

March 31, 2020

Bill Tietzel
Lewis County Environmental Services
2025 N.E. Kresky Avenue
Chehalis, WA

Re: Centralia Landfill 2019 Compliance Monitoring Report

Dear Bill:

This letter report summarizes the 2019 first and third quarter (2019 Q1 and Q3) water quality monitoring events at the Centralia Landfill in Lewis County, Washington (Figure 1). Biannual groundwater and surface water quality monitoring are performed during the wet (first quarter) and dry (third quarter) seasons. All groundwater data and landfill gas monitoring data are submitted to EIM.

The Centralia Landfill (Site) is a closed municipal solid waste landfill that operated between 1958 and 1994. Cleanup activities at the landfill were completed under Cleanup Action Plan Consent Decree C91-5100 as executed in 2001 between the Washington State Department of Ecology (Ecology), Lewis County, the City of Chehalis, the City of Centralia, the City of Morton, the City of Mossyrock, the Town of Pe Ell, and the City of Vader. The final remedial action for the landfill included post-closure monitoring of groundwater and surface water, operation and maintenance of the landfill gas control system, and maintenance of the final landfill cover and surface water control systems. The selected remedy also provided for institutional controls and compliance monitoring.

As of 2019, Ecology allowed Lewis County to combine the two semi-annual monitoring event reports into a single report. Therefore, this report presents all water quality data collected in 2019.

MONITORING PROGRAM

The groundwater and surface water monitoring networks, points of compliance, and regulatory limits are described below.

GROUNDWATER MONITORING NETWORK

Compliance groundwater monitoring at the Centralia Landfill is performed in a network of wells established in the 1999 Compliance Monitoring Plan (CH2M Hill, 1999) and

presented in Figures 2 to 7. The monitoring wells are completed in two water-bearing units identified at the landfill, the Shallow Upper/Upper Unit and the Lower Unit, as follows:

- Shallow Upper/Upper Unit wells: B-1SU, B-1S, B-2SU, B-2S, MW-1S, MW-2SU, MW-2S, MW-3S, MW-4S, MW-5S, and MW-CNE-1S. The suffix “SU” indicates wells that are completed in the Shallow Upper Unit and the suffix “S” indicates wells that are completed in the Upper Unit.
- Lower Unit wells: B-6DR, B-8DR, MW-1D, MW-2D, MW-3D¹, and MW-CNE-1D.

SURFACE WATER MONITORING NETWORK

Runoff from the landfill surface collects in the Weyerhaeuser Ditch that discharges to Salzer Creek. In compliance with the 1999 Compliance Monitoring Plan (CH2M Hill, 1999), the surface water monitoring network consists of a single station, SW-14. This surface water station is located in the Weyerhaeuser Ditch at the southwest corner of the landfill just before water in the ditch flows off the landfill property boundary and discharges into Salzer Creek (Figure 1). As summarized in Ecology’s Second Periodic Review (Ecology, 2016), surface water sampling is performed in March during the wet season and in September during the dry season as required by the Cleanup Action Plan and Consent Decree.

CLEANUP LEVELS AND POINTS OF COMPLIANCE

Cleanup levels for groundwater and surface water were established in the Cleanup Action Plan using the Model Toxics Control Act (MTCA) Method B (WAC 173-340-705), which references Applicable, Relevant, and Appropriate Requirements (ARARs) based on applicable state and federal laws, in addition to providing methods for calculating cleanup levels based on toxic or carcinogenic risk. The following discussion of cleanup levels and points of compliance summarizes information detailed in the Second Periodic Review (Ecology, 2016).

Groundwater

Groundwater in the Upper Unit discharges to the Weyerhaeuser Ditch and Salzer Creek. Therefore, cleanup levels for groundwater in the Upper Unit were established considering both MTCA Method B groundwater *and* surface water standards. The cleanup levels in groundwater for the Centralia Landfill are based on primary drinking water standards for mercury and nitrate; and are based on secondary drinking water standards for chloride, pH, sulfate, TDS, manganese, iron, and zinc. The compliance limit for arsenic in groundwater for the Centralia Landfill, 0.5 µg/L (0.0005 mg/L), is based on the surface water ARAR described in the following section.

¹ MW-3D was not identified as a monitoring well in the 1999 Compliance Monitoring Plan.

Groundwater in the Lower Unit does not discharge to surface water near the Centralia Landfill and therefore only groundwater ARARs were used to establish cleanup levels for this unit. The current Site cleanup levels for iron and manganese are based on federal and state secondary maximum contaminant levels for drinking water. The Second Periodic Review (Ecology, 2016) refers to a Site cleanup level for arsenic of 5 µg/L (0.005 mg/L) for groundwater in the Lower Unit, and the Cleanup Action Plan (unknown, 1999) states this is the MTCA Method A cleanup level based on background concentrations for the State of Washington. The Second Periodic Review (Ecology, 2016) acknowledges that if Site background concentrations of iron, manganese, and/or arsenic are higher than cleanup levels, then background-based alternative cleanup levels will be established. Ecology further states that since there is only one background monitoring well completed in the Lower Unit², continued and expanded background monitoring is required to make this evaluation.

The point of compliance for groundwater cleanup at the Centralia Landfill is the existing property boundary.

Surface Water

Contaminants of concern for surface water at the Centralia Landfill are arsenic, iron, and manganese (Ecology, 2016). A surface water cleanup level for arsenic of 0.27 µg/L (0.00027 mg/L) was previously calculated based on background concentrations. However, this value is less than the practical quantitation limit (PQL) of 0.5 µg/L (0.0005 mg/L), which is the lowest limit that can reliably be achieved during routine laboratory operating conditions and using Ecology-approved methods. Therefore, the compliance level for arsenic in surface water established for this Site is 0.5 µg/L (0.0005 mg/L). Surface water ARARs for iron and manganese are not established.

The surface water point of compliance is monitoring station SW-14, located in the Weyerhaeuser Ditch just before flows pass the Centralia Landfill property boundary and discharge into Salzer Creek.

2019 Q1 WATER QUALITY MONITORING EVENT

Representatives of the City of Centralia performed the 2019 Q1 water quality sampling event as described below. Analytical services were provided by Dragon Analytical Laboratory, Inc. (DAL), in Olympia, Washington. DAL subcontracted analysis of total organic carbon (TOC) to Edge Analytical in Burlington, Washington and subcontracted analysis of total mercury to ALS Group USA Corp. DAL, Edge Analytical, and ALS Group USA Corp are Ecology-accredited laboratories.

² The Second Periodic Review (Ecology, 2016) states there is only one background monitoring well completed in the Lower Unit; however, groundwater contours presented for September 2016 (Centralia Public Works, 2016) and for this report suggest that MW-1D and MW-3D are both located upgradient of the landfill.

During 2019 Q1, groundwater quality samples were collected from the Shallow Upper/Upper Unit wells and Lower Unit wells identified above by representatives of the City of Centralia on May 6 and 7, 2019, with the exceptions of wells B-1S and B-2S which were not sampled. Dedicated submersible pumps were used to purge and collect the samples at the minimal rates possible (approximately 0.3 gallons per minute). Groundwater samples collected from the Centralia Landfill monitoring wells in 2019 Q1 were analyzed for alkalinity, ammonia, chloride, chemical oxygen demand (COD), hardness, nitrate+nitrite, total dissolved solids (TDS), sulfate, nine dissolved metals (arsenic, calcium, iron, magnesium, manganese, mercury, potassium, sodium, and zinc), total mercury, and total organic carbon (TOC). Handheld meters were used to measure pH, specific conductivity, and temperature in the field during sampling at each well. Groundwater samples were delivered to DAL on May 7, 2019 for analysis. Samples collected for dissolved metals analysis were lab-filtered.

Surface water station SW-14 was not sampled during 2019 Q1.

2019 Q1 GROUNDWATER LEVEL DATA

Water levels in all Centralia Landfill monitoring wells were measured on May 6, 2019. Groundwater level elevations for the 2019 Q1 sampling event were calculated relative to elevations provided by the City and are presented in Figures 2 to 4. Groundwater contour maps of the data for the Upper and Lower Units (Figures 3 and 4) indicate that at the time of measurement, groundwater in these units was flowing toward the southwest. Wells completed in the Upper Shallow Unit are configured in a straight line and therefore a groundwater flow direction cannot be calculated (Figure 2). Water level elevations in the Upper Shallow Unit indicate some component of groundwater flow toward the south; however, whether that flow is toward the southwest, south, or southeast cannot be evaluated from the current well network.

2019 Q1 WATER QUALITY RESULTS RELATIVE TO CLEANUP LEVELS

Analytical results and applicable site cleanup levels for Centralia Landfill groundwater samples collected in 2019 Q1 are presented in Table 1 for the Upper Shallow/Shallow Unit wells and in Table 2 for the Lower Unit wells. Time series plots of groundwater quality data are presented in Appendix A for the period-of-record available from Ecology's online Environmental Information Management System (EIM).

Upper Shallow/Shallow Unit Groundwater Quality

The following observations were made regarding 2019 Q1 groundwater concentrations in the Upper Shallow/Shallow Unit wells relative to Site cleanup levels (Table 1):

- The concentrations of TDS in samples collected at B-1SU, MW-2S, MW-2SU, and MW-CNE-1S exceeded the secondary groundwater standard (500 mg/L). Based on groundwater contours for the 2019 Q1 sampling event (Figure 3), MW-

2S is located downgradient of the landfill and MW-CNE-1S is located cross gradient. B-1SU and MW-2SU are located adjacent to the landfill (Figure 2), and are likely downgradient of the landfill although as stated above, water level data in the Upper Shallow Unit could not be contoured.

- The concentrations of dissolved arsenic in all samples except for MW-3S exceeded the Site compliance level of 0.0005 mg/L. Based on Figure 3 two Shallow Unit wells are located upgradient of the landfill, MW-1S and MW-3S. The 2019 Q1 dissolved arsenic concentration in MW-1S exceeded the Site compliance level but dissolved arsenic was not detected in MW-3S.
- The concentrations of dissolved iron exceeded the secondary groundwater standard (0.3 mg/L) in samples collected at Upper Shallow/Shallow Unit wells MW-CNE-1S and MW-2SU. MW-CNE-1S is located cross gradient (Figure 3) and well MW-2SU is located adjacent to the landfill (Figure 2).
- The concentrations of dissolved manganese exceeded the secondary groundwater standard (0.05 mg/L) in all samples collected in the Upper Shallow/Shallow Unit wells with the exceptions of samples B-2SU, MW-3S, MW-4S and MW-5S. Well MW-3S is located upgradient of the landfill (Figure 3).
- Concentrations of chloride, nitrate+nitrite, sulfate, dissolved mercury, total mercury, and dissolved zinc were less than corresponding cleanup levels or were not detected in all samples collected from Upper Shallow/Shallow Unit wells in 2019 Q1.

Lower Unit Groundwater Quality

The Second Periodic Review (Ecology, 2016) compared dissolved arsenic, soluble iron, and manganese (unspecified) to corresponding cleanup levels. The following observations were made regarding the 2019 Q1 groundwater concentrations in the Lower Unit wells relative to cleanup levels for arsenic, iron, and manganese (Table 2):

- The concentration of dissolved arsenic in samples collected from B-6DR and MW-1D were above the cleanup level of 0.005 mg/L referenced in the Second Periodic Review (Ecology, 2016). MW-1D is located northeast and upgradient of the Centralia Landfill while B-6DR is located adjacent to and/or downgradient of the landfill (Figure 4). During 2019 Q1, the dissolved arsenic concentration in MW-1D (upgradient) was greater than the dissolved arsenic concentration in B-6DR.
- The concentrations of dissolved iron in samples collected from MW-1D and MW-3D exceeded the secondary groundwater cleanup level for iron (0.3 mg/L). Based on groundwater contours for the 2019 Q1 event (Figure 4), MW-1D and MW-3D are both located upgradient of the landfill.
- The concentrations of dissolved manganese in all 2019 Q1 samples collected in Lower Unit wells exceeded the secondary groundwater cleanup levels for manganese (0.05 mg/L).

Surface Water Quality

Surface water station SW-14 was not sampled during 2019 Q1.

QUALITY ASSURANCE/QUALITY CONTROL

Quality control/quality assurance (QA/QC) reviews were conducted on the reported analyses. All requested analyses were performed and QA/QC assessments indicate that the data are considered usable for the intended purpose of the project. Notable results identified during the QA/QC review are discussed below.

Field duplicates are a type of QA/QC that may be included in a monitoring program to document the precision of the sampling process, the heterogeneity of the matrix, and reproducibility of sample preparation and analysis. A field duplicate is a second, separate sample taken from the same source, collected in separate containers, and analyzed independently by the same method and laboratory. During the 2019 Q1 sampling event, a field duplicate was collected at MW-CNE-1D and assigned the sample name “Dup 1”. The EPA National Functional Guidelines for Inorganic Superfund Methods Data Review (EPA, 2017), or National Functional Guidelines, provides guidance for evaluating results of duplicate samples. For metals analyses in water samples, the National Functional Guidelines recommend a relative percent difference (RPD) control limit of 20 percent if the original and duplicate concentrations are greater than or equal to 5 times the lab reporting limit, or a control limit of plus/minus the lab reporting limit if either the original or sample result is less than 5 times the lab reporting limit (including non-detects). The duplicate analysis of dissolved metals were within National Functional Guidelines with the following exceptions:

- The RPD for dissolved manganese between MW-CNE-1D and the field duplicate was greater than 20 percent. Therefore, consistent with the National Functional Guidelines sample detections of dissolved manganese were flagged by PGG as estimated, “j,” and non-detect results were flagged “Uj.”

The National Functional Guidelines for duplicate evaluations do not extend to conventional parameters, instead PGG used professional judgement for duplicate evaluations of these parameters. Chemical oxygen demand (COD), a conventional parameter, was not detected in MW-CNE-1D but was detected in the field duplicate at a concentration greater than 5 times the reporting limit. Using professional judgement, PGG qualified the 2019 Q1 COD detections as estimated, “j,” and non-detect COD results as “Uj.”

Laboratory control samples (LCS) are a QA/QC tool to assess general method performance based on the ability of the lab to successfully recover target analytes from a control matrix. LCS are prepared by the lab by adding known concentrations of analytes to aliquots of analyte-free water. The LCS samples are prepared and analyzed in the same manner as field samples. The recovery of the target analytes in the LCS analysis demonstrates whether the methodology is in control and unbiased. The recovery of dissolved potassium from the LCS was out of control low; therefore, DAL flagged the detections of dissolved potassium in the 2019 Q1 samples as estimated, “J.”

Specific conductivity is measured in the field during sample collection using handheld meters and recorded on field sheets. The 2019 Q1 specific conductivity values presented in Table 1 and Appendix A are consistent with the values recorded on the field sheet; however, the 2019 Q1 specific conductivity values are two to three orders of magnitude lower than measurements made at individual wells between 2009 Q3 and 2018 Q3. An instrument or transcription error is suspected and therefore the 2019 Q1 specific conductivity values have been qualified by PGG as estimated, “j.”

2019 Q3 WATER QUALITY MONITORING EVENT

Representatives of the City of Centralia performed the 2019 Q3 water quality sampling event as described below. Analytical services were provided by DAL, in Olympia, Washington. DAL subcontracted analysis of total organic carbon (TOC) to Edge Analytical in Burlington, Washington. Both DAL and Edge Analytical are Ecology-accredited laboratories.

During 2019 Q3, groundwater quality samples were collected from the Shallow Upper/Upper Unit wells and Lower Unit wells identified above by representatives of the City of Centralia on September 23 and 24, 2019. Dedicated submersible pumps were used to purge and collect the samples. Groundwater samples collected from the Centralia Landfill monitoring wells in 2019 Q3 were analyzed for alkalinity, ammonia, chloride, chemical oxygen demand (COD), hardness, nitrate+nitrite, TDS, sulfate, nine dissolved metals (arsenic, calcium, iron, magnesium, manganese, mercury, potassium, sodium, and zinc), and TOC. Handheld meters were used to measure pH, specific conductivity, and temperature in the field during sampling at each well. Groundwater samples were delivered to DAL on September 24, 2019 for analysis. Samples collected for dissolved metals analysis were lab-filtered.

Surface water station SW-14 was not sampled during 2019 Q3.

2019 Q3 GROUNDWATER LEVEL DATA

Water levels in all Centralia Landfill monitoring wells were measured on September 23, 2019. Groundwater level elevations for the 2019 Q3 sampling event were calculated relative to elevations provided by the City and are presented in Figures 5 to 7. Groundwater contour maps of the data for the Upper and Lower Units (Figures 6 and 7) indicate that at the time of measurement, groundwater in these units was flowing toward the west and southwest. Wells completed in the Upper Shallow Unit are configured in a straight line and therefore a groundwater flow direction cannot be calculated (Figure 5). Water level elevations in the Upper Shallow Unit indicate some component of groundwater flow toward the south; however, whether that flow is toward the southwest, south, or southeast cannot be evaluated from the current well network.

2019 Q3 WATER QUALITY RESULTS RELATIVE TO CLEANUP LEVELS

Analytical results for Centralia Landfill groundwater samples collected in 2019 Q3 are presented in Table 3 for the Upper Shallow/Shallow Unit wells and in Table 4 for the Lower Unit wells. Applicable Site cleanup levels are also presented in Tables 3 and 4. Time series plots of groundwater quality data are presented in Appendix A for the period-of-record available from Ecology's online Environmental Information Management System (EIM).

Upper Shallow/Shallow Unit Groundwater Quality

The following observations were made regarding 2019 Q3 groundwater concentrations in the Upper Shallow/Shallow Unit wells relative to Site cleanup levels (Table 3):

- The concentrations of TDS in samples collected at MW-2S and MW-CNE-1S exceeded the secondary groundwater standard (500 mg/L). Based on groundwater contours for the 2019 Q3 sampling event (Figure 3), MW-2S is located down-gradient of the landfill and MW-CNE-1S is located cross gradient.
- The concentration of nitrate+nitrite in sample B-2S exceeded the primary groundwater standard (10 mg/L). Well B-2S is located adjacent to and down-gradient of the landfill.
- The concentrations of dissolved arsenic in all samples except for MW-1S and MW-3S exceeded the Site compliance level of 0.0005 mg/L. Wells MW-1S and MW-3S are both located upgradient of the landfill (Figure 6).
- The concentrations of dissolved iron exceeded the secondary groundwater standard (0.3 mg/L) in samples collected at Upper Shallow/Shallow Unit wells B-1SU, MW-2S, MW-2SU, and MW-CNE-1S. Well MW-2S is located downgradient of the landfill and MW-CNE-1S is located cross gradient (Figure 6). Wells B-1SU and MW-2SU is located adjacent to the landfill (Figure 7). As stated above, water level data in the Upper Shallow Unit could not be contoured.
- The concentrations of dissolved manganese exceeded the secondary groundwater standard (0.05 mg/L) in all samples collected in the Upper Shallow/Shallow Unit wells with the exceptions of samples B-2SU, B-2S, MW-1S, and MW-3S. Wells MW-1S and MW-3S are located upgradient of the landfill and well B-2S is located downgradient of the landfill (Figure 6). As stated above, water level data in the Upper Shallow Unit could not be contoured.
- Concentrations of chloride, sulfate, dissolved mercury, and dissolved zinc were less than corresponding cleanup levels or were not detected in all samples collected from Upper Shallow/Shallow Unit wells in 2019 Q3.

Lower Unit Groundwater Quality

The Second Periodic Review (Ecology, 2016) compared dissolved arsenic, soluble iron, and manganese (unspecified) to corresponding cleanup levels. The following observa-

tions were made regarding the 2019 Q3 groundwater concentrations in the Lower Unit wells relative to cleanup levels for arsenic, iron, and manganese (Table 4):

- The concentrations of dissolved arsenic in samples collected from B-6DR, MW-1D, and MW-2D were above the cleanup level of 0.005 mg/L referenced in the Second Periodic Review (Ecology, 2016). MW-1D is located northeast and up-gradient of the Centralia Landfill while B-6DR and MW-2D are located adjacent to and downgradient of the landfill. During 2019 Q3, the dissolved arsenic concentration in MW-1D (upgradient) was greater than in B-6DR and MW-2D.
- The concentrations of dissolved manganese in all 2019 Q3 samples collected in in Lower Unit wells exceeded the secondary groundwater cleanup levels for manganese (0.05 mg/L).

Surface Water Quality

Surface water station SW-14 was not sampled during 2019 Q3.

Quality Assurance/Quality Control

Quality control/quality assurance (QA/QC) reviews were conducted on the reported analyses. All requested analyses were performed and QA/QC assessments indicate that the data are considered usable for the intended purpose of the project. Notable results were not identified during the QA/QC review with the following exceptions.

Field duplicates are a type of QA/QC that may be included in a monitoring program to document the precision of the sampling process, the heterogeneity of the matrix, and reproducibility of sample preparation and analysis. A field duplicate is a second, separate sample taken from the same source, collected in separate containers, and analyzed independently by the same method and laboratory. During the 2019 Q3 sampling event, a field duplicate was collected at MW-CNE-1D and assigned the sample name “Dup 1”. The EPA National Functional Guidelines for Inorganic Superfund Methods Data Review (EPA, 2017), or National Functional Guidelines, provides guidance for evaluating results of duplicate samples. For metals analyses in water samples, the National Functional Guidelines recommend a relative percent difference (RPD) control limit of 20 percent if the original and duplicate concentrations are greater than or equal to 5 times the lab reporting limit, or a control limit of plus/minus the lab reporting limit if either the original or sample result is less than 5 times the lab reporting limit (including non-detects). Dissolved mercury was not detected in the 2019 Q3 field duplicate but was detected in sample MW-CNE-1D at a concentration less than 5 times the lab reporting limit (reporting limit = 0.1 mg/L). The absolute difference between the dissolved mercury results in the field duplicate and MW-CNE-1D is greater than the lab reporting limit; therefore, consistent with the National Functional Guidelines detected dissolved mercury concentrations in the 2019 Q3 samples have been qualified by PGG as estimated, “j,” and non-detect dissolved mercury concentrations have been qualified “Uj.”

Analysis of total organic carbon (TOC) was sub-contracted to Edge Analytical by Dragon Analytical Labs. Laboratory QA/QC results for TOC were not provided to PGG and were therefore not reviewed with the exception of the field duplicate evaluation, which was considered acceptable.

Specific conductivity is measured in the field during sample collection using handheld meters and recorded on field sheets. The 2019 Q3 specific conductivity values presented in Table 3 and Appendix A are consistent with the value recorded on the field sheet; however, the 2019 Q3 specific conductivity values are two to three orders of magnitude lower than measurements made at individual wells between 2009 Q3 and 2018 Q3 with the exception of MW-3D. An instrument or transcription error is suspected and therefore the 2019 Q3 specific conductivity values have been qualified by PGG as estimated, “j” for all wells except MW-3D.

REFERENCES

- Centralia Public Works. 2016. Compliance Monitoring report for the Centralia Landfill. Letter report provided to Bill Teitzel, Lewis County Environmental Services, by Randy Prevost, City of Centralia.
- CH2M Hill. 1999. Centralia Landfill Compliance Monitoring Plan. Consultant’s report prepared for the Centralia Landfill Closure Group.
- Environmental Protection Agency (EPA). 2016. National Functional Guidelines for Inorganic Superfund Methods Data Review. Office of Superfund Remediation and Technology Innovation (OSRTI). OLEM 9355.0-133. EPA-540-R-2016-001. September 2016.
- Unknown Author. 1999. Exhibit B Cleanup Action Plan Centralia Landfill Lewis County, Washington. September 1999.
- Washington State Department of Ecology (Ecology). 2016. Second Periodic Review Report Final Centralia Landfill Facility Site ID #: 1154. Southwest Region Office Toxics Cleanup Program. January 2016.

