

Annual Groundwater Monitoring Report

Public Service Company of Oklahoma

Northeastern 3&4 Power Station

Landfill CCR Management Unit

7300 E HWY 88

Oologah, Oklahoma

January 2019

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An **AEP** Company

BOUNDLESS ENERGY™

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Appendix I

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I. Overview

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 Public Service Company of Oklahoma's (PSO's), a wholly-owned subsidiary of American Electric Power Company (AEP), Northeastern 3&4 Power Station. The Oklahoma Department of Environmental Quality (ODEQ) CCR rules require that the Annual Groundwater Monitoring Report be posted to the operating record for the preceding year no later than January 31, 2019.

In general, the following activities were completed:

- Initial statistical test demonstrated a SSI for boron.
- SSI evaluation for 2018 data is incomplete at this time.
- Successful demonstrations of ASDs for the boron SSI were submitted to ODEQ and their concurrence is pending.
- Semi-annual groundwater samples were collected and analyzed for Appendix A constituents, as specified in OAC 255:517-9-5 and AEP's *Groundwater Sampling and Analysis Plan*;
- Eight background groundwater sampling events were completed for the ODEQ approved monitoring well network.
- Groundwater data underwent various validation tests, including tests for completeness, valid values, transcription errors, and consistent units;
- Groundwater Monitoring Statistical Evaluation Reports to evaluate groundwater data were prepared and certified in accordance with 252:517-9-4. 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;

- 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.

| Landfill Monitoring Wells | |
|---------------------------|----------------------|
| Up Gradient | Down Gradient |
| MW-8D | MW-1D through MW-13D |
| MW-7D | MW-14 through MW-17 |
| | |
| | |

III. Monitoring Wells Installed or Decommissioned

During 2018, no monitoring wells were installed or decommissioned.

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

Appendix I contains tables showing the applicable groundwater quality data obtained under OAC 252:517-9-1 through 252:517-9-9. 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.

V. Statistical Evaluation of 2018 Events

In 2018, the 2017 statistical analysis summary report was placed on AEP's publically accessible CCR website at <https://www.aep.com/requiredpostings/ccr>

A SSI over background was confirmed for boron.

SSI evaluation for 2018 data is pending.

Eight background samples were collected from 4D, 5D, and 12D and analyzed for Appendix A and B constituents. AEP continues to attempt to collect background samples from 1D, 2D, 10D, 11D, 13D, 14, 16, and 17 as these wells do not produce sufficient groundwater volume after allowing the well to recharge for 24 hours.

VI. Alternate Source Demonstrations

An ASD was conducted for the boron SSI. An alternate source was identified and the report was submitted to ODEQ for approval. ODEQ requested additional information which was provided and ODEQ's additional review is pending.

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

As of this annual groundwater report, the CCR Unit remains in detection monitoring.

The sampling frequency of twice per year will be maintained for the current monitoring program.

VIII. Other Information Required

None at this time.

IX. Description of Any Problems Encountered in 2018 and Actions Taken

As required by the CCR detection monitoring rules in OAC 252:517-9-5, sampling all wells within the monitoring well network for the required Appendix A and B parameters was not possible as wells 1D, 2D, 10D, 11D, 13D, 14, 16, and 17 continue to lack sufficient water volume for sample collection after allowing 24 hours of recharge.

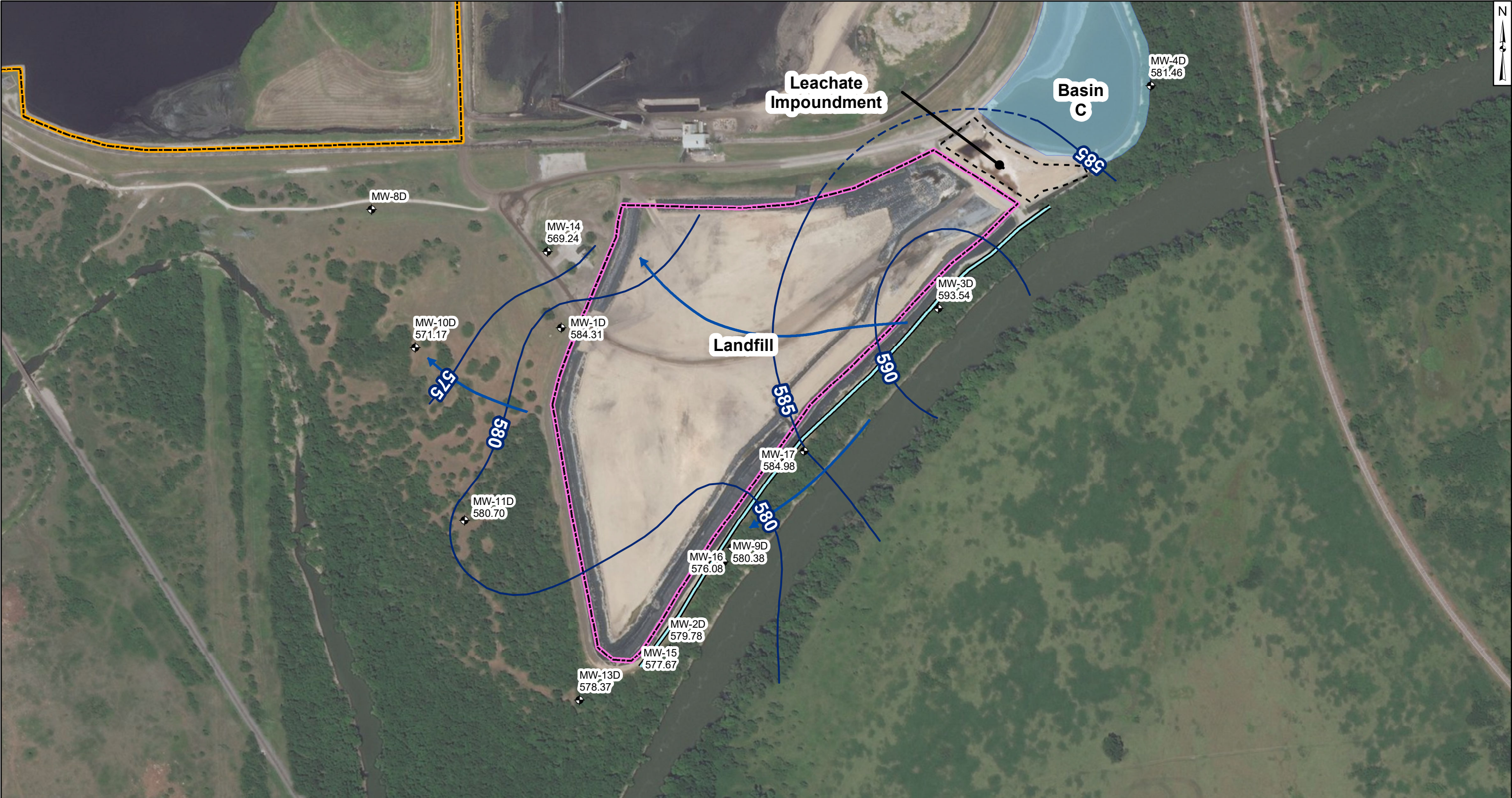
X. A Projection of Key Activities for the Upcoming Year

Key activities for 2019 include:

- Detection monitoring on a twice per year schedule;
- Evaluation of the detection monitoring results from a statistical analysis viewpoint, looking for any SSIs;
- Responding to any new data received in light of CCR rule requirements;
- Preparation of the third 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.

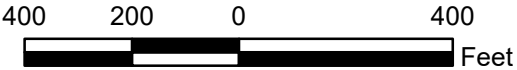


Legend

- project_data_point
- Groundwater Elevation Contour
- Inferred Groundwater Elevation Contour
- Approximate Groundwater Flow Direction
- Bottom Ash Pond Impoundment
- Landfill
- Slurry Wall

Notes

- Monitoring well coordinates and water level data (collected May 30, 2018) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.
- MW-8D was not used in May 2018 contouring due to inconsistent and/or anomolous reading.



**Potentiometric Contours - Uppermost Aquifer
May 2018**

AEP Northeastern Power Plant - Landfill
Oologah, Oklahoma

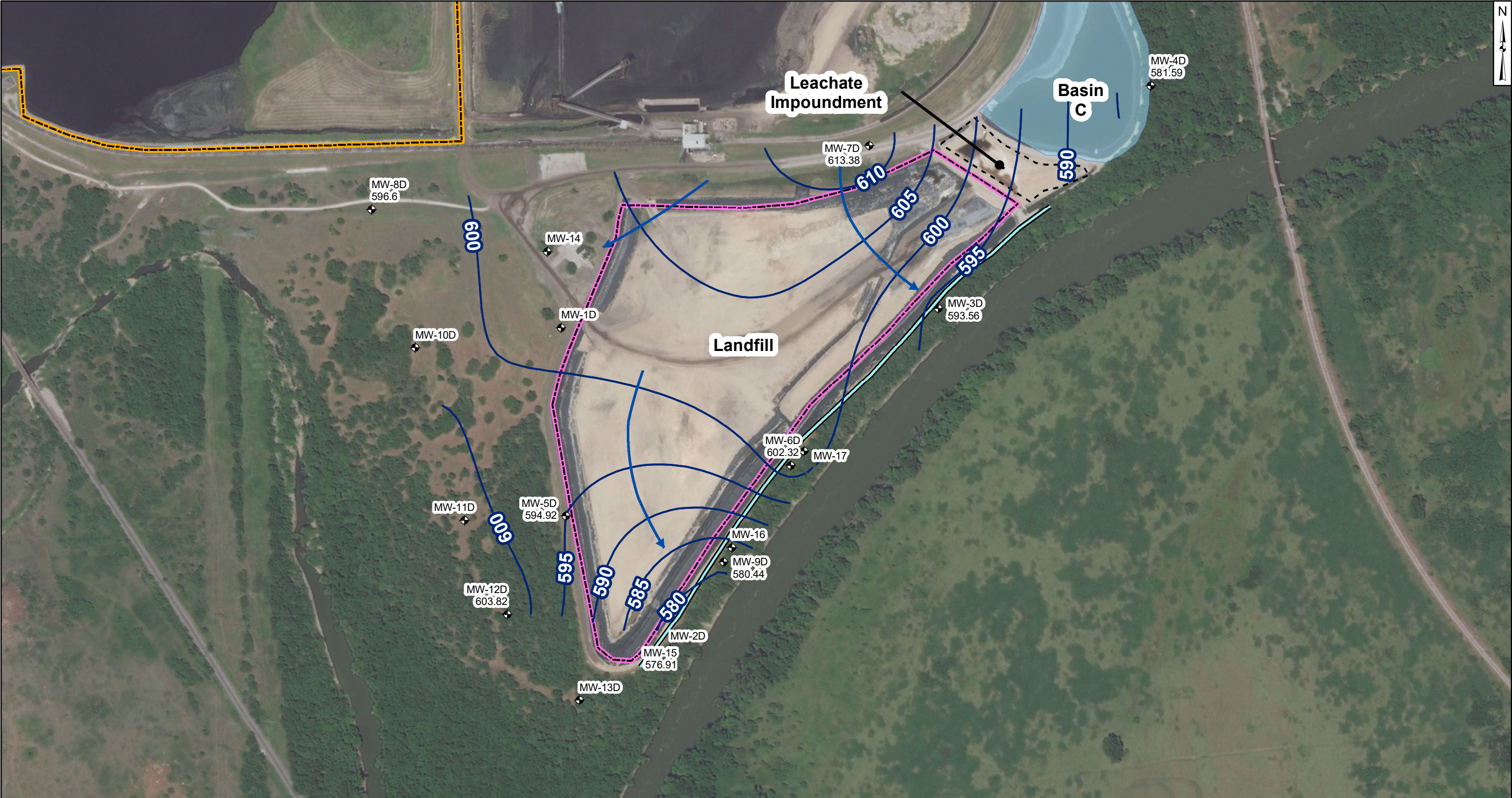
Geosyntec
consultants

Columbus, Ohio

2018/12/31

Figure

1

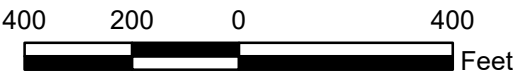


Legend

- project_data_point
- Groundwater Elevation Contour
- Approximate Groundwater Flow Direction
- Bottom Ash Pond Impoundment
- Landfill
- Slurry Wall

Notes

- Monitoring well coordinates and water level data (collected October 22, 2018) provided by AEP.
- River water height 555.52 ft. above msl at time of data collection (USGS 07176000)
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.



**Potentiometric Contours - Uppermost Aquifer
October 2018**

AEP Northeastern Power Plant - Landfill
Oologah, Oklahoma

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Columbus, Ohio

2019/01/23

**Figure
1**

**Table 1: Residence Time Calculation Summary - Landfill
Northeastern Landfill**

Geosyntec Consultants, Inc.

| CCR Management Unit | Monitoring Well | Well Diameter (inches) | 2018-05 | | 2018-10 | |
|---------------------------|----------------------|------------------------------|--------------------------------------|--|--------------------------------------|--|
| | | | Groundwater Velocity (ft/year) | Groundwater Residence Time (days) | Groundwater Velocity (ft/year) | Groundwater Residence Time (days) |
| Landfill | MW-3D ^[2] | 2.0 | 0.4 | 160 | 0.9 | 68 |
| | MW-6D ^[2] | 2.0 | NC | NC | 1.4 | 44 |
| | MW-7D ^[1] | 2.0 | NC | NC | 0.9 | 66 |
| | MW-8D ^[1] | 2.0 | NC | NC | 0.2 | 259 |
| | MW-9D ^[2] | 2.0 | 0.3 | 233 | 0.3 | 191 |
| | MW-15 ^[2] | 2.0 | 0.1 | 412 | 0.8 | 76 |

Notes:

[1] - Background Well

[2] - Downgradient Well

NC - Not calculated. While MW-7D and MW-8D are not typically used in contouring due to their proximity to the Altamont Shale, they were utilized in the October 2018 map due to a lack of available groundwater elevation data.

Table 1: Groundwater Data Summary
Northeastern Plant - Landfill

Geosyntec Consultants, Inc.

| Parameter | Unit | MW-3D | | | | | | | | | | | | |
|------------------------|-------|------------|------------|----------------|-----------|----------------|----------------|-----------|-----------|-----------|-----------|-----------|-----------|------------|
| | | 1/25/2017 | 3/14/2017 | 4/25-4/27/2017 | 5/18/2017 | 6/15-6/16/2017 | 6/27-6/28/2017 | 7/12/2017 | 8/4/2017 | 8/17/2017 | 8/30/2017 | 9/13/2017 | 9/20/2017 | 10/11/2017 |
| | | Background | | | | | | | | | | | | Detection |
| Antimony | mg/L | 0.005U* | 0.005U* | 0.005U | 0.005U | 0.00144J | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.00163J | - |
| Arsenic | mg/L | 0.005U* | 0.005U* | 0.0033J | 0.01064 | 0.00148J | 0.005U | 0.005U | 0.005U | 0.005U | 0.0026J | 0.00452J | 0.00114J | - |
| Barium | mg/L | 0.111 | 0.1 | 0.08964 | 1.04 | 0.15 | 0.09764 | 0.118 | 0.124 | 0.274 | 0.244 | 0.43 | 0.267 | - |
| Beryllium | mg/L | 0.001U* | 0.001U* | 0.001U | 0.00092J | 0.00008J | 0.00009J | 0.00005J | 0.00007J | 0.00017J | 0.00016J | 0.00035J | 0.00017J | - |
| Boron | mg/L | 0.919 | 0.913 | 0.972 | 0.789 | 0.873 | 0.84 | 0.864 | 0.856 | 0.841 | 0.84 | 0.877 | 0.853 | 0.878 |
| Cadmium | mg/L | 0.001U* | 0.001U* | 0.00026J | 0.00061J | 0.00022J | 0.00045J | 0.00008J | 0.00021J | 0.00024J | 0.00033J | 0.00049J | 0.00021J | - |
| Calcium | mg/L | 111 | 120 | 110 | 163 | 137 | 194 | 129 | 135 | 138 | 136 | 152 | 139 | 134 |
| Chloride | mg/L | 16 | 14 | 14 | 12 | 12 | 13 | 13 | 12 | 23 | 12 | 11 | 11 | 13 |
| Chromium | mg/L | 0.002 | 0.001U* | 0.00035J | 0.01806 | 0.00123 | 0.0048 | 0.00041J | 0.00082J | 0.00311 | 0.00236 | 0.00632 | 0.00274 | - |
| Cobalt | mg/L | 0.005U* | 0.005U* | 0.0013J | 0.00532 | 0.00109J | 0.00269J | 0.00082J | 0.00084J | 0.00183J | 0.00154J | 0.00297J | 0.00141J | - |
| Combined Radium | pCi/L | 2.153 | 1.456 | 0.419 | 2.443 | 1.706 | 2.431 | 14.283 | 2.242 | 2.328 | 2.215 | 1.566 | 2.162 | |
| Fluoride | mg/L | 1U* | 1 | 0.77J | 1U | 0.8472J | 0.7591J | 1U | 0.7381J | 1U | 0.7144J | 1U | 1U | 1U |
| Lead | mg/L | 0.005U* | 0.005U* | 0.005U | 0.00324J | 0.00083J | 0.00299J | 0.005U | 0.0008J | 0.005U | 0.005U | 0.00155J | 0.005U | - |
| Lithium | mg/L | 0.017 | 0.016 | 0.01508 | 0.01943 | 0.01451 | 0.01836 | 0.01435 | 0.01344 | 0.01495 | 0.01465 | 0.01639 | 0.01508 | - |
| Mercury | mg/L | 0.000025U* | 0.000025U* | 0.000025U | 0.00001J | 0.000025U | 0.000007J | 0.000025U | 0.000013J | 0.000025U | 0.000025U | 0.000025U | 0.000025U | - |
| Molybdenum | mg/L | 0.005U* | 0.005U* | 0.00197J | 0.00415J | 0.00304J | 0.07928 | 0.00322J | 0.00308J | 0.00291J | 0.00268J | 0.00274J | 0.00333J | - |
| Selenium | mg/L | 0.005U* | 0.005U* | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.001J | 0.005U | 0.005U | 0.005U | - |
| Total Dissolved Solids | mg/L | 658 | 648 | 662 | 598 | 742 | 766 | 728 | 710 | 728 | 696 | 848 | 724 | 722 |
| Sulfate | mg/L | 174 | 175 | 181 | 192 | 225 | 232 | 210 | 227 | 213 | 216 | 212 | 214 | 218 |
| Thallium | mg/L | 0.002U* | 0.002U* | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.00102J | 0.002U | - |
| pH | SU | 7.46 | - | 7.94 | - | 7.33 | 7.29 | 6.86 | 6.74 | 6.81 | 6.85 | 6.79 | 6.94 | 6.92 |

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

Table 1: Groundwater Data Summary
Northeastern Plant - Landfill

Geosyntec Consultants, Inc.

| Parameter | Unit | MW-6D | | | | | | | | |
|------------------------|-------|----------------|----------------|----------------|-----------|-----------|-----------|-----------|-----------|------------|
| | | 6/15-6/16/2017 | 6/27-6/28/2017 | 7/12-7/13/2017 | 8/4/2017 | 8/17/2017 | 8/30/2017 | 9/13/2017 | 9/20/2017 | 10/11/2017 |
| | | Background | | | | | | | | |
| Antimony | mg/L | 0.005U | 0.00128J | 0.005U | 0.005U | 0.00126J | 0.005U | 0.005U | 0.00118J | - |
| Arsenic | mg/L | 0.00199J | 0.005U | 0.005U | 0.005U | 0.00118J | 0.00206J | 0.00119J | 0.00193J | - |
| Barium | mg/L | 0.113 | 0.17 | 0.107 | 0.128 | 0.09954 | 0.103 | 0.109 | 0.07504 | - |
| Beryllium | mg/L | 0.00018J | 0.00006J | 0.00022J | 0.00022J | 0.00019J | 0.00022J | 0.00031J | 0.00014J | - |
| Boron | mg/L | 3.51 | 0.877 | 3.49 | 3.64 | 3.55 | 3.41 | 2.96 | 3.81 | 3.74 |
| Cadmium | mg/L | 0.0008J | 0.00037J | 0.00056J | 0.00093J | 0.00044J | 0.00036J | 0.00049J | 0.00022J | - |
| Calcium | mg/L | 201 | 133 | 218 | 222 | 211 | 210 | 237 | 196 | 165 |
| Chloride | mg/L | 28 | 29 | 30 | 31 | 30 | 30 | 32 | 32 | 29 |
| Chromium | mg/L | 0.00599 | 0.00086J | 0.00682 | 0.00662 | 0.00677 | 0.00668 | 0.00815 | 0.00386 | - |
| Cobalt | mg/L | 0.00373J | 0.00109J | 0.00382J | 0.00339J | 0.00307J | 0.00303J | 0.00371J | 0.00227J | - |
| Combined Radium | pCi/L | 1.822 | 1.917 | 1.784 | 1.115 | 1.155 | 1.057 | 1.377 | 1.43 | - |
| Fluoride | mg/L | 0.8054J | 0.7596J | 1U | 0.7656J | 0.729J | 0.7158J | 0.5406J | 1U | 0.9597J |
| Lead | mg/L | 0.00348J | 0.00076J | 0.005 | 0.00496J | 0.00325J | 0.0025J | 0.00328J | 0.00233J | - |
| Lithium | mg/L | 0.02203 | 0.01356 | 0.02244 | 0.01921 | 0.01925 | 0.01829 | 0.02105 | 0.01701 | - |
| Mercury | mg/L | 0.000012J | 0.000025U | 0.000007J | 0.000016J | 0.000011J | 0.000025U | 0.000025U | 0.000025U | - |
| Molybdenum | mg/L | 0.08501 | 0.00279J | 0.06181 | 0.08211 | 0.08132 | 0.08575 | 0.058 | 0.081 | - |
| Selenium | mg/L | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | - |
| Total Dissolved Solids | mg/L | 1054 | 1024 | 1044 | 1022 | 1016 | 986 | 1140 | 1008 | 1032 |
| Sulfate | mg/L | 508 | 524 | 504 | 532 | 509 | 522 | 521 | 505 | 545 |
| Thallium | mg/L | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | - |
| pH | SU | 7.49 | 7.89 | 7.29 | 6.35 | 6.91 | 7.19 | 7.05 | 7.05 | 6.91 |

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

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

*: Parameter was not present in concentrations above method detection limit and is reported as the method detection limit

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

-: Not sampled

Table 1: Groundwater Data Summary
Northeastern Plant - Landfill

Geosyntec Consultants, Inc.

| Parameter | Unit | MW-7D | | | | | | | | | |
|------------------------|-------|----------------|----------------|----------------|-----------|-----------|-----------|-----------|-----------|-----------|------------|
| | | 6/15-6/16/2017 | 6/27-6/28/2017 | 7/12-7/13/2017 | 8/4/2017 | 8/17/2017 | 8/30/2017 | 9/13/2017 | 9/20/2017 | 10/4/2017 | 10/11/2017 |
| | | Background | | | | | | | | | Detection |
| Antimony | mg/L | 0.00188J | 0.005U | 0.005U | 0.00106J | 0.005U | 0.00284J | 0.00211J | 0.005U | 0.00128J | - |
| Arsenic | mg/L | 0.01324 | 0.01008 | 0.01051 | 0.00368J | 0.01354 | 0.00928 | 0.01314 | 0.07314 | 0.01431 | - |
| Barium | mg/L | 0.101 | 0.136 | 0.14 | 0.158 | 0.307 | 0.503 | 0.773 | 3.84 | 0.751 | - |
| Beryllium | mg/L | 0.00014J | 0.00019J | 0.00025J | 0.00057J | 0.00053J | 0.00076J | 0.00114 | 0.0055 | 0.00118 | - |
| Boron | mg/L | 1.18 | 1.22 | 1.4 | 1.39 | 1.2 | 1.15 | 1.07 | 1.05 | 0.99 | 1.01 |
| Cadmium | mg/L | 0.001U | 0.00017J | 0.00017J | 0.00015J | 0.00031J | 0.00049J | 0.00089J | 0.0053 | 0.00129 | - |
| Calcium | mg/L | 94.5 | 126 | 121 | 133 | 130 | 181 | 236 | 918 | 297 | 392 |
| Chloride | mg/L | 171 | 196 | 299 | 383 | 489 | 525 | 56 | 662 | 418 | 733 |
| Chromium | mg/L | 0.0036 | 0.00607 | 0.006 | 0.00911 | 0.01436 | 0.0203 | 0.03056 | 0.146 | 0.02994 | - |
| Cobalt | mg/L | 0.00273J | 0.00245J | 0.00268J | 0.00541 | 0.00451J | 0.00658 | 0.00891 | 0.04905 | 0.01028 | - |
| Combined Radium | pCi/L | 2.97 | 3.86 | 3.087 | 2.937 | 2.356 | 2.31 | 3.79 | - | 3.55 | - |
| Fluoride | mg/L | 0.9374J | 1U | 1.828 | 2.024 | 2.273 | 3.2484 | 2.3942 | 0.59J | 2.07 | 3.2363 |
| Lead | mg/L | 0.00118J | 0.00289J | 0.00318J | 0.00323J | 0.00714 | 0.00755 | 0.01044 | 0.07031 | 0.01337 | - |
| Lithium | mg/L | 0.118 | 0.151 | 0.116 | 0.08759 | 0.118 | 0.134 | 0.153 | 0.226 | 0.166 | - |
| Mercury | mg/L | 0.000007J | 0.00001J | 0.000025U | 0.000023J | 0.000009J | 0.000017J | 0.000022J | 0.000054 | 0.000028 | - |
| Molybdenum | mg/L | 0.02696 | 0.02077 | 0.02545 | 0.02841 | 0.02914 | 0.04849 | 0.04291 | 0.05095 | 0.03257 | - |
| Selenium | mg/L | 0.00283J | 0.00187J | 0.0028J | 0.00401J | 0.00164J | 0.01845 | 0.01677 | 0.01941 | 0.01615 | - |
| Total Dissolved Solids | mg/L | 1700 | 1874 | 2116 | 2258 | 2698 | 3090 | 3672 | 3837 | 2965 | 4312 |
| Sulfate | mg/L | 635 | 698 | 725 | 841 | 872 | 1118 | 156 | 1632 | 1257 | 1548 |
| Thallium | mg/L | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | - |
| pH | SU | 6.72 | 8.28 | 7.84 | 6.93 | 7.28 | 7.39 | 7.2 | 7.12 | 7.16 | 7.48 |

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

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

*: Parameter was not present in concentrations above method detection limit and is reported as the method detection limit

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

-: Not sampled

Table 1: Groundwater Data Summary
Northeastern Plant - Landfill

Geosyntec Consultants, Inc.

| Parameter | Unit | MW-8D | | | | | | | | | | | |
|------------------------|-------|------------|------------|----------------|-----------|----------------|----------------|----------------|-----------|-----------|-----------|-----------|------------|
| | | 1/25/2017 | 3/15/2017 | 4/24-4/27/2017 | 5/18/2017 | 6/15-6/16/2017 | 6/27-6/28/2017 | 7/12-7/13/2017 | 8/4/2017 | 8/17/2017 | 8/30/2017 | 9/13/2017 | 10/11/2017 |
| | | Background | | | | | | | | | | | |
| Antimony | mg/L | 0.005U* | 0.005 | 0.00256J | 0.00713 | 0.02028 | 0.00467J | 0.00328J | 0.00232J | 0.00794 | 0.00508 | 0.00378J | - |
| Arsenic | mg/L | 0.007 | 0.005U* | 0.00448J | 0.01029 | 0.01341 | 0.00178J | 0.0027J | 0.0043J | 0.0058 | 0.00952 | 0.00704 | - |
| Barium | mg/L | 1.17 | 1.66 | 2.32 | 7.14 | 7.37 | 5.29 | 3.72 | 1.9 | 2.38 | 3.86 | 4.51 | - |
| Beryllium | mg/L | 0.001U* | 0.001U* | 0.00012J | 0.00046J | 0.00074J | 0.00008J | 0.00013J | 0.00017J | 0.00022J | 0.00075J | 0.00045J | - |
| Boron | mg/L | 1.31 | 1.29 | 1.28 | 1.27 | 1.34 | 1.29 | 1.36 | 1.35 | 1.35 | 1.36 | 1.36 | 1.32 |
| Cadmium | mg/L | 0.001 | 0.002 | 0.00093J | 0.00507 | 0.00826 | 0.00254 | 0.00141 | 0.00097J | 0.00139 | 0.00275 | 0.00182 | - |
| Calcium | mg/L | 446 | 417 | 376 | 529 | 861 | 416 | 381 | 416 | 450 | 586 | 479 | 445 |
| Chloride | mg/L | 11967 | 13217 | 11159 | 14606 | 10221 | 11171 | 11796 | 11757 | 11314 | 12305 | 12331 | 11582 |
| Chromium | mg/L | 0.004 | 0.001 | 0.001U | 0.00894 | 0.01536 | 0.00059J | 0.001U | 0.00102 | 0.00175 | 0.0143 | 0.00662 | - |
| Cobalt | mg/L | 0.005U* | 0.005U* | 0.00145J | 0.00592 | 0.01078 | 0.00385J | 0.00235J | 0.00265J | 0.00273J | 0.00653 | 0.0043J | - |
| Combined Radium | pCi/L | 7.48 | 4.66 | 5.29 | 5.583 | 5.37 | - | - | 9.67 | 6.39 | 5.979 | - | - |
| Fluoride | mg/L | 1U* | 1U* | 0.24J | 1U | 1U | 1U | 1U | 1U | 1U | 1U | 1U | 1U |
| Lead | mg/L | 0.005U* | 0.005U* | 0.0009J | 0.00659 | 0.0056 | 0.00231J | 0.00214J | 0.00282J | 0.00217J | 0.00511 | 0.00289J | - |
| Lithium | mg/L | 1.44 | 1.1 | 1.07 | 1.3 | 1.22 | 1.14 | 1.19 | 1.08 | 1.12 | 1.19 | 1.23 | - |
| Mercury | mg/L | 0.000025U* | 0.000025U* | 0.00001J | 0.000022J | 0.000025 | 0.000012J | 0.000015J | 0.000012J | 0.000025U | 0.000029 | 0.00003 | - |
| Molybdenum | mg/L | 0.005U* | 0.005U* | 0.00091J | 0.00243J | 0.00281J | 0.0012J | 0.00168J | 0.0019J | 0.00191J | 0.0034J | 0.00453J | - |
| Selenium | mg/L | 0.006 | 0.005U* | 0.00391J | 0.0037J | 0.00371J | 0.00134J | 0.00578 | 0.00603 | 0.00605 | 0.00474J | 0.00466J | - |
| Total Dissolved Solids | mg/L | 20832 | 19020 | 20810 | 22342 | 20104 | 20996 | 21074 | 22200 | 22396 | 22968 | 23012 | 21896 |
| Sulfate | mg/L | 144 | 72 | 58 | 112 | 122 | 116 | 128 | 113 | 103 | 112 | 126 | 300 |
| Thallium | mg/L | 0.002U* | 0.002U* | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | - |
| pH | SU | 7.1 | - | 7.34 | - | 7.21 | 7.04 | 7.15 | 6.98 | 6.94 | 6.99 | 6.89 | 6.9 |

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

Table 1: Groundwater Data Summary
Northeastern Plant - Landfill

| Parameter | Unit | MW-9D | | | | | | | | | | |
|------------------------|-------|----------------|----------------|-----------|-----------|-----------|-----------|-----------|-----------|------------|------------|-----------|
| | | 6/15-6/16/2017 | 6/27-6/28/2017 | 7/12/2017 | 8/4/2017 | 8/17/2017 | 8/30/2017 | 9/13/2017 | 10/4/2017 | 10/11/2017 | 10/31/2017 | 11/8/2017 |
| | | Background | | | | | | | | Detection | Background | |
| Antimony | mg/L | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | - | - | - |
| Arsenic | mg/L | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | 0.005U | - | - | - |
| Barium | mg/L | 0.188 | 0.05815 | 0.06989 | 0.132 | 0.196 | 0.323 | 0.399 | 0.41 | - | - | - |
| Beryllium | mg/L | 0.00032J | 0.001U | 0.00005J | 0.00017J | 0.00022J | 0.00037J | 0.0004J | 0.00043J | - | - | - |
| Boron | mg/L | 7.09 | 7.01 | 7.63 | 7.59 | 7.46 | 6.93 | 6.78 | 6.68 | 7.07 | - | - |
| Cadmium | mg/L | 0.00081J | 0.00026J | 0.001U | 0.00054J | 0.00025J | 0.00091J | 0.00068J | 0.0024 | | - | - |
| Calcium | mg/L | 229 | 191 | 244 | 337 | 328 | 354 | 366 | 304 | 288 | - | - |
| Chloride | mg/L | 100 | 232 | 98 | 60 | 216 | 64 | 293 | 180 | 314 | - | - |
| Chromium | mg/L | 0.01234 | 0.00089J | 0.00409 | 0.00715 | 0.00952 | 0.02006 | 0.01334 | 0.01479 | - | - | - |
| Cobalt | mg/L | 0.00618 | 0.00714 | 0.00569 | 0.00734 | 0.00817 | 0.01508 | 0.01288 | 0.00838 | - | - | - |
| Combined Radium | pCi/L | 0.931 | - | - | - | - | - | - | - | - | 0.683 | 2.59 |
| Fluoride | mg/L | 0.9857J | 0.8986J | 2.191 | 0.6947J | 0.681J | 1U | 0.37J | 1U | 1.5191 | - | - |
| Lead | mg/L | 0.00702 | 0.00124J | 0.00236J | 0.00426J | 0.00533 | 0.00927 | 0.00828 | 0.00969 | - | - | - |
| Lithium | mg/L | 0.02386 | 0.01647 | 0.02221 | 0.02155 | 0.02401 | 0.02964 | 0.03257 | 0.03222 | - | - | - |
| Mercury | mg/L | 0.000009J | 0.000025U | 0.000025U | 0.000017J | 0.000011J | 0.000016J | 0.000016J | 0.000015J | - | - | - |
| Molybdenum | mg/L | 0.173 | 0.166 | 0.151 | 0.117 | 0.09819 | 0.09384 | 0.07839 | 0.07377 | - | - | - |
| Selenium | mg/L | 0.005 | 0.005U | 0.00132J | 0.00357J | 0.00353J | 0.00294J | 0.0028J | 0.00383J | - | - | - |
| Total Dissolved Solids | mg/L | 1458 | 1114 | 2146 | 2256 | 2486 | 2392 | 2826 | 2296 | 2188 | - | - |
| Sulfate | mg/L | 781 | 876 | 1048 | 1217 | 1193 | 1192 | 1244 | 1079 | 1075 | - | - |
| Thallium | mg/L | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | - | - | - |
| pH | SU | 7.13 | 7.65 | 7.41 | 7.04 | 7.1 | 7.28 | 7.18 | 7.26 | 7.09 | - | - |

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

**Table 1: Groundwater Data Summary
Northeastern Plant - Landfill**

Geosyntec Consultants, Inc.

| Parameter | Unit | MW-15 | | | | | | | | | | | | |
|------------------------|-------|------------|------------|----------------|-----------|----------------|----------------|----------------|-----------|-----------|-----------|-----------|-----------|------------|
| | | 1/25/2017 | 3/13/2017 | 4/25-4/27/2017 | 5/18/2017 | 6/15-6/16/2017 | 6/27-6/28/2017 | 7/12-7/13/2017 | 8/4/2017 | 8/17/2017 | 8/30/2017 | 9/13/2017 | 9/20/2017 | 10/11/2017 |
| | | Background | | | | | | | | | | | | Detection |
| Antimony | mg/L | 0.005U* | 0.005U* | 0.00131J | 0.00138J | 0.005U | 0.005U | 0.00163J | 0.00156J | 0.00099J | 0.005U | 0.005U | 0.005U | - |
| Arsenic | mg/L | 0.005U* | 0.005U* | 0.00285J | 0.01361 | 0.00756 | 0.0044J | 0.00377J | 0.00373J | 0.00444J | 0.00632 | 0.00418J | 0.00387J | - |
| Barium | mg/L | 0.107 | 0.1 | 0.05573 | 0.05206 | 0.212 | 0.09867 | 0.15 | 0.09419 | 0.133 | 0.06487 | 0.05434 | 0.04923 | - |
| Beryllium | mg/L | 0.001U* | 0.001U* | 0.001U | 0.001U | 0.00025J | 0.00002J | 0.00012J | 0.00008J | 0.00009J | 0.00004J | 0.00003J | 0.001U | - |
| Boron | mg/L | 9.45 | 8.23 | 9.44 | 10.2 | 9.74 | 9.75 | 9.87 | 9.66 | 9.53 | 9.59 | 9.13 | 9.65 | 9.62 |
| Cadmium | mg/L | 0.001U* | 0.001U* | 0.001U | 0.00026J | 0.00064J | 0.001U | 0.00009J | 0.00009J | 0.001U | 0.001U | 0.001U | 0.001U | - |
| Calcium | mg/L | 87 | 104 | 73.1 | 52.2 | 126 | 79.2 | 110 | 86.3 | 93.1 | 64.9 | 68 | 67.6 | 80.1 |
| Chloride | mg/L | 19 | 28 | 78 | 111 | 24 | 22 | 19 | 19 | 18 | 17 | 17 | 15 | 46 |
| Chromium | mg/L | 0.003 | 0.003 | 0.00023J | 0.00096J | 0.00857 | 0.00179 | 0.00403 | 0.00151 | 0.0033 | 0.00086J | 0.001U | 0.00023J | - |
| Cobalt | mg/L | 0.005U* | 0.005U* | 0.00064J | 0.00062J | 0.00396J | 0.00129J | 0.00264J | 0.0014J | 0.00169J | 0.00078J | 0.00066J | 0.00077J | - |
| Combined Radium | pCi/L | 0.505 | 1.241 | 0.203 | 1.097 | 1.215 | 1.652 | 0.287 | 0.914 | 0.649 | 0.393 | 1.07 | 0.887 | - |
| Fluoride | mg/L | 2 | 2 | 1.83 | 2 | 1.96 | 1.8739 | 1.894 | 1.759 | 1.691 | 2.0289 | 1.671 | 0.642J | 1.9468 |
| Lead | mg/L | 0.005U* | 0.005U* | 0.005U | 0.0017J | 0.00525 | 0.00242J | 0.00287J | 0.00136J | 0.00144J | 0.005U | 0.005U | 0.005U | - |
| Lithium | mg/L | 0.012 | 0.01 | 0.00786 | 0.00834 | 0.01148 | 0.00722 | 0.0091 | 0.00752 | 0.00823 | 0.00629 | 0.00635 | 0.00621 | - |
| Mercury | mg/L | 0.000025U* | 0.000025U* | 0.000025U | 0.000022J | 0.00002J | 0.000022J | 0.000009J | 0.000021J | 0.000015J | 0.00001J | 0.000008J | 0.000025U | - |
| Molybdenum | mg/L | 0.643 | 0.55 | 0.614 | 0.605 | 0.662 | 0.644 | 0.668 | 0.647 | 0.642 | 0.656 | 0.638 | 0.652 | - |
| Selenium | mg/L | 0.005U* | 0.005U* | 0.00183J | 0.02228 | 0.01246 | 0.00576 | 0.009 | 0.006 | 0.00595 | 0.00924 | 0.00145J | 0.00377J | - |
| Total Dissolved Solids | mg/L | 1112 | 1110 | 1128 | 1092 | 1060 | 1072 | 1076 | 1032 | 1110 | 1038 | 1080 | 1036 | 1124 |
| Sulfate | mg/L | 530 | 551 | 558 | 596 | 559 | 616 | 632 | 612 | 572 | 590 | 584 | 543 | 593 |
| Thallium | mg/L | 0.002U* | 0.002U* | 0.00105J | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | 0.002U | - |
| pH | SU | 7.98 | - | 7.64 | - | 7.94 | 8.54 | 8.21 | 7.6 | 7.83 | 6.73 | 8.58 | 7.47 | 7.64 |

Notes:

mg/L: milligrams per liter

pCi/L: picocuries per liter

SU: standard unit

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

*: Parameter was not present in concentrations above method detection limit and is reported as the method detection limit

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

-: Not sampled

Table 1 – Groundwater Data Summary Northeastern
Landfill - Detection Monitoring

Geosyntec Consultants, Inc.

| Parameter | Unit | MW-3D | | | MW-6D | | | | MW-7D | | MW-8D | | MW-9D | | MW-15 | | | | |
|------------------------|------|-----------|------------|------------|------------|-----------|------------|------------|-----------|------------|-----------|------------|------------|------------|------------|-----------|------------|------------|------------|
| | | 5/30/2018 | 10/22/2018 | 11/28/2018 | 1/22/2018 | 5/30/2018 | 10/22/2018 | 11/28/2018 | 5/30/2018 | 10/22/2018 | 5/30/2018 | 10/22/2018 | 1/22/2018 | 10/22/2018 | 1/22/2018 | 5/30/2018 | 10/15/2018 | 10/22/2018 | 11/28/2018 |
| | | 2018-D1 | 2018-D2 | 2018-D2-V1 | 2017-D1-V1 | 2018-D1 | 2018-D2 | 2018-D2-V1 | 2018-D1 | 2018-D2 | 2018-D1 | 2018-D2 | 2017-D1-V1 | 2018-D2 | 2017-D1-V1 | 2018-D1 | 2018-D1-V1 | 2018-D2 | 2018-D2-V1 |
| Boron | mg/L | 0.952 | 1.02 | 0.964 | 4.24 | 3.35 | 4.34 | - | 0.840 | 1.10 | 1.31 | 1.75 | 7.43 | 7.19 | 9.16 | 8.76 | - | 8.90 | - |
| Calcium | mg/L | 129 | 142 | - | - | 269 | 237 | - | 207 | 357 | 353 | 1290 | - | 199 | - | 105 | - | 250 | 119 |
| Chloride | mg/L | 13.0 | 14.9 | - | - | 32.0 | 31.7 | - | 511 | 568 | 11900 | 11700 | - | 106 | - | 33.0 | - | 46.8 | - |
| Fluoride | mg/L | 0.896 J | 1.09 | 0.648 | 0.760 J | 0.922 J | 1.28 | 0.844 | 3.46 | 0.953 J | 3.31 | <0.083 U | - | 0.600 J | - | 2.33 | 2.27 | 2.17 | - |
| Total Dissolved Solids | mg/L | 724 | 702 | - | - | 1090 | 1150 | - | 5910 | 5840 | 384 | 20900 | - | 1260 | - | 1130 | - | 1080 | - |
| Sulfate | mg/L | 214 | 211 | - | 494 | 401 | 472 | - | 2970 | 1370 | 47.0 | 48.4 | - | 519 | - | 549 | - | 549 | - |
| pH | SU | 7.46 | 7.20 | - | - | 7.39 | 7.25 | - | 7.05 | 7.42 | 6.95 | 7.12 | - | 7.13 | - | 7.71 | - | 7.79 | - |

Notes:
mg/L: milligrams per liter
pCi/L: picocuries per liter
SU: standard unit
U: Parameter was not present in concentrations above method detection limit and is reported as the method detection limit
J: Estimated value. Parameter was detected in concentrations below the reporting limit
-: Not analyzed
2017-D1-V1: Verification sampling, initial detection monitoring event (initial event occurred in 2017, the verification sampling for that event occurred in 2018)
2018-D1: First semi-annual detection monitoring event, initial sampling event
2018-D1-V1: Verification sampling, first semi-annual detection monitoring event
2018-D2: Second semi-annual detection monitoring event, initial sampling event
2018-D2-V1: Verification sampling, second semi-annual detection monitoring event

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.

Memorandum

Date: February 26, 2018
To: David Miller (AEP)
Copies to: Jill Parker-Witt (AEP)
From: Allison Kreinberg and Bruce Sass, Ph.D. (Geosyntec)
Subject: Evaluation of Detection Monitoring Data at
Northeastern Plant's Landfill (LF)

In accordance with the United States Environmental Protection Agency's (USEPA's) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments (40 CFR 257.90-257.98, "CCR rule"), detection monitoring events were completed on October 11, 2017 and January 22, 2018 at the Landfill (LF), an existing CCR unit at the Northeastern Power Plant located in Oologah, Oklahoma.

Eight to twelve background monitoring events were conducted at the Northeastern LF prior to these detection monitoring events, and upper prediction limits (UPLs) were calculated for each Appendix III parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. Details on the calculation of these background values are described in Geosyntec's *Statistical Analysis Summary* report, dated January 15, 2018.

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

Detection monitoring results and the relevant background values are summarized in Table 1. Boron concentrations exceeded the interwell UPL of 1.497 mg/L in both the initial (3.74 mg/L) and second (4.24 mg/L) samples collected at MW-6D, in both the initial (7.07 mg/L) and second (7.43 mg/L) samples collected at MW-9D, and in both the initial (9.62 mg/L) and second (9.16 mg/L) samples collected at MW-15. Therefore, an SSI over background is concluded for boron at

MW-6D, MW-9D, and MW-15. As a result, the Northeastern LF CCR unit will conduct an alternate source demonstration.

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

* * * * *

CERTIFICATION BY QUALIFIED PROFESSIONAL ENGINEER

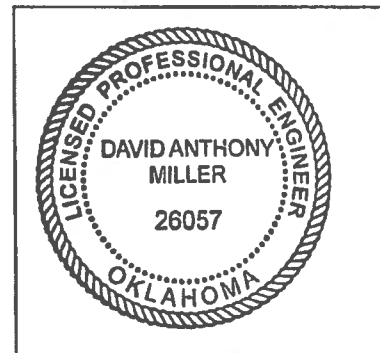
I certify that the selected statistical method, described above and in the January 15, 2018 *Statistical Analysis Summary* report, is appropriate for evaluating the groundwater monitoring data for the Northeastern LF CCR management area and that the requirements of OAC 252:517-9-4(g) have been met.

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature



26057

License Number

OKLAHOMA

Licensing State

02.27.18

Date

Table 1: Detection Monitoring Data Evaluation
Northeastern Plant - Landfill

Geosyntec Consultants, Inc.

| Parameter | Units | Description | MW-3D | MW-6D | | MW-9D | | MW-15 | |
|------------------------|-------|----------------------------------|------------|------------|-----------|------------|-----------|------------|-----------|
| | | | 10/11/2017 | 10/11/2017 | 1/22/2018 | 10/11/2017 | 1/22/2018 | 10/11/2017 | 1/22/2018 |
| Boron | mg/L | Interwell Background Value (UPL) | 1.497 | | | | | | |
| | mg/L | Detection Monitoring Result | 0.878 | 3.74 | 4.24 | 7.07 | 7.43 | 9.62 | 9.16 |
| Calcium | mg/L | Intrawell Background Value (UPL) | 190 | 285 | | 463 | | 132 | |
| | mg/L | Detection Monitoring Result | 134 | 165 | - | 288 | - | 80.1 | - |
| Chloride | mg/L | Intrawell Background Value (UPL) | 16.2 | 33.9 | | 383 | | 78 | |
| | mg/L | Detection Monitoring Result | 13 | 29 | - | 314 | - | 46 | - |
| Fluoride | mg/L | Intrawell Background Value (UPL) | 1 | 0.941 | | 2.28 | | 2.243 | |
| | mg/L | Detection Monitoring Result | 0.083 | 0.9597 | 0.76 | 1.5191 | - | 1.9468 | - |
| pH | SU | Interwell Background Value (UPL) | 8.28 | | | | | | |
| | SU | Interwell Background Value (LPL) | 6.72 | | | | | | |
| | SU | Detection Monitoring Result | 6.92 | 6.91 | 6.85 | 7.09 | 7.14 | 7.64 | 7.24 |
| Total Dissolved Solids | mg/L | Intrawell Background Value (UPL) | 853 | 1159 | | 3591 | | 1152 | |
| | mg/L | Detection Monitoring Result | 722 | 1032 | - | 2188 | - | 1124 | - |
| Sulfate | mg/L | Intrawell Background Value (UPL) | 251 | 543 | | 1524 | | 649 | |
| | mg/L | Detection Monitoring Result | 218 | 545 | 494 | 1075 | - | 593 | - |

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

-: Not Sampled

Bold values exceed the background value.

Background values are shaded gray.

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 STATE AND FEDERAL CCR RULE

Northeastern Power Station Landfill Oologah, Oklahoma

Submitted to



1 Riverside Plaza
Columbus, Ohio 43215-2372

Submitted by



engineers | scientists | innovators

150 East Wilson Bridge Road
Suite 232
Worthington, Ohio 43085

April 13, 2018

CHA8462

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Figure 1 Potentiometric Map

LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|-------|---|
| AEP | American Electric Power |
| ASD | Alternative Source Demonstration |
| CCR | Coal Combustion Residuals |
| CFR | Code of Federal Regulations |
| EPA | Environmental Protection Agency |
| LPL | Lower Prediction Limit |
| OAC | Oklahoma Administrative Code |
| ODEQ | Oklahoma Department of Environmental Quality |
| QA | Quality Assurance |
| QC | Quality Control |
| SSI | Statistically Significant Increase |
| UPL | Upper Prediction Limit |
| USEPA | United States Environmental Protection Agency |

SECTION 1

INTRODUCTION AND SUMMARY

Eight to twelve background monitoring events were conducted at the Northeastern Landfill, and upper prediction limits (UPLs) were calculated for each detection monitoring parameter to represent background values. A lower prediction limit (LPL) was also calculated for pH. Prediction limits were calculated based on a one-of-two retesting procedure. With this procedure, a statistically significant increase (SSI) is concluded only if both detection monitoring samples in a series of two exceed the UPL. In practice, if the initial result did not exceed the UPL, a second sample was not collected or analyzed. Following two detection monitoring events at the Landfill, SSIs were identified for boron at MW-6D, MW-9D, and MW-15 by interwell analysis. No other SSIs were identified.

A summary of the detection monitoring analytical results and the calculated prediction limits to which they were compared is provided in Table 1.

1.1 CCR Rule Requirements

In accordance with the United States Environmental Protection Agency (USEPA) and Oklahoma Department of Environmental Quality (ODEQ) regulations regarding the disposal of coal combustion residuals (CCR) in landfills and surface impoundments, Rule 40 CFR 257.94(e)(2) and OAC 252:517-9-5(e)(2) states the following:

The owner or operator may demonstrate that a source other than the CCR unit caused the statistically significant increase over background levels for a constituent or that the statistically significant increase resulted from error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. The owner or operator must complete the written demonstration within 90 days of detecting a statistically significant increase over background levels to include obtaining a certification from a qualified professional engineer verifying the accuracy of the information in the report.

Pursuant to the Rule, Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternative Source Demonstration (ASD) report, which documents that the SSIs cited above should not be attributed to the Northeastern Landfill.

Two detection monitoring events were conducted on October 11, 2017 and January 22, 2018 at the Northeastern Landfill to identify SSIs over background limits. The CCR Rule allows the owner or operator 90 days from the determination of an SSI to demonstrate that the SSI resulted from a source other than the regulated CCR unit, such as an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality.

1.2 Demonstration of Alternative Sources

An evaluation was completed to assess possible alternative sources to which identified SSIs 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 increases in constituent concentrations were based on a Type III cause and not by a release from the Northeastern Landfill.

SECTION 2

ALTERNATIVE SOURCE DEMONSTRATION

The State and Federal CCR Rules allows the owner or operator 90 days from the determination of an SSI to demonstrate that a source other than the CCR unit caused the SSI. Identified SSIs, evaluation methodology, 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 did not identify ASDs due to Type I or Type II issues. However, a review of the site hydrogeology indicated an issue with the statistical evaluation, resulting in a Type III ASD.

MW-7D and MW-8D were identified as upgradient monitoring wells and were used to develop background concentrations for boron and pH, for which interwell tests were used to evaluate potential SSIs. Intrawell tests were used to evaluate potential SSIs for the other detection monitoring parameters. Based on these analyses, SSIs were identified for boron at MW-6D, MW-9D, and MW-15. No other SSIs were identified (Geosyntec, 2018).

However, the groundwater elevation appears to mound at the Landfill, and MW-7D and MW-8D appear not to be hydrogeologically upgradient of the Landfill as shown on Figure 1. Therefore, it would not be appropriate to establish background concentrations using MW-7D and MW-8D. ODEQ reached the same conclusion, as documented in a January 16, 2018 letter to AEP (ODEQ, 2018). ODEQ also noted that “concentrations of certain constituents” were elevated at MW-8D, providing another line of evidence that MW-8D should not be used as a background monitoring well (ODEQ, 2018). A copy of the ODEQ letter is included as Attachment A.

