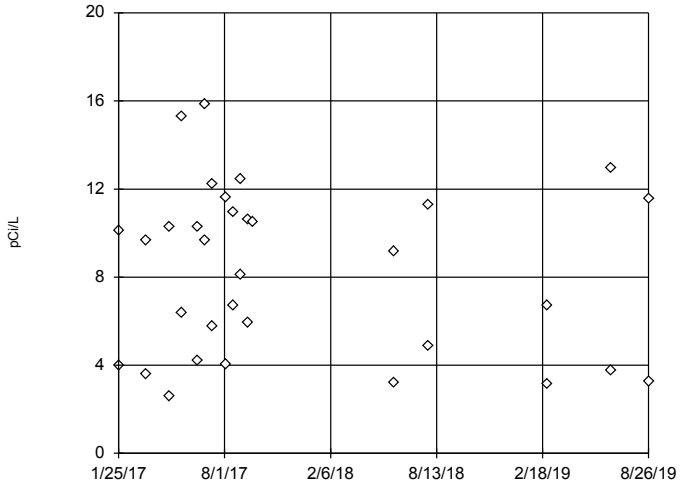
Constituent: Cobalt Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 33

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

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

High cutoff = 32.17, low cutoff = -16.94, based on IQR multiplier of 3.

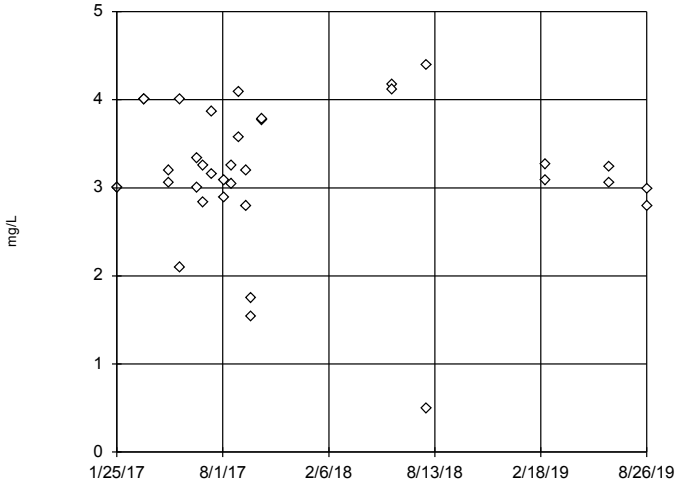
Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 36

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 = 5.492, low cutoff = -2.631, based on IQR multiplier of 3.

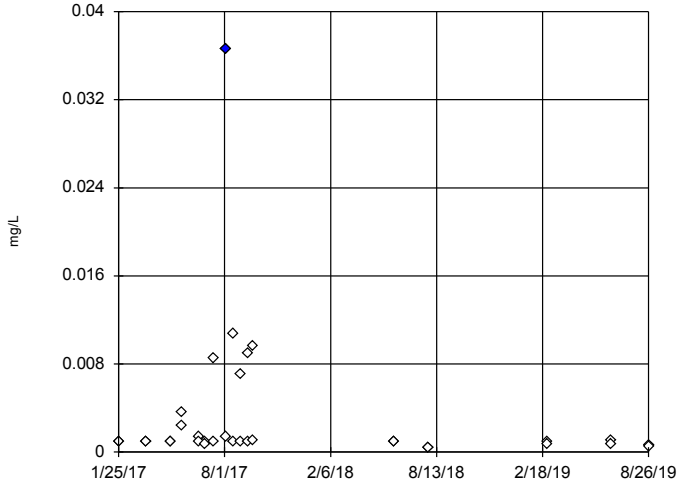
Constituent: Fluoride Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

Outlier is drawn as solid. Tukey's method selected by user.

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

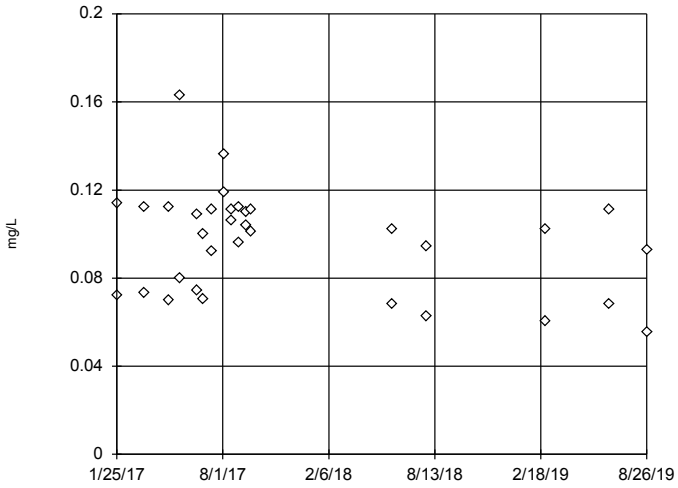
High cutoff = 0.01438, low cutoff = 0.0001192, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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 = 0.2755, low cutoff = 0.00601, based on IQR multiplier of 3.

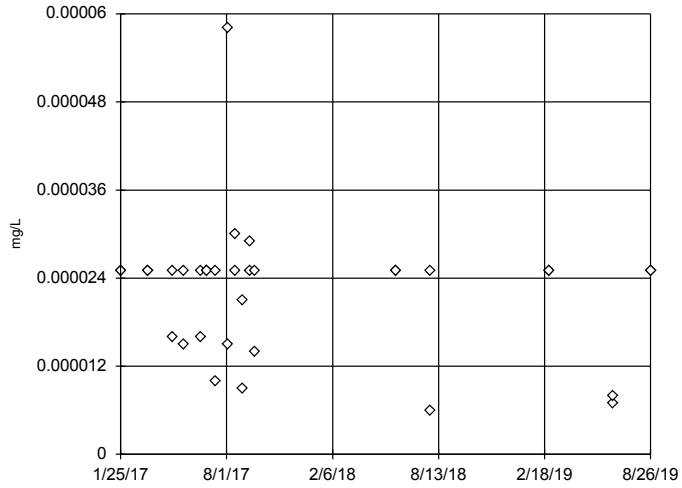
Constituent: Lithium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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 = 0.00007499, low cutoff = 0.000001728, based on IQR multiplier of 3.

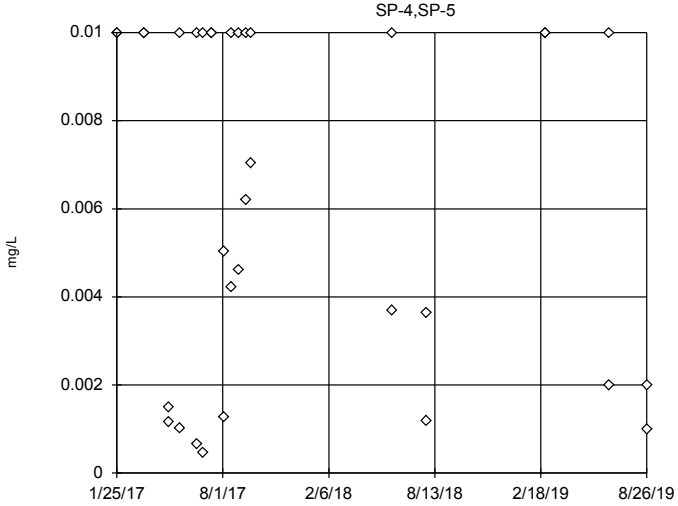
Constituent: Mercury Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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 = 0.1258, low cutoff = -0.004525, based on IQR multiplier of 3.

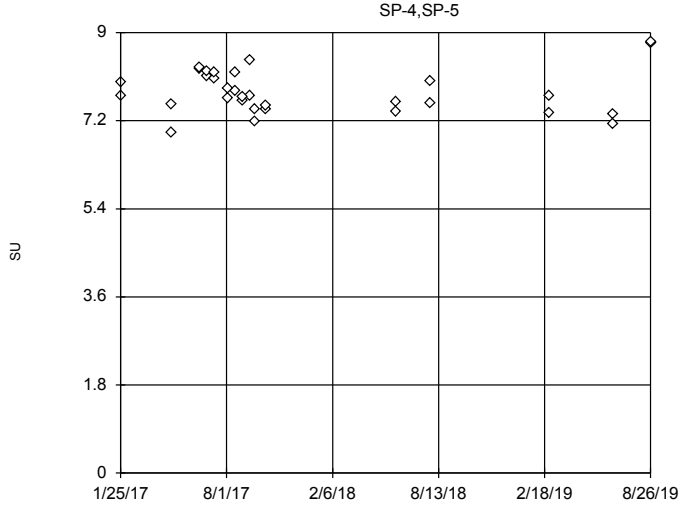
Constituent: Molybdenum Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 32

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

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

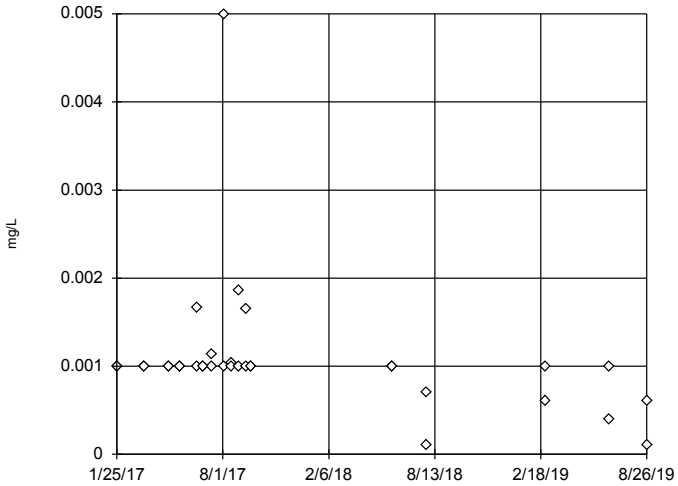
High cutoff = 10.49, low cutoff = 5.804, based on IQR multiplier of 3.

Constituent: pH, field Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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

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

The results were invalidated, because the lower and upper quartiles are equal.

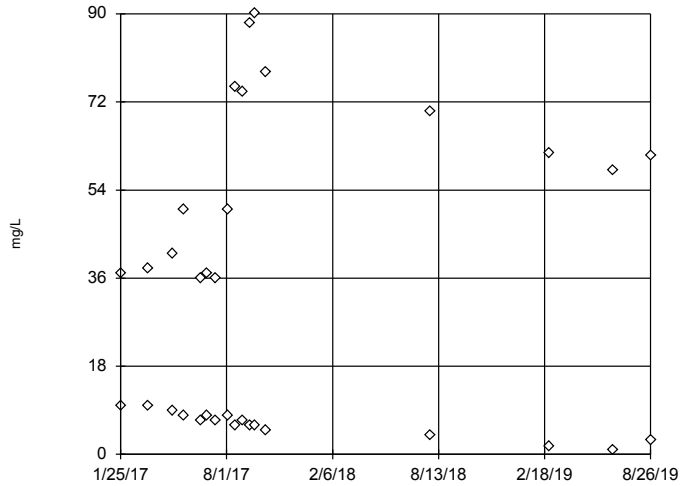
Constituent: Selenium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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 = 45988, low cutoff = 0.008382, based on IQR multiplier of 3.

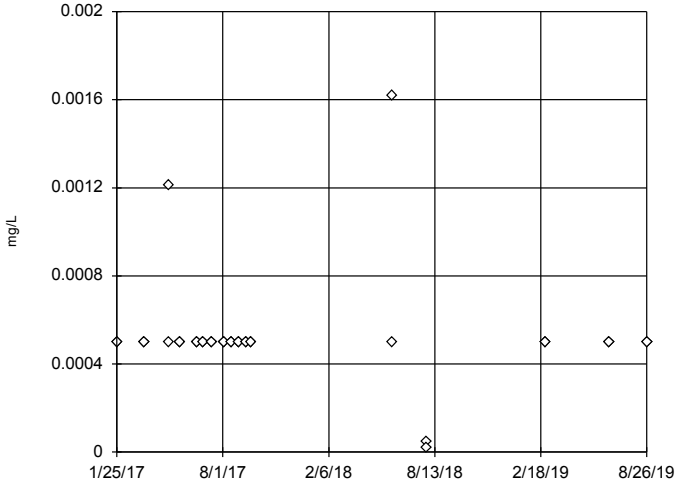
Constituent: Sulfate Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

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

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

The results were invalidated, because the lower and upper quartiles are equal.

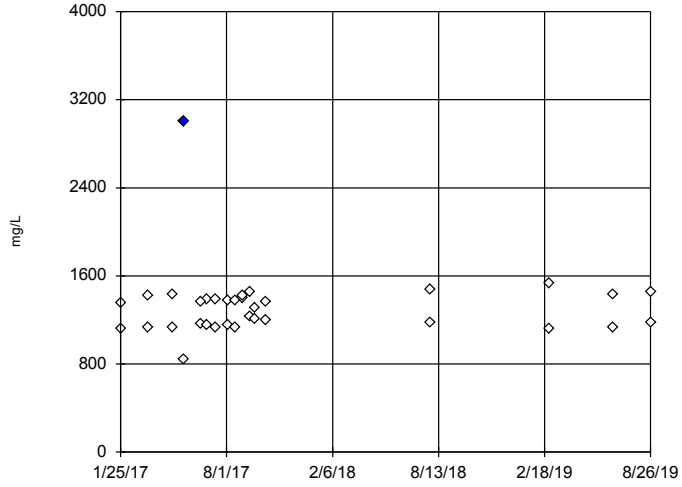
Constituent: Thallium Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening, Pooled Background

SP-4,SP-5



n = 34

Outlier is drawn as solid. Tukey's method selected by user.

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

High cutoff = 2753, low cutoff = 589.4, based on IQR multiplier of 3.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/5/2019 7:05 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Outlier Analysis - Significant Results

Northeastern BAP Client: Geosyntec Data: Northeastern BAP Printed 12/5/2019, 7:09 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Combined Radium 226 + 228 (pCi/L)	**SP-1**	**Yes**	**14.29**	**NP**	**NaN**	**16**	**4.103**	**2.814**	**ln(x)**	**ShapiroWilk**

Outlier Analysis - All Results

Northeastern BAP Client: Geosyntec Data: Northeastern BAP Printed 12/5/2019, 7:09 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Antimony (mg/L)	SP-1	No	n/a	NP	NaN	16	0.003233	0.002181	x^(1/3)	ShapiroWilk
Antimony (mg/L)	SP-10	No	n/a	NP	NaN	13	0.002672	0.001941	ln(x)	ShapiroWilk
Antimony (mg/L)	SP-11	No	n/a	NP	NaN	13	0.003377	0.003125	x^(1/3)	ShapiroWilk
Antimony (mg/L)	SP-2	No	n/a	NP	NaN	16	0.003766	0.002879	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-1	No	n/a	NP	NaN	16	0.003415	0.001954	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-10	No	n/a	NP	NaN	13	0.006745	0.004118	ln(x)	ShapiroWilk
Arsenic (mg/L)	SP-11	No	n/a	NP	NaN	13	0.005585	0.003026	sqrt(x)	ShapiroWilk
Arsenic (mg/L)	SP-2	No	n/a	NP	NaN	16	0.003491	0.002932	ln(x)	ShapiroWilk
Barium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.2006	0.03818	ln(x)	ShapiroWilk
Barium (mg/L)	SP-10	No	n/a	NP	NaN	13	1.744	1.731	x^(1/3)	ShapiroWilk
Barium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.2556	0.169	ln(x)	ShapiroWilk
Barium (mg/L)	SP-2	No	n/a	NP	NaN	16	1.251	0.5881	ln(x)	ShapiroWilk
Beryllium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.0003881	0.0004295	ln(x)	ShapiroWilk
Beryllium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.0002218	0.0002294	ln(x)	ShapiroWilk
Beryllium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.0002799	0.000199	sqrt(x)	ShapiroWilk
Beryllium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.0003344	0.0004011	ln(x)	ShapiroWilk
Cadmium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.000355	0.0001958	ln(x)	ShapiroWilk
Cadmium (mg/L)	SP-10	n/a	n/a	NP	NaN	13	0.0001731	0.00006575	unknown	ShapiroWilk
Cadmium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.0009385	0.001086	ln(x)	ShapiroWilk
Cadmium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.0003475	0.000205	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-1	No	n/a	NP	NaN	17	122.3	10.05	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-10	No	n/a	NP	NaN	13	93.32	58.74	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-11	No	n/a	NP	NaN	13	453.3	447.6	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-2	No	n/a	NP	NaN	16	107.1	35.8	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-4 (bg)	No	n/a	NP	NaN	17	400.9	478.9	ln(x)	ShapiroWilk
Calcium (mg/L)	SP-5 (bg)	No	n/a	NP	NaN	17	67.18	24.87	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.001149	0.0006792	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.01004	0.03012	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.01025	0.01287	ln(x)	ShapiroWilk
Chromium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.001531	0.001234	x^(1/3)	ShapiroWilk
Cobalt (mg/L)	SP-1	No	n/a	NP	NaN	16	0.001367	0.001295	ln(x)	ShapiroWilk
Cobalt (mg/L)	SP-10	No	n/a	NP	NaN	13	0.002623	0.001741	x^(1/3)	ShapiroWilk
Cobalt (mg/L)	SP-11	No	n/a	NP	NaN	13	0.006188	0.004931	x^(1/3)	ShapiroWilk
Cobalt (mg/L)	SP-2	No	n/a	NP	NaN	16	0.001122	0.0008247	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	**SP-1**	**Yes**	**14.29**	**NP**	**NaN**	**16**	**4.103**	**2.814**	**ln(x)**	**ShapiroWilk**
Combined Radium 226 + 228 (pCi/L)	SP-10	No	n/a	NP	NaN	13	6.984	8.061	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	SP-11	No	n/a	NP	NaN	13	3.502	6.649	ln(x)	ShapiroWilk
Combined Radium 226 + 228 (pCi/L)	SP-2	No	n/a	NP	NaN	13	12.31	6.281	ln(x)	ShapiroWilk
Fluoride (mg/L)	SP-1	No	n/a	NP	NaN	17	0.9669	0.8403	ln(x)	ShapiroWilk
Fluoride (mg/L)	SP-10	No	n/a	NP	NaN	15	5.447	2.95	x^2	ShapiroWilk
Fluoride (mg/L)	SP-11	No	n/a	NP	NaN	15	3.185	0.8592	normal	ShapiroWilk
Fluoride (mg/L)	SP-2	No	n/a	NP	NaN	17	2.871	0.7089	x^2	ShapiroWilk
Lead (mg/L)	SP-1	No	n/a	NP	NaN	16	0.002924	0.002167	ln(x)	ShapiroWilk
Lead (mg/L)	SP-10	No	n/a	NP	NaN	13	0.001517	0.0007715	x^(1/3)	ShapiroWilk
Lead (mg/L)	SP-11	No	n/a	NP	NaN	13	0.003791	0.00305	sqrt(x)	ShapiroWilk
Lead (mg/L)	SP-2	No	n/a	NP	NaN	16	0.003164	0.002194	ln(x)	ShapiroWilk
Lithium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.007072	0.006362	ln(x)	ShapiroWilk
Lithium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.2841	0.02877	x^3	ShapiroWilk
Lithium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.08066	0.03839	x^(1/3)	ShapiroWilk
Lithium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.07643	0.02586	x^3	ShapiroWilk
Mercury (mg/L)	SP-1	n/a	n/a	NP	NaN	16	0.00002194	0.000006277	unknown	ShapiroWilk
Mercury (mg/L)	SP-10	No	n/a	NP	NaN	13	0.00001762	0.000007974	normal	ShapiroWilk
Mercury (mg/L)	SP-11	No	n/a	NP	NaN	13	0.00002062	0.00001449	ln(x)	ShapiroWilk
Mercury (mg/L)	SP-2	No	n/a	NP	NaN	16	0.00002069	0.000007939	normal	ShapiroWilk
Molybdenum (mg/L)	SP-1	No	n/a	NP	NaN	16	0.01242	0.004984	normal	ShapiroWilk

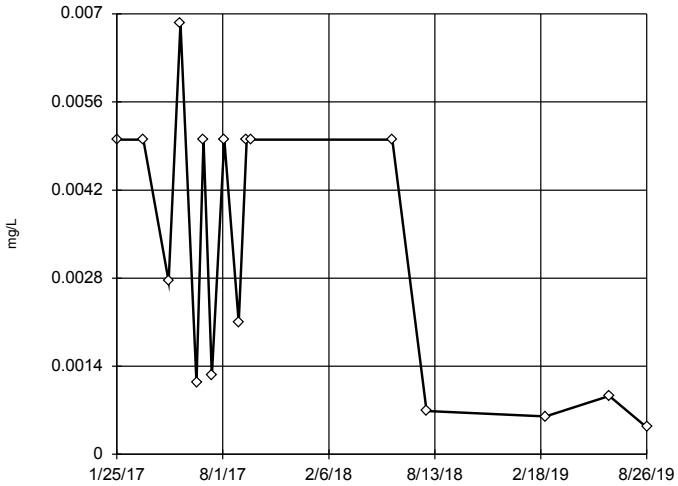
Outlier Analysis - All Results

Northeastern BAP Client: Geosyntec Data: Northeastern BAP Printed 12/5/2019, 7:09 PM

Constituent	Well	Outlier	Value(s)	Method	Alpha	N	Mean	Std. Dev.	Distribution	Normality Test
Molybdenum (mg/L)	SP-10	No	n/a	NP	NaN	13	0.09942	0.2528	ln(x)	ShapiroWilk
Molybdenum (mg/L)	SP-11	No	n/a	NP	NaN	13	0.03278	0.02353	x^2	ShapiroWilk
Molybdenum (mg/L)	SP-2	No	n/a	NP	NaN	16	0.02792	0.007558	normal	ShapiroWilk
Selenium (mg/L)	SP-1	No	n/a	NP	NaN	16	0.005163	0.002543	ln(x)	ShapiroWilk
Selenium (mg/L)	SP-10	No	n/a	NP	NaN	13	0.002548	0.00244	x^(1/3)	ShapiroWilk
Selenium (mg/L)	SP-11	No	n/a	NP	NaN	13	0.003052	0.002409	x^(1/3)	ShapiroWilk
Selenium (mg/L)	SP-2	No	n/a	NP	NaN	16	0.01075	0.01048	ln(x)	ShapiroWilk
Thallium (mg/L)	SP-1	n/a	n/a	NP	NaN	16	0.001693	0.000682	unknown	ShapiroWilk
Thallium (mg/L)	SP-10	n/a	n/a	NP	NaN	13	0.0004646	0.0001276	unknown	ShapiroWilk
Thallium (mg/L)	SP-11	n/a	n/a	NP	NaN	13	0.0004638	0.0001304	unknown	ShapiroWilk
Thallium (mg/L)	SP-2	n/a	n/a	NP	NaN	16	0.00176	0.0006558	unknown	ShapiroWilk

Tukey's Outlier Screening

SP-1



n = 16

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 = 0.05525, low cutoff = -0.001289, based on IQR multiplier of 3.

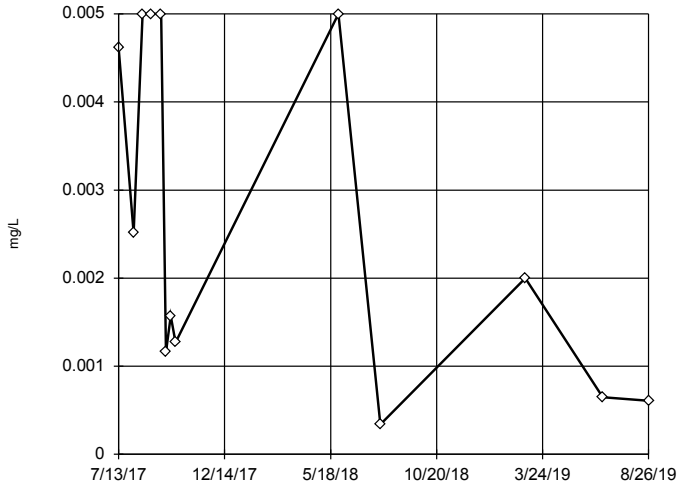
Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

High cutoff = 0.9546, low cutoff = 0.000004548, based on IQR multiplier of 3.

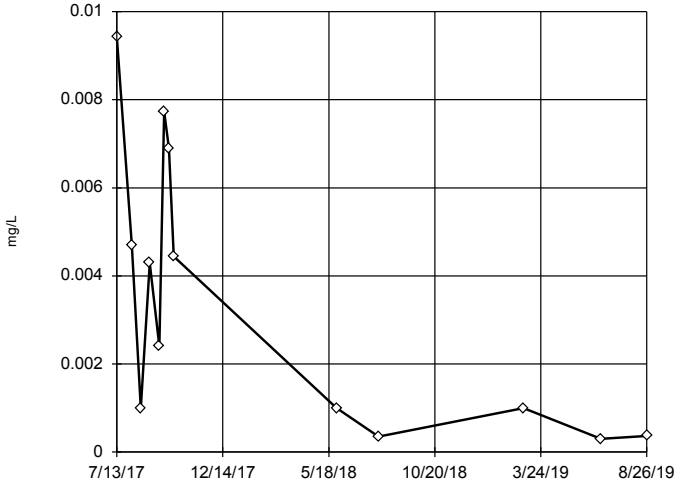
Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 0.09601, low cutoff = -0.007201, based on IQR multiplier of 3.

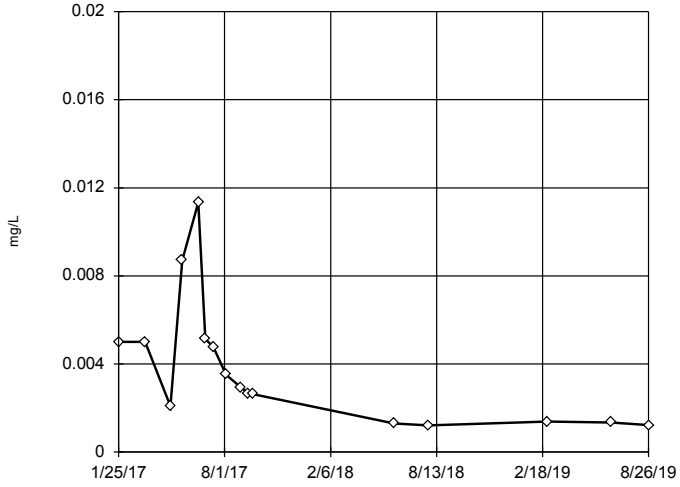
Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



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).

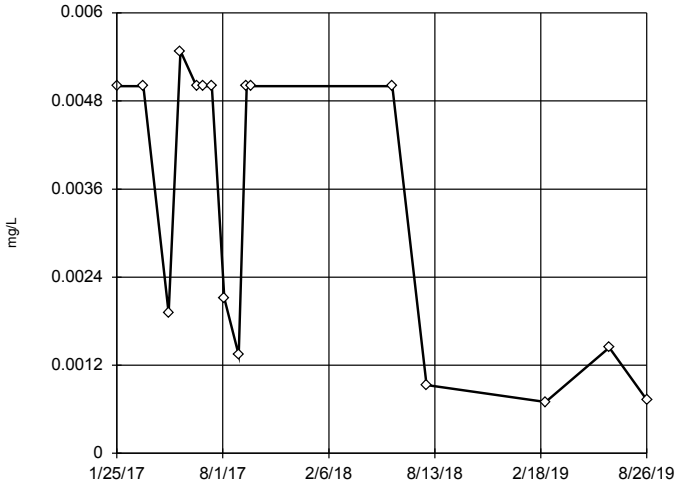
High cutoff = 0.2459, low cutoff = 0.00002775, based on IQR multiplier of 3.

Constituent: Antimony Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



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 = 0.2332, low cutoff = 0.00002979, based on IQR multiplier of 3.

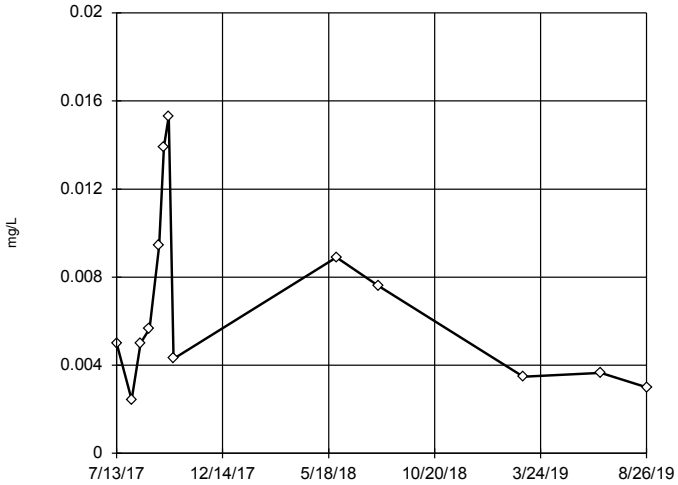
Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

High cutoff = 0.1546, low cutoff = 0.0002113, based on IQR multiplier of 3.

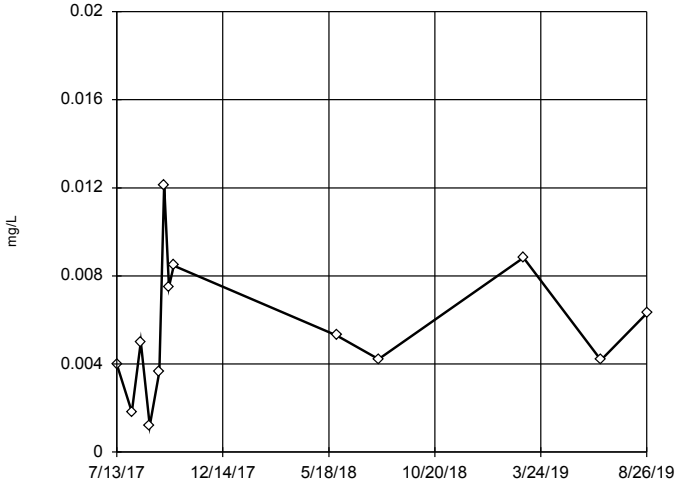
Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 0.02951, low cutoff = -0.0004253, based on IQR multiplier of 3.