We are pleased to provide you with these monitoring services. Please call us if you have any questions

Sincerely,

Pacific Groundwater Group



Stephen P. Swope
Principal Hydrogeologist

Cc: Mohson Kourehdar, Department of Ecology
Kallan Kersavage, Lewis County
Greg Gachowsky, Lewis County

Attachments: Table 1. Shallow Upper/Upper Groundwater Quality Summary, 2019 Q1
Table 2. Lower Unit Groundwater Quality Summary, 2019 Q1
Table 3. Shallow Upper/Upper Groundwater Quality Summary, 2019 Q3
Table 4. Lower Unit Groundwater Quality Summary, 2019 Q3
Figure 1. Centralia Landfill Vicinity
Figure 2. Shallow Upper Aquifer Groundwater Elevations 2019 Q1
Figure 3. Upper Aquifer Groundwater Elevations 2019 Q1
Figure 4. Lower Aquifer Groundwater Elevations 2019 Q1
Figure 5. Shallow Upper Aquifer Groundwater Elevations 2019 Q3
Figure 6. Upper Aquifer Groundwater Elevations 2019 Q3
Figure 7. Lower Aquifer Groundwater Elevations 2019 Q3
Appendix A. Water Quality Time Series Plots

Centralia2019SummaryRpt.docx

Table 1. Shallow Upper/Upper Groundwater Quality Summary, 2019 Q1

Parameter Group	Constituent	Units	CAP Cleanup Level	CAP Compliance Level	Groundwater Standards *	B-1S	B-1SU	B-2S	B-2SU	MW-1S	MW-2S	MW-2SU	MW-3S	MW-4S	MW-5S	MW-CNE-1S
Field Parameters																
	Depth to Water	feet					8.6		7.98	6.6	4.6	5.6	10.2	7.79	5.89	4.9
	pH, Field	std. units					8.22		8.36	8.46	8.01	8.08	7.9	8.76	8.5	7.97
	Specific Conductivity (at 25 deg C)	uS/cm	700				1.34 j		0.547 j	0.325 j	2.28 j	2.26 j	0.288 j	0.253 j	0.462 j	7.39 j
	Temperature, 0 F	0 F					11.84		13.12	15.15	13.65	13.04	14.75	12.73	12.87	14.79
Conventional Parameters																
	Alkalinity, Carb as CaCO3	mg/L					1270		557.1	122.25	928.28	1360	99	151.4	280.6	1220
	Ammonia as N, Total	mg/L					0.3 U		0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
	Carbon, Total Organic	mg/L					3.64		0.44	0.15 U	11.6	11.1	0.36	0.49	0.53	10
	Chemical Oxygen Demand (COD)	mg/L					3850 j		5 Uj	5 Uj	29.74 j	46.2 j	5 Uj	5 Uj	5 Uj	29.74 j
	Chloride	mg/L	250		250		92.804		2.42	1.735	226.325	212.193	5.731	1.675	2.085	64.613
	Hardness	mg/L					142.7312		165.6672	11.05135	570.9944	573.0597	17.49275	18.24692	100.5918	449.7421
	Nitrate+Nitrite as N	mg/L			10		0.1 U		0.142	0.938	0.1 U	0.1 U	0.648	0.965	3.246	0.438
	Solids, Total Dissolved	mg/L			500		594		232	102	982	1040	124	112	152	580
	Sulfate	mg/L			250		0.2 U		6.547	10.432	1.041	0.693	26.684	4.722	9.173	0.207
Dissolved Metals																
	Arsenic, Dissolved	mg/L	0.00027	0.0005	0.00005		0.001866		0.001477	0.007091	0.009449	0.001288	0.0005 U	0.005143	0.006071	0.006671
	Calcium, Dissolved	mg/L					71.4		30	23.2	132	136	13.2	10.5	19.2	77.3
	Iron, Dissolved	mg/L	0.3		0.3		0.09853		0.05 U	0.05 U	0.1352	0.4009	0.05 U	0.05 U	0.05 U	20.4
	Magnesium, Dissolved	mg/L					59.9		21.1	8.35	76.7	69.8	3.61	5.58	12	55.9
	Manganese, Dissolved	mg/L	0.05		0.05		5.29 j		0.002185 j	0.5226 j	11.501 j	8.369 j	0.007531 j	0.002756 j	0.01564 j	1.97 j
	Mercury, Dissolved	mg/L			0.002		0.0001 U		0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
	Potassium, Dissolved	mg/L					1.85 J		1.42 J	1.68 J	6.45 J	6.36 J	0.5839 J	0.4248 J	1.57 J	4.4 J
	Sodium, Dissolved	mg/L					62.2		18.4	21.4	24	22.1	11.5	12.5	15.6	21.7
	Zinc, Dissolved	mg/L			5		0.001 U		0.00564	0.001 U	0.001285	0.001404	0.001445	0.004198	0.003592	0.001966
Total Metals																
	Mercury, Total	mg/L			0.002		0.5		0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

CAP = Cleanup Action Plan (September, 1999)
*Groundwater Primary Standards for Nitrate, Arsenic, and Mercury; Groundwater Secondary Standards for remaining parameters. Arsenic has a primary drinking water standard of 0.01 mg/L and a state ground water quality standard of 0.00005 mg/L. Groundwater Standards presented in this table are consistent with Centralia Landfill Second Periodic Review, Appendix 6.3 (Washington Department of Ecology, January 2016)
U = not detected at associated reporting limit
j = estimated

Table 2. Lower Unit Groundwater Quality Summary, 2019 Q1

Parameter Group	Constituent	Units	CAP Cleanup Level	Groundwater Standards *	B-6DR	B-8DR	MW-1D	MW-2D	MW-3D	MW-CNE-1D
Field Parameters										
	Depth to Water	feet			7.59	8.7	5.9	5.8	12	5.6
	pH, Field	std. units			8.73	8.54	8.5	8.71	8.39	8.46
	Specific Conductivity (at 25 deg C)	uS/cm			0.388 j	0.441 j	0.412 j	0.539 j	0.338 j	0.447 j
	Temperature, 0 F	0 F			13.17	13.6	15.71	13.78	15.6	12.94
Conventional Parameters										
	Alkalinity, Carb as CaCO3	mg/L			369.3	608.85	407.4	420.5	277.5	422.4
	Ammonia as N, Total	mg/L			1.62	1.09	1.5	1.58	0.474	0.3 U
	Carbon, Total Organic	mg/L			2.33	1.77	3.55	1.89	0.94	1.52
	Chemical Oxygen Demand (COD)	mg/L			5 Uj	10.54 j	1940 j	5 Uj	10.54 j	5 Uj
	Chloride	mg/L			13.189	5.072	6.022	10.524	5.666	6.467
	Hardness	mg/L			107.1278	154.6039	101.8452	126.2885	13.54806	102.2296
	Nitrate+Nitrite as N	mg/L			0.1 U	0.1 U	0.1 U	0.1 U	0.103	0.1 U
	Solids, Total Dissolved	mg/L			192	274	188	218	172	176
	Sulfate	mg/L			0.2 U	19.071	0.2 U	0.2 U	0.2 U	0.2 U
Dissolved Metals										
	Arsenic, Dissolved	mg/L	0.005	0.005	0.005531	0.0005 U	0.006806	0.004702	0.001206	0.0005 U
	Calcium, Dissolved	mg/L			26.4	32.6	22.9	29.8	16.1	27.7
	Iron, Dissolved	mg/L	0.3	0.3	0.0563	0.05 U	2.76	0.06565	0.5082	0.05 U
	Magnesium, Dissolved	mg/L			9.69	12.9	8.34	10.7	7.43	7.25
	Manganese, Dissolved	mg/L	0.05	0.05	0.6383 j	0.2487 j	0.6257 j	0.7511 j	0.9425 j	0.1649 j
	Mercury, Dissolved	mg/L			0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U	0.0001 U
	Potassium, Dissolved	mg/L			2.57 J	1.87 J	1.64 J	2.25 J	2.2 J	1.905 J
	Sodium, Dissolved	mg/L			14.2	41.8	21.1	15.4	12.1	20.6
	Zinc, Dissolved	mg/L			0.001 U	0.001 U	0.001321	0.001 U	0.00147	0.001 U
Total Metals										
	Mercury, Total	mg/L			0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U

CAP = Cleanup Action Plan (September, 1999)
*Groundwater Standards presented in this table are consistent with Centralia Landfill Second Periodic Review, Appendix 6.3 (Washington Department of Ecology, January 2016)
U = not detected at associated reporting limit
i = estimated

Table 3. Shallow Upper/Upper Groundwater Quality Summary, 2019 Q3

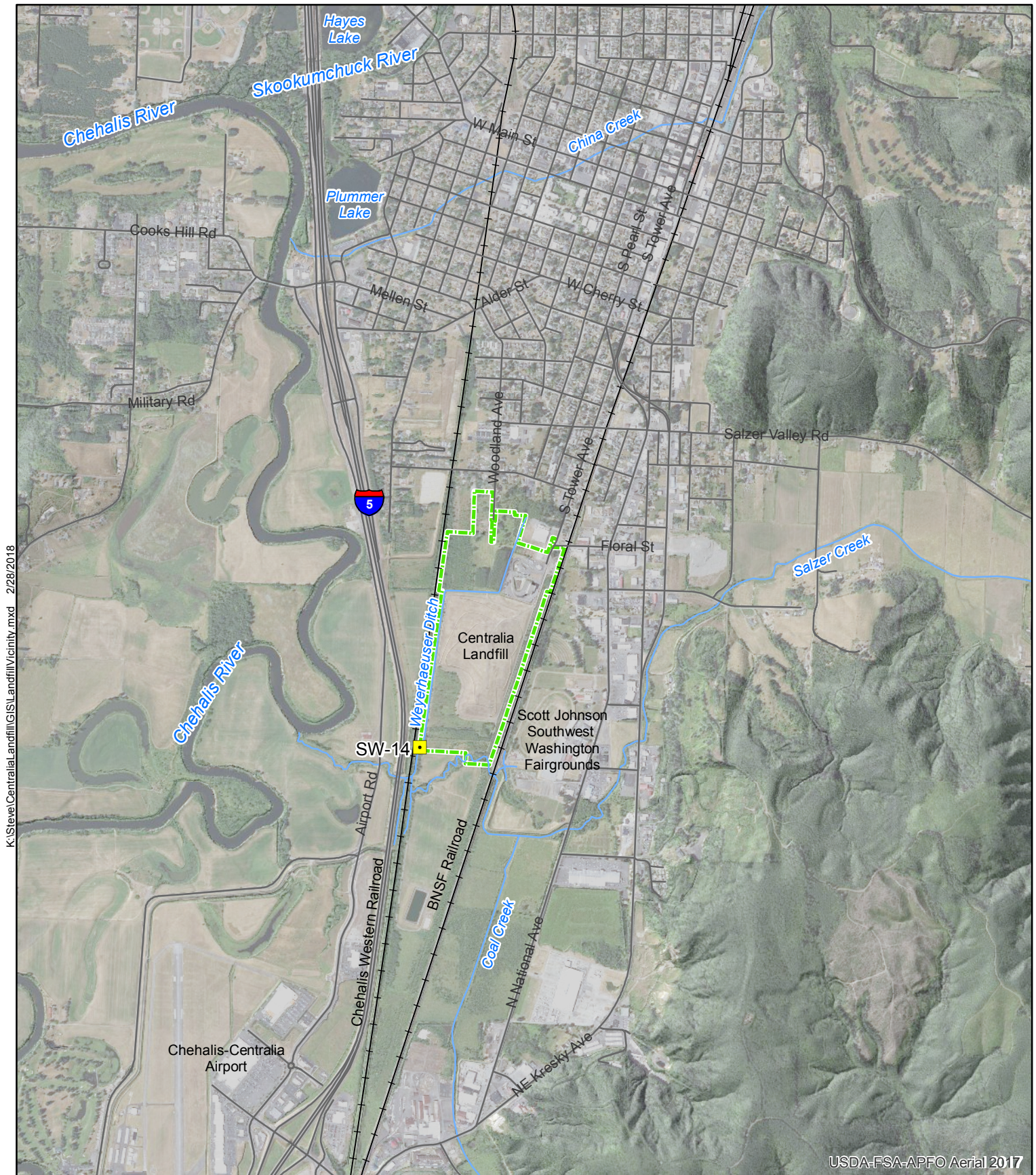
Parameter Group	Constituent	Units	CAP Cleanup Level	CAP Compliance Level	Groundwater Standards *	B-1S	B-1SU	B-2S	B-2SU	MW-1S	MW-2S	MW-2SU	MW-3S	MW-4S	MW-5S	MW-CNE-1S
Field Parameters																
	Depth to Water	feet				10.63	11.2	10.39	11.02	5.85	8.09	8.92	13.32	9.29	9.05	9.06
	pH, Field	std. units				8.88	8.52	8.88	8.54	8.48	8.1	8.03	8.25	8.8	8.69	7.95
	Specific Conductivity (at 25 deg C)	uS/cm	700			0.439 j	0.736 j	0.461 j	5.31 j	0.316 j	2.24 j	1.63 j	0.295 j	0.227 j	0.382 j	1.42 j
	Temperature, 0 F	0 F				56.8	56.5	59	59.2	59.6	59	59.4	59.1	59.4	58.9	56.1
Conventional Parameters																
	Alkalinity, Carb as CaCO3	mg/L				253	498	43.2	314	62.2	1020	898	82	113	217	849
	Ammonia as N, Total	mg/L				0.52	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U	0.3 U
	Chemical Oxygen Demand (COD)	mg/L				5 U	5 U	5 U	5 U	5 U	47.6	7.3	5 U	5 U	5 U	16.9
	Chloride	mg/L	250		250	6.5	11.9	2.1	2.2	1.5	237	124	4.4	2	3.2	58.8
	Hardness	mg/L				95.4	167	149	141	35.5	680	476	47.7	47	88.4	366
	Nitrate+Nitrite as N	mg/L			10	0.1 U	0.1 U	39.7	0.1 U	0.77	0.47	0.27	2.1	0.1 U	1.2	0.47
	Solids, Total Dissolved	mg/L			500	167	253	298	194	80.8	955	194	102	81.6	138	576
	Sulfate	mg/L			250	0.3	0.2 U	4.3	4.9	8.6	0.52	8.3	15.7	8.2	5.6	0.27
Dissolved Metals																
	Arsenic, Dissolved	mg/L	0.00027	0.0005	0.00005	0.0138	0.0056	0.00053	0.00194	0.0005 U	0.0191	0.0026	0.0005 U	0.00059	0.00092	0.006
	Calcium, Dissolved	mg/L				25.2	32.5	39	27.7	10.2	134	102	12.2	10.8	18.5	83.4
	Iron, Dissolved	mg/L	0.3		0.3	0.05 U	2.73	0.05 U	0.05 U	0.05 U	6.3	12.1	0.05 U	0.05 U	0.05 U	16.6
	Magnesium, Dissolved	mg/L				9.85	23.5	12.4	18.5	3.41	74.4	54.3	3.41	5.6	10.9	54.3
	Manganese, Dissolved	mg/L	0.05		0.05	0.81	3.06	0.0075	0.0228	0.00054	9.42	8.75	0.0034	0.0549	0.135	2.08
	Mercury, Dissolved	mg/L			0.002	0.0001 Uj	0.0001 Uj	0.0001 Uj	0.0001 Uj	0.0001 Uj	0.0001 Uj	0.0001 Uj	0.0001 Uj	0.0001 Uj	0.0001 Uj	0.0001 Uj
	Potassium, Dissolved	mg/L				4.53	2.19	0.892	1.44	0.497	6.32	6.26	0.598	0.621	1.88	4.36
	Sodium, Dissolved	mg/L				12	23.4	10.2	16.8	7.61	23.4	31.8	12	8.91	14.1	20.3
	Zinc, Dissolved	mg/L			5	0.001 U	0.001 U	0.0073	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U

CAP = Cleanup Action Plan (September, 1999)
*Groundwater Primary Standards for Nitrate, Arsenic, and Mercury; Groundwater Secondary Standards for remaining parameters. Arsenic has a primary drinking water standard of 0.01 mg/L and a state ground water quality standard of 0.00005 mg/L. Groundwater Standards presented in this table are consistent with Centralia Landfill Second Periodic Review, Appendix 6.3 (Washington Department of Ecology, January 2016)
U = not detected at associated reporting limit
j = estimated

Table 4. Lower Unit Groundwater Quality Summary, 2019 Q3

Parameter Group	Constituent	Units	CAP Cleanup Level	Groundwater Standards *	B-6DR	B-8DR	MW-1D	MW-2D	MW-3D	MW-CNE-1D
Field Parameters										
	Depth to Water	feet			9.95	10.82	11.78	8.67	15.2	8.9
	pH, Field	std. units			8.8	8.56	8.14	8.78	8.33	8.49
	Specific Conductivity (at 25 deg C)	uS/cm			0.449 j	0.636 j	0.5 j	0.528 j	340	0.474 j
	Temperature, 0 F	0 F			56.6	57.1	58.5	58.1	58.1	55.4
Conventional Parameters										
	Alkalinity, Carb as CaCO3	mg/L			249	392	271	353	221	252
	Ammonia as N, Total	mg/L			1.1	0.57	1.13	1.2	0.47	0.3
	Chemical Oxygen Demand (COD)	mg/L			5 U	5 U	5 U	5 U	5 U	5 U
	Chloride	mg/L			13.4	5	5.5	10.4	5.4	6.4
	Hardness	mg/L			110	121	102	130	75.8	88.4
	Nitrate+Nitrite as N	mg/L			0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
	Solids, Total Dissolved	mg/L			176	262	192	205	169	150
	Sulfate	mg/L			0.2 U	24.6	0.2 U	0.2 U	0.2 U	0.2 U
Dissolved Metals										
	Arsenic, Dissolved	mg/L	0.005	0.005	0.0074	0.0005 U	0.0094	0.0059	0.0017	0.0005 U
	Calcium, Dissolved	mg/L			27.2	30.4	22.6	28.1	16.5	27.2
	Iron, Dissolved	mg/L	0.3	0.3	0.05 U	0.05 U	0.05 U	0.05 U	0.233	0.05 U
	Magnesium, Dissolved	mg/L			9.91	12.2	8.5	10.4	7.6	7.3
	Manganese, Dissolved	mg/L	0.05	0.05	0.718	0.241	0.531	0.769	1.02	0.207
	Mercury, Dissolved	mg/L			0.0001 Uj	0.0001 Uj	0.0001 Uj	0.0001 Uj	0.0001 Uj	0.0001 Uj
	Potassium, Dissolved	mg/L			2.64	1.73	1.75	2.2	2.24	2.01
	Sodium, Dissolved	mg/L			14.2	40.5	23.4	15.2	12.6	21.5
	Zinc, Dissolved	mg/L			0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U

CAP = Cleanup Action Plan (September, 1999)
*Groundwater Standards presented in this table are consistent with Centralia Landfill Second Periodic Review, Appendix 6.3 (Washington Department of Ecology, January 2016)
U = not detected at associated reporting limit
i = estimated



K:\Steve\Centralia Landfill\GIS\Landfill Vicinity.mxd 2/28/2018

USDA-FSA-APFO Aerial 2017

- Surface Water Monitoring Station
- City Property

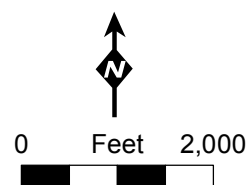
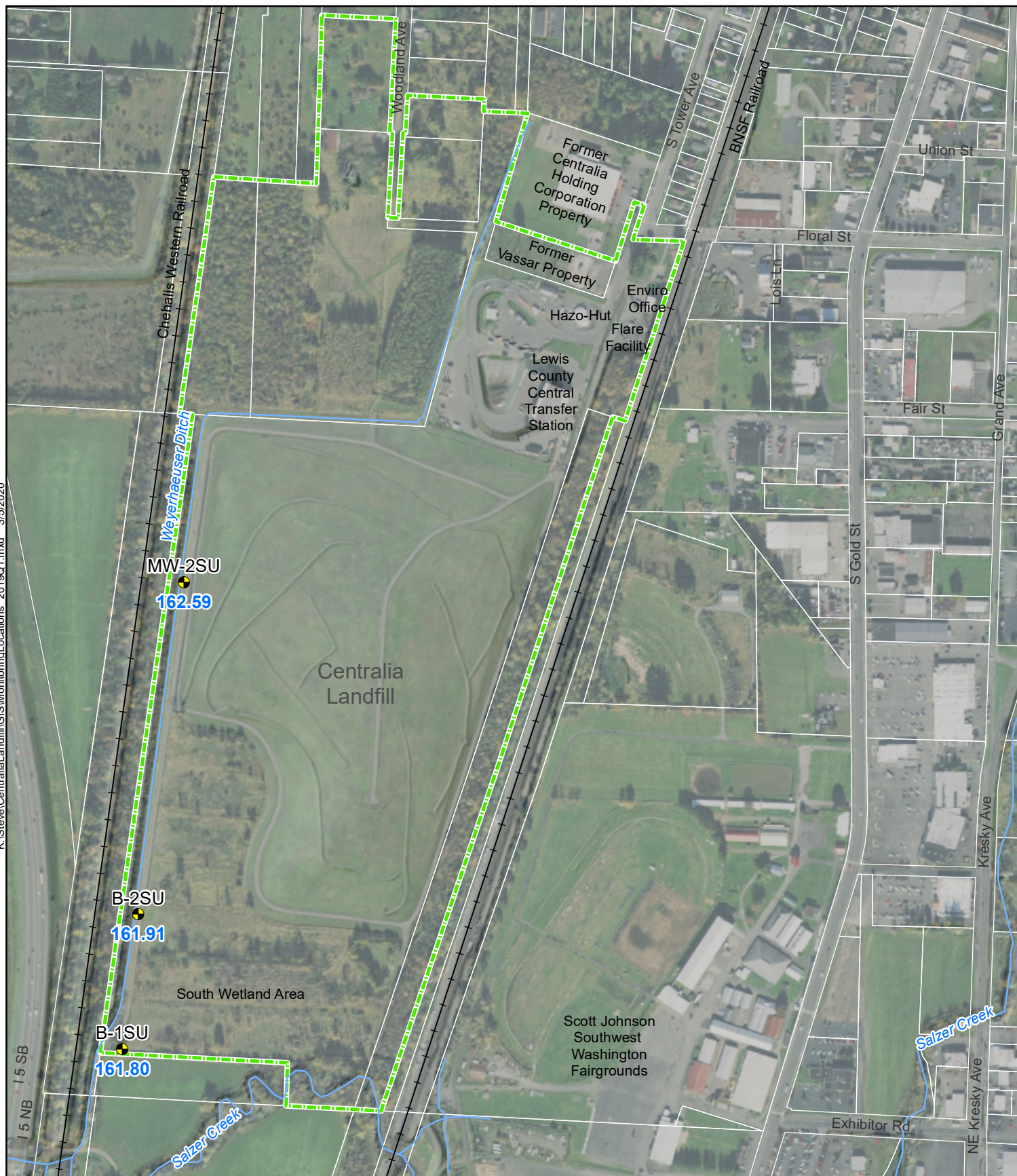


Figure 1
Centralia Landfill
Vicinity

Centralia Landfill
Compliance Monitoring

PGG



-  Monitoring Wells (with Measured Groundwater Elevation)
-  City Property

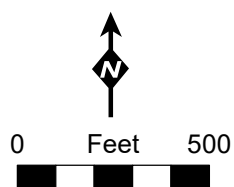
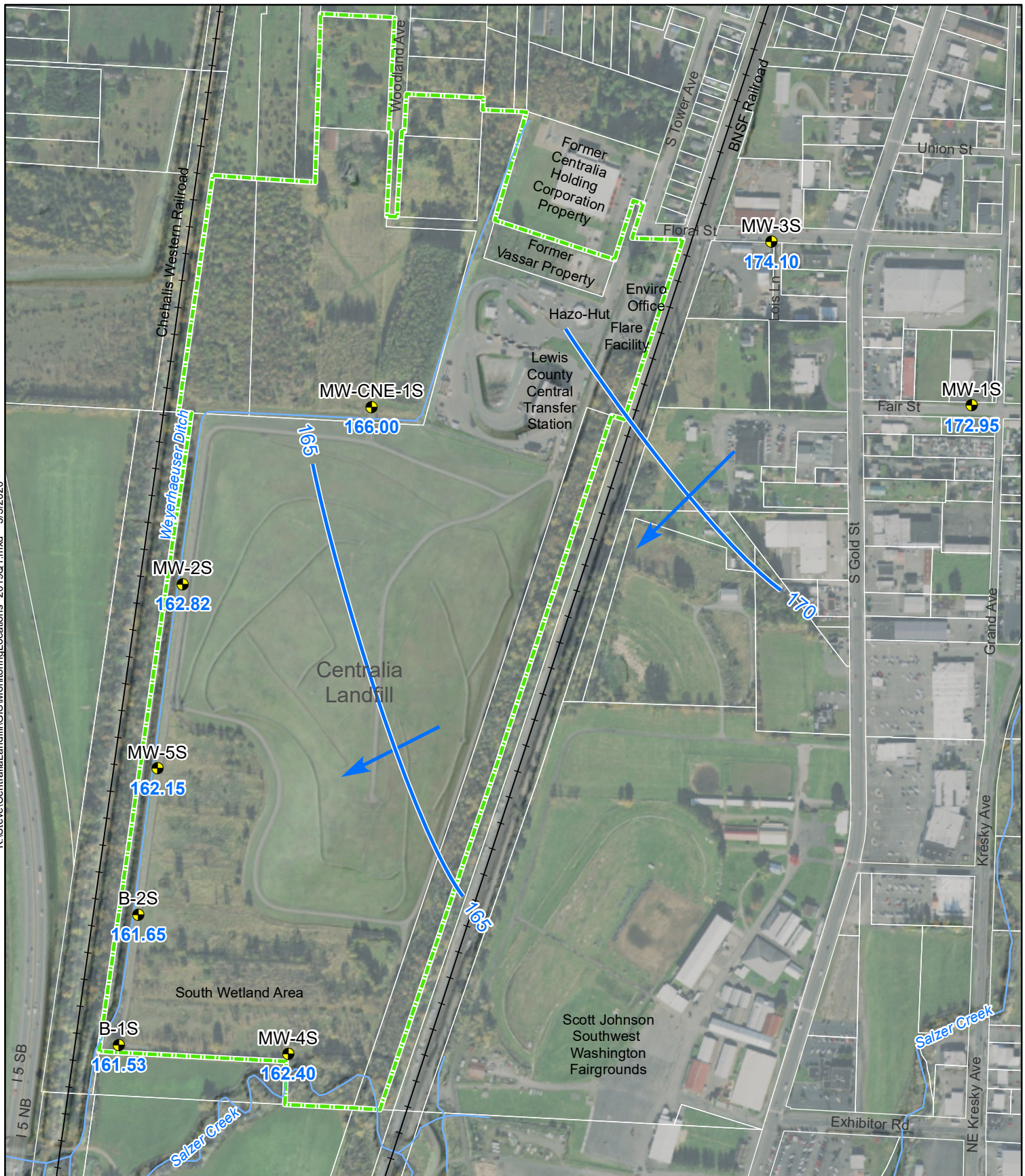


Figure 2
Shallow Upper Aquifer
Groundwater Elevations
2019 Q1

Centralia Landfill
 Compliance Monitoring





- Monitoring Wells (with Measured Groundwater Elevation)
- Groundwater Elevation Contours
- ➔ Estimated Flow Path
- City Property