After consultation with ODEQ, intrawell tests were considered the most appropriate means to evaluate potential SSIs, and intrawell background values were developed for all detection monitoring parameters. The use of non-upgradient wells to establish background concentrations is appropriate under both 40 CFR 257.91(a)(1) and Oklahoma Administrative Code (OAC) 252:517-9-2(a)(1). Because intrawell background values were used to evaluate potential SSIs for calcium, chloride, fluoride, TDS, and sulfate previously, the background values for these five parameters remain unchanged. Because interwell background values were previously used to evaluate potential SSIs for boron and pH, the background values for boron and pH have changed.

Comparing the detection monitoring results to the intrawell background values, SSIs are no longer observed at the Landfill. The boron results at MW-6D, MW-9D, and MW-15 are no longer considered SSIs, and no new SSIs were identified as the result of changes to background values. The revised intrawell background values and detection monitoring results are summarized in Table 2, and the results of the full statistical evaluation are included in Attachment B.

April 13, 2018

Future detection monitoring results will be compared to the applicable intrawell background values. The background values may be updated as additional data are collected, in accordance with the Statistical Analysis Plan (Geosyntec, 2017).

2.2 Sampling Requirements

As the ASD described above supports the position that the identified SSIs are not due to a release from the Northeastern Landfill, the unit will remain in the detection monitoring program. Groundwater at the unit will be sampled for detection monitoring parameters on a semi-annual basis.

2.3 Certification by a Qualified Professional Engineer

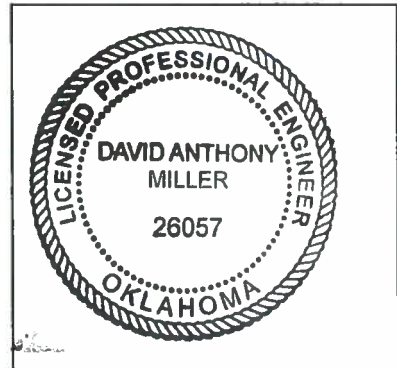
I certify that the selected and above described alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Northeastern Landfill CCR management area and that the requirements of both 40 CFR 257.94(e)(2) and OAC 252:517-9-4(e)(2) have been met.

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature



26057

License Number

OKLAHOMA

Licensing State

04.13.18

Date

SECTION 3

CONCLUSIONS AND RECOMMENDATIONS

The preceding information serves as the ASD prepared in accordance with both 40 CFR 257.94(e)(2) and OAC 252:517-9-4(e)(2) and supports the position that the SSIs in detection monitoring constituents are not due to a release from the Northeastern Landfill during October 2017 through January 2018 detection monitoring events. An investigation into site hydrogeology and a letter from ODEQ to AEP indicated that a Type III ASD is the most likely source for boron in wells MW-6D, MW-9D, and MW-15. Based on these lines of evidence, intrawell background values were developed for each detection monitoring parameter. Comparing the detection monitoring results to the intrawell background values, SSIs are no longer observed for boron at MW-6D, MW-9D, and MW-15. Therefore, no further action is warranted, and the Northeastern Landfill will remain in the detection monitoring program.

SECTION 4

REFERENCES

- EPRI, 2017. Guidelines for Development of Alternative Source Demonstrations at Coal Combustion Residual Site. 3002010920. October.
- Geosyntec. 2017. Statistical Analysis Plan. January 2017.
- Geosyntec. 2018. Statistical Analysis Summary, Stations 3 and 4 Landfill, Northeastern Power Station, Oologah, Oklahoma. January 15, 2018.
- U.S. EPA, 2015. Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (Final Rule). Fed. Reg. 80 FR 21301, pp. 21301-21501, 40 CFR Parts 257 and 261, April.
- ODEQ. 2018. Re: Groundwater Monitoring Network for CCR Compliance – Landfill, Public Service Company of Oklahoma-Northeastern Power Station, Rogers County, Solid Waste Permit No. 3566010. Letter from Hillary Young to Jill Parker-Witt.

TABLES

**Table 1: Detection Monitoring Data Evaluation
Northeastern Plant - Landfill**

Geosyntec Consultants, Inc.

| Parameter | Units | Description | MW-3D | MW-6D | | MW-9D | | MW-15 | |
|------------------------|-------|----------------------------------|------------|------------|-----------|------------|-----------|------------|-----------|
| | | | 10/11/2017 | 10/11/2017 | 1/22/2018 | 10/11/2017 | 1/22/2018 | 10/11/2017 | 1/22/2018 |
| Boron | mg/L | Interwell Background Value (UPL) | 1.497 | | | | | | |
| | mg/L | Detection Monitoring Result | 0.878 | 3.74 | 4.24 | 7.07 | 7.43 | 9.62 | 9.16 |
| Calcium | mg/L | Intrawell Background Value (UPL) | 190 | 285 | | 463 | | 132 | |
| | mg/L | Detection Monitoring Result | 134 | 165 | - | 288 | - | 80.1 | - |
| Chloride | mg/L | Intrawell Background Value (UPL) | 16.2 | 33.9 | | 383 | | 78 | |
| | mg/L | Detection Monitoring Result | 13 | 29 | - | 314 | - | 46 | - |
| Fluoride | mg/L | Intrawell Background Value (UPL) | 1 | 0.941 | | 2.28 | | 2.243 | |
| | mg/L | Detection Monitoring Result | 0.083 | 0.9597 | 0.76 | 1.5191 | - | 1.9468 | - |
| pH | SU | Interwell Background Value (UPL) | 8.28 | | | | | | |
| | SU | Interwell Background Value (LPL) | 6.72 | | | | | | |
| | SU | Detection Monitoring Result | 6.92 | 6.91 | 6.85 | 7.09 | 7.14 | 7.64 | 7.24 |
| Total Dissolved Solids | mg/L | Intrawell Background Value (UPL) | 853 | 1159 | | 3591 | | 1152 | |
| | mg/L | Detection Monitoring Result | 722 | 1032 | - | 2188 | - | 1124 | - |
| Sulfate | mg/L | Intrawell Background Value (UPL) | 251 | 543 | | 1524 | | 649 | |
| | mg/L | Detection Monitoring Result | 218 | 545 | 494 | 1075 | - | 593 | - |

Notes:

UPL: Upper prediction limit

LPL: Lower prediction limit

-: Not Sampled

Background values exceed the background value.

Background values are shaded gray.

**Table 2: Detection Monitoring Data Evaluation
Intrawell Prediction Limits
Northeastern Plant - Landfill**

Geosyntec Consultants, Inc.

| Parameter | Units | Description | MW-3D | MW-6D | | MW-9D | | MW-15 | |
|------------------------|-------|----------------------------------|------------|------------|-----------|------------|-----------|------------|-----------|
| | | | 10/11/2017 | 10/11/2017 | 1/22/2018 | 10/11/2017 | 1/22/2018 | 10/11/2017 | 1/22/2018 |
| Boron | mg/L | Intrawell Background Value (UPL) | 0.975 | 4.35 | | 8.11 | | 10.6 | |
| | mg/L | Detection Monitoring Result | 0.878 | 3.74 | 4.24 | 7.07 | 7.43 | 9.62 | 9.16 |
| Calcium | mg/L | Intrawell Background Value (UPL) | 190 | 285 | | 463 | | 132 | |
| | mg/L | Detection Monitoring Result | 134 | 165 | - | 288 | - | 80.1 | - |
| Chloride | mg/L | Intrawell Background Value (UPL) | 16.2 | 33.9 | | 383 | | 78 | |
| | mg/L | Detection Monitoring Result | 13 | 29 | - | 314 | - | 46 | - |
| Fluoride | mg/L | Intrawell Background Value (UPL) | 1 | 0.9414 | | 2.28 | | 2.243 | |
| | mg/L | Detection Monitoring Result | 0.083 | 0.9597 | 0.76 | 1.5191 | - | 1.9468 | - |
| pH | SU | Intrawell Background Value (UPL) | 8.03 | 8.32 | | 7.77 | | 9.14 | |
| | SU | Intrawell Background Value (LPL) | 6.17 | 5.98 | | 6.74 | | 6.56 | |
| | SU | Detection Monitoring Result | 6.92 | 6.91 | 6.85 | 7.09 | 7.14 | 7.64 | 7.24 |
| Total Dissolved Solids | mg/L | Intrawell Background Value (UPL) | 853 | 1159 | | 3591 | | 1152 | |
| | mg/L | Detection Monitoring Result | 722 | 1032 | - | 2188 | - | 1124 | - |
| Sulfate | mg/L | Intrawell Background Value (UPL) | 251 | 543 | | 1524 | | 649 | |
| | mg/L | Detection Monitoring Result | 218 | 545 | 494 | 1075 | - | 593 | - |

Notes:

UPL: Upper prediction limit

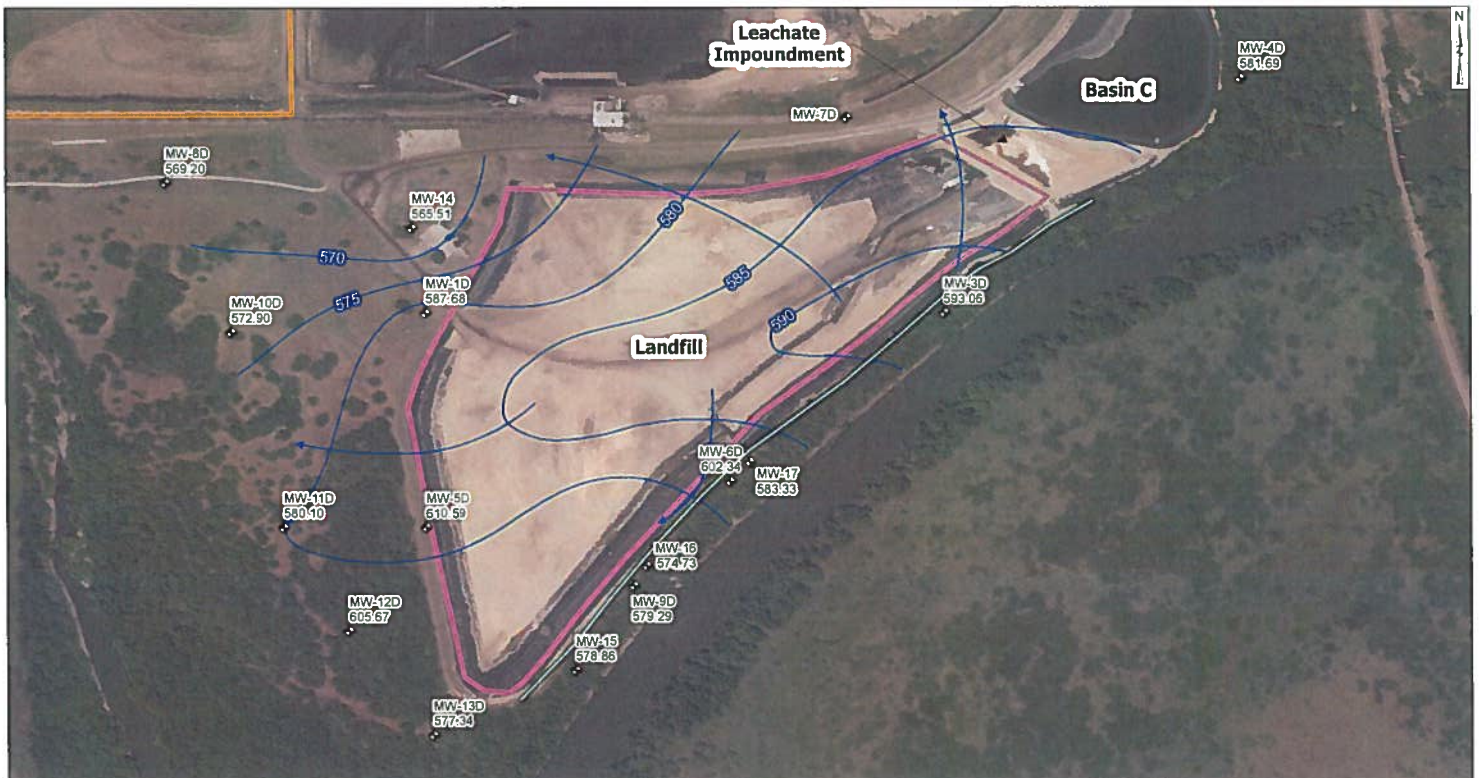
LPL: Lower prediction limit

-: Not Sampled

Bold values exceed the background value.

Background values are shaded gray.

FIGURES



Legend

- Groundwater Monitoring Well
- Groundwater Elevation Contour
- Inferred Groundwater Elevation Contour
- Approximate Groundwater Flow Direction
- Slurry Wall
- Bottom Ash Pond
- Landfill

Notes

- Monitoring well coordinates and water level data (collected November 9, 2016) provided by AEP.
- Site features based on information available in Report 1 - Groundwater Monitoring Network Evaluation - Northeastern Stations 3 and 4 - Bottom Ash Pond (Terracon Consultants, 2015) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.



Potentiometric Contours - Uppermost Aquifer

November 2016
AEP Northeastern Plant
Oklahoma, Oklahoma

Geosyntec
consultants

Figure
1

Columbus, Ohio 2018/03/26

ATTACHMENT A

ODEQ Letter



SCOTT A. THOMPSON
Executive Director

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

MARY FALLIN
Governor

January 16, 2018

Ms. Jill Parker-Witt, P.E.
American Electric Power
502 North Allen Avenue
Shreveport, LA 71101r

RECEIVED JAN 24 2018

Re: Groundwater Monitoring Network for CCR Compliance – Landfill
Public Service Company of Oklahoma-Northeastern Power Station
Rogers County
Solid Waste Permit No. 3566010

Dear Ms. Parker-Witt:

On October 19, 2017, the Oklahoma Department of Environmental Quality (DEQ) received Report 1 – Groundwater Monitoring Network for CCR Compliance for the Non-Hazardous Industrial Waste Landfill (Report) from American Electric Power – Public Service Company of Oklahoma (AEP-PSO) for the Northeastern Power Station (NPS). The Report was submitted for compliance with OAC 252:517-9-1(b).

The existing monitoring well network surrounding the landfill consists of monitoring wells MW1S, MW2S, MW3S, MW4S, MW5S, MW6S, MW7S, MW8S, MW9S, MW10S, MW11S, MW12S, MW13S, MW1D, MW2D, MW3D, MW4D, MW5D, MW6D, MW7D, MW8D, MW9D, MW10D, MW11D, MW12D, MW13D, MW-14, MW-15, MW-16 and MW-17. Thirteen shallow monitoring wells, MW1S-13S, are screened primarily in the gravelly clay, ash and limestone. Fifteen deeper monitoring wells, MW1D, MW3D, MW5D, MW6D, MW7D, MW8D, MW9D, MW10D, MW11D, MW12D, MW13D, MW-14, MW-15, MW-16 and MW-17 are constructed primarily in the Labette shale. Monitoring wells MW2D and MW4D are screened in both the limestone and shale.

A 2,200 foot long slurry wall/grout curtain was constructed in 2011 on the southeastern border of the landfill as a barrier to mitigate contaminated groundwater seeping into the Verdigris River. Monitoring wells MW13S, MW13D, MW2S, MW2D, MW9S, MW9D, MW6S, MW6D, MW3S, and MW3D were constructed between the slurry wall and the Verdigris River to monitor groundwater and determine the performance of the slurry wall/grout curtain.

AEP-PSO evaluated the existing network as required by OAC 252:517-9-2 and proposes to cease monitoring all shallow groundwater wells (MW1S, MW2S, MW3S, MW4S, MW5S, MW6S, MW7S, MW8S, MW9S, MW10S, MW11S, MW12S, MW13S) and some of the deeper shale wells (MW1D, MW2D, MW4D, MW5D, MW10D, MW11D, MW12D, MW13D, MW-14, MW-16 and MW-17). AEP-PSO has proposed to monitor MW7D and MW8D as the upgradient



monitoring wells and MW3D, MW6D, MW9D, and MW15 as the downgradient monitoring wells.

DEQ has evaluated the proposal and has the following concerns:

1. Monitoring wells MW13S, MW13D, MW2S, MW2D, MW9S, MW6S, MW3S, and MW3D in addition to MW6D and MW9D are needed to monitor the performance of the slurry wall/grout curtain.

The proposed monitoring network does not adequately monitor the performance of the slurry wall/grout curtain. Groundwater in MW9S consistently shows levels of arsenic, lead, mercury, nickel, selenium, vanadium and an elevated pH greater than 12. Some of the aforementioned monitoring wells that are dry at sampling events document the ability of the slurry wall/grout curtain to prevent seepage of contaminated groundwater.

2. Monitoring wells MW13S and MW13D, located south of the southern end of the slurry wall/grout curtain, are needed to detect groundwater contamination that may flow around the end of the slurry wall/grout curtain and seep into the Verdigris River.

The proposed monitoring network does not adequately monitor groundwater south of the slurry wall without MW13S and MW13D. Trace amounts of chromium, nickel, and vanadium have been measured in MW13S and MW13D.

3. AEP-PSO submitted the Groundwater Sampling and Analysis Plan (SAP) separately and it will be addressed in a separate letter; however, the proposed monitoring network discontinues the sampling of monitoring wells that have low volume, low yield or are consistently dry without attempting alternative sampling methods.

AEP-PSO has not addressed alternative sampling methods prior to removing monitoring wells from the existing network. Additionally, monitoring wells located east of the landfill, that are dry; indicate the positive performance of the slurry wall/grout curtain to curtail groundwater seepage to the Verdigris River.

DEQ suggests the following to address its concerns:

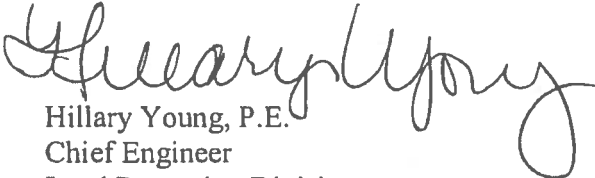
- AEP-PSO separates the existing monitoring network into a performance monitoring network and a groundwater monitoring network. The performance monitoring network, consisting of monitoring wells MW13S, MW2S, MW9S, and MW3S are to be sampled semi-annually to determine the performance of the slurry wall/grout curtain in the limestone and gravelly clay. When all background data samples in MW6S have been completed, MW6S may also be sampled on a semi-annual basis.

Monitoring wells MW1S, MW4S, MW5S, MW7S, MW8S, MW10S, MW11S, MW12S, MW13S will monitor conditions in the limestone and gravelly clay that may be related to the slurry wall/grout curtain performance via groundwater mounding. Monitoring wells MW1D, MW2D, MW3D, MW4D, MW5D, MW6D, MW7D, MW8D, MW9D, MW10D, MW11D, MW12D, MW13D, MW-14, MW-15, MW-16 and MW-17 will monitor groundwater conditions in the shale for detection monitoring. Due to groundwater mounding centered at the landfill, the proposed background wells (MW7D and MW8D) may not be appropriate for statistical analyses using interwell comparisons. Also in the November 17, 2016 groundwater monitoring report, MW8D is excluded as representing background in the shale per DEQ letter dated July 25, 2014 due to high concentrations of certain constituents.

- AEP-PSO addresses the potential of contaminated groundwater migrating past the ends of the slurry wall/grout curtain as well as other pathways due to groundwater mounding and evaluates other methods of contaminant detection related to performance and detection monitoring.

Please provide a revised groundwater monitoring network that addresses the items in this letter. If you have any questions or comments concerning this letter please contact Ms. Cindy Hailes at (405) 702-5114.

Sincerely,

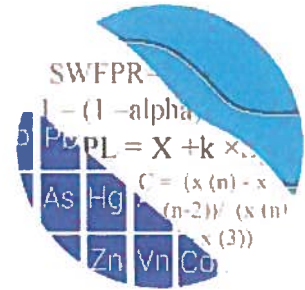


Hillary Young, P.E.
Chief Engineer
Land Protection Division

HY/ckh

ATTACHMENT B
Statistical Analysis Output

GROUNDWATER STATS CONSULTING



March 14, 2018

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

Dear Mr. Sass,

Groundwater Stats Consulting, formerly the statistical consulting division of Sanitas Technologies, is pleased to provide the screening and statistical analysis of background groundwater data for American Electric Power's Northeastern Landfill. 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 Northeastern Landfill for the CCR program in 2016, and 8 background samples have been collected at each of the groundwater monitoring wells. The monitoring well network, as provided by Geosyntec Consultants, consists of the following: background wells MW-7D and MW-8D; and compliance wells MW-3D, MW-6D, MW-9D and MW-15.

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

The following constituents were evaluated: Appendix III parameters – boron, calcium, chloride, fluoride, pH, sulfate, and TDS; and Appendix IV parameters - antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, combined radium 226 & 228, fluoride, lead, lithium, mercury, molybdenum, selenium, and thallium.

Time series plots for Appendix III and IV parameters at all wells are provided for the purpose of screening data at these wells (Figure A). Additionally, box plots are included for all constituents at upgradient and downgradient wells (Figure B). The time series plots are used to initially screen for suspected outliers and trends, while the box plots provide visual representation of variation within individual wells and between all wells.

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

Summary of Statistical Method:

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

Parametric prediction limits are utilized when the screened historical data follow a normal or transformed-normal distribution. When data cannot be normalized or the majority of data are nondetects, a nonparametric test is utilized. The distribution of data is tested using the Shapiro-Wilk/Shapiro-Francia test for normality. While the false positive rate associated with the parametric limits is based on an annual 10% as recommended by the EPA Unified Guidance (2009), the false positive rate associated with the nonparametric limits is dependent upon the available background sample size, number of future comparisons, and verification resample plan. After testing for normality and performing any adjustments as discussed below (US EPA, 2009), data are analyzed using either parametric or non-parametric prediction limits.

- No statistical analyses are required on wells and analytes containing 100% nondetects (USEPA Unified Guidance, 2009, Chapter 6).
- When data contain <15% nondetects in background, simple substitution of one-half the reporting limit is utilized in the statistical analysis. The reporting limit utilized for nondetects is the practical quantification limit (PQL) as reported by the laboratory.
- When data contain between 15-50% nondetects, the Kaplan-Meier nondetect adjustment is applied to the background data. This technique adjusts the mean and standard deviation of the historical concentrations to account for concentrations below the reporting limit.

- Nonparametric prediction limits are used on data containing greater than 50% nondetects.

Background Screening

Outlier Evaluation

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

Tukey's outlier test noted a few outliers that were flagged in the database, and may be seen on the Outlier Data Summary Table. Well MW-7D had observations reported during the 9/20/17 sample event that appeared different from other measurements within the same well; however, these values were not identified as outliers when tested with Tukey's test. If it is determined that these measurements were due to differences in sampling or analytical practices, they may be flagged as outliers in the future. A substitution of the most recent reporting limit was applied when varying detection limits existed in data.

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

While trends may be visual, a quantification of the trend and its significance is needed. The Sen's Slope/Mann Kendall trend test was used to evaluate all data at each well to identify statistically significant increasing or decreasing trends (Figure D). In the absence of suspected contamination, significant trending data are typically not included as part of the background data used for construction of prediction limits. This step serves to eliminate the trend and, thus, reduce variation in background. When statistically significant decreasing trends are present, earlier data are evaluated to determine

whether earlier concentration levels are significantly different than current reported concentrations and will be deselected as necessary. When the historical records of data are truncated for the reasons above, a summary report will be provided to show the date ranges used in construction of the statistical limits.

The results of the trend analyses showed several statistically significant increasing trends, primarily in background wells; and a few statistically significant decreasing trends, as may be seen on the Trend Test Summary table. No adjustments were made to the datasets at this time, since the majority of trends were noted in background wells and limited data are available at this time. Trends noted in background wells are generally an indication that concentrations are changing due to natural variation. However, as more data are collected, if it is determined that earlier measurements are no longer representative of present-day water quality, the records will be re-evaluated for possible truncation of earlier concentrations.

Appendix III – Determination of Spatial Variation

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

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

Appendix III - Statistical Limits

Intrawell limits constructed from carefully screened background data from within each well serve to provide statistical limits that are conservative (i.e. lower) from a regulatory perspective, and that will rapidly identify a change in more recent compliance data from within a given well. This statistical method removes the element of variation across wells and eliminates the chance of mistaking natural spatial variation for a release from

the facility. Prior to performing intrawell prediction limits, several steps are required to reasonably demonstrate downgradient water quality does not have existing impacts from the practices of the facility.

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

In cases where downgradient average concentrations are higher than observed concentrations upgradient for a given constituent, an independent study and hydrogeological investigation are required to identify local geochemical conditions and expected groundwater quality for the region to justify an intrawell approach. Such an assessment is beyond the scope of services provided by Groundwater Stats Consulting. However, further discussion is included below regarding the use of intrawell prediction limits.

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

Confidence intervals were constructed on downgradient wells for each of the Appendix III parameters, using the tolerance limits discussed above, to determine intrawell eligibility (Figure G). When the entire confidence interval is above a background standard for a given parameter, interwell methods are initially recommended as the statistical method. Therefore, only parameters with confidence intervals which did not exceed background standards are eligible for intrawell prediction limits.

Confidence intervals for the above parameters were found to be within their respective background limits for all parameters except for boron. However, previous correspondence between Oklahoma Department of Environmental Quality and AEP demonstrates that due to natural variation in groundwater as well as changes in direction of groundwater flow, the background wells are not representative of upgradient groundwater quality in which case interwell statistical limits are not

recommended. Therefore, all Appendix III parameters are evaluated using intrawell methods.

All available data through November 2017 at each well were used to establish intrawell background limits based on a 1-of-2 resample plan that will be used for future comparisons of compliance measurements during each subsequent semi-annual sampling event (Figure H).

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

In the event of an initial exceedance of compliance well data, the 1-of-2 resample plan allows for collection of one additional sample to determine whether the initial exceedance is confirmed. If the resample falls within the statistical limit, the initial exceedance is considered to be a false positive result and, therefore, no further action is necessary. A summary table of the background prediction limits follows this letter.

Appendix IV – Assessment Monitoring Program

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

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

Recommendations

In summary, as a result of the background screening described in this letter, intrawell prediction limits combined with a 1-of-2 resample plan are recommended for all Appendix III parameters. The statistical analyses will be constructed according to the USEPA Unified Guidance, based on 7 Appendix III parameters and 4 downgradient wells.

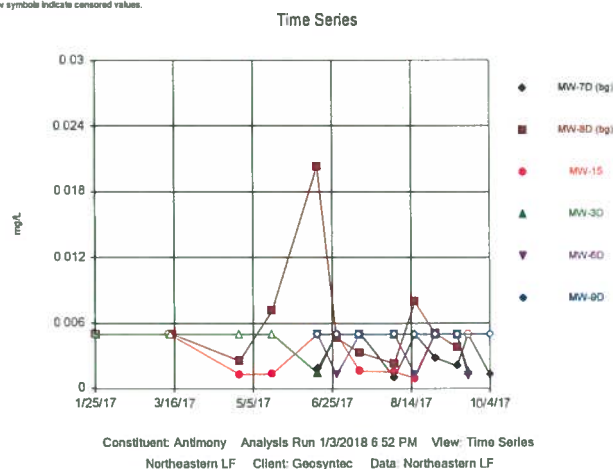
Thank you for the opportunity to assist you in the statistical analysis of groundwater quality for the Northeastern Landfill. If you have any questions or comments, please feel free to contact me.

For Groundwater Stats Consulting,

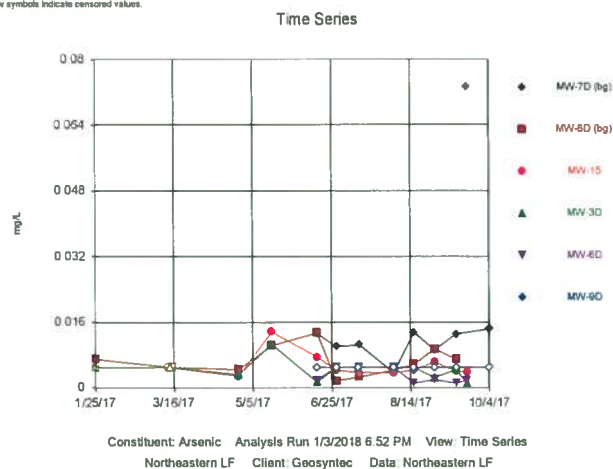
A handwritten signature in cursive script that reads "Kristina Rayner".

Kristina L. Rayner
Groundwater Statistician

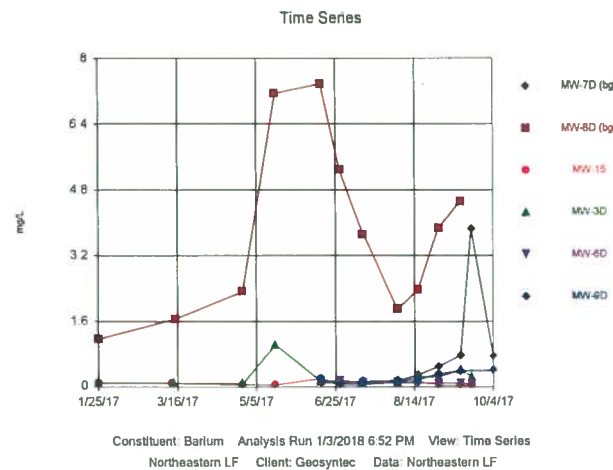
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Hollow symbols indicate censored values.



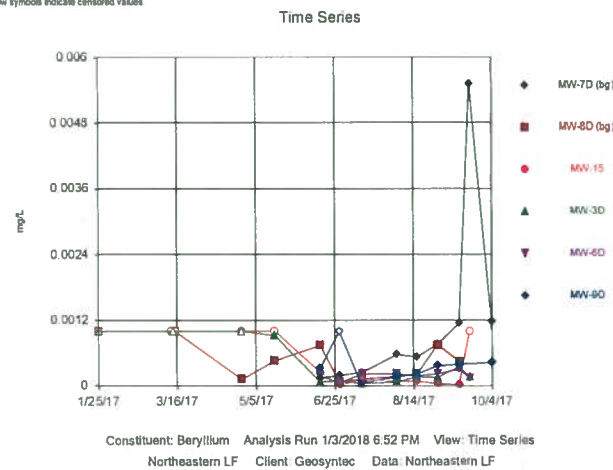
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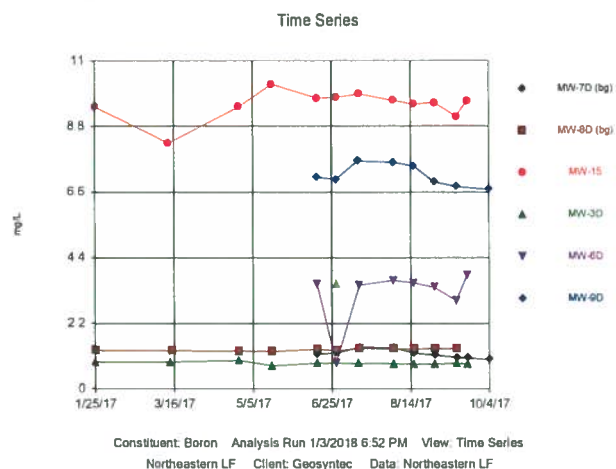
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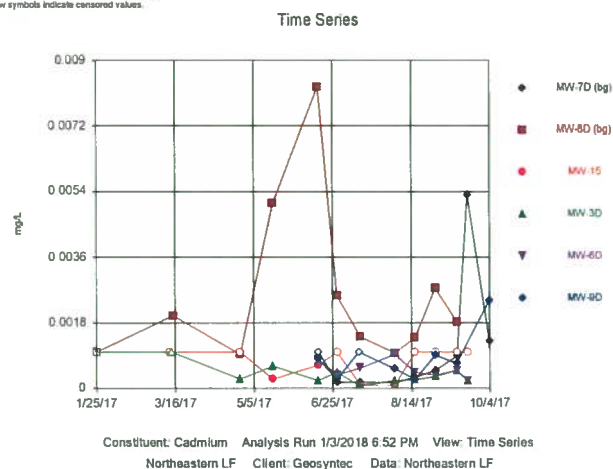
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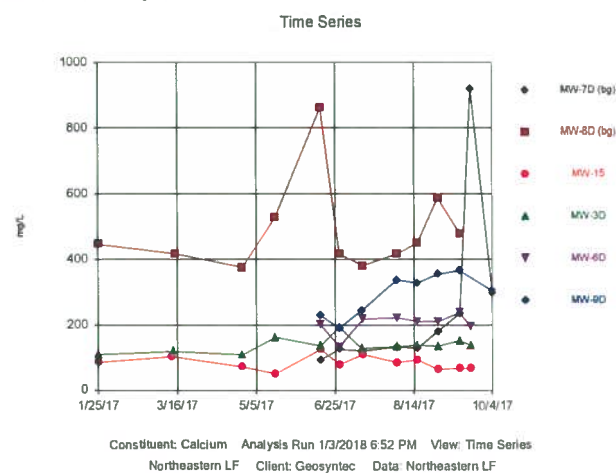
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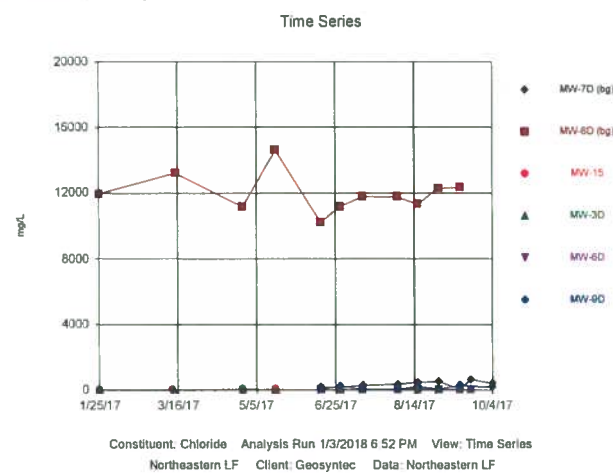
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Hollow symbols indicate censored values.



Series 1 = 9.00 Groundwater Data Consulting, UG

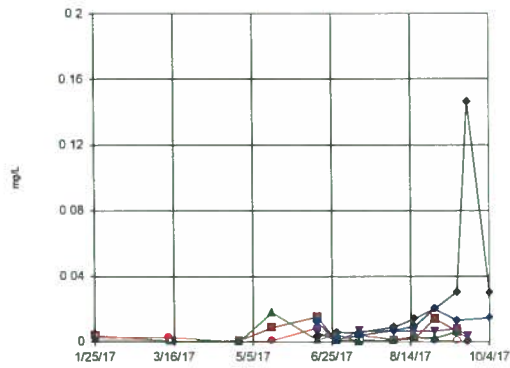


Series 1 = 9.00 Groundwater Data Consulting, UG



Sentia™ v 9.0.0 Groundwater Data Consulting UG
Hollow symbols indicate censored values.

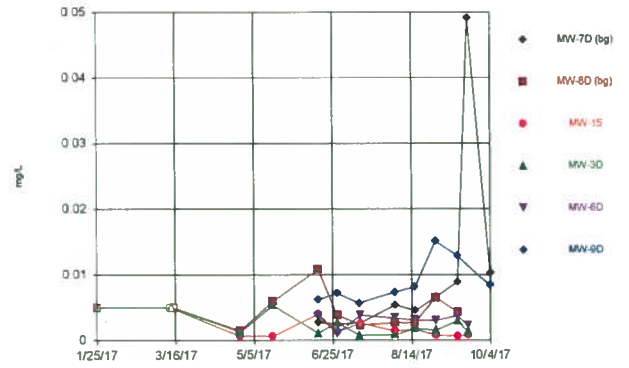
Time Series



Constituent: Chromium Analysis Run 1/3/2018 6:52 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Sentia™ v 9.0.0 Groundwater Data Consulting UG
Hollow symbols indicate censored values.

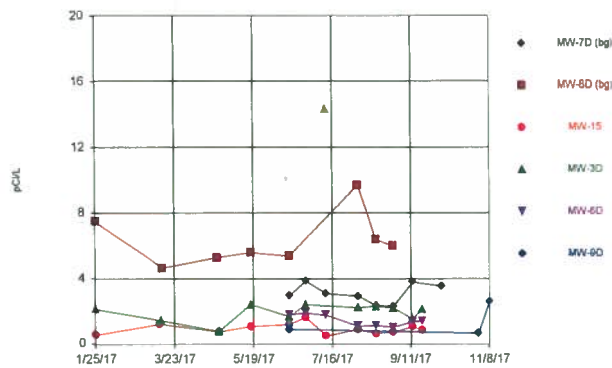
Time Series



Constituent: Cobalt Analysis Run 1/3/2018 6:52 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Sentia™ v 9.0.0 Groundwater Data Consulting UG

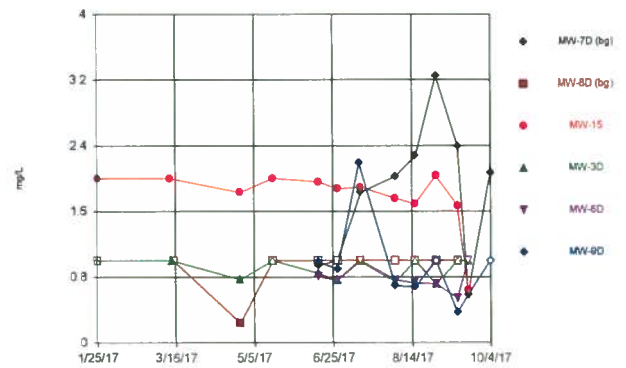
Time Series



Constituent: Combined Radium 226 + 228 Analysis Run 1/3/2018 6:52 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Sentia™ v 9.0.0 Groundwater Data Consulting UG
Hollow symbols indicate censored values.

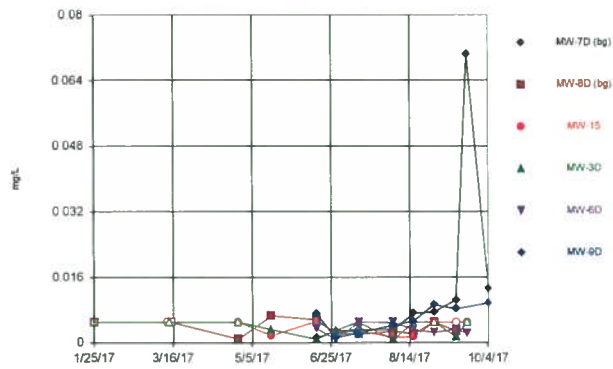
Time Series



Constituent: Fluoride Analysis Run 1/3/2018 6:52 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series 1 - 9.00 Groundwater Data Consulting US
Hollow symbols indicate censored values.

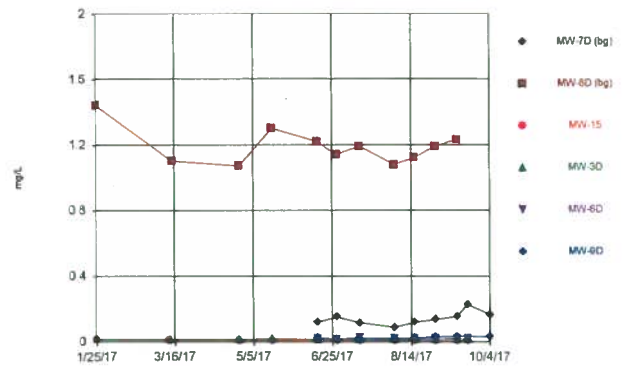
Time Series



Constituent: Lead Analysis Run 1/3/2018 6:52 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series 1 - 9.00 Groundwater Data Consulting US

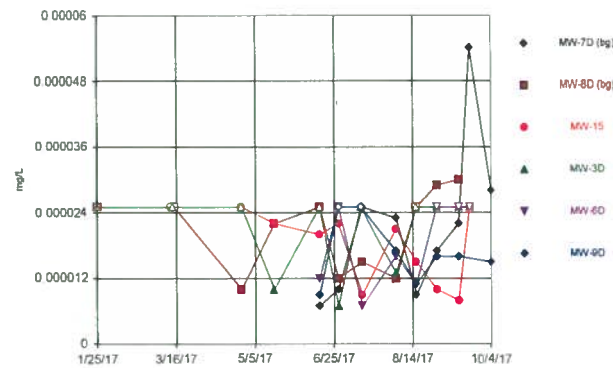
Time Series



Constituent: Lithium Analysis Run 1/3/2018 6:52 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series 1 - 9.00 Groundwater Data Consulting US
Hollow symbols indicate censored values.

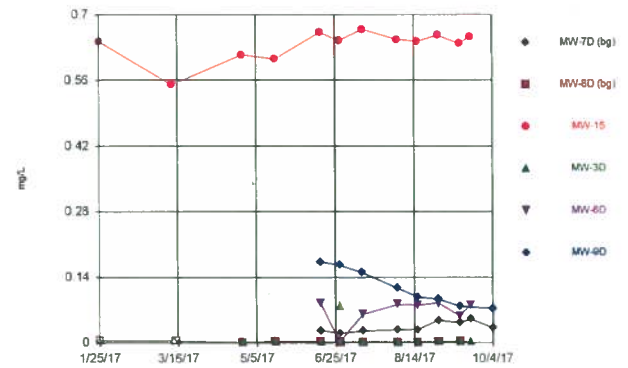
Time Series



Constituent: Mercury Analysis Run 1/3/2018 6:52 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

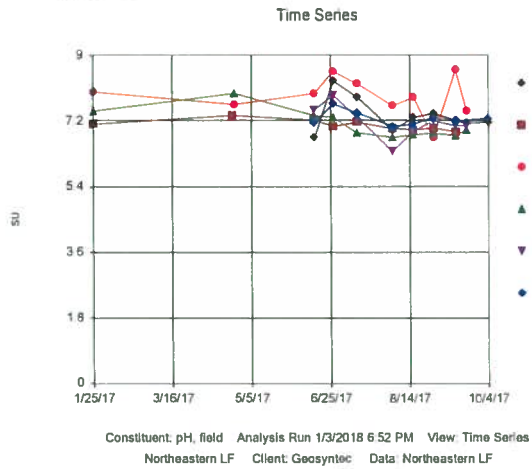
Series 1 - 9.00 Groundwater Data Consulting US
Hollow symbols indicate censored values.

Time Series

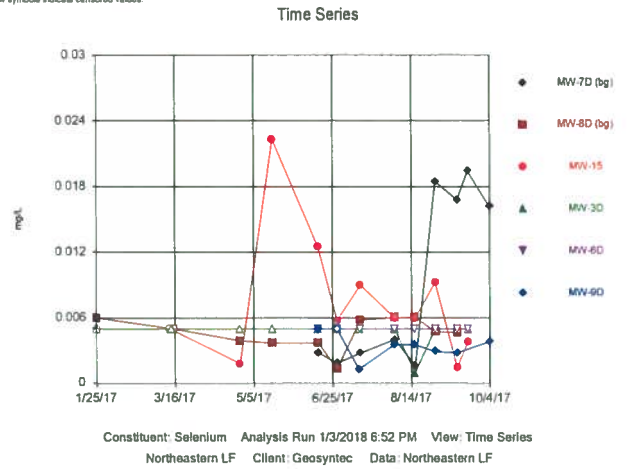


Constituent: Molybdenum Analysis Run 1/3/2018 6:52 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

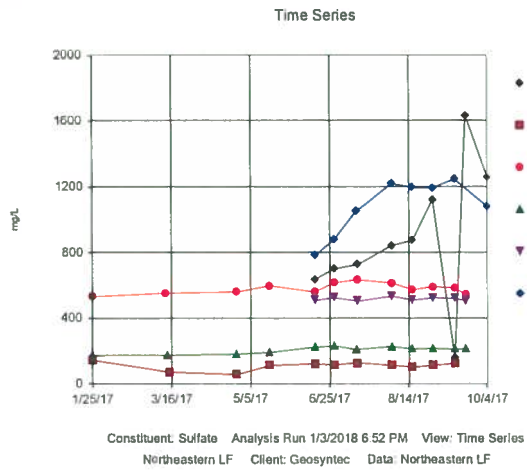
Series 1 ~ 9.00 Groundwater Data Controlling UG



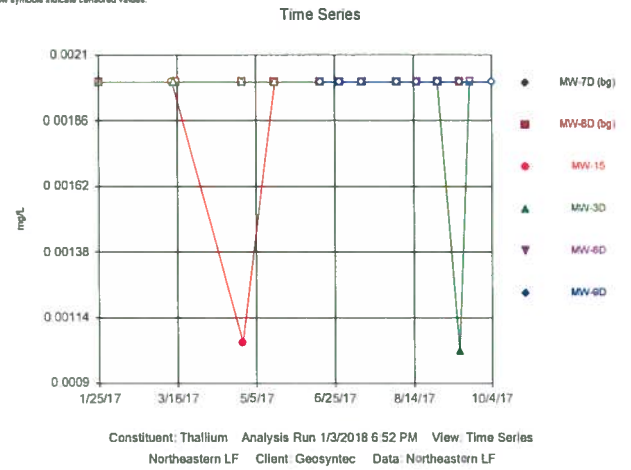
Series 1 ~ 9.00 Groundwater Data Controlling UG
Hollow symbols indicate censored values.

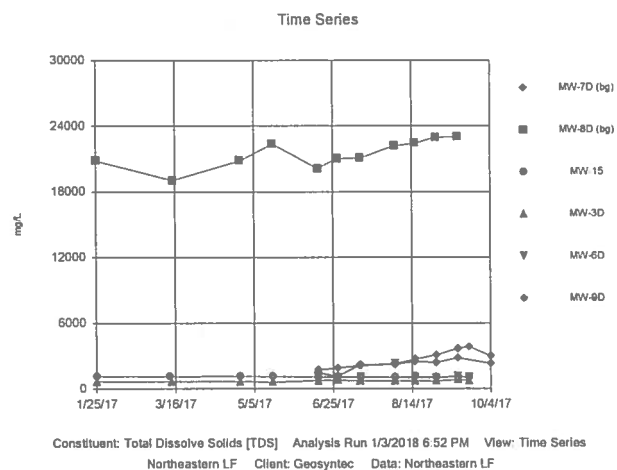


Series 1 ~ 9.00 Groundwater Data Controlling UG

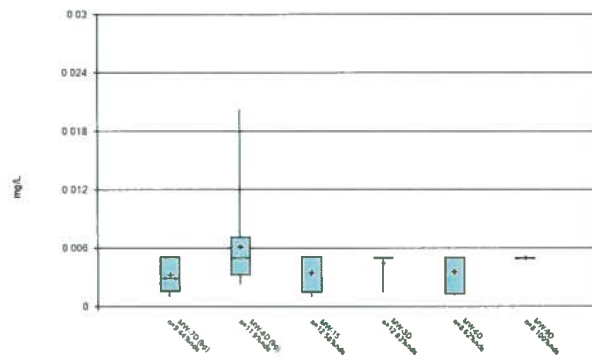


Series 1 ~ 9.00 Groundwater Data Controlling UG
Hollow symbols indicate censored values.



