ANNUAL CCR GROUNDWATER MONITORING & CORRECTIVE ACTION REPORT

Spurlock Landfill

January 31, 2019

Reporting Year – 2018
Revision 01

EAST KENTUCKY POWER COOPERATIVE

A Touchstone Energy® Cooperative

Executive Summary

This annual report documents the status of the groundwater monitoring and corrective action program for Spurlock Station's Coal Combustion Residual (CCR) Landfill (Areas A, B & C) (herein "Spurlock Landfill", "Landfill", or "the Unit") pursuant to 40 Code of Federal Regulations (CFR) §257.90(e). Table 1-1 provides an overview of the status of the groundwater monitoring and corrective action programs for the Unit during the reporting period.

Table 1-1 Overview of the Status of the Groundwater Monitoring & Corrective Action Program for the Unit

Information Required by 40 CFR §257.90(e)(6)	Unit Information
Identify whether the unit was operating at the start of the reporting period under the detection monitoring program or the assessment monitoring program.	Detection monitoring
Identify whether the unit was operating at the end of the reporting period under the detection monitoring program or the assessment monitoring program.	Detection monitoring
If applicable, list all Appendix III (statistically significant increases (SSIs) pursuant to §257.94(e) and the associated monitoring location(s).	MW-3B: Sulfate
If applicable, provide date when the assessment monitoring program was initiated.	Not Applicable. A successful Alternative Source Demonstration was completed thus, assessment monitoring was not initiated.
If applicable, list all Appendix IV statistically significant levels (SSLs) pursuant to §257.95(g) and the associated monitoring location(s).	Not Applicable
If applicable, provide the date when the assessment of corrective measures was initiated.	Not Applicable
If applicable, provide the date when the public meeting was held for the assessment of corrective measures.	Not Applicable
If applicable, provide the date when the assessment of corrective measures was completed.	Not Applicable
If applicable, provide the date when a remedy was selected pursuant to §257.97.	Not Applicable
If applicable, provide the date when remedial activities were initiated or identify if they are ongoing.	Not Applicable

Table of Contents

1.0 Introduction

On April 17, 2015, the EPA issued the final version of the federal Coal Combustion Residual Rule (CCR) Rule to regulate the disposal of CCR materials generated at coal-fired units. The CCR Rule will be administered as part of the Resource Conservation and Recovery Act (RCRA, 42 United States Code [U.S.C.] §6901 et seq.) using the Subtitle D approach.

East Kentucky Power Cooperative (EKPC) is subject to the CCR Rule and as such must prepare an annual groundwater monitoring and corrective action report for all CCR Units per 40 Code of Federal Regulations (CFR) §257.90(e). The annual report must document the status of the groundwater monitoring and corrective action program for the CCR Unit, summarize key actions completed, describe any problems encountered, discuss actions to resolve problems, and project key activities for the upcoming year.

This document has been prepared to meet those requirements for the CCR Landfill at H.L Spurlock Power Station (Spurlock) located near Maysville, Kentucky. This report covers the 2018 reporting period, January 1, 2018 through December 31, 2018.

2.0 CCR Rule Compliance

In accordance with 40 CFR §257.90(e), EKPC is required to, at a minimum, provide the following information, to the extent available:

- A map, aerial image, or diagram showing the CCR unit and all background and downgradient monitoring wells/locations that are a part of the groundwater monitoring system, including identification numbers;
- Identify any monitoring wells/locations that were installed and/or decommissioned during the reporting period, along with a narrative description of why those actions were taken;
- Monitoring data obtained under §257.90 through §257.98, including a summary of the number of samples collected, the dates sampling occurred, and which program those samples were required by;
- A narrative description of any transition between monitoring programs (dates, circumstances, and identifying constituents detected at a SSI over background levels);
- Other information required to be included in the annual report as specified in §257.90 through §257.98, such as:
  - Alternative monitoring frequency
  - Alternate Source Demonstrations
  - Assessment monitoring concentrations
  - Demonstrations of additional time to complete the assessment of corrective measures due to site-specific conditions; and
- A section at the beginning of the annual report that provides an overview of the current stats of groundwater monitoring and corrective action programs for the unit that contains all the information specified by §257.90(e)(6).

Other information being provided in this report includes, but is not limited to;

- Groundwater elevation data;
- Laboratory analytical reports and quantification limits; and

- Statistical analysis packages prepared for each compliance monitoring event during the reporting year

3.0 Facility Information

The CCR Landfill at Spurlock is located along South Ripley Road in Mason, County. The site is located approximately five miles northwest of Maysville, Kentucky, and on the United States Geological Survey's Maysville West, Kentucky topographic map. The moderately rolling to hilly topography of the project area is typical for this region unless along a stream where erosion creates steeper slopes. Vertical relief within the existing Waste Areas A, B, and C of the Landfill is 206 feet. The Landfill is located within a stream valley, and is situated in a tributary to Lawrence Creek. **Appendix A**, prepared by Tetra Tech, Inc., shows the Spurlock Station Landfill property, depicting the groundwater monitoring system present at Spurlock's CCR Landfill. Monitoring wells MW-6 and MW-7 are upgradient monitoring locations, and wells MW-2B, MW-3B, and MW-5B are downgradient monitoring locations.

4.0 Status of Groundwater Monitoring and Corrective Action Program

The CCR Unit did not undergo any program transition in 2108 and EKPC is implementing a detection monitoring program at Spurlock Landfill pursuant to 40 CFR §257.94. In order to comply with the requirements of detection monitoring, EKPC conducts semiannual groundwater sampling and utilizes an intra-well statistical approach for Appendix III constiuents.

At the outset of implementation of the 2015 CCR Rule, EKPC interpreted the Rule's requirement for "semiannual" detection and assessment monitoring to mean two sampling events per year, with one in the first half of the year and one in the second half of the year (without necessarily being six months apart), along with one annual Appendix IV constituent scan per 40 CFR 257.95(b). To that end, detection monitoring occurred in May and December 2018. EKPC will continue to conduct semi-annual monitoring, as needed, approximately every six months and will conduct the annual Appendix IV constituents scan approximately every 12 months, if the unit initiates an assessment monitoring program.

5.0 Summary of Key Actions Completed

This Section provides a narrative of the key actions completed at the CCR Unit during the reporting period.

5.1 Groundwater Monitoring Activities

The CCR Rule requires reporting of monitoring data obtained under 40 CFR §257.90 through §257.98 during the reporting period, including a summary of the number of samples collected, the dates sampling occurred, and which program those samples were required by (background, detection, or assessment). **Table 5-1** summarizes those sampling events that occurred during the reporting period. The sampling results obtained in 2018 and the results from November 2017, i.e., the initial detection monitoring event, which were not available during the 2017 reporting period, are summarized in **Table B-1** in **Appendix B**, while the laboratory analytical reports are included in **Appendix C.** Also included in these appendices are the laboratory analytical results from an Alternate Source Demonstration (ASD) investigation, discussed further in Section 5.3.

During the 2018 reporting year at Spurlock Landfill, EKPC collected two semiannual detection monitoring samples, pursuant to 40 CFR §257.94, from all wells in the Spurlock Landfill monitoring system. The first semi-annual sample was collected on May 31, 2018, and the second sample was collected on December 3, 2018. Groundwater flow maps and velocity calculations from those events are in **Appendix D**.

Table 5-1: Annual Sampling & Analysis Summary

Collection Date	Number of Samples Collected	Location of Collected Samples	Monitoring Program
03/08/18	5	MW-6, MW-7, MW-2B, MW-3B & MW-5B	ASD
5/30/18 & 5/31/18	5	MW-6, MW-7, MW-2B, MW-3B & MW-5B	Detection
12/3/18*	5	MW-6, MW-7, MW-2B, MW-3B & MW-5B	Detection

** The laboratory analytical results for the December 2018 event were not available on or before December 31, 2018, and therefore those concentrations are not included in this report*

5.2 Statistical Analysis and Statistically Significant Increase(s)

Pursuant to 40 CFR §257.93(h)(2), within 90 days after completing sampling and analysis, the owner or operator must determine whether there has been a SSI over background for any Appendix III constituent at each monitoring location. Detection monitoring results, background limits, and SSI(s), if any, are summarized in **Table 1** of the statistical analysis packages in **Appendix E1** and **Appendix E2**.

In January 2018 and within 90 days of receiving the laboratory analysis, Hayley & Aldrich completed the statistical analysis of the detection monitoring sampling and analysis results from November 2017 (i.e. the initial semi-annual detection monitoring event). A SSI for sulfate at MW-3B was identified. EKPC pursued an ASD for this SSI, which was successful and is described further in Section 5.3, and the Landfill remained in detection monitoring. The full statistical analysis package for the November 2017 event is provided in **Appendix E1**.

In October 2018 and within 90 days of receiving the laboratory analysis, Haley & Aldrich completed the statistical analysis of the detection monitoring sampling and analysis results from May 2018 (i.e., the first semi-annual 2018 detection monitoring event). A SSI for sulfate at MW-3B was again identified. EKPC pursued an ASD for this SSI, which was successful and is described further in Section 5.3, and the Landfill remained in detection monitoring. The full statistical analysis package for the April 2021 event is provided in **Appendix E2**.

Statistical analysis of the lab analytical results from December 2018 (i.e. the second semi-annual 2018 detection monitoring event) was not available on or before December 31, 2018, and is not included in this report.

5.3 Alternate Source Demonstration(s)

Pursuant to 40 CFR §257.94(e)(2), if an SSI over background for any constituent is identified by the statistical analysis, an operator or owner may demonstrate that a source other than the CCR Unit caused the SSI, or the SSI resulted from an error in sampling, analysis, statistical evaluation, or natural variation in groundwater quality. Otherwise the operator or owner must establish an assessment monitoring program meeting the requirements of 40 CFR §257.95.

Geosyntec, on behalf of EKPC, prepared two separate Alternate Source Demonstrations (ASD) for the sulfate SSIs measured in MW-3B during the November 2017 and May 2018 detection monitoring events. The ASDs successfully demonstrated that the sulfate concentrations found above background was not due to a leachate release and therefore, the Unit may continue with the detection monitoring program. These ASDs (dated July 2018 and December 2018) are provided in **Appendix F**.

6.0 Problems Encountered and Actions Taken

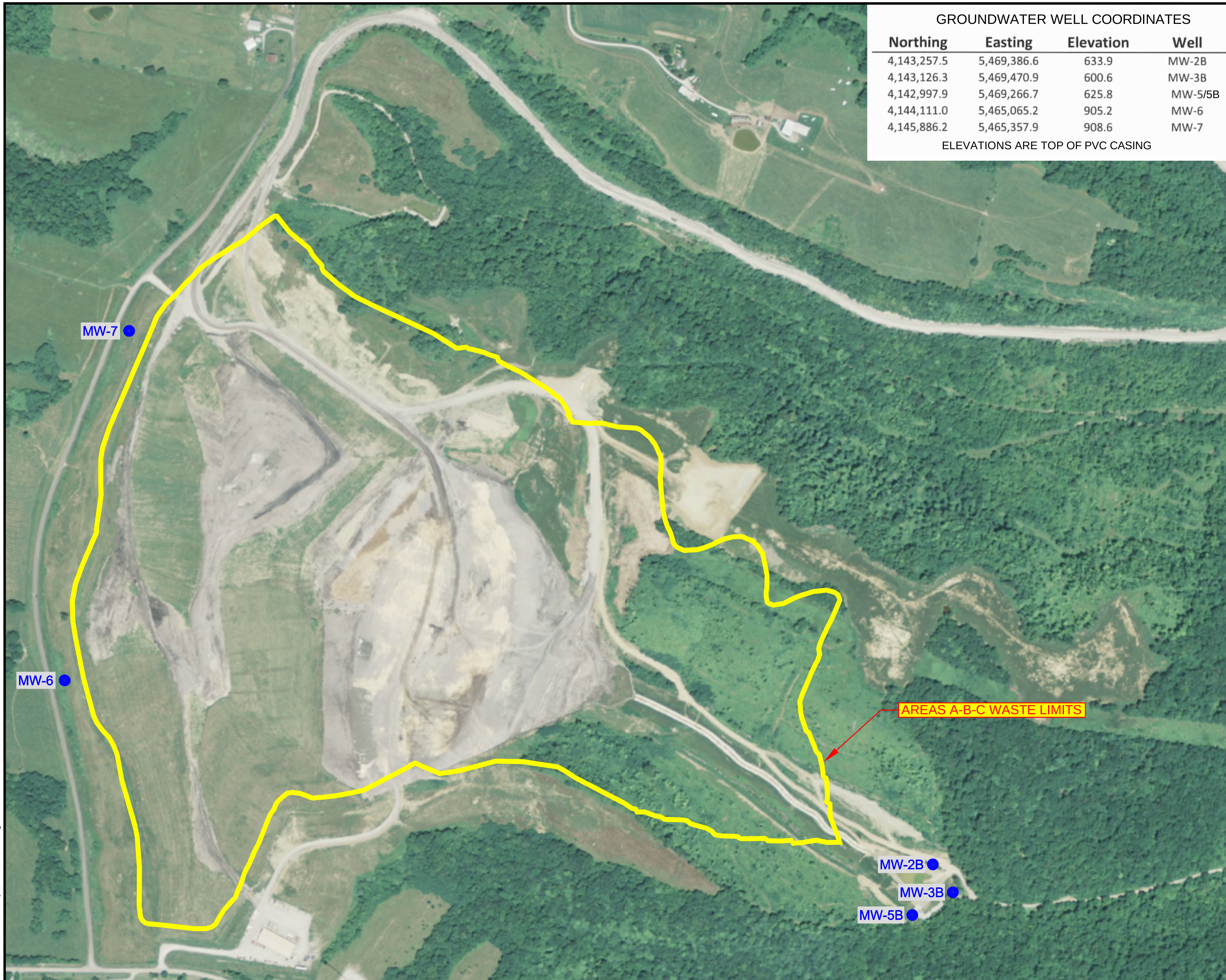
This section describes any problems encountered with the groundwater monitoring program during the reporting period and the actions taken in response.

No significant problems were encountered at Spurlock CCR Landfill in 2018.

7.0 Key Activities Projected for 2019

EKPC will continue semi-annual detection monitoring in 2019. In addition, EKPC will conduct additional investigation into the groundwater monitoring network in 2019 to determine if there is a need to install and decommission wells, and/or a change of statistical methodology to address issues identified in the ASD.

APPENDIX A – Groundwater Monitoring Locations Map



GROUNDWATER WELL COORDINATES

Northing	Easting	Elevation	Well
4,143,257.5	5,469,386.6	633.9	MW-2B
4,143,126.3	5,469,470.9	600.6	MW-3B
4,142,997.9	5,469,266.7	625.8	MW-5/5B
4,144,111.0	5,465,065.2	905.2	MW-6
4,145,886.2	5,465,357.9	908.6	MW-7

ELEVATIONS ARE TOP OF PVC CASING

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LEGEND

- GROUNDWATER MONITORING WELL
- SPURLOCK LANDFILL EXISTING A-B-C BOUNDARY

GROUNDWATER MONITORING WELLS INSTALLED AUGUST/SEPTEMBER 2016.

0 250 500
GRAPHIC SCALE, FEET

AERIAL PHOTOGRAPH, CIRCA 2014, OBTAINED FROM:

GIS Kentucky Division of Geographic Information gis.ky.gov Explore!

FIGURE 6
Groundwater Monitoring Well Locations
East Kentucky Power Cooperative
Spurlock Landfill
Mason County, Kentucky

TETRA TECH, INC.

424 Lewis Hargett Circle Lexington, Kentucky 40503 (859) 223-8000

200-123815-16003-Spurlock Wells.dwg

APPENDIX B – Summary of Analytical Results

Spurlock Landfill

Annual Reporting Year 2018
Table B-1: Summary of Analytical Results

Well ID	Sample Date	Event Type	GW Elevation (ft. MSL)	Boron (µg/L)		Calcium (µg/L)		Chloride (mg/L)		Fluoride (mg/L)	pH (S.U.)	Sulfate (mg/L)		TDS (mg/L)
				Appendix 3 Constituents										
SLF-MW-2B	3/8/2018	ASD				47900	D	1710	D			233	D	
SLF-MW-2B	11/29/2017	Detection	579.50	4580	D	37600		1420	D	1.9	7.66	192		3070
SLF-MW-2B	5/31/2018	Detection	579.80	4370	D	44100		1870	D	2.2	7.56	200	D	3910
SLF-MW-3B	11/29/2017	Detection	584.70	3860	D	205000	D	152	D	< 0.50	7.12	483	D	1210
SLF-MW-3B	3/8/2018	ASD				173000	D	224	D			476	D	
SLF-MW-3B	5/30/2018	Detection	584.90	2650		171000	D	179	D	< 0.50	7.09	454	D	1210
SLF-MW-5R	11/29/2017	Detection	607.10	524		136000	D	24.5		< 0.50	7.10	158		549
SLF-MW-5R	3/8/2018	ASD				105000	D	15.0				89.8		
SLF-MW-5R	5/30/2018	Detection	607.00	517		118000	D	25.5		< 0.50	6.94	158		591
SLF-MW-6	11/29/2017	Detection	764.90	1970	D	1020000	D	16300	D	< 0.50	7.25	97.9		30300
SLF-MW-6	3/8/2018	ASD				1170000	D	20800	D			90.4		
SLF-MW-6	5/30/2018	Detection	781.20	822		846000	D	13700	D	< 0.50	7.11	452	D	27800
SLF-MW-7	11/29/2017	Detection	756.30	5440	D	563000	D	14500	D	< 0.50	7.14	4.2		26200
SLF-MW-7	3/8/2018	ASD				539000	D	15200	D			4.5		
SLF-MW-7	5/30/2018	Detection	756.80	2860		496000	D	10300	D	< 0.50	7.10	10.3		28000

Result Notes :	J - Estimated Value NA - Not available	R - Unusable (Quality Control Failure) D - Result reported from dilution	
Result Units :	mg/L - milligram per liter ft. MSL - feet above mean sea level	µg/L - microgram per liter pCi/L - picocurie per liter	S.U. - Standard Units
Event Type Abbreviations :	A3 - Appendix III Constituents for Detection Monitoring ASD - Alternative Source Demonstration	A4 - Appendix IV Constituents for Assessment Monitoring	
Event Type Constituents :	Background - A3 and A4 Assessment - A3 (All) and A4 (Detected in annual screen).	Detection - A3	Annual Screen - A4 ASD - Tested A3 and A4 parameters

APPENDIX C – Laboratory Analytical Reports

EAST KENTUCKY POWER COOPERATIVE

Report Date: Friday, January 5, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	11/29/2017
Well ID No:	SLF-MW-2B	Sample Collection Time:	10:35 AM
AKGW No.:	8007-0267	Sample Collected By:	BB
Gradient:	Down	Sample Matrix:	Ground Water
Well Depth (Ft.):	63.55	Laboratory Certification ID:	KY# 08012
Well Elevation (Ft. MSL):	579.67		

Field Analyses

Field Analyses	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
pH	7.66	S.U.		SM 4500-H+, B-2011	11/29/2017	10:35 AM	BB

EKPC - Central Laboratory Analyses

Lab Identification #: 171544

Sample Received Date:	12/1/2017	Sample Receipt Temperatures (°C):	<6
Sample Received Time:	9:25 AM	Sample Received By:	JD

Parameter	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Boron	4580	µg/L		EPA 200.8, Rev. 5.4 (1994)	12/13/2017	6:53 PM	JD
Calcium	37600	µg/L		EPA 200.8, Rev. 5.4 (1994)	12/13/2017	7:28 PM	JD
Chloride	1420	mg/L		EPA 300.0 Rev 2.1 (1993)	12/6/2017	3:13 PM	JD
Fluoride	1.99	mg/L	4.0	EPA 300.0 Rev 2.1 (1993)	12/6/2017	12:50 AM	JD
Sulfate	192	mg/L		EPA 300.0 Rev 2.1 (1993)	12/6/2017	1:53 PM	JD
Solids, Total Dissolved	3070	mg/L		SM 2540, C-2011	12/4/2017	3:21 PM	JD

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by: Chemist Laboratory Supervisor

4775 Lexington Rd. 40391
P.O. Box 707, Winchester,
Kentucky 40392-0707

Tel. (859) 744-4812
Fax: (859) 744-6008
www.ekpc.coop

EAST KENTUCKY POWER COOPERATIVE

Report Date: Friday, January 5, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	11/29/2017
Well ID No:	SLF-MW-3B	Sample Collection Time:	9:25 AM
AKGW No.:	8007-0268	Sample Collected By:	BB
Gradient:	Down	Sample Matrix:	Ground Water
Well Depth (Ft.):	33.32	Laboratory Certification ID:	KY# 08012
Well Elevation (Ft. MSL):	585.63		

Field Analyses

Field Analyses	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
pH	7.12	S.U.		SM 4500-H+, B-2011	11/29/2017	9:25 AM	BB

EKPC - Central Laboratory Analyses

Lab Identification #: 171545

Sample Received Date:	12/1/2017	Sample Receipt Temperatures (°C):	<6
Sample Received Time:	9:25 AM	Sample Received By:	JD

Parameter	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Boron	3860	µg/L		EPA 200.8, Rev. 5.4 (1994)	12/13/2017	7:32 PM	JD
Calcium	205000	µg/L		EPA 200.8, Rev. 5.4 (1994)	12/13/2017	6:58 PM	JD
Chloride	152	mg/L		EPA 300.0 Rev 2.1 (1993)	12/6/2017	4:34 PM	JD
Fluoride	< 0.50	mg/L	4.0	EPA 300.0 Rev 2.1 (1993)	12/6/2017	2:10 AM	JD
Sulfate	483	mg/L		EPA 300.0 Rev 2.1 (1993)	12/6/2017	4:34 PM	JD
Solids, Total Dissolved	1210	mg/L		SM 2540, C-2011	12/4/2017	3:21 PM	JD

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by:

Chemist

QA/QC Chemist

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Friday, January 5, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	11/29/2017
Well ID No:	SLF-MW-5R	Sample Collection Time:	11:29 AM
AKGW No.:	8007-0266	Sample Collected By:	BB
Gradient:	Down	Sample Matrix:	Ground Water
Well Depth (Ft.):	27.05	Laboratory Certification ID:	KY# 08012
Well Elevation (Ft. MSL):	625.71		

Field Analyses	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
pH	7.10	S.U.		SM 4500-H+, B-2011	11/29/2017	11:29 AM	BB

EKPC - Central Laboratory Analyses

Lab Identification #: 171546

Sample Received Date:	12/1/2017	Sample Receipt Temperatures (°C):	<6
Sample Received Time:	9:25 AM	Sample Received By:	JD

Parameter	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Boron	524	µg/L		EPA 200.8, Rev. 5.4 (1994)	12/13/2017	7:50 PM	JD
Calcium	136000	µg/L		EPA 200.8, Rev. 5.4 (1994)	12/13/2017	7:02 PM	JD
Chloride	24.5	mg/L		EPA 300.0 Rev 2.1 (1993)	12/5/2017	2:37 AM	JD
Fluoride	< 0.50	mg/L	4.0	EPA 300.0 Rev 2.1 (1993)	12/6/2017	2:37 AM	JD
Sulfate	158	mg/L		EPA 300.0 Rev 2.1 (1993)	12/6/2017	2:37 AM	JD
Solids, Total Dissolved	549	mg/L		SM 2540, C-2011	12/6/2017	4:19 PM	JD

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by: Chemist   QA/QC Chemist

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Friday, January 5, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	11/29/2017
Well ID No:	SLF-MW-6	Sample Collection Time:	1:37 PM
AKGW No.:	8003-8410	Sample Collected By:	BB
Gradient:	Up	Sample Matrix:	Ground Water
Well Depth (Ft.):	163.15	Laboratory Certification ID:	KY# 08012
Well Elevation (Ft. MSL):	905.18		

Field Analyses

Field Analyses	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
pH	7.25	S.U.		SM 4500-H+, B-2011	11/29/2017	1:37 PM	BB

EKPC - Central Laboratory Analyses

Lab Identification #: 171547

Sample Received Date:	12/1/2017	Sample Receipt Temperatures (°C):	<6
Sample Received Time:	9:25 AM	Sample Received By:	JD

Parameter	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Boron	1970	µg/L		EPA 200.8, Rev. 5.4 (1994)	12/13/2017	7:06 PM	JD
Calcium	1020000	µg/L		EPA 200.8, Rev. 5.4 (1994)	1/4/2018	3:21 PM	JD
Chloride	16300	mg/L		EPA 300.0 Rev 2.1 (1993)	12/6/2017	5:01 PM	JD
Fluoride	< 0.50	mg/L	4.0	EPA 300.0 Rev 2.1 (1993)	12/6/2017	3:04 AM	JD
Sulfate	97.9	mg/L		EPA 300.0 Rev 2.1 (1993)	12/6/2017	3:04 AM	JD
Solids, Total Dissolved	30300	mg/L		SM 2540, C-2011	12/4/2017	3:21 PM	JD

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by: [signature] Chemist

[signature] Laboratory Supervisor

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Friday, January 5, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	11/29/2017
Well ID No:	SLF-MW-7	Sample Collection Time:	3:17 PM
AKGW No.:	8003-8409	Sample Collected By:	BB
Gradient:	Up	Sample Matrix:	Ground Water
Well Depth (Ft.):	163.51	Laboratory Certification ID:	KY# 08012
Well Elevation (Ft. MSL):	908.58		

Field Analyses

	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
pH	7.14	S.U.		SM 4500-H+, B-2011	11/29/2017	3:17 PM	BB

EKPC - Central Laboratory Analyses

Lab Identification #: 171548

Sample Received Date:	12/1/2017	Sample Receipt Temperatures (°C):	<6
Sample Received Time:	9:25 AM	Sample Received By:	JD

Parameter	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Boron	5440	µg/L		EPA 200.8, Rev. 5.4 (1994)	12/13/2017	7:11 PM	JD
Calcium	563000	µg/L		EPA 200.8, Rev. 5.4 (1994)	12/13/2017	7:11 PM	JD
Chloride	14500	mg/L		EPA 300.0 Rev 2.1 (1993)	12/6/2017	6:48 PM	JD
Fluoride	< 0.50	mg/L	4.0	EPA 300.0 Rev 2.1 (1993)	12/6/2017	3:31 AM	JD
Sulfate	4.2	mg/L		EPA 300.0 Rev 2.1 (1993)	12/6/2017	3:31 AM	JD
Solids, Total Dissolved	26200	mg/L		SM 2540, C-2011	12/4/2017	3:21 PM	JD

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by:

Chemist

Laboratory Supervisor

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Monday, October 1, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	3/8/2018
Permit Number:	CCR	Sample Collection Time:	3:14 PM
Site ID:	SSI-MW-2B	Sample Collected By:	BTB
Extended Site ID:	Well 2B	Sample Matrix:	Groundwater
		Laboratory Certification ID:	KY# 08012

EKPC - Central Laboratory Analyses

Lab Identification #: 1800637

Sample Received Date:	3/12/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	10:13 AM	Sample Received By:	TY

Parameter	Result	Units	MDL	Report Limit	Analysis Method	Preparation Method	Preparation Date:	Date Analyzed:	Time Analyzed:	Analyst:
Calcium	1210000	µg/L	273	500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/21/2018	11:31 AM	JD
Magnesium	2950	µg/L	60.0	500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:31 AM	JD
Potassium	1090000	µg/L	1280	2500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/19/2018	11:31 AM	JD
Sodium	340000	µg/L	570	2500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:52 AM	JD
Chloride	1710	mg/L	8.4	50.0	EPA 300.0 Rev 2.1 (1993)			3/15/2018	1:54 PM	JE
Sulfate	233	mg/L	1.50	10.0	EPA 300.0 Rev 2.1 (1993)			3/15/2018	1:27 PM	JE

ALS Environmental

Lab Identification #: 1803723-01

Sample Received Date:	3/13/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	2:30 PM	Sample Received By:	JAS

Parameter	Result	Units	MDL	Report Limit	Analysis Method	Preparation Method	Preparation Date:	Date Analyzed:	Time Analyzed:	Analyst:
Alkalinity, Bicarbonate (as CaCO3)	440	mg/L	8.4	10	A2320 B-97			3/15/2018	2:15 PM	ED

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by:

Chemist

QA/QC Chemist

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Monday, October 1, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	3/8/2018
Permit Number:	CCR	Sample Collection Time:	2:22 PM
Site ID:	SLF-MW-3B	Sample Collected By:	BTB
Extended Site ID:	Well 3B	Sample Matrix:	Groundwater
		Laboratory Certification ID:	KY# 08012

EKPC - Central Laboratory Analyses

Lab Identification #: 1800638

Sample Received Date:	3/12/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	10:13 AM	Sample Received By:	TY

Parameter	Result	Units	MDL	Report Limit	Analysis Method	Preparation Method	Preparation Date:	Date Analyzed:	Time Analyzed:	Analyst:
Calcium	173000	µg/L	273	500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:33 AM	JD
Magnesium	35000	µg/L	60.0	500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:33 AM	JD
Potassium	15500	µg/L	1280	2500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:33 AM	JD
Sodium	195000	µg/L	114	500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:33 AM	JD
Chloride	224	mg/L	0.8	5.0	EPA 300.0 Rev 2.1 (1993)			3/15/2018	11:13 AM	JE
Sulfate	476	mg/L	1.50	10.0	EPA 300.0 Rev 2.1 (1993)			3/15/2018	11:13 AM	JE

ALS Environmental

Lab Identification #: 1803723-02

Sample Received Date:	3/13/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	2:30 PM	Sample Received By:	JAS

Parameter	Result	Units	MDL	Report Limit	Analysis Method	Preparation Method	Preparation Date:	Date Analyzed:	Time Analyzed:	Analyst:
Alkalinity, Bicarbonate (as CaCO3)	220	mg/L	8.4	10	A2320 B-97			3/15/2018	2:15 PM	ED

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by: Chemist QA/QC Chemist

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Monday, October 1, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	3/8/2018
Permit Number:	CCR	Sample Collection Time:	3:52 PM
Site ID:	SLF-MW-5R	Sample Collected By:	BTB
Extended Site ID:		Sample Matrix:	Groundwater
		Laboratory Certification ID:	KY# 08012

EKPC - Central Laboratory Analyses

Lab Identification #: 1800639

Sample Received Date:	3/12/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	10:13 AM	Sample Received By:	TY

Parameter	Result	Units	MDL	Report Limit	Analysis Method	Preparation Method	Preparation Date:	Date Analyzed:	Time Analyzed:	Analyst:
Calcium	105000	µg/L	273	500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:34 AM	JD
Magnesium	22800	µg/L	60.0	500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:34 AM	JD
Potassium	2180	µg/L	128	250	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/19/2018	11:52 AM	JD
Sodium	11800	µg/L	114	500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:34 AM	JD
Chloride	15.0	mg/L	0.1	0.5	EPA 300.0 Rev 2.1 (1993)			3/13/2018	8:28 PM	JE
Sulfate	89.8	mg/L	0.15	1.0	EPA 300.0 Rev 2.1 (1993)			3/13/2018	8:28 PM	JE

ALS Environmental

Lab Identification #: 1803723-03

Sample Received Date:	3/13/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	2:30 PM	Sample Received By:	JAS

Parameter	Result	Units	MDL	Report Limit	Analysis Method	Preparation Method	Preparation Date:	Date Analyzed:	Time Analyzed:	Analyst:
Alkalinity, Bicarbonate (as CaCO3)	260	mg/L	8.4	10	A2320 B-97			3/15/2018	2:15 PM	ED

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by: ______________ Chemist ______________ QA/QC Chemist

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Monday, October 1, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	3/8/2018
Permit Number:	CCR	Sample Collection Time:	12:10 PM
Site ID:	SLF-MW-6	Sample Collected By:	BTB
Extended Site ID:	Well 6	Sample Matrix:	Groundwater
		Laboratory Certification ID:	KY# 08012

EKPC - Central Laboratory Analyses

Lab Identification #: 1800640

Sample Received Date:	3/12/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	10:13 AM	Sample Received By:	TY

Parameter	Result	Units	MDL	Report Limit	Analysis Method	Preparation Method	Preparation Date:	Date Analyzed:	Time Analyzed:	Analyst:
Calcium	1170000	µg/L	2730	5000	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:54 AM	JD
Magnesium	332000	µg/L	60.0	500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:35 AM	JD
Potassium	112000	µg/L	1280	2500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:35 AM	JD
Sodium	10900000	µg/L	5700	25000	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	12:13 PM	JD
Chloride	20800	mg/L	42.0	250.0	EPA 300.0 Rev 2.1 (1993)			3/26/2018	12:27 PM	JE
Sulfate	90.4	mg/L	0.15	1.0	EPA 300.0 Rev 2.1 (1993)			3/13/2018	8:55 PM	JE

ALS Environmental

Lab Identification #: 1803723-04

Sample Received Date:	3/13/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	2:30 PM	Sample Received By:	JAS

Parameter	Result	Units	MDL	Report Limit	Analysis Method	Preparation Method	Preparation Date:	Date Analyzed:	Time Analyzed:	Analyst:
Alkalinity, Bicarbonate (as CaCO3)	150	mg/L	8.4	10	A2320 B-97			3/15/2018	2:15 PM	ED

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by: ______________ Chemist ______________ QA/QC Chemist

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Wednesday, October 3, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	3/8/2018
Permit Number:	CCR	Sample Collection Time:	10:28 AM
Site ID:	SLF-MW-7	Sample Collected By:	BTB
Extended Site ID:	Well 7	Sample Matrix:	Groundwater
		Laboratory Certification ID:	KY# 08012

EKPC - Central Laboratory Analyses

Lab Identification #: 1800641

Sample Received Date:	3/12/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	10:13 AM	Sample Received By:	TY

Parameter	Result	Units	MDL	Report Limit	Analysis Method	Preparation Method	Preparation Date:	Date Analyzed:	Time Analyzed:	Analyst:
Calcium	539000	µg/L	273	500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:37 AM	JD
Magnesium	207000	µg/L	60.0	500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:37 AM	JD
Potassium	94100	µg/L	1280	2500	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:37 AM	JD
Sodium	8180000	µg/L	1140	5000	EPA 200.8, Rev. 5.4 (1994)	EPA 3015A	3/15/2018	3/16/2018	11:55 AM	JD
Chloride	15200	mg/L	42.0	250.0	EPA 300.0 Rev 2.1 (1993)			4/4/2018	2:30 PM	JE
Sulfate	4.5	mg/L	0.15	1.0	EPA 300.0 Rev 2.1 (1993)			4/4/2018	1:36 PM	JE

ALS Environmental

Lab Identification #: 1803723-05

Sample Received Date:	3/13/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	2:30 PM	Sample Received By:	JAS

Parameter	Result	Units	MDL	Report Limit	Analysis Method	Preparation Method	Preparation Date:	Date Analyzed:	Time Analyzed:	Analyst:
Alkalinity, Bicarbonate (as CaCO3)	150	mg/L	8.4	10	A2320 B-97			3/15/2018	2:15 PM	ED

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by:

Chemist

QA/QC Chemist

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Tuesday, July 3, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	5/31/2018
Well ID No:	SLF-MW-2B	Sample Collection Time:	9:48 AM
AKGW No.:	8007-0267	Sample Collected By:	BTB
Gradient:	Down	Sample Matrix:	Ground Water
Well Depth (Ft.):	63.55	Laboratory Certification ID:	KY# 08012
Well Elevation (Ft. MSL):	633.90		

Field Analyses

Field Analyses	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Groundwater Elevation	579.8	MSL		EPA 410.4 R2.0	5/31/2018	9:48 AM	BTB
pH	7.56	S.U.		SM 4500-H+, B-2011	5/31/2018	9:48 AM	BTB

EKPC - Central Laboratory Analyses

Lab Identification #: 1800895

Sample Received Date:	5/31/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	2:51 PM	Sample Received By:	JD

Parameter	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Boron	4370	µg/L		EPA 200.8, Rev. 5.4 (1994)	6/25/2018	12:54 PM	JD
Calcium	44100	µg/L		EPA 200.8, Rev. 5.4 (1994)	6/21/2018	1:04 PM	JD
Chloride	1870	mg/L		EPA 300.0 Rev 2.1 (1993)	6/4/2018	11:08 AM	JWE
Fluoride	2.20	mg/L	4.0	EPA 300.0 Rev 2.1 (1993)	6/1/2018	6:51 PM	JWE
Sulfate	200	mg/L		EPA 300.0 Rev 2.1 (1993)	6/4/2018	10:41 AM	JWE
Solids, Total Dissolved	3910	mg/L		SM 2540, C-2011	6/1/2018	8:38 AM	JWE

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by:

Chemist

QA/QC Chemist

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Tuesday, July 3, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	5/30/2018
Well ID No:	SLF-MW-3B	Sample Collection Time:	5:27 PM
AKGW No.:	8007-0268	Sample Collected By:	BTB
Gradient:	Down	Sample Matrix:	Ground Water
Well Depth (Ft.):	33.32	Laboratory Certification ID:	KY# 08012
Well Elevation (Ft. MSL):	600.64		

Field Analyses	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Groundwater Elevation	584.9	MSL		EPA 410.4 R2.0	5/30/2018	5:27 PM	BTB
pH	7.09	S.U.		SM 4500-H+, B-2011	5/30/2018	5:27 PM	BTB

EKPC - Central Laboratory Analyses

Lab Identification #: 1800896

Sample Received Date:	5/31/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	2:51 PM	Sample Received By:	JD

Parameter	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Boron	2650	µg/L		EPA 200.8, Rev. 5.4 (1994)	6/12/2018	11:31 AM	JD
Calcium	171000	µg/L		EPA 200.8, Rev. 5.4 (1994)	6/12/2018	1:19 PM	JD
Chloride	179	mg/L		EPA 300.0 Rev 2.1 (1993)	6/4/2018	1:22 PM	JWE
Fluoride	< 0.50	mg/L	4.0	EPA 300.0 Rev 2.1 (1993)	6/1/2018	9:05 PM	JWE
Sulfate	454	mg/L		EPA 300.0 Rev 2.1 (1993)	6/4/2018	1:22 PM	JWE
Solids, Total Dissolved	1210	mg/L		SM 2540, C-2011	6/1/2018	8:38 AM	JWE

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by:

Chemist

QA/QC Chemist

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Tuesday, July 3, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	5/30/2018
Well ID No:	SLF-MW-5R	Sample Collection Time:	6:34 PM
AKGW No.:	8007-0266	Sample Collected By:	BTB
Gradient:	Down	Sample Matrix:	Ground Water
Well Depth (Ft.):	27.05	Laboratory Certification ID:	KY# 08012
Well Elevation (Ft. MSL):	625.71		

Field Analyses

Field Analyses	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Groundwater Elevation	607.0	MSL		EPA 410.4 R2.0	5/30/2018	6:34 PM	BTB
pH	6.94	S.U.		SM 4500-H+, B-2011	5/30/2018	6:34 PM	BTB

EKPC - Central Laboratory Analyses

Lab Identification #: 1800897

Sample Received Date:	5/31/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	2:51 PM	Sample Received By:	JD

Parameter	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Boron	517	µg/L		EPA 200.8, Rev. 5.4 (1994)	6/12/2018	11:35 AM	JD
Calcium	118000	µg/L		EPA 200.8, Rev. 5.4 (1994)	6/12/2018	1:20 PM	JD
Chloride	25.5	mg/L		EPA 300.0 Rev 2.1 (1993)	6/1/2018	7:18 PM	JWE
Fluoride	< 0.50	mg/L	4.0	EPA 300.0 Rev 2.1 (1993)	6/1/2018	7:18 PM	JWE
Sulfate	158	mg/L		EPA 300.0 Rev 2.1 (1993)	6/1/2018	7:18 PM	JWE
Solids, Total Dissolved	591	mg/L		SM 2540, C-2011	6/1/2018	8:38 AM	JWE

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by:

Chemist

QA/QC Chemist

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Tuesday, July 3, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	5/30/2018
Well ID No:	SLF-MW-6	Sample Collection Time:	12:25 PM
AKGW No.:	8003-8410	Sample Collected By:	BTB
Gradient:	Up	Sample Matrix:	Ground Water
Well Depth (Ft.):	163.15	Laboratory Certification ID:	KY# 08012
Well Elevation (Ft. MSL):	905.18		

Field Analyses	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Groundwater Elevation	781.2	MSL		EPA 410.4 R2.0	5/30/2018	12:25 PM	BTB
pH	7.11	S.U.		SM 4500-H+, B-2011	5/30/2018	12:25 PM	BTB

EKPC - Central Laboratory Analyses

Lab Identification #: 1800898

Sample Received Date:	5/31/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	2:51 PM	Sample Received By:	JD

Parameter	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Boron	822	µg/L		EPA 200.8, Rev. 5.4 (1994)	6/12/2018	11:40 AM	JD
Calcium	846000	µg/L		EPA 200.8, Rev. 5.4 (1994)	6/12/2018	1:57 PM	JD
Chloride	13700	mg/L		EPA 300.0 Rev 2.1 (1993)	6/4/2018	11:35 AM	JWE
Fluoride	< 0.50	mg/L	4.0	EPA 300.0 Rev 2.1 (1993)	6/1/2018	7:44 PM	JWE
Sulfate	452	mg/L		EPA 300.0 Rev 2.1 (1993)	6/4/2018	12:01 PM	JWE
Solids, Total Dissolved	27800	mg/L		SM 2540, C-2011	6/1/2018	8:38 AM	JWE

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by:

Chemist

QA/QC Chemist

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EAST KENTUCKY POWER COOPERATIVE

Report Date: Tuesday, July 3, 2018

Certificate of Analysis

Station:	H.L. Spurlock Power Station	Sample Collection Date:	5/30/2018
Well ID No:	SLF-MW-7	Sample Collection Time:	3:25 PM
AKGW No.:	8003-8409	Sample Collected By:	BTB
Gradient:	Up	Sample Matrix:	Ground Water
Well Depth (Ft.):	163.51	Laboratory Certification ID:	KY# 08012
Well Elevation (Ft. MSL):	908.58		

Field Analyses

Field Analyses	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Groundwater Elevation	756.8	MSL		EPA 410.4 R2.0	5/30/2018	3:25 PM	BTB
pH	7.10	S.U.		SM 4500-H+, B-2011	5/30/2018	3:25 PM	BTB

EKPC - Central Laboratory Analyses

Lab Identification #: 1800899

Sample Received Date:	5/31/2018	Sample Receipt Temperatures (°C):	< 6
Sample Received Time:	2:51 PM	Sample Received By:	JD

Parameter	Result	Units	MCL	Analysis Method	Date Analyzed:	Time Analyzed:	Analyst:
Boron	2860	µg/L		EPA 200.8, Rev. 5.4 (1994)	6/12/2018	11:44 AM	JD
Calcium	496000	µg/L		EPA 200.8, Rev. 5.4 (1994)	6/12/2018	1:58 PM	JD
Chloride	10300	mg/L		EPA 300.0 Rev 2.1 (1993)	6/4/2018	12:28 PM	JWE
Fluoride	< 0.50	mg/L	4.0	EPA 300.0 Rev 2.1 (1993)	6/1/2018	8:11 PM	JWE
Sulfate	10.3	mg/L		EPA 300.0 Rev 2.1 (1993)	6/1/2018	8:11 PM	JWE
Solids, Total Dissolved	28000	mg/L		SM 2540, C-2011	6/1/2018	8:38 AM	JWE

Comments / Notes:

Sample Results are compliant with East Kentucky Power Cooperatives Quality Assurance program. Quality Control sample results achieved laboratory specification.

Approved by:

Chemist

QA/QC Chemist

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APPENDIX D – Flow Calculations & Direction Maps

GROUNDWATER FLOW VELOCITY CALCULATION

Facility Name: **Spurlock Landfill**
Sampling Event Date: **June 27th, 2019**

$$V = \frac{K_h * i}{n_e}$$

INPUT VARIABLES:

Hydraulic Conductivity (K_h) =	3.67E-08	ft/s
Upgradient Water Elevation (h_1) =	639	ft
Downgradient Water Elevation (h_2) =	583	ft
Flow Length (L) =	865	ft
Effective Porosity (n_e) =	0.05	unitless

CALCULATIONS:

dh =	56	ft
Hydraulic Gradient (i) =	0.065	ft/ft
GW Flow Velocity (K_h*i)/n_e =	4.11E-03	ft/day

V = Groundwater flow velocity $\left(\frac{feet}{day}\right)$

K_h = Horizontal Hydraulic Conductivity $\left(\frac{feet}{day}\right)$

i = Horizontal hydraulic gradient $\left(\frac{feet}{foot}\right) = \frac{h_1 - h_2}{L}$

h_1 and h_2 = Groundwater elevation at location 1 and 2

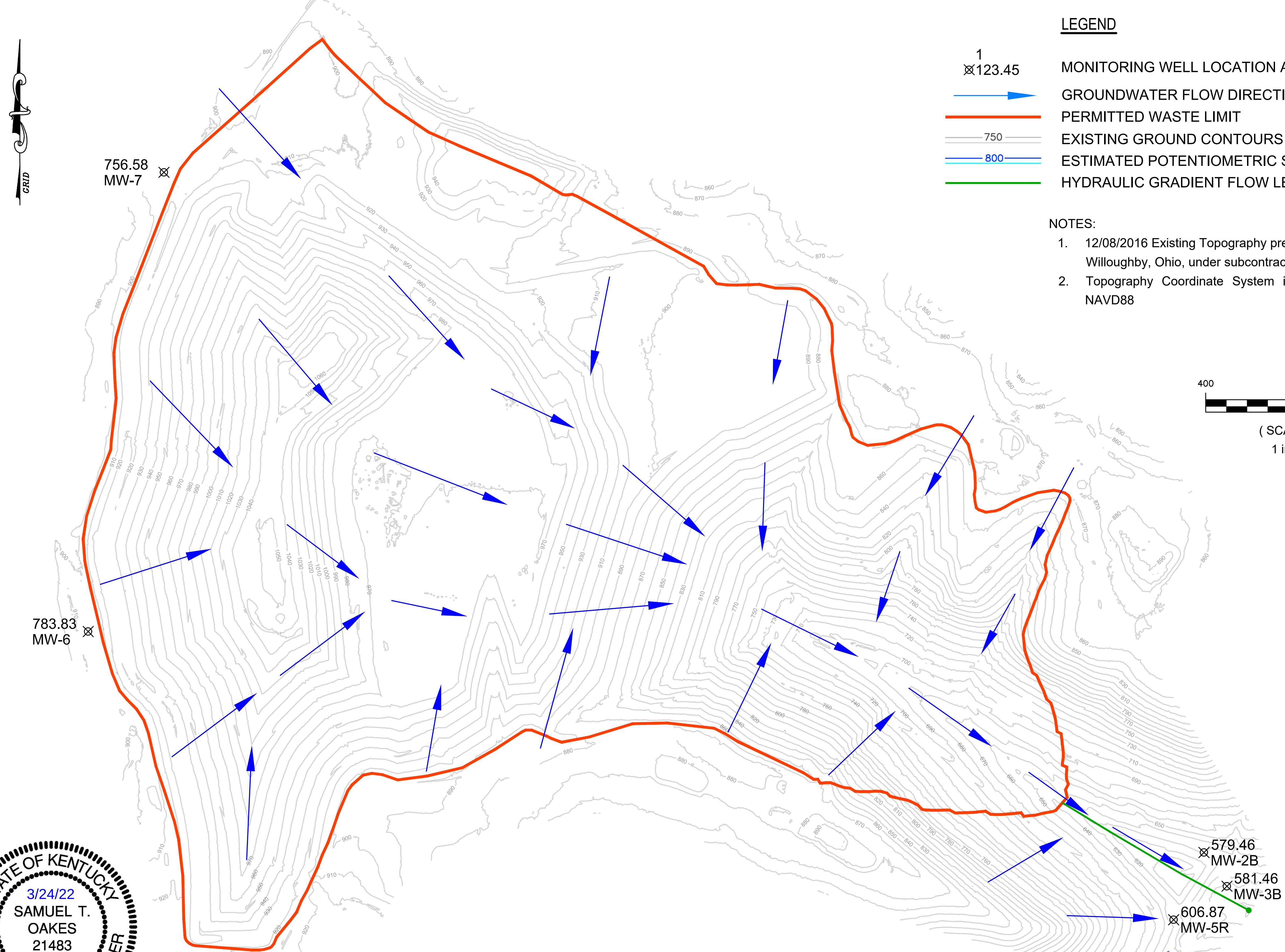
L = Distance between location 1 and 2

n_e = Effective porosity

Notes:

1. Effective porosity estimates based on values from Ordovician limestone according to Groundwater Monitoring System and Hydrogeologic Investigation Report for Spurlock LF dated Oct. 2017 by Tetra Tech.
2. The location of h1 at SE corner of the permitted waste boundary, groundwater elevation of h1 based on creek bed prior to development.
3. The location of h2 is downgradient of the pond and monitoring wells in the creek bed, groundwater elevation of h2 based on creek bed prior to development.
4. Hydraulic conductivity estimates taken from the Groundwater Monitoring System and Hydrogeologic Investigation Report for Peg's Hill dated February 2019 by Geosyntec.
5. Calculations are based on available information and limited data points, therefore, the results reflect estimated values.
6. Flow Length distance is estimated using CAD software measuring from the SE corner of the permitted waste boundary to a location downstream of the pond just beyond the monitoring wells in the creek bed.

STATE OF KENTUCKY
3/24/22
SAMUEL T.
OAKES
21483
LICENSED
PROFESSIONAL ENGINEER



LEGEND

1 ⊠123.45	MONITORING WELL LOCATION AND WATER ELEVATION
(blue arrow)	GROUNDWATER FLOW DIRECTION
(red line)	PERMITTED WASTE LIMIT
750	EXISTING GROUND CONTOURS
800	ESTIMATED POTENTIOMETRIC SURFACE CONTOURS
(green line)	HYDRAULIC GRADIENT FLOW LENGTH

NOTES:

1. 12/08/2016 Existing Topography prepared by Kucera International, Inc., Willoughby, Ohio, under subcontract to Mikon Corporation.
2. Topography Coordinate System is KY State Plane Single Zone, NAD83, NAVD88

400 0 200 400

(SCALE IN FEET)

1 inch = 400 ft.

STATE OF KENTUCKY
3/24/22
SAMUEL T. OAKES
21483
LICENSED
PROFESSIONAL ENGINEER

JUNE 27, 2019 EVENT

KENVIRONS
Civil & Environmental Engineers

Project: 2016135
Checked By: STO
Date: 03-09-22
Scale: 1"=400'

SPURLOCK STATION LANDFILL
MASON COUNTY, KENTUCKY
GROUNDWATER FLOW MAP

GROUNDWATER FLOW VELOCITY CALCULATION

Facility Name: **Spurlock Landfill**
Sampling Event Date: **November 4th, 2019 Resample Event**

$$V = \frac{K_h * i}{n_e}$$

INPUT VARIABLES:

Hydraulic Conductivity (K_h) =	3.67E-08 ft/s
Upgradient Water Elevation (h_1) =	639 ft
Downgradient Water Elevation (h_2) =	583 ft
Flow Length (L) =	865 ft
Effective Porosity (n_e) =	0.05 unitless

CALCULATIONS:

dh =	56 ft
Hydraulic Gradient (i) =	0.065 ft/ft
GW Flow Velocity (K_h*i)/n_e =	4.11E-03 ft/day

V = Groundwater flow velocity $\left(\frac{feet}{day}\right)$

K_h = Horizontal Hydraulic Conductivity $\left(\frac{feet}{day}\right)$

i = Horizontal hydraulic gradient $\left(\frac{feet}{foot}\right) = \frac{h_1 - h_2}{L}$

h_1 and h_2 = Groundwater elevation at location 1 and 2

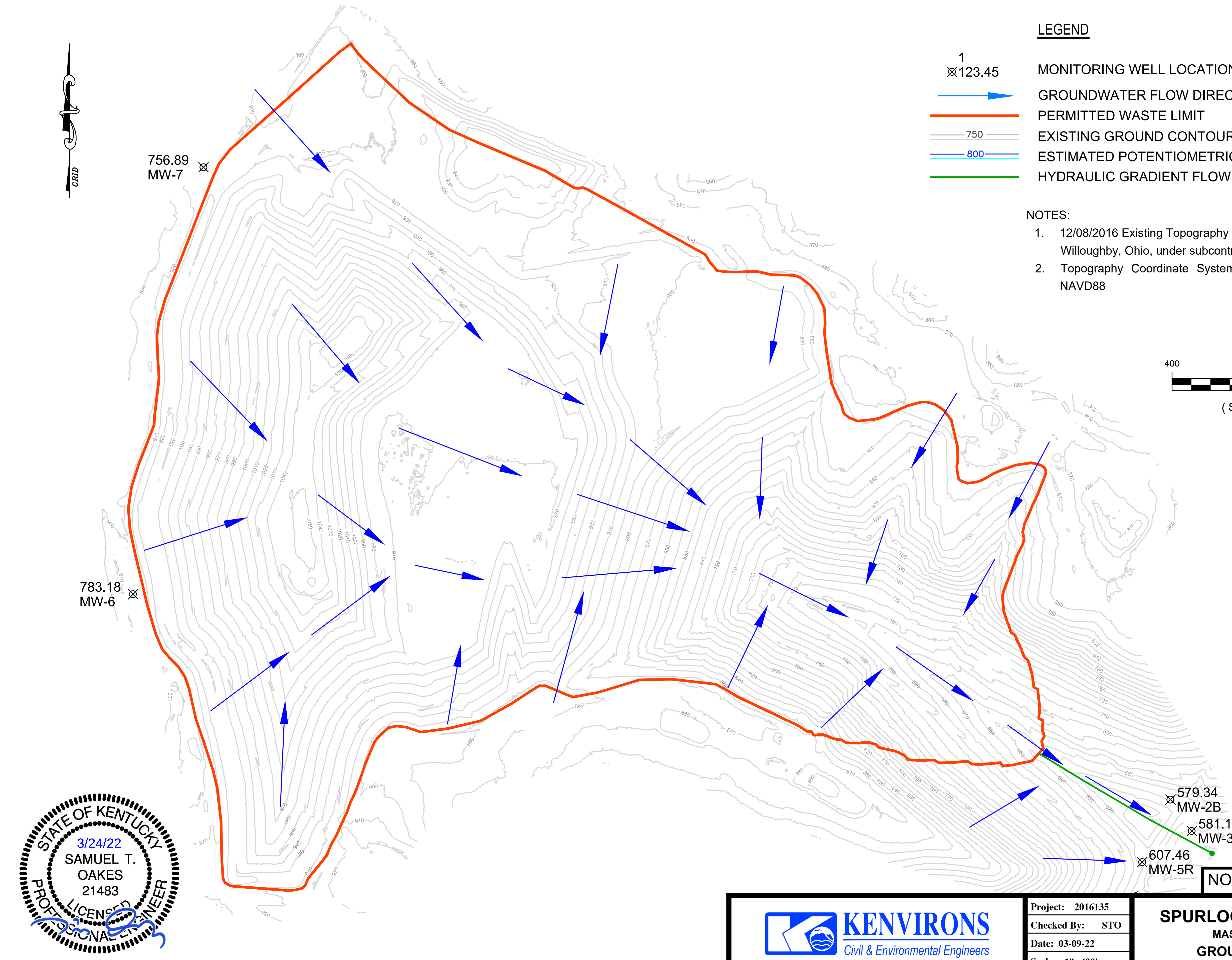
L = Distance between location 1 and 2

n_e = Effective porosity

Notes:

1. Effective porosity estimates based on values from Ordovician limestone according to Groundwater Monitoring System and Hydrogeologic Investigation Report for Spurlock LF dated Oct. 2017 by Tetra Tech.
2. The location of h1 at SE corner of the permitted waste boundary, groundwater elevation of h1 based on creek bed prior to development.
3. The location of h2 is downgradient of the pond and monitoring wells in the creek bed, groundwater elevation of h2 based on creek bed prior to development.
4. Hydraulic conductivity estimates taken from the Groundwater Monitoring System and Hydrogeologic Investigation Report for Peg's Hill dated February 2019 by Geosyntec.
5. Calculations are based on available information and limited data points, therefore, the results reflect estimated values.
6. Flow Length distance is estimated using CAD software measuring from the SE corner of the permitted waste boundary to a location downstream of the pond just beyond the monitoring wells in the creek bed.