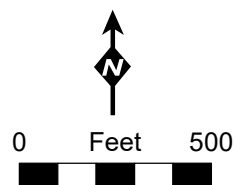


Figure 3
Upper Aquifer
Groundwater Elevations
2019 Q1

Centralia Landfill
Compliance Monitoring

pgg

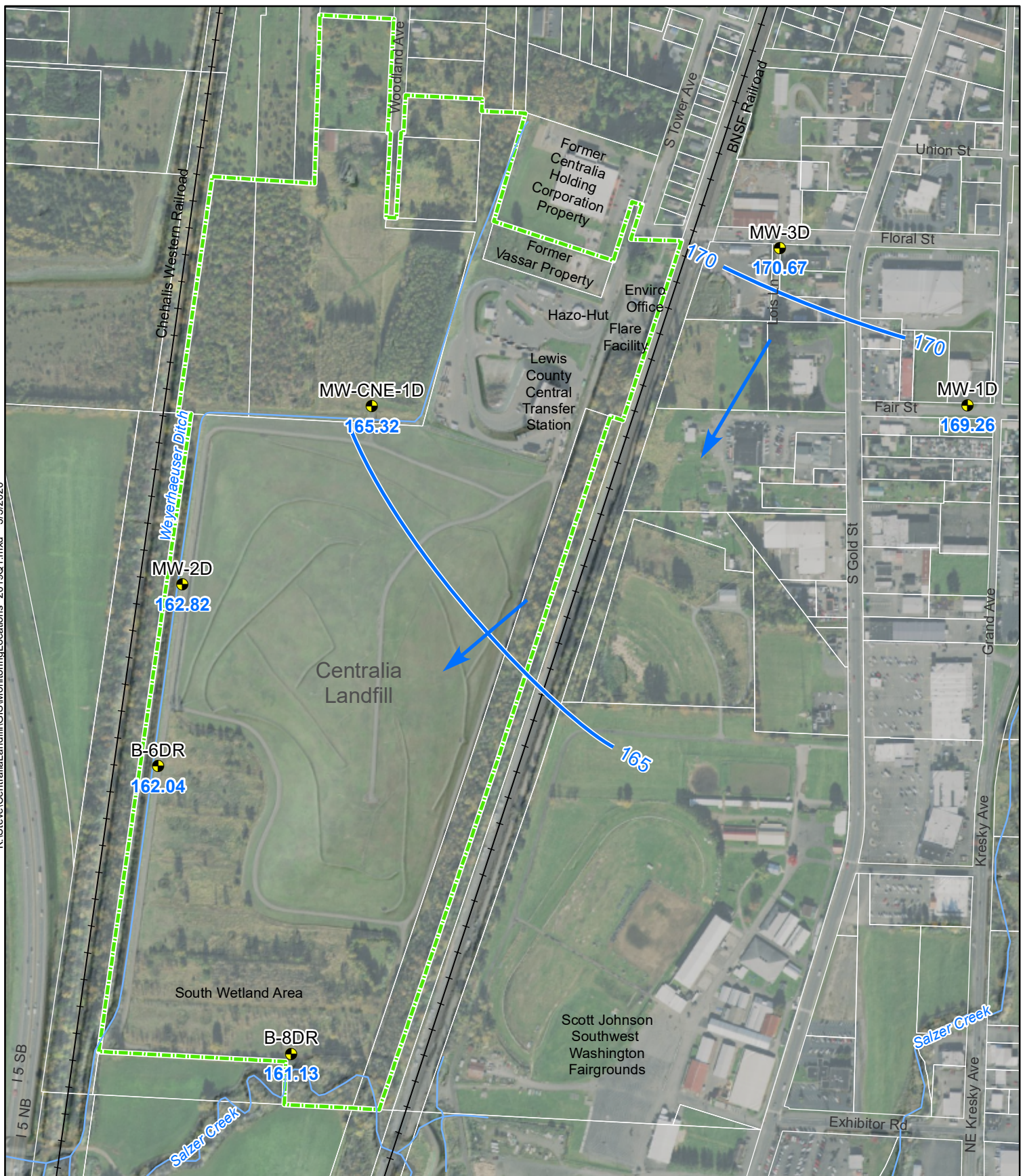
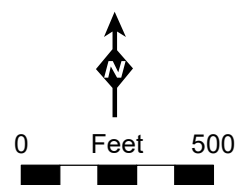


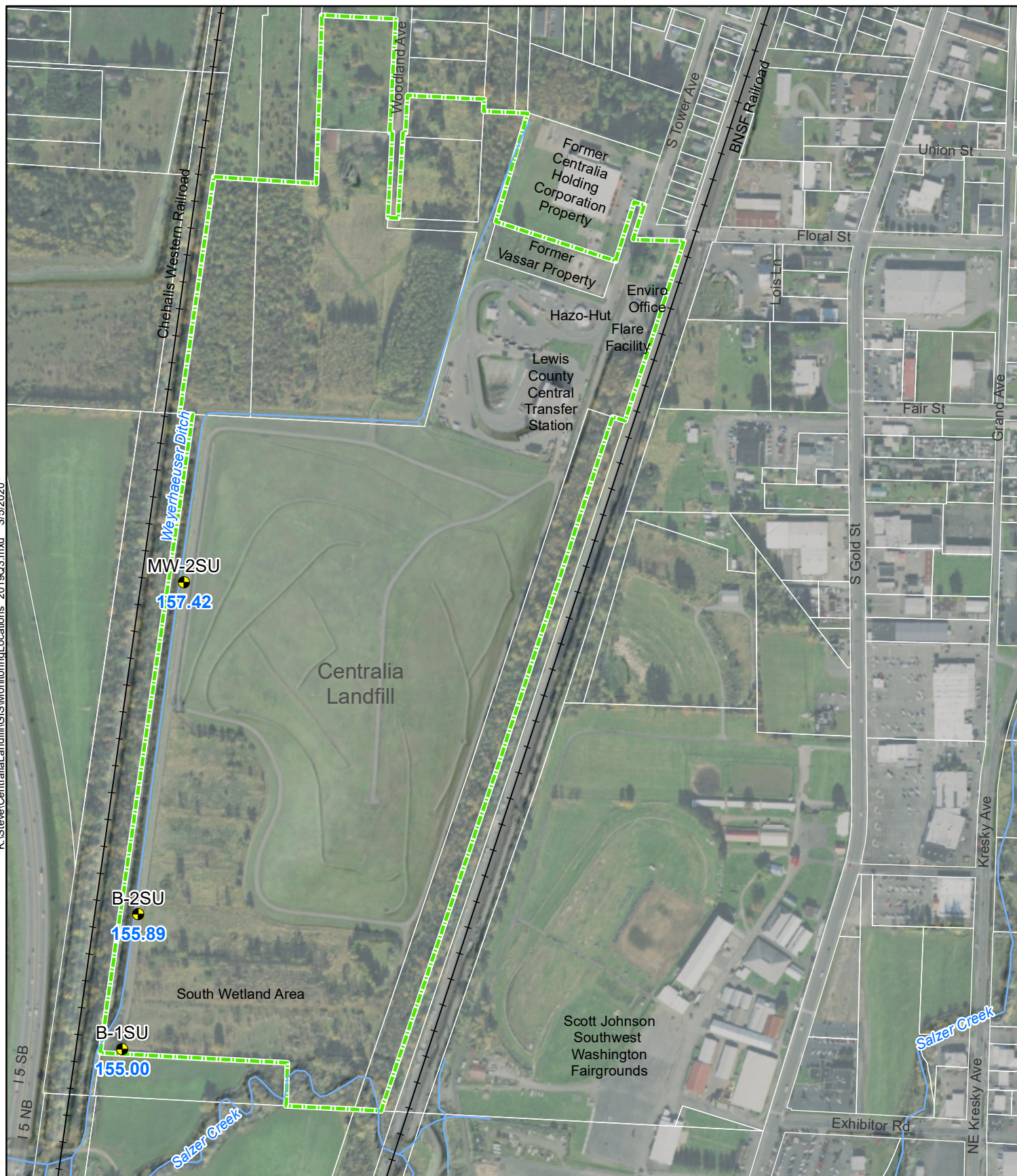
Figure 4

Lower Aquifer
Groundwater Elevations
2019 Q1

Centralia Landfill
Compliance Monitoring

PGG





-  Monitoring Wells (with Measured Groundwater Elevation)
-  City Property

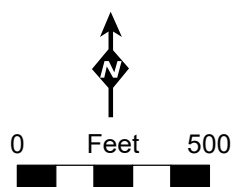
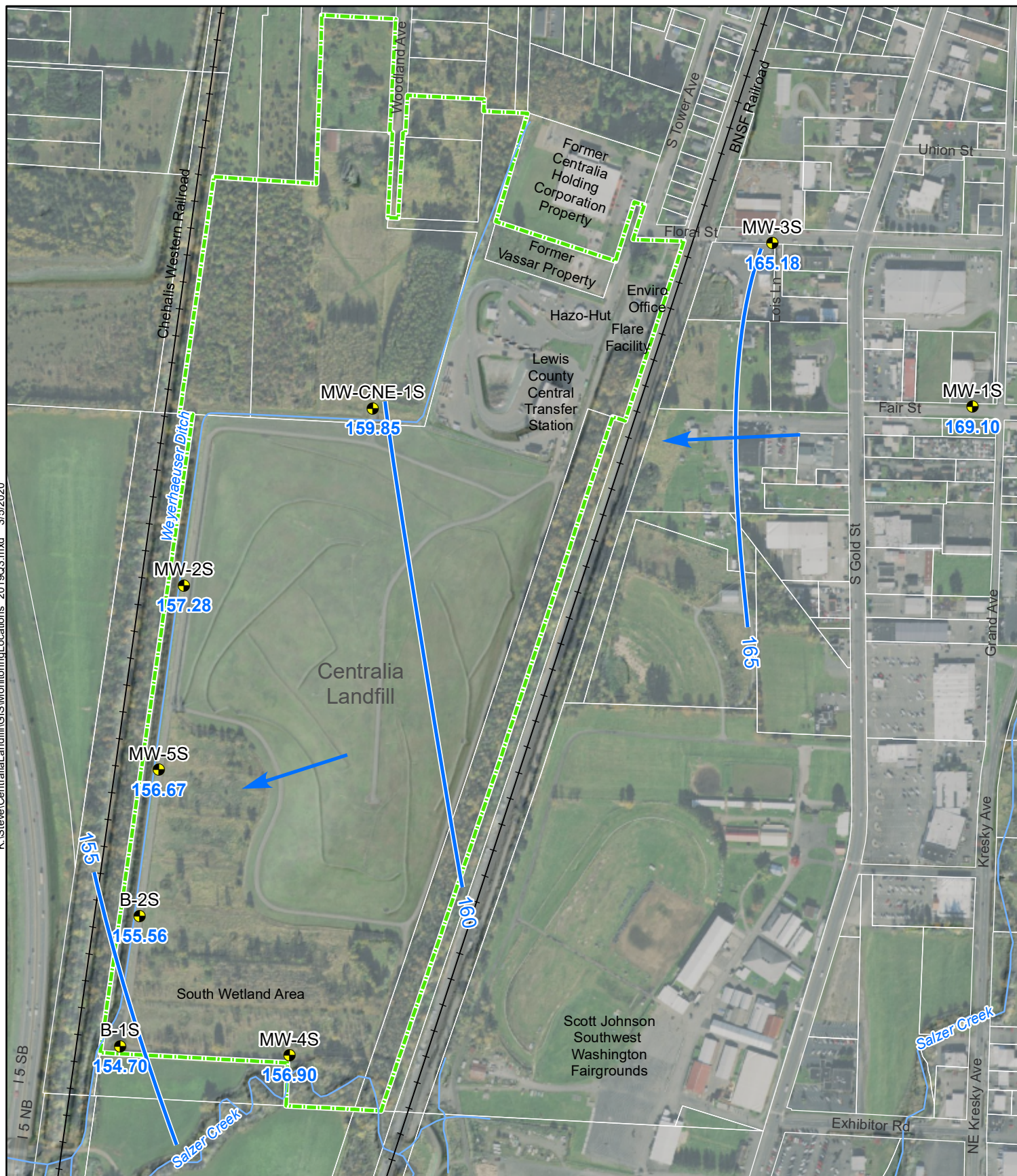


Figure 5
Shallow Upper Aquifer
Groundwater Elevations
2019 Q3

Centralia Landfill
 Compliance Monitoring





- Monitoring Wells (with Measured Groundwater Elevation)
- Groundwater Elevation Contours
- ➔ Estimated Flow Path
- ▭ City Property

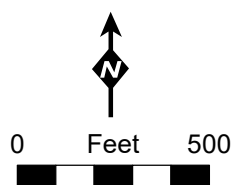
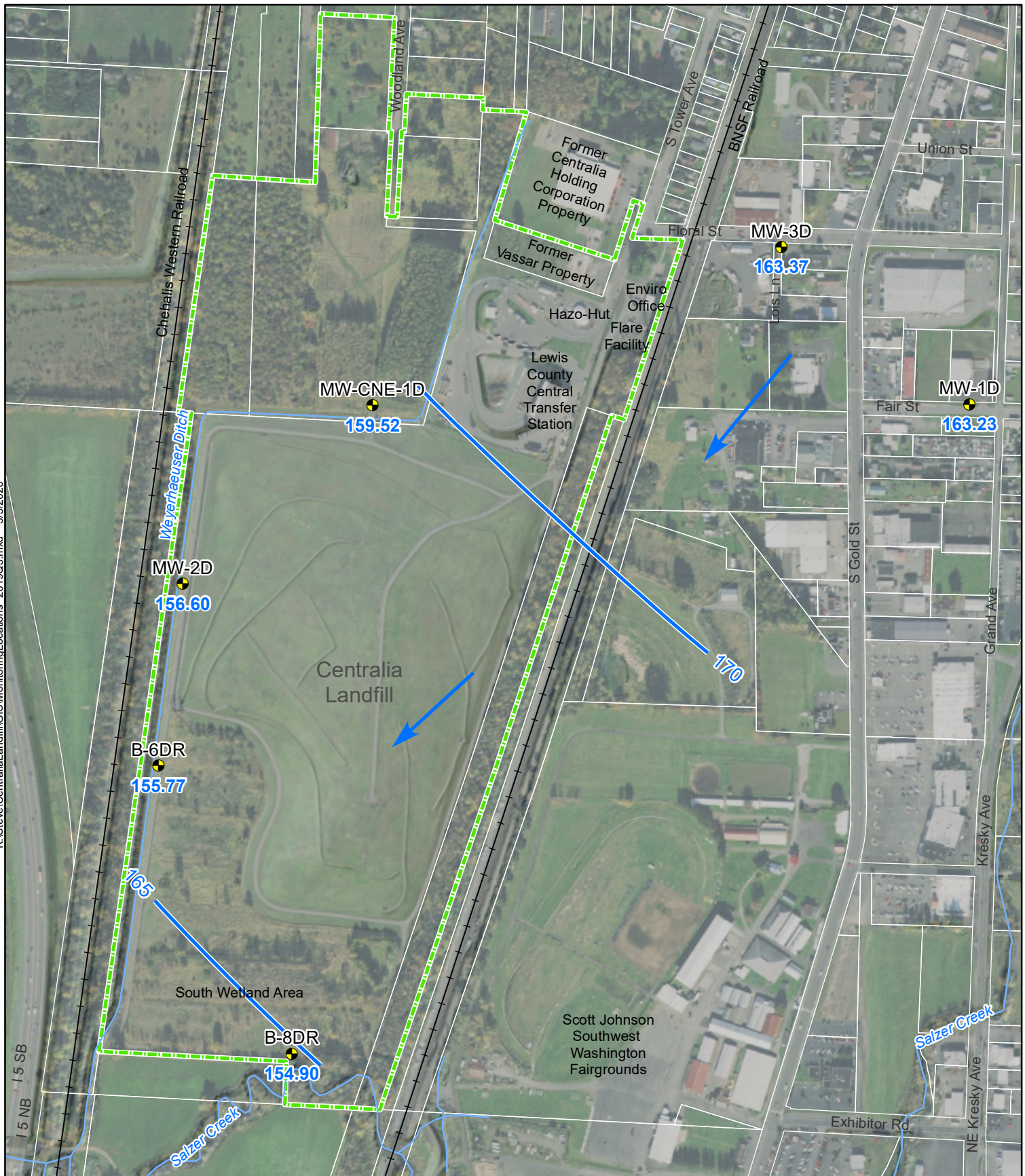


Figure 6
Upper Aquifer
Groundwater Elevations
2019 Q3

Centralia Landfill
Compliance Monitoring

PgG



- Monitoring Wells (with Measured Groundwater Elevation)
- Groundwater Elevation Contours
- ➔ Estimated Flow Path
- City Property

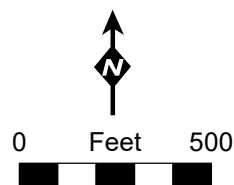
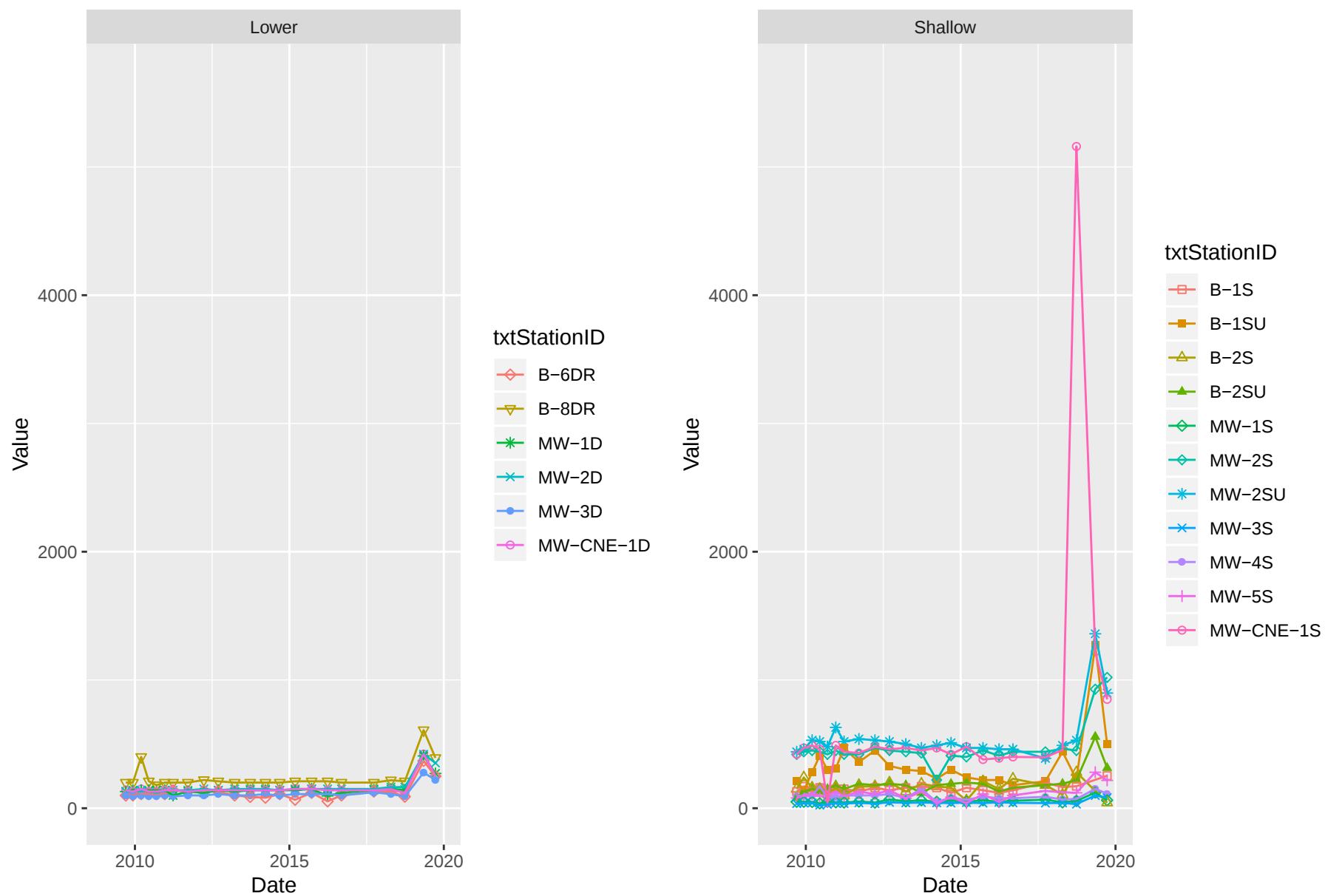


Figure 7
Lower Aquifer
Groundwater Elevations
2019 Q3

Centralia Landfill
 Compliance Monitoring

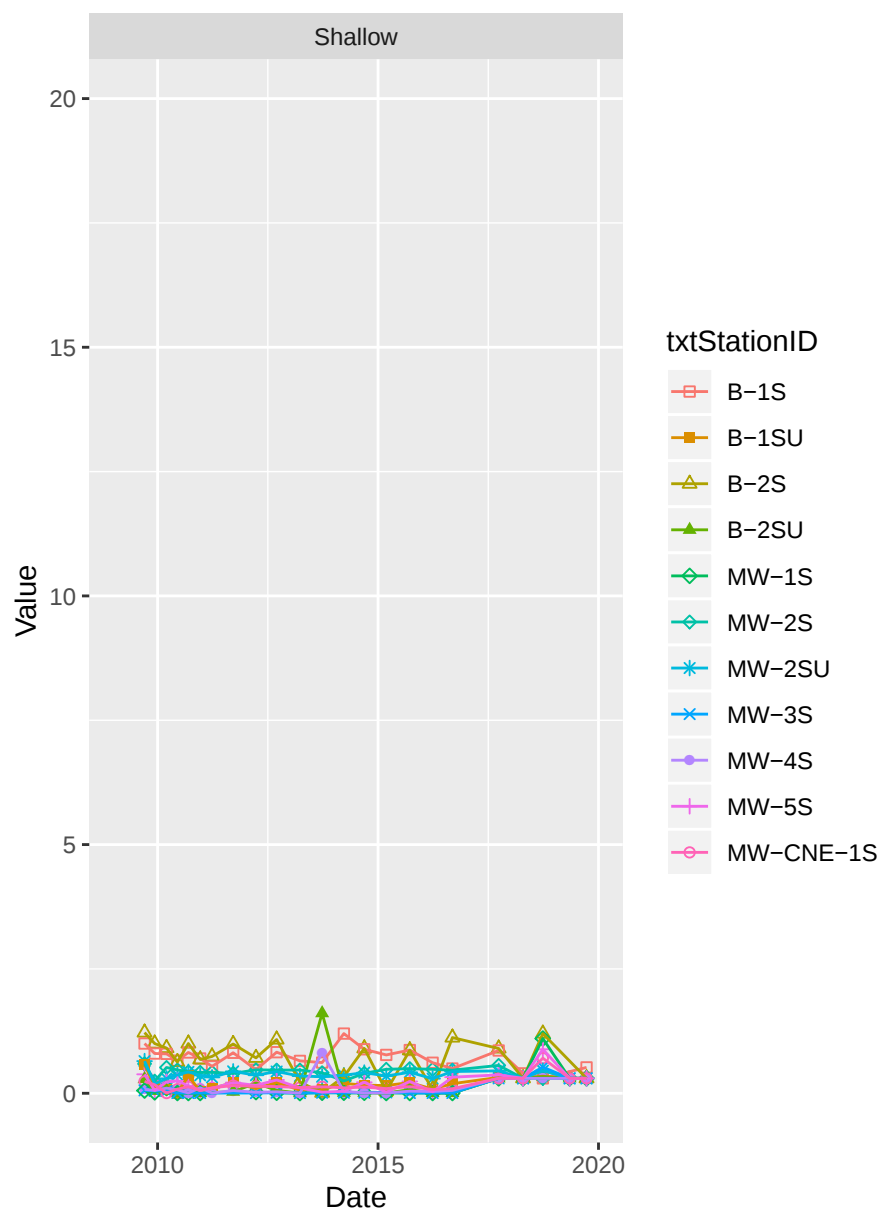
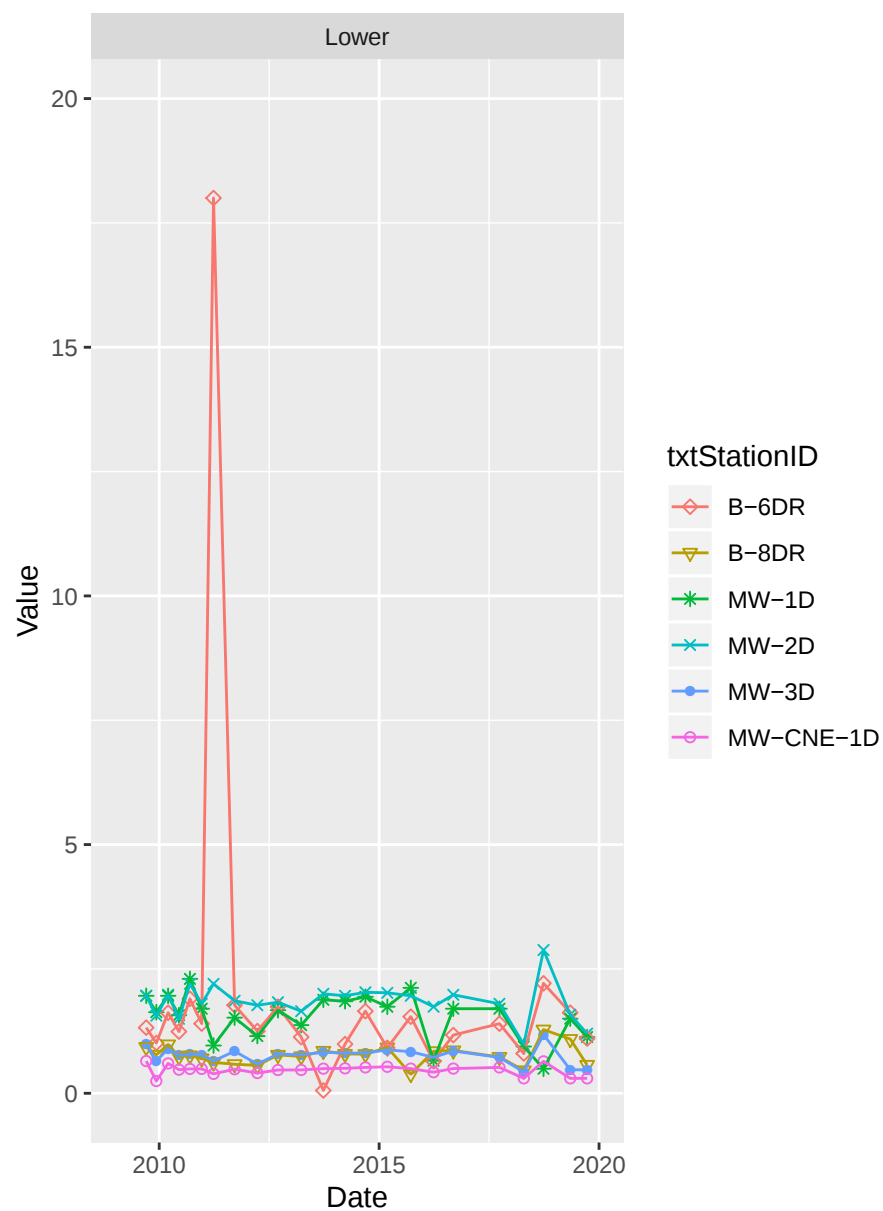
pgg