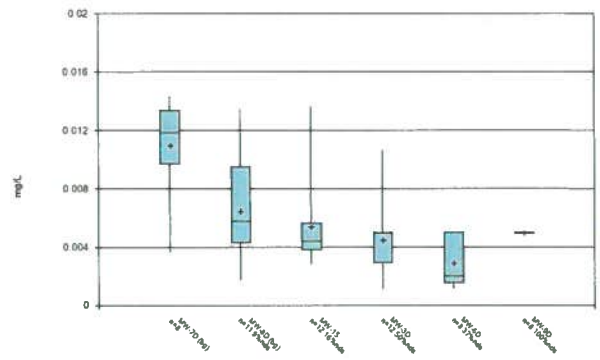


Box & Whiskers Plot



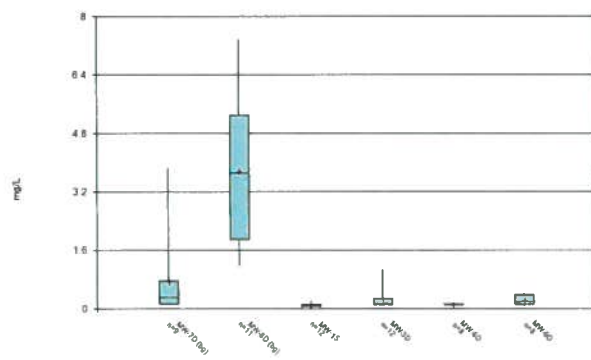
Constituent: Antimony Analysis Run 1/3/2018 9:01 PM View: Time Series
 Northeastern LF Client: Geosyntec Data: Northeastern LF

Box & Whiskers Plot



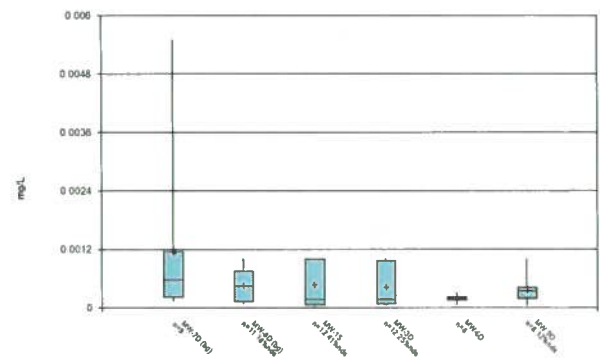
Constituent: Arsenic Analysis Run 1/3/2018 9:01 PM View: Time Series
 Northeastern LF Client: Geosyntec Data: Northeastern LF

Box & Whiskers Plot



Constituent: Barium Analysis Run 1/3/2018 9:01 PM View: Time Series
 Northeastern LF Client: Geosyntec Data: Northeastern LF

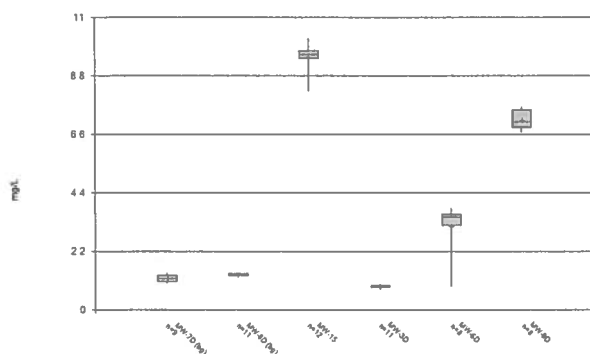
Box & Whiskers Plot



Constituent: Beryllium Analysis Run 1/3/2018 9:01 PM View: Time Series
 Northeastern LF Client: Geosyntec Data: Northeastern LF

Section 1 - 9.8.00 Groundwater Data Consulting US

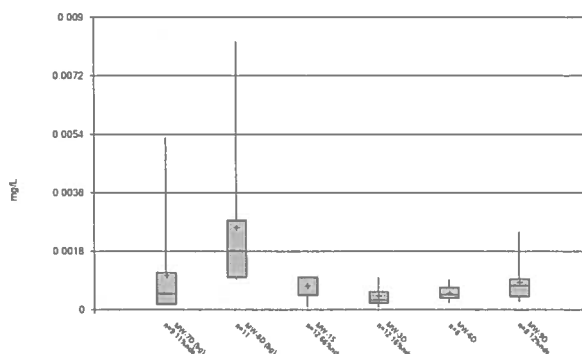
Box & Whiskers Plot



Constituent: Boron Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Section 1 - 9.8.00 Groundwater Data Consulting US

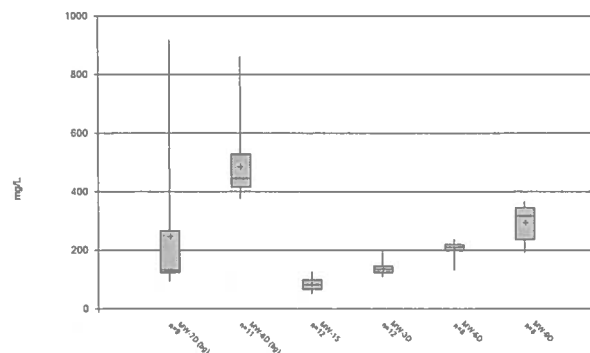
Box & Whiskers Plot



Constituent: Cadmium Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Section 1 - 9.8.00 Groundwater Data Consulting US

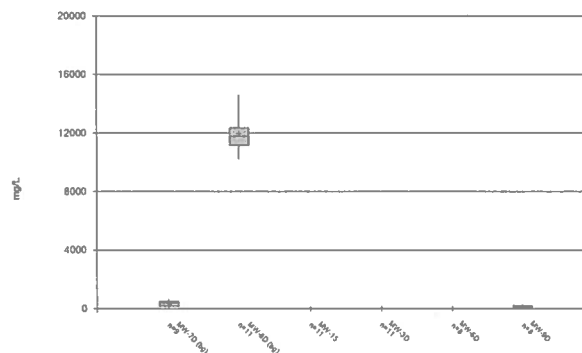
Box & Whiskers Plot



Constituent: Calcium Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Section 1 - 9.8.00 Groundwater Data Consulting US

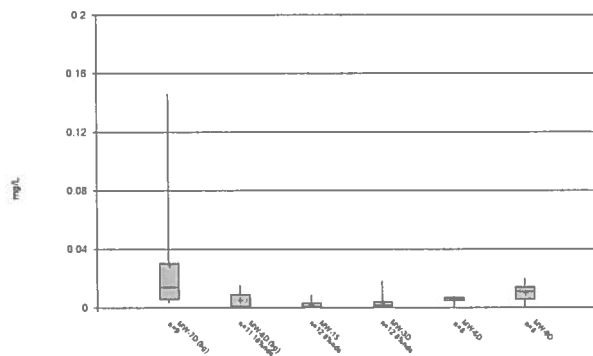
Box & Whiskers Plot



Constituent: Chloride Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series 1 ~ 9:00 Groundwater Data Consulting UG

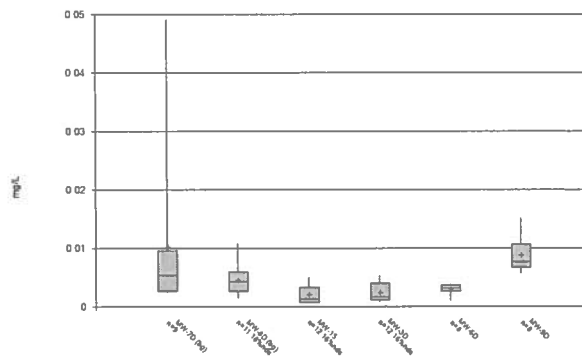
Box & Whiskers Plot



Constituent: Chromium Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series 1 ~ 9:00 Groundwater Data Consulting UG

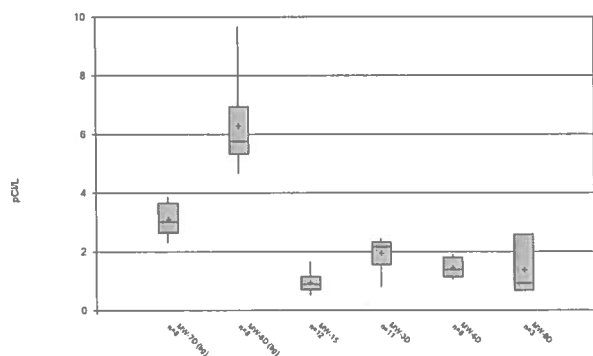
Box & Whiskers Plot



Constituent: Cobalt Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series 1 ~ 9:00 Groundwater Data Consulting UG

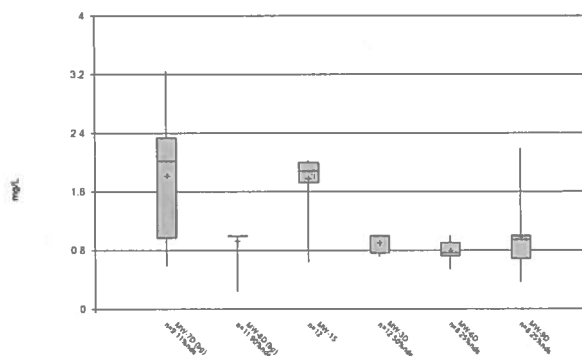
Box & Whiskers Plot



Constituent: Combined Radium 226 + 228 Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series 1 ~ 9:00 Groundwater Data Consulting UG

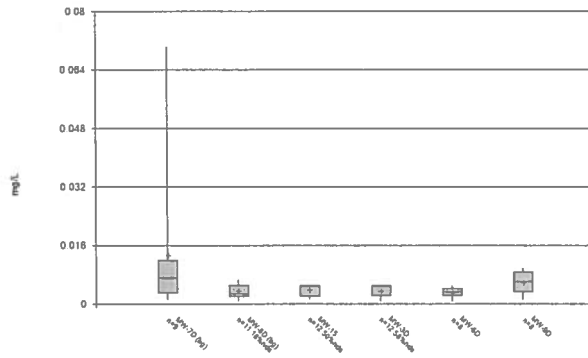
Box & Whiskers Plot



Constituent: Fluoride Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series 1 - 8.00 Groundwater Data Consulting, US

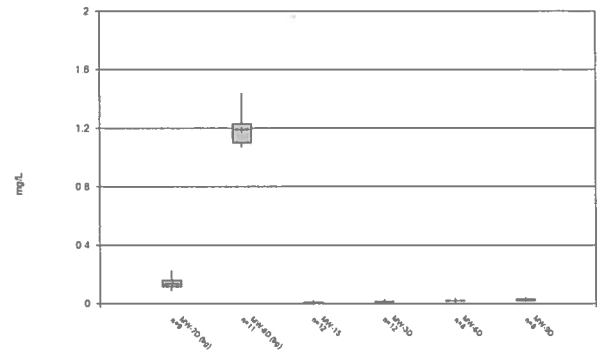
Box & Whiskers Plot



Constituent: Lead Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series 1 - 8.00 Groundwater Data Consulting, US

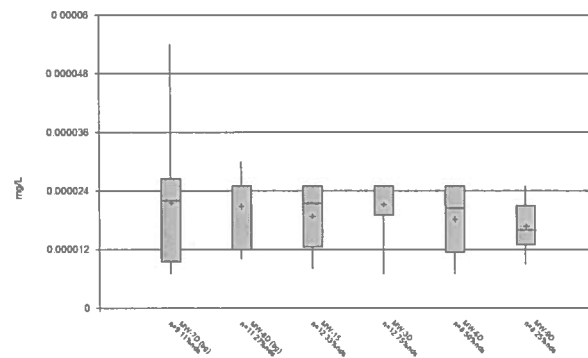
Box & Whiskers Plot



Constituent: Lithium Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series 1 - 8.00 Groundwater Data Consulting, US

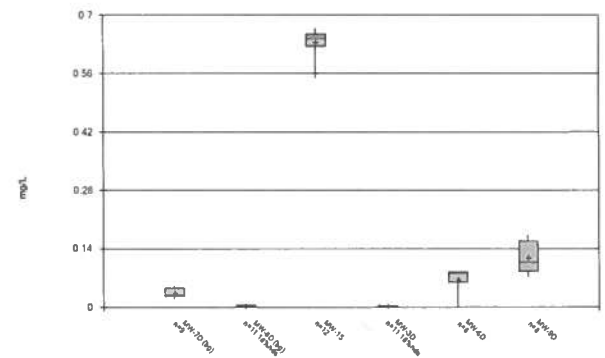
Box & Whiskers Plot



Constituent: Mercury Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series 1 - 8.00 Groundwater Data Consulting, US

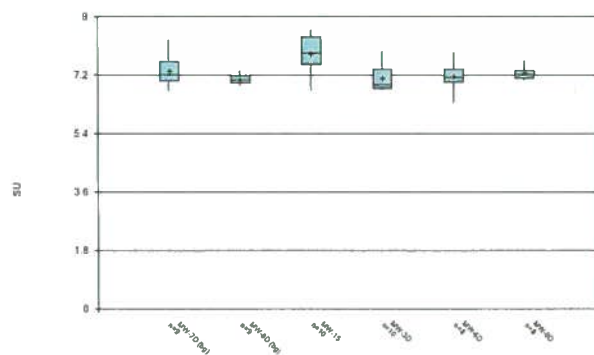
Box & Whiskers Plot



Constituent: Molybdenum Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Sentinel™ v 9.6.00 Groundwater Data Consulting UG

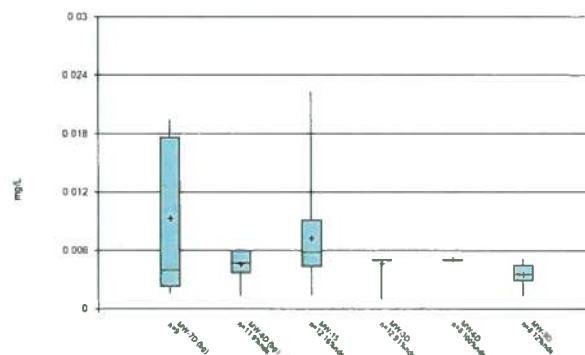
Box & Whiskers Plot



Constituent: pH, field Analysis Run 1/3/2018 9:01 PM View Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Sentinel™ v 9.6.00 Groundwater Data Consulting UG

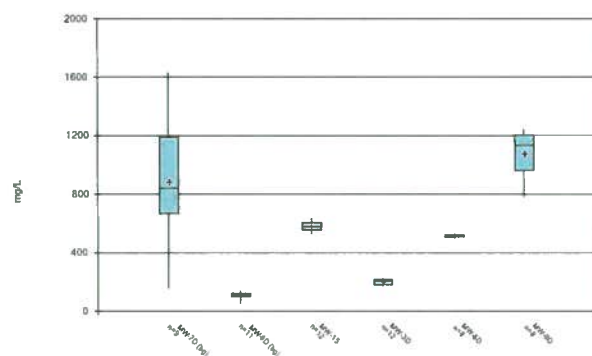
Box & Whiskers Plot



Constituent: Selenium Analysis Run 1/3/2018 9:01 PM View Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Sentinel™ v 9.6.00 Groundwater Data Consulting UG

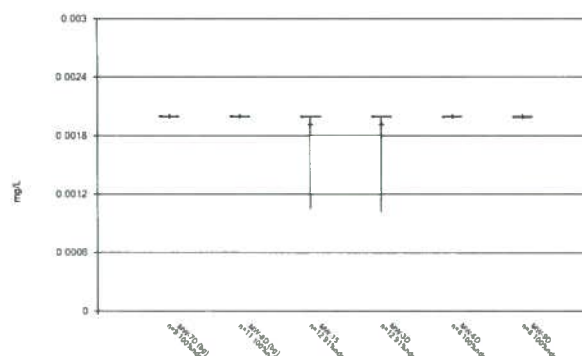
Box & Whiskers Plot



Constituent: Sulfate Analysis Run 1/3/2018 9:01 PM View Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

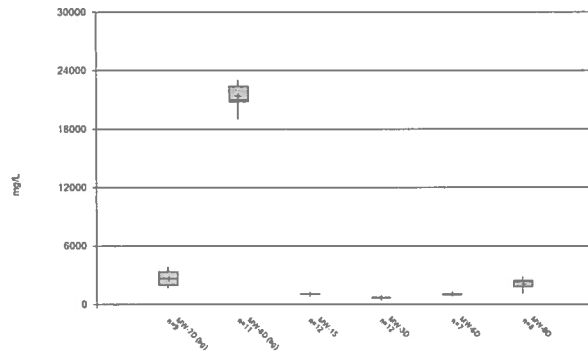
Sentinel™ v 9.6.00 Groundwater Data Consulting UG

Box & Whiskers Plot



Constituent: Thallium Analysis Run 1/3/2018 9:01 PM View Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Box & Whiskers Plot



Constituent: Total Dissolve Solids [TDS] Analysis Run 1/3/2018 9:01 PM View: Time Series
Northeastern LF Client: Geosyntec Data: Northeastern LF

Outlier Summary Table

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/3/2018, 6:49 PM

| | MW-7D Arsenic (mg/L) | MW-3D Boron (mg/L) | MW-15 Chloride (mg/L) | MW-3D Chloride (mg/L) | MW-3D Combined Radium 226 + 228 (pCi/L) | MW-3D Molybdenum (mg/L) | MW-6D Total Dissolve Solids [TDS] (mg/L) |
|-----------|----------------------|--------------------|-----------------------|-----------------------|---|-------------------------|--|
| 5/18/2017 | | | 111 (o) | | | | |
| 6/28/2017 | | 3.52 (o) | | | 0.07928 (o) | | |
| 7/12/2017 | | | | 14.283 (o) | | | |
| 8/4/2017 | | | | | | | 2320 (o) |
| 8/17/2017 | | | 23 (o) | | | | |
| 9/20/2017 | 0.07314 (o) | | | | | | |

Outlier Analysis - Upgradient Wells

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/2/2018, 10 14 PM

| Constituent | Well | Outlier | Value(s) | Method | N | Mean | Std. Dev. | Distribution | Normality Test |
|------------------------------------|-------------|---------|----------|----------|----|------------|------------|--------------|----------------|
| Antimony (mg/L) | MW-7D,MW-8D | No | n/a | NP | 20 | 0.00481 | 0.004077 | In(x) | ShapiroWilk |
| Arsenic (mg/L) | MW-7D,MW-8D | No | n/a | NP | 20 | 0.01161 | 0.01501 | In(x) | ShapiroWilk |
| Barium (mg/L) | MW-7D,MW-8D | No | n/a | NP | 20 | 2.401 | 2.318 | x^(1/3) | ShapiroWilk |
| Beryllium (mg/L) | MW-7D,MW-8D | No | n/a | NP | 20 | 0.000769 | 0.001171 | In(x) | ShapiroWilk |
| Boron (mg/L) | MW-7D,MW-8D | No | n/a | NP (nrm) | 20 | 1.261 | 0.1194 | unknown | ShapiroWilk |
| Cadmium (mg/L) | MW-7D,MW-8D | No | n/a | NP | 20 | 0.001896 | 0.002079 | In(x) | ShapiroWilk |
| Calcium (mg/L) | MW-7D,MW-8D | No | n/a | NP | 20 | 379.7 | 230.8 | x^(1/3) | ShapiroWilk |
| Chloride (mg/L) | MW-7D,MW-8D | No | n/a | NP (nrm) | 20 | 6752 | 5998 | unknown | ShapiroWilk |
| Chromium (mg/L) | MW-7D,MW-8D | No | n/a | NP | 20 | 0.01608 | 0.03191 | In(x) | ShapiroWilk |
| Cobalt (mg/L) | MW-7D,MW-8D | No | n/a | NP | 20 | 0.007158 | 0.01021 | In(x) | ShapiroWilk |
| Combined Radium 226 + 228 (pCi/L) | MW-7D,MW-8D | No | n/a | NP | 16 | 4.705 | 2.021 | In(x) | ShapiroWilk |
| Fluoride (mg/L) | MW-7D,MW-8D | No | n/a | NP (nrm) | 20 | 1.33 | 0.7279 | unknown | ShapiroWilk |
| Lead (mg/L) | MW-7D,MW-8D | No | n/a | NP | 20 | 0.007991 | 0.015 | In(x) | ShapiroWilk |
| Lithium (mg/L) | MW-7D,MW-8D | No | n/a | NP (nrm) | 20 | 0.7175 | 0.5414 | unknown | ShapiroWilk |
| Mercury (mg/L) | MW-7D,MW-8D | No | n/a | NP | 20 | 0.00002125 | 0.00001067 | In(x) | ShapiroWilk |
| Molybdenum (mg/L) | MW-7D,MW-8D | No | n/a | NP (nrm) | 20 | 0.01682 | 0.01741 | unknown | ShapiroWilk |
| pH, field (SU) | MW-7D,MW-8D | No | n/a | NP | 18 | 7.198 | 0.3633 | In(x) | ShapiroWilk |
| Selenium (mg/L) | MW-7D,MW-8D | No | n/a | NP | 20 | 0.006742 | 0.005823 | In(x) | ShapiroWilk |
| Sulfate (mg/L) | MW-7D,MW-8D | No | n/a | NP (nrm) | 20 | 457 | 479.2 | unknown | ShapiroWilk |
| Thallium (mg/L) | MW-7D,MW-8D | No | n/a | NP (nrm) | 20 | 0.002 | 0 | unknown | ShapiroWilk |
| Total Dissolve Solids (TDS) (mg/L) | MW-7D,MW-8D | No | n/a | NP (nrm) | 20 | 12998 | 9623 | unknown | ShapiroWilk |

Outlier Analysis - Significant Results Individual Upgradient Wells

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/3/2018, 6:04 PM

| <u>Constituent</u> | <u>Well</u> | <u>Outlier</u> | <u>Value(s)</u> | <u>Method</u> | <u>N</u> | <u>Mean</u> | <u>Std. Dev.</u> | <u>Distribution</u> | <u>Normality Test</u> |
|--------------------|-------------|----------------|-----------------|---------------|----------|-------------|------------------|---------------------|-----------------------|
| Arsenic (mg/L) | MW-7D (bg) | Yes | 0.07314 | NP | 9 | 0.01788 | 0.02098 | In(x) | ShapiroWilk |

Outlier Analysis - Significant Downgradient Wells

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/2/2018, 10:20 PM

| <u>Constituent</u> | <u>Well</u> | <u>Outlier</u> | <u>Value(s)</u> | <u>Method</u> | <u>N</u> | <u>Mean</u> | <u>Std. Dev.</u> | <u>Distribution</u> | <u>Normality Test</u> |
|------------------------------------|-------------|----------------|-----------------|---------------|----------|-------------|------------------|---------------------|-----------------------|
| Boron (mg/L) | MW-3D | Yes | 3.52 | NP | 12 | 1.093 | 0.7657 | In(x) | ShapiroWilk |
| Chloride (mg/L) | MW-15 | Yes | 111 | NP | 12 | 32.25 | 30.12 | In(x) | ShapiroWilk |
| Chloride (mg/L) | MW-3D | Yes | 23 | NP | 12 | 13.58 | 3.288 | In(x) | ShapiroWilk |
| Combined Radium 226 + 228 (pCi/L) | MW-3D | Yes | 14.28 | NP | 12 | 2.982 | 3.592 | In(x) | ShapiroWilk |
| Molybdenum (mg/L) | MW-3D | Yes | 0.07928 | NP | 12 | 0.0097 | 0.02193 | In(x) | ShapiroWilk |
| Total Dissolve Solids [TDS] (mg/L) | MW-6D | Yes | 2320 | NP | 8 | 1199 | 455.3 | In(x) | ShapiroWilk |

Outlier Analysis - All Downgradient Wells

Northeastern LF Client Geosyntec Data Northeastern LF Printed 1/2/2018, 10:20 PM

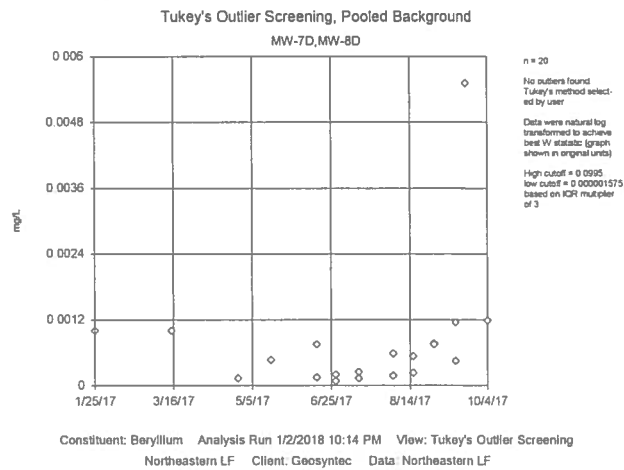
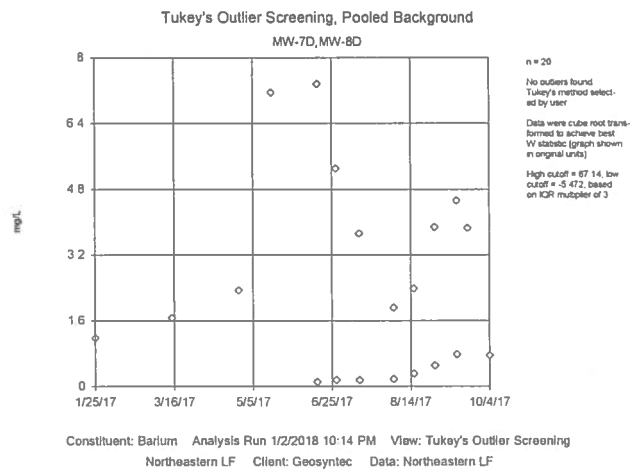
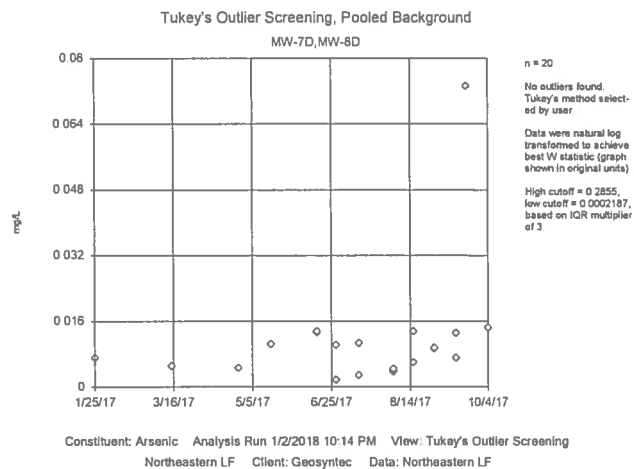
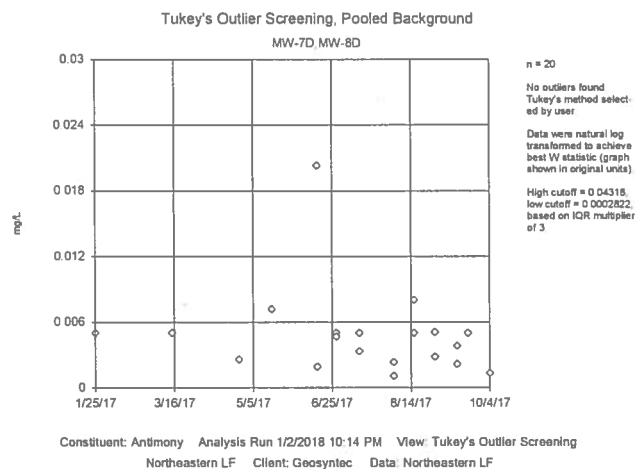
| Constituent | Well | Outlier | Value(s) | Method | N | Mean | Std. Dev. | Distribution | Normality Test |
|-----------------------------------|-------|---------|----------|----------|----|-----------|------------|--------------|----------------|
| Antimony (mg/L) | MW-15 | No | n/a | NP (nrm) | 12 | 0.003489 | 0.001873 | unknown | ShapiroWilk |
| Antimony (mg/L) | MW-3D | No | n/a | NP (nrm) | 12 | 0.004422 | 0.001349 | unknown | ShapiroWilk |
| Antimony (mg/L) | MW-6D | No | n/a | NP (nrm) | 8 | 0.00359 | 0.001946 | unknown | ShapiroWilk |
| Antimony (mg/L) | MW-9D | No | n/a | NP (nrm) | 8 | 0.005 | 0 | unknown | ShapiroWilk |
| Arsenic (mg/L) | MW-15 | No | n/a | NP | 12 | 0.005394 | 0.002875 | ln(x) | ShapiroWilk |
| Arsenic (mg/L) | MW-3D | No | n/a | NP (nrm) | 12 | 0.004473 | 0.002424 | unknown | ShapiroWilk |
| Arsenic (mg/L) | MW-6D | No | n/a | NP | 8 | 0.002919 | 0.001756 | ln(x) | ShapiroWilk |
| Arsenic (mg/L) | MW-9D | No | n/a | NP (nrm) | 8 | 0.005 | 0 | unknown | ShapiroWilk |
| Barium (mg/L) | MW-15 | No | n/a | NP | 12 | 0.09759 | 0.0489 | ln(x) | ShapiroWilk |
| Barium (mg/L) | MW-3D | No | n/a | NP | 12 | 0.2538 | 0.2682 | ln(x) | ShapiroWilk |
| Barium (mg/L) | MW-6D | No | n/a | NP | 8 | 0.1131 | 0.02738 | ln(x) | ShapiroWilk |
| Barium (mg/L) | MW-9D | No | n/a | NP | 8 | 0.222 | 0.1398 | x^(1/3) | ShapiroWilk |
| Beryllium (mg/L) | MW-15 | No | n/a | NP (nrm) | 12 | 0.0004692 | 0.0004722 | unknown | ShapiroWilk |
| Beryllium (mg/L) | MW-3D | No | n/a | NP | 12 | 0.0004217 | 0.00042 | ln(x) | ShapiroWilk |
| Beryllium (mg/L) | MW-6D | No | n/a | NP | 8 | 0.0001925 | 0.00007226 | normal | ShapiroWilk |
| Beryllium (mg/L) | MW-9D | No | n/a | NP | 8 | 0.00037 | 0.0002851 | x^(1/3) | ShapiroWilk |
| Boron (mg/L) | MW-15 | No | n/a | NP | 12 | 9.52 | 0.482 | x^6 | ShapiroWilk |
| Boron (mg/L) | MW-3D | Yes | 3.52 | NP | 12 | 1.093 | 0.7657 | ln(x) | ShapiroWilk |
| Boron (mg/L) | MW-6D | No | n/a | NP | 8 | 3.156 | 0.9525 | x^6 | ShapiroWilk |
| Boron (mg/L) | MW-9D | No | n/a | NP | 8 | 7.146 | 0.3683 | ln(x) | ShapiroWilk |
| Cadmium (mg/L) | MW-15 | No | n/a | NP (nrm) | 12 | 0.0007567 | 0.0003841 | unknown | ShapiroWilk |
| Cadmium (mg/L) | MW-3D | No | n/a | NP | 12 | 0.000425 | 0.0003052 | ln(x) | ShapiroWilk |
| Cadmium (mg/L) | MW-6D | No | n/a | NP | 8 | 0.0005213 | 0.0002371 | ln(x) | ShapiroWilk |
| Cadmium (mg/L) | MW-9D | No | n/a | NP | 8 | 0.0008563 | 0.0006827 | ln(x) | ShapiroWilk |
| Calcium (mg/L) | MW-15 | No | n/a | NP | 12 | 84.28 | 21.28 | ln(x) | ShapiroWilk |
| Calcium (mg/L) | MW-3D | No | n/a | NP | 12 | 138.7 | 23.13 | ln(x) | ShapiroWilk |
| Calcium (mg/L) | MW-6D | No | n/a | NP | 8 | 203.5 | 31.18 | x^6 | ShapiroWilk |
| Calcium (mg/L) | MW-9D | No | n/a | NP | 8 | 294.1 | 64.61 | x^4 | ShapiroWilk |
| Chloride (mg/L) | MW-15 | Yes | 111 | NP | 12 | 32.25 | 30.12 | ln(x) | ShapiroWilk |
| Chloride (mg/L) | MW-3D | Yes | 23 | NP | 12 | 13.58 | 3.288 | ln(x) | ShapiroWilk |
| Chloride (mg/L) | MW-6D | No | n/a | NP | 8 | 30.25 | 1.389 | sqrt(x) | ShapiroWilk |
| Chloride (mg/L) | MW-9D | No | n/a | NP | 8 | 155.4 | 86.93 | sqrt(x) | ShapiroWilk |
| Chromium (mg/L) | MW-15 | No | n/a | NP | 12 | 0.002373 | 0.002321 | x^(1/3) | ShapiroWilk |
| Chromium (mg/L) | MW-3D | No | n/a | NP | 12 | 0.0036 | 0.004898 | ln(x) | ShapiroWilk |
| Chromium (mg/L) | MW-6D | No | n/a | NP | 8 | 0.005719 | 0.002302 | x^3 | ShapiroWilk |
| Chromium (mg/L) | MW-9D | No | n/a | NP | 8 | 0.01027 | 0.00617 | normal | ShapiroWilk |
| Cobalt (mg/L) | MW-15 | No | n/a | NP | 12 | 0.002037 | 0.001699 | ln(x) | ShapiroWilk |
| Cobalt (mg/L) | MW-3D | No | n/a | NP | 12 | 0.002484 | 0.001713 | ln(x) | ShapiroWilk |
| Cobalt (mg/L) | MW-6D | No | n/a | NP | 8 | 0.003014 | 0.0009294 | x^4 | ShapiroWilk |
| Cobalt (mg/L) | MW-9D | No | n/a | NP | 8 | 0.008858 | 0.003339 | ln(x) | ShapiroWilk |
| Combined Radium 226 + 228 (pCi/L) | MW-15 | No | n/a | NP | 12 | 0.9451 | 0.3271 | ln(x) | ShapiroWilk |
| Combined Radium 226 + 228 (pCi/L) | MW-3D | Yes | 14.28 | NP | 12 | 2.982 | 3.592 | ln(x) | ShapiroWilk |
| Combined Radium 226 + 228 (pCi/L) | MW-6D | No | n/a | NP | 8 | 1.457 | 0.3437 | ln(x) | ShapiroWilk |
| Fluoride (mg/L) | MW-15 | No | n/a | NP | 12 | 1.779 | 0.3789 | x^6 | ShapiroWilk |
| Fluoride (mg/L) | MW-3D | No | n/a | NP (nrm) | 12 | 0.9024 | 0.1244 | unknown | ShapiroWilk |
| Fluoride (mg/L) | MW-6D | No | n/a | NP | 8 | 0.7895 | 0.1518 | x^(1/3) | ShapiroWilk |
| Fluoride (mg/L) | MW-9D | No | n/a | NP | 8 | 0.9776 | 0.5368 | ln(x) | ShapiroWilk |
| Lead (mg/L) | MW-15 | No | n/a | NP (nrm) | 12 | 0.003753 | 0.001635 | unknown | ShapiroWilk |
| Lead (mg/L) | MW-3D | No | n/a | NP (nrm) | 12 | 0.003701 | 0.001753 | unknown | ShapiroWilk |
| Lead (mg/L) | MW-6D | No | n/a | NP | 8 | 0.003195 | 0.001395 | normal | ShapiroWilk |
| Lead (mg/L) | MW-9D | No | n/a | NP | 8 | 0.005931 | 0.00316 | normal | ShapiroWilk |
| Lithium (mg/L) | MW-15 | No | n/a | NP | 12 | 0.008383 | 0.001941 | ln(x) | ShapiroWilk |
| Lithium (mg/L) | MW-3D | No | n/a | NP | 12 | 0.01577 | 0.001757 | ln(x) | ShapiroWilk |
| Lithium (mg/L) | MW-6D | No | n/a | NP | 8 | 0.01911 | 0.00291 | x^3 | ShapiroWilk |
| Lithium (mg/L) | MW-9D | No | n/a | NP | 8 | 0.02532 | 0.005668 | sqrt(x) | ShapiroWilk |

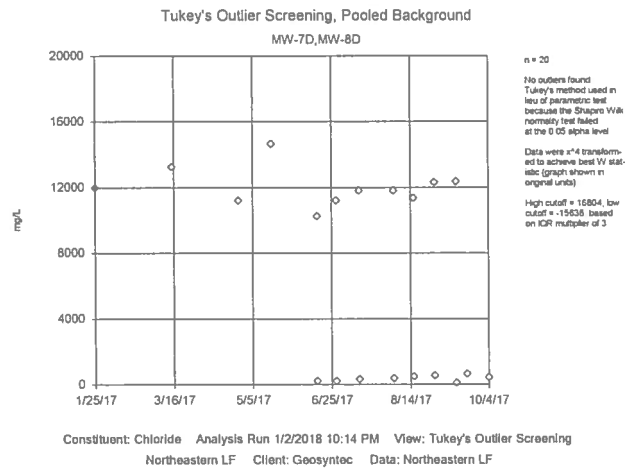
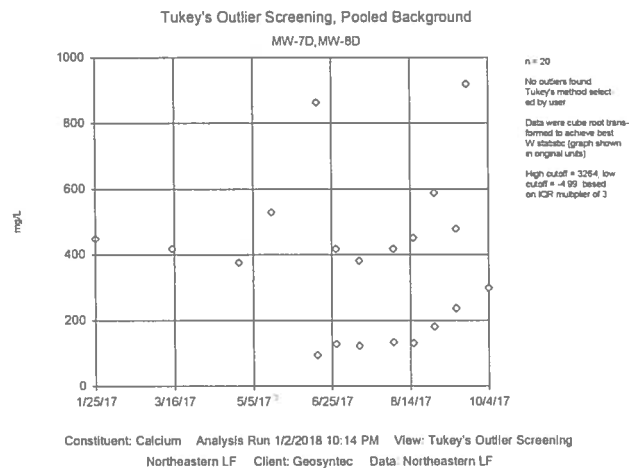
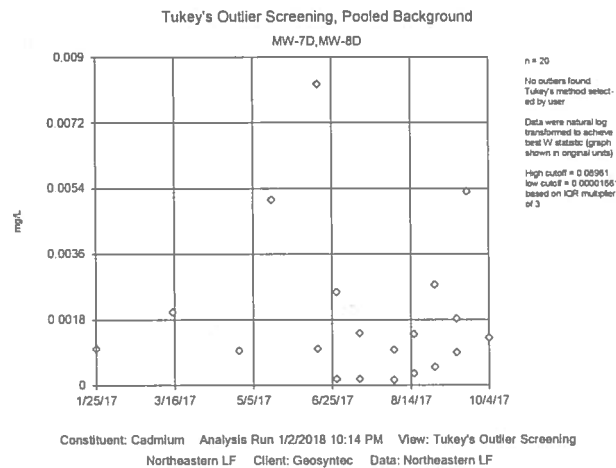
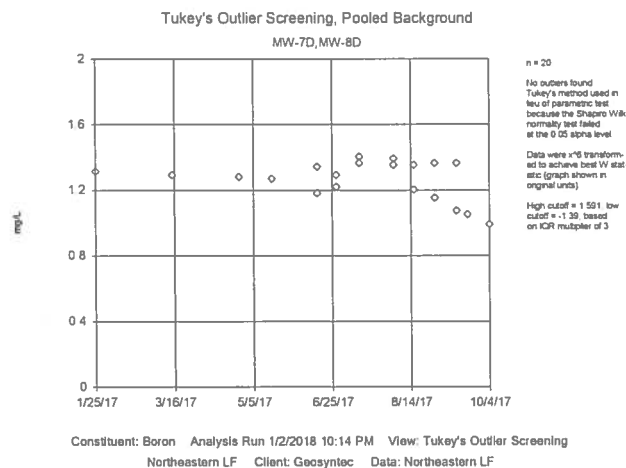
Outlier Analysis - All Downgradient Wells

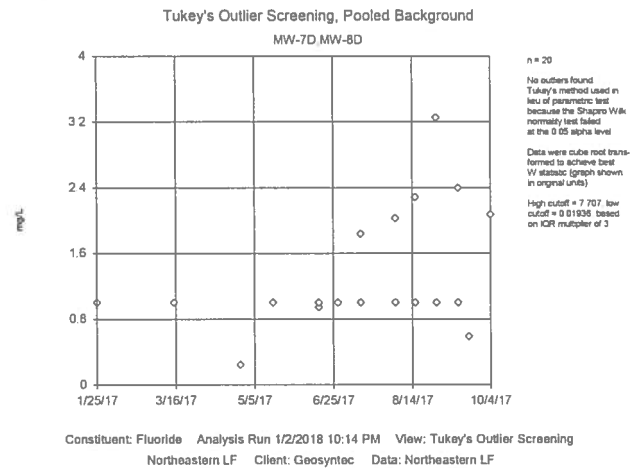
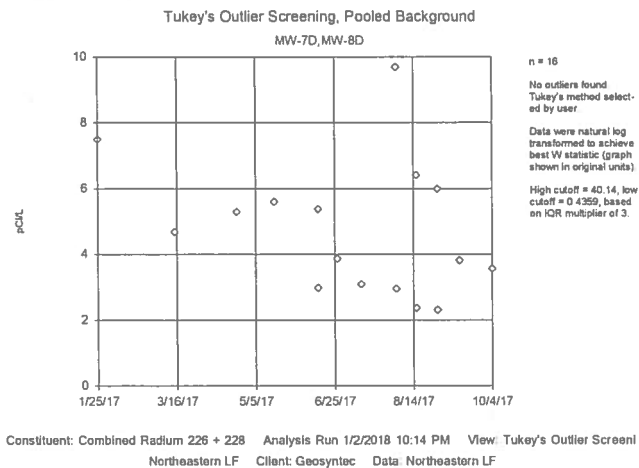
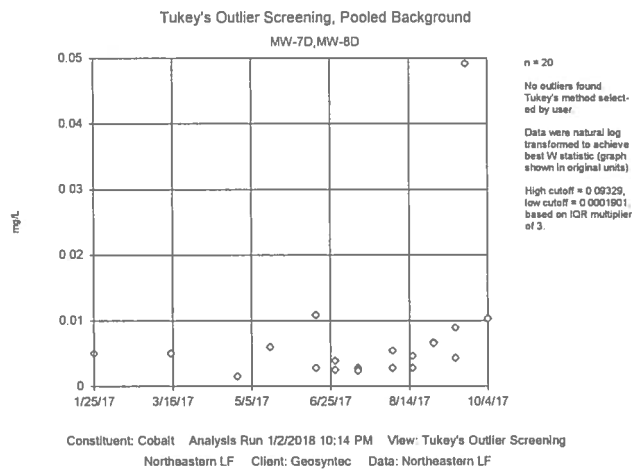
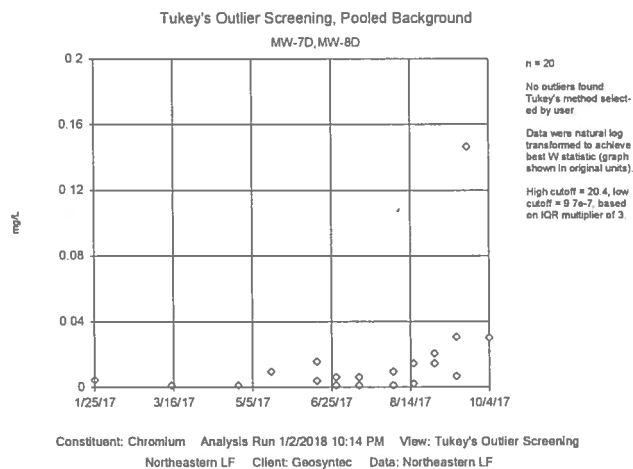
Page 2

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/2/2018, 10:20 PM

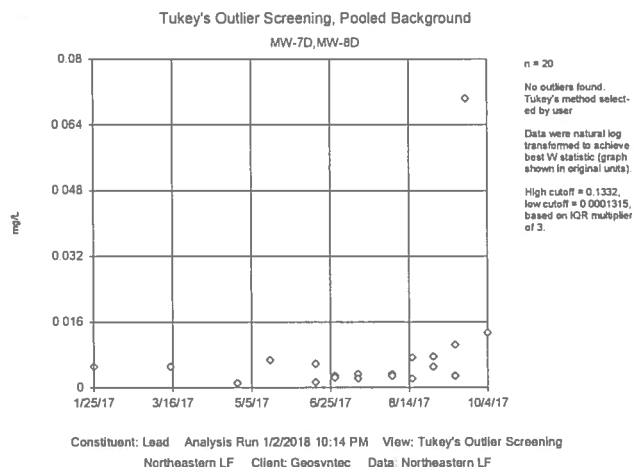
| Constituent | Well | Outlier | Value(s) | Method | N | Mean | Std. Dev. | Distribution | Normality Test |
|------------------------------------|-------|---------|----------|----------|----|------------|-------------|--------------|----------------|
| Mercury (mg/L) | MW-15 | No | n/a | NP (nrm) | 12 | 0.00001892 | 0.00000664 | unknown | ShapiroWilk |
| Mercury (mg/L) | MW-3D | No | n/a | NP (nrm) | 12 | 0.00002125 | 0.000006904 | unknown | ShapiroWilk |
| Mercury (mg/L) | MW-6D | No | n/a | NP | 8 | 0.00001825 | 0.000007611 | ln(x) | ShapiroWilk |
| Mercury (mg/L) | MW-9D | No | n/a | NP | 8 | 0.00001675 | 0.000005776 | ln(x) | ShapiroWilk |
| Molybdenum (mg/L) | MW-15 | No | n/a | NP | 12 | 0.6351 | 0.03228 | x^6 | ShapiroWilk |
| Molybdenum (mg/L) | MW-3D | Yes | 0.07928 | NP | 12 | 0.0097 | 0.02193 | ln(x) | ShapiroWilk |
| Molybdenum (mg/L) | MW-6D | No | n/a | NP (nrm) | 8 | 0.06722 | 0.02812 | unknown | ShapiroWilk |
| Molybdenum (mg/L) | MW-9D | No | n/a | NP | 8 | 0.1189 | 0.03949 | ln(x) | ShapiroWilk |
| pH, field (SU) | MW-15 | No | n/a | NP | 10 | 7.852 | 0.5446 | x^4 | ShapiroWilk |
| pH, field (SU) | MW-3D | No | n/a | NP | 10 | 7.101 | 0.3915 | ln(x) | ShapiroWilk |
| pH, field (SU) | MW-6D | No | n/a | NP | 8 | 7.153 | 0.4475 | x^2 | ShapiroWilk |
| pH, field (SU) | MW-9D | No | n/a | NP | 8 | 7.256 | 0.1972 | ln(x) | ShapiroWilk |
| Selenium (mg/L) | MW-15 | No | n/a | NP | 12 | 0.007312 | 0.005647 | ln(x) | ShapiroWilk |
| Selenium (mg/L) | MW-3D | No | n/a | NP (nrm) | 12 | 0.004667 | 0.001155 | unknown | ShapiroWilk |
| Selenium (mg/L) | MW-6D | No | n/a | NP (nrm) | 8 | 0.005 | 0 | unknown | ShapiroWilk |
| Selenium (mg/L) | MW-9D | No | n/a | NP | 8 | 0.003499 | 0.001205 | normal | ShapiroWilk |
| Sulfate (mg/L) | MW-15 | No | n/a | NP | 12 | 578.6 | 31.72 | ln(x) | ShapiroWilk |
| Sulfate (mg/L) | MW-3D | No | n/a | NP | 12 | 205.9 | 20.34 | x^6 | ShapiroWilk |
| Sulfate (mg/L) | MW-6D | No | n/a | NP | 8 | 515.6 | 10.41 | ln(x) | ShapiroWilk |
| Sulfate (mg/L) | MW-9D | No | n/a | NP | 8 | 1079 | 170.3 | x^6 | ShapiroWilk |
| Thallium (mg/L) | MW-15 | No | n/a | NP (nrm) | 12 | 0.001921 | 0.0002742 | unknown | ShapiroWilk |
| Thallium (mg/L) | MW-3D | No | n/a | NP (nrm) | 12 | 0.001918 | 0.0002829 | unknown | ShapiroWilk |
| Thallium (mg/L) | MW-6D | No | n/a | NP (nrm) | 8 | 0.002 | 0 | unknown | ShapiroWilk |
| Thallium (mg/L) | MW-9D | No | n/a | NP (nrm) | 8 | 0.002 | 0 | unknown | ShapiroWilk |
| Total Dissolve Solids [TDS] (mg/L) | MW-15 | No | n/a | NP | 12 | 1079 | 32.67 | x^6 | ShapiroWilk |
| Total Dissolve Solids [TDS] (mg/L) | MW-3D | No | n/a | NP | 12 | 709 | 64.4 | ln(x) | ShapiroWilk |
| Total Dissolve Solids [TDS] (mg/L) | MW-6D | Yes | 2320 | NP | 8 | 1199 | 455.3 | ln(x) | ShapiroWilk |
| Total Dissolve Solids [TDS] (mg/L) | MW-9D | No | n/a | NP | 8 | 2122 | 561.5 | x^3 | ShapiroWilk |



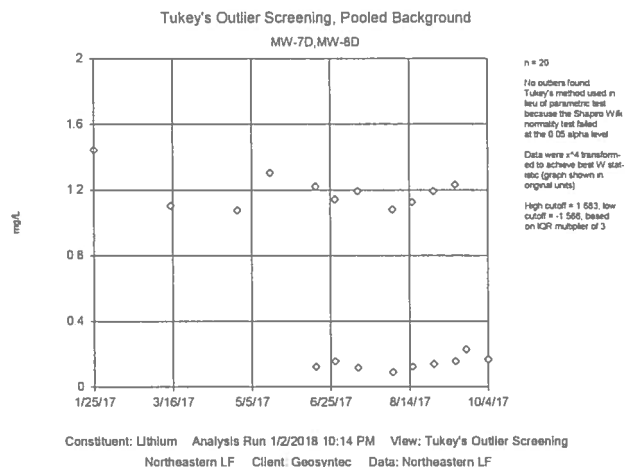




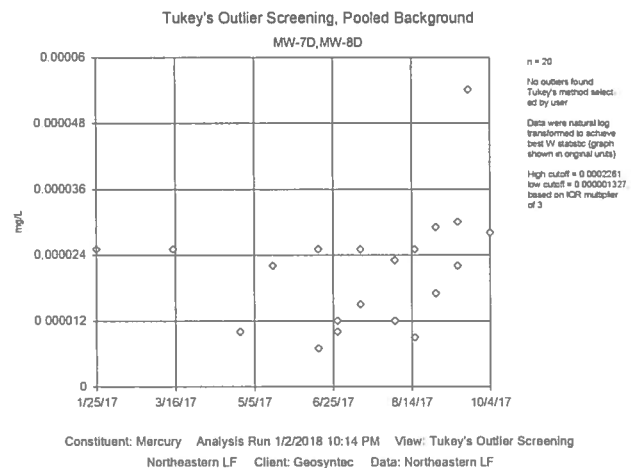
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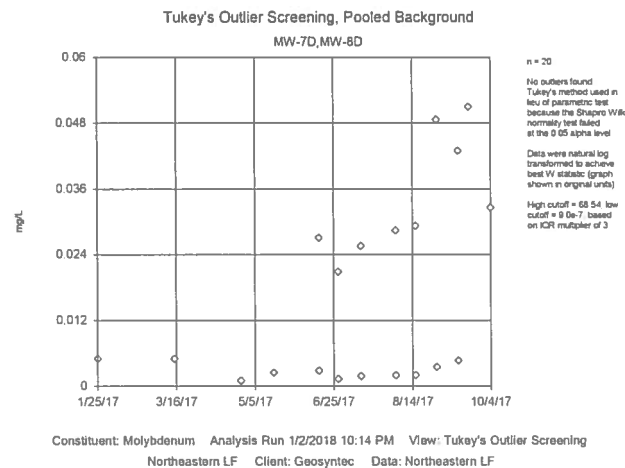
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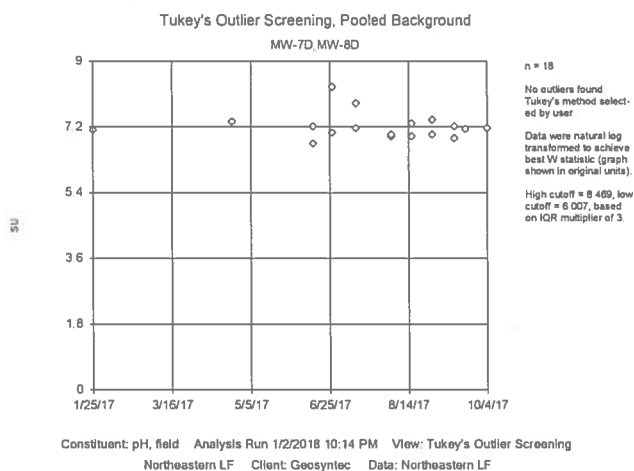
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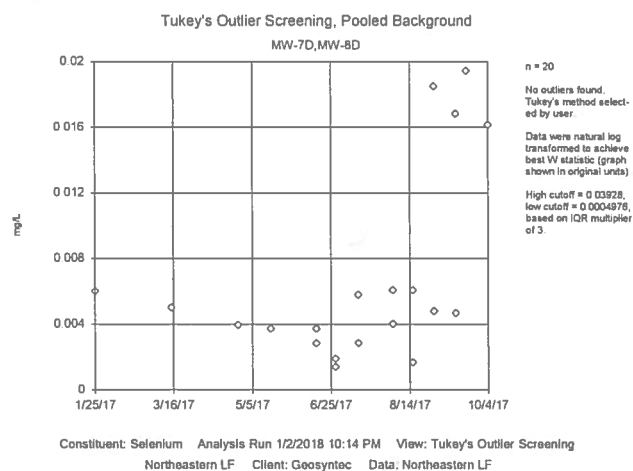
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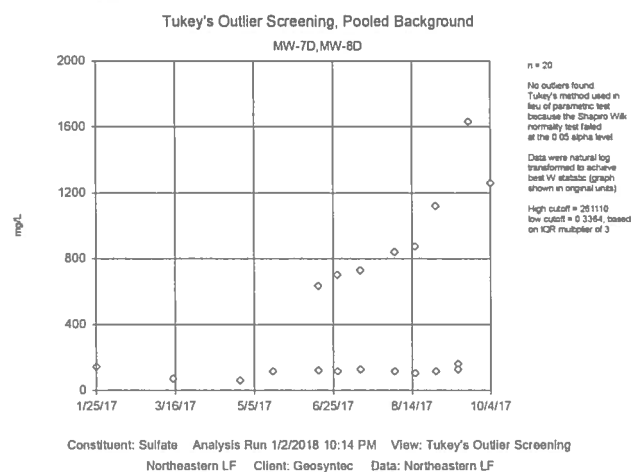
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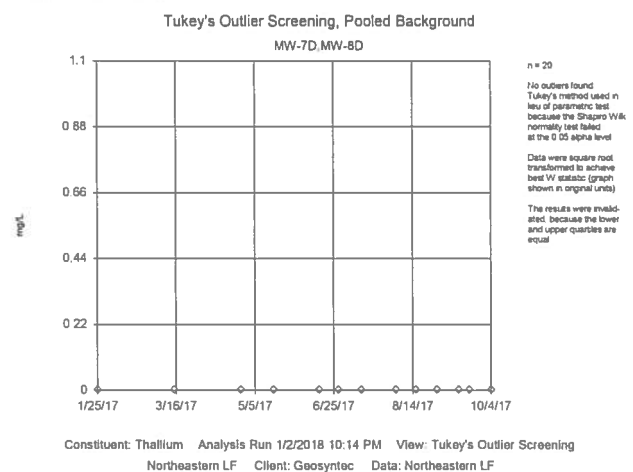
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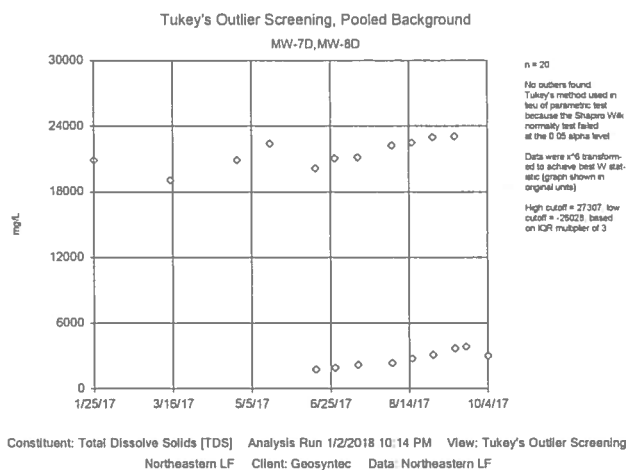


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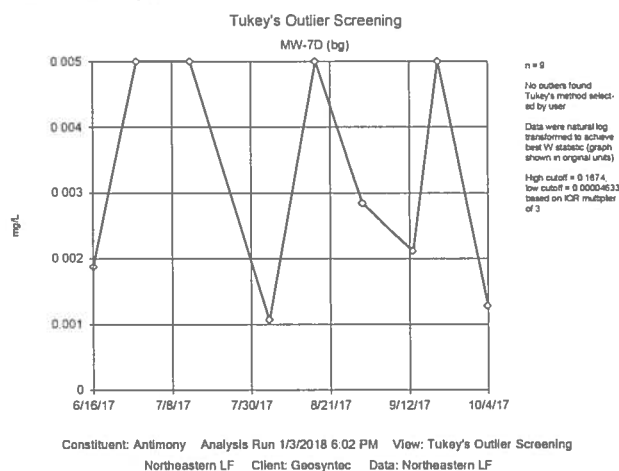


