Div of Waste Management
and Radiation Control

MAR 10 2022

ENERGY FUELS

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DRC 2022-005461

March 7, 2022

Sent VIA E-MAIL AND OVERNIGHT DELIVERY

Mr. Doug Hansen
Director
Division of Waste Management and Radiation Control
Utah Department of Environmental Quality
195 North 1950 West
Salt Lake City, UT 84114-4880

Re: Transmittal of Source Assessment Report for MW-11 White Mesa Mill Groundwater Discharge Permit UGW370004

Dear Mr. Hansen:

Enclosed are two copies of Energy Fuels Resource (USA) Inc.'s ("EFRI's") Source Assessment Report ("SAR") for MW-11 at the White Mesa Mill. This SAR addresses the constituents that were identified as exceeding the GWCL in the 4th Quarter 2021 as described in the Division of Waste Management and Radiation Control ("DWMRC")-approved Q4 2021 Plan and Time Schedule. EFRI submitted the Plan and Time Schedule for MW-11 on November 16, 2021. DWMRC approval of the Plan and Time Schedule was received by EFRI on December 7, 2021. Pursuant to the Plan and Time Schedule EFRI has prepared this SAR.

This transmittal also includes two CDs each containing a word searchable electronic copy of the report.

If you should have any questions regarding this report please contact me.

Yours very truly,

Kathy Weinel

ENERGY FUELS RESOURCES (USA) INC.
Kathy Weinel
Director, Regulatory Compliance

CC: Jordan App
David Frydenlund
Garrin Palmer
Logan Shumway
Scott Bakken
Stewart Smith (HGC)
Angie Persico (Intera)

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White Mesa Uranium Mill

State of Utah Groundwater Discharge Permit No. UGW370004

Source Assessment Report Under Part I.G.4

For Exceedances in MW-11 in the Fourth Quarter of 2021

Prepared by:

Energy Fuels Resources (USA) Inc.
225 Union Boulevard, Suite 600
Lakewood, CO 80228

March 7, 2022

EXECUTIVE SUMMARY

This Source Assessment Report ("SAR") is an assessment of the sources, extent, and potential dispersion of manganese and sulfate in MW-11 at the White Mesa Mill ("the Mill") as required under State of Utah Groundwater Discharge Permit UGW370004 (the "GWDP") Part I.G.4 relating to violations of Part I.G.2 of the GWDP. Manganese and sulfate have exhibited exceedances of the applicable Groundwater Compliance Limits ("GWCLs").

MW-11 has been included in multiple recent investigations and reports, including the Revised Background Groundwater Quality Report for Existing Wells (INTERA, 2007a), a Regional Background Report (INTERA, 2007b), an isotopic investigation (Hurst and Solomon, 2008), a 2012 SAR (INTERA, 2012a), a pH Report (INTERA, 2012b), and a 2019 SAR (INTERA, 2019). GWCL exceedances of manganese in MW-11 were assessed and included in the 2012 and 2019 SARs. Increases of manganese and sulfate were present at the time that the isotopic investigation (Hurst and Solomon, 2008) demonstrated no groundwater impacts from the tailings management system ("TMS"). In addition, manganese and sulfate in MW-11 were found to have significantly increasing trends at the time of the Background Report, the 2012 SAR and the 2019 SARs. The previous SARs noted that the trends in manganese and sulfate in MW-11 were due to natural influences, consistent with the conclusions of Hurst and Solomon (2008) which included MW-11 in their analysis. The previous SARs concluded that the observed manganese trend in MW-11 is due to increased pyrite oxidation and the resulting decrease in pH, which causes dissolution of carbonate cement in the Burro Canyon Formation, and thereby mobilizing manganese substituted for calcium in the carbonate cement.

While the trends in sulfate have been noted since the Background report, recalculation of the GWCL has not been required because sulfate has not exceeded the GWCL until recently. Revised GWCLs for manganese were approved by the State of Utah Division of Waste Management and Radiation Control ("DWMRC") in April of 2013 and September 2019.

Since the time of the Background Report and subsequent SARs, the behavior of constituents in MW-11 has not changed significantly. Manganese and sulfate concentrations continue to increase. As the results of this analysis will demonstrate, trends in manganese and sulfate are the result of background conditions unrelated to disposal of materials in the TMS. In addition, concentrations of both manganese and sulfate are within the range of site-wide conditions.

Revising the GWCL to reflect the variations in manganese and sulfate concentrations is proposed. In accordance with the DWMRC-approved Flowsheet (from INTERA [2007a], included as **Appendix D**), increasing trends may necessitate a modified approach, which has been approved in previous SARs, for calculation of GWCLs. A modified approach for calculating a revised GWCL for manganese and sulfate used the greater of (1) mean + 2 standard deviations, (2) highest historical value, or (3) mean x 1.25 to determine representative and appropriate GWCLs for trending constituents. Regular revisions to GWCLs for constituents in wells with significantly increasing trends over time due to background is consistent with the United States Environmental Protection Agency ("USEPA") Unified Guidance (USEPA, 2009). Such revisions account for variability in larger datasets and minimize unwarranted out-of-compliance status.

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Background Reports	*collectively refers to relevant background reports for this well and site*: the Existing Wells Background Report (INTERA, 2007a), the Regional Background Report (INTERA, 2007b), and the New Wells Background Report (INTERA, 2008)
CAP	Corrective Action Plan
CFCs	chlorofluorocarbons
CIR	Contaminant Investigation Report
DF	Dilution Factor
DI	Deionized
Director	Director of the Division of Waste Management and Radiation Control
DWMRC	State of Utah Division of Waste Management and Radiation Control
EFRI	Energy Fuels Resources (USA) Inc.
GWCL	Groundwater Compliance Limit
GWDP	State of Utah Ground Water Discharge Permit UGW370004
GWQS	Groundwater Quality Standard
µg/L	micrograms per liter
mg/L	milligrams per liter
Mill	White Mesa Uranium Mill
OOC	out of compliance
Q1	first quarter
Q2	second quarter
Q3	third quarter
Q4	fourth quarter
SAR	Source Assessment Report
TDS	Total Dissolved Solids
TMS	Tailings Management System
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

Energy Fuels Resources (USA) Inc. ("EFRI") operates the White Mesa Uranium Mill (the "Mill"), located near Blanding, Utah (**Figure 1A**). Groundwater at the Mill is regulated under the State of Utah Groundwater Discharge Permit UGW370004 (the "GWDP"). This is the Source Assessment Report ("SAR") required under Part I.G.4 of the GWDP relating to Part I.G.2 of the GWDP with respect to the manganese and sulfate in MW-11.

Part I.G.2 of the GWDP provides that an out-of-compliance status exists when the concentration of a constituent in two consecutive samples from a compliance monitoring point exceeds a groundwater compliance limit ("GWCL") in Table 2 of the GWDP. The GWDP was originally issued in March 2005, at which time GWCLs were set on an interim basis, based on fractions of State of Utah Ground Water Quality Standards ("GWQSs") or the equivalent, without reference to natural background at the Mill. The GWDP also required that EFRI prepare a background groundwater quality report to evaluate all historical data for the purposes of establishing background groundwater quality at the Mill site and developing GWCLs under the GWDP. As required by then Part I.H.3 of the GWDP, EFRI submitted three "Background Groundwater Quality Reports" (INTERA 2007a, 2007b, 2008) (collectively, the "Background Reports") to the Director (the "Director") of the State of Utah Division of Waste Management and Radiation Control ("DWMRC") (the Director was formerly the Executive Secretary of the Utah Radiation Control Board and the Co-Executive Secretary of the Utah Water Quality Board).

Based on a review of the Background Reports and other information and analyses, the Director re-opened the GWDP and modified the GWCLs to be equal to the mean concentration plus two standard deviations ("mean + 2σ") or the equivalent for each constituent in each well, based on an "intra-well" approach. That is, the compliance status for each constituent in a well is determined based on current concentrations of that constituent in that well compared to the historic concentrations for that constituent in that well, rather than compared to the concentrations of the same constituent in other monitoring wells. The modified GWCLs became effective on January 20, 2010. On January 19, 2018, March 19, 2019, and March 8, 2021 revised GWDPs were issued, which set revised GWCLs for certain constituents in certain monitoring wells as approved by the Director through previously approved SARs relating to those constituents in those wells. GWCLs apply to groundwater monitoring wells located in the perched aquifer at the Mill.

Figure 1B is a site map showing perched well and piezometer locations, fourth quarter ("Q4") 2021 perched groundwater elevations, and other relevant site features, such as the locations of formerly used (unlined) wildlife ponds, the historical pond, and the boundaries of two shallow groundwater plumes (the nitrate/chloride plume and the chloroform plume) which are under active remediation by pumping. Specifically, Figure 1B shows the commingled nitrate and chloride components of the nitrate/chloride plume.

Figure 1C shows the same features as Figure 1B, except that water levels and plume boundaries are as they existed just prior to cessation of water delivery to the wildlife ponds in the first quarter ("Q1") of 2012. As shown in Figures 1B and 1C, perched groundwater flows generally to the southwest across the site, and the nitrate/chloride plume extends more than 1,000 feet upgradient of the tailings management system ("TMS") indicating an upgradient source. As discussed in HGC (2018), the chloroform plume originated from disposal of laboratory wastes to two former sanitary leach fields that were used prior to Mill construction and operation. Both Figures 1B and 1C show that MW-11 is located immediately downgradient of the nitrate/chloride plume.

Groundwater quality at individual wells is impacted by transient conditions at the site. Currently the perched groundwater system that is monitored at the site does not approach steady state over much of the monitored area. A large part of the site perched water system is in a transient state and affected by long-term changes in water levels due to past and current activities unrelated to the disposal of materials to the TMS. Changes in water levels have historically been related to seepage from the unlined wildlife ponds; however past impacts related to the historical pond, and to a lesser extent formerly used sanitary leach fields, are also expected, as discussed in HGC (2018). Water levels have decreased at some locations due to chloroform and nitrate pumping and reduced recharge from the wildlife ponds.

Figure 2 is a plot of groundwater elevations and nitrate concentrations over time at MW-11 since 1984. Groundwater levels have increased by approximately 19 feet since the well was installed, and by approximately 17 feet since 1990; and nitrate concentrations have increased since 2018 with concentrations now above the detection limit. As discussed above, the water level increase is attributable to former wildlife pond recharge. The nitrate increase is attributable to migration of the leading edge of the nitrate/chloride plume towards MW-11.

1.1 Source Assessment Report Organization

Analyses of manganese, sulfate, and indicator parameters in MW-11 were performed. A description of the approach used for analysis is provided in Section 2.0, and the results of the analysis are presented in Section 3.0. The calculation of GWCLs is discussed in

Section 4.0, and conclusions and recommendations are reviewed in Section 5.0. Section 6.0 provides a list of references cited in this SAR.

The appendices comprise the analyses performed for this SAR and are organized in the following manner: **Appendix A** contains the statistical analysis performed on manganese and sulfate in MW-11. **Appendix B** contains the indicator parameter analysis performed on MW-11. **Appendix C** summarizes the mass balance analysis. **Appendix D** contains the Groundwater Data Preparation and Statistical Process Flow for Calculating Groundwater Protection Standards, White Mesa Mill Site, San Juan County, Utah ("Flowsheet") that was developed based on the United States Environmental Protection Agency's ("USEPA") Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified Guidance (USEPA, 2009), which was approved by DWMRC prior to completion of the Background Reports. **Appendix E** is included on the compact disc that accompanies this SAR and contains the electronic input and output files used for statistical analysis.

Statistical analysis was performed using the software package "R." R is a free statistical package that allows the analyst to perform statistical analysis and format and output graphs more effectively than the Statistica software package used in the past. Input and output files included in **Appendix E** can be imported into either R or Statistica to replicate the results presented in this SAR.

2.0 CATEGORIES AND APPROACHES FOR ANALYSIS

Previously EFRI has categorized wells and constituents in five categories as follows:

- Constituents Potentially Impacted by Decreasing pH Trends Across the Site
- Newly Installed Wells with Interim GWCLs
- Constituents in Wells with Previously Identified Rising Trends
- Pumping Wells
- Other Constituents

This SAR addresses manganese and sulfate in MW-11, which both fall into category three; Constituents in Wells with Previously Identified Rising Trends. Increasing trends in manganese and sulfate concentrations in MW-11 were observed in the 2007 Existing Wells Background Report, the 2012 SAR (INTERA, 2012a), the pH Report (INTERA, 2012b), and the 2019 SAR (INTERA, 2019). These trends were already present at the time of the University of Utah isotopic study (Hurst and Solomon, 2008; described below) that determined there had been no impacts to groundwater from the TMS.

Additional factors that contributed to changes in groundwater conditions at MW-11 are discussed in Sections 3.1, 3.2, and 3.3. These factors include the site-wide pH changes, wildlife pond seepage, and the location of MW-11 immediately downgradient of the nitrate/chloride plume which extends approximately 1,000 feet upgradient of the TMS. Subsequent to about 2018, both nitrate and chloride show unambiguously increasing trends at MW-11. Although MW-11 is not within the nitrate/chloride plume (because nitrate and chloride concentrations are below 10 mg/L and 100 mg/L, respectively), these increasing trends are consistent with ongoing downgradient migration of the plume toward MW-11.

2.1 Approach for Analysis

The first step in the analysis is to assess the potential sources for the exceedances to determine whether they are due to background influences or Mill activities. If the exceedances are determined to be within natural variability or due to site-wide influences, then it is not necessary to perform any further evaluations on the extent and potential dispersion of the contamination or to perform an evaluation of potential remedial actions. Monitoring will continue; and, where appropriate, revised GWCLs are proposed to reflect changes in background conditions.

The analysis performed in this SAR considers all available data to date to evaluate the behavior of the constituents in the well. Analysis will determine if there have been any changes in the behavior of potential TMS seepage indicator parameters (e.g., chloride, sulfate, fluoride, and uranium) since the date of the Existing Wells Background Report that may suggest a change in the behavior of the groundwater in MW-11.

As discussed in the Background Reports (INTERA, 2007a, 2007b, 2008), indicator parameters of potential TMS seepage include chloride, sulfate, fluoride, and uranium. Chloride is typically the best indicator of potential TMS seepage; however, chloride is problematic as an indicator parameter for groundwater monitoring wells at the Mill impacted by the nitrate/chloride plume which originates upgradient of the TMS (**Figures 1B and 1C**) (HGC, 2018a). Although MW-11 is not within the nitrate/chloride plume, it is immediately downgradient of the plume and is now affected by elevated concentrations of chloride and nitrate at the leading edge of the plume.

Sulfate and fluoride are useful indicator parameters when the geochemical conditions allow these constituents to behave conservatively (i.e., are non-reactive). However, because sulfate has displayed a long-term increasing trend that was present at the time that the Hurst and Solomon isotopic investigation (Hurst and Solomon, 2008; discussed in Section 2.3) concluded there were no impacts to groundwater from the TMS, it is also not a useful indicator parameter at MW-11. In addition, although uranium may be the most mobile metal under some conditions, its behavior ranges from conservative to non-conservative, and is likely to behave relatively non-conservatively due to relatively strong sorption expected at the near-neutral pH of MW-11 (see Section 3.3 for further discussion). Therefore fluoride is the best indicator parameter at MW-11.

Although any potential seepage from the TMS would be expected to cause increasing concentrations of chloride, sulfate, fluoride, and uranium, as discussed above, sulfate and chloride are not useful indicators at MW-11, and uranium is expected to be strongly retarded compared to fluoride at MW-11 due to sorption and precipitation, and would not show increases in groundwater until sometime after fluoride concentrations had begun to increase. However, as shown in Figure 3, while chloride is increasing due to the influence of the nitrate/chloride plume, fluoride is decreasing, indicating that there are no impacts from the TMS. As noted in Section 12.0 of INTERA (2007a), while the absence of a rising trend in chloride concentration would demonstrate that there has been no impact from the TMS, a rising trend in chloride concentration as well as in other indicator parameters can be due to natural influences unrelated to disposal of materials to the TMS.

The evaluation of SAR and indicator parameters in MW-11 was supported by a statistical analysis that followed the process outlined in the Flowsheet (INTERA, 2007a), a copy of which is attached as **Appendix D.** The Flowsheet was designed based on USEPA's *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities, Unified*

Guidance (USEPA, 2009), and was approved by DWMRC prior to completion of the Background Reports.

2.2 Approach for Setting Revised GWCLs

If the preceding approach resulted in the conclusion that the analysis in the Background Reports has not changed, or that the increasing concentrations of manganese and sulfate in MW-11 are due to natural variability in groundwater; geochemical changes caused by the downgradient migration of the nitrate/chloride plume; or site-wide influences such as the oxidation of pyrite; then a new GWCL may be proposed. In proposing revised GWCLs, The DWMRC-approved Flowsheet approach was adopted, including the last decision of the process that directs the analyst to consider a modified approach to determining a GWCL if an increasing trend is present.

Appendix A-1 summarizes the geochemical analysis for SAR parameters in MW-11 and presents the revised GWCLs for manganese and sulfate, based on the Flowsheet. A modified approach for both manganese and sulfate is being proposed to address issues with revising GWCLs in constituents with significantly increasing trends and to minimize unwarranted out-of-compliance situations.

2.3 University of Utah Study

At the request of the DWMRC, T. Grant Hurst and D. Kip Solomon of the Department of Geology and Geophysics of the University of Utah performed a groundwater study (the "University of Utah Study") at the Mill site in July 2007 (Hurst and Solomon, 2008). The purpose of this study was to characterize groundwater flow, chemical composition, noble gas composition, and age to evaluate whether the increasing and elevated trace metal concentrations in monitoring wells at the Mill, all of which were identified in the Background Reports, may indicate that potential seepage from the tailings system is occurring.

To evaluate sources of solute concentrations at the Mill, low-flow groundwater sampling was used as a method for collecting groundwater quality samples from 15 monitoring wells, including MW-11. In addition, surface water samples were collected from TMS cells 1, 3, and 4A, and two wildlife ponds. Passive diffusion samplers were also deployed and collected to characterize the dissolved gas composition of groundwater at different depths within the wells. Samples were collected and analyzed for the following constituents: tritium, nitrate, sulfate, deuterium and oxygen-18 of water, sulfur-34 and oxygen-18 of sulfate, trace metals (uranium, manganese, and selenium), and chlorofluorocarbons ("CFCs").

Hurst and Solomon (2008, page iii) concluded generally that,

> *[t]he data show that groundwater at the Mill is largely older than 50 years, based on apparent recharge dates from chlorofluorocarbons and tritium concentrations. Wells exhibiting groundwater that has recharged within the last 50 years appears to be a result of recharge from wildlife ponds near the site. Stable isotope fingerprints do not suggest contamination of groundwater by tailings cell leakage, evidence that is corroborated by trace metal concentrations similar to historically-observed observations.*

Hurst and Solomon (2008) conclude that,

> *[i]n general, the data collected in this study do not provide evidence that tailings cell leakage is leading to contamination of groundwater in the area around the White Mesa Mill. Evidence of old water in the majority of wells, and significantly different isotopic fingerprints between wells with the highest concentrations of trace metals and surface water sites, supports this conclusion. The only evidence linking surface waters to recharging groundwater is seen in MW-27 and MW-19. Measurable tritium and CFC concentrations indicate relatively young water, with low concentrations of selenium, manganese, and uranium. Furthermore, stable isotope fingerprints of ðD and* $\delta^{18}O$ *suggest mixing between wildlife pond recharge and older groundwater in MW-19 and MW-27.* $D^{34}S\text{-}SO_4$ *and* $\delta^{18}O\text{-}SO_4$ *fingerprints closely relate MW-27 to wildlife pond water, while the exceptionally low concentration of sulfate in MW-27, the only groundwater site to exhibit sulfate levels below 100 mg/L, suggest no leachate from the tailings cells has reached the well.*

It should be further noted that, subsequent to the University of Utah Study, EFRI submitted a *Contaminant Investigation Report, White Mesa Uranium Mill Site, Blanding Utah*, dated December 30, 2009 (INTERA, 2009) ("CIR"), in connection with the nitrate/chloride plume at the Mill site. The CIR discusses the presence of a historical pond that existed for many years at a location upgradient from MW-27 (Figures 1B and 1C), which was much closer to MW-27 than the wildlife ponds. This historical pond was a contributor of surface water to MW-27.

3.0 RESULTS OF ANALYSIS

This section describes the geochemical influences on groundwater in MW-11 and results of the analyses, summaries of which are provided in **Appendix A-1, Appendix B-1**, and **Appendix C**. A statistical analysis of pH was performed as part of the indicator parameter analyses for MW-11. The pH analysis included box plots to identify and omit extreme outliers, a Shapiro-Wilk test of normality, and trend tests (see **Appendix B**).

3.1 Site-Wide pH Changes

As discussed below, pH in nearly all MW-series monitoring wells, including MW-11, was decreasing prior to about 2016. This has resulted in mobilization of pH-sensitive metals and increases in concentrations of these metals in groundwater. However, since about 2016, the site-wide decreasing pH trend has reversed in nearly all MW-series monitoring wells (including MW-11), and pH is now generally increasing.

3.1.1 pH Decrease Prior to 2016

As has been documented in INTERA (2012), a decreasing trend in pH was observed in almost every groundwater monitoring well across the site, including upgradient and far downgradient monitoring wells; and decreasing pH is one of the most important contributors to increasing concentrations of many naturally-occurring parameters.

Hydro Geo Chem, Inc. (["HGC"]), 2012a) ("The Pyrite Report") attributed the decline in pH across the Mill site to the site-wide existence and oxidation of pyrite in the perched groundwater monitored at the site. Based on HGC (2012a) pyrite has been noted in approximately $^{2}/_{3}$ of the lithologic logs for wells installed at the site since 1999, and verified by laboratory analysis in core and cuttings from at least 25 monitoring wells. The presence or absence of pyrite at MW-11 is unknown as detailed lithologic logs are not available. However, as discussed in HGC (2012), pyrite is essentially ubiquitous at the site and is therefore likely present in the Burro Canyon Formation in the vicinity of MW-11.

Pyrite will oxidize according to the following reaction (Williamson and Rimstidt, 1994):

$$FeS_{2(s)} + 7/2O_{2(g)} + H_2O \rightarrow Fe^{2+}_{(aq)} + 2SO_4^{2-}{}_{(aq)} + 2H^+ \quad \text{(Reaction 1)}$$

Reaction 1 will increase hydrogen ion (acid) concentrations, which results in decreasing pH. Oxidation of pyrite and the resulting decrease in pH enables subsequent pH-dependent reactions to occur, including the mobilization of naturally-occurring metals and metalloids (such as uranium) in the formation (McClean and Bledsoe, 1992). In addition, pyrite typically contains many contaminants including manganese (Nickel, 1954; Price, 1972) that are released upon pyrite oxidation. Furthermore, naturally occurring uranium reduced by and sorbed onto pyrite (Descotes et al 2010; Glizaud, 2006) makes it available for release upon oxidation. As discussed in EFRI (2021), bottle-roll tests using 'generic' pyrite resulted in bottle-roll solutions initially consisting of laboratory-grade deionized ("DI") water generating between 25 micrograms per liter ("μg/L") and 3,420 μg/L uranium. Bottle-roll tests using pyrite-bearing core from the formation hosting perched groundwater at the site yielded bottle-roll solutions having as much as 6,700 μg/L uranium. In addition, bottle-roll test solutions generated as much as 8,200 μg/L manganese from the 'generic' pyrite sample; and as much as 4,120 μg/L manganese from a pyritic core sample.

The causes for site-wide oxidation of pyrite include processes that increase oxygen transport to groundwater. Monitoring well casings themselves provide direct conduits for oxygen to impact groundwater in the immediate vicinities of the wells. Additional factors that increase oxygen transport to groundwater include: (1) infiltration of oxidized water from the wildlife ponds upgradient of the Mill site; (2) changing water levels and incorporation of oxygen in air-filled pore spaces into groundwater; (3) the introduction of oxygen during pumping related treatment of the nitrate/chloride plume; and (4) the introduction of oxygen during increased sampling of monitoring wells (INTERA, 2012). Many of these mechanisms, in particular changing water levels, are impacting MW-11. Water levels at many site wells increased due to former seepage from the northern wildlife ponds located upgradient of the TMS. As shown in Figure 2, as a result of former wildlife pond seepage and expansion of the resulting perched groundwater mound, water levels at MW-11 increased by approximately 19 feet since installation; and by approximately 17 feet since 1990.

Although MW-11 is influenced by the downgradient migration of the nitrate and chloride plume, MW-11 is not within the plume because the plume is defined in the CAP as nitrate concentrations greater than 10 mg/L. As discussed above, the nitrate/chloride plume originates more than 1,000 feet upgradient of the TMS.

Pyrite is oxidized by nitrate by the following mechanisms as discussed in HGC (2018) The pathway most commonly applied in geochemical studies (Kolle *et al.*, 1983, 1985; Postma *et al.*, 1991; Korom, 1992; Robertson *et al.*, 1996; Pauwels *et al.*, 1998; Hartog *et al.*, 2001, 2004; Spiteri *et al.*, 2008) is a bacteria-mediated reaction that yields ferrous iron, sulfate, water, and nitrogen gas as follows:

$$5FeS_2 + 14NO_3^- + 4H^+ = 7N_2 + 10SO_4^{2-} + 5Fe^{2+} + 2H_2O \text{ (Reaction 2).}$$

By Reaction 2, five moles of pyrite reduce 14 moles of nitrate, consuming four moles of acid. Reaction 2 is considered applicable when pyrite concentrations exceed nitrate concentrations (van Beek, 1999). Where nitrate concentrations exceed pyrite concentrations, Reaction 3 is a more likely mechanism (Kolle *et al.*, 1987; van Beek, 1999; Schlippers and Jorgensen, 2002):

$$2FeS_2 + 6NO_3^- + 4H_2O = 3N_2 + 4SO_4^{2-} + 2Fe(OH)_3 + 2H^+ \text{ (Reaction 3).}$$

By Reaction 3, two moles of pyrite reduce six moles of nitrate, yielding iron hydroxide, sulfate, acid, and nitrogen gas. Therefore, when nitrate concentrations exceed pyrite concentrations (Reaction 3), denitrification by pyrite is more efficient than when pyrite is in excess (Reaction 2). Additionally, Reaction 3 produces acid, while Reaction 2 consumes acid, indicating that the impact of denitrification by pyrite on aquifer geochemistry is controlled by the relative abundance of pyrite and nitrate.

Reaction 3 is an overall reaction that combines Reaction 2 and a second step whereby ferrous iron is oxidized by nitrate. This second step is more likely to occur when excess nitrate is present and available to oxidize ferrous iron (Kolle *et al.*, 1987; Rivett *et al.*, 2008; Zhang 2012).

3.1.2 pH Increase Post-2016

As shown in Figure 4, pH at MW-11 generally decreased until about 2016, then became stable to increasing. The post-2016 increase in pH is inconsistent with a TMS source as TMS solutions have a low pH, and mixing of potential seepage of TMS solution with groundwater would cause a decrease (rather than increase) in pH. The increasing pH shows that MW-11 is unimpacted by the TMS, consistent with the decreasing fluoride shown in Figure 3. Recently increasing chloride, which correlates with increasing nitrate (Figure 5), is the result of downgradient migration of the nitrate/chloride plume toward MW-11, as will be discussed in Section 3.3.

3.2 Changes in Groundwater at MW-11

As discussed in Section 1, Figure 1B shows water levels and chloroform, nitrate and chloride plume boundaries for the fourth quarter of 2021. Figure 1C shows the same features as Figure 1B, except that water levels and plume boundaries are as they existed just prior to cessation of water delivery to the wildlife ponds. A comparison between Figure 1B and Figure 1C shows the substantial changes in water levels that have occurred in about 10 years due cessation of water delivery to the wildlife ponds. Currently, although water levels have declined substantially in the center of the perched groundwater mound associated with the northern wildlife ponds, water levels have not returned to pre-pond seepage conditions, and consequently the groundwater mound is still expanding.

The transient status of a large portion of the perched water system, manifested in long-term changes in saturated thicknesses and rates of groundwater flow, results in trends in pH and in the concentrations of many dissolved constituents that are unrelated to site operations. Changes in saturated thicknesses and rates of groundwater flow can result in changes in concentrations of dissolved constituents (or pH) for many reasons. For example, as discussed in HGC (2012), groundwater rising into a vadose zone having a different chemistry than the saturated zone will result in changes in pH and groundwater constituent concentrations. If the rise in groundwater represents a long-term trend, long-term changes in groundwater constituent concentrations (or pH) result.

3.2.1 Manganese

Statistical analysis of manganese in MW-11 shows that the dataset is neither normally or lognormally distributed, and concentrations are increasing significantly (**Appendix A-1**). The trend of increasing manganese concentrations in MW-11 is likely to result from mobilization from natural sources within the Burro Canyon Formation hosting perched groundwater at the site.

In sedimentary environments, manganese tends to occur as dissolved Mn^{2+}, and as a component in carbonate, oxide, and hydroxide minerals. The solubility and mobility of manganese is highly dependent on the acidity (pH) and redox conditions of an environment. As discussed in INTERA (2019), in general, manganese solubility is highest in more acidic (lower pH) and more reducing (lower oxygen) conditions.

Prior to about 2016, pH at MW-11 was decreasing significantly (**Figure 4**); however, chloride was stable and nitrate was generally not detected as shown in Figure 5, indicating that the nitrate/chloride plume had not yet impacted MW-11. Although pH was decreasing prior to 2016, the redox potential has been increasing significantly over time (**Figure 6**). Decreasing pH values could cause manganese minerals in the Burro Canyon Formation to dissolve and release manganese into the perched groundwater; however, the increasing redox potential is not expected to result in increased mobility of manganese. The response of manganese to increased redox potential is often similar to that of iron, where increased redox potential causes the dissolved metal to oxidize and precipitate as an oxide or hydroxide mineral. Although the trend is not significant, iron concentrations in MW-11 have been decreasing since early 2012, and are now below detection limits ("DLs") (**Figure 7**). The decreasing iron concentrations are most likely a result of increasing redox potential and precipitation of secondary iron minerals. Since manganese concentrations are increasing, a process other than increased redox potential is likely responsible for manganese behavior at MW-11.

In a survey of the geochemistry of mineralized and unmineralized areas within the Salt Wash Member of the Morrison Formation, which underlies the Burro Canyon Formation at the Mill site, Shoemaker et al. (1959) observed a strong correlation between manganese and calcium in the sandstone samples. They attributed this manganese-calcium relationship to the predominance of calcium carbonate cement, and possible substitution of manganese for calcium in this cement. Solid solutions of calcite ($CaCO_3$) and rhodochrosite ($MnCO_3$) are common (Nesse, 2012). A relatively strong correlation between dissolved manganese and calcium concentrations also exists for MW-11 groundwater over time (**Figure 8**). It is conceivable that the same process of manganese coprecipitation with carbonate cement during formation of the Salt Wash Member could also have occurred during formation of the Burro Canyon Formation.