Non-detect values plotted at Method Reporting Limit value

Figure A1. Time Series

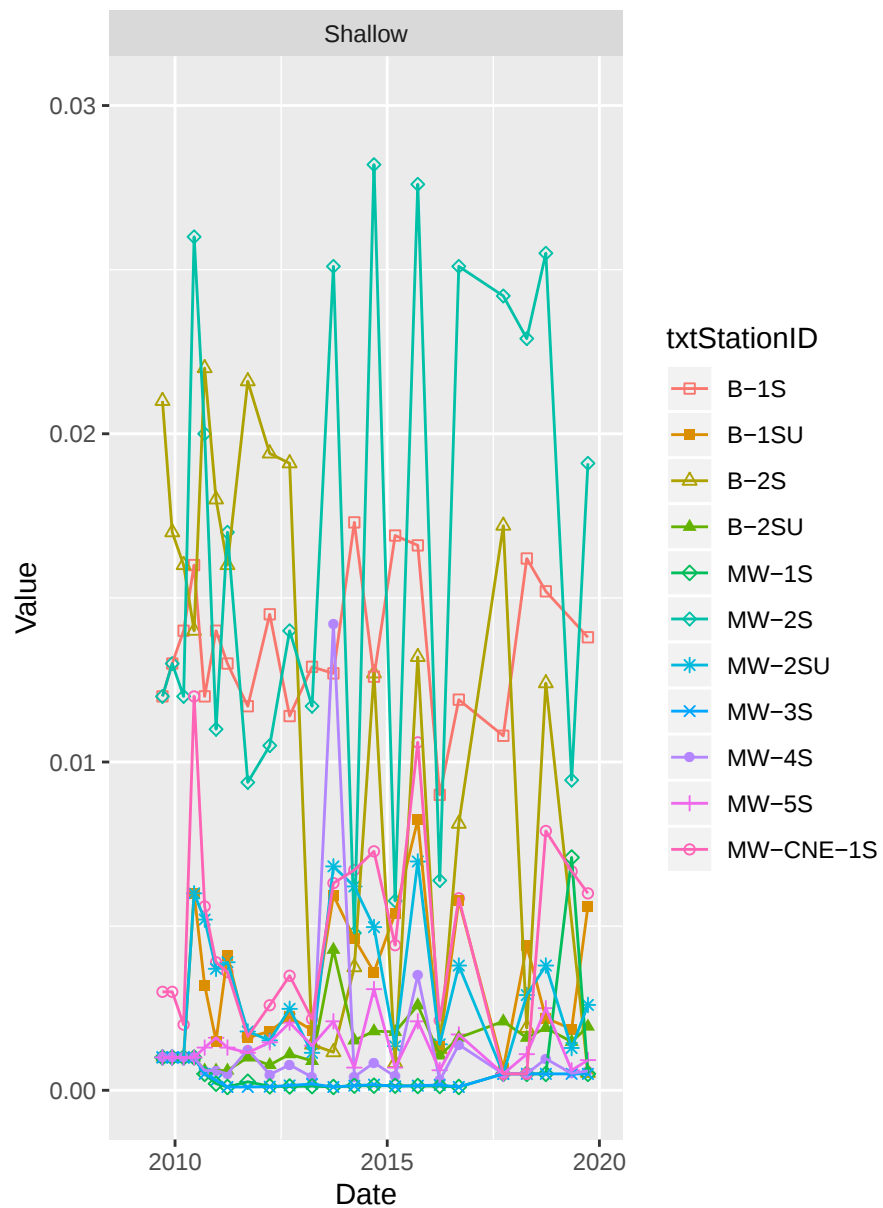
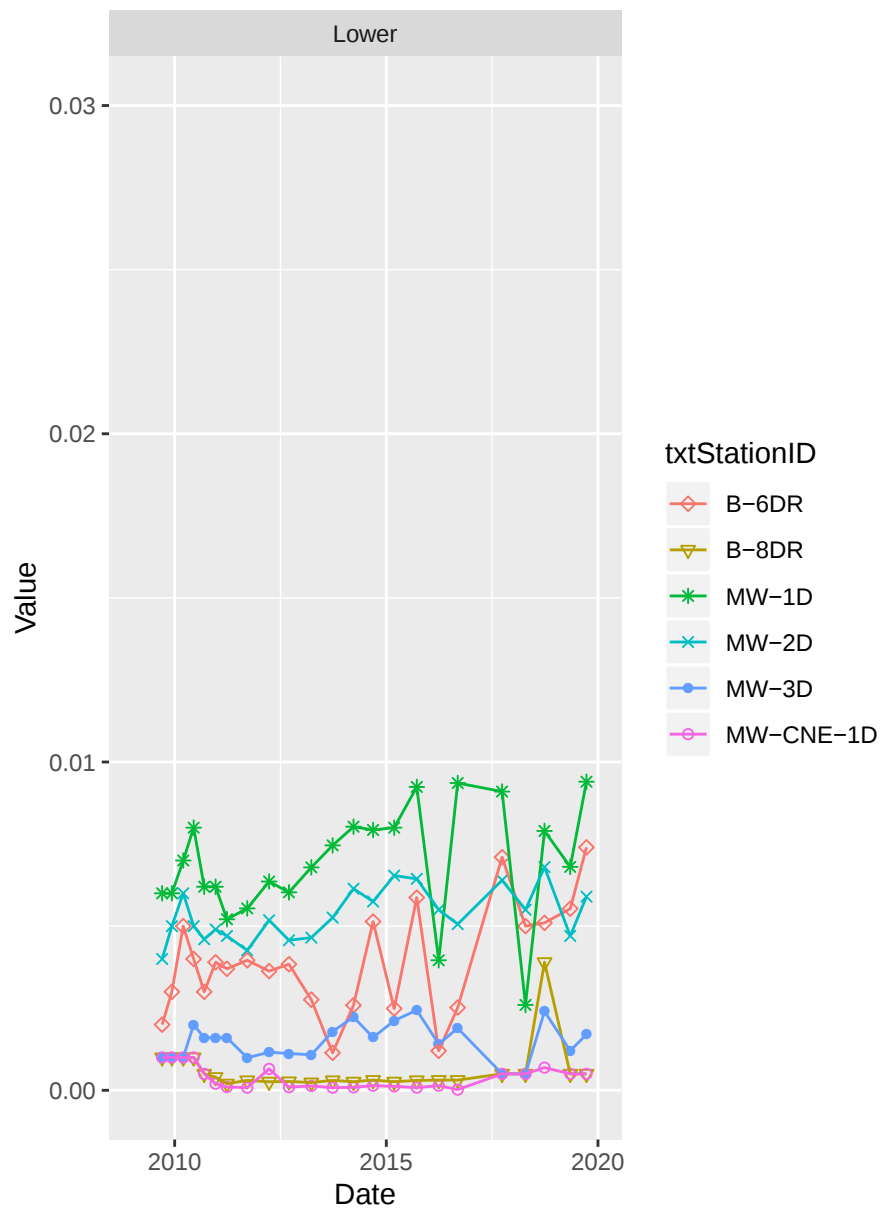
Alkalinity, Carb as CaCO₃, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A2. Time Series

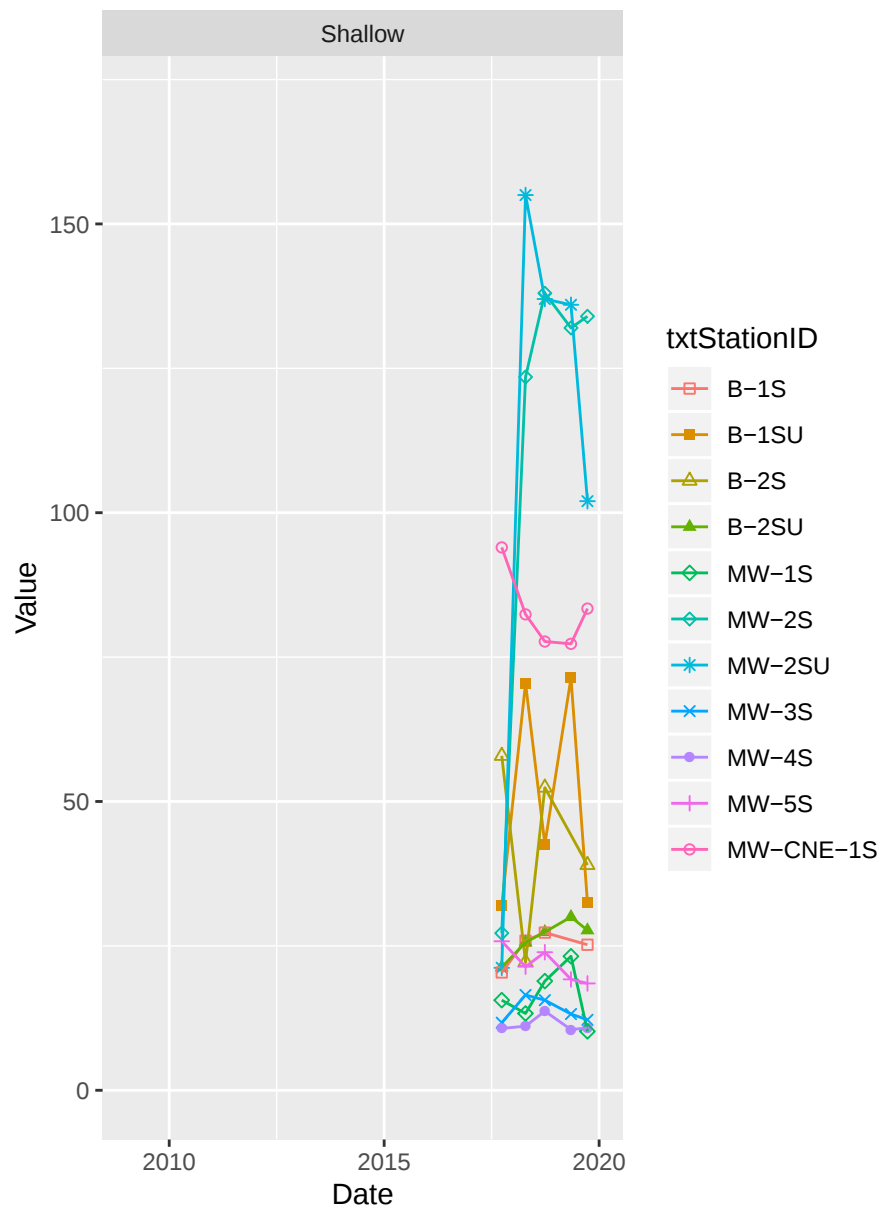
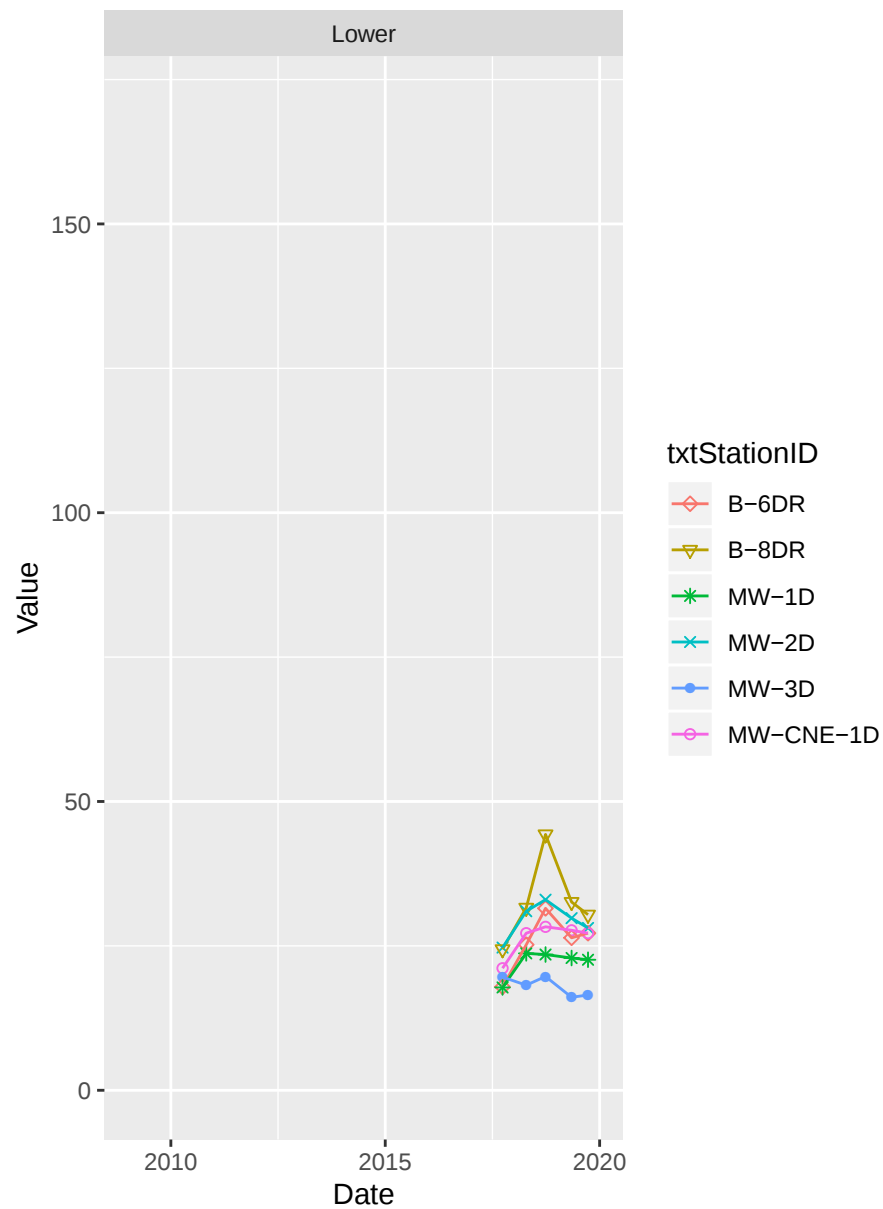
Ammonia as N, Total, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A3. Time Series

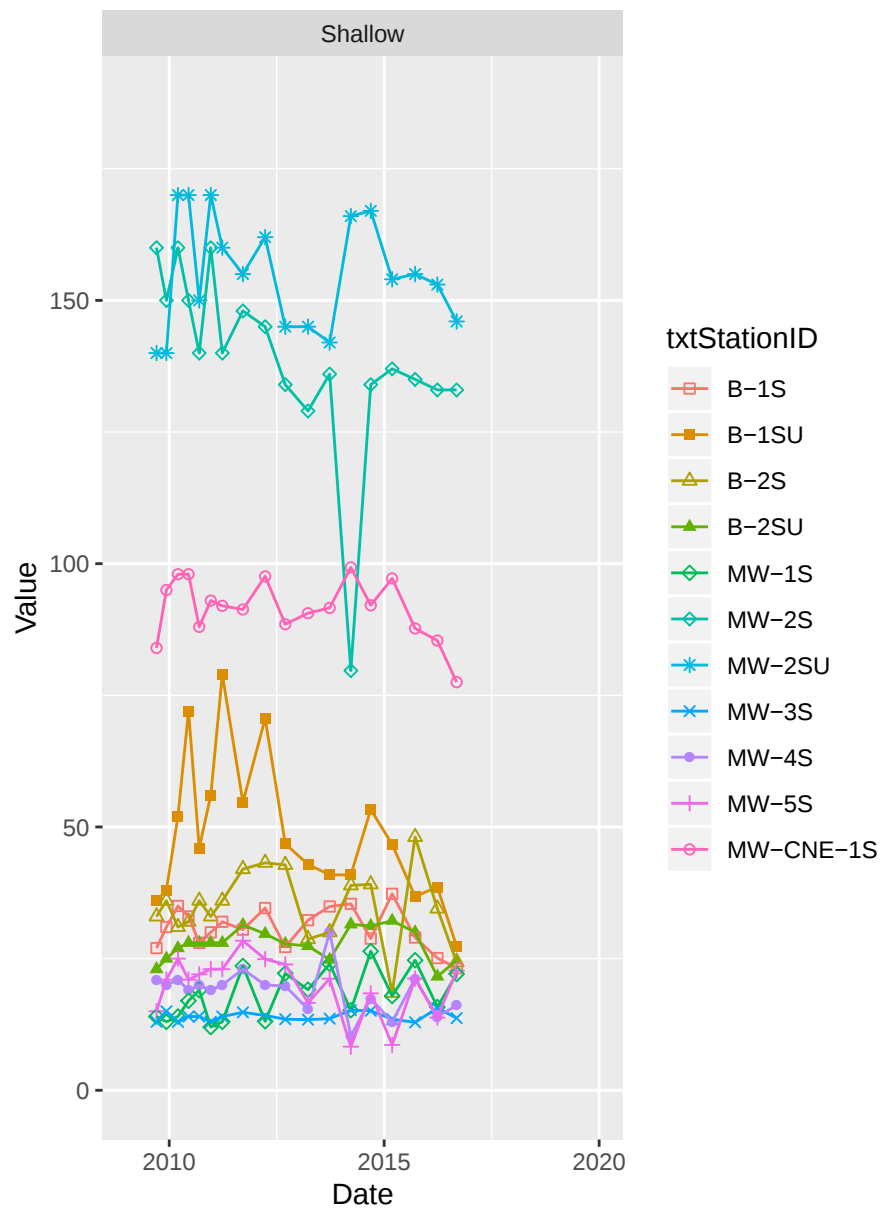
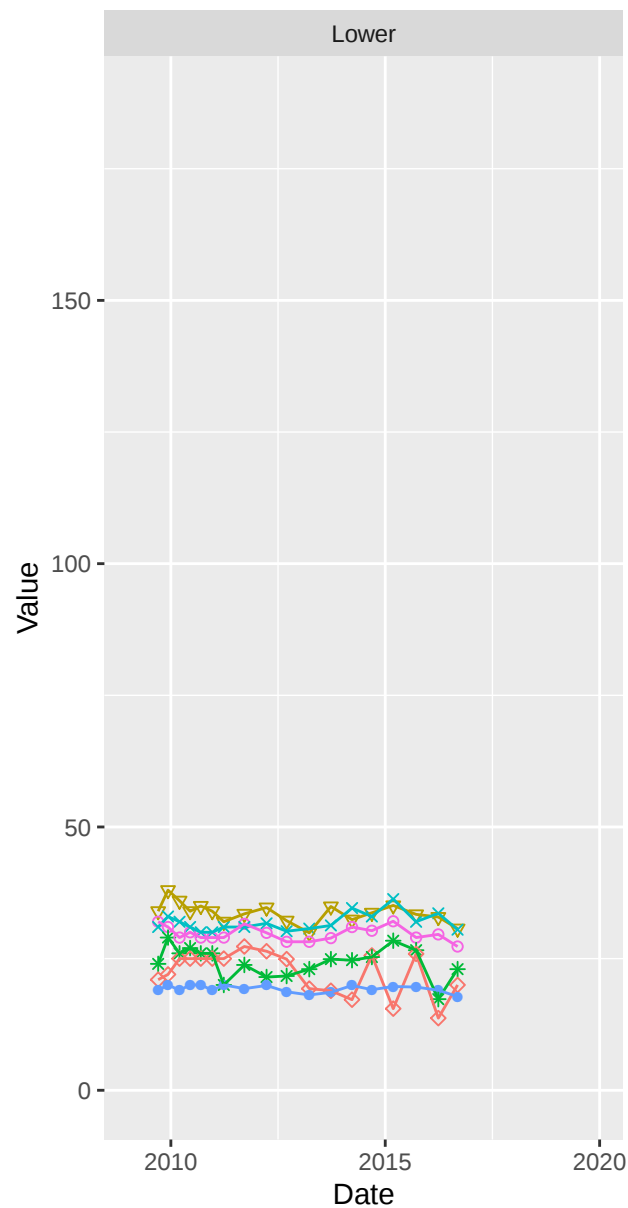
Arsenic, Dissolved, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A4. Time Series

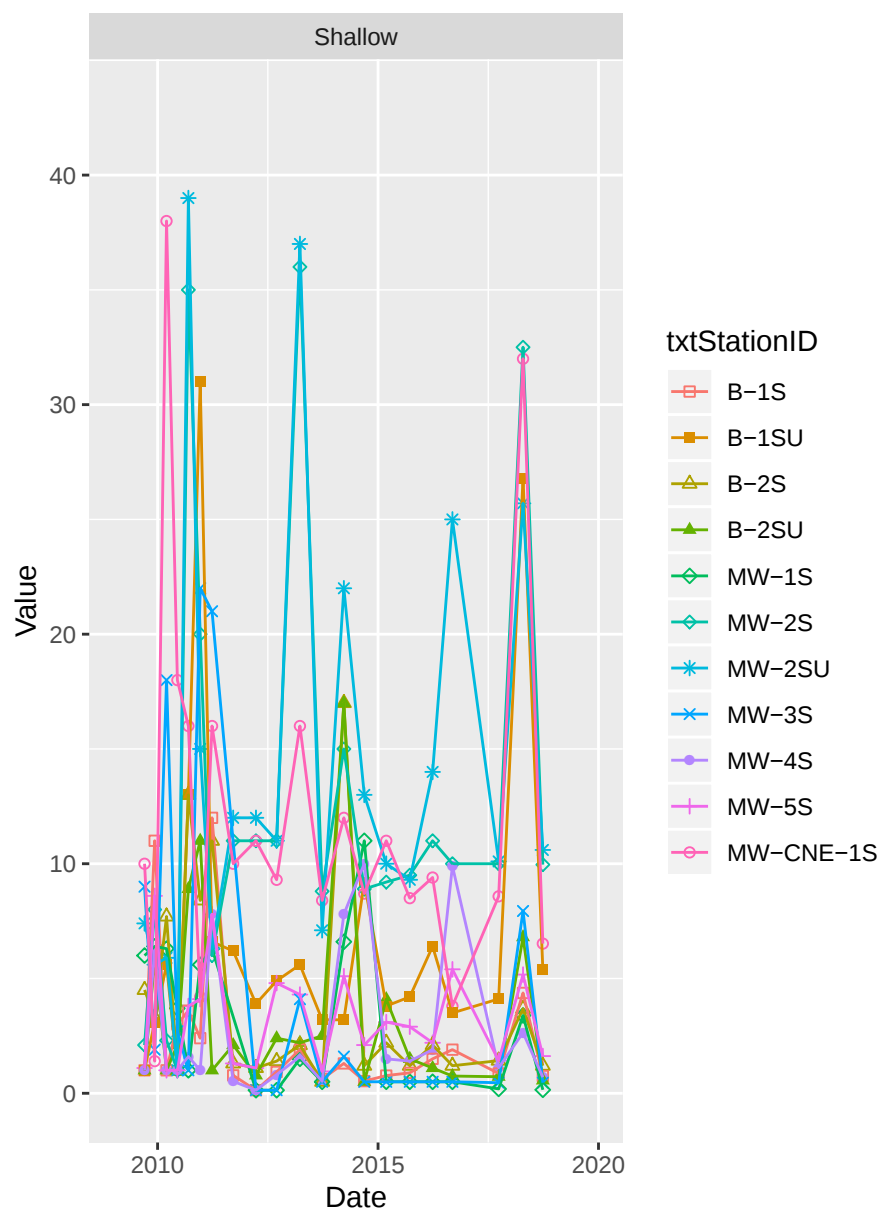
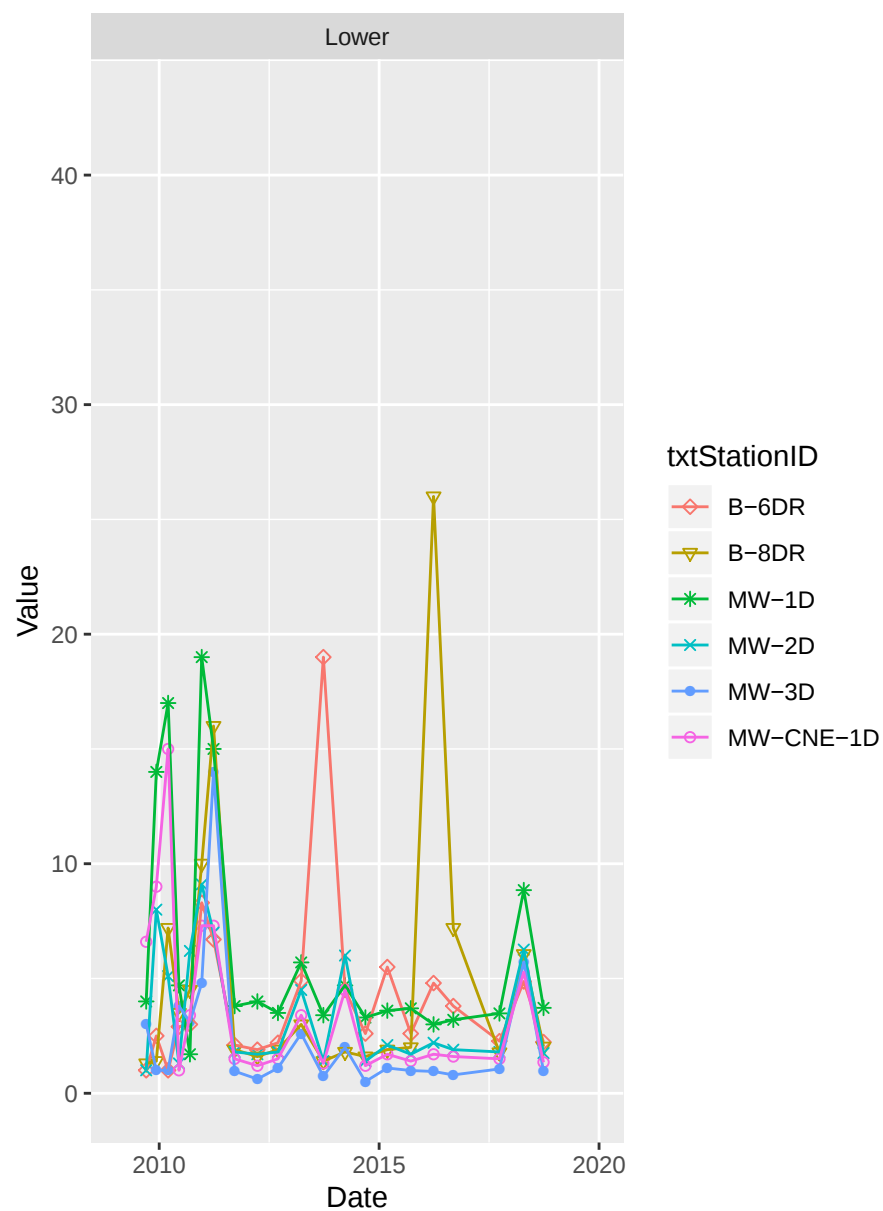
Calcium, Dissolved, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A5. Time Series

