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Monticello Mill Tailings Site
Operable Unit III
Annual Groundwater Report
May 2023–April 2024

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U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

AOA	Area of Attainment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CI	confidence interval
COC	contaminant of concern
DOE	U.S. Department of Energy
FS	Feasibility Study
ft	feet
gpm	gallons per minute
GRO	Groundwater Remedy Optimization
IC	institutional control
lb	pounds
LM	Office of Legacy Management
LOESS	locally estimated scatterplot smoothing
mg/kg	milligrams per kilogram
µg/L	micrograms per liter
mm	millimeters
MMTS	Monticello Mill Tailings Site
MNA	monitored natural attenuation
OU	Operable Unit
PRB	permeable reactive barrier
ZVI	zero-valent iron

Executive Summary

The Monticello Mill Tailings Site (MMTS) Operable Unit (OU) III Annual Groundwater Report documents remedial system performance and alluvial aquifer restoration progress for the period from May 2023 through April 2024. The MMTS and its companion site, the Monticello Vicinity Properties, are operated by the U.S. Department of Energy Office of Legacy Management as the Monticello, Utah, Disposal and Processing Sites. The OU III remedy is monitored natural attenuation and active remediation with institutional controls that restrict alluvial aquifer groundwater use in an area roughly corresponding to the footprint of the uranium plume. The active remediation component of the remedy focuses on the Area of Attainment (AOA), a portion of the alluvial aquifer having the highest uranium groundwater concentrations.

Eight extraction wells, collectively referred to as the Groundwater Remedy Optimization (GRO) system, were installed in the AOA, and pumping started in 2015. Extracted water is piped to an evaporation pond for volume reduction. Because of a need to match extraction rates with pond evaporation rates and limits on the availability of groundwater, only a few of the extraction wells are operated at the same time. The cumulative pumping rate from the GRO system ranges between approximately 2 and 16 gallons per minute as a function of monthly pond evaporation rates. During this performance period, the GRO system removed 3.3 million gallons of groundwater containing 13 pounds (lb) of uranium from the AOA. During the previous performance period from May 2022 to April 2023, the GRO system removed approximately 1.5 million gallons of contaminated groundwater and 8 lb of uranium. The increased groundwater volume and uranium mass extracted during this performance period is due to the increased snowfall in winter 2022–2023. Since system startup in 2015, the GRO system has removed 32.4 million gallons of groundwater and 159 lb of uranium from the AOA. For comparison, an estimated 1400 lb of dissolved and solid-phase uranium are calculated to be remaining in the AOA. AOA uranium groundwater concentrations have been reduced from a maximum of 1400 micrograms per liter (µg/L) at GRO startup (January 2015) to a maximum of 732 µg/L in April 2024. The decline in AOA uranium concentration is primarily attributable to operation of the GRO system.

While AOA uranium concentrations are expected to decline in response to pumping, the decline will be punctuated by periodic increases in uranium concentrations in response to rising water tables or recharge, caused primarily by snowmelt events. Rising water tables or recharge may dissolve solid-phase uranium stored in the vadose zone. Additionally, infiltrating snowmelt dissolves uranium from the margins of the former mill site and a supplemental standard area outside the OU III plume footprint, and the uranium-containing water flows on the top of bedrock and delivers uranium to the margins of the alluvial aquifer.

Bulk plume metrics, including mass, volume, and average concentration, were estimated locally for the AOA and for the OU III uranium plume as a whole. Comparison of 2008 and 2024 bulk uranium plume metrics shows continual improvement of OU III alluvial aquifer groundwater quality resulting primarily from natural attenuation. The OU III uranium plume mass decreased from a maximum of 66 lb in spring 2008 to approximately 30 lb in April 2024. The OU III uranium plume volume has fluctuated between a minimum of 13.7 million gallons and a maximum of 27.6 million gallons from 2001 to 2024, with an average volume near 20 million gallons. The OU III uranium plume average concentration declined from approximately 300 µg/L in 2008 to 150 µg/L by April 2024. Although GRO system operation

reduced AOA uranium groundwater concentrations, concentration reductions can be reversed as a function of changing meteorological conditions. The AOA uranium plume mass decreased from a maximum of 9.7 lb in 2014 to a minimum of 2 lb in 2018. Since spring 2019, the AOA uranium plume mass has generally been increasing due to the increasing plume volume during the same period. Seasonal variations ranging from springtime highs up to 7.0 lb to summertime lows as low as 3.5 lb are notable after spring 2019.

Other contaminants of concern (COCs) in the alluvial aquifer include arsenic, manganese, molybdenum, nitrate, selenium, and vanadium. These contaminants are present in alluvial groundwater at concentrations exceeding their respective remediation goals, but these exceedances are not as widely distributed as those of uranium.

The Burro Canyon Formation water quality results from October 2021 to April 2024 are all below the OU III groundwater remediation goals, with the exception of arsenic (358 µg/L in October 2021) and manganese (891 µg/L in October 2021) in monitoring well 31NE93-205. The 2021 measured arsenic and manganese concentrations are consistent with historical concentrations.

Uranium concentrations in the portion of Montezuma Creek within the former mill site remain below the surface water remediation goal and have decreasing trends. Downstream of the groundwater plume, where the plume has discharged to Montezuma Creek, uranium concentrations in the creek exceeded the surface water remediation goal during the performance period and have stable trends. Other than uranium, surface water COCs include arsenic, selenium, and nitrate. Concentrations of these other surface water COCs were below remediation goals in Montezuma Creek.

Six of the seven seep locations within OU III have declining or stable uranium concentration trends. An increasing uranium concentration trend was identified at Seep 6. The source of the Seep 6 uranium is believed to be tailings-contaminated soil used in a municipal water utility corridor that contains sanitary sewer and secondary water lines. Selenium concentrations exceeded remediation goals at Seep 3 and Seep 6, and nitrate concentrations exceeded remediation goals at Seep 3. Arsenic concentrations did not exceed remediation goals at any of the seep locations. Three of the seven seeps were dry during the sampling events completed during this performance period.

1.0 Introduction

This report provides the annual analysis (May 2023–April 2024) of water quality restoration for Operable Unit (OU) III at the Monticello Mill Tailings Site (MMTS). The MMTS and its companion site, the Monticello Vicinity Properties, are operated by the U.S. Department of Energy (DOE) Office of Legacy Management (LM) as the Monticello, Utah, Disposal and Processing Sites. The MMTS is a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) National Priorities List site in and near the City of Monticello, San Juan County, Utah (Figure 1). Groundwater and surface water at the MMTS are designated as OU III, with water quality restoration managed by LM.

The focus of the Annual Groundwater Report is OU III water quality restoration. Recent study findings separate from Annual Groundwater Report evaluations are reported when relevant. Information related to site history, compliance strategies, hydrogeology, and remedial activities is provided as summaries. Details related to OU III can be found in the documents referenced throughout the report.

In addition, the Annual Groundwater Report focuses on alluvial aquifer uranium groundwater and surface water concentration trends within OU III. Uranium is the most widely distributed OU III groundwater contaminant, is confined to the alluvial aquifer and Montezuma Creek, and is the primary contributor to potential risk to human health. Although other OU III alluvial aquifer contaminants of concern (COCs) were not extensively evaluated, trend graphs and summary tables for those constituents can be found in Appendix A.

COCs are largely absent from bedrock monitoring wells, and water quality results for these wells are not discussed in this report—this report focuses on uranium within the alluvial aquifer. Appendix B presents bedrock monitoring well COC trend graphs. Appendix C contains surface water and seep COC (absent uranium, which is discussed in the report) trend graphs.

1.1 Site History

From 1941 to 1960, a uranium and vanadium mill operated at the MMTS. The majority of groundwater contamination occurred during that time, primarily from infiltration of tailings fluids through the bottom of four unlined tailings impoundments (DOE 1998a). The mill closed in 1960, and the site remained idle until surface remediation began in 1990 in response to the MMTS being placed on the CERCLA National Priorities List in 1989. From 1992 to 1999, mill tailings and tailings-contaminated surface soils were collected from the MMTS (OU I) and peripheral properties (OU II) and encapsulated in an engineered disposal cell on DOE property (Figure 2). OU III sediment, groundwater, and surface water were characterized concurrently with tailings removal. In 1999, a permeable reactive barrier (PRB) was installed to passively treat uranium and vanadium groundwater contamination (Figure 2) (DOE 1998b). A pump-and-treat program was implemented in 2005, and the system was expanded in 2014 (DOE 2008; DOE 2014). The original OU III remedy (2004) was monitored natural attenuation (MNA) with institutional controls (ICs) prohibiting alluvial aquifer groundwater use within an area roughly corresponding to the footprint of the uranium plume, which is contained wholly within the OU III boundary and includes the Area of Attainment (AOA) (DOE 2004b). In 2009, to improve aquifer restoration progress, the remedy was changed to MNA and active remediation combined with the same ICs (DOE 2009a). Section 1.3 provides additional details about OU III groundwater remedial activities.

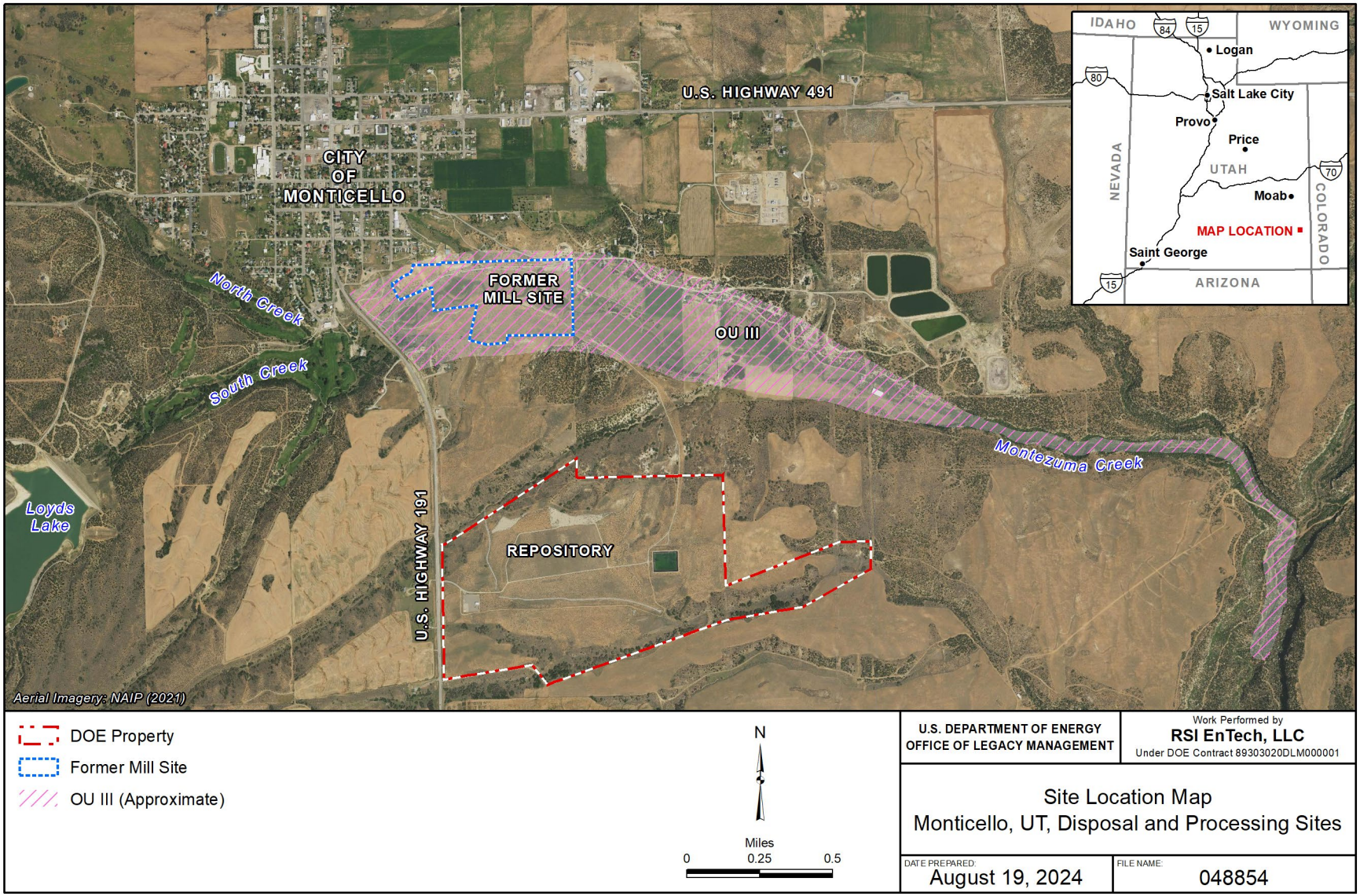


Figure 1. Location of the Monticello Mill Tailings Site

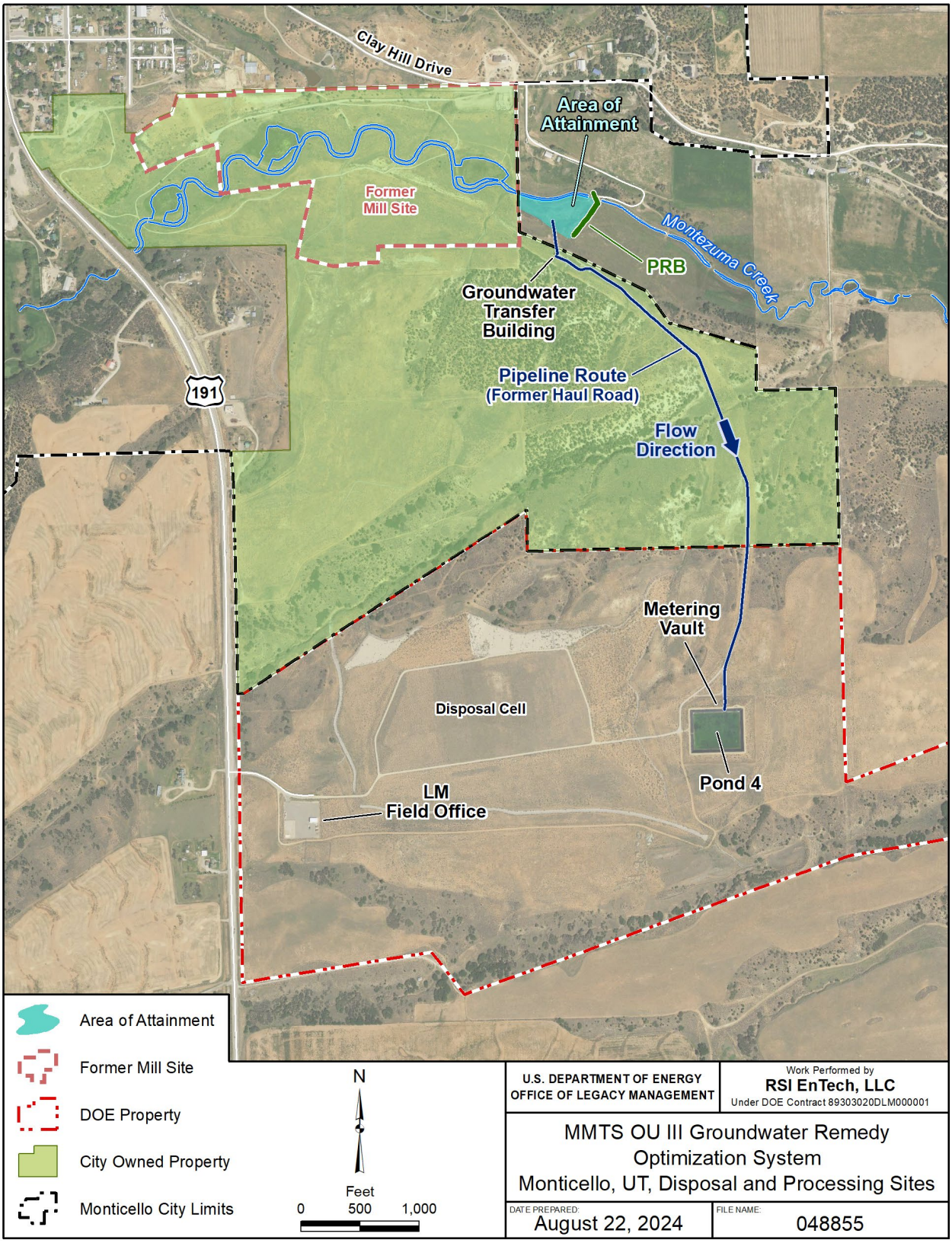


Figure 2. Monticello Mill Tailings Site Features

1.2 Hydrologic Setting

Because groundwater contamination is limited to the alluvial aquifer, the lateral extent of the MMTS hydrologic domain is based on the hydrologic extent of the alluvial aquifer and the distribution of mill-related groundwater contamination (Figure 3). The alluvial aquifer is bounded to the north and south by increasing bedrock elevations, which cause the unconsolidated silts, sands, and gravels composing the aquifer to pinch out. Because mill-related groundwater contamination is absent west of U.S. Highway 191, the western boundary of the MMTS terminates at the highway. To the east, the MMTS hydrologic domain terminates where the Morrison Formation subcrops, downgradient of the area where contaminated alluvial aquifer groundwater discharges to Montezuma Creek upon being displaced by clean Burro Canyon Formation groundwater.

The alluvial aquifer within the MMTS hydrologic domain comprises 10–15 feet (ft) of unconsolidated silts, sands, and gravels. In general, the alluvial aquifer consists of an average of 3–4 ft of sand or gravel overlain by silt extending to ground surface (Figure 3). AOA pumping test results indicate that the sand or gravel layer is semiconfined when groundwater levels extend above the sand or gravel and silt contact (DOE 2019b). Groundwater moves downward from the overlying silt into the underlying sand or gravel primarily during colder periods following recharge events and upward during the growing season in response to evapotranspiration. Within the sand or gravel, groundwater flow is mostly horizontal from west to east, mimicking declining surface topography.

The alluvial aquifer is underlain by the Mancos Shale, Dakota Sandstone, Burro Canyon, and Morrison Formations (Figure 3). The Mancos Shale is not shown in Figure 3 because it is completely eroded away below the aquifer within the valley except to the west of the former mill site. The Dakota Sandstone forms an aquitard beneath the alluvial aquifer until about 0.6 mile downgradient of the former mill site. There, the formation is absent due to erosion in the Montezuma Creek valley. This exposes the permeable Burro Canyon Formation, a regional water supply aquifer, allowing direct hydraulic communication with the alluvial aquifer. Burro Canyon sandstone is underlain by low-permeability mudstones of the Morrison Formation, which subcrop approximately 2 miles east of the MMTS due to erosion in the creek valley.

Due to the low hydraulic conductivity of the Dakota Sandstone, there is minimal hydraulic connection between the Dakota Sandstone and the overlying alluvial aquifer. At some locations within the MMTS hydrologic domain, lithologic logs describe the Dakota Sandstone as being dry. An upward hydraulic gradient develops between the Burro Canyon Formation and the alluvial aquifer 500–2000 ft downgradient of the eastern limit of the Dakota Sandstone in the Montezuma Creek valley.

Montezuma Creek extends the entire length of the MMTS hydrologic domain (Figure 3). Flow in Montezuma Creek is highly variable depending on the season and irrigation returns. During summer months it is not unusual for the creek to be dry over extended lengths. Portions of Montezuma Creek that remain wet during summer months are locations where groundwater discharges to the creek. When creek levels rise in response to precipitation events or irrigation returns, the creek recharges the alluvial aquifer in the area of the former mill site (DOE 2004a).

In the spring following big snow years, creek levels rise enough to recharge the alluvial aquifer throughout OU III. Because the high creek levels temporarily prevent groundwater discharge to the creek, alluvial aquifer groundwater elevations rise everywhere within OU III, a condition, because of storage, that remains for months after creek levels decline.

Precipitation recharge occurs across the entire MMTS hydrologic domain (Figure 3). Infiltration of irrigation water on agricultural land east of the former mill site adds additional water to the MMTS hydrologic domain during the growing season. Lateral inflow associated with precipitation runoff from the surrounding higher elevations also contributes water to the MMTS hydrologic domain. Evapotranspiration removes water from the hydrologic domain, primarily during the summer growing season when plant activity is at a maximum. The water removed by evapotranspiration is a combination of groundwater and percolated precipitation and irrigation water that has yet to reach the water table.

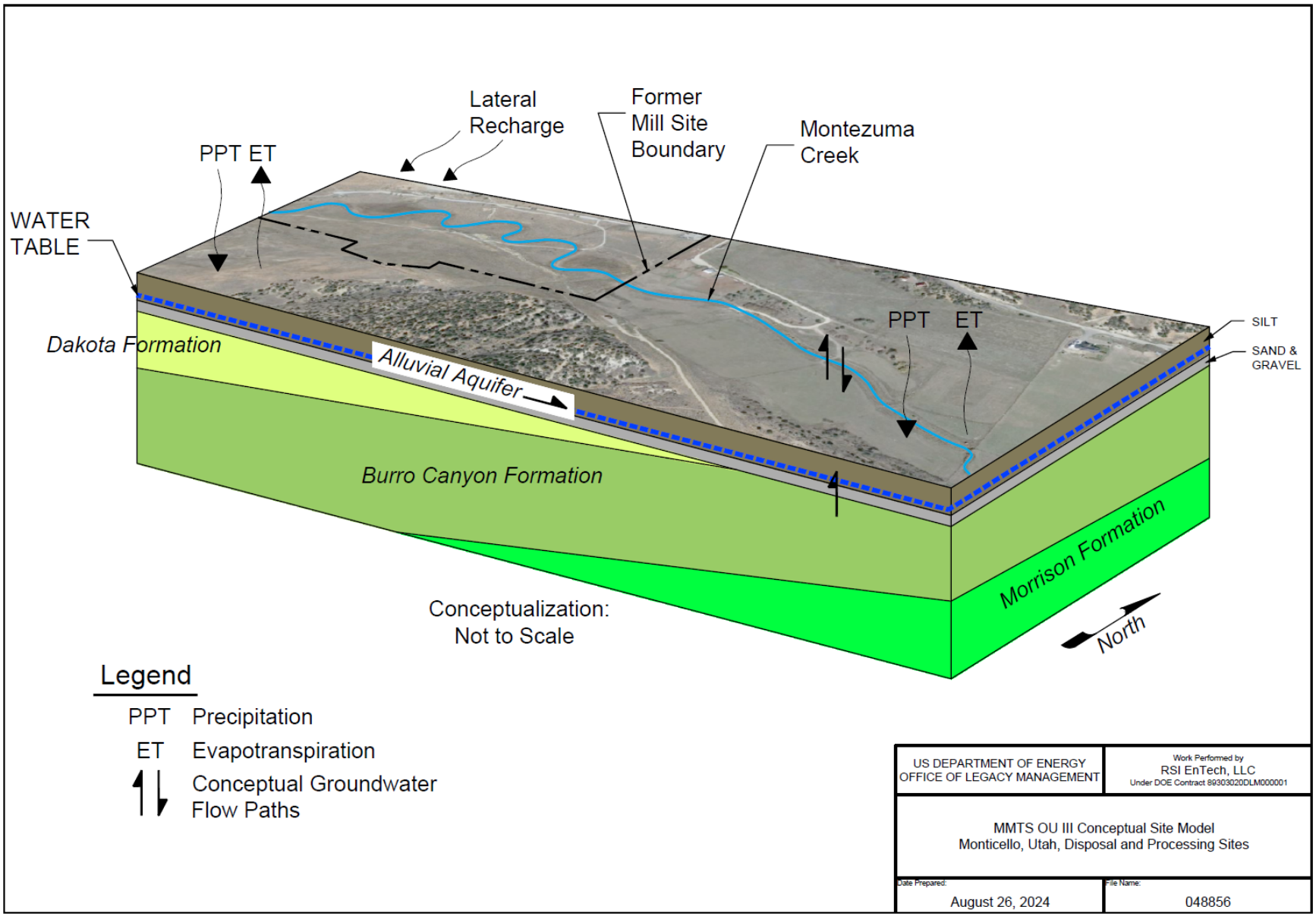


Figure 3. MMTS Hydrogeologic Conceptual Site Model

1.3 Site Remediation, Compliance Strategy, and Water Quality Monitoring

Groundwater and surface water quality characterization performed in the 1990s identified COCs at the MMTS. In 2004, based on evaluations of COC migration and attenuation potentials, groundwater remedial undertakings, risk assessment, groundwater flow and transport modeling, and COC trend evaluations, MNA with ICs prohibiting alluvial aquifer groundwater use within an area roughly corresponding to the uranium plume footprint was selected as the remedy (DOE 2004b). In 2009, the remedy was modified to include active remediation (DOE 2009a). Groundwater and surface water quality sampling is routinely performed to assess COC concentration trends and remedy performance.

1.3.1 COCs and Remedial Goals

Surface water and groundwater sampling conducted during characterization activities identified arsenic, manganese, molybdenum, nitrate, selenium, uranium, vanadium, and gross alpha and gross beta activity as OU III COCs (DOE 2004b). Table 1 lists the remediation goals for these constituents in groundwater and surface water.

Table 1. OU III COCs and Groundwater and Surface Water Remediation Goals

COC[a]	OU III Groundwater Remediation Goals[a]	Surface Water Remediation Goals[a,b]
Arsenic	10 µg/L[c]	10 µg/L
Manganese	880 µg/L[d]	—
Molybdenum	100 µg/L[e]	—
Nitrate (as nitrogen)	10,000 µg/L[c]	4000 µg/L
Selenium	50 µg/L[c]	5 µg/L
Uranium—metal toxicity	30 µg/L[c]	—
Vanadium	330 µg/L[d]	—
Uranium-234 plus Uranium-238—radiological dose	30 pCi/L[e]	30 pCi/L[b]
Gross alpha activity	15 pCi/L[c,f]	15 pCi/L[g]

Notes:
[a] From DOE (2004b).
[b] State of Utah's standard for surface water; Utah's uranium standard postdates the OU III Record of Decision (DOE 2004b).
[c] U.S. Environmental Protection Agency's (EPA) maximum contaminant level in the Safe Drinking Water Act.
[d] Based on OU III human health risk assessment.
[e] EPA's maximum concentration limit established for the Uranium Mill Tailings Remedial Action Project.
[f] Excluding uranium and radon.
[g] Excluding uranium and radon for MMTS OU III.

Abbreviations:
µg/L = micrograms per liter
pCi/L= picocuries per liter

1.3.2 Timeline

Table 2 provides a timeline of MMTS remedial activities and when various compliance remedies were adopted. Note that neither the 1999 PRB installation nor the extraction well

installed in 2005 was a requirement of the original MNA with ICs remedy. OU III ICs prohibit alluvial aquifer groundwater use within an area roughly corresponding to the footprint of the uranium plume. The decision to change the remedy from MNA with ICs to MNA and active remediation was based on a 2007 evaluation (DOE 2007) that showed COC concentrations were not declining within OU III at the rate predicted by modeling. To increase uranium mass removal, eight extraction wells were installed and pumped in an area within OU III having the highest alluvial aquifer uranium concentrations (DOE 2014). Additional details related to remediation and compliance remedies can be found in the references listed in Table 2.

Table 2. Summary of Site Remedial Activities and Compliance Remedies

Activity	Date	References
MMTS OU I and OU II remedial actions initiated.	1992	DOE 1990; DOE 2002b
Surface remediation of mill site started.	May 1997	DOE 2000; DOE 2001
PRB treatability study started for OU III.	June 1999	DOE 1998b; DOE 2002a; DOE 2006a; DOE 2006b
Tailings removal completed from OU I and OU II.	August 1999	DOE 2002b; DOE 2004a
Mill site restoration completed (OU I).	August 2001	DOE 2004a
Record of Decision (ROD) for OU III signed. The ROD documented MNA and continued maintenance of ICs as the selected remedy for OU III.	May 2004	DOE 2004b
Ex situ groundwater treatment system installed as a treatability study for OU III.	2005	DOE 2008
Ex situ groundwater treatment system expanded.	2007	DOE 2008
Explanation of Significant Difference issued to implement a pump-and-treat contingency remedy for MMTS OU III.	January 2009	DOE 2009a
Groundwater Remedy Optimization system installed in the AOA.	2014	DOE 2014; DOE 2016

1.3.3 AOA Extraction Well Field, Monitoring Well Network, and Pumping Schedule

In 2014, eight extraction wells, collectively referred to as the Groundwater Remedy Optimization (GRO) system, were installed upgradient of the PRB (Figure 4) to improve uranium mass removal rates from groundwater in a portion of the alluvial aquifer having the highest uranium concentrations and the greatest saturated thickness (i.e., in the AOA) (Figure 2). The concept behind the GRO system was that focused pumping in the AOA would increase uranium mass removal rates relative to ambient mass removal rates and lessen the time required to reach the OU III uranium groundwater remediation goal of 30 micrograms per liter (µg/L).

