BACKGROUND WATER QUALITY STATISTICAL CERTIFICATION

for Compliance with the Coal Combustion Residuals (CCR) Rule and Michigan Part 115 Solid Waste Management

Former BC Cobb Power Plant

Muskegon, Michigan

Muskegon Environmental Redevelopment Group, LLC

November 1, 2024

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Table of Abbreviations and Acronyms

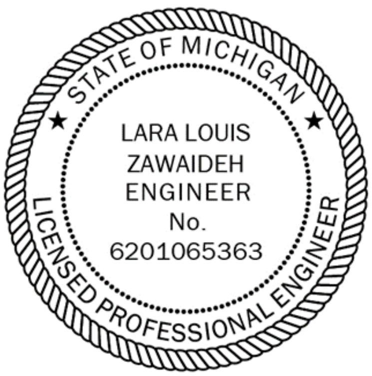
Abbreviation	Definition
BDL	below detection limits
BTV	background threshold value
CCR	Coal Combustion Residuals
COI	constituent of interest
EDD	electronic data deliverable
EGLE	Michigan Department of Environment, Great Lakes, and Energy
EPA	Environmental Protection Agency
MDL	method detection limit
ND	non-detects
SOP	Standard Operating Procedure
SSI	statistically significant increase
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UPL	upper prediction limit

Certification

Background Water Quality Statistical Certification for Compliance with the Coal Combustion Residuals Rule

I hereby certify to the best of my knowledge that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area.

I am duly licensed Professional Engineer under the laws of the State of Michigan.



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1.0 Introduction

The U.S. Environmental Protection Agency's (EPA's) final Coal Combustion Residuals (CCR) Rule establishes a comprehensive set of requirements for the management and disposal of CCR (or coal ash) in landfills and surface impoundments by electric utilities. The former BC Cobb Power Plant ("BCC" or "Site"), located in Muskegon, Michigan (**Figure 1**). Consumers Energy Company (CEC) operated BCC between 1948 and 2016. During operations, coal combustion residuals (CCR) were deposited in Ponds 0-8 and the Bottom Ash Pond (**Figure 2**). The CCR ponds are considered one CCR multi-unit. The CCR unit is subject to the CCR Rule and Michigan Part 115 Solid Waste Management statute. Part §257.93 of the Rule requires that a certification be obtained from a professional engineer describing the statistical method selected to evaluate the groundwater monitoring data at the facility.

At BCC, groundwater monitoring has been conducted to collect eight rounds of background sampling plus the initial detection monitoring and semiannual assessment monitoring as specified under CCR Rule Part §257.94. The objective of this report is to document the selection of the statistical method for each Appendix III, Appendix IV, and Michigan Part 115 constituent of interest (COI). The water quality data collected from the monitoring wells located upgradient of the CCR unit has been compiled and statistically analyzed to update the background threshold values (BTVs) for the impoundments. The original version of this report was issued by TRC in 2018 as a part of the 2017 Annual Groundwater Monitoring Report (TRC, 2018). This update reflects a recalculation of the BTVs for the CCR unit at the former BC Cobb Power Plant to include more data into the background data set from the upgradient wells as a result of continued monitoring over time and includes data from between November 2015 and March 2024. Data collection for additional Michigan Part 115 COIs began in October 2020.

This background water quality report documents the background sample events and describes the statistics performed to develop the BTVs.

2.0 Facility Description

The Site is in close proximity with several water bodies. The site is adjacent to the North Branch of the Muskegon River on the north and northwest perimeter berms, and the Veterans Memorial Pond is to the northeast. The Discharge Channel is along the southern border of the Site and discharges into the North Branch of the Muskegon River. The CCR unit, which includes Ponds 0-8 and the Bottom Ash Pond, were wet ash dewatering areas. From 1984 through plant closure in 2016, CCR was deposited in the ponds by utilizing sluicing methods. Bottom ash slurry was directed into the Bottom Ash Pond, with Bottom Ash Pond overflow directed into either Ponds 5 or 6. Fly ash from the power plant was directed into Ponds 7 and 8. The ponded CCR was routed through the remaining ponds in series. Each pond allowed a portion of CCR particles to settle out before the overflow was transferred to the next pond. The overflow from Pond 4 was discharged to a National Pollutant Discharge Elimination System (NPDES) outfall located on the Discharge Channel. CCR was periodically removed from the ponds and disposed offsite or beneficially reused. During operation of the CCR units, the pond surface water elevations were at 588 feet. Since plant closure in 2016, the pond water elevation has lowered and before dewatering efforts began, appeared to be approximately that of the adjacent Muskegon River.

MERG initiated clean closure of the ponds in 2020 by installing a slurry wall around the perimeter berm adjacent to the North Branch of the Muskegon River. Dewatering began in July 2020 to prepare for excavation and removal of waste CCR and disposal offsite. Ash removal began in August 2020. Excavation, and ash removal was completed in April of 2022, and dewatering ceased on June 15, 2022.

2.1 Hydrogeology

The subsurface materials in the pond area generally consist of CCR ranging from 3 to 28 feet below ground surface (ft bgs) overlying 10 to 20 feet of poorly graded, fine-grained sand. Discontinuous layers of organic materials (i.e., humus and peat) are present within the fine-grained sand. Organic-rich silt was also encountered at depths ranging from 20 to 30 ft bgs, beneath the fine-grained sand, ranging in thickness from approximately 1 to 13 feet. The organic-rich silt deposits are thickest in the perimeter berms along the southernmost edge of the pond area (toward Muskegon Lake). Thinner deposits of the organic-rich silt were encountered toward the northernmost edge of the pond area. Silty clay and/or poorly graded, fine- to medium-grained sand is generally observed within 30 to 40 ft bgs, beneath the organic-rich silt. An underlying clay was encountered throughout the pond area at approximately 40 ft bgs, beneath the fine to medium-grained sand.

Ponds 0-8 are bound by surface water features (**Figure 2**): The North Branch Muskegon River and former plant-associated discharge channel adjoin the western and southernmost boundaries of the pond area, and Veterans Memorial Park is located north and northeast of the pond area. MERG understands that there is surface water pumping at the Veterans Memorial Park on an occasional basis to limit the flooding in some areas of the park. Pumping performed at the park has the potential to influence the groundwater flow conditions at BCC. Therefore, changes over time in groundwater flow conditions at the Site boundary will need to give consideration that potential for impact.

Groundwater flow within the uppermost aquifer has varied during plant operations and the post-shutdown period. While the ponds were actively receiving CCR and non-CCR wastewater, groundwater in the pond area was several feet higher than the surrounding surface water in Muskegon River and upgradient groundwater, creating a mound under the BCC Ponds, with groundwater flowing outward toward the surface water features. Since the plant shut down in April 2016, groundwater was encountered at a similar elevation to the surrounding surface water, generally within the range of 579 to 583 feet above mean sea level (ft AMSL). Using the average hydraulic conductivity measured at the monitoring wells of 58 feet/day (ARCADIS, 2016), and an assumed effective porosity of 0.3, this results in groundwater flow rate of approximately 0.31 feet/day (approximately 113 feet/year).

2.2 Monitoring Well Network

The monitoring system for the CCR impoundments includes the following wells (**Figure 2**):

- Background (upgradient wells): MW-15002, MW-15003, MW-15004, MW-15005, MW-15006, MW-15007, and MW-15008
- Deep downgradient compliance wells: MW-15009, MW-15010, MW-15013, MW-15014R, MW-15015R, MW-15016R, MW-15017, MW-15018, MW-15019, MW-15020, MW-15021, MW-15022, and MW-15023
- Shallow downgradient compliance wells: MW-17001R, MW-17002, MW-17003, MW-17004, MW-17005, and MW-17006
- Water level monitoring well: MW-15001

The operation and monitoring of the CCR units are described further in the Groundwater Monitoring System Certification for the former BC Cobb Power Plant (HDR, 2024).

Figure 1. Vicinity Map for the former BC Cobb Power Plant

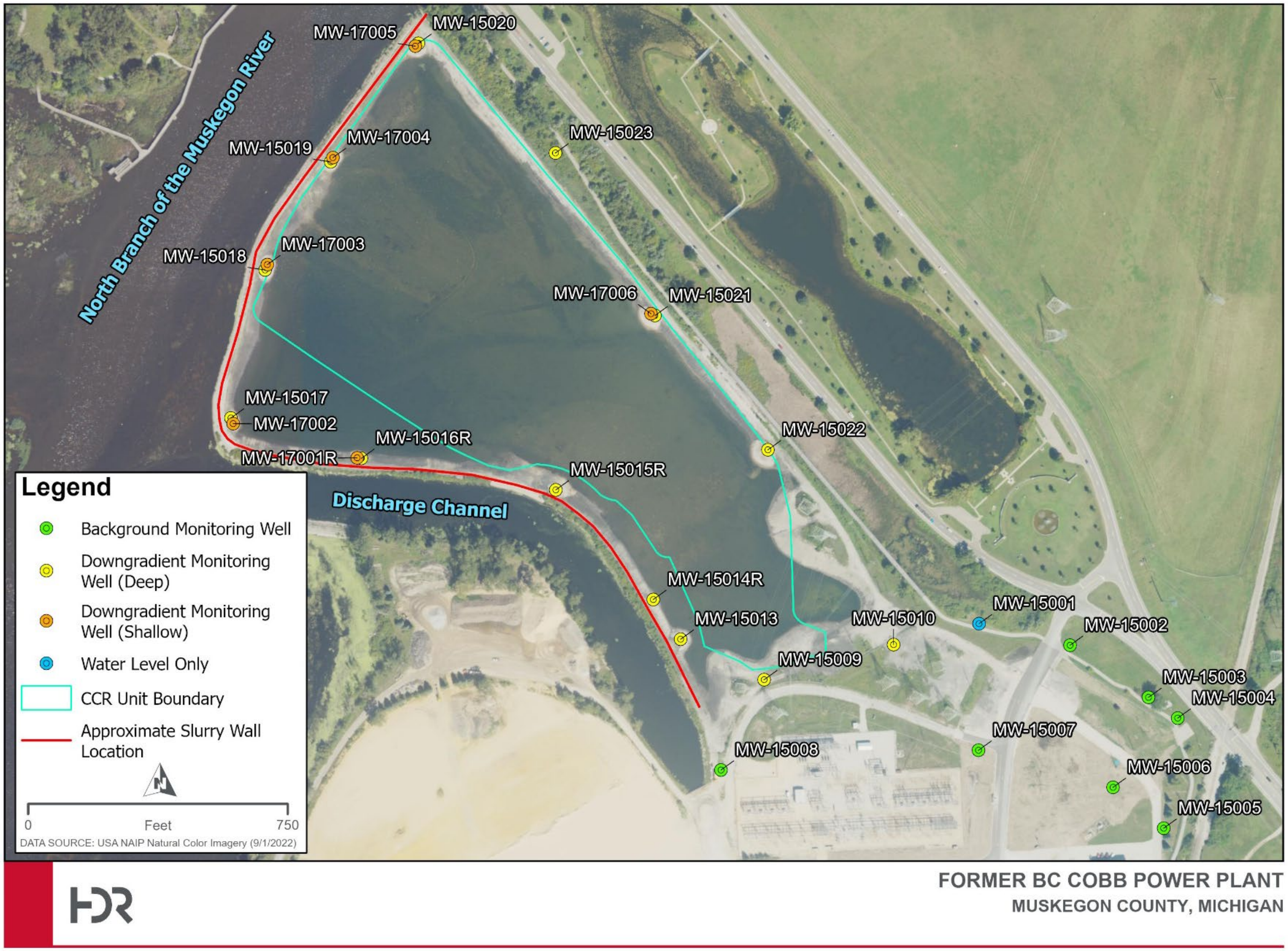


Figure 2. BC Cobb CCR Unit and Monitoring Wells

3.0 Monitoring Methods

3.1 Monitoring Frequency

Groundwater sampling events occurred between November 2015 and March 2024. Each round of sampling included a sample collected from the background wells for the CCR multi-unit at BCC (MW-15002, MW-15003, MW-15004, MW-15005, MW-15006, MW-15007, and MW-15008). Data was collected from the background wells on the following dates:

- ✓ November 30, 2015
- ✓ February 17, 2016
- ✓ April 12, 2016
- ✓ July 12, 2016
- ✓ September 27, 2016
- ✓ February 13, 2017
- ✓ April 4, 2017
- ✓ July 11, 2017
- ✓ September 14, 2017
- ✓ April 19, 2018
- ✓ June 14, 2018
- ✓ November 28, 2018
- ✓ April 8, 2019
- ✓ September 25, 2019
- ✓ May 4, 2020
- ✓ April 19, 2021
- ✓ October 19, 2021
- ✓ May 5, 2022
- ✓ August 11, 2022
- ✓ October 21, 2022
- ✓ April 11, 2023
- ✓ October 2, 2023
- ✓ March 28, 2024

Sampling for the Michigan Part 115 constituents began in October 2020. This Background Memorandum presents the updated background values calculated from the data collected from all seven of the background wells.

3.2 Water Levels and Sample Collection

Water levels were recorded for each of the monitoring wells when groundwater quality samples were collected. Groundwater sample collection protocols followed the Groundwater Sample Collection Standard Operating Procedure (SOP) (HDR, 2020). Water samples were delivered under Chain of Custody to Pace Analytical Laboratories in Grand Rapids, Michigan, and Trace Analytical Laboratories in Muskegon, Michigan beginning in October 2020. Only the upgradient wells are discussed in this report, for update and development of BTVs.

3.3 Analytical Testing

Groundwater samples were analyzed for the parameters shown in **Table 1**, which include all of the parameters in Appendices III and IV of CCR Rule Part §257 and Total Suspended Solids (TSS).

Table 1. Constituents of Interest

Appendix III Constituents	**Appendix IV Constituents**
Boron	Antimony
Calcium	Arsenic
Chloride	Barium
Fluoride	Beryllium
pH	Cadmium
Sulfate	Chromium
Total Dissolved Solids (TDS)	Cobalt
	Fluoride

Table 1. Constituents of Interest	
Additional Parameters	Lead
Total Suspended Solids (TSS)	Lithium
	Mercury
Michigan Part 115 Parameters	Molybdenum
Copper	Selenium
Iron	Thallium
Nickel	Radium-226 and -228 combined
Silver	
Vanadium	
Zinc	

4.0 Data Validation and Data Management

Data validation and data management tasks were performed per the Statistical Procedures Plan for Compliance with the Coal Combustion Residuals Rule (HDR, 2020). Data validation was conducted to eliminate data that did not meet validation criteria and designate a data qualifier for data quality limitation discovered.

5.0 Water Levels and Flow Direction

Water levels were measured in the monitoring wells during each sample event. The potentiometric water contours for March 2024 are displayed in **Appendix A**, which illustrate the groundwater wells chosen for development of BTVs for the site are located upgradient of the CCR units. Groundwater flow is generally from southeast to northwest toward the north branch of the Muskegon River.

6.0 Evaluation of Background Water Quality Data

The statistical analyses detailed in the sections below pertain to samples collected from groundwater at BBC.

The purpose of the statistical analysis is to develop (BTVs per constituent of interest for the Site. Prior to estimating the BTVs, a preliminary data analysis using statistical methods such as sample means, medians and standard deviations, tests for sample distributions, statistical outliers, autocorrelation, seasonality, spatial variability, and trends over time are conducted to confirm if all observed concentrations are representative of field conditions. Details of statistical output tables and supporting charts are found in **Appendices B, C, D and E.** Appendices B and C are based on sampling events used to produce the BTVs after removing outliers or anomalous concentrations. Appendices D and E contain all sampling events, including outliers for information purposes.

6.1 Constituents

The statistical analysis for the Site pertains to samples collected from background monitoring wells MW-15002, MW-15003, MW-15004, MW-15005, MW-15006, MW-15007, and MW-15008 between November 2015 and March 2024. For constituents monitored under the Michigan State CCR program, the first samples were collected in October 2020. The number of samples for each constituent of interest listed in

Appendix III and IV of the CCR rule, ranges from 58 to 165. There were 58 samples for constituents monitored under the Michigan State CCR program.

Reporting units, number of observations (n), number of non-detects (NDs), and percentage of NDs below detection limits (BDL) are listed in **Table 2** for each constituent.

Table 2. Constituents – BCC Background Wells

Constituent	Unit	n	No. BDLs	% BDL
Appendix III				
Boron	ug/L	156	3	2%
Calcium	mg/L	156	0	0%
Chloride	mg/L	156	0	0%
Fluoride	ug/L	162	103	64%
pH, Field	SU	165	0	0%
Sulfate	mg/L	156	33	21%
TDS	mg/L	156	0	0%
Appendix IV				
Antimony	ug/L	149	136	91%
Arsenic	ug/L	156	58	37%
Barium	ug/L	156	0	0%
Beryllium	ug/L	149	149	100%
Cadmium	ug/L	149	147	99%
Chromium	ug/L	156	83	53%
Cobalt	ug/L	149	138	93%
Fluoride	ug/L	162	103	64%
Lead	ug/L	149	141	95%
Lithium	ug/L	156	108	69%
Mercury	ug/L	149	149	100%
Molybdenum	ug/L	156	117	75%
Radium-226+228	pCi/L	156	77	49%
Selenium	ug/L	156	119	76%
Thallium	ug/L	149	148	99%
Part 115				
Copper	ug/L	58	37	64%
Iron	ug/L	58	1	2%
Nickel	ug/L	58	44	76%
Silver	ug/L	58	58	100%
Vanadium	ug/L	58	56	97%
Zinc	ug/L	58	31	53%

6.2 Outliers

Outliers are values that are not representative of the population from which they are sampled. The data sets were screened for outliers using the Dixon's outlier test or Rosner's outlier test; the Dixon's test is used for sample sizes smaller than 25 and the Rosner's outlier test is used for sample sizes 25 and above. Both tests assume that the data follow a normal distribution which may or may not be correct. However, the outlier tests are informative, and the outliers should be investigated if they are representative of natural field conditions. Both tests are conducted with NDs excluded and using a significance level of 1 percent.

Laboratory and sampling quality control protocols and notes were referenced when evaluating statistical outliers. If statistical outlier sampling events had weather-related or anthropogenic reasons for the high concentrations, they were excluded from the analysis to avoid biasing BTV estimates.

In the analysis of BCC monitoring wells, five Appendix III constituents (boron, chloride, sulfate, sulfate, fluoride, and total dissolved solids) and three Appendix IV constituents (arsenic, barium, and fluoride) had outliers across several dates (see **Appendix D, Table 5 and Table 6**). Among the Michigan CCR monitoring constituents, only copper had an outlier, which was recorded on October 19th, 2021. A list of all outliers at the 1% significance level is presented in **Table 3**.

The outliers for arsenic at MW-15006 on June 14, 2018, and at MW-15008 on April 19, 2021, were excluded in the analysis.

The outlier concentrations remaining are within an order of magnitude of other values measured under typical conditions, and differences between the highest and penultimate values do not indicate that the highest value was a result of contamination from a source or event outside regular site and field conditions. The outlier concentrations are within an order of magnitude of other detected values, and differences between the highest and penultimate values do not indicate that the highest value was a result of contamination from a source or event outside regular site and field conditions.

With respect to the BCC monitoring wells, high turbidity (above 10 NTU) was observed for MW-15002, MW-15004, MW-15005, MW-15007, and MW-15008 on May 4th, 2020. High turbidity was also observed at MW-15005 on October 26th, 2020.

Table 3. Outliers at the 1% significance level

Well	Constituent	Unit	n	No. NDs	% NDs	Date	Value
Appendix III							
MW-15002	Boron	ug/L	156	3	2%	5/5/2022	5,400
MW-15002	Boron	ug/L	156	3	2%	8/11/2022	4,900
MW-15002	Boron	ug/L	156	3	2%	10/21/2022	4,900
MW-15002	Boron	ug/L	156	3	2%	4/11/2023	4,900
MW-15002	Boron	ug/L	156	3	2%	10/2/2023	4,800
MW-15002	Boron	ug/L	156	3	2%	3/27/2024	3,800
MW-15003	Boron	ug/L	156	3	2%	4/12/2016	2,370
MW-15007	Chloride	mg/L	156	0	0%	4/12/2016	2,480
MW-15007	Chloride	mg/L	156	0	0%	9/27/2016	2,390
MW-15007	Chloride	mg/L	156	0	0%	2/17/2016	2,300

Well	Constituent	Unit	n	No. NDs	% NDs	Date	Value
MW-15007	Chloride	mg/L	156	0	0%	7/12/2016	2,280
MW-15007	Chloride	mg/L	156	0	0%	9/14/2017	1,940
MW-15007	Chloride	mg/L	156	0	0%	11/30/2015	1,900
MW-15007	Chloride	mg/L	156	0	0%	7/12/2017	1,900
MW-15007	Chloride	mg/L	156	0	0%	2/13/2017	1,850
MW-15007	Chloride	mg/L	156	0	0%	4/4/2017	1,670
MW-15004	Fluoride	ug/L	162	103	64%	4/19/2021	1,400
MW-15002	Sulfate	mg/L	156	33	21%	2/17/2016	327
MW-15002	Sulfate	mg/L	156	33	21%	4/12/2016	300
MW-15002	Sulfate	mg/L	156	33	21%	11/30/2015	250
MW-15007	Sulfate	mg/L	156	33	21%	4/11/2023	240
MW-15002	Sulfate	mg/L	156	33	21%	10/2/2023	220
MW-15002	Sulfate	mg/L	156	33	21%	7/12/2016	202
MW-15007	Sulfate	mg/L	156	33	21%	10/21/2022	190
MW-15007	Sulfate	mg/L	156	33	21%	5/5/2022	170
MW-15008	Sulfate	mg/L	156	33	21%	5/5/2022	170
MW-15008	Sulfate	mg/L	156	33	21%	10/21/2022	140
MW-15007	TDS	mg/L	156	0	0%	9/27/2016	4,800
MW-15007	TDS	mg/L	156	0	0%	7/12/2016	4,500
MW-15007	TDS	mg/L	156	0	0%	4/12/2016	3,900
MW-15007	TDS	mg/L	156	0	0%	11/30/2015	3,700
MW-15007	TDS	mg/L	156	0	0%	2/13/2017	3,700
MW-15007	TDS	mg/L	156	0	0%	7/12/2017	3,700
MW-15007	TDS	mg/L	156	0	0%	4/4/2017	3,100
Appendix IV							
MW-15008	Arsenic	ug/L	156	58	37%	4/19/2021	74
MW-15006	Arsenic	ug/L	156	58	37%	6/14/2018	41
MW-15008	Arsenic	ug/L	156	58	37%	10/26/2020	18
MW-15008	Arsenic	ug/L	156	58	37%	10/19/2021	17
MW-15006	Arsenic	ug/L	156	58	37%	10/19/2021	15
MW-15008	Arsenic	ug/L	156	58	37%	10/2/2023	12
MW-15002	Arsenic	ug/L	156	58	37%	11/30/2015	10
MW-15006	Arsenic	ug/L	156	58	37%	10/2/2023	10
MW-15007	Barium	ug/L	156	0	0%	9/27/2016	377
MW-15004	Fluoride	ug/L	162	103	64%	4/19/2021	1,400
Part 115							
MW-15007	Copper	ug/L	58	37	64%	10/19/2021	4.9

Scatter plots of the constituents with outlier detects are presented in **Figure 3** to **10**. Additional data visualizations of the full BCC dataset area available in **Appendix E, Scatter Plots.**

Figure 3: Scatter Plot, Boron

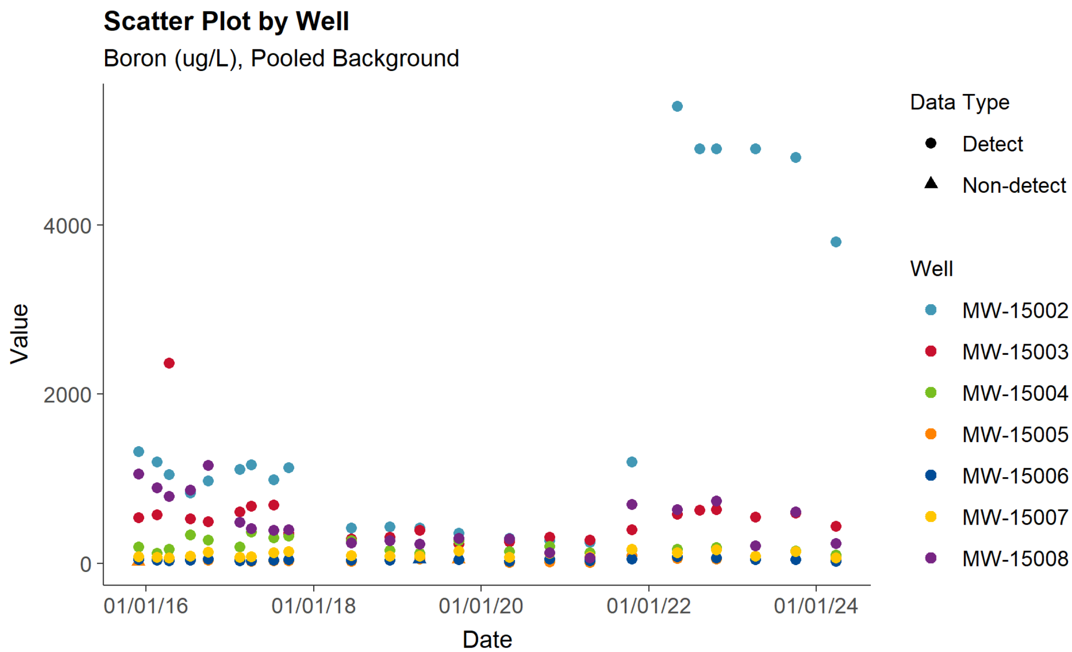


Figure 4. Scatter Plot, Chloride

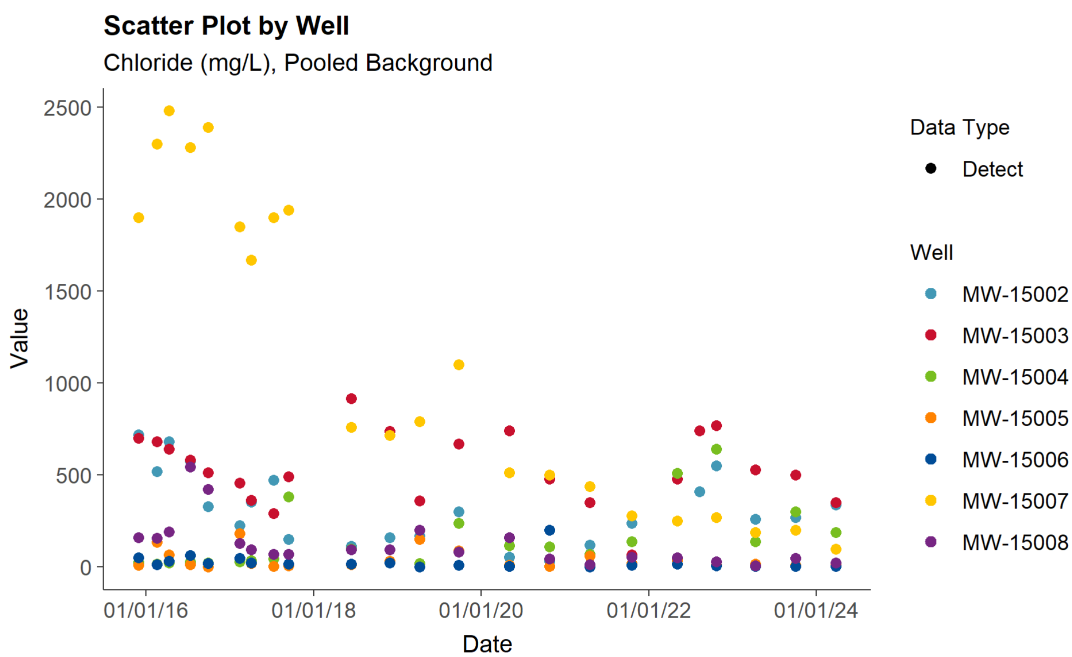


Figure 5. Scatter Plot, Fluoride

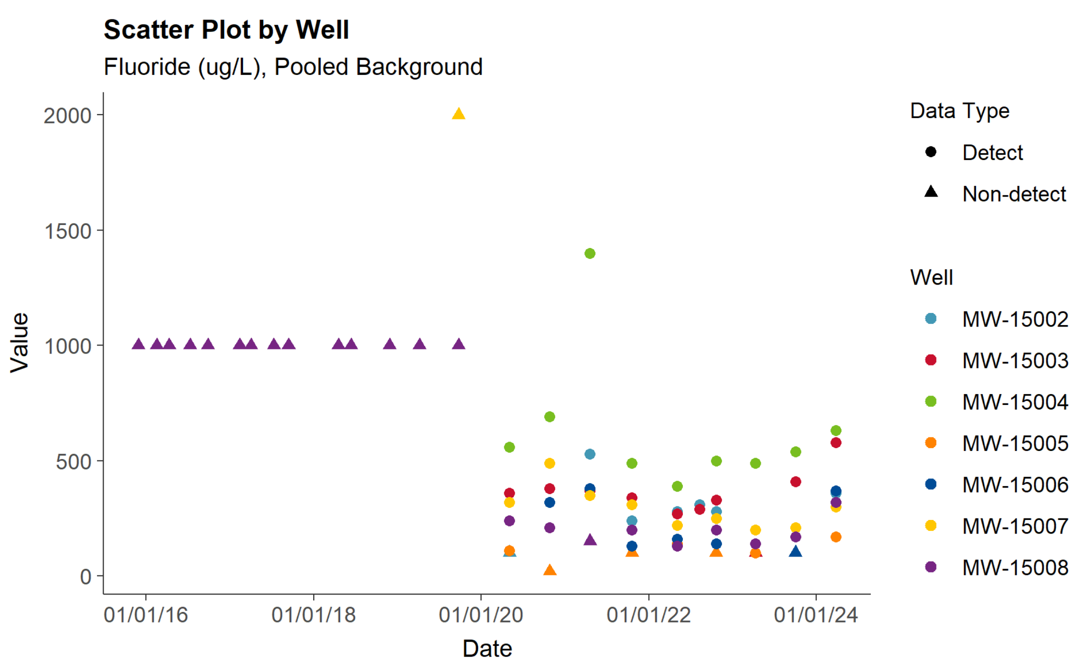


Figure 6. Scatter Plot, Sulfate

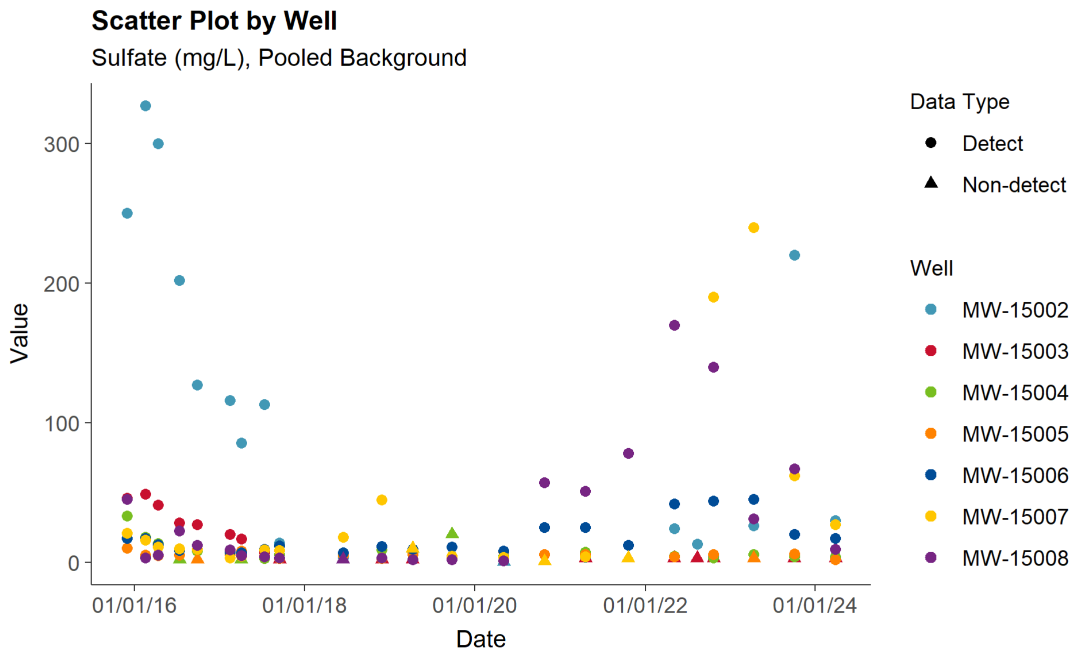


Figure 7. Scatter Plot, Total Dissolved Solids

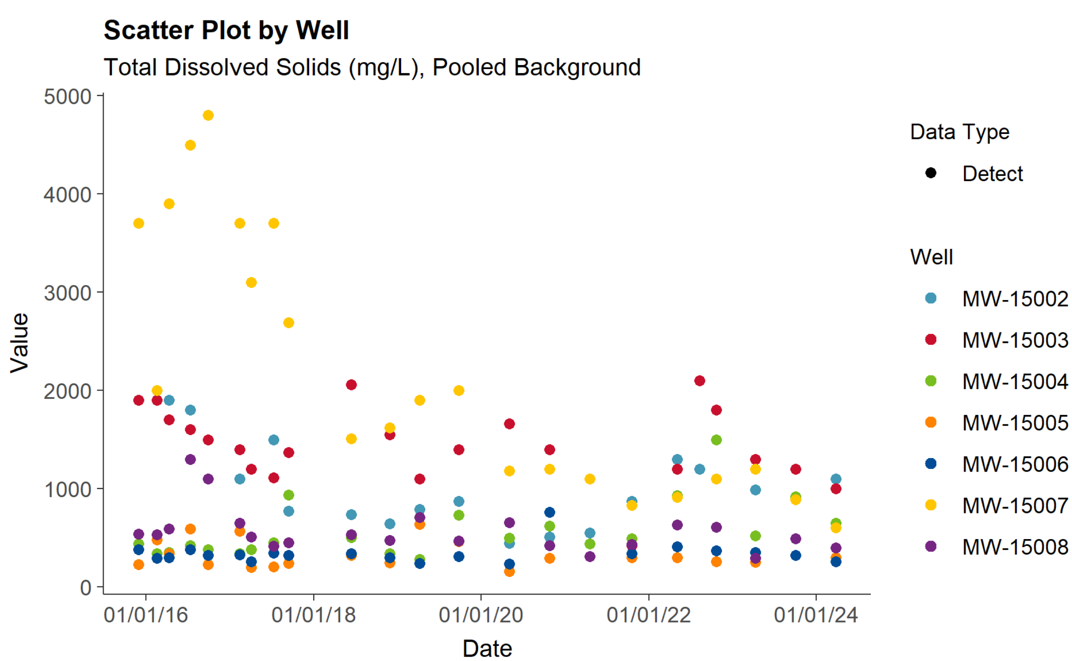


Figure 8. Scatter Plot, Arsenic

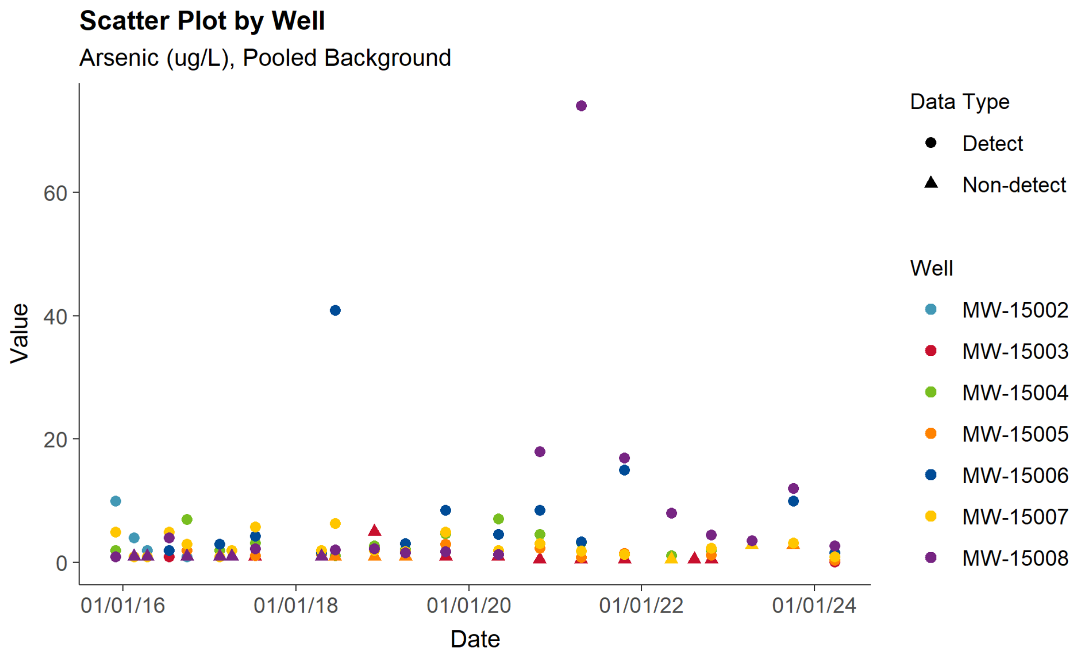


Figure 9. Scatter Plot, Barium

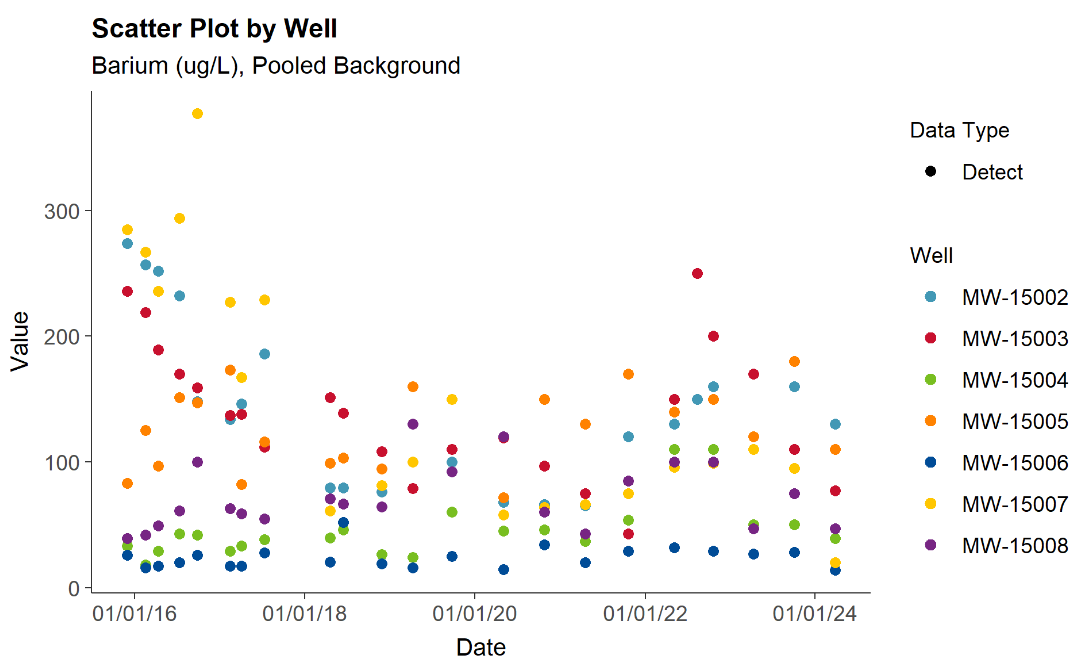
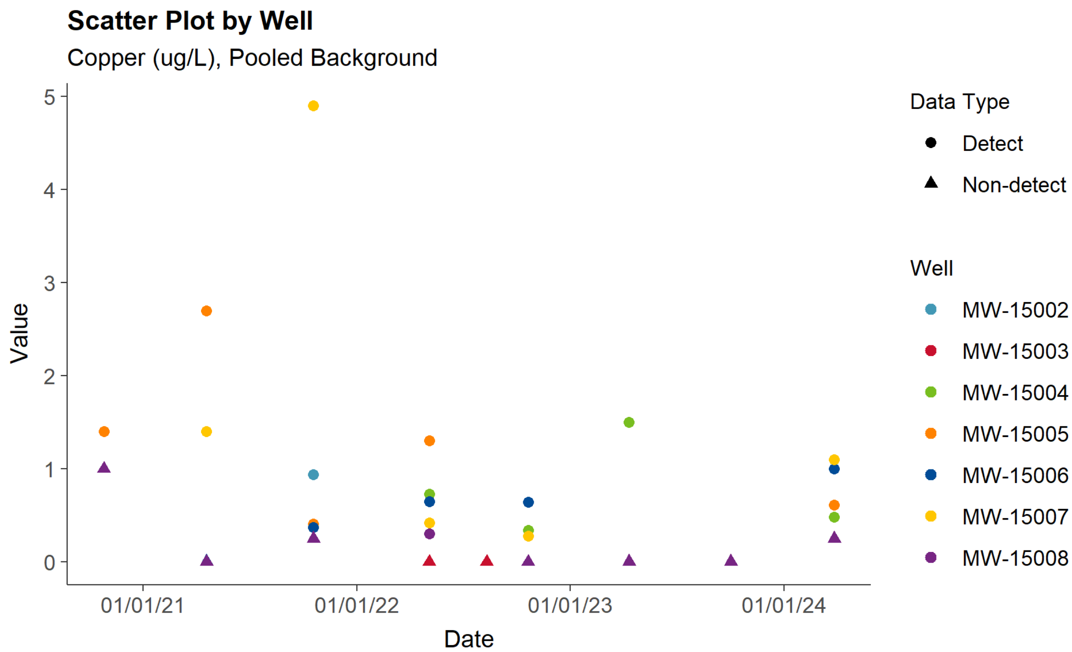


Figure 10. Scatter Plot, Copper



All the detected values flagged as statistical outliers other than the two dropped arsenic samples are within an order of magnitude of other detected values, and none of the outlier samples were recorded on high turbidity dates at the wells they were drawn from, so they are included in the analysis.

Concentrations in MW-15002 remain high since a significant increase was observed in May 2022. Given the groundwater flow direction, the increased concentrations of boron at background well MW-15002 appear to indicate an offsite source from the east.

6.3 Distributions

Groundwater data were fit to known distribution models using goodness-of-fit (GOF) tests. GOF tests were not conducted on data sets with less than four detected values due to insufficient data. For purposes of estimating background concentration levels, nonparametric methods will be used on data sets with less than four detected values or more than 50 percent NDs.

All Appendix III constituents were found to have nonparametric fits to their respective datasets. Appendix IV constituent barium was treated under parametric assumptions, while the remaining constituents followed nonparametric distributions. Michigan part 115 constituent iron was the only constituent treated under parametric assumptions for this group. Fluoride, antimony, beryllium, cadmium, chromium, cobalt, lead, lithium, mercury, molybdenum, selenium, thallium, copper, nickel, silver, vanadium, and zinc all had over 50 percent NDs. As such, additional sampling rounds are needed to determine if these constituents' datasets are better described using parametric distributions such as normal, lognormal, or gamma. The summary tables presented in **Appendix B** present the exploratory data analysis including GOF results and recommended distributions for the Site, without outliers. In some cases, these differ from the distributions reported in the **Appendix D** where GOF tests were conducted on the full dataset including samples identified as outliers.

6.4 Autocorrelation

Autocorrelation occurs when values of a single variable data set are correlated over successive (i.e., lagged) time intervals. Five Appendix IV constituents exhibited autocorrelation; however, this is a result of the pooling of background wells. We sampled the same constituents from multiple wells on the same day, creating a synthetic autocorrelation.

6.5 Seasonality

Temporal variability in groundwater samples can be due to seasonal effects (i.e., seasonality) or temporal effects (i.e., autocorrelation or trends). 40 C.F.R. § 257.93(g)(6) requires that, if necessary, the statistical method must include procedures to control or correct for seasonal as well as temporal correlation in the data.

Groundwater data may exhibit predictable recurring increases and decreases in concentrations, termed seasonality. Constituents are analyzed for seasonality using the Kruskal-Wallis, ANOVA, and log-transformed ANOVA tests **(Table 7 of Appendix B)**.

The data contains 0-17 winter samples, 28-62 spring samples, 2-23 summer samples, and 28-63 fall samples. The sample sizes per season for some constituents do not allow for accurate statistical analysis of seasonality; a minimum of eight sampling events (that is, eight distinct dates) per season is recommended to test for seasonal differences but at least twenty sampling events per season are recommended to de-seasonalize the data. Of the constituents with at least 8 sampling dates representing 20 pooled samples in at least two seasons, seasonality tests based on detected data find seasonality in only arsenic and chromium. Constituents will be analyzed for seasonality as additional sampling is conducted to determine if samples are affected by seasonality.

6.6 Spatial Variability

An assumption when deriving background groundwater quality is that concentrations of constituents measured at the background wells over time when pooled represent an estimate of overall well field conditions for those constituents. This assumption implies the variability of the concentrations per well is comparable and the values are independent of each other. A means to test this assumption is to study the spatial variability of the observations across the wells. Spatial variability exists when the distribution or pattern of concentrations changes between well locations, either from natural or anthropogenic factors.

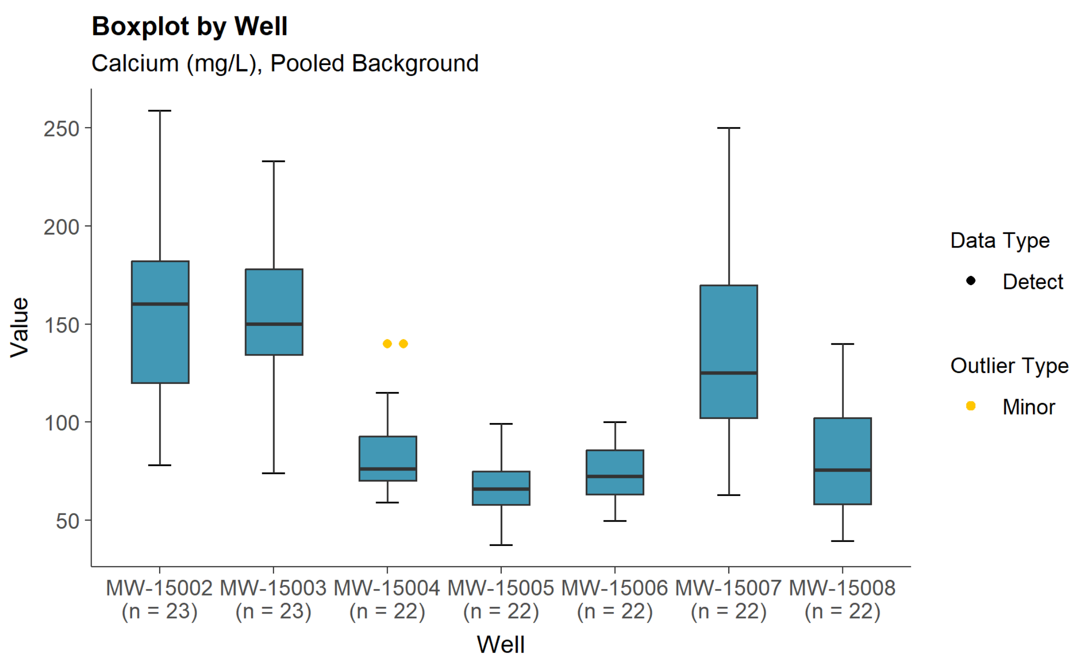
To evaluate the potential for spatial variability in background wells, scatter series plots of concentrations were used for each constituent at the wells (**Appendix C, Scatter Plots**). Visual cues from the observed variability of concentrations across the wells per constituent were corroborated using both parametric and nonparametric ANOVA tests where appropriate that tested if differences in mean or median concentrations were statistically significant.

As reported below, spatial variability was detected in the dataset. However, in cases where spatial variability was detected, nonparametric methods were used to calculate the background threshold values. Nonparametric methods avoid the use of erroneous assumptions regarding the underlying distribution that may arise when samples from wells with spatial variability are pooled. In cases where parametric methods were still used (iron, barium), the averages across wells were not meaningfully different, and the range and variability of the pooled data were well approximated by a parametric distribution. For these reasons, further analysis to mitigate the impact of spatial variabilities such as redefining the background well network or sequestering sets of sampling events from analysis were not conducted.

For constituents with nonparametric fits, the ANOVA Kruskal-Wallis test including NDs was the appropriate test to reference. Otherwise, for constituents with parametric distributions, ANOVA or Log ANOVA tests were used. Spatial variability was present in the data for 13 of the 27 constituents at the 1% level of significance based on the Kruskal-Wallis test for differences in medians or the ANOVA or Log ANOVA test for differences in means **Table 1, Appendix F.**

Figure 11 demonstrates an example of a constituent with 100% detected data, calcium, that exhibited spatial variability between the wells. Over time as the sample size increases, spatial variability may be less pronounced. While statistically different well averages for the constituents exhibiting spatial variability (boron, calcium, chloride, fluoride (app. III), pH, sulfate, total dissolved solids, arsenic, barium, fluoride (app IV), molybdenum, radium-226+228, iron, and zinc) are flagged using either the ANOVA or the Kruskal-Wallis test at the 1% level of significance, the sample concentrations are approximately within an order of magnitude of each other and reflect the natural variability of the concentrations for the constituents of interest across the background field area (see **Appendix C, Scatter Plots**).

Figure 11. Boxplot by Well, Calcium



6.7 Trends

A key assumption for hypothesis testing is that sample data are stationary through time, free of any trends. Constituents that follow a parametric distribution and do not demonstrate seasonality were analyzed for trends within the data set using a lognormal Maximum Likelihood Estimate (MLE) regression. The Mann-Kendall test and Theil-Sen slope was used to analyze linear trends for constituents that could not be fit to any of the three tested distributions. The Mann-Kendall test is suitable for data sets with no seasonality and only one unique detection limit such as a method detection limit (MDL). For those that showed statistically significant upwards or downwards trends, trends were checked against results using piecewise linear-linear or piecewise linear-linear-linear analyses as a visual aid. The linear-linear regression assumes and identifies one structural break within the time series, and the linear-linear-linear regression assumes two structural breaks within the time series.

Results for both parametric and nonparametric trend tests are summarized in **Table 4**, with detailed results in **Table 8 of Appendix B.** Constituents with more 50% or more NDs are not tested for trends given limited information in the datasets. For those datasets with less than 50% NDs and are best described using nonparametric distribution assumptions, only those datasets with one unique MDL value are tested using the Mann-Kendall test given the test's assumptions. For parametric tests, the "Slope" column contains the MLE slope on a log-linear scale with respect to time (measured in days), and the "*p*-value" column contains the *p*-value associated with that slope. For nonparametric tests, the "Slope" column contains the Theil-Sen slope estimator, and the "*p*-value" column contains the *p*-value from the Mann-Kendall test. The "Trend" column indicates upward or downward trends when the *p*-value is below 1%.

No upwards or downwards trends were identified at the 1% significance level.

Table 4. Trend tests at the 1% significance level

Constituent	Unit	n	No. BDL	% BDL	Method	Slope	*p-value*	Trend
Appendix III								
Calcium	mg/L	156	0	0%	MK	-0.00096	0.744966	↔
Chloride	mg/L	156	0	0%	MK	-0.01551	0.067891	↔
pH, Field	SU	165	0	0%	MK	0	0.570119	↔
TDS	mg/L	156	0	0%	MK	-0.04086	0.162101	↔
Appendix IV								
Barium	ug/L	156	0	0%	Log MLE	0	0.456887	↔
Part 115								
Iron	ug/L	58	1	2%	Log MLE	-0.00066	0.221719	↔

6.8 Summary of Statistical Analysis

Table 5 contains key summaries of the outlier tests, distribution tests, and trend tests for each constituent. A "✓" symbol denotes that the constituent was flagged by the indicated test. Additional sampling is necessary to determine the validity of outlier samples, distributional assumptions, and stationarity assumptions.

Table 5. Summary of statistical analysis

Constituent	Outliers	Nonparametric	Trend
Appendix III			
Boron	✓	✓	
Calcium		✓	
Chloride	✓	✓	
Fluoride	✓	✓	
pH, Field		✓	
Sulfate	✓	✓	
TDS	✓	✓	
Appendix IV			
Antimony		✓	
Arsenic	✓	✓	
Barium	✓		

Constituent	Outliers	Nonparametric	Trend
Beryllium		✓	
Cadmium		✓	
Chromium		✓	
Cobalt		✓	
Fluoride	✓	✓	
Lead		✓	
Lithium		✓	
Mercury		✓	
Molybdenum		✓	
Radium-226+228		✓	
Selenium		✓	
Thallium		✓	
Part 115			
Copper	✓	✓	
Iron			
Nickel		✓	
Silver		✓	
Vanadium		✓	
Zinc		✓	
Copper		✓	

6.9 Detection Monitoring Background Threshold Values

BTVs were estimated to represent background concentration levels for future use in evaluating whether downgradient samples exhibit statistically significant increases (SSIs) during detection monitoring. The BTVs are the upper prediction limits (UPLs) of the background data, which are one of the statistical methods specified under 40 C.F.R. § 257.93(f)(3) for evaluating groundwater monitoring data. The number of verification samples and the significance levels associated with each UPL are chosen such that the site-wide false positive rate over all comparisons is no more than 10 percent and such that the power of each test exceeds the EPA Reference Power Curve (ERPC) at either 3 standard deviations above background, 4 standard deviations above background, or both.

Note that for pH, both the UPL and the lower prediction limit (LPL) are of interest as pH values above the UPL or below the LPL at the downgradient wells can be considered statistically significant.

For constituents that do not have any detected values, the maximum MDL is chosen as the BTV and the double quantification rule (DQR) is used to evaluate whether there is an SSI; that is, an SSI is registered for a downgradient well-constituent pair if there are two consecutive detections above the BTV. These constituents are excluded from the determination of target false positive rates.

Table 6 contains the estimated UPLs for Appendix III constituents and iron from the Part 115 constituents. These UPLs are used during detection monitoring of the CCR Rule’s implementation. Detailed information on the UPLs is available in **Appendix G**.

The number of retests and the rank of the order statistic for nonparametric UPLs are chosen such that the significance level does not exceed the per-constituent false positive rate of 0.0131, and such that the test power exceeds the EPA Reference Power Curve (ERPC) at either 3 standard deviations (SDs) above background, 4 SDs above background, or both. The maximum per-constituent false positive rate is computed based on a site-wide false positive rate of 10% subdivided across the eight constituents that had at least one detected sample.

For parametric (normal, lognormal, or gamma) UPLs, the number of retests and the value of the K factor are chosen such that the significance level does not exceed the per-test false positive rate of 0.000693 and such that the test power exceeds the ERPC at either 3 SDs above background, 4 SDs above background, or both. The maximum per-test false positive rate is computed based on a site-wide false positive rate of 10% subdivided across eight constituents and 19 downgradient wells.

Table 6. Background threshold values for detection monitoring

Constituent	Unit	n	No. BDL	% BDL	Recommended distribution	No. of verification samples	UPL
Appendix III							
Boron	ug/L	156	3	2%	Nonparametric	1	4,900
Calcium	mg/L	156	0	0%	Nonparametric	1	250
Chloride	mg/L	156	0	0%	Nonparametric	1	2,400
Fluoride	ug/L	162	103	64%	Nonparametric	1	1,400
pH, Field, LPL	SU	165	0	0%	Nonparametric	1	6.6
pH, Field, UPL	SU	165	0	0%	Nonparametric	1	8.2
Sulfate	mg/L	156	33	21%	Nonparametric	1	300
TDS	mg/L	156	0	0%	Nonparametric	1	4,500
Part 115							
Iron	ug/L	58	1	2%	Gamma	0	31,000

6.10 Assessment Monitoring Background Threshold Values

Table 7 contains the estimated UPLs for Appendix III, Appendix IV, and Part 115 constituents. These UPLs are the background threshold values during assessment monitoring of the CCR Rule's implementation. Detailed information on the assessment monitoring UPLs is available in **Appendix H**.

The number of retests and the rank of the order statistic for nonparametric UPLs are chosen such that the significance level does not exceed the per-constituent false positive rate of 0.00438, and such that the test power exceeds the EPA Reference Power Curve (ERPC) at either 3 standard deviations (SDs) above background, 4 SDs above background, or both. The maximum per-constituent false positive rate is computed based on a site-wide false positive rate of 10% subdivided across nineteen constituents with at least one detected value.

For parametric (normal, lognormal, or gamma) UPLs, the number of retests and the value of the K factor are chosen such that the significance level does not exceed the per-test false positive rate of 0.000213, and such that the test power exceeds the ERPC at either 3 SDs above background, 4 SDs above background, or both. The maximum per-test false positive rate is computed based on a site-wide false positive rate of 10% subdivided across 24 constituents and 19 downgradient wells. Detailed information on the UPLs is available in **Appendix H.**

Table 7. Background threshold values for assessment monitoring

Constituent	Units	n	NDs	% NDs	Recommended distribution	No. of Verification Samples[3]	UPL
Appendix III							
Boron	ug/L	156	3	2%	Nonparametric	2	4,900
Calcium	mg/L	156	0	0%	Nonparametric	2	230
Chloride	mg/L	156	0	0%	Nonparametric	2	2,300
Fluoride	ug/L	162	103	64%	Nonparametric	2	1,400
pH, Field, LPL	SU	165	0	0%	Nonparametric	2	6.6
pH, Field, UPL	SU	165	0	0%	Nonparametric	2	8.2
Sulfate	mg/L	156	33	21%	Nonparametric	2	250
TDS	mg/L	156	0	0%	Nonparametric	2	3,900
Appendix IV							
Antimony	ug/L	149	136	91%	Nonparametric	2	1.2
Arsenic	ug/L	154	58	38%	Nonparametric	2	15
Barium	ug/L	156	0	0%	Gamma	0	640
Beryllium	ug/L	149	149	100%	Nonparametric	2	1.2*
Cadmium	ug/L	149	147	99%	Nonparametric	2	0.22
Chromium	ug/L	156	83	53%	Nonparametric	2	3.7
Cobalt	ug/L	149	138	93%	Nonparametric	2	1.2
Fluoride	ug/L	162	103	64%	Nonparametric	2	1,400
Lead	ug/L	149	141	95%	Nonparametric	2	2.0
Lithium	ug/L	156	108	69%	Nonparametric	2	34
Mercury	ug/L	149	149	100%	Nonparametric	2	0.20*
Molybdenum	ug/L	156	117	75%	Nonparametric	2	9.7
Radium-226+228	pCi/L	156	77	49%	Nonparametric	2	2.80
Selenium	ug/L	156	119	76%	Nonparametric	2	3.0
Thallium	ug/L	149	148	99%	Nonparametric	2	0.19
Part 115							
Copper	ug/L	58	37	64%	Nonparametric	2	2.7
Iron	ug/L	58	1	2%	Gamma	1	26,000
Nickel	ug/L	58	44	76%	Nonparametric	2	0.84
Silver	ug/L	58	58	100%	Nonparametric	2	0.20*
Vanadium	ug/L	58	56	97%	Nonparametric	2	1.7
Zinc	ug/L	58	31	53%	Nonparametric	2	43

*Constituent is 100% non-detects, so the method detection limit is chosen as the UPL.

6.11 Groundwater Protection Standards Development for Assessment Monitoring

The Unified Guidance has recommended that the upper tolerance limit (UTL) be used as a fixed value similar to a groundwater protection standard for constituents for which MCLs have not been established (USEPA, 2009). 40 C.F.R. § 257.95(h) requires that if no standard exists, then the background concentration is used. As such, UTLs are used during development of the Groundwater Protection Standard for the assessment monitoring program.

UTLs are estimated using a coverage proportion of 95% and a confidence level of 95%. However, nonparametric rank based UTLs are unable to achieve both 95% coverage and 95% confidence when the sample size is below 60. In this case, nonparametric UTLs are chosen to maximize coverage while maintaining a 95% confidence level, as recommended by the Unified Guidance. The UTLs are listed in **Table 8**. Detailed information on the UTLs is available in **Appendix I.**

Table 8. Upper tolerance limits with 95% coverage and 95% confidence

Constituent	Unit	n	No. BDL	% BDL	Recommended distribution	UTL
Appendix III						
Boron	ug/L	156	3	2%	Nonparametric	5,400
Calcium	mg/L	156	0	0%	Nonparametric	260
Chloride	mg/L	156	0	0%	Nonparametric	2,500
Fluoride	ug/L	162	103	64%	Nonparametric	1,400
pH, Field	SU	165	0	0%	Nonparametric	8.3
Sulfate	mg/L	156	33	21%	Nonparametric	330
TDS	mg/L	156	0	0%	Nonparametric	4,800
Appendix IV						
Antimony	ug/L	149	136	91%	Nonparametric	1.4
Arsenic	ug/L	154	58	38%	Nonparametric	18
Barium	ug/L	156	0	0%	Gamma	270
Beryllium	ug/L	149	149	100%	Nonparametric	1.2*
Cadmium	ug/L	149	147	99%	Nonparametric	0.22
Chromium	ug/L	156	83	53%	Nonparametric	3.7
Cobalt	ug/L	149	138	93%	Nonparametric	1.2
Fluoride	ug/L	162	103	64%	Nonparametric	1,400
Lead	ug/L	149	141	95%	Nonparametric	2.0
Lithium	ug/L	156	108	69%	Nonparametric	48
Mercury	ug/L	149	149	100%	Nonparametric	0.20*
Molybdenum	ug/L	156	117	75%	Nonparametric	9.7
Radium-226+228	pCi/L	156	77	49%	Nonparametric	3.74
Selenium	ug/L	156	119	76%	Nonparametric	3.3
Thallium	ug/L	149	148	99%	Nonparametric	0.19
Part 115						

Constituent	Unit	n	No. BDL	% BDL	Recommended distribution	UTL
Copper	ug/L	58	37	64%	Nonparametric	4.9
Iron	ug/L	58	1	2%	Gamma	12,000
Nickel	ug/L	58	44	76%	Nonparametric	0.84
Silver	ug/L	58	58	100%	Nonparametric	0.20*
Vanadium	ug/L	58	56	97%	Nonparametric	1.7
Zinc	ug/L	58	31	53%	Nonparametric	48

*Constituent is 100% non-detects, so the method detection limit is chosen as the UTL.

7.0 References

HDR, 2020. Groundwater Sample Collection Standard Operating Procedure. August 14, 2020.

HDR, 2020. Statistical Procedures Plan for Compliance with the Coal Combustion Residuals Rule. August 14, 2020.

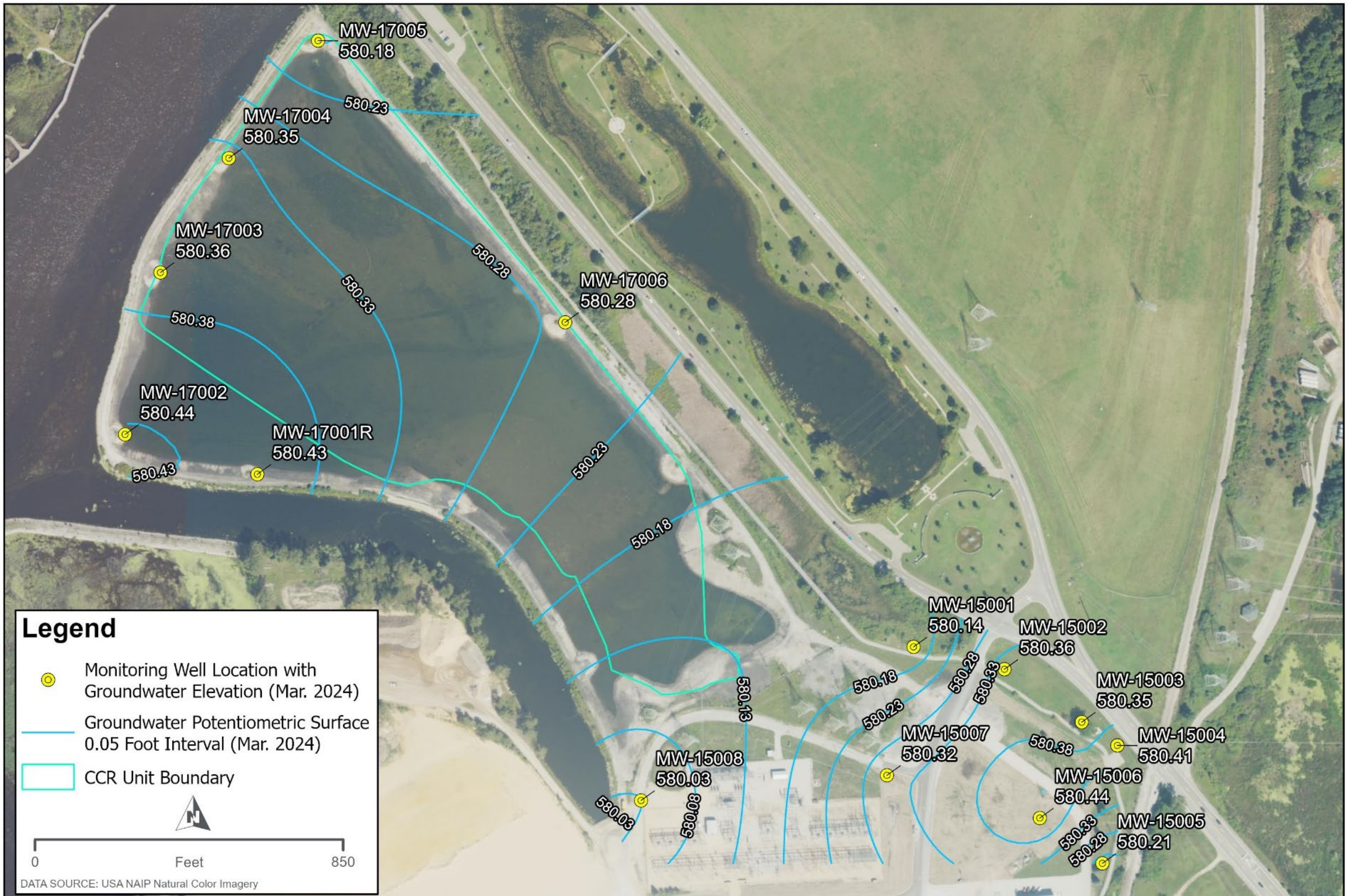
HDR, 2024. Groundwater Monitoring System Certification. October 11, 2024.

TRC, 2018. Annual Groundwater Monitoring Report. January 2018.

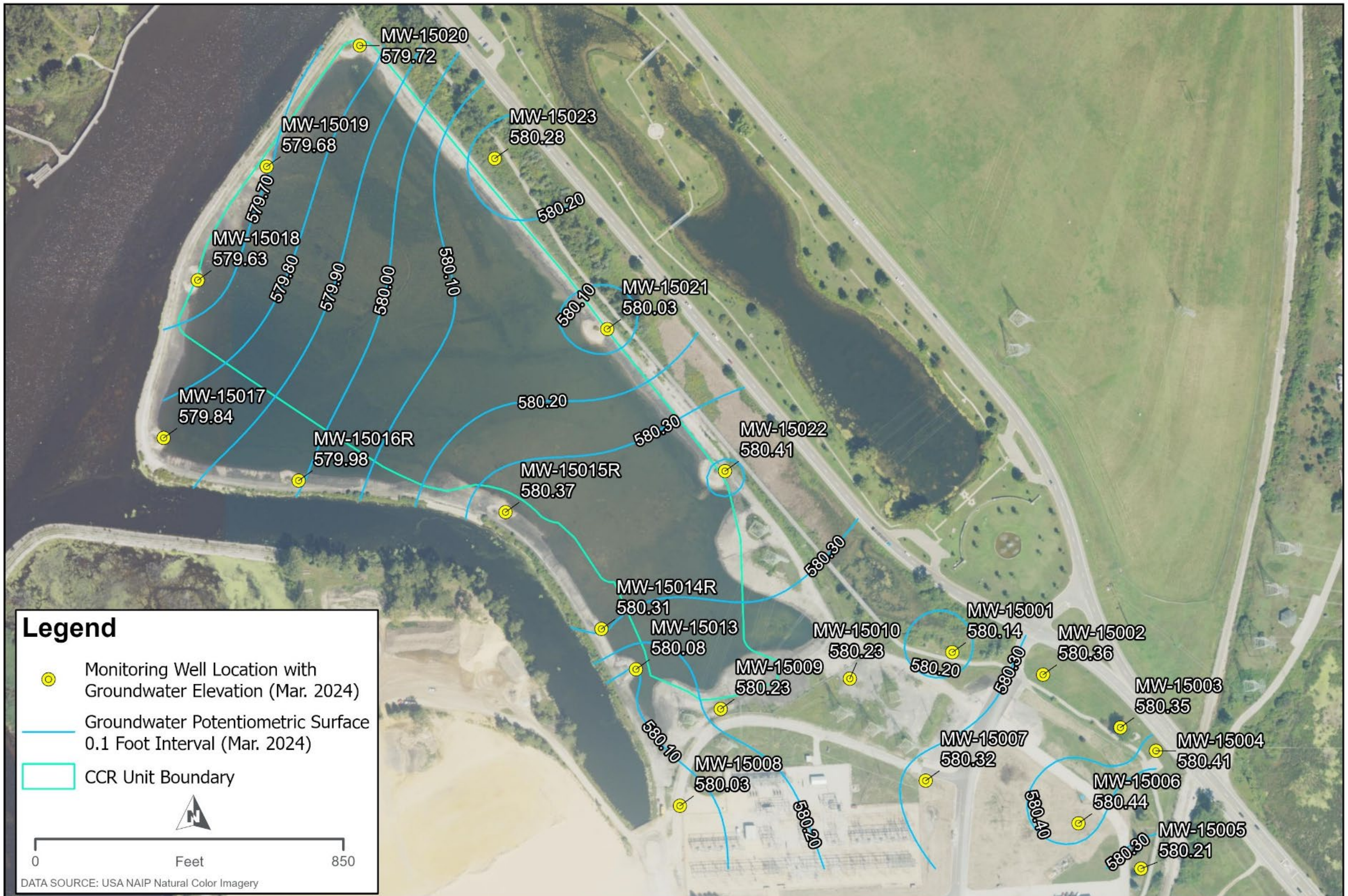
U.S. Environmental Protection Agency (USEPA), 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities: Unified Guidance. Office of Resource Conservation and Recovery, Program Implementation and Information Division, USEPA, EPA 530/R-09-007, 2009.

A

Groundwater Contour Maps



FORMER BC COBB POWER PLANT
MUSKEGON COUNTY, MICHIGAN



FORMER BC COBB POWER PLANT
MUSKEGON COUNTY, MICHIGAN

B

Statistical Tables

Table 1: Summary Statistics, Non-Detects Included

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Date Range	Distributions Fit[a]	Recommended Distribution	Mean	Median	Minimum	Maximum	SD	CV	MAD/0.675	Skewness	Kurtosis
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	479	170	13.1	5400	937	1.96	189	3.97	16.3
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	108	92.2	37.3	259	50.3	0.465	41.6	0.952	0.0872
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	335	145	1.23	2480	500	1.49	195	2.65	7.32
1_114	Pooled Background	Appendix III	Fluoride	ug/L	162	103	64%	2015-11-30 to 2024-03-27	Gamma; Lognormal	Nonparametric	732	1000	20.0	2000	374	0.511	0	-0.352	-0.708
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	7.21	7.20	6.60	8.30	0.320	0.0443	0.296	0.648	0.866
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	28.3	7.45	0.250	327	56.6	2.0	6.74	3.31	11.3
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	940	615	158	4800	847	0.901	467	2.22	5.91
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	0.814	1.00	0.140	1.40	0.349	0.429	0	-0.868	-0.946
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	154	58	38%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	2.49	1.55	0.120	18.0	2.85	1.15	0.815	3.18	12.0
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	2015-11-30 to 2024-03-27	Gamma	Gamma	100	84.0	14.0	377	69.6	0.697	67.1	1.13	1.31
2_104	Pooled Background	Appendix IV	Beryllium	ug/L	149	149	100%	2015-11-30 to 2024-03-27		Nonparametric	0.760	1.00	0.200	1.20	0.378	0.498	0	-0.594	-1.53
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	149	147	99%	2015-11-30 to 2024-03-27		Nonparametric	0.318	0.200	0.0780	1.20	0.300	0.942	0	2.55	4.69
2_109	Pooled Background	Appendix IV	Chromium	ug/L	156	83	53%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	1.04	1.00	0.250	5.00	0.660	0.633	0.222	2.22	9.37
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	8.22	6.00	0.110	30.0	6.96	0.847	8.50	0.139	-1.38
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	162	103	64%	2015-11-30 to 2024-03-27	Gamma; Lognormal	Nonparametric	732	1000	20.0	2000	374	0.511	0	-0.352	-0.708
2_116	Pooled Background	Appendix IV	Lead	ug/L	149	141	95%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	1.08	1.00	0.550	5.00	0.688	0.636	0	2.65	8.29
2_117	Pooled Background	Appendix IV	Lithium	ug/L	156	108	69%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	11.0	10.0	1.20	48.0	7.11	0.645	1.48	1.82	6.10
2_118	Pooled Background	Appendix IV	Mercury	ug/L	149	149	100%	2015-11-30 to 2024-03-27		Nonparametric	0.200	0.200	0.200	0.200	0	0	0	NA	NA
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	4.58	5.00	0.710	25.0	3.08	0.672	0.519	3.60	23.5
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	156	77	49%	2015-11-30 to 2024-03-27	Gamma; Normal	Nonparametric	1.11	1.00	0.0996	3.74	0.571	0.515	0.585	1.25	3.06
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	1.12	1.00	0.110	3.30	0.632	0.567	0	1.50	1.65
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	2015-11-30 to 2024-03-27		Nonparametric	1.52	2.00	0.190	10.0	1.02	0.669	0	3.62	31.7
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Nonparametric	0.524	0.250	0.000250	4.90	0.810	1.55	0.370	3.24	14.7
4_115	Pooled Background	Michigan CCR	Iron	ug/L	58	1	2%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Gamma	2586	1500	0.250	11000	2757	1.07	1481	1.52	1.38
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	58	44	76%	2020-10-26 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	6.30	0.128	0.000250	50.0	16.3	2.60	0.189	2.39	3.84
4_127	Pooled Background	Michigan CCR	Silver	ug/L	58	58	100%	2020-10-26 to 2024-03-27		Nonparametric	0.0363	0.000250	0.0000500	0.200	0.0647	1.78	0.000296	1.95	2.50
4_134	Pooled Background	Michigan CCR	Vanadium	ug/L	58	56	97%	2020-10-26 to 2024-03-27		Nonparametric	1.50	0.00620	0.00120	10.0	3.22	2.14	0.00741	2.27	3.51
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Nonparametric	6.99	1.90	0.00120	48.0	10.6	1.52	2.81	2.27	5.32

[a] Non-detects are excluded from goodness-of-fit tests.

Table 2: Summary Statistics, Non-Detects Excluded

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Date Range	Distributions Fit	Recommended Distribution	Mean	Median	Minimum	Maximum	SD	CV	MAD/0.675	Skewness	Kurtosis
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	488	190	13.1	5400	944	1.94	215	3.94	15.9
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	108	92.2	37.3	259	50.3	0.465	41.6	0.952	0.0872
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	335	145	1.23	2480	500	1.49	195	2.65	7.32
1_114	Pooled Background	Appendix III	Fluoride	ug/L	162	103	64%	2015-11-30 to 2024-03-27	Gamma; Lognormal	Nonparametric	339	310	100	1400	209	0.617	148	2.51	10.4
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	7.21	7.20	6.60	8.30	0.320	0.0443	0.296	0.648	0.866
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	34.9	9.40	1.10	327	62.2	1.78	8.59	2.89	8.27
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	940	615	158	4800	847	0.901	467	2.22	5.91
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	0.673	0.650	0.140	1.40	0.358	0.531	0.474	0.470	-0.256
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	154	58	38%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	3.23	2.00	0.120	18.0	3.34	1.03	1.48	2.59	7.46
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	2015-11-30 to 2024-03-27	Gamma	Gamma	100	84.0	14.0	377	69.6	0.697	67.1	1.13	1.31
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	149	147	99%	2015-11-30 to 2024-03-27		Nonparametric	0.149	0.149	0.0780	0.220	0.100	0.674	0.105	NA	NA
2_109	Pooled Background	Appendix IV	Chromium	ug/L	156	83	53%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	1.13	1.00	0.250	3.70	0.769	0.680	0.919	0.957	0.651
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	0.519	0.520	0.110	1.20	0.358	0.690	0.385	0.900	0.220
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	162	103	64%	2015-11-30 to 2024-03-27	Gamma; Lognormal	Nonparametric	339	310	100	1400	209	0.617	148	2.51	10.4
2_116	Pooled Background	Appendix IV	Lead	ug/L	149	141	95%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	1.12	1.05	0.680	2.00	0.466	0.417	0.474	1.12	0.514
2_117	Pooled Background	Appendix IV	Lithium	ug/L	156	108	69%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	15.1	13.0	1.40	48.0	10.1	0.668	7.41	1.08	1.61
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	4.40	4.60	0.710	9.70	2.72	0.618	3.56	0.167	-1.39
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	156	77	49%	2015-11-30 to 2024-03-27	Gamma; Normal	Nonparametric	1.25	1.14	0.0996	3.74	0.695	0.556	0.723	0.916	1.36
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	1.34	1.00	0.110	3.30	0.756	0.565	0.311	0.964	0.499
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	2015-11-30 to 2024-03-27		Nonparametric	0.190	0.190	0.190	0.190	NA	NA	0	NA	NA
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Nonparametric	1.09	0.730	0.280	4.90	1.05	0.964	0.548	2.71	8.72
4_115	Pooled Background	Michigan CCR	Iron	ug/L	58	1	2%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Gamma	2631	1500	52.0	11000	2760	1.05	1481	1.51	1.32
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	58	44	76%	2020-10-26 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	0.524	0.500	0.350	0.840	0.142	0.272	0.156	0.688	0.0423
4_134	Pooled Background	Michigan CCR	Vanadium	ug/L	58	56	97%	2020-10-26 to 2024-03-27		Nonparametric	1.35	1.35	1.00	1.70	0.495	0.367	0.519	NA	NA
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Nonparametric	12.6	8.50	1.30	48.0	13.0	1.04	8.30	1.49	1.49

Table 3: Goodness-of-Fit Tests, Non-Detects Excluded

								Normal				Lognormal				Gamma						
								S-W		Lilliefors		S-W		Lilliefors		K-S		A-D				
ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Stat.	p-Value	Stat.	p-Value	Stat.	p-Value	Stat.	p-Value	Stat.	p-Value	Stat.	p-Value	Log-SD (NDs excl.)	ProUCL Distributions Fit	Recommended Distribution
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	0.468	0.000	0.308	0.000	0.973	0.004	0.073	0.047	0.116	< 0.01	5.296	< 0.01	1.314	Nonparametric	Nonparametric
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	0.901	0.000	0.154	0.000	0.969	0.001	0.093	0.002	0.113	< 0.01	2.816	< 0.01	0.443	Nonparametric	Nonparametric
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	0.650	0.000	0.252	0.000	0.971	0.003	0.077	0.023	0.080	0.01 <= p < 0.05	1.443	< 0.01	1.727	Nonparametric	Nonparametric
1_114	Pooled Background	Appendix III	Fluoride	ug/L	162	103	64%	0.796	0.000	0.168	0.000	0.984	0.631	0.059	0.878	0.092	>= 0.10	0.459	>= 0.10	0.534	Gamma; Lognormal	Nonparametric
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	0.968	0.001	0.101	0.000	0.977	0.007	0.092	0.002	0.095	< 0.01	0.982	0.01 <= p < 0.05	0.044	Nonparametric	Nonparametric
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	0.551	0.000	0.298	0.000	0.941	0.000	0.113	0.001	0.190	< 0.01	7.755	< 0.01	1.284	Nonparametric	Nonparametric
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	0.754	0.000	0.185	0.000	0.961	0.000	0.091	0.003	0.122	< 0.01	3.496	< 0.01	0.763	Nonparametric	Nonparametric
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	0.957	0.709	0.141	0.682	0.943	0.503	0.153	0.555	0.137	>= 0.10	0.240	>= 0.10	0.630	Gamma; Lognormal; Normal	Nonparametric
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	154	58	38%	0.690	0.000	0.233	0.000	0.956	0.003	0.126	0.001	0.150	< 0.01	2.682	< 0.01	0.868	Nonparametric	Nonparametric
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	0.909	0.000	0.109	0.000	0.972	0.003	0.092	0.003	0.050	>= 0.10	0.544	>= 0.10	0.770	Gamma	Gamma
2_104	Pooled Background	Appendix IV	Beryllium	ug/L	149	149	100%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		NA		Nonparametric
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	149	147	99%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		0.733		Nonparametric
2_109	Pooled Background	Appendix IV	Chromium	ug/L	156	83	53%	0.868	0.000	0.211	0.000	0.918	0.000	0.170	0.000	0.161	< 0.01	2.182	< 0.01	0.744	Nonparametric	Nonparametric
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	0.868	0.073	0.251	0.052	0.908	0.228	0.261	0.034	0.228	>= 0.10	0.466	>= 0.10	0.793	Gamma; Lognormal; Normal	Nonparametric
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	162	103	64%	0.796	0.000	0.168	0.000	0.984	0.631	0.059	0.878	0.092	>= 0.10	0.459	>= 0.10	0.534	Gamma; Lognormal	Nonparametric
2_116	Pooled Background	Appendix IV	Lead	ug/L	149	141	95%	0.869	0.149	0.265	0.100	0.918	0.415	0.195	0.491	0.218	>= 0.10	0.388	>= 0.10	0.389	Gamma; Lognormal; Normal	Nonparametric
2_117	Pooled Background	Appendix IV	Lithium	ug/L	156	108	69%	0.919	0.003	0.139	0.021	0.898	0.001	0.215	0.000	0.164	< 0.01	0.939	0.01 <= p < 0.05	0.867	Nonparametric	Nonparametric
2_118	Pooled Background	Appendix IV	Mercury	ug/L	149	149	100%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		NA		Nonparametric
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	0.914	0.006	0.164	0.010	0.901	0.002	0.173	0.005	0.150	0.01 <= p < 0.05	1.274	< 0.01	0.787	Nonparametric	Nonparametric
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	156	77	49%	0.950	0.004	0.070	0.444	0.950	0.004	0.130	0.002	0.089	>= 0.10	0.427	>= 0.10	0.656	Gamma; Normal	Nonparametric
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	0.883	0.001	0.248	0.000	0.878	0.001	0.203	0.000	0.179	< 0.01	1.273	< 0.01	0.664	Nonparametric	Nonparametric
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		NA		Nonparametric
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	0.689	0.000	0.252	0.001	0.952	0.364	0.110	0.733	0.147	>= 0.10	0.630	>= 0.10	0.748	Gamma; Lognormal	Nonparametric
4_115	Pooled Background	Michigan CCR	Iron	ug/L	58	1	2%	0.789	0.000	0.225	0.000	0.965	0.102	0.108	0.092	0.123	0.01 <= p < 0.05	0.682	0.05 <= p < 0.10	1.204	Gamma; Lognormal	Gamma
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	58	44	76%	0.924	0.248	0.174	0.298	0.944	0.468	0.165	0.378	0.162	>= 0.10	0.397	>= 0.10	0.265	Gamma; Lognormal; Normal	Nonparametric
4_127	Pooled Background	Michigan CCR	Silver	ug/L	58	58	100%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		NA		Nonparametric
4_134	Pooled Background	Michigan CCR	Vanadium	ug/L	58	56	97%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		0.375		Nonparametric
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	0.803	0.000	0.221	0.002	0.957	0.316	0.090	0.830	0.129	>= 0.10	0.471	>= 0.10	1.095	Gamma; Lognormal	Nonparametric

Note: p-values above 0.05 suggest a fit to the tested distribution; a distribution passes its GOF test when at least one of the two p-values is above 0.05.

Table 4: Autocorrelation Tests, Non-Detects Excluded

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Autocorrelation	Box-Ljung p-value	Sig.
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	0.129	0.107	
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	0.067	0.397	
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	-0.118	0.137	
1_114	Pooled Background	Appendix III	Fluoride	ug/L	162	103	64%	0.083	0.512	
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	-0.148	0.055	
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	0.129	0.147	
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	-0.096	0.225	
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	0.340	0.170	
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	154	58	38%	-0.084	0.404	
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	-0.232	0.003	**
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	149	147	99%	-0.500	0.157	
2_109	Pooled Background	Appendix IV	Chromium	ug/L	156	83	53%	0.422	0.000	***
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	0.609	0.021	*
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	162	103	64%	0.083	0.512	
2_116	Pooled Background	Appendix IV	Lead	ug/L	149	141	95%	-0.002	0.995	
2_117	Pooled Background	Appendix IV	Lithium	ug/L	156	108	69%	0.395	0.005	**
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	0.465	0.003	**
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	156	77	49%	0.326	0.003	**
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	0.197	0.211	
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	NA	NA	
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	-0.035	0.863	
4_115	Pooled Background	Michigan CCR	Iron	ug/L	58	1	2%	0.086	0.504	
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	58	44	76%	0.164	0.495	
4_134	Pooled Background	Michigan CCR	Vanadium	ug/L	58	56	97%	-0.500	0.157	
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	-0.174	0.341	

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 5: Outlier Counts by Date

Date	Count
2015-11-30	4
2016-02-17	2
2016-04-12	4
2016-07-12	3
2016-09-27	3
2017-02-13	2
2017-04-04	2
2017-07-12	2
2017-09-14	1
2020-10-26	1
2021-04-19	2
2021-10-19	3
2022-05-05	3
2022-08-11	1
2022-10-21	3
2023-04-11	2
2023-10-02	4
2024-03-27	1

Table 6: Outliers Identified at the 1% Significance Level, Non-Detects Excluded

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	No. Detects	Date	Value
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2022-05-05	5400
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2022-08-11	4900
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2022-10-21	4900
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2023-04-11	4900
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2023-10-02	4800
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2024-03-27	3800
1_105	MW-15003	Appendix III	Boron	ug/L	156	3	2%	153	2016-04-12	2370
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2016-04-12	2480
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2016-09-27	2390
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2016-02-17	2300
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2016-07-12	2280
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2017-09-14	1940
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2015-11-30	1900
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2017-07-12	1900
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2017-02-13	1850
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2017-04-04	1670
1_114	MW-15004	Appendix III	Fluoride	ug/L	162	103	64%	59	2021-04-19	1400
1_128	MW-15002	Appendix III	Sulfate	mg/L	156	33	21%	123	2016-02-17	327
1_128	MW-15002	Appendix III	Sulfate	mg/L	156	33	21%	123	2016-04-12	300

(Table continues on next page)

Table 6: Outliers Identified at the 1% Significance Level, Non-Detects Excluded *(continued)*

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	No. Detects	Date	Value
1_128	MW-15002	Appendix III	Sulfate	mg/L	156	33	21%	123	2015-11-30	250
1_128	MW-15007	Appendix III	Sulfate	mg/L	156	33	21%	123	2023-04-11	240
1_128	MW-15002	Appendix III	Sulfate	mg/L	156	33	21%	123	2023-10-02	220
1_128	MW-15002	Appendix III	Sulfate	mg/L	156	33	21%	123	2016-07-12	202
1_128	MW-15007	Appendix III	Sulfate	mg/L	156	33	21%	123	2022-10-21	190
1_128	MW-15007	Appendix III	Sulfate	mg/L	156	33	21%	123	2022-05-05	170
1_128	MW-15008	Appendix III	Sulfate	mg/L	156	33	21%	123	2022-05-05	170
1_128	MW-15008	Appendix III	Sulfate	mg/L	156	33	21%	123	2022-10-21	140
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2016-09-27	4800
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2016-07-12	4500
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2016-04-12	3900
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2015-11-30	3700
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2017-02-13	3700
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2017-07-12	3700
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2017-04-04	3100
2_102	MW-15008	Appendix IV	Arsenic	ug/L	154	58	38%	96	2020-10-26	18.0
2_102	MW-15008	Appendix IV	Arsenic	ug/L	154	58	38%	96	2021-10-19	17.0
2_102	MW-15006	Appendix IV	Arsenic	ug/L	154	58	38%	96	2021-10-19	15.0
2_102	MW-15008	Appendix IV	Arsenic	ug/L	154	58	38%	96	2023-10-02	12.0
2_102	MW-15002	Appendix IV	Arsenic	ug/L	154	58	38%	96	2015-11-30	10.0
2_102	MW-15006	Appendix IV	Arsenic	ug/L	154	58	38%	96	2023-10-02	10.0
2_103	MW-15007	Appendix IV	Barium	ug/L	156	0	0%	156	2016-09-27	377
2_114	MW-15004	Appendix IV	Fluoride	ug/L	162	103	64%	59	2021-04-19	1400
4_112	MW-15007	Michigan CCR	Copper	ug/L	58	37	64%	21	2021-10-19	4.90

Table 7: Seasonality Tests

						Full											Without Non-Detects										
						Sample Size					p-Value						Sample Size					p-Value					
ID	Well	Constituent Type	Constituent	Unit	% NDs	Winter	Spring	Summer	Fall	Total	Kruskal-Wallis		ANOVA		Log ANOVA		Winter	Spring	Summer	Fall	Total	Kruskal-Wallis		ANOVA		Log ANOVA	
1_105	Pooled Background	Appendix III	Boron	ug/L	2%	14	56	23	63	156	0.669		0.964		0.760		14	55	23	61	153	0.625		0.968		0.732	
1_107	Pooled Background	Appendix III	Calcium	mg/L	0%	14	56	23	63	156	0.588		0.257		0.543		14	56	23	63	156	0.588		0.257		0.543	
1_108	Pooled Background	Appendix III	Chloride	mg/L	0%	14	56	23	63	156	0.548		0.358		0.501		14	56	23	63	156	0.548		0.358		0.501	
1_114	Pooled Background	Appendix III	Fluoride	ug/L	64%	14	62	23	63	162	0.000	***	0.000	***	0.000	***	0	33	2	24	59	0.998		0.916		0.997	
1_122	Pooled Background	Appendix III	pH, Field	SU	0%	17	62	23	63	165	0.500		0.504		0.495		17	62	23	63	165	0.500		0.504		0.495	
1_128	Pooled Background	Appendix III	Sulfate	mg/L	21%	14	56	23	63	156	0.449		0.723		0.575		14	46	18	45	123	0.617		0.868		0.663	
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	0%	14	56	23	63	156	0.314		0.256		0.331		14	56	23	63	156	0.314		0.256		0.331	
2_101	Pooled Background	Appendix IV	Antimony	ug/L	91%	14	63	23	49	149	0.129		0.012	*	0.007	**	1	6	1	5	13	0.214		0.088		0.321	
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	38%	14	62	22	56	154	0.003	**	0.001	***	0.001	***	9	33	15	39	96	0.001	**	0.004	**	0.001	***
2_103	Pooled Background	Appendix IV	Barium	ug/L	0%	14	63	23	56	156	0.365		0.134		0.342		14	63	23	56	156	0.365		0.134		0.342	
2_104	Pooled Background	Appendix IV	Beryllium	ug/L	100%	14	63	23	49	149	0.041	*	0.002	**	0.001	***	NA	NA	NA	NA	NA	NA		NA		NA	
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	99%	14	63	23	49	149	0.000	***	0.030	*	0.008	**	0	1	1	0	2	0.317		NA		NA	
2_109	Pooled Background	Appendix IV	Chromium	ug/L	53%	14	63	23	56	156	0.019	*	0.024	*	0.003	**	10	30	11	22	73	0.002	**	0.002	**	0.001	***
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	93%	14	63	23	49	149	0.000	***	0.000	***	0.000	***	0	7	0	4	11	0.107		0.267		0.138	
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	64%	14	62	23	63	162	0.000	***	0.000	***	0.000	***	0	33	2	24	59	0.998		0.916		0.997	
2_116	Pooled Background	Appendix IV	Lead	ug/L	95%	14	63	23	49	149	0.341		0.639		0.973		0	4	2	2	8	0.905		0.970		0.971	
2_117	Pooled Background	Appendix IV	Lithium	ug/L	69%	14	63	23	56	156	0.420		0.796		0.111		2	20	8	18	48	0.667		0.964		0.593	
2_118	Pooled Background	Appendix IV	Mercury	ug/L	100%	14	63	23	49	149	NA		0.568		0.568		NA	NA	NA	NA	NA	NA		NA		NA	
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	75%	14	63	23	56	156	0.212		0.183		0.023	*	2	22	3	12	39	0.017	*	0.018	*	0.035	*
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	49%	14	63	23	56	156	0.004	**	0.008	**	0.011	*	9	28	9	33	79	0.028	*	0.083		0.046	*
2_126	Pooled Background	Appendix IV	Selenium	ug/L	76%	14	63	23	56	156	0.536		0.794		0.690		2	18	6	11	37	0.211		0.076		0.214	
2_130	Pooled Background	Appendix IV	Thallium	ug/L	99%	14	63	23	49	149	0.000	***	0.044	*	0.001	**	0	1	0	0	1	NA		NA		NA	
4_112	Pooled Background	Michigan CCR	Copper	ug/L	64%	0	28	2	28	58	0.128		0.632		0.144		0	13	0	8	21	0.246		0.815		0.511	
4_115	Pooled Background	Michigan CCR	Iron	ug/L	2%	0	28	2	28	58	0.092		0.245		0.579		0	28	2	27	57	0.047	*	0.193		0.071	
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	76%	0	28	2	28	58	0.087		0.015	*	0.079		0	9	0	5	14	0.738		0.688		0.680	
4_127	Pooled Background	Michigan CCR	Silver	ug/L	100%	0	28	2	28	58	0.013	*	0.009	**	0.027	*	NA	NA	NA	NA	NA	NA		NA		NA	
4_134	Pooled Background	Michigan CCR	Vanadium	ug/L	97%	0	28	2	28	58	0.010	*	0.009	**	0.020	*	0	1	0	1	2	0.317		NA		NA	
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	53%	0	28	2	28	58	0.141		0.623		0.090		0	17	0	10	27	0.269		0.488		0.255	

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 8: Trend Tests: Lognormal MLE and MK

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Type	Method	Slope	p-value	Trend
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	Nonparametric	MK	-0.000962	0.745	↔
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	Nonparametric	MK	-0.0155	0.068	↔
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	Nonparametric	MK	0	0.570	↔
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	Nonparametric	MK	-0.0409	0.162	↔
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	Parametric	Lognormal MLE	-0.0000472	0.457	↔
4_115	Pooled Background	Michigan CCR	Iron	ug/L	58	1	2%	Parametric	Lognormal MLE	-0.000656	0.222	↔

Table 9: Trend Tests: Piecewise Linear-Linear

								Line 1			Line 2					
ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Slope	p-Value	Trend	Slope	p-Value	Trend	Break 1	R-Squared	Overall Trend
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	-0.257	0.241	↔	0.634	0.012	↔	2020-01-07	0.072	↔
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	-0.0518	0.016	↔	0.0119	0.166	↔	2018-07-04	0.073	↔
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	-0.297	0.161	↔	-0.0377	0.658	↔	2018-10-28	0.071	↔
1_114	Pooled Background	Appendix III	Fluoride	ug/L	162	103	64%	0	1.000	↔	0	0.000	↓	2018-04-08	0.705	↔
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	0.000144	0.024	↔	-0.000212	0.040	↔	2020-05-04	0.058	↔
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	-0.0834	0.009	↓	0.0208	0.015	↔	2018-01-02	0.088	↔
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	-0.415	0.038	↔	0.0630	0.781	↔	2020-01-14	0.065	↔
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	-0.000305	0.000	↓	0.000468	0.013	↔	2022-02-22	0.387	↔
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	-0.0728	0.007	↓	0.0102	0.387	↔	2018-06-15	0.086	↔
2_104	Pooled Background	Appendix IV	Beryllium	ug/L	149	149	100%	-0.000408	0.000	↓	0.000607	0.001	↑	2021-10-19	0.505	↔
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	149	147	99%	0.0000315	0.412	↔	0.000608	0.000	↑	2021-09-26	0.358	↔
2_109	Pooled Background	Appendix IV	Chromium	ug/L	156	83	53%	-0.000429	0.000	↓	0.000454	0.245	↔	2022-05-04	0.248	↔
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	-0.00852	0.000	↓	0.00115	0.422	↔	2021-06-24	0.841	↔
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	162	103	64%	0	1.000	↔	0	0.000	↓	2018-04-08	0.705	↔
2_116	Pooled Background	Appendix IV	Lead	ug/L	149	141	95%	-0.000150	0.092	↔	0.00140	0.002	↑	2022-01-04	0.150	↔
2_117	Pooled Background	Appendix IV	Lithium	ug/L	156	108	69%	-0.00189	0.080	↔	0.00546	0.130	↔	2021-04-19	0.041	↔
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	-0.00162	0.000	↓	0.00339	0.082	↔	2022-05-04	0.143	↔
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	156	77	49%	-0.0000633	0.248	↔	-0.00278	0.101	↔	2023-09-21	0.062	↔
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	-0.000293	0.001	↓	0.00111	0.000	↑	2021-07-11	0.166	↔
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	-0.000779	0.000	↓	0.000912	0.110	↔	2022-03-09	0.325	↔
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	-0.00108	0.005	↓	0.00317	0.167	↔	2023-09-17	0.187	↔
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	58	44	76%	-0.284	0.000	↓	0.000409	0.039	↔	2021-04-19	0.999	↔
4_127	Pooled Background	Michigan CCR	Silver	ug/L	58	58	100%	-0.000414	0.000	↓	0.0000574	0.033	↔	2021-12-20	0.658	↔
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	-0.0277	0.078	↔	0.0103	0.145	↔	2022-01-06	0.104	↔

Table 10: Trend Tests: Piecewise Linear-Linear-Linear

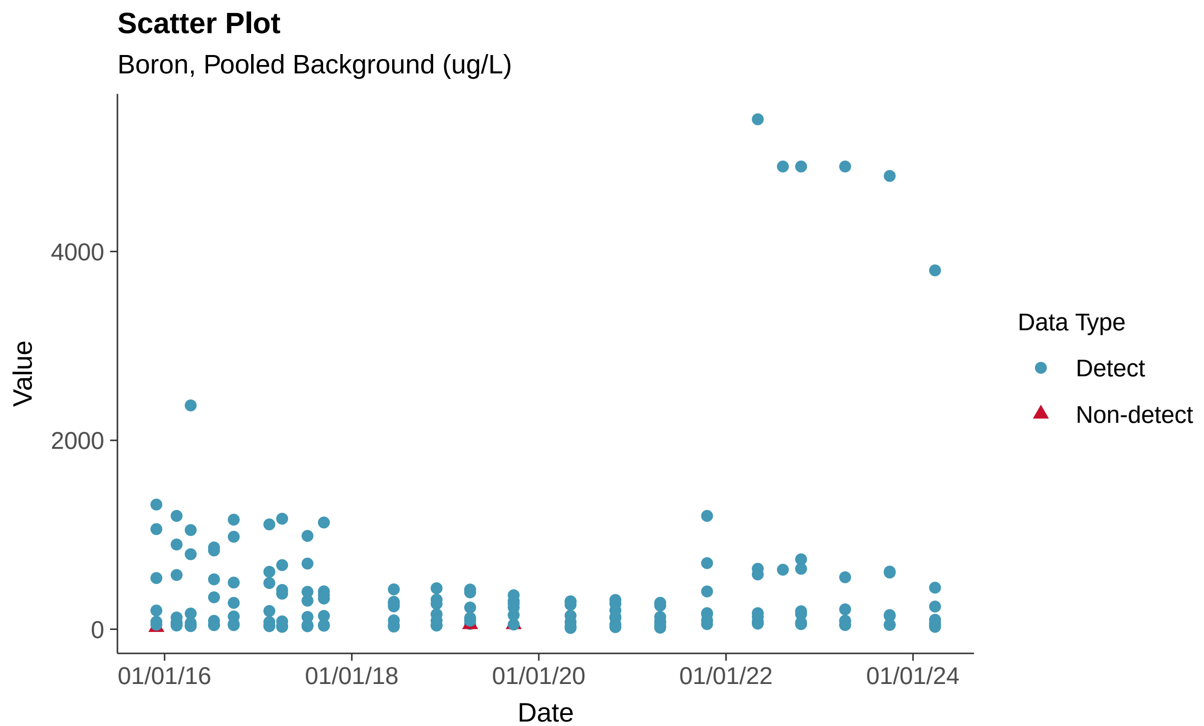
								Line 1			Line 2			Line 3						
ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Slope	p-Value	Trend	Slope	p-Value	Trend	Slope	p-Value	Trend	Break 1	Break 2	R-Squared	Overall Trend
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	-0.304	0.446	↔	-0.000908	1.000	↔	0.633	0.013	↔	2018-11-05	2020-05-03	0.072	↔
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	-0.0274	0.000	↓	0.175	0.177	↔	-0.0993	0.020	↔	2021-06-19	2022-08-03	0.128	↔
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	0.523	0.788	↔	-0.375	0.246	↔	-0.0368	0.667	↔	2016-04-12	2018-07-18	0.072	↔
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	-0.0834	0.008	↓	0.0288	0.008	↑	-0.222	0.178	↔	2018-02-28	2023-10-01	0.109	↔
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	0.934	0.626	↔	-0.941	0.414	↔	-0.0125	0.923	↔	2016-07-12	2018-04-16	0.071	↔
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	0.0000121	0.851	↔	-0.00396	0.000	↓	0.000487	0.000	↑	2020-04-29	2020-11-20	0.571	↔
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	154	58	38%	-0.0186	0.330	↔	0.000704	0.022	↔	-0.0154	0.072	↔	2016-02-17	2023-10-01	0.061	↔
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	-0.0728	0.007	↓	0.0302	0.086	↔	-0.0846	0.408	↔	2018-10-28	2022-11-20	0.104	↔
2_104	Pooled Background	Appendix IV	Beryllium	ug/L	149	149	100%	0	1.000	↔	-0.00144	0.000	↓	0.000572	0.000	↑	2019-02-28	2020-11-07	0.647	↔
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	0	1.000	↔	-0.0303	0.000	↓	0.000679	0.201	↔	2018-06-08	2019-10-03	0.925	↔
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	0.00184	0.037	↔	-0.00626	0.000	↓	0.00378	0.006	↑	2018-11-28	2021-06-10	0.265	↔
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	-0.000289	0.000	↓	0.00794	0.000	↑	-0.0112	0.000	↓	2022-08-11	2023-07-21	0.603	↔
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	0.000460	0.061	↔	-0.00245	0.000	↓	0.00114	0.003	↑	2018-11-28	2021-05-22	0.475	↔
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	-0.000458	0.845	↔	-0.00137	0.063	↔	0.00354	0.130	↔	2021-10-18	2023-09-13	0.193	↔
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	-0.0283	0.074	↔	0.0262	0.110	↔	-0.00562	0.859	↔	2022-03-16	2023-04-11	0.128	↔

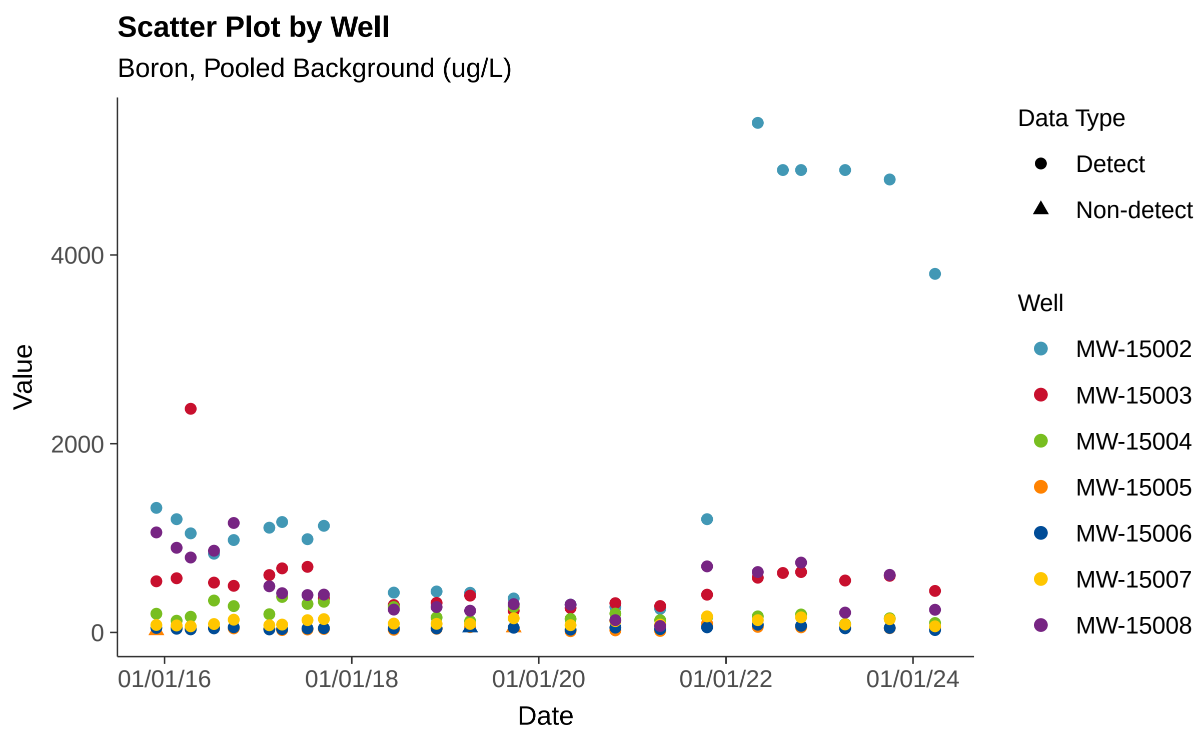
C

Scatter Plots

Appendix III: Boron, Pooled Background

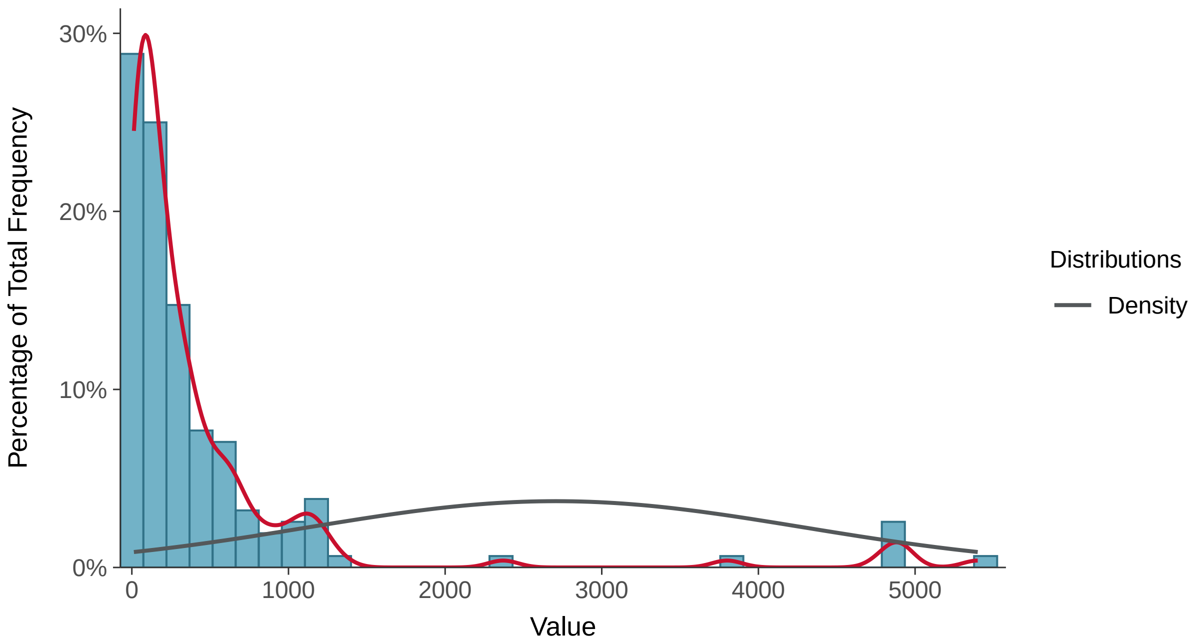
ID: 1_105





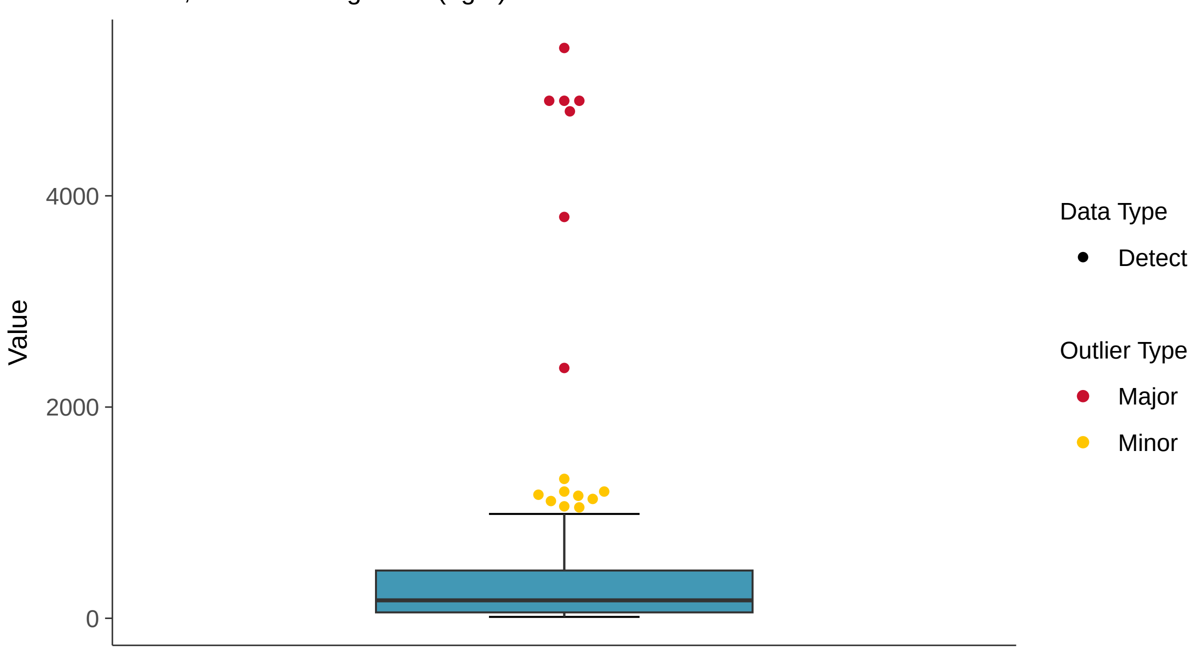
Histogram

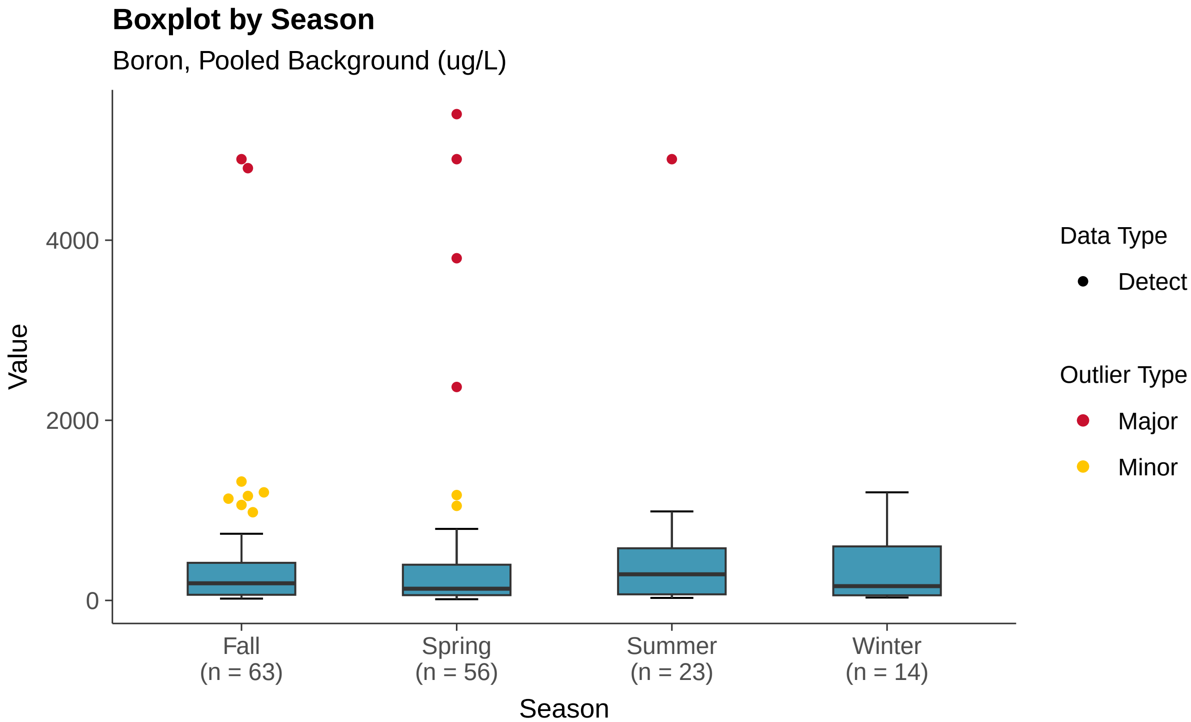
Boron, Pooled Background (ug/L)

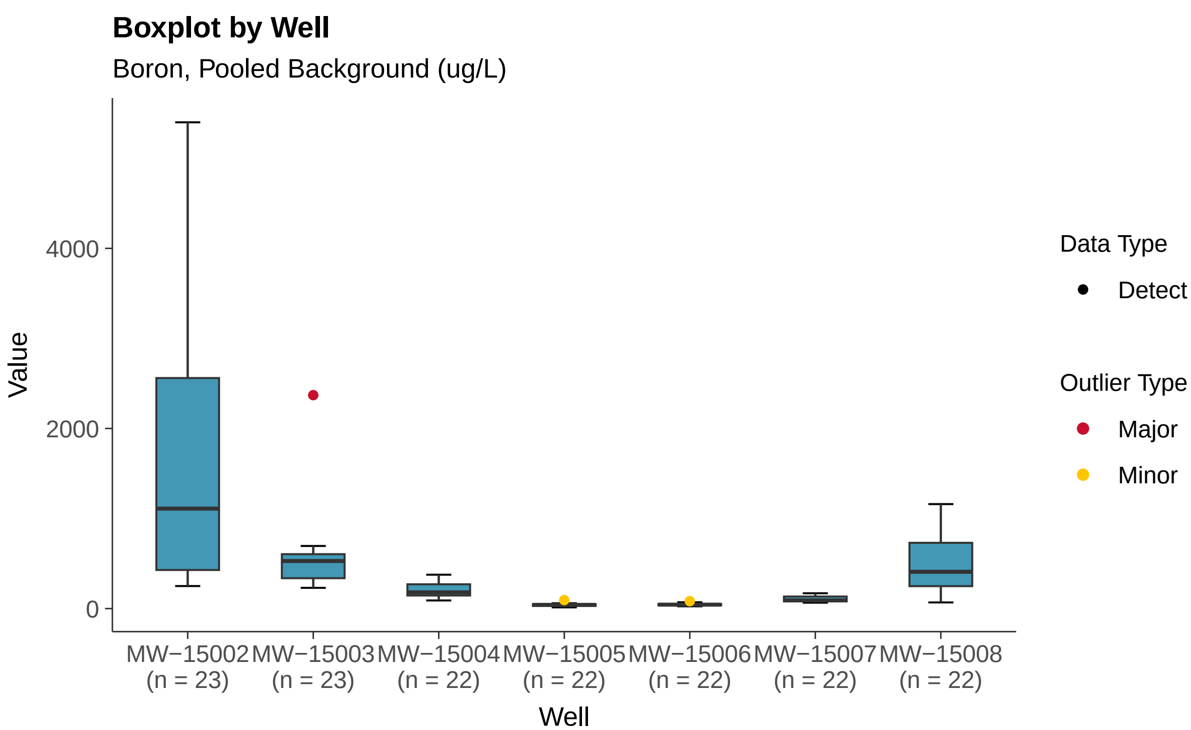


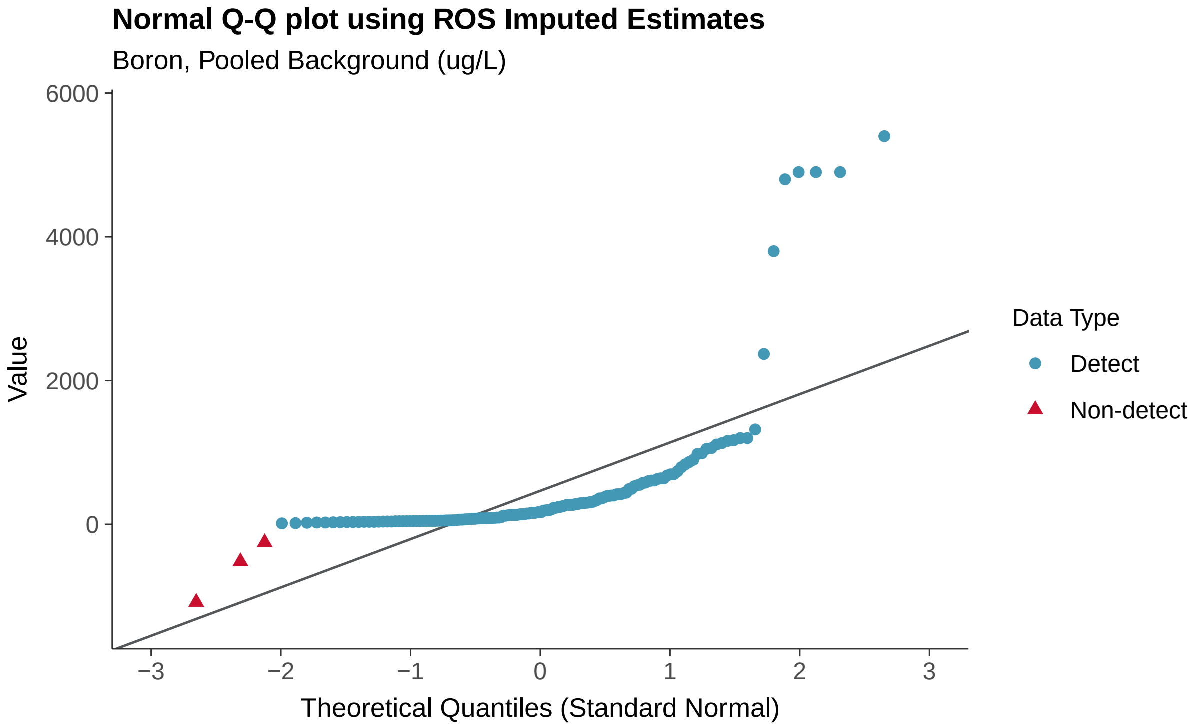
Boxplot

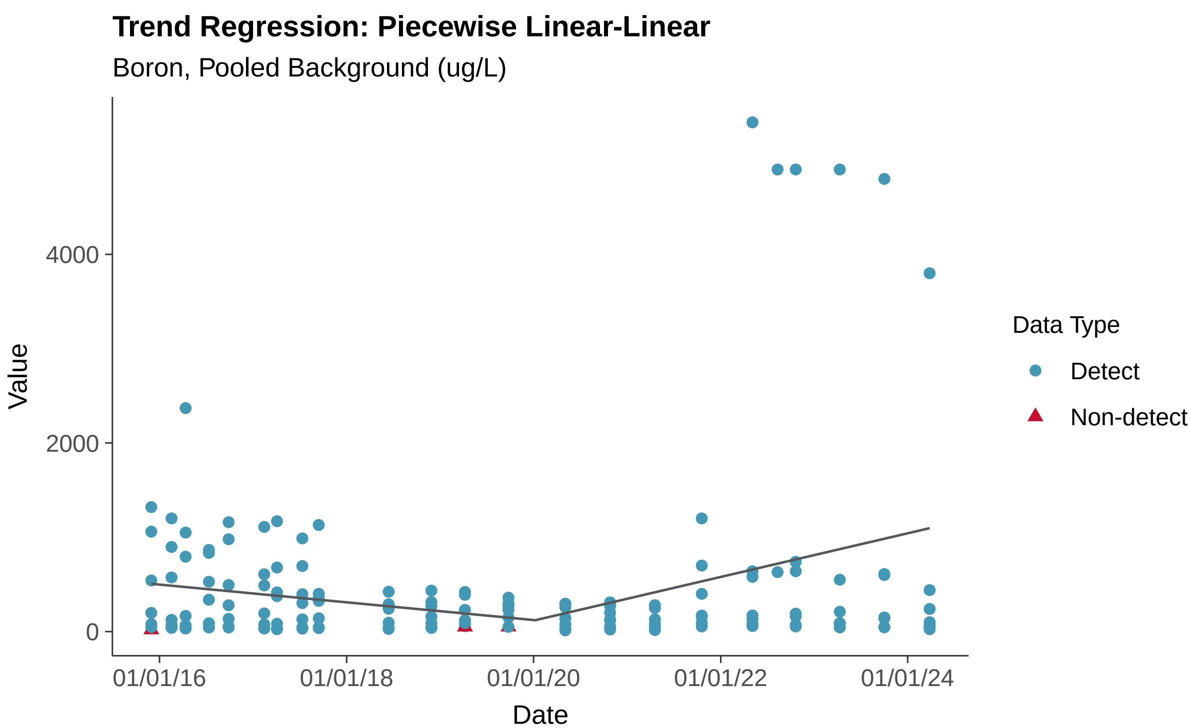
Boron, Pooled Background (ug/L)




Boxplot by Season
Boron, Pooled Background (ug/L)
Value
4000
2000
0
Fall
(n = 63)
Spring
(n = 56)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Outlier Type
Major
Minor

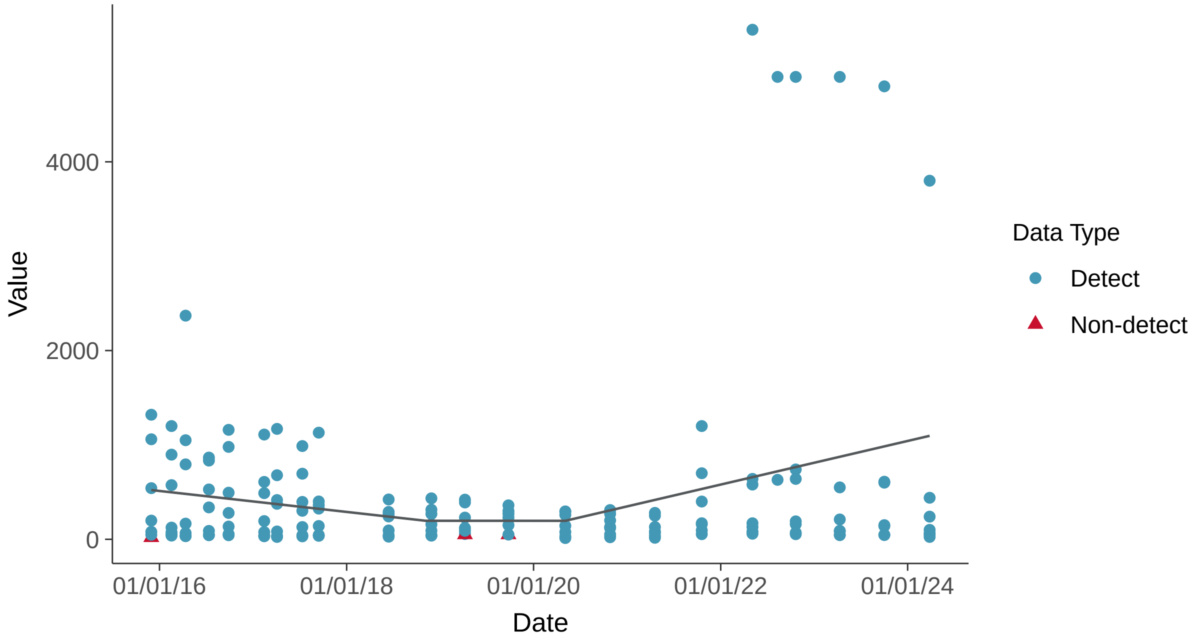

Boxplot by Well
Boron, Pooled Background (ug/L)
Value
4000
2000
0
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 22)
MW−15007
(n = 22)
MW−15008
(n = 22)
Well
Data Type
Detect
Outlier Type
Major
Minor


Normal Q-Q plot using ROS Imputed Estimates
Boron, Pooled Background (ug/L)
Value
6000
4000
2000
0
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Boron, Pooled Background (ug/L)
Value
4000
2000
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

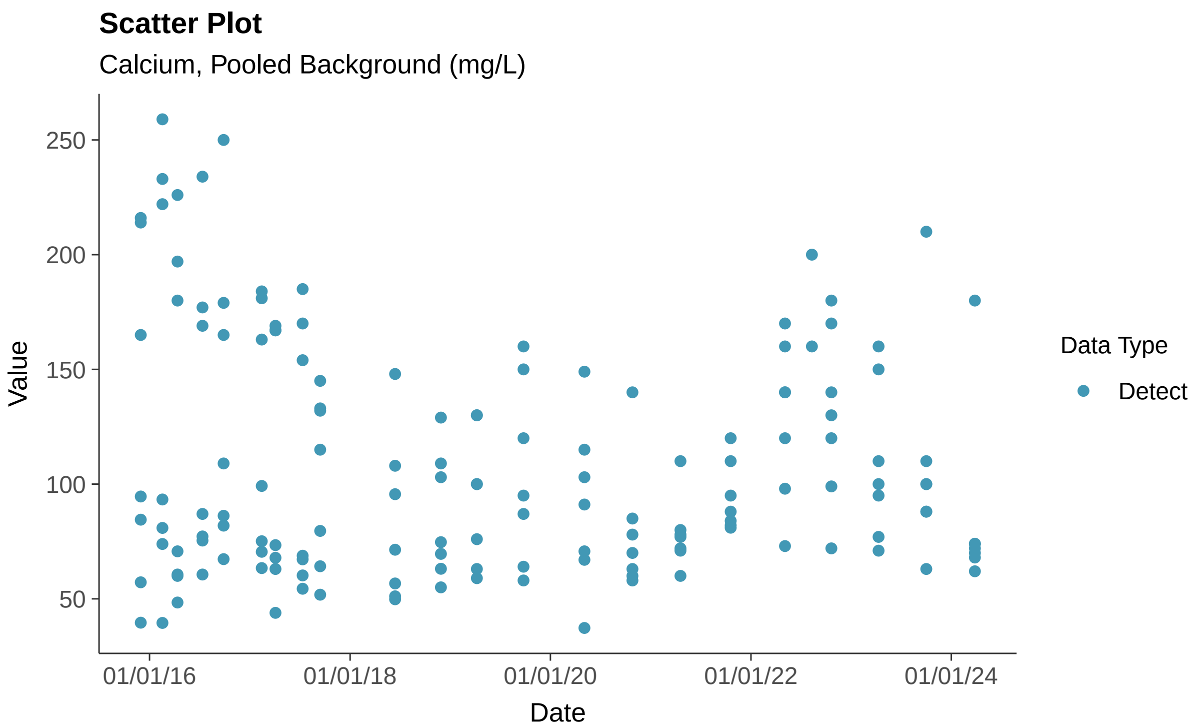
Trend Regression: Piecewise Linear-Linear-Linear

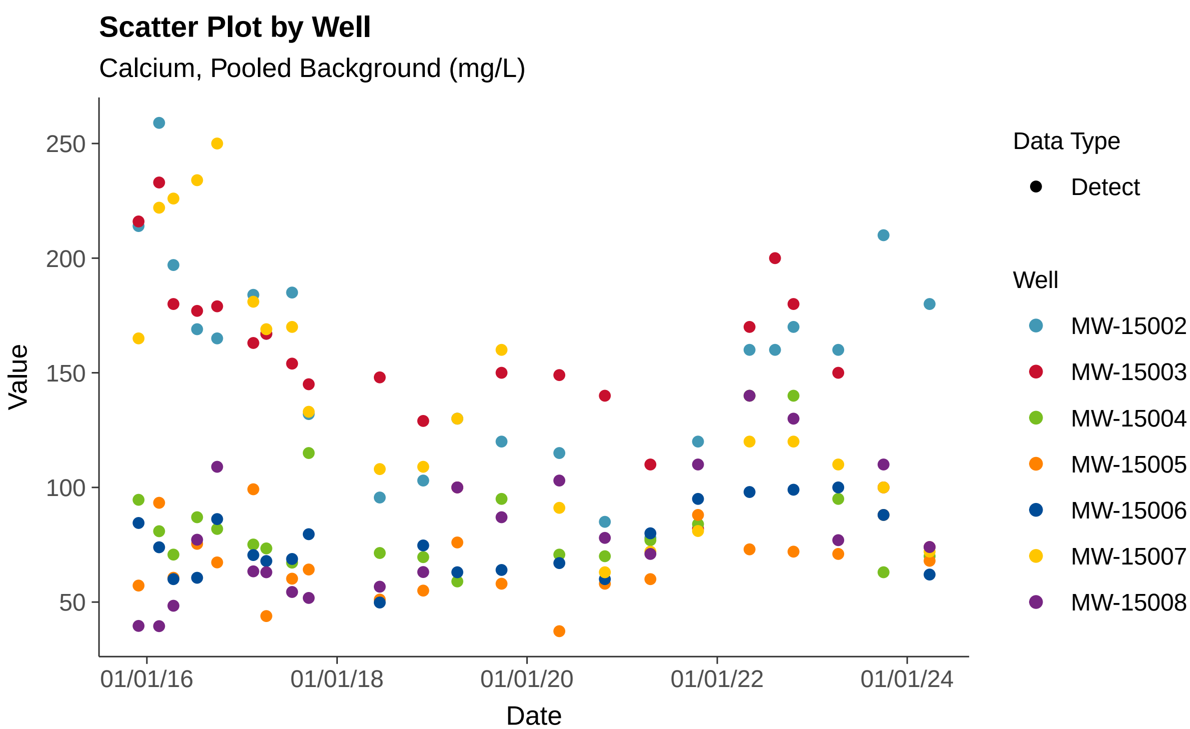
Boron, Pooled Background (ug/L)



Appendix III: Calcium, Pooled Background

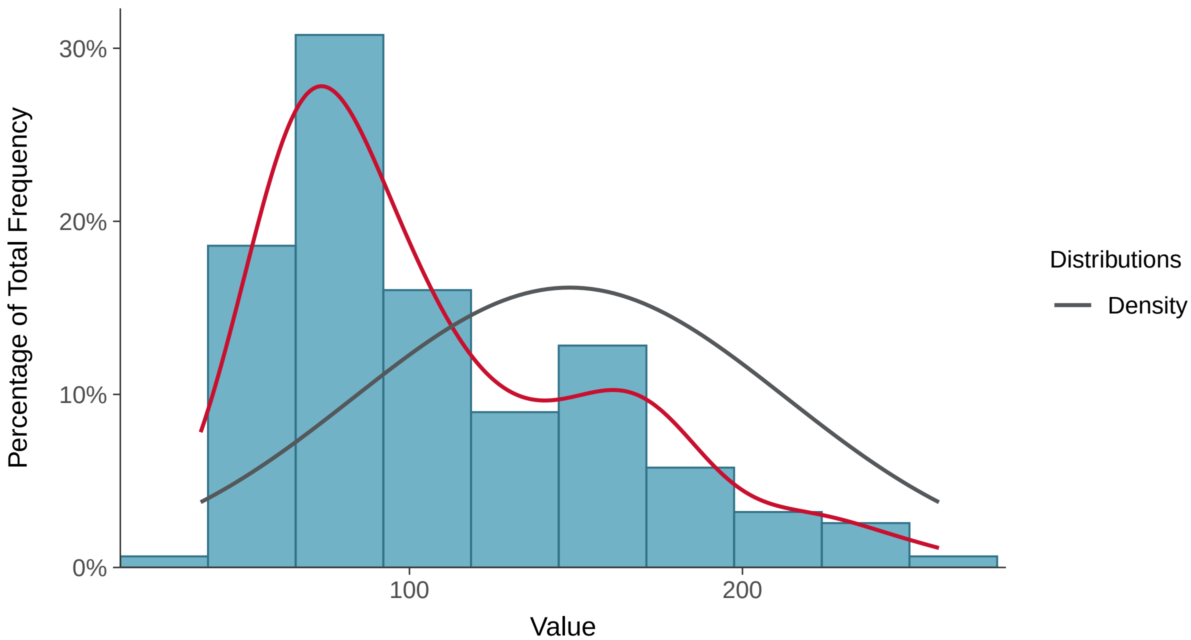
ID: 1_107





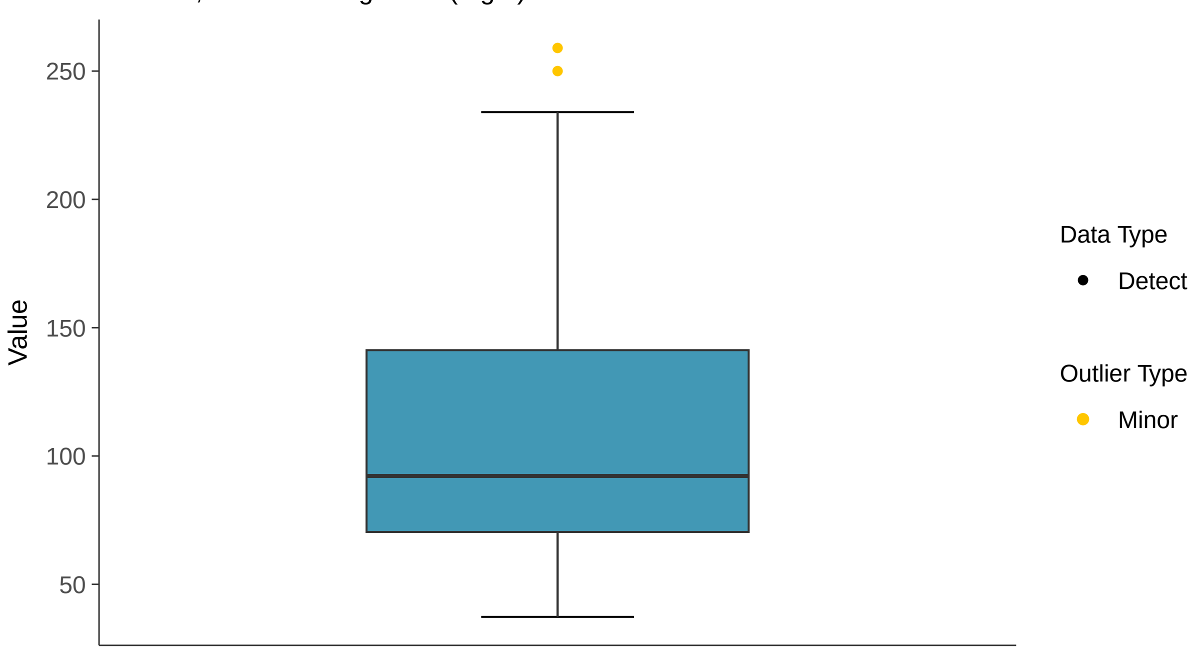
Histogram

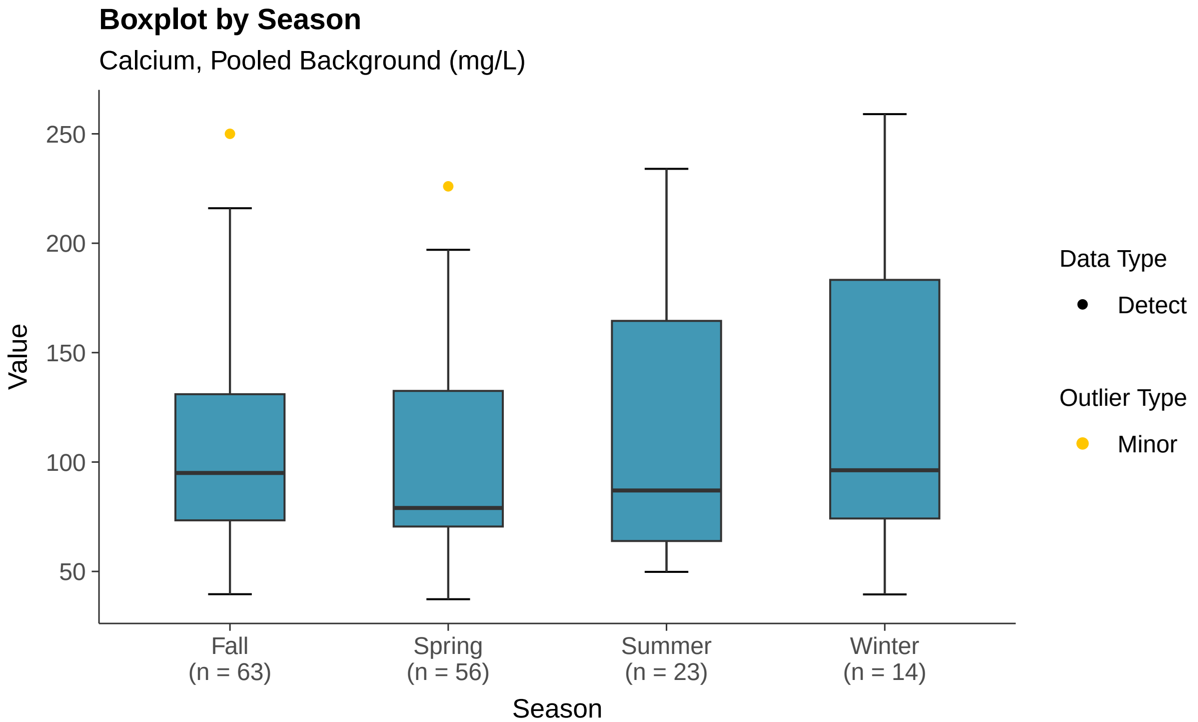
Calcium, Pooled Background (mg/L)

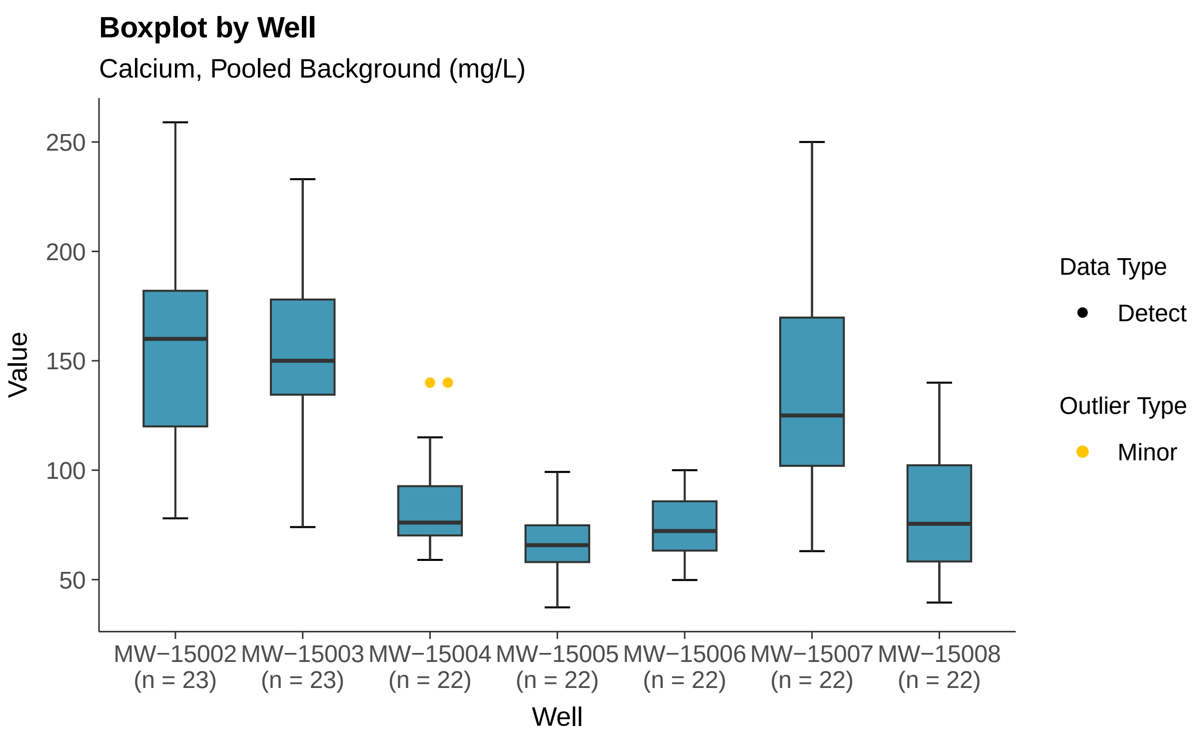


Boxplot

Calcium, Pooled Background (mg/L)

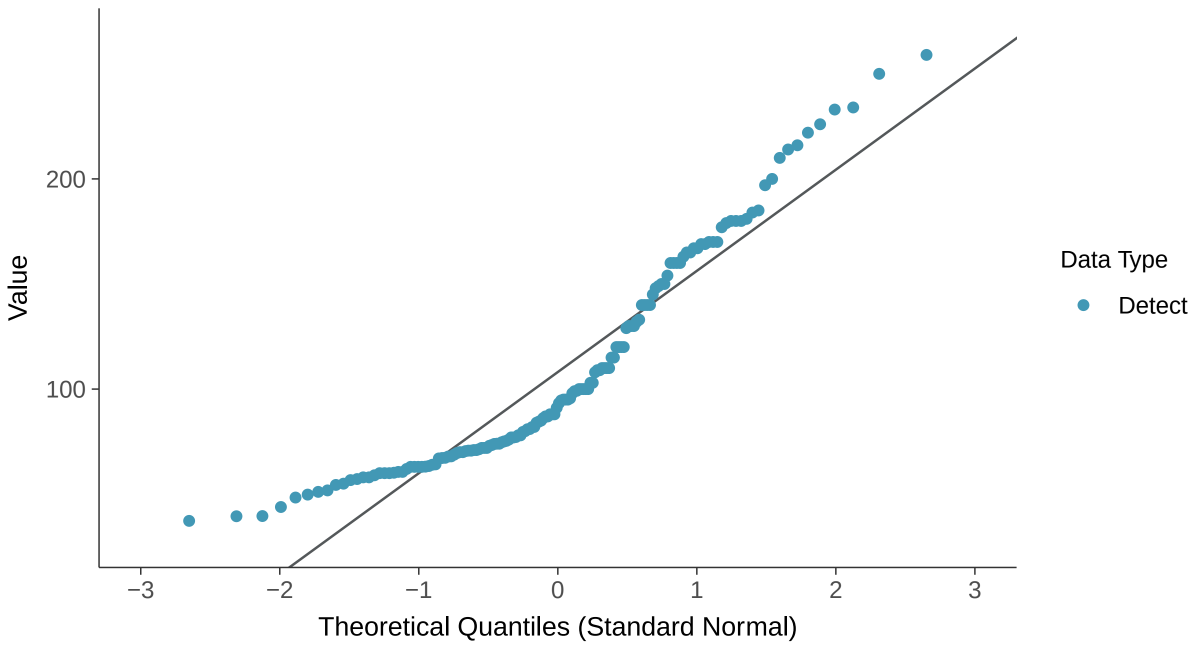



Boxplot by Season
Calcium, Pooled Background (mg/L)
Value
250
200
150
100
50
Fall (n = 63)
Spring (n = 56)
Summer (n = 23)
Winter (n = 14)
Season
Data Type
Detect
Outlier Type
Minor


Boxplot by Well
Calcium, Pooled Background (mg/L)
Value
250
200
150
100
50
MW−15002 (n = 23)
MW−15003 (n = 23)
MW−15004 (n = 22)
MW−15005 (n = 22)
MW−15006 (n = 22)
MW−15007 (n = 22)
MW−15008 (n = 22)
Well
Data Type
Detect
Outlier Type
Minor

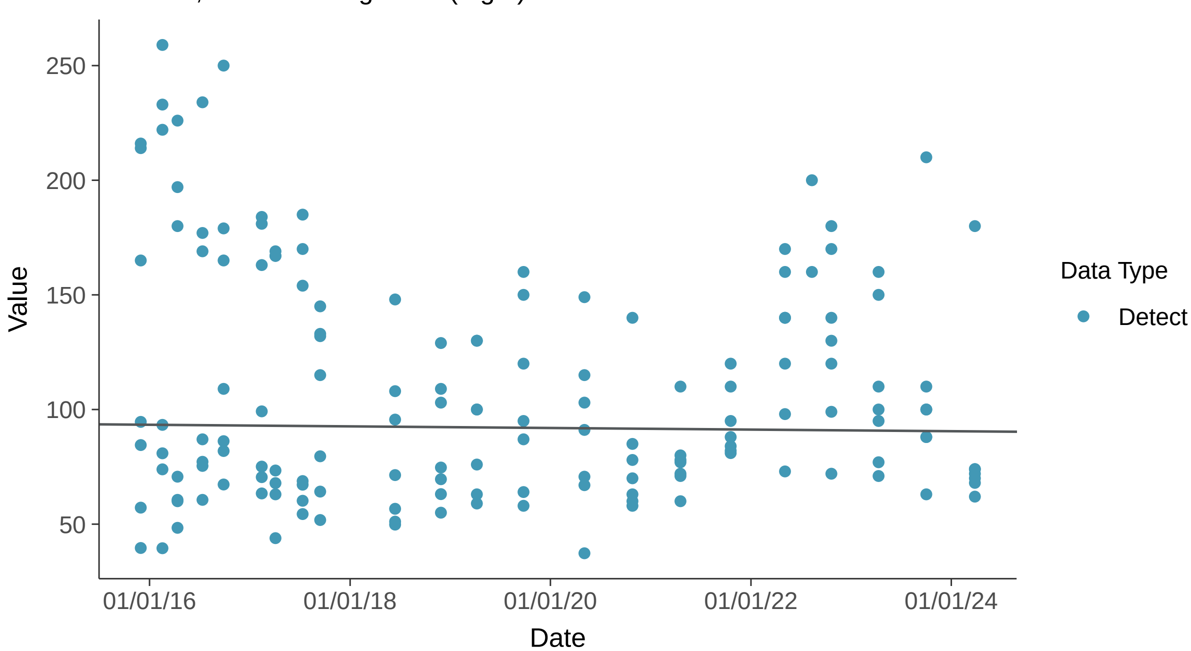
Normal Q-Q plot

Calcium, Pooled Background (mg/L)



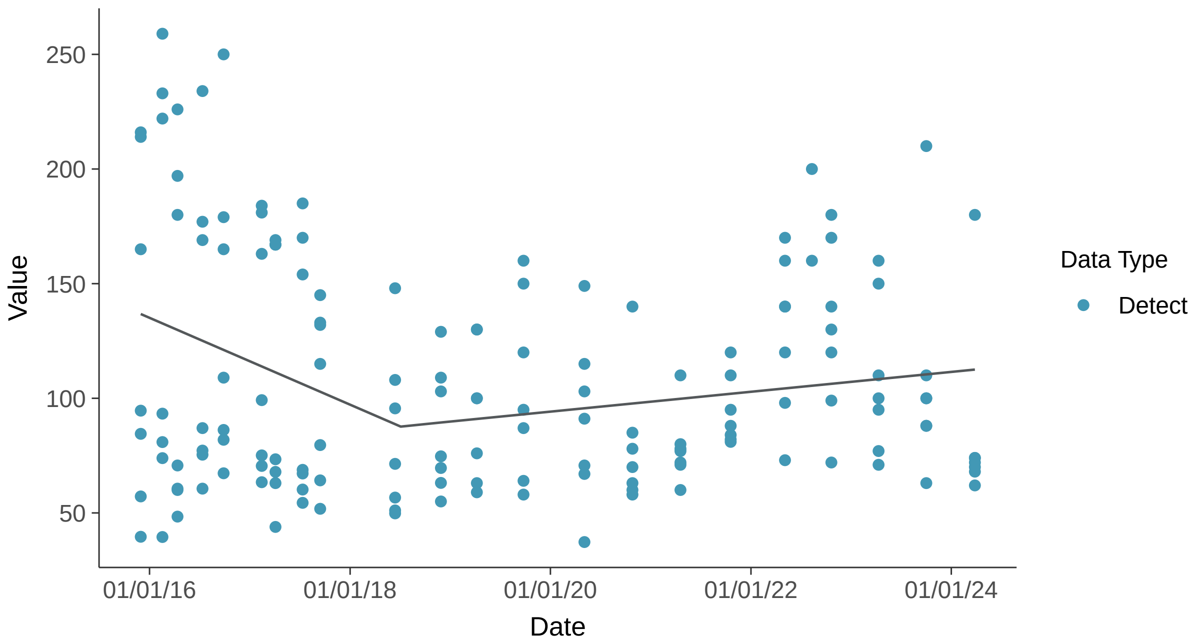
Trend Regression: Mann-Kendall/Theil-Sen Estimate

Calcium, Pooled Background (mg/L)



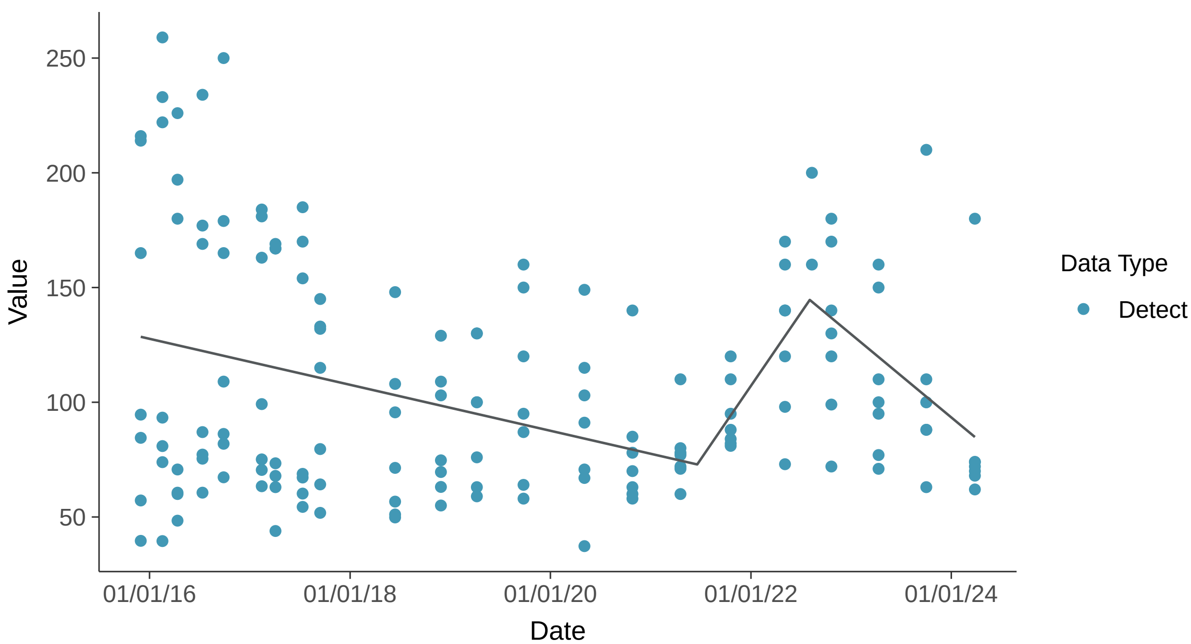
Trend Regression: Piecewise Linear-Linear

Calcium, Pooled Background (mg/L)



Trend Regression: Piecewise Linear-Linear-Linear

Calcium, Pooled Background (mg/L)

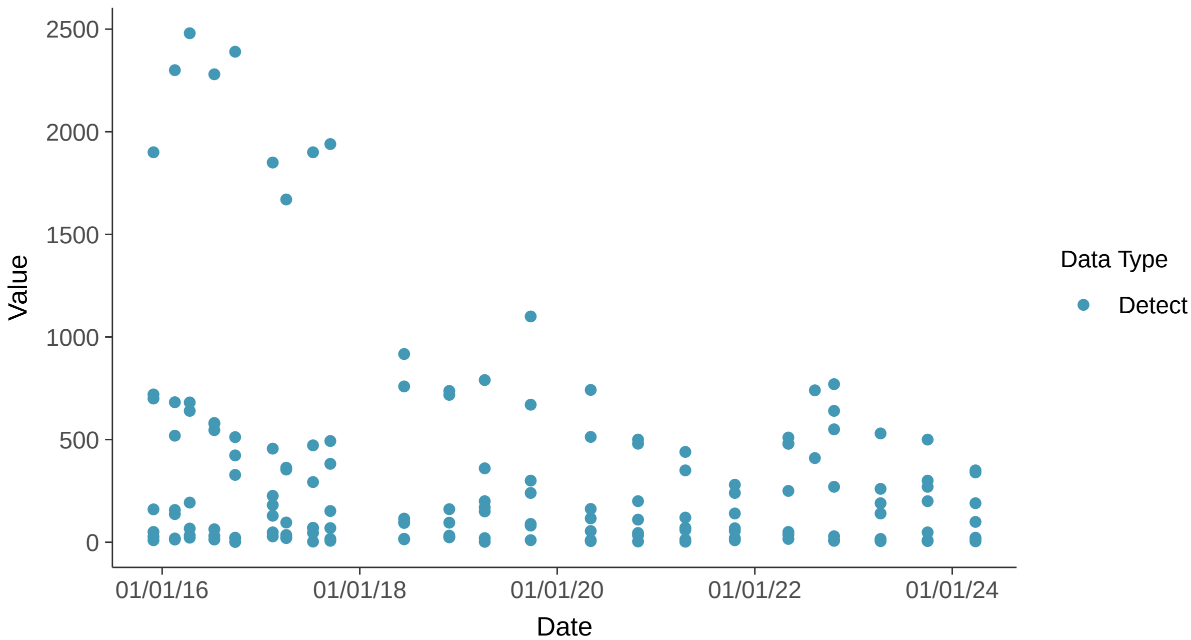


Appendix III: Chloride, Pooled Background

ID: 1_108

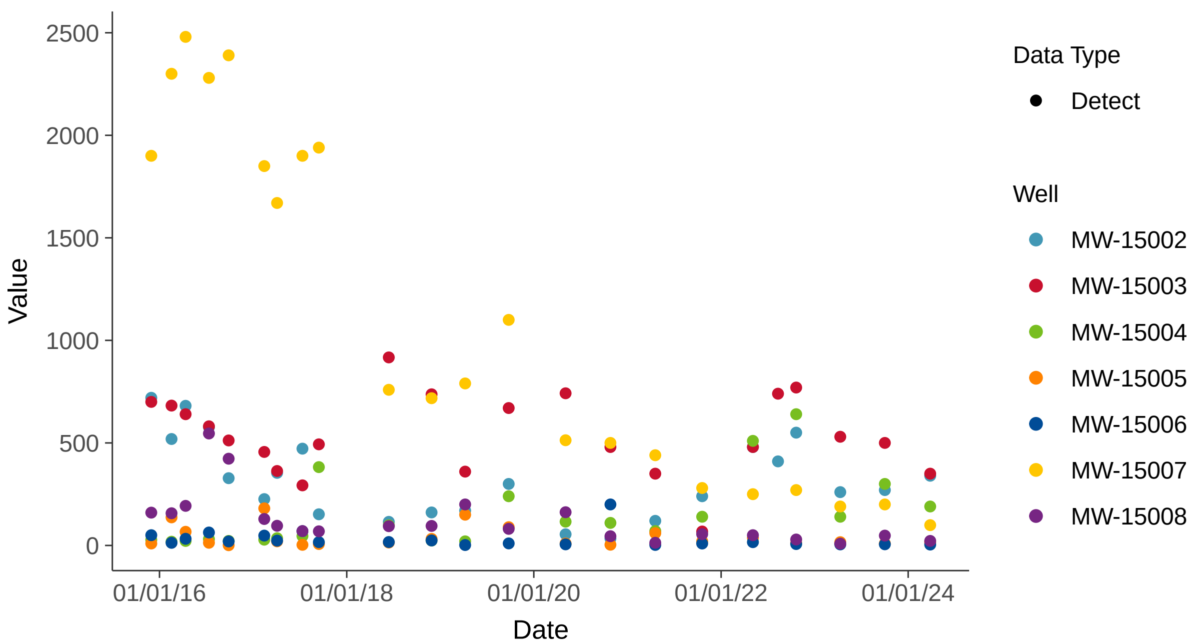
Scatter Plot

Chloride, Pooled Background (mg/L)



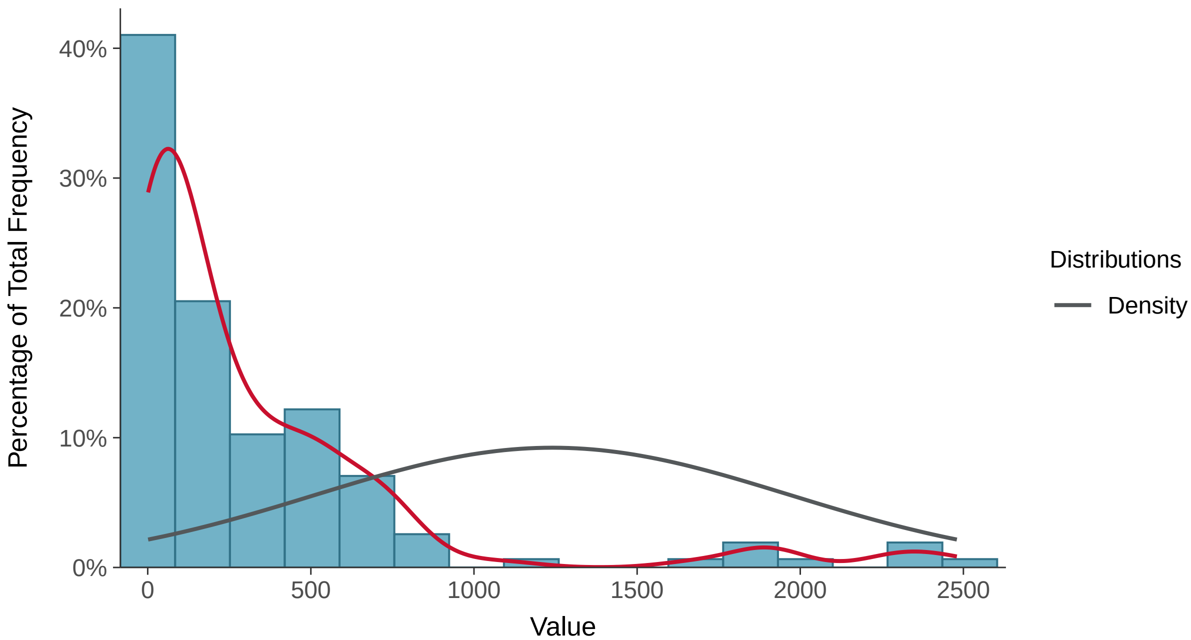
Scatter Plot by Well

Chloride, Pooled Background (mg/L)



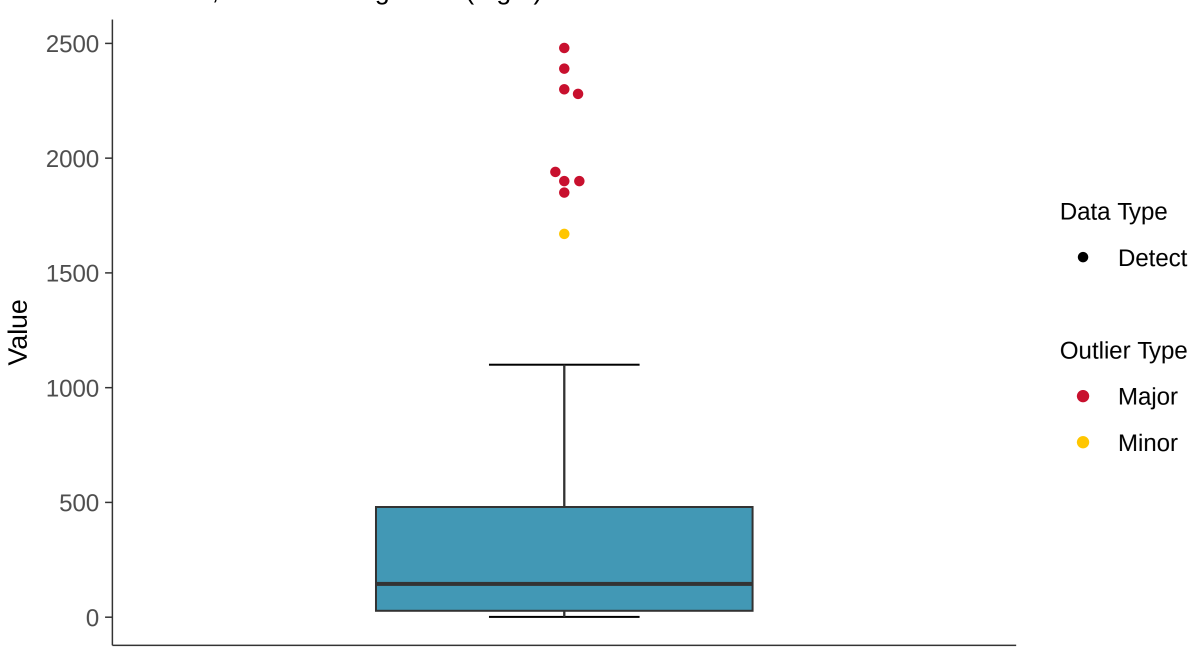
Histogram

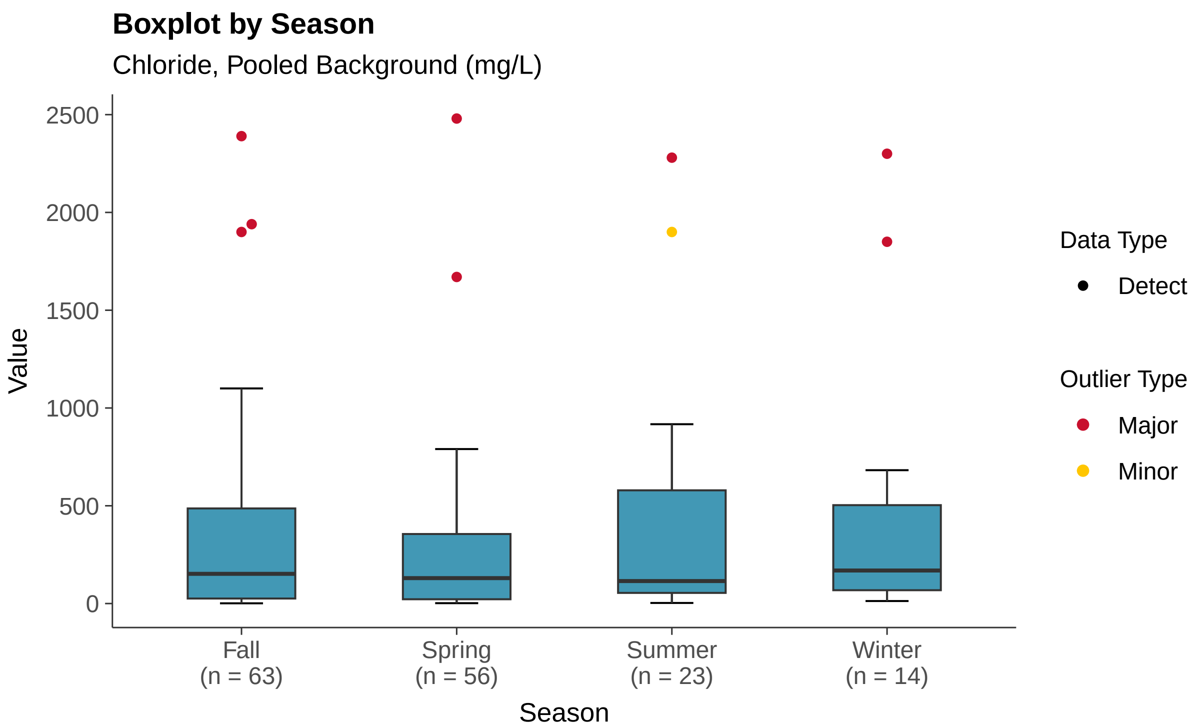
Chloride, Pooled Background (mg/L)

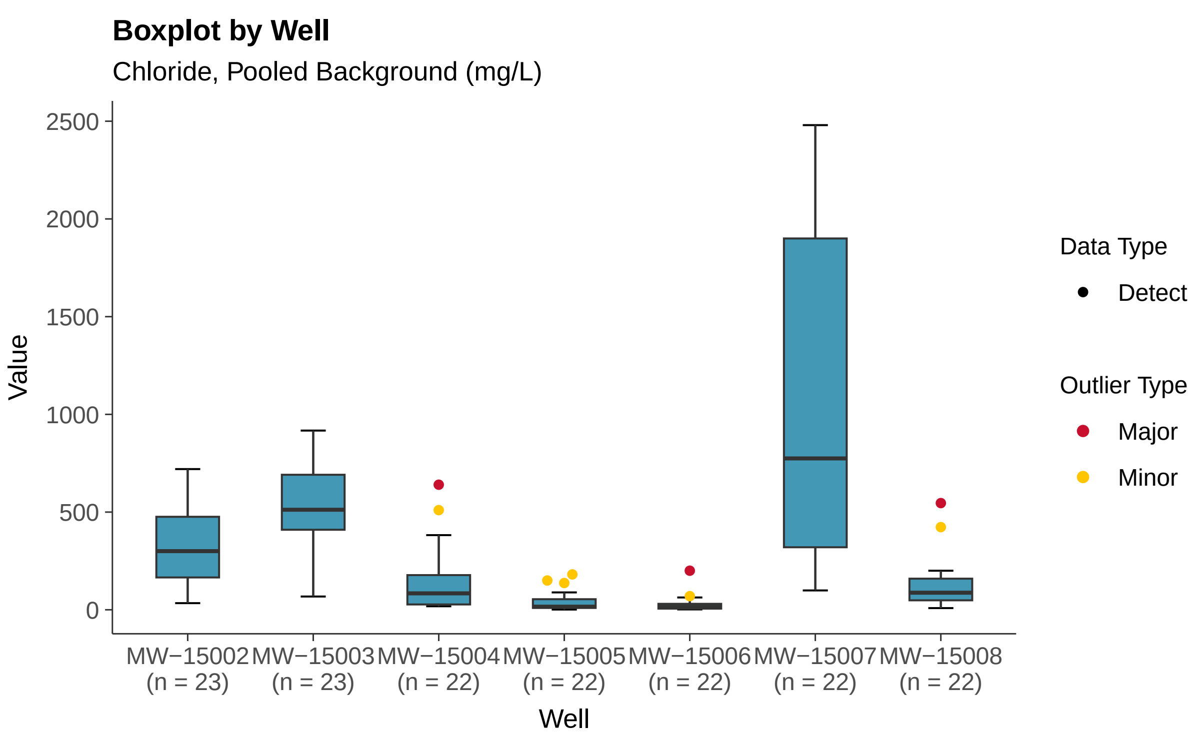


Boxplot

Chloride, Pooled Background (mg/L)

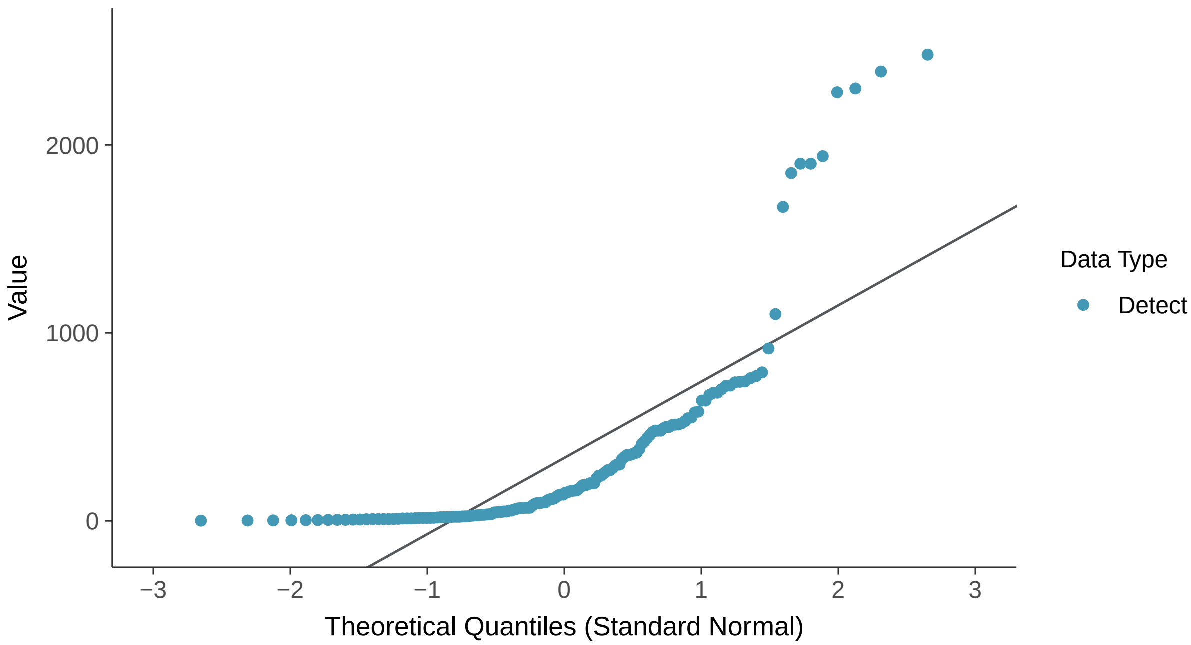



Boxplot by Season
Chloride, Pooled Background (mg/L)
Value
2500
2000
1500
1000
500
0
Fall
(n = 63)
Spring
(n = 56)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Well
Chloride, Pooled Background (mg/L)
Value
2500
2000
1500
1000
500
0
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 22)
MW−15007
(n = 22)
MW−15008
(n = 22)
Well
Data Type
Detect
Outlier Type
Major
Minor

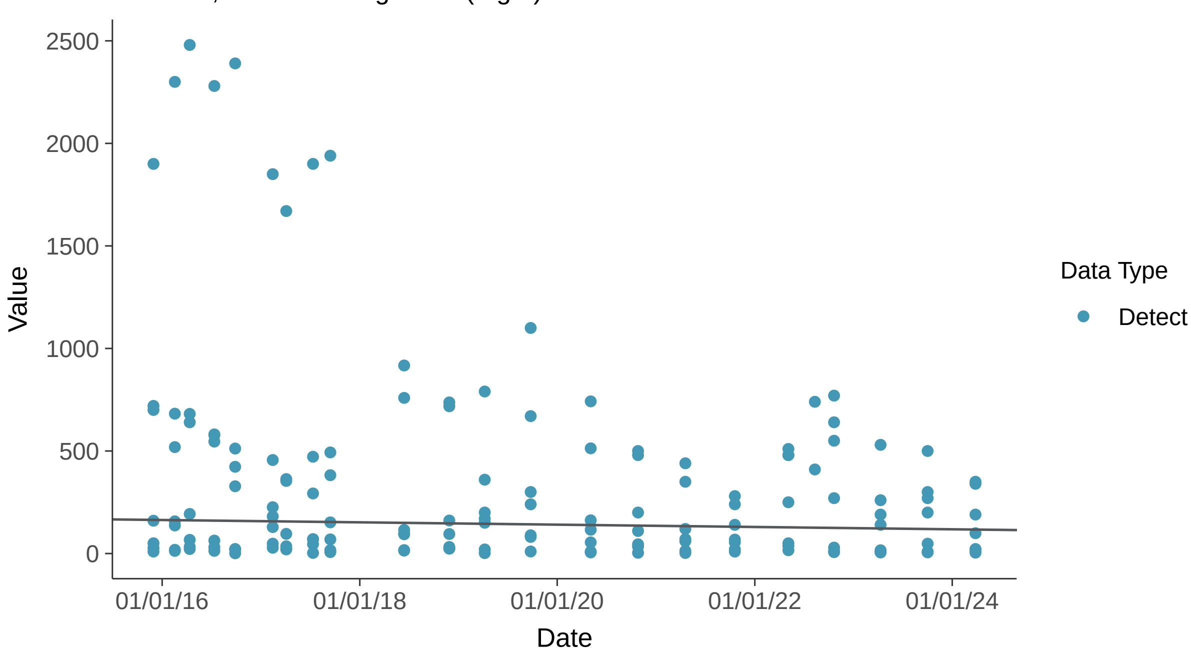
Normal Q-Q plot

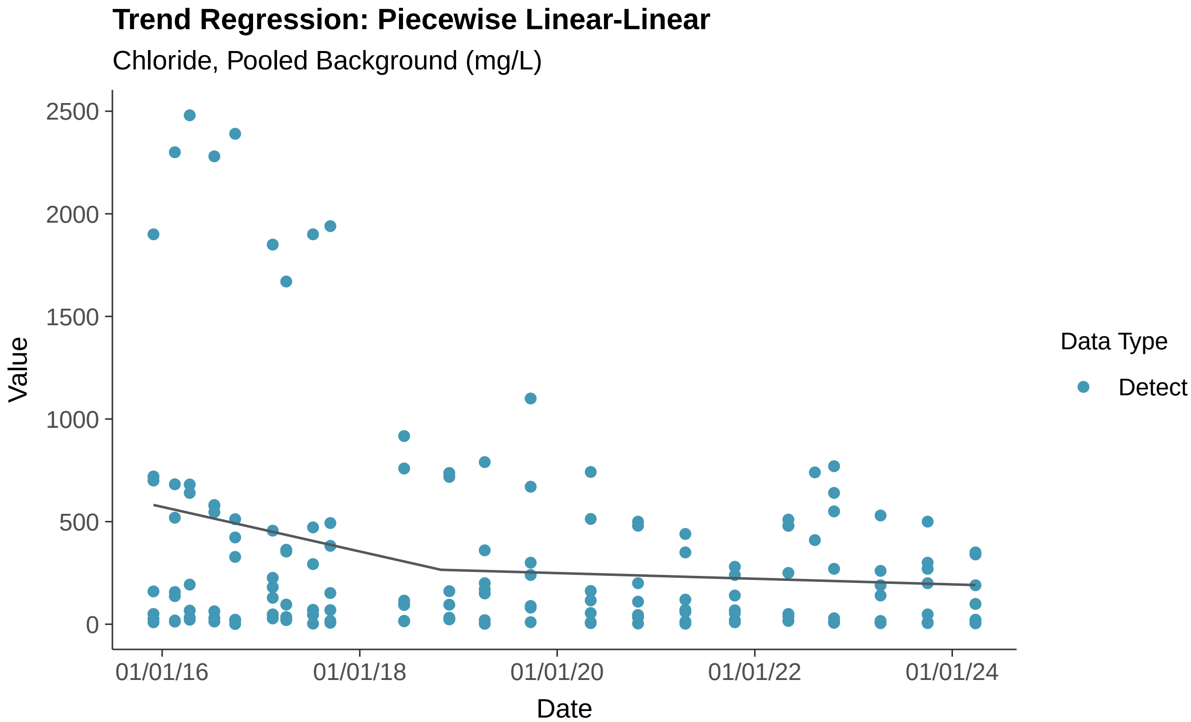
Chloride, Pooled Background (mg/L)

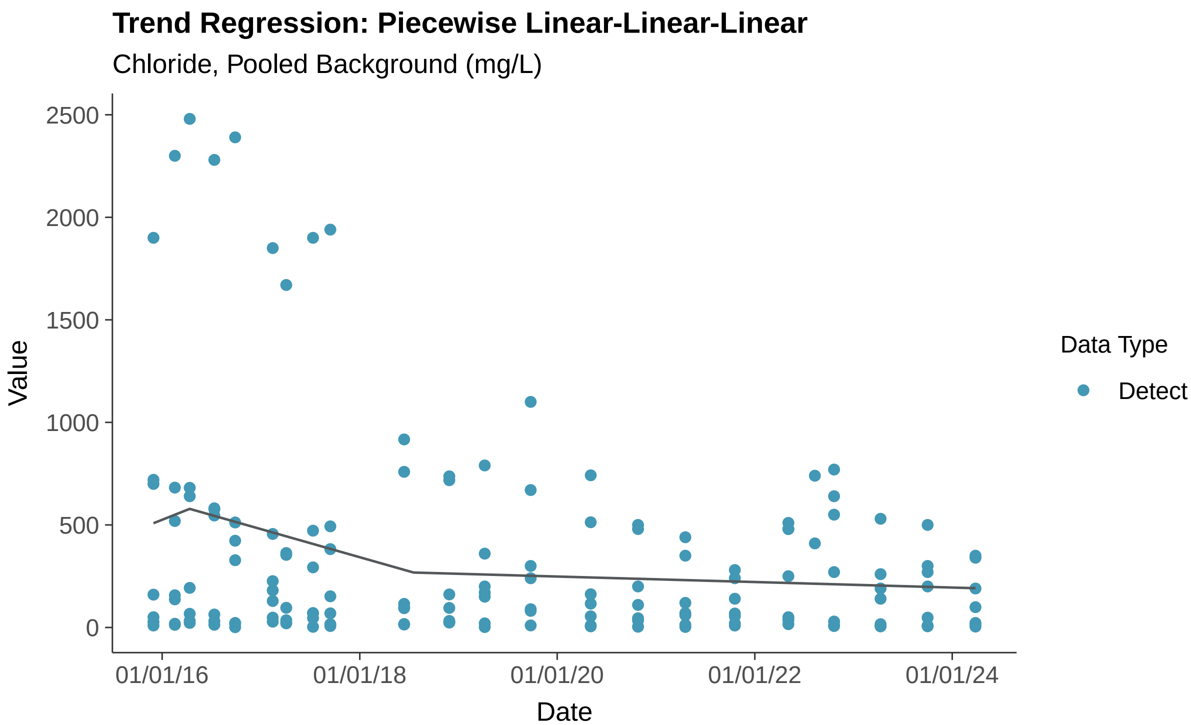


Trend Regression: Mann-Kendall/Theil-Sen Estimate

Chloride, Pooled Background (mg/L)

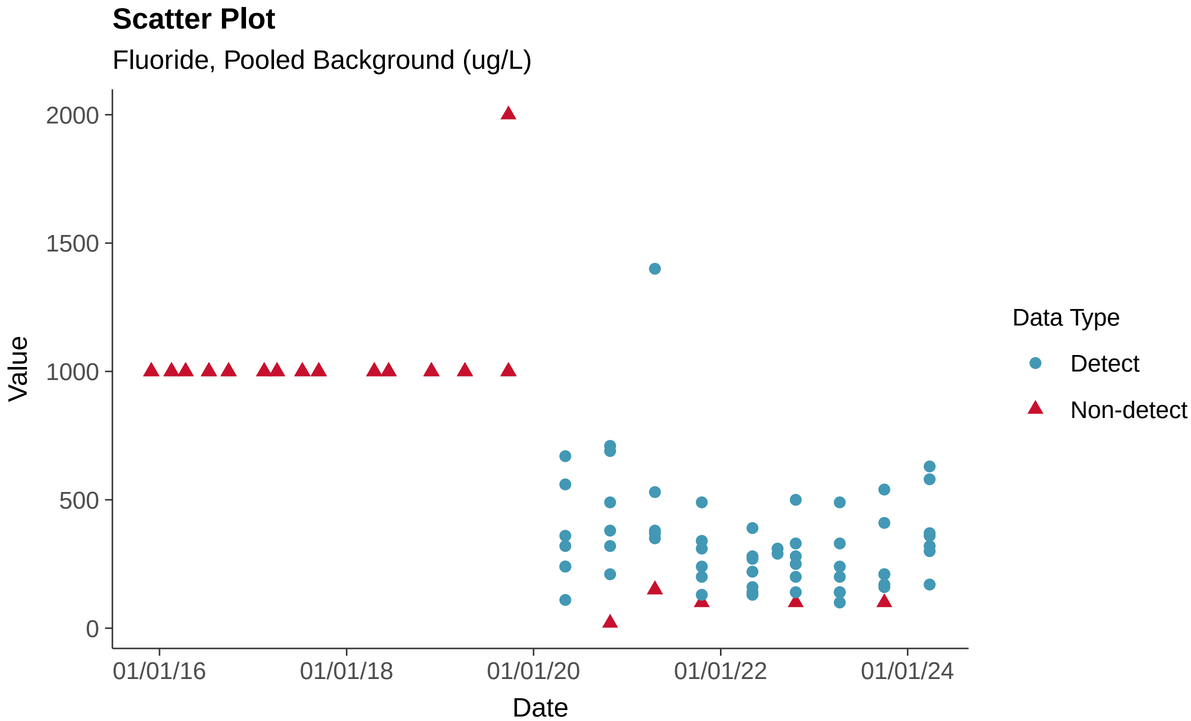


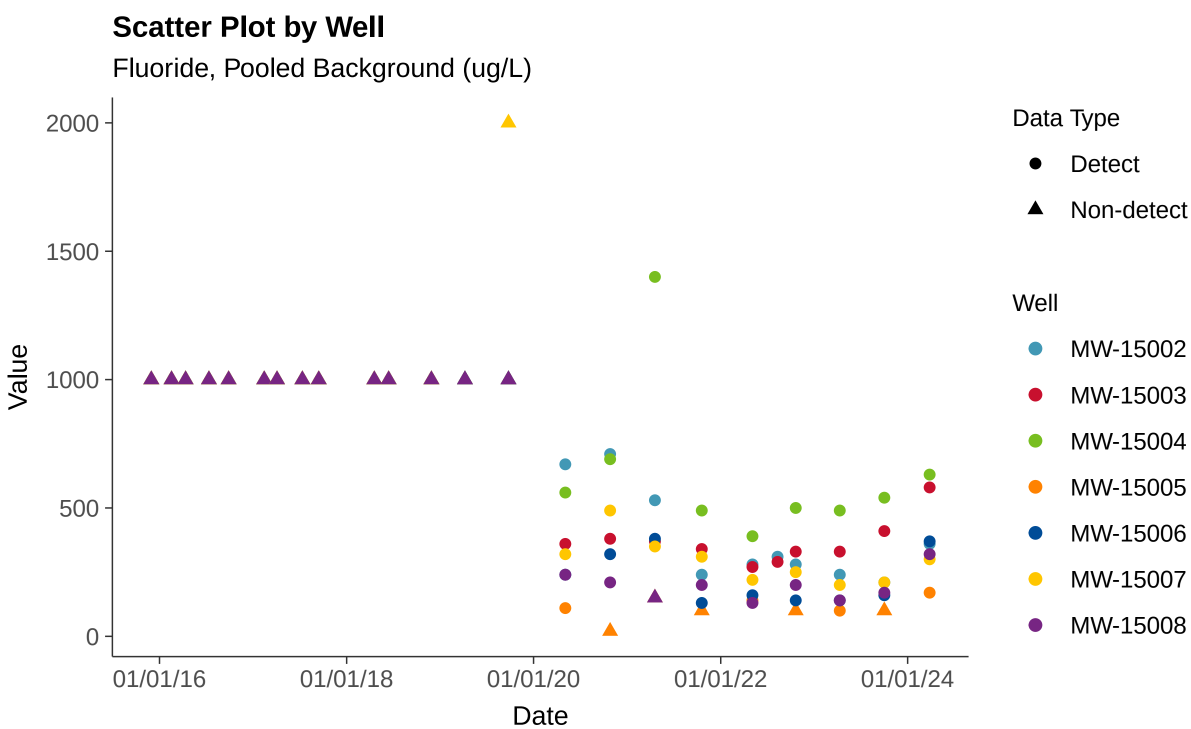

Trend Regression: Piecewise Linear-Linear
Chloride, Pooled Background (mg/L)
Value
2500
2000
1500
1000
500
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect


Trend Regression: Piecewise Linear-Linear-Linear
Chloride, Pooled Background (mg/L)
Value
2500
2000
1500
1000
500
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect

Appendix III: Fluoride, Pooled Background

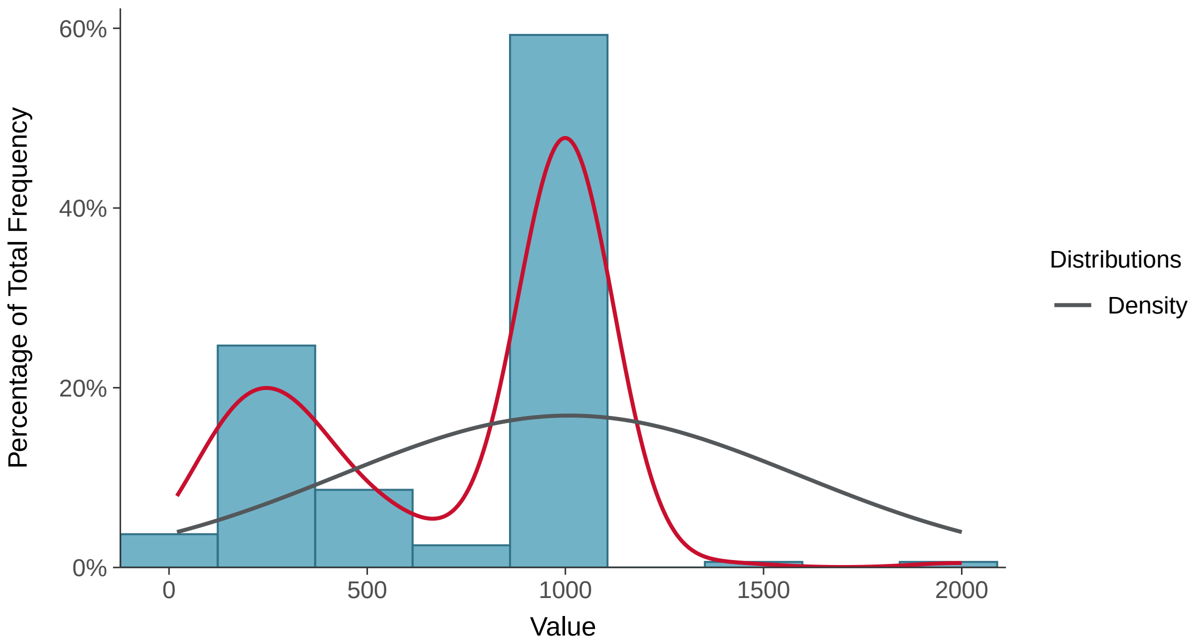
ID: 1_114





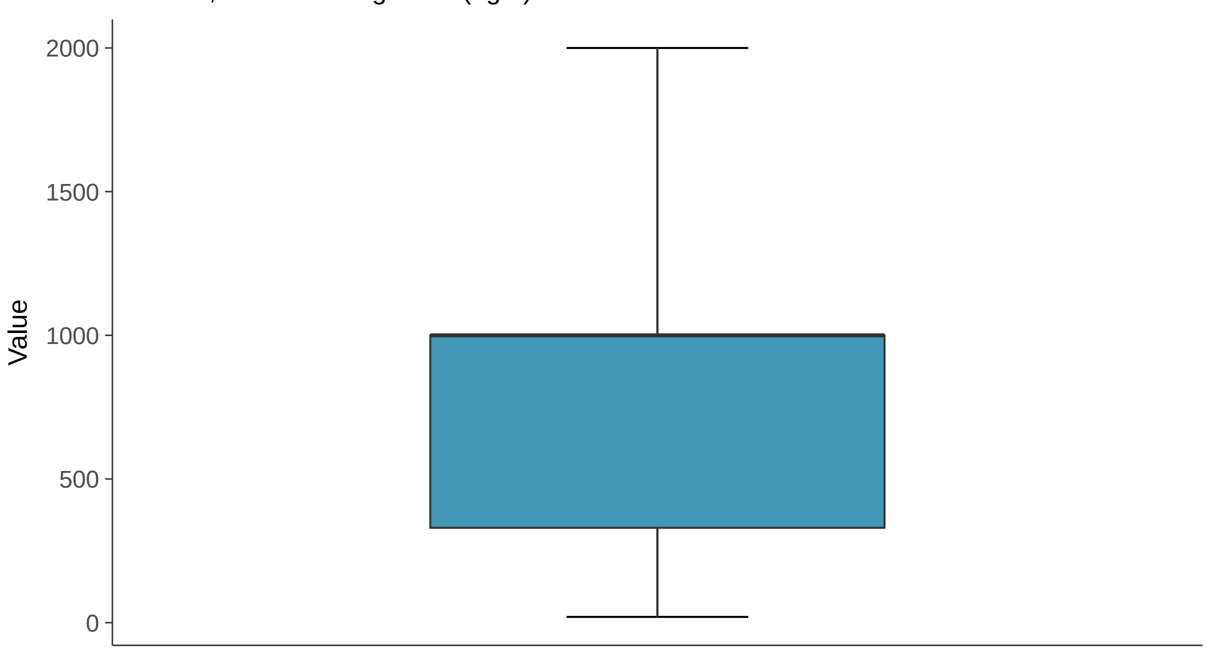
Histogram

Fluoride, Pooled Background (ug/L)