STATE OF KENTUCKY
3/24/22
SAMUEL T.
OAKES
21483
LICENSED
PROFESSIONAL ENGINEER



LEGEND

1 ⊠123.45	MONITORING WELL LOCATION AND WATER ELEVATION
	GROUNDWATER FLOW DIRECTION
	PERMITTED WASTE LIMIT
750	EXISTING GROUND CONTOURS
800	ESTIMATED POTENTIOMETRIC SURFACE CONTOURS
	HYDRAULIC GRADIENT FLOW LENGTH

NOTES:

1. 12/08/2016 Existing Topography prepared by Kucera International, Inc., Willoughby, Ohio, under subcontract to Mikon Corporation.
2. Topography Coordinate System is KY State Plane Single Zone, NAD83, NAVD88

400 0 200 400

(SCALE IN FEET)

1 inch = 400 ft.

NOVEMBER 4, 2019 RESAMPLE EVENT

KENVIRONS
Civil & Environmental Engineers

Project: 2016135
Checked By: STO
Date: 03-09-22
Scale: 1"=400'

SPURLOCK STATION LANDFILL
MASON COUNTY, KENTUCKY
GROUNDWATER FLOW MAP

GROUNDWATER FLOW VELOCITY CALCULATION

Facility Name: **Spurlock Landfill**
Sampling Event Date: **December 2nd, 2019**

$$V = \frac{K_h * i}{n_e}$$

INPUT VARIABLES:

Hydraulic Conductivity (K_h) =	3.67E-08	ft/s
Upgradient Water Elevation (h_1) =	639	ft
Downgradient Water Elevation (h_2) =	583	ft
Flow Length (L) =	865	ft
Effective Porosity (n_e) =	0.05	unitless

CALCULATIONS:

dh =	56	ft
Hydraulic Gradient (i) =	0.065	ft/ft
GW Flow Velocity (K_h*i)/n_e =	4.11E-03	ft/day

V = Groundwater flow velocity $\left(\frac{feet}{day}\right)$

K_h = Horizontal Hydraulic Conductivity $\left(\frac{feet}{day}\right)$

i = Horizontal hydraulic gradient $\left(\frac{feet}{foot}\right) = \frac{h_1 - h_2}{L}$

h_1 and h_2 = Groundwater elevation at location 1 and 2

L = Distance between location 1 and 2

n_e = Effective porosity

Notes:
1. Effective porosity estimates based on values from Ordovician limestone according to Groundwater Monitoring System and Hydrogeologic Investigation Report for Spurlock LF dated Oct. 2017 by Tetra Tech.
2. The location of h1 at SE corner of the permitted waste boundary, groundwater elevation of h1 based on creek bed prior to development.
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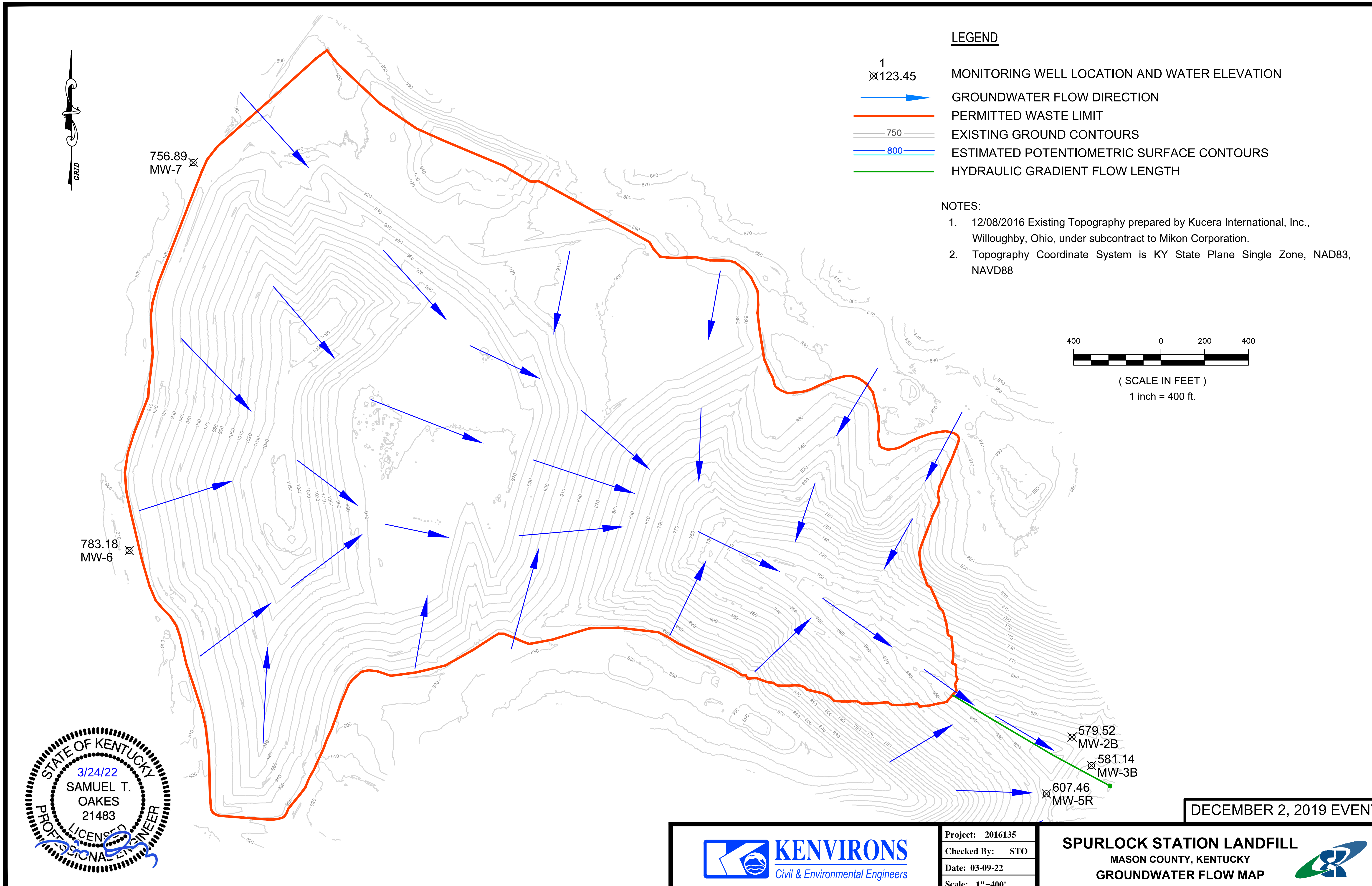


N:\P\2016135\Design\Spurlock Landfill Potentiometric Flow Map_11x17.dwg, 3/24/2022 7:30:20 AM, MAS

APPENDIX E1 – Statistical Analysis Package (November 2018)

HALEY & ALDRICH, INC.
6500 Rockside Road
Suite 200
Cleveland, OH 44131
216.739.0555

16 April 2018
File No. 130592-007

East Kentucky Power Cooperative
4775 Lexington Road
Winchester, KY 40392

Subject: Summary of Appendix III Semi-Annual
Groundwater Detection Monitoring Statistical Evaluation
East Kentucky Power Cooperative
H.L. Spurlock Generating Station Landfill, Maysville, Kentucky

East Kentucky Power Cooperative, Inc. (EKPC) is implementing the 17 April 2015 U.S. Environmental Protection Agency (U.S. EPA) Federal Coal Combustion Residuals (CCR) Rule (40 CFR § 257 and 261) for the H.L. Spurlock Generating Station Landfill, located in Mason County, Kentucky. The CCR Rule establishes requirements for the operation, maintenance and closure of landfills and surface impoundments of CCR.

On 5 January 2018, EKPC provided Haley & Aldrich with groundwater monitoring data collected from a groundwater monitoring system that meets the requirements of 40 CFR §257.91. Background and downgradient locations were defined in the *Groundwater Monitoring System and Hydrogeologic Investigation Report, Spurlock Landfill, H.L. Spurlock Generating Station, Maysville, Kentucky* (Tetra Tech, 10 October 2017).. This memorandum summarizes the results of statistical evaluations conducted to determine if Appendix III groundwater monitoring constituents have been detected in downgradient wells are at levels that exhibit a statistically significant increase (SSI) above background or upgradient wells consistent with the requirements in 40 CFR § 257.94. The results presented herein were previously communicated verbally to EKPC on 15 January 2018.

Data from the most recent groundwater sampling event from the downgradient monitoring wells were compared to the Upper Tolerance Limit (UTL) calculated from the background data from upgradient wells for the Appendix III constituents (boron, calcium, chloride, fluoride, pH, sulfate, and total dissolved solids) to identify statistically significant increases. Based on these comparisons, the statistical results identify at least one Appendix III SSI above background concentrations. The results of the groundwater detection monitoring evaluation are provided below.

Statistical Evaluation of Appendix III Constituents

The Rule, 40 CFR §257.93(f) (1-4), provides four specific options to statistically evaluate whether water quality downgradient of the CCR Unit represents an SSI of Appendix III parameters compared to background water quality of the CCR Unit. The Upper Tolerance Limit (UTL) was used to evaluate potential SSIs as specified in the certification statement of 17 October 2017. A 95% Upper Tolerance Limit for 99% coverage was calculated to compare to downgradient groundwater analytical results for this evaluation.

UTL STATISTICAL ANALYSIS

The UTL is an accepted statistical method identified in the CCR Rule to evaluate the groundwater analytical data at CCR Units. A tolerance interval is a concentration range, with some confidence level, designed to contain a pre-specified proportion (e.g., 99 percent) of the underlying population from which the statistical sample is drawn (background). The upper endpoint of a tolerance interval is called the upper tolerance limit or UTL. Depending on the assumed distribution of the background, parametric or non-parametric procedures were used to develop the UTL. Parametric tolerance limits utilize assumed distributions of the sample background data to develop the UTL, and non-parametric limits utilize order statistics or bootstrap methods to develop the UTL. The UTL was calculated using the U.S. EPA's ProUCL 5.1 from the background well data after testing for outlier sample results that would warrant removal from the dataset based on likely error in sampling or measurement. Both visual and statistical outlier tests for the background data were performed using ProUCL, and a visual inspection of the data was performed for the downgradient sample data. Except as noted below, no sample data were deemed as outliers that warranted removal from the dataset.

BACKGROUND DISTRIBUTIONS AND UTLS

The groundwater analytical results from the two background monitoring wells (SLF-MW-6 and SLF-MW-7) were combined to calculate the 95% UTL with 99% coverage. The variability and distribution of the pooled dataset was evaluated to determine the method for UTL calculation. Samples from background locations were collected from 20 October 2016 through 29 November 2017 (Table 1). The development of the UTL for each of the Appendix III constituents is summarized in Table 1 and discussed below. Appendix III parameters are graphed in Attachment 1. Supporting statistical software output is included in Attachment 2.

Boron

Based on graphical data distribution and results of the goodness of fit testing (Attachment 2), a non-parametric distribution was used for the calculation of the UTL for boron. The non-parametric UTL with 99% coverage for boron is 5,464 ug/L (Attachment 2).

Calcium

Based on graphical data distribution with an apparent left skew and results of goodness of fit testing (Attachment 2), a gamma distribution was used for calculation of the UTL. The 95% UTL with 99% coverage for calcium is 1,250,847 ug/L (Attachment 2).

Chloride

The groundwater analytical result for chloride from MW-7 collected on 20 October 2016 is considered an outlier and potential transcription error and was not used in the UTL calculation. The determination of a statistical increase is the same with or without this sample result included. Based on the graphical data distribution and results of goodness of fit testing (Attachment 2), a normal distribution was used for calculation of the UTL. The 95% UTL with 99% coverage for chloride is 18,841 mg/L (Attachment 2).

Fluoride

Based on the low frequency of detection (Table 1), graphical data distribution and results of goodness of fit testing (Attachment 2), a non-parametric distribution was used for calculation of the UTL. The non-parametric UTL with 99% coverage for fluoride is 2.5 mg/L (Attachment 2).

pH

Based on the graphical data distribution and results of goodness of fit testing (Attachment 2), a lognormal distribution was used for calculation of the UTL. The 95% UTL with 99% coverage for pH is 8.855 (Attachment 2).

Sulfate

Based on the graphical data distribution and results of goodness of fit testing (Attachment 2), a gamma distribution was used for calculation of the UTL. The 95% UTL with 99% coverage for sulfate is 441 mg/L (Attachment 2).

Total Dissolved Solids

Based on the graphical data distribution and results of goodness of fit testing (Attachment 2), a gamma distribution was used for calculation of the UTL. The 95% UTL with 99% coverage for total dissolved solids is 41052 mg/L (Attachment 2).

RESULTS OF APPENDIX III DOWNGRADIENT STATISTICAL COMPARISONS

The sample concentrations from the downgradient wells for each of the Appendix III constituents from the November 2017 detection monitoring sampling event were compared to their respective UTLs. A sample concentration greater than the UTL is considered to represent a statistically significant increase. Based on these comparisons, the statistically significant increase(s) over background are:

- SLF-MW-3B sample exceeded the UTL for sulfate.

We appreciate the opportunity to provide environmental consulting services on this project. Please do not hesitate to call if you have any questions or comments.

Sincerely,
HALEY & ALDRICH, INC.

Lloyd S. Ross
Senior Scientist

Enclosures:
Table 1. Summary of Background Sample Results and Comparison of Downgradient Sample Results
Attachment 1. Appendix III Time Series Graphs
Attachment 2. Statistical Output

TABLE

TABLE 1

SUMMARY OF BACKGROUND SAMPLE RESULTS AND COMPARISON OF DOWNGRADIENT SAMPLE RESULTS
SPURLOCK GENERATING STATION LANDFILL
MAYSVILLE, KENTUCKY

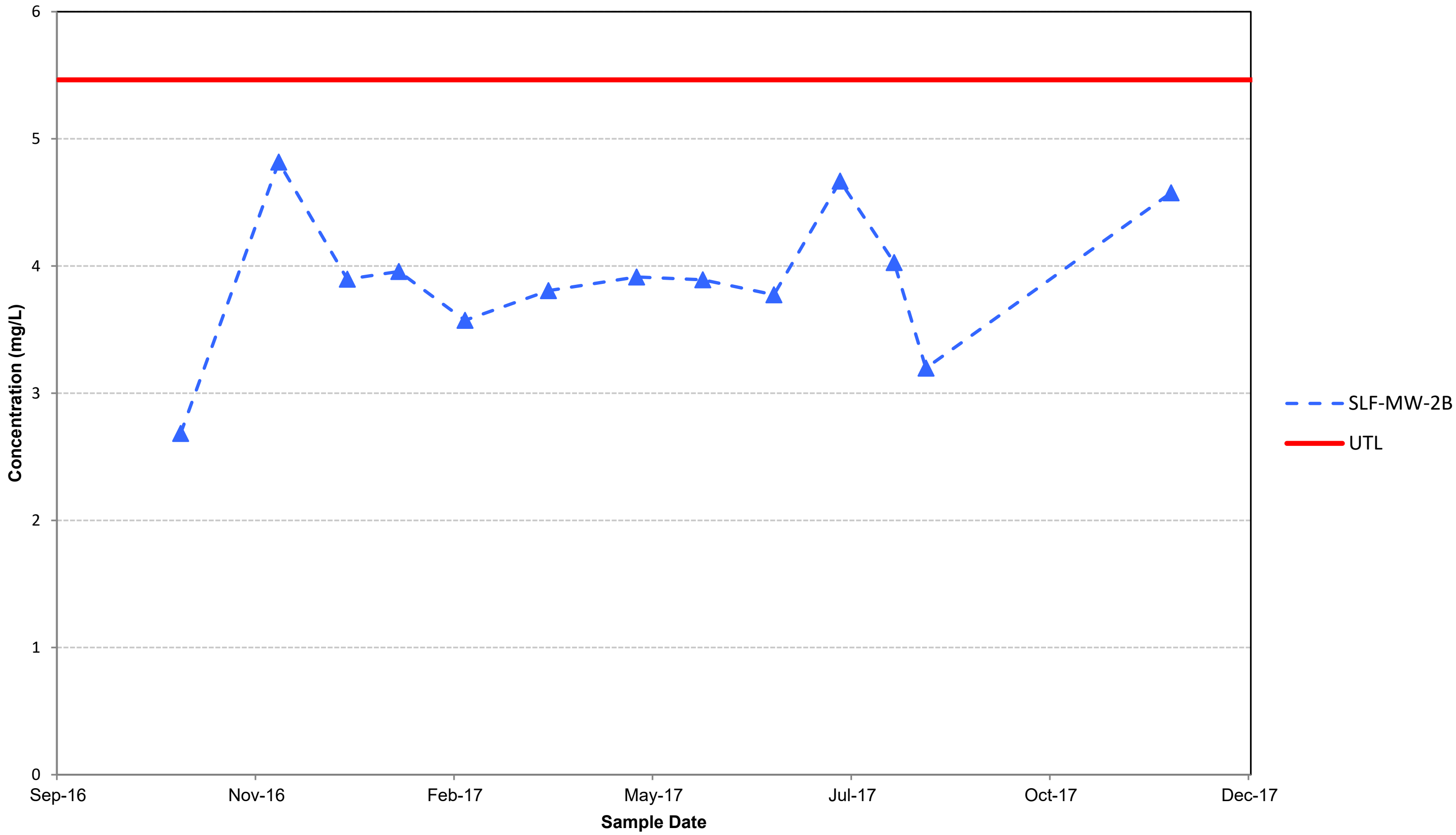
Background Well	Sample Date	Boron (ug/L)	Calcium (ug/L)	Chloride (mg/L)	Fluoride (mg/L)	pH	Sulfate (mg/L)	Total Dissolved Solids (mg/L)
SLF-MW-6	11/30/2016	1634.33	367433	15695.1	ND (< 1)	7.61	71.2993	19640
SLF-MW-6	12/28/2016	1628.04	390089	10367	ND (< 0.5)	7.48	97.9	17360
SLF-MW-6	1/17/2017	1558.49	289437	9962.47	ND (< 2.5)	7.64	57.7945	17420
SLF-MW-6	2/14/2017	1225.35	363980	10629.4	2.3161	7.84	100.277	20620
SLF-MW-6	3/20/2017	1330.47	239494	11189.9	0.5073	7.34	129.498	22420
SLF-MW-6	4/25/2017	1510.69	450493	11191.7	ND (< 0.5)	7.32	108.462	24240
SLF-MW-6	5/22/2017	1384.59	398635	10905	0.7815	7.82	111.552	20660
SLF-MW-6	6/20/2017	1572.54	516978	11652.1	ND (< 0.5)	7.2	237.465	25460
SLF-MW-6	7/18/2017	1558	561449	12486	ND (< 0.5)	8.31	295	26440
SLF-MW-6	8/8/2017	1593	675251	18877	ND (< 0.5)	6.68	38.5	26100
SLF-MW-6	8/22/2017	1804	798246	16817	ND (< 0.5)	8.47	65.2	22566.7
SLF-MW-6	11/29/2017	1970	1022530	16285	ND (< 0.5)	7.25	97.9	30260
SLF-MW-7	10/20/2016	2730.18	380241	1548.06 [A]	ND (< 0.5)	7.09	64.2535	24300
SLF-MW-7	11/30/2016	4462.57	582396	14651.3	ND (< 0.5)	7.02	61.0442	20500
SLF-MW-7	12/28/2016	4635.55	723046	14099	ND (< 0.5)	7.1	55.716	23566.7
SLF-MW-7	1/17/2017	4953.83	536189	14482.3	ND (< 0.5)	7	65.5636	23400
SLF-MW-7	2/14/2017	3563.48	580195	14298.7	2.3737	7.24	89.8117	27233
SLF-MW-7	3/20/2017	4023.47	311304	14446.8	0.855	7.03	64.6524	28480
SLF-MW-7	4/25/2017	4699.06	559928	14560	0.9404	7.08	59.9715	29980
SLF-MW-7	5/22/2017	3931.94	538847	13191.3	0.7626	7.17	99.5501	26780
SLF-MW-7	6/19/2017	5463.53	580485	14471.8	ND (< 0.5)	7.19	104.377	28640
SLF-MW-7	7/18/2017	4180	568243	14203	0.7	7.48	47	28620
SLF-MW-7	8/8/2017	4756	515124	14166	0.7	7.93	22.7	30233.3
SLF-MW-7	8/22/2017	4575	527797	15101	0.7	7.84	47.1	33066.7
SLF-MW-7	11/29/2017	5435	563176	14520	ND (< 0.5)	7.14	4.1	26200
Assumed Data Distribution for Calculation of UTL		Non-parametric	Gamma	Normal	Non-parametric	Lognormal	Gamma	Gamma
95% Upper Tolerance Limit for 99% coverage*		5464	1250847	18841	2.5	8.855	441	41052
Minimum Detection		1225	239494	9962 [A]	0.507	6.68	4.1	17360
Maximum Detection		5464	1022530	18877	2.374	8.47	295	33067
Frequency of Detection		100%	100%	100%	40%	100%	100%	100%
Downgradient Well	**Sample Date**	**Boron (ug/L)**	**Calcium (ug/L)**	**Chloride (mg/L)**	**Fluoride (mg/L)**	**pH**	**Sulfate (mg/L)**	**Total Dissolved Solids (mg/L)**
SLF-MW-2B	11/29/2017	4576	37641	1421	2	7.66	191.6	3072
SLF-MW-3B	11/29/2017	3860	204990	152	ND (< 0.5)	7.12	483	1208
SLF-MW-5R	11/29/2017	524	136418	24.5	ND (< 0.5)	7.1	157.8	549

Notes and Abbreviations:

1. ND: Not Detected at concentrations greater than specified reporting limit.
2. Shaded downgradient result is a statistically significant increase based on comparison to calculated UTL.
3. Chloride results from MW-7 collected on 10/20/2016 is considered an outlier and likely transcription error and was not used in UTL calculation. Statisical comparison is same with our without sample result.

ATTACHMENT 1

Appendix III Time Series Graphs



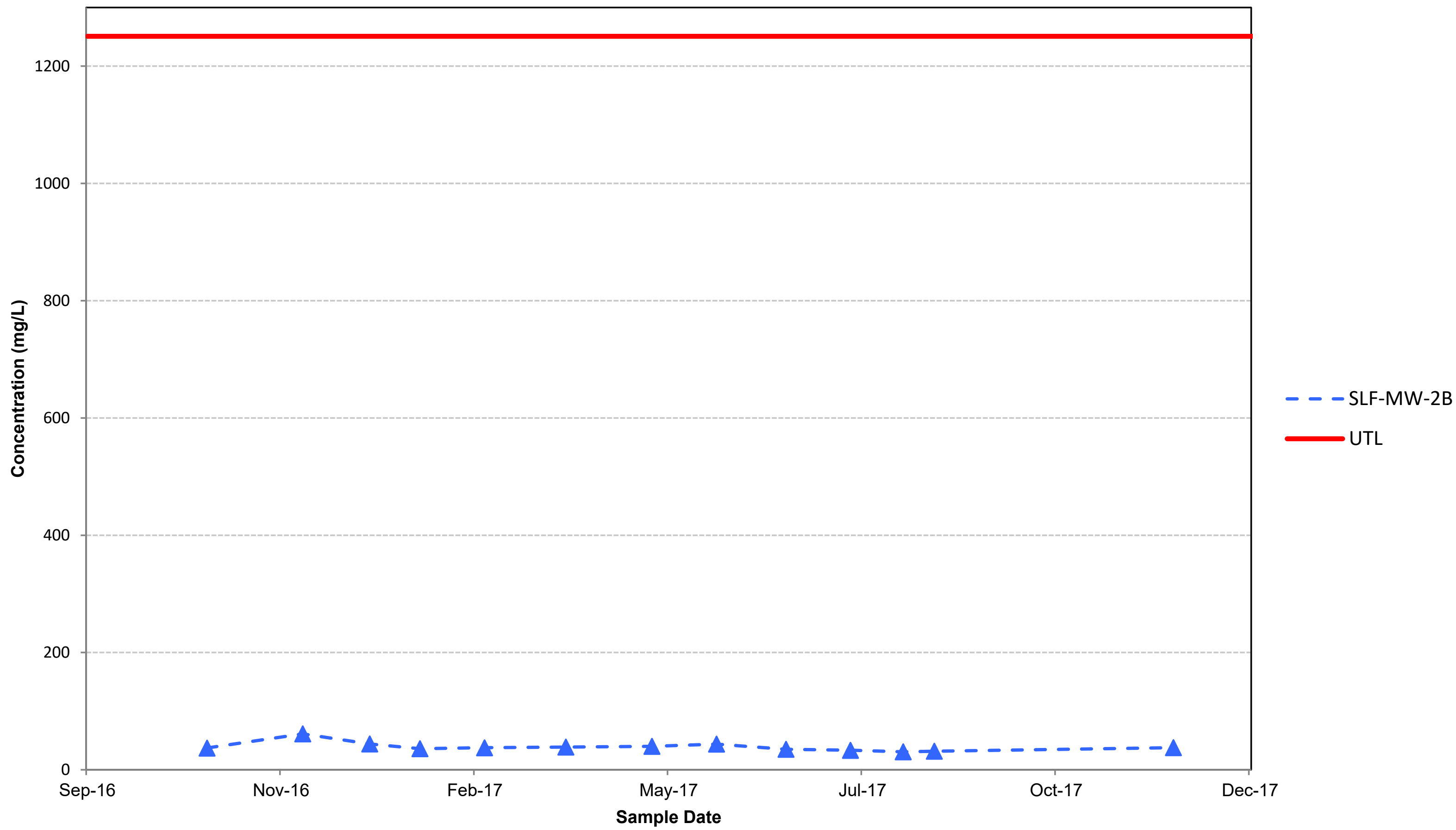
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

BORON
CONCENTRATION VS. TIME

April 2018 **Figure F-1**



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2. Screening Level shown is the Upper Tolerance Limit (UTL).
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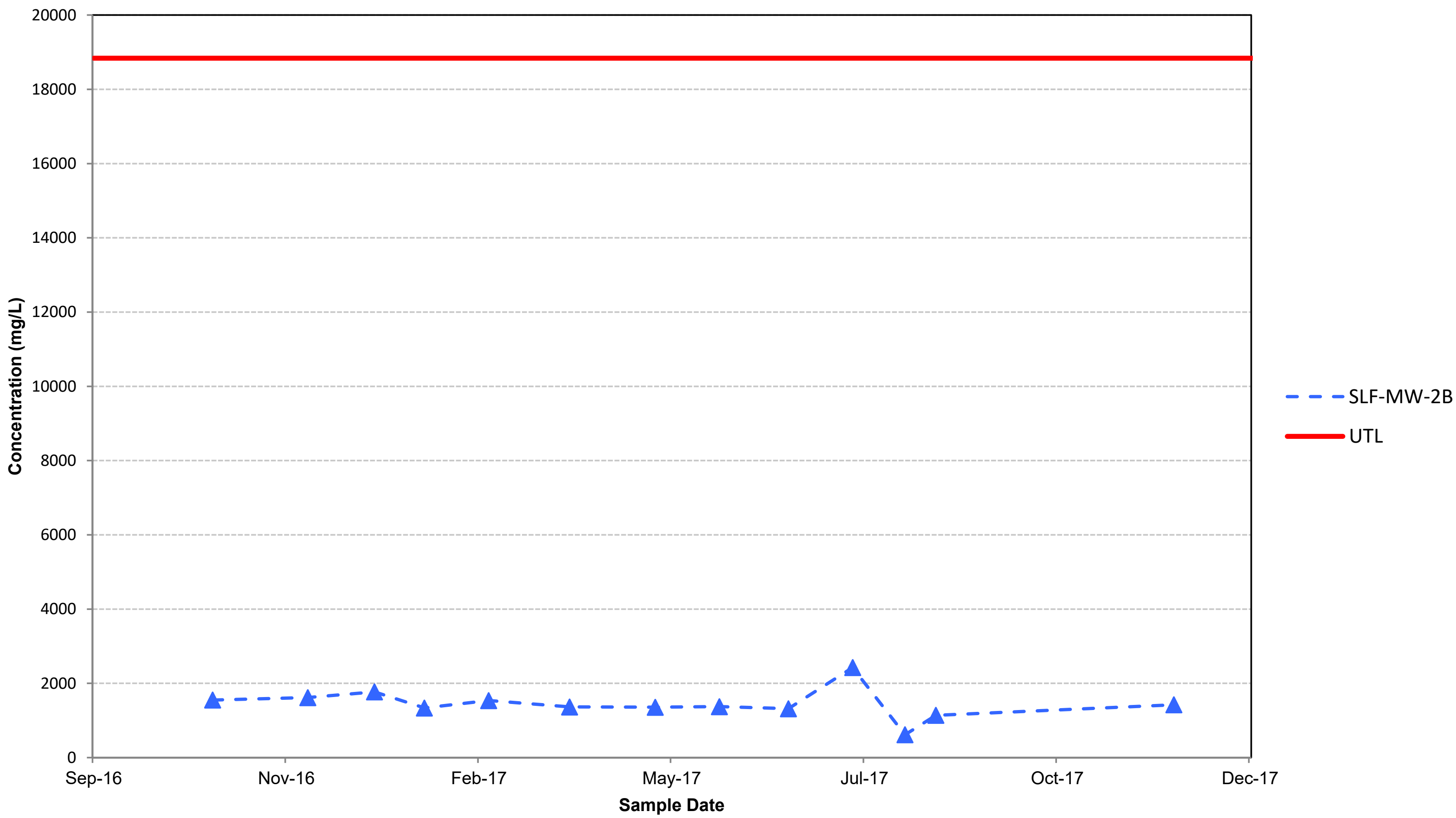
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CALCIUM
CONCENTRATION VS. TIME

April 2018 **Figure F-2**



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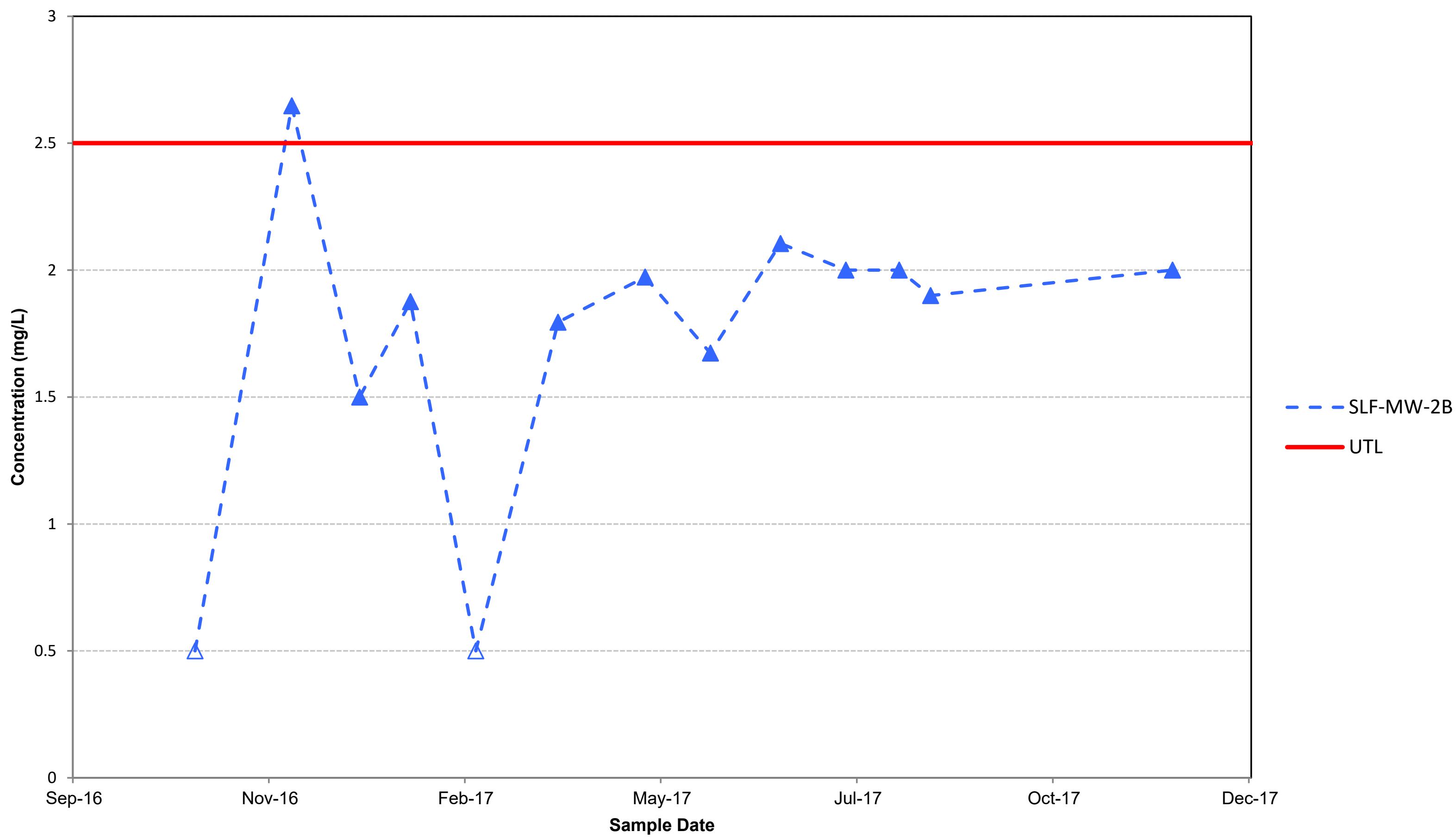
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CHLORIDE
CONCENTRATION VS. TIME

April 2018 **Figure F-3**



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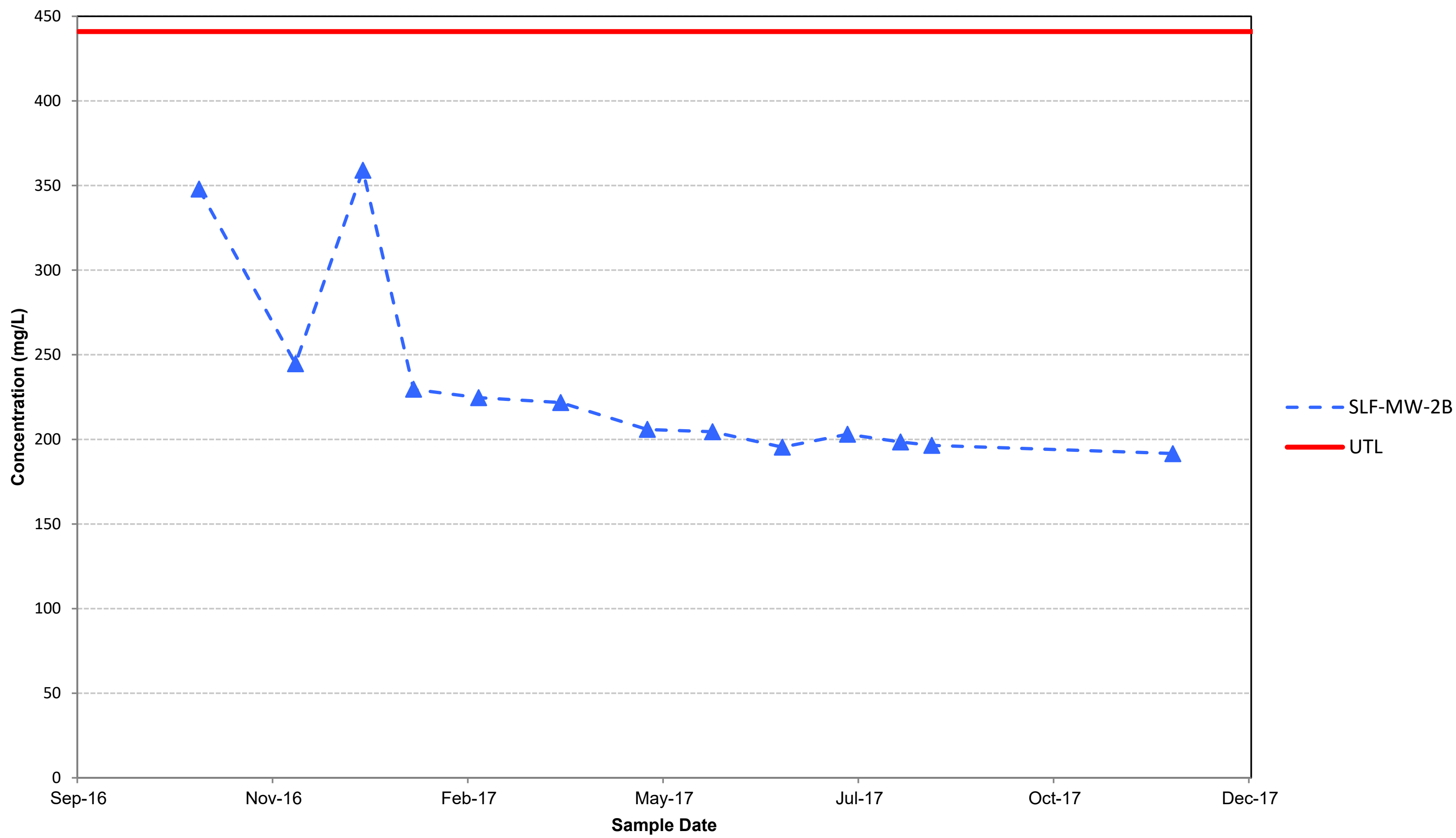
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

FLUORIDE
CONCENTRATION VS. TIME

April 2018 **Figure F-4**



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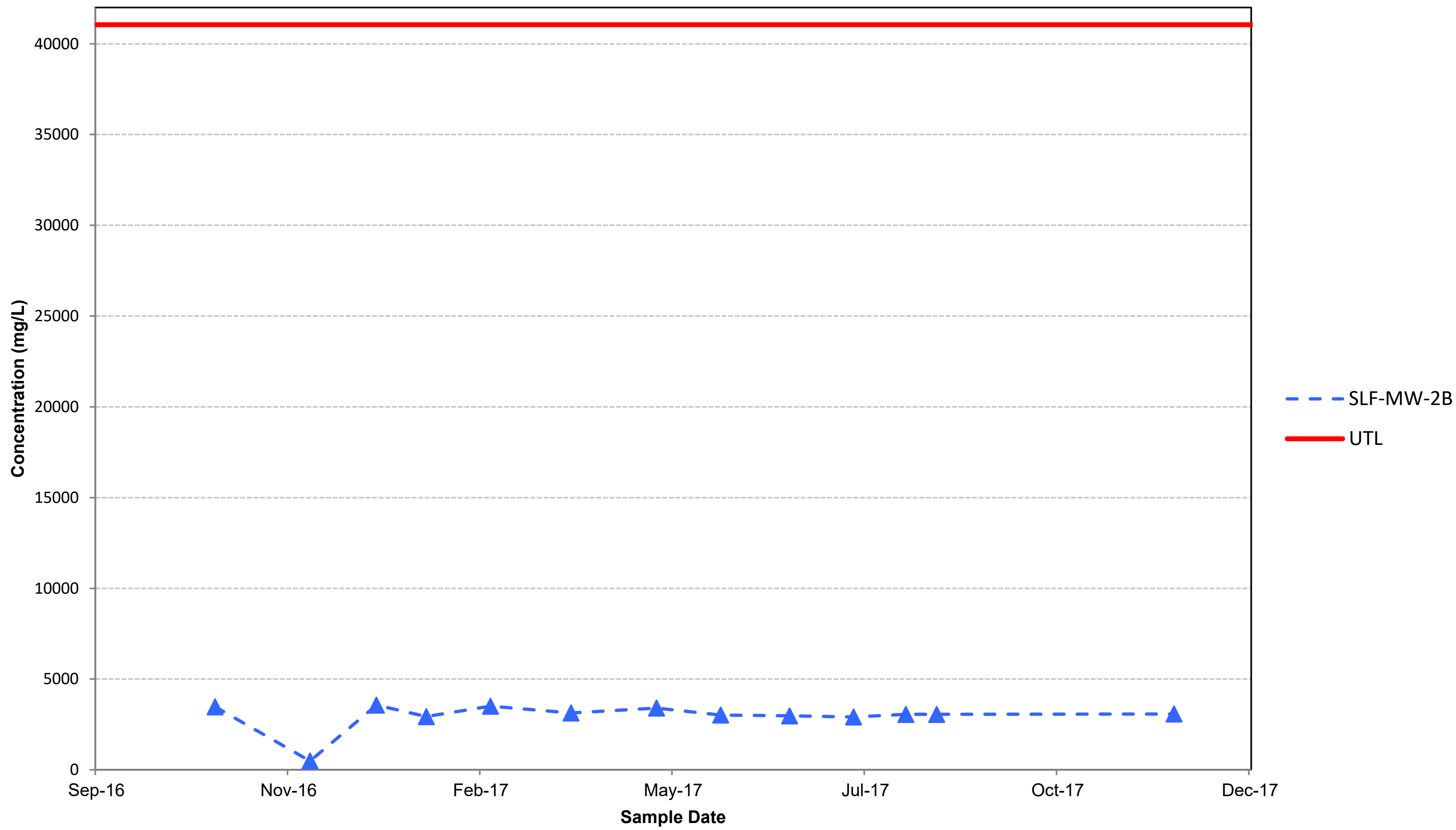
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

SULFATE
CONCENTRATION VS. TIME

April 2018 **Figure F-5**



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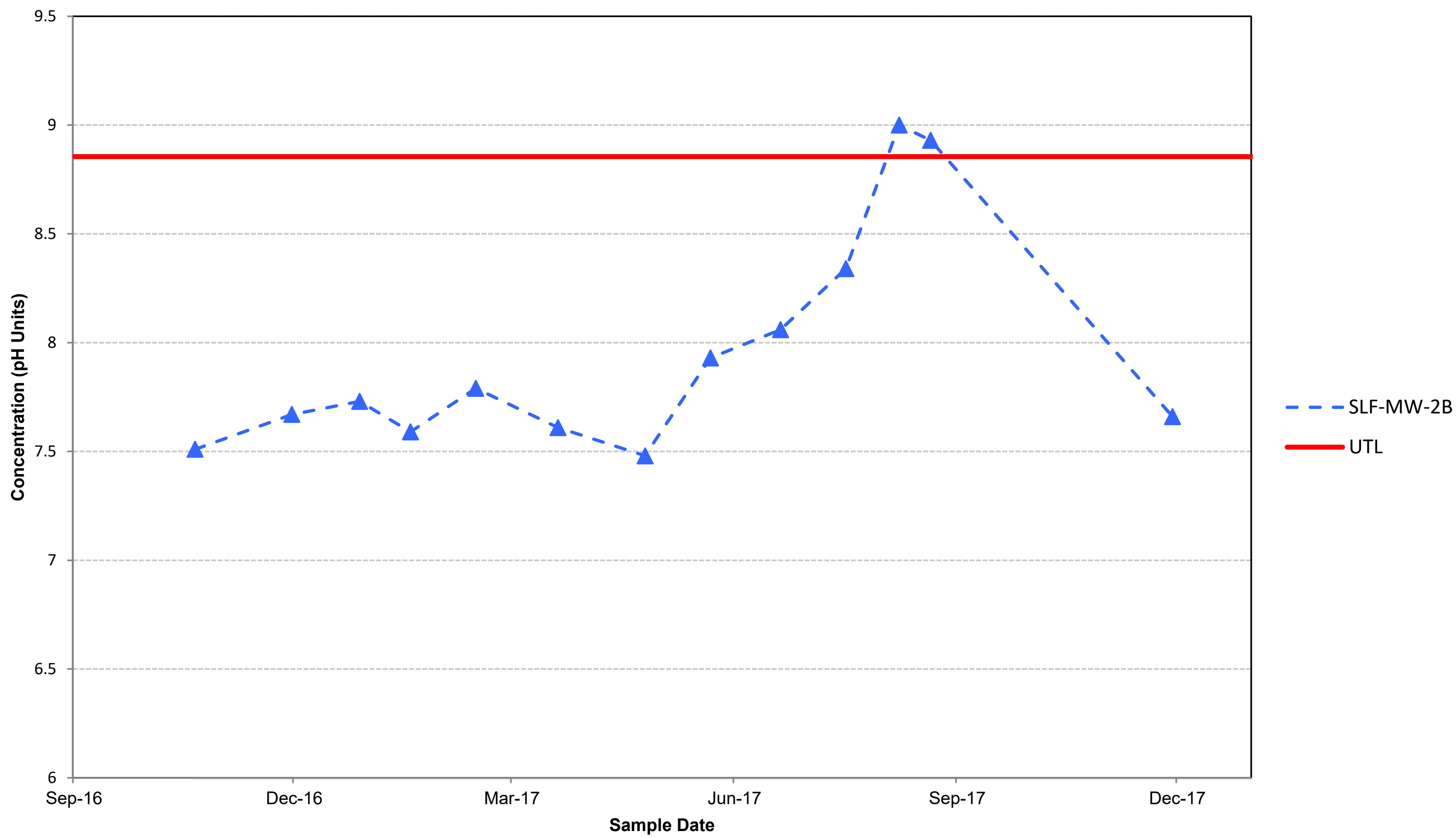
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION VS. TIME

April 2018 **Figure F-6**



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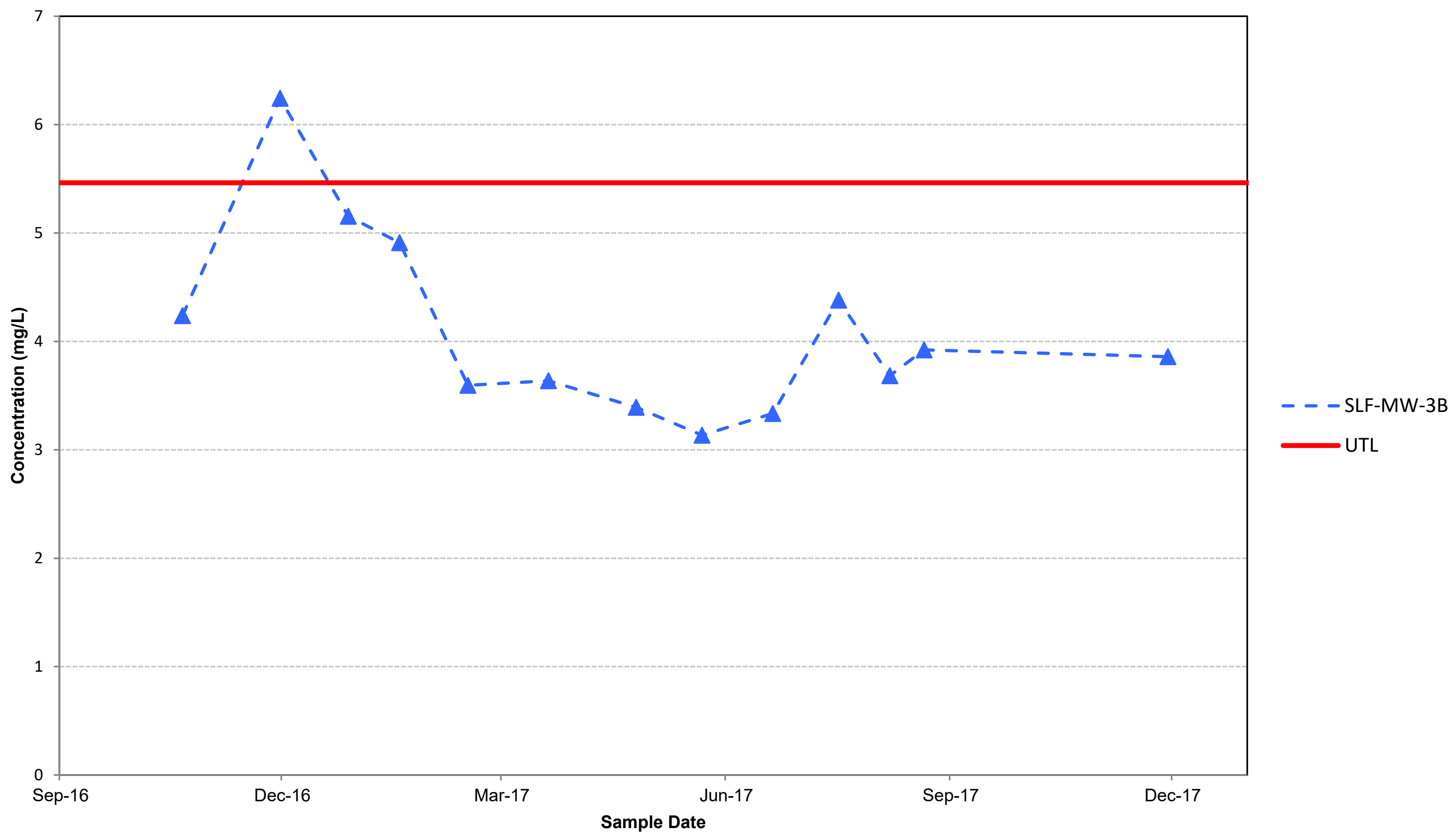
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

PH, FIELD
CONCENTRATION VS. TIME

April 2018 **Figure F-7**



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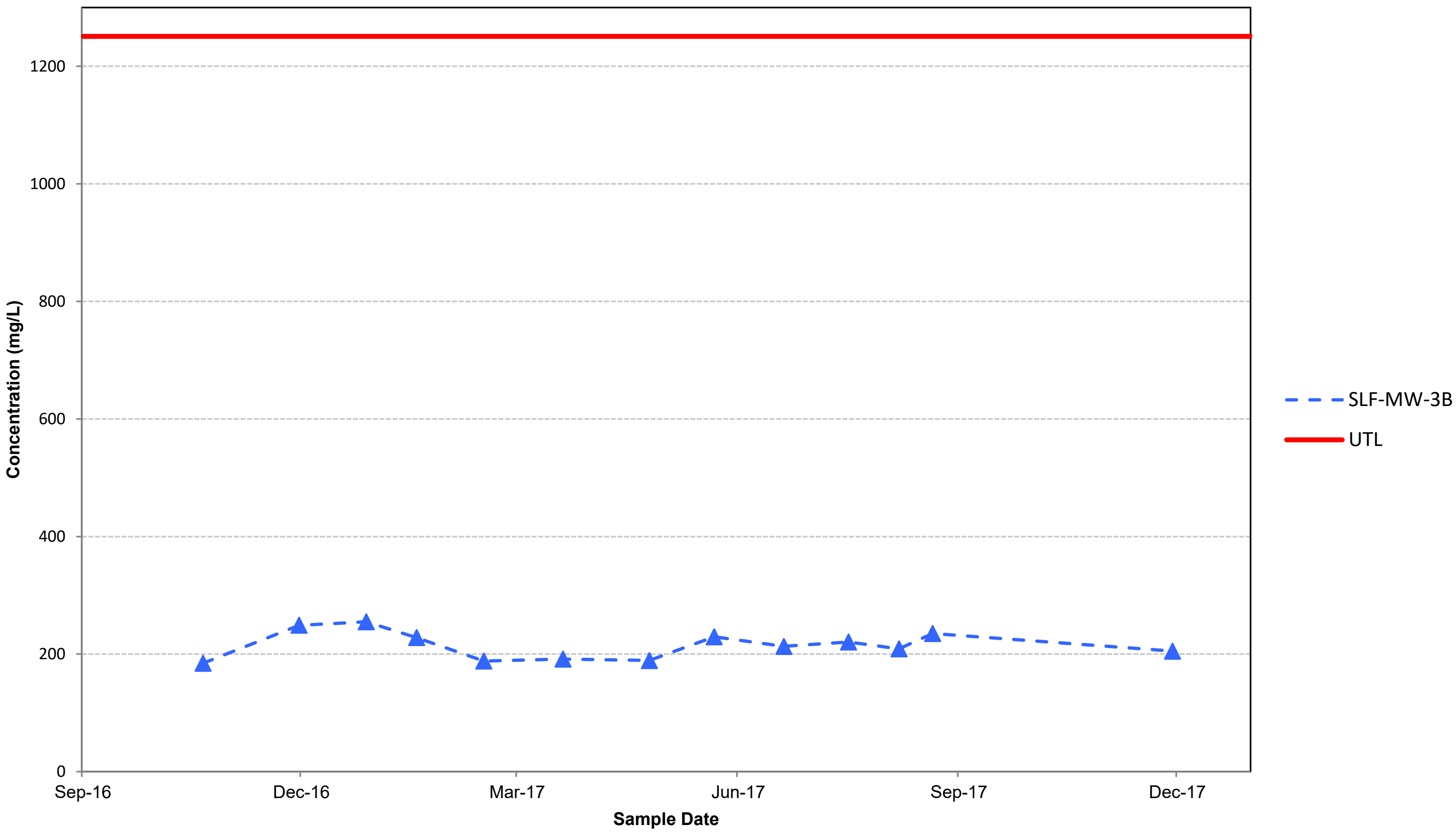
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