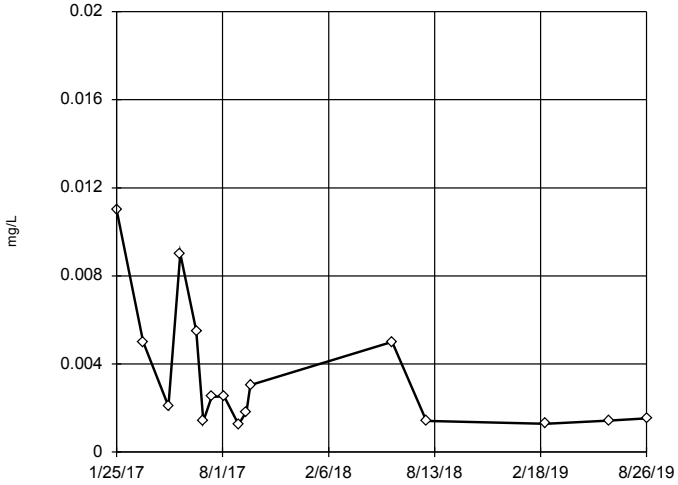
Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



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).

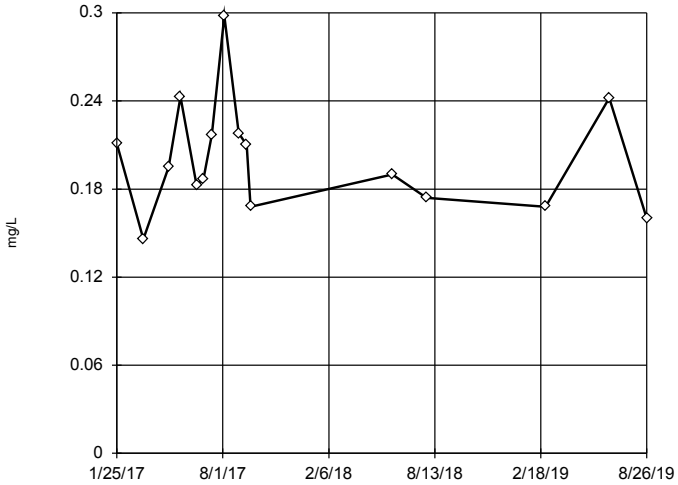
High cutoff = 0.216, low cutoff = 0.00003299, based on IQR multiplier of 3.

Constituent: Arsenic Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



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 = 0.4478, low cutoff = 0.08305, based on IQR multiplier of 3.

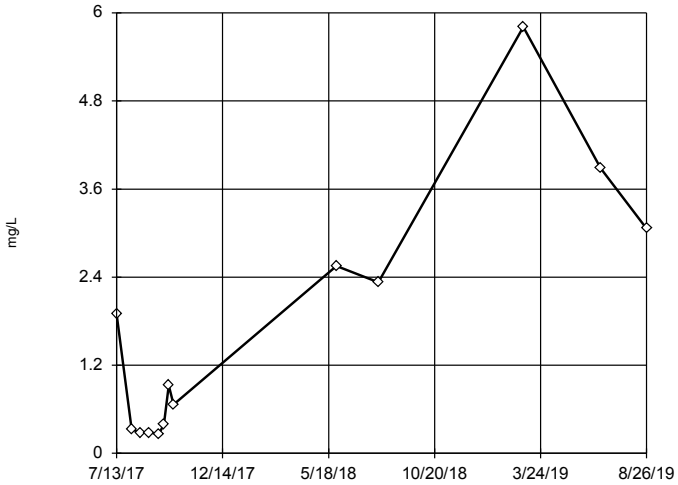
Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

High cutoff = 47.27, low cutoff = -3.605, based on IQR multiplier of 3.

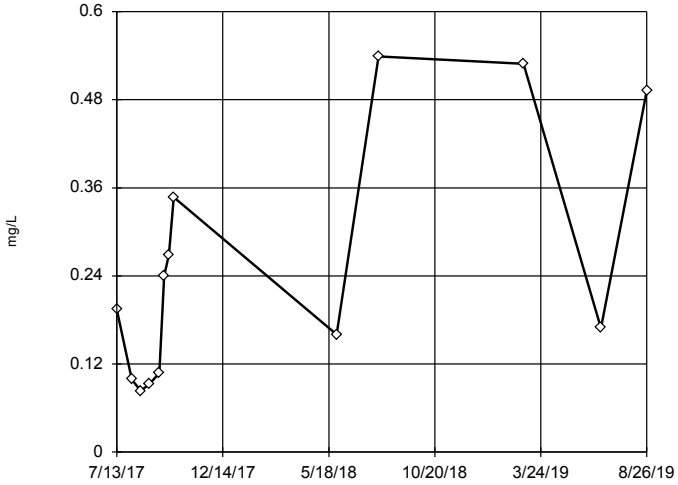
Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 26.47, low cutoff = 0.001612, based on IQR multiplier of 3.

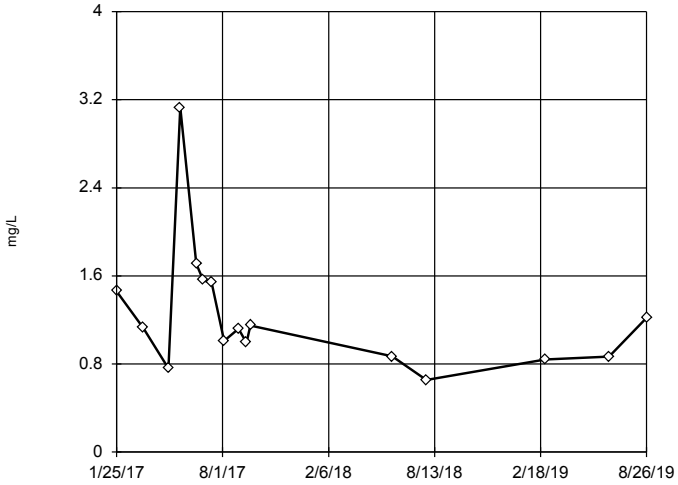
Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



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).

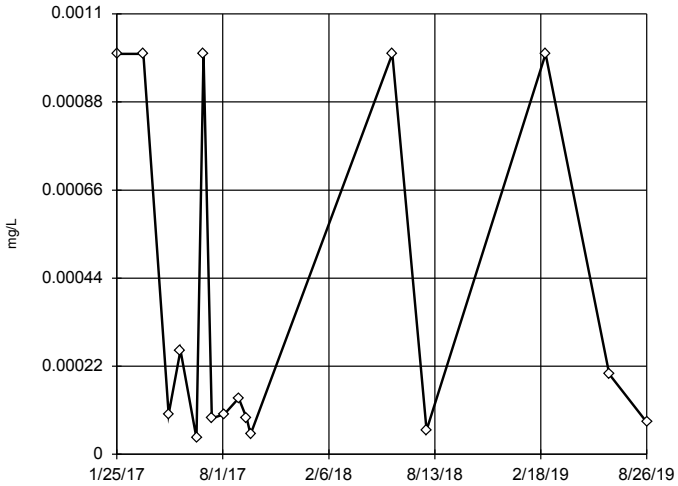
High cutoff = 7.717, low cutoff = 0.1688, based on IQR multiplier of 3.

Constituent: Barium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



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 = 1.637, low cutoff = 5.2e-8, based on IQR multiplier of 3.

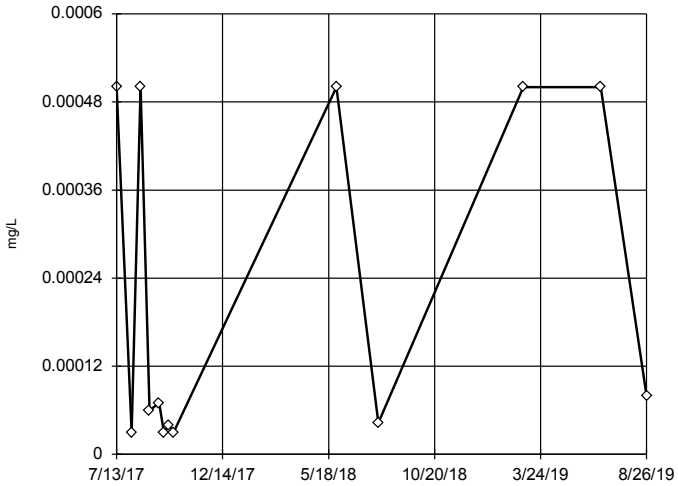
Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

High cutoff = 1.504, low cutoff = 1.2e-8, based on IQR multiplier of 3.

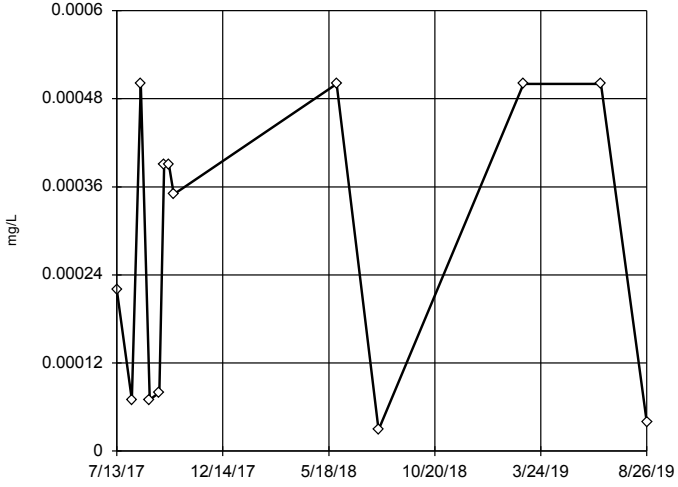
Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 0.00414, low cutoff = -0.00113, based on IQR multiplier of 3.

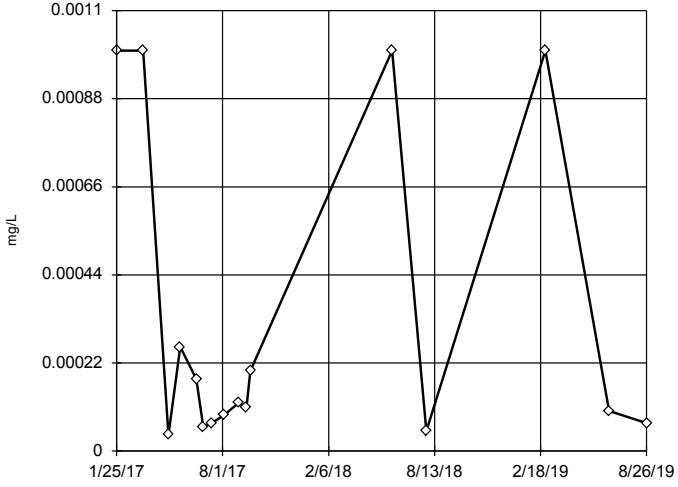
Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



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).

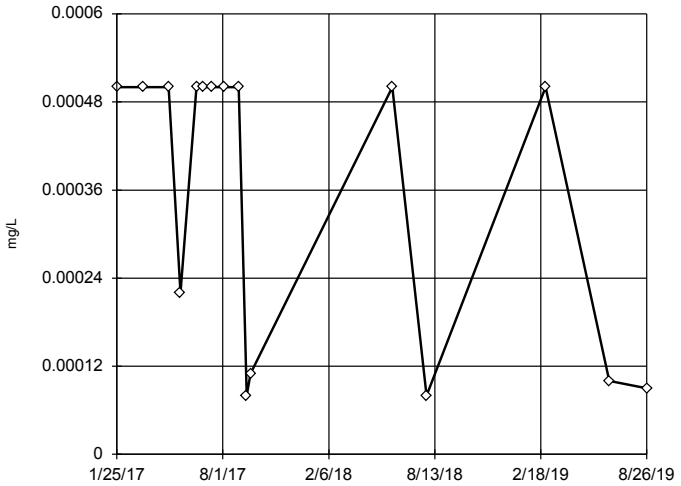
High cutoff = 0.1971, low cutoff = 1.8e-7, based on IQR multiplier of 3.

Constituent: Beryllium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



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 = 0.05417, low cutoff = 9.7e-7, based on IQR multiplier of 3.

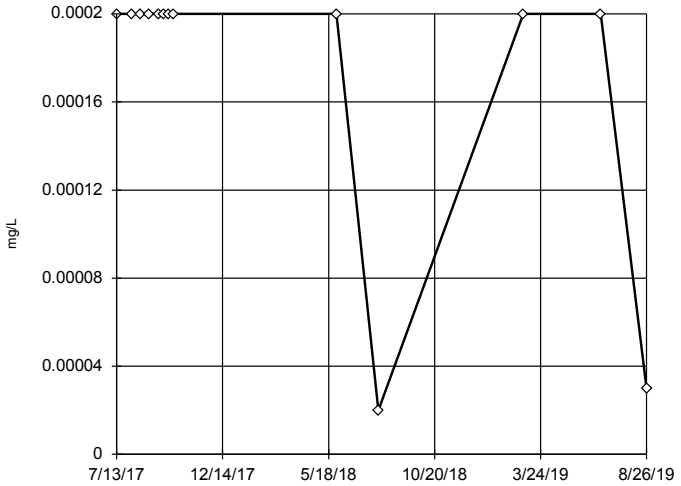
Constituent: Cadmium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

The results were invalidated, because the lower and upper quartiles are equal.

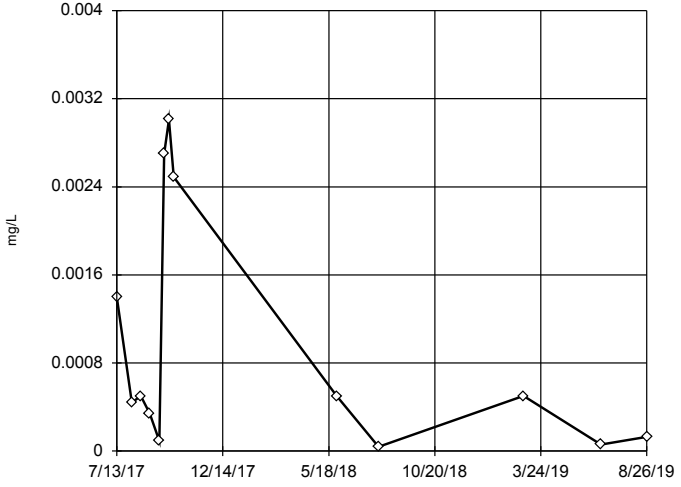
Constituent: Cadmium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 9.602, low cutoff = 2.1e-8, based on IQR multiplier of 3.

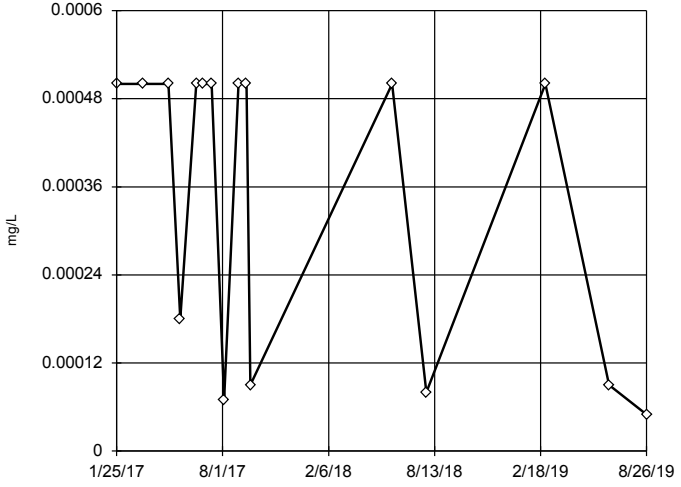
Constituent: Cadmium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



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).

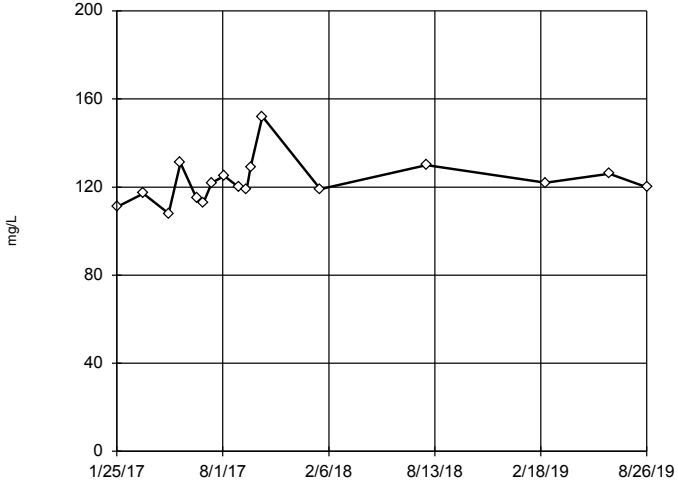
High cutoff = 0.08573, low cutoff = 5.2e-7, based on IQR multiplier of 3.

Constituent: Cadmium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-1



n = 17

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 = 169.3, low cutoff = 87.36, based on IQR multiplier of 3.

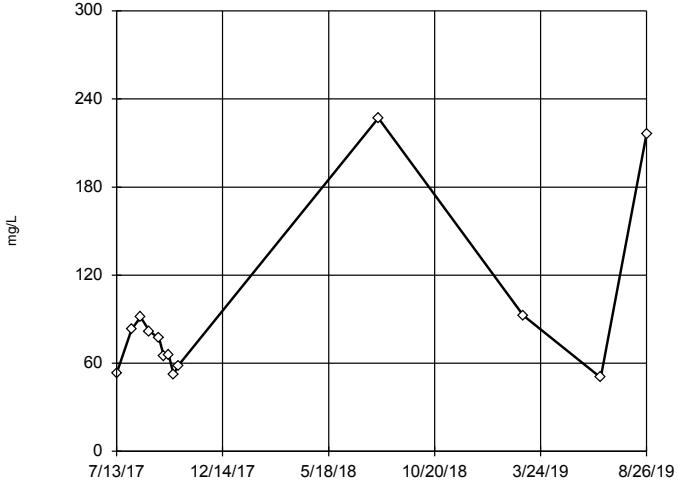
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

High cutoff = 416, low cutoff = 12.3, based on IQR multiplier of 3.

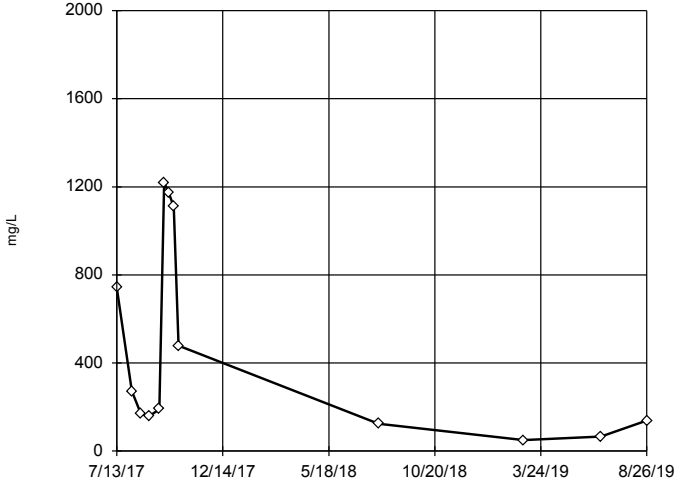
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 299778, low cutoff = 0.3975, based on IQR multiplier of 3.

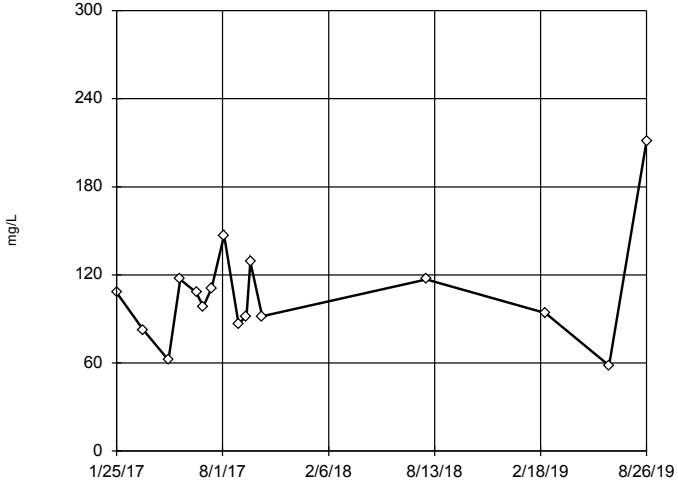
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



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).

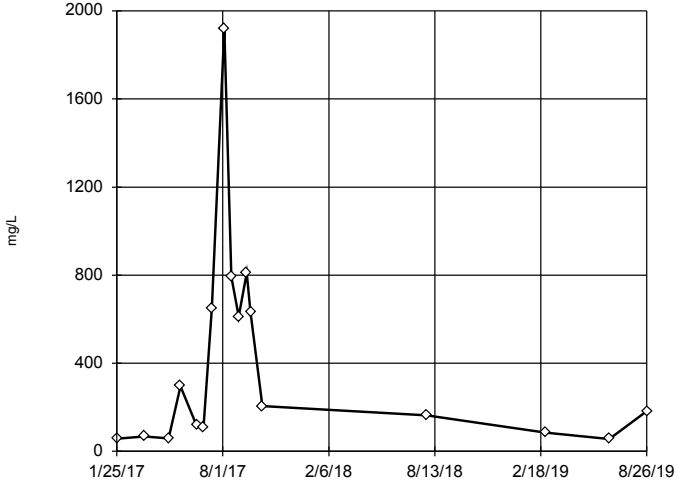
High cutoff = 263.5, low cutoff = 39.64, based on IQR multiplier of 3.

Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-4 (bg)



n = 17

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 = 383715, low cutoff = 0.1261, based on IQR multiplier of 3.

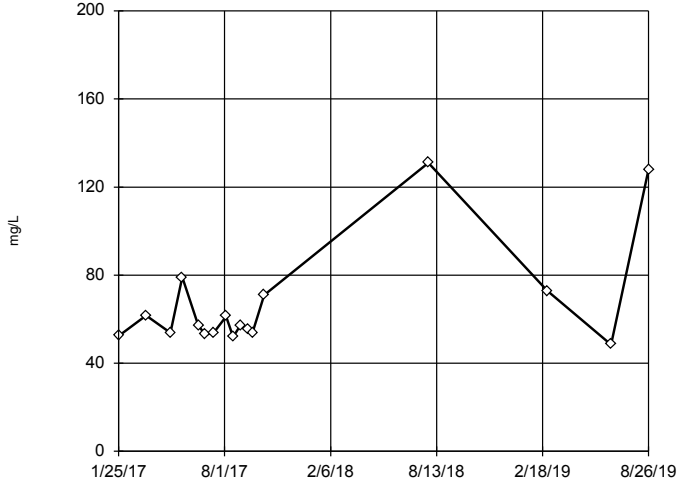
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-5 (bg)



n = 17

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, low cutoff = 21.8, based on IQR multiplier of 3.

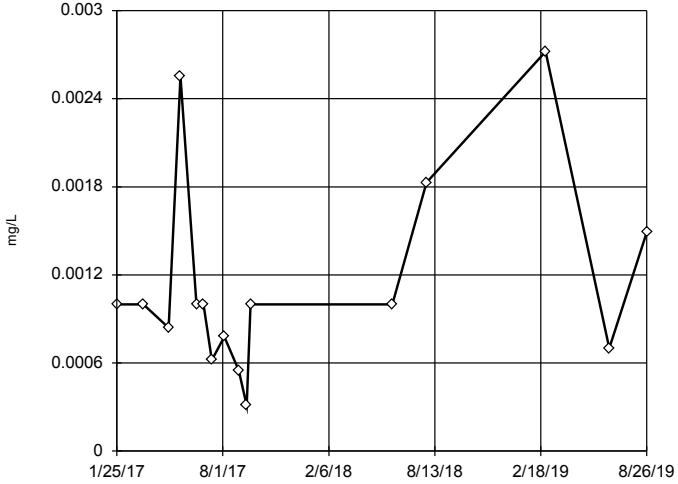
Constituent: Calcium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



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 = 0.005503, low cutoff = 0.0001639, based on IQR multiplier of 3.

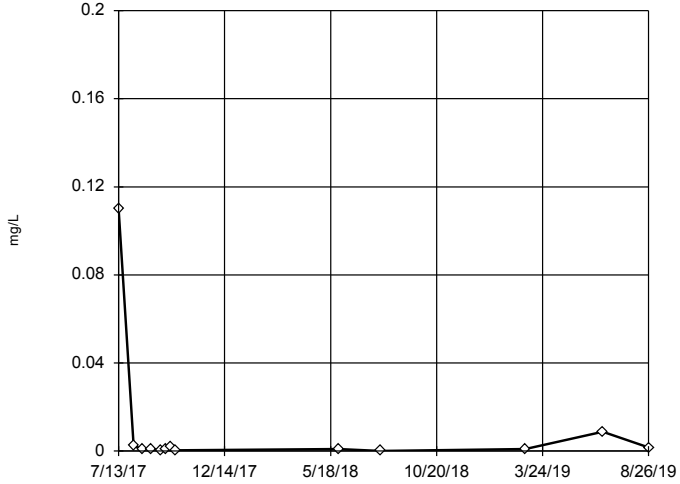
Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

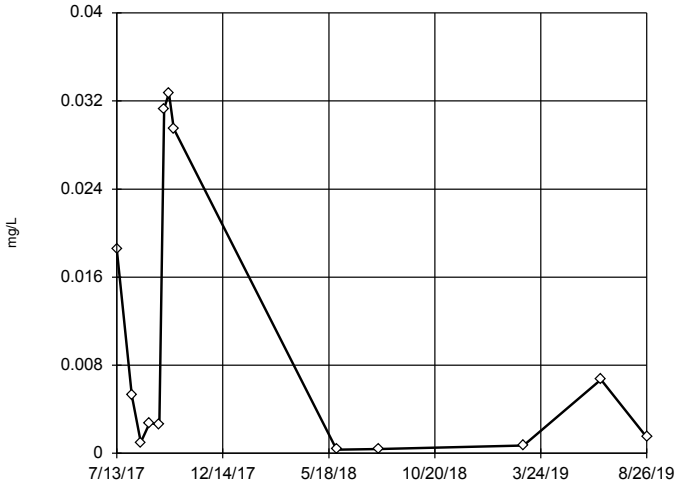
High cutoff = 0.1338, low cutoff = 0.000009664, based on IQR multiplier of 3.

Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 509.3, low cutoff = 3.8e-8, based on IQR multiplier of 3.

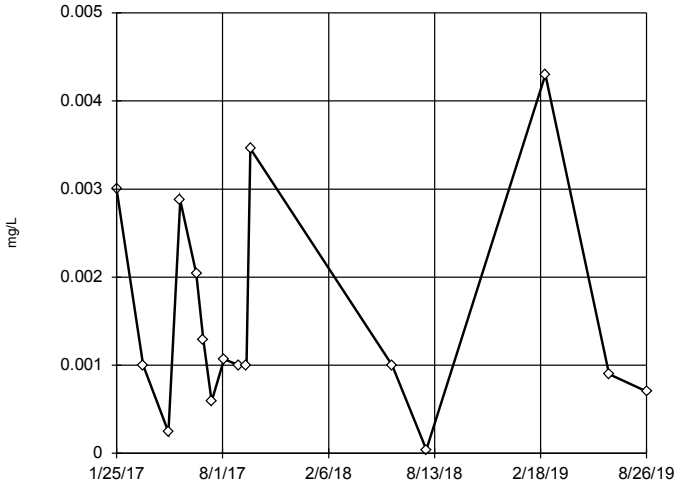
Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

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 = 0.01754, low cutoff = -0.00003478, based on IQR multiplier of 3.

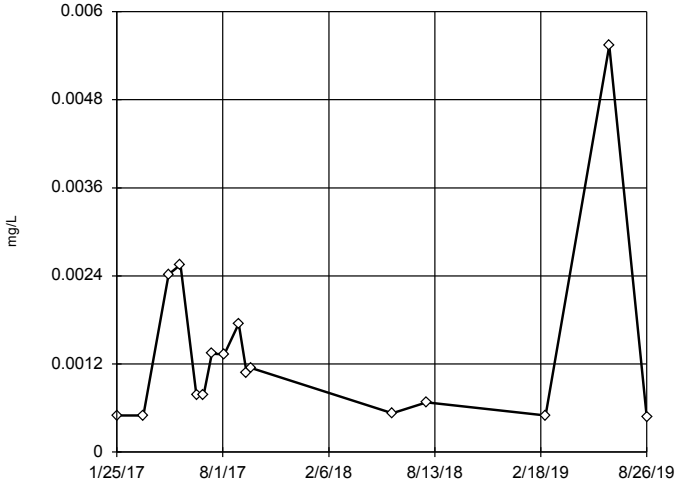
Constituent: Chromium Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



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 = 0.04031, low cutoff = 0.00001956, based on IQR multiplier of 3.

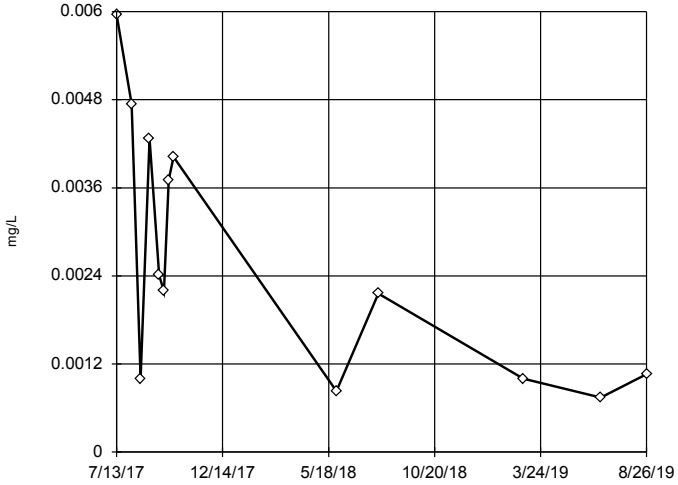
Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

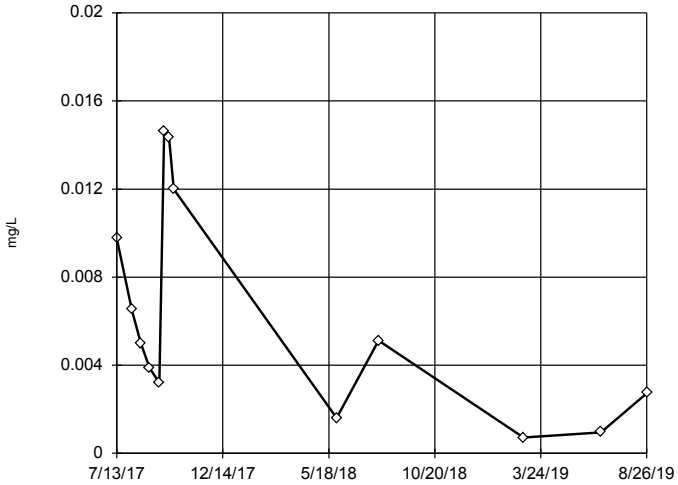
High cutoff = 0.04017, low cutoff = -0.0005485, based on IQR multiplier of 3.

Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 0.1248, low cutoff = -0.003371, based on IQR multiplier of 3.

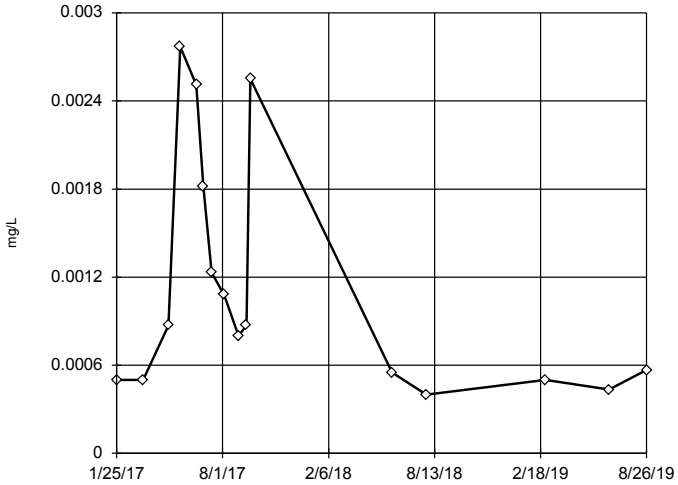
Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



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 = 0.04009, low cutoff = 0.00001866, based on IQR multiplier of 3.

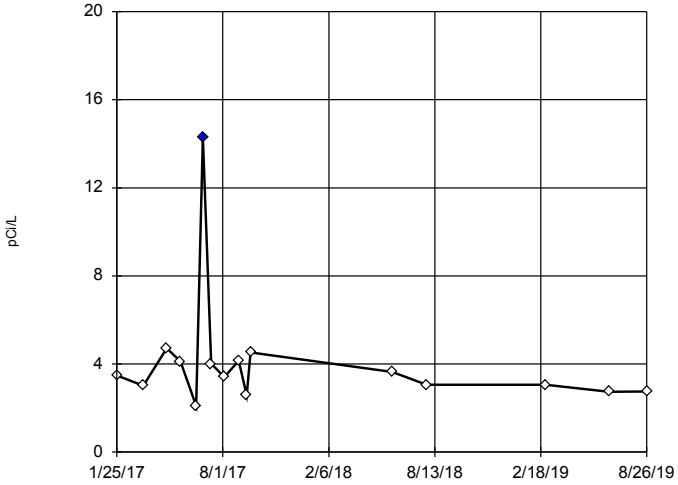
Constituent: Cobalt Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

Outlier is drawn as solid. Tukey's method selected by user.

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

High cutoff = 12.25, low cutoff = 0.9717, based on IQR multiplier of 3.

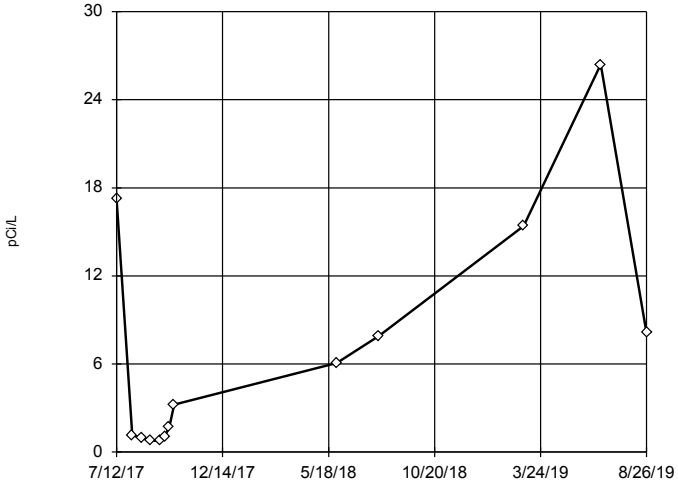
Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

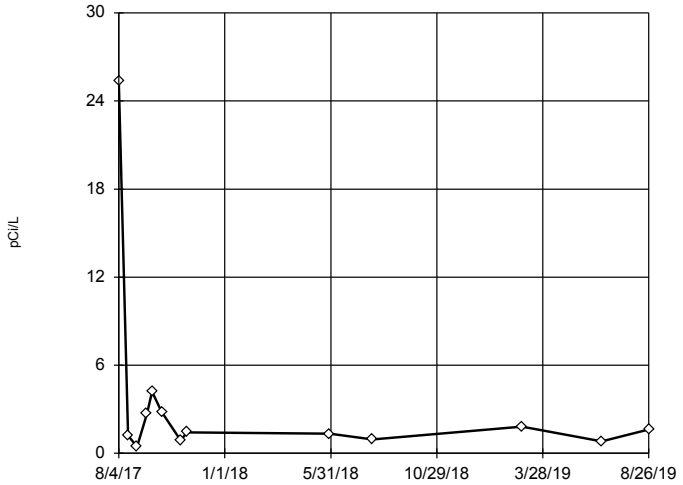
High cutoff = 14360, low cutoff = 0.0008, based on IQR multiplier of 3.

Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 77.88, low cutoff = 0.03186, based on IQR multiplier of 3.

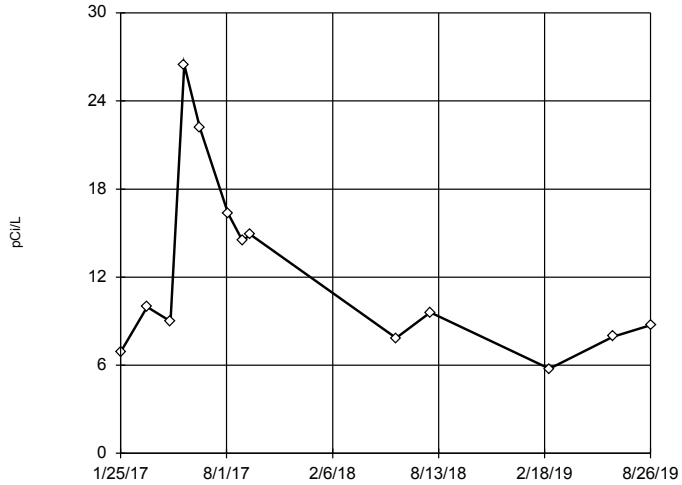
Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 13

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

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

High cutoff = 120.3, low cutoff = 1.024, based on IQR multiplier of 3.

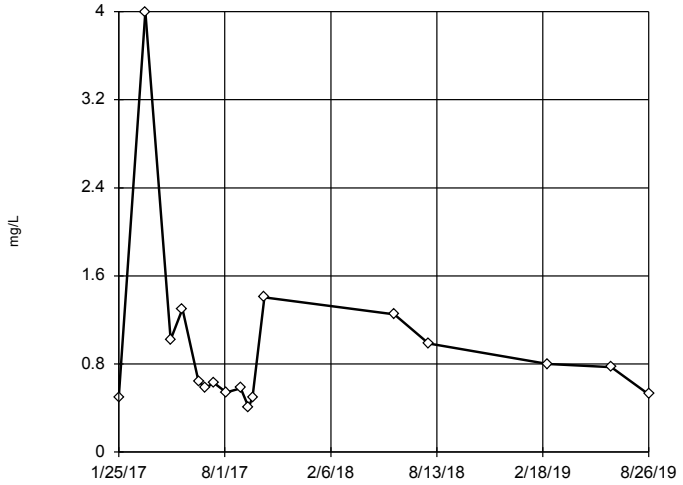
Constituent: Combined Radium 226 + 228 Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 17

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 = 10.71, low cutoff = 0.05624, based on IQR multiplier of 3.

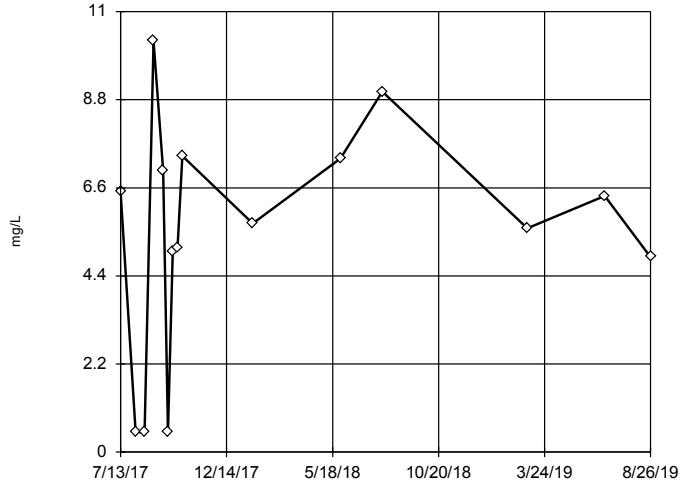
Constituent: Fluoride Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 15

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

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

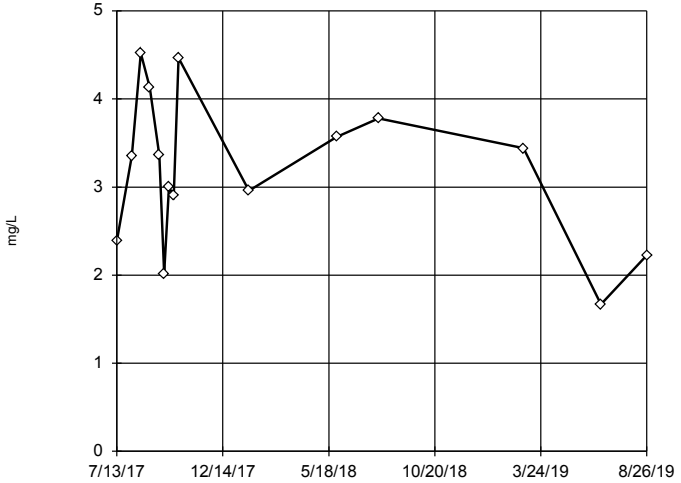
High cutoff = 11.99, low cutoff = -8.134, based on IQR multiplier of 3.

Constituent: Fluoride Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 15

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

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

High cutoff = 7.962, low cutoff = -1.796, based on IQR multiplier of 3.

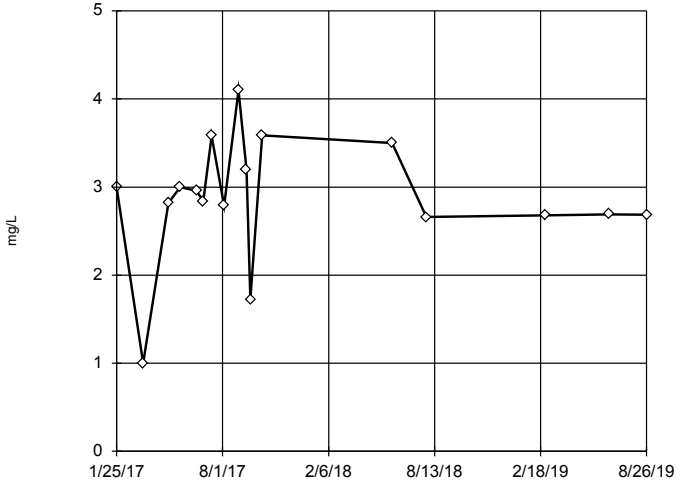
Constituent: Fluoride Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 17

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 = 4.831, low cutoff = -2.217, based on IQR multiplier of 3.

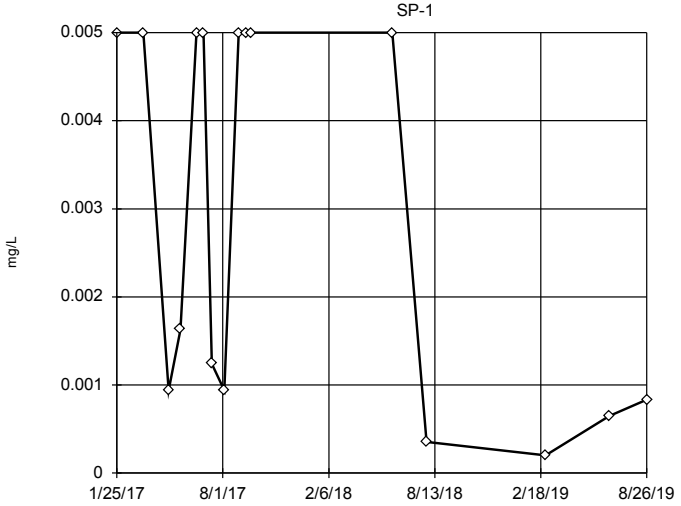
Constituent: Fluoride Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



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 = 0.8988, low cutoff = 0.000004929, based on IQR multiplier of 3.

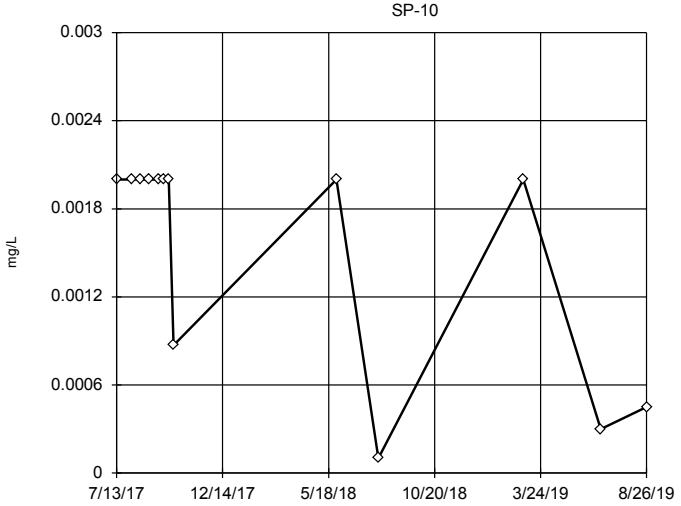
Constituent: Lead Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

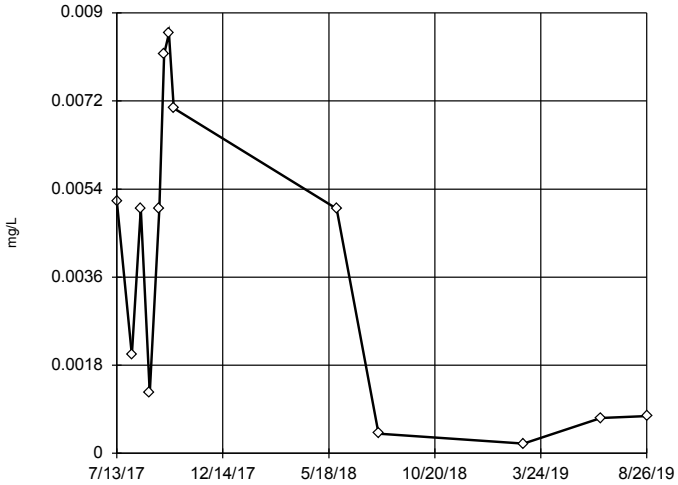
High cutoff = 0.01487, low cutoff = -0.00003896, based on IQR multiplier of 3.

Constituent: Lead Analysis Run 12/5/2019 7:07 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 0.05286, low cutoff = -0.01557, based on IQR multiplier of 3.

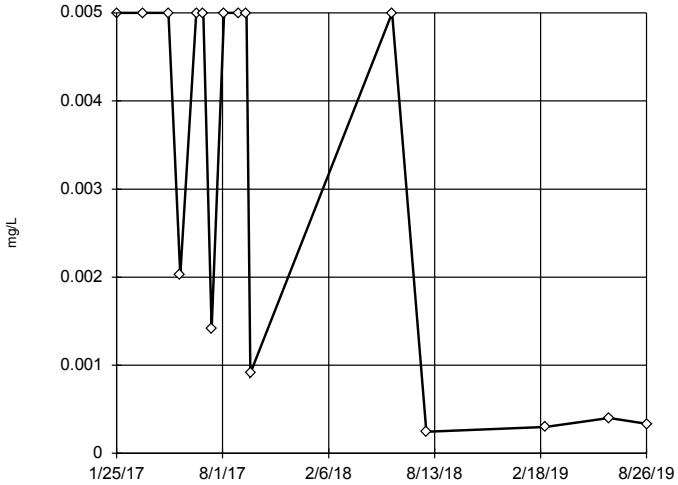
Constituent: Lead Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



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 = 2.846, low cutoff = 0.00000106, based on IQR multiplier of 3.

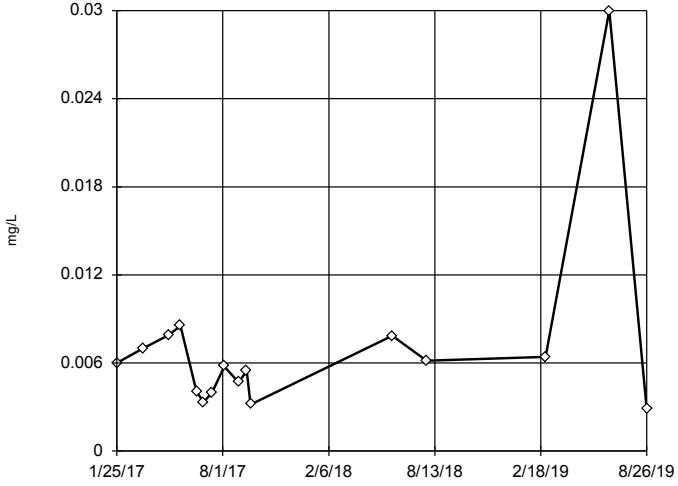
Constituent: Lead Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



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 = 0.04684, low cutoff = 0.0006345, based on IQR multiplier of 3.

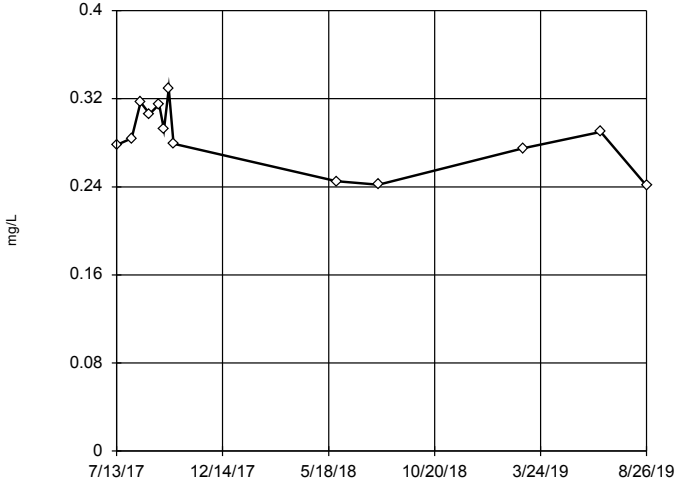
Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

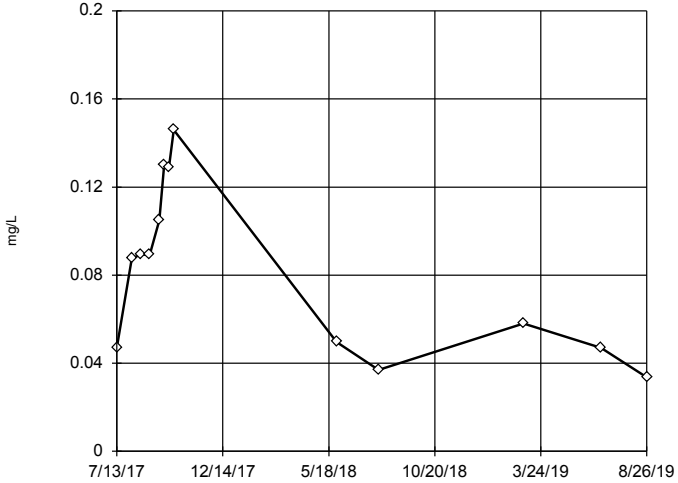
High cutoff = 0.4053, low cutoff = -0.2662, based on IQR multiplier of 3.

Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 0.662, low cutoff = -0.00001086, based on IQR multiplier of 3.

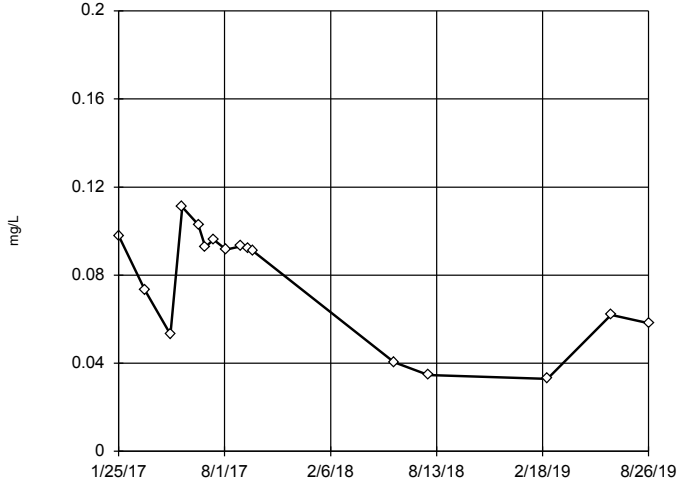
Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

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

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

High cutoff = 0.1421, low cutoff = -0.1227, based on IQR multiplier of 3.

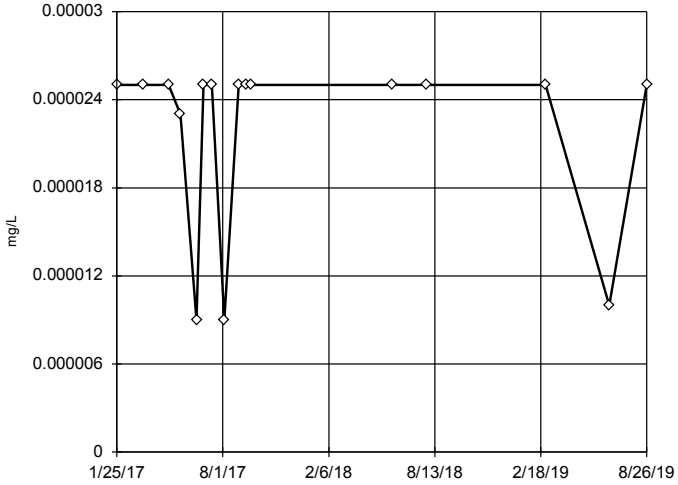
Constituent: Lithium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

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

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

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

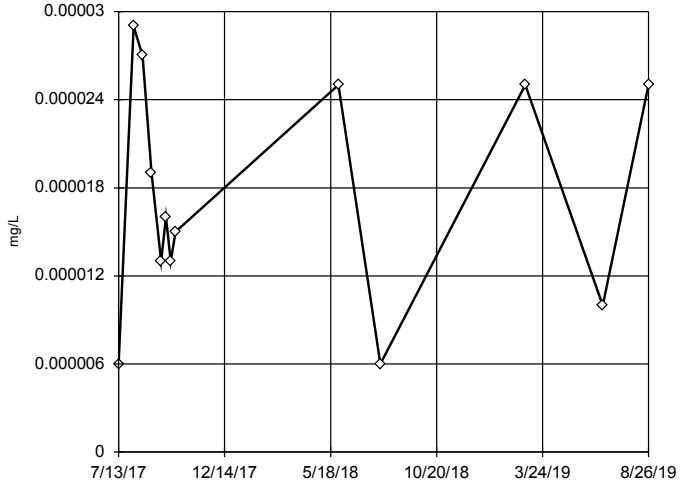
Constituent: Mercury Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

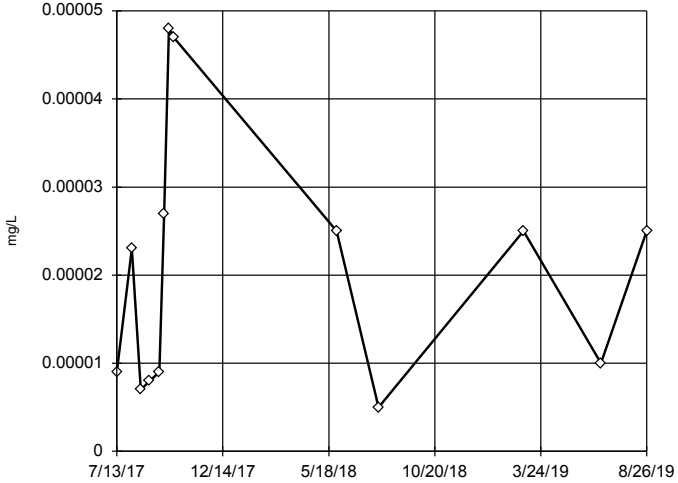
High cutoff = 0.0000655, low cutoff = -0.000029, based on IQR multiplier of 3.

Constituent: Mercury Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 0.0007458, low cutoff = 3.0e-7, based on IQR multiplier of 3.

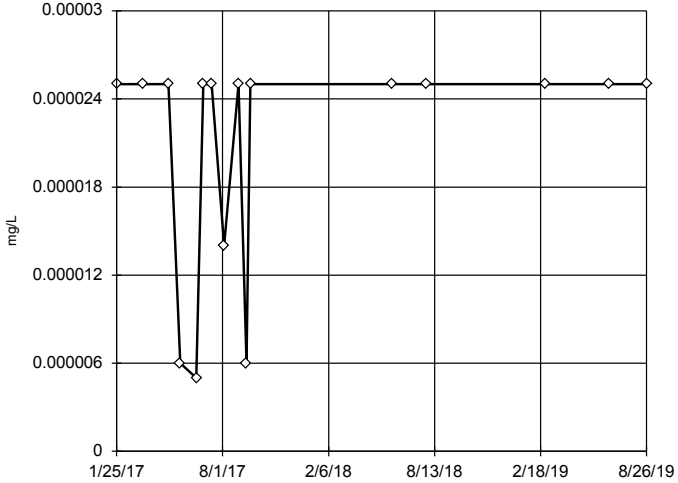
Constituent: Mercury Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

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

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

High cutoff = 0.0000415, low cutoff = 0.000003, based on IQR multiplier of 3.

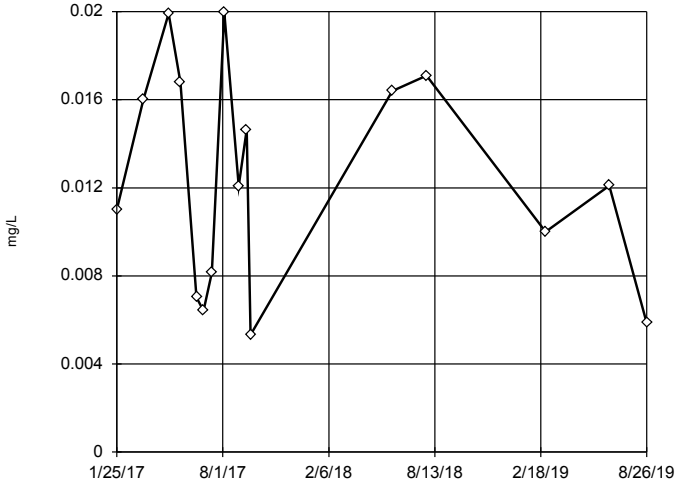
Constituent: Mercury Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

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

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

High cutoff = 0.0436, low cutoff = -0.01944, based on IQR multiplier of 3.

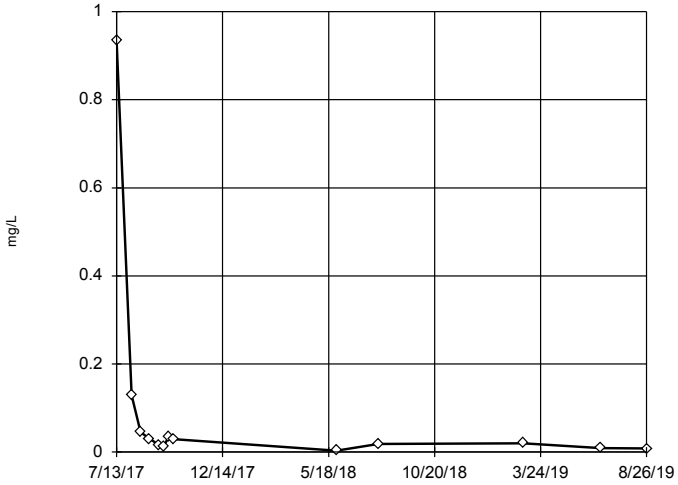
Constituent: Molybdenum Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

High cutoff = 1.972, low cutoff = 0.0002265, based on IQR multiplier of 3.

Constituent: Molybdenum Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11

n = 13

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

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

High cutoff = 0.09964, low cutoff = -0.08594, based on IQR multiplier of 3.

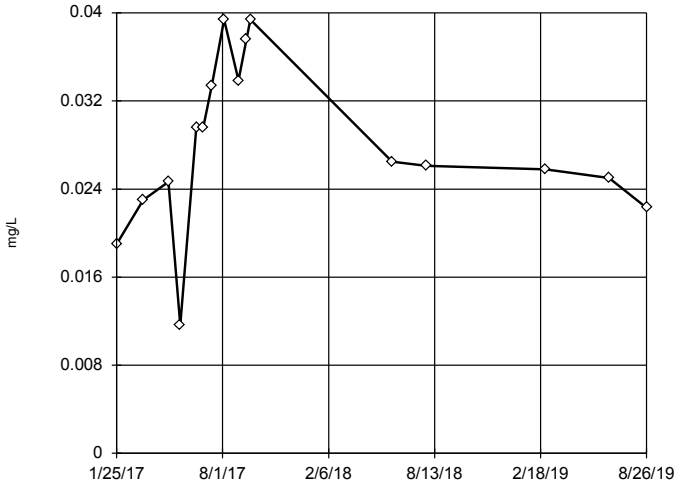
Constituent: Molybdenum Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



n = 16

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

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

High cutoff = 0.06286, low cutoff = -0.00543, based on IQR multiplier of 3.

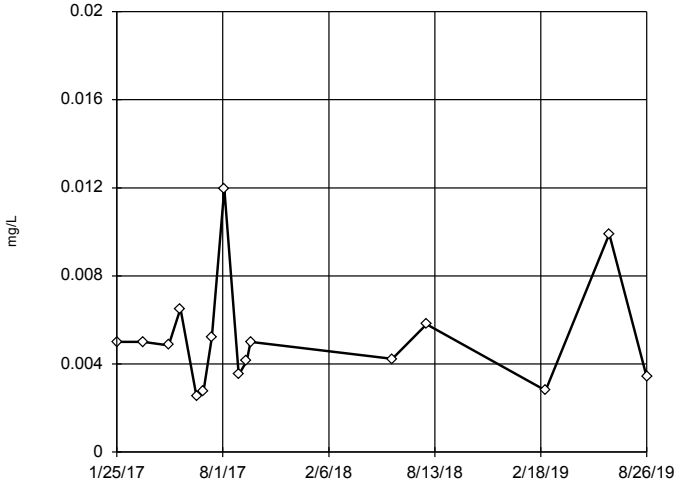
Constituent: Molybdenum Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



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 = 0.02215, low cutoff = 0.0008574, based on IQR multiplier of 3.