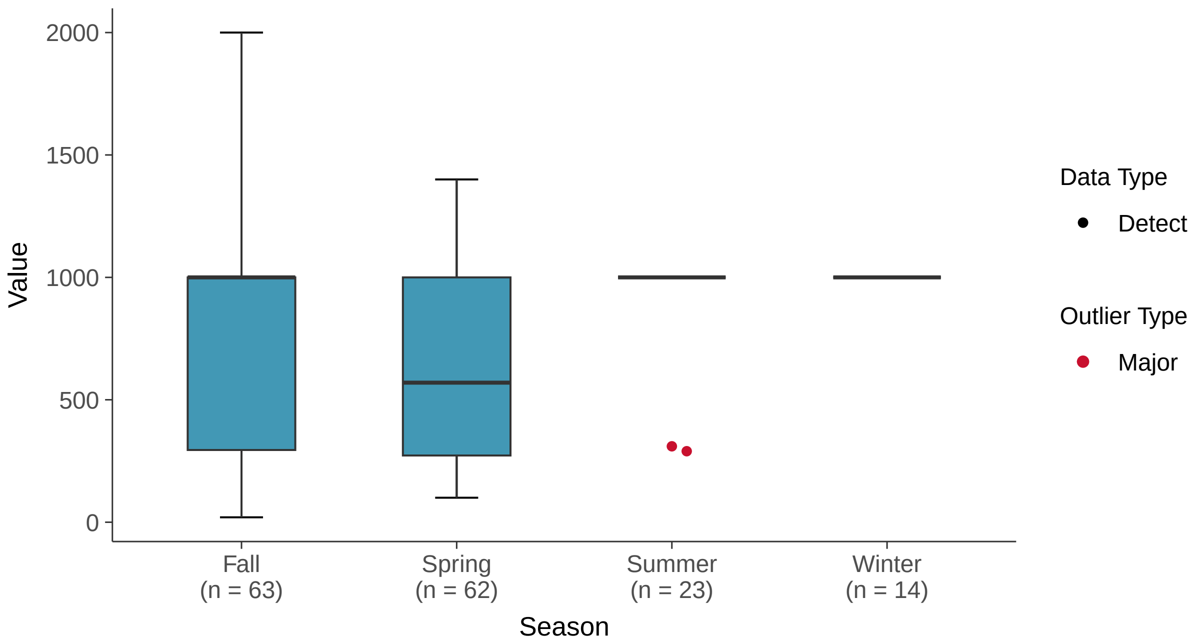
Boxplot

Fluoride, Pooled Background (ug/L)



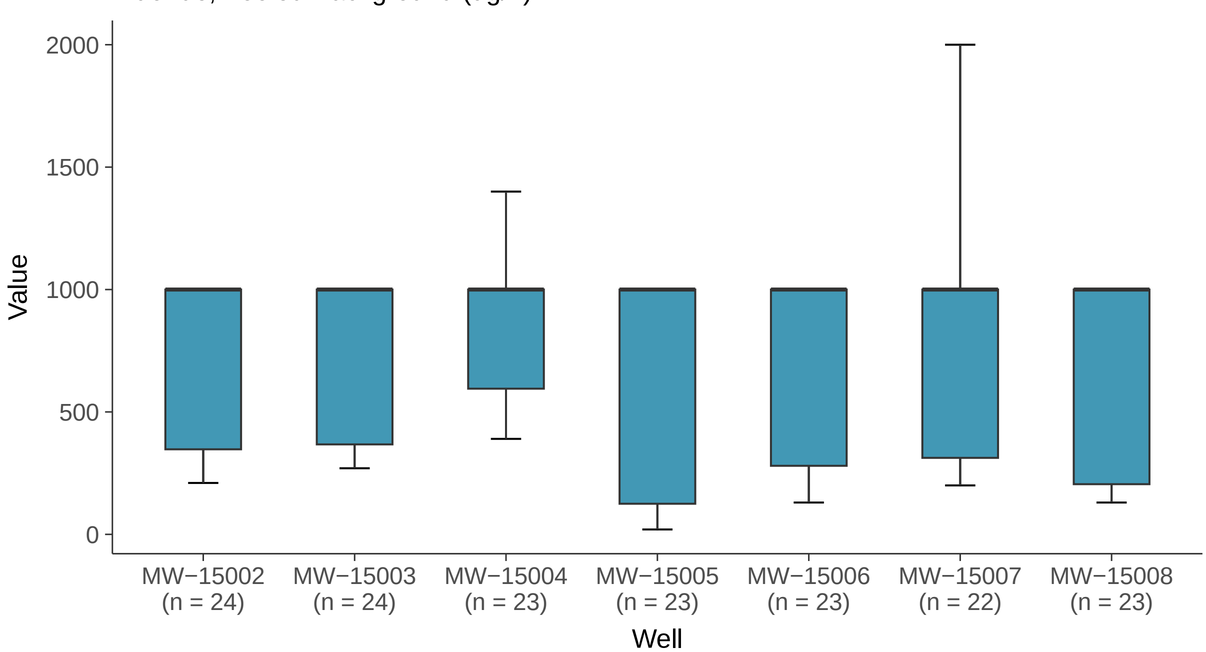
Boxplot by Season

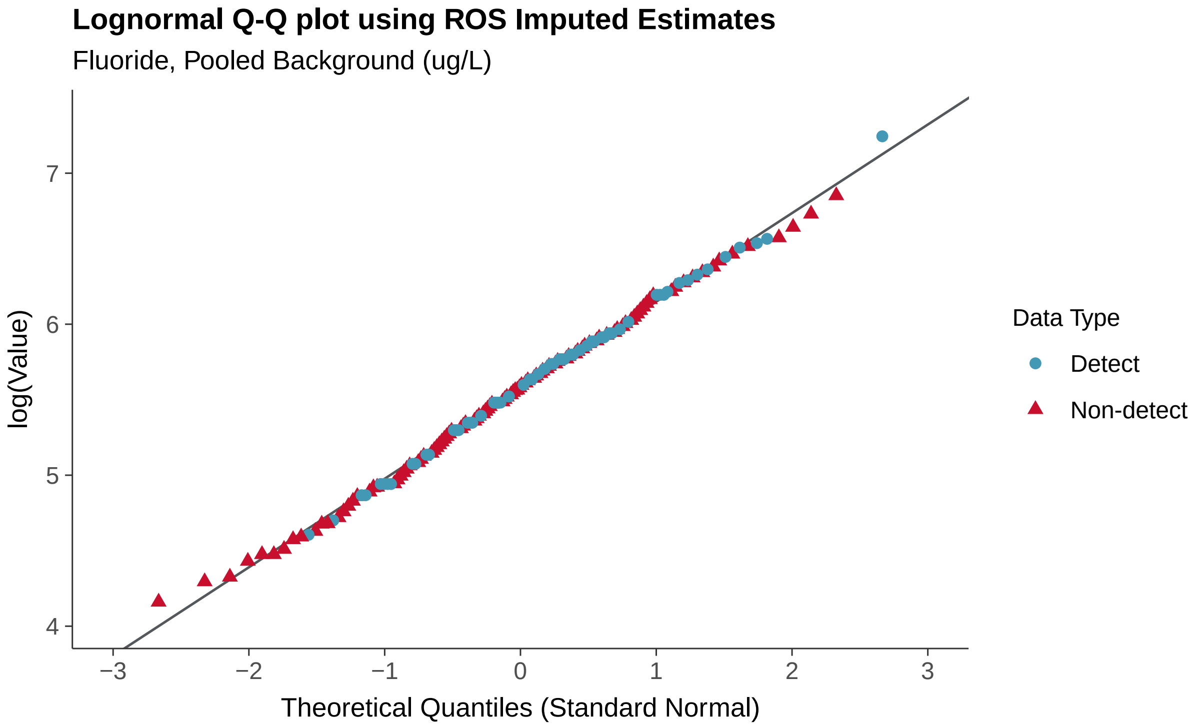
Fluoride, Pooled Background (ug/L)

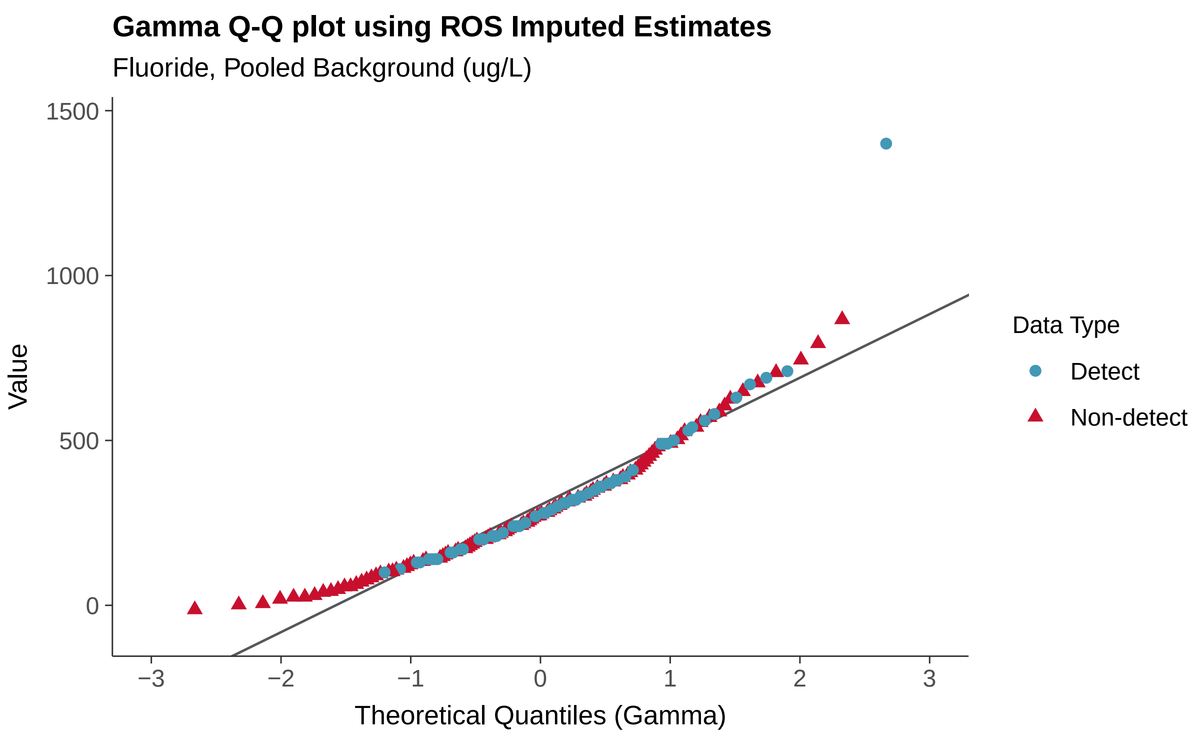


Boxplot by Well

Fluoride, Pooled Background (ug/L)

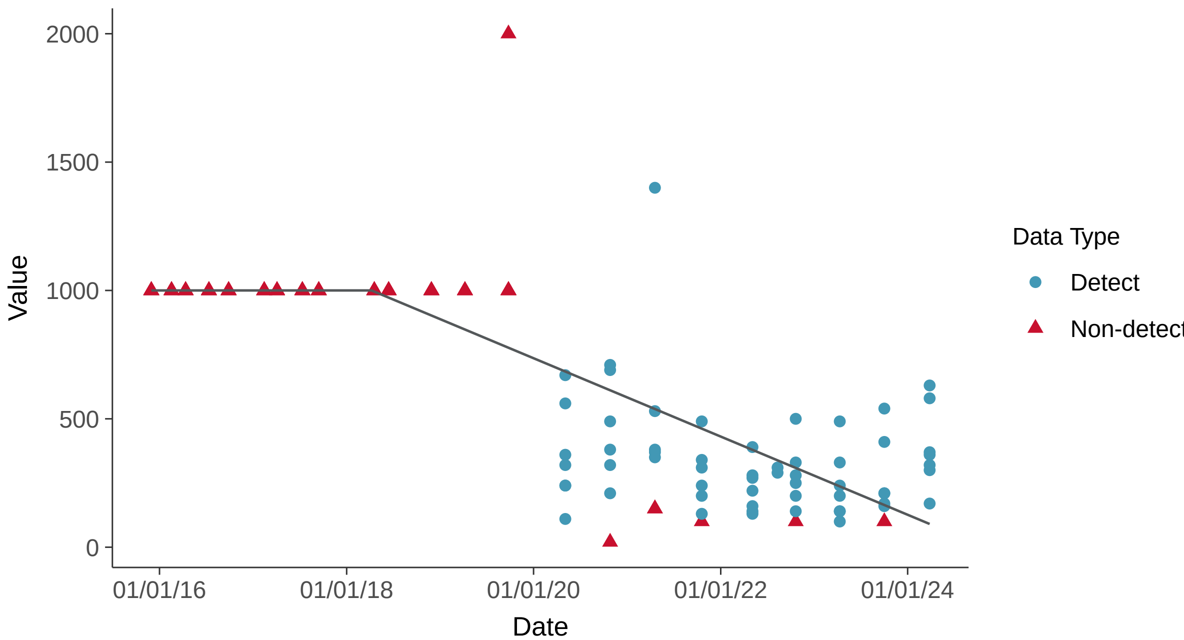



Lognormal Q-Q plot using ROS Imputed Estimates
Fluoride, Pooled Background (ug/L)
log(Value)
7
6
5
4
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Gamma Q-Q plot using ROS Imputed Estimates
Fluoride, Pooled Background (ug/L)
Value
1500
1000
500
0
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Gamma)
Data Type
Detect
Non-detect

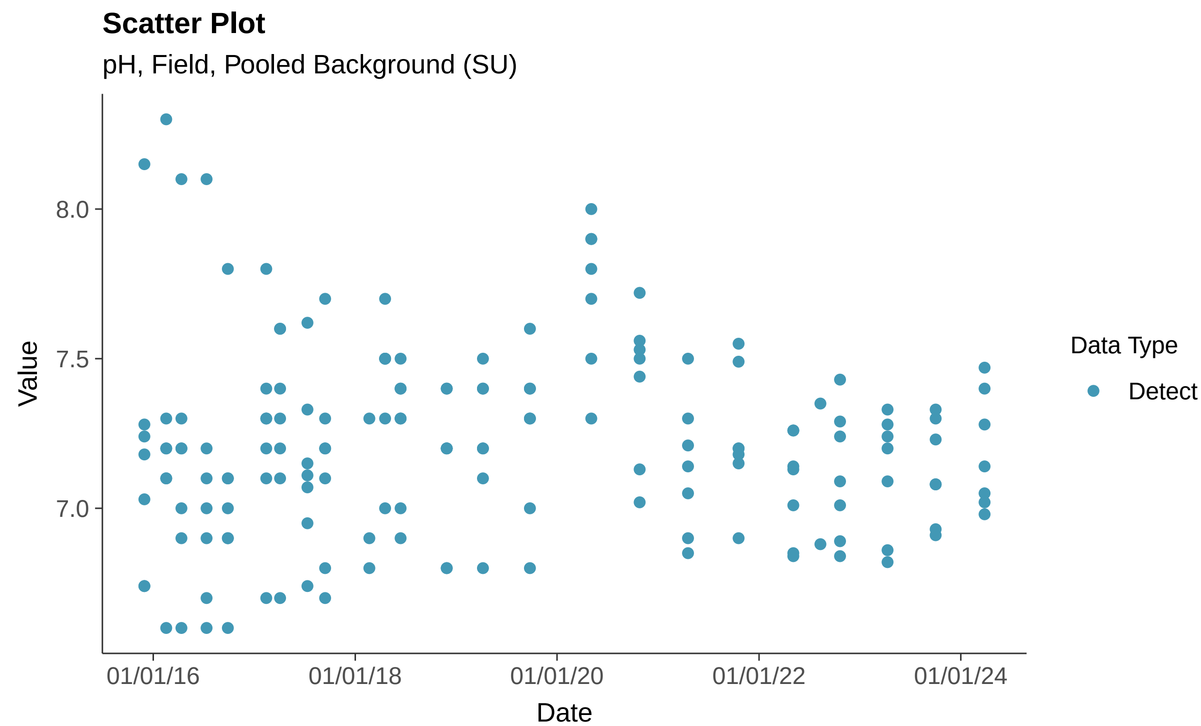
Trend Regression: Piecewise Linear-Linear

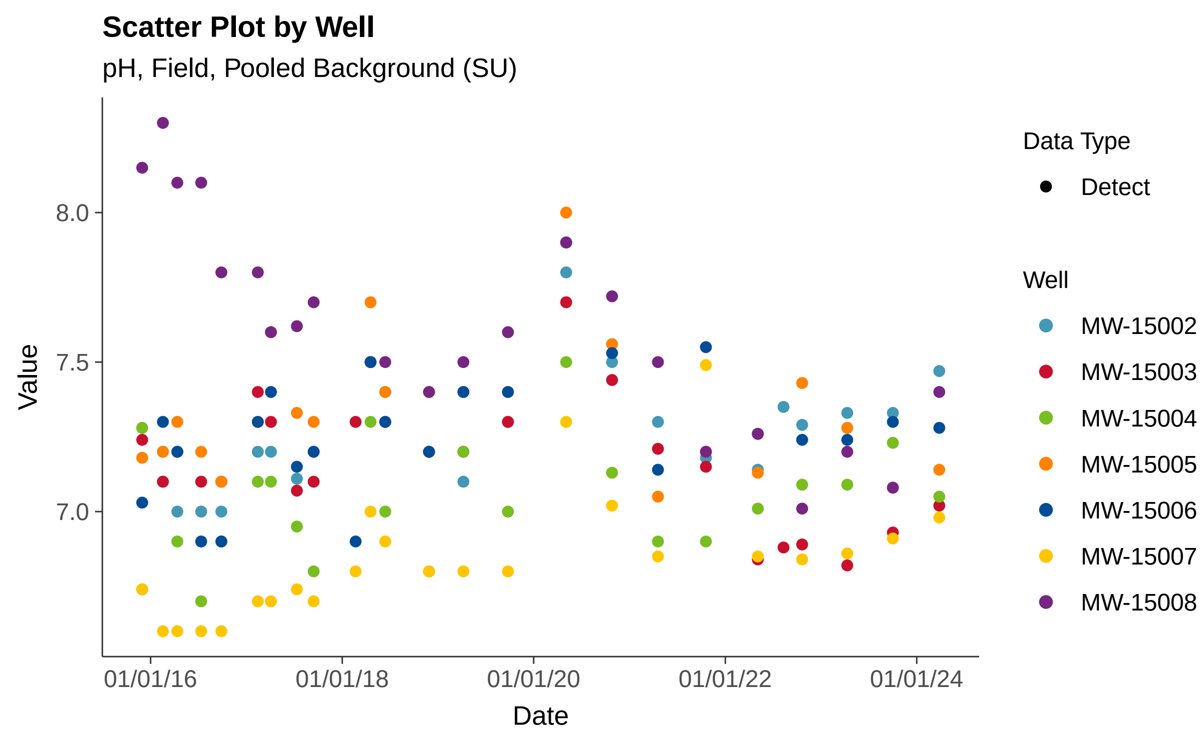
Fluoride, Pooled Background (ug/L)



Appendix III: pH, Field, Pooled Background

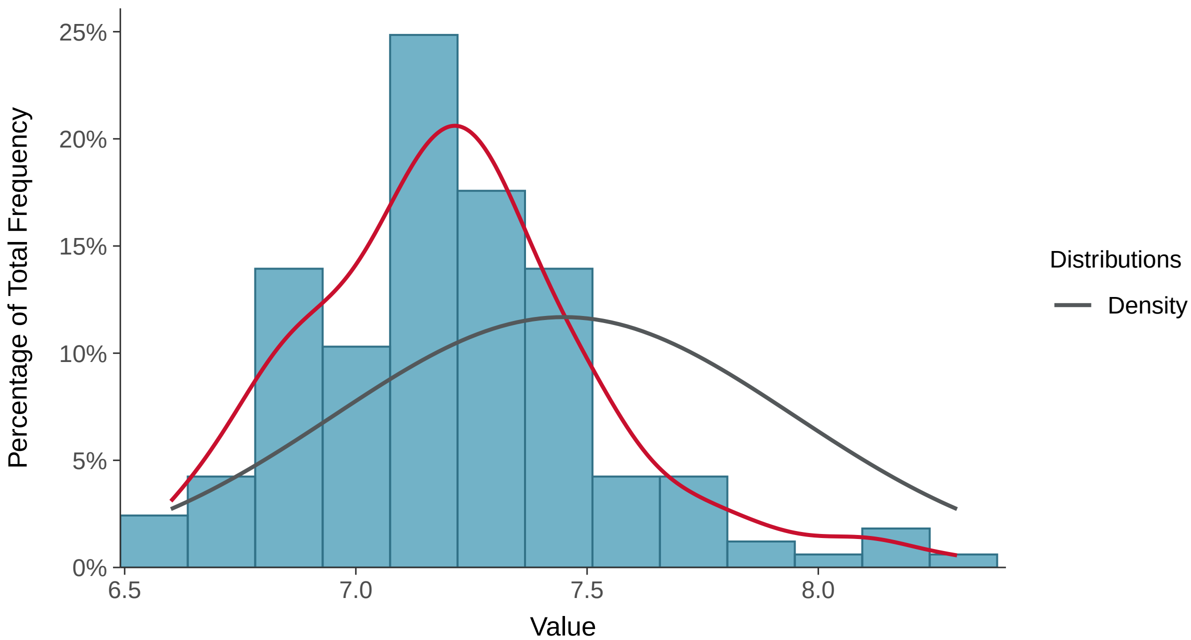
ID: 1_122





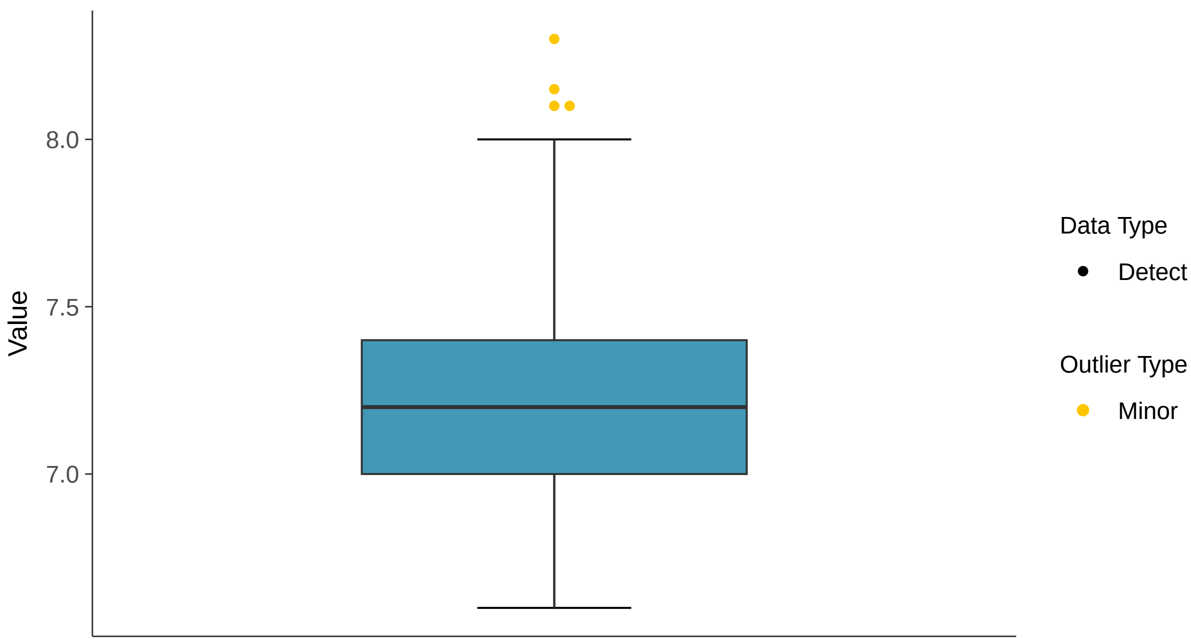
Histogram

pH, Field, Pooled Background (SU)



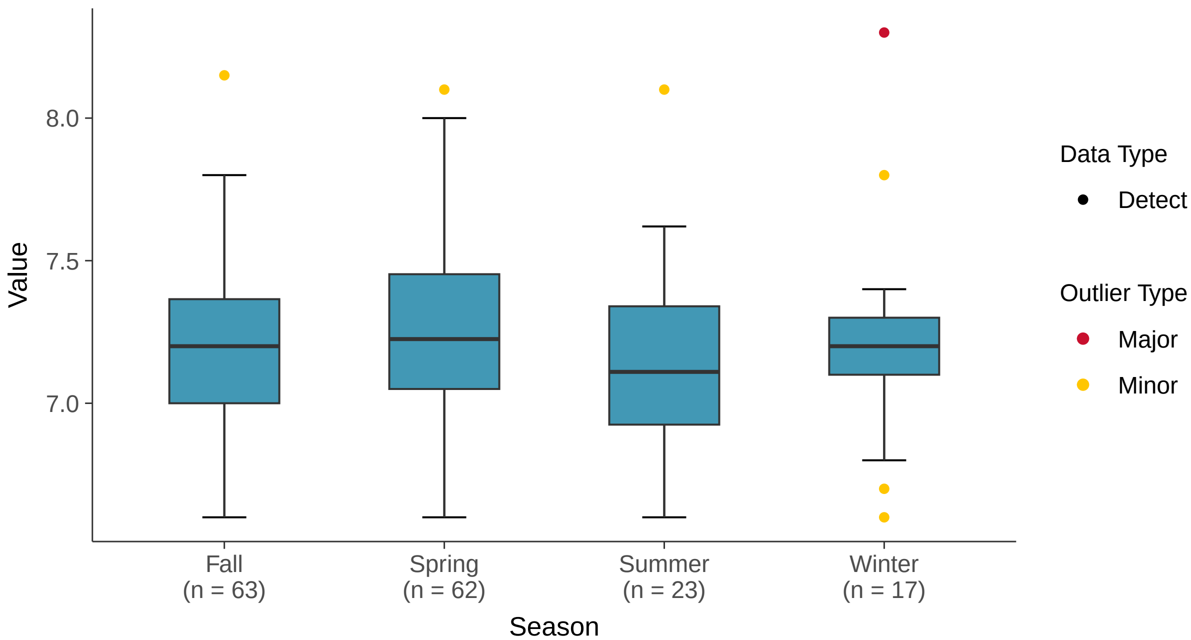
Boxplot

pH, Field, Pooled Background (SU)



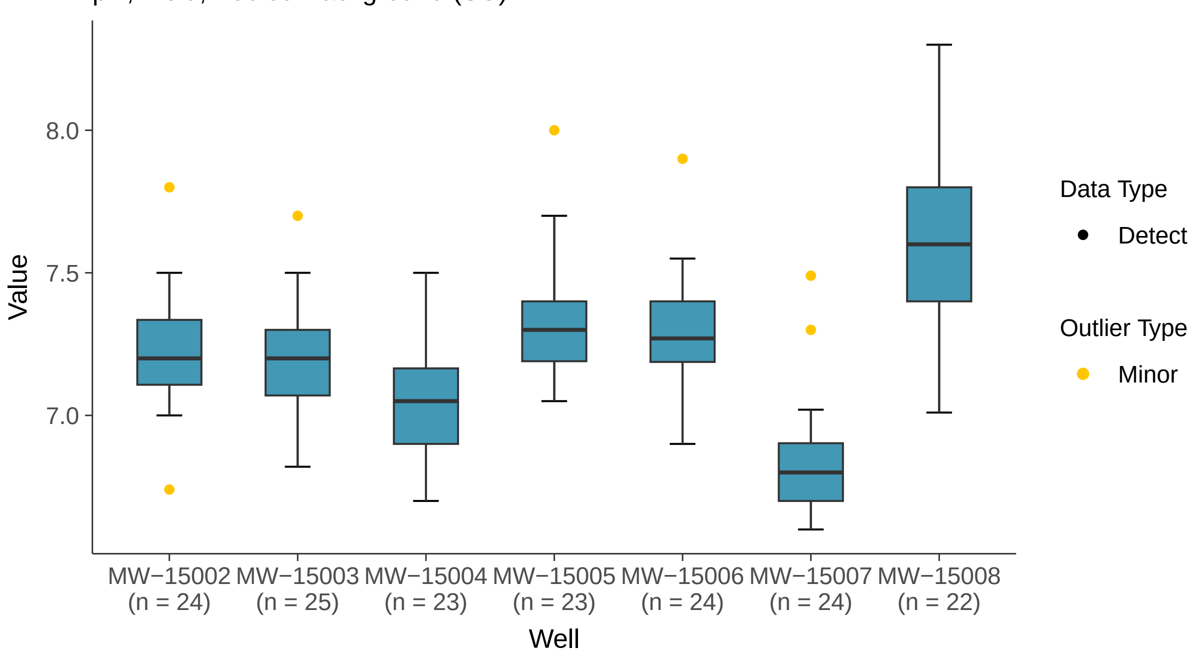
Boxplot by Season

pH, Field, Pooled Background (SU)



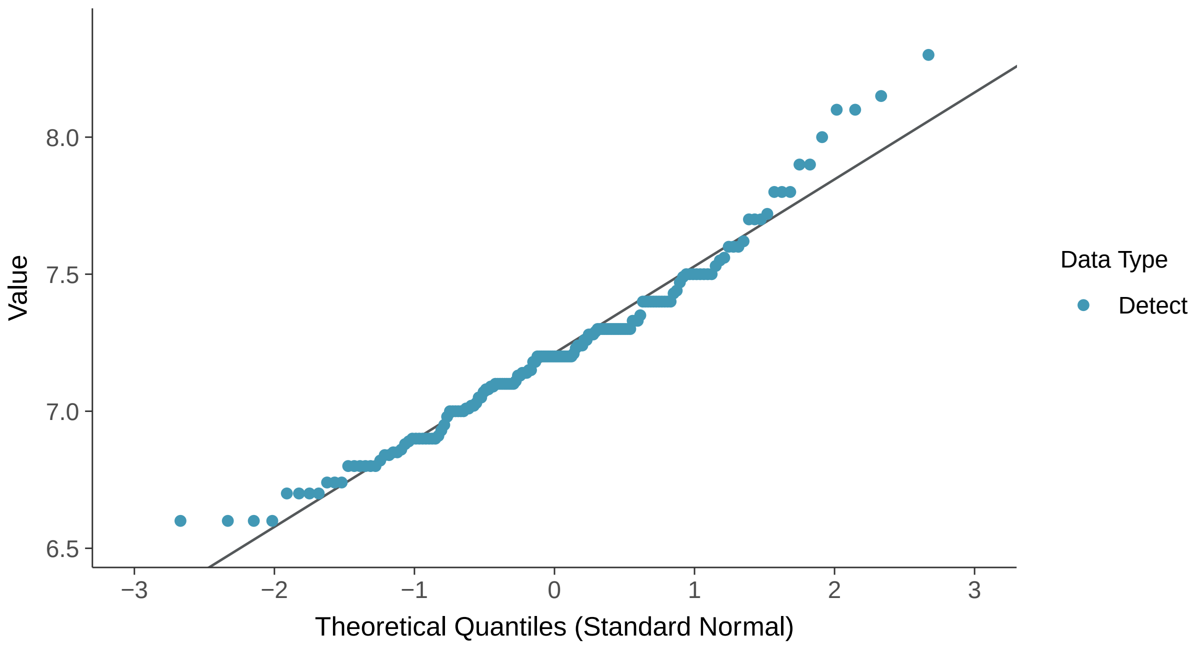
Boxplot by Well

pH, Field, Pooled Background (SU)



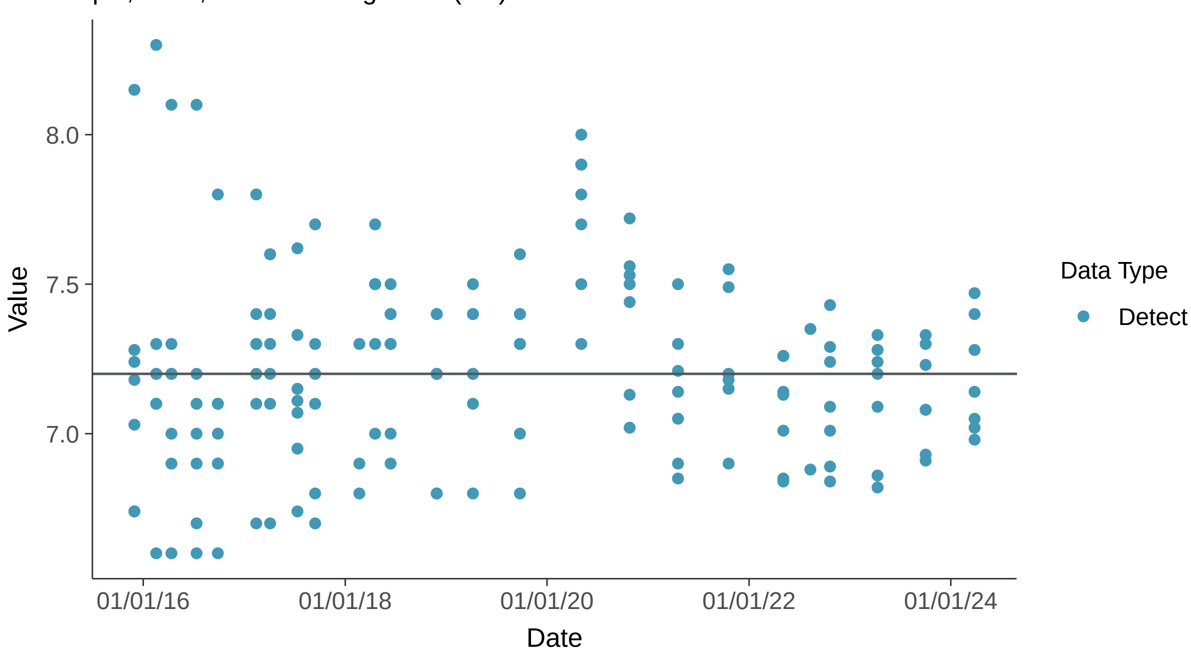
Normal Q-Q plot

pH, Field, Pooled Background (SU)



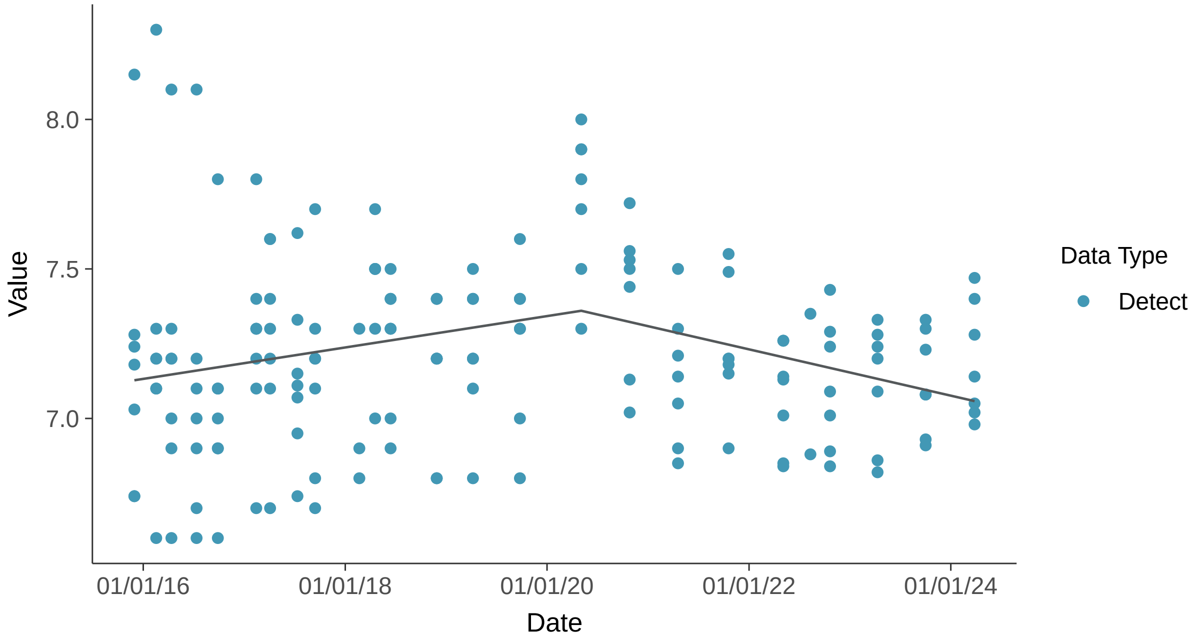
Trend Regression: Mann-Kendall/Theil-Sen Estimate

pH, Field, Pooled Background (SU)



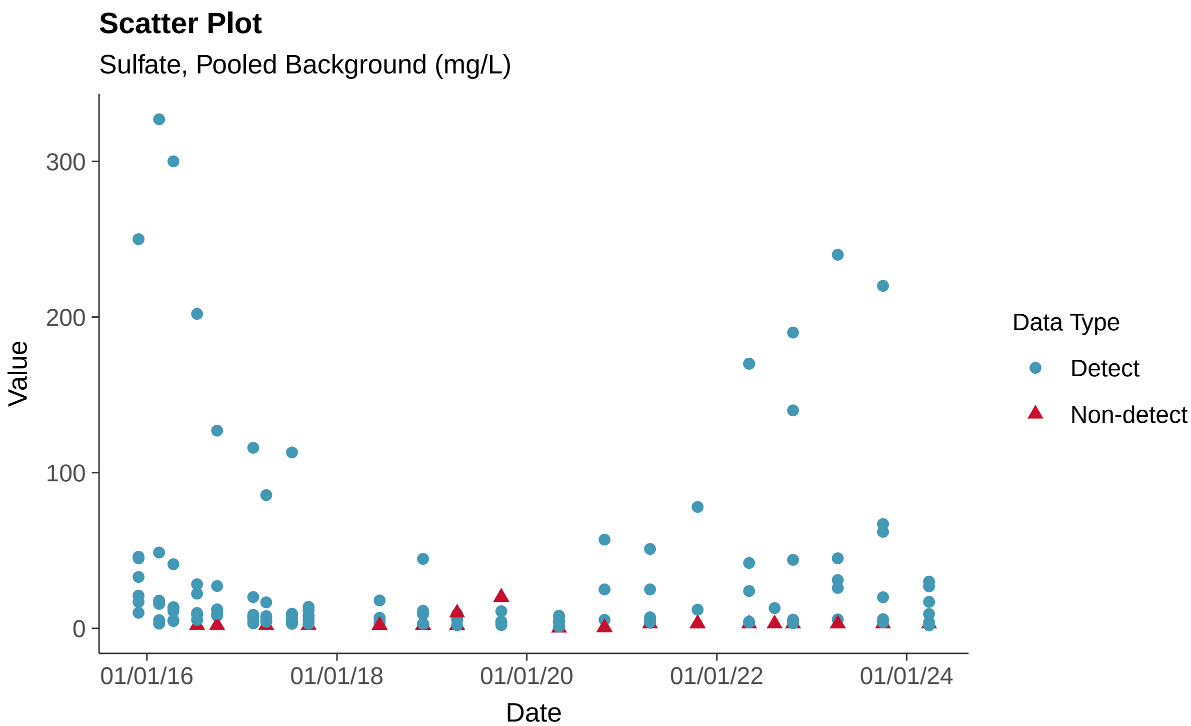
Trend Regression: Piecewise Linear-Linear

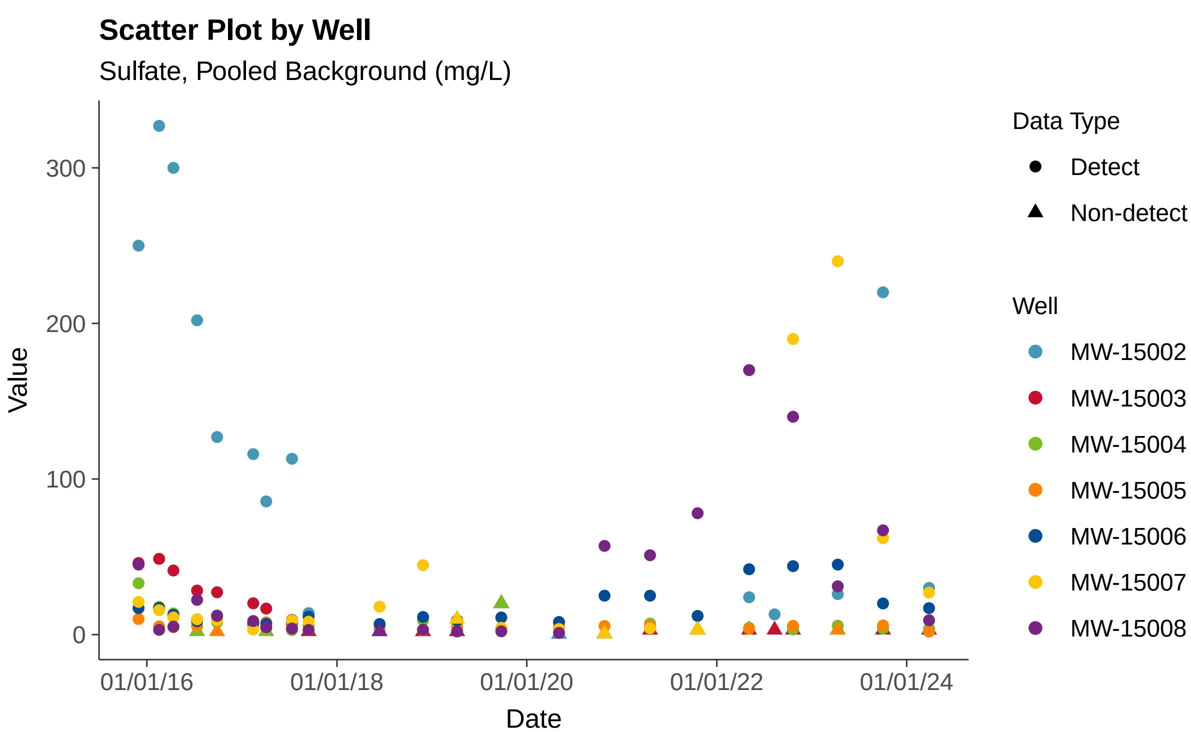
pH, Field, Pooled Background (SU)



Appendix III: Sulfate, Pooled Background

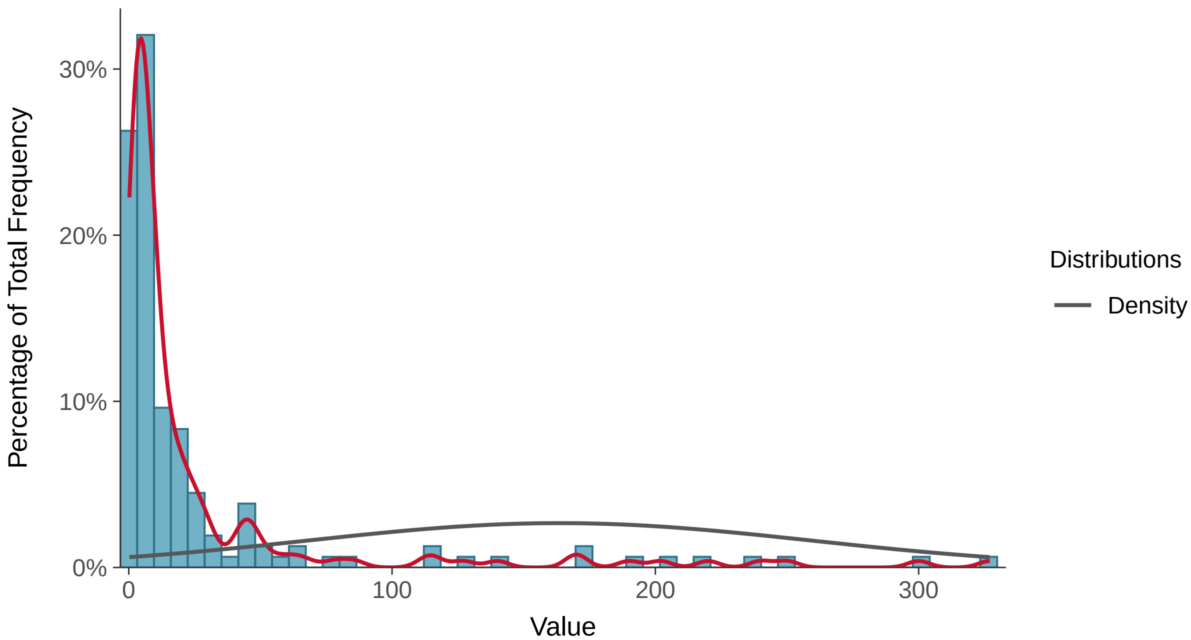
ID: 1_128





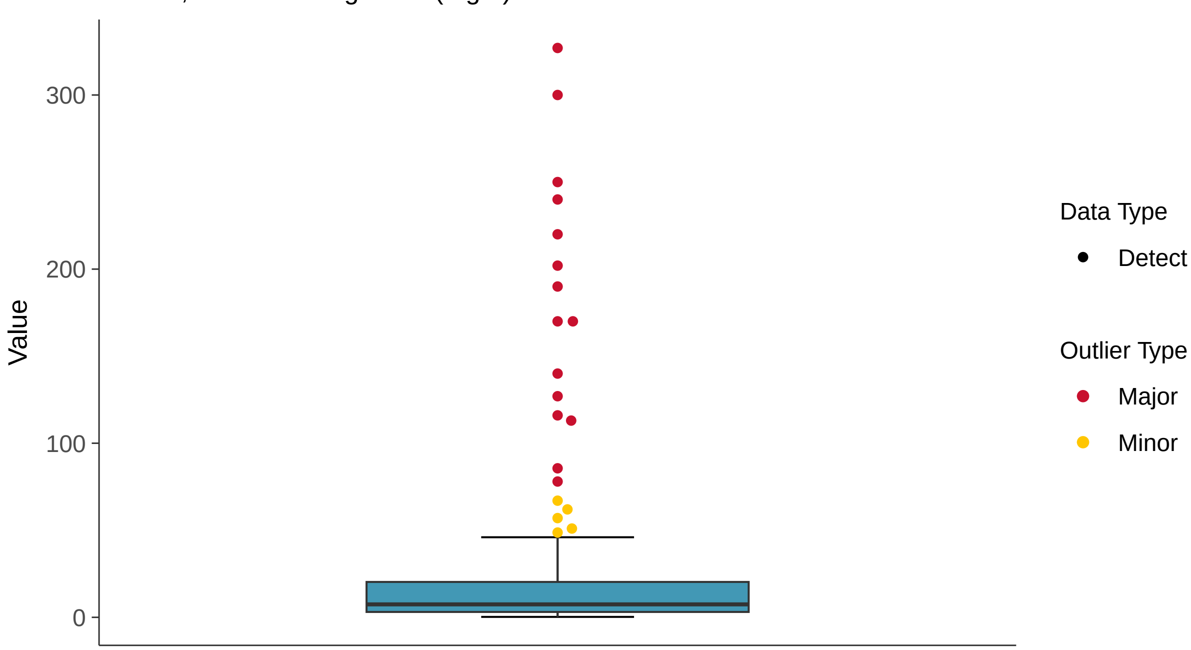
Histogram

Sulfate, Pooled Background (mg/L)



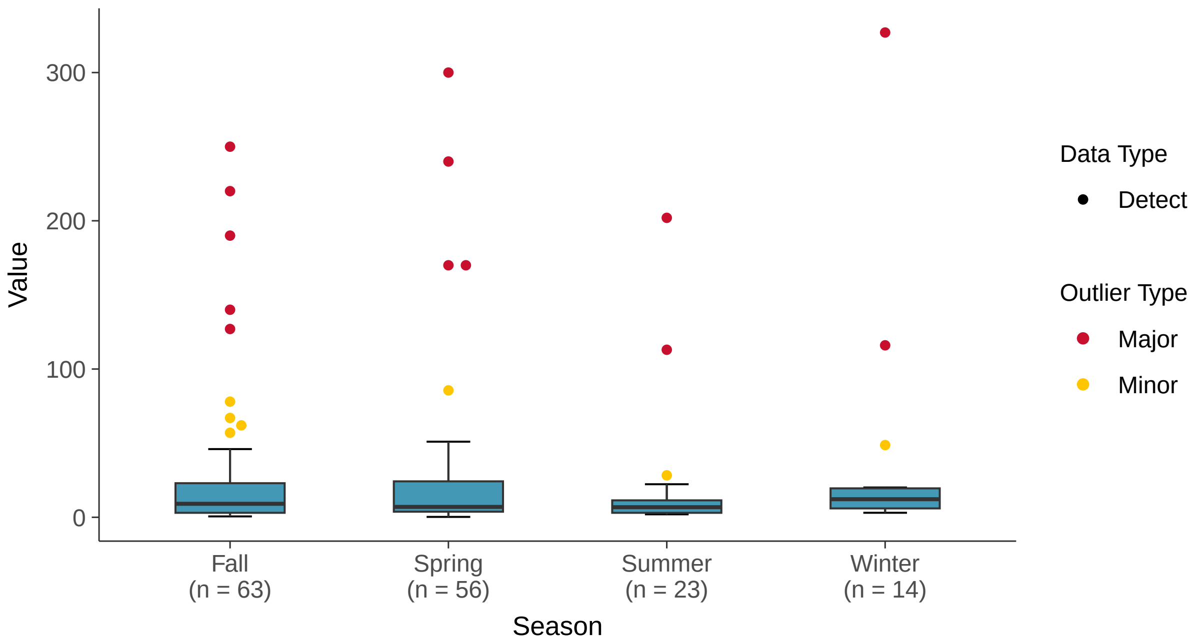
Boxplot

Sulfate, Pooled Background (mg/L)



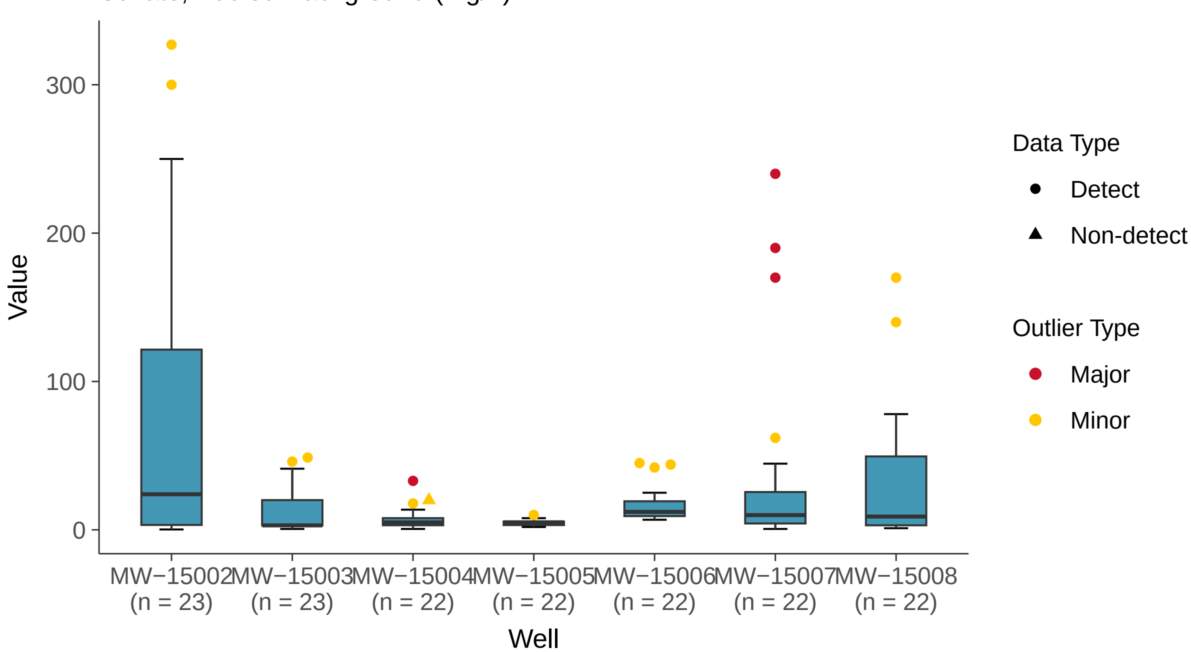
Boxplot by Season

Sulfate, Pooled Background (mg/L)



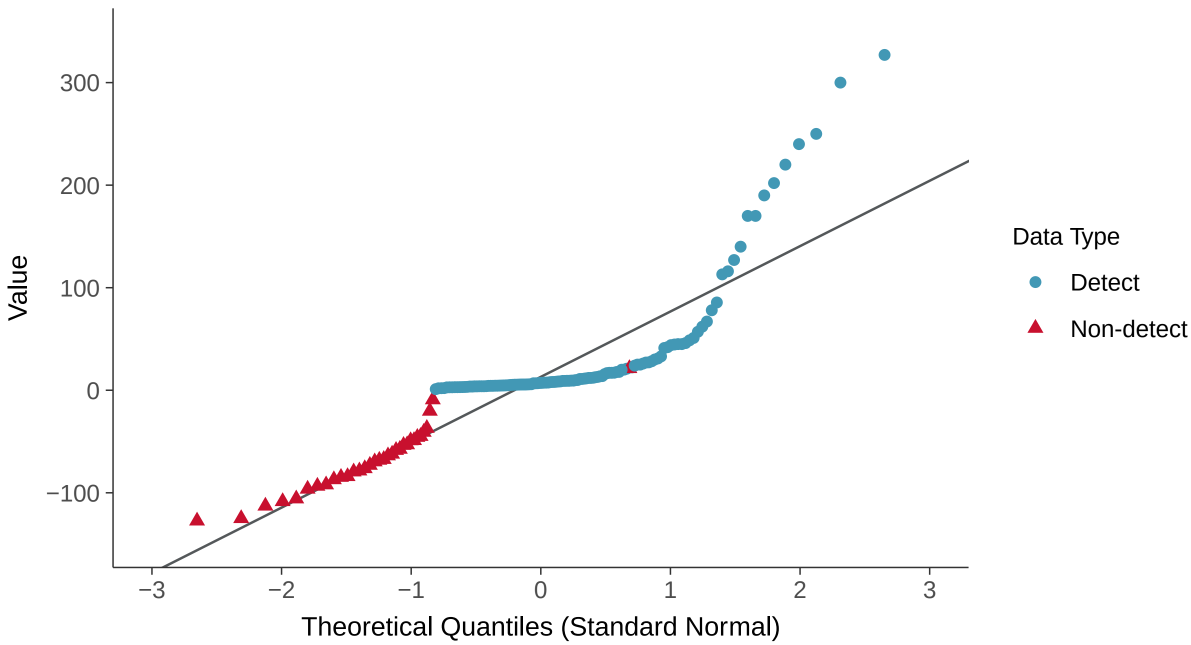
Boxplot by Well

Sulfate, Pooled Background (mg/L)



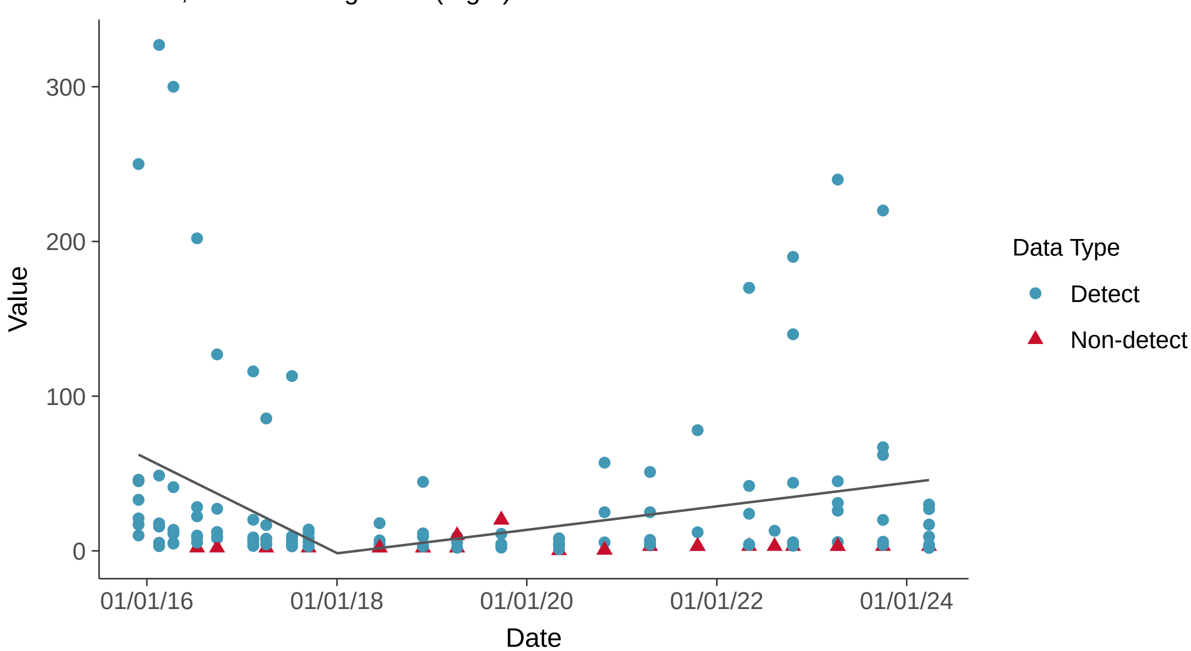
Normal Q-Q plot using ROS Imputed Estimates

Sulfate, Pooled Background (mg/L)



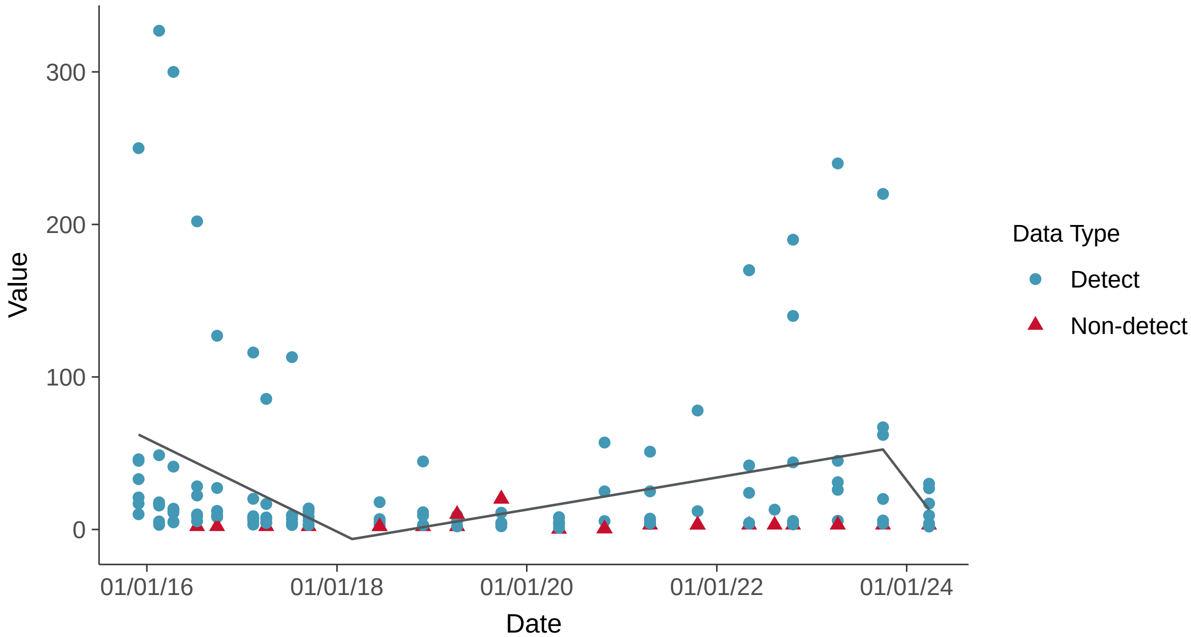
Trend Regression: Piecewise Linear-Linear

Sulfate, Pooled Background (mg/L)



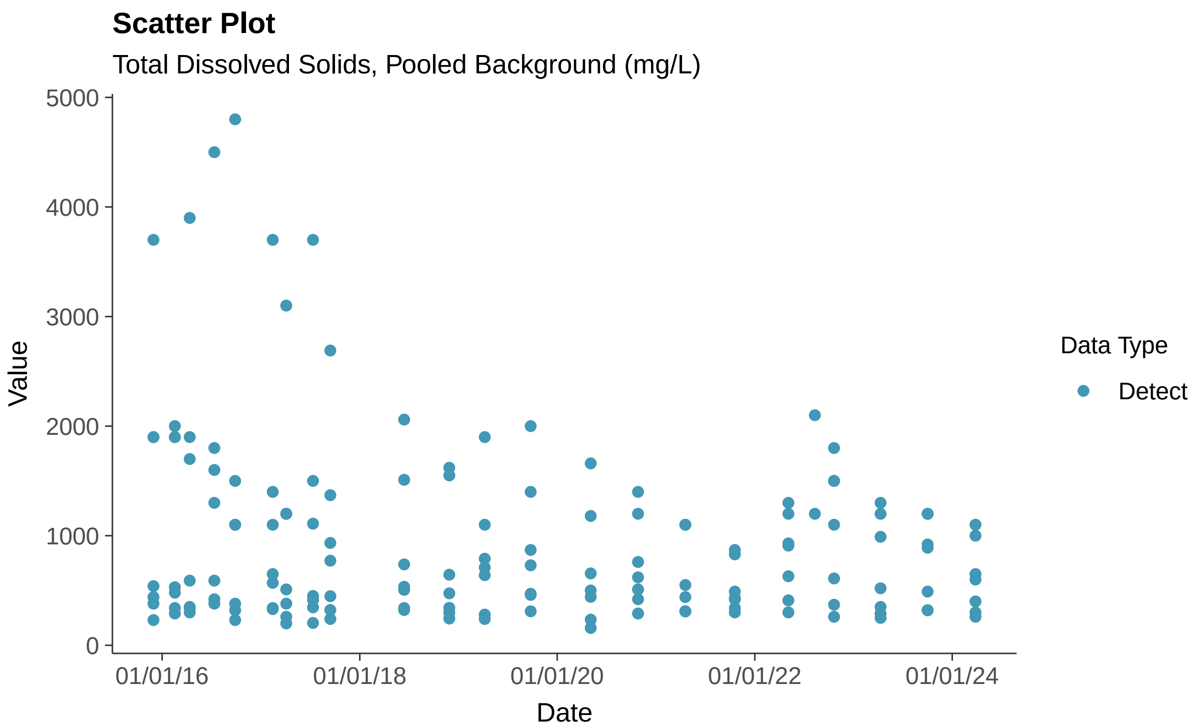
Trend Regression: Piecewise Linear-Linear-Linear

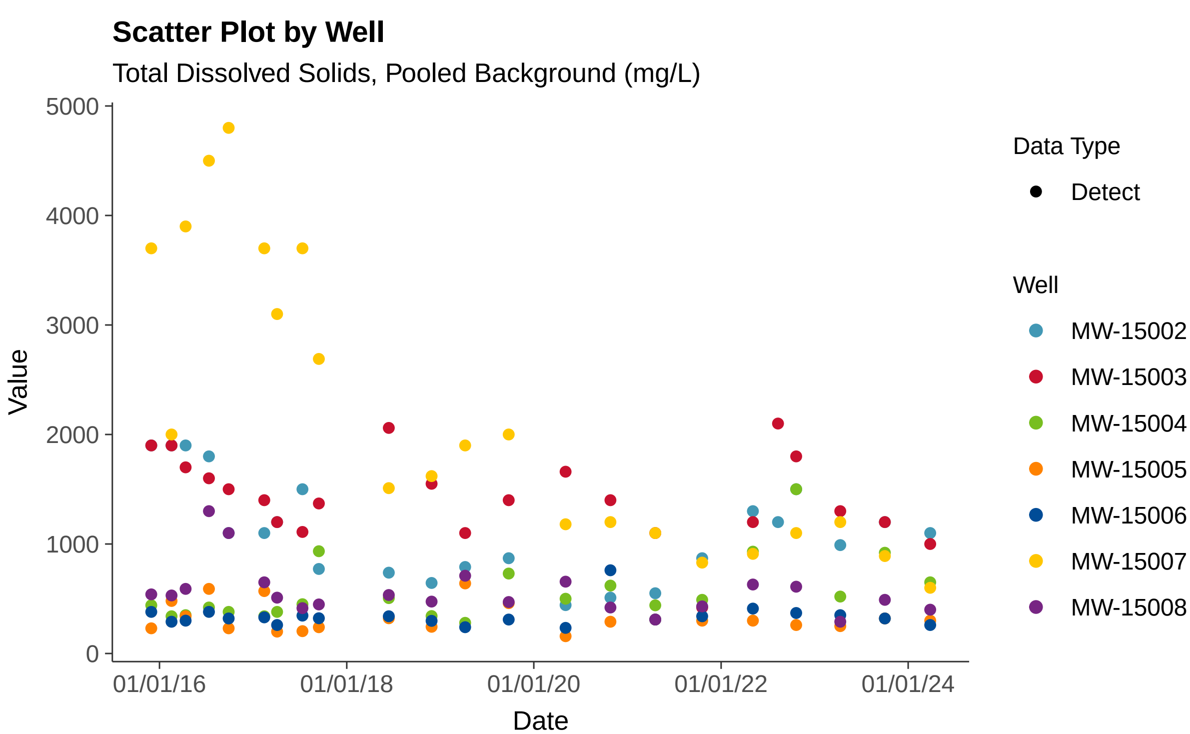
Sulfate, Pooled Background (mg/L)



Appendix III: Total Dissolved Solids, Pooled Background

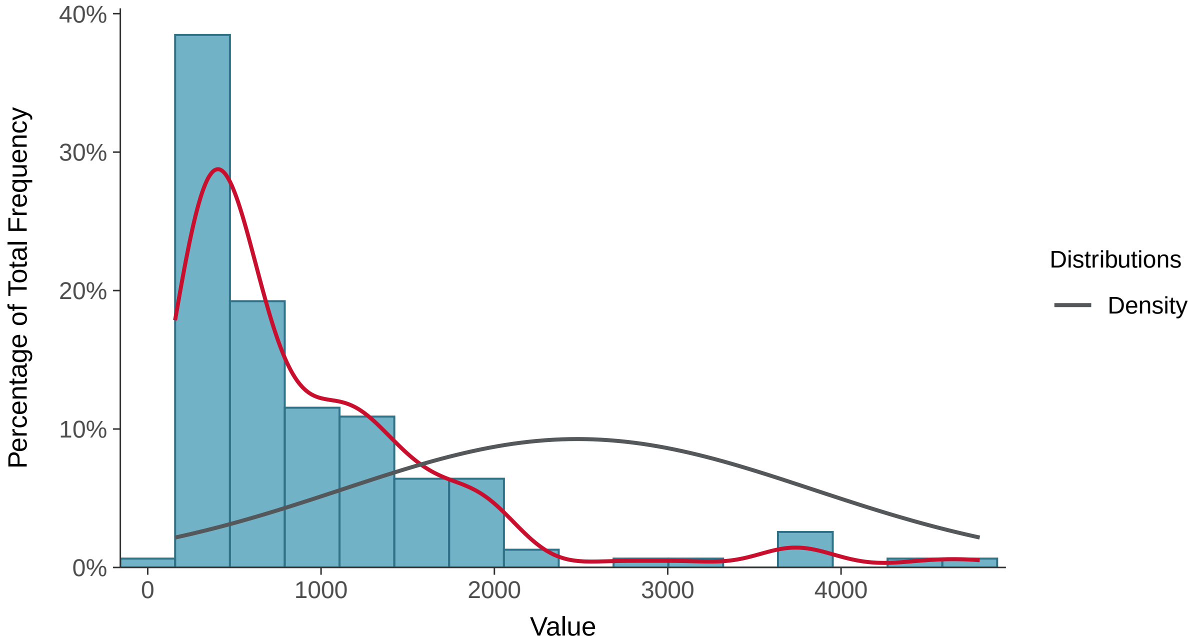
ID: 1_131





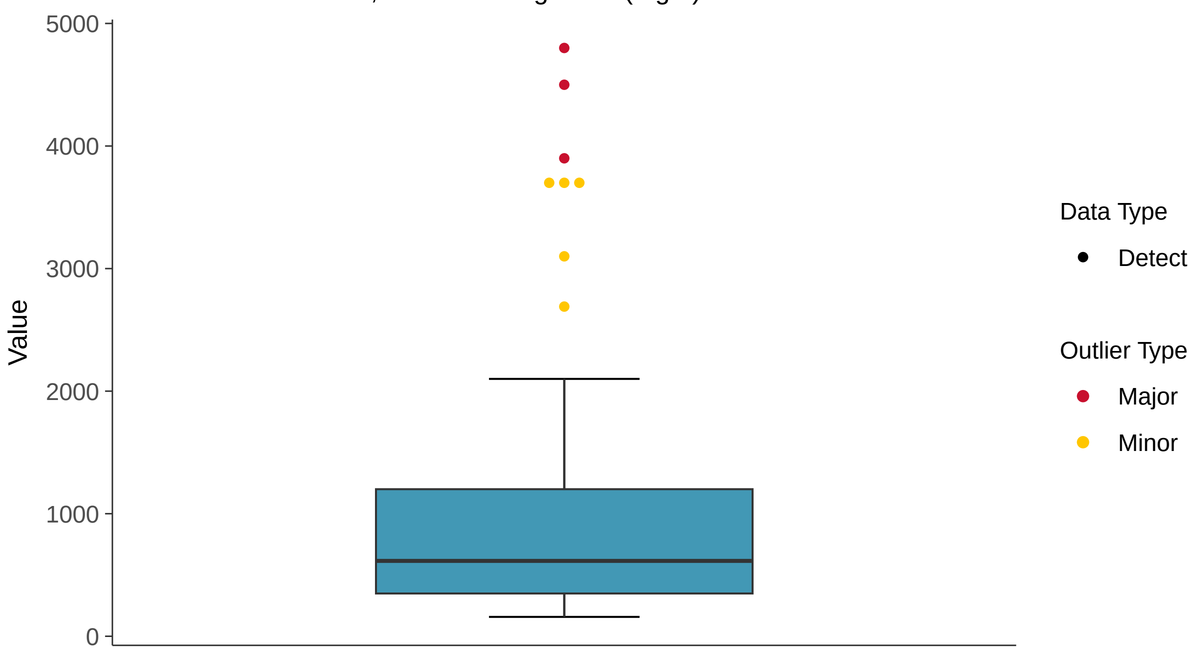
Histogram

Total Dissolved Solids, Pooled Background (mg/L)



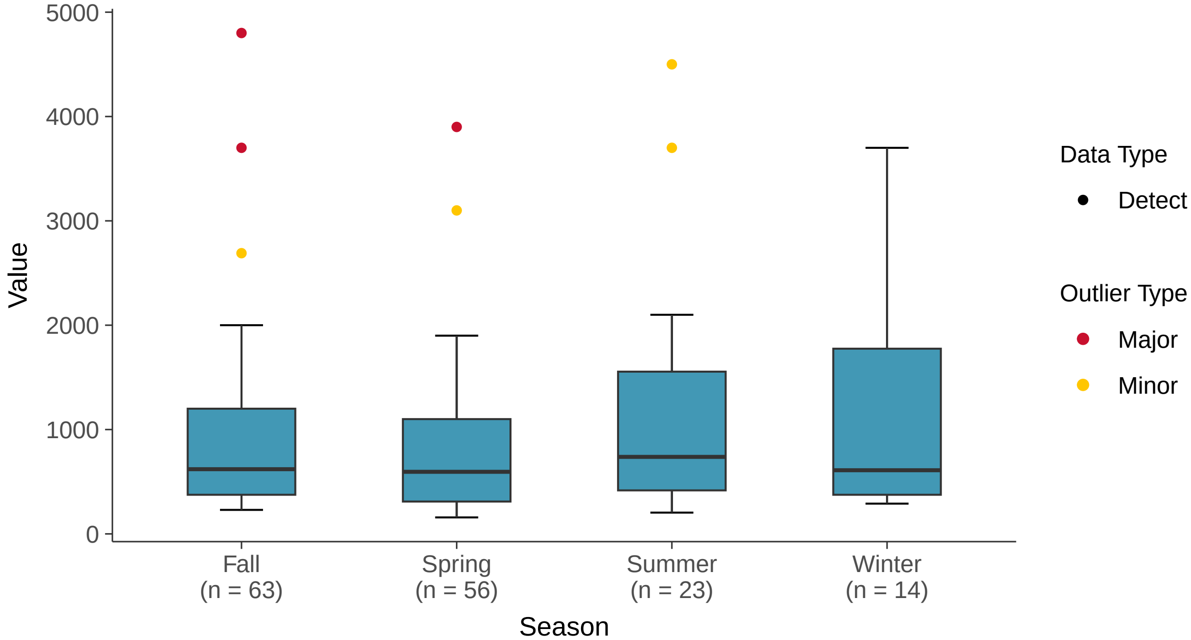
Boxplot

Total Dissolved Solids, Pooled Background (mg/L)



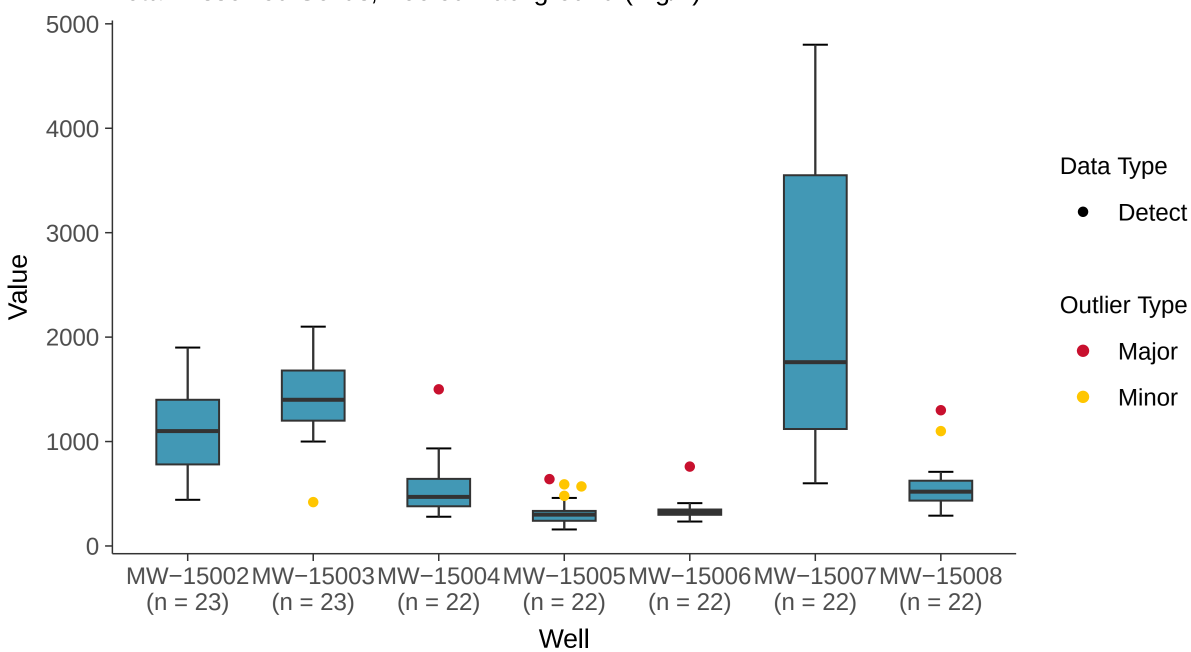
Boxplot by Season

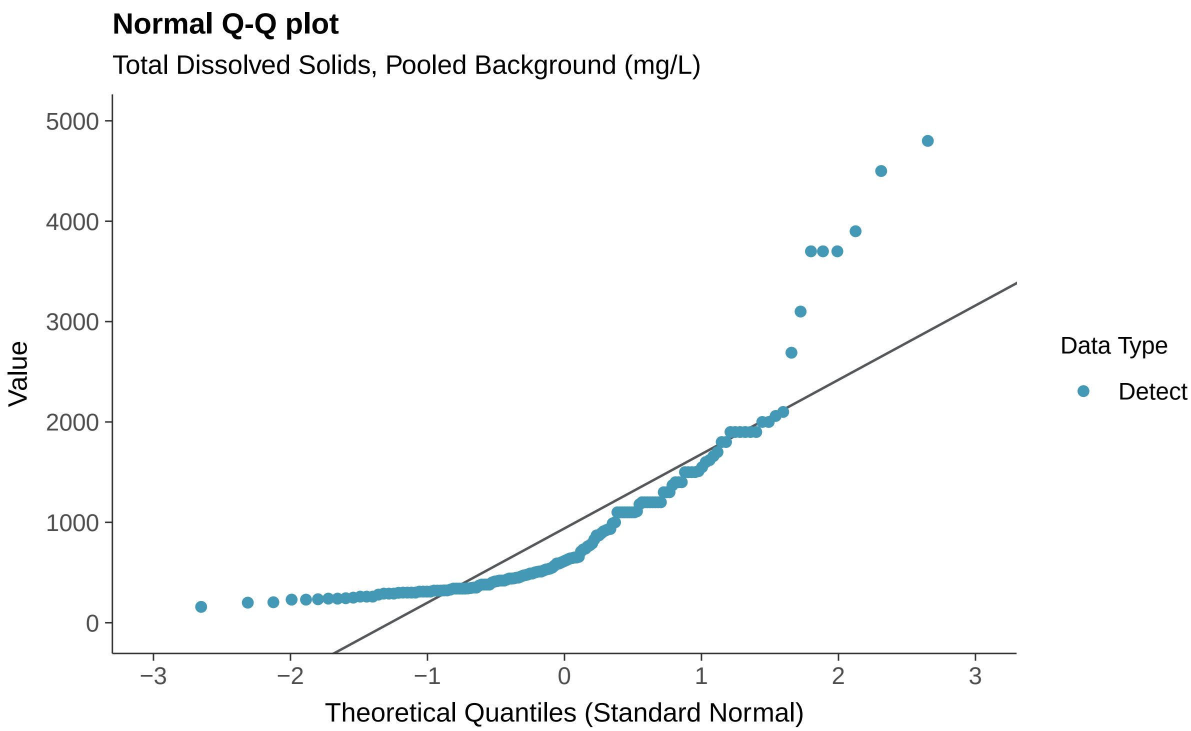
Total Dissolved Solids, Pooled Background (mg/L)

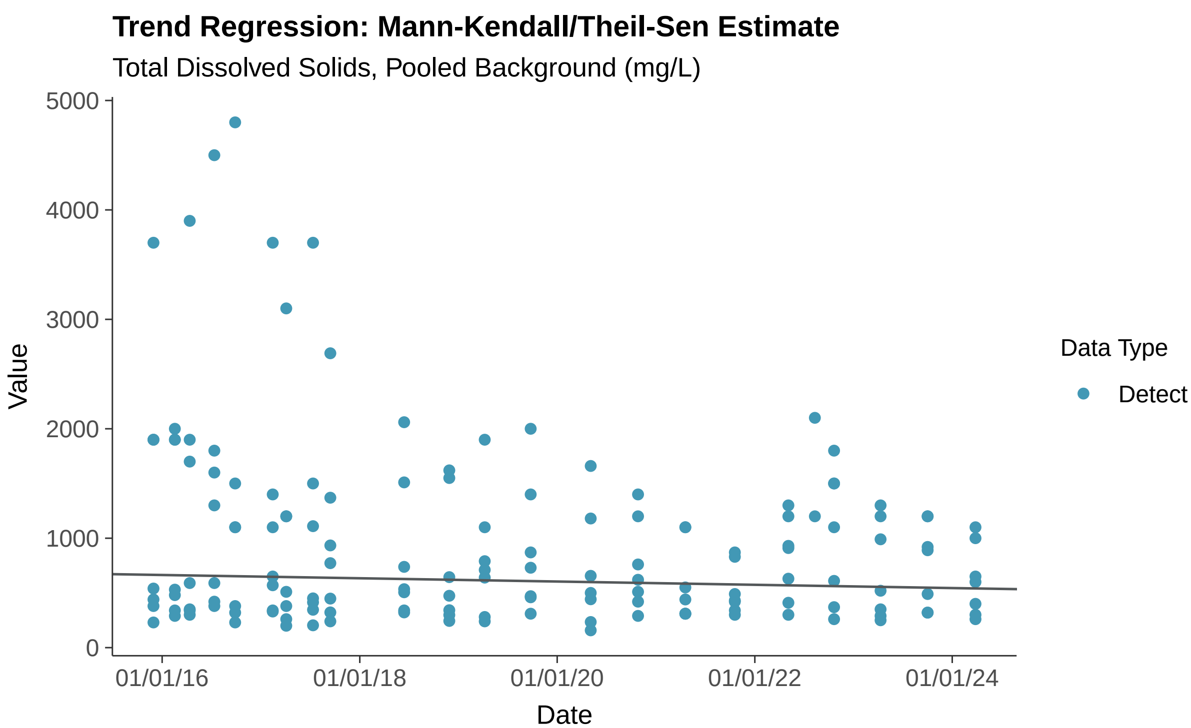


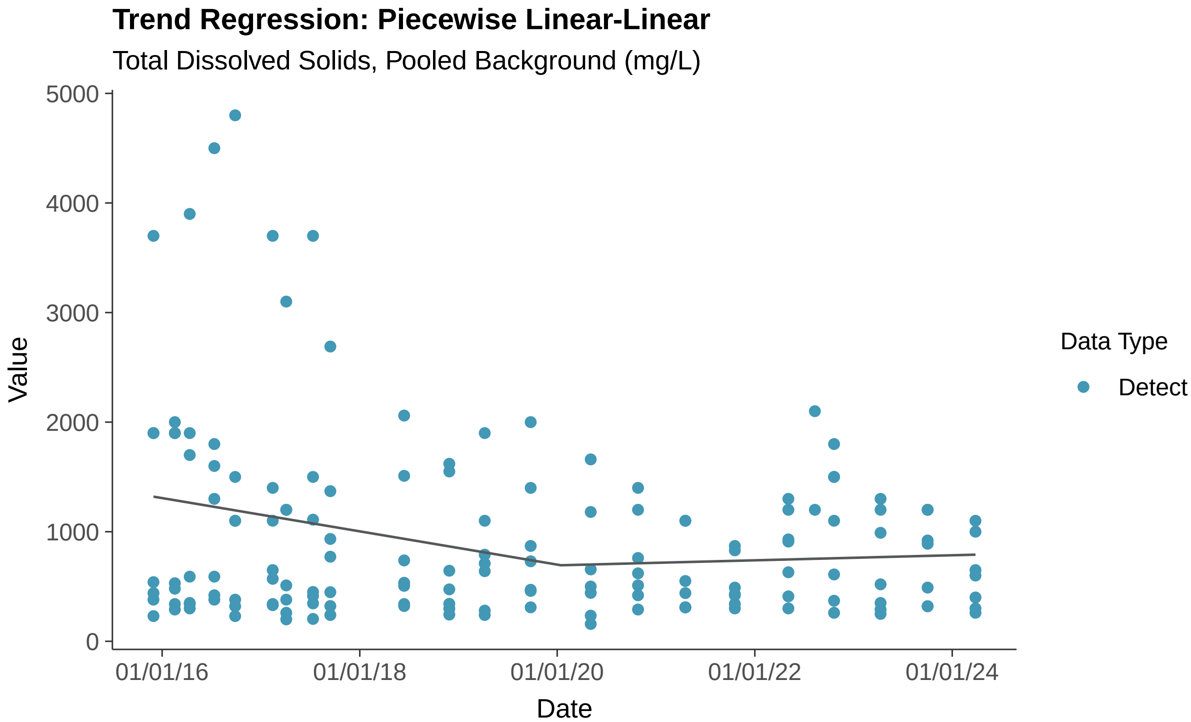
Boxplot by Well

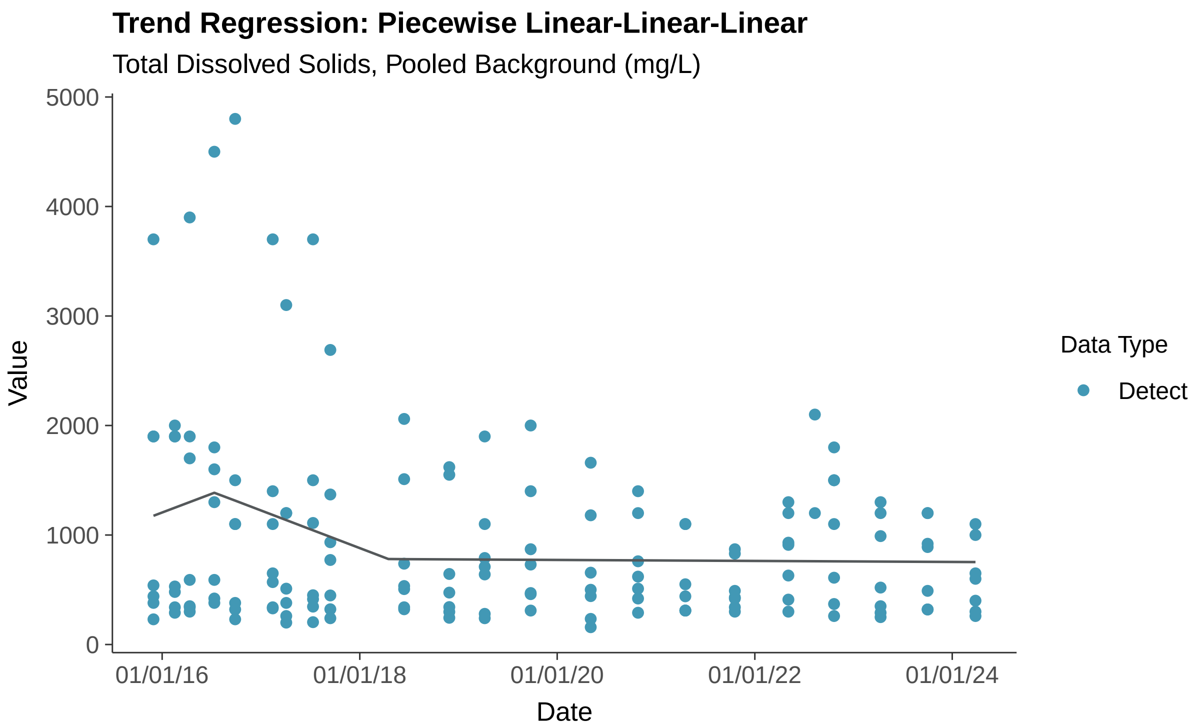
Total Dissolved Solids, Pooled Background (mg/L)




Normal Q-Q plot
Total Dissolved Solids, Pooled Background (mg/L)
Value
5000
4000
3000
2000
1000
0
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect

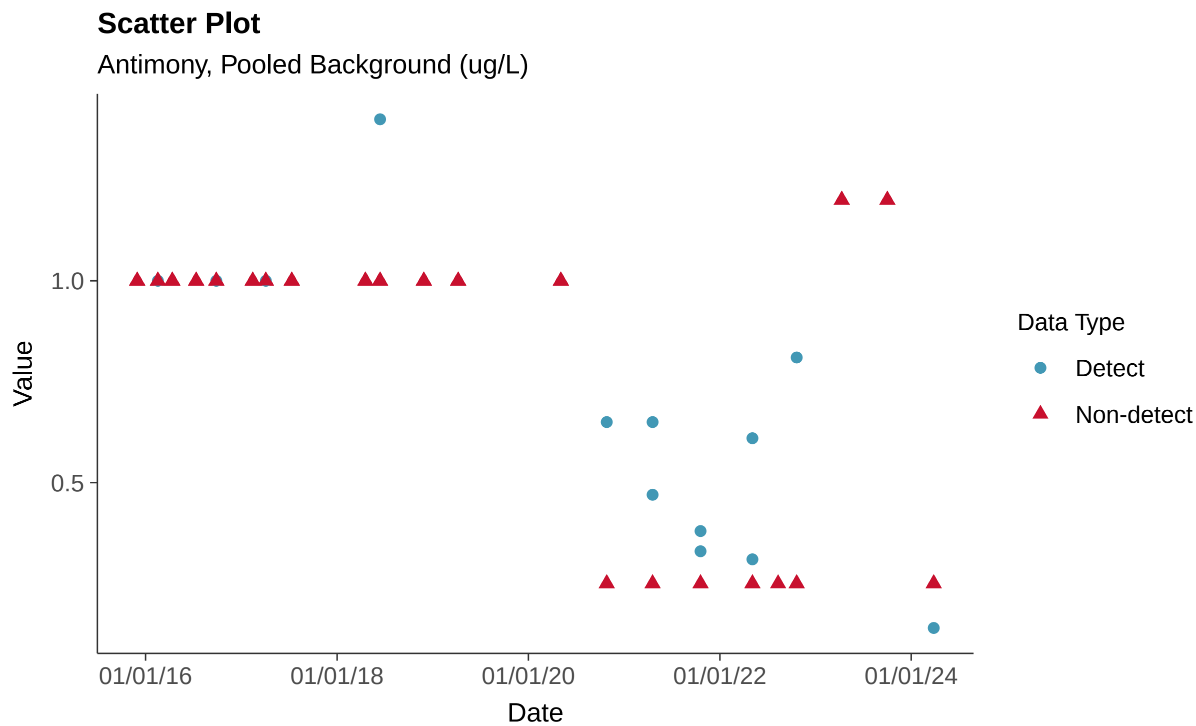

Trend Regression: Mann-Kendall/Theil-Sen Estimate
Total Dissolved Solids, Pooled Background (mg/L)
Value
5000
4000
3000
2000
1000
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect

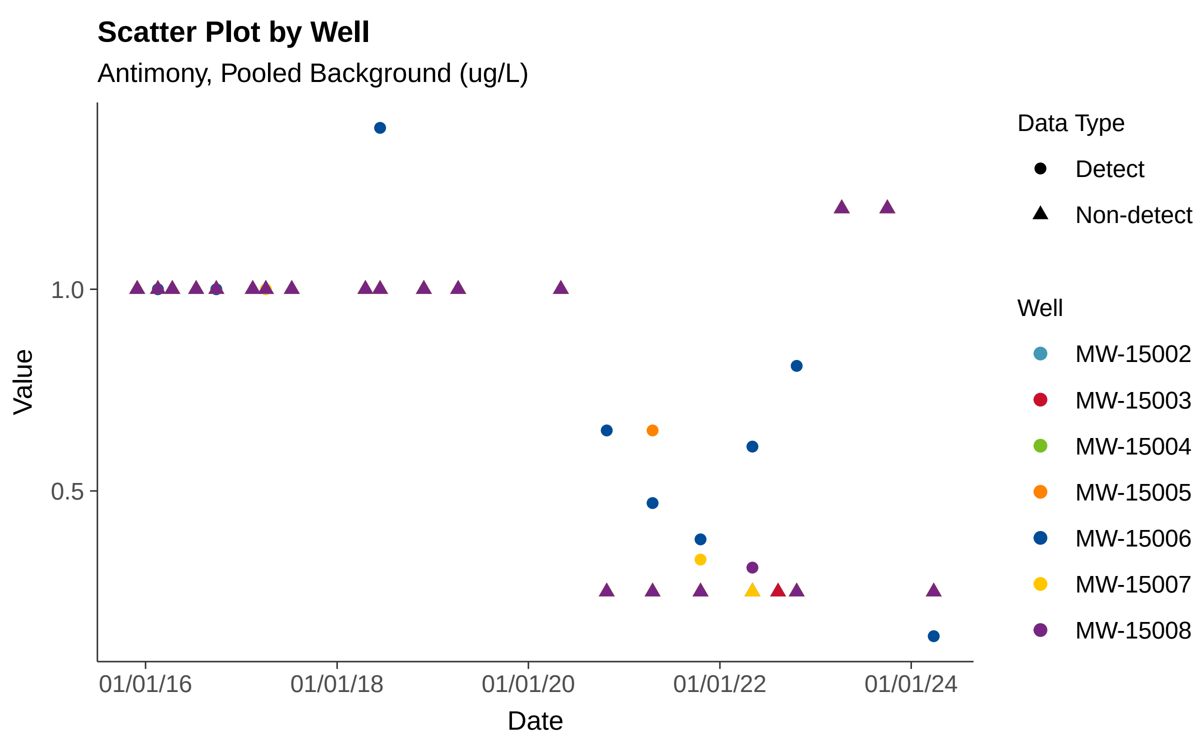

Trend Regression: Piecewise Linear-Linear
Total Dissolved Solids, Pooled Background (mg/L)
Value
5000
4000
3000
2000
1000
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect


Trend Regression: Piecewise Linear-Linear-Linear
Total Dissolved Solids, Pooled Background (mg/L)
Value
5000
4000
3000
2000
1000
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect

Appendix IV: Antimony, Pooled Background

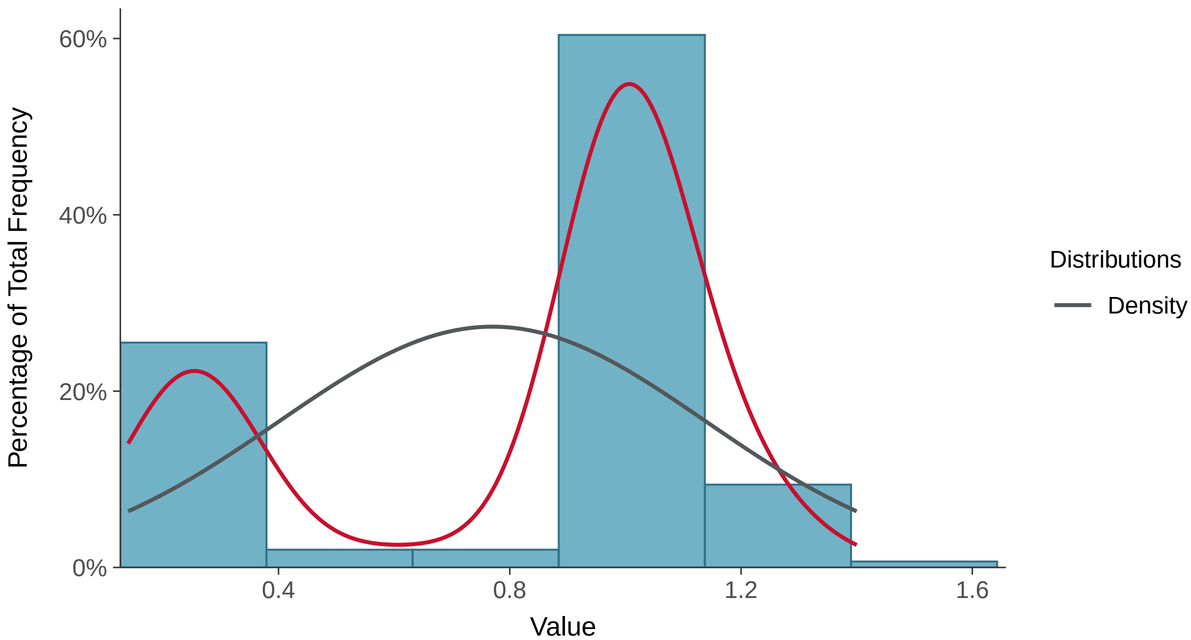
ID: 2_101





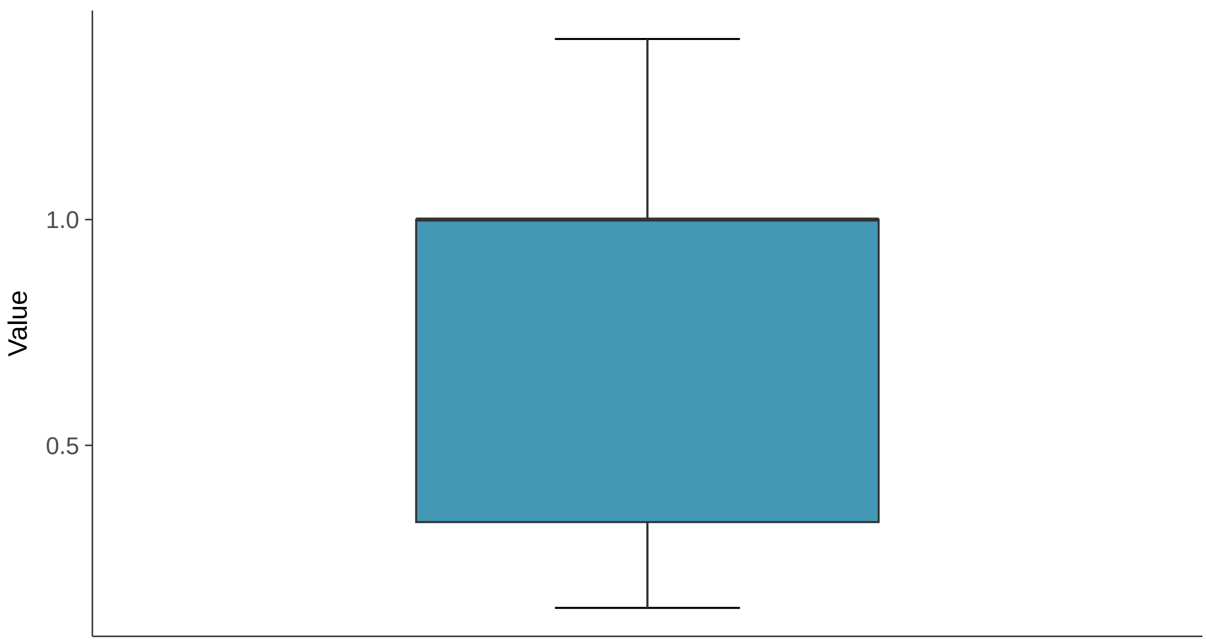
Histogram

Antimony, Pooled Background (ug/L)



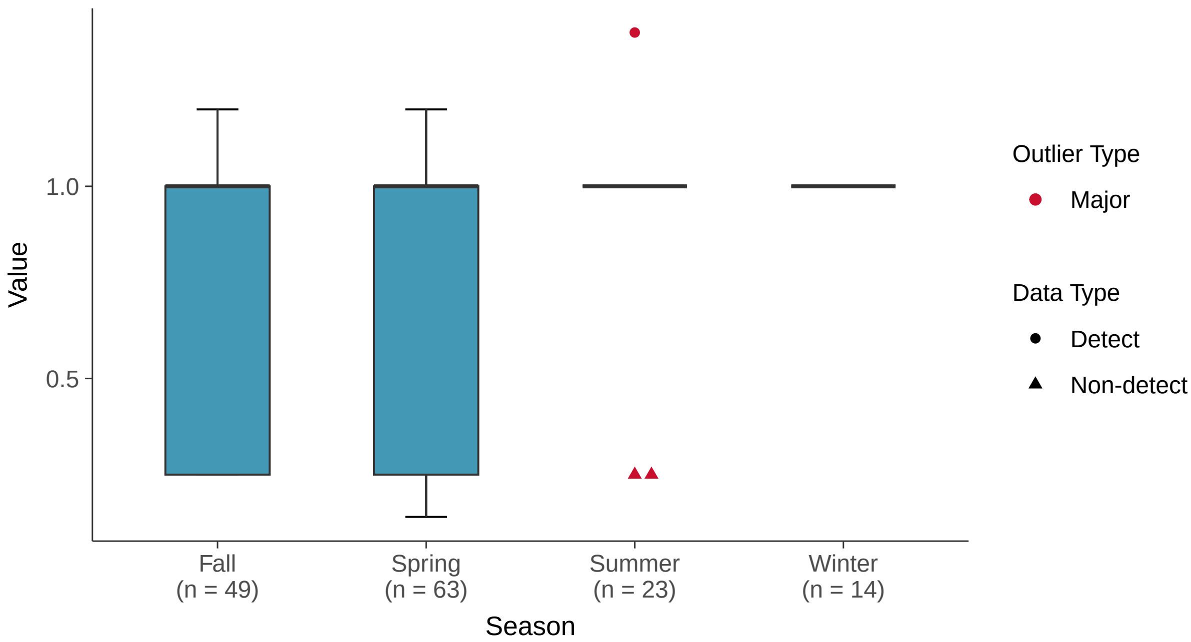
Boxplot

Antimony, Pooled Background (ug/L)



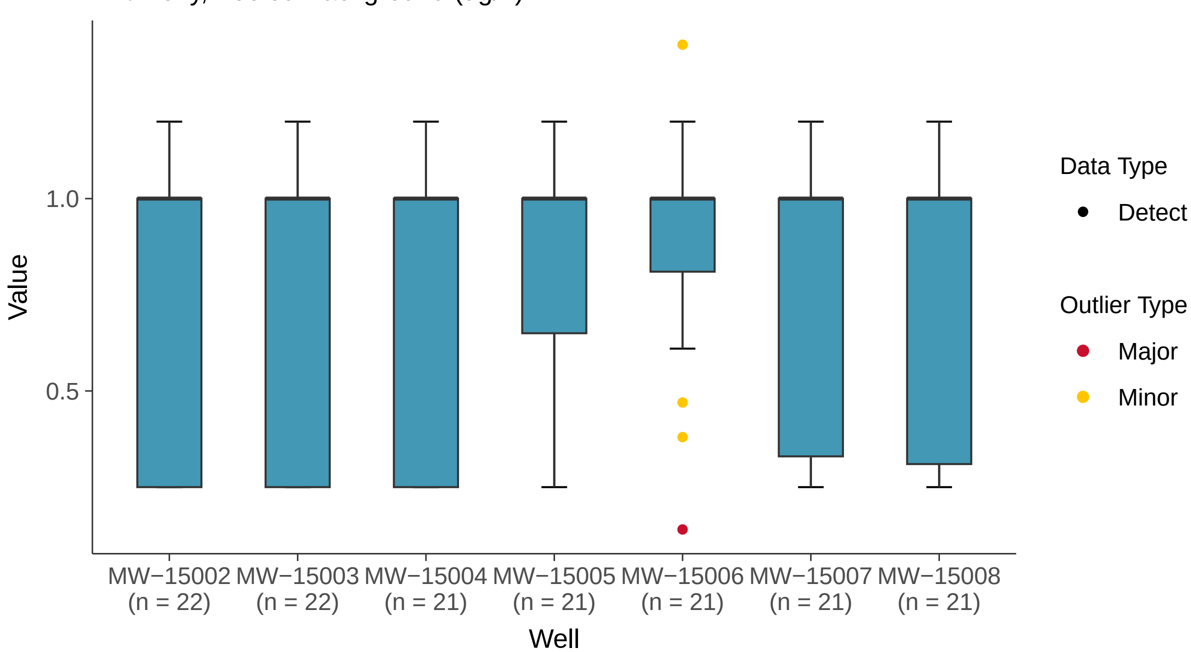
Boxplot by Season

Antimony, Pooled Background (ug/L)



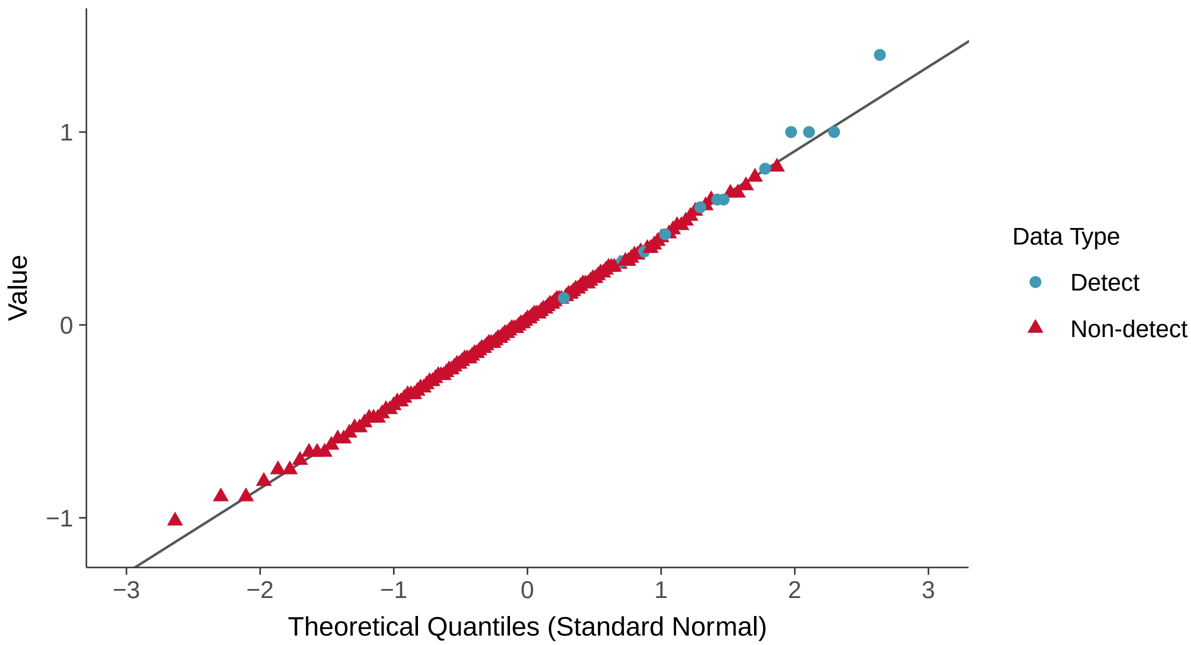
Boxplot by Well

Antimony, Pooled Background (ug/L)



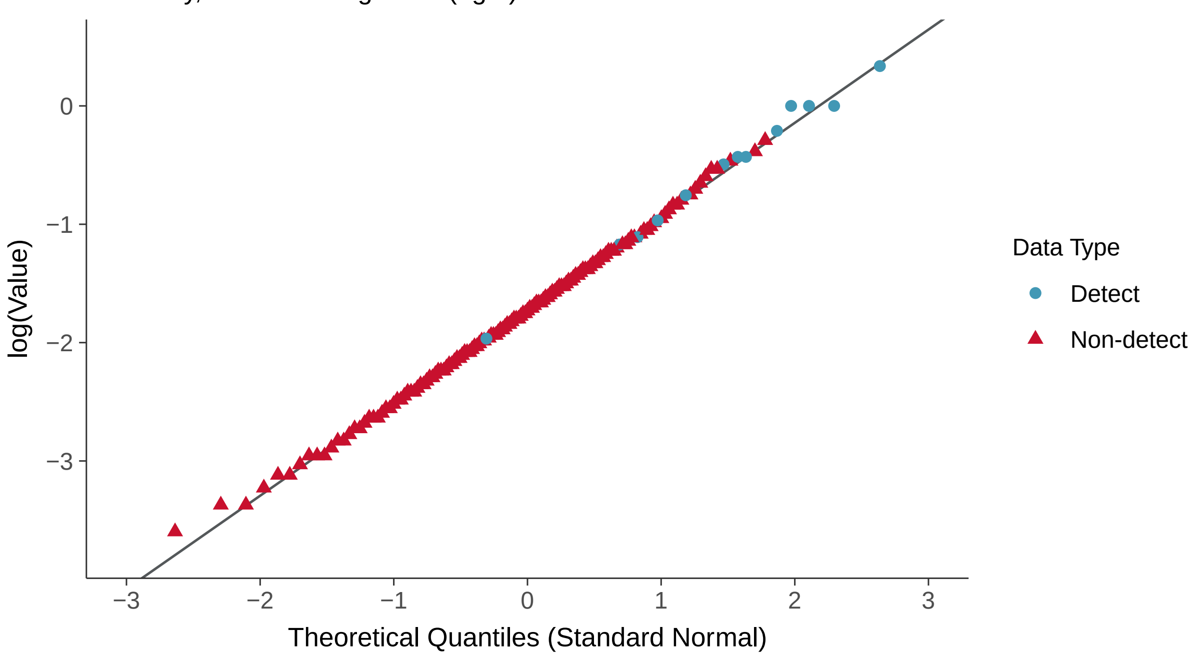
Normal Q-Q plot using ROS Imputed Estimates

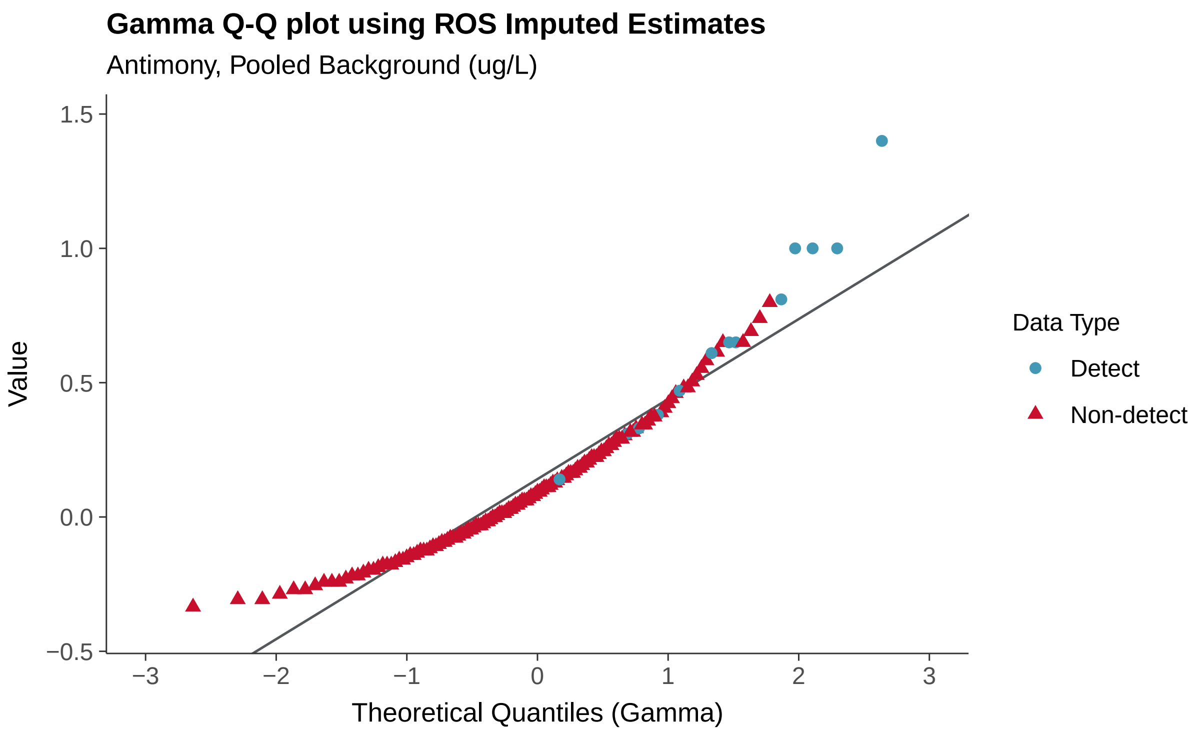
Antimony, Pooled Background (ug/L)

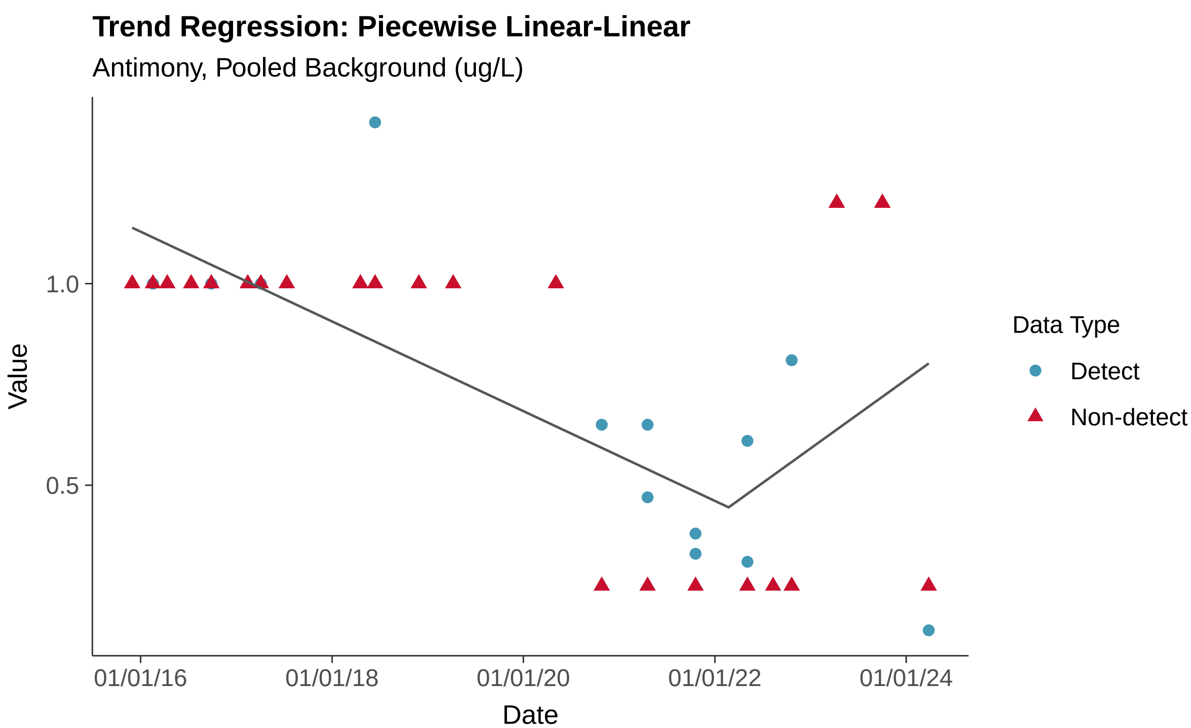


Lognormal Q-Q plot using ROS Imputed Estimates

Antimony, Pooled Background (ug/L)

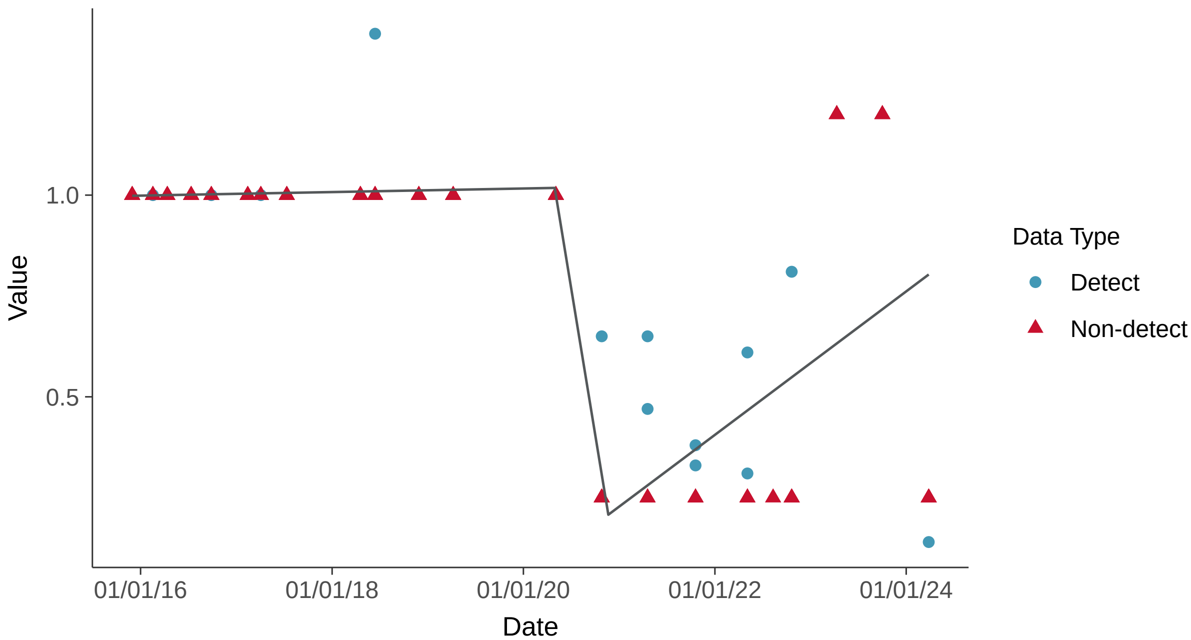



Gamma Q-Q plot using ROS Imputed Estimates
Antimony, Pooled Background (ug/L)
Value
1.5
1.0
0.5
0.0
−0.5
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Gamma)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Antimony, Pooled Background (ug/L)
Value
1.0
0.5
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

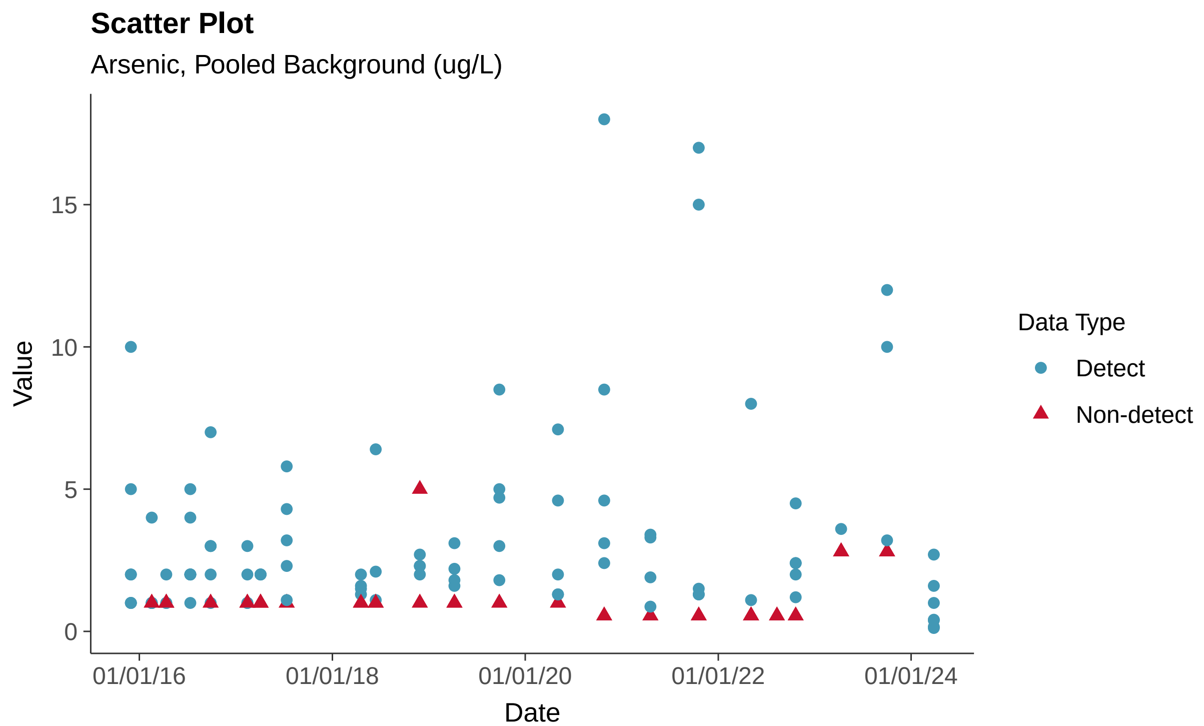
Trend Regression: Piecewise Linear-Linear-Linear

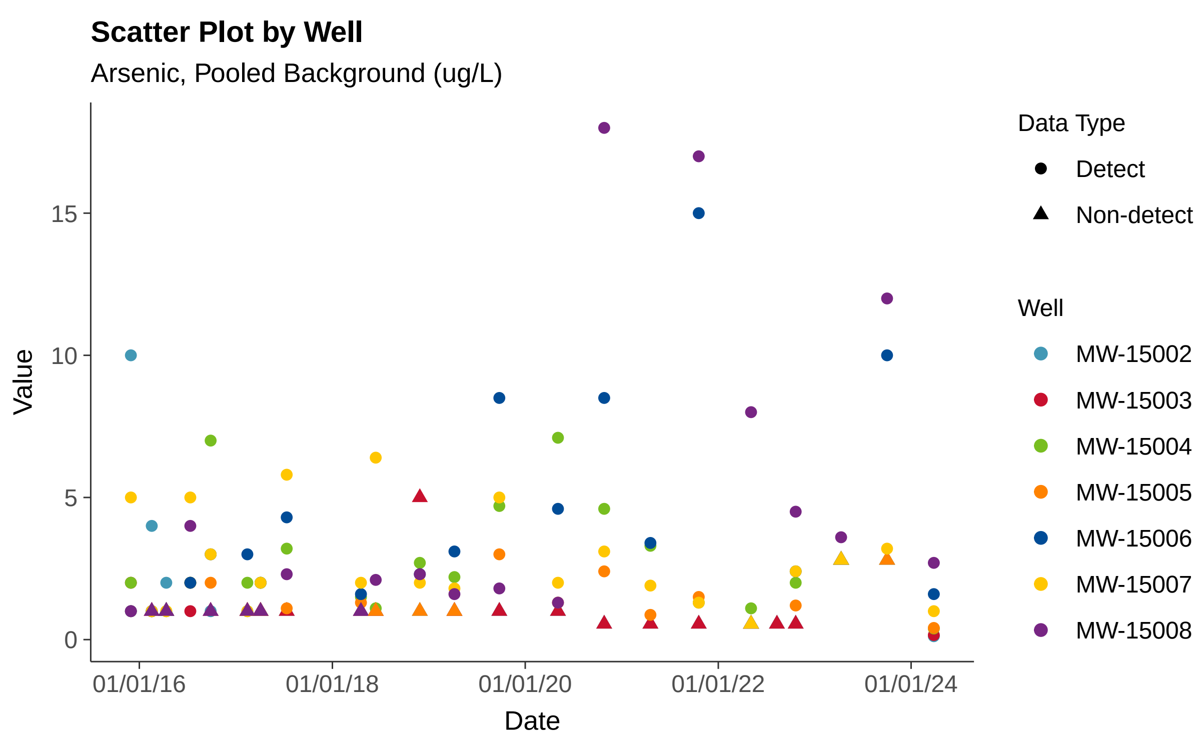
Antimony, Pooled Background (ug/L)



Appendix IV: Arsenic, Pooled Background

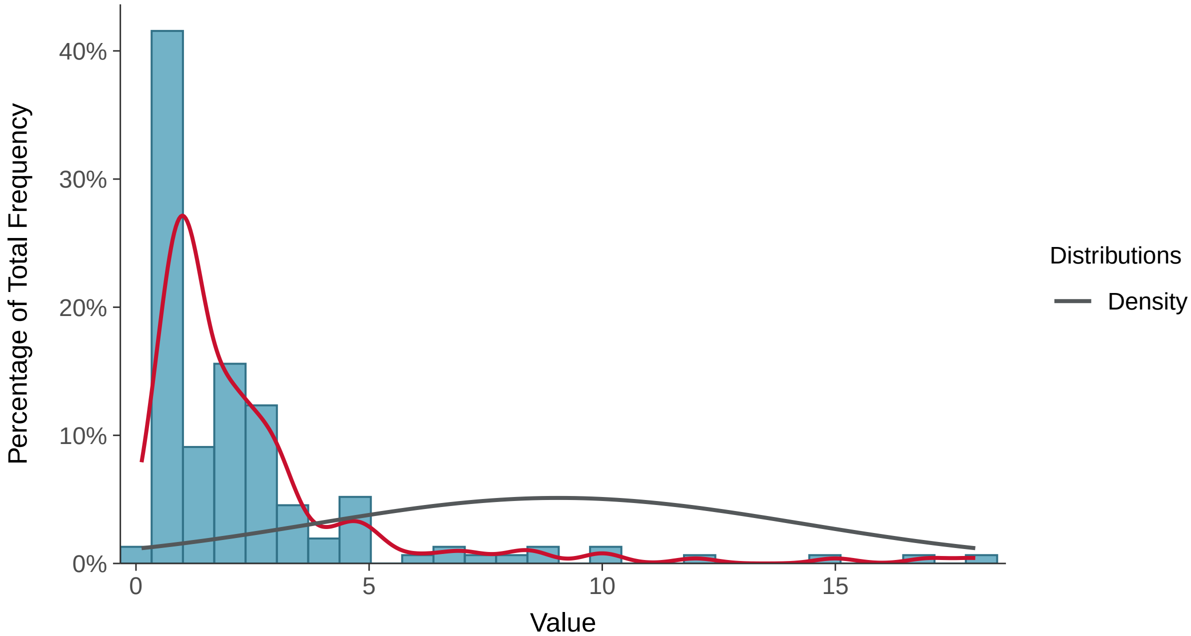
ID: 2_102





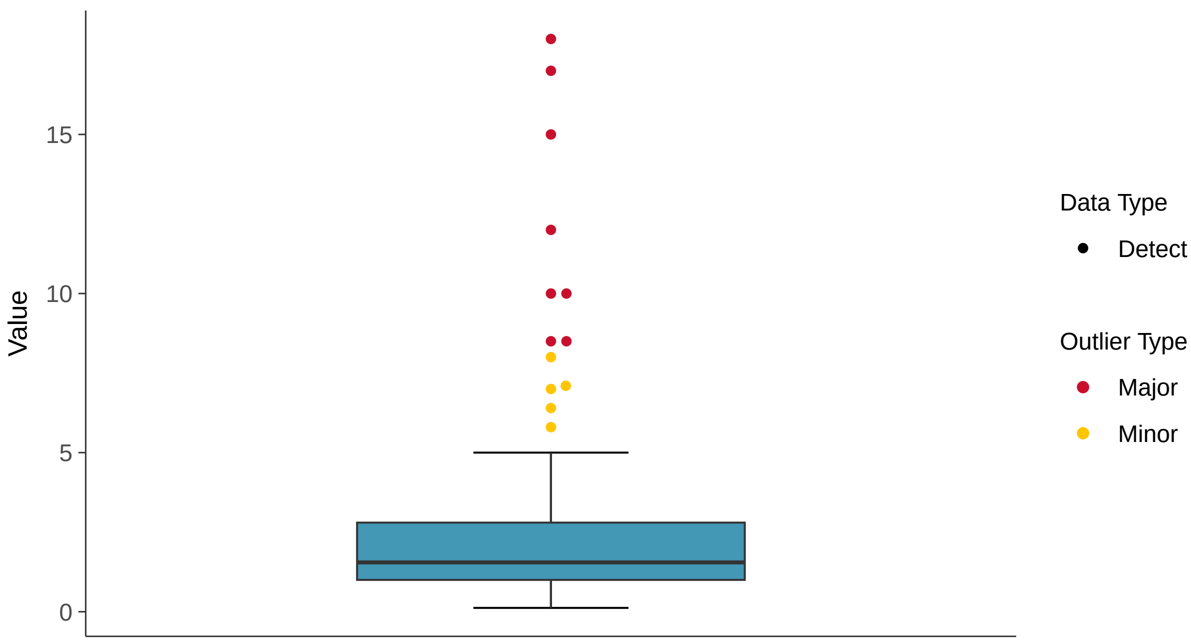
Histogram

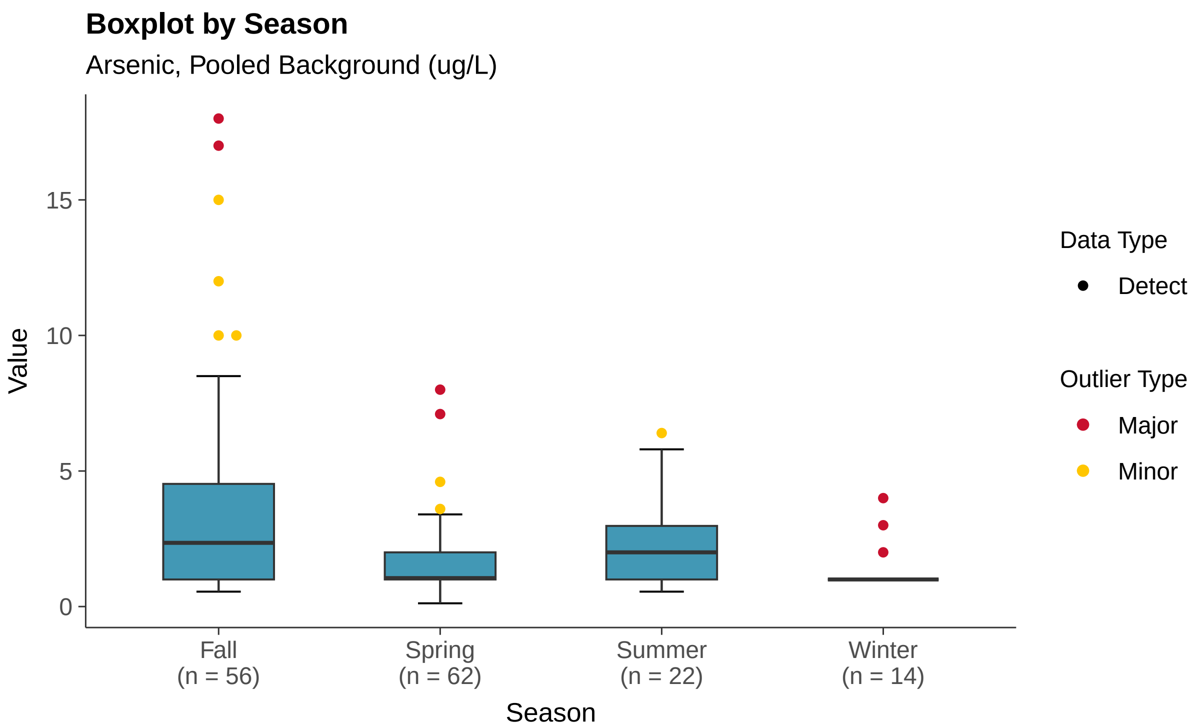
Arsenic, Pooled Background (ug/L)

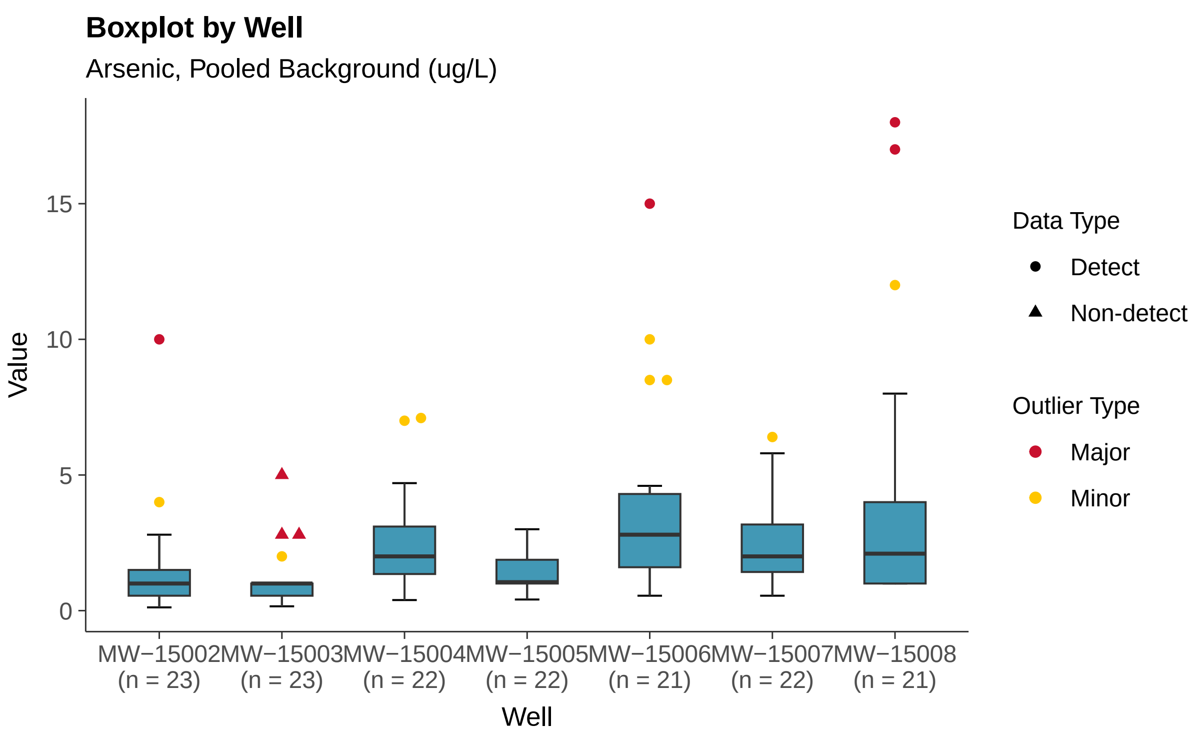


Boxplot

Arsenic, Pooled Background (ug/L)

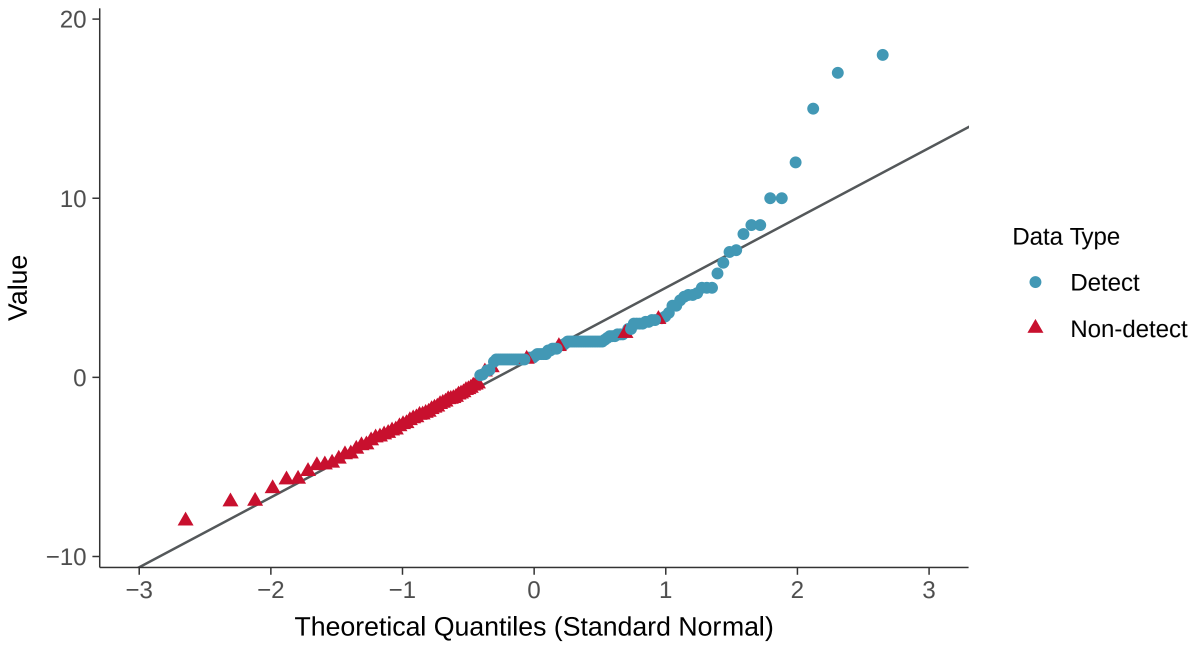



Boxplot by Season
Arsenic, Pooled Background (ug/L)
Value
0
5
10
15
Fall
(n = 56)
Spring
(n = 62)
Summer
(n = 22)
Winter
(n = 14)
Season
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Well
Arsenic, Pooled Background (ug/L)
Value
0
5
10
15
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 21)
MW−15007
(n = 22)
MW−15008
(n = 21)
Well
Data Type
Detect
Non-detect
Outlier Type
Major
Minor

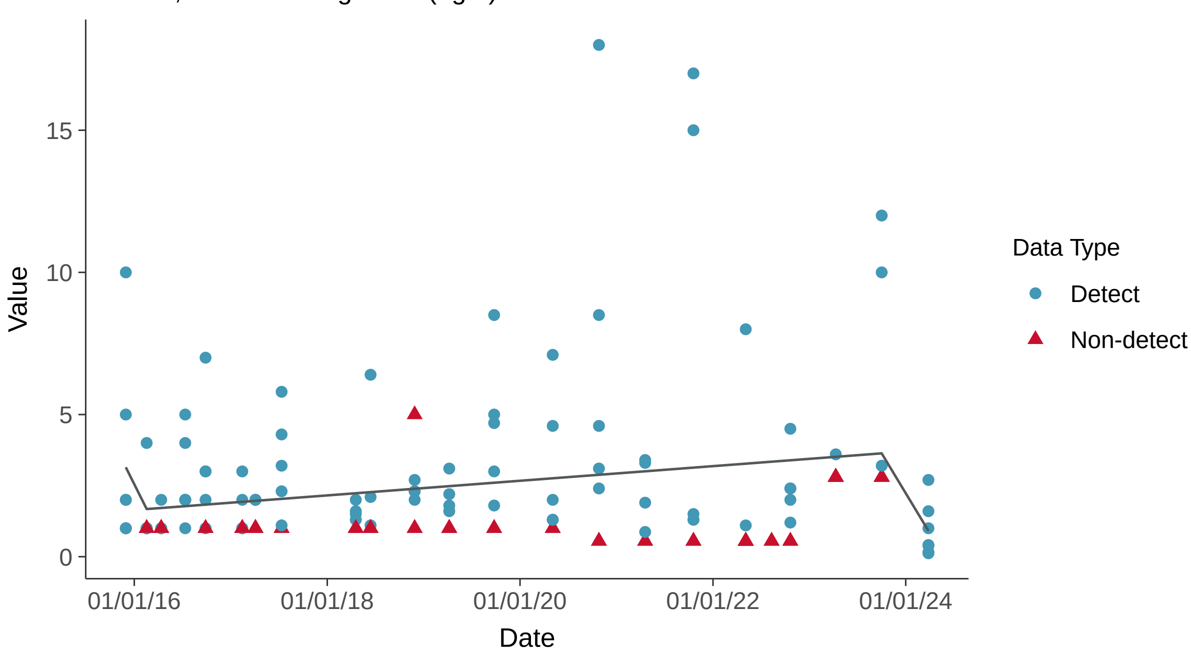
Normal Q-Q plot using ROS Imputed Estimates

Arsenic, Pooled Background (ug/L)



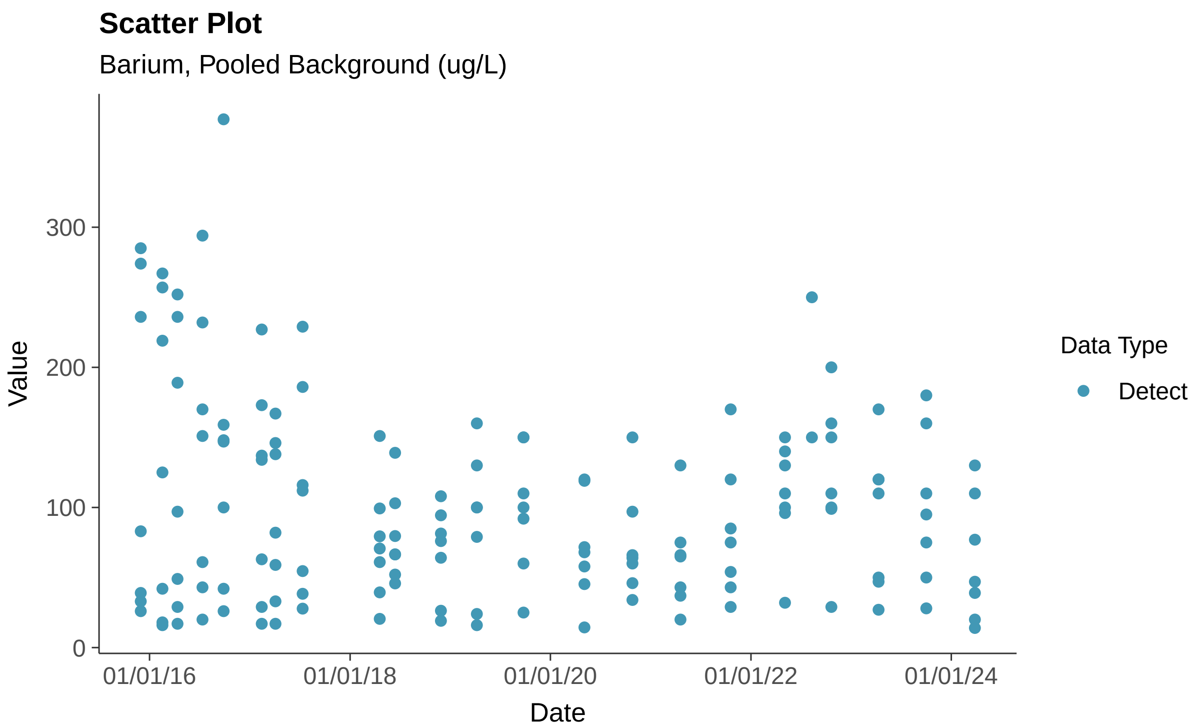
Trend Regression: Piecewise Linear-Linear-Linear

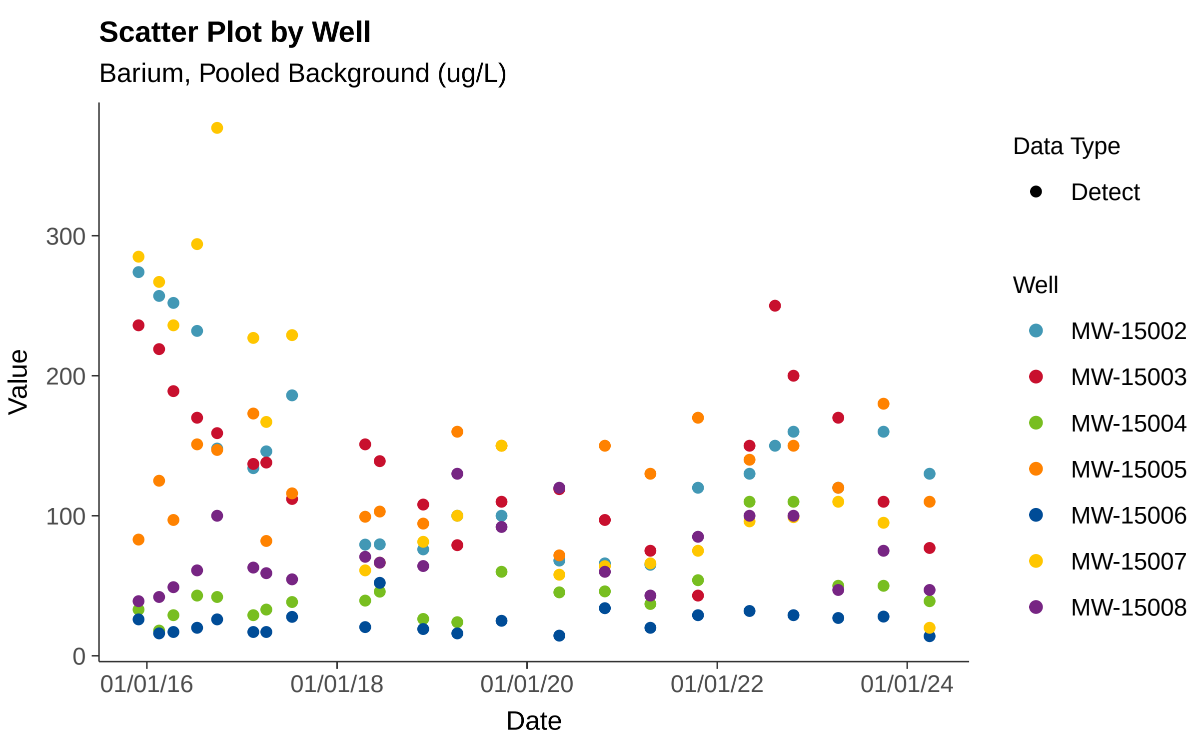
Arsenic, Pooled Background (ug/L)

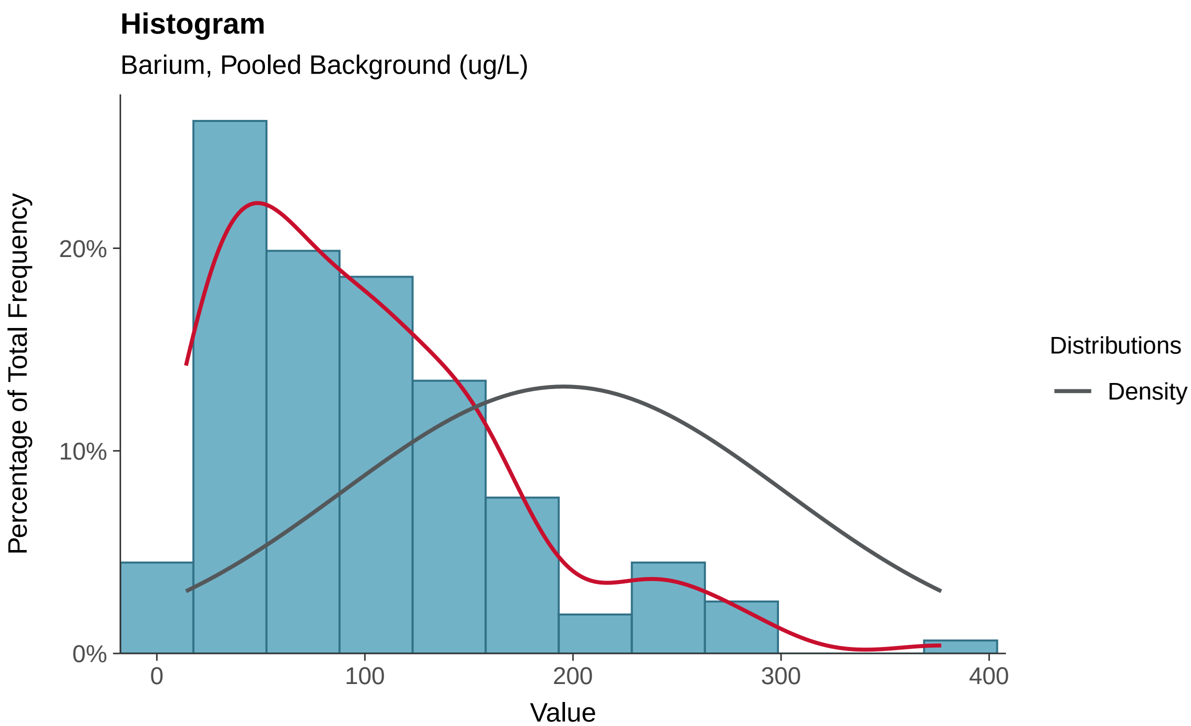


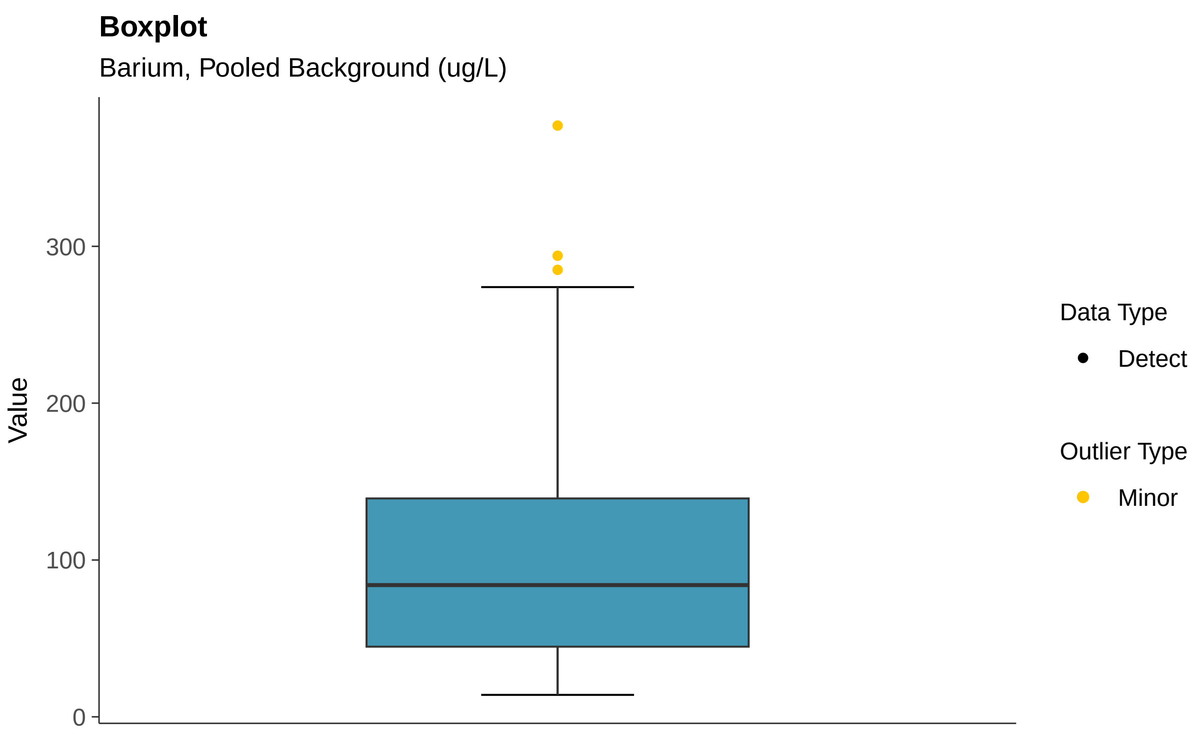
Appendix IV: Barium, Pooled Background

ID: 2_103



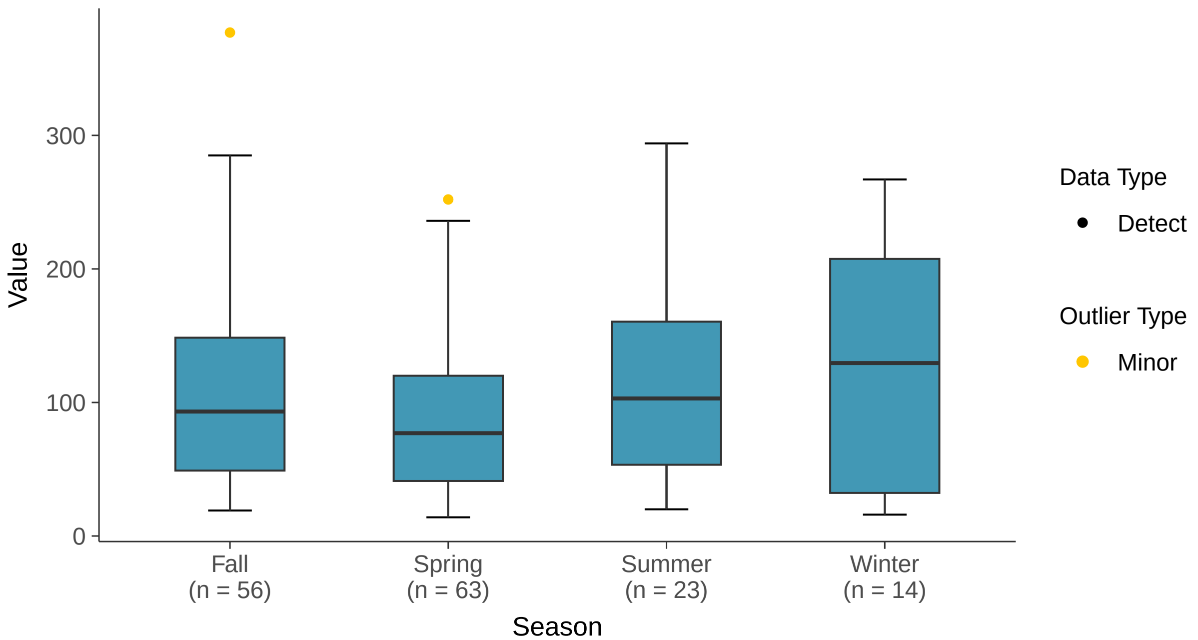



Histogram
Barium, Pooled Background (ug/L)
Percentage of Total Frequency
20%
10%
0%
0
100
200
300
400
Value
Distributions
Density


Boxplot
Barium, Pooled Background (ug/L)
Value
300
200
100
0
Data Type
Detect
Outlier Type
Minor

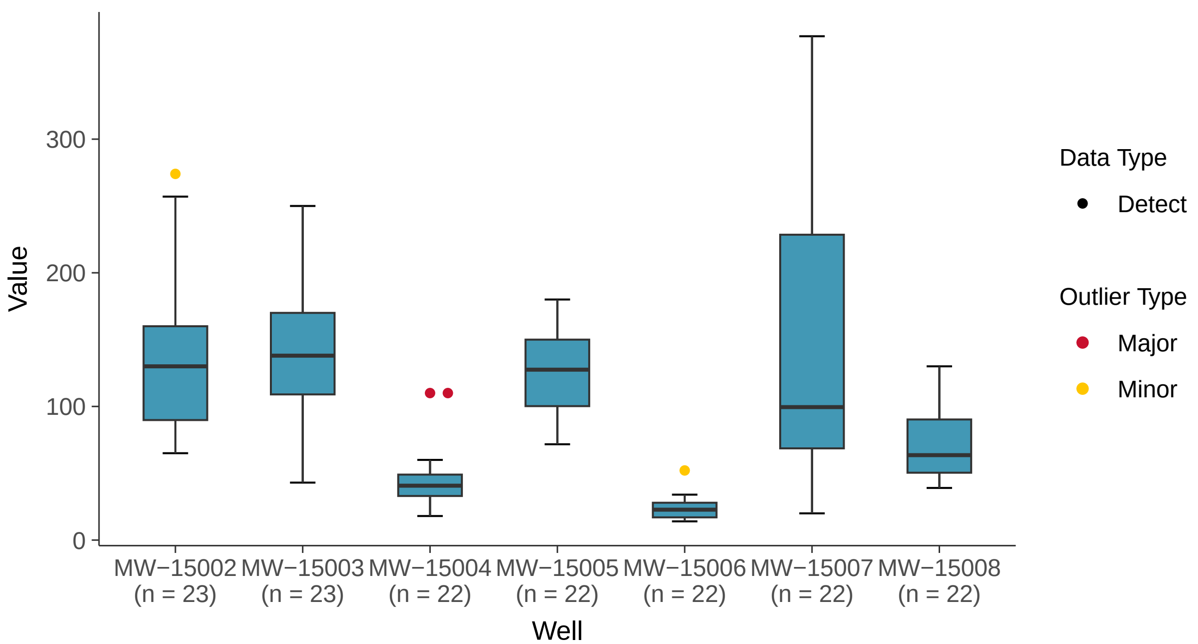
Boxplot by Season

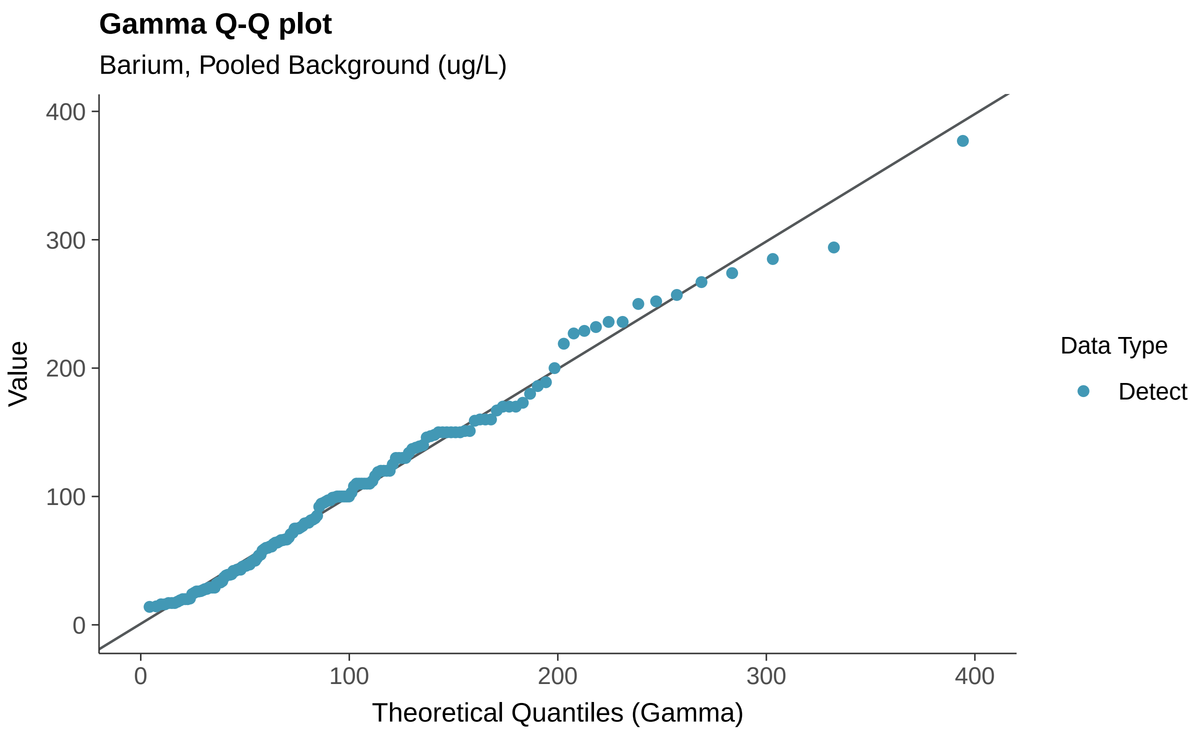
Barium, Pooled Background (ug/L)

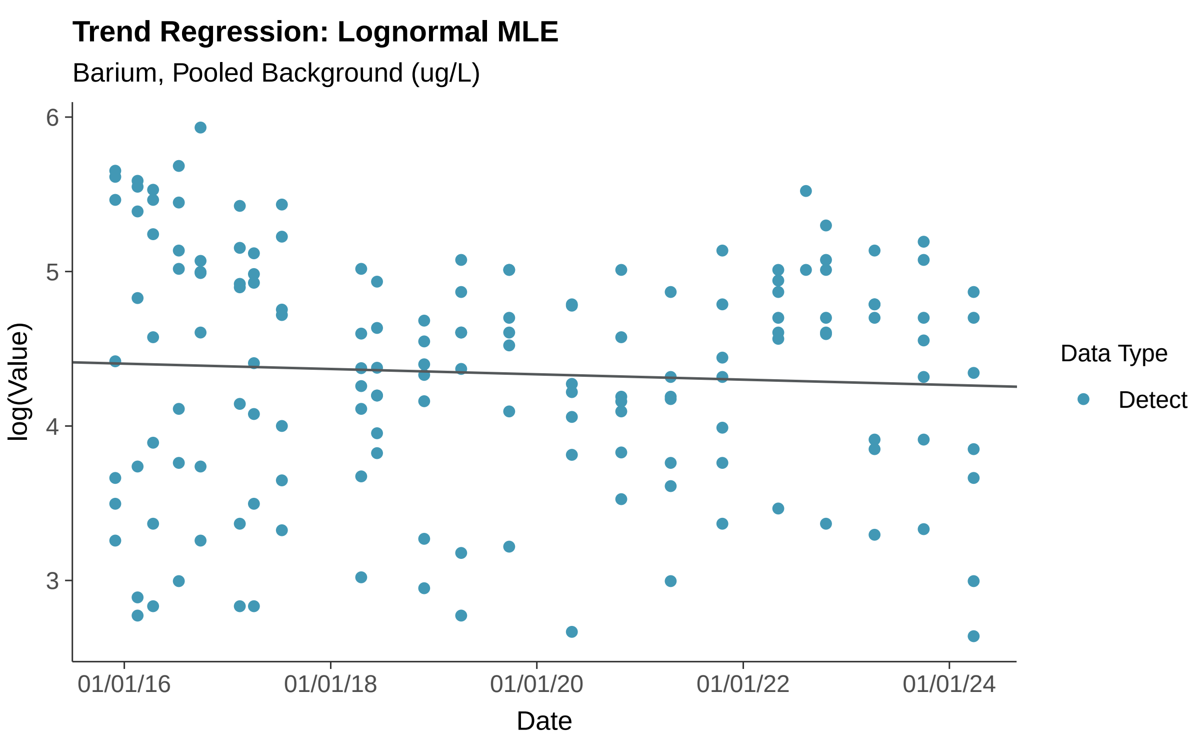


Boxplot by Well

Barium, Pooled Background (ug/L)

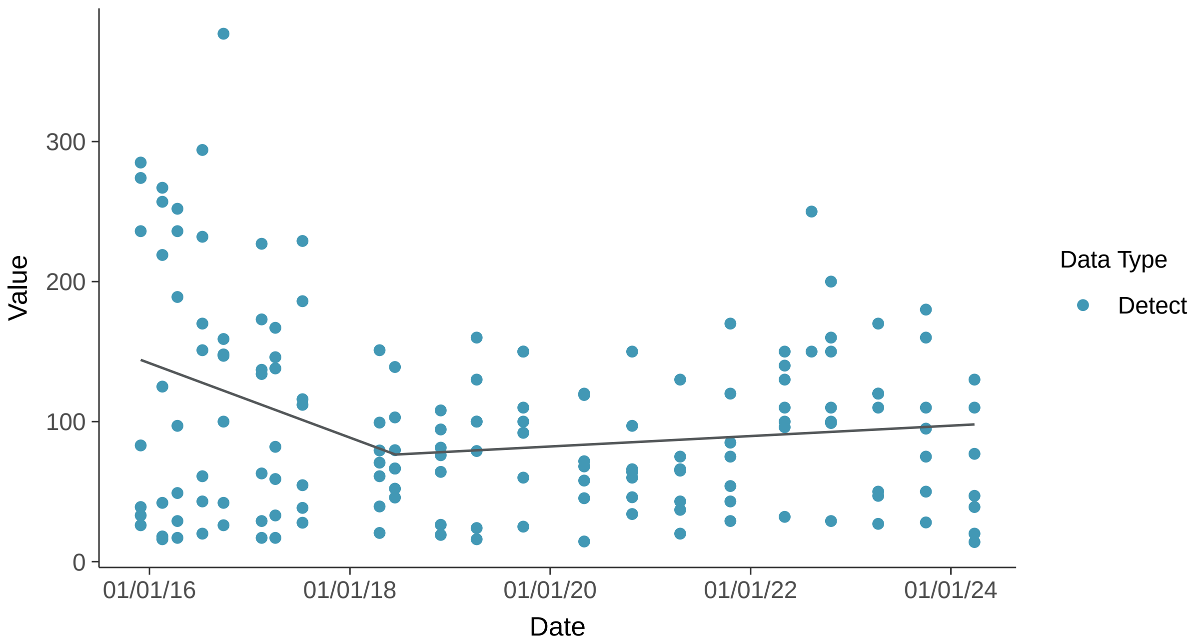



Gamma Q-Q plot
Barium, Pooled Background (ug/L)
Value
Theoretical Quantiles (Gamma)
Data Type
Detect
0
100
200
300
400


Trend Regression: Lognormal MLE
Barium, Pooled Background (ug/L)
log(Value)
Date
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Data Type
Detect

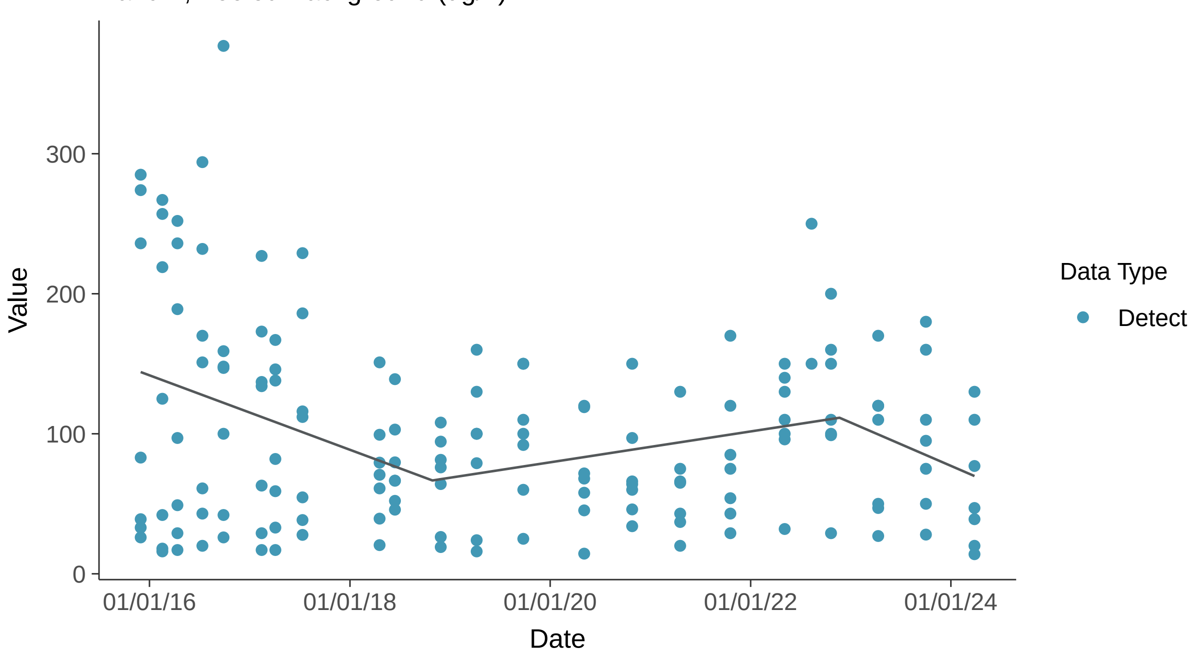
Trend Regression: Piecewise Linear-Linear

Barium, Pooled Background (ug/L)



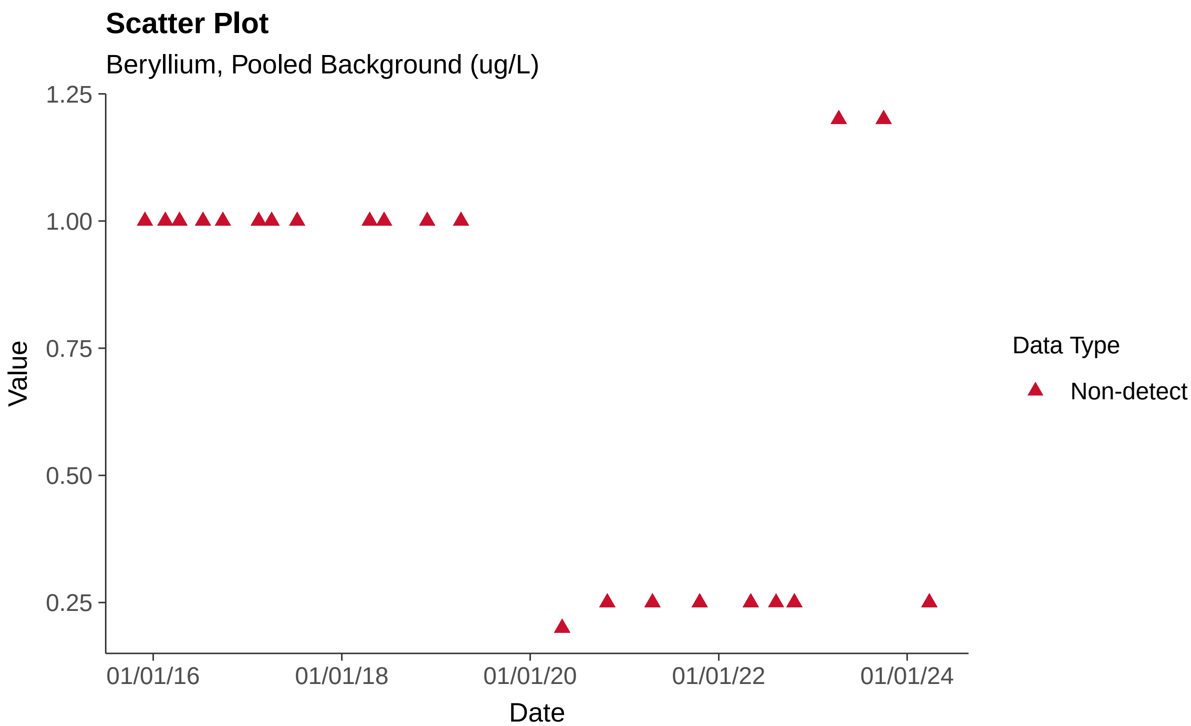
Trend Regression: Piecewise Linear-Linear-Linear

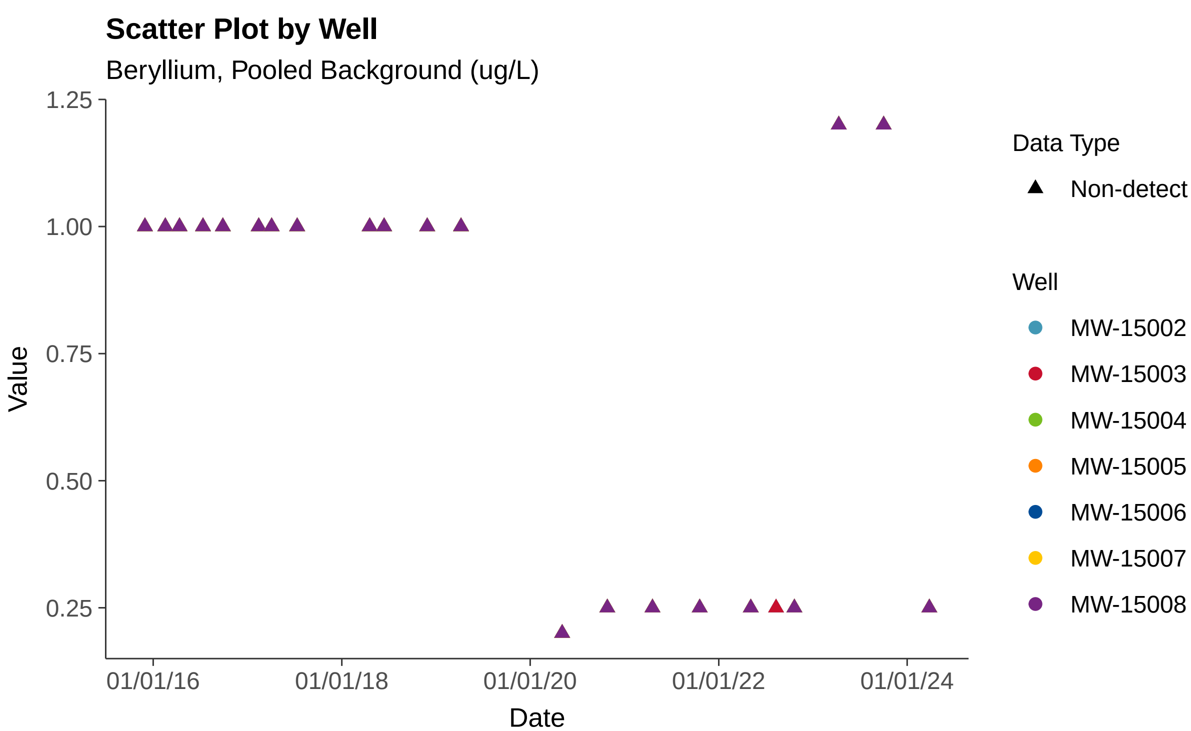
Barium, Pooled Background (ug/L)



Appendix IV: Beryllium, Pooled Background

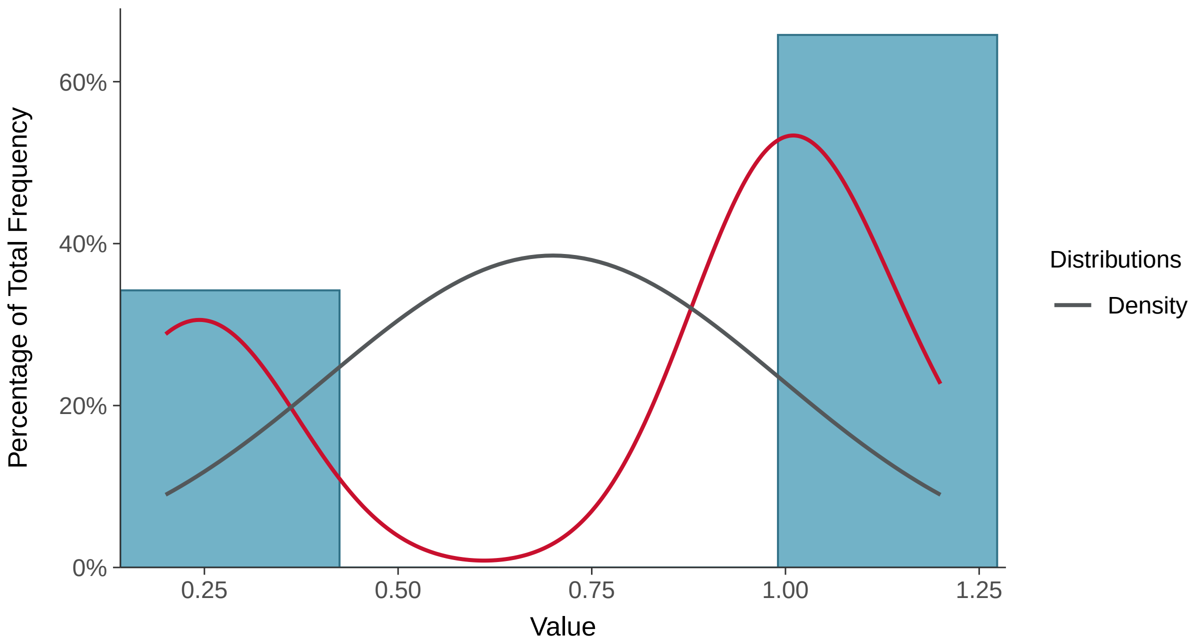
ID: 2_104





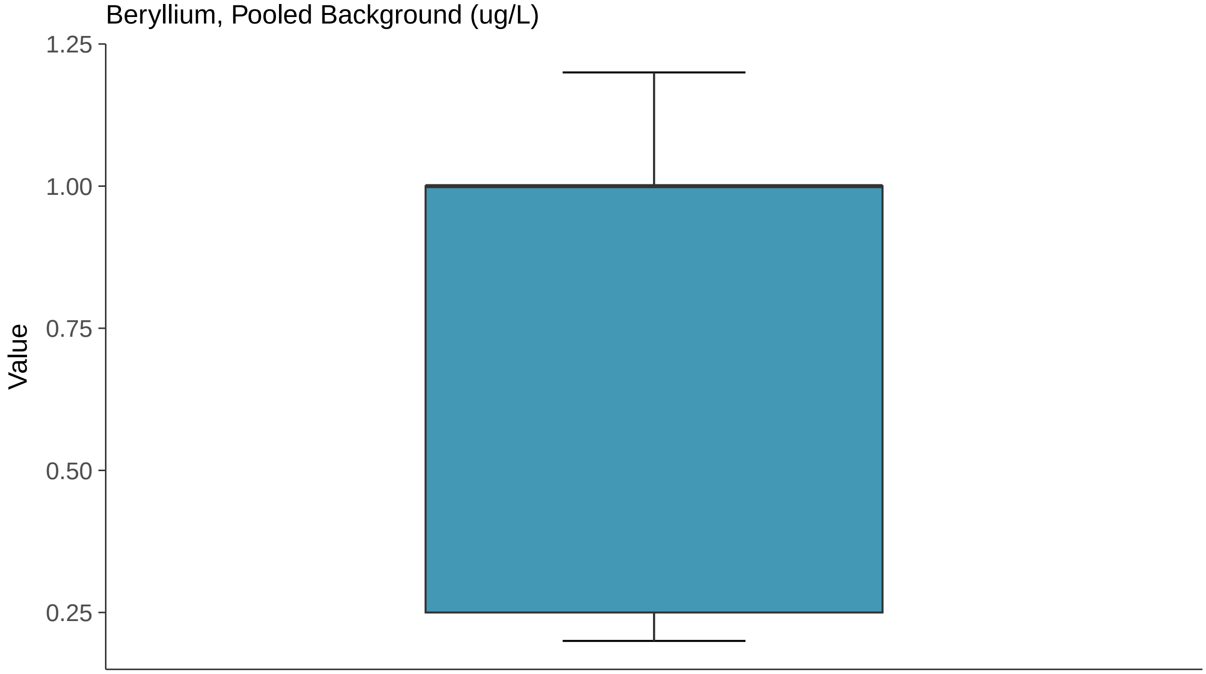
Histogram

Beryllium, Pooled Background (ug/L)



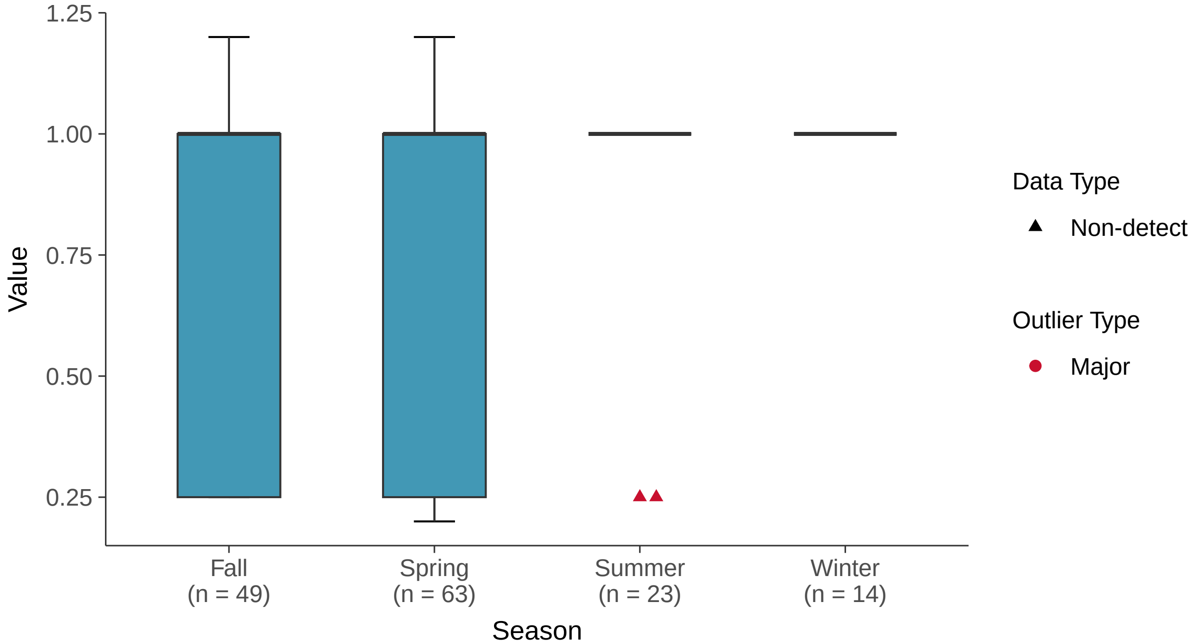
Boxplot

Beryllium, Pooled Background (ug/L)



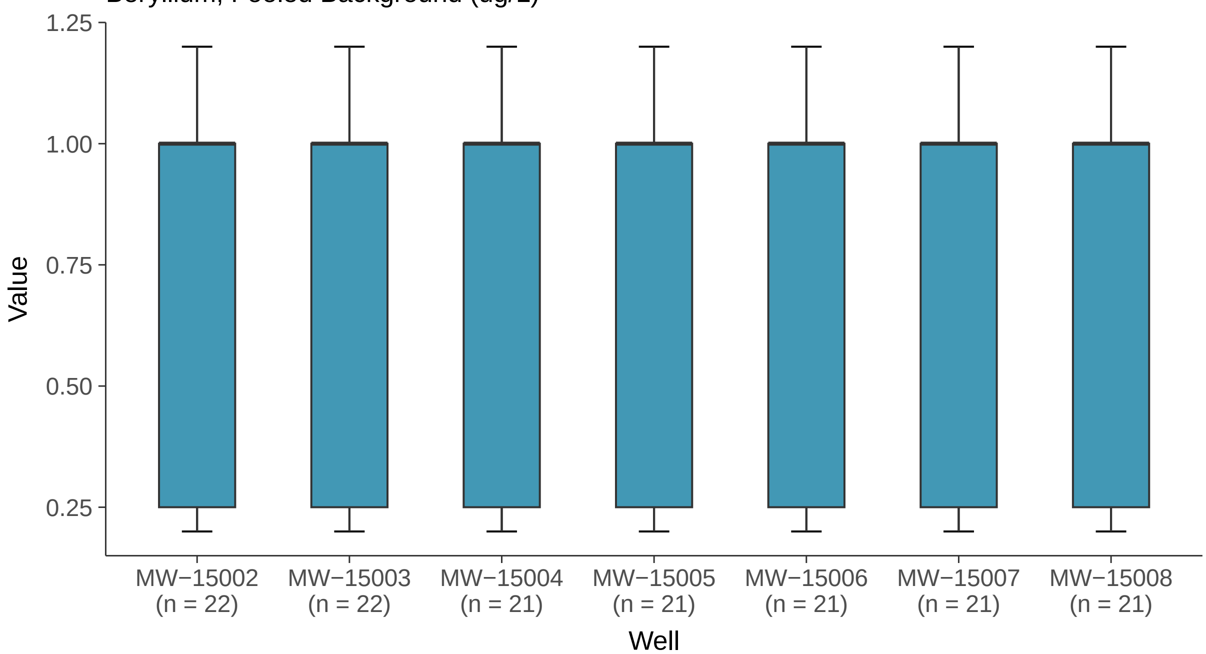
Boxplot by Season

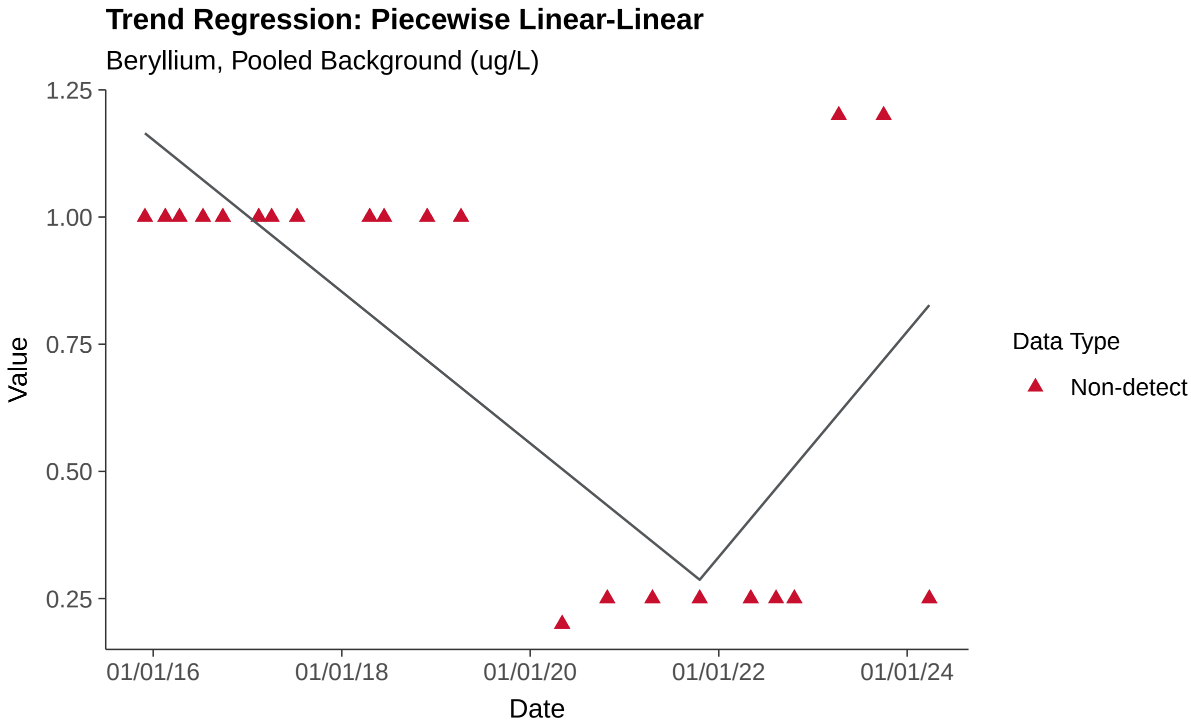
Beryllium, Pooled Background (ug/L)

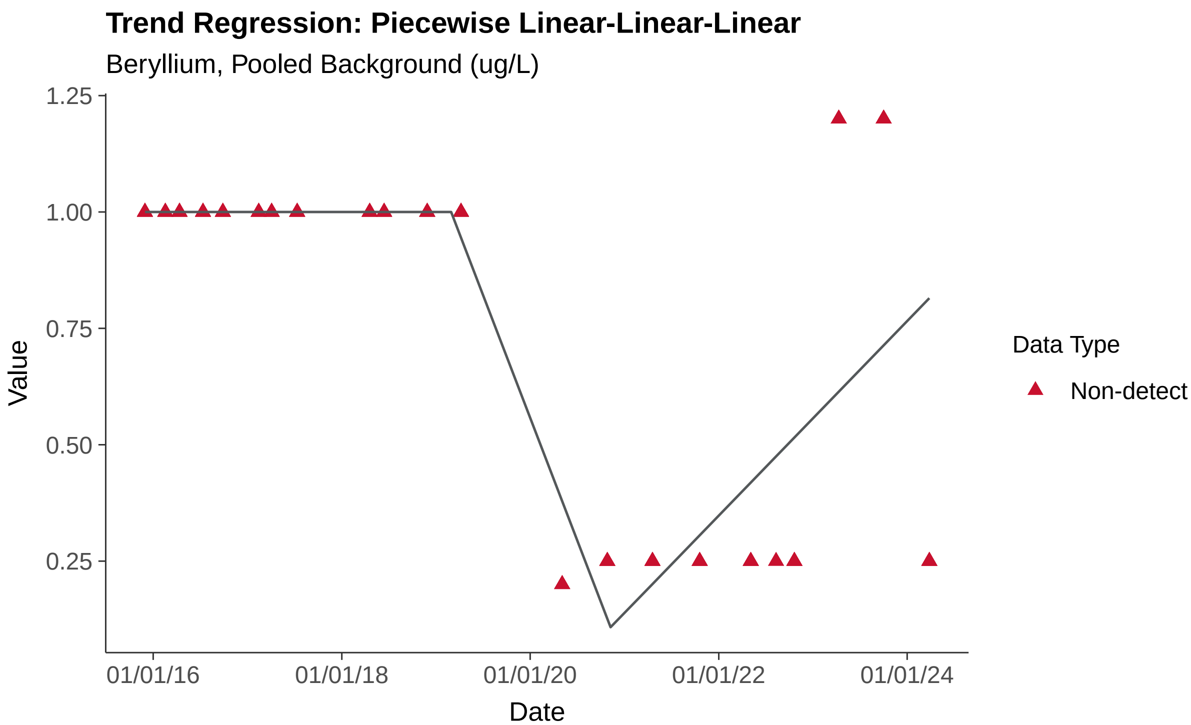


Boxplot by Well

Beryllium, Pooled Background (ug/L)

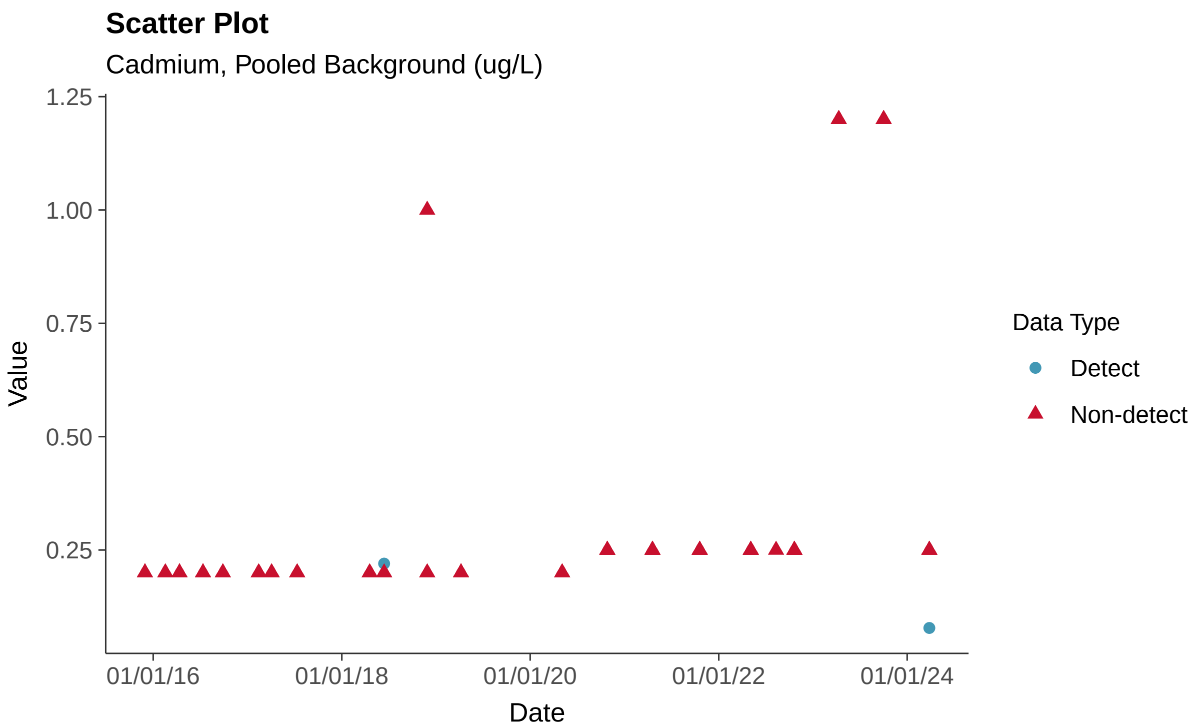


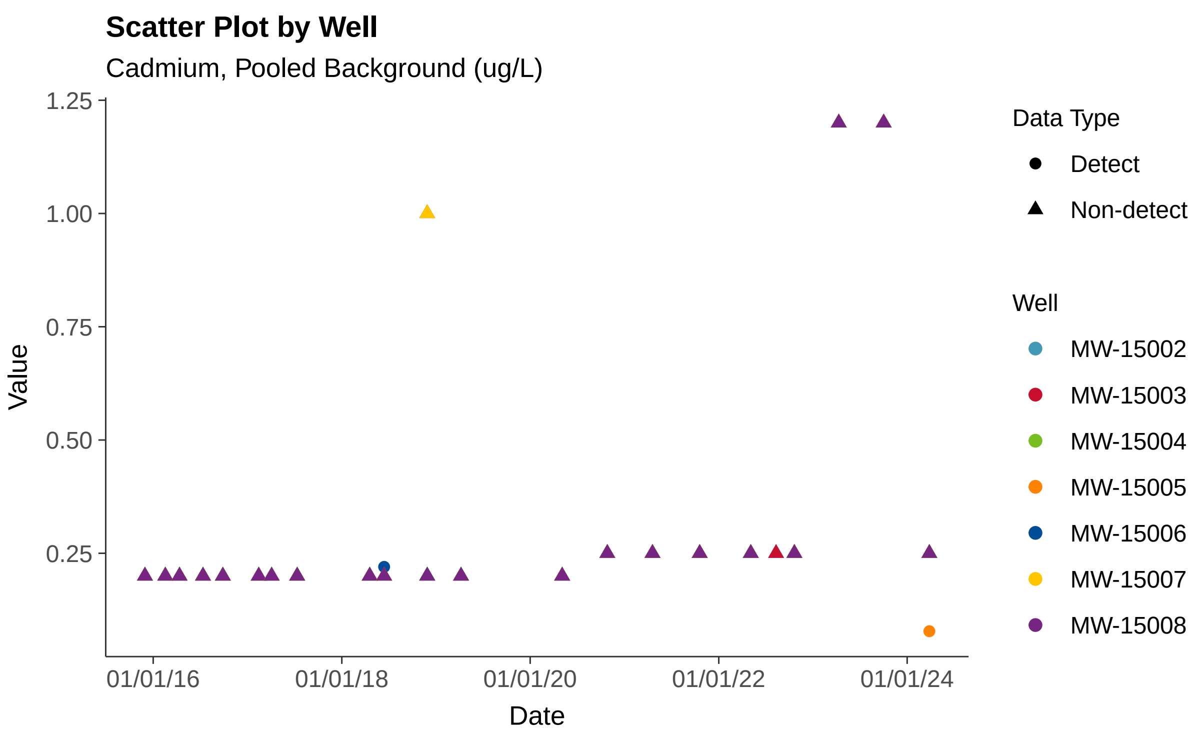

Trend Regression: Piecewise Linear-Linear
Beryllium, Pooled Background (ug/L)
Value
1.25
1.00
0.75
0.50
0.25
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Non-detect