In 2014, 16 monitoring wells (Figure 4) were installed in the AOA to monitor trends in groundwater levels and groundwater quality. Six additional monitoring wells were installed in 2017 north of Montezuma Creek (Figure 4) to assess uranium groundwater concentration and groundwater elevation trends in an area that may or may not be influenced by GRO system operation. When Montezuma Creek is dry, it may be possible that groundwater in the area of the six monitoring wells flows under the creek and is captured by the GRO system. When Montezuma Creek levels are sufficiently high, the creek recharges the alluvial aquifer, which might prevent groundwater from flowing under the creek to the GRO extraction wells.

Groundwater extracted by the GRO extraction wells is piped to Pond 4 (Figure 2), where the extracted volume is reduced by evaporation. Maintaining the Pond 4 level at a constant elevation requires matching the GRO system monthly cumulative extraction rates to mean monthly pond evaporation rates, which can be zero when the pond is frozen, but generally range between 2 gallons per minute (gpm) during cooler months and 16 gpm during warmer months (Figure 5) (DOE 2018a). In 2017, an evaluation (ranking test) assessed individual extraction well uranium mass removal rates at different pumping rates (DOE 2018a). The evaluation found that extraction well uranium effluent concentration was independent of the pumping rate, suggesting that individual extraction wells should be pumped at the highest rate possible. The evaluation also determined that to maximize uranium mass removal, priority should be given to pumping the extraction wells having the highest uranium effluent concentrations. Based on the evaluation results, a monthly pumping schedule was developed that maximizes AOA uranium mass removal while matching monthly pond evaporation rates (Table 3). Because the listed pumping schedule is based on mean monthly pond evaporation rates, and the actual monthly pond evaporation rates will differ from the mean values, the pumping schedule is adjusted each month to match actual pond evaporation rates, based on the concept that extraction wells having the highest effluent uranium concentrations should be preferentially operated over extraction wells having lower effluent concentrations. Thus, when pond levels drop below a prescribed elevation (approximately 50% capacity), GRO pumping is increased, and when pond levels rise above the prescribed pond elevation, GRO pumping is decreased. GRO system operation also depends on the availability of groundwater in the alluvial aquifer. During dry conditions, there may be insufficient groundwater in the AOA to match pumping rates to pond evaporation rates. Under these circumstances, the pond level drops until wetter conditions prevail, when pumping rates can be increased to exceed evaporation rates and return the pond level to its target elevation.

1.3.4 Groundwater and Surface Water Monitoring Schedule and Locations

OU III groundwater and surface water samples were collected in October 2023 (fall) and April 2024 (spring), as listed in Table 4. In addition, a number of monitoring wells are sampled once every 5 years (Table 4). Figure 6 shows the OU III monitoring well locations and surface water sampling locations, and Figure 7 shows monitoring locations within and adjacent to the PRB.

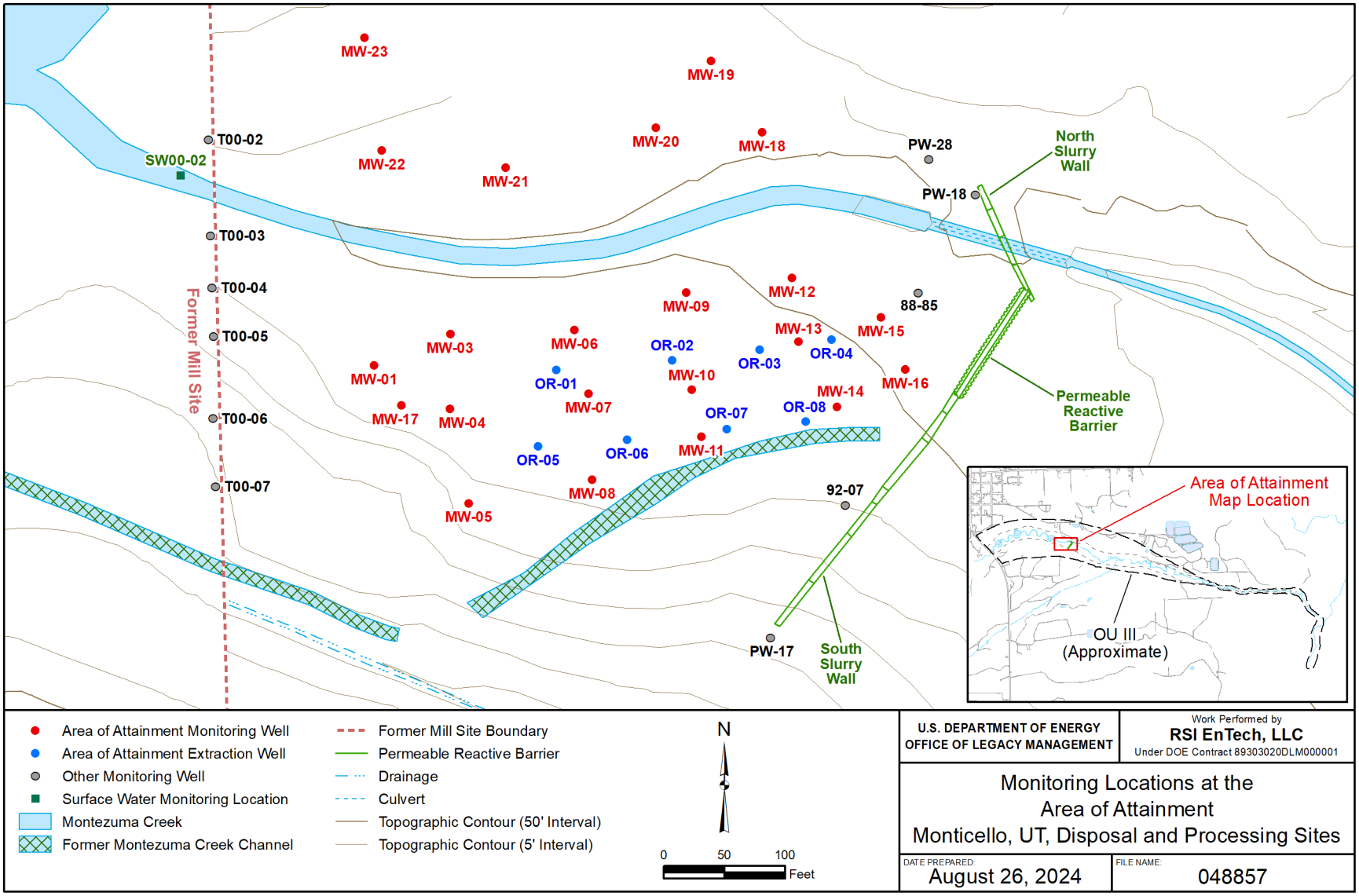


Figure 4. AOA Extraction and Monitoring Well Locations

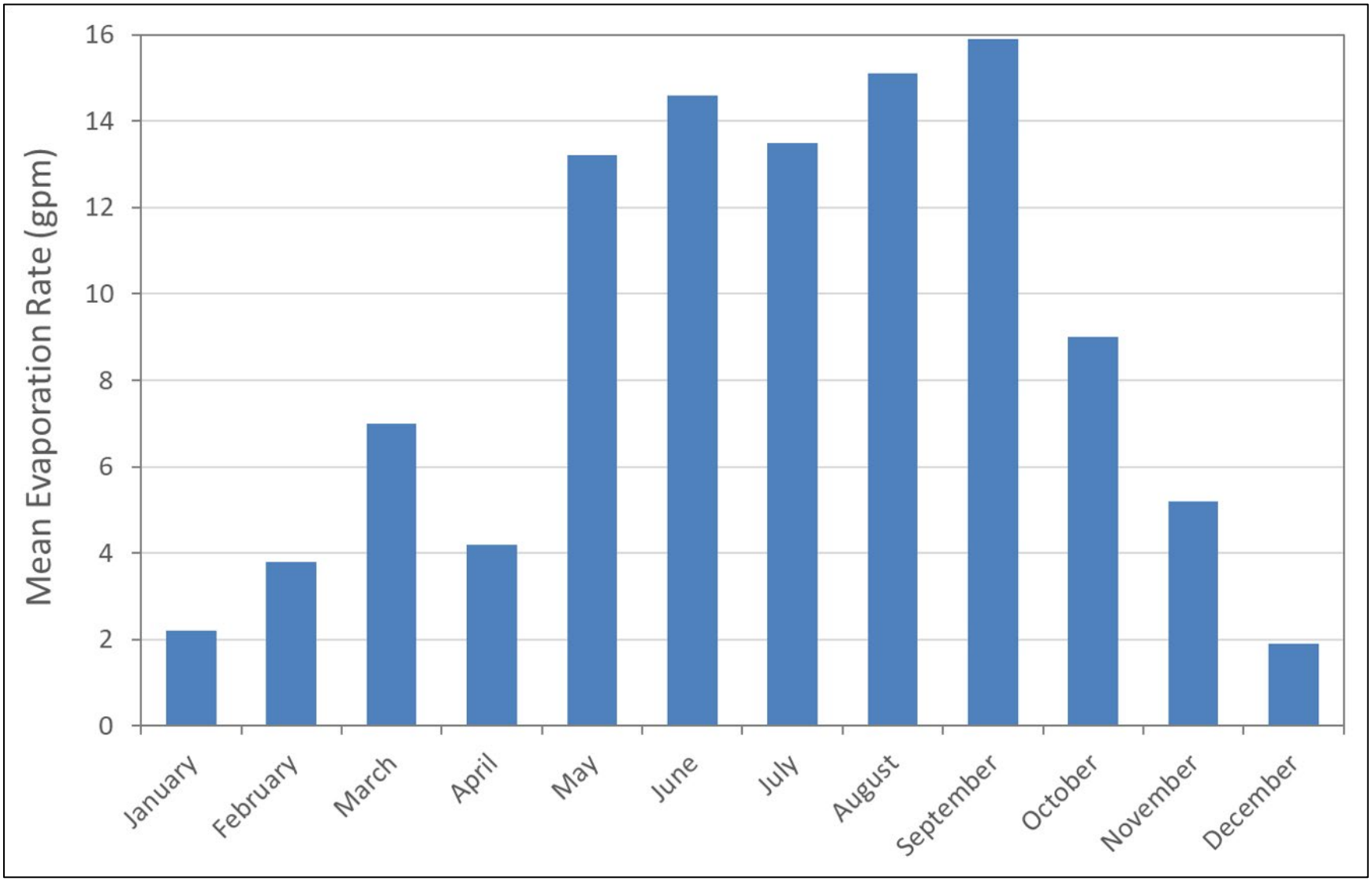


Figure 5. Pond 4 Monthly Average Evaporation Rates

Table 3. Nominal Monthly GRO Pumping Schedule

Month	Extraction Well			OR-2		OR-3		OR-5		OR-6		OR-7		OR-8	
	Uranium Concentration, µg/L			675		550		675		675		700		475	
	Average Pond Evaporation Rate, gpm	Total Extraction Rate, gpm	Total Mass Uranium Removed, lb	Extraction Rate, gpm	Mass Uranium Removed, lb	Extraction Rate, gpm	Mass Uranium Removed, lb	Extraction Rate, gpm	Mass Uranium Removed, lb	Extraction Rate, gpm	Mass Uranium Removed, lb	Extraction Rate, gpm	Mass Uranium Removed, lb	Extraction Rate, gpm	Mass Uranium Removed, lb
Jan	2.2	2.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.6	0.0	0.0
Feb	3.8	3.8	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.9	0.0	0.0
Mar	7.0	7.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.8	4.0	1.0	0.0	0.0
Apr	4.2	4.2	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	1.1	0.0	0.0
May	13.2	13.2	3.4	2.5	0.6	0.0	0.0	3.0	0.8	3.5	0.9	4.2	1.1	0.0	0.0
Jun	14.6	14.6	3.5	2.5	0.6	1.4	0.3	3.0	0.7	3.5	0.9	4.2	1.1	0.0	0.0
Jul	13.5	13.7	3.5	2.5	0.6	0.5	0.1	3.0	0.8	3.5	0.9	4.2	1.1	0.0	0.0
Aug	15.1	14.1	3.5	1.5	0.4	2.1	0.4	3.0	0.8	3.5	0.9	4.0	1.0	0.0	0.0
Sep	15.9	14.9	3.5	1.5	0.4	2.0	0.4	3.0	0.7	3.5	0.9	4.0	1.0	0.9	0.2
Oct	9.0	9.1	2.3	0.8	0.2	0.0	0.0	0.8	0.2	3.5	0.9	4.0	1.0	0.0	0.0
Nov	5.2	5.2	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.3	4.0	1.0	0.0	0.0
Dec	1.9	1.9	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.5	0.0	0.0

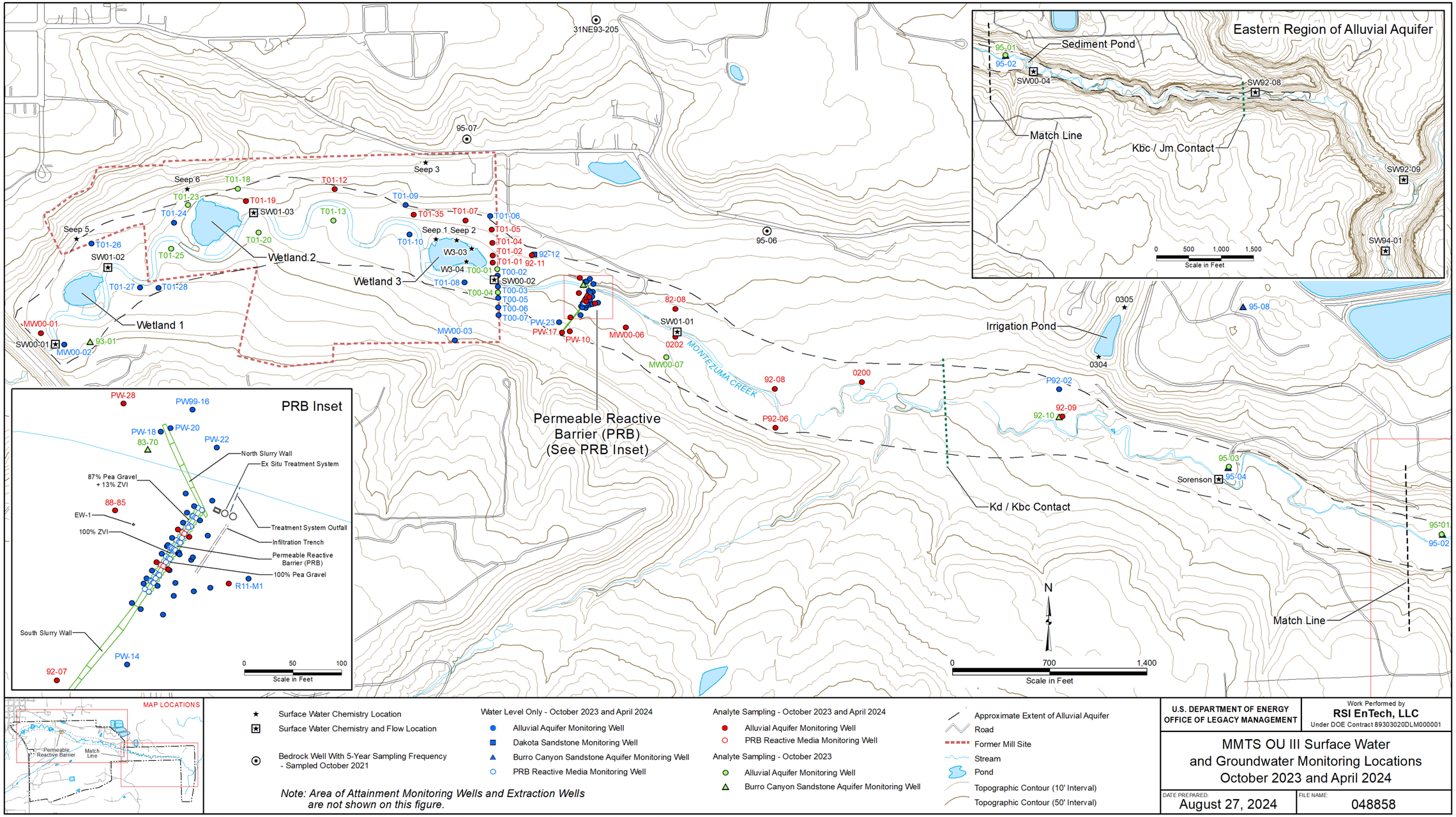
Abbreviation:
lb = pounds

Table 4. OU III Monitoring Well Sampling Schedule

Well	Aquifer/Formation Monitored	October 2023 (Fall)	April 2024 (Spring)	Every 5 Years, Last Sampled October 2021
0200	Alluvial	Yes	Yes	No
0202	Alluvial	Yes	Yes	No
82-08	Alluvial	Yes	Yes	No
83-70	Burro Canyon	Yes	No	No
88-85	Alluvial	Yes	Yes	No
92-07	Alluvial	Yes	Yes	No
92-08	Alluvial	Yes	Yes	No
92-09	Alluvial	Yes	Yes	No
92-10	Burro Canyon	Yes	No	No
92-11	Alluvial	Yes	Yes	No
93-01	Burro Canyon	Yes	No	No
95-01	Alluvial	Yes	No	No
95-03	Alluvial	Yes	No	No
MW00-01	Alluvial	Yes	Yes	No
MW00-06	Alluvial	Yes	Yes	No
MW00-07	Alluvial	Yes	No	No
MW-01	Alluvial	Yes	Yes	No
MW-03	Alluvial	Yes	Yes	No
MW-04	Alluvial	Yes	Yes	No
MW-05	Alluvial	Yes	Yes	No
MW-06	Alluvial	Yes	Yes	No
MW-07	Alluvial	Yes	Yes	No
MW-08	Alluvial	Yes	Yes	No
MW-09	Alluvial	Yes	Yes	No
MW-10	Alluvial	Yes	Yes	No
MW-11	Alluvial	Yes	Yes	No
MW-12	Alluvial	Yes	Yes	No
MW-13	Alluvial	Yes	Yes	No
MW-14	Alluvial	Yes	Yes	No
MW-15	Alluvial	Yes	Yes	No
MW-16	Alluvial	Yes	Yes	No
MW-17	Alluvial	Yes	Yes	No
MW-18	Alluvial	Yes	Yes	No
MW-19	Alluvial	Yes	Yes	No
MW-20	Alluvial	Yes	Yes	No
MW-21	Alluvial	Yes	Yes	No
MW-22	Alluvial	Yes	Yes	No
MW-23	Alluvial	Yes	Yes	No
OR-01	Alluvial	Yes	Yes	No
OR-02	Alluvial	Yes	Yes	No

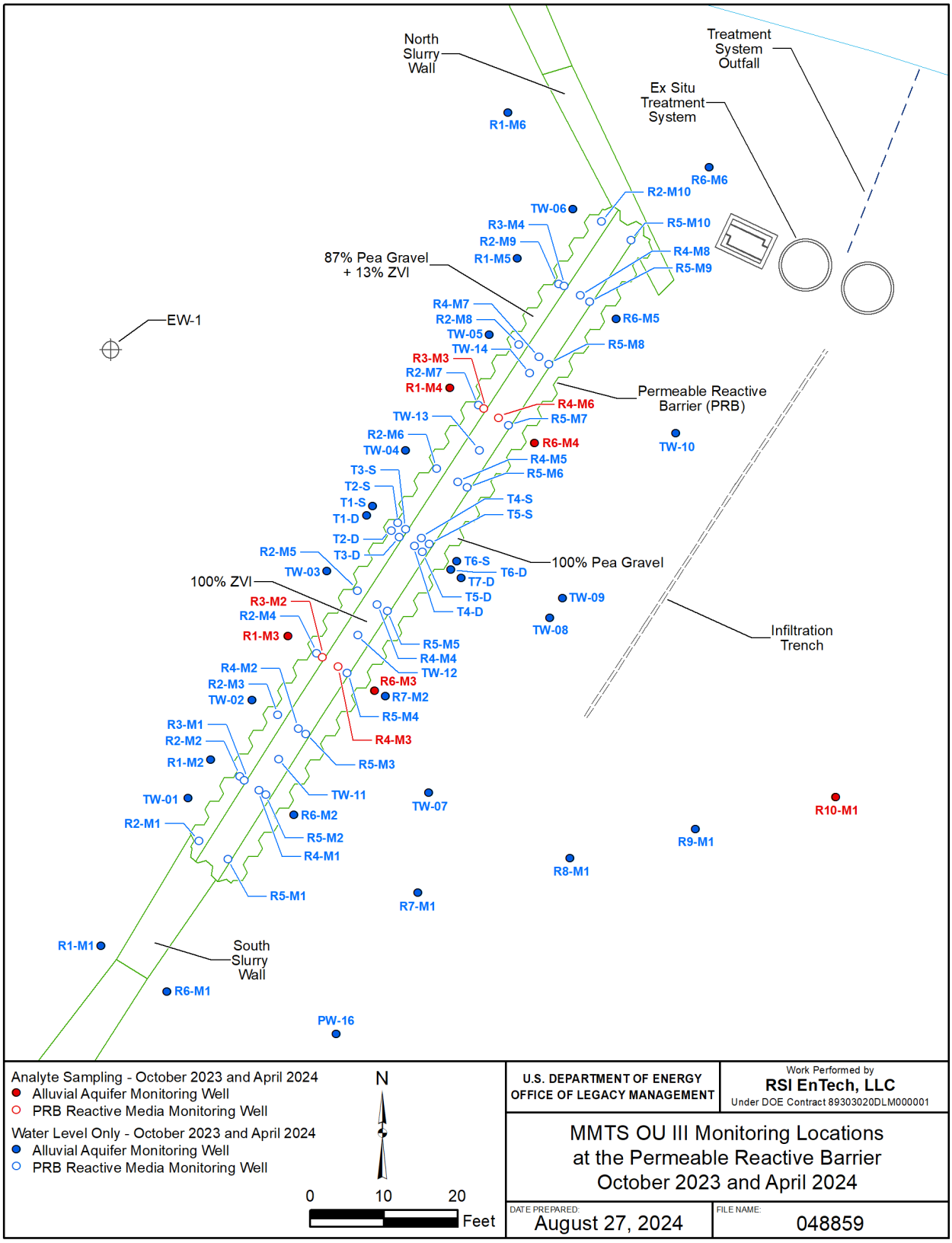
Table 4. OU III Monitoring Well Sampling Schedule (continued)

Well	Aquifer/Formation Monitored	October 2023 (Fall)	April 2024 (Spring)	Every 5 Years, Last Sampled October 2021
OR-03	Alluvial	Yes	Yes	No
OR-04	Alluvial	Yes	Yes	No
OR-05	Alluvial	Yes	Yes	No
OR-06	Alluvial	Yes	Yes	No
OR-07	Alluvial	Yes	Yes	No
OR-08	Alluvial	Yes	Yes	No
P92-06	Alluvial	Yes	Yes	No
PW-10	Alluvial	Yes	Yes	No
PW-17	Alluvial	Yes	Yes	No
PW-28	Alluvial	Yes	Yes	No
R10-M1	Alluvial	Yes	Yes	No
R1-M3	Alluvial	Yes	Yes	No
R1-M4	Alluvial	Yes	Yes	No
R3-M2	Alluvial	Yes	Yes	No
R3-M3	Alluvial	Yes	Yes	No
R4-M3	Alluvial	Yes	No	No
R4-M6	Alluvial	Yes	Yes	No
R6-M3	Alluvial	Yes	No	No
R6-M4	Alluvial	Yes	No	No
T00-01	Alluvial	Yes	No	No
T00-04	Alluvial	Yes	No	No
T01-01	Alluvial	No	Yes	No
T01-02	Alluvial	Yes	Yes	No
T01-04	Alluvial	Yes	Yes	No
T01-05	Alluvial	Yes	Yes	No
T01-07	Alluvial	Yes	Yes	No
T01-12	Alluvial	Yes	Yes	No
T01-13	Alluvial	Yes	No	No
T01-18	Alluvial	Yes	No	No
T01-19	Alluvial	Yes	Yes	No
T01-20	Alluvial	Yes	No	No
T01-23	Alluvial	Yes	No	No
T01-25	Alluvial	Yes	No	No
T01-35	Alluvial	Yes	Yes	No
31NE93-205	Burro Canyon	No	No	Yes
95-06	Burro Canyon	No	No	Yes
95-07	Burro Canyon	No	No	Yes



Abbreviations: Jm = Jurassic Morrison Formation, Kbc = Cretaceous Burro Canyon Formation, Kd = Cretaceous Dakota Sandstone, ZVI = zero-valent iron

Figure 6. OU III Water Quality Monitoring Locations



Abbreviation: ZVI = zero-valent iron

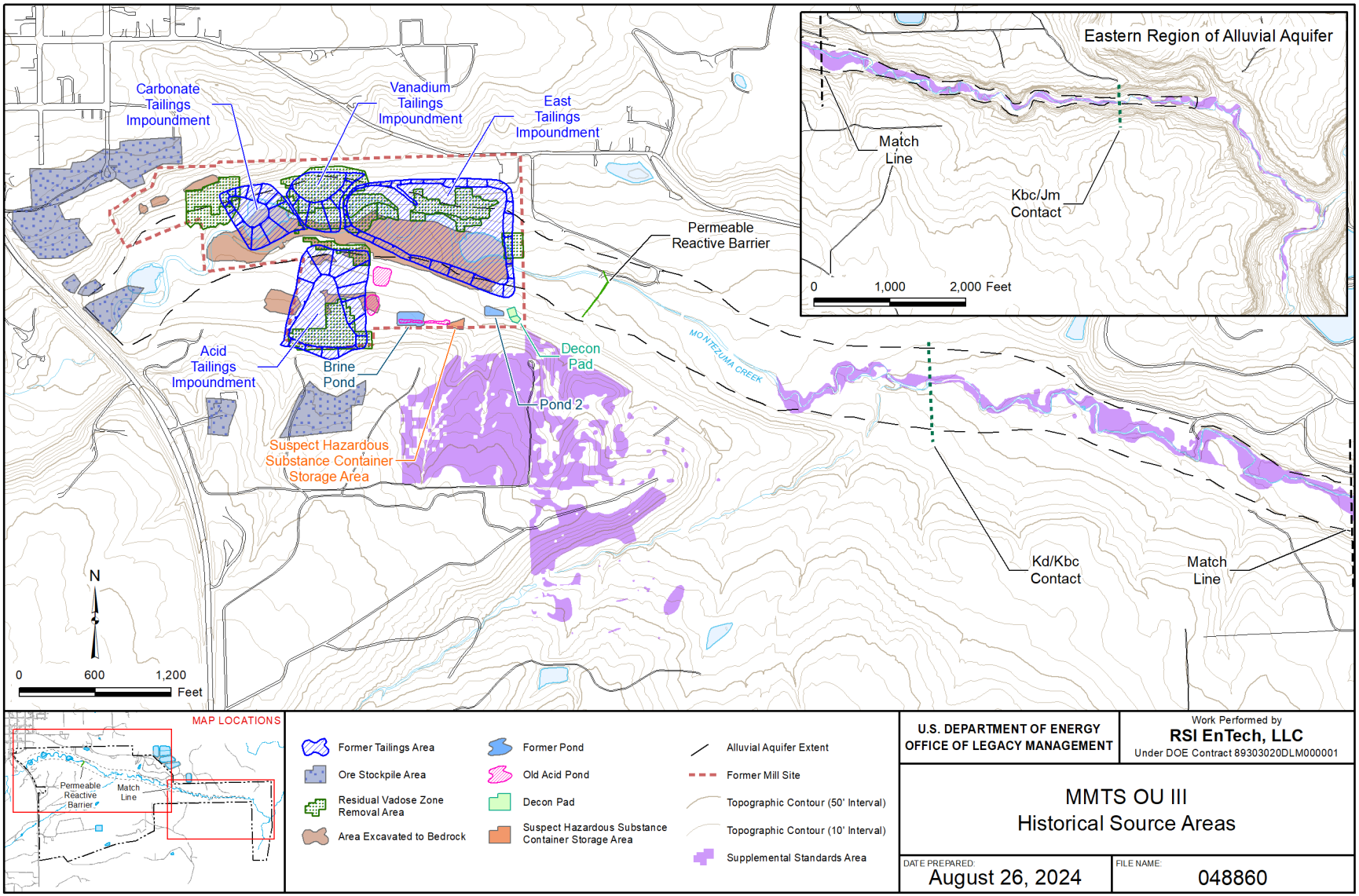
Figure 7. Location of PRB Monitoring Wells

1.4 Source Area Geometry and Mass

The locations of historic uranium sources at the MMTS are shown in Figure 8. The primary source of uranium and other contaminants to the alluvial aquifer was the four unlined tailings impoundments that were active during milling operations (1941 to 1960). The tailings impoundments covered approximately 44 acres and were removed between 1997 and 1999 during surface remediation activities. Tailings and contaminated soils associated with the tailings impoundments were removed and encapsulated in the onsite disposal cell. The estimated uranium mass associated with the tailings and contaminated soils removed from the mill site during surface remediation is 2 million pounds (lb) (DOE 2021).

