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TECHNICAL MEMORANDUM

To: **Mr. Dennis Laybourn**
Senior Environmental Manager

From: **Brian Wellington**

Project: **CCR Landfill, TS Power Plant Project**

Project No: **475.0221**

Subject: **Background Analysis Update**

Date: **November 26, 2018**

1. INTRODUCTION

In 2016 a background analysis was performed for Newmont Nevada Energy Investment to characterize background concentration limits of various chemical constituents in ground water at its TS Power Plant Ash Landfill. The analysis was updated in 2017 after the collection of additional background data. During both the 2016 and 2017 analysis, well TSMW-8 had limited data for analysis. Currently additional data has been collected in 2018 for all wells including TSMW-8. This report provides the results of an updated analysis of background data from well TSMW-8.

2. METHODOLOGY

The upper background limit (UBL) of all data are calculated as the 95% upper tolerance limit with 95% coverage. The UBL are based on the underlying population of the data. Where the underlying population cannot be identified, a non-parametric method was used for analysis. The UBL analysis was performed using ProUCL (USEPA, 2015).

Prior to determination of background concentration limits for groundwater constituents, the consistency of existing groundwater data relative to the underlying statistical assumptions was examined. Specifically, a background dataset must often meet the following criteria:

1. Data independence: Each measured concentration is independent of other measurements in the same dataset.
2. Temporal Stationarity: The statistical properties of the background dataset, including its mean and standard deviation, should not exhibit secular (increasing or decreasing) temporal trends.

The statistical procedures used to assess the suitability of the groundwater data set for background analysis are described in the prior background analysis memorandum (NewFields 2016). All computations are performed using the IBM SPSS version 19.0 (SPSS, 2010) software.

3. RESULTS

3.1. Data Description

The investigated background dataset consists of groundwater data for the following analytes, in well TSMW-8: Arsenic, Barium, Boron, Calcium, Chloride, Fluoride, Selenium, Sulfate, Total Dissolved Solids (TDS). Data used in the analysis were sampled during the period October 2015 to October 2018. A summary of the data is provided in Table 1.

Table 1: Descriptive Statistics of Analysis Data

Analyte	Minimum	Maxiumum	Average	Count
Arsenic	0.013	0.015	0.014	13
Barium	0.034	0.068	0.042	13
Boron	0.205	0.235	0.221	13
Calcium	63.4	77.9	70.9	13
Chloride	104.0	150.0	132.2	13
Fluoride	0.655	0.966	0.768	13
Selenium	0.005	0.007	0.006	13
Sulfate	153	202	182	13
TDS	620	757	689	13

3.2. Data Independence

A summary of the first lag correlation results for each analyte using all existing data at each well is shown in Table 2 and data with significant correlations are highlighted.

Table 2: Calculated first lag correlation coefficient significance levels for constituents. Highlighted values are significant at 5% level

Analyte	Significance
Arsenic	0.465
Barium	0.225
Boron	0.232
Calcium	0.004
Chloride	0.032
Fluoride	0.273
Selenium	0.468
Sulfate	0.119
TDS	0.707

As indicated in Table 2 with the exception of Calcium and Chloride all analytes measured in well TSMW-8 show no significant autocorrelations and thus exhibit data independence. In the case

of Calcium and Chloride which do exhibit significant autocorrelations, the samples are collected with a quarterly sampling interval, this is the minimum recommended interval to avoid the possibility of autocorrelation. It can therefore be concluded that in; general, the groundwater data are independent and suitable for background analysis.

3.3. Temporal Stationarity

The secular trends results based on all existing data and calculated using the Mann-Kendall test are provided in Table 3.

Table 3: Mann-Kendall secular trend results for analyte concentrations within wells showing a statistically significant trend. Highlighted values are significant at 5% level.

Analyte	Kendall's Tau	Significance	Count
Arsenic	-0.065	0.380	13
Barium	-0.710	0.000	13
Boron	0.390	0.033	13
Calcium	0.821	0.000	13
Chloride	0.872	0.000	13
Fluoride	-0.487	0.010	13
Selenium	0.040	0.427	13
Sulfate	0.692	0.000	13
TDS	0.597	0.002	13

Various constituents appear to exhibit significant trend. However, TSMW-8 was installed on October 15, 2015 and the initial measurements in newly installed wells tend to be unstable. An analysis of trends in data collected in 2018 show no significant trends, Table 4, indicating that the measurements in TSMW-8 are currently stable.

Table 4: Mann-Kendall secular trend results for analyte concentrations within wells showing a statistically significant trend. Highlighted values are significant at 5% level. (Post 2018 Data)

Analyte	Kendall's Tau	Significance	Count
Arsenic	0.333	0.248	4
Barium	0.667	0.087	4
Boron	0.183	0.359	4
Calcium	-0.333	0.248	4
Chloride	0.333	0.248	4
Fluoride	-0.333	0.248	4
Selenium	0.183	0.359	4
Sulfate	-0.333	0.248	4
TDS	0.333	0.248	4

3.4. Upper Background Limit

The UBL results and the method of analysis as recommended by ProUCL is presented in Table 5.

Table 5: Upper Background Limit of Constituents Measured in Well TSMW-8

Analyte	95UTL	Method
Arsenic	0.016	Normal
Barium	0.068	HW Approx. Gamma UTL
Boron	0.242	Normal
Calcium	82.3	Normal
Chloride	166.3	Normal
Fluoride	1.0	Normal
Selenium	0.008	Normal
Sulfate	214.9	Normal
TDS	804.7	Normal

A Plot of the existing data and UBL are shown in Appendix A.