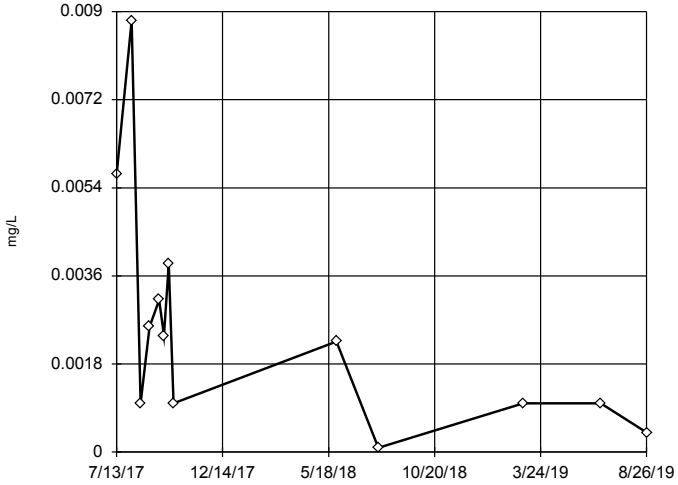
Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

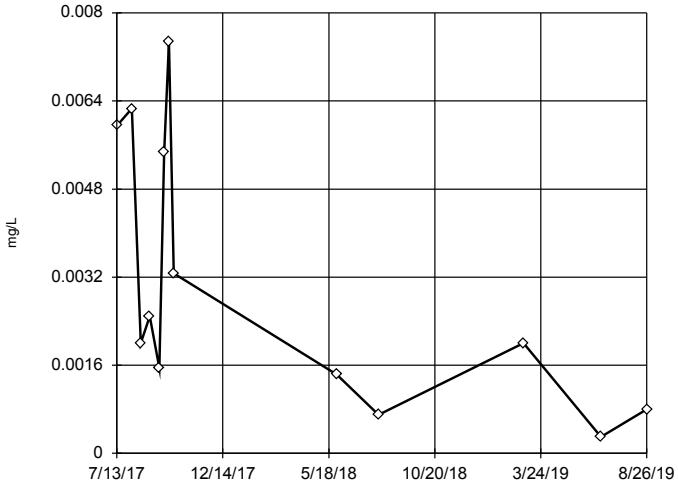
High cutoff = 0.02841, low cutoff = -0.0001561, based on IQR multiplier of 3.

Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

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

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

High cutoff = 0.0671, low cutoff = -0.001951, based on IQR multiplier of 3.

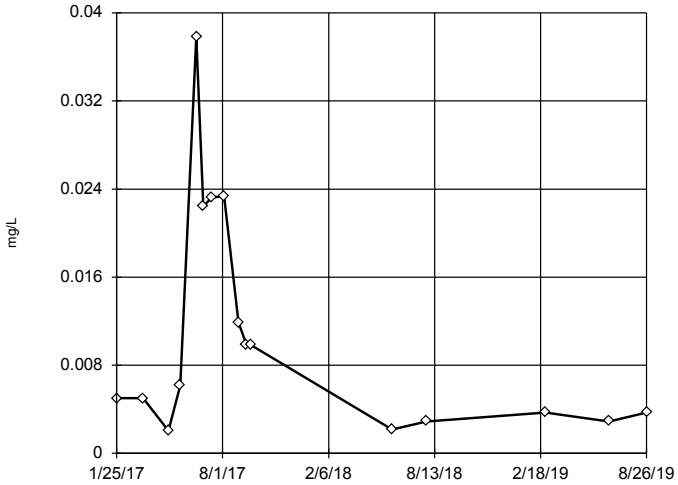
Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



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 = 2.01, low cutoff = 0.00002657, based on IQR multiplier of 3.

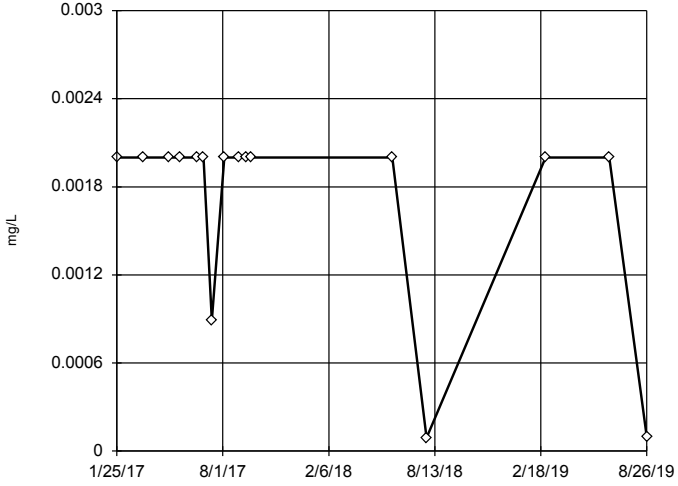
Constituent: Selenium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-1



n = 16

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

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

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

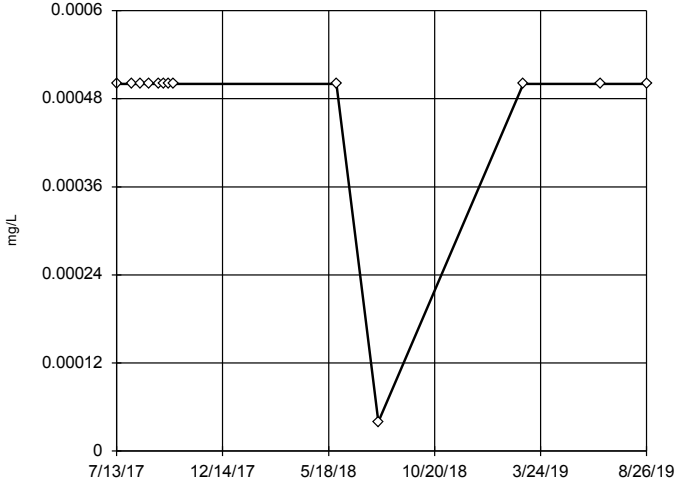
Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-10



n = 13

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

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

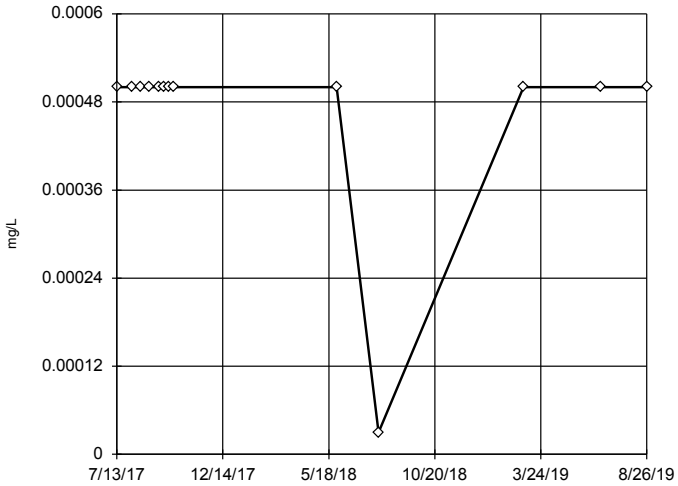
The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Tukey's Outlier Screening

SP-11



n = 13

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

Data were x^4 transformed to achieve best W statistic (graph shown in original units).

The results were invalidated, because the lower and upper quartiles are equal.

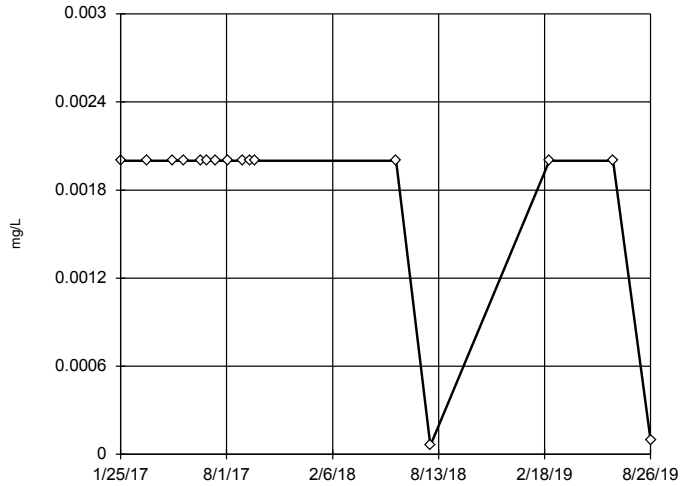
Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tukey's Outlier Screening

SP-2



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).

The results were invalidated, because the lower and upper quartiles are equal.

Constituent: Thallium Analysis Run 12/5/2019 7:08 PM

Northeastern BAP Client: Geosyntec Data: Northeastern BAP

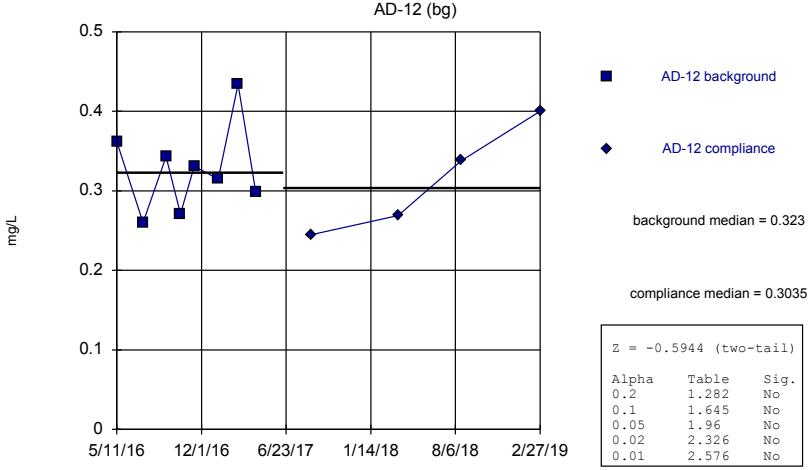
Welch's t-test/Mann-Whitney - All Results (No Significant Results)

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 7:57 AM

Constituent	Well	Calc.	0.01	Method
Calcium, total (mg/L)	AD-12 (bg)	-0.5944	No	Mann-W
Calcium, total (mg/L)	AD-13 (bg)	1.953	No	Mann-W
Calcium, total (mg/L)	AD-22	0.5131	No	Mann-W
Calcium, total (mg/L)	AD-33	-1.537	No	Mann-W
Calcium, total (mg/L)	AD-7	0.6587	No	Mann-W
pH, field (SU)	AD-12 (bg)	1.613	No	Mann-W
pH, field (SU)	AD-13 (bg)	0.5944	No	Mann-W
pH, field (SU)	AD-22	0.7656	No	Mann-W
pH, field (SU)	AD-33	1.104	No	Mann-W
pH, field (SU)	AD-7	-0.4246	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-12 (bg)	-1.361	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-13 (bg)	-1.79	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-22	0.2932	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-33	-2.278	No	Mann-W
Total Dissolved Solids [TDS] (mg/L)	AD-7	-1.248	No	Mann-W

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)



Z = -0.5944 (two-tail)

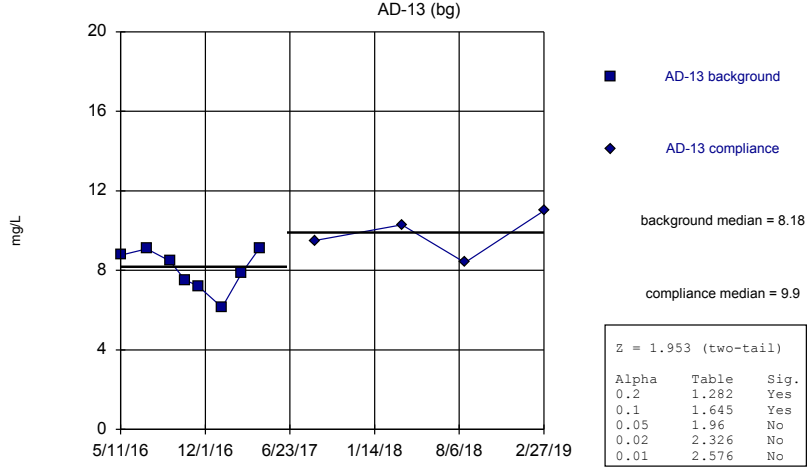
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-13 (bg)



Z = 1.953 (two-tail)

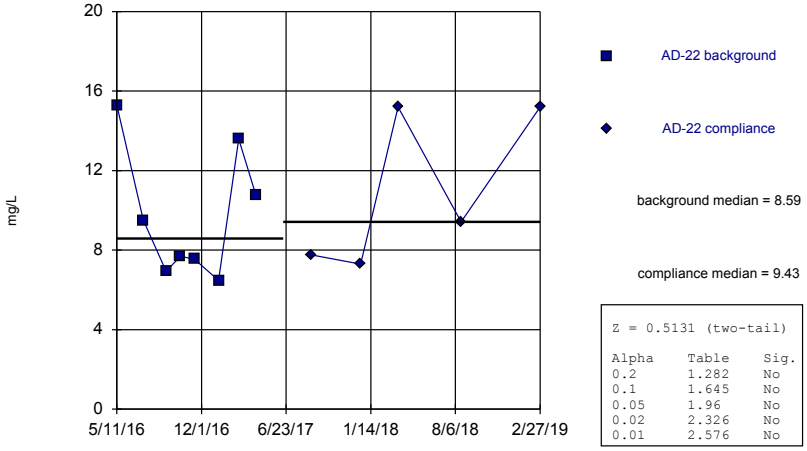
Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-22



Z = 0.5131 (two-tail)

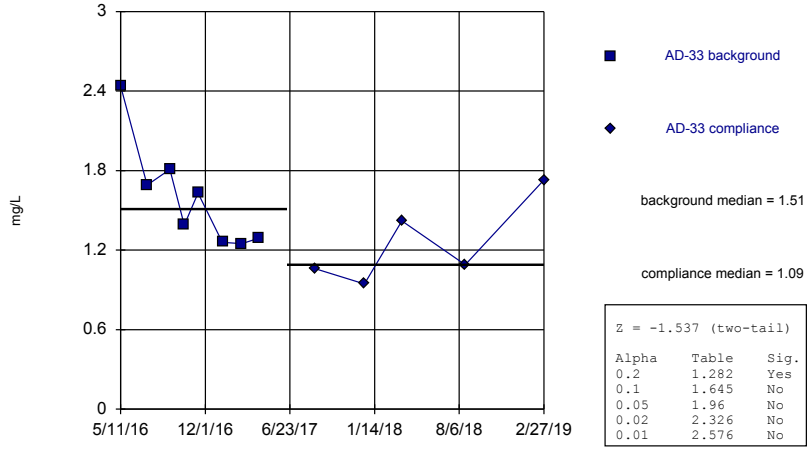
Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-33



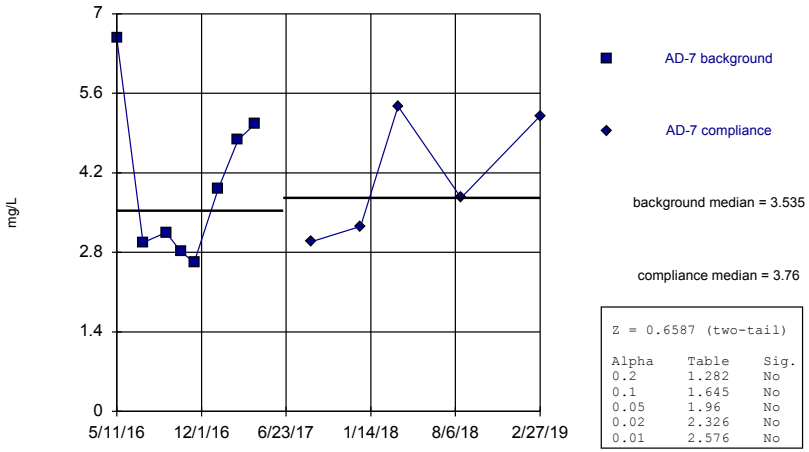
Z = -1.537 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

AD-7

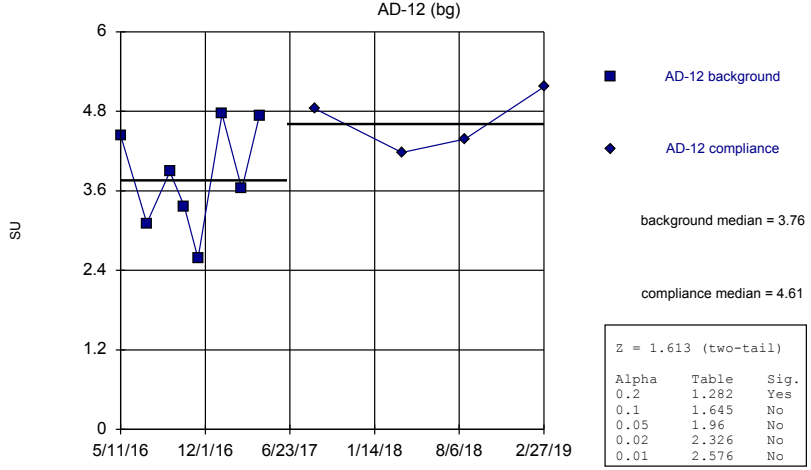


Constituent: Calcium, total Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)

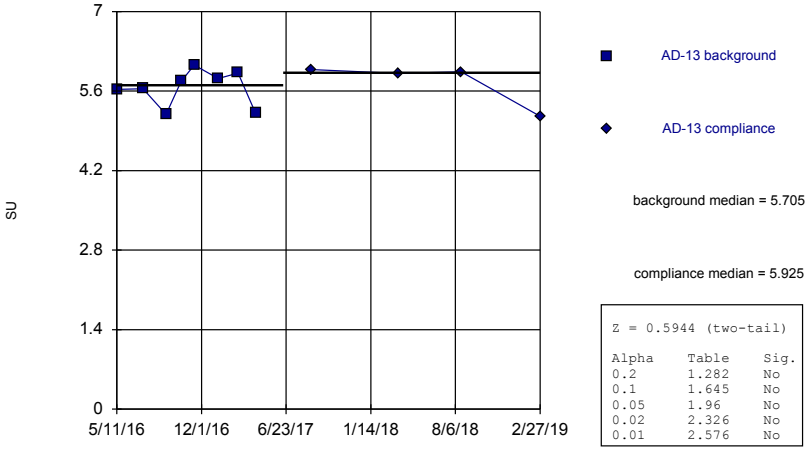


Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-13 (bg)

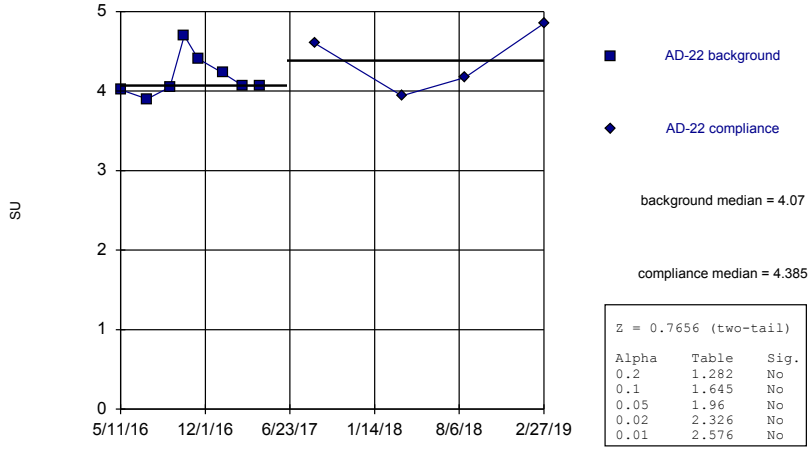


Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

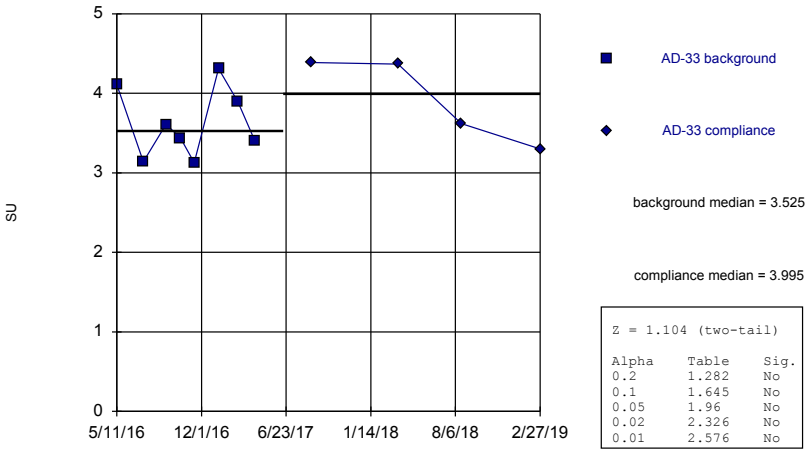
AD-22



Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

AD-33

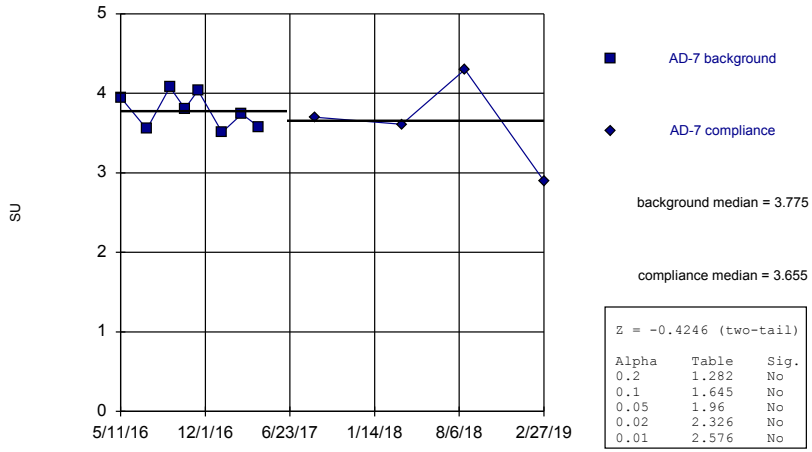


Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-7

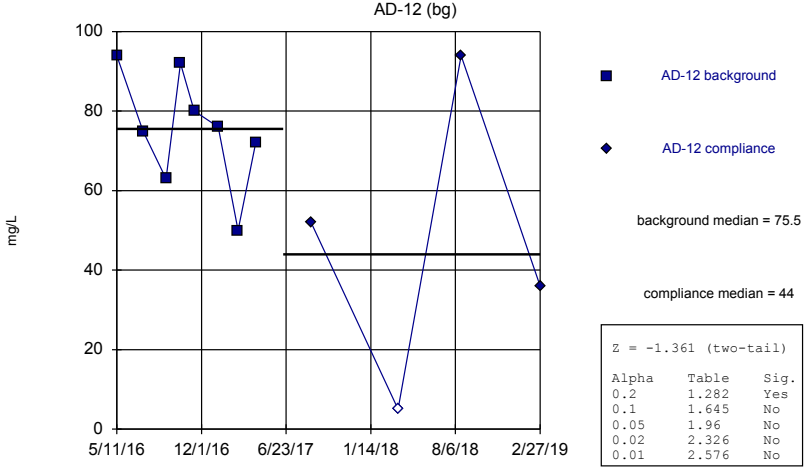


Constituent: pH, field Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Mann-Whitney (Wilcoxon Rank Sum)

AD-12 (bg)

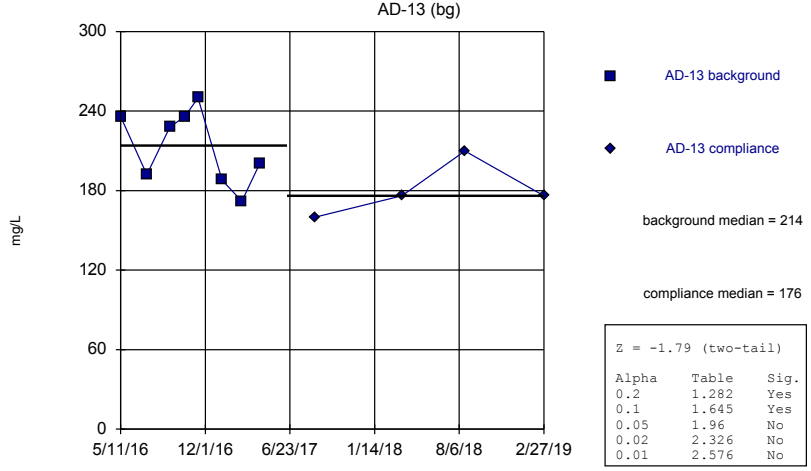


Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

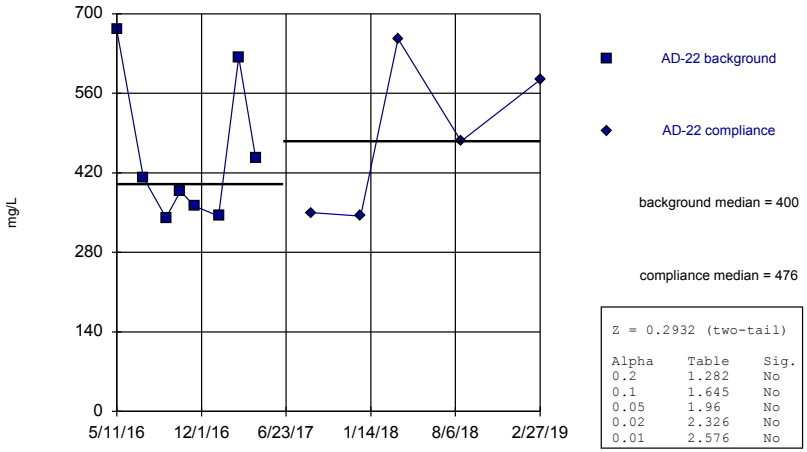
AD-13 (bg)



Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Mann-Whitney (Wilcoxon Rank Sum)

AD-22



background median = 400

compliance median = 476

Z = 0.2932 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

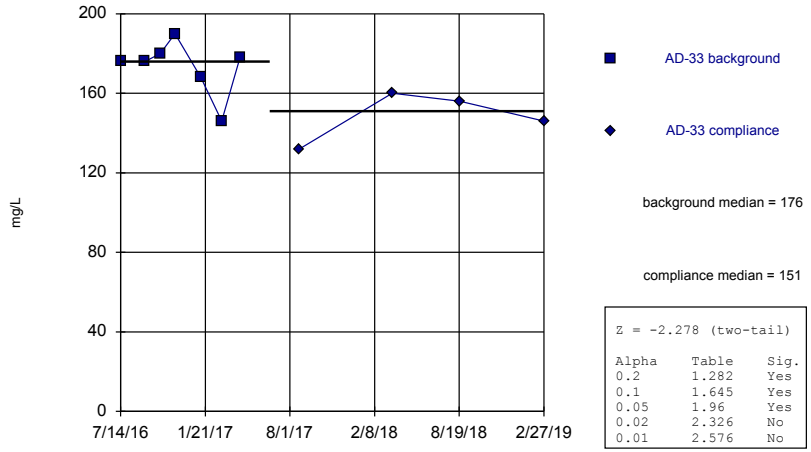
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-33



background median = 176

compliance median = 151

Z = -2.278 (two-tail)

Alpha	Table	Sig.
0.2	1.282	Yes
0.1	1.645	Yes
0.05	1.96	Yes
0.02	2.326	No
0.01	2.576	No

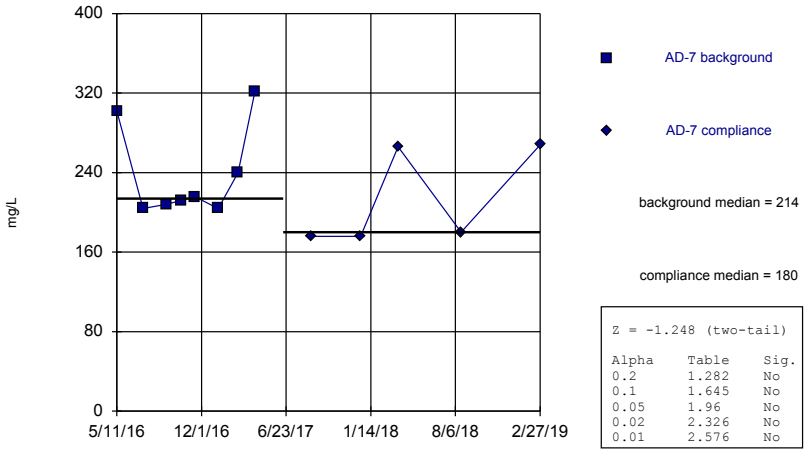
Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Mann-Whitney (Wilcoxon Rank Sum)

AD-7



background median = 214

compliance median = 180

Z = -1.248 (two-tail)

Alpha	Table	Sig.
0.2	1.282	No
0.1	1.645	No
0.05	1.96	No
0.02	2.326	No
0.01	2.576	No

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:57 AM View: Intrawell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

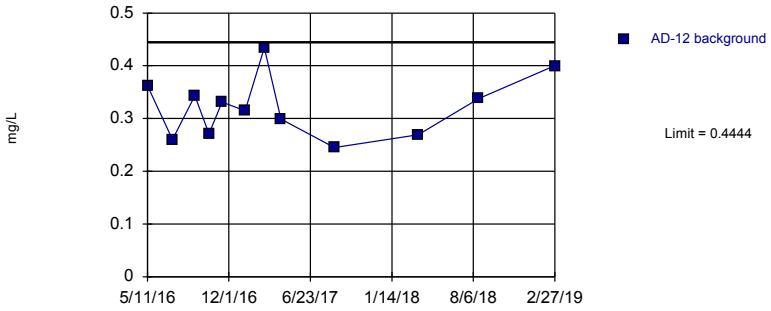
Intrawell Prediction Limit Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 8:00 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-12	0.4444	n/a	n/a	1 future	n/a	12	0.3223	0.05781	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-13	11.44	n/a	n/a	1 future	n/a	12	8.617	1.337	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-33	2.292	n/a	n/a	1 future	n/a	13	1.462	0.3998	0	None	No	0.002505	Param Intra 1 of 2
pH, field (SU)	AD-12	5.754	2.427	n/a	1 future	n/a	12	4.091	0.7877	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-13	6.376	4.995	n/a	1 future	n/a	12	5.686	0.3269	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-22	4.917	3.585	n/a	1 future	n/a	12	4.251	0.3153	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-33	4.725	2.726	n/a	1 future	n/a	12	3.726	0.4733	0	None	No	0.001253	Param Intra 1 of 2
pH, field (SU)	AD-7	4.486	2.976	n/a	1 future	n/a	12	3.731	0.3575	0	None	No	0.001253	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-12	121.8	n/a	n/a	1 future	n/a	12	65.75	26.52	8.333	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-13	264.6	n/a	n/a	1 future	n/a	12	202	29.65	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-33	203.2	n/a	n/a	1 future	n/a	11	164.4	17.84	0	None	No	0.002505	Param Intra 1 of 2