Soils beneath portions of the MMTS tailings impoundments were removed down to or near bedrock (Figure 8), thus removing a significant mass of solid-phase uranium that is an ongoing source at other sites (DOE 2018b). During milling, tailings fluids were either very acidic (pH approximately 2) or very basic (pH approximately 11), depending on the milling process. Because of pH extremes, infiltrating fluids originating from the different tailings impoundments contained high concentrations of dissolved metals. Soils beneath and downgradient of the tailings impoundment buffered the tailings fluids to near neutral pH, potentially causing uranium to sorb to iron precipitating from solution onto the aquifer solids. Clean groundwater or precipitation infiltration flowing through the sorbed uranium can remobilize this uranium and continue to feed the uranium plume.

Because soils beneath portions of the former tailings impoundments were excavated to or near bedrock, uranium source mass associated with the former tailings impoundments was greatly reduced. However, for those portions of the former mill site that were not excavated to bedrock, uranium was left in place at concentrations up to 10–12 milligrams per kilogram (mg/kg), and these soils are continuing sources of uranium to OU III groundwater. In comparison, background uranium levels are typically less than 2 mg/kg (DOE 2020). The estimated total mobile uranium mass remaining at the MMTS is approximately 24,000 lb (DOE 2021). Of this amount, approximately 8000 lb are associated with saturated zone solids in the uranium plume, 10,000 lb are diffused throughout portions of the former mill site vadose zone that were not excavated to bedrock, 5000 lb are associated with vadose zone solids in the plume area downgradient of the PRB, and 1000 lb are associated with supplemental standards areas. On the hillsides of the former mill site, snowmelt dissolves uranium and flows for a brief period in the spring along the bedrock surface to the margins of the alluvial aquifer. This flow path is incomplete for the rest of the year. There are supplemental standards areas south of the former mill site that may also contribute uranium by this mechanism (Figure 8). Additionally, downgradient vadose zone uranium secondary sources associated with the precipitation and evapotranspiration cycle continue to store and release uranium to OU III groundwater as a function of snowmelt (DOE 2020).



Abbreviations: Jm = Jurassic Morrison Formation, Kbc = Cretaceous Burro Canyon Formation, Kd = Cretaceous Dakota Sandstone

Figure 8. MMTS OU III Historical Source Areas

1.5 Evaluations Conducted This Performance Period

The Sixth CERCLA Five-Year Review for the MMTS was completed in July 2022 (DOE 2022). The Sixth Five-Year Review covered the period June 2017–June 2022. The report concluded that a protectiveness determination cannot be made for OU III until LM obtains further information regarding the potential risks posed by surface water contaminants. LM is currently addressing the issues and recommendations for OU III documented in the Sixth Five-Year Review report by continuing work on a Feasibility Study (FS), evaluating ecological risks of uranium in Montezuma Creek, assessing IC options to prevent human consumption of Montezuma Creek water as a domestic drinking water source, and continuing a climate vulnerability and resilience assessment for the MMTS. The objective of the FS is to perform a more robust remedial alternatives evaluation for groundwater and surface water that incorporates recent, significant updates to the conceptual site model for the MMTS. The FS was submitted to the U.S. Environmental Protection Agency and Utah Department of Environmental Quality on August 8, 2024, outside of the May 2023–April 2024 performance period. An ecological risk evaluation was completed in December 2023 and is included in the FS. This risk evaluation used a weight-of-evidence approach to assess the protectiveness of the OU III remedy to ecological receptors in Montezuma Creek. Although Montezuma Creek is not currently used as a drinking water source, it is classified as Class 1C for domestic use, and LM is evaluating surface water use restrictions that will prevent its future use for drinking water. The climate vulnerability and resilience assessment is being conducted because the MMTS was identified at medium to high vulnerability for climate change in a screening assessment (DOE 2019a).

On August 7, 2023, a leak was discovered at vault CS-MNT-10, which is connected to the buried groundwater transmission line that transfers water from the Groundwater Transfer Building to Pond 4. The leak was recognized by water overflowing from the top of vault CS-MNT-10 and saturated soil adjacent to and downgradient of the vault. The saturated soil at vault CS-MNT-10, which is on property owned by the City of Monticello, continued downgradient and crossed onto adjacent private property. The leak was repaired on October 25, 2023. The cause of the leak was a broken PVC adapter that connects the transmission line to vault CS-MNT-10. A Sampling and Analysis Plan was prepared to describe the sampling, analytical, and data evaluation requirements necessary to determine if soils were adversely impacted from the leak of contaminated groundwater (DOE 2024). The sampling occurred July 2, 2024, and therefore was not completed during the May 2023–April 2024 performance period.

2.0 Compliance Remedy Performance

The current OU III remedy is MNA and active remediation with ICs. To assess the effectiveness of the OU III remedy, current and historical trends of alluvial aquifer groundwater levels and flow directions, uranium plume geometry and concentrations, and uranium plume mass, volume, and average concentrations are compared to baseline conditions. OU III baseline conditions correspond to 2001 when the mill site reconstruction was completed and the current monitoring well network was first established. Although monitoring wells have been abandoned and installed since 2001, the overall coverage of the monitoring well network has remained relatively consistent, which allows conditions in 2001 to be compared to subsequent years. AOA baseline conditions correspond to 2014, the year before the GRO system became operational. To complete the evaluation, current and historical surface water concentration trends are also

compared to baseline conditions. In addition to comparison to baseline conditions, GRO system performance was evaluated by examining historical extraction volumes and uranium mass removal rates.

MNA is an in situ remediation technique that relies on natural processes in soil and groundwater to reduce, without active intervention, uranium mass in the subsurface. Because of a long radioactive half-life (245,500 years for uranium-234 and 4.5 billion years for uranium-238), the only natural attenuation mechanisms available to reduce OU III subsurface uranium mass are discharge to Montezuma Creek, dispersion along the plume flow path, sorption, and mineral precipitation due to changing geochemical conditions. Active remediation at OU III is accomplished by pumping, which removes COC mass from the aquifer. Subsurface physical and chemical processes that retard uranium plume movement relative to corresponding OU III groundwater movement reduce the efficiency of the remedy. This evaluation examines remedy efficiency and the progress of alluvial aquifer water quality restoration.

2.1 GRO System Pumping Volumes and Uranium Mass Removal

Since 2015, the GRO system has removed 32.4 million gallons of contaminated groundwater and approximately 159 lb of uranium (Figure 9). Current estimates suggest that 1400 lb of uranium are remaining in the AOA as solid-phase and dissolved mass. From May 2023 to April 2024, the GRO system removed approximately 3.3 million gallons of contaminated groundwater and 13 lb of uranium. In comparison, from May 2022 to April 2023, the GRO system removed approximately 1.5 million gallons of contaminated groundwater and 8 lb of uranium. The increased groundwater volume and uranium mass extracted during this performance period is due to the increased snowfall in winter 2022–2023.

2.2 Alluvial Aquifer Groundwater Levels

The 2014 AOA water table is shown in Figure 10. Groundwater levels are higher upgradient than downgradient of the PRB, showing that the permeability of the PRB, installed in 1999, is reduced relative to design specification and has restricted groundwater movement through the treatment zone. The water table also shows that groundwater is migrating around the southern end of the PRB in response to higher groundwater levels caused by declining PRB permeability. In addition, reduced PRB permeability directs groundwater flow around the northern end of the PRB. Downgradient of the PRB, the water table shows groundwater flowing to the east.

The April 2024 AOA water table is shown in Figure 11. Similar to the case in 2014 and the following years, groundwater levels are higher upgradient relative to downgradient of the PRB. As before, the difference in upgradient and downgradient water levels results from reduced PRB permeability. GRO system pumping lowers the water table in the vicinity of the AOA extraction wells that were operating during the measurement period (wells OR-02, OR-05, OR-06, and OR-07). Operation of the GRO system results in groundwater capture from an extensive region surrounding the pumping wells (Figure 11). Some groundwater still flows around the southern end of the PRB but at a reduced rate relative to 2014, due to pumping. Downgradient of the PRB, the water table shows groundwater flowing to the east.

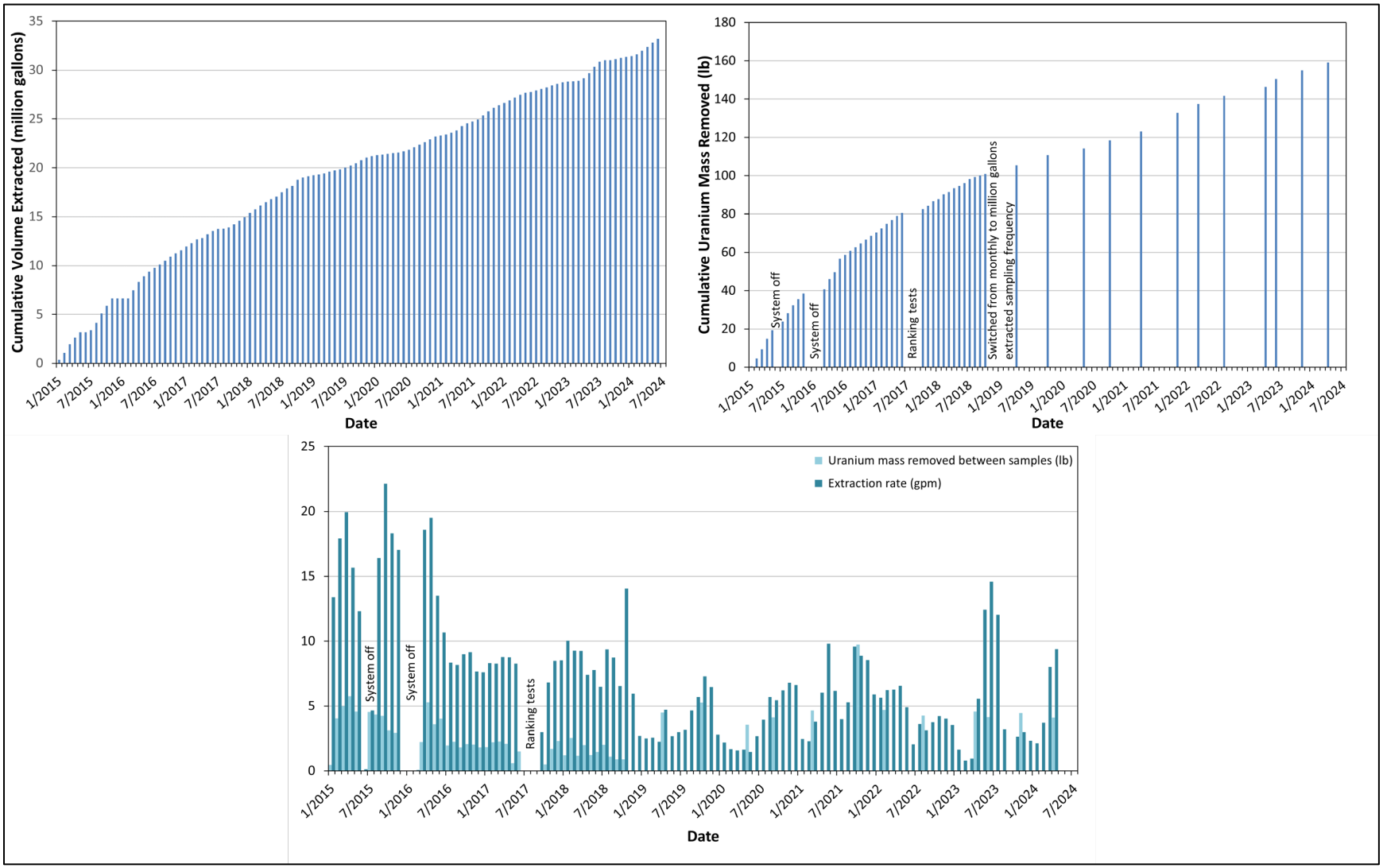
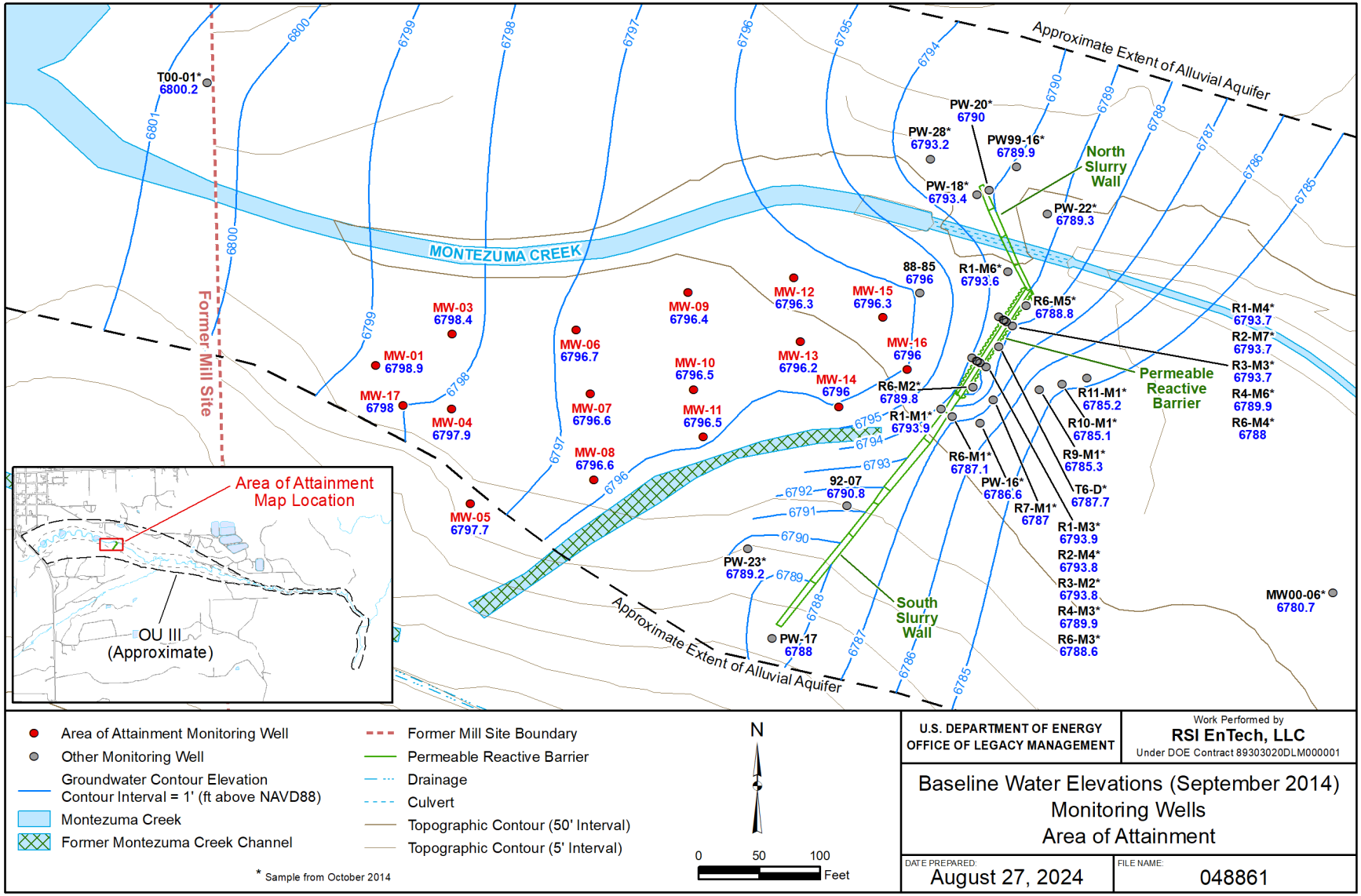
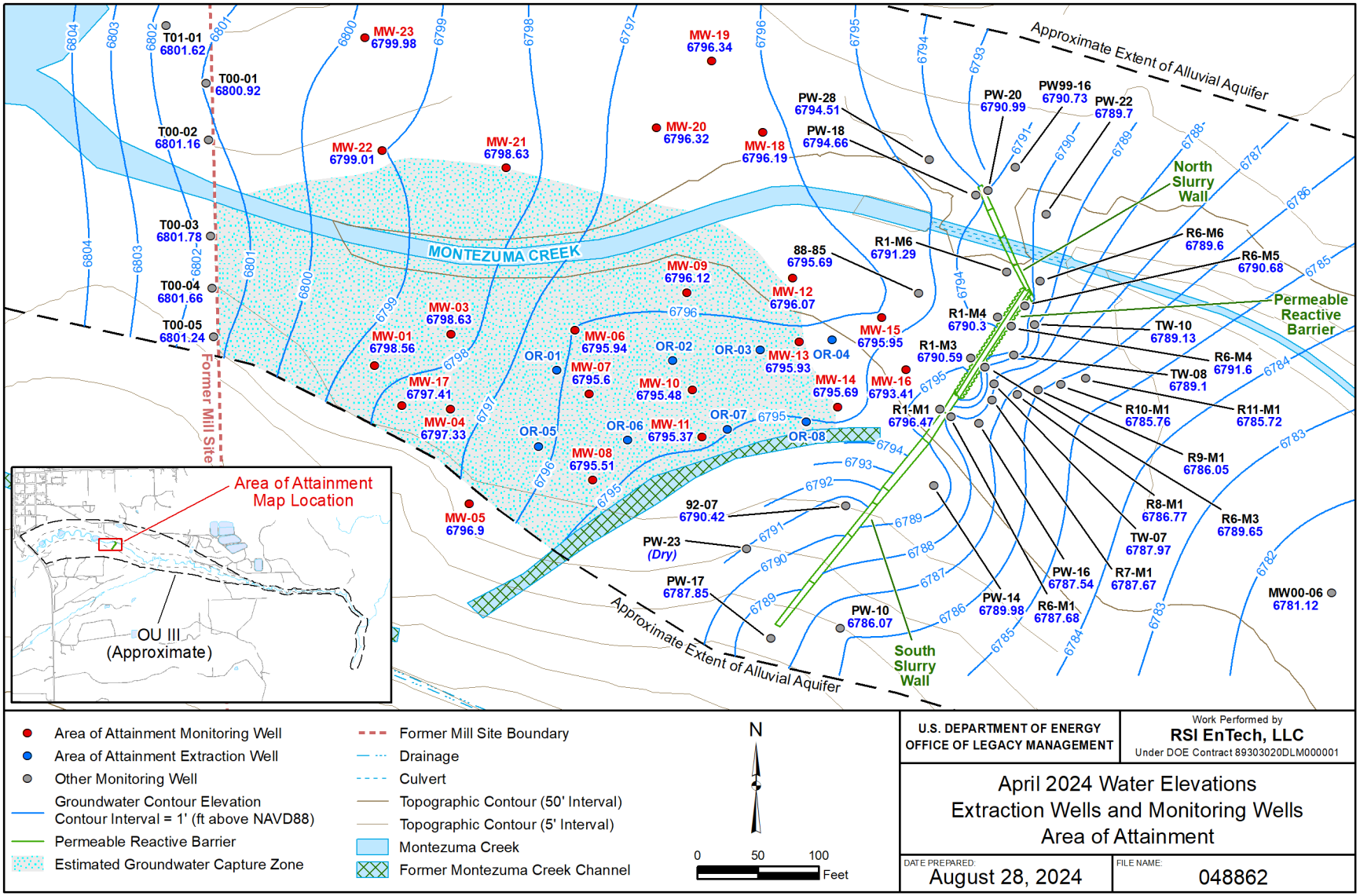


Figure 9. Cumulative Extraction Volumes, Uranium Mass Removed, and Monthly Pumping Performance



Abbreviation: NAVD88 = North American Vertical Datum of 1988

Figure 10. 2014 AOA Water Table



Abbreviation: NAVD88 = North American Vertical Datum of 1988

Figure 11. 2024 AOA Water Table

2.3 Alluvial Aquifer Monitoring Well Uranium Concentration Trends

Uranium groundwater concentration trends for the monitoring wells listed in Table 5 are shown in Figure 12 through Figure 16. Mann-Kendall trend analysis was performed to characterize whether uranium concentration trends were upward, stable (no trend), or declining. For the wells identified as having declining trends, linear regression of the log-transformed concentration data was performed to determine when a well's uranium concentration was expected to decline below the groundwater standard. Both the Mann-Kendall trends and linear regression analysis predictions are representative of conditions spanning the duration of the measurements.

For the statistical trend analyses, the number of samples used for each well was reduced to a sample frequency of every two months as necessary to ensure statistical independence. Figure 17 shows the location of the wells, color codes identifying uranium concentration trends, and estimated range in years, for wells having declining trends, until the remediation goal of 30 µg/L is reached. Mann-Kendall trend analysis using a 0.05 significance level identified 16 of the 29 AOA monitoring wells as having decreasing uranium concentration trends (Figure 12 and Figure 13, Table 5). Increasing trends were identified at three wells (MW-15, MW-18, and MW-19) that are outside the capture zone of the GRO system (Figure 11). The remaining 10 monitoring wells were identified as having no significant statistical trends. The lack of a discernable trend at wells MW-20, MW-21, MW-22, and MW-23 might be due to the relatively short monitoring record (2017–2024) at these locations. Overall, the trend analysis results for AOA monitoring wells indicate that uranium concentrations are decreasing within the capture zone of the GRO system.

In the upgradient portion of OU III, Mann-Kendall trend analysis results identified 14 of the 16 monitoring wells as having decreasing uranium concentration trends (Figure 14, Table 5). Monitoring well T01-18, identified as having no significant trend overall, shows uranium concentrations initially increasing followed by decreasing concentrations. The recent decreases in concentration in this well suggest that uranium concentrations are decreasing throughout the upgradient portion of OU III. The second monitoring well (MW00-01) identified as having no significant trend is a background monitoring well that has uranium concentrations below the 30 µg/L uranium standard.

The downgradient portion of OU III has variable uranium concentration trends (Figure 15, Table 5). Mann-Kendall trend analysis results for the downgradient portion of OU III identified 7 of 14 monitoring wells as having no significant trend, 4 of 14 monitoring wells as having downward trends, and 3 monitoring wells as having an increasing trend. The increasing trends at wells R6-M4 and R10-M1 are likely related to PRB performance. These wells are immediately downgradient of the PRB. As mineralization has reduced the flow of treated water through the PRB, more contaminated water has been forced around the northern slurry wall (DOE 2019b). The increasing uranium concentration trend at wells R6-M4 and R10-M1 may be caused by this increasing volume of flow around the northern slurry wall relative to the decreasing volume of treated water flowing through the PRB. The increasing trend at well 82-08 might also be the result of changing flow patterns around the PRB. Well R6-M3 is also directly downgradient of the PRB, but it is closer to the southern end of the PRB. The lack of a statistical trend at well R6-M3 indicates that this location is still influenced more by the flow of treated water through the PRB than by the flow of contaminated water around the slurry walls. Two monitoring wells (MW00-06 and MW00-07) previously had increasing

concentration trends caused by higher AOA concentrations that migrated around the southern slurry wall (Section 2.4). Currently, both monitoring wells visually have decreasing trends, although the Mann-Kendall results indicate no trend. Wells 95-01 and 95-03 are downgradient monitoring wells with uranium concentrations below the 30 µg/L uranium standard, and the stable trends at these wells indicate that the plume is not expanding.

Well PW-10 is representative of flow around the southern slurry wall, and the visual change in trend slope around 2015 may indicate that the GRO system is responsible for the statistically decreasing concentration trend at this well. As pumping has captured the more contaminated groundwater within the southern portion of the AOA, relatively cleaner water has begun to flow around the southern slurry wall. The other three decreasing trends (wells 0200, 0202, and 92-08) reflect uranium plume attenuation. Because these three wells are near Montezuma Creek along a losing reach of the stream (DOE 2019b), they receive more volume of clean recharge than other downgradient wells, resulting in greater attenuation rates. The other two downgradient wells with stable trends are near the margin of the aquifer (well P92-06) or at the downgradient end of the plume near a gaining reach of Montezuma Creek (well 92-09). Uranium concentrations at these wells are also expected to decrease eventually as the downgradient portion of the aquifer continues to slowly respond to the upgradient remedial efforts, particularly the tailings removal.

The four monitoring wells within the PRB did not have significant uranium concentration trends (Figure 16, Table 5). Wells R3-M2 and R3-M3 in the upgradient gravel/zero-valent iron (ZVI) portion of the PRB show stable uranium concentrations. Likewise, wells R4-M3 and R4-M6 within the 100% ZVI portion of the PRB show no significant trend. Note that measurements taken before October 2009 were not used in the trend analysis for wells R4-M3 and R4-M6 because of the high number of results below the detection limit and a change in the analytical detection limit. The concentrations remain below the uranium standard at R4-M3 and R4-M6 (Figure 16).

For the 33 monitoring wells identified as having decreasing trends with concentrations above the remediation goal, linear regression of the log-transformed concentration data was performed to determine the uranium attenuation half-lives and associated upper and lower 95% confidence intervals (CI) (Table 5). Based on the attenuation half-lives and CIs, the year that average uranium levels in individual monitoring wells would decrease below the remediation goal of 30 µg/L was calculated (Table 5). The attenuation half-lives are applicable to current site conditions. Changing site conditions—such as removal of the PRB, termination of the GRO system, or variable temporal recharge rates—could change the half-lives. To account for uncertainty, upper and lower 95% confidence level predictions that bracket the year that the uranium remediation goal concentration would be reached were also calculated. For some wells where the measured uranium concentration is near the remediation goal but not below the goal, the lower confidence level for remediation is in a past year. These unintuitive results reflect (1) the statistical variability of concentration measurements and (2) the imperfect fit between the exponential decay model and the concentration data.

Within the AOA, trend evaluation predicts that if current uranium concentration trends continued, the uranium remedial standard would be reached in the 16 monitoring wells having decreasing trends sometime between 2041 (MW-14, lower 95% CI) and 2312 (MW-08, upper 95% CI). In the upgradient portion of OU III, the uranium remedial standard is predicted to be reached in the 13 monitoring wells having decreasing trends sometime between 2018

(T01-23, lower 95% CI) and 2522 (T01-12, upper 95% CI). In the downgradient portion of OU III, the uranium remedial standard is predicted to be reached in the four monitoring wells having decreasing trends sometime between 2048 (0202, lower 95% CI) and 2096 (PW-10, upper 95% CI). The predicted years to reach uranium remedial standards and some of the wells defining the range of dates when cleanup will be achieved are different than those in the May 2022 through April 2023 performance period (DOE 2023). This is because the duration estimates are based on best-fit lines whose slope changes as additional data points are added to the regression analysis.

The time to reach the uranium remediation goal concentration for the monitoring wells characterized as having no statistical trend is unknown but likely will be longer than that required for the monitoring wells having statistically identifiable downward concentration trends.