4. CONCLUSIONS

The existing groundwater data in TSMW-8 are currently stable and suitable for determining background concentration limits for analytes to be monitored under the Coal Combustion Residuals (CCR) Rule. The upper background limits for groundwater concentrations for monitoring well TSMW-8 have been recalculated based on the current dataset and are provided in the report.

5. REFERENCES

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold, New York, NY

Helsel, D.R., Hirsch, R.M., 1995. Statistical Methods in Water Resources. Elsevier.

NewFields 2016, Technical Memorandum CCR Landfill, TS Power Plant Background Analysis NewFields Job No. 475.0221, June 10, 2016.

Salas, J.D., 1993, Analysis and modeling of hydrologic time series; in Maidment, D.R., ed., Handbook of Hydrology, McGraw-Hill, New York.

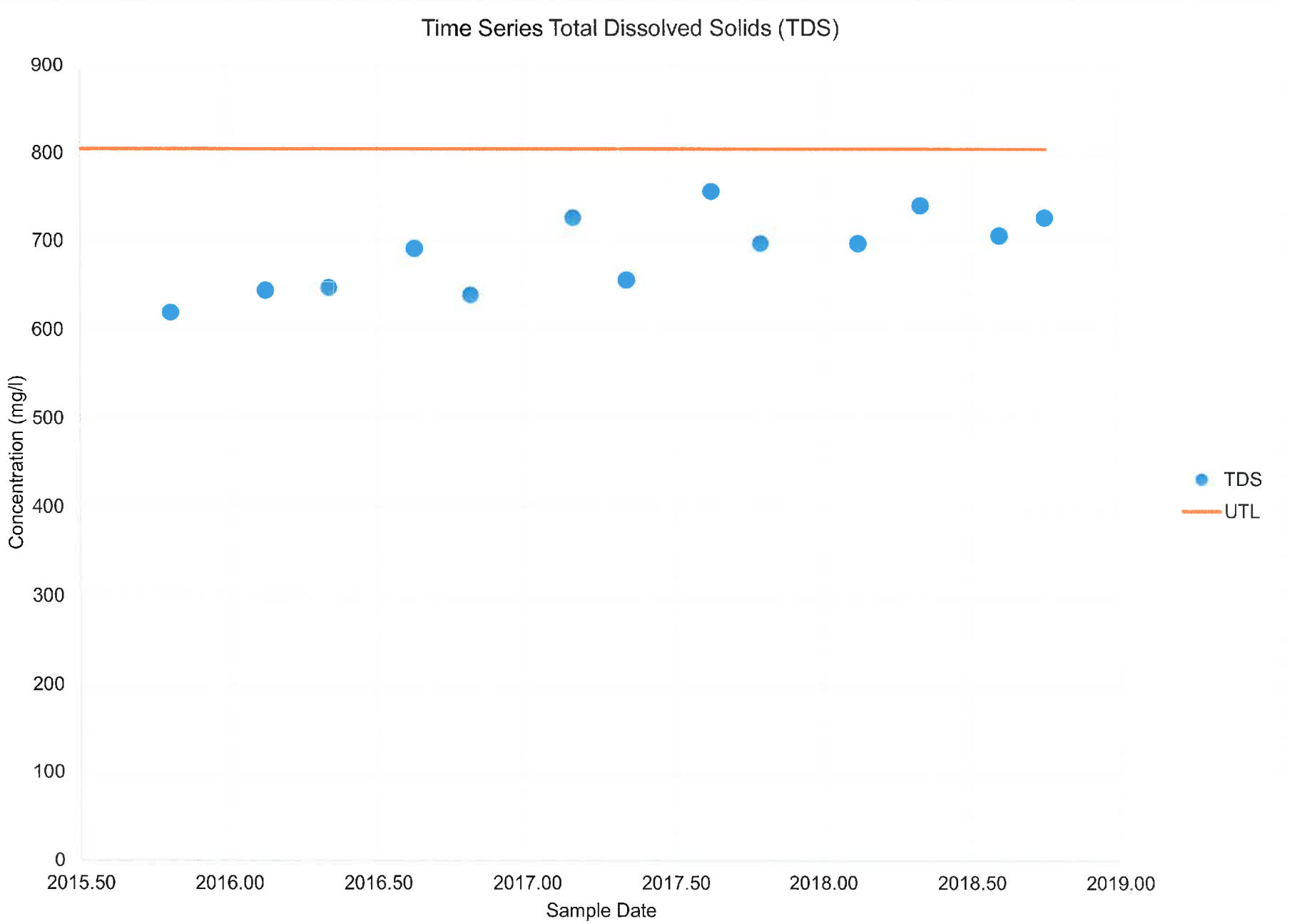
USEPA, 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities Unified Guidance, EPA 530/R-09-007. Office of Resource Conservation and Recovery Program Implementation Division.