Prediction Limit

Intrawell Parametric, AD-12 (bg)

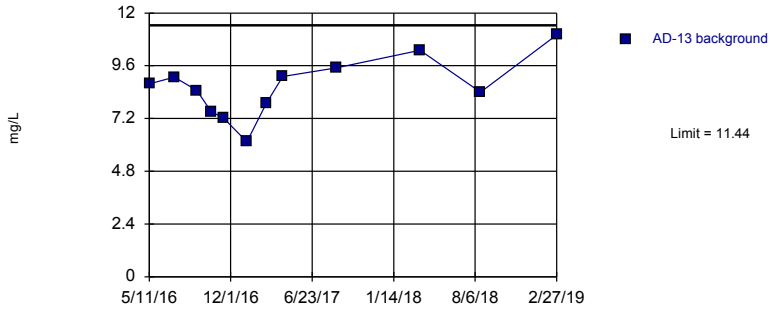


Background Data Summary: Mean=0.3223, Std. Dev.=0.05781, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9547, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-13 (bg)

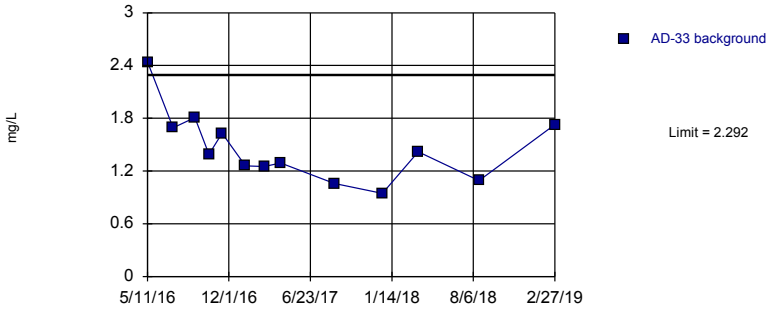


Background Data Summary: Mean=8.617, Std. Dev.=1.337, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9916, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-33

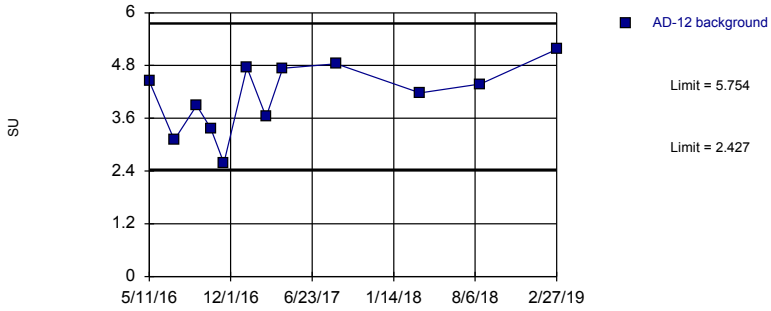


Background Data Summary: Mean=1.462, Std. Dev.=0.3998, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9183, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-12 (bg)

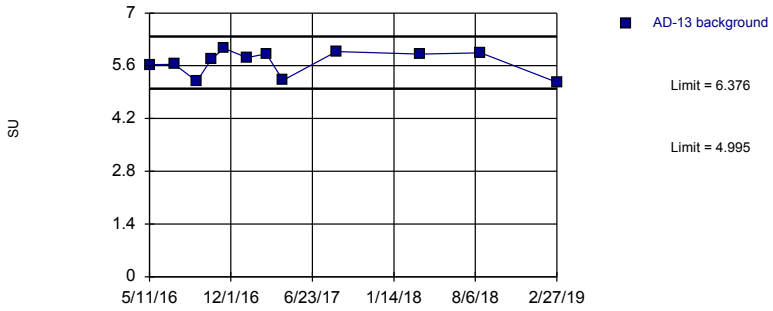


Background Data Summary: Mean=4.091, Std. Dev.=0.7877, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9544, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-13 (bg)



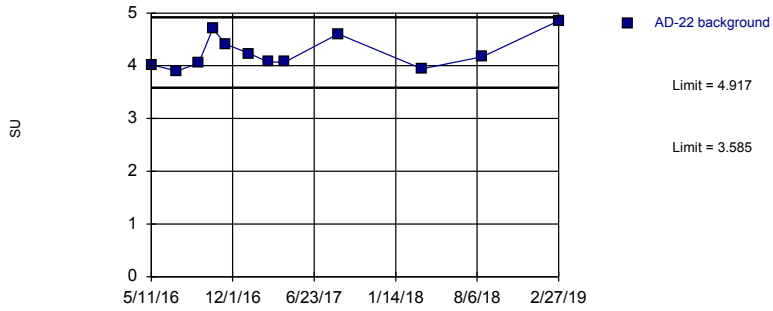
Background Data Summary: Mean=5.686, Std. Dev.=0.3269, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8494, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-22



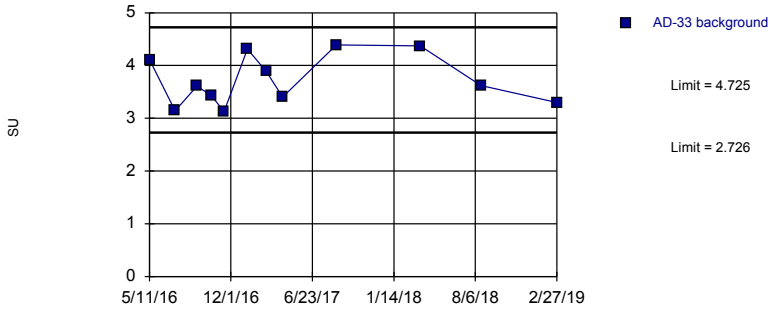
Background Data Summary: Mean=4.251, Std. Dev.=0.3153, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.885, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-33



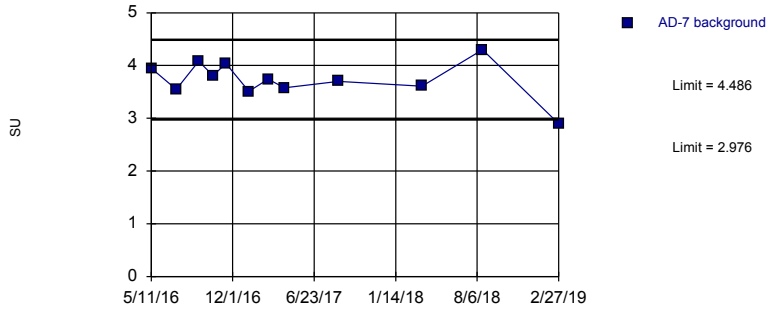
Background Data Summary: Mean=3.726, Std. Dev.=0.4733, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9014, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-7



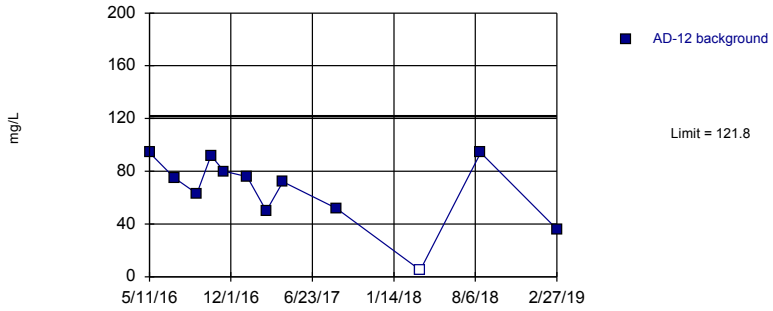
Background Data Summary: Mean=3.731, Std. Dev.=0.3575, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9396, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: pH, field Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Hollow symbols indicate censored values.

Prediction Limit

Intrawell Parametric, AD-12 (bg)

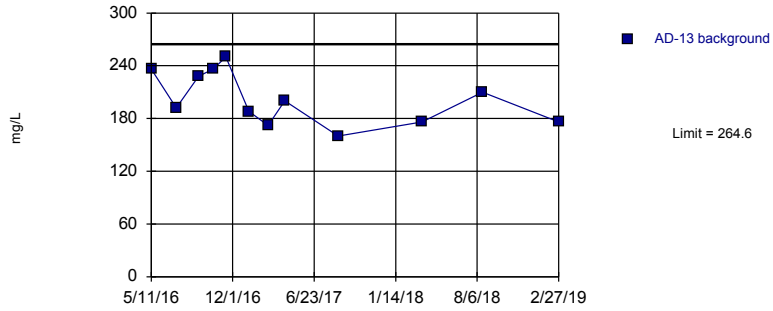


Background Data Summary: Mean=65.75, Std. Dev.=26.52, n=12, 8.333% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9032, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-13 (bg)

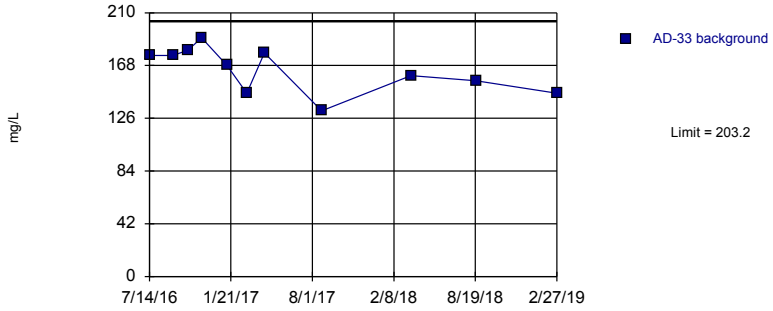


Background Data Summary: Mean=202, Std. Dev.=29.65, n=12. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9362, critical = 0.805. Kappa = 2.112 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Prediction Limit

Intrawell Parametric, AD-33



Background Data Summary: Mean=164.4, Std. Dev.=17.84, n=11. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9491, critical = 0.792. Kappa = 2.175 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS] Analysis Run 12/9/2019 7:59 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

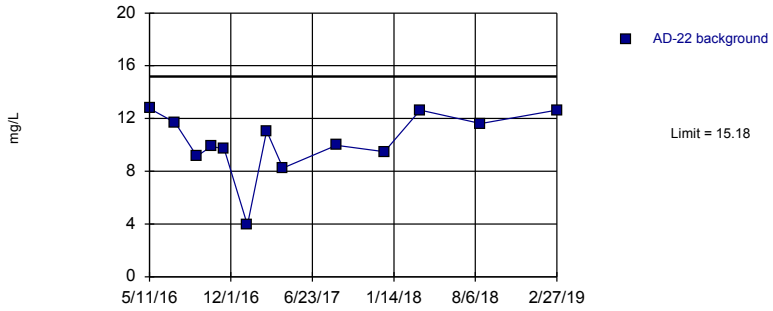
Deseasonalized Intrawell Prediction Limit Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 8:06 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Calcium, total (mg/L)	AD-22	15.18	n/a	n/a	1 future	n/a	13	10.21	2.393	0	None	No	0.002505	Param Intra 1 of 2
Calcium, total (mg/L)	AD-7	5.315	n/a	n/a	1 future	n/a	13	4.037	0.6157	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-22	651.2	n/a	n/a	1 future	n/a	13	461.5	91.38	0	None	No	0.002505	Param Intra 1 of 2
Total Dissolved Solids [TDS] (mg/L)	AD-7	291.3	n/a	n/a	1 future	n/a	13	228.8	30.1	0	None	No	0.002505	Param Intra 1 of 2

Prediction Limit

Intrawell Parametric, AD-22



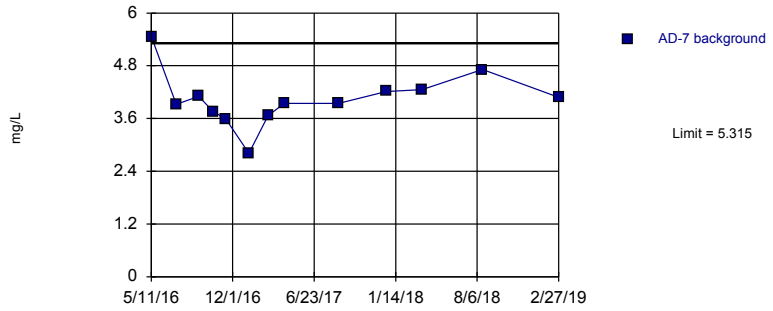
Background Data Summary: Mean=10.21, Std. Dev.=2.393, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8604, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total, Alt. Values Analysis Run 12/9/2019 8:05 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-7



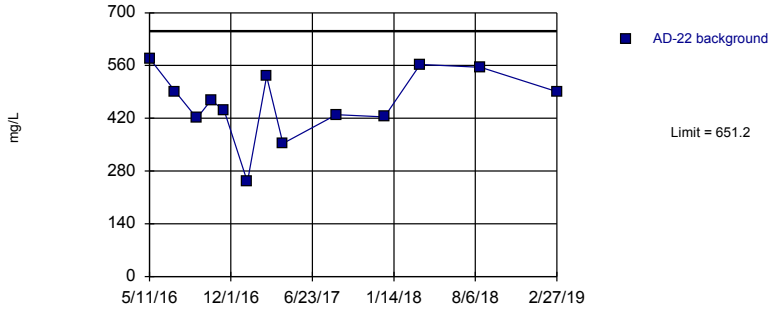
Background Data Summary: Mean=4.037, Std. Dev.=0.6157, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9217, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Calcium, total, Alt. Values Analysis Run 12/9/2019 8:05 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-22



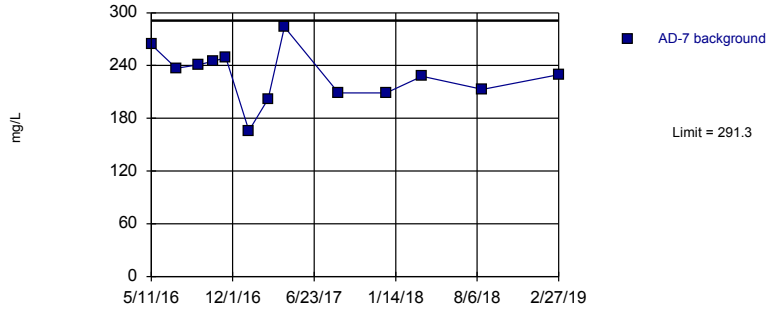
Background Data Summary: Mean=461.5, Std. Dev.=91.38, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9344, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS], Alt. Values Analysis Run 12/9/2019 8:05 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Prediction Limit

Intrawell Parametric, AD-7



Background Data Summary: Mean=228.8, Std. Dev.=30.1, n=13. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9799, critical = 0.814. Kappa = 2.077 (c=7, w=3, 1 of 2, event alpha = 0.05132). Report alpha = 0.002505. Assumes 1 future value.

Constituent: Total Dissolved Solids [TDS], Alt. Values Analysis Run 12/9/2019 8:06 AM View: Intrawell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Trend Tests Summary Table - Upgradient Wells

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/6/2019, 11:26 AM

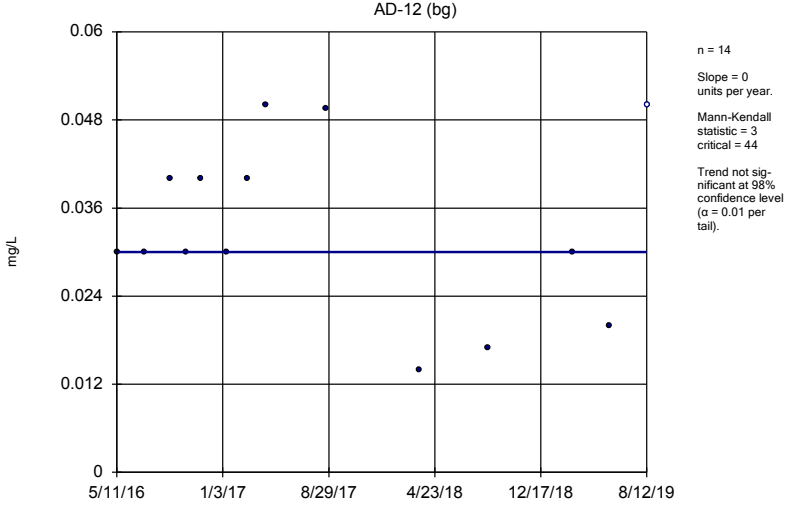
Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Boron, total (mg/L)	AD-12 (bg)	0	3	44	No	14	7.143	n/a	n/a	0.02	NP
Boron, total (mg/L)	AD-13 (bg)	0.002834	32	44	No	14	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-12 (bg)	0.1051	23	44	No	14	0	n/a	n/a	0.02	NP
Chloride, total (mg/L)	AD-13 (bg)	4.358	32	44	No	14	0	n/a	n/a	0.02	NP
Fluoride, total (mg/L)	**AD-12 (bg)**	**-0.08118**	**-46**	**-44**	**Yes**	**14**	**64.29**	**n/a**	**n/a**	**0.02**	**NP**
Fluoride, total (mg/L)	AD-13 (bg)	-0.08825	-23	-44	No	14	28.57	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-12 (bg)	-0.7952	-35	-44	No	14	0	n/a	n/a	0.02	NP
Sulfate, total (mg/L)	AD-13 (bg)	7.178	38	44	No	14	0	n/a	n/a	0.02	NP

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0 units per year.

Mann-Kendall statistic = 3 critical = 44

Trend not significant at 98% confidence level (α = 0.01 per tail).

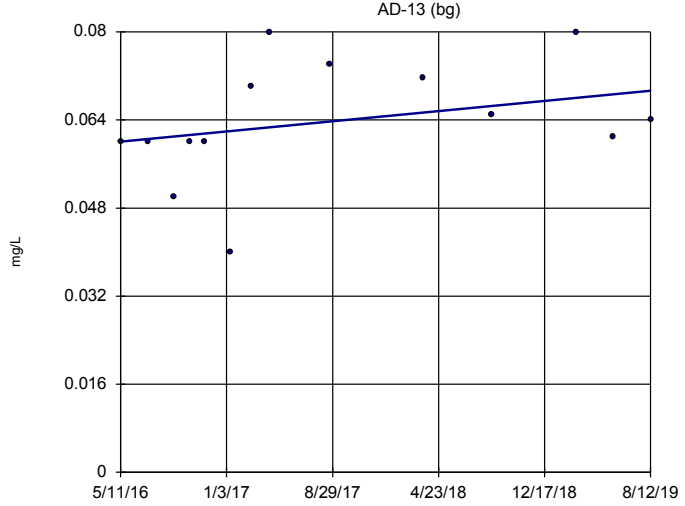
Constituent: Boron, total Analysis Run 12/6/2019 11:25 AM View: Interwell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = 0.002834 units per year.

Mann-Kendall statistic = 32 critical = 44

Trend not significant at 98% confidence level (α = 0.01 per tail).

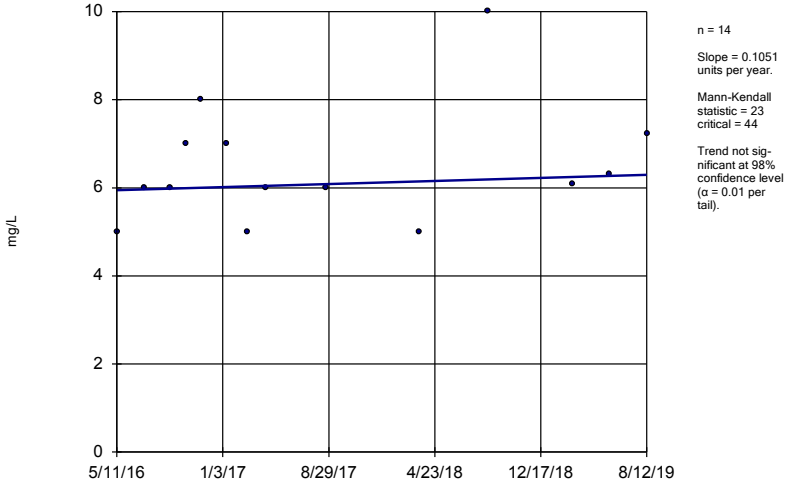
Constituent: Boron, total Analysis Run 12/6/2019 11:25 AM View: Interwell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = 0.1051 units per year.

Mann-Kendall statistic = 23 critical = 44

Trend not significant at 98% confidence level (α = 0.01 per tail).

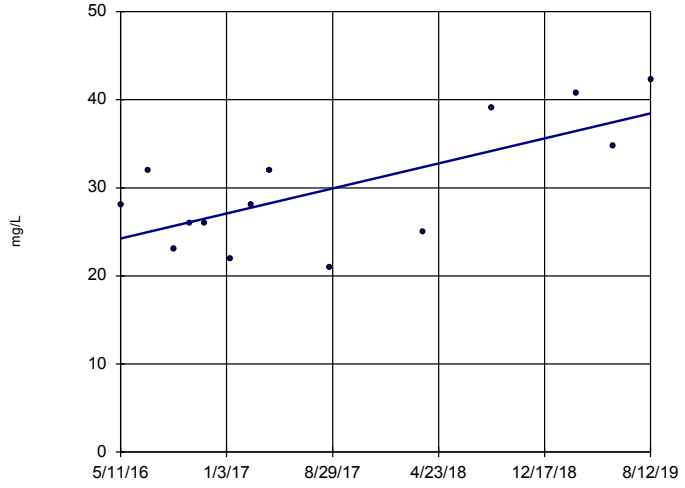
Constituent: Chloride, total Analysis Run 12/6/2019 11:25 AM View: Interwell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = 4.358 units per year.

Mann-Kendall statistic = 32 critical = 44

Trend not significant at 98% confidence level (α = 0.01 per tail).

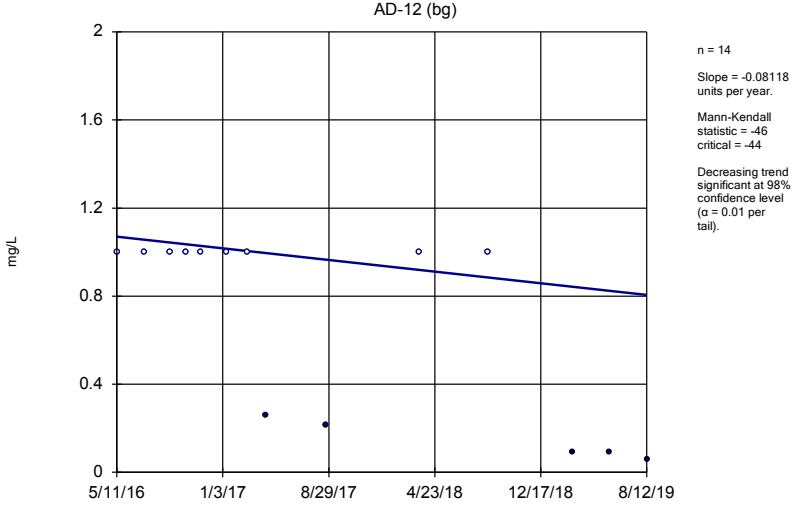
Constituent: Chloride, total Analysis Run 12/6/2019 11:25 AM View: Interwell

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.08118 units per year.

Mann-Kendall statistic = -46
critical = -44

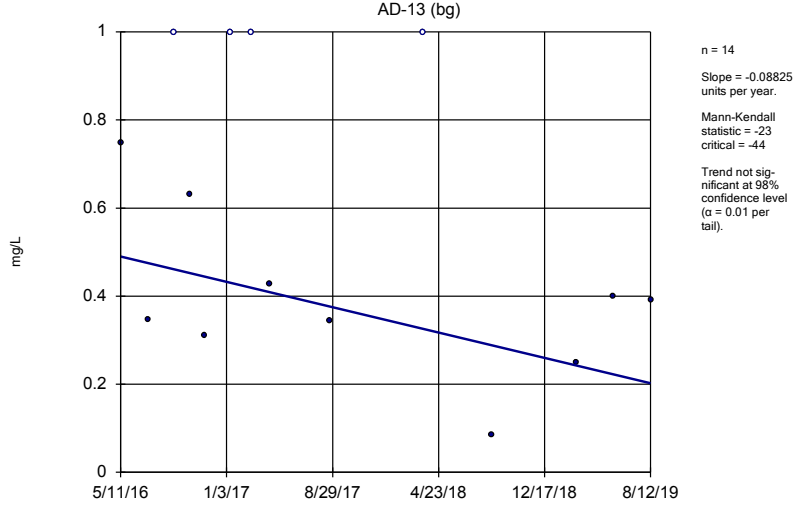
Decreasing trend significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG
Hollow symbols indicate censored values.

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = -0.08825 units per year.

Mann-Kendall statistic = -23
critical = -44

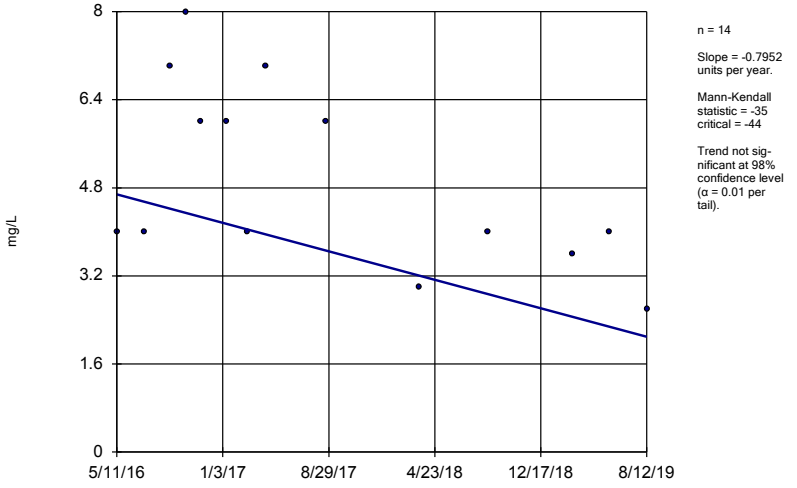
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Fluoride, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-12 (bg)



n = 14

Slope = -0.7952 units per year.

Mann-Kendall statistic = -35
critical = -44

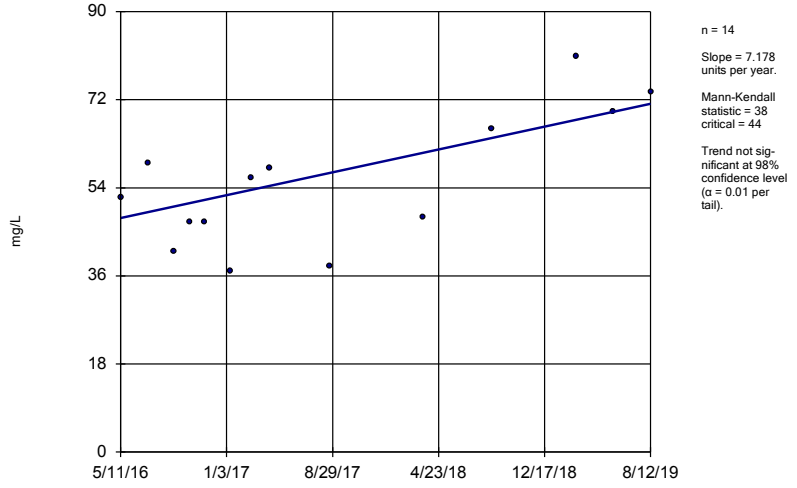
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Sulfate, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Sen's Slope Estimator

AD-13 (bg)



n = 14

Slope = 7.178 units per year.