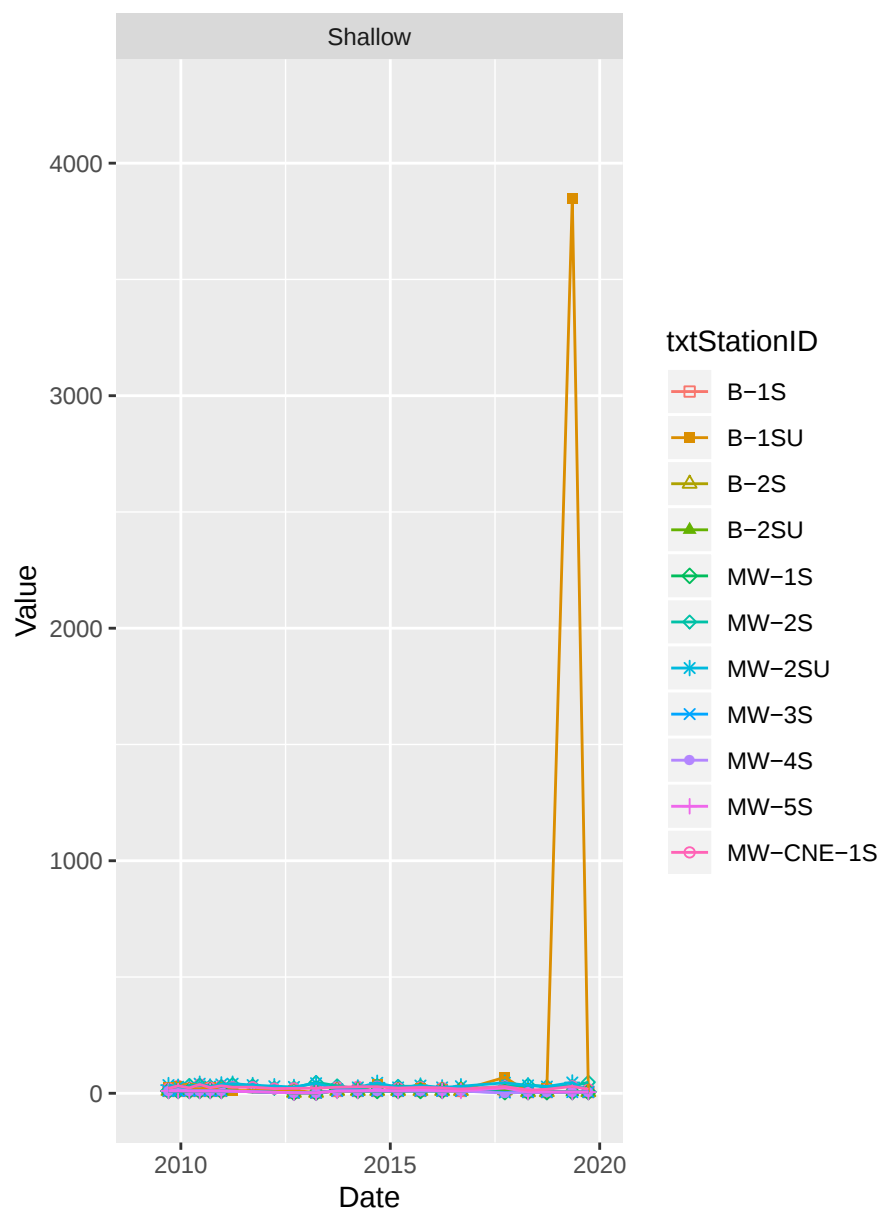
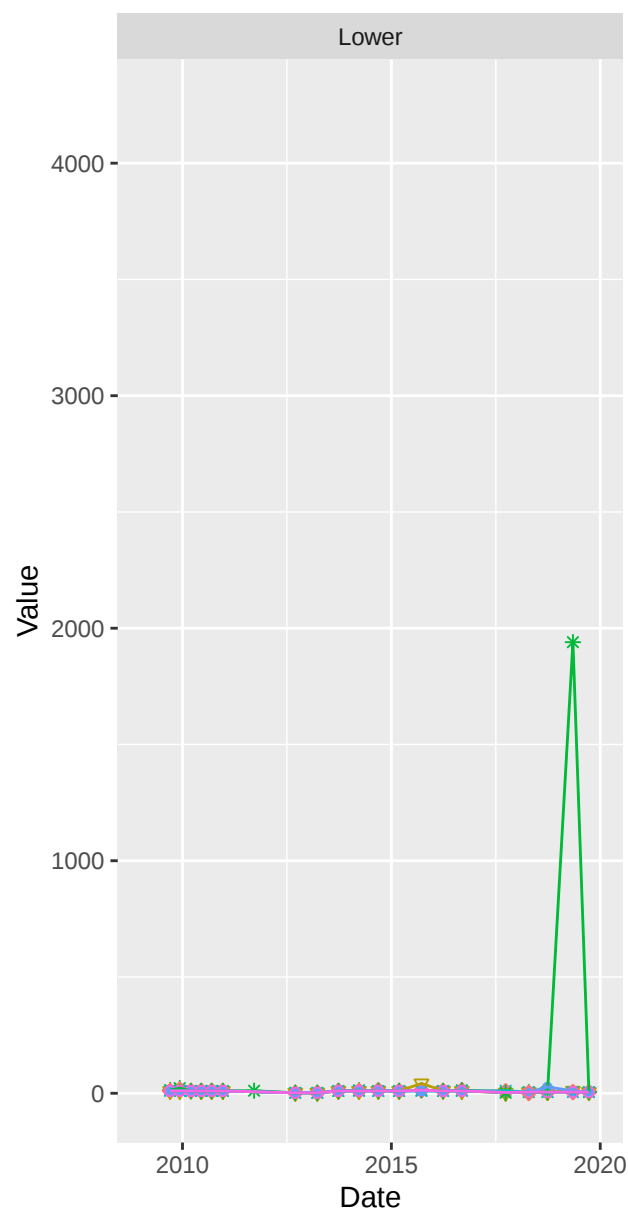
Calcium, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A6. Time Series

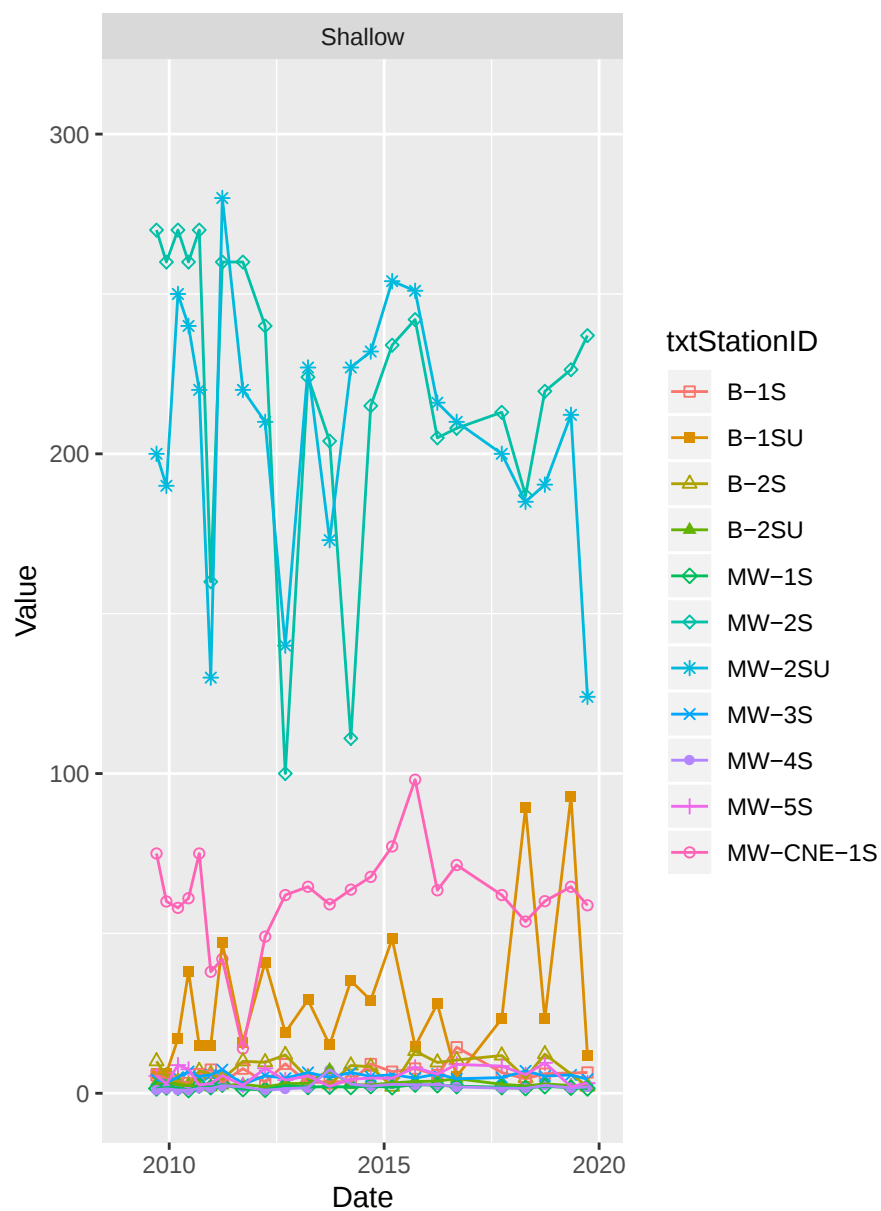
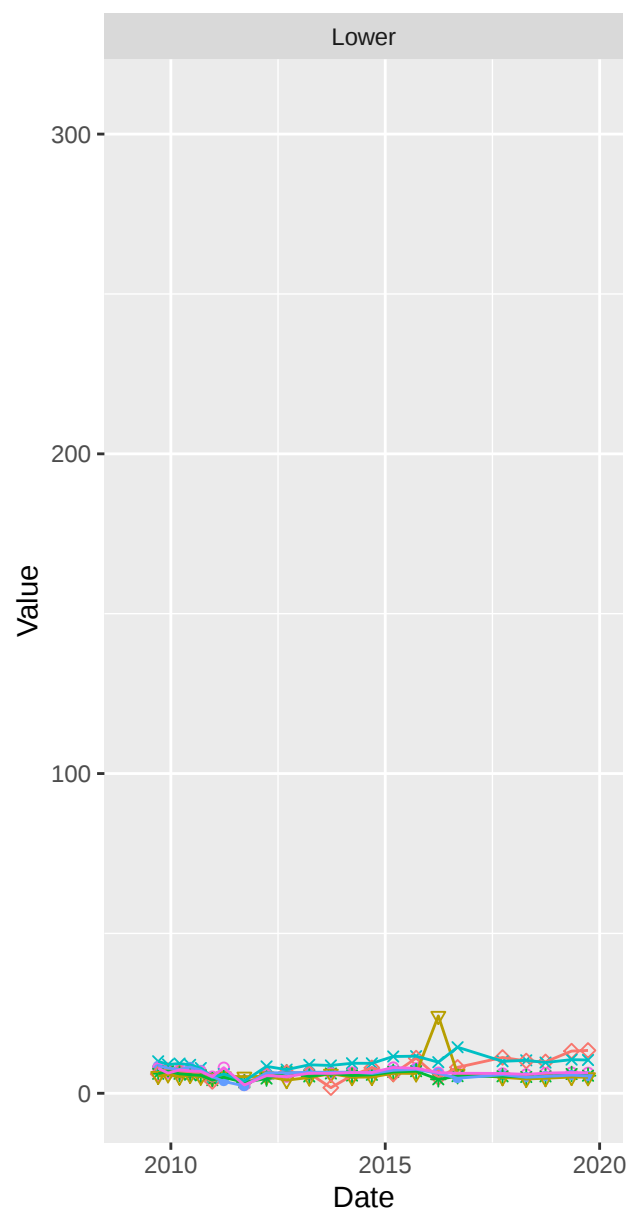
Carbon, Total Organic, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A7. Time Series

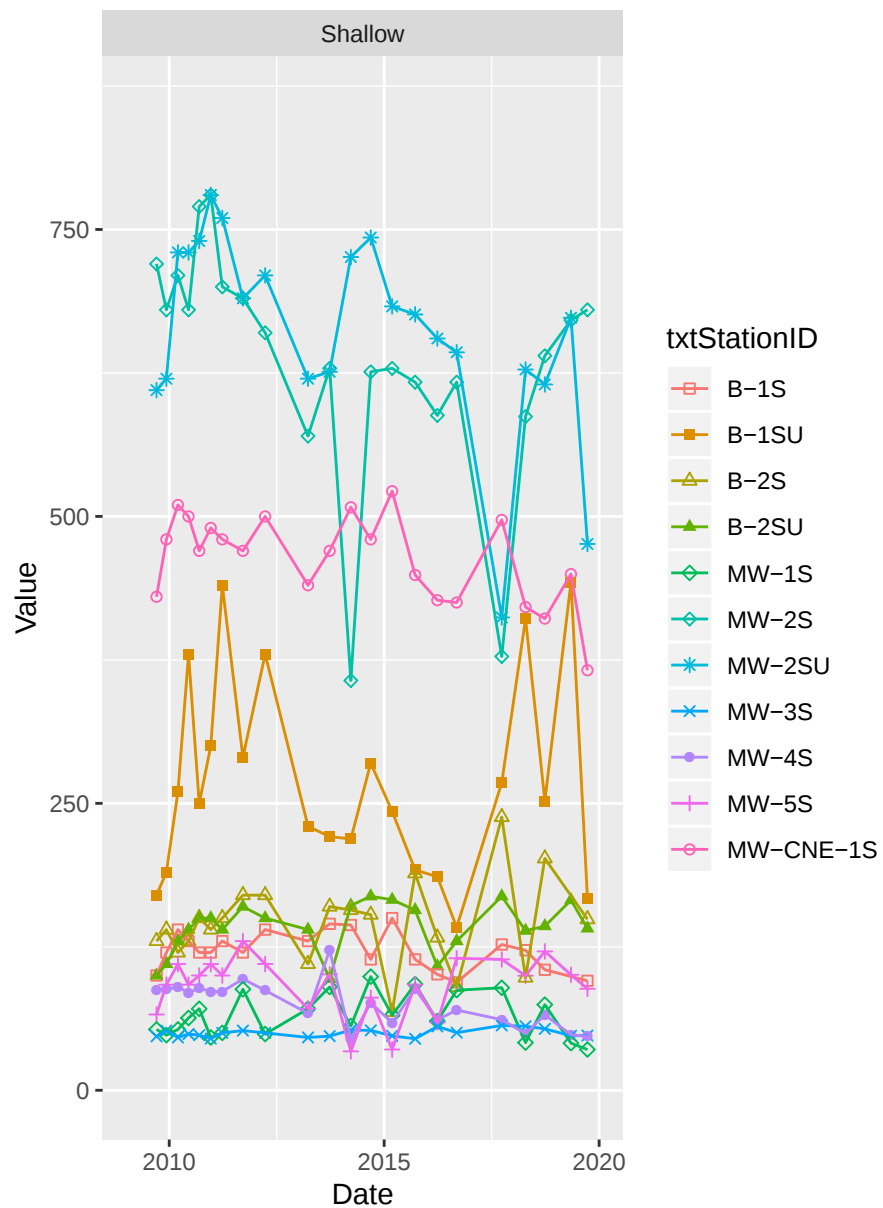
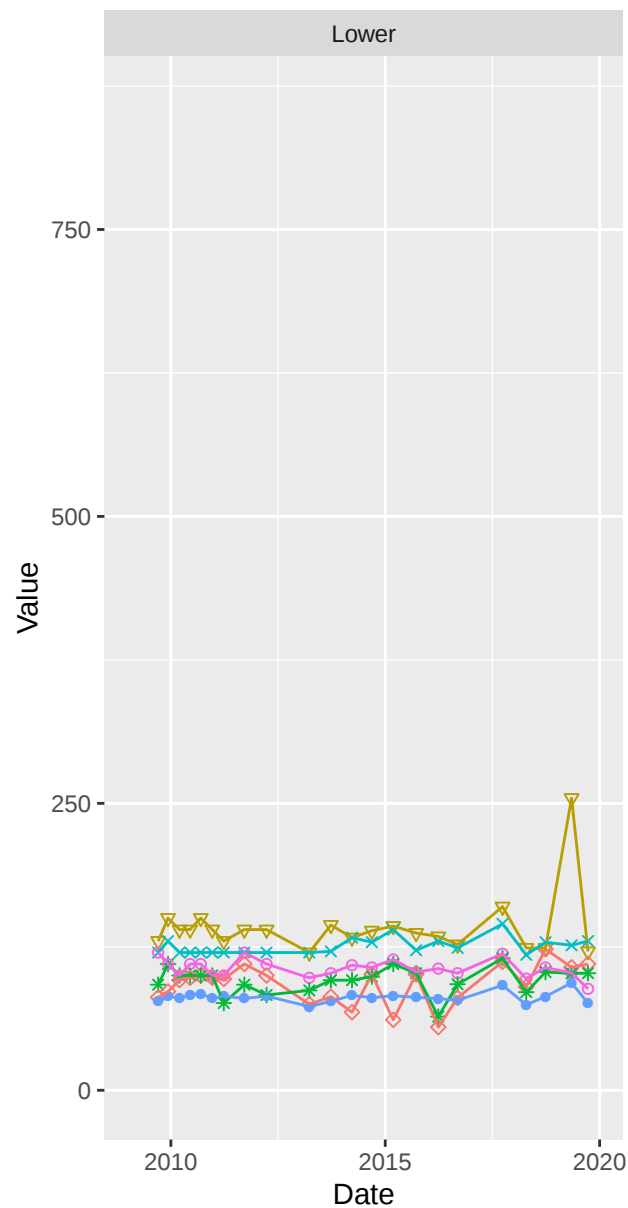
Chemical Oxygen Demand (COD), mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A8. Time Series

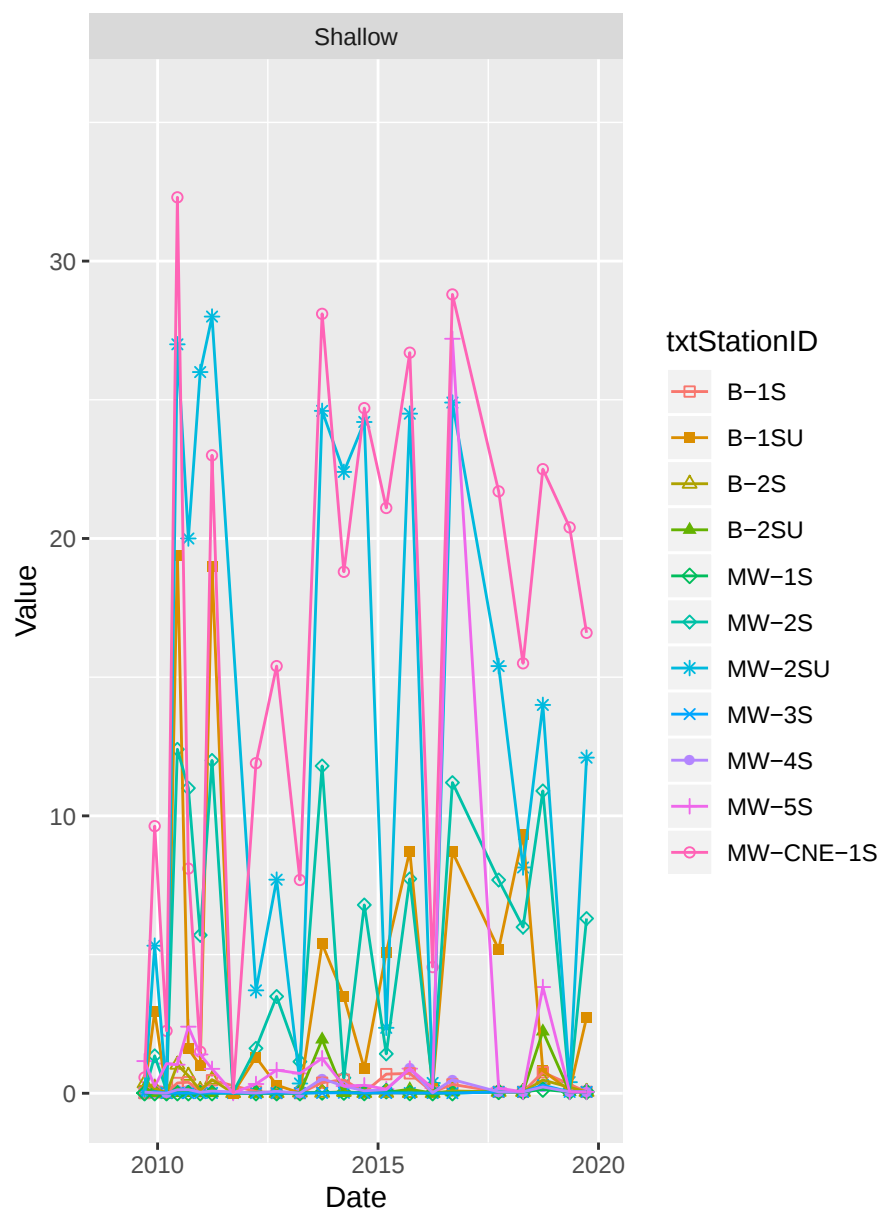
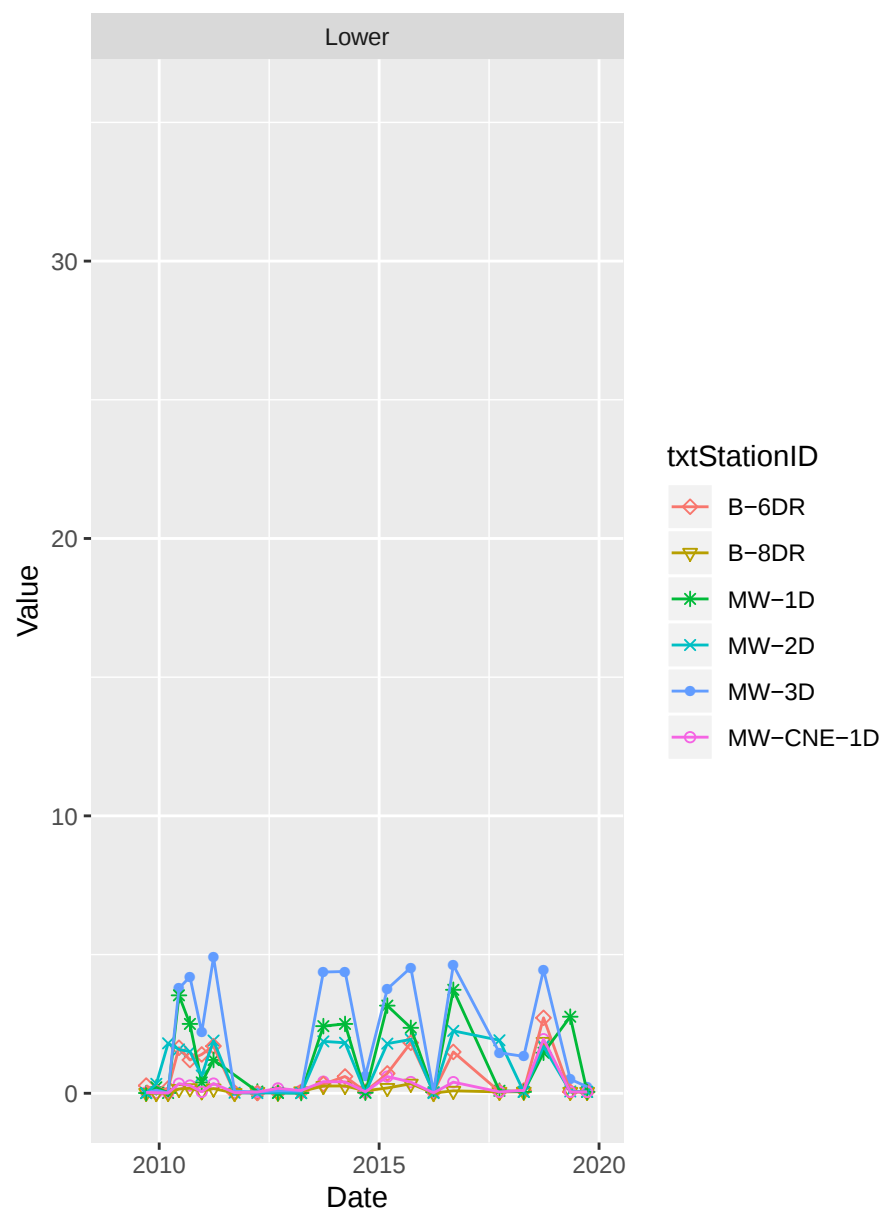
Chloride, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A9. Time Series