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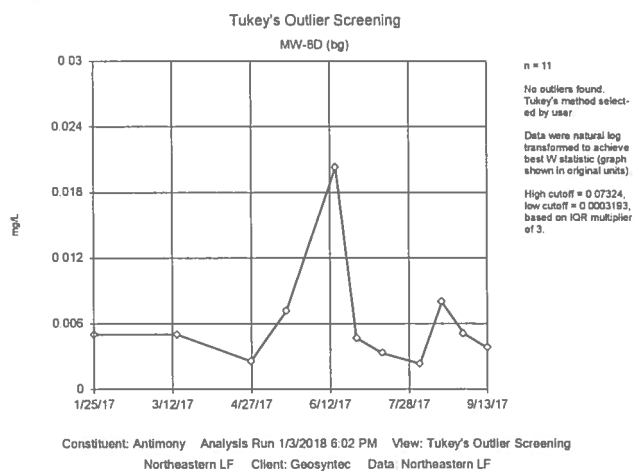




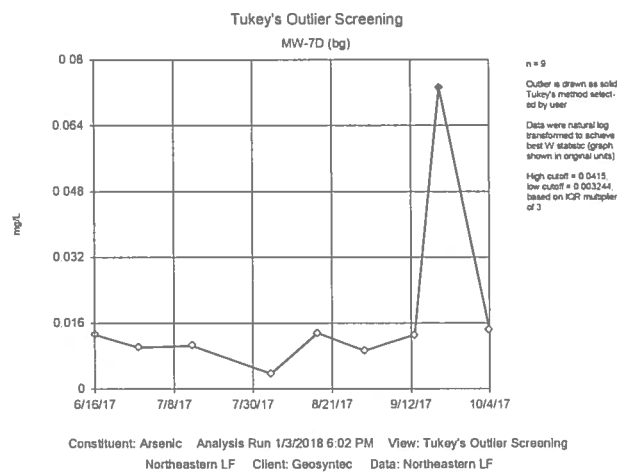
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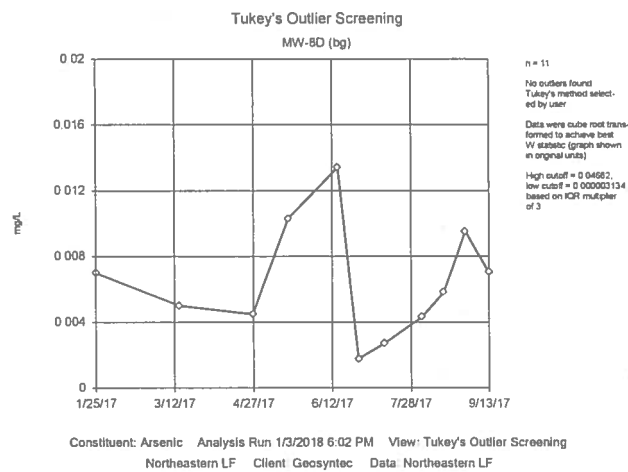
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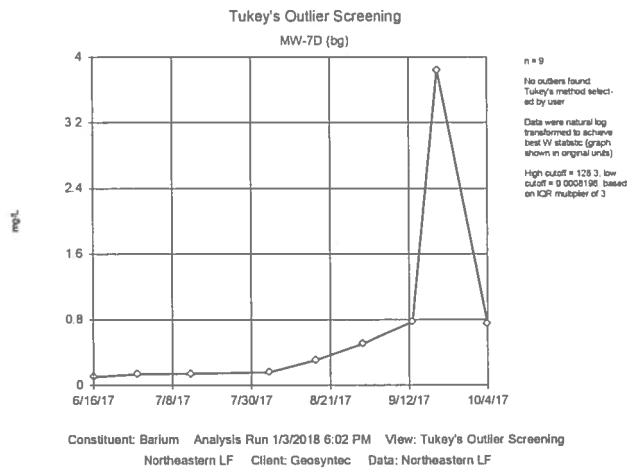
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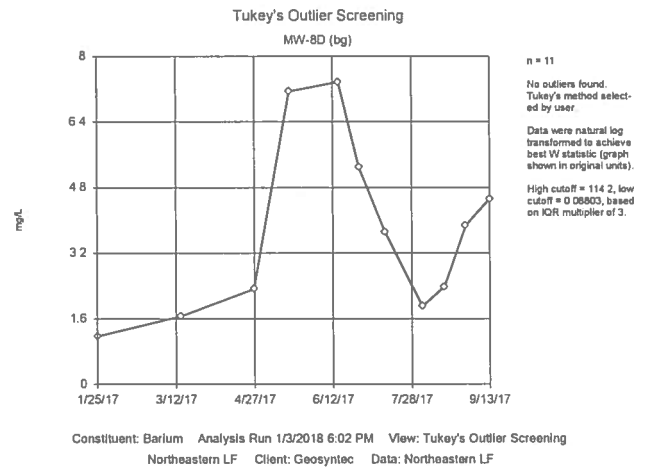
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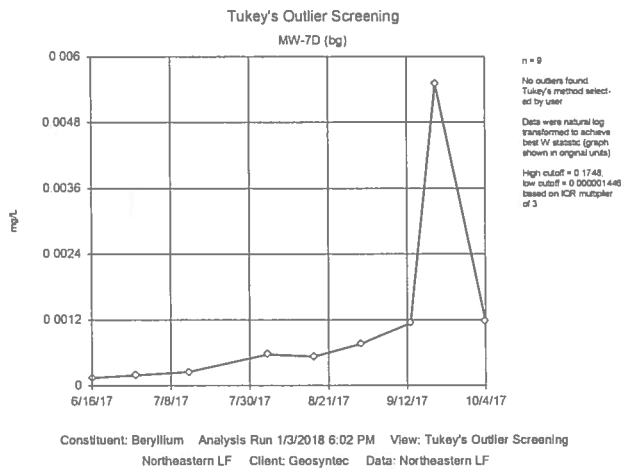
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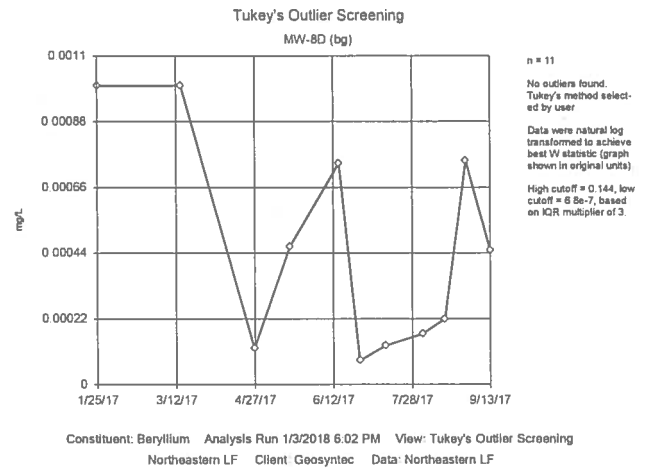
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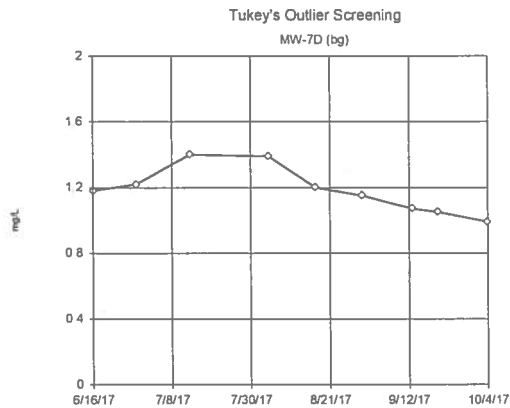


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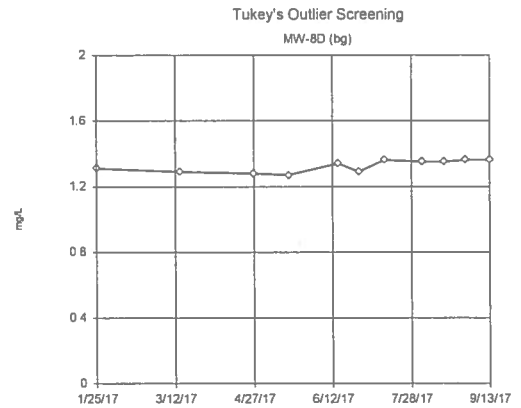


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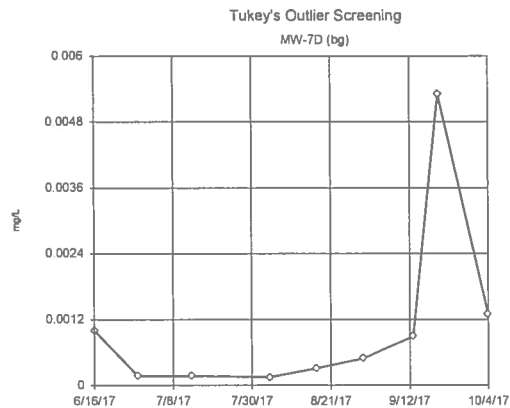




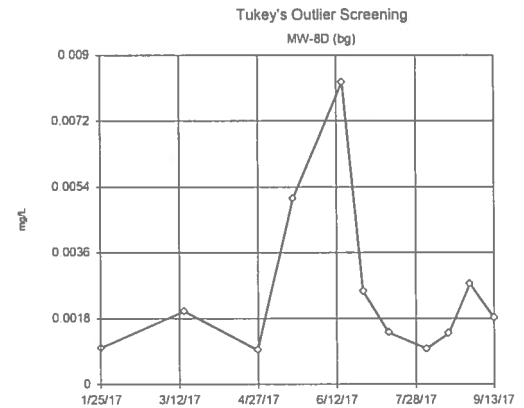
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Northeastern LF Client: Geosyntec Data: Northeastern LF



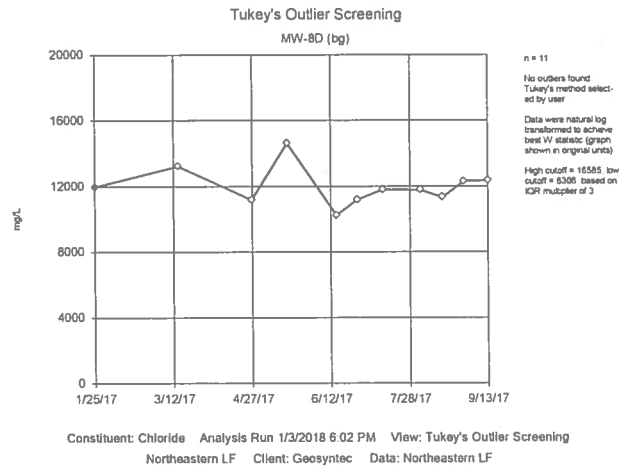
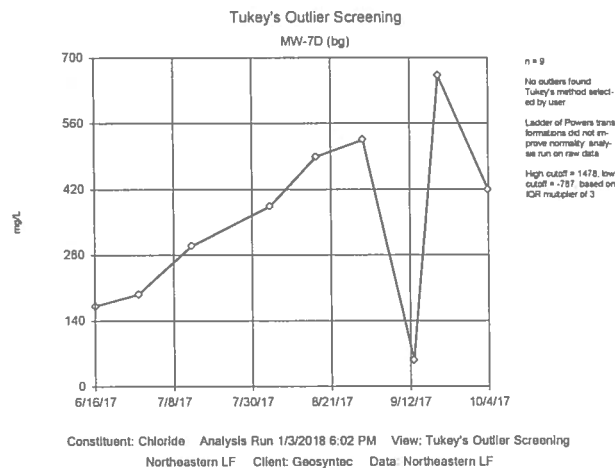
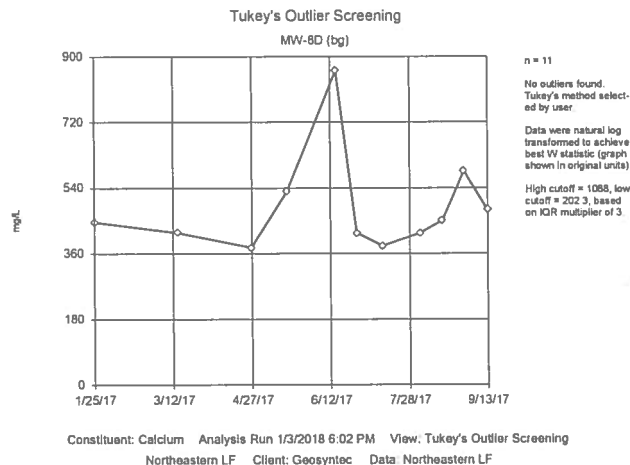
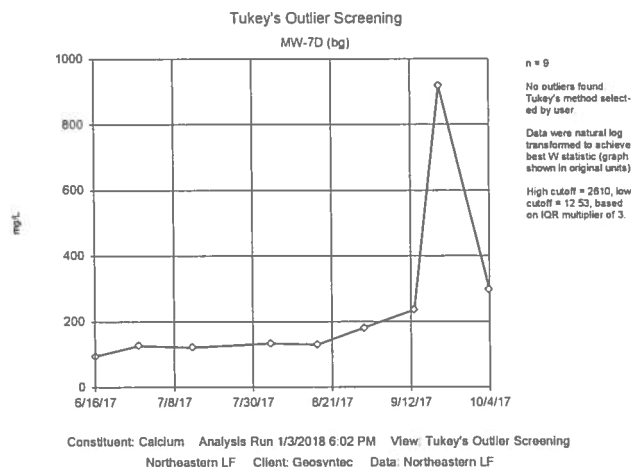
Constituent: Boron Analysis Run 1/3/2018 6:02 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF



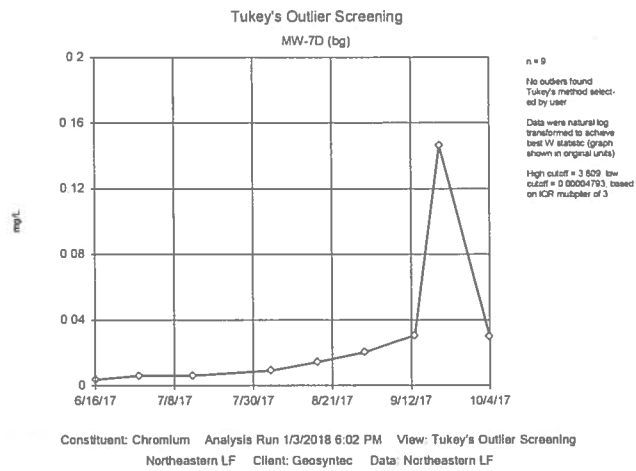
Constituent: Cadmium Analysis Run 1/3/2018 6:02 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF



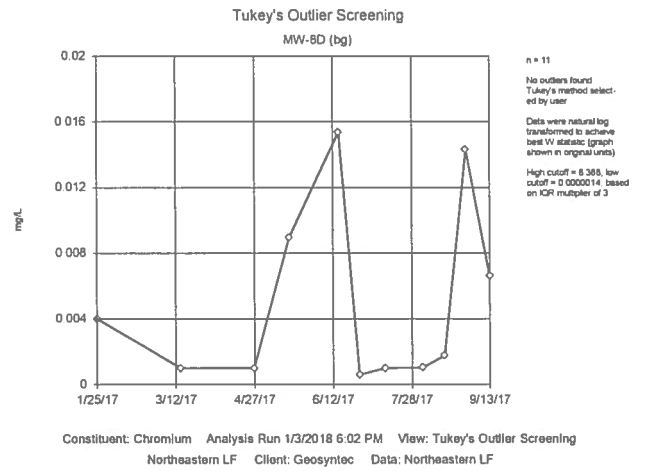
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Northeastern LF Client: Geosyntec Data: Northeastern LF



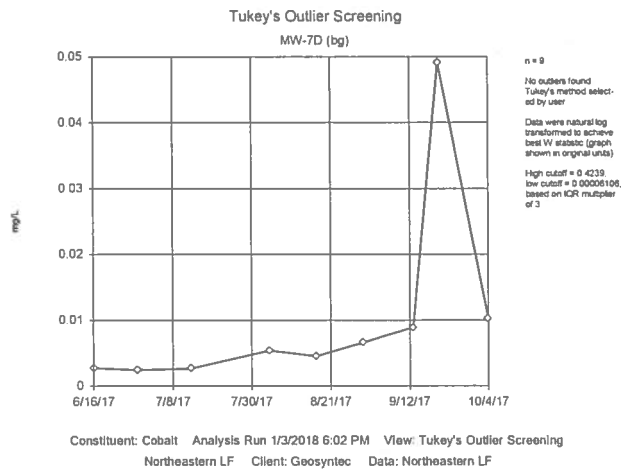
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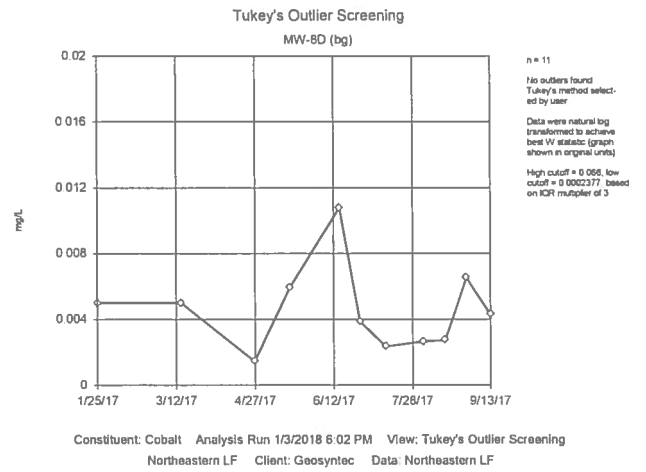
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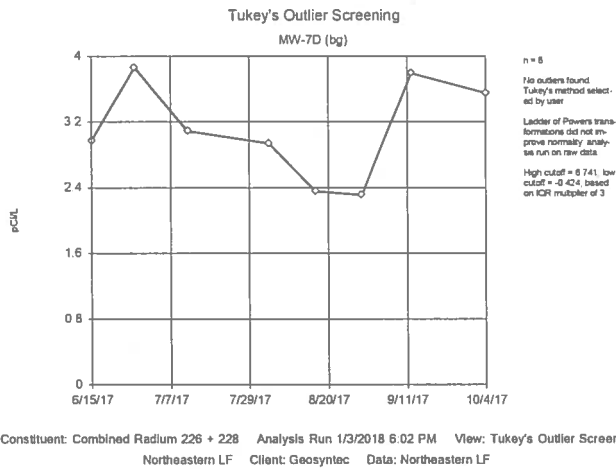
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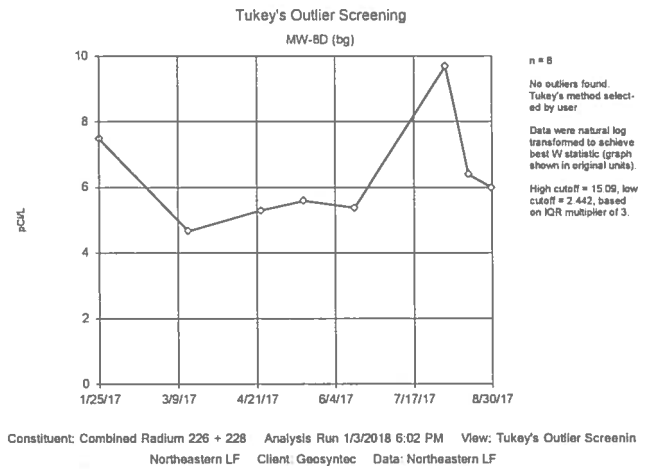
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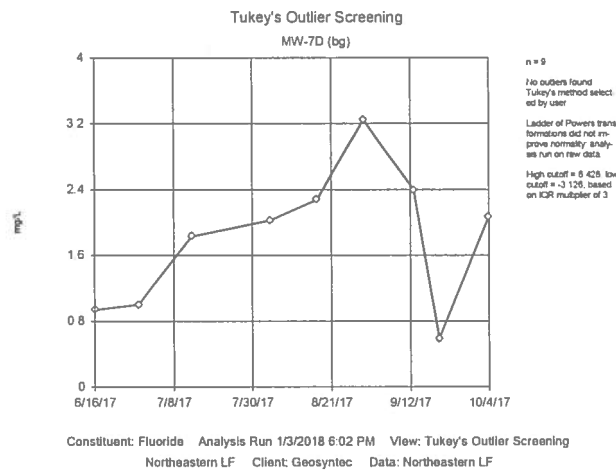
Session 1 - 8:00 Groundwater Data Collecting UG



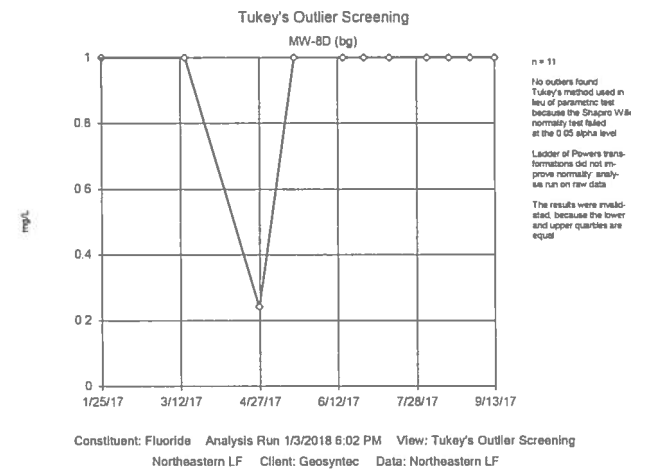
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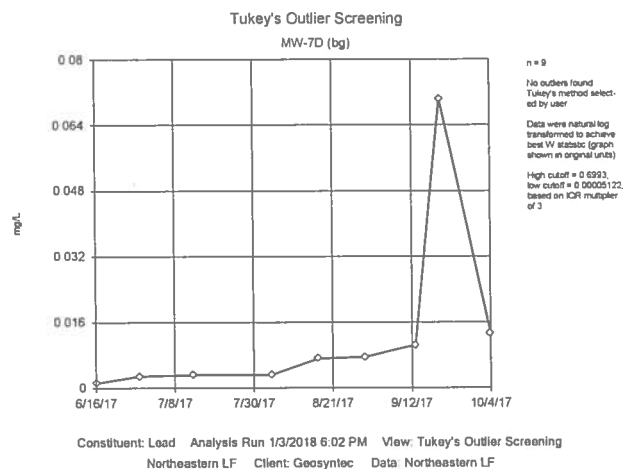
Session 1 - 8:00 Groundwater Data Collecting UG



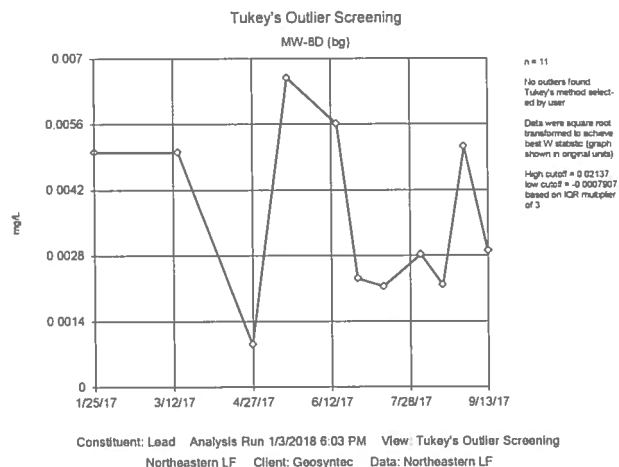
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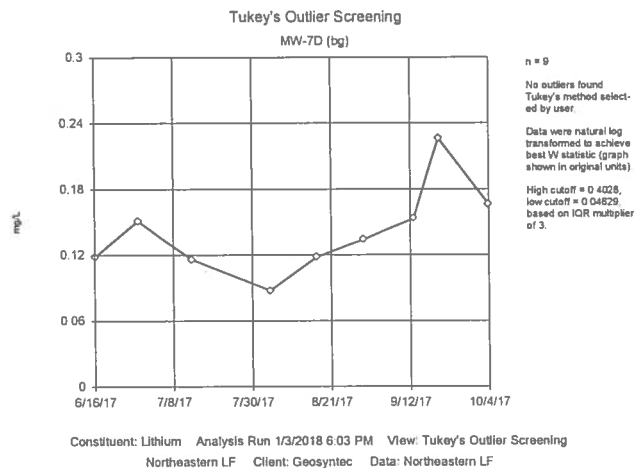
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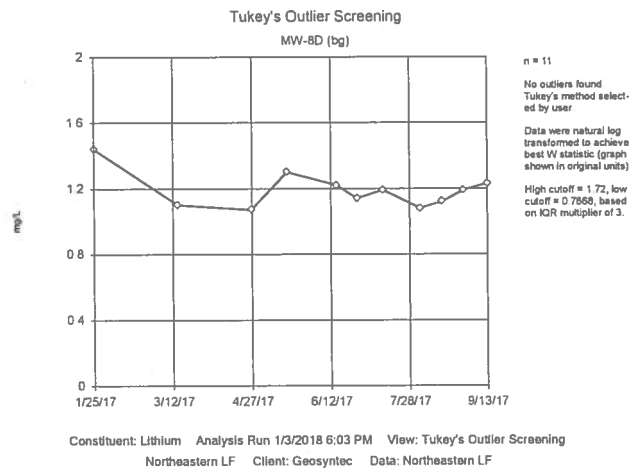
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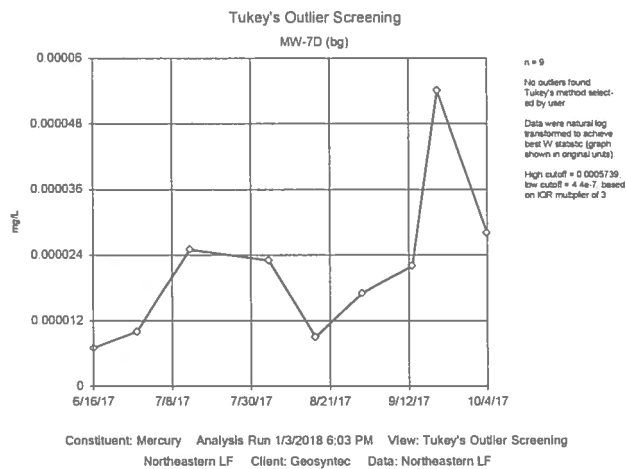
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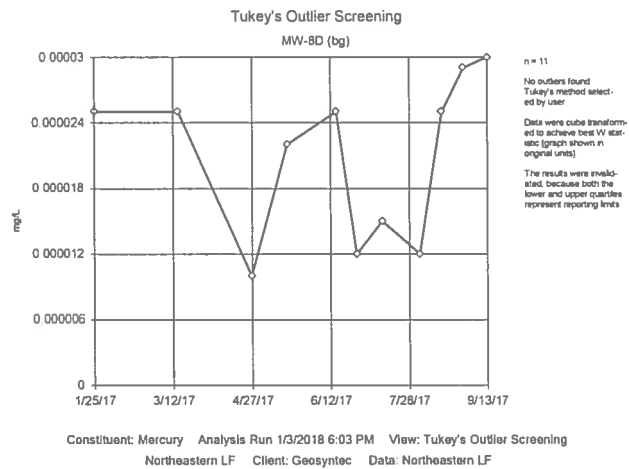
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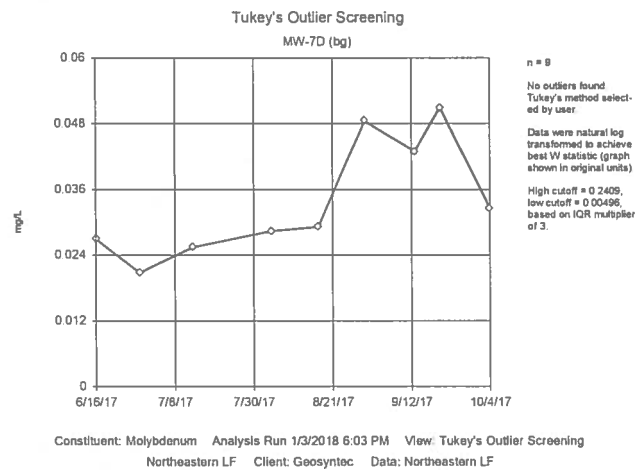
Santa Clara 9800 Groundwater Data Consulting, LLC



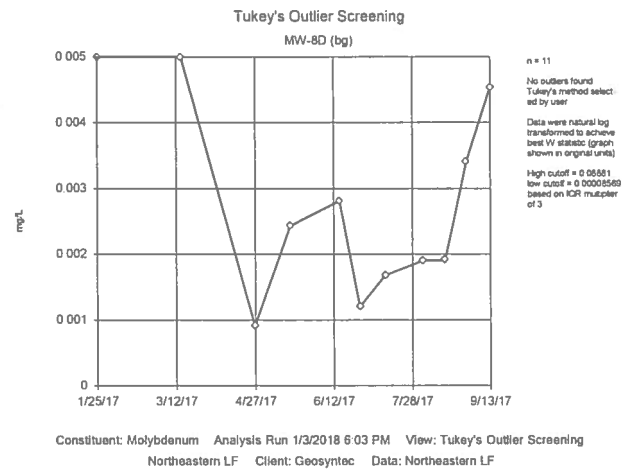
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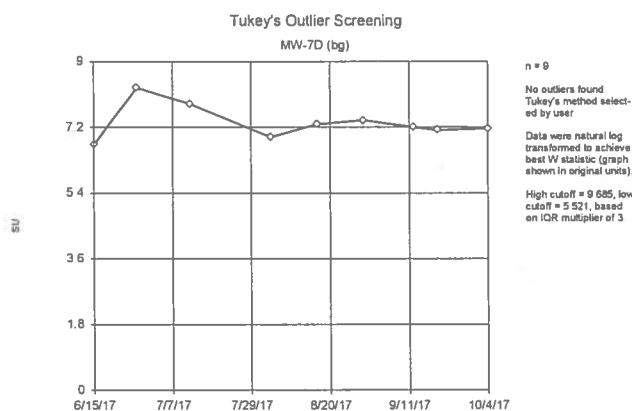
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Santa Clara 9800 Groundwater Data Consulting, LLC

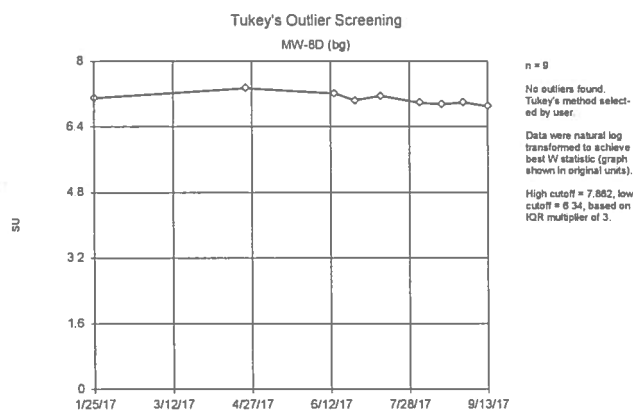


Series1 ~ v 9.8.00 Groundwater Start Consulting UG



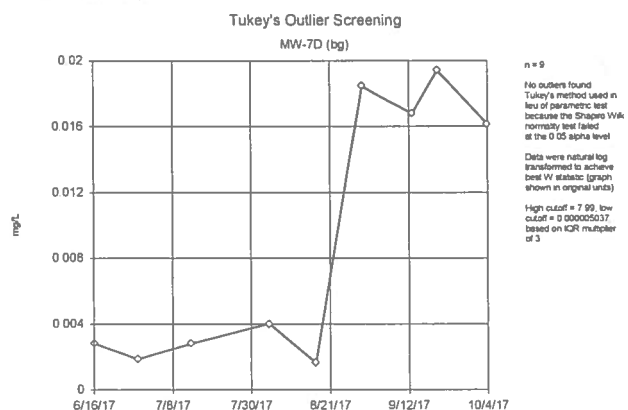
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Northeastern LF Client: Geosyntec Data: Northeastern LF

Series1 ~ v 9.8.00 Groundwater Start Consulting UG



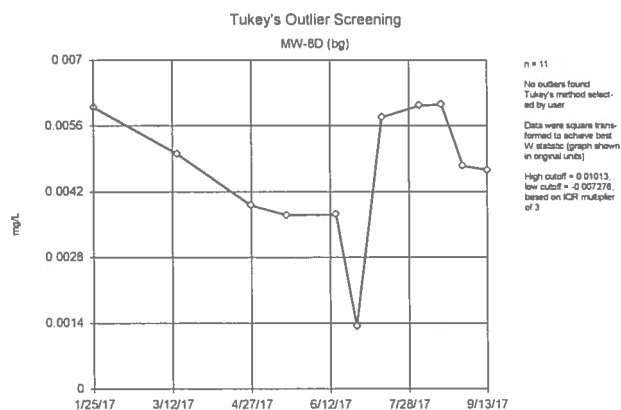
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Northeastern LF Client: Geosyntec Data: Northeastern LF

Series1 ~ v 9.8.00 Groundwater Start Consulting UG



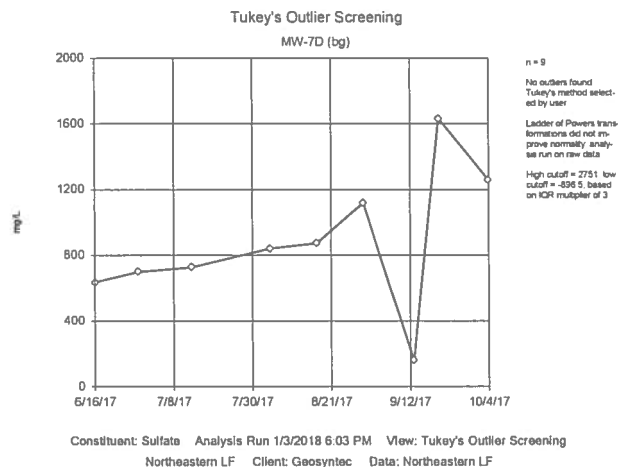
Constituent: Selenium Analysis Run 1/3/2018 6:03 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series1 ~ v 9.8.00 Groundwater Start Consulting UG

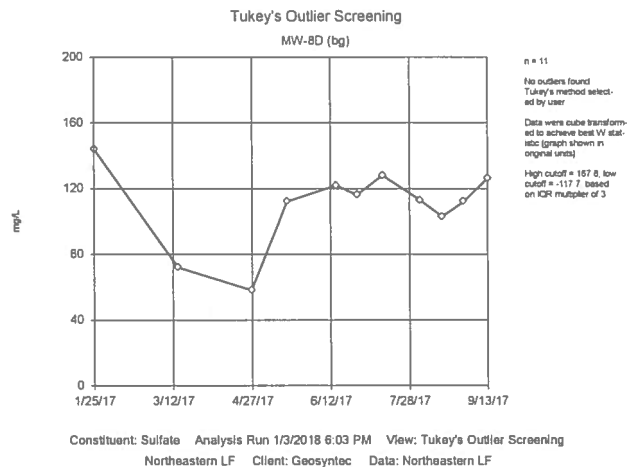


Constituent: Selenium Analysis Run 1/3/2018 6:03 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

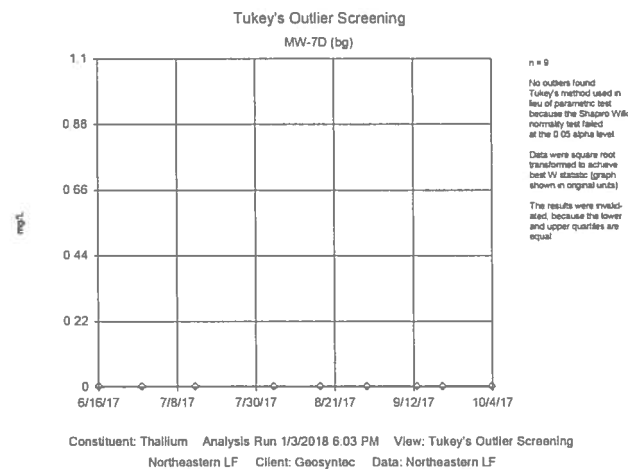
Series 1 ~ 9.00 Groundwater Data Consulting, LLC



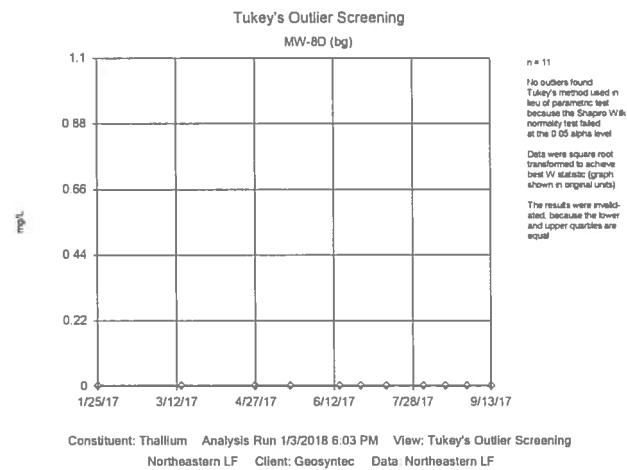
Series 1 ~ 9.00 Groundwater Data Consulting, LLC

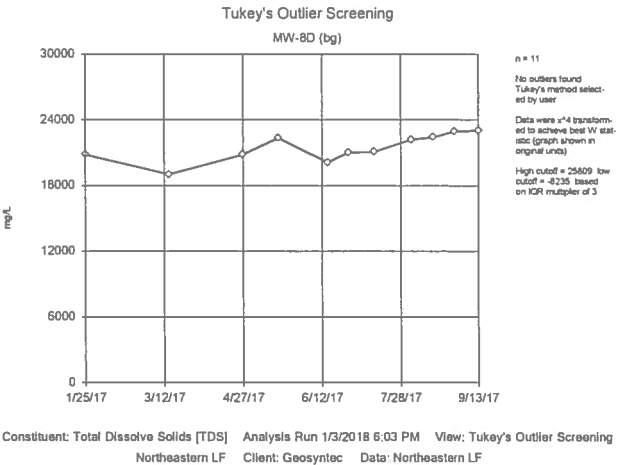
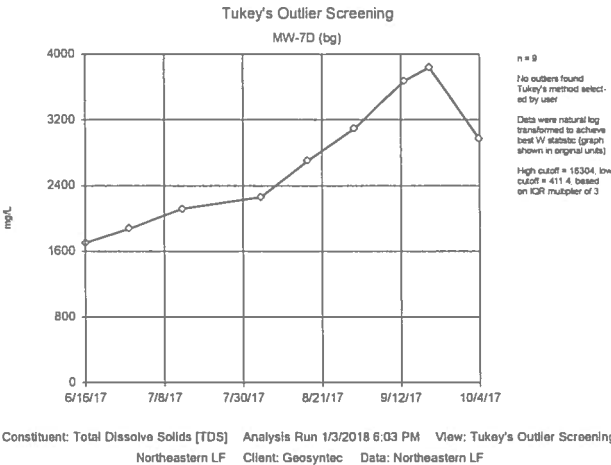


Series 1 ~ 9.00 Groundwater Data Consulting, LLC



Series 1 ~ 9.00 Groundwater Data Consulting, LLC

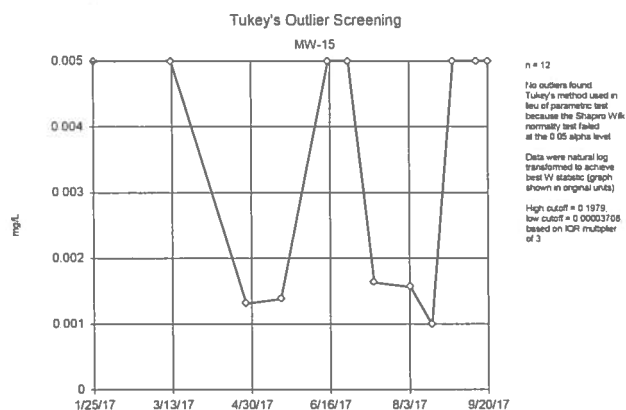




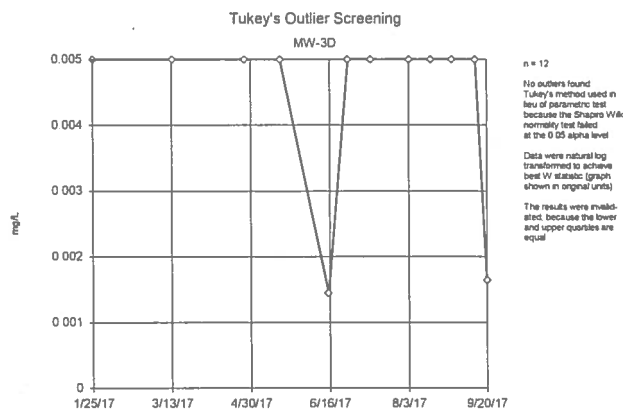
Outlier Analysis - All Results Individual Upgradient Wells

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/3/2018, 6:04 PM

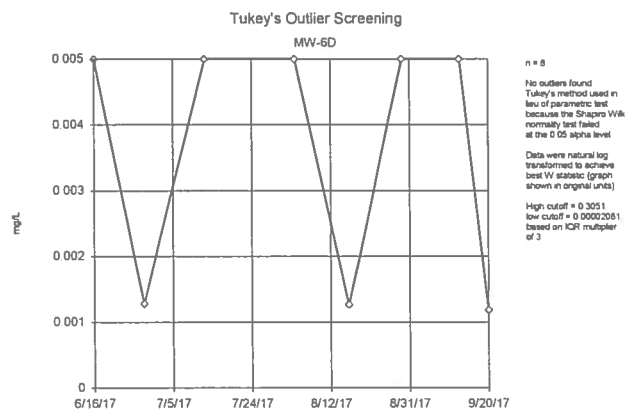
| <u>Constituent</u> | <u>Well</u> | <u>Outlier</u> | <u>Value(s)</u> | <u>Method</u> | <u>N</u> | <u>Mean</u> | <u>Std. Dev.</u> | <u>Distribution</u> | <u>Normality Test</u> |
|--------------------|-------------|----------------|-----------------|---------------|----------|-------------|------------------|---------------------|-----------------------|
| Arsenic (mg/L) | MW-7D (bg) | Yes | 0.07314 | NP | 9 | 0.01788 | 0.02098 | In(x) | ShapiroWilk |



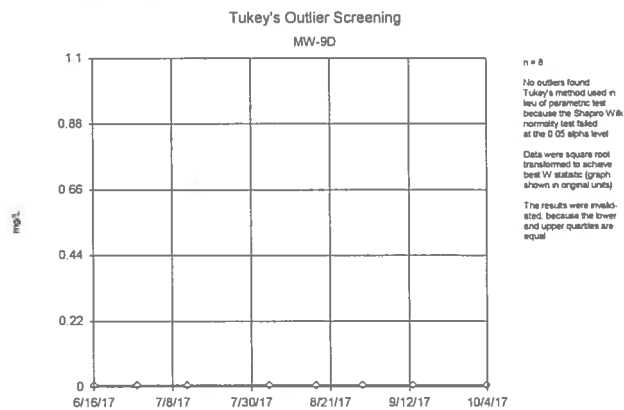
Constituent: Antimony Analysis Run 1/2/2018 10:15 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF



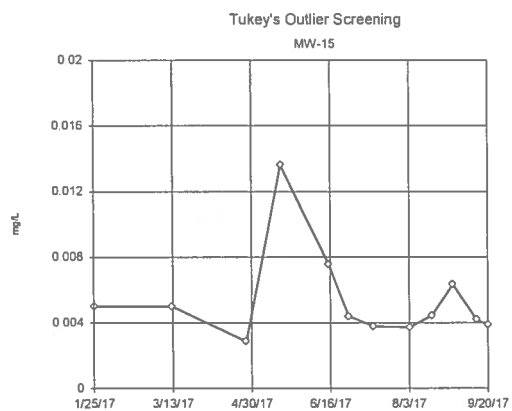
Constituent: Antimony Analysis Run 1/2/2018 10:15 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF



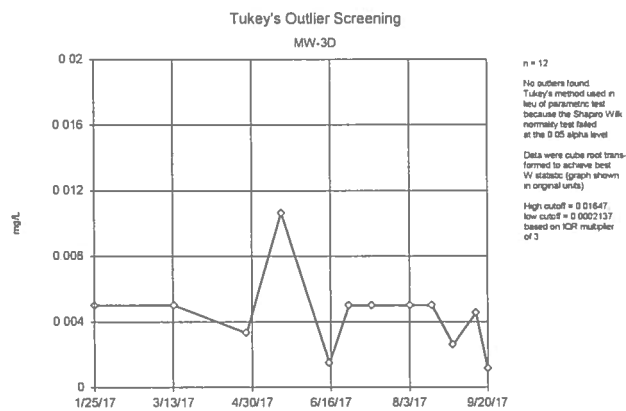
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Northeastern LF Client: Geosyntec Data: Northeastern LF



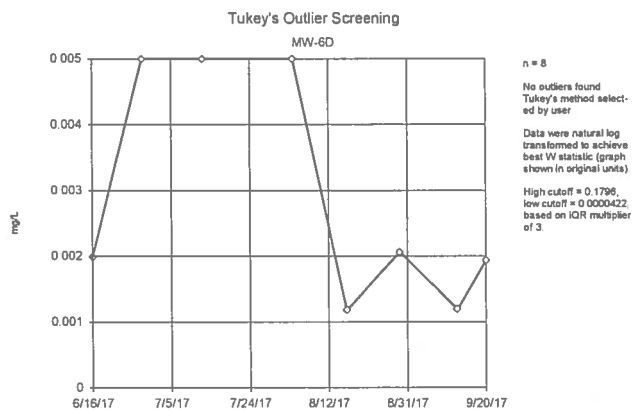
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Northeastern LF Client: Geosyntec Data: Northeastern LF



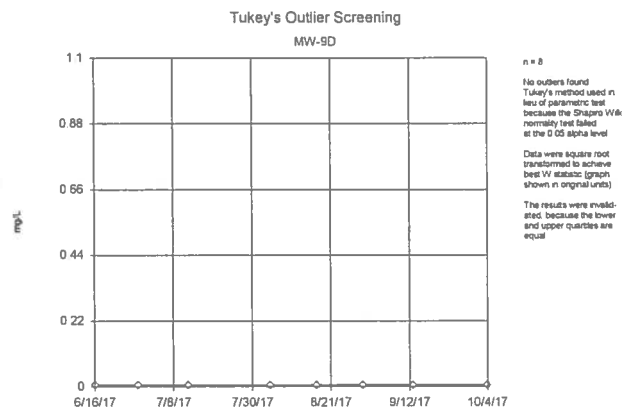
Constituent: Arsenic Analysis Run 1/2/2018 10:15 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF



Constituent: Arsenic Analysis Run 1/2/2018 10:15 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

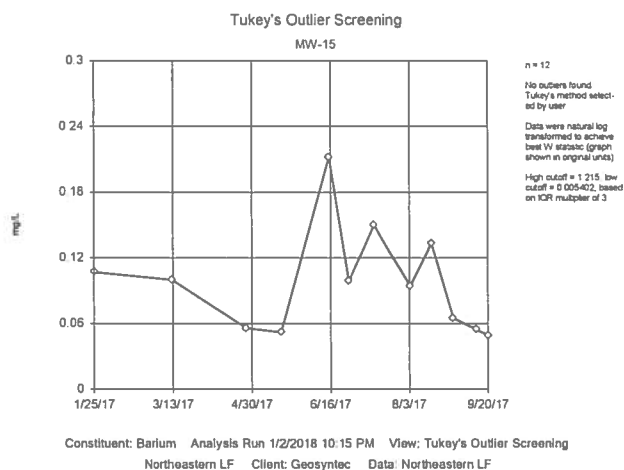


Constituent: Arsenic Analysis Run 1/2/2018 10:15 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

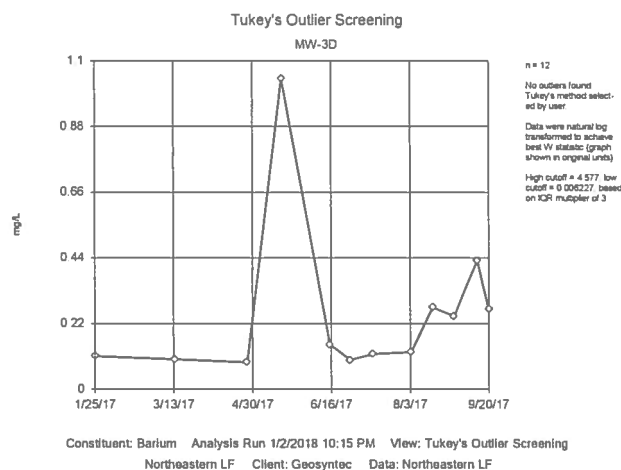


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Northeastern LF Client: Geosyntec Data: Northeastern LF

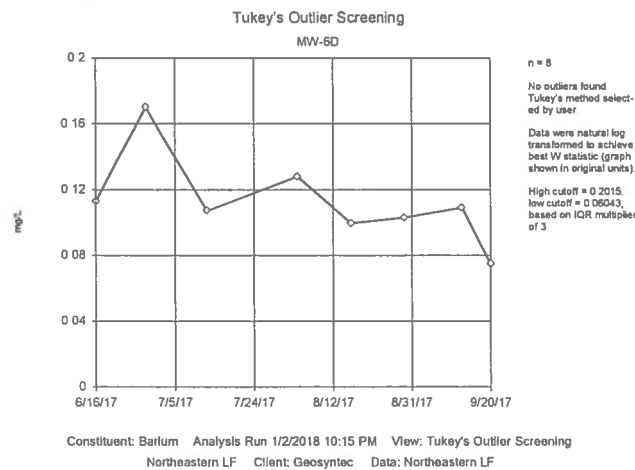
Series™ v 9.00 Groundwater Data Consulting, LLC



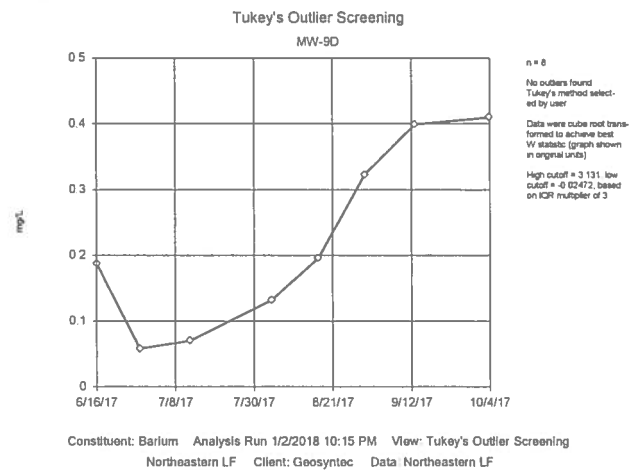
Series™ v 9.00 Groundwater Data Consulting, LLC