To test the likelihood of the presence of calcite and rhodochrosite in the Burro Canyon Formation, a speciation calculation was performed in 2019 (as discussed in INTERA, 2019) using the Geochemist's Workbench software (v. 11.0.8) and the SpecE8 module and the minteq database. Input parameters were based on data for MW-11 collected January 15, 2019. The solution was calculated to be slightly supersaturated with calcite and slightly undersaturated with rhodochrosite. If MW-11 groundwater is near equilibrium with calcite and rhodochrosite, then decreasing pH is expected to cause these minerals to dissolve. Given the prior decreasing pH at MW-11, increased dissolution of carbonate cement that contains manganese was the most plausible mechanism for increased manganese concentrations in MW-11 groundwater.

Prior to about 2016, increased pyrite oxidation and the resulting decrease in pH likely caused dissolution of carbonate cement in Burro Canyon Formation, thereby mobilizing manganese substituted for calcium in the carbonate cement. However, since 2016, pH at MW-11 has been stable to increasing, suggesting that if pyrite oxidation is still occurring, any associated acid production must occur in areas localized enough that mixing with surrounding groundwater does not result in an overall pH decrease.

In addition, manganese is a common contaminant in pyrite (Nickel, 1954; Price, 1972). As discussed above and in EFRI (2021) bottle-roll test solutions generated as much as 8,200 μg/L manganese from a 'generic' pyrite sample; and as much as much as 4,120 μg/L manganese from a pyritic core sample. Because nitrate oxidation of pyrite can proceed by a pathway that consumes rather than produces acid, and there is sufficient nitrate recently to produce the measured manganese, increasing manganese at MW-11 can result from pyrite oxidation with stable to increasing pH.

Regardless, because increasing concentrations of manganese are due to background influences unrelated to disposal of materials to the TMS, a revised GWCL for manganese is proposed. The current GWCL is 237 micrograms per liter (µg/L). The proposed revised GWCL is 376 µg/L, which is the highest historical value. The proposed revised GWCL was calculated by a modified approach in accordance with the DWMRC-approved Flowsheet (**Appendix D**). A discussion of the modified approach for manganese is included in Section 4.1.1.

3.2.2 Sulfate

Sulfate concentrations have been increasing gradually since the time of the Existing Wells Background Report (INTERA, 2007a). Sulfate is naturally occurring in groundwater and is released into solution during the oxidation of pyrite (reactions 1 and 2) and dissolution of common sulfate-bearing minerals such as gypsum and anhydrite, both of which have been detected in the perched zone at the Mill (HGC, 2012a). Sulfate concentrations in MW-11 are significantly increasing, but remain within the sitewide range of concentrations at the Mill (**Appendix A-9**).

Since increasing concentrations of sulfate are due to background influences unrelated to disposal of materials to the TMS, a revised GWCL for sulfate is proposed. The current GWCL is 1,309 milligrams per liter (mg/L). The proposed revised GWCL is 1,493.6 mg/L, which is the mean x 1.25. The proposed revised GWCL was calculated by a modified approach in accordance with the DWMRC-approved Flowsheet (**Appendix D**). A discussion of the modified approach for sulfate is included in Section 4.2.

3.3 Indicator Parameter Analysis

A summary of statistical analysis of indicator parameters is included in **Appendix B-1**. **Appendix B-2** presents a descriptive statistics comparison for indicator parameters from the Existing Wells Background Report (INTERA, 2007a), the 2012 SAR (INTERA, 2012a), the 2019 SAR (INTERA, 2019), and this SAR. Data used in the analysis and data removed prior to analysis are presented in **Appendices B-3** and **B-4**, respectively. The distribution and identification of outliers and extreme outliers in indicator parameter concentration datasets are demonstrated in the box plots included in **Appendix B-5**. Histograms and timeseries plots are included in **Appendix B-6** and **B-7**, respectively.

MW-11 indicator parameters chloride, sulfate and uranium exhibit significantly increasing trends; whereas indicator parameter fluoride exhibits a significantly decreasing trend (Figure 3) (**Appendix B-1**). The decreasing fluoride indicates that MW-11 is not impacted by any potential seepage from the TMS. The increase in chloride has occurred only since about 2018, correlates to an increase in nitrate (Figure 5), and is due to the migration of the nitrate/chloride plume towards MW-11.

The increase in sulfate concentrations is more gradual (**Appendix B-7**) than the increase in manganese and uranium concentrations (**Appendix B-7**). In addition, both sulfate and manganese have been increasing since the time of the Existing Wells Background Report (INTERA, 2007a); and were increasing at the time of the Hurst and Solomon isotopic investigation report (Hurst and Solomon, 2008). Because the isotopic analysis concluded that there were no impacts to groundwater from the TMS, the trends in sulfate and manganese are indicative of background conditions unrelated to the disposal of materials to the TMS. Furthermore, isotopic measurements indicated that MW-11 contained the largest component of water that predated the TMS (Hurst and Solomon, 2008), additional demonstration of the lack of a TMS impact. Although sulfate concentrations in MW-11 have been increasing since the time of the Background Report, they remain within the sitewide range of concentrations at the Mill as summarized in Appendix A-9. As described in Section 3.2.3, sulfate is naturally occurring in groundwater and is released into solution as a result of pyrite oxidation.

The recent (post-2018) increase in uranium corresponds to nearly simultaneous increases in chloride and nitrate (Figures 5 and 9). However, chloride and nitrate are anions that do not sorb onto aquifer materials and are not retarded with respect to groundwater flow. In contrast, uranium is expected to have a mobility that is orders of magnitude lower than chloride or nitrate at the near-neutral pH conditions at MW-11.

USEPA (2007) provides soil-water equilibrium distribution coefficients (Kd) for uranium. The higher the Kd, the less mobile uranium is expected to be; and the lower the Kd, the more mobile uranium is expected to be. As indicated in USEPA (2007), Kd values for uranium are pH-dependent, with the highest Kd associated with near-neutral to slightly acidic pH). The *minimum* Kd values reported for uranium increase from 0.4 mL/g at pH 4 to 100 mL/g at pH 6; drop to 63 mL/g at pH 7; then drop to 0.4 mL/g at pH 8. The actual Kd values for uranium at the site are expected to be higher than these minimum values due to the fine-grained nature of the formations hosting perched groundwater at the site. USEPA (2007) provides maximum Kd for uranium that increase from 5,000 mL/g at pH 4; to 1,000,000 mL/g at pH 6; drop to 630,000 mL/g at pH 7; then drop to 250,000 mg/L at pH 8. The actual uranium Kd values for the Mill are expected to lie within the ranges of minimum and maximum Kd specified in USEPA (2007). Conversely, Kd for anions such as chloride and nitrate are expected to be negligible.

In order to impact groundwater at MW-11, any solution seeping from the TMS would have to penetrate more than 60 feet of vadose materials, then migrate within perched groundwater toward MW-11. Because, as discussed above, the expected Kd for uranium is at least one or more orders of magnitude higher than the expected (negligible) Kd for chloride and nitrate, the substantial retardation of uranium with respect to chloride and nitrate that would occur would prevent the nearly simultaneous increases in all three constituents that have been measured. The only condition that would allow simultaneous increases in constituents with substantially different Kd would be a 'fast pathway' that could conduct TMS solution directly to the immediate vicinity of MW-11 without sorption or any other significant attenuation process. However, if such a 'fast pathway' existed, then nearly simultaneous increases in *all* TMS constituents would occur, rather than just a few. In particular, iron, which typically has the highest measured concentrations in the TMS, would be expected to increase substantially; yet, as discussed above and as shown in Figure 7, iron at MW-11 has *decreased* in concentration since the first quarter of 2012 and has not been detected since the third quarter of 2018.

Recent (post-2018) increases in uranium are attributable to mobilization of naturally-occurring uranium by nitrate (Asta et al, 2020; Senko et al, 2002; and Senko et al, 2005) and to oxidation of pyrite by nitrate (Section 3.1.1). Similar to manganese, and as discussed above, uranium can exist as a contaminant in pyrite (Descotes et al 2010; Glizaud, 2006). As discussed above and in EFRI (2021) bottle-roll test solutions initially consisting of laboratory-grade DI water generated between 25 µg/L and 3,420 µg/L uranium from 'generic' pyrite samples. Bottle-roll tests using pyrite-bearing core from the formation hosting perched groundwater at the site yielded bottle-roll solutions having as much as 6,700 µg/L uranium. Because nitrate oxidation of pyrite can proceed by a pathway that consumes rather than produces acid, and there is sufficient nitrate to produce the measured uranium, recently increasing uranium at MW-11 can result from pyrite oxidation with stable to increasing pH.

3.4 Mass Balance Analyses

Since 1990, water levels at MW-11 have risen by more than 17 feet, and the saturated thickness has increased from approximately 29.8 to 47.1 feet. TMS solutions contain chloride, a conservative solute, at an average concentration exceeding 28,000 mg/L. If the water level changes at MW-11 were due to potential TMS seepage, and resulted in a mixture containing approximately 37 % TMS solution, chloride concentrations at MW-11 would exceed 10,000 mg/L, rather than the fourth quarter, 2021 value of approximately 53 mg/L. Similarly, based on the average concentrations (since 2003) in TMS solutions, the fluoride concentration would exceed 1,200 mg/L (rather than the fourth quarter, 2021 value of approximately 0.38 mg/L); the sulfate concentration would exceed 69,000 mg/L (rather than the fourth quarter, 2021 value of approximately 1,360 mg/L); the uranium concentration would exceed 148,000 ug/L (rather than the fourth quarter, 2021 value of approximately 2.1 ug/); and the manganese concentration would exceed 244,000 ug/L rather than the fourth quarter, 2021 value of 286 ug/L).These calculations demonstrate that the observed increases in water levels at MW-11 do not result from potential TMS seepage.

In addition, as discussed above, fluoride concentrations at MW-11 are decreasing (Figure 3 and Appendix C). Because fluoride is a relatively mobile anion, and, after chloride, is the next most useful indicator parameter, the decreasing trend demonstrates that MW-11 cannot be impacted by potential TMS seepage. Overall, the mass balance analyses and geochemical considerations demonstrate that potential TMS seepage is not a contributor to the groundwater chemistry at MW-11.

3.5 Summary of Results

As will be discussed below, increases in manganese and sulfate at MW-11 are the result of background conditions unrelated to disposal of materials to the TMS.

3.5.1 Manganese and Sulfate at MW-11

Manganese and sulfate were both increasing in MW-11 at the time of the Hurst and Solomon (2008) isotopic investigation which included MW-11 in its analysis and concluded that there were no impacts to groundwater from the TMS; therefore, increases in sulfate and manganese are the result of background conditions unrelated to disposal of materials to the TMS. Decreasing fluoride and increasing pH (since 2016) also indicate that MW-11 groundwater is unimpacted by the TMS.

Increasing sulfate and manganese are both attributable to oxidation of naturally-occurring pyrite which releases sulfate as well as manganese that exists as a contaminant in pyrite. Prior to 2016, during the time when pH at MW-11 was trending downward, oxidation of pyrite was likely caused by oxygen introduced into the groundwater near MW-11 via various mechanisms (as discussed above). Oxidation of pyrite by oxygen releases acid as well as sulfate. However, post-2016, nitrate oxidation of pyrite likely became dominant as the effects of the nitrate/chloride plume became increasingly important. As discussed in Section 3.1.2, oxidation of pyrite by nitrate can occur via a mechanism that consumes rather than produces acid, thus releasing manganese without a corresponding pH decrease.

In addition, manganese likely contained within carbonate cement within the Burro Canyon Formation hosting the monitored perched groundwater at the site can be released by acid produced via pyrite oxidation. Such a mechanism could continue even accompanied by an overall pH increase provided it occurs within sufficiently localized regions.

3.5.2 Summary of Factors Demonstrating no Impact to MW-11 From the TMS

The following factors indicate that changes in constituent concentrations at MW-11 do not result from potential TMS seepage:

1. Key indicator parameter fluoride is decreasing.
2. pH has been stable to increasing since 2016.
3. Iron (which is the constituent having the highest concentration in the TMS) has been decreasing since the first quarter of 2012.
4. Statistically significant increasing trends in sulfate and manganese were present in MW-11 at the time of the Hurst and Solomon (2008) isotopic investigation report which included MW-11 in its analysis and that concluded there were no impacts to groundwater from the TMS, indicating that these trends are not the result of potential TMS seepage. Trends in both constituents are attributable to oxidation of naturally-occurring pyrite at the site. In addition, manganese may be released from carbonate cement; and sulfate may be released by gypsum and anhydrite.
5. Although not within the plume, concurrently increasing chloride and nitrate at MW-11 since 2018 result from the increasing influence of the nitrate/chloride plume. The increasing influence of the nitrate/chloride plume, which originates approximately 1,000 feet upgradient of the TMS, results from continued downgradient migration of the plume towards MW-11. One consequence of the increasing nitrate is mobilization of naturally-occurring uranium at MW-11.
6. Because uranium is substantially less mobile than nitrate or chloride at the near-neutral pH conditions at MW-11, concurrently increasing uranium, nitrate, and chloride indicate geochemical changes in the immediate vicinity of MW-11 (caused in part by the increasing influence of the nitrate/chloride plume) rather than transport from a remote source such as the TMS.
7. Increasing water levels are expected to impact the MW-11 groundwater chemistry and contribute to trends in dissolved constituents.
8. Mass balance analysis indicates that water level increases at MW-11 are unrelated to potential TMS seepage.

3.5.3 Revised GWCLs

Because increasing concentrations of manganese and sulfate are not the result of potential TMS seepage, revised GWCLs for these parameters are proposed. Section 4 presents the methods used to calculate GWCLs using a modified approach for trending constituents, in accordance with the Flowsheet.

4.0 CALCULATIONS OF GROUNDWATER COMPLIANCE LIMITS

Because manganese and sulfate concentrations in MW-11 are increasing significantly (**Appendix A-1**, and **A-11**), the Flowsheet (**Appendix D**) dictates that a modified approach should be used to calculate a GWCL. This section describes the rationale used to select a modified approach to calculating a GWCL for manganese and sulfate in MW-11.

4.1 Modified Approach to Calculation of GWCLs for Trending Constituents

According to the DWMRC-approved Flowsheet, if an increasing trend is present, a modified approach should be considered for determining GWCLs. The modified approach used for manganese and sulfate includes calculating a revised GWCL by selecting the greater of (1) mean + 2 standard deviations, (2) highest historical value, or (3) mean x 1.25 using a complete dataset or subset of the data defined by a point of inflection to determine representative and appropriate GWCLs for trending constituents.

Manganese and sulfate both exhibit significantly increasing trends that can be attributed to pyrite oxidation. The modified approach for calculating a revised manganese GWCL includes selecting the highest historical value of the complete data set. For manganese, the highest historical value, which is greater than the mean + 2 standard deviations or the mean x 1.25, is selected as the proposed GWCL. The highest historical value was recorded recently and concentrations of manganese are likely to continue to increase, therefore regular evaluation and revision of this GWCL will be necessary to minimize unwarranted out-of-compliance status.

The mobility of manganese and sulfate in groundwater is sensitive to changes in pH as described in Section 3.1. pH trends in MW-11 were decreasing prior to 2016 and are increasing after 2016. This point of inflection (January 1, 2016) identified in the pH data informed the data set used to calculate a revised GWCL for sulfate. The modified approach for the sulfate GWCL includes multiplying 1.25 times the background concentration as defined in UAC R317-6-4.5-B.3 using a subset of data to determine representative and appropriate GWCLs for trending constituents.

The UAC R317-6-4.5 recognizes that "contaminants" may be present as part of naturally occurring background conditions. In this rule, background concentration is defined as the "concentration of a pollutant in ground water upgradient or lateral hydraulically equivalent point from a facility, practice or activity which has not been affected by that facility, practice or activity." Background at the Mill has been determined on an intra-well basis, as defined in the Background Reports. Therefore, to be conservative, the mean concentration is used as background for the purposes of this calculation.

GWCLs using a modified approach decreases the likelihood of false positives (exceedances) associated with increasing trends related to natural background conditions including site-wide oxidation of pyrite. The proposed GWCLs maintain the intra-well approach that has been established for compliance at the Mill, combining elements from the Flowsheet and from previously approved GWCLs calculated using a modified approach. The flowsheet calculations and the proposed GWCLs using the modified approach, are presented in **Appendix A-1** and **Table 1**, respectively.

4.2 Proposed Revised GWCLs

GWCLs determined according to the Flowsheet are presented in **Table 1.**

Table 1
Proposed Revised GWCLs for MW-11

Parameter	Current GWCL	Modified Approach Proposed GWCL	Rationale
Manganese (ug/L)	237	376	Highest historical value
Sulfate (mg/L)	1309	1493.6	Post January 1, 2016 Mean x 1.25

5.0 CONCLUSIONS AND RECOMMENDATIONS

The Mill site was recently thoroughly studied in the Background Reports (INTERA, 2007a, 2007b, 2008), in various SARs, and in the University of Utah Study (Hurst and Solomon, 2008). The Background Reports (INTERA, 2007a, 2007b, 2008) and the University of Utah Study concluded that groundwater at the Mill site, including in MW-11, has not been impacted by Mill operations. Both of those studies also acknowledged that there are natural influences at play at the Mill site that have given rise to increasing trends and general variability of background groundwater at the Mill site.

The focus of this SAR was, therefore, to identify any changes in the circumstances identified in those studies. Evaluation of SAR parameters and indicator parameters in MW-11 were performed in accordance with the DWMRC-approved Flowsheet (**Appendix D**). Manganese in MW-11 has exhibited a significantly increasing trend since the time of the Existing Wells Background Report (INTERA, 2007a). Although indicator parameters chloride, sulfate and uranium exhibit significantly increasing trends, fluoride is significantly decreasing. Nearly simultaneous increases in chloride and nitrate are caused by migration of the nitrate/chloride plume (which extends approximately 1,000 feet upgradient of the TMS) toward MW-11. Stable to increasing pH (since 2016) and decreasing fluoride indicate that MW-11 is unimpacted by the TMS.

In addition, manganese and sulfate were already increasing at the time that the University of Utah study which included MW-11 in its analysis, concluded that there were no impacts to groundwater from the TMS; and iron, the metal that exists at the highest concentrations in the TMS solutions, has been decreasing since the first quarter of 2012. Both factors indicate there are no impacts from the TMS. Furthermore, mass balance analysis indicates that increases in water levels at MW-11 are unrelated to any potential seepage from the TMS.

EFRI recommends adopting the revised GWCLs for MW-11 in accordance with the Flowsheet. Regular revisions to GWCLs are consistent with the USEPA Unified Guidance (USEPA, 2009). Such revisions account for variability in larger datasets and minimize unwarranted out-of-compliance status.

6.0 SIGNATURE AND CERTIFICATION

This document was prepared by Energy Fuels Resources (USA) Inc.

Energy Fuels Resources (USA) Inc.

By:

Scott A. Bakken Vice President, Regulatory Affairs	3/7/22 Date

Certification:

I certify, under penalty of law, that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Scott A. Bakken
Vice President, Regulatory Affairs
Energy Fuels Resources (USA) Inc.

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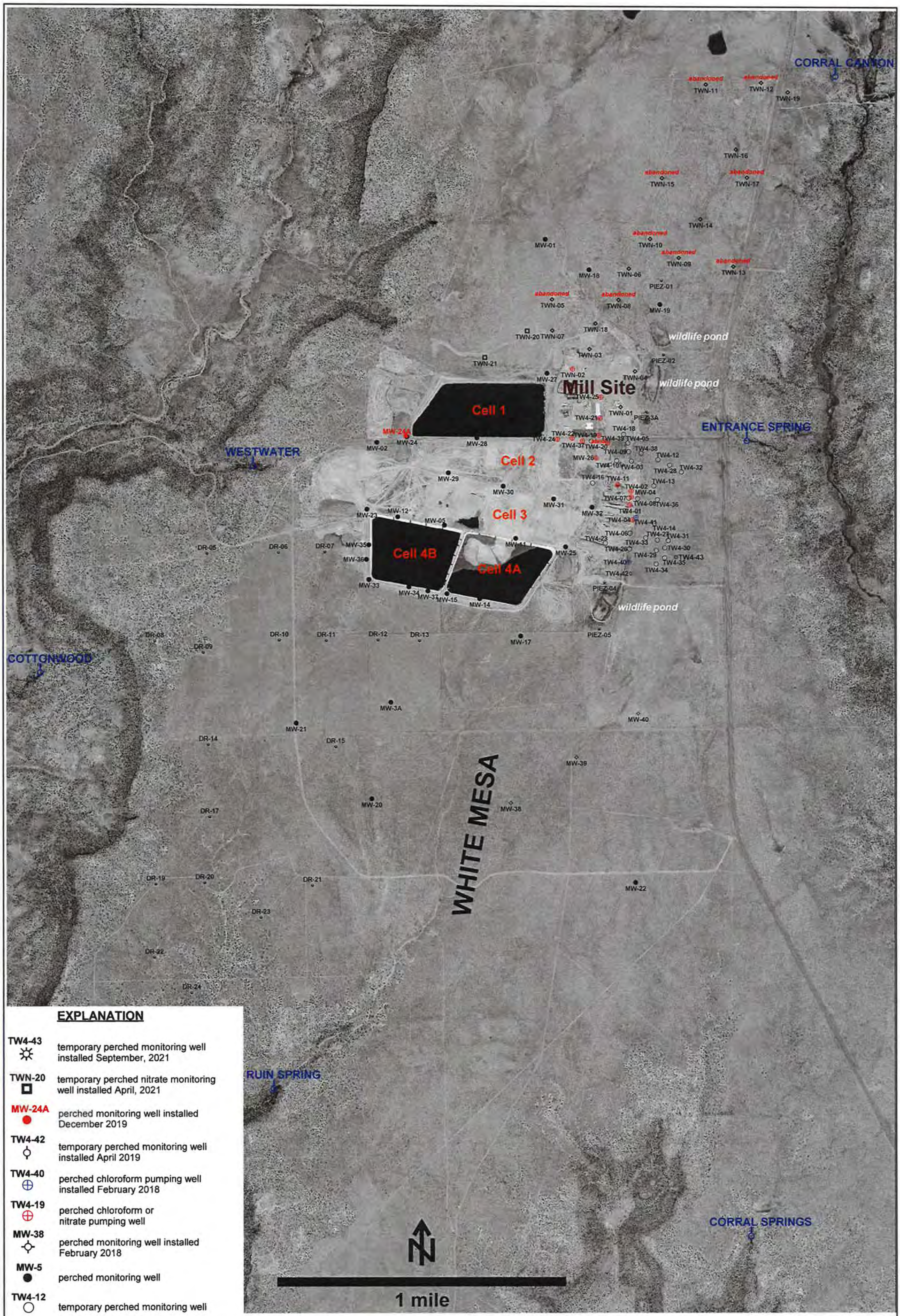
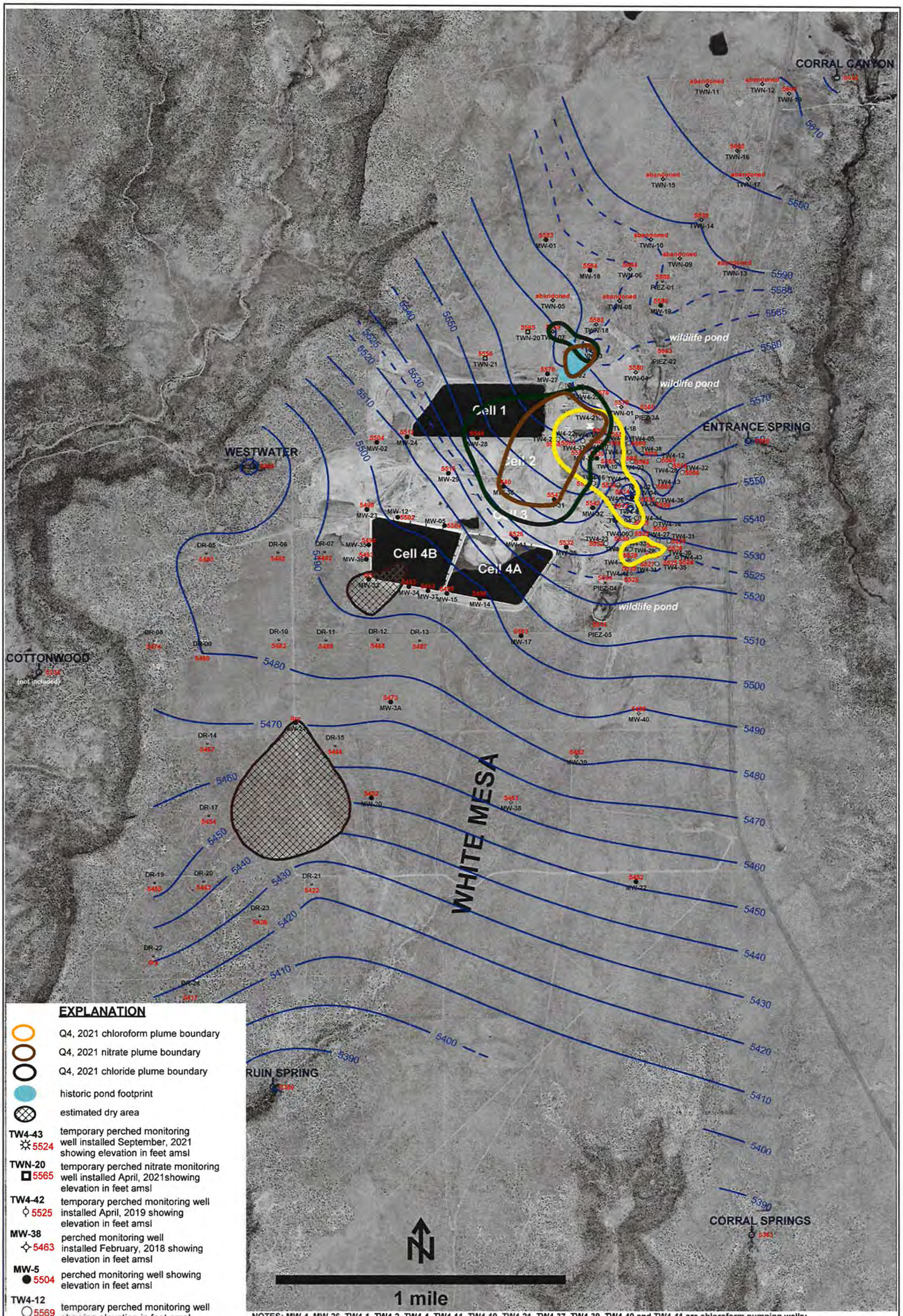
FIGURES



HYDRO GEO CHEM, INC.

WHITE MESA SITE PLAN SHOWING LOCATIONS OF PERCHED WELLS AND PIEZOMETERS

APPROVED	DATE	REFERENCE	FIGURE
		H:/718000/MW11/ MW11_SAR_2022/figures/Uwelloc1221.srf	1A

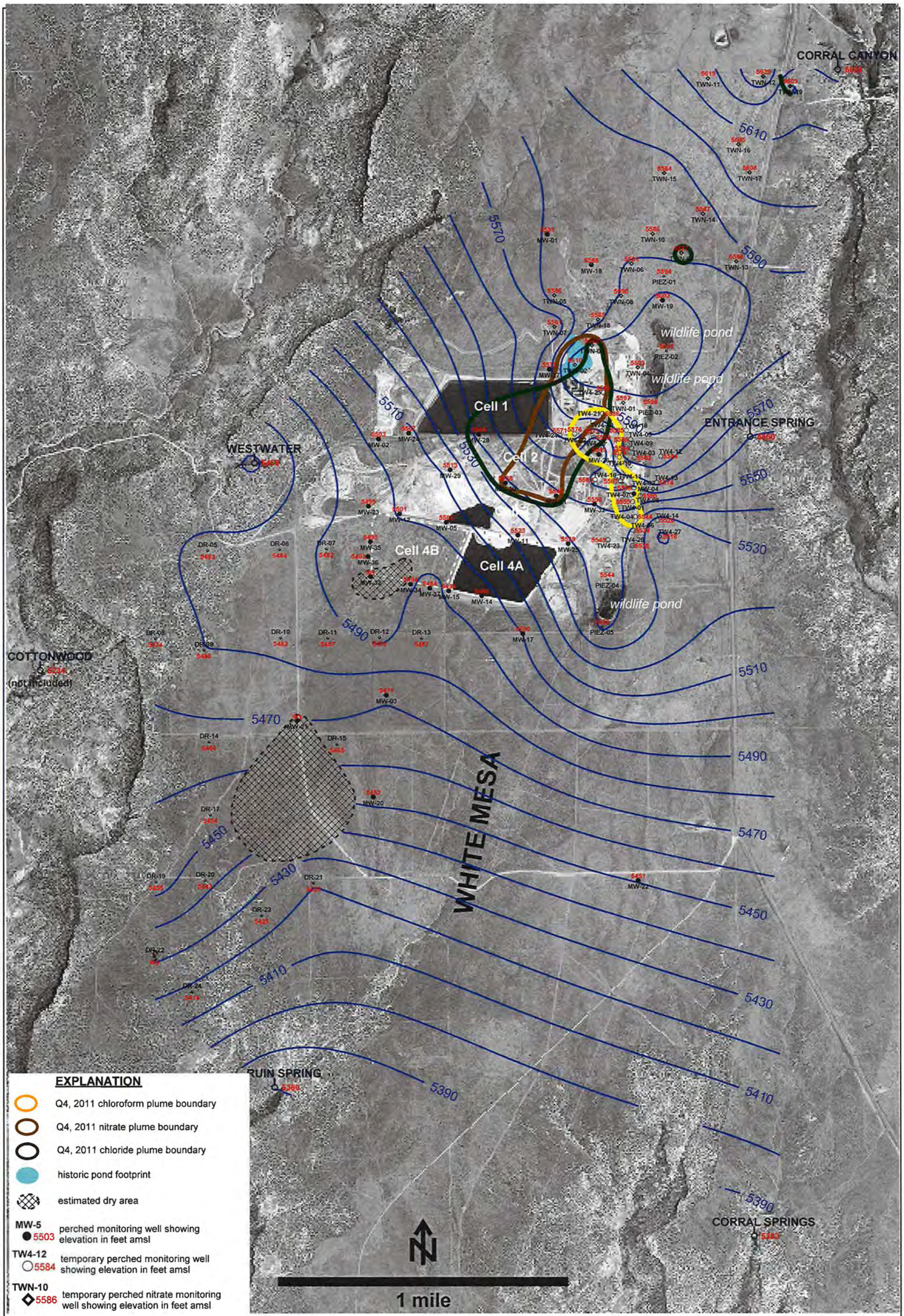


NOTES: MW-4, MW-26, TW4-1, TW4-2, TW4-4, TW4-11, TW4-19, TW4-21, TW4-37, TW4-39, TW4-40 and TW4-41 are chloroform pumping wells; TW4-22, TW4-24, TW4-25 and TWN-2 are nitrate pumping wells; TW4-1, TW4-2 and TW4-11 water levels are below the base of the Burro Canyon Formation

HYDRO GEO CHEM, INC.