Table 5. AOA and OU III Monitoring Well Uranium Concentration Trends and Year Remediation Goal Is Reached

Monitoring Well	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Mann-Kendall		Half-Life (years)			Year Remedial Goal of 30 µg/L Reached		
				Concentration Trend	Tau Value	Trend Line	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Trend Line	Lower 95% Confidence Interval	Upper 95% Confidence Interval
AOA											
MW-01	3/31/2015	6/13/2023	14	None	–0.31	Not applicable, no trend					
MW-03	3/31/2015	4/16/2024	33	None	0.06	Not applicable, no trend					
MW-04	3/31/2015	4/16/2024	28	Decreasing	–0.48	13.0	8.5	27.3	2073	2054	2134
MW-05	3/31/2015	6/14/2023	19	None	0.01	Not applicable, no trend					
MW-06	4/1/2015	4/16/2024	33	Decreasing	–0.69	7.7	6.1	10.4	2050	2043	2061
MW-07	4/1/2015	4/16/2024	32	Decreasing	–0.48	18.3	12.5	34.0	2096	2072	2163
MW-08	4/1/2015	4/16/2024	33	Decreasing	–0.33	24.6	15.2	64.8	2130	2087	2312
MW-09	4/1/2015	4/16/2024	30	Decreasing	–0.57	9.1	7.1	12.5	2053	2045	2066
MW-10	4/1/2015	4/16/2024	32	Decreasing	–0.83	6.2	5.2	7.7	2047	2042	2054
MW-11	4/1/2015	4/16/2024	32	Decreasing	–0.78	12.4	10.3	15.6	2079	2069	2094
MW-12	4/1/2015	4/16/2024	33	None	–0.15	Not applicable, no trend					
MW-13	4/1/2015	4/16/2024	33	Decreasing	–0.52	11.1	7.9	19.0	2058	2047	2086
MW-14	3/31/2015	4/16/2024	33	Decreasing	–0.63	7.8	5.8	11.7	2048	2041	2063
MW-15	3/31/2015	4/16/2024	33	Increasing	0.26	Not applicable, increasing trend					
MW-16	3/31/2015	4/16/2024	33	None	–0.15	Not applicable, no trend					
MW-17	3/31/2015	6/14/2023	26	None	0.17	Not applicable, no trend					
MW-18	8/22/2017	4/16/2024	21	Increasing	0.48	Not applicable, increasing trend					
MW-19	8/22/2017	4/16/2024	21	Increasing	0.34	Not applicable, increasing trend					
MW-20	8/22/2017	4/16/2024	16	None	0.34	Not applicable, no trend					
MW-21	8/22/2017	4/16/2024	19	None	0.13	Not applicable, no trend					
MW-22	8/22/2017	4/16/2024	21	None	–0.21	Not applicable, no trend					
MW-23	8/22/2017	4/16/2024	21	None	–0.23	Not applicable, no trend					
88-85[a]	10/17/2001	4/17/2024	52	Decreasing	–0.64	19.6	16.3	24.5	2071	2061	2086
92-07[a]	10/16/2001	4/17/2024	52	Decreasing	–0.41	11.6	9.4	15.2	2062	2053	2078
92-11[a]	10/15/2001	4/16/2024	51	Decreasing	–0.53	19.6	15.9	25.7	2066	2056	2083
PW-17[a]	10/16/2001	4/17/2024	51	Decreasing	–0.33	13.9	10.9	19.1	2075	2062	2098

Table 5. AOA and OU III Monitoring Well Uranium Concentration Trends and Year Remediation Goal Is Reached (continued)

Monitoring Well	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Mann-Kendall		Half-Life (years)			Year Remedial Goal of 30 µg/L Reached		
				Concentration Trend	Tau Value	Trend Line	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Trend Line	Lower 95% Confidence Interval	Upper 95% Confidence Interval
PW-28[a]	10/16/2001	4/17/2024	48	Decreasing	–0.59	32.0	25.9	41.8	2097	2081	2123
R1-M3	10/15/2001	4/17/2024	51	Decreasing	–0.42	14.5	11.5	19.5	2065	2054	2083
R1-M4	10/11/2001	4/17/2024	51	Decreasing	–0.33	21.3	16.0	32.2	2088	2069	2126
PRB Wells											
R3-M2	9/30/2002	4/17/2024	45	None	–0.19	Not applicable, no trend					
R3-M3	9/30/2002	4/17/2024	45	None	0.08	Not applicable, no trend					
R4-M3	10/6/2009	4/17/2024	25	None	0.18	Not applicable, concentration less than remediation goal					
R4-M6	10/6/2009	4/17/2024	30	None	0.24	Not applicable, concentration less than remediation goal					
OU III Upgradient, Former Mill Site											
MW00-01	10/8/2001	4/15/2024	47	None	0.02	Not applicable, concentration less than remediation goal					
T00-01	10/9/2001	10/18/2023	31	Decreasing	–0.63	5.9	4.7	7.9	2024	2021	2029
T00-04	10/15/2001	10/18/2023	29	Decreasing	–0.81	4.6	4.1	5.2	2025	2023	2027
T01-01[a]	10/9/2001	4/17/2024	44	Decreasing	–0.63	7.8	6.3	10.3	2025	2023	2029
T01-02[a]	1/30/2002	4/17/2024	48	Decreasing	–0.68	13.8	11.6	17.1	2046	2041	2054
T01-04[a]	10/10/2001	4/17/2024	48	Decreasing	–0.53	27.2	20.3	41.5	2077	2061	2111
T01-05[a]	10/9/2001	4/17/2024	49	Decreasing	–0.65	27.1	22.2	35.0	2073	2062	2090
T01-07[a]	10/9/2001	4/17/2024	48	Decreasing	–0.64	21.9	18.0	27.9	2062	2053	2075
T01-12[a]	10/9/2001	4/16/2024	43	Decreasing	–0.26	51.3	29.2	212.6	2135	2082	2522
T01-13	4/3/2002	10/17/2023	19	Decreasing	–0.86	10.8	9.1	13.3	2039	2035	2045
T01-18	10/10/2001	10/16/2023	26	None	–0.07	Not applicable, no trend					
T01-19[a]	10/10/2001	4/16/2024	46	Decreasing	–0.22	Decreasing trend according to Mann-Kendall analysis, but no trend by linear regression					
T01-20	10/11/2001	10/17/2023	27	Decreasing	–0.45	19.0	12.6	38.8	2070	2050	2131
T01-23	10/8/2001	10/16/2023	29	Decreasing	–0.49	38.9	26.3	74.8	2021	2018	2031
T01-25	10/11/2001	10/17/2023	28	Decreasing	–0.65	Not applicable, concentration less than remediation goal					
T01-35[a]	10/23/2001	4/17/2024	51	Decreasing	–0.53	30.2	23.1	43.6	2067	2054	2091

Table 5. AOA and OU III Monitoring Well Uranium Concentration Trends and Year Remediation Goal Is Reached (continued)

Monitoring Well	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Mann-Kendall		Half-Life (years)			Year Remedial Goal of 30 µg/L Reached		
				Concentration Trend	Tau Value	Trend Line	Lower 95% Confidence Interval	Upper 95% Confidence Interval	Trend Line	Lower 95% Confidence Interval	Upper 95% Confidence Interval
OU III Downgradient of PRB											
0200	10/5/2004	4/17/2024	40	Decreasing	–0.57	18.5	14.2	26.7	2070	2057	2094
0202	10/5/2004	4/17/2024	40	Decreasing	–0.64	16.1	13.1	21.0	2055	2048	2068
82-08[a]	10/17/2001	4/17/2024	48	Increasing	0.20	Not applicable, increasing trend					
92-08[a]	10/16/2001	4/17/2024	47	Decreasing	–0.60	18.4	14.9	24.2	2069	2058	2087
92-09[a]	10/16/2001	4/16/2024	46	None	–0.03	Not applicable, no trend					
95-01	10/17/2001	10/18/2023	22	None	–0.23	Not applicable, concentration less than remediation goal					
95-03	10/11/2001	10/18/2023	23	None	0.06	Not applicable, concentration less than remediation goal					
MW00-06[a]	10/16/2001	4/17/2024	49	None	–0.02	Not applicable, no trend					
MW00-07[a]	10/16/2001	10/17/2023	22	None	–0.05	Not applicable, no trend					
P92-06[a]	10/16/2001	4/17/2024	48	None	–0.14	Not applicable, no trend					
PW-10	10/16/2001	4/17/2024	39	Decreasing	–0.45	13.1	10.1	18.9	2071	2057	2096
R10-M1[a]	10/11/2001	4/17/2024	51	Increasing	0.29	Not applicable, increasing trend					
R6-M3	10/16/2001	4/17/2024	45	None	0.05	Not applicable, no trend					
R6-M4	10/11/2001	4/17/2024	48	Increasing	0.39	Not applicable, increasing trend					

Note:
[a] Monitoring well identified for trend analysis in Appendix B of the 2004 Record of Decision (DOE 2004b).

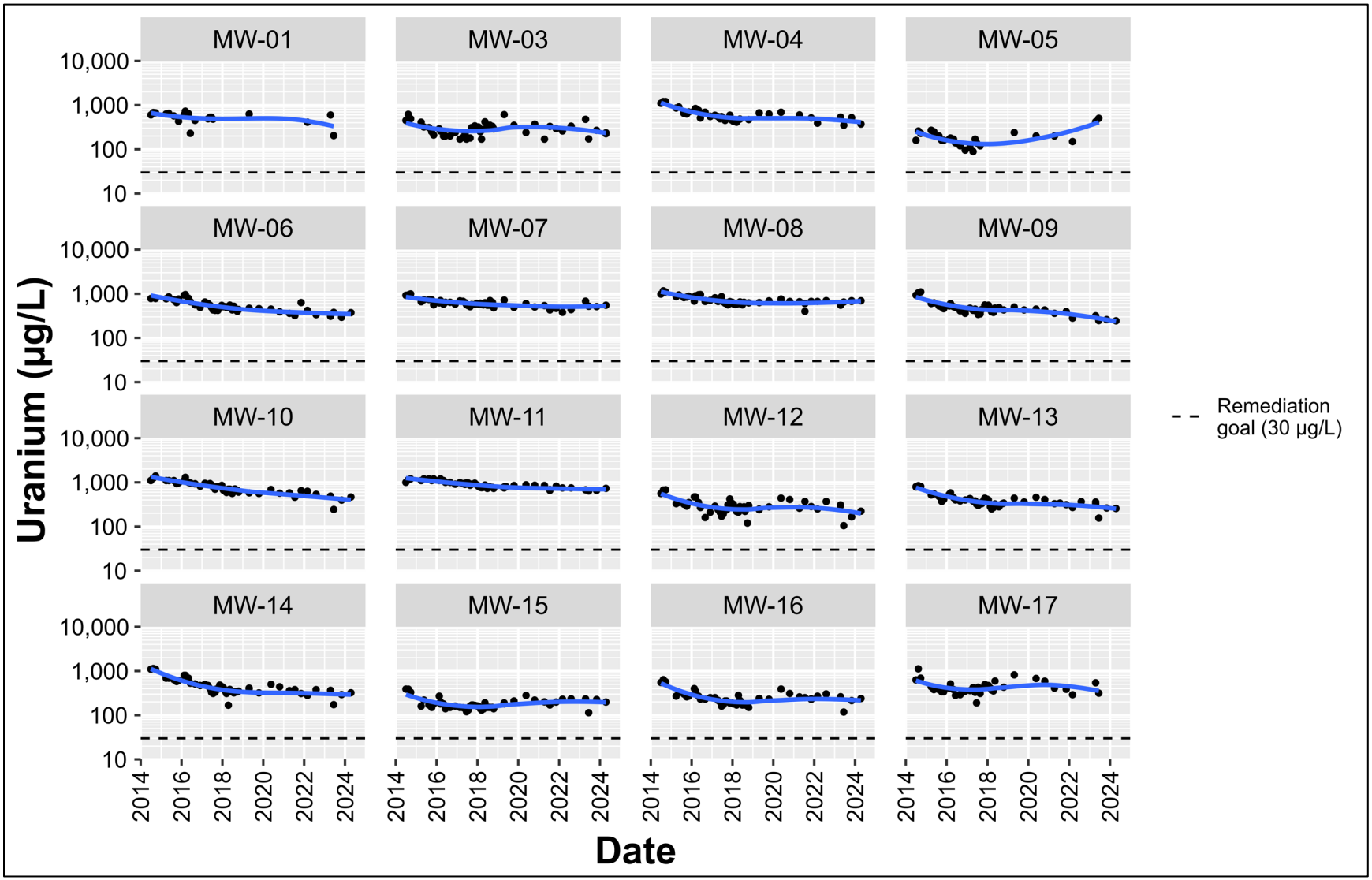
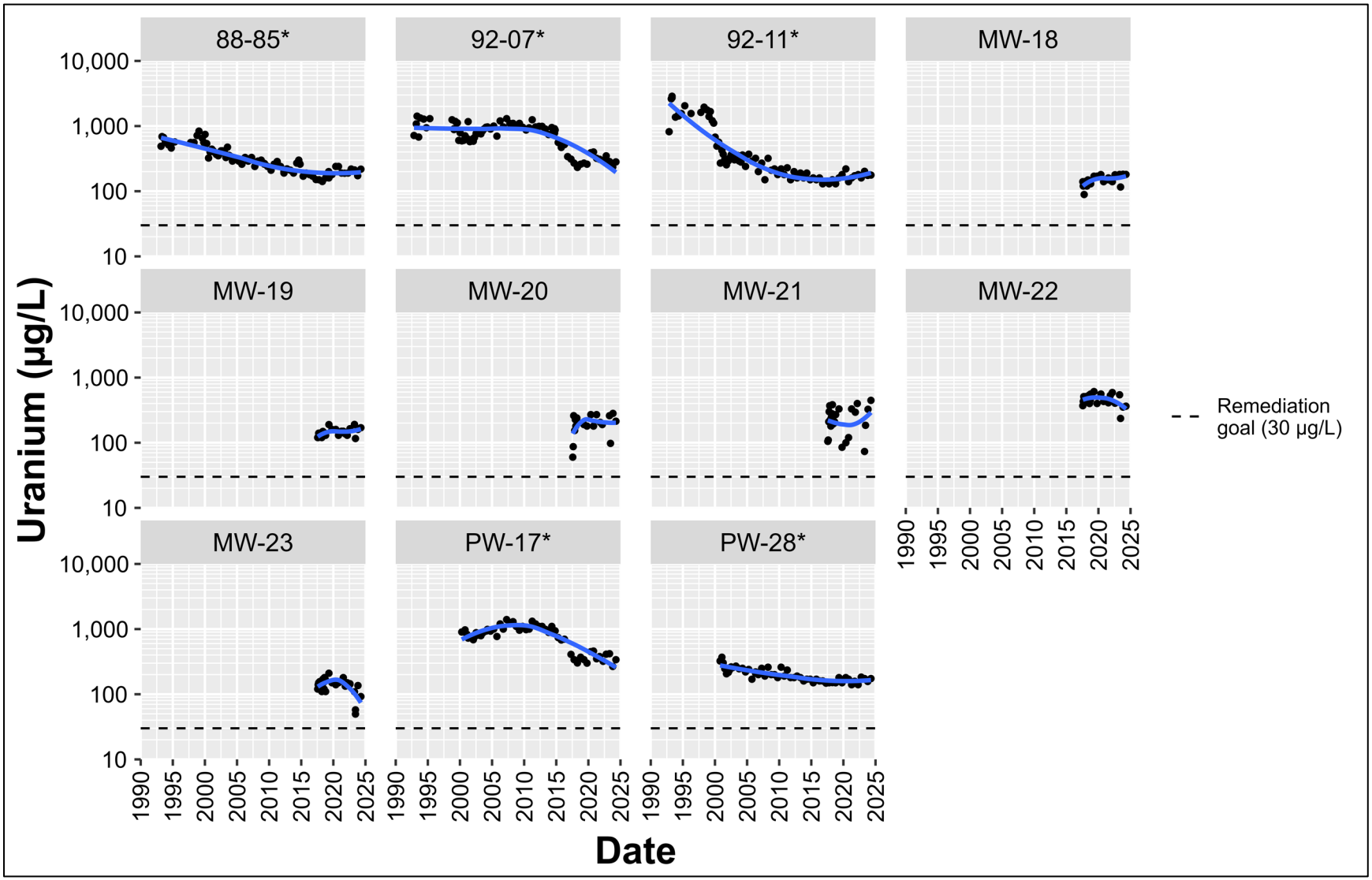
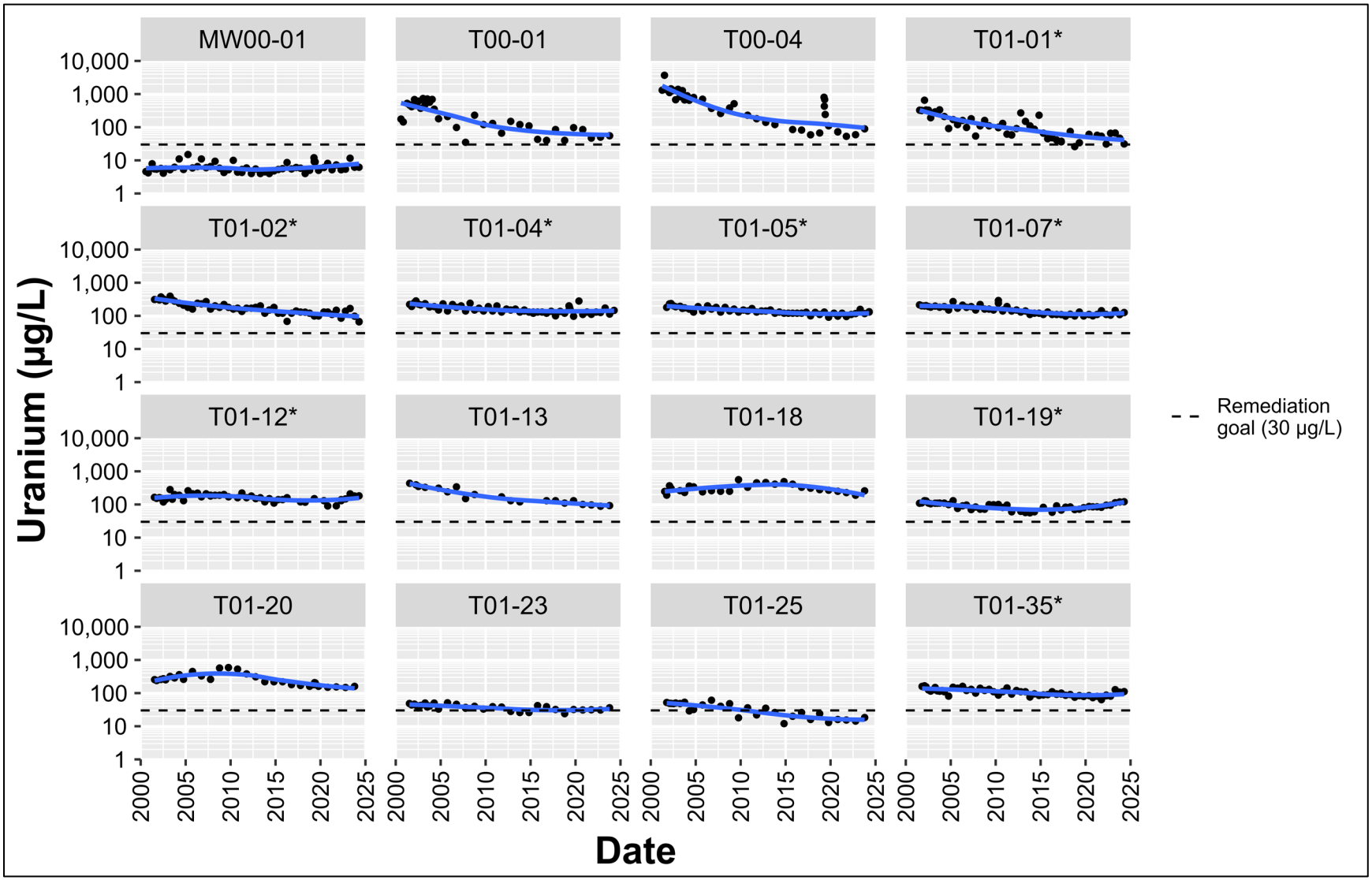


Figure 12. AOA Monitoring Well (Installed 2014) Uranium Concentration Trends



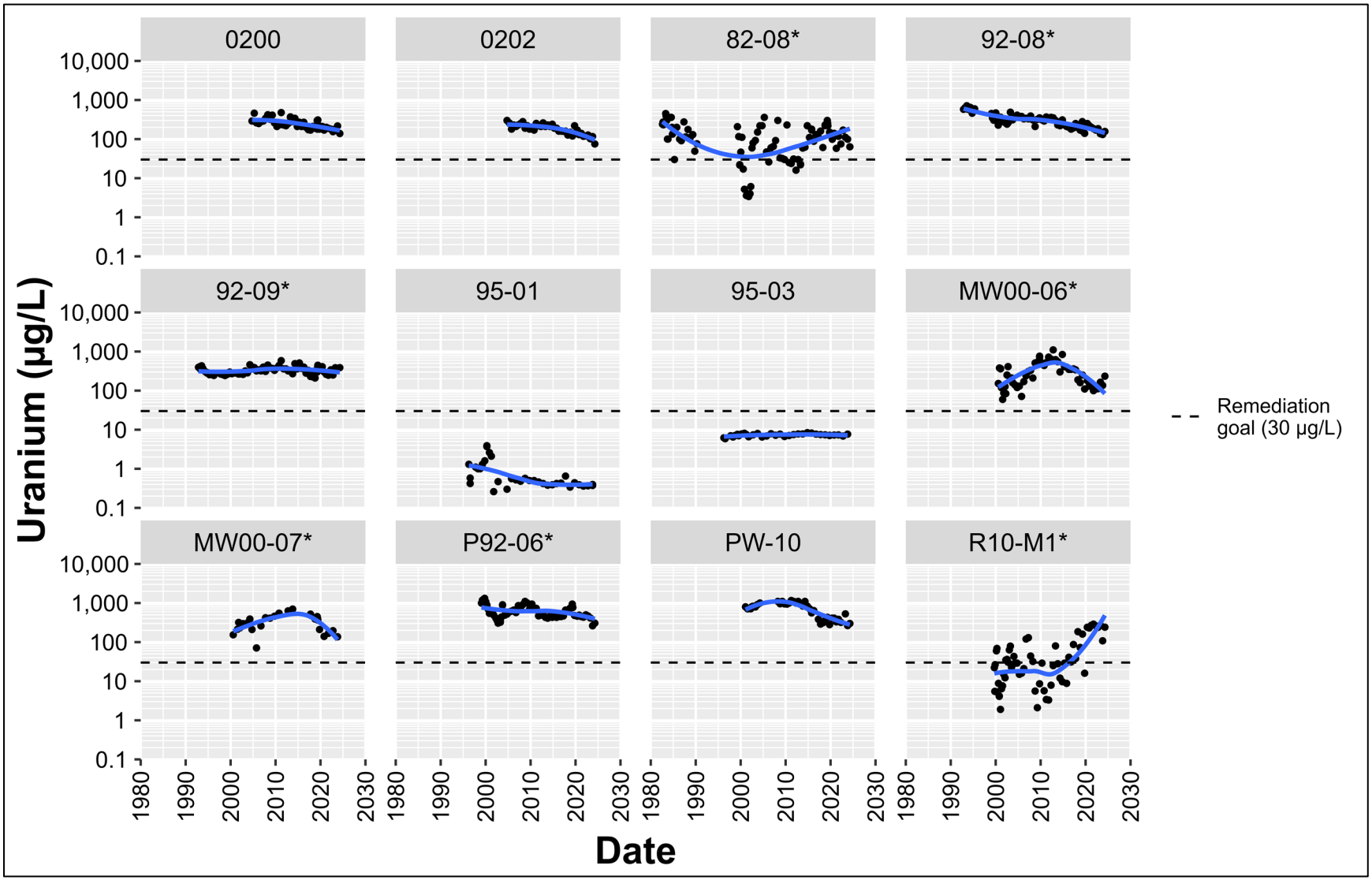
Note: * Monitoring well identified for trend analysis in Appendix B of the 2004 Record of Decision (DOE 2004b).

Figure 13. AOA Other Monitoring Well Uranium Concentration Trends



Note: * Monitoring well identified for trend analysis in Appendix B of the 2004 Record of Decision (DOE 2004b).

Figure 14. OU III Upgradient Monitoring Well Uranium Concentration Trends



Note: * Monitoring well identified for trend analysis in Appendix B of the 2004 Record of Decision (DOE 2004b).

Figure 15. OU III Downgradient Monitoring Well Uranium Concentration Trends

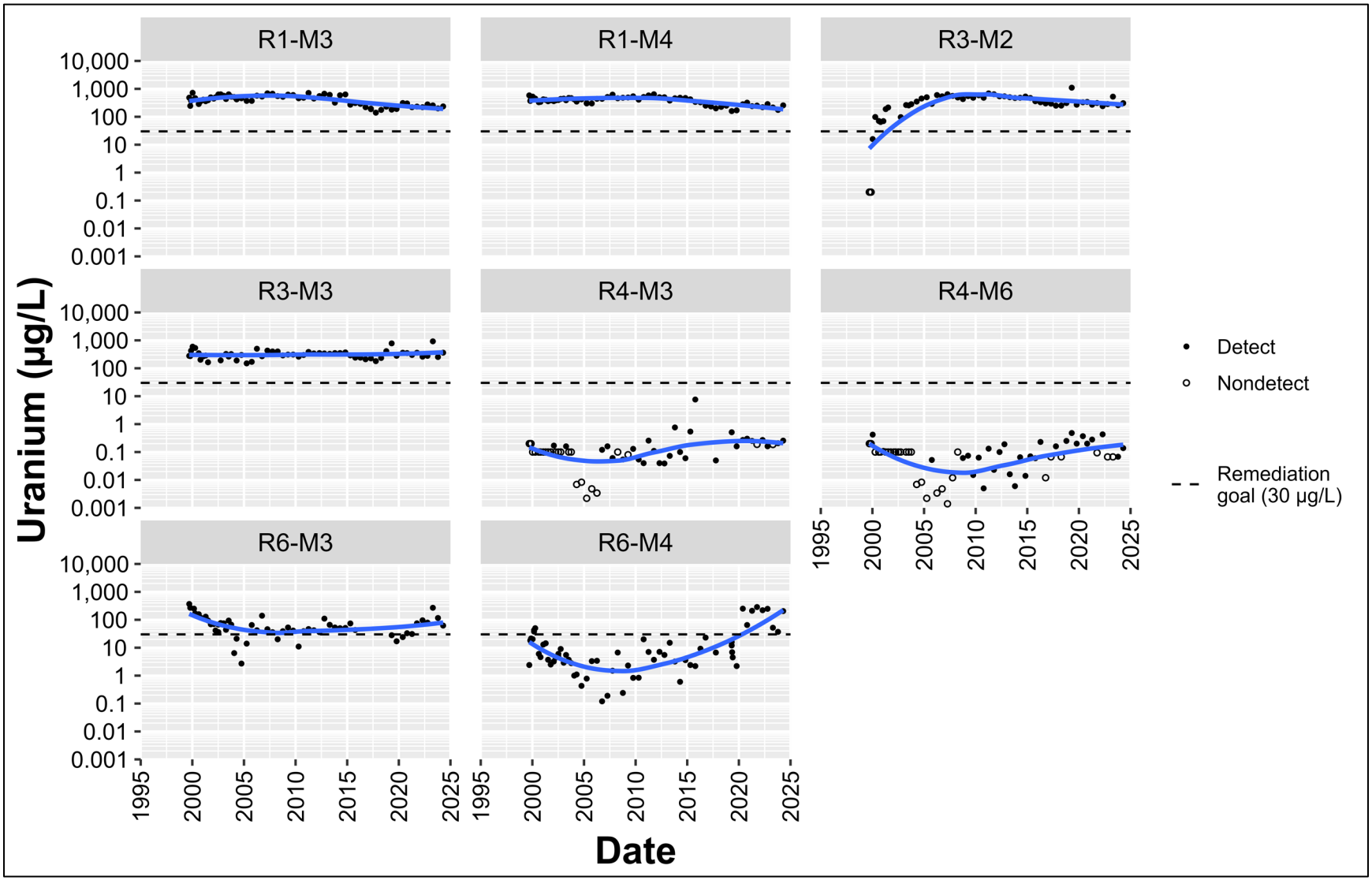
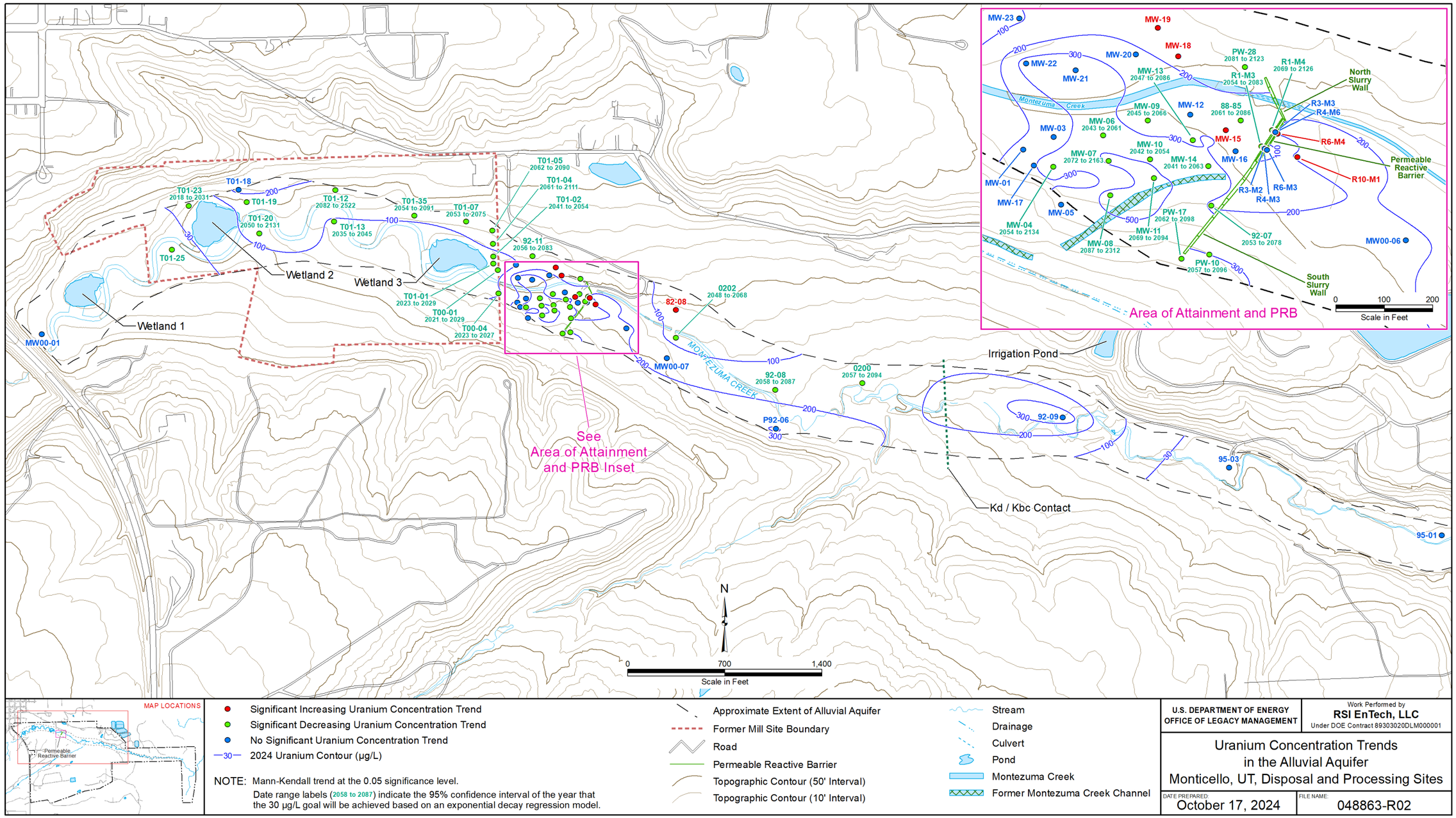