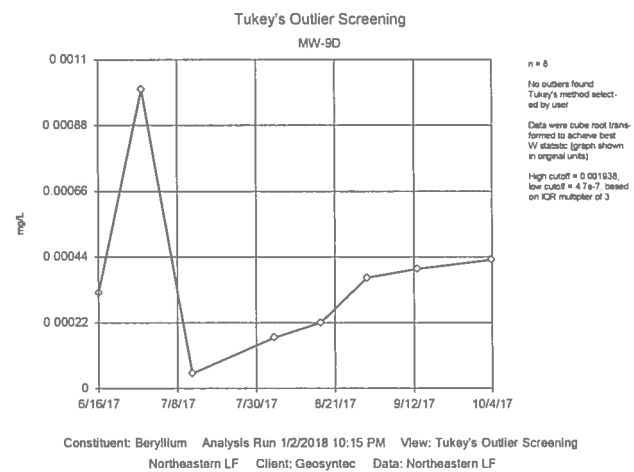
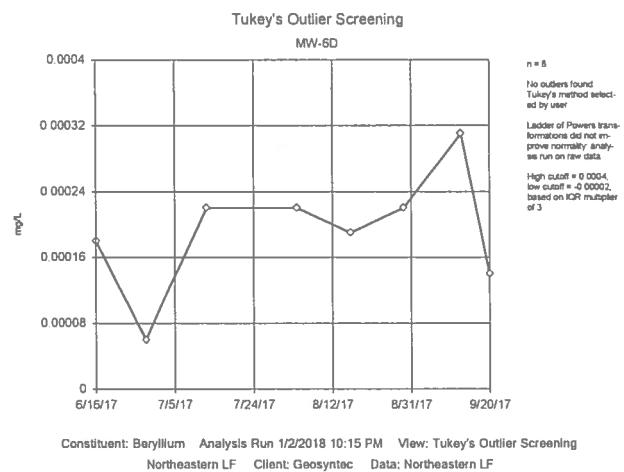
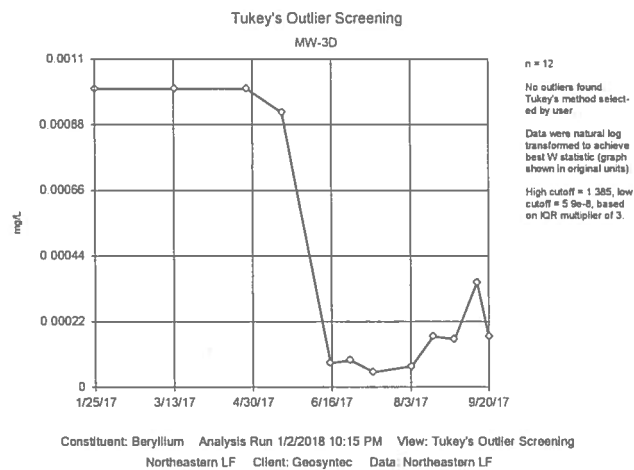
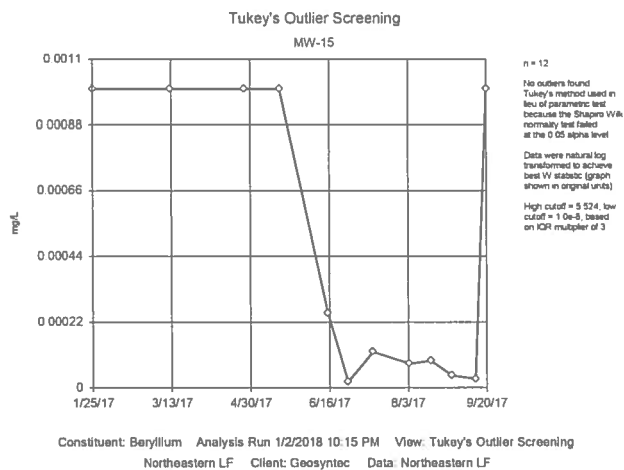


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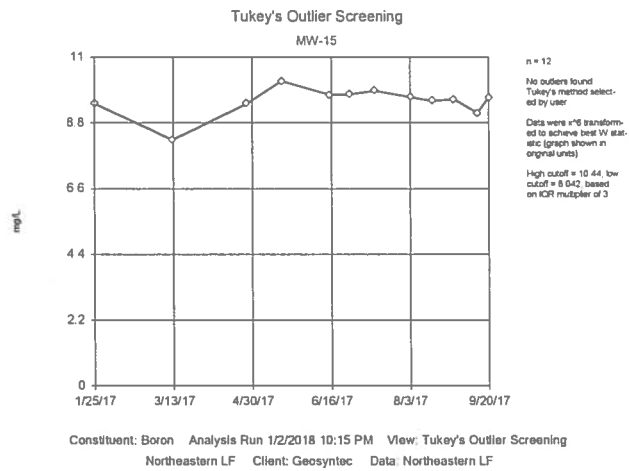


Series™ v 9.00 Groundwater Data Consulting, LLC

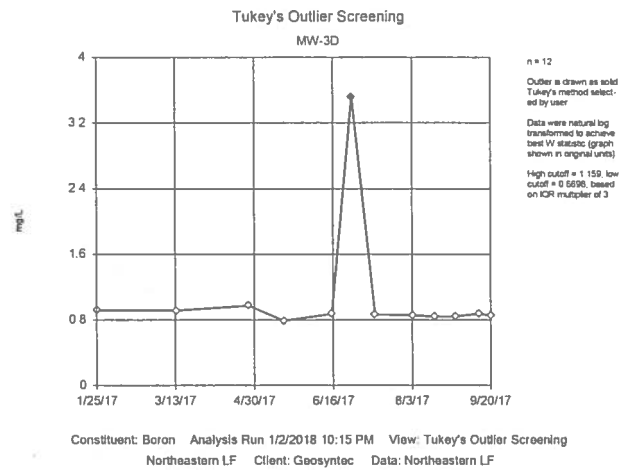




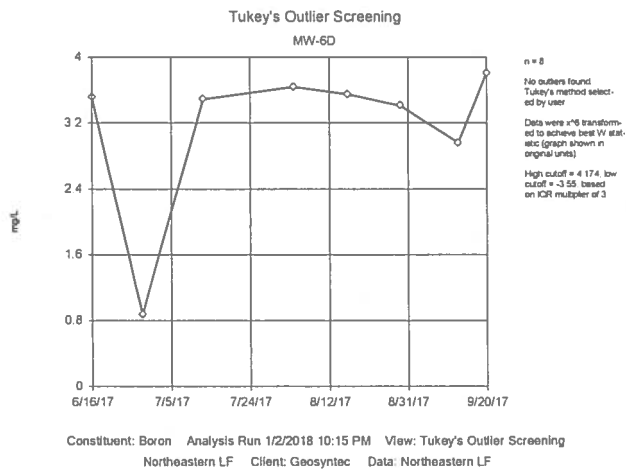
Sentinel™ v 9.0.00 Groundwater Data Consulting, LLC



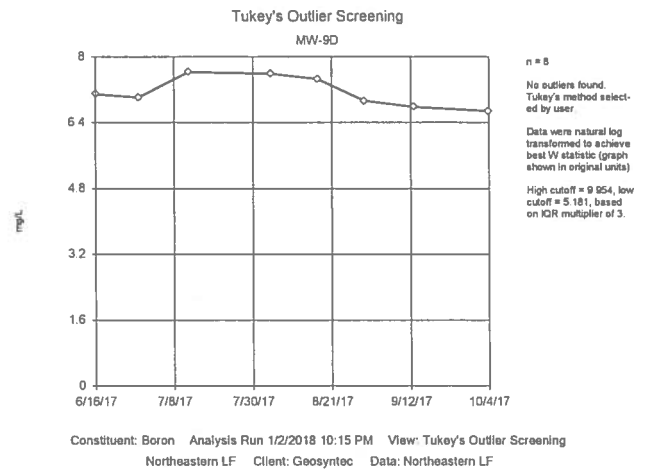
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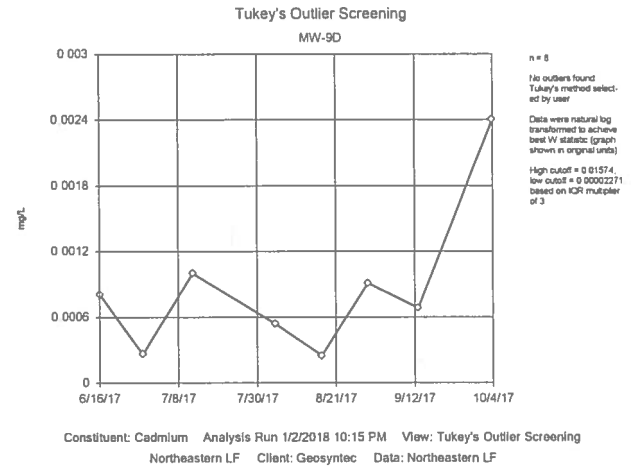
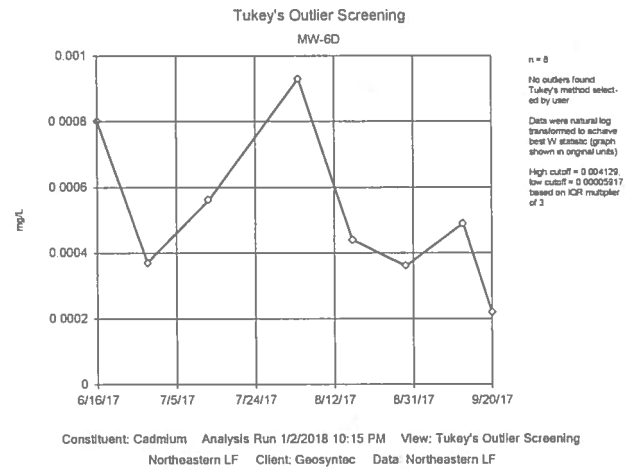
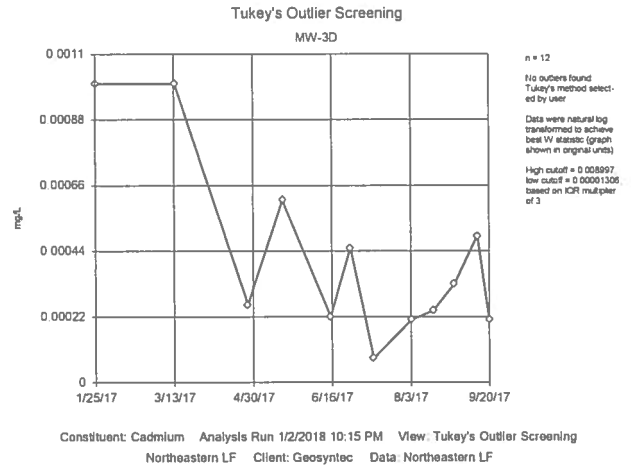
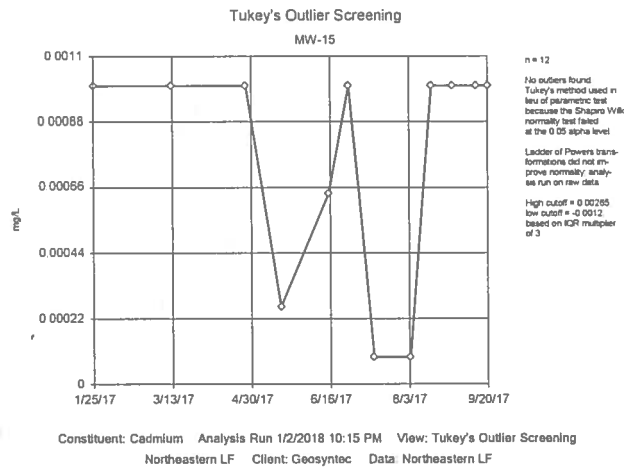


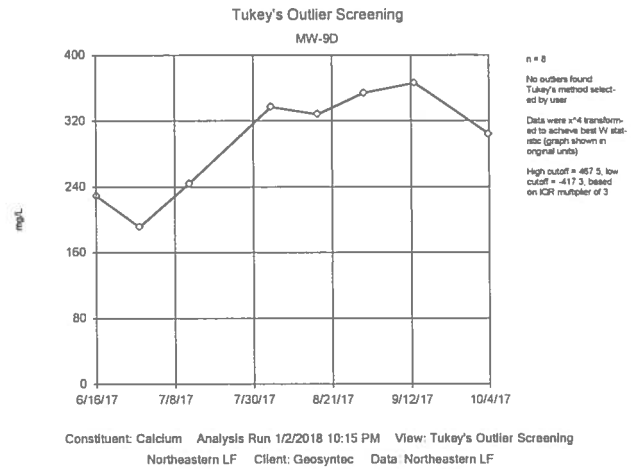
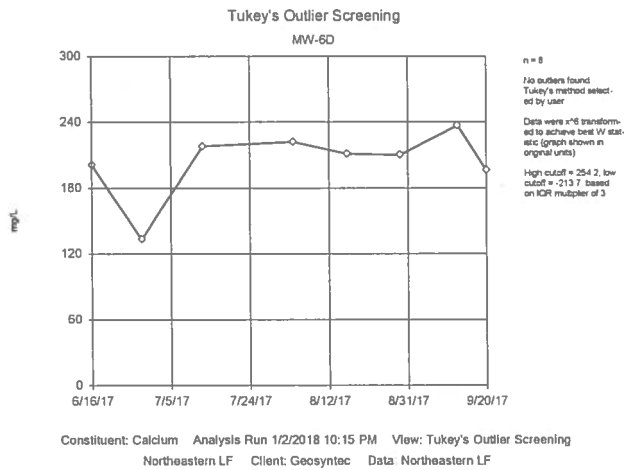
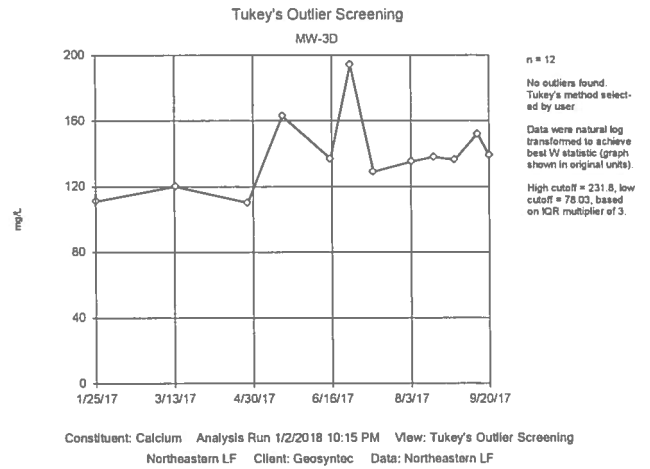
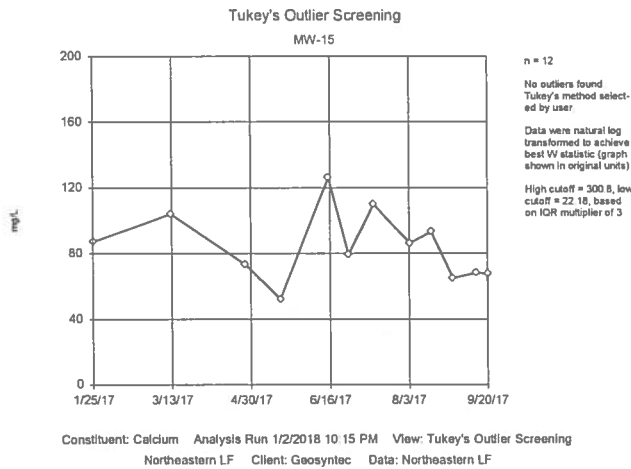
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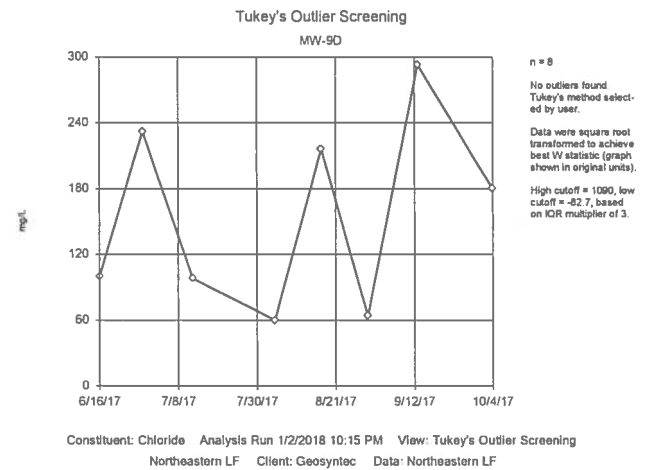
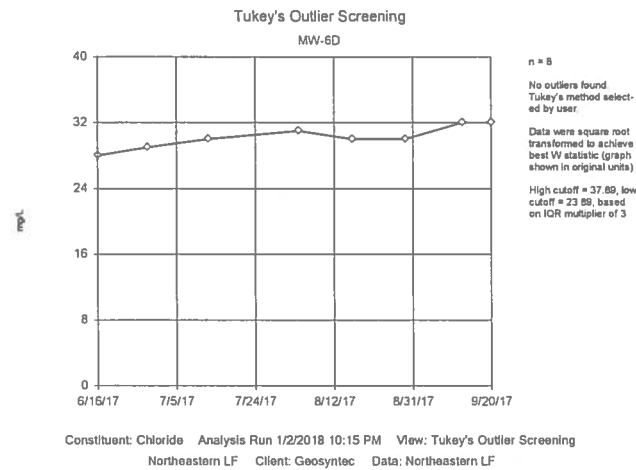
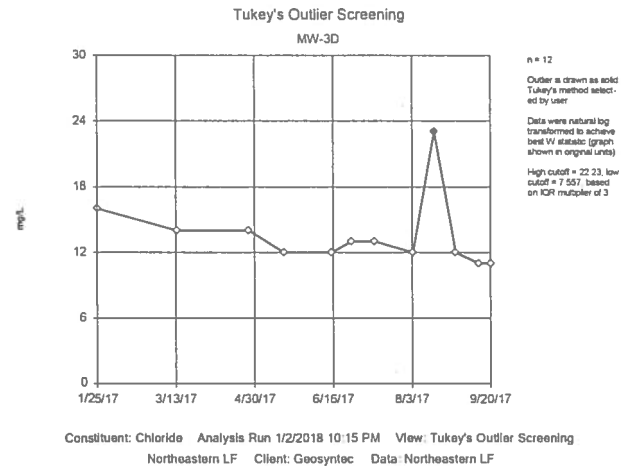
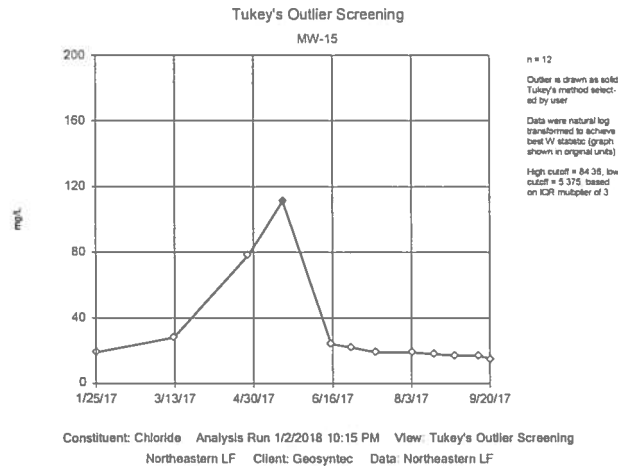


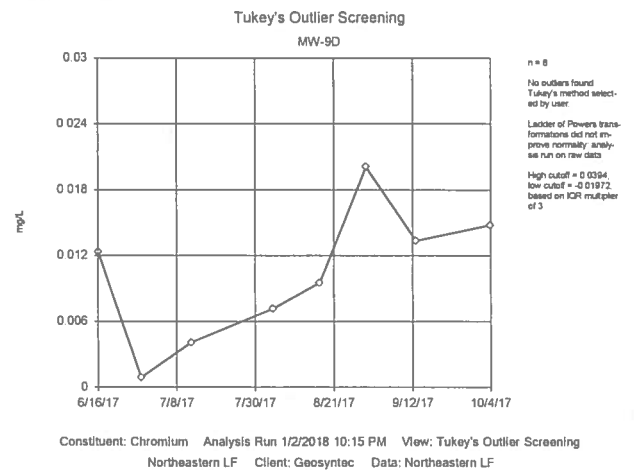
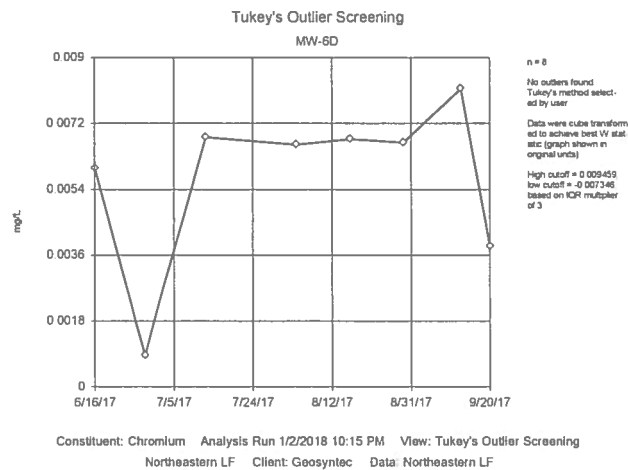
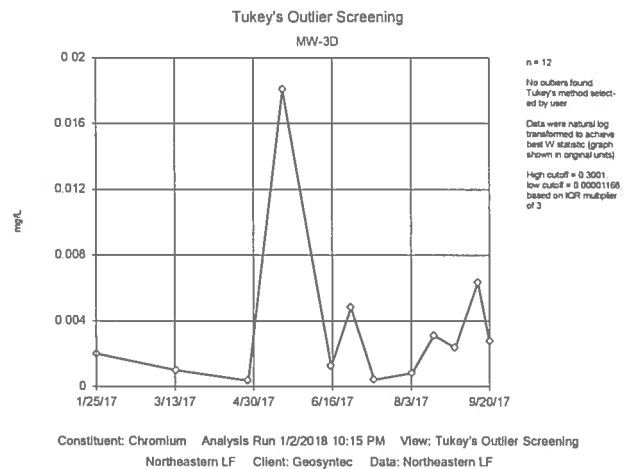
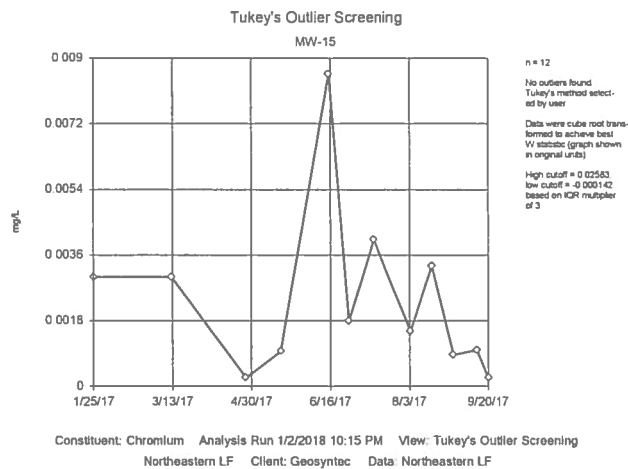
Sentinel™ v 9.0.00 Groundwater Data Consulting, LLC



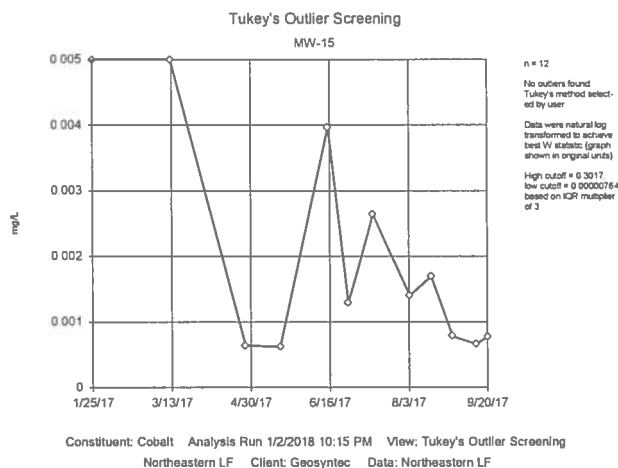




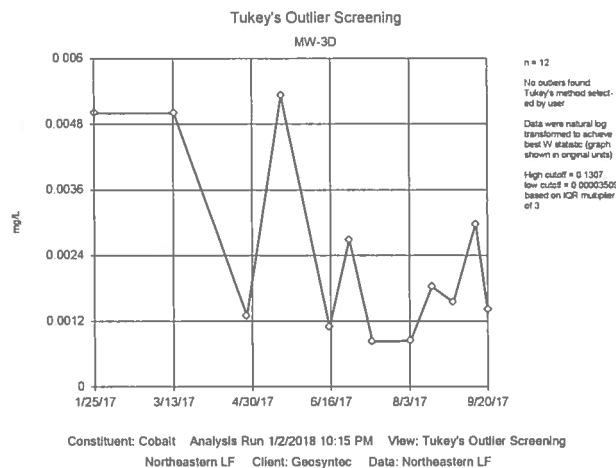




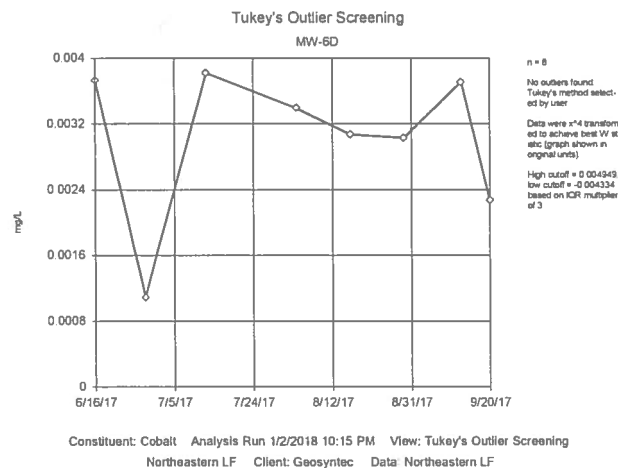
Senza™ v 9.0.0 Groundwater Data Consulting, LLC



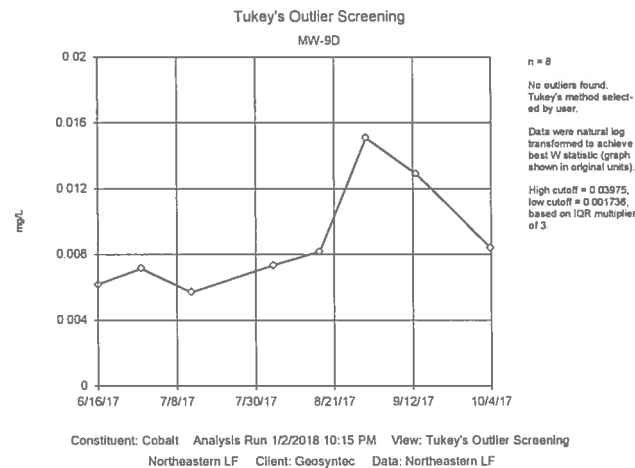
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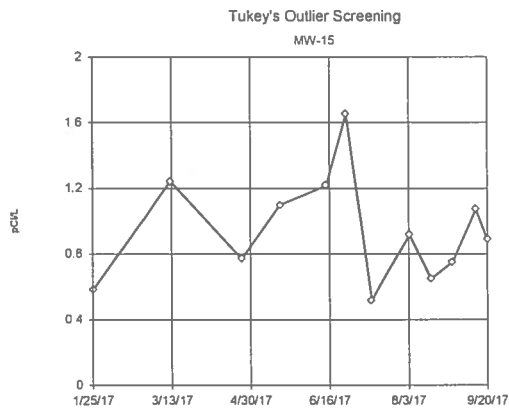


Senza™ v 9.0.0 Groundwater Data Consulting, LLC

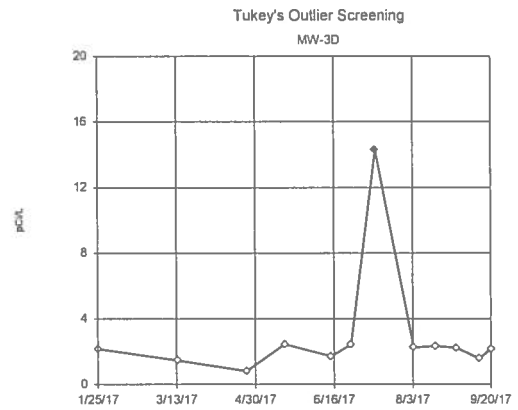


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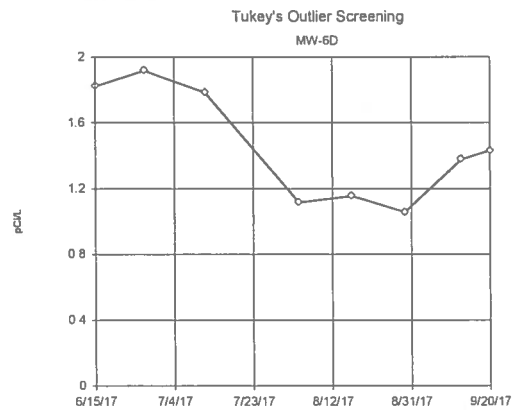




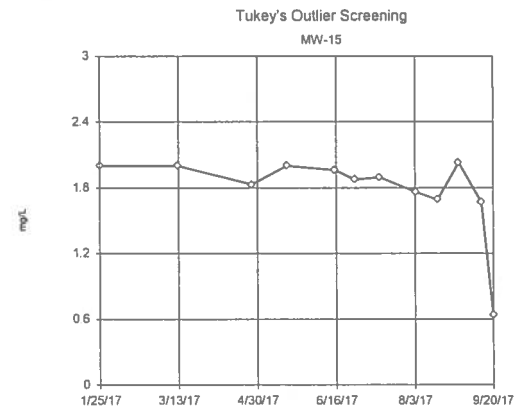
Constituent: Combined Radium 226 + 228 Analysis Run 1/2/2018 10:15 PM View: Tukey's Outlier Screen
Northeastern LF Client: Geosyntec Data: Northeastern LF



Constituent: Combined Radium 226 + 228 Analysis Run 1/2/2018 10:15 PM View: Tukey's Outlier Screen
Northeastern LF Client: Geosyntec Data: Northeastern LF

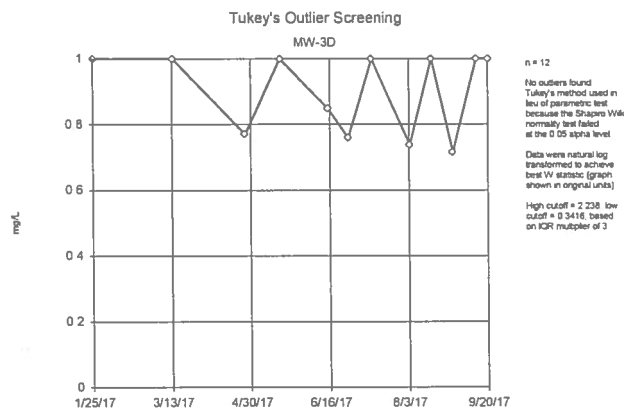


Constituent: Combined Radium 226 + 228 Analysis Run 1/2/2018 10:15 PM View: Tukey's Outlier Screen
Northeastern LF Client: Geosyntec Data: Northeastern LF



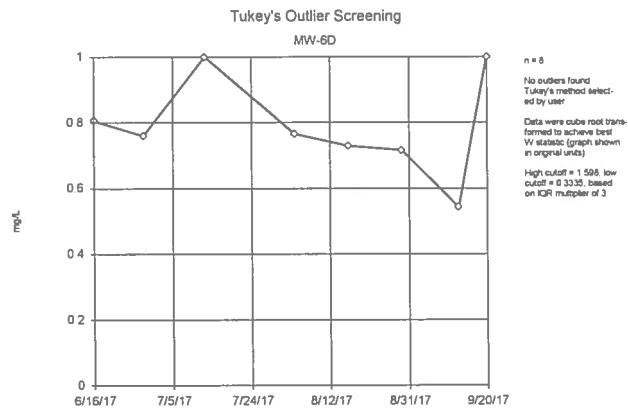
Constituent: Fluoride Analysis Run 1/2/2018 10:15 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

Seabrook - 9800 Groundwater Status Consulting, UG



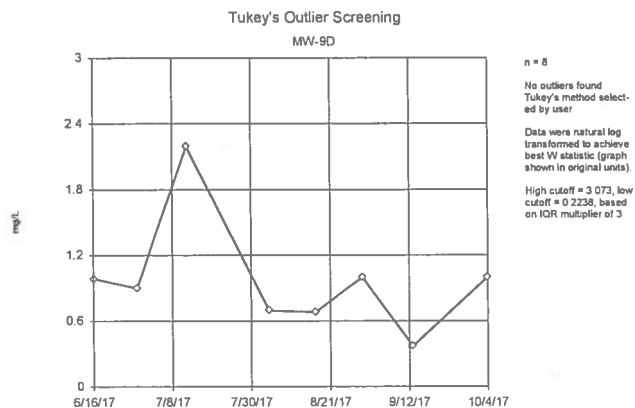
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Northeastern LF Client: Geosyntec Data: Northeastern LF

Seabrook - 9800 Groundwater Status Consulting, UG



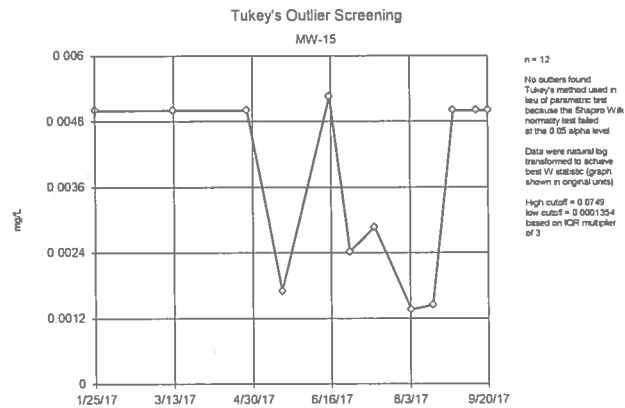
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Northeastern LF Client: Geosyntec Data: Northeastern LF

Seabrook - 9800 Groundwater Status Consulting, UG

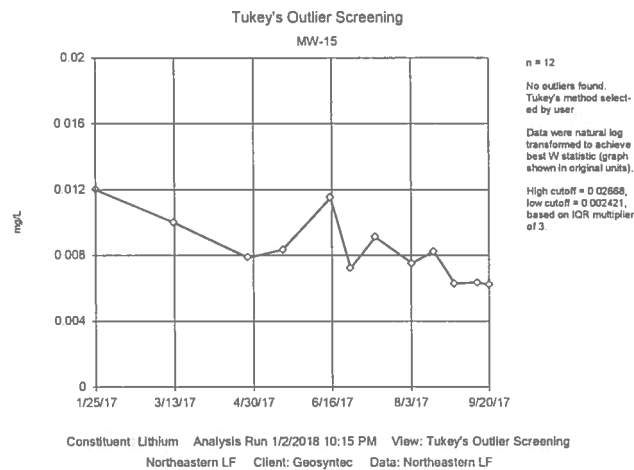
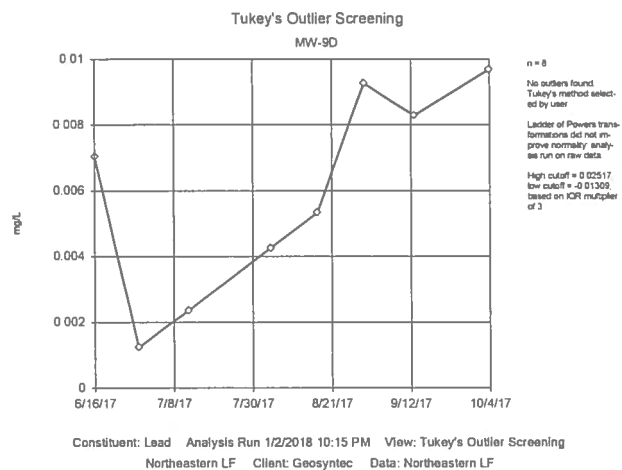
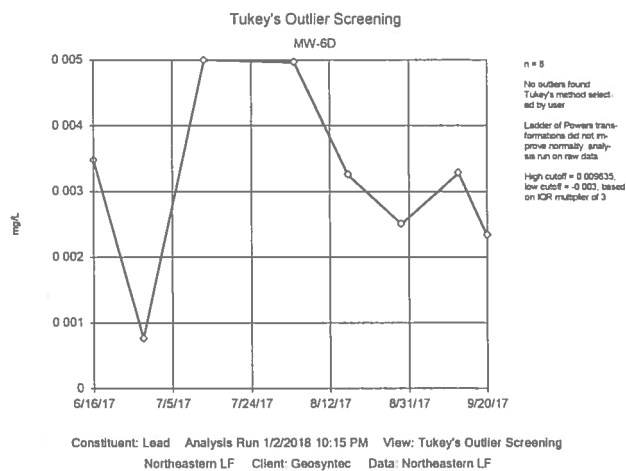
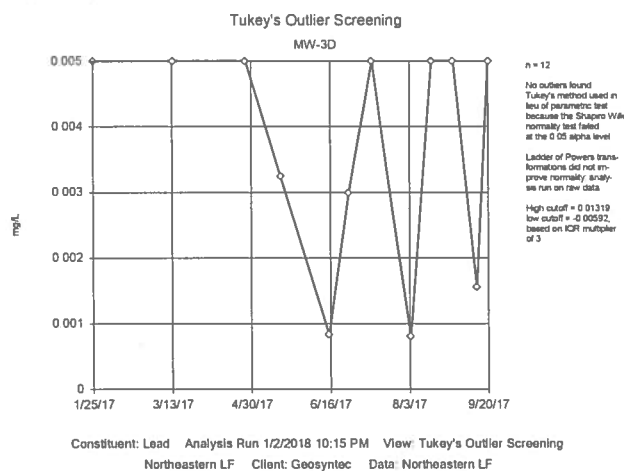


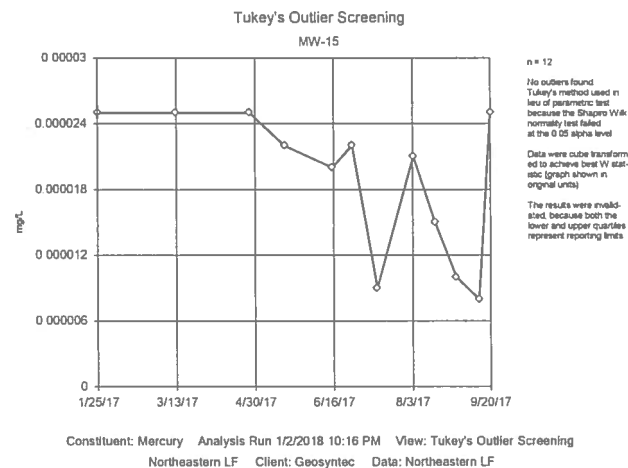
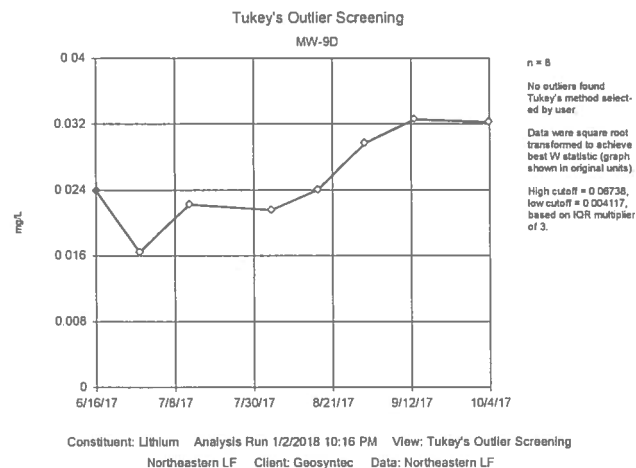
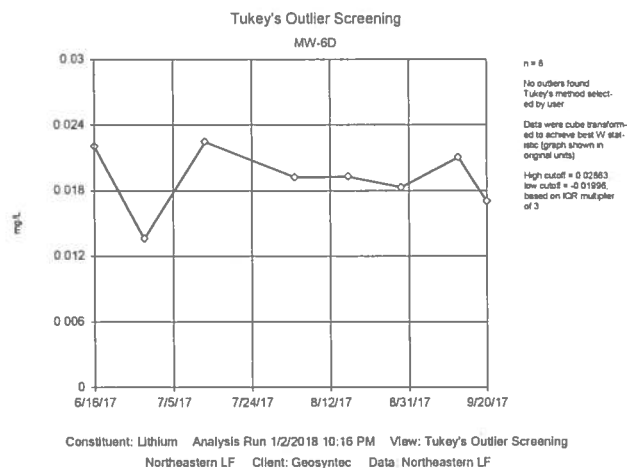
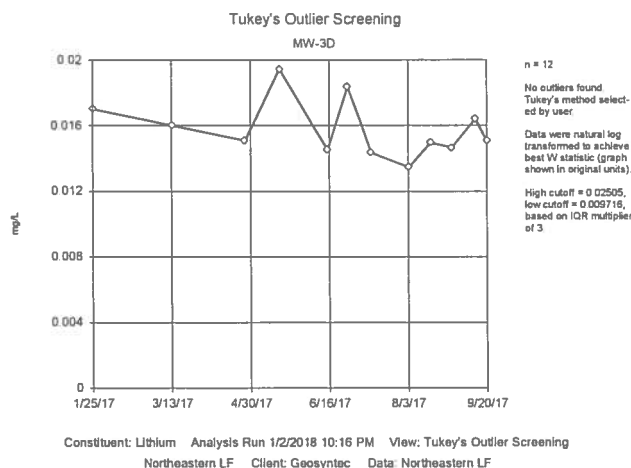
Constituent: Fluoride Analysis Run 1/2/2018 10:15 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

Seabrook - 9800 Groundwater Status Consulting, UG

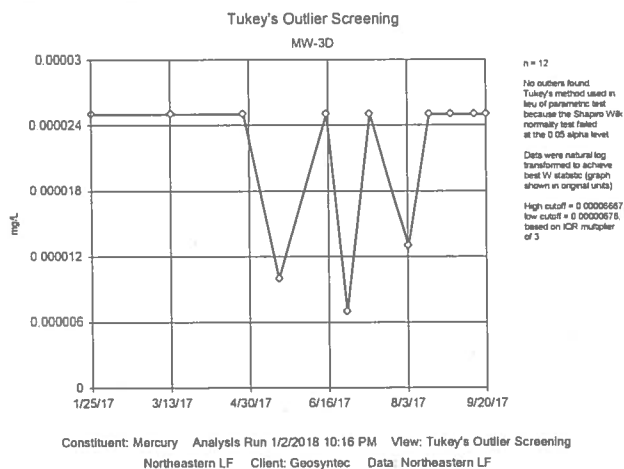


Constituent: Lead Analysis Run 1/2/2018 10:15 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

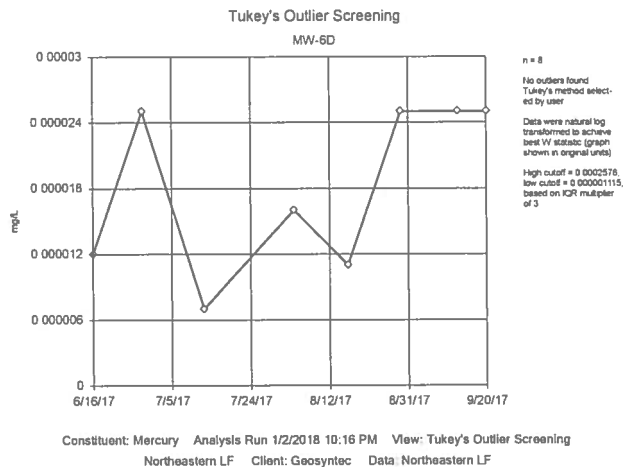




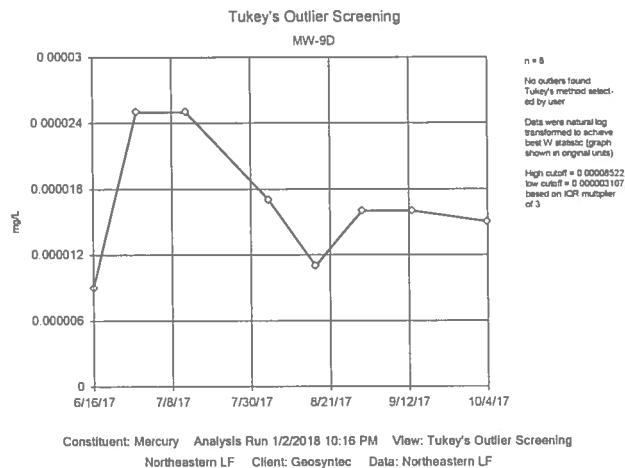
Santos™ v 9.6.00 Groundwater Data Consulting, LLC



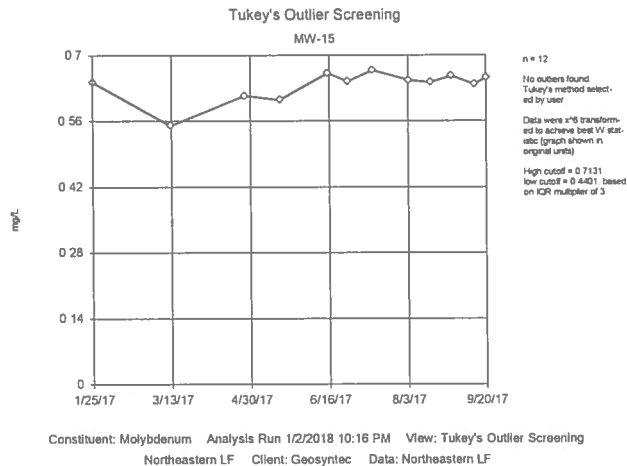
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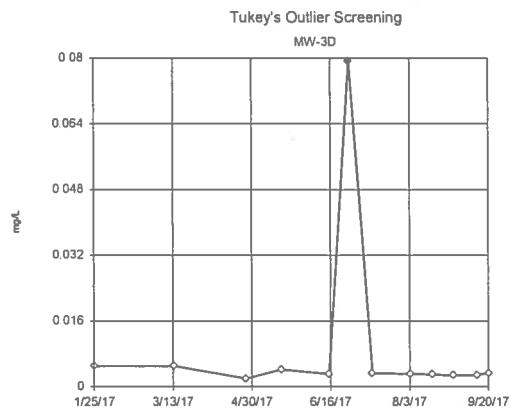


Santos™ v 9.6.00 Groundwater Data Consulting, LLC

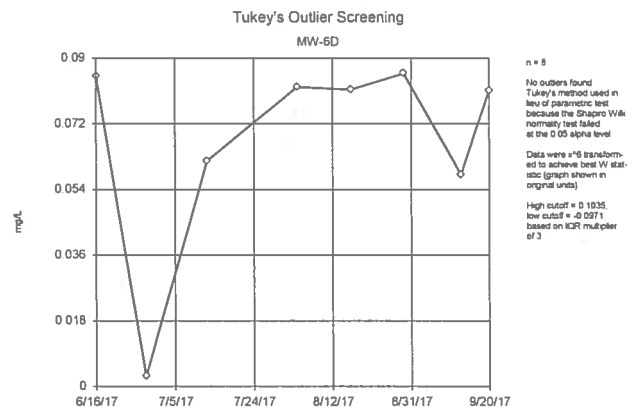


Santos™ v 9.6.00 Groundwater Data Consulting, LLC

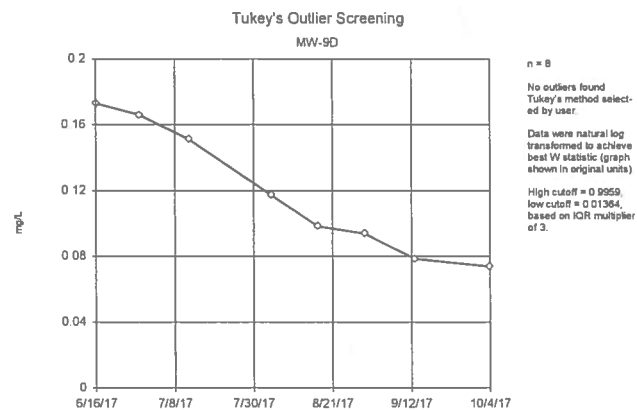




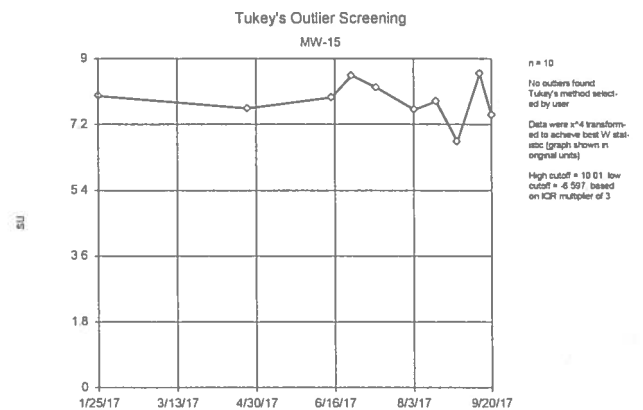
Constituent: Molybdenum Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF



Constituent: Molybdenum Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

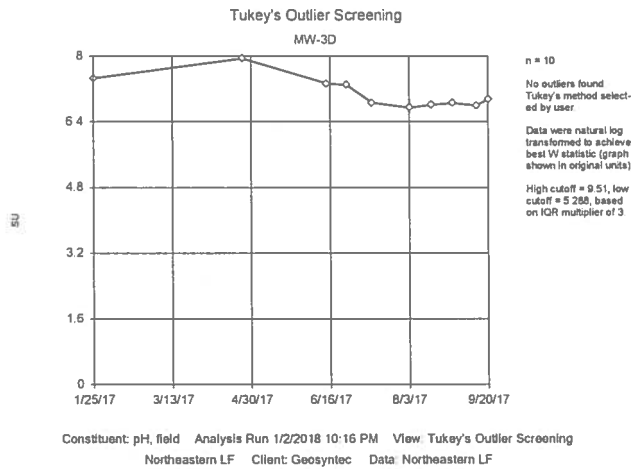


Constituent: Molybdenum Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

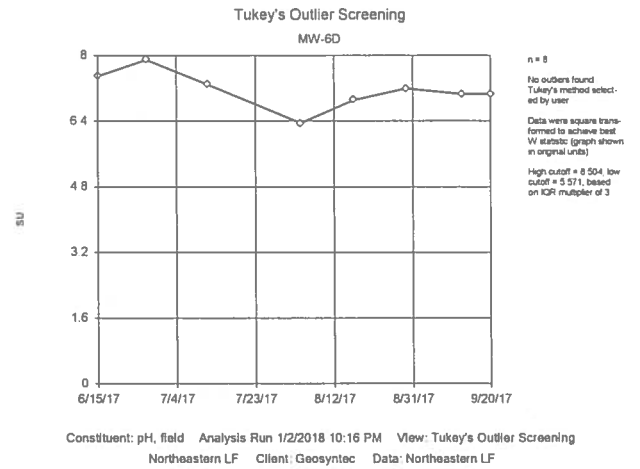


Constituent: pH, field Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

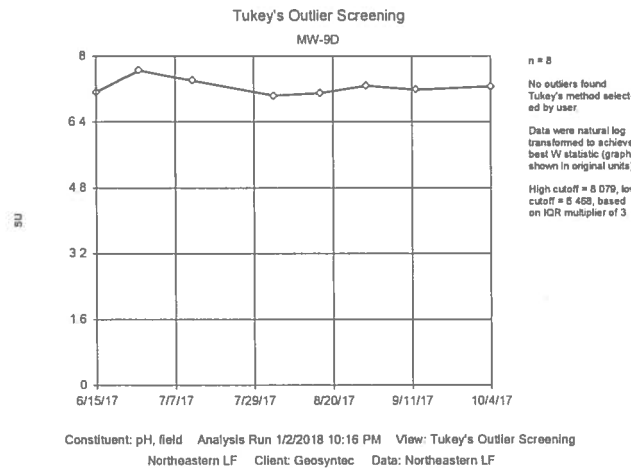
Series1 ~ v 9.6.00 Groundwater Data Consulting, LLC



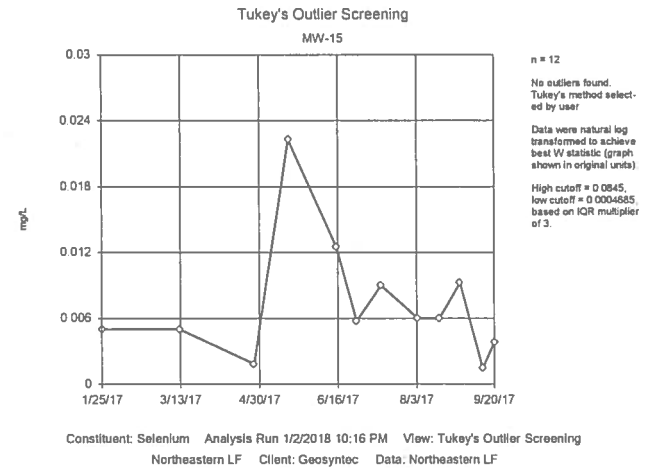
Series1 ~ v 9.6.00 Groundwater Data Consulting, LLC



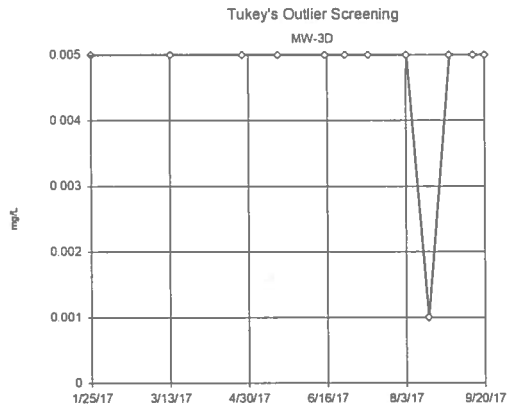
Series1 ~ v 9.6.00 Groundwater Data Consulting, LLC