KRIGED 4th QUARTER 2021WATER LEVELS AND PLUME BOUNDARIES WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
		H:/718000/MW11/ MW11_SAR_2022/figures/UwlPlumes4Q21.srf	1B

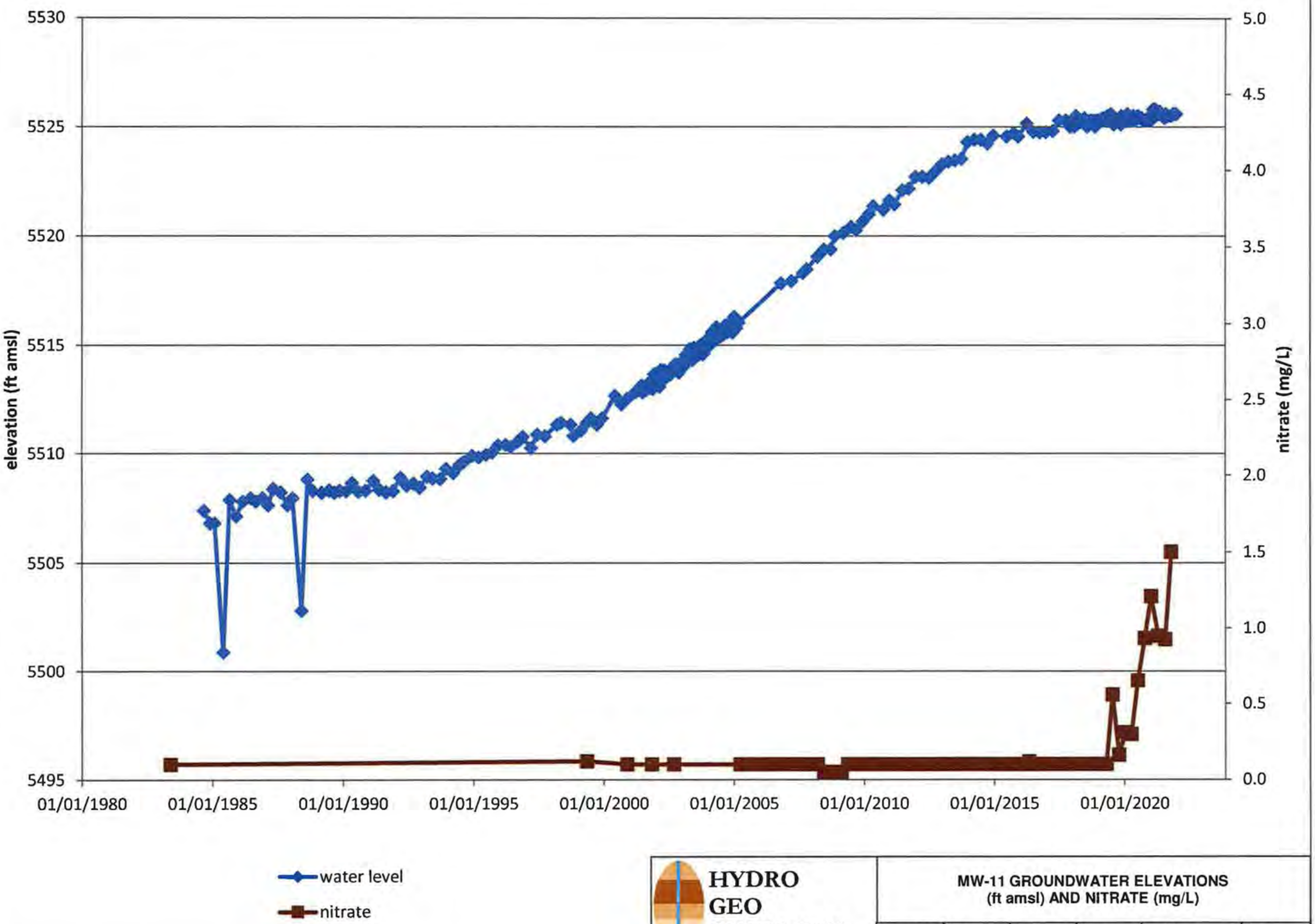


NOTE: MW-4, MW-26, TW4-4, TW4-19, and TW4-20 are pumping wells

HYDRO GEO CHEM, INC.

KRIGED 4th QUARTER, 2011 WATER LEVELS AND PLUME BOUNDARIES WHITE MESA SITE

APPROVED	DATE	REFERENCE	FIGURE
		H:/718000/MW11/ MW11_SAR_2022/Figures/Uwl_Plumes_4Q11.srf	1C

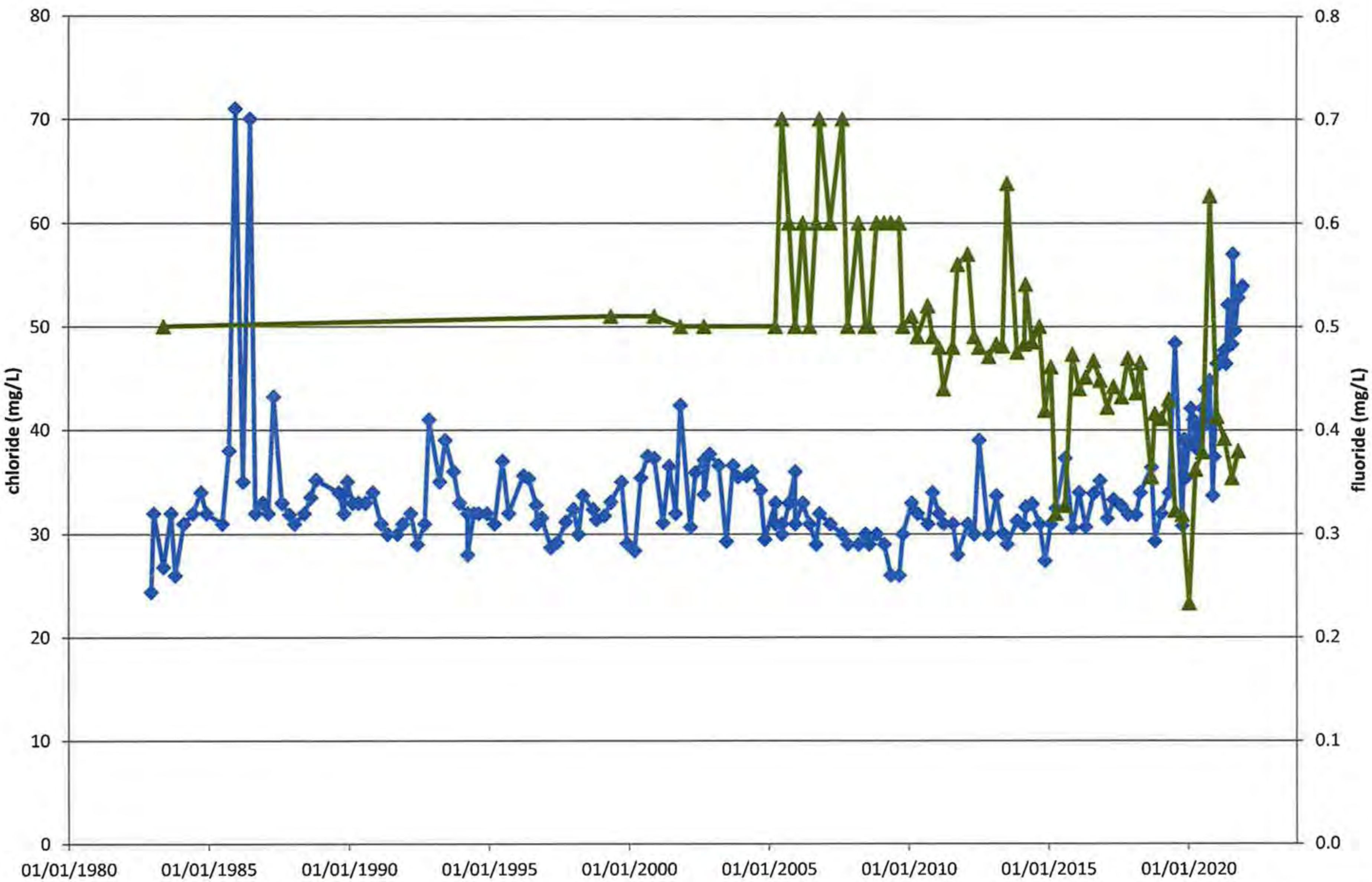


HYDRO GEO CHEM, INC.

MW-11 GROUNDWATER ELEVATIONS (ft amsl) AND NITRATE (mg/L)

Approved	Date	Author	Date	File Name	Figure
SJS	2/21/22	SJS	2/21/22	F2 WL and no3	2

H:\718000\MW11\MW11_SAR_2022\figures\MW11_AllAnalyt_WL_field_123121.xlsx: F2 WL and NO3

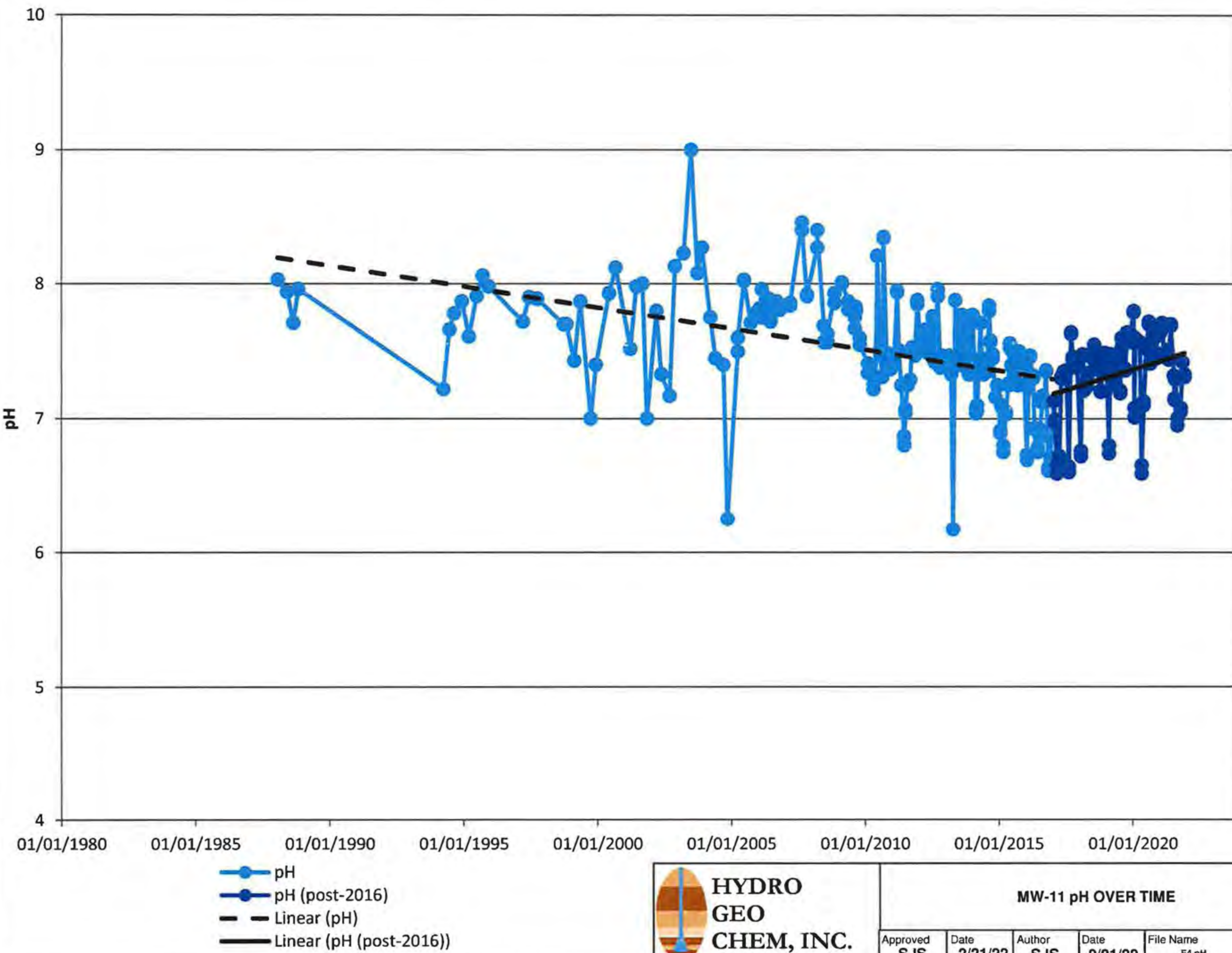


HYDRO GEO CHEM, INC.

MW-11 CHLORIDE (mg/L) AND FLUORIDE (mg/L) OVER TIME

Approved	Date	Author	Date	File Name	Figure
SJS	2/21/22	SJS	2/21/22	F3 CL and F	3

H:\718000\MW11\MW11_SAR_2022\figures\MW11_AllAnalyt_WL_field_123121.xlsx: F3 Cl and F

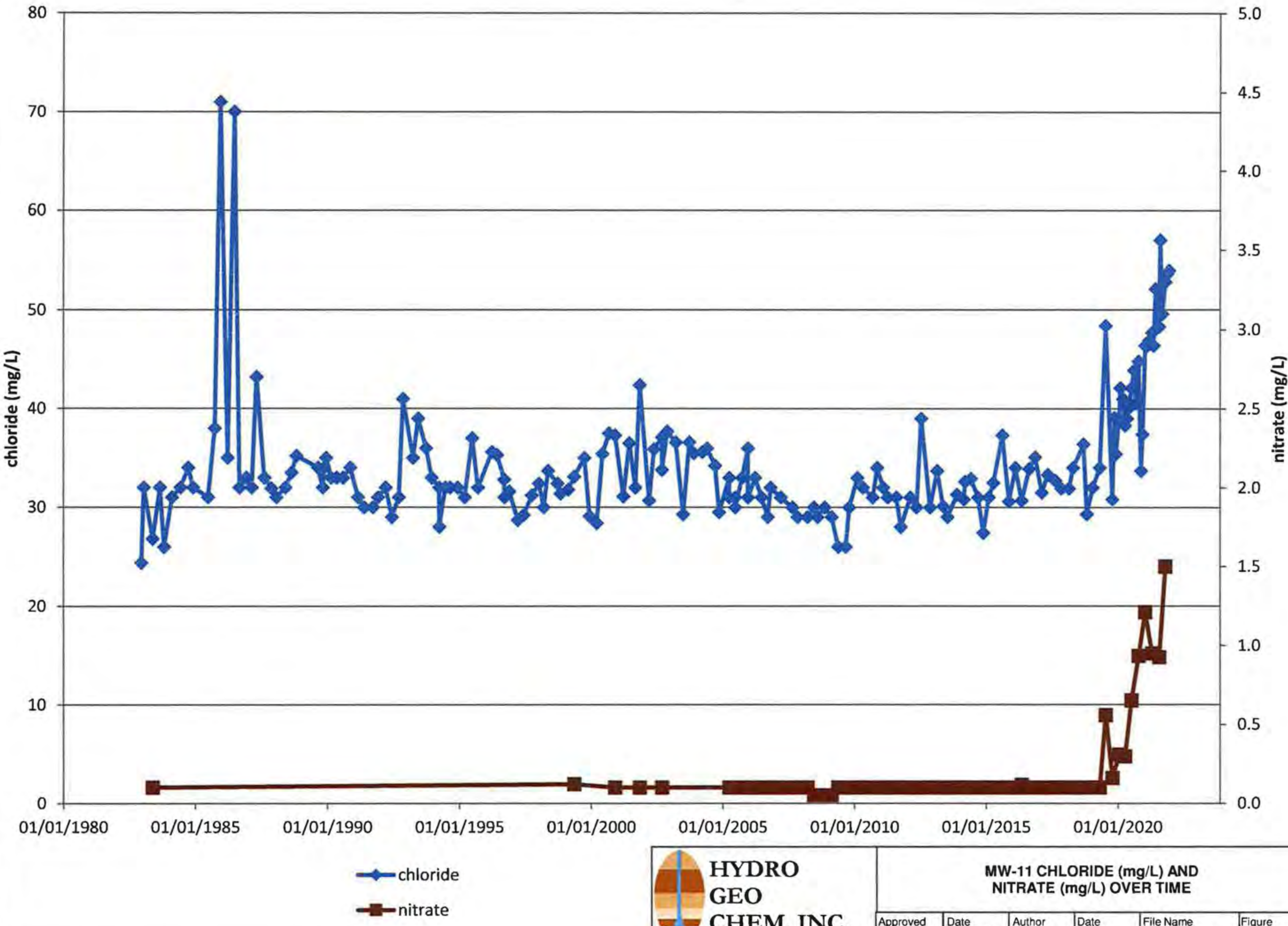


HYDRO GEO CHEM, INC.

MW-11 pH OVER TIME

Approved	Date	Author	Date	File Name	Figure
SJS	2/21/22	SJS	2/21/22	F4 pH	4

H:\718000\MW11\MW11_SAR_2022\figures\MW11_AllAnalyt_WL_field_123121.xlsx: F4 pH

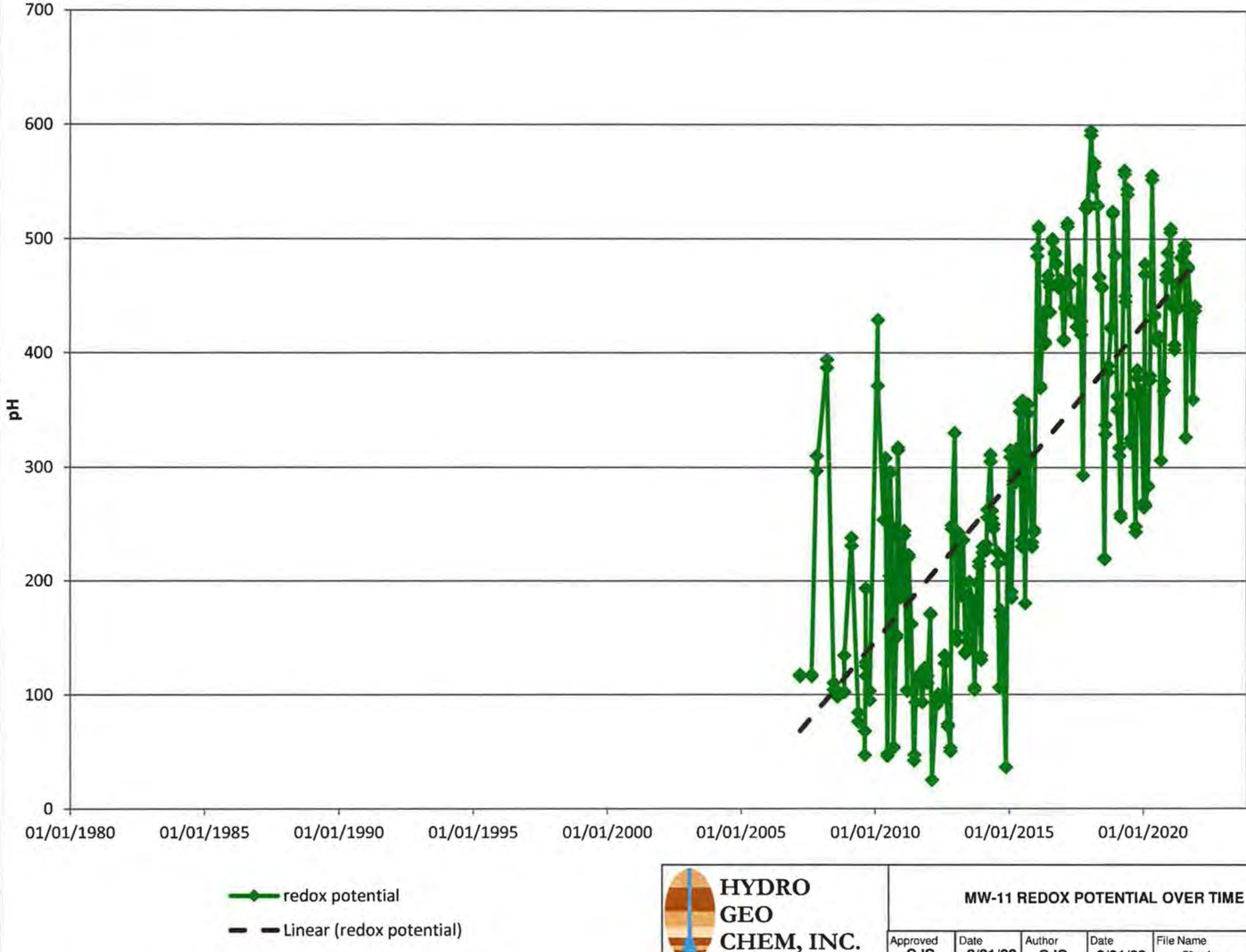


HYDRO GEO CHEM, INC.

MW-11 CHLORIDE (mg/L) AND NITRATE (mg/L) OVER TIME

Approved	Date	Author	Date	File Name	Figure
SJS	2/21/22	SJS	2/21/22	F5 CL and NO3	5

H:\718000\MW11\MW11_SAR_2022\figures\MW11_AllAnalyt_WL_field_123121.xlsx: F5 Cl and NO3

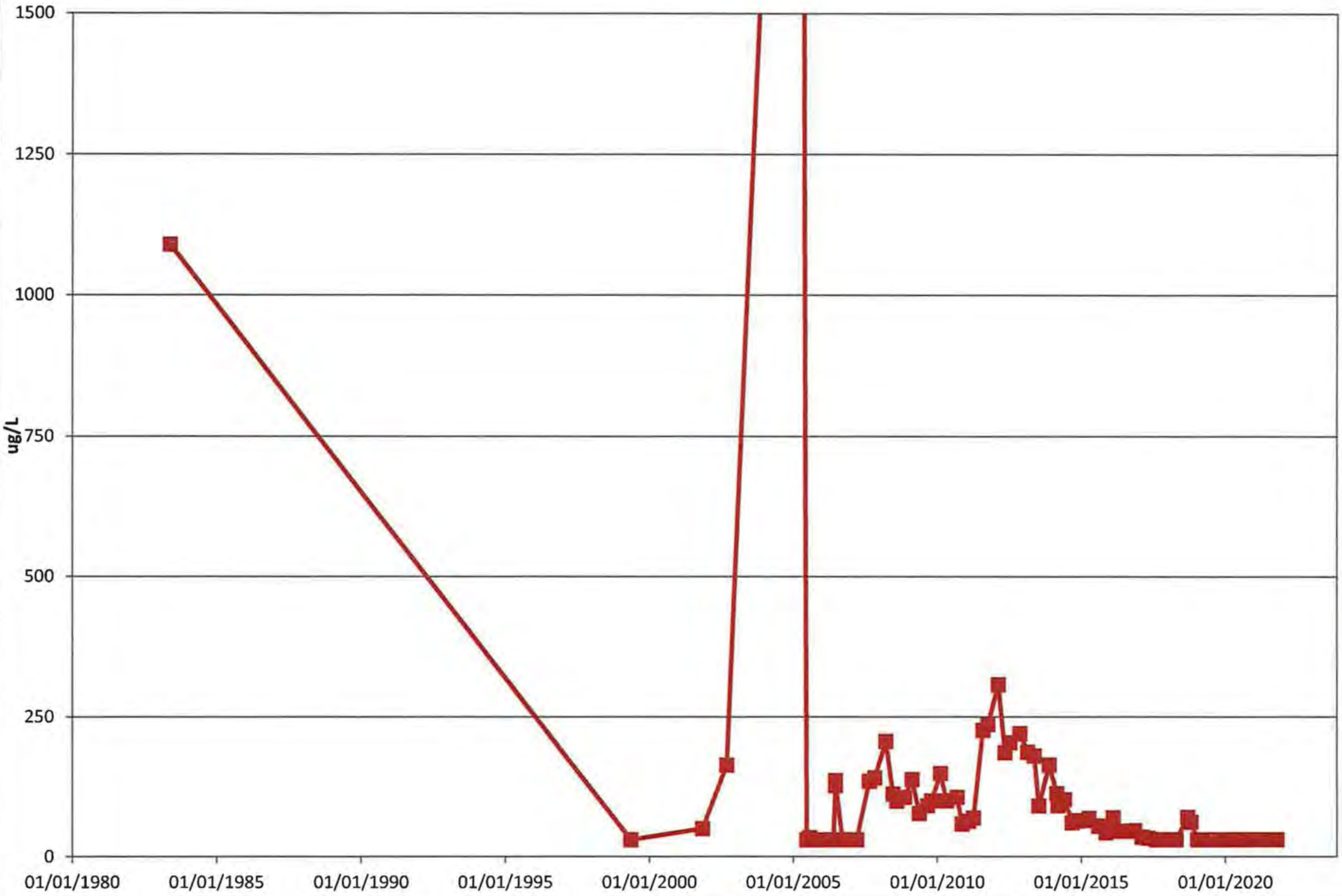


HYDRO GEO CHEM, INC.

MW-11 REDOX POTENTIAL OVER TIME

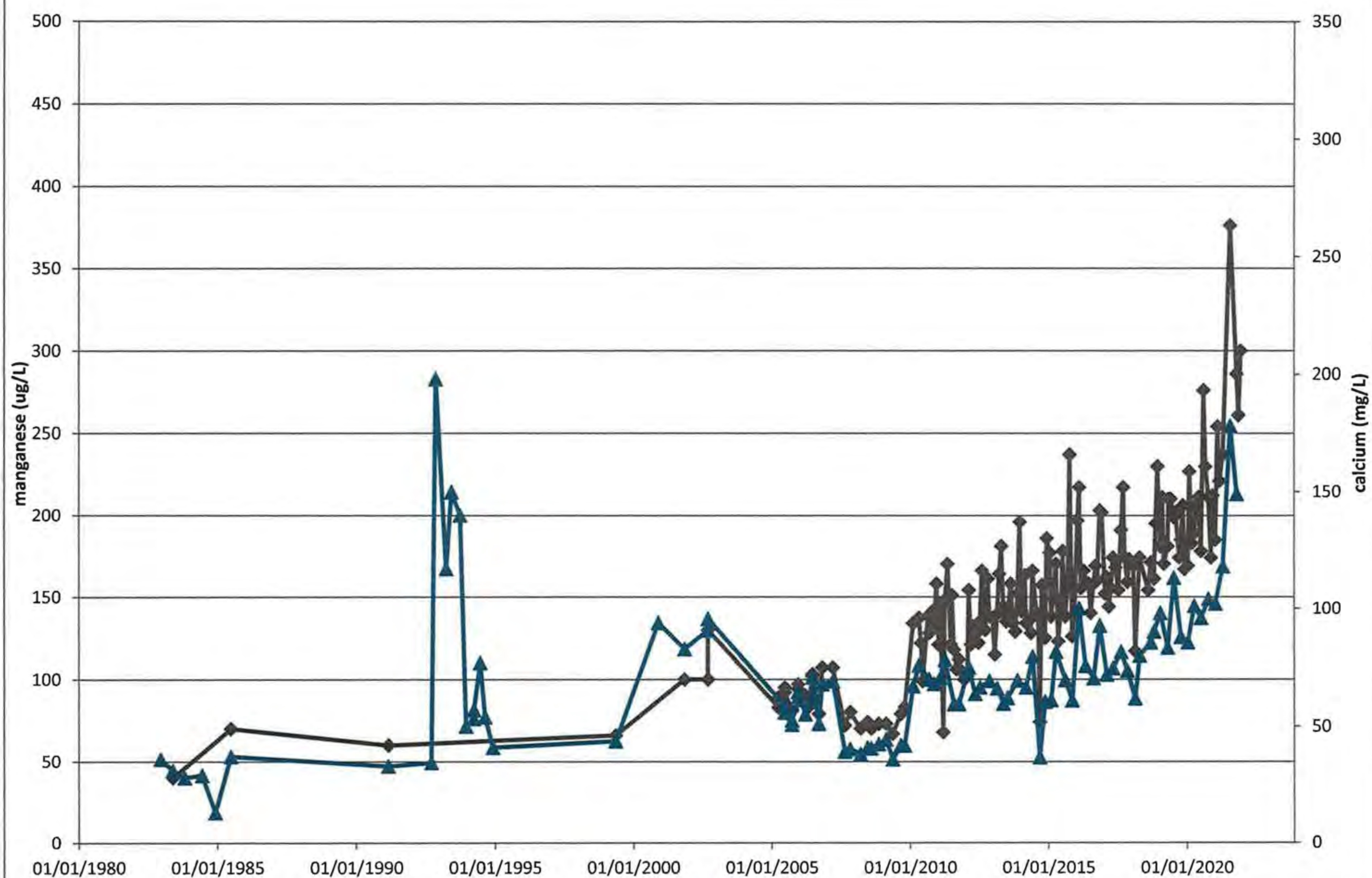
Approved	Date	Author	Date	File Name	Figure
SJS	2/21/22	SJS	2/21/22	F6 redox	6

H:\718000\MW11\MW11_SAR_2022\figures\MW11_AllAnalyt_WL_field_123121.xlsx: F6 redox



HYDRO GEO CHEM, INC.	MW-11 IRON (ug/L) OVER TIME					
	Approved SJS	Date 2/21/22	Author SJS	Date 2/21/22	File Name F7 Fe	Figure 7

H:\718000\MW11\MW11_SAR_2022\figures\MW11_AllAnalyt_WL_field_123121.xlsx: F7 Fe

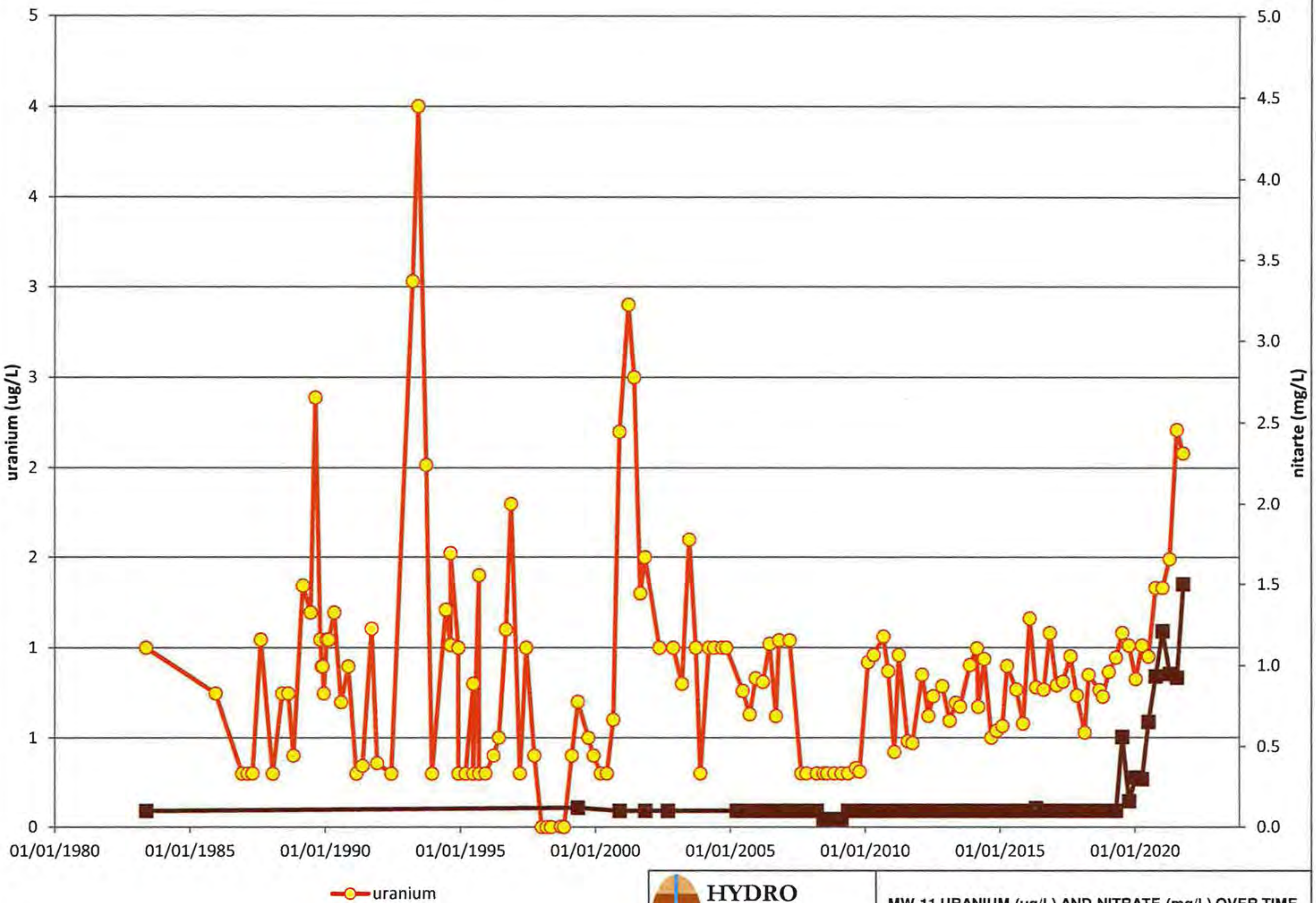


HYDRO GEO CHEM, INC.