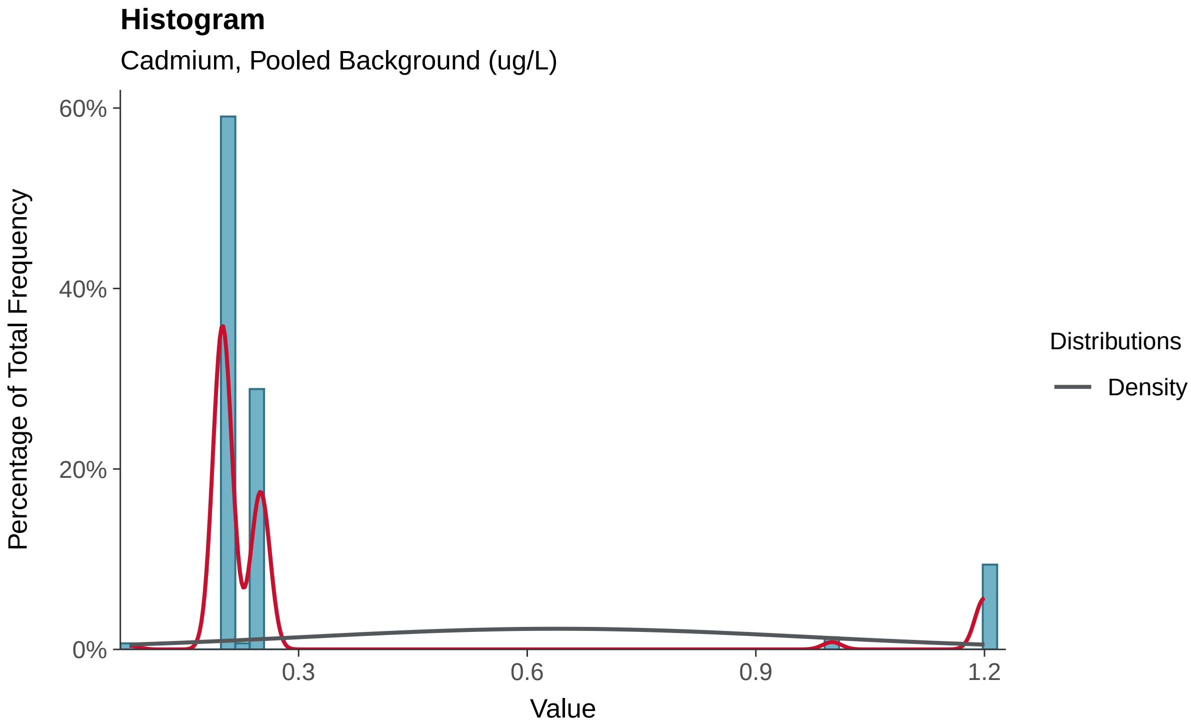

Trend Regression: Piecewise Linear-Linear-Linear
Beryllium, Pooled Background (ug/L)
Value
1.25
1.00
0.75
0.50
0.25
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Non-detect

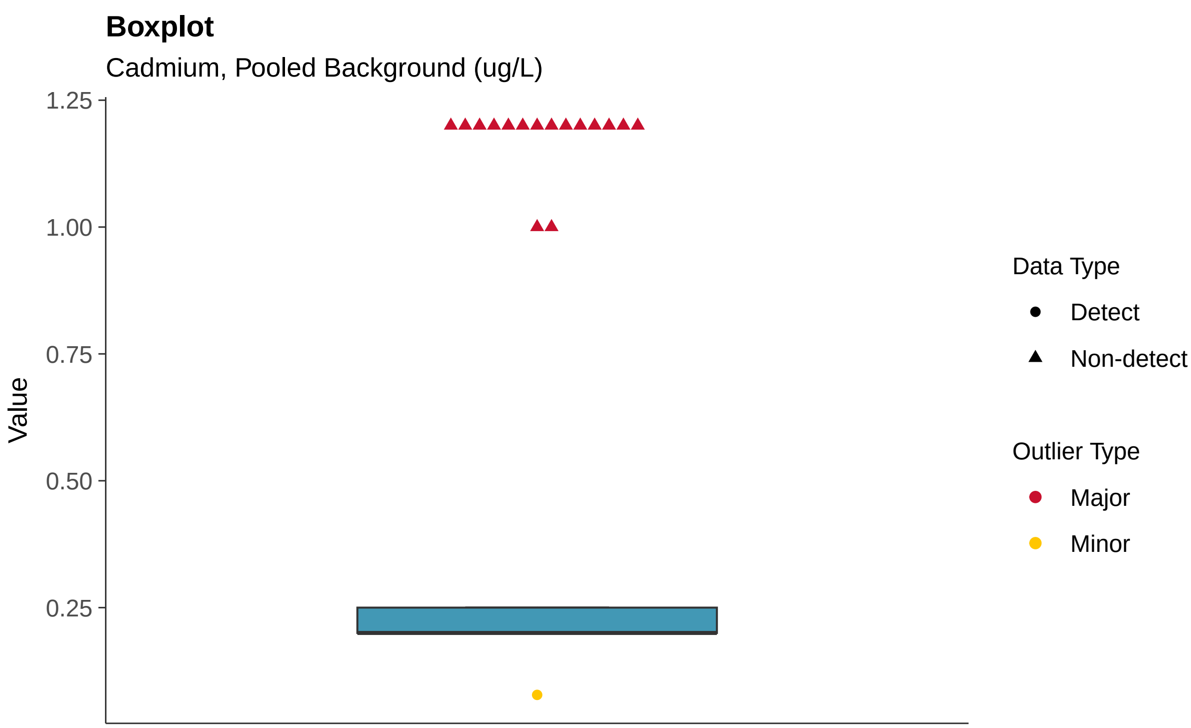
Appendix IV: Cadmium, Pooled Background

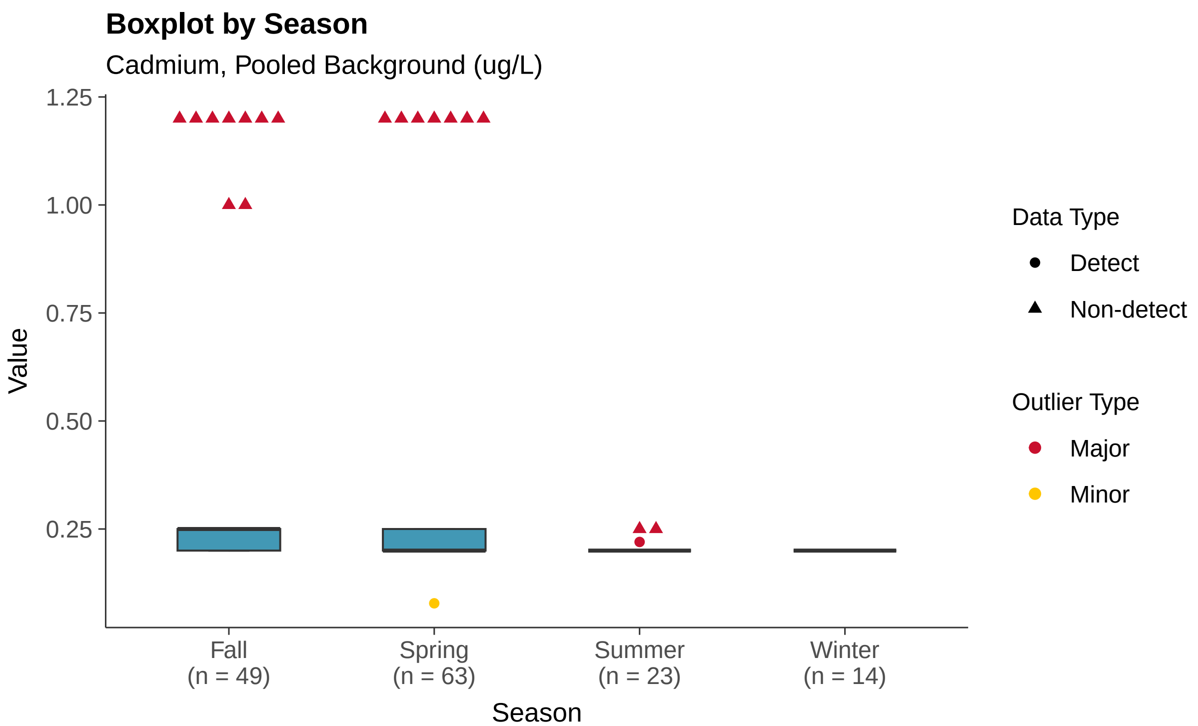
ID: 2_106

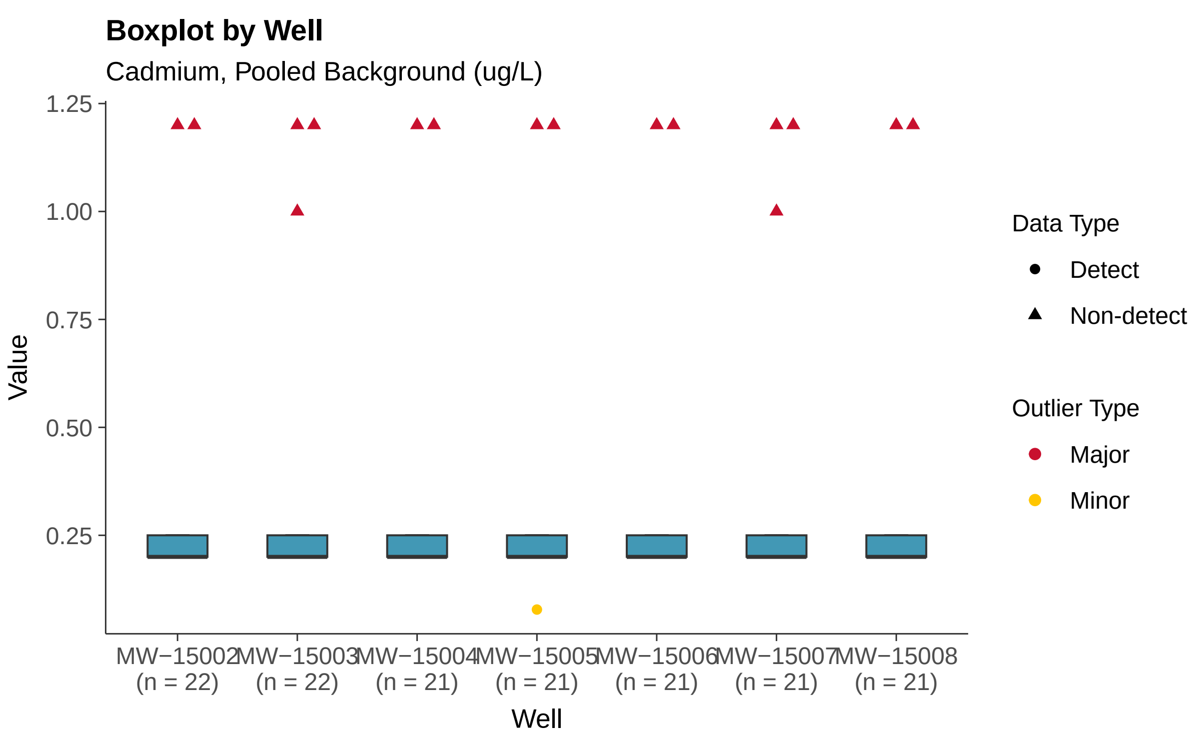


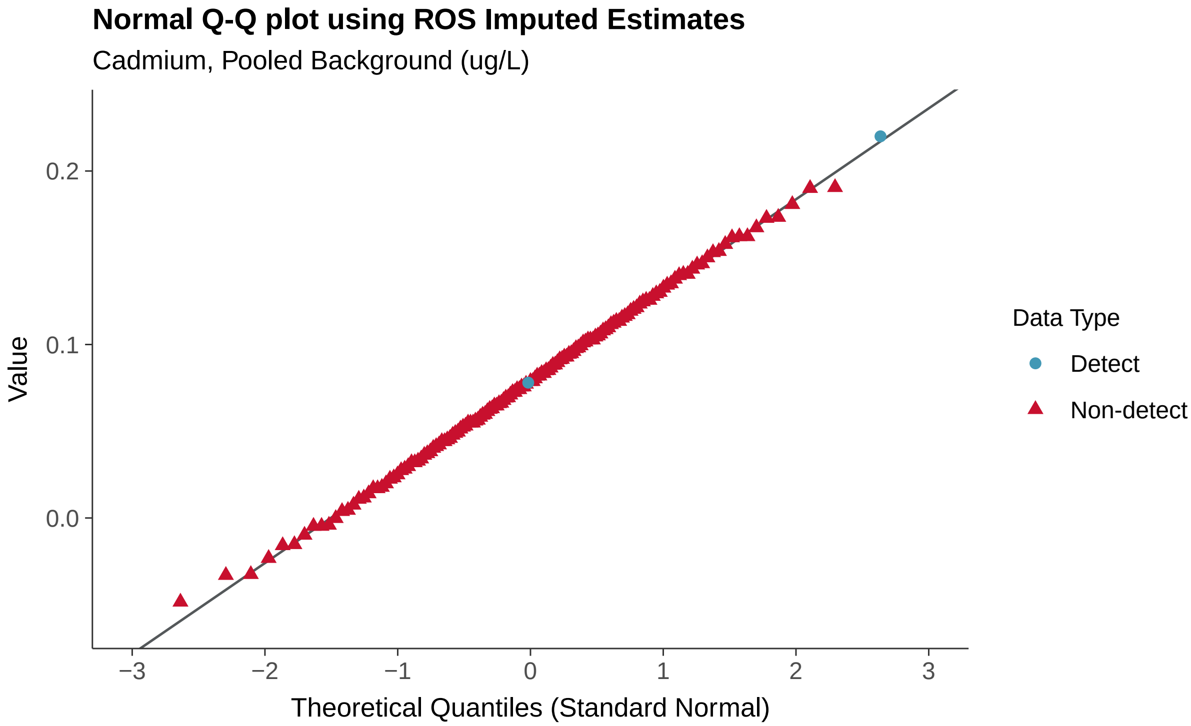


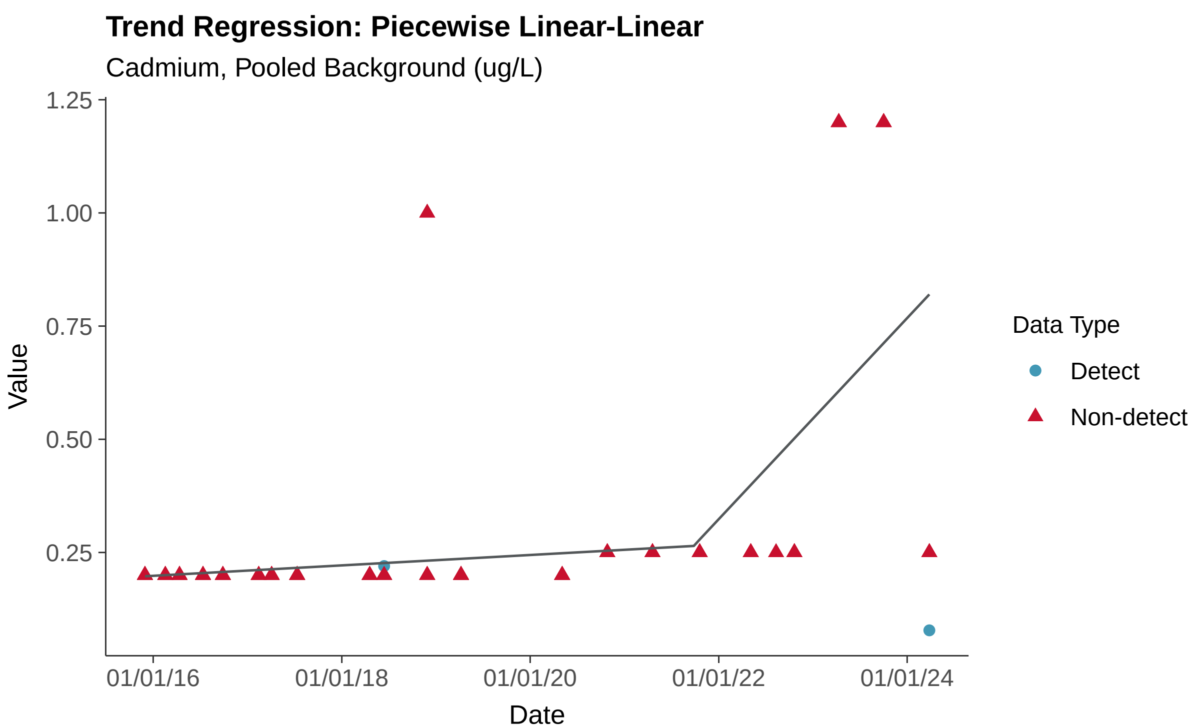

Histogram
Cadmium, Pooled Background (ug/L)
Percentage of Total Frequency
60%
40%
20%
0%
0.3
0.6
0.9
1.2
Value
Distributions
Density


Boxplot
Cadmium, Pooled Background (ug/L)
Value
1.25
1.00
0.75
0.50
0.25
Data Type
Detect
Non-detect
Outlier Type
Major
Minor


Boxplot by Season
Cadmium, Pooled Background (ug/L)
1.25
1.00
0.75
0.50
0.25
Value
Fall
(n = 49)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Non-detect
Outlier Type
Major
Minor

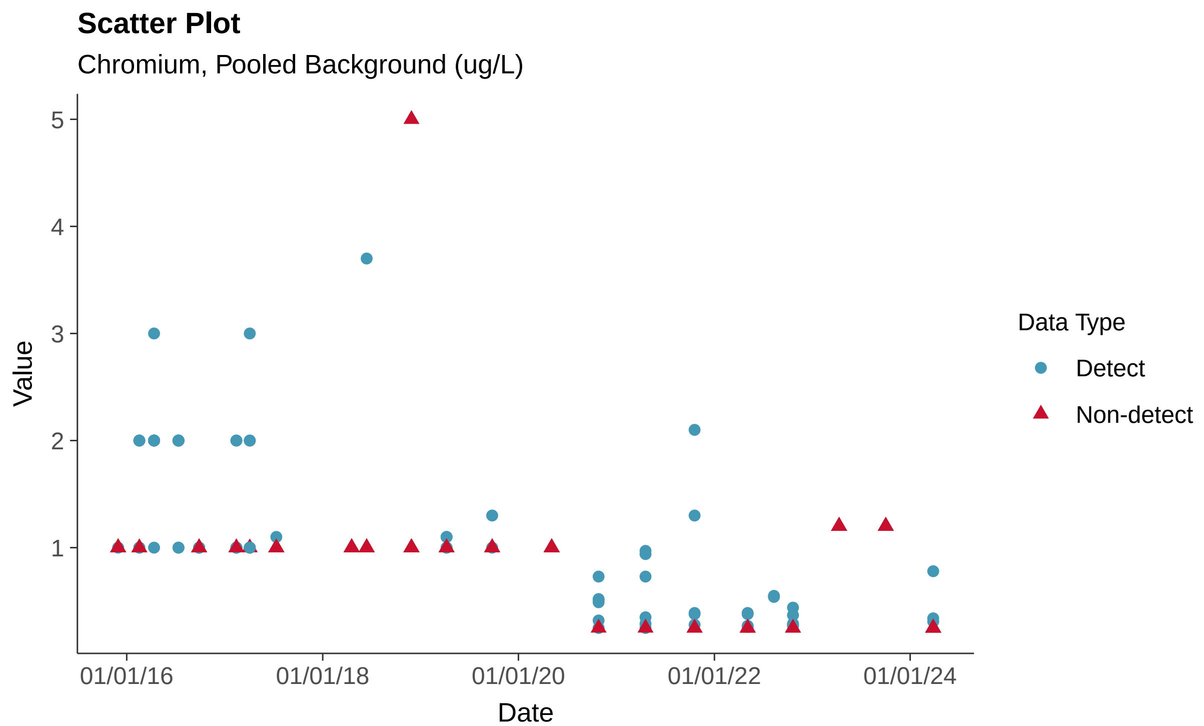

Boxplot by Well
Cadmium, Pooled Background (ug/L)
1.25
1.00
0.75
0.50
0.25
Value
MW−15002
(n = 22)
MW−15003
(n = 22)
MW−15004
(n = 21)
MW−15005
(n = 21)
MW−15006
(n = 21)
MW−15007
(n = 21)
MW−15008
(n = 21)
Well
Data Type
Detect
Non-detect
Outlier Type
Major
Minor

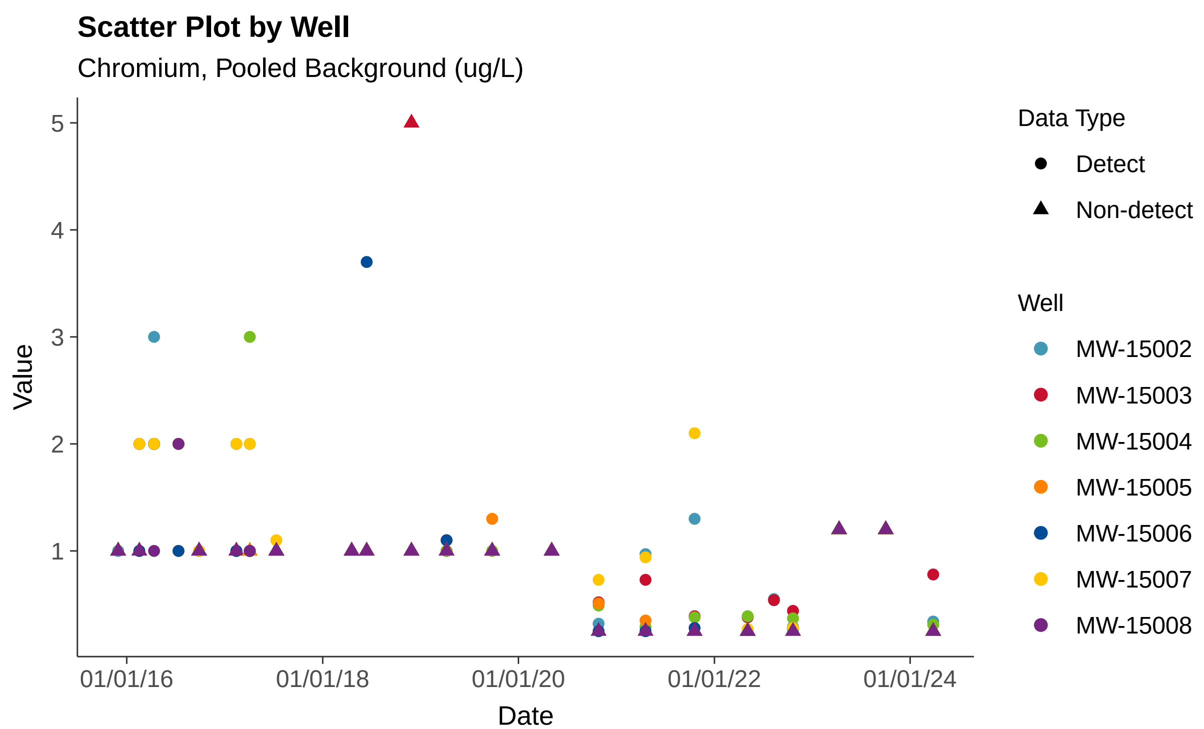

Normal Q-Q plot using ROS Imputed Estimates
Cadmium, Pooled Background (ug/L)
Value
0.2
0.1
0.0
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Cadmium, Pooled Background (ug/L)
Value
1.25
1.00
0.75
0.50
0.25
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

Appendix IV: Chromium, Pooled Background

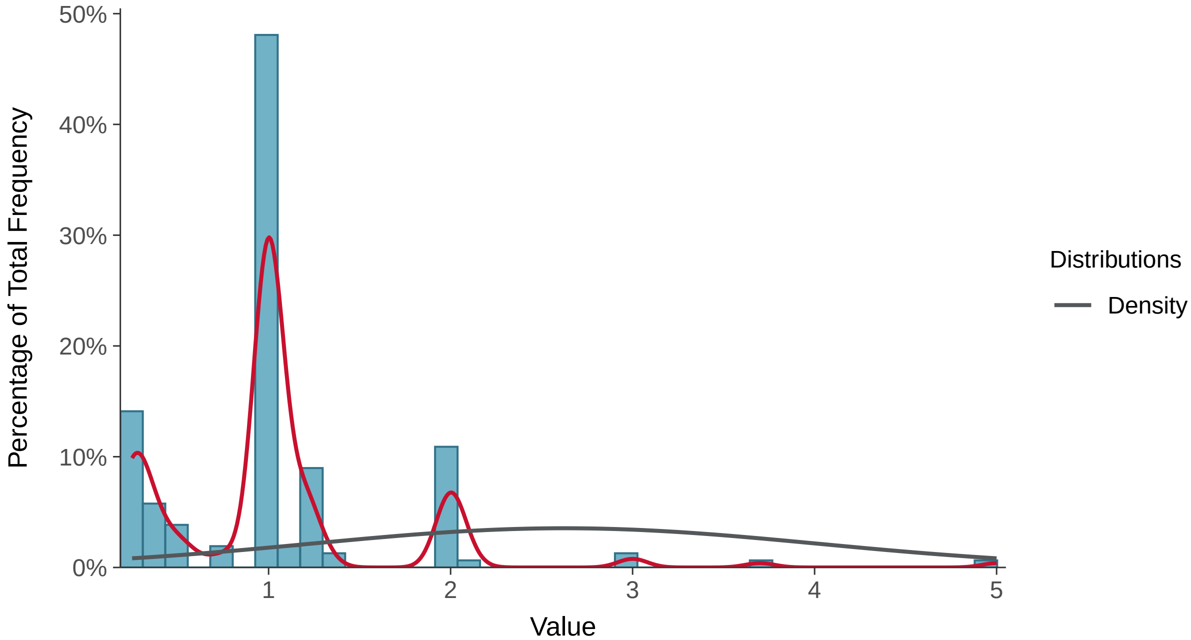
ID: 2_109





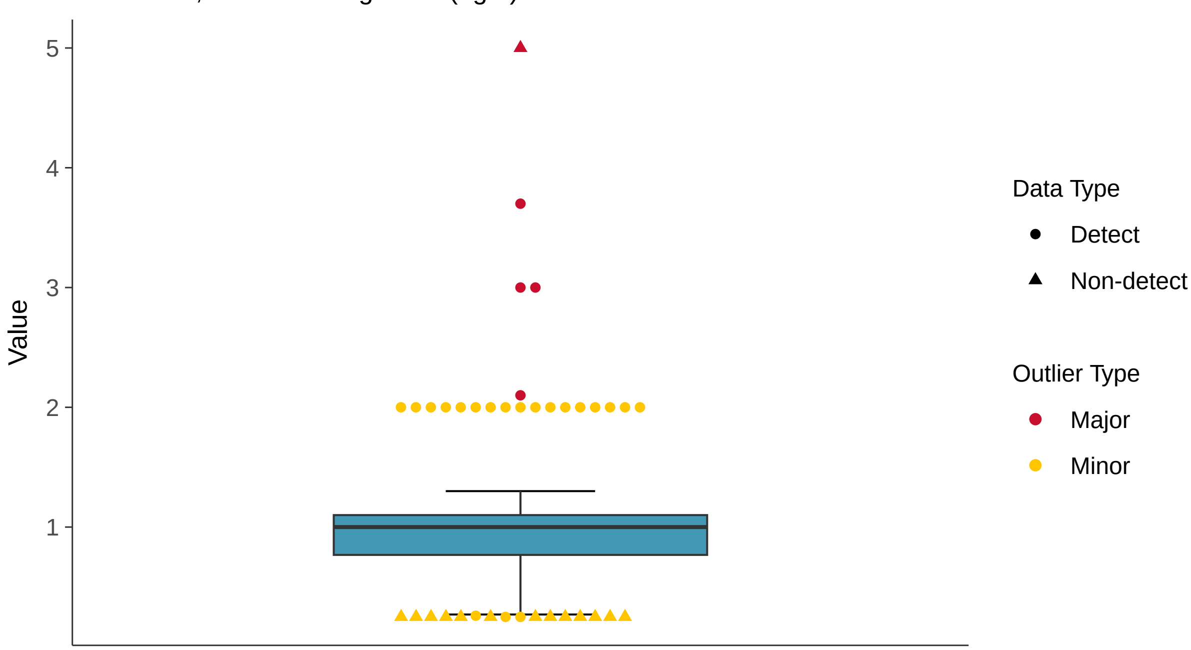
Histogram

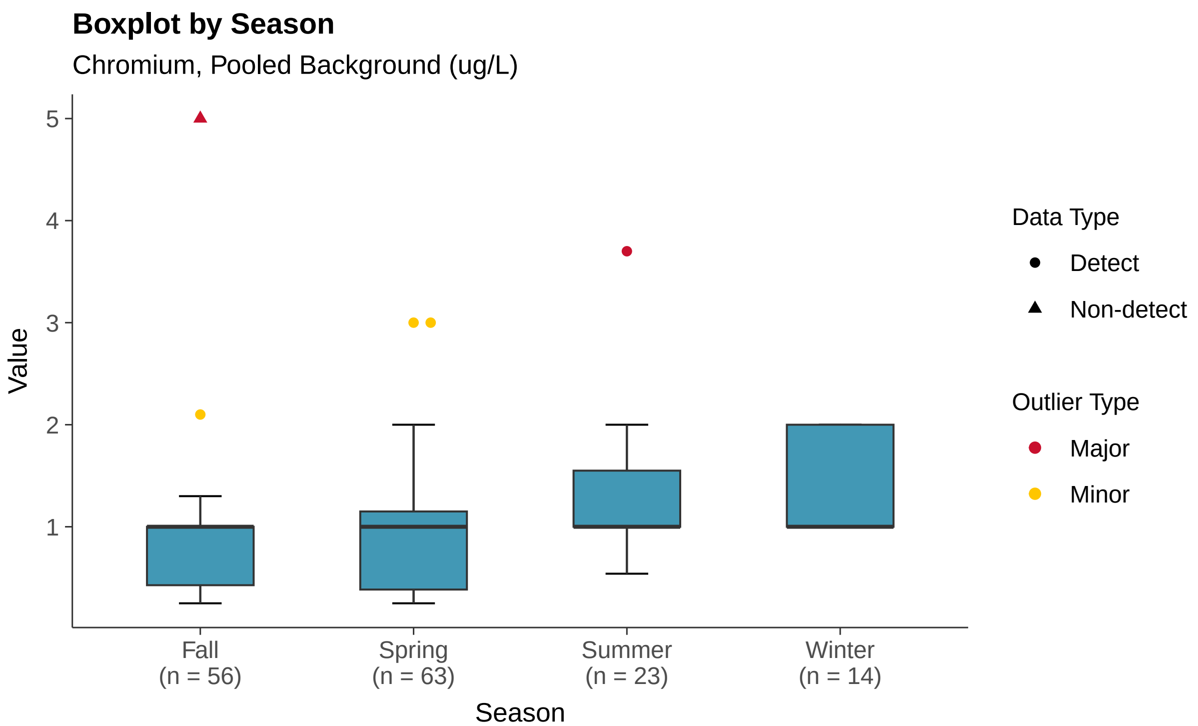
Chromium, Pooled Background (ug/L)

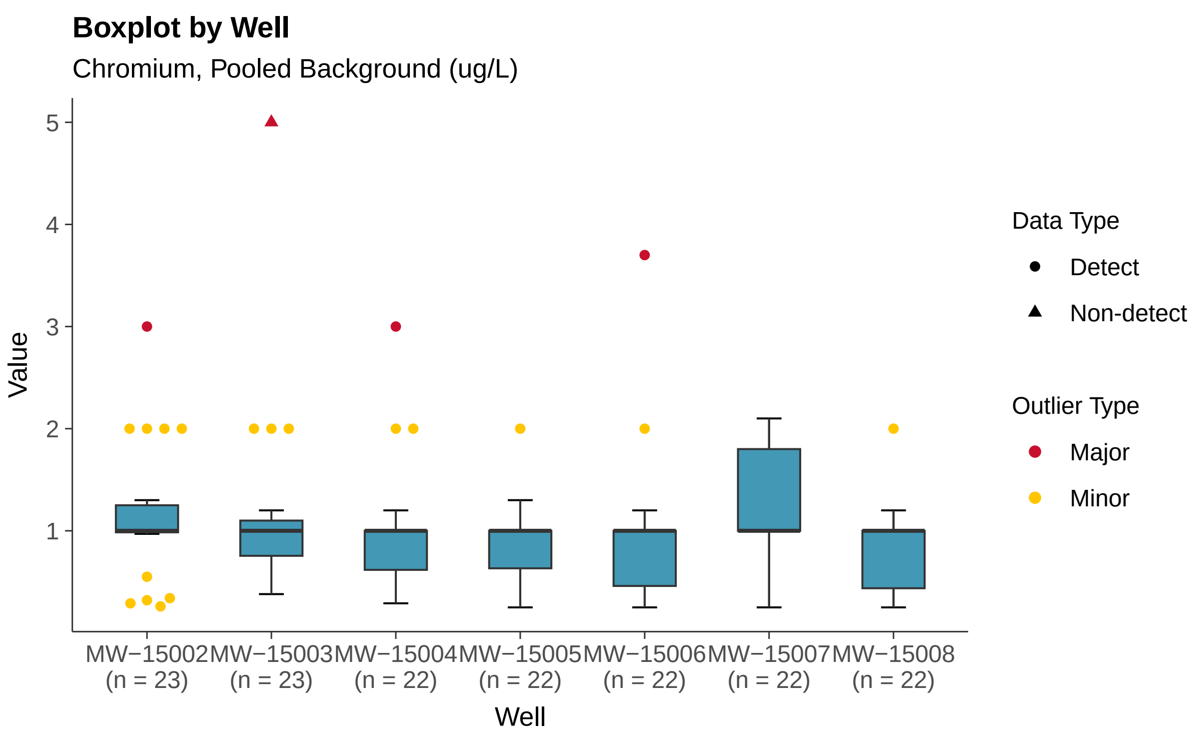


Boxplot

Chromium, Pooled Background (ug/L)

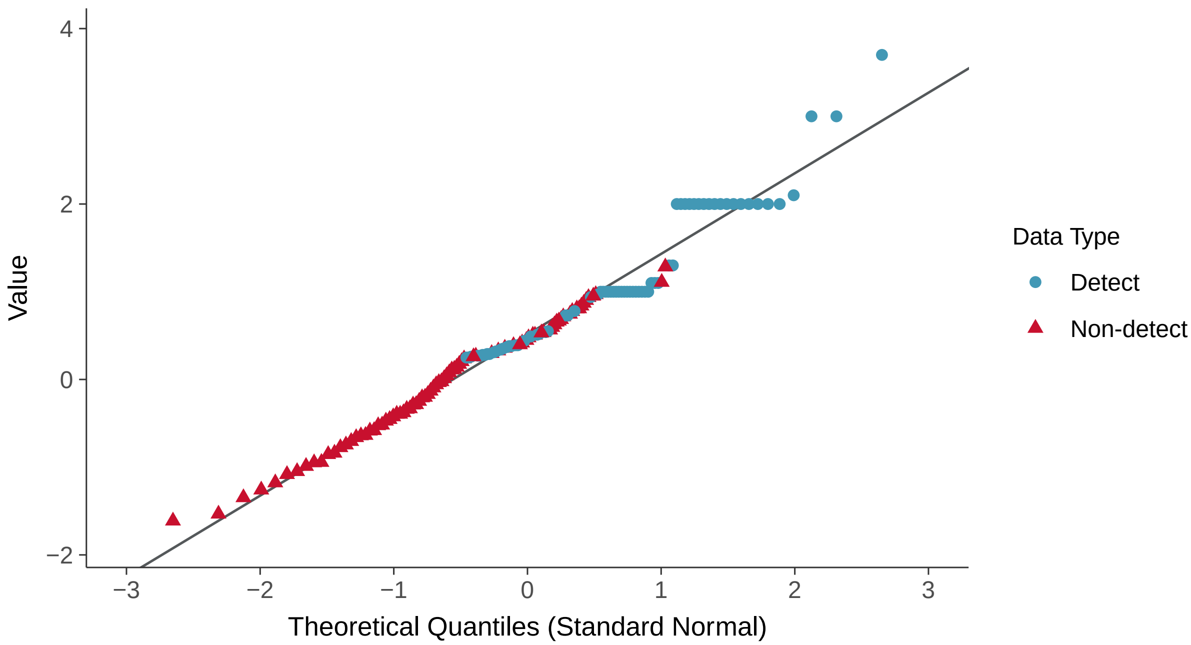



Boxplot by Season
Chromium, Pooled Background (ug/L)
Value
5
4
3
2
1
Fall
(n = 56)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Non-detect
Outlier Type
Major
Minor


Boxplot by Well
Chromium, Pooled Background (ug/L)
Value
5
4
3
2
1
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 22)
MW−15007
(n = 22)
MW−15008
(n = 22)
Well
Data Type
Detect
Non-detect
Outlier Type
Major
Minor

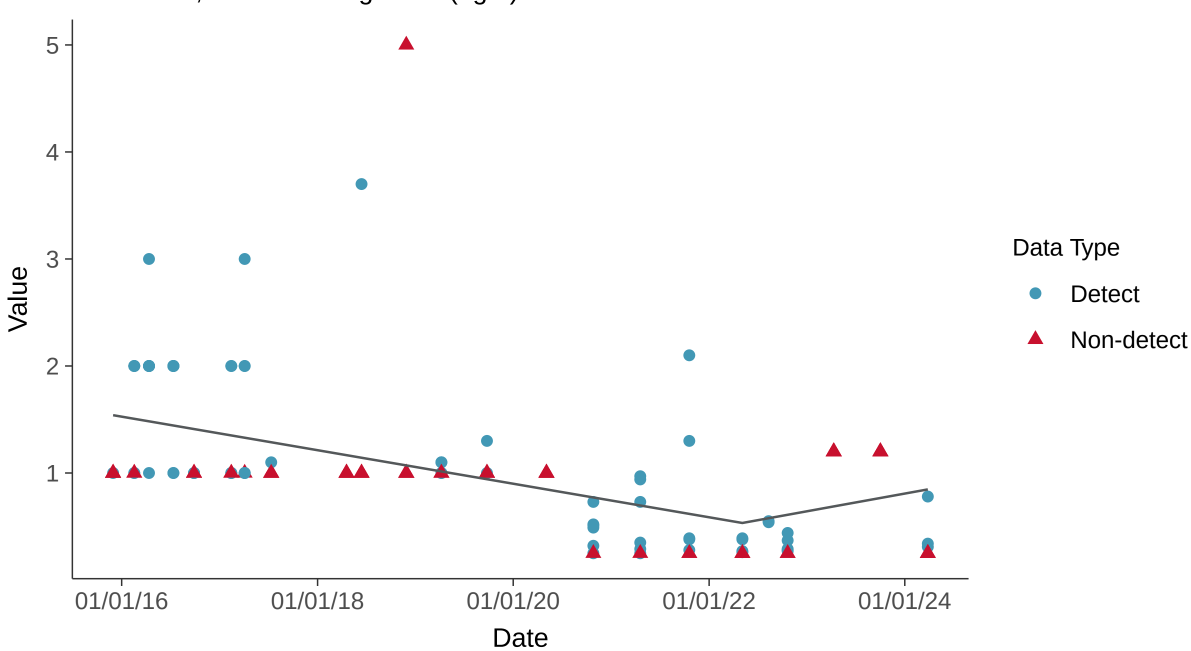
Normal Q-Q plot using ROS Imputed Estimates

Chromium, Pooled Background (ug/L)



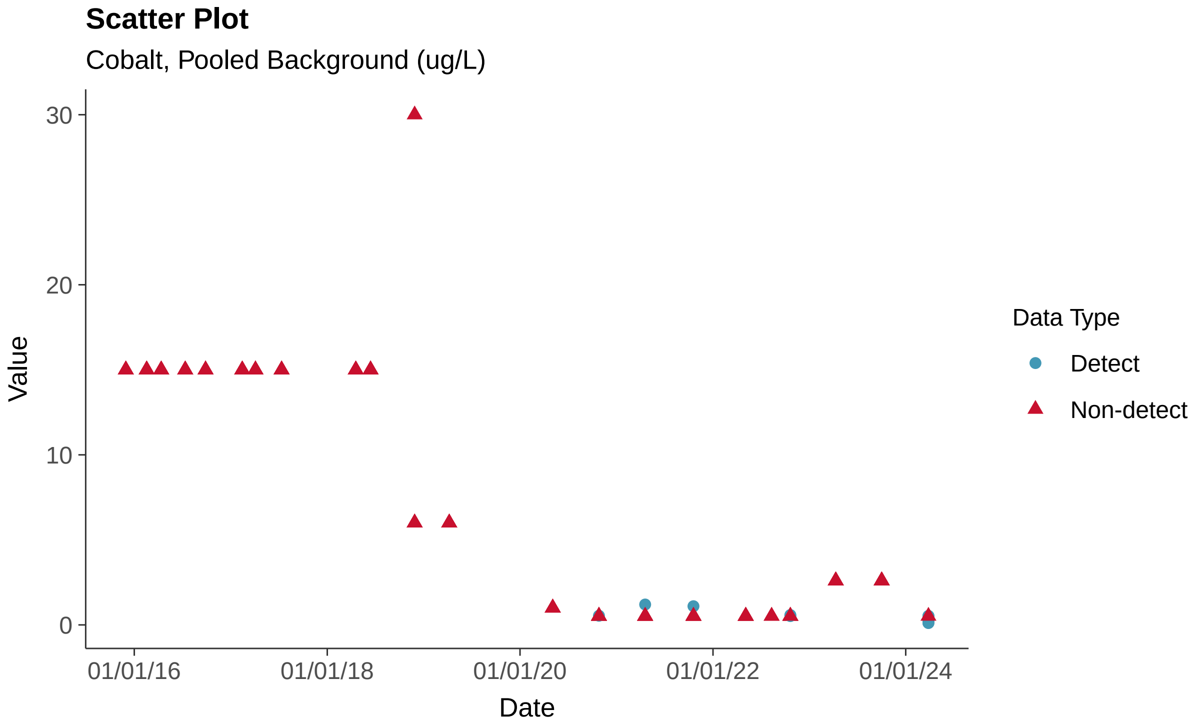
Trend Regression: Piecewise Linear-Linear

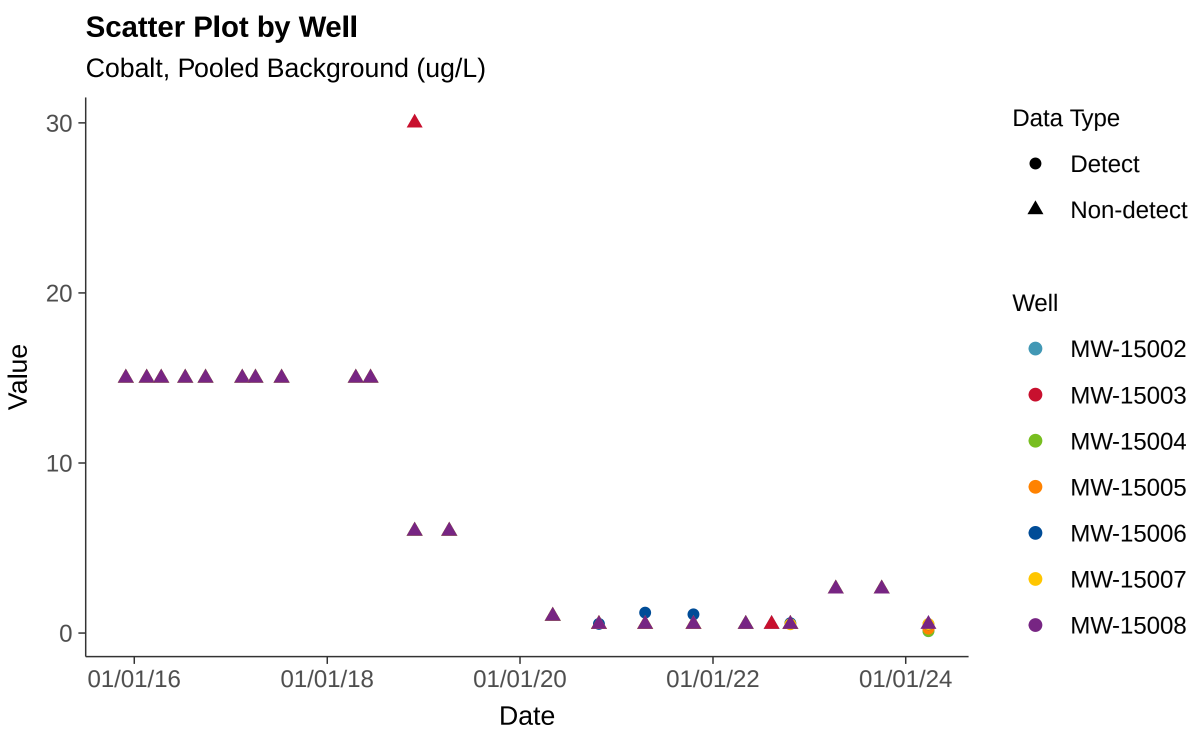
Chromium, Pooled Background (ug/L)



Appendix IV: Cobalt, Pooled Background

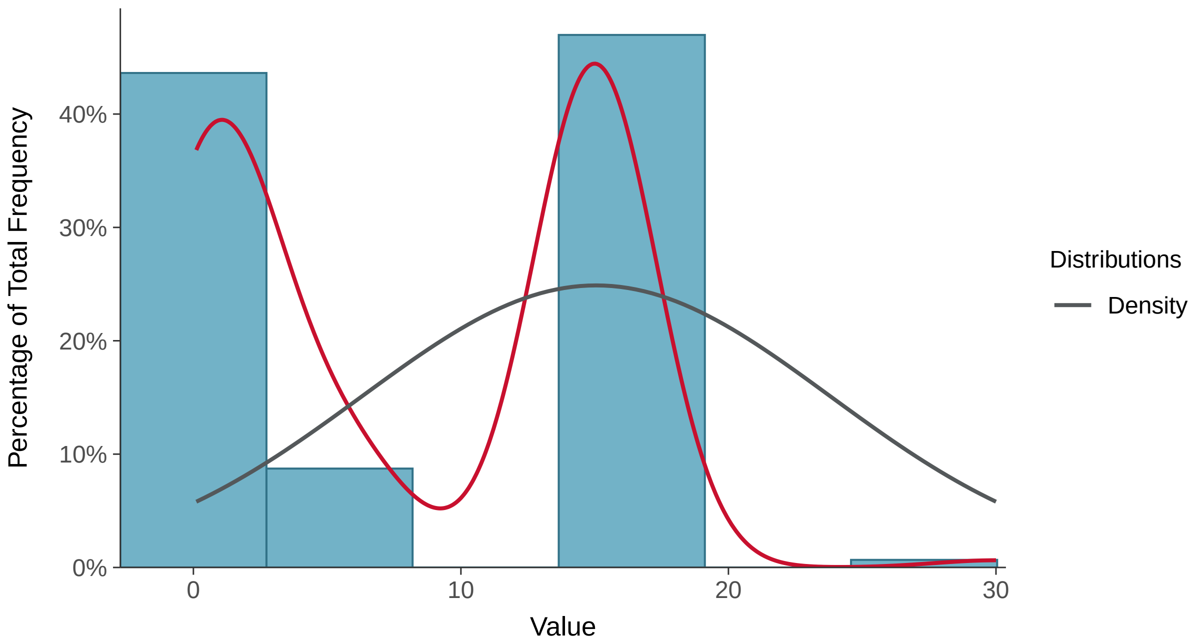
ID: 2_110





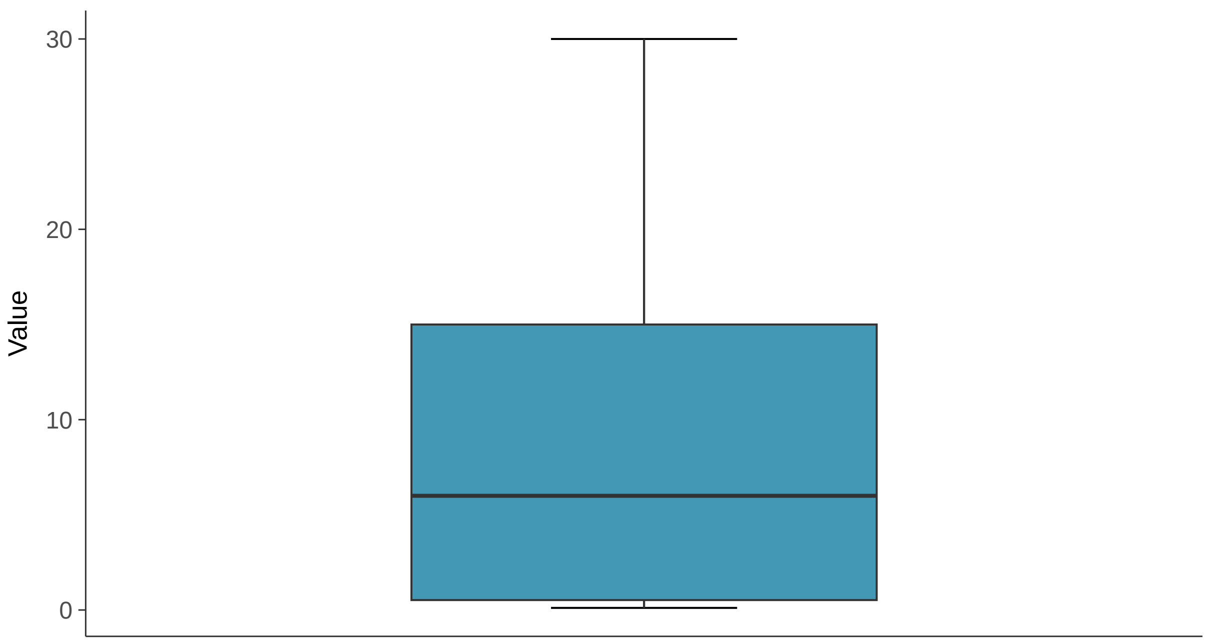
Histogram

Cobalt, Pooled Background (ug/L)



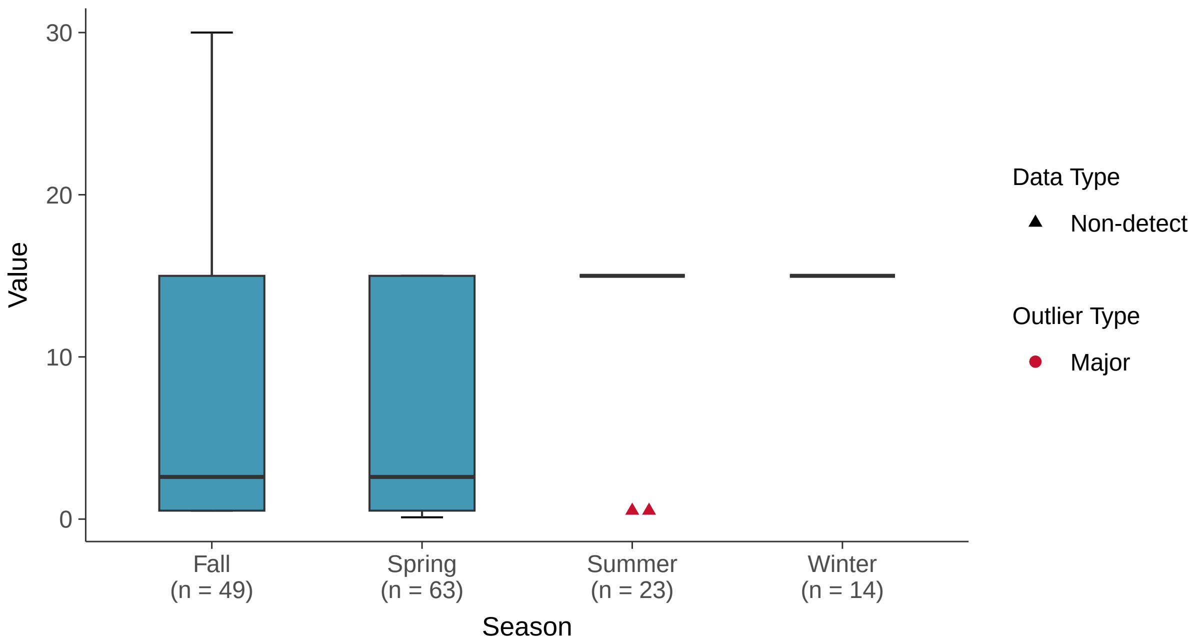
Boxplot

Cobalt, Pooled Background (ug/L)



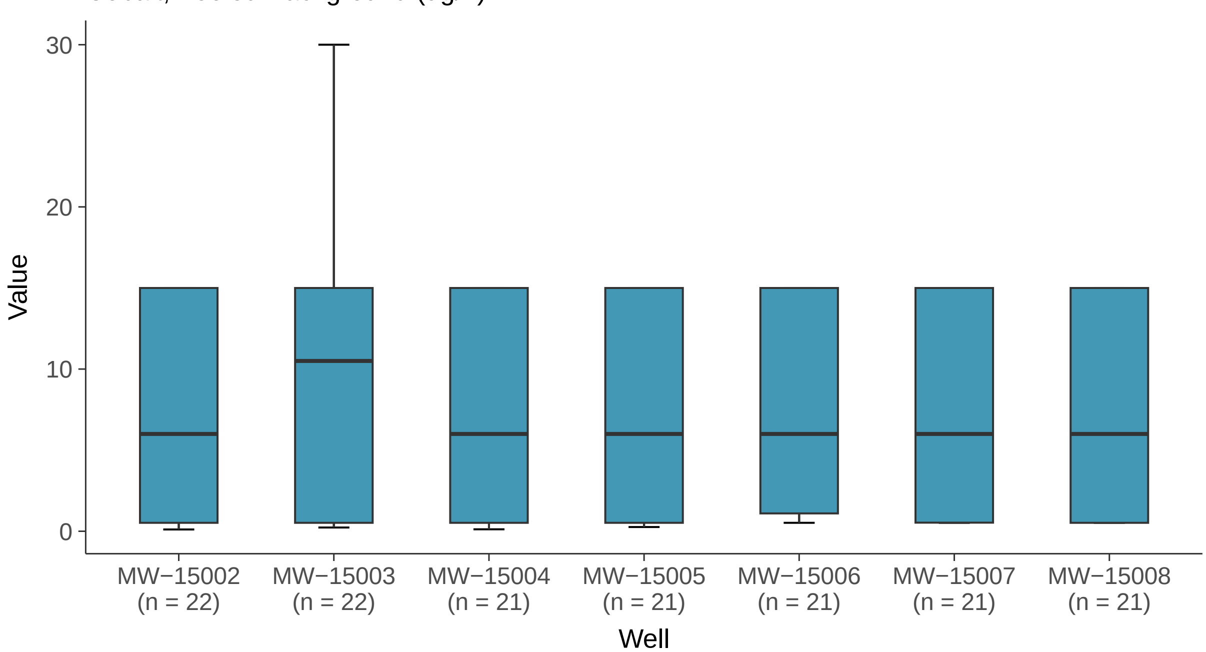
Boxplot by Season

Cobalt, Pooled Background (ug/L)



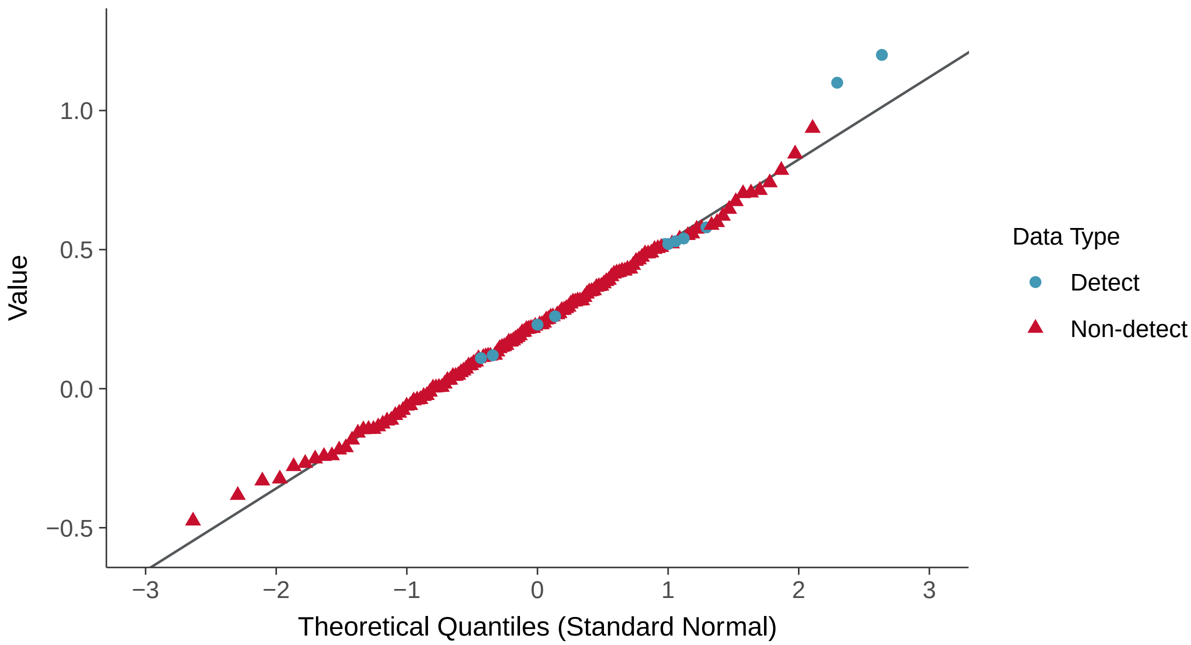
Boxplot by Well

Cobalt, Pooled Background (ug/L)



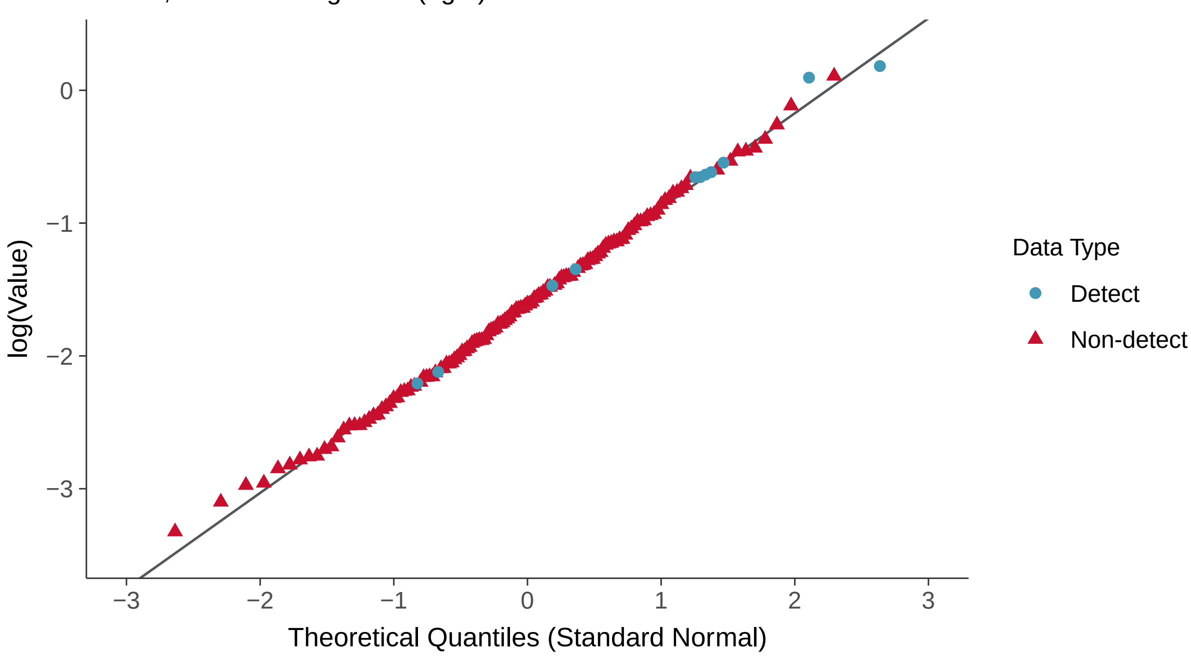
Normal Q-Q plot using ROS Imputed Estimates

Cobalt, Pooled Background (ug/L)



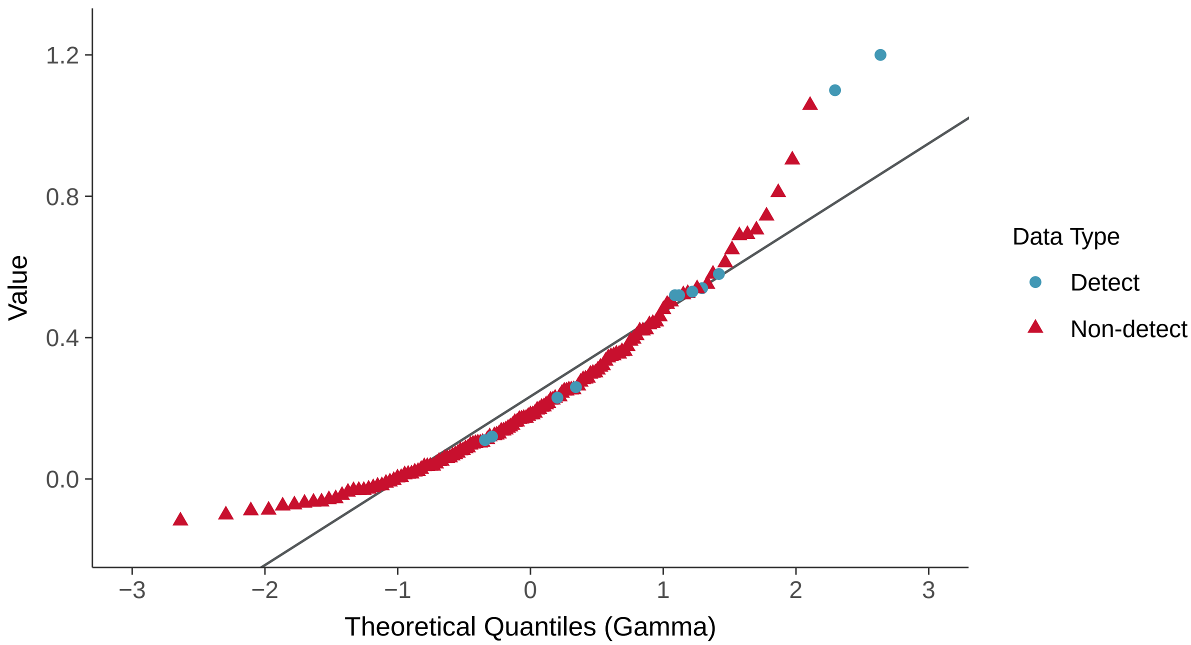
Lognormal Q-Q plot using ROS Imputed Estimates

Cobalt, Pooled Background (ug/L)



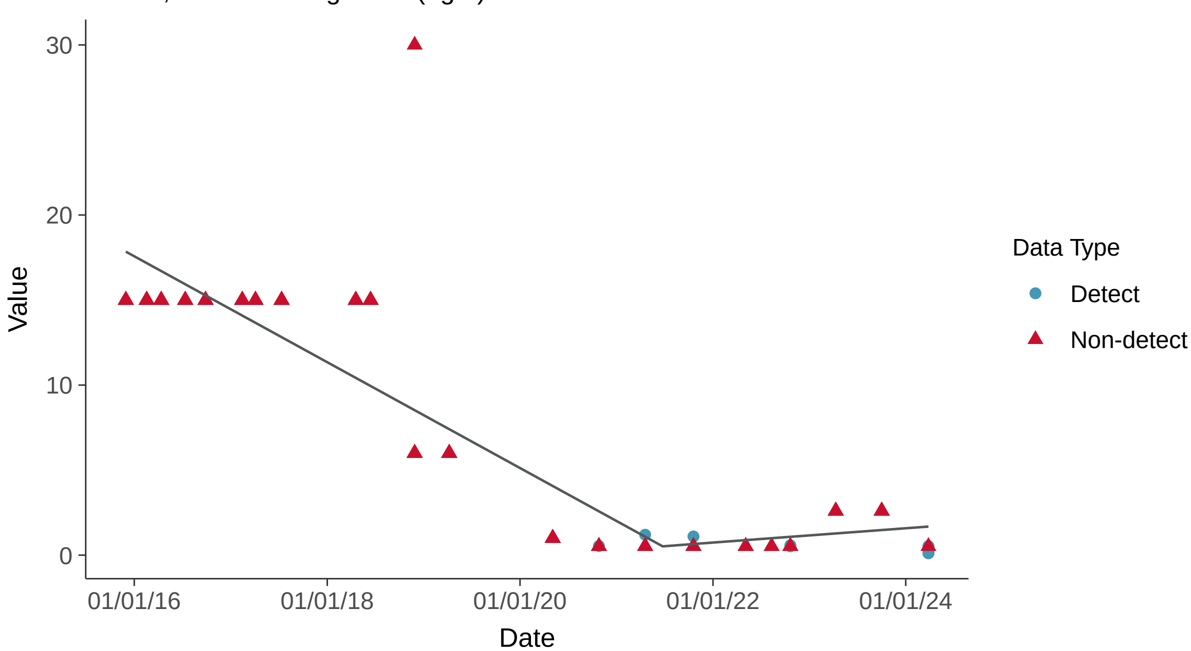
Gamma Q-Q plot using ROS Imputed Estimates

Cobalt, Pooled Background (ug/L)



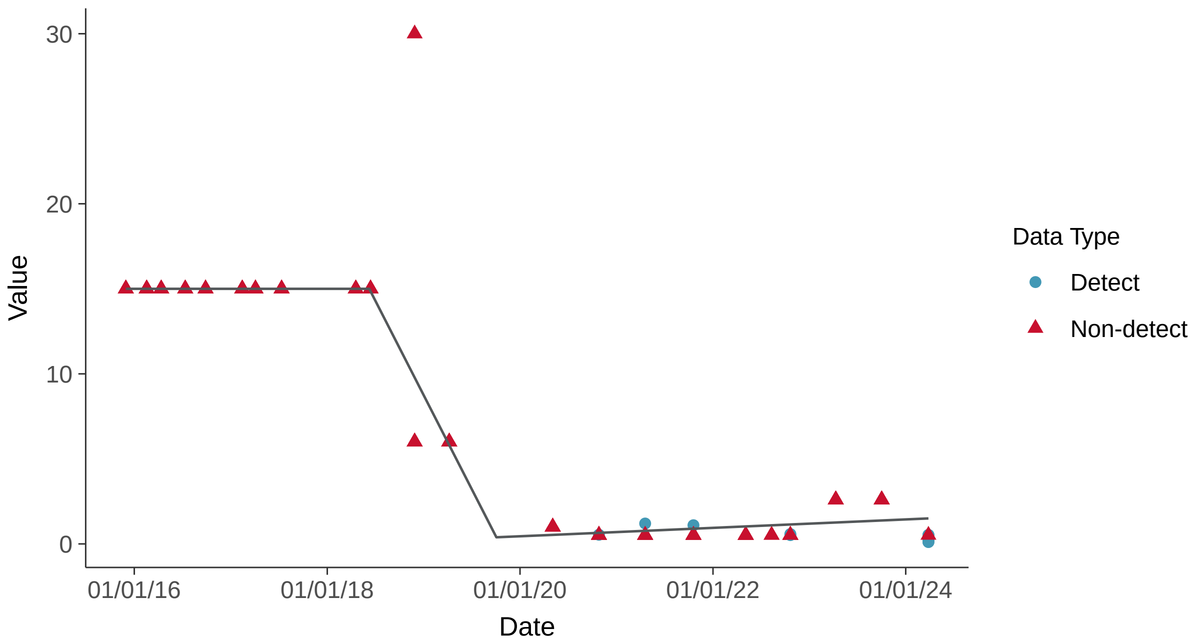
Trend Regression: Piecewise Linear-Linear

Cobalt, Pooled Background (ug/L)



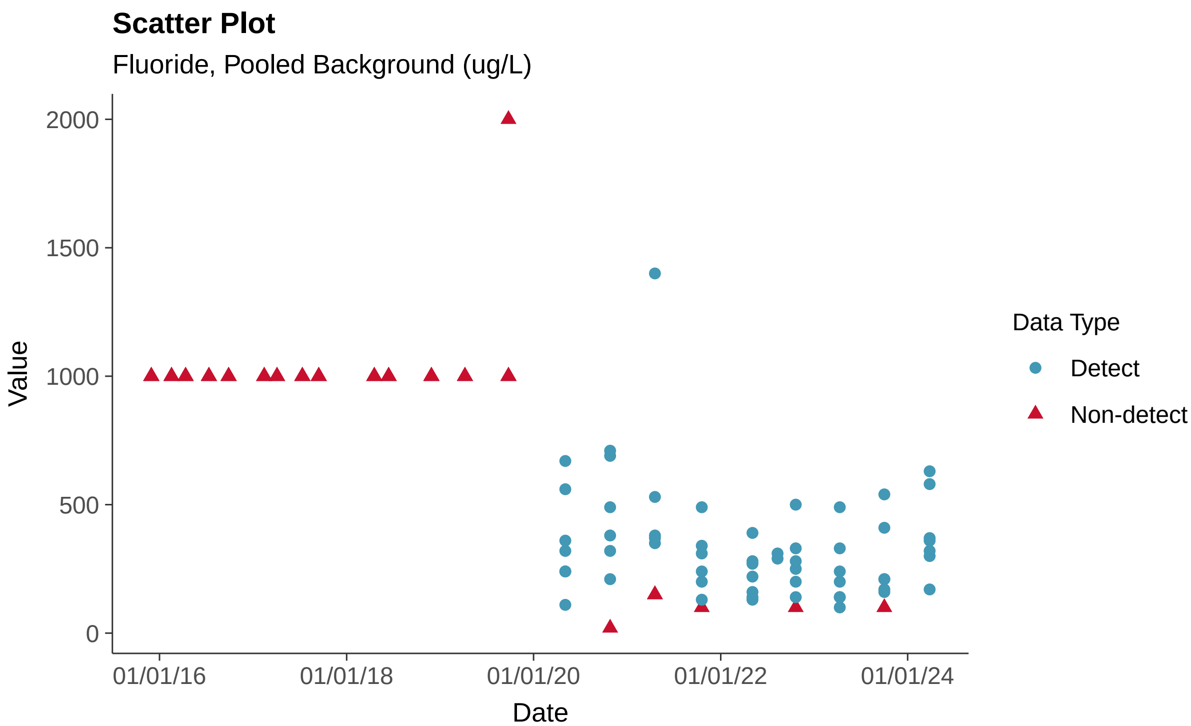
Trend Regression: Piecewise Linear-Linear-Linear

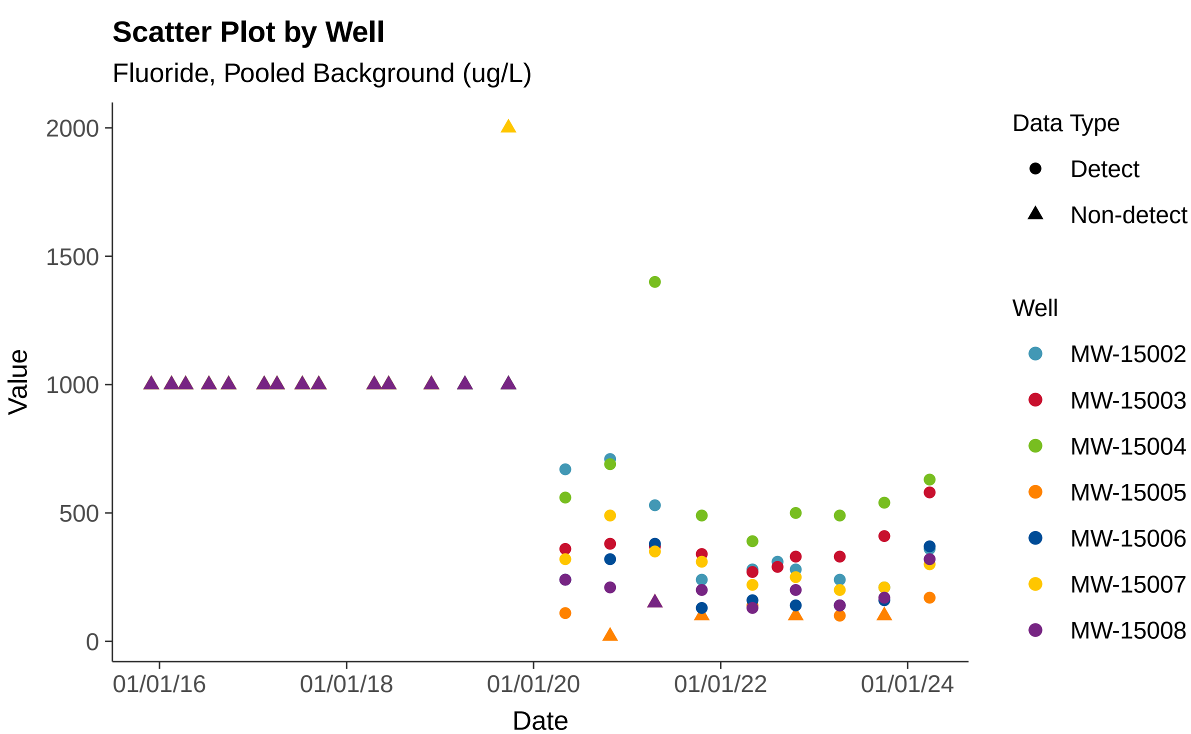
Cobalt, Pooled Background (ug/L)



Appendix IV: Fluoride, Pooled Background

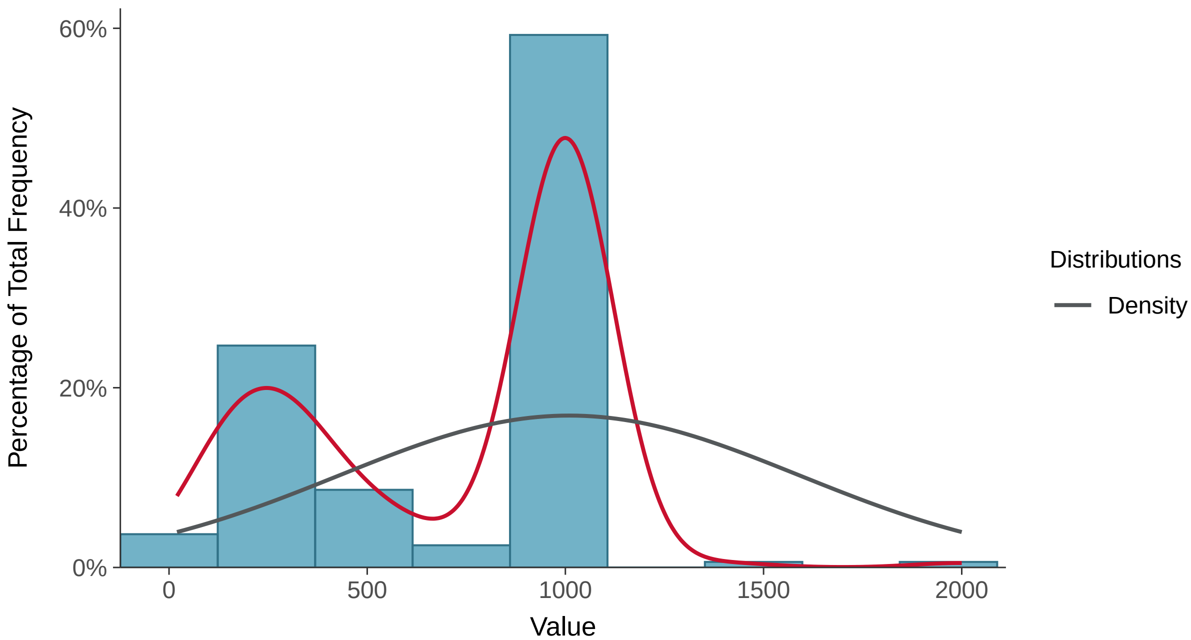
ID: 2_114





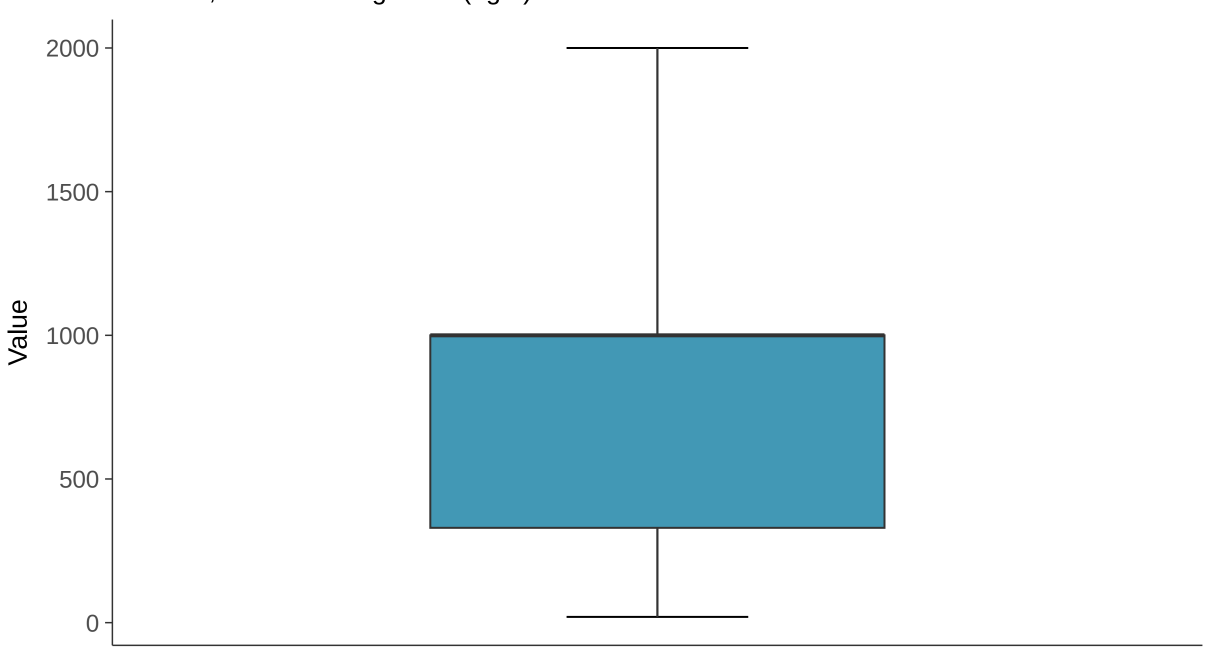
Histogram

Fluoride, Pooled Background (ug/L)



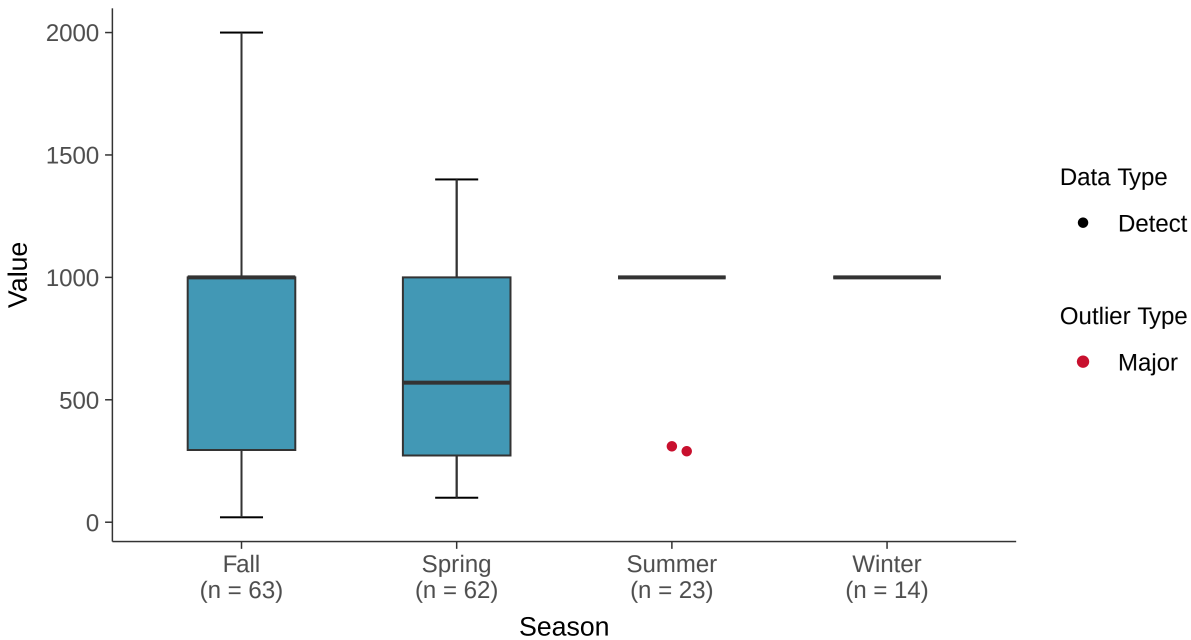
Boxplot

Fluoride, Pooled Background (ug/L)



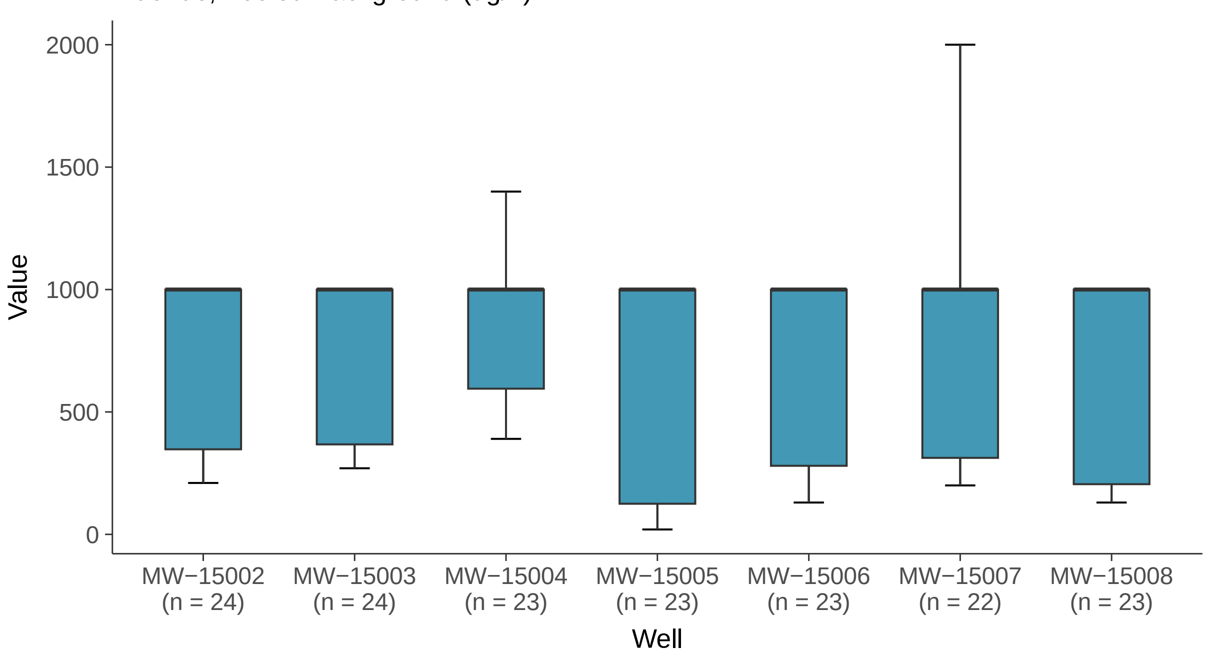
Boxplot by Season

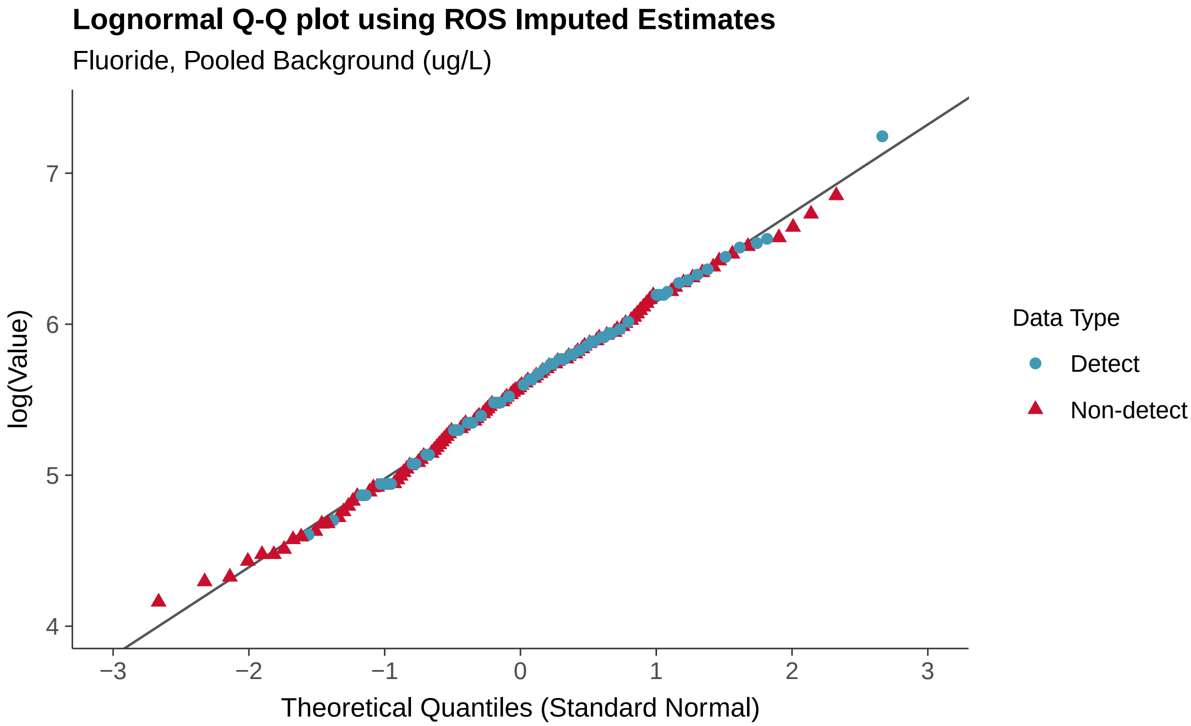
Fluoride, Pooled Background (ug/L)

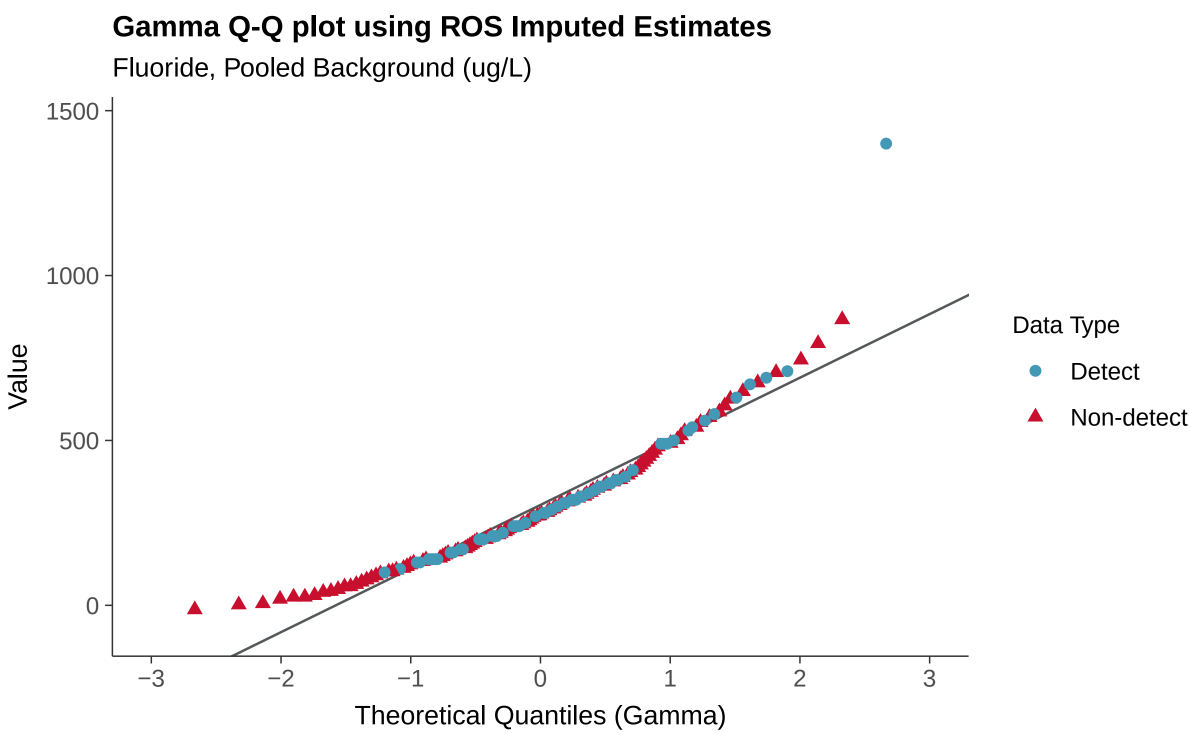


Boxplot by Well

Fluoride, Pooled Background (ug/L)

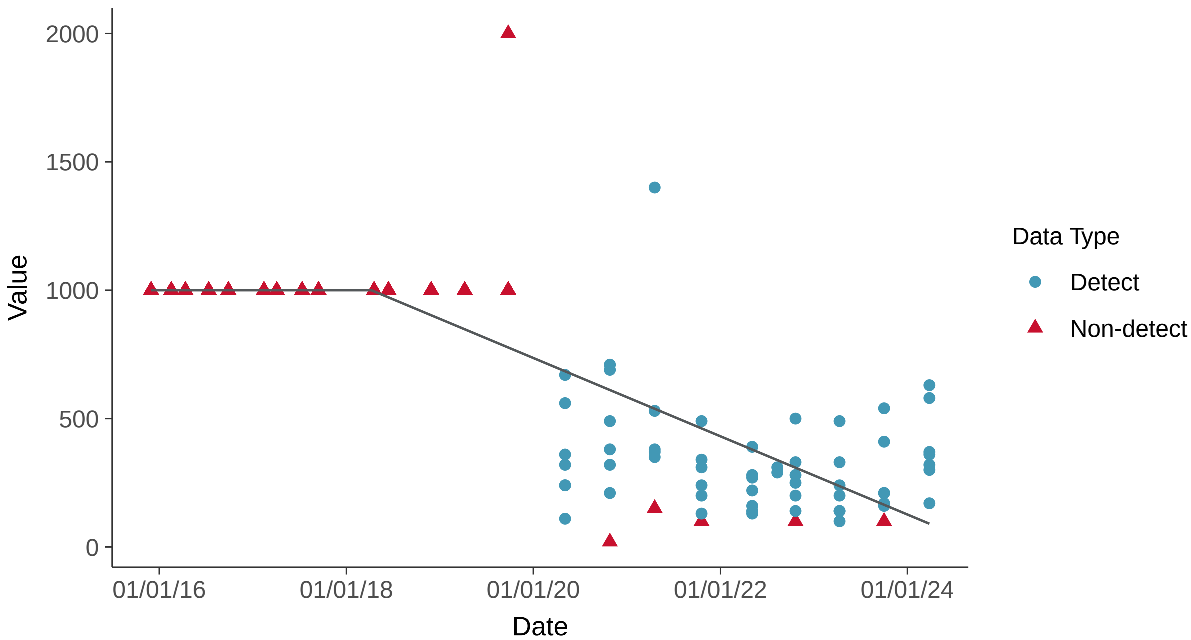



Lognormal Q-Q plot using ROS Imputed Estimates
Fluoride, Pooled Background (ug/L)
log(Value)
7
6
5
4
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Gamma Q-Q plot using ROS Imputed Estimates
Fluoride, Pooled Background (ug/L)
Value
1500
1000
500
0
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Gamma)
Data Type
Detect
Non-detect

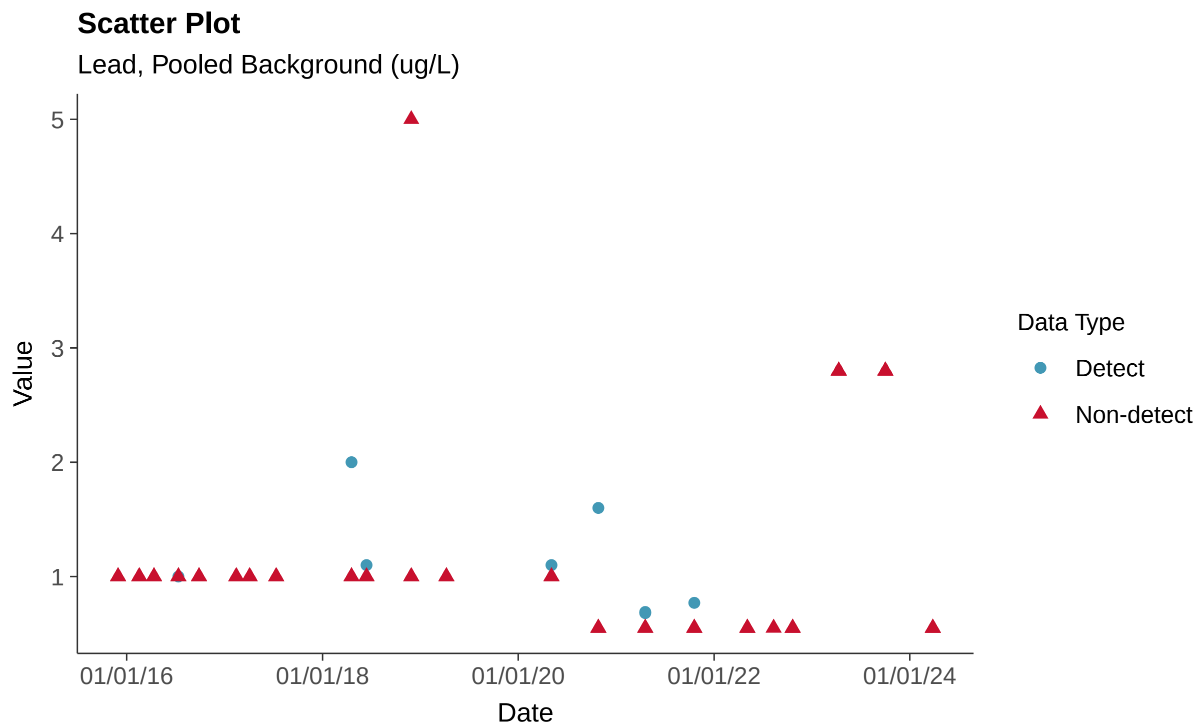
Trend Regression: Piecewise Linear-Linear

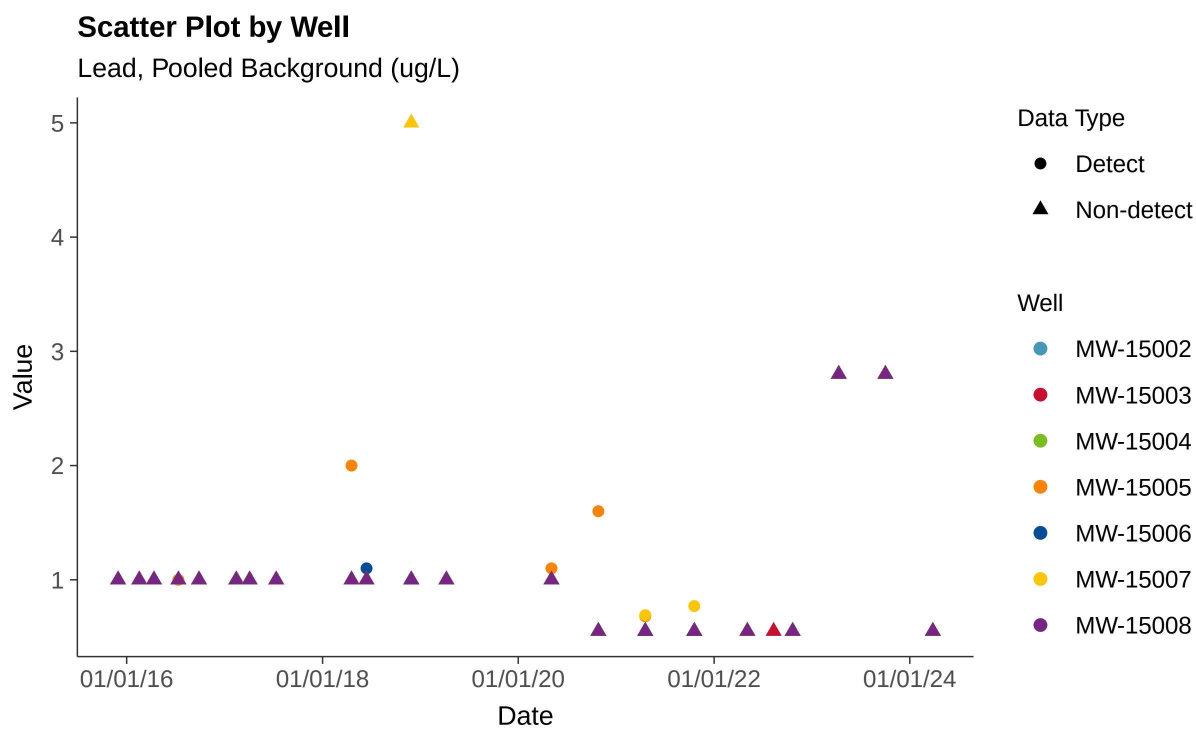
Fluoride, Pooled Background (ug/L)



Appendix IV: Lead, Pooled Background

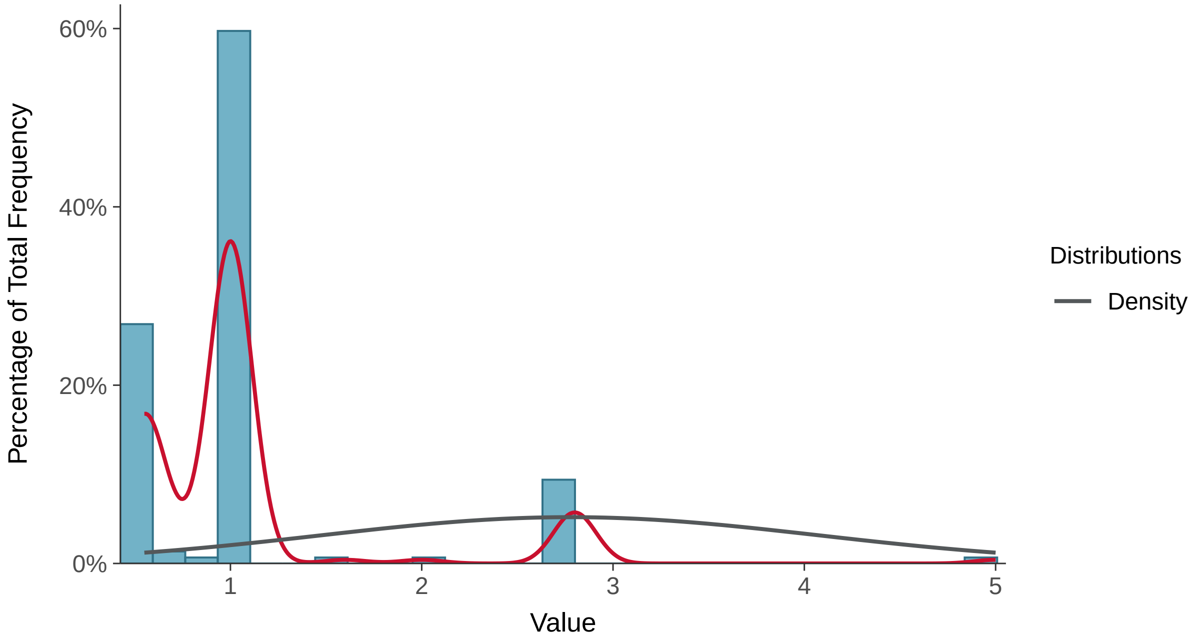
ID: 2_116





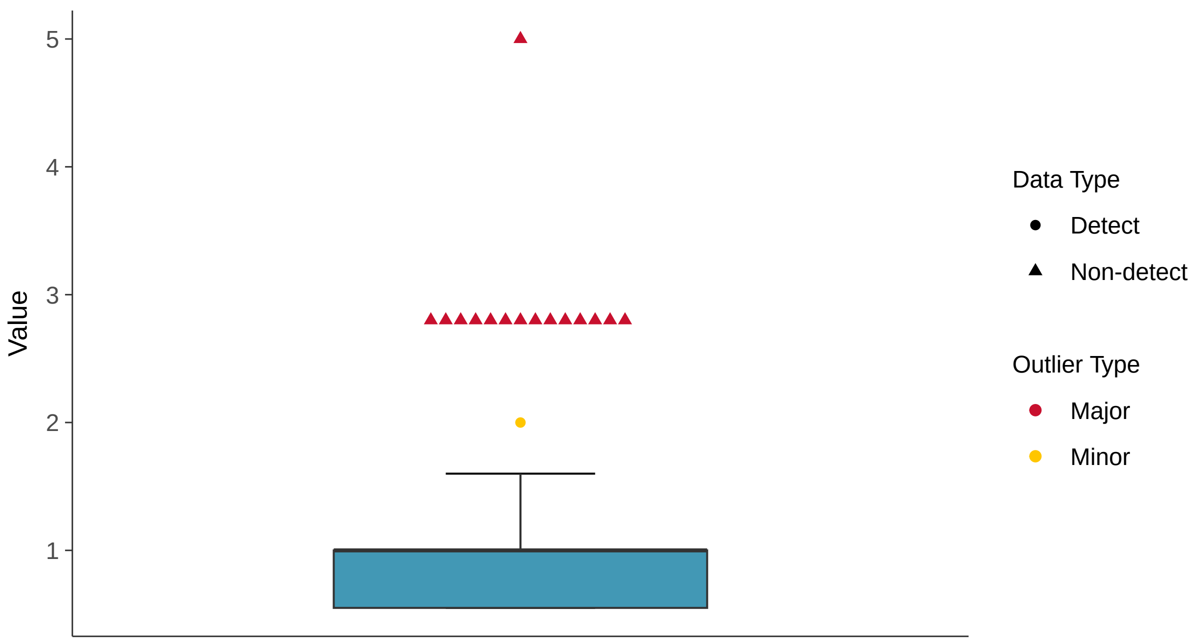
Histogram

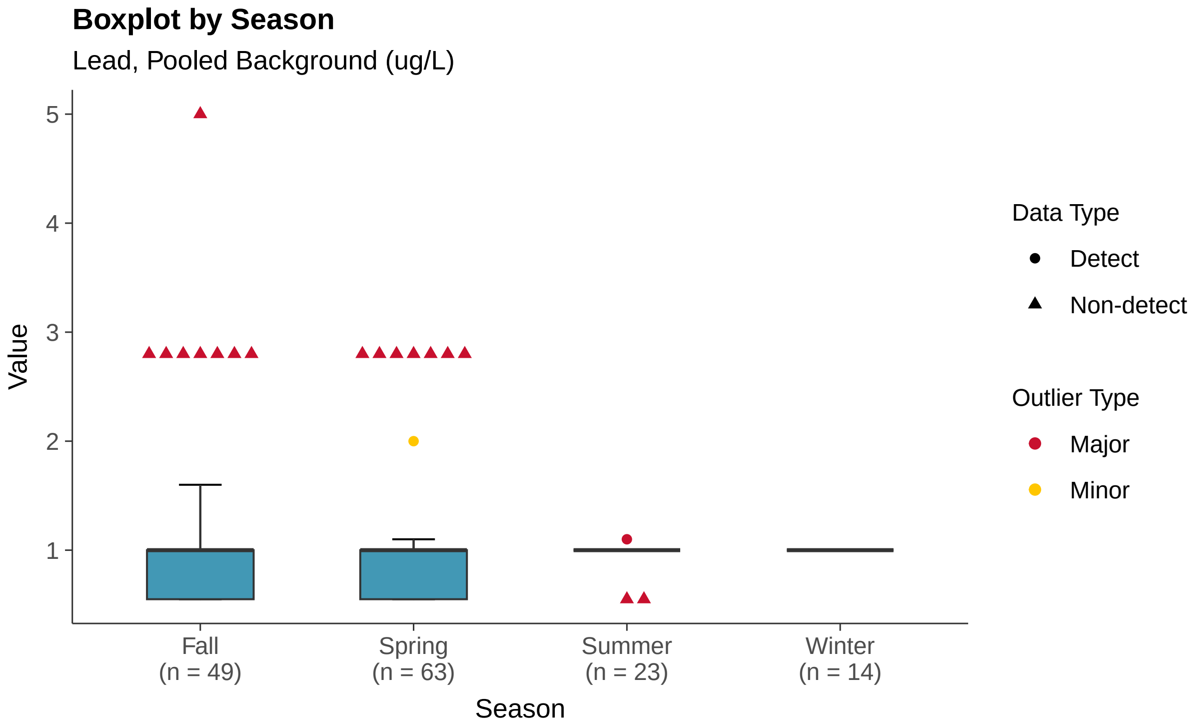
Lead, Pooled Background (ug/L)

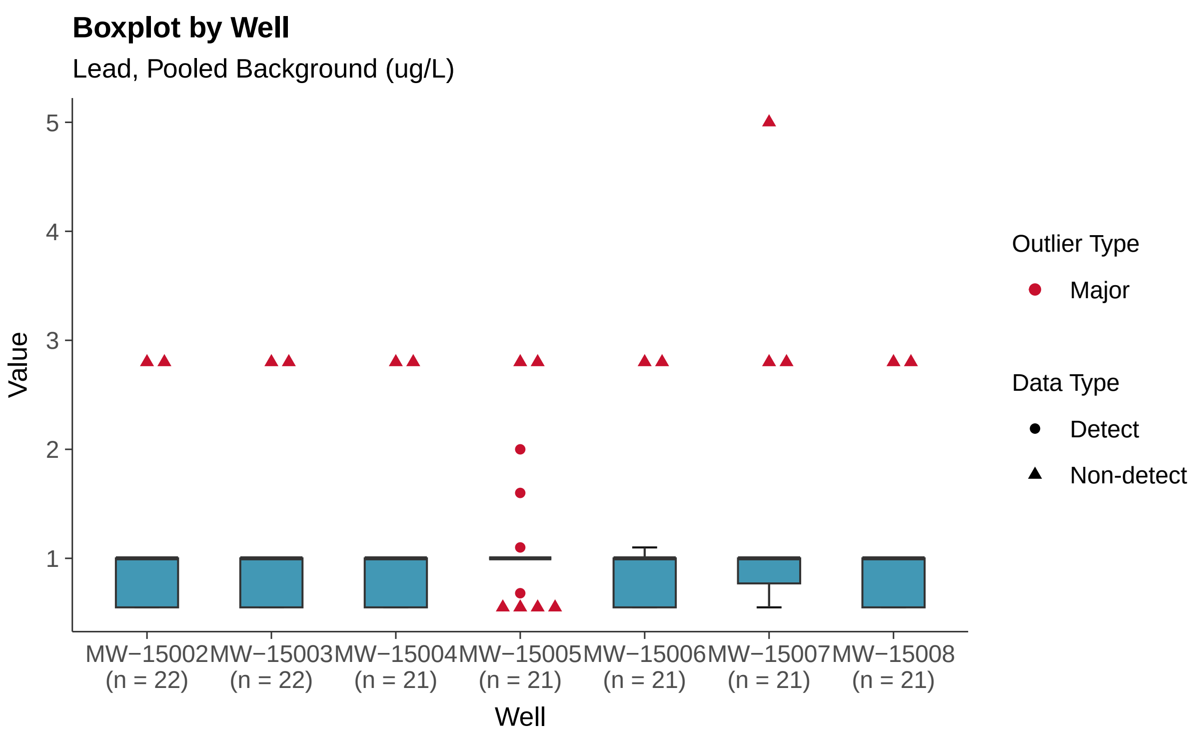


Boxplot

Lead, Pooled Background (ug/L)

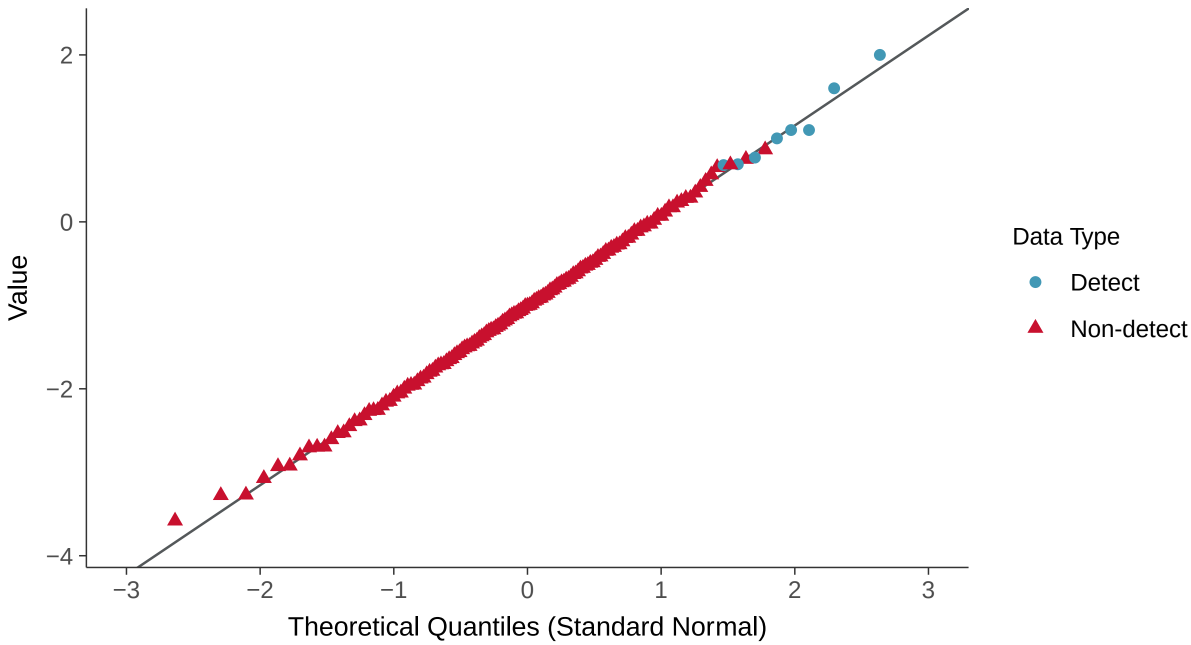



Boxplot by Season
Lead, Pooled Background (ug/L)
Value
5
4
3
2
1
Fall
(n = 49)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Non-detect
Outlier Type
Major
Minor


Boxplot by Well
Lead, Pooled Background (ug/L)
Value
5
4
3
2
1
MW−15002
(n = 22)
MW−15003
(n = 22)
MW−15004
(n = 21)
MW−15005
(n = 21)
MW−15006
(n = 21)
MW−15007
(n = 21)
MW−15008
(n = 21)
Well
Outlier Type
Major
Data Type
Detect
Non-detect

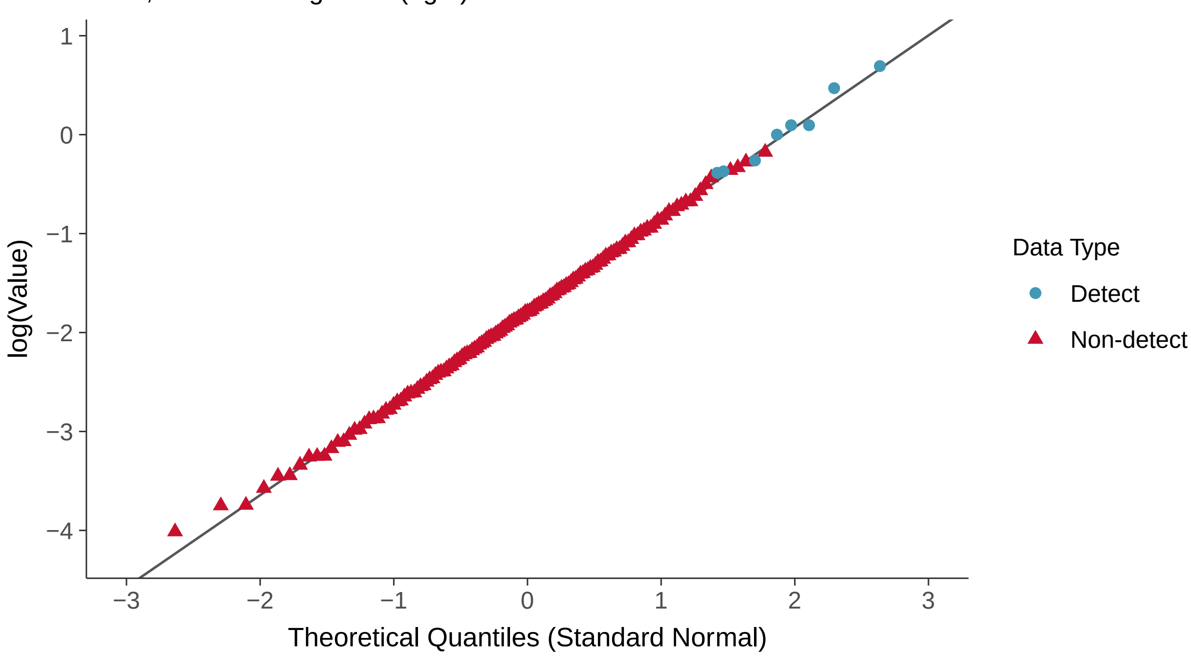
Normal Q-Q plot using ROS Imputed Estimates

Lead, Pooled Background (ug/L)



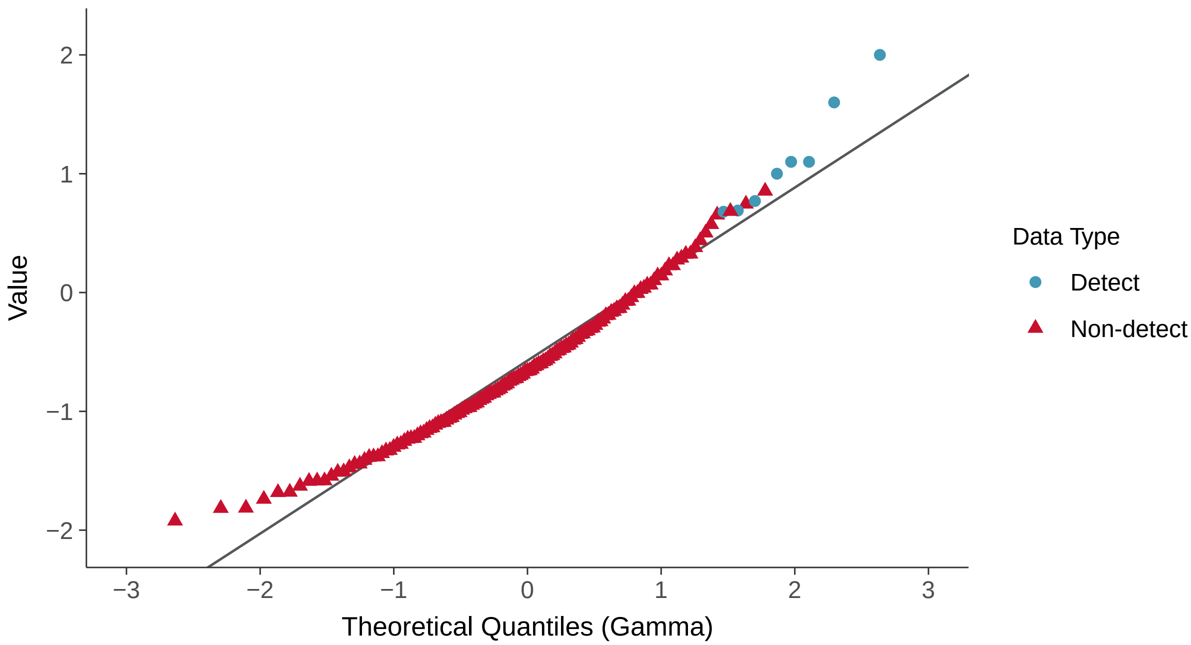
Lognormal Q-Q plot using ROS Imputed Estimates

Lead, Pooled Background (ug/L)



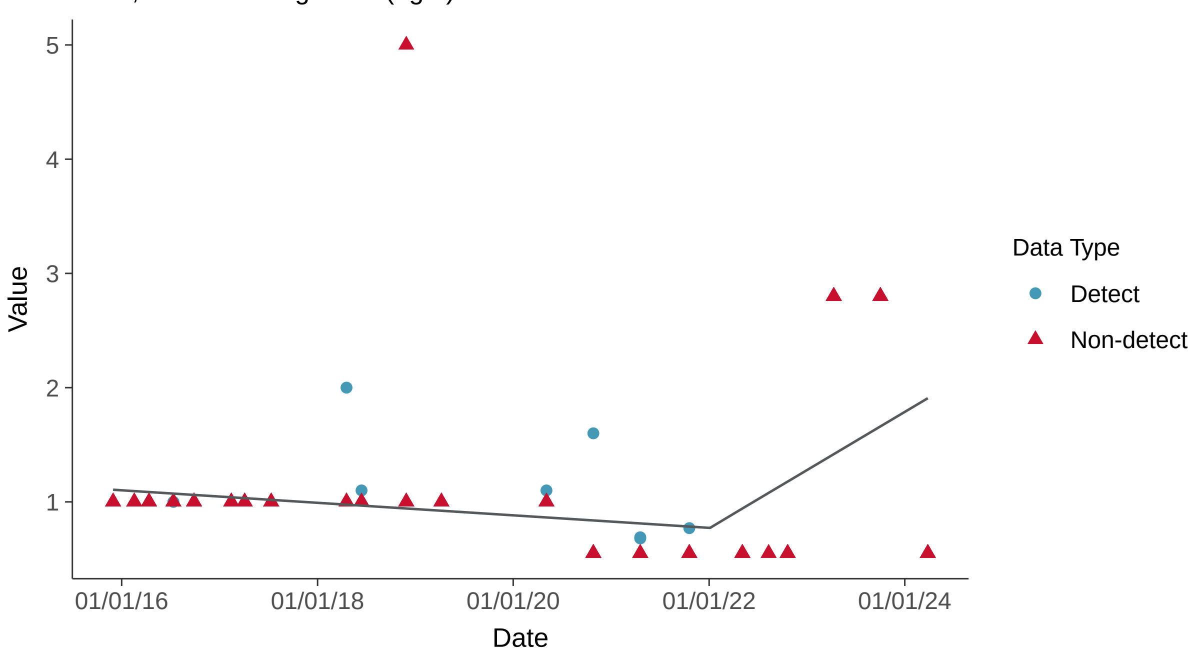
Gamma Q-Q plot using ROS Imputed Estimates

Lead, Pooled Background (ug/L)



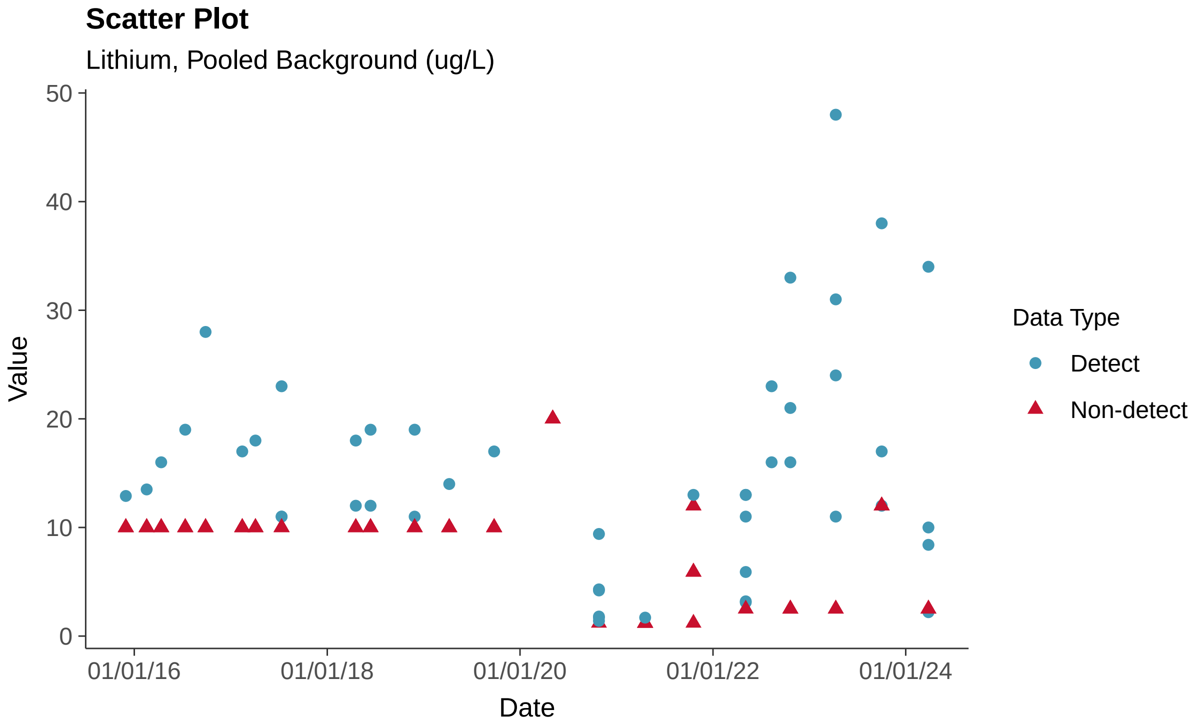
Trend Regression: Piecewise Linear-Linear

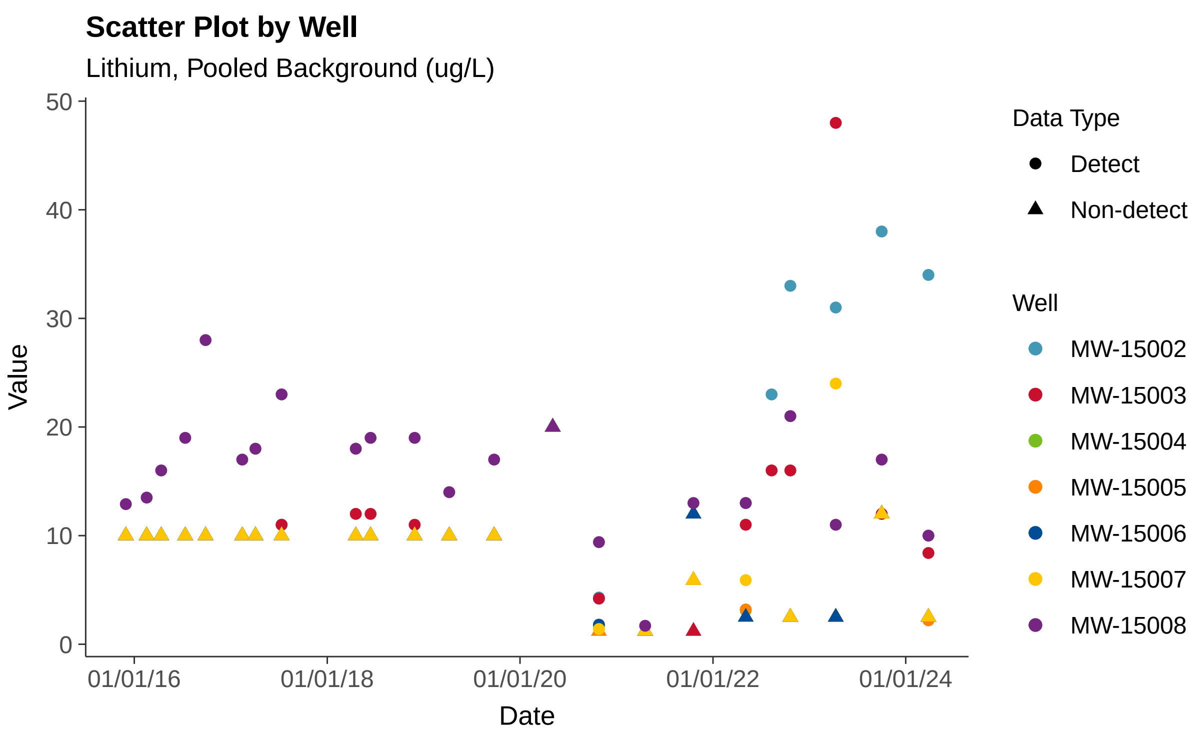
Lead, Pooled Background (ug/L)



Appendix IV: Lithium, Pooled Background

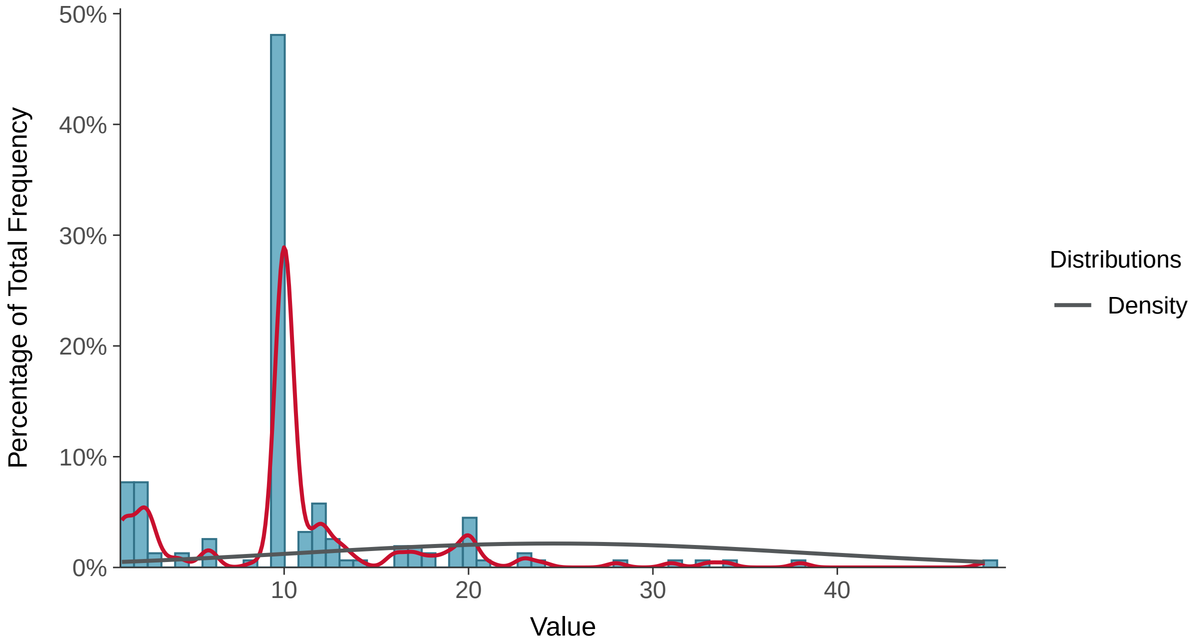
ID: 2_117





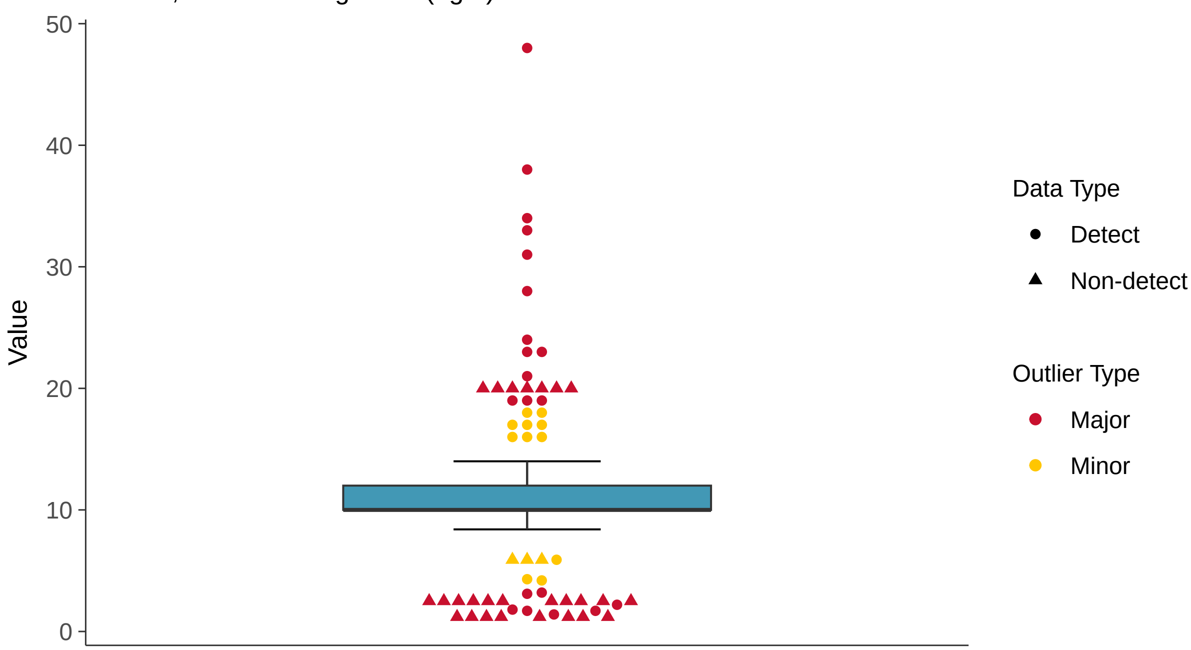
Histogram

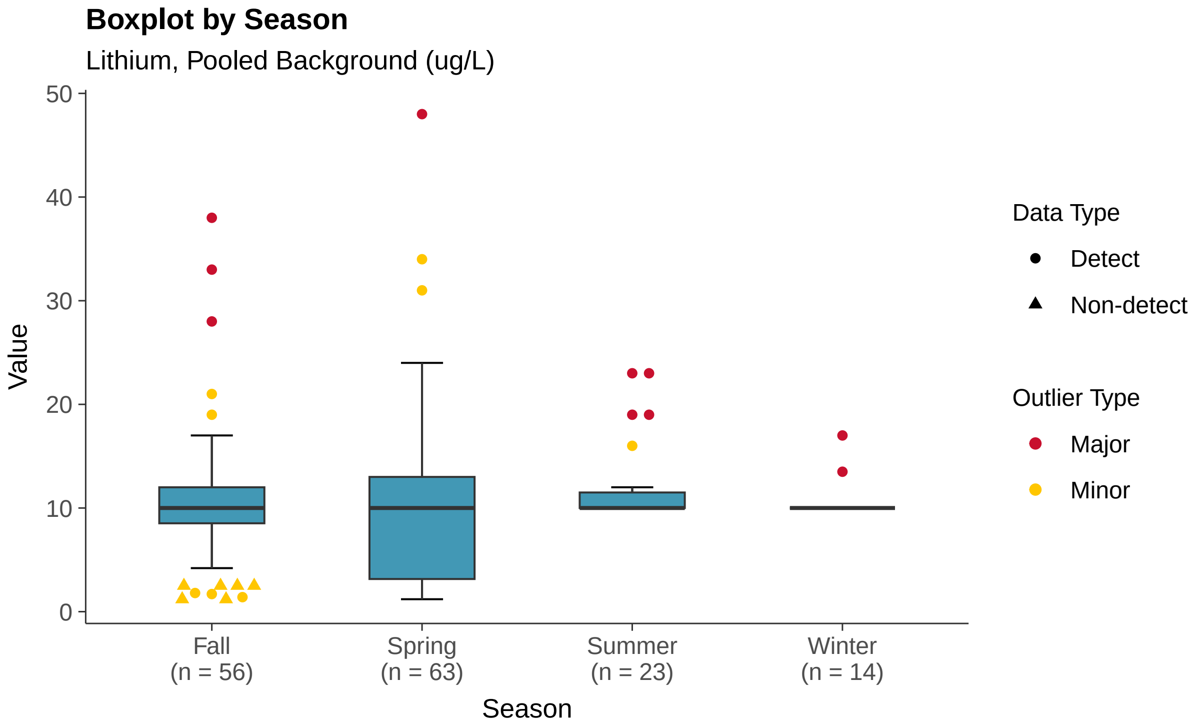
Lithium, Pooled Background (ug/L)

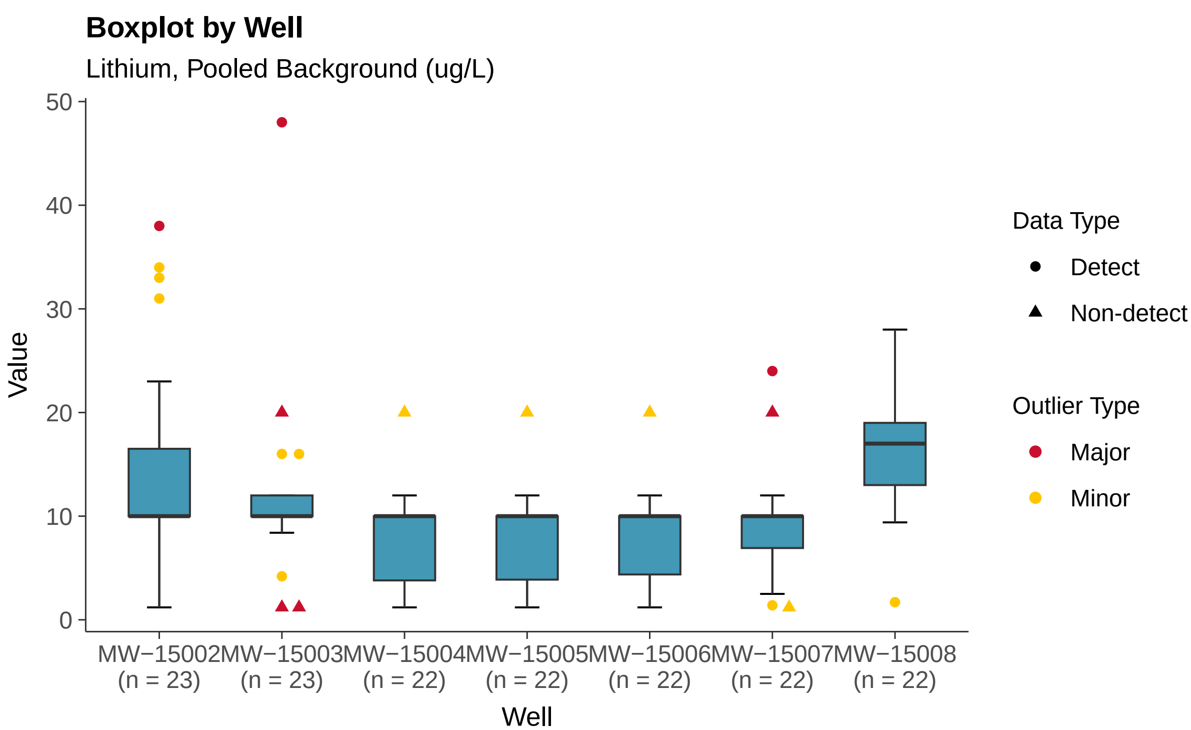


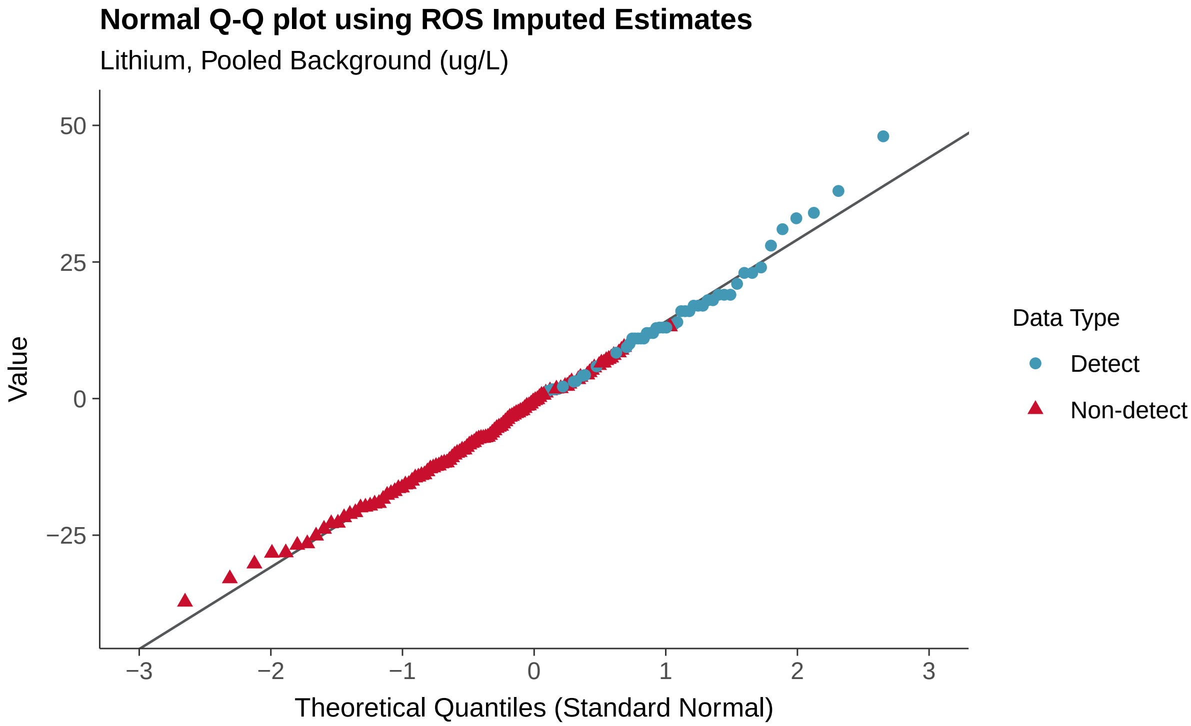
Boxplot

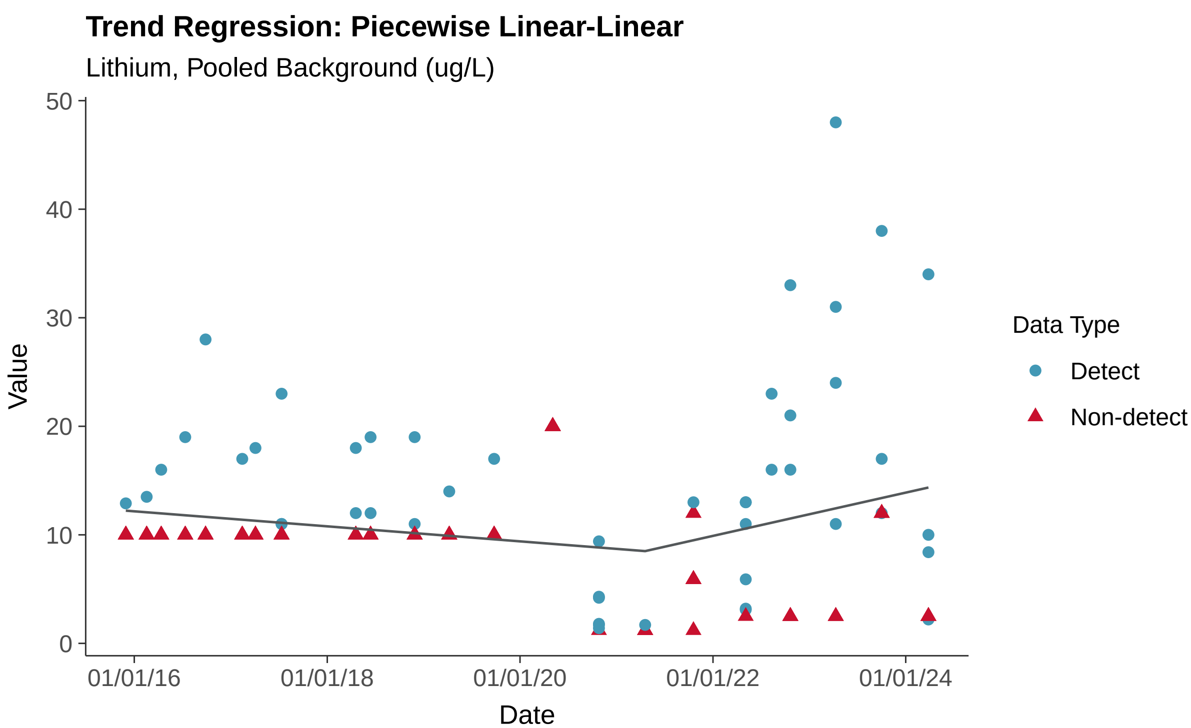
Lithium, Pooled Background (ug/L)




Boxplot by Season
Lithium, Pooled Background (ug/L)
Value
50
40
30
20
10
0
Fall
(n = 56)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Non-detect
Outlier Type
Major
Minor

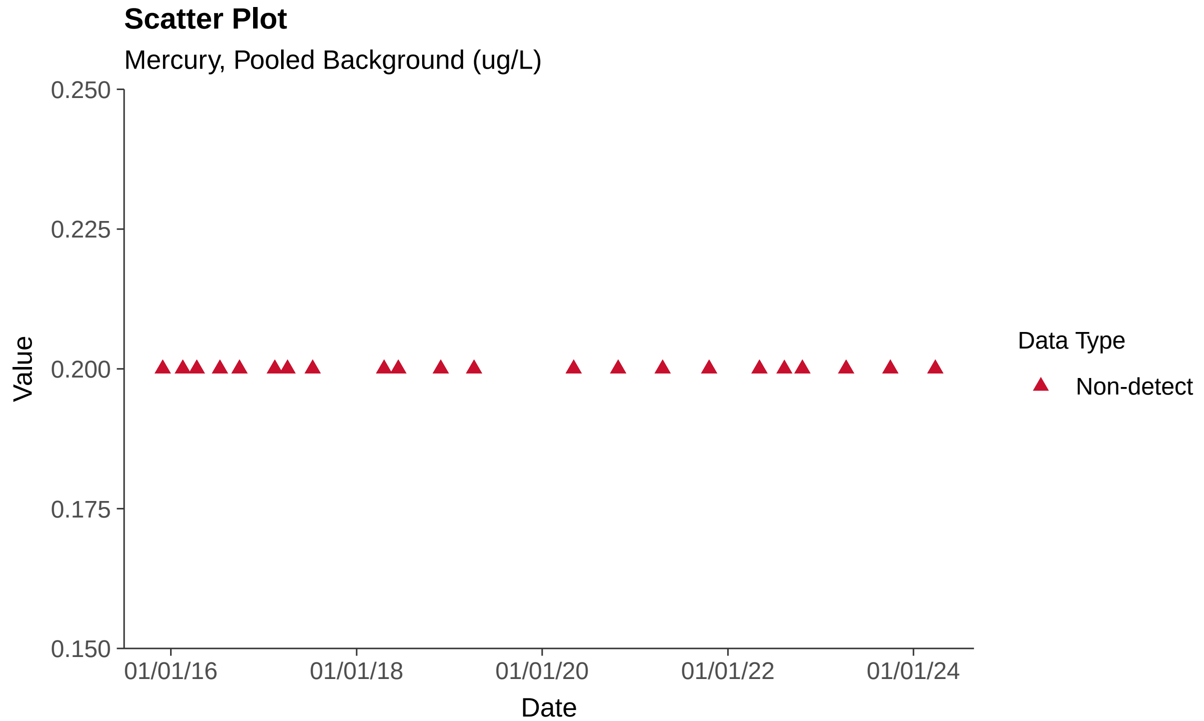

Boxplot by Well
Lithium, Pooled Background (ug/L)
Value
50
40
30
20
10
0
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 22)
MW−15007
(n = 22)
MW−15008
(n = 22)
Well
Data Type
Detect
Non-detect
Outlier Type
Major
Minor

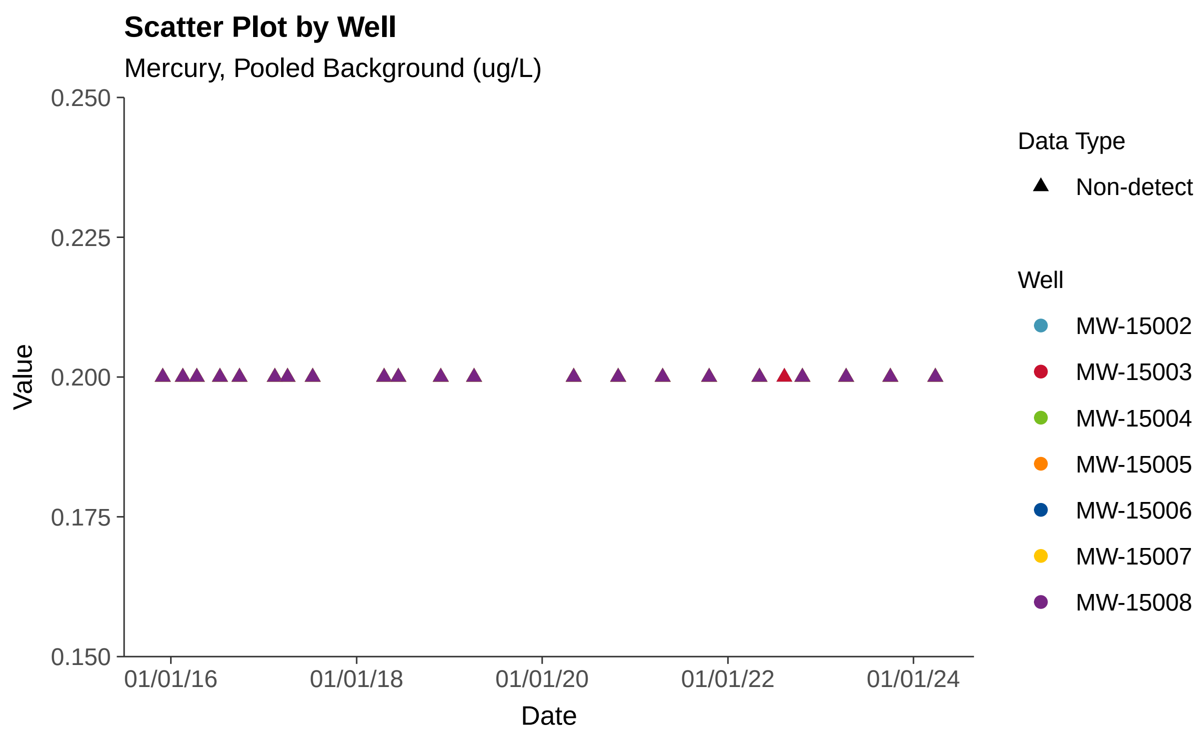

Normal Q-Q plot using ROS Imputed Estimates
Lithium, Pooled Background (ug/L)
Value
50
25
0
−25
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Lithium, Pooled Background (ug/L)
Value
50
40
30
20
10
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

Appendix IV: Mercury, Pooled Background

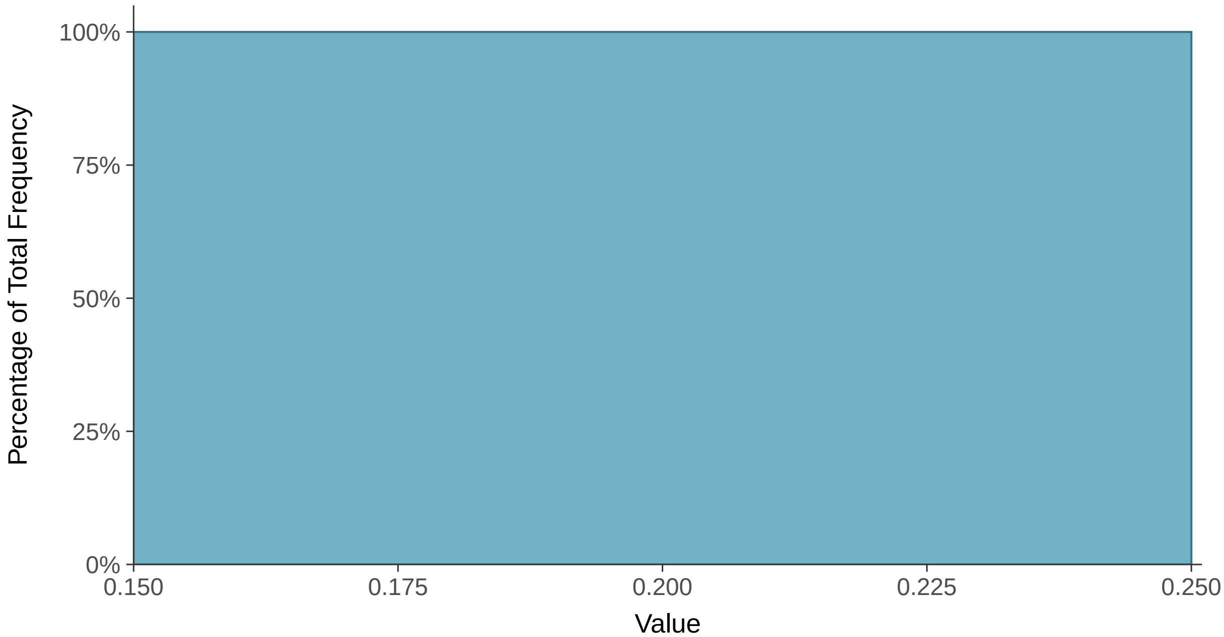
ID: 2_118





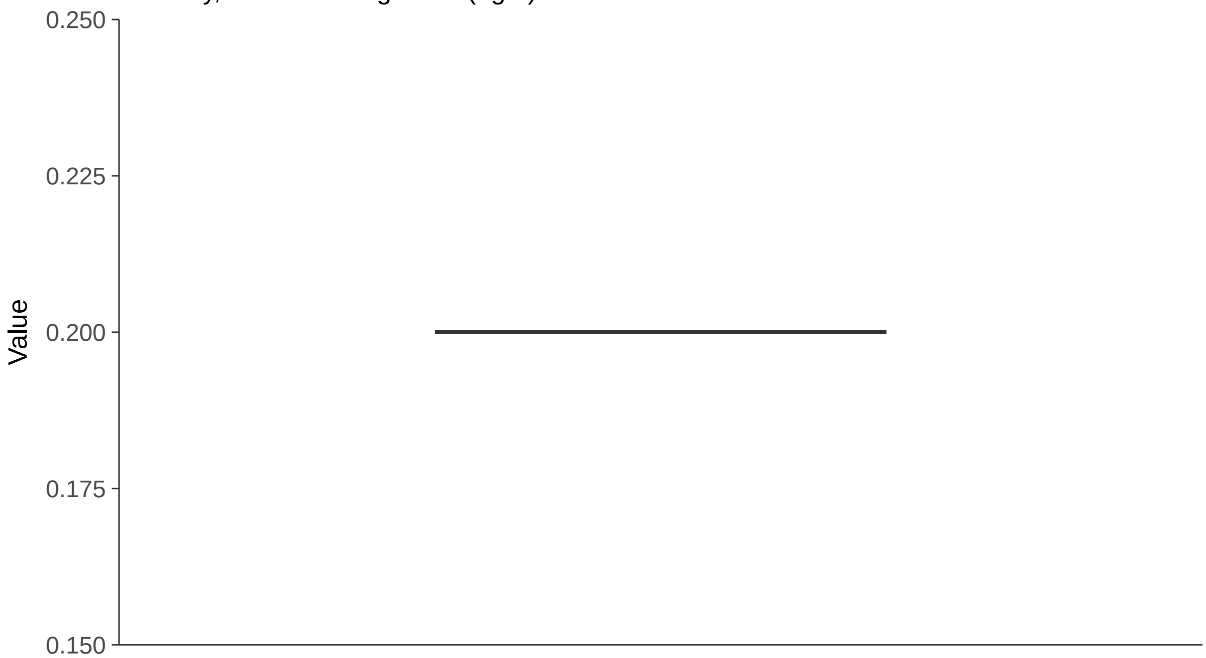
Histogram

Mercury, Pooled Background (ug/L)



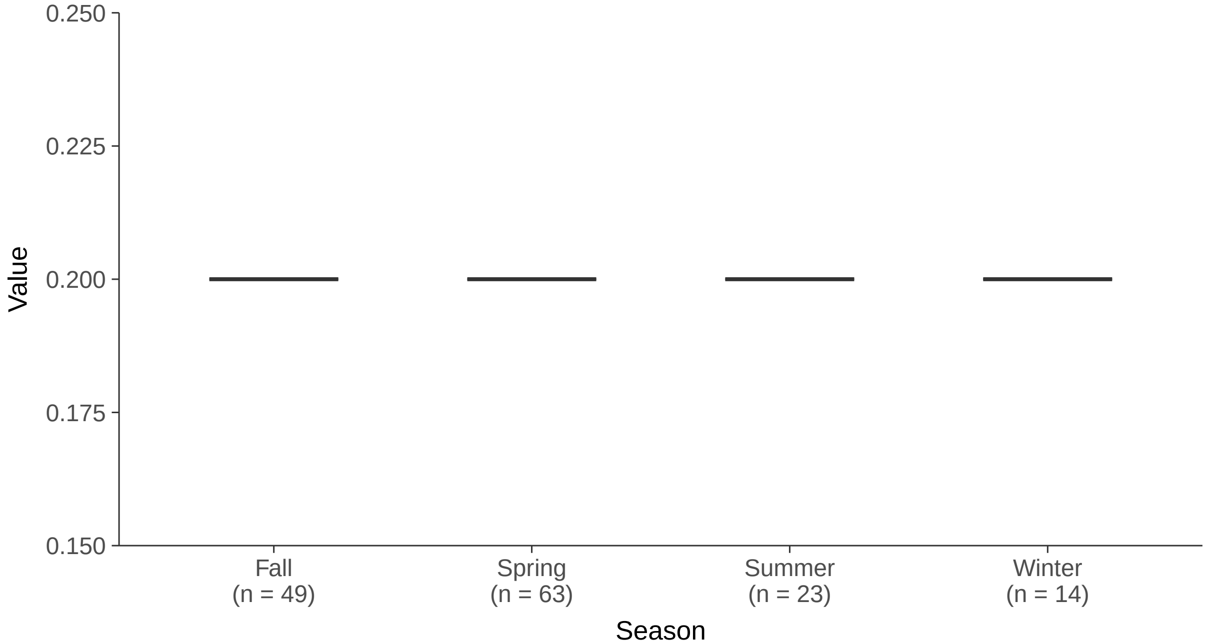
Boxplot

Mercury, Pooled Background (ug/L)



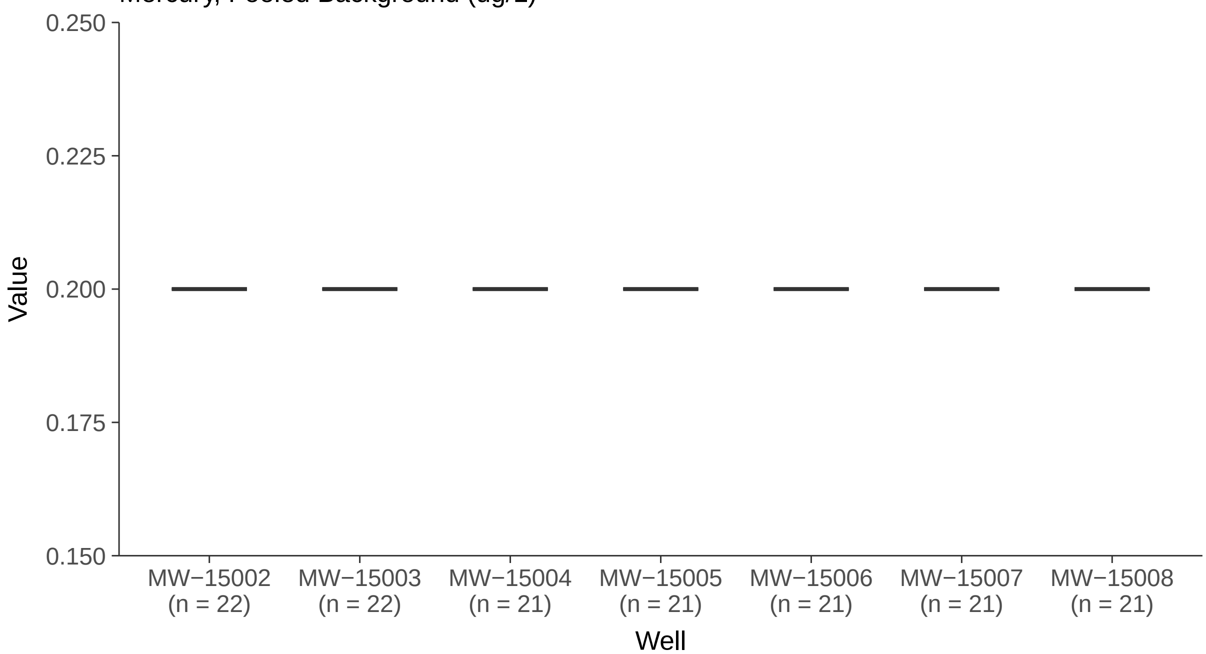
Boxplot by Season

Mercury, Pooled Background (ug/L)



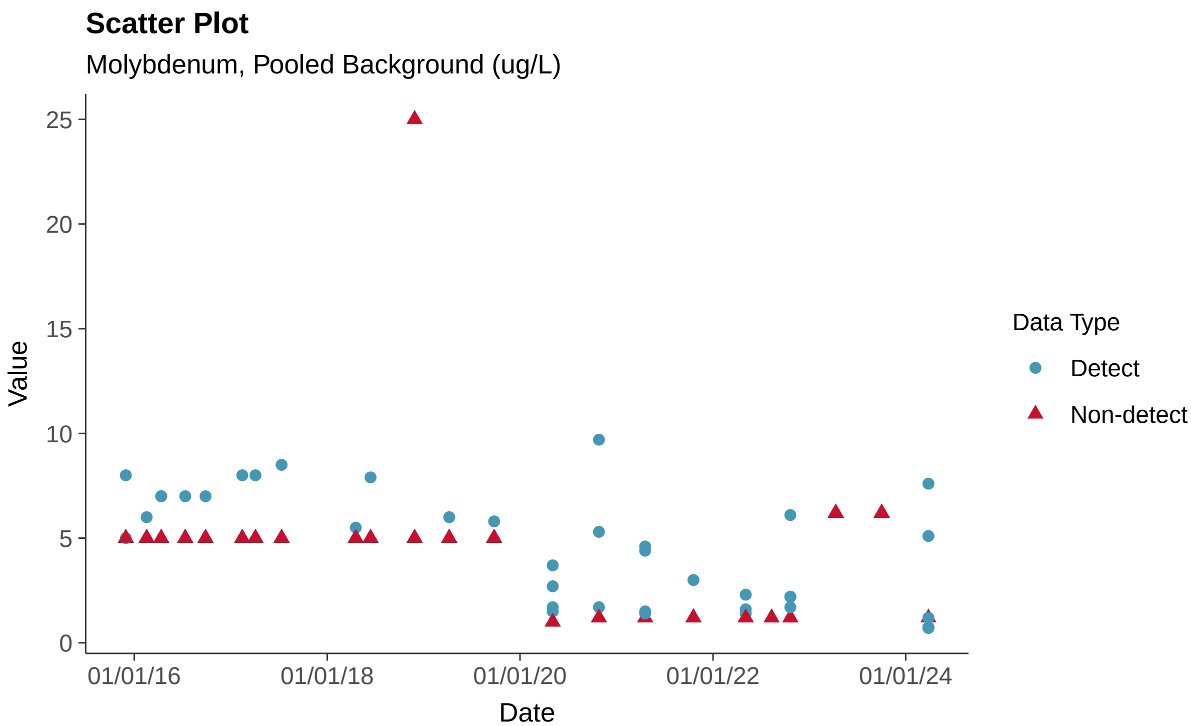
Boxplot by Well

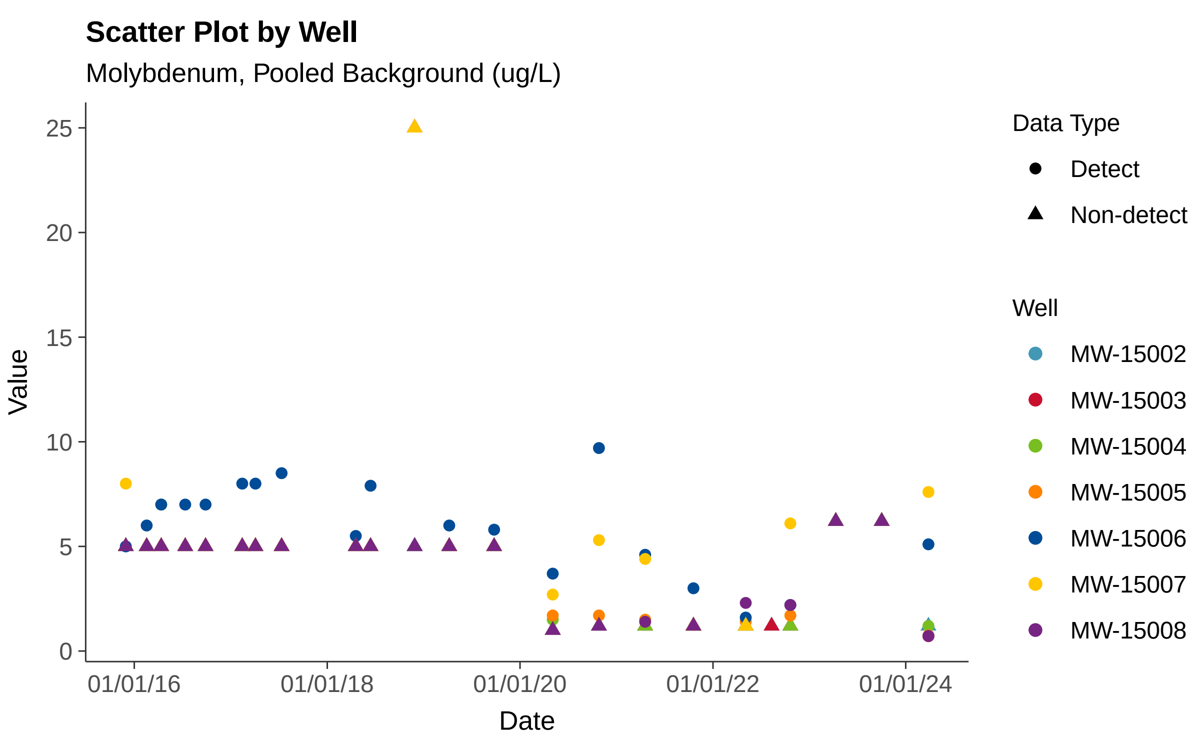
Mercury, Pooled Background (ug/L)



Appendix IV: Molybdenum, Pooled Background

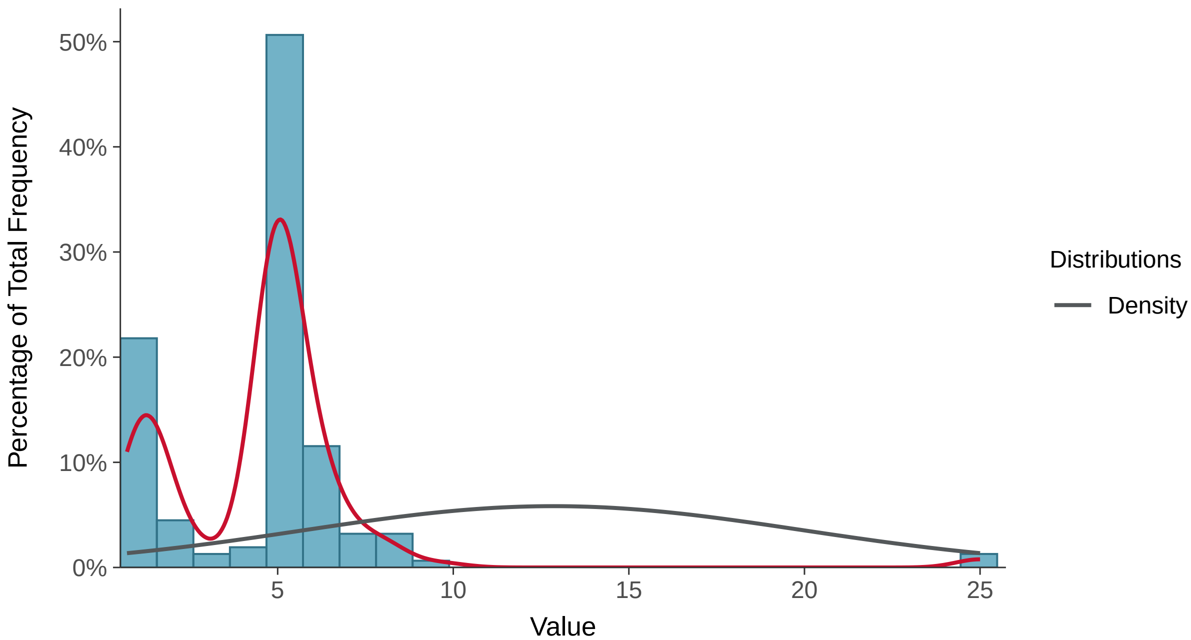
ID: 2_119





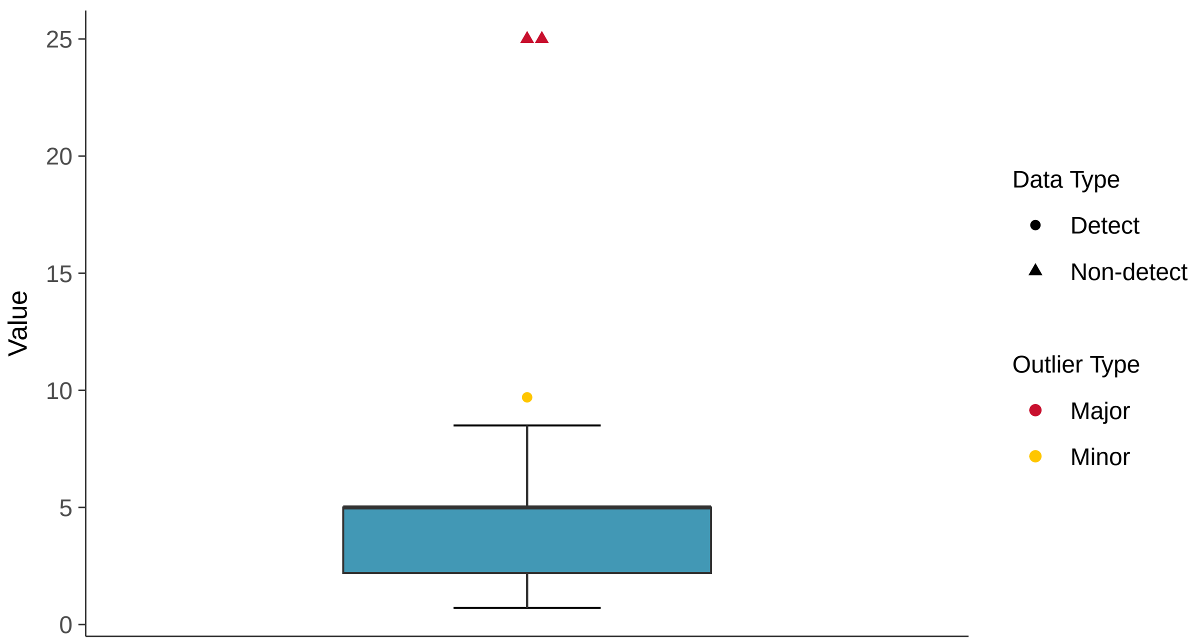
Histogram

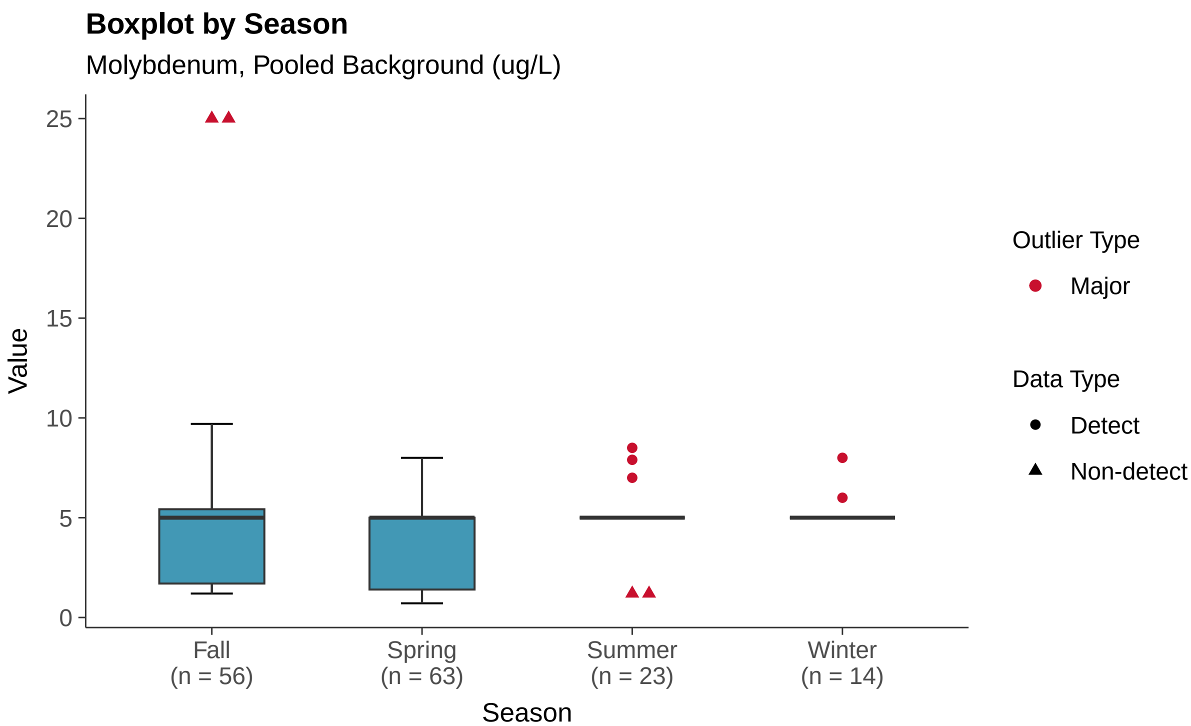
Molybdenum, Pooled Background (ug/L)

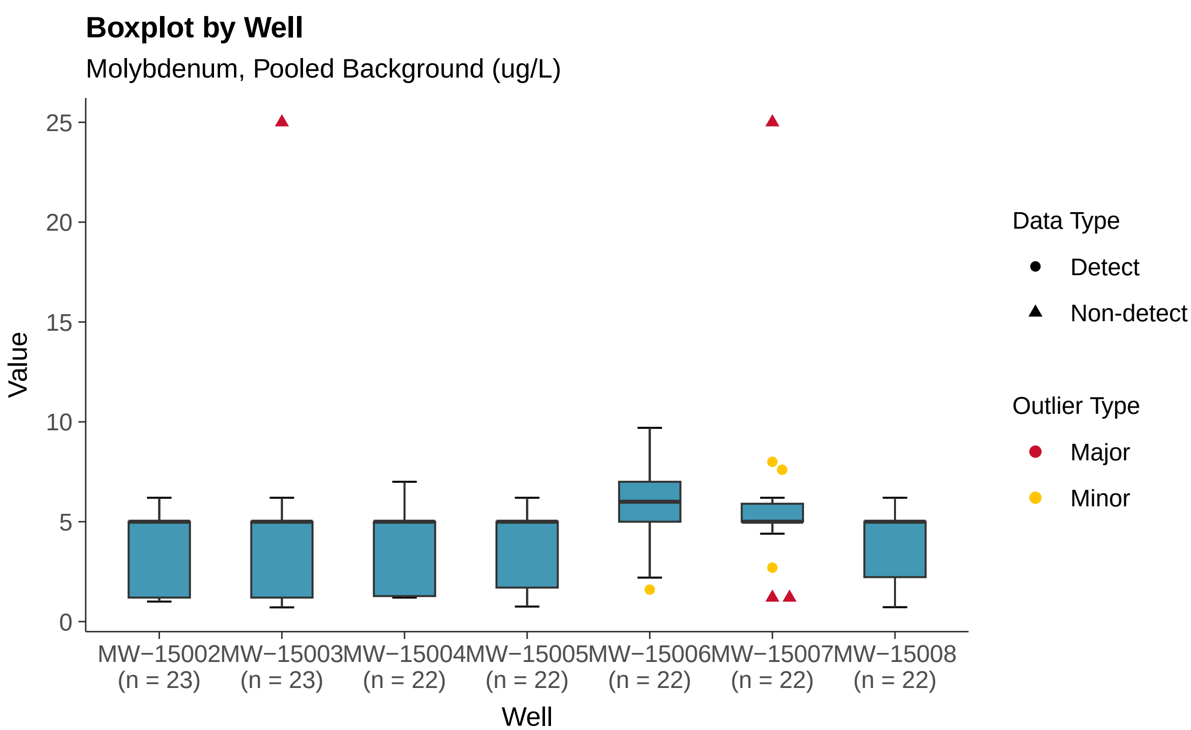


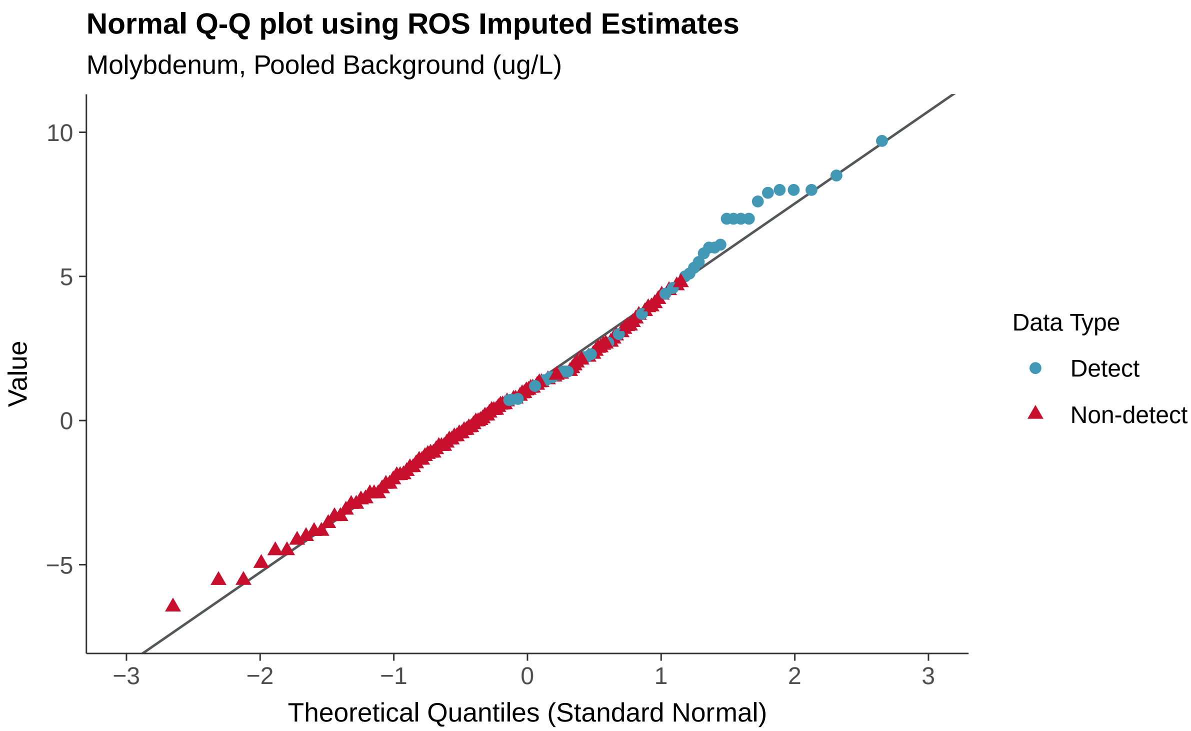
Boxplot

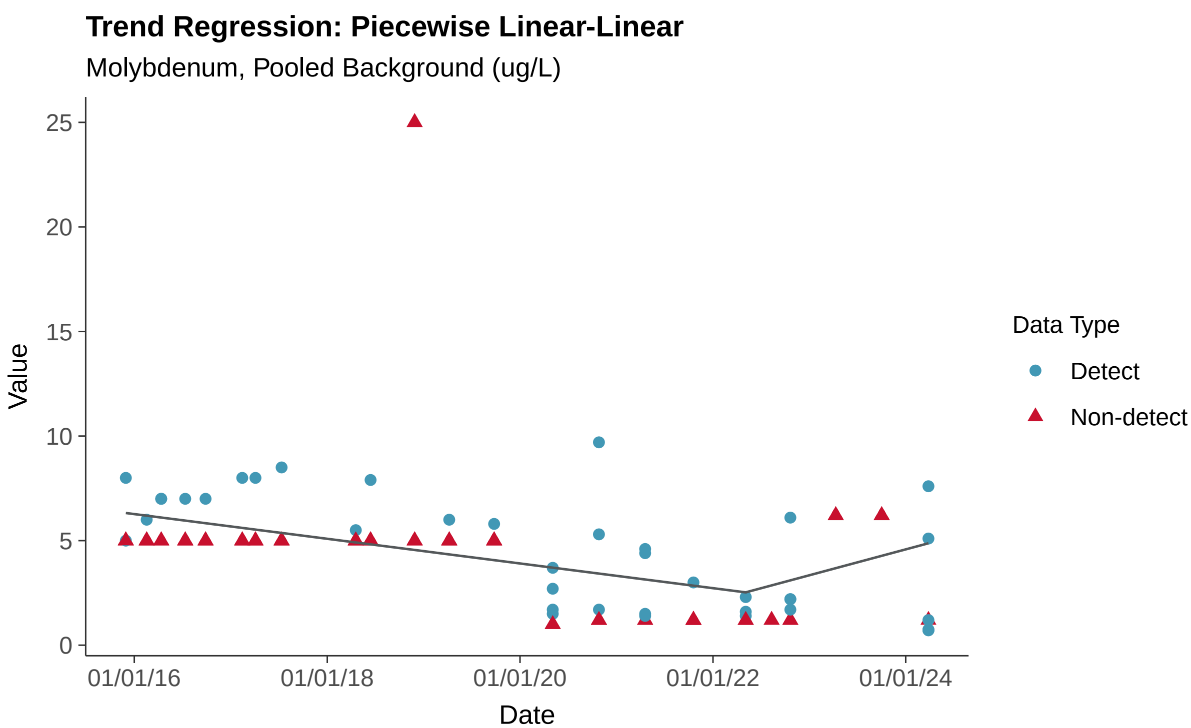
Molybdenum, Pooled Background (ug/L)




Boxplot by Season
Molybdenum, Pooled Background (ug/L)
Value
25
20
15
10
5
0
Fall
(n = 56)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Outlier Type
Major
Data Type
Detect
Non-detect

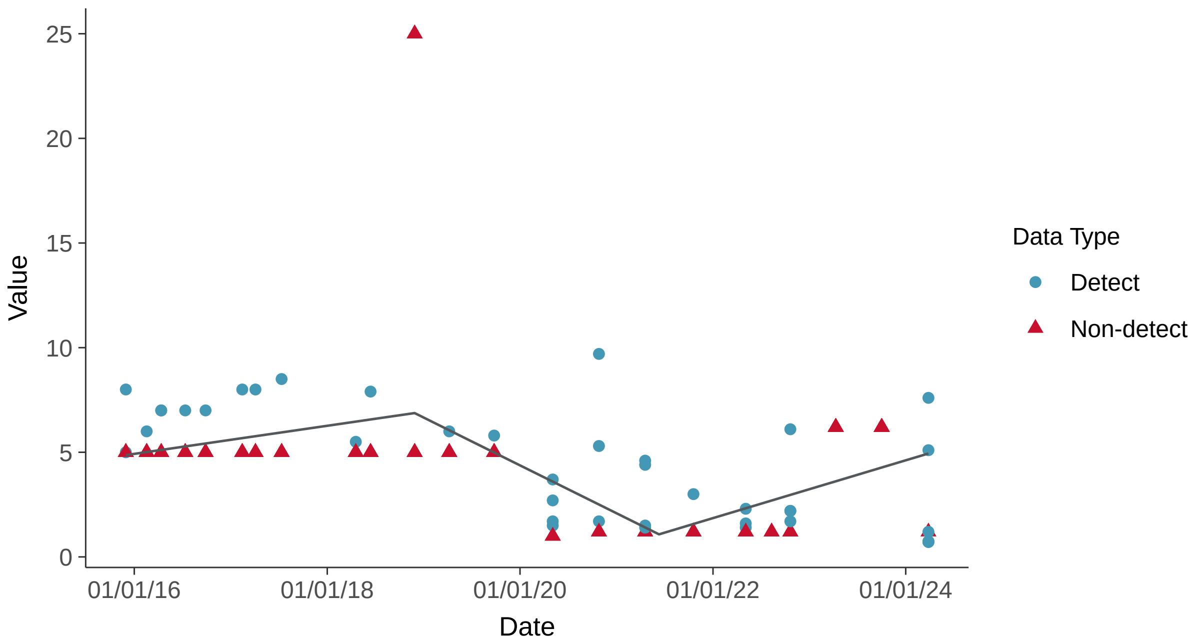

Boxplot by Well
Molybdenum, Pooled Background (ug/L)
Value
25
20
15
10
5
0
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 22)
MW−15007
(n = 22)
MW−15008
(n = 22)
Well
Data Type
Detect
Non-detect
Outlier Type
Major
Minor


Normal Q-Q plot using ROS Imputed Estimates
Molybdenum, Pooled Background (ug/L)
Value
10
5
0
−5
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Molybdenum, Pooled Background (ug/L)
Value
25
20
15
10
5
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

Trend Regression: Piecewise Linear-Linear-Linear

Molybdenum, Pooled Background (ug/L)

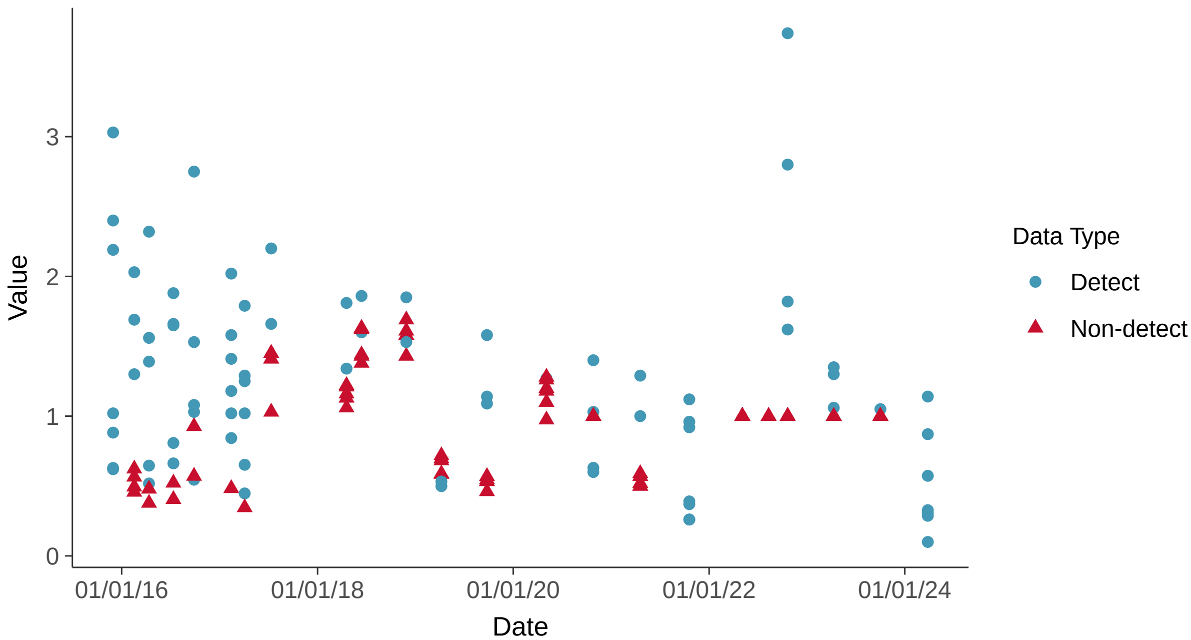


Appendix IV: Radium-226+228, Pooled Background

ID: 2_124

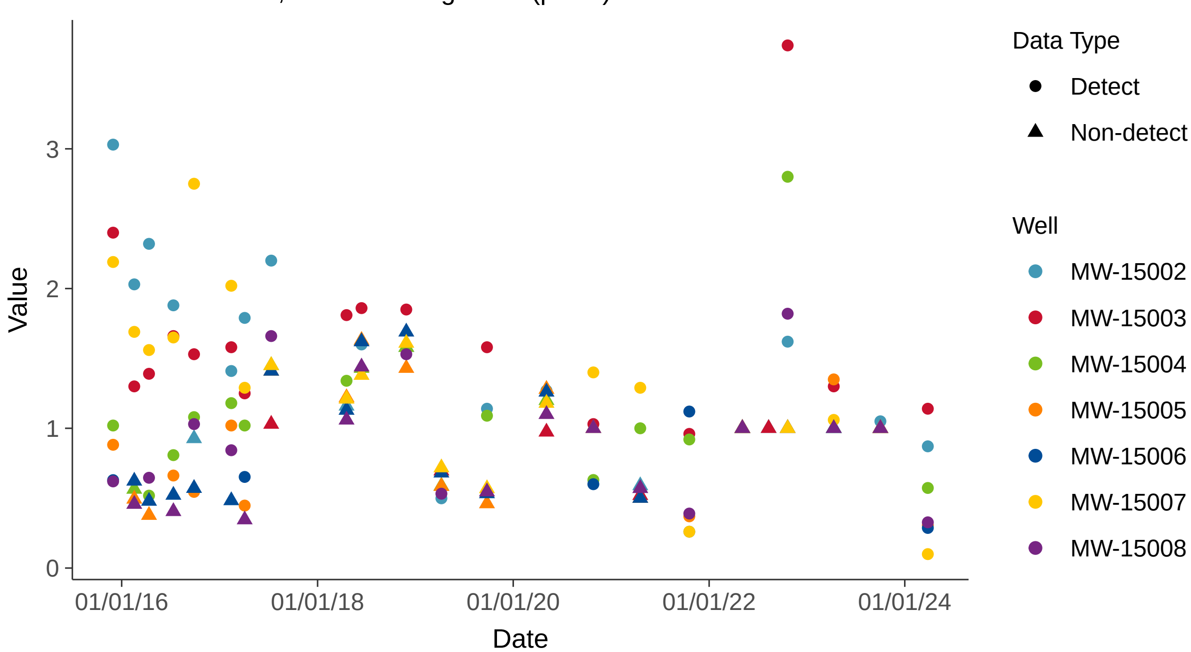
Scatter Plot

Radium-226+228, Pooled Background (pCi/L)



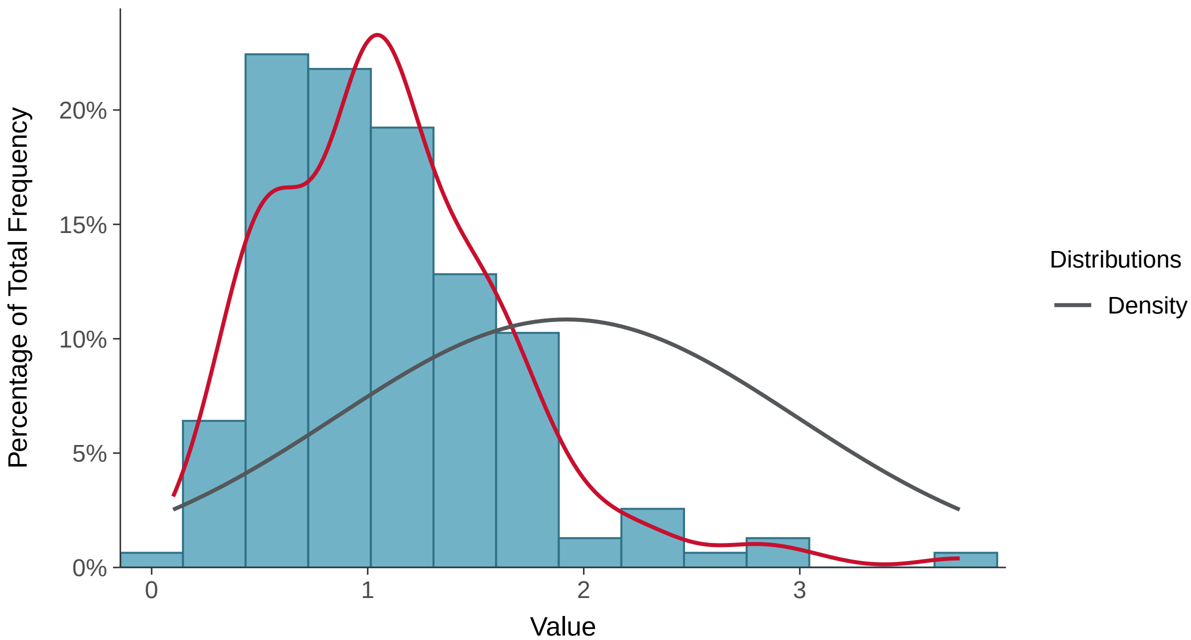
Scatter Plot by Well

Radium-226+228, Pooled Background (pCi/L)