Mann-Kendall statistic = 38
critical = 44

Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Sulfate, total Analysis Run 12/6/2019 11:25 AM View: Interwell
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Interwell Prediction Limit Summary Table - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 8:08 AM

Constituent	Well	Upper Lim.	Lower Lim.	Date	Observ.	Sig.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Boron, total (mg/L)	n/a	0.08453	n/a	n/a	3 future	n/a	24	0.0488	0.01937	0	None	No	0.002505	Param Inter 1 of 2
Chloride, total (mg/L)	n/a	40.8	n/a	n/a	3 future	n/a	24	n/a	n/a	0	n/a	n/a	0.003036	NP Inter (normality) 1 of 2
Fluoride, total (mg/L)	n/a	1	n/a	n/a	3 future	n/a	24	n/a	n/a	54.17	n/a	n/a	0.003036	NP Inter (NDs) 1 of 2
Sulfate, total (mg/L)	n/a	80.8	n/a	n/a	3 future	n/a	24	n/a	n/a	0	n/a	n/a	0.003036	NP Inter (normality) 1 of 2

Upper Tolerance Limits - App IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/6/2019, 11:38 AM

Constituent	Upper Lim.	Bg N	Bg Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	0.005	26	n/a	n/a	92.31	n/a	n/a	0.2635	NP Inter(NDs)
Arsenic, total (mg/L)	0.006425	25	0.002391	0.00176	48	Kaplan-Meier	No	0.05	Inter
Barium, total (mg/L)	0.0514	26	0.03266	0.008226	0	None	No	0.05	Inter
Beryllium, total (mg/L)	0.002	26	n/a	n/a	15.38	n/a	n/a	0.2635	NP Inter(normality)
Cadmium, total (mg/L)	0.001	24	n/a	n/a	75	n/a	n/a	0.292	NP Inter(normality)
Chromium, total (mg/L)	0.001869	26	-7.997	0.7528	50	Kaplan-Meier	ln(x)	0.05	Inter
Cobalt, total (mg/L)	0.056	26	n/a	n/a	0	n/a	n/a	0.2635	NP Inter(normality)
Combined Radium 226 + 228 (pCi/L)	2.935	26	1.183	0.769	0	None	No	0.05	Inter
Fluoride, total (mg/L)	1	28	n/a	n/a	46.43	n/a	n/a	0.2378	NP Inter(normality)
Lead, total (mg/L)	0.005	26	n/a	n/a	88.46	n/a	n/a	0.2635	NP Inter(NDs)
Lithium, total (mg/L)	0.165	26	n/a	n/a	3.846	n/a	n/a	0.2635	NP Inter(normality)
Mercury, total (mg/L)	0.000025	26	n/a	n/a	84.62	n/a	n/a	0.2635	NP Inter(NDs)
Molybdenum, total (mg/L)	0.005	22	n/a	n/a	95.45	n/a	n/a	0.3235	NP Inter(NDs)
Selenium, total (mg/L)	0.005	26	n/a	n/a	73.08	n/a	n/a	0.2635	NP Inter(normality)
Thallium, total (mg/L)	0.002	24	n/a	n/a	75	n/a	n/a	0.292	NP Inter(normality)

Tolerance Limit

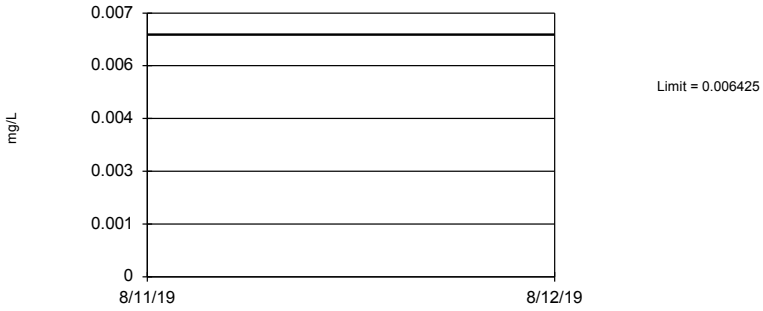
Interwell Non-parametric

Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 26 background values. 92.31% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Antimony, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Parametric

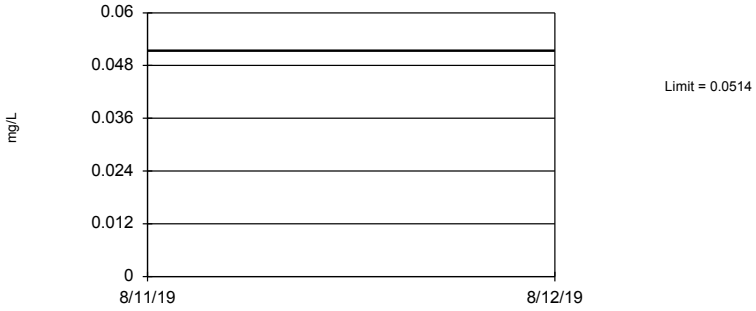


95% coverage. Background Data Summary (after Kaplan-Meier Adjustment): Mean=0.002391, Std. Dev.=0.00176, n=25, 48% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.8904, critical = 0.888. Report alpha = 0.05.

Constituent: Arsenic, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Parametric

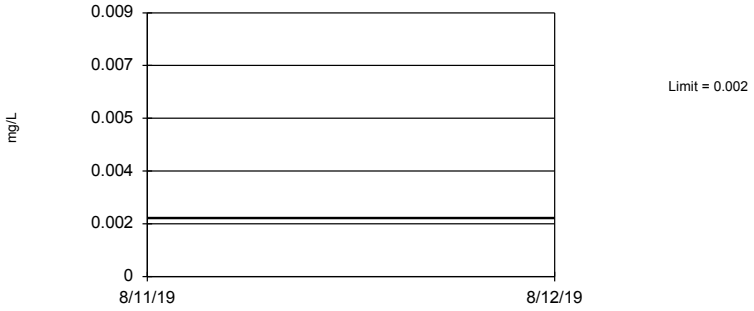


95% coverage. Background Data Summary: Mean=0.03266, Std. Dev.=0.008226, n=26. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9085, critical = 0.891. Report alpha = 0.05.

Constituent: Barium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Non-parametric

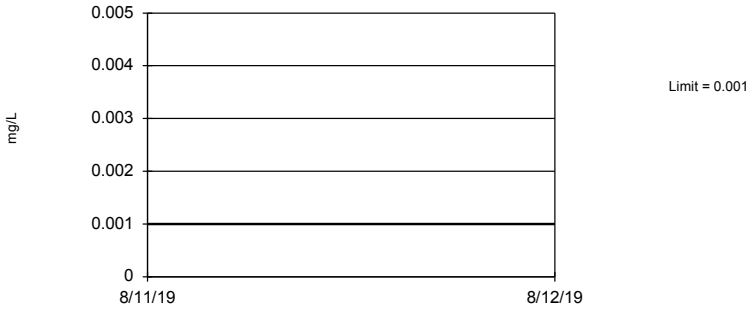


Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 15.38% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Beryllium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Non-parametric



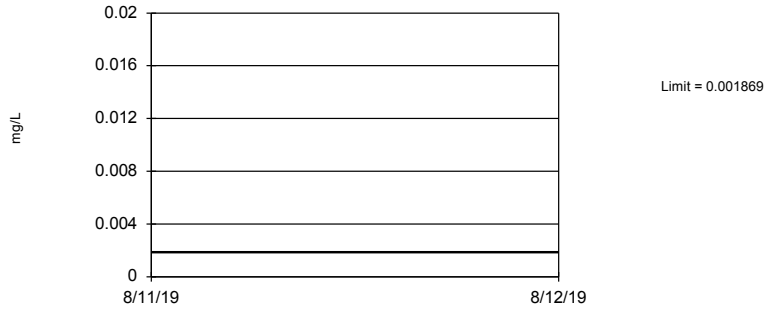
Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 24 background values. 75% NDs. 82.62% coverage at alpha=0.01; 88.09% coverage at alpha=0.05; 97.07% coverage at alpha=0.5. Report alpha = 0.292.

Constituent: Cadmium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Parametric



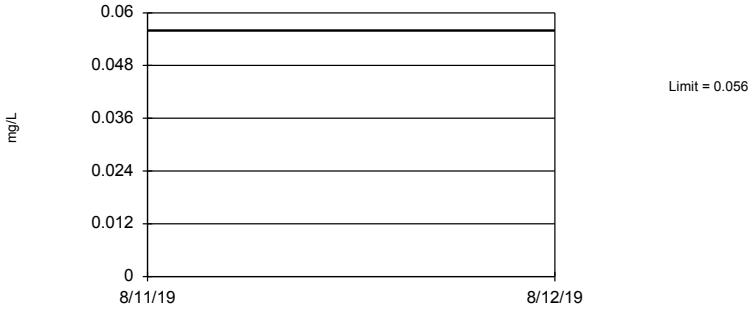
95% coverage. Background Data Summary (based on natural log transformation) (after Kaplan-Meier Adjustment): Mean=-7.997, Std. Dev.=0.7528, n=26, 50% NDs. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9156, critical = 0.891. Report alpha = 0.05.

Constituent: Chromium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



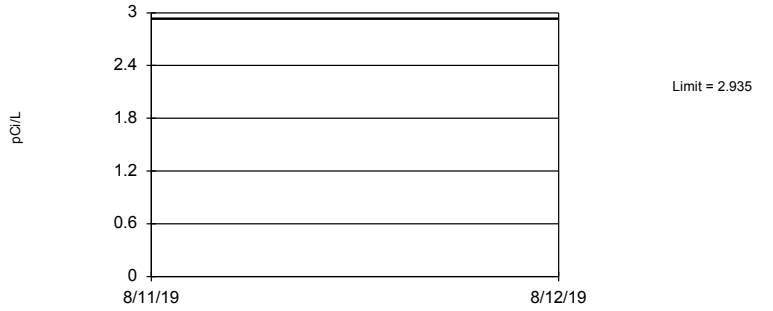
Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Cobalt, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Parametric



95% coverage. Background Data Summary: Mean=1.183, Std. Dev.=0.769, n=26. Normality test: Shapiro Wilk @alpha = 0.01, calculated = 0.9406, critical = 0.891. Report alpha = 0.05.

Constituent: Combined Radium 226 + 228 Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Non-parametric

Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 28 background values. 46.43% NDs. 84.96% coverage at alpha=0.01; 90.04% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2378.

Constituent: Fluoride, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric

Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 26 background values. 88.46% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

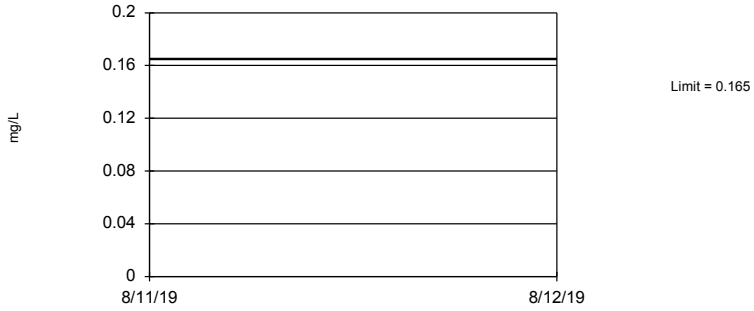
Constituent: Lead, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 3.846% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

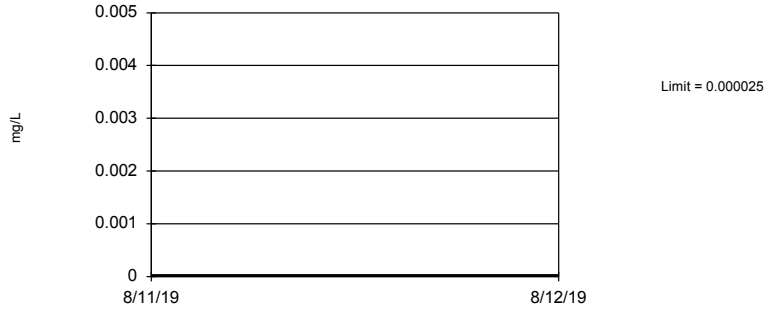
Constituent: Lithium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.23 Groundwater Stats Consulting. UG

Tolerance Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 26 background values. 84.62% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Mercury, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Non-parametric

Non-parametric test used in lieu of parametric tolerance limit because censored data exceeded 75%. Limit is highest of 22 background values. 95.45% NDs. 81.05% coverage at alpha=0.01; 87.3% coverage at alpha=0.05; 97.07% coverage at alpha=0.5. Report alpha = 0.3235.

Constituent: Molybdenum, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

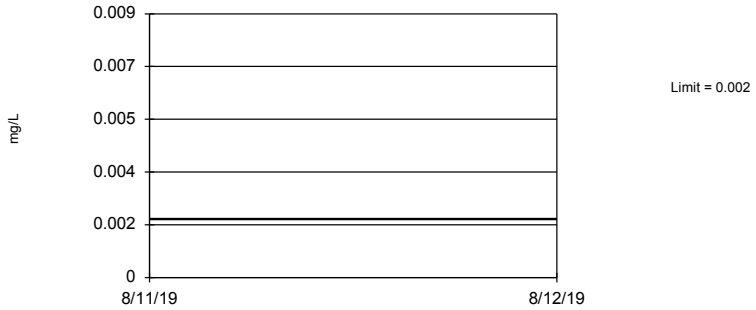
Interwell Non-parametric

Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 26 background values. 73.08% NDs. 83.79% coverage at alpha=0.01; 89.26% coverage at alpha=0.05; 97.46% coverage at alpha=0.5. Report alpha = 0.2635.

Constituent: Selenium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Tolerance Limit

Interwell Non-parametric



Non-parametric test used in lieu of parametric tolerance limit because the Shapiro Wilk normality test showed the data to be non-normal at the 0.01 alpha level. Limit is highest of 24 background values. 75% NDs. 82.62% coverage at alpha=0.01; 88.09% coverage at alpha=0.05; 97.07% coverage at alpha=0.5. Report alpha = 0.292.

Constituent: Thallium, total Analysis Run 12/6/2019 11:37 AM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

PIRKEY STACKOUT GWPS				
Constituent Name	**MCL**	**CCR-Rule Specified**	**Background Limit**	**GWPS**
Antimony, Total (mg/L)	0.006		0.005	0.006
Arsenic, Total (mg/L)	0.01		0.006	0.01
Barium, Total (mg/L)	2		0.051	2
Beryllium, Total (mg/L)	0.004		0.002	0.004
Cadmium, Total (mg/L)	0.005		0.001	0.005
Chromium, Total (mg/L)	0.1		0.002	0.1
Cobalt, Total (mg/L)	n/a	0.006	0.056	0.056
Combined Radium, Total (pCi/L)	5		2.94	5
Fluoride, Total (mg/L)	4		1	4
Lead, Total (mg/L)	0.015		0.005	0.015
Lithium, Total (mg/L)	n/a	0.04	0.17	0.17
Mercury, Total (mg/L)	0.002		0.000025	0.002
Molybdenum, Total (mg/L)	n/a	0.1	0.005	0.1
Selenium, Total (mg/L)	0.05		0.005	0.05
Thallium, Total (mg/L)	0.002		0.002	0.002

**Grey cell indicates ACL is higher than MCL.*

**MCL = Maximum Contaminant Level*

**GWPS = Groundwater Protection Standard*

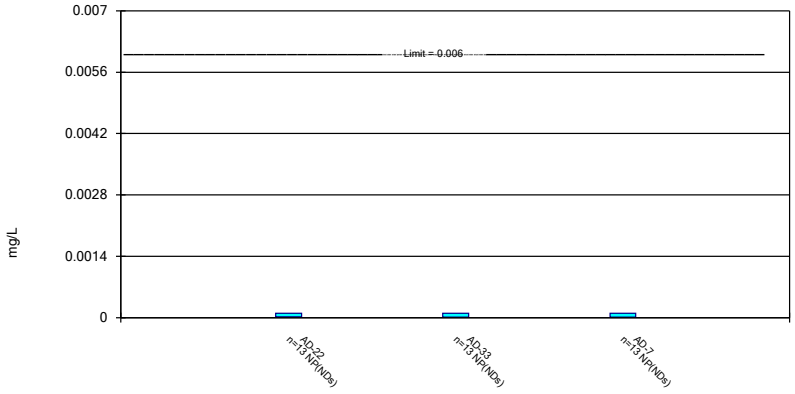
Confidence Intervals - All Results (No Significant Results)

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 4:00 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Antimony, total (mg/L)	AD-22	0.0001	0.00002	0.006	No	13	0.00009385	0.00002219	92.31	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-33	0.0001	0.00001	0.006	No	13	0.00009308	0.00002496	92.31	None	No	0.01	NP (NDs)
Antimony, total (mg/L)	AD-7	0.0001	0.00001	0.006	No	13	0.00009308	0.00002496	92.31	None	No	0.01	NP (NDs)
Arsenic, total (mg/L)	AD-22	0.0119	0.003558	0.01	No	13	0.008725	0.007096	0	None	ln(x)	0.01	Param.
Arsenic, total (mg/L)	AD-33	0.002226	0.0007882	0.01	No	12	0.001759	0.001185	16.67	Kaplan-...	ln(x)	0.01	Param.
Arsenic, total (mg/L)	AD-7	0.00212	0.00064	0.01	No	13	0.001606	0.000583	46.15	None	No	0.01	NP (normality)
Barium, total (mg/L)	AD-22	0.06983	0.02348	2	No	13	0.05145	0.03652	0	None	ln(x)	0.01	Param.
Barium, total (mg/L)	AD-33	0.059	0.04908	2	No	12	0.05355	0.007029	0	None	x^4	0.01	Param.
Barium, total (mg/L)	AD-7	0.05491	0.04271	2	No	13	0.04881	0.008201	0	None	No	0.01	Param.
Beryllium, total (mg/L)	AD-33	0.002	0.000905	0.004	No	13	0.001408	0.0008662	0	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-22	0.001419	0.0005284	0.005	No	13	0.001051	0.0006467	0	None	ln(x)	0.01	Param.
Cadmium, total (mg/L)	AD-33	0.001	0.00015	0.005	No	13	0.0007857	0.0004051	69.23	None	No	0.01	NP (normality)
Cadmium, total (mg/L)	AD-7	0.0008453	0.0006926	0.005	No	13	0.0007716	0.0001049	0	None	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-22	0.006766	0.0005802	0.1	No	13	0.007602	0.009954	23.08	Kaplan-...	ln(x)	0.01	Param.
Chromium, total (mg/L)	AD-33	0.003782	0.0004179	0.1	No	12	0.003324	0.002412	25	Kaplan-...	sqrt(x)	0.01	Param.
Chromium, total (mg/L)	AD-7	0.0005141	0.0001399	0.1	No	13	0.001829	0.001811	38.46	Kaplan-...	ln(x)	0.01	Param.
Cobalt, total (mg/L)	AD-33	0.01095	0.008577	0.056	No	12	0.009762	0.001509	0	None	No	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-22	5.243	3.065	5	No	13	4.266	1.616	0	None	ln(x)	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-33	3.871	1.394	5	No	13	2.945	2.369	0	None	ln(x)	0.01	Param.
Fluoride, total (mg/L)	AD-22	0.9636	0.3593	4	No	15	0.8634	0.3438	40	Kaplan-...	x^2	0.01	Param.
Fluoride, total (mg/L)	AD-33	1	0.25	4	No	14	0.7641	0.3458	64.29	None	No	0.01	NP (normality)
Fluoride, total (mg/L)	AD-7	1	0.5	4	No	14	0.8172	0.2657	64.29	None	No	0.01	NP (normality)
Lead, total (mg/L)	AD-22	0.00273	0.000386	0.015	No	13	0.001583	0.0008065	53.85	None	No	0.01	NP (normality)
Lead, total (mg/L)	AD-33	0.002	0.000151	0.015	No	12	0.001688	0.0007297	83.33	None	No	0.01	NP (NDs)
Lead, total (mg/L)	AD-7	0.002	0.000529	0.015	No	13	0.001592	0.0006531	69.23	None	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-22	0.2166	0.1302	0.17	No	13	0.1776	0.06412	0	None	ln(x)	0.01	Param.
Lithium, total (mg/L)	AD-33	0.029	0.0178	0.17	No	13	0.02515	0.01008	7.692	None	No	0.01	NP (normality)
Lithium, total (mg/L)	AD-7	0.1054	0.09375	0.17	No	13	0.09663	0.01678	0	None	x^6	0.01	Param.
Mercury, total (mg/L)	AD-22	0.005651	0.0003861	0.002	No	9	0.003167	0.003618	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-33	0.0007483	0.0002828	0.002	No	13	0.0005656	0.0004313	0	None	ln(x)	0.01	Param.
Mercury, total (mg/L)	AD-7	0.0002192	0.00007226	0.002	No	13	0.0001458	0.00009883	0	None	No	0.01	Param.
Molybdenum, total (mg/L)	AD-22	0.002	0.002	0.1	No	11	0.001825	0.0005819	90.91	None	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-33	0.002	0.002	0.1	No	11	0.001885	0.000381	90.91	None	No	0.006	NP (NDs)
Molybdenum, total (mg/L)	AD-7	0.002	0.002	0.1	No	12	0.002	0	100	None	No	0.01	NP (NDs)
Selenium, total (mg/L)	AD-22	0.0059	0.001866	0.05	No	12	0.003778	0.001715	50	None	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-33	0.005	0.0011	0.05	No	13	0.003724	0.001742	61.54	None	No	0.01	NP (normality)
Selenium, total (mg/L)	AD-7	0.0071	0.001047	0.05	No	13	0.004142	0.001857	61.54	None	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-22	0.0009472	0.0002236	0.002	No	12	0.0005724	0.0003552	50	Kaplan-...	x^(1/3)	0.01	Param.
Thallium, total (mg/L)	AD-33	0.001192	0.00005	0.002	No	12	0.0006091	0.0003905	75	None	No	0.01	NP (normality)
Thallium, total (mg/L)	AD-7	0.001032	0.0002	0.002	No	12	0.0004926	0.0002079	75	None	No	0.01	NP (normality)

Non-Parametric Confidence Interval

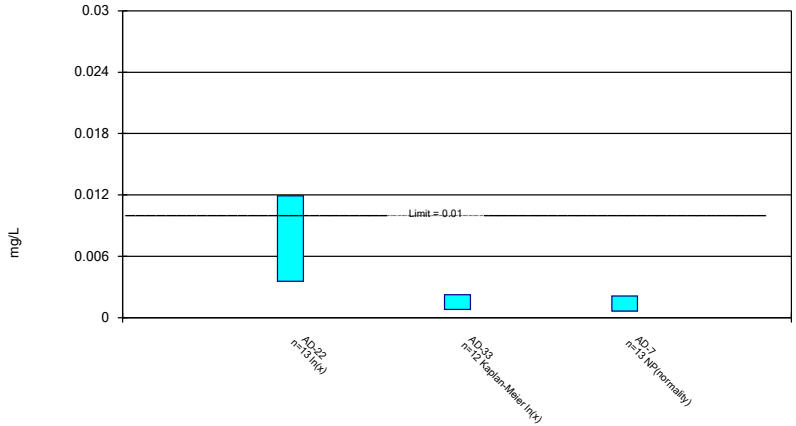
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Antimony, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

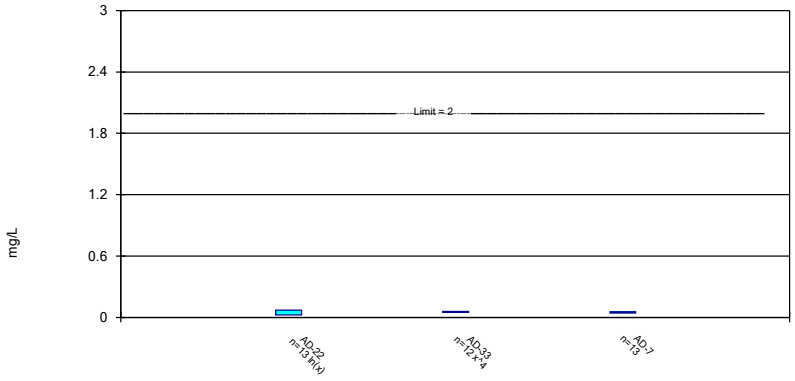
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Arsenic, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

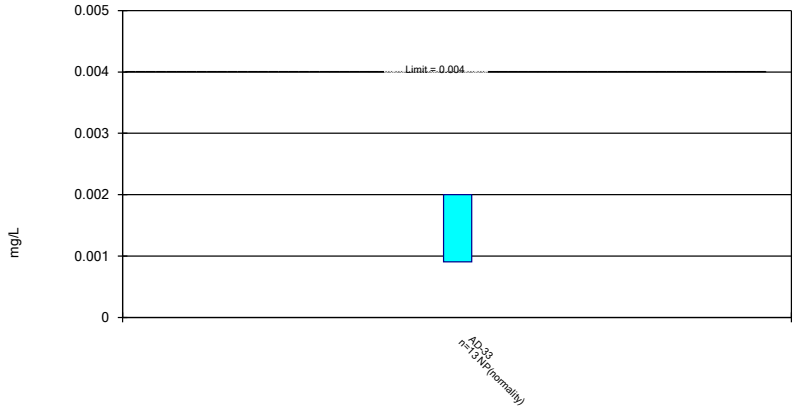
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Barium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

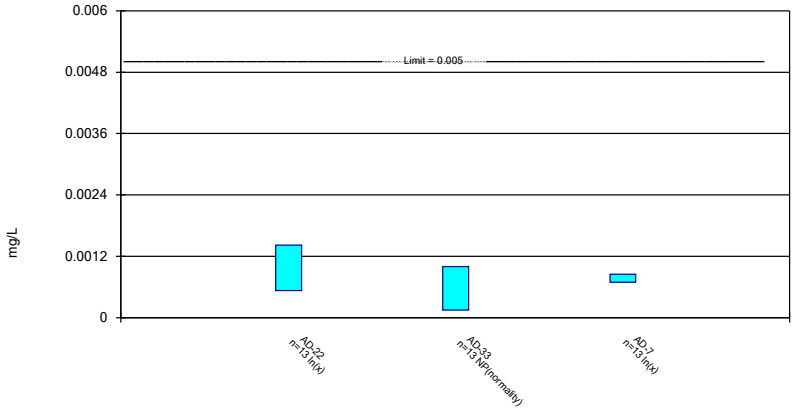
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Beryllium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

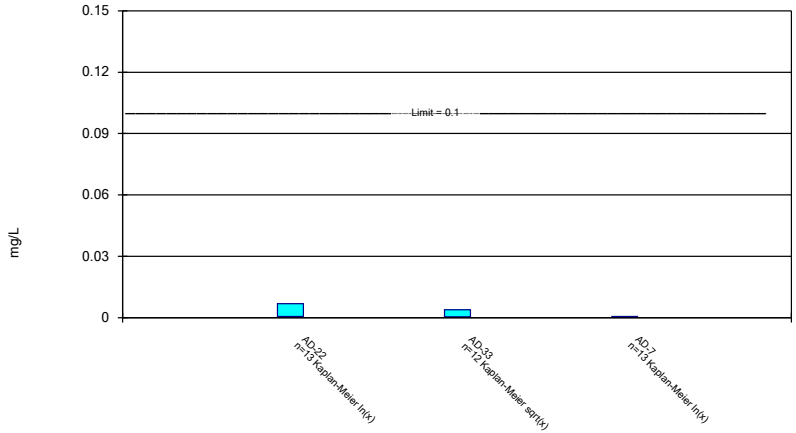
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cadmium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

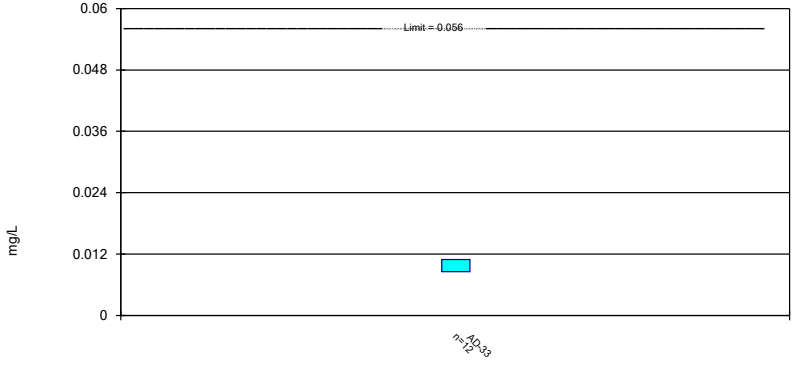
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Chromium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

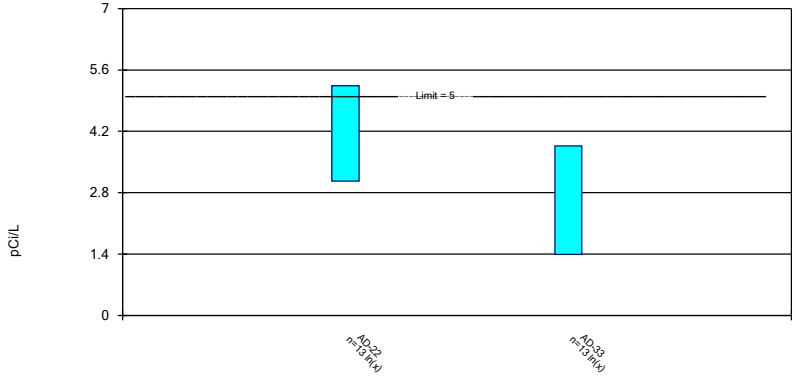
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Cobalt, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

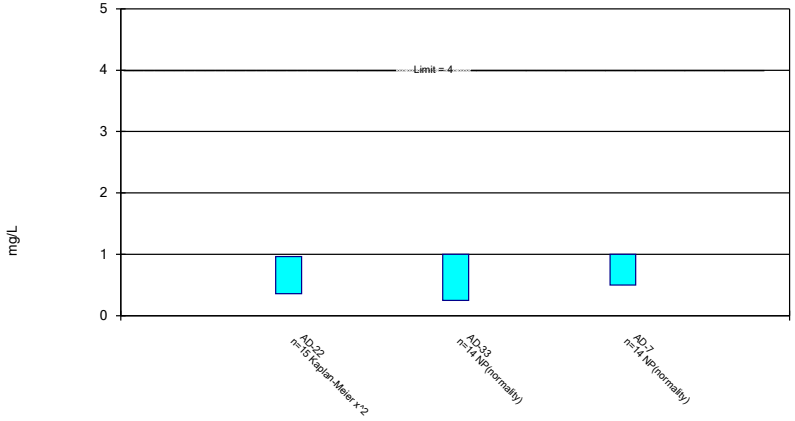
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Combined Radium 226 + 228 Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

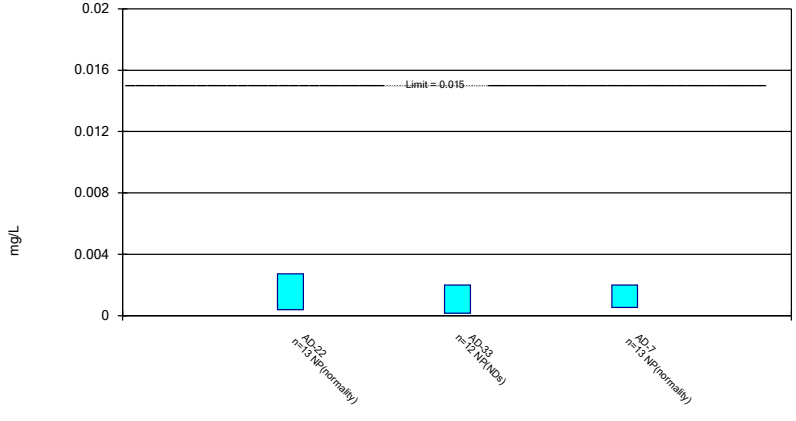
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Fluoride, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

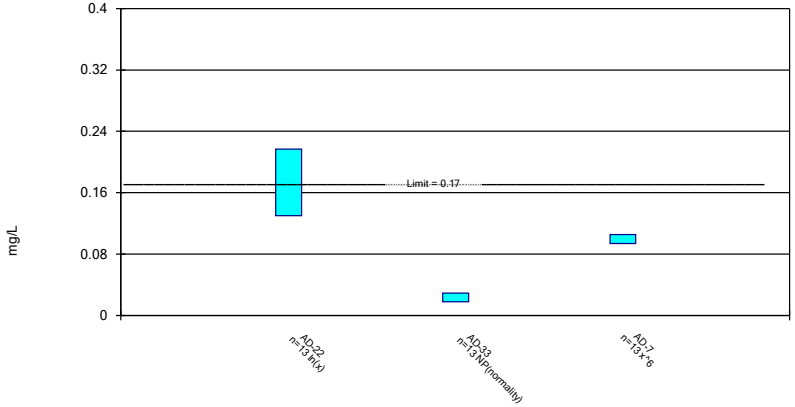
Compliance Limit is not exceeded. Per-well alpha = 0.01.