MW-11 MANGANESE (ug/L) AND CALCIUM (mg/L)

Approved	Date	Author	Date	File Name	Figure
SJS	2/21/22	SJS	2/21/22	F8 Mn and Ca	8

H:\718000\MW11\MW11_SAR_2022\figures\MW11_AllAnalyt_WL_field_123121.xlsx: F8 Mn and Ca



HYDRO GEO CHEM, INC.

MW-11 URANIUM (ug/L) AND NITRATE (mg/L) OVER TIME

Approved	Date	Author	Date	File Name	Figure
SJS	2/21/22	SJS	2/21/22	F9 U and NO3	9

H:\718000\MW11\MW11_SAR_2022\figures\MW11_AllAnalyt_WL_field_123121.xlsx: F9 U and NO3

APPENDICES

APPENDIX A

Appendix A-1: Summary of Statistical Analysis for Out of Compliance Constituents in MW-11

Well	Data Set	Constituent	Units	N	% Non-Detected Values	Mean	Standard Deviation	Shapiro-Wilk Test for Normality		Normally or Lognormally distributed?	Mann Kendall Trend Analysis		Linear Trend Analysis		Significant Trend	Previously Identified Increasing Trend?	Current GWCL	Mean + 2σ	Mean x 1.25	Highest Historical Value (HHV)	Fractional Approach GWCL	Flowsheet GWCL	Rationale	Modified GWCL	Rationale
								W	p		S	p	r^2	p											
MW-11	ALL 2022 SAR Data	Manganese	µg/L	159	0	151.8	51.2	0.966	6.69E-04	Not Normal	8426	0.00E+00	NA	NA	Increasing	Yes	237	254.22	189.80	376	200	376	HHV	376	HHV
	GWCL Subset Post January 2016[a]	Manganese	µg/L	64	0	193.1	42.4	0.951	1.31E-02	Not normal	985	0.00E+00	NA	NA	Increasing	Yes	237	277.95	241.41	376	200	376	HHV	376	HHV
	ALL 2022 SAR Data	Sulfate	mg/L	153	0	1092.46	141.6	0.945	1.01E-05	Not Normal	6463	0.00E+00	NA	NA	Increasing	Yes	1309	1375.68	1365.57	1507	NA	1507	HHV	1365.6	Mean x 1.25
	GWCL Subset Post January 2016[a]	Sulfate	mg/L	49	0	1194.88	143.05	0.727	0.00	Not normal	464	3.21E-05	NA	NA	Increasing	Yes	1309	1480.99	1493.60	1410	NA	1410	HHV	1493.60	Mean x 1.25

Notes:

σ = sigma
µg/L = micrograms per liter
N = number of valid data points

p = probability
W = Shapiro Wilk test value
S = Mann-Kendall statistic

r^2 = The measure of how well the trendline fits the data where r2=1 represents a perfect fit.
FA= Fraction of GWQS as defined in UAC R317-6
NA= Not Applicable

a = increasing trends identified in pH at MW-11 since about 2016
Distribution = Distribution as determined by the Shapiro-Wilk distribution test for constituents with % Detect > 50% and N>8
Mean = The arithmatic mean as determined for normally or log-normally distributed constituents with % Detect > 50%
Standard Deviation = The standard deviation as determined for normally or log-normally distributed constituents with % Detect > 85%
Highest Historical Value = The highest observed value for constituents with % Detect < 50%
Flowsheet GWCL does not take into account increasing trends

ALL 2022 SAR Data = All data with extremes removed
GWCL Subset Post January 20116 = All data post January 2016

Appendix A-2: Comparison of Calculated and Measured TDS in MW-11

Date Sampled	Alkalinity (mg/L as HCO_3)	Calcium (mg/L)	Chloride (mg/L)	Potassium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)	Measured TDS (mg/L)	Calculated TDS (mg/L)	Ratio
12/16/1982	399	36	24.4	5.7	8.8	550	926	1812	1950	108%
5/24/1983	363	31	26.8	4.7	7.7	530	943	1728	1906	110%
10/26/1983	402	28	26	5.0	6.7	540	922	1697	1930	114%
6/12/1984	330	29	32	5.0	7	530	920	1700	1853	109%
11/27/2000	382	94	37.3	7.6	30.6	487	1140	2130	2179	102%
11/6/2001	375	82.9	42.4	7.9	25.4	574	1150	2100	2258	108%
9/10/2002	372	90.8	33.8	7.4	30	540	1160	1850	2234	121%
6/21/2005	364	58.7	31	6.3	18.2	544	1090	1950	2112	108%
9/22/2005	378	50.7	33	6.3	15.3	551	968	1930	2002	104%
12/13/2005	375	61.2	36	6.8	19.3	544	1070	1930	2112	109%
3/21/2006	381	55.2	33	6.2	16.8	551	1120	1920	2163	113%
6/20/2006	374	62.1	31	7.3	20.1	554	1150	2000	2199	110%
9/13/2006	380	51.1	29	6.7	14.9	558	1060	1910	2100	110%
10/25/2006	378	67.9	32	7.2	21.7	559	1200	1860	2266	122%
3/15/2007	375	69.2	31	7.6	22.1	571	1120	2040	2196	108%
8/21/2007	383	39.2	30	6.2	10.9	668	1060	1800	2197	122%
10/30/2007	378	40.3	29	7.5	11.1	580	1020	1770	2066	117%
3/18/2008	380	38.1	29	6.0	10	606	1040	1750	2109	121%
6/16/2008	356	40.8	30	6.1	10.7	632	1050	1790	2126	119%
8/5/2008	380	40.6	29	6.0	10.6	631	1060	1780	2157	121%
11/10/2008	351	42.4	30	6.2	11	655	1100	1830	2196	120%
2/16/2009	356	44.4	29	6.3	12.4	581	977	1910	2006	105%
5/17/2009	366	36	26	5.9	10	548	1060	1850	2052	111%
8/31/2009	374	41.9	26	6.1	11.2	602	1090	1840	2151	117%
10/19/2009	389	41.8	30	6.0	11.4	641	1040	1830	2159	118%
2/10/2010	410	67	33	6.8	19.7	567	1140	2040	2244	110%
4/28/2010	387	75.9	32	7.1	23.1	642	1150	2040	2317	114%
9/8/2010	410	70	31	7.0	20.9	614	1140	1960	2293	117%
11/11/2010	387	68	34	6.9	20.1	573	1180	2020	2269	112%
2/2/2011	385	70.6	32	6.8	21.2	601	1190	1980	2307	116%
4/4/2011	387	78.2	31	7.3	23.4	622	1140	2070	2289	111%
8/3/2011	347	59.4	31	6.6	17.3	628	1090	1940	2179	112%
10/4/2011	363	59.4	28	6.5	17.3	580	1140	1930	2194	114%
2/13/2012	360	75	31	6.9	22.9	626	1160	2090	2282	109%
5/8/2012	376	63.7	30	7.0	19.3	517	1090	2040	2103	103%
7/11/2012	374	66.5	39	7.4	19.6	618	1080	2020	2205	109%
11/12/2012	372.1	69.3	30	7.0	21.4	562	1110	2050	2172	106%
2/20/2013	380.64	66.1	33.7	7.2	19.6	578	1080	1970	2165	110%
5/14/2013	409.92	59.6	30.1	6.5	18.3	563	763	1820	1850	102%
7/10/2013	401.38	61.9	29	6.6	20.1	538	1240	2010	2297	114%
11/19/2013	373.32	69.5	31.3	6.3	21.2	547	1050	1980	2099	106%
3/11/2014	367.22	66.5	32.6	6.7	21.7	540	904	1940	1939	100%
6/3/2014	417.24	79.5	32.9	6.7	24.9	580	1140	1990	2281	115%
9/8/2014	475.8	36.8	31	6.0	10.9	542	1030	1930	2133	110%
11/17/2014	323.3	60.4	27.4	6.2	18	643	1140	1840	2218	121%
2/3/2015	373.32	61	31	6.8	19.9	576	1110	1880	2178	116%
4/8/2015	384.3	81.7	32.5	7.0	26.3	621	1170	2010	2323	116%
8/10/2015	402.6	69.7	37.3	6.8	21	554	1050	1960	2141	109%
11/11/2015	378.2	60.9	30.6	5.9	18.3	554	1220	1790	2268	127%
2/8/2016	390.4	100	34	7.0	31.8	582	1160	2090	2305	110%
5/3/2016	369.66	75.6	30.7	7.0	23.8	613	1200	2000	2320	116%
8/16/2016	363.56	70.5	33.9	7.1	22.2	608	1160	2070	2265	109%
11/7/2016	375.76	92.7	35.1	7.1	29.2	537	1290	2100	2367	113%
2/8/2017	367.22	71.9	31.5	7.6	22.9	608	1050	1920	2159	112%
5/2/2017	363.56	74.6	33.3	6.9	25.1	568	1140	1970	2211	112%

Appendix A-2: Comparison of Calculated and Measured TDS in MW-11

Date Sampled	Alkalinity (mg/L as HCO_3)	Calcium (mg/L)	Chloride (mg/L)	Potassium (mg/L)	Magnesium (mg/L)	Sodium (mg/L)	Sulfate (mg/L)	Measured TDS (mg/L)	Calculated TDS (mg/L)	Ratio
8/15/2017	373.32	81.6	32.7	7.0	26	595	1360	1990	2476	124%
11/7/2017	380.64	73.5	31.9	6.7	23.1	575	1060	2020	2151	106%
2/20/2018	381.86	61.7	31.9	6.5	18.1	583	1120	1880	2203	117%
4/18/2018	373.32	80	34	7.2	26.3	567	1110	1980	2198	111%
9/11/2018	373.32	85.5	36.4	7.1	27	665	1160	1960	2354	120%
10/25/2018	424.56	90.2	29.3	7.2	26.9	670	1190	1880	2438	130%
1/15/2019	392.84	97.9	32	7.3	30.1	658	1150	2040	2368	116%
4/24/2019	385.52	83.4	34	7.3	27.1	608	1160	1890	2305	122%
7/16/2019	375.76	113	48.4	8.0	38	641	1410	1890	2634	139%
10/15/2019	458.72	87.9	30.8	8.0	27.2	525	1290	2100	2428	116%
1/15/2020	378.2	85.6	38.9	7.8	28.2	572	1180	1920	2291	119%

Appendix A-3: Charge Balance Calculations for Major Cations and Anions in MW-11

Well	Date	Calcium (meq/L)	Sodium (meq/L)	Magnesium (meq/L)	Potassium (meq/L)	Total Cation Charge (meq/L)	HCO_3 (meq/L)	Chloride (meq/L)	SO_4 (meq/L)	Total Anion Charge (meq/L)	Charge Balance Error
MW-11	12/16/1982	1.80	23.92	0.72	0.15	**26.59**	-6.54	-0.69	-19.28	**-26.51**	-0.54%
MW-11	5/24/1983	1.55	23.05	0.63	0.12	**25.35**	-5.95	-0.76	-19.63	**-26.34**	5.53%
MW-11	10/26/1983	1.40	23.49	0.55	0.13	**25.56**	-6.59	-0.73	-19.20	**-26.52**	3.30%
MW-11	6/12/1984	1.45	23.05	0.58	0.13	**25.20**	-5.41	-0.90	-19.15	**-25.47**	0.71%
MW-11	11/27/2000	4.69	21.18	2.52	0.19	**28.59**	-6.26	-1.05	-23.74	**-31.05**	11.68%
MW-11	11/6/2001	4.14	24.97	2.09	0.20	**31.40**	-6.15	-1.20	-23.94	**-31.28**	1.67%
MW-11	9/10/2002	4.53	23.49	2.47	0.19	**30.68**	-6.10	-0.95	-24.15	**-31.20**	3.30%
MW-11	6/21/2005	2.93	23.66	1.50	0.16	**28.25**	-5.97	-0.87	-22.69	**-29.53**	2.02%
MW-11	9/22/2005	2.53	23.97	1.26	0.16	**27.92**	-6.19	-0.93	-20.15	**-27.28**	1.31%
MW-11	12/13/2005	3.05	23.66	1.59	0.17	**28.48**	-6.15	-1.02	-22.28	**-29.44**	1.70%
MW-11	3/21/2006	2.75	23.97	1.38	0.16	**28.26**	-6.24	-0.93	-23.32	**-30.49**	-0.58%
MW-11	6/20/2006	3.10	24.10	1.65	0.19	**29.04**	-6.13	-0.87	-23.94	**-30.95**	1.35%
MW-11	9/13/2006	2.55	24.27	1.23	0.17	**28.22**	-6.23	-0.82	-22.07	**-29.12**	4.84%
MW-11	10/25/2006	3.39	24.31	1.79	0.18	**29.67**	-6.19	-0.90	-24.98	**-32.08**	2.49%
MW-11	3/15/2007	3.45	24.84	1.82	0.19	**30.30**	-6.15	-0.87	-23.32	**-30.34**	1.41%
MW-11	8/21/2007	1.96	29.06	0.90	0.16	**32.07**	-6.28	-0.85	-22.07	**-29.19**	-2.28%
MW-11	10/30/2007	2.01	25.23	0.91	0.19	**28.34**	-6.19	-0.82	-21.24	**-28.25**	3.89%
MW-11	3/18/2008	1.90	26.36	0.82	0.15	**29.24**	-6.23	-0.82	-21.65	**-28.70**	2.62%
MW-11	6/16/2008	2.04	27.49	0.88	0.16	**30.56**	-5.83	-0.85	-21.86	**-28.54**	4.07%
MW-11	8/5/2008	2.03	27.45	0.87	0.15	**30.50**	-6.23	-0.82	-22.07	**-29.12**	-0.57%
MW-11	11/10/2008	2.12	28.49	0.90	0.16	**31.67**	-5.75	-0.85	-22.90	**-29.50**	4.65%
MW-11	2/16/2009	2.22	25.27	1.02	0.16	**28.67**	-5.83	-0.82	-20.34	**-26.99**	2.69%
MW-11	5/17/2009	1.80	23.84	0.82	0.15	**26.61**	-6.00	-0.73	-22.07	**-28.80**	1.00%
MW-11	8/31/2009	2.09	26.19	0.92	0.16	**29.35**	-6.13	-0.73	-22.69	**-29.56**	-0.22%
MW-11	10/19/2009	2.09	27.88	0.94	0.15	**31.06**	-6.37	-0.85	-21.65	**-28.87**	3.18%
MW-11	2/10/2010	3.34	24.66	1.62	0.17	**29.80**	-6.72	-0.93	-23.74	**-31.39**	1.74%
MW-11	4/28/2010	3.79	27.93	1.90	0.18	**33.80**	-6.34	-0.90	-23.94	**-31.19**	1.77%
MW-11	9/8/2010	3.49	26.71	1.72	0.18	**32.10**	-6.72	-0.87	-23.74	**-31.33**	5.07%
MW-11	11/11/2010	3.39	24.92	1.65	0.18	**30.15**	-6.34	-0.96	-24.57	**-31.87**	4.81%
MW-11	2/2/2011	3.52	26.14	1.74	0.17	**31.58**	-6.31	-0.90	-24.78	**-31.99**	0.49%
MW-11	4/4/2011	3.90	27.06	1.93	0.19	**33.07**	-6.34	-0.87	-23.74	**-30.95**	3.98%
MW-11	8/3/2011	2.96	27.32	1.42	0.17	**31.87**	-5.69	-0.87	-22.69	**-29.26**	2.69%
MW-11	10/4/2011	2.96	25.23	1.42	0.17	**29.78**	-5.95	-0.79	-23.74	**-30.47**	-0.52%
MW-11	2/13/2012	3.74	27.23	1.88	0.18	**33.03**	-5.90	-0.87	-24.15	**-30.93**	-1.62%
MW-11	5/8/2012	3.18	22.49	1.59	0.18	**27.43**	-6.16	-0.85	-22.69	**-29.70**	-2.63%
MW-11	7/11/2012	3.32	26.88	1.61	0.19	**32.00**	-6.13	-1.10	-22.49	**-29.72**	-0.02%
MW-11	11/12/2012	3.46	24.45	1.76	0.18	**29.84**	-6.10	-0.85	-23.11	**-30.05**	3.12%
MW-11	2/20/2013	3.30	25.14	1.61	0.18	**30.24**	-6.24	-0.95	-22.49	**-29.67**	-1.68%
MW-11	5/14/2013	2.97	24.49	1.51	0.17	**29.14**	-6.72	-0.85	-15.89	**-23.45**	-0.75%
MW-11	7/10/2013	3.09	23.40	1.65	0.17	**28.31**	-6.58	-0.82	-25.82	**-33.21**	-0.37%
MW-11	11/19/2013	3.47	23.79	1.74	0.16	**29.17**	-6.12	-0.88	-21.86	**-28.86**	0.59%
MW-11	3/11/2014	3.32	23.49	1.79	0.17	**28.76**	-6.02	-0.92	-18.82	**-25.76**	-1.67%
MW-11	6/3/2014	3.97	25.23	2.05	0.17	**31.42**	-6.84	-0.93	-23.74	**-31.50**	3.31%
MW-11	9/8/2014	1.84	23.58	0.90	0.15	**26.46**	-7.80	-0.87	-21.44	**-30.12**	1.95%

Appendix A-4: Descriptive Statistics for Out of Compliance Constituents in MW-11

Data Set	Analyte	Units	% Non-Detects	N	Distribution	Mean	Min. Conc.	Max. Conc.	Std. Dev.	Range	Geometric Mean	Skewness	Q25	Median	Q75
2007 Background Report	Manganese	µg/L	0	16	Normal	87.8	40	130.0	21.8	90.0	84.8	-0.37	74.5	92.0	101.0
2012 SAR	Manganese	µg/L	0	53	Normal	104.9	40	170.0	29.9	130.0	100.5	0.12	79.0	102.0	128.0
2019 SAR	Manganese	µg/L	0	132	Not Normal	138.0	40	237	39.6	197.0	131.6	-0.10	114.3	139.0	163.3
2022 SAR Full	Manganese	µg/L	0	159	Not Normal	151.8	40	376	51.2	336	143.1	0.71	122.0	152	177.5
2007 Background Report	Sulfate	mg/L	0	70	Non Parametric	1014.3	659	1309	99.1	650	1009.6	0.40	951	1000	1060
2012 SAR	Sulfate	mg/L	0	87	Not Normal	1039.0	895	1309	90.8	414	1035.2	0.70	968	1023	1090
2019 SAR	Sulfate	mg/L	0	125	Not Normal	1057.9	561	1507	122.6	946	1050.4	-0.24	976	1060	1140
2022 SAR Full	Sulfate	mg/L	0	153	Not Normal	1092.5	561	1507	141.6	946	1082.9	-0.06	986.0	1090	1170.0

2022 SAR Full = All data with extremes removed

µg/L = micrograms per liter
N = number of valid data points

Appendix A-5: MW-11 Data Used for Analysis

Well	Date Sampled	Parameter Name	Report Result	Report Units	Qualifier
MW-11	5/24/1983	Manganese	40	ug/L	
MW-11	6/28/1985	Manganese	70	ug/L	
MW-11	2/28/1991	Manganese	60	ug/L	
MW-11	5/11/1999	Manganese	66	ug/L	
MW-11	11/6/2001	Manganese	100	ug/L	
MW-11	9/10/2002	Manganese	100	ug/L	
MW-11	9/10/2002	Manganese	130	ug/L	
MW-11	3/30/2005	Manganese	83	ug/L	
MW-11	6/21/2005	Manganese	95	ug/L	
MW-11	9/22/2005	Manganese	81	ug/L	
MW-11	12/13/2005	Manganese	94	ug/L	
MW-11	3/21/2006	Manganese	90	ug/L	
MW-11	6/20/2006	Manganese	102	ug/L	
MW-11	9/13/2006	Manganese	79	ug/L	
MW-11	10/25/2006	Manganese	107	ug/L	
MW-11	3/15/2007	Manganese	107	ug/L	
MW-11	8/21/2007	Manganese	72	ug/L	
MW-11	10/30/2007	Manganese	80	ug/L	
MW-11	3/18/2008	Manganese	70	ug/L	
MW-11	6/16/2008	Manganese	74	ug/L	
MW-11	8/5/2008	Manganese	70	ug/L	
MW-11	11/10/2008	Manganese	73	ug/L	
MW-11	2/16/2009	Manganese	73	ug/L	
MW-11	5/17/2009	Manganese	67	ug/L	
MW-11	8/31/2009	Manganese	79	ug/L	
MW-11	10/19/2009	Manganese	83	ug/L	
MW-11	2/10/2010	Manganese	134	ug/L	
MW-11	4/28/2010	Manganese	137	ug/L	
MW-11	5/24/2010	Manganese	122	ug/L	
MW-11	6/16/2010	Manganese	99	ug/L	
MW-11	8/25/2010	Manganese	138	ug/L	
MW-11	9/8/2010	Manganese	128	ug/L	
MW-11	10/20/2010	Manganese	141	ug/L	
MW-11	11/11/2010	Manganese	133	ug/L	
MW-11	12/15/2010	Manganese	158	ug/L	
MW-11	1/11/2011	Manganese	121	ug/L	
MW-11	2/2/2011	Manganese	145	ug/L	
MW-11	3/15/2011	Manganese	68	ug/L	
MW-11	4/4/2011	Manganese	148	ug/L	
MW-11	5/10/2011	Manganese	170	ug/L	
MW-11	6/20/2011	Manganese	121	ug/L	
MW-11	7/6/2011	Manganese	151	ug/L	
MW-11	8/3/2011	Manganese	118	ug/L	
MW-11	9/7/2011	Manganese	106	ug/L	
MW-11	10/4/2011	Manganese	112	ug/L	

Appendix A-5: MW-11 Data Used for Analysis

Well	Date Sampled	Parameter Name	Report Result	Report Units	Qualifier
MW-11	11/9/2011	Manganese	105	ug/L	
MW-11	12/14/2011	Manganese	100	ug/L	
MW-11	1/26/2012	Manganese	102	ug/L	
MW-11	2/13/2012	Manganese	154	ug/L	
MW-11	3/13/2012	Manganese	121	ug/L	
MW-11	4/10/2012	Manganese	132	ug/L	
MW-11	5/8/2012	Manganese	127	ug/L	
MW-11	6/19/2012	Manganese	122	ug/L	
MW-11	7/11/2012	Manganese	135	ug/L	
MW-11	8/7/2012	Manganese	166	ug/L	
MW-11	9/19/2012	Manganese	130	ug/L	
MW-11	10/23/2012	Manganese	161	ug/L	
MW-11	11/12/2012	Manganese	138	ug/L	
MW-11	12/24/2012	Manganese	137	ug/L	
MW-11	1/23/2013	Manganese	115	ug/L	
MW-11	2/20/2013	Manganese	139	ug/L	
MW-11	3/20/2013	Manganese	164	ug/L	
MW-11	4/16/2013	Manganese	181	ug/L	
MW-11	5/14/2013	Manganese	144	ug/L	
MW-11	6/25/2013	Manganese	135	ug/L	
MW-11	7/10/2013	Manganese	138	ug/L	
MW-11	8/20/2013	Manganese	158	ug/L	
MW-11	9/18/2013	Manganese	134	ug/L	
MW-11	10/22/2013	Manganese	129	ug/L	
MW-11	11/19/2013	Manganese	152	ug/L	
MW-11	12/18/2013	Manganese	196	ug/L	
MW-11	1/8/2014	Manganese	141	ug/L	
MW-11	2/24/2014	Manganese	163	ug/L	
MW-11	3/11/2014	Manganese	134	ug/L	
MW-11	4/25/2014	Manganese	136	ug/L	
MW-11	5/14/2014	Manganese	128	ug/L	
MW-11	6/3/2014	Manganese	166	ug/L	
MW-11	7/29/2014	Manganese	139	ug/L	
MW-11	8/20/2014	Manganese	139	ug/L	
MW-11	9/8/2014	Manganese	74	ug/L	
MW-11	10/6/2014	Manganese	157	ug/L	
MW-11	11/17/2014	Manganese	125	ug/L	
MW-11	12/10/2014	Manganese	186	ug/L	
MW-11	1/21/2015	Manganese	177	ug/L	
MW-11	2/3/2015	Manganese	138	ug/L	
MW-11	3/3/2015	Manganese	149	ug/L	
MW-11	4/8/2015	Manganese	170	ug/L	
MW-11	5/11/2015	Manganese	123	ug/L	
MW-11	6/23/2015	Manganese	149	ug/L	
MW-11	7/7/2015	Manganese	178	ug/L	

Appendix A-5: MW-11 Data Used for Analysis

Well	Date Sampled	Parameter Name	Report Result	Report Units	Qualifier
MW-11	8/10/2015	Manganese	138	ug/L	
MW-11	9/16/2015	Manganese	160	ug/L	
MW-11	10/7/2015	Manganese	237	ug/L	
MW-11	11/11/2015	Manganese	126	ug/L	
MW-11	12/8/2015	Manganese	139	ug/L	
MW-11	1/20/2016	Manganese	197	ug/L	
MW-11	2/8/2016	Manganese	217	ug/L	
MW-11	3/3/2016	Manganese	155	ug/L	
MW-11	4/12/2016	Manganese	166	ug/L	
MW-11	5/3/2016	Manganese	159	ug/L	
MW-11	6/14/2016	Manganese	158	ug/L	
MW-11	7/13/2016	Manganese	140	ug/L	
MW-11	8/16/2016	Manganese	158	ug/L	
MW-11	9/14/2016	Manganese	169	ug/L	
MW-11	10/5/2016	Manganese	160	ug/L	
MW-11	11/7/2016	Manganese	203	ug/L	
MW-11	12/6/2016	Manganese	202	ug/L	
MW-11	1/18/2017	Manganese	152	ug/L	
MW-11	2/8/2017	Manganese	162	ug/L	
MW-11	3/6/2017	Manganese	144	ug/L	
MW-11	4/5/2017	Manganese	155	ug/L	
MW-11	5/2/2017	Manganese	174	ug/L	
MW-11	6/5/2017	Manganese	168	ug/L	
MW-11	7/12/2017	Manganese	154	ug/L	
MW-11	8/15/2017	Manganese	191	ug/L	
MW-11	9/12/2017	Manganese	217	ug/L	
MW-11	10/5/2017	Manganese	174	ug/L	
MW-11	11/7/2017	Manganese	159	ug/L	
MW-11	12/5/2017	Manganese	173	ug/L	
MW-11	1/24/2018	Manganese	169	ug/L	
MW-11	2/20/2018	Manganese	117	ug/L	
MW-11	4/18/2018	Manganese	174	ug/L	
MW-11	8/9/2018	Manganese	154	ug/L	
MW-11	9/11/2018	Manganese	171	ug/L	
MW-11	10/25/2018	Manganese	161	ug/L	
MW-11	11/14/2018	Manganese	195	ug/L	
MW-11	12/11/2018	Manganese	230	ug/L	
MW-11	1/15/2019	Manganese	181	ug/L	
MW-11	2/13/2019	Manganese	211	ug/L	
MW-11	3/6/2019	Manganese	170	ug/L	
MW-11	4/24/2019	Manganese	181	ug/L	
MW-11	5/7/2019	Manganese	210	ug/L	
MW-11	6/3/2019	Manganese	210	ug/L	
MW-11	7/16/2019	Manganese	199	ug/L	
MW-11	8/5/2019	Manganese	202	ug/L	