BORON
CONCENTRATION VS. TIME

April 2018 **Figure F-8**



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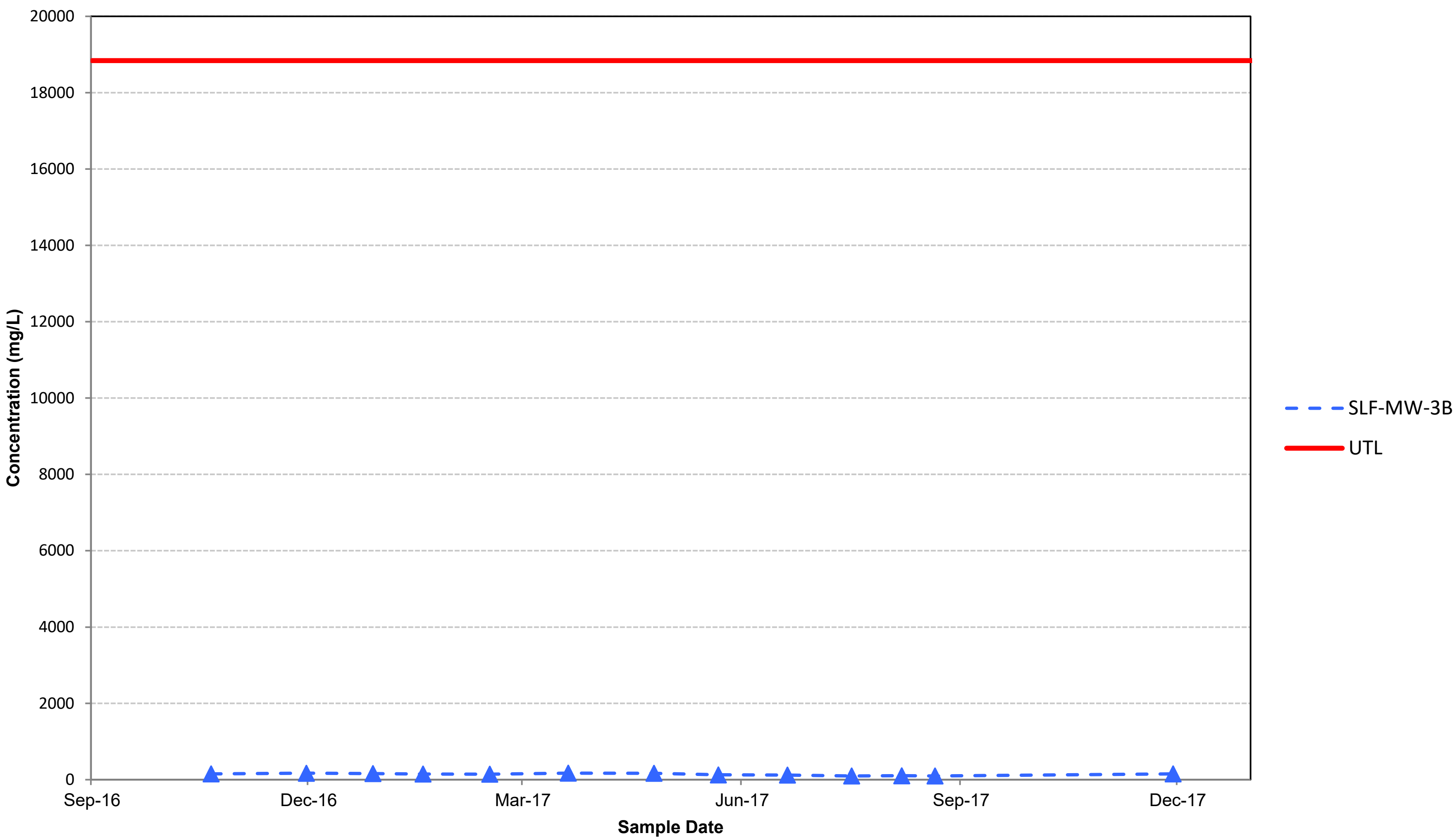
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CALCIUM
CONCENTRATION VS. TIME

April 2018 **Figure F-9**



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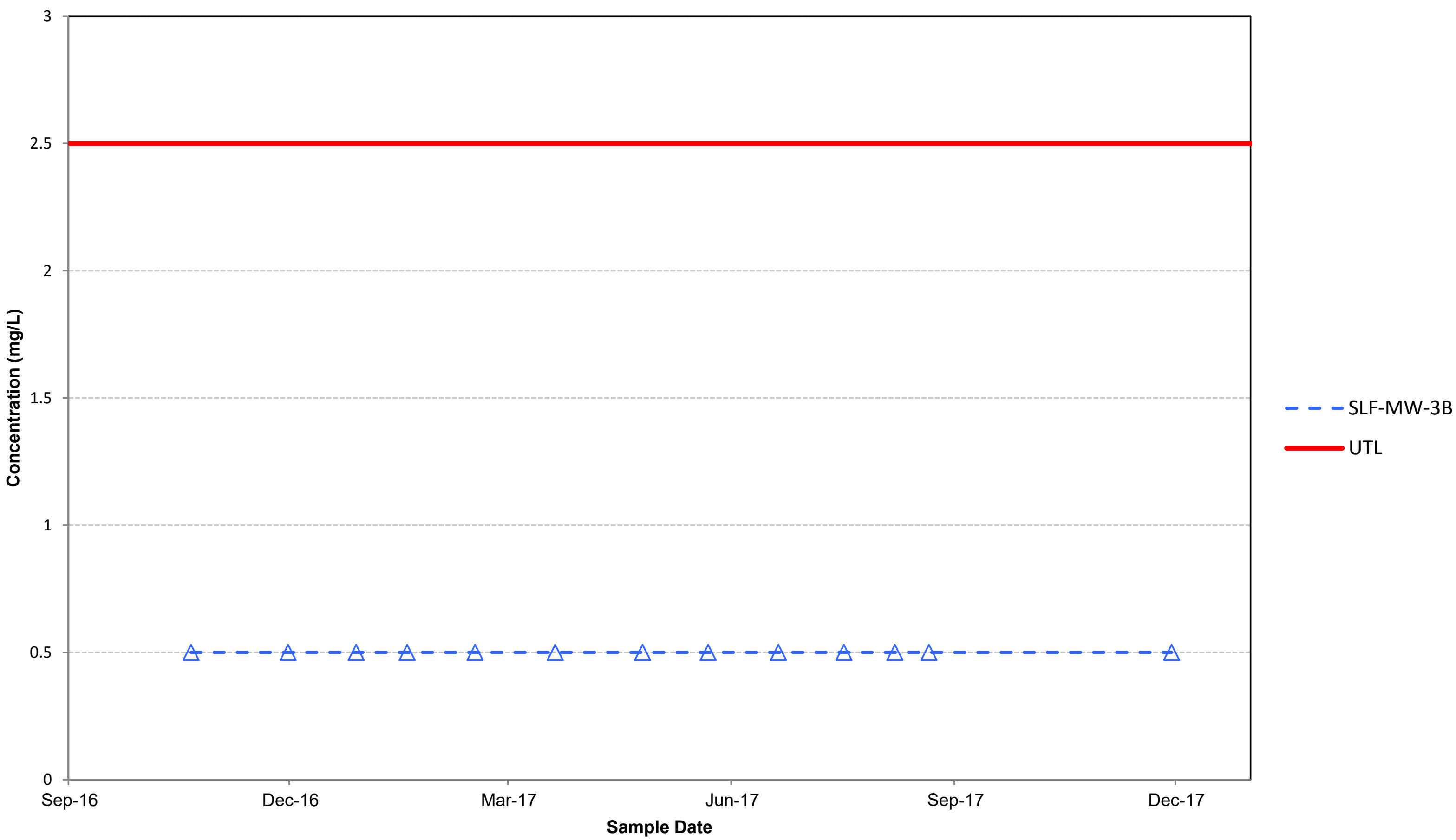
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CHLORIDE
CONCENTRATION VS. TIME

April 2018 **Figure F-10**



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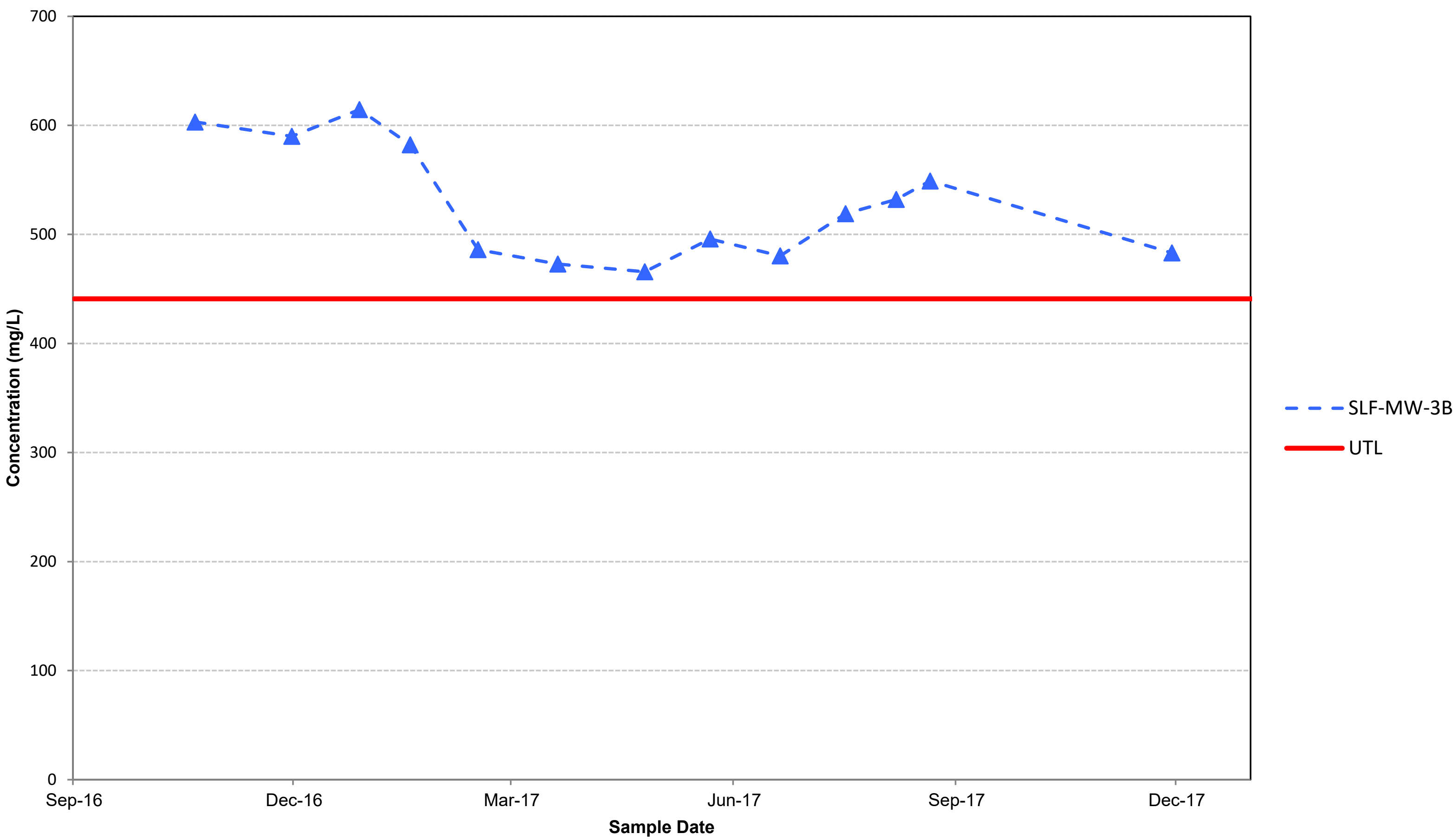
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

FLUORIDE
CONCENTRATION VS. TIME

April 2018 **Figure F-11**



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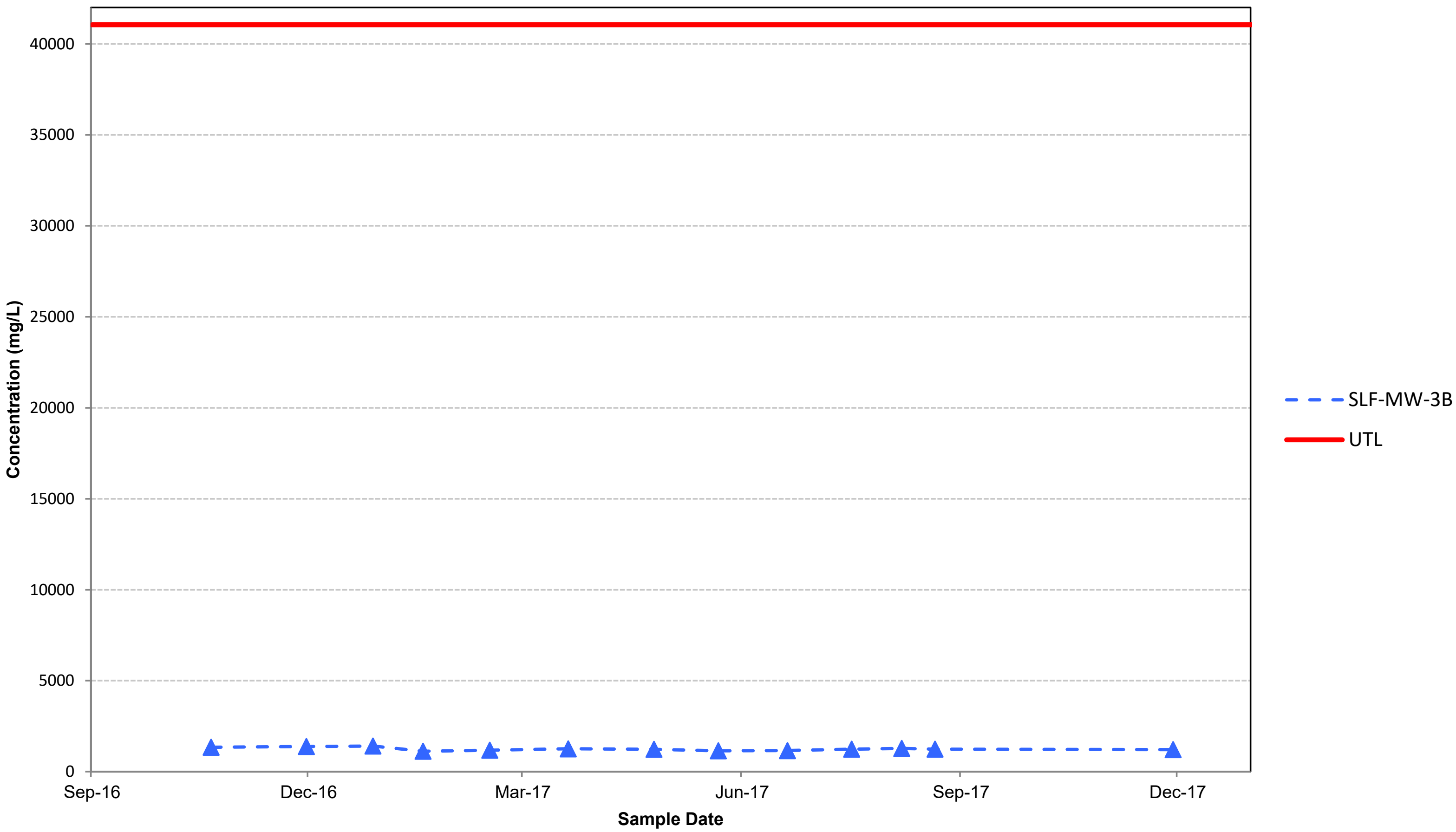
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

SULFATE
CONCENTRATION VS. TIME

April 2018 **Figure F-12**



NOTES:

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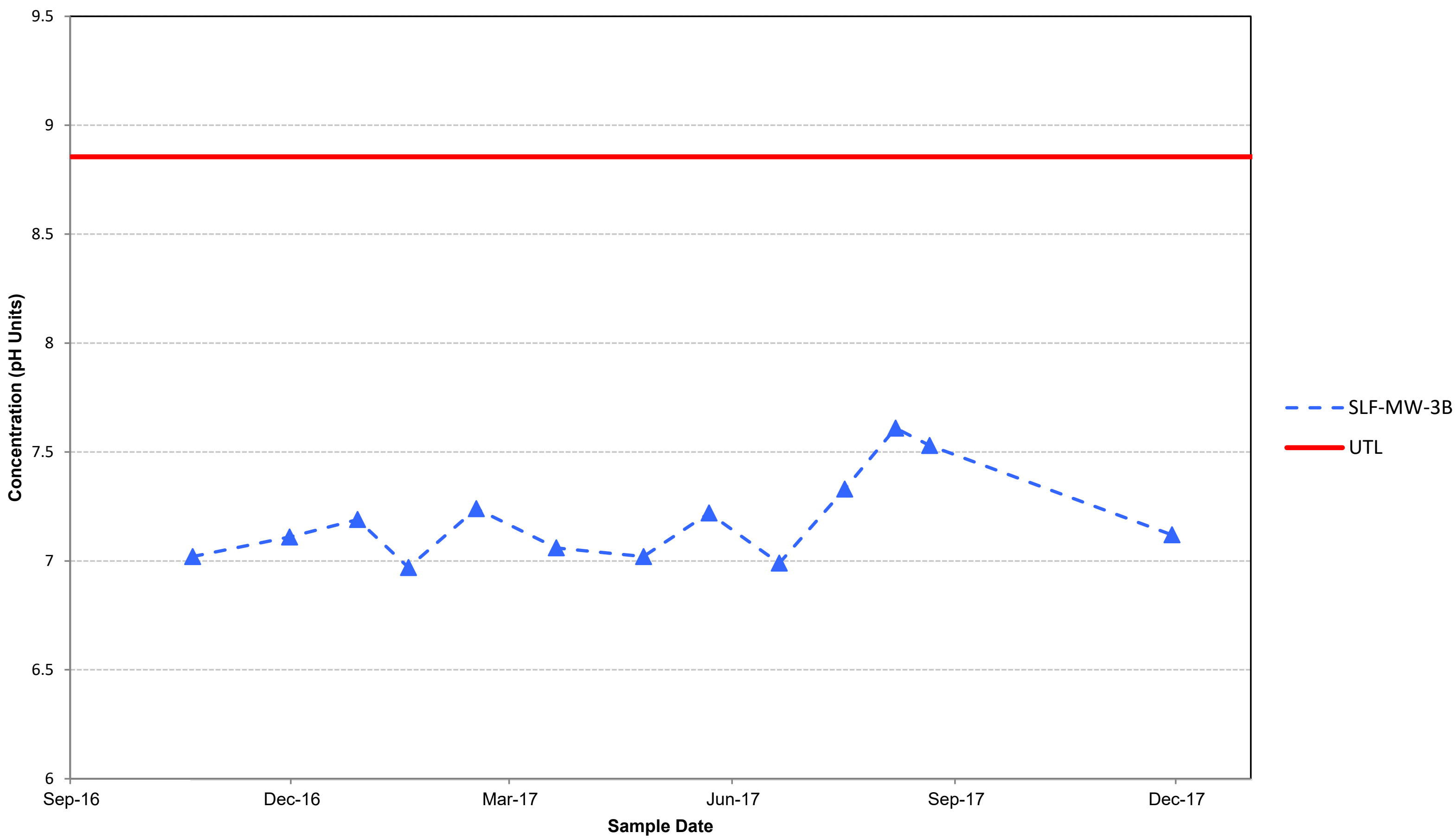
HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION VS. TIME

April 2018 **Figure F-13**



NOTES:

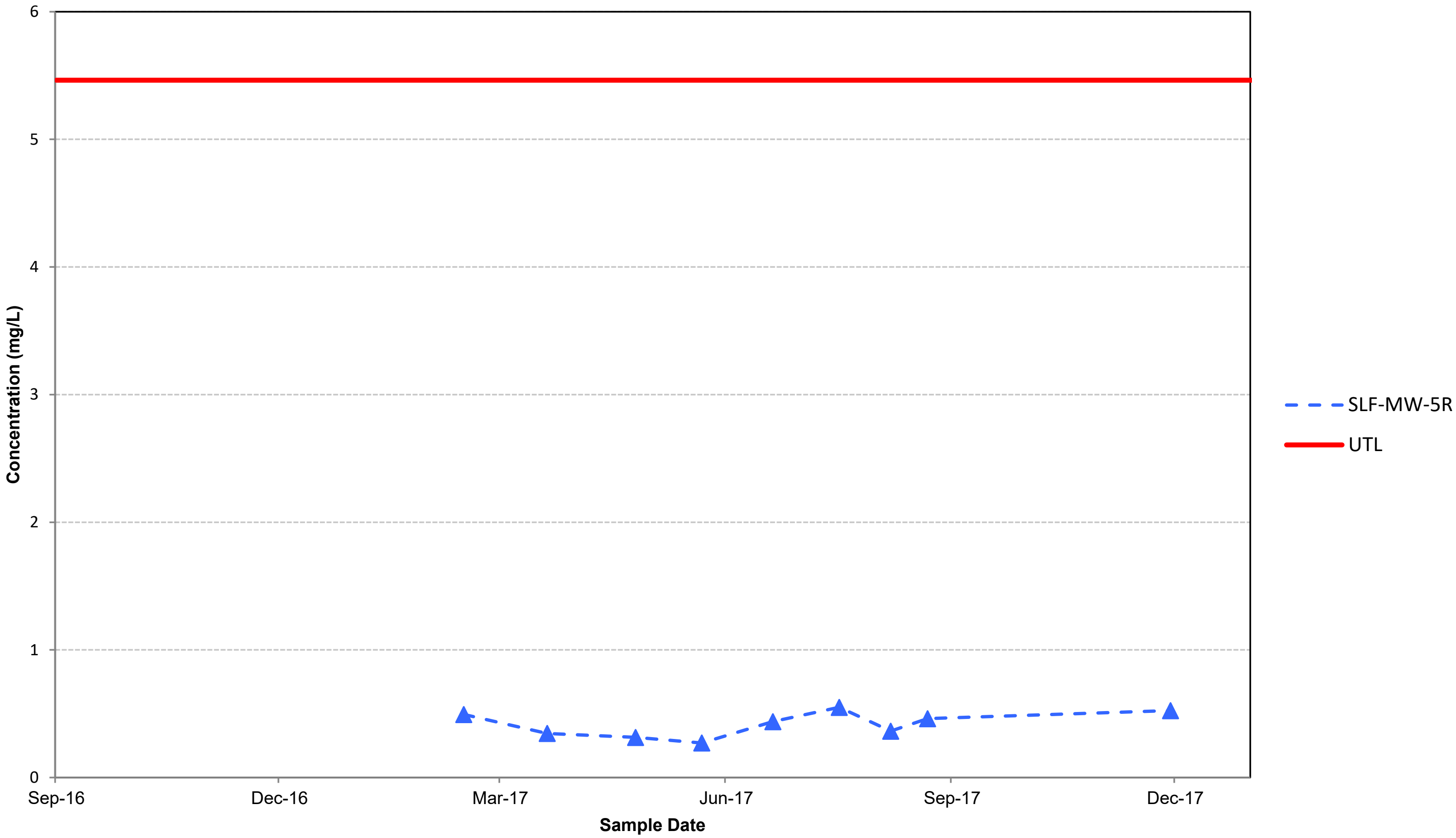
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

PH, FIELD
CONCENTRATION VS. TIME

April 2018 **Figure F-14**



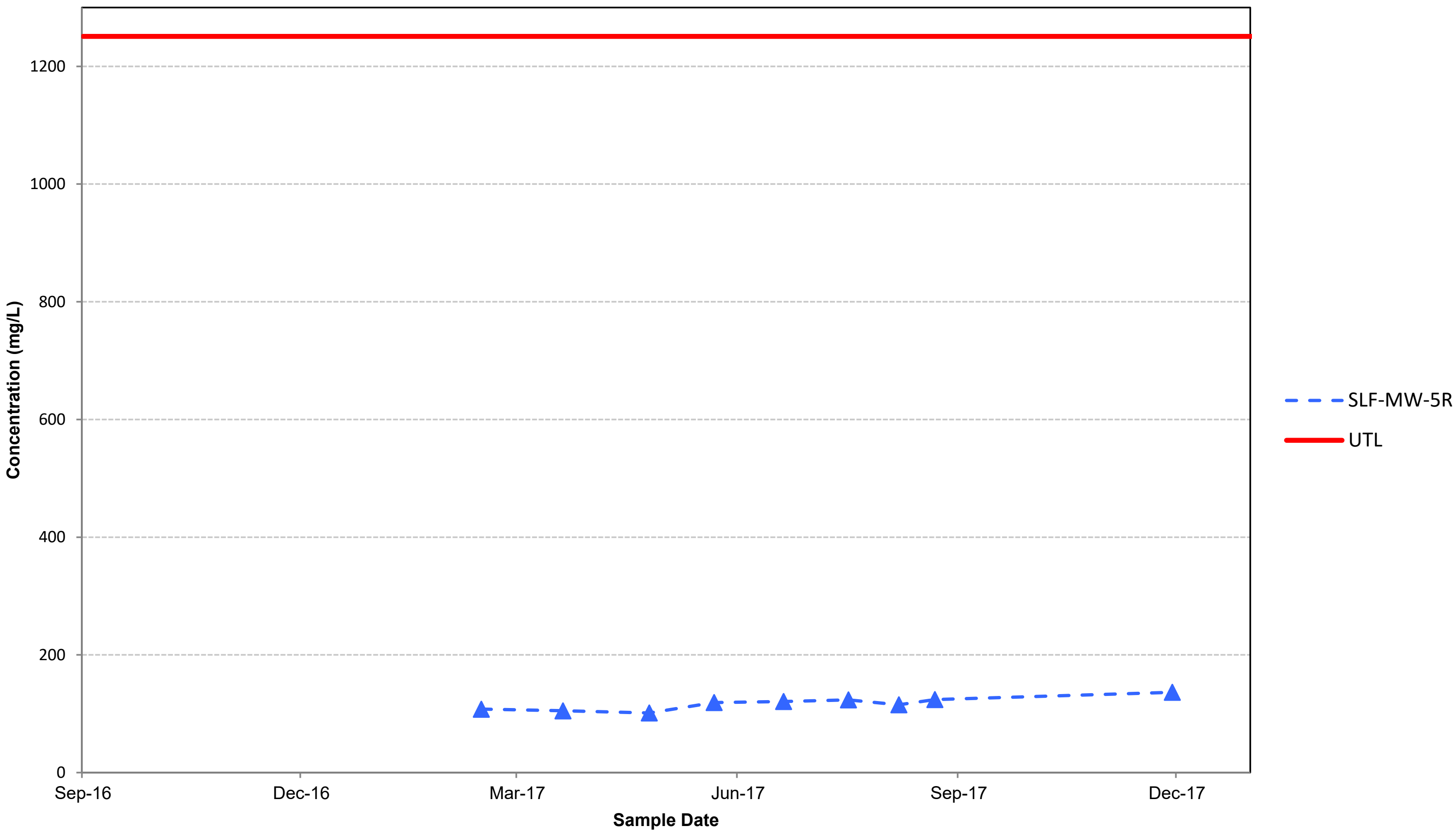
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

BORON
CONCENTRATION VS. TIME

April 2018 **Figure F-15**



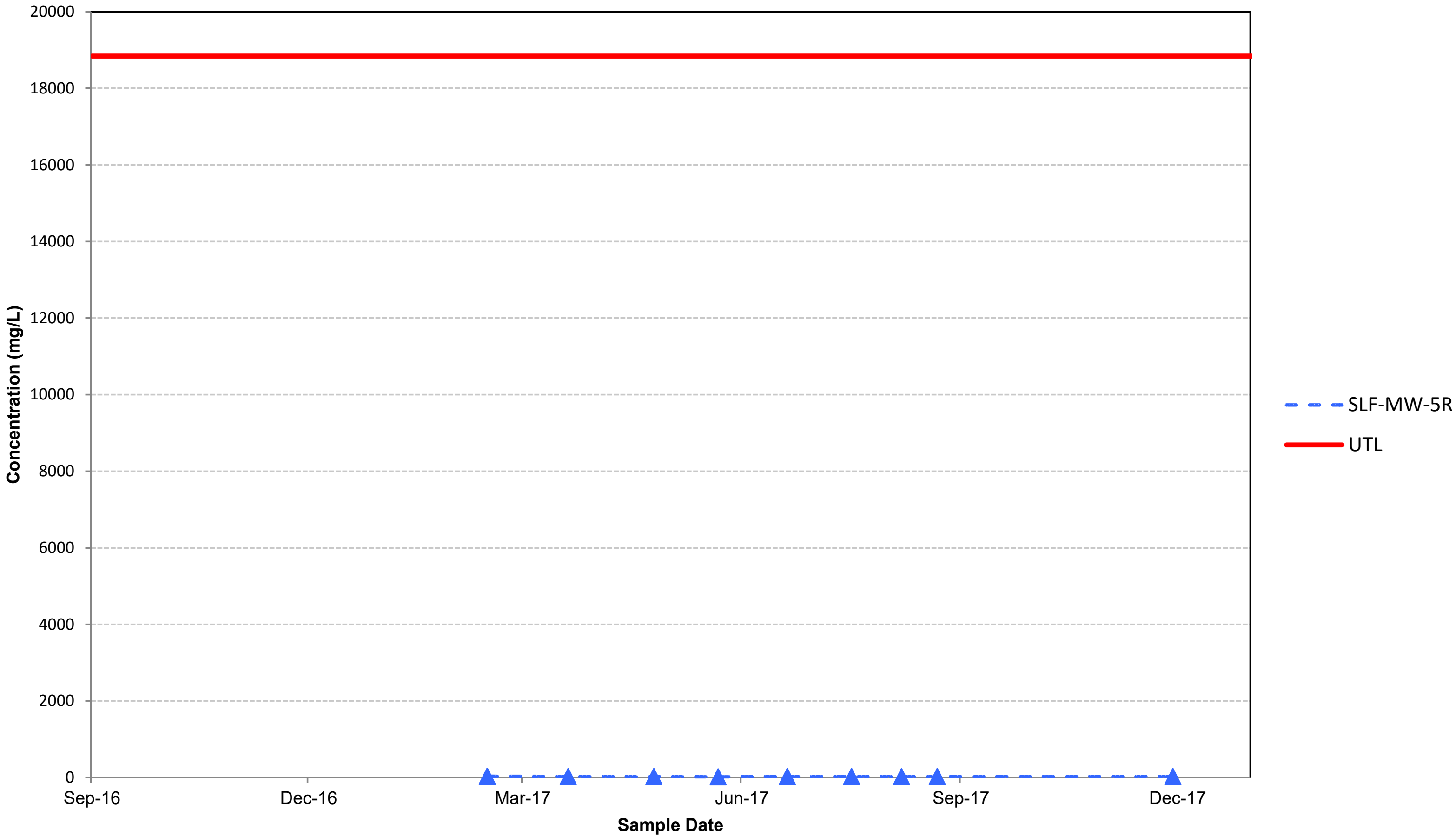
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CALCIUM
CONCENTRATION VS. TIME

April 2018 **Figure F-16**



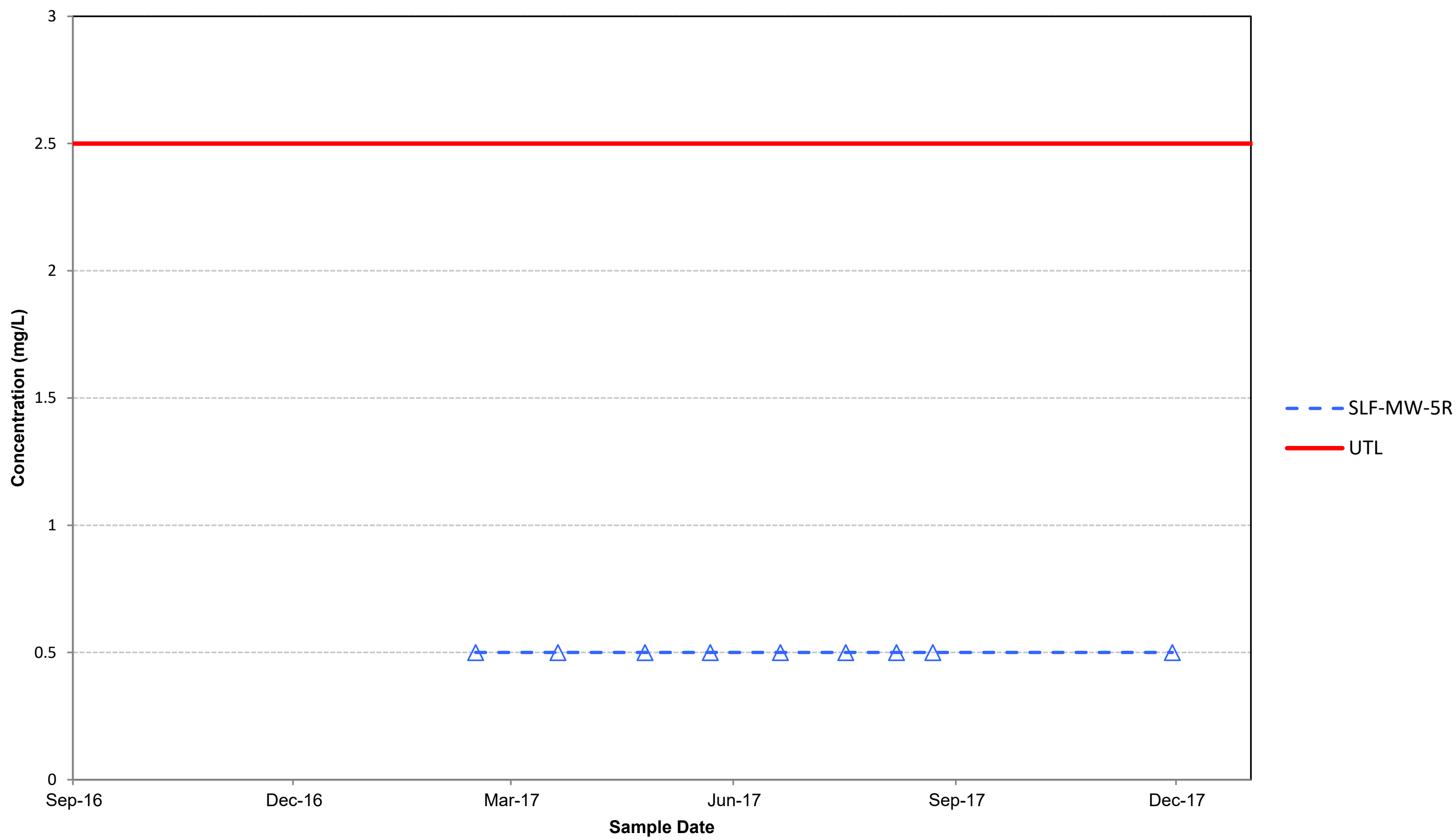
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CHLORIDE
CONCENTRATION VS. TIME

April 2018 **Figure F-17**



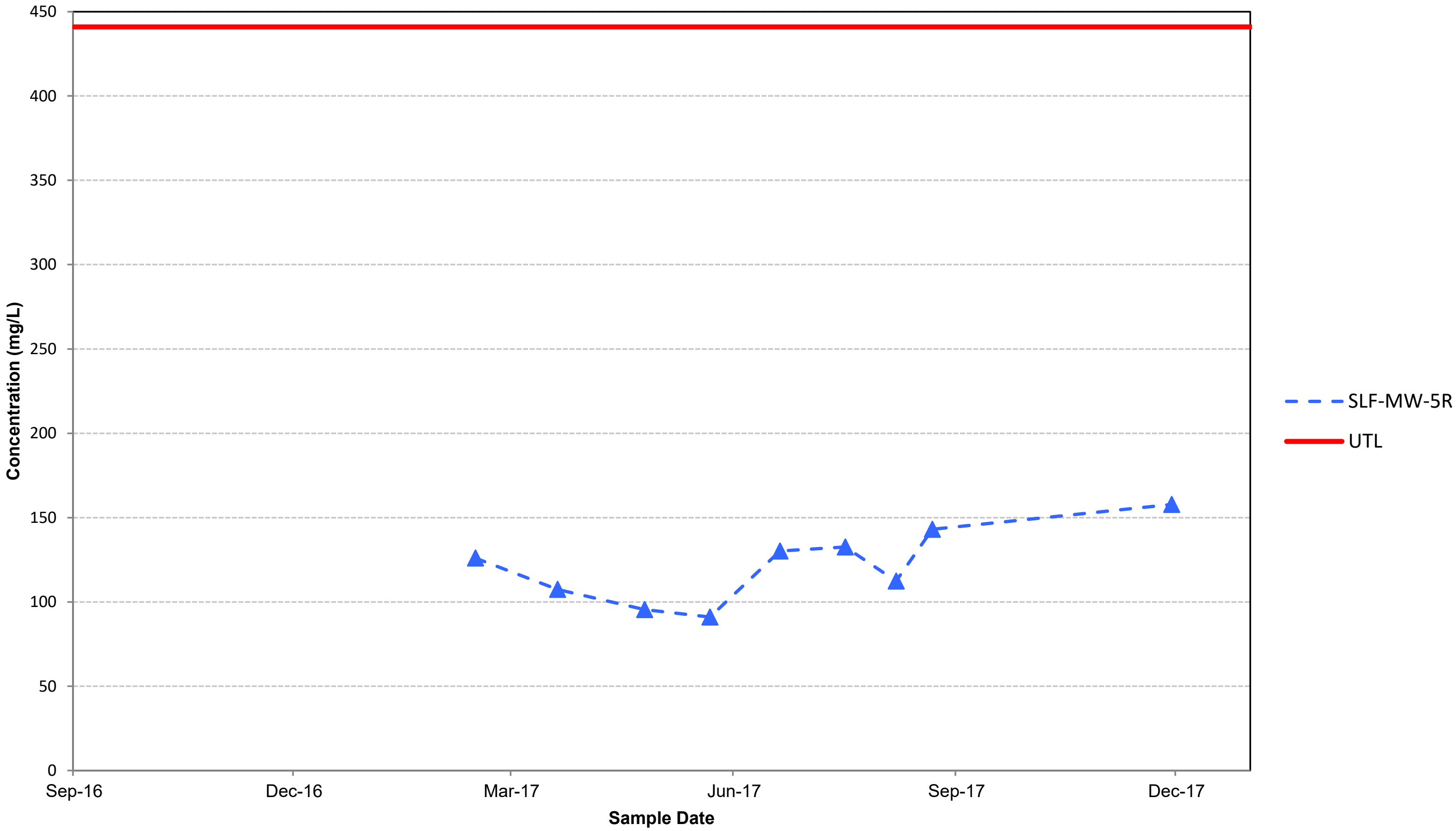
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

FLUORIDE
CONCENTRATION VS. TIME

April 2018 **Figure F-18**



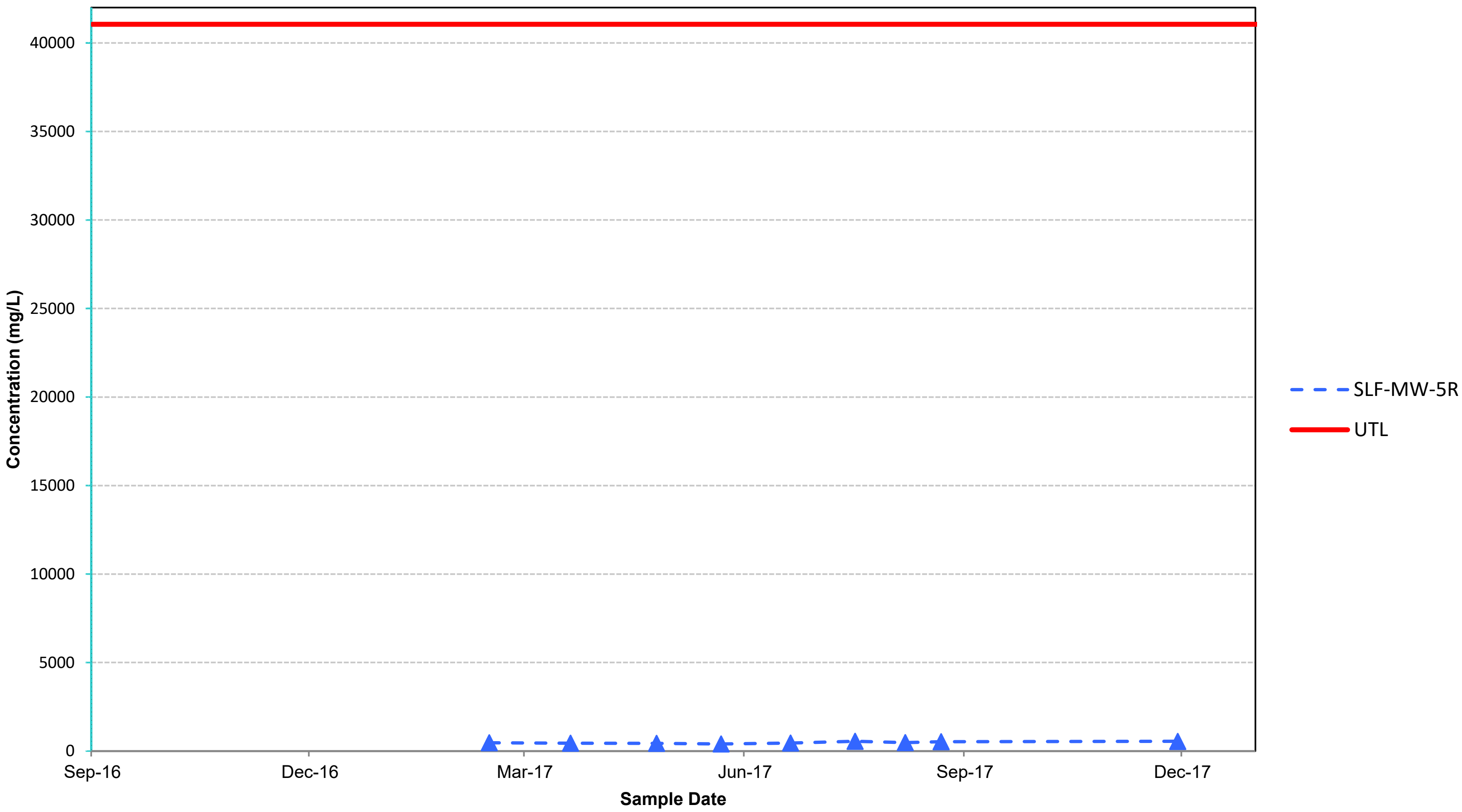
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

SULFATE
CONCENTRATION VS. TIME

April 2018 **Figure F-19**



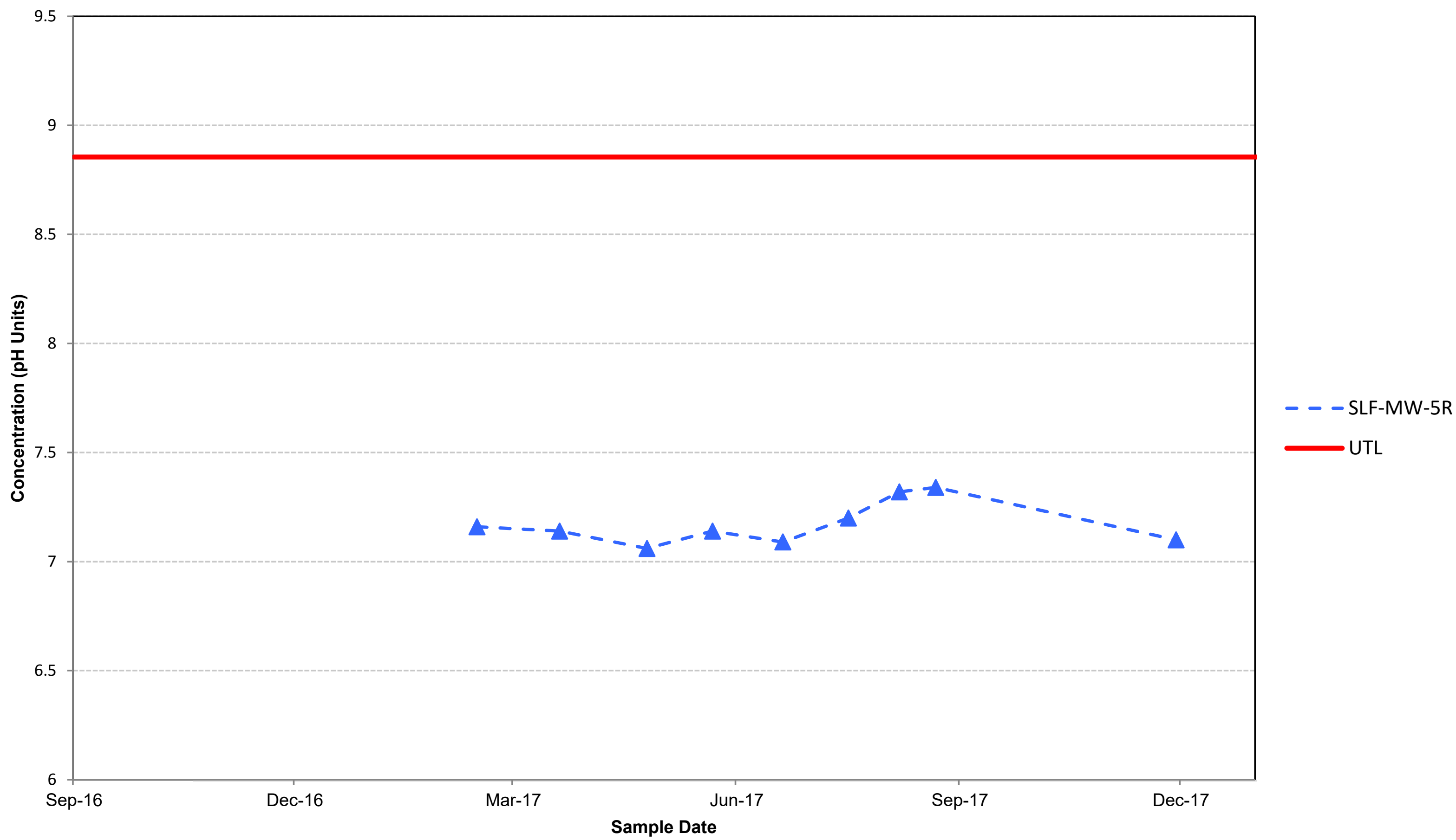
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION VS. TIME

April 2018 **Figure F-20**



NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

PH, FIELD
CONCENTRATION VS. TIME

April 2018 **Figure F-21**

ATTACHMENT 2

Statistical Output

	Background Statistics for Uncensored Full Data Sets		
User Selected Options			
Date/Time of Computation	ProUCL 5.11/13/2018 11:34:35 AM		
Full Precision	OFF		
Confidence Coefficient	95%		
Coverage	99%		
New or Future K Observations	1		
Number of Bootstrap Operations	2000		

Boron

General Statistics

Total Number of Observations	25	Number of Distinct Observations	25
Minimum	1225	First Quartile	1573
Second Largest	5435	Median	2730
Maximum	5464	Third Quartile	4575
Mean	3047	SD	1553
Coefficient of Variation	0.51	Skewness	0.202
Mean of logged Data	7.883	SD of logged Data	0.548

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663

Normal GOF Test

Shapiro Wilk Test Statistic	0.835	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.236	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.173	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 99% Coverage	7952	90% Percentile (z)	5038
95% UPL (t)	5757	95% Percentile (z)	5602
95% USL	7183	99% Percentile (z)	6661

Gamma GOF Test

A-D Test Statistic	1.803	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.749	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.22	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.175	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.769	k star (bias corrected MLE)	3.344
Theta hat (MLE)	808.4	Theta star (bias corrected MLE)	911.3
nu hat (MLE)	188.5	nu star (bias corrected)	167.2
MLE Mean (bias corrected)	3047	MLE Sd (bias corrected)	1666

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	6344	90% Percentile	5282
95% Hawkins Wixley (HW) Approx. Gamma UPL	6460	95% Percentile	6202
95% WH Approx. Gamma UTL with 99% Coverage	10814	99% Percentile	8184
95% HW Approx. Gamma UTL with 99% Coverage	11524		
95% WH USL	9066	95% HW USL	9497

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.836	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.918	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.211	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.173	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 99% Coverage	14995	90% Percentile (z)	5358
95% UPL (t)	6908	95% Percentile (z)	6539
95% USL	11429	99% Percentile (z)	9503

Nonparametric Distribution Free Background Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	25	95% UTL with 99% Coverage	5464
Approx, f used to compute achieved CC	0.253	Approximate Actual Confidence Coefficient achieved by UTL	0.222
		Approximate Sample Size needed to achieve specified CC	299
95% Percentile Bootstrap UTL with 99% Coverage	5464	95% BCA Bootstrap UTL with 99% Coverage	5464
95% UPL	5455	90% Percentile	4875
90% Chebyshev UPL	7799	95% Percentile	5339
95% Chebyshev UPL	9952	99% Percentile	5457
95% USL	5464		
Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.			
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers			
and consists of observations collected from clean unimpacted locations.			
The use of USL tends to provide a balance between false positives and false negatives provided the data			
represents a background data set and when many onsite observations need to be compared with the BTV.			
Calcium			
General Statistics			
Total Number of Observations	25	Number of Distinct Observations	25
Minimum	239494	First Quartile	390089
Second Largest	798246	Median	536189
Maximum	1022530	Third Quartile	580195
Mean	521639	SD	170000
Coefficient of Variation	0.326	Skewness	0.925
Mean of logged Data	13.11	SD of logged Data	0.326
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663
Normal GOF Test			
Shapiro Wilk Test Statistic	0.928	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.2	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.173	Data Not Normal at 5% Significance Level	
Data appear Approximate Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 99% Coverage	1058498	90% Percentile (z)	739503
95% UPL (t)	818249	95% Percentile (z)	801264
95% USL	974327	99% Percentile (z)	917118
Gamma GOF Test			
A-D Test Statistic	0.519	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.166	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.175	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data appear Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	10.14	k star (bias corrected MLE)	8.949
Theta hat (MLE)	51447	Theta star (bias corrected MLE)	58289
nu hat (MLE)	507	nu star (bias corrected)	447.5
MLE Mean (bias corrected)	521639	MLE Sd (bias corrected)	174372
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	846971	90% Percentile	753842
95% Hawkins Wixley (HW) Approx. Gamma UPL	853112	95% Percentile	837594
95% WH Approx. Gamma UTL with 99% Coverage	1216988	99% Percentile	1010261
95% HW Approx. Gamma UTL with 99% Coverage	1250847		
95% WH USL	1077140	95% HW USL	1098420
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.963	**Shapiro Wilk Lognormal GOF Test**	

5% Shapiro Wilk Critical Value	0.918	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.186	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.173	Data Not Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 99% Coverage	1390280	90% Percentile (z)	753707
95% UPL (t)	876681	95% Percentile (z)	848563
95% USL	1182881	99% Percentile (z)	1059874
Nonparametric Distribution Free Background Statistics			
Data appear Approximate Normal at 5% Significance Level			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	25	95% UTL with 99% Coverage	1022530
Approx, f used to compute achieved CC	0.253	Approximate Actual Confidence Coefficient achieved by UTL	0.222
		Approximate Sample Size needed to achieve specified CC	299
95% Percentile Bootstrap UTL with 99% Coverage	1022530	95% BCA Bootstrap UTL with 99% Coverage	1022530
95% UPL	955245	90% Percentile	703928
90% Chebyshev UPL	1041738	95% Percentile	783206
95% Chebyshev UPL	1277325	99% Percentile	968702
95% USL	1022530		
Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.			
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers			
and consists of observations collected from clean unimpacted locations.			
The use of USL tends to provide a balance between false positives and false negatives provided the data			
represents a background data set and when many onsite observations need to be compared with the BTV.			
Chloride			
General Statistics			
Total Number of Observations	25	Number of Distinct Observations	25
Minimum	1548	First Quartile	11192
Second Largest	16817	Median	14203
Maximum	18877	Third Quartile	14560
Mean	13192	SD	3268
Coefficient of Variation	0.248	Skewness	-1.794
Mean of logged Data	9.424	SD of logged Data	0.463
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663
Normal GOF Test			
Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.209	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.173	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 99% Coverage	23511	90% Percentile (z)	17380
95% UPL (t)	18893	95% Percentile (z)	18567
95% USL	21893	99% Percentile (z)	20794
Gamma GOF Test			
A-D Test Statistic	2.639	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.746	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.221	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.175	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	8.026	k star (bias corrected MLE)	7.09
Theta hat (MLE)	1644	Theta star (bias corrected MLE)	1861
nu hat (MLE)	401.3	nu star (bias corrected)	354.5
MLE Mean (bias corrected)	13192	MLE Sd (bias corrected)	4954

Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	22405	90% Percentile	19805
95% Hawkins Wixley (HW) Approx. Gamma UPL	23323	95% Percentile	22255
95% WH Approx. Gamma UTL with 99% Coverage	33104	99% Percentile	27353
95% HW Approx. Gamma UTL with 99% Coverage	36014		
95% WH USL	29038	95% HW USL	31094
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.529	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.279	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.173	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 99% Coverage	53375	90% Percentile (z)	22400
95% UPL (t)	27754	95% Percentile (z)	26500
95% USL	42446	99% Percentile (z)	36325
Nonparametric Distribution Free Background Statistics			
Data do not follow a Discernible Distribution (0.05)			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	25	95% UTL with 99% Coverage	18877
Approx, f used to compute achieved CC	0.253	Approximate Actual Confidence Coefficient achieved by UTL	0.222
		Approximate Sample Size needed to achieve specified CC	299
95% Percentile Bootstrap UTL with 99% Coverage	18877	95% BCA Bootstrap UTL with 99% Coverage	18877
95% UPL	18259	90% Percentile	16049
90% Chebyshev UPL	23189	95% Percentile	16711
95% Chebyshev UPL	27717	99% Percentile	18383
95% USL	18877		
Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.			
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers			
and consists of observations collected from clean unimpacted locations.			
The use of USL tends to provide a balance between false positives and false negatives provided the data			
represents a background data set and when many onsite observations need to be compared with the BTV.			
pH			
General Statistics			
Total Number of Observations	25	Number of Distinct Observations	23
Minimum	6.68	First Quartile	7.1
Second Largest	8.31	Median	7.25
Maximum	8.47	Third Quartile	7.64
Mean	7.411	SD	0.43
Coefficient of Variation	0.058	Skewness	0.891
Mean of logged Data	2.001	SD of logged Data	0.0569
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663
Normal GOF Test			
Shapiro Wilk Test Statistic	0.922	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Data appear Normal at 5% Significance Level	
Lilliefors Test Statistic	0.166	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.173	Data appear Normal at 5% Significance Level	
Data appear Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 99% Coverage	8.769	90% Percentile (z)	7.962
95% UPL (t)	8.161	95% Percentile (z)	8.118
95% USL	8.556	99% Percentile (z)	8.411
Gamma GOF Test			
A-D Test Statistic	0.745	**Anderson-Darling Gamma GOF Test**	

5% A-D Critical Value	0.742	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.165	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.174	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data follow Appr. Gamma Distribution at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	318	k star (bias corrected MLE)	279.8
Theta hat (MLE)	0.0233	Theta star (bias corrected MLE)	0.0265
nu hat (MLE)	15898	nu star (bias corrected)	13992
MLE Mean (bias corrected)	7.411	MLE Sd (bias corrected)	0.443
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	8.167	90% Percentile	7.984
95% Hawkins Wixley (HW) Approx. Gamma UPL	8.168	95% Percentile	8.154
95% WH Approx. Gamma UTL with 99% Coverage	8.824	99% Percentile	8.48
95% HW Approx. Gamma UTL with 99% Coverage	8.831		
95% WH USL	8.59	95% HW USL	8.595
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.16	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.173	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 99% Coverage	8.855	90% Percentile (z)	7.959
95% UPL (t)	8.171	95% Percentile (z)	8.125
95% USL	8.609	99% Percentile (z)	8.446
Nonparametric Distribution Free Background Statistics			
Data appear Normal at 5% Significance Level			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	25	95% UTL with 99% Coverage	8.47
Approx, f used to compute achieved CC	0.253	Approximate Actual Confidence Coefficient achieved by UTL	0.222
		Approximate Sample Size needed to achieve specified CC	299
95% Percentile Bootstrap UTL with 99% Coverage	8.47	95% BCA Bootstrap UTL with 99% Coverage	8.47
95% UPL	8.422	90% Percentile	7.894
90% Chebyshev UPL	8.727	95% Percentile	8.234
95% Chebyshev UPL	9.323	99% Percentile	8.432
95% USL	8.47		
Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.			
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers			
and consists of observations collected from clean unimpacted locations.			
The use of USL tends to provide a balance between false positives and false negatives provided the data			
represents a background data set and when many onsite observations need to be compared with the BTV.			
Sulfate			
General Statistics			
Total Number of Observations	25	Number of Distinct Observations	24
Minimum	4.1	First Quartile	57.79
Second Largest	237.5	Median	65.56
Maximum	295	Third Quartile	100.3
Mean	87.87	SD	61.79
Coefficient of Variation	0.703	Skewness	2.124
Mean of logged Data	4.243	SD of logged Data	0.796
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663
Normal GOF Test			
Shapiro Wilk Test Statistic	0.777	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.231	**Lilliefors GOF Test**	