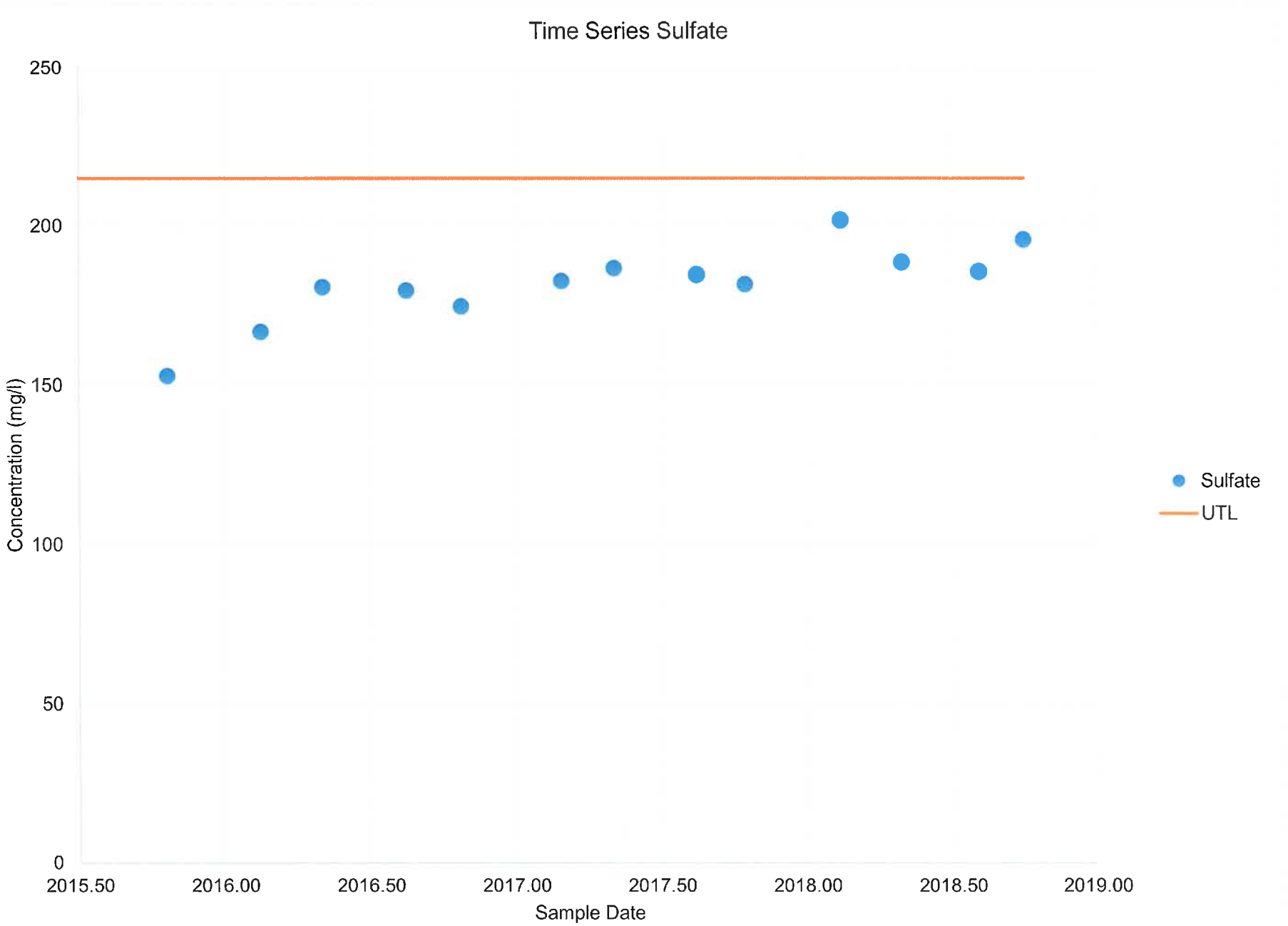
USEPA, 2015. ProUCL Version 5.1.002 User Guide Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations, EPA/600/R-07/041. Office of Research and Development Washington, Washington, D.C.