Appendix A-5: MW-11 Data Used for Analysis

Well	Date Sampled	Parameter Name	Report Result	Report Units	Qualifier
MW-11	9/24/2019	Manganese	174	ug/L	
MW-11	10/15/2019	Manganese	185	ug/L	
MW-11	11/12/2019	Manganese	206	ug/L	
MW-11	12/3/2019	Manganese	167	ug/L	
MW-11	1/15/2020	Manganese	169	ug/L	
MW-11	2/4/2020	Manganese	227	ug/L	
MW-11	3/10/2020	Manganese	183	ug/L	
MW-11	4/8/2020	Manganese	189	ug/L	
MW-11	5/5/2020	Manganese	206	ug/L	
MW-11	6/2/2020	Manganese	211	ug/L	
MW-11	7/7/2020	Manganese	178	ug/L	
MW-11	8/11/2020	Manganese	276	ug/L	
MW-11	9/2/2020	Manganese	230	ug/L	
MW-11	10/12/2020	Manganese	211	ug/L	
MW-11	11/16/2020	Manganese	174	ug/L	
MW-11	12/7/2020	Manganese	212	ug/L	
MW-11	1/12/2021	Manganese	185	ug/L	
MW-11	2/9/2021	Manganese	254	ug/L	
MW-11	3/8/2021	Manganese	221	ug/L	
MW-11	4/20/2021	Manganese	237	ug/L	
MW-11	7/27/2021	Manganese	376	ug/L	
MW-11	10/20/2021	Manganese	286	ug/L	
MW-11	11/16/2021	Manganese	261	ug/L	
MW-11	12/13/2021	Manganese	300	ug/L	
MW-11	12/16/1982	Sulfate	926	mg/L	
MW-11	5/24/1983	Sulfate	943	mg/L	
MW-11	10/26/1983	Sulfate	922	mg/L	
MW-11	6/12/1984	Sulfate	920	mg/L	
MW-11	12/4/1984	Sulfate	949	mg/L	
MW-11	6/28/1985	Sulfate	909	mg/L	
MW-11	9/27/1985	Sulfate	1025	mg/L	
MW-11	3/27/1986	Sulfate	946	mg/L	
MW-11	6/26/1986	Sulfate	949	mg/L	
MW-11	9/4/1986	Sulfate	956	mg/L	
MW-11	12/10/1986	Sulfate	911	mg/L	
MW-11	2/20/1987	Sulfate	895	mg/L	
MW-11	4/28/1987	Sulfate	1020	mg/L	
MW-11	4/29/1987	Sulfate	1020	mg/L	
MW-11	8/14/1987	Sulfate	951	mg/L	
MW-11	8/19/1987	Sulfate	951	mg/L	
MW-11	11/20/1987	Sulfate	961	mg/L	
MW-11	1/27/1988	Sulfate	919	mg/L	
MW-11	6/1/1988	Sulfate	947	mg/L	
MW-11	8/24/1988	Sulfate	915	mg/L	
MW-11	11/2/1988	Sulfate	974	mg/L	
MW-11	8/25/1989	Sulfate	1030	mg/L	

Appendix A-5: MW-11 Data Used for Analysis

Well	Date Sampled	Parameter Name	Report Result	Report Units	Qualifier
MW-11	11/1/1989	Sulfate	986	mg/L	
MW-11	11/17/1989	Sulfate	993	mg/L	
MW-11	12/15/1989	Sulfate	1010	mg/L	
MW-11	2/20/1990	Sulfate	1010	mg/L	
MW-11	5/8/1990	Sulfate	1000	mg/L	
MW-11	8/7/1990	Sulfate	973	mg/L	
MW-11	11/13/1990	Sulfate	975	mg/L	
MW-11	2/28/1991	Sulfate	967	mg/L	
MW-11	5/22/1991	Sulfate	936	mg/L	
MW-11	9/24/1991	Sulfate	956	mg/L	
MW-11	12/4/1991	Sulfate	968	mg/L	
MW-11	3/17/1992	Sulfate	976	mg/L	
MW-11	6/12/1992	Sulfate	976	mg/L	
MW-11	9/15/1992	Sulfate	1005	mg/L	
MW-11	11/12/1992	Sulfate	1507	mg/L	
MW-11	3/30/1993	Sulfate	1162	mg/L	
MW-11	6/10/1993	Sulfate	1309	mg/L	
MW-11	9/29/1993	Sulfate	1307	mg/L	
MW-11	12/15/1993	Sulfate	1054	mg/L	
MW-11	3/30/1994	Sulfate	1020	mg/L	
MW-11	3/30/1994	Sulfate	1050	mg/L	
MW-11	6/20/1994	Sulfate	1118	mg/L	
MW-11	8/23/1994	Sulfate	1035	mg/L	
MW-11	12/7/1994	Sulfate	983	mg/L	
MW-11	3/14/1995	Sulfate	1010	mg/L	
MW-11	6/27/1995	Sulfate	659	mg/L	
MW-11	9/15/1995	Sulfate	978	mg/L	
MW-11	3/27/1996	Sulfate	1008	mg/L	
MW-11	6/6/1996	Sulfate	1051	mg/L	
MW-11	9/12/1996	Sulfate	1061	mg/L	
MW-11	9/17/1996	Sulfate	1085	mg/L	
MW-11	11/22/1996	Sulfate	981	mg/L	
MW-11	3/19/1997	Sulfate	922	mg/L	
MW-11	5/11/1999	Sulfate	945	mg/L	
MW-11	11/27/2000	Sulfate	1140	mg/L	
MW-11	11/6/2001	Sulfate	1150	mg/L	
MW-11	9/10/2002	Sulfate	1160	mg/L	
MW-11	9/10/2002	Sulfate	1220	mg/L	
MW-11	3/30/2005	Sulfate	1080	mg/L	
MW-11	6/21/2005	Sulfate	1090	mg/L	
MW-11	9/22/2005	Sulfate	968	mg/L	
MW-11	12/13/2005	Sulfate	1070	mg/L	
MW-11	3/21/2006	Sulfate	1120	mg/L	
MW-11	6/20/2006	Sulfate	1150	mg/L	
MW-11	9/13/2006	Sulfate	1060	mg/L	
MW-11	10/25/2006	Sulfate	1200	mg/L	
MW-11	3/15/2007	Sulfate	1120	mg/L	

Appendix A-5: MW-11 Data Used for Analysis

Well	Date Sampled	Parameter Name	Report Result	Report Units	Qualifier
MW-11	8/21/2007	Sulfate	1060	mg/L	
MW-11	10/30/2007	Sulfate	1020	mg/L	
MW-11	3/18/2008	Sulfate	1040	mg/L	
MW-11	6/16/2008	Sulfate	1050	mg/L	
MW-11	8/5/2008	Sulfate	1060	mg/L	
MW-11	11/10/2008	Sulfate	1100	mg/L	
MW-11	2/16/2009	Sulfate	977	mg/L	
MW-11	5/17/2009	Sulfate	1060	mg/L	
MW-11	8/31/2009	Sulfate	1090	mg/L	
MW-11	10/19/2009	Sulfate	1040	mg/L	
MW-11	2/10/2010	Sulfate	1140	mg/L	
MW-11	4/28/2010	Sulfate	1150	mg/L	
MW-11	9/8/2010	Sulfate	1140	mg/L	
MW-11	11/11/2010	Sulfate	1180	mg/L	
MW-11	2/2/2011	Sulfate	1190	mg/L	
MW-11	4/4/2011	Sulfate	1140	mg/L	
MW-11	8/3/2011	Sulfate	1090	mg/L	
MW-11	10/4/2011	Sulfate	1140	mg/L	
MW-11	2/13/2012	Sulfate	1160	mg/L	
MW-11	5/8/2012	Sulfate	1090	mg/L	
MW-11	7/11/2012	Sulfate	1080	mg/L	
MW-11	11/12/2012	Sulfate	1110	mg/L	
MW-11	2/20/2013	Sulfate	1080	mg/L	
MW-11	5/14/2013	Sulfate	763	mg/L	
MW-11	7/10/2013	Sulfate	1240	mg/L	
MW-11	11/19/2013	Sulfate	1050	mg/L	
MW-11	2/24/2014	Sulfate	1150	mg/L	
MW-11	3/11/2014	Sulfate	904	mg/L	
MW-11	6/3/2014	Sulfate	1140	mg/L	
MW-11	9/8/2014	Sulfate	1030	mg/L	
MW-11	11/17/2014	Sulfate	1140	mg/L	
MW-11	2/3/2015	Sulfate	1110	mg/L	
MW-11	4/8/2015	Sulfate	1170	mg/L	
MW-11	8/10/2015	Sulfate	1050	mg/L	
MW-11	11/11/2015	Sulfate	1220	mg/L	
MW-11	2/8/2016	Sulfate	1160	mg/L	
MW-11	5/3/2016	Sulfate	1200	mg/L	
MW-11	8/16/2016	Sulfate	1160	mg/L	
MW-11	11/7/2016	Sulfate	1290	mg/L	
MW-11	2/8/2017	Sulfate	1050	mg/L	
MW-11	5/2/2017	Sulfate	1140	mg/L	
MW-11	8/15/2017	Sulfate	1360	mg/L	
MW-11	11/7/2017	Sulfate	1060	mg/L	
MW-11	12/5/2017	Sulfate	1130	mg/L	
MW-11	1/24/2018	Sulfate	561	mg/L	
MW-11	2/20/2018	Sulfate	1120	mg/L	
MW-11	3/6/2018	Sulfate	1180	mg/L	

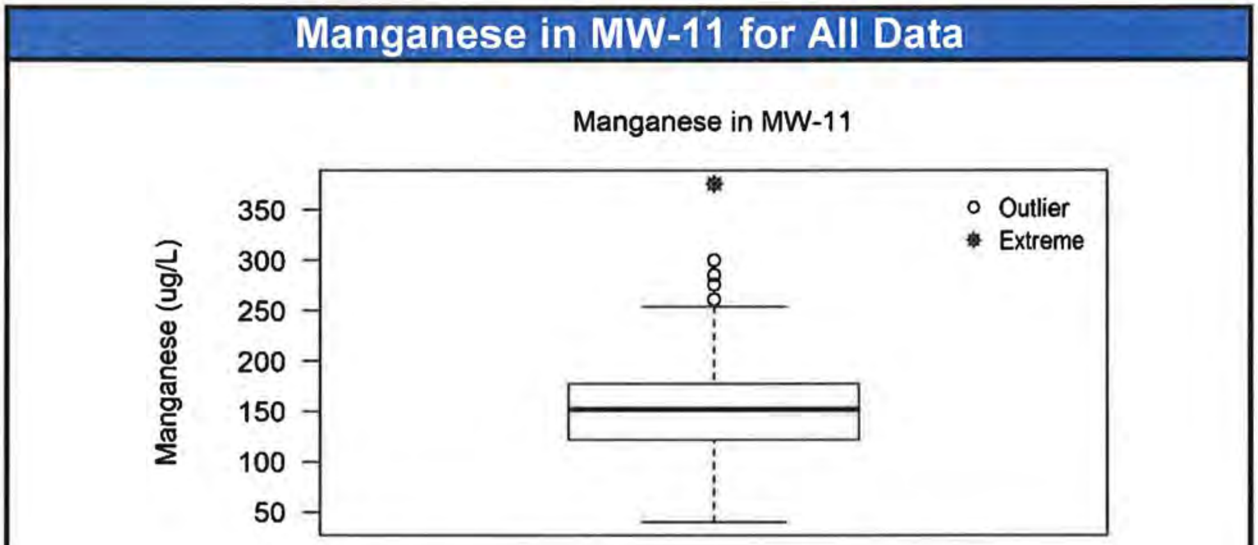
Appendix A-5: MW-11 Data Used for Analysis

Well	Date Sampled	Parameter Name	Report Result	Report Units	Qualifier
MW-11	4/18/2018	Sulfate	1110	mg/L	
MW-11	5/15/2018	Sulfate	1140	mg/L	
MW-11	6/19/2018	Sulfate	1060	mg/L	
MW-11	7/24/2018	Sulfate	1170	mg/L	
MW-11	8/9/2018	Sulfate	1090	mg/L	
MW-11	9/11/2018	Sulfate	1160	mg/L	
MW-11	10/25/2018	Sulfate	1190	mg/L	
MW-11	1/15/2019	Sulfate	1150	mg/L	
MW-11	4/24/2019	Sulfate	1160	mg/L	
MW-11	7/16/2019	Sulfate	1410	mg/L	
MW-11	10/15/2019	Sulfate	1290	mg/L	
MW-11	11/12/2019	Sulfate	1140	mg/L	

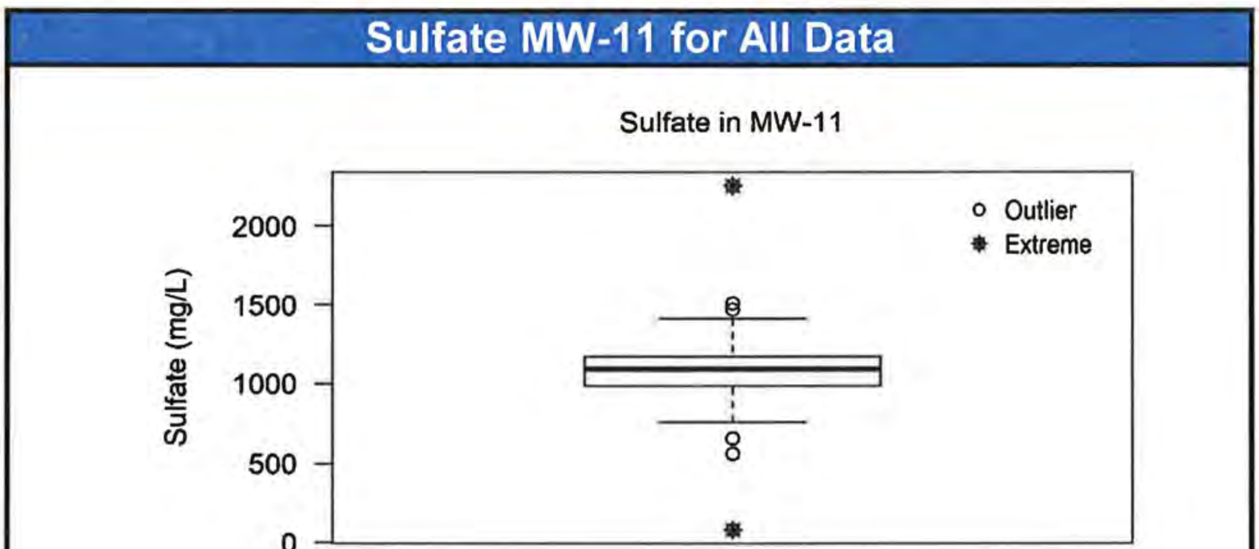
Appendix A-6: Extreme Outliers Removed from Analysis

Reason	Location ID	Date Sampled	Parameter Name	Report Result	Report Units
Extreme (High)	MW-11	2/15/1984	Sulfate	2250	mg/L
Extreme (Low)	MW-11	12/15/1985	Sulfate	79	mg/L

Appendix A-7: Box Plots

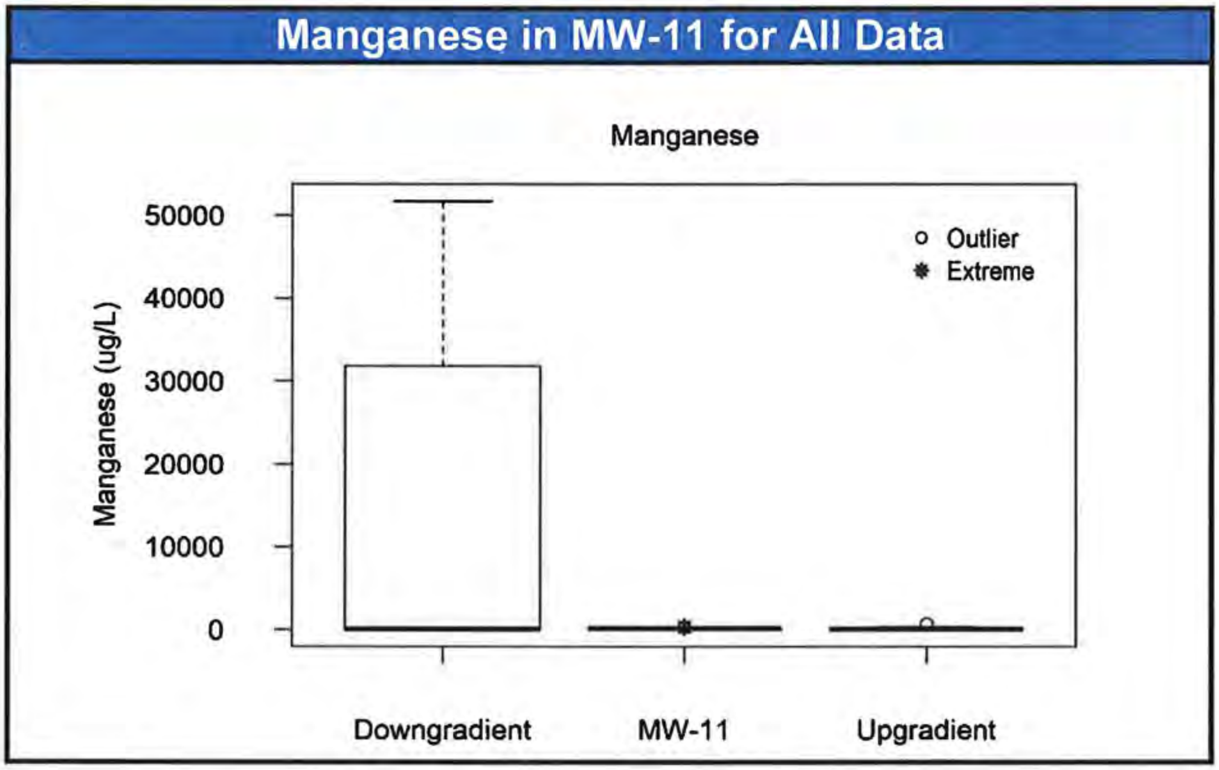


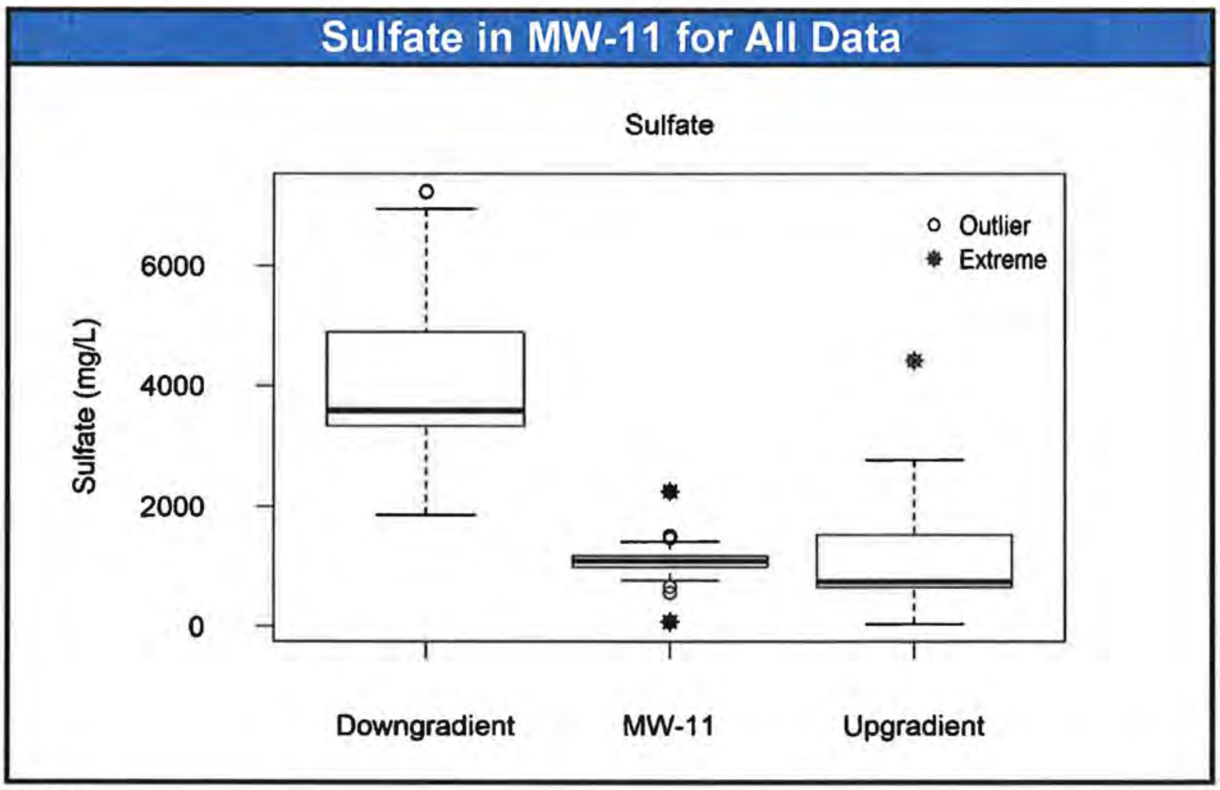
Percent nondetect: 0%
Min: 40, Mean: 151.84, Max: 376, Std Dev: 51.19
Upper extreme threshold (Q75 + 3xH): 344
Lower extreme threshold (Q25 - 3xH): -44.5



Percent nondetect: 0%
Min: 79, Mean: 1093.39, Max: 2250, Std Dev: 187.52
Upper extreme threshold (Q75 + 3xH): 1726.5
Lower extreme threshold (Q25 - 3xH): 428

Appendix A-8: Box Plots for MW-11 and Upgradient and Downgradient Wells





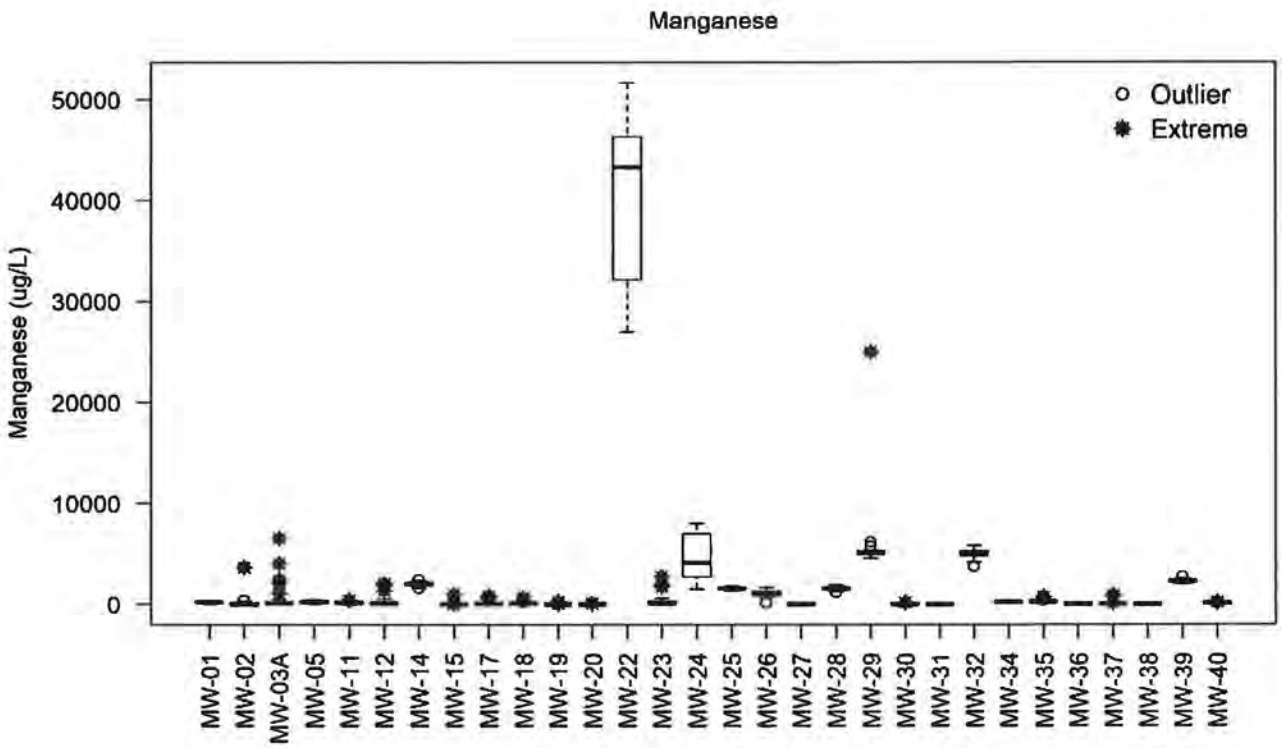
Notes

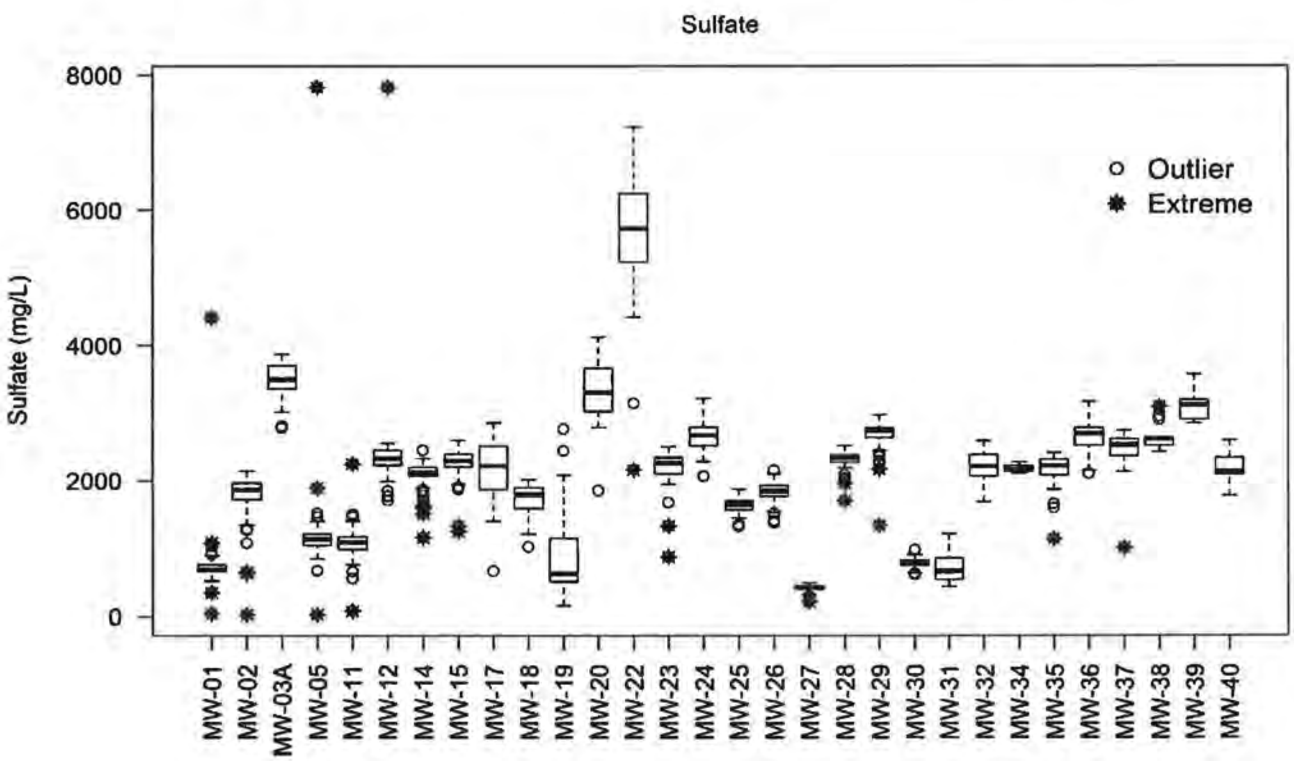
All available data used in box plots

Downgradient wells: MW-3A, MW-20, and MW-22.