Figure 16. PRB Monitoring Well Uranium Concentration Trends



Abbreviations: Kbc = Cretaceous Burro Canyon Formation, Kd = Cretaceous Dakota Sandstone

Figure 17. Uranium Concentration Trends in the Alluvial Aquifer and Estimated Time Frame the Uranium Remediation Goal Will Be Reached in the Alluvial Aquifer

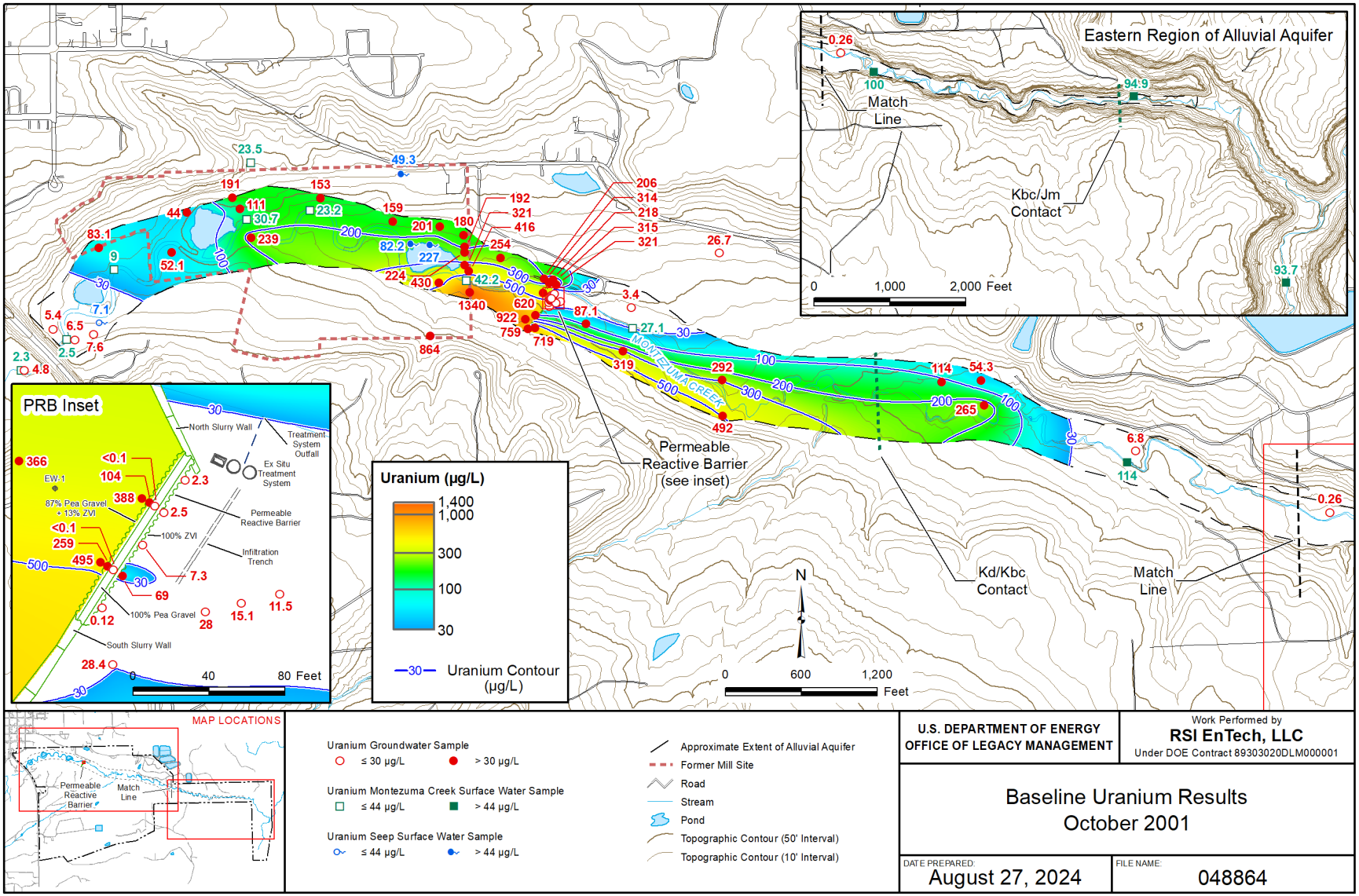
2.4 Alluvial Aquifer Uranium Plume Geometry and Concentrations

A map depicting the uranium plume in the alluvial aquifer in October 2001 after the conclusion of tailings removal and site restoration is provided in Figure 18 as a reference baseline condition, and a map depicting the current uranium plume is provided in Figure 19. GRO system extraction wells were installed in 2014 and began operation in 2015, and a uranium plume map for the AOA in September 2014 is provided in Figure 20 as a reference baseline condition for GRO system performance. The current uranium plume in the AOA is shown in Figure 21.

In 2001, the highest alluvial aquifer uranium plume concentrations (1340 µg/L) were upgradient of the PRB in the AOA (Figure 18). Uranium groundwater concentrations approaching 500 µg/L were present downgradient of the PRB along the southern margins of the alluvial aquifer. In the western portion of the former mill site, uranium groundwater concentrations were 239 µg/L or less.

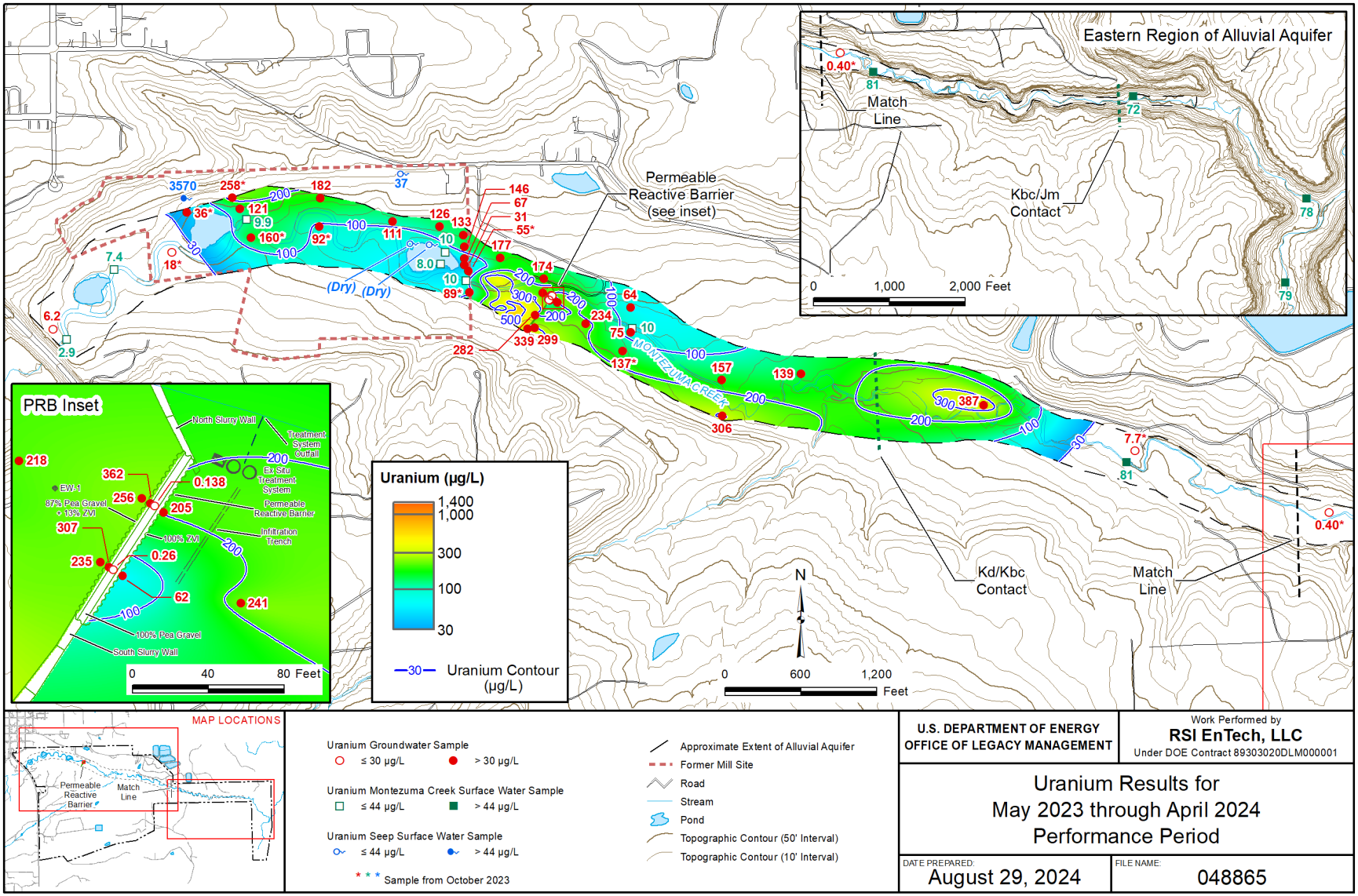
Uranium concentrations greater than 300 µg/L are still found upgradient of the PRB in the AOA (Figure 21). In the western portion of the former mill site, current uranium groundwater concentrations (Figure 19) are generally lower than 2001 concentrations (Figure 18).

The installation of 16 new monitoring wells within the AOA well field in 2014 allowed for more detailed characterization of the spatial distribution of uranium contamination in groundwater relative to that of 2001. Data from the new monitoring wells showed that in 2014 a significant portion of the AOA had uranium groundwater concentrations above 500 µg/L, with a high concentration of 1400 µg/L (Figure 20). In 2024, the area containing uranium groundwater concentrations above 500 µg/L has contracted significantly relative to that of 2014, and the maximum concentration declined to 732 µg/L (Figure 21). The reduction in AOA uranium groundwater concentrations is a function of GRO system operation. In 2014, an area of lower uranium concentrations was present downgradient of the PRB, suggesting that some groundwater was passing through the PRB and uranium was being sequestered despite the reduction in PRB permeability. Also, concentrations immediately downgradient of the PRB in 2024 were 62 µg/L or above, which shows that the flow of treated water through the PRB has become minimal.



Abbreviations: Jm = Jurassic Morrison Formation, Kbc = Cretaceous Burro Canyon Formation, Kd = Cretaceous Dakota Sandstone

Figure 18. 2001 OU III Uranium Plume



Abbreviations: Jm = Jurassic Morrison Formation, Kbc = Cretaceous Burro Canyon Formation, Kd = Cretaceous Dakota Sandstone

Figure 19. 2024 OU III Uranium Plume

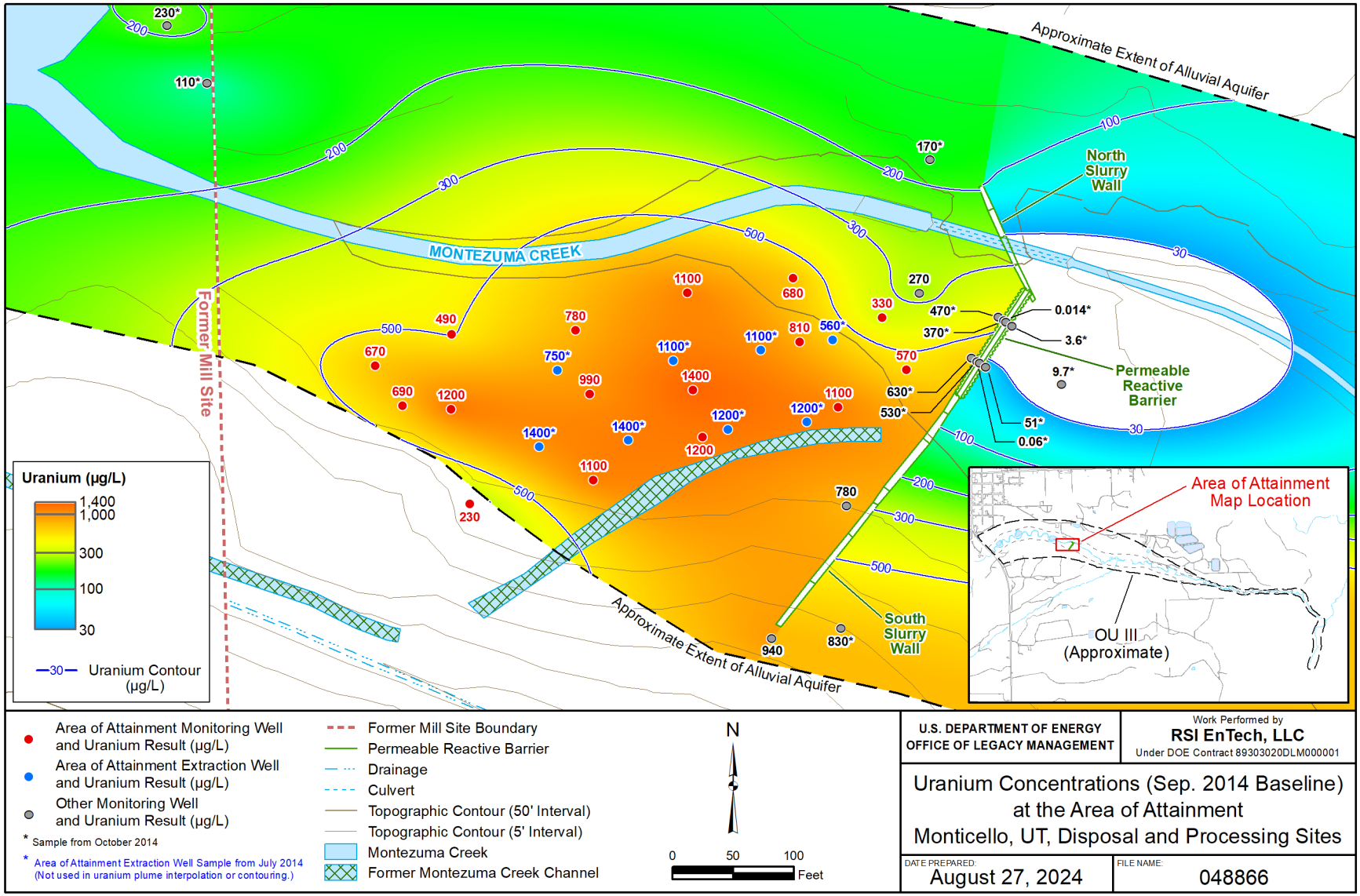


Figure 20. 2014 AOA Uranium Plume

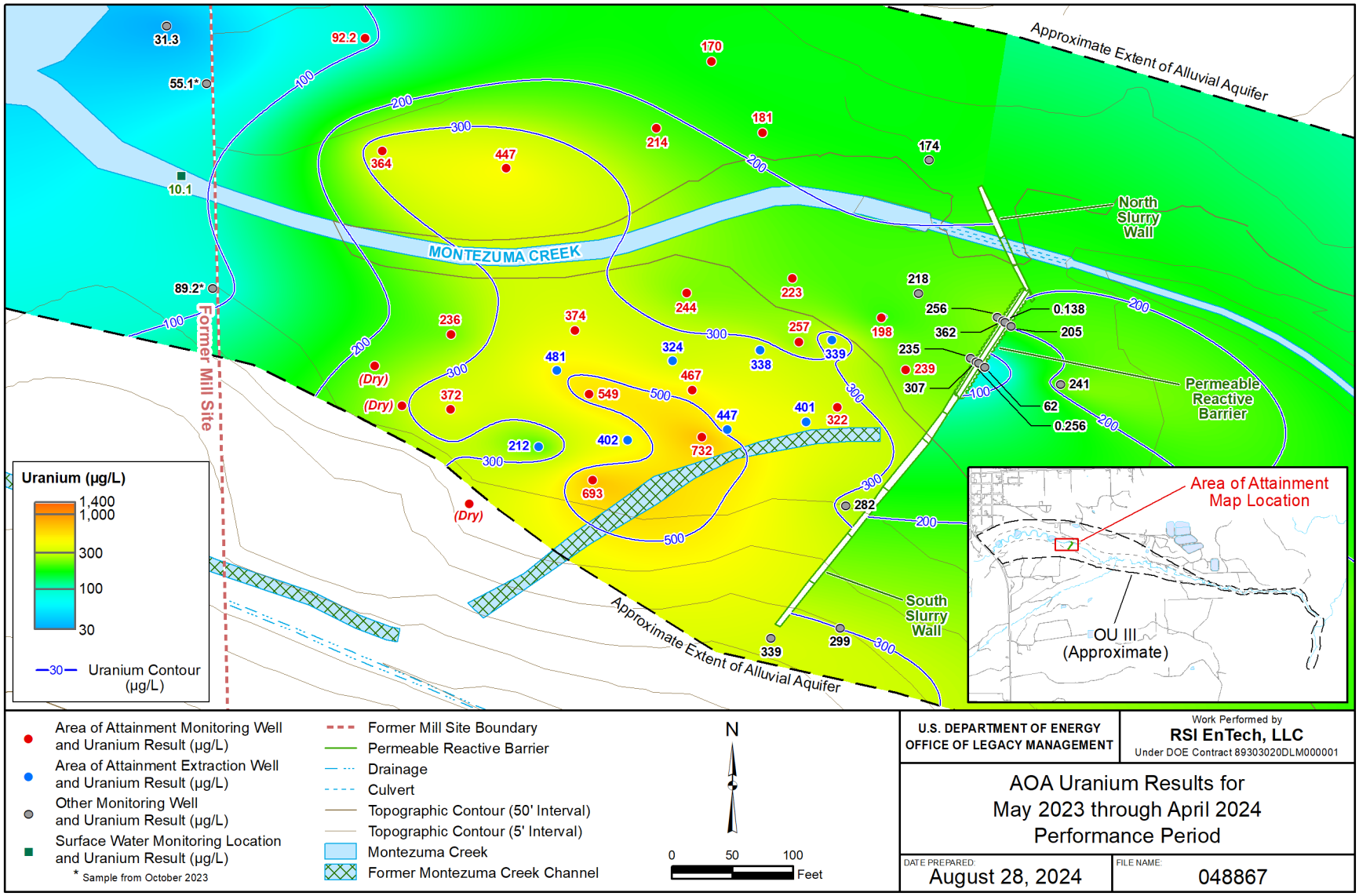


Figure 21. 2024 AOA Uranium Plume

2.5 Bulk Uranium Plume Metrics

Bulk plume metrics were calculated using the Earth Volumetric Studio software. The calculation was performed by three-dimensional interpolation of well concentration data using kriging for each recorded sampling event since October 2001. A 10:1 horizontal-to-vertical anisotropy was assumed. The interpolated plume volume was bounded on the bottom by the top of bedrock surface (interpolated from lithologic logs) and bounded on the top by the water table (interpolated from groundwater elevation measurements for each sampling event) or the top of the sand or gravel layer (interpolated from lithologic logs), whichever was at a lower elevation. A porosity of 0.25 was assumed for pore volume and plume mass calculations. Because this interpolation uses dynamic water table elevations and spatially variable top of bedrock and sand or gravel elevations when estimating plume volumes, the reported values will be different than those previously calculated using either a constant alluvial aquifer saturated thickness (pre-2016–2017) or an unconfined water table surface as the upper bound (2017–2018) (DOE 2018c).

Bulk plume metrics were calculated separately for the OU III uranium plume, including all contaminated groundwater in the alluvial aquifer, and for the AOA uranium plume, including the limited area of contaminated groundwater from the eastern boundary of the former mill site to the PRB. Alluvial aquifer monitoring wells with an annual or semiannual sampling frequency (Figure 6) were used for the calculation of OU III bulk uranium plume metrics from October 2001 through April 2024. The GRO system monitoring wells (MW-01 and MW-03 through MW-17) were not used for the OU III uranium plume calculations because they were installed in 2014, and a consistent set of wells should be used for analyzing temporal trends in bulk plume metrics. In case a well was not sampled during a particular sampling event, linear interpolation was used to assign a uranium concentration to that well for that event. The GRO system monitoring wells (with the exception of MW-01 and MW-05 because they are frequently dry) along with a subset of wells within or near the AOA (92-07, 92-11, PW-17, PW-28, T01-01, T01-02, T01-04, and T01-05) were used for calculation of the AOA bulk plume metrics from April 2014 through April 2024. Because different sets of wells were used for calculation of bulk plume metrics of the OU III uranium plume versus the AOA uranium plume, the results are not directly comparable. The OU III uranium plume results are more representative of the overall plume attenuation subsequent to mill site restoration, whereas the AOA uranium plume results are more representative of the effects of GRO system operation.

Bulk plume metrics characterizing plume volume, dissolved plume mass, and average plume concentration provide an assessment of OU III groundwater restoration progress (Figure 22 through Figure 24). The blue line is the locally estimated scatterplot smoothing (LOESS) line; the surrounding gray area represents the 95% CIs about the LOESS line. Because the plume footprint has remained relatively constant (Figure 18 and Figure 19), the relationship between increasing and decreasing uranium plume volume (Figure 22) is obvious; a rising water table results in greater saturated thickness (the sand or gravel layer is not saturated everywhere, temporally within OU III), which causes plume volume to increase; a dropping water table results in less saturated thickness and causes the plume volume to decrease. The relationship between dissolved uranium plume mass and uranium plume average concentration and water table elevation change is not obvious and is discussed more below.

Residual uranium throughout the mill site vadose zone and in supplemental standards areas, along with uranium accumulated in the vadose zone by an evapotranspiration mechanism,

represent a potential ongoing source of uranium to the alluvial aquifer (DOE 2020; DOE 2021). Infiltration of spring snowmelt and rainfall during periods of minimal transpiration (winter and early spring months) causes increases in dissolved plume mass and the plume average concentration. During the growing season, transpiration results in groundwater moving upward from the water table toward land surface. Except for large precipitation events, transpiration generally prevents water that infiltrates land surface from reaching the water table. During the winter and spring months, water infiltrating land surface can reach the water table when transpiration is absent or minimal. If the infiltrating water remained clean as it migrated through the unsaturated zone, then uranium plume concentrations would decrease due to dilution, and the dissolved mass would remain constant; however, the opposite effect is observed. It is therefore inferred that as the water moves from land surface to the water table the water leaches uranium stored in the unsaturated zone, causing increases in plume uranium concentrations, which results in increases in dissolved uranium plume mass and in uranium plume average concentration. This conclusion is corroborated by geochemical investigations at the site (DOE 2020; DOE 2021).

This phenomenon is illustrated in the temporal plots of average plume concentration (Figure 24). In spring 2011, the uranium plume average concentration was 315 µg/L but declined to less than 240 µg/L by the fall of that year. While not as dramatic, similar spring and fall trends were present in other years as well. Spring and fall increases and decreases in uranium plume average concentration and volume produce similar trends in the dissolved plume mass (Figure 23).

A statistical analysis of the uranium plume volume, mass, and average concentration was performed to quantify the seasonal effects that are qualitatively apparent in Figure 22 through Figure 24. The regression residuals (i.e., the difference between each data point and the LOESS line) were calculated for each of the three metrics. If seasonal effects were present, then some seasons would be expected to have more positive residuals on average while other seasons would have more negative residuals on average. Wilcoxon Rank Sum tests were performed to determine if the spring residuals are statistically different than the fall residuals. A statistical difference between the spring and fall residuals was identified for uranium plume volume, mass, and average concentration at the 0.05 significance level, which indicates that these three metrics are influenced by seasonal effects.

Nonparametric CIs were calculated for the difference between spring and fall medians. The results of the analysis indicate with 95% confidence that the plume volume is typically 1–4 million gallons greater in the spring than in the fall, the plume mass is 4–11 lb greater in the spring than in the fall, and the average plume concentration is 4–25 µg/L greater in the spring than in the fall.

In response to changes in precipitation recharge, the OU III uranium plume volume has fluctuated between a minimum of 13.7 million gallons and a maximum of 27.6 million gallons from 2001 to 2024, with an average volume near 20 million gallons (Figure 22). Note that the volume of groundwater extracted by the GRO system represents a relatively small fraction of the overall water budget, so groundwater extraction has a minimal influence on plume volume (DOE 2019b).

In 2001, OU III dissolved uranium plume mass was 35 lb (Figure 23). After 2001, the uranium plume mass increased to a maximum of 66 lb in spring 2008, reflecting the transfer of unsaturated zone uranium to groundwater, probably in response to recharge and increases in

water table elevation. Note that from 2001 to 2008, dissolved uranium was also being removed from the alluvial aquifer by the PRB, extraction well pumping, and discharge to Montezuma Creek. The uranium plume mass was approximately 30 lb in April 2024.

The OU III uranium plume average concentration LOESS line has been decreasing since approximately 2008 (Figure 24). The average OU III uranium plume concentration declined from approximately 300 µg/L in 2008 to 150 µg/L in April 2024, potentially as a result of uranium being removed from the aquifer in response to transpiration, extraction well pumping, and plume discharge to Montezuma Creek.