Constituent: Lead, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric and Non-Parametric (NP) Confidence Interval

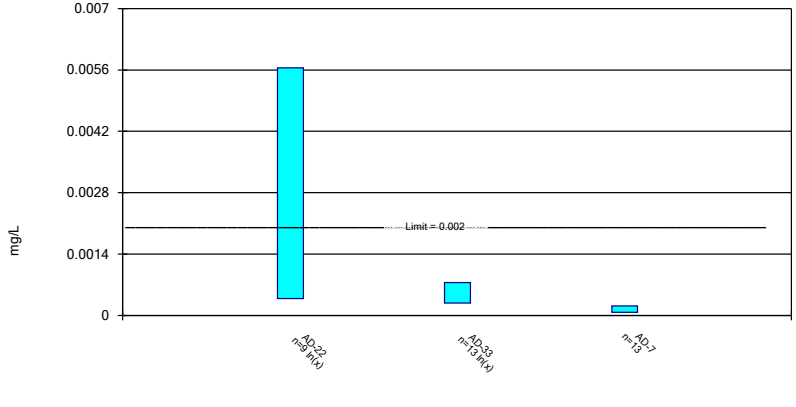
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Lithium, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Parametric Confidence Interval

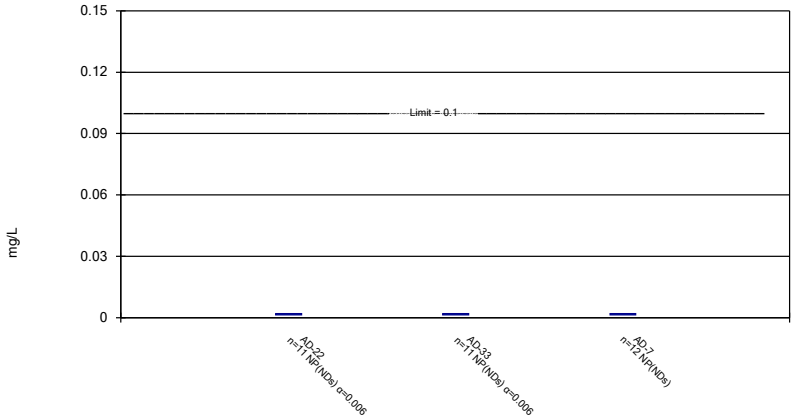
Compliance Limit is not exceeded. Per-well alpha = 0.01. Normality Test: Shapiro Wilk, alpha based on n.



Constituent: Mercury, total Analysis Run 12/9/2019 3:59 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

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

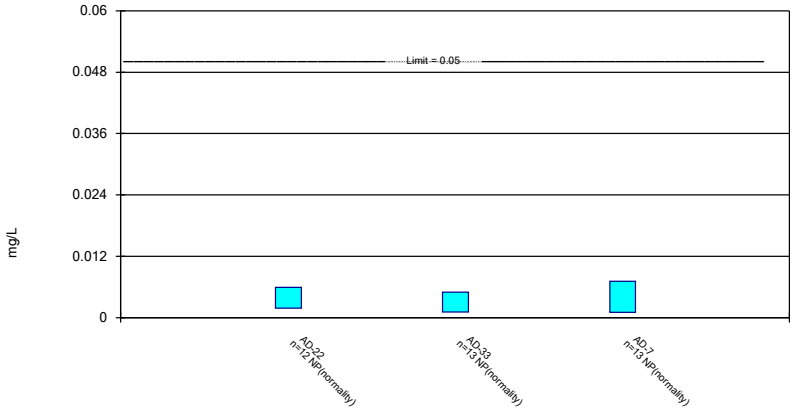


Constituent: Molybdenum, total Analysis Run 12/9/2019 4:00 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Non-Parametric Confidence Interval

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

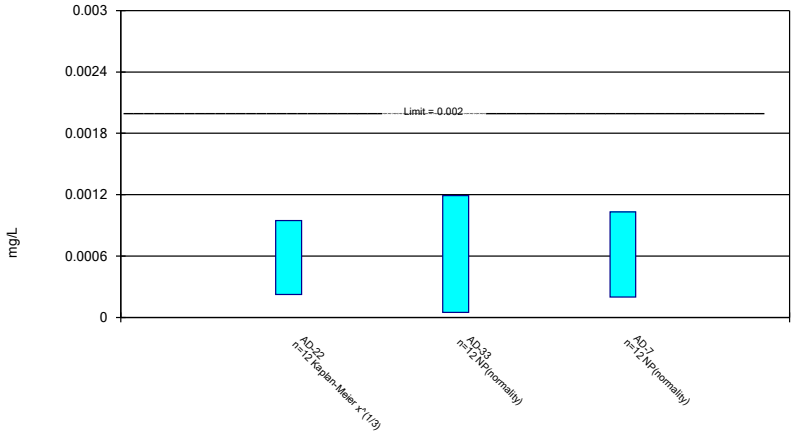


Constituent: Selenium, total Analysis Run 12/9/2019 4:00 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric and Non-Parametric (NP) Confidence Interval

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



Constituent: Thallium, total Analysis Run 12/9/2019 4:00 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Deseasonalized Confidence Intervals - Significant Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 3:57 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.009355**	**0.006032**	**0.004**	**Yes**	**13**	**0.007429**	**0.002706**	**0**	**None**	**x^2**	**0.01**	**Param.**
Beryllium, total (mg/L)	**AD-7**	**0.005761**	**0.004471**	**0.004**	**Yes**	**13**	**0.005046**	**0.0009302**	**0**	**None**	**x^3**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-22**	**0.09829**	**0.07274**	**0.056**	**Yes**	**13**	**0.08234**	**0.02336**	**0**	**None**	**x^3**	**0.01**	**Param.**

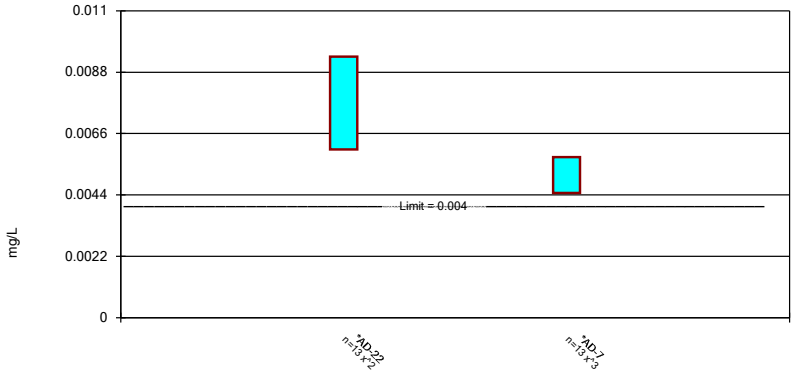
Deseasonalized Confidence Intervals - All Results

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 12/9/2019, 3:56 PM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	Mean	Std. Dev.	%NDs	ND Adj.	Transform	Alpha	Method
Beryllium, total (mg/L)	**AD-22**	**0.009355**	**0.006032**	**0.004**	**Yes**	**13**	**0.007429**	**0.002706**	**0**	**None**	**x^2**	**0.01**	**Param.**
Beryllium, total (mg/L)	**AD-7**	**0.005761**	**0.004471**	**0.004**	**Yes**	**13**	**0.005046**	**0.0009302**	**0**	**None**	**x^3**	**0.01**	**Param.**
Cobalt, total (mg/L)	**AD-22**	**0.09829**	**0.07274**	**0.056**	**Yes**	**13**	**0.08234**	**0.02336**	**0**	**None**	**x^3**	**0.01**	**Param.**
Cobalt, total (mg/L)	AD-7	0.03833	0.03041	0.056	No	13	0.0342	0.005454	0	None	x^2	0.01	Param.
Combined Radium 226 + 228 (pCi/L)	AD-7	4.162	3.027	5	No	13	3.487	0.9136	0	None	x^3	0.01	Param.

Parametric Confidence Interval

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

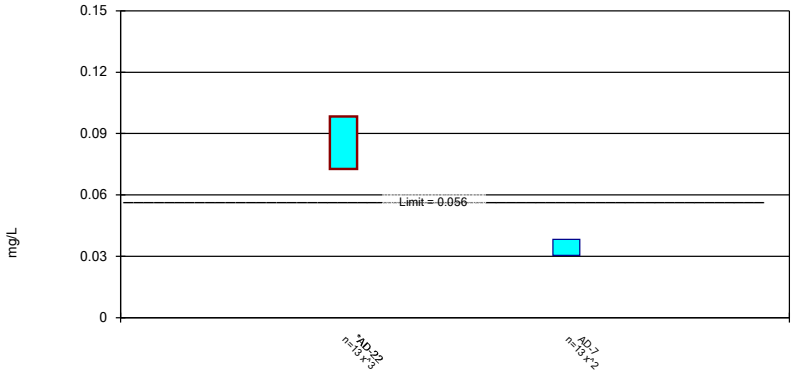


Constituent: Beryllium, total, Alt. Values Analysis Run 12/9/2019 3:55 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric Confidence Interval

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

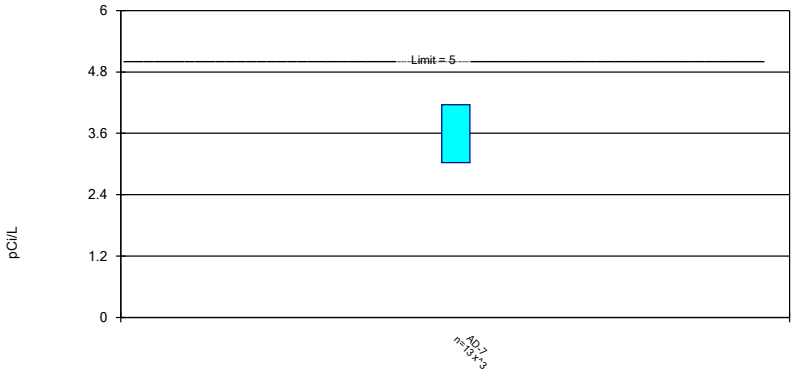


Constituent: Cobalt, total, Alt. Values Analysis Run 12/9/2019 3:55 PM View: Appendix IV
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Sanitas™ v.9.6.24 Groundwater Stats Consulting. UG

Parametric Confidence Interval

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



Constituent: Combined Radium 226 + 228, Alt. Values Analysis Run 12/9/2019 3:55 PM View: Appendix I
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

APPENDIX III

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

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

February 14, 2019

CHA8473

TABLE OF CONTENTS

FIGURES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EPRI	Electric Power Research Institute
FGD	Flue Gas Desulfurization
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
RSL	Regional Screening Level
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

In 2018, two assessment monitoring events were conducted at the FGD Stackout Area at the H.W. Pirkey Plant in accordance with 40 CFR 257.95. The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or regional screening level (RSL). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether Appendix IV parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). An SSL was identified for mercury at AD-22 at the FGD Stackout Area (Geosyntec, 2018).

1.1 CCR Rule Requirements

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

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

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for mercury at AD-22 should not be attributed to the Pirkey FGD Stackout Area.

1.2 Demonstration of Alternative Sources

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

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

A demonstration was conducted to show that the SSL identified for mercury at AD-22 was based on a Type III cause at AD-22 and not by a release from the Pirkey FGD Stackout Area.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

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

2.1 Proposed Alternative Source

Initial review of site geochemistry, site historical data, and laboratory QA/QC data did not identify ASDs due to a Type I (sampling causes) or Type II (laboratory causes) issue. As described below, the SSL was attributed to a statistical evaluation cause, which is a Type III issue.

A review of mercury results at AD-22 suggests that mercury concentrations have decreased at AD-22 over time (Figure 1). As indicated by the Unified Guidance (USEPA, 2009), collecting "data over time and successively re-computing confidence limits is appropriate for stable (i.e., stationary) populations", but "can give misleading or false results when the underlying population is changing". In such cases, Section 7.4.4 of the Unified Guidance recommends the following:

> *An important preliminary step is to track the individual compliance point measurements on a time series plot. If a discrete shift in concentration level is evident, a confidence limit should be computed on the most recent stable measurements. Limiting the observations in this fashion to a specific time period is often termed a 'moving window.' The reduction in sample size will often be more than offset by the gain in statistical power. More recent measurements may exhibit less variation around the shifted mean value, resulting in a shorter confidence interval. The sample size included in the moving window should be sufficient to achieve the desired statistical power…However, measurements that are clearly unrepresentative of the newly shifted distribution should not be included, even if the sample size suffers.*

Based on the above recommendations, the mercury results at AD-22 were visually inspected on a time series plot and were tested for statistically significant trends via Mann-Kendall analysis. While the Mann-Kendall analysis indicated no significant increasing or decreasing trend ($\alpha = 0.02$) using all of the data, decreasing concentrations over time were observed on the time series plot (Figure 1). As a result, the statistical evaluation was limited to the "moving window" of the seven most recent data points (i.e., results collected from October 2016 onward), which were observed to exhibit similar behavior in terms of trend, average concentration, and variance. A confidence interval was calculated using this truncated dataset. The calculated LCL for mercury at AD-22 is 0.22 µg/L ($\alpha = 0.008$), which is below the GWPS for mercury of 2 µg/L. This confidence limit is considered more representative of current conditions at AD-22, and therefore there is no SSL for mercury at AD-22. The results of the statistical tests are included as Appendix A.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSL is not due to a release from the Pirkey FGD Stackout Area, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of mercury for AD-22 identified during assessment monitoring in 2018 was not due to a release from the Pirkey FGD Stackout Area. The identified SSL was, instead, attributed to an error in the statistical evaluation. Therefore, no further action is warranted, and the Pirkey FGD Stackout Area will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment B.

SECTION 4

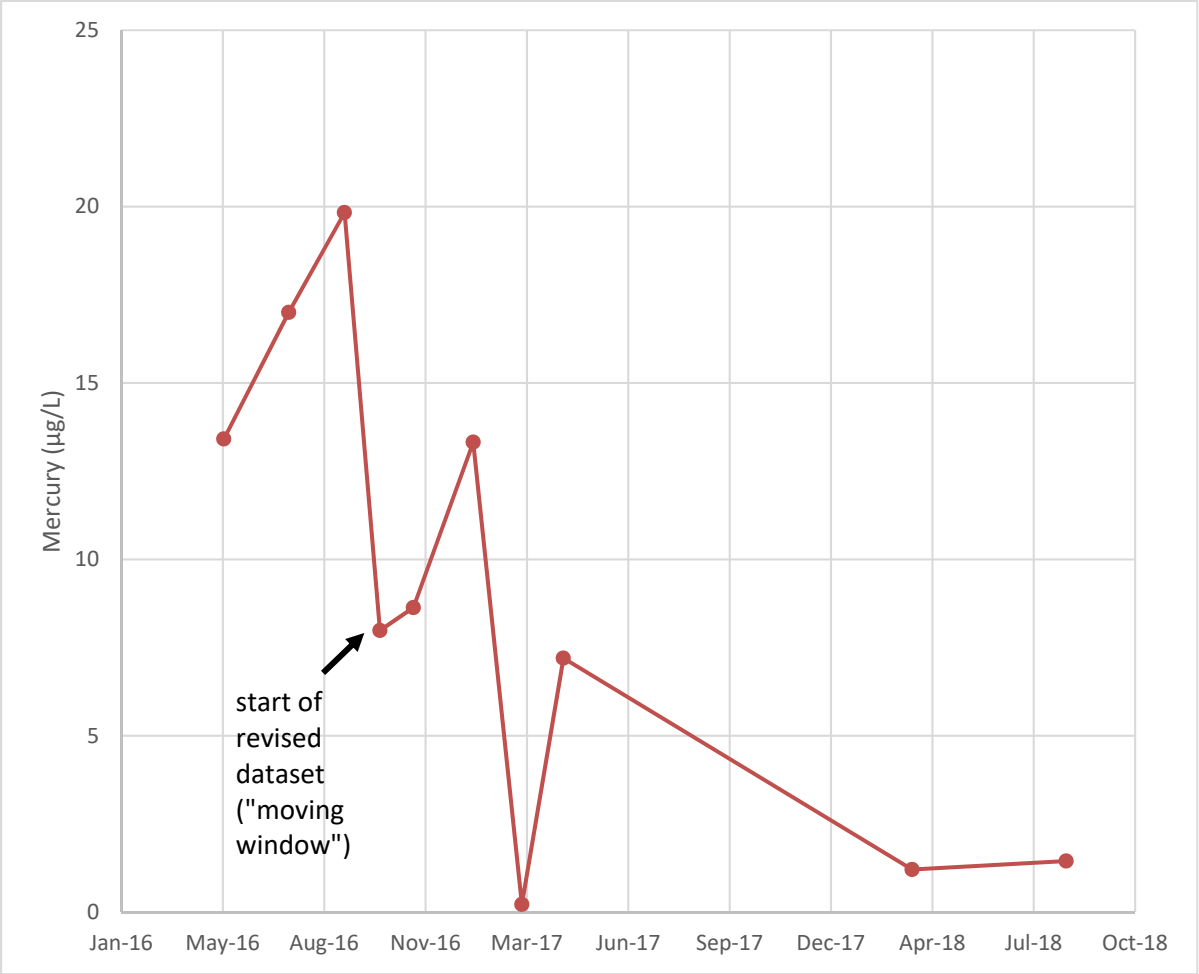
REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.

Geosyntec Consultants, 2018. Statistical Analysis Summary – H.W. Pirkey Power Plant. Hallsville, Texas. December.

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



Notes: The dataset was truncated to all values after October 2016 based on similar behavior in terms of trend, average, concentration, and variance.

Mercury Time Series Graph for AD-22

Pirkey FGD Stackout Pad

Geosyntec consultants

Columbus, Ohio

AMERICAN ELECTRIC POWER

14-Feb-2019

Figure 1

internal info: path, date revised, author

ATTACHMENT A

Statistical Analysis Output

Trend Test Summary Table

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 2/5/2019, 8:16 AM

Constituent	Well	Slope	Calc.	Critical	Sig.	N	%NDs	Normality	Xform	Alpha	Method
Mercury, total (mg/L)	AD-22	-0.00738	-25	-27	No	10	0	n/a	n/a	0.02	NP

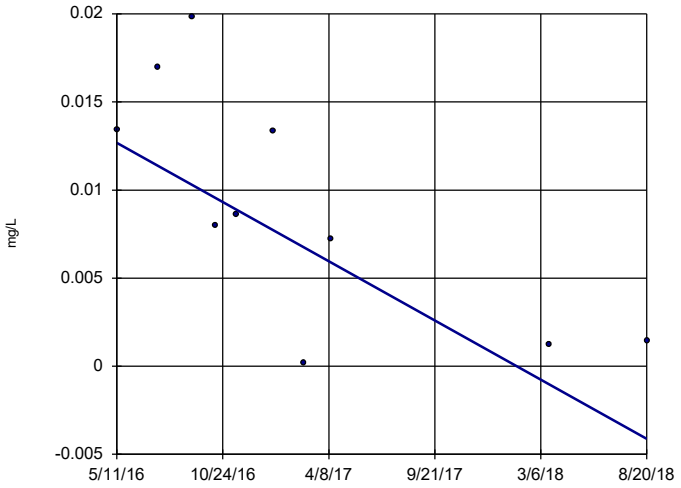
Confidence Interval Summary Table

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout Printed 2/5/2019, 8:16 AM

Constituent	Well	Upper Lim.	Lower Lim.	Compliance	Sig.	N	%NDs	Transform	Alpha	Method
Mercury, total (mg/L)	AD-22	0.01332	0.00022	0.002	No	7	0	No	0.008	NP (selected)

Sen's Slope Estimator

AD-22



n = 10

Slope = -0.00738 units per year.

Mann-Kendall statistic = -25 critical = -27

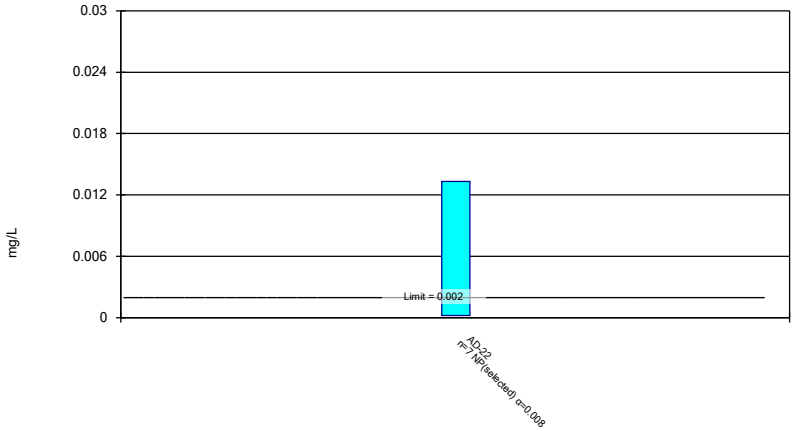
Trend not significant at 98% confidence level (α = 0.01 per tail).

Constituent: Mercury, total Analysis Run 2/5/2019 12:58 PM

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

Non-Parametric Confidence Interval

Compliance Limit is not exceeded.



Normality testing disabled.

Constituent: Mercury, total Analysis Run 2/5/2019 8:15 AM

Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

ATTACHMENT B
Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

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

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864	Texas	February 18, 2019
License Number	Licensing State	Date

ALTERNATIVE SOURCE DEMONSTRATION REPORT FEDERAL CCR RULE

H.W. Pirkey Power Plant Flue Gas Desulfurization (FGD) Stackout Area Hallsville, Texas

Submitted to

1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by

Geosyntec consultants

engineers | scientists | innovators

941 Chatham Lane
Suite 103
Columbus, OH 43221

October 3, 2019

CHA8462

TABLE OF CONTENTS

FIGURES

ATTACHMENTS

LIST OF ACRONYMS

AEP	American Electric Power
ASD	Alternative Source Demonstration
CCR	Coal Combustion Residuals
CFR	Code of Federal Regulations
EDS	Energy Dispersive Spectroscopic Analyzer
EPRI	Electric Power Research Institute
FGD	Flue Gas Desulfurization
GSC	Groundwater Stats Consulting, LLC
GWPS	Groundwater Protection Standard
LCL	Lower Confidence Limit
MCL	Maximum Contaminant Level
QA	Quality Assurance
QC	Quality Control
SEM	Scanning Electron Microscopy
SSL	Statistically Significant Level
UTL	Upper Tolerance Limit
USEPA	United States Environmental Protection Agency

SECTION 1

INTRODUCTION AND SUMMARY

The H.W. Pirkey Plant, located in Hallsville, Texas, has four regulated coal combustion residuals (CCR) storage units, including the Flue Gas Desulfurization (FGD) Stackout Area (Figure 1). In February 2019, a semi-annual assessment monitoring event was conducted at the FGD Stackout Area in accordance with 40 CFR 257.95(d)(1). The monitoring data were submitted to Groundwater Stats Consulting, LLC (GSC) for statistical analysis. Groundwater protection standards (GWPSs) were previously established for each Appendix IV parameter in accordance with the statistical analysis plan developed for the facility (AEP, 2017) and United States Environmental Protection Agency's (USEPA) *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance* (Unified Guidance; USEPA, 2009). The GWPS for each parameter was established as the greater of the background concentration and the maximum contaminant level (MCL) or risk-based level specified in 40 CFR 257.95(h)(2). To determine background concentrations, an upper tolerance limit (UTL) was calculated using pooled data from the background wells collected during the background monitoring and assessment monitoring events.

Confidence intervals were calculated for Appendix IV parameters at the compliance wells to assess whether these parameters were present at a statistically significant level (SSL) above the GWPSs. An SSL was concluded if the lower confidence limit (LCL) of a parameter exceeded the GWPS (i.e., if the entire confidence interval exceeded the GWPS). At the FGD Stackout Area, an SSL was identified for beryllium at AD-22, where the LCL of 0.00413 milligrams per liter (mg/L) was above the calculated GWPS of 0.00400 mg/L (Geosyntec, 2019). No other SSLs were identified.

1.1 CCR Rule Requirements

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

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

Pursuant to 40 CFR 257.95(g)(3)(ii), Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report to document that the SSL identified for beryllium at AD-22 should not be attributed to the FGD Stackout Area.

1.2 Demonstration of Alternative Sources

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

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

A demonstration was conducted to show that the SSL identified for beryllium at AD-22 was based on a Type IV cause and not by a release from the Pirkey FGD Stackout Area.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

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

2.1 Proposed Alternative Source

An initial review of site geochemistry, site historical data, and laboratory quality assurance/quality control (QA/QC) data did not identify ASDs due to Type I (sampling), Type II (laboratory), or Type III (statistical evaluation) issues. As described below, the SSL has been attributed to natural variation associated with the seasonal effects, which is a Type IV issue.

As shown in Figure 2, beryllium concentrations at AD-22 appear to correlate with groundwater elevations in the well. These changes approximately correspond to annual cycles, with higher beryllium concentrations occurring in early spring and lower concentrations in early fall. EPRI guidance suggests evaluating major ion chemistry to assess if natural variability is due to seasonal change (EPRI, 2017). As shown in a Schoeller diagram in Figure 3, concentrations of almost all major ions tends to be higher in the early spring, with declining concentrations later in the year. A Kruskal-Wallis test, in which non-parametric analysis of variance testing for differences between seasons is completed, was performed to evaluate seasonality. The Kruskal-Wallis test found significant results at the 5% significance level (Attachment A).

Additional evidence shows that the beryllium concentration at AD-22 is correlated with seasonal changes in other constituents, including lithium and calcium (Figure 4). The correlation between beryllium and both monovalent (lithium) and divalent (calcium) cations suggests that the increases in beryllium concentration are related to cation exchange phenomenon in the native soil.

A review of the boring log for AD-22 shows that clay is present from 0.5 to 12 feet below ground surface (ft bgs), which corresponds to elevations of 343 to 354.5 feet above mean sea level (ft amsl) (Attachment B). Groundwater elevations during the background monitoring period fluctuated between approximately 344 and 351 ft amsl, resulting in variation in the amount of the clay that was in contact with groundwater. At higher groundwater elevations, more clay material is in contact with groundwater, allowing greater desorption of cations from the cation exchange sites on the clay. As shown in Figure 2, higher groundwater elevations correlated with higher beryllium concentrations.

A groundwater sample was collected from AD-22 and then passed through a 1.5-micron filter. The solid material retained on the filter was submitted for analysis of total metals and by scanning electron microscopy (SEM) using an energy dispersive spectroscopic analyzer (EDS).

The SEM/EDS analysis showed that the solid material separated from groundwater was composed of abundant clay-size particles with mainly aluminum and silicon identified in the EDS output (Attachment C). The presence of these clay particles provides evidence to support the hypothesis that elevated beryllium is due to desorption from the cation exchange sites on the clays.

The exceedance for beryllium at AD-22 was attributed to the effects of seasonal groundwater elevation changes, and the resulting cation exchange between groundwater and the confining clay above the aquifer material, on groundwater quality. Additionally, the lack of other Appendix IV exceedances and the marginal difference between the LCL for AD-22 and the GWPS provides additional evidence that the beryllium exceedance should not be attributed to the FGD Stackout Area.

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSL is not due to a release from the Pirkey FGD Stackout Area, the unit will remain in the assessment monitoring program. Groundwater at the unit will continue to be sampled for Appendix IV parameters on a semi-annual basis.

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with 40 CFR 257.95(g)(3)(ii) and supports the position that the SSL of beryllium at AD-22 identified during assessment monitoring in February 2019 was not due to a release from the FGD Stackout Area. The identified SSL was, instead, attributed to seasonal effects on groundwater quality, which is an effect of natural variation. Therefore, no further action is warranted, and the Pirkey FGD Stackout Area will remain in the assessment monitoring program. Certification of this ASD by a qualified professional engineer is provided in Attachment D.

SECTION 4

REFERENCES

AEP, 2017. Statistical Analysis Plan – H.W. Pirkey Power Plant. Hallsville, Texas. January.

EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.

Geosyntec Consultants, 2019. Statistical Analysis Summary, FGD Stackout Area. H.W. Pirkey Power Plant. Hallsville, Texas. July.

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

FIGURES

Monitoring Well Network

- Downgradient Sampling Location
- Upgradient Sampling Locatoin
- FGD Stackout Pad

Notes

- Monitoring well coordinates and water level data provided by AEP.
- Site features based on information available in CCR Groundwater Monitoring Well Network Evaluations (Arcadis, 2016) provided by AEP.

500 250 0 500 Feet

Site Layout
FGD Stackout Area

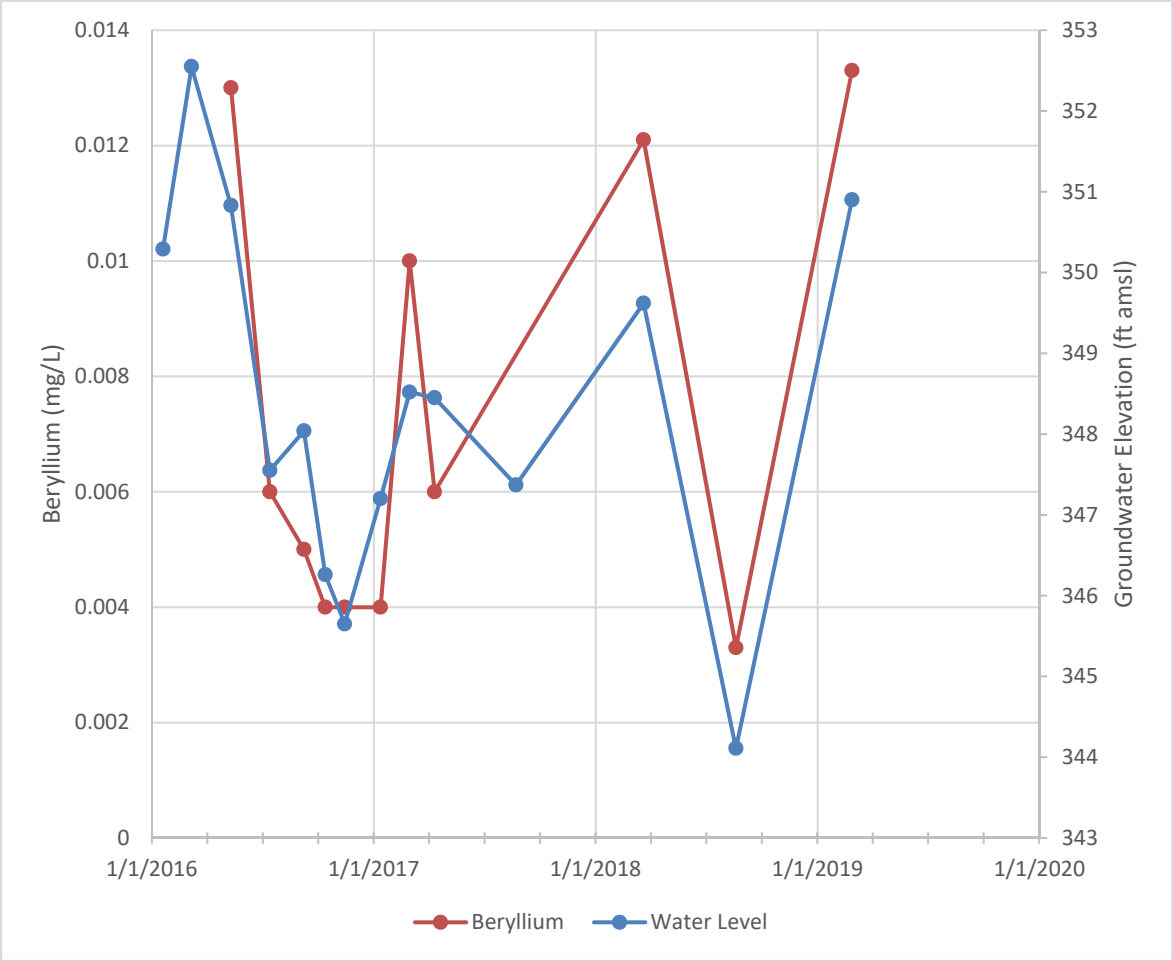
AEP Pirkey Power Plant Hallsville, Texas

Geosyntec consultants

Columbus, Ohio | 2018/01/26

Figure **1**

C:\Users\mmuenich\Documents\local_projects\AEP_GIS\Pirkey\MXDs\AEP-Pirkey_Stacker_Site_Layout.mxd. MMuenich. 1/26/2018. Project/Phase/Task.