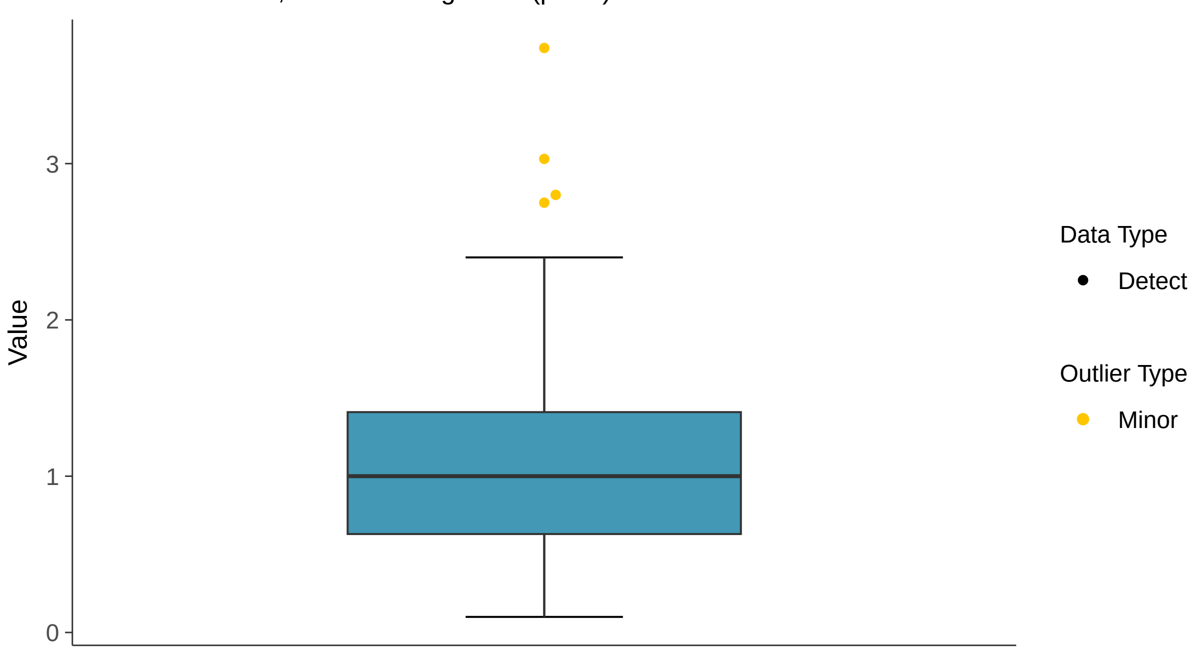
Histogram

Radium-226+228, Pooled Background (pCi/L)



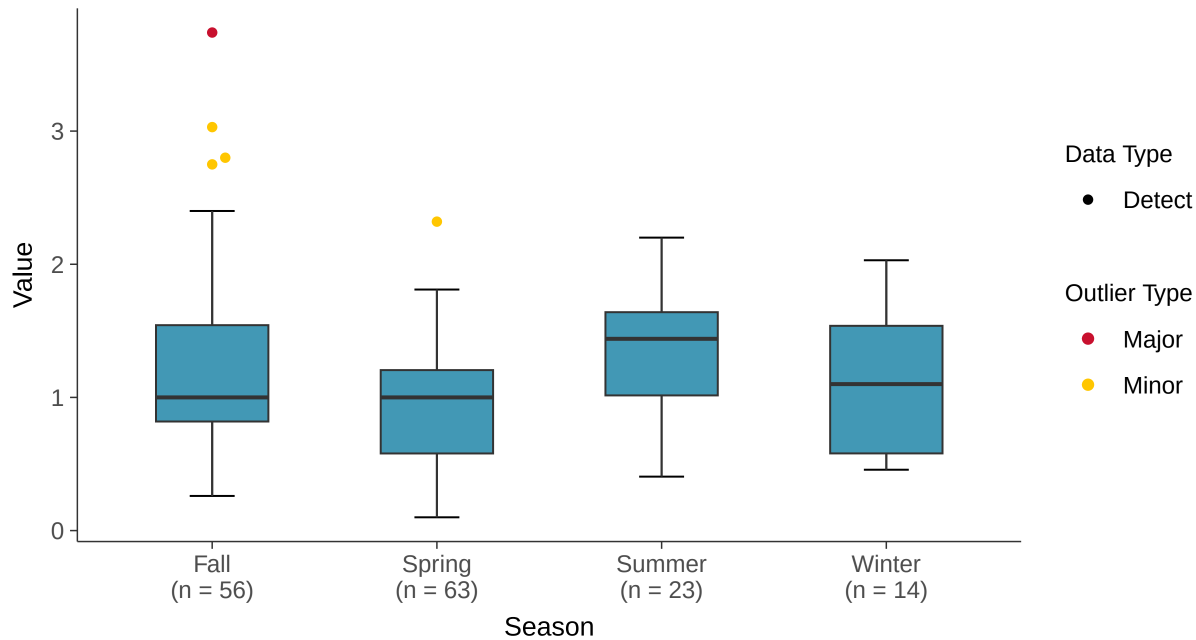
Boxplot

Radium-226+228, Pooled Background (pCi/L)



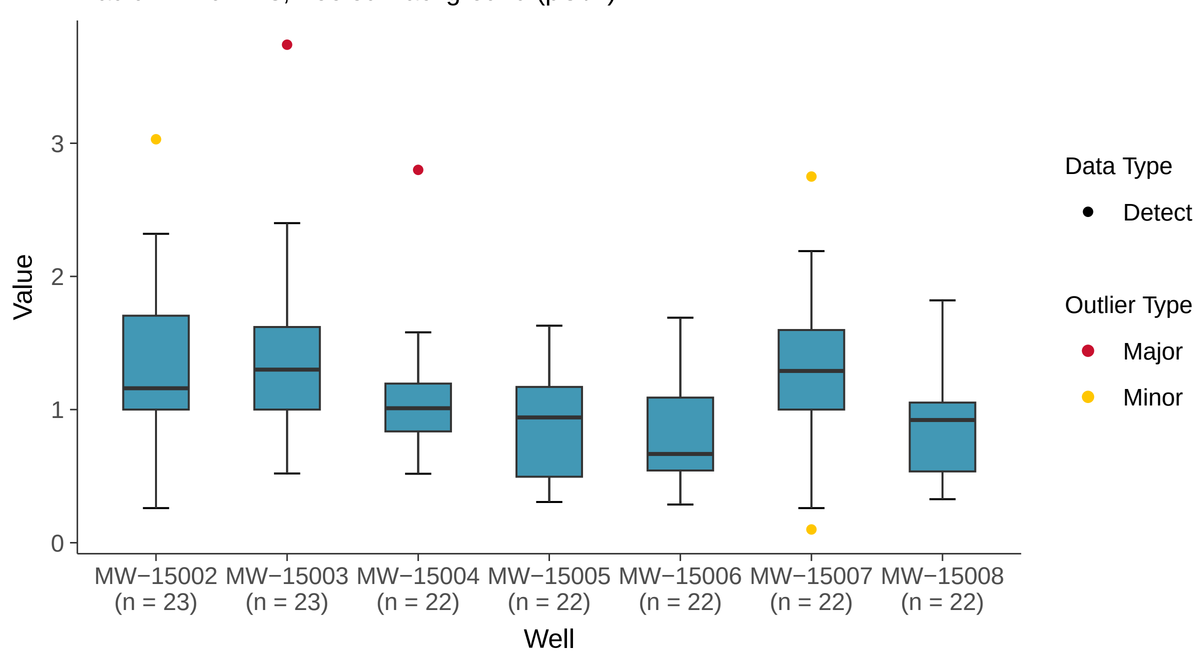
Boxplot by Season

Radium-226+228, Pooled Background (pCi/L)



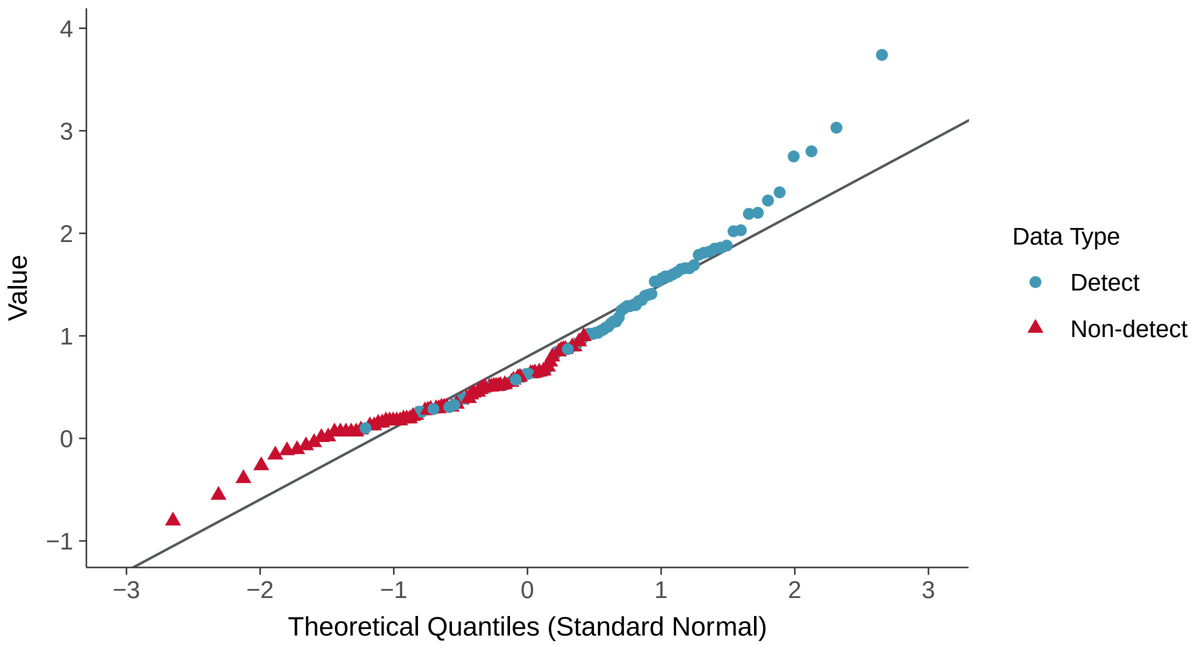
Boxplot by Well

Radium-226+228, Pooled Background (pCi/L)



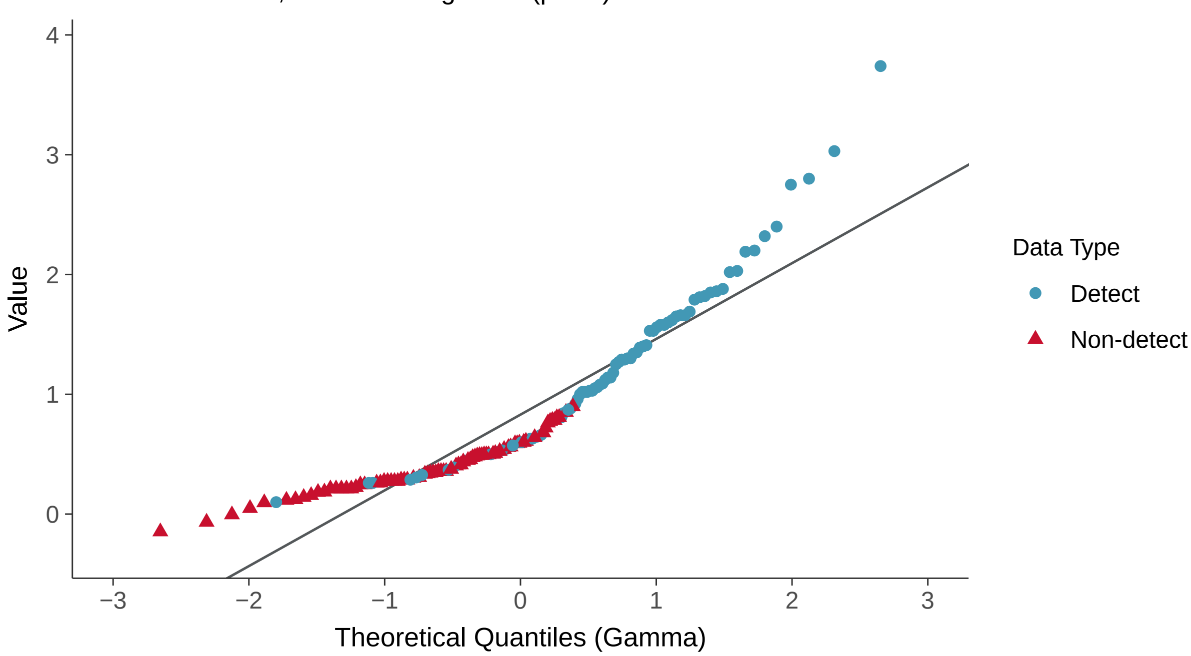
Normal Q-Q plot using ROS Imputed Estimates

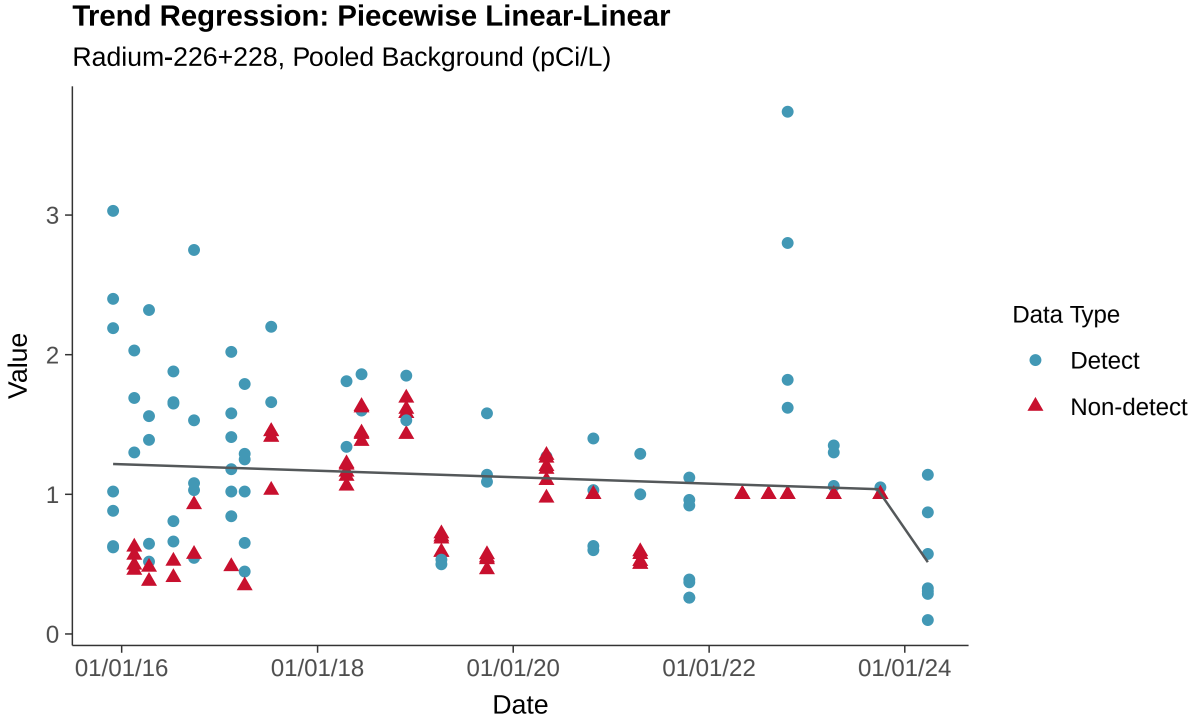
Radium-226+228, Pooled Background (pCi/L)



Gamma Q-Q plot using ROS Imputed Estimates

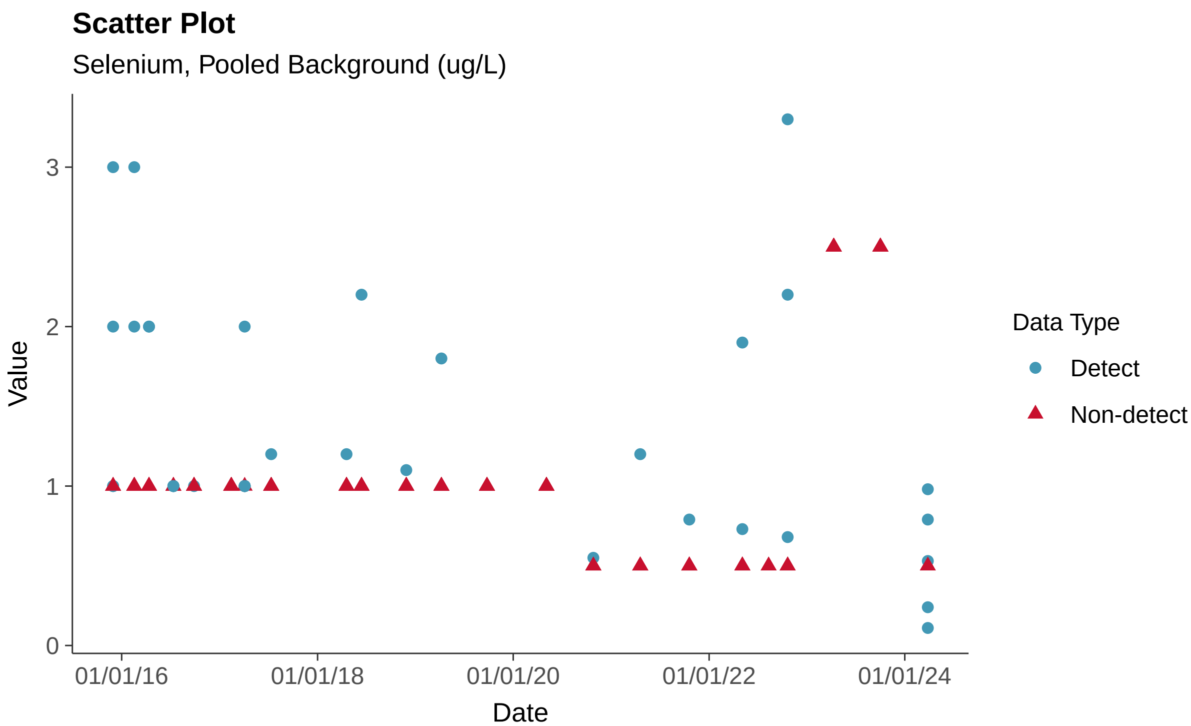
Radium-226+228, Pooled Background (pCi/L)

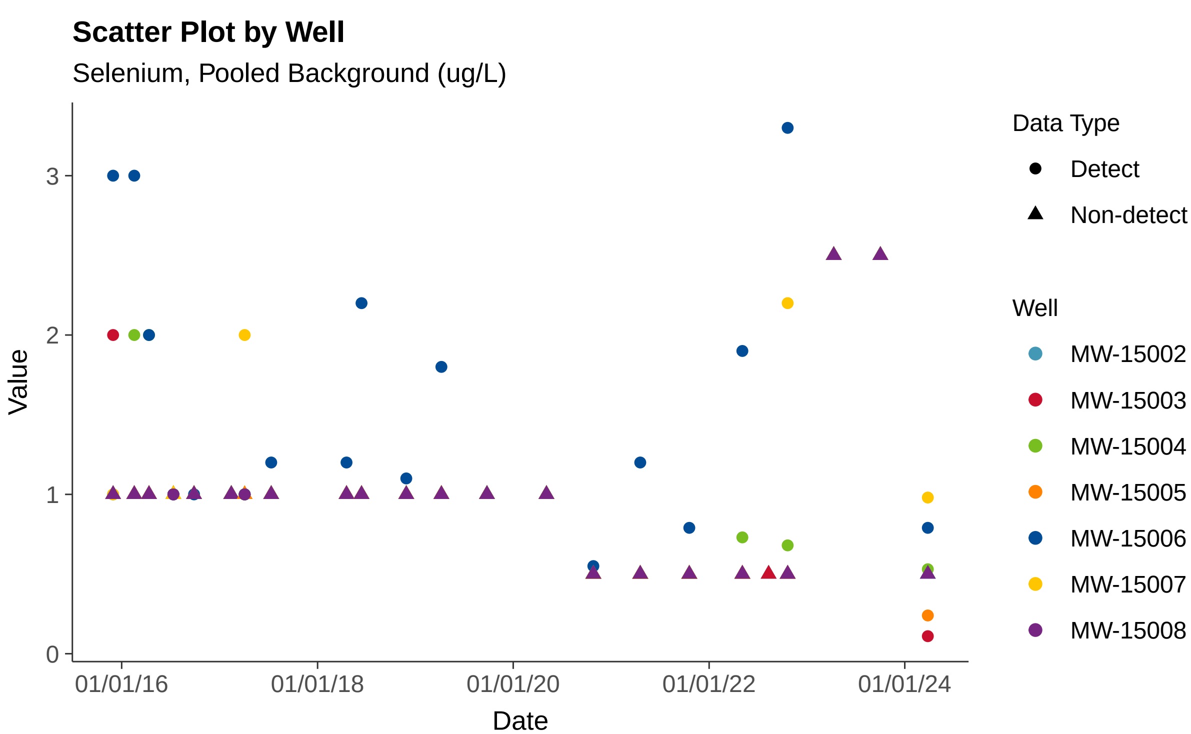



Trend Regression: Piecewise Linear-Linear
Radium-226+228, Pooled Background (pCi/L)
Value
0
1
2
3
Date
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Data Type
Detect
Non-detect

Appendix IV: Selenium, Pooled Background

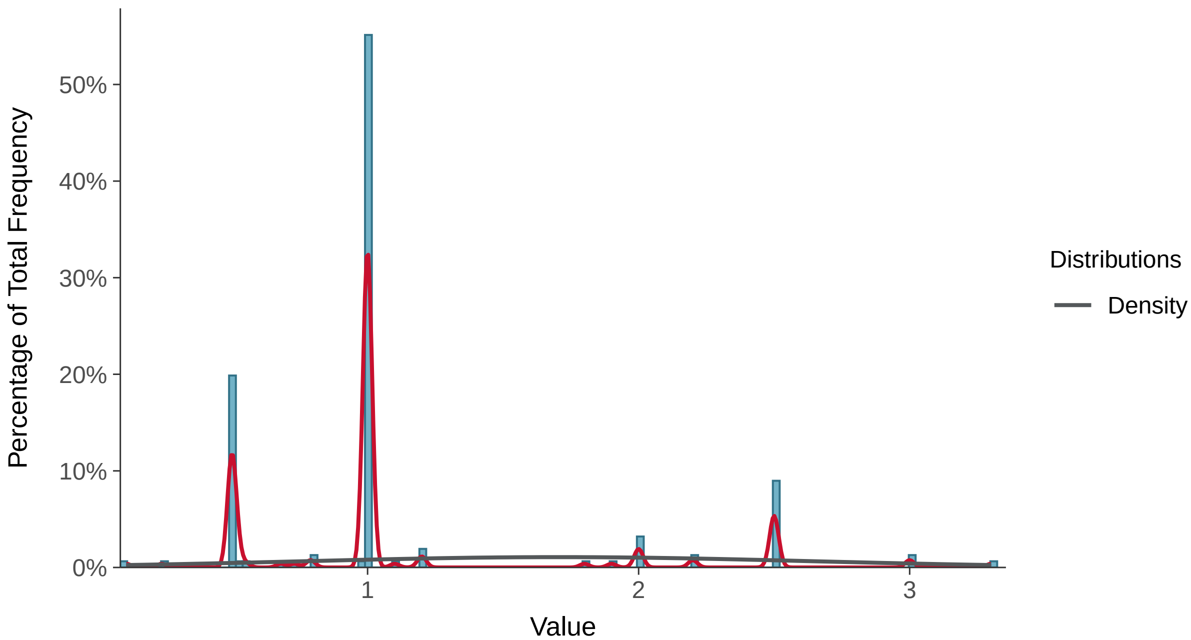
ID: 2_126





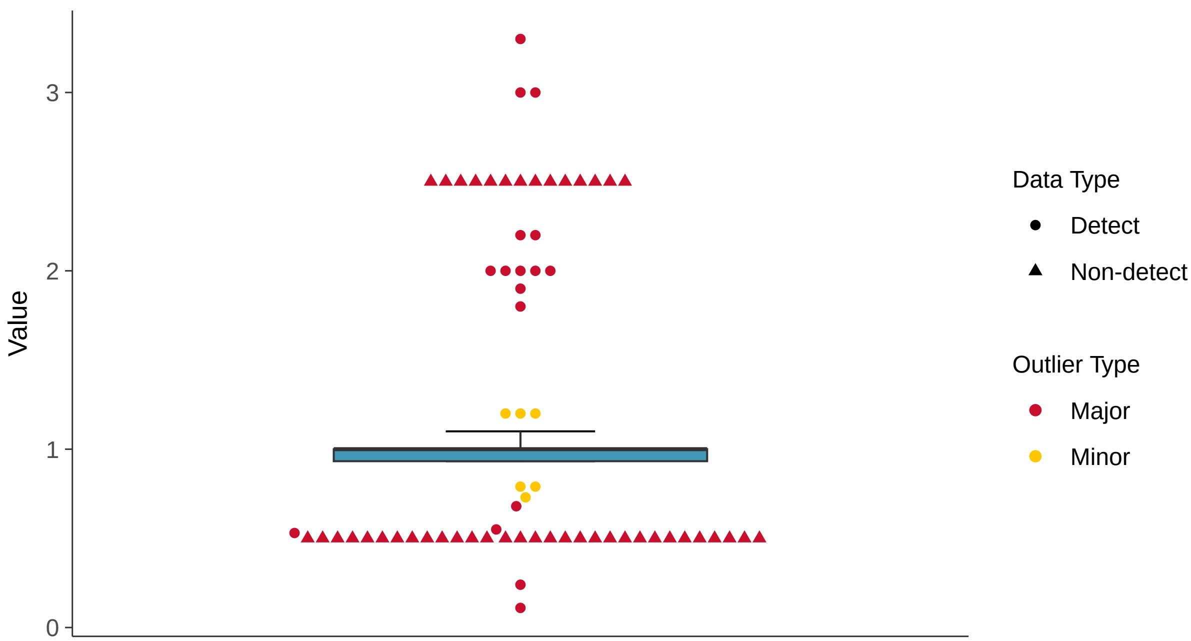
Histogram

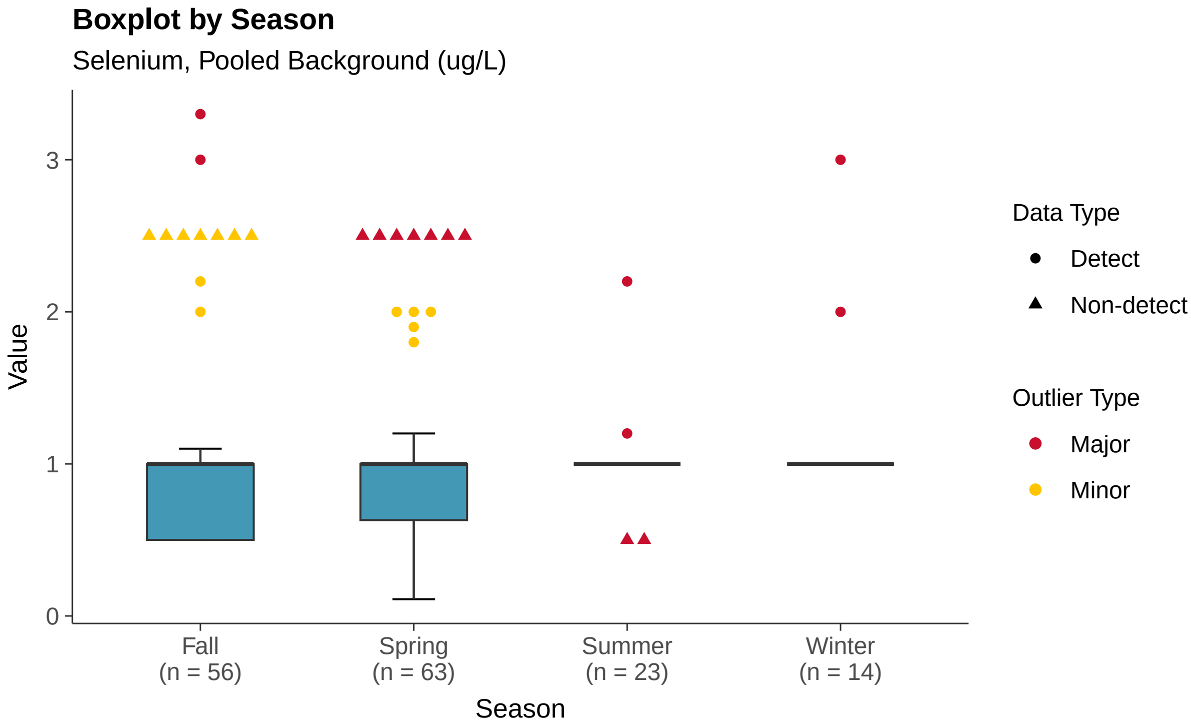
Selenium, Pooled Background (ug/L)

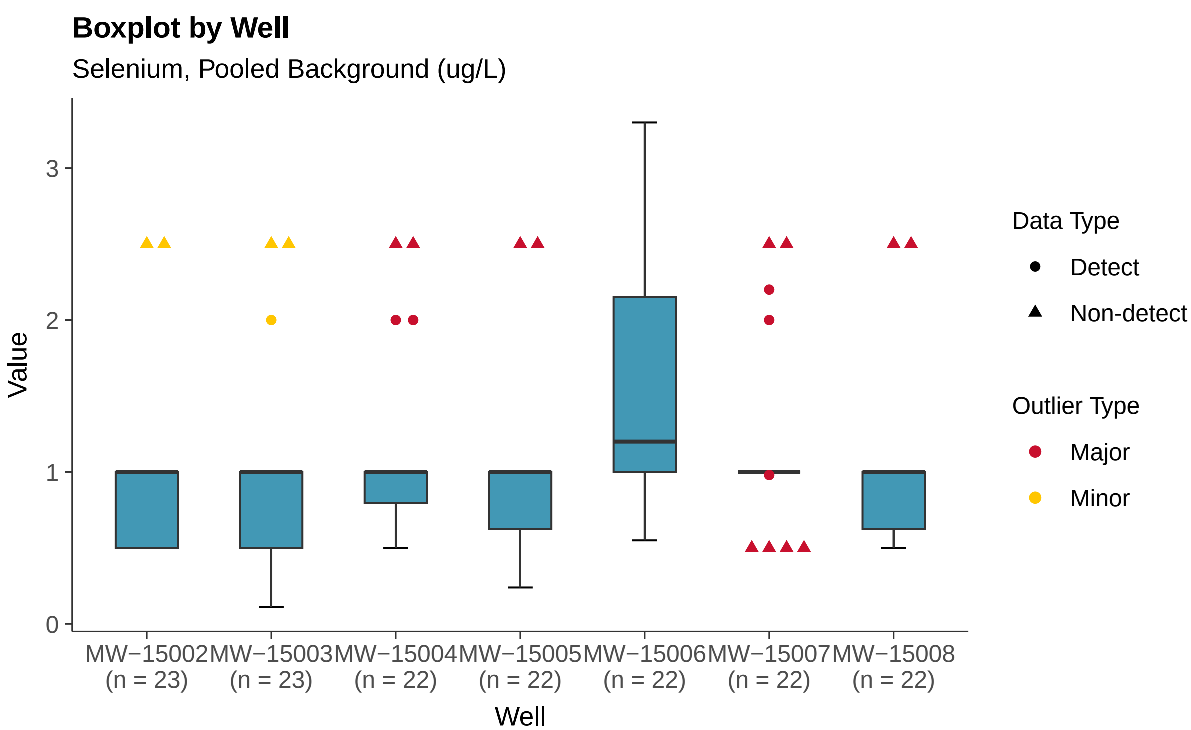


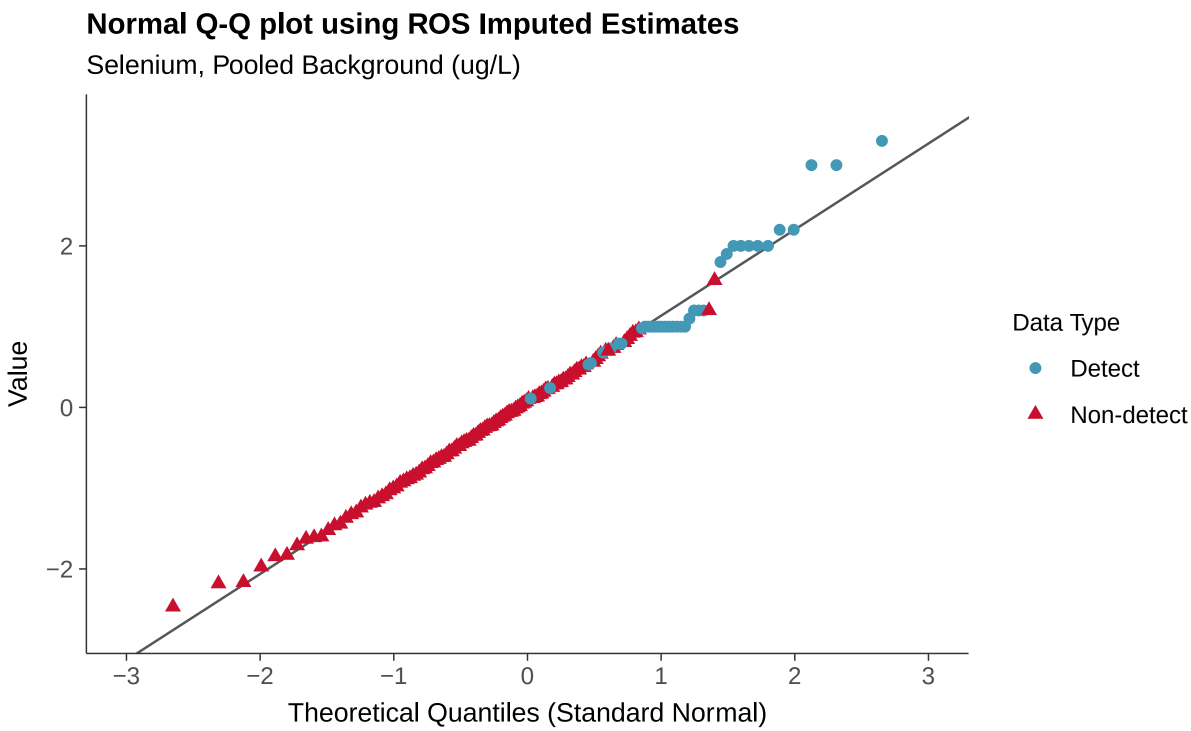
Boxplot

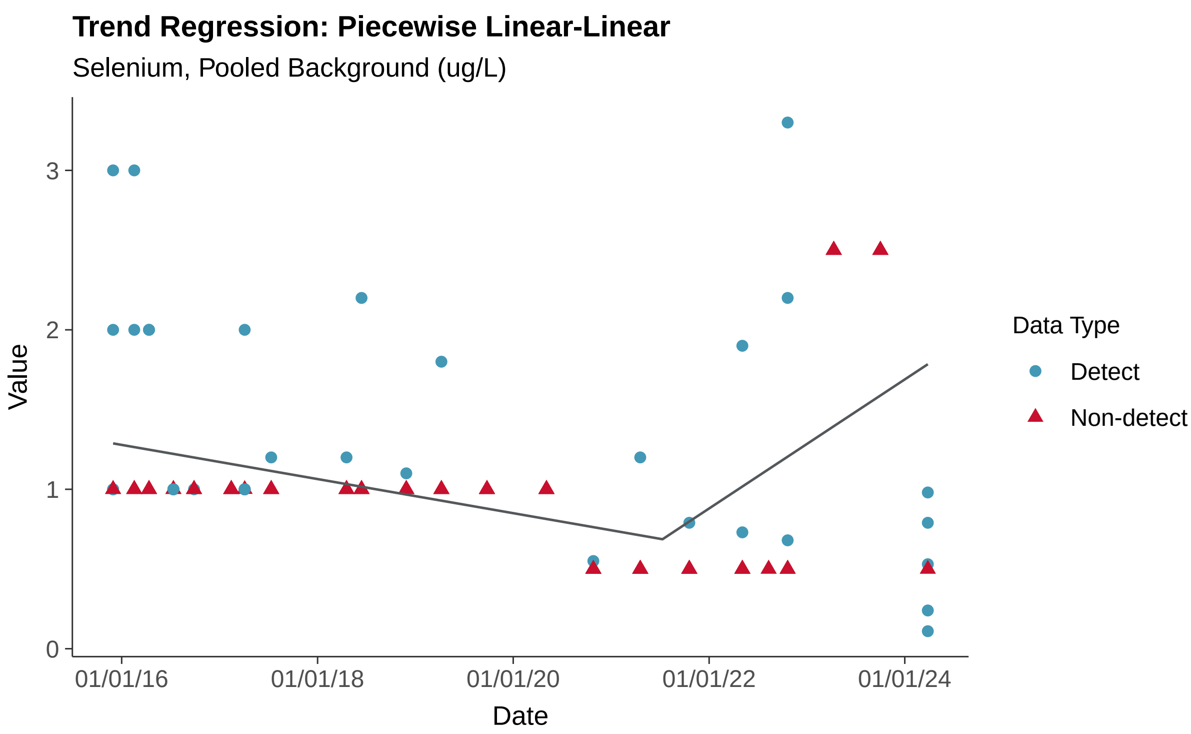
Selenium, Pooled Background (ug/L)




Boxplot by Season
Selenium, Pooled Background (ug/L)
Value
0
1
2
3
Fall
(n = 56)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Non-detect
Outlier Type
Major
Minor

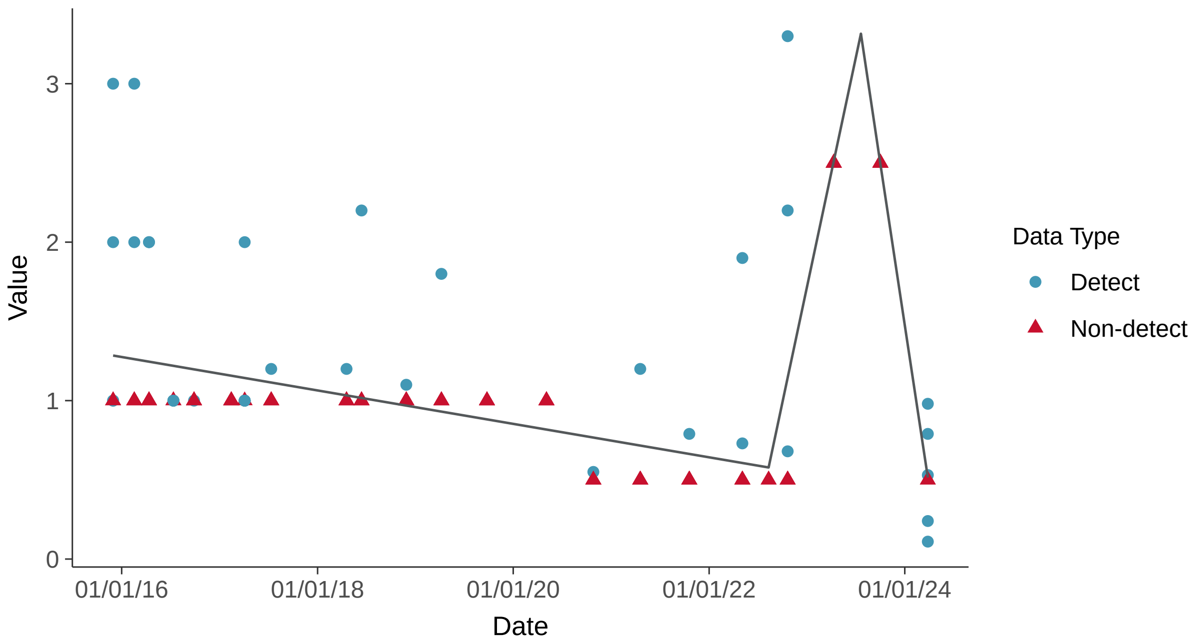

Boxplot by Well
Selenium, Pooled Background (ug/L)
Value
0
1
2
3
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 22)
MW−15007
(n = 22)
MW−15008
(n = 22)
Well
Data Type
Detect
Non-detect
Outlier Type
Major
Minor


Normal Q-Q plot using ROS Imputed Estimates
Selenium, Pooled Background (ug/L)
Value
2
0
−2
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Selenium, Pooled Background (ug/L)
Value
3
2
1
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

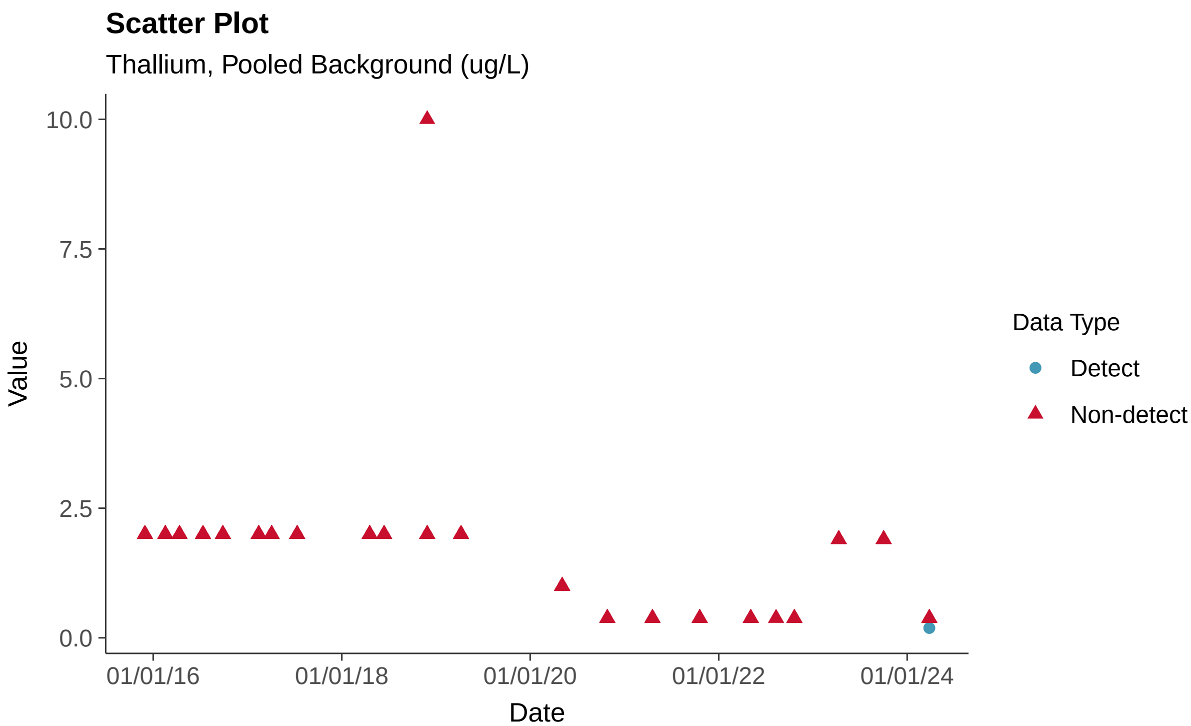
Trend Regression: Piecewise Linear-Linear-Linear

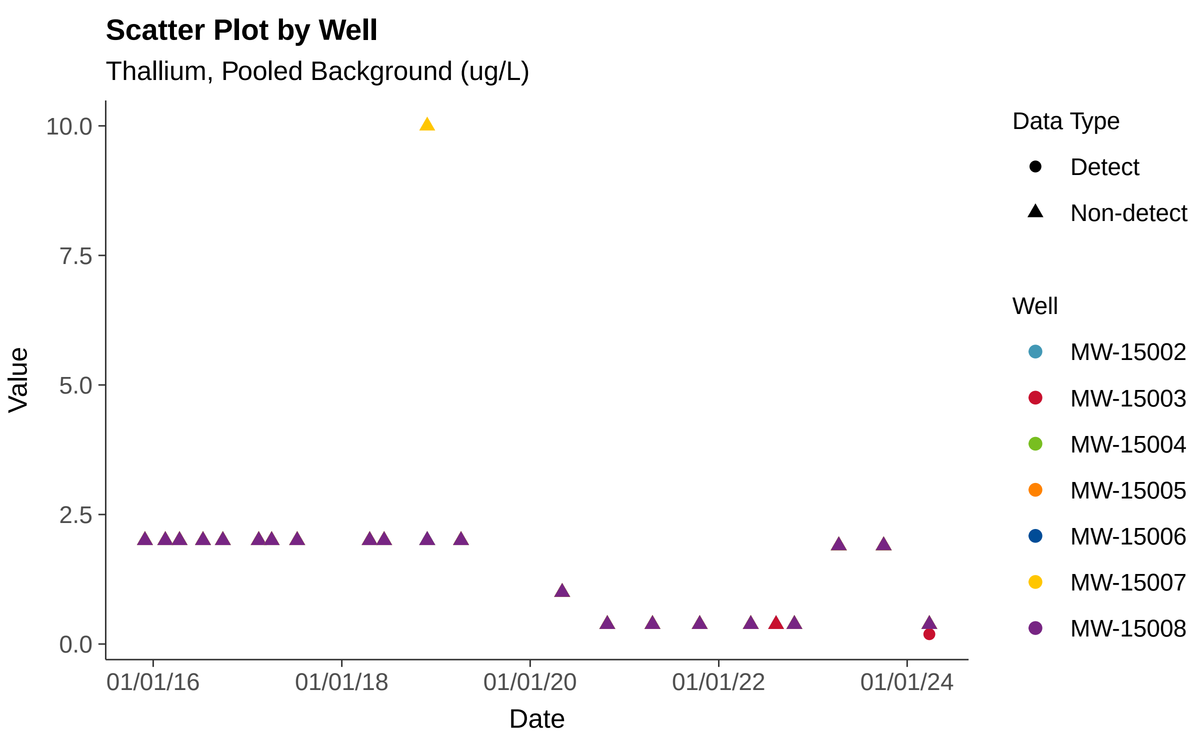
Selenium, Pooled Background (ug/L)



Appendix IV: Thallium, Pooled Background

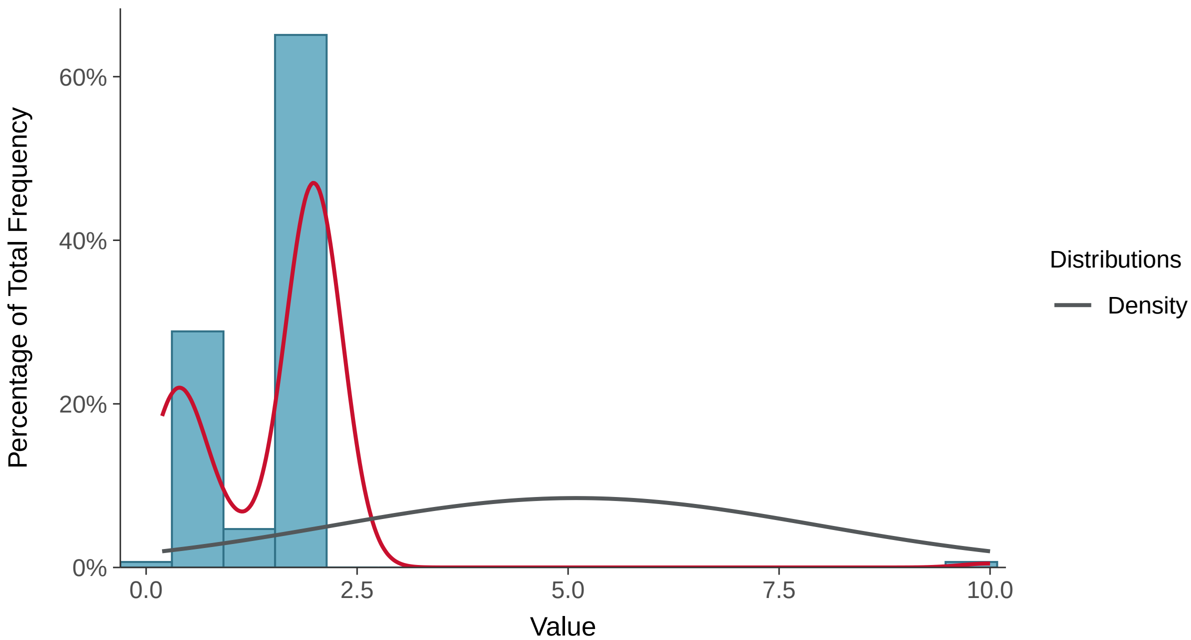
ID: 2_130





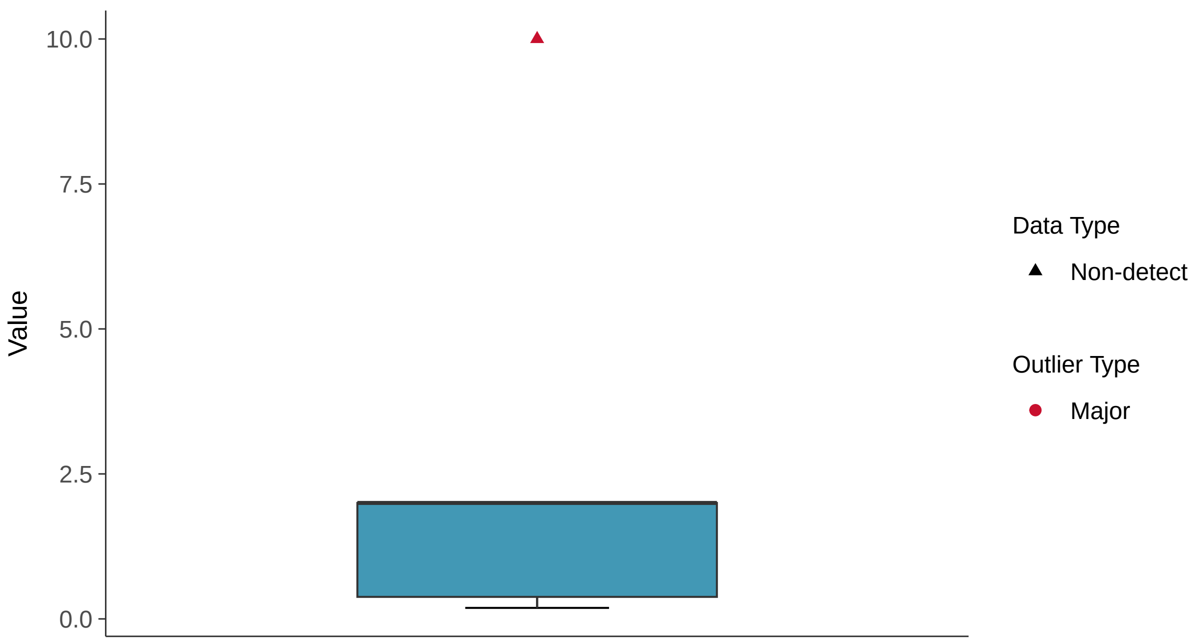
Histogram

Thallium, Pooled Background (ug/L)



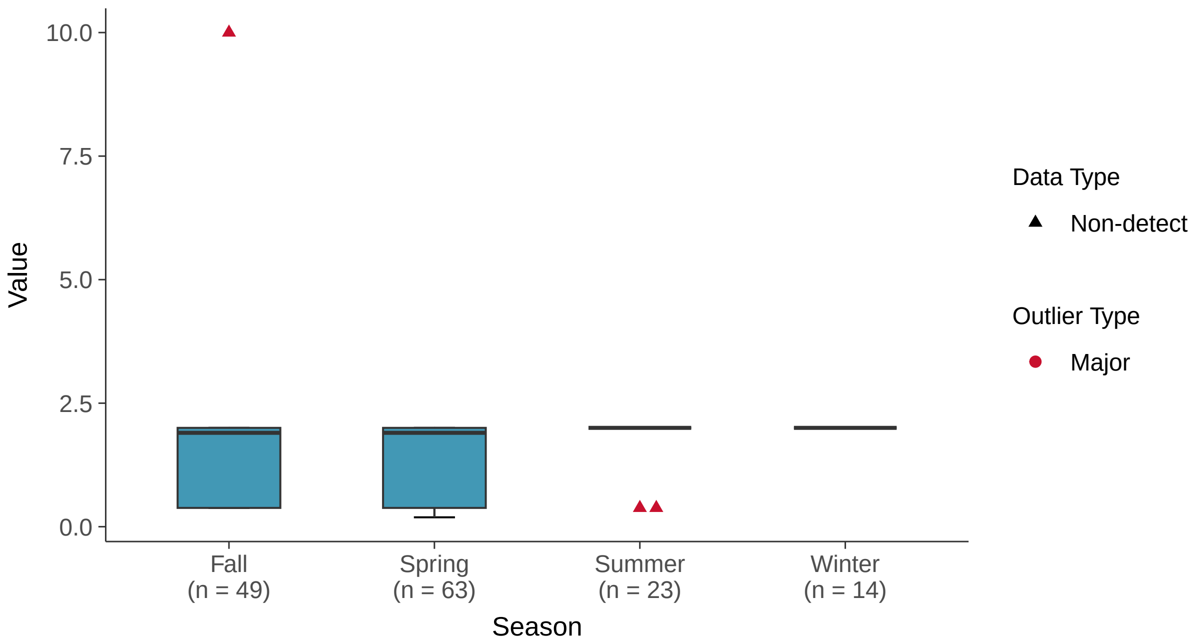
Boxplot

Thallium, Pooled Background (ug/L)



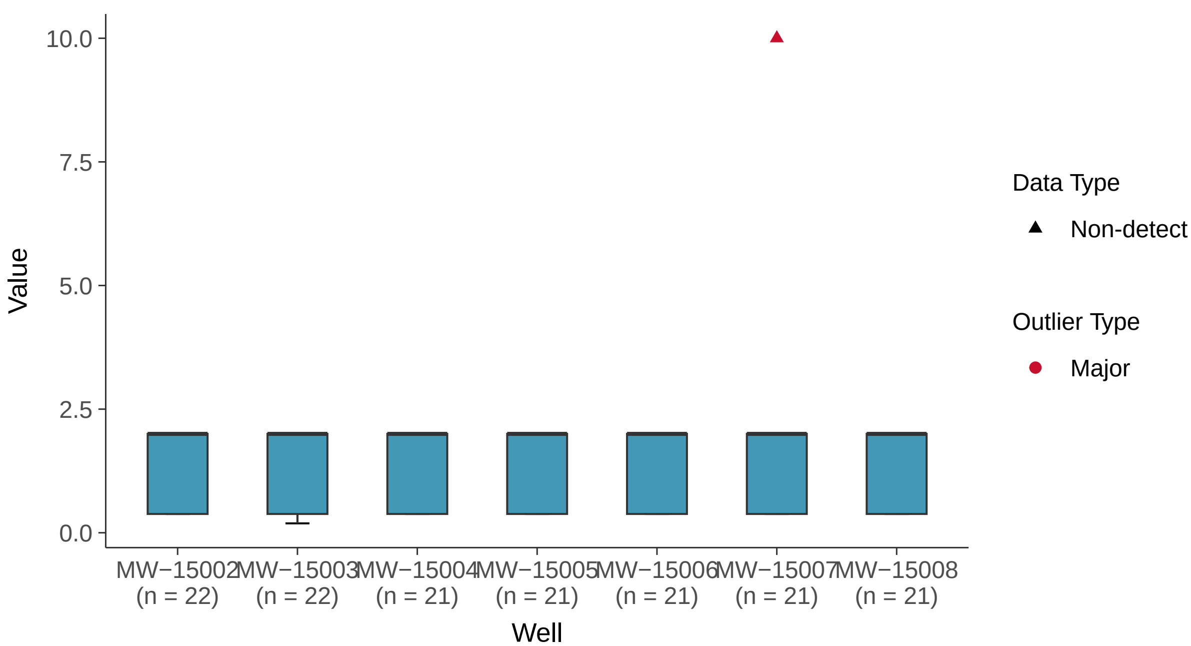
Boxplot by Season

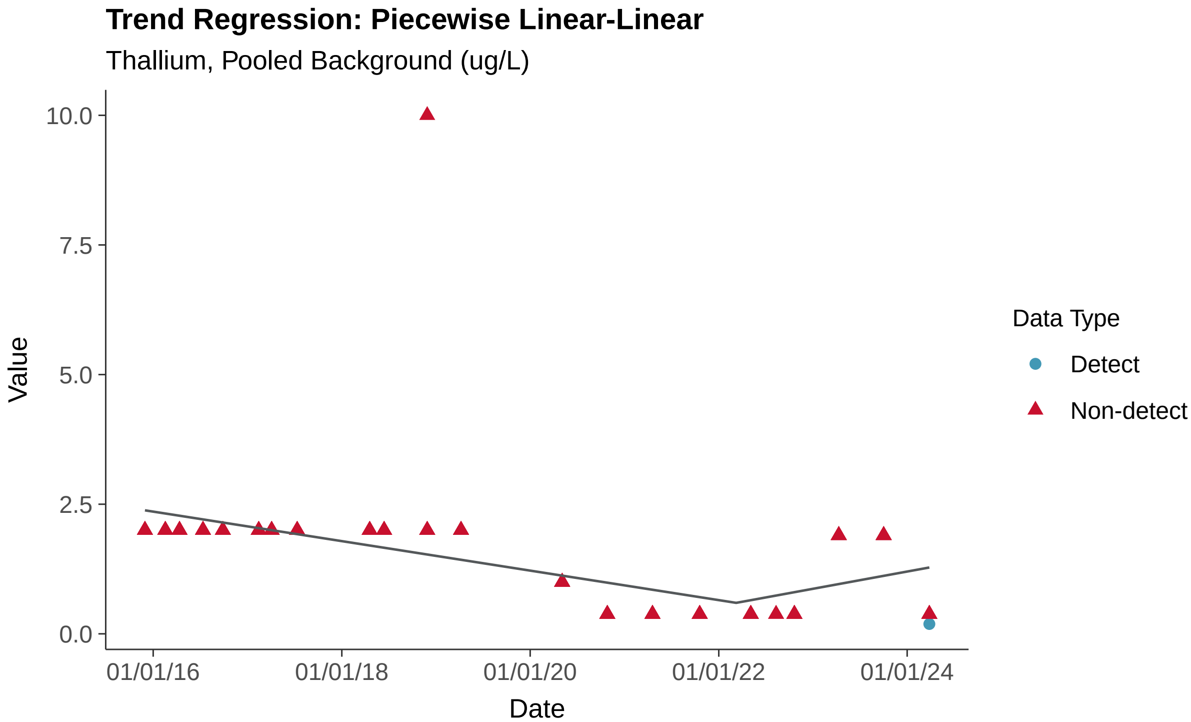
Thallium, Pooled Background (ug/L)

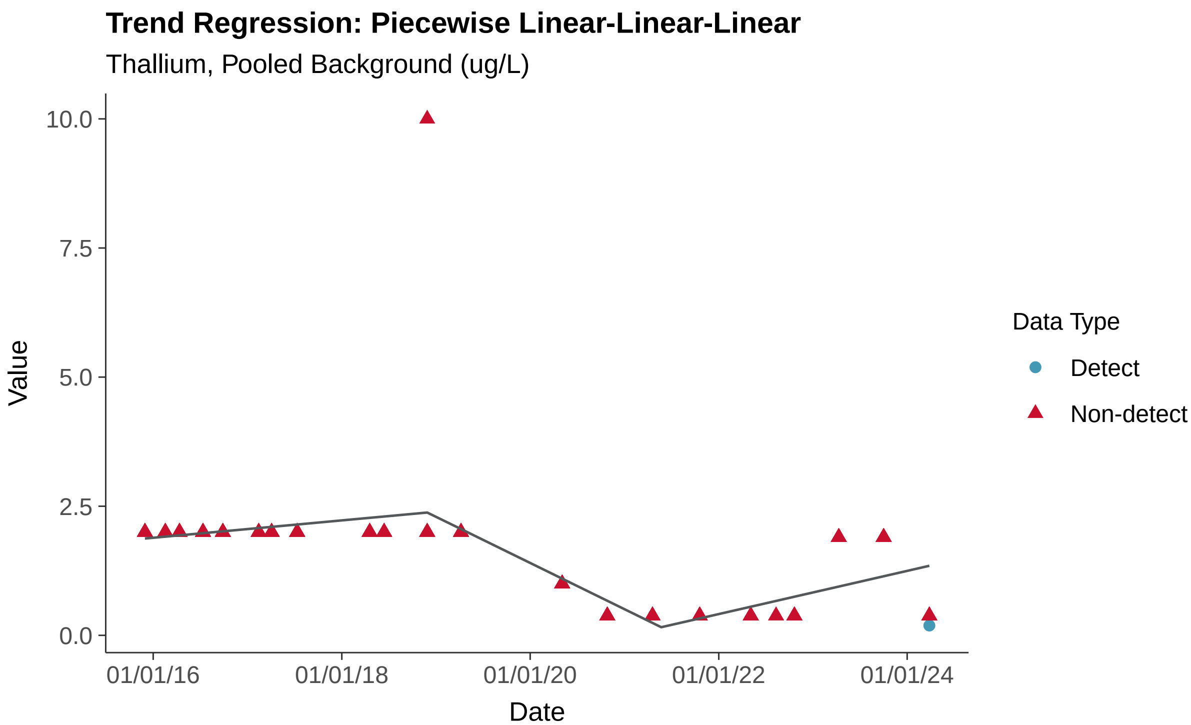


Boxplot by Well

Thallium, Pooled Background (ug/L)

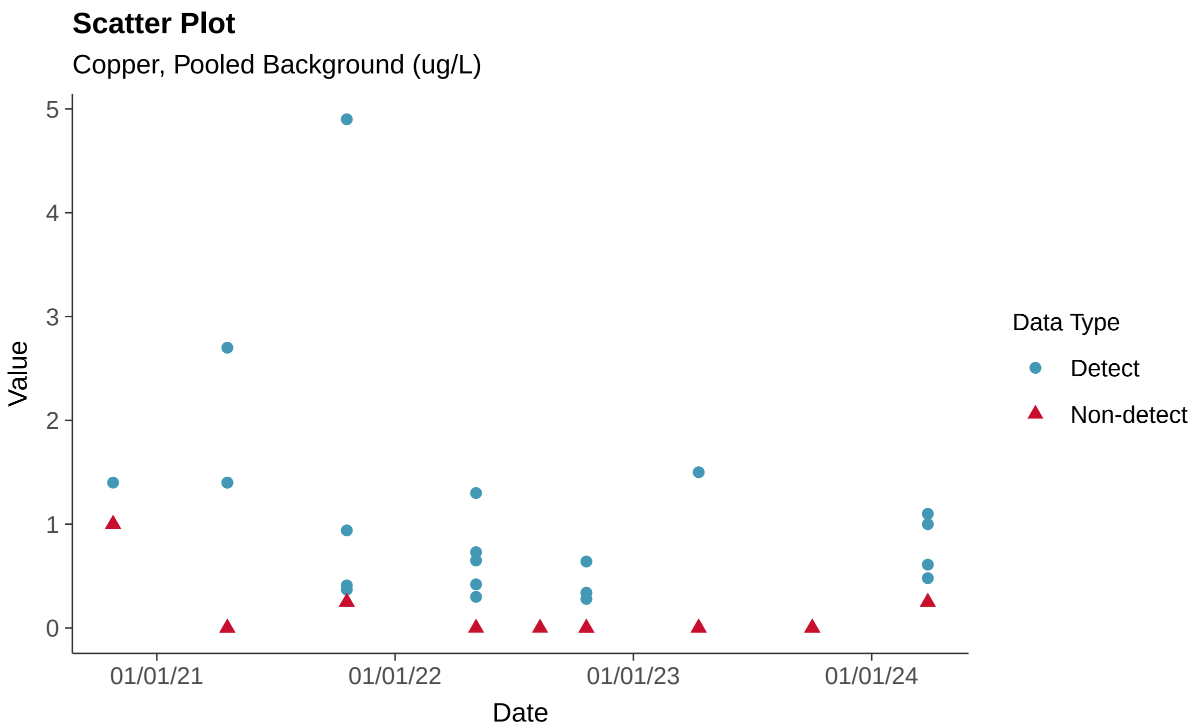


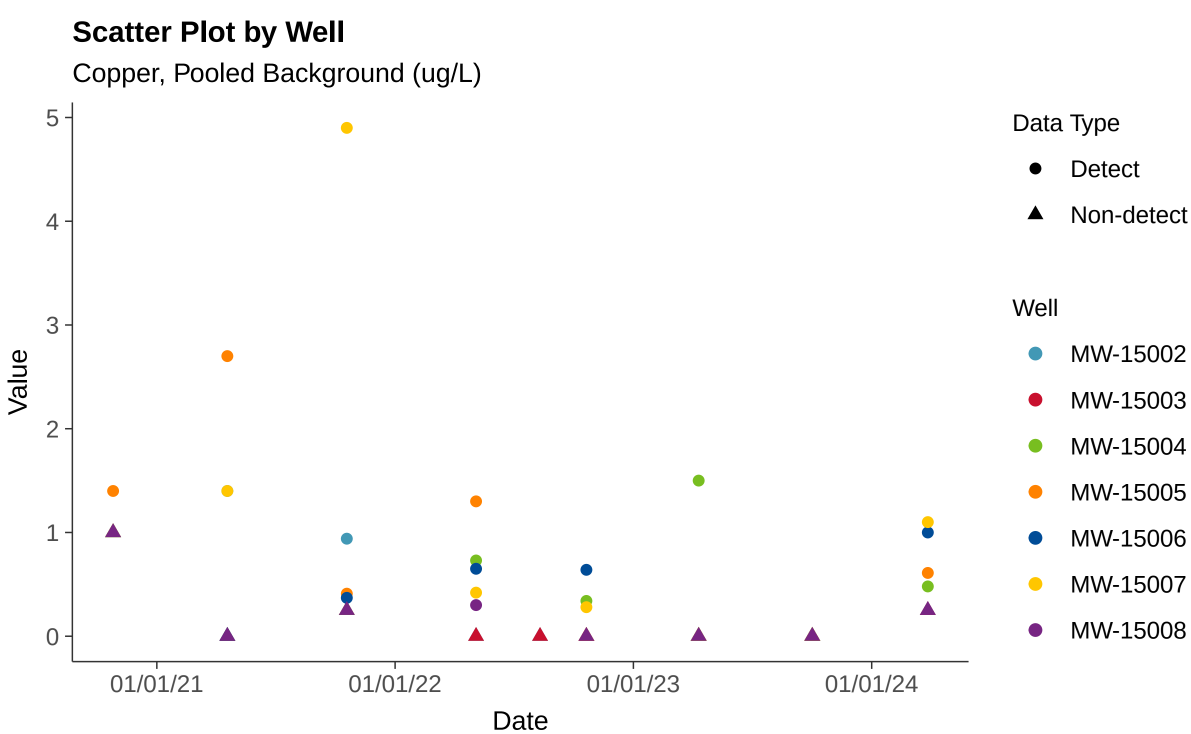

Trend Regression: Piecewise Linear-Linear
Thallium, Pooled Background (ug/L)
Value
10.0
7.5
5.0
2.5
0.0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear-Linear
Thallium, Pooled Background (ug/L)
Value
10.0
7.5
5.0
2.5
0.0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

Michigan CCR: Copper, Pooled Background

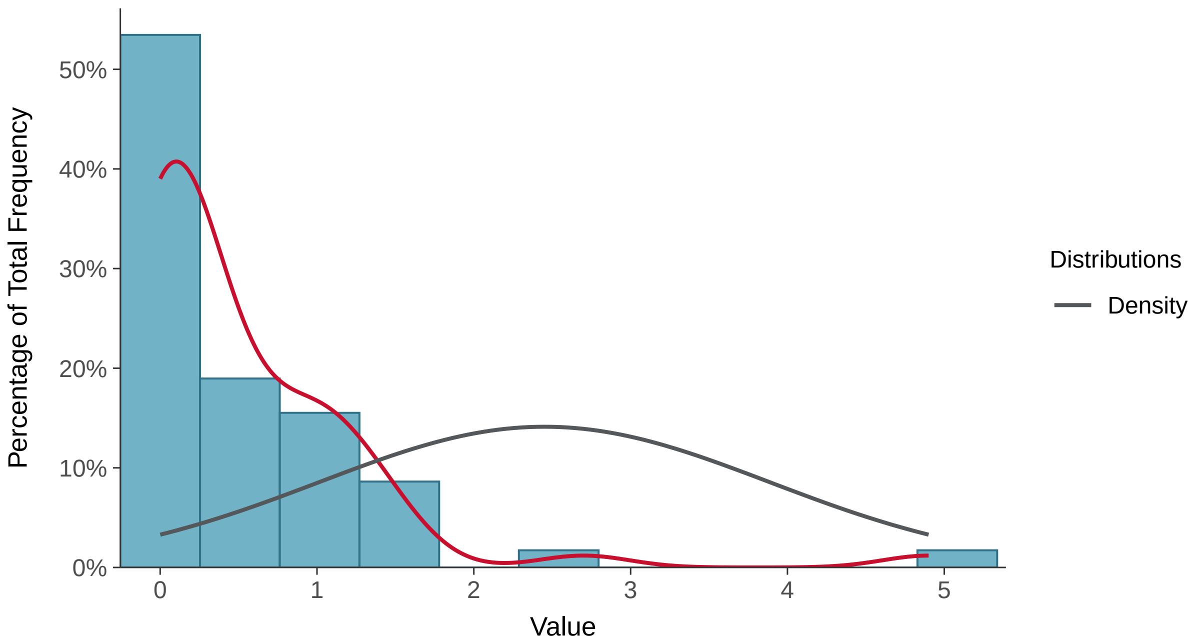
ID: 4_112





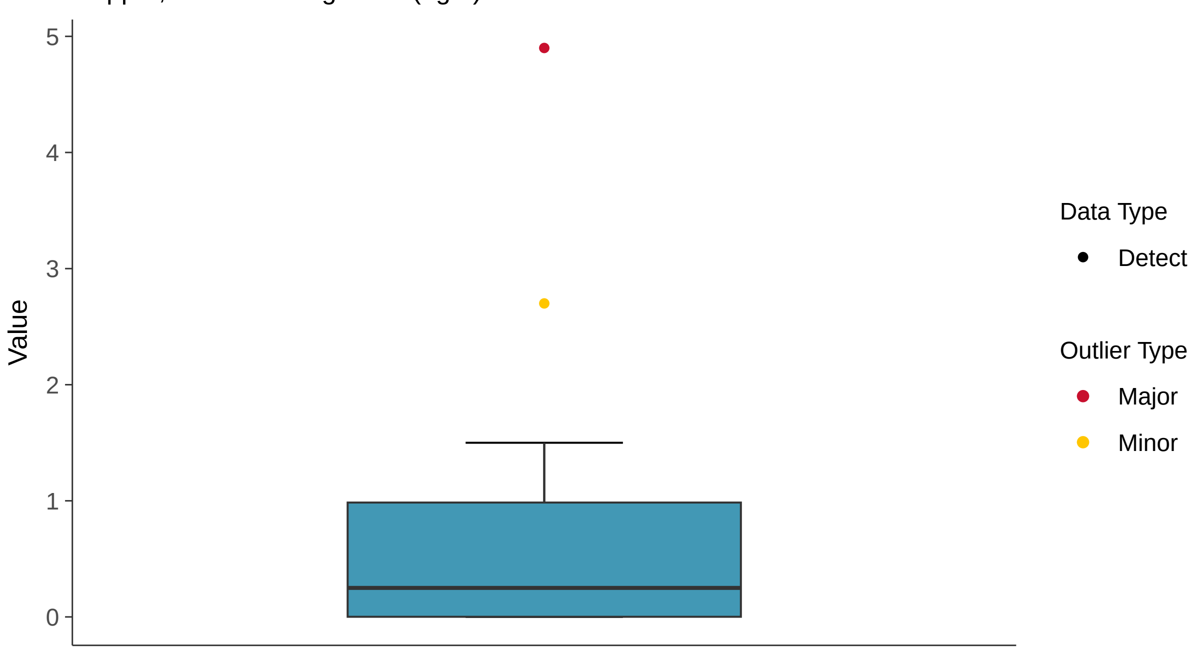
Histogram

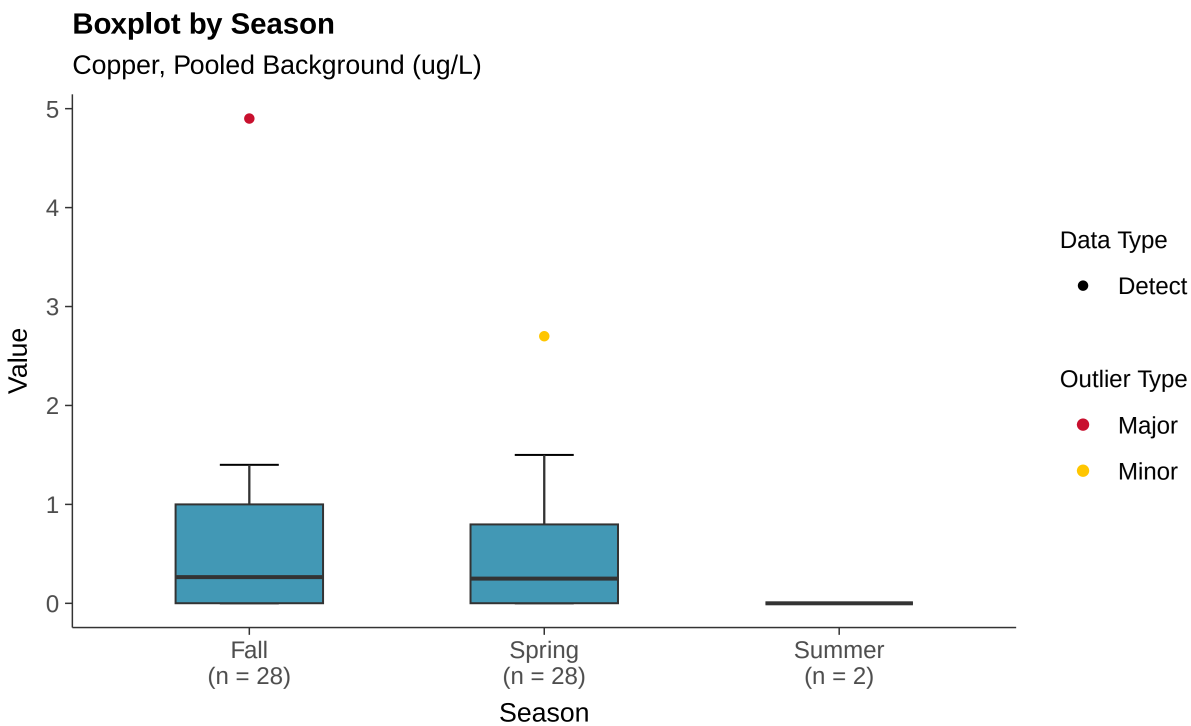
Copper, Pooled Background (ug/L)

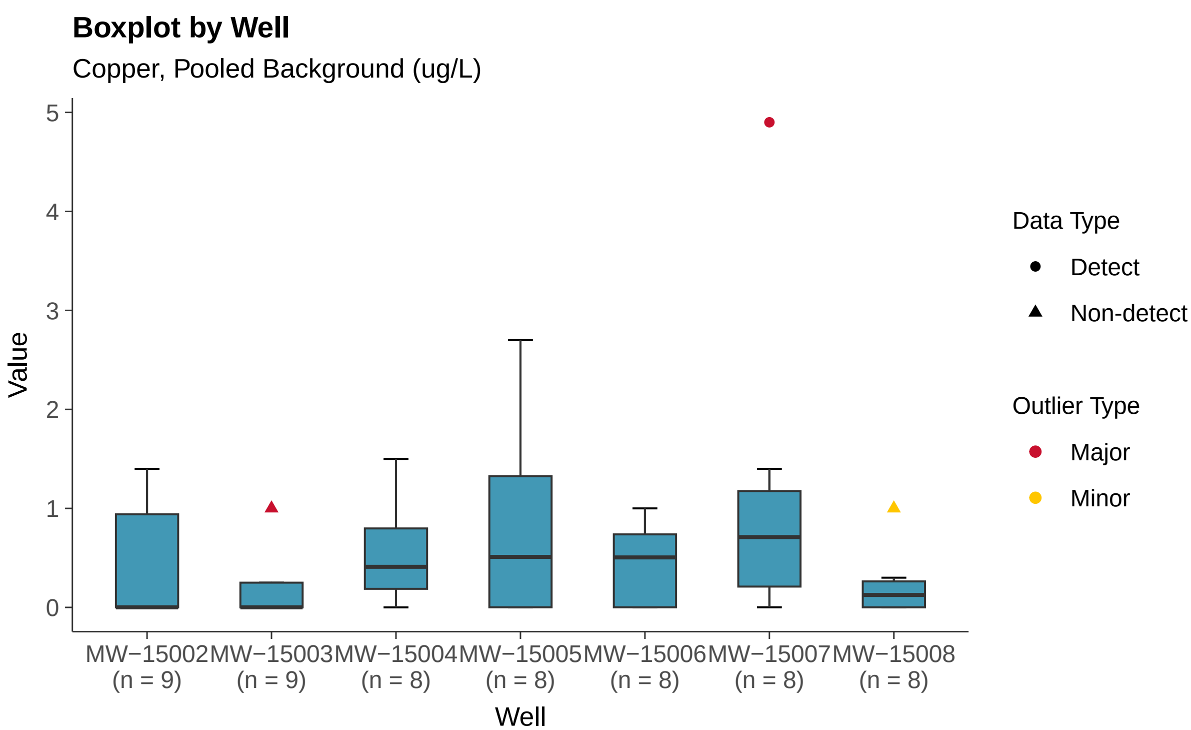


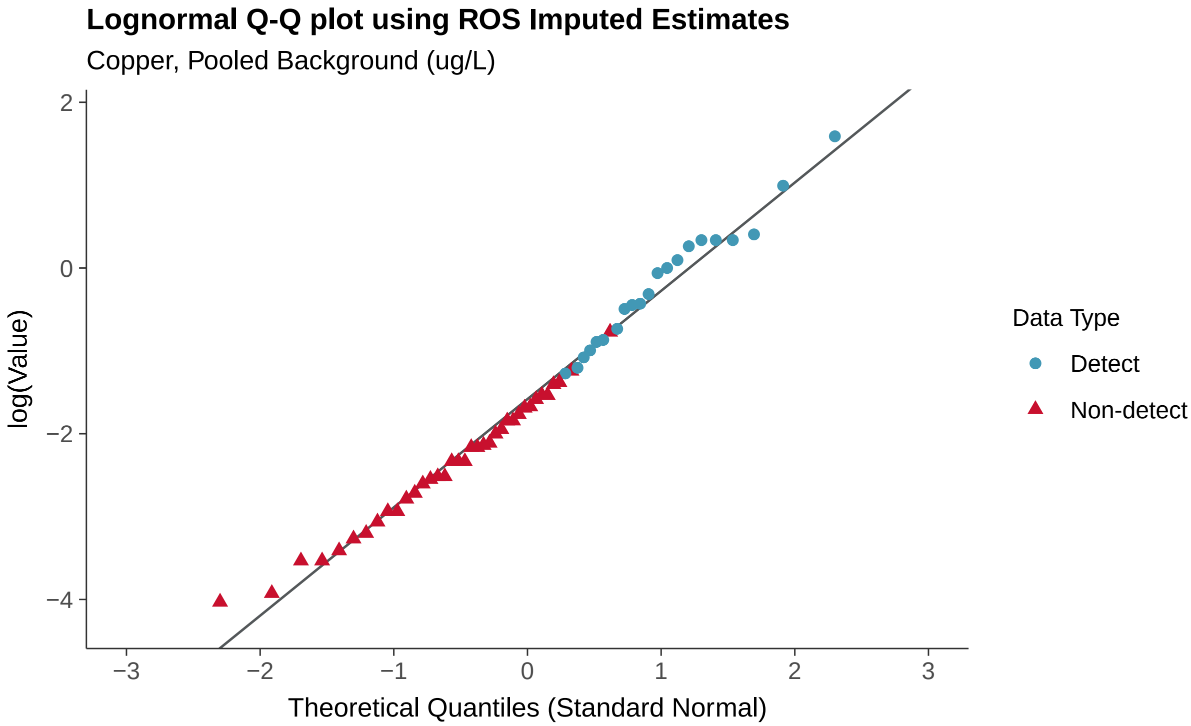
Boxplot

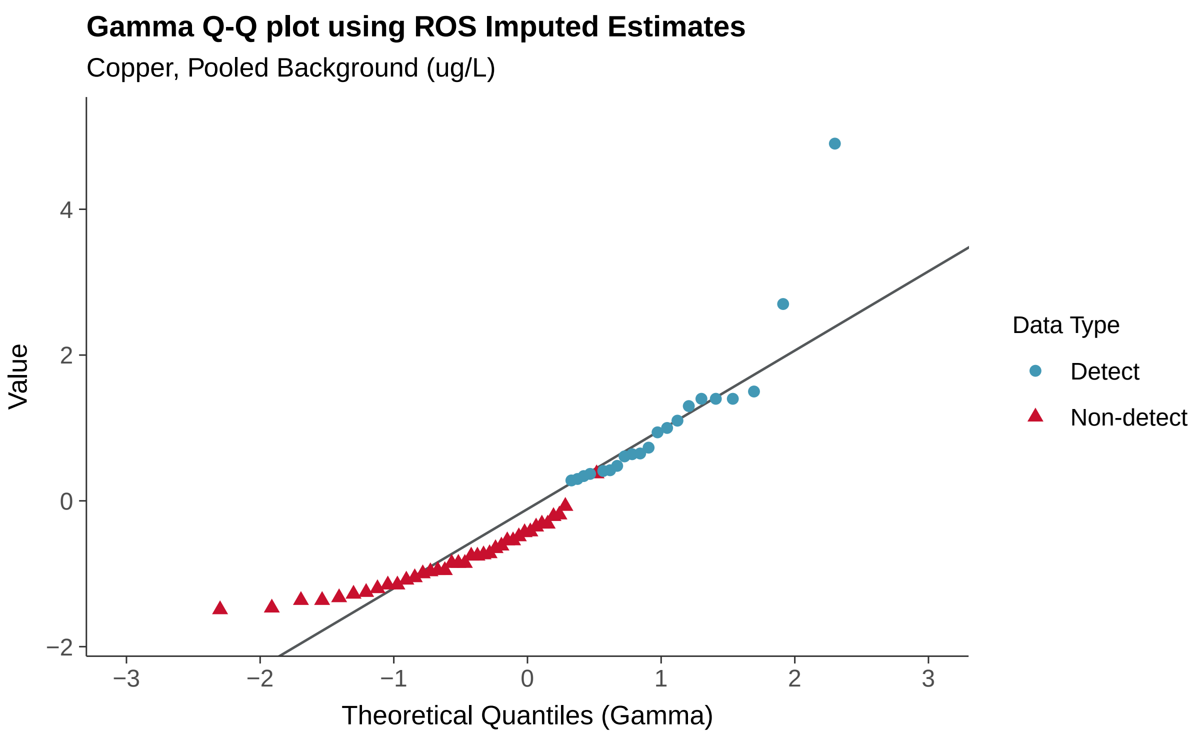
Copper, Pooled Background (ug/L)

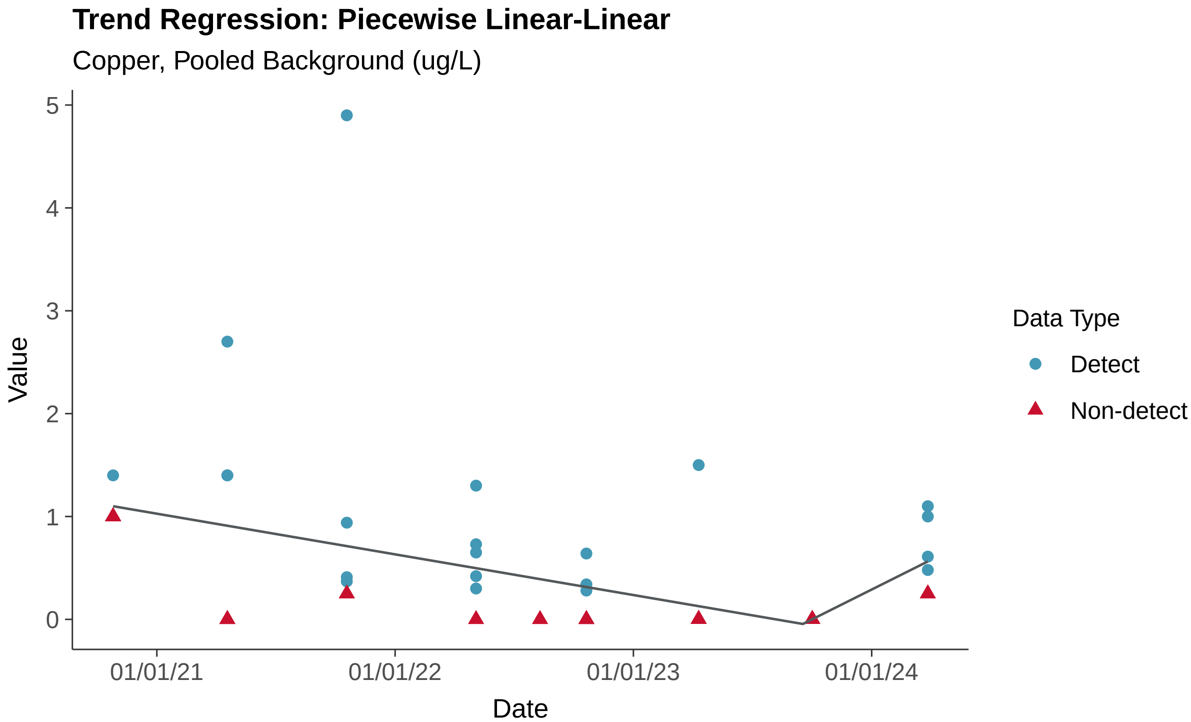


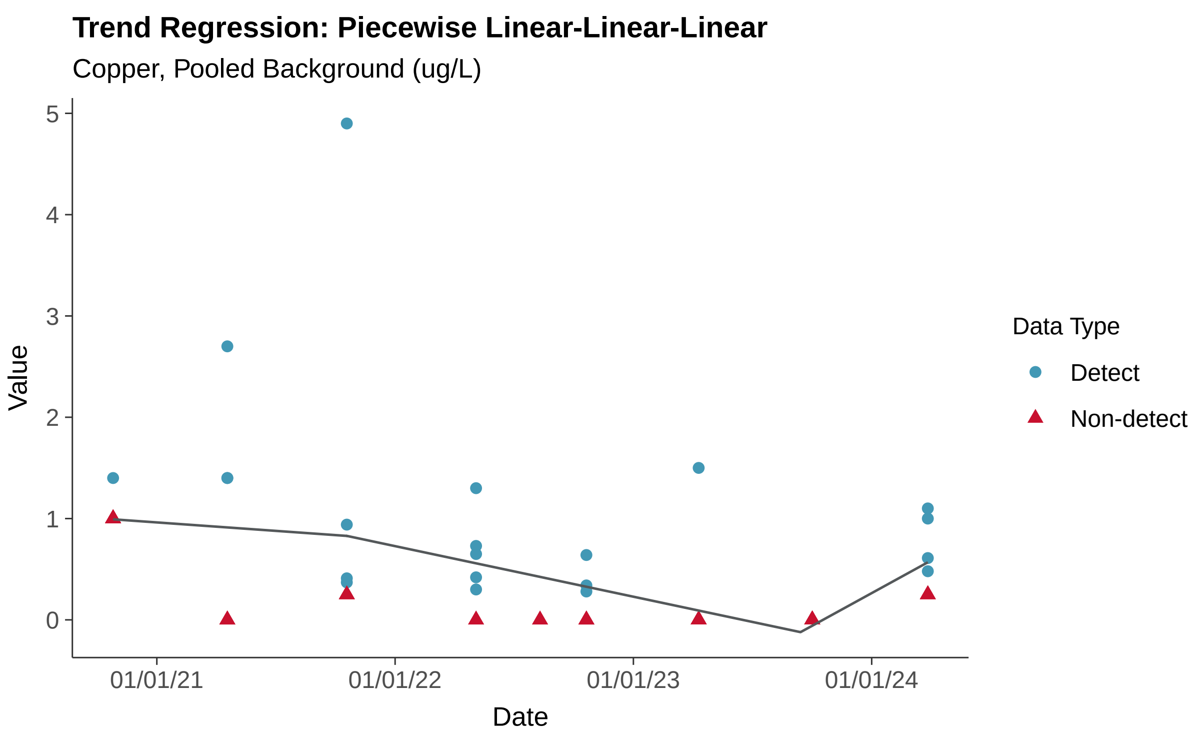

Boxplot by Season
Copper, Pooled Background (ug/L)
Value
5
4
3
2
1
0
Fall
(n = 28)
Spring
(n = 28)
Summer
(n = 2)
Season
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Well
Copper, Pooled Background (ug/L)
Value
5
4
3
2
1
0
MW−15002
(n = 9)
MW−15003
(n = 9)
MW−15004
(n = 8)
MW−15005
(n = 8)
MW−15006
(n = 8)
MW−15007
(n = 8)
MW−15008
(n = 8)
Well
Data Type
Detect
Non-detect
Outlier Type
Major
Minor


Lognormal Q-Q plot using ROS Imputed Estimates
Copper, Pooled Background (ug/L)
log(Value)
2
0
−2
−4
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Gamma Q-Q plot using ROS Imputed Estimates
Copper, Pooled Background (ug/L)
Value
4
2
0
−2
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Gamma)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Copper, Pooled Background (ug/L)
Value
5
4
3
2
1
0
01/01/21
01/01/22
01/01/23
01/01/24
Date
Data Type
Detect
Non-detect

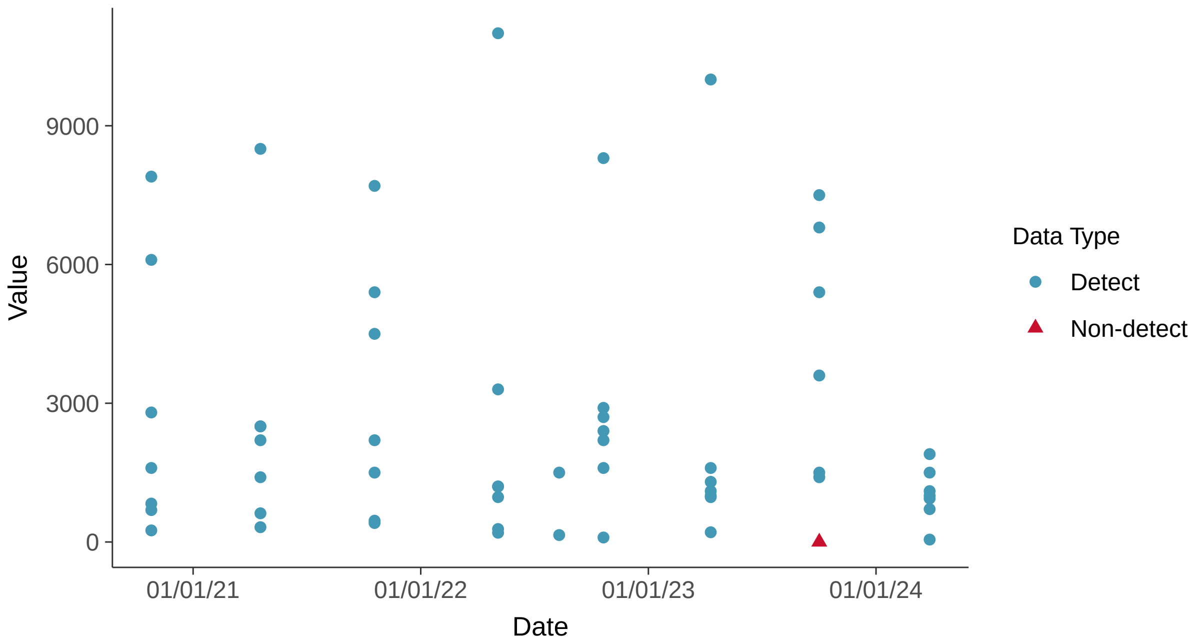

Trend Regression: Piecewise Linear-Linear-Linear
Copper, Pooled Background (ug/L)
Value
5
4
3
2
1
0
01/01/21
01/01/22
01/01/23
01/01/24
Date
Data Type
Detect
Non-detect

Michigan CCR: Iron, Pooled Background

ID: 4_115

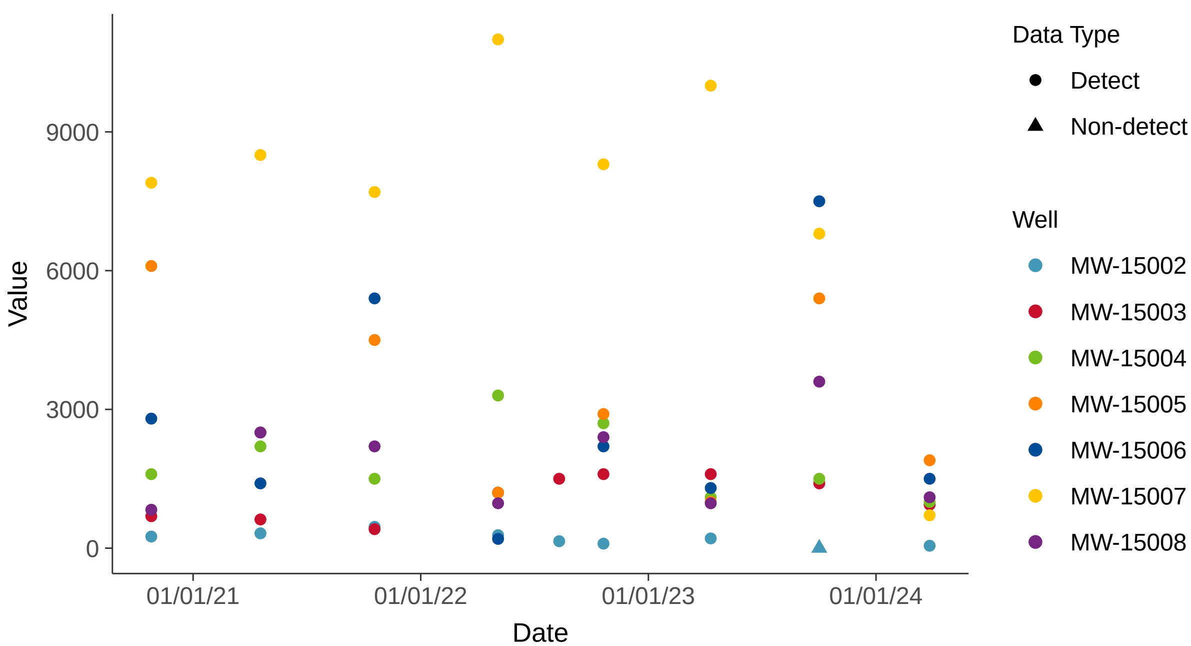
Scatter Plot

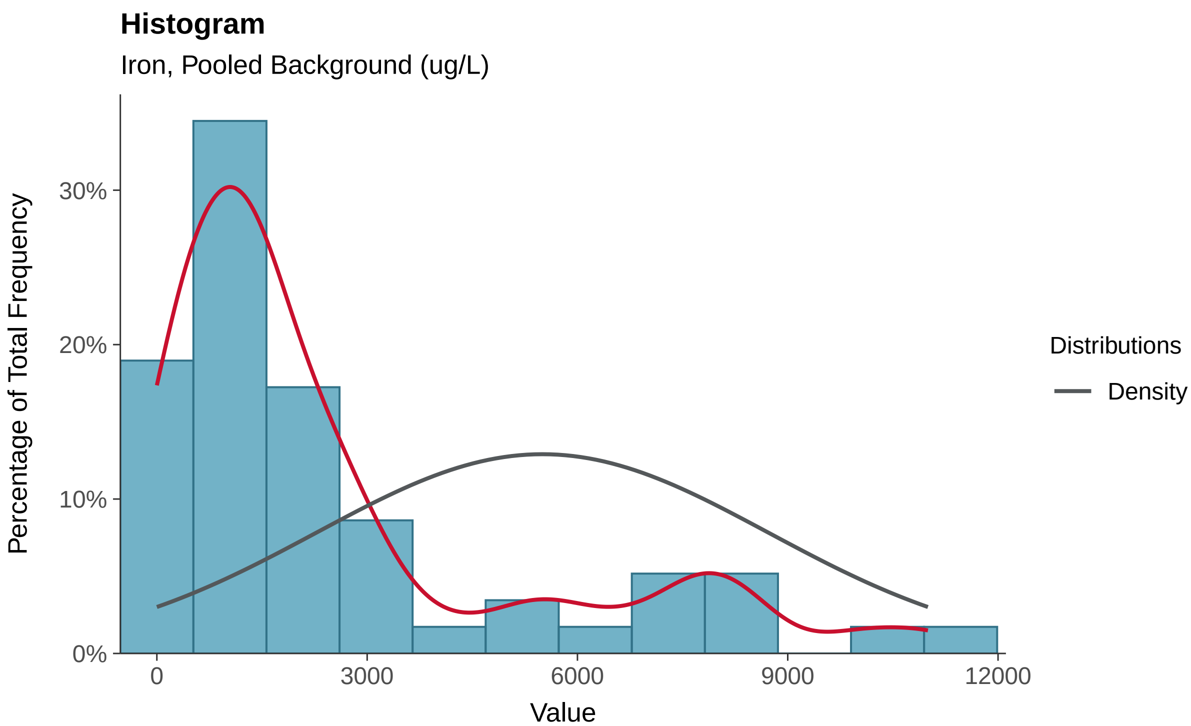
Iron, Pooled Background (ug/L)

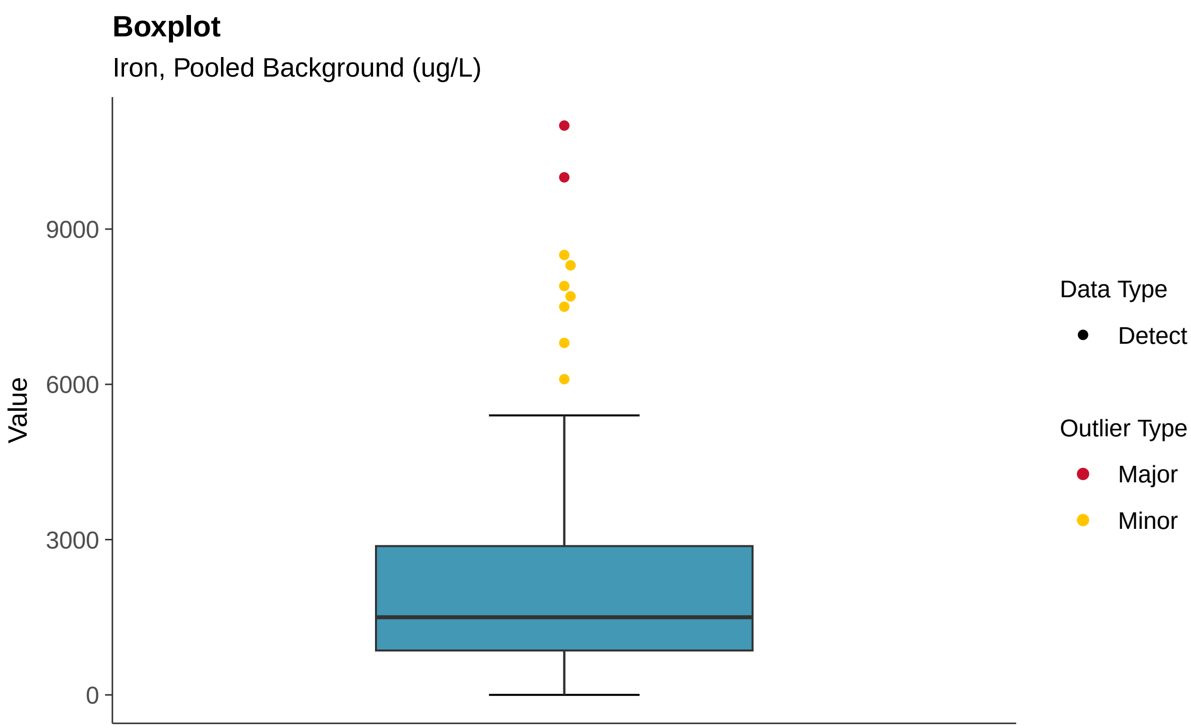


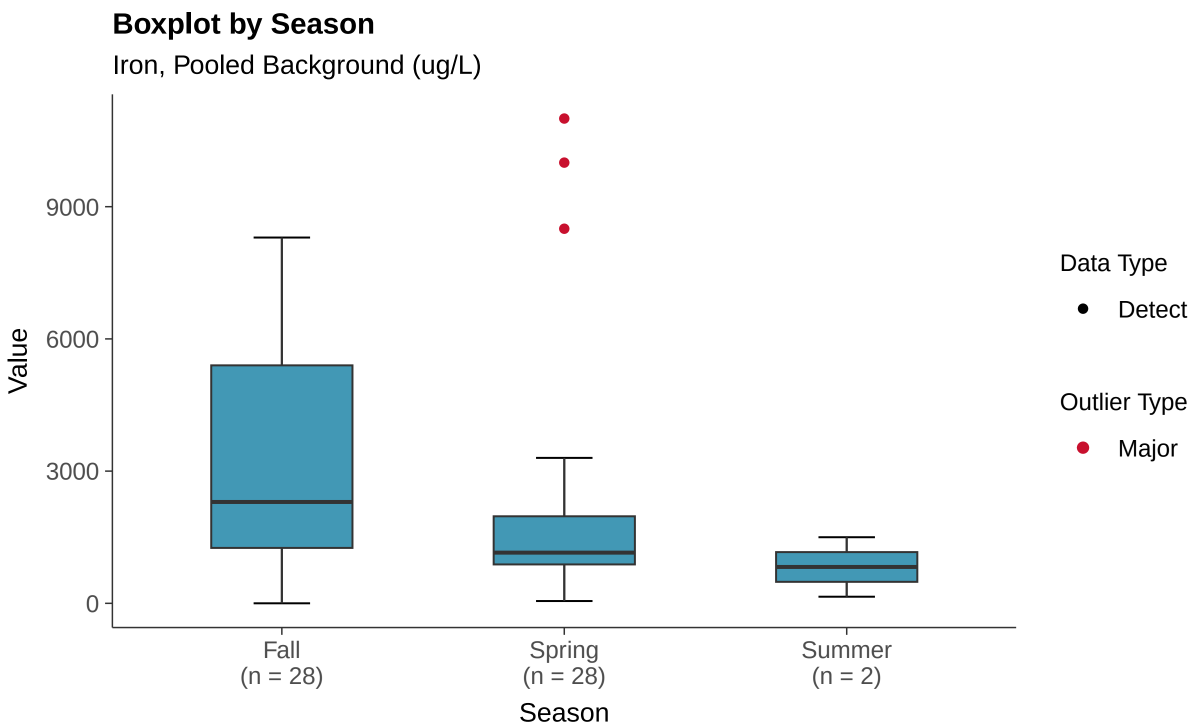
Scatter Plot by Well

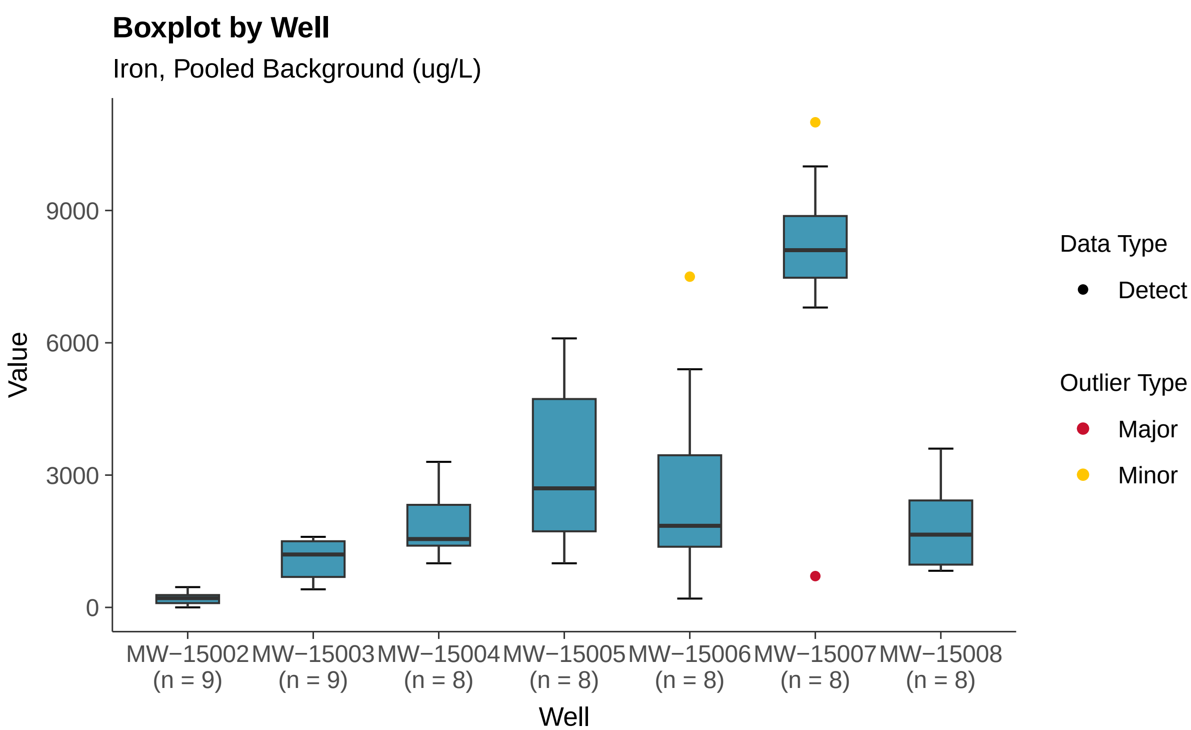
Iron, Pooled Background (ug/L)

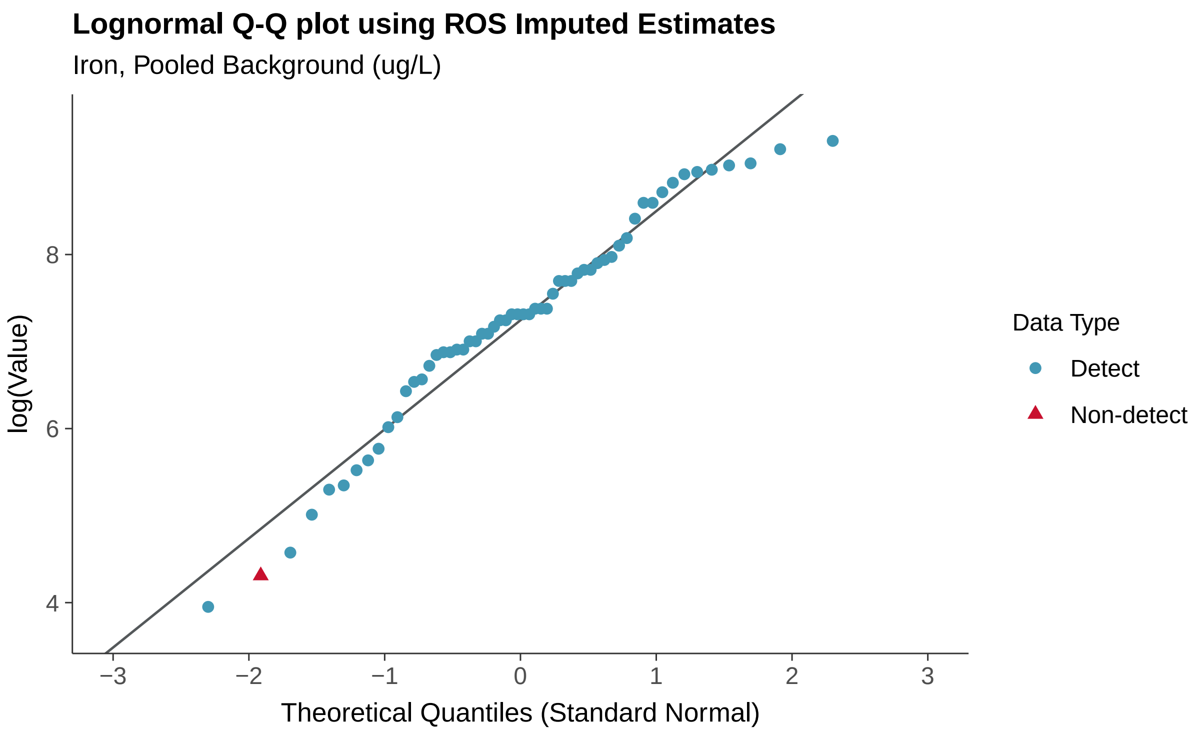


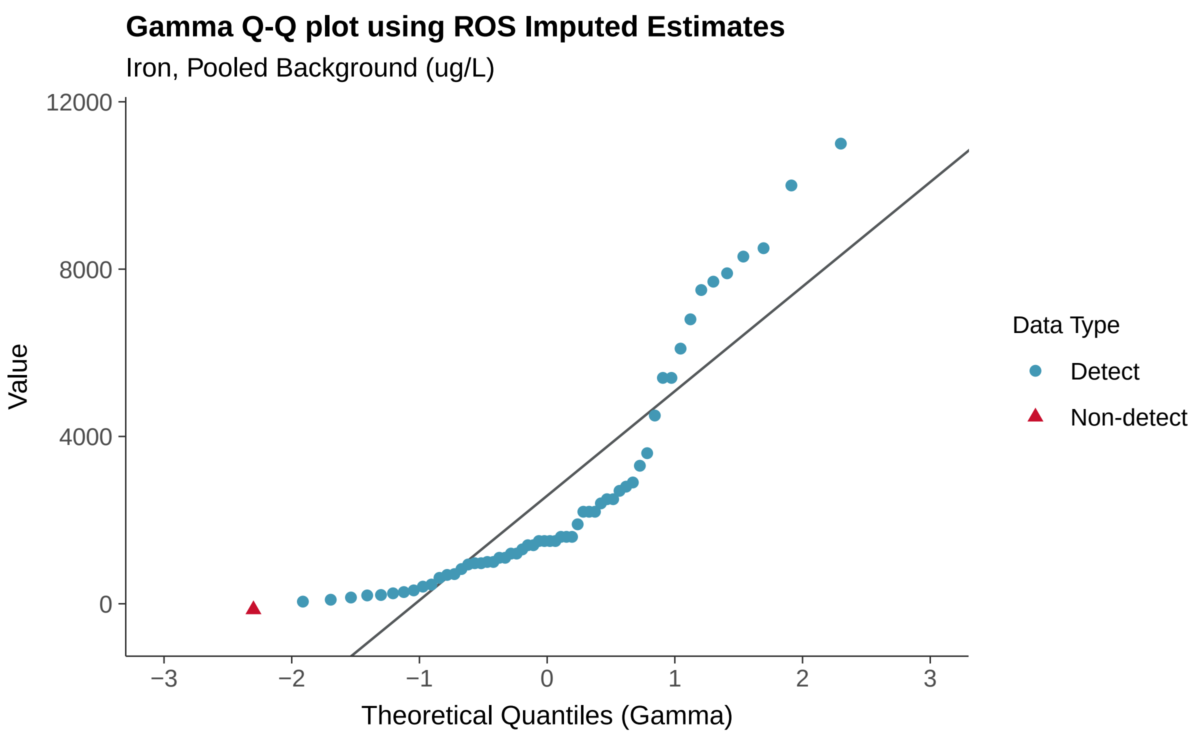

Histogram
Iron, Pooled Background (ug/L)
Percentage of Total Frequency
30%
20%
10%
0%
0
3000
6000
9000
12000
Value
Distributions
Density


Boxplot
Iron, Pooled Background (ug/L)
Value
9000
6000
3000
0
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Season
Iron, Pooled Background (ug/L)
Value
9000
6000
3000
0
Fall
(n = 28)
Spring
(n = 28)
Summer
(n = 2)
Season
Data Type
Detect
Outlier Type
Major

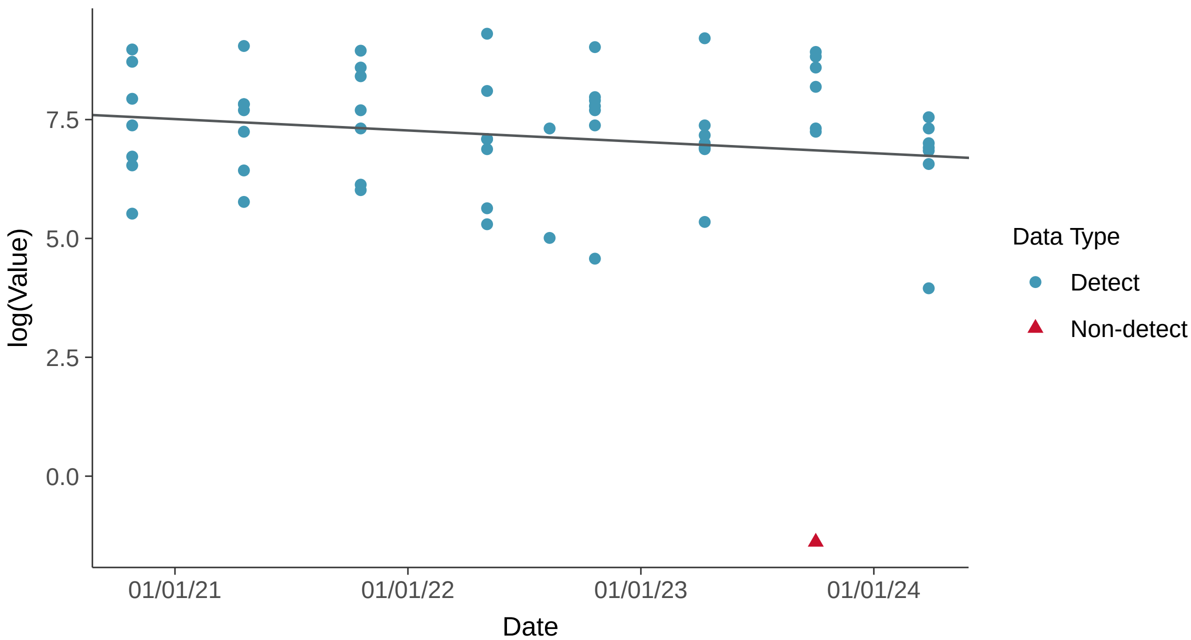

Boxplot by Well
Iron, Pooled Background (ug/L)
Value
9000
6000
3000
0
MW−15002
(n = 9)
MW−15003
(n = 9)
MW−15004
(n = 8)
MW−15005
(n = 8)
MW−15006
(n = 8)
MW−15007
(n = 8)
MW−15008
(n = 8)
Well
Data Type
Detect
Outlier Type
Major
Minor


Lognormal Q-Q plot using ROS Imputed Estimates
Iron, Pooled Background (ug/L)
log(Value)
8
6
4
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Gamma Q-Q plot using ROS Imputed Estimates
Iron, Pooled Background (ug/L)
Value
12000
8000
4000
0
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Gamma)
Data Type
Detect
Non-detect

Trend Regression: Lognormal MLE

Iron, Pooled Background (ug/L)

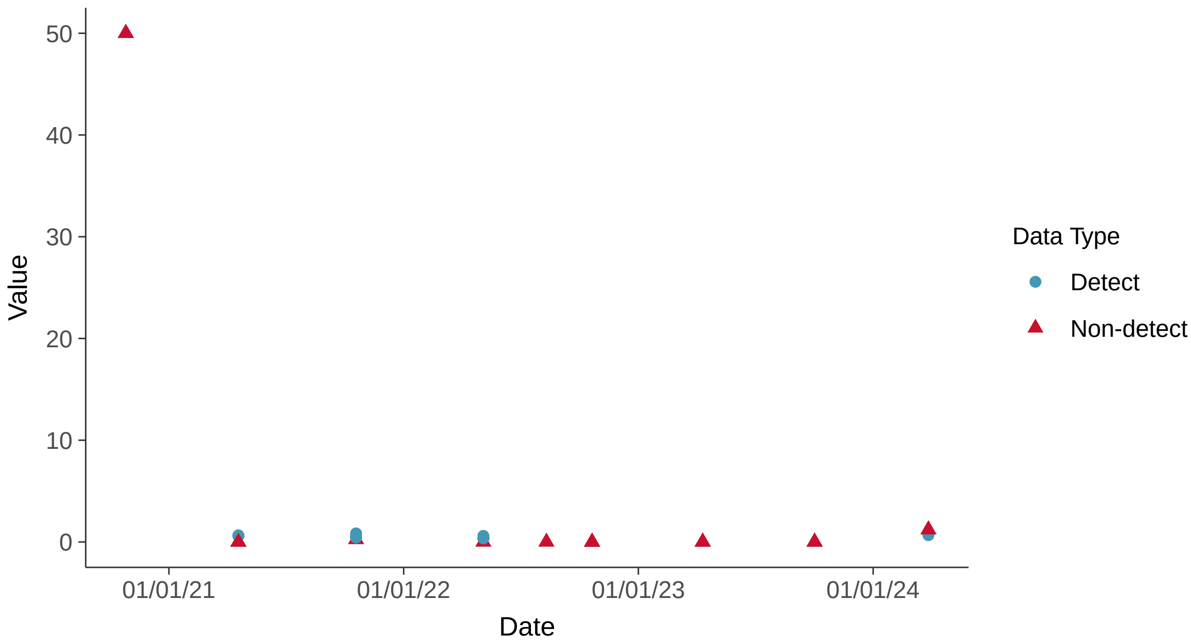


Michigan CCR: Nickel, Pooled Background

ID: 4_120

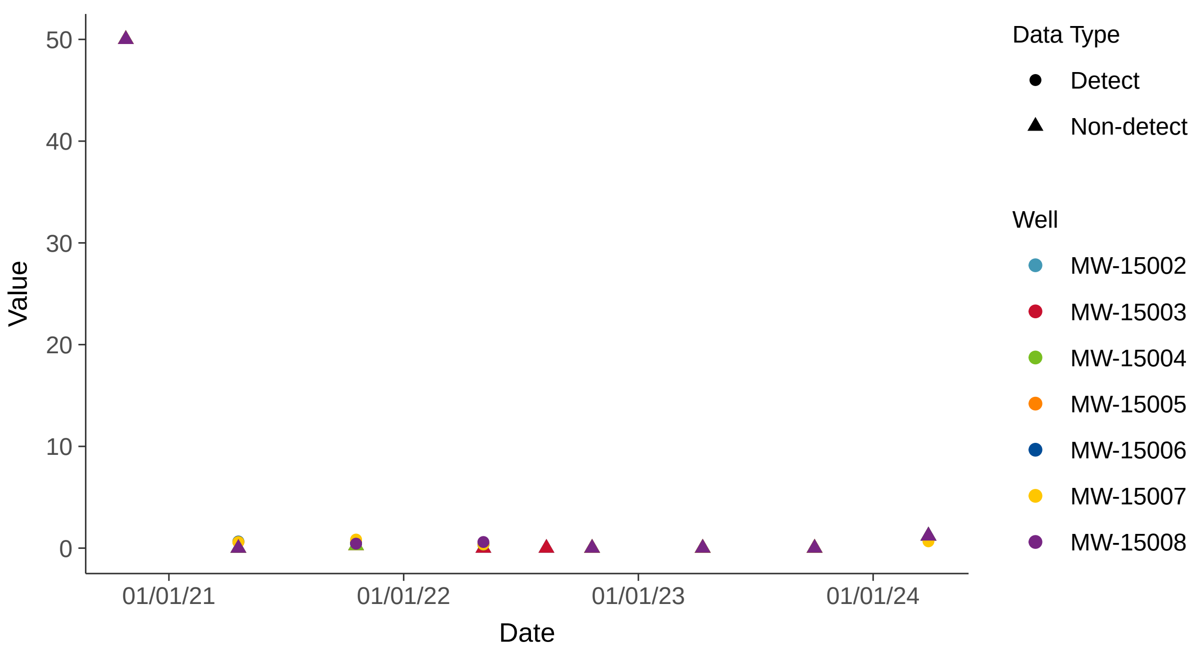
Scatter Plot

Nickel, Pooled Background (ug/L)



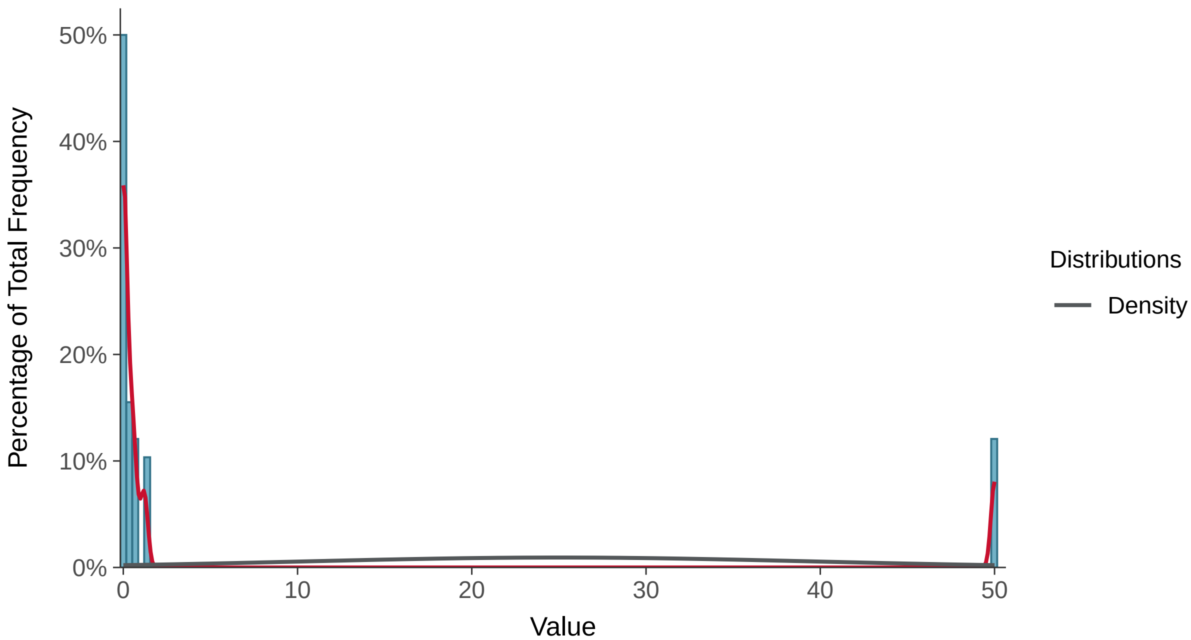
Scatter Plot by Well

Nickel, Pooled Background (ug/L)



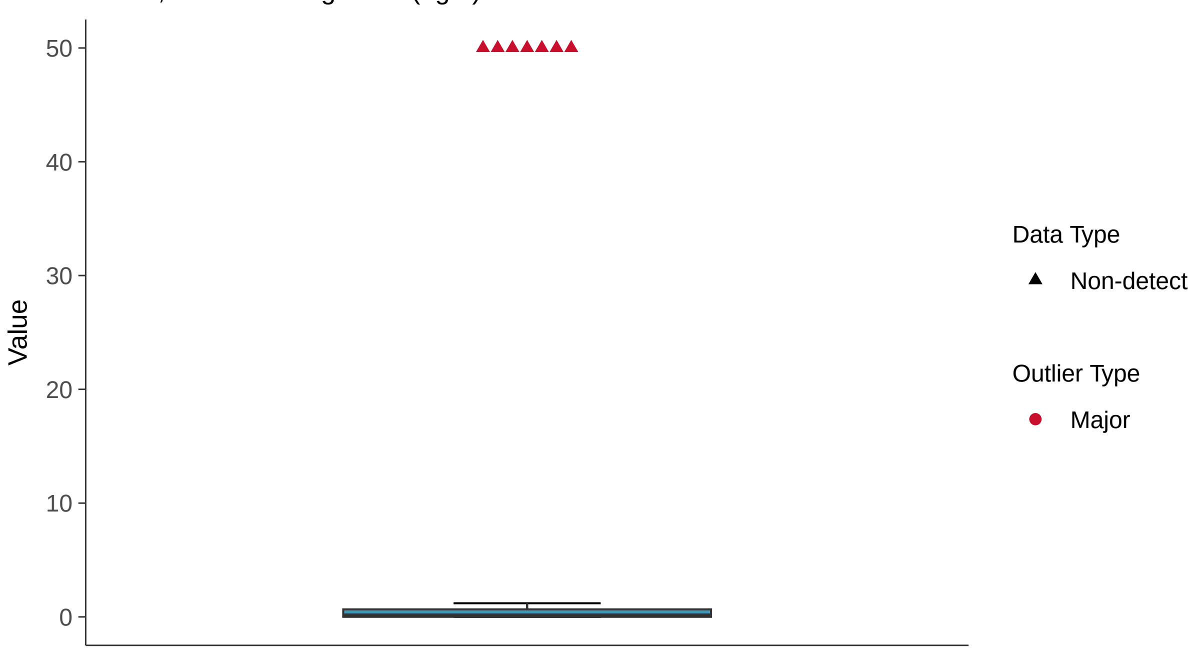
Histogram

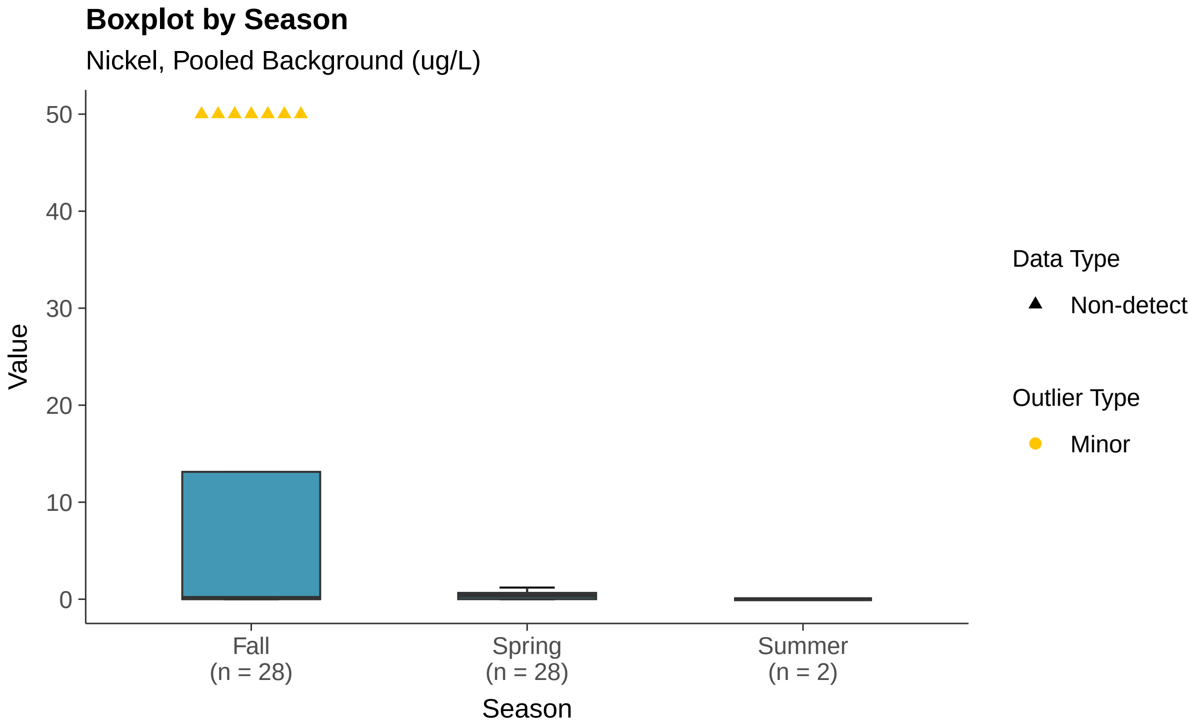
Nickel, Pooled Background (ug/L)

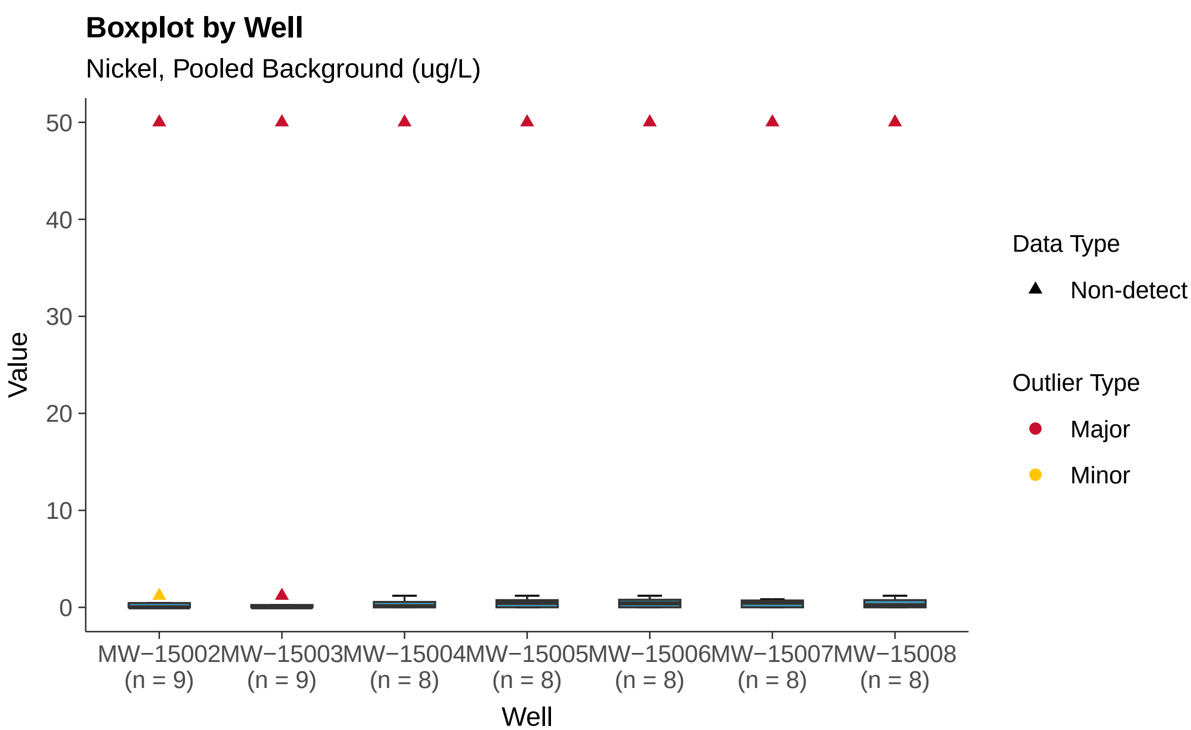


Boxplot

Nickel, Pooled Background (ug/L)

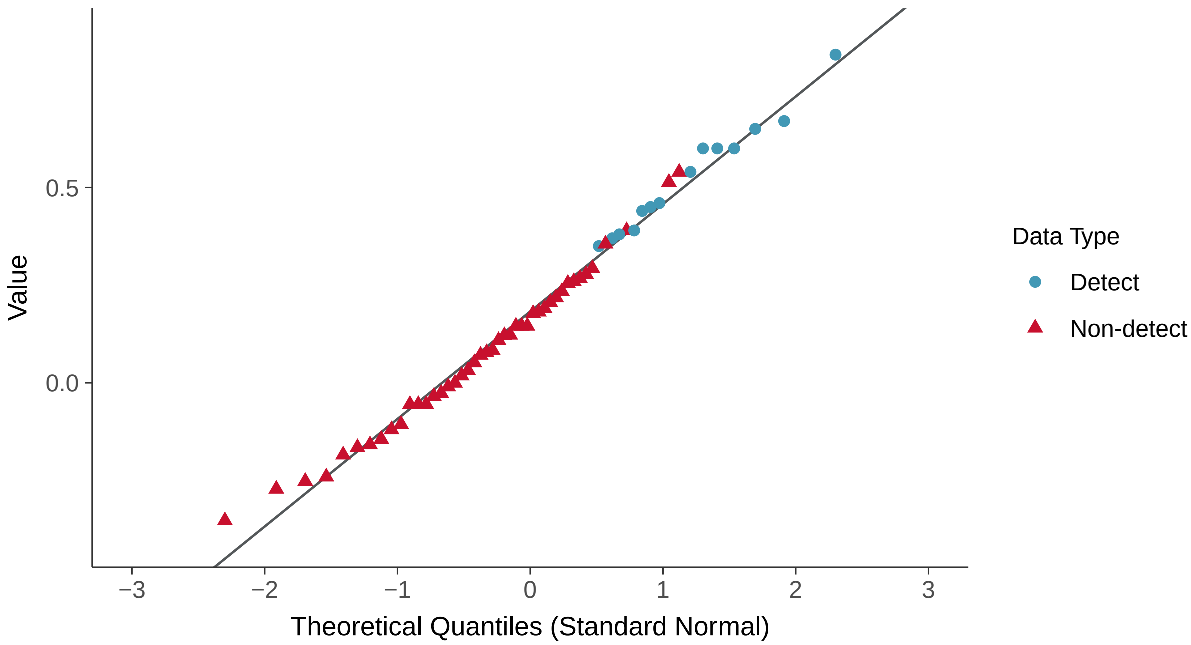



Boxplot by Season
Nickel, Pooled Background (ug/L)
50
40
30
20
10
0
Value
Fall
(n = 28)
Spring
(n = 28)
Summer
(n = 2)
Season
Data Type
Non-detect
Outlier Type
Minor


Boxplot by Well
Nickel, Pooled Background (ug/L)
50
40
30
20
10
0
Value
MW−15002
(n = 9)
MW−15003
(n = 9)
MW−15004
(n = 8)
MW−15005
(n = 8)
MW−15006
(n = 8)
MW−15007
(n = 8)
MW−15008
(n = 8)
Well
Data Type
Non-detect
Outlier Type
Major
Minor

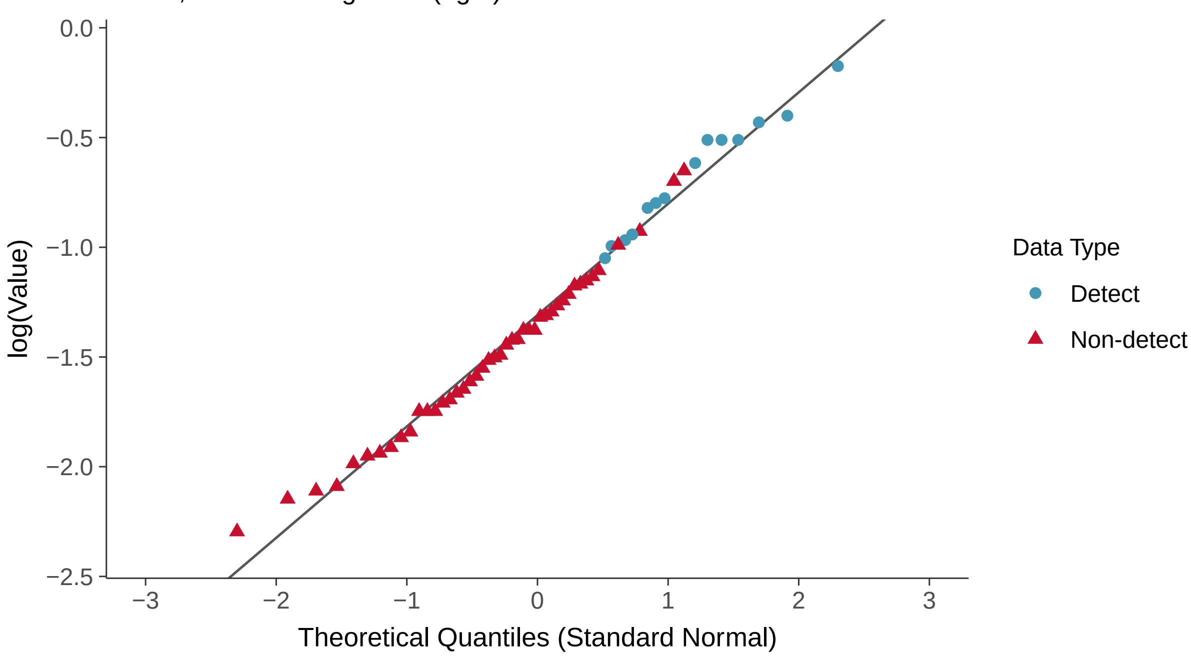
Normal Q-Q plot using ROS Imputed Estimates

Nickel, Pooled Background (ug/L)



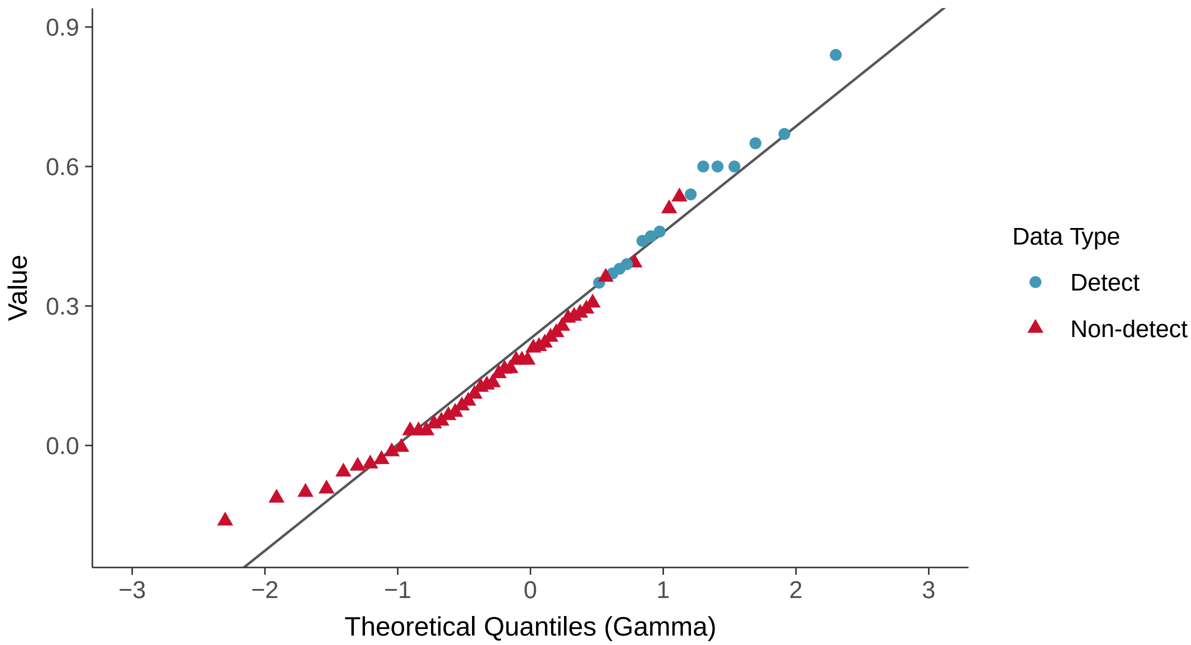
Lognormal Q-Q plot using ROS Imputed Estimates

Nickel, Pooled Background (ug/L)



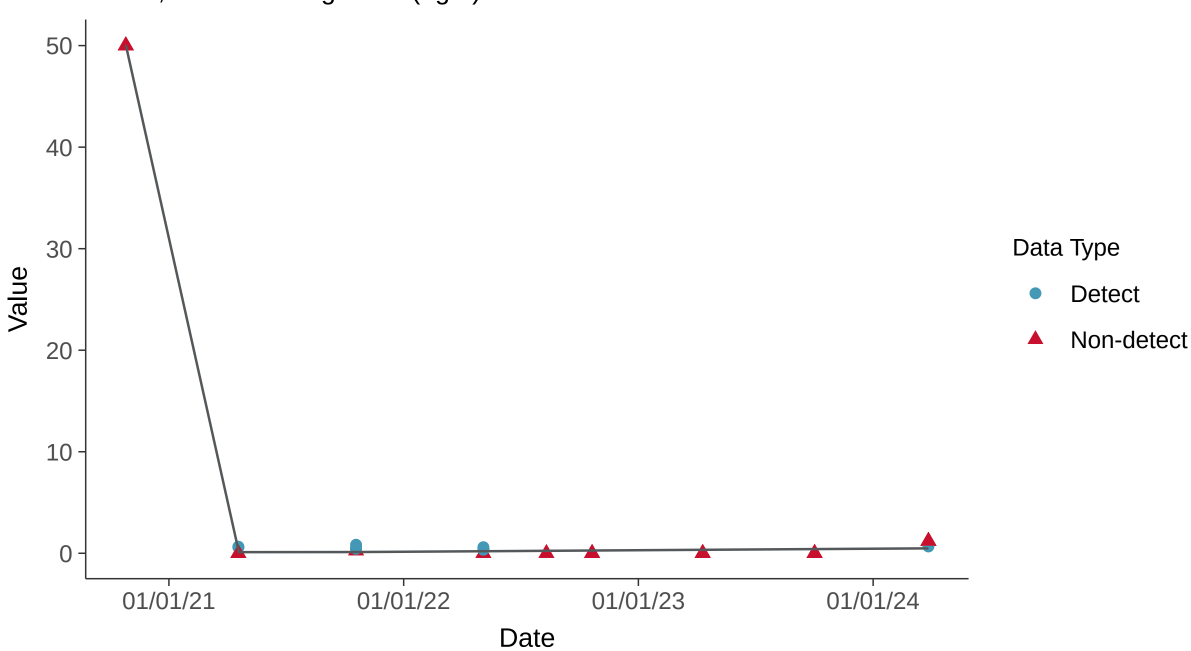
Gamma Q-Q plot using ROS Imputed Estimates

Nickel, Pooled Background (ug/L)



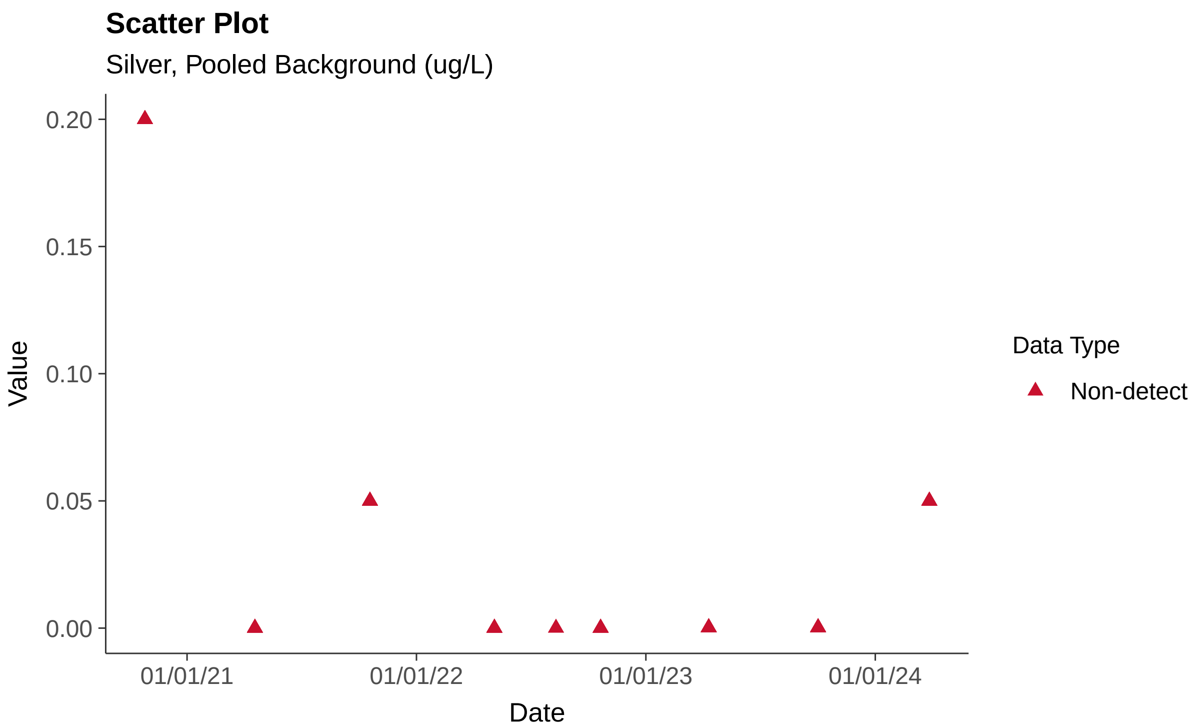
Trend Regression: Piecewise Linear-Linear

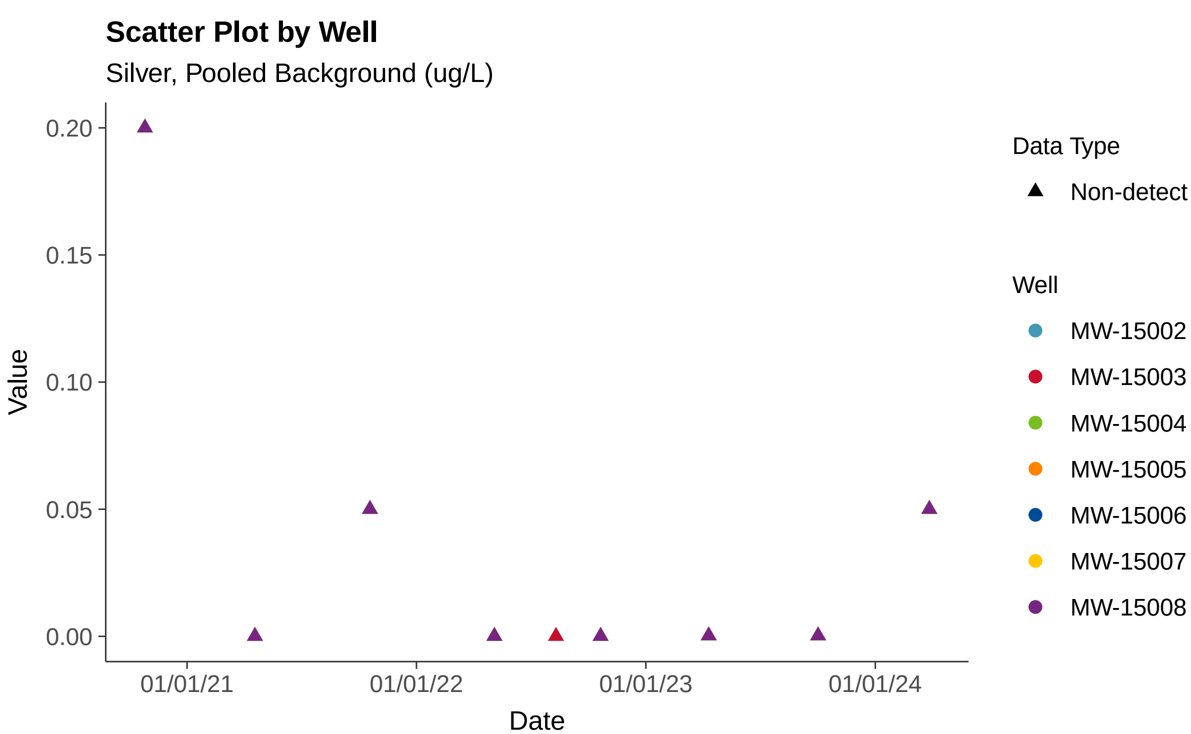
Nickel, Pooled Background (ug/L)



Michigan CCR: Silver, Pooled Background

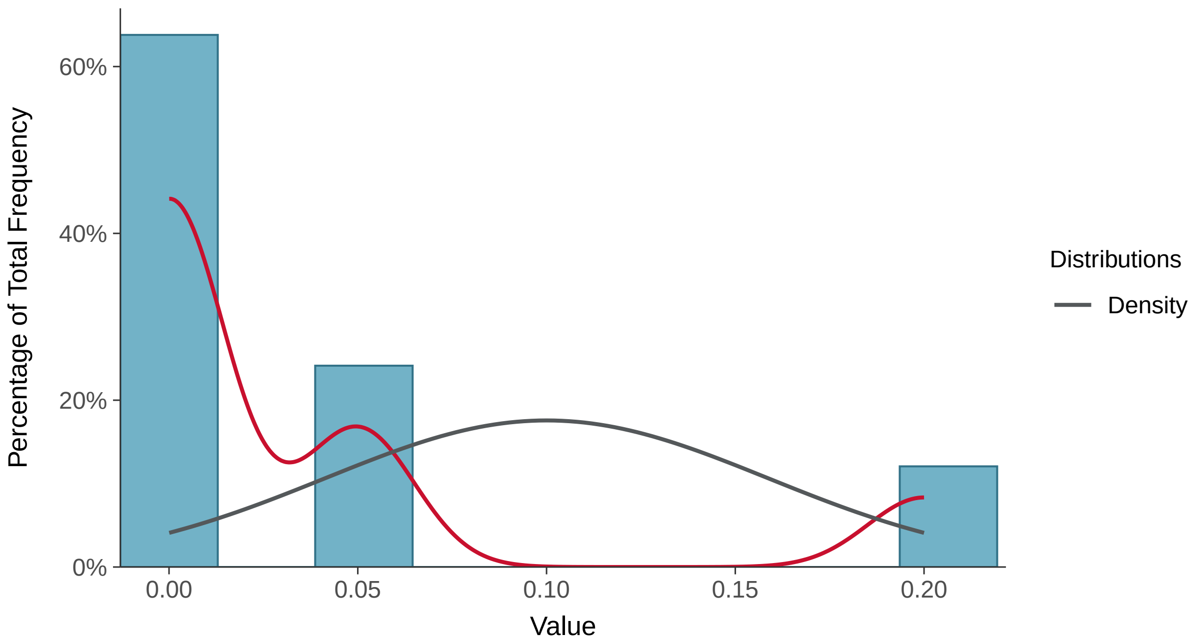
ID: 4_127





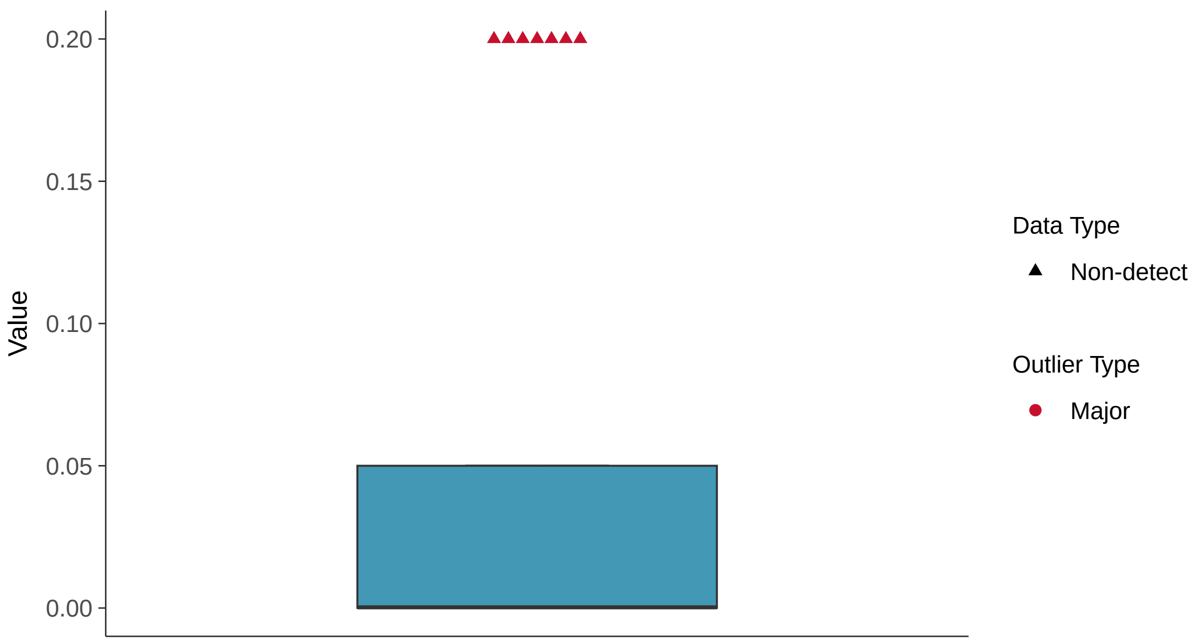
Histogram

Silver, Pooled Background (ug/L)



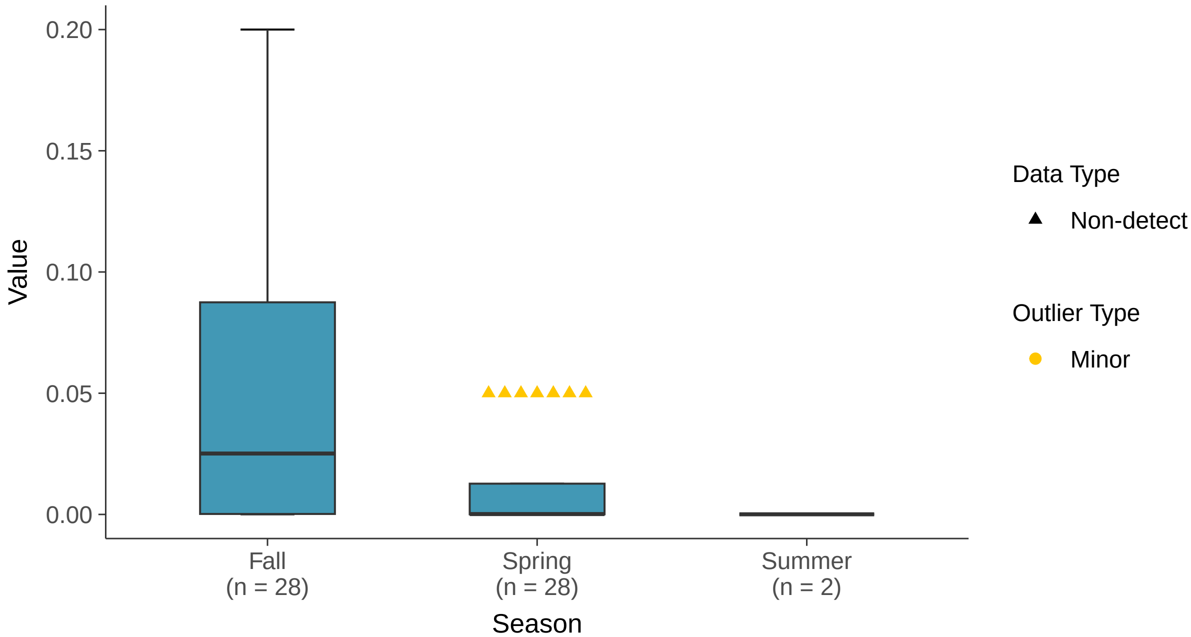
Boxplot

Silver, Pooled Background (ug/L)



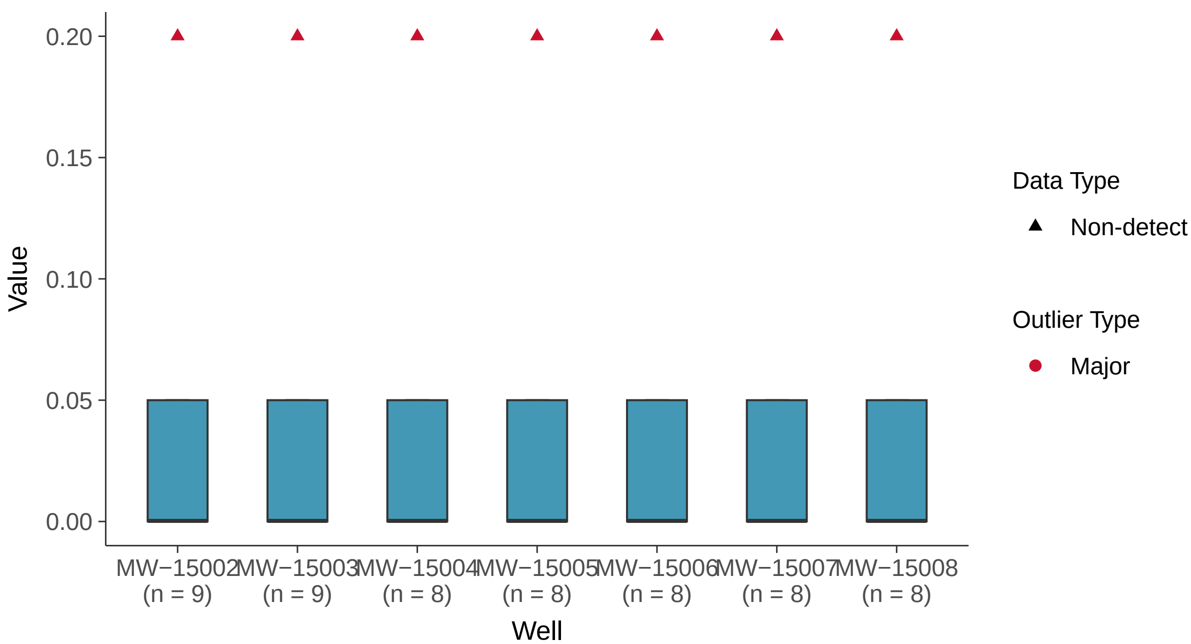
Boxplot by Season

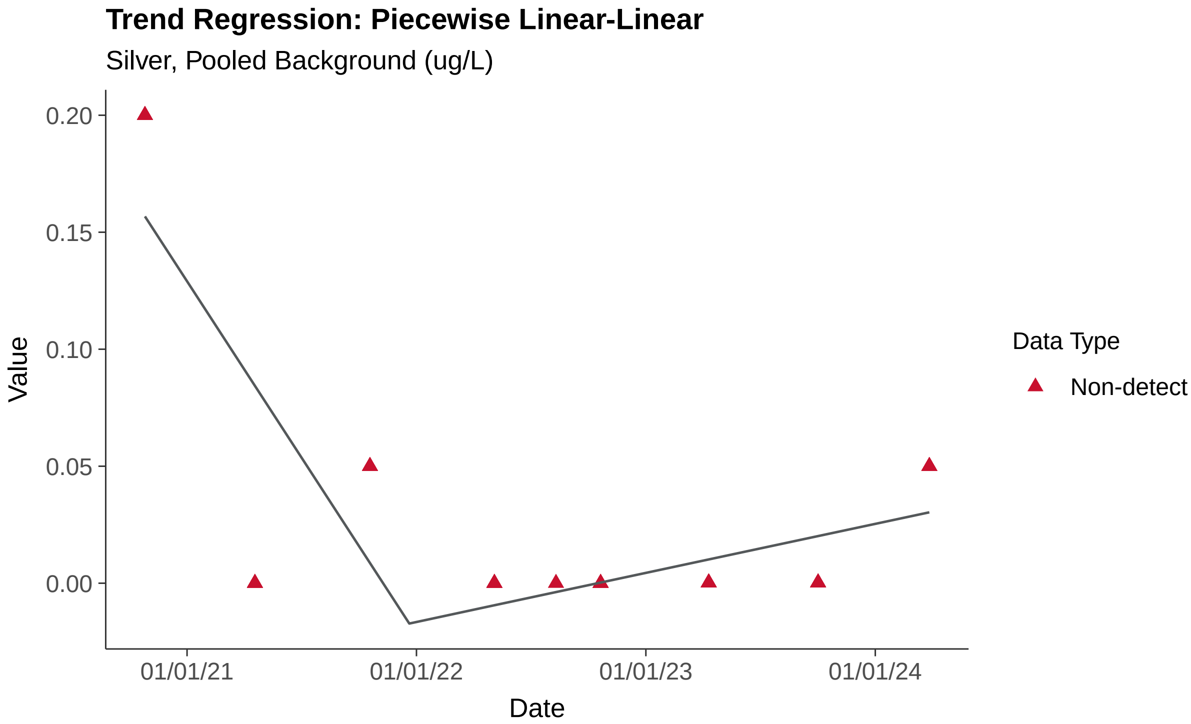
Silver, Pooled Background (ug/L)



Boxplot by Well

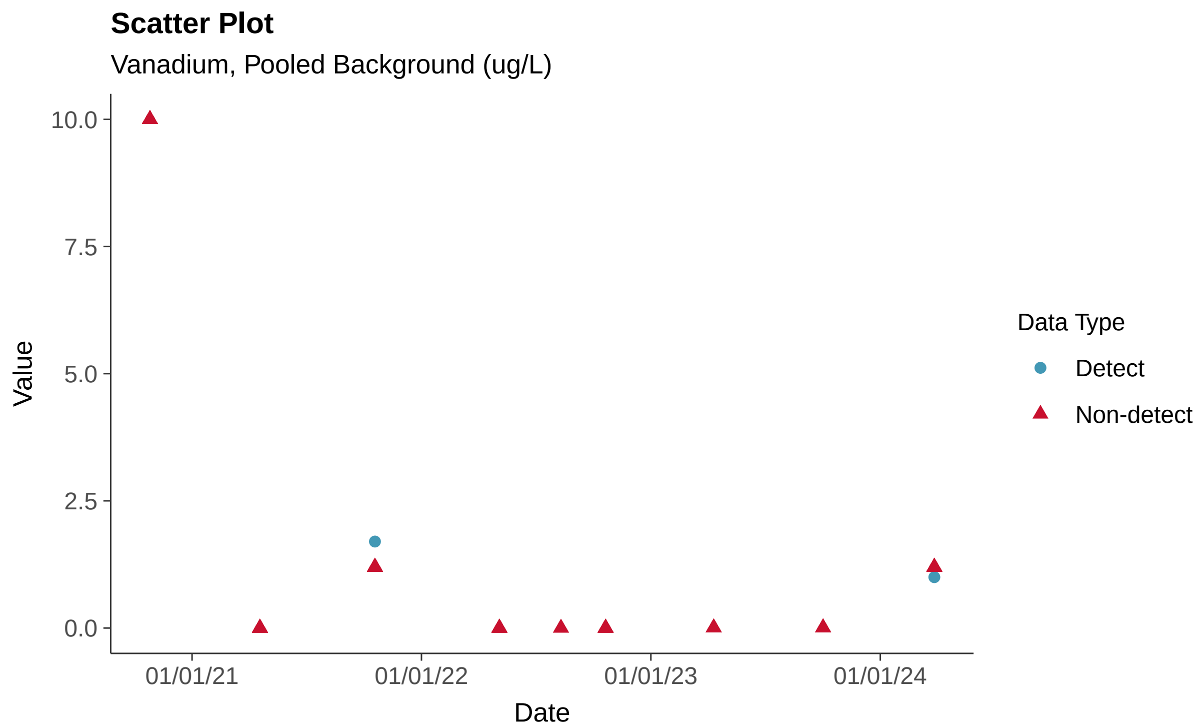
Silver, Pooled Background (ug/L)

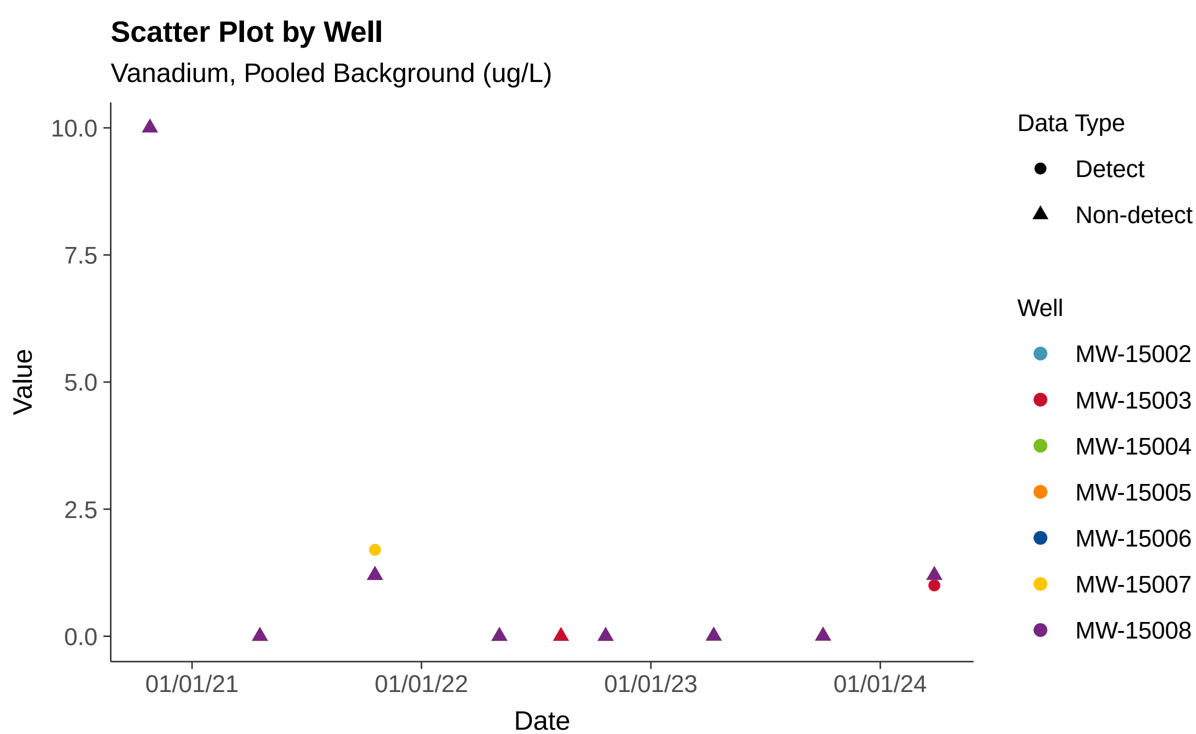



Trend Regression: Piecewise Linear-Linear
Silver, Pooled Background (ug/L)
Value
0.20
0.15
0.10
0.05
0.00
01/01/21
01/01/22
01/01/23
01/01/24
Date
Data Type
Non-detect

Michigan CCR: Vanadium, Pooled Background

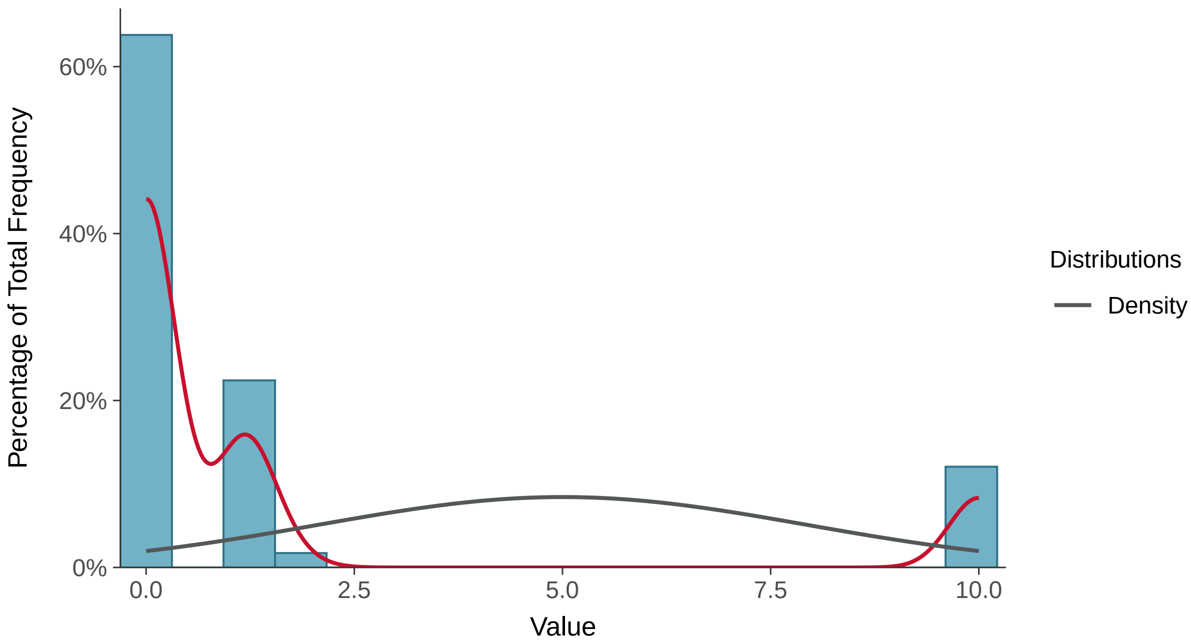
ID: 4_134





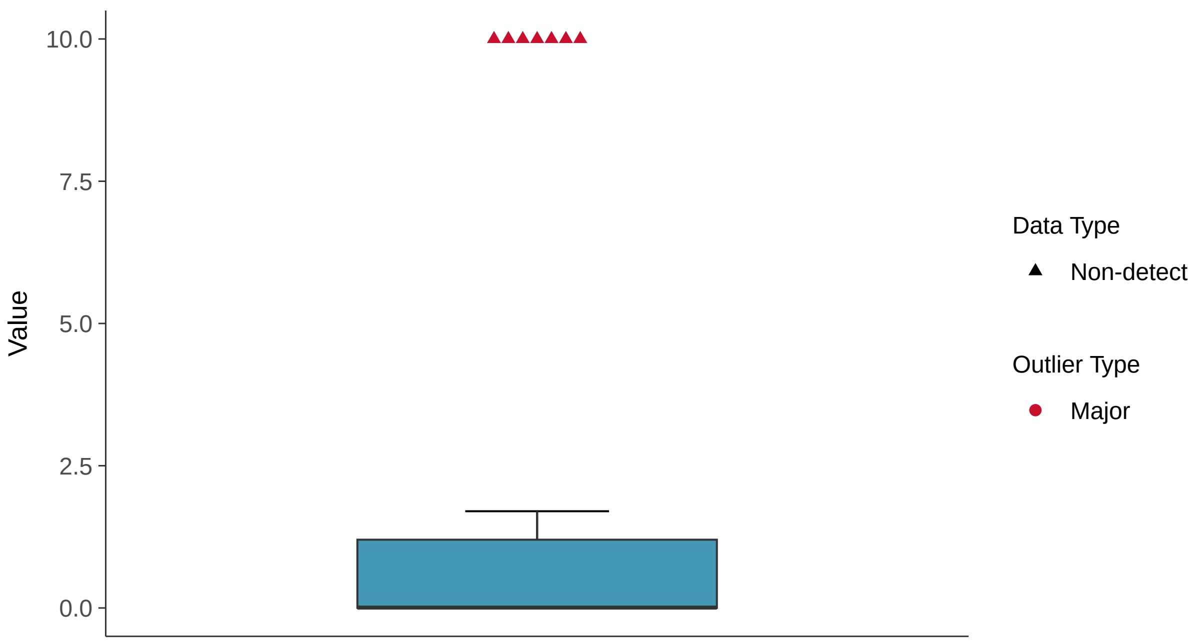
Histogram

Vanadium, Pooled Background (ug/L)



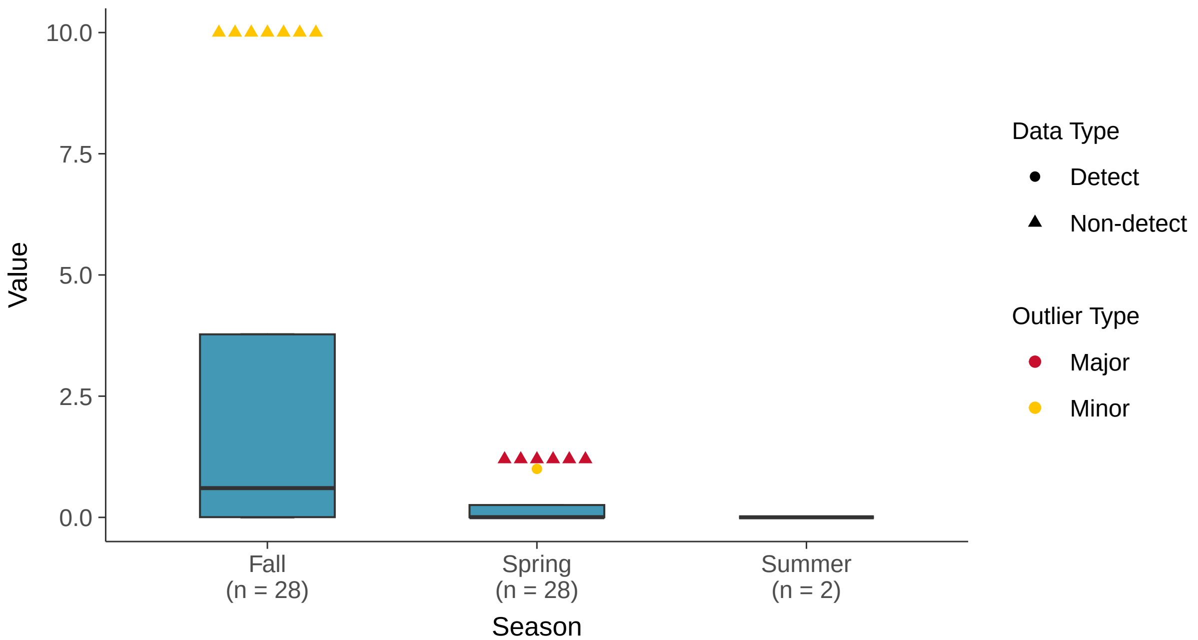
Boxplot

Vanadium, Pooled Background (ug/L)



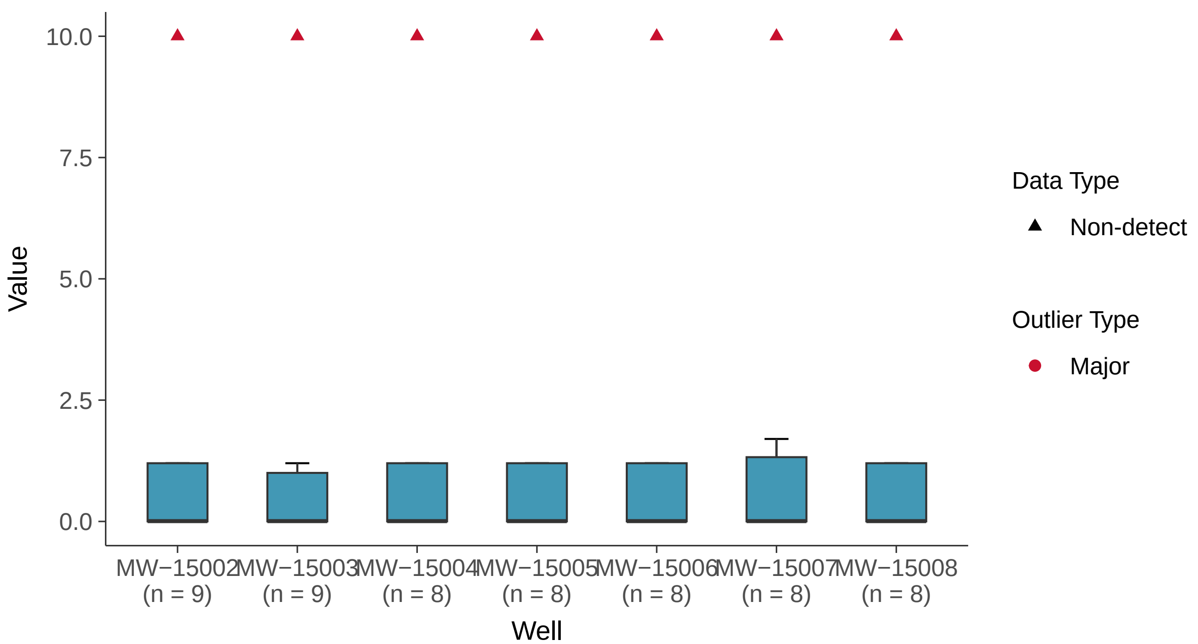
Boxplot by Season

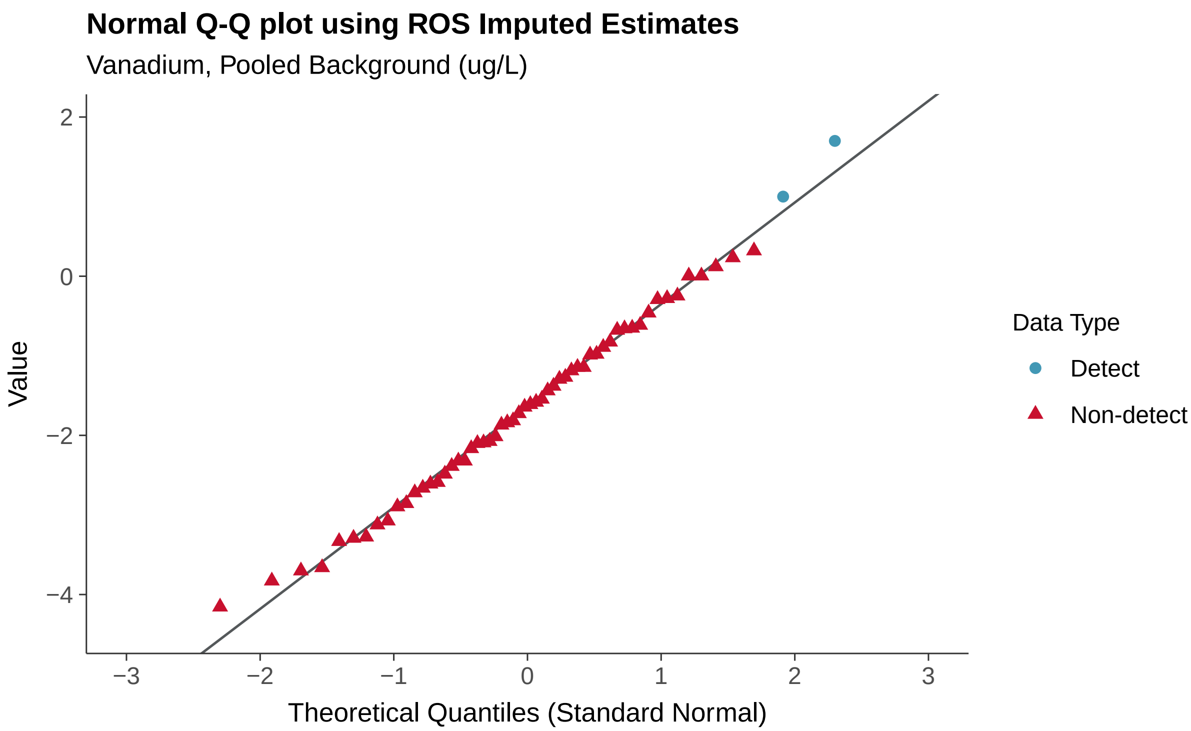
Vanadium, Pooled Background (ug/L)



Boxplot by Well

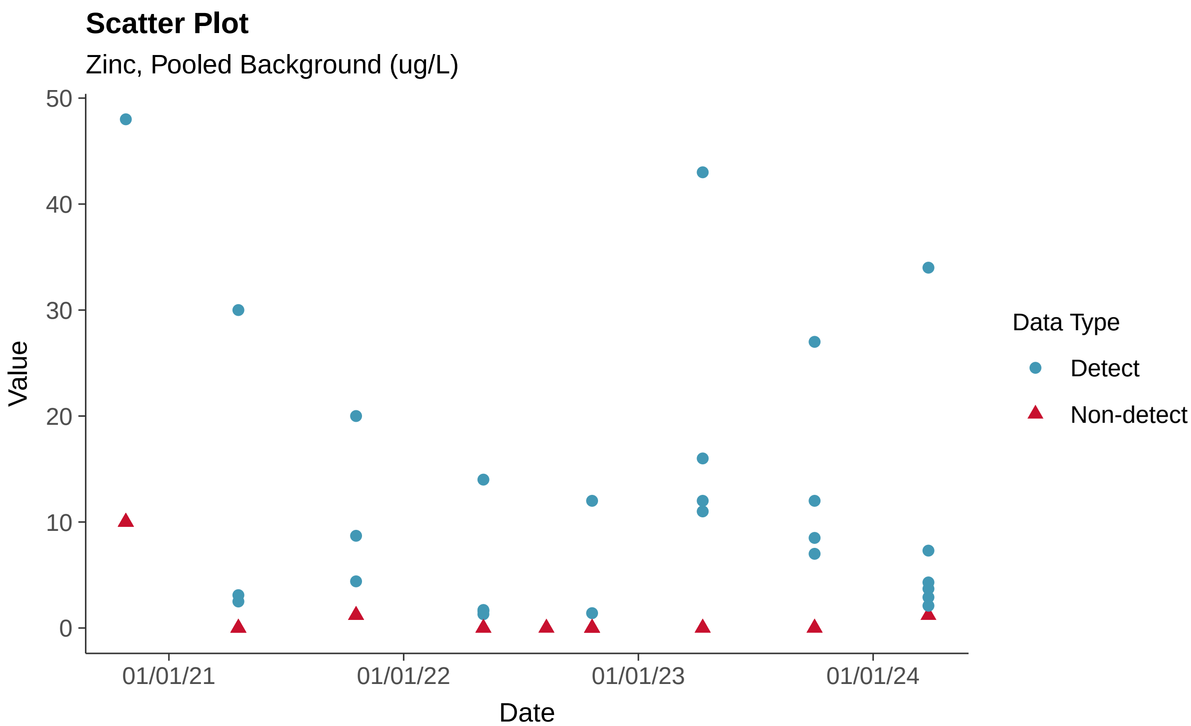
Vanadium, Pooled Background (ug/L)

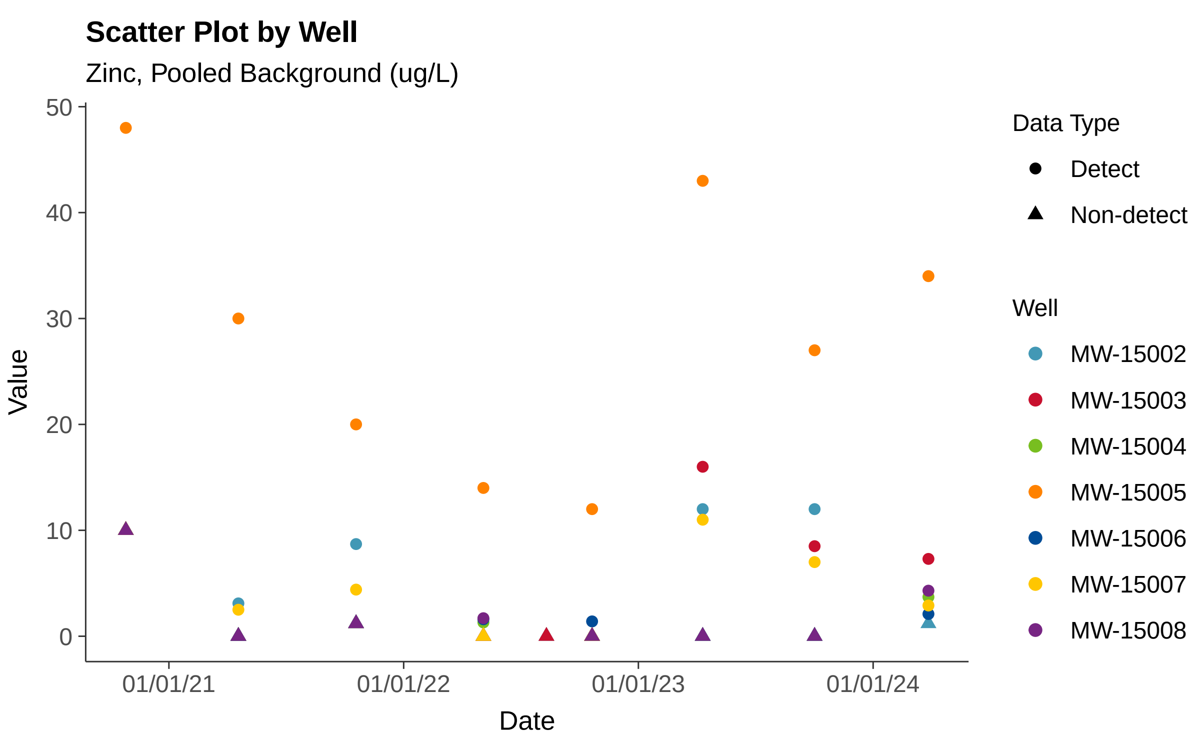


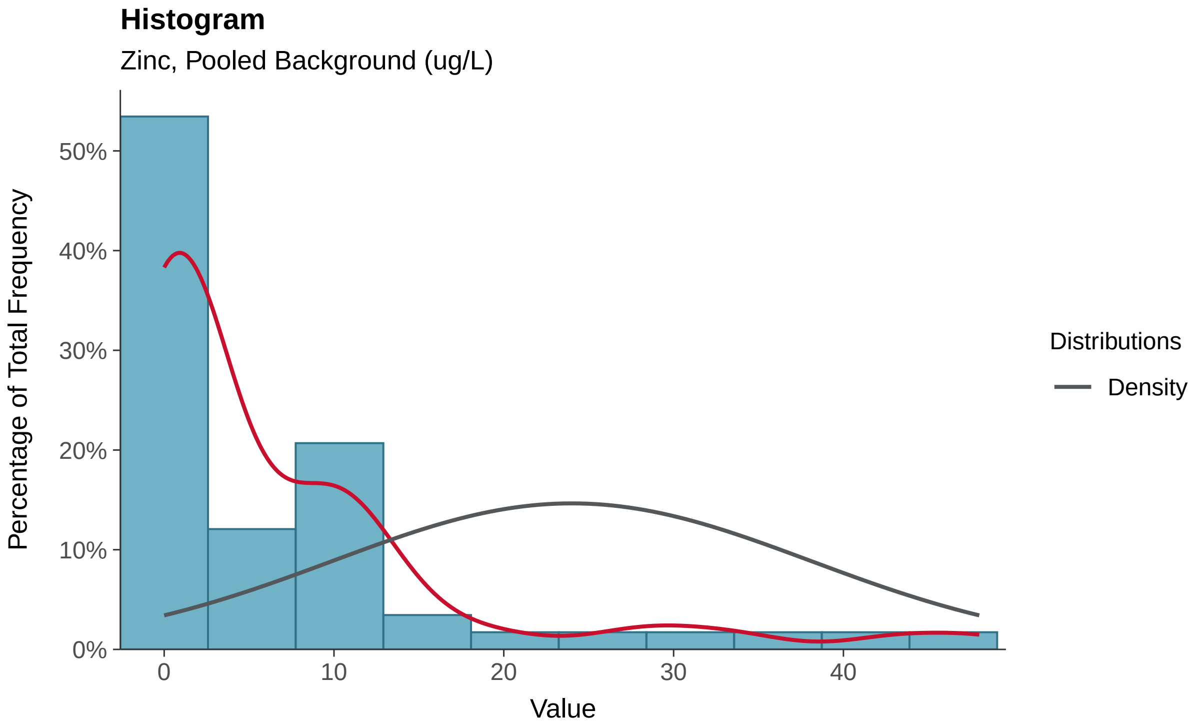

Normal Q-Q plot using ROS Imputed Estimates
Vanadium, Pooled Background (ug/L)
Value
2
0
−2
−4
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect

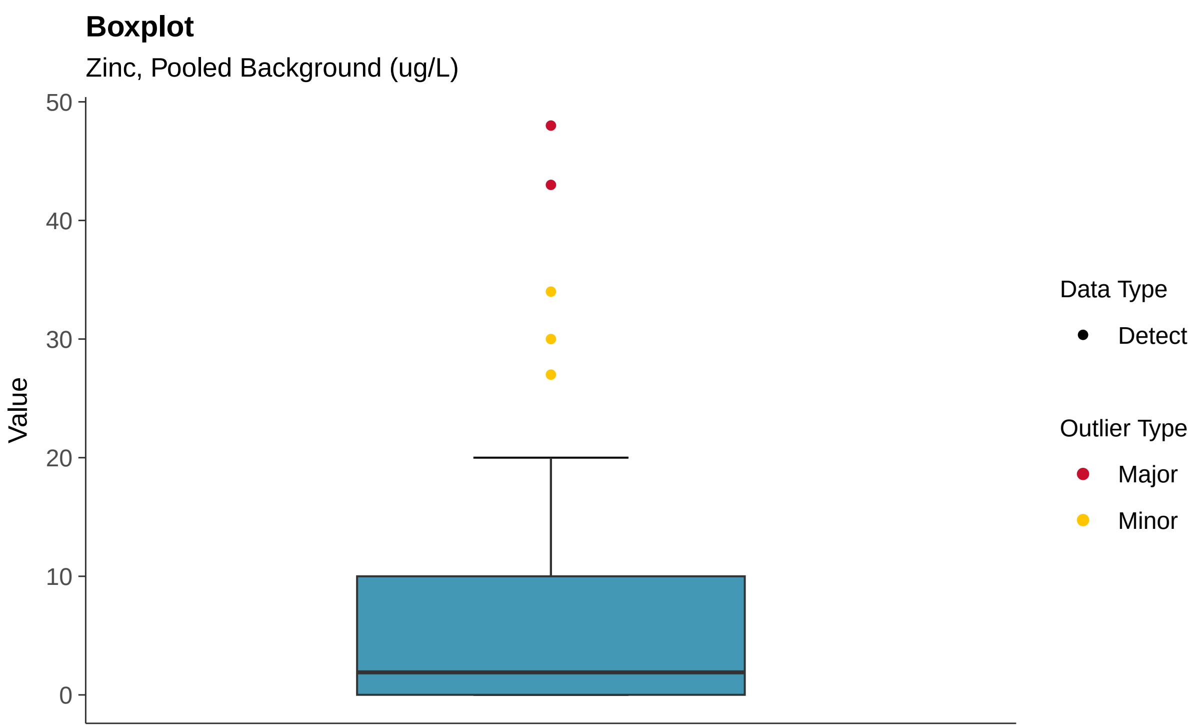
Michigan CCR: Zinc, Pooled Background

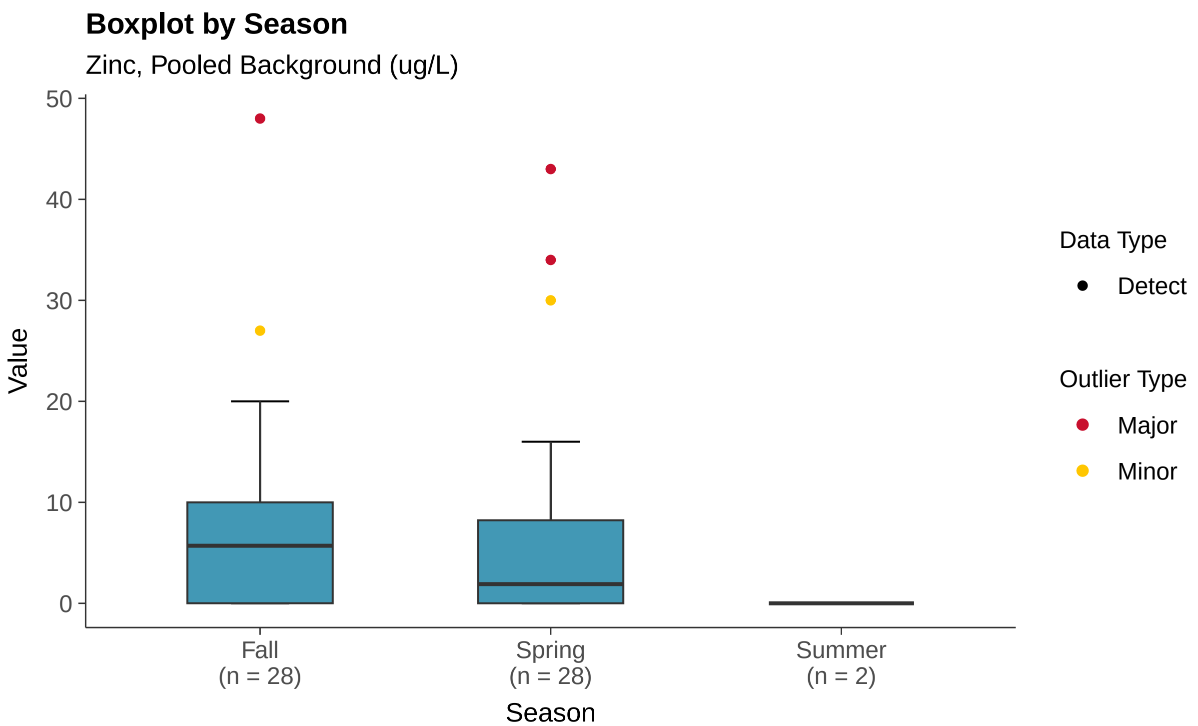
ID: 4_135

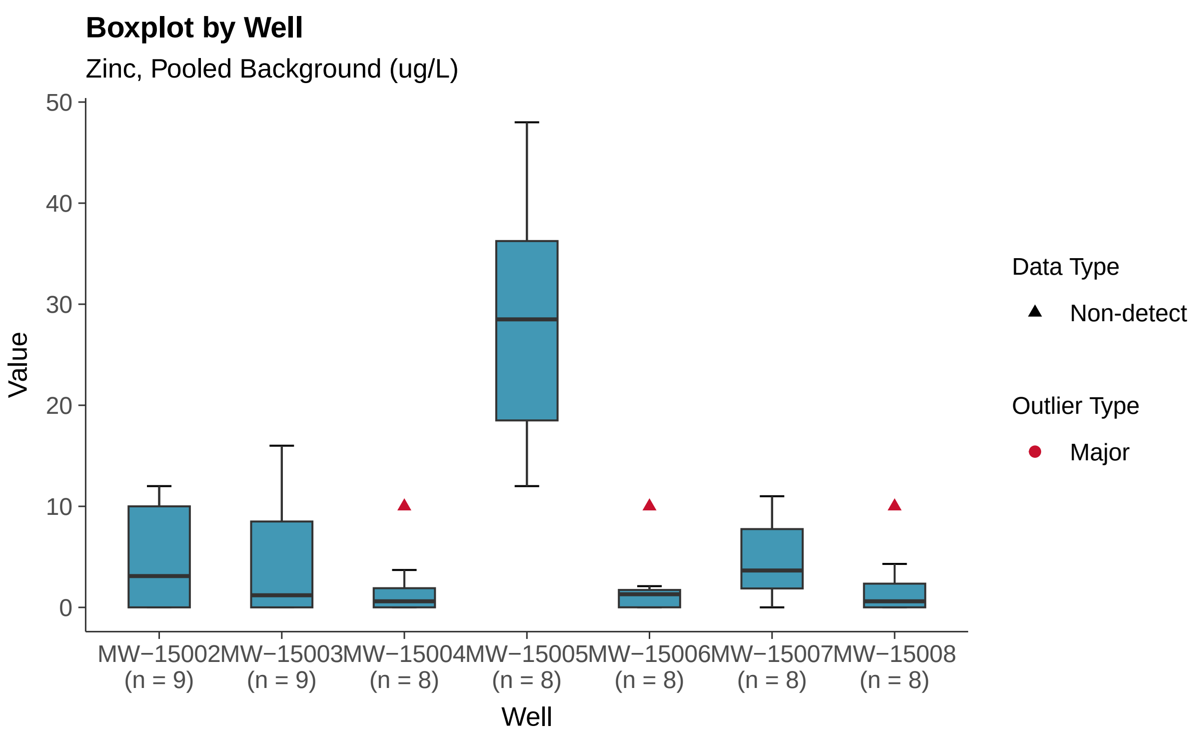





Histogram
Zinc, Pooled Background (ug/L)
Percentage of Total Frequency
50%
40%
30%
20%
10%
0%
0
10
20
30
40
Value
Distributions
Density

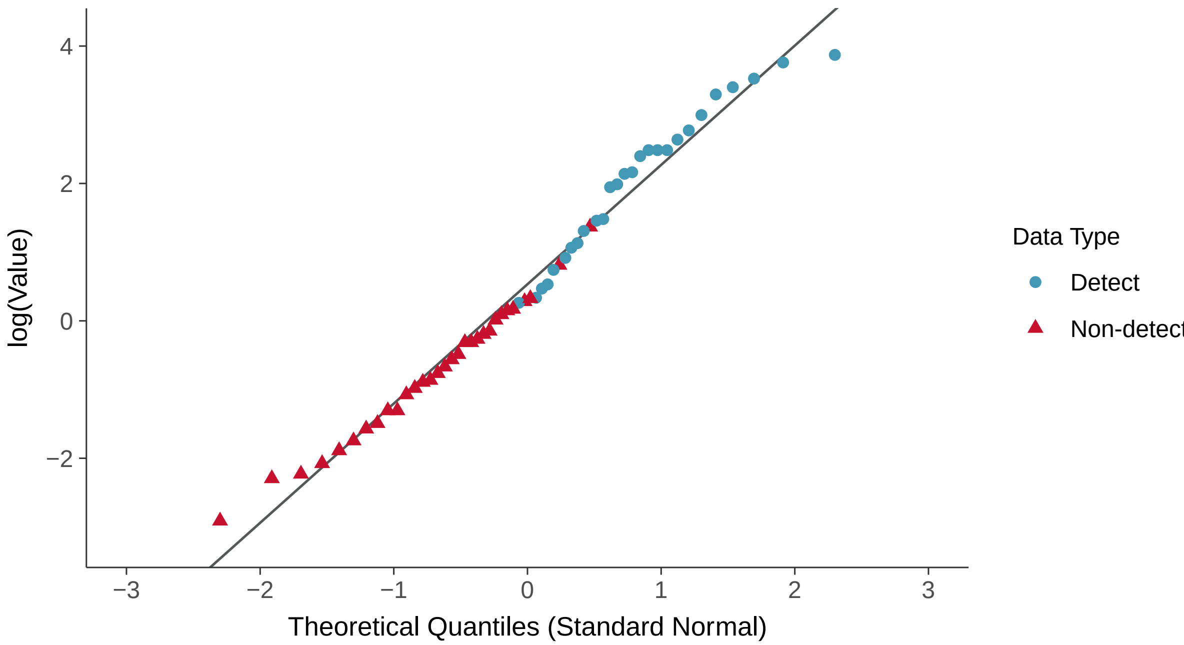

Boxplot
Zinc, Pooled Background (ug/L)
Value
50
40
30
20
10
0
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Season
Zinc, Pooled Background (ug/L)
Value
50
40
30
20
10
0
Fall
(n = 28)
Spring
(n = 28)
Summer
(n = 2)
Season
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Well
Zinc, Pooled Background (ug/L)
Value
50
40
30
20
10
0
MW−15002
(n = 9)
MW−15003
(n = 9)
MW−15004
(n = 8)
MW−15005
(n = 8)
MW−15006
(n = 8)
MW−15007
(n = 8)
MW−15008
(n = 8)
Well
Data Type
Non-detect
Outlier Type
Major

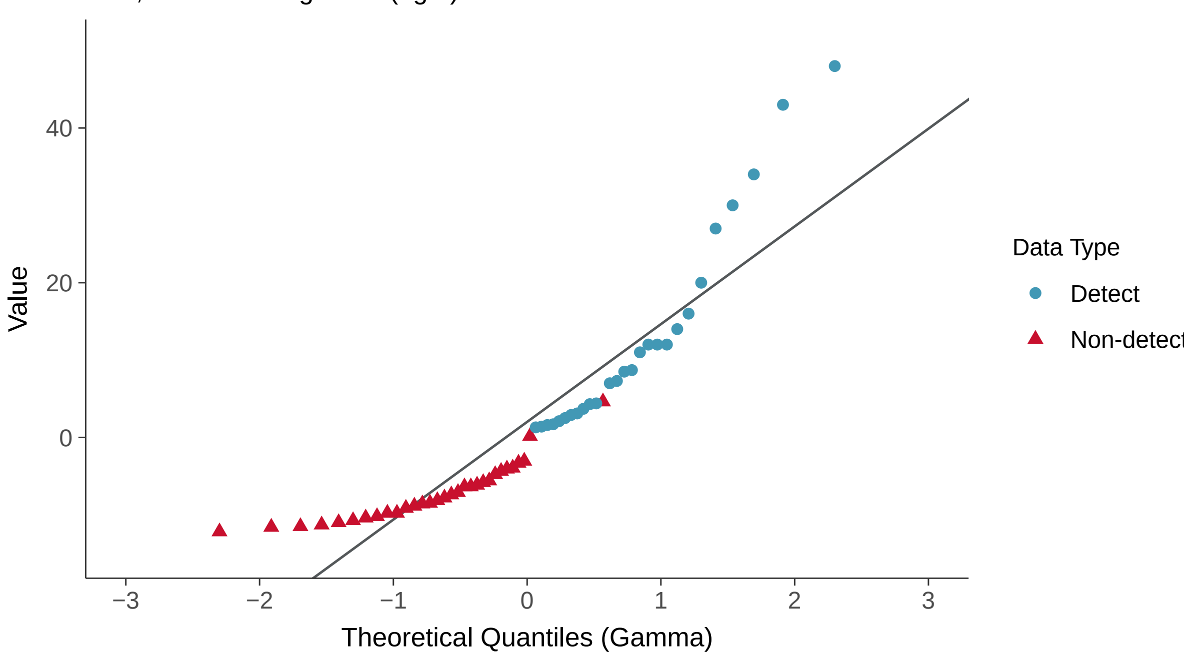
Lognormal Q-Q plot using ROS Imputed Estimates

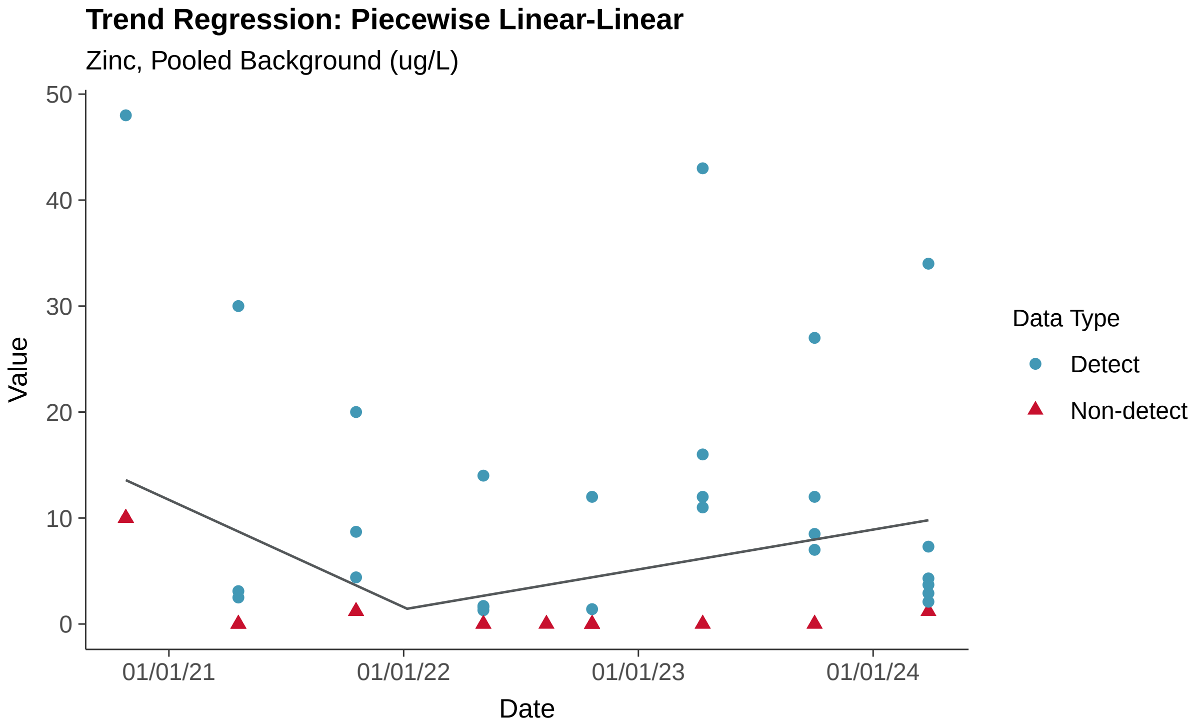
Zinc, Pooled Background (ug/L)

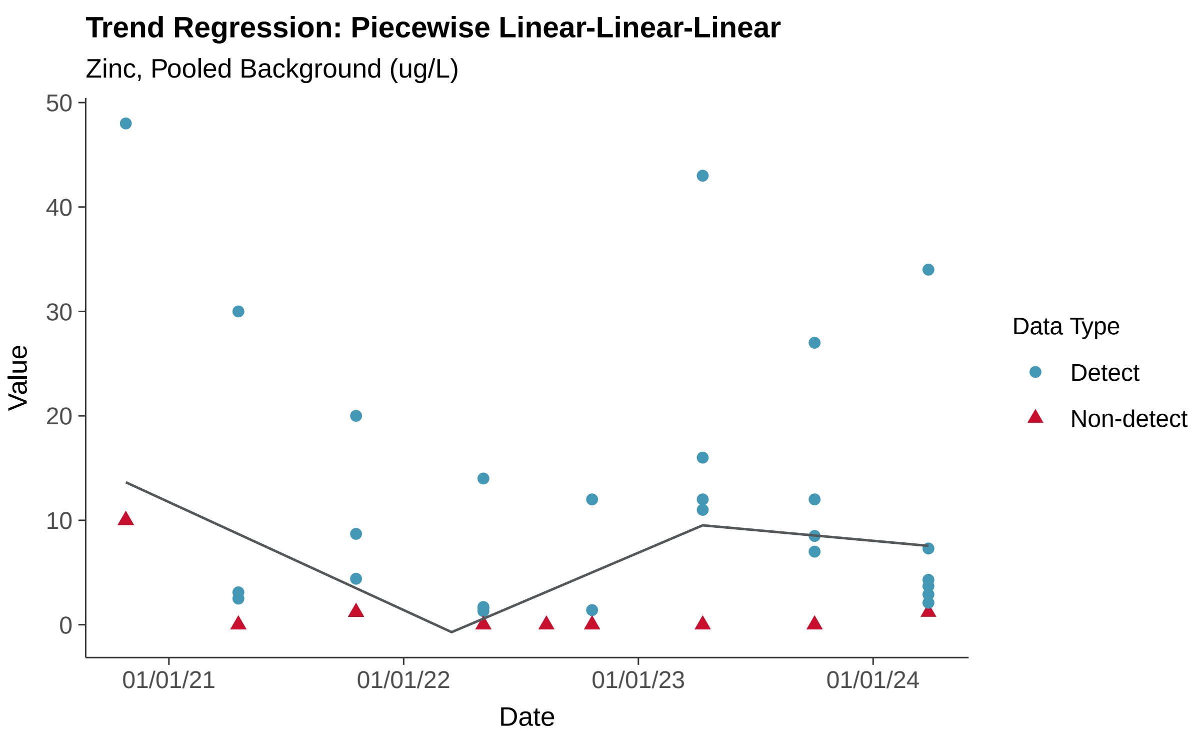


Gamma Q-Q plot using ROS Imputed Estimates

Zinc, Pooled Background (ug/L)




Trend Regression: Piecewise Linear-Linear
Zinc, Pooled Background (ug/L)
Value
Date
01/01/21
01/01/22
01/01/23
01/01/24
0
10
20
30
40
50
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear-Linear
Zinc, Pooled Background (ug/L)
Value
Date
01/01/21
01/01/22
01/01/23
01/01/24
0
10
20
30
40
50
Data Type
Detect
Non-detect

D

Full Statistical Tables

Table 1: Summary Statistics, Non-Detects Included

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Date Range	Distributions Fit[a]	Recommended Distribution	Mean	Median	Minimum	Maximum	SD	CV	MAD/0.675	Skewness	Kurtosis
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	479	170	13.1	5400	937	1.96	189	3.97	16.3
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	108	92.2	37.3	259	50.3	0.465	41.6	0.952	0.0872
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	335	145	1.23	2480	500	1.49	195	2.65	7.32
1_114	Pooled Background	Appendix III	Fluoride	ug/L	162	103	64%	2015-11-30 to 2024-03-27	Gamma; Lognormal	Nonparametric	732	1000	20.0	2000	374	0.511	0	-0.352	-0.708
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	7.21	7.20	6.60	8.30	0.320	0.0443	0.296	0.648	0.866
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	28.3	7.45	0.250	327	56.6	2.0	6.74	3.31	11.3
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	940	615	158	4800	847	0.901	467	2.22	5.91
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	0.814	1.00	0.140	1.40	0.349	0.429	0	-0.868	-0.946
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	156	58	37%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	3.19	1.60	0.120	74.0	7.07	2.22	0.889	7.70	70
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	2015-11-30 to 2024-03-27	Gamma	Gamma	100	84.0	14.0	377	69.6	0.697	67.1	1.13	1.31
2_104	Pooled Background	Appendix IV	Beryllium	ug/L	149	149	100%	2015-11-30 to 2024-03-27		Nonparametric	0.760	1.00	0.200	1.20	0.378	0.498	0	-0.594	-1.53
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	149	147	99%	2015-11-30 to 2024-03-27		Nonparametric	0.318	0.200	0.0780	1.20	0.300	0.942	0	2.55	4.69
2_109	Pooled Background	Appendix IV	Chromium	ug/L	156	83	53%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	1.04	1.00	0.250	5.00	0.660	0.633	0.222	2.22	9.37
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	8.22	6.00	0.110	30.0	6.96	0.847	8.50	0.139	-1.38
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	162	103	64%	2015-11-30 to 2024-03-27	Gamma; Lognormal	Nonparametric	732	1000	20.0	2000	374	0.511	0	-0.352	-0.708
2_116	Pooled Background	Appendix IV	Lead	ug/L	149	141	95%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	1.08	1.00	0.550	5.00	0.688	0.636	0	2.65	8.29
2_117	Pooled Background	Appendix IV	Lithium	ug/L	156	108	69%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	11.0	10.0	1.20	48.0	7.11	0.645	1.48	1.82	6.10
2_118	Pooled Background	Appendix IV	Mercury	ug/L	149	149	100%	2015-11-30 to 2024-03-27		Nonparametric	0.200	0.200	0.200	0.200	0	0	0	NA	NA
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	4.58	5.00	0.710	25.0	3.08	0.672	0.519	3.60	23.5
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	156	77	49%	2015-11-30 to 2024-03-27	Gamma; Normal	Nonparametric	1.11	1.00	0.0996	3.74	0.571	0.515	0.585	1.25	3.06
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	1.12	1.00	0.110	3.30	0.632	0.567	0	1.50	1.65
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	2015-11-30 to 2024-03-27		Nonparametric	1.52	2.00	0.190	10.0	1.02	0.669	0	3.62	31.7
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Nonparametric	0.524	0.250	0.000250	4.90	0.810	1.55	0.370	3.24	14.7
4_115	Pooled Background	Michigan CCR	Iron	ug/L	58	1	2%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Gamma	2586	1500	0.250	11000	2757	1.07	1481	1.52	1.38
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	58	44	76%	2020-10-26 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	6.30	0.128	0.000250	50.0	16.3	2.60	0.189	2.39	3.84
4_127	Pooled Background	Michigan CCR	Silver	ug/L	58	58	100%	2020-10-26 to 2024-03-27		Nonparametric	0.0363	0.000250	0.0000500	0.200	0.0647	1.78	0.000296	1.95	2.50
4_134	Pooled Background	Michigan CCR	Vanadium	ug/L	58	56	97%	2020-10-26 to 2024-03-27		Nonparametric	1.50	0.00620	0.00120	10.0	3.22	2.14	0.00741	2.27	3.51
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Nonparametric	6.99	1.90	0.00120	48.0	10.6	1.52	2.81	2.27	5.32

[a] Non-detects are excluded from goodness-of-fit tests.