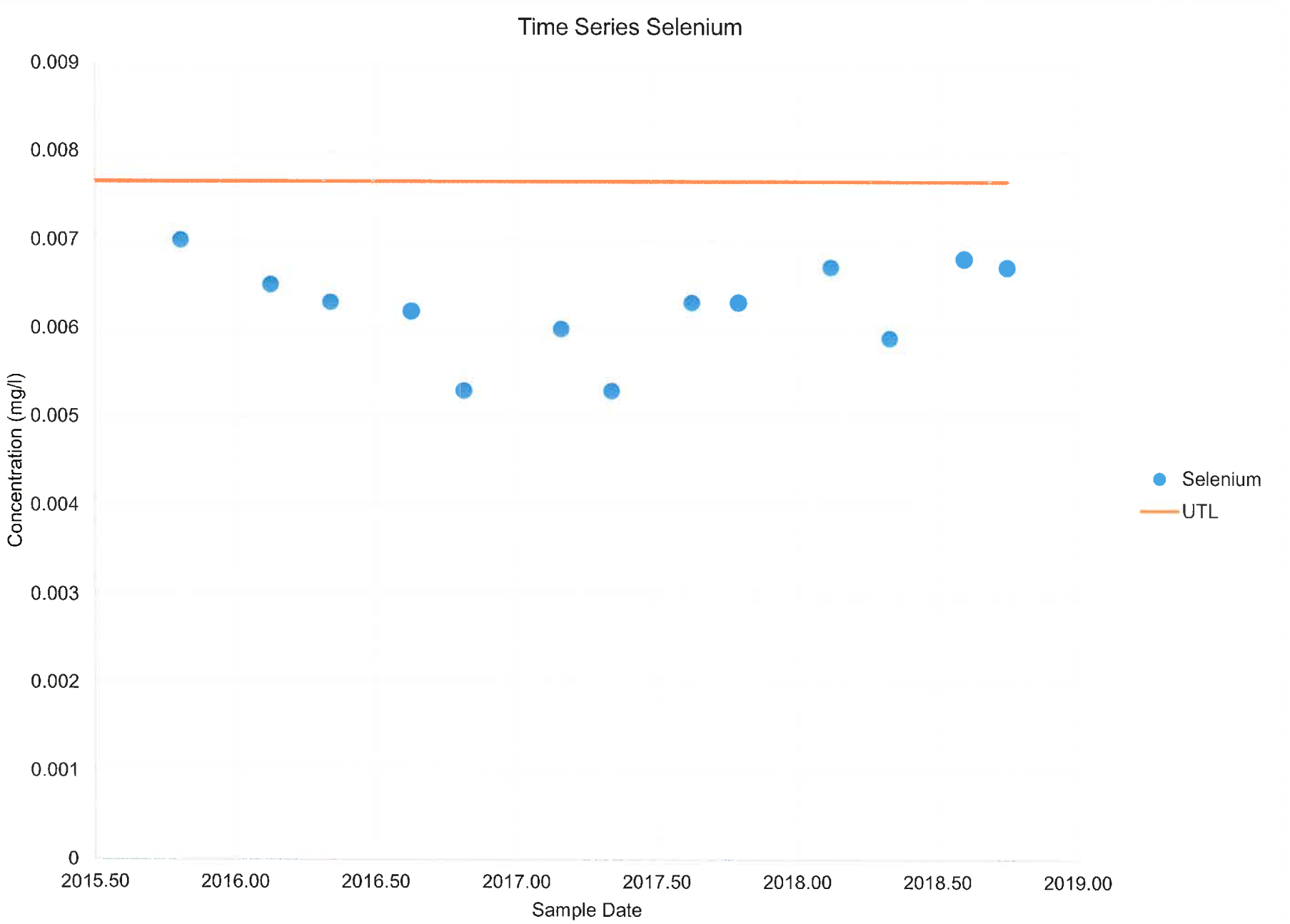
Appendix A

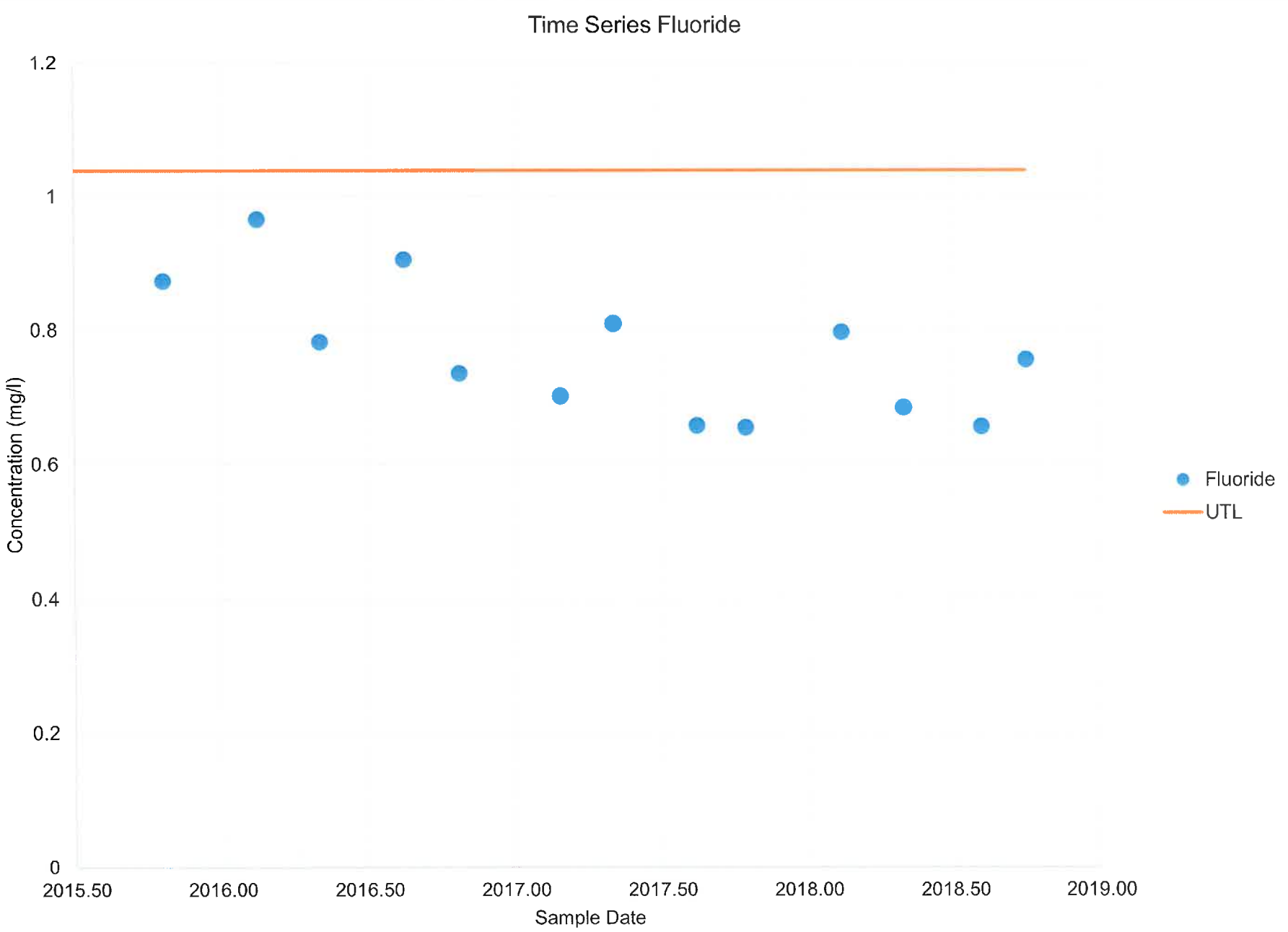
TSMW-8