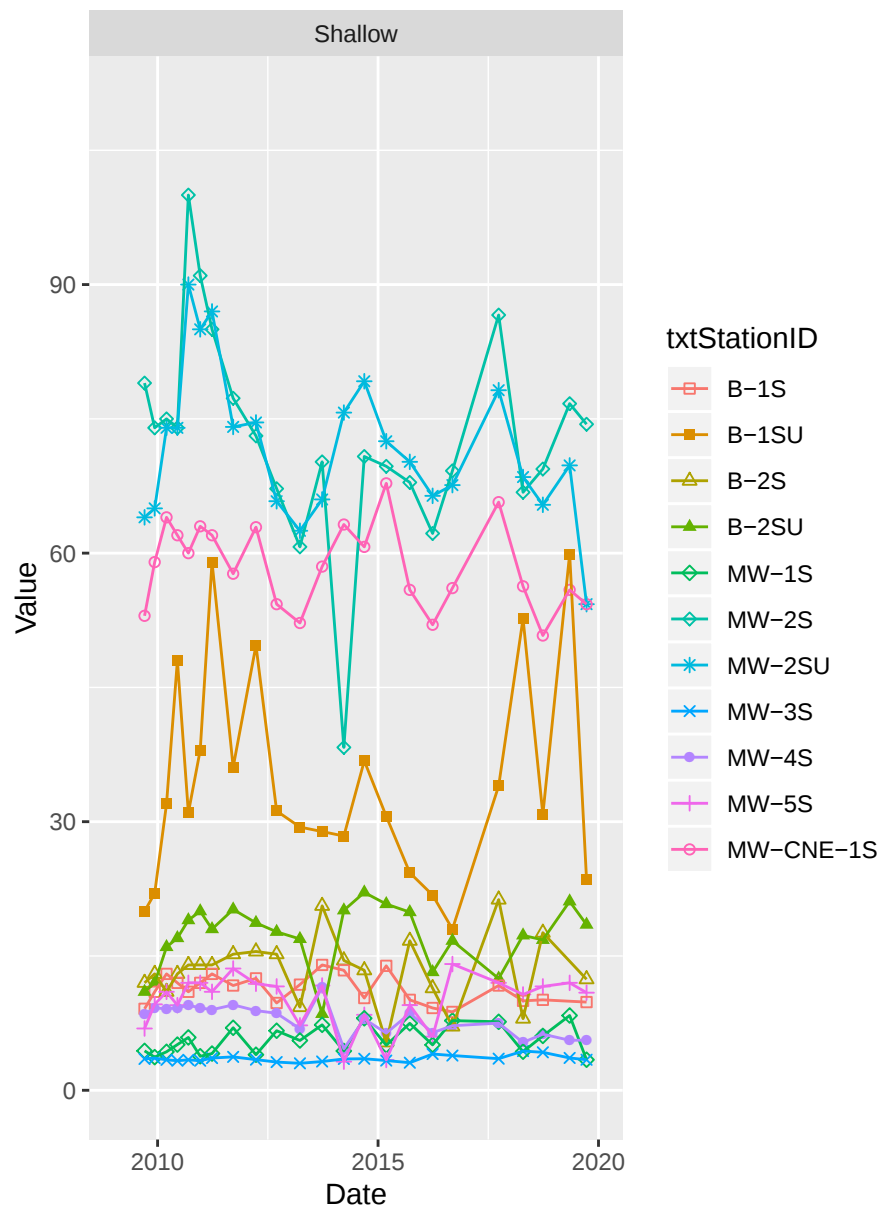
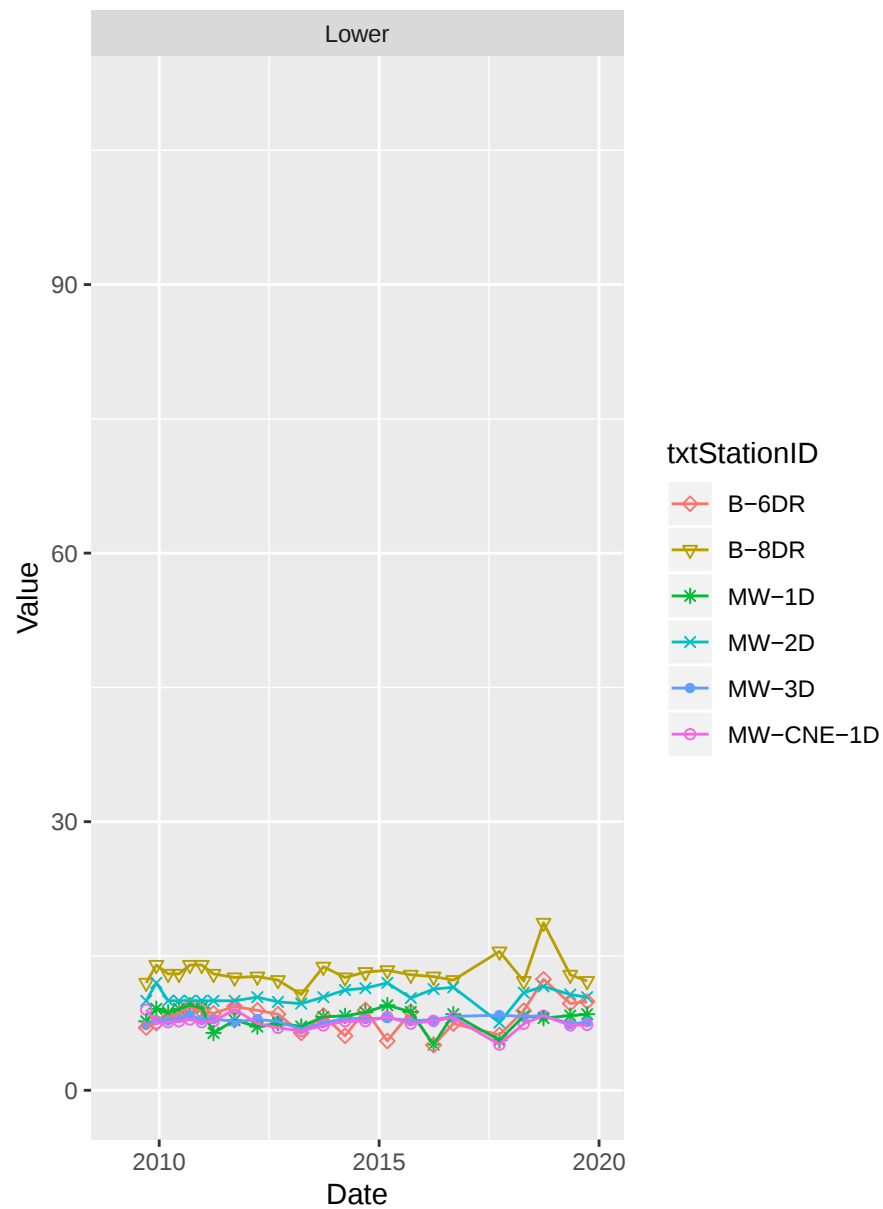
Hardness, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A10. Time Series

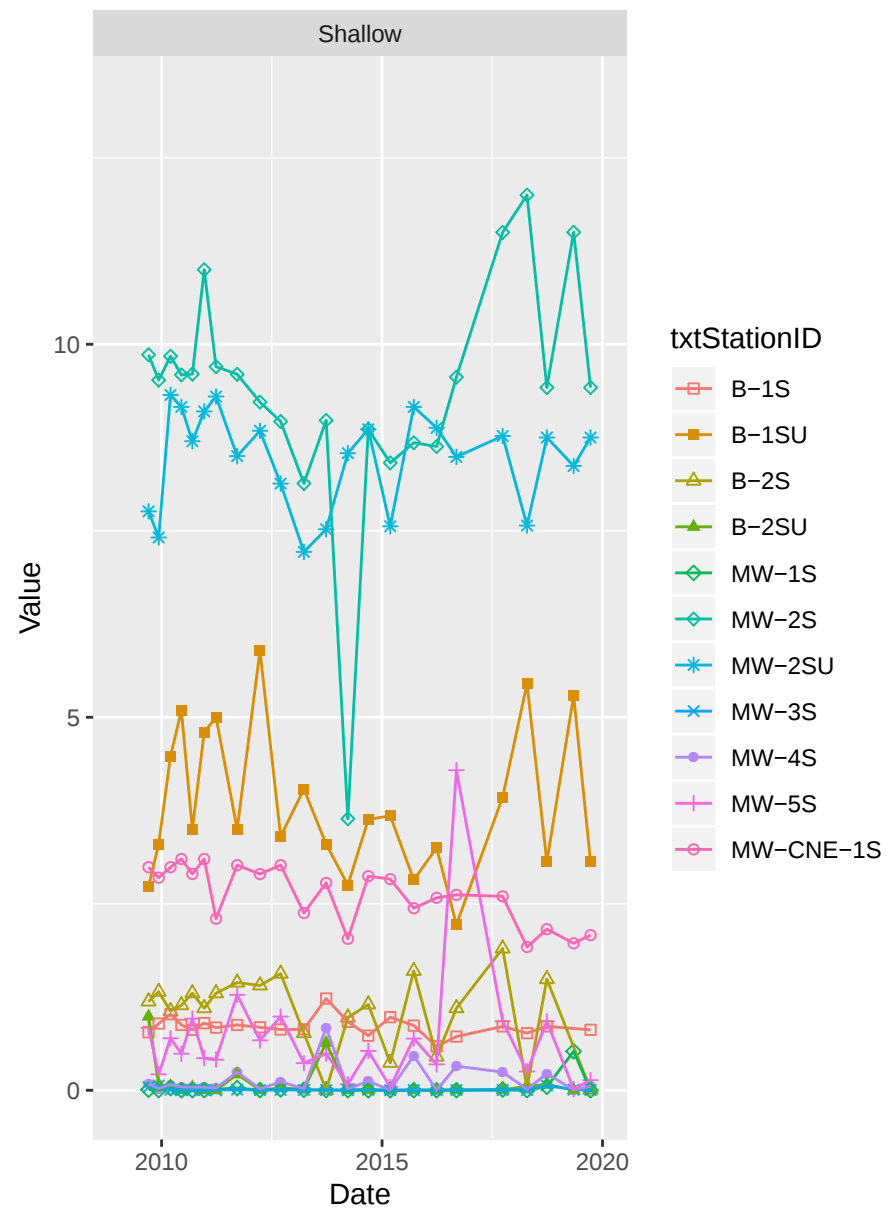
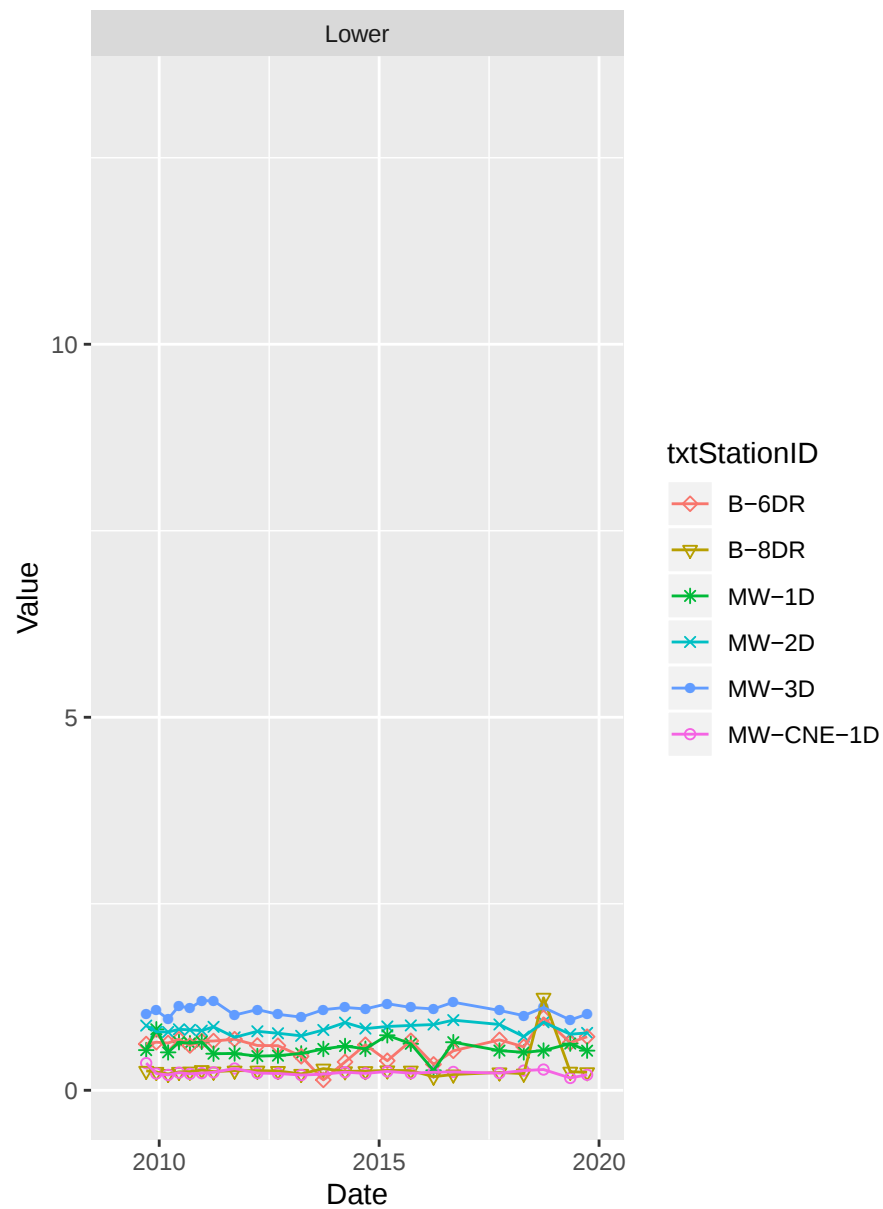
Iron, Dissolved, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A11. Time Series

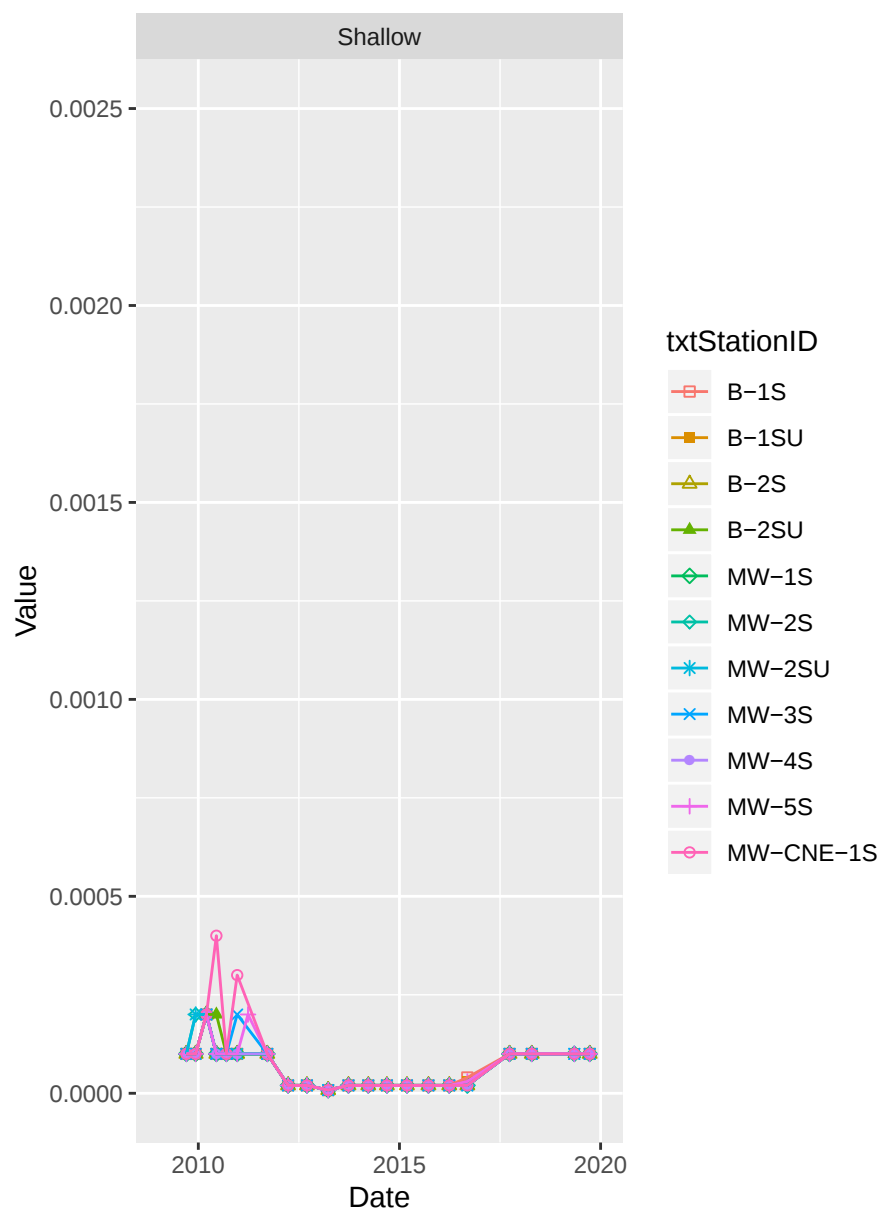
Magnesium, Dissolved, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A12. Time Series

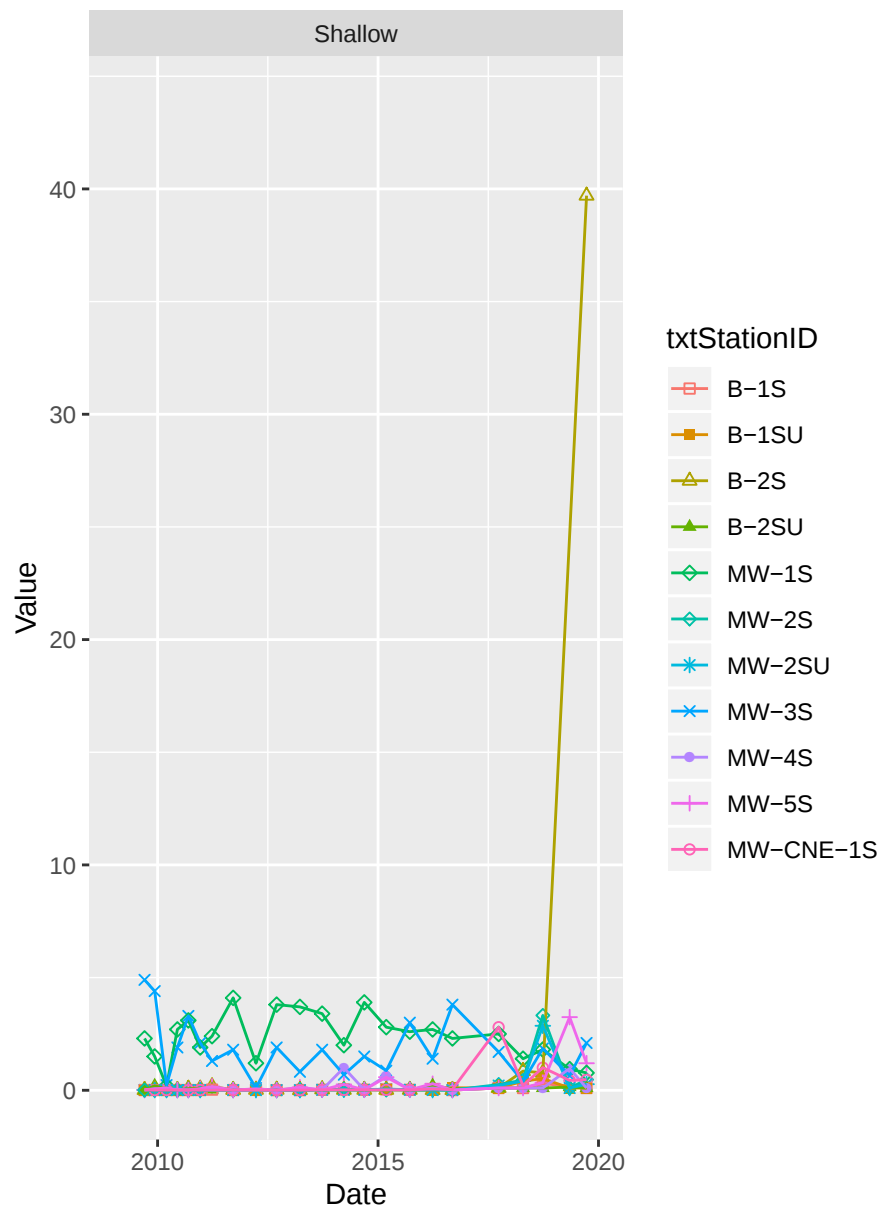
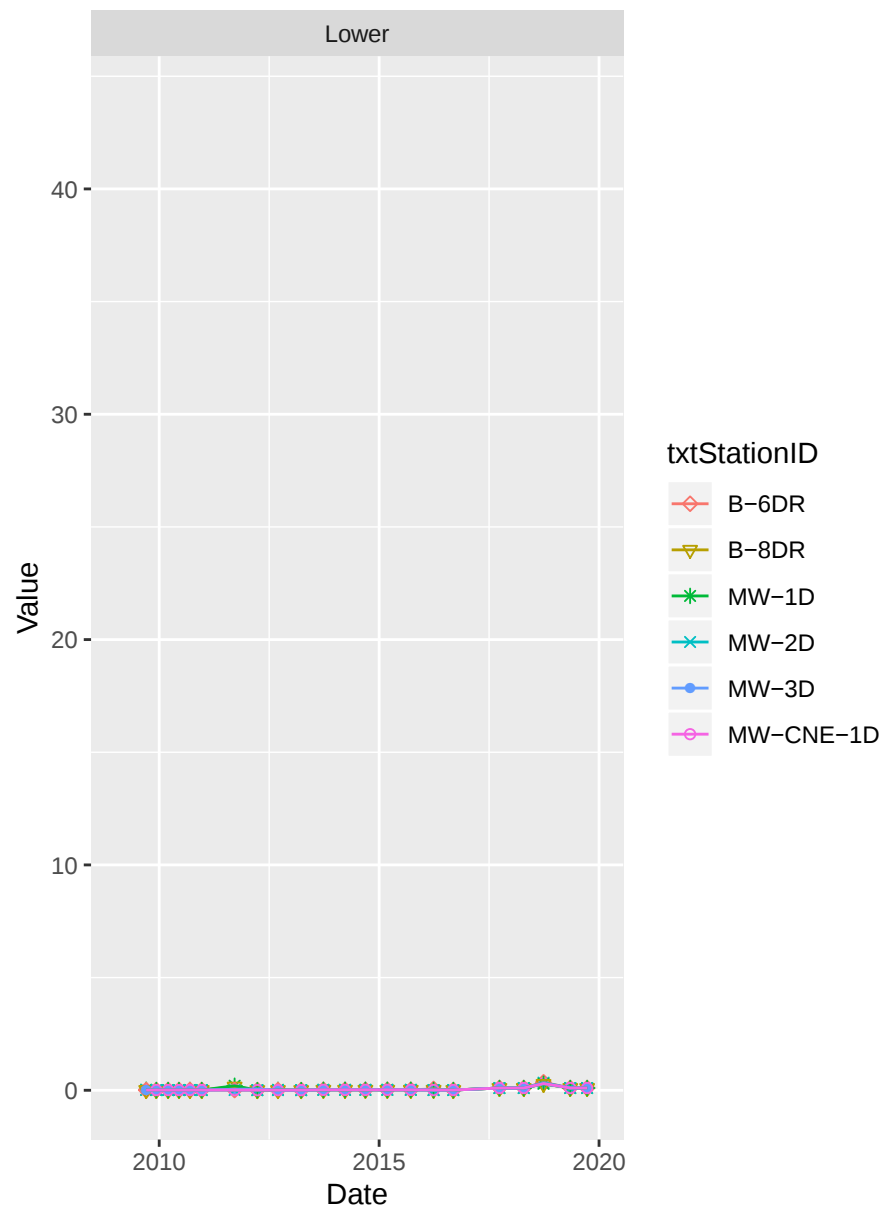
Manganese, Dissolved, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A13. Time Series