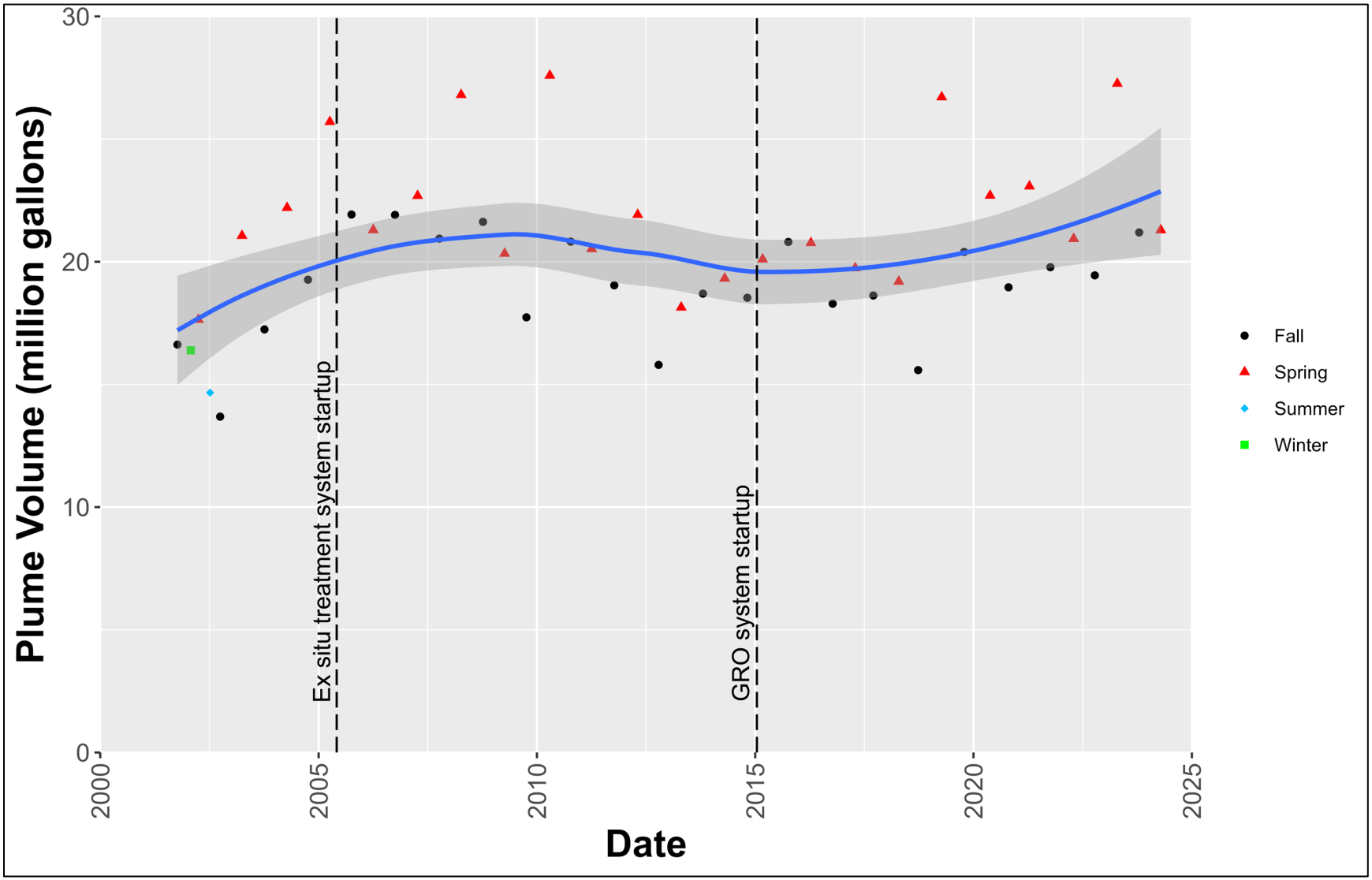


Figure 22. OU III Uranium Plume Volume Trend

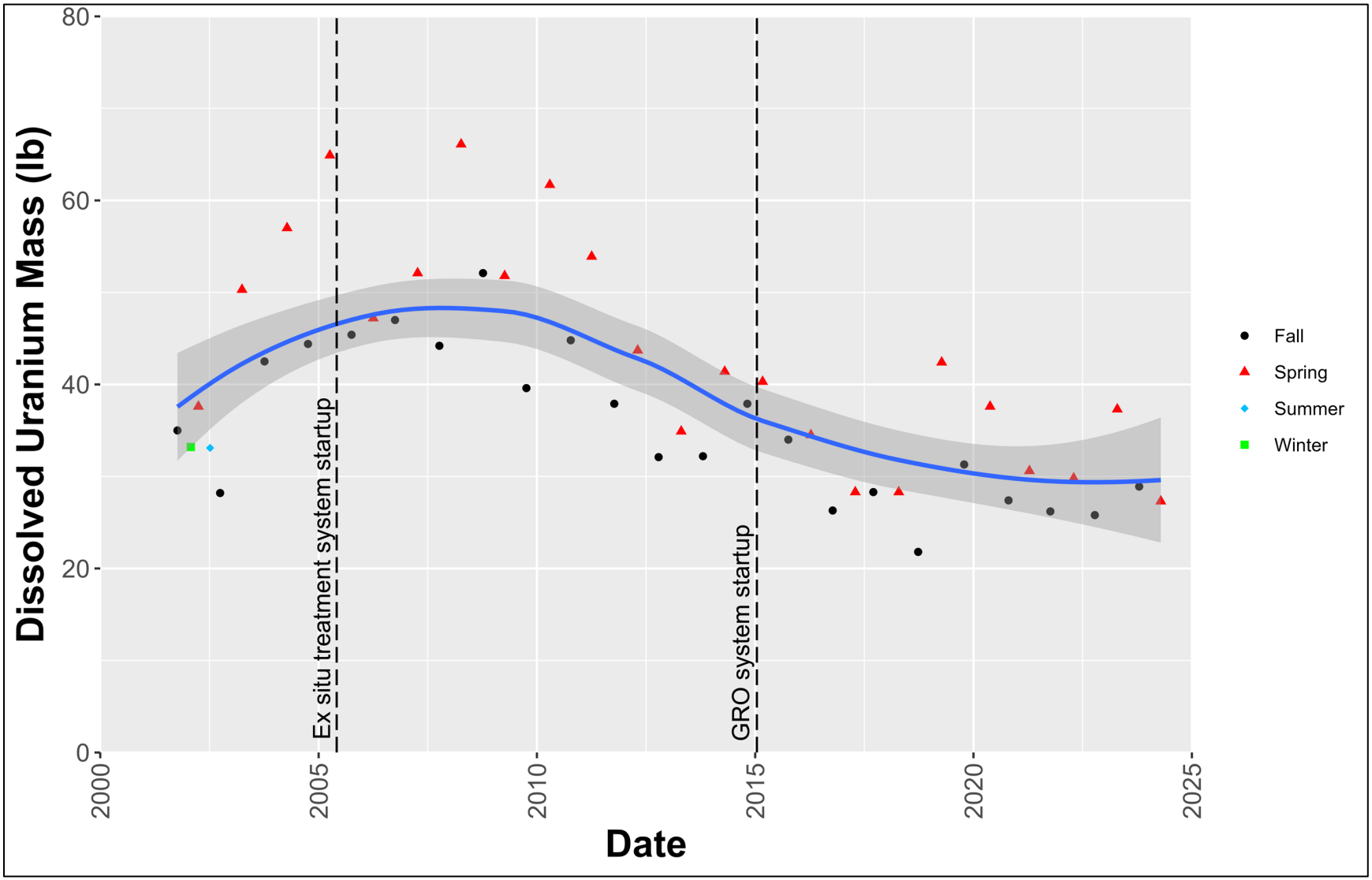


Figure 23. OU III Uranium Plume Mass Trend

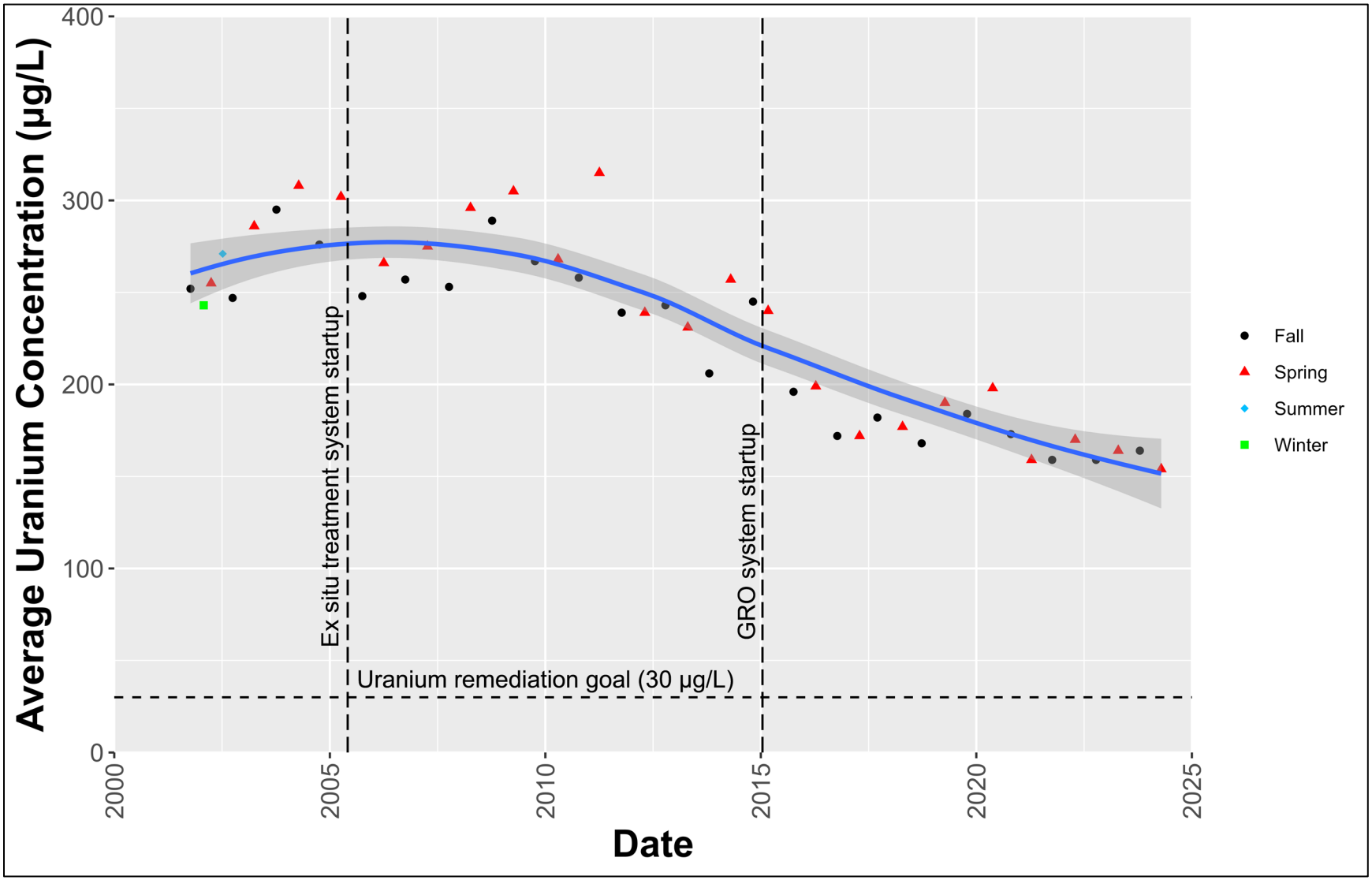


Figure 24. OU III Uranium Plume Average Concentration Trend

AOA uranium plume volume, uranium plume mass, and uranium plume average concentration trends (Figure 25 through Figure 27) between 2014, just before GRO system installation, and 2024 were also evaluated to assess aquifer restoration progress. The AOA uranium plume volume increased by approximately 0.5 million gallons between fall 2014 and spring 2015 despite GRO system startup in January 2015. Groundwater levels in the AOA respond to both extraction well field pumping and precipitation recharge, making it impossible to separate the influence of one from the other. Monticello's annual precipitation was 8.7 inches (222 millimeters [mm]) in 2014 and 17.0 inches (433 mm) in 2015, suggesting that the rise in the AOA water table elevation is in response to increased precipitation (DOE 2018c). After GRO system startup, the AOA plume volume decreased until about 2019, after which the AOA plume volume has generally increased in response to above-average snowfall raising the water table. Short-term nonpumping periods appear to have minimal if any effect on uranium plume volume.

From 2014 through 2018, the AOA uranium plume mass decreased from a maximum of 9.7 lb to a minimum of 2 lb (Figure 26). Since spring 2019, the AOA uranium plume mass has generally been increasing due to the increasing plume volume during the same period. Seasonal variations ranging from springtime highs up to 7.0 lb to summertime lows as low as 3.5 lb are notable after spring 2019. Short-term nonpumping periods appear to have minimal, if any, effect on uranium plume mass.

The AOA uranium plume average concentration declined from approximately 500 to 250 µg/L between 2014 and 2019 (Figure 27). As with the uranium plume mass, the reduction in uranium plume average concentration until 2019 is a function of both AOA groundwater levels and groundwater extraction. Since 2019, the average uranium concentration in the AOA has stabilized in the range of approximately 200–300 µg/L, with springtime peaks in wet years. Short-term nonpumping periods appear to have minimal if any effect on uranium plume average concentration.

A statistical analysis of seasonal differences was not performed for the AOA uranium plume. An autocorrelation analysis indicates that the number of samples should be reduced to a sample frequency of every two months before statistical testing to ensure statistical independence. After reducing the AOA dataset sample frequency and classifying the data points by season, too few data points are available for each season to perform a meaningful statistical comparison. Data for 9 complete seasonal cycles are available since the GRO system began operation, and an estimated 17 seasons of data would be needed to estimate a difference similar in magnitude to that detected for the OU III uranium plume as a whole.

The temporal location of the center of plume mass is a bulk plume metric that characterizes the temporal distribution of contamination concentration within the plume. In the case of the OU III uranium plume, decreases in former mill site and AOA uranium concentrations in groundwater (Figure 12 through Figure 14) and mostly stable uranium concentrations in groundwater downgradient of the PRB (Figure 15) caused the center of mass (Figure 28) to move downgradient between 2001 and 2024.

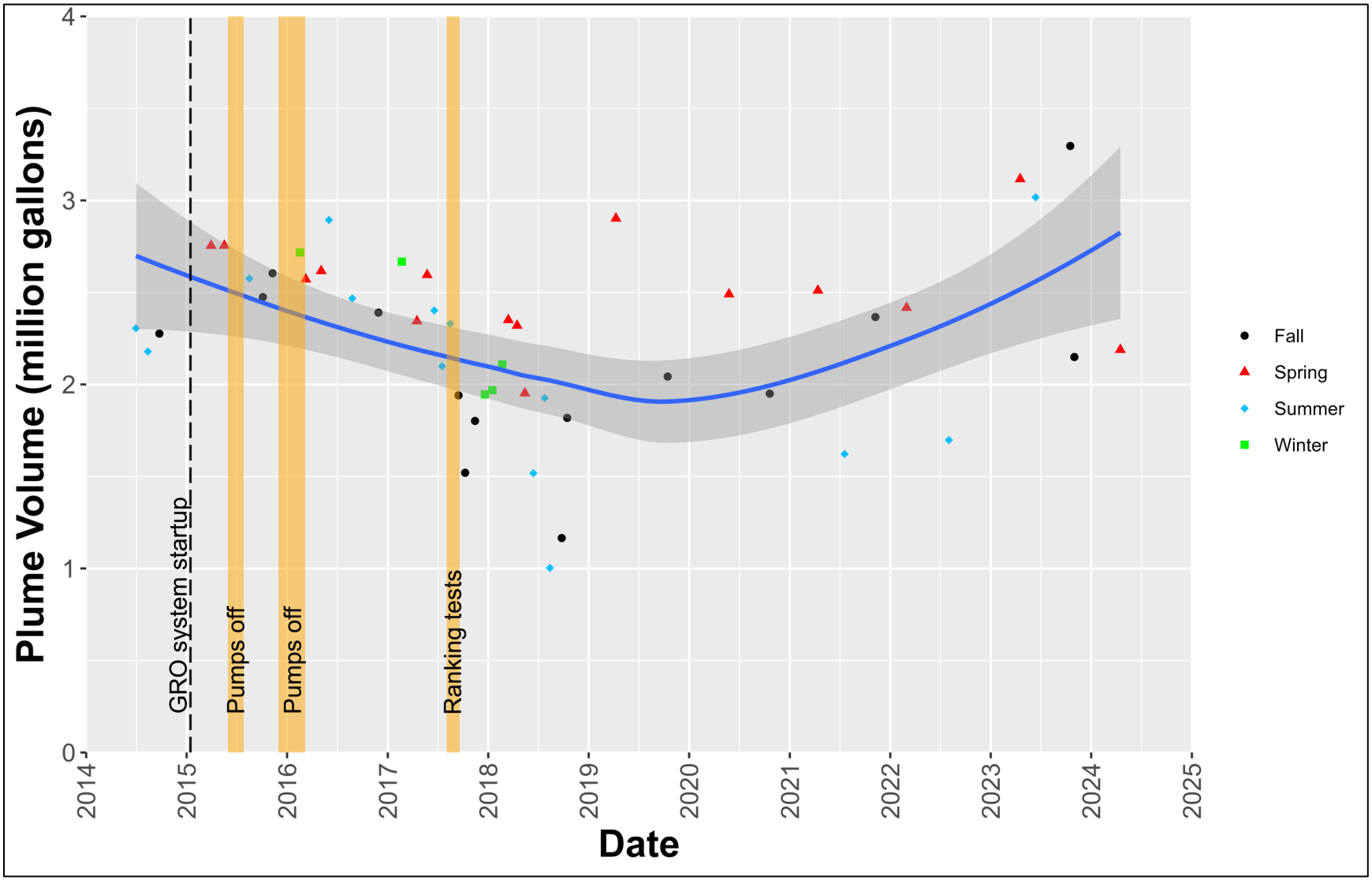


Figure 25. AOA Uranium Plume Volume Trend

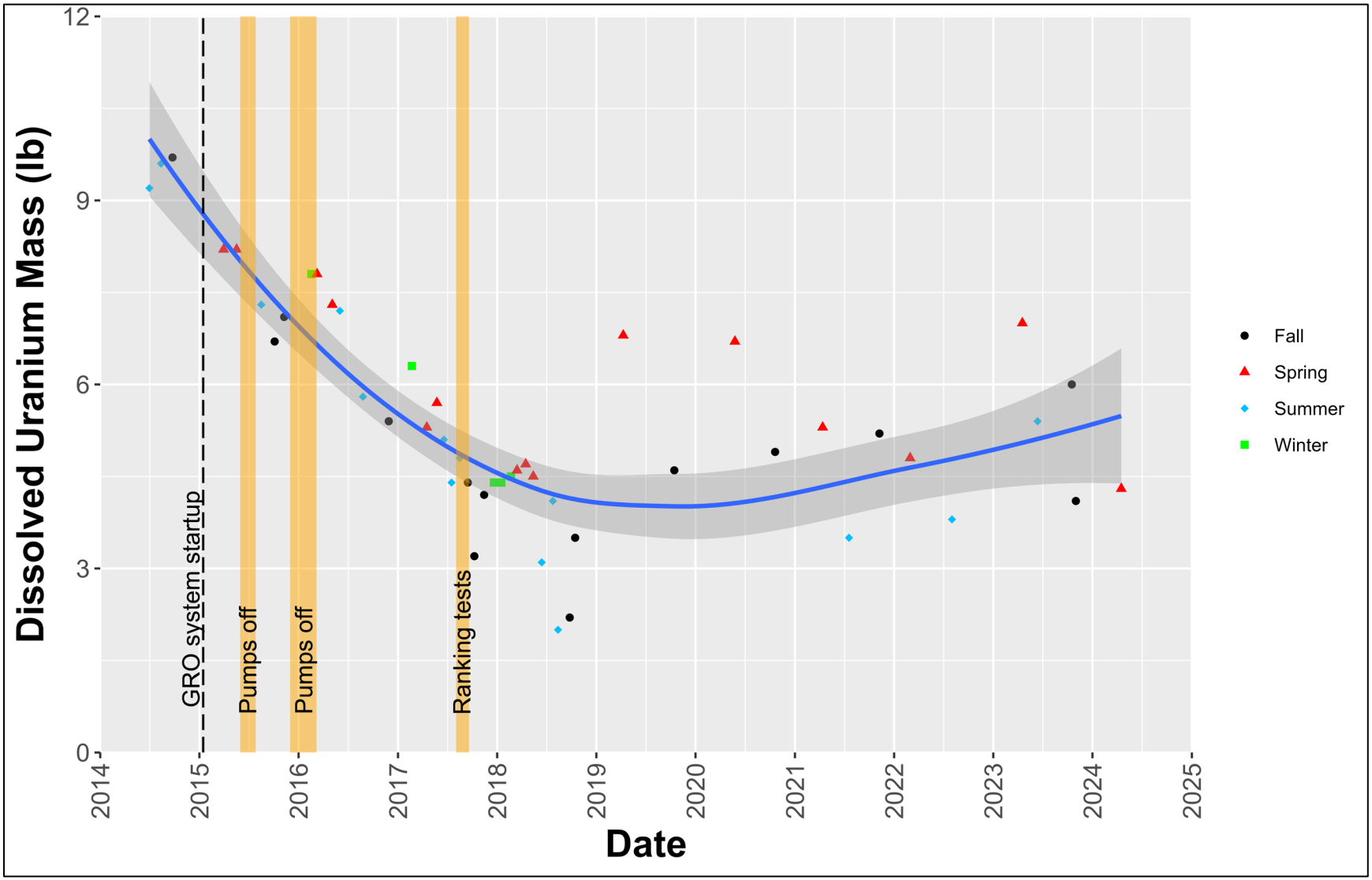


Figure 26. AOA Uranium Plume Mass Trend

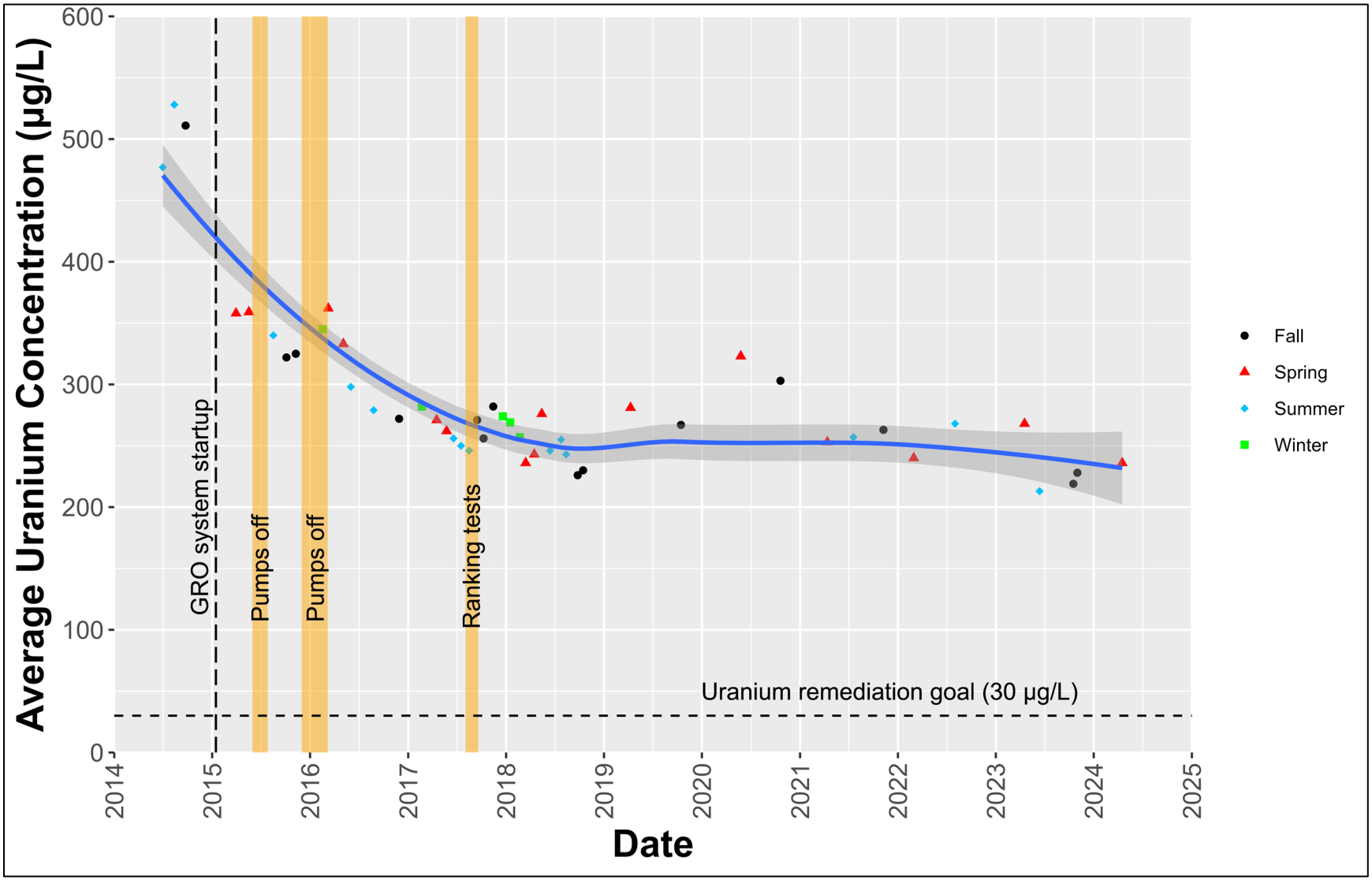


Figure 27. AOA Uranium Plume Average Concentration Trend

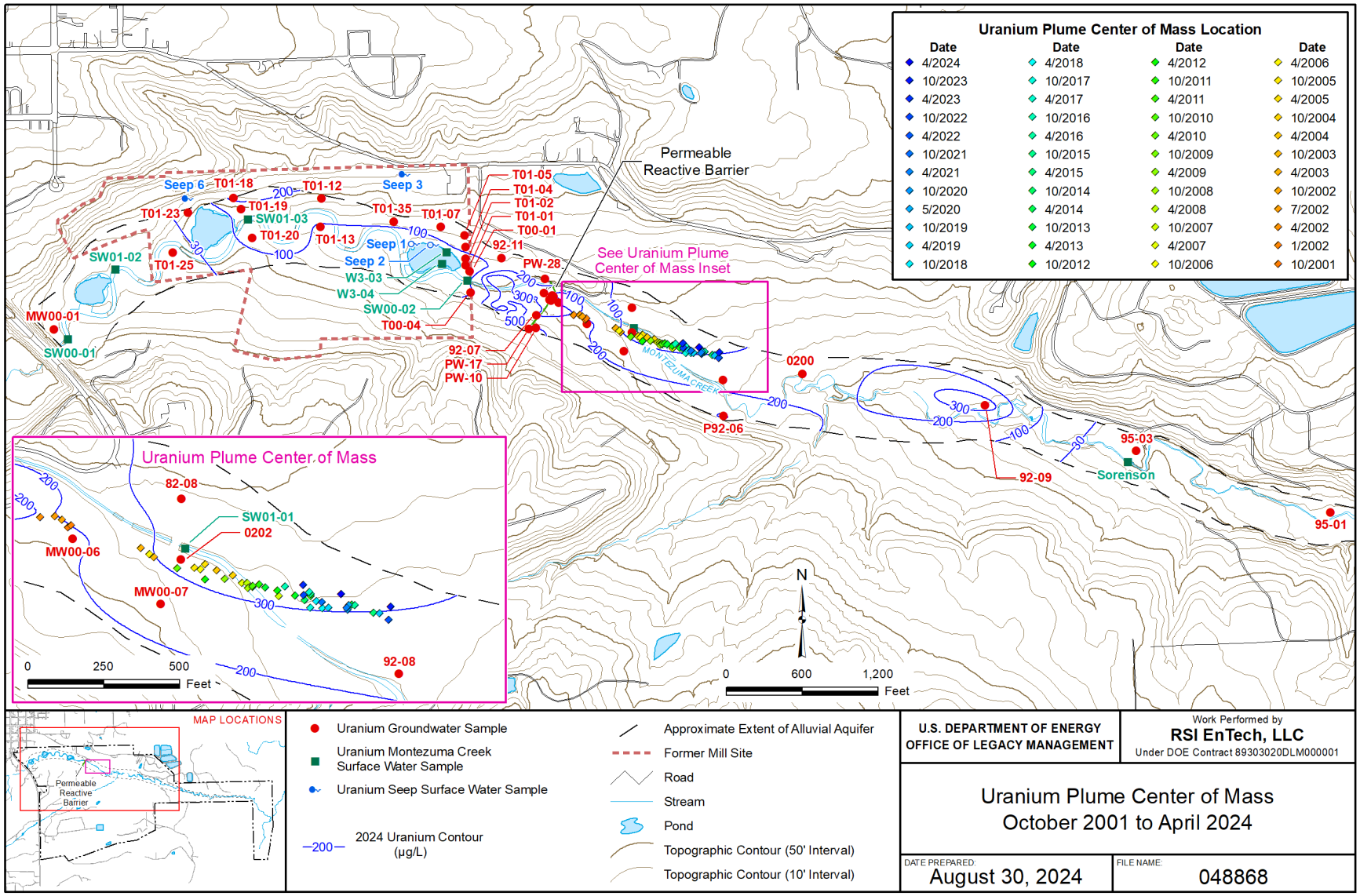


Figure 28. OU III Uranium Plume Center of Mass Temporal Locations

2.6 Surface Water Uranium Concentration Trends

Surface water samples were collected from 10 locations within Montezuma Creek during the May 2023 to April 2024 sampling period. Figure 29 shows historical Montezuma Creek uranium concentrations. Location SW00-01 represents background concentrations and has no statistical trend by Mann-Kendall analysis. Location SW01-02, the next monitoring location downstream of location SW00-01, likewise does not have a statistically significant trend. The other three most upgradient surface water sample locations (SW01-03, SW00-02, and SW01-01) have statistically significant declining uranium concentration trends that have historically remained below the State of Utah surface water uranium standard of 44 µg/L. The trend graphs for the five most-upgradient sampling locations show that uranium surface water concentrations increase upstream to downstream due to discharge of contaminated groundwater to the creek in the former mill site. At the Sorenson sampling location, uranium concentrations are typically above the State of Utah surface water uranium standard of 44 µg/L. The October 2023 and April 2024 uranium concentrations at this location were 138 and 81.4 µg/L, respectively. Downstream, sample results from the next four sampling locations (SW00-04, SW92-08, SW92-09, and SW94-01) are similar, with October 2023 concentrations between 111 to 138 µg/L and April 2024 concentrations between 72 to 80.5 µg/L. There was not a statistically identifiable trend by Mann-Kendall analysis at the Sorenson location or any of the monitoring stations downstream of Sorenson.

The observed uranium concentration trend with distance along the creek is related to groundwater discharge. Upstream, where the Dakota Sandstone is present, contaminated groundwater discharge to the creek is minimal and as such uranium surface water concentrations are relatively low. Upgradient of the Sorenson surface water sampling location, the Dakota Sandstone pinches out, allowing the underlying Burro Canyon Formation to come into direct contact with the alluvial aquifer (Section 1.2). The addition of Burro Canyon Formation water to the alluvial aquifer causes the uranium plume to discharge to Montezuma Creek downgradient of the pinch-out location. The correlation between the area where the uranium plume ends and the occurrence of historically elevated uranium surface water concentrations suggests that plume discharge, and not supplemental standard areas adjacent to and within the creek bed, is responsible for the increased uranium surface water concentrations. Supplemental standard areas are places where mill-contaminated soils were left in place adjacent to and within Montezuma Creek based on cost-benefit and risk analyses. For example, contaminated soils were left in place when removal of those soils would compromise fish and wildlife habitat and the contaminated soils were determined to have minimal adverse effects on human health and the environment. Contaminated soils were also left in place if removal costs outweighed potential benefits.