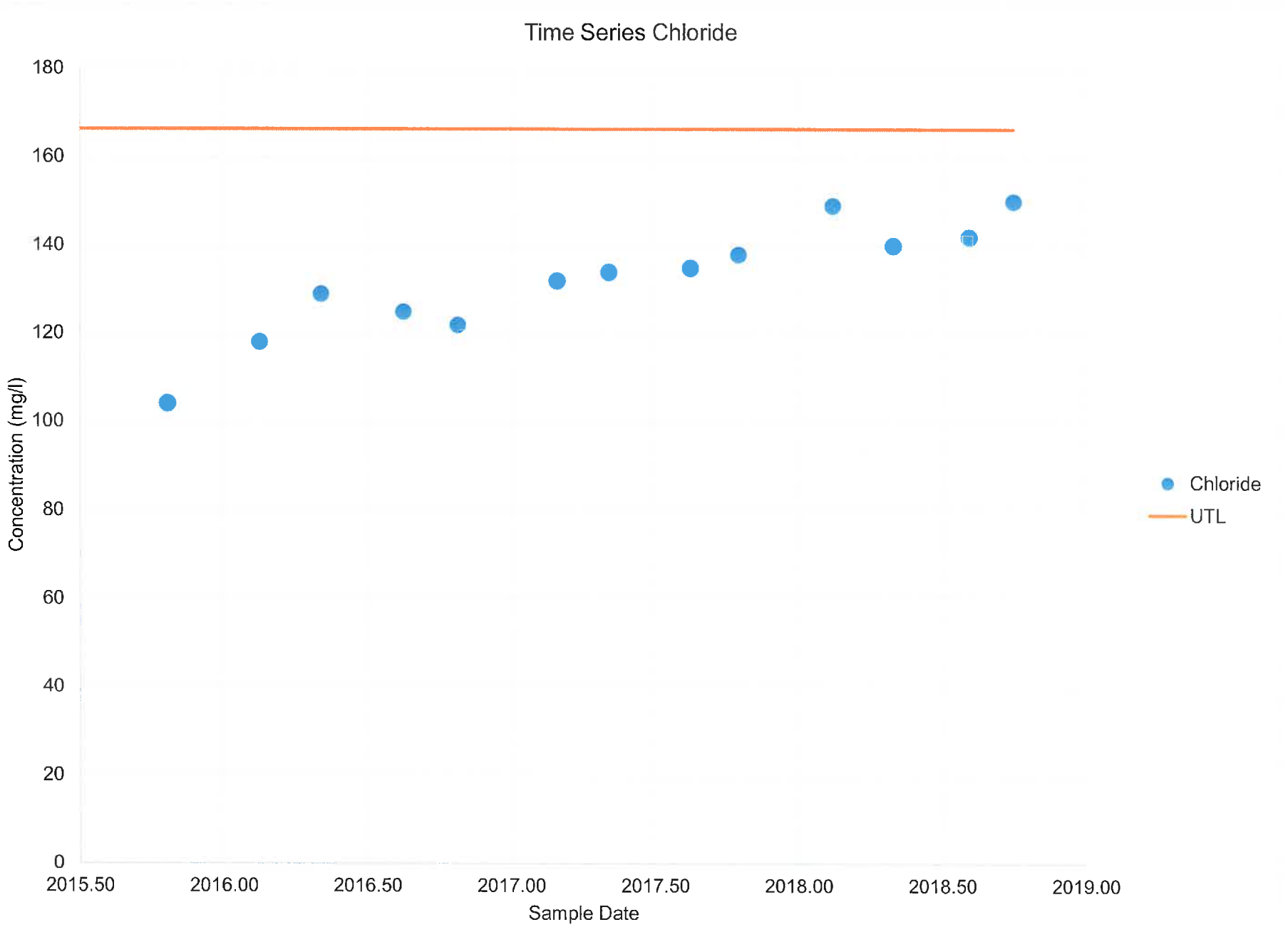
Time Series Plots of Analytes and Upper Background Limits