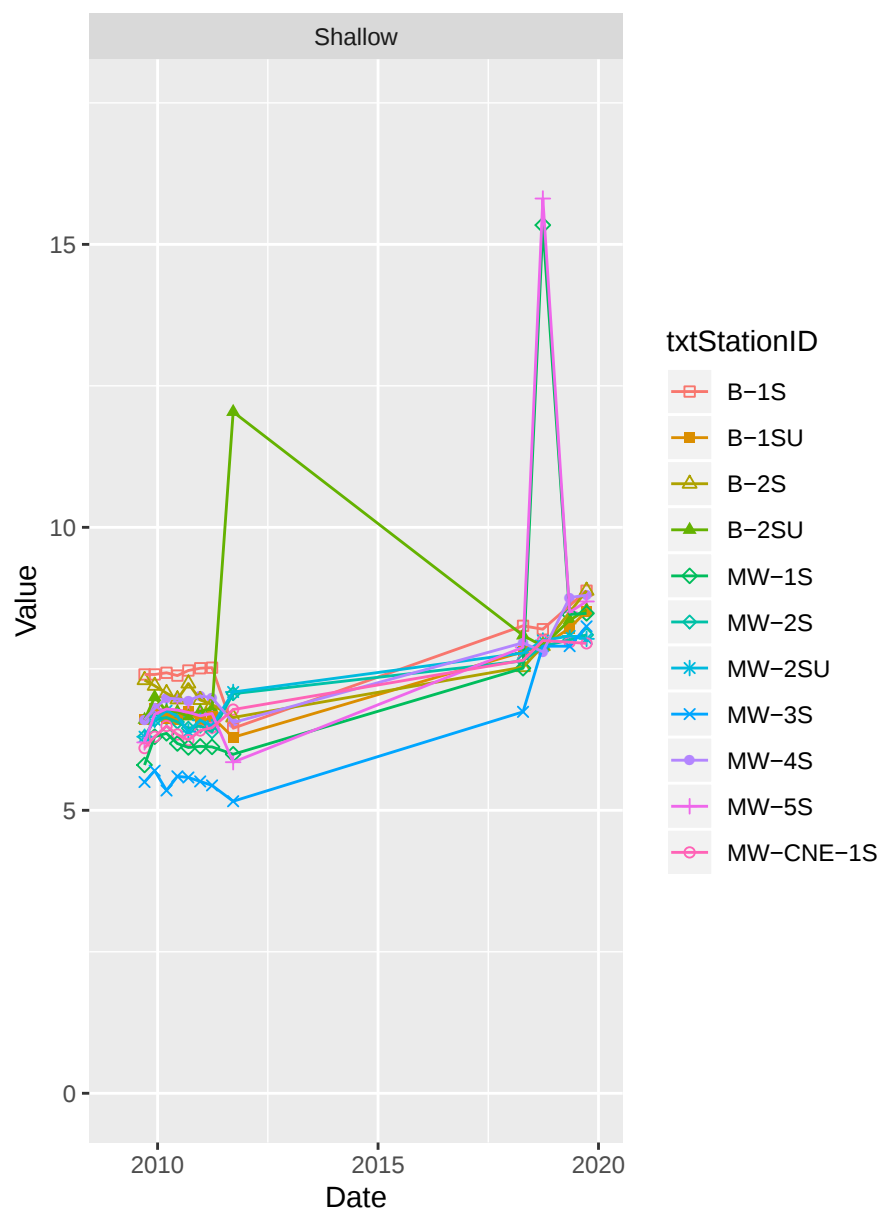
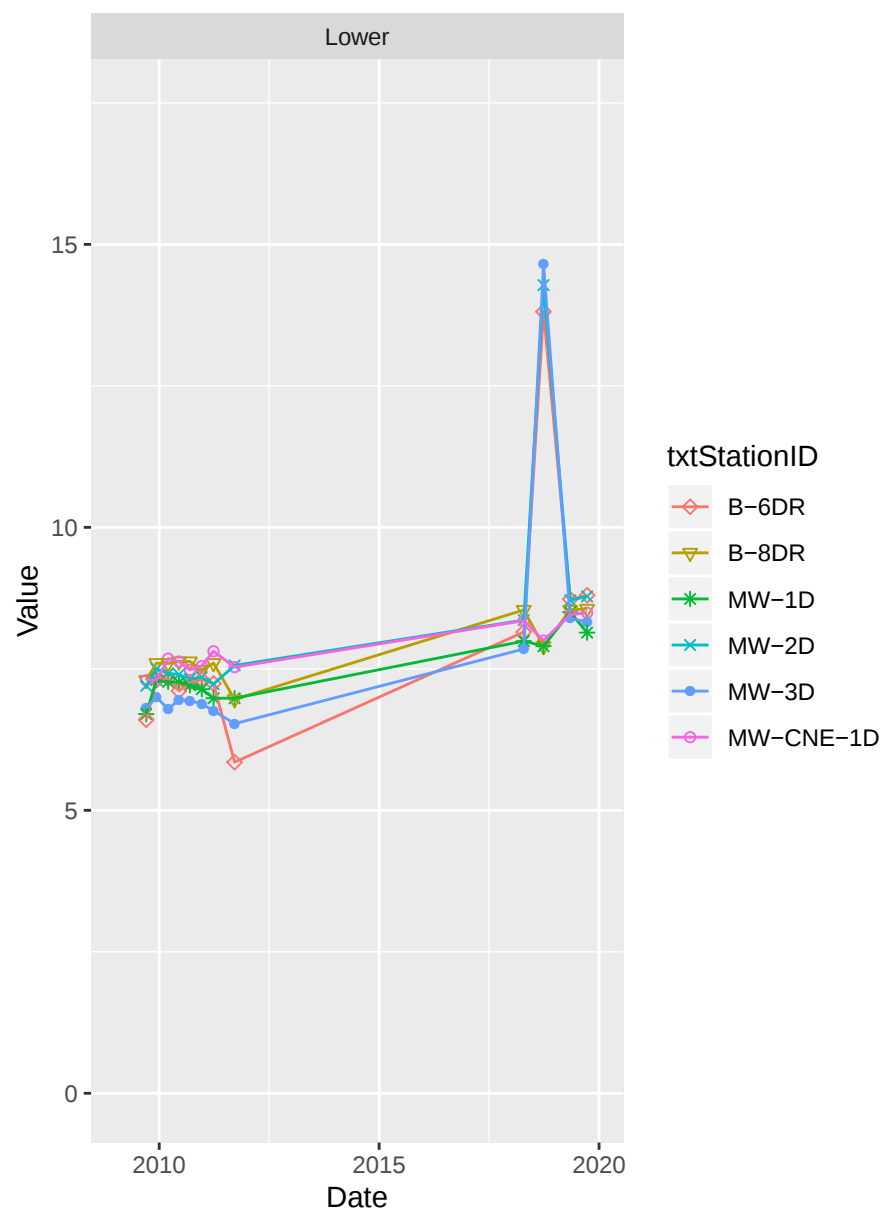
Mercury, Dissolved, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A14. Time Series

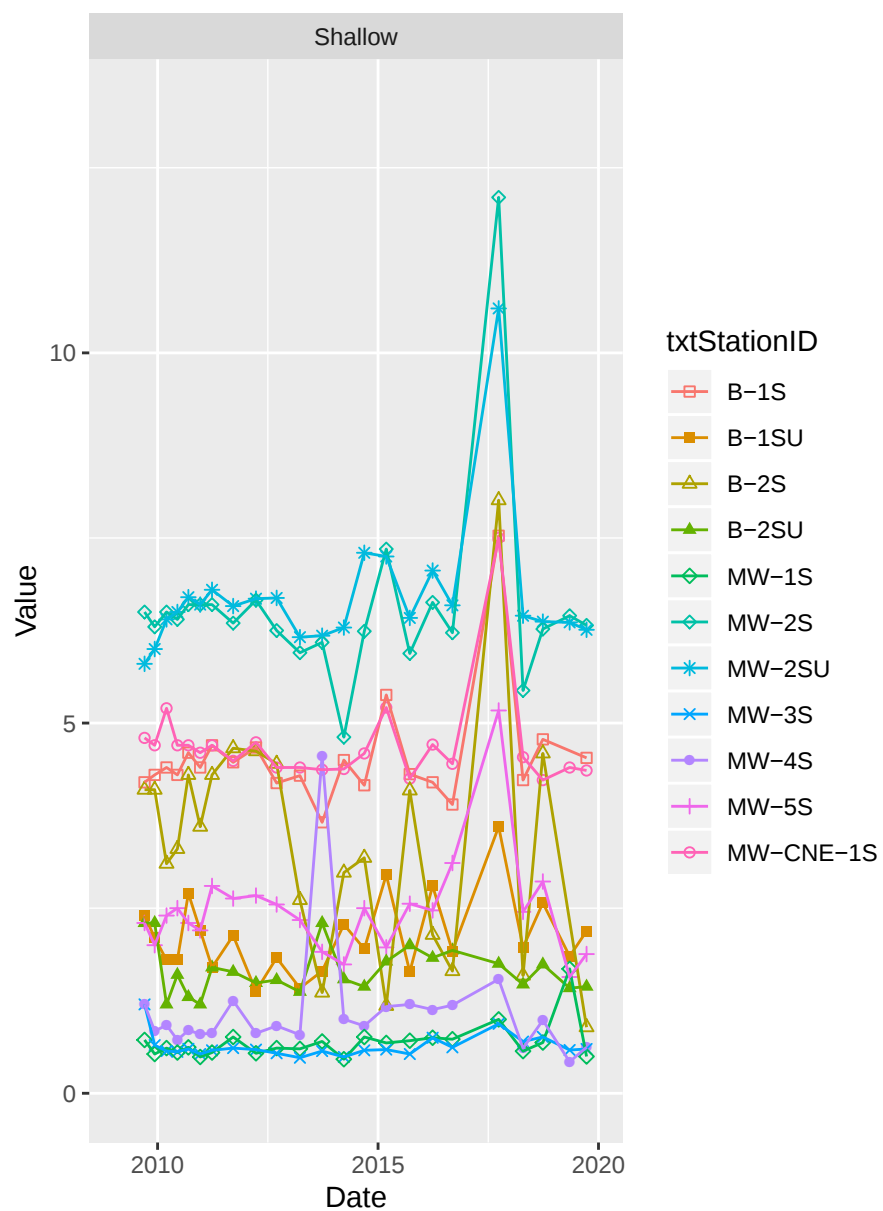
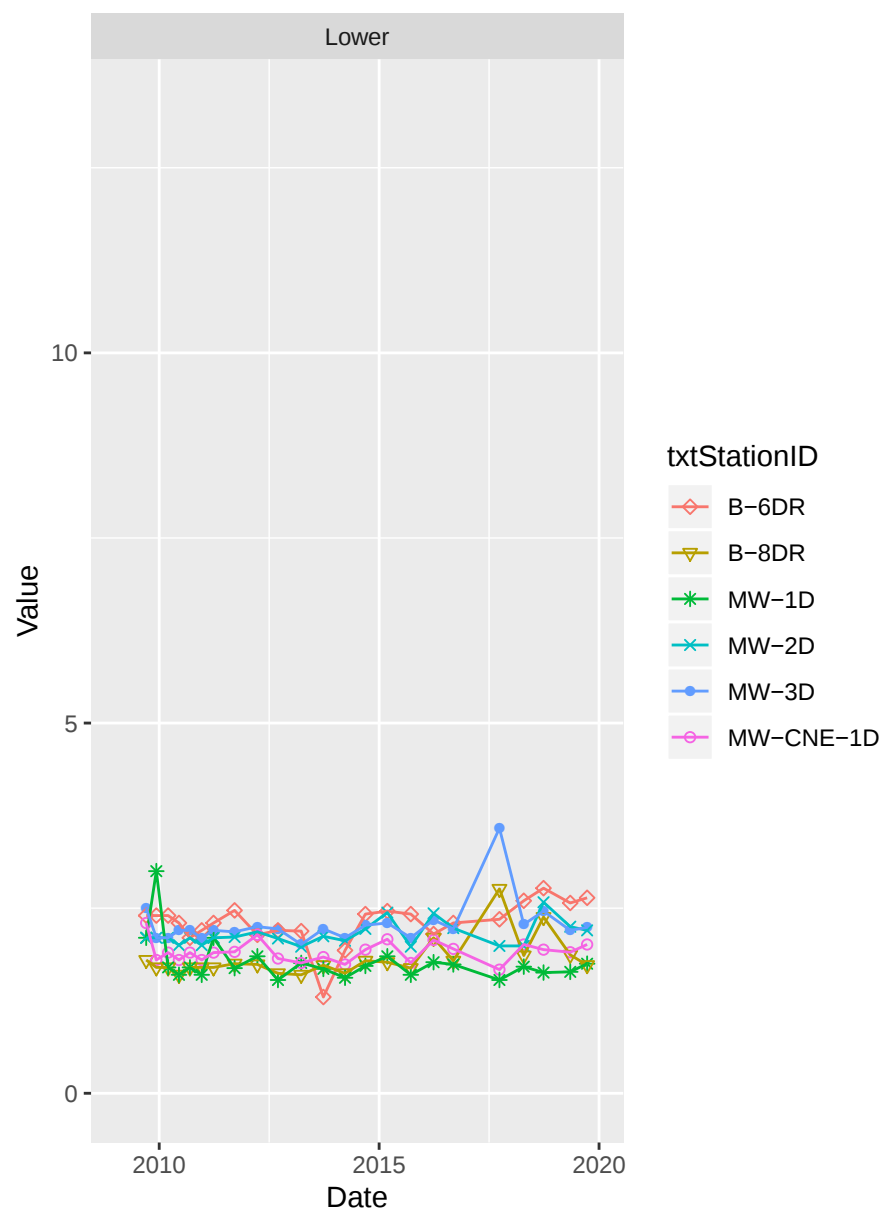
Nitrate+Nitrite as N, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A15. Time Series

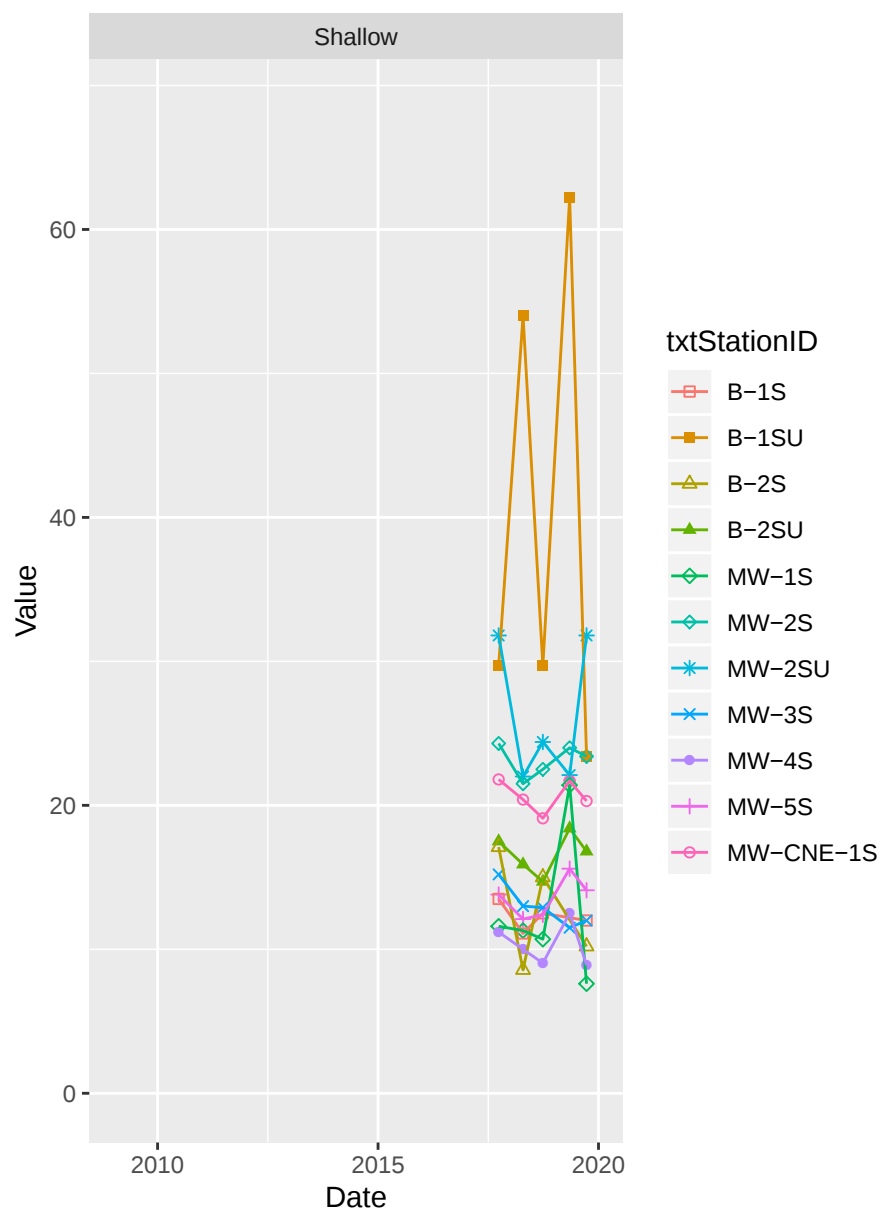
pH, Field, std. units



Non-detect values plotted at Method Reporting Limit value

Figure A16. Time Series

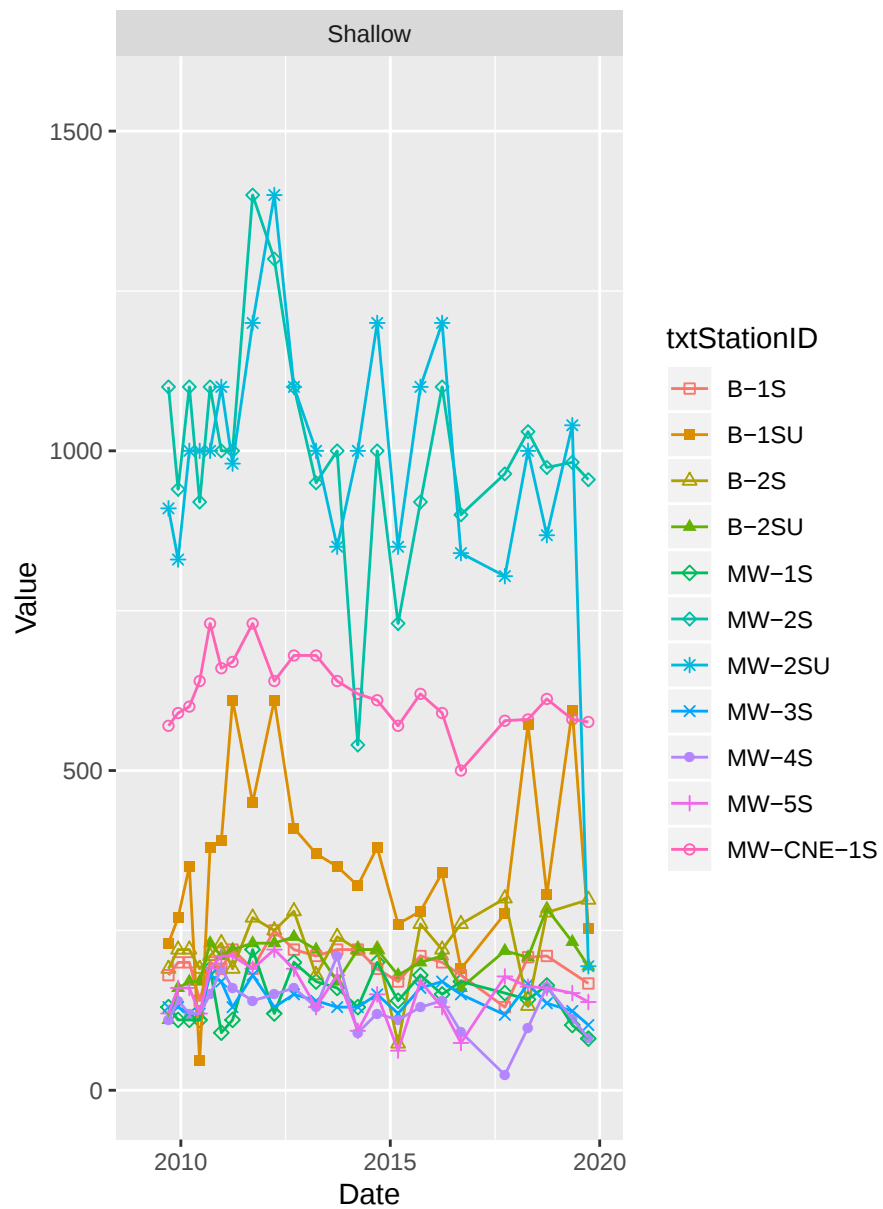
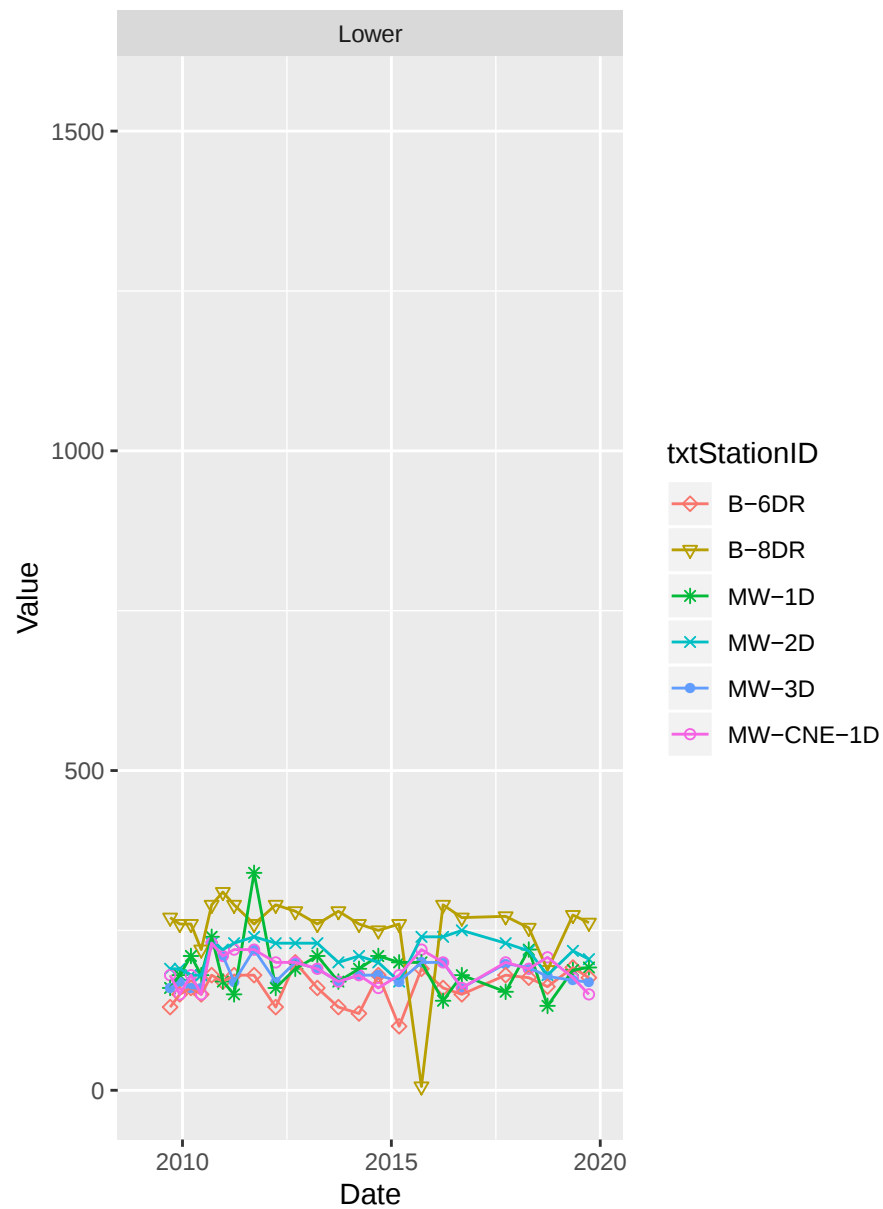
Potassium, Dissolved, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A17. Time Series