5% Lilliefors Critical Value	0.173	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 99% Coverage	283	90% Percentile (z)	167
95% UPL (t)	195.7	95% Percentile (z)	189.5
95% USL	252.4	99% Percentile (z)	231.6
Gamma GOF Test			
A-D Test Statistic	0.887	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.156	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.176	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data follow Appr. Gamma Distribution at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.299	k star (bias corrected MLE)	2.05
Theta hat (MLE)	38.22	Theta star (bias corrected MLE)	42.86
nu hat (MLE)	115	nu star (bias corrected)	102.5
MLE Mean (bias corrected)	87.87	MLE Sd (bias corrected)	61.37
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	210.3	90% Percentile	169.9
95% Hawkins Wixley (HW) Approx. Gamma UPL	219	95% Percentile	206.8
95% WH Approx. Gamma UTL with 99% Coverage	394	99% Percentile	288.5
95% HW Approx. Gamma UTL with 99% Coverage	441		
95% WH USL	320.9	95% HW USL	349.9
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.838	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.191	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.173	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 99% Coverage	858.9	90% Percentile (z)	193
95% UPL (t)	279	95% Percentile (z)	257.7
95% USL	579.3	99% Percentile (z)	443.2
Nonparametric Distribution Free Background Statistics			
Data appear Approximate Gamma Distribution at 5% Significance Level			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	25	95% UTL with 99% Coverage	295
Approx, f used to compute achieved CC	0.253	Approximate Actual Confidence Coefficient achieved by UTL	0.222
		Approximate Sample Size needed to achieve specified CC	299
95% Percentile Bootstrap UTL with 99% Coverage	295	95% BCA Bootstrap UTL with 99% Coverage	295
95% UPL	277.7	90% Percentile	122.3
90% Chebyshev UPL	276.9	95% Percentile	215.9
95% Chebyshev UPL	362.5	99% Percentile	281.2
95% USL	295		
Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.			
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers			
and consists of observations collected from clean unimpacted locations.			
The use of USL tends to provide a balance between false positives and false negatives provided the data			
represents a background data set and when many onsite observations need to be compared with the BTV.			
TotalDissolvedSolids			
General Statistics			
Total Number of Observations	25	Number of Distinct Observations	25
Minimum	17360	First Quartile	22420
Second Largest	30260	Median	25460
Maximum	33067	Third Quartile	28480
Mean	24967	SD	4171

	A	B	C	D	E	F	G	H	I	J	K	L
403					Coefficient of Variation	0.167					Skewness	-0.12
404					Mean of logged Data	10.11					SD of logged Data	0.173
405												
406						**Critical Values for Background Threshold Values (BTVs)**						
407					Tolerance Factor K (For UTL)	3.158					d2max (for USL)	2.663
408												
409						**Normal GOF Test**						
410					Shapiro Wilk Test Statistic	0.975					**Shapiro Wilk GOF Test**	
411					5% Shapiro Wilk Critical Value	0.918					Data appear Normal at 5% Significance Level	
412					Lilliefors Test Statistic	0.0891					**Lilliefors GOF Test**	
413					5% Lilliefors Critical Value	0.173					Data appear Normal at 5% Significance Level	
414						**Data appear Normal at 5% Significance Level**						
415												
416						**Background Statistics Assuming Normal Distribution**						
417					95% UTL with 99% Coverage	38140					90% Percentile (z)	30313
418					95% UPL (t)	32245					95% Percentile (z)	31828
419					95% USL	36074					99% Percentile (z)	34671
420												
421						**Gamma GOF Test**						
422					A-D Test Statistic	0.279					**Anderson-Darling Gamma GOF Test**	
423					5% A-D Critical Value	0.743					Detected data appear Gamma Distributed at 5% Significance Level	
424					K-S Test Statistic	0.107					**Kolmogorov-Smirnov Gamma GOF Test**	
425					5% K-S Critical Value	0.174					Detected data appear Gamma Distributed at 5% Significance Level	
426						**Detected data appear Gamma Distributed at 5% Significance Level**						
427												
428						**Gamma Statistics**						
429					k hat (MLE)	35.89					k star (bias corrected MLE)	31.61
430					Theta hat (MLE)	695.7					Theta star (bias corrected MLE)	789.9
431					nu hat (MLE)	1795					nu star (bias corrected)	1580
432					MLE Mean (bias corrected)	24967					MLE Sd (bias corrected)	4441
433												
434						**Background Statistics Assuming Gamma Distribution**						
435					95% Wilson Hilferty (WH) Approx. Gamma UPL	32872					90% Percentile	30801
436					95% Hawkins Wixley (HW) Approx. Gamma UPL	32969					95% Percentile	32693
437					95% WH Approx. Gamma UTL with 99% Coverage	40636					99% Percentile	36442
438					95% HW Approx. Gamma UTL with 99% Coverage	41052						
439					95% WH USL	37791					95% HW USL	38068
440												
441						**Lognormal GOF Test**						
442					Shapiro Wilk Test Statistic	0.961					**Shapiro Wilk Lognormal GOF Test**	
443					5% Shapiro Wilk Critical Value	0.918					Data appear Lognormal at 5% Significance Level	
444					Lilliefors Test Statistic	0.112					**Lilliefors Lognormal GOF Test**	
445					5% Lilliefors Critical Value	0.173					Data appear Lognormal at 5% Significance Level	
446						**Data appear Lognormal at 5% Significance Level**						
447												
448						**Background Statistics assuming Lognormal Distribution**						
449					95% UTL with 99% Coverage	42510					90% Percentile (z)	30729
450					95% UPL (t)	33292					95% Percentile (z)	32722
451					95% USL	39021					99% Percentile (z)	36815
452												
453						**Nonparametric Distribution Free Background Statistics**						
454						**Data appear Normal at 5% Significance Level**						
455												
456						**Nonparametric Upper Limits for Background Threshold Values**						
457					Order of Statistic, r	25					95% UTL with 99% Coverage	33067
458					Approx, f used to compute achieved CC	0.253					Approximate Actual Confidence Coefficient achieved by UTL	0.222
459											Approximate Sample Size needed to achieve specified CC	299
460					95% Percentile Bootstrap UTL with 99% Coverage	33067					95% BCA Bootstrap UTL with 99% Coverage	33067
461					95% UPL	32225					90% Percentile	30132
462					90% Chebyshev UPL	37728					95% Percentile	30255
463					95% Chebyshev UPL	43509					99% Percentile	32393
464					95% USL	33067						
465												
466						Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.						
467						Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers						
468						and consists of observations collected from clean unimpacted locations.						
469						The use of USL tends to provide a balance between false positives and false negatives provided the data						

	A	B	C	D	E	F	G	H	I	J	K	L
470	represents a background data set and when many onsite observations need to be compared with the BTV.											
471												

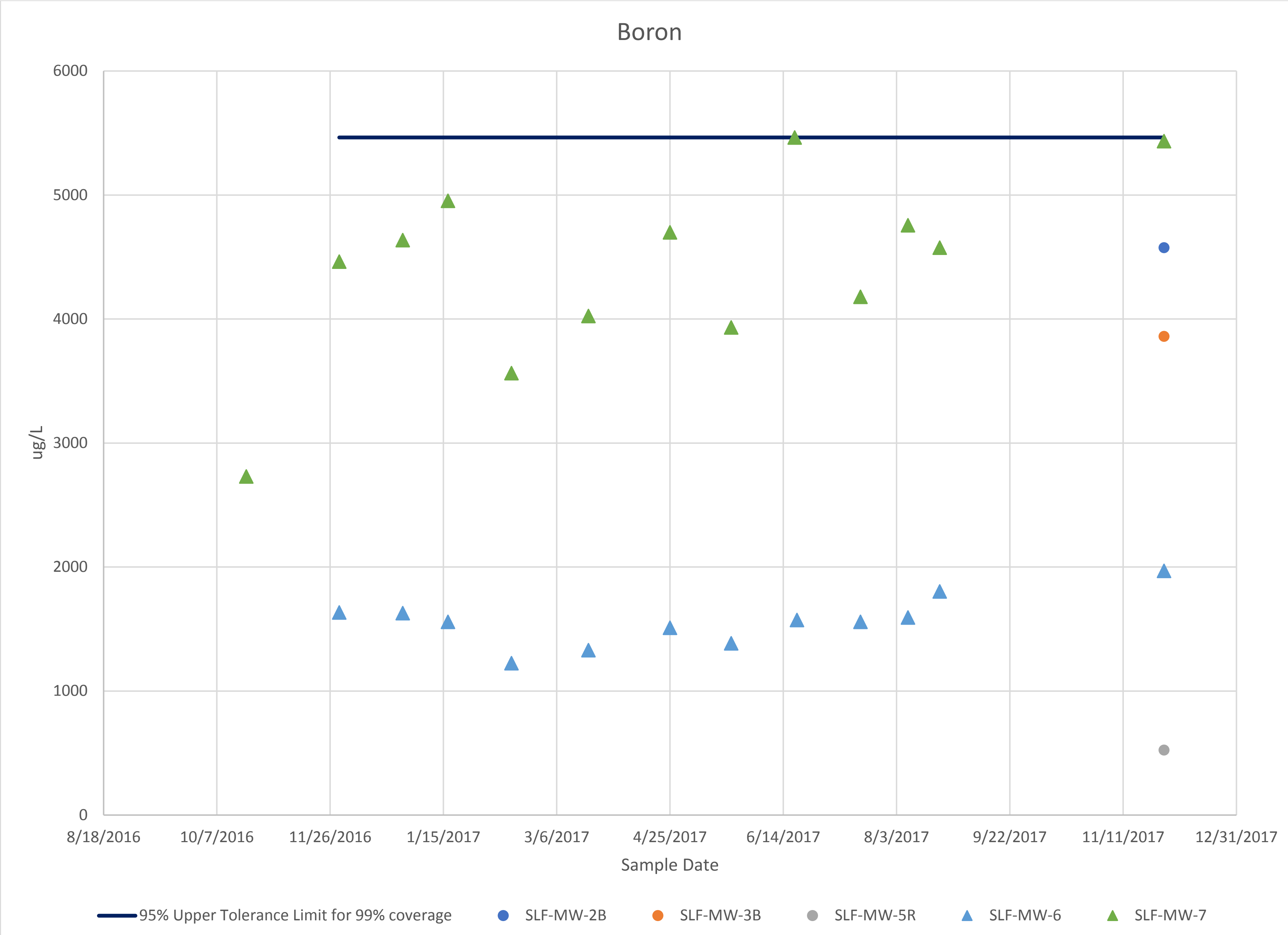
	Background Statistics for Data Sets with Non-Detects
User Selected Options	
Date/Time of Computation	ProUCL 5.11/13/2018 11:49:22 AM
Full Precision	OFF
Confidence Coefficient	95%
Coverage	99%
erent or Future K Observations	1
umber of Bootstrap Operations	2000

Fluoride

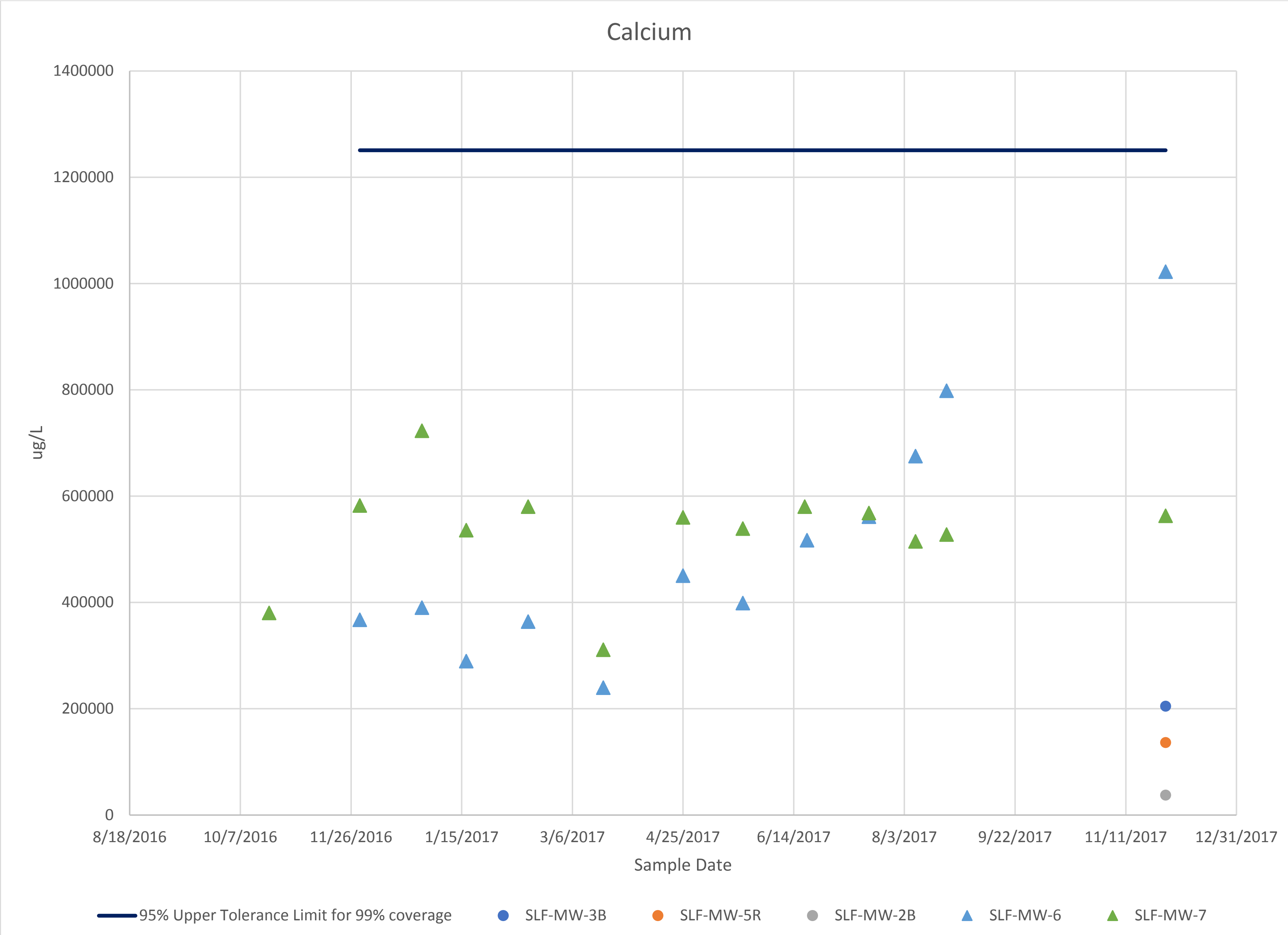
General Statistics			
Total Number of Observations	25	Number of Missing Observations	0
Number of Distinct Observations	11		
Number of Detects	10	Number of Non-Detects	15
Number of Distinct Detects	8	Number of Distinct Non-Detects	3
Minimum Detect	0.507	Minimum Non-Detect	0.5
Maximum Detect	2.374	Maximum Non-Detect	2.5
Variance Detected	0.469	Percent Non-Detects	60%
Mean Detected	1.064	SD Detected	0.685
Mean of Detected Logged Data	-0.078	SD of Detected Logged Data	0.516
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663
Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.664	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.371	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Kaplan Meier (KM) Background Statistics Assuming Normal Distribution			
KM Mean	0.739	KM SD	0.502
95% UTL99% Coverage	2.325	95% KM UPL (t)	1.615
90% KM Percentile (z)	1.383	95% KM Percentile (z)	1.565
99% KM Percentile (z)	1.907	95% KM USL	2.077
DL/2 Substitution Background Statistics Assuming Normal Distribution			
Mean	0.625	SD	0.591
95% UTL99% Coverage	2.491	95% UPL (t)	1.656
90% Percentile (z)	1.383	95% Percentile (z)	1.597
99% Percentile (z)	2	95% USL	2.199
DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons			
Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	1.339	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.73	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.323	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.268	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics on Detected Data Only			
k hat (MLE)	3.737	k star (bias corrected MLE)	2.683
Theta hat (MLE)	0.285	Theta star (bias corrected MLE)	0.396
nu hat (MLE)	74.74	nu star (bias corrected)	53.65
MLE Mean (bias corrected)	1.064		
MLE Sd (bias corrected)	0.649	95% Percentile of Chisquare (2kstar)	11.63
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
For such situations, GROS method may yield incorrect values of UCLs and BTVs			
This is especially true when the sample size is small.			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	0.01	Mean	0.451
Maximum	2.374	Median	0.114

	A	B	C	D	E	F	G	H	I	J	K	L
68					SD	0.662					CV	1.468
69					k hat (MLE)	0.418					k star (bias corrected MLE)	0.395
70					Theta hat (MLE)	1.079					Theta star (bias corrected MLE)	1.143
71					nu hat (MLE)	20.91					nu star (bias corrected)	19.73
72					MLE Mean (bias corrected)	0.451					MLE Sd (bias corrected)	0.718
73					95% Percentile of Chisquare (2kstar)	3.295					90% Percentile	1.277
74					95% Percentile	1.883					99% Percentile	3.409
75	**The following statistics are computed using Gamma ROS Statistics on Imputed Data**											
76	**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**											
77					WH	HW					WH	HW
78				% Approx. Gamma UTL with 99% Coverage	5.51	7.466				95% Approx. Gamma UPL	1.871	2.048
79				95% Gamma USL	3.938	4.969						
80												
81	**Estimates of Gamma Parameters using KM Estimates**											
82					Mean (KM)	0.739					SD (KM)	0.502
83					Variance (KM)	0.252					SE of Mean (KM)	0.108
84					k hat (KM)	2.162					k star (KM)	1.929
85					nu hat (KM)	108.1					nu star (KM)	96.47
86					theta hat (KM)	0.342					theta star (KM)	0.383
87					80% gamma percentile (KM)	1.111					90% gamma percentile (KM)	1.449
88					95% gamma percentile (KM)	1.772					99% gamma percentile (KM)	2.491
89												
90	**The following statistics are computed using gamma distribution and KM estimates**											
91	**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**											
92					WH	HW					WH	HW
93				% Approx. Gamma UTL with 99% Coverage	2.036	2.038				95% Approx. Gamma UPL	1.464	1.446
94				95% KM Gamma Percentile	1.408	1.389				95% Gamma USL	2.058	2.061
95												
96	**Lognormal GOF Test on Detected Observations Only**											
97					Shapiro Wilk Test Statistic	0.781	**Shapiro Wilk GOF Test**					
98					5% Shapiro Wilk Critical Value	0.842	Data Not Lognormal at 5% Significance Level					
99					Lilliefors Test Statistic	0.287	**Lilliefors GOF Test**					
100					5% Lilliefors Critical Value	0.262	Data Not Lognormal at 5% Significance Level					
101	**Data Not Lognormal at 5% Significance Level**											
102												
103	**Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects**											
104					Mean in Original Scale	0.586					Mean in Log Scale	-0.887
105					SD in Original Scale	0.585					SD in Log Scale	0.84
106					95% UTL99% Coverage	5.836					95% BCA UTL99% Coverage	2.374
107					95% Bootstrap (%) UTL99% Coverage	2.374					95% UPL (t)	1.782
108					90% Percentile (z)	1.208					95% Percentile (z)	1.638
109					99% Percentile (z)	2.903					95% USL	3.851
110												
111	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**											
112					KM Mean of Logged Data	-0.431					95% KM UTL (Lognormal)99% Coverage	2.589
113					KM SD of Logged Data	0.438					95% KM UPL (Lognormal)	1.395
114					95% KM Percentile Lognormal (z)	1.335					95% KM USL (Lognormal)	2.084
115												
116	**Background DL/2 Statistics Assuming Lognormal Distribution**											
117					Mean in Original Scale	0.625					Mean in Log Scale	-0.771
118					SD in Original Scale	0.591					SD in Log Scale	0.739
119					95% UTL99% Coverage	4.776					95% UPL (t)	1.68
120					90% Percentile (z)	1.193					95% Percentile (z)	1.561
121					99% Percentile (z)	2.583					95% USL	3.312
122	**DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.**											
123												
124	**Nonparametric Distribution Free Background Statistics**											
125	**Data do not follow a Discernible Distribution (0.05)**											
126												
127	**Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)**											
128					Order of Statistic, r	25					95% UTL with99% Coverage	2.5
129					Approx, f used to compute achieved CC	0.253					Approximate Actual Confidence Coefficient achieved by UTL	0.222
130					pproximate Sample Size needed to achieve specified CC	299					95% UPL	2.462
131					95% USL	2.5					95% KM Chebyshev UPL	2.972
132												
133	Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.											
134	Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers											

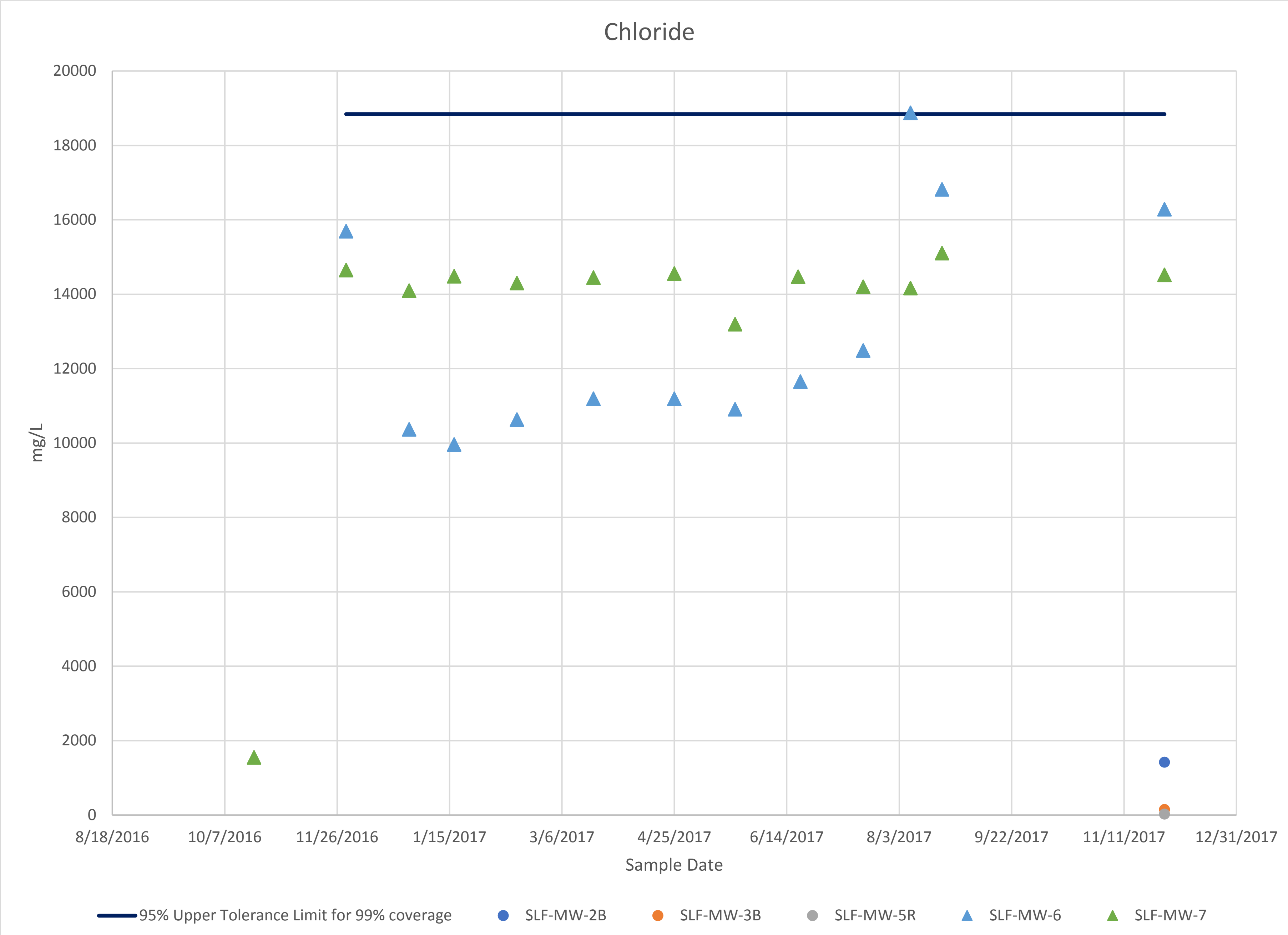
	A	B	C	D	E	F	G	H	I	J	K	L
135	and consists of observations collected from clean unimpacted locations.											
136	The use of USL tends to provide a balance between false positives and false negatives provided the data											
137	represents a background data set and when many onsite observations need to be compared with the BTV.											
138												



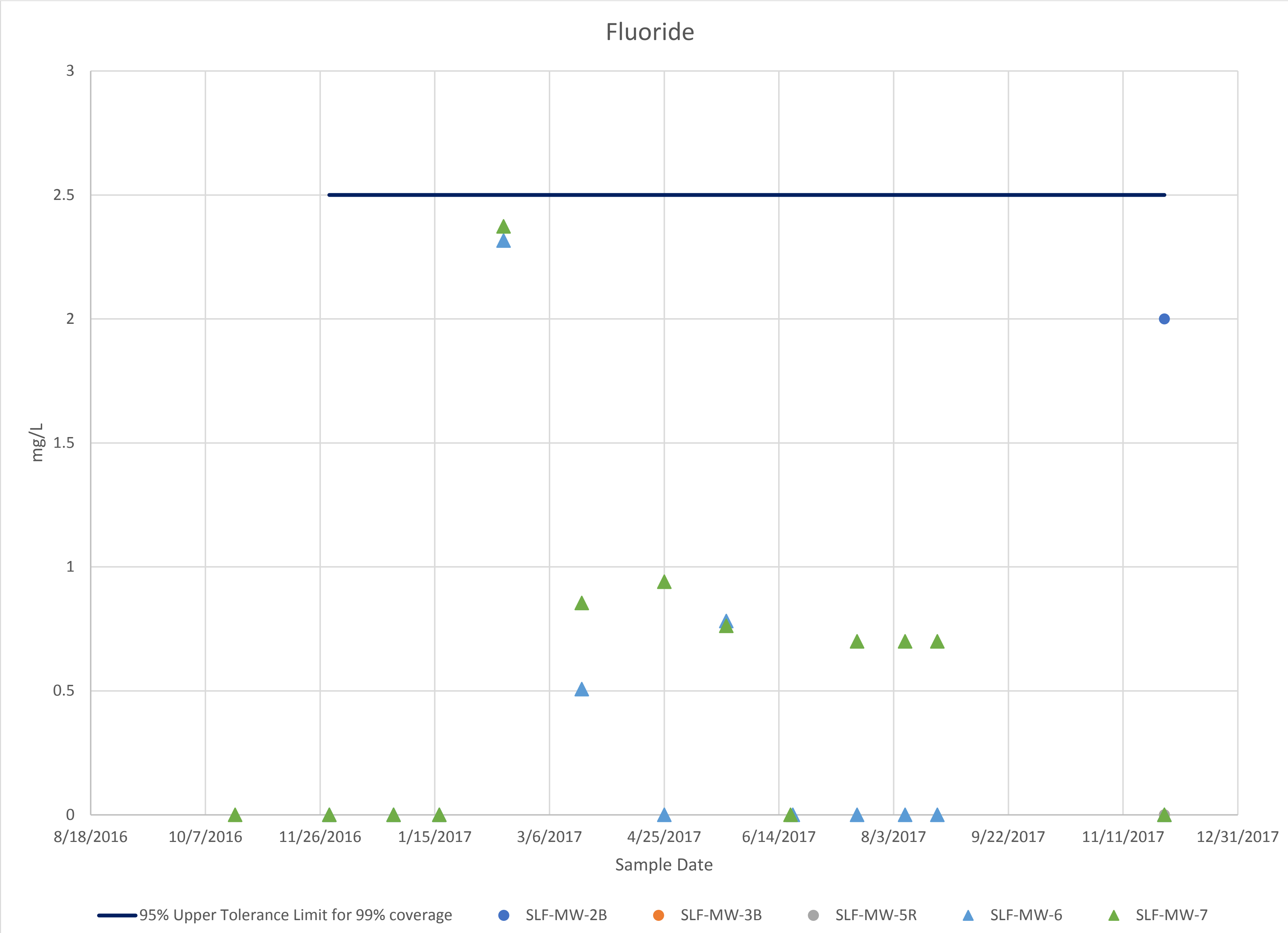
Boron
6000
5000
4000
3000
2000
1000
0
ug/L
8/18/2016
10/7/2016
11/26/2016
1/15/2017
3/6/2017
4/25/2017
6/14/2017
8/3/2017
9/22/2017
11/11/2017
12/31/2017
Sample Date
95% Upper Tolerance Limit for 99% coverage
SLF-MW-2B
SLF-MW-3B
SLF-MW-5R
SLF-MW-6
SLF-MW-7

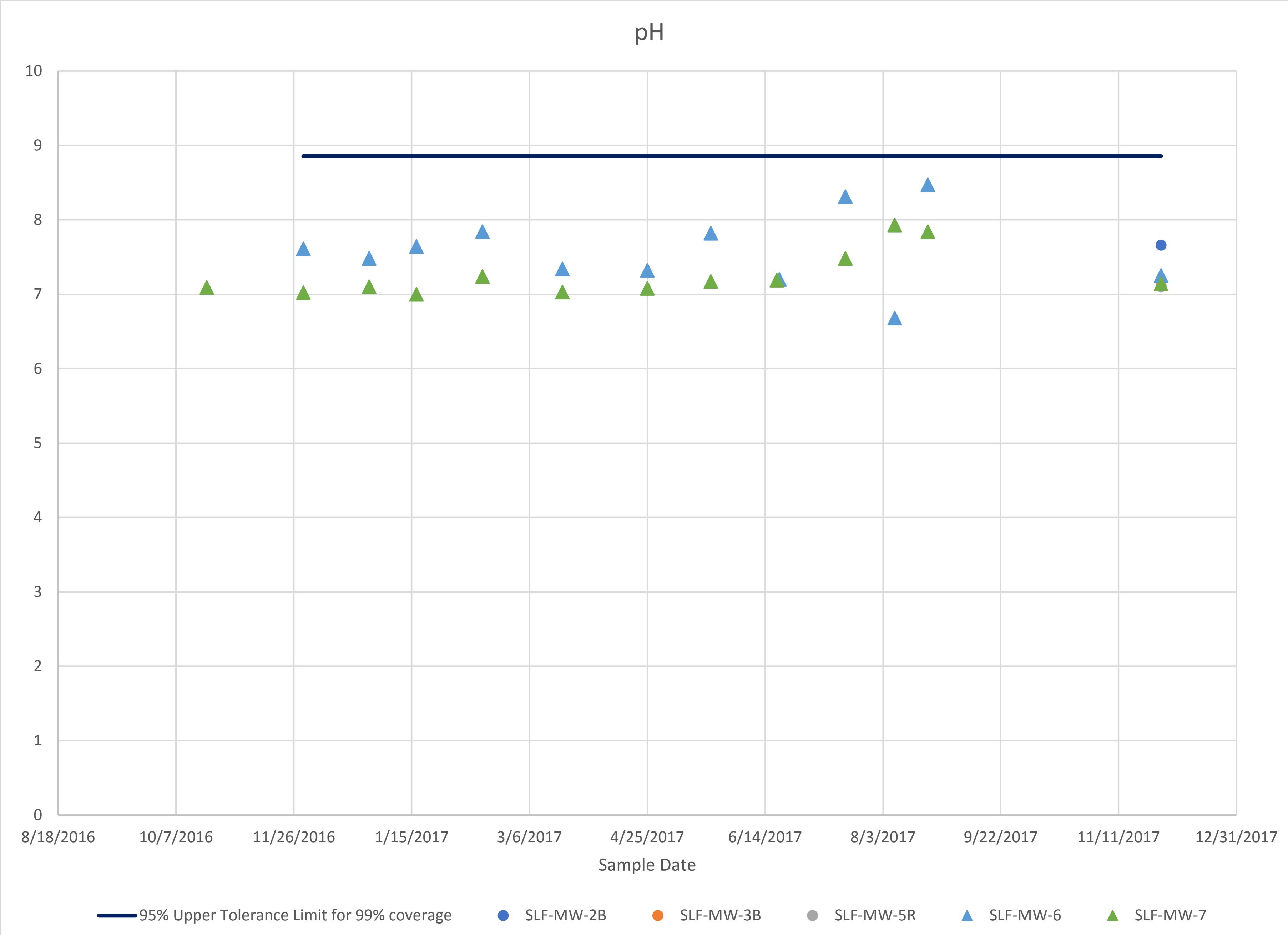


Calcium
1400000
1200000
1000000
800000
600000
400000
200000
0
ug/L
8/18/2016
10/7/2016
11/26/2016
1/15/2017
3/6/2017
4/25/2017
6/14/2017
8/3/2017
9/22/2017
11/11/2017
12/31/2017
Sample Date
95% Upper Tolerance Limit for 99% coverage
SLF-MW-3B
SLF-MW-5R
SLF-MW-2B
SLF-MW-6
SLF-MW-7

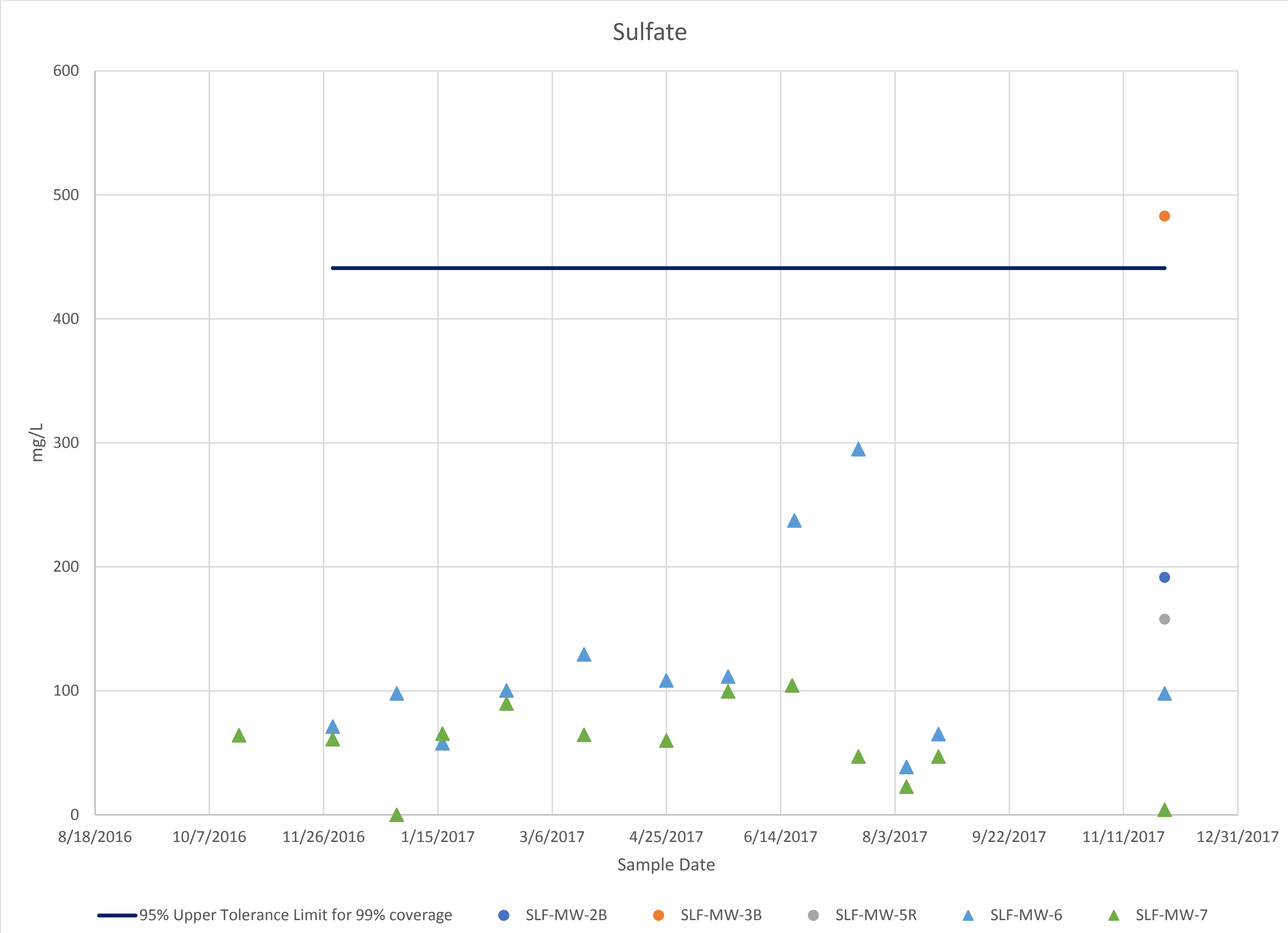


Chloride
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
mg/L
8/18/2016
10/7/2016
11/26/2016
1/15/2017
3/6/2017
4/25/2017
6/14/2017
8/3/2017
9/22/2017
11/11/2017
12/31/2017
Sample Date
95% Upper Tolerance Limit for 99% coverage
SLF-MW-2B
SLF-MW-3B
SLF-MW-5R
SLF-MW-6
SLF-MW-7

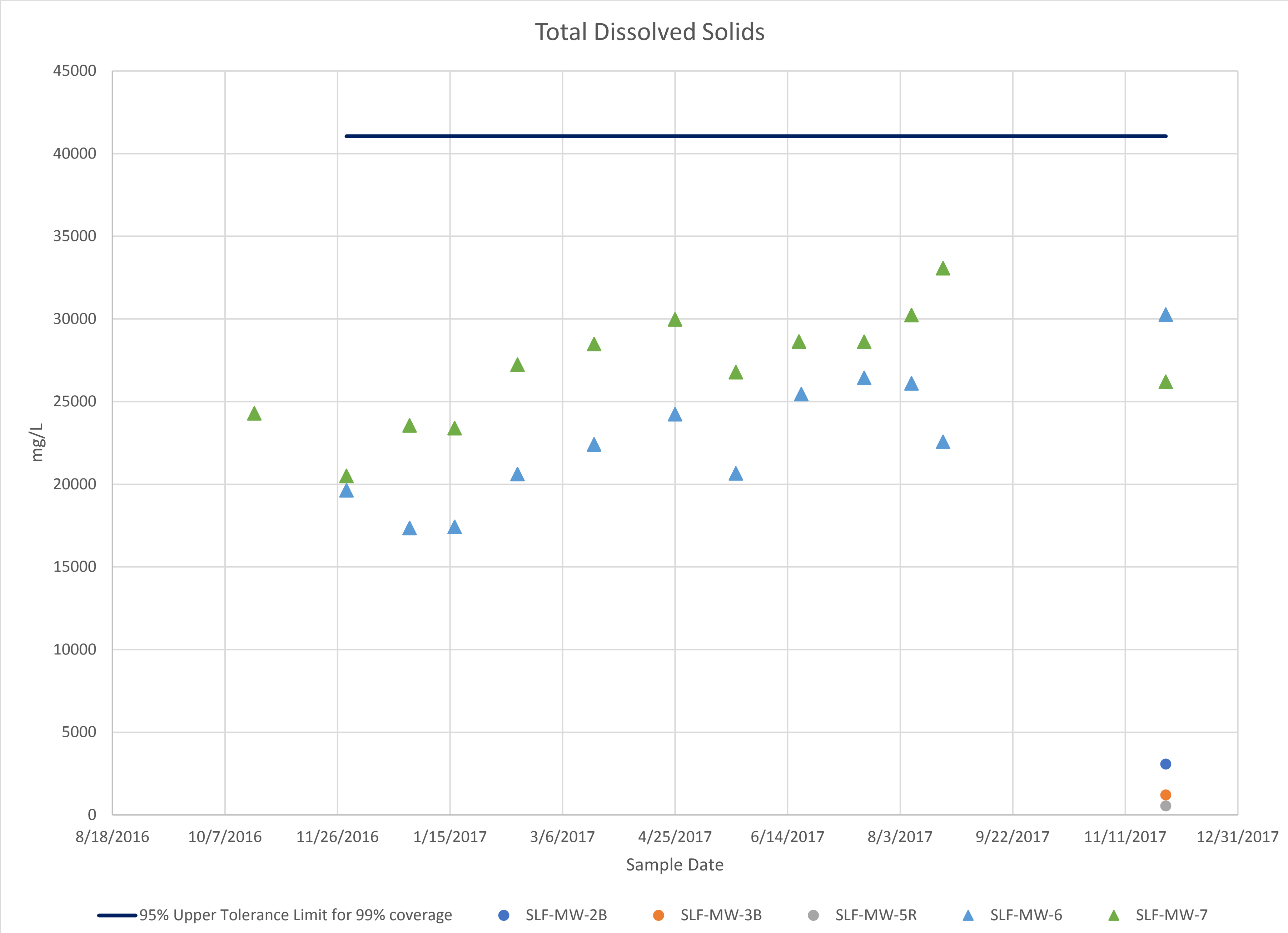

Fluoride
mg/L
3
2.5
2
1.5
1
0.5
0
8/18/2016
10/7/2016
11/26/2016
1/15/2017
3/6/2017
4/25/2017
6/14/2017
8/3/2017
9/22/2017
11/11/2017
12/31/2017
Sample Date
95% Upper Tolerance Limit for 99% coverage
SLF-MW-2B
SLF-MW-3B
SLF-MW-5R
SLF-MW-6
SLF-MW-7



pH
10
9
8
7
6
5
4
3
2
1
0
8/18/2016
10/7/2016
11/26/2016
1/15/2017
3/6/2017
4/25/2017
6/14/2017
8/3/2017
9/22/2017
11/11/2017
12/31/2017
Sample Date
95% Upper Tolerance Limit for 99% coverage
SLF-MW-2B
SLF-MW-3B
SLF-MW-5R
SLF-MW-6
SLF-MW-7



Sulfate
600
500
400
300
200
100
0
mg/L
8/18/2016
10/7/2016
11/26/2016
1/15/2017
3/6/2017
4/25/2017
6/14/2017
8/3/2017
9/22/2017
11/11/2017
12/31/2017
Sample Date
95% Upper Tolerance Limit for 99% coverage
SLF-MW-2B
SLF-MW-3B
SLF-MW-5R
SLF-MW-6
SLF-MW-7


Total Dissolved Solids
mg/L
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
8/18/2016
10/7/2016
11/26/2016
1/15/2017
3/6/2017
4/25/2017
6/14/2017
8/3/2017
9/22/2017
11/11/2017
12/31/2017
Sample Date
95% Upper Tolerance Limit for 99% coverage
SLF-MW-2B
SLF-MW-3B
SLF-MW-5R
SLF-MW-6
SLF-MW-7

APPENDIX E2 – Statistical Analysis Package (May 2018)

HALEY & ALDRICH, INC.
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Cleveland, OH 44131
216.739.0555

22 October 2018
File No. 130592-007

East Kentucky Power Cooperative
4775 Lexington Road
Winchester, KY 40392

Subject: Summary of Appendix III Semi-Annual
Groundwater Detection Monitoring Statistical Evaluation
East Kentucky Power Cooperative
H.L. Spurlock Generating Station Landfill, Maysville, Kentucky

East Kentucky Power Cooperative, Inc. (EKPC) is implementing the 17 April 2015 U.S. Environmental Protection Agency (U.S. EPA) Federal Coal Combustion Residuals (CCR) Rule (40 CFR § 257 and 261) for the H.L. Spurlock Generating Station Landfill, located in Mason County, Kentucky. The CCR Rule establishes requirements for the operation, maintenance and closure of landfills and surface impoundments of CCR.

On 10 July 2018, EKPC provided Haley & Aldrich with groundwater monitoring data collected from a groundwater monitoring system that meets the requirements of 40 CFR §257.91. Background and downgradient locations were defined in the *Groundwater Monitoring System and Hydrogeologic Investigation Report, Spurlock Landfill, H.L. Spurlock Generating Station, Maysville, Kentucky* (Tetra Tech, 10 October 2017). This memorandum summarizes the results of statistical evaluations conducted to determine if Appendix III groundwater monitoring constituents have been detected in downgradient wells are at levels that exhibit a statistically significant increase (SSI) above background or upgradient wells consistent with the requirements in 40 CFR § 257.94. The results presented herein were previously communicated verbally to EKPC on 3 October 2018.

To identify statistically significant increases, data from the most recent groundwater sampling event from the downgradient monitoring wells were compared to the Upper Tolerance Limit (UTL) calculated from the background data from upgradient wells for the Appendix III constituents (boron, calcium, chloride, fluoride, pH, sulfate, and total dissolved solids). Based on these comparisons, the statistical results identify at least one Appendix III SSI above background concentrations. The results of the groundwater detection monitoring evaluation are provided below.

Statistical Evaluation of Appendix III Constituents

The Rule, 40 CFR §257.93(f) (1-4), provides four specific options to statistically evaluate whether water quality downgradient of the CCR Unit represents an SSI of Appendix III parameters compared to background water quality of the CCR Unit. The Upper Tolerance Limit (UTL) was used to evaluate potential SSIs as specified in the certification statement of 17 October 2017. A 95% Upper Tolerance Limit for 99% coverage was calculated to compare to downgradient groundwater analytical results for this evaluation.

UTL STATISTICAL ANALYSIS

The UTL is an accepted statistical method identified in the CCR Rule to evaluate the groundwater analytical data at CCR Units. A tolerance interval is a concentration range, with some confidence level, designed to contain a pre-specified proportion (e.g., 99 percent) of the underlying population from which the statistical sample is drawn (background). The upper endpoint of a tolerance interval is called the upper tolerance limit or UTL. Depending on the assumed distribution of the background, parametric or non-parametric procedures were used to develop the UTL. Parametric tolerance limits utilize assumed distributions of the sample background data to develop the UTL, and non-parametric limits utilize order statistics or bootstrap methods to develop the UTL. The UTL was calculated using the U.S. EPA's ProUCL 5.1 from the background well data after testing for outlier sample results that would warrant removal from the dataset based on likely error in sampling or measurement. Both visual and statistical outlier tests for the background data were performed using ProUCL, and a visual inspection of the data was performed for the downgradient sample data. Except as noted below, no sample data were deemed as outliers that warranted removal from the dataset.

BACKGROUND DISTRIBUTIONS AND UTLS

The groundwater analytical results from the two background monitoring wells (SLF-MW-6 and SLF-MW-7) were combined to calculate the 95% UTL with 99% coverage. The variability and distribution of the pooled dataset was evaluated to determine the method for UTL calculation. Samples from background locations were collected from 20 October 2016 through 29 November 2017 (Table 1). The development of the UTL for each of the Appendix III constituents is summarized in Table 1 and discussed below. Appendix III parameters are graphed in Attachment 1. Supporting statistical software output is included in Attachment 2.

Boron

Based on graphical data distribution and results of the goodness of fit testing (Attachment 2), a non-parametric distribution was used for the calculation of the UTL for boron. The non-parametric UTL with 99% coverage for boron is 5,464 ug/L (Attachment 2).

Calcium

Based on graphical data distribution with an apparent left skew and results of goodness of fit testing (Attachment 2), a gamma distribution was used for calculation of the UTL. The 95% UTL with 99% coverage for calcium is 1,250,847 ug/L (Attachment 2).

Chloride

The groundwater analytical result for chloride from MW-7 collected on 20 October 2016 is considered an outlier and potential transcription error and was not used in the UTL calculation. The determination of a statistical increase is the same with or without this sample result included. Based on the graphical data distribution and results of goodness of fit testing (Attachment 2), a normal distribution was used for calculation of the UTL. The 95% UTL with 99% coverage for chloride is 18,841 mg/L (Attachment 2).

Fluoride

Based on the low frequency of detection (Table 1), graphical data distribution and results of goodness of fit testing (Attachment 2), a non-parametric distribution was used for calculation of the UTL. The non-parametric UTL with 99% coverage for fluoride is 2.5 mg/L (Attachment 2).

pH

Based on the graphical data distribution and results of goodness of fit testing (Attachment 2), a lognormal distribution was used for calculation of the UTL. The 95% UTL with 99% coverage for pH is 8.855 (Attachment 2).

Sulfate

Based on the graphical data distribution and results of goodness of fit testing (Attachment 2), a gamma distribution was used for calculation of the UTL. The 95% UTL with 99% coverage for sulfate is 441 mg/L (Attachment 2).

Total Dissolved Solids

Based on the graphical data distribution and results of goodness of fit testing (Attachment 2), a gamma distribution was used for calculation of the UTL. The 95% UTL with 99% coverage for total dissolved solids is 41052 mg/L (Attachment 2).

RESULTS OF APPENDIX III DOWNGRADIENT STATISTICAL COMPARISONS

The sample concentrations at the downgradient wells for each of the Appendix III constituents from the May 2018 detection monitoring sampling event were compared to their respective UTLs. A sample concentration greater than the UTL is considered to represent a statistically significant increase. Based on these comparisons, the statistically significant increase(s) over background are:

- SLF-MW-3B sample exceeded the UTL for sulfate.

We appreciate the opportunity to provide environmental consulting services on this project. Please do not hesitate to call if you have any questions or comments.

Sincerely,
HALEY & ALDRICH, INC.

Lloyd S. Ross
Senior Scientist

Enclosures:
Table 1. Summary of Background Sample Results and Comparison of Downgradient Sample Results
Attachment 1. Appendix III Time Series Graphs
Attachment 2. Statistical Output

TABLE

TABLE 1

SUMMARY OF BACKGROUND SAMPLE RESULTS AND COMPARISON OF DOWNGRADIENT SAMPLE RESULTS

SPURLOCK GENERATING STATION LANDFILL

MAYSVILLE, KENTUCKY

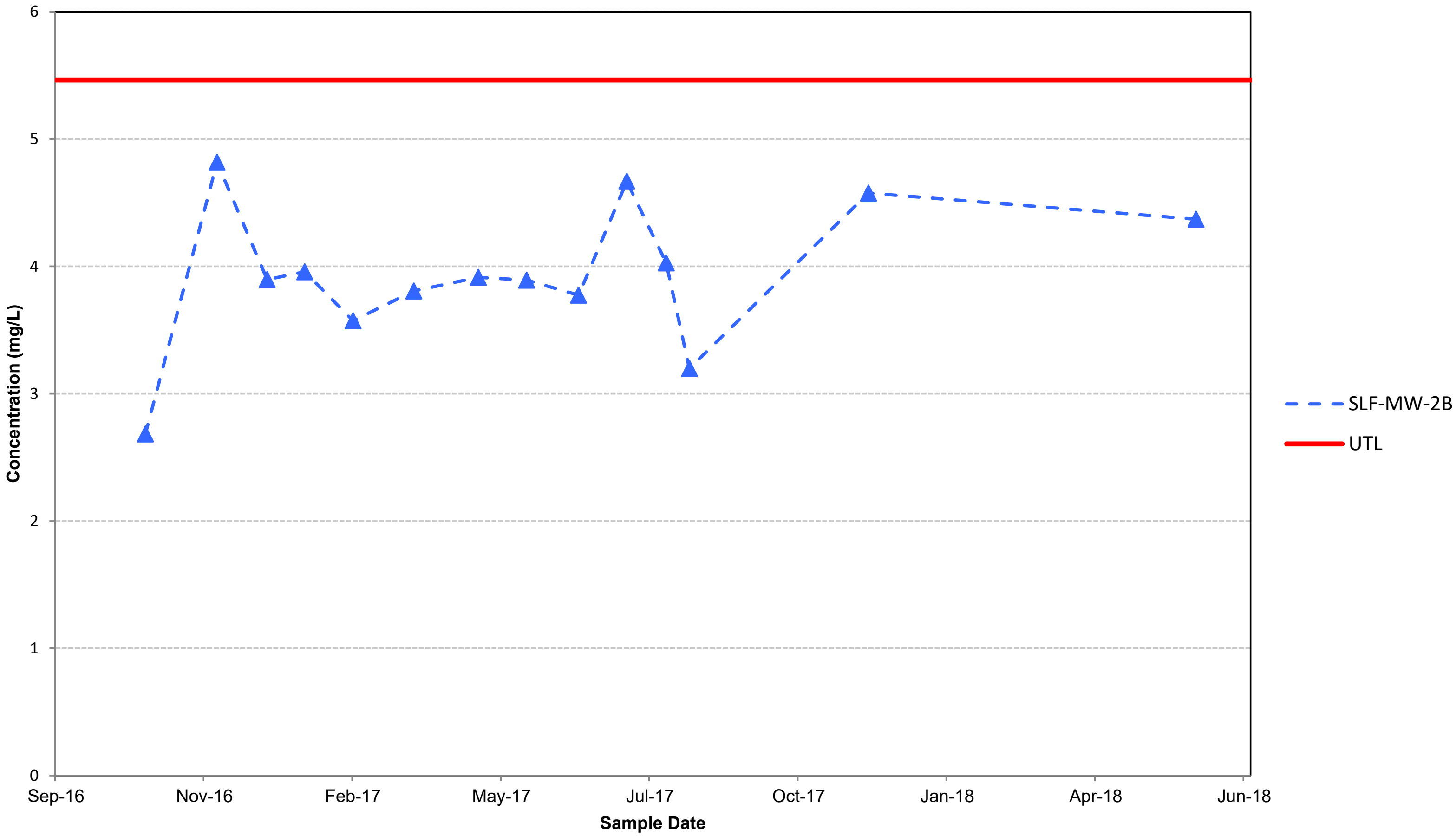
Background Well	Sample Date	Boron (ug/L)	Calcium (ug/L)	Chloride (mg/L)	Fluoride (mg/L)	pH	Sulfate (mg/L)	Total Dissolved Solids (mg/L)
SLF-MW-6	11/30/2016	1634.33	367433	15695.1	ND (< 1)	7.61	71.2993	19640
SLF-MW-6	12/28/2016	1628.04	390089	10367	ND (< 0.5)	7.48	97.9	17360
SLF-MW-6	1/17/2017	1558.49	289437	9962.47	ND (< 2.5)	7.64	57.7945	17420
SLF-MW-6	2/14/2017	1225.35	363980	10629.4	2.3161	7.84	100.277	20620
SLF-MW-6	3/20/2017	1330.47	239494	11189.9	0.5073	7.34	129.498	22420
SLF-MW-6	4/25/2017	1510.69	450493	11191.7	ND (< 0.5)	7.32	108.462	24240
SLF-MW-6	5/22/2017	1384.59	398635	10905	0.7815	7.82	111.552	20660
SLF-MW-6	6/20/2017	1572.54	516978	11652.1	ND (< 0.5)	7.2	237.465	25460
SLF-MW-6	7/18/2017	1558	561449	12486	ND (< 0.5)	8.31	295	26440
SLF-MW-6	8/8/2017	1593	675251	18877	ND (< 0.5)	6.68	38.5	26100
SLF-MW-6	8/22/2017	1804	798246	16817	ND (< 0.5)	8.47	65.2	22566.7
SLF-MW-6	11/29/2017	1970	1022530	16285	ND (< 0.5)	7.25	97.9	30260
SLF-MW-7	10/20/2016	2730.18	380241	1548.06 [A]	ND (< 0.5)	7.09	64.2535	24300
SLF-MW-7	11/30/2016	4462.57	582396	14651.3	ND (< 0.5)	7.02	61.0442	20500
SLF-MW-7	12/28/2016	4635.55	723046	14099	ND (< 0.5)	7.1	55.716	23566.7
SLF-MW-7	1/17/2017	4953.83	536189	14482.3	ND (< 0.5)	7	65.5636	23400
SLF-MW-7	2/14/2017	3563.48	580195	14298.7	2.3737	7.24	89.8117	27233
SLF-MW-7	3/20/2017	4023.47	311304	14446.8	0.855	7.03	64.6524	28480
SLF-MW-7	4/25/2017	4699.06	559928	14560	0.9404	7.08	59.9715	29980
SLF-MW-7	5/22/2017	3931.94	538847	13191.3	0.7626	7.17	99.5501	26780
SLF-MW-7	6/19/2017	5463.53	580485	14471.8	ND (< 0.5)	7.19	104.377	28640
SLF-MW-7	7/18/2017	4180	568243	14203	0.7	7.48	47	28620
SLF-MW-7	8/8/2017	4756	515124	14166	0.7	7.93	22.7	30233.3
SLF-MW-7	8/22/2017	4575	527797	15101	0.7	7.84	47.1	33066.7
SLF-MW-7	11/29/2017	5435	563176	14520	ND (< 0.5)	7.14	4.1	26200
Assumed Data Distribution for Calculation of UTL		Non-Parametric	Gamma	Normal	Non-Parametric	Lognormal	Gamma	Gamma
95% Upper Tolerance Limit for 99% coverage*		5464	1250847	18841	2.5	8.855	441	41052
Minimum Detection		1225	239494	9962 [A]	0.507	6.68	4.1	17360
Maximum Detection		5464	1022530	18877	2.374	8.47	295	33067
Frequency of Detection		100%	100%	100%	40%	100%	100%	100%
Downgradient Well	**Sample Date**	**Boron (ug/L)**	**Calcium (ug/L)**	**Chloride (mg/L)**	**Fluoride (mg/L)**	**pH**	**Sulfate (mg/L)**	**Total Dissolved Solids (mg/L)**
SLF-MW-2B	5/31/2018	4370	44100	1870	2.2	7.56	200	3910
SLF-MW-3B	5/30/2018	2650	171000	179	ND (< 0.5)	7.09	454	1210
SLF-MW-5R	5/30/2018	517	118000	25.5	ND (< 0.5)	6.94	158	591

Notes and Abbreviations:

1. ND: Not Detected at concentrations greater than specified reporting limit.
2. Shaded downgradient result is a statistically significant increase based on comparison to calculated UTL.
3. Chloride results from MW-7 collected on 10/20/2016 is considered an outlier and likely transcription error and was not used in UTL calculation. Statisical comparison is same with our without sample result.