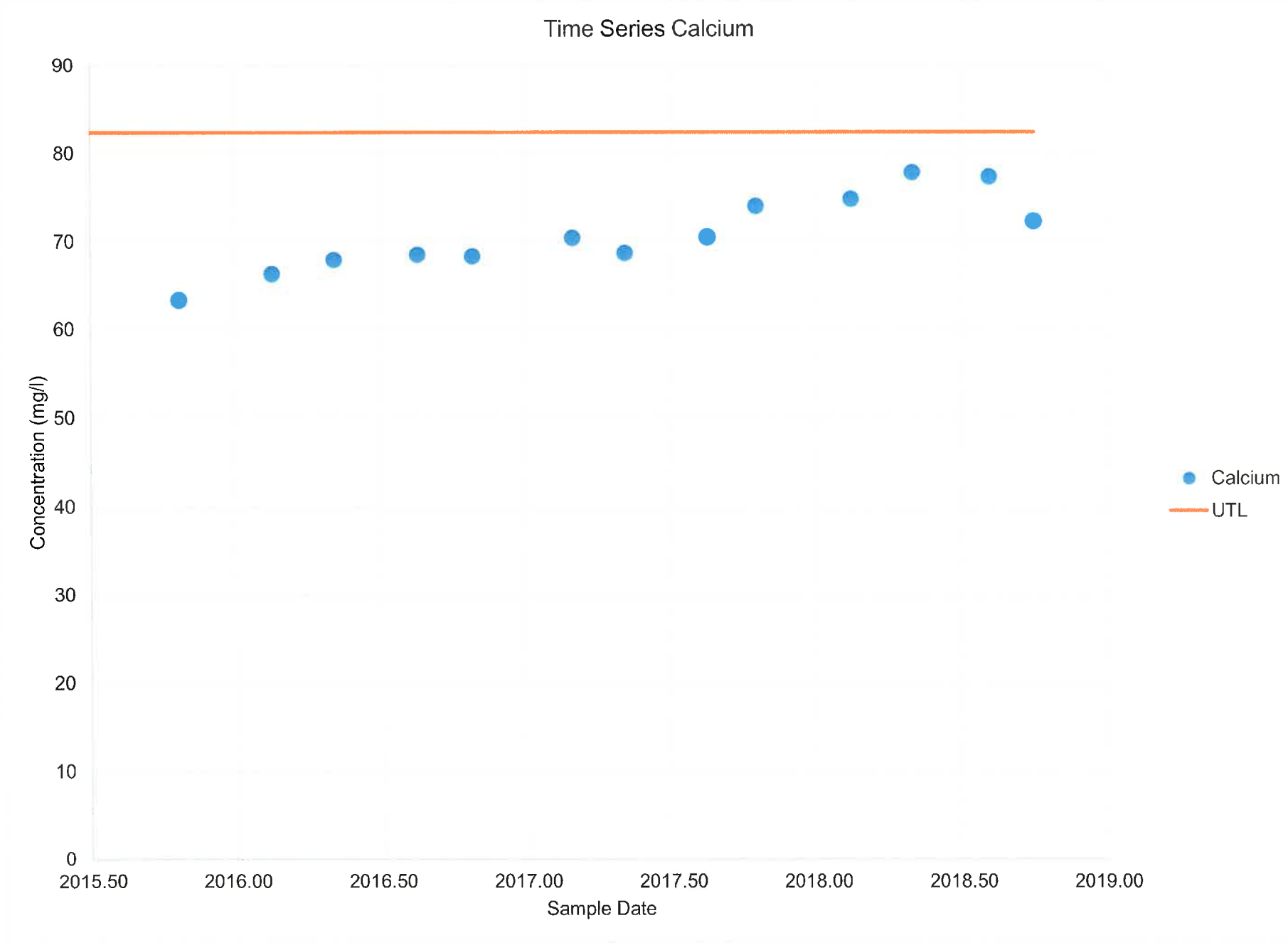

Time Series Total Dissolved Solids (TDS)
900
800
700
600
500
400
300
200
100
0
Concentration (mg/l)
2015.50
2016.00
2016.50
2017.00
2017.50
2018.00
2018.50
2019.00
Sample Date
TDS
UTL