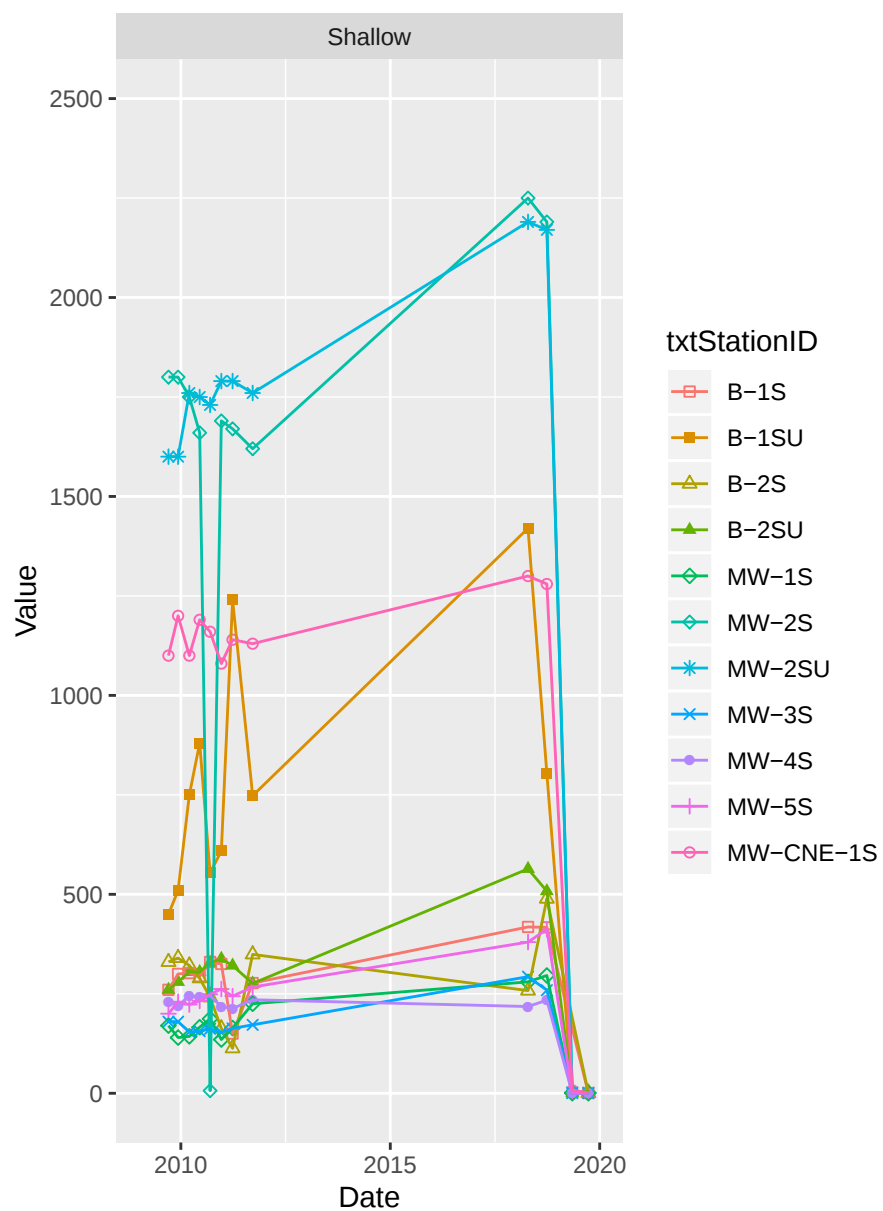
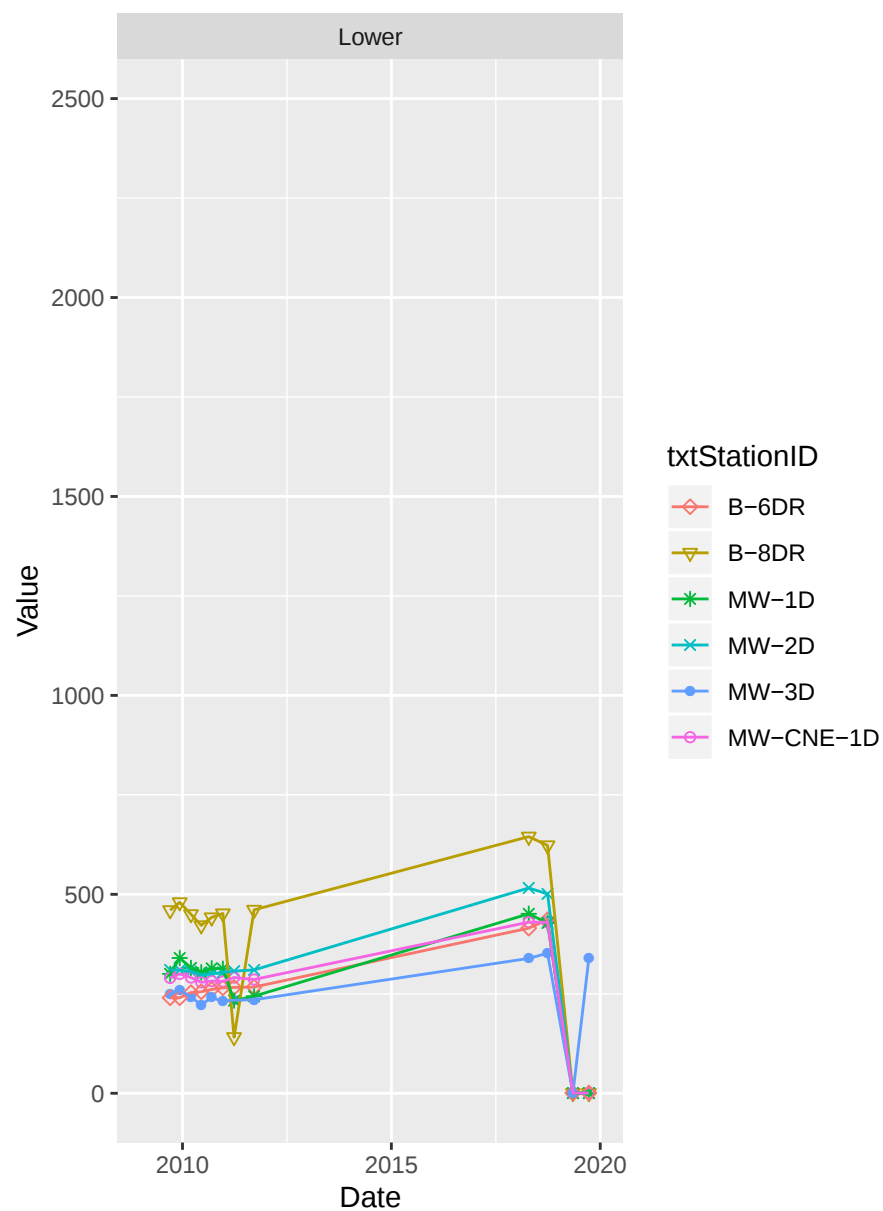
Sodium, Dissolved, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A18. Time Series

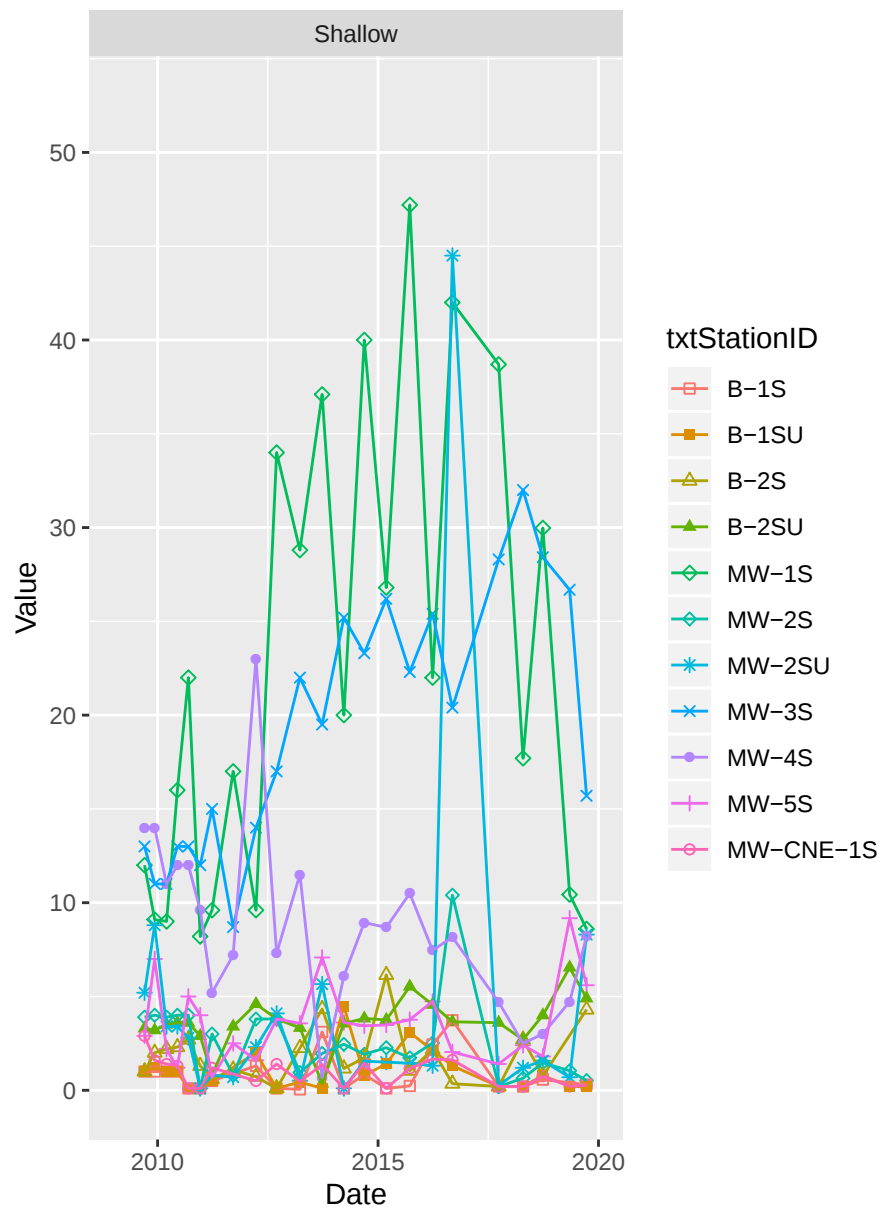
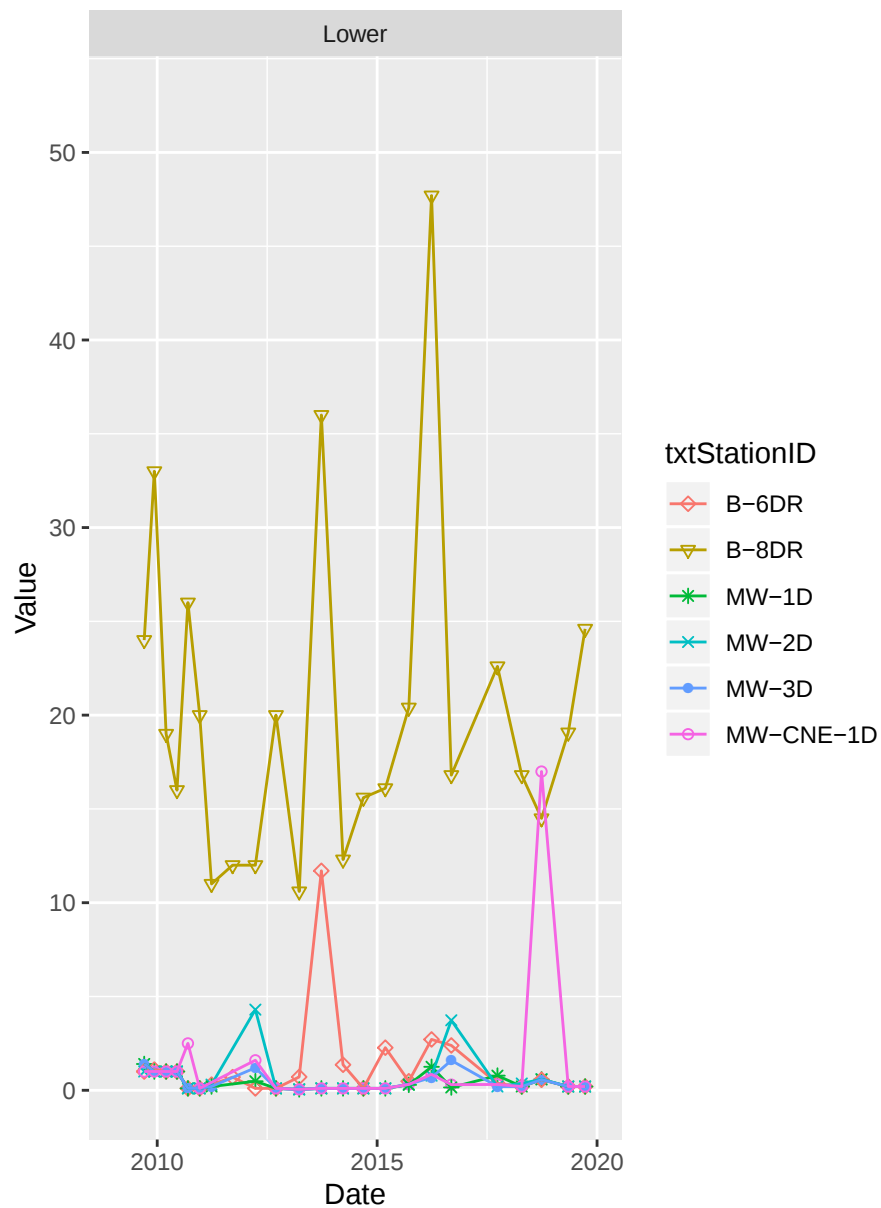
Solids, Total Dissolved, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A19. Time Series

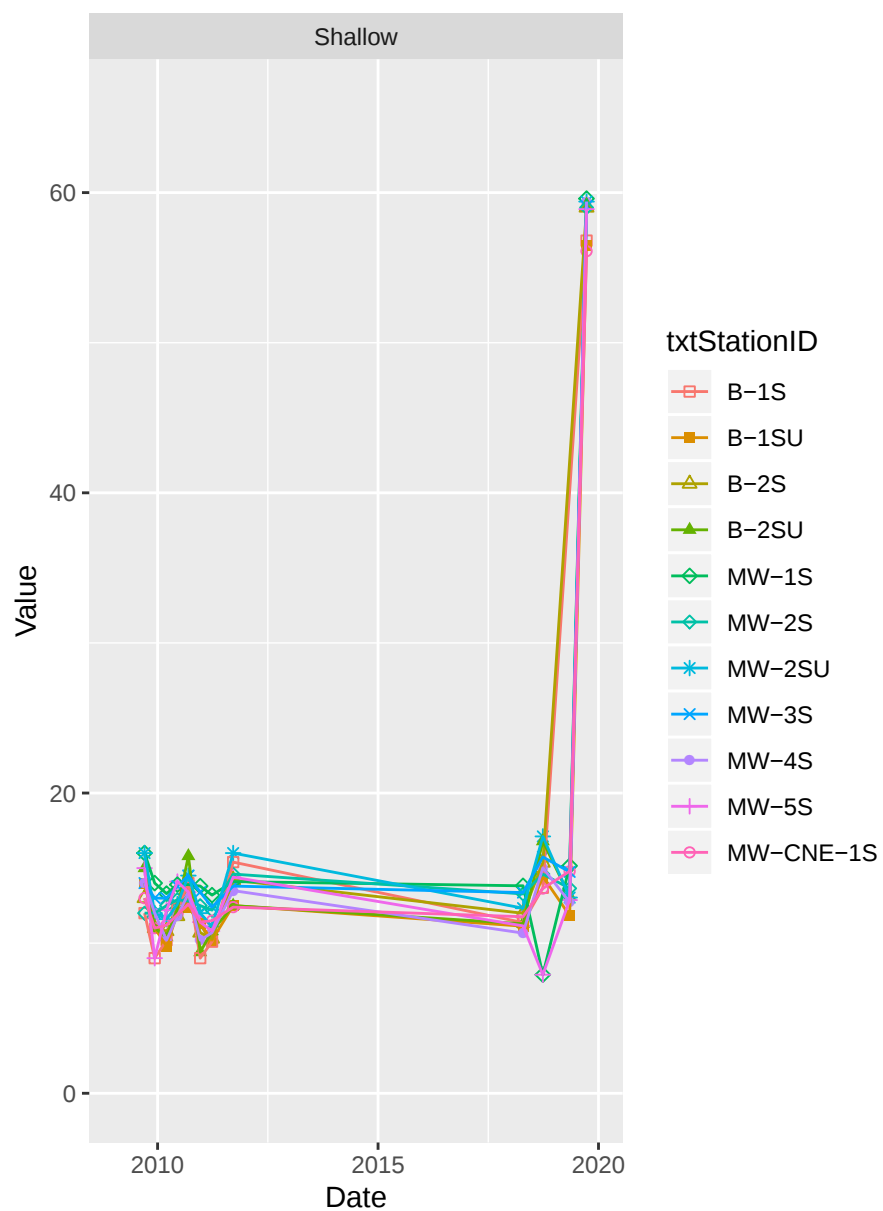
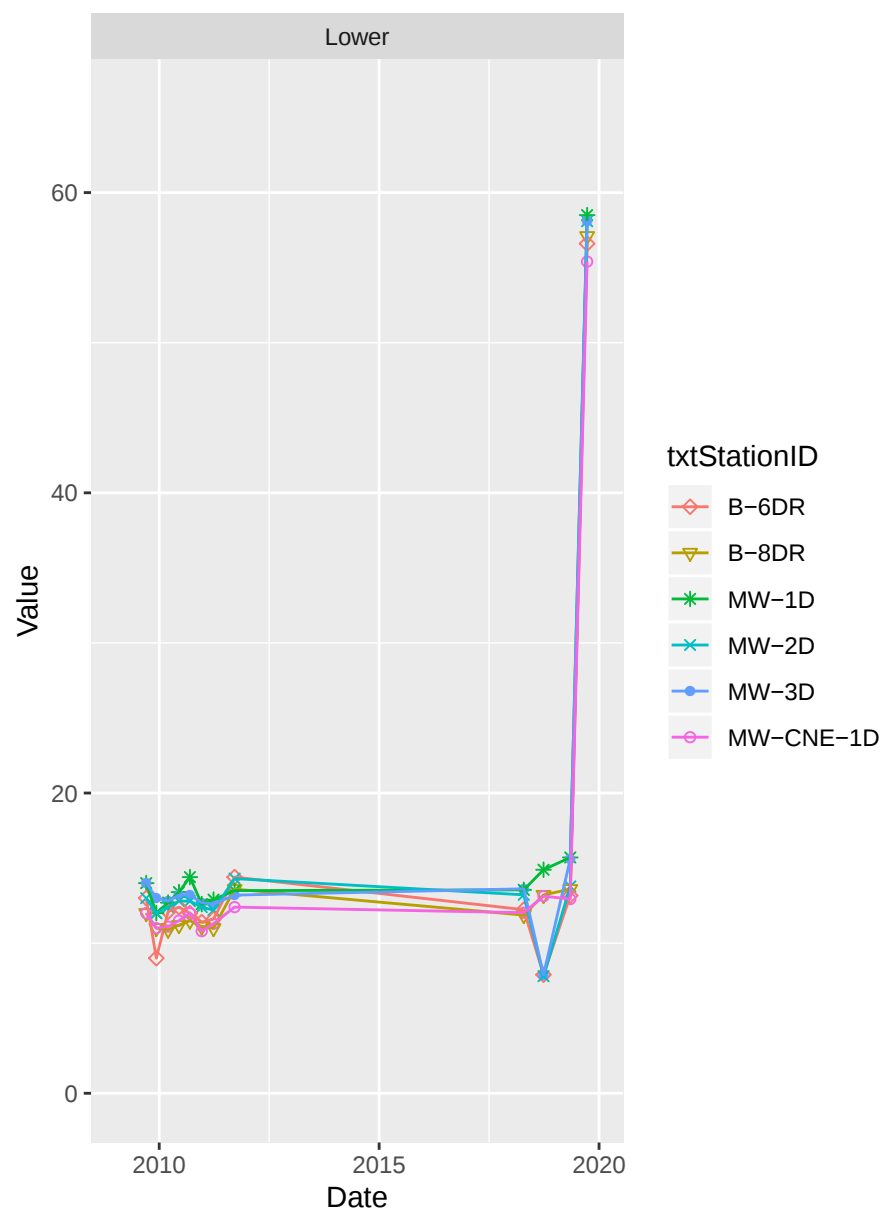
Specific Conductivity (at 25 deg C), uS/cm



Non-detect values plotted at Method Reporting Limit value

Figure A20. Time Series

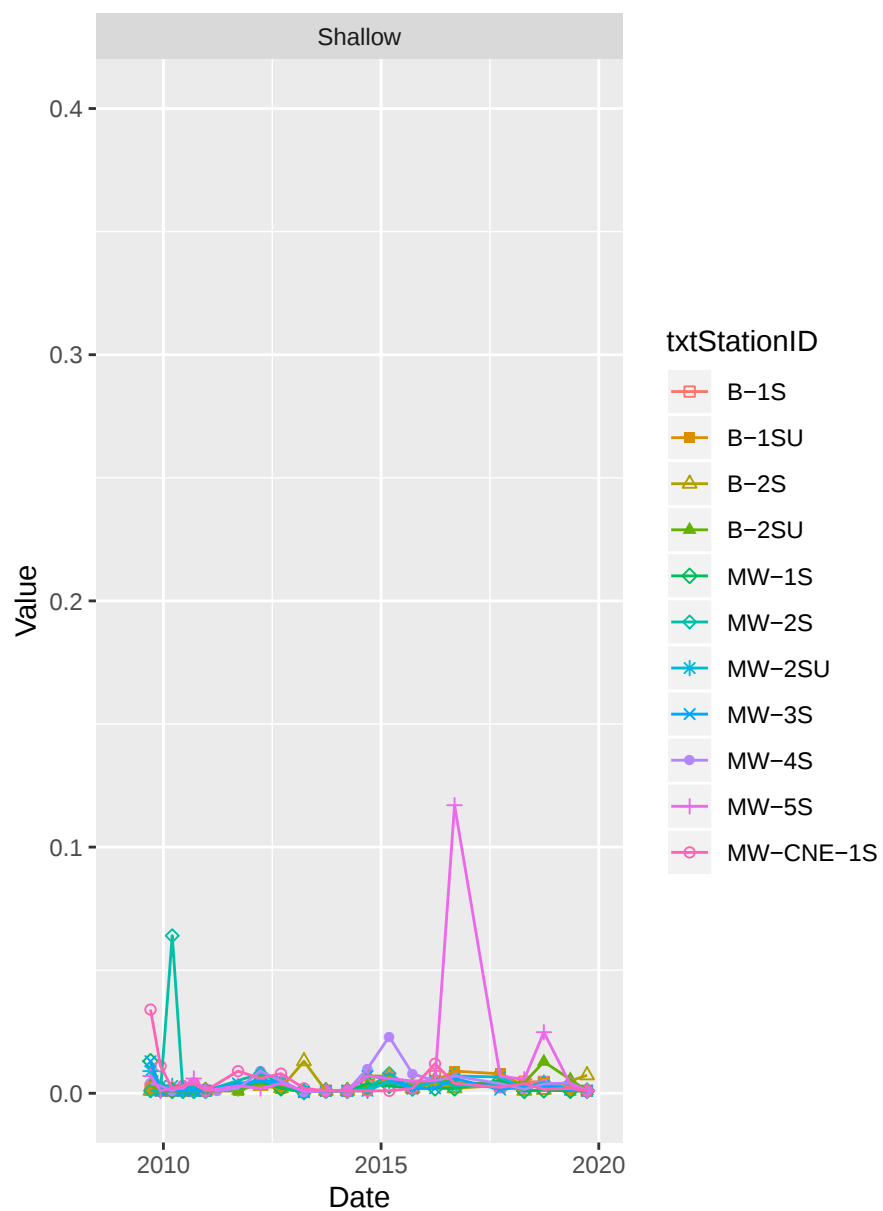
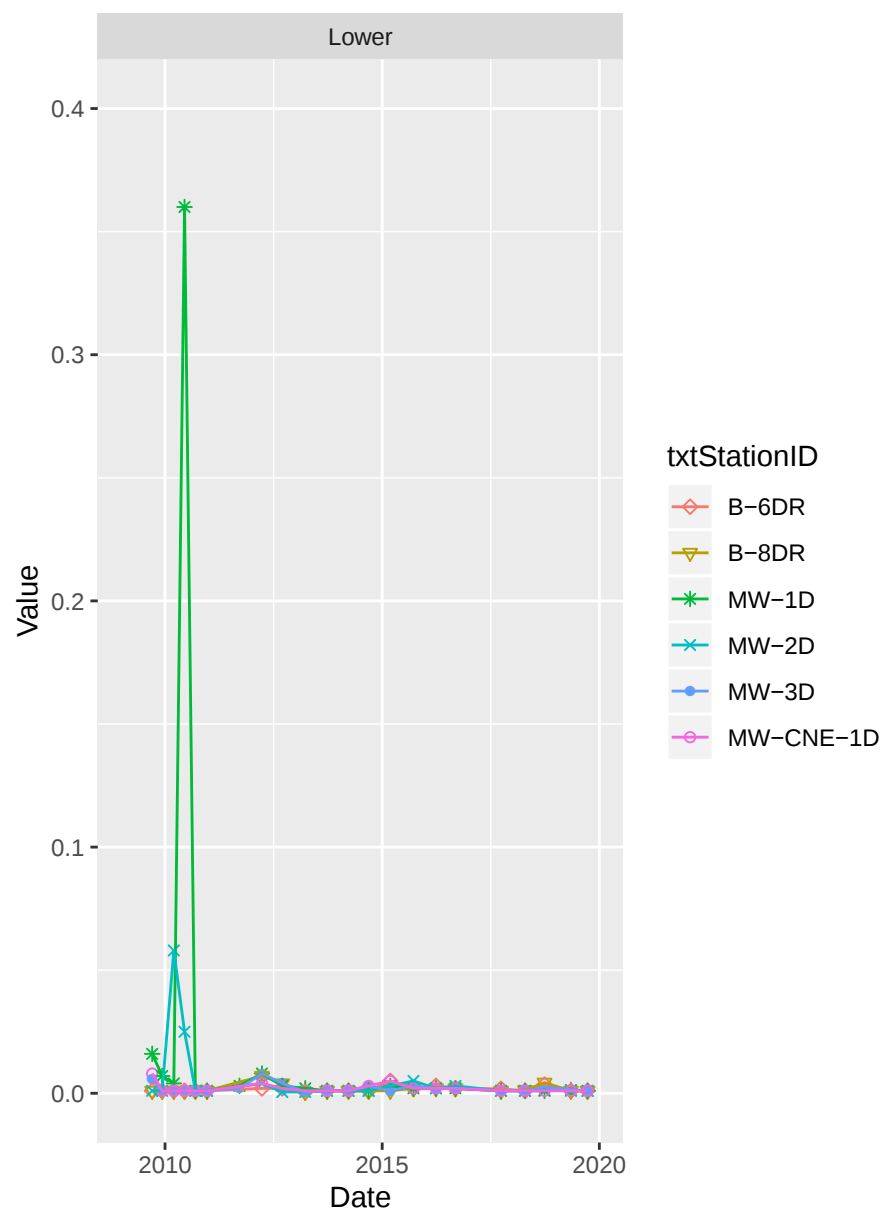
Sulfate, mg/L



Non-detect values plotted at Method Reporting Limit value

Figure A21. Time Series

Temperature, 0 F, 0 F



Non-detect values plotted at Method Reporting Limit value

Figure A22. Time Series

Zinc, Dissolved, mg/L