ATTACHMENT 1

Appendix III Time Series Graphs



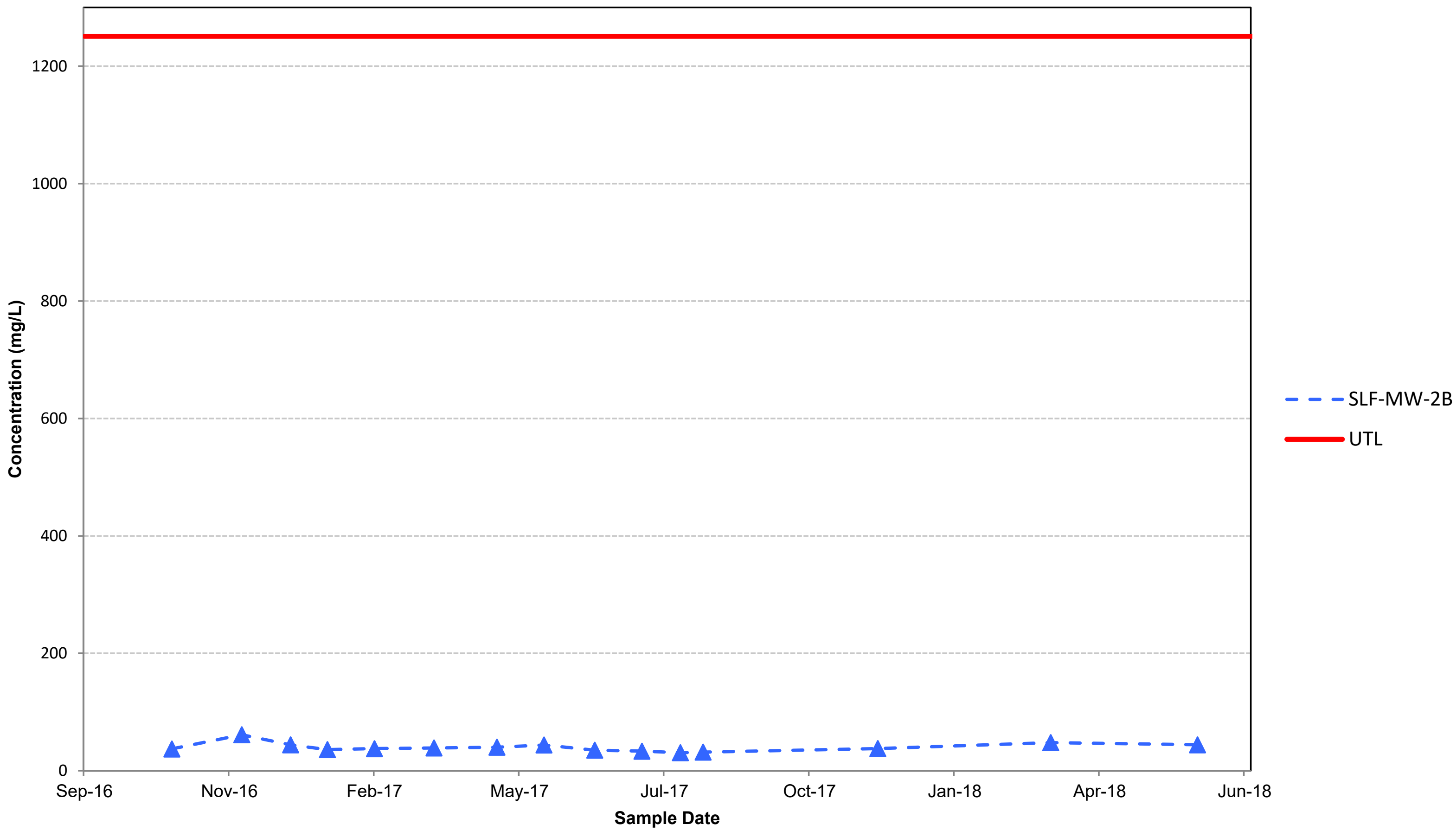
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

BORON
CONCENTRATION VS. TIME

October 2018 **Figure F-1**



NOTES:

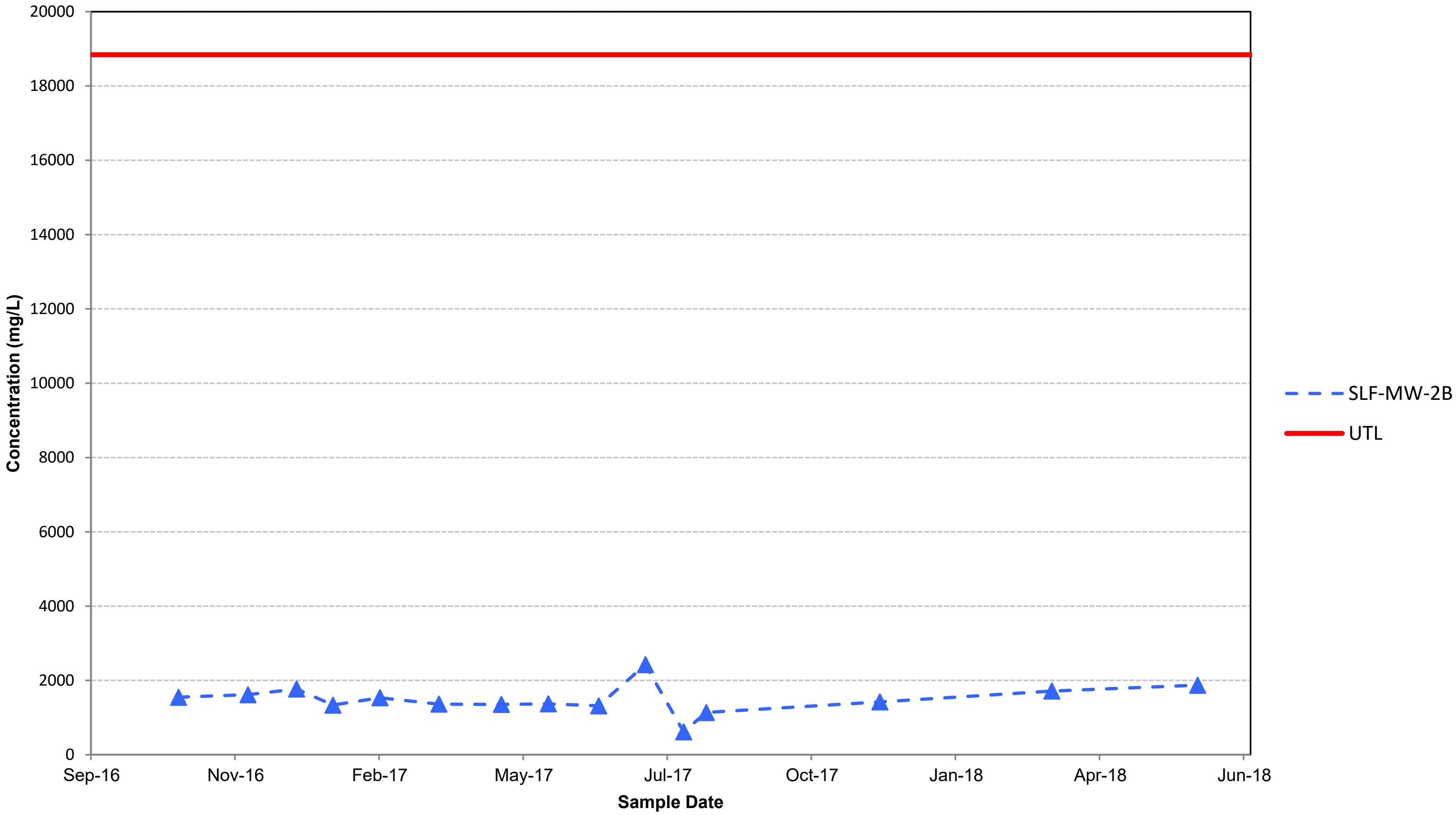
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CALCIUM
CONCENTRATION VS. TIME

October 2018 **Figure F-2**



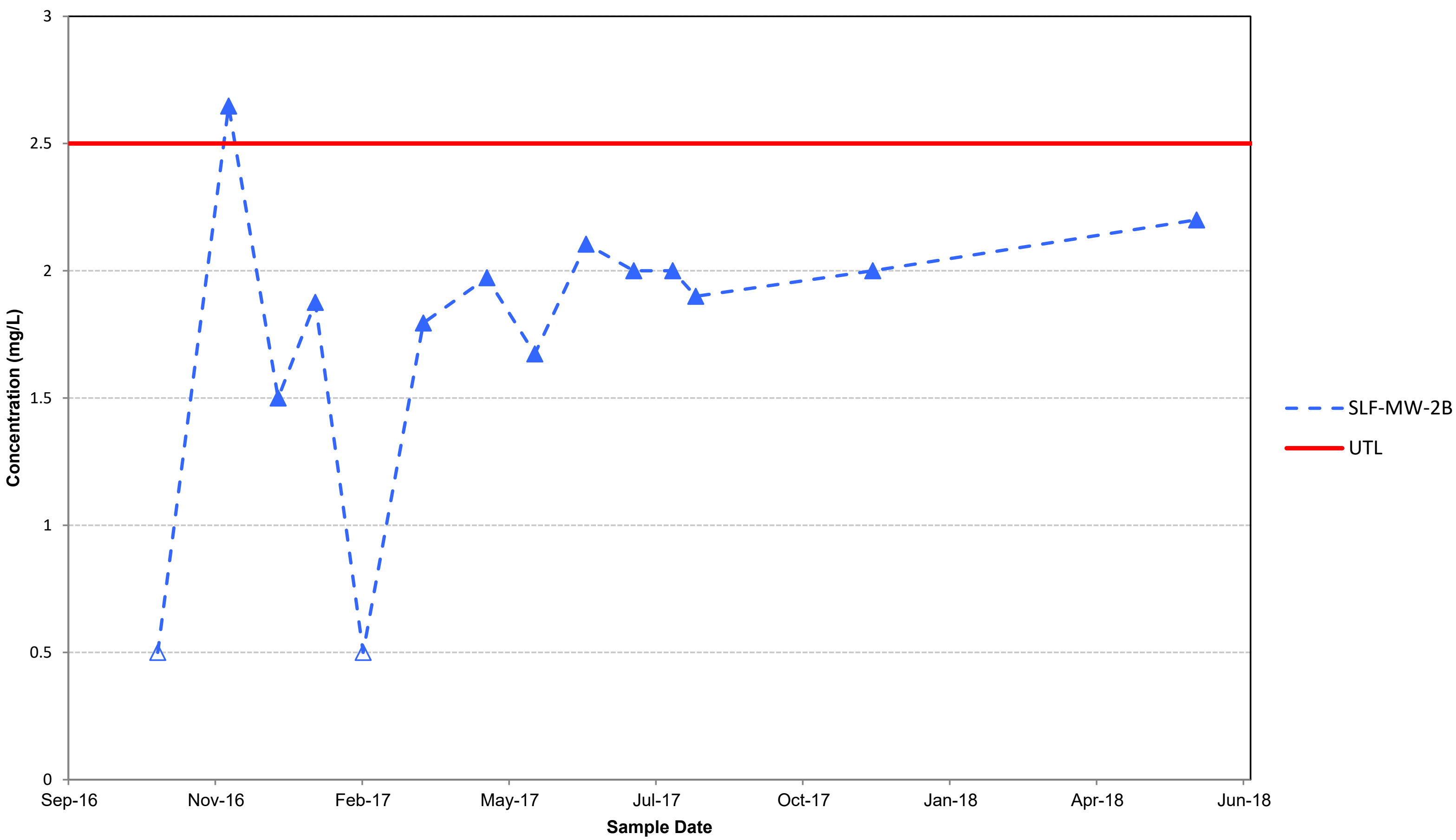
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CHLORIDE
CONCENTRATION VS. TIME

October 2018 **Figure F-3**



NOTES:

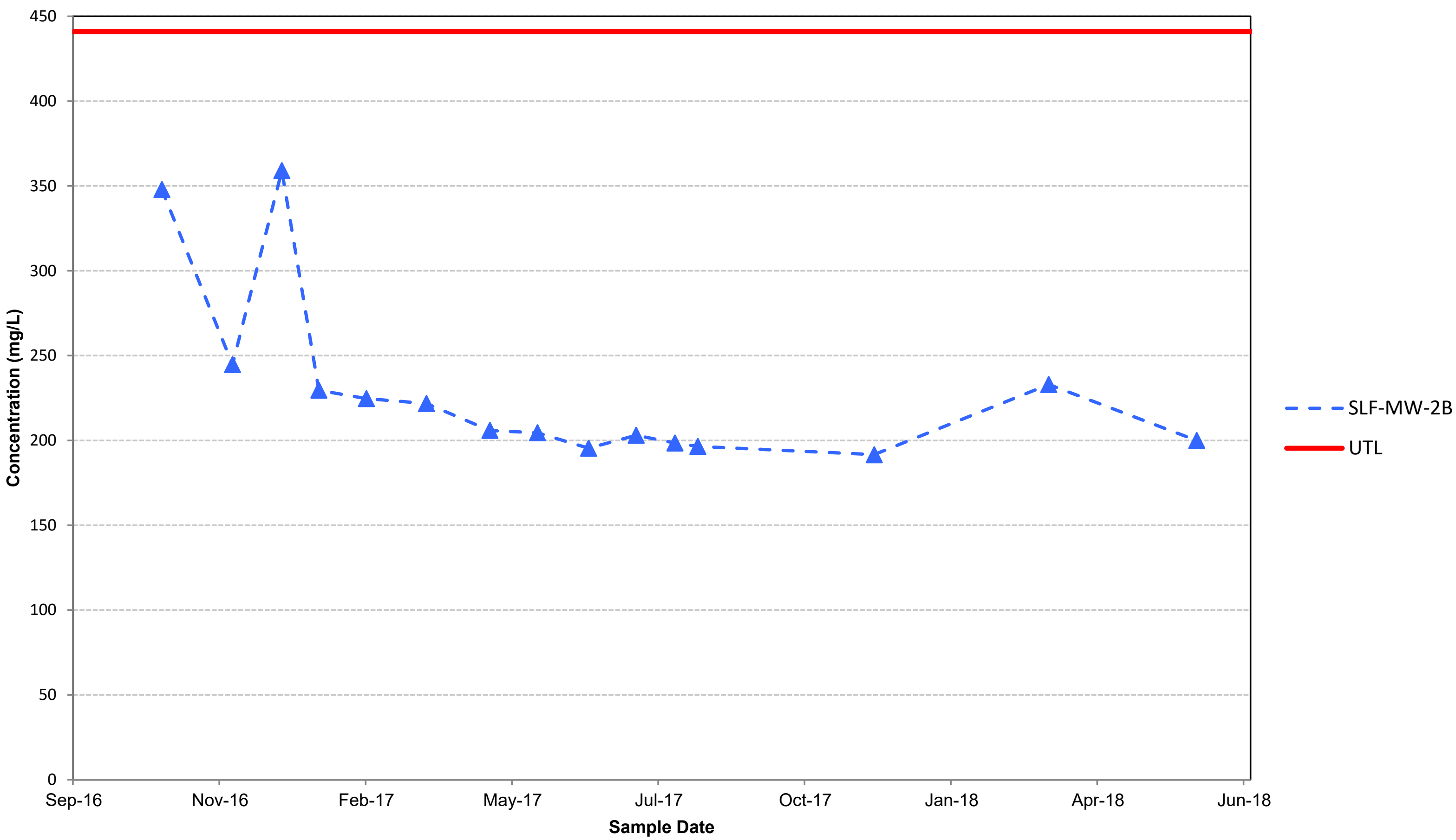
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

FLUORIDE
CONCENTRATION VS. TIME

October 2018 **Figure F-4**



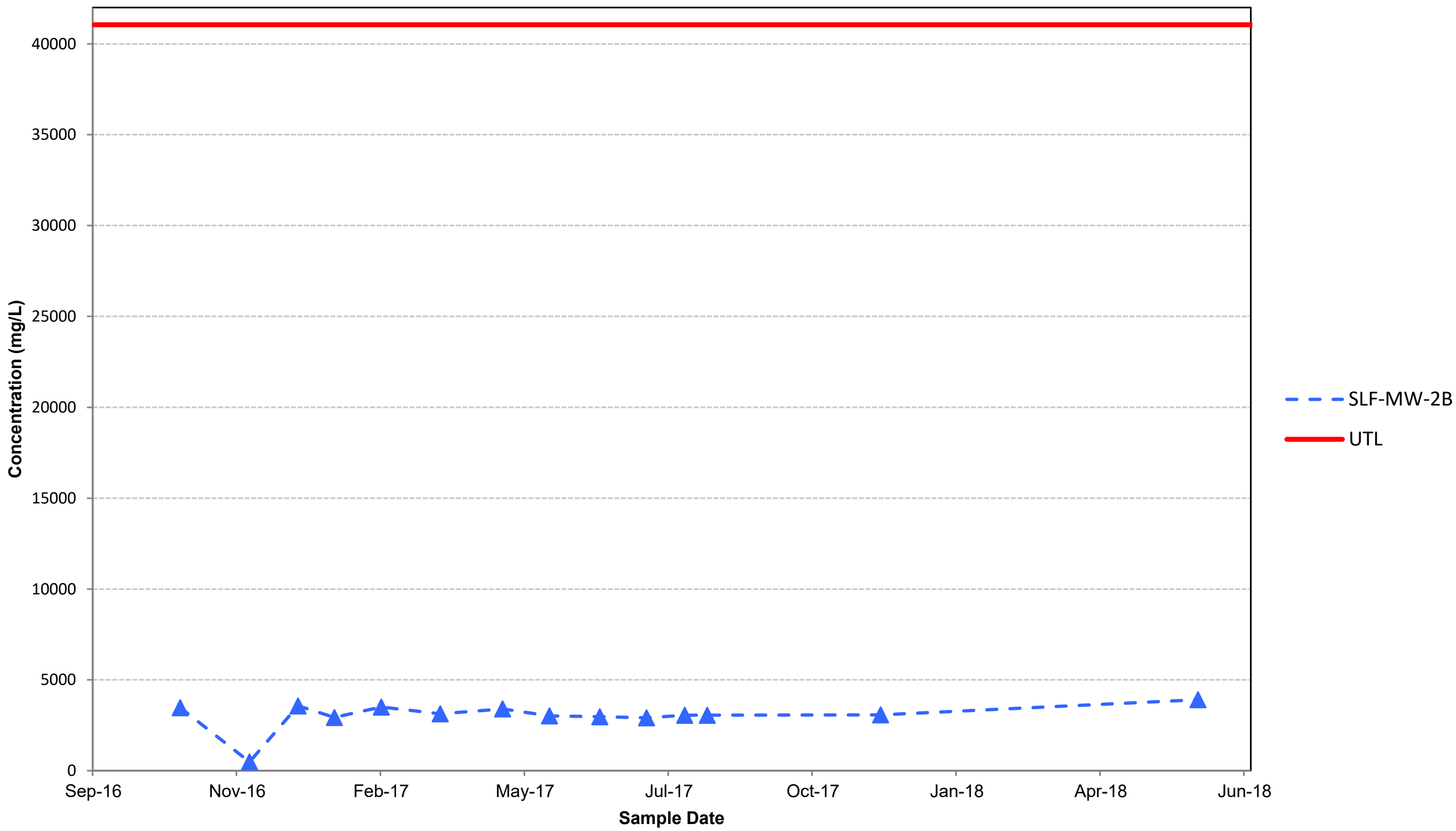
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

SULFATE
CONCENTRATION VS. TIME

October 2018 **Figure F-5**



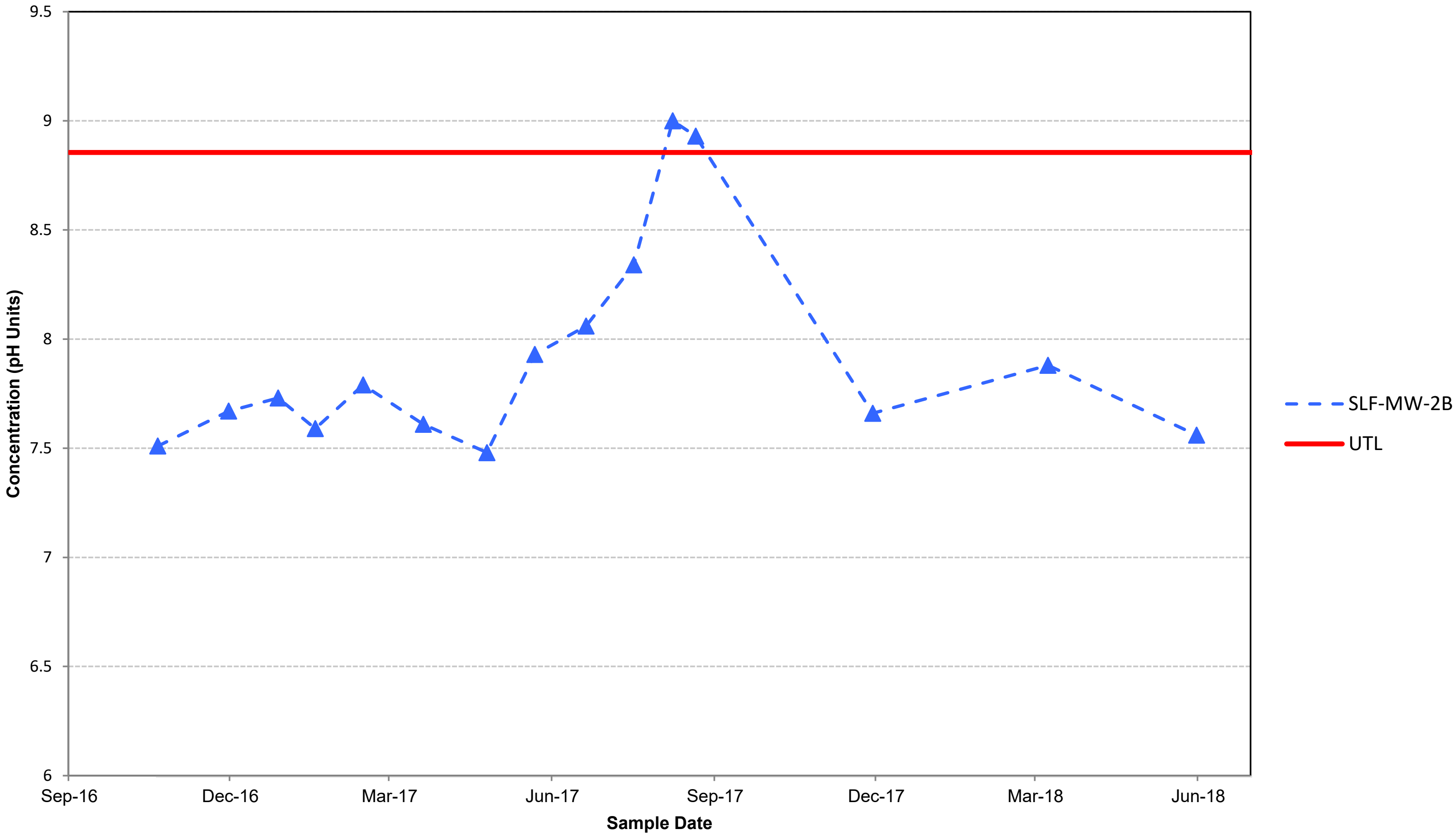
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION VS. TIME

October 2018 **Figure F-6**



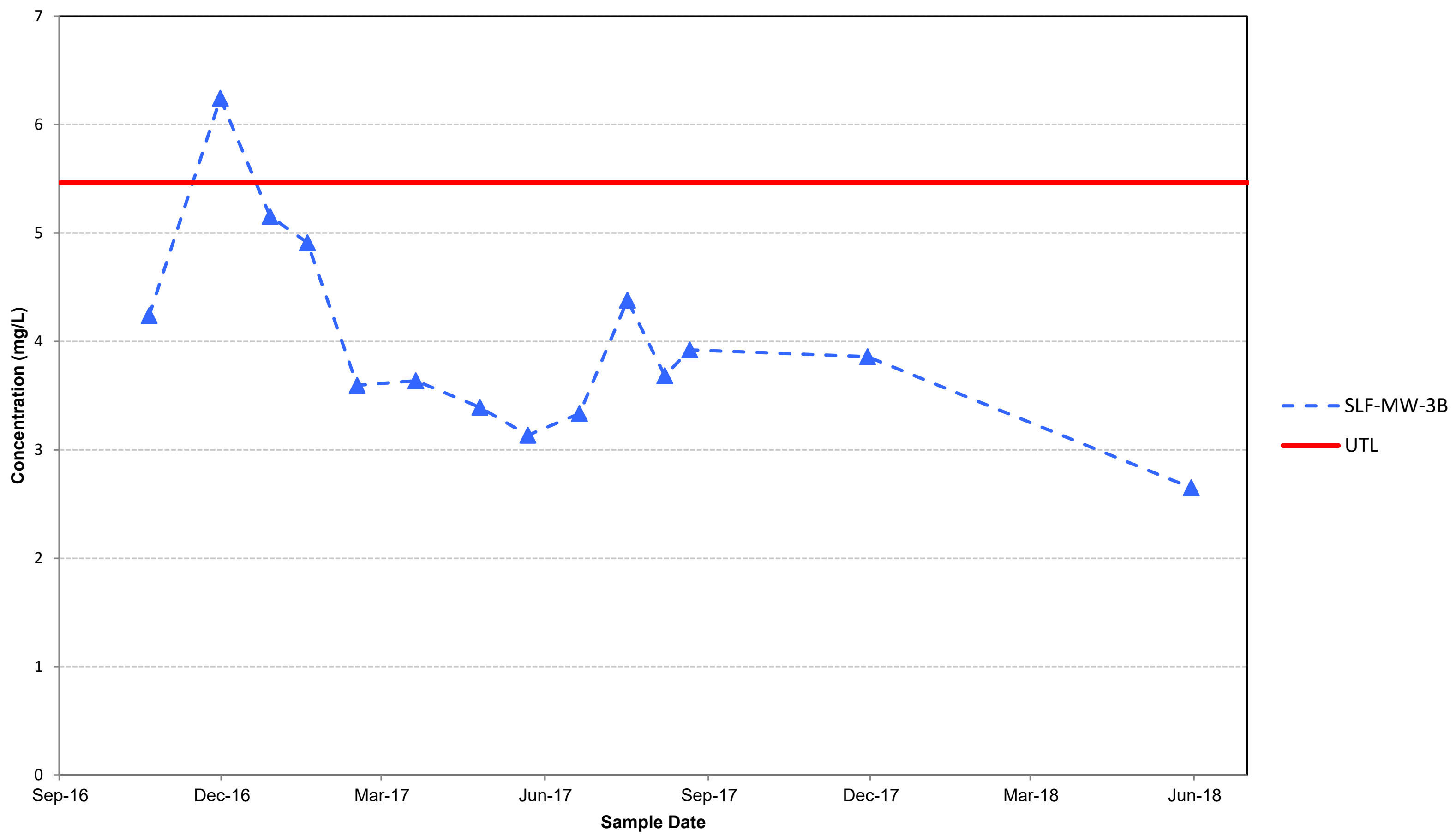
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

PH, FIELD
CONCENTRATION VS. TIME

October 2018 **Figure F-7**



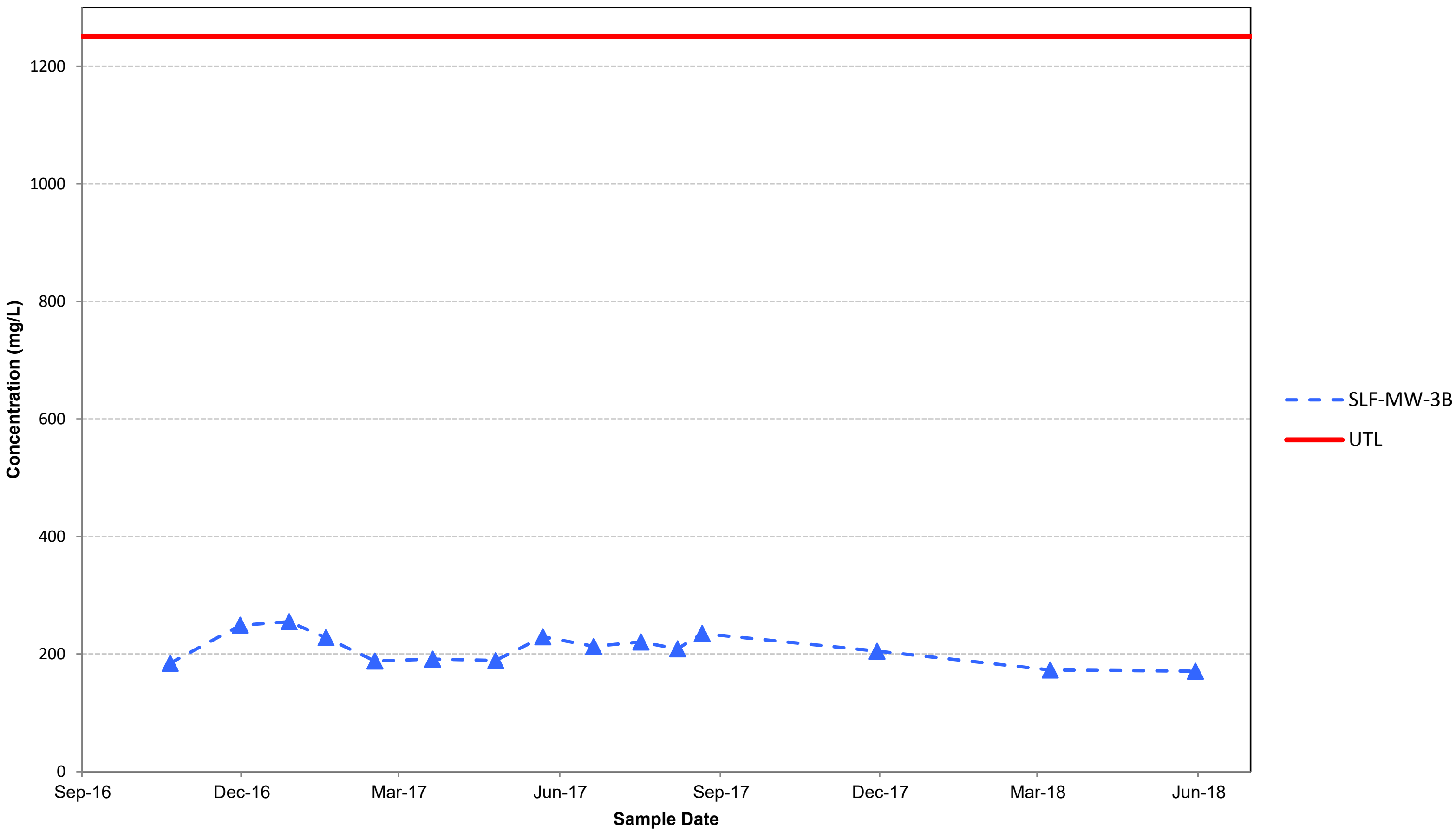
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

BORON
CONCENTRATION VS. TIME

October 2018 **Figure F-8**



NOTES:

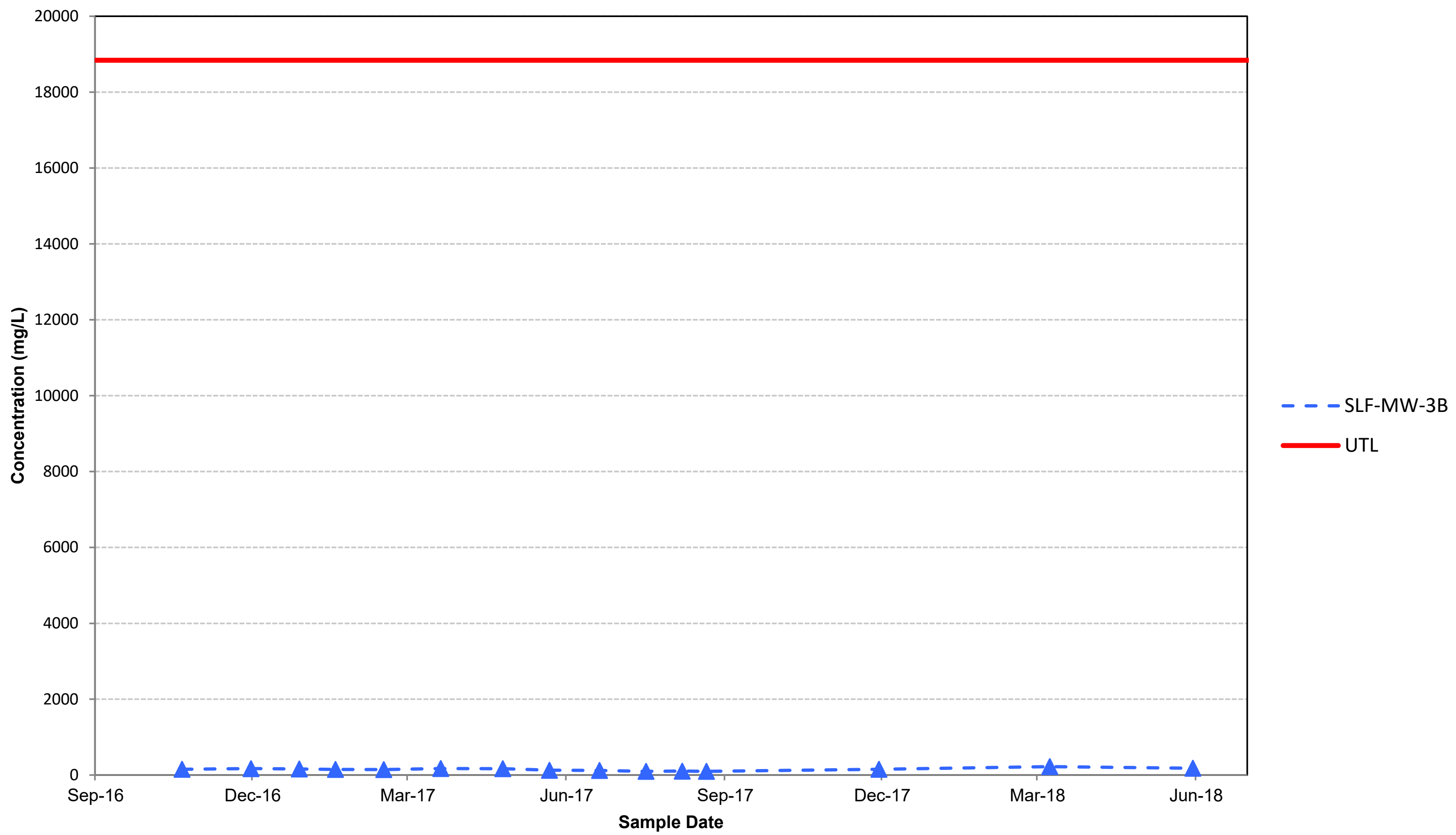
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CALCIUM
CONCENTRATION VS. TIME

October 2018 **Figure F-9**



NOTES:

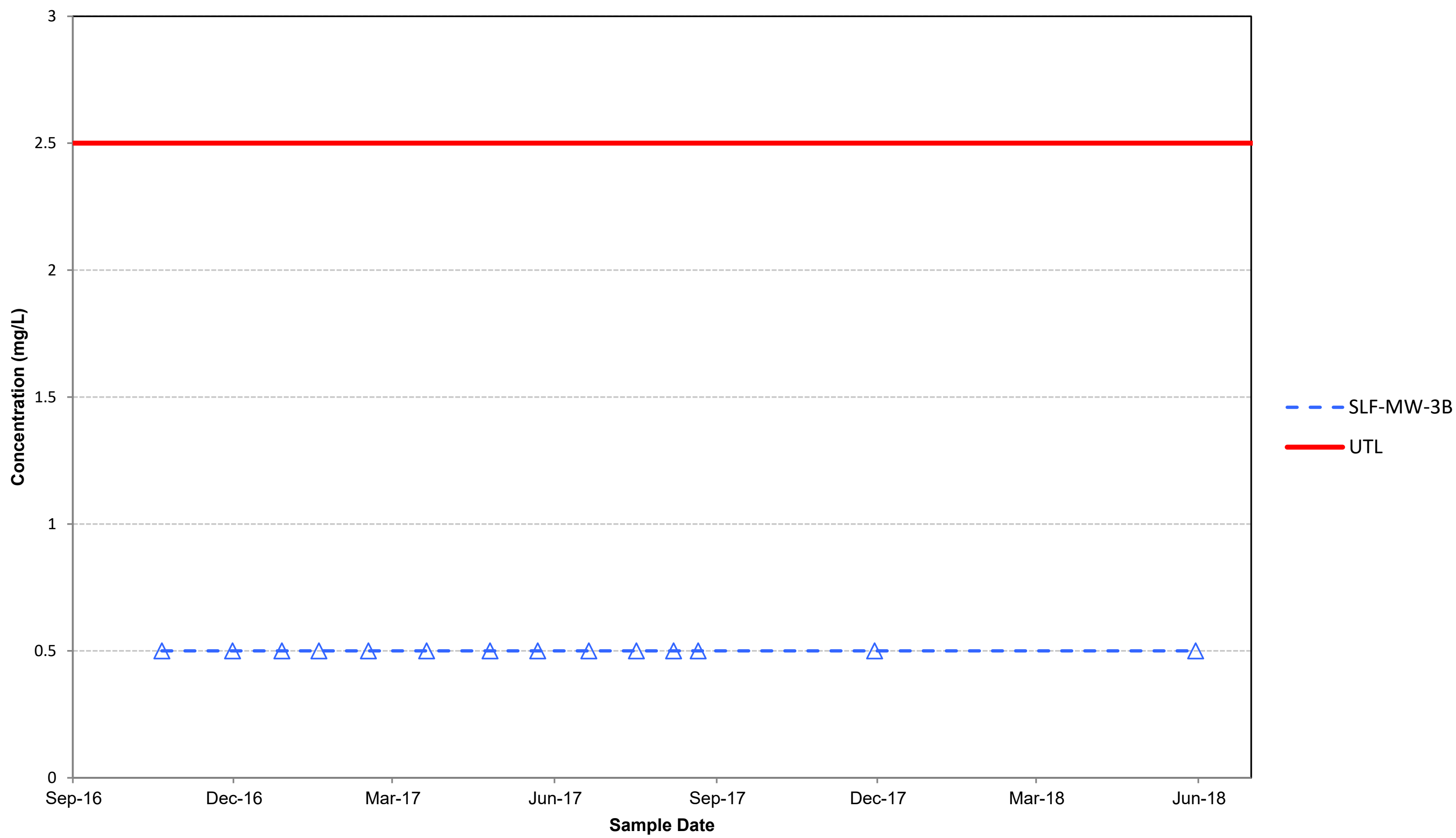
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CHLORIDE
CONCENTRATION VS. TIME

October 2018 **Figure F-10**



NOTES:
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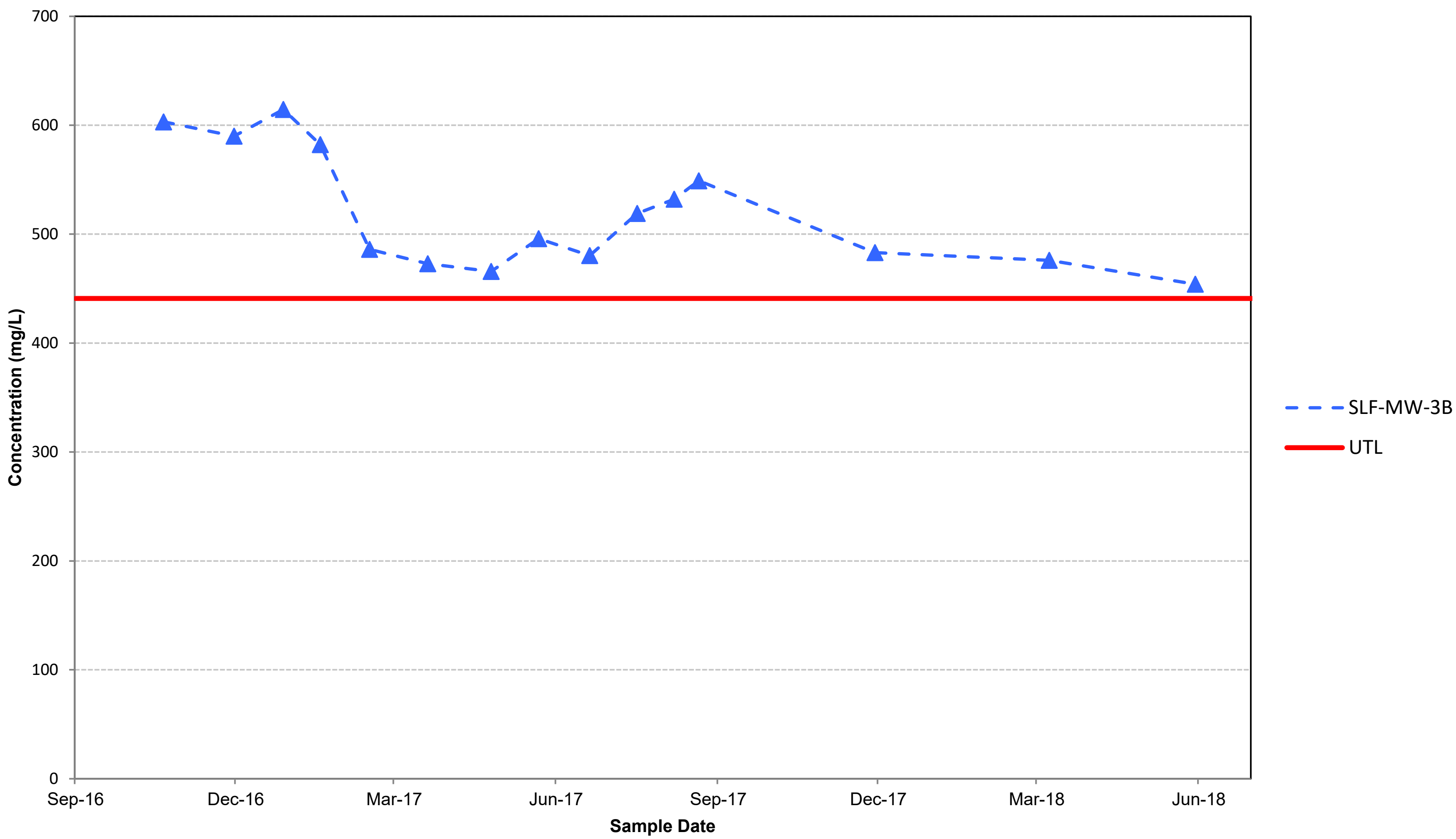
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

FLUORIDE
CONCENTRATION VS. TIME

October 2018 **Figure F-11**



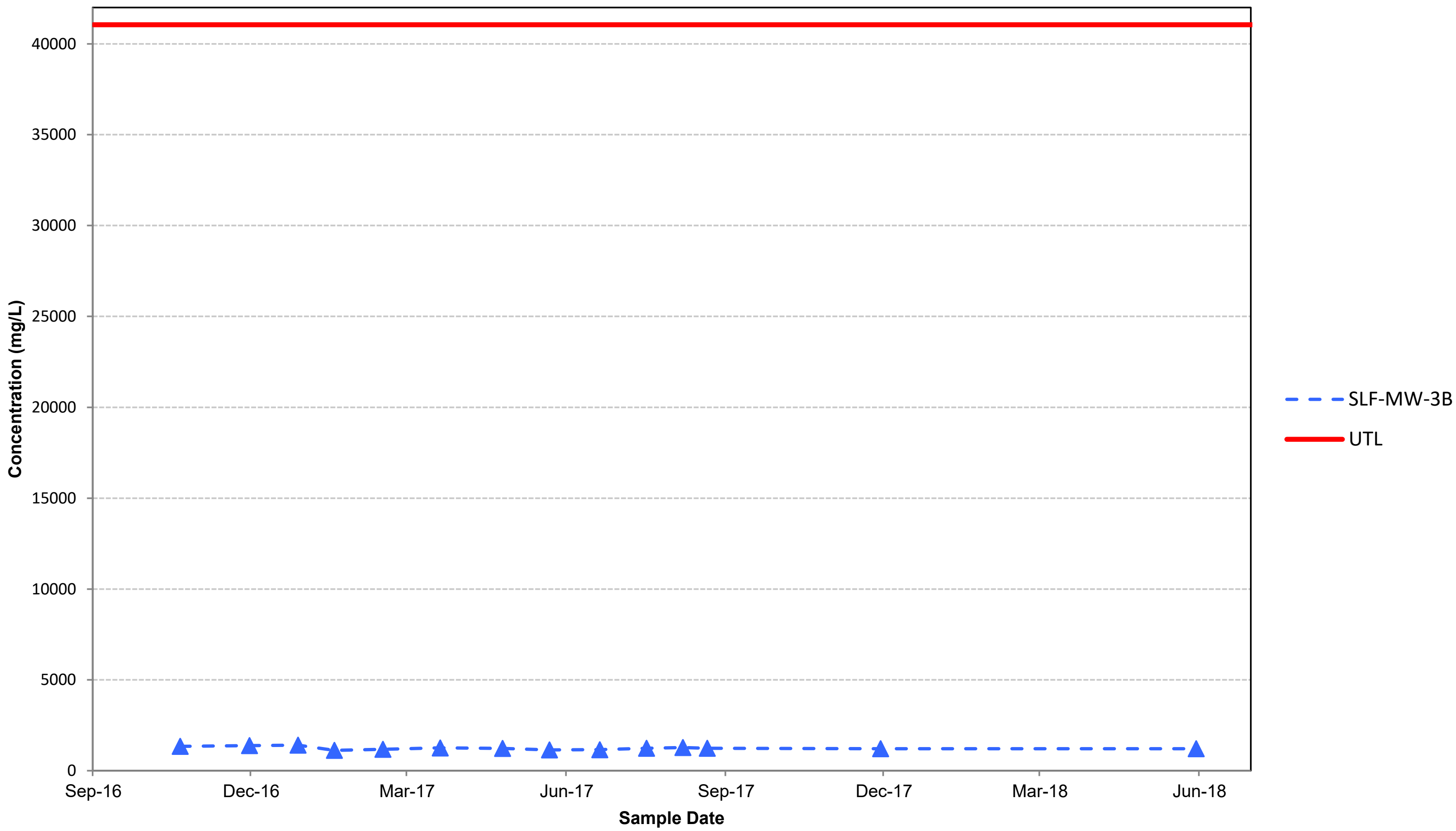
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

SULFATE
CONCENTRATION VS. TIME

October 2018 **Figure F-12**



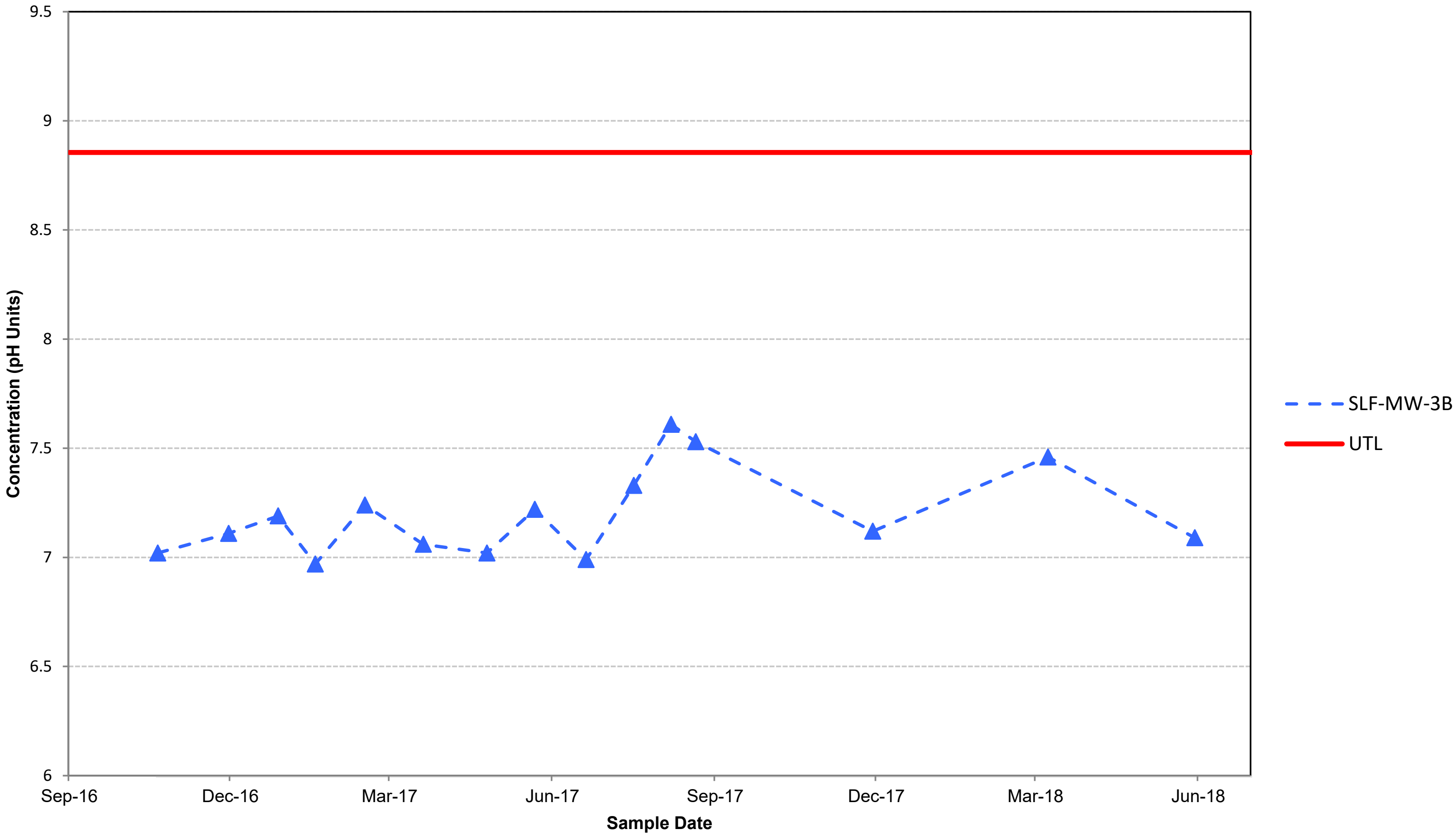
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION VS. TIME

October 2018 **Figure F-13**



NOTES:

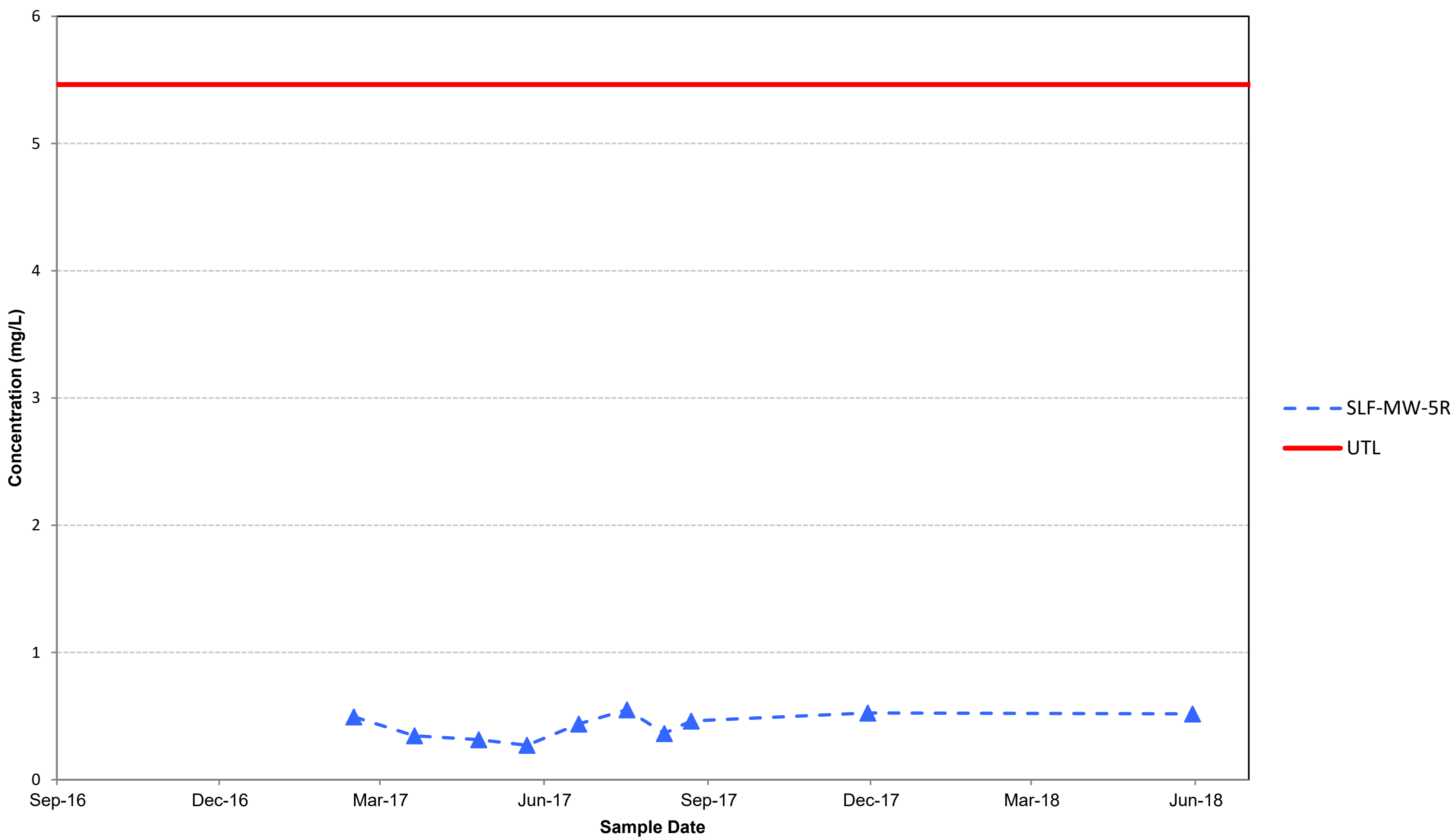
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