Table 2: Summary Statistics, Non-Detects Excluded

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Date Range	Distributions Fit	Recommended Distribution	Mean	Median	Minimum	Maximum	SD	CV	MAD/0.675	Skewness	Kurtosis
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	488	190	13.1	5400	944	1.94	215	3.94	15.9
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	108	92.2	37.3	259	50.3	0.465	41.6	0.952	0.0872
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	335	145	1.23	2480	500	1.49	195	2.65	7.32
1_114	Pooled Background	Appendix III	Fluoride	ug/L	162	103	64%	2015-11-30 to 2024-03-27	Gamma; Lognormal	Nonparametric	339	310	100	1400	209	0.617	148	2.51	10.4
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	7.21	7.20	6.60	8.30	0.320	0.0443	0.296	0.648	0.866
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	34.9	9.40	1.10	327	62.2	1.78	8.59	2.89	8.27
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	940	615	158	4800	847	0.901	467	2.22	5.91
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	0.673	0.650	0.140	1.40	0.358	0.531	0.474	0.470	-0.256
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	156	58	37%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	4.34	2.00	0.120	74.0	8.71	2.01	1.48	6.24	45.3
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	2015-11-30 to 2024-03-27	Gamma	Gamma	100	84.0	14.0	377	69.6	0.697	67.1	1.13	1.31
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	149	147	99%	2015-11-30 to 2024-03-27		Nonparametric	0.149	0.149	0.0780	0.220	0.100	0.674	0.105	NA	NA
2_109	Pooled Background	Appendix IV	Chromium	ug/L	156	83	53%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	1.13	1.00	0.250	3.70	0.769	0.680	0.919	0.957	0.651
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	0.519	0.520	0.110	1.20	0.358	0.690	0.385	0.900	0.220
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	162	103	64%	2015-11-30 to 2024-03-27	Gamma; Lognormal	Nonparametric	339	310	100	1400	209	0.617	148	2.51	10.4
2_116	Pooled Background	Appendix IV	Lead	ug/L	149	141	95%	2015-11-30 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	1.12	1.05	0.680	2.00	0.466	0.417	0.474	1.12	0.514
2_117	Pooled Background	Appendix IV	Lithium	ug/L	156	108	69%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	15.1	13.0	1.40	48.0	10.1	0.668	7.41	1.08	1.61
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	4.40	4.60	0.710	9.70	2.72	0.618	3.56	0.167	-1.39
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	156	77	49%	2015-11-30 to 2024-03-27	Gamma; Normal	Nonparametric	1.25	1.14	0.0996	3.74	0.695	0.556	0.723	0.916	1.36
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	2015-11-30 to 2024-03-27	Nonparametric	Nonparametric	1.34	1.00	0.110	3.30	0.756	0.565	0.311	0.964	0.499
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	2015-11-30 to 2024-03-27		Nonparametric	0.190	0.190	0.190	0.190	NA	NA	0	NA	NA
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Nonparametric	1.09	0.730	0.280	4.90	1.05	0.964	0.548	2.71	8.72
4_115	Pooled Background	Michigan CCR	Iron	ug/L	58	1	2%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Gamma	2631	1500	52.0	11000	2760	1.05	1481	1.51	1.32
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	58	44	76%	2020-10-26 to 2024-03-27	Gamma; Lognormal; Normal	Nonparametric	0.524	0.500	0.350	0.840	0.142	0.272	0.156	0.688	0.0423
4_134	Pooled Background	Michigan CCR	Vanadium	ug/L	58	56	97%	2020-10-26 to 2024-03-27		Nonparametric	1.35	1.35	1.00	1.70	0.495	0.367	0.519	NA	NA
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	2020-10-26 to 2024-03-27	Gamma; Lognormal	Nonparametric	12.6	8.50	1.30	48.0	13.0	1.04	8.30	1.49	1.49

Table 3: Goodness-of-Fit Tests, Non-Detects Excluded

								Normal				Lognormal				Gamma						
								S-W		Lilliefors		S-W		Lilliefors		K-S		A-D				
ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Stat.	p-Value	Stat.	p-Value	Stat.	p-Value	Stat.	p-Value	Stat.	p-Value	Stat.	p-Value	Log-SD (NDs excl.)	ProUCL Distributions Fit	Recommended Distribution
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	0.468	0.000	0.308	0.000	0.973	0.004	0.073	0.047	0.116	< 0.01	5.296	< 0.01	1.314	Nonparametric	Nonparametric
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	0.901	0.000	0.154	0.000	0.969	0.001	0.093	0.002	0.113	< 0.01	2.816	< 0.01	0.443	Nonparametric	Nonparametric
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	0.650	0.000	0.252	0.000	0.971	0.003	0.077	0.023	0.080	0.01 <= p < 0.05	1.443	< 0.01	1.727	Nonparametric	Nonparametric
1_114	Pooled Background	Appendix III	Fluoride	ug/L	162	103	64%	0.796	0.000	0.168	0.000	0.984	0.631	0.059	0.878	0.092	>= 0.10	0.459	>= 0.10	0.534	Gamma; Lognormal	Nonparametric
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	0.968	0.001	0.101	0.000	0.977	0.007	0.092	0.002	0.095	< 0.01	0.982	0.01 <= p < 0.05	0.044	Nonparametric	Nonparametric
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	0.551	0.000	0.298	0.000	0.941	0.000	0.113	0.001	0.190	< 0.01	7.755	< 0.01	1.284	Nonparametric	Nonparametric
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	0.754	0.000	0.185	0.000	0.961	0.000	0.091	0.003	0.122	< 0.01	3.496	< 0.01	0.763	Nonparametric	Nonparametric
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	0.957	0.709	0.141	0.682	0.943	0.503	0.153	0.555	0.137	>= 0.10	0.240	>= 0.10	0.630	Gamma; Lognormal; Normal	Nonparametric
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	156	58	37%	0.365	0.000	0.317	0.000	0.942	0.000	0.136	0.000	0.188	< 0.01	5.681	< 0.01	0.973	Nonparametric	Nonparametric
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	0.909	0.000	0.109	0.000	0.972	0.003	0.092	0.003	0.050	>= 0.10	0.544	>= 0.10	0.770	Gamma	Gamma
2_104	Pooled Background	Appendix IV	Beryllium	ug/L	149	149	100%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		NA		Nonparametric
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	149	147	99%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		0.733		Nonparametric
2_109	Pooled Background	Appendix IV	Chromium	ug/L	156	83	53%	0.868	0.000	0.211	0.000	0.918	0.000	0.170	0.000	0.161	< 0.01	2.182	< 0.01	0.744	Nonparametric	Nonparametric
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	0.868	0.073	0.251	0.052	0.908	0.228	0.261	0.034	0.228	>= 0.10	0.466	>= 0.10	0.793	Gamma; Lognormal; Normal	Nonparametric
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	162	103	64%	0.796	0.000	0.168	0.000	0.984	0.631	0.059	0.878	0.092	>= 0.10	0.459	>= 0.10	0.534	Gamma; Lognormal	Nonparametric
2_116	Pooled Background	Appendix IV	Lead	ug/L	149	141	95%	0.869	0.149	0.265	0.100	0.918	0.415	0.195	0.491	0.218	>= 0.10	0.388	>= 0.10	0.389	Gamma; Lognormal; Normal	Nonparametric
2_117	Pooled Background	Appendix IV	Lithium	ug/L	156	108	69%	0.919	0.003	0.139	0.021	0.898	0.001	0.215	0.000	0.164	< 0.01	0.939	0.01 <= p < 0.05	0.867	Nonparametric	Nonparametric
2_118	Pooled Background	Appendix IV	Mercury	ug/L	149	149	100%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		NA		Nonparametric
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	0.914	0.006	0.164	0.010	0.901	0.002	0.173	0.005	0.150	0.01 <= p < 0.05	1.274	< 0.01	0.787	Nonparametric	Nonparametric
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	156	77	49%	0.950	0.004	0.070	0.444	0.950	0.004	0.130	0.002	0.089	>= 0.10	0.427	>= 0.10	0.656	Gamma; Normal	Nonparametric
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	0.883	0.001	0.248	0.000	0.878	0.001	0.203	0.000	0.179	< 0.01	1.273	< 0.01	0.664	Nonparametric	Nonparametric
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		NA		Nonparametric
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	0.689	0.000	0.252	0.001	0.952	0.364	0.110	0.733	0.147	>= 0.10	0.630	>= 0.10	0.748	Gamma; Lognormal	Nonparametric
4_115	Pooled Background	Michigan CCR	Iron	ug/L	58	1	2%	0.789	0.000	0.225	0.000	0.965	0.102	0.108	0.092	0.123	0.01 <= p < 0.05	0.682	0.05 <= p < 0.10	1.204	Gamma; Lognormal	Gamma
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	58	44	76%	0.924	0.248	0.174	0.298	0.944	0.468	0.165	0.378	0.162	>= 0.10	0.397	>= 0.10	0.265	Gamma; Lognormal; Normal	Nonparametric
4_127	Pooled Background	Michigan CCR	Silver	ug/L	58	58	100%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		NA		Nonparametric
4_134	Pooled Background	Michigan CCR	Vanadium	ug/L	58	56	97%	NA	NA	NA	NA	NA	NA	NA	NA	NA		NA		0.375		Nonparametric
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	0.803	0.000	0.221	0.002	0.957	0.316	0.090	0.830	0.129	>= 0.10	0.471	>= 0.10	1.095	Gamma; Lognormal	Nonparametric

Note: p-values above 0.05 suggest a fit to the tested distribution; a distribution passes its GOF test when at least one of the two p-values is above 0.05.

Table 4: Autocorrelation Tests, Non-Detects Excluded

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Autocorrelation	Box-Ljung p-value	Sig.
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	0.129	0.107	
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	0.067	0.397	
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	-0.118	0.137	
1_114	Pooled Background	Appendix III	Fluoride	ug/L	162	103	64%	0.083	0.512	
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	-0.148	0.055	
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	0.129	0.147	
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	-0.096	0.225	
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	0.340	0.170	
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	156	58	37%	-0.053	0.595	
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	-0.232	0.003	**
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	149	147	99%	-0.500	0.157	
2_109	Pooled Background	Appendix IV	Chromium	ug/L	156	83	53%	0.422	0.000	***
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	0.609	0.021	*
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	162	103	64%	0.083	0.512	
2_116	Pooled Background	Appendix IV	Lead	ug/L	149	141	95%	-0.002	0.995	
2_117	Pooled Background	Appendix IV	Lithium	ug/L	156	108	69%	0.395	0.005	**
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	0.465	0.003	**
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	156	77	49%	0.326	0.003	**
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	0.197	0.211	
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	NA	NA	
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	-0.035	0.863	
4_115	Pooled Background	Michigan CCR	Iron	ug/L	58	1	2%	0.086	0.504	
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	58	44	76%	0.164	0.495	
4_134	Pooled Background	Michigan CCR	Vanadium	ug/L	58	56	97%	-0.500	0.157	
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	-0.174	0.341	

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 5: Outlier Counts by Date

Date	Count
2015-11-30	4
2016-02-17	2
2016-04-12	4
2016-07-12	3
2016-09-27	3
2017-02-13	2
2017-04-04	2
2017-07-12	2
2017-09-14	1
2018-06-14	1
2020-10-26	1
2021-04-19	3
2021-10-19	3
2022-05-05	3
2022-08-11	1
2022-10-21	3
2023-04-11	2
2023-10-02	4
2024-03-27	1

Table 6: Outliers Identified at the 1% Significance Level, Non-Detects Excluded

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	No. Detects	Date	Value
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2022-05-05	5400
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2022-08-11	4900
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2022-10-21	4900
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2023-04-11	4900
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2023-10-02	4800
1_105	MW-15002	Appendix III	Boron	ug/L	156	3	2%	153	2024-03-27	3800
1_105	MW-15003	Appendix III	Boron	ug/L	156	3	2%	153	2016-04-12	2370
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2016-04-12	2480
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2016-09-27	2390
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2016-02-17	2300
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2016-07-12	2280
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2017-09-14	1940
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2015-11-30	1900
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2017-07-12	1900
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2017-02-13	1850
1_108	MW-15007	Appendix III	Chloride	mg/L	156	0	0%	156	2017-04-04	1670
1_114	MW-15004	Appendix III	Fluoride	ug/L	162	103	64%	59	2021-04-19	1400
1_128	MW-15002	Appendix III	Sulfate	mg/L	156	33	21%	123	2016-02-17	327

(Table continues on next page)

Table 6: Outliers Identified at the 1% Significance Level, Non-Detects Excluded *(continued)*

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	No. Detects	Date	Value
1_128	MW-15002	Appendix III	Sulfate	mg/L	156	33	21%	123	2016-04-12	300
1_128	MW-15002	Appendix III	Sulfate	mg/L	156	33	21%	123	2015-11-30	250
1_128	MW-15007	Appendix III	Sulfate	mg/L	156	33	21%	123	2023-04-11	240
1_128	MW-15002	Appendix III	Sulfate	mg/L	156	33	21%	123	2023-10-02	220
1_128	MW-15002	Appendix III	Sulfate	mg/L	156	33	21%	123	2016-07-12	202
1_128	MW-15007	Appendix III	Sulfate	mg/L	156	33	21%	123	2022-10-21	190
1_128	MW-15007	Appendix III	Sulfate	mg/L	156	33	21%	123	2022-05-05	170
1_128	MW-15008	Appendix III	Sulfate	mg/L	156	33	21%	123	2022-05-05	170
1_128	MW-15008	Appendix III	Sulfate	mg/L	156	33	21%	123	2022-10-21	140
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2016-09-27	4800
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2016-07-12	4500
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2016-04-12	3900
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2015-11-30	3700
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2017-02-13	3700
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2017-07-12	3700
1_131	MW-15007	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	156	2017-04-04	3100
2_102	MW-15008	Appendix IV	Arsenic	ug/L	156	58	37%	98	2021-04-19	74.0
2_102	MW-15006	Appendix IV	Arsenic	ug/L	156	58	37%	98	2018-06-14	40.9
2_102	MW-15008	Appendix IV	Arsenic	ug/L	156	58	37%	98	2020-10-26	18.0
2_102	MW-15008	Appendix IV	Arsenic	ug/L	156	58	37%	98	2021-10-19	17.0
2_102	MW-15006	Appendix IV	Arsenic	ug/L	156	58	37%	98	2021-10-19	15.0
2_102	MW-15008	Appendix IV	Arsenic	ug/L	156	58	37%	98	2023-10-02	12.0
2_102	MW-15002	Appendix IV	Arsenic	ug/L	156	58	37%	98	2015-11-30	10.0
2_102	MW-15006	Appendix IV	Arsenic	ug/L	156	58	37%	98	2023-10-02	10.0
2_103	MW-15007	Appendix IV	Barium	ug/L	156	0	0%	156	2016-09-27	377
2_114	MW-15004	Appendix IV	Fluoride	ug/L	162	103	64%	59	2021-04-19	1400
4_112	MW-15007	Michigan CCR	Copper	ug/L	58	37	64%	21	2021-10-19	4.90

Table 7: Seasonality Tests

						Full											Without Non-Detects										
						Sample Size					p-Value						Sample Size					p-Value					
ID	Well	Constituent Type	Constituent	Unit	% NDs	Winter	Spring	Summer	Fall	Total	Kruskal-Wallis		ANOVA		Log ANOVA		Winter	Spring	Summer	Fall	Total	Kruskal-Wallis		ANOVA		Log ANOVA	
1_105	Pooled Background	Appendix III	Boron	ug/L	2%	14	56	23	63	156	0.669		0.964		0.760		14	55	23	61	153	0.625		0.968		0.732	
1_107	Pooled Background	Appendix III	Calcium	mg/L	0%	14	56	23	63	156	0.588		0.257		0.543		14	56	23	63	156	0.588		0.257		0.543	
1_108	Pooled Background	Appendix III	Chloride	mg/L	0%	14	56	23	63	156	0.548		0.358		0.501		14	56	23	63	156	0.548		0.358		0.501	
1_114	Pooled Background	Appendix III	Fluoride	ug/L	64%	14	62	23	63	162	0.000	***	0.000	***	0.000	***	0	33	2	24	59	0.998		0.916		0.997	
1_122	Pooled Background	Appendix III	pH, Field	SU	0%	17	62	23	63	165	0.500		0.504		0.495		17	62	23	63	165	0.500		0.504		0.495	
1_128	Pooled Background	Appendix III	Sulfate	mg/L	21%	14	56	23	63	156	0.449		0.723		0.575		14	46	18	45	123	0.617		0.868		0.663	
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	0%	14	56	23	63	156	0.314		0.256		0.331		14	56	23	63	156	0.314		0.256		0.331	
2_101	Pooled Background	Appendix IV	Antimony	ug/L	91%	14	63	23	49	149	0.129		0.012	*	0.007	**	1	6	1	5	13	0.214		0.088		0.321	
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	37%	14	63	23	56	156	0.004	**	0.675		0.007	**	9	34	16	39	98	0.002	**	0.782		0.011	*
2_103	Pooled Background	Appendix IV	Barium	ug/L	0%	14	63	23	56	156	0.365		0.134		0.342		14	63	23	56	156	0.365		0.134		0.342	
2_104	Pooled Background	Appendix IV	Beryllium	ug/L	100%	14	63	23	49	149	0.041	*	0.002	**	0.001	***	NA	NA	NA	NA	NA	NA		NA		NA	
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	99%	14	63	23	49	149	0.000	***	0.030	*	0.008	**	0	1	1	0	2	0.317		NA		NA	
2_109	Pooled Background	Appendix IV	Chromium	ug/L	53%	14	63	23	56	156	0.019	*	0.024	*	0.003	**	10	30	11	22	73	0.002	**	0.002	**	0.001	***
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	93%	14	63	23	49	149	0.000	***	0.000	***	0.000	***	0	7	0	4	11	0.107		0.267		0.138	
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	64%	14	62	23	63	162	0.000	***	0.000	***	0.000	***	0	33	2	24	59	0.998		0.916		0.997	
2_116	Pooled Background	Appendix IV	Lead	ug/L	95%	14	63	23	49	149	0.341		0.639		0.973		0	4	2	2	8	0.905		0.970		0.971	
2_117	Pooled Background	Appendix IV	Lithium	ug/L	69%	14	63	23	56	156	0.420		0.796		0.111		2	20	8	18	48	0.667		0.964		0.593	
2_118	Pooled Background	Appendix IV	Mercury	ug/L	100%	14	63	23	49	149	NA		0.568		0.568		NA	NA	NA	NA	NA	NA		NA		NA	
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	75%	14	63	23	56	156	0.212		0.183		0.023	*	2	22	3	12	39	0.017	*	0.018	*	0.035	*
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	49%	14	63	23	56	156	0.004	**	0.008	**	0.011	*	9	28	9	33	79	0.028	*	0.083		0.046	*
2_126	Pooled Background	Appendix IV	Selenium	ug/L	76%	14	63	23	56	156	0.536		0.794		0.690		2	18	6	11	37	0.211		0.076		0.214	
2_130	Pooled Background	Appendix IV	Thallium	ug/L	99%	14	63	23	49	149	0.000	***	0.044	*	0.001	**	0	1	0	0	1	NA		NA		NA	
4_112	Pooled Background	Michigan CCR	Copper	ug/L	64%	0	28	2	28	58	0.128		0.632		0.144		0	13	0	8	21	0.246		0.815		0.511	
4_115	Pooled Background	Michigan CCR	Iron	ug/L	2%	0	28	2	28	58	0.092		0.245		0.579		0	28	2	27	57	0.047	*	0.193		0.071	
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	76%	0	28	2	28	58	0.087		0.015	*	0.079		0	9	0	5	14	0.738		0.688		0.680	
4_127	Pooled Background	Michigan CCR	Silver	ug/L	100%	0	28	2	28	58	0.013	*	0.009	**	0.027	*	NA	NA	NA	NA	NA	NA		NA		NA	
4_134	Pooled Background	Michigan CCR	Vanadium	ug/L	97%	0	28	2	28	58	0.010	*	0.009	**	0.020	*	0	1	0	1	2	0.317		NA		NA	
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	53%	0	28	2	28	58	0.141		0.623		0.090		0	17	0	10	27	0.269		0.488		0.255	

*** p < 0.001, ** p < 0.01, * p < 0.05

Table 8: Trend Tests: Lognormal MLE and MK

ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Type	Method	Slope	p-value	Trend
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	Nonparametric	MK	-0.000962	0.745	↔
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	Nonparametric	MK	-0.0155	0.068	↔
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	Nonparametric	MK	0	0.570	↔
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	Nonparametric	MK	-0.0409	0.162	↔
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	Parametric	Lognormal MLE	-0.0000472	0.457	↔
4_115	Pooled Background	Michigan CCR	Iron	ug/L	58	1	2%	Parametric	Lognormal MLE	-0.000656	0.222	↔

Table 9: Trend Tests: Piecewise Linear-Linear

								Line 1			Line 2					
ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Slope	p-Value	Trend	Slope	p-Value	Trend	Break 1	R-Squared	Overall Trend
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	-0.257	0.241	↔	0.634	0.012	↔	2020-01-07	0.072	↔
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	-0.0518	0.016	↔	0.0119	0.166	↔	2018-07-04	0.073	↔
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	-0.297	0.161	↔	-0.0377	0.658	↔	2018-10-28	0.071	↔
1_114	Pooled Background	Appendix III	Fluoride	ug/L	162	103	64%	0	1.000	↔	0	0.000	↓	2018-04-08	0.705	↔
1_122	Pooled Background	Appendix III	pH, Field	SU	165	0	0%	0.000144	0.024	↔	-0.000212	0.040	↔	2020-05-04	0.058	↔
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	-0.0834	0.009	↓	0.0208	0.015	↔	2018-01-02	0.088	↔
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	-0.415	0.038	↔	0.0630	0.781	↔	2020-01-14	0.065	↔
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	-0.000305	0.000	↓	0.000468	0.013	↔	2022-02-22	0.387	↔
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	156	58	37%	0.00228	0.035	↔	-0.00408	0.256	↔	2021-04-19	0.037	↔
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	-0.0728	0.007	↓	0.0102	0.387	↔	2018-06-15	0.086	↔
2_104	Pooled Background	Appendix IV	Beryllium	ug/L	149	149	100%	-0.000408	0.000	↓	0.000607	0.001	↑	2021-10-19	0.505	↔
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	149	147	99%	0.0000315	0.412	↔	0.000608	0.000	↑	2021-09-26	0.358	↔
2_109	Pooled Background	Appendix IV	Chromium	ug/L	156	83	53%	-0.000429	0.000	↓	0.000454	0.245	↔	2022-05-04	0.248	↔
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	-0.00852	0.000	↓	0.00115	0.422	↔	2021-06-24	0.841	↔
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	162	103	64%	0	1.000	↔	0	0.000	↓	2018-04-08	0.705	↔
2_116	Pooled Background	Appendix IV	Lead	ug/L	149	141	95%	-0.000150	0.092	↔	0.00140	0.002	↑	2022-01-04	0.150	↔
2_117	Pooled Background	Appendix IV	Lithium	ug/L	156	108	69%	-0.00189	0.080	↔	0.00546	0.130	↔	2021-04-19	0.041	↔
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	-0.00162	0.000	↓	0.00339	0.082	↔	2022-05-04	0.143	↔
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	156	77	49%	-0.0000633	0.248	↔	-0.00278	0.101	↔	2023-09-21	0.062	↔
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	-0.000293	0.001	↓	0.00111	0.000	↑	2021-07-11	0.166	↔
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	-0.000779	0.000	↓	0.000912	0.110	↔	2022-03-09	0.325	↔
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	-0.00108	0.005	↓	0.00317	0.167	↔	2023-09-17	0.187	↔
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	58	44	76%	-0.284	0.000	↓	0.000409	0.039	↔	2021-04-19	0.999	↔
4_127	Pooled Background	Michigan CCR	Silver	ug/L	58	58	100%	-0.000414	0.000	↓	0.0000574	0.033	↔	2021-12-20	0.658	↔
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	-0.0277	0.078	↔	0.0103	0.145	↔	2022-01-06	0.104	↔

Table 10: Trend Tests: Piecewise Linear-Linear-Linear

								Line 1			Line 2			Line 3						
ID	Well	Constituent Type	Constituent	Unit	n	No. NDs	% NDs	Slope	p-Value	Trend	Slope	p-Value	Trend	Slope	p-Value	Trend	Break 1	Break 2	R-Squared	Overall Trend
1_105	Pooled Background	Appendix III	Boron	ug/L	156	3	2%	-0.304	0.446	↔	-0.000908	1.000	↔	0.633	0.013	↔	2018-11-05	2020-05-03	0.072	↔
1_107	Pooled Background	Appendix III	Calcium	mg/L	156	0	0%	-0.0274	0.000	↓	0.175	0.177	↔	-0.0993	0.020	↔	2021-06-19	2022-08-03	0.128	↔
1_108	Pooled Background	Appendix III	Chloride	mg/L	156	0	0%	0.523	0.788	↔	-0.375	0.246	↔	-0.0368	0.667	↔	2016-04-12	2018-07-18	0.072	↔
1_128	Pooled Background	Appendix III	Sulfate	mg/L	156	33	21%	-0.0834	0.008	↓	0.0288	0.008	↑	-0.222	0.178	↔	2018-02-28	2023-10-01	0.109	↔
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	156	0	0%	0.934	0.626	↔	-0.941	0.414	↔	-0.0125	0.923	↔	2016-07-12	2018-04-16	0.071	↔
2_101	Pooled Background	Appendix IV	Antimony	ug/L	149	136	91%	0.0000121	0.851	↔	-0.00396	0.000	↓	0.000487	0.000	↑	2020-04-29	2020-11-20	0.571	↔
2_103	Pooled Background	Appendix IV	Barium	ug/L	156	0	0%	-0.0728	0.007	↓	0.0302	0.086	↔	-0.0846	0.408	↔	2018-10-28	2022-11-20	0.104	↔
2_104	Pooled Background	Appendix IV	Beryllium	ug/L	149	149	100%	0	1.000	↔	-0.00144	0.000	↓	0.000572	0.000	↑	2019-02-28	2020-11-07	0.647	↔
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	149	138	93%	0	1.000	↔	-0.0303	0.000	↓	0.000679	0.201	↔	2018-06-08	2019-10-03	0.925	↔
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	156	117	75%	0.00184	0.037	↔	-0.00626	0.000	↓	0.00378	0.006	↑	2018-11-28	2021-06-10	0.265	↔
2_126	Pooled Background	Appendix IV	Selenium	ug/L	156	119	76%	-0.000289	0.000	↓	0.00794	0.000	↑	-0.0112	0.000	↓	2022-08-11	2023-07-21	0.603	↔
2_130	Pooled Background	Appendix IV	Thallium	ug/L	149	148	99%	0.000460	0.061	↔	-0.00245	0.000	↓	0.00114	0.003	↑	2018-11-28	2021-05-22	0.475	↔
4_112	Pooled Background	Michigan CCR	Copper	ug/L	58	37	64%	-0.000458	0.845	↔	-0.00137	0.063	↔	0.00354	0.130	↔	2021-10-18	2023-09-13	0.193	↔
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	58	31	53%	-0.0283	0.074	↔	0.0262	0.110	↔	-0.00562	0.859	↔	2022-03-16	2023-04-11	0.128	↔

E

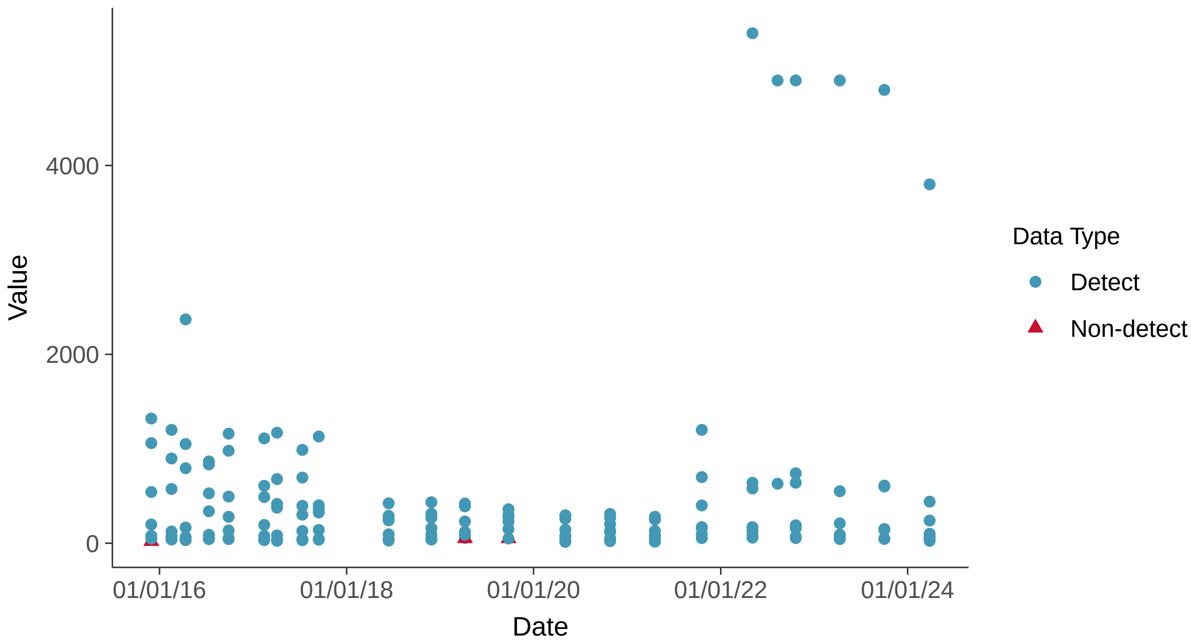
Full Scatter Plots

Appendix III: Boron, Pooled Background

ID: 1_105

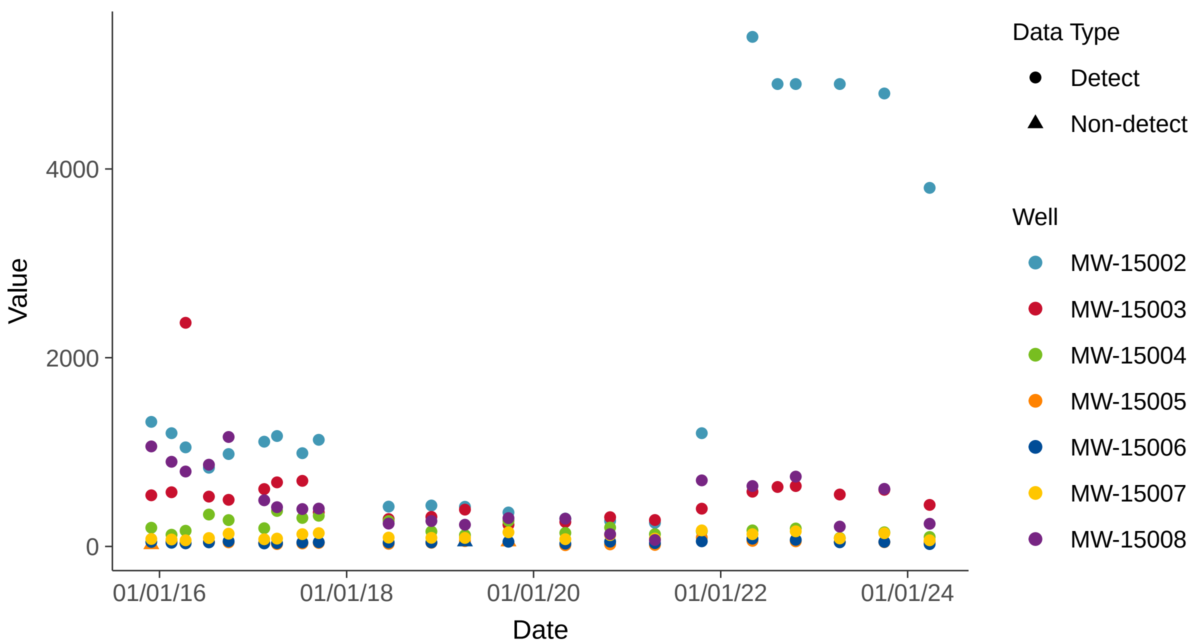
Scatter Plot

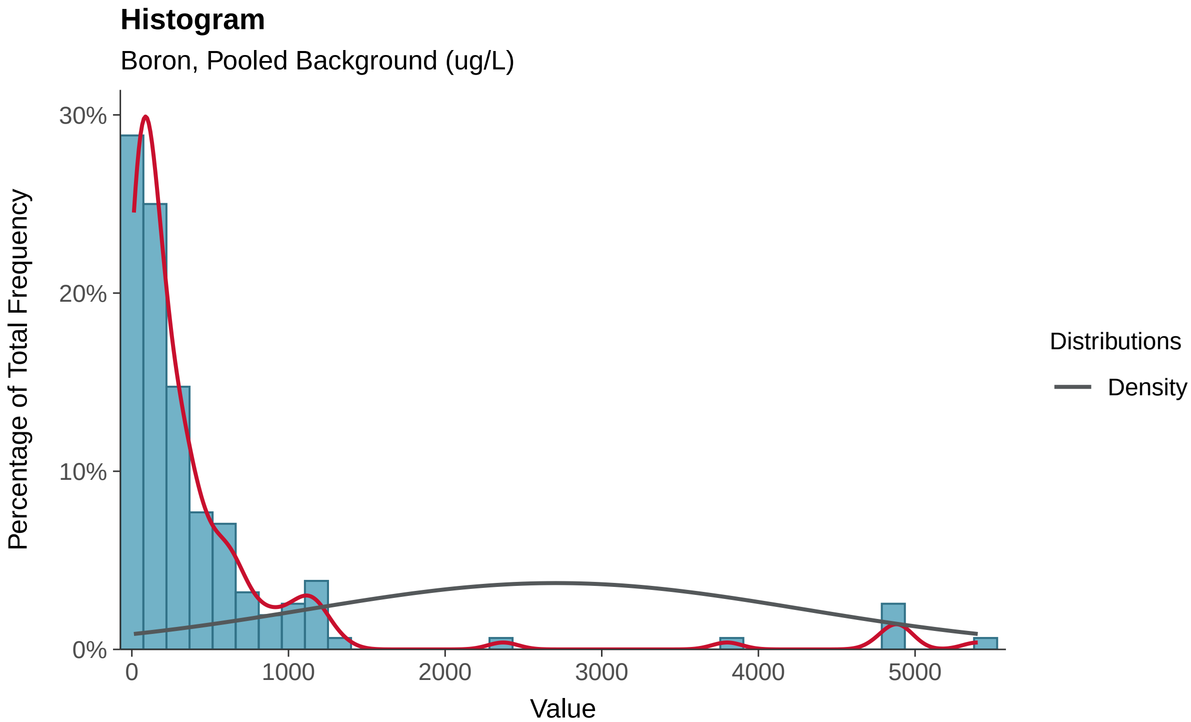
Boron, Pooled Background (ug/L)

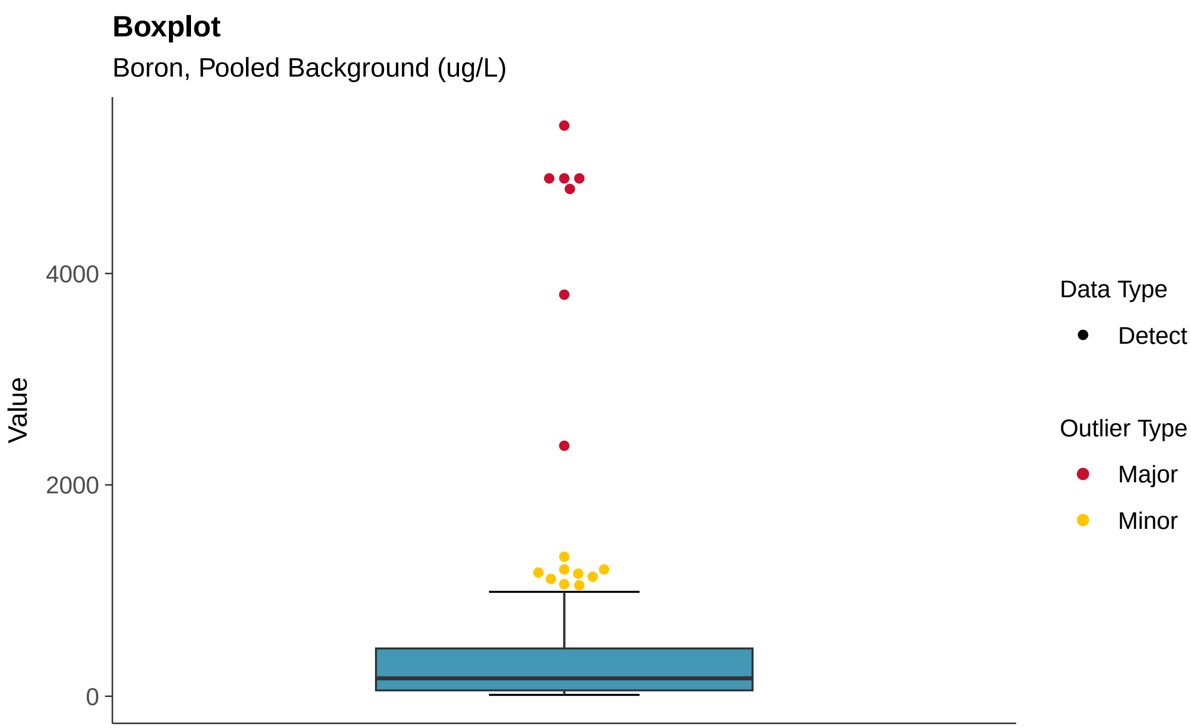


Scatter Plot by Well

Boron, Pooled Background (ug/L)

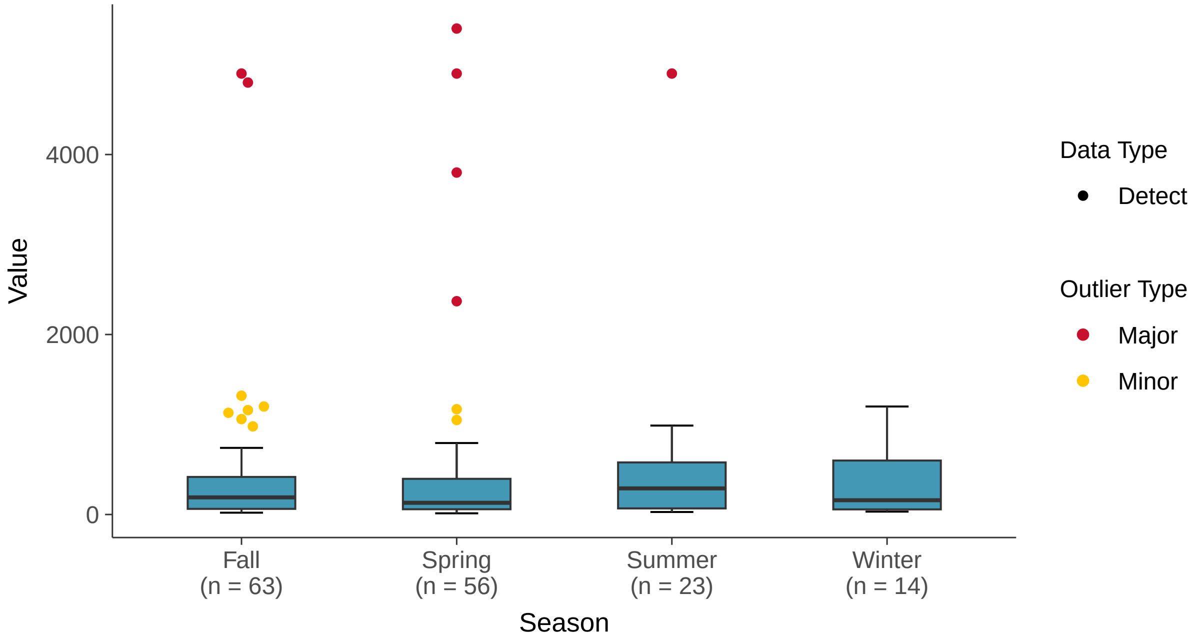



Histogram
Boron, Pooled Background (ug/L)
Percentage of Total Frequency
30%
20%
10%
0%
0
1000
2000
3000
4000
5000
Value
Distributions
Density


Boxplot
Boron, Pooled Background (ug/L)
Value
4000
2000
0
Data Type
Detect
Outlier Type
Major
Minor

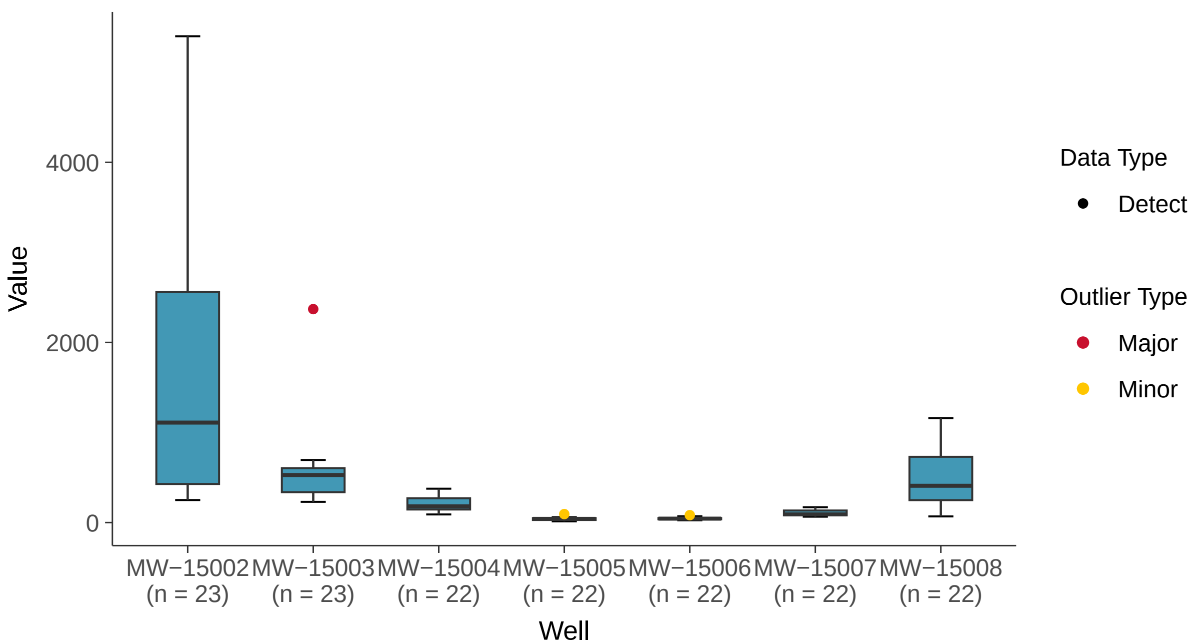
Boxplot by Season

Boron, Pooled Background (ug/L)



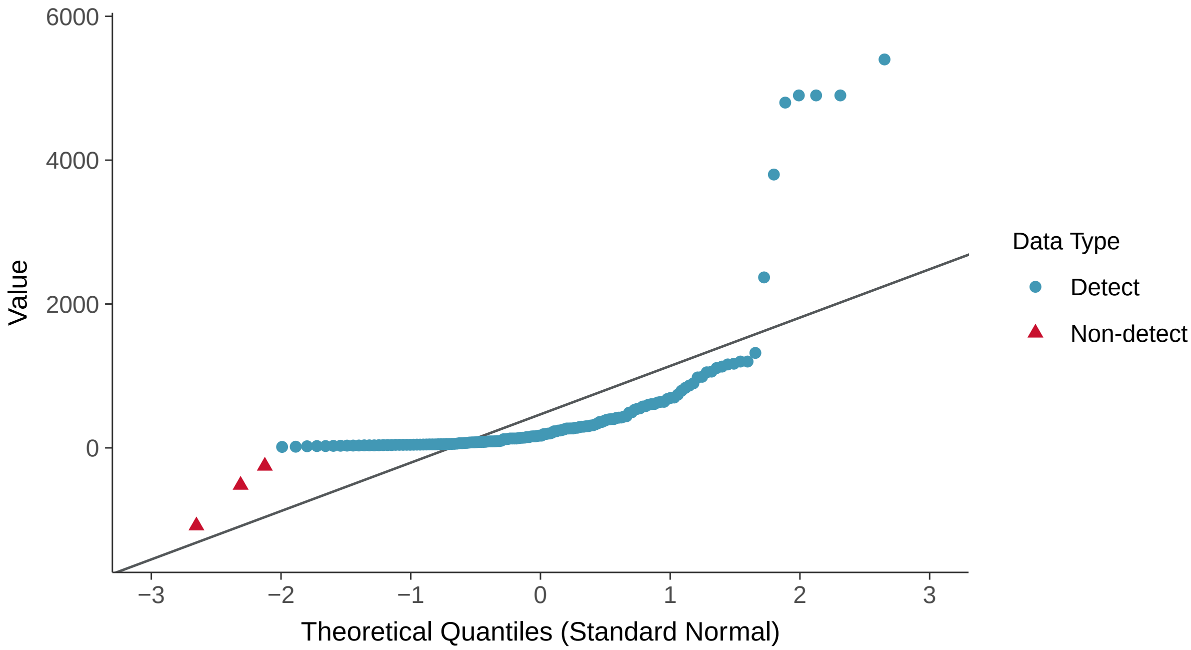
Boxplot by Well

Boron, Pooled Background (ug/L)



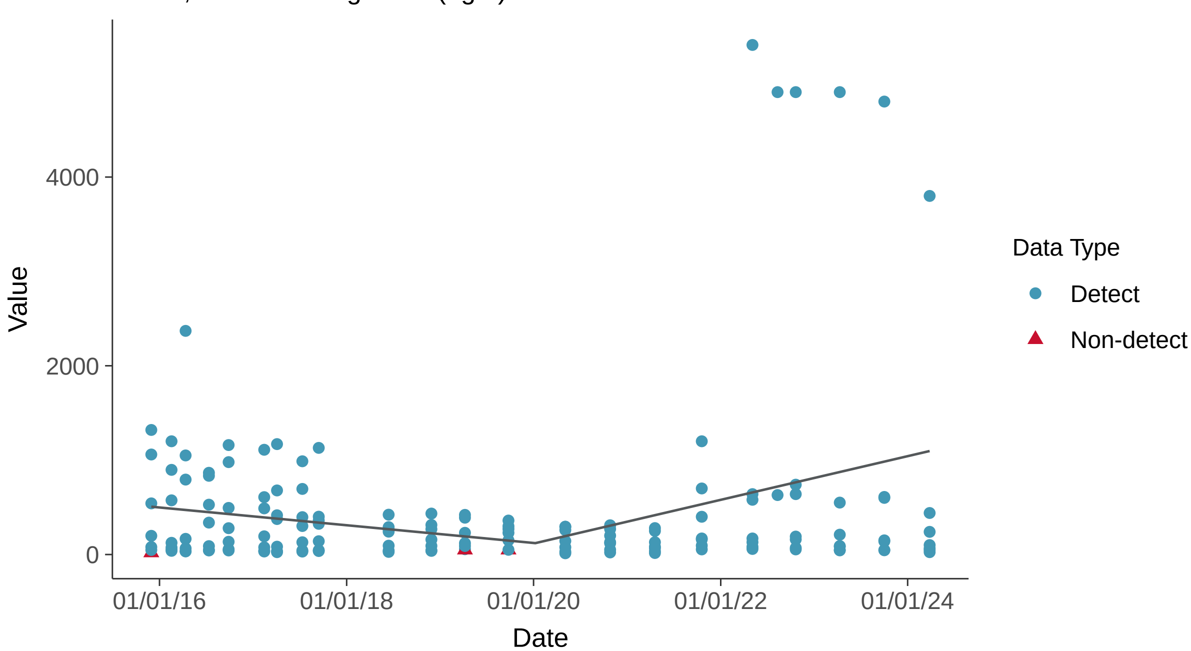
Normal Q-Q plot using ROS Imputed Estimates

Boron, Pooled Background (ug/L)



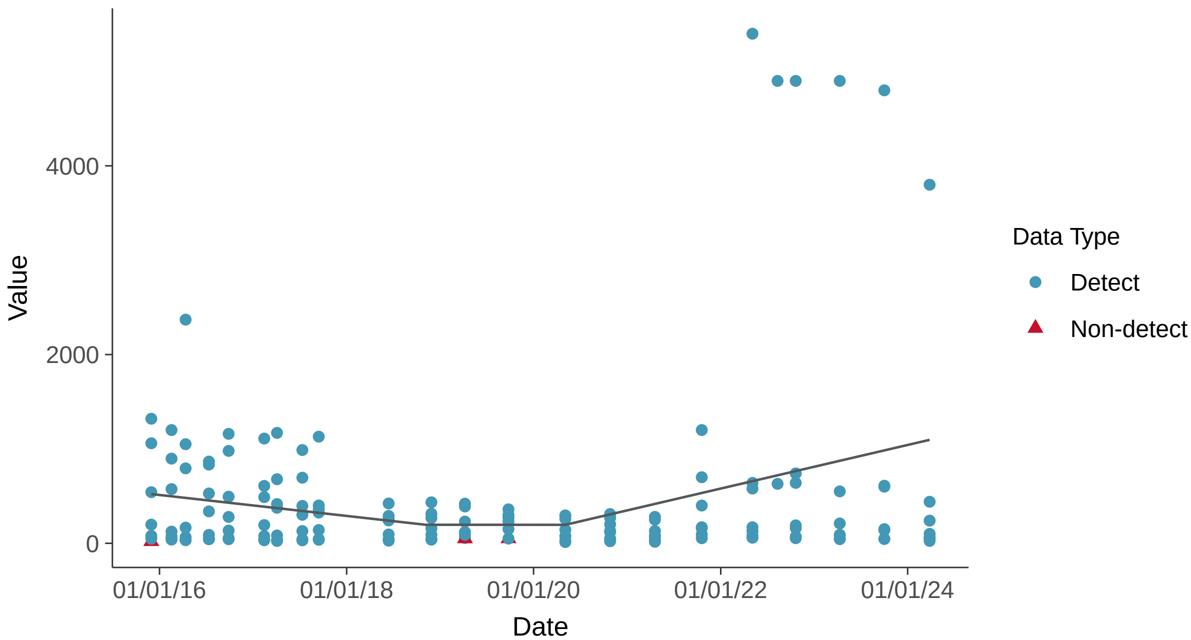
Trend Regression: Piecewise Linear-Linear

Boron, Pooled Background (ug/L)



Trend Regression: Piecewise Linear-Linear-Linear

Boron, Pooled Background (ug/L)

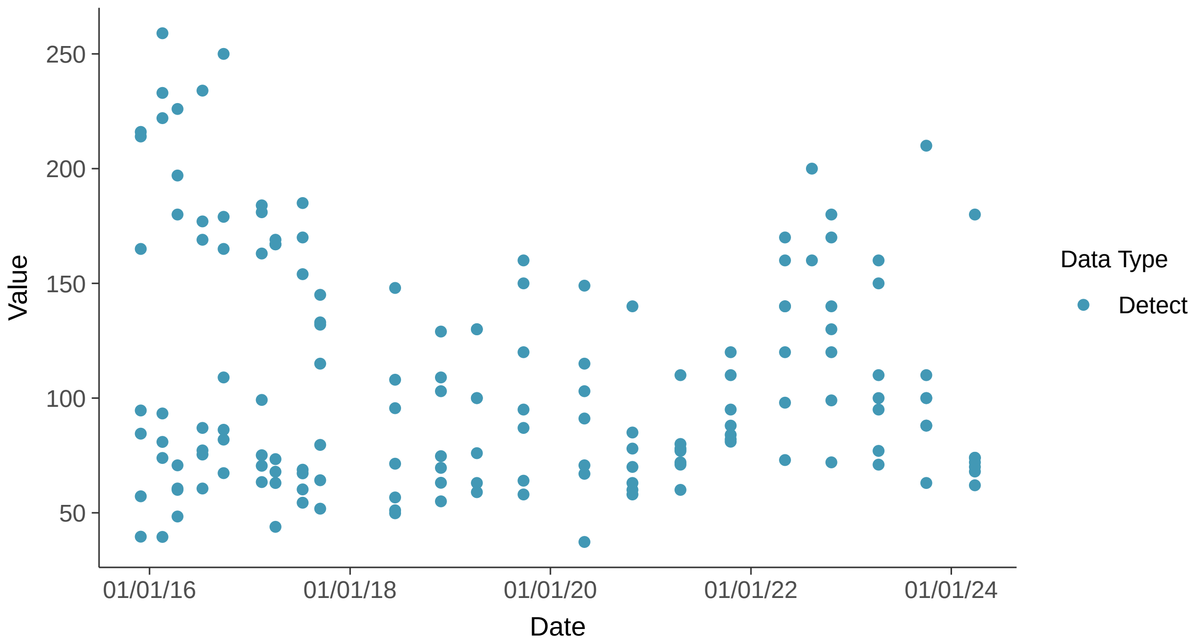


Appendix III: Calcium, Pooled Background

ID: 1_107

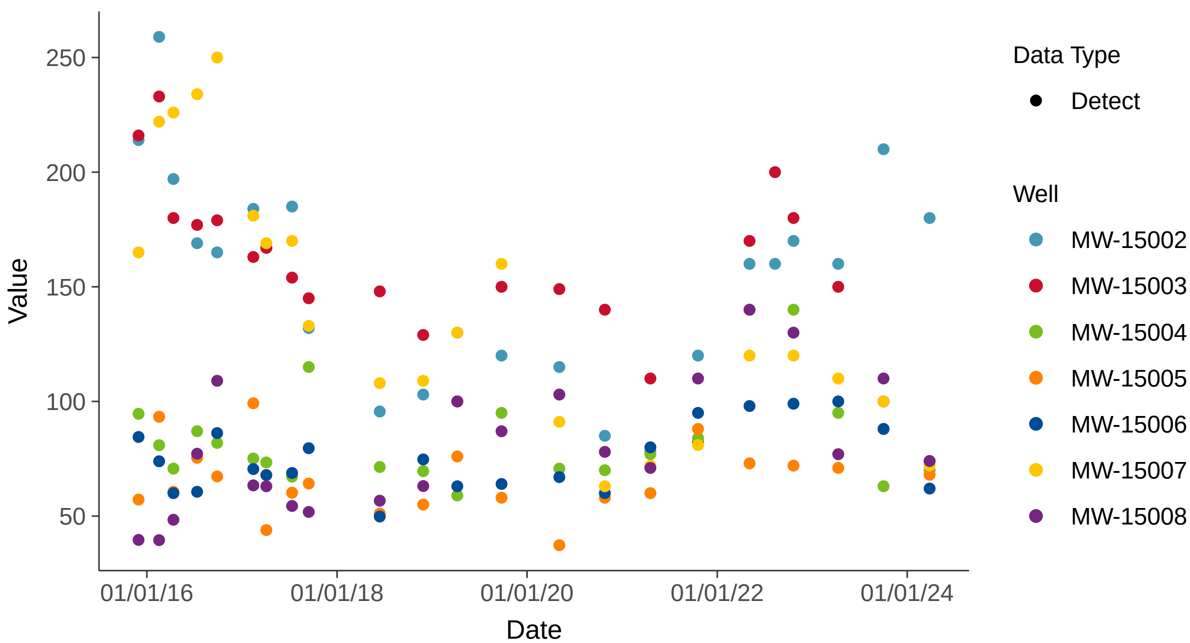
Scatter Plot

Calcium, Pooled Background (mg/L)



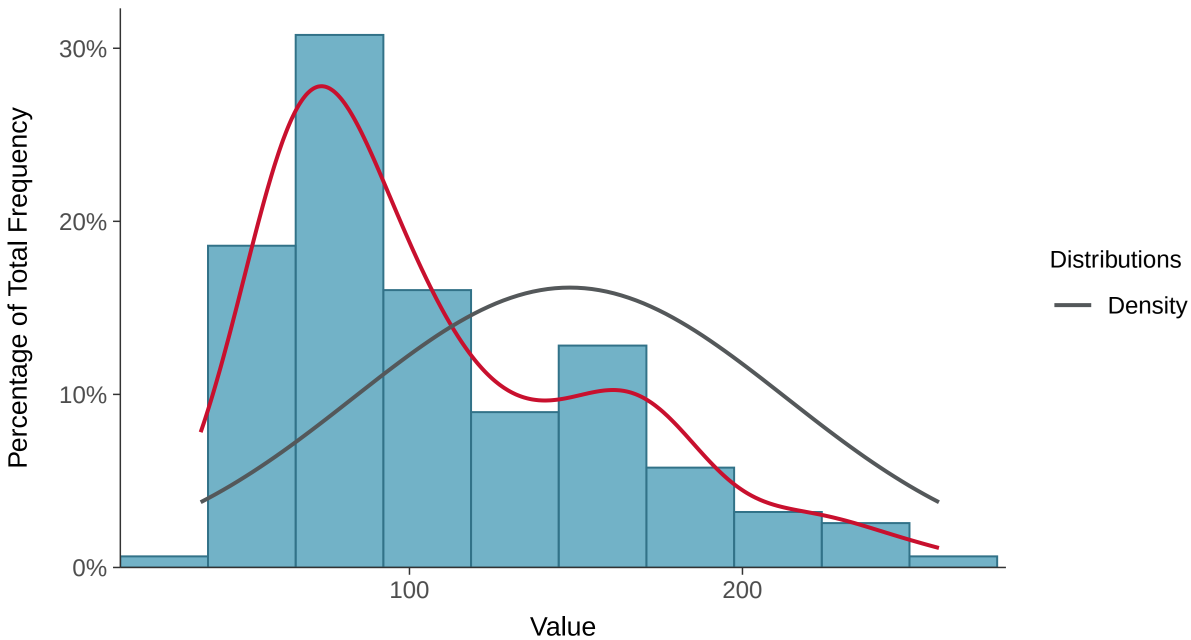
Scatter Plot by Well

Calcium, Pooled Background (mg/L)



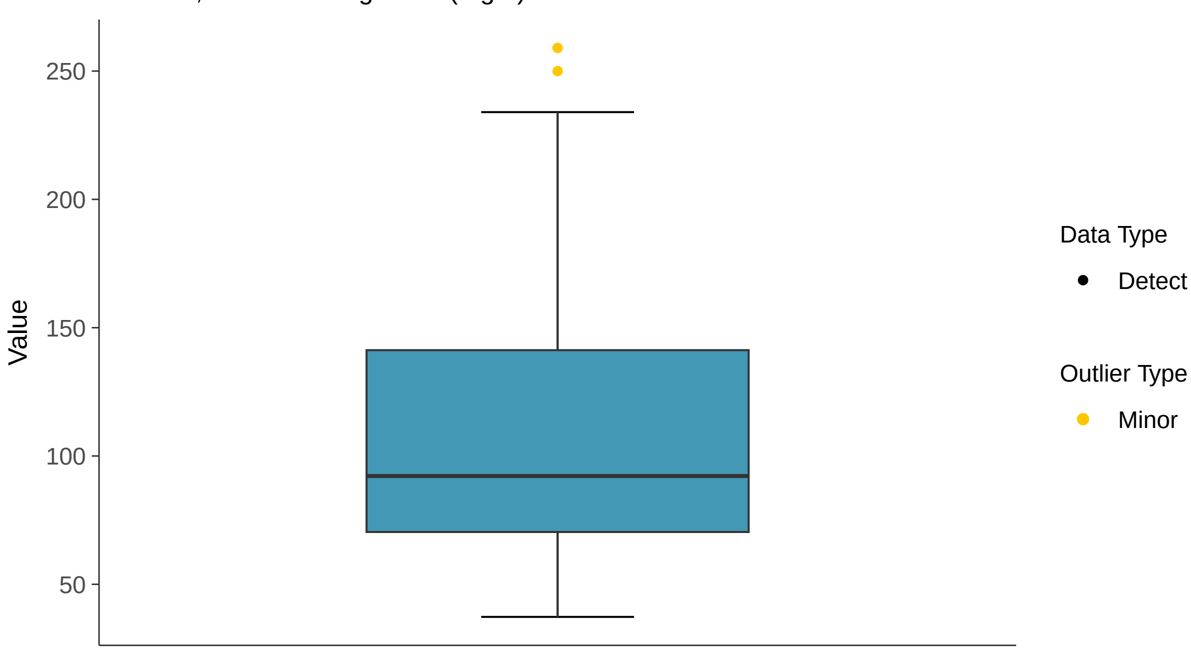
Histogram

Calcium, Pooled Background (mg/L)



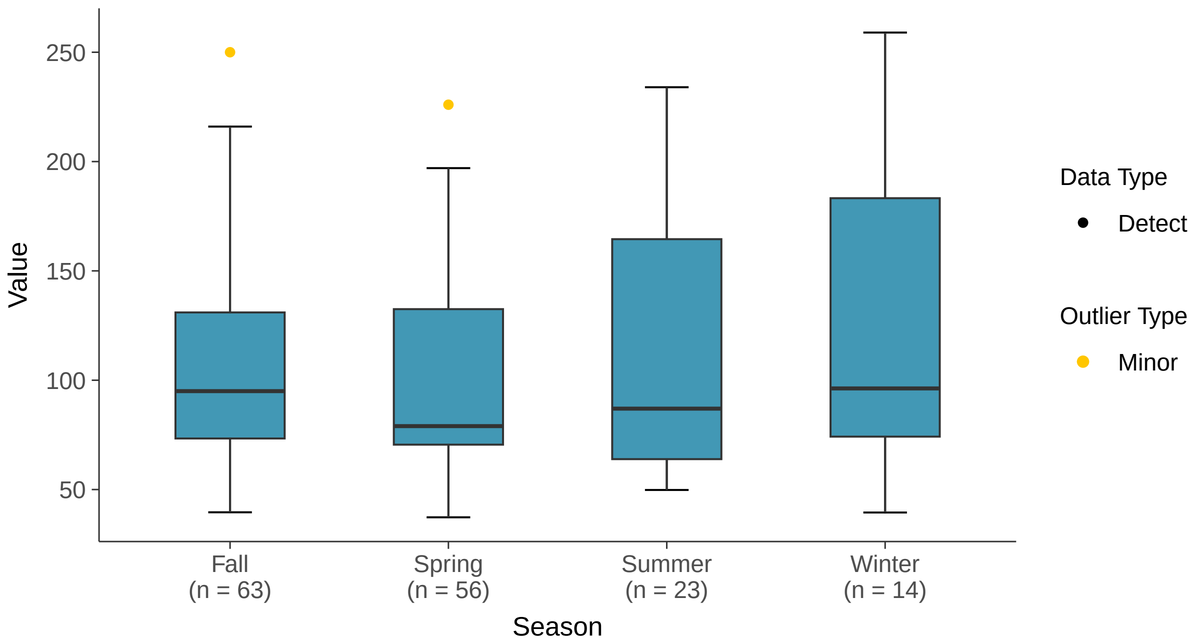
Boxplot

Calcium, Pooled Background (mg/L)



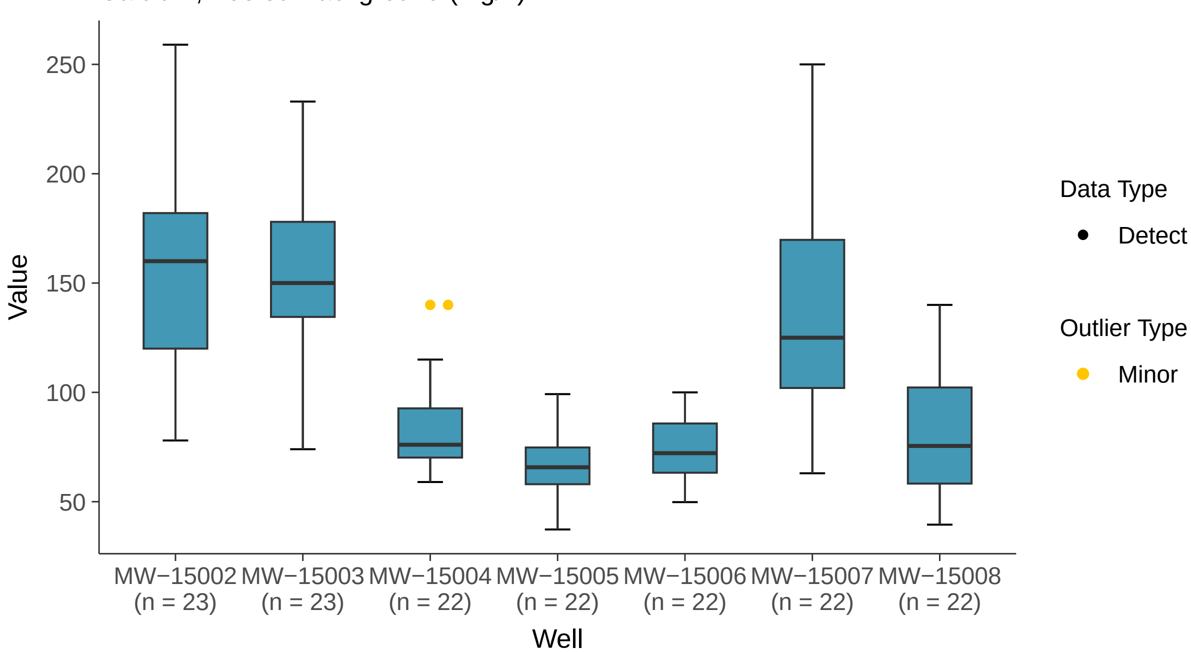
Boxplot by Season

Calcium, Pooled Background (mg/L)



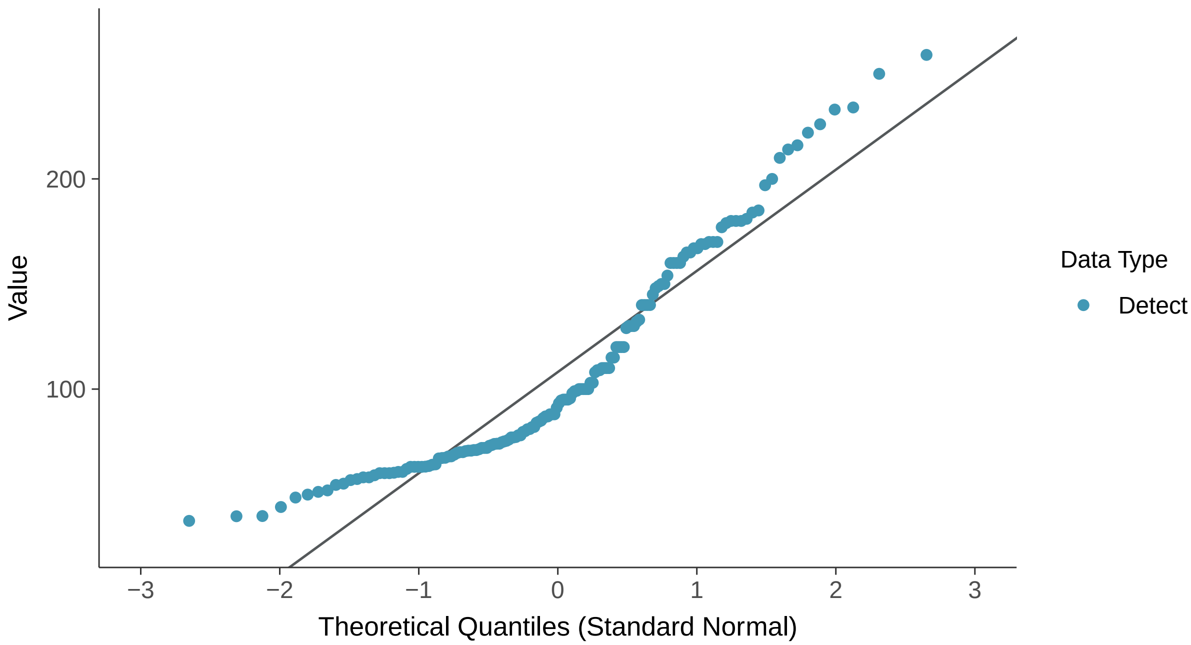
Boxplot by Well

Calcium, Pooled Background (mg/L)



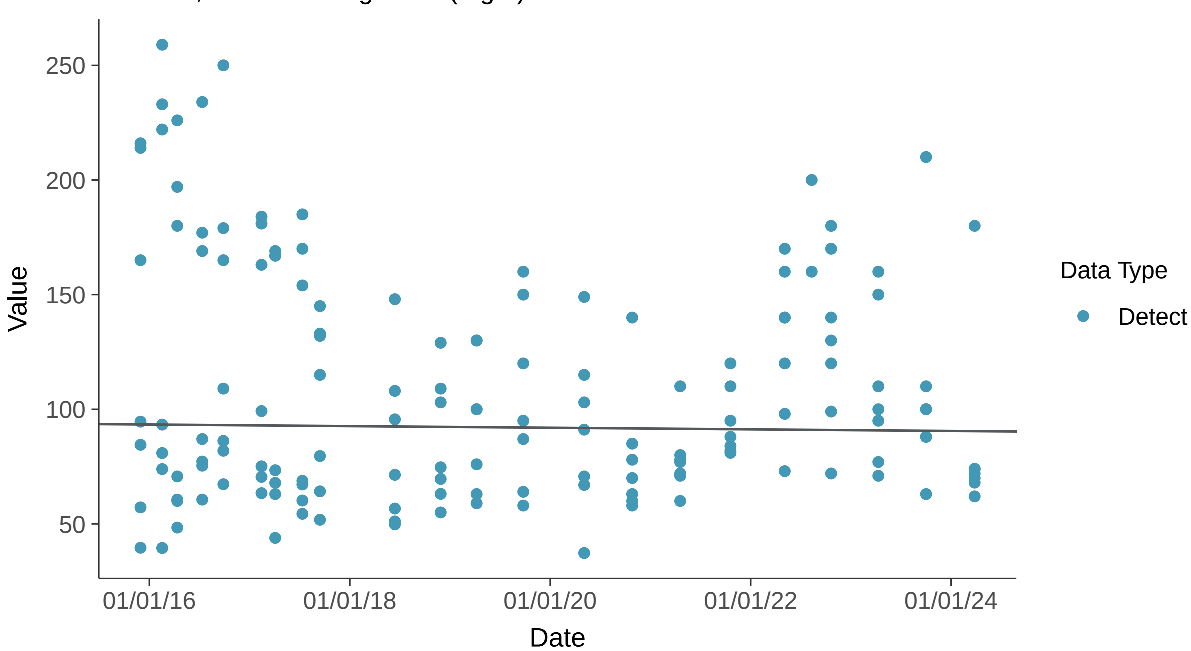
Normal Q-Q plot

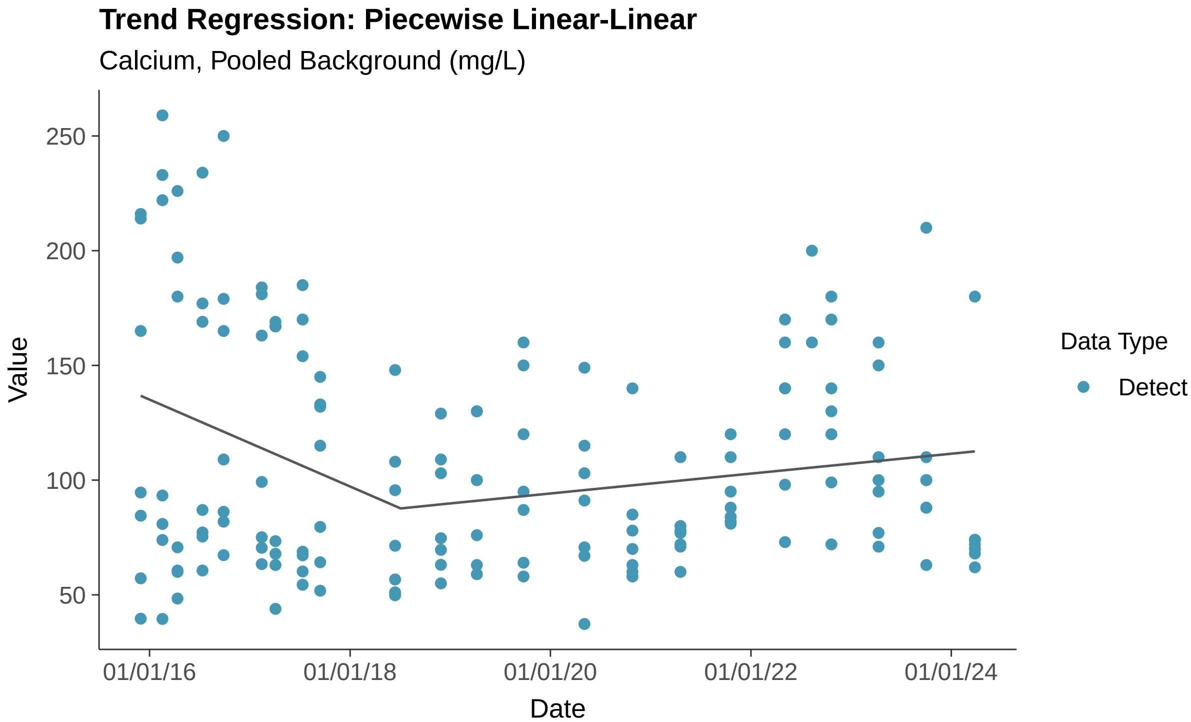
Calcium, Pooled Background (mg/L)

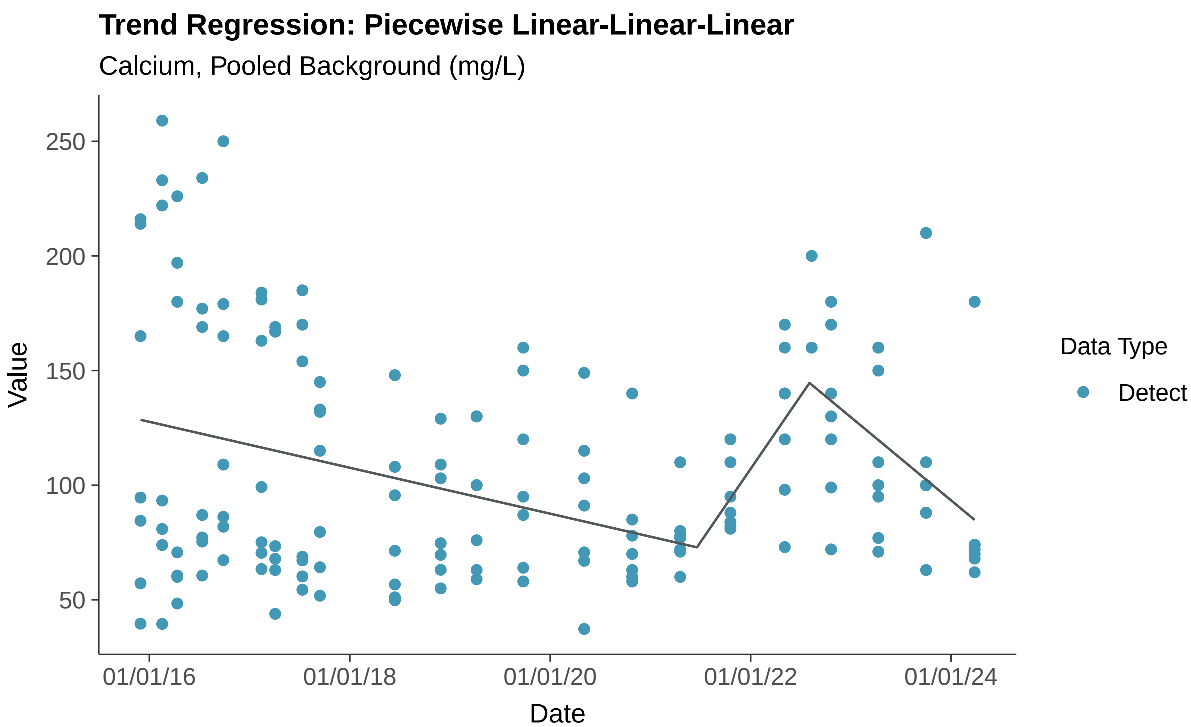


Trend Regression: Mann-Kendall/Theil-Sen Estimate

Calcium, Pooled Background (mg/L)

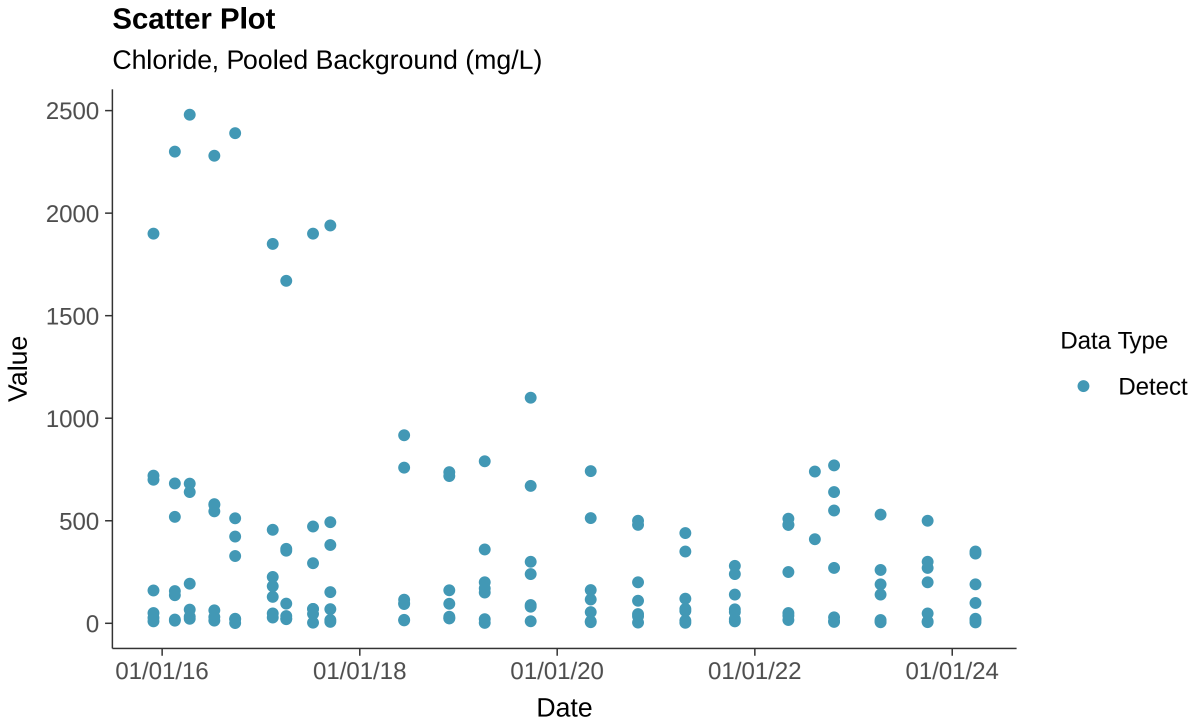


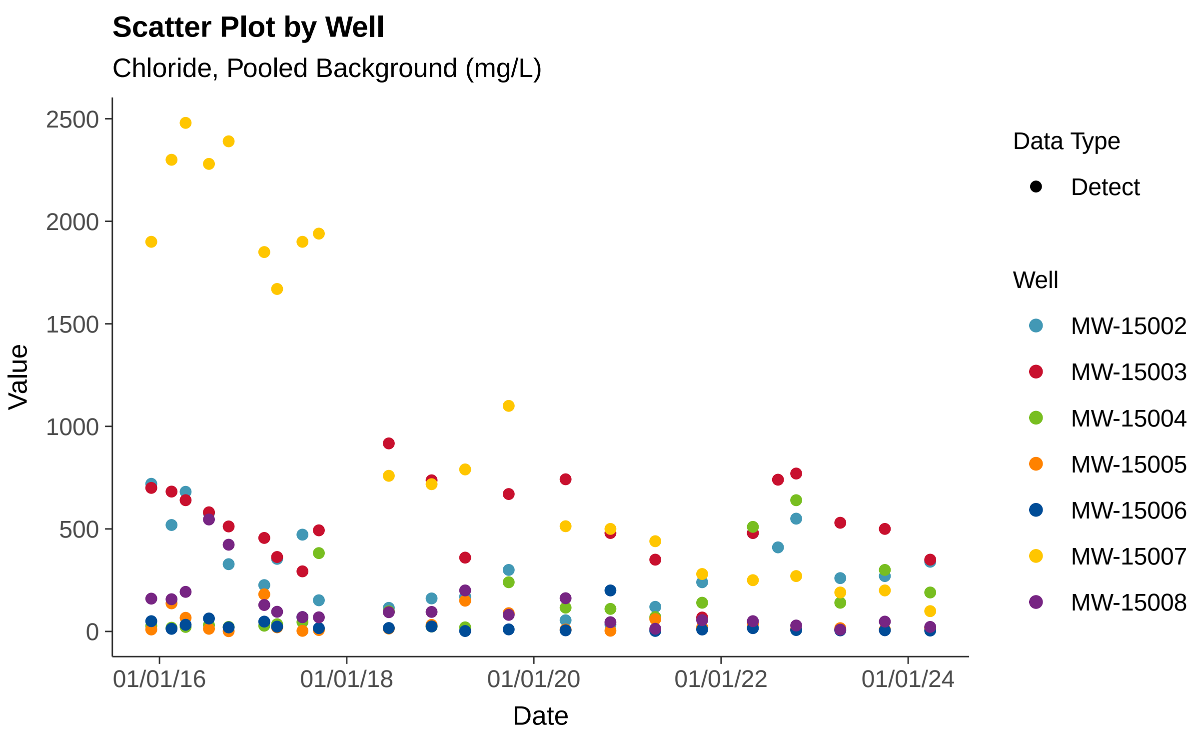

Trend Regression: Piecewise Linear-Linear
Calcium, Pooled Background (mg/L)
Value
250
200
150
100
50
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect

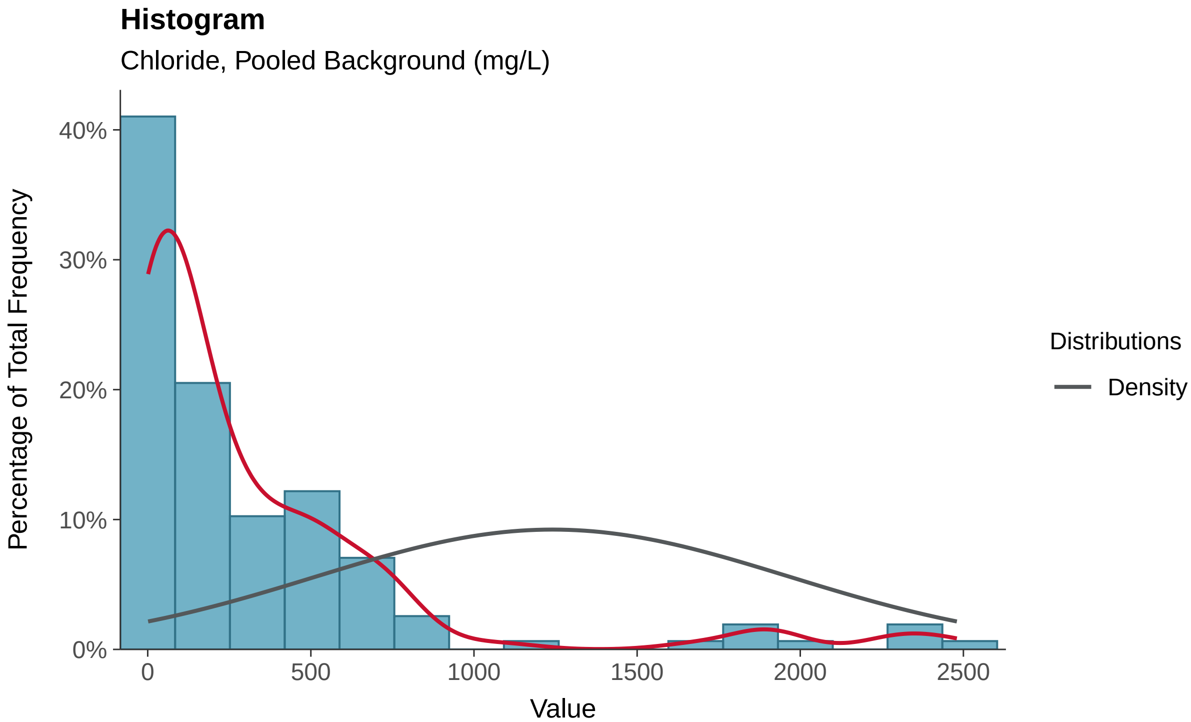

Trend Regression: Piecewise Linear-Linear-Linear
Calcium, Pooled Background (mg/L)
Value
250
200
150
100
50
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect

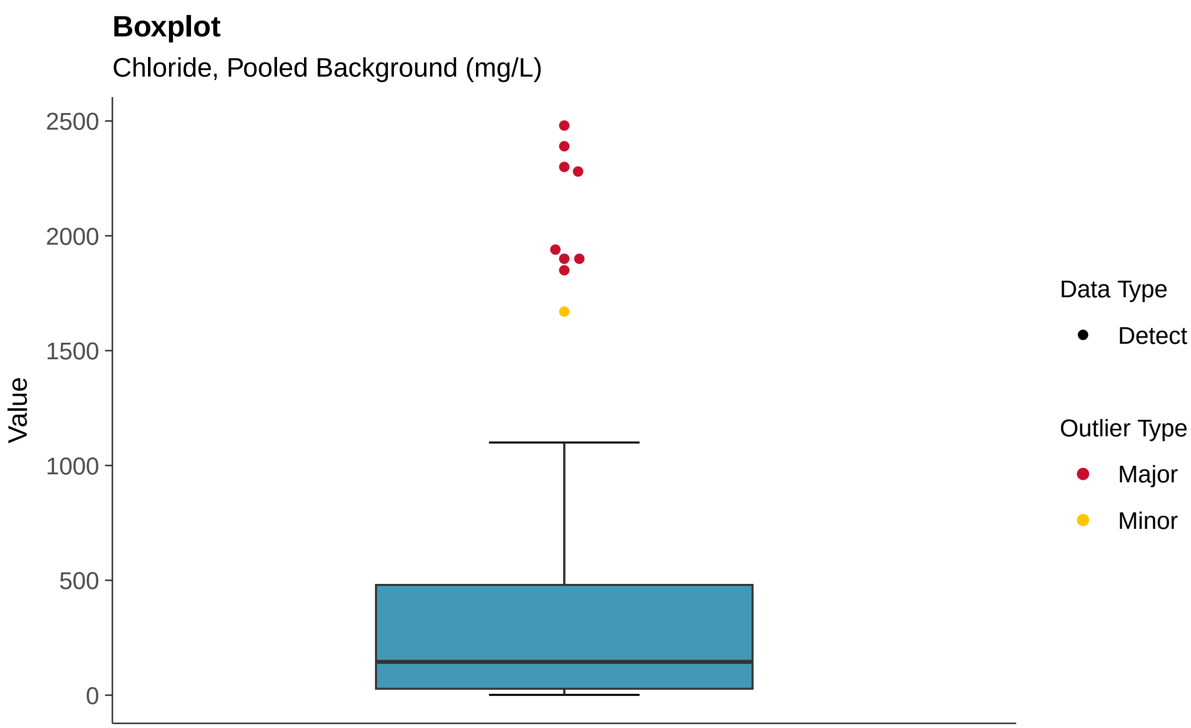
Appendix III: Chloride, Pooled Background

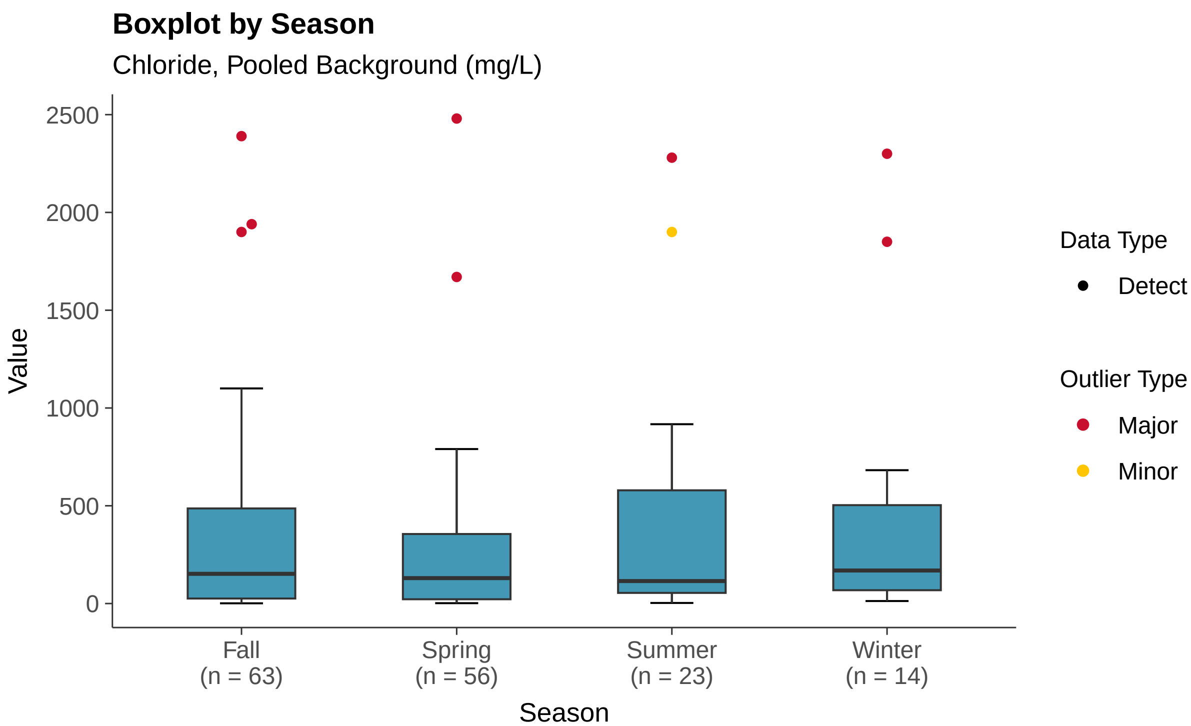
ID: 1_108

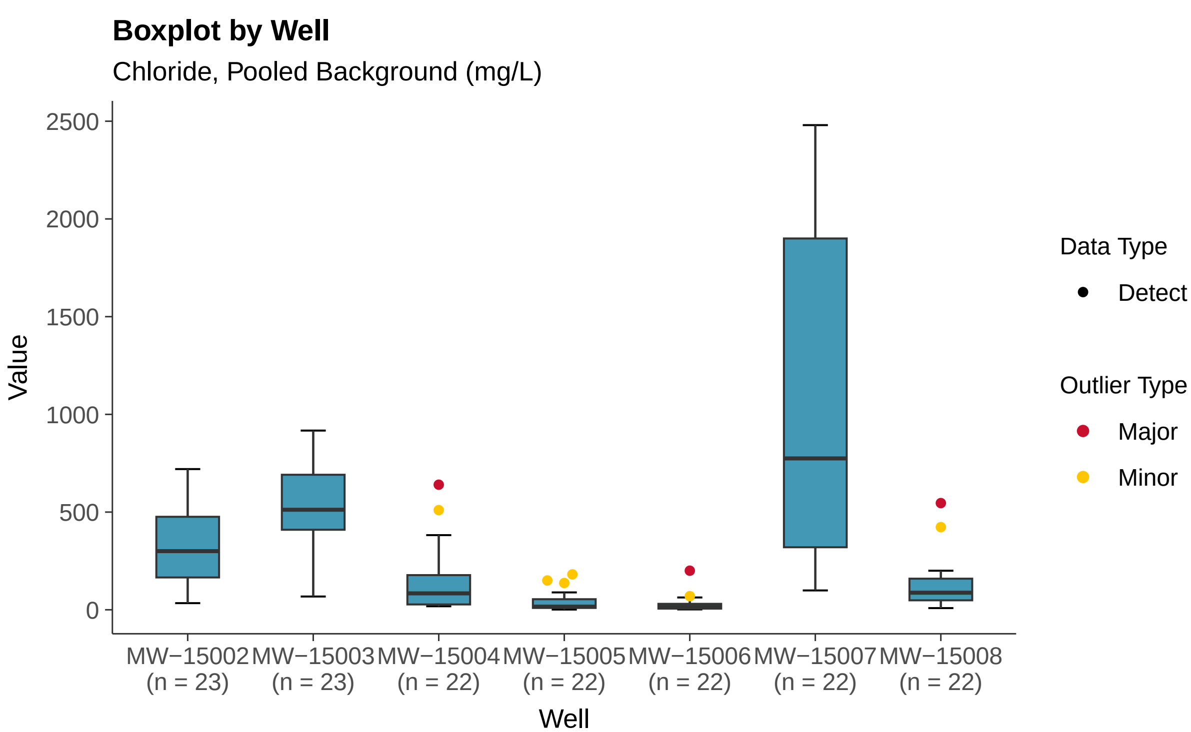





Histogram
Chloride, Pooled Background (mg/L)
Percentage of Total Frequency
40%
30%
20%
10%
0%
0
500
1000
1500
2000
2500
Value
Distributions
Density

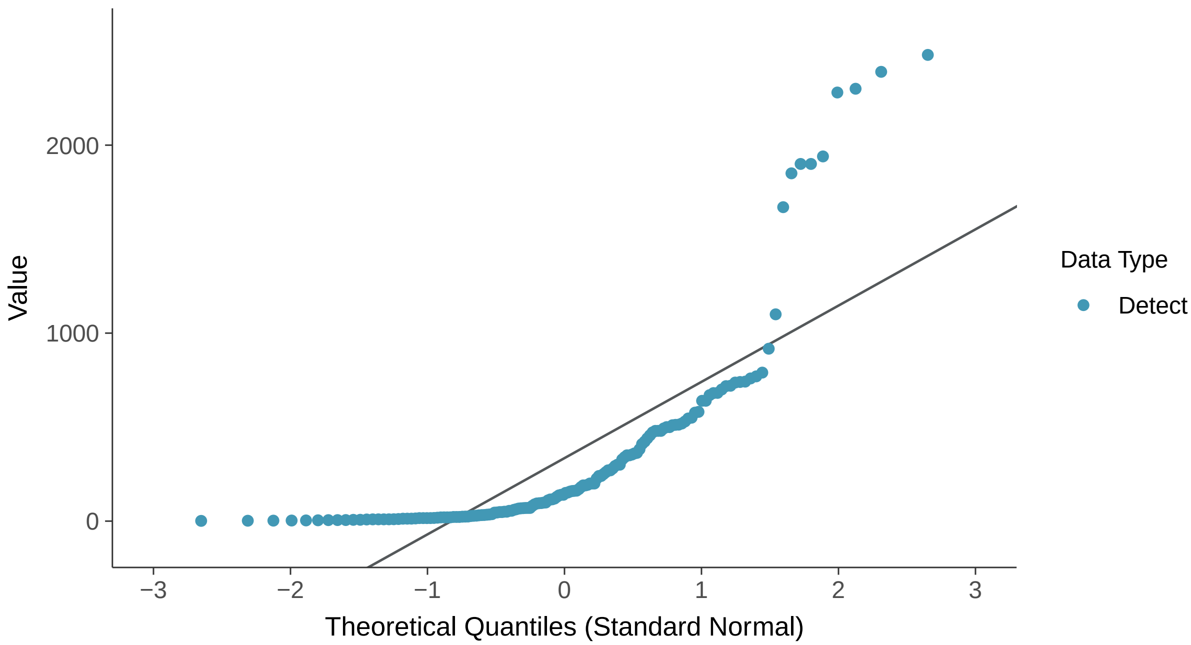

Boxplot
Chloride, Pooled Background (mg/L)
Value
2500
2000
1500
1000
500
0
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Season
Chloride, Pooled Background (mg/L)
Value
2500
2000
1500
1000
500
0
Fall
(n = 63)
Spring
(n = 56)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Well
Chloride, Pooled Background (mg/L)
Value
2500
2000
1500
1000
500
0
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 22)
MW−15007
(n = 22)
MW−15008
(n = 22)
Well
Data Type
Detect
Outlier Type
Major
Minor

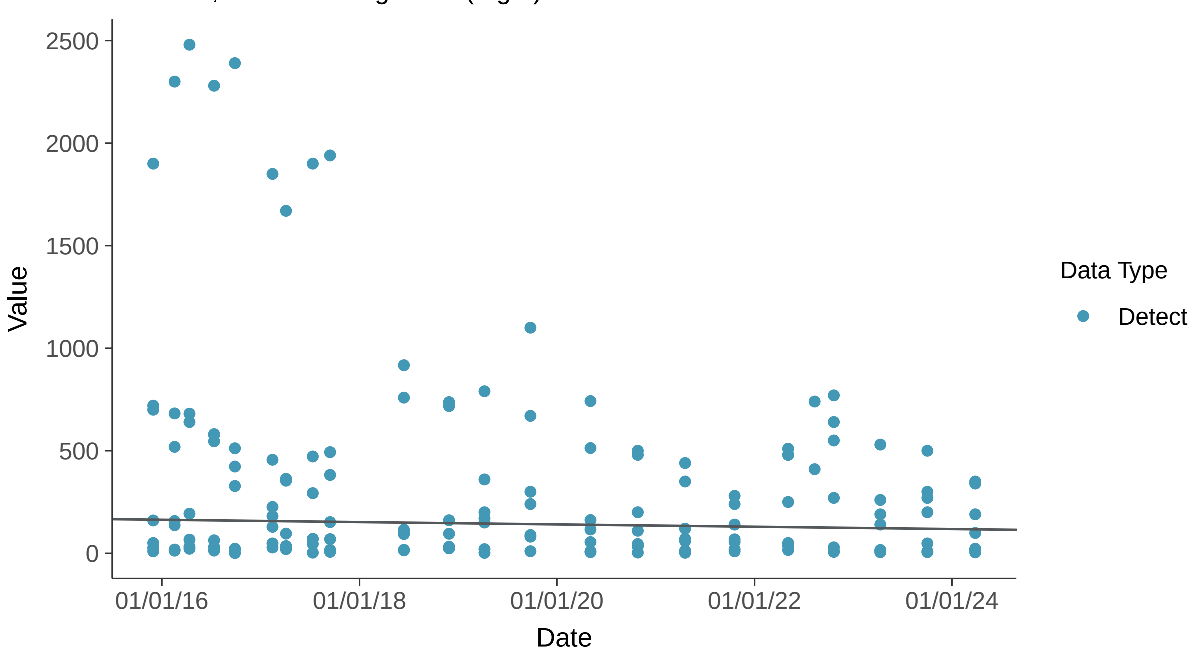
Normal Q-Q plot

Chloride, Pooled Background (mg/L)



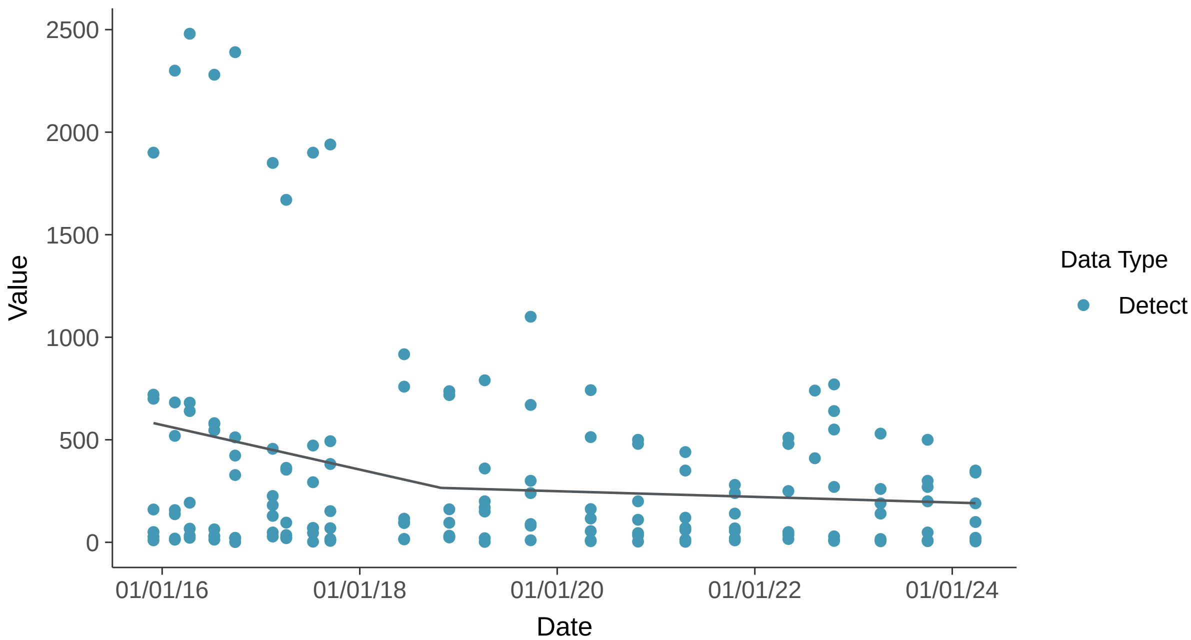
Trend Regression: Mann-Kendall/Theil-Sen Estimate

Chloride, Pooled Background (mg/L)



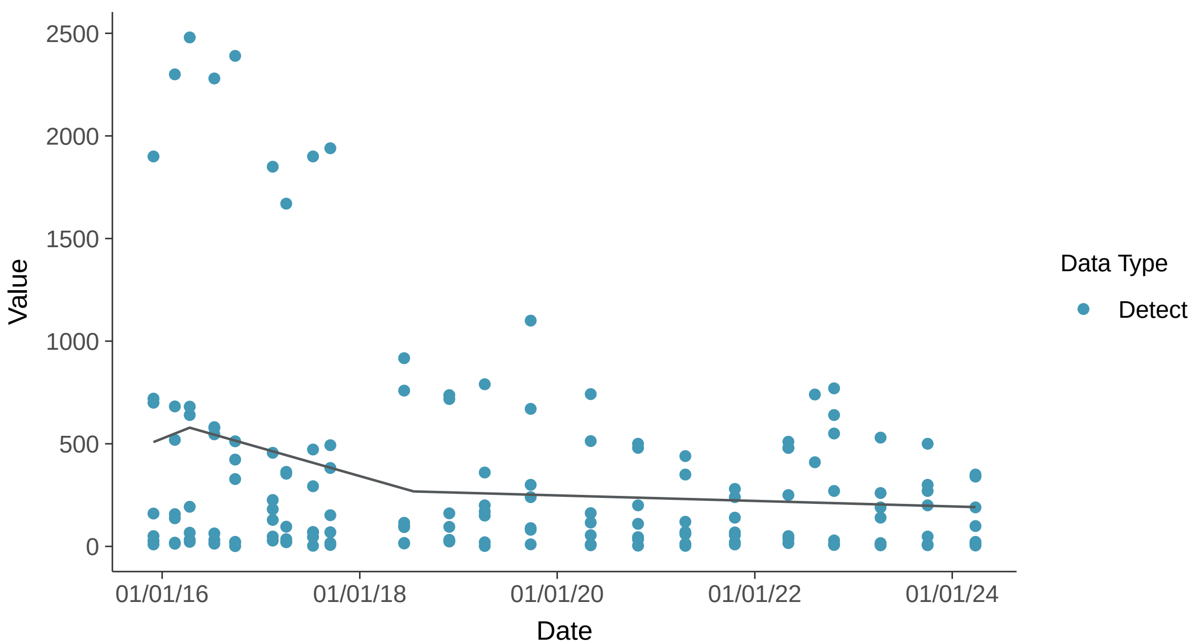
Trend Regression: Piecewise Linear-Linear

Chloride, Pooled Background (mg/L)



Trend Regression: Piecewise Linear-Linear-Linear

Chloride, Pooled Background (mg/L)

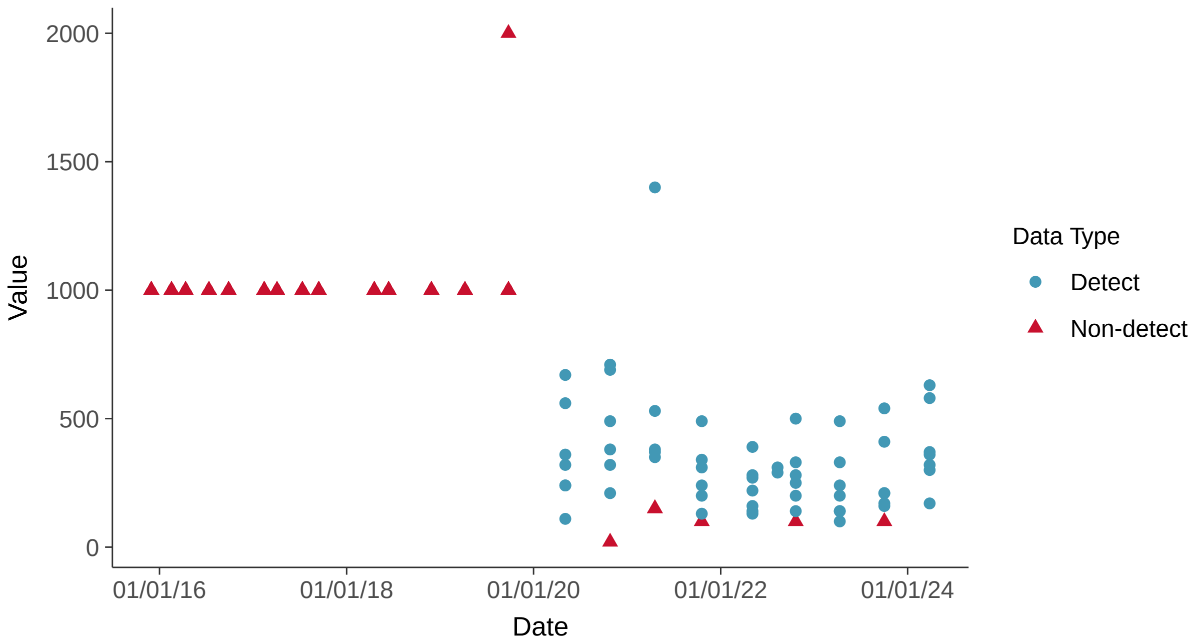


Appendix III: Fluoride, Pooled Background

ID: 1_114

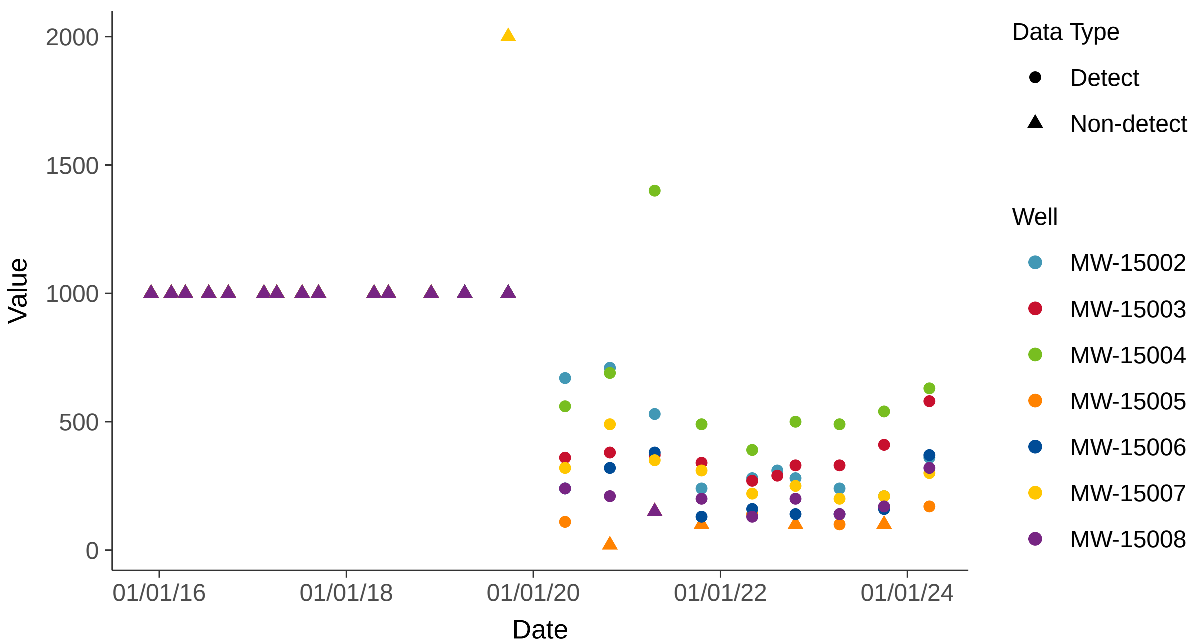
Scatter Plot

Fluoride, Pooled Background (ug/L)



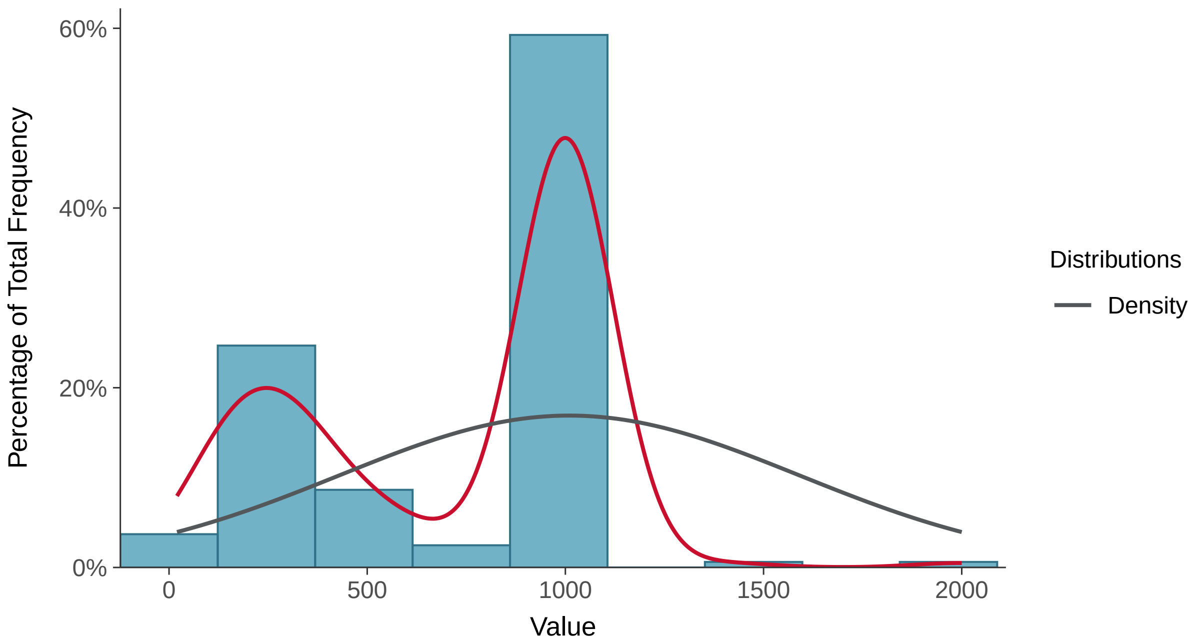
Scatter Plot by Well

Fluoride, Pooled Background (ug/L)



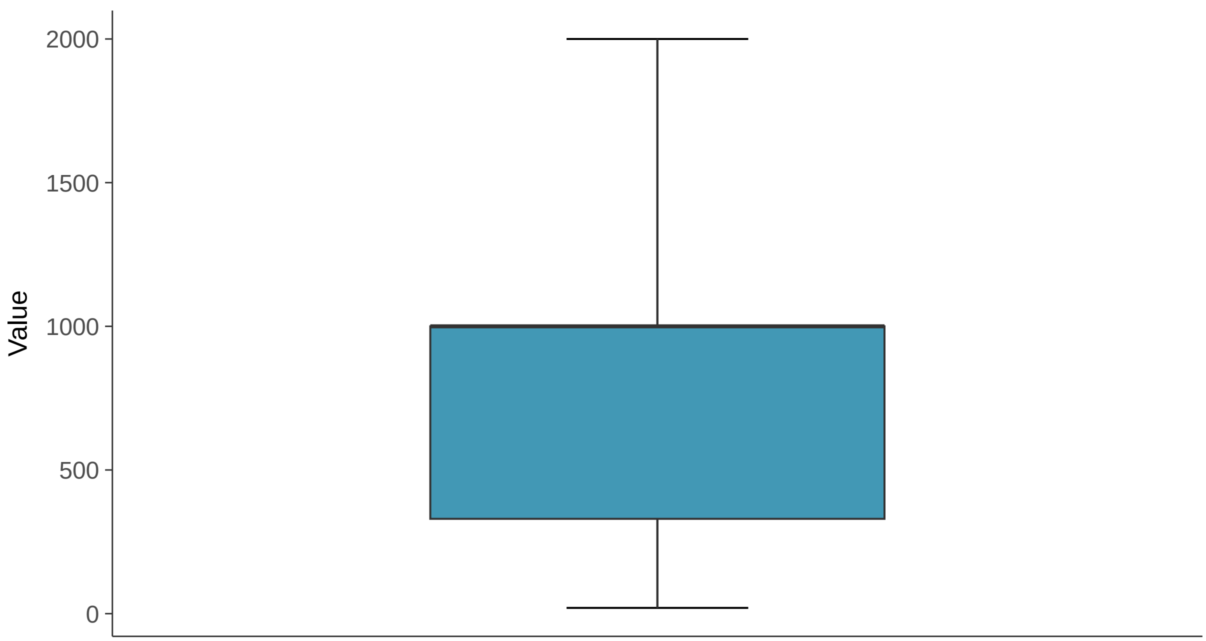
Histogram

Fluoride, Pooled Background (ug/L)



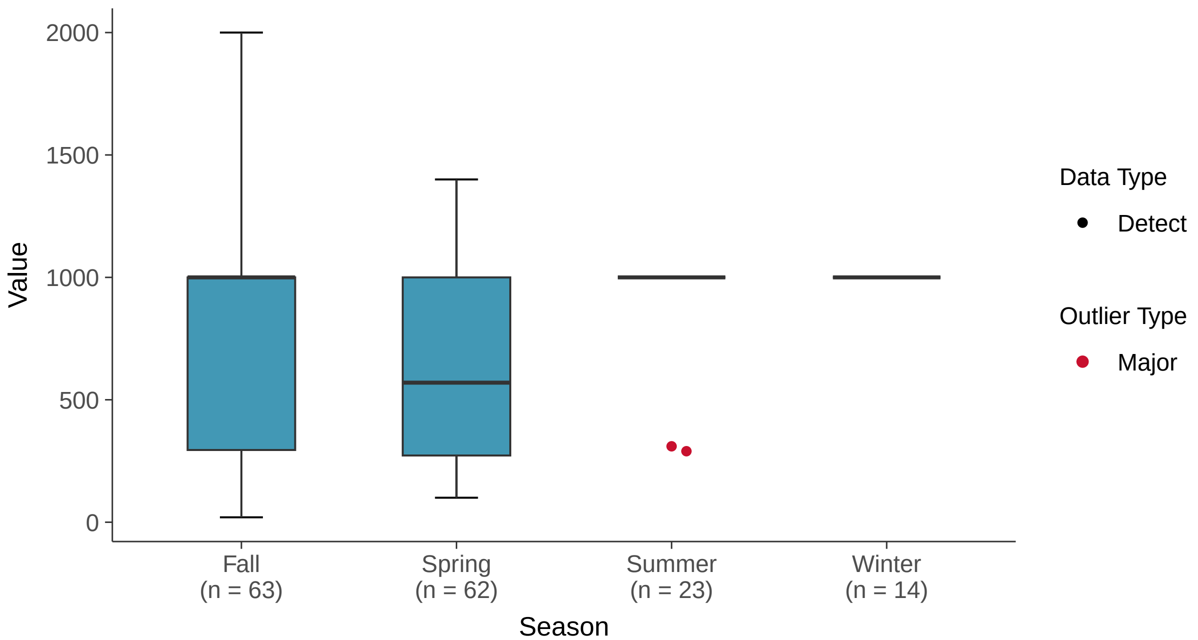
Boxplot

Fluoride, Pooled Background (ug/L)



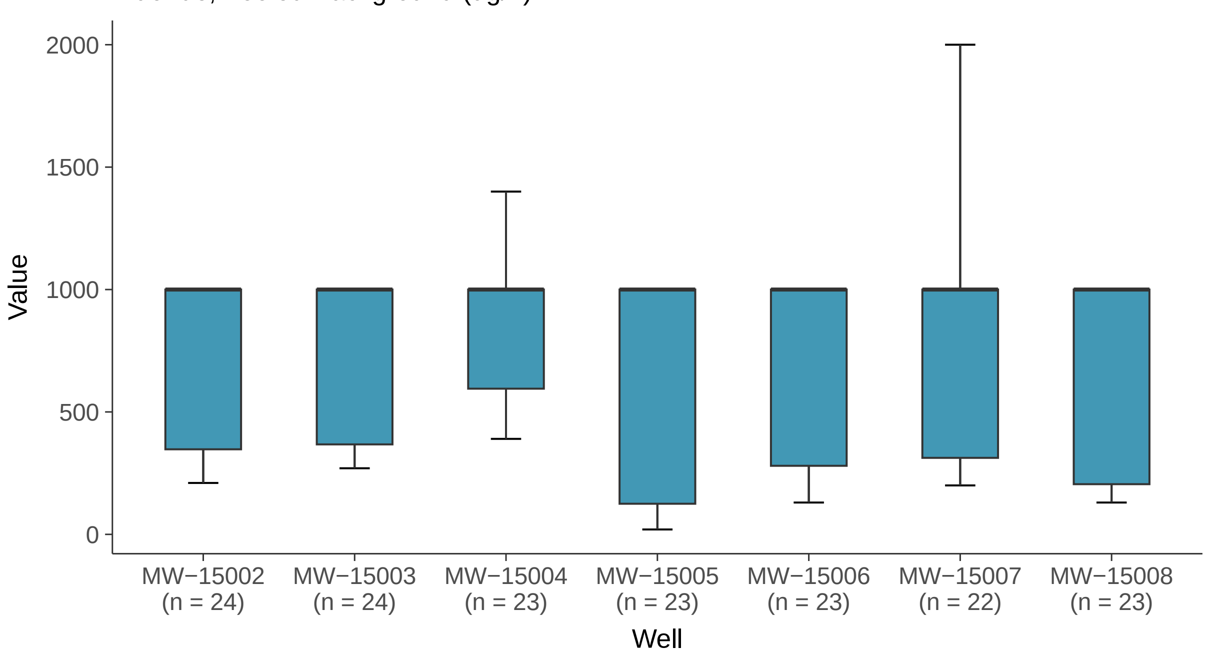
Boxplot by Season

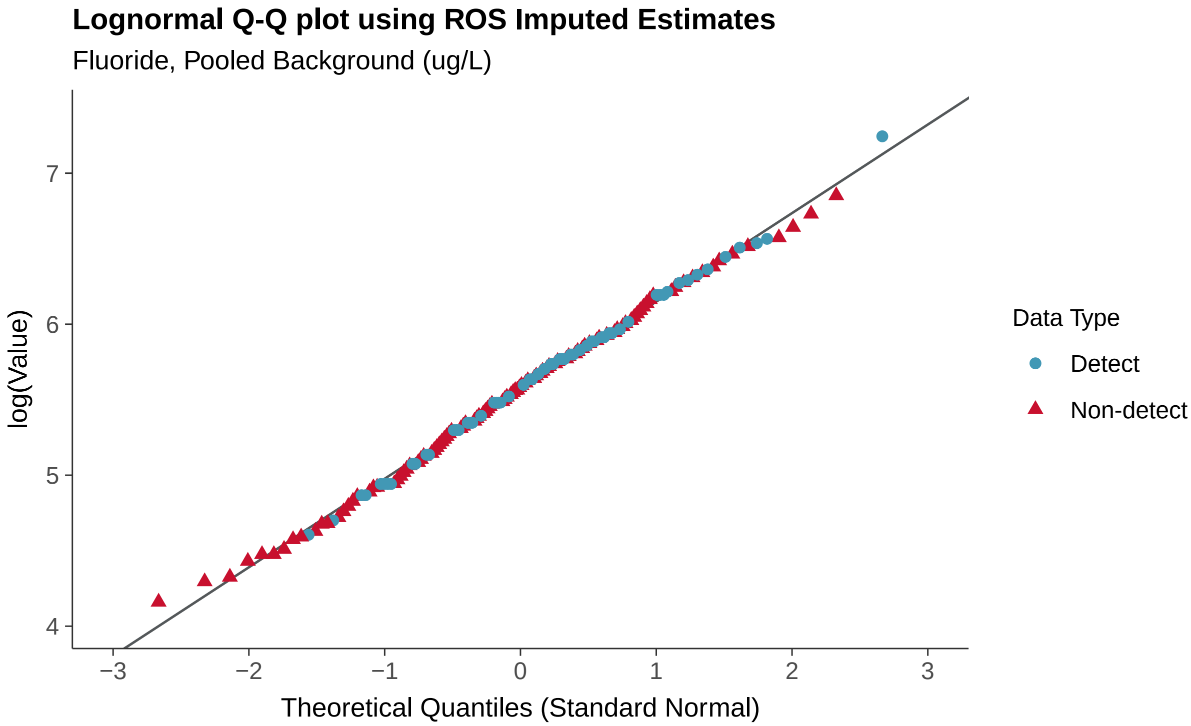
Fluoride, Pooled Background (ug/L)

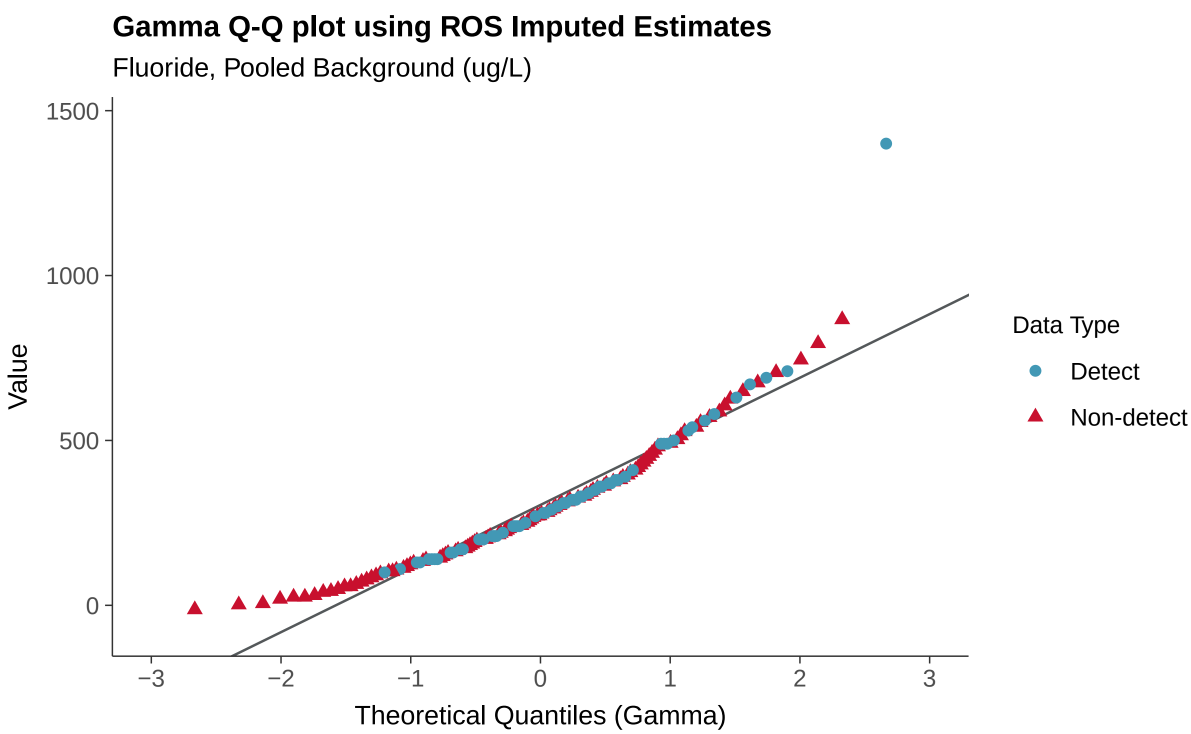


Boxplot by Well

Fluoride, Pooled Background (ug/L)

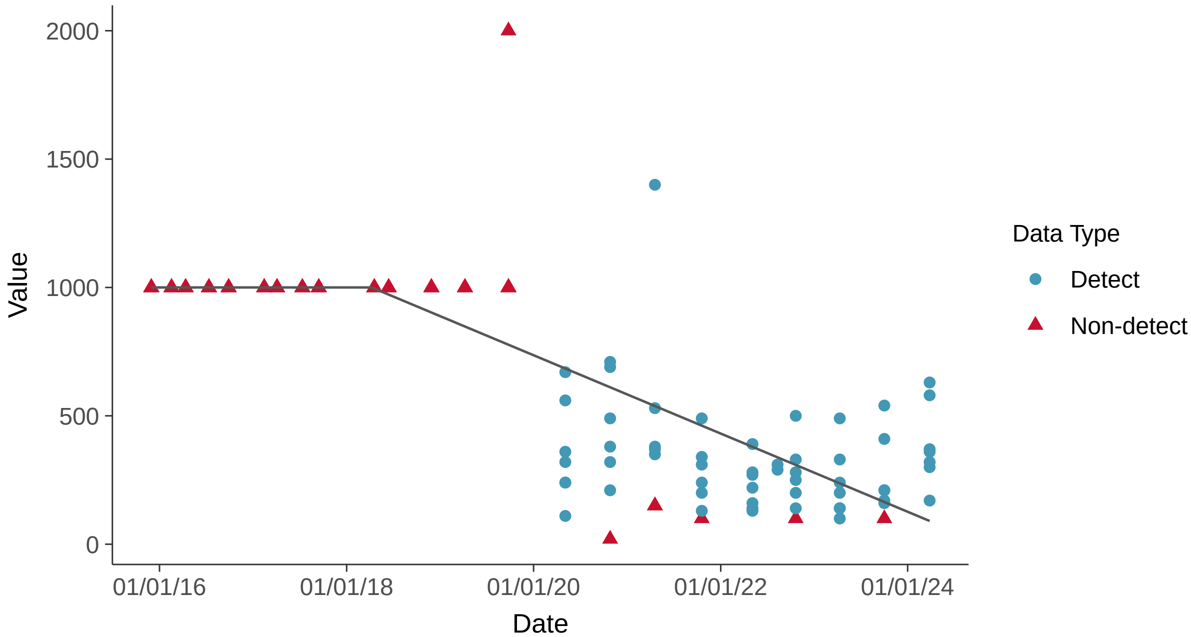



Lognormal Q-Q plot using ROS Imputed Estimates
Fluoride, Pooled Background (ug/L)
log(Value)
7
6
5
4
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Gamma Q-Q plot using ROS Imputed Estimates
Fluoride, Pooled Background (ug/L)
Value
1500
1000
500
0
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Gamma)
Data Type
Detect
Non-detect

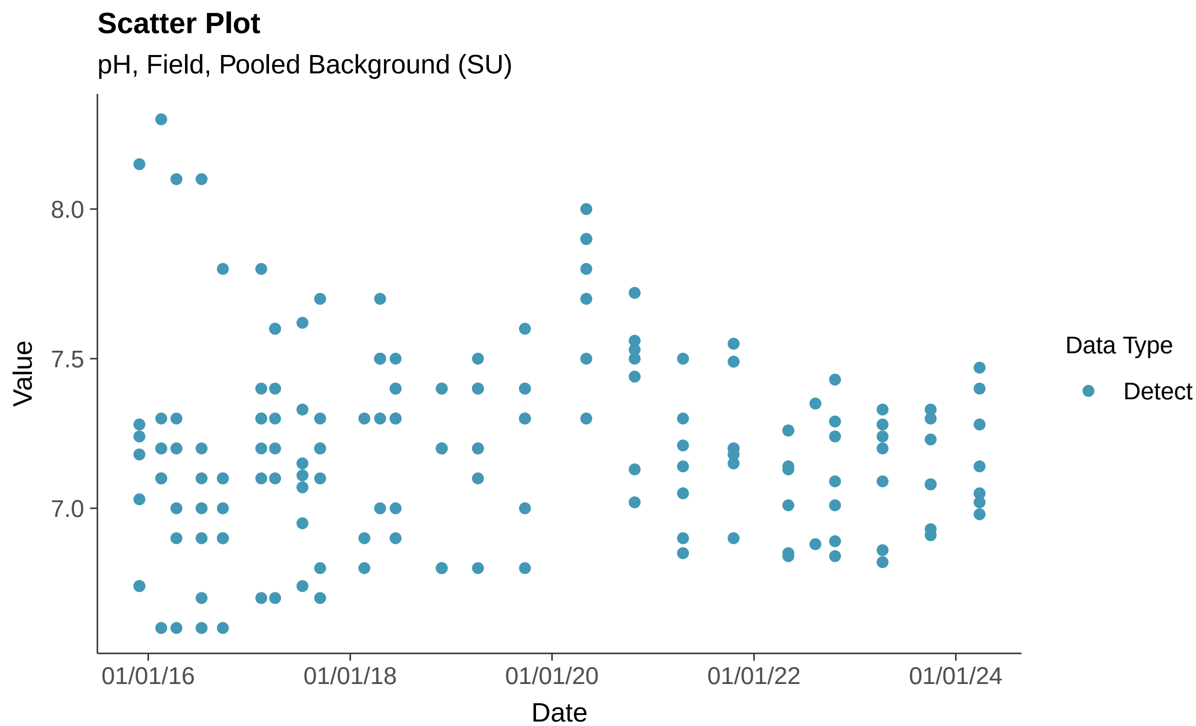
Trend Regression: Piecewise Linear-Linear

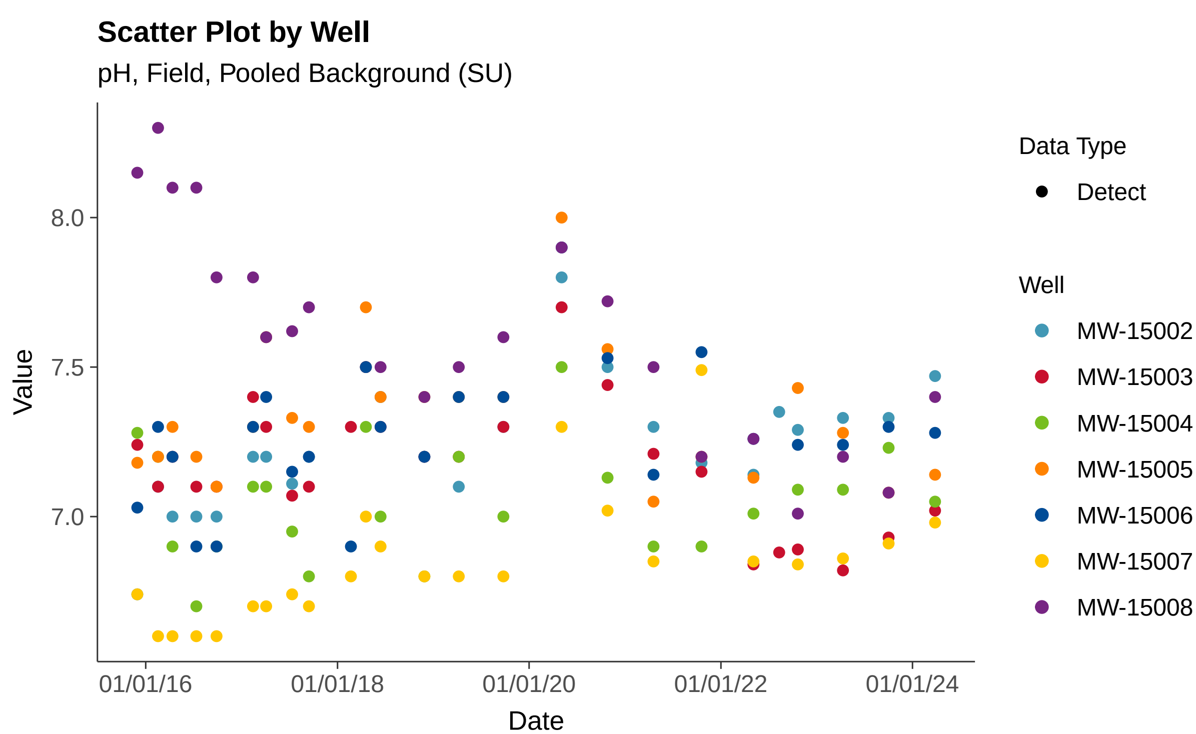
Fluoride, Pooled Background (ug/L)



Appendix III: pH, Field, Pooled Background

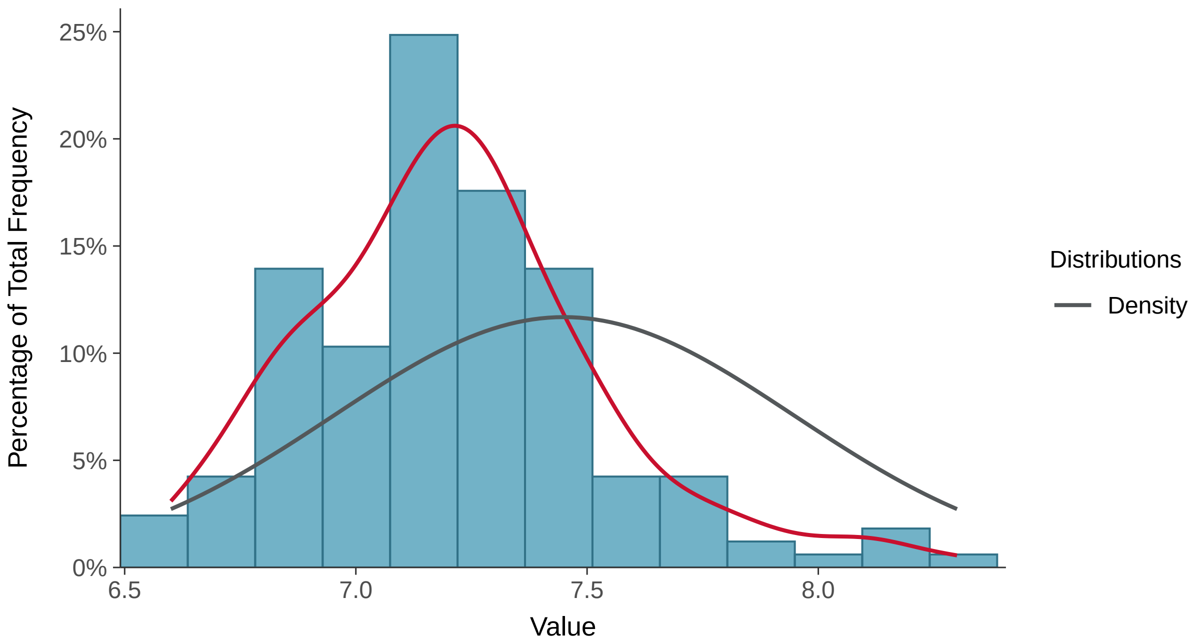
ID: 1_122





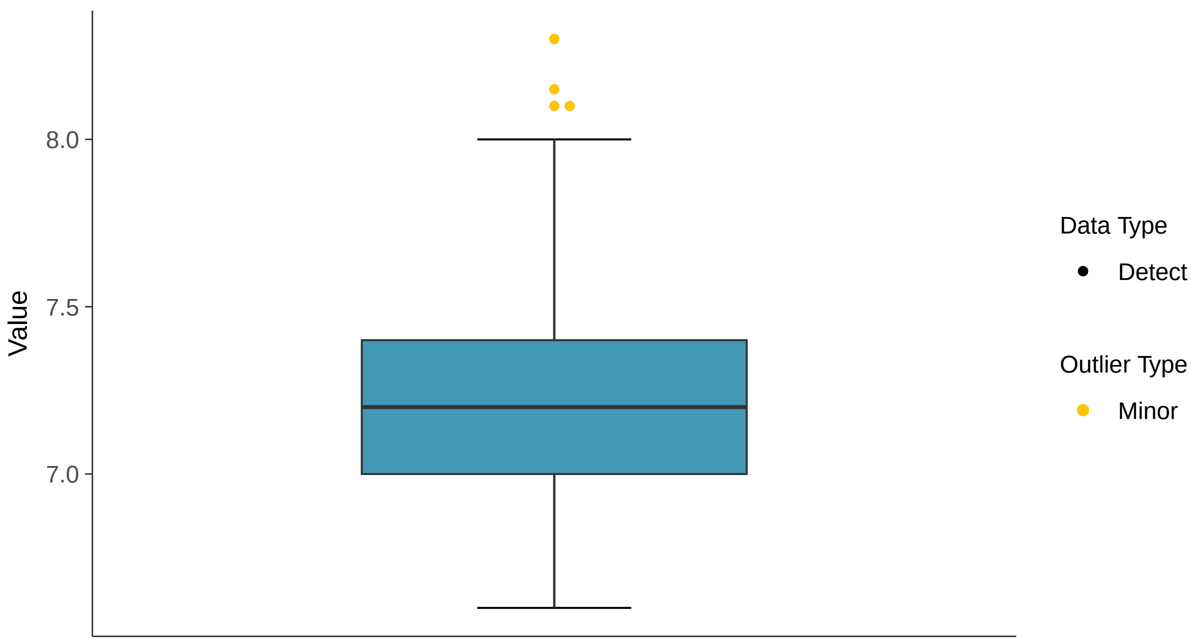
Histogram

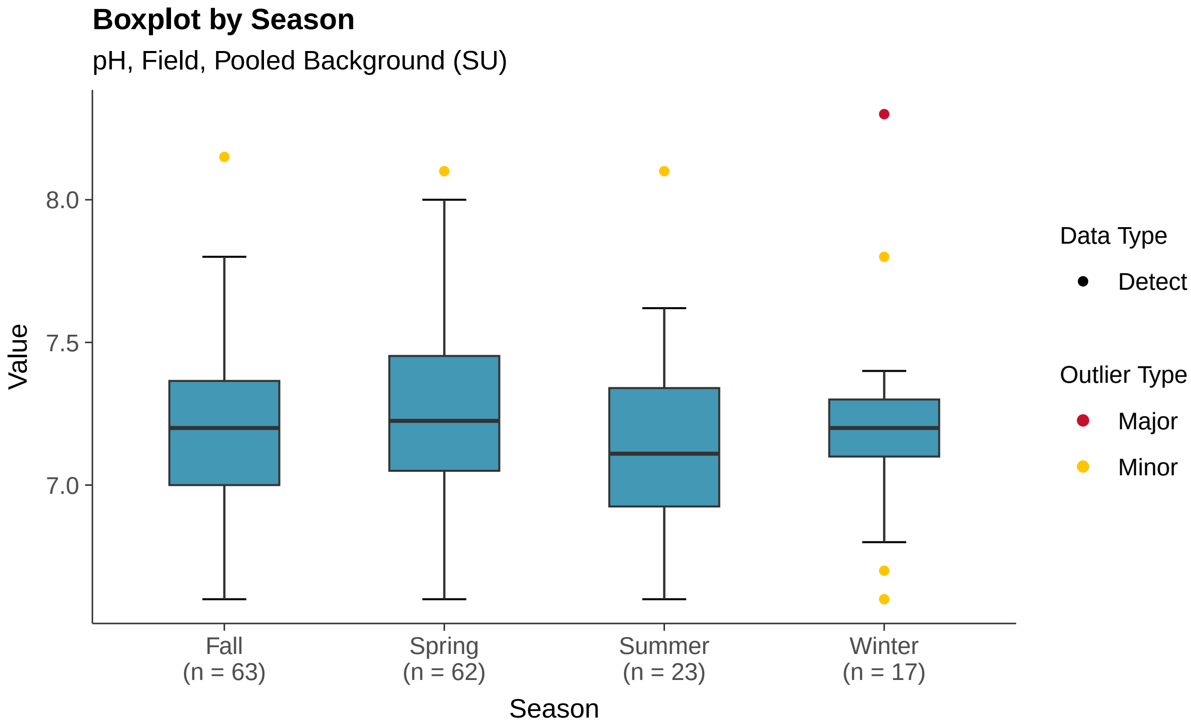
pH, Field, Pooled Background (SU)

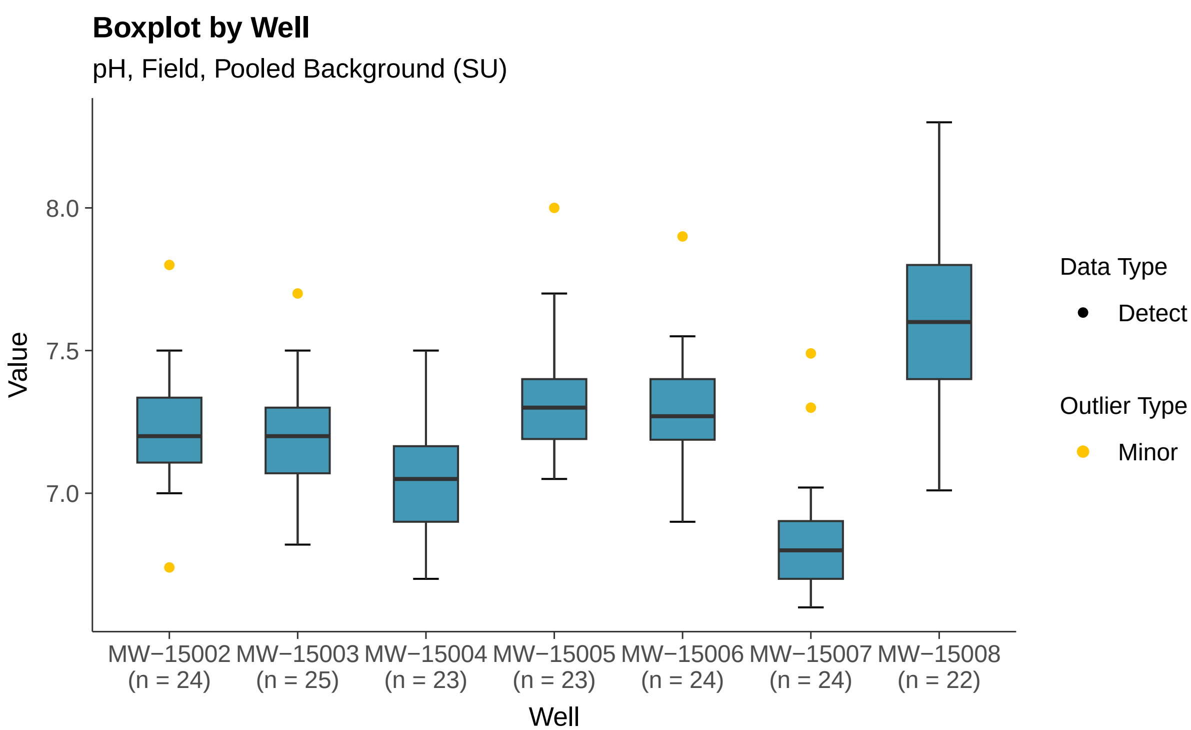


Boxplot

pH, Field, Pooled Background (SU)

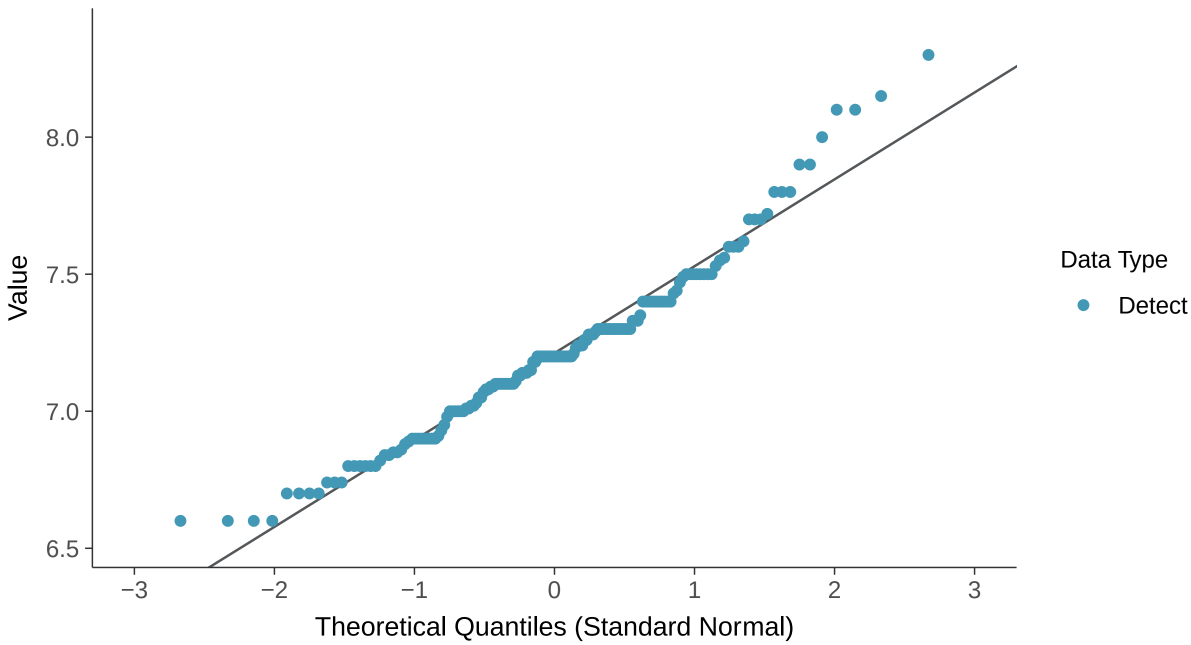



Boxplot by Season
pH, Field, Pooled Background (SU)
Value
8.0
7.5
7.0
Fall
(n = 63)
Spring
(n = 62)
Summer
(n = 23)
Winter
(n = 17)
Season
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Well
pH, Field, Pooled Background (SU)
Value
8.0
7.5
7.0
MW−15002
(n = 24)
MW−15003
(n = 25)
MW−15004
(n = 23)
MW−15005
(n = 23)
MW−15006
(n = 24)
MW−15007
(n = 24)
MW−15008
(n = 22)
Well
Data Type
Detect
Outlier Type
Minor

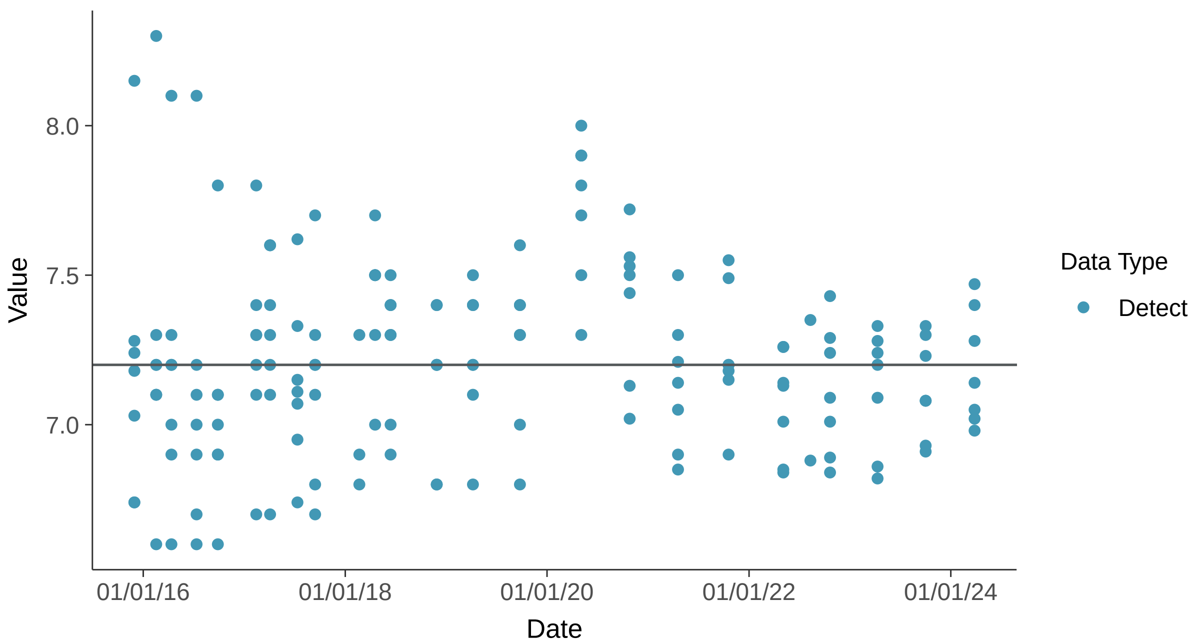
Normal Q-Q plot

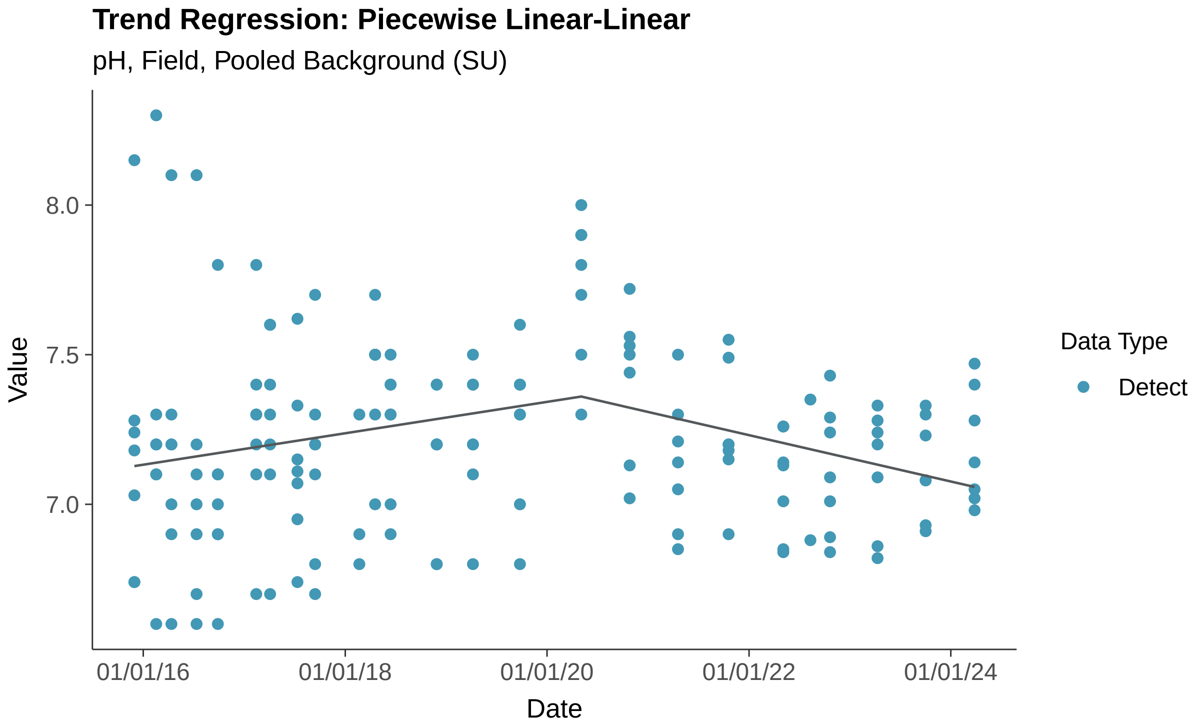
pH, Field, Pooled Background (SU)



Trend Regression: Mann-Kendall/Theil-Sen Estimate

pH, Field, Pooled Background (SU)



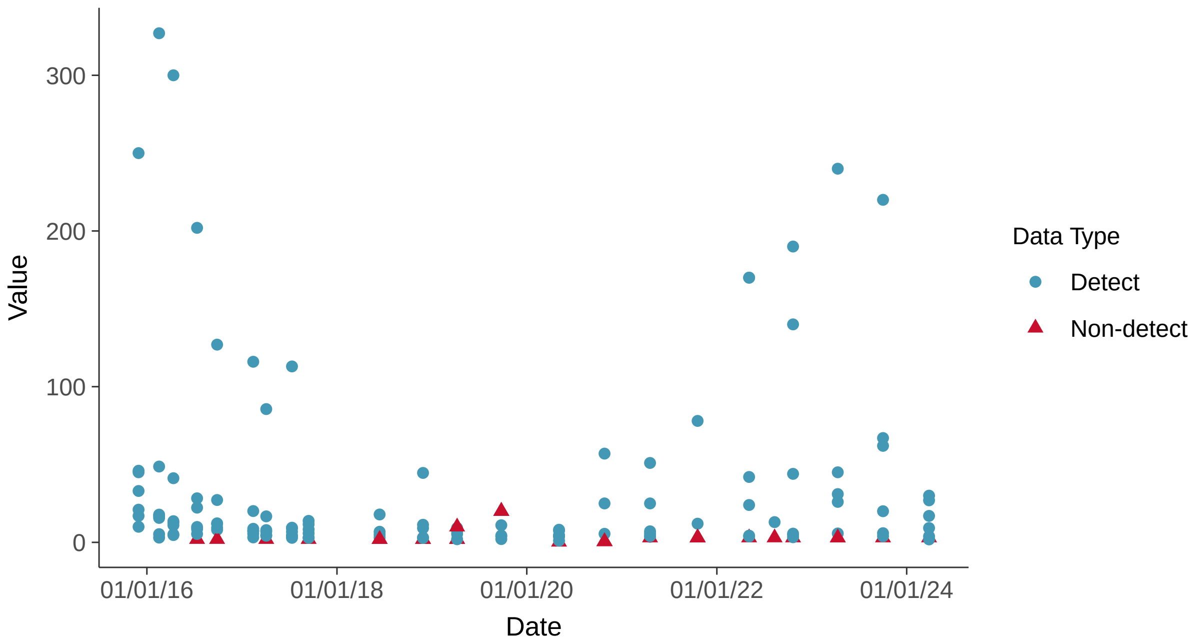

Trend Regression: Piecewise Linear-Linear
pH, Field, Pooled Background (SU)
Value
8.0
7.5
7.0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect

Appendix III: Sulfate, Pooled Background

ID: 1_128

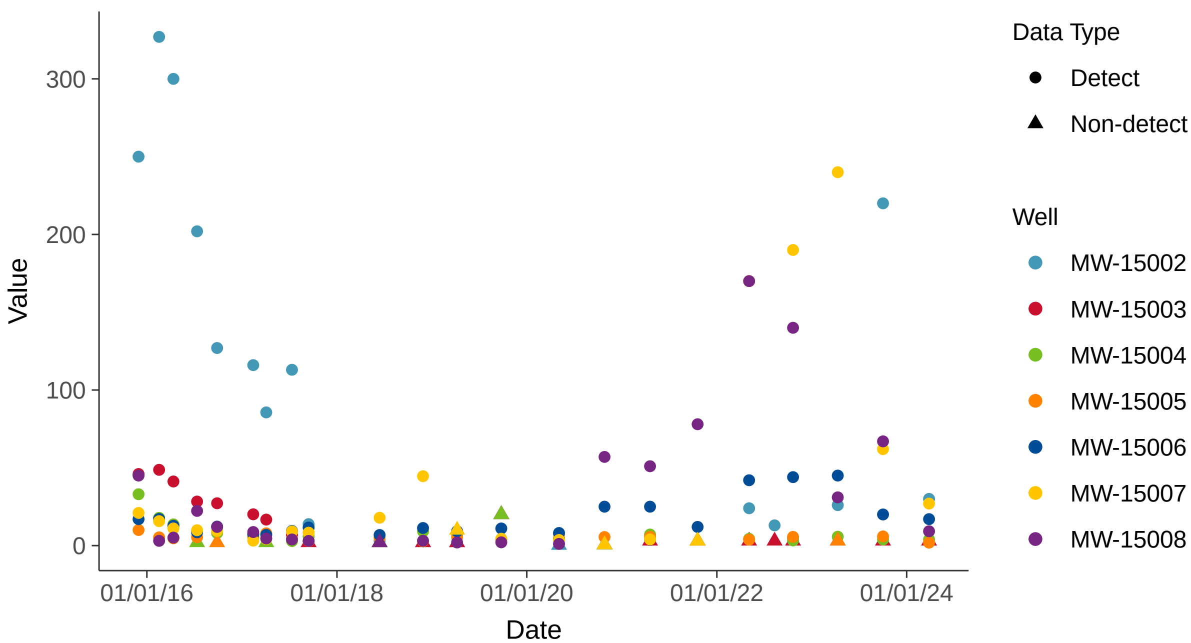
Scatter Plot

Sulfate, Pooled Background (mg/L)



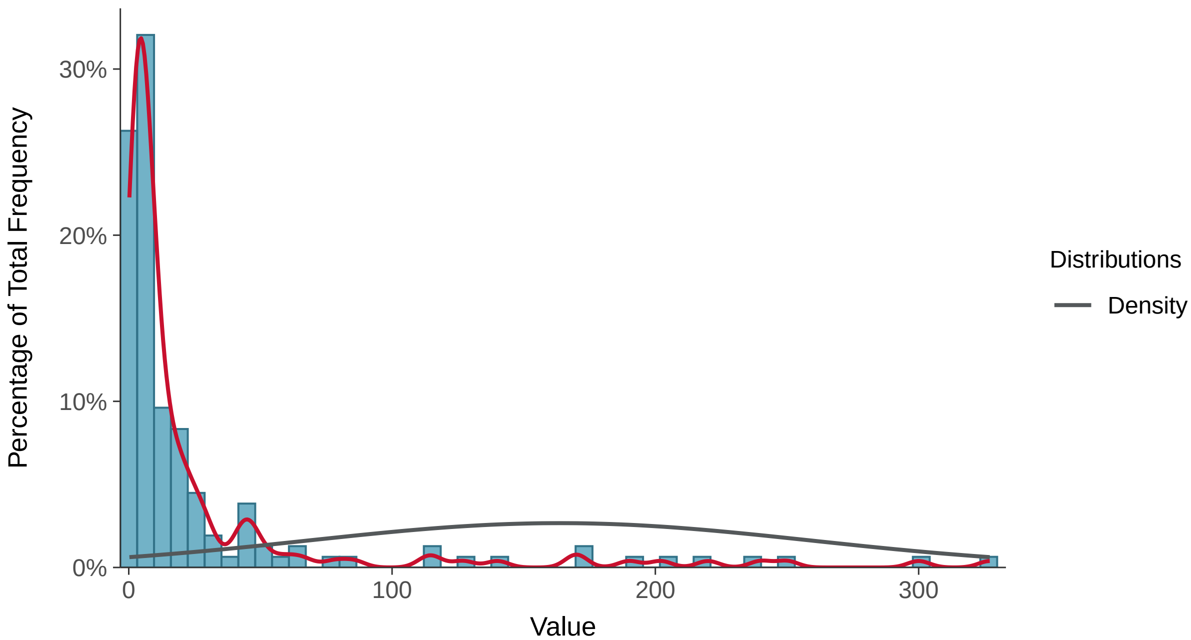
Scatter Plot by Well

Sulfate, Pooled Background (mg/L)



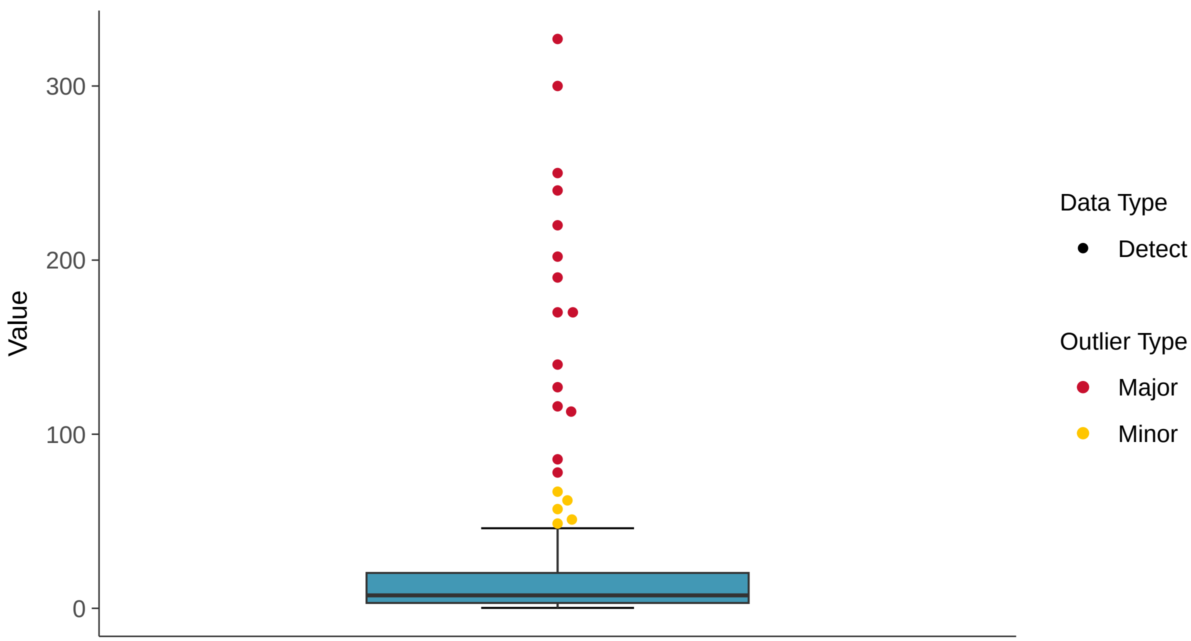
Histogram

Sulfate, Pooled Background (mg/L)



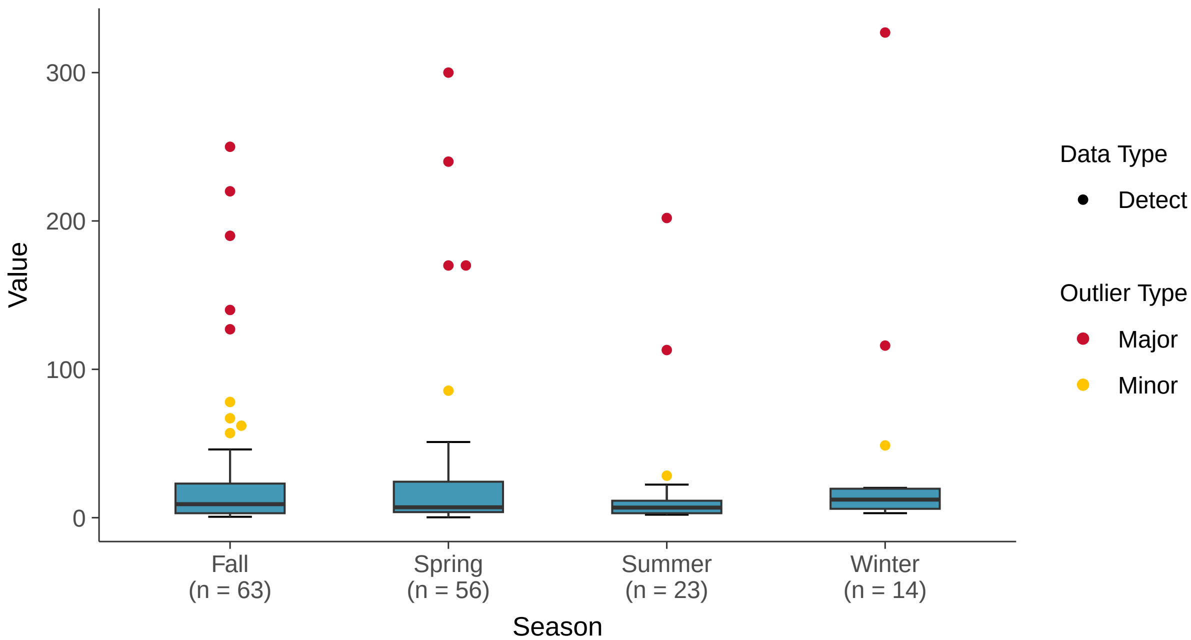
Boxplot

Sulfate, Pooled Background (mg/L)



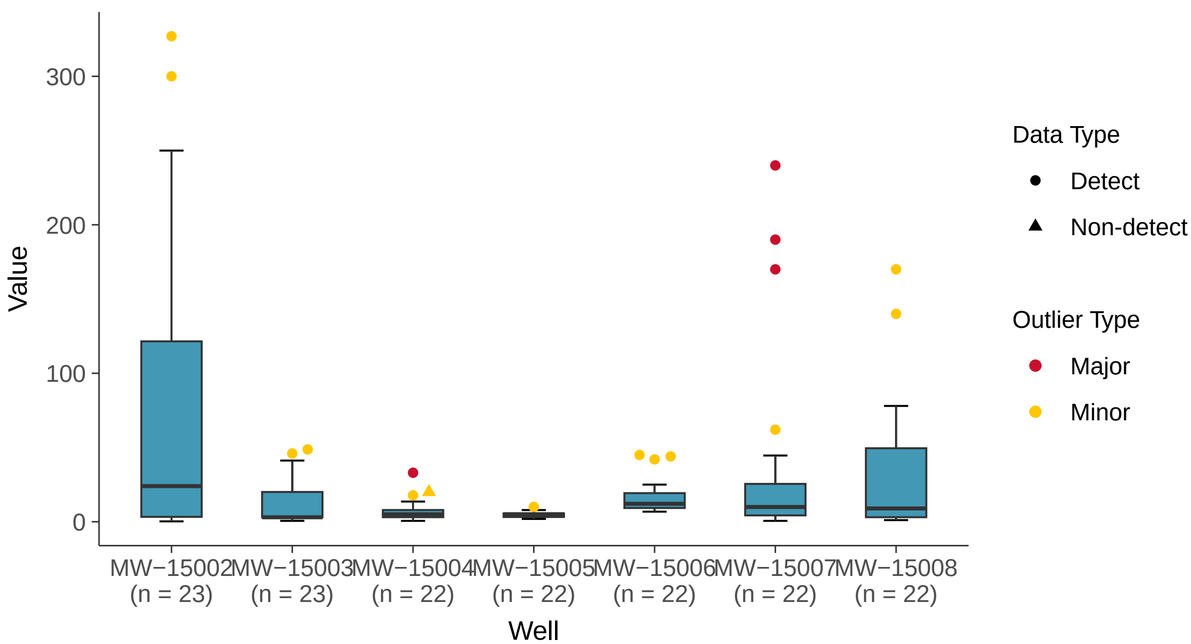
Boxplot by Season

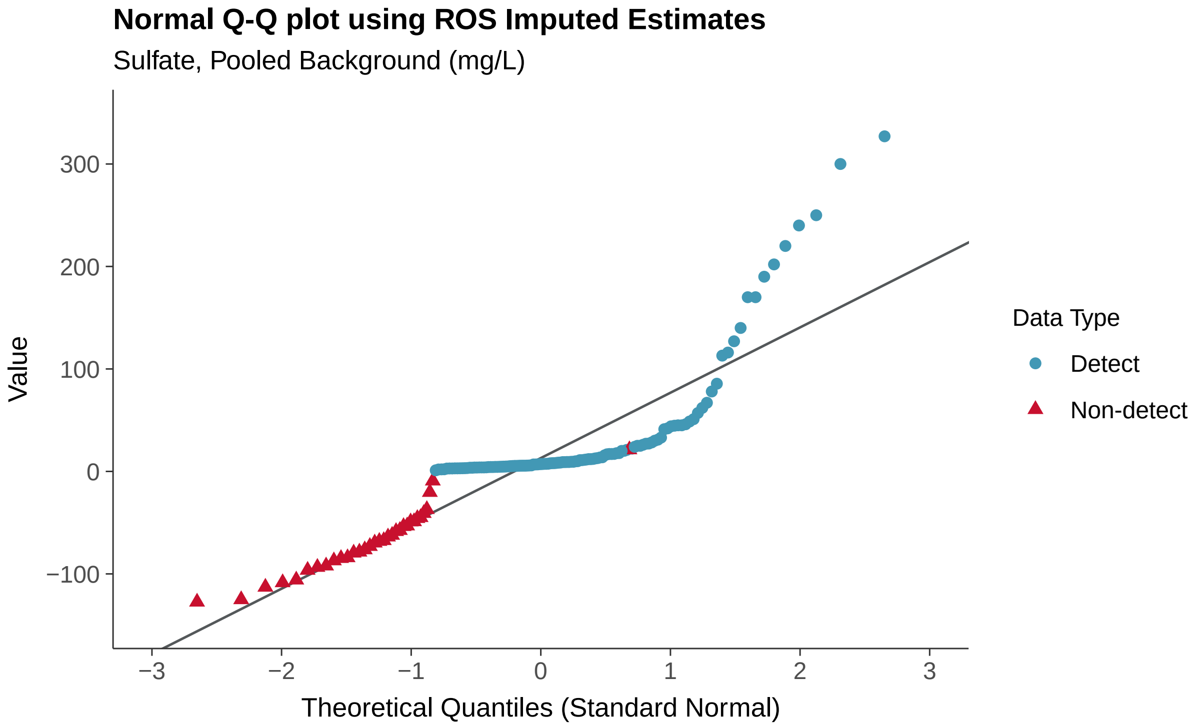
Sulfate, Pooled Background (mg/L)