Series1 ~ v 9.6.00 Groundwater Data Consulting, LLC

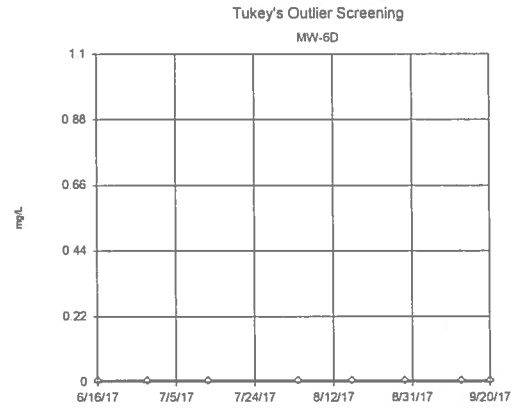


Series1 ~ 9.8 00 Groundwater Data Consulting, LLC



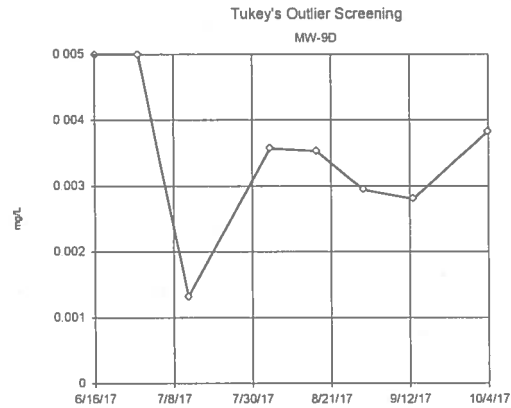
Constituent: Selenium Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series1 ~ 9.8 00 Groundwater Data Consulting, LLC



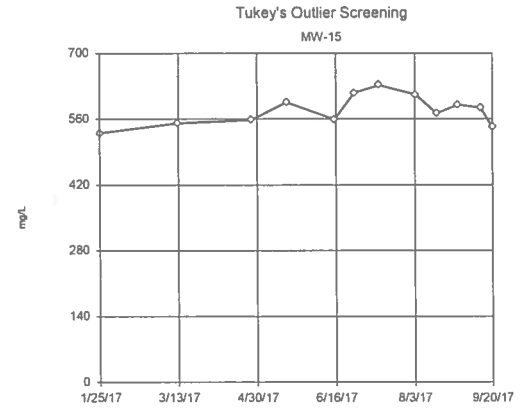
Constituent: Selenium Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series1 ~ 9.8 00 Groundwater Data Consulting, LLC



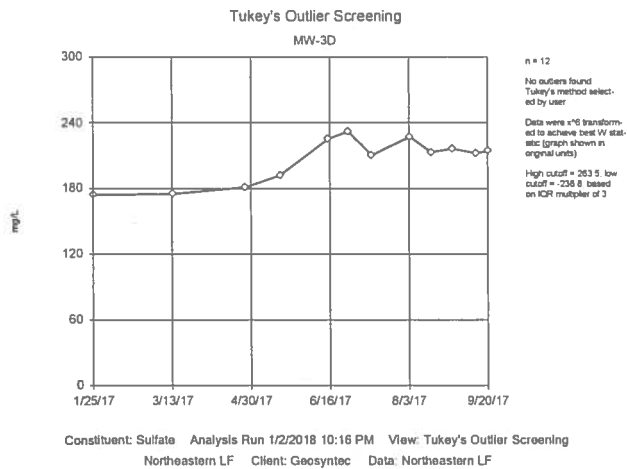
Constituent: Selenium Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

Series1 ~ 9.8 00 Groundwater Data Consulting, LLC

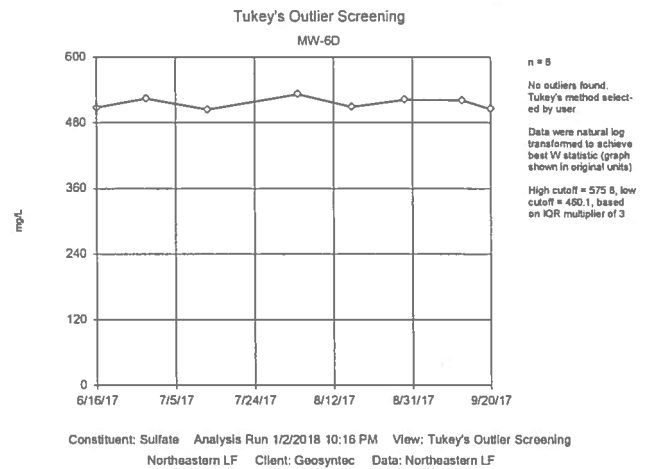


Constituent: Sulfate Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF

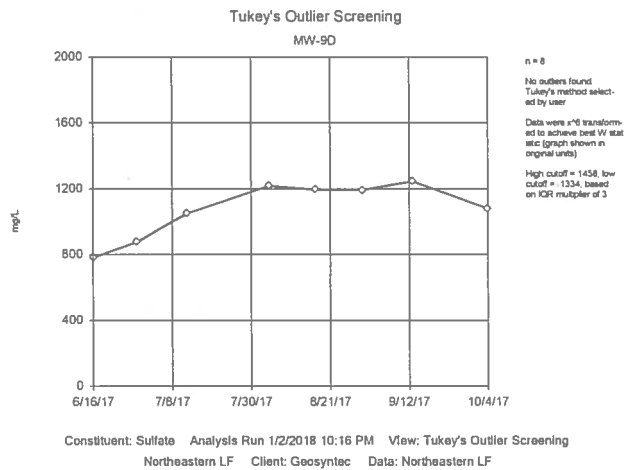
Sendes™ v 9.0.00 Groundwater Data Consulting, LLC



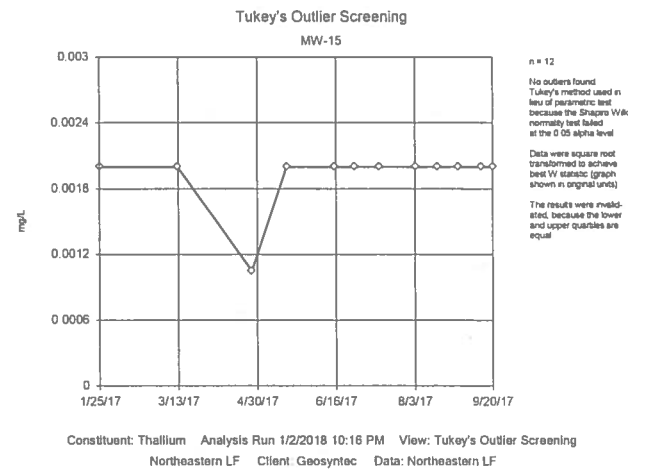
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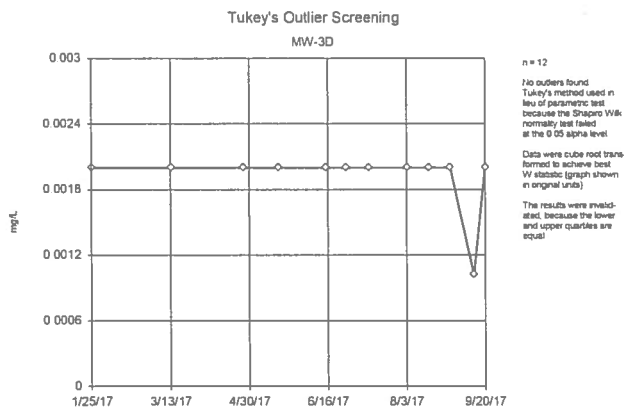


Sendes™ v 9.0.00 Groundwater Data Consulting, LLC

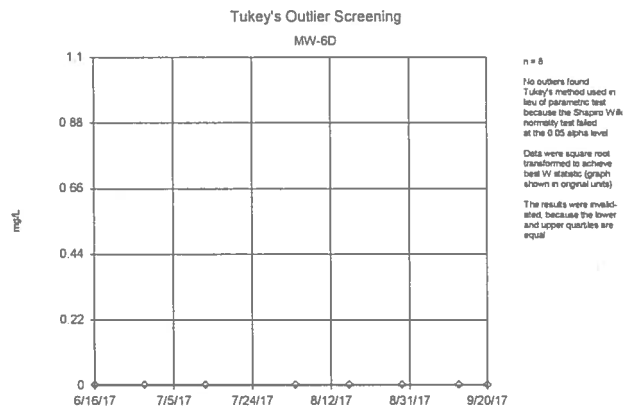


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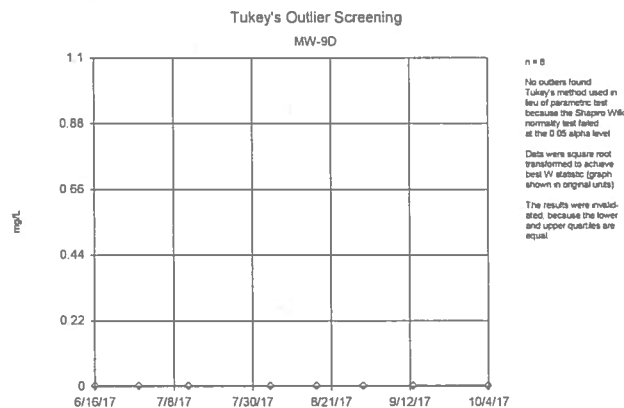




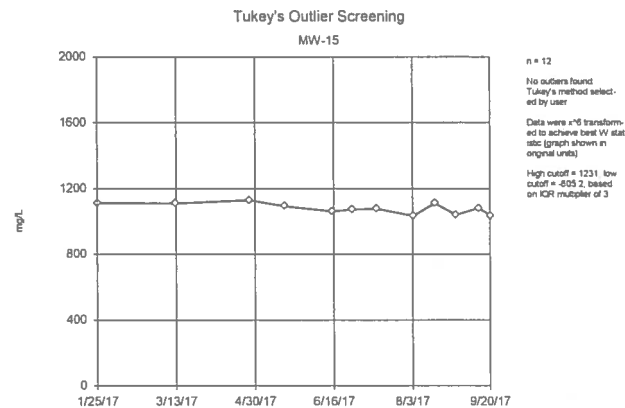
Constituent: Thallium Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF



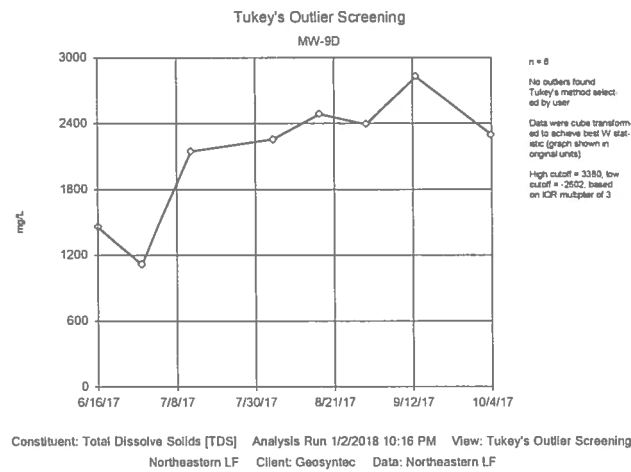
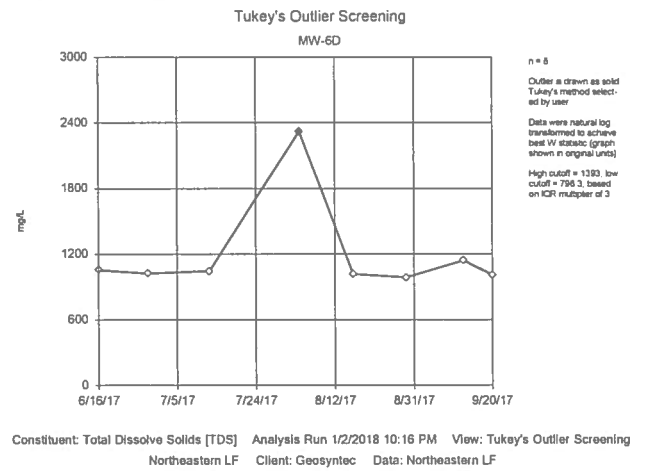
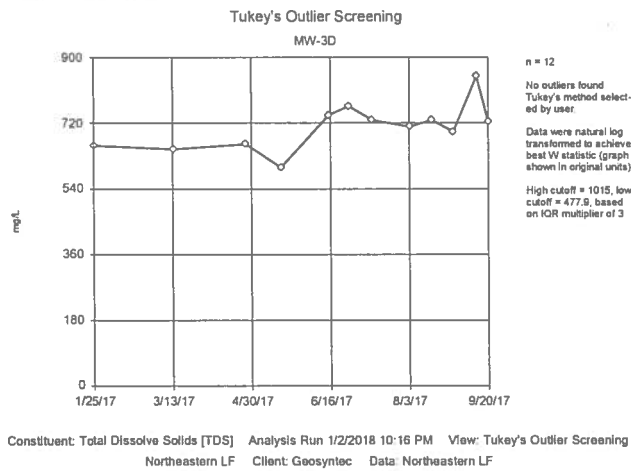
Constituent: Thallium Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF



Constituent: Thallium Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF



Constituent: Total Dissolve Solids [TDS] Analysis Run 1/2/2018 10:16 PM View: Tukey's Outlier Screening
Northeastern LF Client: Geosyntec Data: Northeastern LF



Trend Tests Summary Table - Significant Results

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/2/2018, 10:28 PM

| <u>Constituent</u> | <u>Well</u> | <u>Slope</u> | <u>Calc.</u> | <u>Critical</u> | <u>Sig.</u> | <u>N</u> | <u>%NDs</u> | <u>Normality</u> | <u>Xform</u> | <u>Alpha</u> | <u>Method</u> |
|------------------------------------|-------------|--------------|--------------|-----------------|-------------|----------|-------------|------------------|--------------|--------------|---------------|
| Barium (mg/L) | MW-7D (bg) | 2.758 | 32 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Barium (mg/L) | MW-9D | 1.295 | 22 | 21 | Yes | 8 | 0 | n/a | n/a | 0.01 | NP |
| Beryllium (mg/L) | MW-7D (bg) | 0.003984 | 32 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Calcium (mg/L) | MW-7D (bg) | 675.4 | 30 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Chloride (mg/L) | MW-15 | -26.93 | -41 | -34 | Yes | 11 | 0 | n/a | n/a | 0.01 | NP |
| Chloride (mg/L) | MW-3D | -6.518 | -38 | -34 | Yes | 11 | 0 | n/a | n/a | 0.01 | NP |
| Chromium (mg/L) | MW-7D (bg) | 0.1097 | 30 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Cobalt (mg/L) | MW-7D (bg) | 0.02943 | 28 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Lead (mg/L) | MW-7D (bg) | 0.04368 | 34 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Lithium (mg/L) | MW-15 | -0.007242 | -42 | -38 | Yes | 12 | 0 | n/a | n/a | 0.01 | NP |
| Molybdenum (mg/L) | MW-9D | -0.3866 | -28 | -21 | Yes | 8 | 0 | n/a | n/a | 0.01 | NP |
| Total Dissolve Solids [TDS] (mg/L) | MW-7D (bg) | 6905 | 30 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Total Dissolve Solids [TDS] (mg/L) | MW-8D (bg) | 6248 | 39 | 34 | Yes | 11 | 0 | n/a | n/a | 0.01 | NP |

Trend Tests Summary Table - All Results

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/2/2018, 10:28 PM

| Constituent | Well | Slope | Calc. | Critical | Sig. | N | %NDs | Normality | Xform | Alpha | Method |
|------------------|------------|------------|-------|----------|------|----|-------|-----------|-------|-------|--------|
| Antimony (mg/L) | MW-7D (bg) | 0 | -4 | -25 | No | 9 | 44.44 | n/a | n/a | 0.01 | NP |
| Antimony (mg/L) | MW-8D (bg) | -0.0008848 | -4 | -34 | No | 11 | 9.091 | n/a | n/a | 0.01 | NP |
| Antimony (mg/L) | MW-15 | 0 | 3 | 38 | No | 12 | 58.33 | n/a | n/a | 0.01 | NP |
| Antimony (mg/L) | MW-3D | 0 | -7 | -38 | No | 12 | 83.33 | n/a | n/a | 0.01 | NP |
| Antimony (mg/L) | MW-6D | 0 | -6 | -21 | No | 8 | 62.5 | n/a | n/a | 0.01 | NP |
| Antimony (mg/L) | MW-9D | 0 | 0 | 21 | No | 8 | 100 | n/a | n/a | 0.01 | NP |
| Arsenic (mg/L) | MW-7D (bg) | 0.01562 | 12 | 25 | No | 9 | 0 | n/a | n/a | 0.01 | NP |
| Arsenic (mg/L) | MW-8D (bg) | 0.001884 | 3 | 34 | No | 11 | 9.091 | n/a | n/a | 0.01 | NP |
| Arsenic (mg/L) | MW-15 | -0.001524 | -13 | -38 | No | 12 | 16.67 | n/a | n/a | 0.01 | NP |
| Arsenic (mg/L) | MW-3D | -0.001668 | -21 | -38 | No | 12 | 50 | n/a | n/a | 0.01 | NP |
| Arsenic (mg/L) | MW-6D | -0.004025 | -9 | -21 | No | 8 | 37.5 | n/a | n/a | 0.01 | NP |
| Arsenic (mg/L) | MW-9D | 0 | 0 | 21 | No | 8 | 100 | n/a | n/a | 0.01 | NP |
| Barium (mg/L) | MW-7D (bg) | 2.758 | 32 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Barium (mg/L) | MW-8D (bg) | 3.65 | 15 | 34 | No | 11 | 0 | n/a | n/a | 0.01 | NP |
| Barium (mg/L) | MW-15 | -0.07315 | -22 | -38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Barium (mg/L) | MW-3D | 0.3013 | 28 | 38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Barium (mg/L) | MW-6D | -0.1567 | -14 | -21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Barium (mg/L) | MW-9D | 1.295 | 22 | 21 | Yes | 8 | 0 | n/a | n/a | 0.01 | NP |
| Beryllium (mg/L) | MW-7D (bg) | 0.003984 | 32 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Beryllium (mg/L) | MW-8D (bg) | -0.0004205 | -6 | -34 | No | 11 | 18.18 | n/a | n/a | 0.01 | NP |
| Beryllium (mg/L) | MW-15 | -0.000982 | -30 | -38 | No | 12 | 41.67 | n/a | n/a | 0.01 | NP |
| Beryllium (mg/L) | MW-3D | -0.001158 | -20 | -38 | No | 12 | 25 | n/a | n/a | 0.01 | NP |
| Beryllium (mg/L) | MW-6D | 0.0002463 | 7 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Beryllium (mg/L) | MW-9D | 0.0007039 | 10 | 21 | No | 8 | 12.5 | n/a | n/a | 0.01 | NP |
| Boron (mg/L) | MW-7D (bg) | -1.397 | -24 | -25 | No | 9 | 0 | n/a | n/a | 0.01 | NP |
| Boron (mg/L) | MW-8D (bg) | 0.1352 | 30 | 34 | No | 11 | 0 | n/a | n/a | 0.01 | NP |
| Boron (mg/L) | MW-15 | 0.05173 | 0 | 38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Boron (mg/L) | MW-3D | -0.1204 | -23 | -34 | No | 11 | 0 | n/a | n/a | 0.01 | NP |
| Boron (mg/L) | MW-6D | 0.797 | 4 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Boron (mg/L) | MW-9D | -1.731 | -16 | -21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Cadmium (mg/L) | MW-7D (bg) | 0.004366 | 17 | 25 | No | 9 | 11.11 | n/a | n/a | 0.01 | NP |
| Cadmium (mg/L) | MW-8D (bg) | 0.0006978 | 3 | 34 | No | 11 | 0 | n/a | n/a | 0.01 | NP |
| Cadmium (mg/L) | MW-15 | 0 | 1 | 38 | No | 12 | 66.67 | n/a | n/a | 0.01 | NP |
| Cadmium (mg/L) | MW-3D | -0.0009236 | -24 | -38 | No | 12 | 16.67 | n/a | n/a | 0.01 | NP |
| Cadmium (mg/L) | MW-6D | -0.00166 | -12 | -21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Cadmium (mg/L) | MW-9D | 0.002329 | 6 | 21 | No | 8 | 12.5 | n/a | n/a | 0.01 | NP |
| Calcium (mg/L) | MW-7D (bg) | 675.4 | 30 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Calcium (mg/L) | MW-8D (bg) | 124.3 | 10 | 34 | No | 11 | 0 | n/a | n/a | 0.01 | NP |
| Calcium (mg/L) | MW-15 | -29.89 | -16 | -38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Calcium (mg/L) | MW-3D | 44.4 | 26 | 38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Calcium (mg/L) | MW-6D | 62.62 | 4 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Calcium (mg/L) | MW-9D | 537.8 | 16 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Chloride (mg/L) | MW-7D (bg) | 1721 | 18 | 25 | No | 9 | 0 | n/a | n/a | 0.01 | NP |
| Chloride (mg/L) | MW-8D (bg) | 568.5 | 5 | 34 | No | 11 | 0 | n/a | n/a | 0.01 | NP |
| Chloride (mg/L) | MW-15 | -26.93 | -41 | -34 | Yes | 11 | 0 | n/a | n/a | 0.01 | NP |
| Chloride (mg/L) | MW-3D | -6.518 | -38 | -34 | Yes | 11 | 0 | n/a | n/a | 0.01 | NP |
| Chloride (mg/L) | MW-6D | 12.4 | 20 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Chloride (mg/L) | MW-9D | 160.8 | 2 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Chromium (mg/L) | MW-7D (bg) | 0.1097 | 30 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Chromium (mg/L) | MW-8D (bg) | 0.002444 | 12 | 34 | No | 11 | 18.18 | n/a | n/a | 0.01 | NP |
| Chromium (mg/L) | MW-15 | -0.003672 | -16 | -38 | No | 12 | 8.333 | n/a | n/a | 0.01 | NP |
| Chromium (mg/L) | MW-3D | 0.00314 | 14 | 38 | No | 12 | 8.333 | n/a | n/a | 0.01 | NP |
| Chromium (mg/L) | MW-6D | 0.004402 | 6 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Chromium (mg/L) | MW-9D | 0.0501 | 16 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Cobalt (mg/L) | MW-7D (bg) | 0.02943 | 28 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |

Trend Tests Summary Table - All Results

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Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/2/2018, 10:28 PM

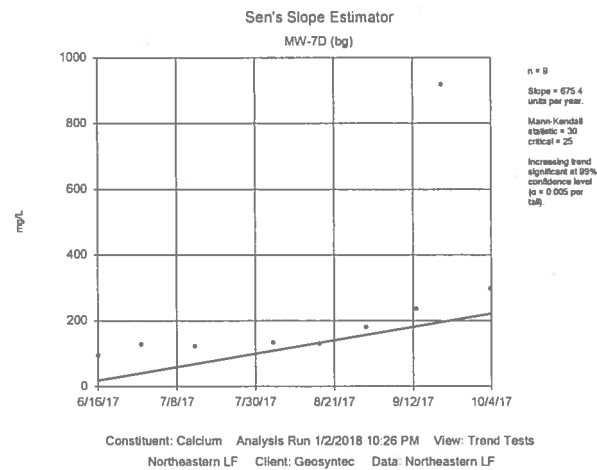
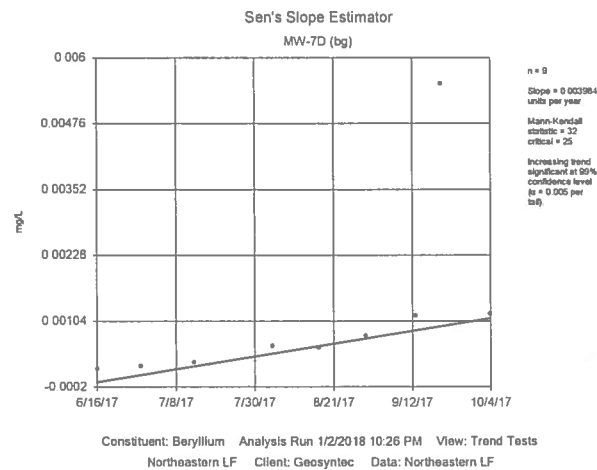
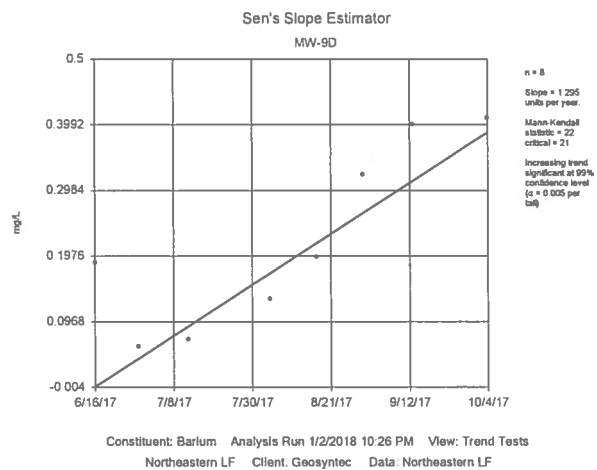
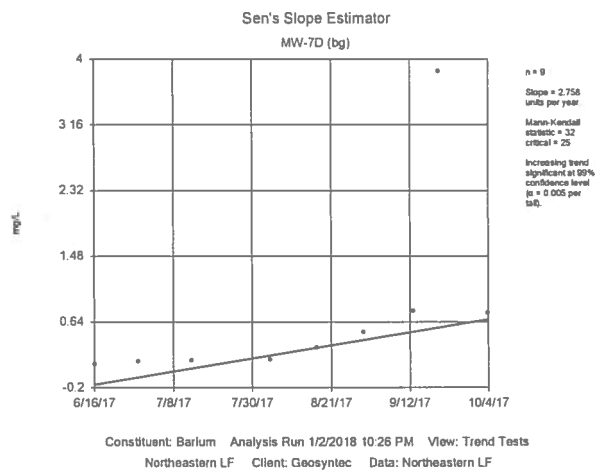
| Constituent | Well | Slope | Calc. | Critical | Sig. | N | %NDs | Normality | Xform | Alpha | Method |
|-----------------------------------|------------|-------------|-------|----------|------|----|-------|-----------|-------|-------|--------|
| Cobalt (mg/L) | MW-8D (bg) | 0 | 0 | 34 | No | 11 | 18.18 | n/a | n/a | 0.01 | NP |
| Cobalt (mg/L) | MW-15 | -0.006205 | -23 | -38 | No | 12 | 16.67 | n/a | n/a | 0.01 | NP |
| Cobalt (mg/L) | MW-3D | -0.00392 | -15 | -38 | No | 12 | 16.67 | n/a | n/a | 0.01 | NP |
| Cobalt (mg/L) | MW-6D | -0.00297 | -8 | -21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Cobalt (mg/L) | MW-9D | 0.01751 | 18 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Combined Radium 226 + 228 (pCi/L) | MW-7D (bg) | -0.7352 | -4 | -21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Combined Radium 226 + 228 (pCi/L) | MW-8D (bg) | 2.841 | 8 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Combined Radium 226 + 228 (pCi/L) | MW-15 | -0.09224 | -4 | -38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Combined Radium 226 + 228 (pCi/L) | MW-3D | 0.1043 | 3 | 34 | No | 11 | 0 | n/a | n/a | 0.01 | NP |
| Combined Radium 226 + 228 (pCi/L) | MW-6D | -1.969 | -10 | -21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Combined Radium 226 + 228 (pCi/L) | MW-9D | 4.147 | NaN | NaN | No | 3 | 0 | n/a | n/a | NaN | NP |
| Fluoride (mg/L) | MW-7D (bg) | 3.568 | 14 | 25 | No | 9 | 11.11 | n/a | n/a | 0.01 | NP |
| Fluoride (mg/L) | MW-8D (bg) | 0 | 6 | 34 | No | 11 | 90.91 | n/a | n/a | 0.01 | NP |
| Fluoride (mg/L) | MW-15 | -0.6635 | -35 | -38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Fluoride (mg/L) | MW-3D | 0 | -7 | -38 | No | 12 | 50 | n/a | n/a | 0.01 | NP |
| Fluoride (mg/L) | MW-6D | -0.4033 | -9 | -21 | No | 8 | 25 | n/a | n/a | 0.01 | NP |
| Fluoride (mg/L) | MW-9D | -1.691 | -5 | -21 | No | 8 | 25 | n/a | n/a | 0.01 | NP |
| Lead (mg/L) | MW-7D (bg) | 0.04368 | 34 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Lead (mg/L) | MW-8D (bg) | -0.002385 | -4 | -34 | No | 11 | 18.18 | n/a | n/a | 0.01 | NP |
| Lead (mg/L) | MW-15 | 0 | -5 | -38 | No | 12 | 50 | n/a | n/a | 0.01 | NP |
| Lead (mg/L) | MW-3D | 0 | -7 | -38 | No | 12 | 58.33 | n/a | n/a | 0.01 | NP |
| Lead (mg/L) | MW-6D | -0.003664 | -8 | -21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Lead (mg/L) | MW-9D | 0.03008 | 18 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Lithium (mg/L) | MW-7D (bg) | 0.2229 | 19 | 25 | No | 9 | 0 | n/a | n/a | 0.01 | NP |
| Lithium (mg/L) | MW-8D (bg) | -0.05141 | -2 | -34 | No | 11 | 0 | n/a | n/a | 0.01 | NP |
| Lithium (mg/L) | MW-15 | -0.007242 | -42 | -38 | Yes | 12 | 0 | n/a | n/a | 0.01 | NP |
| Lithium (mg/L) | MW-3D | -0.00293 | -15 | -38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Lithium (mg/L) | MW-6D | -0.01464 | -6 | -21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Lithium (mg/L) | MW-9D | 0.05519 | 18 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Mercury (mg/L) | MW-7D (bg) | 0.00008047 | 18 | 25 | No | 9 | 11.11 | n/a | n/a | 0.01 | NP |
| Mercury (mg/L) | MW-8D (bg) | 0.00000869 | 14 | 34 | No | 11 | 27.27 | n/a | n/a | 0.01 | NP |
| Mercury (mg/L) | MW-15 | -0.00001855 | -33 | -38 | No | 12 | 33.33 | n/a | n/a | 0.01 | NP |
| Mercury (mg/L) | MW-3D | 0 | 4 | 38 | No | 12 | 75 | n/a | n/a | 0.01 | NP |
| Mercury (mg/L) | MW-6D | 0.00004557 | 10 | 21 | No | 8 | 50 | n/a | n/a | 0.01 | NP |
| Mercury (mg/L) | MW-9D | -0.0000112 | -6 | -21 | No | 8 | 25 | n/a | n/a | 0.01 | NP |
| Molybdenum (mg/L) | MW-7D (bg) | 0.06326 | 24 | 25 | No | 9 | 0 | n/a | n/a | 0.01 | NP |
| Molybdenum (mg/L) | MW-8D (bg) | 0.0002808 | 2 | 34 | No | 11 | 18.18 | n/a | n/a | 0.01 | NP |
| Molybdenum (mg/L) | MW-15 | 0.05851 | 18 | 38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Molybdenum (mg/L) | MW-3D | -0.003103 | -20 | -34 | No | 11 | 18.18 | n/a | n/a | 0.01 | NP |
| Molybdenum (mg/L) | MW-6D | 0.00008302 | 0 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Molybdenum (mg/L) | MW-9D | -0.3866 | -28 | -21 | Yes | 8 | 0 | n/a | n/a | 0.01 | NP |
| pH, field (SU) | MW-7D (bg) | -1.4 | -6 | -25 | No | 9 | 0 | n/a | n/a | 0.01 | NP |
| pH, field (SU) | MW-8D (bg) | -0.8495 | -24 | -25 | No | 9 | 0 | n/a | n/a | 0.01 | NP |
| pH, field (SU) | MW-15 | -0.6373 | -9 | -30 | No | 10 | 0 | n/a | n/a | 0.01 | NP |
| pH, field (SU) | MW-3D | -1.376 | -25 | -30 | No | 10 | 0 | n/a | n/a | 0.01 | NP |
| pH, field (SU) | MW-6D | -1.72 | -11 | -21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| pH, field (SU) | MW-9D | -0.1912 | -2 | -21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Selenium (mg/L) | MW-7D (bg) | 0.05794 | 16 | 25 | No | 9 | 0 | n/a | n/a | 0.01 | NP |
| Selenium (mg/L) | MW-8D (bg) | 0.00008946 | 3 | 34 | No | 11 | 9.091 | n/a | n/a | 0.01 | NP |
| Selenium (mg/L) | MW-15 | -0.001645 | -5 | -38 | No | 12 | 16.67 | n/a | n/a | 0.01 | NP |
| Selenium (mg/L) | MW-3D | 0 | -5 | -38 | No | 12 | 91.67 | n/a | n/a | 0.01 | NP |
| Selenium (mg/L) | MW-6D | 0 | 0 | 21 | No | 8 | 100 | n/a | n/a | 0.01 | NP |
| Selenium (mg/L) | MW-9D | -0.005692 | -9 | -21 | No | 8 | 12.5 | n/a | n/a | 0.01 | NP |
| Sulfate (mg/L) | MW-7D (bg) | 1994 | 22 | 25 | No | 9 | 0 | n/a | n/a | 0.01 | NP |
| Sulfate (mg/L) | MW-8D (bg) | 16.4 | 4 | 34 | No | 11 | 0 | n/a | n/a | 0.01 | NP |

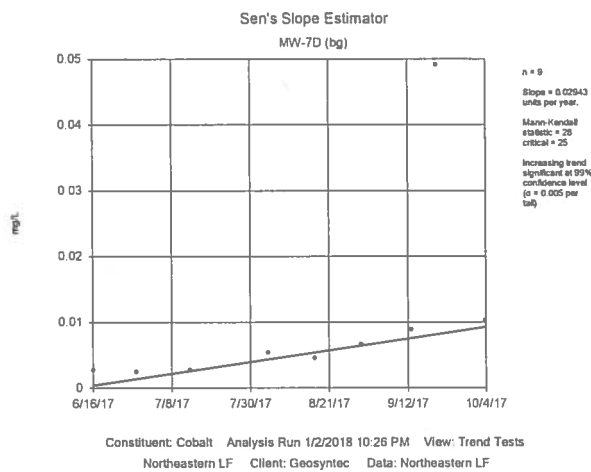
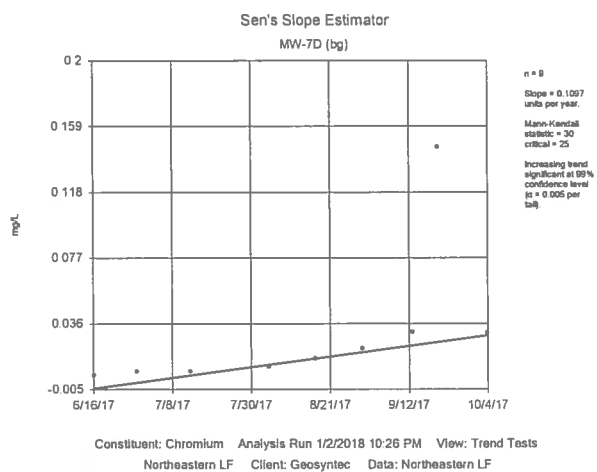
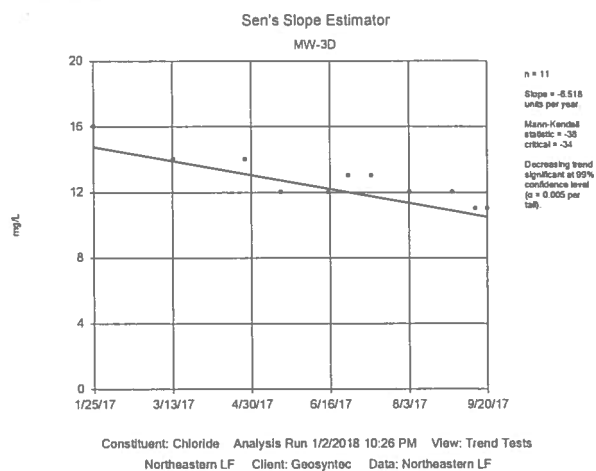
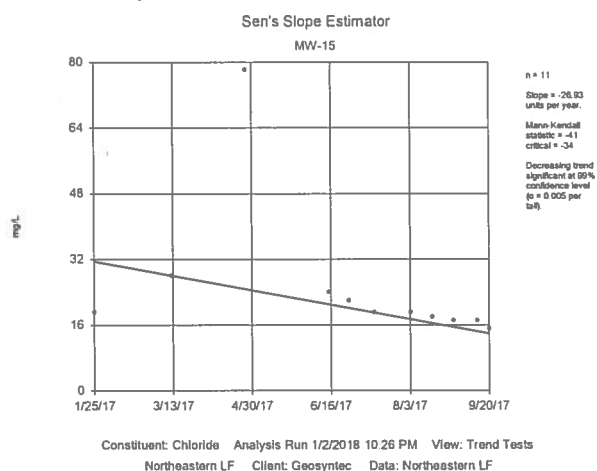
Trend Tests Summary Table - All Results

Page 3

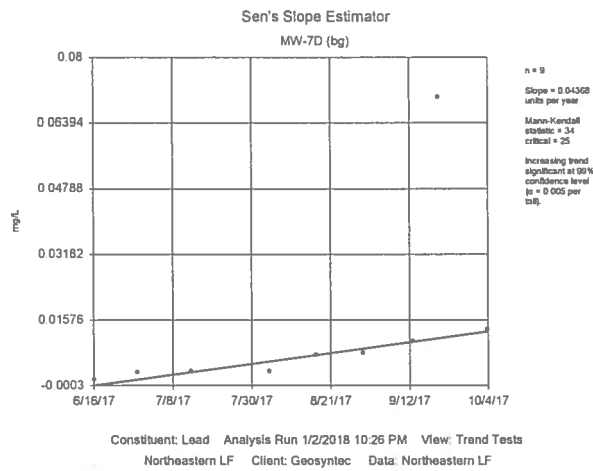
Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/2/2018, 10:28 PM

| <u>Constituent</u> | <u>Well</u> | <u>Slope</u> | <u>Calc.</u> | <u>Critical</u> | <u>Sig.</u> | <u>N</u> | <u>%NDs</u> | <u>Normality</u> | <u>Xform</u> | <u>Alpha</u> | <u>Method</u> |
|------------------------------------|-------------|--------------|--------------|-----------------|-------------|----------|-------------|------------------|--------------|--------------|---------------|
| Sulfate (mg/L) | MW-15 | 66.87 | 14 | 38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Sulfate (mg/L) | MW-3D | 70.21 | 30 | 38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Sulfate (mg/L) | MW-6D | -111.5 | -2 | -21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Sulfate (mg/L) | MW-9D | 1246 | 14 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |
| Thallium (mg/L) | MW-7D (bg) | 0 | 0 | 25 | No | 9 | 100 | n/a | n/a | 0.01 | NP |
| Thallium (mg/L) | MW-8D (bg) | 0 | 0 | 34 | No | 11 | 100 | n/a | n/a | 0.01 | NP |
| Thallium (mg/L) | MW-15 | 0 | 7 | 38 | No | 12 | 91.67 | n/a | n/a | 0.01 | NP |
| Thallium (mg/L) | MW-3D | 0 | -9 | -38 | No | 12 | 91.67 | n/a | n/a | 0.01 | NP |
| Thallium (mg/L) | MW-6D | 0 | 0 | 21 | No | 8 | 100 | n/a | n/a | 0.01 | NP |
| Thallium (mg/L) | MW-9D | 0 | 0 | 21 | No | 8 | 100 | n/a | n/a | 0.01 | NP |
| Total Dissolve Solids [TDS] (mg/L) | MW-7D (bg) | 6905 | 30 | 25 | Yes | 9 | 0 | n/a | n/a | 0.01 | NP |
| Total Dissolve Solids [TDS] (mg/L) | MW-8D (bg) | 6248 | 39 | 34 | Yes | 11 | 0 | n/a | n/a | 0.01 | NP |
| Total Dissolve Solids [TDS] (mg/L) | MW-15 | -111.8 | -31 | -38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Total Dissolve Solids [TDS] (mg/L) | MW-3D | 153.5 | 23 | 38 | No | 12 | 0 | n/a | n/a | 0.01 | NP |
| Total Dissolve Solids [TDS] (mg/L) | MW-6D | -135.2 | -7 | -18 | No | 7 | 0 | n/a | n/a | 0.01 | NP |
| Total Dissolve Solids [TDS] (mg/L) | MW-9D | 4474 | 18 | 21 | No | 8 | 0 | n/a | n/a | 0.01 | NP |

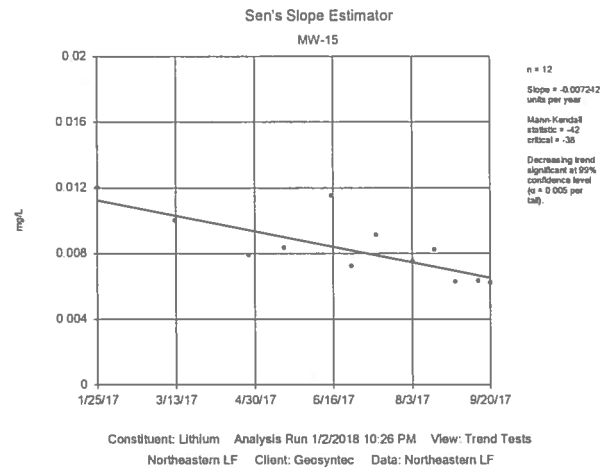




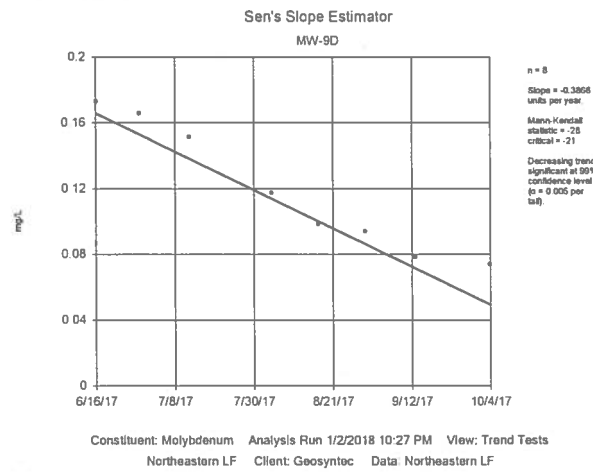
Series 1 ~ 9.600 Groundwater Data Consulting UG



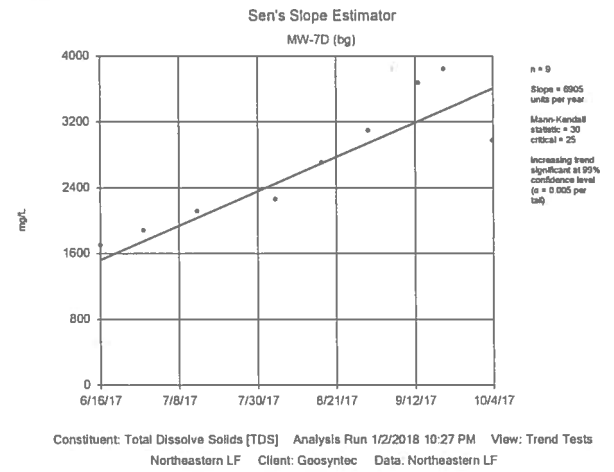
Series 1 ~ 9.600 Groundwater Data Consulting UG

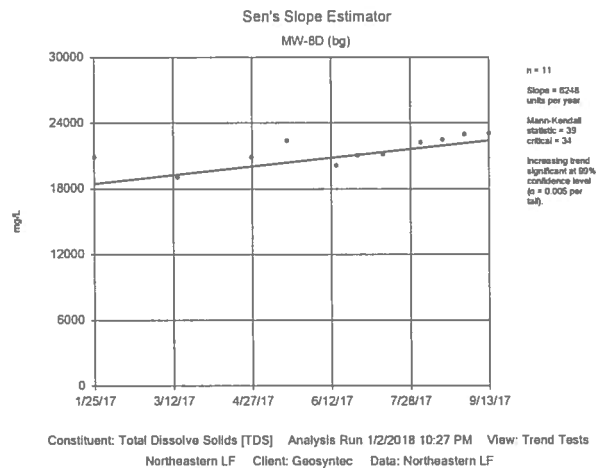


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Series 1 ~ 9.600 Groundwater Data Consulting UG





Analysis of Variance

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/2/2018, 10:36 PM

| <u>Constituent</u> | <u>Crit.</u> | <u>Sig.</u> | <u>Alpha</u> | <u>Transform</u> | <u>ANOVA Sig.</u> | <u>Calc.</u> | <u>Alpha</u> | <u>Method</u> |
|------------------------------------|--------------|-------------|--------------|------------------|-------------------|--------------|--------------|----------------|
| Boron (mg/L) | n/a | n/a | n/a | No | Yes | 4.385 | 0.05 | NP (eq. var.) |
| Calcium (mg/L) | n/a | n/a | n/a | No | Yes | 8.562 | 0.05 | NP (eq. var.) |
| Chloride (mg/L) | n/a | n/a | n/a | sqrt(x) | Yes | 1387 | 0.05 | Param. |
| Fluoride (mg/L) | n/a | n/a | n/a | No | Yes | 4.151 | 0.05 | NP (normality) |
| pH, field (SU) | n/a | n/a | n/a | ln(x) | No | 2.314 | 0.05 | Param. |
| Sulfate (mg/L) | n/a | n/a | n/a | No | Yes | 14.15 | 0.05 | NP (normality) |
| Total Dissolve Solids [TDS] (mg/L) | n/a | n/a | n/a | No | Yes | 1525 | 0.05 | Param. |

Non-Parametric ANOVA

Constituent: Boron Analysis Run 1/2/2018 10:36 PM View: ANOVA
Northeastern LF Client: Geosyntec Data: Northeastern LF

For observations made between 1/25/2017 and 10/4/2017, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 4.385

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

There were 3 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) = 4.365

Adjusted Kruskal-Wallis statistic (H') = 4.385

Non-Parametric ANOVA

Constituent: Calcium Analysis Run 1/2/2018 10:36 PM View: ANOVA
Northeastern LF Client: Geosyntec Data: Northeastern LF

For observations made between 1/25/2017 and 10/4/2017, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 8.562

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

There were 1 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) = 8.556

Adjusted Kruskal-Wallis statistic (H') = 8.562

Parametric ANOVA

Constituent: Chloride Analysis Run 1/2/2018 10:36 PM View: ANOVA
Northeastern LF Client: Geosyntec Data: Northeastern LF

For observations made between 1/25/2017 and 10/4/2017 the parametric analysis of variance test (after square root transformation) indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 1387

Tabulated F statistic = 4.41 with 1 and 18 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Squares | F |
|---------------------|----------------|--------------------|--------------|------|
| Between Groups | 1.7e9 | 1 | 1.7e9 | 1525 |
| Error Within Groups | 2.1e7 | 18 | 1140393 | |
| Total | 1.8e9 | 19 | | |

The Shapiro Wilk normality test on the residuals passed after square root transformation. Alpha = 0.01, calculated = 0.9895, critical = 0.868. Levene's Equality of Variance test passed. Calculated = 0.3135, tabulated = 4.41.

Non-Parametric ANOVA

Constituent: Fluoride Analysis Run 1/2/2018 10:36 PM View: ANOVA
Northeastern LF Client: Geosyntec Data: Northeastern LF

For observations made between 1/25/2017 and 10/4/2017, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 4.151

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

There were 1 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) = 3.465

Adjusted Kruskal-Wallis statistic (H') = 4.151

Parametric ANOVA

Constituent: pH, field Analysis Run 1/2/2018 10:36 PM View: ANOVA
Northeastern LF Client: Geosyntec Data: Northeastern LF

For observations made between 1/25/2017 and 10/4/2017 the parametric analysis of variance test (after natural log transformation) indicates NO VARIATION at the 5% significance level. Because the calculated F statistic is less than or equal to the tabulated F statistic, the hypothesis of a single homogeneous population is accepted.

Calculated F statistic = 2.314

Tabulated F statistic = 4.49 with 1 and 16 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Squares | F |
|---------------------|----------------|--------------------|--------------|------|
| Between Groups | 1.7e9 | 1 | 1.7e9 | 1525 |
| Error Within Groups | 2.1e7 | 18 | 1140393 | |
| Total | 1.8e9 | 19 | | |

The Shapiro Wilk normality test on the residuals passed after natural log transformation. Alpha = 0.05, calculated = 0.9074, critical = 0.897. Levene's Equality of Variance test passed. Calculated = 4.417, tabulated = 4.49.

Non-Parametric ANOVA

Constituent: Sulfate Analysis Run 1/2/2018 10:36 PM View: ANOVA
Northeastern LF Client: Geosyntec Data: Northeastern LF

For observations made between 1/25/2017 and 10/4/2017, the non-parametric analysis of variance test indicates a DIFFERENCE between the medians of the groups tested at the 5% significance level. Because the calculated Kruskal-Wallis statistic is greater than the Chi-squared value, we conclude that at least one group has a significantly different median concentration of this constituent when compared to another group.

Calculated Kruskal-Wallis statistic = 14.15

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

There were 1 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) = 14.14

Adjusted Kruskal-Wallis statistic (H') = 14.15

Parametric ANOVA

Constituent: Total Dissolve Solids [TDS] Analysis Run 1/2/2018 10:36 PM View: ANOVA
Northeastern LF Client: Geosyntec Data: Northeastern LF

For observations made between 1/25/2017 and 10/4/2017 the parametric analysis of variance test indicates VARIATION at the 5% significance level. Because the calculated F statistic is greater than the tabulated F statistic, the hypothesis of a single homogeneous population is rejected.

Calculated F statistic = 1525

Tabulated F statistic = 4.41 with 1 and 18 degrees of freedom at the 5% significance level.

ONE-WAY PARAMETRIC ANOVA TABLE

| Source of Variation | Sum of Squares | Degrees of Freedom | Mean Squares | F |
|---------------------|----------------|--------------------|--------------|------|
| Between Groups | 1.7e9 | 1 | 1.7e9 | 1525 |
| Error Within Groups | 2.1e7 | 18 | 1140393 | |
| Total | 1.8e9 | 19 | | |

The Shapiro Wilk normality test on the residuals passed on the raw data. Alpha = 0.01, calculated = 0.9568, critical = 0.868. Levene's Equality of Variance test passed. Calculated = 3.197, tabulated = 4.41.