PH, FIELD
CONCENTRATION VS. TIME

October 2018 **Figure F-14**



NOTES:
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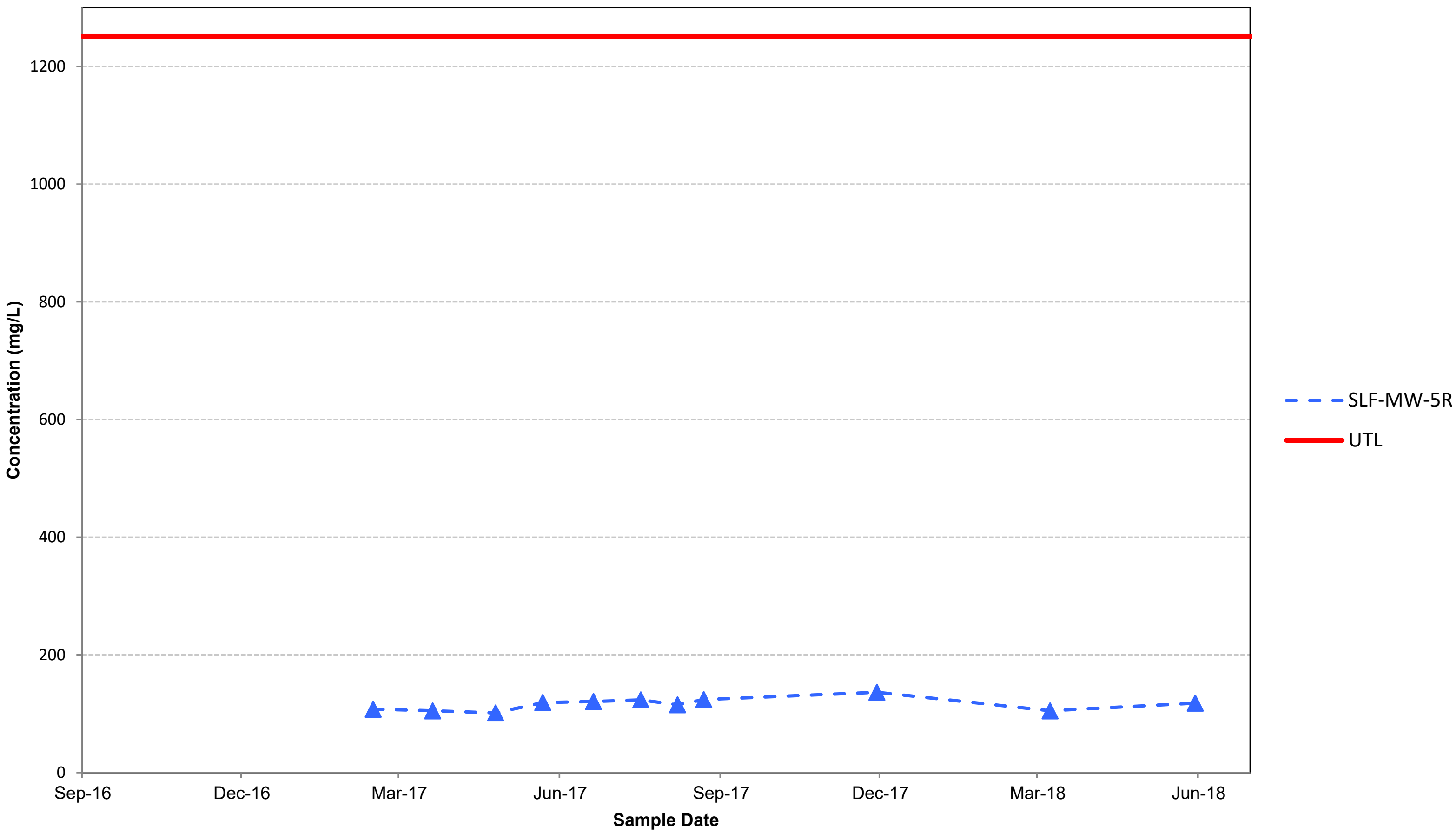
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

BORON
CONCENTRATION VS. TIME

October 2018 **Figure F-15**



NOTES:

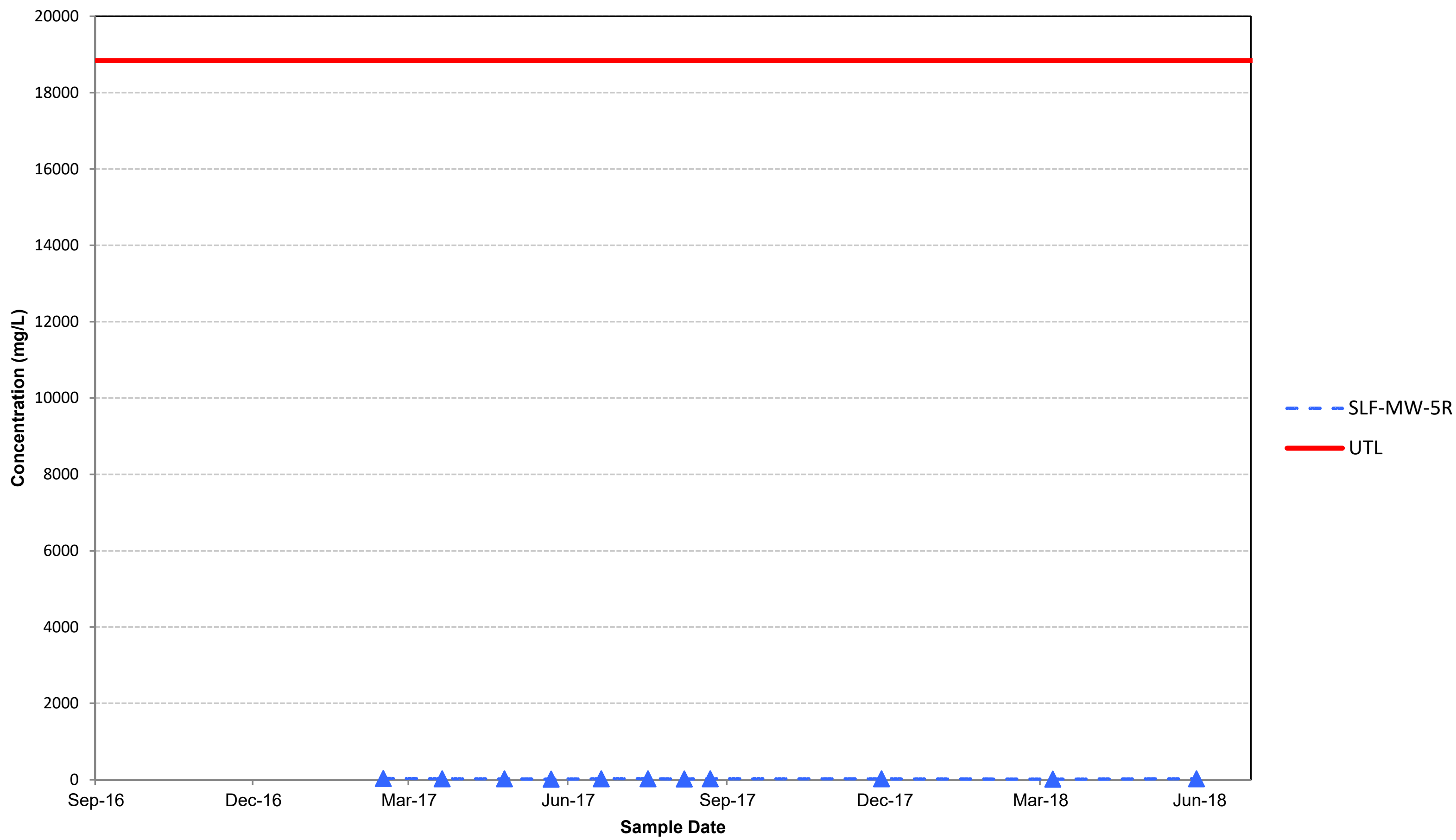
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CALCIUM
CONCENTRATION VS. TIME

October 2018 **Figure F-16**



NOTES:

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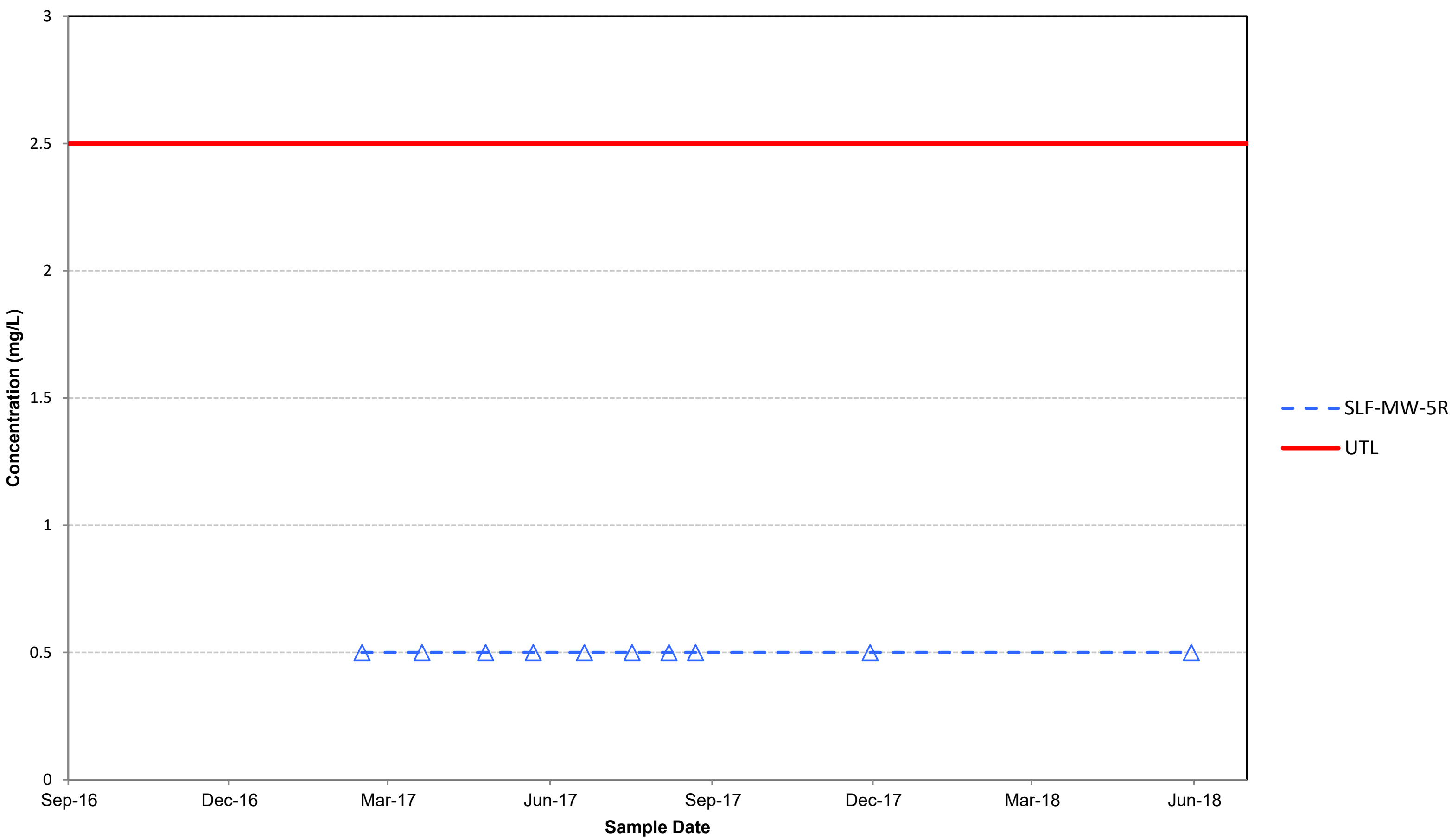
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

CHLORIDE
CONCENTRATION VS. TIME

October 2018 **Figure F-17**



NOTES:
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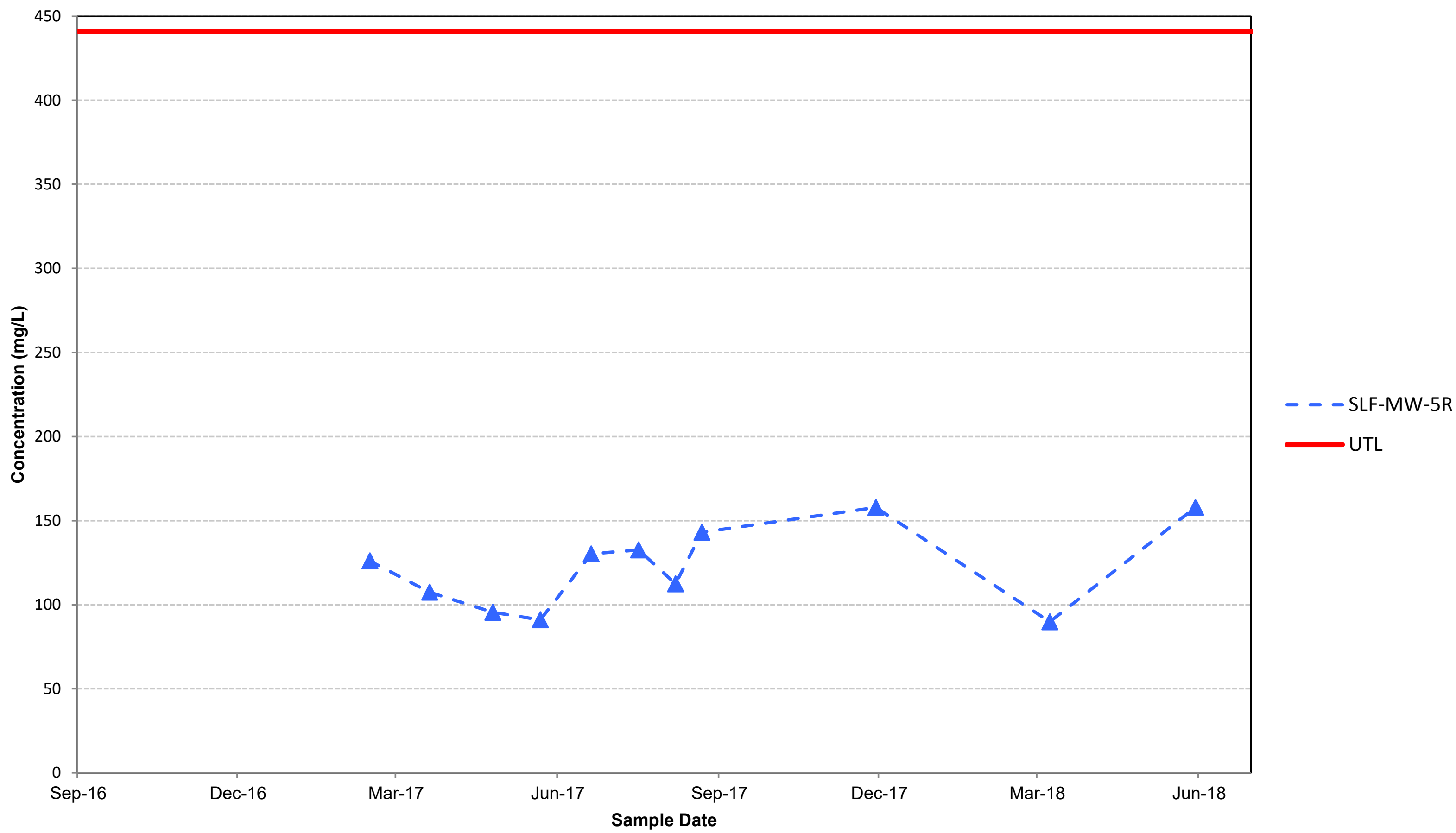
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

FLUORIDE
CONCENTRATION VS. TIME

October 2018 **Figure F-18**



NOTES:

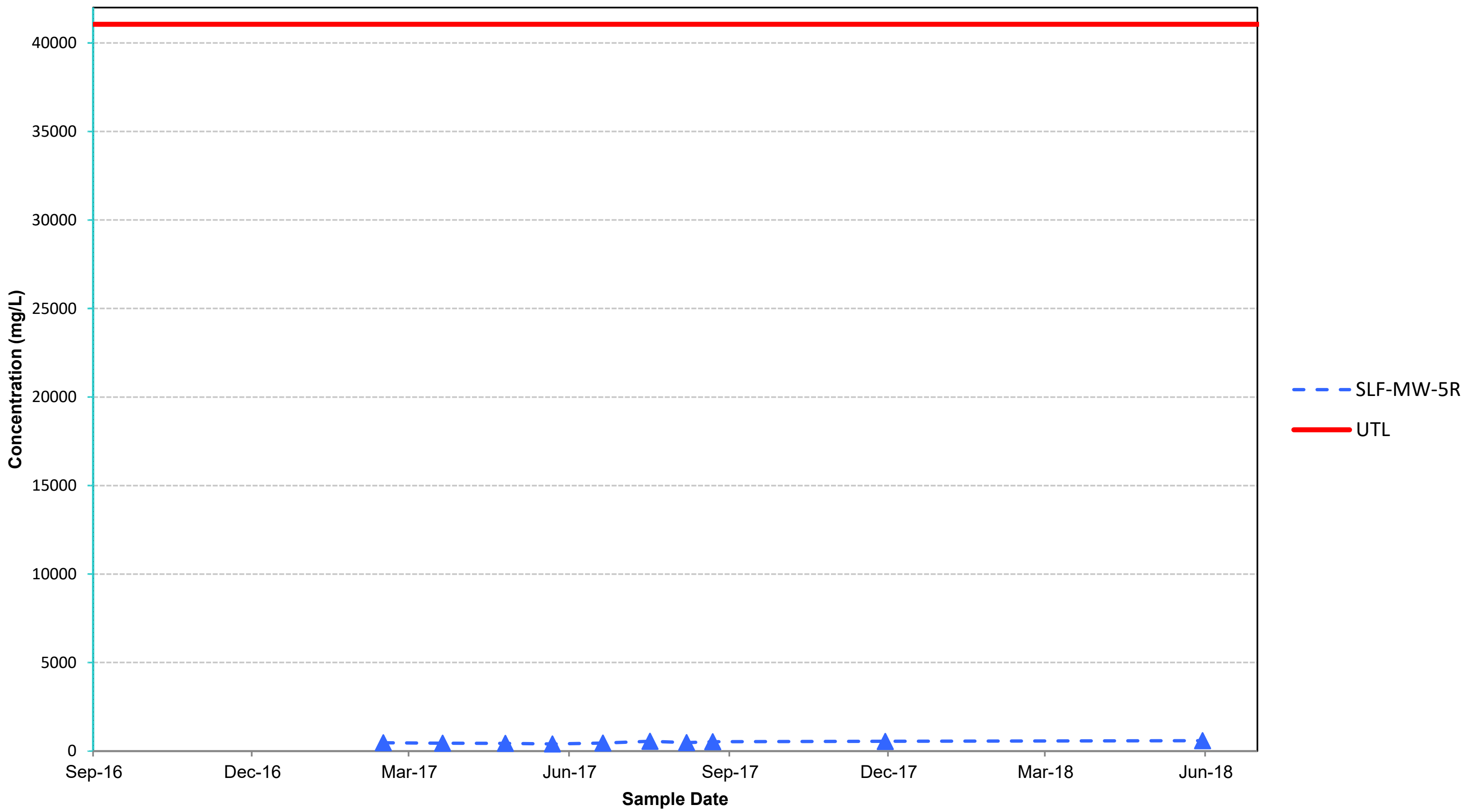
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

SULFATE
CONCENTRATION VS. TIME

October 2018 **Figure F-19**



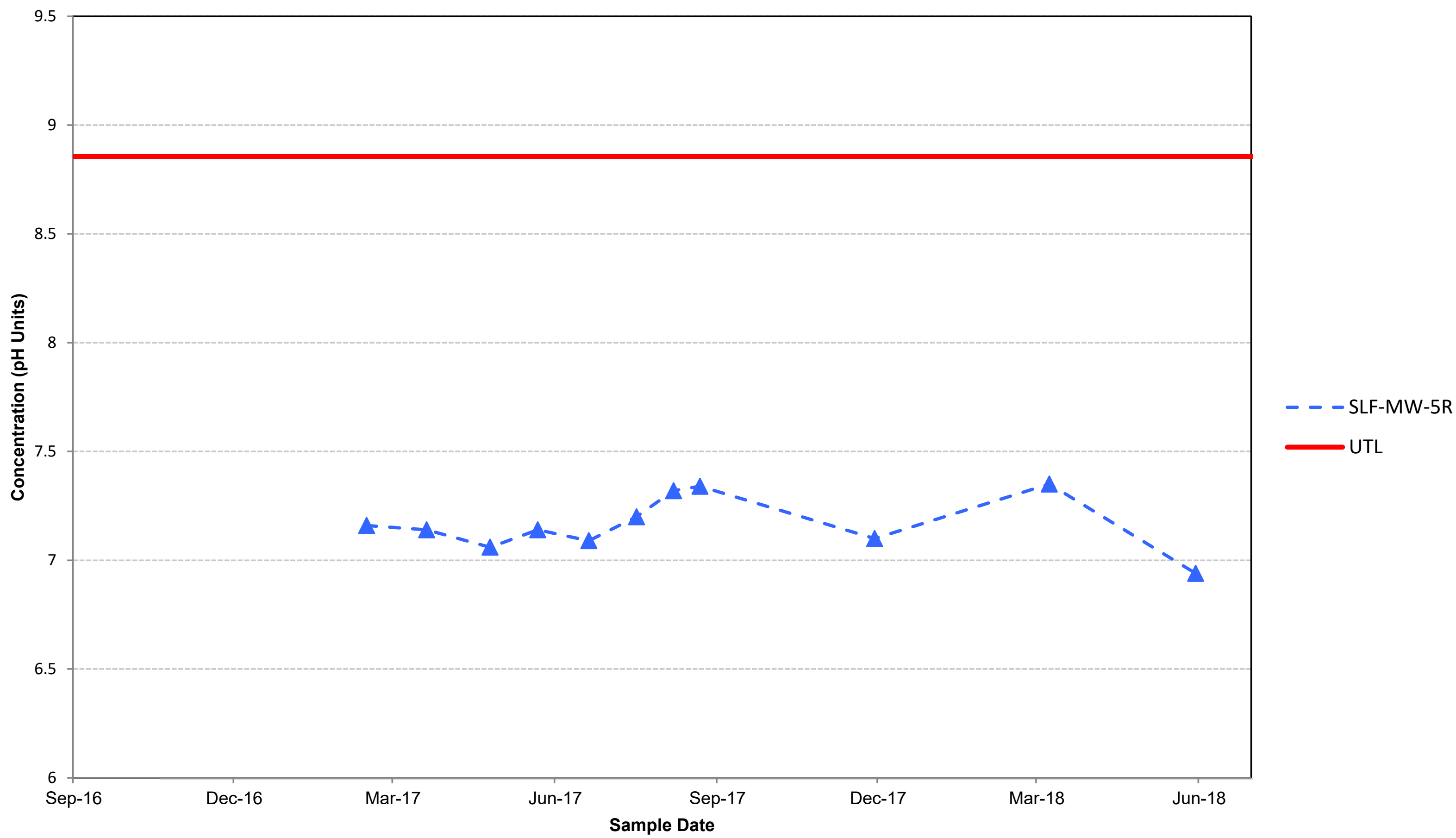
NOTES:
1. Solid symbol indicates a detected concentration. Open symbol indicates a non-detect, the laboratory reporting limit is graphed.
2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

TOTAL DISSOLVED SOLIDS (TDS) CONCENTRATION VS. TIME

October 2018 **Figure F-20**



NOTES:
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2. Screening Level shown is the Upper Tolerance Limit (UTL).
3. Detection Monitoring was initiated on October 17, 2017.

HALEY ALDRICH

H.L. SPURLOCK GENERATING STATION
MAYSVILLE, KENTUCKY

PH, FIELD
CONCENTRATION VS. TIME

October 2018 **Figure F-21**

ATTACHMENT 2

Statistical Output

Background Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.11/13/2018 11:34:35 AM
Full Precision	OFF
Confidence Coefficient	95%
Coverage	99%
New or Future K Observations	1
Number of Bootstrap Operations	2000

Boron

General Statistics

Total Number of Observations	25	Number of Distinct Observations	25
Minimum	1225	First Quartile	1573
Second Largest	5435	Median	2730
Maximum	5464	Third Quartile	4575
Mean	3047	SD	1553
Coefficient of Variation	0.51	Skewness	0.202
Mean of logged Data	7.883	SD of logged Data	0.548

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663

Normal GOF Test

Shapiro Wilk Test Statistic	0.835	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.236	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.173	Data Not Normal at 5% Significance Level

Data Not Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 99% Coverage	7952	90% Percentile (z)	5038
95% UPL (t)	5757	95% Percentile (z)	5602
95% USL	7183	99% Percentile (z)	6661

Gamma GOF Test

A-D Test Statistic	1.803	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.749	Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.22	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.175	Data Not Gamma Distributed at 5% Significance Level

Data Not Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.769	k star (bias corrected MLE)	3.344
Theta hat (MLE)	808.4	Theta star (bias corrected MLE)	911.3
nu hat (MLE)	188.5	nu star (bias corrected)	167.2
MLE Mean (bias corrected)	3047	MLE Sd (bias corrected)	1666

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	6344	90% Percentile	5282
95% Hawkins Wixley (HW) Approx. Gamma UPL	6460	95% Percentile	6202
95% WH Approx. Gamma UTL with 99% Coverage	10814	99% Percentile	8184
95% HW Approx. Gamma UTL with 99% Coverage	11524		
95% WH USL	9066	95% HW USL	9497

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.836	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.918	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.211	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.173	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 99% Coverage	14995	90% Percentile (z)	5358
95% UPL (t)	6908	95% Percentile (z)	6539
95% USL	11429	99% Percentile (z)	9503

Nonparametric Distribution Free Background Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	25	95% UTL with 99% Coverage	5464
Approx, f used to compute achieved CC	0.253	Approximate Actual Confidence Coefficient achieved by UTL	0.222
		Approximate Sample Size needed to achieve specified CC	299
95% Percentile Bootstrap UTL with 99% Coverage	5464	95% BCA Bootstrap UTL with 99% Coverage	5464
95% UPL	5455	90% Percentile	4875
90% Chebyshev UPL	7799	95% Percentile	5339
95% Chebyshev UPL	9952	99% Percentile	5457
95% USL	5464		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

Calcium

General Statistics

Total Number of Observations	25	Number of Distinct Observations	25
Minimum	239494	First Quartile	390089
Second Largest	798246	Median	536189
Maximum	1022530	Third Quartile	580195
Mean	521639	SD	170000
Coefficient of Variation	0.326	Skewness	0.925
Mean of logged Data	13.11	SD of logged Data	0.326

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663

Normal GOF Test

Shapiro Wilk Test Statistic	0.928	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.2	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.173	Data Not Normal at 5% Significance Level

Data appear Approximate Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 99% Coverage	1058498	90% Percentile (z)	739503
95% UPL (t)	818249	95% Percentile (z)	801264
95% USL	974327	99% Percentile (z)	917118

Gamma GOF Test

A-D Test Statistic	0.519	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.745	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.166	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.175	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	10.14	k star (bias corrected MLE)	8.949
Theta hat (MLE)	51447	Theta star (bias corrected MLE)	58289
nu hat (MLE)	507	nu star (bias corrected)	447.5
MLE Mean (bias corrected)	521639	MLE Sd (bias corrected)	174372

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	846971	90% Percentile	753842
95% Hawkins Wixley (HW) Approx. Gamma UPL	853112	95% Percentile	837594
95% WH Approx. Gamma UTL with 99% Coverage	1216988	99% Percentile	1010261
95% HW Approx. Gamma UTL with 99% Coverage	1250847		
95% WH USL	1077140	95% HW USL	1098420

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.963	**Shapiro Wilk Lognormal GOF Test**

5% Shapiro Wilk Critical Value	0.918	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.186	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.173	Data Not Lognormal at 5% Significance Level	
Data appear Approximate Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 99% Coverage	1390280	90% Percentile (z)	753707
95% UPL (t)	876681	95% Percentile (z)	848563
95% USL	1182881	99% Percentile (z)	1059874
Nonparametric Distribution Free Background Statistics			
Data appear Approximate Normal at 5% Significance Level			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	25	95% UTL with 99% Coverage	1022530
Approx, f used to compute achieved CC	0.253	Approximate Actual Confidence Coefficient achieved by UTL	0.222
		Approximate Sample Size needed to achieve specified CC	299
95% Percentile Bootstrap UTL with 99% Coverage	1022530	95% BCA Bootstrap UTL with 99% Coverage	1022530
95% UPL	955245	90% Percentile	703928
90% Chebyshev UPL	1041738	95% Percentile	783206
95% Chebyshev UPL	1277325	99% Percentile	968702
95% USL	1022530		
Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.			
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers			
and consists of observations collected from clean unimpacted locations.			
The use of USL tends to provide a balance between false positives and false negatives provided the data			
represents a background data set and when many onsite observations need to be compared with the BTV.			
Chloride			
General Statistics			
Total Number of Observations	25	Number of Distinct Observations	25
Minimum	1548	First Quartile	11192
Second Largest	16817	Median	14203
Maximum	18877	Third Quartile	14560
Mean	13192	SD	3268
Coefficient of Variation	0.248	Skewness	-1.794
Mean of logged Data	9.424	SD of logged Data	0.463
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663
Normal GOF Test			
Shapiro Wilk Test Statistic	0.843	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.209	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.173	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 99% Coverage	23511	90% Percentile (z)	17380
95% UPL (t)	18893	95% Percentile (z)	18567
95% USL	21893	99% Percentile (z)	20794
Gamma GOF Test			
A-D Test Statistic	2.639	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.746	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.221	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.175	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	8.026	k star (bias corrected MLE)	7.09
Theta hat (MLE)	1644	Theta star (bias corrected MLE)	1861
nu hat (MLE)	401.3	nu star (bias corrected)	354.5
MLE Mean (bias corrected)	13192	MLE Sd (bias corrected)	4954

Background Statistics Assuming Gamma Distribution

95% Wilson Hilferty (WH) Approx. Gamma UPL	22405	90% Percentile	19805
95% Hawkins Wixley (HW) Approx. Gamma UPL	23323	95% Percentile	22255
95% WH Approx. Gamma UTL with 99% Coverage	33104	99% Percentile	27353
95% HW Approx. Gamma UTL with 99% Coverage	36014		
95% WH USL	29038	95% HW USL	31094

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.529	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.918	Data Not Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.279	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.173	Data Not Lognormal at 5% Significance Level

Data Not Lognormal at 5% Significance Level

Background Statistics assuming Lognormal Distribution

95% UTL with 99% Coverage	53375	90% Percentile (z)	22400
95% UPL (t)	27754	95% Percentile (z)	26500
95% USL	42446	99% Percentile (z)	36325

Nonparametric Distribution Free Background Statistics

Data do not follow a Discernible Distribution (0.05)

Nonparametric Upper Limits for Background Threshold Values

Order of Statistic, r	25	95% UTL with 99% Coverage	18877
Approx, f used to compute achieved CC	0.253	Approximate Actual Confidence Coefficient achieved by UTL	0.222
		Approximate Sample Size needed to achieve specified CC	299
95% Percentile Bootstrap UTL with 99% Coverage	18877	95% BCA Bootstrap UTL with 99% Coverage	18877
95% UPL	18259	90% Percentile	16049
90% Chebyshev UPL	23189	95% Percentile	16711
95% Chebyshev UPL	27717	99% Percentile	18383
95% USL	18877		

Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers
and consists of observations collected from clean unimpacted locations.
The use of USL tends to provide a balance between false positives and false negatives provided the data
represents a background data set and when many onsite observations need to be compared with the BTV.

pH

General Statistics

Total Number of Observations	25	Number of Distinct Observations	23
Minimum	6.68	First Quartile	7.1
Second Largest	8.31	Median	7.25
Maximum	8.47	Third Quartile	7.64
Mean	7.411	SD	0.43
Coefficient of Variation	0.058	Skewness	0.891
Mean of logged Data	2.001	SD of logged Data	0.0569

Critical Values for Background Threshold Values (BTVs)

Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663

Normal GOF Test

Shapiro Wilk Test Statistic	0.922	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.918	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.166	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.173	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Background Statistics Assuming Normal Distribution

95% UTL with 99% Coverage	8.769	90% Percentile (z)	7.962
95% UPL (t)	8.161	95% Percentile (z)	8.118
95% USL	8.556	99% Percentile (z)	8.411

Gamma GOF Test

A-D Test Statistic	0.745	**Anderson-Darling Gamma GOF Test**

5% A-D Critical Value	0.742	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.165	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.174	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data follow Appr. Gamma Distribution at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	318	k star (bias corrected MLE)	279.8
Theta hat (MLE)	0.0233	Theta star (bias corrected MLE)	0.0265
nu hat (MLE)	15898	nu star (bias corrected)	13992
MLE Mean (bias corrected)	7.411	MLE Sd (bias corrected)	0.443
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	8.167	90% Percentile	7.984
95% Hawkins Wixley (HW) Approx. Gamma UPL	8.168	95% Percentile	8.154
95% WH Approx. Gamma UTL with 99% Coverage	8.824	99% Percentile	8.48
95% HW Approx. Gamma UTL with 99% Coverage	8.831		
95% WH USL	8.59	95% HW USL	8.595
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.934	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Data appear Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.16	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.173	Data appear Lognormal at 5% Significance Level	
Data appear Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 99% Coverage	8.855	90% Percentile (z)	7.959
95% UPL (t)	8.171	95% Percentile (z)	8.125
95% USL	8.609	99% Percentile (z)	8.446
Nonparametric Distribution Free Background Statistics			
Data appear Normal at 5% Significance Level			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	25	95% UTL with 99% Coverage	8.47
Approx, f used to compute achieved CC	0.253	Approximate Actual Confidence Coefficient achieved by UTL	0.222
		Approximate Sample Size needed to achieve specified CC	299
95% Percentile Bootstrap UTL with 99% Coverage	8.47	95% BCA Bootstrap UTL with 99% Coverage	8.47
95% UPL	8.422	90% Percentile	7.894
90% Chebyshev UPL	8.727	95% Percentile	8.234
95% Chebyshev UPL	9.323	99% Percentile	8.432
95% USL	8.47		
Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.			
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers			
and consists of observations collected from clean unimpacted locations.			
The use of USL tends to provide a balance between false positives and false negatives provided the data			
represents a background data set and when many onsite observations need to be compared with the BTV.			
Sulfate			
General Statistics			
Total Number of Observations	25	Number of Distinct Observations	24
Minimum	4.1	First Quartile	57.79
Second Largest	237.5	Median	65.56
Maximum	295	Third Quartile	100.3
Mean	87.87	SD	61.79
Coefficient of Variation	0.703	Skewness	2.124
Mean of logged Data	4.243	SD of logged Data	0.796
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663
Normal GOF Test			
Shapiro Wilk Test Statistic	0.777	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.231	**Lilliefors GOF Test**	

5% Lilliefors Critical Value	0.173	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Background Statistics Assuming Normal Distribution			
95% UTL with 99% Coverage	283	90% Percentile (z)	167
95% UPL (t)	195.7	95% Percentile (z)	189.5
95% USL	252.4	99% Percentile (z)	231.6
Gamma GOF Test			
A-D Test Statistic	0.887	**Anderson-Darling Gamma GOF Test**	
5% A-D Critical Value	0.755	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.156	**Kolmogorov-Smirnov Gamma GOF Test**	
5% K-S Critical Value	0.176	Detected data appear Gamma Distributed at 5% Significance Level	
Detected data follow Appr. Gamma Distribution at 5% Significance Level			
Gamma Statistics			
k hat (MLE)	2.299	k star (bias corrected MLE)	2.05
Theta hat (MLE)	38.22	Theta star (bias corrected MLE)	42.86
nu hat (MLE)	115	nu star (bias corrected)	102.5
MLE Mean (bias corrected)	87.87	MLE Sd (bias corrected)	61.37
Background Statistics Assuming Gamma Distribution			
95% Wilson Hilferty (WH) Approx. Gamma UPL	210.3	90% Percentile	169.9
95% Hawkins Wixley (HW) Approx. Gamma UPL	219	95% Percentile	206.8
95% WH Approx. Gamma UTL with 99% Coverage	394	99% Percentile	288.5
95% HW Approx. Gamma UTL with 99% Coverage	441		
95% WH USL	320.9	95% HW USL	349.9
Lognormal GOF Test			
Shapiro Wilk Test Statistic	0.838	**Shapiro Wilk Lognormal GOF Test**	
5% Shapiro Wilk Critical Value	0.918	Data Not Lognormal at 5% Significance Level	
Lilliefors Test Statistic	0.191	**Lilliefors Lognormal GOF Test**	
5% Lilliefors Critical Value	0.173	Data Not Lognormal at 5% Significance Level	
Data Not Lognormal at 5% Significance Level			
Background Statistics assuming Lognormal Distribution			
95% UTL with 99% Coverage	858.9	90% Percentile (z)	193
95% UPL (t)	279	95% Percentile (z)	257.7
95% USL	579.3	99% Percentile (z)	443.2
Nonparametric Distribution Free Background Statistics			
Data appear Approximate Gamma Distribution at 5% Significance Level			
Nonparametric Upper Limits for Background Threshold Values			
Order of Statistic, r	25	95% UTL with 99% Coverage	295
Approx, f used to compute achieved CC	0.253	Approximate Actual Confidence Coefficient achieved by UTL	0.222
		Approximate Sample Size needed to achieve specified CC	299
95% Percentile Bootstrap UTL with 99% Coverage	295	95% BCA Bootstrap UTL with 99% Coverage	295
95% UPL	277.7	90% Percentile	122.3
90% Chebyshev UPL	276.9	95% Percentile	215.9
95% Chebyshev UPL	362.5	99% Percentile	281.2
95% USL	295		
Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.			
Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers			
and consists of observations collected from clean unimpacted locations.			
The use of USL tends to provide a balance between false positives and false negatives provided the data			
represents a background data set and when many onsite observations need to be compared with the BTV.			
TotalDissolvedSolids			
General Statistics			
Total Number of Observations	25	Number of Distinct Observations	25
Minimum	17360	First Quartile	22420
Second Largest	30260	Median	25460
Maximum	33067	Third Quartile	28480
Mean	24967	SD	4171

	A B C D E	F	G H I J K	L
403	Coefficient of Variation	0.167	Skewness	-0.12
404	Mean of logged Data	10.11	SD of logged Data	0.173
405				
406	**Critical Values for Background Threshold Values (BTVs)**			
407	Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663
408				
409	**Normal GOF Test**			
410	Shapiro Wilk Test Statistic	0.975	**Shapiro Wilk GOF Test**	
411	5% Shapiro Wilk Critical Value	0.918	Data appear Normal at 5% Significance Level	
412	Lilliefors Test Statistic	0.0891	**Lilliefors GOF Test**	
413	5% Lilliefors Critical Value	0.173	Data appear Normal at 5% Significance Level	
414	**Data appear Normal at 5% Significance Level**			
415				
416	**Background Statistics Assuming Normal Distribution**			
417	95% UTL with 99% Coverage	38140	90% Percentile (z)	30313
418	95% UPL (t)	32245	95% Percentile (z)	31828
419	95% USL	36074	99% Percentile (z)	34671
420				
421	**Gamma GOF Test**			
422	A-D Test Statistic	0.279	**Anderson-Darling Gamma GOF Test**	
423	5% A-D Critical Value	0.743	Detected data appear Gamma Distributed at 5% Significance Level	
424	K-S Test Statistic	0.107	**Kolmogorov-Smirnov Gamma GOF Test**	
425	5% K-S Critical Value	0.174	Detected data appear Gamma Distributed at 5% Significance Level	
426	**Detected data appear Gamma Distributed at 5% Significance Level**			
427				
428	**Gamma Statistics**			
429	k hat (MLE)	35.89	k star (bias corrected MLE)	31.61
430	Theta hat (MLE)	695.7	Theta star (bias corrected MLE)	789.9
431	nu hat (MLE)	1795	nu star (bias corrected)	1580
432	MLE Mean (bias corrected)	24967	MLE Sd (bias corrected)	4441
433				
434	**Background Statistics Assuming Gamma Distribution**			
435	95% Wilson Hilferty (WH) Approx. Gamma UPL	32872	90% Percentile	30801
436	95% Hawkins Wixley (HW) Approx. Gamma UPL	32969	95% Percentile	32693
437	95% WH Approx. Gamma UTL with 99% Coverage	40636	99% Percentile	36442
438	95% HW Approx. Gamma UTL with 99% Coverage	41052		
439	95% WH USL	37791	95% HW USL	38068
440				
441	**Lognormal GOF Test**			
442	Shapiro Wilk Test Statistic	0.961	**Shapiro Wilk Lognormal GOF Test**	
443	5% Shapiro Wilk Critical Value	0.918	Data appear Lognormal at 5% Significance Level	
444	Lilliefors Test Statistic	0.112	**Lilliefors Lognormal GOF Test**	
445	5% Lilliefors Critical Value	0.173	Data appear Lognormal at 5% Significance Level	
446	**Data appear Lognormal at 5% Significance Level**			
447				
448	**Background Statistics assuming Lognormal Distribution**			
449	95% UTL with 99% Coverage	42510	90% Percentile (z)	30729
450	95% UPL (t)	33292	95% Percentile (z)	32722
451	95% USL	39021	99% Percentile (z)	36815
452				
453	**Nonparametric Distribution Free Background Statistics**			
454	**Data appear Normal at 5% Significance Level**			
455				
456	**Nonparametric Upper Limits for Background Threshold Values**			
457	Order of Statistic, r	25	95% UTL with 99% Coverage	33067
458	Approx, f used to compute achieved CC	0.253	Approximate Actual Confidence Coefficient achieved by UTL	0.222
459			Approximate Sample Size needed to achieve specified CC	299
460	95% Percentile Bootstrap UTL with 99% Coverage	33067	95% BCA Bootstrap UTL with 99% Coverage	33067
461	95% UPL	32225	90% Percentile	30132
462	90% Chebyshev UPL	37728	95% Percentile	30255
463	95% Chebyshev UPL	43509	99% Percentile	32393
464	95% USL	33067		
465				
466	Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.			
467	Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers			
468	and consists of observations collected from clean unimpacted locations.			
469	The use of USL tends to provide a balance between false positives and false negatives provided the data			

	A	B	C	D	E	F	G	H	I	J	K	L
470	represents a background data set and when many onsite observations need to be compared with the BTV.											
471												

Background Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.11/13/2018 11:49:22 AM
Full Precision	OFF
Confidence Coefficient	95%
Coverage	99%
erent or Future K Observations	1
umber of Bootstrap Operations	2000

Fluoride

General Statistics			
Total Number of Observations	25	Number of Missing Observations	0
Number of Distinct Observations	11		
Number of Detects	10	Number of Non-Detects	15
Number of Distinct Detects	8	Number of Distinct Non-Detects	3
Minimum Detect	0.507	Minimum Non-Detect	0.5
Maximum Detect	2.374	Maximum Non-Detect	2.5
Variance Detected	0.469	Percent Non-Detects	60%
Mean Detected	1.064	SD Detected	0.685
Mean of Detected Logged Data	-0.078	SD of Detected Logged Data	0.516
Critical Values for Background Threshold Values (BTVs)			
Tolerance Factor K (For UTL)	3.158	d2max (for USL)	2.663
Normal GOF Test on Detects Only			
Shapiro Wilk Test Statistic	0.664	**Shapiro Wilk GOF Test**	
5% Shapiro Wilk Critical Value	0.842	Data Not Normal at 5% Significance Level	
Lilliefors Test Statistic	0.371	**Lilliefors GOF Test**	
5% Lilliefors Critical Value	0.262	Data Not Normal at 5% Significance Level	
Data Not Normal at 5% Significance Level			
Kaplan Meier (KM) Background Statistics Assuming Normal Distribution			
KM Mean	0.739	KM SD	0.502
95% UTL99% Coverage	2.325	95% KM UPL (t)	1.615
90% KM Percentile (z)	1.383	95% KM Percentile (z)	1.565
99% KM Percentile (z)	1.907	95% KM USL	2.077
DL/2 Substitution Background Statistics Assuming Normal Distribution			
Mean	0.625	SD	0.591
95% UTL99% Coverage	2.491	95% UPL (t)	1.656
90% Percentile (z)	1.383	95% Percentile (z)	1.597
99% Percentile (z)	2	95% USL	2.199
DL/2 is not a recommended method. DL/2 provided for comparisons and historical reasons			
Gamma GOF Tests on Detected Observations Only			
A-D Test Statistic	1.339	**Anderson-Darling GOF Test**	
5% A-D Critical Value	0.73	Data Not Gamma Distributed at 5% Significance Level	
K-S Test Statistic	0.323	**Kolmogorov-Smirnov GOF**	
5% K-S Critical Value	0.268	Data Not Gamma Distributed at 5% Significance Level	
Data Not Gamma Distributed at 5% Significance Level			
Gamma Statistics on Detected Data Only			
k hat (MLE)	3.737	k star (bias corrected MLE)	2.683
Theta hat (MLE)	0.285	Theta star (bias corrected MLE)	0.396
nu hat (MLE)	74.74	nu star (bias corrected)	53.65
MLE Mean (bias corrected)	1.064		
MLE Sd (bias corrected)	0.649	95% Percentile of Chisquare (2kstar)	11.63
Gamma ROS Statistics using Imputed Non-Detects			
GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs			
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)			
For such situations, GROS method may yield incorrect values of UCLs and BTVs			
This is especially true when the sample size is small.			
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates			
Minimum	0.01	Mean	0.451
Maximum	2.374	Median	0.114

Row	A–E	E	F	G–K	K	L
68	SD		0.662	CV		1.468
69	k hat (MLE)		0.418	k star (bias corrected MLE)		0.395
70	Theta hat (MLE)		1.079	Theta star (bias corrected MLE)		1.143
71	nu hat (MLE)		20.91	nu star (bias corrected)		19.73
72	MLE Mean (bias corrected)		0.451	MLE Sd (bias corrected)		0.718
73	95% Percentile of Chisquare (2kstar)		3.295	90% Percentile		1.277
74	95% Percentile		1.883	99% Percentile		3.409
75	**The following statistics are computed using Gamma ROS Statistics on Imputed Data**					
76	**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**					
77		WH	HW		WH	HW
78	% Approx. Gamma UTL with 99% Coverage	5.51	7.466	95% Approx. Gamma UPL	1.871	2.048
79	95% Gamma USL	3.938	4.969			
80						
81	**Estimates of Gamma Parameters using KM Estimates**					
82	Mean (KM)		0.739	SD (KM)		0.502
83	Variance (KM)		0.252	SE of Mean (KM)		0.108
84	k hat (KM)		2.162	k star (KM)		1.929
85	nu hat (KM)		108.1	nu star (KM)		96.47
86	theta hat (KM)		0.342	theta star (KM)		0.383
87	80% gamma percentile (KM)		1.111	90% gamma percentile (KM)		1.449
88	95% gamma percentile (KM)		1.772	99% gamma percentile (KM)		2.491
89						
90	**The following statistics are computed using gamma distribution and KM estimates**					
91	**Upper Limits using Wilson Hilferty (WH) and Hawkins Wixley (HW) Methods**					
92		WH	HW		WH	HW
93	% Approx. Gamma UTL with 99% Coverage	2.036	2.038	95% Approx. Gamma UPL	1.464	1.446
94	95% KM Gamma Percentile	1.408	1.389	95% Gamma USL	2.058	2.061
95						
96	**Lognormal GOF Test on Detected Observations Only**					
97	Shapiro Wilk Test Statistic		0.781	**Shapiro Wilk GOF Test**		
98	5% Shapiro Wilk Critical Value		0.842	Data Not Lognormal at 5% Significance Level		
99	Lilliefors Test Statistic		0.287	**Lilliefors GOF Test**		
100	5% Lilliefors Critical Value		0.262	Data Not Lognormal at 5% Significance Level		
101	**Data Not Lognormal at 5% Significance Level**					
102						
103	**Background Lognormal ROS Statistics Assuming Lognormal Distribution Using Imputed Non-Detects**					
104	Mean in Original Scale		0.586	Mean in Log Scale		-0.887
105	SD in Original Scale		0.585	SD in Log Scale		0.84
106	95% UTL99% Coverage		5.836	95% BCA UTL99% Coverage		2.374
107	95% Bootstrap (%) UTL99% Coverage		2.374	95% UPL (t)		1.782
108	90% Percentile (z)		1.208	95% Percentile (z)		1.638
109	99% Percentile (z)		2.903	95% USL		3.851
110						
111	**Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution**					
112	KM Mean of Logged Data		-0.431	95% KM UTL (Lognormal)99% Coverage		2.589
113	KM SD of Logged Data		0.438	95% KM UPL (Lognormal)		1.395
114	95% KM Percentile Lognormal (z)		1.335	95% KM USL (Lognormal)		2.084
115						
116	**Background DL/2 Statistics Assuming Lognormal Distribution**					
117	Mean in Original Scale		0.625	Mean in Log Scale		-0.771
118	SD in Original Scale		0.591	SD in Log Scale		0.739
119	95% UTL99% Coverage		4.776	95% UPL (t)		1.68
120	90% Percentile (z)		1.193	95% Percentile (z)		1.561
121	99% Percentile (z)		2.583	95% USL		3.312
122	**DL/2 is not a Recommended Method. DL/2 provided for comparisons and historical reasons.**					
123						
124	**Nonparametric Distribution Free Background Statistics**					
125	**Data do not follow a Discernible Distribution (0.05)**					
126						
127	**Nonparametric Upper Limits for BTVs(no distinction made between detects and nondetects)**					
128	Order of Statistic, r		25	95% UTL with99% Coverage		2.5
129	Approx, f used to compute achieved CC		0.253	Approximate Actual Confidence Coefficient achieved by UTL		0.222
130	pproximate Sample Size needed to achieve specified CC		299	95% UPL		2.462
131	95% USL		2.5	95% KM Chebyshev UPL		2.972
132						
133	Note: The use of USL tends to yield a conservative estimate of BTV, especially when the sample size starts exceeding 20.					
134	Therefore, one may use USL to estimate a BTV only when the data set represents a background data set free of outliers					

	A	B	C	D	E	F	G	H	I	J	K	L
135	and consists of observations collected from clean unimpacted locations.											
136	The use of USL tends to provide a balance between false positives and false negatives provided the data											
137	represents a background data set and when many onsite observations need to be compared with the BTV.											
138												

APPENDIX F – Alternate Source Demonstration(s)

Prepared for

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EAST KENTUCKY POWER COOPERATIVE
A Touchstone Energy Cooperative

ALTERNATE SOURCE DEMONSTRATION

SPURLOCK STATION LANDFILL
MAYSVILLE, KENTUCKY

Prepared by

Geosyntec consultants

engineers | scientists | innovators

1255 Roberts Boulevard, Suite 200
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Project Number GR6562

July 2018

EAST KENTUCKY POWER COOPERATIVE

A Touchstone Energy Cooperative

ALTERNATE SOURCE DEMONSTRATION

H.L. Spurlock Generating Station
Spurlock Landfill
Maysville, Kentucky

July 13, 2018

Herwig Goldemund, Ph.D.
Senior Scientist

Robert Glazier
Project Director

Certification Statement

Alternate Source Demonstration
H.L. Spurlock Generating Station
Spurlock Landfill
Maysville, Kentucky
July 13, 2018

I, Scott Graves, a qualified professional engineer registered in the Commonwealth of Kentucky, certify that the above document was completed consistent with the requirements stipulated in 40 CFR 257.94(e)(2) and that the information contained herein is, to the best of my knowledge, accurate.

Seal and Signature

7/13/2018
Date

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ASD	alternate source demonstration
B	boron
bgs	below ground surface
Ca	calcium
CCR	coal combustion residual
CFR	Code of Federal Regulations
cm/sec	centimeter per second
Cl	chloride
DO	dissolved oxygen
EKPC	East Kentucky Power Cooperative
ERIS	Environmental Risk Information Services
F	fluoride
FGD	flue gas desulfurization
ft. bgs	feet below ground surface
ft./ft.	feet per feet
ft./yr.	feet per year
H&A	Haley & Aldrich, Inc.
HCO_3	bicarbonate
K	potassium
KAR	Kentucky Administrative Regulations
KPDES	Kentucky Pollution Discharge Elimination System
Mg	magnesium
mg/L	milligram per liter
µS/cm	microsiemens per cm
µg/L	microgram per liter
Na	sodium
NTU	nephelometric turbidity unit
P.E.	professional engineer
SSI	statistically significant increase
SO_4	sulfate
TDS	total dissolved solids
U.S. EPA	United States Environmental Protection Agency
UTL	upper tolerance limit

1. INTRODUCTION

1.1 Purpose

The Federal Coal Combustion Residuals (CCR) Rule provides a process under 40 Code of Federal Regulations (CFR) Section 257.94(e)(2) for the owner/operator of a regulated CCR unit to demonstrate that a statistically significant increase (SSI) above background concentrations of Appendix III constituents during the Detection Monitoring Program is from a source other than the CCR unit. An SSI for one or more Appendix III constituents is a potential indication of a release of CCR constituents from the CCR unit to groundwater. If it can be demonstrated that the SSIs are due to an error (i.e., sampling error, laboratory error, statistical analysis error), due to natural variation in groundwater quality, or due to an alternate source (other than the regulated CCR unit) for the constituents in groundwater, then the CCR unit may remain in the Detection Monitoring Program. If a successful alternate source demonstration is not made, or if a successful demonstration is not completed by July 16, 2018, then the CCR unit must establish an Assessment Monitoring Program by that date. If a successful demonstration is completed after July 16, 2018, the CCR unit may return to the Detection Monitoring Program at that time. The Federal CCR Rule does not contain requirements nor reference agency guidance for a successful alternate source demonstration other than certification of its accuracy by a Professional Engineer.