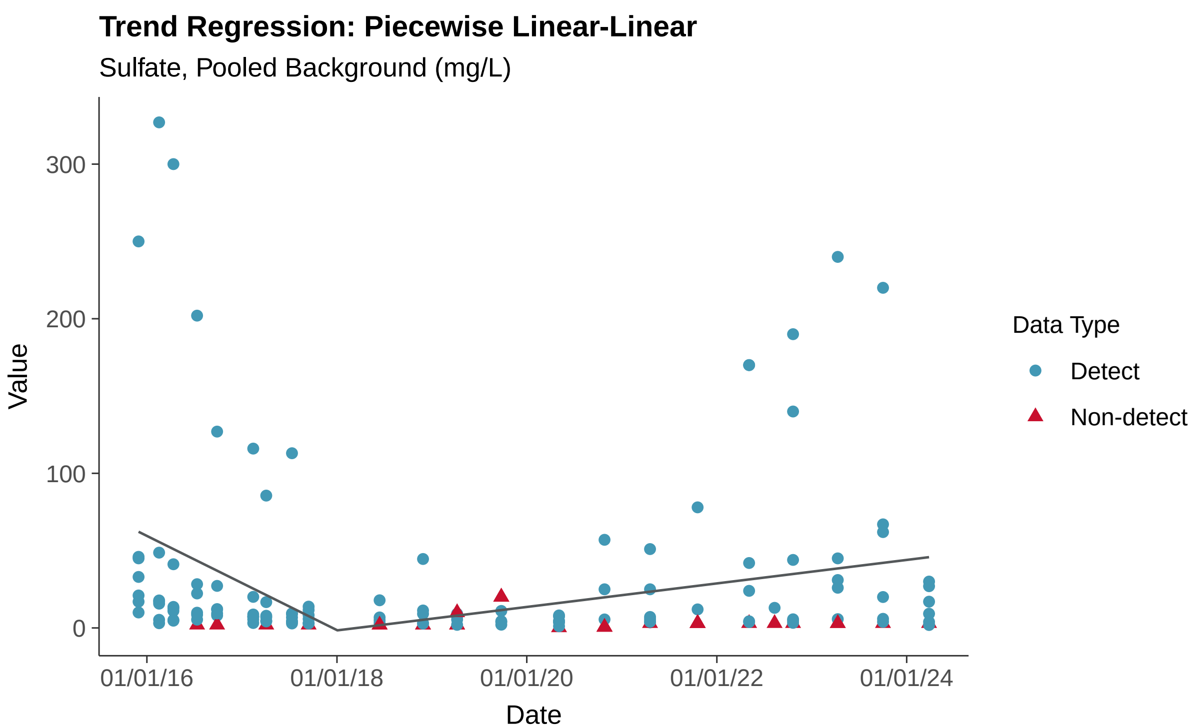


Boxplot by Well

Sulfate, Pooled Background (mg/L)

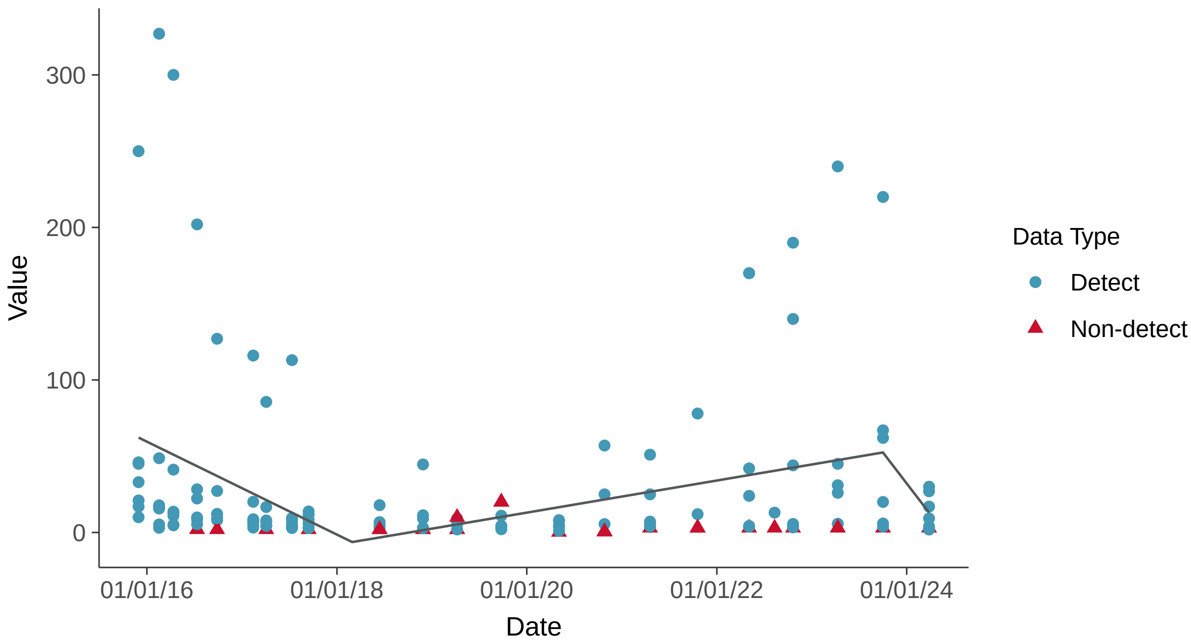



Normal Q-Q plot using ROS Imputed Estimates
Sulfate, Pooled Background (mg/L)
Value
300
200
100
0
−100
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Sulfate, Pooled Background (mg/L)
Value
300
200
100
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

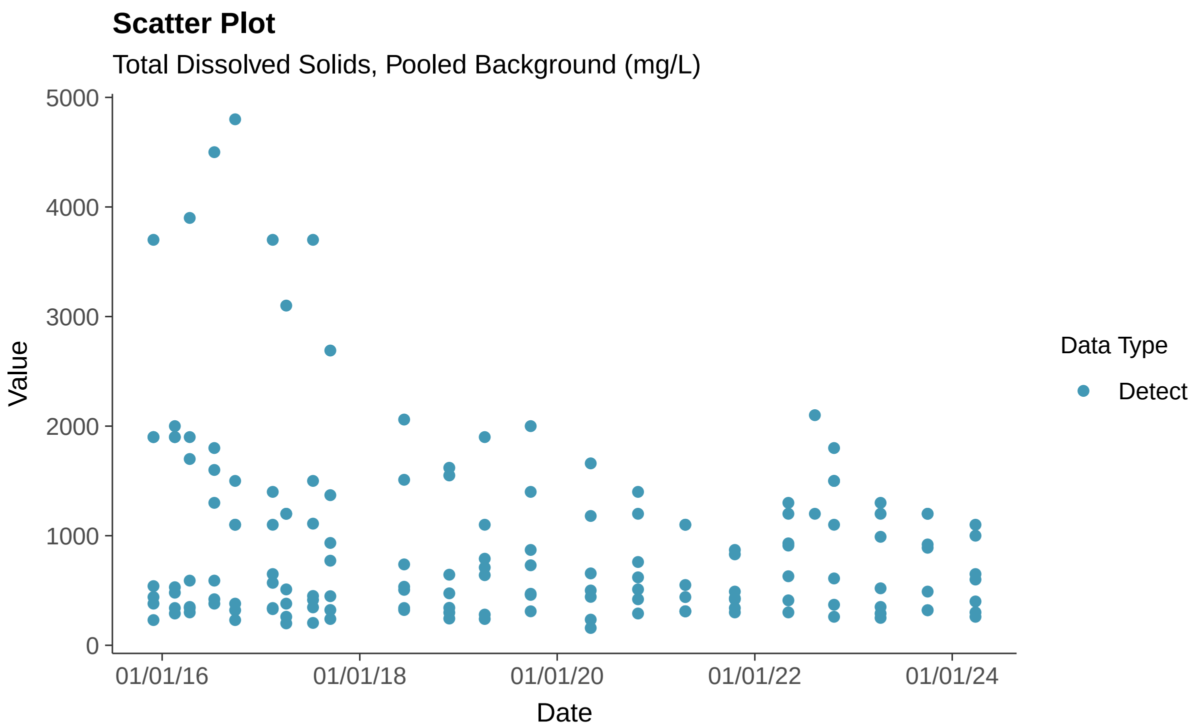
Trend Regression: Piecewise Linear-Linear-Linear

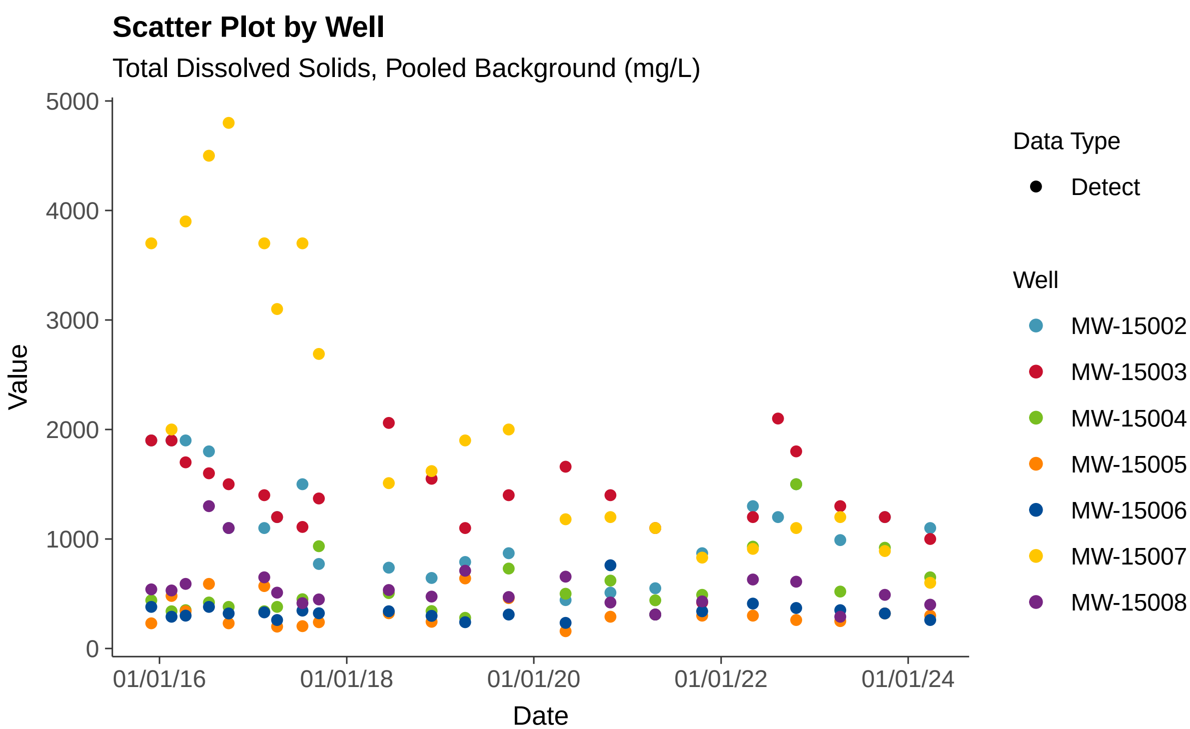
Sulfate, Pooled Background (mg/L)



Appendix III: Total Dissolved Solids, Pooled Background

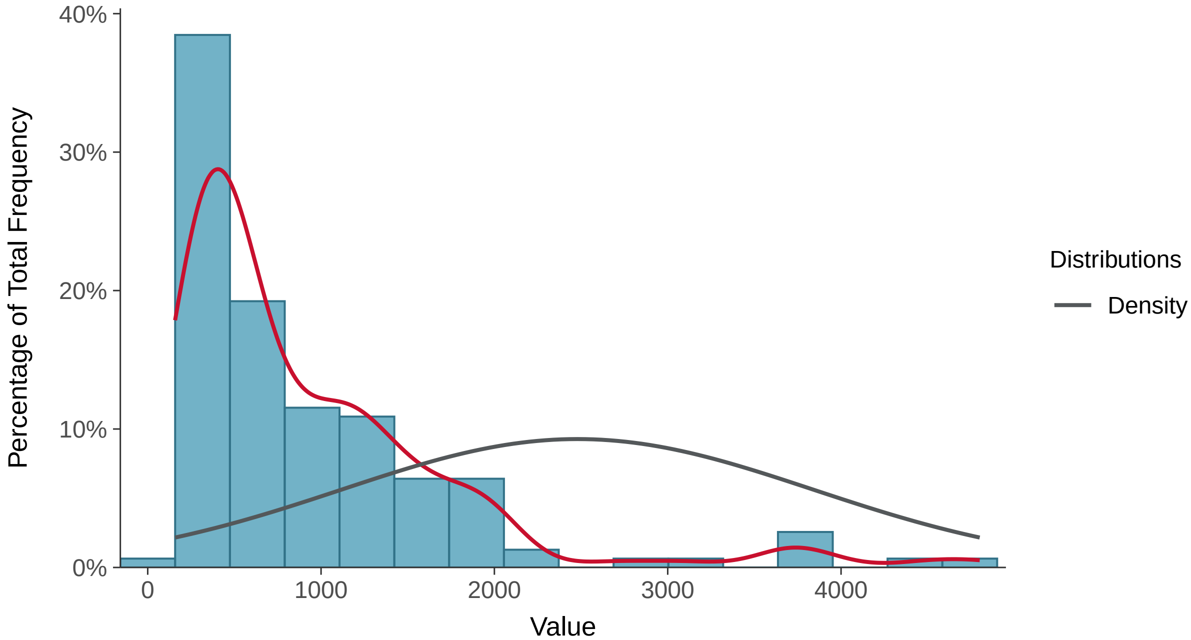
ID: 1_131





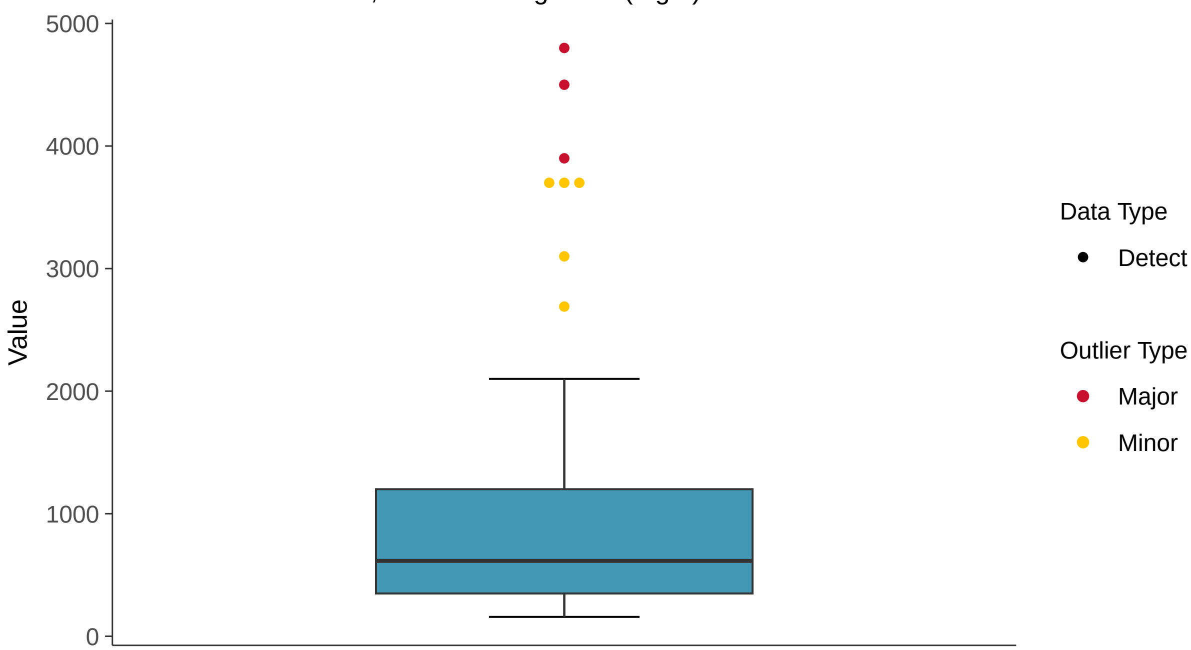
Histogram

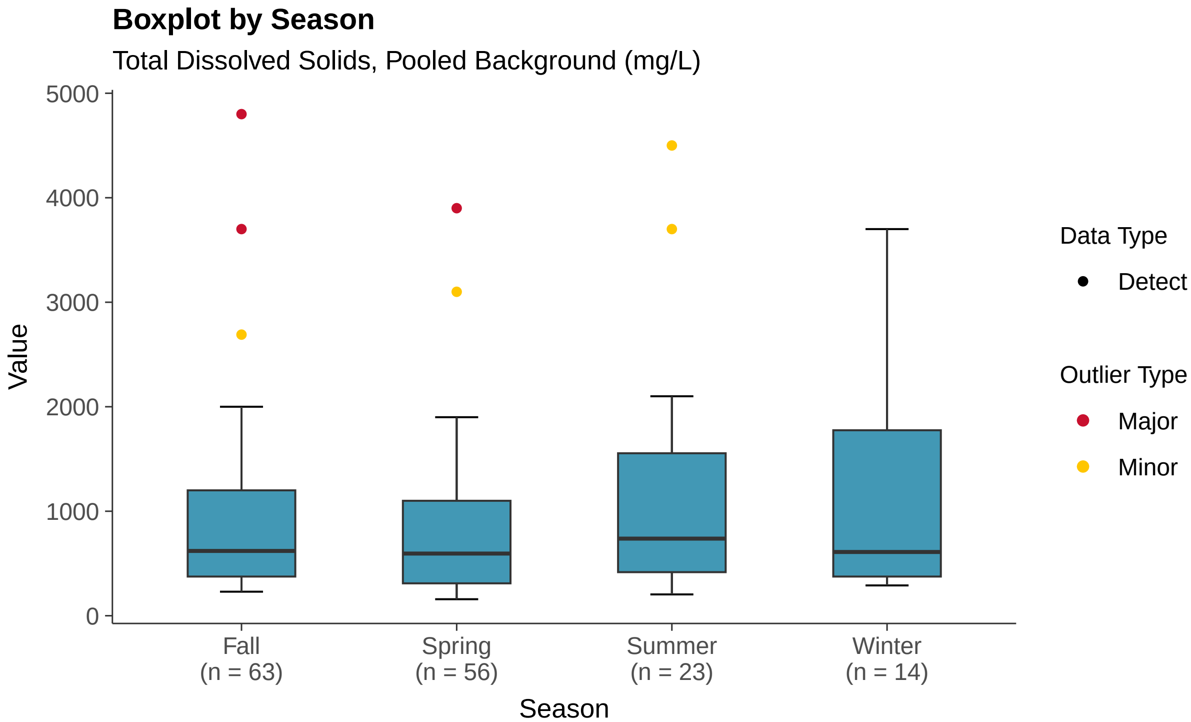
Total Dissolved Solids, Pooled Background (mg/L)

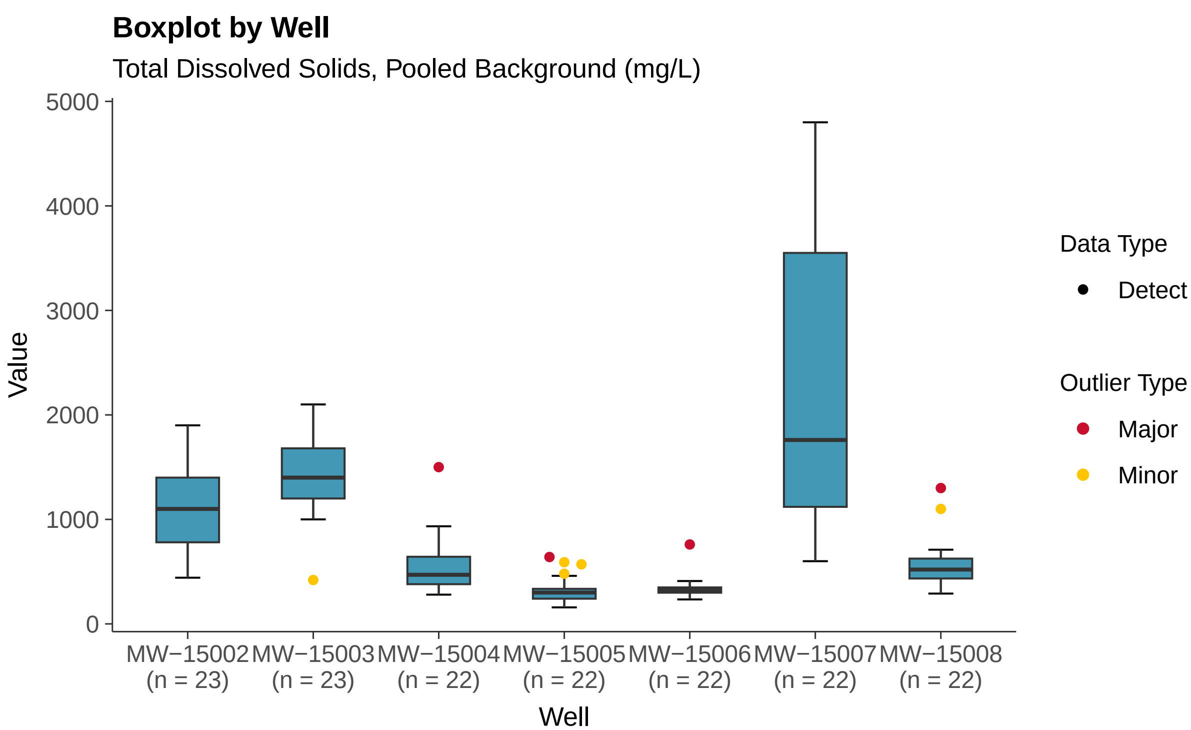


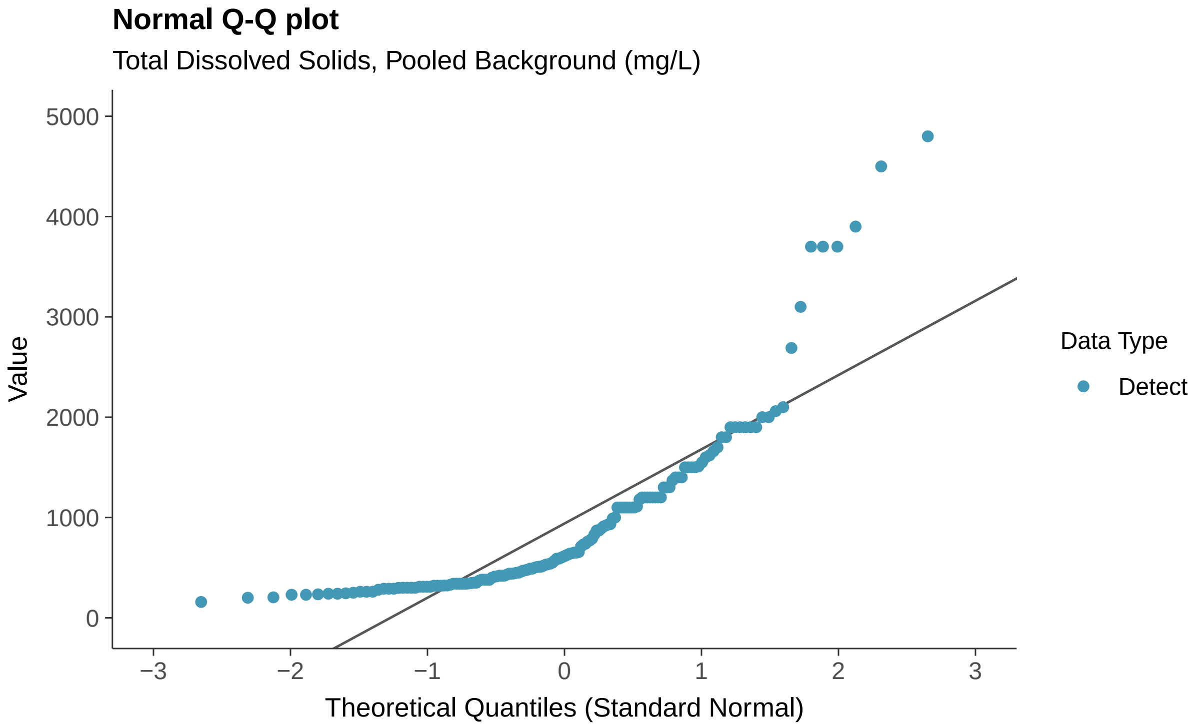
Boxplot

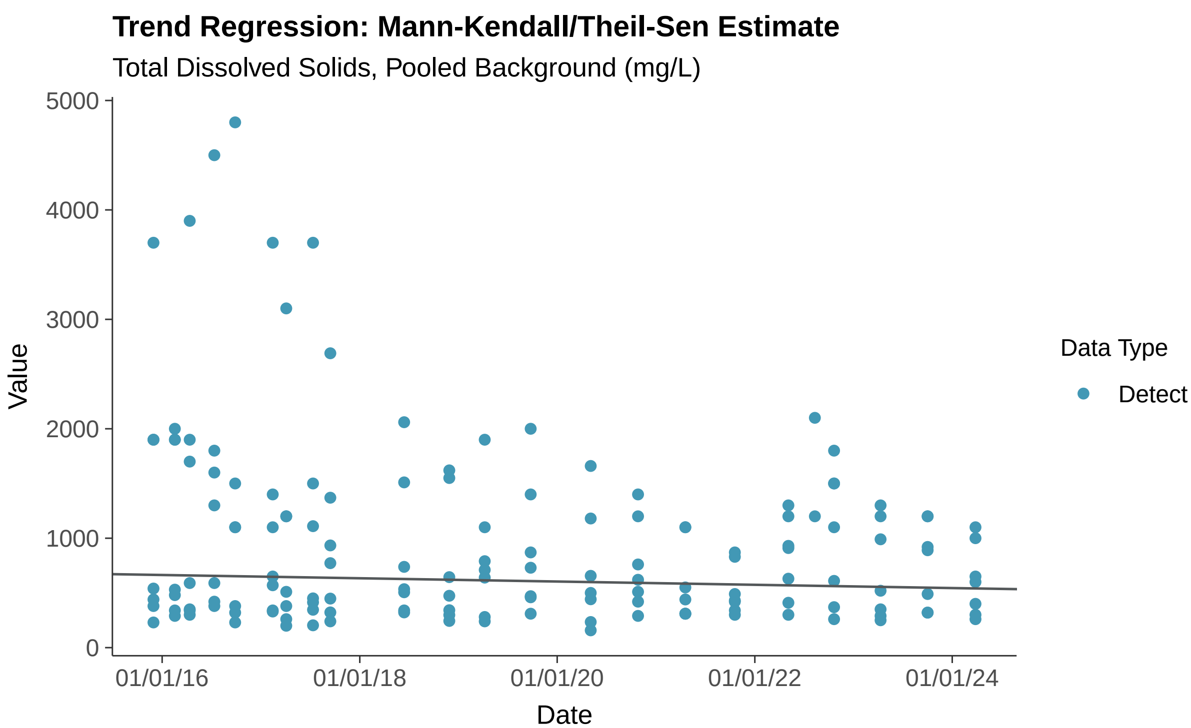
Total Dissolved Solids, Pooled Background (mg/L)

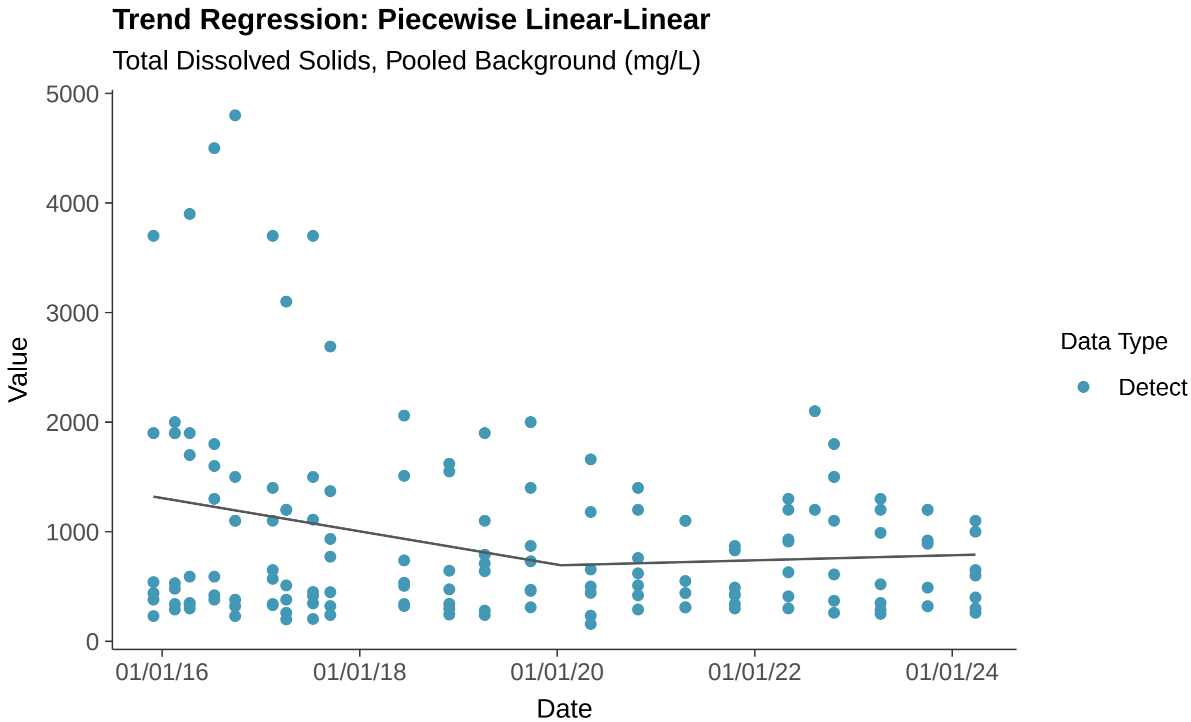


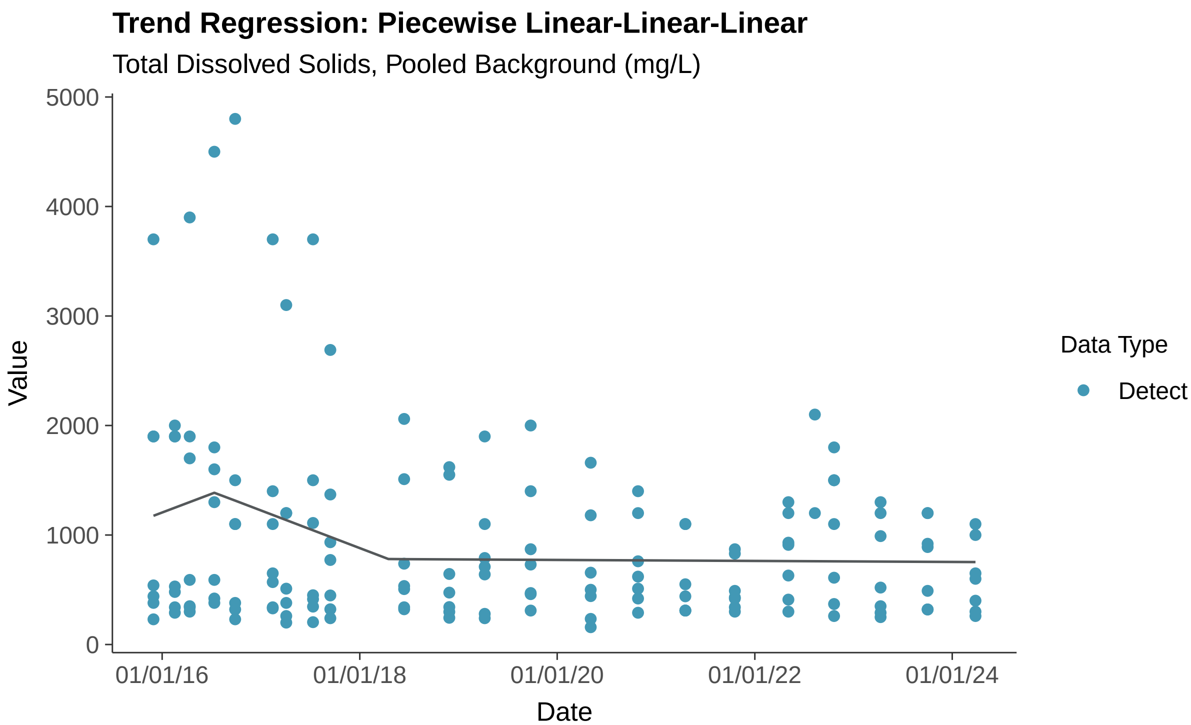

Boxplot by Season
Total Dissolved Solids, Pooled Background (mg/L)
Value
5000
4000
3000
2000
1000
0
Fall (n = 63)
Spring (n = 56)
Summer (n = 23)
Winter (n = 14)
Season
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Well
Total Dissolved Solids, Pooled Background (mg/L)
Value
5000
4000
3000
2000
1000
0
MW−15002 (n = 23)
MW−15003 (n = 23)
MW−15004 (n = 22)
MW−15005 (n = 22)
MW−15006 (n = 22)
MW−15007 (n = 22)
MW−15008 (n = 22)
Well
Data Type
Detect
Outlier Type
Major
Minor


Normal Q-Q plot
Total Dissolved Solids, Pooled Background (mg/L)
Value
5000
4000
3000
2000
1000
0
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect

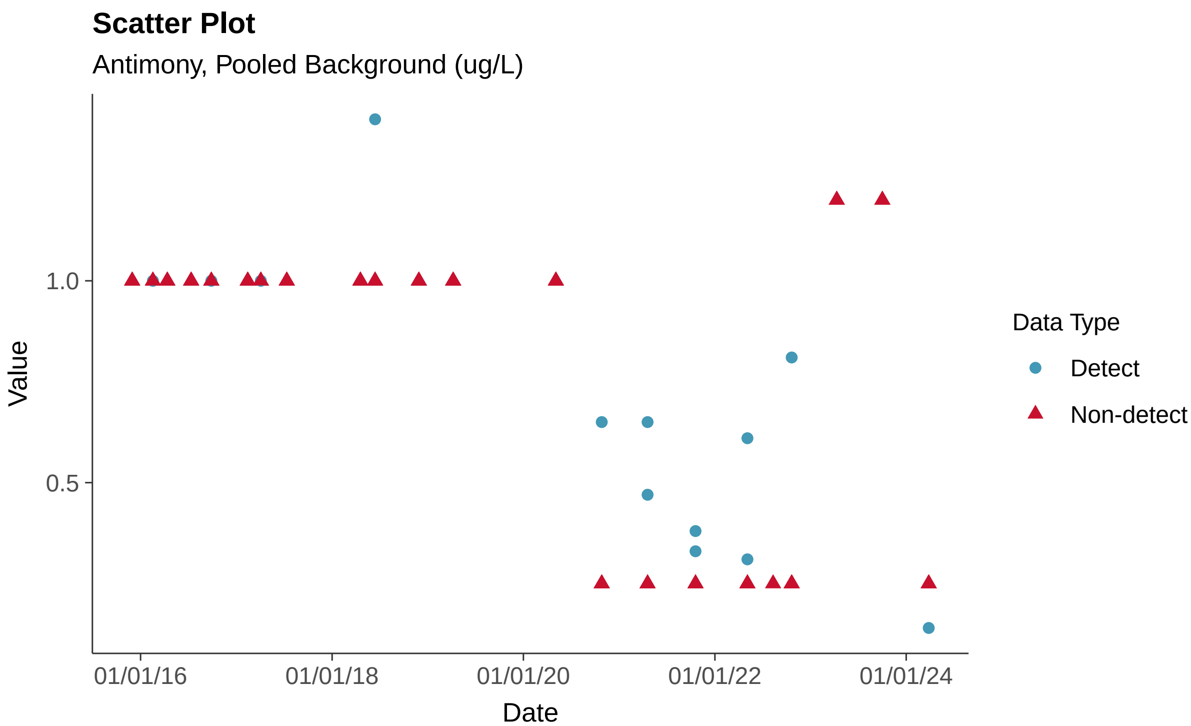

Trend Regression: Mann-Kendall/Theil-Sen Estimate
Total Dissolved Solids, Pooled Background (mg/L)
Value
5000
4000
3000
2000
1000
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect

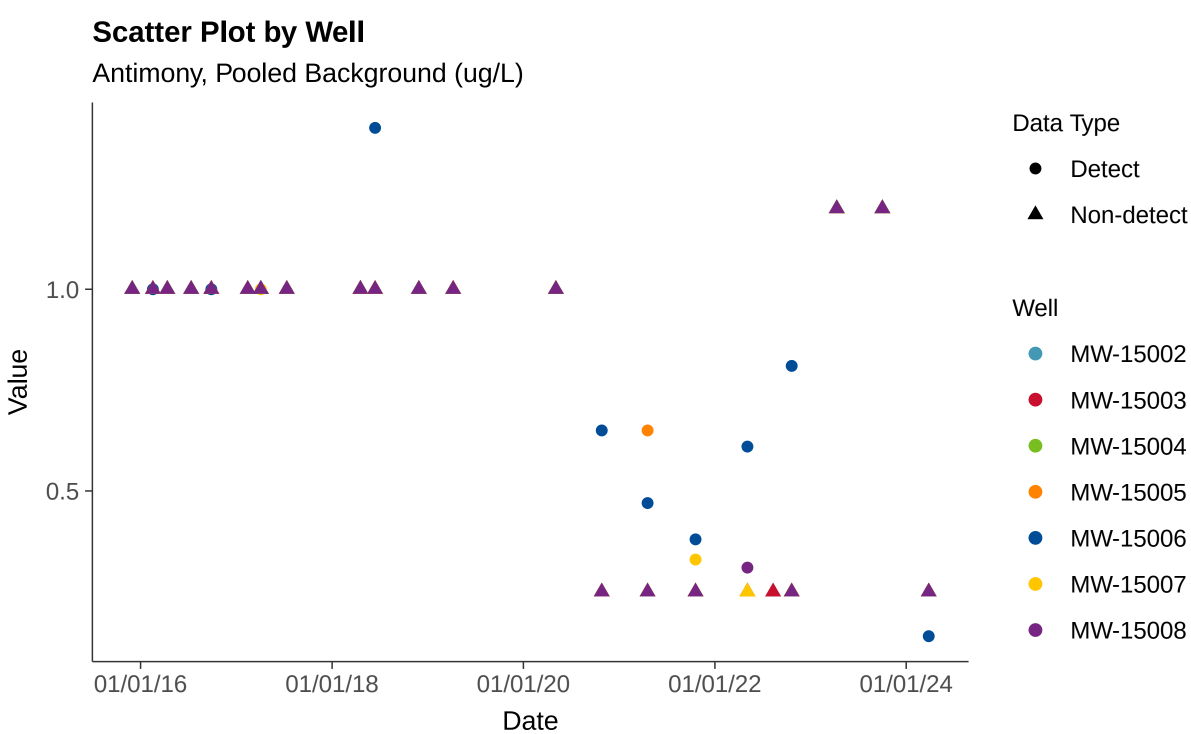

Trend Regression: Piecewise Linear-Linear
Total Dissolved Solids, Pooled Background (mg/L)
Value
5000
4000
3000
2000
1000
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect


Trend Regression: Piecewise Linear-Linear-Linear
Total Dissolved Solids, Pooled Background (mg/L)
Value
5000
4000
3000
2000
1000
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect

Appendix IV: Antimony, Pooled Background

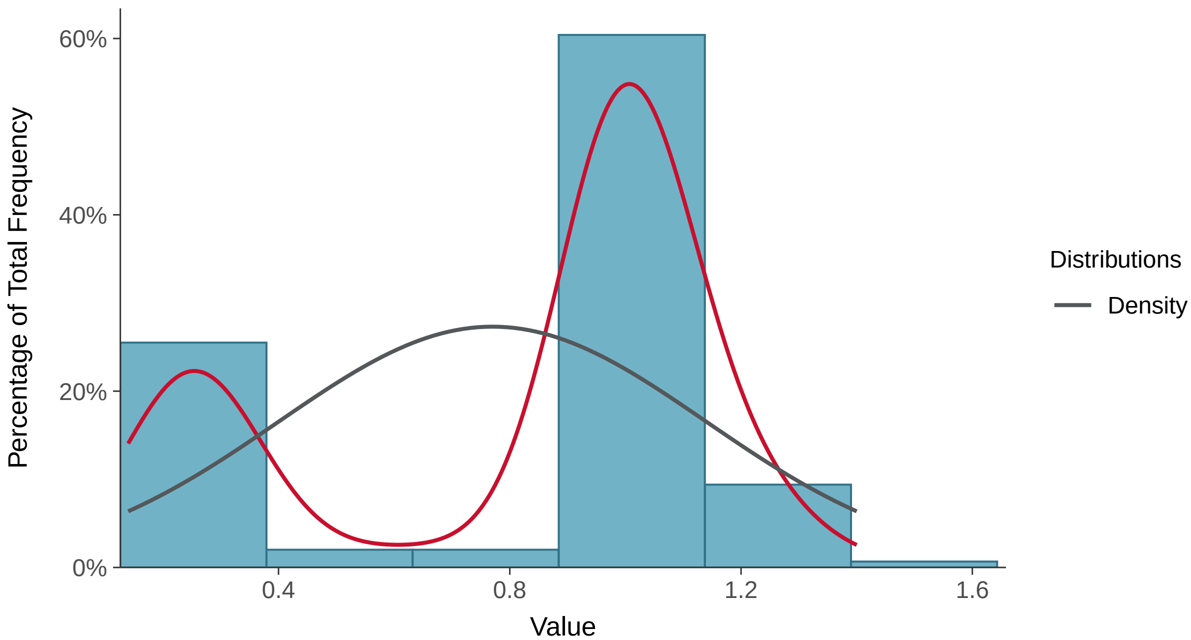
ID: 2_101





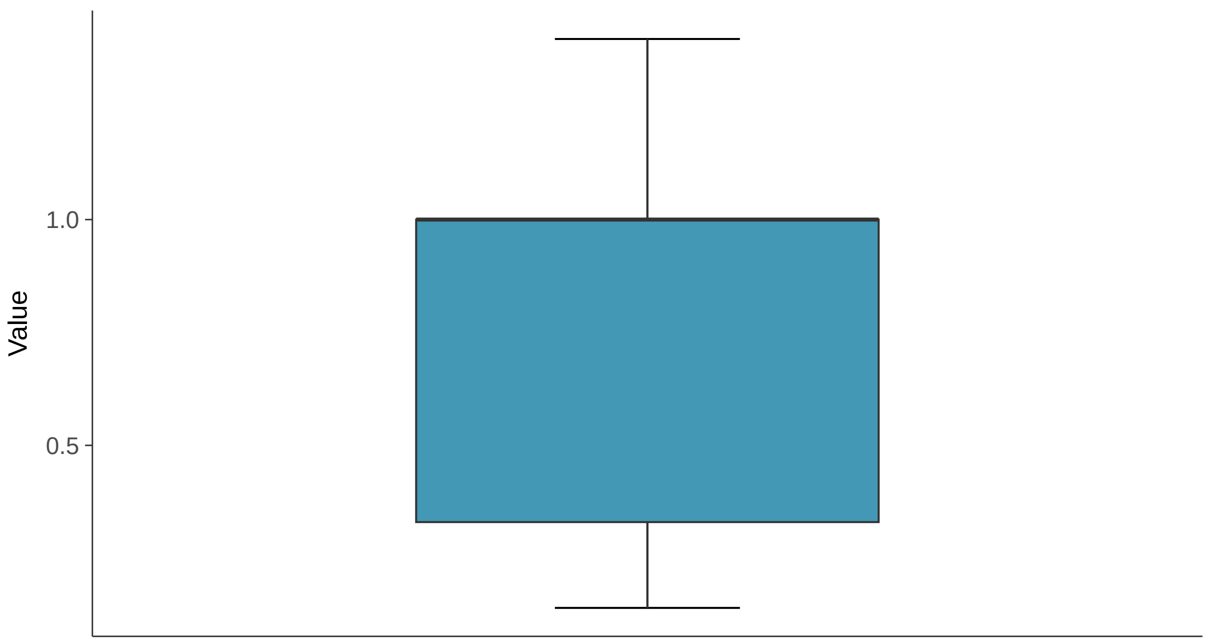
Histogram

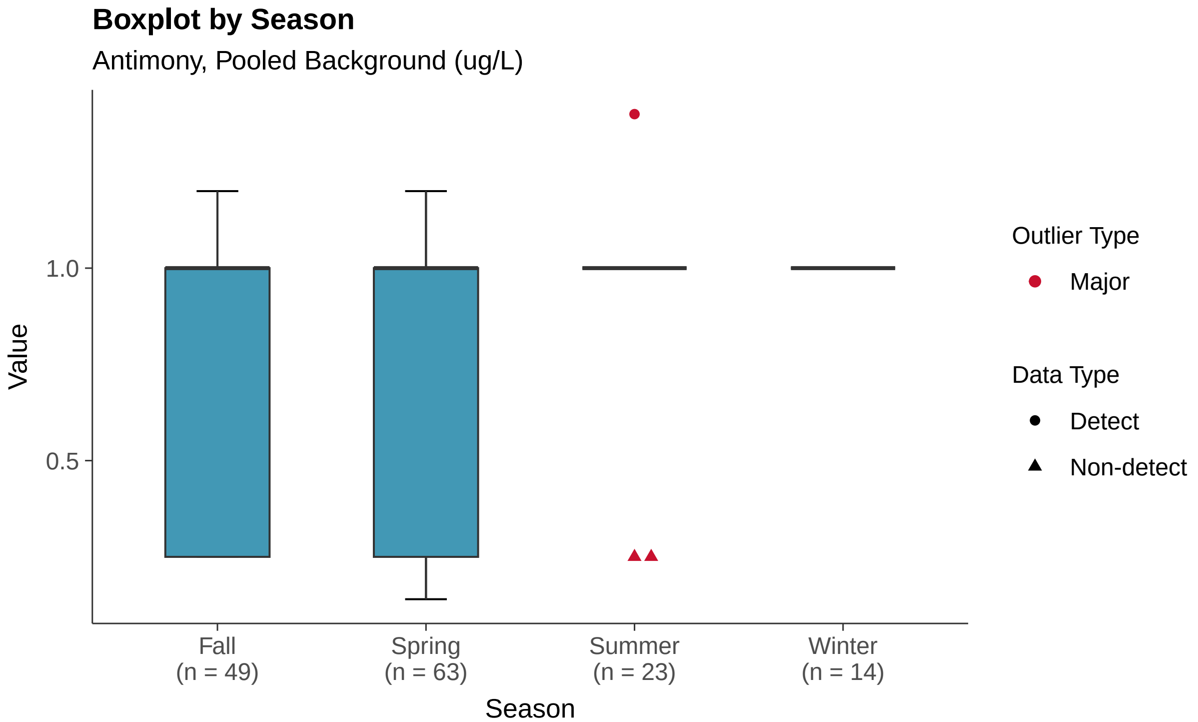
Antimony, Pooled Background (ug/L)

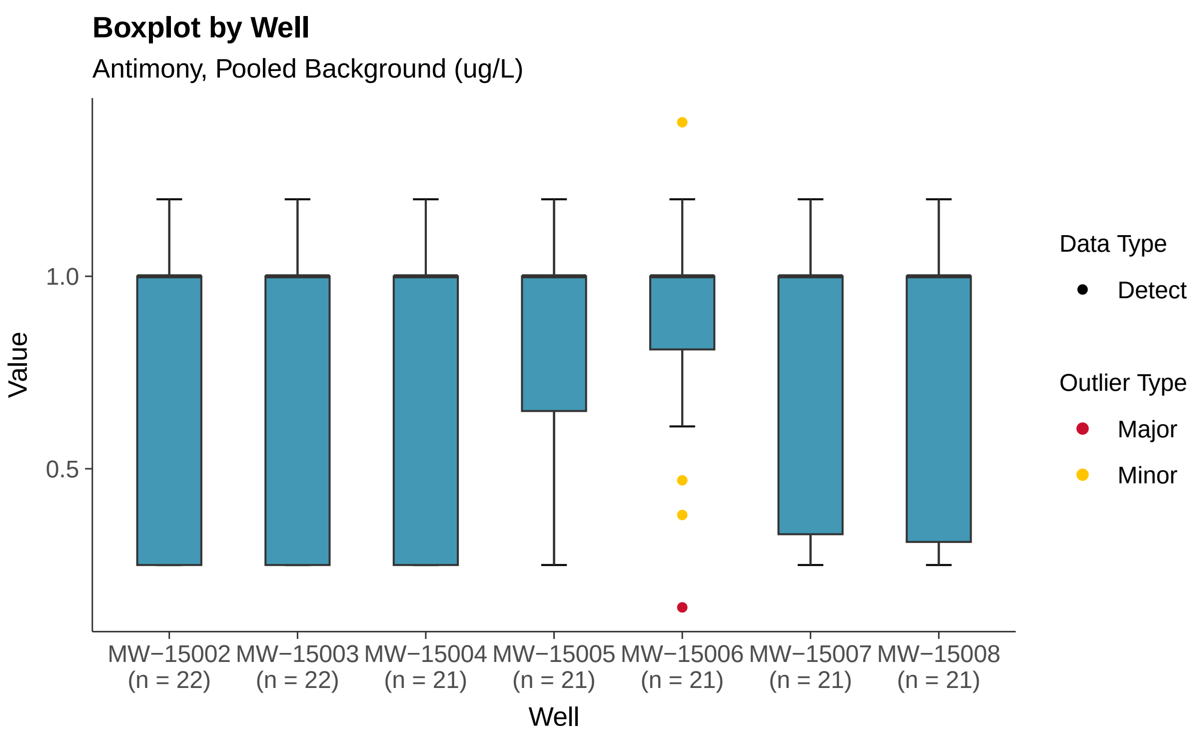


Boxplot

Antimony, Pooled Background (ug/L)

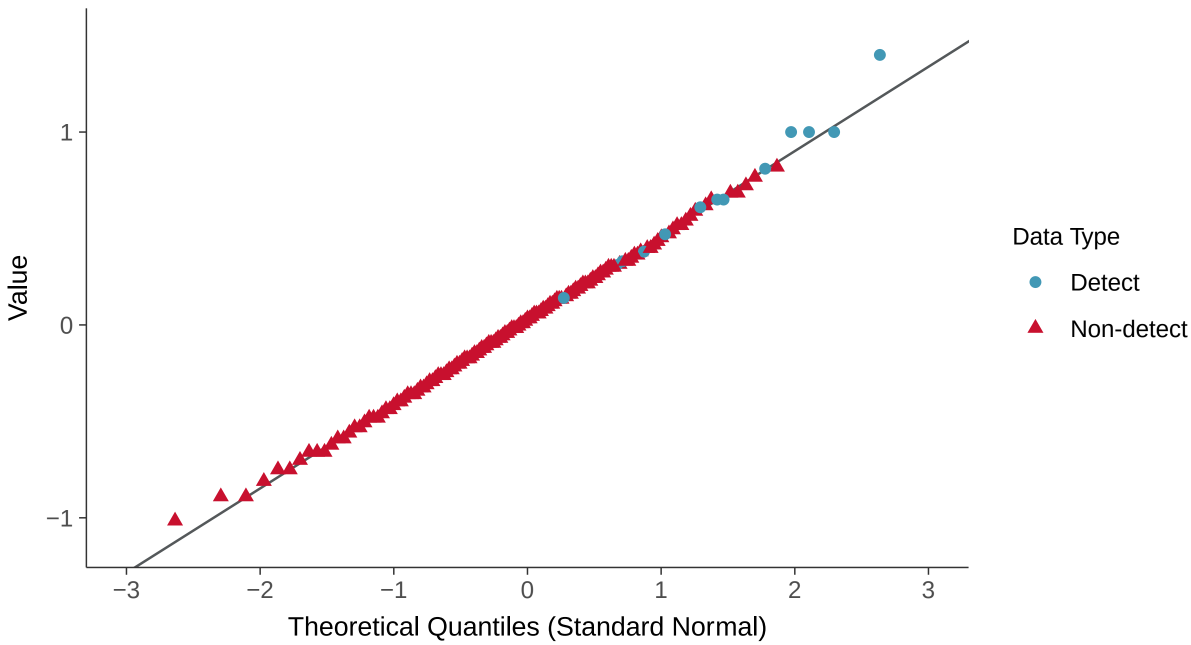



Boxplot by Season
Antimony, Pooled Background (ug/L)
Value
1.0
0.5
Fall
(n = 49)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Outlier Type
Major
Data Type
Detect
Non-detect


Boxplot by Well
Antimony, Pooled Background (ug/L)
Value
1.0
0.5
MW−15002
(n = 22)
MW−15003
(n = 22)
MW−15004
(n = 21)
MW−15005
(n = 21)
MW−15006
(n = 21)
MW−15007
(n = 21)
MW−15008
(n = 21)
Well
Data Type
Detect
Outlier Type
Major
Minor

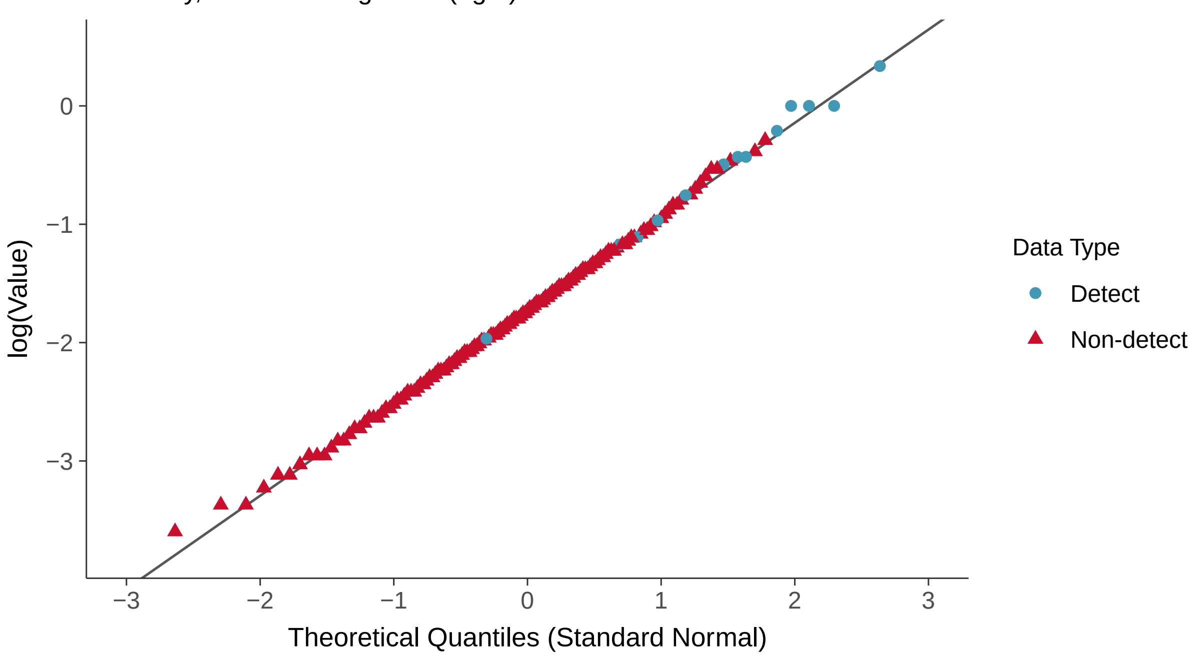
Normal Q-Q plot using ROS Imputed Estimates

Antimony, Pooled Background (ug/L)



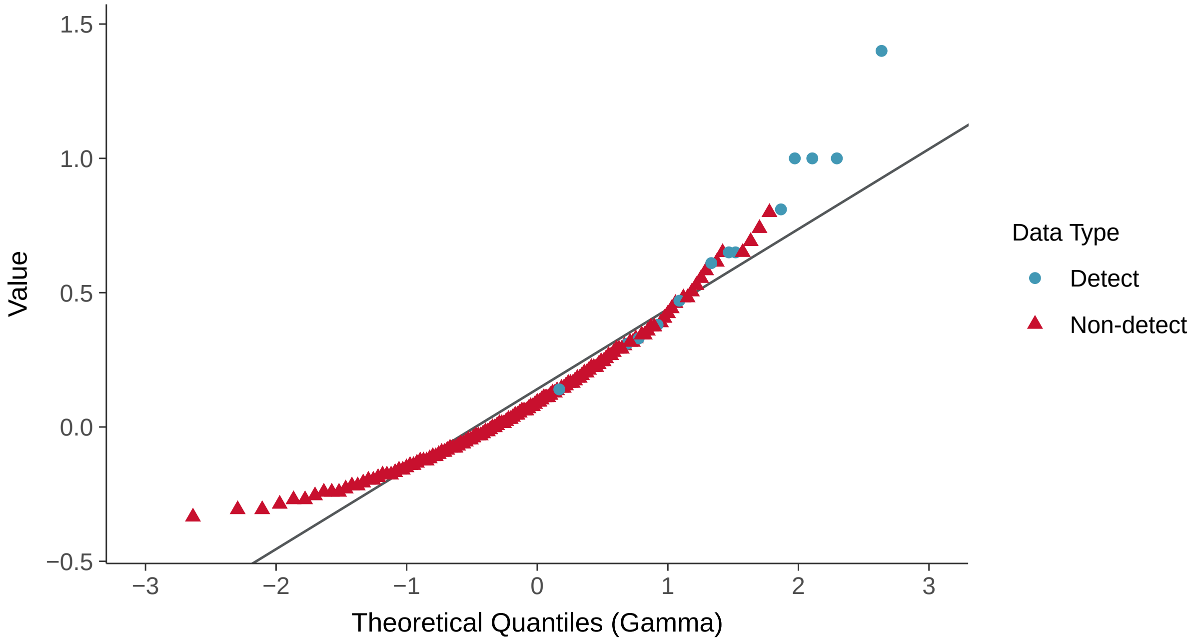
Lognormal Q-Q plot using ROS Imputed Estimates

Antimony, Pooled Background (ug/L)



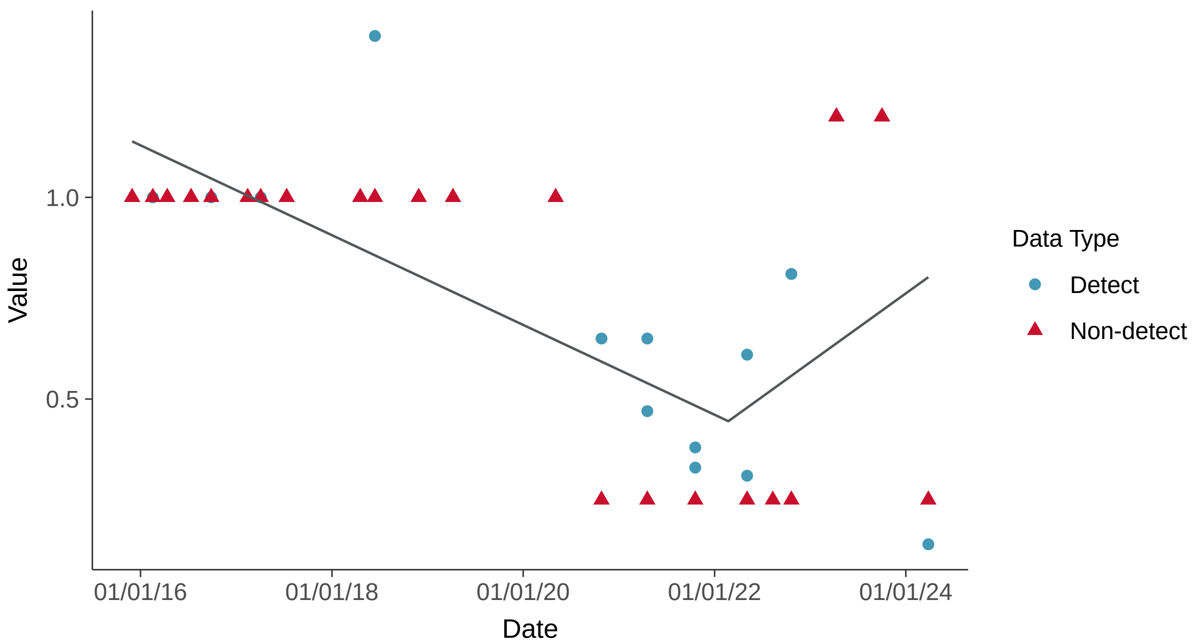
Gamma Q-Q plot using ROS Imputed Estimates

Antimony, Pooled Background (ug/L)



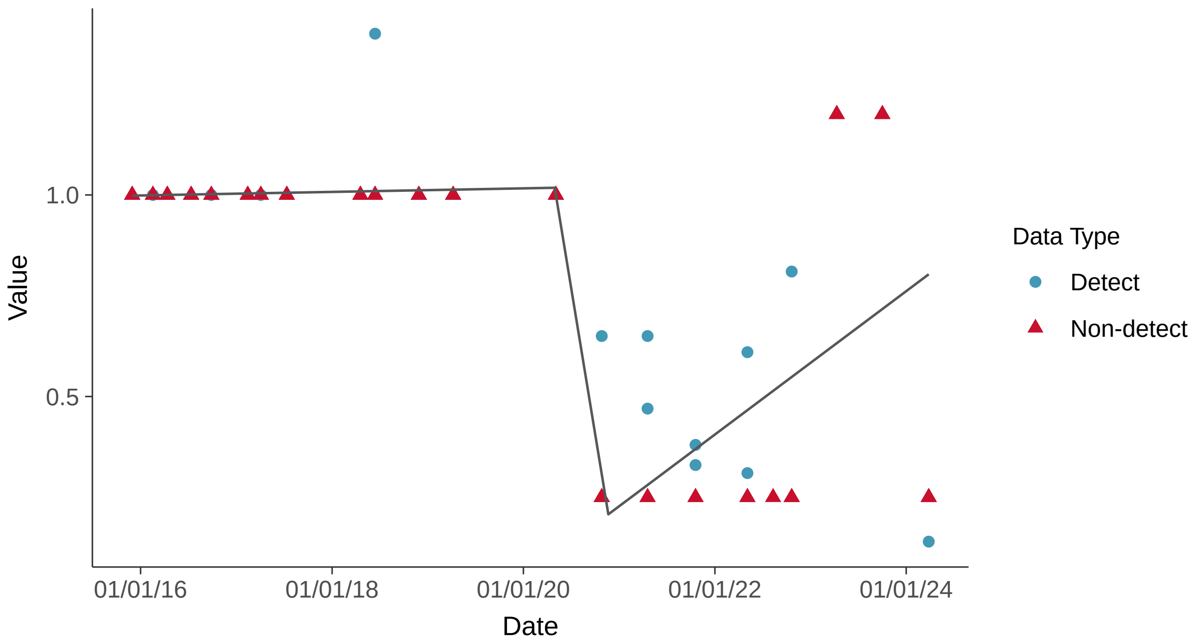
Trend Regression: Piecewise Linear-Linear

Antimony, Pooled Background (ug/L)



Trend Regression: Piecewise Linear-Linear-Linear

Antimony, Pooled Background (ug/L)

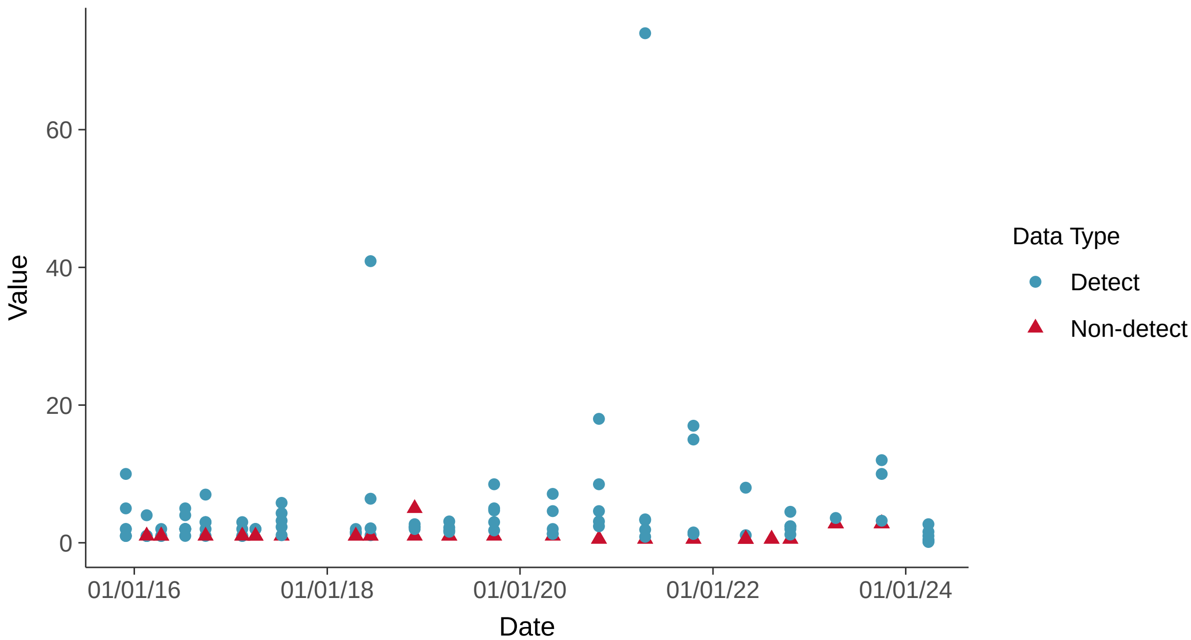


Appendix IV: Arsenic, Pooled Background

ID: 2_102

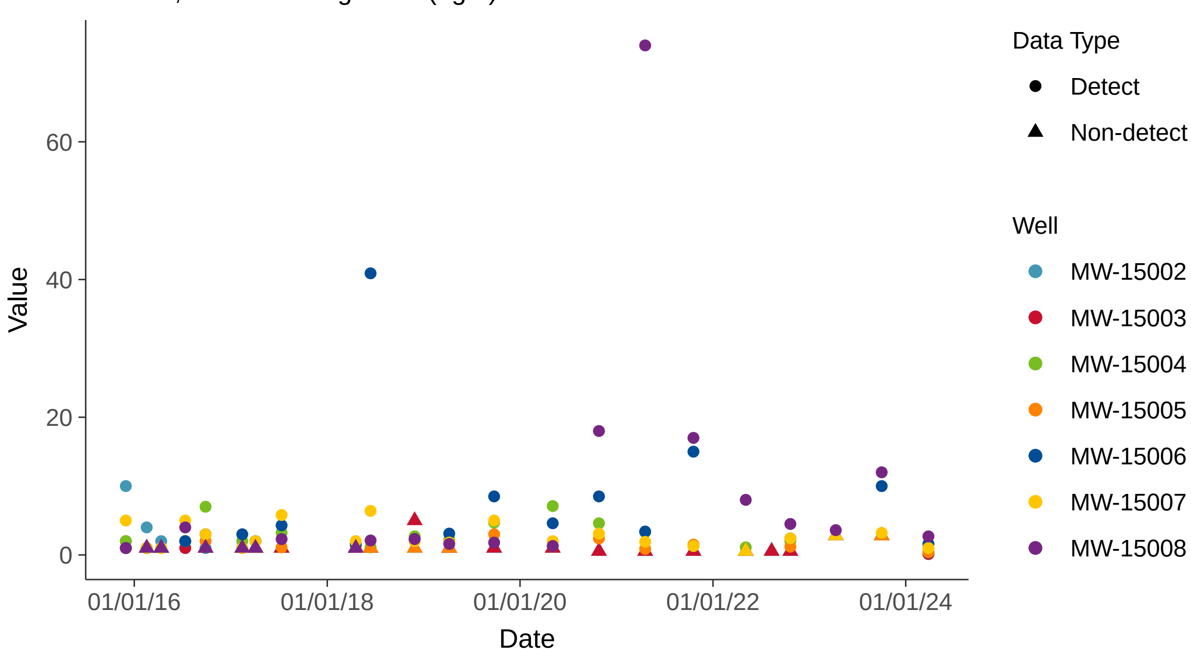
Scatter Plot

Arsenic, Pooled Background (ug/L)



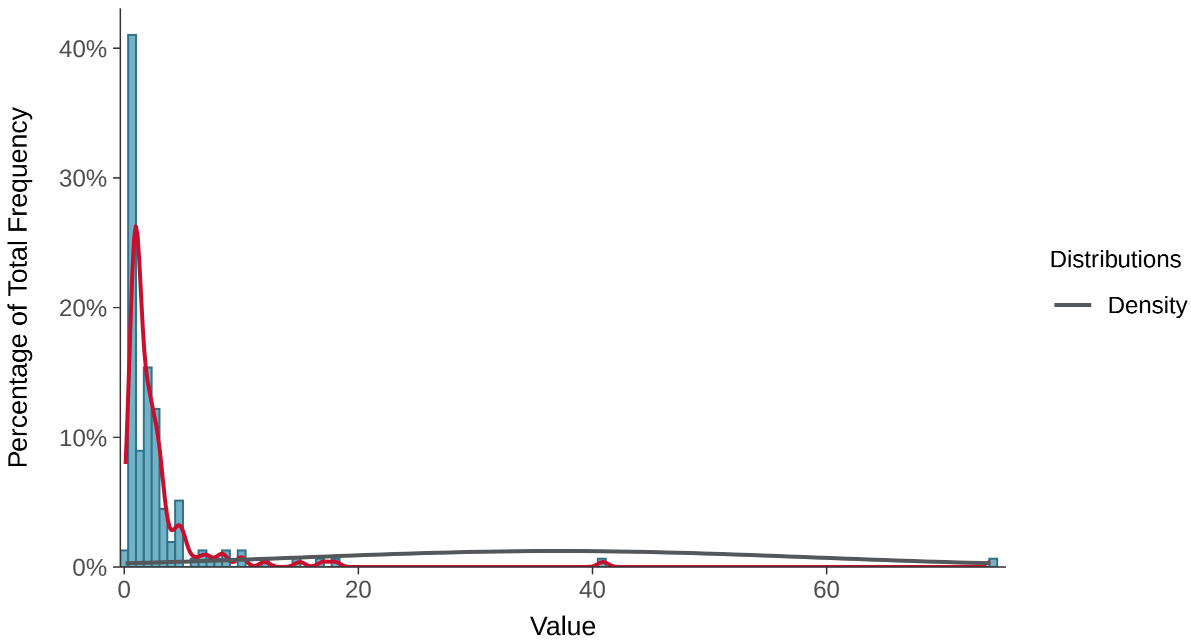
Scatter Plot by Well

Arsenic, Pooled Background (ug/L)



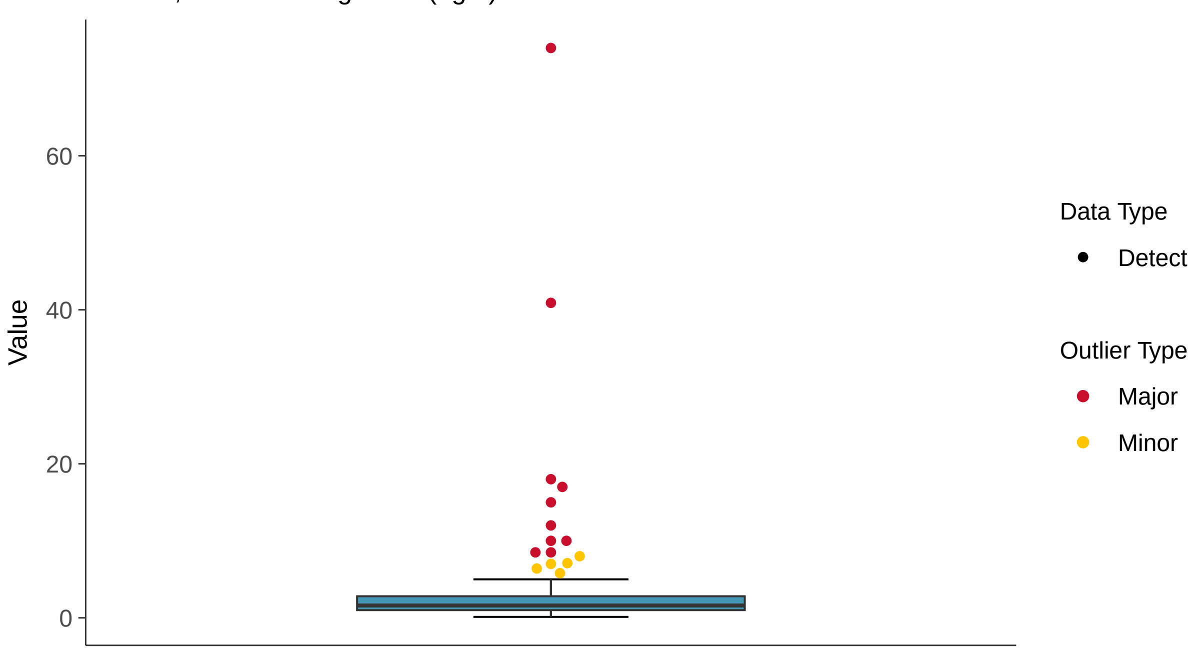
Histogram

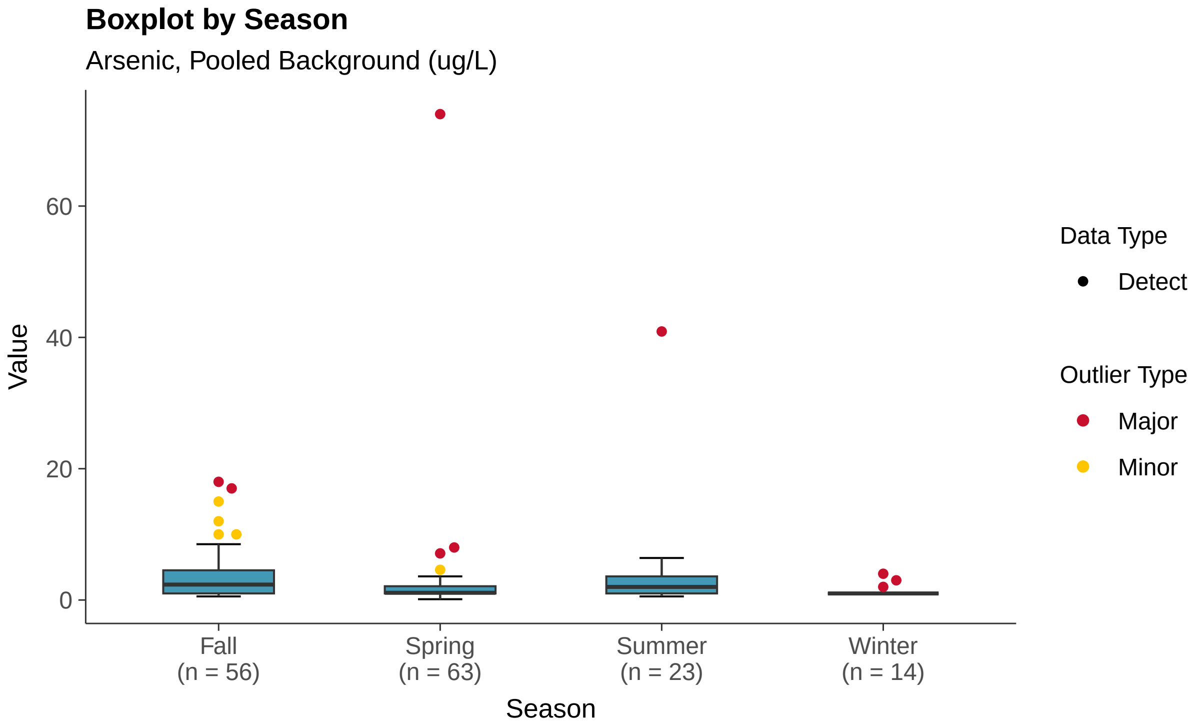
Arsenic, Pooled Background (ug/L)

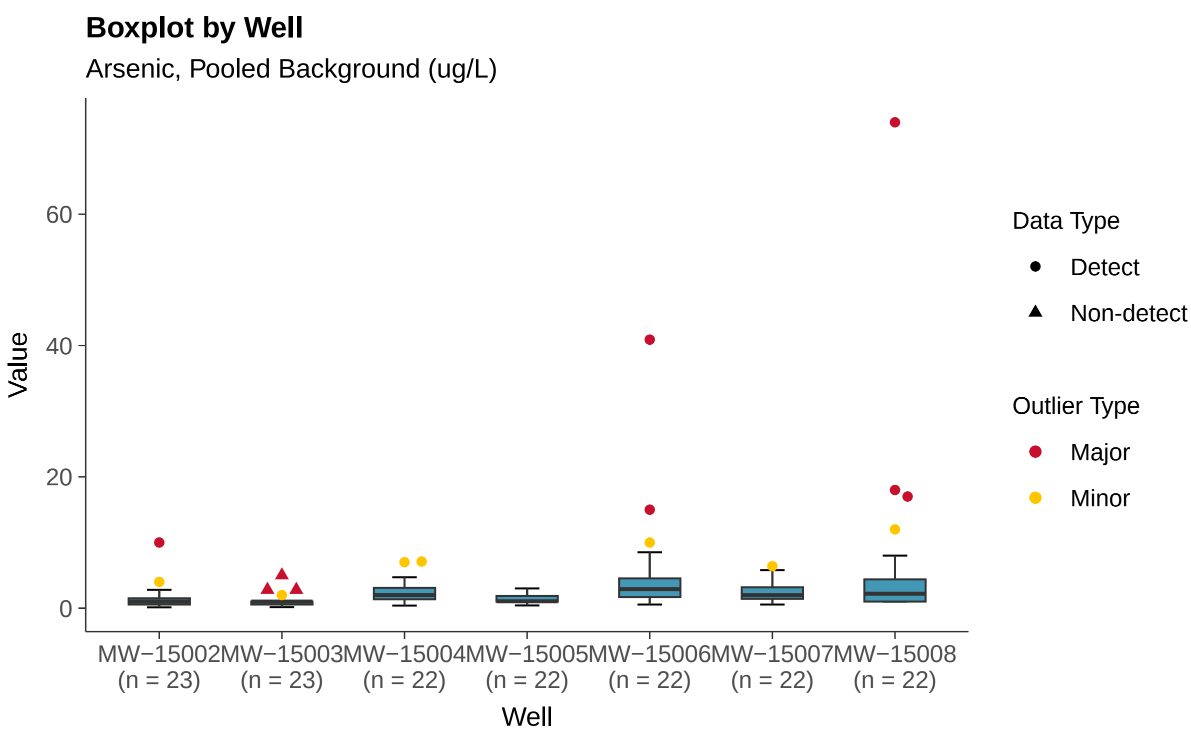


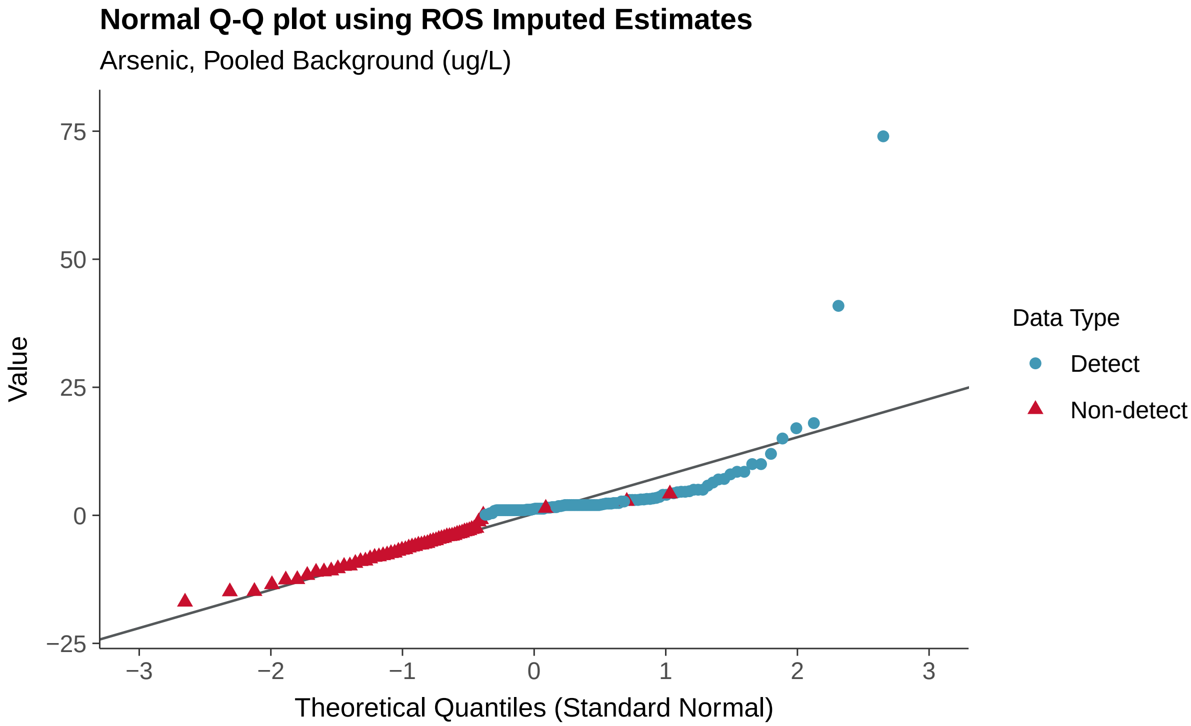
Boxplot

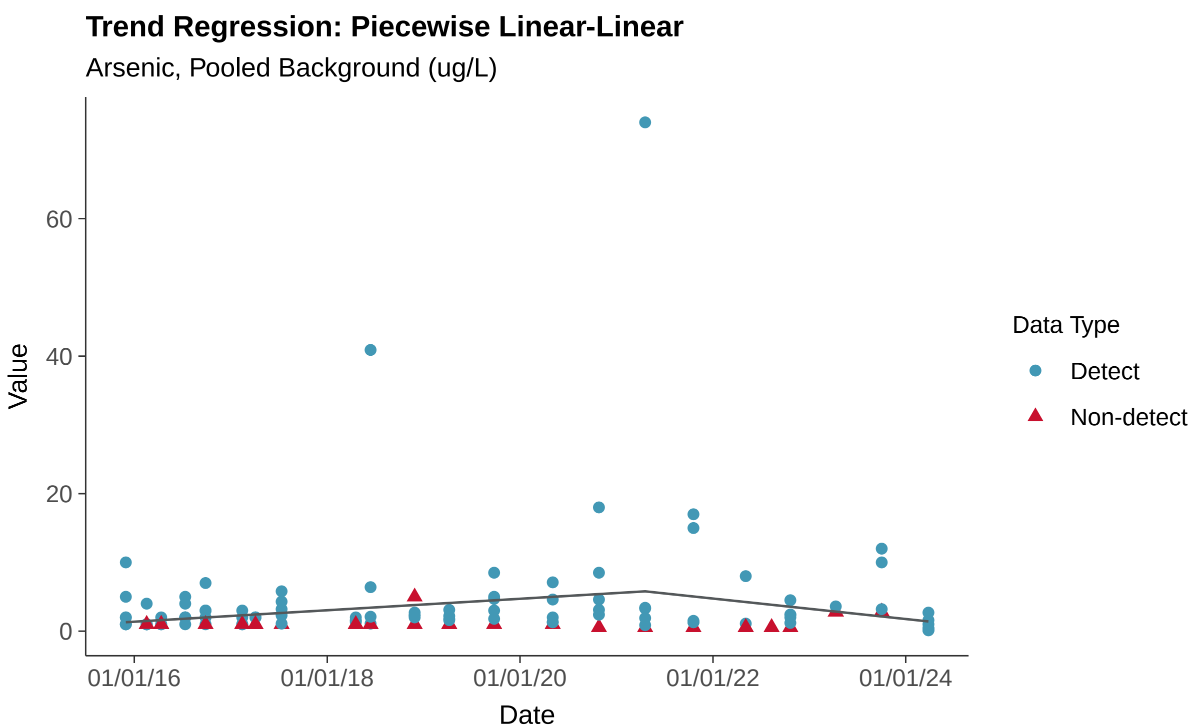
Arsenic, Pooled Background (ug/L)




Boxplot by Season
Arsenic, Pooled Background (ug/L)
Value
0
20
40
60
Fall
(n = 56)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Outlier Type
Major
Minor

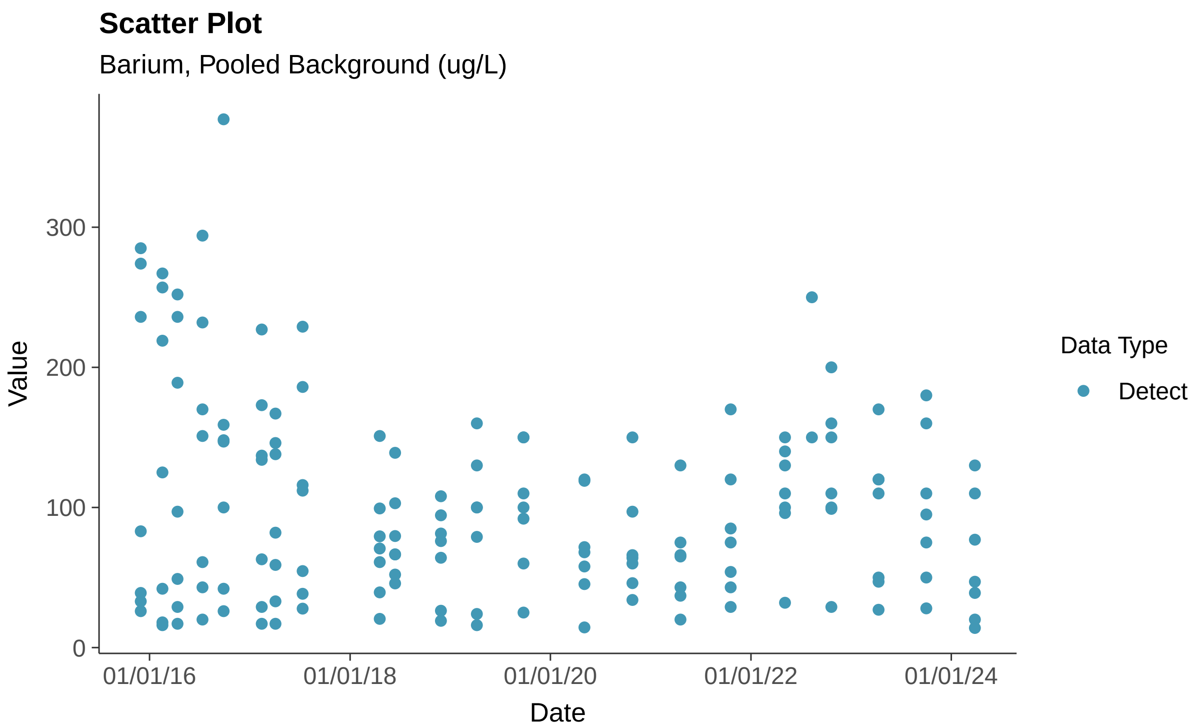

Boxplot by Well
Arsenic, Pooled Background (ug/L)
Value
0
20
40
60
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 22)
MW−15007
(n = 22)
MW−15008
(n = 22)
Well
Data Type
Detect
Non-detect
Outlier Type
Major
Minor

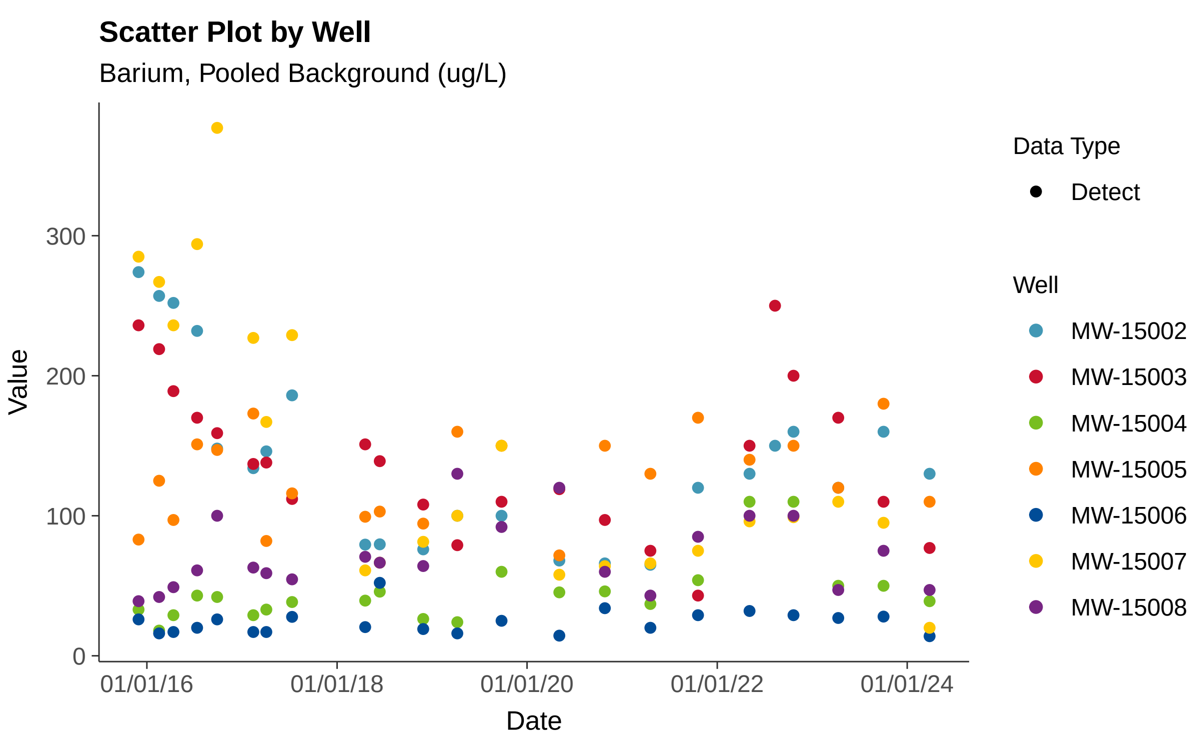

Normal Q-Q plot using ROS Imputed Estimates
Arsenic, Pooled Background (ug/L)
Value
75
50
25
0
−25
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Arsenic, Pooled Background (ug/L)
Value
60
40
20
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

Appendix IV: Barium, Pooled Background

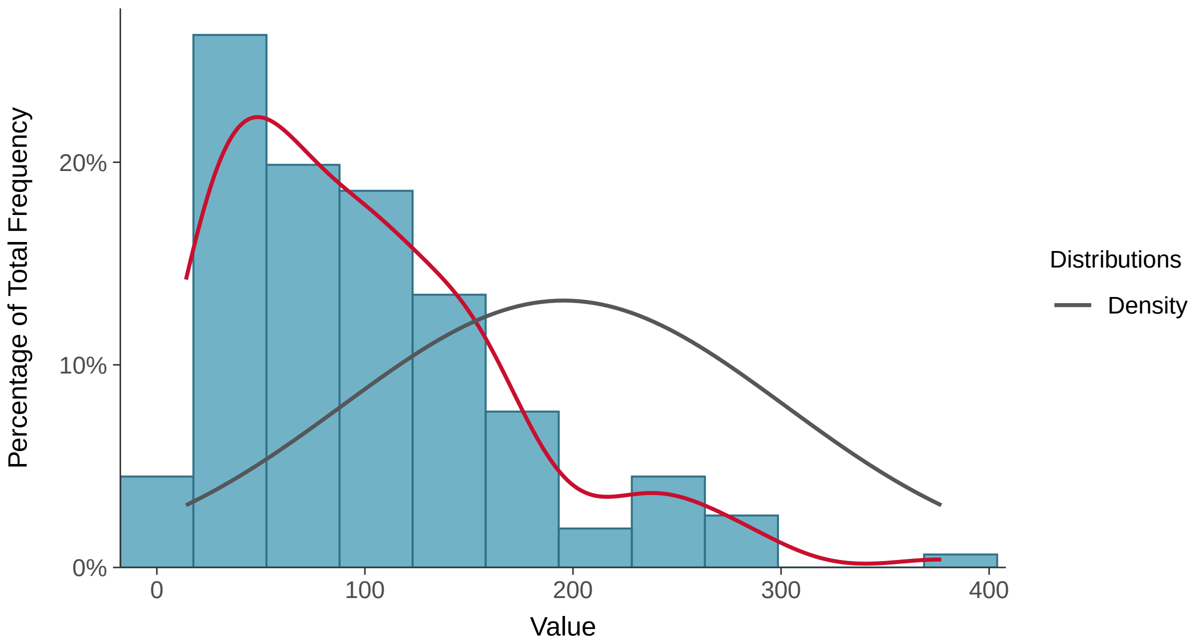
ID: 2_103





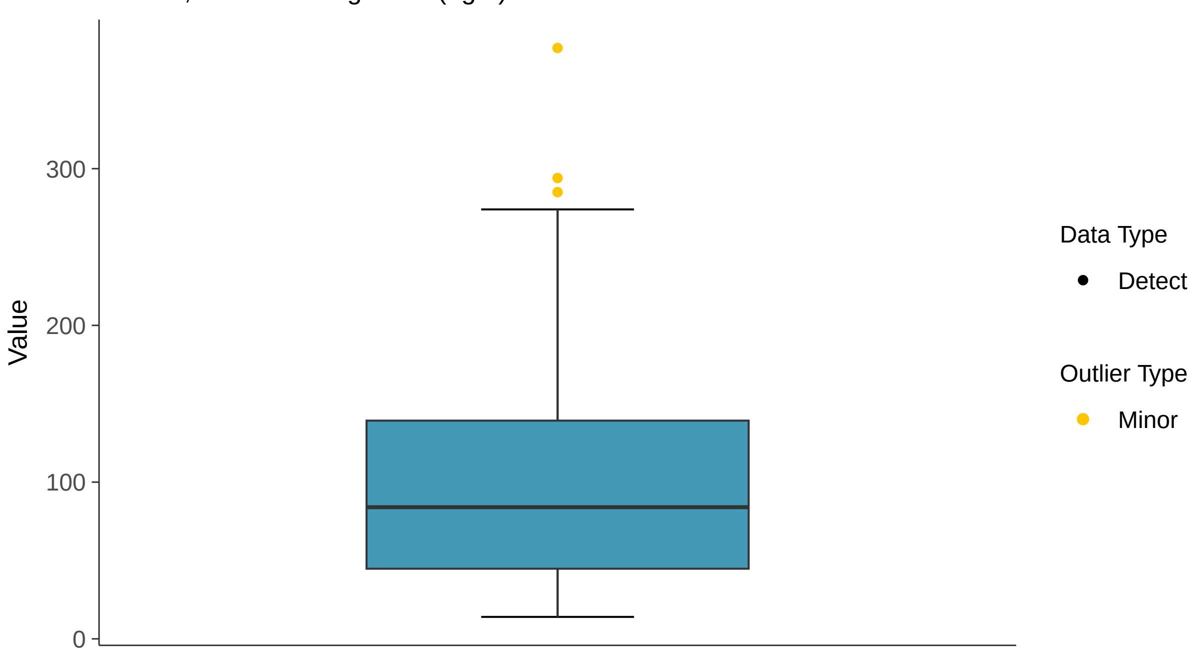
Histogram

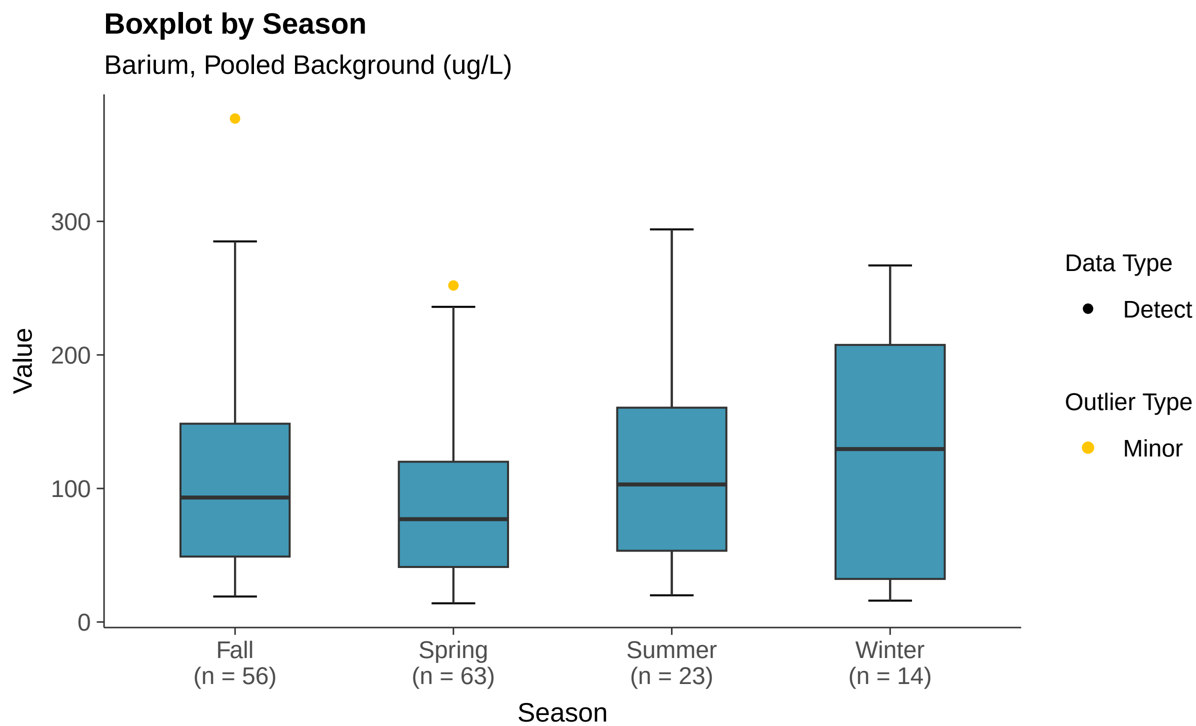
Barium, Pooled Background (ug/L)

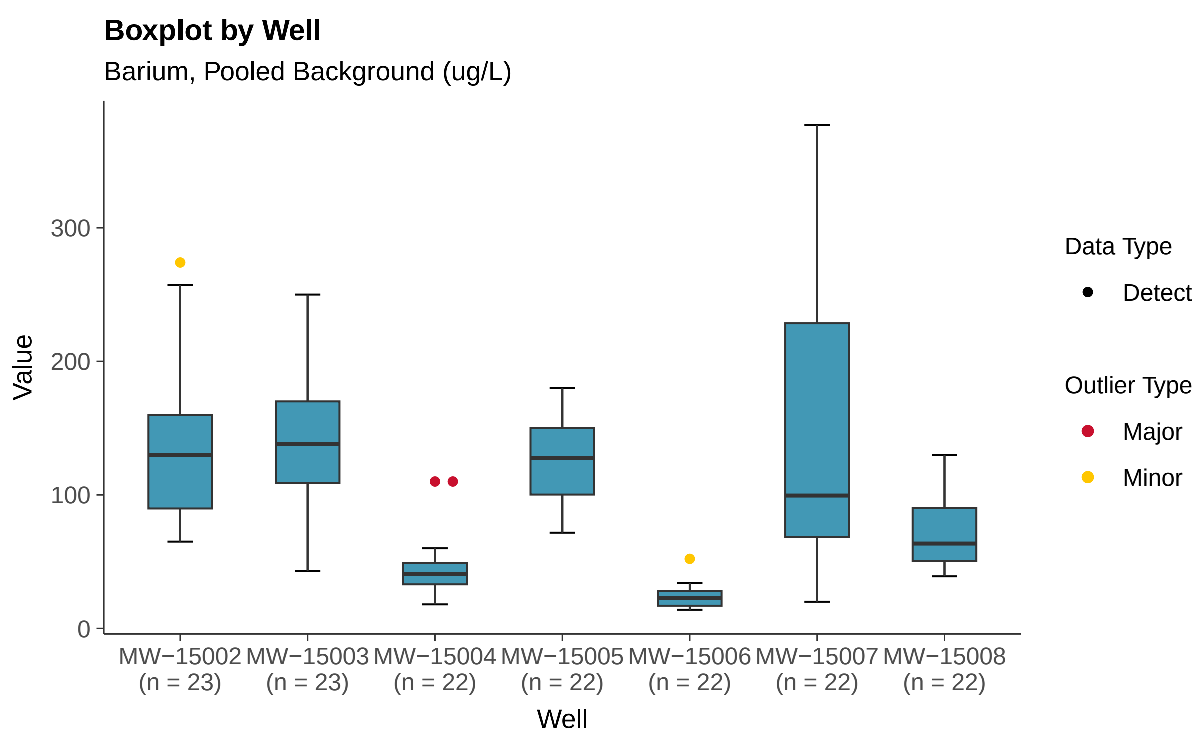


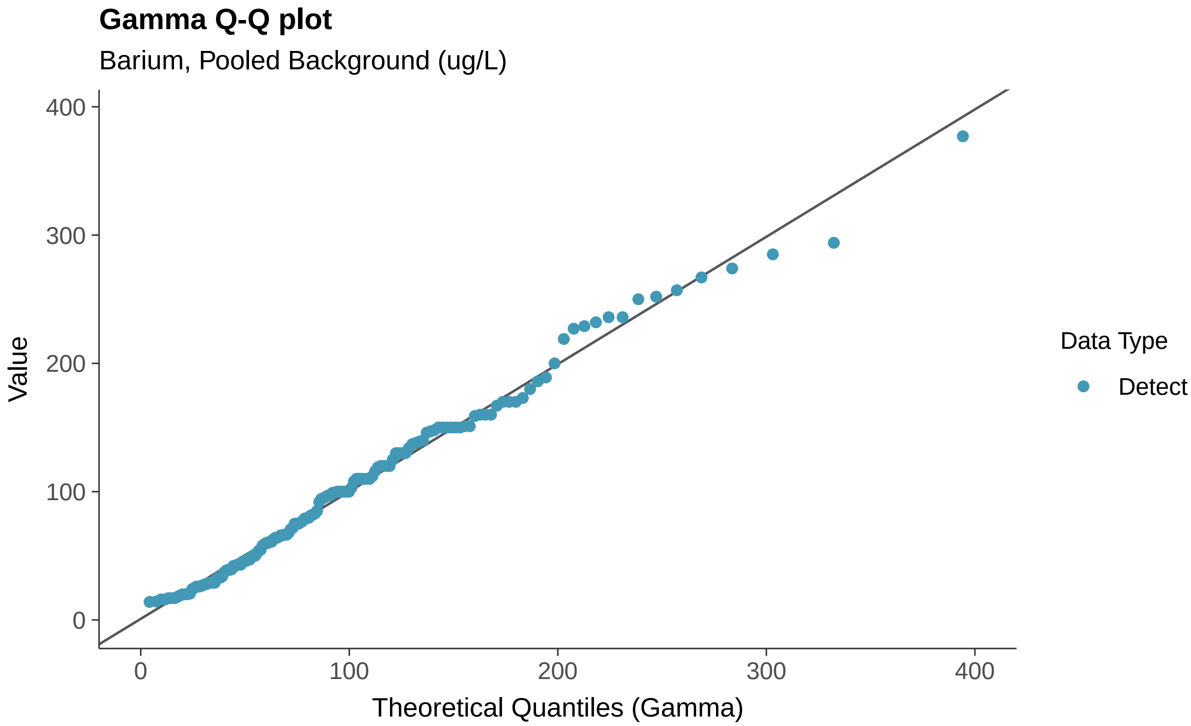
Boxplot

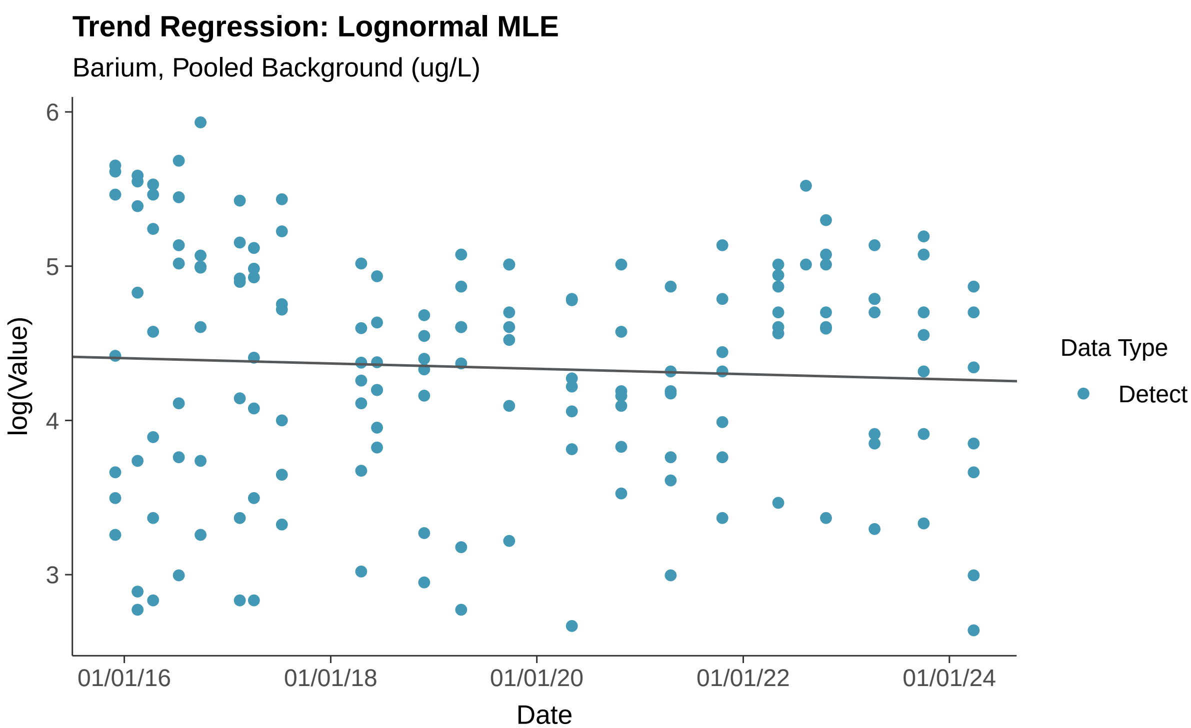
Barium, Pooled Background (ug/L)

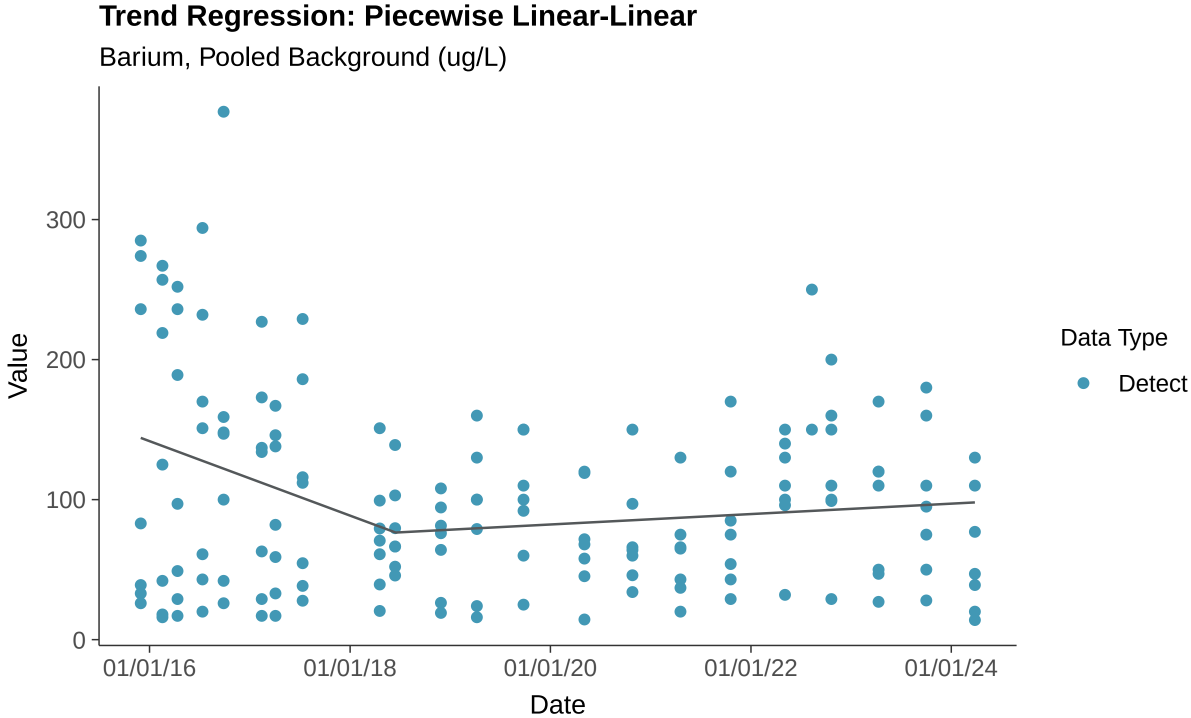


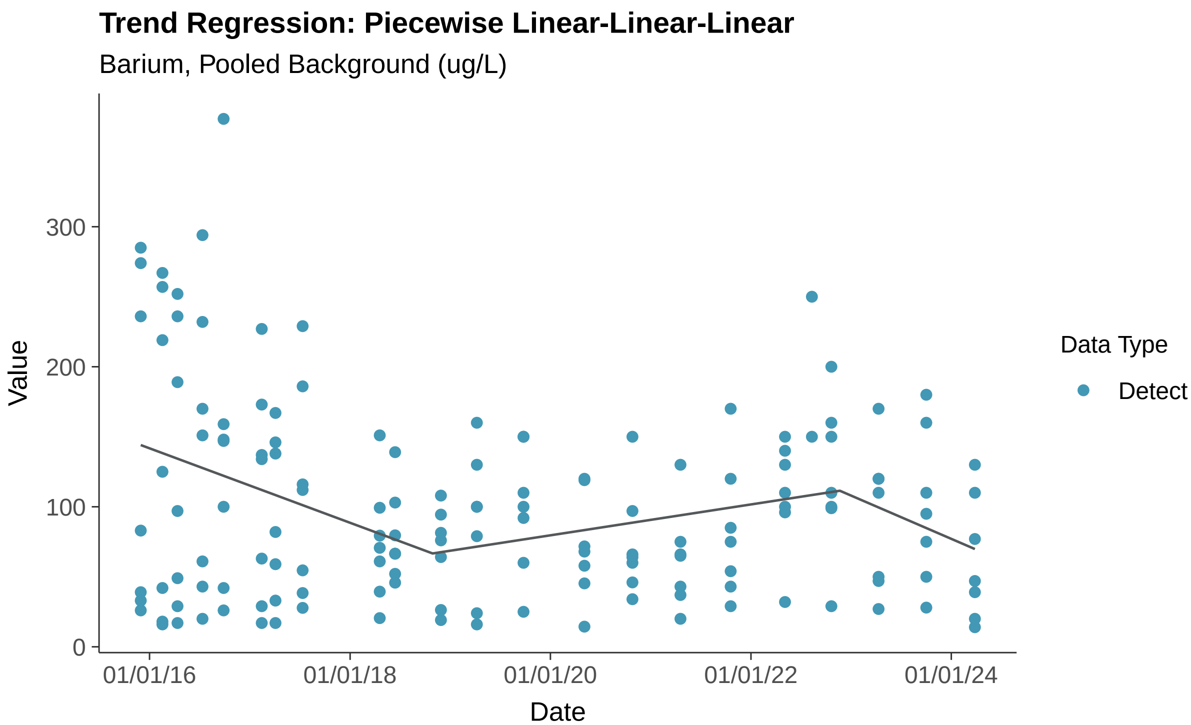

Boxplot by Season
Barium, Pooled Background (ug/L)
Value
300
200
100
0
Fall
(n = 56)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Outlier Type
Minor


Boxplot by Well
Barium, Pooled Background (ug/L)
Value
300
200
100
0
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 22)
MW−15007
(n = 22)
MW−15008
(n = 22)
Well
Data Type
Detect
Outlier Type
Major
Minor


Gamma Q-Q plot
Barium, Pooled Background (ug/L)
Value
400
300
200
100
0
0
100
200
300
400
Theoretical Quantiles (Gamma)
Data Type
Detect

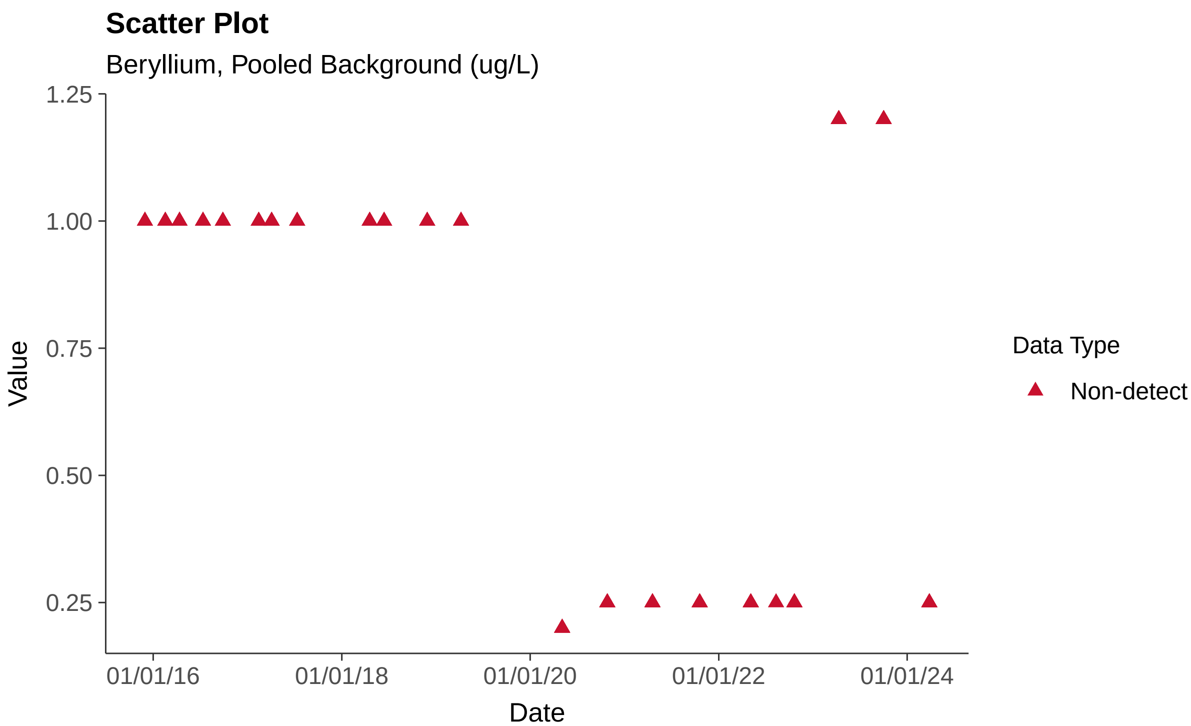

Trend Regression: Lognormal MLE
Barium, Pooled Background (ug/L)
log(Value)
6
5
4
3
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect

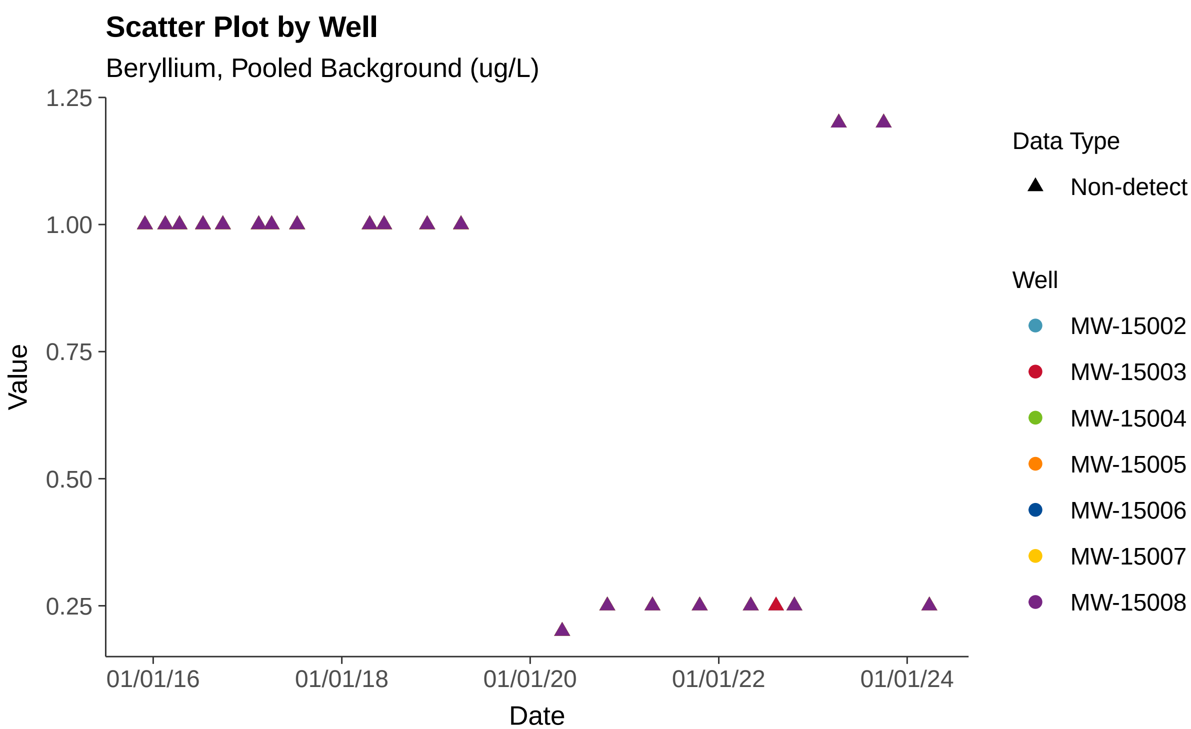

Trend Regression: Piecewise Linear-Linear
Barium, Pooled Background (ug/L)
Value
300
200
100
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect


Trend Regression: Piecewise Linear-Linear-Linear
Barium, Pooled Background (ug/L)
Value
300
200
100
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect

Appendix IV: Beryllium, Pooled Background

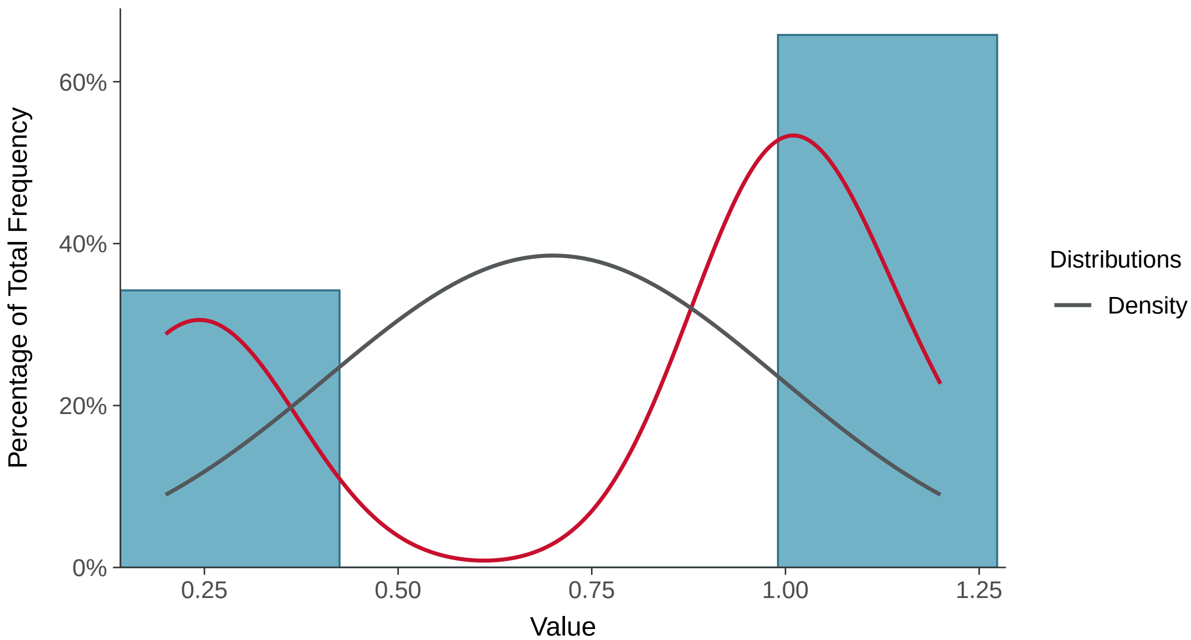
ID: 2_104





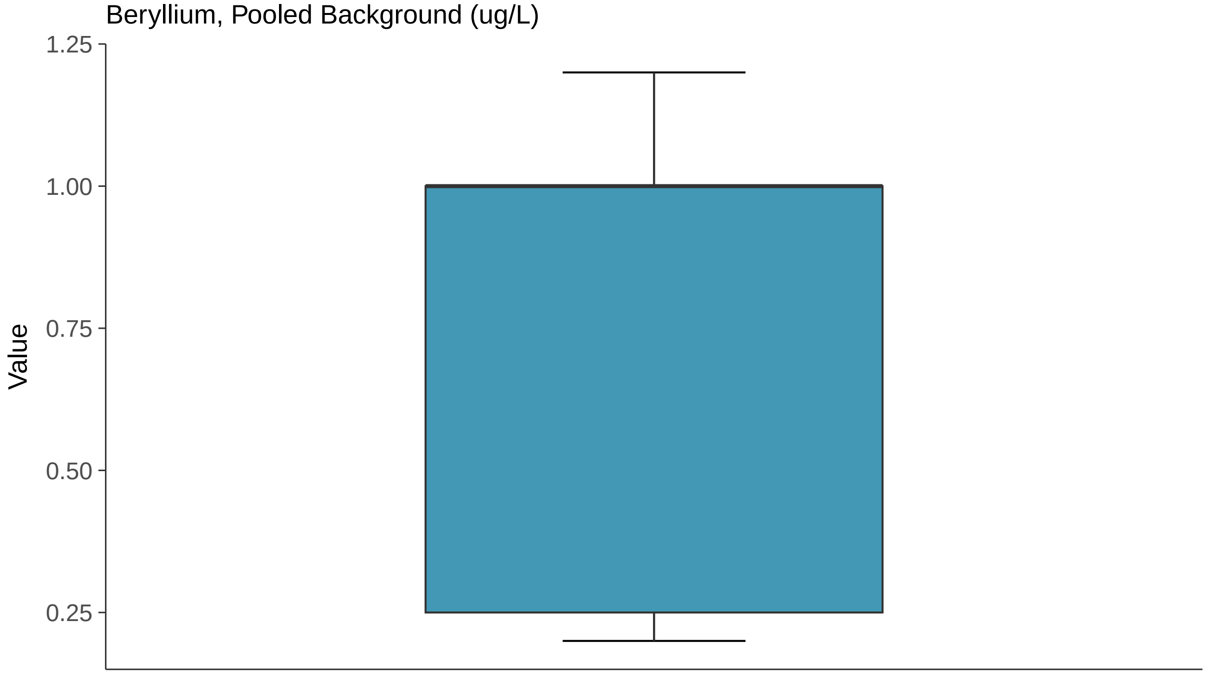
Histogram

Beryllium, Pooled Background (ug/L)



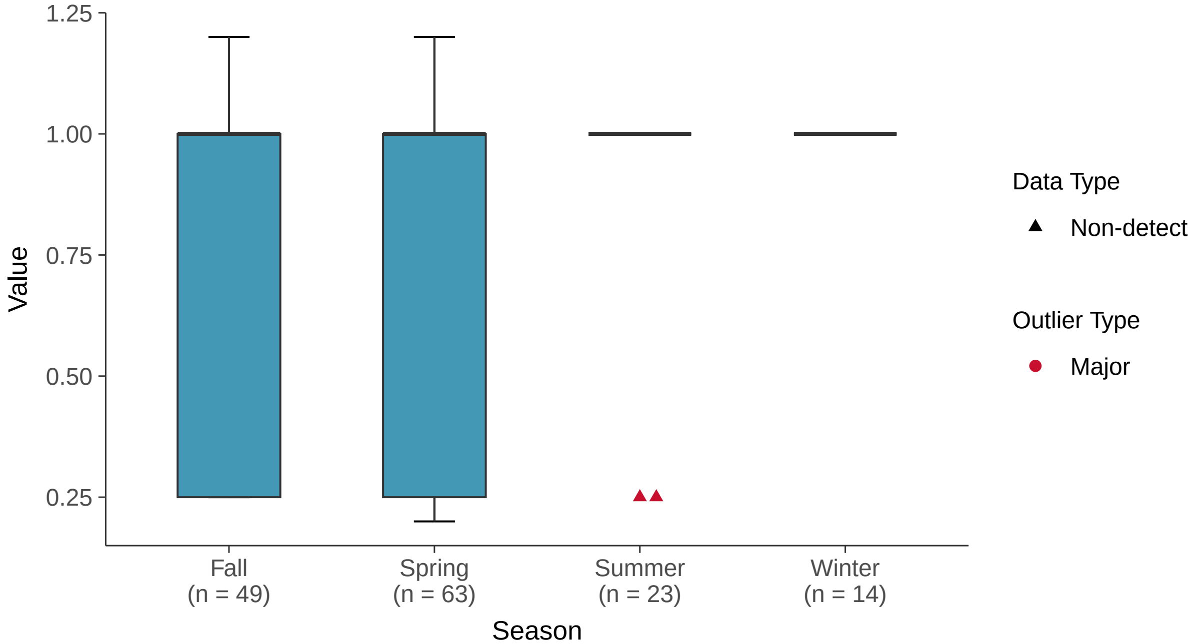
Boxplot

Beryllium, Pooled Background (ug/L)



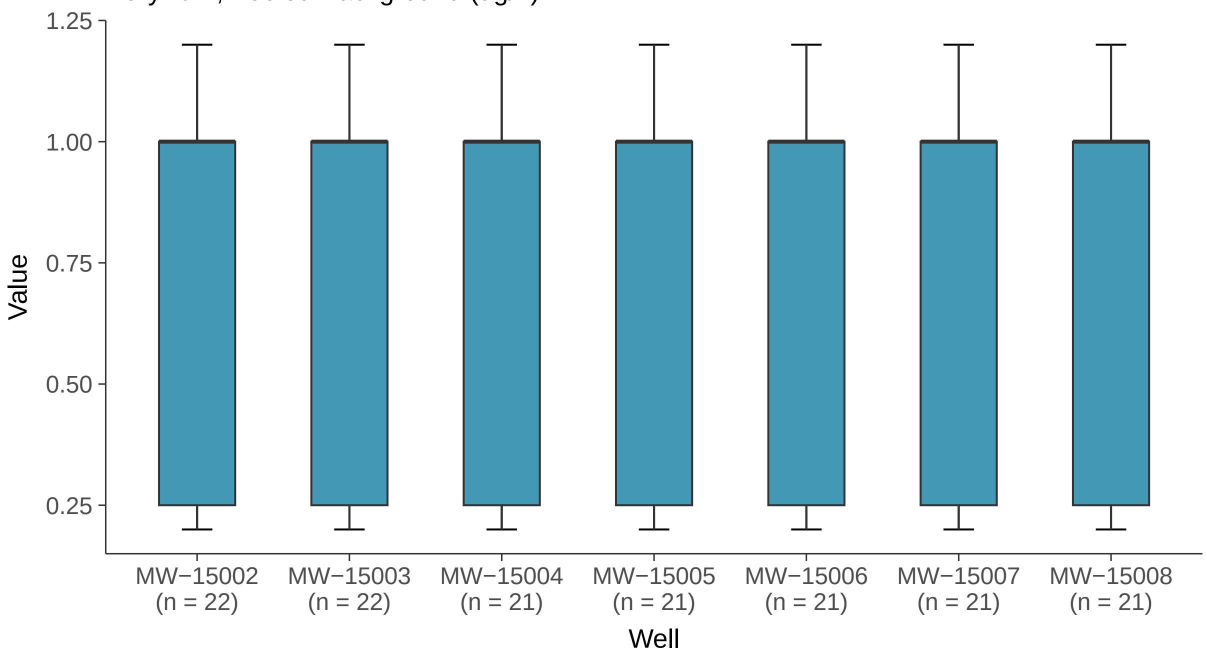
Boxplot by Season

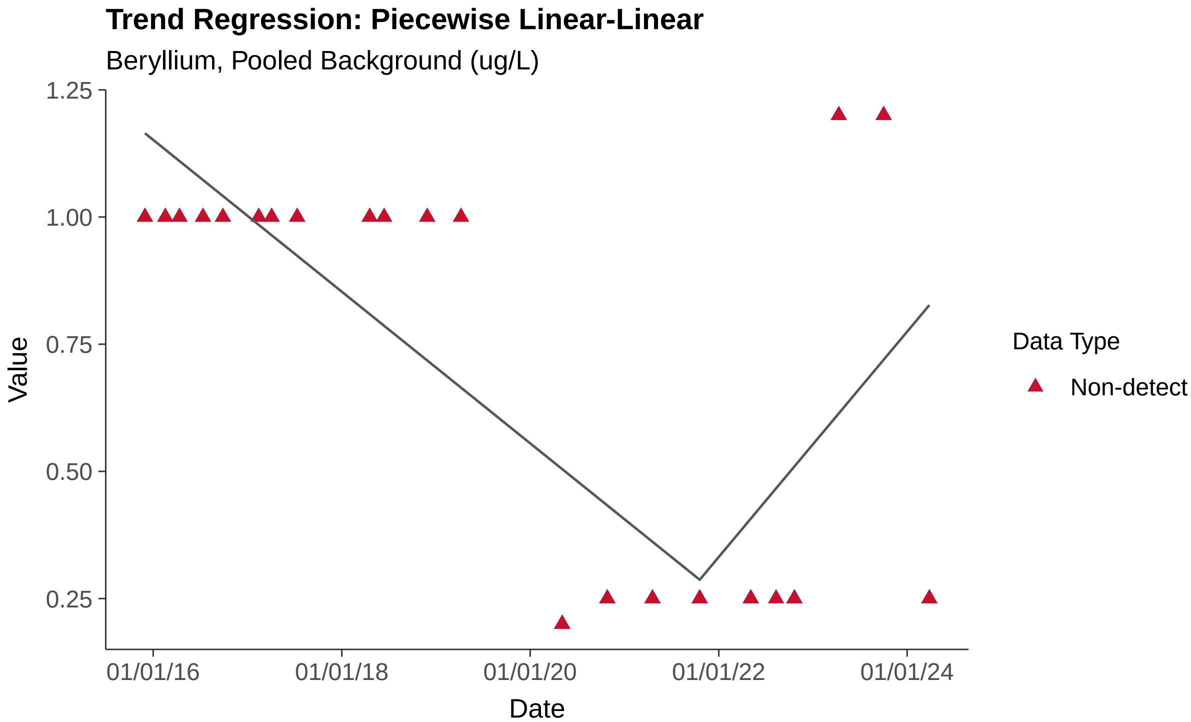
Beryllium, Pooled Background (ug/L)

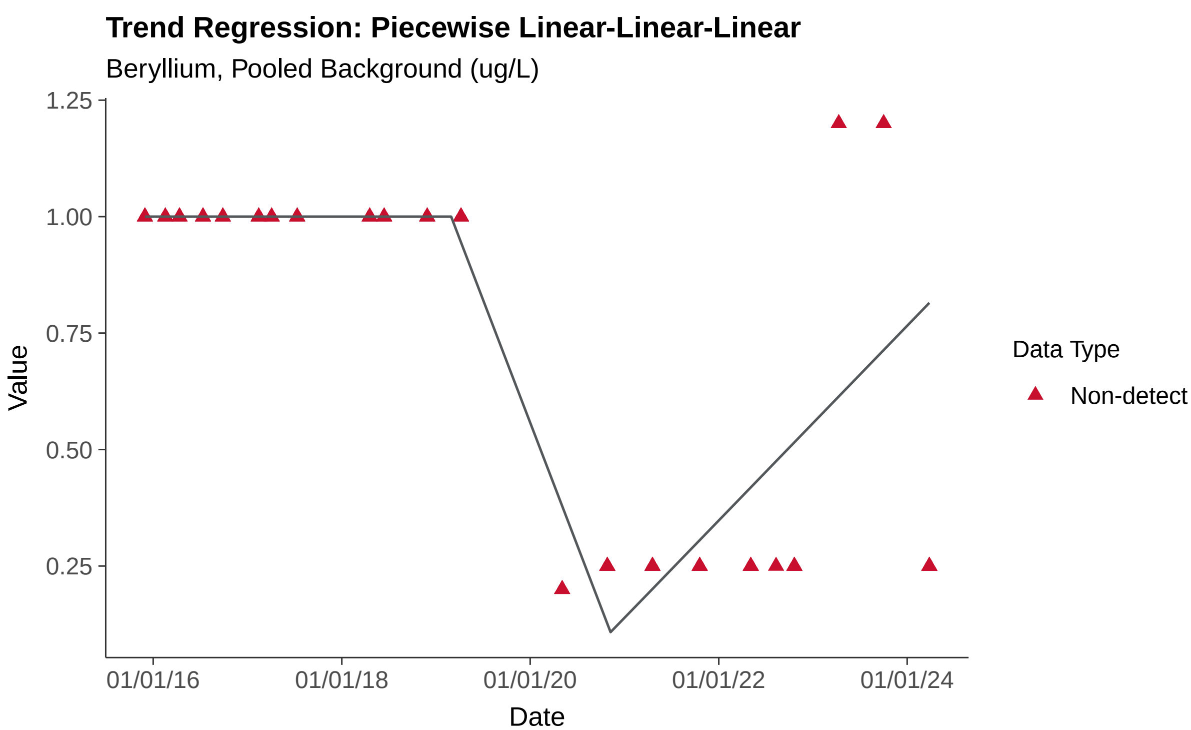


Boxplot by Well

Beryllium, Pooled Background (ug/L)




Trend Regression: Piecewise Linear-Linear
Beryllium, Pooled Background (ug/L)
1.25
1.00
0.75
0.50
0.25
Value
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Non-detect

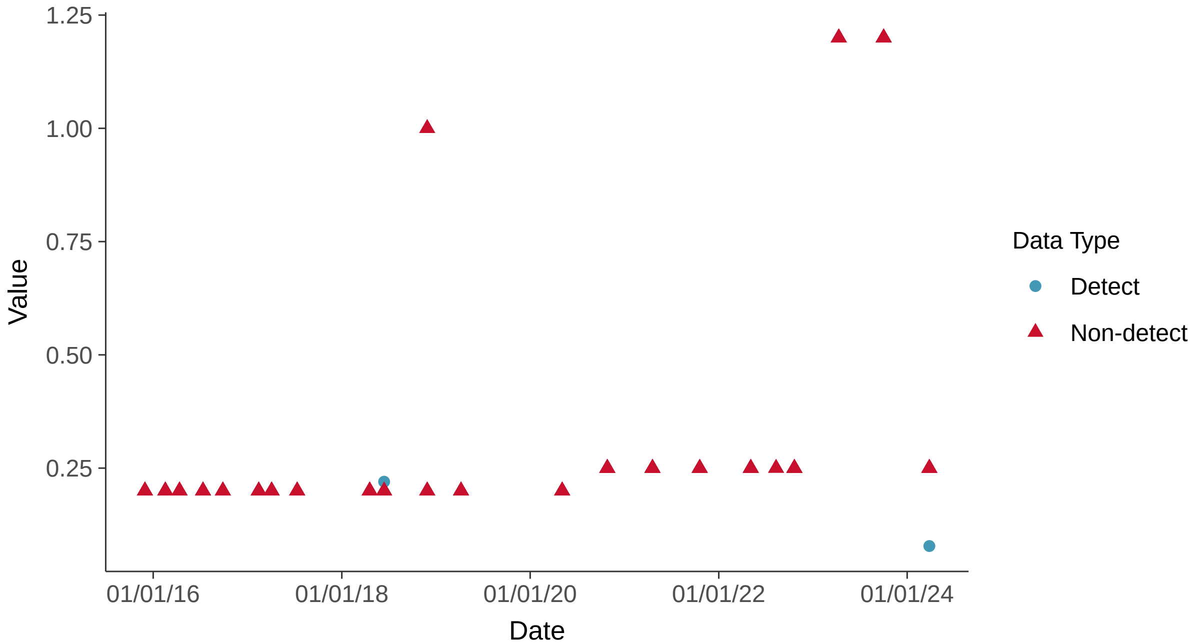

Trend Regression: Piecewise Linear-Linear-Linear
Beryllium, Pooled Background (ug/L)
1.25
1.00
0.75
0.50
0.25
Value
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Non-detect

Appendix IV: Cadmium, Pooled Background

ID: 2_106

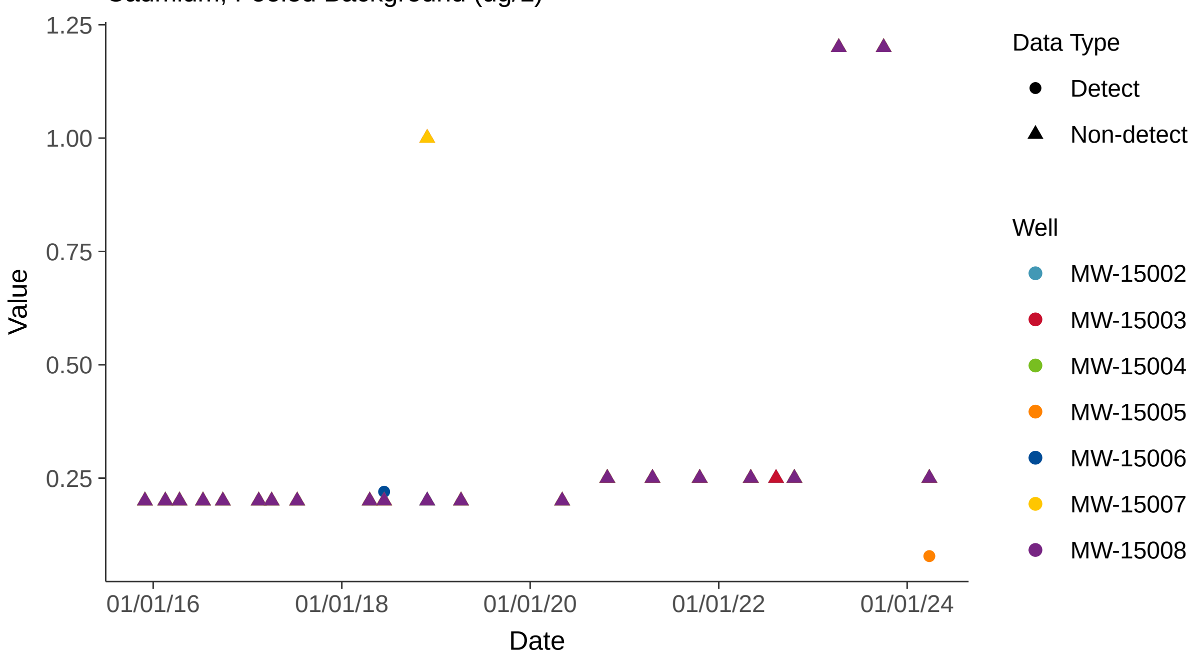
Scatter Plot

Cadmium, Pooled Background (ug/L)



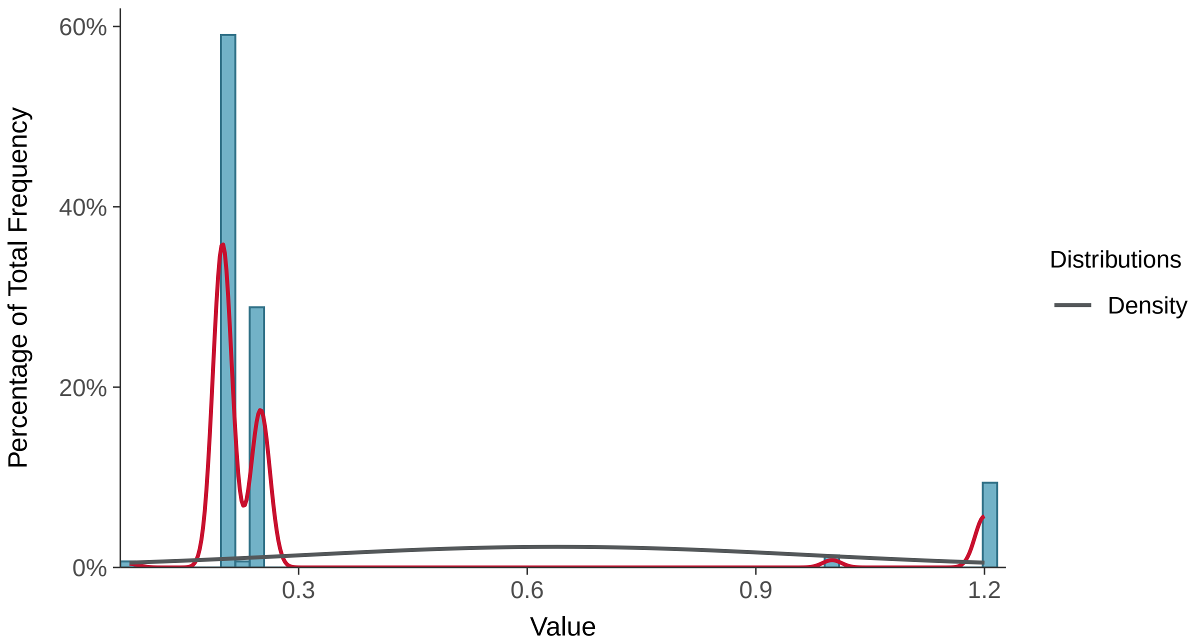
Scatter Plot by Well

Cadmium, Pooled Background (ug/L)



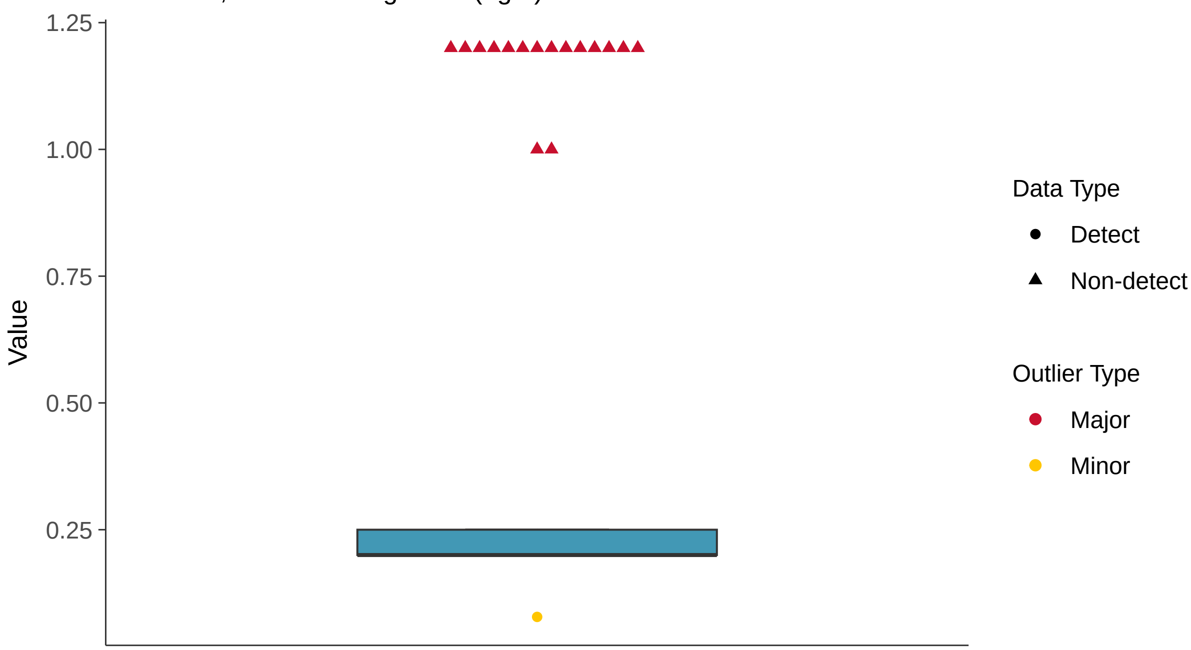
Histogram

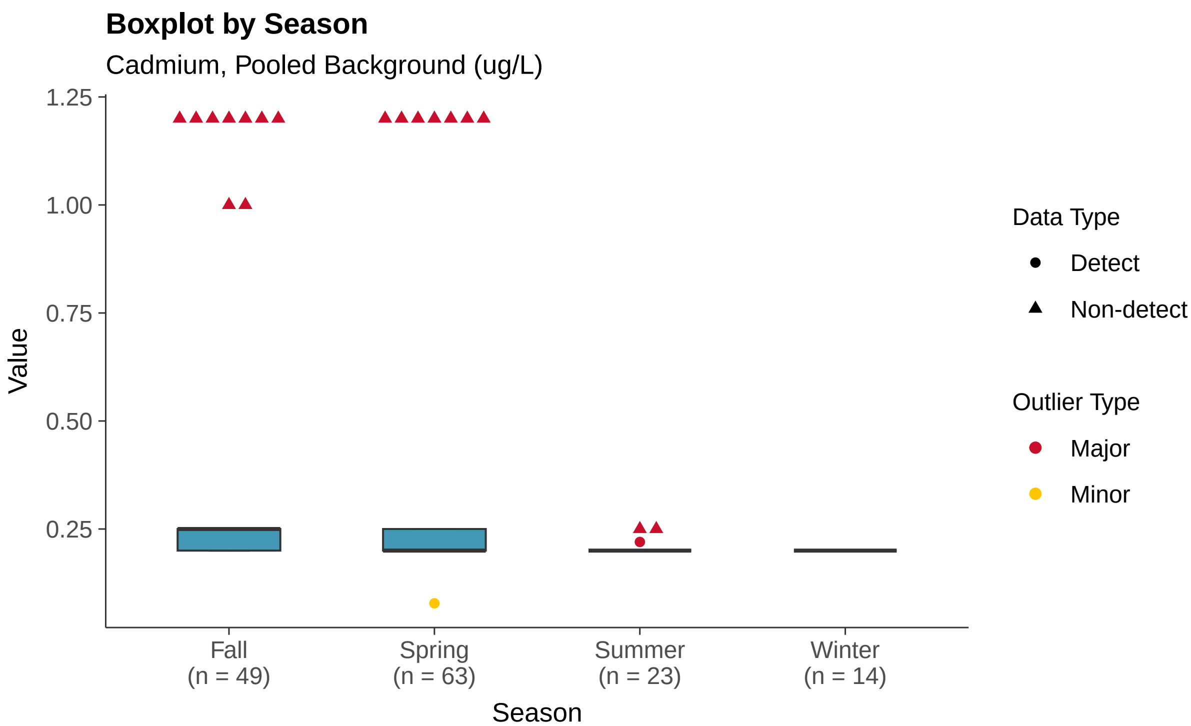
Cadmium, Pooled Background (ug/L)

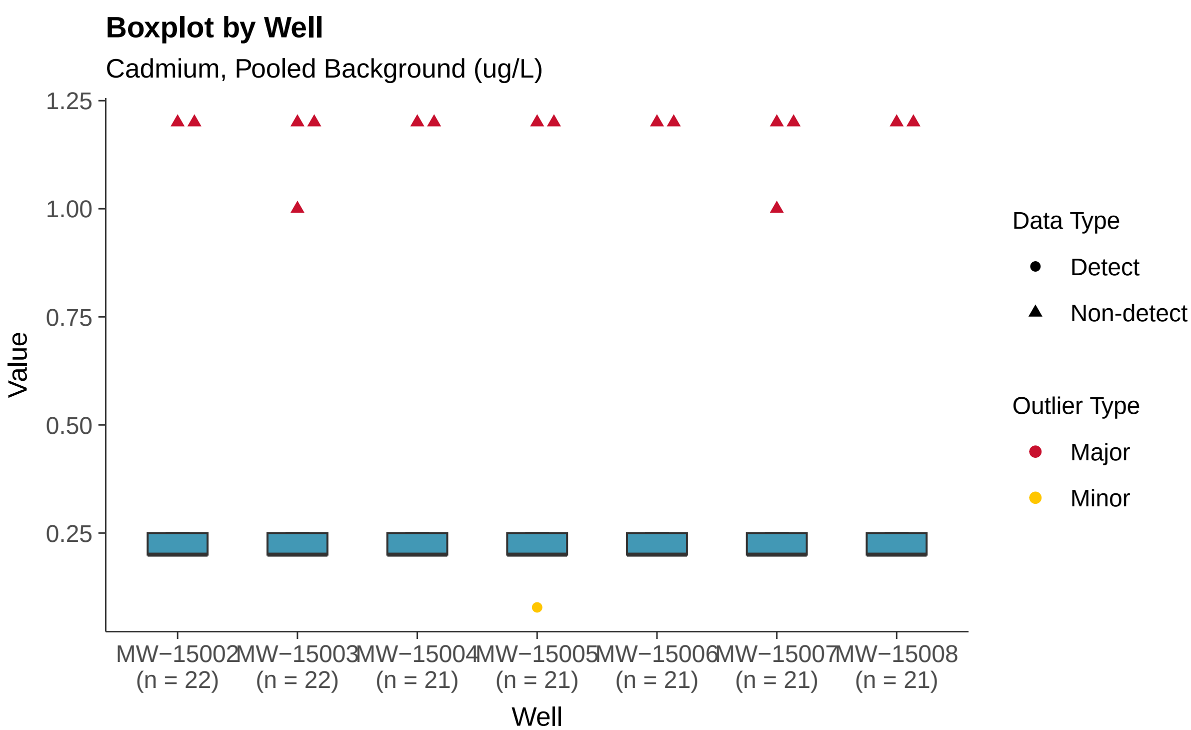


Boxplot

Cadmium, Pooled Background (ug/L)

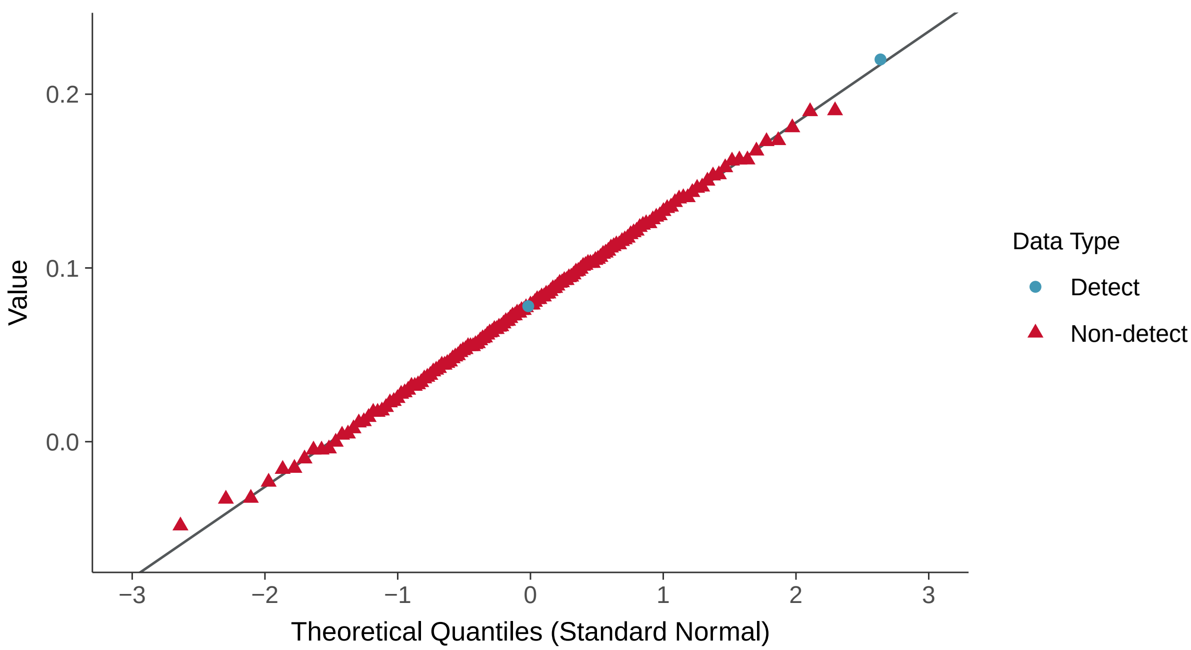



Boxplot by Season
Cadmium, Pooled Background (ug/L)
1.25
1.00
0.75
0.50
0.25
Value
Fall
(n = 49)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Non-detect
Outlier Type
Major
Minor


Boxplot by Well
Cadmium, Pooled Background (ug/L)
1.25
1.00
0.75
0.50
0.25
Value
MW−15002
(n = 22)
MW−15003
(n = 22)
MW−15004
(n = 21)
MW−15005
(n = 21)
MW−15006
(n = 21)
MW−15007
(n = 21)
MW−15008
(n = 21)
Well
Data Type
Detect
Non-detect
Outlier Type
Major
Minor

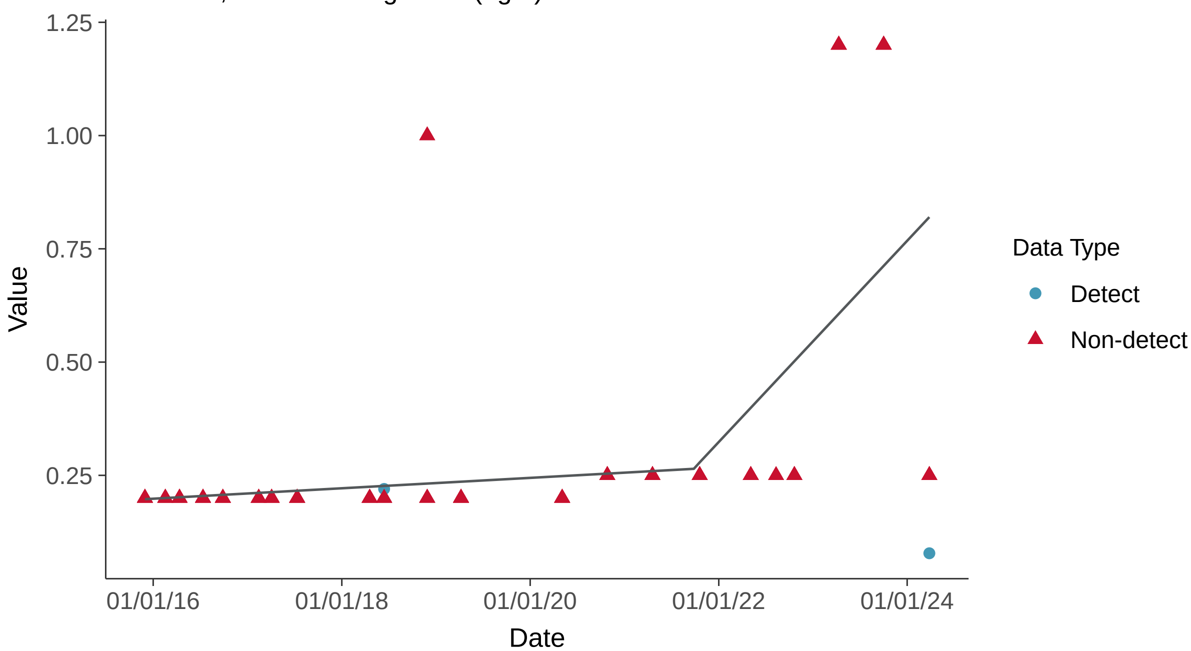
Normal Q-Q plot using ROS Imputed Estimates

Cadmium, Pooled Background (ug/L)



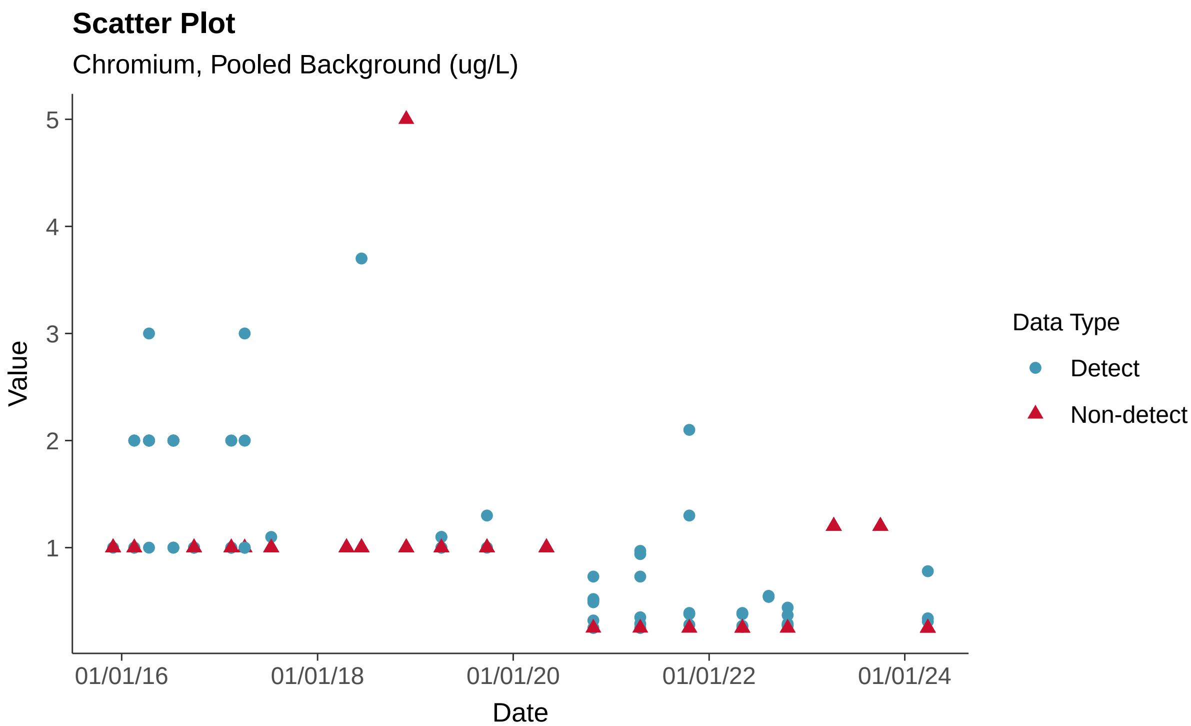
Trend Regression: Piecewise Linear-Linear

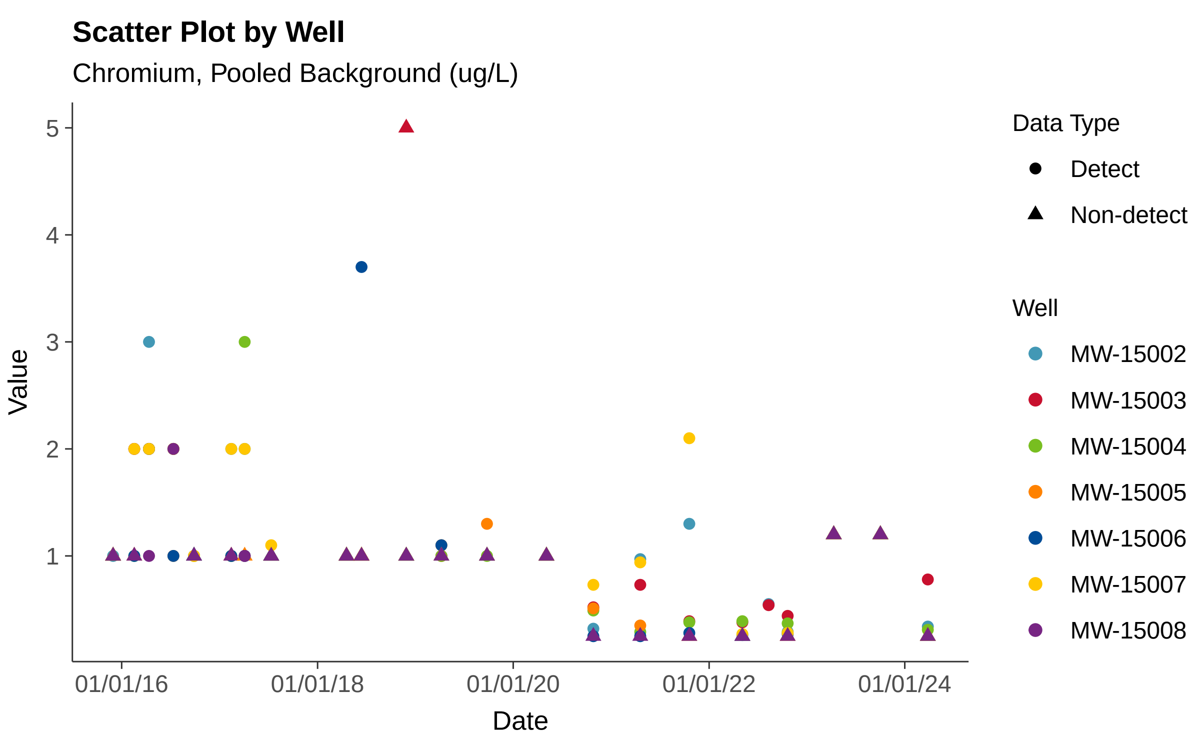
Cadmium, Pooled Background (ug/L)



Appendix IV: Chromium, Pooled Background

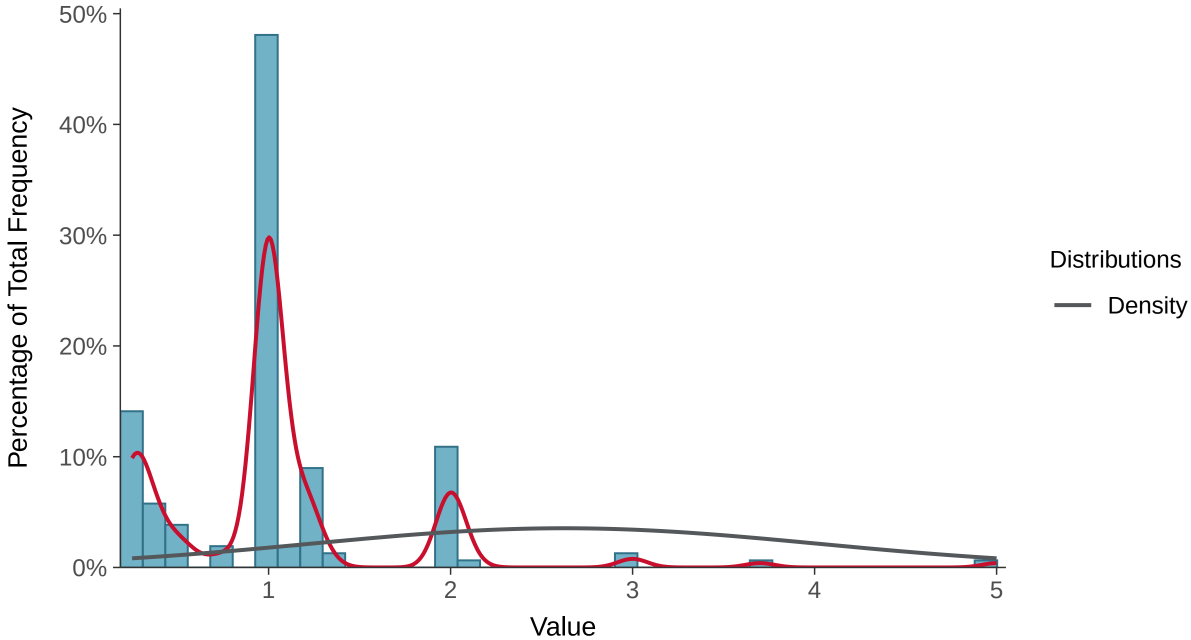
ID: 2_109





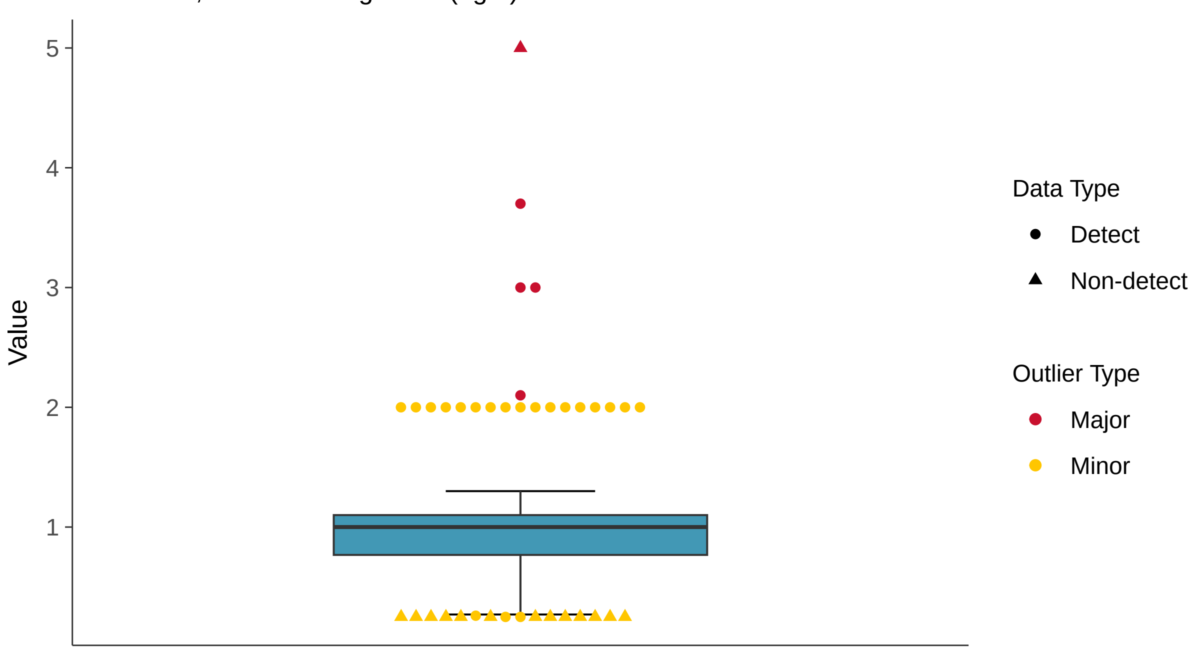
Histogram

Chromium, Pooled Background (ug/L)



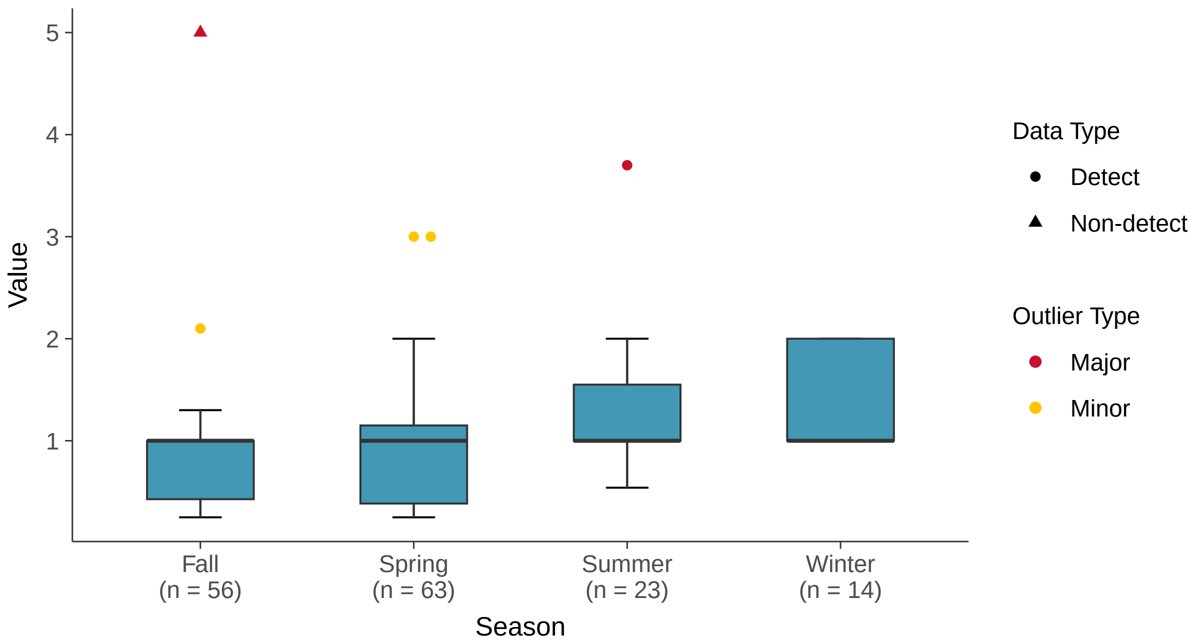
Boxplot

Chromium, Pooled Background (ug/L)



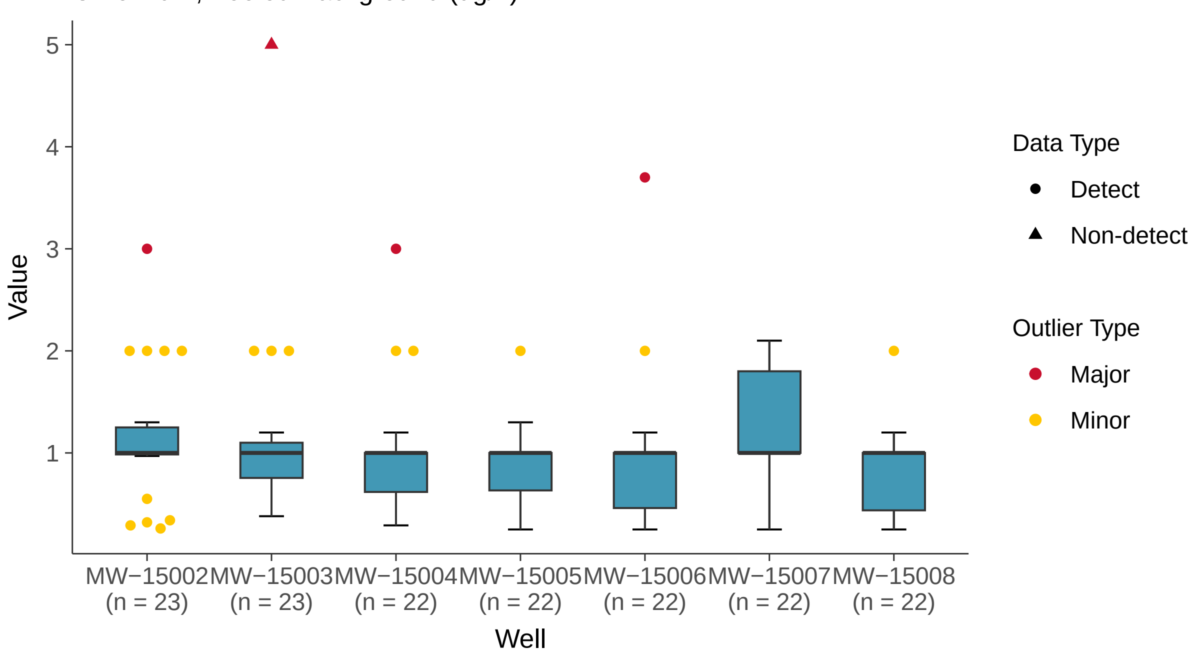
Boxplot by Season

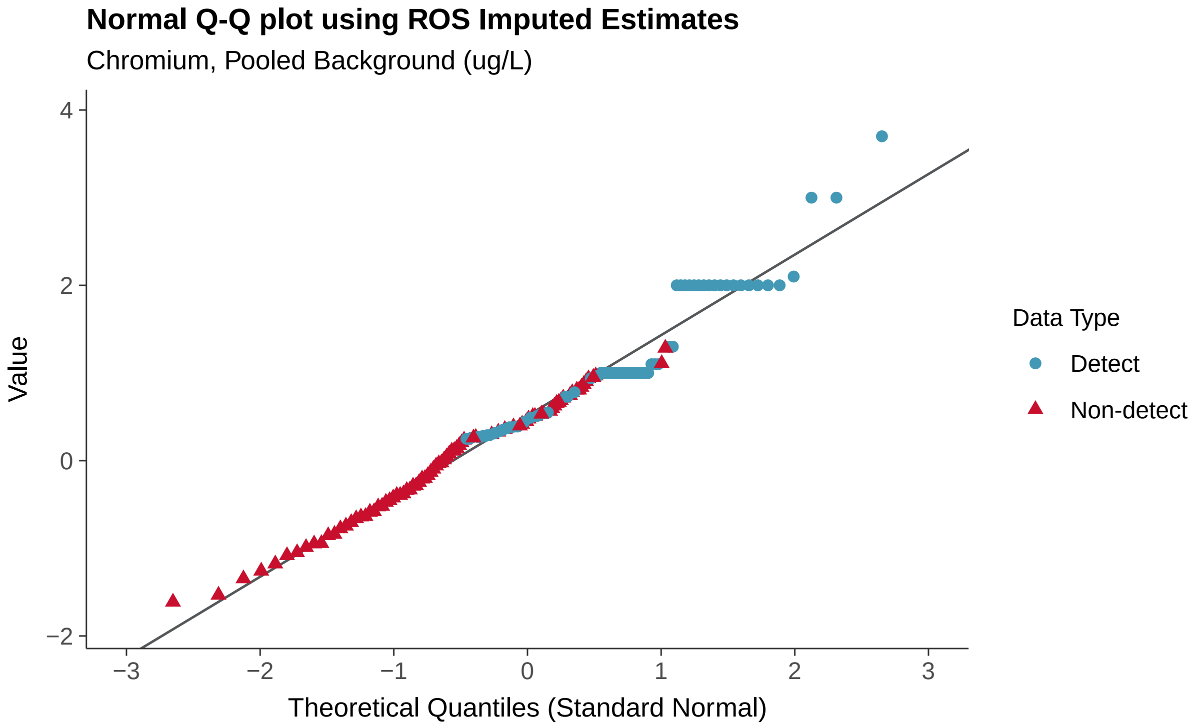
Chromium, Pooled Background (ug/L)

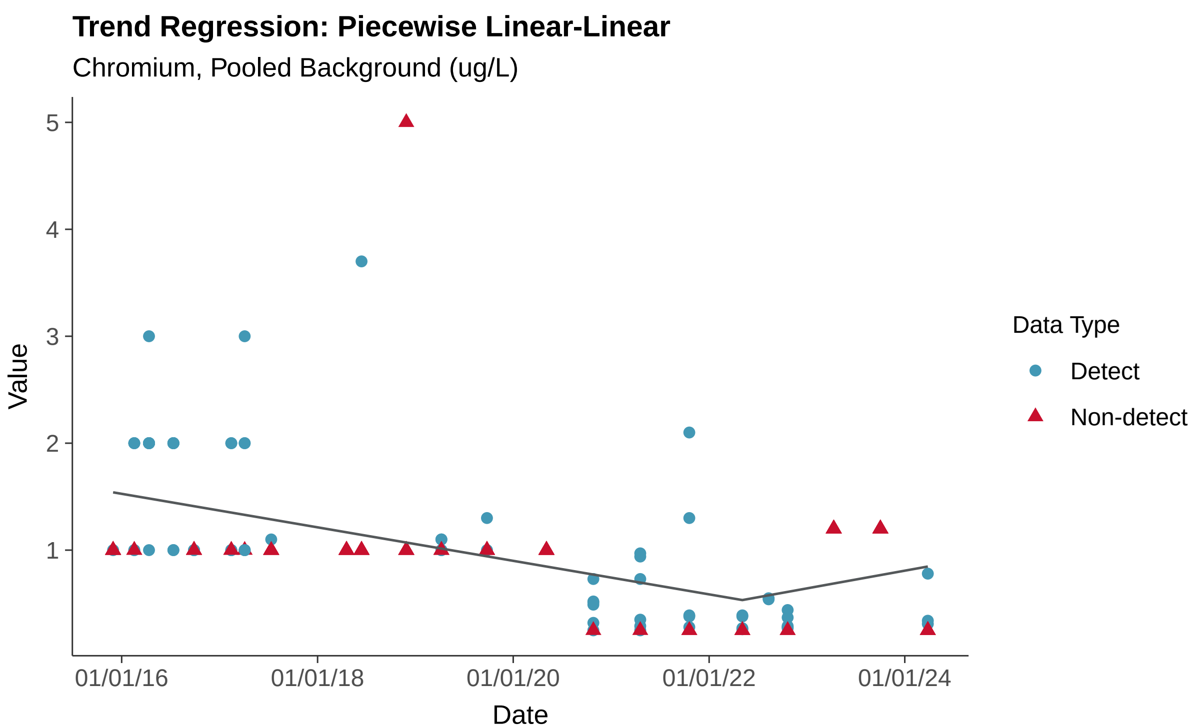


Boxplot by Well

Chromium, Pooled Background (ug/L)

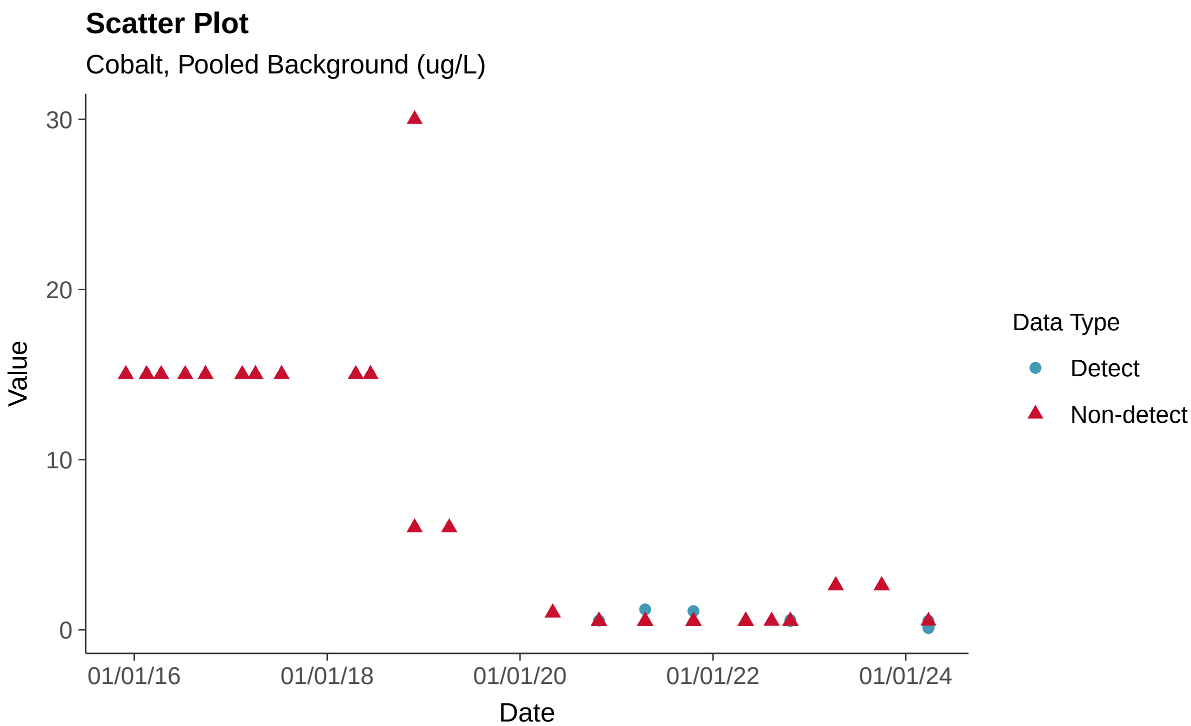


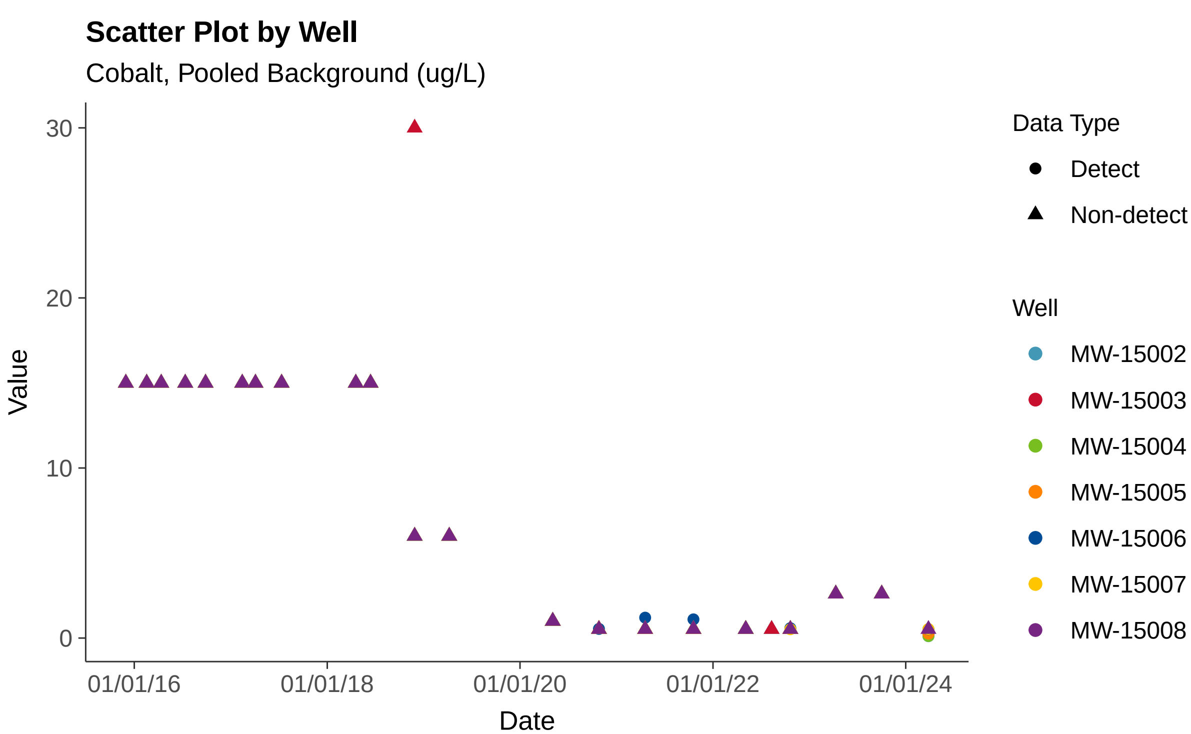

Normal Q-Q plot using ROS Imputed Estimates
Chromium, Pooled Background (ug/L)
Value
4
2
0
−2
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Chromium, Pooled Background (ug/L)
Value
5
4
3
2
1
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

Appendix IV: Cobalt, Pooled Background

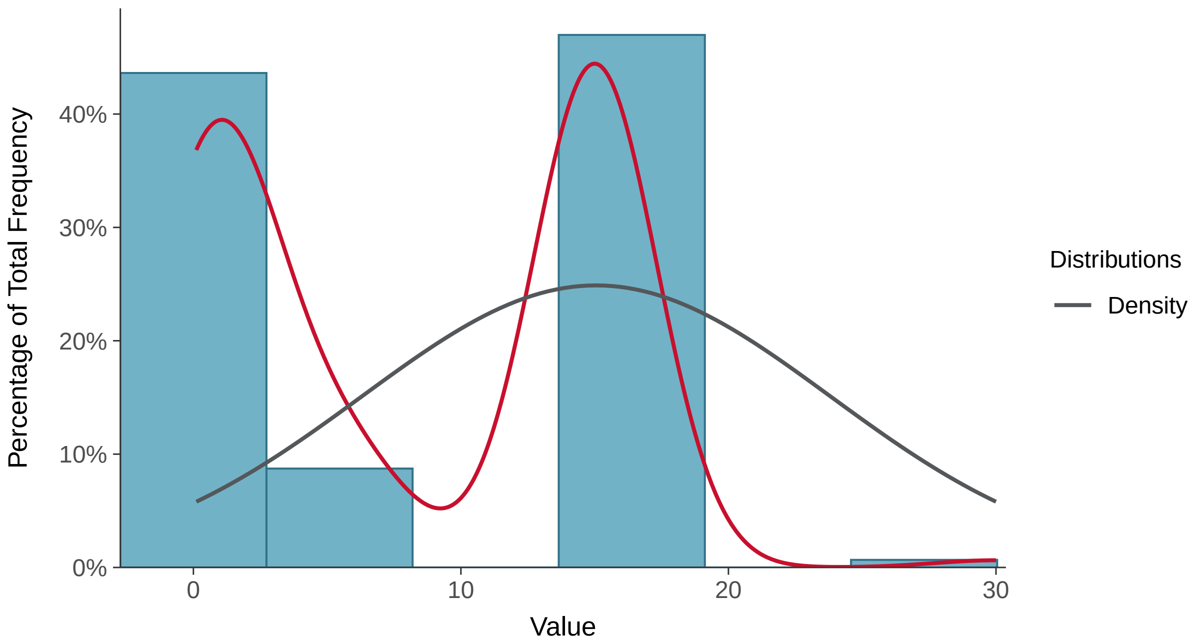
ID: 2_110





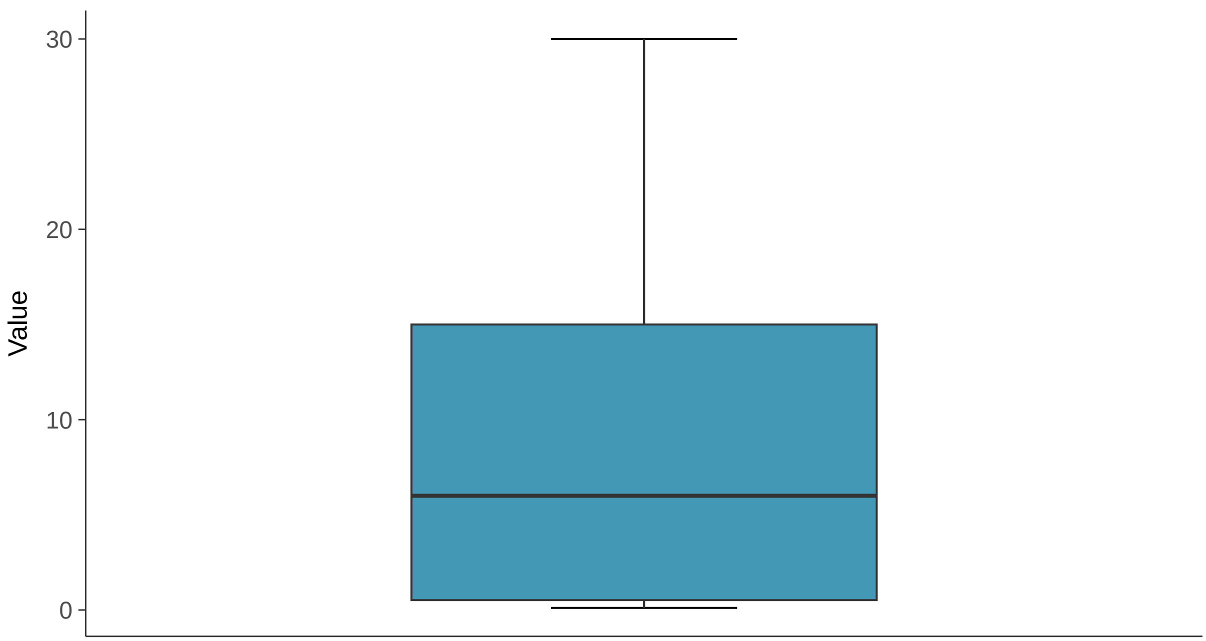
Histogram

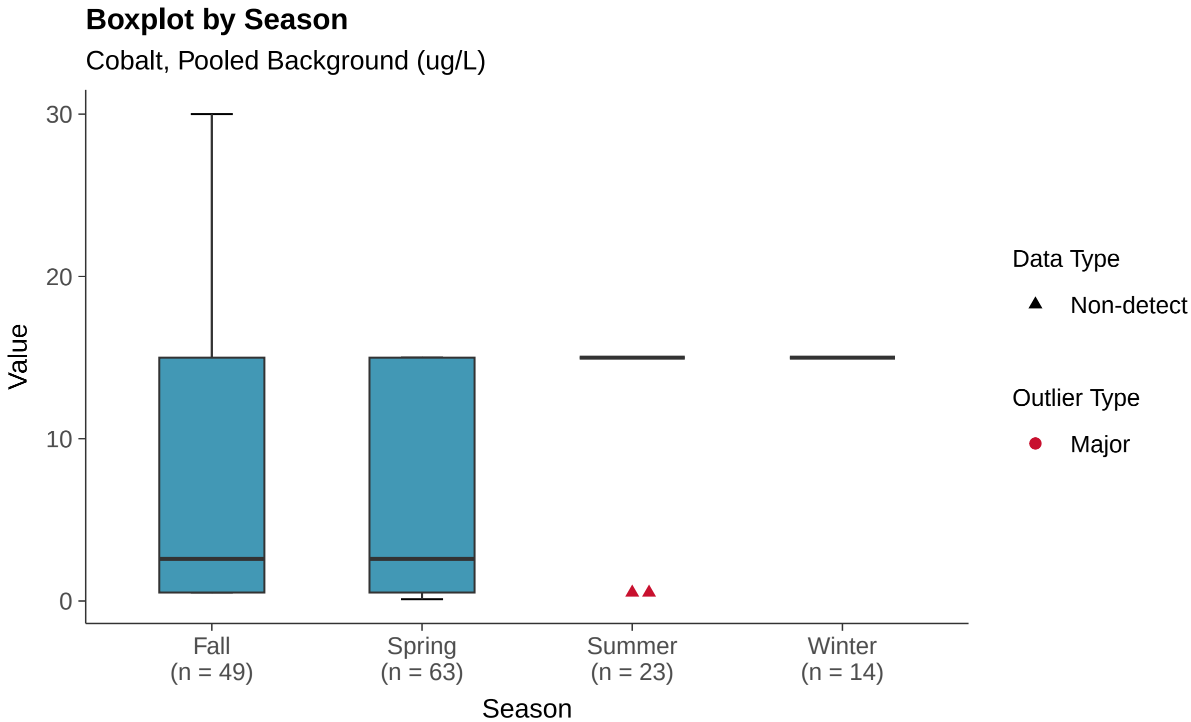
Cobalt, Pooled Background (ug/L)