Tolerance Limits - Appendix III

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/2/2018, 10:38 PM

| <u>Constituent</u> | <u>Upper Lim.</u> | <u>Lower Lim.</u> | <u>Bq N</u> | <u>Bq Mean</u> | <u>Std. Dev.</u> | <u>%NDs</u> | <u>ND Adj.</u> | <u>Transform</u> | <u>Alpha</u> | <u>Method</u> |
|------------------------------------|-------------------|-------------------|-------------|----------------|------------------|-------------|----------------|------------------|--------------|---------------------|
| Boron (mg/L) | 1.596 | n/a | 20 | 1.261 | 0.1194 | 0 | None | No | 0.01 | Inter |
| Calcium (mg/L) | 1028 | n/a | 20 | 379.7 | 230.8 | 0 | None | No | 0.01 | Inter |
| Chloride (mg/L) | 14606 | n/a | 20 | n/a | n/a | 0 | n/a | n/a | 0.3585 | NP Inter(normality) |
| Fluoride (mg/L) | 3.248 | n/a | 20 | n/a | n/a | 55 | n/a | n/a | 0.3585 | NP Inter(normality) |
| pH, field (SU) | 8.28 | 6.72 | 18 | n/a | n/a | 0 | n/a | n/a | 0.7735 | NP Inter(normality) |
| Sulfate (mg/L) | 1632 | n/a | 20 | n/a | n/a | 0 | n/a | n/a | 0.3585 | NP Inter(normality) |
| Total Dissolve Solids [TDS] (mg/L) | 23012 | n/a | 20 | n/a | n/a | 0 | n/a | n/a | 0.3585 | NP Inter(normality) |

Confidence Interval Summary Table - Significant Results Appendix III

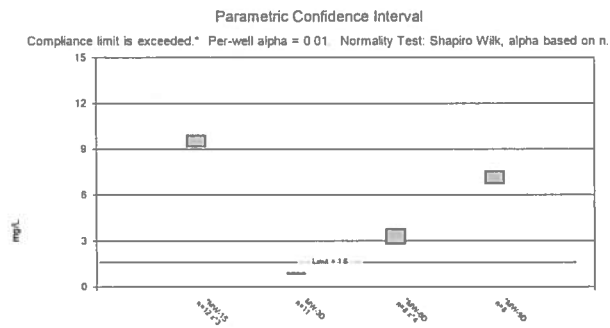
Northeastern LF Client Geosyntec Data Northeastern LF Printed 1/2/2018, 10:40 PM

| <u>Constituent</u> | <u>Well</u> | <u>Upper Lim.</u> | <u>Lower Lim.</u> | <u>Compliance</u> | <u>Sig. N</u> | <u>Mean</u> | <u>Std. Dev.</u> | <u>%NDs</u> | <u>ND Adj.</u> | <u>Transform</u> | <u>Alpha</u> | <u>Method</u> |
|--------------------|-------------|-------------------|-------------------|-------------------|---------------|-------------|------------------|-------------|----------------|------------------|--------------|---------------|
| Boron (mg/L) | MW-15 | 9.88 | 9.177 | 1.6 | Yes 12 | 9.52 | 0.482 | 0 | None | x^3 | 0.01 | Param. |
| Boron (mg/L) | MW-6D | 3.767 | 2.818 | 1.6 | Yes 8 | 3.156 | 0.9525 | 0 | None | x^4 | 0.01 | Param. |
| Boron (mg/L) | MW-9D | 7.537 | 6.756 | 1.6 | Yes 8 | 7.146 | 0.3683 | 0 | None | No | 0.01 | Param. |

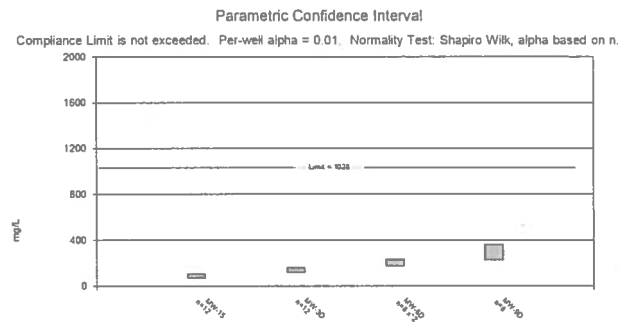
Confidence Interval Summary Table - All Results Appendix III

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 1/2/2018, 10:40 PM

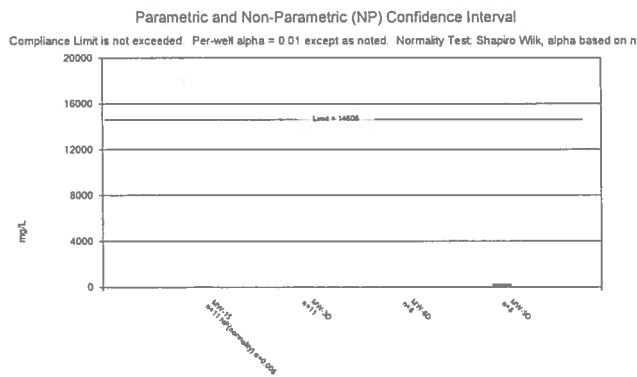
| Constituent | Well | Upper Lim. | Lower Lim. | Compliance | Sig. N | Mean | Std. Dev. | %NDs | ND Adj | Transform | Alpha | Method |
|------------------------------------|-------|------------|------------|------------|--------|--------|-----------|------|---------|-----------|-------|------------------|
| Boron (mg/L) | MW-15 | 9.88 | 9.177 | 1.6 | Yes 12 | 9.52 | 0.482 | 0 | None | x^3 | 0.01 | Param. |
| Boron (mg/L) | MW-3D | 0.9128 | 0.8321 | 1.6 | No 11 | 0.8725 | 0.04844 | 0 | None | No | 0.01 | Param. |
| Boron (mg/L) | MW-6D | 3.767 | 2.818 | 1.6 | Yes 8 | 3.156 | 0.9525 | 0 | None | x^4 | 0.01 | Param. |
| Boron (mg/L) | MW-9D | 7.537 | 6.758 | 1.6 | Yes 8 | 7.146 | 0.3683 | 0 | None | No | 0.01 | Param. |
| Calcium (mg/L) | MW-15 | 101 | 67.59 | 1028 | No 12 | 84.28 | 21.28 | 0 | None | No | 0.01 | Param. |
| Calcium (mg/L) | MW-3D | 156.8 | 120.5 | 1028 | No 12 | 138.7 | 23.13 | 0 | None | No | 0.01 | Param. |
| Calcium (mg/L) | MW-6D | 233 | 173.9 | 1028 | No 8 | 203.5 | 31.18 | 0 | None | x^2 | 0.01 | Param. |
| Calcium (mg/L) | MW-9D | 362.6 | 225.6 | 1028 | No 8 | 294.1 | 64.61 | 0 | None | No | 0.01 | Param. |
| Chloride (mg/L) | MW-15 | 28 | 15 | 14606 | No 11 | 25.09 | 17.92 | 0 | None | No | 0.006 | NP (normality) |
| Chloride (mg/L) | MW-3D | 13.97 | 11.49 | 14606 | No 11 | 12.73 | 1.489 | 0 | None | No | 0.01 | Param. |
| Chloride (mg/L) | MW-6D | 31.72 | 28.78 | 14606 | No 8 | 30.25 | 1.389 | 0 | None | No | 0.01 | Param. |
| Chloride (mg/L) | MW-9D | 247.5 | 63.23 | 14606 | No 8 | 155.4 | 86.93 | 0 | None | No | 0.01 | Param. |
| Fluoride (mg/L) | MW-15 | 1.988 | 1.682 | 3.25 | No 12 | 1.779 | 0.3789 | 0 | None | x^4 | 0.01 | Param. |
| Fluoride (mg/L) | MW-3D | 1 | 0.7381 | 3.25 | No 12 | 0.9024 | 0.1244 | 50 | None | No | 0.01 | NP (normality) |
| Fluoride (mg/L) | MW-6D | 1.013 | 0.6152 | 3.25 | No 8 | 0.7895 | 0.1518 | 25 | Cohen's | No | 0.01 | Param. |
| Fluoride (mg/L) | MW-9D | 2.191 | 0.37 | 3.25 | No 8 | 0.9776 | 0.5368 | 25 | None | No | 0.004 | NP (Cohens/xfrm) |
| pH, field (SU) | MW-15 | 8.412 | 7.292 | 8.28 | No 10 | 7.852 | 0.5446 | 0 | None | No | 0.005 | Param. |
| pH, field (SU) | MW-3D | 7.499 | 6.705 | 8.28 | No 10 | 7.101 | 0.3915 | 0 | None | sqrt(x) | 0.005 | Param. |
| pH, field (SU) | MW-6D | 7.706 | 6.599 | 8.28 | No 8 | 7.153 | 0.4475 | 0 | None | No | 0.005 | Param. |
| pH, field (SU) | MW-9D | 7.5 | 7.012 | 8.28 | No 8 | 7.256 | 0.1972 | 0 | None | No | 0.005 | Param. |
| Sulfate (mg/L) | MW-15 | 603.5 | 553.7 | 1632 | No 12 | 578.6 | 31.72 | 0 | None | No | 0.01 | Param. |
| Sulfate (mg/L) | MW-3D | 221.9 | 190 | 1632 | No 12 | 205.9 | 20.34 | 0 | None | No | 0.01 | Param. |
| Sulfate (mg/L) | MW-6D | 526.7 | 504.6 | 1632 | No 8 | 515.6 | 10.41 | 0 | None | No | 0.01 | Param. |
| Sulfate (mg/L) | MW-9D | 1259 | 898.2 | 1632 | No 8 | 1079 | 170.3 | 0 | None | No | 0.01 | Param. |
| Total Dissolve Solids [TDS] (mg/L) | MW-15 | 1104 | 1053 | 23012 | No 12 | 1079 | 32.67 | 0 | None | No | 0.01 | Param. |
| Total Dissolve Solids [TDS] (mg/L) | MW-3D | 759.5 | 658.5 | 23012 | No 12 | 709 | 64.4 | 0 | None | No | 0.01 | Param. |
| Total Dissolve Solids [TDS] (mg/L) | MW-6D | 1098 | 979.5 | 23012 | No 7 | 1039 | 49.96 | 0 | None | No | 0.01 | Param. |
| Total Dissolve Solids [TDS] (mg/L) | MW-9D | 2717 | 1527 | 23012 | No 8 | 2122 | 561.5 | 0 | None | No | 0.01 | Param. |



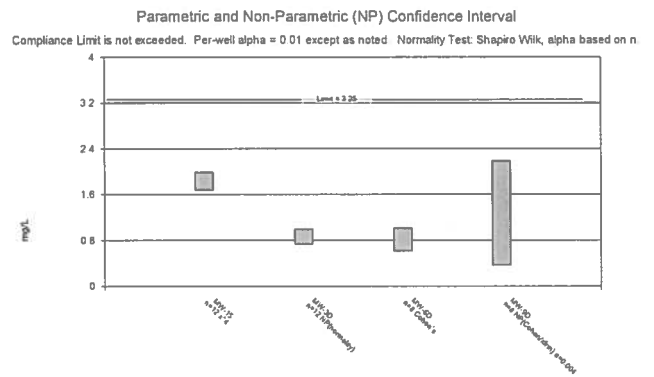
Constituent: Boron Analysis Run 1/2/2018 10:39 PM View: Confidence Intervals - App III
Northeastern LF Client: Geosyntec Data: Northeastern LF



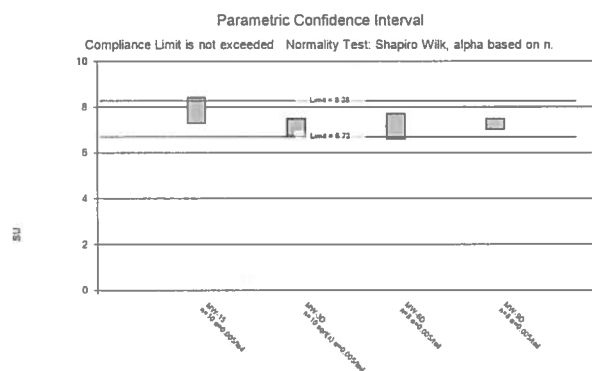
Constituent: Calcium Analysis Run 1/2/2018 10:39 PM View: Confidence Intervals - App III
Northeastern LF Client: Geosyntec Data: Northeastern LF



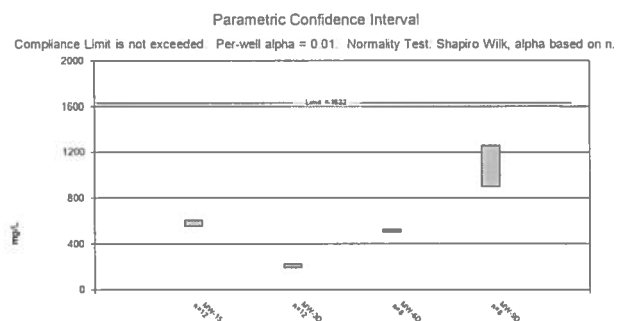
Constituent: Chloride Analysis Run 1/2/2018 10:39 PM View: Confidence Intervals - App III
Northeastern LF Client: Geosyntec Data: Northeastern LF



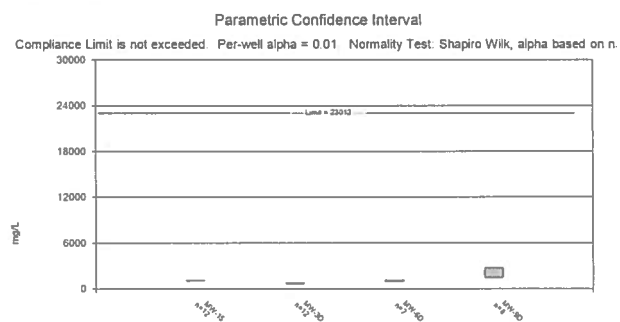
Constituent: Fluoride Analysis Run 1/2/2018 10:39 PM View: Confidence Intervals - App III
Northeastern LF Client: Geosyntec Data: Northeastern LF



Constituent: pH, field Analysis Run 1/2/2018 10:39 PM View: Confidence Intervals - App III
Northeastern LF Client: Geosyntec Data: Northeastern LF



Constituent: Sulfate Analysis Run 1/2/2018 10:39 PM View: Confidence Intervals - App III
Northeastern LF Client: Geosyntec Data: Northeastern LF



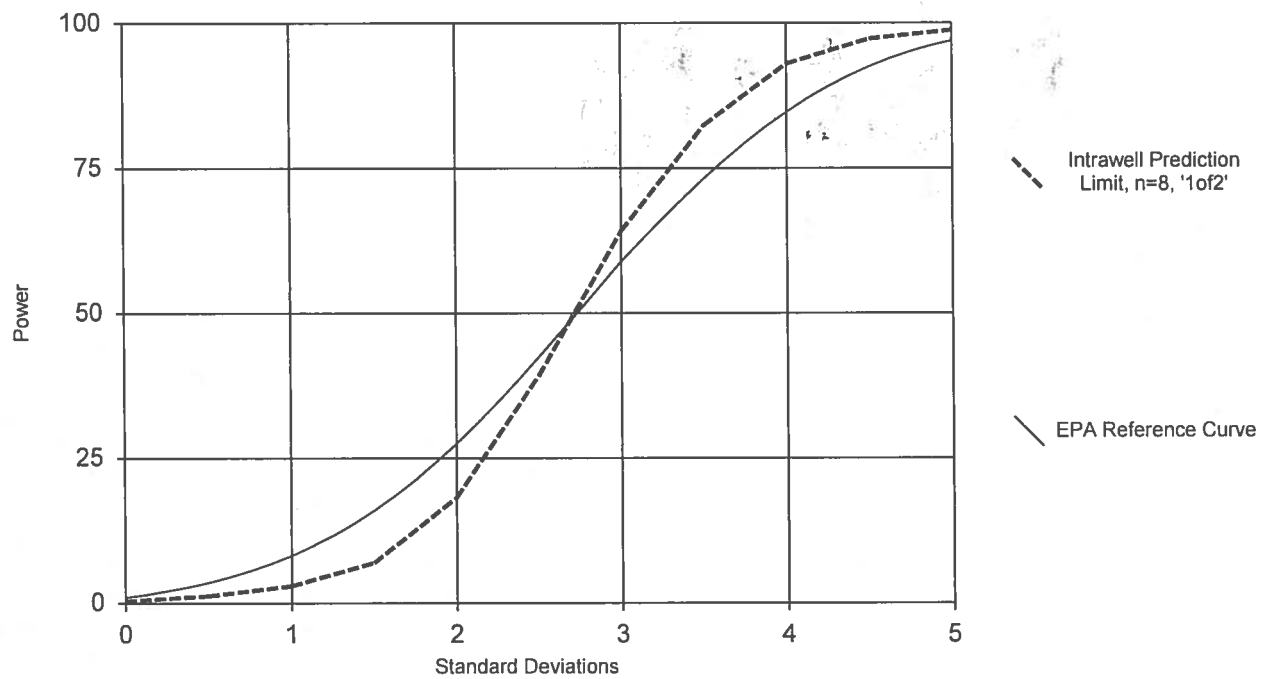
Constituent: Total Dissolve Solids (TDS) Analysis Run 1/2/2018 10:39 PM View: Confidence Intervals - App III
Northeastern LF Client: Geosyntec Data: Northeastern LF

Intrawell Prediction Limit Summary Table

Northeastern LF Client: Geosyntec Data: Northeastern LF Printed 3/14/2018, 10:04 AM

| Constituent | Well | Upper Lim. | Lower Lim. | Bq N | Bq Mean | Std. Dev. | %NDs | ND Adj. | Transform | Alpha | Method |
|------------------------------------|-------|------------|------------|------|---------|-----------|-------|--------------|-----------|-----------|-----------------------------|
| Boron (mg/L) | MW-7D | 1.536 | n/a | 9 | 1.183 | 0.1416 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Boron (mg/L) | MW-8D | 1.406 | n/a | 11 | 1.324 | 0.03585 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Boron (mg/L) | MW-15 | 10.6 | n/a | 12 | 9.52 | 0.482 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Boron (mg/L) | MW-3D | 0.9749 | n/a | 12 | 0.8698 | 0.04713 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Boron (mg/L) | MW-6D | 4.347 | n/a | 8 | 37.54 | 17.06 | 0 | None | x^3 | 0.00188 | Param Intra 1 of 2 |
| Boron (mg/L) | MW-9D | 8.11 | n/a | 8 | 7.146 | 0.3683 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Calcium (mg/L) | MW-7D | 1060 | n/a | 9 | 5.235 | 0.6946 | 0 | None | ln(x) | 0.00188 | Param Intra 1 of 2 |
| Calcium (mg/L) | MW-8D | 813.1 | n/a | 11 | 7.815 | 0.6602 | 0 | None | x^(1/3) | 0.00188 | Param Intra 1 of 2 |
| Calcium (mg/L) | MW-15 | 131.8 | n/a | 12 | 84.28 | 21.28 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Calcium (mg/L) | MW-3D | 190.3 | n/a | 12 | 138.7 | 23.13 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Calcium (mg/L) | MW-6D | 285.1 | n/a | 8 | 203.5 | 31.18 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Calcium (mg/L) | MW-9D | 463.1 | n/a | 8 | 294.1 | 64.61 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Chloride (mg/L) | MW-7D | 836 | n/a | 9 | 355.4 | 192.9 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Chloride (mg/L) | MW-8D | 14668 | n/a | 11 | 11986 | 1166 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Chloride (mg/L) | MW-15 | 78 | n/a | 11 | n/a | n/a | 0 | n/a | n/a | 0.01276 | NP Intra (normality) 1 of 2 |
| Chloride (mg/L) | MW-3D | 16.15 | n/a | 11 | 12.73 | 1.489 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Chloride (mg/L) | MW-6D | 33.88 | n/a | 8 | 30.25 | 1.389 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Chloride (mg/L) | MW-9D | 382.8 | n/a | 8 | 155.4 | 86.93 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Fluoride (mg/L) | MW-7D | 4.041 | n/a | 9 | 1.763 | 0.9141 | 11.11 | None | No | 0.00188 | Param Intra 1 of 2 |
| Fluoride (mg/L) | MW-8D | 1 | n/a | 11 | n/a | n/a | 90.91 | n/a | n/a | 0.01276 | NP Intra (NDs) 1 of 2 |
| Fluoride (mg/L) | MW-15 | 2.243 | n/a | 12 | 6.216 | 2.269 | 0 | None | x^3 | 0.00188 | Param Intra 1 of 2 |
| Fluoride (mg/L) | MW-3D | 1 | n/a | 12 | n/a | n/a | 50 | n/a | n/a | 0.01077 | NP Intra (normality) 1 of 2 |
| Fluoride (mg/L) | MW-6D | 0.9414 | n/a | 8 | 0.7193 | 0.08487 | 25 | Kaplan-Meier | No | 0.00188 | Param Intra 1 of 2 |
| Fluoride (mg/L) | MW-9D | 2.28 | n/a | 8 | 0.9091 | 0.5239 | 25 | Kaplan-Meier | No | 0.00188 | Param Intra 1 of 2 |
| pH, field (SU) | MW-7D | 8.503 | 6.146 | 9 | 7.324 | 0.4731 | 0 | None | No | 0.0009398 | Param Intra 1 of 2 |
| pH, field (SU) | MW-8D | 7.428 | 6.714 | 9 | 7.071 | 0.1434 | 0 | None | No | 0.0009398 | Param Intra 1 of 2 |
| pH, field (SU) | MW-15 | 9.142 | 6.562 | 10 | 7.852 | 0.5446 | 0 | None | No | 0.0009398 | Param Intra 1 of 2 |
| pH, field (SU) | MW-3D | 8.028 | 6.174 | 10 | 7.101 | 0.3915 | 0 | None | No | 0.0009398 | Param Intra 1 of 2 |
| pH, field (SU) | MW-6D | 8.323 | 5.982 | 8 | 7.153 | 0.4475 | 0 | None | No | 0.0009398 | Param Intra 1 of 2 |
| pH, field (SU) | MW-9D | 7.772 | 6.74 | 8 | 7.256 | 0.1972 | 0 | None | No | 0.0009398 | Param Intra 1 of 2 |
| Sulfate (mg/L) | MW-7D | 1927 | n/a | 9 | 881.6 | 419.4 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Sulfate (mg/L) | MW-8D | 166.6 | n/a | 11 | 109.6 | 24.76 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Sulfate (mg/L) | MW-15 | 649.4 | n/a | 12 | 578.6 | 31.72 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Sulfate (mg/L) | MW-3D | 251.3 | n/a | 12 | 205.9 | 20.34 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Sulfate (mg/L) | MW-6D | 542.8 | n/a | 8 | 515.6 | 10.41 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Sulfate (mg/L) | MW-9D | 1524 | n/a | 8 | 1079 | 170.3 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Total Dissolve Solids [TDS] (mg/L) | MW-7D | 4596 | n/a | 9 | 2690 | 764.7 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Total Dissolve Solids [TDS] (mg/L) | MW-8D | 24328 | n/a | 11 | 21432 | 1259 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Total Dissolve Solids [TDS] (mg/L) | MW-15 | 1152 | n/a | 12 | 1079 | 32.67 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Total Dissolve Solids [TDS] (mg/L) | MW-3D | 852.8 | n/a | 12 | 709 | 64.4 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Total Dissolve Solids [TDS] (mg/L) | MW-6D | 1159 | n/a | 8 | 1037 | 46.63 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |
| Total Dissolve Solids [TDS] (mg/L) | MW-9D | 3591 | n/a | 8 | 2122 | 561.5 | 0 | None | No | 0.00188 | Param Intra 1 of 2 |

Power Curve



Kappa = 2.616, based on 4 compliance wells and 7 constituents, evaluated semi-annually (this report reflects annual total).

Analysis Run 1/2/2018 10:42 PM View: Confidence Intervals - App III
Northeastern LF Client: Geosyntec Data: Northeastern LF



SCOTT A. THOMPSON
Executive Director

OKLAHOMA DEPARTMENT OF ENVIRONMENTAL QUALITY

MARY FALLIN
Governor

August 2, 2018

CERTIFIED MAIL RETURN RECEIPT REQUESTED

Ms. Jill Parker-Witt, P.E.
American Electric Power
502 North Allen Avenue
Shreveport, LA 71101

RECEIVED AUG 08 2018

Re: Alternate Source Demonstration – Coal Combustion Residuals (CCR) Landfill
Public Service Company of Oklahoma-Northeastern Power Station Ash Landfill
Rogers County
Solid Waste Permit No. 3566010

NOTICE OF DEFICIENCY

Dear Ms. Parker-Witt:

On May 3, 2018, the Department of Environmental Quality (DEQ) received the Alternate Source Demonstration – Landfill and Bottom Ash Pond (ASD) for Northeastern Power Station (NPS). The initial statistical analysis, performed on the data from the October 17, 2017 groundwater sampling event, indicated statistically significant increases (SSIs) for boron at groundwater monitoring wells MW-6D, MW-9D and MW-15. Oklahoma Administrative Code (OAC) 252:517-9-5(e)(2) allows NPS to demonstrate, within (ninety) 90 days of detecting an SSI, that a source other than the Coal Combustion Residuals (CCR) landfill caused the SSIs over background levels. This submittal meets the 90 day condition.

In letters dated January 16, 2018 and March 15, 2018, DEQ requested NPS to review whether MW-7D and MW-8D were appropriate as upgradient background wells for statistical analyses due to groundwater mounding at the CCR landfill. NPS evaluated MW-7D and MW-8D and determined that these background monitoring wells did not appear to be hydrogeologically upgradient of the CCR landfill and do not represent upgradient groundwater quality. The ASD concluded interwell evaluations of the groundwater monitoring data are not appropriate.

NPS evaluated the groundwater data for boron at MW-6D, MW-9D and MW-15 using intrawell analyses. SSIs were not confirmed with the intrawell analyses. The demonstration concluded that the SSIs were due to a statistical evaluation cause and not a release from the CCR landfill.

Before DEQ can determine the viability of the ASD, NPS must:

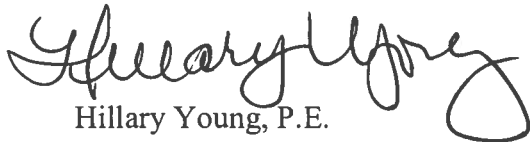


Ms. Jill Parker-Witt, P.E.
American Electric Power – Northeastern Power Station
August 2, 2018
Page 2 of 2

1. For the case where boron downgradient concentrations are higher than upgradient, conduct an independent study and hydrogeological investigation to identify local geochemical conditions and expected groundwater quality for boron near MW-6D, MW-9D and MW-15 to justify the intrawell approach. The evaluation must be completed within 60 days of receipt of this letter. Alternately, prepare an assessment monitoring plan and submit to DEQ for approval;
2. If justification of the intrawell approach is successful, please evaluate MW-7D and MW-8D using intrawell statistical analyses;
3. If the intrawell approach cannot be justified, please review the hydrogeology upgradient of the CCR landfill and determine an alternative monitoring well, or location for the construction of a new monitoring well to be used as an upgradient monitoring well for interwell statistical analyses. Also, implement the assessment monitoring plan within 90 days of DEQ approval; and
4. Revise Figure 1 to add monitoring well MW-2D to the potentiometric contour map.

Detection monitoring for the CCR landfill may continue during the hydrogeology review. If you have any questions, please contact Ms. Cynthia Hailes, P.E. at (405) 702-5114.

Sincerely,

A handwritten signature in black ink, appearing to read "Hillary Young", with a large, stylized loop at the end.

Hillary Young, P.E.
Chief Engineer
Land Protection Division

HY/ckh

October 25, 2018

Jill Parker-Witt
American Electric Power
Environmental Engineering Principal
502 North Allen Avenue
Shreveport, Louisiana 71101

Subject: Response to Notice of Deficiency – Alternate Source Demonstration

Dear Ms. Parker-Witt:

On August 8, 2018, Northeastern Power Station (NPS) received a Notice of Deficiency (NOD) from the Oklahoma Department of Environmental Quality (DEQ) regarding an Alternate Source Demonstration (ASD) which was submitted for the Landfill on May 3, 2018. The ASD contained NPS's assessment of boron concentrations at MW-6D, MW-9D and MW-15 and concluded that SSIs were not confirmed with the intrawell analysis method. The ASD concluded that the SSIs were due to a statistical evaluation cause and not to a release from the CCR landfill. However, the NOD included a request that NPS conduct an independent study and hydrogeological investigation to identify local geochemical conditions near MW-6D, MW-9D, and MW-15 and the expected groundwater quality for boron to justify the selected use of intrawell statistics. Furthermore, if the rationale for the intrawell method is successful, DEQ requested that MW-7D and MW-8D also be evaluated using intrawell statistical analysis. Additionally, DEQ requested that the Site Layout drawing (Figure 1) be revised to show the location of MW-2D. The revised figure is attached.

As part of the independent study, a geochemical mixing model was constructed to test whether boron in groundwater could have originated from Landfill leachate. Leachate samples collected on 6/5/2017 and 8/23/2017 showed the boron concentrations were 23.1 milligrams per liter (mg/L) and 7.88 mg/L respectively, and total dissolved solids (TDS) was greater than 50,000 mg/L in both samples. It was concluded that boron levels in the leachate are low relative to the TDS. Consequently, a mixing model could not be constructed to simultaneously replicate the concentrations of boron and other common inorganic species. Therefore, landfill leakage was dismissed as a source of boron in groundwater due to an inability to simulate observed groundwater data using the mixing model.

Initially, this study sought correlations between boron and other inorganic species to help identify a possible cause for elevated boron. In addition to Appendix III and Appendix IV constituents, NPS has been collecting geochemical parameters to assist with understanding the geochemistry of the Landfill. Altogether, roughly 30 parameters were used in this assessment. A correlation between sodium and boron was identified at MW-6D, MW-9D and MW-15. Sodium was the only parameter found to be positively correlated with boron, although calcium was found to have a negative correlation (calcium decreases as boron increases). No other wells in the Landfill exhibited a strong correlation between boron and sodium.

Figure 2 shows sodium and boron concentrations in landfill groundwater that was collected in June 2017 and May 2018. Groundwater at each well was classified into one of three types based on the observed boron and sodium concentrations (Figure 2). The first type, labeled 'Native Groundwater' in Figure 2, has low boron concentrations (0.5 to 1.5 mg/L) and low sodium (<100 mg/L). This group includes MW-3D which is between the slurry wall and Verdigris River and wells that are outside of this area (MW-4D, MW-5D and MW-13D). Groundwater at these locations is considered native because of low levels of boron and dissolved salts.

The second type of groundwater, labeled 'Elevated Salts' in Figure 2, includes the two background wells for statistical analysis, MW-7D and MW-8D. As argued in the original ASD, these wells appear to have unique geochemistry which indicate impacts from salts that coincided with a pipe repair project and are not reflective of groundwater geochemistry across the site. This provides further evidence for the selection of intrawell method for statistical analyses.

The third groundwater type includes MW-6D, MW-9D and MW-15. Based on as-built construction drawings, these wells were installed in locations where coal ash had been used as structural fill, as noted in Figure 2. The groundwater collected from these wells has higher boron concentrations than other wells in the Landfill (roughly 3 to 10 mg/L). Also, sodium concentrations are between 100 and 300 mg/L, which is greater than the background groundwater but below the levels found in MW-7D and MW-8D. In addition, boron and sodium appear to be correlated, as indicated by the dashed line with positive slope. Boron in this group of wells is suspected to be leaching from the ash used as structural fill, rather than ash that is contained in the Landfill.

The Landfill improvement project that was conducted between 2012 and 2013 involved construction of a 3 ft wide by 25 ft deep 2,200 ft-long slurry wall, followed by a 1,400 ft-long grout curtain on the southeast side of the Landfill within the constructed dike (Terracon

Consultants, 2017). Construction of the slurry wall involved excavating 25 feet of ash/limestone overburden, followed by keying the slurry wall into the underlying shale unit. The grout curtain was installed beneath the slurry wall by injecting bentonite to elevations of 590-595 ft above mean sea level (amsl) along the southern edge of the Landfill (Hydrogeologic Summary Report, Terracon, March 2017). Monitoring wells MW-6D and MW-9D were installed prior to the slurry wall construction and through fly ash used in the Landfill dike construction, as shown in Figure 3. MW-15, shown on Figure 1, was installed after the slurry wall/grout curtain construction and was meant to replace MW-2D; MW-15 has a total depth of 71.45 ft, whereas MW-2D had a total depth of 61.56 ft. The following materials were used for constructing the grout curtain and well seals at NPS:

- Bentonite, which was manufactured under the trade name Puregold® Gel by Cetco Construction Drilling Products (Hoffman Estates, IL). The active component is smectite clay.
- Portland cement manufactured under the trade name QUIKRETE® Portland Cement (Atlanta, GA). The active components include pulverized limestone, fly ash, gypsum and lime.
- Plasticizer under the trade name SUPERCIZER 5. The active components include sulfonated naphthalene condensate and sodium salt.
- Pel Plug TR30 was routinely used as a well/borehole sealant. This product contains time release coated bentonite pellets (smectite) and is manufactured by PDSCo, Inc. (El Dorado, AR). Safety data sheets for the materials described above are contained in (Attachment A).

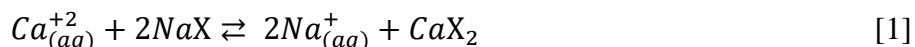
Boron is known to adsorb to bentonite (smectite), with greater capacity when pH is between 8 and 10 and with the presence of magnesium in solution (Goldberg et al., 1996; Karahan et al., 2005; Masindi et al., 2015; Guan et al., 2016; Rajamohan and Al-Sinani, 2016). Results of rate experiments suggest that equilibration is rapid. One article cites that adsorption occurs within 30 minutes for 1 gram of bentonite in a solution containing 20 mg/L boron (Masindi et al., 2015).

Smectite clay, the main component in bentonite, has a large cation exchange capacity (CEC) compared with other clays. When treated with a sodium salt, the clay interlayer region becomes populated by sodium ions and water (Figure 4, left). Absorption of water and swelling of the interlayer region gives sodium-bentonite its gel-like characteristics and creates a low permeability seal. When groundwater flows through limestone or unconsolidated sediment with appreciable calcite content, calcium concentrations in the water will increase until they reach saturation with respect to calcium minerals. Calcite saturation is observed in groundwater at the NPS Landfill,

based on geochemical modeling results with PHREEQC. Because sodium is present in relatively low concentrations in site groundwater, the interaction of calcium-rich (sodium-poor) groundwater with sodium-bentonite over time causes calcium to be exchanged for sodium. Calcium has a much higher affinity for smectite than does sodium. Thus, for as long as the composition of the upgradient groundwater does not change, conversion of the clay to calcium-bentonite is essentially irreversible.

According to Egloffstein (2001) sodium-bentonite converts to calcium-bentonite over a period of approximately one to three years in geosynthetic clay liners that contain sodium bentonite, assuming the cover-soil is shallow enough to allow infiltration of surface water. Because of cation exchange, sodium ions are released to the aqueous phase and calcium partitions into the clay, resulting in lower dissolved calcium (Figure 4, right). In addition, conversion of sodium-bentonite to calcium-bentonite reduces the space between the (silicate) clay layers and expels bound water. Adsorbed boron is also contained in the interlayer (note figure), hence both boron and sodium increase in the groundwater as calcium decreases. The partial collapse of the interlayer structure may be accompanied by an increase in hydraulic conductivity of approximately half to one order of magnitude, as noted by Egloffstein (2001).

The relationship between exchanging cations can be described by the following equation



where X^- represents the cation exchange surface and aq stands for the aqueous (or dissolved) phase. According to the stoichiometry of Eq. 1, two moles of sodium are released into the aqueous phase for one mole of calcium that is adsorbed. Therefore, as calcium-rich groundwater encounters the clay the water will lose calcium and gain sodium until equilibrium is reached between the groundwater and clay. However, groundwater moves under influence of a hydraulic gradient. Hence, equilibrium conditions may change over time and over distance.

Because of the hydraulic gradient between the grout curtain and river, fresh groundwater is continuously undergoing ion exchange. If the rate of groundwater movement is slow relative to the rate of ion exchange, then steady state conditions will be maintained. According to the article by Masindi et al. (2015), the rate of ion exchange with bentonite is rapid. Because the amount of bentonite used in the grout curtain is large, it is possible that the groundwater is in approximate equilibrium with the clay at fixed locations and over a relatively short time (~ 1 year). This can be tested by applying an equilibrium expression to Eq. 1, as follows:

$$K = \left(\frac{m_{Na^+}^2}{m_{Ca^{+2}}} \right) \cdot \Phi \quad [2]$$

where K is the equilibrium constant, m stands for molality (moles per kilogram) of the subscripted ion and Φ is a function containing activity coefficients for the aqueous and adsorbed species and composition of the exchange sites. Because we have no information about Φ , we will focus on the aqueous chemistry part of the equation, which can be represented by an apparent equilibrium constant K' :

$$K' = \left(\frac{m_{Na^+}^2}{m_{Ca^{+2}}} \right) \quad [3]$$

Figure 5 shows concentrations of sodium and calcium in the Landfill groundwater at MW-6D, MW-9D and MW-15, with the dashed lines representing Eq. 3. The apparent equilibrium constants, K' , vary from 0.005 to 0.033 (per mole) and the values increase in the downgradient direction. This suggests that calcium ion exchange is more extensive in the upgradient direction (MW-6D) and less exchange has taken place in the downgradient direction (MW-15). This trend is expected because bentonite in the upgradient direction has been exposed to the highest calcium concentrations, whereas downgradient water is progressively depleted in calcium. The hydraulic constraints imposed on the groundwater by the slurry wall and river bed aquifer in this area approximates one-dimensional transport as in a laboratory column test. The finding that K' is relatively constant at each well location is indicative of steady state conditions at points along the groundwater flow direction. Small excursions near the equilibrium point occur, which are evident in MW-6D and MW-15 (Figure 5), are probably the result of collecting samples at different times when the balance between dissolved calcium and dissolved sodium has shifted slightly due to seasonal changes in water level and other perturbations.

During the original construction of the Landfill's southern embankment, ash was placed above the limestone unit in some locations. A Landfill improvement project consisted of a slurry wall being installed along this embankment by craving out the top 25 feet of the ash/limestone unit and the slurry wall was keyed into the underlying shale unit. A grout curtain was then emplaced beneath a slurry wall to prevent leachate from seeping outside of the landfill. In the area of interest, the water table is near the base of the ash and above the limestone. Cross-sectional diagrams indicate that MW-6D, MW-9D and MW-15 were installed through the ash and are screened in the shale unit, as shown in Figure 3. As noted in the figure and in text above, MW-15 replaced MW-2D, which was damaged. It is hypothesized that since the start of construction, boron leached from the ash and

was adsorbed by the bentonite grout. Adsorption of boron was likely enhanced by the high pH environment created by the Portland cement slurry wall.

It is proposed that boron is now being released to the deep groundwater as a result of calcium partitioning from the native groundwater to the clay, which causes a partial collapse of the interlayer region which releases boron, sodium and interstitial water. It is surmised that fractures exist in the limestone and shale which allow boron-enriched water to be detected in the three deep monitoring wells which are the subject of this ASD. Based on this independent study, the Landfill should remain in detection monitoring because the source of the boron exceedances at MW-6D, MW-9D and MW-15 is not due to a release from the Landfill. Revised intrawell statistics which include values for MW-7D and MW-8D are included as Table 1.

Sincerely,



Bruce M. Sass, Ph.D.
Senior Consultant



Robert A. Ferree, CPG
Senior Principal

Copies to: David Miller, P.E.; Brian Newton

| | |
|--------------|---|
| Table 1 | Detection Monitoring Data Comparison |
| Figure 1 | Potentiometric Contours – Uppermost Aquifer |
| Figure 2 | Observed Groundwater Types |
| Figure 3 | Area of Interest Cross-Section |
| Figure 4 | Ion Exchange in Bentonite |
| Figure 5 | Apparent Equilibrium Concentrations |
| Attachment A | Grout Safety Data Sheets |

Certification by a Qualified Professional Engineer

I certify that the independent study described above as part of the submitted alternative source demonstration is appropriate for evaluating the groundwater monitoring data for the Northeastern Landfill CCR management area as requested by the Oklahoma Department of Environmental Quality.

DAVID ANTHONY MILLER

Printed Name of Licensed Professional Engineer

David Anthony Miller

Signature

26057

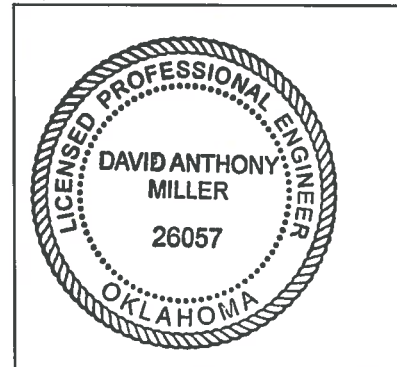
License Number

OKLAHOMA

Licensing State

10.29.18

Date



References

- Goldberg, S., Forster, H. S., Lesch, S. M., & Heick, E. L. (1996). Influence of anion competition on boron adsorption by clays and soils. *Soil Science*, 161, 2, 99-103.
- Guan, Z., Lv, J., Bai, P., & Guo, X. (2016). Boron removal from aqueous solutions by adsorption — A review. *Desalination*, 383, 29-37.
- Karahan, S., Yurdakoç, M., Seki, Y., & Yurdakoç, K. (2006). Removal of boron from aqueous solution by clays and modified clays. *Journal of Colloid and Interface Science*, 293, 1, 36-42.
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- Rajamohan, N. & Al-Sinani, J. (2016). Removal of boron using clay-effect of process parameters, kinetic and isotherm studies. *Journal of Engineering Science and Technology*, 11, 3, 311-326.
- Terracon Consultants (2017). Report 1 - Groundwater Monitoring Network for CCR Compliance for the Public Service Company of Oklahoma, Northeastern Station 3&4, Non-Hazardous Industrial Waste (NHIW) Landfill, Permit No. FA3566010, October.

Table 1: Detection Monitoring Data Evaluation
Intrawell Prediction Limits
Northeastern Plant - Landfill

Geosyntec Consultants, Inc.

| Parameter | Units | Description | MW-7D | MW-8D | MW-3D | MW-6D | | MW-9D | | MW-15 | |
|------------------------|-------|----------------------------------|-------|-------|------------|--------------|-----------|------------|-----------|------------|-----------|
| | | | -- | -- | 10/11/2017 | 10/11/2017 | 1/22/2018 | 10/11/2017 | 1/22/2018 | 10/11/2017 | 1/22/2018 |
| Boron | mg/L | Intrawell Background Value (UPL) | 1.54 | 1.41 | 0.975 | 4.35 | | 8.11 | | 10.6 | |
| | | Detection Monitoring Result | -- | -- | 0.878 | 3.74 | 4.24 | 7.07 | 7.43 | 9.62 | 9.16 |
| Calcium | mg/L | Intrawell Background Value (UPL) | 1060 | 813 | 190 | 285 | | 463 | | 132 | |
| | | Detection Monitoring Result | -- | -- | 134 | 165 | - | 288 | - | 80.1 | - |
| Chloride | mg/L | Intrawell Background Value (UPL) | 836 | 14668 | 16.2 | 33.9 | | 383 | | 78 | |
| | | Detection Monitoring Result | -- | -- | 13 | 29 | - | 314 | - | 46 | - |
| Fluoride | mg/L | Intrawell Background Value (UPL) | 4.041 | 1 | 1 | 0.941 | | 2.28 | | 2.243 | |
| | | Detection Monitoring Result | -- | -- | 0.083 | 0.960 | 0.76 | 1.519 | - | 1.947 | - |
| pH | SU | Intrawell Background Value (UPL) | 8.50 | 6.15 | 8.03 | 8.32 | | 7.77 | | 9.14 | |
| | | Intrawell Background Value (LPL) | 7.43 | 6.71 | 6.17 | 5.98 | | 6.74 | | 6.56 | |
| | | Detection Monitoring Result | -- | -- | 6.92 | 6.91 | 6.85 | 7.09 | 7.14 | 7.64 | 7.24 |
| Total Dissolved Solids | mg/L | Intrawell Background Value (UPL) | 4596 | 24328 | 853 | 1159 | | 3591 | | 1152 | |
| | | Detection Monitoring Result | -- | -- | 722 | 1032 | - | 2188 | - | 1124 | - |
| Sulfate | mg/L | Intrawell Background Value (UPL) | 1927 | 167 | 251 | 543 | | 1524 | | 649 | |
| | | Detection Monitoring Result | -- | -- | 218 | 545 | 494 | 1075 | - | 593 | - |

Notes:

UPL: Upper prediction limit

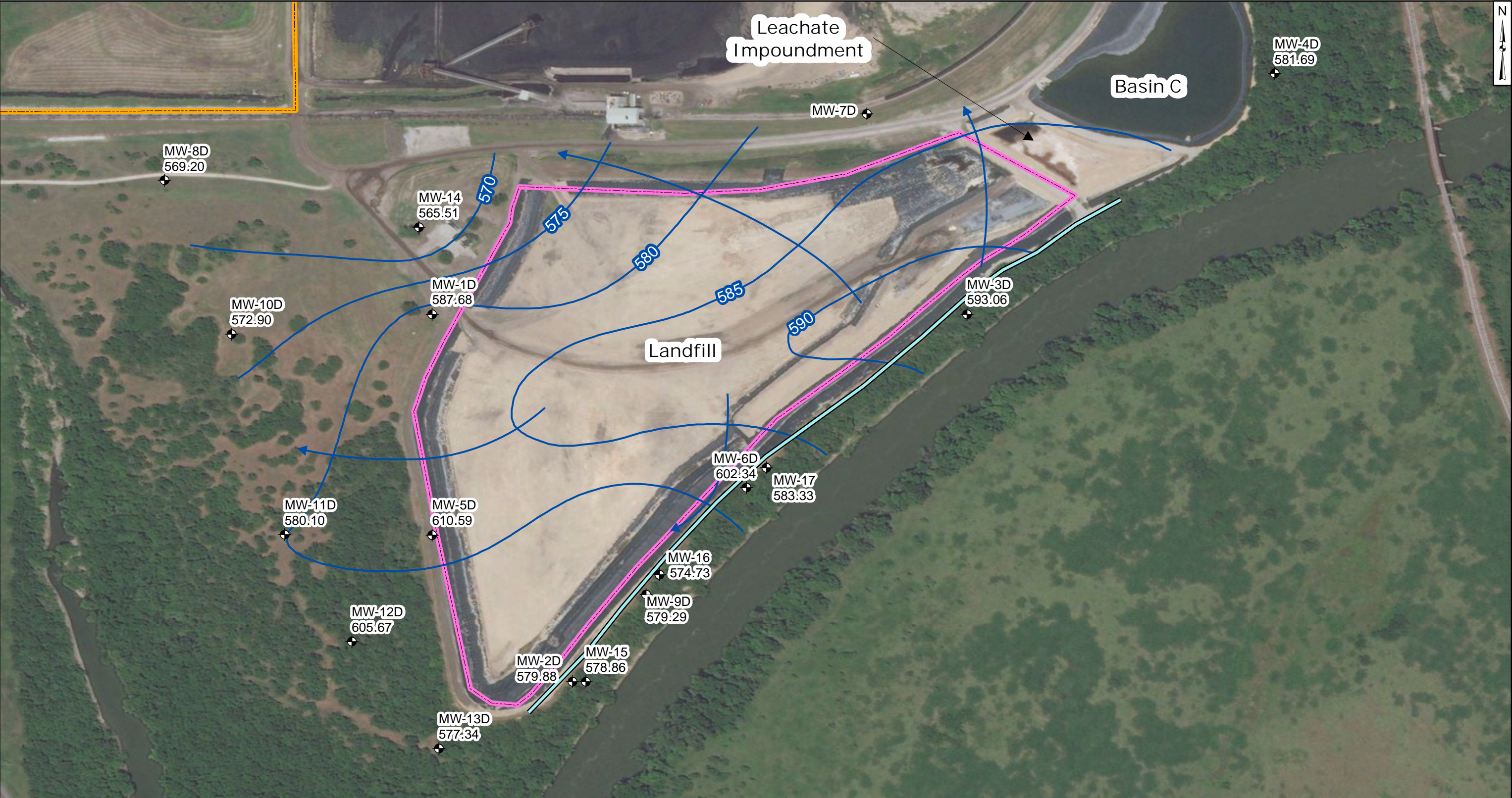
LPL: Lower prediction limit

--: Not Sampled

Background values exceed the background value.

Background values are shaded gray.

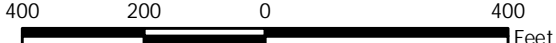
MW-7D and MW-8D are background monitoring wells.



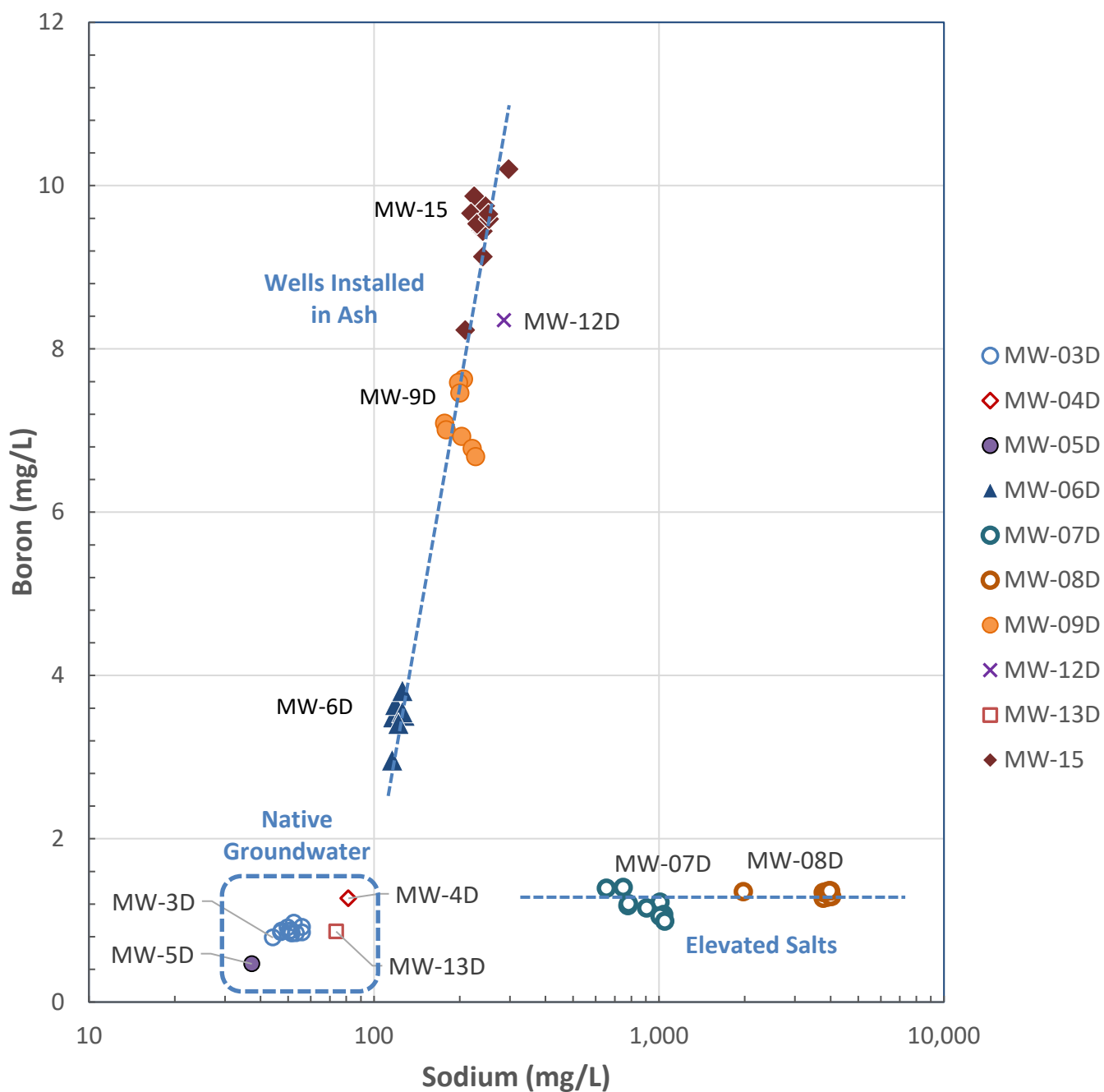
- Legend
- Groundwater Monitoring Well
 - Groundwater Elevation Contour
 - Inferred Groundwater Elevation Contour
 - Approximate Groundwater Flow Direction
 - Slurry Wall
 - Bottom Ash Pond
 - Landfill

Notes

- Monitoring well coordinates and water level data (collected November 9, 2016) provided by AEP.
- Site features based on information available in Report 1 - Groundwater Monitoring Network Evaluation - Northeastern Stations 3 and 4 - Bottom Ash Pond (Terracon Consultants, 2015) provided by AEP.
- Groundwater elevation units are feet above mean sea level (ft. msl).
- Only wells screened in the Bandera Shale were used for contouring.



| | |
|---|------------|
| Potentiometric Contours - Uppermost Aquifer Landfill November 2016 AEP Northeastern Plant Oologah, Oklahoma | |
| Geosyntec consultants | |
| Columbus, Ohio | 2018/09/28 |
| Figure 1 | |



Notes: The groundwater at each monitoring well location was classified into one of three types based upon the observed relationship between sodium and boron.