Seven OU III seep locations are included in the monitoring program (Figure 30). The Mann-Kendall analysis indicates an increasing uranium concentration trend at Seep 6. The April 2024 uranium concentration at Seep 6 was 3570 µg/L. The source of the Seep 6 uranium is believed to be tailings-contaminated soil used in a municipal water utility corridor that contains sanitary sewer and secondary water lines (DOE 2009b). Seep 1 and Seep 2 have typically been dry since 2014, and they were last sampled in October 2022. Although uranium concentrations at Seep 1 and Seep 2 historically have exceeded the surface water remediation goal, the October 2022 results were below the uranium concentration goal at both seeps. Seep 5 has been dry since 2013. Locations W3-03, W3-04, Seep 2, and Seep 3 have statistically decreasing uranium concentration trends by Mann-Kendall analysis, whereas Seep 1 has no statistically identifiable trend. The most recent uranium concentration measurements at locations W3-03, W3-04, Seep 3, and Seep 5 were below the State of Utah surface water uranium standard of 44 µg/L (Figure 30).

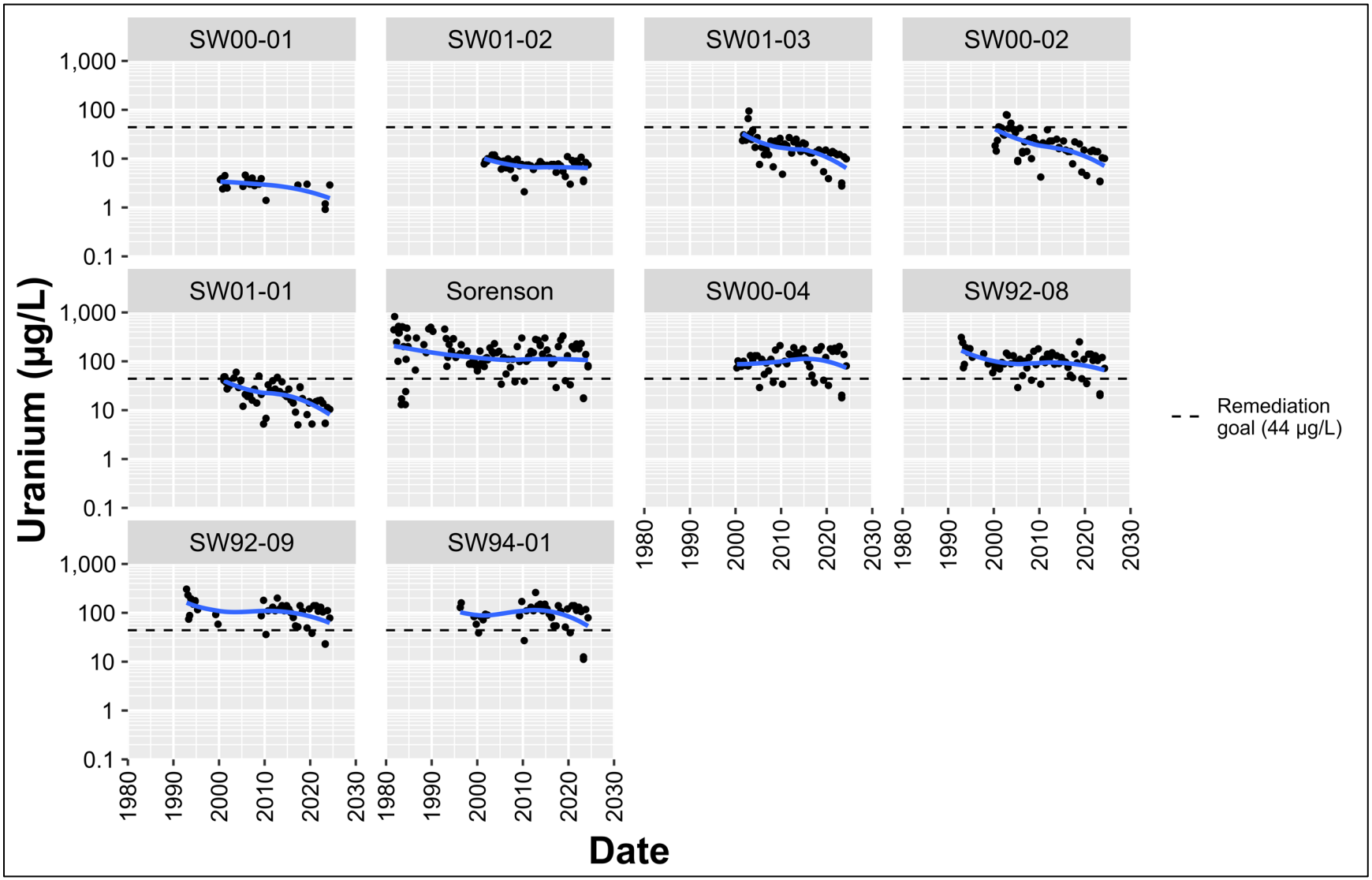


Figure 29. OU III Surface Water Uranium Concentration Trends

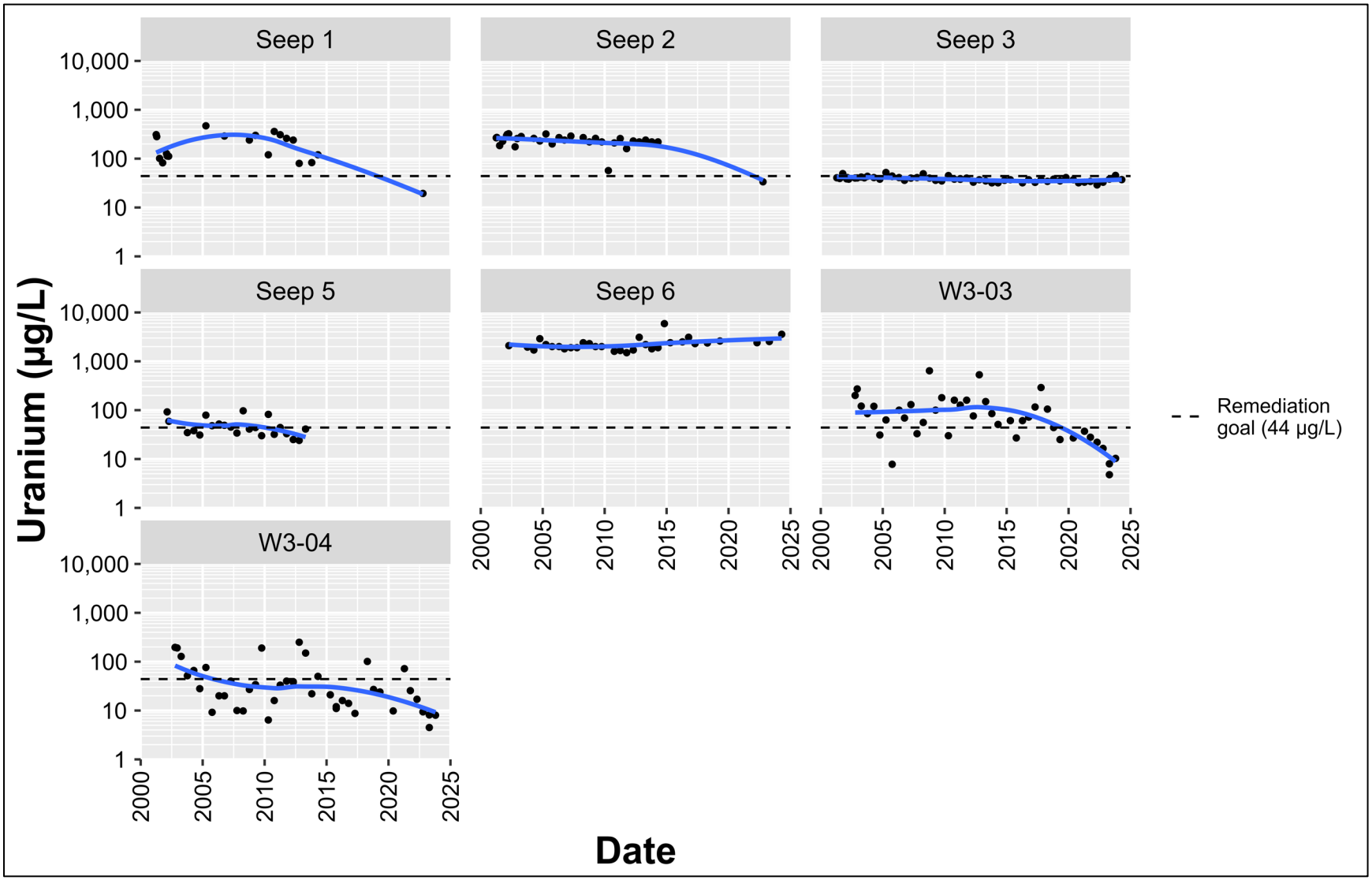


Figure 30. OU III Seep Uranium Concentration Trends

3.0 Compliance Remedy Performance Summary

The current OU III remedy is MNA and active remediation with ICs. MNA relies on natural physical and chemical processes in soil and groundwater to reduce uranium mass in the subsurface. Because of a long radioactive half-life (245,500 years for uranium-234 and 4.5 billion years for uranium-238), the only natural attenuation mechanisms available to reduce OU III subsurface uranium concentration are discharge to Montezuma Creek, dispersion along the plume flow path, sorption, and mineral precipitation due to changing geochemical conditions. This evaluation examined uranium groundwater concentrations and bulk plume metrics to characterize uranium attenuation progress (aquifer restoration) in OU III and the AOA and whether there are physical and chemical processes that may impede the remedy's efficiency. In addition, the annual extraction volumes and uranium mass removed by the GRO system were evaluated to characterize the system performance.

With respect to OU III groundwater:

Seasonal patterns of plume volume, mass, and average concentration are apparent, with spring highs and fall lows. Mixing of spring snowmelt and rainfall infiltration with uranium stored in the unsaturated zone can cause dissolved plume mass and average plume concentration to increase relative to fall conditions (Figure 23 and Figure 24). Springtime infiltration of snowmelt that leaches uranium stored in the unsaturated zone caused uranium plume mass to increase significantly in wet years. The rapid increase in uranium plume mass between fall and spring suggests how rapidly springtime infiltration mobilizes uranium stored in the unsaturated zone, and the rapid decrease in uranium plume mass between spring and fall indicates how effective natural attenuation mechanisms are at removing uranium from groundwater.

From 2008 to 2024, uranium plume mass and average concentration have steadily declined, whereas plume volume was variable during this period (Figure 22 through Figure 24). Over the 15-year period, OU III uranium plume mass declined from a maximum of 66 lb in 2008 to approximately 30 lb in April 2024. Similarly, the OU III uranium plume average concentration declined from approximately 300 µg/L in 2008 to 150 µg/L in April 2024. The declining trends of the uranium plume mass and average concentration show that OU III alluvial aquifer water quality improved from 2008 to 2024 as a result of active remediation and natural attenuation processes.

With respect to the AOA groundwater and GRO performance:

Since becoming operational in 2015, the GRO system has removed approximately 32.4 million gallons of contaminated groundwater containing approximately 159 lb of uranium (Figure 9). The maximum AOA uranium plume pore volume was 3.3 million gallons. Based on the maximum plume volume and assuming all the groundwater extracted by the GRO system was plume water, the GRO system has removed 9.8 AOA plume pore volumes since beginning operation in 2015. Based on the 2014 AOA uranium plume pore volume of 2.3 million gallons, the GRO system has removed 14.1 pore volumes since 2015. Before GRO system startup in January 2015, the AOA plume contained approximately 9.5 lb of dissolved uranium. At the conclusion of this performance period in April 2024, the average dissolved uranium mass in the AOA plume, indicated by the blue LOESS line in Figure 26, was 5.5 lb, a reduction of 4.0 lb relative to initial conditions. The discrepancy between the AOA uranium plume mass reduction

(4.0 lb) and the mass of uranium removed by the GRO system (159 lb) since January 2015 results because there is significant (approximately 1400 lb) solid-phase uranium remaining in the AOA that continues to feed the plume. In addition, the margins of the mill site vadose zone and a supplemental standards area south of the AOA continue to provide uranium to groundwater at the margins of the aquifer seasonally following snowmelt events. From 2014 to 2019, AOA uranium plume volume, mass, and average concentration decreased; however, from 2019 to 2024, the AOA plume volume and mass have increased while the average concentration has remained stable (Figure 25, Figure 26, and Figure 27).

With respect to the bedrock aquifer:

The Burro Canyon Formation water quality results from May 2023 to April 2024 are all below the OU III groundwater remediation goals. For bedrock wells on a 5-year sampling frequency, there were exceedances of arsenic (358 µg/L in October 2021) and manganese (891 µg/L in October 2021) in monitoring well 31NE93-205 (Appendix B). The 2021 measured arsenic and manganese concentrations are consistent with historical concentrations dating back to 1995.

With respect to OU III surface water:

Surface water uranium concentrations in the upper reaches of Montezuma Creek, above the Sorenson sampling location (Figure 6) where contaminated groundwater discharge to the creek is minimal relative to the downstream reaches, are declining and remain below the State of Utah surface water uranium standard of 44 µg/L (Figure 29). From the Sorenson sampling location and farther downstream, uranium surface water concentrations were 111–138 µg/L in October 2023 and 72–81.4 µg/L in April 2024. The April 2024 uranium results are lower than the October 2023 results because of snowmelt runoff diluting the creek concentrations in April. Contaminated groundwater discharging to this portion of Montezuma Creek is primarily responsible for the uranium measured at these surface water sampling locations. Montezuma Creek water quality will improve as OU III groundwater quality improves.

Six of the seven seep locations (Figure 6) have declining or stable uranium concentration trends (Figure 30). An increasing uranium concentration trend was identified at Seep 6. The source of the Seep 6 uranium is believed to be tailings-contaminated soil used in a municipal water utility corridor that contains sanitary sewer and secondary water lines (DOE 2009b). Three seep locations (Seeps 1, 2, and 5) were dry during sampling events conducted this performance period.

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Appendix A

Alluvial Aquifer Concentration Trends
May 2023–April 2024

Arsenic, Manganese, Molybdenum, Nitrate, Selenium, Vanadium

Arsenic

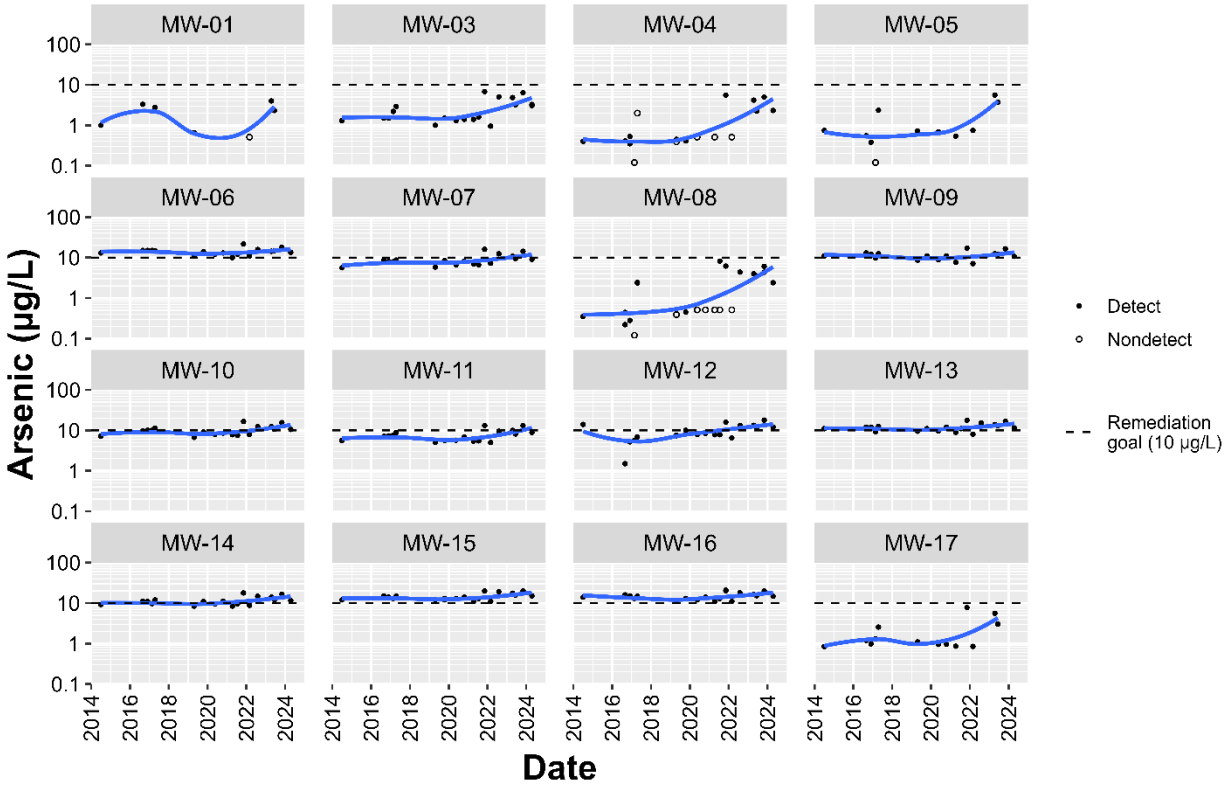
Groundwater Remediation Goal: 10 µg/L

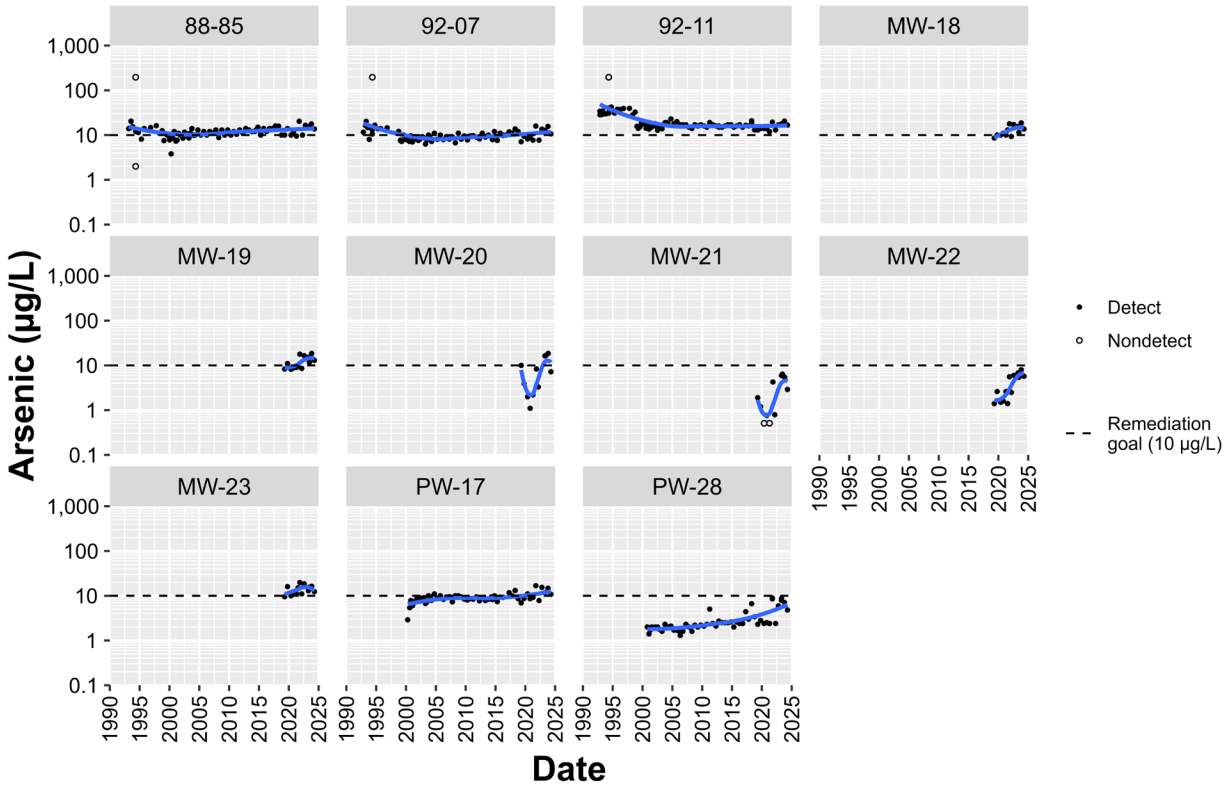
Sample Locations Are Shown in Figure 6

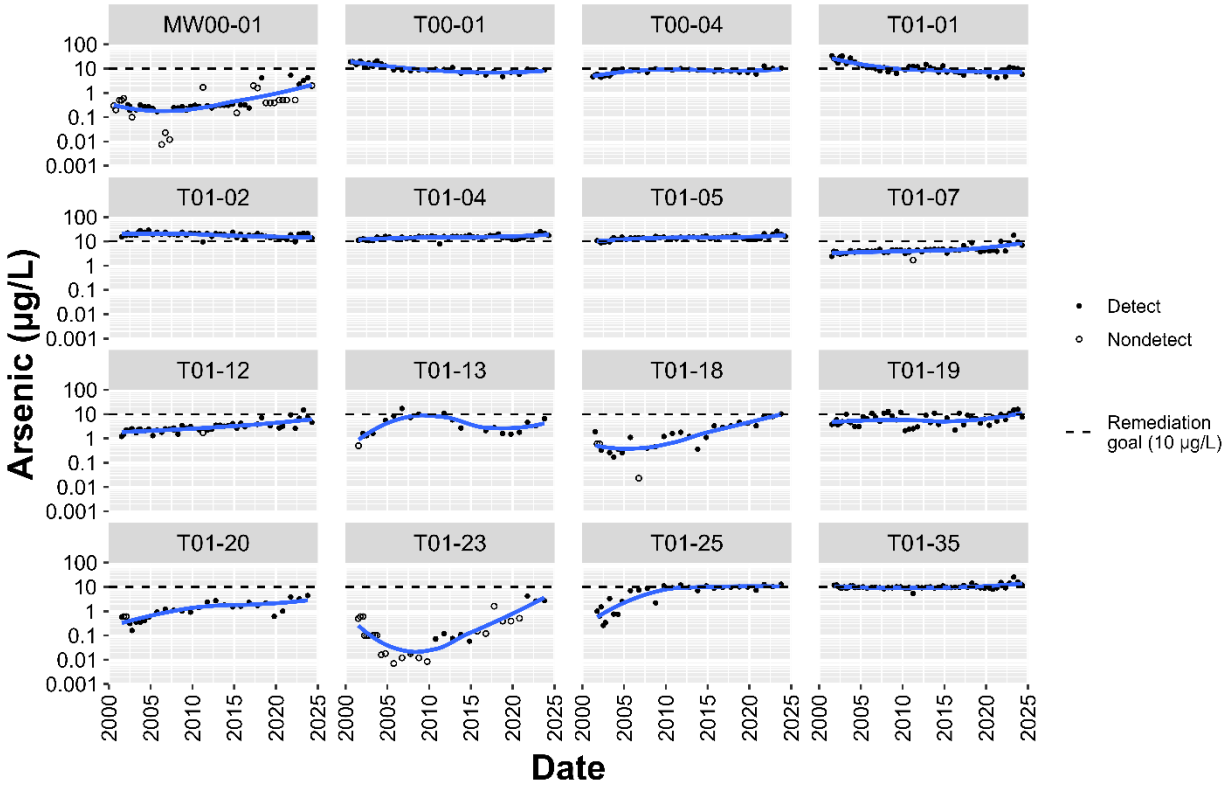
OU III Monitoring Wells Having Arsenic Concentrations Above the Remediation Goal This Performance Period

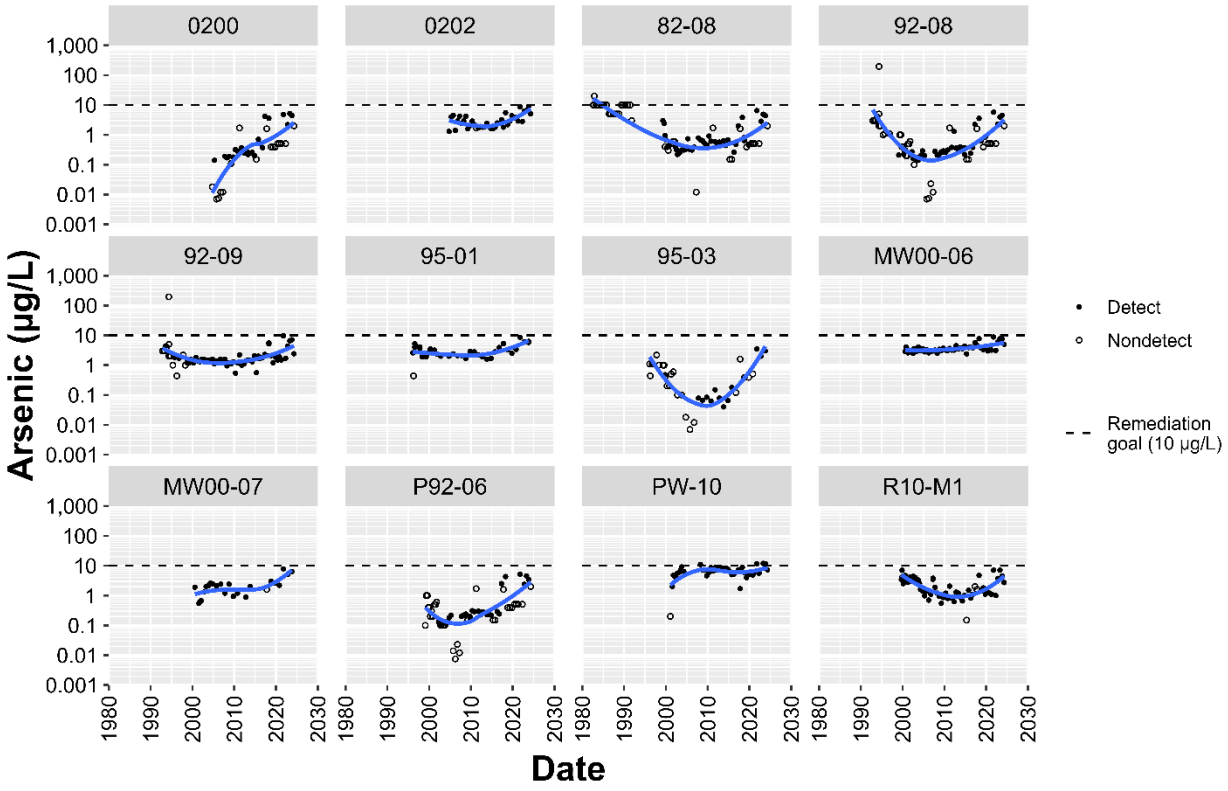
Well	Sample Date	Arsenic Concentration (µg/L)
88-85	10/17/2023	17.7
88-85	4/17/2024	13.7
92-07	10/18/2023	15.6
92-07	4/17/2024	10.6
92-11	10/17/2023	20.4
92-11	4/16/2024	16.7
MW-06	6/13/2023	14.8
MW-06	11/1/2023	18
MW-06	4/16/2024	13.5
MW-07	11/2/2023	14.3
MW-09	6/13/2023	12.1
MW-09	11/1/2023	16.5
MW-09	4/16/2024	10.7
MW-10	6/14/2023	10.7
MW-10	11/2/2023	15.5
MW-10	4/16/2024	10.5
MW-11	11/1/2023	13.1
MW-12	6/13/2023	11.8
MW-12	11/2/2023	17.9
MW-12	4/16/2024	12
MW-13	6/14/2023	12.9
MW-13	11/2/2023	16.8
MW-13	4/16/2024	11.5
MW-14	6/13/2023	12.1
MW-14	11/2/2023	16.6
MW-14	4/16/2024	11.5