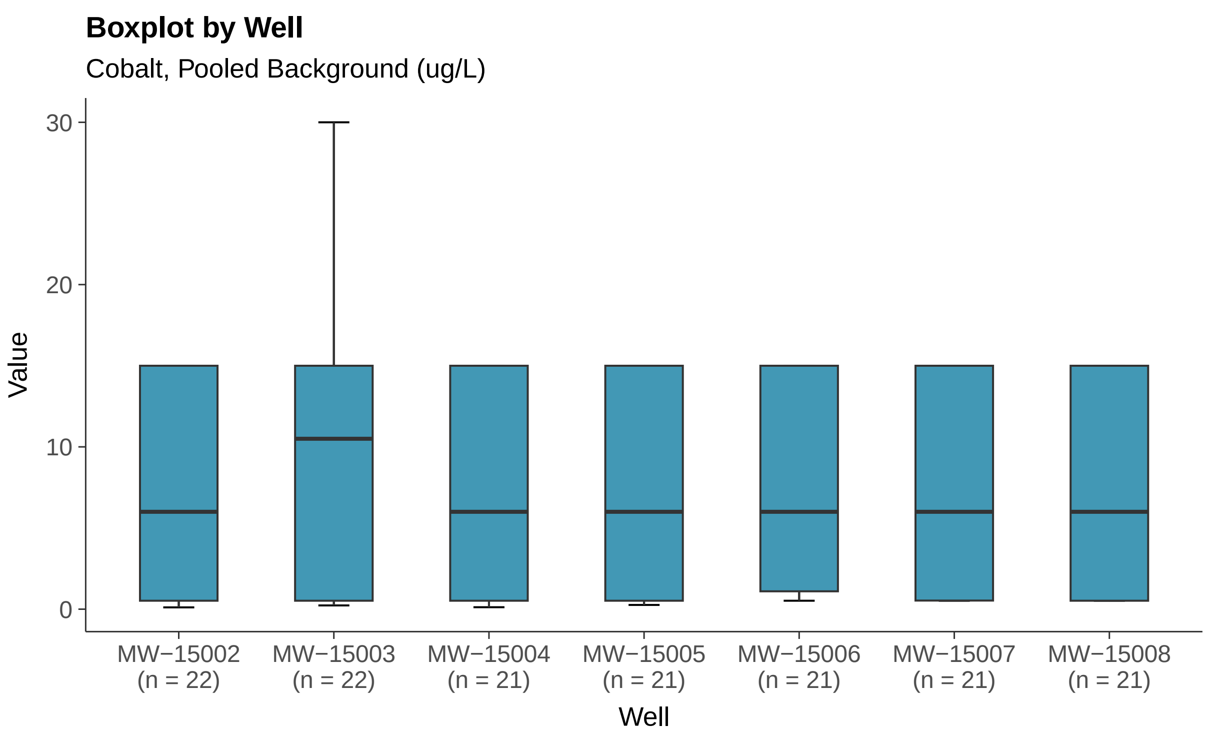


Boxplot

Cobalt, Pooled Background (ug/L)

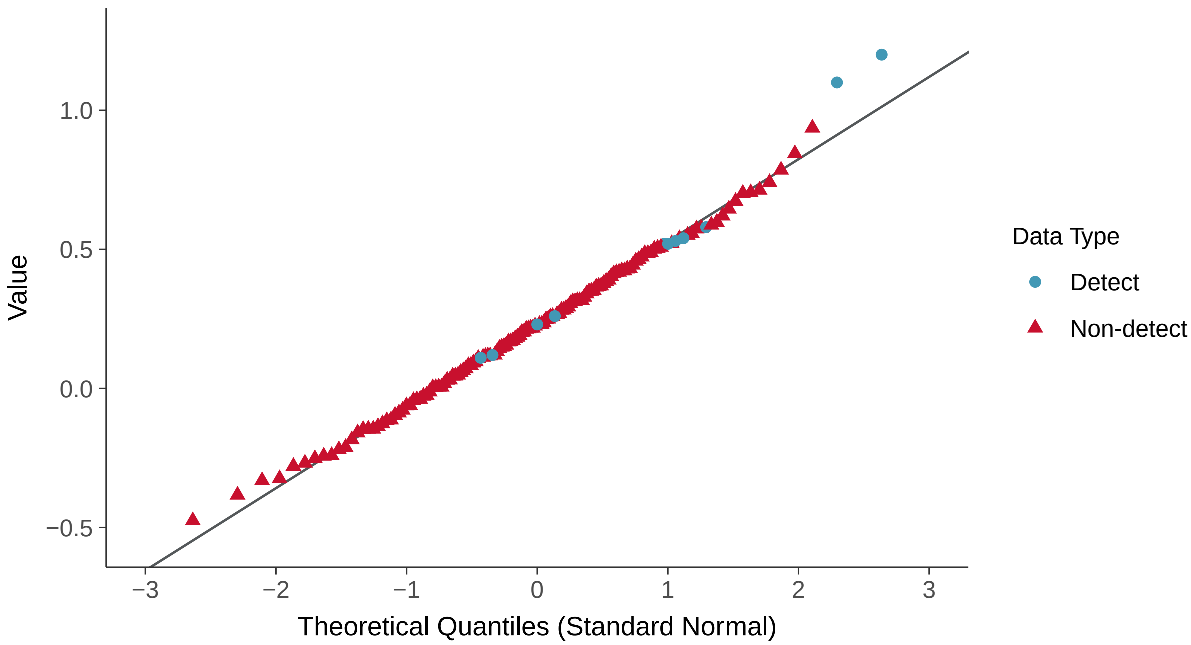



Boxplot by Season
Cobalt, Pooled Background (ug/L)
Value
30
20
10
0
Fall
(n = 49)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Non-detect
Outlier Type
Major


Boxplot by Well
Cobalt, Pooled Background (ug/L)
Value
30
20
10
0
MW−15002
(n = 22)
MW−15003
(n = 22)
MW−15004
(n = 21)
MW−15005
(n = 21)
MW−15006
(n = 21)
MW−15007
(n = 21)
MW−15008
(n = 21)
Well

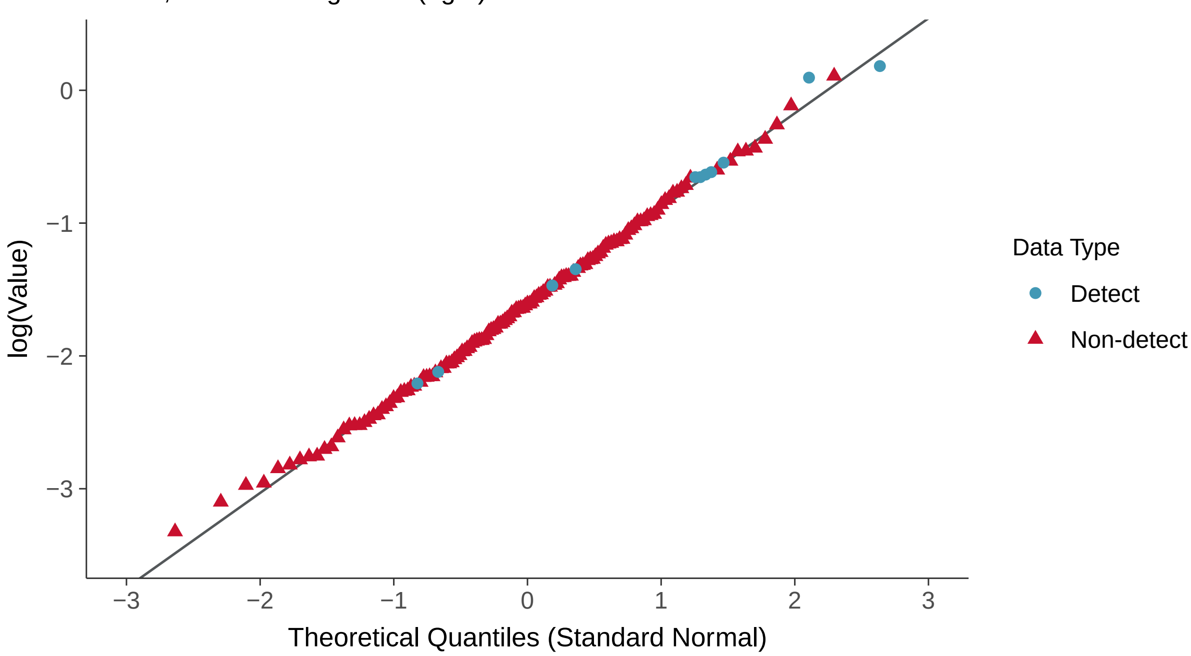
Normal Q-Q plot using ROS Imputed Estimates

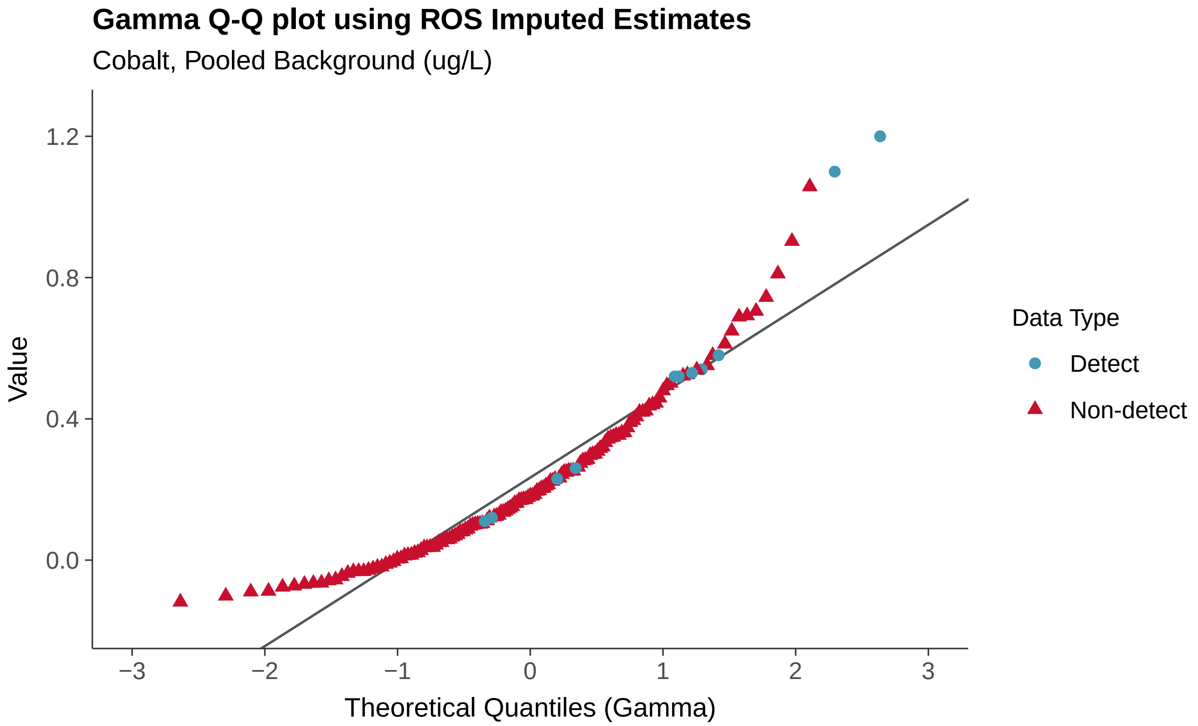
Cobalt, Pooled Background (ug/L)

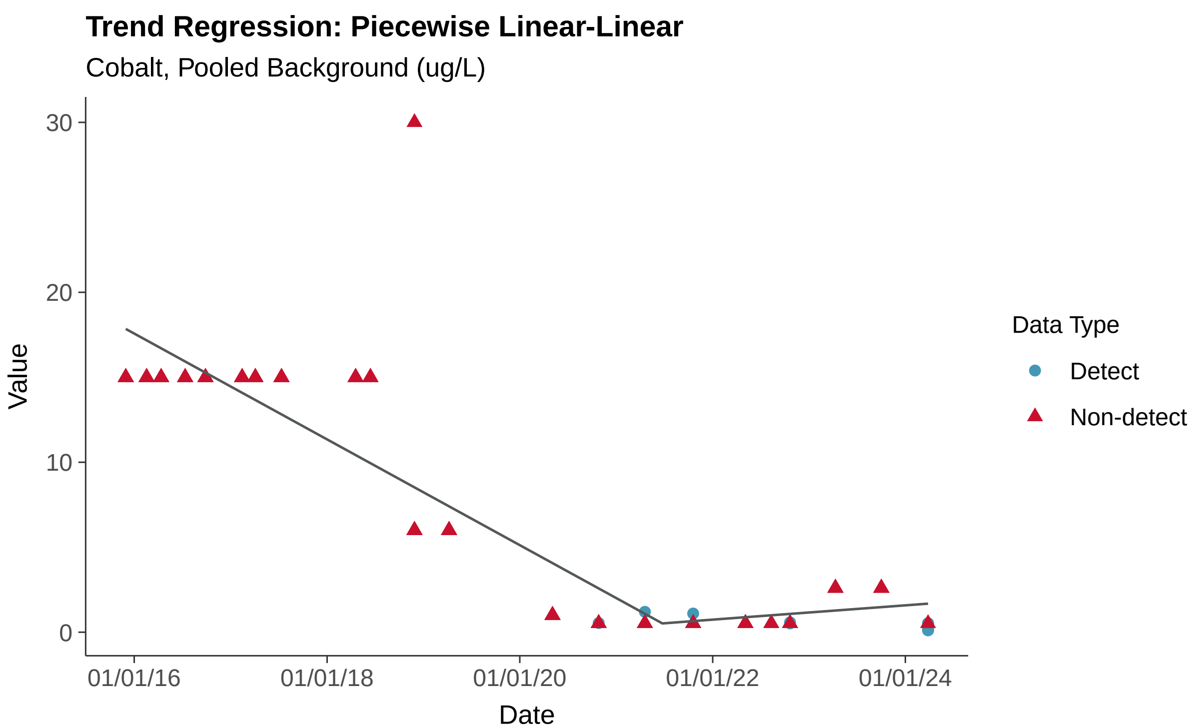


Lognormal Q-Q plot using ROS Imputed Estimates

Cobalt, Pooled Background (ug/L)

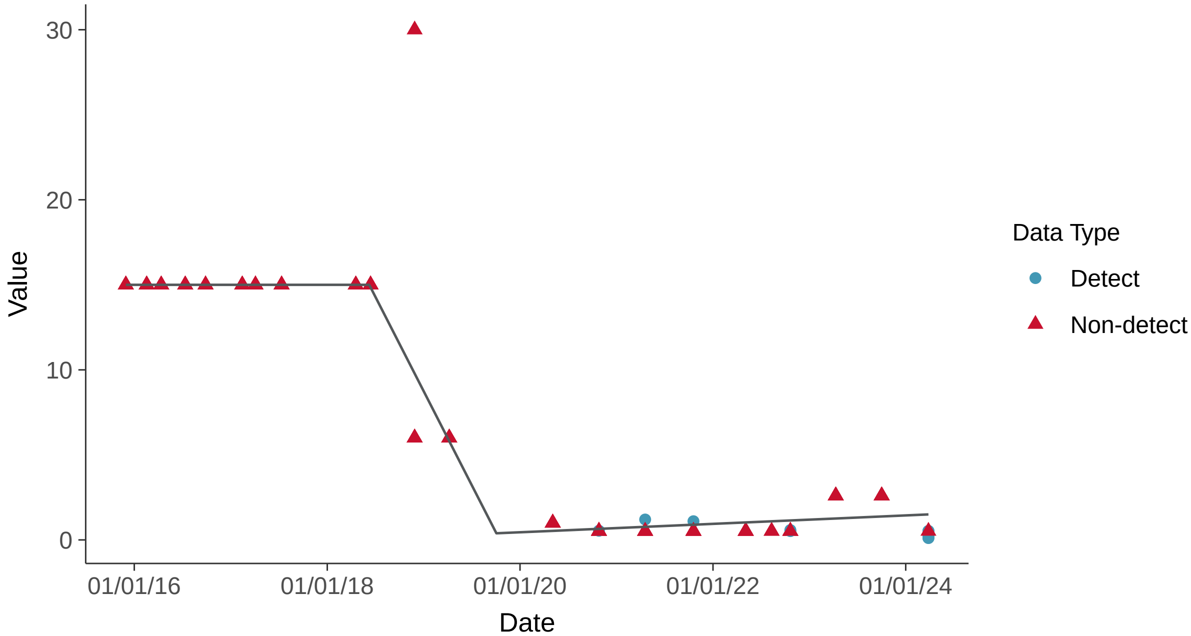



Gamma Q-Q plot using ROS Imputed Estimates
Cobalt, Pooled Background (ug/L)
Value
1.2
0.8
0.4
0.0
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Gamma)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Cobalt, Pooled Background (ug/L)
Value
30
20
10
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

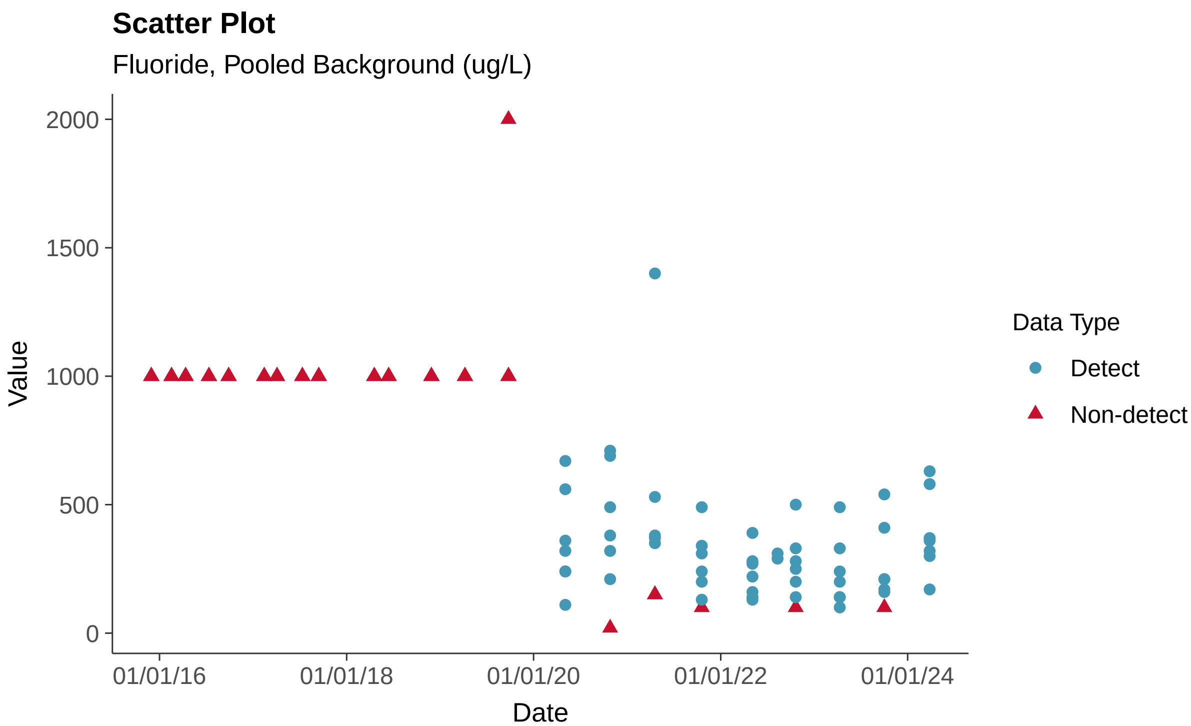
Trend Regression: Piecewise Linear-Linear-Linear

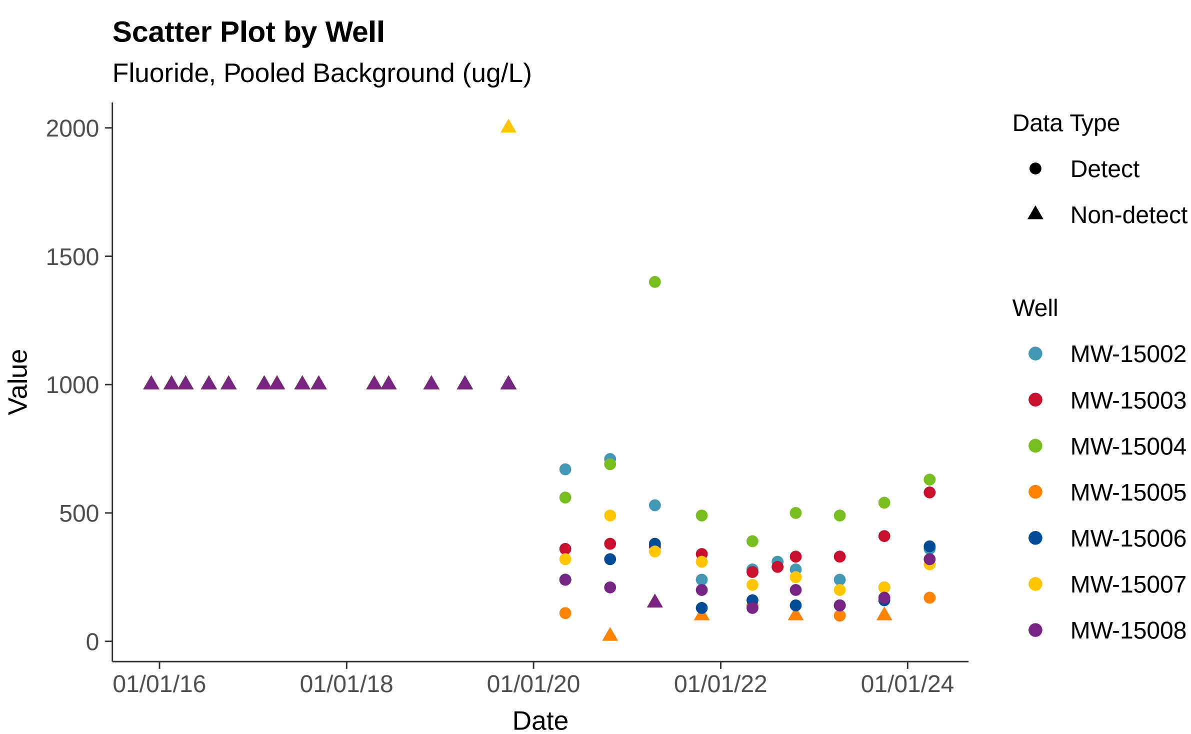
Cobalt, Pooled Background (ug/L)



Appendix IV: Fluoride, Pooled Background

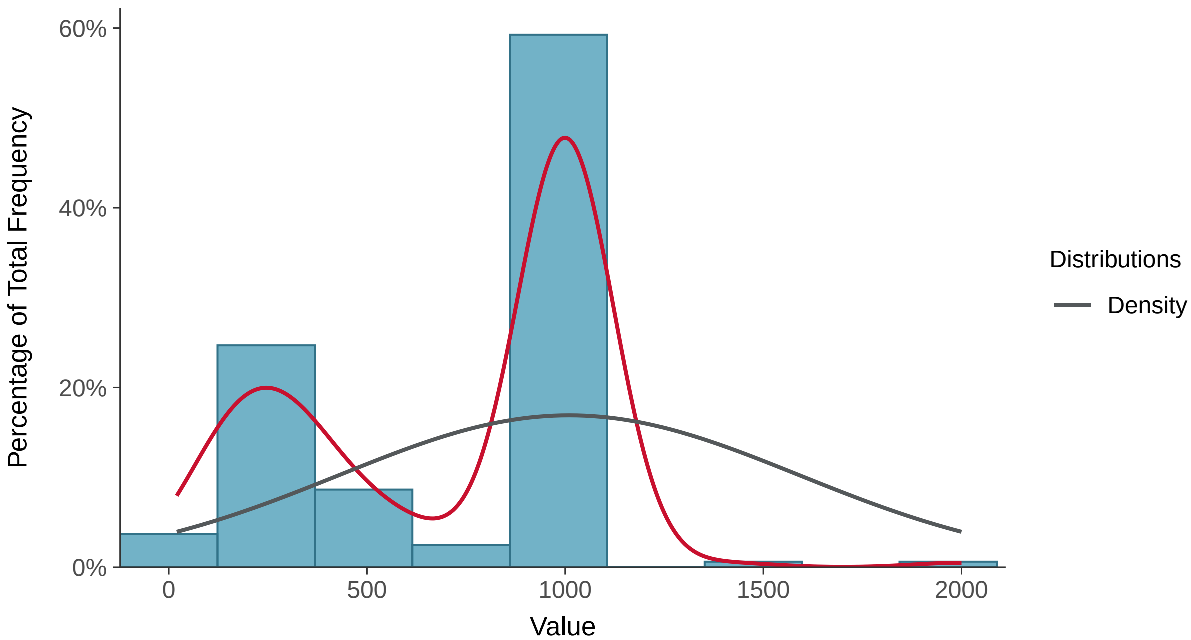
ID: 2_114





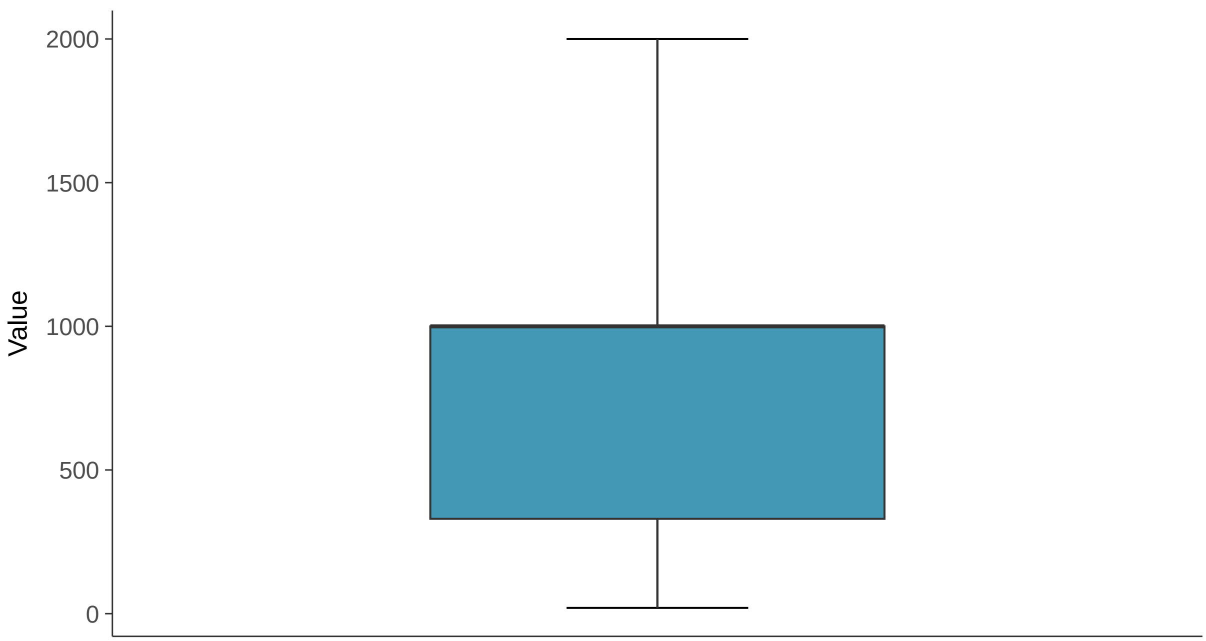
Histogram

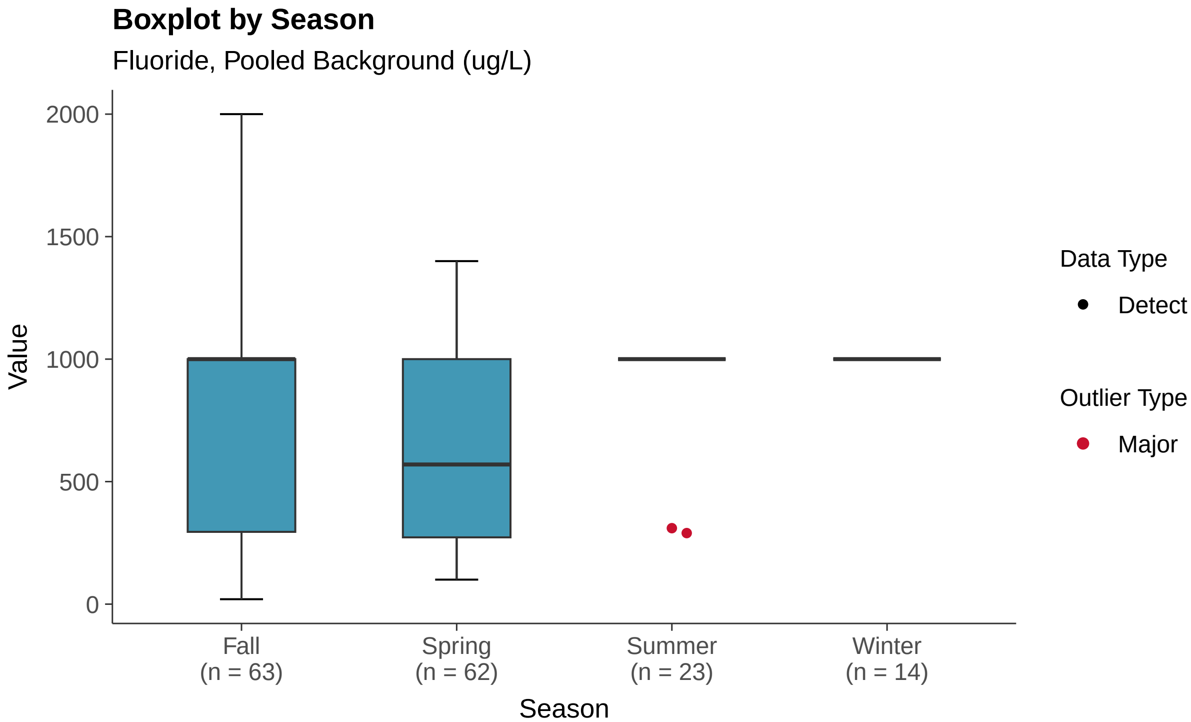
Fluoride, Pooled Background (ug/L)

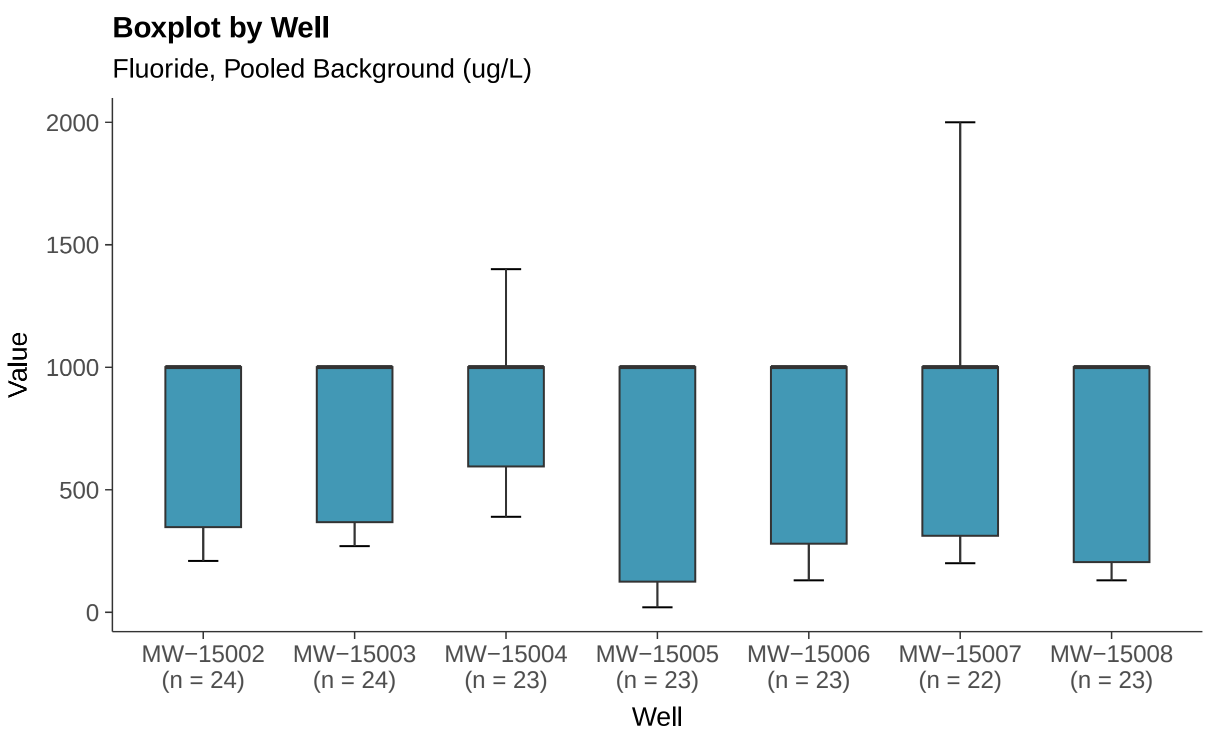


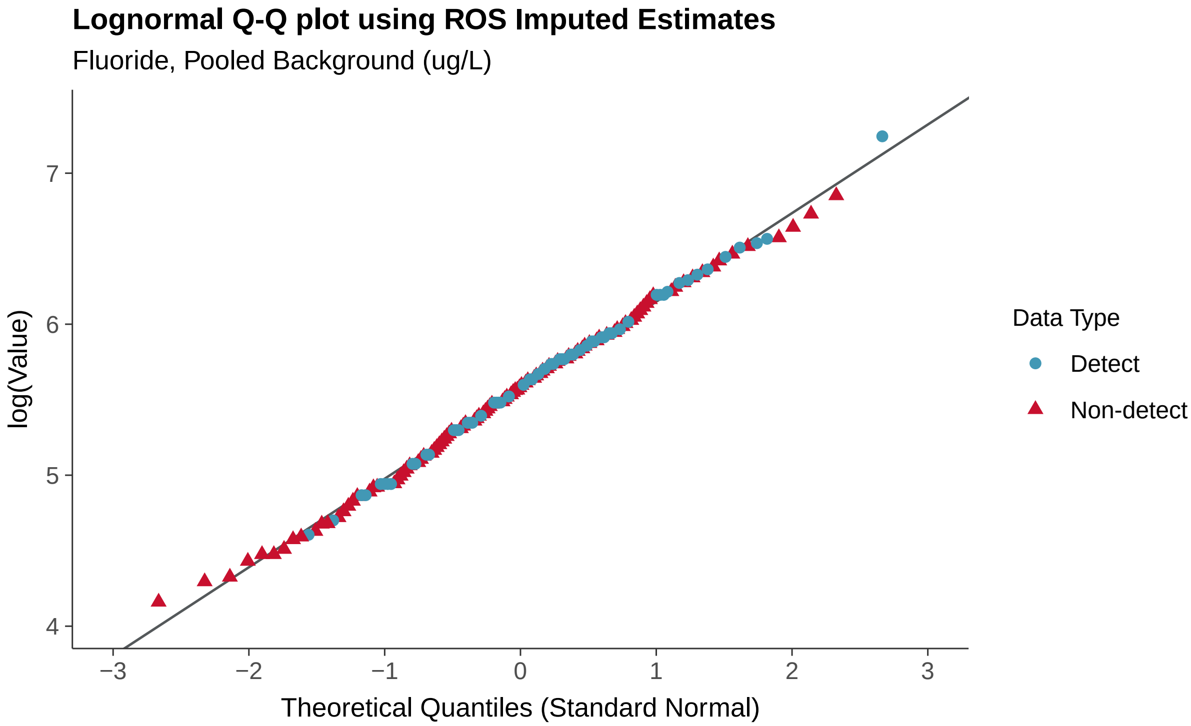
Boxplot

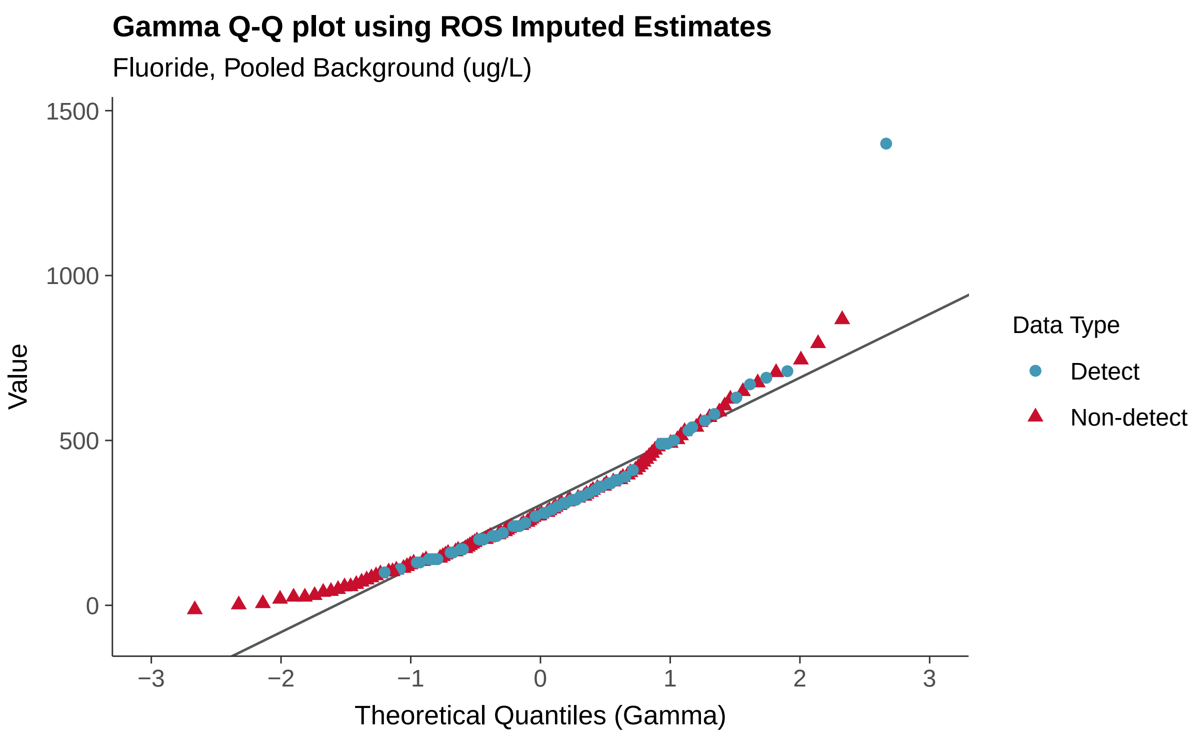
Fluoride, Pooled Background (ug/L)




Boxplot by Season
Fluoride, Pooled Background (ug/L)
Value
2000
1500
1000
500
0
Fall
(n = 63)
Spring
(n = 62)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Outlier Type
Major

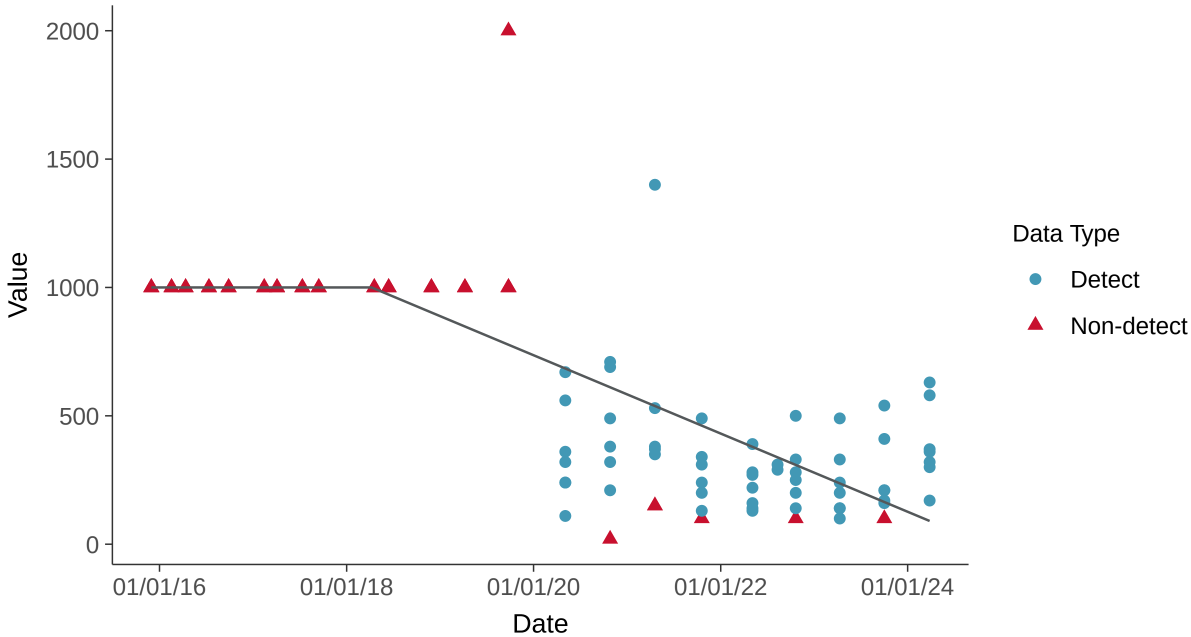

Boxplot by Well
Fluoride, Pooled Background (ug/L)
Value
2000
1500
1000
500
0
MW−15002
(n = 24)
MW−15003
(n = 24)
MW−15004
(n = 23)
MW−15005
(n = 23)
MW−15006
(n = 23)
MW−15007
(n = 22)
MW−15008
(n = 23)
Well


Lognormal Q-Q plot using ROS Imputed Estimates
Fluoride, Pooled Background (ug/L)
log(Value)
7
6
5
4
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Gamma Q-Q plot using ROS Imputed Estimates
Fluoride, Pooled Background (ug/L)
Value
1500
1000
500
0
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Gamma)
Data Type
Detect
Non-detect

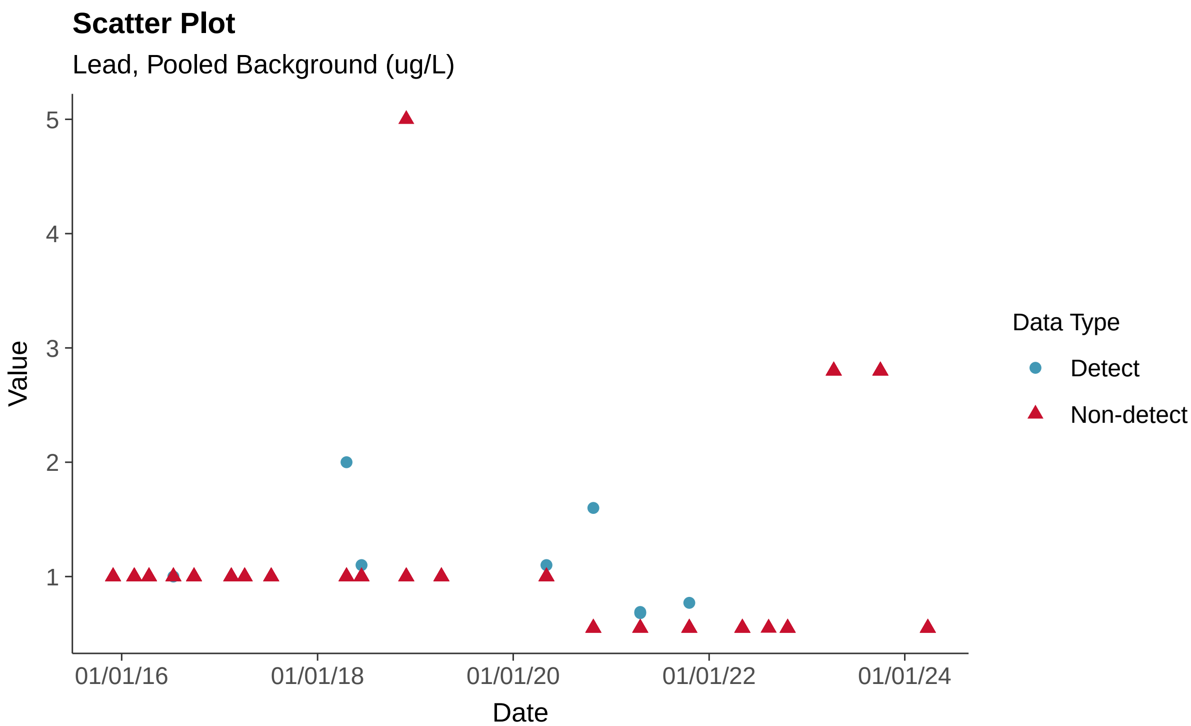
Trend Regression: Piecewise Linear-Linear

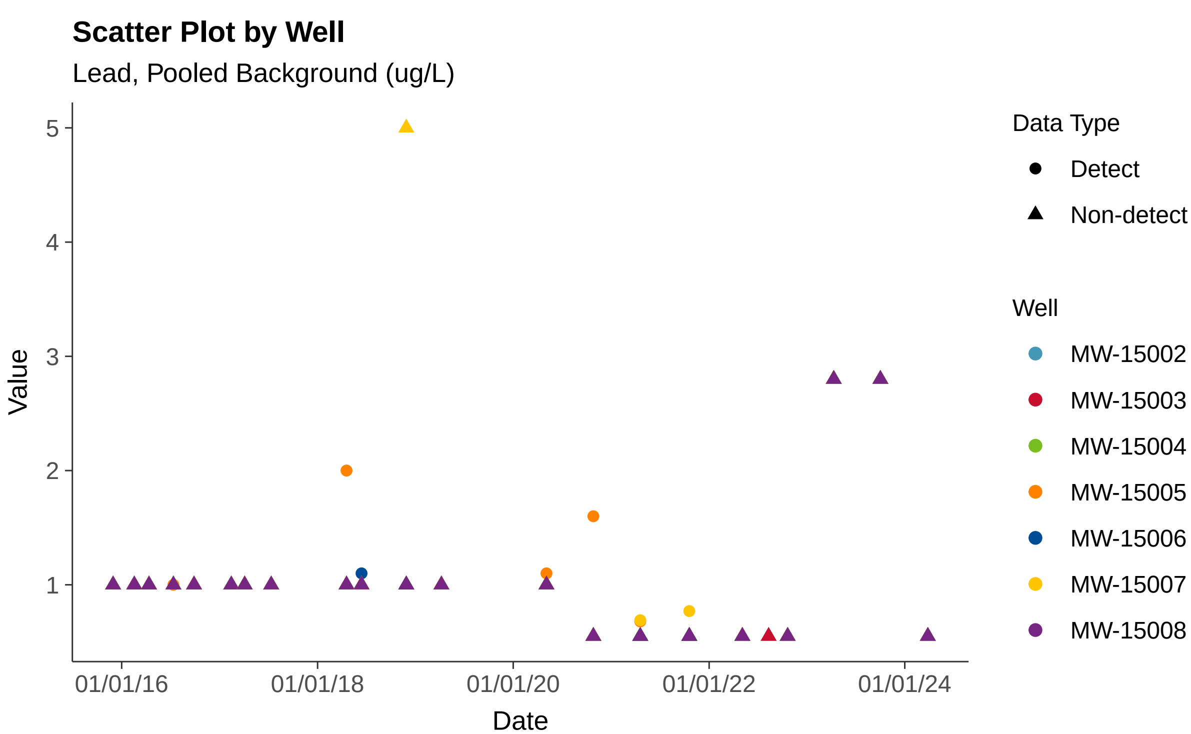
Fluoride, Pooled Background (ug/L)



Appendix IV: Lead, Pooled Background

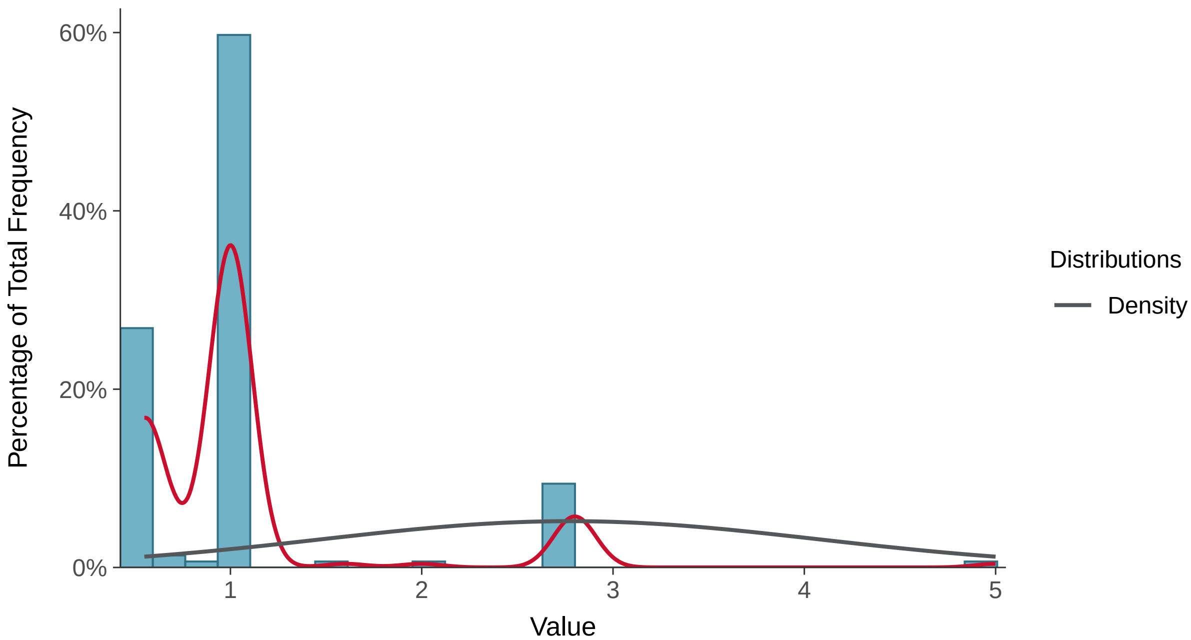
ID: 2_116





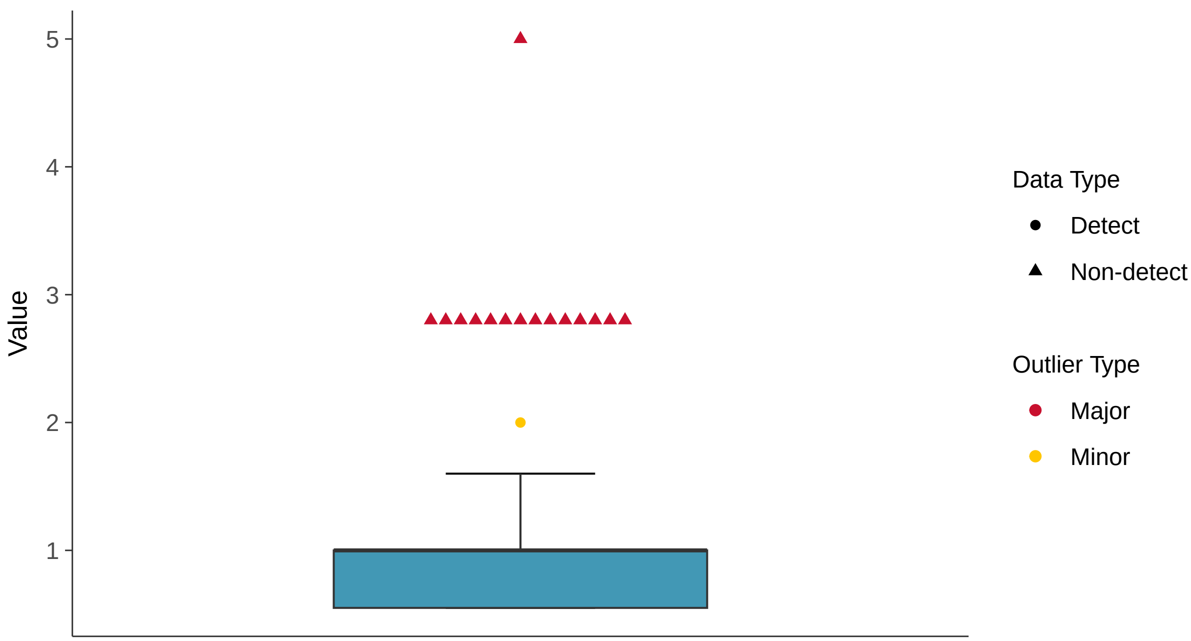
Histogram

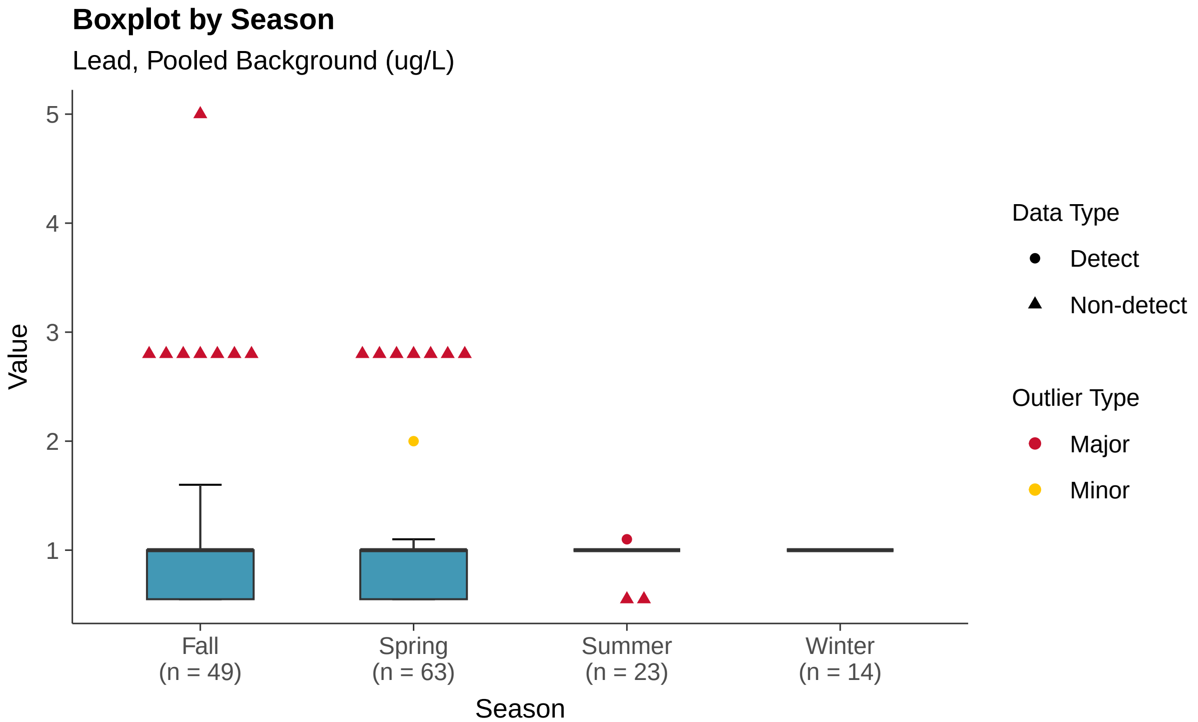
Lead, Pooled Background (ug/L)

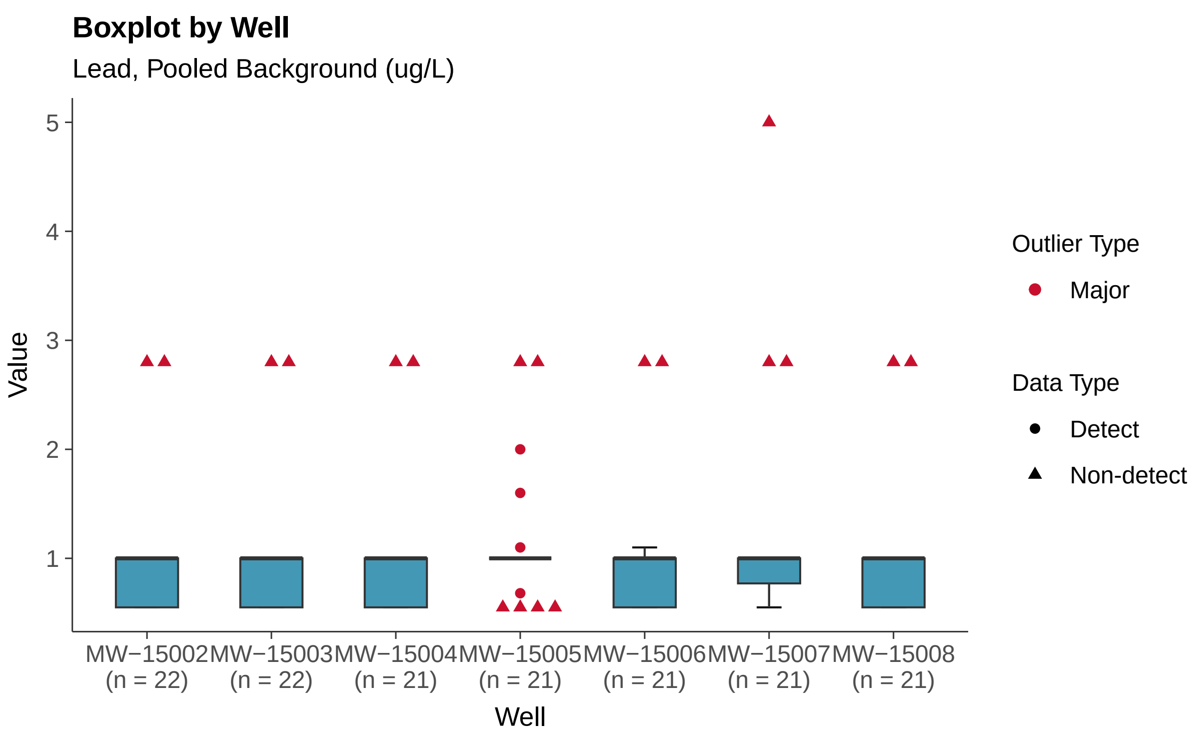


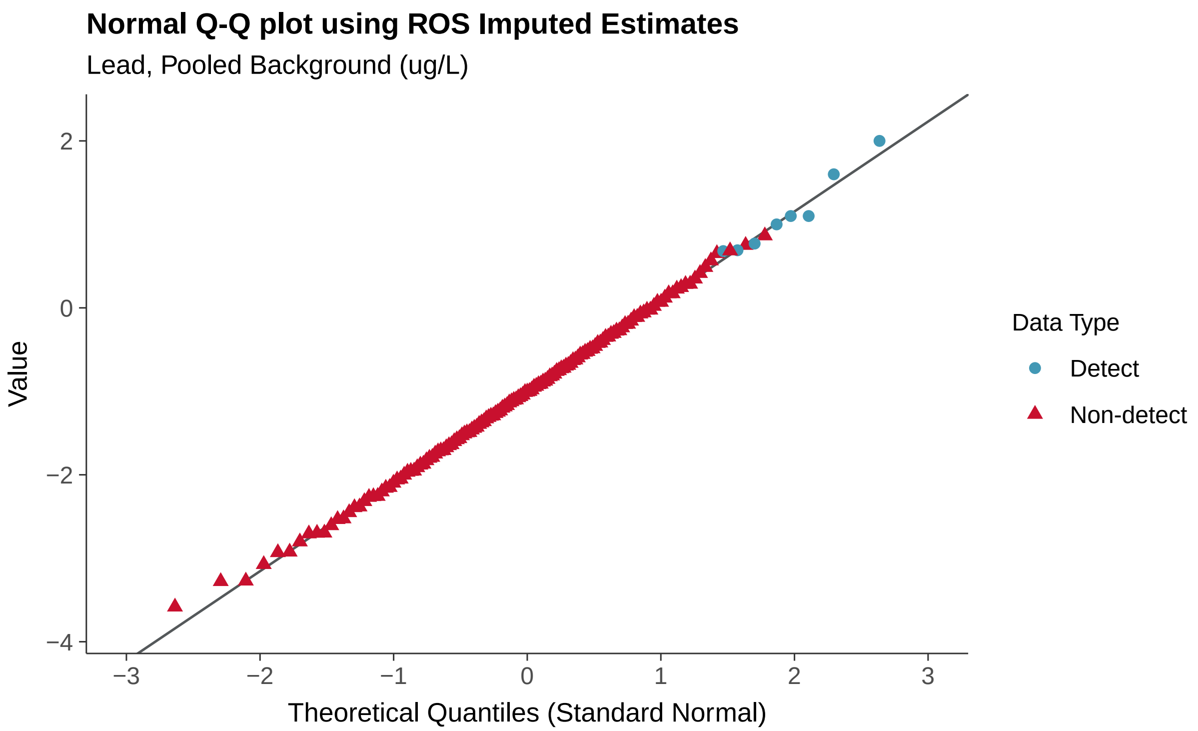
Boxplot

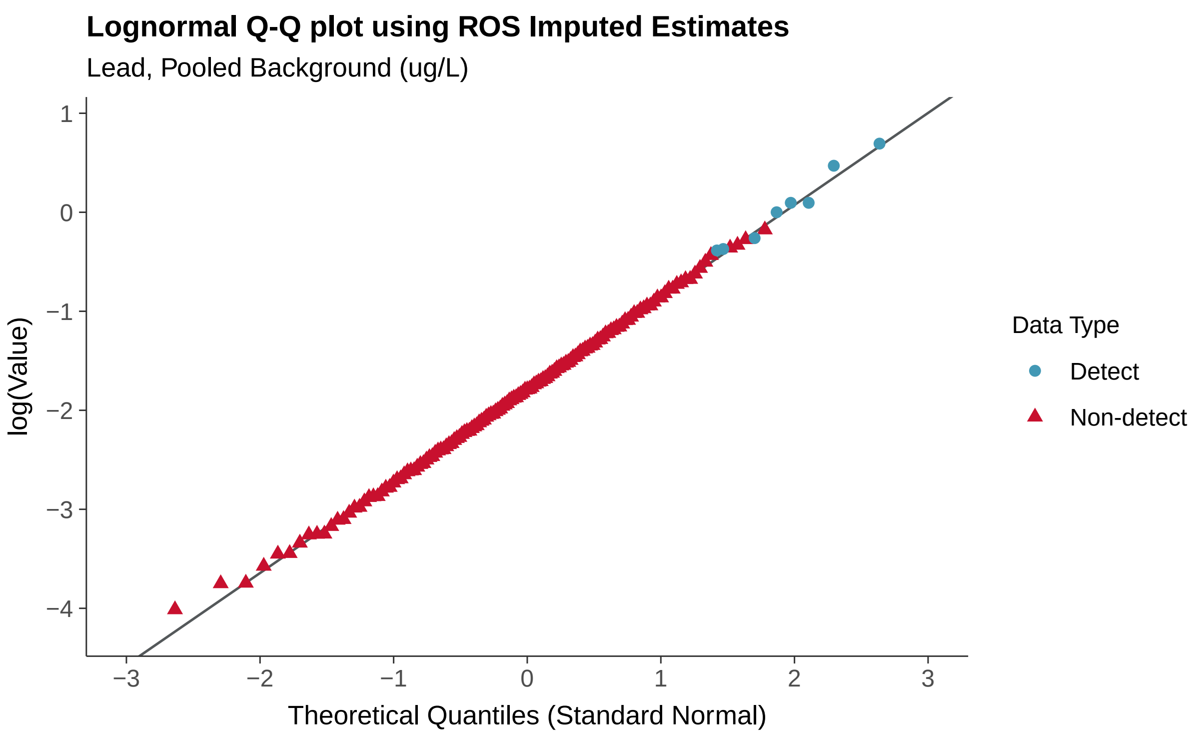
Lead, Pooled Background (ug/L)




Boxplot by Season
Lead, Pooled Background (ug/L)
Value
5
4
3
2
1
Fall
(n = 49)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Non-detect
Outlier Type
Major
Minor

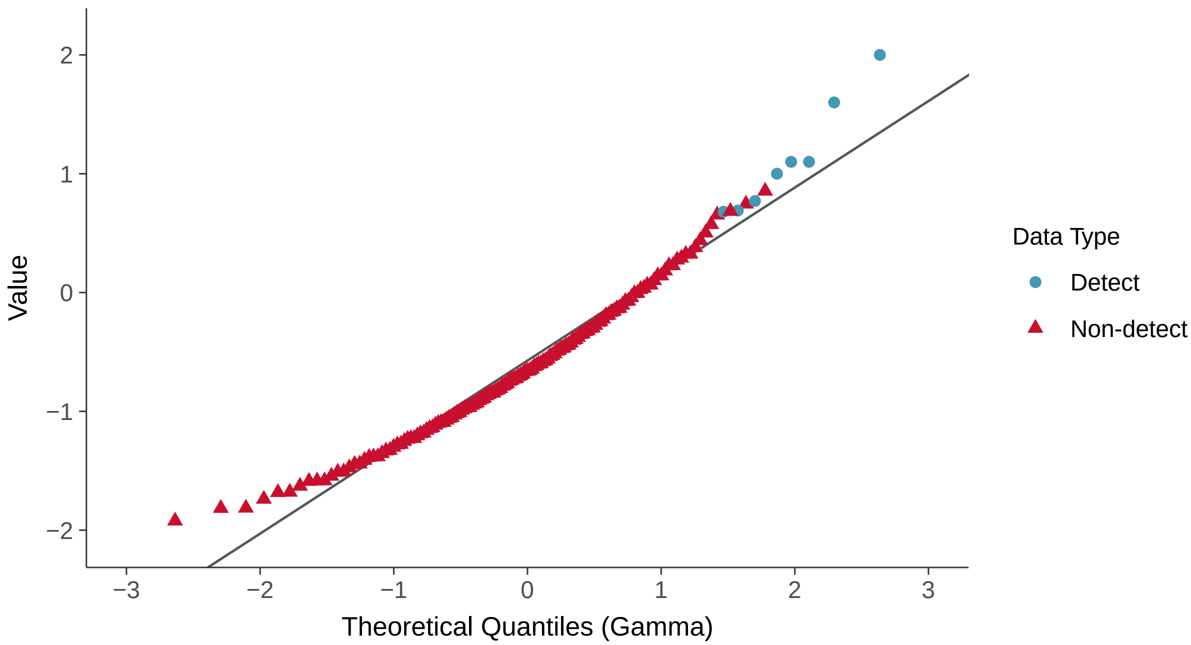

Boxplot by Well
Lead, Pooled Background (ug/L)
Value
5
4
3
2
1
MW−15002
(n = 22)
MW−15003
(n = 22)
MW−15004
(n = 21)
MW−15005
(n = 21)
MW−15006
(n = 21)
MW−15007
(n = 21)
MW−15008
(n = 21)
Well
Outlier Type
Major
Data Type
Detect
Non-detect


Normal Q-Q plot using ROS Imputed Estimates
Lead, Pooled Background (ug/L)
Value
2
0
−2
−4
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Lognormal Q-Q plot using ROS Imputed Estimates
Lead, Pooled Background (ug/L)
log(Value)
1
0
−1
−2
−3
−4
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect

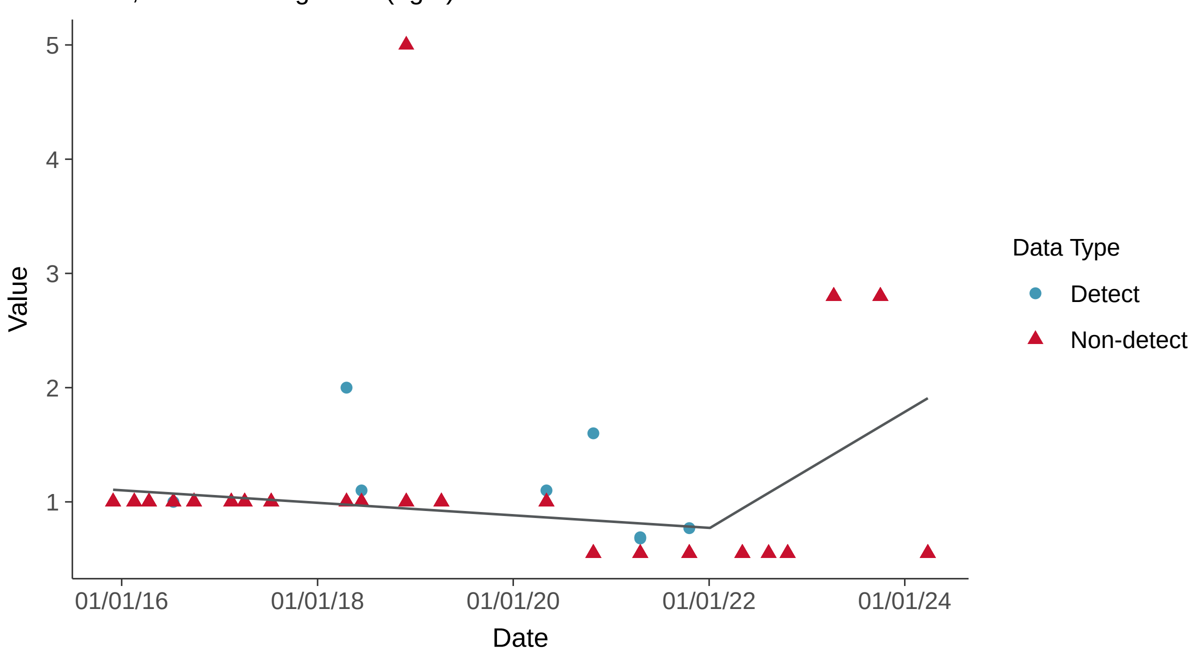
Gamma Q-Q plot using ROS Imputed Estimates

Lead, Pooled Background (ug/L)



Trend Regression: Piecewise Linear-Linear

Lead, Pooled Background (ug/L)

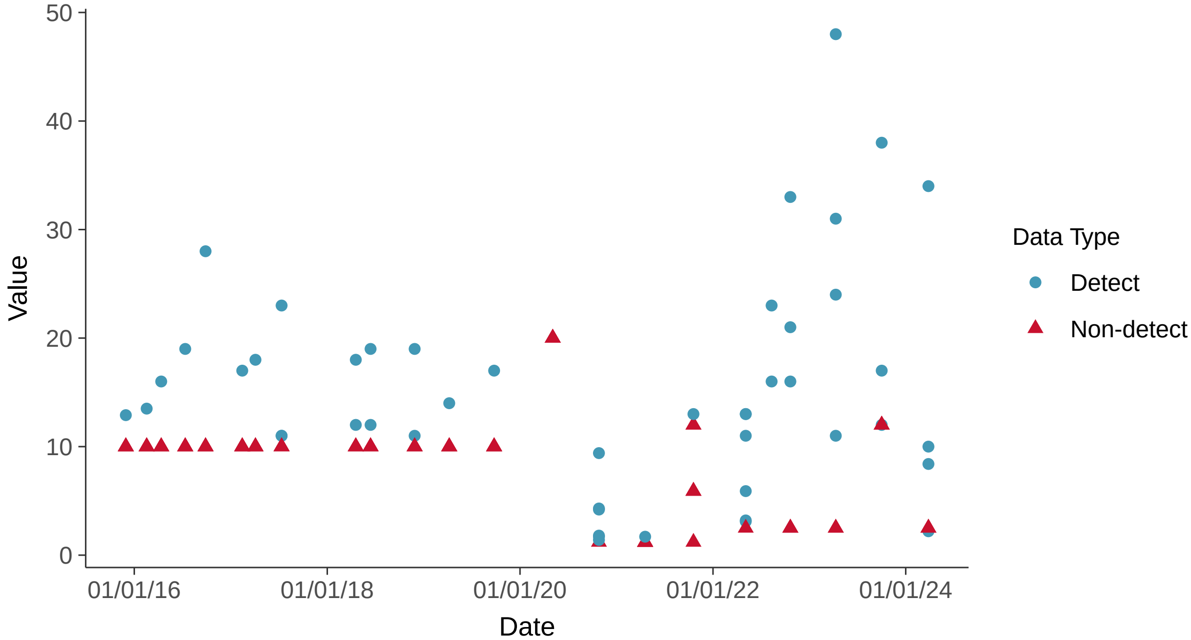


Appendix IV: Lithium, Pooled Background

ID: 2_117

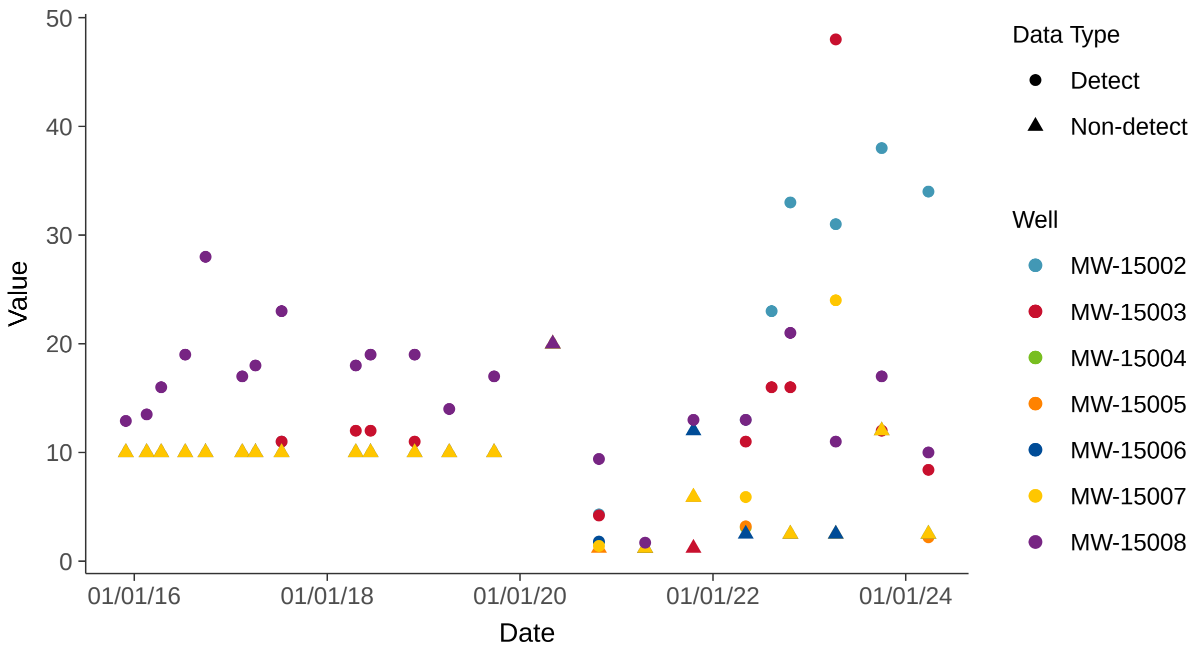
Scatter Plot

Lithium, Pooled Background (ug/L)



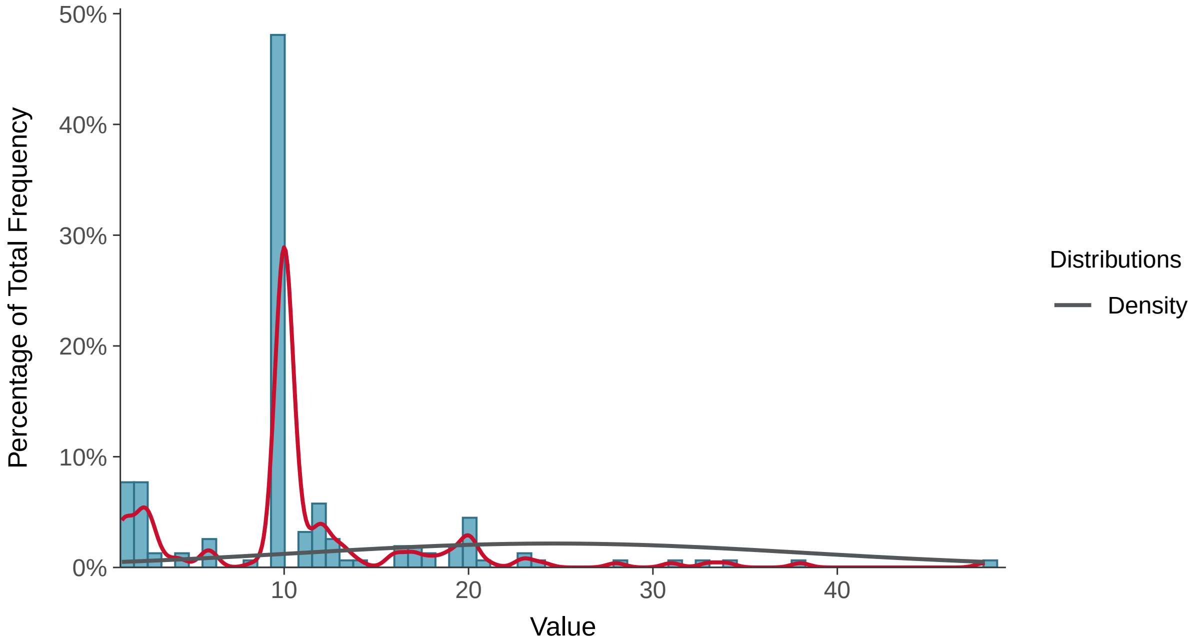
Scatter Plot by Well

Lithium, Pooled Background (ug/L)



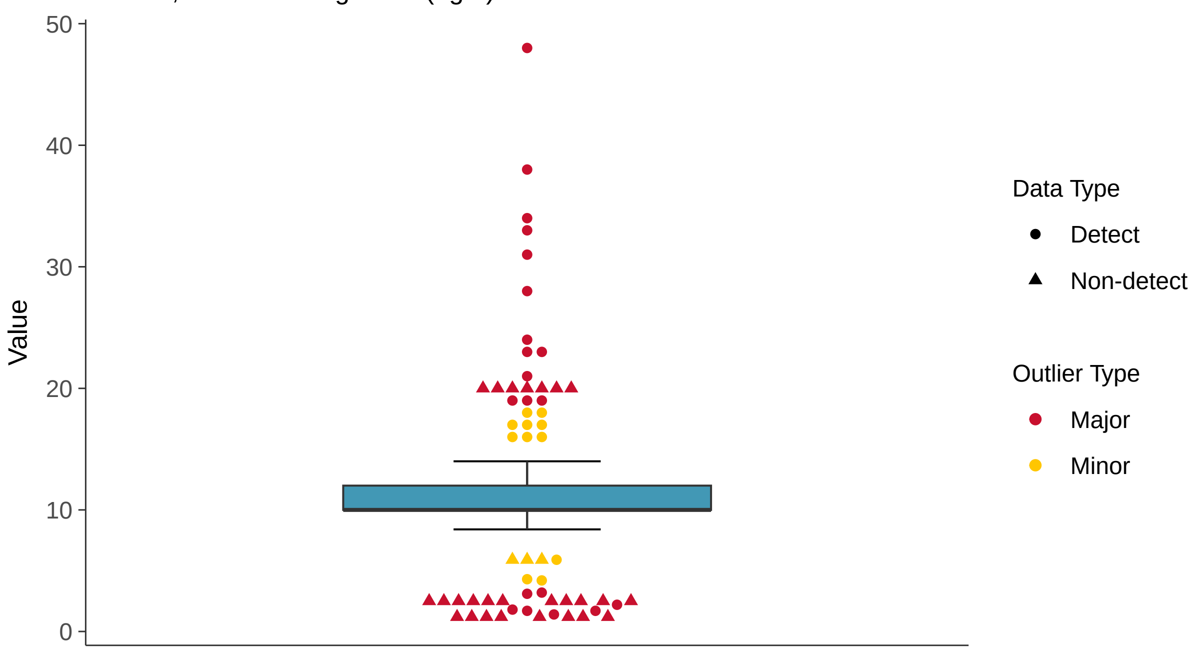
Histogram

Lithium, Pooled Background (ug/L)



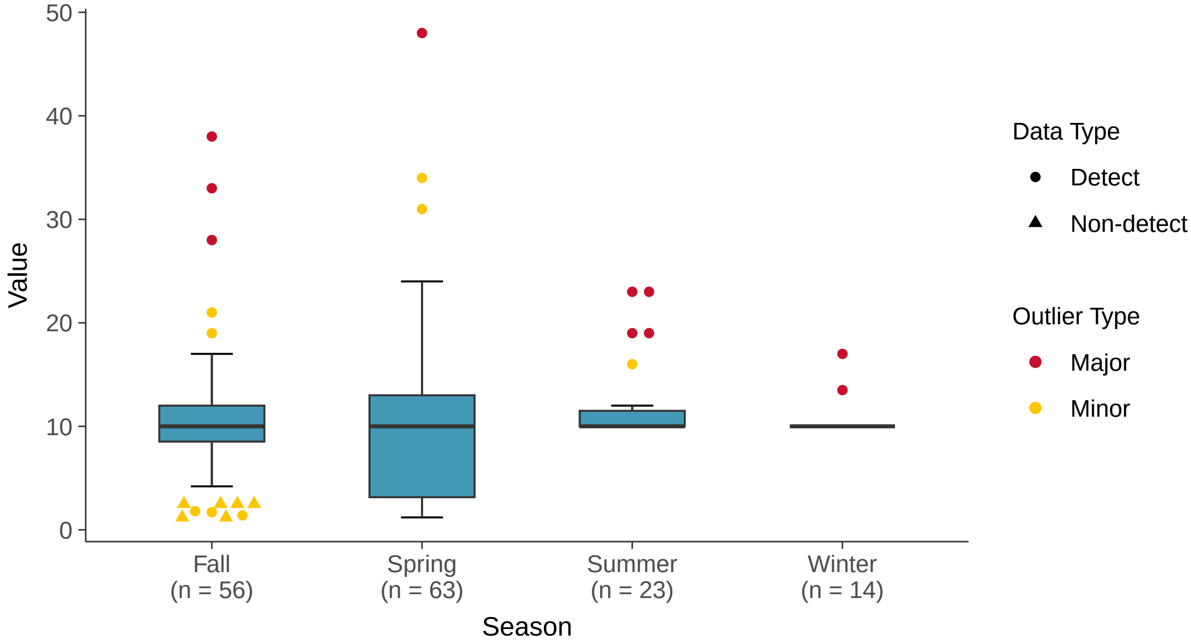
Boxplot

Lithium, Pooled Background (ug/L)



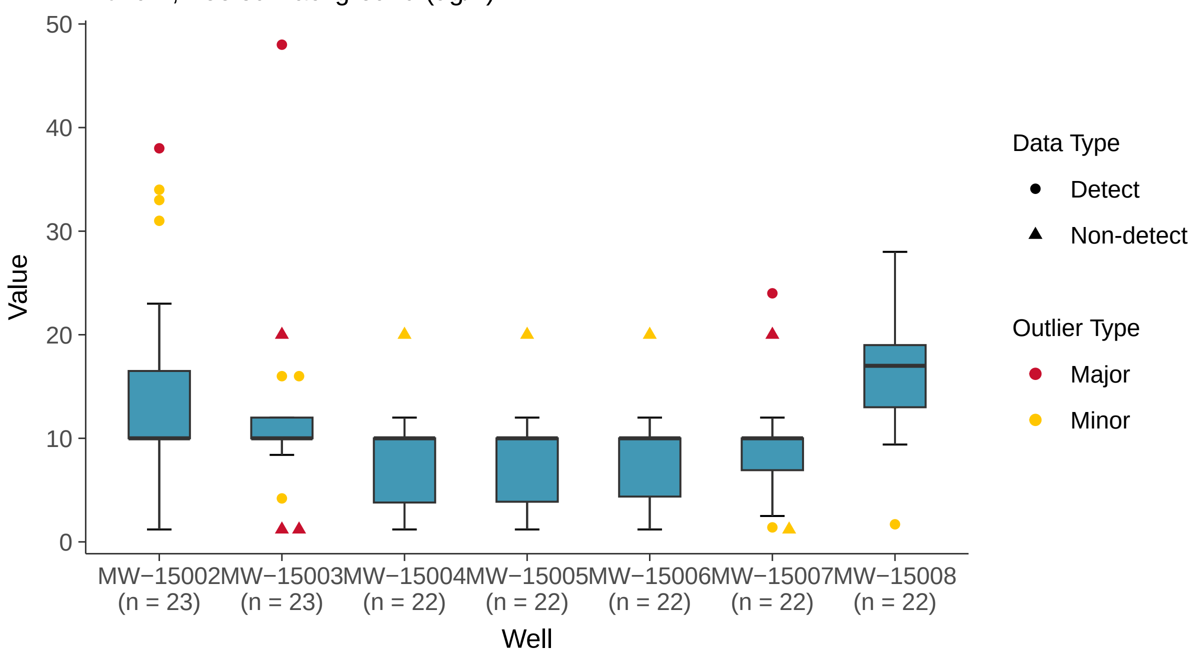
Boxplot by Season

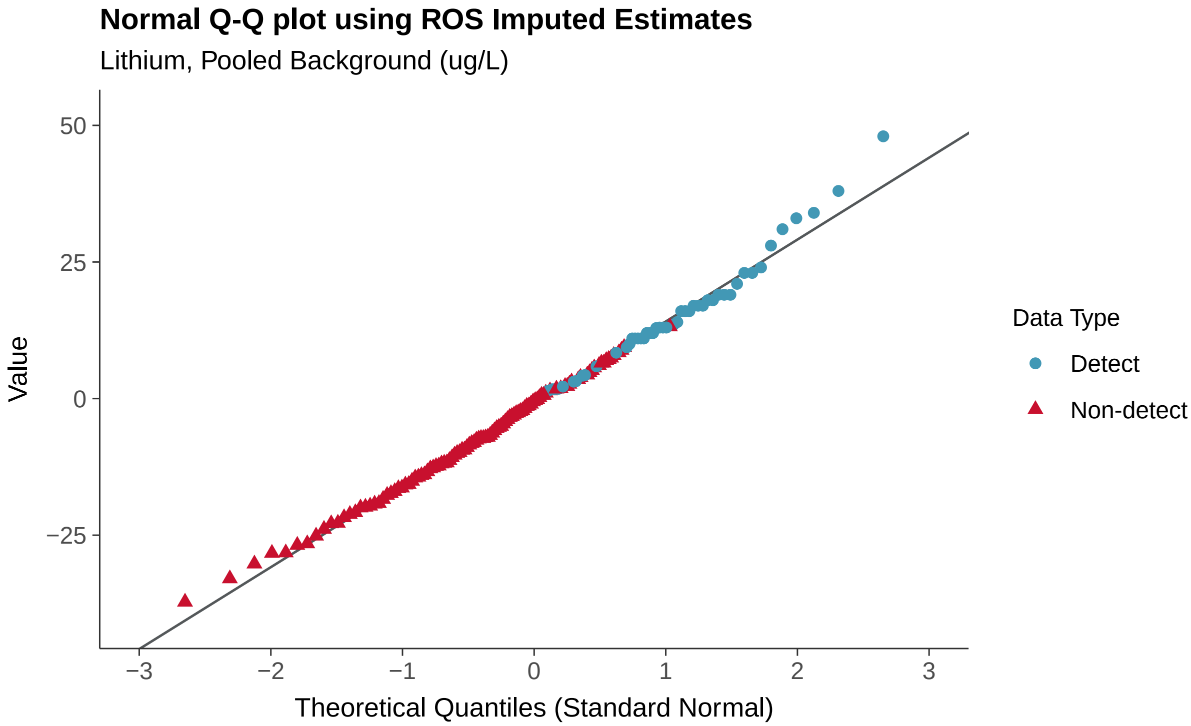
Lithium, Pooled Background (ug/L)

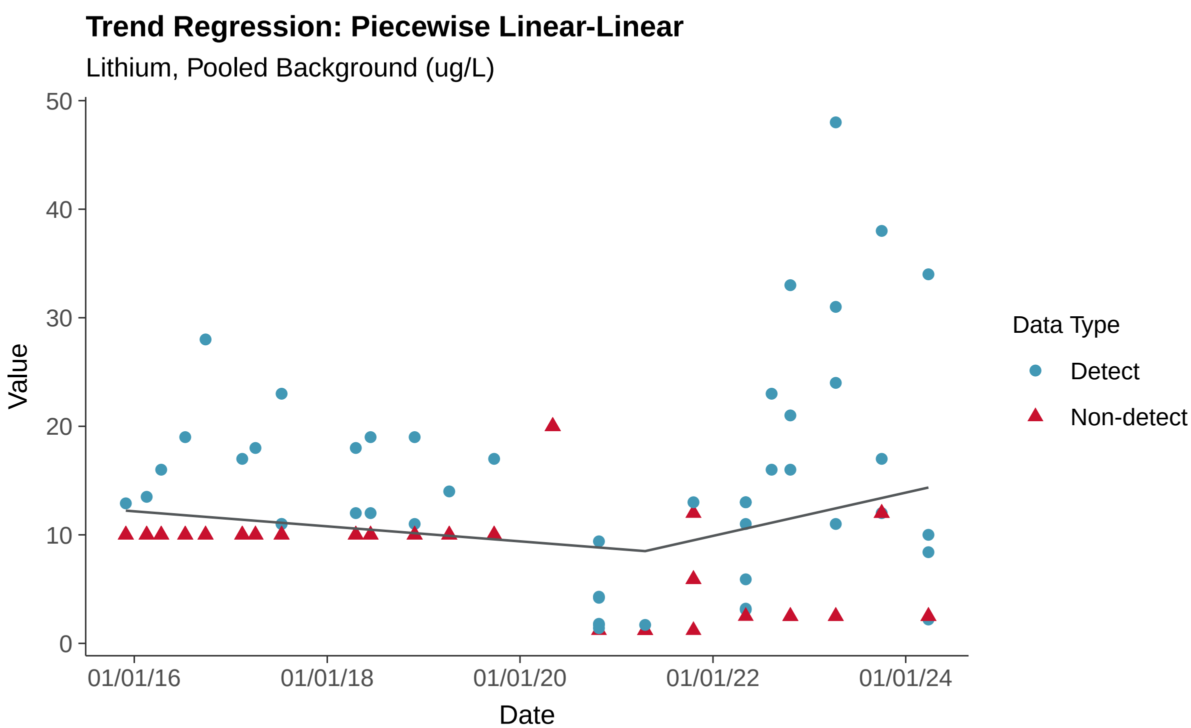


Boxplot by Well

Lithium, Pooled Background (ug/L)

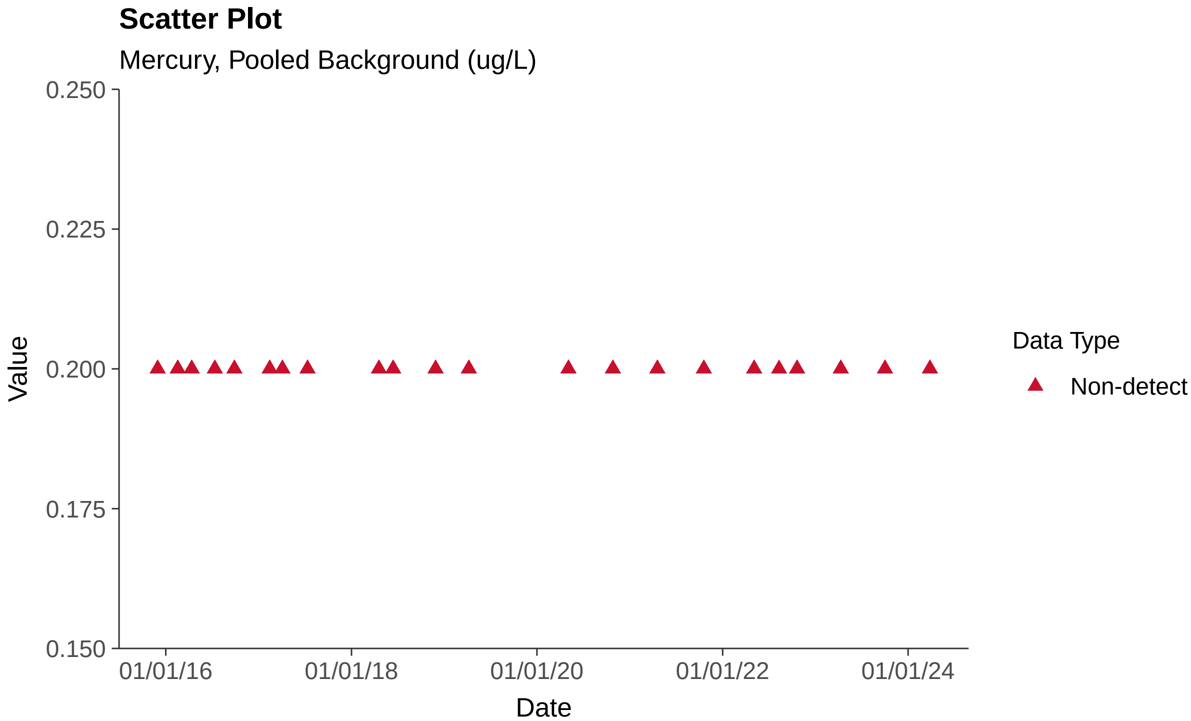


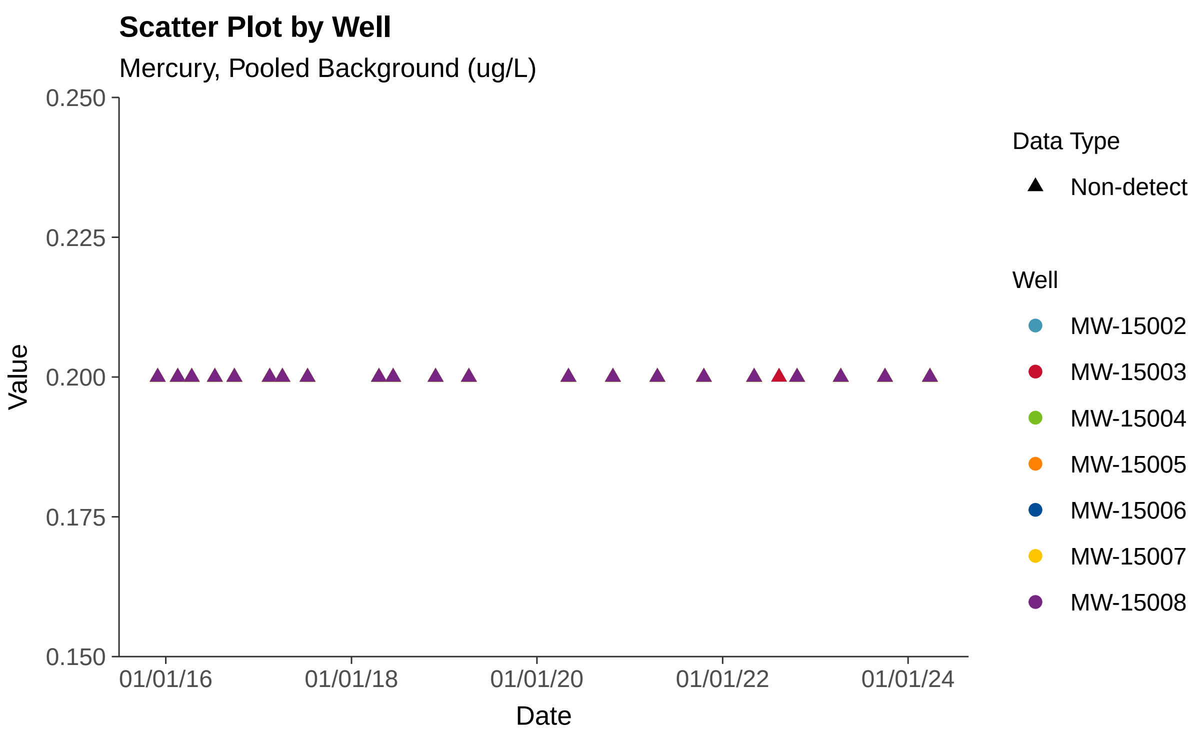

Normal Q-Q plot using ROS Imputed Estimates
Lithium, Pooled Background (ug/L)
Value
50
25
0
−25
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Lithium, Pooled Background (ug/L)
Value
50
40
30
20
10
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

Appendix IV: Mercury, Pooled Background

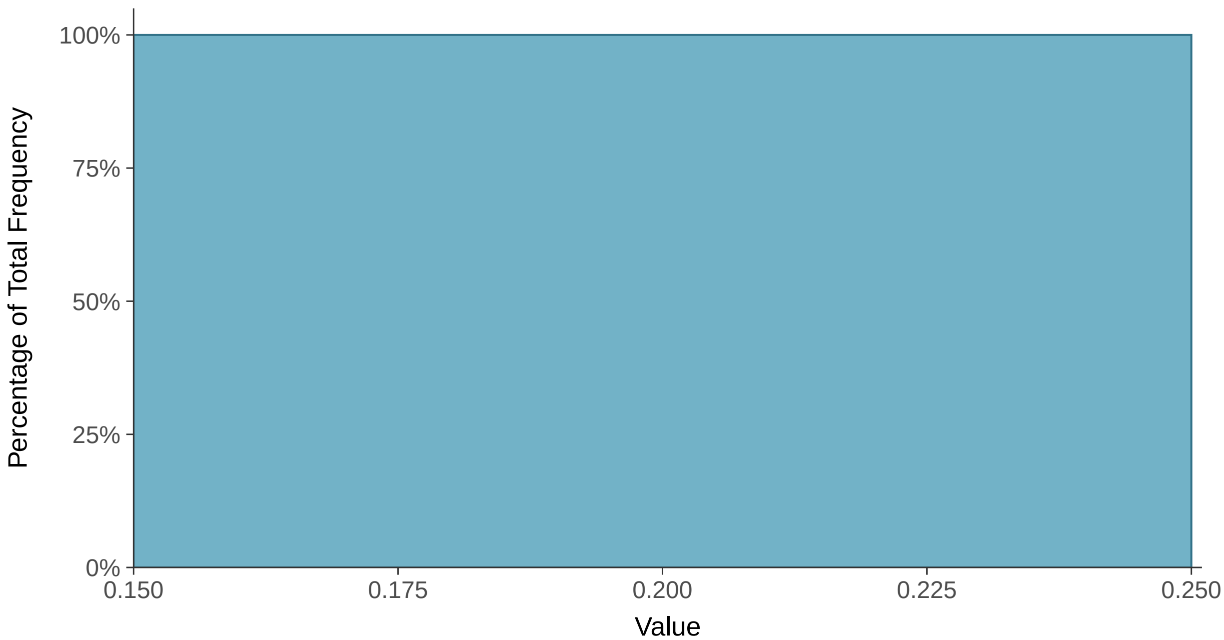
ID: 2_118





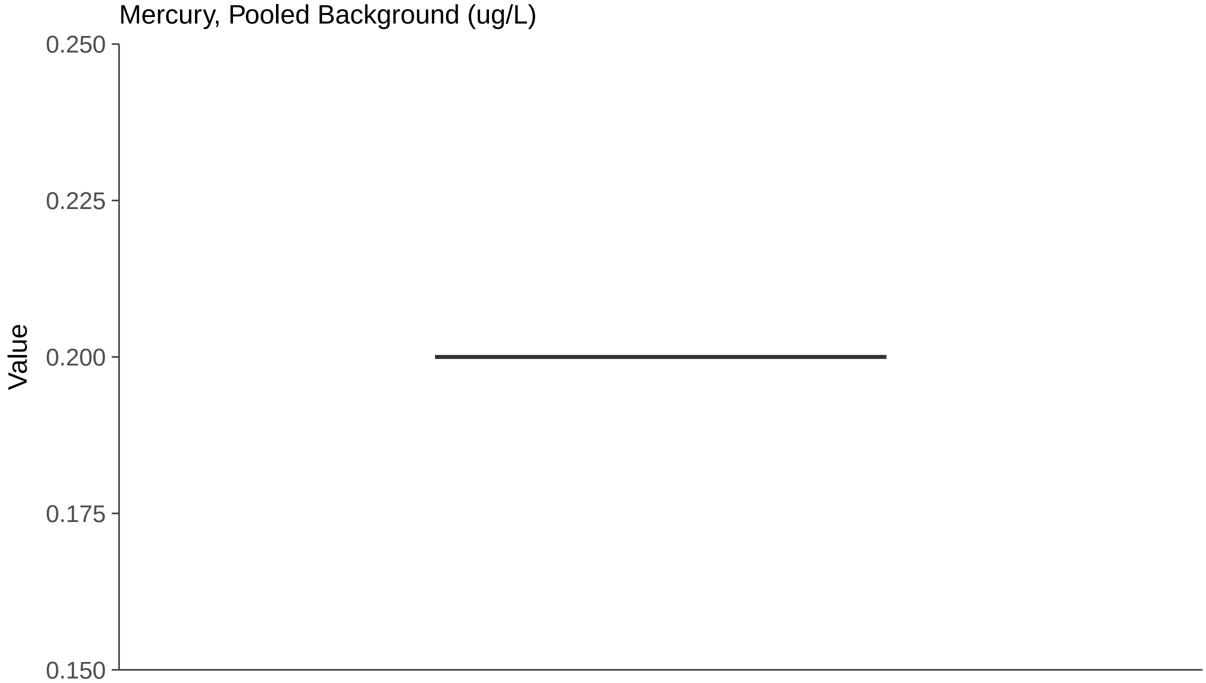
Histogram

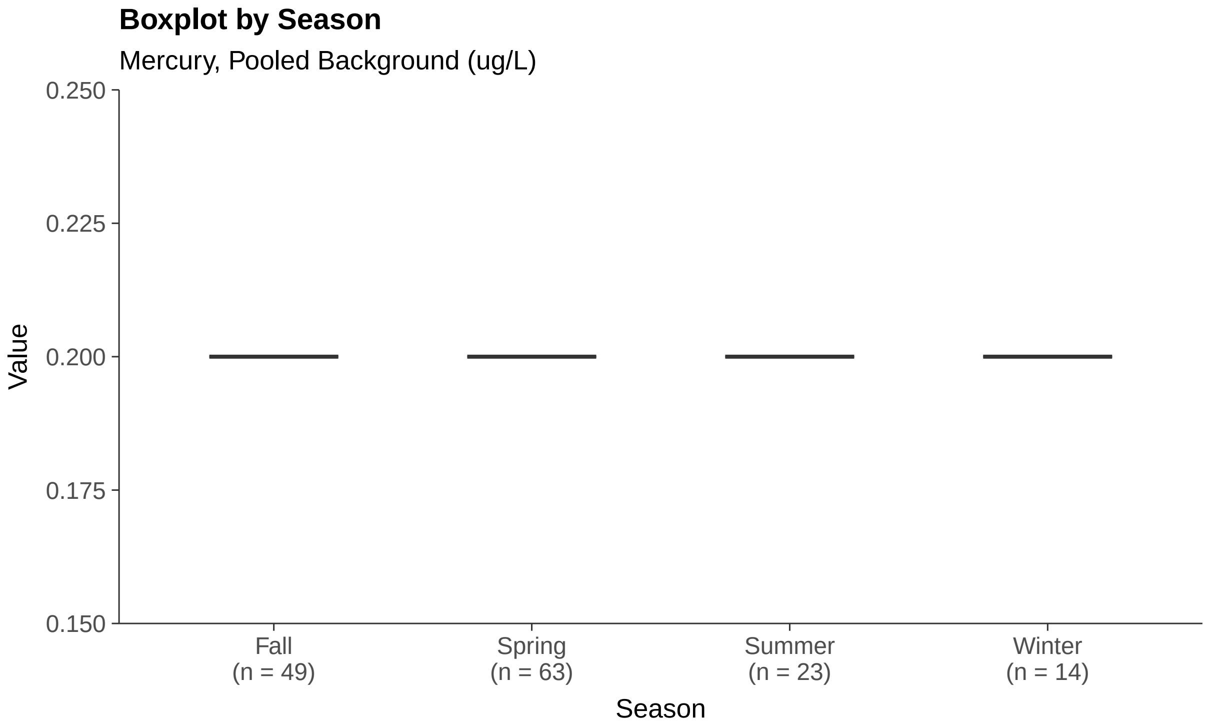
Mercury, Pooled Background (ug/L)

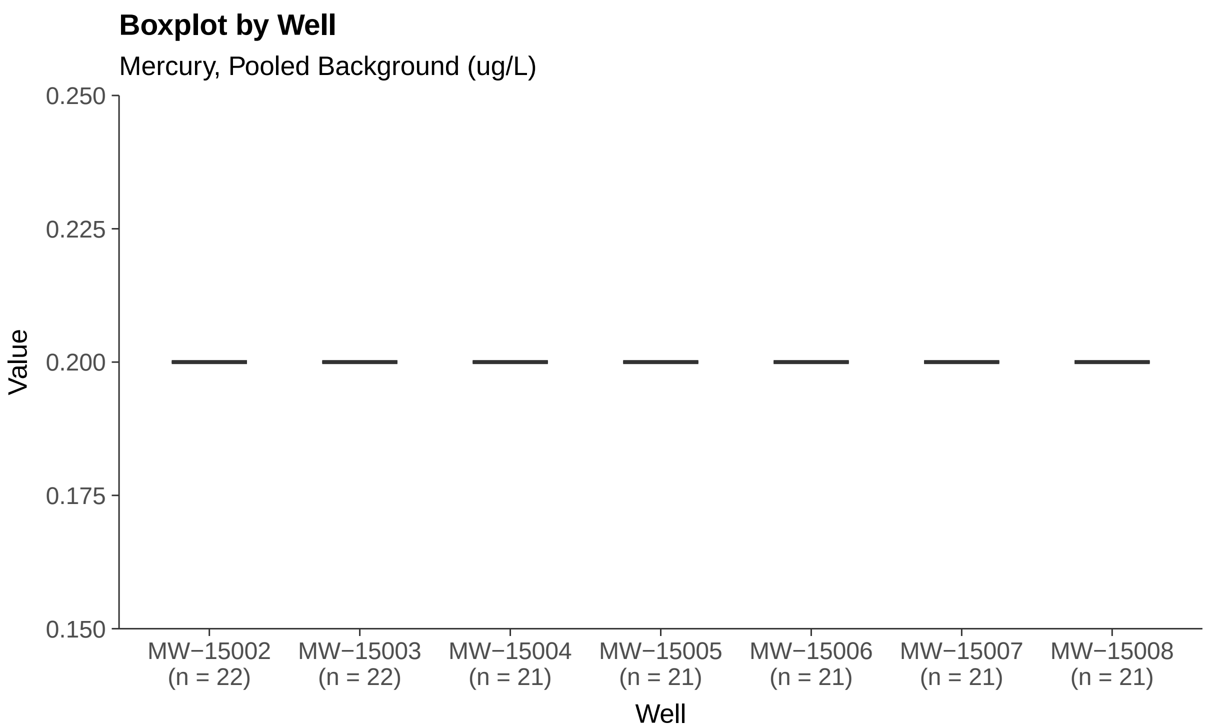


Boxplot

Mercury, Pooled Background (ug/L)

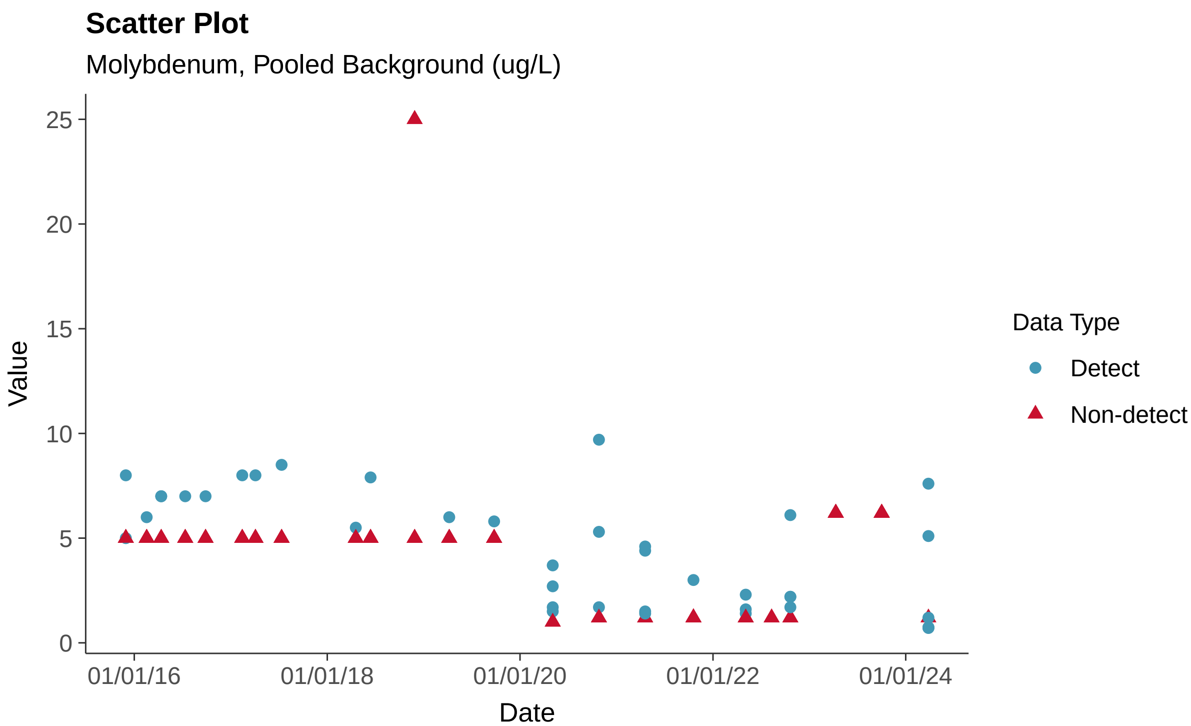


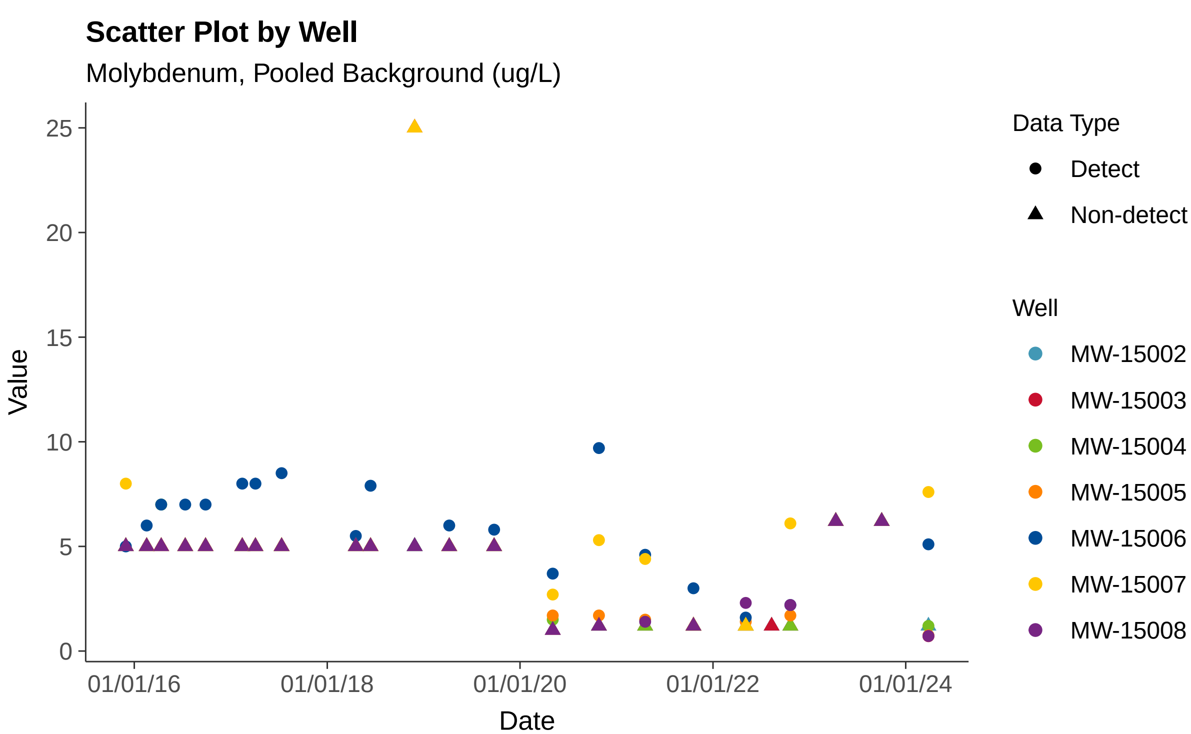

Boxplot by Season
Mercury, Pooled Background (ug/L)
0.250
0.225
0.200
0.175
0.150
Value
Fall
(n = 49)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season

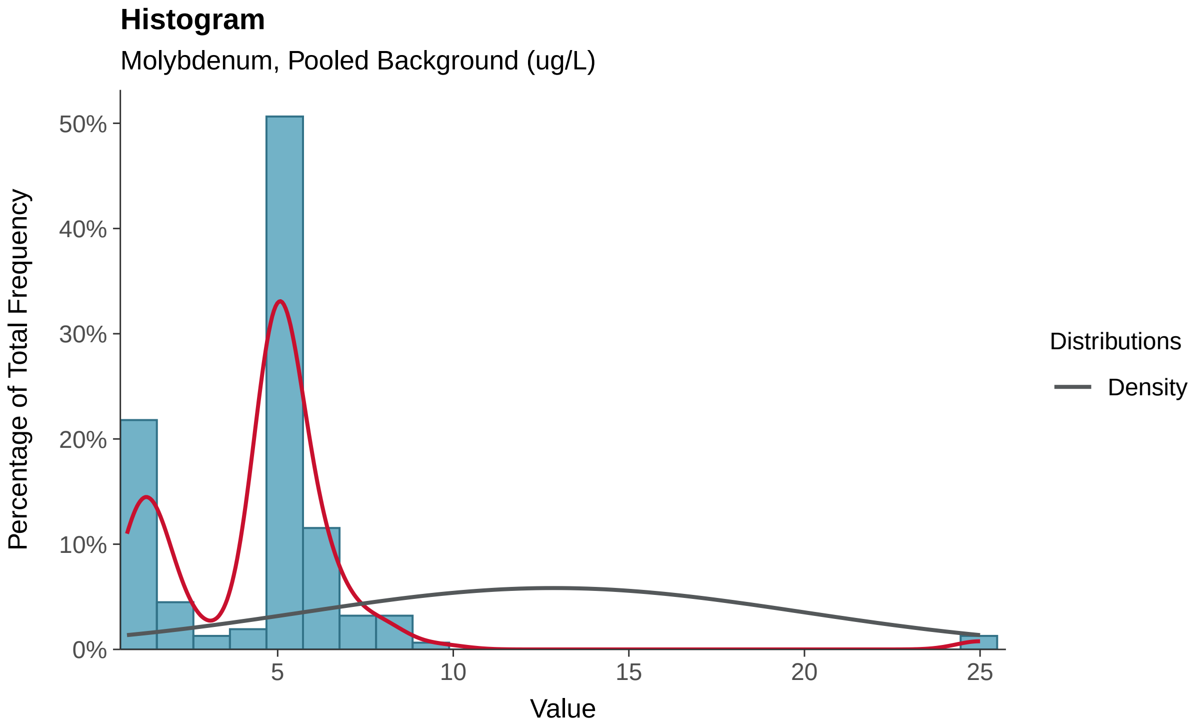

Boxplot by Well
Mercury, Pooled Background (ug/L)
0.250
0.225
0.200
0.175
0.150
Value
MW−15002
(n = 22)
MW−15003
(n = 22)
MW−15004
(n = 21)
MW−15005
(n = 21)
MW−15006
(n = 21)
MW−15007
(n = 21)
MW−15008
(n = 21)
Well

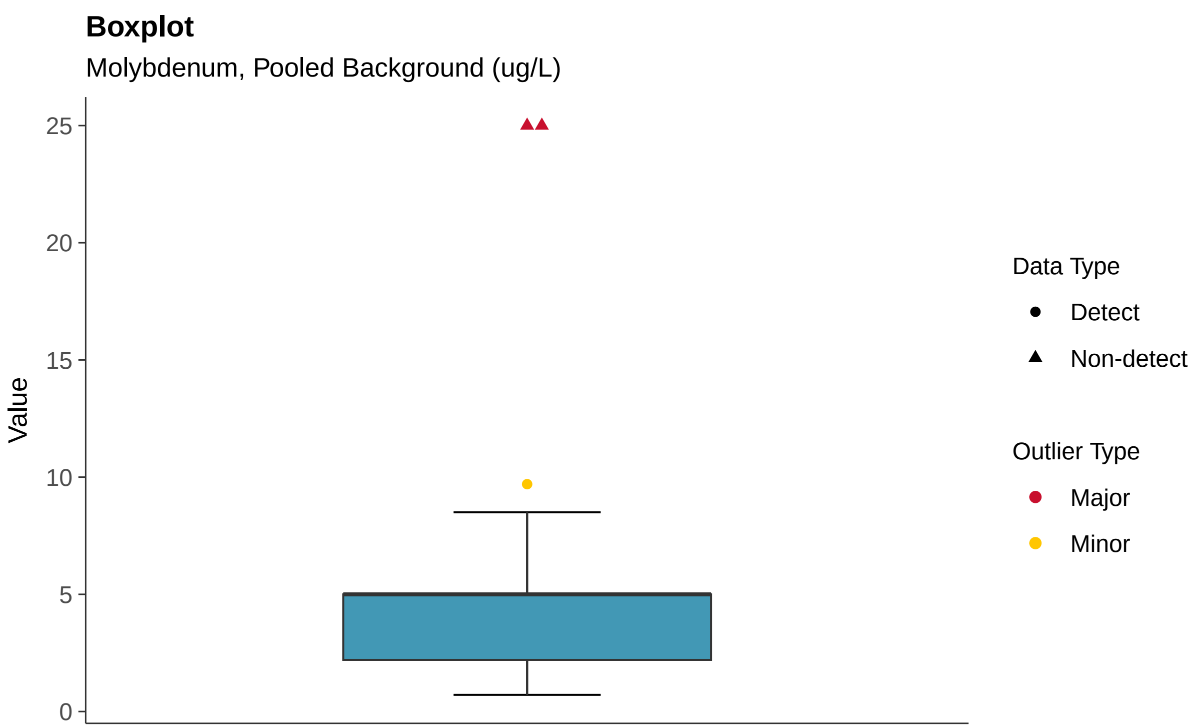
Appendix IV: Molybdenum, Pooled Background

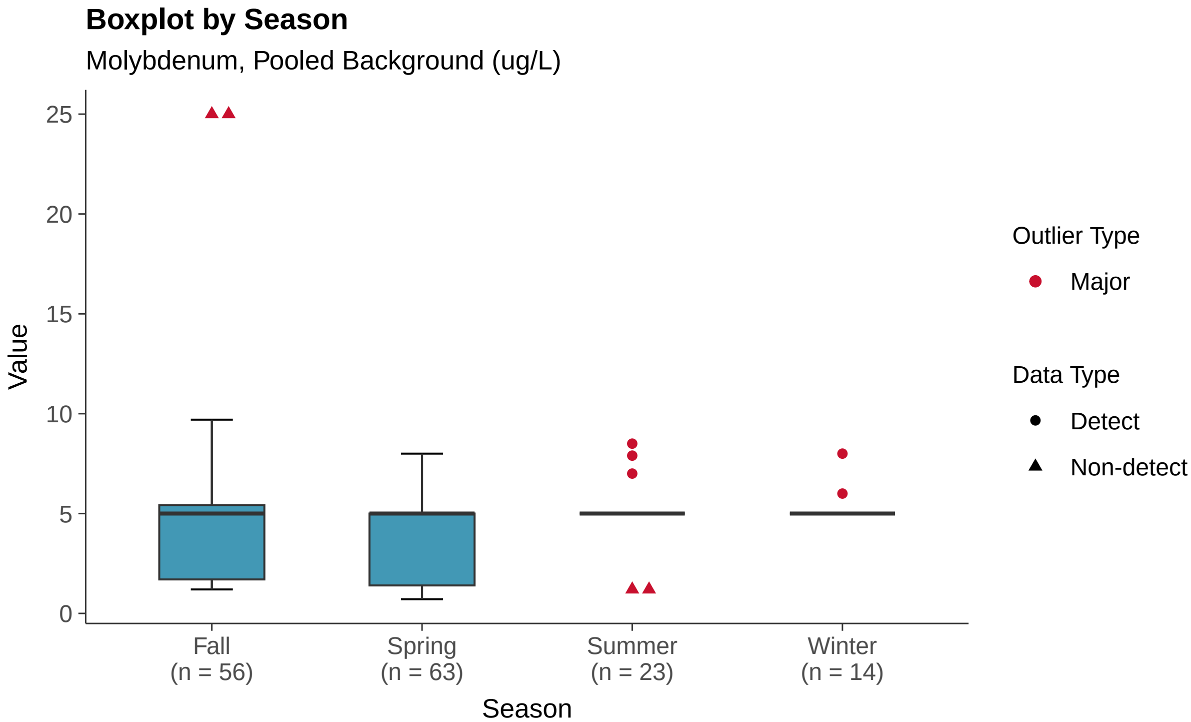
ID: 2_119

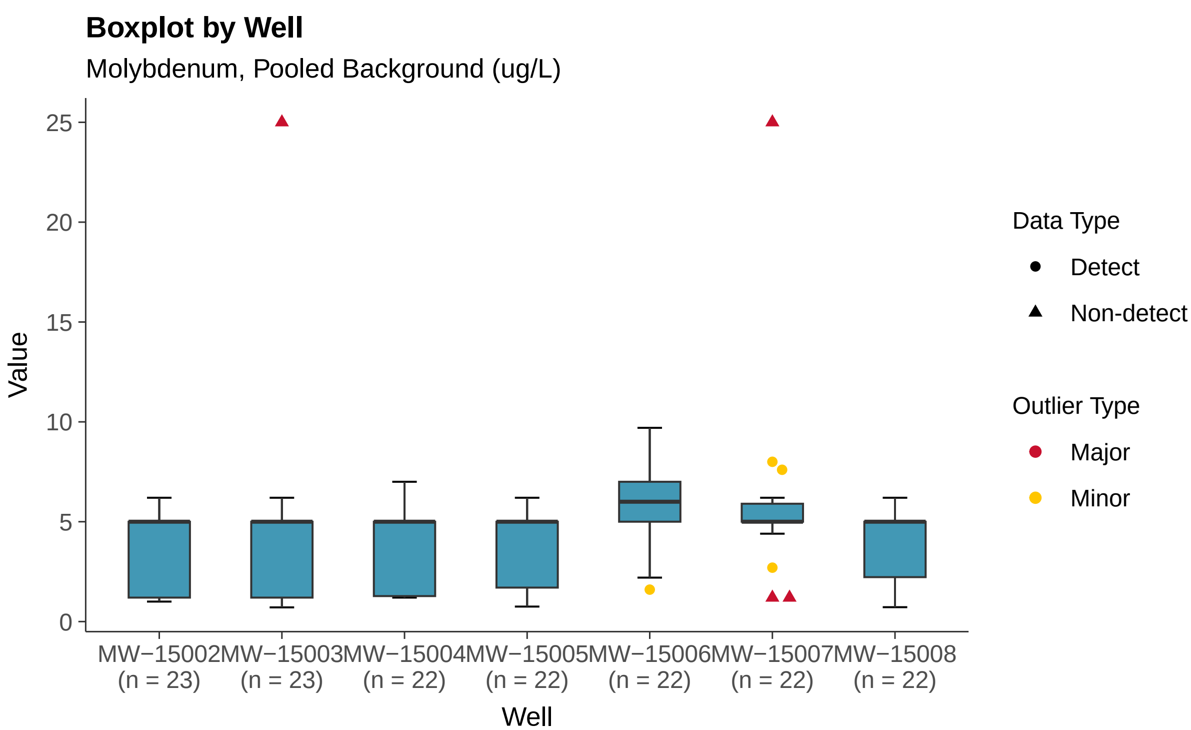





Histogram
Molybdenum, Pooled Background (ug/L)
Percentage of Total Frequency
50%
40%
30%
20%
10%
0%
5
10
15
20
25
Value
Distributions
Density

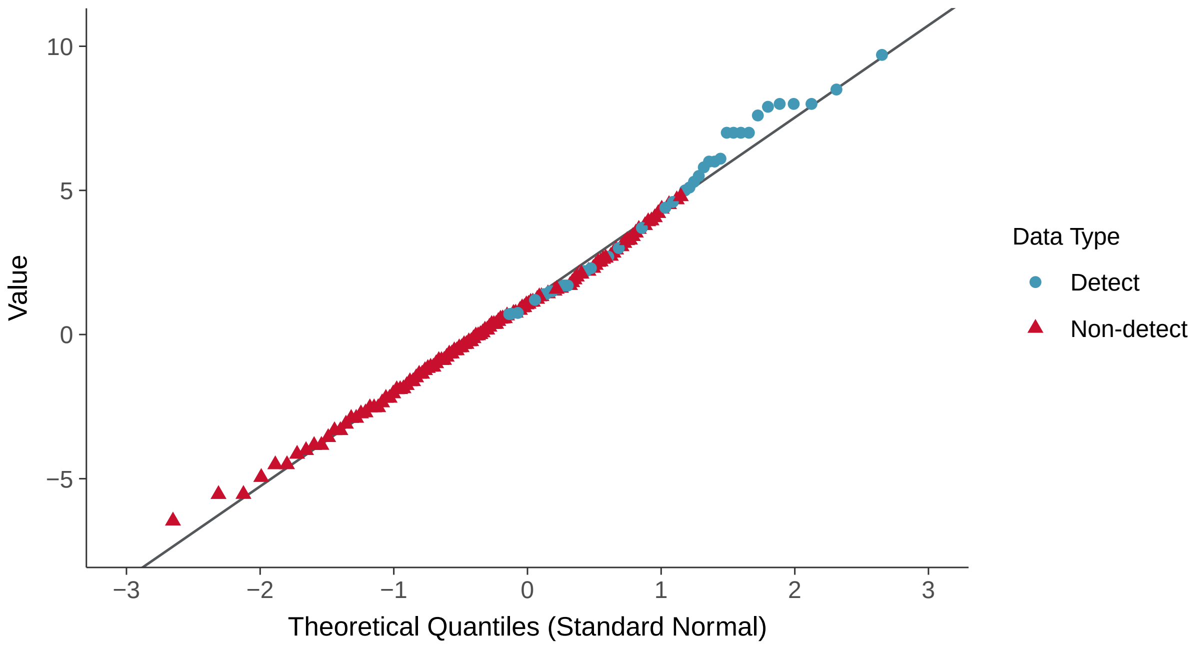

Boxplot
Molybdenum, Pooled Background (ug/L)
Value
25
20
15
10
5
0
Data Type
Detect
Non-detect
Outlier Type
Major
Minor


Boxplot by Season
Molybdenum, Pooled Background (ug/L)
Value
25
20
15
10
5
0
Fall
(n = 56)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Outlier Type
Major
Data Type
Detect
Non-detect


Boxplot by Well
Molybdenum, Pooled Background (ug/L)
Value
25
20
15
10
5
0
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 22)
MW−15007
(n = 22)
MW−15008
(n = 22)
Well
Data Type
Detect
Non-detect
Outlier Type
Major
Minor

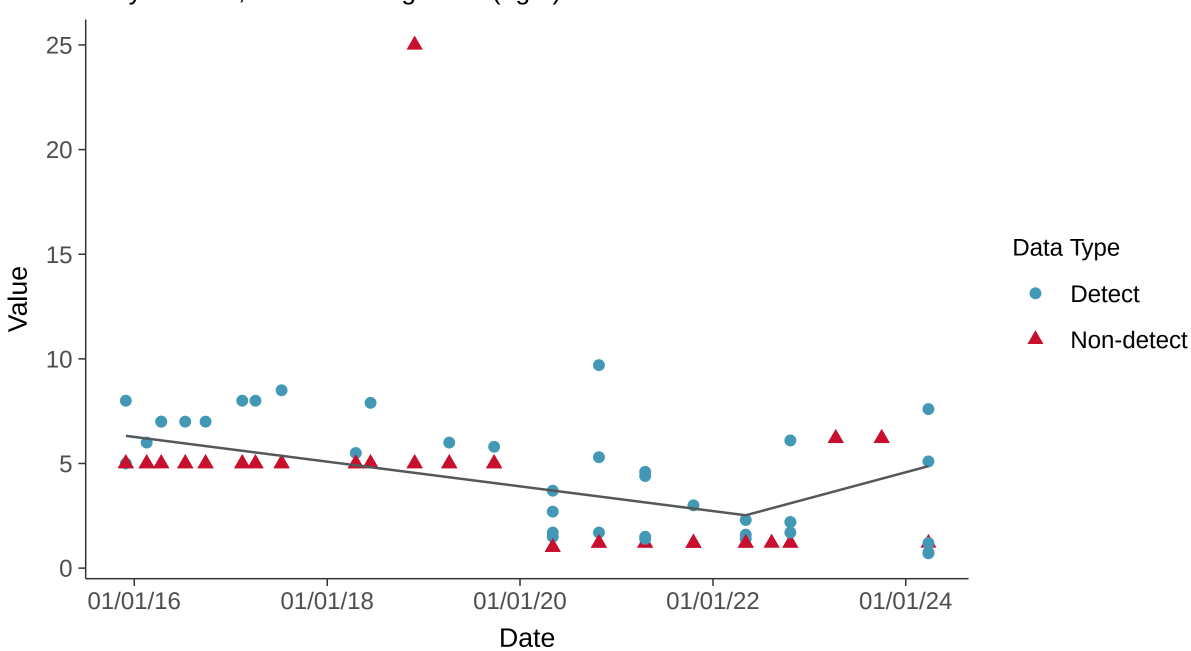
Normal Q-Q plot using ROS Imputed Estimates

Molybdenum, Pooled Background (ug/L)



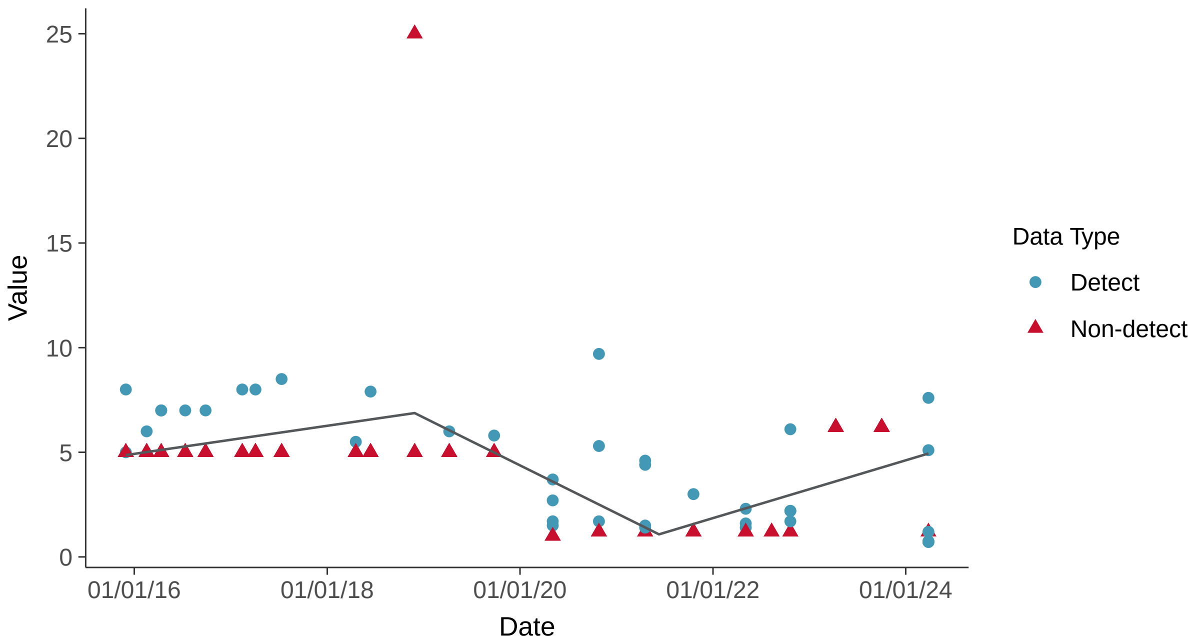
Trend Regression: Piecewise Linear-Linear

Molybdenum, Pooled Background (ug/L)



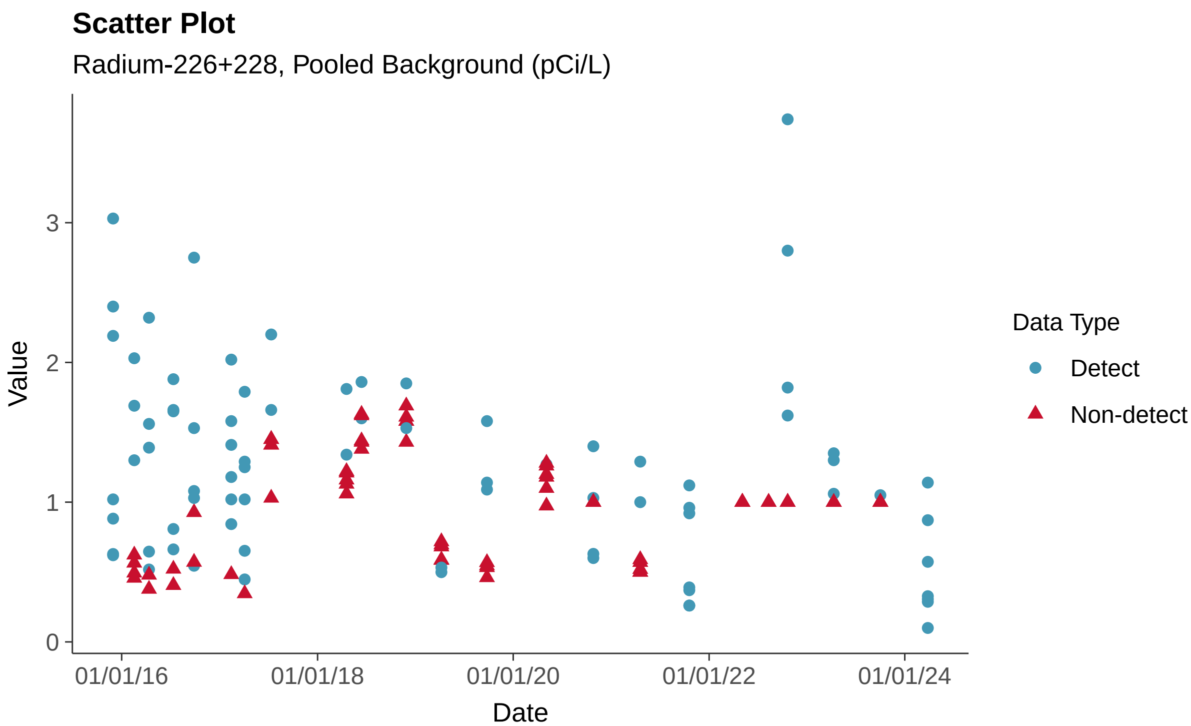
Trend Regression: Piecewise Linear-Linear-Linear

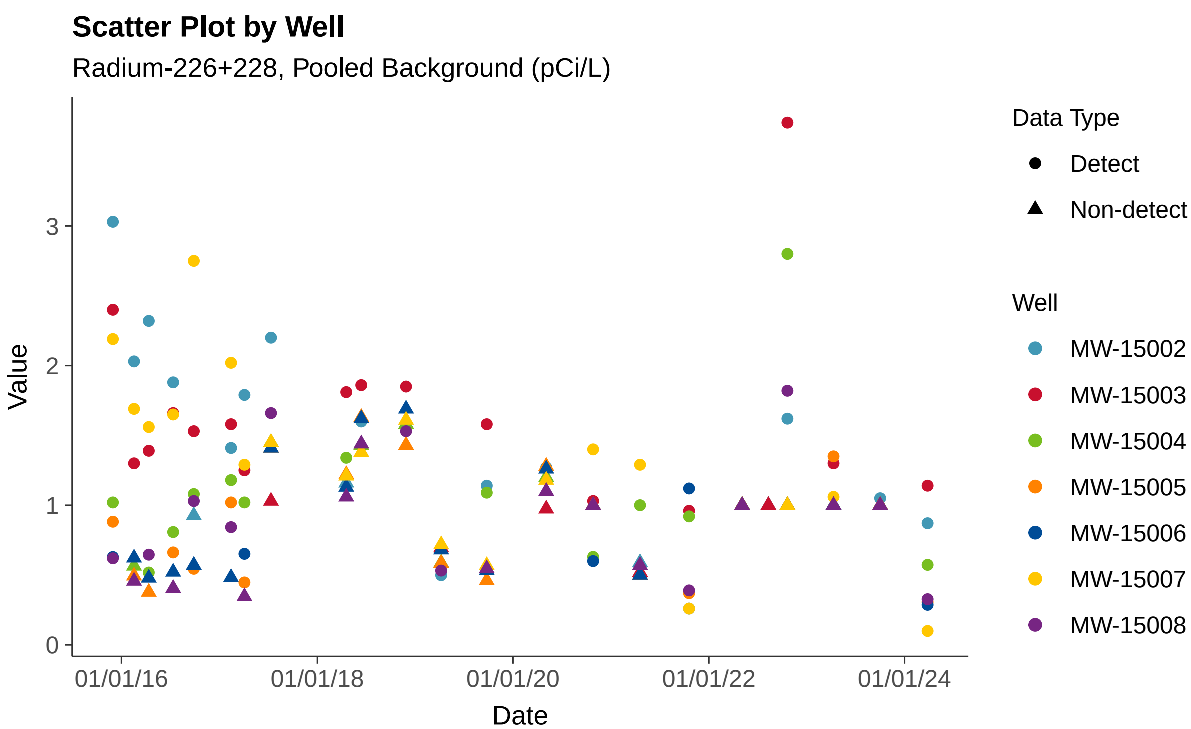
Molybdenum, Pooled Background (ug/L)



Appendix IV: Radium-226+228, Pooled Background

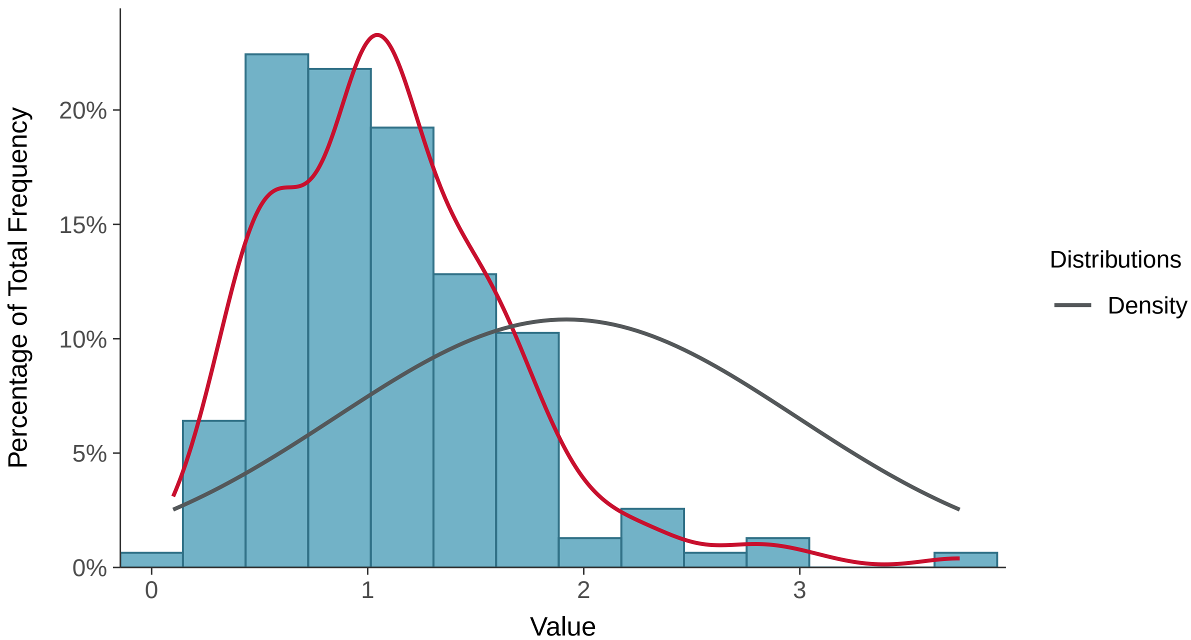
ID: 2_124





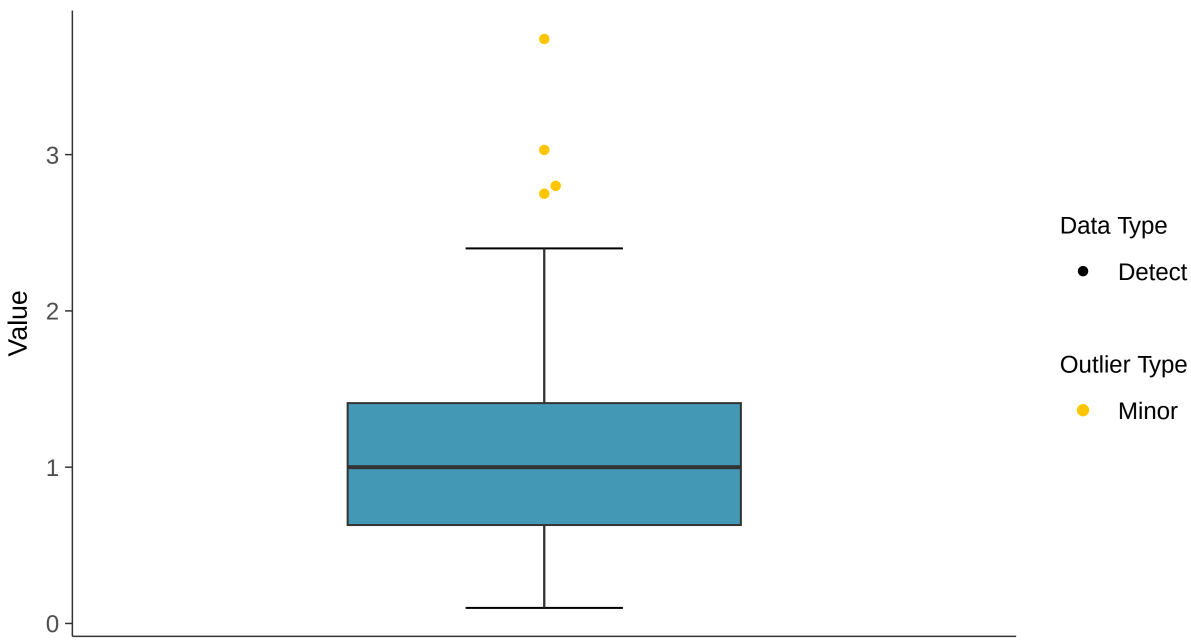
Histogram

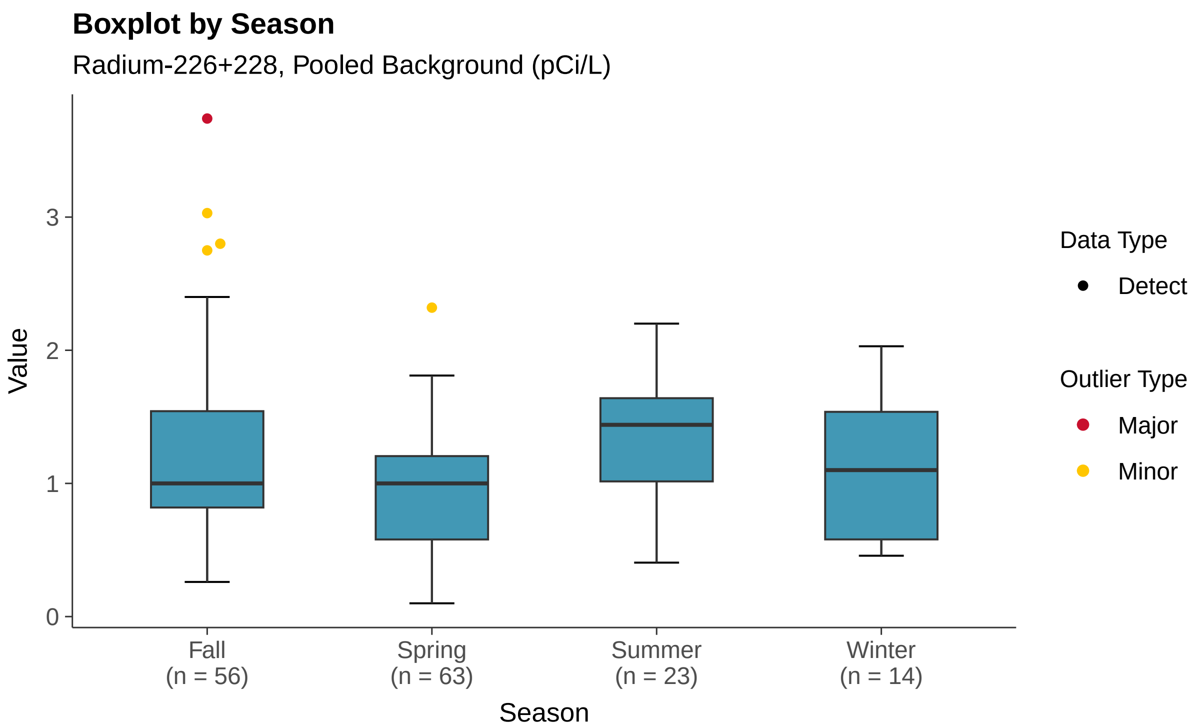
Radium-226+228, Pooled Background (pCi/L)

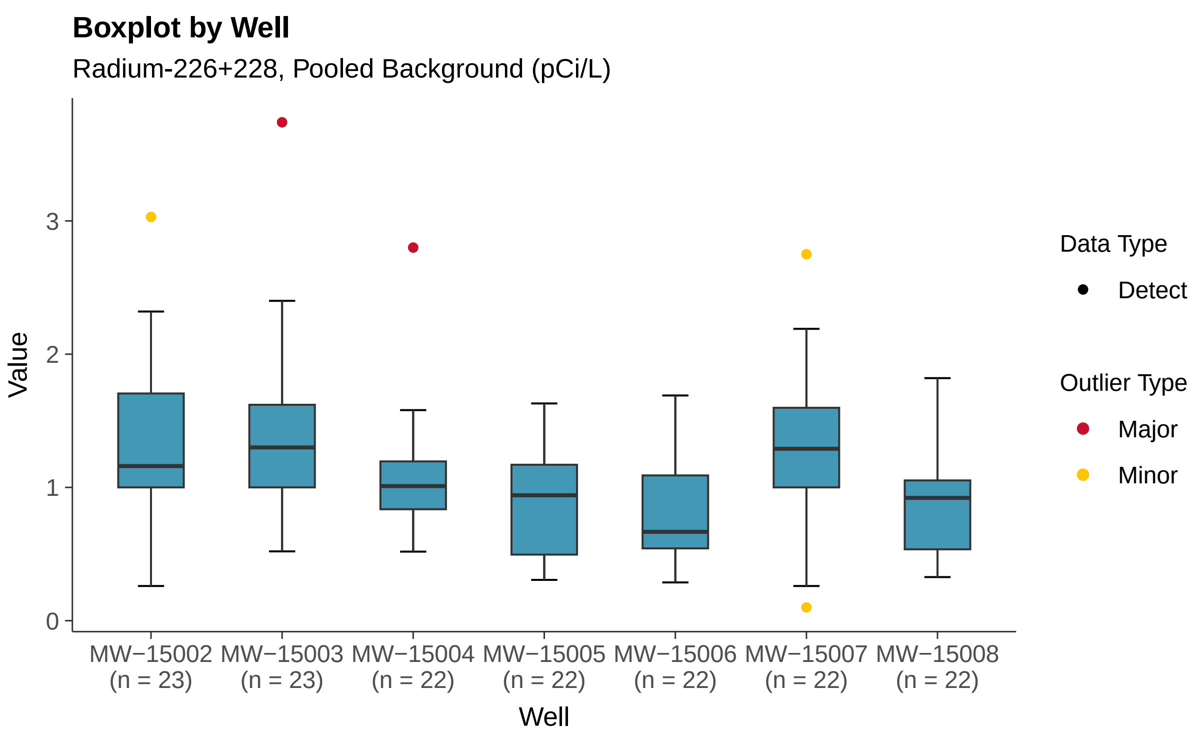


Boxplot

Radium-226+228, Pooled Background (pCi/L)

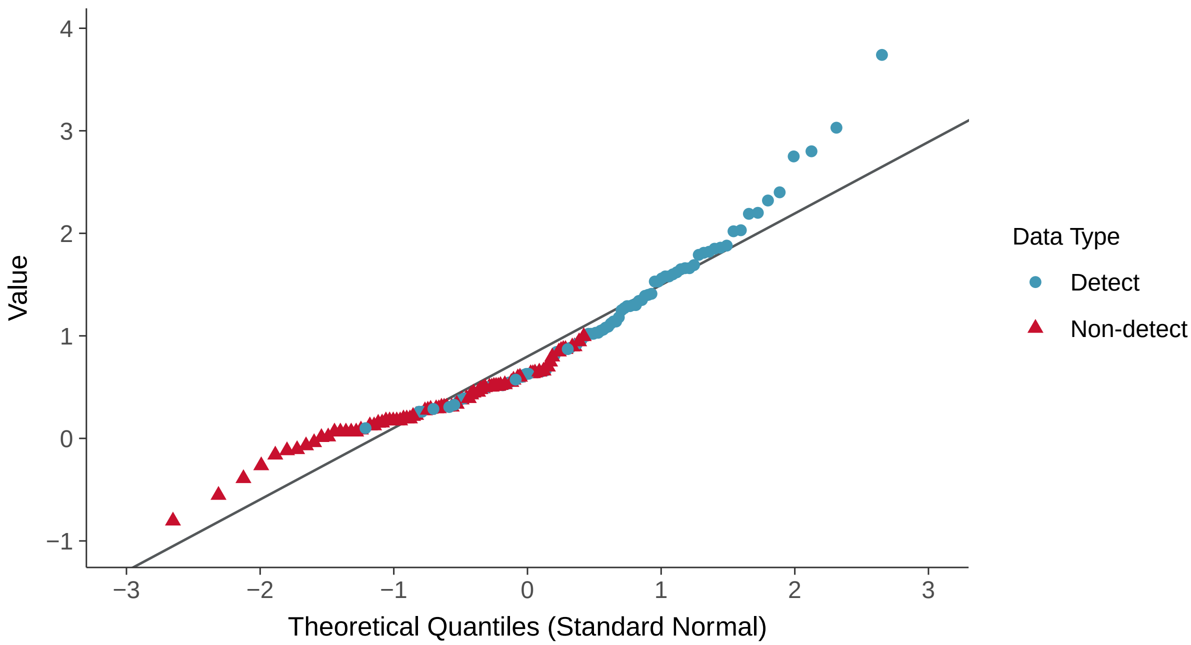



Boxplot by Season
Radium-226+228, Pooled Background (pCi/L)
Value
0
1
2
3
Fall
(n = 56)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Well
Radium-226+228, Pooled Background (pCi/L)
Value
0
1
2
3
MW−15002
(n = 23)
MW−15003
(n = 23)
MW−15004
(n = 22)
MW−15005
(n = 22)
MW−15006
(n = 22)
MW−15007
(n = 22)
MW−15008
(n = 22)
Well
Data Type
Detect
Outlier Type
Major
Minor

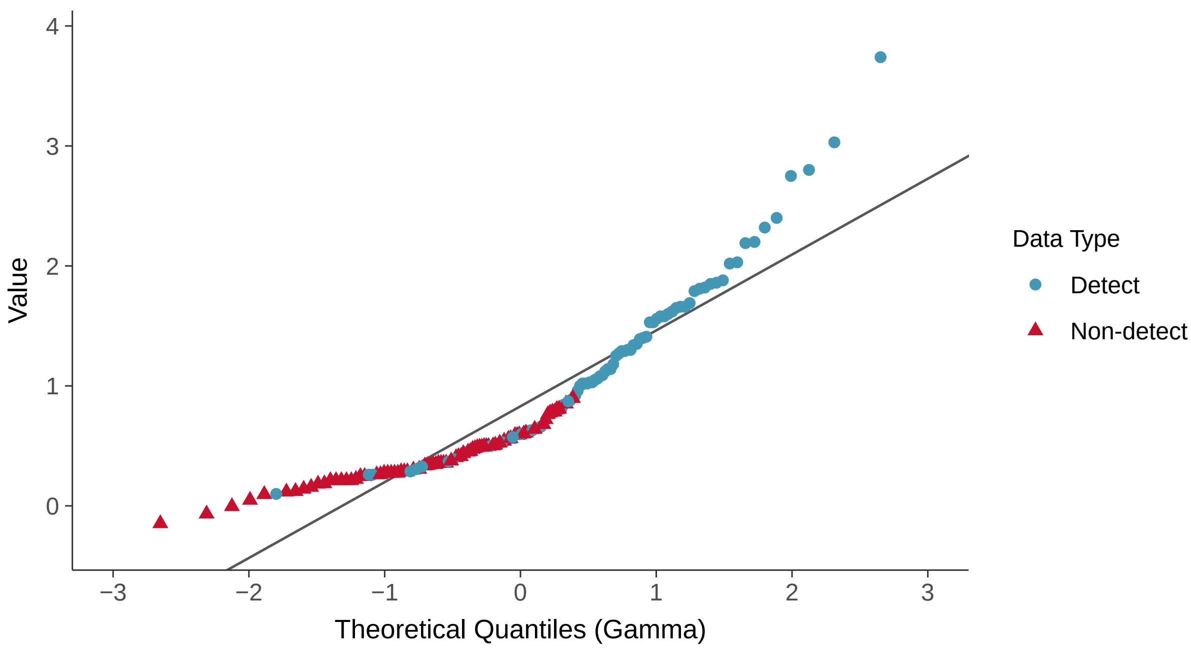
Normal Q-Q plot using ROS Imputed Estimates

Radium-226+228, Pooled Background (pCi/L)



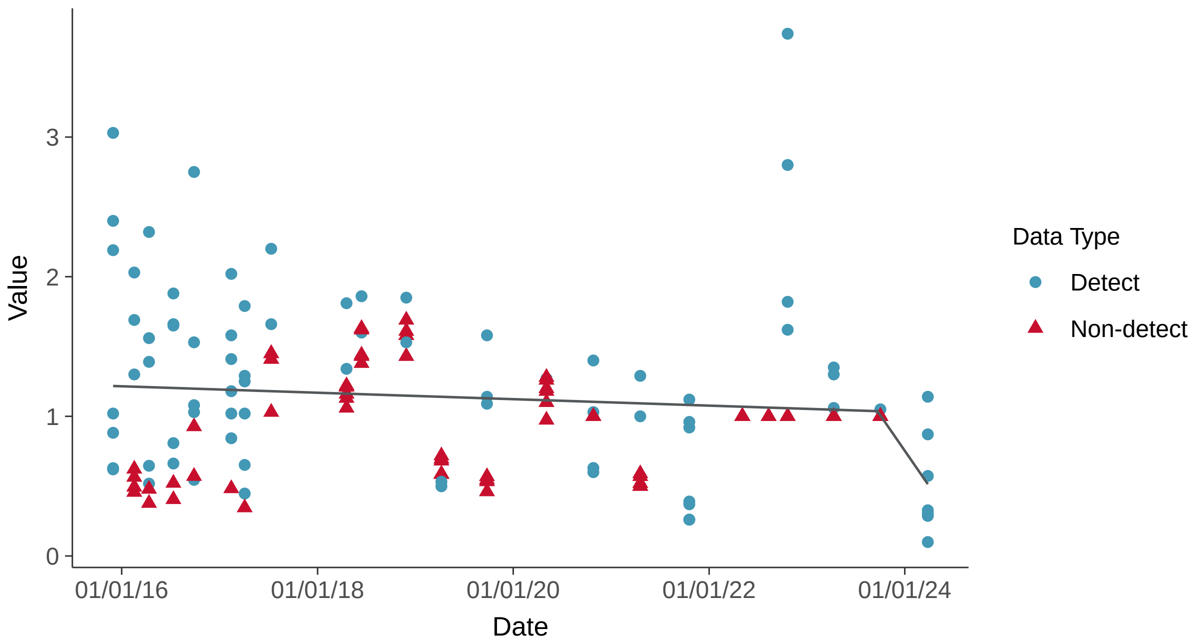
Gamma Q-Q plot using ROS Imputed Estimates

Radium-226+228, Pooled Background (pCi/L)



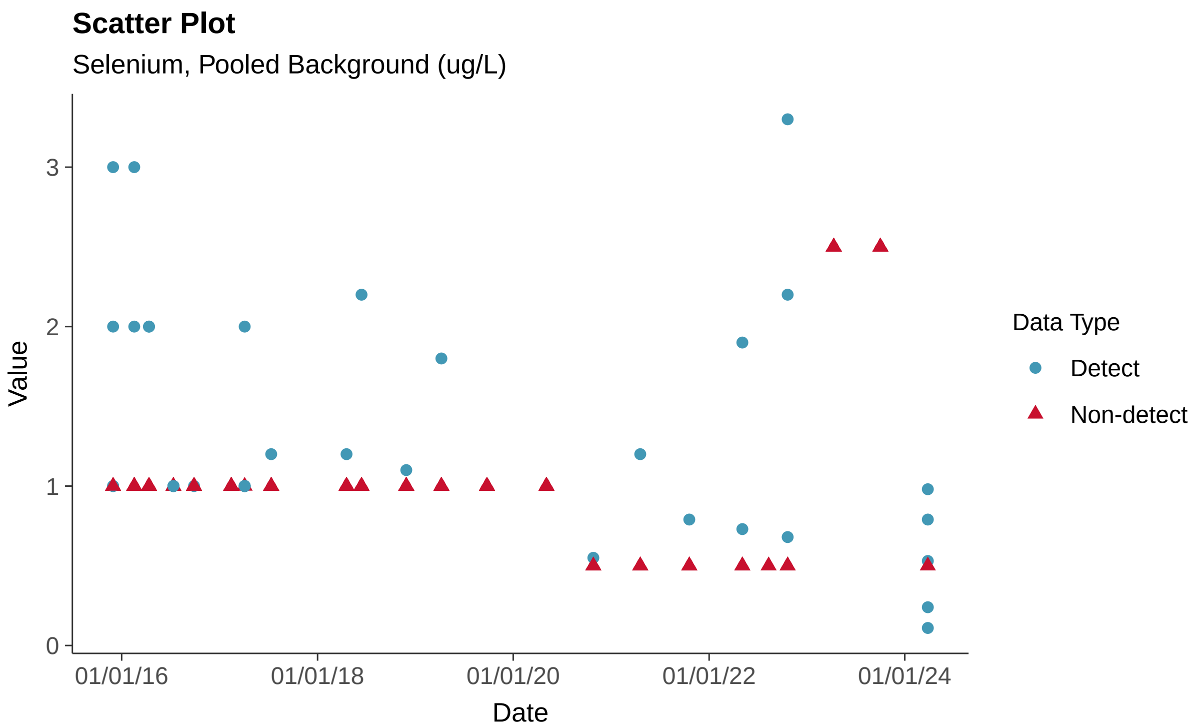
Trend Regression: Piecewise Linear-Linear

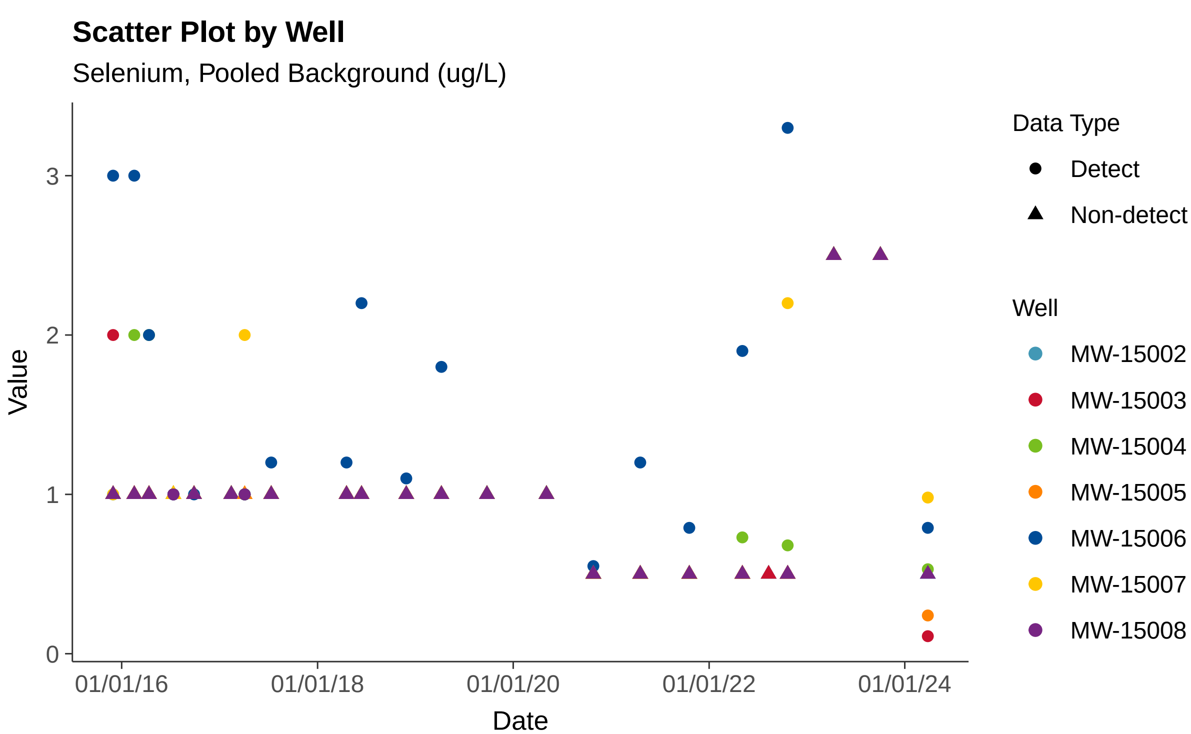
Radium-226+228, Pooled Background (pCi/L)



Appendix IV: Selenium, Pooled Background

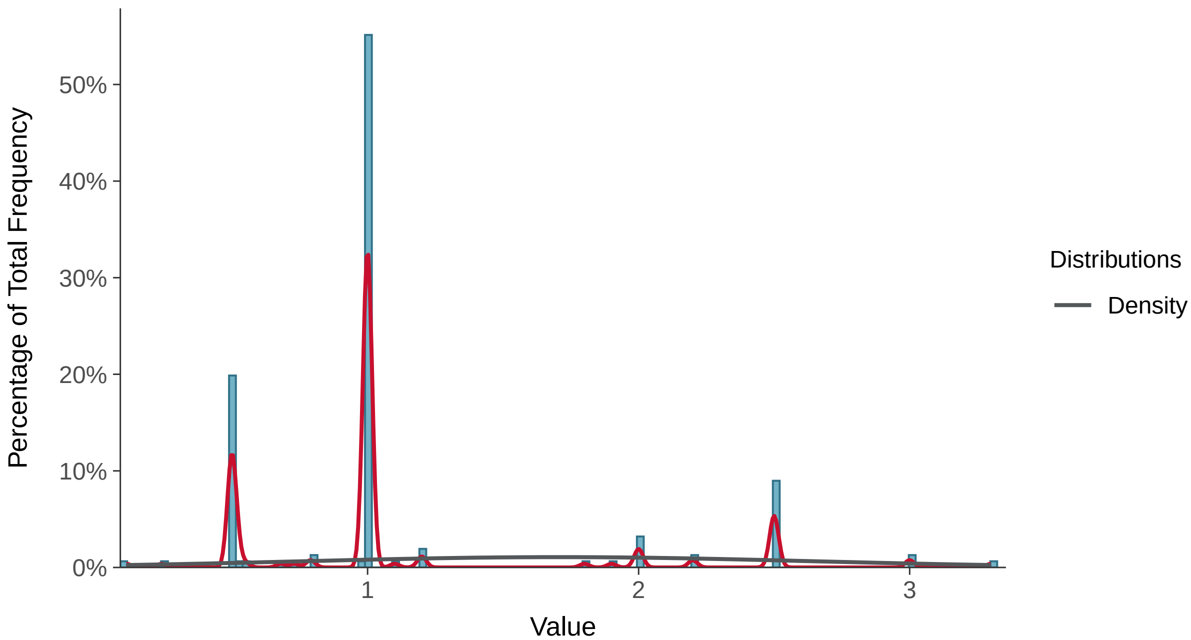
ID: 2_126





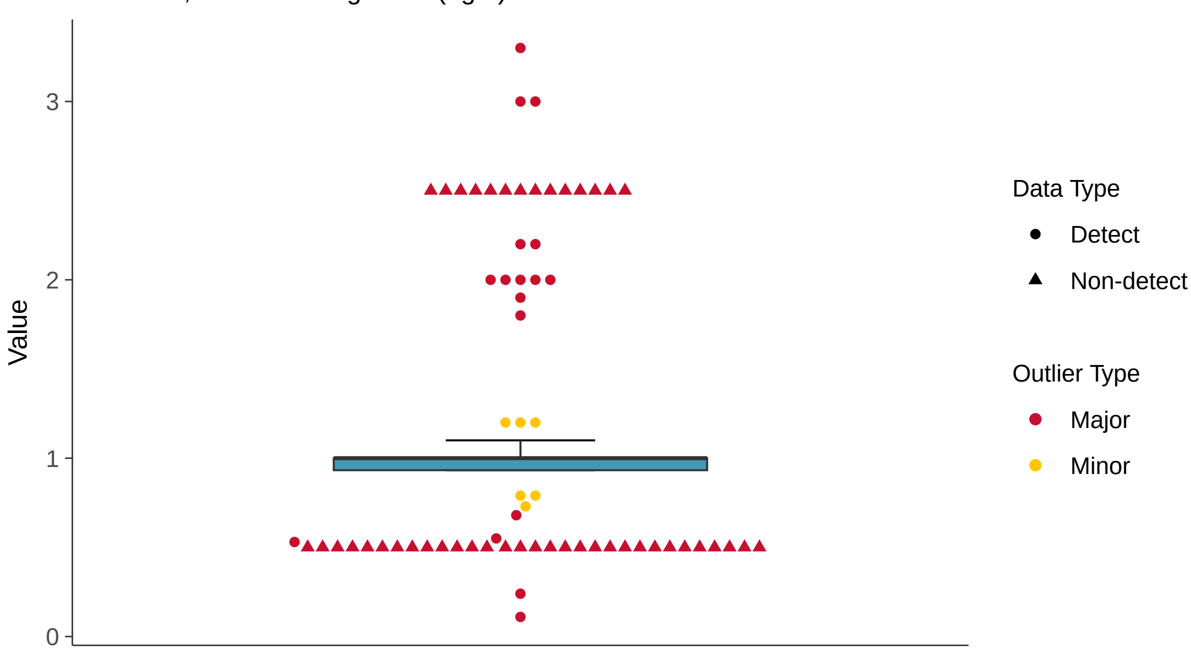
Histogram

Selenium, Pooled Background (ug/L)



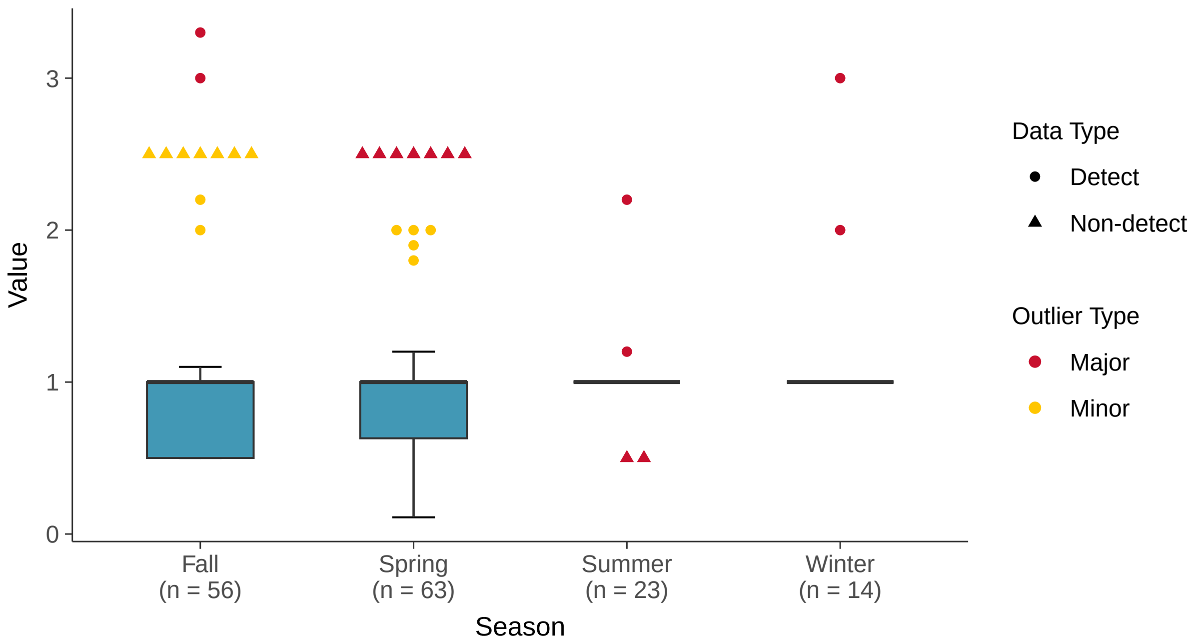
Boxplot

Selenium, Pooled Background (ug/L)



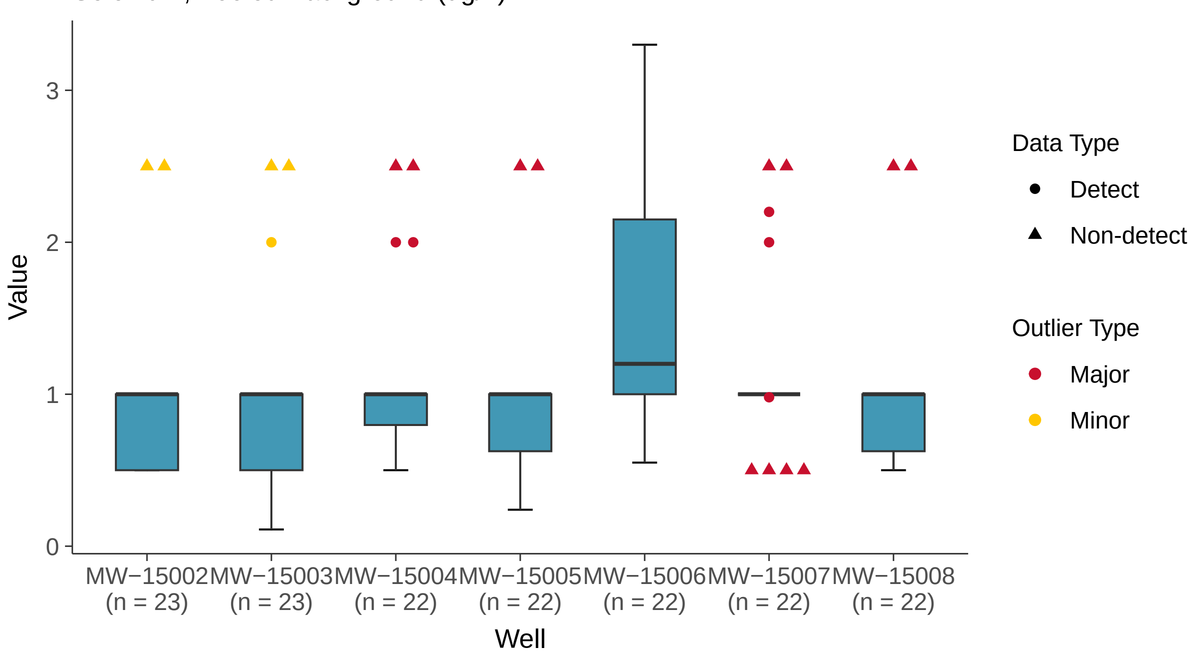
Boxplot by Season

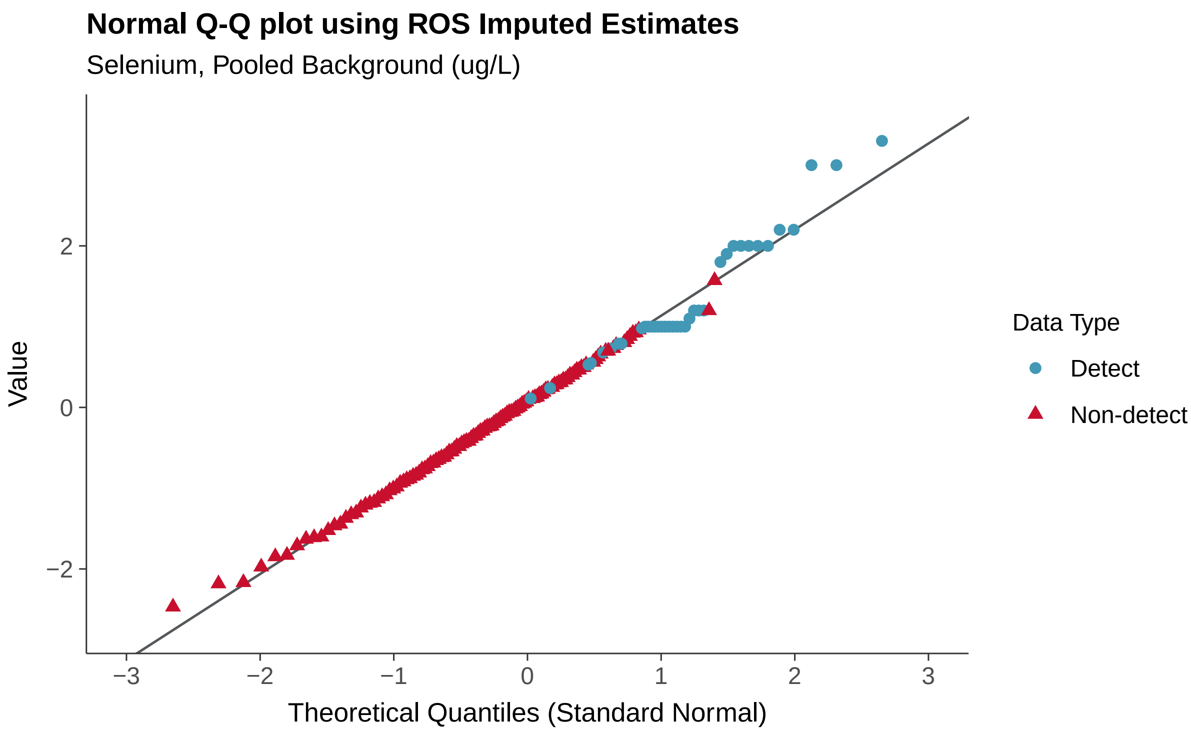
Selenium, Pooled Background (ug/L)

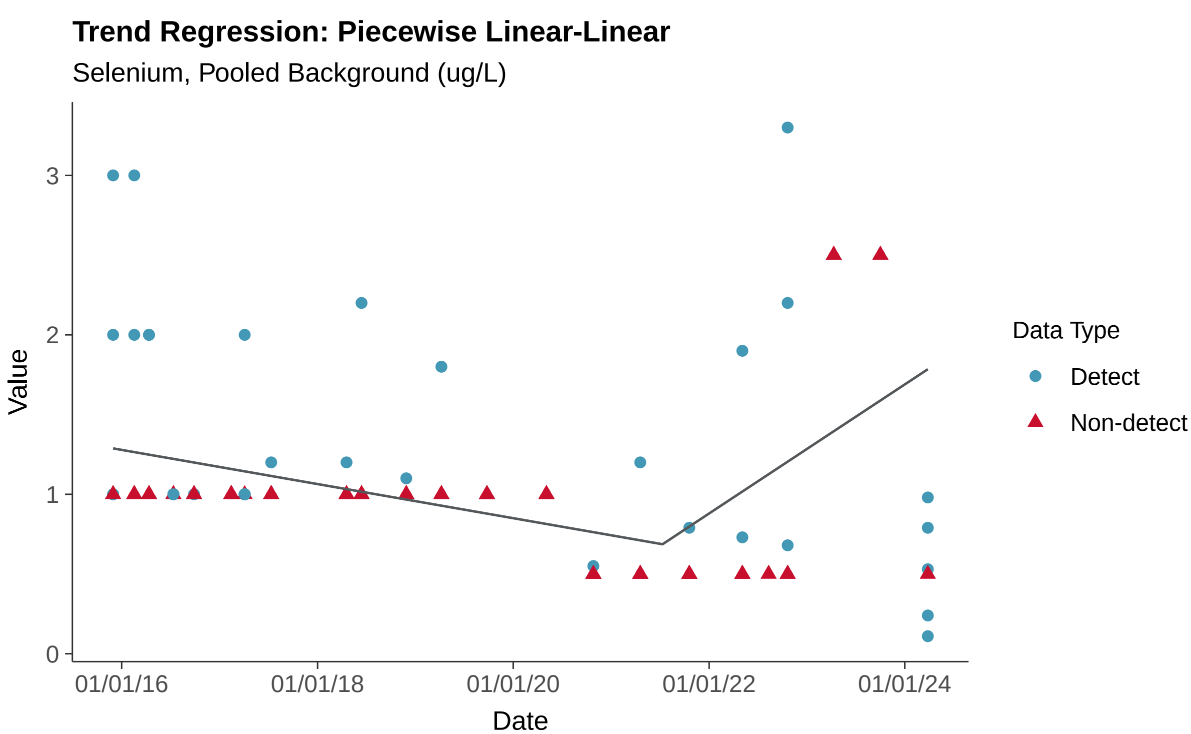


Boxplot by Well

Selenium, Pooled Background (ug/L)

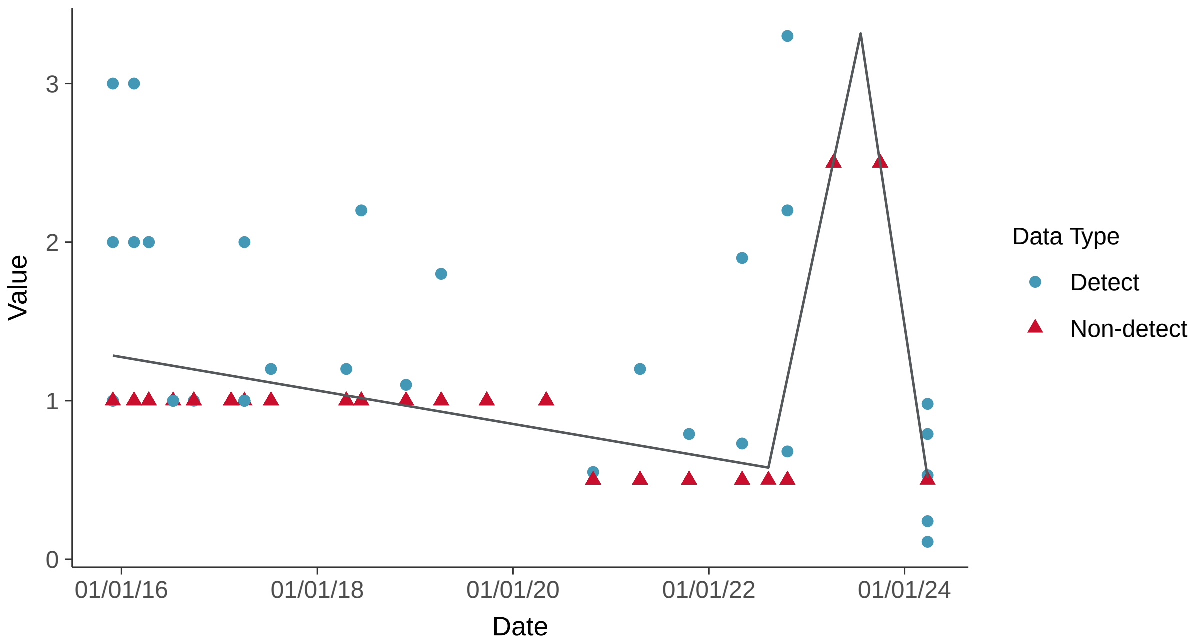



Normal Q-Q plot using ROS Imputed Estimates
Selenium, Pooled Background (ug/L)
Value
2
0
−2
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Selenium, Pooled Background (ug/L)
Value
3
2
1
0
01/01/16
01/01/18
01/01/20
01/01/22
01/01/24
Date
Data Type
Detect
Non-detect

Trend Regression: Piecewise Linear-Linear-Linear

Selenium, Pooled Background (ug/L)

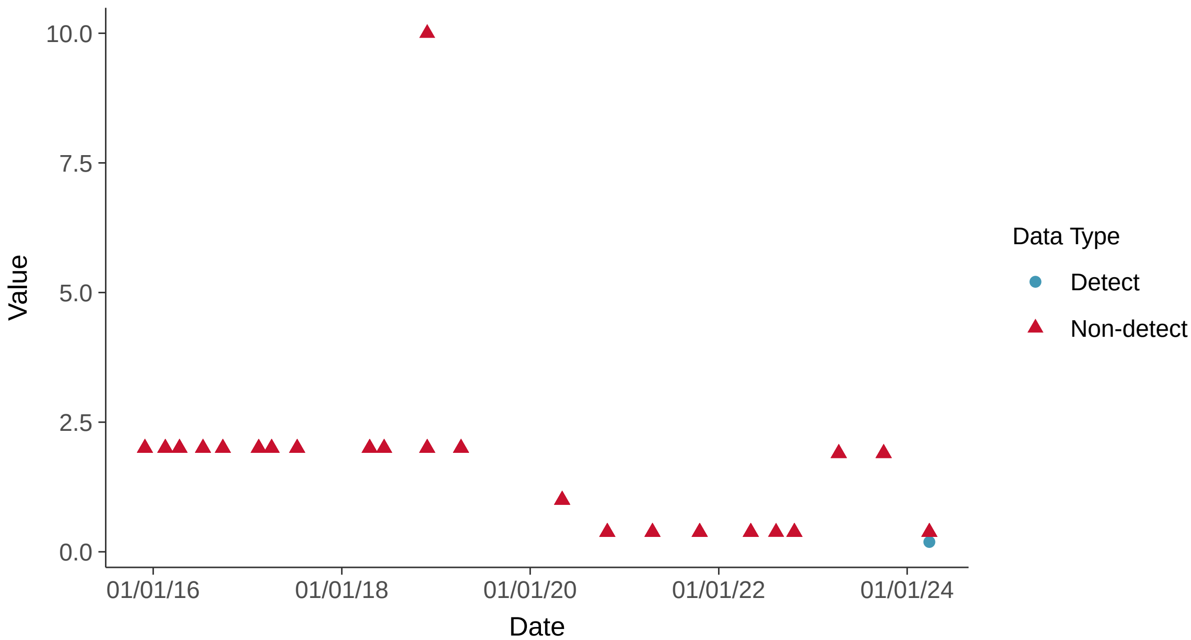


Appendix IV: Thallium, Pooled Background

ID: 2_130

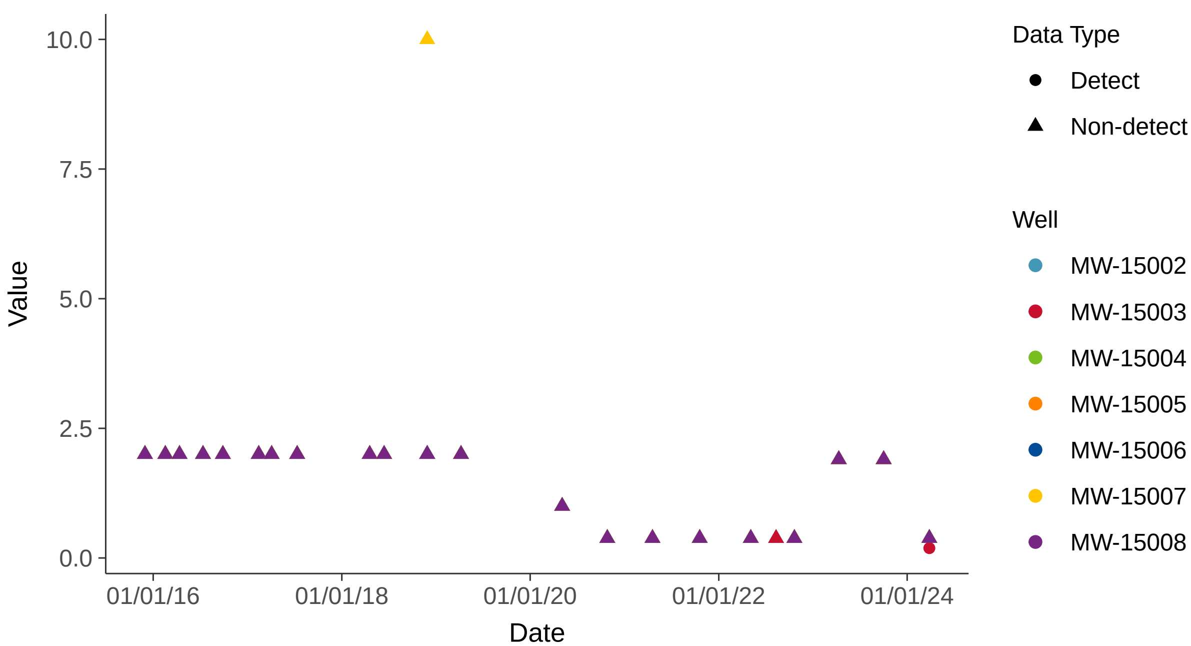
Scatter Plot

Thallium, Pooled Background (ug/L)



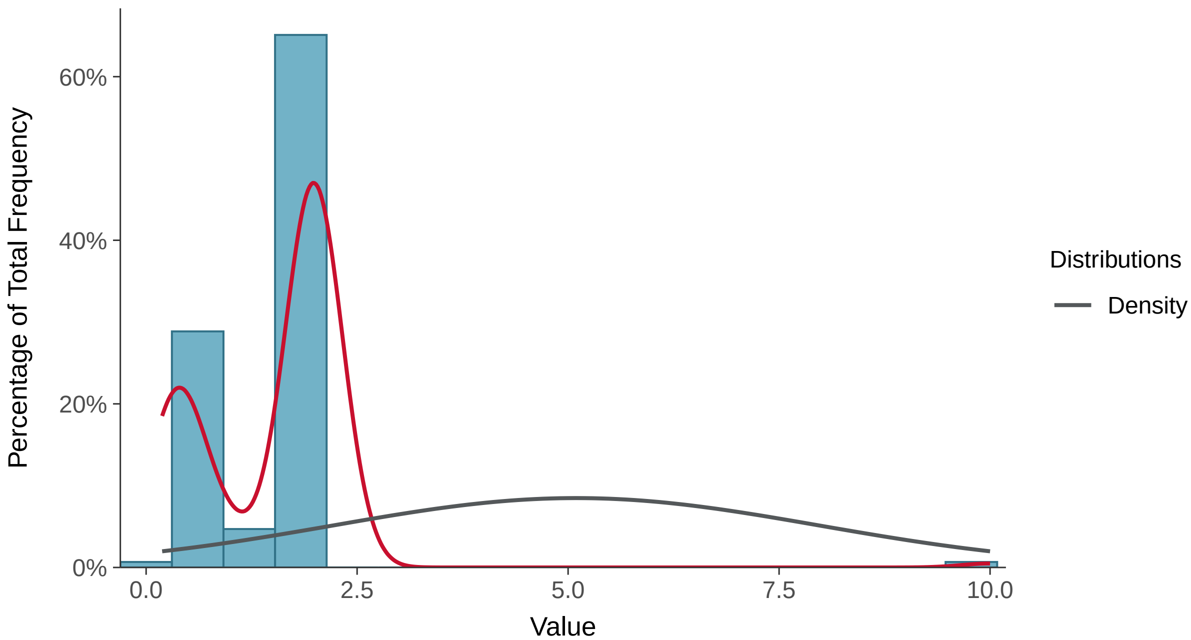
Scatter Plot by Well

Thallium, Pooled Background (ug/L)