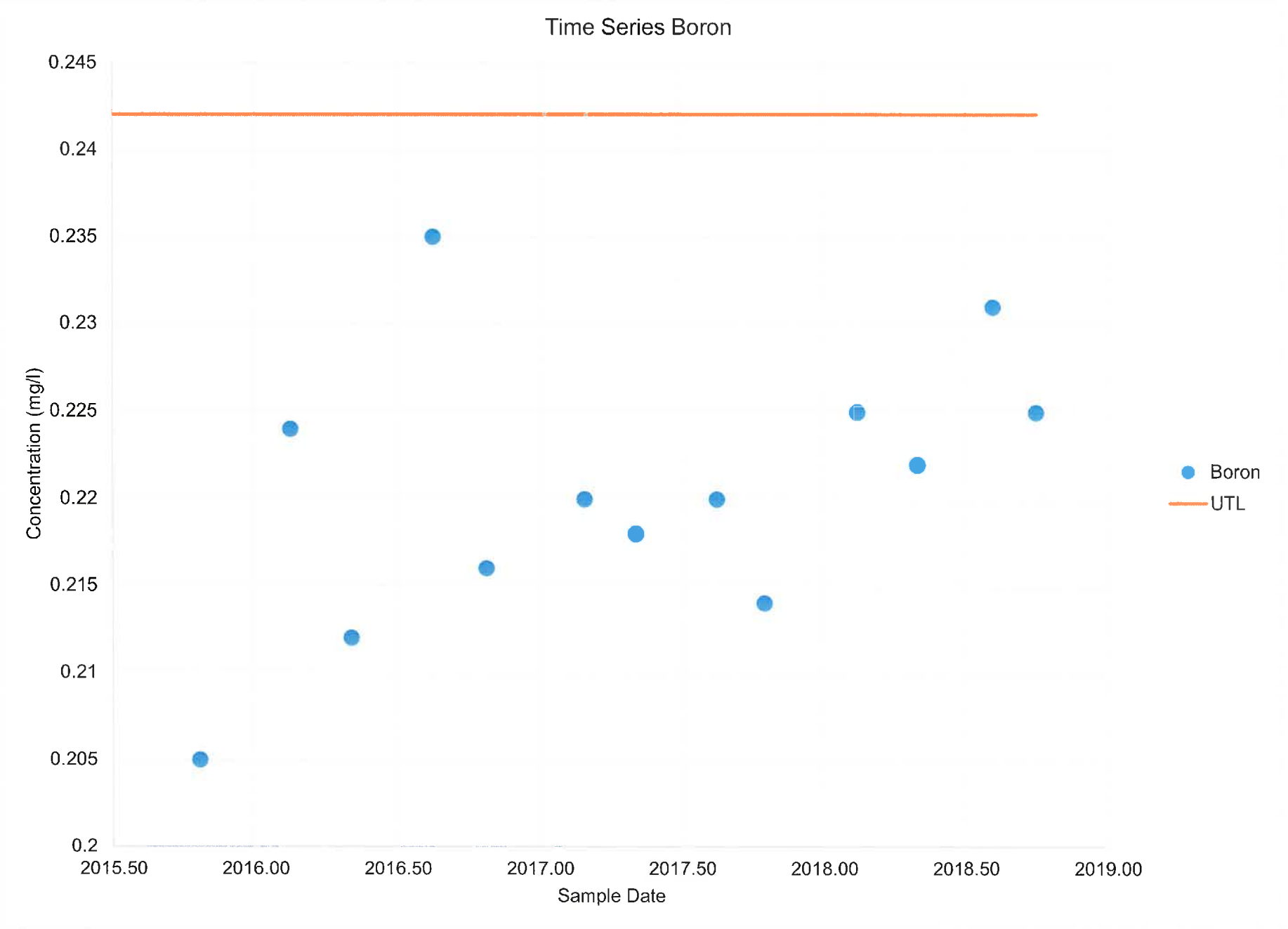

Time Series Sulfate
250
200
150
100
50
0
Concentration (mg/l)
2015.50
2016.00
2016.50
2017.00
2017.50
2018.00
2018.50
2019.00
Sample Date
Sulfate
UTL

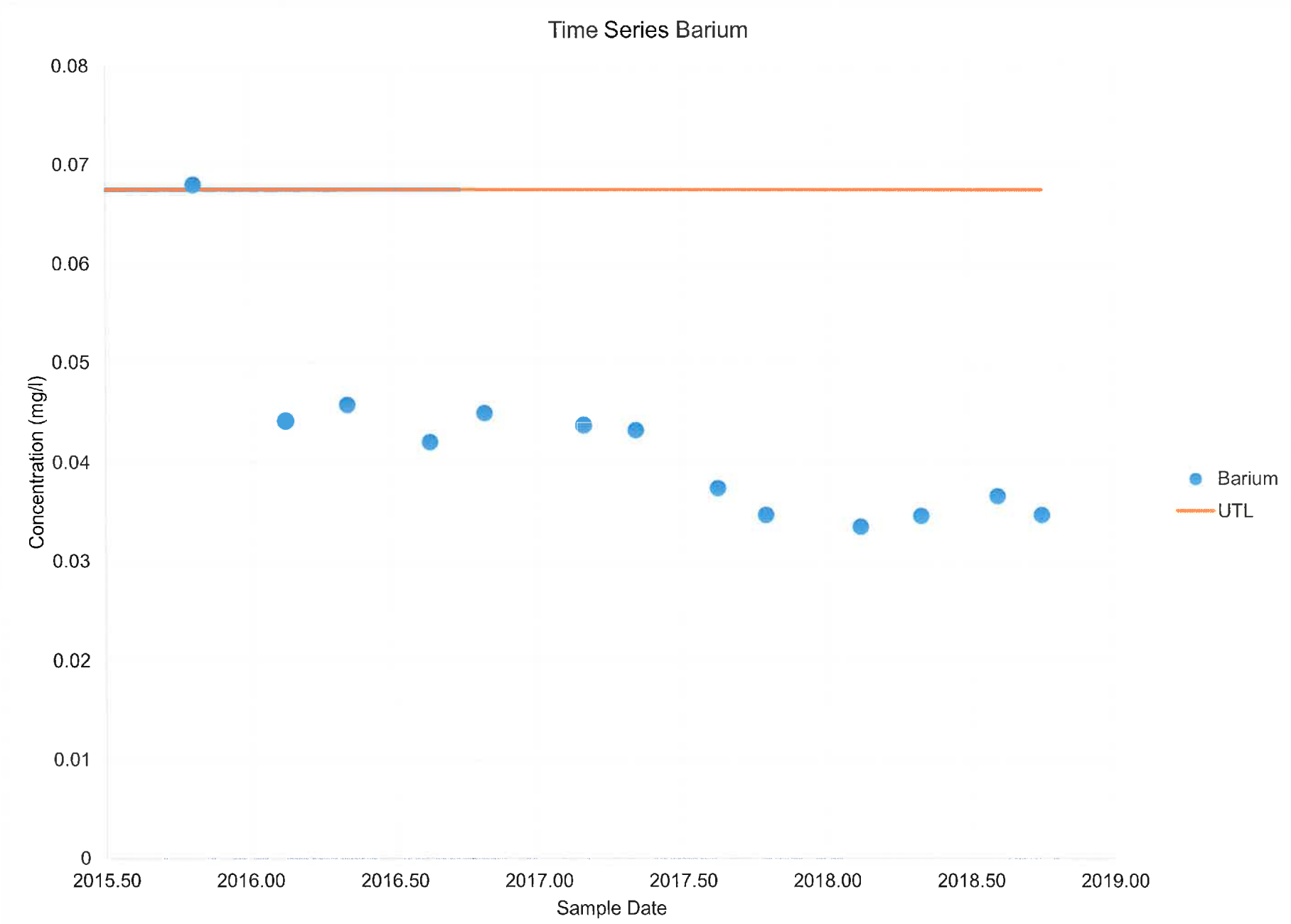

Time Series Selenium
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
Concentration (mg/l)
2015.50
2016.00
2016.50
2017.00
2017.50
2018.00
2018.50
2019.00
Sample Date
Selenium
UTL