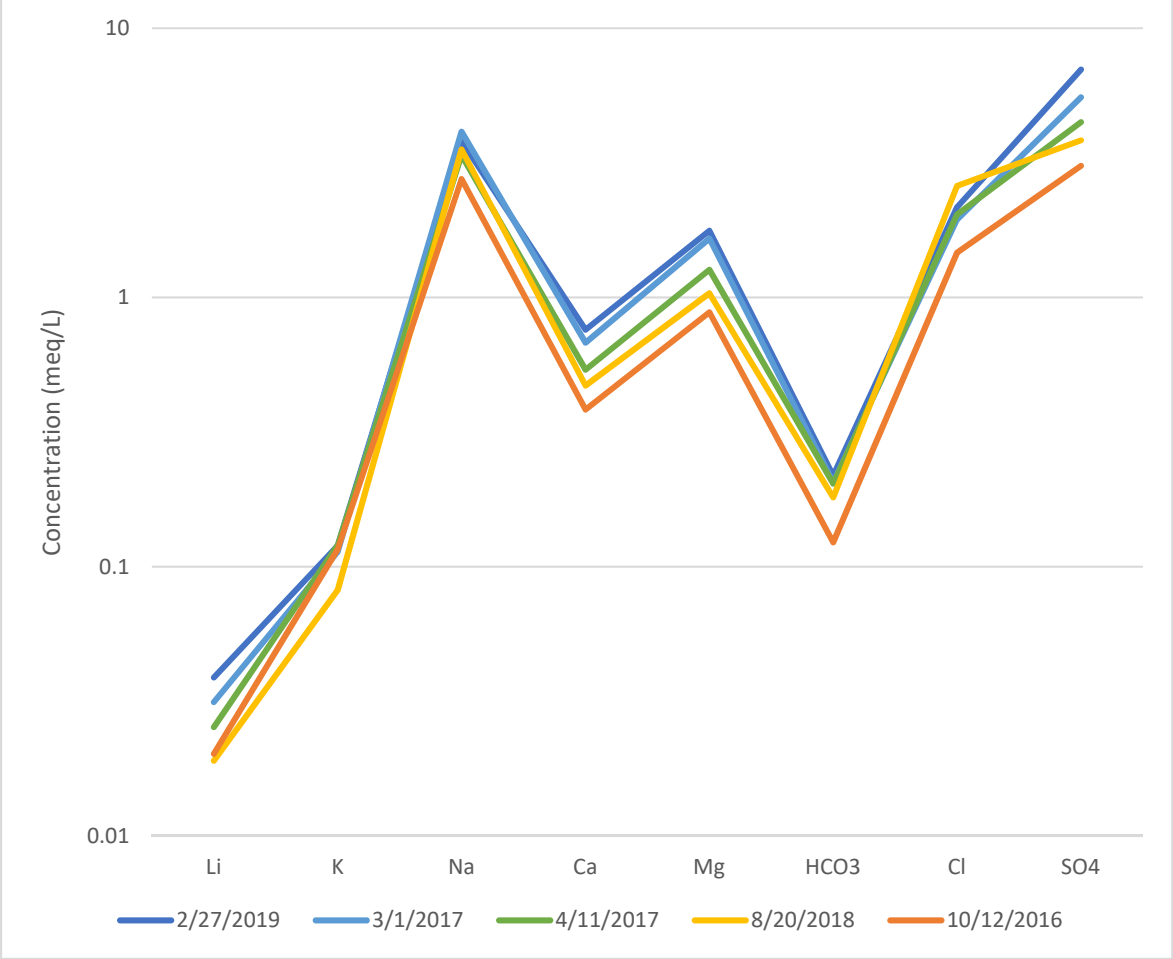
Notes: Beryllium concentrations are shown in milligrams per liter (mg/L). Groundwater elevation is shown as feet above mean sea level (ft amsl).

Beryllium v. Groundwater Elevation
Pirkey FGD Stackout Pad

Geosyntec consultants | AMERICAN ELECTRIC POWER | Figure 2

Columbus, Ohio | 23-Sep-2019

internal info: path, date revised, author



Notes: Concentrations are shown in milliequivalents per liter (meq/L).

AD-22 Schoeller Diagram
Pirkey FGD Stackout Pad

Geosyntec consultants

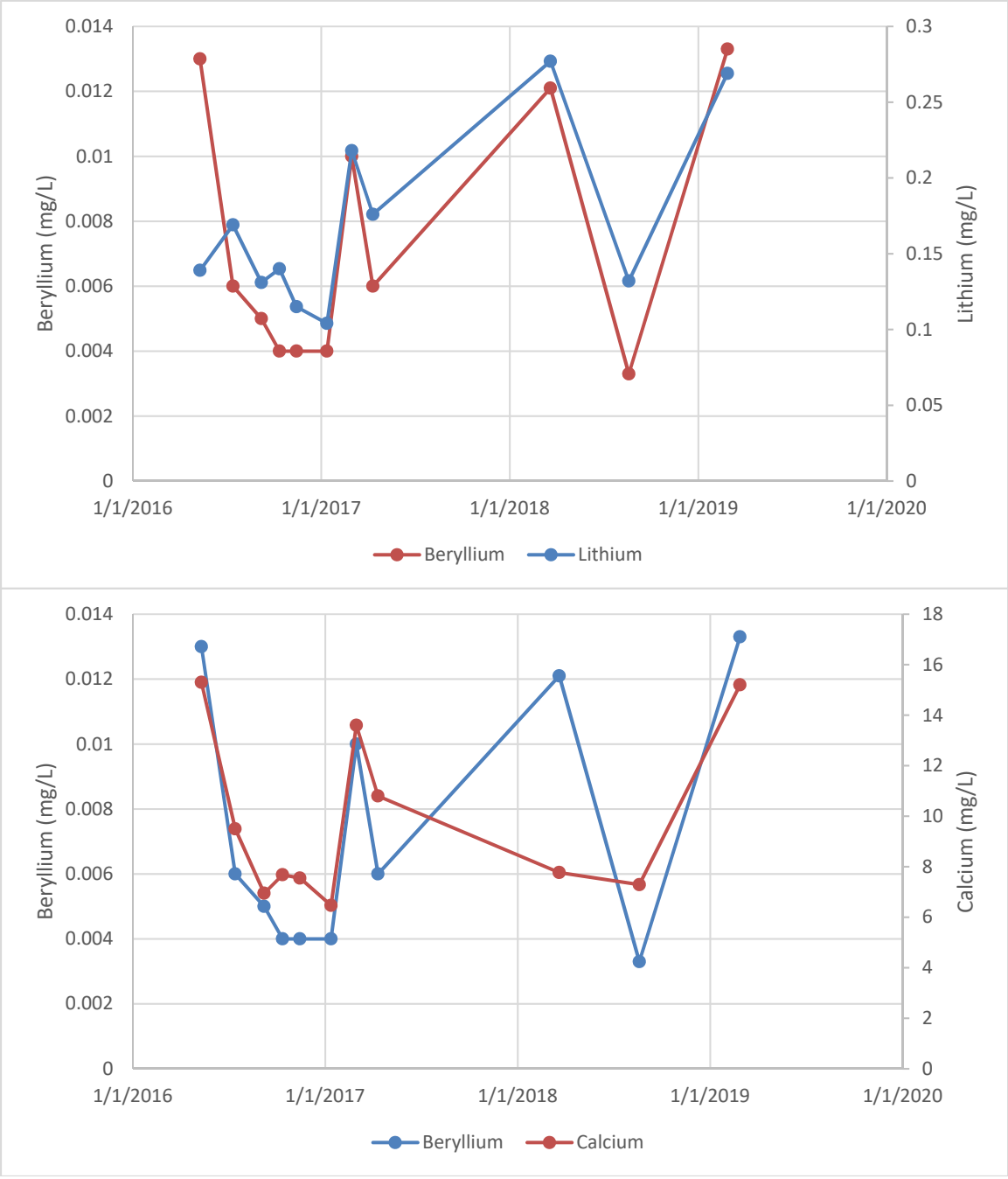
AMERICAN ELECTRIC POWER

Columbus, Ohio

23-Sep-2019

Figure 3

internal info: path, date revised, author



Notes: Beryllium, lithium, and calcium concentrations are shown in milligrams per liter (mg/L).

Beryllium v. Cations
Pirkey FGD Stackout Pad

Geosyntec consultants

AMERICAN ELECTRIC POWER

Figure 4

Columbus, Ohio

23-Sep-2019

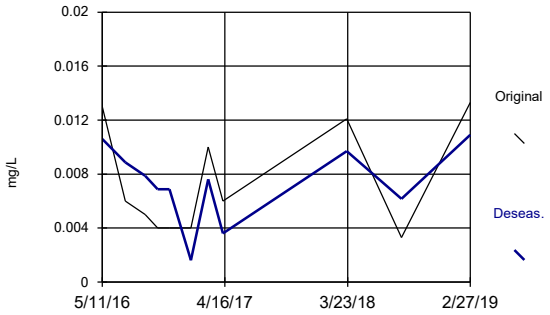
internal info: path, date revised, author

ATTACHMENT A

Statistical Evaluation - Seasonality at AD-22

Seasonality: AD-22

For the selected data, the Kruskal-Wallis test indicates SEASONALITYat the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one season has a significantly different median concentration of this constituent than any other season.
Calculated Kruskal-Wallis statistic = 4.511
Tabulated Chi-Squared value = 3.841 with 1 degrees 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) = 4.408
Adjusted Kruskal-Wallis statistic (H') = 4.511



Constituent: Beryllium, total Analysis Run 9/22/2019 7:11 AM
Pirkey Stackout Client: Geosyntec Data: Pirkey Stackout

ATTACHMENT B
AD-22 Boring Log

☐ BORING ■ MONITOR WELL

APEX PROJECT NO.: 110-089 BORING NUMBER: ____ MONITOR WELL NUMBER: AD-22

FACILITY NAME: AEP- Pirkey Power Plant FACILITY ID NO.: N/A

FACILITY ADDRESS: Hallsville, Texas

DRILLING COMPANY/METHOD/RIG: Apex Geoscience Inc. / Hollow-stem Augers/ CME-55 Track Rig

DRILLER: Ed Wilson, Apex Geoscience Inc. COMPLETION DATE: 12/16/2010

PREPARED BY: David Bedford LOGGED BY: David Bedford

LATTITUDE: N 32°27'03.3" Datum: WGS-84 WELL LOCATION: Triangle- South side Quansit Hut

LONGITUDE: W94°29'41.3"

DEPTH (FEET)	PID (PPM)	SAMPLE INTERVAL	WELL LOG AND COMPLETION DETAILS	USCS CODE	SOIL DESCRIPTION AND COMMENTS	Odor	Moisture
1			0-0.5	SC	Clayey sand, light brown, very fine grained	None	Moist
2			0.5-12	CL	Lean clay, light brown mottled with light gray	None	Slightly Moist
3							
4					Few iron ore (small) pebbles in clayey sandy streaks		
5							
6							
7							
8							
9							
10							
11							
12							
13			▽	12-20	SC	Clayey sand, grayish brown with orangish brown streaks, very fine grained	None	Slightly Wet
14					Slightly wet @ 12.5' from seepage		
15					Large amount of iron ore 15-17'		
16							
17							
18							
19					Very firm 18-18.5'		
20							
21				20-25	SC	(Dense crystalline rock 21-21.1'), light brown clayey sand, greenish black, mica, black clay streaks, very fine grained, wet @ 20'	None	Wet
22							
23							
24							
25							
26				25-30	SM	Sand, greenish brown (1') grading to orangish brown, silty, very fine grained	None	Wet
27							
28							
29							
30							
31					Boring Terminated at 30'		
32							
33							
34							
35							
36							
37							
38							
39							
40							

Cement Bentonite Filter Sand ▽ Water Level

Apex geoscience inc.

Total Depth: 30 feet Riser Interval: +3 (ags)-10'

Filter Sand (Size/Interval): 8-30' Screen Interval: 10-30'

Grout (Type/Interval): Grout from 0-2'; Bentonite from 2-8' Water level: 12.5'

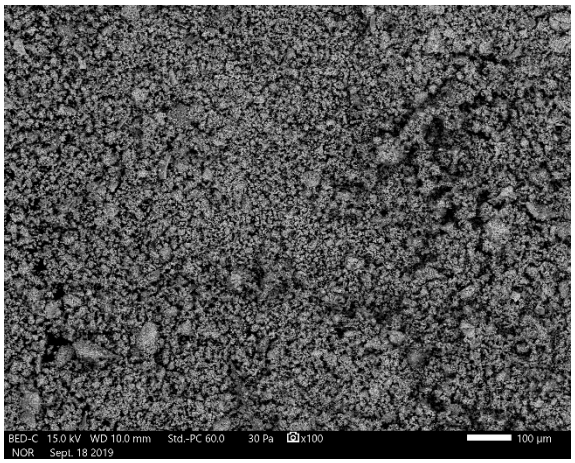
Surface Completion ☐ Flush ■ Above Ground 3'

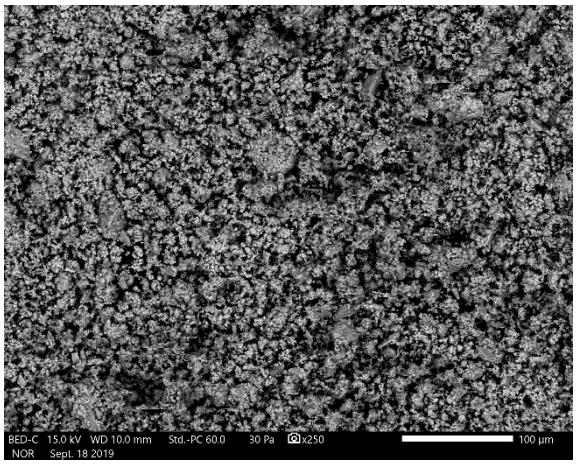
Note: This log is not to be used separate from this report.

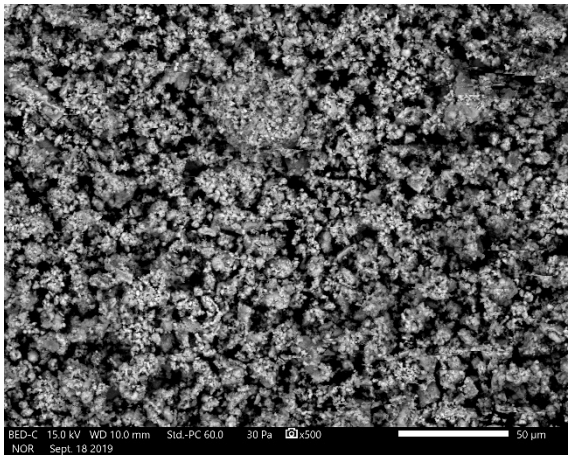
ATTACHMENT C
SEM/EDS Analysis

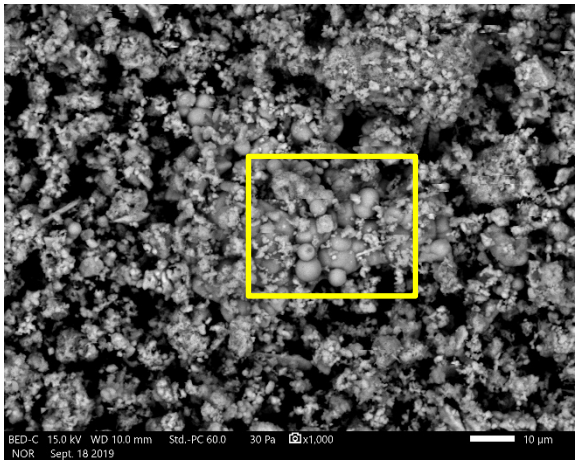
September 22, 2019

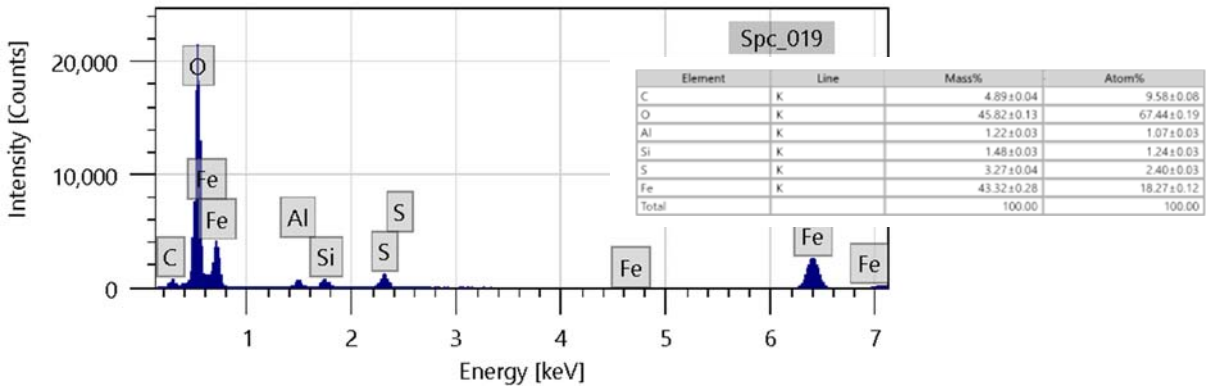
Dr. Bruce Sass
941 Chatham Lane, Suite 103, Columbus, OH 43221
via Email: BSass@geosyntec.com











Sample AD-22. Backscattered electron micrographs show the sample at 100X, 250X, 500X, and 1000 X. EDS spectrum at bottom is an area scan of the region shown in the 1000X micrograph. The analysis is shown on the right. The globular phase appears to consist mainly of iron oxide/hydroxide.

ATTACHMENT D
Certification by Qualified Professional Engineer

CERTIFICATION BY A QUALIFIED PROFESSIONAL ENGINEER

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

Beth Ann Gross
Printed Name of Licensed Professional Engineer

Beth Ann Gross
Signature

Geosyntec Consultants
8217 Shoal Creek Blvd., Suite 200
Austin, TX 78757

Texas Registered Engineering Firm
No. F-1182

79864	Texas	10/3/2019
License Number	Licensing State	Date

APPENDIX IV

Notices of groundwater monitoring program transitions are included in this appendix.

APPENDIX V

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

STATE OF TEXAS WELL REPORT for Tracking #506035

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.08" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 58.82" W**
Well County:	**Harrison**	Elevation:	**No Data**
			****Plugged Within 48 Hours****

****This well has been plugged**** **Plugging Report Tracking #185184**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/19/2019** Drilling End Date: **2/20/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**31**	**38**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

	Description (number of sacks & material)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Plug Information:	**SAND**	**50**	**60**

Water Quality:

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

Chemical Analysis Made: **No**

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

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

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**clay brown**
1	**5**	**silty sand**
5	**9.5**	**clay**
9.5	**11**	**sand**
11	**32**	**clay**
32	**39**	**sand and clay**
39	**55**	**sand**
55	**60**	**fine sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**40**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**40**	**50**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS PLUGGING REPORT for Tracking #185184

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB10**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.08" N**
		Longitude:	**094° 29' 58.82" W**
	LOCATED ON OWNERS PROPERTY	Elevation:	**No Data**
Well County:	**Harrison**		

Well Type: **Monitor**

Drilling Information

Company: **Plains Environmental Services** Date Drilled: **2/20/2019**

Driller: **Jesse Kalvig** License Number: **5025**

Well Report Tracking #506035

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**60**

Plugging Information

Date Plugged: **2/21/2019** Plugger: **Jesse Kalvig**

Plug Method: **Pour in 3/8 bentonite chips when standing water in well is less than 100 feet depth, cement top 2 feet**

Casing Left in Well:

DIa (in.)	*Top (ft.)*	*Bottom (ft.)*
2	**15**	**50**

Plug(s) Placed in Well:

Top (ft.)	*Bottom (ft.)*	*Description (number of sacks & material)*
1	**40**	**Bentonite 10 Bags/Sacks**

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

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

STATE OF TEXAS WELL REPORT for Tracking #506039

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD37**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 56.32" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 41.78" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**17**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**10**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **No**

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

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

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**8.5**	**CLAYS WITH SOME SAND**
8.5	**10.5**	**SAND**
10.5	**13**	**CLAY SOME SAND**
13	**15**	**SAND WITH SOME CLAYS**
15	**17**	**CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**12**	**17**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #506038

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD38**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 46.12" N**
		Longitude:	**094° 29' 43.34" W**
	LOCATED ON OWNERS PROPERTY	Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/21/2019** Drilling End Date: **2/21/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **No**

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

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

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**CLAY RED**
5	**7**	**CLAY GRAY/RED**
7	**11.5**	**SAND/CLAY**
11.5	**17.5**	**SAND SOME CLAYS**
17.5	**18**	**CLAY SLITS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #506037

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**AD39**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-4**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 26' 52.05" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 58.84" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/20/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**12**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**5**	**Bentonite 3 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **No**

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

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

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**1**	**CLAY**
1	**5**	**CLAY/SAND**
5	**9.5**	**CLAY**
9.5	**12**	**SAND/CLAY**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**7**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**7**	**12**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508688

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**AD-40 (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/10/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**40**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
27	**40**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**13**	**Cement**
13	**27**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**40**	**red and grey sand with occasional clay intervals**

Casing:
BLANK PIPE & WELL SCREEN DATA

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

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508686

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB(MW)-01A**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 28' 03" N**
		Longitude:	**094° 29' 00.5" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/9/2019** Drilling End Date: **3/10/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**100**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
86	**100**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**86**	**Bentonite 17 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**6**	**tan and brown sandy, silty clay**
6	**15**	**red and tan sand**
15	**28**	**red and grey clay**
28	**85**	**red and grey sand with occasional clay intervals**
85	**88**	**grey clay**
88	**100**	**grey sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**90**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**90**	**100**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508703

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**22**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
8	**22**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**3**	**Cement**
3	**8**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**22**	**red and grey sand w/occ. lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**12**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**12**	**22**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508695

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-4 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 55" N**
		Longitude:	**094° 29' 50" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/20/2019** Drilling End Date: **2/22/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**80**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
56	**80**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**56**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**7**	**tan and brown sandy, silty clay**
7	**36**	**red and grey sand w/occ. lignite layers**
36	**41**	**red and tan clay**
41	**69**	**red and grey sand with occasional clay iand lignite layers**
69	**80**	**grey sandy clay with lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**59**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**59**	**69**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508712

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/24/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**25**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
12	**25**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**8**	**Cement**
8	**12**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**25**	**brown sand**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**15**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**15**	**25**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508708

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-5 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 48" N**
		Longitude:	**094° 29' 53" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
45	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**45**	**Bentonite 9 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**5**	**tan and brown sandy, silty clay**
5	**18**	**red and grey sand w/occ. clay layers**
18	**20**	**gray clay**
20	**28**	**brown sand**
28	**41**	**brown and grey silty clay**
41	**70**	**grey sand with occasional lignite layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #506040

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6S**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 30.34" N**
		Longitude:	**094° 29' 27.76" W**
	LOCAATED ON OWNERS PROPERTY	Elevation:	**No Data**
Well County:	**Harrison**		

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/23/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**18**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**11**	**Bentonite 5 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **No**

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

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

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**18**	**SANDS AND CLAYS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**13**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**13**	**18**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #506041

Owner:	**H W PIRKEY POWER PLANT**	Owner Well #:	**SB6D**
Address:	**2400 FM 3251 HALLSVILLE, TX 75650**	Grid #:	**35-37-1**
Well Location:	**2400 FM 3251 HALLSVILLE, TX 75650**	Latitude:	**32° 27' 30.28" N**
	LOCATED ON OWNERS PROPERTY	Longitude:	**094° 29' 27.75" W**
Well County:	**Harrison**	Elevation:	**No Data**

Type of Work: **New Well** Proposed Use: **Monitor**

Drilling Start Date: **2/22/2019** Drilling End Date: **2/23/2019**

	Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
Borehole:	**8.25**	**0**	**65**

Drilling Method: **Hollow Stem Auger**

Borehole Completion: **Screened**

	Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
Annular Seal Data:	**1**	**53**	**Bentonite 19 Bags/Sacks**

Seal Method: **Tremie**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **No Data** **Surface Completion NOT by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **No**

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

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

Company Information: **Plains Environmental Services**

1900 Tonys Rd
salina, KS 67401

Driller Name: **Jesse Kalvig** License Number: **5025**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**10**	**CLAYS**
10	**24**	**SANDS AND CLAYS**
24	**29**	**CLAYS**
29	**42.5**	**SANDS AND CLAYS**
42.5	**48.5**	**SANDS WITH SOME CLAY**
48.5	**56**	**CLAYS WITH SOME SAND**
56	**65**	**SILY SANDS**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.1**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508722

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/3/2019** Drilling End Date: **3/3/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**45**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
32	**45**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**32**	**Bentonite 6 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**45**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**35**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**35**	**45**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508720

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-7 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 27" N**
		Longitude:	**094° 30' 08" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/28/2019** Drilling End Date: **2/28/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**70**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
57	**70**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**57**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**70**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**60**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**60**	**70**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508724

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**35**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
23	**35**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**23**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**35**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**25**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**25**	**35**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508729

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 medium (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/27/2019** Drilling End Date: **2/27/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**65**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
52	**65**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**53**	**Bentonite 4 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**65**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**55**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**55**	**65**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508777

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-8 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 10" N**
		Longitude:	**094° 30' 12" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **2/24/2019** Drilling End Date: **2/26/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**93**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
77	**93**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**77**	**Bentonite 15 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**90**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**
90	**93**	**gray clay (old pit base?)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**80**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**80**	**90**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508781

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/5/2019** Drilling End Date: **3/5/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**30**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
17	**30**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**17**	**Bentonite 1 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**30**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

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

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508779

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-9 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 27' 01" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/4/2019** Drilling End Date: **3/4/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**60**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
48	**60**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**12**	**Cement**
12	**48**	**Bentonite 10 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**60**	**tan and brown sandy, silty clay and occasional lignite inclusions (reclaim)**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**50**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**50**	**60**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508718

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 shallow (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/8/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**15**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
3	**15**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**1**	**Cement**
1	**3**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**5**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**5**	**15**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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

STATE OF TEXAS WELL REPORT for Tracking #508717

Owner:	**AEP Pirkey Power Plant**	Owner Well #:	**SB-11 deep (MW)**
Address:	**2400 FM 3251 Hallsville, TX 75650**	Grid #:	**35-36-6**
Well Location:	**2400 FM 3251 Hallsville, TX 75650**	Latitude:	**32° 26' 41" N**
		Longitude:	**094° 30' 11" W**
Well County:	**Harrison**	Elevation:	**No Data**
Type of Work:	**New Well**	Proposed Use:	**Monitor**

Drilling Start Date: **3/7/2019** Drilling End Date: **3/8/2019**

Borehole:

Diameter (in.)	*Top Depth (ft.)*	*Bottom Depth (ft.)*
6.75	**0**	**43**

Drilling Method: **Mud (Hydraulic) Rotary**

Borehole Completion: **Filter Packed**

Filter Pack Intervals:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Filter Material*	*Size*
30	**43**	**Sand**	**16/30**

Annular Seal Data:

Top Depth (ft.)	*Bottom Depth (ft.)*	*Description (number of sacks & material)*
0	**10**	**Cement**
10	**30**	**Bentonite 5 Bags/Sacks**

Seal Method: **Gravity**

Sealed By: **Driller**

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

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

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

Method of Verification: **No Data**

Surface Completion: **Surface Sleeve Installed** **Surface Completion by Driller**

Water Level: **No Data**

Packers: **No Data**

Type of Pump: **No Data**

Well Tests: **No Test Data Specified**

Water Quality:

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

Chemical Analysis Made: **Yes**

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

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

Company Information: **Mhc x-ploration corp**

P.O. Box 7405
Tyler, TX 75711

Driller Name: **James K. Collum** License Number: **3184**

Apprentice Name: **Jason Smith** Apprentice Number: **60448**

Comments: **No Data**

Lithology:
DESCRIPTION & COLOR OF FORMATION MATERIAL

Top (ft.)	Bottom (ft.)	Description
0	**18**	**tan and brown sandy, silty clay and occasional gravel**
18	**43**	**red and grey sand w/occ. clay layers**

Casing:
BLANK PIPE & WELL SCREEN DATA

Dia (in.)	Type	Material	Sch./Gage	Top (ft.)	Bottom (ft.)
2	**Riser**	**New Plastic (PVC)**	**40**	**0**	**33**
2	**Screen**	**New Plastic (PVC)**	**40 0.010**	**33**	**43**

IMPORTANT NOTICE FOR PERSONS HAVING WELLS DRILLED CONCERNING CONFIDENTIALITY

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

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

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