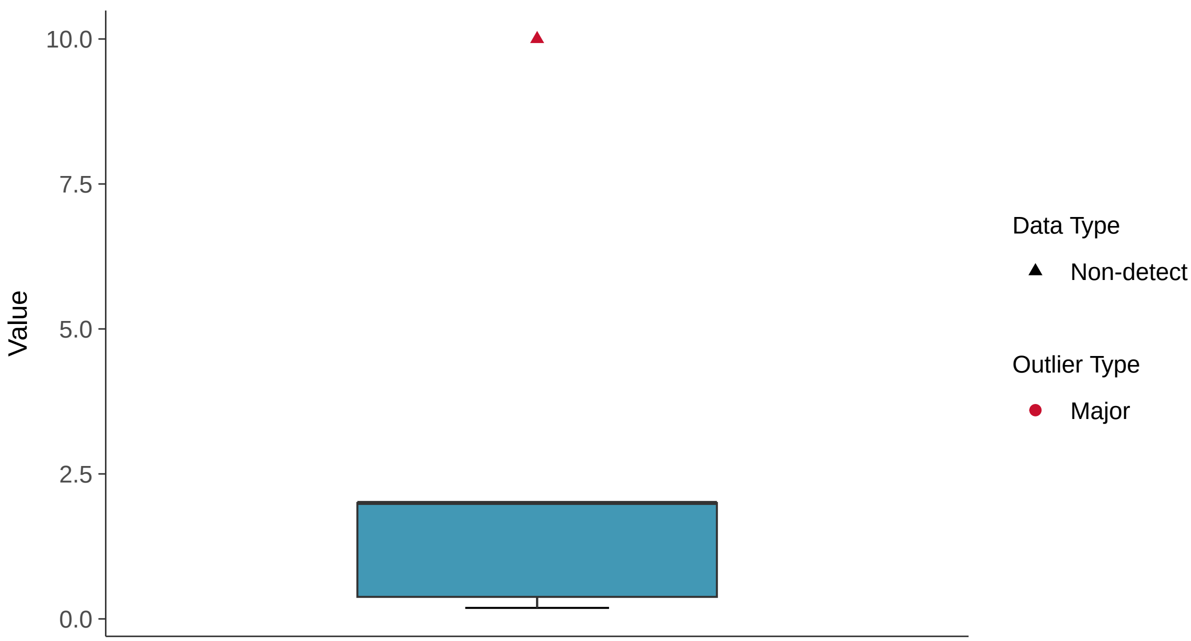
Histogram

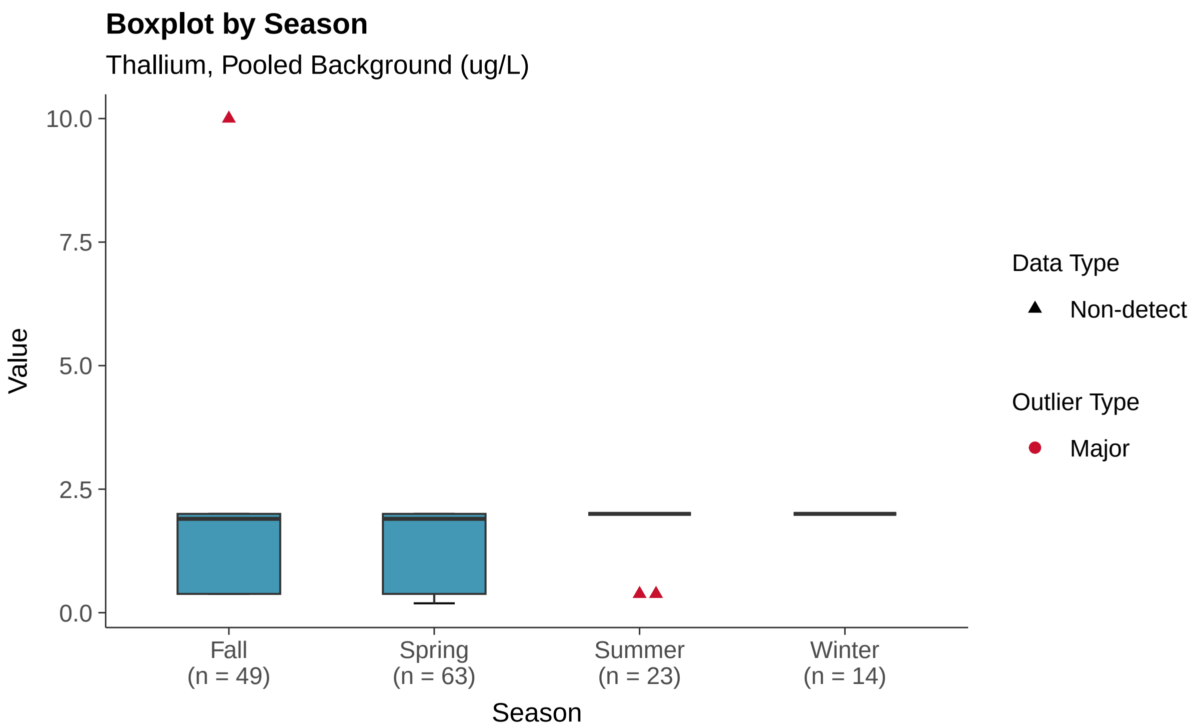
Thallium, Pooled Background (ug/L)

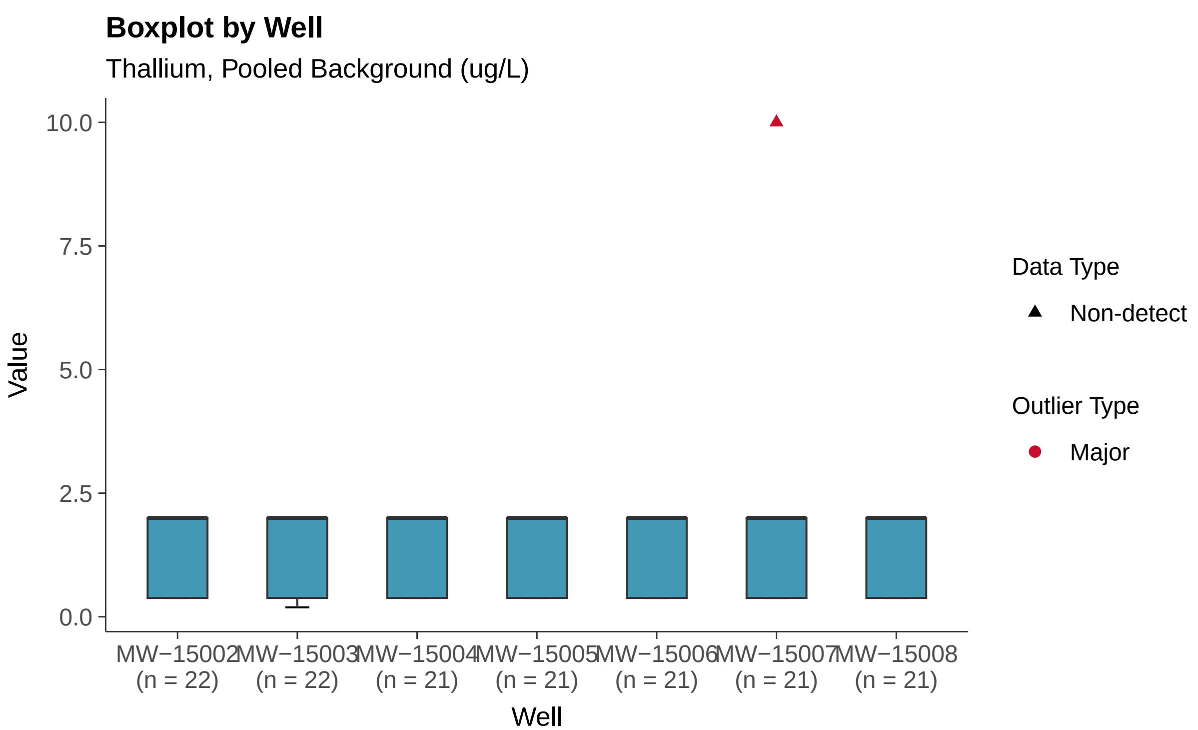


Boxplot

Thallium, Pooled Background (ug/L)

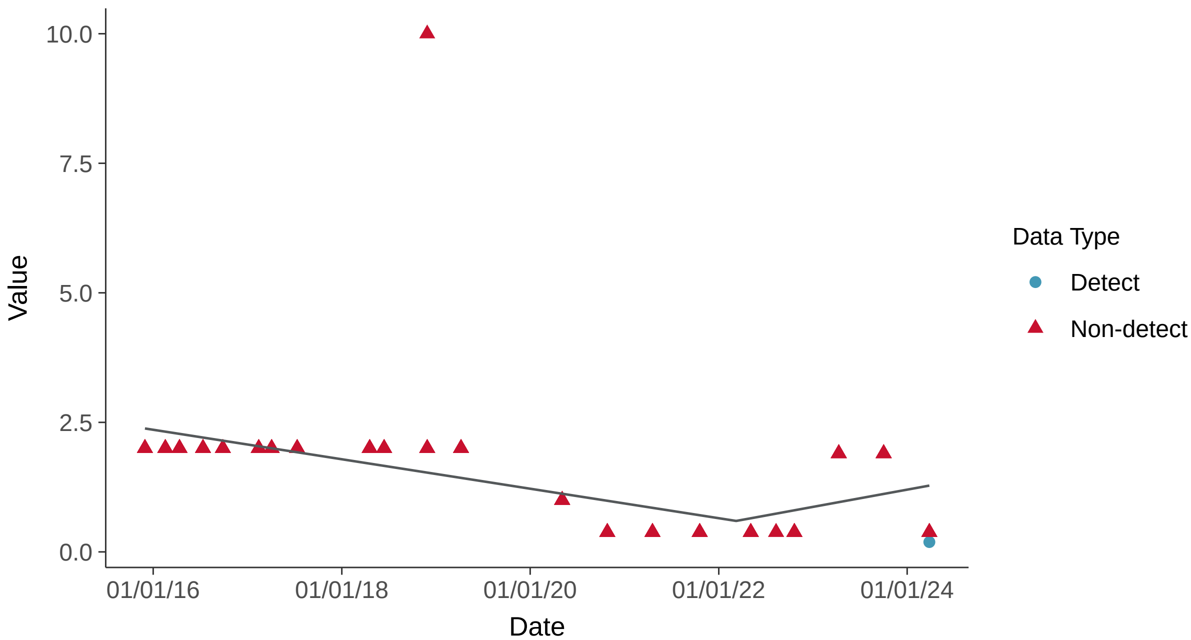



Boxplot by Season
Thallium, Pooled Background (ug/L)
Value
10.0
7.5
5.0
2.5
0.0
Fall
(n = 49)
Spring
(n = 63)
Summer
(n = 23)
Winter
(n = 14)
Season
Data Type
Non-detect
Outlier Type
Major


Boxplot by Well
Thallium, Pooled Background (ug/L)
Value
10.0
7.5
5.0
2.5
0.0
MW−15002
(n = 22)
MW−15003
(n = 22)
MW−15004
(n = 21)
MW−15005
(n = 21)
MW−15006
(n = 21)
MW−15007
(n = 21)
MW−15008
(n = 21)
Well
Data Type
Non-detect
Outlier Type
Major

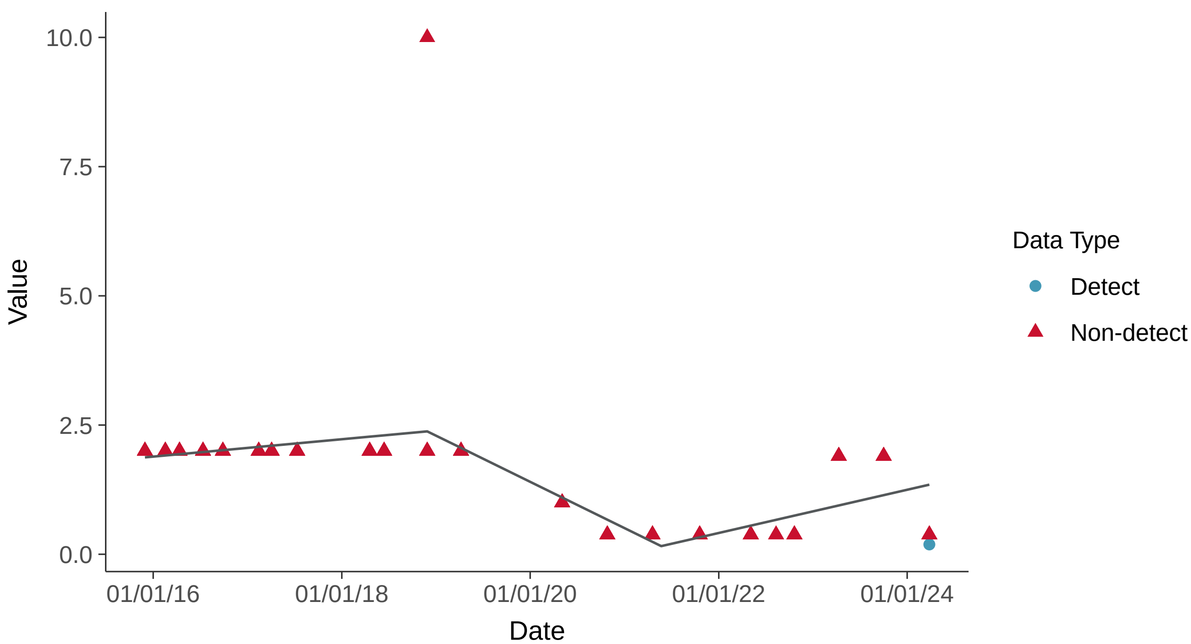
Trend Regression: Piecewise Linear-Linear

Thallium, Pooled Background (ug/L)



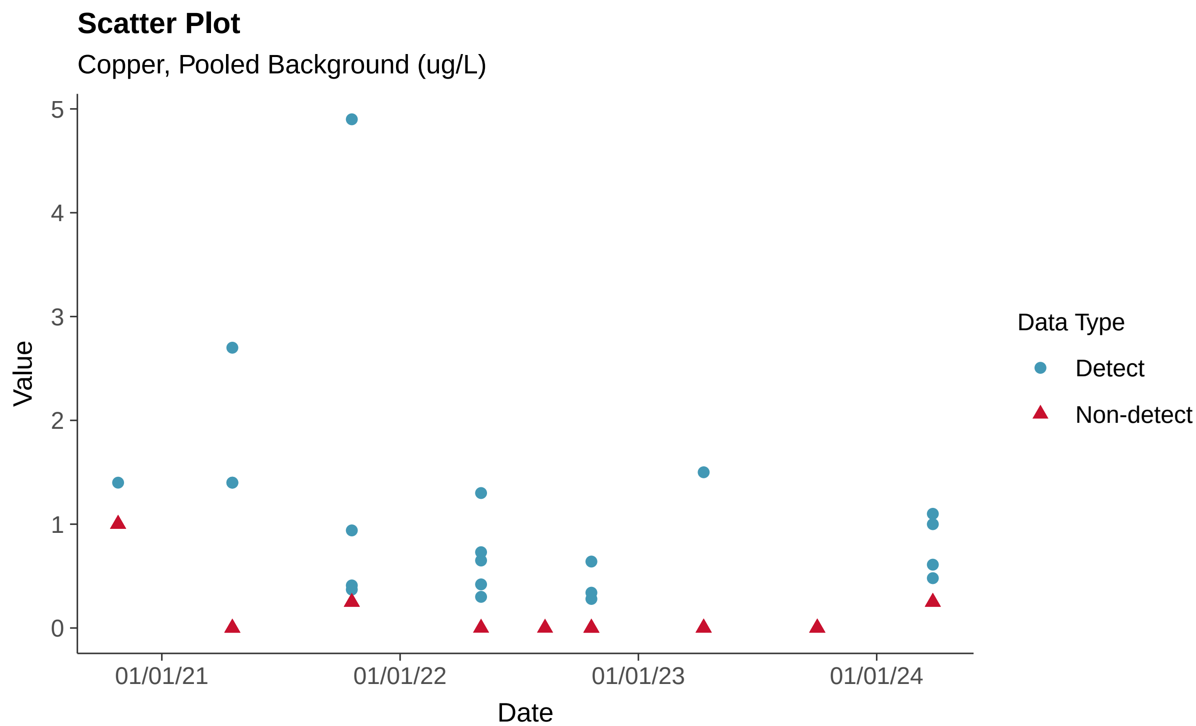
Trend Regression: Piecewise Linear-Linear-Linear

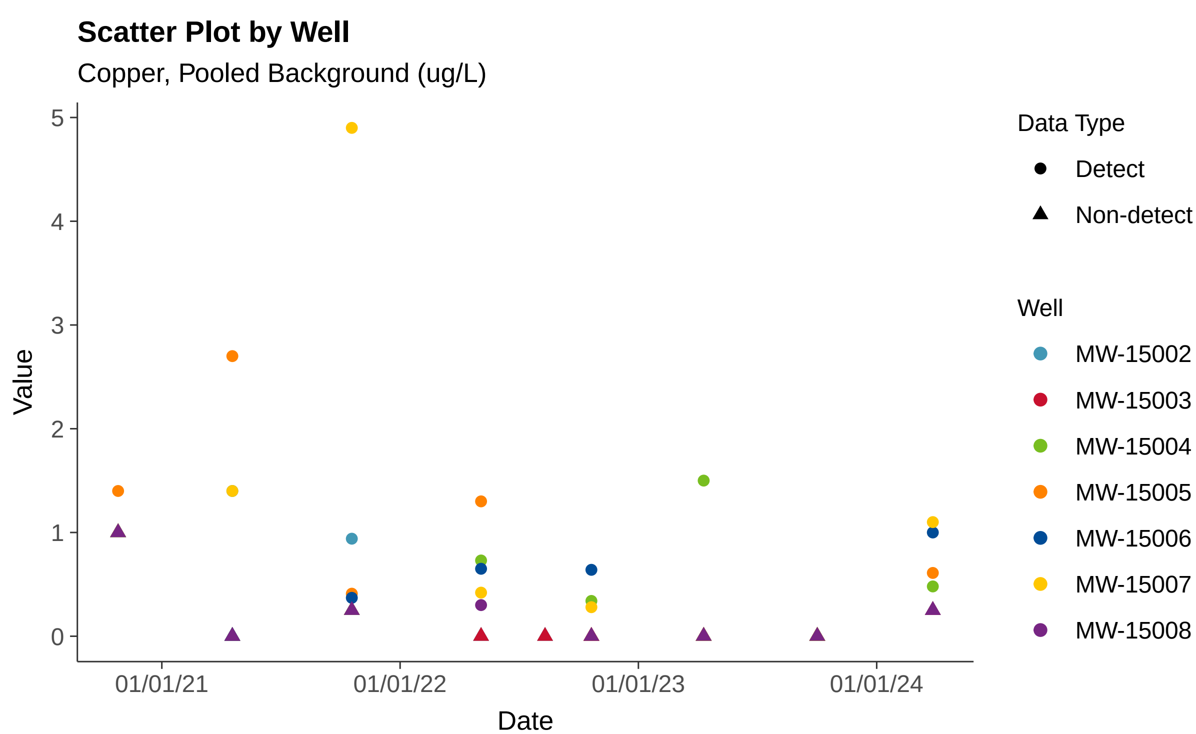
Thallium, Pooled Background (ug/L)

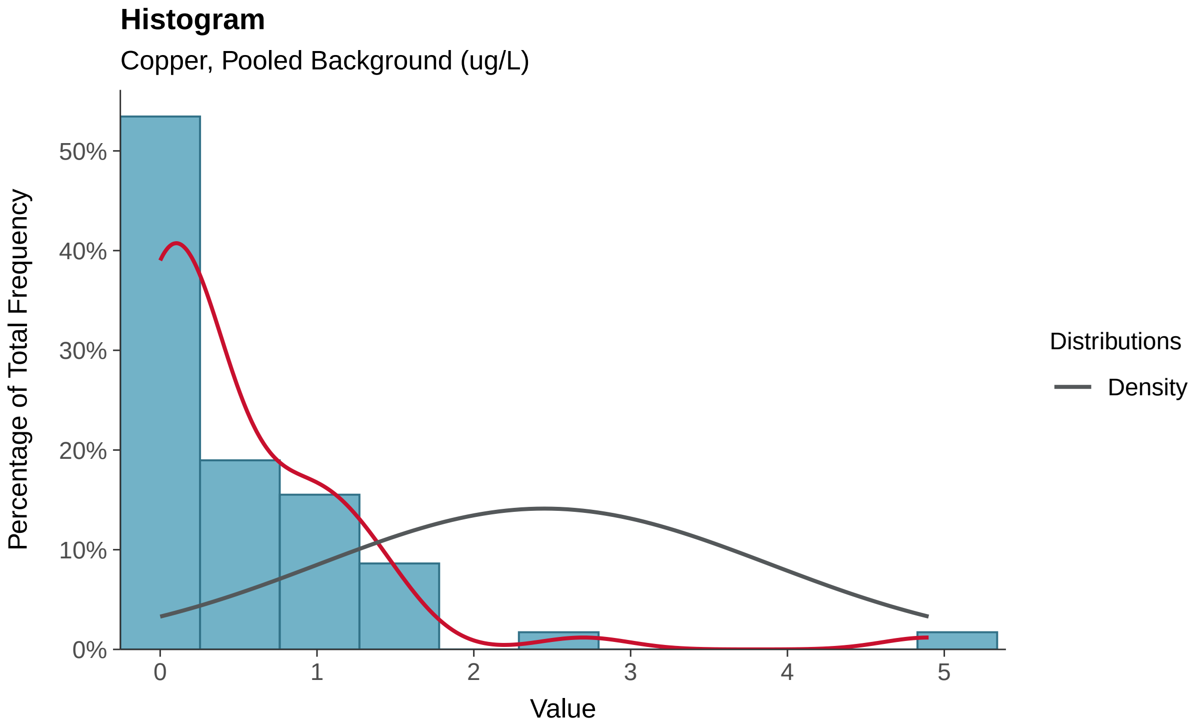


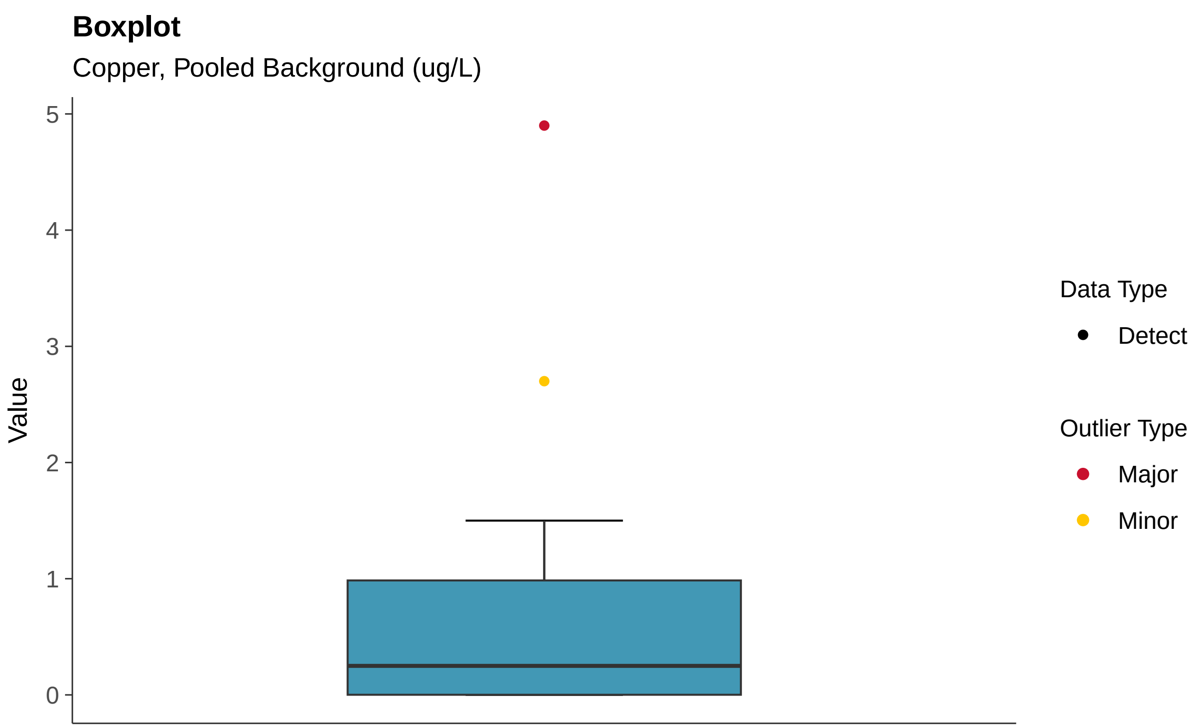
Michigan CCR: Copper, Pooled Background

ID: 4_112



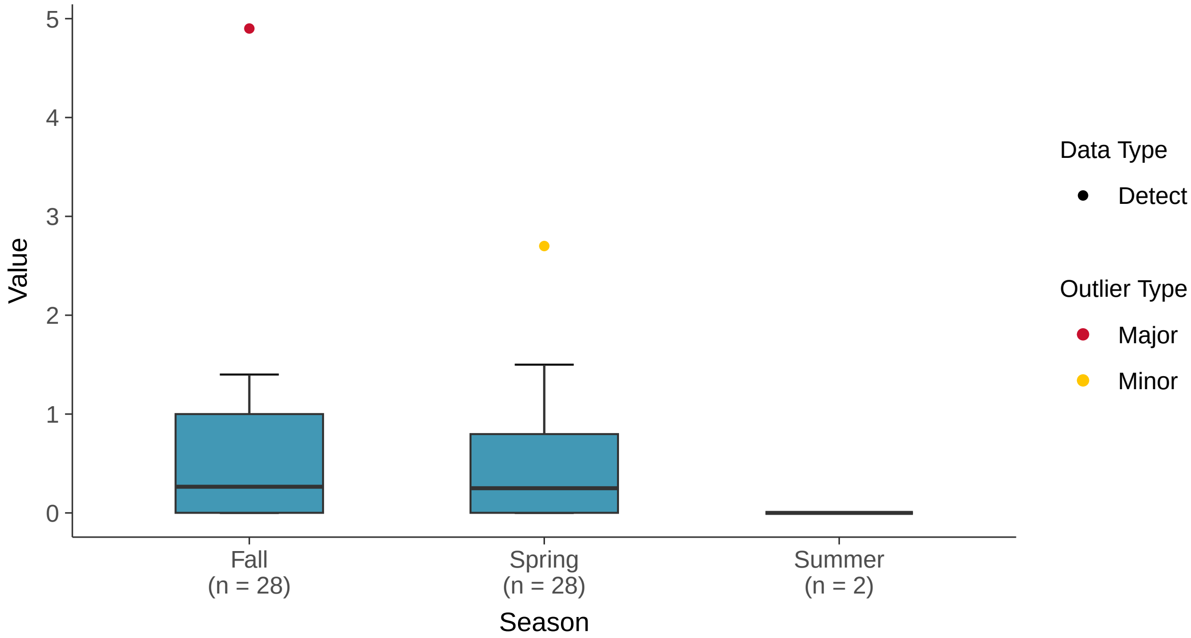



Histogram
Copper, Pooled Background (ug/L)
Percentage of Total Frequency
50%
40%
30%
20%
10%
0%
0
1
2
3
4
5
Value
Distributions
Density


Boxplot
Copper, Pooled Background (ug/L)
Value
5
4
3
2
1
0
Data Type
Detect
Outlier Type
Major
Minor

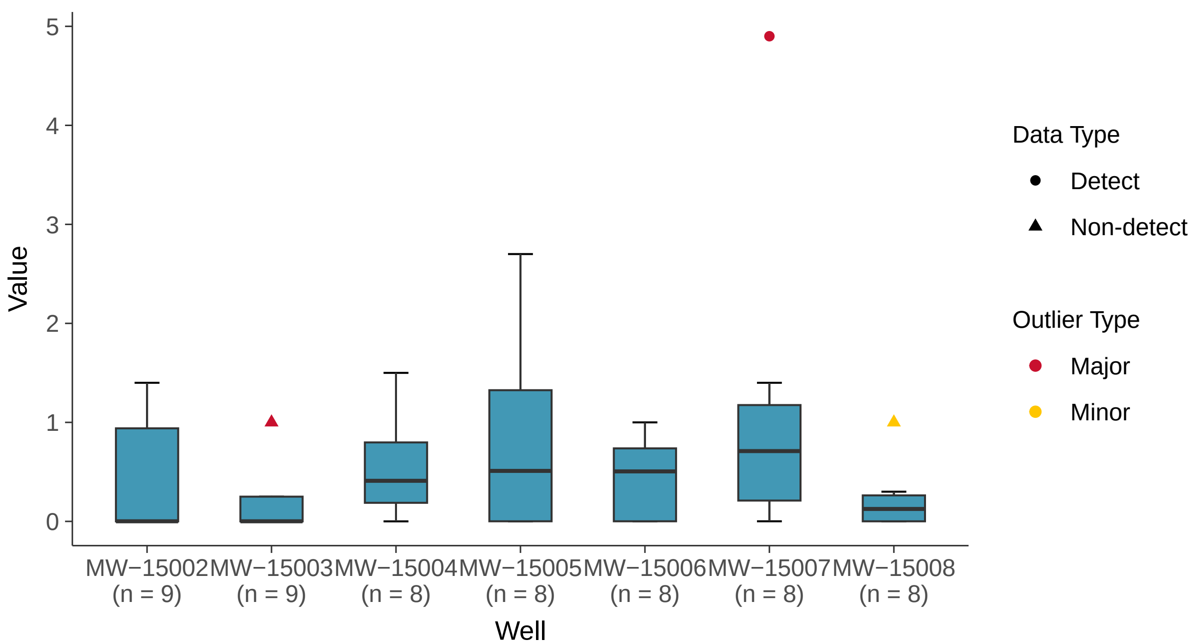
Boxplot by Season

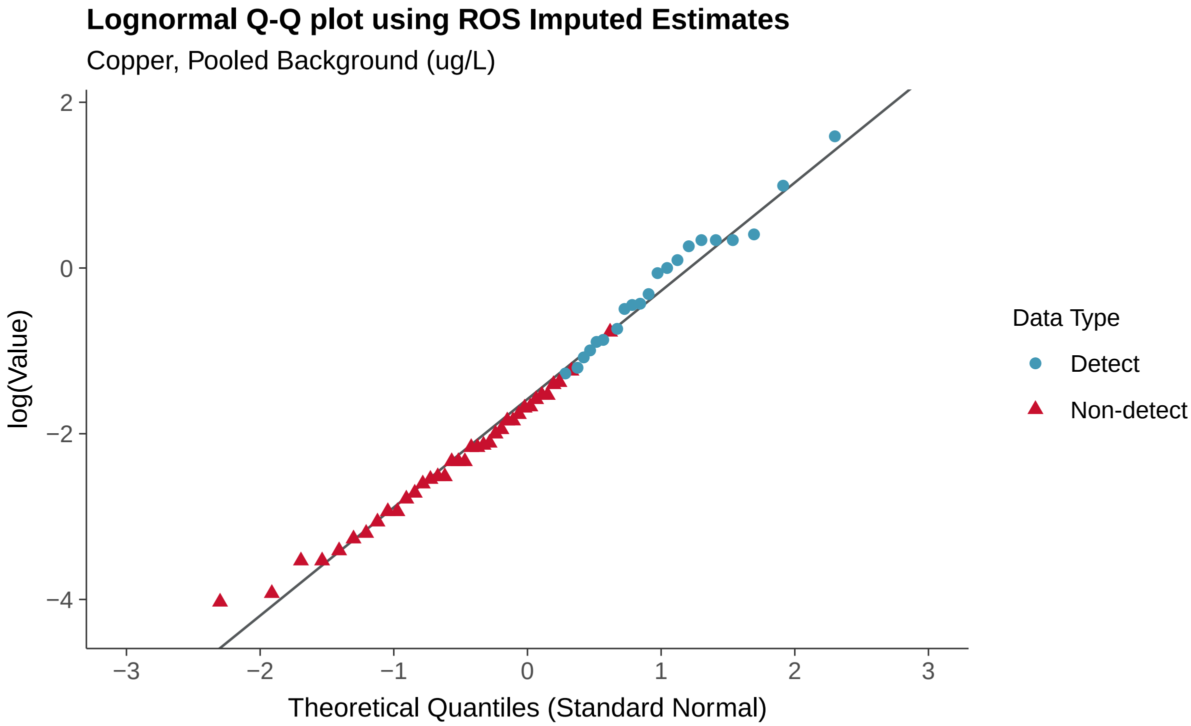
Copper, Pooled Background (ug/L)

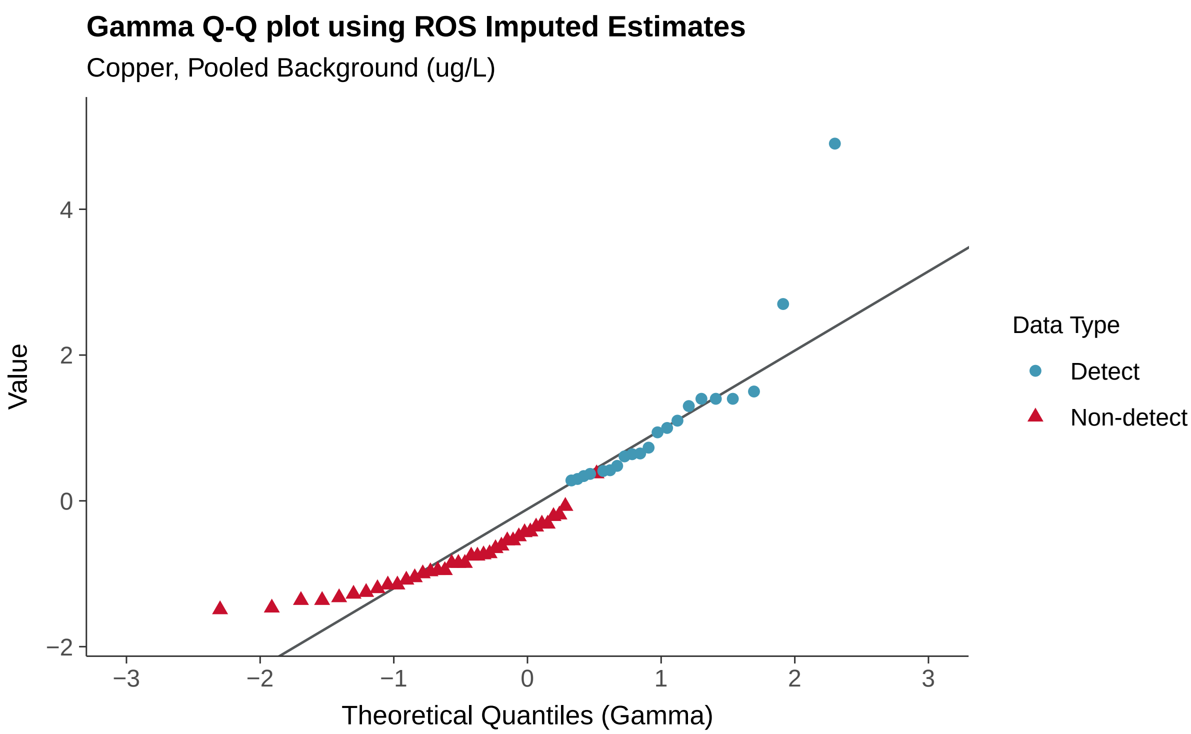


Boxplot by Well

Copper, Pooled Background (ug/L)

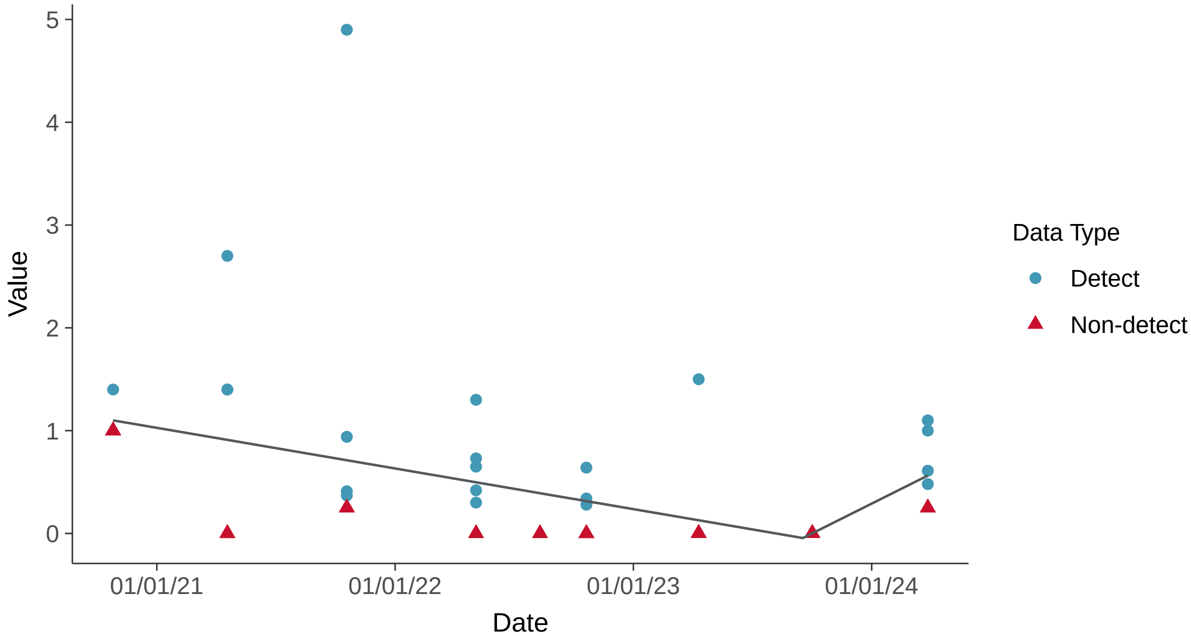



Lognormal Q-Q plot using ROS Imputed Estimates
Copper, Pooled Background (ug/L)
log(Value)
2
0
−2
−4
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Gamma Q-Q plot using ROS Imputed Estimates
Copper, Pooled Background (ug/L)
Value
4
2
0
−2
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Gamma)
Data Type
Detect
Non-detect

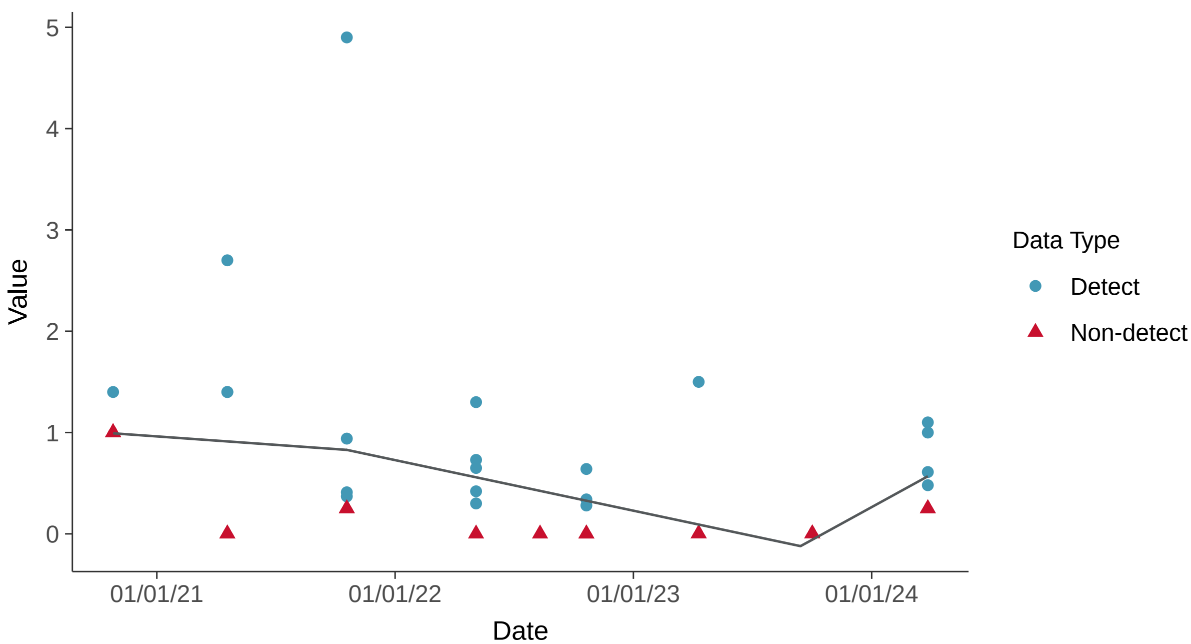
Trend Regression: Piecewise Linear-Linear

Copper, Pooled Background (ug/L)



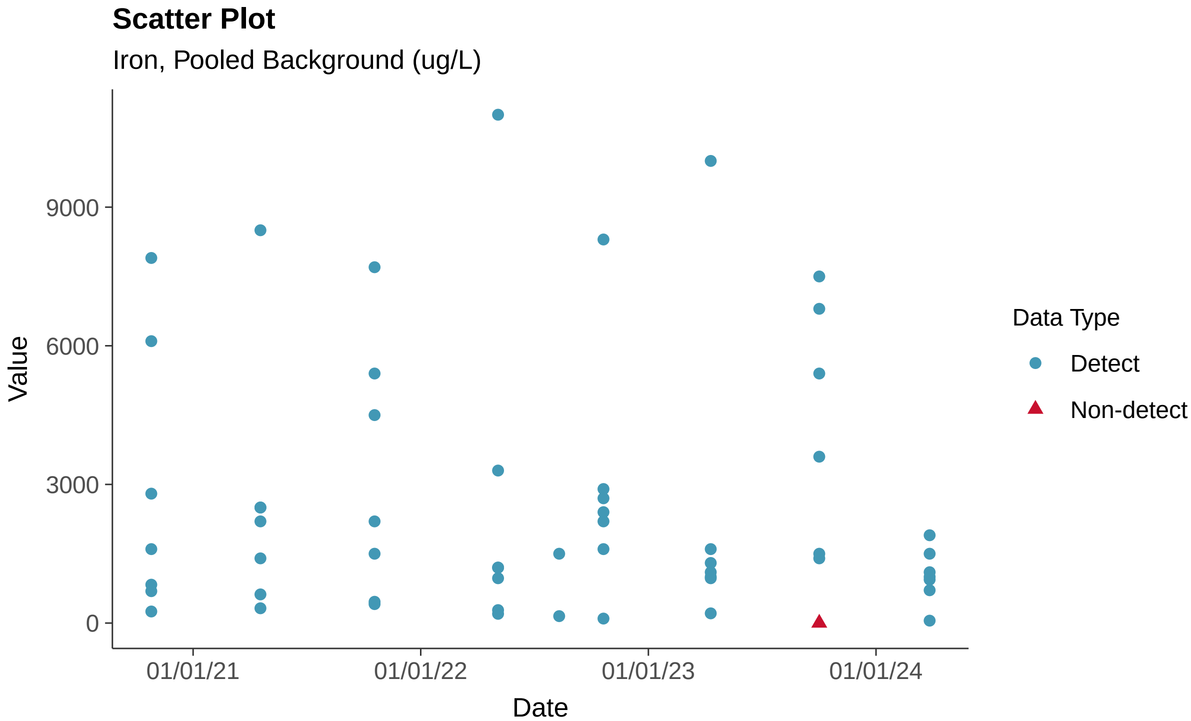
Trend Regression: Piecewise Linear-Linear-Linear

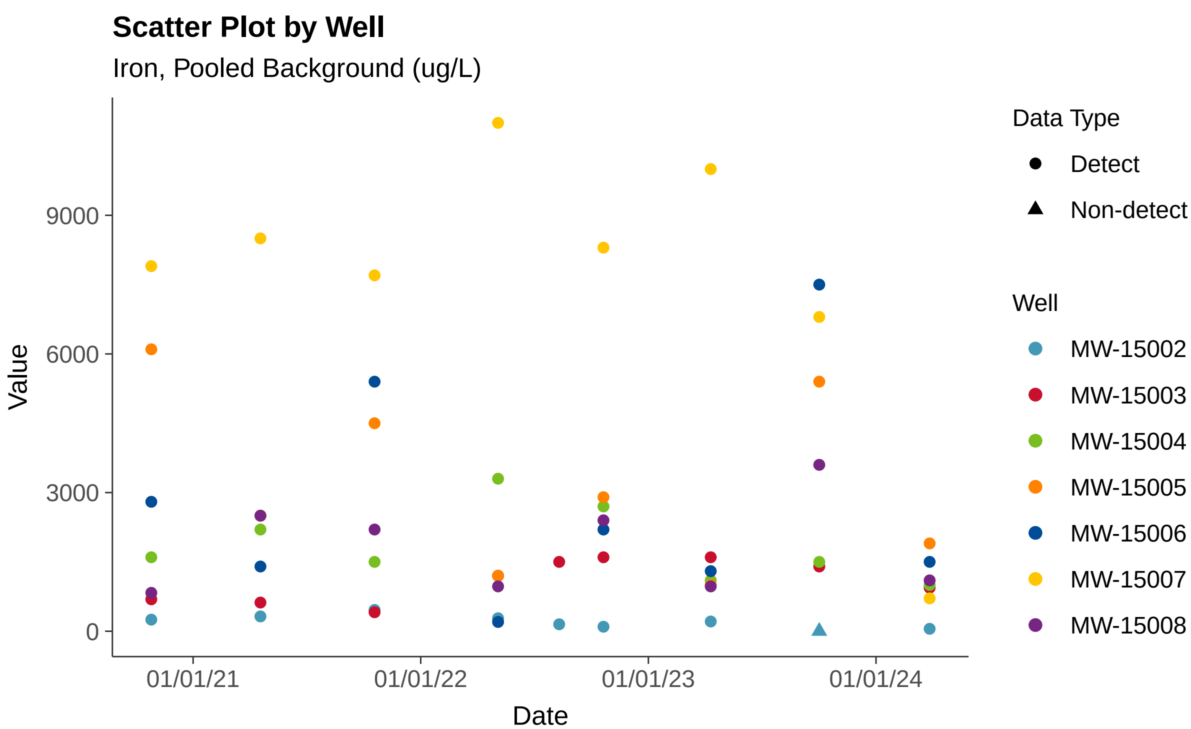
Copper, Pooled Background (ug/L)



Michigan CCR: Iron, Pooled Background

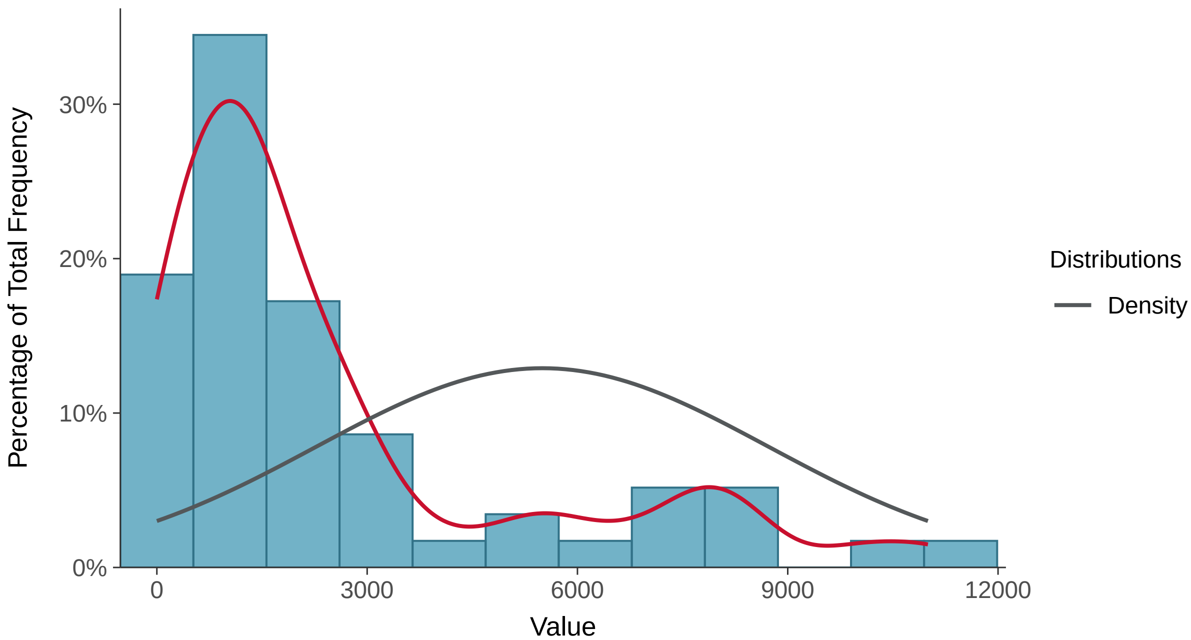
ID: 4_115





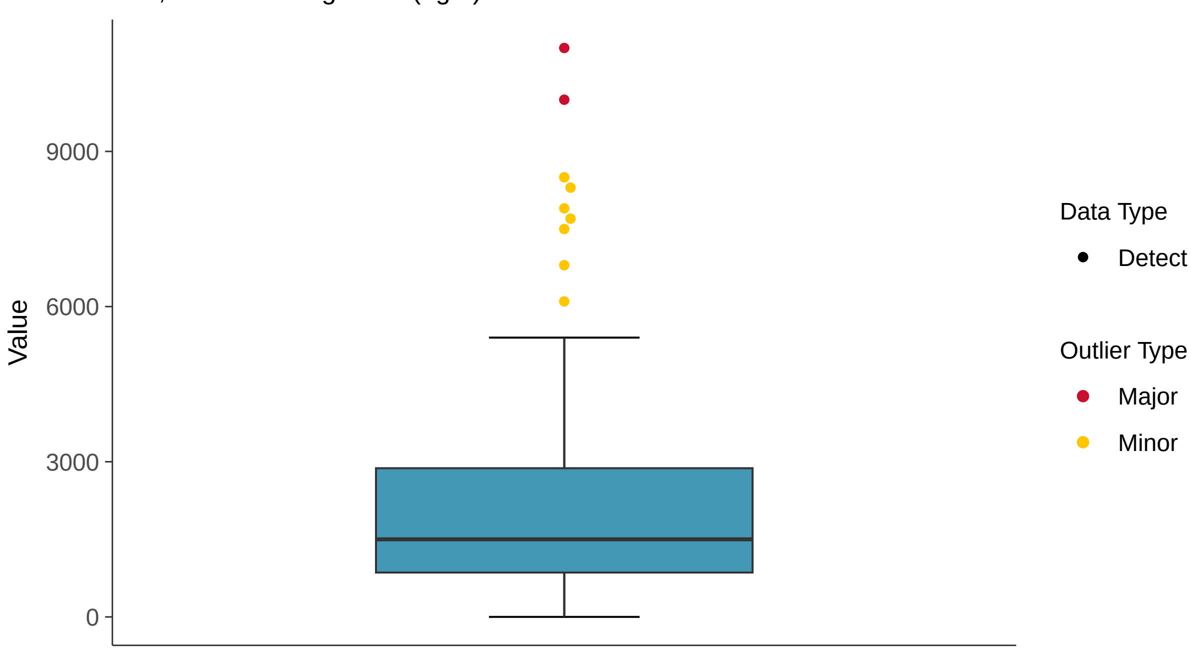
Histogram

Iron, Pooled Background (ug/L)



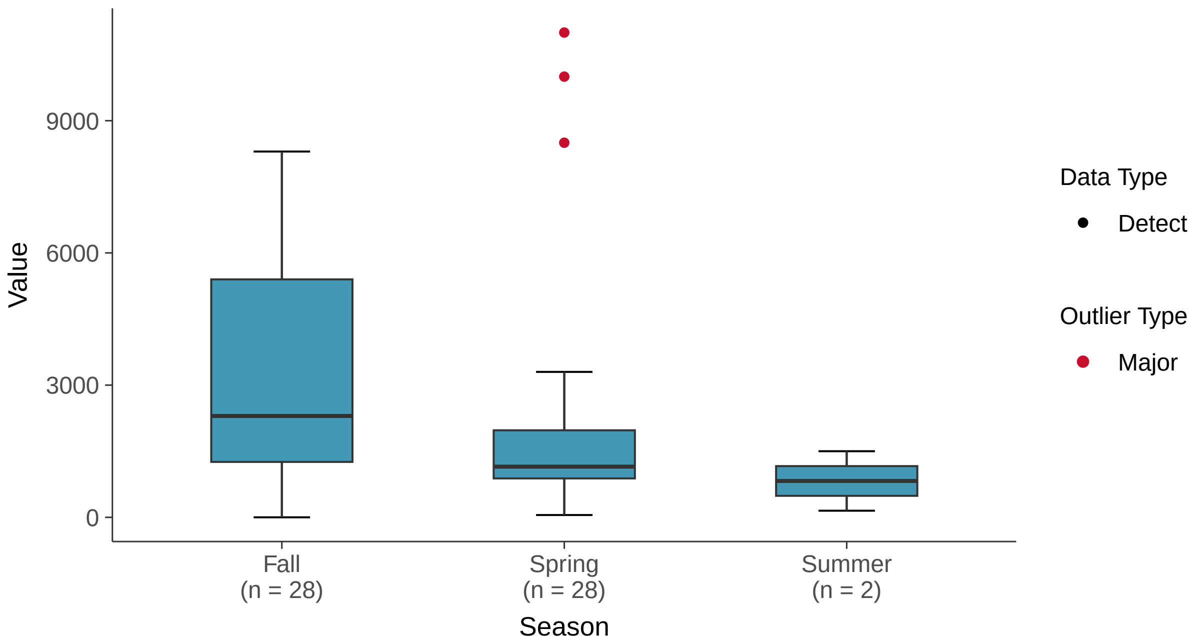
Boxplot

Iron, Pooled Background (ug/L)



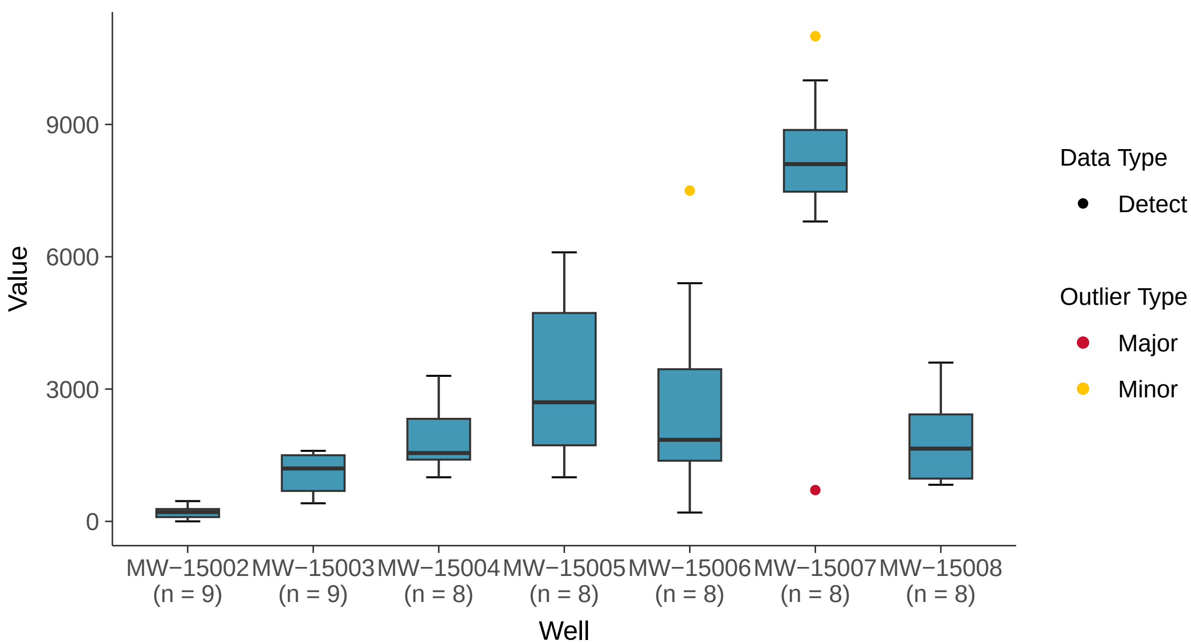
Boxplot by Season

Iron, Pooled Background (ug/L)



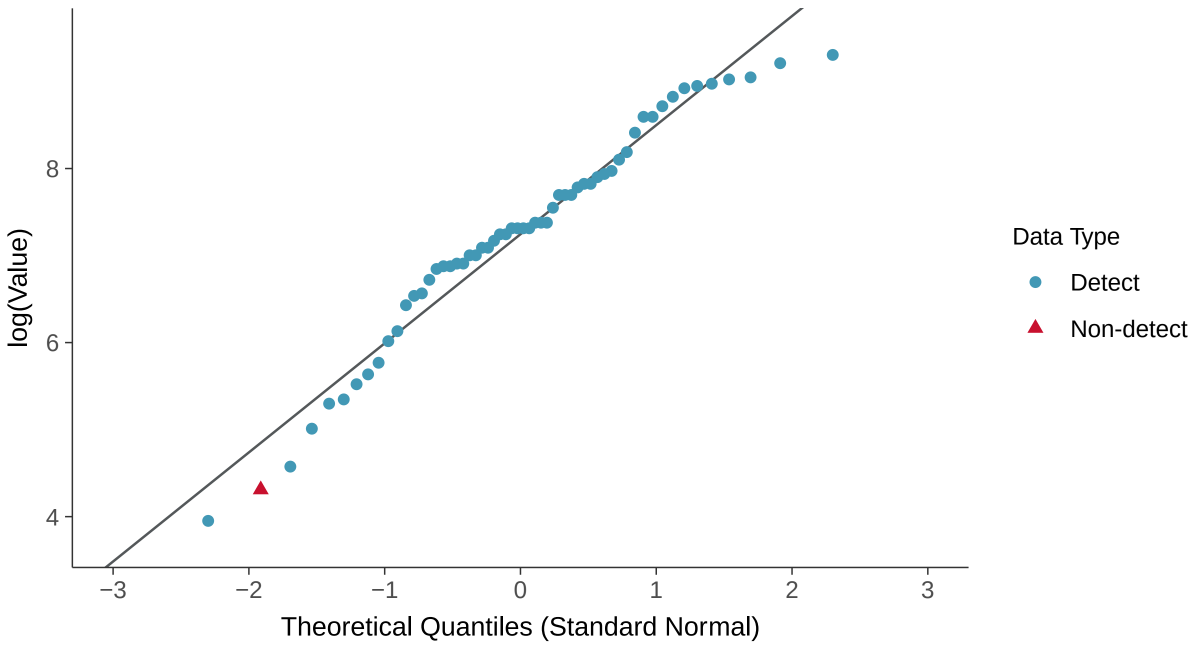
Boxplot by Well

Iron, Pooled Background (ug/L)



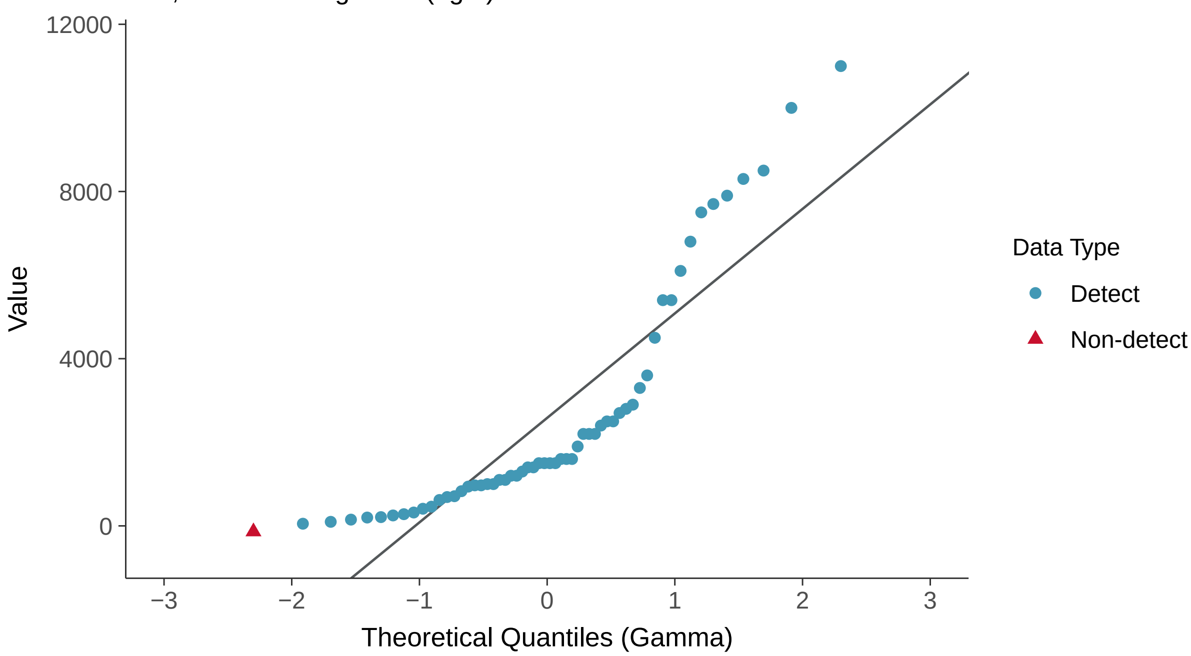
Lognormal Q-Q plot using ROS Imputed Estimates

Iron, Pooled Background (ug/L)



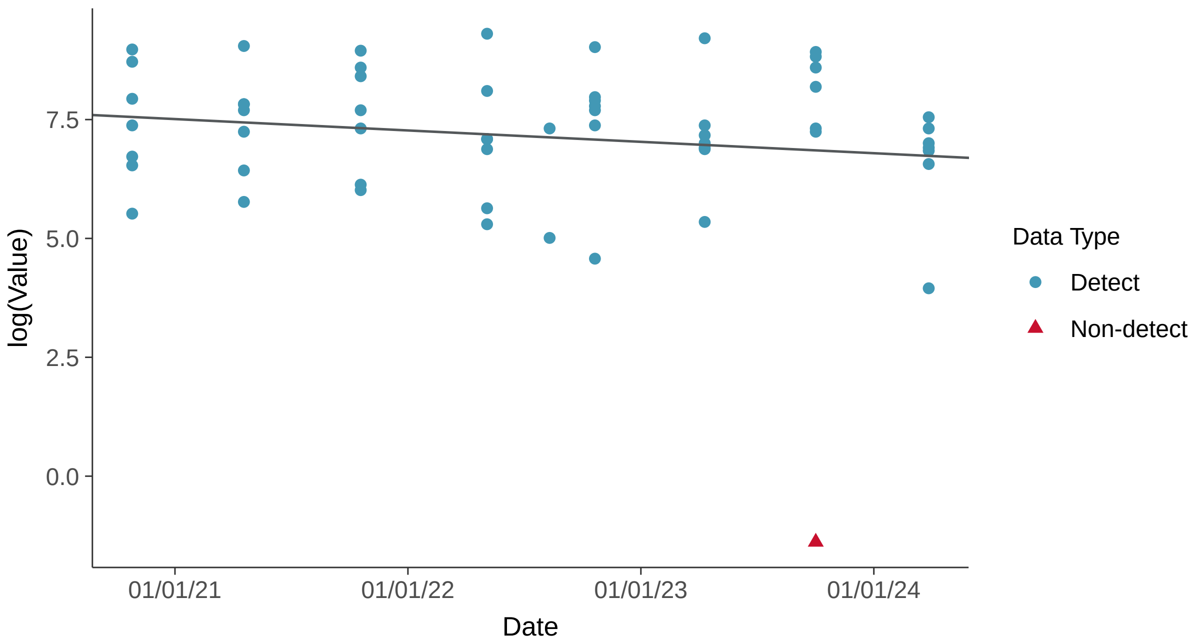
Gamma Q-Q plot using ROS Imputed Estimates

Iron, Pooled Background (ug/L)



Trend Regression: Lognormal MLE

Iron, Pooled Background (ug/L)

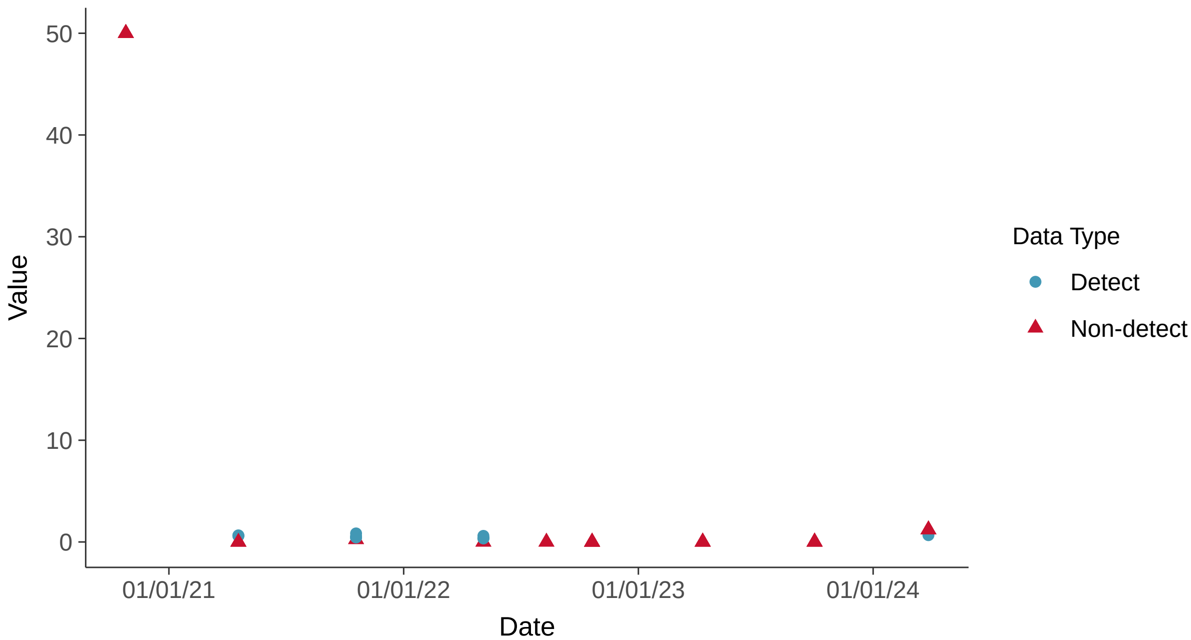


Michigan CCR: Nickel, Pooled Background

ID: 4_120

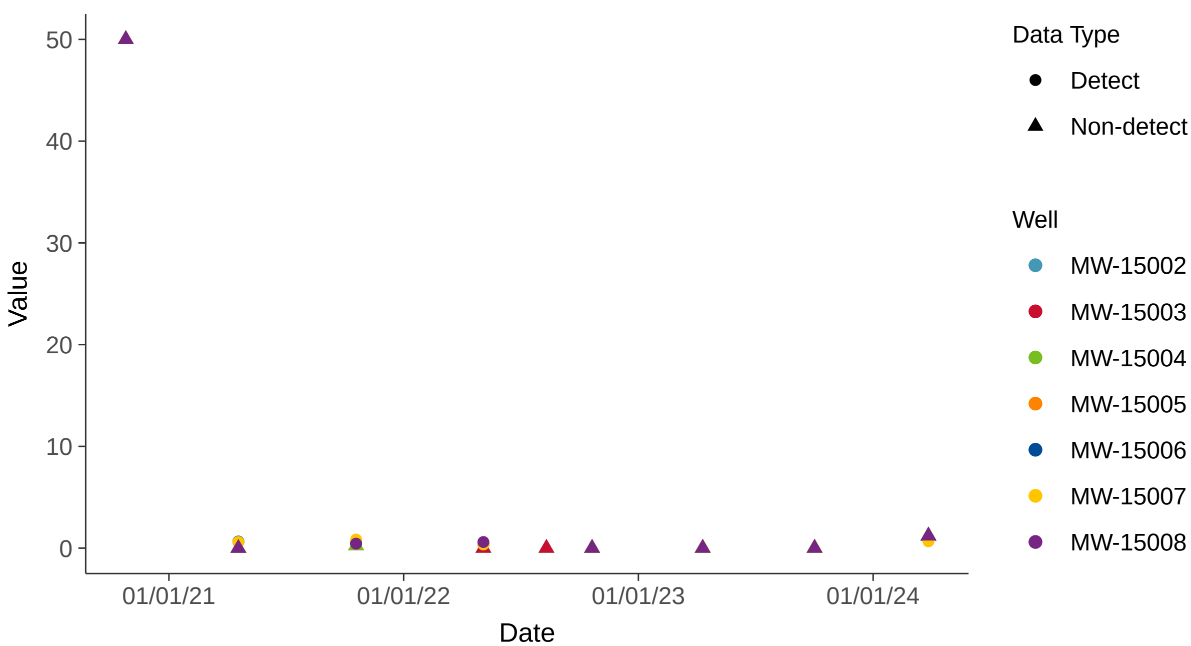
Scatter Plot

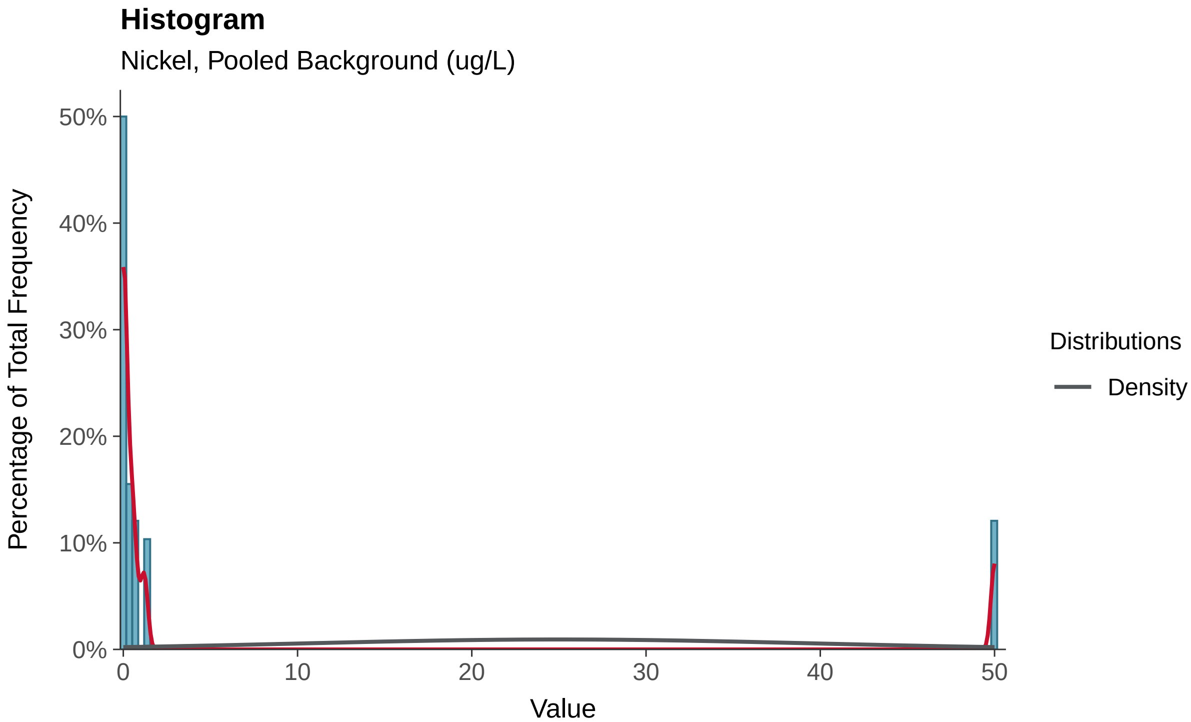
Nickel, Pooled Background (ug/L)

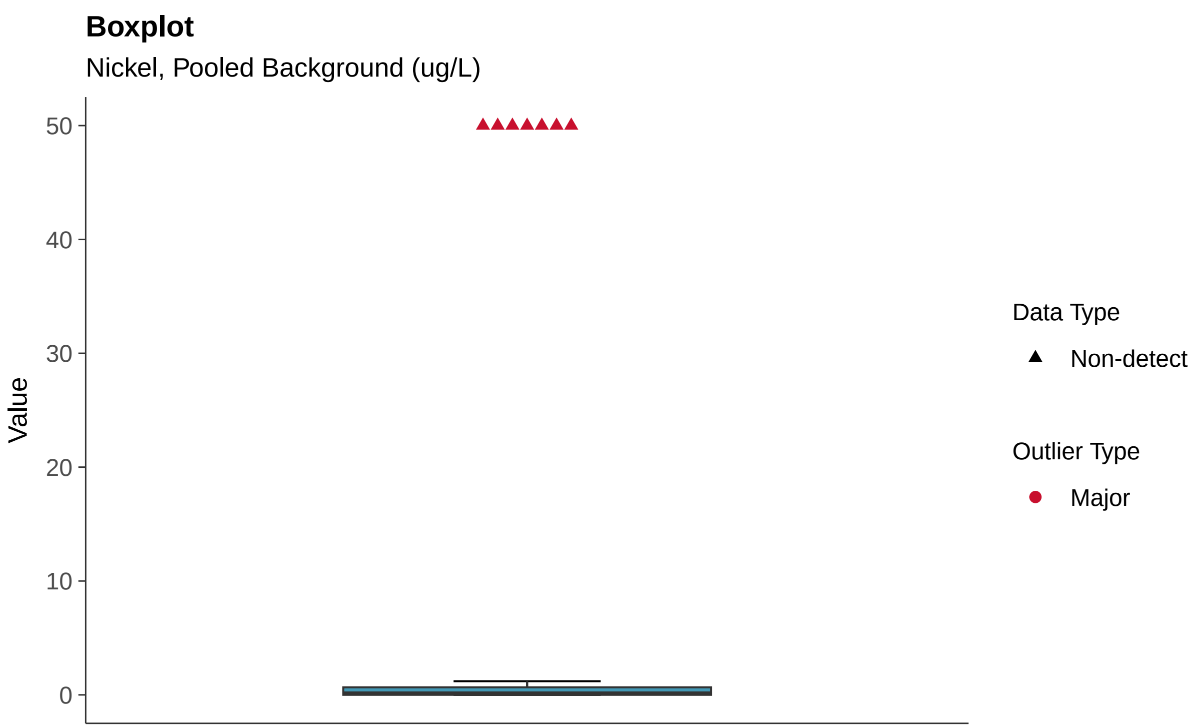


Scatter Plot by Well

Nickel, Pooled Background (ug/L)

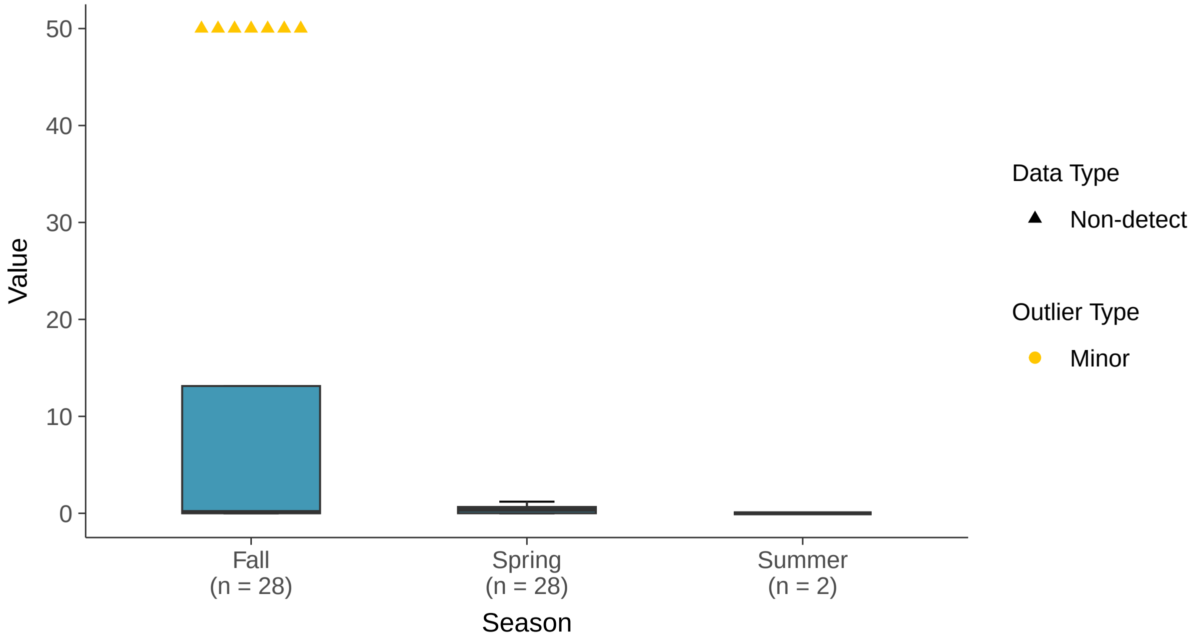



Histogram
Nickel, Pooled Background (ug/L)
Percentage of Total Frequency
50%
40%
30%
20%
10%
0%
0
10
20
30
40
50
Value
Distributions
Density


Boxplot
Nickel, Pooled Background (ug/L)
Value
50
40
30
20
10
0
Data Type
Non-detect
Outlier Type
Major

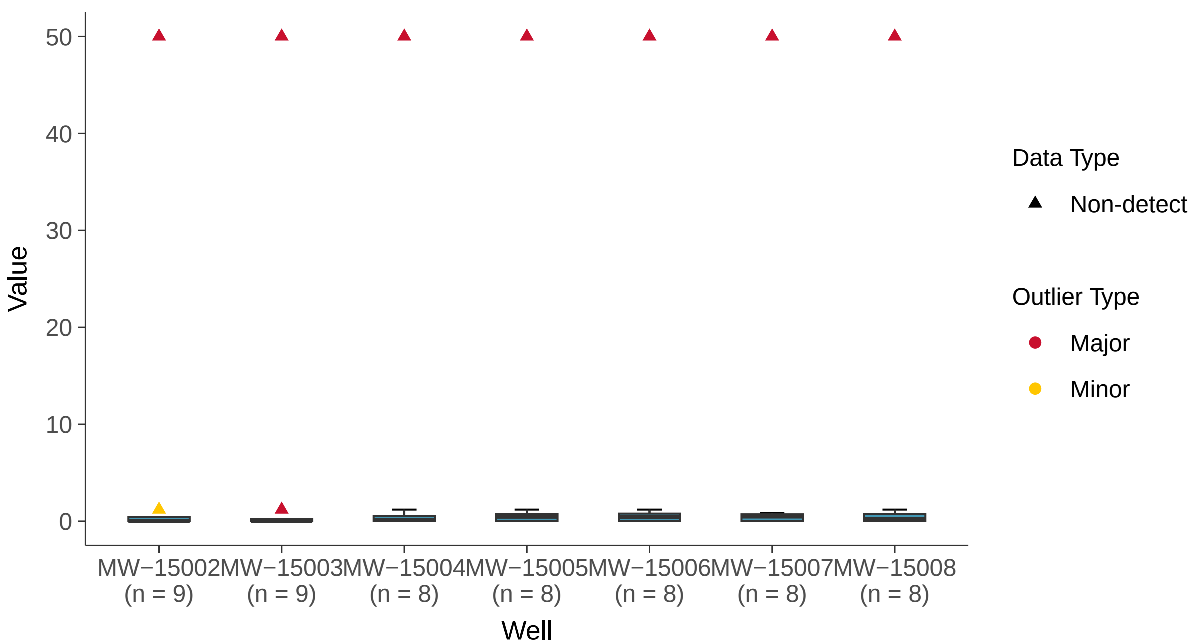
Boxplot by Season

Nickel, Pooled Background (ug/L)



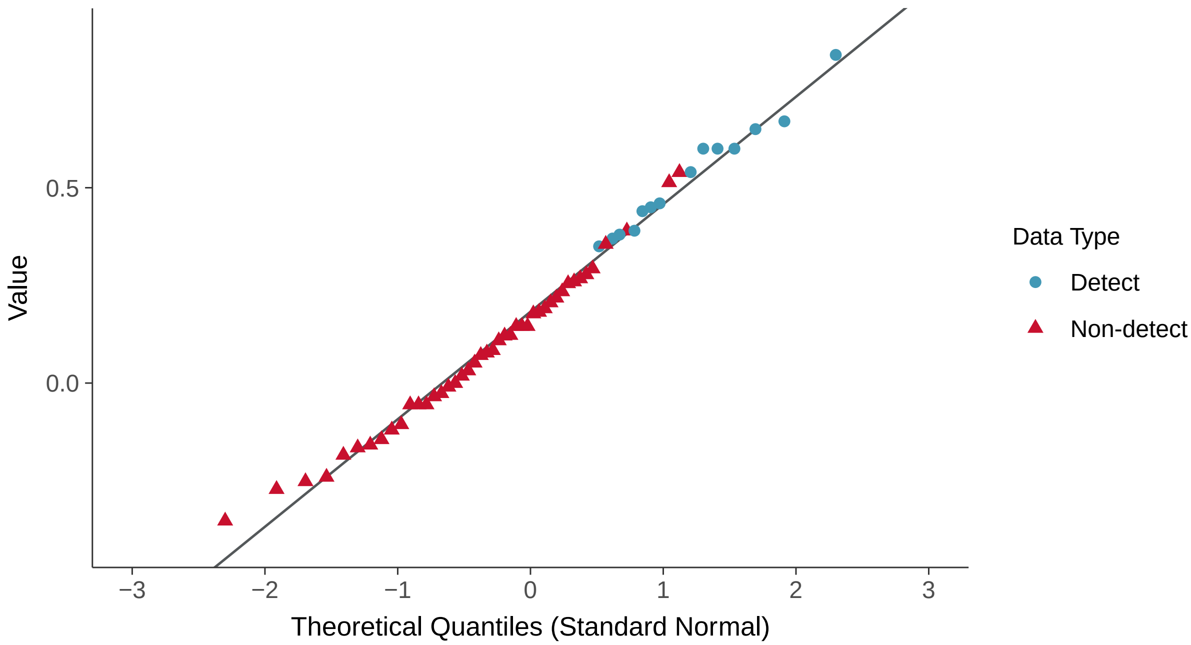
Boxplot by Well

Nickel, Pooled Background (ug/L)



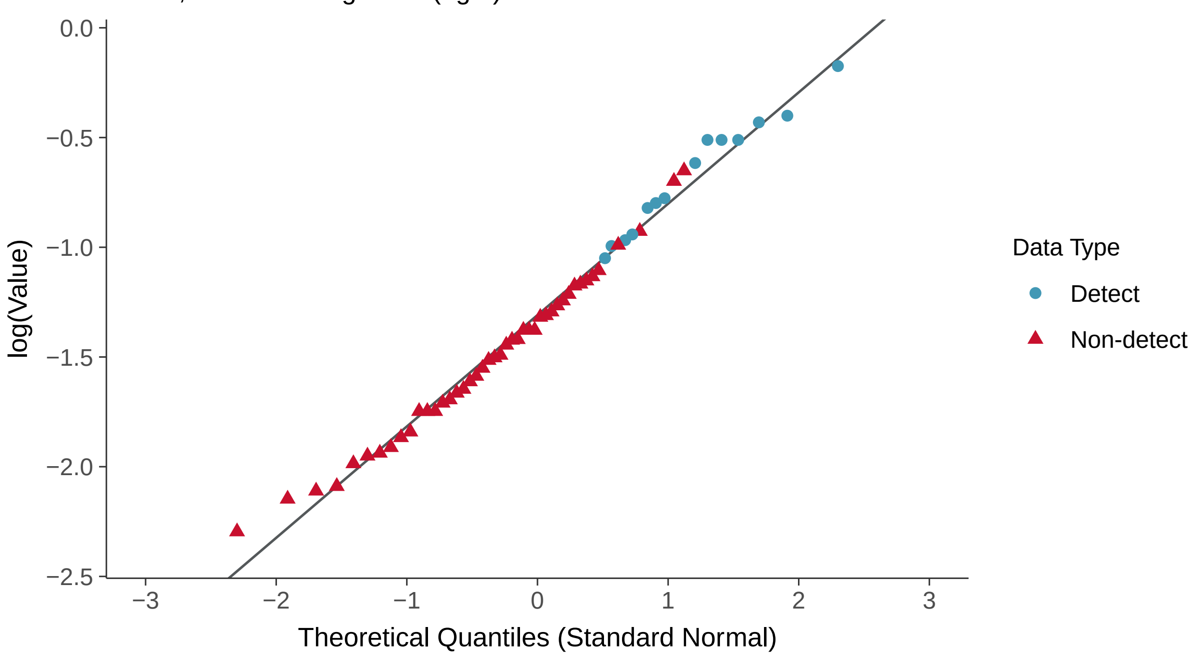
Normal Q-Q plot using ROS Imputed Estimates

Nickel, Pooled Background (ug/L)



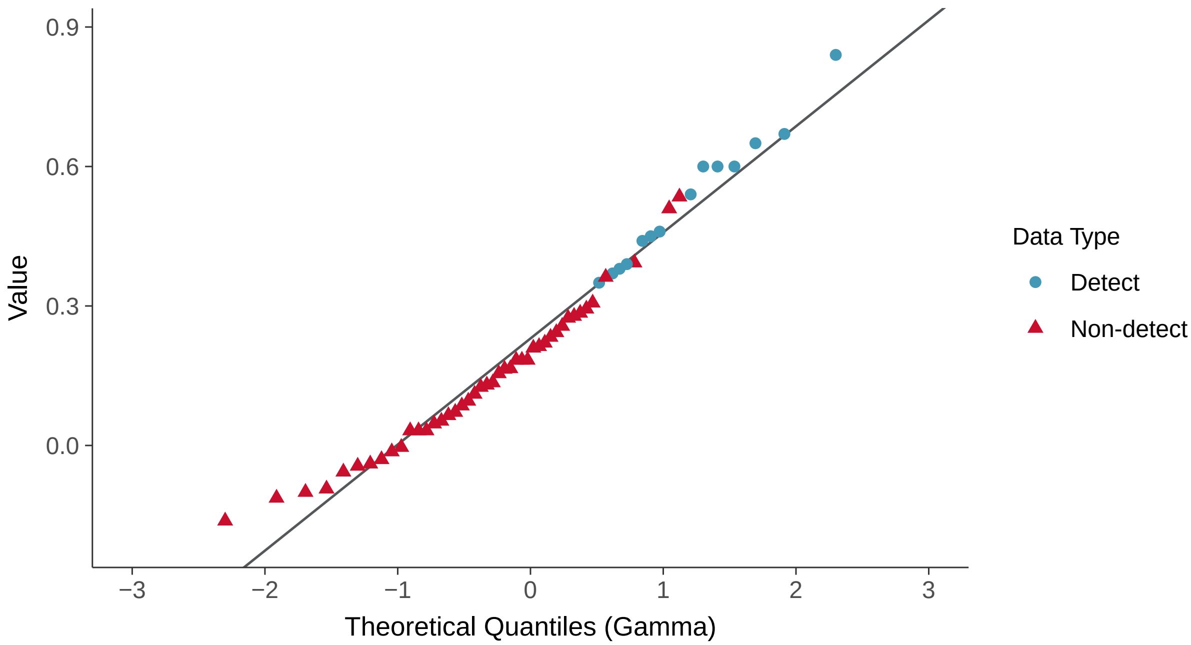
Lognormal Q-Q plot using ROS Imputed Estimates

Nickel, Pooled Background (ug/L)



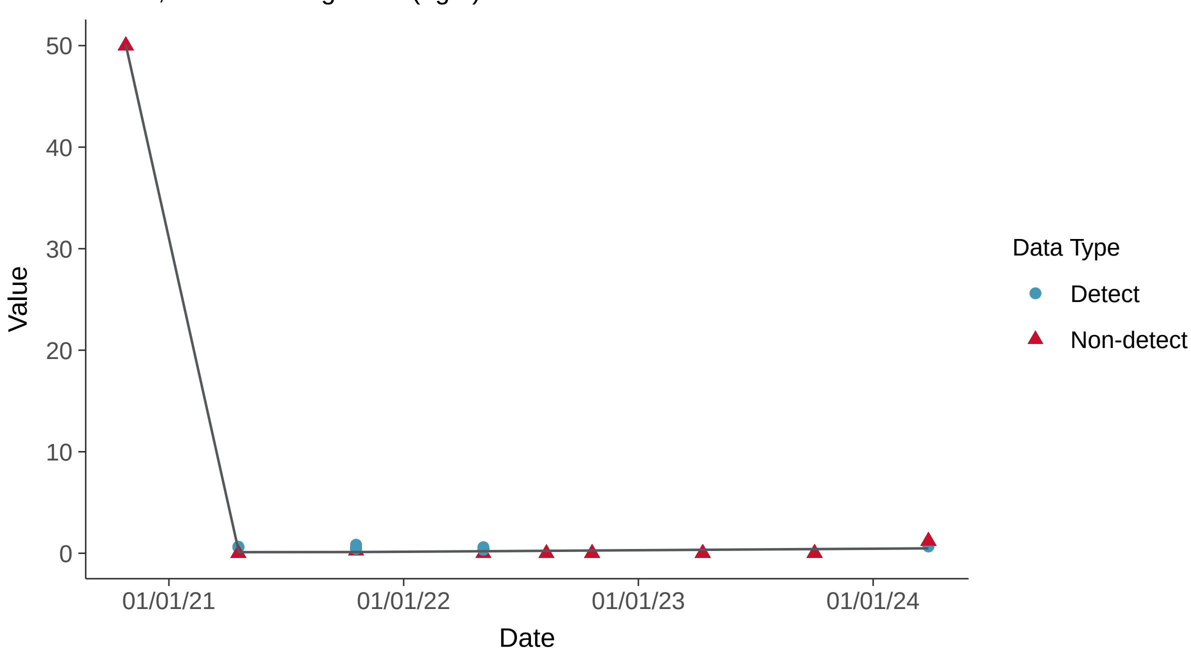
Gamma Q-Q plot using ROS Imputed Estimates

Nickel, Pooled Background (ug/L)



Trend Regression: Piecewise Linear-Linear

Nickel, Pooled Background (ug/L)

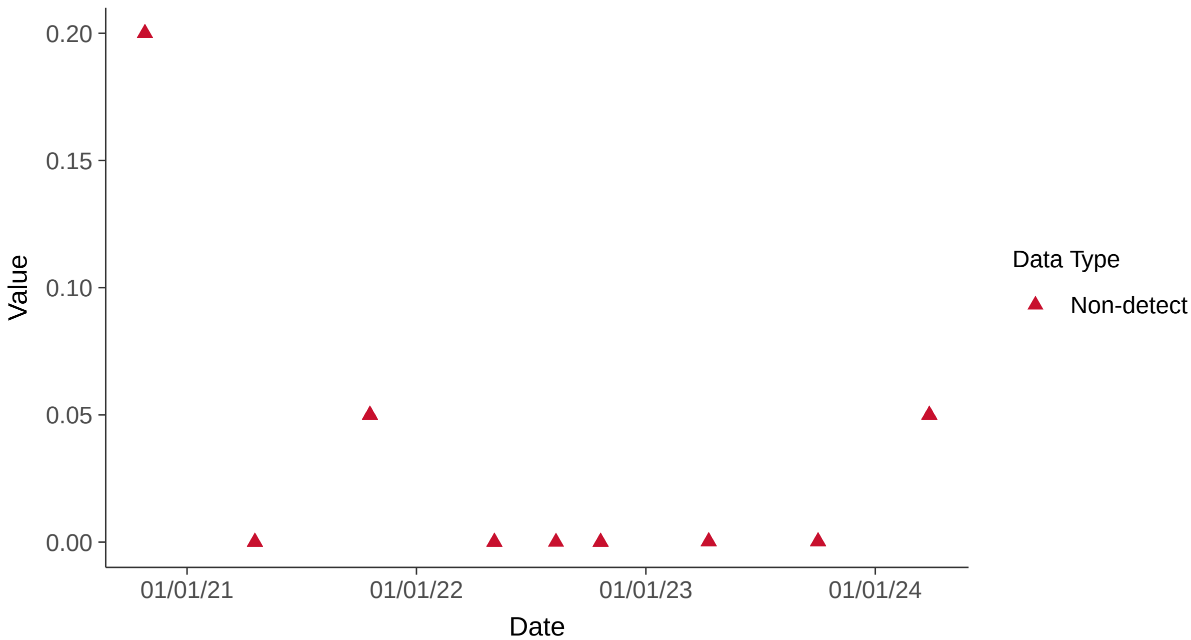


Michigan CCR: Silver, Pooled Background

ID: 4_127

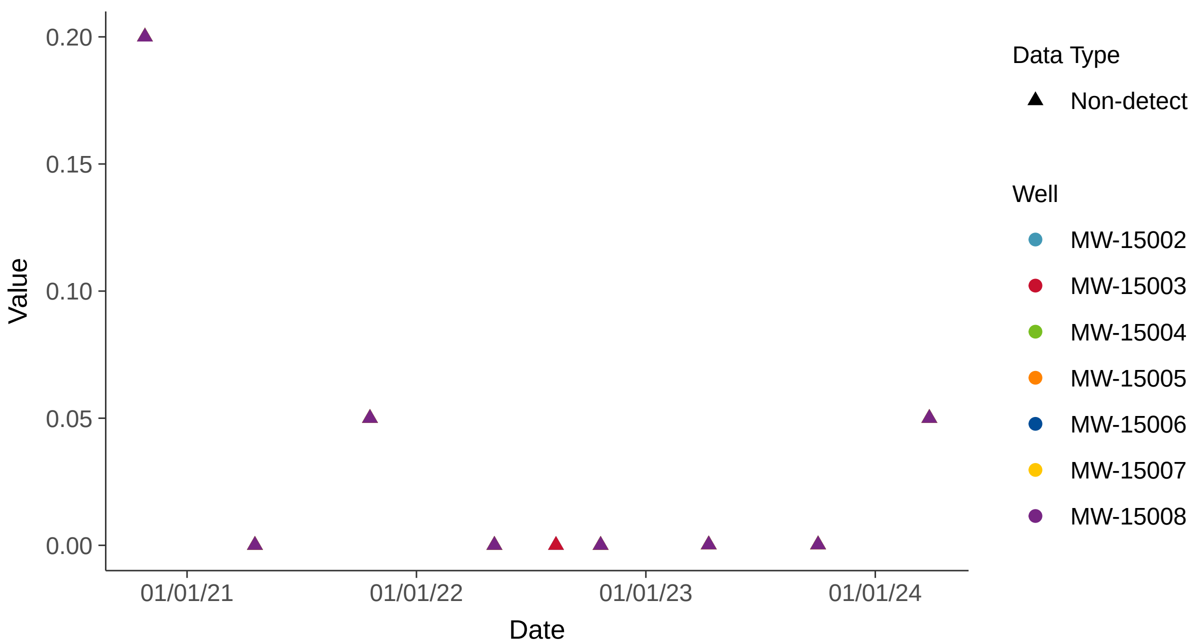
Scatter Plot

Silver, Pooled Background (ug/L)



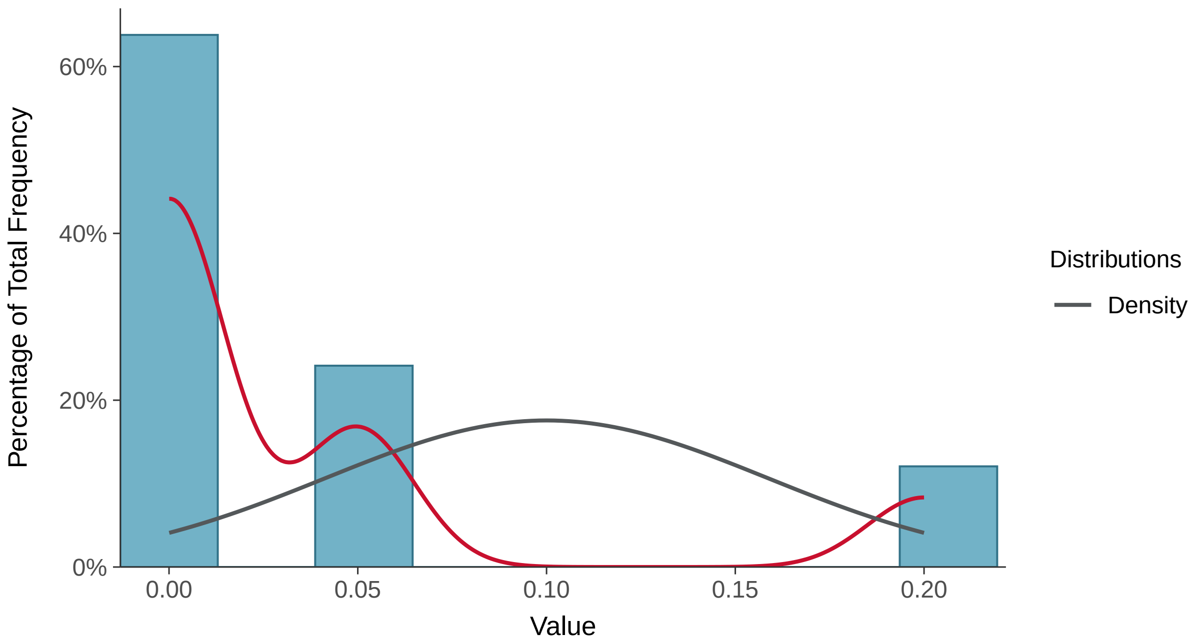
Scatter Plot by Well

Silver, Pooled Background (ug/L)



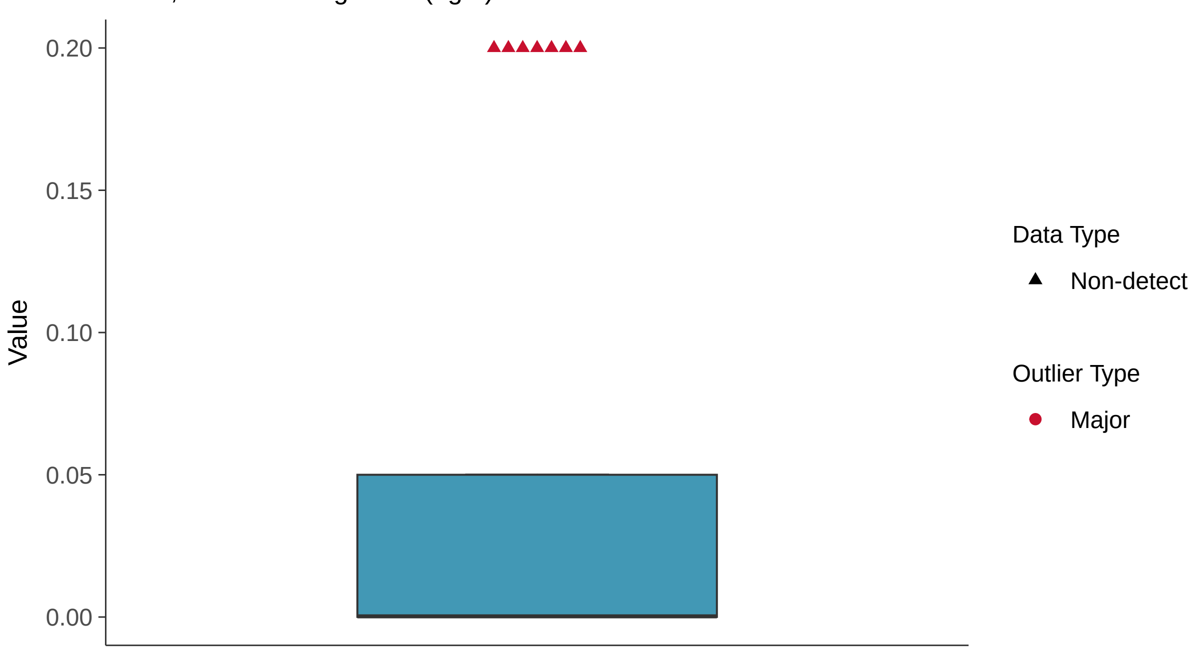
Histogram

Silver, Pooled Background (ug/L)



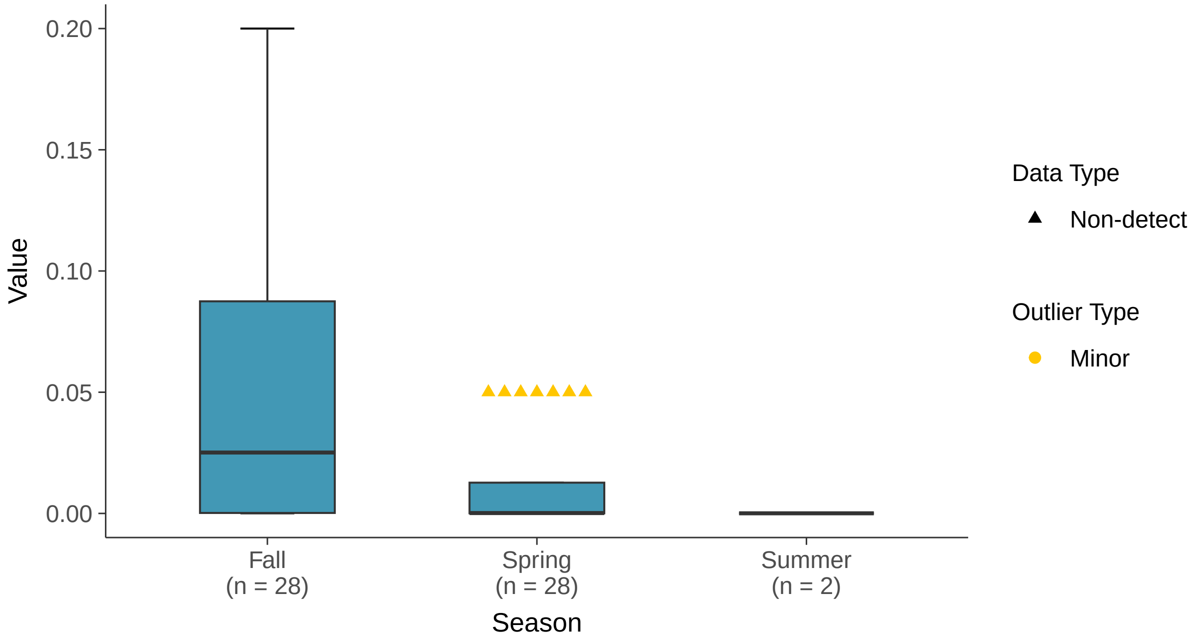
Boxplot

Silver, Pooled Background (ug/L)



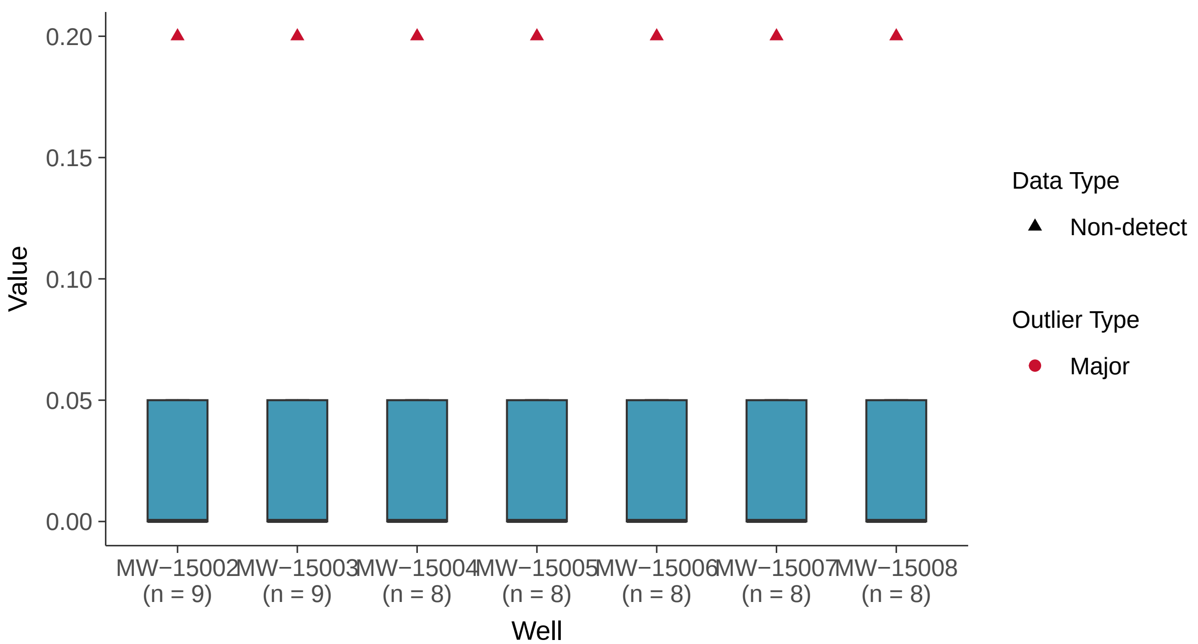
Boxplot by Season

Silver, Pooled Background (ug/L)



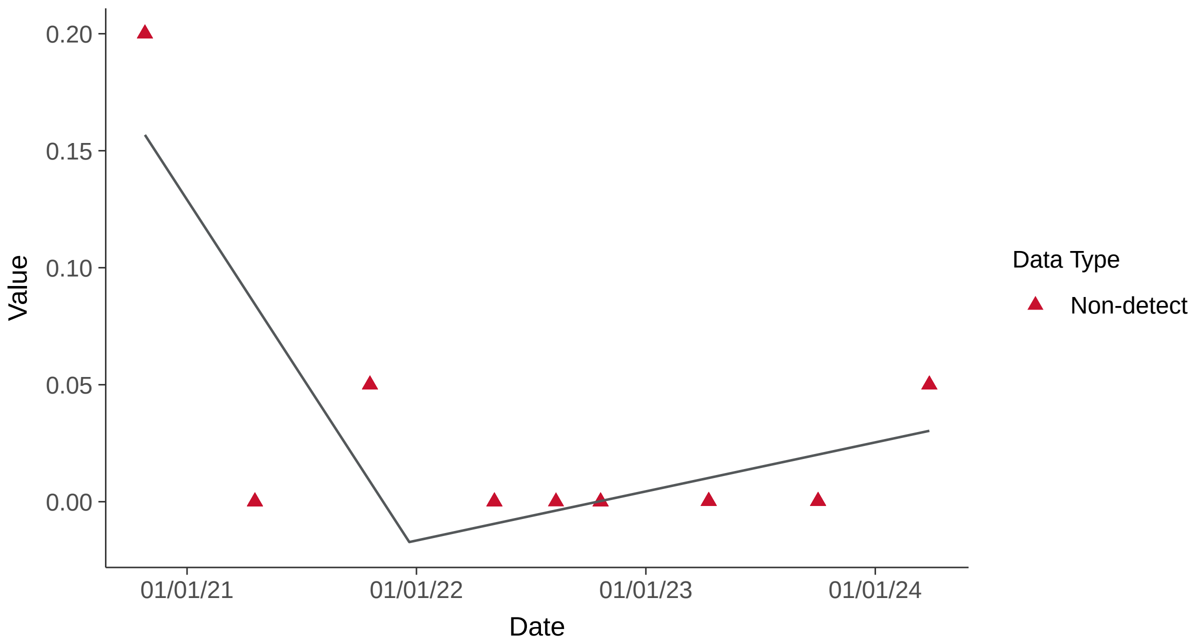
Boxplot by Well

Silver, Pooled Background (ug/L)



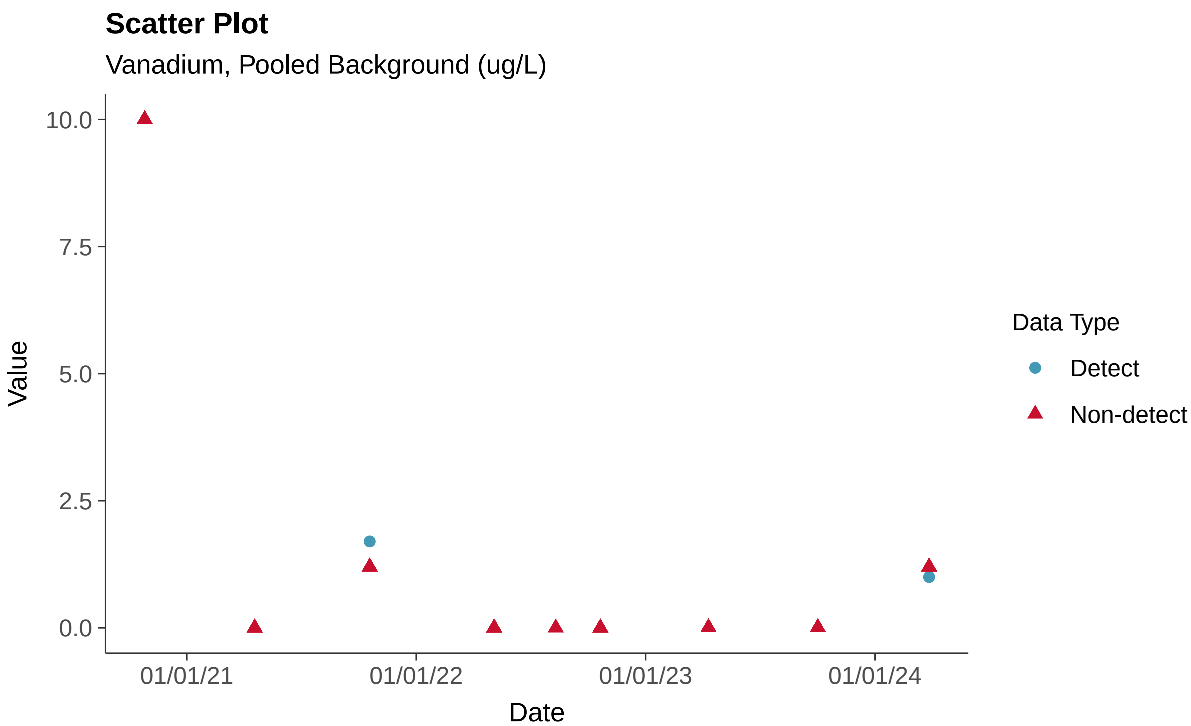
Trend Regression: Piecewise Linear-Linear

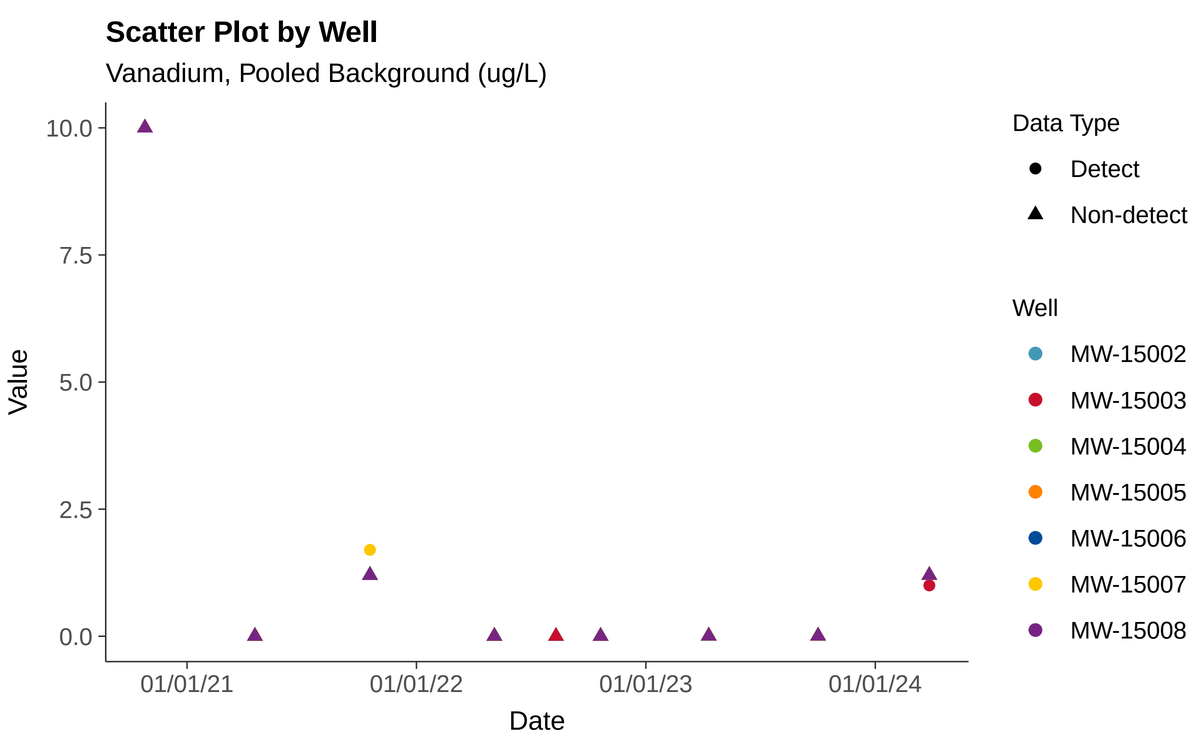
Silver, Pooled Background (ug/L)



Michigan CCR: Vanadium, Pooled Background

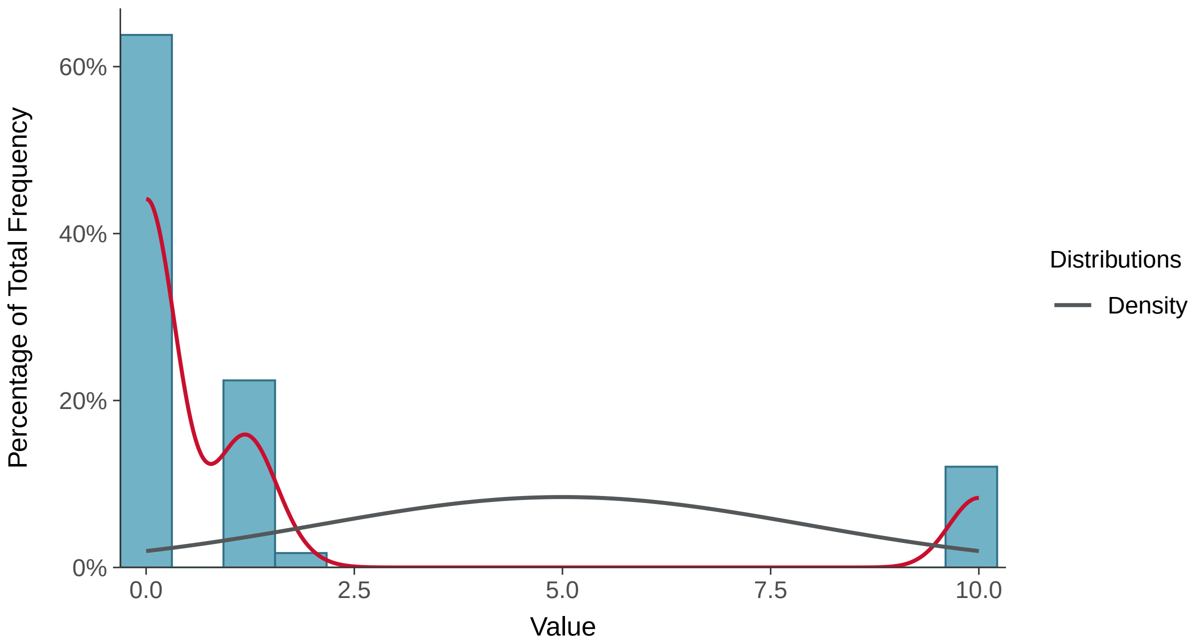
ID: 4_134





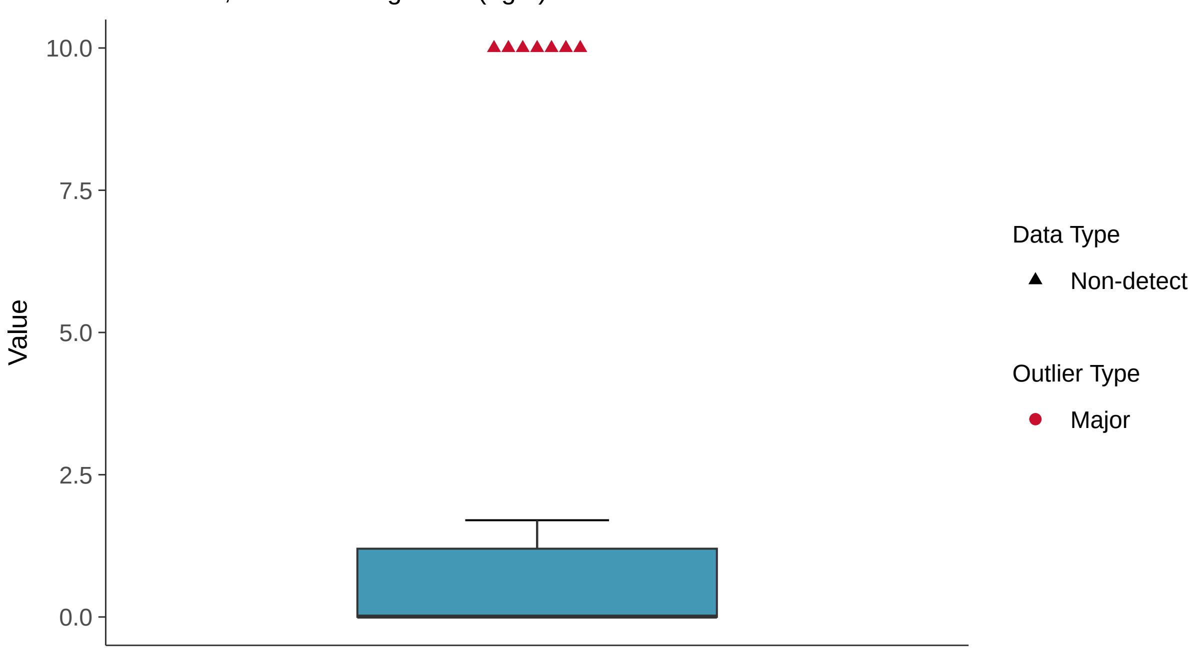
Histogram

Vanadium, Pooled Background (ug/L)



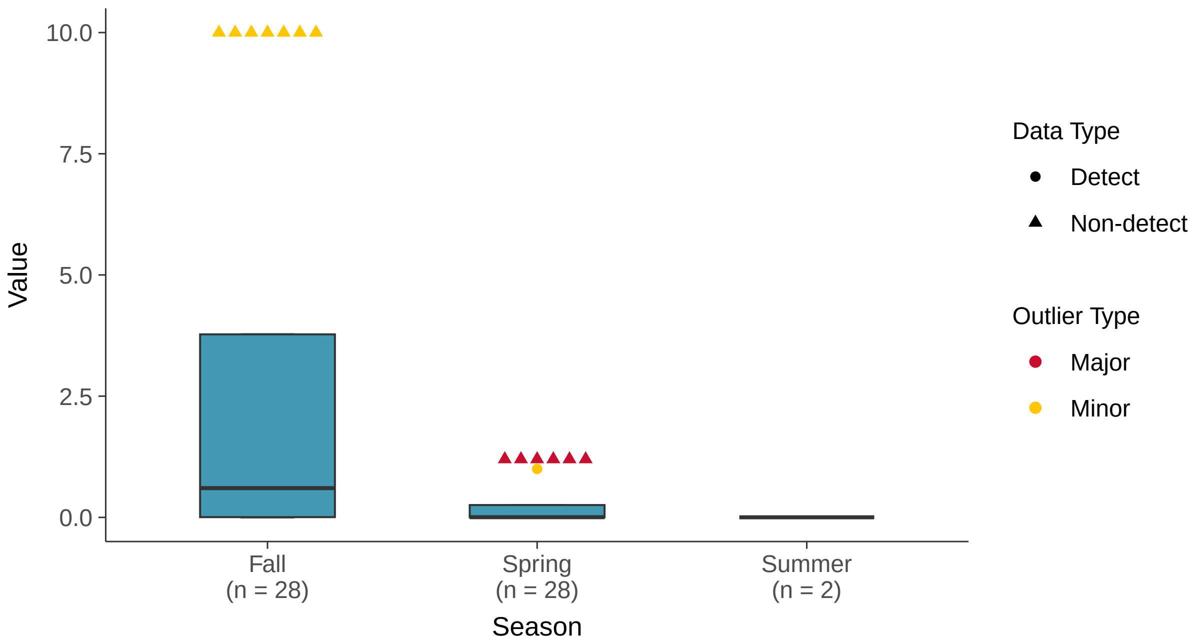
Boxplot

Vanadium, Pooled Background (ug/L)



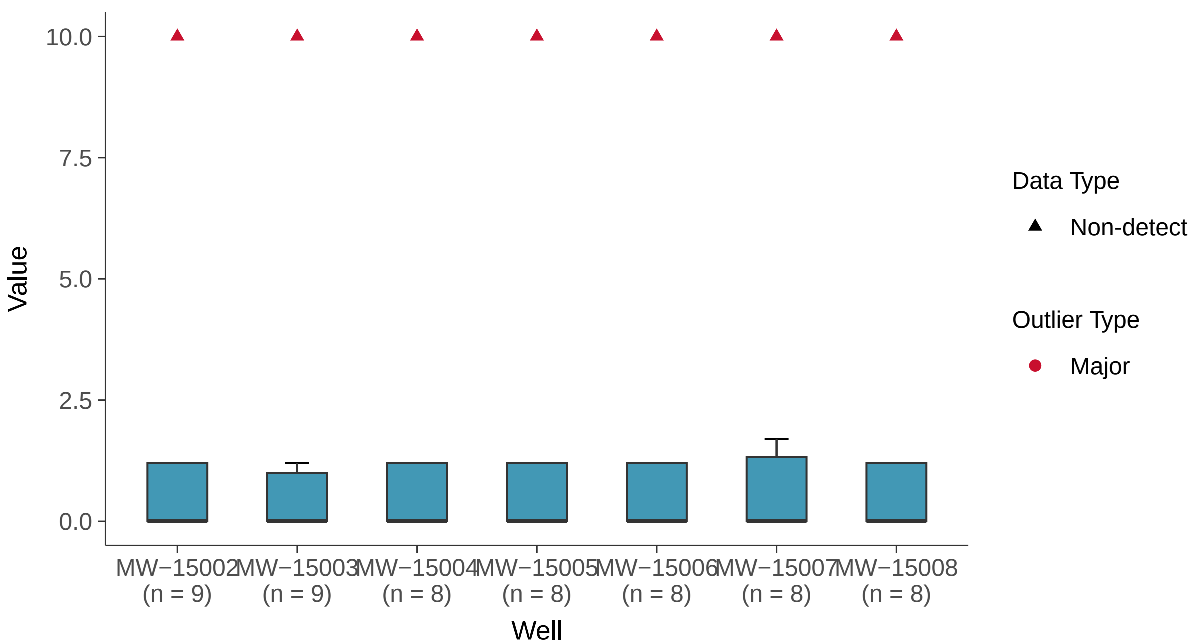
Boxplot by Season

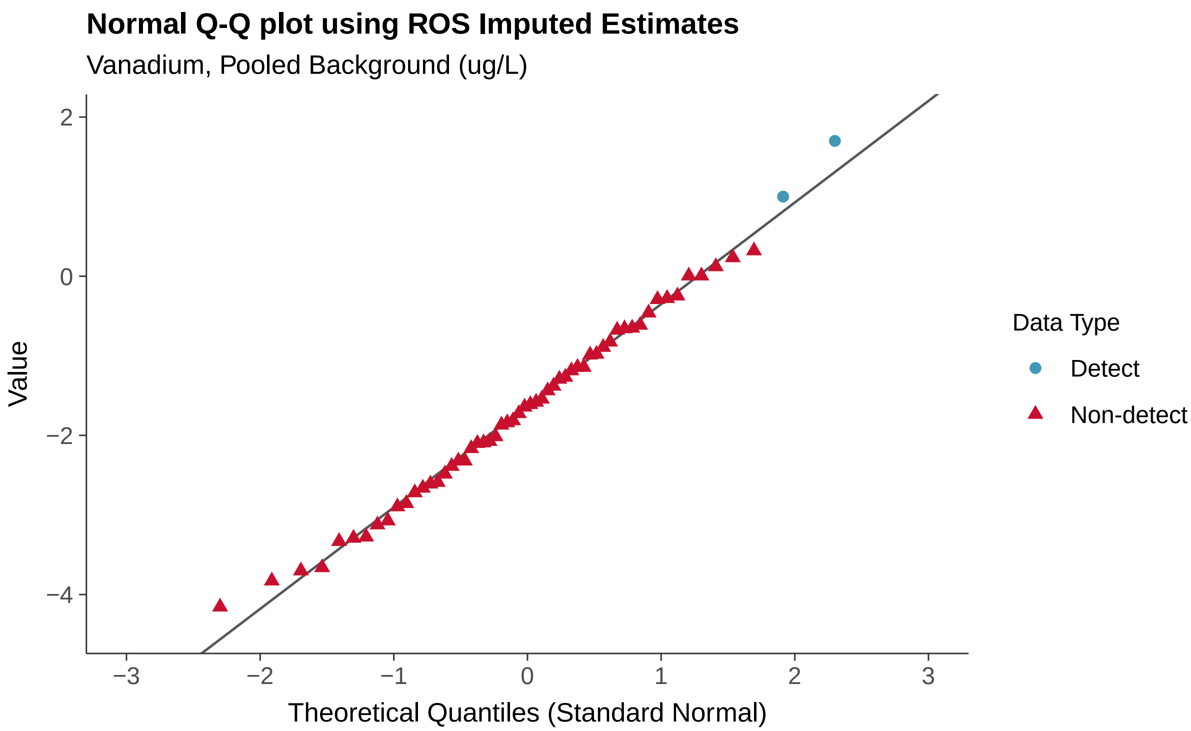
Vanadium, Pooled Background (ug/L)



Boxplot by Well

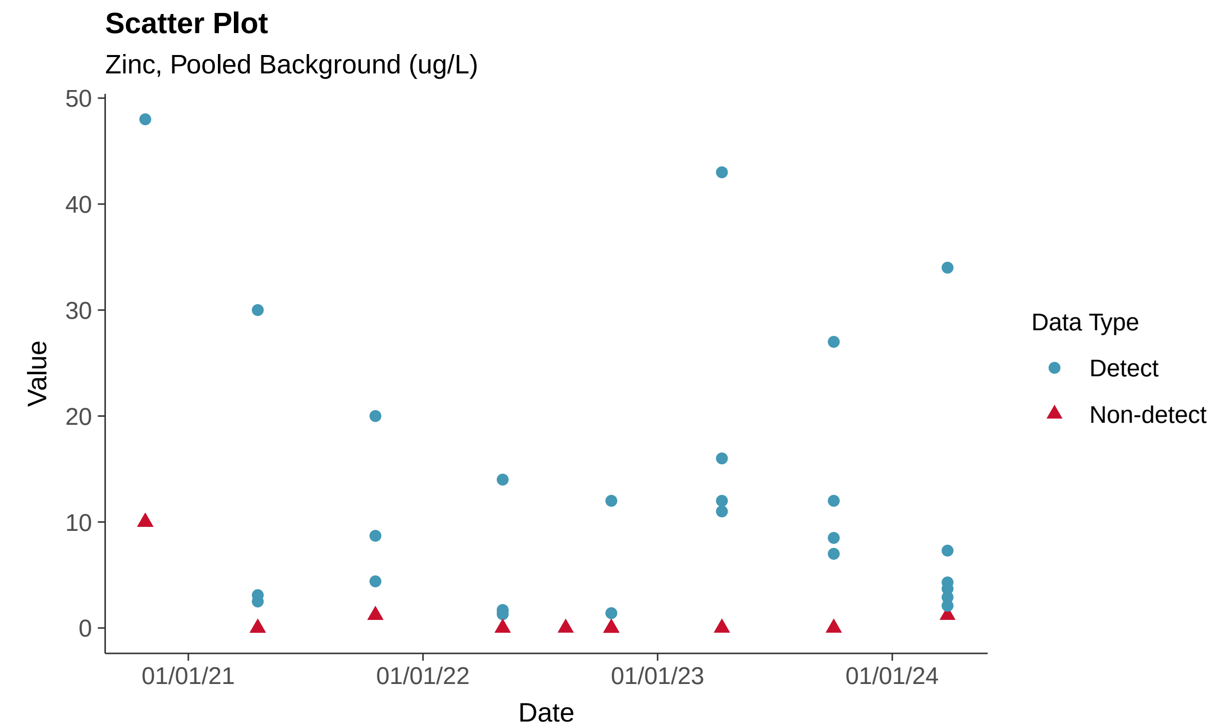
Vanadium, Pooled Background (ug/L)

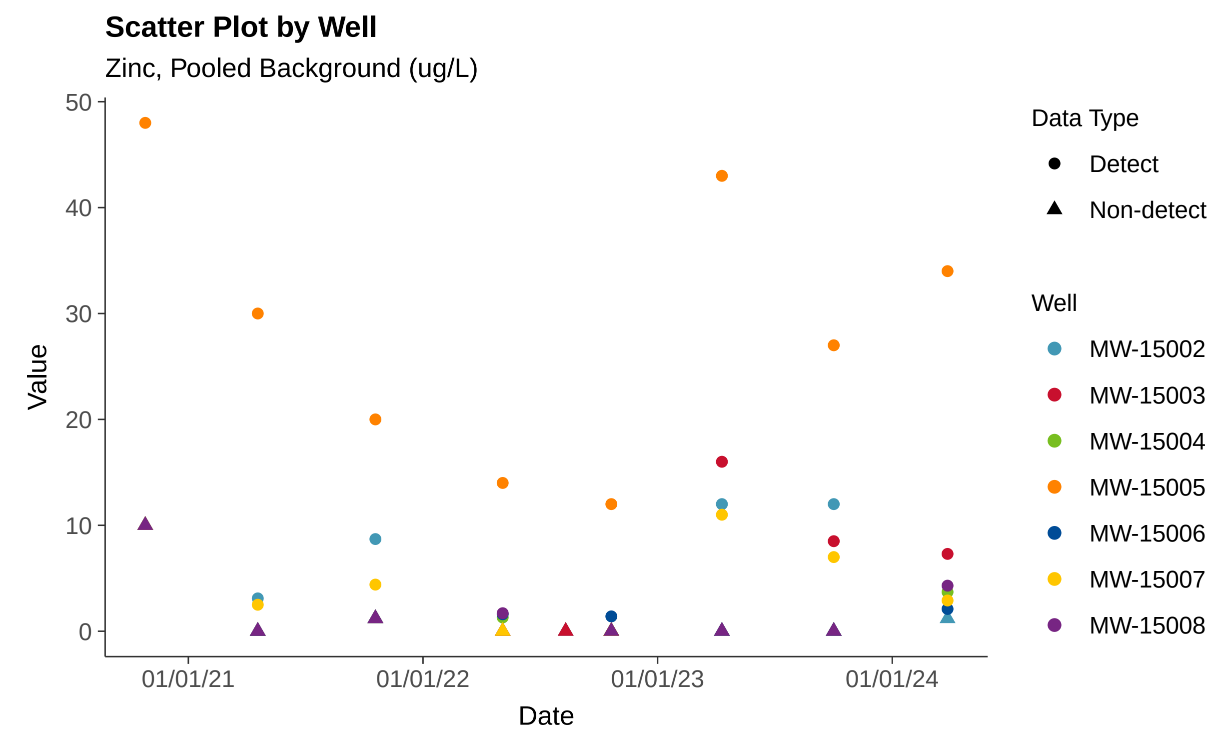


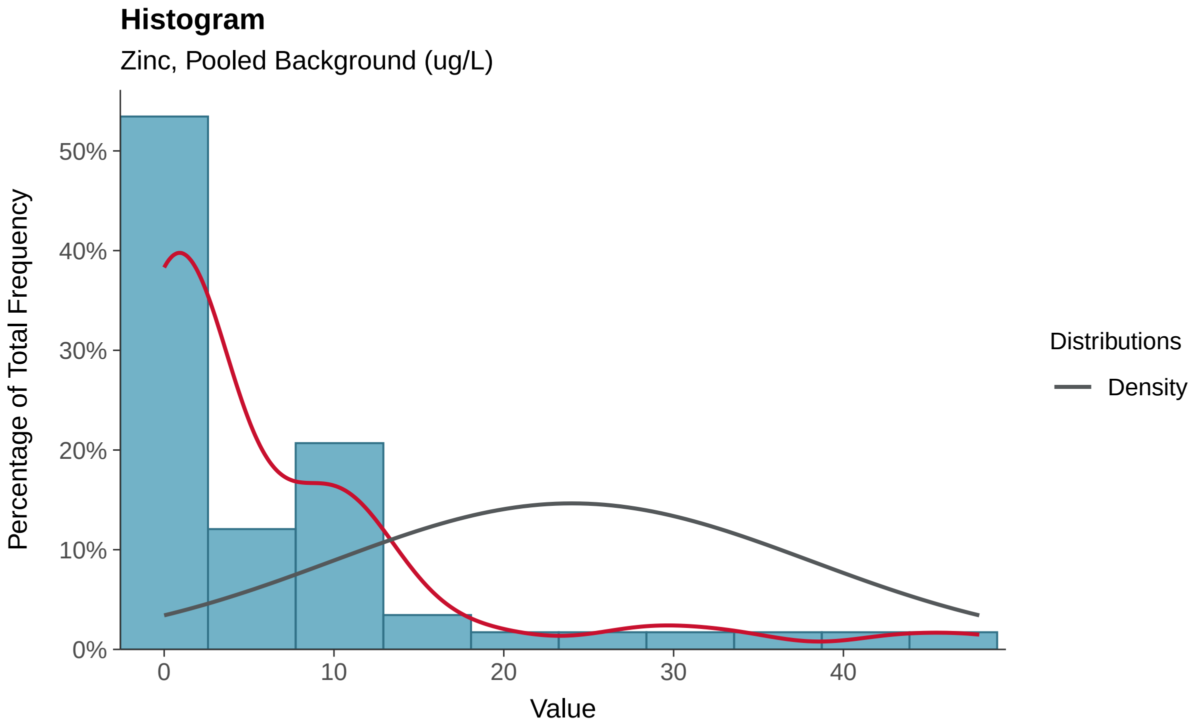

Normal Q-Q plot using ROS Imputed Estimates
Vanadium, Pooled Background (ug/L)
Value
2
0
−2
−4
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect

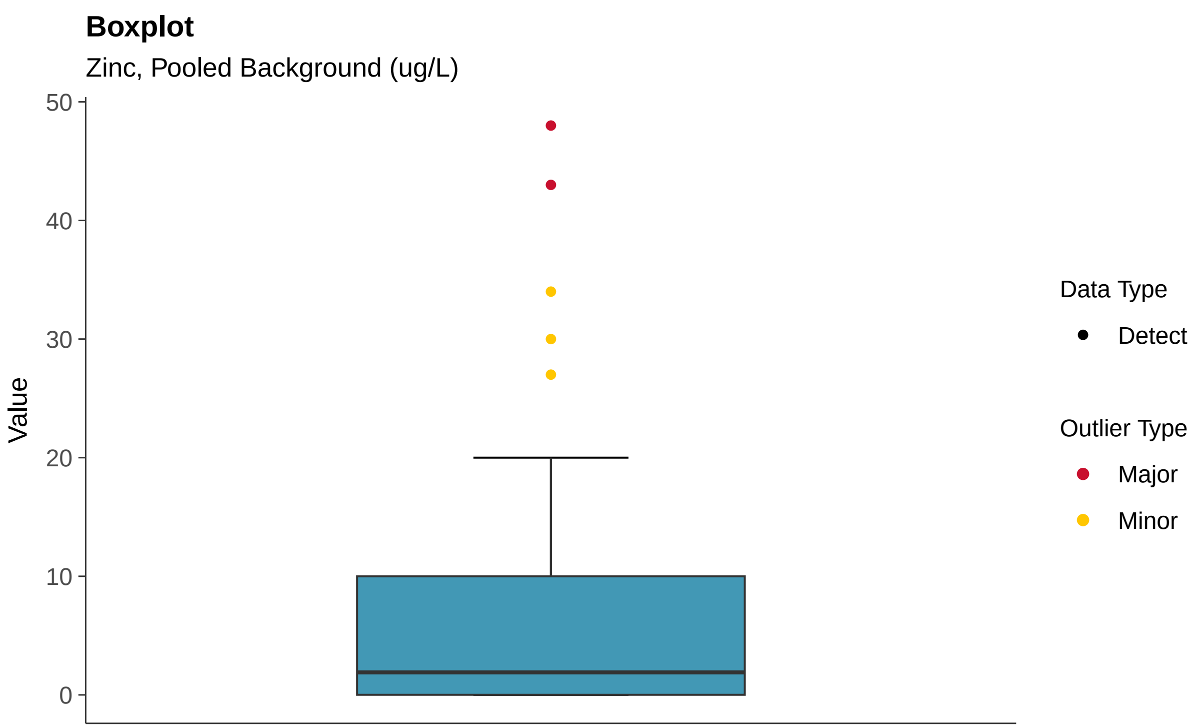
Michigan CCR: Zinc, Pooled Background

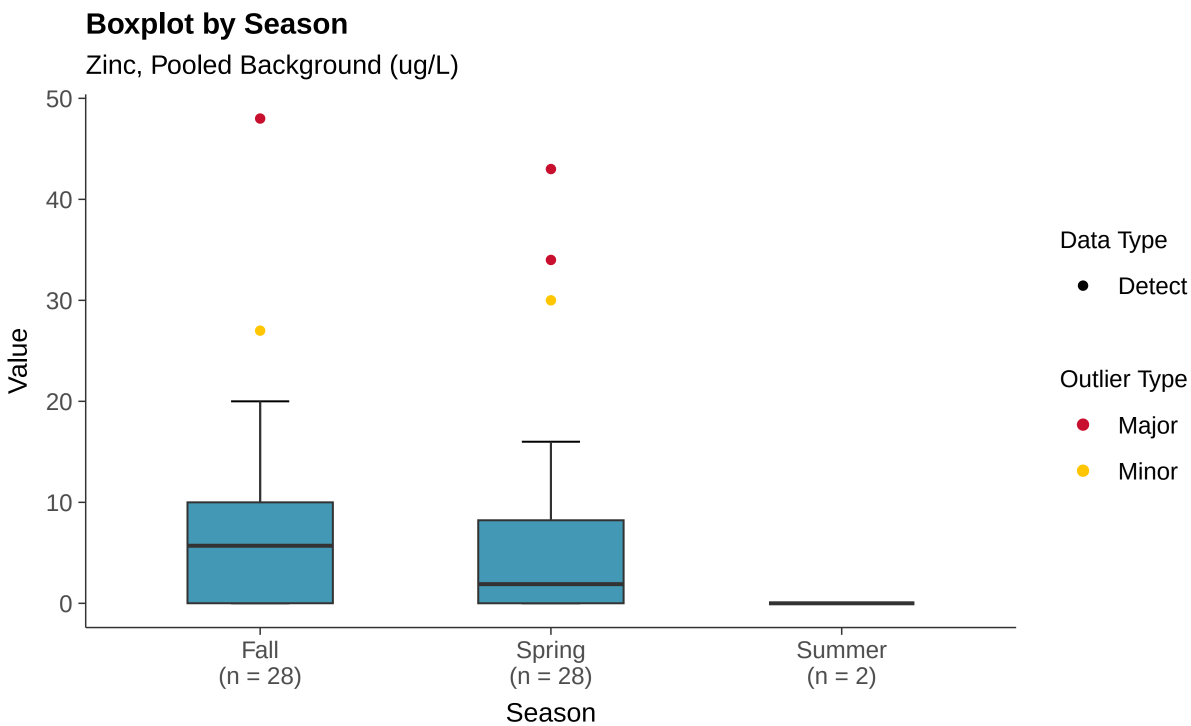
ID: 4_135

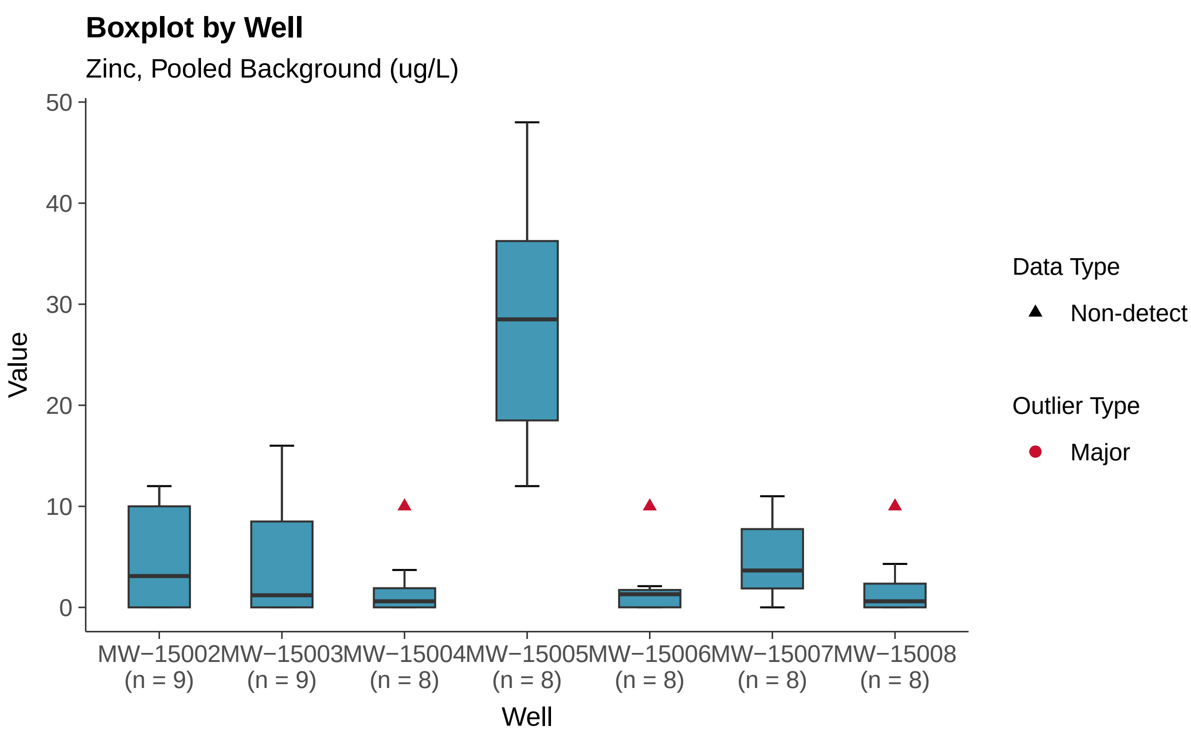


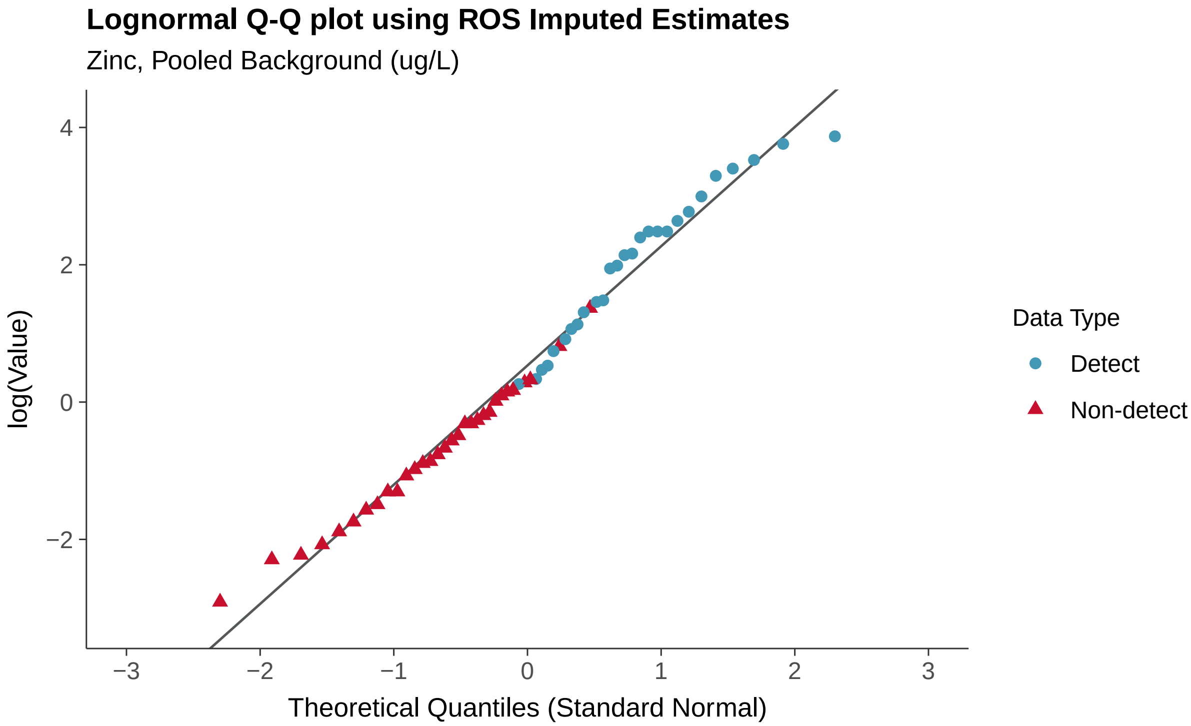


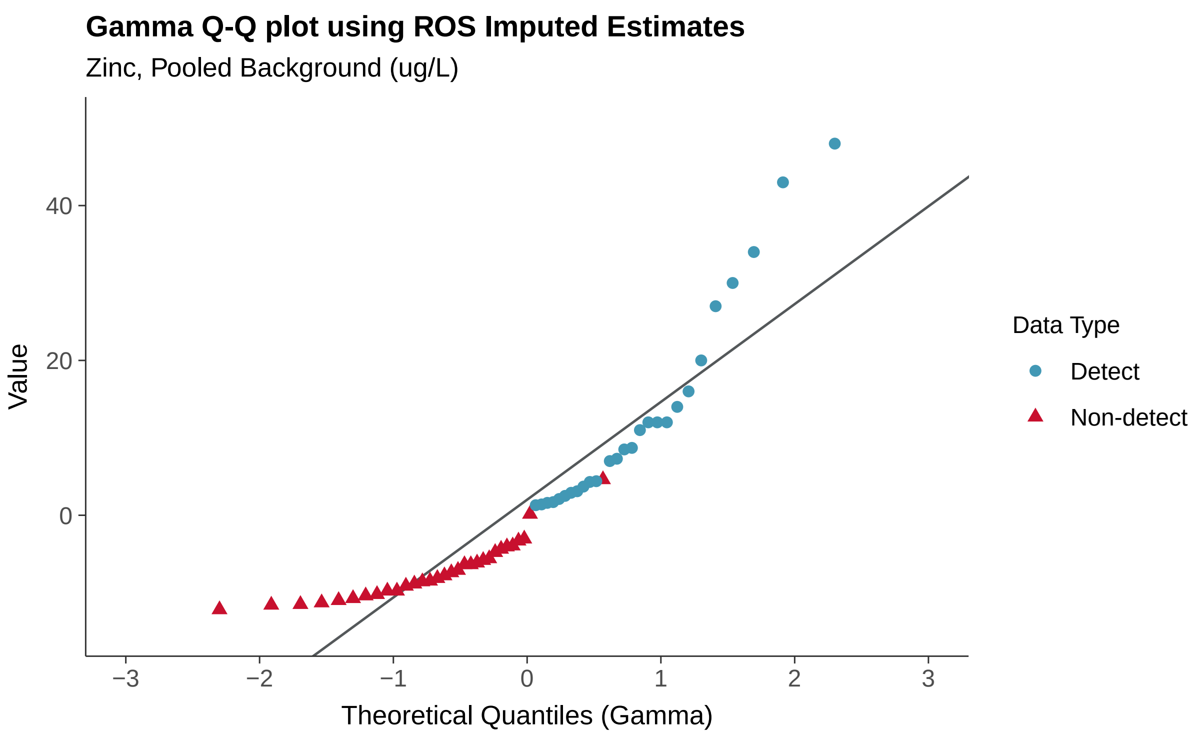

Histogram
Zinc, Pooled Background (ug/L)
Percentage of Total Frequency
50%
40%
30%
20%
10%
0%
0
10
20
30
40
Value
Distributions
Density

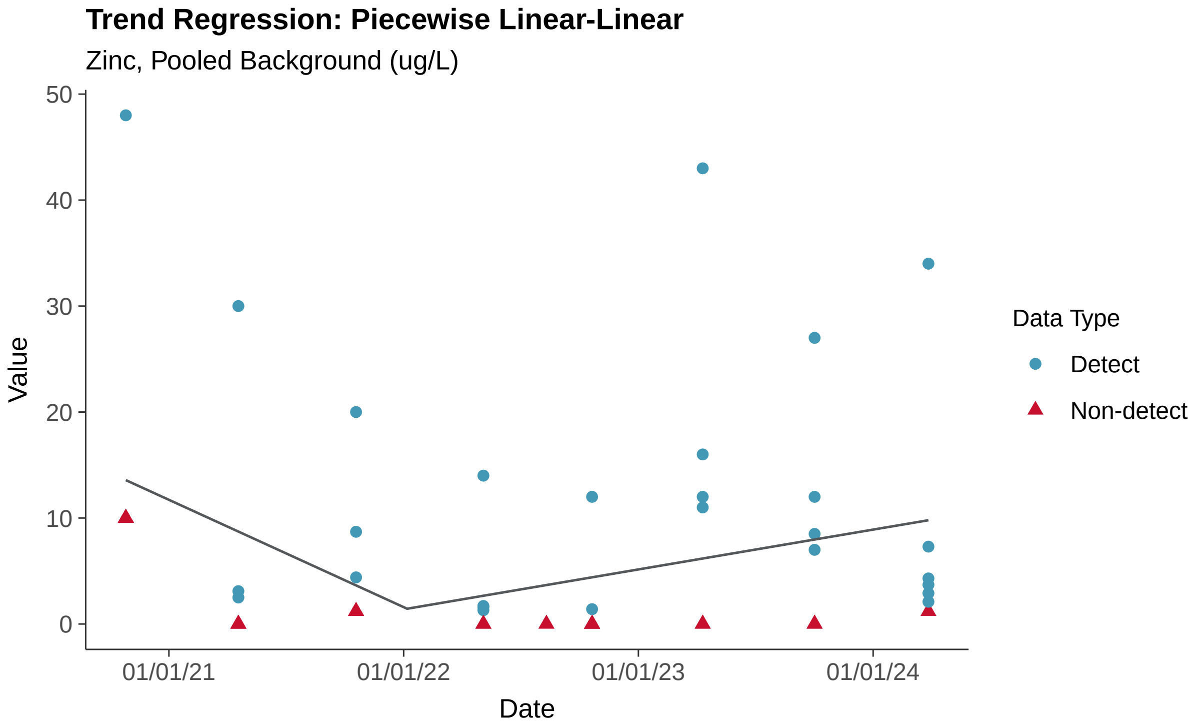

Boxplot
Zinc, Pooled Background (ug/L)
Value
50
40
30
20
10
0
Data Type
Detect
Outlier Type
Major
Minor

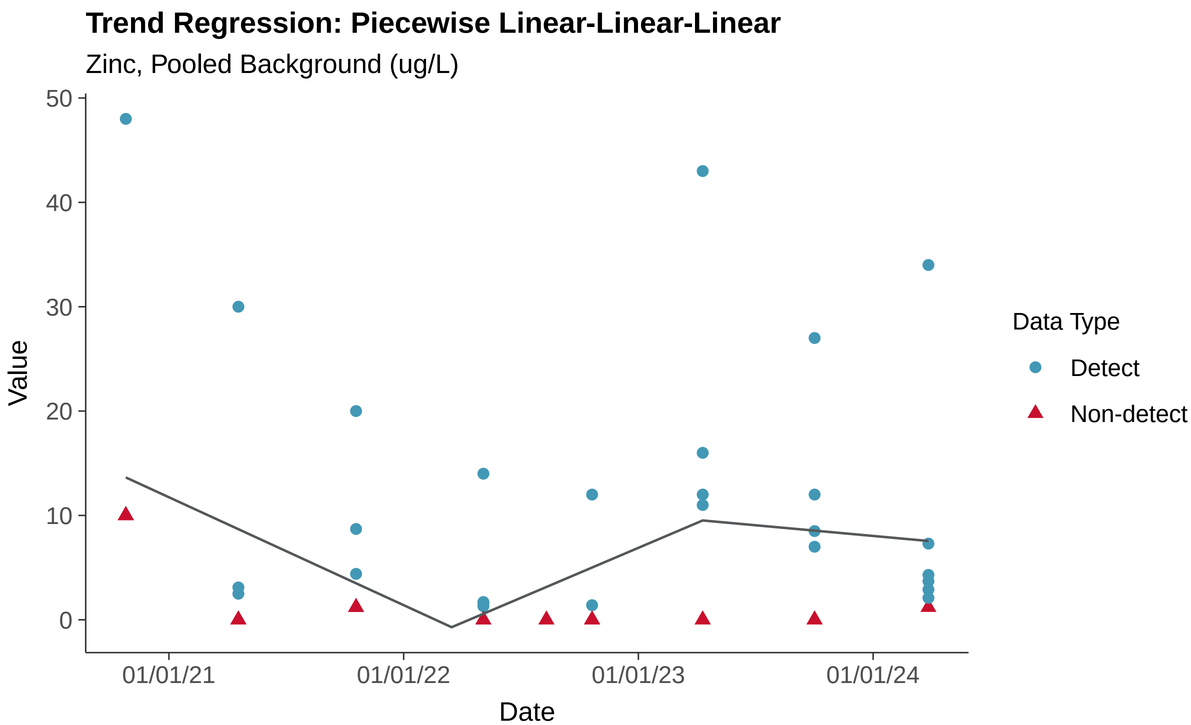

Boxplot by Season
Zinc, Pooled Background (ug/L)
Value
50
40
30
20
10
0
Fall
(n = 28)
Spring
(n = 28)
Summer
(n = 2)
Season
Data Type
Detect
Outlier Type
Major
Minor


Boxplot by Well
Zinc, Pooled Background (ug/L)
Value
50
40
30
20
10
0
MW−15002
(n = 9)
MW−15003
(n = 9)
MW−15004
(n = 8)
MW−15005
(n = 8)
MW−15006
(n = 8)
MW−15007
(n = 8)
MW−15008
(n = 8)
Well
Data Type
Non-detect
Outlier Type
Major


Lognormal Q-Q plot using ROS Imputed Estimates
Zinc, Pooled Background (ug/L)
log(Value)
4
2
0
−2
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Standard Normal)
Data Type
Detect
Non-detect


Gamma Q-Q plot using ROS Imputed Estimates
Zinc, Pooled Background (ug/L)
Value
40
20
0
−3
−2
−1
0
1
2
3
Theoretical Quantiles (Gamma)
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear
Zinc, Pooled Background (ug/L)
Value
50
40
30
20
10
0
01/01/21
01/01/22
01/01/23
01/01/24
Date
Data Type
Detect
Non-detect


Trend Regression: Piecewise Linear-Linear-Linear
Zinc, Pooled Background (ug/L)
Value
50
40
30
20
10
0
01/01/21
01/01/22
01/01/23
01/01/24
Date
Data Type
Detect
Non-detect

F

Spatial Variability Tests

Table 1: Spatial Variability Tests

						Full											Without Non-Detects										
						Sample Sizes								p-Value			Sample Sizes								p-Value		
ID	Well	Constituent Type	Constituent	Unit	% NDs	MW-15002	MW-15003	MW-15004	MW-15005	MW-15006	MW-15007	MW-15008	Total	kw_p	anova_p	anova_log_p	MW-15002	MW-15003	MW-15004	MW-15005	MW-15006	MW-15007	MW-15008	Total	kw_p	anova_p	anova_log_p
1_105	Pooled Background	Appendix III	Boron	ug/L	2%	23	23	22	22	22	22	22	156	0 ***	0 ***	0 ***	23	23	22	20	21	22	22	153	0 ***	0 ***	0 ***
1_107	Pooled Background	Appendix III	Calcium	mg/L	0%	23	23	22	22	22	22	22	156	0 ***	0 ***	0 ***	23	23	22	22	22	22	22	156	0 ***	0 ***	0 ***
1_108	Pooled Background	Appendix III	Chloride	mg/L	0%	23	23	22	22	22	22	22	156	0 ***	0 ***	0 ***	23	23	22	22	22	22	22	156	0 ***	0 ***	0 ***
1_114	Pooled Background	Appendix III	Fluoride	ug/L	64%	24	24	23	23	23	22	23	162	0.60	0.65	0.083	10	10	9	4	9	9	8	59	0 ***	0 ***	0 ***
1_122	Pooled Background	Appendix III	pH, Field	SU	0%	24	25	23	23	24	24	22	165	0 ***	0 ***	0 ***	24	25	23	23	24	24	22	165	0 ***	0 ***	0 ***
1_128	Pooled Background	Appendix III	Sulfate	mg/L	21%	23	23	22	22	22	22	22	156	0.00030 ***	0 ***	0.00050 ***	17	9	16	19	22	19	21	123	0 ***	0 ***	0 ***
1_131	Pooled Background	Appendix III	Total Dissolved Solids	mg/L	0%	23	23	22	22	22	22	22	156	0 ***	0 ***	0 ***	23	23	22	22	22	22	22	156	0 ***	0 ***	0 ***
2_101	Pooled Background	Appendix IV	Antimony	ug/L	91%	22	22	21	21	21	21	21	149	0.99	0.95	0.93	0	0	0	1	9	2	1	13	0.61	0.81	0.83
2_102	Pooled Background	Appendix IV	Arsenic	ug/L	38%	23	23	22	22	21	22	21	154	0 ***	0.00056 ***	0 ***	7	3	20	13	18	20	15	96	0.0083 **	0.018 *	0.0019 **
2_103	Pooled Background	Appendix IV	Barium	ug/L	0%	23	23	22	22	22	22	22	156	0 ***	0 ***	0 ***	23	23	22	22	22	22	22	156	0 ***	0 ***	0 ***
2_104	Pooled Background	Appendix IV	Beryllium	ug/L	100%	22	22	21	21	21	21	21	149	1.0	1.0	1.0											
2_106	Pooled Background	Appendix IV	Cadmium	ug/L	99%	22	22	21	21	21	21	21	149	0.98	1.0	0.99	0	0	0	1	1	0	0	2	0.32		
2_109	Pooled Background	Appendix IV	Chromium	ug/L	53%	23	23	22	22	22	22	22	156	0.54	0.47	0.44	13	14	14	6	11	12	3	73	0.79	0.88	0.82
2_110	Pooled Background	Appendix IV	Cobalt	ug/L	93%	22	22	21	21	21	21	21	149	1.0	1.0	1.0	1	1	1	1	5	2	0	11	0.14	0.25	0.018 *
2_114	Pooled Background	Appendix IV	Fluoride	ug/L	64%	24	24	23	23	23	22	23	162	0.60	0.65	0.083	10	10	9	4	9	9	8	59	0 ***	0 ***	0 ***
2_116	Pooled Background	Appendix IV	Lead	ug/L	95%	22	22	21	21	21	21	21	149	0.93	0.92	0.94	0	0	0	5	1	2	0	8	0.40	0.44	0.37
2_117	Pooled Background	Appendix IV	Lithium	ug/L	69%	23	23	22	22	22	22	22	156	0 ***	0 ***	0.00096 ***	8	11	2	2	1	3	21	48	0.012 *	0.017 *	0.000056 ***
2_118	Pooled Background	Appendix IV	Mercury	ug/L	100%	22	22	21	21	21	21	21	149		0.45	0.45											
2_119	Pooled Background	Appendix IV	Molybdenum	ug/L	75%	23	23	22	22	22	22	22	156	0.0011 **	0.065	0.027 *	0	1	3	6	19	6	4	39	0.00083 ***	0 ***	0 ***
2_124	Pooled Background	Appendix IV	Radium-226+228	pCi/L	49%	23	23	22	22	22	22	22	156	0.00026 ***	0.00014 ***	0.00064 ***	15	16	13	8	5	12	10	79	0.00046 ***	0.0012 **	0.0031 **
2_126	Pooled Background	Appendix IV	Selenium	ug/L	76%	23	23	22	22	22	22	22	156	0.011 *	0.012 *	0.017 *	3	4	6	1	17	4	2	37	0.35	0.41	0.096
2_130	Pooled Background	Appendix IV	Thallium	ug/L	99%	22	22	21	21	21	21	21	149	1.0	0.83	1.0	0	1	0	0	0	0	0	1			
4_112	Pooled Background	Michigan CCR	Copper	ug/L	64%	9	9	8	8	8	8	8	58	0.12	0.19	0.30	2	0	4	5	4	5	1	21	0.57	0.74	0.62
4_115	Pooled Background	Michigan CCR	Iron	ug/L	2%	9	9	8	8	8	8	8	58	0 ***	0 ***	0 ***	8	9	8	8	8	8	8	57	0 ***	0 ***	0 ***
4_120	Pooled Background	Michigan CCR	Nickel	ug/L	76%	9	9	8	8	8	8	8	58	0.57	1.0	0.69	1	0	1	3	3	4	2	14	0.59	0.68	0.68
4_127	Pooled Background	Michigan CCR	Silver	ug/L	100%	9	9	8	8	8	8	8	58	1.0	1.0	1.0											
4_134	Pooled Background	Michigan CCR	Vanadium	ug/L	97%	9	9	8	8	8	8	8	58	1.0	1.0	1.0	0	1	0	0	0	1	0	2	0.32		
4_135	Pooled Background	Michigan CCR	Zinc	ug/L	53%	9	9	8	8	8	8	8	58	0.0014 **	0 ***	0.052	4	3	2	8	3	5	2	27	0.0016 **	0.00022 ***	0 ***

*** p < 0.001, ** p < 0.01, * p <0.05

G

Detection Monitoring UPLs

Charah Cobb State Program, Pooled Background Wells MW-15002, MW-15003, MW-15004, MW-15005, MW-15006, MW-15007, and MW-15008 as of March 27, 2024
UPLs for Detection Monitoring

ID	Dates	Constituent Type	Constituent	Unit	n	NDs	% NDs	Unique Obs.	Normal		Lognormal			Gamma			Nonparametric	Average UPL by Distribution				Maximum	Maximum Detect	Log SD of Detects	Distributions Fit (based on detected data)	Recommended Distribution[1]	Retests	Rank	Retests	K	No. of Verification Samples[4]	UPL	Notes
									UPL	KM UPL	UPL	ROS UPL	KM UPL	UPL	ROS UPL	KM UPL	Rank-based UPL	Normal	Lognormal	Gamma	Nonparametric												
1_105	2015-11-30 to 2024-03-27	Appendix III	Boron	ug/L	156	3	1.9%	128		3,700		15,000	19,000		5,600	5,800	4,900	3,700	17,000	5,700	4,900	5,400	5,400	1.3	Nonparametric	Nonparametric	2	2	1	3.5	1	4,900	
1_107	2015-11-30 to 2024-03-27	Appendix III	Calcium	mg/L	156	0	0.0%	107	270		420			350			250	270	420	350	250	260	260	0.44	Nonparametric	Nonparametric	2	2	1	3.5	1	250	
1_108	2015-11-30 to 2024-03-27	Appendix III	Chloride	mg/L	156	0	0.0%	136	2,000		31,000			4,500			2,400	2,000	31,000	4,500	2,400	2,500	2,500	1.7	Nonparametric	Nonparametric	2	2	1	3.5	1	2,400	
1_114	2015-11-30 to 2024-03-27	Appendix III	Fluoride	ug/L	162	103	63.6%	40		960		1,700	4,440		3,900	1,800	1,400	960	3,100	2,900	1,400	2,000	1,400	0.53	Gamma; Lognormal	Nonparametric	2	2	1	3.5	1	1,400	a, d
1_122	2015-11-30 to 2024-03-27	Appendix III	pH, Field, LPL	SU	165	0	0.0%	58	6.1		6.2			0.0			6.6	6.1	6.2	0.0	6.6	6.6	6.6	0.044	Nonparametric	Nonparametric	2	2	1	3.5	1	6.6	e
1_122	2015-11-30 to 2024-03-27	Appendix III	pH, Field, UPL	SU	165	0	0.0%	58	8.3		8.4			8.4			8.2	8.3	8.4	8.4	8.2	8.3	8.3	0.044	Nonparametric	Nonparametric	2	2	1	3.5	1	8.2	e
1_128	2015-11-30 to 2024-03-27	Appendix III	Sulfate	mg/L	156	33	21.2%	107		220		1,500	3,500		520	440	300	220	2,500	480	300	330	330	1.3	Nonparametric	Nonparametric	2	2	1	3.5	1	300	
1_131	2015-11-30 to 2024-03-27	Appendix III	Total Dissolved Solids	mg/L	156	0	0.0%	95	3,700		8,400			5,500			4,500	3,700	8,400	5,500	4,500	4,800	4,800	0.76	Nonparametric	Nonparametric	2	2	1	3.5	1	4,500	
4_115	2020-10-26 to 2024-03-27	Michigan CCR	Iron	ug/L	58	1	1.7%	44		12,000		99,000	470,000		29,000	32,000	8,500	12,000	290,000	31,000	8,500	11,000	11,000	1.2	Gamma; Lognormal	Gamma	3	3	1	3.6	0	31,000	

Notes

a: Nonparametric methods were used since the percent below MDL is greater than 50%.

b: Constituent is 100% non-detects so the maximum detection limit is chosen as the BTV. Double Quantification Rule (DQR) is recommended for determining if an exceedance has occurred.

c: Maximum detected value was chosen as the UPL as the number of detects is less than 4.

d: Sample contains MDLs that are greater than the maximum detect value.

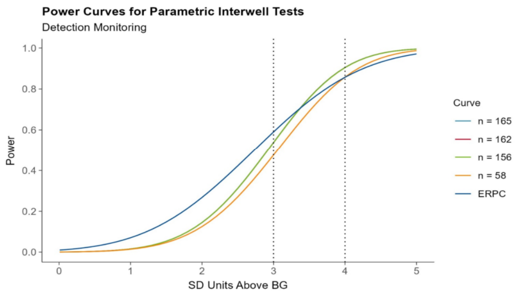
e: Limits are based on a two-sided prediction interval.

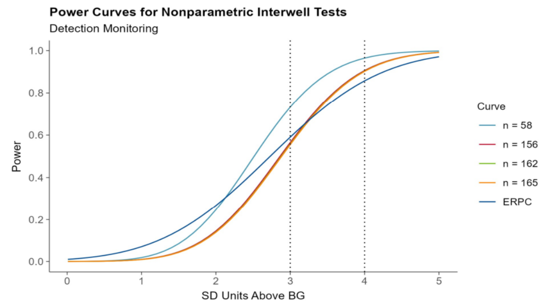
[1] To optimize the process for estimating a reference background concentration when there are multiple forms of the UPL formulae for data sets with assumed distributional properties, the averaging of the results over the multiple methods is done. The formulae are comparable and each one offers advantages and also has inherent errors in their methods. The action of averaging these estimates produces a pooled estimated closest to the unknown common truth based on how this error is perceived. For example, the UPL with assumed gamma distributional properties with non-detects has Kaplan-Meier (KM) and regression on order statistics (ROS) for estimating the UPL for samples with non-detects. The averaging of the two estimates is done to produce one recommended estimate for the UPL. In situations where a method's estimate is notably different from the other methods' results (assessed based on subject matter expertise), then that particular method is excluded from the averaging.

[2] The number of retests and the rank of the order statistic for nonparametric UPLs are chosen such that the confidence level does not exceed the per-constituent false positive rate of 0.01308, and such that the test power exceeds the EPA Reference Power Curve (ERPC) at either 3 standard deviations (SDs) above background, 4 SDs above background, or both. The maximum per-constituent false positive rate is computed based on a site-wide false positive rate of 10% subdivided across 8 constituents. Test power varies by sample size, and is plotted below for all samples sizes in the data alongside the ERPC.

[3] The number of retests and the value of the K factor are chosen such that the confidence level does not exceed the per-test false positive rate of 0.0006929, and such that the test power exceeds the ERPC at either 3 SDs above background, 4 SDs above background, or both. The maximum per-test false positive rate is computed based on a site-wide false positive rate of 10% subdivided across 8 constituents and 19 downgradient wells. Test power varies by sample size, and is plotted below for all sample sizes in the data alongside the ERPC.

[4] The number of verification samples is equal to (m - 1), where m represents the number of retests in a 1-of-m retesting plan. For each row, if the recommended distribution is parametric then the value in this column is based on the number of retests under a parametric UPL specification. Otherwise, it is based on the number of retests under a nonparametric specification.





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Assessment Monitoring UPLs

Charah Cobb State Program, Pooled Background Wells MW-15002, MW-15003, MW-15004, MW-15005, MW-15006, MW-15007, and MW-15008 as of March 27, 2024
UPLs for Assessment Monitoring

ID	Dates	Constituent Type	Constituent	Unit	n	NDs	% NDs	Unique Obs.	Normal		Lognormal			Gamma			Nonparametric	Average UPL by Distribution				Maximum	Maximum Detect	Log SD of Detects	Distributions Fit (based on detected data)	Recommended Distribution[1]	Retests	Rank	Retests	K	No. of Verification Samples[4]	UPL	Notes
									UPL	KM UPL	UPL	ROS UPL	KM UPL	UPL	ROS UPL	KM UPL	Rank-based UPL	Normal	Lognormal	Gamma	Nonparametric												
1_105	2015-11-30 to 2024-03-27	Appendix III	Boron	ug/L	156	3	1.9%	128		3,800		23,000	20,000		6,900	6,000	4,900	3,800	21,000	6,500	4,900	5,400	5,400	1.3	Nonparametric	Nonparametric	3	3	1	3.5	2	4,900	
1_107	2015-11-30 to 2024-03-27	Appendix III	Calcium	mg/L	156	0	0.0%	107	290		480			390			230	290	480	390	230	260	260	0.44	Nonparametric	Nonparametric	3	3	1	3.5	2	230	
1_108	2015-11-30 to 2024-03-27	Appendix III	Chloride	mg/L	156	0	0.0%	136	2,100		54,000			5,600			2,300	2,100	54,000	5,600	2,300	2,500	2,500	1.7	Nonparametric	Nonparametric	3	3	1	3.5	2	2,300	
1_114	2015-11-30 to 2024-03-27	Appendix III	Fluoride	ug/L	162	103	63.6%	40		960		2,100	4,500		5,200	1,800	1,000	960	3,300	3,500	1,000	2,000	1,400	0.53	Gamma; Lognormal	Nonparametric	3	3	1	3.5	2	1,400	a, b
1_122	2015-11-30 to 2024-03-27	Appendix III	pH, Field, LPL	SU	165	0	0.0%	58	6.0		6.1			0.0			6.6	6.0	6.1	0.0	6.6	6.6	6.6	0.044	Nonparametric	Nonparametric	3	3	1	3.5	2	6.6	e
1_122	2015-11-30 to 2024-03-27	Appendix III	pH, Field, UPL	SU	165	0	0.0%	58	8.4		8.5			8.5			8.1	8.4	8.5	8.5	8.1	8.3	8.3	0.044	Nonparametric	Nonparametric	3	3	1	3.5	2	8.2	e
1_128	2015-11-30 to 2024-03-27	Appendix III	Sulfate	mg/L	156	33	21.2%	107		230		2,500	3,900		670	450	250	230	3,200	560	250	330	330	1.3	Nonparametric	Nonparametric	3	3	1	3.5	2	250	
1_131	2015-11-30 to 2024-03-27	Appendix III	Total Dissolved Solids	mg/L	156	0	0.0%	95	4,000		11,000			6,400			3,900	4,000	11,000	6,400	3,900	4,800	4,800	0.76	Nonparametric	Nonparametric	3	3	1	3.5	2	3,900	
2_101	2015-11-30 to 2024-03-27	Appendix IV	Antimony	ug/L	149	136	91.3%	12		1.0		3.0	1.5		0.83	1.3	1.2	1.0	2.2	1.0	1.2	1.4	1.4	0.63	Gamma; Lognormal; Normal	Nonparametric	3	3	1	3.5	2	1.2	a
2_102	2015-11-30 to 2024-03-27	Appendix IV	Arsenic	ug/L	154	58	37.7%	44		13		71	97		53	26	15	13	84	40	15	18	18	0.87	Nonparametric	Nonparametric	3	3	1	3.5	2	15	
2_103	2015-11-30 to 2024-03-27	Appendix IV	Barium	ug/L	156	0	0.0%	106	350		1,200			640			290	350	1,200	640	290	380	380	0.77	Gamma	Gamma	3	3	1	3.5	0	640	
2_104	2015-11-30 to 2024-03-27	Appendix IV	Beryllium	ug/L	149	149	100.0%	4									1.2				1.2	1.2				Nonparametric	3	3	1	3.5	2	1.2	a, b
2_106	2015-11-30 to 2024-03-27	Appendix IV	Cadmium	ug/L	149	147	98.7%	6									1.2				1.2	1.2	0.22	0.73		Nonparametric	3	3	1	3.5	2	0.22	a, c, d
2_109	2015-11-30 to 2024-03-27	Appendix IV	Chromium	ug/L	156	83	53.2%	32		3.1		13	7.7		13	4.9	3.0	3.1	10	9.1	3.0	5.0	3.7	0.74	Nonparametric	Nonparametric	3	3	1	3.5	2	3.7	a, d
2_110	2015-11-30 to 2024-03-27	Appendix IV	Cobalt	ug/L	149	138	92.6%	16		1.0		2.6	1.8		0.50	1.4	15	1.0	2.2	0.94	15	30	1.2	0.79	Gamma; Lognormal; Normal	Nonparametric	3	3	1	3.5	2	1.2	a, d
2_114	2015-11-30 to 2024-03-27	Appendix IV	Fluoride	ug/L	162	103	63.6%	40		960		2,100	4,500		5,200	1,800	1,000	960	3,300	3,500	1,000	2,000	1,400	0.53	Gamma; Lognormal	Nonparametric	3	3	1	3.5	2	1,400	a, b
2_116	2015-11-30 to 2024-03-27	Appendix IV	Lead	ug/L	149	141	94.6%	10		1.2		4.6	1.1		0.74	1.1	2.8	1.2	2.9	0.93	2.8	5.0	2.0	0.39	Gamma; Lognormal; Normal	Nonparametric	3	3	1	3.5	2	2.0	a, d
2_117	2015-11-30 to 2024-03-27	Appendix IV	Lithium	ug/L	156	108	69.2%	34		35		280	150		150	67	34	35	210	110	34	48	48	0.87	Nonparametric	Nonparametric	3	3	1	3.5	2	34	a
2_118	2015-11-30 to 2024-03-27	Appendix IV	Mercury	ug/L	149	149	100.0%	1									0.20				0.20	0.20				Nonparametric	3	3	1	3.5	2	0.20	a, b
2_119	2015-11-30 to 2024-03-27	Appendix IV	Molybdenum	ug/L	156	117	75.0%	31		9.4		37	24		29	15	9.7	9.4	31	22	9.7	25	9.7	0.79	Nonparametric	Nonparametric	3	3	1	3.5	2	9.7	a, d
2_124	2015-11-30 to 2024-03-27	Appendix IV	Radium-226+228	pCi/L	156	77	49.4%	109		3.18		7.93	10.6		16.4	5.64	2.80	3.18	9.25	11.0	2.80	3.74	3.74	0.656	Gamma; Normal	Nonparametric	3	3	1	3.52	2	2.80	
2_126	2015-11-30 to 2024-03-27	Appendix IV	Selenium	ug/L	156	119	76.3%	19		2.7		12	9.8		7.1	4.8	3.0	2.7	11	6.0	3.0	3.3	3.3	0.66	Nonparametric	Nonparametric	3	3	1	3.5	2	3.0	a
2_130	2015-11-30 to 2024-03-27	Appendix IV	Thallium	ug/L	149	148	99.3%	6									2.0				2.0	10	0.19			Nonparametric	3	3	1	3.5	2	0.19	a, c, d
4_112	2020-10-26 to 2024-03-27	Michigan CCR	Copper	ug/L	58	37	63.8%	23		2.4		26	100		11	5.0	2.7	2.4	64	7.8	2.7	4.9	4.9	0.75	Gamma; Lognormal	Nonparametric	3	2	2	2.5	2	2.7	a
4_115	2020-10-26 to 2024-03-27	Michigan CCR	Iron	ug/L	58	1	1.7%	44		9,400		160,000	73,000		36,000	16,000	10,000	9,400	110,000	26,000	10,000	11,000	11,000	1.2	Gamma; Lognormal	Gamma	3	2	2	2.5	1	26,000	
4_120	2020-10-26 to 2024-03-27	Michigan CCR	Nickel	ug/L	58	44	75.9%	18		0.79		1.8	17		2.9	1.9	50	0.79	9.2	2.4	50	50	0.84	0.27	Gamma; Lognormal; Normal	Nonparametric	3	2	2	2.5	2	0.84	a, d
4_127	2020-10-26 to 2024-03-27	Michigan CCR	Silver	ug/L	58	58	100.0%	4									0.20				0.20	0.20				Nonparametric	3	2	2	2.5	2	0.20	a, b
4_134	2020-10-26 to 2024-03-27	Michigan CCR	Vanadium	ug/L	58	56	96.6%	6									10				10	10	1.7	0.38		Nonparametric	3	2	2	2.5	2	1.7	a, c, d
4_135	2020-10-26 to 2024-03-27	Michigan CCR	Zinc	ug/L	58	31	53.4%	29		32		1,100	5,100		220	77	43	32	3,100	150	43	48	48	1.1	Gamma; Lognormal	Nonparametric	3	2	2	2.5	2	43	a

Notes

a: Nonparametric methods were used since the percent below MDL is greater than 50%.

b: Constituent is 100% non-detects so the maximum detection limit is chosen as the BTV. Double Quantification Rule (DQR) is recommended for determining if an exceedance has occurred.

c: Maximum detected value was chosen as the UPL as the number of detects is less than 4.

d: Sample contains MDLs that are greater than the maximum detect value.

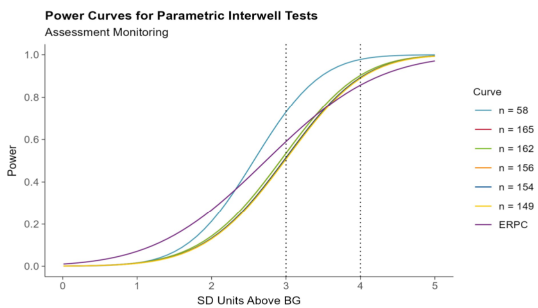
e: Limits are based on a two-sided prediction interval.

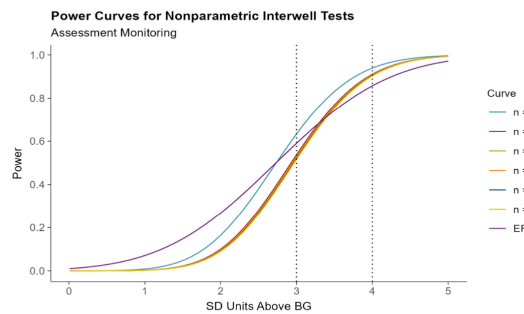
[1] To optimize the process for estimating a reference background concentration when there are multiple forms of the UPL formulae for data sets with assumed distributional properties, the averaging of the results over the multiple methods is done. The formulae are comparable and each one offers advantages and also has inherent errors in their methods. The action of averaging these estimates produces a pooled estimated closest to the unknown common truth based on how this error is perceived. For example, the UPL with assumed gamma distributional properties with non-detects has Kaplan-Meier (KM) and regression on order statistics (ROS) for estimatin the UPL for samples with non-detects. The averaging of the two estimates is done to produce one recommended estimate for the UPL. In situations where a method's estimate is notably different from the other methods' results (assessed based on subject matter expertise), then that particular method is excluded from the averaging.

[2] The number of retests and the rank of the order statistic for nonparametric UPLs are chosen such that the confidence level does not exceed the per-constituent false positive rate of 0.00438, and such that the test power exceeds the EPA Reference Power Curve (ERPC) at either 3 standard deviations (SDs) above background, 4 SDs above background, or both. The maximum per-constituent false positive rate is computed based on a site-wide false positive rate of 10% subdivided across 24 constituents. Test power varies by sample size, and is plotted below for all samples sizes in the data alongside the ERPC.

[3] The number of retests and the value of the K factor are chosen such that the confidence level does not exceed the per-test false positive rate of 0.000231, and such that the test power exceeds the ERPC at either 3 SDs above background, 4 SDs above background, or both. The maximum per-test false positive rate is computed based on a site-wide false positive rate of 10% subdivided across 24 constituents and 19 downgradient wells. Test power varies by sample size, and is plotted below for all sample sizes in the data alongside the ERPC.

[4] The number of verification samples is equal to (m - 1), where m represents the number of retests in a 1-of-m retesting plan. For each row, if the recommended distribution is parametric then the value in this column is based on the number of retests under a parametric UPL specification. Otherwise, it is based on the number of retests under a nonparametric specification.





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UTLs

Charah Cobb State Program, Pooled Background Wells MW-15002, MW-15003, MW-15004, MW-15005, MW-15006, MW-15007, and MW-15008 as of March 27, 2024
95-95 UTLs

ID	Dates	Constituent Type	Constituent	Unit	n	NDs	% NDs	Unique Obs.	Normal			Lognormal				Gamma			Nonparametric	Average UTL by distribution				Maximum	Maximum Detect	Log SD of Detects	Distributions Fit (based on detected data)	Recommended Distribution[1]	UTL	Notes
									UTL	KM UTL	MLE UTL	UTL	ROS UTL	KM UTL	MLE UTL	UTL	KM UTL	MLE UTL	Rank-based UTL	Normal	Lognormal	Gamma	Nonparametric							
1_105	2015-11-30 to 2024-03-27	Appendix III	Boron	ug/L	156	3	1.9%	128		2,200	2,200		2,200	2,200	2,200		1,900	1,800	5,400	2,200	2,200	1,900	5,400	5,400	5,400	1.3	Nonparametric	Nonparametric	5,400	
1_107	2015-11-30 to 2024-03-27	Appendix III	Calcium	mg/L	156	0	0.0%	107	200			220				220			260	200	220	220	260	260	260	0.44	Nonparametric	Nonparametric	260	
1_108	2015-11-30 to 2024-03-27	Appendix III	Chloride	mg/L	156	0	0.0%	136	1,300			2,800				1,600			2,500	1,300	2,800	1,600	2,500	2,500	2,500	1.7	Nonparametric	Nonparametric	2,500	
1_114	2015-11-30 to 2024-03-27	Appendix III	Fluoride	ug/L	162	103	63.6%	40		650	720			1,100	830		830	760	2,000	690	1,100	830	2,000	2,000	1,400	0.53	Gamma; Lognormal	Nonparametric	1,400	a, d
1_122	2015-11-30 to 2024-03-27	Appendix III	pH, Field	SU	165	0	0.0%	58	7.8			7.8				7.8			8.3	7.8	7.8	7.8	8.3	8.3	8.3	0.044	Nonparametric	Nonparametric	8.3	
1_128	2015-11-30 to 2024-03-27	Appendix III	Sulfate	mg/L	156	33	21.2%	107		130	140			200	170		140	140	330	140	200	140	330	330	330	1.3	Nonparametric	Nonparametric	330	
1_131	2015-11-30 to 2024-03-27	Appendix III	Total Dissolved Solids	mg/L	156	0	0.0%	95	2,500			2,900				2,600			4,800	2,500	2,900	2,600	4,800	4,800	4,800	0.76	Nonparametric	Nonparametric	4,800	
2_101	2015-11-30 to 2024-03-27	Appendix IV	Antimony	ug/L	149	136	91.3%	12		0.65	0.90			0.56	0.85		0.58	0.86	1.4	0.78	0.56	0.58	1.4	1.4	1.4	0.63	Gamma; Lognormal; Normal	Nonparametric	1.4	a
2_102	2015-11-30 to 2024-03-27	Appendix IV	Arsenic	ug/L	154	58	37.7%	44		7.7	8.6			12	10		8.7	8.9	18	8.1	12	8.7	18	18	18	0.87	Nonparametric	Nonparametric	18	
2_103	2015-11-30 to 2024-03-27	Appendix IV	Barium	ug/L	156	0	0.0%	106	230			320				270			380	230	320	270	380	380	380	0.77	Gamma	Gamma	270	
2_104	2015-11-30 to 2024-03-27	Appendix IV	Beryllium	ug/L	149	149	100.0%	4											1.2				1.2	1.2				Nonparametric	1.2	a, b
2_106	2015-11-30 to 2024-03-27	Appendix IV	Cadmium	ug/L	149	147	98.7%	6											1.2				1.2	1.2	0.22	0.73		Nonparametric	0.22	a, c, d
2_109	2015-11-30 to 2024-03-27	Appendix IV	Chromium	ug/L	156	83	53.2%	32		2.0	2.2		2.6	2.2	2.7		2.1	2.4	5.0	2.1	2.4	2.1	5.0	5.0	3.7	0.74	Nonparametric	Nonparametric	3.7	a, d
2_110	2015-11-30 to 2024-03-27	Appendix IV	Cobalt	ug/L	149	138	92.6%	16		0.67	0.83		0.76	0.65	0.85		0.64	0.83	30	0.75	0.71	0.64	30	30	1.2	0.79	Gamma; Lognormal; Normal	Nonparametric	1.2	a, d
2_114	2015-11-30 to 2024-03-27	Appendix IV	Fluoride	ug/L	162	103	63.6%	40		650	720			1,100	830		230	760	2,000	690	1,100	830	2,000	2,000	1,400	0.53	Gamma; Lognormal	Nonparametric	1,400	a, d
2_116	2015-11-30 to 2024-03-27	Appendix IV	Lead	ug/L	149	141	94.6%	10		0.92	1.1		0.94	0.81	1.0		0.83	1.0	5.0	1.0	0.88	0.83	5.0	5.0	2.0	0.39	Gamma; Lognormal; Normal	Nonparametric	2.0	a, d
2_117	2015-11-30 to 2024-03-27	Appendix IV	Lithium	ug/L	156	108	69.2%	34		22	27			24	38		22	32	48	24	24	22	48	48	48	0.87	Nonparametric	Nonparametric	48	a
2_118	2015-11-30 to 2024-03-27	Appendix IV	Mercury	ug/L	149	149	100.0%	1																0.20				Nonparametric	0.20	a, b
2_119	2015-11-30 to 2024-03-27	Appendix IV	Molybdenum	ug/L	156	117	75.0%	31		5.9	7.4			6.2	8.7		6.0	8.1	25	6.7	6.2	6.0	25	25	9.7	0.79	Nonparametric	Nonparametric	9.7	a, d
2_124	2015-11-30 to 2024-03-27	Appendix IV	Radium-226+228	pCi/L	156	77	49.4%	109		2.09	2.28		2.43	2.82	2.78		2.41	2.52	3.74	2.19	2.63	2.41	3.74	3.74	3.74	0.656	Gamma; Normal	Nonparametric	3.74	
2_126	2015-11-30 to 2024-03-27	Appendix IV	Selenium	ug/L	156	119	76.3%	19		1.7	2.1			1.9	2.2		1.8	2.2	3.3	1.9	1.9	1.8	3.3	3.3	3.3	0.66	Nonparametric	Nonparametric	3.3	a
2_130	2015-11-30 to 2024-03-27	Appendix IV	Thallium	ug/L	149	148	99.3%	6											10				10	10	0.19			Nonparametric	0.19	a, c, d
4_112	2020-10-26 to 2024-03-27	Michigan CCR	Copper	ug/L	58	37	63.8%	23		2.0	2.8			18	544		4.9	108	4.9	2.4	18	4.9	4.9	4.9	4.9	0.75	Gamma; Lognormal	Nonparametric	4.9	a
4_115	2020-10-26 to 2024-03-27	Michigan CCR	Iron	ug/L	58	1	1.7%	44		8,100	8,200			35,000	18,000		12,000	12,000	11,000	8,200	35,000	12,000	11,000	11,000	11,000	1.2	Gamma; Lognormal	Gamma	12,000	
4_120	2020-10-26 to 2024-03-27	Michigan CCR	Nickel	ug/L	58	44	75.9%	18		0.68	1.0			3.4	0.82		1.4	0.81	50	0.86	3.4	1.4	50	50	0.84	0.27	Gamma; Lognormal; Normal	Nonparametric	0.84	a, d
4_127	2020-10-26 to 2024-03-27	Michigan CCR	Silver	ug/L	58	58	100.0%	4											0.20				0.20	0.20				Nonparametric	0.20	a, b
4_134	2020-10-26 to 2024-03-27	Michigan CCR	Vanadium	ug/L	58	56	96.6%	6											10				10	10	1.7	0.38		Nonparametric	1.7	a, c, d
4_135	2020-10-26 to 2024-03-27	Michigan CCR	Zinc	ug/L	58	31	53.4%	29		28	35			720	12,000		84	1,200	48	31	720	84	48	48	48	1.1	Gamma; Lognormal	Nonparametric	48	a

Notes

a: Nonparametric methods were used since the percent below MDL is greater than 50%.

b: Constituent is 100% non-detects so the maximum detection limit is chosen as the BTV. Double Quantification Rule (DQR) is recommended for determining if an exceedance has occurred.

c: Maximum detected value was chosen as the UTL as the number of detects is less than 4.

d: Sample contains MDLs that are greater than the maximum detect value.

[1] To optimize the process for estimating a reference background concentration when there are multiple forms of the UTL formulae for data sets with assumed distributional properties, the averaging of the results over the multiple methods is done. The formulae are comparable and each one offers advantages and also has inherent errors in their methods. The action of averaging these estimates produces a pooled estimated closest to the unknown common truth based on how this error is perceived. For example, the UTL with assumed gamma distributional properties with non-detects has Kaplan-Meier (KM), regression on order statistics (ROS) and maximum likelihood estimation (MLE) methods for estimating the UTL for samples with non-detects. The averaging of all three estimates is done to produce one recommended estimate for the UTL. In situations where a method's estimate is notably different from the other methods' results (assessed based on subject matter expertise), then that particular method is excluded from the averaging.