Observed Groundwater Types Northeastern Landfill

Geosyntec
consultants



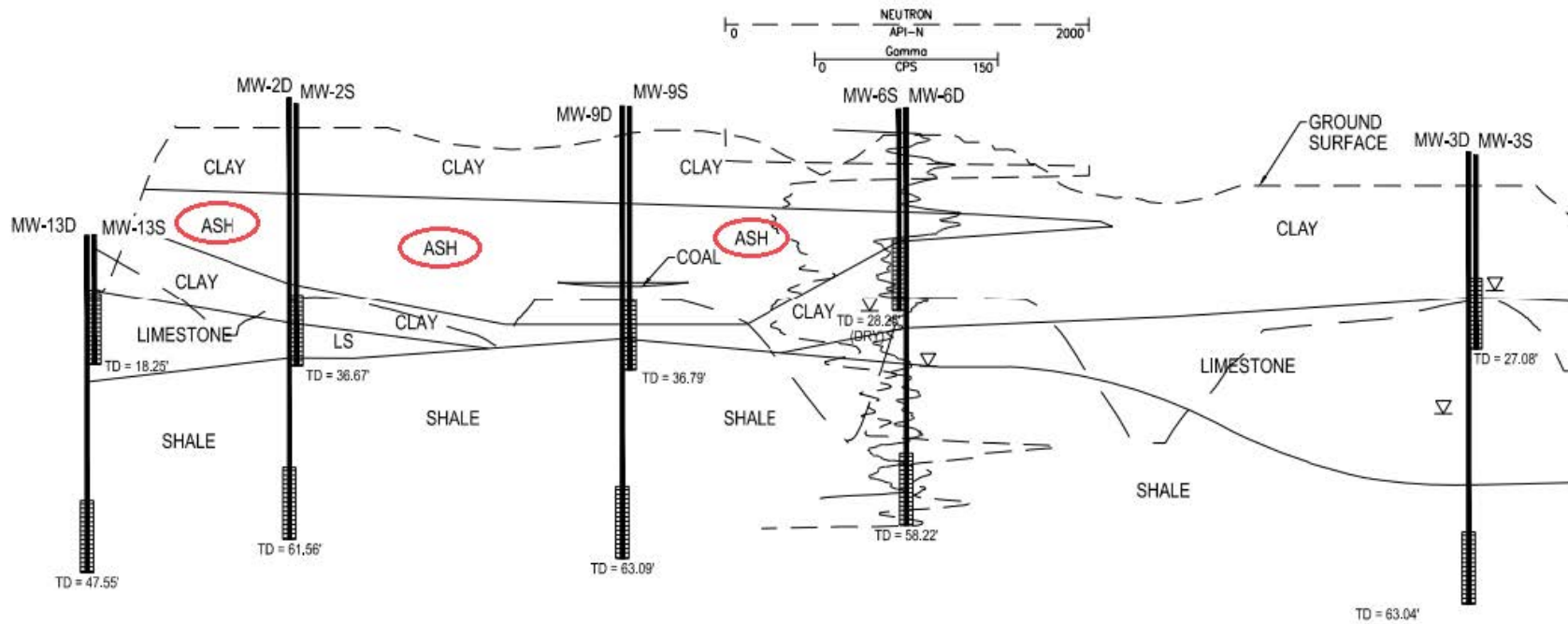
Figure
2

Columbus, Ohio

09-Oct-2018

SOUTHWEST

NORTHEAST



Notes:

MW-15 is located immediately adjacent to MW-2D with a total depth (TD) of 71.45 feet

Figure was originally provided in "Report 1 – Groundwater Monitoring Network for CCR Compliance" (Terracon, 2017)

Area of Interest Cross-Section

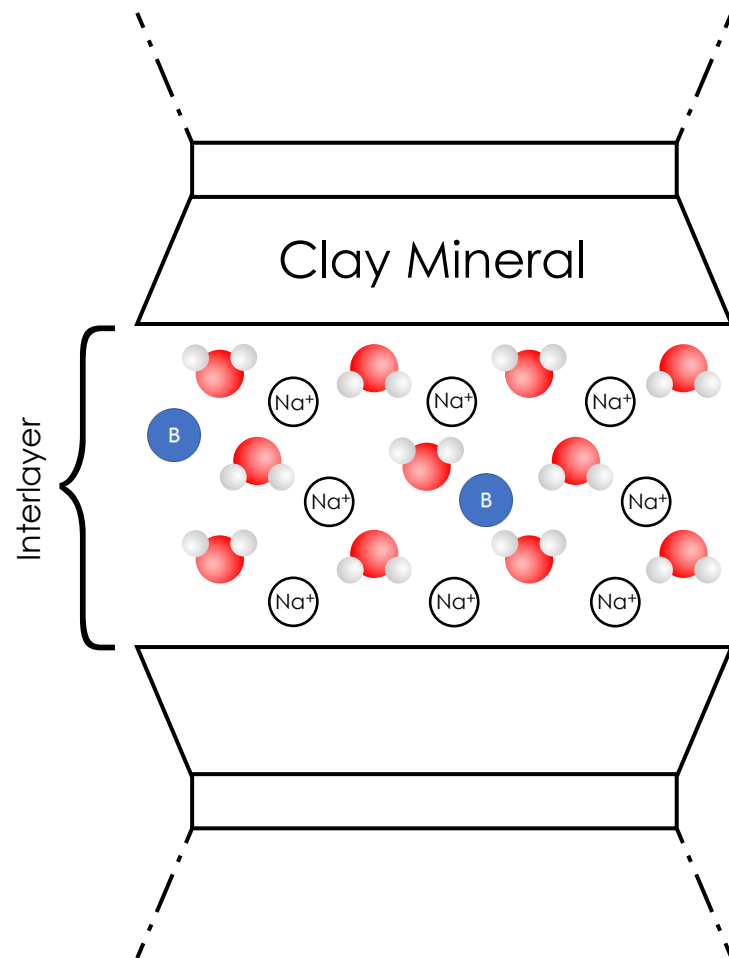
Northeastern Landfill

Geosyntec
consultants

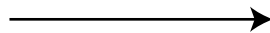
Figure
3

Columbus, Ohio

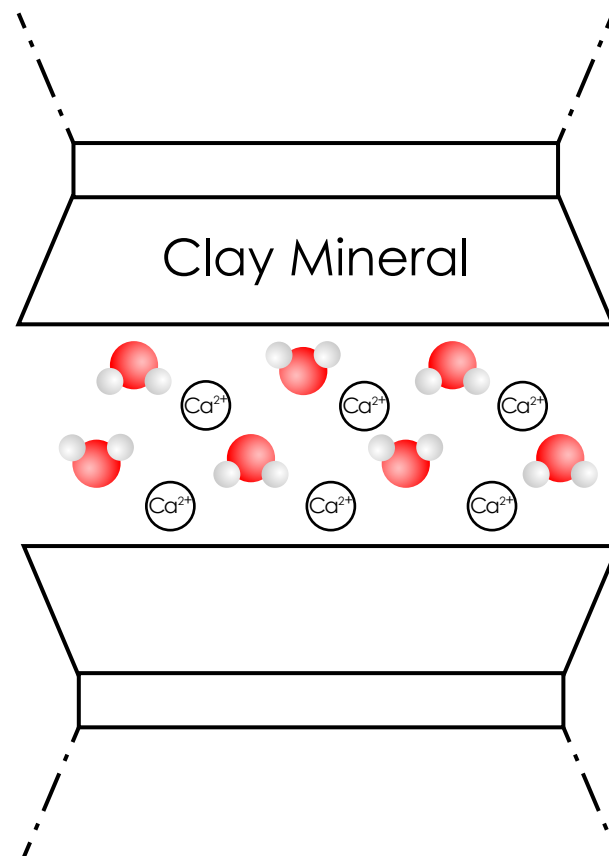
11-Oct-2018



Calcium Exchange



Sodium Exchange



Ion Exchange in Bentonite

Geosyntec
consultants

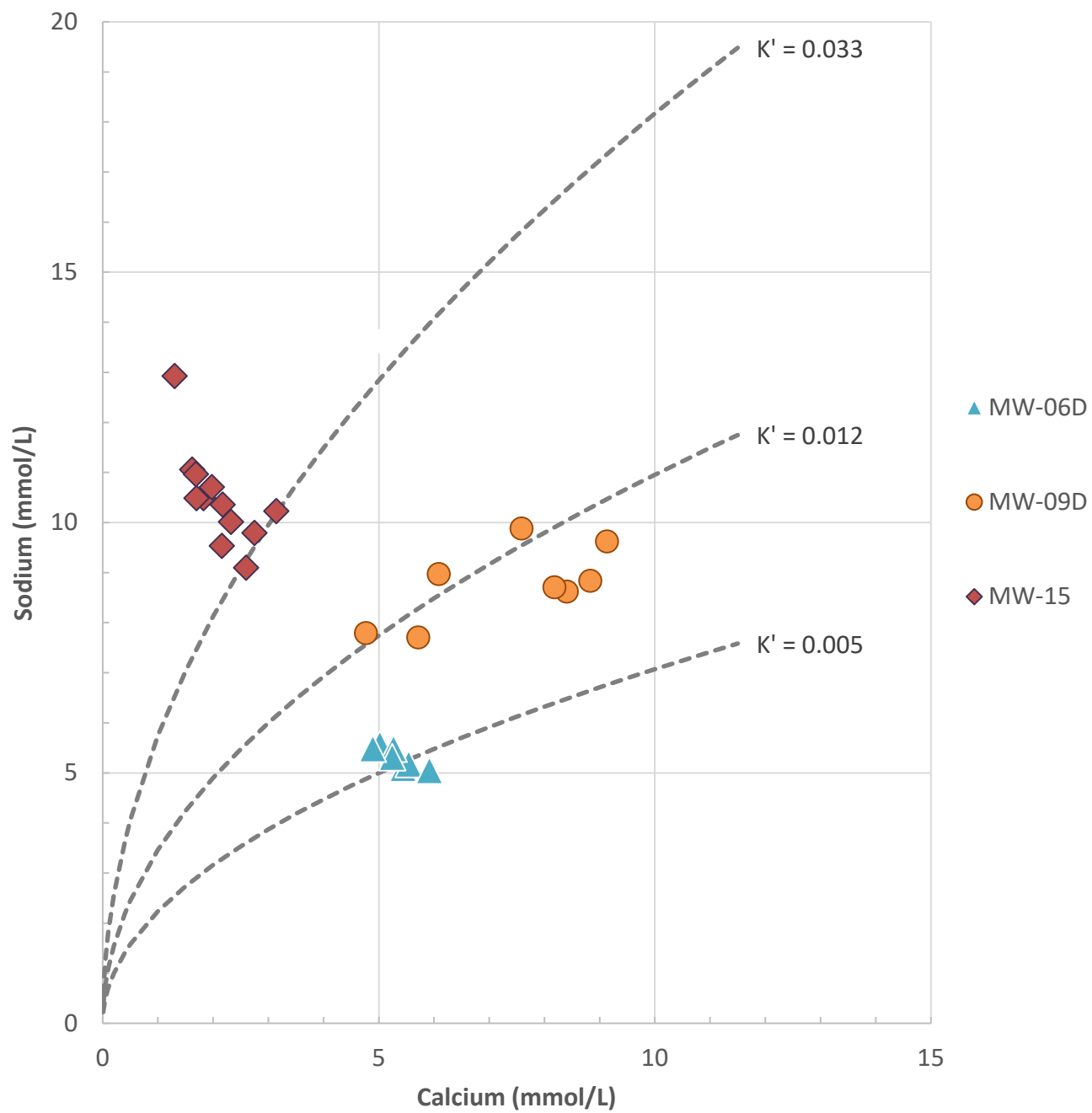
Guelph

October 2018

Figure
4

In the presence of dissolved calcium, sodium ions that are adsorbed onto the clay are displaced by calcium and the sodium is released to the aqueous phase. Overall, conversion of sodium-bentonite to calcium-bentonite expels water and boron from the interlayer. Hence both boron (B) and sodium (Na) concentrations in the groundwater increase as calcium (Ca) decreases. Partial collapse of the interlayer space increases the permeability of the bentonite.

Note: This figure is modeled after a drawing in Egloffstein (2001)



Notes: The dashed lines represent the apparent equilibrium constant, K' , at each monitoring well location.

Apparent Equilibrium Concentrations Northeastern Landfill

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consultants



Figure
5

Columbus, Ohio

09-Oct-2018

ATTACHMENT A
Grout Safety Data Sheets



MATERIAL SAFETY DATA SHEET

1. Product and Company Identification

Material name PUREGOLD® GEL
Version # 13
Revision date 21-February-2009
Chemical description Smectite Clay
Manufacturer CETCO
Construction Drilling Products
2870 Forbs Avenue
Hoffman Estates, IL 60192 US
safetydata@amcol.com
<http://www.constructiondrilling.com/>
General Information (800) 527-9948
CHEMTREC® (800) 424-9300

2. Hazards Identification

Emergency overview Material can be slippery when wet

Potential health effects

Routes of exposure Inhalation.

Eyes Dust or powder may irritate eye tissue.

Skin Non-irritating to the skin.

Inhalation Repeated or prolonged inhalation may cause toxic effects. For additional information on inhalation hazards, see Section 11 of this safety data sheet.

Ingestion No significant adverse effects are expected upon ingestion of the product.

Target organs Lungs.

Chronic effects This product has the potential for generation of respirable dust during handling and use. Dust may contain respirable crystalline silica. Overexposure to dust may result in pneumoconiosis, a respiratory disease caused by inhalation of mineral dust, which can lead to fibrotic changes to the lung tissue, or silicosis, a respiratory disease caused by inhalation of silica dust, which can lead to inflammation and fibrosis of the lung tissue. Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled.

3. Composition / Information on Ingredients

The manufacturer lists no ingredients as hazardous according to OSHA 29 CFR 1910.1200.

Composition comments Bentonite contains naturally occurring crystalline silica (not listed in Annex I of Directive 67/548/EEC) in quantities less than 6%. Occupational Exposure Limits for impurities are listed in Section 8.

4. First Aid Measures

First aid procedures

Eye contact Flush eyes immediately with large amounts of water. If irritation persists get medical attention.

Skin contact No special measures required. Get medical attention if irritation develops or persists.

Inhalation Remove to fresh air. If not breathing, give artificial respiration or give oxygen by trained personnel. Get medical attention, if needed.

Ingestion No special measures required. If ingestion of a large amount does occur, seek medical attention.

Notes to physician Provide general supportive measures and treat symptomatically.

5. Fire Fighting Measures

Flammable properties This material will not burn.

Extinguishing media

Suitable extinguishing media Use any media suitable for the surrounding fires. Dry chemical, CO₂, water spray or regular foam.

Protection of firefighters**Protective equipment and precautions for firefighters**

Material can be slippery when wet

Hazardous combustion products

None known.

6. Accidental Release Measures**Personal precautions**

Material can be slippery when wet. Wear a dust mask if dust is generated above exposure limits.

Environmental precautions

No special environmental precautions required.

Methods for cleaning up

Avoid the generation of dusts during clean-up. Collect dust or particulates using a vacuum cleaner with a HEPA filter. Reduce airborne dust and prevent scattering by moistening with water.

7. Handling and Storage**Handling**

Keep formation of airborne dusts to a minimum. Provide appropriate exhaust ventilation at places where dust is formed. In case of insufficient ventilation, wear suitable respiratory equipment.

Storage

Guard against dust accumulation of this material. No special storage conditions required. No special restrictions on storage with other products.

8. Exposure Controls / Personal Protection**Occupational exposure limits****ACGIH****Impurities****Type****Value****Form**

INERT OR NUISANCE DUST (SEQ250)

TWA

10 mg/m³

Inhalable particles.

3 mg/m³

Respirable particles.

QUARTZ (14808-60-7)

TWA

0.025 mg/m³

Respirable fraction.

U.S. - OSHA**Impurities****Type****Value****Form**

INERT OR NUISANCE DUST (SEQ250)

PEL

15 mg/m³

Total dust.

5 mg/m³

Respirable fraction.

TWA

5 mg/m³

Respirable fraction.

50 mppcf

Total dust.

15 mppcf

Respirable fraction.

QUARTZ (14808-60-7)

TWA

15 mg/m³

Total dust.

2.4 mppcf

Respirable.

0.3 mg/m³

Total dust.

0.1 mg/m³

Respirable.

0.1 mg/m³

Respirable dust.

Exposure guidelines

Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled.

Engineering controls

If material is ground, cut, or used in any operation which may generate dusts, use appropriate local exhaust ventilation to keep exposures below the recommended exposure limits. If engineering measures are not sufficient to maintain concentrations of dust particulates below the OEL, suitable respiratory protection must be worn.

Personal protective equipment**Eye / face protection**

Wear dust goggles. Eye wash fountain is recommended.

Skin protection

No special protective equipment required.

Respiratory protection

Use a particulate filter respirator for particulate concentrations exceeding the Occupational Exposure Limit.

General hygiene considerations

Use good industrial hygiene practices in handling this material.

9. Physical & Chemical Properties**Appearance**

Not available.

Color

Not available.

| | |
|---|--------------------------------------|
| Odor | None. |
| Odor threshold | Not available. |
| Physical state | Solid. |
| Form | Granular. Powder. Pellets. or Chips. |
| pH | 7 - 11 |
| Melting point | Not available. |
| Freezing point | Not available. |
| Boiling point | Not available. |
| Flash point | Non-flammable |
| Evaporation rate | Not available. |
| Flammability | Not available. |
| Flammability limits in air, upper, % by volume | Not available. |
| Flammability limits in air, lower, % by volume | Non-explosive |
| Vapor pressure | Not available. |
| Vapor density | Not available. |
| Specific gravity | 2.5497 estimated |
| Relative density | Not available. |
| Solubility (water) | Negligible |
| Partition coefficient (n-octanol/water) | Not available. |
| Auto-ignition temperature | Not available. |
| Decomposition temperature | Not available. |
| VOC | 0 % estimated |

10. Chemical Stability & Reactivity Information

| | |
|---|------------------------------|
| Chemical stability | Stable at normal conditions. |
| Conditions to avoid | None known. |
| Incompatible materials | None known. |
| Hazardous decomposition products | None known. |
| Possibility of hazardous reactions | Will not occur. |

11. Toxicological Information

Chronic effects

In 1997, IARC (the International Agency for Research on Cancer) concluded that crystalline silica inhaled from occupational sources can cause lung cancer in humans. However in making the overall evaluation, IARC noted that "carcinogenicity was not detected in all industrial circumstances studied. Carcinogenicity may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity or distribution of its polymorphs." (IARC Monographs on the evaluation of the carcinogenic risks of chemicals to humans, Silica, silicates dust and organic fibres, 1997, Vol. 68, IARC, Lyon, France.)

In June 2003, SCOEL (the EU Scientific Committee on Occupational Exposure Limits) concluded that the main effect in humans of the inhalation of respirable crystalline silica dust is silicosis. "There is sufficient information to conclude that the relative risk of lung cancer is increased in persons with silicosis (and, apparently, not in employees without silicosis exposed to silica dust in quarries and in the ceramic industry). Therefore, preventing the onset of silicosis will also reduce the cancer risk..." (SCOEL SUM Doc 94-final, June 2003)

According to the current state of the art, worker protection against silicosis can be consistently assured by respecting the existing regulatory occupational exposure limits. Occupational exposure to nuisance dust (total and respirable) and respirable crystalline silica should be monitored and controlled.

Carcinogenicity

IARC Monographs on Occupational Exposures to Chemical Agents: Overall evaluation

QUARTZ (14808-60-7) 1 Human carcinogen.

US ACGIH Threshold Limit Values: A2 carcinogen

QUARTZ (14808-60-7) Group A2 Suspected human carcinogen.

US NTP Report on Carcinogens: Known carcinogen

QUARTZ (14808-60-7) Known carcinogen.

12. Ecological Information

Ecotoxicological data

| Product | Test Results |
|---------------|---|
| PUREGOLD® GEL | LC50 Fish: 19005 mg/l 96.00 Hours estimated |

* Estimates for product may be based on additional component data not shown.

| | |
|--------------------------------------|--|
| Ecotoxicity | This material is not expected to be harmful to aquatic life. |
| Environmental effects | Based on the physical properties of this product, significant environmental persistence and bioaccumulation would not be expected. |
| Persistence and degradability | Not available. |

13. Disposal Considerations

| | |
|------------------------------|---|
| Disposal instructions | Dispose in accordance with all applicable regulations. Material should be recycled if possible. |
|------------------------------|---|

14. Transport Information

DOT

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

15. Regulatory Information

| | |
|-------------------------------|---|
| US federal regulations | OSHA Process Safety Standard: This material is not known to be hazardous by the OSHA Highly Hazardous Process Safety Standard, 29 CFR 1910.119. |
|-------------------------------|---|

Superfund Amendments and Reauthorization Act of 1986 (SARA)

| | |
|--------------------------|---|
| Hazard categories | Immediate Hazard - No Delayed Hazard - Yes Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No |
|--------------------------|---|

| | |
|--|----|
| Section 302 extremely hazardous substance | No |
|--|----|

| | |
|---------------------------------------|-----|
| Section 311 hazardous chemical | Yes |
|---------------------------------------|-----|

Inventory status

| Country(s) or region | Inventory name | On inventory (yes/no)* |
|----------------------|--|------------------------|
| Australia | Australian Inventory of Chemical Substances (AICS) | Yes |
| Canada | Domestic Substances List (DSL) | Yes |
| Canada | Non-Domestic Substances List (NDSL) | No |
| China | Inventory of Existing Chemical Substances in China (IECSC) | Yes |
| Europe | European Inventory of New and Existing Chemicals (EINECS) | No |
| Europe | European List of Notified Chemical Substances (ELINCS) | No |
| Japan | Inventory of Existing and New Chemical Substances (ENCS) | Yes |
| Korea | Existing Chemicals List (ECL) | Yes |
| New Zealand | New Zealand Inventory | Yes |

| Country(s) or region | Inventory name | On inventory (yes/no)* |
|-----------------------------|---|------------------------|
| Philippines | Philippine Inventory of Chemicals and Chemical Substances (PICCS) | Yes |
| United States & Puerto Rico | Toxic Substances Control Act (TSCA) Inventory | Yes |

A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)

State regulations WARNING: This product contains a chemical known to the State of California to cause cancer.

US - California Proposition 65 - Carcinogens & Reproductive Toxicity (CRT): Listed substance

QUARTZ (14808-60-7) Listed.

US - California Proposition 65 - CRT: Listed date/Carcinogenic substance

QUARTZ (14808-60-7) Listed: October 1, 1988 Carcinogenic.

US - Pennsylvania RTK - Hazardous Substances: Listed substance

QUARTZ (14808-60-7) Listed.

16. Other Information

Further information

This safety datasheet only contains information relating to safety and does not replace any product information or product specification.

Recommended restrictions

Workers (and your customers or users in the case of resale) should be informed of the potential presence of respirable dust and respirable crystalline silica as well as their potential hazards. Appropriate training in the proper use and handling of this material should be provided as required under applicable regulations.

HMIS ratings



NFPA ratings

Health: 1
Flammability: 0
Instability: 0

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The manufacturer expressly does not make any representations, warranties, or guarantees as to its accuracy, reliability or completeness nor assumes any liability, for its use. It is the user's responsibility to verify the suitability and completeness of such information for each particular use.

Third party materials: Insofar as materials not manufactured or supplied by this manufacturer are used in conjunction with, or instead of this product, it is the responsibility of the customer to obtain, from the manufacturer or supplier, all technical data and other properties relating to these and other materials and to obtain all necessary information relating to them. No liability can be accepted in respect of the use of this product in conjunction with materials from another supplier. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Issue date

21-February-2009

Other information

CETCO is an AMCOL International company.



SAFETY DATA SHEET

Revision: 03/03/2017

1. Identification

Trade Name: Pel Plug TR30
Description: Time release coated bentonite pellets
Synonyms: Bentonite – Montmorillonite - Smectite
Intended use: Well / Borehole Sealant
Recommended Restrictions: Workers (and your customers or users in the cases of resale) should be informed of the potential presence of respirable dust and respirable crystalline silica as well as their potential hazards. Appropriate training in the proper use and handling of this material should be provided as required under applicable regulations.

Manufacturer: PDSCo, Inc.
105 W. Sharp St
El Dorado, AR 71730
USA
Tel – 870 863 5707
Fax – 870 863 0603
sales@pdscoinc.com
www.pdscoinc.com

2. Hazards Identification

Product not classified as hazardous according to US/EU regulations.

Physical Hazards: Not classified
Health Hazards: Not classified
Environmental Hazards: Not classified
OSHA Defined Hazards: Not classified

Label Elements

Hazard Symbol: None
Signal Word: None
Hazard Statement: The substance does not meet the criteria for classification.

Precautionary Statement

Prevention: Observe good industrial hygiene practices.
Response: Wash hands after handling.
Storage: Store away from incompatible materials
Disposal: Dispose of waste in accordance with local authority requirements.

3. Composition/Information on Ingredients

| Substances: | Name & Synonyms | CAS number | % |
|---------------|-----------------|--------------|--------|
| | Trade Secret* | Proprietary* | |
| | Bentonite | 1302-78-9 | 90-100 |
| | Montmorillonite | | |
| | Smectite | | |
| Constituents: | | | |
| | Quartz | 14808-60-7 | <= 5 |
| | Feldspars | 68476-23-5 | <= 5 |
| | Cristobalite | 14464-46-1 | <= 2 |

- Designates that a specific chemical identity and/or percentage of composition has been withheld as a trade secret.

Composition: Occupational Exposure Limits for constituents are listed in section 8. Bentonite is composed mainly of smectite group minerals but the composition is varied, as expected for a UVCB substance, and other mineral constituents will be present in small and varying amounts. These minor constituents are not relevant for classification and labeling. The purity of the product is 100% w/w. Impurities are not applicable for a UVCB substance.

4. First-Aid Measures

| | |
|----------------------|---|
| Inhalation: | Remove the source of contamination or remove the affected to fresh air. Seek medical attention if respiratory symptoms persist. No specific first aid measures noted. |
| Ingestion: | No specific first aid measures noted. |
| Skin: | No hazards which require first aid measures. Wash the skin with soap and water. If any irritation persists seek medical attention. |
| Eyes: | No hazards which require first aid measures. If irritation occurs flush thoroughly with water. If irritation persists seek medical attention. |
| General Information: | No hazards which require special first aid measures. Provide general supportive measures and treat symptomatically. |

5. Firefighting Measures

| | |
|--|--|
| Suitable extinguishing media: | All standard firefighting media. |
| Extinguishing media which must not be used for safety reasons: | None known. |
| Special exposure hazards: | Non-combustible. The product itself will not burn. The product becomes slippery when wet. |
| Special protective equipment for firefighters: | Standard protective clothing and firefighting equipment. |

6 Accidental Release Measures

| | |
|----------------------------|--|
| Personal precautions: | No specific precautions are necessary. Avoid creating and breathing dust – see section 8. The product becomes slippery when wet. |
| Environmental precautions: | No special environmental precautions required. |
| Methods for cleaning up: | Avoid creating and breathing dust. |

7. Handling and Storage

| | |
|-----------|--|
| Handling: | Do not breathe airborne dust and avoid creating dusty conditions. Material is slippery when wet. |
| Storage: | Store in dry storage area. Close container when not in use. No restrictions on storage with other products. |

8. Exposure Controls/Personal Protection

Occupational Exposure Limits

OSHA Table Z-1 Limits for Air Contaminants (29 CFR 1910.1000)

| Constituents | Type | Value | Form |
|---|------|----------------------|---------------------|
| Inert or Nuisance Dusts (CAS SEQ250) | PEL | 5 mg/m ³ | Respirable Fraction |
| | | 15 mg/m ³ | Total Dust |

OSHA Table Z-3 Limits for Mineral Dusts (29 CFR 1910.1000)

| Constituents | Type | Values | Form |
|---|------|---------------------------------|---------------------|
| Inert or Nuisance Dusts (CAS SEQ250) | TWA | 5 mg/m ³ & 15 MPPCF | Respirable Fraction |
| | | 15 mg/m ³ & 50 MPPCF | Total Dust |

ACGIH Threshold Limit Values

| Constituents | Type | Values | Form |
|---|------|----------------------|---------------------|
| Inert or Nuisance Dusts (CAS SEQ250) | TWA | 3 mg/m ³ | Respirable Fraction |
| | | 10 mg/m ³ | Total Dust |

| | |
|-----------------------------------|---|
| Biological Limit Values: | No biological exposure limits noted for the ingredients. |
| Appropriate Engineering Controls: | Use approved industrial ventilation and local exhaust as required to maintain exposures below applicable exposure limits. |
| Personal Protective Equipment: | If engineering controls and work practices cannot prevent excessive exposure, the selection of personal protective equipment should be determined by a qualified professional based on specific application of this product. |
| Respiratory Protection: | Ensure good ventilation. Use a NIOSH/MSHA approved respirator If there is risk of exposure to dust at levels exceeding the exposure limits. |
| Hand Protection: | Not required under normal conditions. |
| Eye Protection: | Goggles or safety glasses when there is danger of eye contact. |
| Skin Protection: | Standard work clothing. Environmental Exposure Controls: No special requirements. |
| General Hygiene: | Always observe good hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Use good industrial hygiene practices in handling this material. |

9. Physical and Chemical Properties

| | |
|---------------------|-----------------|
| Appearance: | Pellets |
| Odor: | None/slight |
| PH (0.5% solution): | 7 - 11 |
| Melting point | Not determined. |
| Boiling point: | Not applicable |
| Flash point: | Not applicable |

| | |
|------------------------|-----------------------|
| Explosive properties: | Not explosive |
| Oxidizing properties: | Not determined |
| Vapor pressure: | Not determined |
| Vapor density: | Not applicable |
| Relative density: | 2.6 g/cm ³ |
| Solubility | |
| - water solubility: | < 0.9 mg/l |
| Partition coefficient: | |
| n-octanol/water: | Not applicable |
| Viscosity: | Not applicable |
| Evaporation rate: | Not applicable |

10. Stability and Reactivity

| | |
|-----------------------------------|--|
| Stability: | Stable under normal conditions of use. |
| Conditions to avoid: | Moisture |
| Materials to avoid: | None known |
| Hazardous decomposition products: | None |

11. Toxicological Information

| | |
|-----------------|---|
| Acute toxicity: | Not classified |
| Eye Contact: | Dust in the eyes may cause irritation. |
| Ingestion: | Not classified |
| Inhalation: | Inhalation of dust may irritate respiratory system. |
| Skin contact: | Dust may irritate skin. |

Toxicology Data

| Substance | CAS Number | LD50 Oral | LD50 Dermal | LC50 Inhalation |
|-----------|------------|------------------------------------|--------------------|------------------------------|
| Bentonite | 1302-78-9 | > 5000 mg (rat) > 2000 mg (rat) | No data No data | > 5.27 mg/L (rat) No data |

| | |
|----------------------------|--|
| Skin Corrosion: | Not classified. |
| Serous Eye Irritation: | Not classified. Dust, mild irritant to eyes. |
| Respiratory Sensitization: | Not classified |
| Skin sensitization: | Not classified |
| Germ Cell Mutagenicity | Not classified |

| | |
|-----------------|---|
| Carcinogenicity | In June 2003, SCOEL (the EU Scientific Committee on Occupational Exposure Limits) concluded that the main effect in humans of the inhalation of respirable crystalline silica dust is silicosis. "There is sufficient information to conclude that the relative risk of lung cancer is increased in persons with silicosis (and, apparently, not in employees without silicosis exposed to silica dust in quarries and in the ceramic industry). Therefore, preventing the onset of silicosis will also reduce the cancer risk..." (SCOEL SUM Doc 94-final, June 2003) According to the current state of the art, worker protection against silicosis can be consistently assured by respecting the existing regulatory occupational exposure limits. Occupational exposure to respirable dust and respirable crystalline silica should be monitored and controlled. This product contains <10% total crystalline silica. The respirable crystalline silica as determined by the SWeRF method is <1% w/w. |
|-----------------|---|

| | |
|------------------------|-----------------|
| Reproductive Toxicity: | Not classified. |
|------------------------|-----------------|

| | |
|--------------------|---------------------------|
| Aspiration Hazard: | Not an aspiration hazard. |
|--------------------|---------------------------|

12. Ecological Information

Ecotoxicity The product is not classified as environmentally hazardous, however, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

| Substance | CAS Number | Species | Toxicity Results |
|-----------|------------|-----------------------|-----------------------------|
| Bentonite | 1302-78-9 | Oncorhynchus Mykiss | TLM96 10000 ppm |
| | | Oncorhynchus Mykiss | LC50 (96h) 16000-19000 mg/L |
| | | Black Bass | LC50 (24h) 2800-3200 mg/L |
| | | Warmouth Bass | LC50 (24h) 2800-3200 mg/L |
| | | Blue Gill | LC50 (24h) 2800-3200 mg/L |
| | | Sunfish | LC50 (24h) 2800-3200 mg/L |
| | | Metacarcinus Magister | EC50 (96h) 81.6 mg/L |
| | | Pandalus Danae | EC50 (96h) 24.8 mg/L |
| | | Daphnia Magna | EC50 (48h) > 100 mg/L |

| | |
|--------------------------------|---|
| Persistence and Degradability: | Not applicable to inorganic substances |
| Bioaccumulative Potential: | Will not bioaccumulate. |
| Mobility in Soil: | Near insoluble, low mobility in soil. |
| Other Adverse Effects: | No adverse ecological effects are expected. |

13. Disposal Considerations

| | |
|-------------------------|--|
| Disposal Instructions: | Dispose according to all local, state and federal regulations. |
| Hazardous waste code: | Not regulated |
| Contaminated packaging: | Follow all applicable regulations. |

14. Transport Information

| | |
|----------------------------|--|
| Land transport (DOT/ADR) | Not classified as dangerous for transport. |
| Sea transport (IMDG/IMO): | Not classified as dangerous for transport. |
| Air transport (IATA/ICAO): | Not classified as dangerous for transport. |

Transport in bulk according to Annex II
of MARPOL 73/78 and the IBC Code: Not applicable

15. Regulatory Information

| | |
|-------------------------|---|
| US Federal Regulations: | This product is not known to be a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200 |
|-------------------------|---|

CERCLA Hazardous
Substances List (40 CFR 302.4) Not listed

Superfund Amendments and Reauthorization Act of 1986 (SARA)
Hazard Categories:

| | |
|--------------------|----|
| Immediate Hazard: | No |
| Delayed Hazard: | No |
| Fire Hazard: | No |
| Pressure Hazard: | No |
| Reactivity Hazard: | No |

16. Regulatory Information

US Federal Regulations: This product is not known to be a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200

CERCLA Hazardous
Substances List (40 CFR 302.4) Not listed

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard Categories:

| | |
|--------------------|----|
| Immediate Hazard: | No |
| Delayed Hazard: | No |
| Fire Hazard: | No |
| Pressure Hazard: | No |
| Reactivity Hazard: | No |

SARA 302 Extremely Hazardous Substances

No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.
None present

SARA 311/312 Hazardous Chemical: No

SARA 313 – Specific Toxic Chemical Listings

This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

None present. Not Regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)
Not listed

17. Other Information

HMIS Rating

Health: 1

Flammability: 0

Reactivity: 0

NFPA Rating

Health: 1

Fire: 0

Reactivity: 0

Training Advice: Read the safety data sheet and technical data sheet prior to using the product.

Further Information: UVCB = a substance of Unknown or Variable composition, Complex reaction products or Biological materials

SWeRF = Size Weighted Respirable Fraction methodology is a scientific method developed to quantify the content of respirable particles within a bulk product.

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe

handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The manufacturer expressly does not make any representations, warranties, or guarantees as to its accuracy, reliability or completeness nor assumes any liability for its use. It is the user's responsibility to verify the suitability and completeness of such information for each particular use. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text. PDSCo, Inc. cannot anticipate under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.



Material Safety Data Sheet

| NFPA | HCS Risk Phrases | Protective Clothing |
|------|---------------------------------|--|
| | HCS Class: Irritating substance | Splash goggles Respirator Gloves |

Section I. Chemical Product and Company Identification

| | | | | | | |
|----------------------------|--|--|---------------------|------|---|---------------|
| Common Name/ Trade Name | | | SUPERCIZER 5 | | Last Update 03/01/2008 | |
| Supplier/ Manufacturer: | FRITZ-PAK CORPORATION 4821 Eastover Circle Mesquite, TX 75149 U.S.A. Tel: 214-221-9494 Fax: 214-349-3182 | | | CAS# | 9084-06-4 | |
| | | | | TSCA | On the TSCA list | |
| | | | | DSL | All the ingredients are on the DSL list | |
| Chemical Family | Sulfonated Naphthalene Condensate, Sodium Salt (Salt). | | | | Material Uses | Not Available |

Section II. Composition and Information on Ingredients:

| Name | CAS # | % by Weight | TLV/PEL | LC ₅₀ /LD ₅₀ |
|--------------|---------|-------------|---------|------------------------------------|
| Formaldehyde | 50-00-0 | Trace | 1.0 ppm | |

Section III. Hazards Identification

| | |
|---|---|
| Potential Acute Health and Chronic Effects | May irritate skin. Mildly irritating to eyes. |
|---|---|

Section IV. First Aid Measures

| | |
|--------------|---|
| Eye Contact | IMMEDIATELY flush eyes with running water. |
| Skin Contact | Rinse with water. |
| Inhalation | May be irritating to the respiratory tract. Treat as nuisance dust. |
| Ingestion | Have conscious person drink several glasses of water or milk. Seek medical attention. |

Section V. Fire and Explosion Data - Non-Flammable

Section VI. Accidental Release Measures

| | |
|-------------|--|
| Small Spill | Use appropriate tools to put the spilled solid in a convenient waste disposal container. |
| Large Spill | Use a shovel to put material into a convenient waste disposal container. Dispose of it in an approved chemical waste landfill. |

Section VII. Handling and Storage

| | |
|-------------|--|
| Precautions | DO NOT breathe dust. In case of insufficient ventilation, wear suitable respiratory equipment. |
| Storage | Keep container dry. Keep in a cool place. |

Section VIII. Exposure Controls/Personal Protection

| | |
|----------------------|---|
| Engineering Controls | Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. If user operations generate dust, fume or mist, use ventilation to keep exposure to airborne contaminants below the exposure limit. |
| Personal Protection | Splash goggles. Dust respirator. |

Continued on Next Page

Section IX. Physical and Chemical Properties

| | | | |
|-------------------------------|--|-------|----------------|
| Physical state and appearance | Solid | Odor | Smoky. Sweet. |
| pH (1% soln) | 10 | Color | Brown (Light). |
| Specific Gravity | 0.8 (Water = 1) | | |
| Volatility | 3% (v/v) | | |
| Water/Oil Dist. Coeff. | Only soluble or dispersed in water.. | | |
| Solubility | Easily soluble in cold water, hot water, methanol. Very slightly soluble in diethyl ether. Insoluble in n-octanol. | | |

Section X. Stability and Reactivity Data

| | |
|---|--|
| Stability | The product is stable. |
| Incompatibility with various substances | Slightly reactive to reactive with oxidizing agents. |
| Corrosivity | Non-corrosive in presence of glass. |


Section XI. Toxicological Information

| | |
|-----------------|-----------------------|
| Routes of Entry | Ingestion. Inhalation |
|-----------------|-----------------------|

Section XII. Ecological Information - Not Available**Section XIII. Disposal Considerations**

| | |
|----------------|----------|
| Waste Disposal | Landfill |
|----------------|----------|

Section XIV. Transport Information - Non-Hazardous**Section XV. Other Regulatory Information and Pictograms**

| | | | |
|-------------------------------|---------------------|--------------------------------------|--|
| Federal and State Regulations | Not available | | |
| Other Classifications | WHMIS (Canada) | Not controlled under WHMIS (Canada) | |
| | DSCL (EEC) | R36/38– Irritating to eyes and skin. | |
| HMIS (U. S. A.) | Health Hazard | 2 | National Fire Protection Association (U. S. A.) Health  Fire Hazard Reactivity Specific Hazard |
| | Fire Hazard | 0 | |
| | Reactivity | 0 | |
| | Personal Protection | e | |

WHMIS (Canada)
(Pictograms) Not controlled under WHMIS (Canada)

TDG (Canada)
Pictograms



The information contained herein is based on data considered accurate. However, no warranty is expressed or implied regarding the accuracy of these data or the results to be obtained from the use thereof. Fritz-Pak Corporation assumes no responsibility for personal injury or property damage to vendees, users or third parties caused by the material. Such vendees or users assume all risks associated with the use of the material.



CEMENT & CONCRETE PRODUCTS™

Cements

MATERIAL SAFETY DATA SHEET (Complies with OSHA 29 CFR 1910.1200)

SECTION I: PRODUCT IDENTIFICATION

The QUIKRETE® Companies
One Securities Centre
3490 Piedmont Road, Suite 1300
Atlanta, GA 30329

Emergency Telephone Number
(770) 216-9580

Information Telephone Number
(770) 216-9580

MSDS K1
Revision: Feb-07

| QUIKRETE® Product Name | Code # |
|---------------------------|---------|
| QUIKRETE® PORTLAND CEMENT | 1124 |
| PORTLAND/POZZOLAN CEMENT | 1118-35 |



PRODUCT USE: HYDRAULIC CEMENTS FOR GENERAL CONSTRUCTION AND REPAIR

SECTION II - HAZARD IDENTIFICATION

Route(s) of Entry: Inhalation, Skin, Ingestion

Acute Exposure: Product becomes alkaline when exposed to moisture. Exposure can dry the skin, cause alkali burns and affect the mucous membranes. Dust can irritate the eyes and upper respiratory system. Toxic effects noted in animals include, for acute exposures, alveolar damage with pulmonary edema.

Chronic Exposure: Dust can cause inflammation of the lining tissue of the interior of the nose and inflammation of the cornea. Hypersensitive individuals may develop an allergic dermatitis.

Carcinogenicity: Since Portland cement and blended cements are manufactured from raw materials mined from the earth (limestone, marl, sand, shale, etc.) and process heat is provided by burning fossil fuels, trace, but detectable, amounts of naturally occurring, and possibly harmful, elements may be found during chemical analysis. Under ASTM standards, Portland cement may contain 0.75 % insoluble residue. A fraction of these residues may be free crystalline silica. Respirable crystalline silica (quartz) can cause silicosis, a fibrosis (scarring) of the lungs and possibly cancer. There is evidence that exposure to respirable silica or the disease silicosis is associated with an increased incidence of Scleroderma, tuberculosis and kidney disorders.

| | | |
|----------------------------------|------------------|----------------------------|
| Carcinogenicity Listings: | NTP: | Known carcinogen |
| | OSHA: | Not listed as a carcinogen |
| | IARC Monographs: | Group 1 Carcinogen |



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California Proposition 65: Known carcinogen

NTP: The National Toxicology Program, in its "Ninth Report on Carcinogens" (released May 15, 2000) concluded that "Respirable crystalline silica (RCS), primarily quartz dusts occurring in industrial and occupational settings, is *known to be a human carcinogen*, based on sufficient evidence of carcinogenicity from studies in humans indicating a causal relationship between exposure to RCS and increased lung cancer rates in workers exposed to crystalline silica dust (reviewed in IAC, 1997; Brown *et al.*, 1997; Hind *et al.*, 1997)

IARC: The International Agency for Research on Cancer ("IARC") concluded that there was "*sufficient evidence* in humans for the carcinogenicity of crystalline silica in the forms of quartz or cristobalite from occupational sources", and that there is "*sufficient evidence* in experimental animals for the carcinogenicity of quartz or cristobalite." The overall IARC evaluation was that "crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is *carcinogenic to humans* (Group 1)." The IARC evaluation noted that "carcinogenicity was not detected in all industrial circumstances or studies. Carcinogenicity may be dependent on inherent characteristics of the crystalline silica or on external factors affecting its biological activity or distribution of its polymorphs." For further information on the IARC evaluation, see IARC Monographs on the Evaluation of carcinogenic Risks to Humans, Volume 68, "Silica, Some Silicates." (1997)

Signs and Symptoms of Exposure: Symptoms of excessive exposure to the dust include shortness of breath and reduced pulmonary function. Excessive exposure to skin and eyes especially when mixed with water can cause caustic burns as severe as third degree.

Medical Conditions Generally Aggravated by Exposure: Individuals with sensitive skin and with pulmonary and/or respiratory disease, including, but not limited to, asthma and bronchitis, or subject to eye irritation, should be precluded from exposure. Exposure to crystalline silica or the disease silicosis is associated with increased incidence of scleroderma, Tuberculosis and possibly increased incidence of kidney lesions.

Chronic Exposure: Dust can cause inflammation of the lining tissue of the interior of the nose and inflammation of the cornea. Hypersensitive individuals may develop an allergic dermatitis. (May contain trace (<0.05 %) amounts of chromium salts or compounds including hexavalent chromium, or other metals found to be hazardous or toxic in some chemical forms. These metals are mostly present as trace substitutions within the principal minerals)

Medical Conditions Generally Aggravated by Exposure: Individuals with sensitive skin and with pulmonary and/or respiratory disease, including, but not limited to, asthma and bronchitis, or subject to eye irritation, should be precluded from exposure.

SECTION III - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

| Hazardous Components | CAS No. | PEL (OSHA) mg/M ³ | TLV (ACGIH) mg/M ³ |
|----------------------|------------|---------------------------------|----------------------------------|
| Portland Cement | 65997-15-1 | 5 | 5 |
| May contain: | | | |

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| | | | |
|--------------------------|------------|------------------------|-------------------|
| Silica Sand, crystalline | 14808-60-7 | $\frac{10}{\%SiO_2+2}$ | 0.05 (respirable) |
| Pulverized Limestone | 01317-65-3 | 5 | 5 |
| Fly Ash | 68131-74-8 | 5 | 5 |
| Gypsum | 10101-41-4 | 5 | 5 |
| Lime | 01305-62-0 | 5 | 5 |

Although these products contain no intentionally added Silica, they may contain small amounts of silica occurring as natural impurities in the other raw materials.

Other Limits: National Institute for Occupational Safety and Health (NIOSH). Recommended standard maximum permissible concentration=0.05 mg/M³ (respirable free silica) as determined by a full-shift sample up to 10-hour working day, 40-hour work week. See NIOSH Criteria for a Recommended Standard Occupational Exposure to Crystalline Silica.

SECTION IV – First Aid Measures

Eyes: Immediately flush eye thoroughly with water. Continue flushing eye for at least 15 minutes, including under lids, to remove all particles. Call physician immediately.

Skin: Wash skin with cool water and pH-neutral soap or a mild detergent. Seek medical treatment if irritation or inflammation develops or persists. Seek immediate medical treatment in the event of burns.

Inhalation: Remove person to fresh air. If breathing is difficult, administer oxygen. If not breathing, give artificial respiration. Seek medical help if coughing and other symptoms do not subside. Inhalations of large amounts of Portland cement require immediate medical attention.

Ingestion: Do not induce vomiting. If conscious, have the victim drink plenty of water and call a physician immediately.

SECTION V - FIRE AND EXPLOSION HAZARD DATA

Flammability: Noncombustible and not explosive.

Auto-ignition Temperature: Not Applicable

Flash Points: Not Applicable

SECTION VI – ACCIDENTAL RELEASE MEASURES

If spilled, use dustless methods (vacuum) and place into covered container for disposal (if not contaminated or wet). Use adequate ventilation to keep exposure to airborne contaminants below the exposure limit.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND STORAGE

Do not allow water to contact the product until time of use. DO NOT BREATHE DUST. In dusty environments, the use of an OSHA, MSHA or NIOSH approved respirator and tight fitting goggles is recommended.



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SECTION VIII – EXPOSURE CONTROL MEASURES

Engineering Controls: Local exhaust can be used, if necessary, to control airborne dust levels.

Personal Protection: The use of barrier creams or impervious gloves, boots and clothing to protect the skin from contact is recommended. Following work, workers should shower with soap and water. Precautions must be observed because burns occur with little warning -- little heat is sensed.

WARN EMPLOYEES AND/OR CUSTOMERS OF THE HAZARDS AND REQUIRED OSHA PRECAUTIONS ASSOCIATED WITH THE USE OF THIS PRODUCT.

Exposure Limits: Consult local authorities for acceptable exposure limits

SECTION IX - PHYSICAL/CHEMICAL CHARACTERISTICS

Appearance: Gray to gray-brown colored powder. Some products available in white and other colors.

Specific Gravity: 2.6 to 3.15

Boiling Point: >2700°F

Vapor Density: Not Applicable

Solubility in Water: Slight

Melting Point:

Vapor Pressure:

Evaporation Rate:

Odor:

>2700°F

Not Applicable

Not Applicable

Not Applicable

SECTION X - REACTIVITY DATA

Stability: Stable.

Incompatibility (Materials to Avoid): Material when mixed with water will react with Aluminum and other alkali and alkaline earth elements liberating hydrogen gas.

Hazardous Decomposition or By-products: None

Hazardous Polymerization: Will Not Occur.

Condition to Avoid: Keep dry until used to preserve product utility.

SECTION XI – TOXICOLOGICAL INFORMATION

Routes of Entry: Inhalation, Ingestion

Toxicity to Animals:

LD50: Not Available

LC50: Not Available

Chronic Effects on Humans: Conditions aggravated by exposure include eye disease, skin disorders and Chronic Respiratory conditions.

Special Remarks on Toxicity: Not Available

SECTION XII – ECOLOGICAL INFORMATION

Ecotoxicity: Not Available

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BOD5 and COD: Not Available

Products of Biodegradation: Not available

Toxicity of the Products of Biodegradation: Not available

Special Remarks on the Products of Biodegradation: Not available

SECTION XIII – DISPOSAL CONSIDERATIONS

Waste Disposal Method: The packaging and material may be land filled; however, material should be covered to minimize generation of airborne dust. This product is not classified as a hazardous waste under the authority of the RCRA (40CFR 261) or CERCLA (40CFR 117&302).

SECTION XIV – TRANSPORT INFORMATION

DOT/UN Shipping Name: Non-regulated

DOT Hazard Class: Non-regulated

Shipping Name: Non-regulated

Non-Hazardous under U.S. DOT and TDG Regulations

SECTION XV – OTHER REGULATORY INFORMATION

US OSHA 29CFR 1910.1200: Considered hazardous under this regulation and should be included in the employers hazard communication program

SARA (Title III) Sections 311 & 312: Qualifies as a hazardous substance with delayed health effects

SARA (Title III) Section 313: Not subject to reporting requirements

TSCA (May 1997): All components are on the TSCA inventory list

Federal Hazardous Substances Act: Is a hazardous substance subject to statutes promulgated under the subject act

Canadian Environmental Protection Act: Not listed

Canadian WHMIS Classification: Considered to be a hazardous material under the Hazardous Products Act as defined by the Controlled Products Regulations (Class D2A, E- Corrosive Material) and subject to the requirements of Health Canada's Workplace Hazardous Material Information (WHMIS). This product has been classified according to the hazard criteria of the Controlled Products Regulation (CPR). This document complies with the WHMIS requirements of the Hazardous Products Act (HPA) and the CPR.

SECTION XVI – OTHER INFORMATION

HMIS-III:

| | |
|---------------|---|
| Health – | 0 = No significant health risk |
| | 1 = Irritation or minor reversible injury possible |
| | 2 = Temporary or minor injury possible |
| | 3 = Major injury possible unless prompt action is taken |
| | 4 = Life threatening, major or permanent damage possible |
| Flammability- | 0 = Material will not burn |
| | 1 = Material must be preheated before ignition will occur |

| | |
|------------------|--|
| Physical Hazard- | 2 = Material must be exposed to high temperatures before ignition |
| | 3 = Material capable of ignition under normal temperatures |
| | 4 = Flammable gases or very volatile liquids; may ignite spontaneously |
| | 0 = Material is normally stable, even under fire conditions |
| | 1 = Material normally stable but may become unstable at high temps |
| | 2 = Materials that are unstable and may undergo react at room temp |
| | 3 = Materials that may form explosive mixtures with water |
| | 4 = Materials that are readily capable of explosive water reaction |

Abbreviations:

| | |
|---------------|--|
| ACGIH | American Conference of Government Industrial Hygienists |
| CAS | Chemical Abstract Service |
| CERCLA | Comprehensive Environmental Response, Compensation & Liability Act |
| CFR | Code of Federal Regulations |
| CPR | Controlled Products Regulations (Canada) |
| DOT | Department of Transportation |
| IARC | International Agency for Research |
| MSHA | Mine Safety and Health Administration |
| NIOSH | National Institute for Occupational Safety and Health |
| NTP | National Toxicity Program |
| OSHA | Occupational Safety and Health Administration |
| PEL | Permissible Exposure Limit |
| RCRA | Resource Conservation and Recovery Act |
| SARA | Superfund Amendments and Reauthorization Act |
| TLV | Threshold Limit Value |
| TWA | Time-weighted Average |
| WHMIS | Workplace Hazardous Material Information System |

Revision #07-01, supersedes all previous revisions

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NOTE: The information and recommendations contained herein are based upon data believed to be correct. However, no guarantee or warranty of any kind, express or implied, is made with respect to the information contained herein. We accept no responsibility and disclaim all liability for any harmful effects which may be caused by exposure to silica contained in our products.