Upgradient wells: MW-1, MW-18, and MW-19

Appendix A-9: Box Plots for SAR Parameters in Groundwater Monitoring Wells

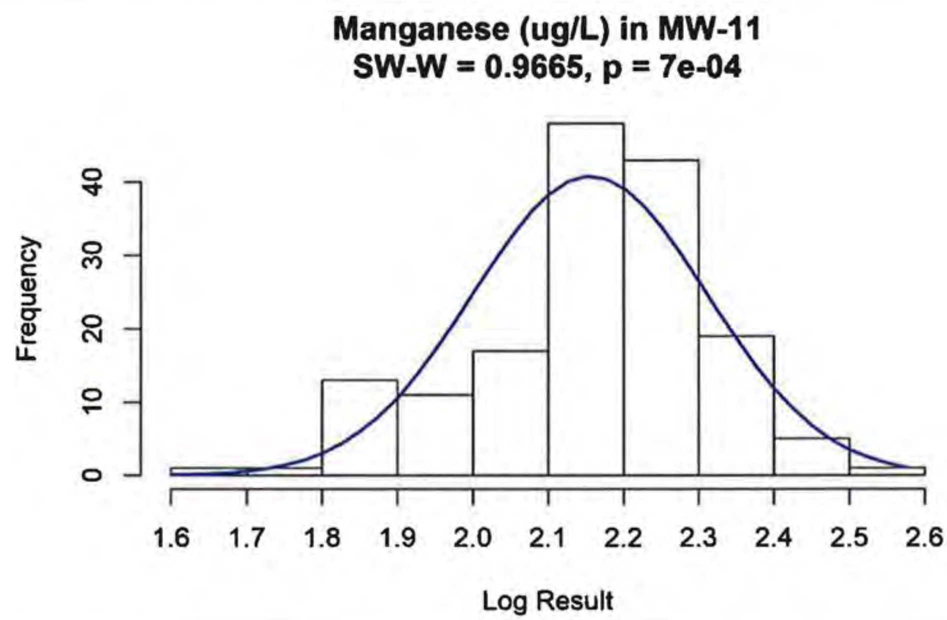




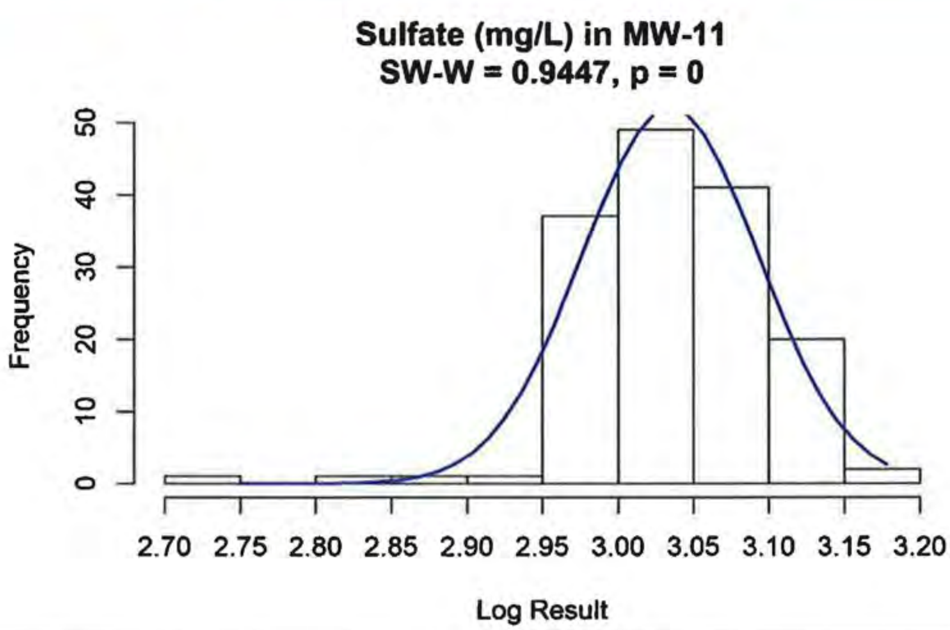
Notes
All available data used in box plots

Appendix A-10: Histograms

Managnese in MW-11 for All Data

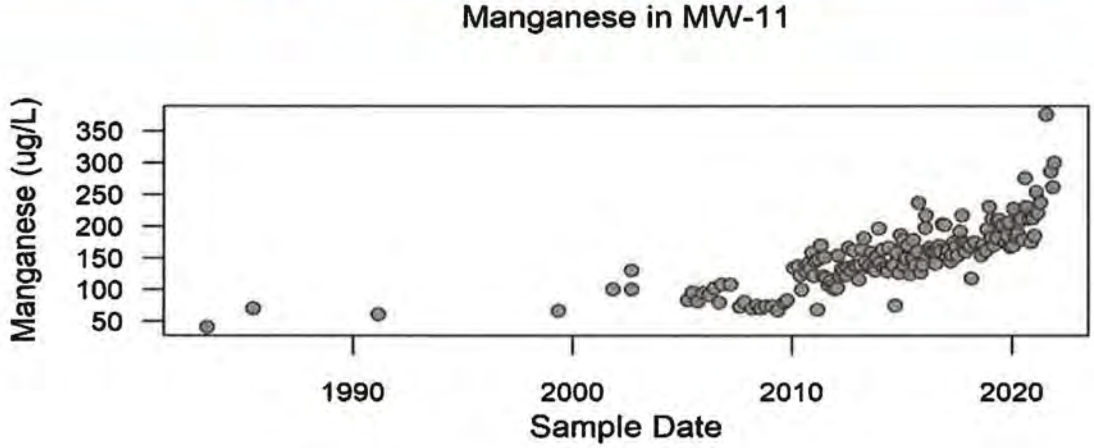


Sulfate in MW-11 for All Data

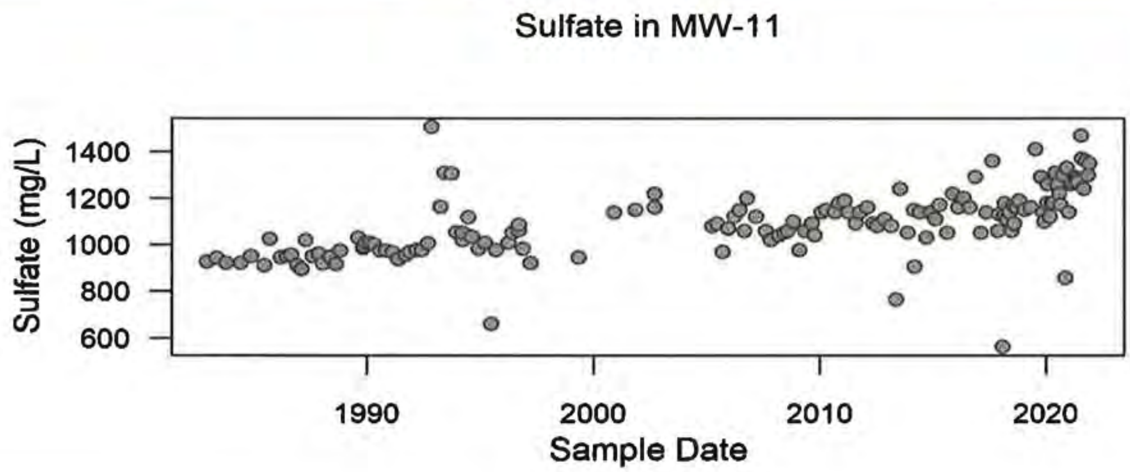


Appendix A-11: Timeseries Plots

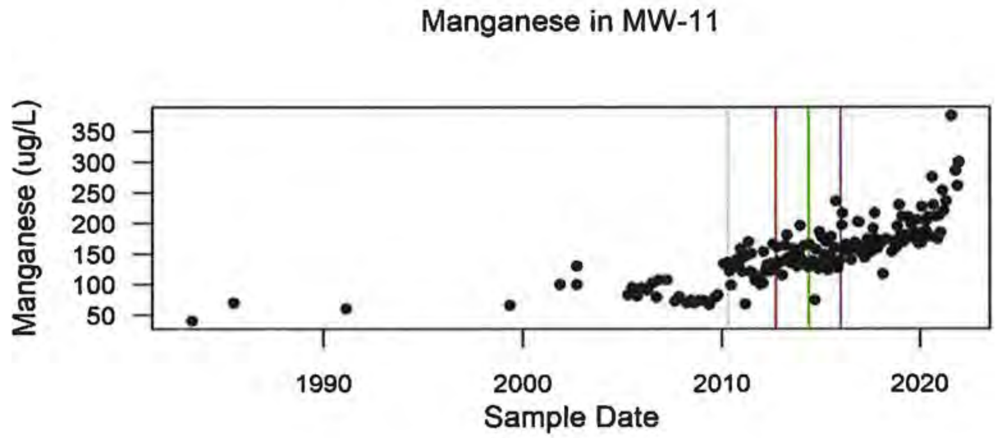
Manganese in MW-11 for All Data

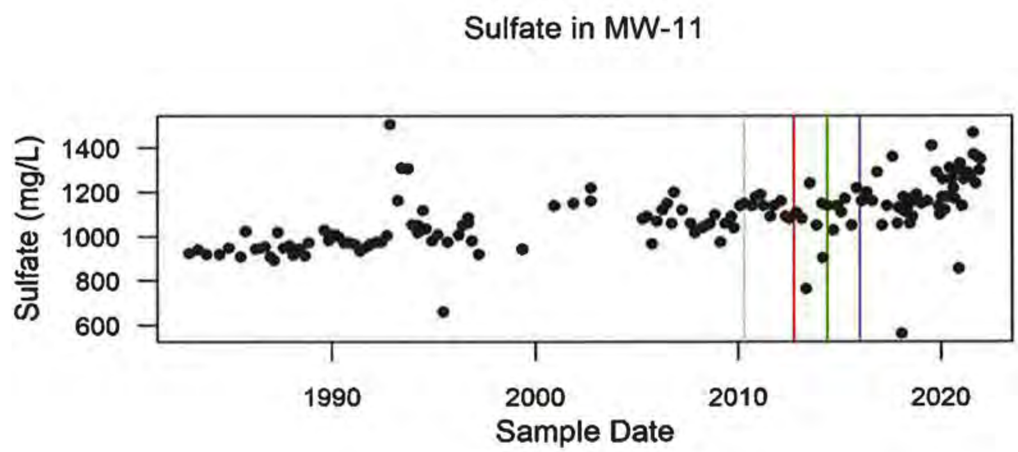


Sulfate in MW-11 for All Data



Appendix A-12: Timeseries Plots with Events





2010-04-28 Well Redevelopment
2012-10-01 Lab Change
2014-06-01 Five New Chloroform Pumping Wells Brought Online
2016-01-01 Point of Inflection (sitewide shift in pH)

APPENDIX B

Appendix B-1: Summary of Statistical Analysis for Indicator Parameters in MW-11

Well	Data Set	Constituent	N	% Non-Detected Values	Mean	Standard Deviation	Shapiro-Wilk Test for Normality		Normally or Lognormally distributed?	Least Squares Regression Trend Analysis[a]		Mann-Kendall Trend Analysis[b]		Background Report Trend?	2021 Significant Trend
							W	p		r^2	p	S	p		
MW-11	ALL 2022 SAR Data	Chloride (mg/L)	176	0.006	34.4	5.8	0.892	5.27E-10	Not Normal	NA	NA	3131	3.03E-05	None	Increasing
	ALL 2022 SAR Data	Fluoride (mg/L)	73	0	0.5	0.09	0.952	7.25E-03	Not Normal	NA	NA	-1541	1.08E-13	None	Decreasing
	ALL 2022 SAR Data	pH (pH Units)	213	0	7.5	0.39	0.975	7.48E-04	Not Normal	NA	NA	-6848	2.26E-11	None	Decreasing
	ALL 2022 SAR Data	Sulfate (mg/L)	153	0	1092.5	141.6	0.945	1.01E-05	Not Normal	NA	NA	6463	0.00	Upward	Increasing
	ALL 2022 SAR Data	Uranium (µg/L)	140	0.207	0.8	0.47	0.533	2.99E-19	Not Normal	NA	NA	1108	0.02	Upward	Increasing

Notes:

σ = sigma

%ND = percent of non-detected values

µg/L = micrograms per liter

mg/L = milligrams per liter

N = number of valid data points

p = probability

W = Shapiro-Wilk test value

r^2 = The measure of how well the trendline fits the data where r2=1 represents a perfect fit.

S = Mann-Kendall statistic

a = A regression test was performed on data that was determined to have normal or log-normal distribution

b = The Mann-Kendall test was performed on data that are not normally or lognormally distributed

scriptive Statistics for Indicator Parameters in MW-11

	2007 Background Report				2012 SAR				2019 SAR				2022 SAR			
	Chloride	Fluoride	Sulfate	Uranium	Chloride	Fluoride	Sulfate	Uranium	Chloride	Fluoride	Sulfate	Uranium	Chloride	Fluoride	Sulfate	Uranium
	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	mg/L	ug/L
	0.0	0.0	0.0	23.3					0.007	0.0	0.0	0.22	0.006	0.0	0.0	0.21
	104	14	71	86	120	35	87	104	146	63	125	130	176	73	153	140
Log[illegible]y Distributed?	Lognormal	Not Normal or Lognormal	Not Normal or Lognormal	Not Normal or Lognormal	Not Normal or Lognormal	Not Normal or Lognormal	Not Normal or Lognormal	Not Normal or Lognormal	Not Normal	Not Normal	Not Normal	Not Normal	Not normal	Not normal	Not normal	Not normal
Mean	32.9	0.6	1014.3	0.9	32.4	0.5	90.8	0.6	32.37	0.50	1057.90	0.76	34.37	0.48	1092.46	0.80
Min. Conc.	24.4	0.5	659	0.0	24.4	0.4	895	0.0	24.40	0.32	561.00	0.00	24.40	0.23	561.00	0.00
Max. Conc.	43.2	0.7	1309	4.0	43.2	0.7	1309	3.0	42.40	0.71	1507.00	2.50	57.00	0.71	1507.00	2.50
Std. Dev.	3.1	0.07	99.12	0.7	3.18	0.06	90.78	0.59	2.92	0.07	122.57	0.45	5.77	0.09	141.61	0.47
Range	18.8	0.2	650	4.0	18.80	0.27	414.00	3.03	18.00	0.39	946.00	2.50	32.60	0.47	946.00	2.50
Geometric Mean	32.8	0.554	1009.6	0.431	32.22	0.54	1035.17	0.48	32.24	0.50	1050.41	0.52	33.95	0.48	1082.94	0.55
Skewness	0.5	0.978	0.397	1.72	0.56	1.36	0.70	1.56	0.41	0.39	-0.24	1.17	1.65	-0.05	-0.06	1.09
25th Quartile	31.0	0.5	951	0.34	30.85	0.50	968.00	0.30	31.00	0.46	976.00	0.37	31.00	0.44	986.00	0.40
Median	32.4	0.51	1000	0.75	32.00	0.54	1023.00	0.75	32.00	0.49	1060.00	0.75	32.75	0.48	1090.00	0.78
75th Quartile	35.0	0.6	1060	1.04	34.0	0.6	1090	1.0	34.00	0.54	1140.00	1.00	36.00	0.54	1170.00	1.00

Appendix B-3: Data Used for Statistical Analysis

Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Chloride	12/16/1982	24	mg/L	
MW-11	Chloride	1/19/1983	32	mg/L	
MW-11	Chloride	5/24/1983	27	mg/L	
MW-11	Chloride	9/1/1983	32	mg/L	
MW-11	Chloride	10/26/1983	26	mg/L	
MW-11	Chloride	2/15/1984	31	mg/L	
MW-11	Chloride	6/12/1984	32	mg/L	
MW-11	Chloride	9/25/1984	34	mg/L	
MW-11	Chloride	12/4/1984	32	mg/L	
MW-11	Chloride	6/28/1985	31	mg/L	
MW-11	Chloride	9/27/1985	38	mg/L	
MW-11	Chloride	3/27/1986	35	mg/L	
MW-11	Chloride	9/4/1986	32	mg/L	
MW-11	Chloride	12/10/1986	33	mg/L	
MW-11	Chloride	2/20/1987	32	mg/L	
MW-11	Chloride	4/28/1987	43	mg/L	
MW-11	Chloride	4/29/1987	43	mg/L	
MW-11	Chloride	8/14/1987	33	mg/L	
MW-11	Chloride	8/19/1987	33	mg/L	
MW-11	Chloride	11/20/1987	32	mg/L	
MW-11	Chloride	1/27/1988	31	mg/L	
MW-11	Chloride	6/1/1988	32	mg/L	
MW-11	Chloride	8/24/1988	34	mg/L	
MW-11	Chloride	11/2/1988	35	mg/L	
MW-11	Chloride	8/25/1989	34	mg/L	
MW-11	Chloride	11/1/1989	32	mg/L	
MW-11	Chloride	11/17/1989	34	mg/L	
MW-11	Chloride	12/15/1989	35	mg/L	
MW-11	Chloride	2/20/1990	33	mg/L	
MW-11	Chloride	5/8/1990	33	mg/L	
MW-11	Chloride	8/7/1990	33	mg/L	
MW-11	Chloride	11/13/1990	34	mg/L	
MW-11	Chloride	2/28/1991	31	mg/L	
MW-11	Chloride	5/22/1991	30	mg/L	
MW-11	Chloride	9/24/1991	30	mg/L	
MW-11	Chloride	12/4/1991	31	mg/L	
MW-11	Chloride	3/17/1992	32	mg/L	
MW-11	Chloride	6/12/1992	29	mg/L	
MW-11	Chloride	9/15/1992	31	mg/L	
MW-11	Chloride	11/12/1992	41	mg/L	
MW-11	Chloride	3/30/1993	35	mg/L	
MW-11	Chloride	6/10/1993	39.00	mg/L	
MW-11	Chloride	9/29/1993	36.00	mg/L	
MW-11	Chloride	12/15/1993	33.00	mg/L	
MW-11	Chloride	3/30/1994	28.00	mg/L	
MW-11	Chloride	3/30/1994	32.00	mg/L	
MW-11	Chloride	6/20/1994	32.00	mg/L	
MW-11	Chloride	8/23/1994	32.00	mg/L	
MW-11	Chloride	12/7/1994	32.00	mg/L	

Appendix B-3: Data Used for Statistical Analysis

Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Chloride	3/14/1995	31.00	mg/L	
MW-11	Chloride	6/27/1995	37.00	mg/L	
MW-11	Chloride	9/15/1995	32.00	mg/L	
MW-11	Chloride	3/27/1996	35.60	mg/L	
MW-11	Chloride	6/6/1996	35.30	mg/L	
MW-11	Chloride	9/12/1996	32.80	mg/L	
MW-11	Chloride	9/17/1996	31.00	mg/L	
MW-11	Chloride	11/22/1996	31.60	mg/L	
MW-11	Chloride	3/19/1997	28.70	mg/L	
MW-11	Chloride	6/11/1997	29.20	mg/L	U
MW-11	Chloride	9/30/1997	31.20	mg/L	
MW-11	Chloride	1/8/1998	32.40	mg/L	
MW-11	Chloride	3/16/1998	30.00	mg/L	
MW-11	Chloride	5/12/1998	33.70	mg/L	
MW-11	Chloride	9/24/1998	32.40	mg/L	
MW-11	Chloride	11/3/1998	31.40	mg/L	
MW-11	Chloride	2/18/1999	31.80	mg/L	
MW-11	Chloride	5/11/1999	33.10	mg/L	
MW-11	Chloride	9/30/1999	35.00	mg/L	
MW-11	Chloride	12/9/1999	29.10	mg/L	
MW-11	Chloride	3/17/2000	28.40	mg/L	
MW-11	Chloride	6/6/2000	35.40	mg/L	
MW-11	Chloride	9/3/2000	37.50	mg/L	
MW-11	Chloride	11/27/2000	37.30	mg/L	
MW-11	Chloride	3/23/2001	31.10	mg/L	
MW-11	Chloride	6/12/2001	36.50	mg/L	
MW-11	Chloride	9/4/2001	32.00	mg/L	
MW-11	Chloride	11/6/2001	42.40	mg/L	
MW-11	Chloride	3/14/2002	30.70	mg/L	
MW-11	Chloride	5/20/2002	35.90	mg/L	
MW-11	Chloride	9/10/2002	33.80	mg/L	
MW-11	Chloride	9/10/2002	37.10	mg/L	
MW-11	Chloride	11/21/2002	37.70	mg/L	
MW-11	Chloride	3/20/2003	36.60	mg/L	
MW-11	Chloride	6/27/2003	29.30	mg/L	
MW-11	Chloride	9/24/2003	36.60	mg/L	
MW-11	Chloride	11/24/2003	35.50	mg/L	
MW-11	Chloride	3/19/2004	35.60	mg/L	
MW-11	Chloride	5/27/2004	36.00	mg/L	
MW-11	Chloride	9/14/2004	34.20	mg/L	
MW-11	Chloride	11/9/2004	29.50	mg/L	
MW-11	Chloride	3/30/2005	33.00	mg/L	
MW-11	Chloride	6/21/2005	31.00	mg/L	
MW-11	Chloride	9/22/2005	33.00	mg/L	
MW-11	Chloride	12/13/2005	36.00	mg/L	
MW-11	Chloride	3/21/2006	33.00	mg/L	
MW-11	Chloride	6/20/2006	31.00	mg/L	
MW-11	Chloride	9/13/2006	29.00	mg/L	
MW-11	Chloride	10/25/2006	32.00	mg/L	

Appendix B-3: Data Used for Statistical Analysis

Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Chloride	3/15/2007	31.00	mg/L	
MW-11	Chloride	8/21/2007	30.00	mg/L	
MW-11	Chloride	10/30/2007	29.00	mg/L	
MW-11	Chloride	3/18/2008	29.00	mg/L	
MW-11	Chloride	6/16/2008	30.00	mg/L	
MW-11	Chloride	8/5/2008	29.00	mg/L	
MW-11	Chloride	11/10/2008	30.00	mg/L	
MW-11	Chloride	2/16/2009	29.00	mg/L	
MW-11	Chloride	5/17/2009	26.00	mg/L	
MW-11	Chloride	8/31/2009	26.00	mg/L	
MW-11	Chloride	10/19/2009	30.00	mg/L	
MW-11	Chloride	2/10/2010	33.00	mg/L	
MW-11	Chloride	4/28/2010	32.00	mg/L	
MW-11	Chloride	9/8/2010	31.00	mg/L	
MW-11	Chloride	11/11/2010	34.00	mg/L	
MW-11	Chloride	2/2/2011	32.00	mg/L	
MW-11	Chloride	4/4/2011	31.00	mg/L	
MW-11	Chloride	8/3/2011	31.00	mg/L	
MW-11	Chloride	10/4/2011	28.00	mg/L	
MW-11	Chloride	2/13/2012	31.00	mg/L	
MW-11	Chloride	5/8/2012	30.00	mg/L	
MW-11	Chloride	7/11/2012	39.00	mg/L	
MW-11	Chloride	11/12/2012	30.00	mg/L	
MW-11	Chloride	2/20/2013	33.70	mg/L	
MW-11	Chloride	5/14/2013	30.10	mg/L	
MW-11	Chloride	7/10/2013	29.00	mg/L	
MW-11	Chloride	11/19/2013	31.30	mg/L	
MW-11	Chloride	2/24/2014	30.80	mg/L	
MW-11	Chloride	3/11/2014	32.60	mg/L	
MW-11	Chloride	6/3/2014	32.90	mg/L	
MW-11	Chloride	9/8/2014	31.00	mg/L	
MW-11	Chloride	11/17/2014	27.40	mg/L	
MW-11	Chloride	2/3/2015	31.00	mg/L	
MW-11	Chloride	4/8/2015	32.50	mg/L	
MW-11	Chloride	8/10/2015	37.30	mg/L	
MW-11	Chloride	11/11/2015	30.60	mg/L	
MW-11	Chloride	2/8/2016	34.00	mg/L	
MW-11	Chloride	5/3/2016	30.70	mg/L	
MW-11	Chloride	8/16/2016	33.90	mg/L	
MW-11	Chloride	11/7/2016	35.10	mg/L	
MW-11	Chloride	2/8/2017	31.50	mg/L	
MW-11	Chloride	5/2/2017	33.30	mg/L	
MW-11	Chloride	8/15/2017	32.70	mg/L	
MW-11	Chloride	11/7/2017	31.90	mg/L	
MW-11	Chloride	2/20/2018	31.90	mg/L	
MW-11	Chloride	4/18/2018	34.00	mg/L	
MW-11	Chloride	9/11/2018	36.40	mg/L	
MW-11	Chloride	10/25/2018	29.30	mg/L	
MW-11	Chloride	1/15/2019	32.00	mg/L	

Appendix B-3: Data Used for Statistical Analysis

Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Chloride	4/24/2019	34.00	mg/L	
MW-11	Chloride	7/16/2019	48.40	mg/L	
MW-11	Chloride	10/15/2019	30.80	mg/L	
MW-11	Chloride	11/12/2019	39.10	mg/L	
MW-11	Chloride	12/3/2019	35.40	mg/L	
MW-11	Chloride	1/15/2020	38.90	mg/L	
MW-11	Chloride	2/4/2020	42.10	mg/L	
MW-11	Chloride	3/10/2020	41.00	mg/L	
MW-11	Chloride	4/8/2020	38.30	mg/L	
MW-11	Chloride	5/5/2020	39.00	mg/L	
MW-11	Chloride	6/2/2020	40.10	mg/L	
MW-11	Chloride	7/7/2020	42.10	mg/L	
MW-11	Chloride	8/11/2020	43.90	mg/L	
MW-11	Chloride	9/2/2020	40.60	mg/L	
MW-11	Chloride	10/12/2020	44.80	mg/L	
MW-11	Chloride	11/16/2020	33.70	mg/L	
MW-11	Chloride	12/7/2020	37.40	mg/L	
MW-11	Chloride	1/12/2021	46.40	mg/L	
MW-11	Chloride	2/9/2021	46.40	mg/L	
MW-11	Chloride	3/8/2021	46.90	mg/L	
MW-11	Chloride	4/20/2021	47.70	mg/L	
MW-11	Chloride	5/10/2021	46.40	mg/L	
MW-11	Chloride	6/8/2021	52.10	mg/L	
MW-11	Chloride	7/27/2021	48.30	mg/L	
MW-11	Chloride	8/10/2021	57.00	mg/L	
MW-11	Chloride	9/7/2021	49.60	mg/L	
MW-11	Chloride	10/20/2021	52.80	mg/L	
MW-11	Chloride	11/16/2021	53.60	mg/L	
MW-11	Chloride	12/13/2021	53.90	mg/L	
MW-11	Fluoride	5/24/1983	0.50	mg/L	
MW-11	Fluoride	5/11/1999	0.51	mg/L	
MW-11	Fluoride	11/27/2000	0.51	mg/L	
MW-11	Fluoride	11/6/2001	0.50	mg/L	
MW-11	Fluoride	9/10/2002	0.50	mg/L	
MW-11	Fluoride	3/30/2005	0.49	mg/L	
MW-11	Fluoride	6/21/2005	0.70	mg/L	
MW-11	Fluoride	9/22/2005	0.58	mg/L	
MW-11	Fluoride	12/13/2005	0.54	mg/L	
MW-11	Fluoride	3/21/2006	0.56	mg/L	
MW-11	Fluoride	6/20/2006	0.52	mg/L	
MW-11	Fluoride	9/13/2006	0.60	mg/L	
MW-11	Fluoride	10/25/2006	0.71	mg/L	
MW-11	Fluoride	3/15/2007	0.56	mg/L	
MW-11	Fluoride	8/21/2007	0.67	mg/L	
MW-11	Fluoride	10/30/2007	0.54	mg/L	
MW-11	Fluoride	3/18/2008	0.57	mg/L	
MW-11	Fluoride	6/16/2008	0.53	mg/L	
MW-11	Fluoride	8/5/2008	0.54	mg/L	
MW-11	Fluoride	11/10/2008	0.56	mg/L	

Appendix B-3: Data Used for Statistical Analysis

Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Fluoride	2/16/2009	0.56	mg/L	
MW-11	Fluoride	5/17/2009	0.55	mg/L	
MW-11	Fluoride	8/31/2009	0.55	mg/L	
MW-11	Fluoride	10/19/2009	0.54	mg/L	
MW-11	Fluoride	2/10/2010	0.51	mg/L	
MW-11	Fluoride	4/28/2010	0.49	mg/L	
MW-11	Fluoride	9/8/2010	0.52	mg/L	
MW-11	Fluoride	11/11/2010	0.49	mg/L	
MW-11	Fluoride	2/2/2011	0.48	mg/L	
MW-11	Fluoride	4/4/2011	0.44	mg/L	
MW-11	Fluoride	8/3/2011	0.48	mg/L	
MW-11	Fluoride	10/4/2011	0.56	mg/L	
MW-11	Fluoride	2/13/2012	0.57	mg/L	
MW-11	Fluoride	5/8/2012	0.49	mg/L	
MW-11	Fluoride	7/11/2012	0.48	mg/L	
MW-11	Fluoride	11/12/2012	0.47	mg/L	
MW-11	Fluoride	2/20/2013	0.48	mg/L	
MW-11	Fluoride	5/14/2013	0.48	mg/L	
MW-11	Fluoride	7/10/2013	0.64	mg/L	
MW-11	Fluoride	11/19/2013	0.48	mg/L	
MW-11	Fluoride	2/24/2014	0.48	mg/L	
MW-11	Fluoride	3/11/2014	0.54	mg/L	
MW-11	Fluoride	6/3/2014	0.49	mg/L	
MW-11	Fluoride	9/8/2014	0.50	mg/L	
MW-11	Fluoride	11/17/2014	0.42	mg/L	
MW-11	Fluoride	2/3/2015	0.46	mg/L	
MW-11	Fluoride	4/8/2015	0.32	mg/L	
MW-11	Fluoride	8/10/2015	0.33	mg/L	
MW-11	Fluoride	11/11/2015	0.47	mg/L	
MW-11	Fluoride	2/8/2016	0.44	mg/L	
MW-11	Fluoride	5/3/2016	0.45	mg/L	
MW-11	Fluoride	8/16/2016	0.47	mg/L	
MW-11	Fluoride	11/7/2016	0.45	mg/L	
MW-11	Fluoride	2/8/2017	0.42	mg/L	
MW-11	Fluoride	5/2/2017	0.44	mg/L	
MW-11	Fluoride	8/15/2017	0.43	mg/L	
MW-11	Fluoride	11/7/2017	0.47	mg/L	
MW-11	Fluoride	2/20/2018	0.44	mg/L	
MW-11	Fluoride	4/18/2018	0.47	mg/L	
MW-11	Fluoride	9/11/2018	0.36	mg/L	
MW-11	Fluoride	10/25/2018	0.42	mg/L	
MW-11	Fluoride	1/15/2019	0.41	mg/L	
MW-11	Fluoride	4/24/2019	0.43	mg/L	
MW-11	Fluoride	7/16/2019	0.32	mg/L	
MW-11	Fluoride	10/15/2019	0.32	mg/L	
MW-11	Fluoride	1/15/2020	0.23	mg/L	
MW-11	Fluoride	4/8/2020	0.36	mg/L	
MW-11	Fluoride	7/7/2020	0.38	mg/L	
MW-11	Fluoride	10/12/2020	0.63	mg/L	

Appendix B-3: Data Used for Statistical Analysis

Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Fluoride	1/12/2021	0.41	mg/L	
MW-11	Fluoride	4/20/2021	0.39	mg/L	
MW-11	Fluoride	7/27/2021	0.35	mg/L	
MW-11	Fluoride	10/20/2021	0.38	mg/L	
MW-11	Sulfate	12/16/1982	926.00	mg/L	
MW-11	Sulfate	5/24/1983	943.00	mg/L	
MW-11	Sulfate	10/26/1983	922.00	mg/L	
MW-11	Sulfate	6/12/1984	920.00	mg/L	
MW-11	Sulfate	12/4/1984	949.00	mg/L	
MW-11	Sulfate	6/28/1985	909.00	mg/L	
MW-11	Sulfate	9/27/1985	1025.00	mg/L	
MW-11	Sulfate	3/27/1986	946.00	mg/L	
MW-11	Sulfate	6/26/1986	949.00	mg/L	
MW-11	Sulfate	9/4/1986	956.00	mg/L	
MW-11	Sulfate	12/10/1986	911.00	mg/L	
MW-11	Sulfate	2/20/1987	895.00	mg/L	
MW-11	Sulfate	4/28/1987	1020.00	mg/L	
MW-11	Sulfate	4/29/1987	1020.00	mg/L	
MW-11	Sulfate	8/14/1987	951.00	mg/L	
MW-11	Sulfate	8/19/1987	951.00	mg/L	
MW-11	Sulfate	11/20/1987	961.00	mg/L	
MW-11	Sulfate	1/27/1988	919.00	mg/L	
MW-11	Sulfate	6/1/1988	947	mg/L	
MW-11	Sulfate	8/24/1988	915	mg/L	
MW-11	Sulfate	11/2/1988	974	mg/L	
MW-11	Sulfate	8/25/1989	1030	mg/L	
MW-11	Sulfate	11/1/1989	986	mg/L	
MW-11	Sulfate	11/17/1989	993	mg/L	
MW-11	Sulfate	12/15/1989	1010	mg/L	
MW-11	Sulfate	2/20/1990	1010	mg/L	
MW-11	Sulfate	5/8/1990	1000	mg/L	
MW-11	Sulfate	8/7/1990	973	mg/L	
MW-11	Sulfate	11/13/1990	975	mg/L	
MW-11	Sulfate	2/28/1991	967	mg/L	
MW-11	Sulfate	5/22/1991	936	mg/L	
MW-11	Sulfate	9/24/1991	956	mg/L	
MW-11	Sulfate	12/4/1991	968	mg/L	
MW-11	Sulfate	3/17/1992	976	mg/L	
MW-11	Sulfate	6/12/1992	976	mg/L	
MW-11	Sulfate	9/15/1992	1005	mg/L	
MW-11	Sulfate	11/12/1992	1507	mg/L	
MW-11	Sulfate	3/30/1993	1162	mg/L	
MW-11	Sulfate	6/10/1993	1309	mg/L	
MW-11	Sulfate	9/29/1993	1307	mg/L	
MW-11	Sulfate	12/15/1993	1054	mg/L	
MW-11	Sulfate	3/30/1994	1020	mg/L	
MW-11	Sulfate	3/30/1994	1050	mg/L	
MW-11	Sulfate	6/20/1994	1118	mg/L	
MW-11	Sulfate	8/23/1994	1035	mg/L	