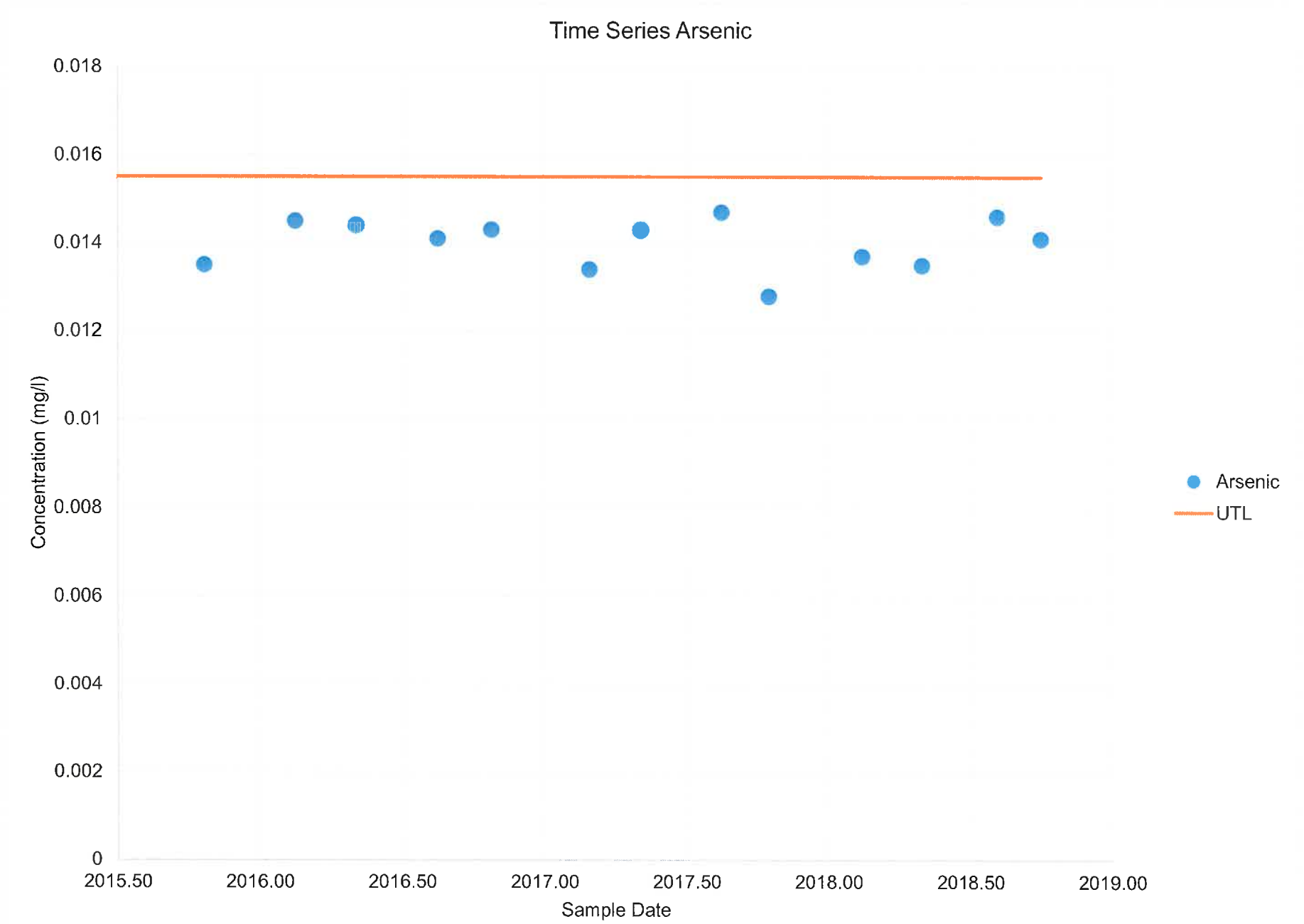

Time Series Fluoride
1.2
1
0.8
0.6
0.4
0.2
0
Concentration (mg/l)
2015.50
2016.00
2016.50
2017.00
2017.50
2018.00
2018.50
2019.00
Sample Date
Fluoride
UTL


Time Series Chloride
180
160
140
120
100
80
60
40
20
0
Concentration (mg/l)
2015.50
2016.00
2016.50
2017.00
2017.50
2018.00
2018.50
2019.00
Sample Date
Chloride
UTL


Time Series Calcium
90
80
70
60
50
40
30
20
10
0
Concentration (mg/l)
2015.50
2016.00
2016.50
2017.00
2017.50
2018.00
2018.50
2019.00
Sample Date
Calcium
UTL


Time Series Boron
0.245
0.24
0.235
0.23
0.225
0.22
0.215
0.21
0.205
0.2
Concentration (mg/l)
2015.50
2016.00
2016.50
2017.00
2017.50
2018.00
2018.50
2019.00
Sample Date
Boron
UTL


Time Series Barium
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Concentration (mg/l)
2015.50
2016.00
2016.50
2017.00
2017.50
2018.00
2018.50
2019.00
Sample Date
Barium
UTL


Time Series Arsenic
0.018
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Concentration (mg/l)
2015.50
2016.00
2016.50
2017.00
2017.50
2018.00
2018.50
2019.00
Sample Date
Arsenic
UTL