Geosyntec Consultants, Inc. (Geosyntec) has prepared this Alternate Source Demonstration (ASD) Report for the Landfill CCR unit at East Kentucky Power Cooperative Inc.'s (EKPC's) Spurlock Station Landfill located in Maysville, Kentucky (referred to herein as the Landfill or the Site) to demonstrate that a source other than the regulated CCR unit is responsible for the sulfate (SO_4) SSI at downgradient monitoring well MW-3B through previous groundwater monitoring activities.

1.2 Site Description

The CCR Landfill at Spurlock is located along South Ripley Road in Mason County, Kentucky. The Site is located approximately five miles northwest of Maysville, Kentucky (**Figure 1**). The Landfill is permitted as a special waste landfill under Kentucky regulations and has been issued Permit # SW08100005, which includes its own groundwater monitoring requirements under 401 KAR 45:160. However, only groundwater monitoring and corrective action requirements under 40 CFR 257.90 through 257.98 are discussed herein.

The CCR Landfill consists of three phases, designated as Areas A, B, and C and accepts approximately 500,000 tons of CCR waste annually, including fly ash, bottom ash, and FGD process waste. According to Permit # SW08100005, the Landfill currently occupies a disposal area of 176.67 acres within a total permitted area of 1,602.06 acres.

Geosyntec completed visual site reconnaissance of surficial conditions surrounding the Landfill on February 13, 2018. They were accompanied by EKPC personnel during the site visit. Geosyntec reviewed historical aerial photos and historical topographic maps, which were part of the Environmental Risk Information Services (ERIS) Database Report for the Landfill and its surroundings, and the basis of the monitoring well certification under the CCR Rule (Tetra Tech, 2017), prior to the site visit.

Based on this site visit, there were no observed aboveground structures or site improvements (i.e., other than the CCR Landfill itself) that would indicate potential sources for sulfate-containing materials that could have affected SO_4 concentrations in groundwater monitoring wells.

1.3 Description of the CCR Unit

The areal extent of the Landfill was developed in three major phases, as indicated by the designations Area A, Area B, and Area C, with Area A being the earliest phase of landfilling operations, which began in 1982, and Area C being the most recent expansion which began construction approximately in 2010. The CCR unit that is the subject of this ASD includes all three areas of the Landfill, which are underlain by different liner systems as further described in Subsection 2.2 below. **Figure 2** depicts the layout of the Landfill together with the groundwater monitoring well network. This CCR unit is regulated by both the Commonwealth of Kentucky (special waste permit # SW08100005) and the Federal CCR Rule.

1.4 Groundwater Monitoring System

A *Groundwater Monitoring System and Hydrogeologic Investigation Report* was prepared in support of certifying the monitoring well network at the Spurlock Landfill (Tetra Tech, 2017). Groundwater monitoring activities were implemented to comply with the requirements of 40 CFR 257.90 through 257.98.

The Landfill is underlain by three bedrock formations, including (from top to bottom) the Grant Lake Formation (both Upper and Lower members), the Fairview Formation, and the Kope Formation, all of which were deposited and formed during the Upper Ordovician geologic period. All three formations are comprised of interbedded limestone and shale, but their percentages vary in each of the formations. The Grant Formation contains about 70-90% limestone, the Fairview Formation contains about 50-60% limestone, while the Kope Formation consists of 20-30% limestone. The uppermost aquifer was determined to be in the weathered and fractured (upper) portion of the Kope Formation. (Tetra Tech, 2017).

The design of the monitoring network was based on a hydrogeologic investigation conducted in October 2015, during which three piezometers were installed into the top of the Kope Formation. Two piezometers (i.e., PZ-6 and PZ-7) were installed upgradient of the Landfill to depths of 160 feet below ground surface (ft. bgs), which was about 30 feet into the Kope Formation, and PZ-5 was installed downgradient of the Landfill to a depth of 43.5 ft. bgs, which was about 25 feet into the Kope Formation. Slug tests conducted within upgradient piezometer PZ-7 and existing downgradient monitoring well MW-5B yielded hydraulic conductivities of 2.92×10^{-5} centimeters per second (cm/s) and 1.35×10^{-4} cm/s. The hydraulic gradient between these two monitoring points was calculated to be 0.0279 feet per feet (ft./ft.) and the groundwater flow velocity around PZ-7 was estimated at 16.8 feet per year (ft./yr.) and the flow velocity around MW-5B was estimated at 77.8 ft./yr. Following the conclusion of the hydrogeologic investigation, Tetra Tech installed five groundwater monitoring wells in July and August 2016 to serve as the monitoring well network under the CCR Rule.

The background monitoring wells were installed as 2-inch diameter wells adjacent to piezometers PZ-6 and PZ-7 to a total depth of 160 ft. bgs with a 10-foot screened interval between 150 ft. and 160 ft. bgs. These upgradient wells were subsequently designated as MW-6 and MW-7, respectively. Two of the downgradient wells were installed as 2-inch diameter wells near existing monitoring wells MW-2A and MW-3A, which have served as part of the state groundwater monitoring network. These downgradient wells were subsequently designated as MW-2B and MW-3B and installed to total depths of 60 ft. bgs and 30 ft. bgs, respectively. They were screened with a 10-foot screen at the bottom of the boring. A third downgradient monitoring well was installed as a 2-inch diameter well approximately 320 feet downgradient (i.e., east) of piezometer PZ-5, and subsequently designated as MW-5. This well did not produce sufficient volumes of water for sampling, and it was subsequently replaced in January 2017 with a 4-inch well at the same location and designated as groundwater monitoring well MW-5B, which is screened from 14 ft. to 24 ft. bgs. All well screens have an opening size of 0.01 inches (i.e., 10-slot).

The final certified groundwater monitoring well network consists of two upgradient monitoring wells (MW-6 and MW-7) and three downgradient monitoring wells (MW-2B, MW-3B, and MW-5B). The monitoring well network is depicted on **Figure 2**. The groundwater flow direction at this Site is down-valley, generally following the surface topography, toward the east. A potentiometric surface map from 17 November 2015 from the 2017 Tetra Tech report is included in **Appendix A**.

1.5 Detection Monitoring Program

Groundwater monitoring at the Landfill under the CCR Rule began in October 2016. At least eight baseline groundwater samples were collected from each upgradient and downgradient well prior to October 17, 2017. Baseline sampling events were conducted between October 2016 and August 2017 for wells MW-2B, MW-3B, MW-5B (or also designated as MW-5R), MW-6, and MW-7. The initial Detection Monitoring Program sampling event was conducted in November 2017. All baseline samples as well as the first Detection Monitoring Program sample were analyzed for Appendix III constituents.

Statistical estimates of the upper end of the range of background concentrations were calculated by Haley and Aldrich (H&A, 2018a) using the baseline monitoring event data. The background concentrations were calculated using the Upper Tolerance Limit (UTL) method as described in the U.S. Environmental Protection Agency's (USEPA) 2009 Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance (Unified Guidance) and 40 CFR Section 257.93(f)(3).

The groundwater analytical results from the two background monitoring wells (MW-6 and MW-7) were combined to calculate the background UTL with 99% coverage. Non-parametric distributions were used for the constituents boron (B) and fluoride (F). Normal (or log-normal) distributions were used for chloride (Cl) and pH, and gamma distributions were used for calcium (Ca), SO_4, and total dissolved solids (TDS).

Table 1 summarizes the background UTL for each of the Appendix III parameters and the concentrations of these parameters detected in downgradient groundwater monitoring wells during the November 2017 detection monitoring event.

1.6 Basis of the Statistically Significant Increase

The sample concentrations from the downgradient wells for each of the Appendix III constituents from the November 2017 detection monitoring sampling event were compared to their respective UTLs. A sample concentration greater than the UTL is considered to represent an SSI. Concentrations greater than the UTL are indicated as bold numbers in **Table 1**. Based on these comparisons, the SO_4 concentration of 483 milligrams per liter (mg/L) at well MW-3B exceeded the background UTL of 441 mg/L by approximately 10%, which constituted an SSI. No other Appendix III constituents indicated an SSI at the downgradient monitoring wells.

2. CONCEPTUAL SITE MODEL

2.1 Waste Description

The Landfill currently occupies a disposal area of 176.67 acres and accepts approximately 500,000 tons of CCR materials annually. These materials include fly ash, bottom ash, and FGD process waste.

2.2 Engineered Barrier Systems

Based on design drawings presented in the March 2002 Permit Modification Application (Kenvirons, 2002), the expansion areas of the Landfill are underlain by an engineered 24-inch clay liner with a maximum hydraulic conductivity of 10^{-7} cm/sec. This engineered 24-inch clay liner is also present at the side slopes of the expansion areas. The original extent of Areas A and B is underlain by in-situ clay material that was not engineered to meet certain thickness and/or hydraulic performance criteria (EKPC, personal communication). However, in-situ clay materials tested for the expansion design had measured hydraulic conductivities of approximately 10^{-8} cm/sec (Kenvirons, 2002). In addition, a material termed "Poz-O-Tec," which is fly ash and lime-stabilized FGD scrubber sludge, was placed at the bottom of Area A. This material exhibits low hydraulic conductivity (EKPC, personal communication). Similar to the expansion areas, Phases 1 and 2 of Area C are underlain by an engineered 24-inch clay liner with a maximum hydraulic conductivity of 10^{-7} cm/sec. Areas underlain by this engineered clay liner also contain a leachate collection layer composed of materials with a hydraulic conductivity of 10^{-2} cm/sec on top of the clay liner.

The liner system for Phase 3 of Area C consists of two components to meet 40 CFR 257.70: an upper component consisting of a 60-mil HDPE geomembrane and a lower component consisting of at least a two-foot compacted soil layer with a maximum hydraulic conductivity of 10^{-7} cm/sec over subgrade construction. Areas underlain by this CCR Rule engineered liner system also contain a leachate collection and removal system that meets the requirements of 40 CFR 257.70 (Kenvirons, 2018).

2.3 Potential Release Mechanisms

The potential release mechanism for CCR constituents from the Landfill to groundwater would be via infiltration of precipitation into the ash, dissolution of the soluble components of the CCR materials into leachate, and (potential) migration of leachate to groundwater through defects and cracks in the engineered barrier system. It is noted, however, that the expansion areas (including Area C) containing an engineered liner system are equipped with a leachate collection system composed of a drainage layer containing materials with a hydraulic conductivity of 10^{-2} cm/sec on top of the 24-inch clay liner. This drainage layer conveys leachate towards Pond 1, where it mixes with storm water and is treated by aeration/gravity settling before discharge via Outfall 008 permitted through the Kentucky Pollutant Discharge Elimination System (KPDES) Permit No. KY0022250. While the removal of leachate from large portions of the Landfill reduces the downward driving force, seepage into the subsurface cannot be excluded, especially from the original areas that may not contain a fully engineered liner system with a drainage layer on top. However, seepage is expected to be relatively minor due to low leachate generation rate as a result of the dry-handling of the CCR waste, the low permeability of the CCR waste (which limits percolation of rainwater through the waste), the storm water run-on/runoff controls, and the engineered clay liner systems for the horizontal and vertical expansion areas.

2.4 Migration Pathways

To illustrate potential groundwater migration pathways within, below, and around the Landfill, three cross sections were developed. Two of the cross sections originate at the background wells MW-6 (i.e., cross section A-A') and MW-7 (i.e., cross section B-B') following the general topography and drainage pathways / groundwater flow direction towards the downgradient compliance wells around the storm water and leachate ponds at the bottom of the valley. The third cross section (i.e., cross section C-C') is cut perpendicular to the other two cross section from soil boring S-5 to the reference well MW-1 under the state monitoring program (see **Figure 2** for the location of the cross sections). **Figures 3A** through **3C** depict cross sections A-A', B-B', and C-C', respectively.

Where available, water levels are indicated for the wells and soil borings used to construct these cross-sections. While the upgradient wells MW-6 and MW-7 do have some water at the very bottom of the well, and they are completed at a similar stratigraphic horizon as the downgradient compliance wells, it is not clear that there is a continuous aquifer that connects the upgradient locations with the downgradient locations. Both of the upgradient wells are located on a ridge that is likely a local shallow groundwater divide, and the downgradient locations intercept groundwater from both sides of the valley that gets recharged following rain events. In contrast, groundwater within the upgradient locations is not encountered until about 140 ft. to 150 ft. bgs. The discussion of groundwater quality in each well in Section 3 below indicates that these wells, with the possible exception of MW-2B, may not be in communication along a common groundwater migration pathway.

3. ALTERNATE SOURCE DEMONSTRATION

Geosyntec completed additional field and laboratory investigations as well as data interpretations in 2018 to evaluate whether the SO_4 SSI in MW-3B might be due to an alternate source. The analytical results for the March 2018 samples collected to support the ASD are summarized in **Table 2** and they are discussed in the following sections.

3.1 Evaluation of Error

3.1.1 Potential Sampling Error

Turbidity of the samples was generally low and all Appendix III constituents except Ca have a low potential for adsorption to suspended particulates in the samples. Furthermore, field parameter measurements were consistent among the November 2017 Detection Monitoring Program samples, the preceding baseline monitoring samples, and the subsequent ASD samples collected in March 2018 to aid the ASD investigation. Therefore, there is little potential for false positive laboratory results due to suspended solids in the samples or inconsistent purging/sampling technique.

The baseline samples were collected over a period of approximately ten months which might not include the full range of seasonal background groundwater quality variation, especially given the low hydraulic conductivity of the formation. This limited temporal coverage in the baseline background monitoring program could potentially be classified as a sampling error and might account for the SO_4 SSI in MW-3B that was only 10% above the background UTL calculated using the available data.

The upgradient wells MW-6 and MW-7 indicate concentrations of Appendix III constituents as well as major ions not included in Appendix III at concentrations comparable to seawater and/or saline groundwater brines (see **Table 2**). While this may not be due to "sampling error" in the sense that incorrect sampling techniques were employed, these saline upgradient conditions are not likely representative of shallow groundwater "background" conditions of the uppermost aquifer. During the installation and certification of the groundwater monitoring well network, these analytical results obtained through the subsequent baseline sampling events were not available and therefore, it was not clear at the time whether upgradient wells MW-6 and MW-7 would be representative of shallow groundwater background conditions. Additional discussion of these conditions is provided in the following subsections, but given these saline conditions in upgradient wells, subsequent inter-well statistical analyses would be inappropriate.

3.1.2 Potential Laboratory Analysis Error

Geosyntec did not review the laboratory reports to evaluate whether laboratory analysis errors might have occurred. However, the March 2018 data collected for this ASD were checked for cation vs. anion charge balance and the differences were within normally acceptable limits (i.e., ±10% relative percent difference); in fact, they were within a very narrow range of less than ±5%, which is generally indicative of good data quality.

3.1.3 Potential Statistical Analysis Error

Geosyntec performed a high-level review of the final report on development of background statistics prepared by H&A (2018b) and did not identify concerns in the approach presented. Geosyntec completed its own statistical calculation using the same background data set and obtained similar background UTLs to those reported by H&A (2018a) and an SSI for SO_4 at MW-3B for the November 2017 Detection Monitoring Program sample. Therefore, the potential for statistical analysis error is low.

The narrow temporal range of collecting the baseline monitoring samples and the first Detection Monitoring Program sample might not qualify these samples as "truly independent," especially in upgradient wells with low hydraulic conductivities.

While it is unclear at this time what the ultimate cause of the saline conditions in upgradient wells might be, the analytical results indicate that subsequent inter-well statistical analyses would be inappropriate. Therefore, and similar to the "sampling error" discussion above, this issue could be qualified as a "statistical error," even though there appears to be no "technical error" in the execution of the statistical analyses. Further discussion of this issue is provided in the subsections below.

3.2 Natural Variation

While both upgradient and downgradient wells were installed within the same stratigraphic horizon of the uppermost aquifer, which should result in little natural variability due to the hydro-stratigraphy, there is a large variation between (saline) upgradient conditions and downgradient conditions. However, there is little intra-well variation due to these conditions. While the full seasonal/temporal variation in groundwater quality may not have been captured due to a compressed sampling schedule and a low hydraulic conductivity, the consistency in sampling results within each well make it less likely that natural variation due to seasonality or hydro-stratigraphy might have had a material impact on the outcome of the statistical analyses. However, upgradient conditions are unrepresentative of background conditions, and the difference between saline upgradient wells and downgradient compliance wells are of such a magnitude that they cannot be used to detect differences in upgradient and downgradient wells that would be attributable to a potential release from the CCR unit.

3.3 Alternate Source

3.3.1 Sampling and Analysis Approach

Geosyntec designed and implemented a chemical forensics investigation to evaluate whether the SO_4 SSI at downgradient well MW-3B detected during the November 2017 Detection Monitoring Program event might be due to an alternate source, and therefore not due to a release of Appendix III constituents from the CCR unit. Therefore, a supplemental leachate and groundwater sampling event was conducted, including:

- The collection of a leachate sample for Appendix III parameters, major ions, and stable isotopes; and
- The collection of a round of groundwater samples from upgradient and downgradient locations for the analysis of major cations and anions, as well as stable isotopes.

On March 8, 2018, a round of groundwater samples was collected for field parameters as well as the major cations Ca, magnesium (Mg), potassium (K), and sodium (Na), and the major anions bicarbonate (HCO_3), Cl, and SO_4 using low-flow sampling protocols. In addition, samples were collected at select wells for stable isotope analyses. Furthermore, a leachate sample was collected from the end of the pipe where leachate from the Landfill discharges into the first storm water and leachate collection pond, where primary settlement of solids occurs. The samples were submitted under chain-of-custody protocol for chemical analyses at the following laboratories:

- Appendix III parameters (B, Ca, Cl, F, pH, SO_4, and TDS) as well as Na, K, Mg, and HCO_3 were analyzed (or subcontracted) by EKPC's Central Laboratory in Winchester, Kentucky;

- Stable isotopes of boron were analyzed by Tetra Tech, Inc. of Fort Collins, Colorado; and

- Stable isotopes of sulfur (in sulfate), as well as oxygen and hydrogen (in water) were analyzed by Isotope Tracer Technologies, Inc. of Waterloo, Ontario, Canada.

The major ions and isotope analytical data are presented in **Table 2** and facilitated development of forensics diagrams presented on **Figure 4** through **Figure 7** that could not be developed using the Appendix III concentration data alone.

A multiple lines of evidence approach was used in this evaluation including visualization of major solute composition using Piper and Stiff diagrams, binary plots, as well as stable isotope ratios and mixing curves.

3.3.2 Leachate and Groundwater Chemistry

Table 2 summarizes the leachate sample analytical results together with the upgradient and downgradient groundwater wells for field parameters, Appendix III parameters, and the additional major ions that are not already part of the Appendix III list. In addition, select analytes from seawater as well as a typical oil field production brine are included in **Table 2** for comparison purposes, since the chemistry of the upgradient wells appears to be consistent with seawater and/or saline groundwater.

As can be seen in **Table 2**, the field parameters for leachate indicate high dissolved oxygen (DO) concentrations and the oxidation-reduction potential (ORP) is aerobic. The pH conditions are on the slightly alkaline side and somewhat higher than pH values in upgradient and downgradient groundwater wells. With the exception of B, SO_4, and K, constituent concentrations were lower in CCR leachate as compared to upgradient monitoring wells.

Sodium and Cl conditions were approximately 30- to 50-times higher in upgradient wells compared to leachate. These highly saline conditions are comparable to seawater or deep saline groundwater and are not likely to be representative of background shallow groundwater conditions. Note that downgradient well MW-2B also has greater salinity compared to the other compliance wells but did not have an SSI for SO_4 (or other Appendix III parameters). MW-2B is a 2-inch well installed adjacent to a 4-inch well (i.e., MW-2A) that was historically used under the state-specific groundwater monitoring program mandated by Permit # SW08100005. This adjacent 4-inch well had Cl concentrations of approximately 50-100 mg/L during permit compliance monitoring versus the 1,710 mg/L result from March 2018 in MW-2B. Similarly, TDS concentrations in well MW-2A were on the order of 500-900 mg/L, versus the >3,000 mg/L result detected in MW-2B. This difference in concentrations of these adjacent wells indicates that there is significant variability in groundwater quality over short distances at the Site.

The major ions monitored as part of the Appendix III list (i.e., Ca, Cl, and SO_4) were detected in CCR Rule groundwater monitoring wells at concentrations consistent with the previous baseline and Detection Monitoring Program events. The major ions were used to construct Piper and Stiff diagrams and to calculate ion ratios, as further discussed in the subsections below. The stable isotope results are also discussed in the subsections below.

3.3.3 Piper and Stiff Diagrams

Piper and Stiff diagrams are among the most common tools for assessing geochemical similarities and differences between aqueous samples. Laboratory data, which are normally reported in mg/L, are converted to milliequivalents per liter (meq/L) when plotted on a Piper or Stiff diagram.

Piper diagrams are trilinear diagrams that plot the relative contributions of major ions to the overall geochemical makeup of a liquid sample. The diagram has three components. The large diamond-shaped component displays the combined cation and anion composition of major solutes. The two smaller triangular components display the cation components and the anion components, separately and in greater detail. The sample data are plotted as a percentage of the total milliequivalents on the diagram with each component reaching 100 percent at its respective corner of the diagram. If the results from discrete samples plot relatively close to each other, their respective chemical compositions are similar, and they might have a similar (or the same) source of solutes. One can also see mixing of different waters if the samples fall along straight lines between various water types (e.g., mixing of sodium chloride water with calcium bicarbonate water).

Stiff diagrams plot the chemical compositions of each sample as polygons. Similar-shaped polygons for different samples indicate similar geochemical compositions, and they might have a similar (or the same) source of solutes. The relative size of each polygon is an indication of the ionic strength (or "concentration") of the respective sample.

The resulting Piper diagram is presented as **Figure 4**, and the Stiff diagrams are presented as **Figures 5A** and **5B**. Note that, as a comparison, the composition of seawater and an oil field production brine was included given the high salinity of upgradient wells.

As can be seen on **Figure 4**, the two upgradient wells plot very close to each other and close to both the seawater and oil field production brine chemistries. While it is unclear what the cause of the elevated salinity is in the upgradient wells, they clearly represent salt brine conditions and not "background" conditions. In contrast, all three downgradient wells plot substantially apart from each other in totally different areas of the trilinear diagram. Therefore, they do not appear to represent similar groundwater types. Note that well MW-2B plots relatively close to the upgradient wells, potentially indicating a similar brine signature. Moreover, the geochemistry of the downgradient wells cannot be explained by mixing of upgradient wells with leachate, since these wells do not fall along a mixing line between these two "end members."

Figure 5A depicts the Stiff diagrams for the upgradient wells as well as seawater and oil field production brine conditions as a comparison. It is evident from these diagrams that the upgradient wells are similar to seawater and/or oil field production brine conditions and not "background" conditions. **Figure 5B** represents these diagrams for downgradient wells and leachate conditions. Note the difference in scale between **Figure 5A** and **Figures 5B**, indicating that samples from upgradient wells are at least 10- to 20-fold more concentrated compared to leachate, and about 10 times as concentrated as the most concentrated downgradient well (i.e., MW-2B). As can be seen on these figures, the geochemical makeup of groundwater well MW-2B is similar to the upgradient wells and the "brine conditions" (albeit more dilute), while all three downgradient wells are dissimilar from each other.

In conclusion, the two upgradient wells are representative of brine conditions, and all three downgradient wells appear to represent three different geochemical conditions. In addition, the geochemistry of downgradient wells cannot be explained by mixing of CCR leachate with upgradient groundwater.

3.3.4 Major Solute Binary Plots

Binary plots are another way to visualize the data collected for Appendix III constituents, including the baseline and detection monitoring sampling results. They also allow evaluation of mixing of various waters. Binary plots are provided on **Figure 6A** and **Figure 6B** for two pairs of highly mobile constituents, including B versus SO_4 and B versus Cl. Again, the seawater sample is also included for comparison purposes. Both binary plots indicate that the relative concentrations of these constituents in downgradient compliance wells cannot be produced by mixing CCR leachate with background groundwater. This is consistent with the evidence provided through the Piper and Stiff diagrams.

3.3.5 Ion Ratios

Ion ratios for highly mobile and less reactive solutes that are present at high concentrations in leachate relative to background groundwater are useful indicators for geochemical fingerprinting purposes since dilution of "source leachate" with background groundwater generally does not change these ratios unless there are high concentrations of the select ions in background. Note that since B was not included on the list of analytes during the supplemental groundwater sampling event in March 2018, the last round of groundwater results from the November 2017 Detection Monitoring Program event were used to calculate ion ratios that included B. Therefore, B/SO_4 and B/Cl ratios in groundwater were calculated using B, Cl and SO_4 results from November 2017, while the SO_4/Cl ratio in groundwater as well as all ion ratios in CCR leachate were calculated using the March 2018 sampling results.

Due to the higher salinity in upgradient and, to a certain extent, in downgradient monitoring wells compared to leachate, these ratios are not considered useful indicators. As can be seen in **Table 2**, the ion ratios indicate high variability and do not appear to allow any diagnostic interpretations.

3.3.6 Boron Isotope Mixing Diagrams

Stable isotope ratios of solutes are powerful tools to fingerprint the potential sources of detected solutes. Samples were collected in March 2018 for stable isotope analysis at the same time as the major solute samples were collected. **Figure 7** depicts a B mixing diagram developed based on the B isotope analytical data. The diagram plots the sample's B concentration on the x-axis vs. its stable B isotope composition on the y-axis. The diagram also includes a mixing line connecting calculated values for hypothetical mixtures of the two end members, CCR leachate and background groundwater. Note that downgradient well MW-2B was not included in the isotope sampling program, but it did not have an SSI.

It is clear from this figure that the B detected in the downgradient wells MW-3B and MW-5B/R is not likely derived from leachate from the regulated CCR unit. This presents another line of evidence that the geochemical fingerprints within samples of downgradient groundwater monitoring wells are unlikely to be derived from a release of CCR leachate.

3.3.7 Other Isotope Signatures

Table 2 summarizes the results for all stable isotope analyses performed. These results are not further discussed herein, except to state that the isotope signatures of upgradient monitoring wells MW-6 and MW-7 exhibit very unique signatures that are substantially different from the signatures of downgradient wells and/or CCR leachate. Besides the highly saline conditions, including B concentrations that are higher than in seawater and/or in downgradient wells, this is another line of evidence that these upgradient wells are not representative of background conditions.

4. CONCLUSIONS

This ASD was prepared in accordance with 40 CFR 257.94(e)(2). The following lines of evidence demonstrate that the SSI of an Appendix III constituent from the Detection Monitoring Program samples is not due to a leachate release from the regulated CCR unit.

1. Piper and Stiff diagrams show that the two upgradient wells MW-6 and MW-7 are not representative of background conditions, but are representative of highly saline/brine conditions, and that all three downgradient wells appear to represent three different geochemical conditions. In addition, the geochemistry of downgradient wells cannot be explained by mixing of CCR leachate with upgradient groundwater.

2. Binary plots of highly mobile constituents, including B versus SO_4 and B versus Cl indicate that the major solute compositions detected in the compliance wells cannot be derived from mixing of background groundwater with CCR leachate, consistent with the evidence from Piper and Stiff diagrams.

3. Boron isotope mixing diagrams indicate that the B detected in downgradient groundwater monitoring wells is not derived from mixing CCR leachate with upgradient groundwater, providing another line of evidence that the geochemical fingerprints in downgradient groundwater samples are unlikely to be from a release of CCR leachate.

4. Upgradient wells MW-6 and MW-7 exhibit very unique isotopic signatures that are substantially different from the signatures of downgradient wells and/or CCR leachate. Besides the highly saline conditions, including B concentrations that are higher than in seawater and/or in downgradient wells, this is another line of evidence that these upgradient wells are not representative of background conditions.

5. The highly saline upgradient conditions affect the outcome of the statistical analyses, which compare groundwater conditions between upgradient and downgradient wells that do not appear to be comparable. While there is a low likelihood that this represents “sampling error” or “statistical error” in the way the groundwater samples were collected and/or statistically

analyzed, it does have a high likelihood of leading to erroneous statistical outcomes. This was not anticipated during the installation and certification of the monitoring well network, which did not have the benefit of the current data set. However, this ASD clearly demonstrates that statistical analyses using the current monitoring well network will likely lead to erroneous outcomes and interpretations.

Nevertheless, even given the concern identified about the representativeness of the upgradient monitoring wells, multiple lines of evidence demonstrate that the SSI for an Appendix III constituent in the downgradient monitoring well MW-3B is not due to a leachate release from the regulated CCR landfill unit. Based on these findings, Geosyntec has determined that the CCR unit may remain in the Detection Monitoring Program pursuant to 40 CFR 257.94(e)(2) and does not need to establish an Assessment Monitoring Program.

5. REFERENCES

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TABLES

Table 1. Summary of Appendix III Statistical Analysis at the Spurlock Landfill

	Compliance Wells[1]			Upgradient Wells	
	MW-2B	**MW-3B**	**MW-5R**	**Assumed Data Distribution**	**95% UTL[2]**
Appendix III					
Boron (mg/L)	4.576	3.86	0.524	Non-parametric	5.46
Calcium (mg/L)	37.64	204.99	136.42	Gamma	1,250
Chloride (mg/L)	1,421	152	24.5	Normal	18,800
Fluoride (mg/L)	2	<0.5	<0.5	Non-parametric	2.5
pH (s.u.)	7.66	7.12	7.10	Lognormal	8.86
Sulfate (mg/L)	191.6	**483**[3]	157.8	Gamma	441
TDS (mg/L)	3,072	1,208	549	Gamma	41,100

[1]Values for compliance wells are November 2017 detection monitoring results.

[2]95% Upper Tolerance Limit with 99% coverage, rounded from values presented in H&A (2017).

[3]**Bold** numbers indicate that concentration is greater than the UTL, representing a SSI.

Table 2. CCR Leachate and Groundwater Characteristics at the Spurlock Landfill

	Leachate	Upgradient Wells		Downgradient Wells			Seawater[1]	Oil Brine[2]
		MW-6	MW-7	MW-2B	MW-3B	MW-5R		
Field Parameters								
pH (s.u.)	8.26	7.40	7.20	7.88	7.46	7.35	--	--
Conductivity (µS/cm)	5,001	55,307	40,003	6,624	2,070	695	--	--
DO (mg/L)	7.11	0.61	0.90	1.04	1.24	4.07	--	--
ORP (mV)	125.4	-97.7	-16.9	-108.8	-15.7	63.9	--	--
Turbidity (NTU)	2.67	4.0	1.1	0.5	0.4	3.3	--	--
Appendix III								
Boron (mg/L)	31.1	1.97[3]	5.435[3]	4.576[3]	3.86[3]	0.524[3]	4.5	--
Calcium (mg/L)	507	1,170	539	47.9	173	105	412	2,940
Chloride (mg/L)	325	20,800	15,200	1,710	224	15	19,354	35,700
Fluoride (mg/L)	<0.5	<0.5[3]	<0.5[3]	2.0[3]	<0.5[3]	<0.5[3]	1.3	
pH (s.u.)	8.26	7.40	7.20	7.88	7.46	7.35	--	6.60
Sulfate (mg/L)	2,160	90.4	4.5	233	476	89.8	2,712	325
TDS (mg/L)	4,084	30,260[3]	26,200[3]	3,072[3]	1,208[3]	549[3]	35,000	58,400
Major Ions								
Magnesium (mg/L)	33.7	332	207	16.6	35	22.8	1,290	967
Potassium (mg/L)	558	112	94.1	21.1	15.5	2.18	399	201
Sodium (mg/L)	303	10,900	8,180	1,360	195	11.8	10,770	17,700
Bicarbonate (mg/L as $CaCO_3$)	110	150	150	440	220	260	142	164
Ion Ratios (mol/mol)								
B/SO_4 (x10^3)	128	179	11,795	213	71.1	29.5	14.8	--
B/Cl (x10^3)	315	0.40	1.23	10.6	83.5	70.3	0.76	--
SO_4/Cl	2.46	0.0016	0.0001	0.05	0.79	2.21	0.052	0.034
Stable Isotopes								
δ^{11}Boron (‰)	9.3	21.3	27.0	NS[4]	9.1	6.5	39[5]	--
δ^{34}Sulfur (‰)	2.4	22.9	17.7	NS[4]	6.6	7.1	--	--
δ^{18}Oxygen (‰)	-6.4	-4.6	-5.2	NS[4]	-6.5	-6.7	--	--
δ^{2}H (Deuterium) (‰)	-43.6	-30.0	-32.9	NS[4]	-41.9	-41.9	--	--

[1]From Stumm and Morgan (1996)

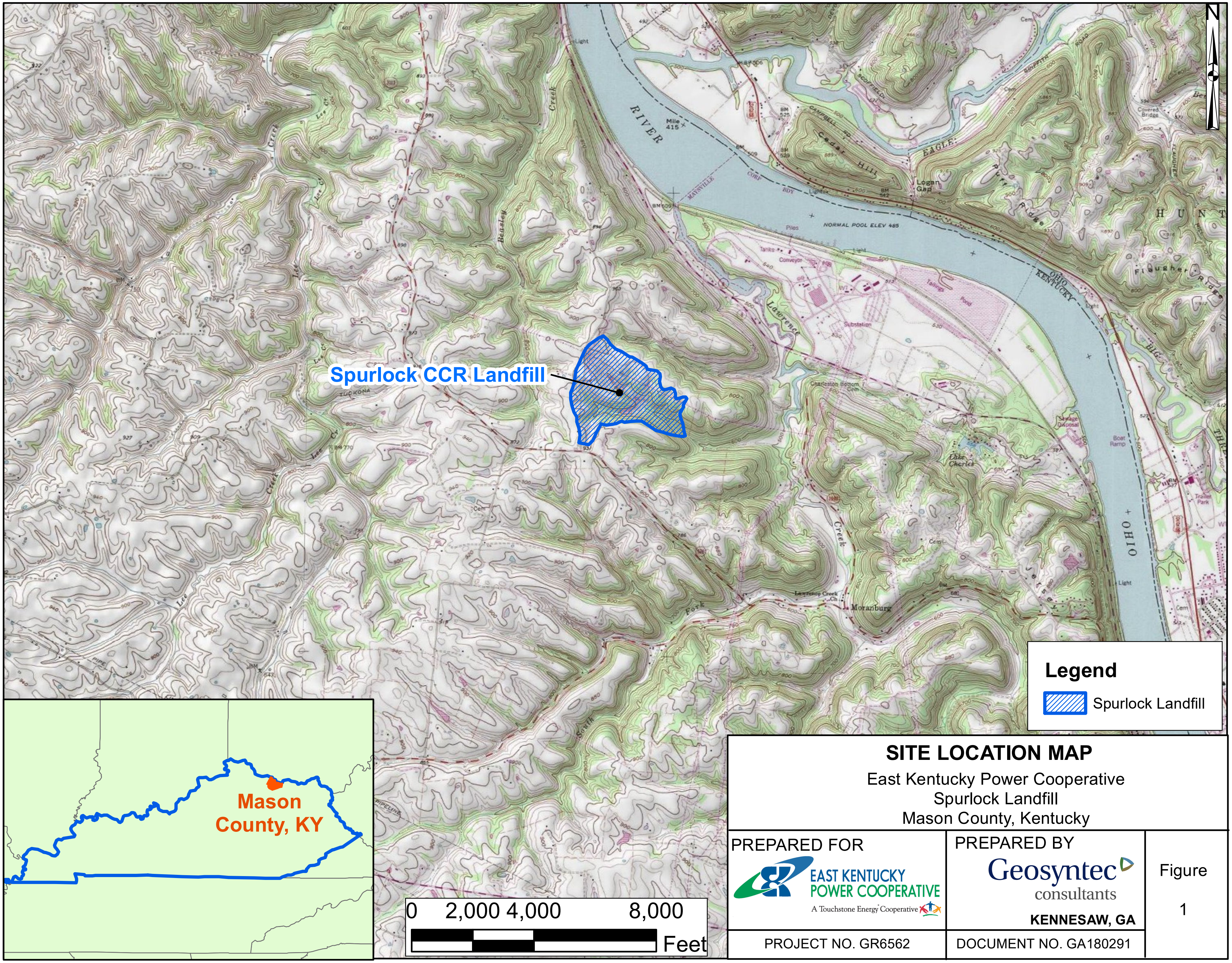
[2]Data from a Kansas Oil Brine summarized in Glazier (1984)

[3]Results for 11/29/2017 samples, all other samples collected in March 2018

[4]NS = not sampled

[5]Cited in Vinson et al. (2011)

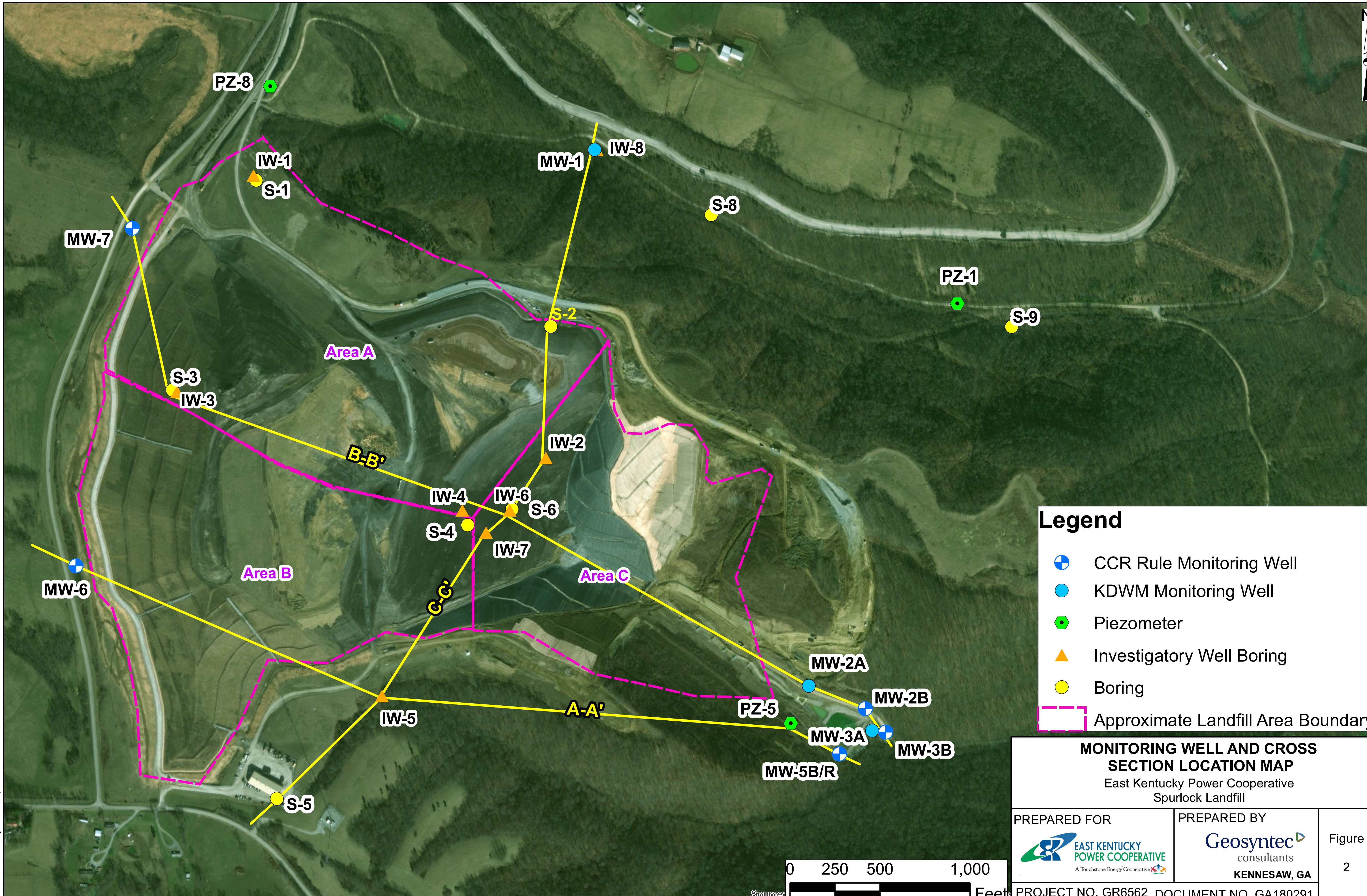
FIGURES



SITE LOCATION MAP

East Kentucky Power Cooperative
Spurlock Landfill
Mason County, Kentucky

PREPARED FOR	PREPARED BY	Figure
EAST KENTUCKY POWER COOPERATIVE A Touchstone Energy Cooperative	Geosyntec consultants KENNESAW, GA	1
PROJECT NO. GR6562	DOCUMENT NO. GA180291	



MONITORING WELL AND CROSS SECTION LOCATION MAP

East Kentucky Power Cooperative
Spurlock Landfill

PREPARED FOR: East Kentucky Power Cooperative (A Touchstone Energy Cooperative)

PREPARED BY: Geosyntec consultants, KENNESAW, GA

Figure 2

PROJECT NO. GR6562 DOCUMENT NO. GA180291

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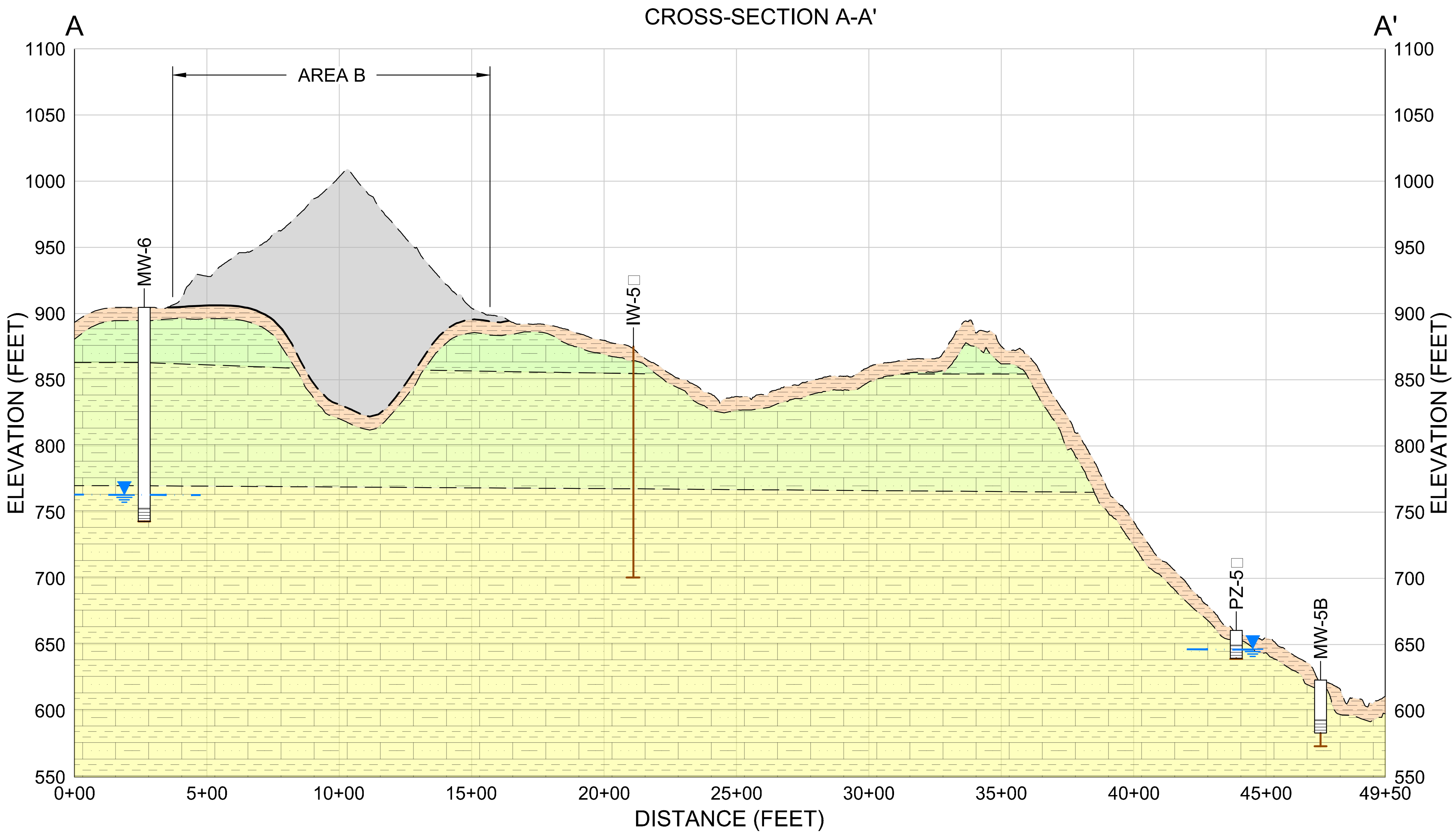


LEGEND

LITHOLOGIC DESCRIPTIONS

- ASH
- LIGHT BROWN OR RED BROWN OR BROWN SILTY CLAY, LEAN CLAY OR FAT CLAY WITH LIMESTONE PIECES
- LOWER GRANT LAKE FORMATION (INTERBEDDED LIMESTONE (70-75□) WITH SHALE (25-30□))
- FAIRVIEW FORMATION (INTERBEDDED LIMESTONE (55-60□) WITH SHALE (35-45□))
- KOPE FORMATION (INTERBEDDED SHALE (70-80□) WITH LIMESTONE (20-30□))

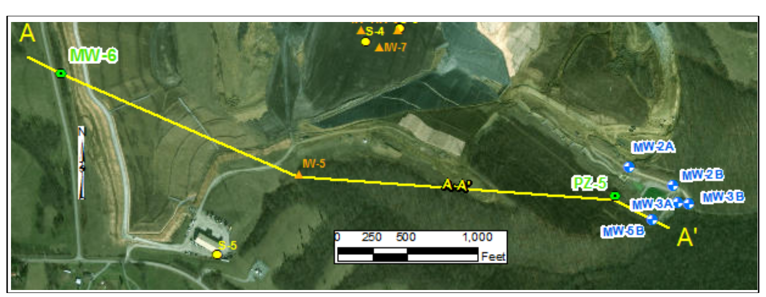
- PIEZOMETER / WELL
- SCREEN INTERVAL
- SOIL BORING

- GROUNDWATER ELEVATION (17 NOVEMBER 2015)
- 24" SOIL LINER ($1X10^{-7}$ CM/SEC)
- CLAY / POZOTEC LAYER
- □ ABANDONED BORING / WELL

0 500□ 1000□
HORIZONTAL SCALE IN FEET

0 100□ 200□
VERTICAL SCALE IN FEET

VERTICAL EXAGGERATION = 5X



KEY MAP SECTION A-A□

NOTE:

1. TOP OF ASH ELEVATION WAS OBTAINED FROM DWG FILE PROVIDED BY EKPC ON 6 MARCH 2018.

PREPARED BY:	PREPARED FOR:		FIGURE
Geosyntec consultants	EAST KENTUCKY POWER COOPERATIVE A Touchstone Energy Cooperative		3A
KENNESAW, GA	PRO□ECT □: GR6562	□UNE 2018	

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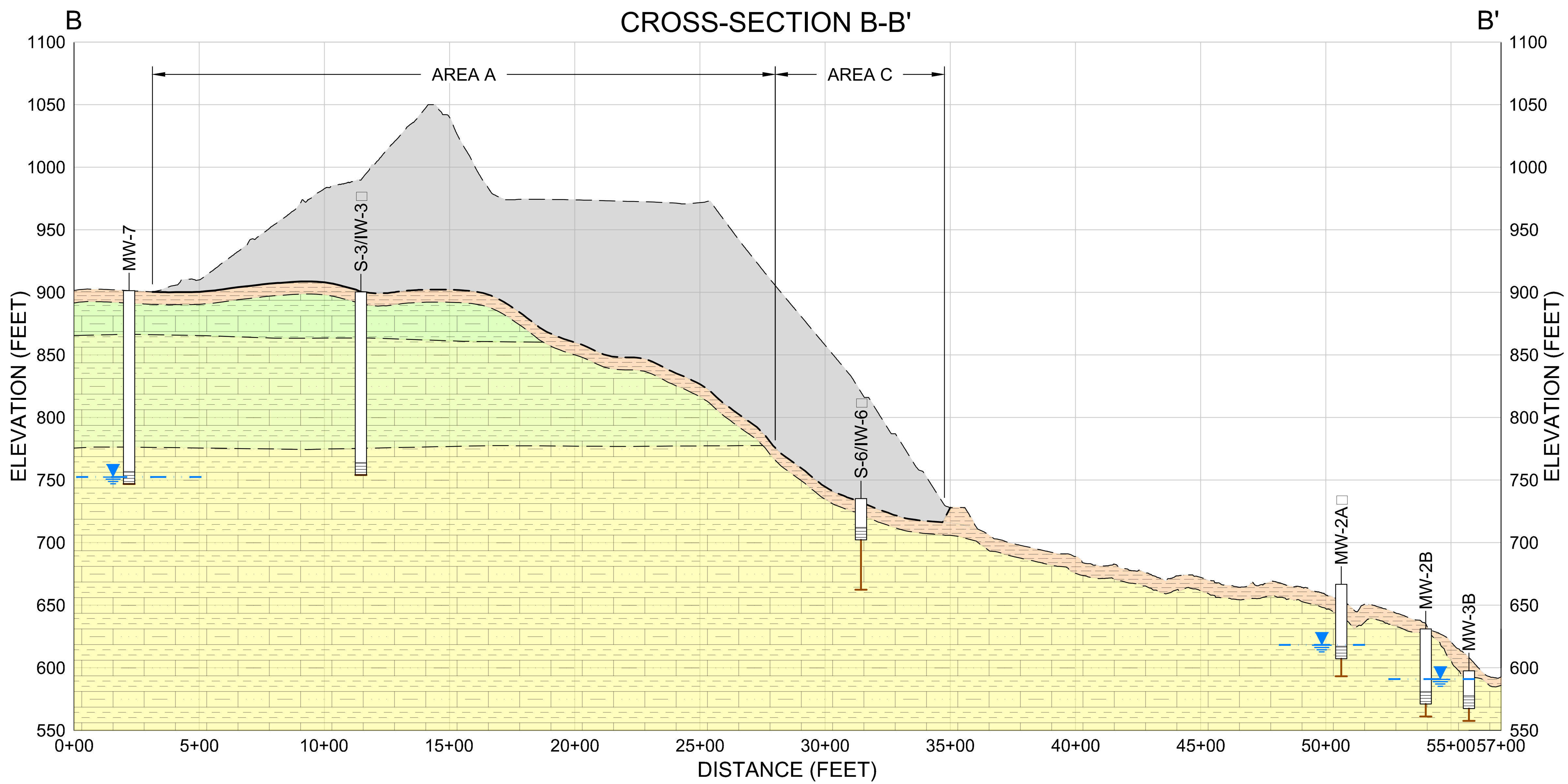

LEGEND

LITHOLOGIC DESCRIPTIONS

ASH

LIGHT BROWN OR RED BROWN OR BROWN SILTY CLAY, LEAN CLAY OR FAT CLAY WITH LIMESTONE PIECES

LOWER GRANT LAKE FORMATION (INTERBEDDED LIMESTONE (70-75%) WITH SHALE (25-30%))

FAIRVIEW FORMATION (INTERBEDDED LIMESTONE (55-60%) WITH SHALE (35-45%))

KOPE FORMATION (INTERBEDDED SHALE (70-80%) WITH LIMESTONE (20-30%))

PIEZOMETER / WELL

SCREEN INTERVAL

SOIL BORING

GROUNDWATER ELEVATION (17 NOVEMBER 2015)

24" SOIL LINER (1X10^{-7} CM/SEC)

CLAY / POZOTEC LAYER

ABANDONED BORING / WELL

0 500' 1000'

HORIZONTAL SCALE IN FEET

0 100' 200'

VERTICAL SCALE IN FEET

VERTICAL EXAGGERATION = 5X

KEY MAP SECTION B-B'

NOTE:

1. TOP OF ASH ELEVATION FROM MAY 2017 WAS OBTAINED FROM DWG FILES PROVIDED BY EKPC ON 6 MARCH 2018.

PREPARED BY:	PREPARED FOR:		FIGURE
Geosyntec consultants	EAST KENTUCKY POWER COOPERATIVE A Touchstone Energy Cooperative		3B
KENNESAW, GA	PROJECT: GR6562	JUNE 2018	

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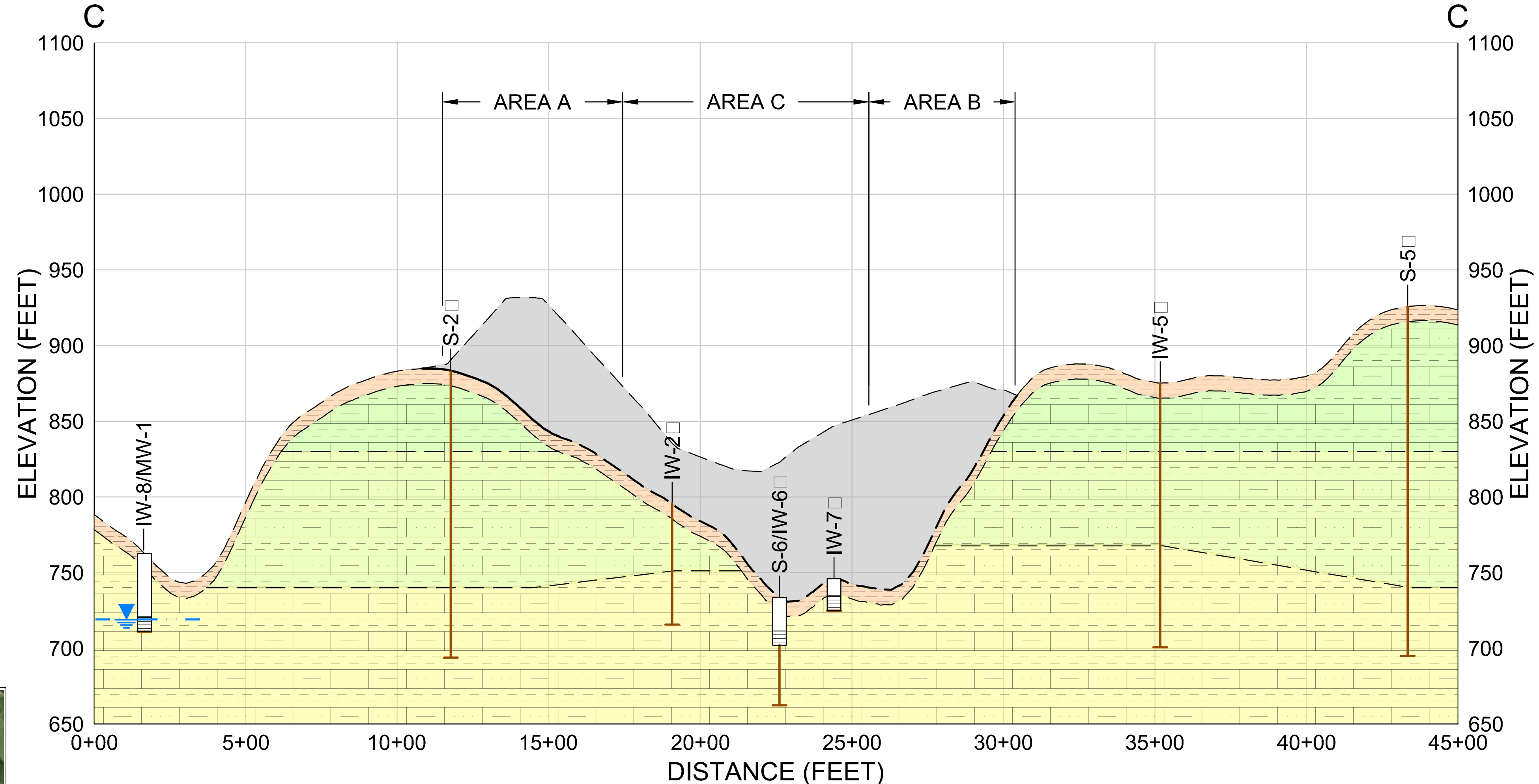
CROSS-SECTION C-C'