Appendix B-3: Data Used for Statistical Analysis

Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Sulfate	12/7/1994	983	mg/L	
MW-11	Sulfate	3/14/1995	1010	mg/L	
MW-11	Sulfate	6/27/1995	659	mg/L	
MW-11	Sulfate	9/15/1995	978	mg/L	
MW-11	Sulfate	3/27/1996	1008	mg/L	
MW-11	Sulfate	6/6/1996	1051	mg/L	
MW-11	Sulfate	9/12/1996	1061	mg/L	
MW-11	Sulfate	9/17/1996	1085	mg/L	
MW-11	Sulfate	11/22/1996	981	mg/L	
MW-11	Sulfate	3/19/1997	922	mg/L	
MW-11	Sulfate	5/11/1999	945.00	mg/L	
MW-11	Sulfate	11/27/2000	1140.00	mg/L	
MW-11	Sulfate	11/6/2001	1150.00	mg/L	
MW-11	Sulfate	9/10/2002	1160.00	mg/L	
MW-11	Sulfate	9/10/2002	1220.00	mg/L	
MW-11	Sulfate	3/30/2005	1080.00	mg/L	
MW-11	Sulfate	6/21/2005	1090.00	mg/L	
MW-11	Sulfate	9/22/2005	968.00	mg/L	
MW-11	Sulfate	12/13/2005	1070.00	mg/L	
MW-11	Sulfate	3/21/2006	1120.00	mg/L	
MW-11	Sulfate	6/20/2006	1150.00	mg/L	
MW-11	Sulfate	9/13/2006	1060.00	mg/L	
MW-11	Sulfate	10/25/2006	1200.00	mg/L	
MW-11	Sulfate	3/15/2007	1120.00	mg/L	
MW-11	Sulfate	8/21/2007	1060.00	mg/L	
MW-11	Sulfate	10/30/2007	1020.00	mg/L	
MW-11	Sulfate	3/18/2008	1040.00	mg/L	
MW-11	Sulfate	6/16/2008	1050.00	mg/L	
MW-11	Sulfate	8/5/2008	1060.00	mg/L	
MW-11	Sulfate	11/10/2008	1100.00	mg/L	
MW-11	Sulfate	2/16/2009	977.00	mg/L	
MW-11	Sulfate	5/17/2009	1060.00	mg/L	
MW-11	Sulfate	8/31/2009	1090.00	mg/L	
MW-11	Sulfate	10/19/2009	1040.00	mg/L	
MW-11	Sulfate	2/10/2010	1140.00	mg/L	
MW-11	Sulfate	4/28/2010	1150.00	mg/L	
MW-11	Sulfate	9/8/2010	1140.00	mg/L	
MW-11	Sulfate	11/11/2010	1180.00	mg/L	
MW-11	Sulfate	2/2/2011	1190.00	mg/L	
MW-11	Sulfate	4/4/2011	1140.00	mg/L	
MW-11	Sulfate	8/3/2011	1090.00	mg/L	
MW-11	Sulfate	10/4/2011	1140.00	mg/L	
MW-11	Sulfate	2/13/2012	1160.00	mg/L	
MW-11	Sulfate	5/8/2012	1090.00	mg/L	
MW-11	Sulfate	7/11/2012	1080.00	mg/L	
MW-11	Sulfate	11/12/2012	1110.00	mg/L	
MW-11	Sulfate	2/20/2013	1080.00	mg/L	
MW-11	Sulfate	5/14/2013	763.00	mg/L	
MW-11	Sulfate	7/10/2013	1240.00	mg/L	

Appendix B-3: Data Used for Statistical Analysis

Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Sulfate	11/19/2013	1050.00	mg/L	
MW-11	Sulfate	2/24/2014	1150.00	mg/L	
MW-11	Sulfate	3/11/2014	904.00	mg/L	
MW-11	Sulfate	6/3/2014	1140.00	mg/L	
MW-11	Sulfate	9/8/2014	1030.00	mg/L	
MW-11	Sulfate	11/17/2014	1140.00	mg/L	
MW-11	Sulfate	2/3/2015	1110.00	mg/L	
MW-11	Sulfate	4/8/2015	1170.00	mg/L	
MW-11	Sulfate	8/10/2015	1050.00	mg/L	
MW-11	Sulfate	11/11/2015	1220.00	mg/L	
MW-11	Sulfate	2/8/2016	1160.00	mg/L	
MW-11	Sulfate	5/3/2016	1200.00	mg/L	
MW-11	Sulfate	8/16/2016	1160.00	mg/L	
MW-11	Sulfate	11/7/2016	1290.00	mg/L	
MW-11	Sulfate	2/8/2017	1050.00	mg/L	
MW-11	Sulfate	5/2/2017	1140.00	mg/L	
MW-11	Sulfate	8/15/2017	1360.00	mg/L	
MW-11	Sulfate	11/7/2017	1060.00	mg/L	
MW-11	Sulfate	12/5/2017	1130.00	mg/L	
MW-11	Sulfate	1/24/2018	561.00	mg/L	
MW-11	Sulfate	2/20/2018	1120.00	mg/L	
MW-11	Sulfate	3/6/2018	1180.00	mg/L	
MW-11	Sulfate	4/18/2018	1110.00	mg/L	
MW-11	Sulfate	5/15/2018	1140.00	mg/L	
MW-11	Sulfate	6/19/2018	1060.00	mg/L	
MW-11	Sulfate	7/24/2018	1170.00	mg/L	
MW-11	Sulfate	8/9/2018	1090.00	mg/L	
MW-11	Sulfate	9/11/2018	1160.00	mg/L	
MW-11	Sulfate	10/25/2018	1190.00	mg/L	
MW-11	Sulfate	1/15/2019	1150.00	mg/L	
MW-11	Sulfate	4/24/2019	1160.00	mg/L	
MW-11	Sulfate	7/16/2019	1410.00	mg/L	
MW-11	Sulfate	10/15/2019	1290.00	mg/L	
MW-11	Sulfate	11/12/2019	1140.00	mg/L	
MW-11	Sulfate	12/3/2019	1100.00	mg/L	
MW-11	Sulfate	1/15/2020	1180.00	mg/L	
MW-11	Sulfate	2/4/2020	1260.00	mg/L	
MW-11	Sulfate	3/10/2020	1120.00	mg/L	
MW-11	Sulfate	4/8/2020	1180.00	mg/L	
MW-11	Sulfate	5/5/2020	1180.00	mg/L	
MW-11	Sulfate	6/2/2020	1310.00	mg/L	
MW-11	Sulfate	7/7/2020	1260.00	mg/L	
MW-11	Sulfate	8/11/2020	1220.00	mg/L	
MW-11	Sulfate	9/2/2020	1170.00	mg/L	
MW-11	Sulfate	10/12/2020	1300.00	mg/L	
MW-11	Sulfate	11/16/2020	858.00	mg/L	
MW-11	Sulfate	12/7/2020	1330.00	mg/L	
MW-11	Sulfate	1/12/2021	1140.00	mg/L	
MW-11	Sulfate	2/9/2021	1260.00	mg/L	

Appendix B-3: Data Used for Statistical Analysis

Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Sulfate	3/8/2021	1270.00	mg/L	
MW-11	Sulfate	4/20/2021	1290.00	mg/L	
MW-11	Sulfate	5/10/2021	1280.00	mg/L	
MW-11	Sulfate	6/8/2021	1270.00	mg/L	
MW-11	Sulfate	7/27/2021	1470.00	mg/L	
MW-11	Sulfate	8/10/2021	1370.00	mg/L	
MW-11	Sulfate	9/7/2021	1240.00	mg/L	
MW-11	Sulfate	10/20/2021	1360.00	mg/L	
MW-11	Sulfate	11/16/2021	1300.00	mg/L	
MW-11	Sulfate	12/13/2021	1350.00	mg/L	
MW-11	Uranium	5/24/1983	1.00	ug/L	U
MW-11	Uranium	12/15/1985	0.75	ug/L	
MW-11	Uranium	12/10/1986	0.30	ug/L	U
MW-11	Uranium	2/20/1987	0.30	ug/L	U
MW-11	Uranium	4/29/1987	0.30	ug/L	
MW-11	Uranium	8/19/1987	1.04	ug/L	
MW-11	Uranium	1/27/1988	0.30	ug/L	U
MW-11	Uranium	6/1/1988	0.75	ug/L	
MW-11	Uranium	8/24/1988	0.75	ug/L	
MW-11	Uranium	11/2/1988	0.40	ug/L	
MW-11	Uranium	3/9/1989	1.34	ug/L	
MW-11	Uranium	6/22/1989	1.19	ug/L	
MW-11	Uranium	8/25/1989	2.39	ug/L	
MW-11	Uranium	10/31/1989	1.04	ug/L	
MW-11	Uranium	11/17/1989	0.90	ug/L	
MW-11	Uranium	11/29/1989	0.90	ug/L	
MW-11	Uranium	12/15/1989	0.75	ug/L	
MW-11	Uranium	1/24/1990	1.04	ug/L	
MW-11	Uranium	2/20/1990	1.04	ug/L	
MW-11	Uranium	5/8/1990	1.19	ug/L	
MW-11	Uranium	8/7/1990	0.70	ug/L	
MW-11	Uranium	11/13/1990	0.90	ug/L	
MW-11	Uranium	2/28/1991	0.30	ug/L	U
MW-11	Uranium	5/22/1991	0.34	ug/L	
MW-11	Uranium	9/24/1991	1.10	ug/L	
MW-11	Uranium	12/4/1991	0.36	ug/L	
MW-11	Uranium	6/12/1992	0.30	ug/L	U
MW-11	Uranium	9/29/1993	2.01	ug/L	
MW-11	Uranium	12/15/1993	0.30	ug/L	U
MW-11	Uranium	6/20/1994	1.21	ug/L	
MW-11	Uranium	8/23/1994	1.01	ug/L	
MW-11	Uranium	8/23/1994	1.52	ug/L	
MW-11	Uranium	12/7/1994	0.30	ug/L	U
MW-11	Uranium	12/7/1994	1.00	ug/L	
MW-11	Uranium	3/14/1995	0.30	ug/L	U
MW-11	Uranium	6/27/1995	0.30	ug/L	U
MW-11	Uranium	6/27/1995	0.80	ug/L	
MW-11	Uranium	9/15/1995	0.30	ug/L	U
MW-11	Uranium	9/15/1995	1.40	ug/L	

Appendix B-3: Data Used for Statistical Analysis

Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Uranium	12/7/1995	0.30	ug/L	U
MW-11	Uranium	3/27/1996	0.40	ug/L	
MW-11	Uranium	6/6/1996	0.50	ug/L	
MW-11	Uranium	9/12/1996	1.10	ug/L	
MW-11	Uranium	11/22/1996	1.80	ug/L	
MW-11	Uranium	3/19/1997	0.30	ug/L	U
MW-11	Uranium	6/11/1997	1.00	ug/L	
MW-11	Uranium	9/30/1997	0.40	ug/L	
MW-11	Uranium	1/8/1998	0.00	ug/L	U
MW-11	Uranium	3/16/1998	0.00	ug/L	
MW-11	Uranium	5/12/1998	0.00	ug/L	
MW-11	Uranium	9/24/1998	0.00	ug/L	
MW-11	Uranium	11/3/1998	0.00	ug/L	U
MW-11	Uranium	2/18/1999	0.40	ug/L	
MW-11	Uranium	5/11/1999	0.70	ug/L	
MW-11	Uranium	9/30/1999	0.50	ug/L	
MW-11	Uranium	12/9/1999	0.40	ug/L	
MW-11	Uranium	3/17/2000	0.30	ug/L	
MW-11	Uranium	6/6/2000	0.30	ug/L	U
MW-11	Uranium	9/3/2000	0.60	ug/L	
MW-11	Uranium	11/27/2000	2.20	ug/L	
MW-11	Uranium	6/12/2001	2.50	ug/L	
MW-11	Uranium	9/4/2001	1.30	ug/L	
MW-11	Uranium	11/6/2001	1.50	ug/L	
MW-11	Uranium	5/20/2002	1.00	ug/L	
MW-11	Uranium	11/21/2002	1.00	ug/L	
MW-11	Uranium	3/20/2003	0.80	ug/L	
MW-11	Uranium	6/27/2003	1.60	ug/L	
MW-11	Uranium	9/24/2003	1.00	ug/L	
MW-11	Uranium	11/24/2003	0.30	ug/L	U
MW-11	Uranium	3/19/2004	1.00	ug/L	
MW-11	Uranium	5/27/2004	1.00	ug/L	U
MW-11	Uranium	9/14/2004	1.00	ug/L	U
MW-11	Uranium	11/9/2004	1.00	ug/L	U
MW-11	Uranium	6/21/2005	0.76	ug/L	
MW-11	Uranium	9/22/2005	0.63	ug/L	
MW-11	Uranium	12/13/2005	0.83	ug/L	
MW-11	Uranium	3/21/2006	0.81	ug/L	
MW-11	Uranium	6/20/2006	1.02	ug/L	
MW-11	Uranium	9/13/2006	0.62	ug/L	
MW-11	Uranium	10/25/2006	1.04	ug/L	
MW-11	Uranium	3/15/2007	1.04	ug/L	
MW-11	Uranium	8/21/2007	0.30	ug/L	U
MW-11	Uranium	10/30/2007	0.30	ug/L	U
MW-11	Uranium	3/18/2008	0.30	ug/L	U
MW-11	Uranium	6/16/2008	0.30	ug/L	U
MW-11	Uranium	8/5/2008	0.30	ug/L	U
MW-11	Uranium	11/10/2008	0.30	ug/L	U
MW-11	Uranium	2/16/2009	0.30	ug/L	U

Appendix B-3: Data Used for Statistical Analysis

Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Uranium	5/17/2009	0.30	ug/L	U
MW-11	Uranium	8/31/2009	0.33	ug/L	
MW-11	Uranium	10/19/2009	0.31	ug/L	
MW-11	Uranium	2/10/2010	0.92	ug/L	
MW-11	Uranium	4/28/2010	0.96	ug/L	
MW-11	Uranium	9/8/2010	1.06	ug/L	
MW-11	Uranium	11/11/2010	0.87	ug/L	
MW-11	Uranium	2/2/2011	0.42	ug/L	
MW-11	Uranium	4/4/2011	0.96	ug/L	
MW-11	Uranium	8/3/2011	0.48	ug/L	
MW-11	Uranium	10/4/2011	0.47	ug/L	
MW-11	Uranium	2/13/2012	0.85	ug/L	
MW-11	Uranium	5/8/2012	0.62	ug/L	
MW-11	Uranium	7/11/2012	0.73	ug/L	
MW-11	Uranium	11/12/2012	0.79	ug/L	
MW-11	Uranium	2/20/2013	0.59	ug/L	
MW-11	Uranium	5/14/2013	0.69	ug/L	
MW-11	Uranium	7/10/2013	0.67	ug/L	
MW-11	Uranium	11/19/2013	0.90	ug/L	
MW-11	Uranium	2/24/2014	1.00	ug/L	
MW-11	Uranium	3/11/2014	0.67	ug/L	
MW-11	Uranium	6/3/2014	0.94	ug/L	
MW-11	Uranium	9/8/2014	0.50	ug/L	U
MW-11	Uranium	11/17/2014	0.54	ug/L	
MW-11	Uranium	2/3/2015	0.56	ug/L	
MW-11	Uranium	4/8/2015	0.90	ug/L	
MW-11	Uranium	8/10/2015	0.77	ug/L	
MW-11	Uranium	11/11/2015	0.58	ug/L	
MW-11	Uranium	2/8/2016	1.16	ug/L	
MW-11	Uranium	5/3/2016	0.78	ug/L	
MW-11	Uranium	8/16/2016	0.77	ug/L	
MW-11	Uranium	11/7/2016	1.08	ug/L	
MW-11	Uranium	2/8/2017	0.79	ug/L	
MW-11	Uranium	5/2/2017	0.81	ug/L	
MW-11	Uranium	8/15/2017	0.95	ug/L	
MW-11	Uranium	11/7/2017	0.73	ug/L	
MW-11	Uranium	2/20/2018	0.53	ug/L	
MW-11	Uranium	4/18/2018	0.85	ug/L	
MW-11	Uranium	9/11/2018	0.76	ug/L	
MW-11	Uranium	10/25/2018	0.73	ug/L	
MW-11	Uranium	1/15/2019	0.86	ug/L	
MW-11	Uranium	4/24/2019	0.94	ug/L	
MW-11	Uranium	7/16/2019	1.08	ug/L	
MW-11	Uranium	10/15/2019	1.01	ug/L	
MW-11	Uranium	1/15/2020	0.82	ug/L	
MW-11	Uranium	4/8/2020	1.01	ug/L	
MW-11	Uranium	7/7/2020	0.95	ug/L	
MW-11	Uranium	10/12/2020	1.33	ug/L	
MW-11	Uranium	1/12/2021	1.33	ug/L	

Appendix B-3: Data Used for Statistical Analysis

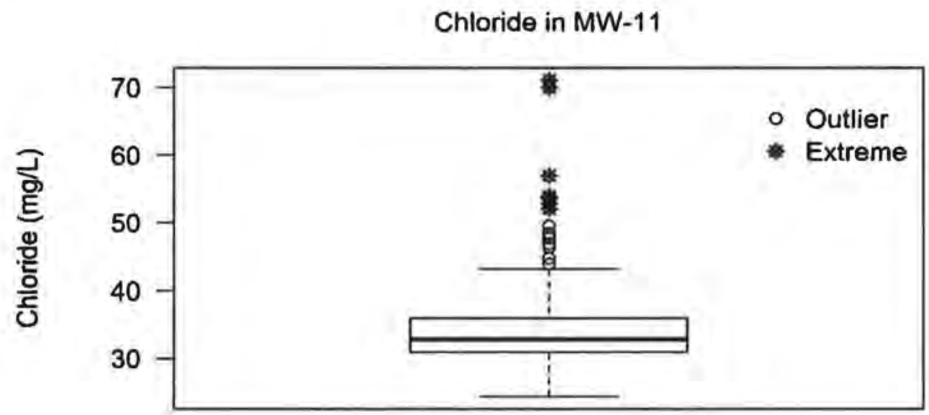
Well	Sample Date	Parameter	Result	Units	Qualifier
MW-11	Uranium	4/20/2021	1.49	ug/L	
MW-11	Uranium	7/27/2021	2.21	ug/L	
MW-11	Uranium	10/20/2021	2.08	ug/L	

U= Analyte not detected at method detection limit

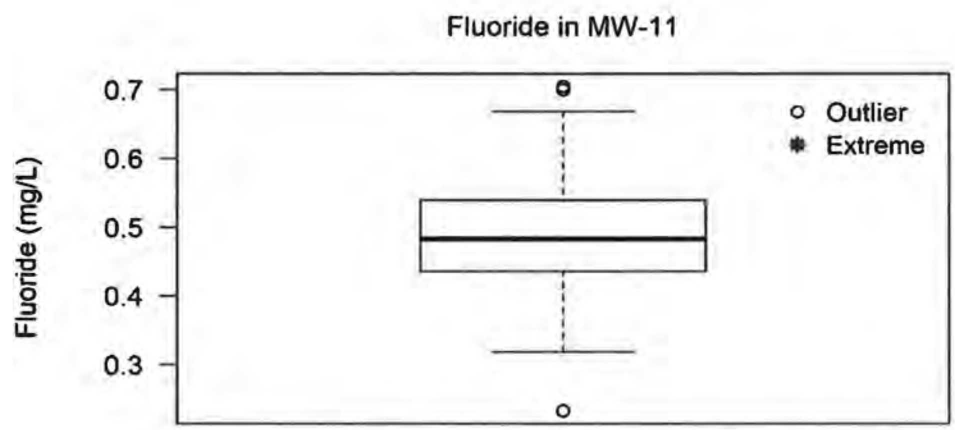
Appendix B-4: Indicator Parameter Data Removed from Analysis

Reason	Location ID	Date Sampled	Parameter Name	Report Result	Report Units
Extreme Outlier (upper)	MW-11	12/15/1985	Chloride	71.00	mg/L
Extreme Outlier (upper)	MW-11	06/26/1986	Chloride	70.00	mg/L
Extreme Outlier (upper)	MW-11	02/15/1984	Sulfate	2250.00	mg/L
Extreme Outlier (lower)	MW-11	12/15/1985	Sulfate	79.00	mg/L
Extreme Outlier (upper)	MW-11	03/30/1993	Uranium	3.03	ug/L
Extreme Outlier (upper)	MW-11	06/10/1993	Uranium	4.00	ug/L
Extreme Outlier (upper)	MW-11	03/23/2001	Uranium	2.90	ug/L

Appendix B-5: Box Plots for Indicator Parameters in MW-11

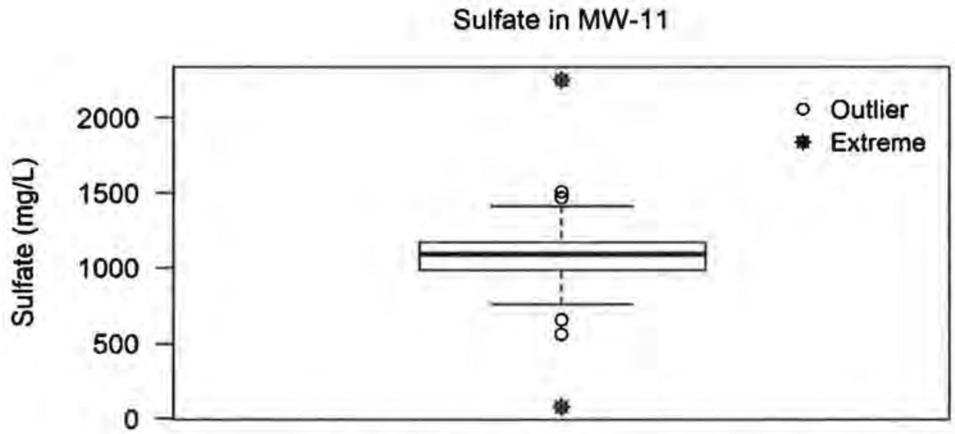


Percent nondetect: 1%
Min: 24.4, Mean: 34.78, Max: 71, Std Dev: 6.89
Upper extreme threshold (Q75 + 3xH): 51
Lower extreme threshold (Q25 - 3xH): 16

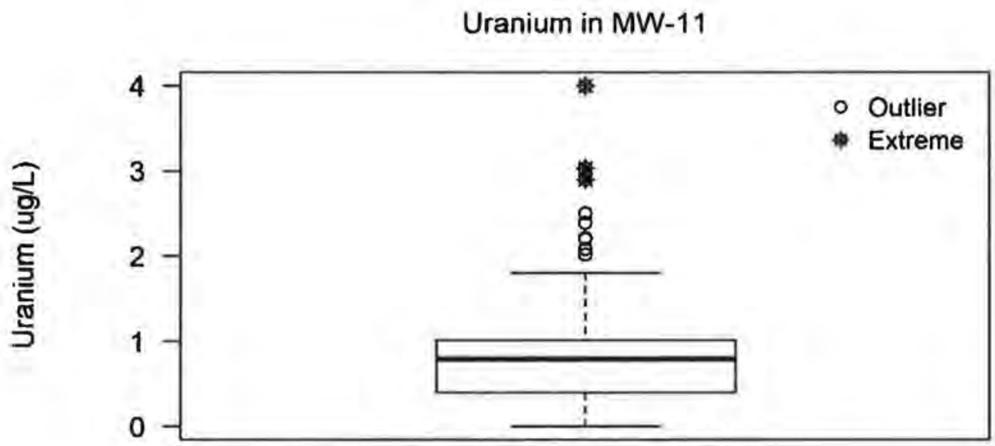


Percent nondetect: 0%
Min: 0.233, Mean: 0.48, Max: 0.705059075537998, Std Dev: 0.09
Upper extreme threshold (Q75 + 3xH): 0.852
Lower extreme threshold (Q25 - 3xH): 0.124

Appendix B-5: Box Plots for Indicator Parameters in MW-11

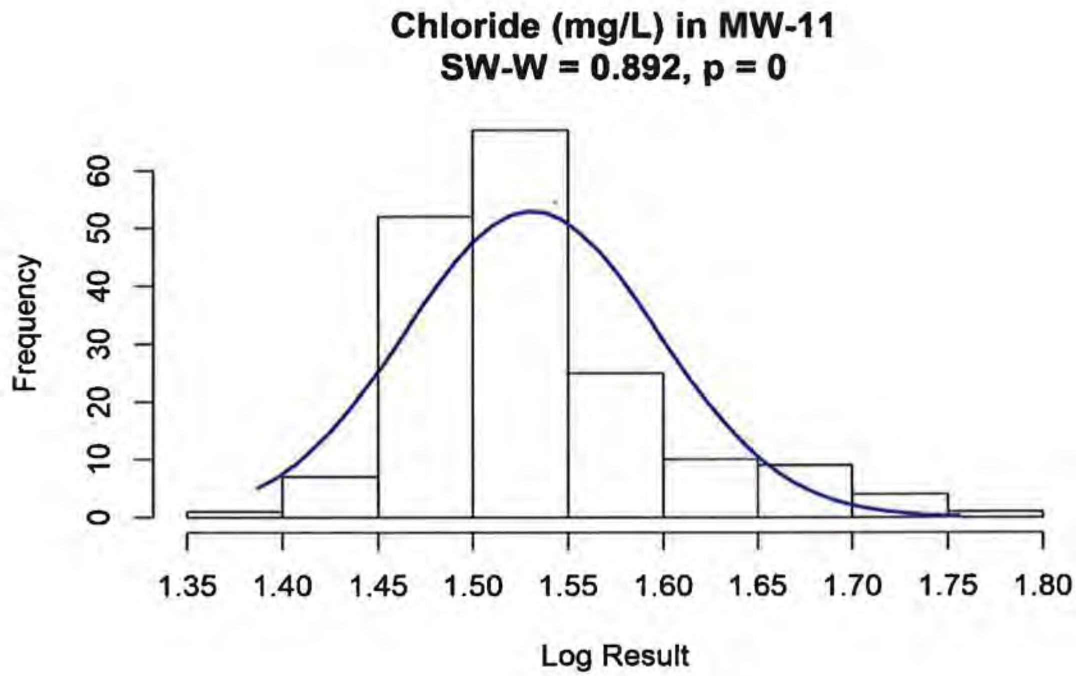


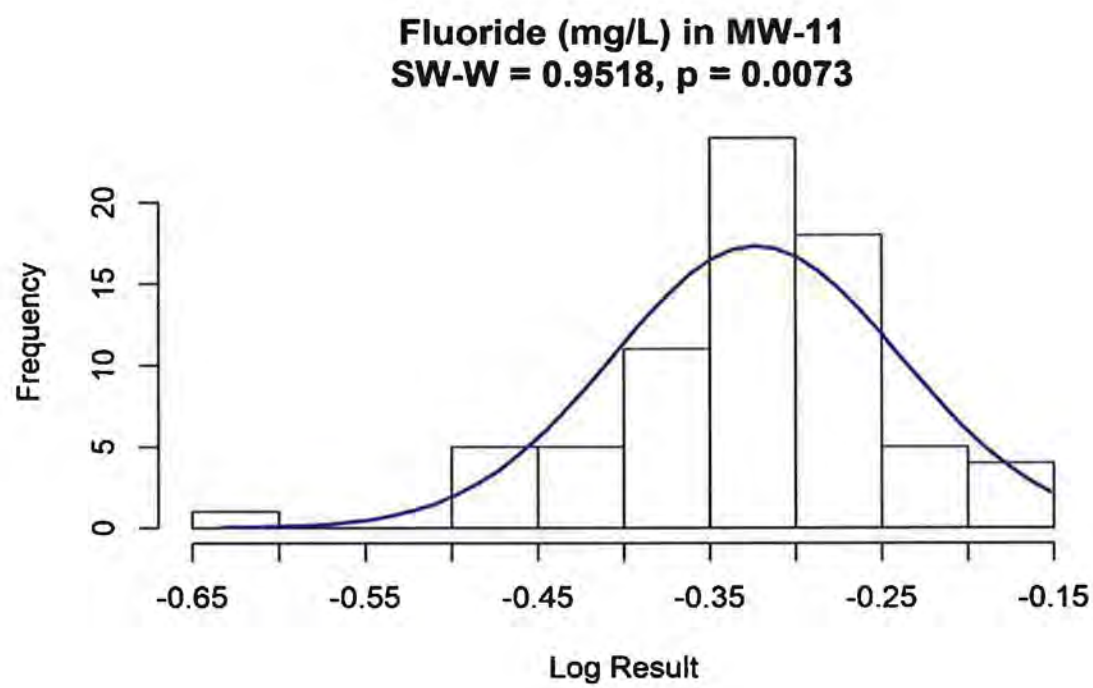
Percent nondetect: 0%
Min: 79, Mean: 1093.39, Max: 2250, Std Dev: 187.52
Upper extreme threshold (Q75 + 3xH): 1726.5
Lower extreme threshold (Q25 - 3xH): 428



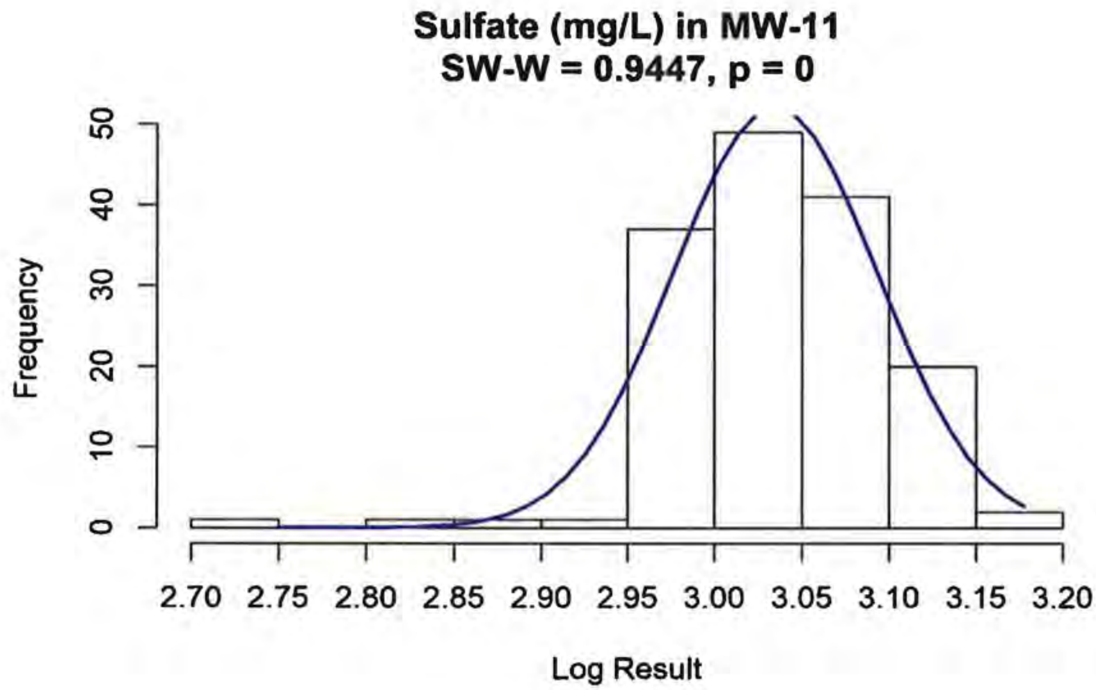
Percent nondetect: 20%
Min: 3e-04, Mean: 0.85, Max: 4, Std Dev: 0.6
Upper extreme threshold (Q75 + 3xH): 2.849850746
Lower extreme threshold (Q25 - 3xH): -1.4373880595