LEGEND

LITHOLOGIC DESCRIPTIONS

ASH

LIGHT BROWN OR RED BROWN OR BROWN SILTY CLAY, LEAN CLAY OR FAT CLAY WITH LIMESTONE PIECES

LOWER GRANT LAKE FORMATION (INTERBEDDED LIMESTONE (70-75□) WITH SHALE (25-30□))

FAIRVIEW FORMATION (INTERBEDDED LIMESTONE (55-60□) WITH SHALE (35-45□))

KOPE FORMATION (INTERBEDDED SHALE (70-80□) WITH LIMESTONE (20-30□))

PIEZOMETER / WELL

SCREEN INTERVAL

SOIL BORING

GROUNDWATER ELEVATION (17 NOVEMBER 2015)

24" SOIL LINER (1X10^{-7} CM/SEC)

CLAY / POZOTEC LAYER

ABANDONED BORING / WELL

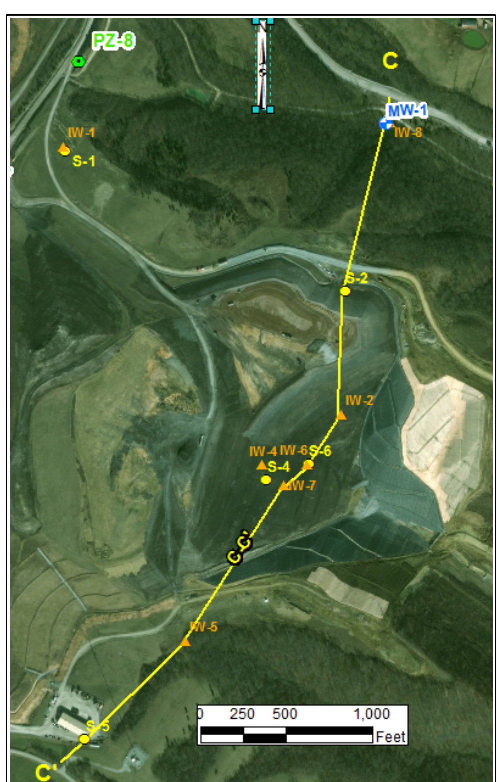
0 500□ 1000□

HORIZONTAL SCALE IN FEET

0 100□ 200□

VERTICAL SCALE IN FEET

VERTICAL EXAGGERATION = 5X



KEY MAP SECTION C-C□

NOTE:

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PREPARED BY:	PREPARED FOR:		FIGURE
Geosyntec consultants	EAST KENTUCKY POWER COOPERATIVE A Touchstone Energy Cooperative		3C
KENNESAW, GA	PRO□ECT □: GR6562	□UNE 2018	

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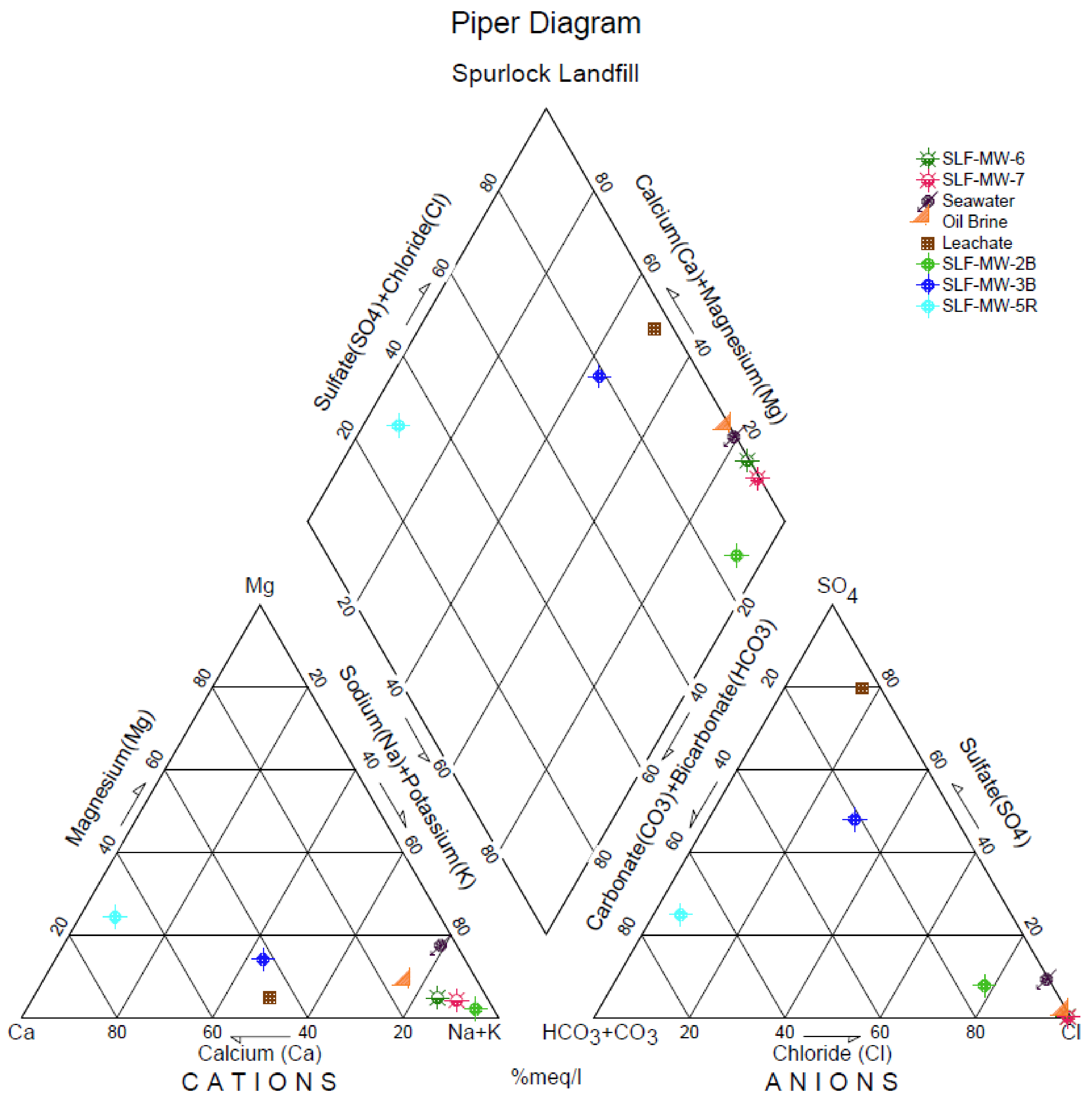
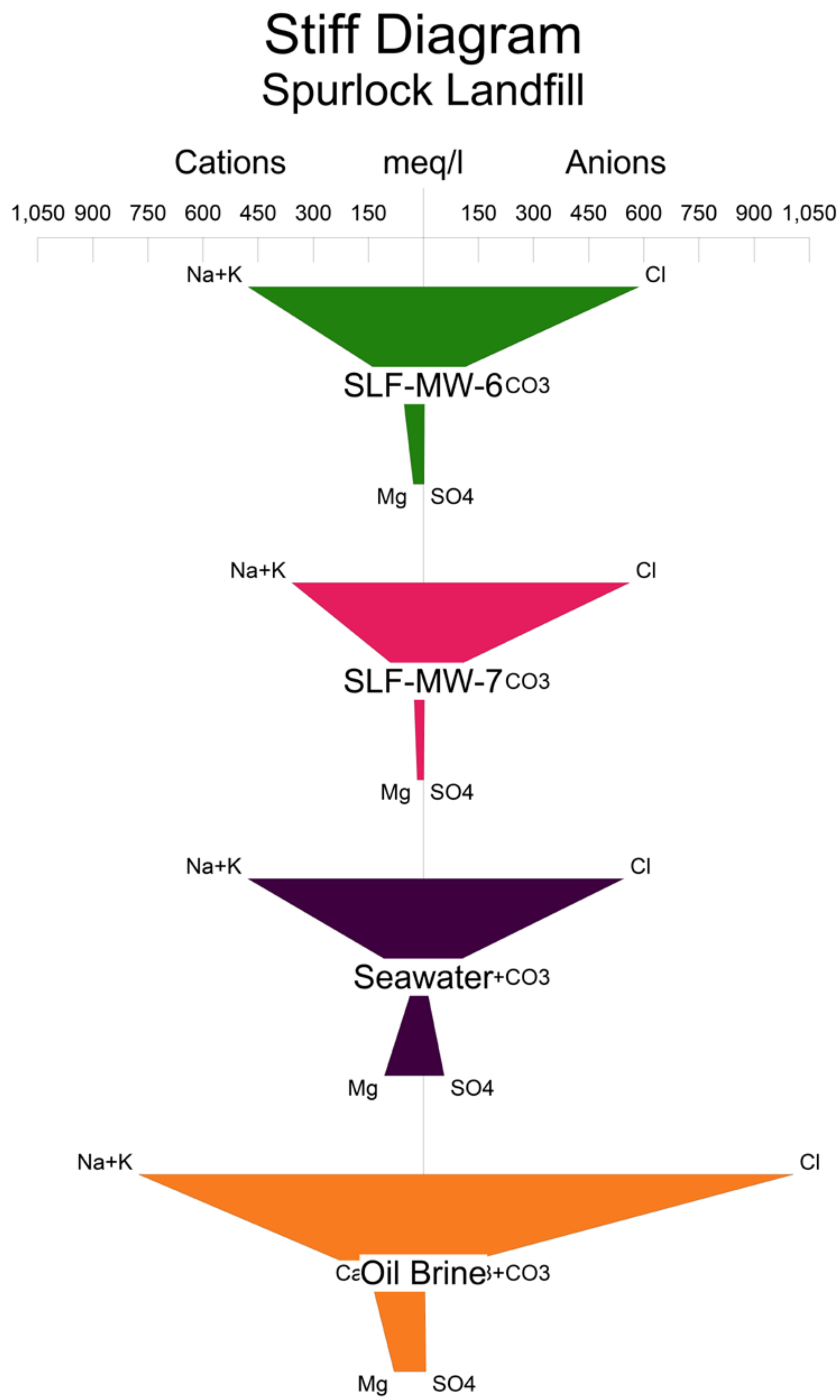


Notes: Diagram includes compositions of seawater and an oil production field brine for comparison purposes.

Piper Diagram

Spurlock Station Landfill
Maysville, Kentucky

PREPARED FOR	PREPARED BY	
EAST KENTUCKY POWER COOPERATIVE A Touchstone Energy Cooperative	Geosyntec consultants KENNESAW, GA	**Figure** **4**
PROJECT NO. GR6562	DOCUMENT NO. GA180291	



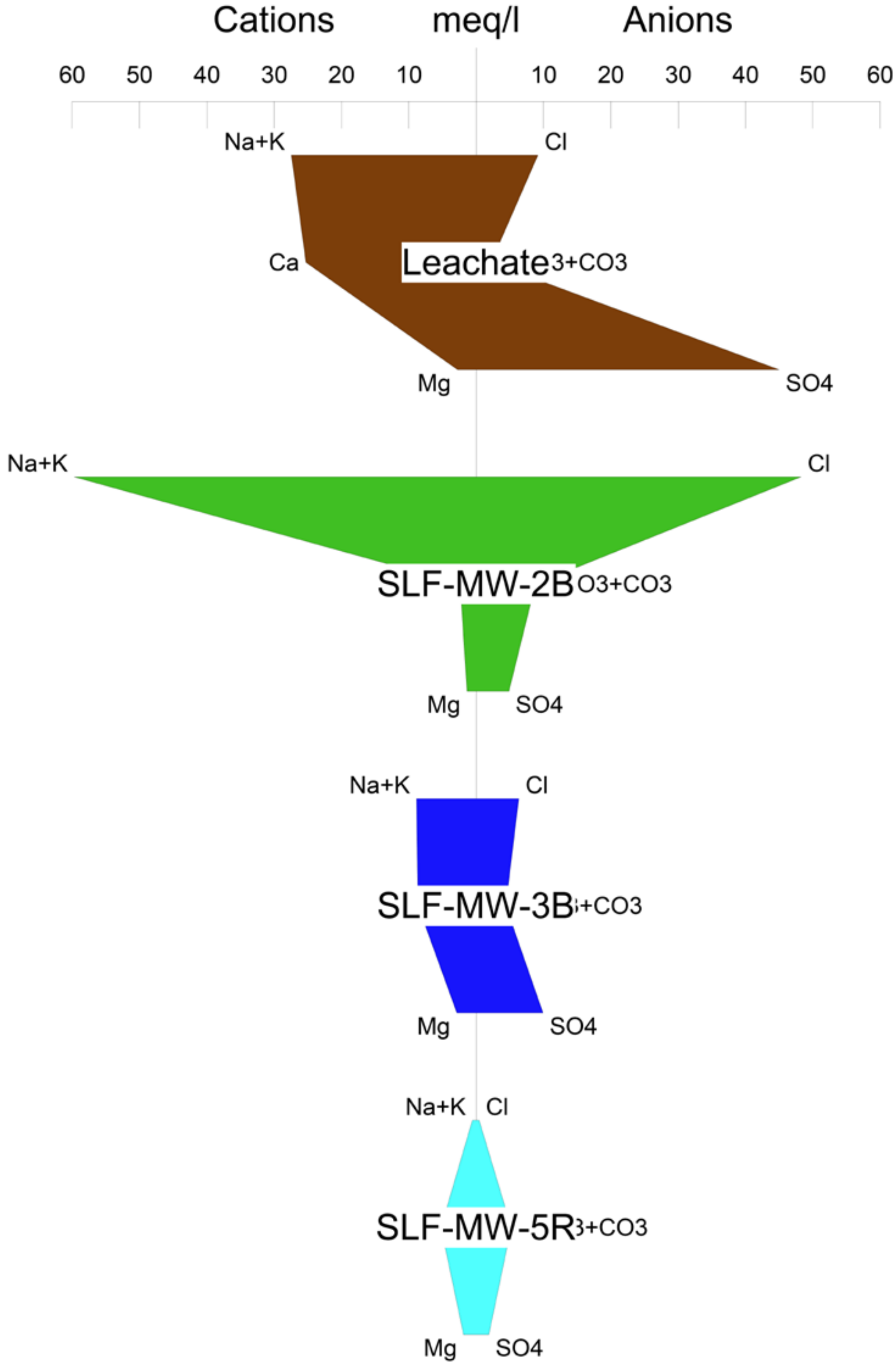
Notes: Upgradient wells MW-6 and MW-7 in comparison to seawater and an oil production field brine.

Stiff Diagram

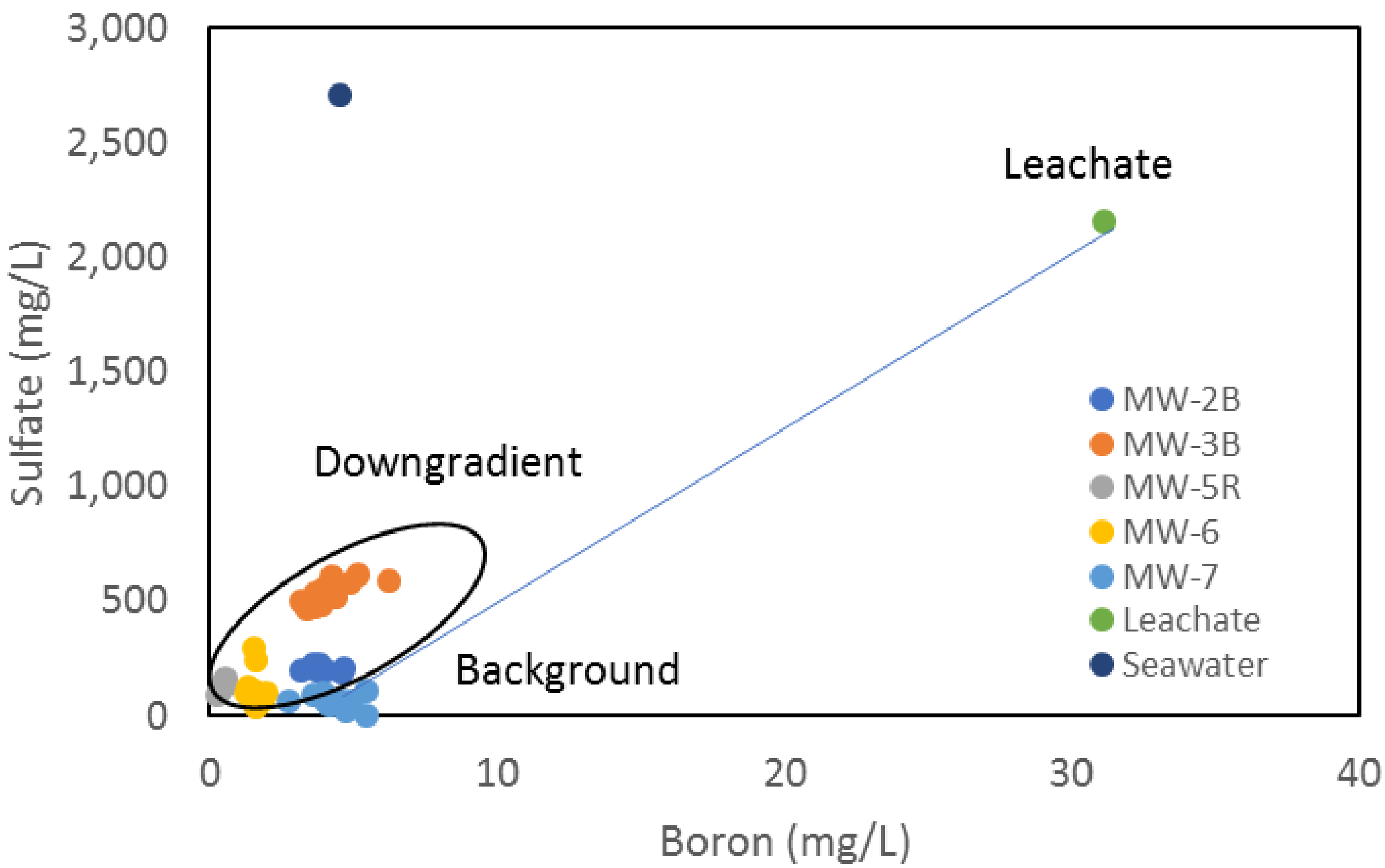
Spurlock Station Landfill
Maysville, Kentucky

PREPARED FOR	PREPARED BY	
EAST KENTUCKY POWER COOPERATIVE A Touchstone Energy Cooperative	Geosyntec consultants KENNESAW, GA	**Figure**
PROJECT NO. GR6562	DOCUMENT NO. GA180291	**5A**

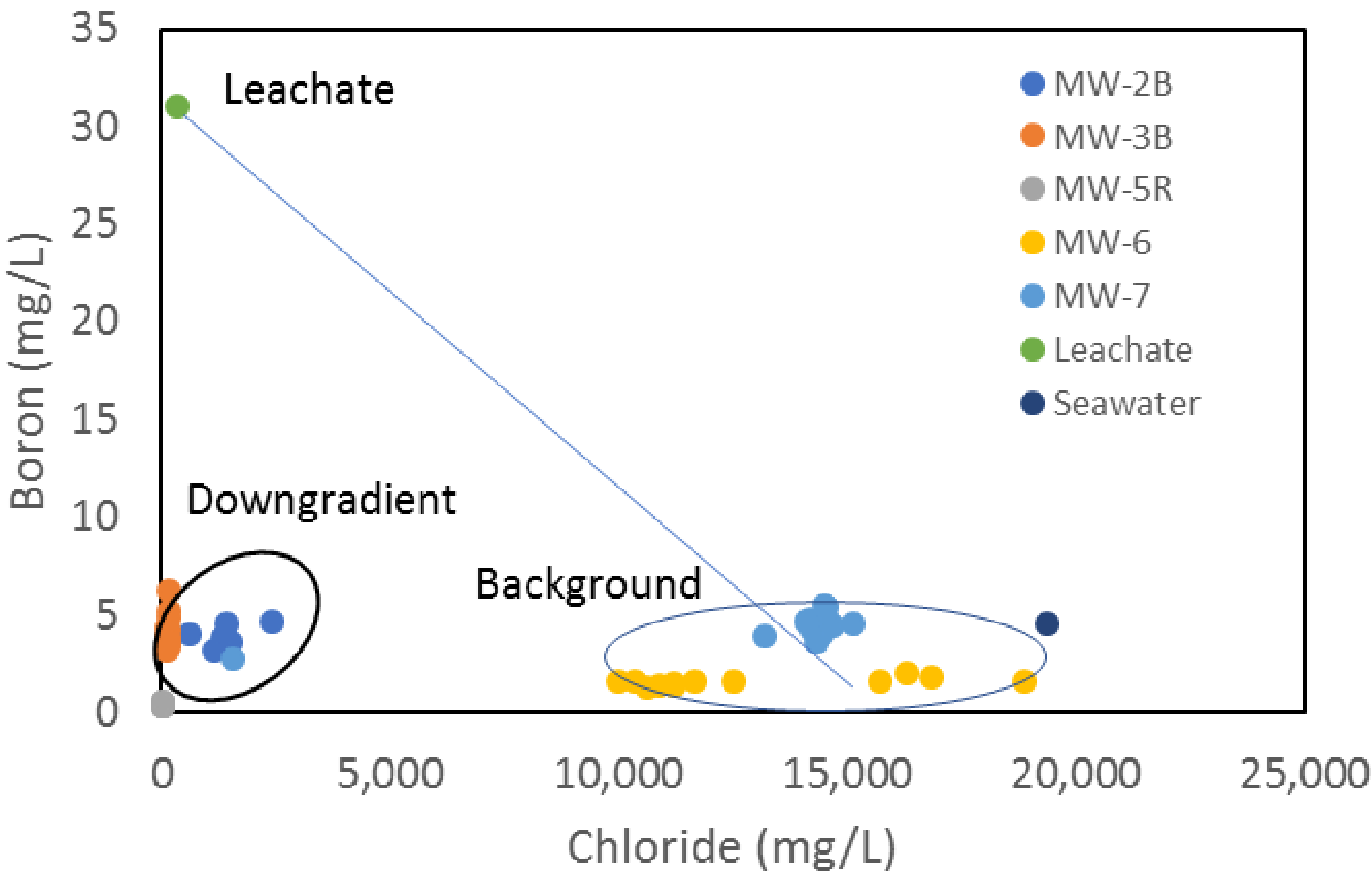
Stiff Diagram
Spurlock Landfill



Notes: CCR leachate and downgradient wells	**Stiff Diagram** Spurlock Station Landfill Maysville, Kentucky		
	PREPARED FOR EAST KENTUCKY POWER COOPERATIVE A Touchstone Energy Cooperative	PREPARED BY Geosyntec consultants KENNESAW, GA	**Figure** **5B**
	PROJECT NO. GR6562	DOCUMENT NO. GA180291	



Notes: Includes seawater for comparison purposes	**Boron versus Sulfate Binary Plot** Spurlock Station Landfill Maysville, Kentucky		
	PREPARED FOR EAST KENTUCKY POWER COOPERATIVE A Touchstone Energy Cooperative	PREPARED BY Geosyntec consultants KENNESAW, GA	**Figure** **6A**
	PROJECT NO. GR6562	DOCUMENT NO. GA180291	



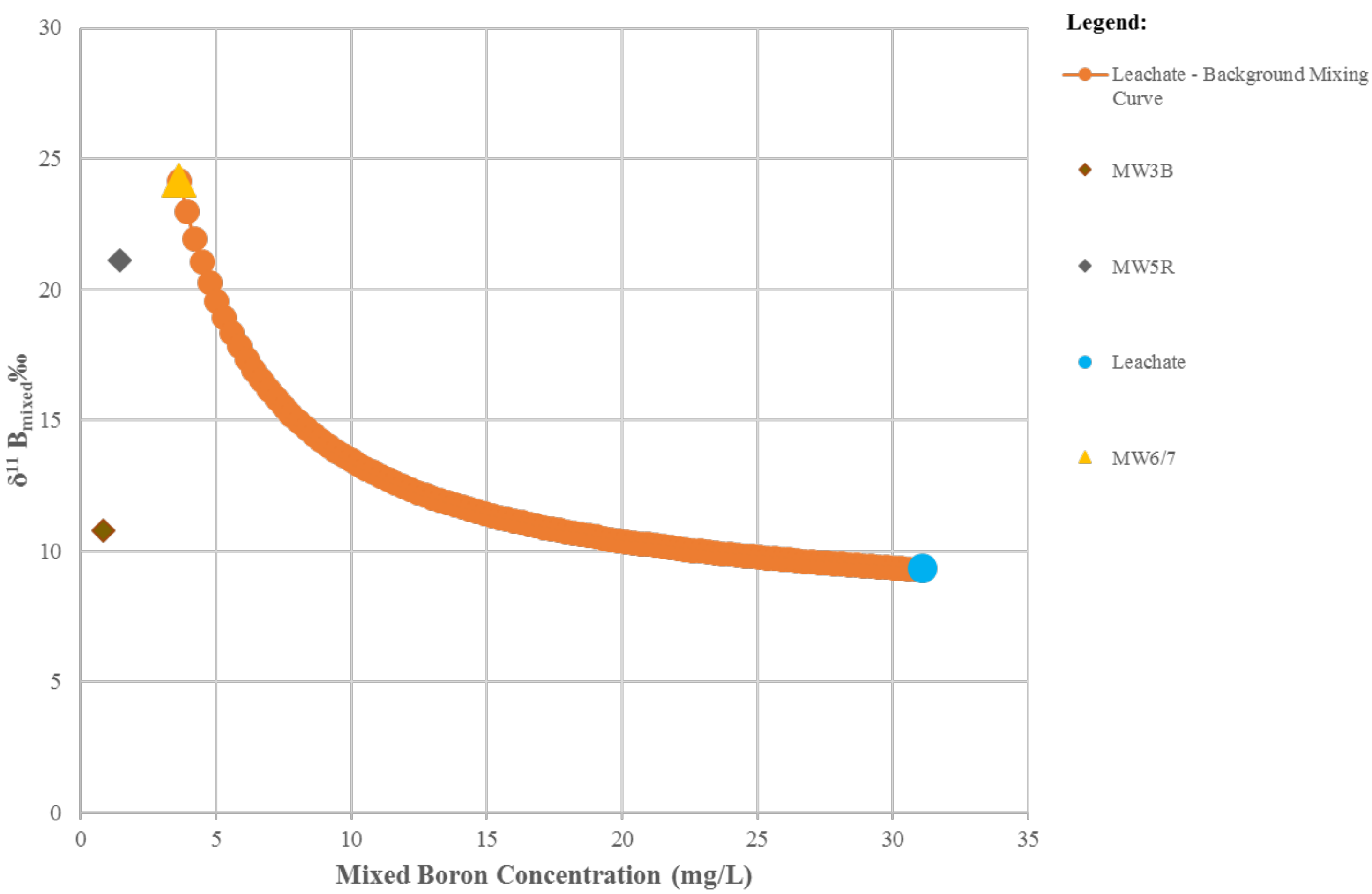
Notes: Includes seawater for comparison purposes

Boron versus Chloride Binary Plot

Spurlock Station Landfill
Maysville, Kentucky

PREPARED FOR	PREPARED BY	Figure
EAST KENTUCKY POWER COOPERATIVE A Touchstone Energy Cooperative	Geosyntec consultants KENNESAW, GA	6B
PROJECT NO. GR6562	DOCUMENT NO. GA180291	

N:\E\East Kentucky Power\Appendix III ASDs\Spurlock Landfill



Notes:

Boron Mixing Curve

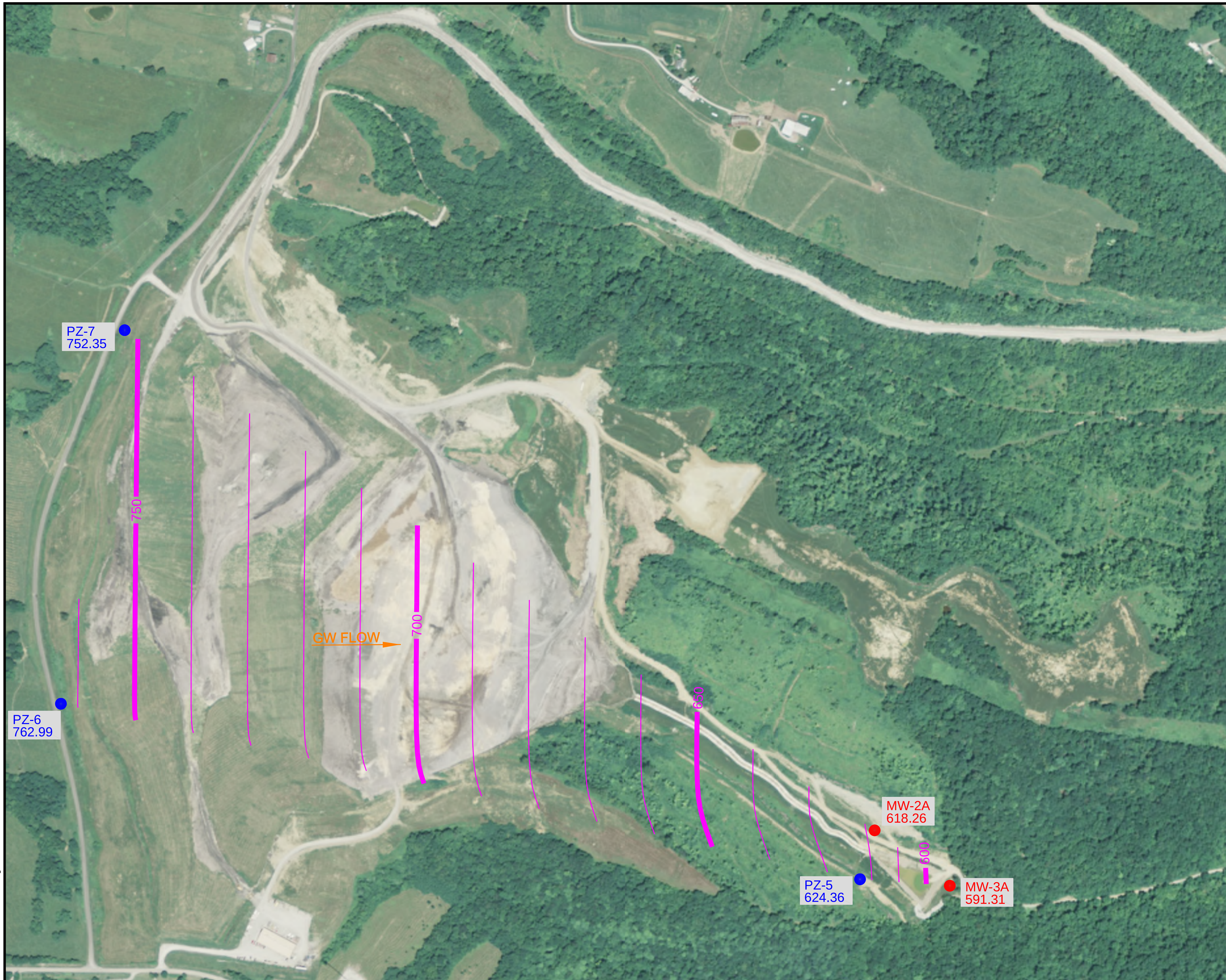
Spurlock Station Landfill
Maysville, Kentucky

PREPARED FOR	PREPARED BY	Figure
East Kentucky Power Cooperative	Geosyntec consultants KENNESAW, GA	7
PROJECT NO. GR6562	DOCUMENT NO. GA180291	

N:\E\East Kentucky Power\Appendix III ASDs\Spurlock Landfill

APPENDIX A

17 November 2015 Potentiometric Surface Map from October 2017 Tetra Tech Hydrogeologic Investigation Report



LEGEND

- PIEZOMETER
- EXISTING MONITORING WELL
- INDEX POTENTIOMETRIC CONTOUR
- INTERMEDIATE POTENTIOMETRIC CONTOUR

MW-2A INSTALLED JULY 2010
MW-3A INSTALLED OCTOBER 2010
PIEZOMETERS 5, 6, & 7 INSTALLED OCTOBER 2015

GROUNDWATER (GW) ELEVATIONS

MW/PZ	GW ELEV.
MW-2A	618.26
MW-3A	591.31
PZ-5	624.36
PZ-6	762.99
PZ-7	752.35

0 250 500
GRAPHIC SCALE, FEET

AERIAL PHOTOGRAPH, CIRCA 2014, OBTAINED FROM:

GIS Kentucky Division of Geographic Information gis.ky.gov

FIGURE 5

Potentiometric Surface Map (on November 17, 2015)
East Kentucky Power Cooperative
Spurlock Landfill
Mason County, Kentucky

TETRA TECH, INC.

424 Lewis Hargett Circle Lexington, Kentucky 40503 (859) 223-8000

200-115476-15010-P01.dwg

Prepared for

East Kentucky Power Cooperative
P.O. Box 707
Winchester, Kentucky 40392-0707

SUPPLEMENTAL

ALTERNATE SOURCE DEMONSTRATION

SPURLOCK STATION LANDFILL
MAYSVILLE, KENTUCKY

Prepared by

Geosyntec consultants

engineers | scientists | innovators

1255 Roberts Boulevard, Suite 200
Kennesaw, Georgia 30144

Project Number GR6812

December 2018

Geosyntec consultants

EAST KENTUCKY POWER COOPERATIVE
A Touchstone Energy Cooperative

SUPPLEMENTAL ALTERNATE SOURCE DEMONSTRATION

Spurlock Station Landfill
Maysville, Kentucky

December 28, 2018

Herwig Goldemund, Ph.D.
Senior Scientist

Robert Glazier
Project Director

Certification Statement

Supplemental Alternate Source Demonstration
Spurlock Station Landfill
Maysville, Kentucky
December 28, 2018

I, Scott Graves, a qualified professional engineer registered in the Commonwealth of Kentucky, certify that the above document was completed consistent with the requirements stipulated in 40 CFR 257.94(e)(2) and that the information contained herein is, to the best of my knowledge, accurate.

STATE OF KENTUCKY
SCOTT M. GRAVES
21274
LICENSED
PROFESSIONAL ENGINEER

12/28/2018

Seal and Signature | Date

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ASD	alternate source demonstration
CCR	coal combustion residual
CFR	Code of Federal Regulations
EKPC	East Kentucky Power Cooperative
H&A	Haley & Aldrich, Inc.
mg/L	milligram per liter
P.E.	professional engineer
SSI	statistically significant increase
U.S. EPA	United States Environmental Protection Agency
UTL	upper tolerance limit

1. INTRODUCTION

1.1 Purpose

Geosyntec Consultants, Inc. (Geosyntec) previously prepared an Alternate Source Demonstration (ASD) Report for East Kentucky Power Cooperative's (EKPC's) Coal Combustion Residuals (CCR) Landfill Unit at the Spurlock Generating Station in Maysville, Kentucky (referred to herein as the site, the landfill, and the CCR Unit). The ASD demonstrated that a source other than the regulated CCR Unit was responsible for the statistically significant increase (SSI) above background for sulfate detected during the November 2017 Detection Monitoring Program sample collected from the downgradient compliance well MW-3B. An additional SSI above background for sulfate in MW-3B was subsequently detected in the May 2018 Detection Monitoring event sample. This report constitutes a Supplemental ASD to demonstrate that the SSI for the May 2018 sample is consistent with the previous findings and does not indicate a release from the regulated CCR Unit.

1.2 Regulatory Framework

The Federal CCR Rule provides an opportunity under Title 40 Code of Federal Regulations (CFR) Part 257.94(e)(2) for the owner/operator of a regulated CCR Unit to demonstrate that an SSI above background concentrations of Appendix III constituents during the Detection Monitoring Program is from a source other than the CCR Unit. An SSI for one or more Appendix III constituents is a potential indication of a release of CCR constituents to groundwater. If it can be demonstrated that the SSIs are due to an error (i.e., sampling error, laboratory error, statistical analysis error), due to natural variation in groundwater quality, or due to an alternate source (other than the regulated CCR Unit) for the constituents in groundwater, then the CCR Unit may remain in the Detection Monitoring Program. If a successful ASD is not made, then the CCR Unit must initiate an Assessment Monitoring Program. The Federal CCR Rule does not contain requirements nor reference agency guidance for a successful ASD other than certification of its accuracy by a Professional Engineer.

1.3 Site Background

A description of the site, its operational history, groundwater monitoring system, Detection Monitoring Program, Conceptual Site Model, and the geochemical forensics that were previously completed in the initial ASD for the first Detection Monitoring event samples, are given in the *Alternate Source Demonstration, Spurlock Station Landfill,* *Maysville, Kentucky*, prepared by Geosyntec in July 2018. At least eight baseline monitoring program events (October 2016 through August 2017) were completed at all background and compliance monitoring wells for Appendix III constituents. Statistical estimates of the upper end of the range of background concentrations were calculated and presented in the *Summary of Appendix III Semi-Annual Groundwater Detection Monitoring Statistical Evaluation, East Kentucky Power Cooperative, H.L. Spurlock Generating Station Landfill, Maysville, Kentucky*, prepared by Haley and Aldrich in April 2018 using the baseline monitoring event data from the two background wells. The background concentrations were calculated using the Upper Tolerance Limit (UTL) method as described in the U.S. Environmental Protection Agency's (USEPA) 2009 *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance* (Unified Guidance). The calculated background UTLs are provided in **Table 1** together with a summary of the sampling results for downgradient compliance wells.

The first round of Detection Monitoring Program groundwater samples for Appendix III constituents was collected in November 2017 after the baseline sampling program was completed. The subject of this report is the second round of Detection Monitoring Program well samples that were collected in May 2018. Sampling locations are shown on **Figure 1**.

2. ALTERNATE SOURCE DEMONSTRATION

2.1 May 2018 Statistically Significant Increases

Calculated background UTLs were compared to the results of the second Detection Monitoring Program samples (May 2018) at the three downgradient compliance wells. No SSIs were detected at any compliance monitoring wells for boron, calcium, chloride, fluoride, pH, or total dissolved solids (TDS). An SSI above the background UTL was detected for sulfate in monitoring well MW-3B. The same SSI in the same monitoring well was previously identified for the November 2017 samples and addressed by the initial ASD Report. For each compliance well, **Table 1** presents the calculated background UTLs, the May 2018 sample concentrations, the previous November 2017 sample concentrations, and the maximum sample concentrations detected for samples collected during the baseline sampling events. The November 2017 and prior sample results were all considered by the initial ASD.

2.2 Alternate Source Demonstration

The initial ASD Report showed that the SSI for sulfate detected in monitoring well MW-3B during the November 2017 Detection Monitoring sampling event was attributed to a source other than the regulated CCR Unit. Therefore, any subsequent SSIs that have concentrations less than the prior maximum baseline monitoring concentrations are considered to not be indicative of a release from the CCR Unit. The May 2018 SSI for sulfate at MW-3B is less than the concentration in the November 2017 SSI sample and also less than the previous maximum baseline concentrations. Therefore, conditions during May 2018 are not due to a release from the CCR Unit.

An additional line of evidence is provided by constituent binary diagrams that were among the geochemical forensic tools used in the first ASD. Binary diagrams were used to visualize the data collected for highly mobile Appendix III constituents, including the eight baseline monitoring events, the first Detection Monitoring event (November 2017), and an additional March 2018 monitoring event that supported the first ASD. The binary plots show chemical fingerprints for background and leachate samples, as well as the downgradient compliance wells. They also allow evaluation of mixing of various waters. Updated binary plots are provided on **Figures 2A** and **2B** for pairs of highly mobile constituents, including boron vs. sulfate and boron vs. chloride. Each diagram has a mixing line formed by the concentrations in each of the two background wells and the concentration in leachate. If the concentration detected in a downgradient compliance wells resulted from a release of leachate into shallow groundwater, it would plot along the mixing line. **Figures 2A** and **2B** show that the May 2018 data for MW-3B, as well as all prior data for MW-3B, do not plot along the mixing line. Therefore, the composition detected in samples from the compliance wells in May 2018 cannot be produced by mixing CCR leachate with background groundwater. The May 2018 Detection Monitoring samples plot within the same domains as the previous samples at their respective wells. Therefore, the SSIs detected in May 2018 samples are derived from the same alternative source as the November 2017 samples, and are not due to a release of leachate from the regulated CCR Unit.

3. CONCLUSIONS

The only SSI in both the November 2017 and the May 2018 Detection Monitoring Program events was sulfate in compliance well MW-3B. The sulfate concentration detected in the May 2018 sample is less than previous baseline maximum concentrations that were considered by the initial ASD and determined not to indicate a release from the CCR Unit. In addition, the binary plots of Appendix III constituents indicate that the major solute compositions detected in samples from MW-3B cannot be derived from mixing of background groundwater with leachate from the regulated CCR Unit and therefore provide another convincing line of evidence that the SSI in the May 2018 sample are not due to a release of CCR leachate from the regulated Unit.

TABLE

Table 1 - Summary of Detection Monitoring Program Data

Supplemental Alternate Source Demonstration, Federal CCR Rule

Spurlock Station Landfill, Maysville, Kentucky

Constituent	Upper Tolerance Limit	MW-2B			MW-3B			MW-5R		
		May 2018	Nov. 2017	Baseline Maximum	May 2018	Nov. 2017	Baseline Maximum	May 2018	Nov. 2017	Baseline Maximum
Boron	5.464	4.370	4.567	4.817	2.650	3.860	6.242	0.517	0.524	0.550
Calcium	1,250.847	44.100	37.641	61.316	171.000	204.990	254.980	118.000	136.418	123.97
Chloride	18,841	1,870	1,421	1,768	179	152	171	25.5	24.5	33.6
Fluoride	2.5	2.2	2.0	2.6	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
pH	8.855	7.560	7.660	9.000	7.090	7.120	7.610	6.940	7.100	7.340
Sulfate	441	200	192	359	**454**	**483**	615	158	158	143
Total Dissolved Solids	41,052	3,910	3,072	3,567	1,210	1,208	1,410	591	549	556

All concentrations are in milligrams per liter (mg/L).

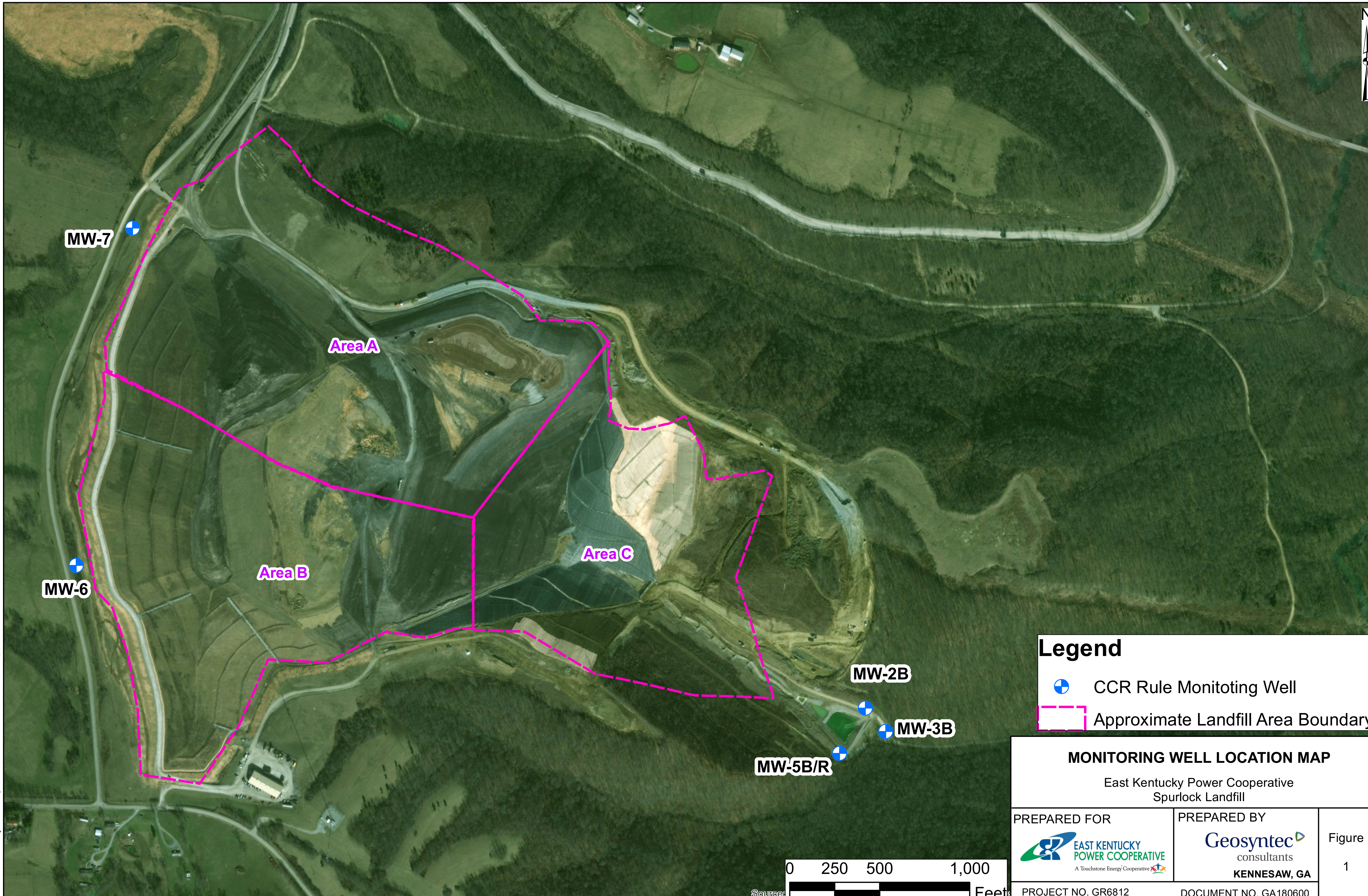
UTL - 95% Upper Tolerance Limit developed by Haley & Aldrich.

Bold value indicates statistically significant increase above background UTL for November 2017 and May 2018 Detection Monitoring Program samples.

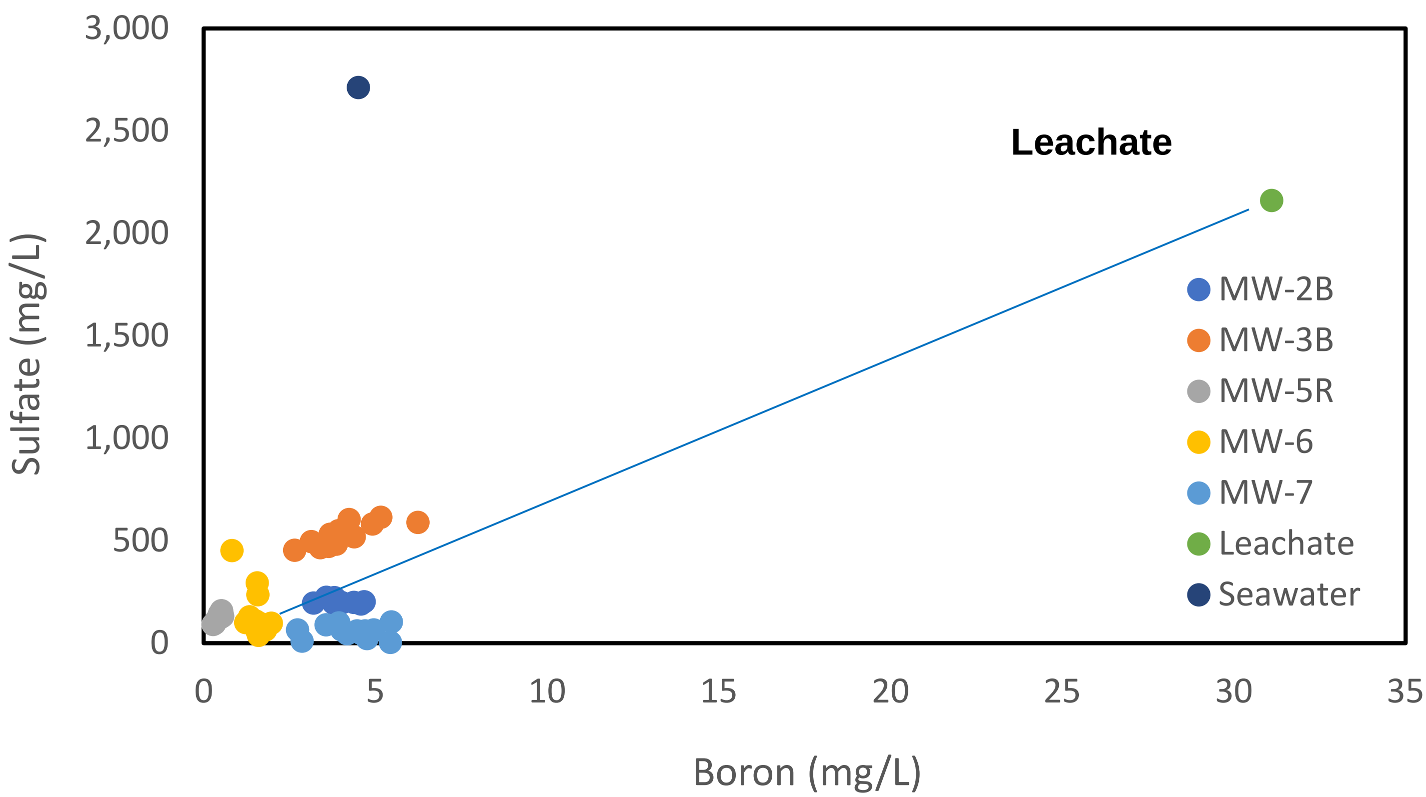
Shaded value is greater than the May 2018 sample result; shading not shown if May 2018 sample result is not an SSI.

Sample results provided by East Kentucky Power Coop.

FIGURES



N:\E\East Kentucky Power\Spurlock Landfill\GIS\MXD\Monitoring Well Location Map.mxd

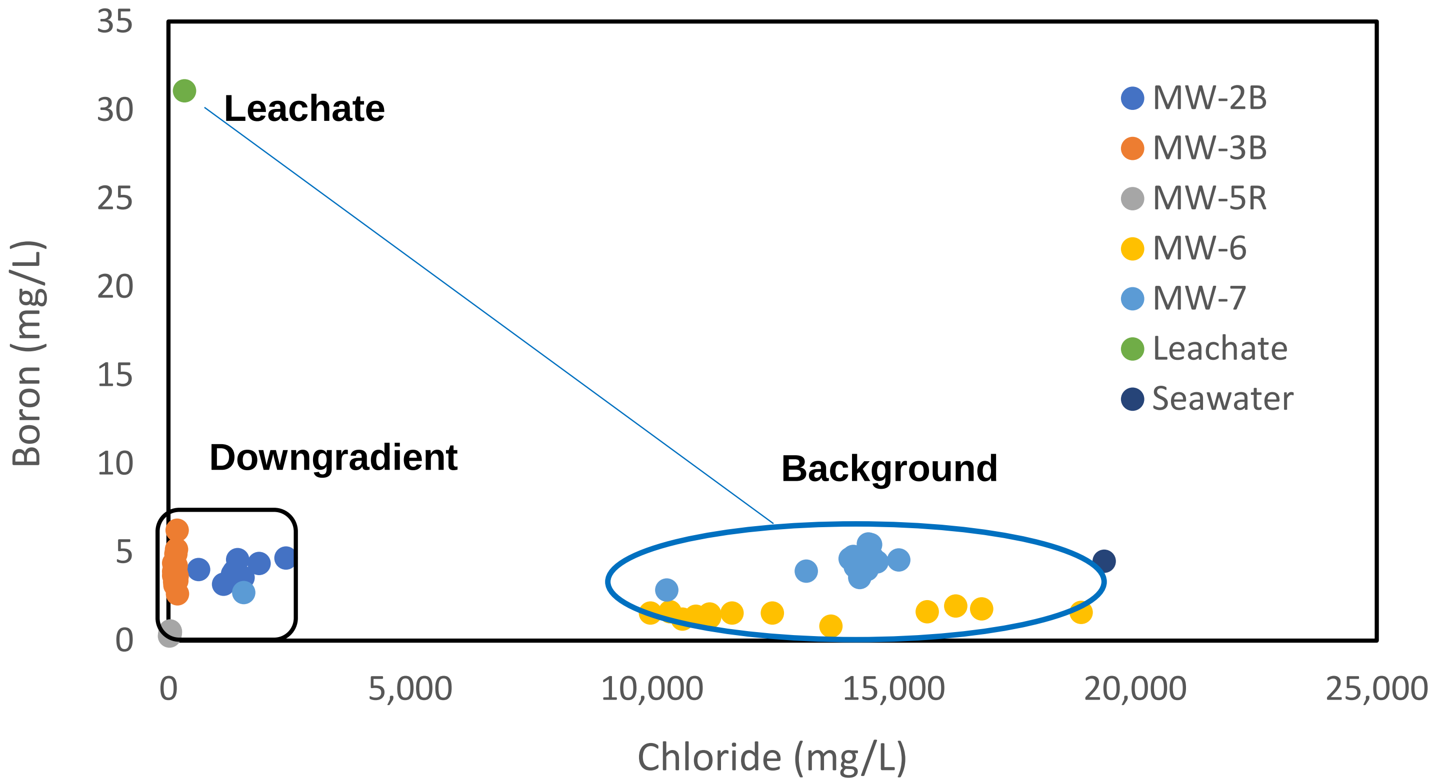


Notes: Includes seawater for comparison purposes

Boron - Sulfate Binary Plot

Spurlock Station Landfill
Maysville, Kentucky

PREPARED FOR	PREPARED BY	Figure
EAST KENTUCKY POWER COOPERATIVE A Touchstone Energy Cooperative	Geosyntec consultants KENNESAW, GA	2A
PROJECT NO. GR6812	DOCUMENT NO. GA180600	



Notes: Includes seawater for comparison purposes

Boron - Chloride Binary Plot

Spurlock Station Landfill
Maysville, Kentucky

PREPARED FOR	PREPARED BY	Figure
EAST KENTUCKY POWER COOPERATIVE	Geosyntec consultants KENNESAW, GA	2B
PROJECT NO. GR6812	DOCUMENT NO. GA180600	