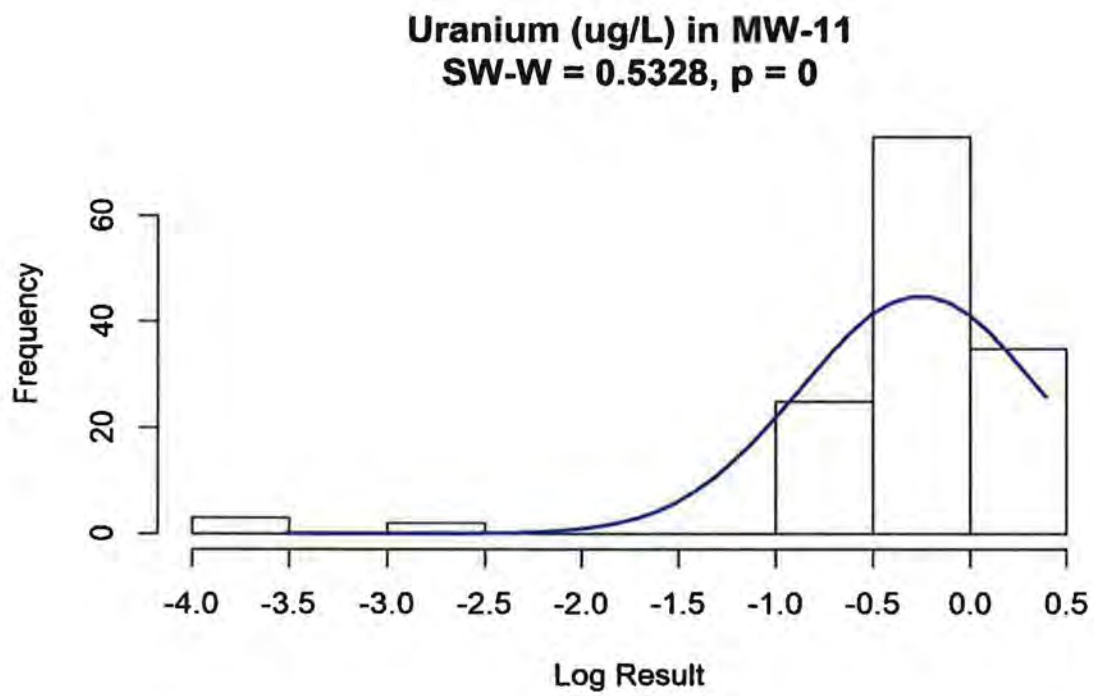
Appendix B-6: Histograms for Indicator Parameters in MW-11



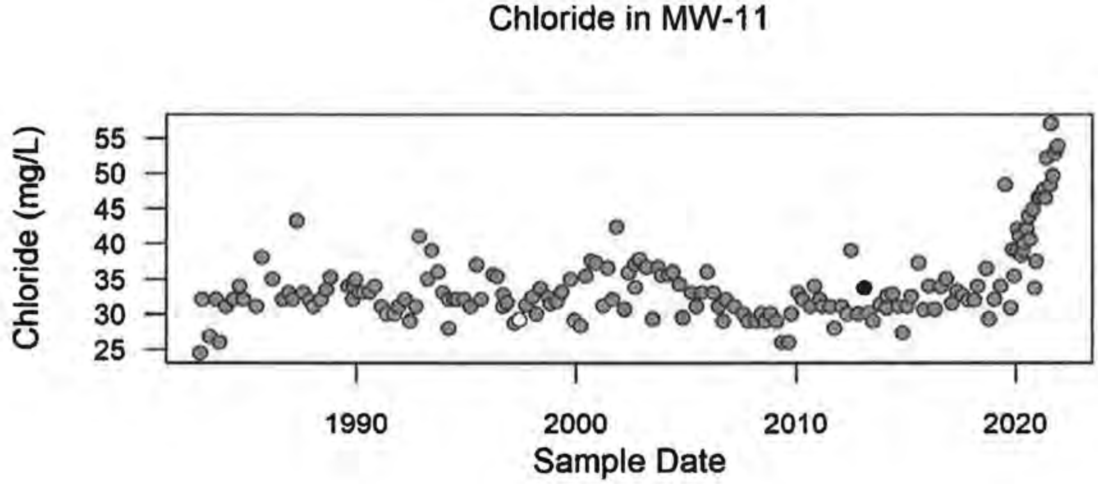


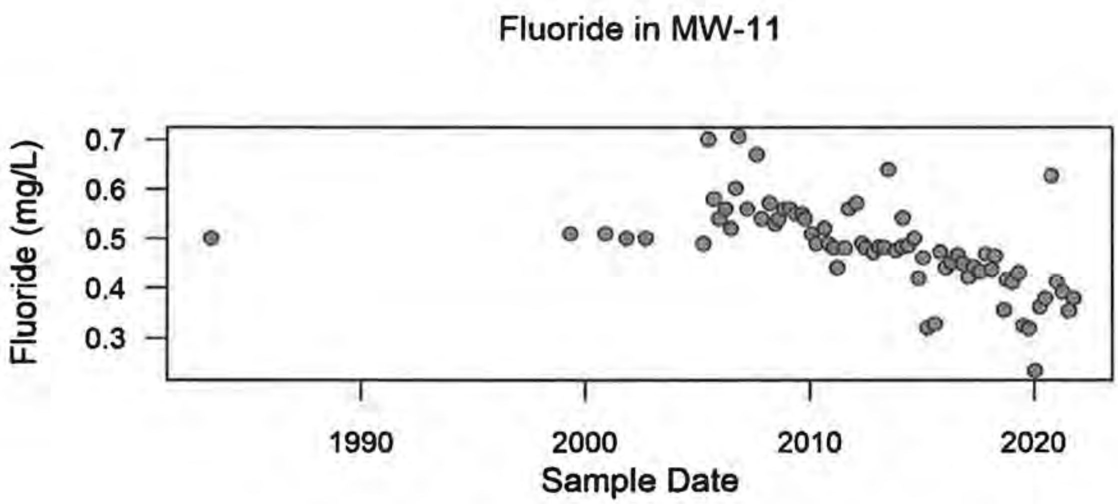
Appendix B-6: Histograms for Indicator Parameters in MW-11



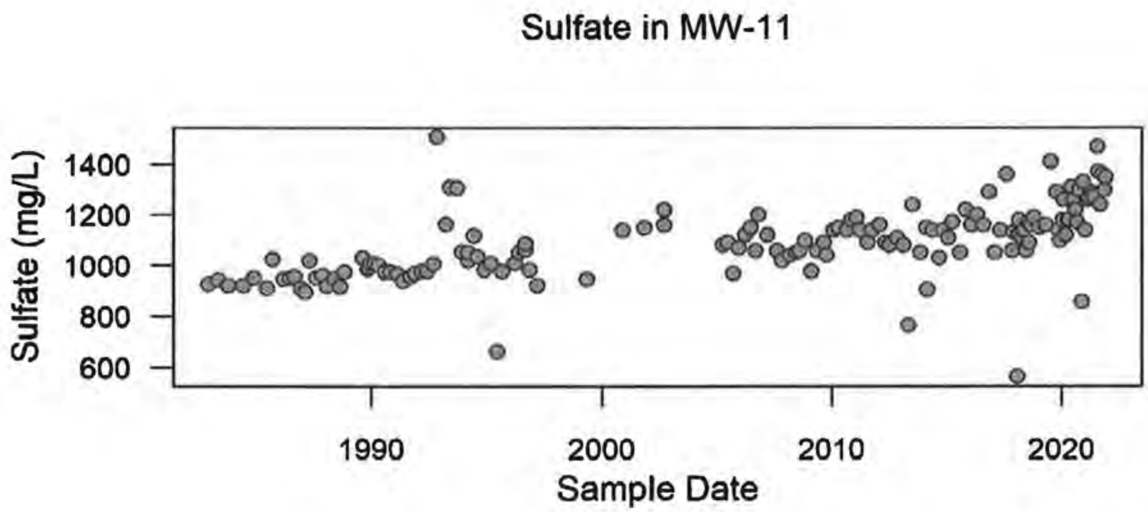


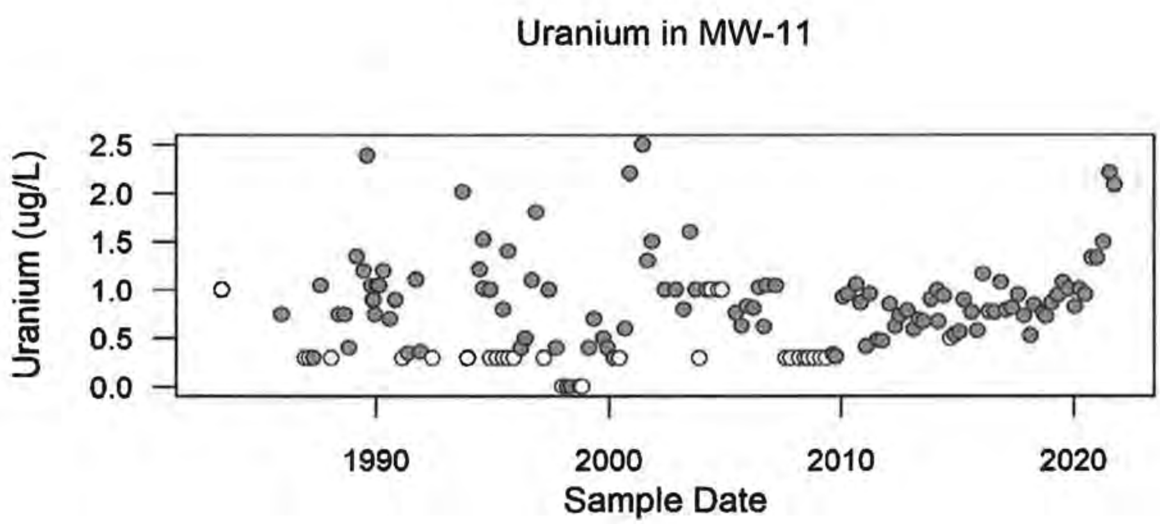
Appendix B-7: Time Series Plots and Linear Regressions for Indicator Parameters in MW-11



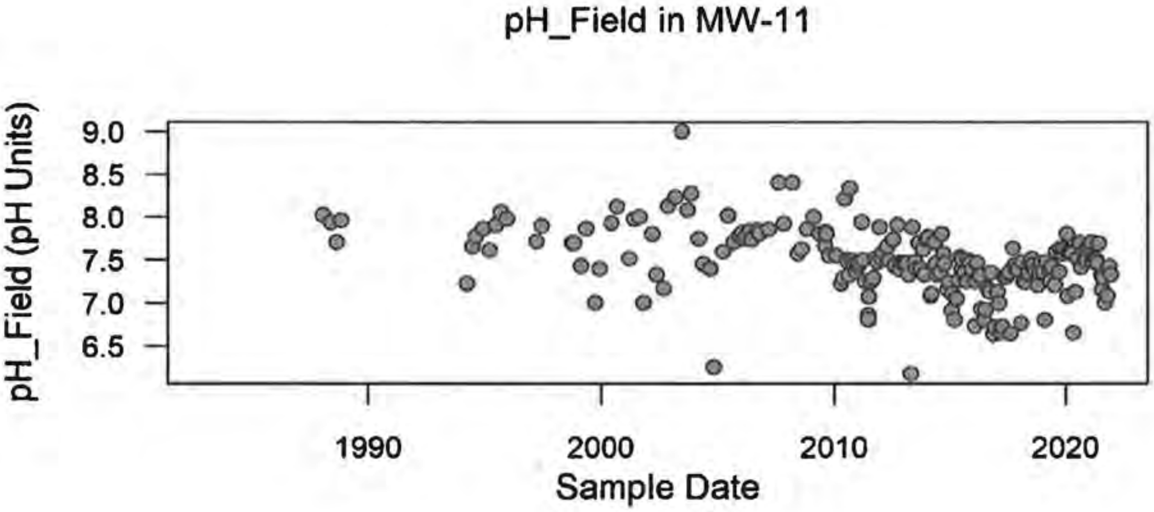


Appendix B-7: Time Series Plots and Linear Regressions for Indicator Parameters in MW-11

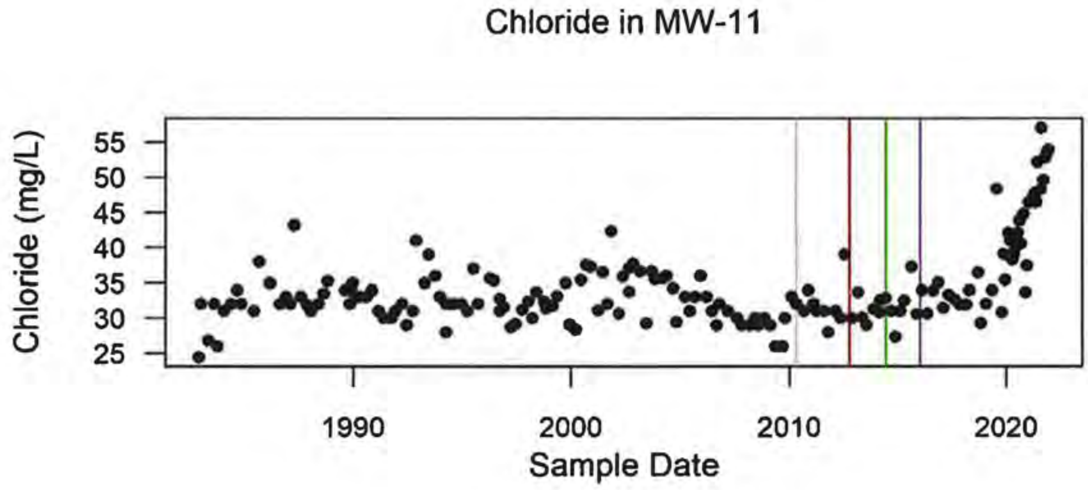


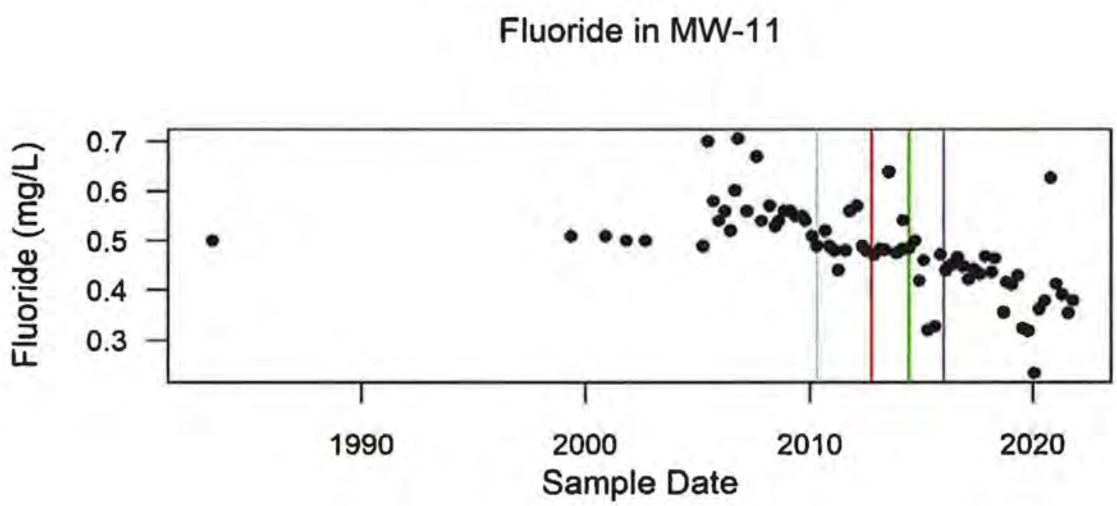


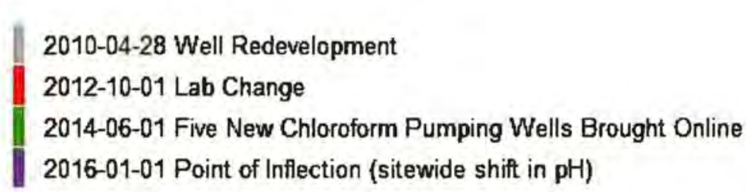
Appendix B-7: Time Series Plots and Linear Regressions for Indicator Parameters in MW-11



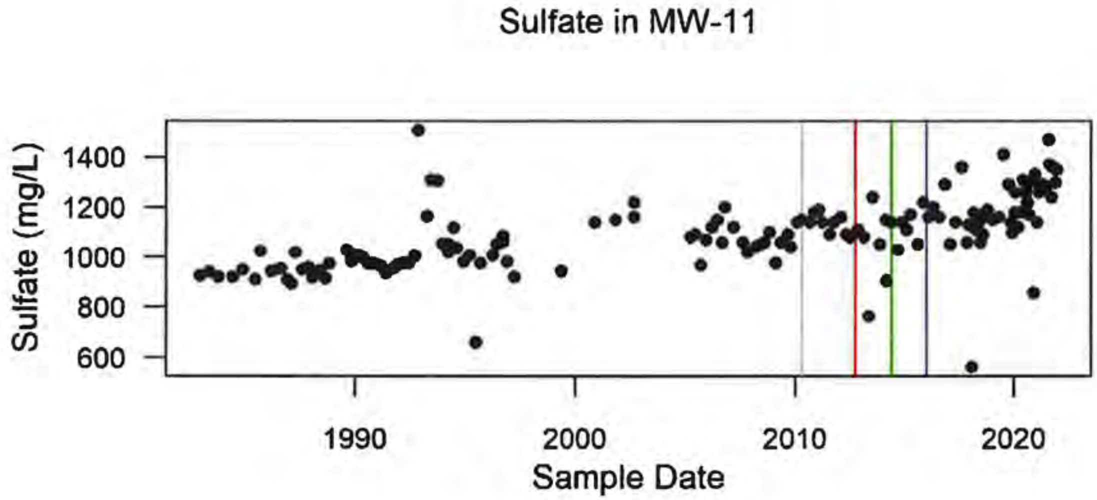
Appendix B-8: Time Series with Events

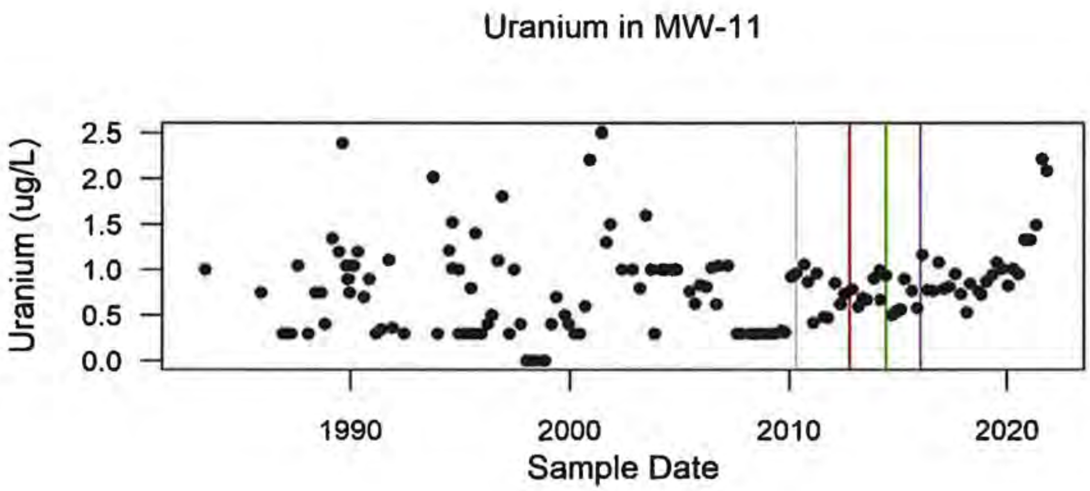






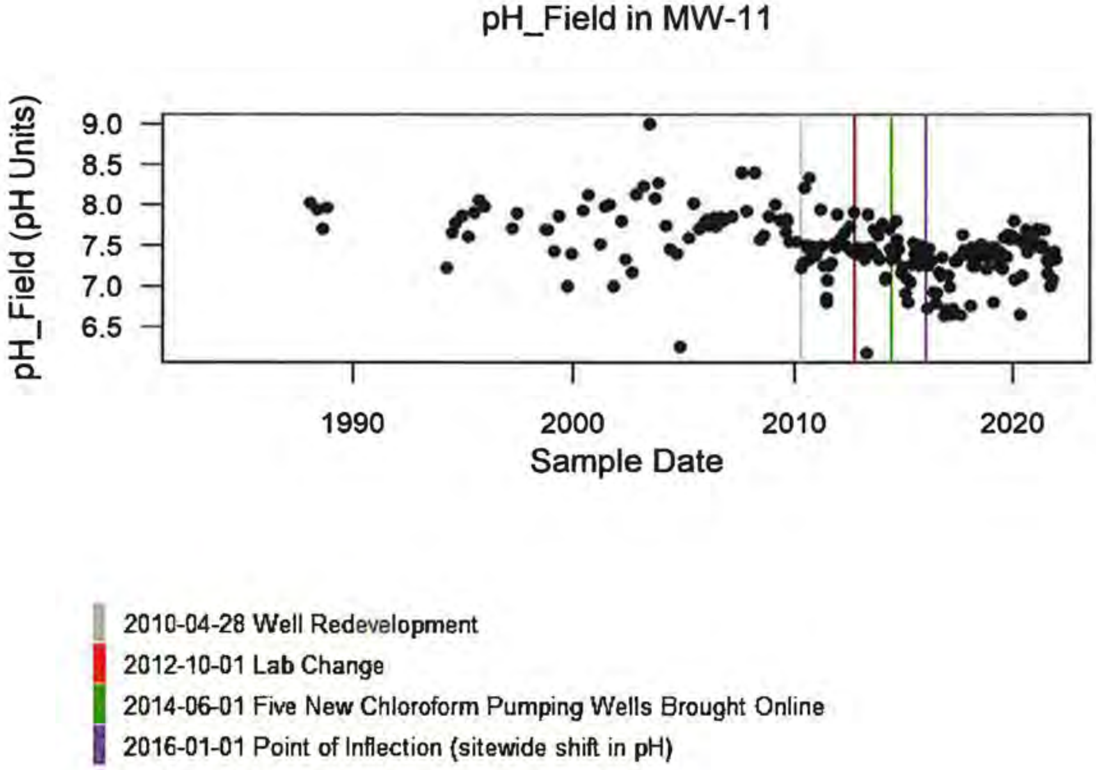
Appendix B-8: Time Series with Events



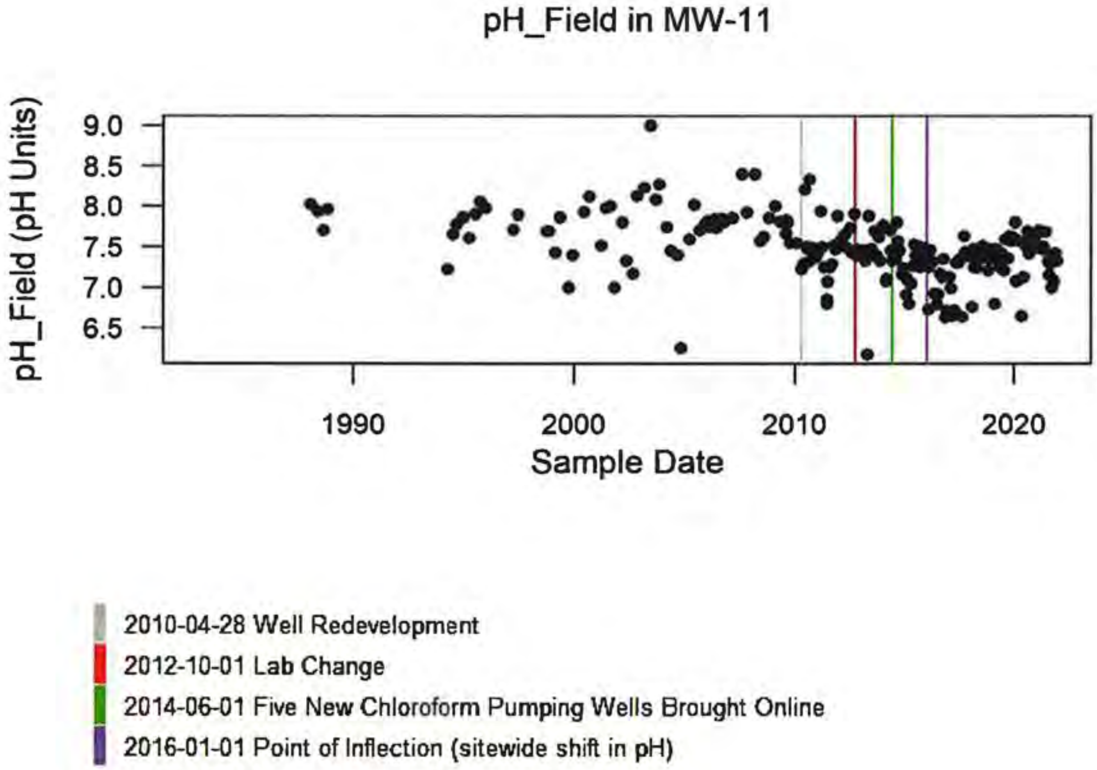


- 2010-04-28 Well Redevelopment
- 2012-10-01 Lab Change
- 2014-06-01 Five New Chloroform Pumping Wells Brought Online
- 2016-01-01 Point of Inflection (sitewide shift in pH)

Appendix B-8: Time Series with Events



Appendix B-8: Time Series with Events



APPENDIX C

Table C.1

Predicted MW-11 Concentrations Based on a Mass Balance Assuming a TMS Impact[1]

constituent	average constituent concentration in TMS	[2]predicted concentration in MW-11 assuming TMS impact	Q4, 2021 measured concentration in MW-11
chloride (mg/L)	28,359	10,526	53
fluoride (mg/L)	3,357	1,242	0.38
sulfate (mg/L)	184,267	69,036	1,360
uranium (ug/L)	401,320	148,490	2.1
manganese (ug/L)	661,044	244,766	286

[1] *assumes water level increase at MW-11 due to TMS impact*

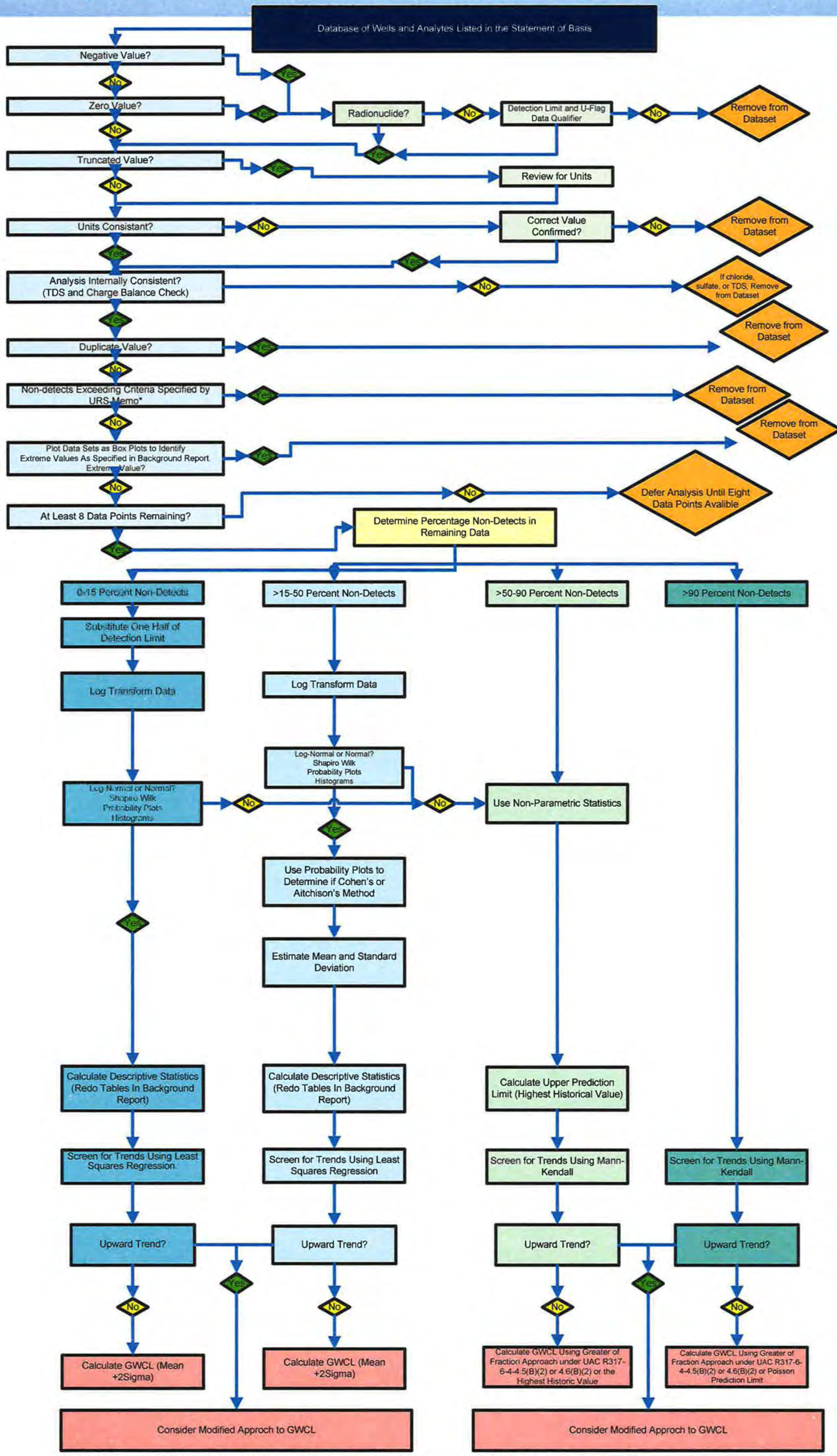
[2] *assumes conservative behavior (no sorption, hydrodynamic dispersion or degradation)*

mg/L = milligrams per liter

ug/L = micrograms per liter

APPENDIX D

Appendix D. Flowsheet
Groundwater Data Preparation and Statistical Process Flow for Calculating Groundwater Protection Standards, White Mesa Mill Site, San Juan County, Utah



*A non-detect considered "insensitive" will be the maximum reporting limit in a dataset and will exceed other non-detects by, for example, an order of magnitude (e.g., <10 versus <1.0 µg/L). In some cases, insensitive non-detects may also exceed detectable values in a dataset (e.g., <10 versus 3.5 µg/L).

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APPENDIX E

Input and Output Files (Electronic Only)