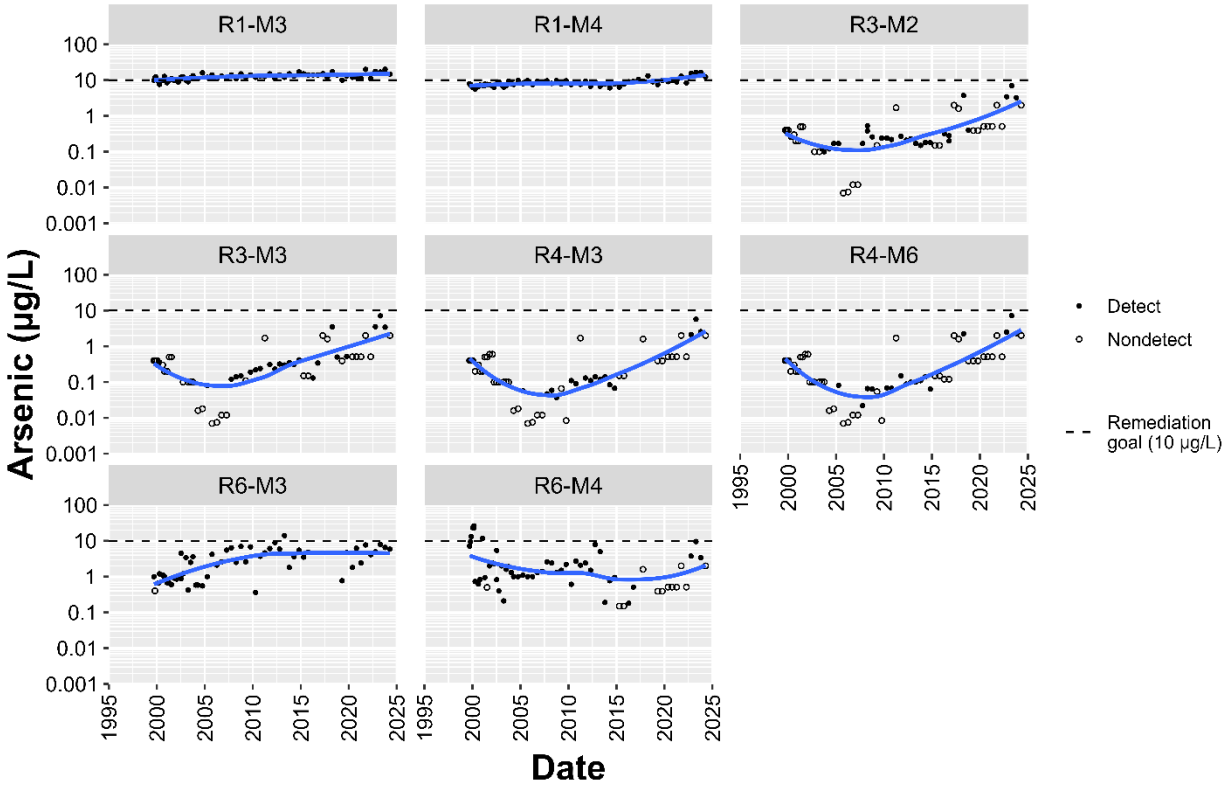
Well	Sample Date	Arsenic Concentration (µg/L)
MW-15	6/13/2023	15.8
MW-15	11/2/2023	20
MW-15	4/16/2024	15.1
MW-16	6/13/2023	15.2
MW-16	11/2/2023	20
MW-16	4/16/2024	14.8
MW-18	6/13/2023	11.5
MW-18	11/1/2023	18.7
MW-18	4/16/2024	13.7
MW-19	6/13/2023	11.8
MW-19	11/1/2023	18.5
MW-19	4/16/2024	13
MW-20	6/13/2023	16.7
MW-20	11/1/2023	18.5
MW-23	6/13/2023	14.5
MW-23	6/13/2023	15.5
MW-23	11/1/2023	16.3
MW-23	4/16/2024	12.4
PW-10	10/18/2023	11.7
PW-17	10/18/2023	14.7
PW-17	4/17/2024	10.8
R1-M3	10/17/2023	20
R1-M3	4/17/2024	14.8
R1-M4	10/17/2023	16.3
R1-M4	4/17/2024	12.3
T00-04	10/18/2023	10.5
T01-02	10/18/2023	21
T01-02	4/17/2024	13.7
T01-02	4/17/2024	13.4
T01-04	10/18/2023	21.9
T01-04	4/17/2024	17.6
T01-05	10/18/2023	19.3
T01-05	4/17/2024	16.2
T01-05	4/17/2024	16
T01-18	10/16/2023	10.2
T01-19	10/16/2023	15.8
T01-25	10/17/2023	12.9
T01-35	10/16/2023	15.6
T01-35	4/17/2024	12


MW-01
MW-03
MW-04
MW-05
MW-06
MW-07
MW-08
MW-09
MW-10
MW-11
MW-12
MW-13
MW-14
MW-15
MW-16
MW-17
Arsenic (µg/L)
100
10
1
0.1
2014
2016
2018
2020
2022
2024
Date
Detect
Nondetect
Remediation goal (10 µg/L)


88-85
92-07
92-11
MW-18
MW-19
MW-20
MW-21
MW-22
MW-23
PW-17
PW-28
Arsenic (µg/L)
1,000
100
10
1
0.1
1990
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (10 µg/L)


MW00-01
T00-01
T00-04
T01-01
T01-02
T01-04
T01-05
T01-07
T01-12
T01-13
T01-18
T01-19
T01-20
T01-23
T01-25
T01-35
Arsenic (µg/L)
Date
Detect
Nondetect
Remediation goal (10 µg/L)


0200
0202
82-08
92-08
92-09
95-01
95-03
MW00-06
MW00-07
P92-06
PW-10
R10-M1
Arsenic (µg/L)
Date
Detect
Nondetect
Remediation goal (10 µg/L)


R1-M3
R1-M4
R3-M2
R3-M3
R4-M3
R4-M6
R6-M3
R6-M4
Arsenic (µg/L)
100
10
1
0.1
0.01
0.001
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (10 µg/L)

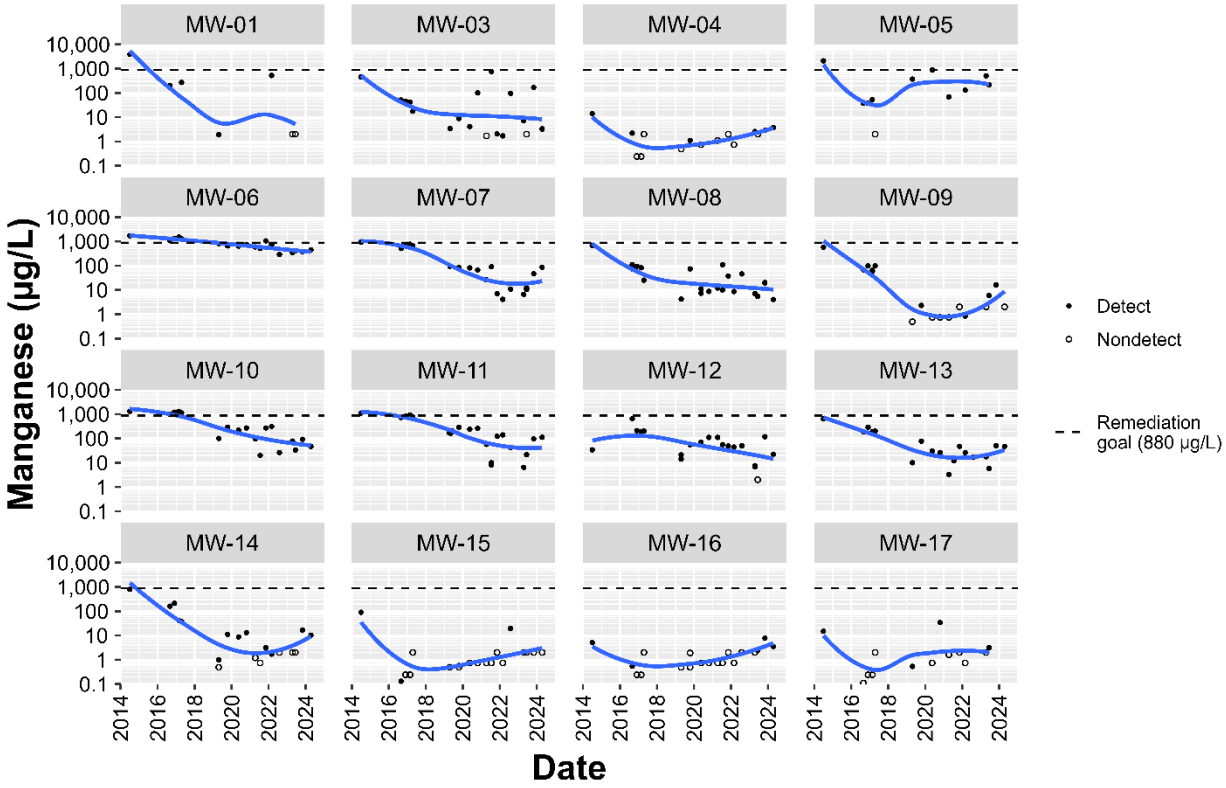
Manganese

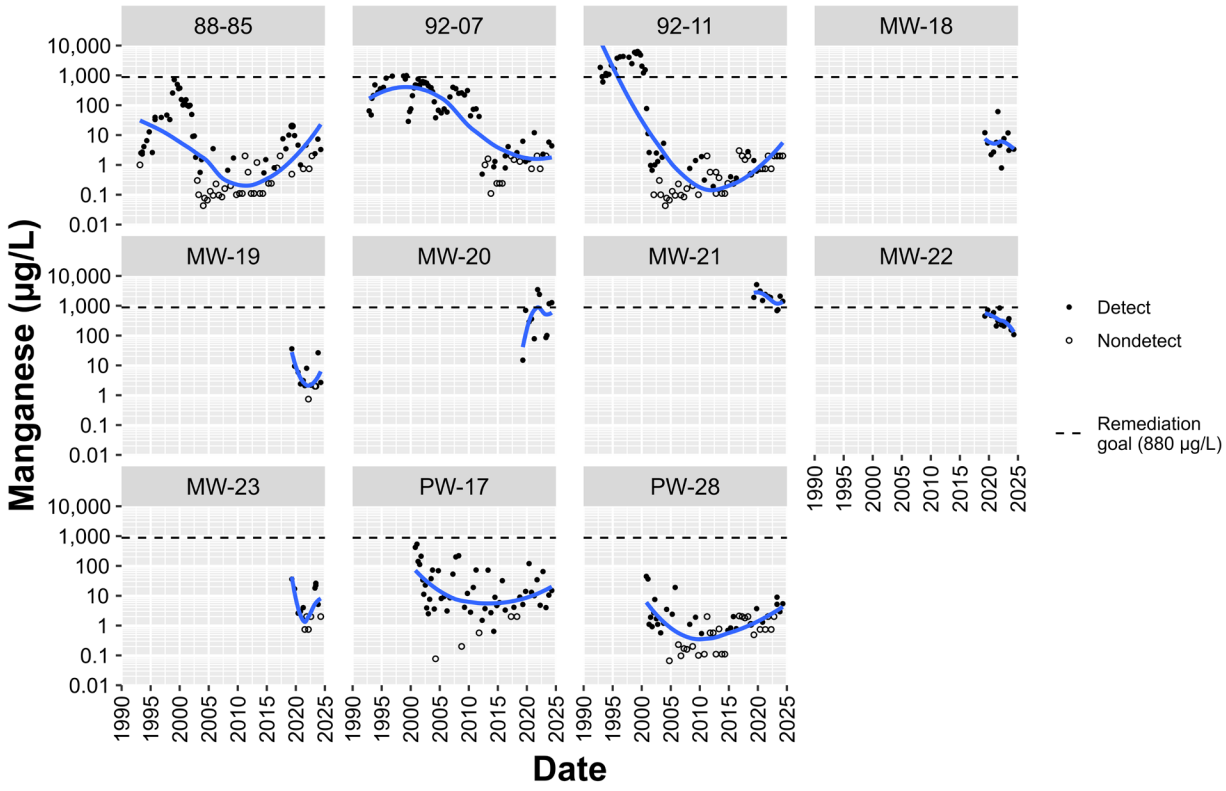
Groundwater Remediation Goal: 880 µg/L

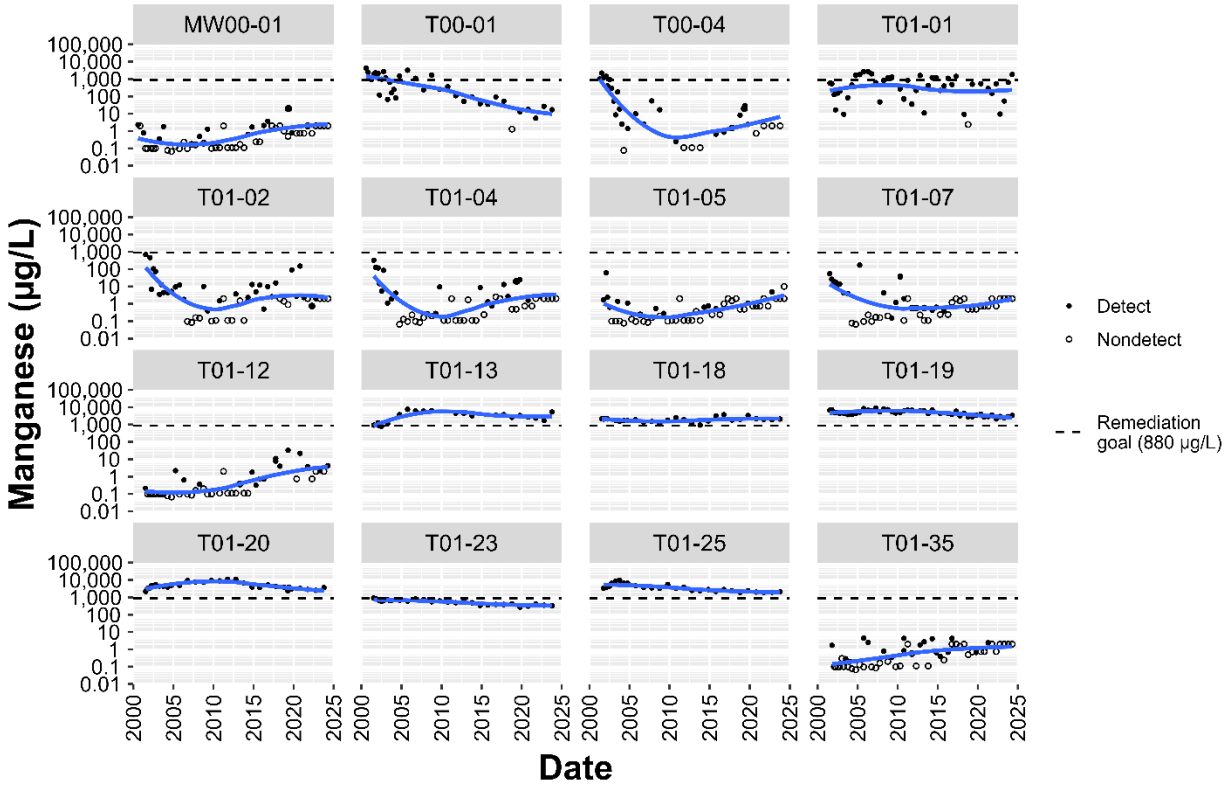
Sample Locations Are Shown in Figure 6

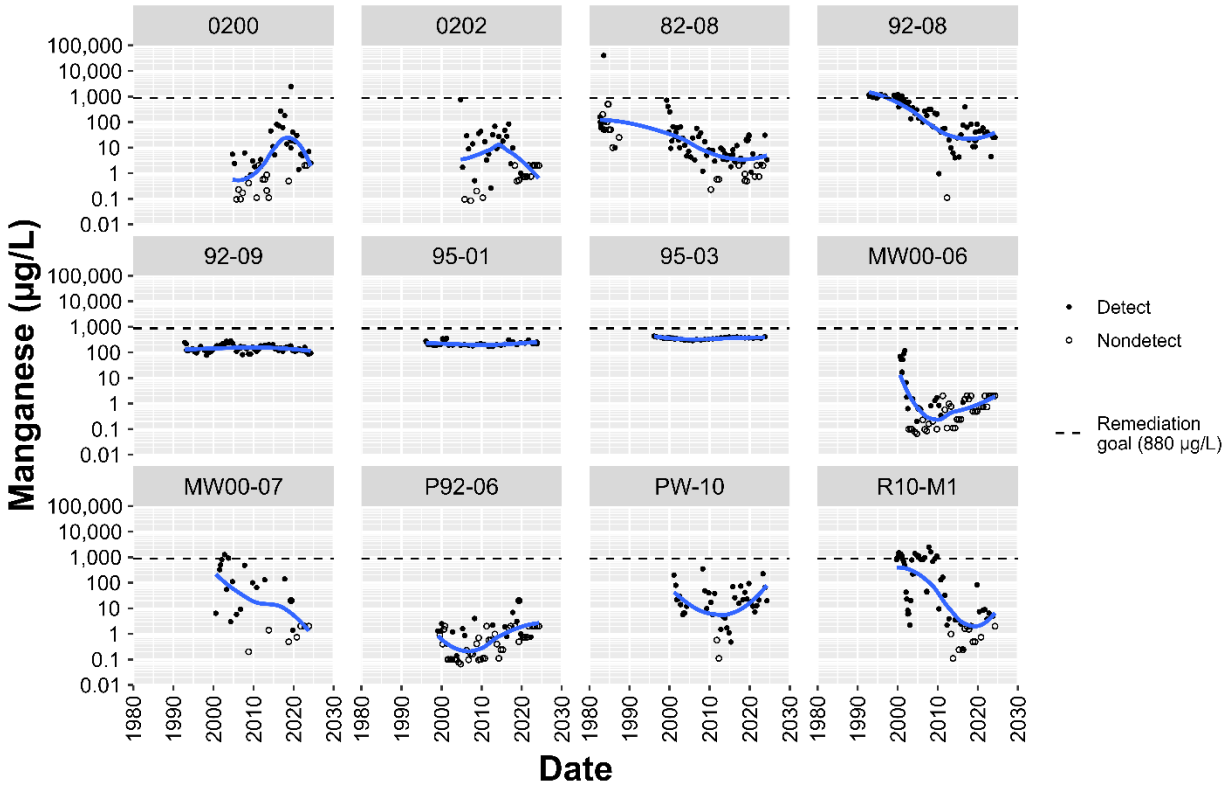
OU III Monitoring Wells Having Manganese Concentrations Above the Remediation Goal This Performance Period

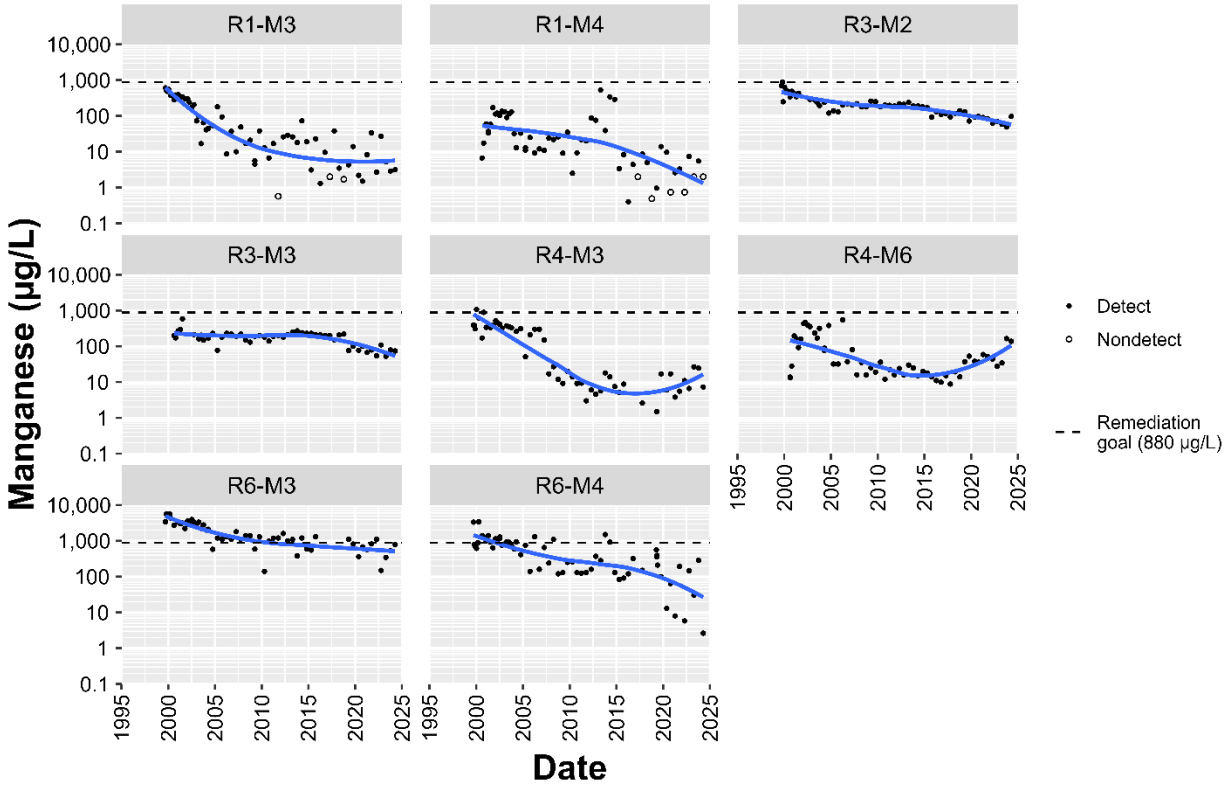
Well	Sample Date	Manganese Concentration (µg/L)
MW-20	11/1/2023	1170
MW-20	4/16/2024	1270
MW-21	11/1/2023	2090
MW-21	4/16/2024	1410
T01-01	4/17/2024	1850
T01-13	10/17/2023	5330
T01-18	10/16/2023	2080
T01-19	10/16/2023	2880
T01-19	4/16/2024	3350
T01-20	10/17/2023	3630
T01-25	10/17/2023	2070


MW-01
MW-03
MW-04
MW-05
MW-06
MW-07
MW-08
MW-09
MW-10
MW-11
MW-12
MW-13
MW-14
MW-15
MW-16
MW-17
Manganese (µg/L)
10,000
1,000
100
10
1
0.1
2014
2016
2018
2020
2022
2024
Date
Detect
Nondetect
Remediation goal (880 µg/L)


88-85
92-07
92-11
MW-18
MW-19
MW-20
MW-21
MW-22
MW-23
PW-17
PW-28
Manganese (µg/L)
10,000
1,000
100
10
1
0.1
0.01
1990
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (880 µg/L)


MW00-01
T00-01
T00-04
T01-01
T01-02
T01-04
T01-05
T01-07
T01-12
T01-13
T01-18
T01-19
T01-20
T01-23
T01-25
T01-35
Manganese (µg/L)
100,000
10,000
1,000
100
10
1
0.1
0.01
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (880 µg/L)


0200
0202
82-08
92-08
92-09
95-01
95-03
MW00-06
MW00-07
P92-06
PW-10
R10-M1
Manganese (µg/L)
100,000
10,000
1,000
100
10
1
0.1
0.01
1980
1990
2000
2010
2020
2030
Date
Detect
Nondetect
Remediation goal (880 µg/L)


R1-M3
R1-M4
R3-M2
R3-M3
R4-M3
R4-M6
R6-M3
R6-M4
Manganese (µg/L)
10,000
1,000
100
10
1
0.1
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (880 µg/L)

Molybdenum

Groundwater Remediation Goal: 100 µg/L

Sample Locations Are Shown in Figure 6

OU III Monitoring Wells Having Molybdenum Concentrations Above the Remediation Goal This Performance Period

Well	Sample Date	Molybdenum Concentration (µg/L)
MW-01	6/13/2023	148
MW-03	6/13/2023	184
MW-03	11/1/2023	102
MW-04	6/14/2023	261
MW-04	11/1/2023	207
MW-04	4/16/2024	114
MW-08	6/14/2023	126
MW-08	11/1/2023	204
MW-08	11/1/2023	198
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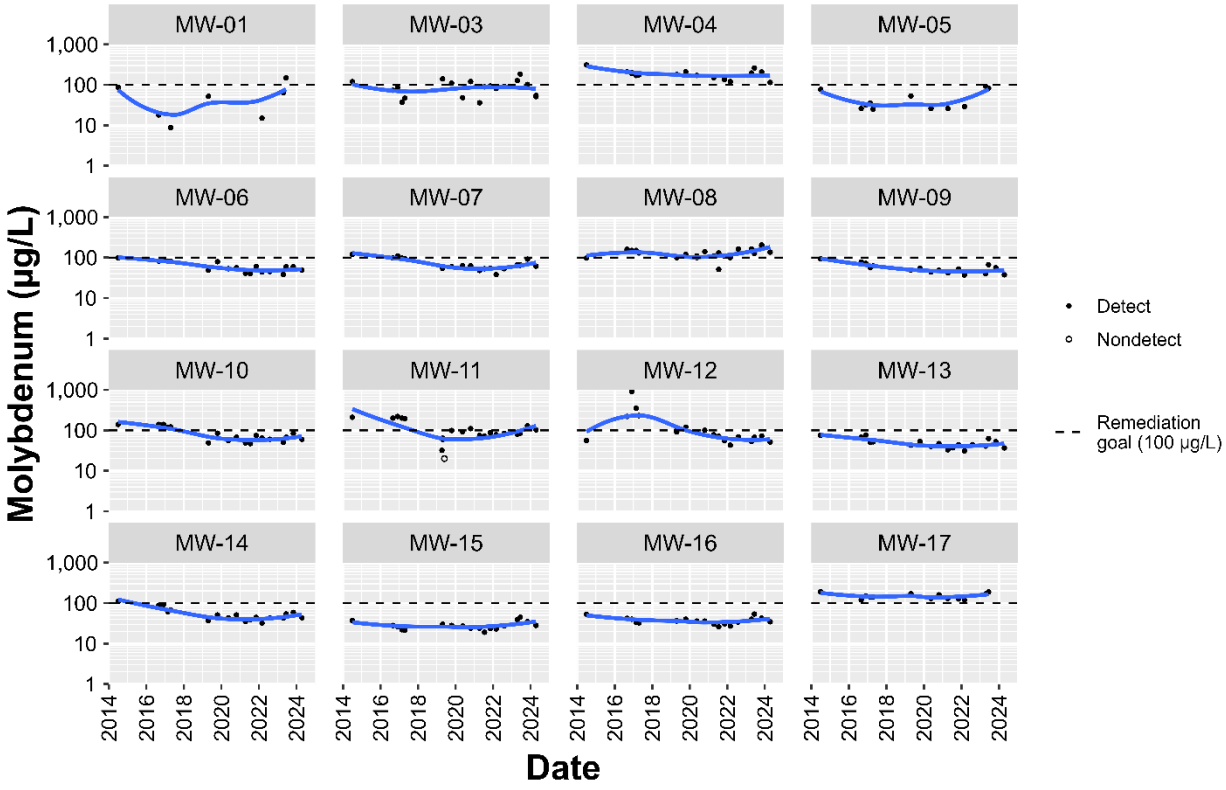
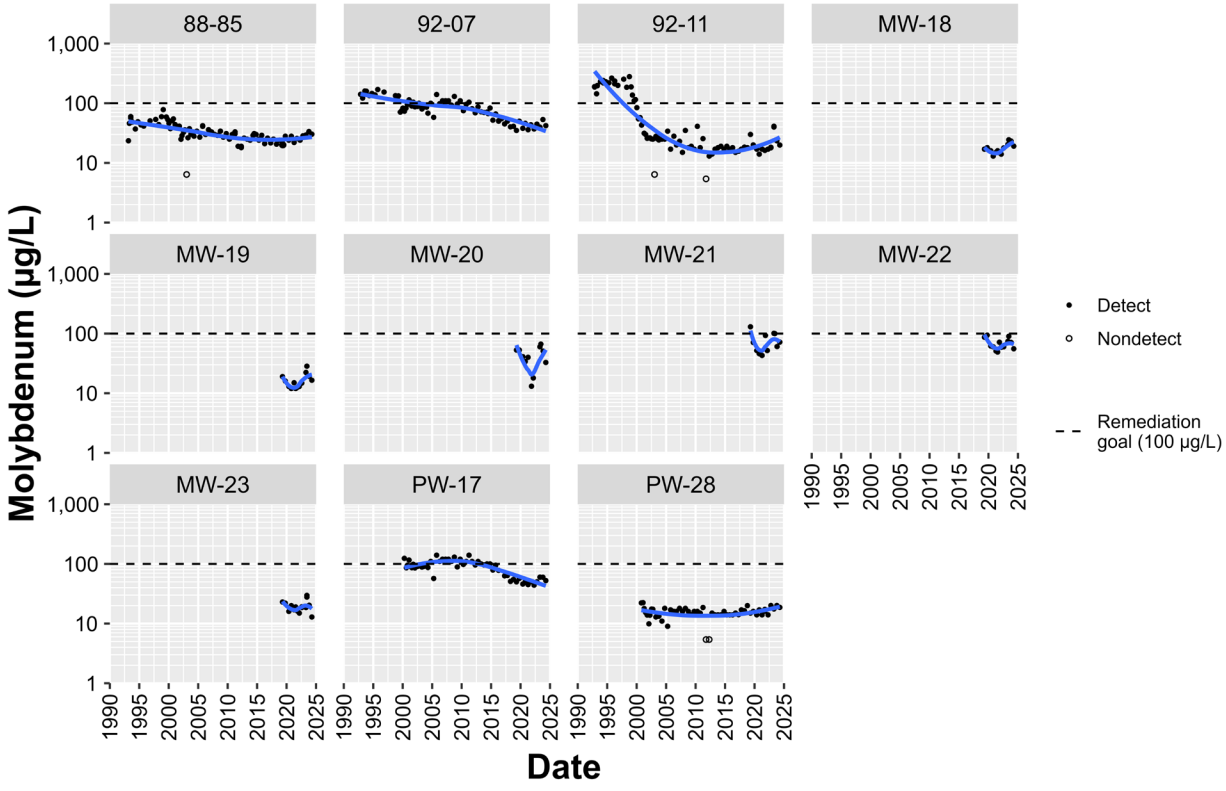
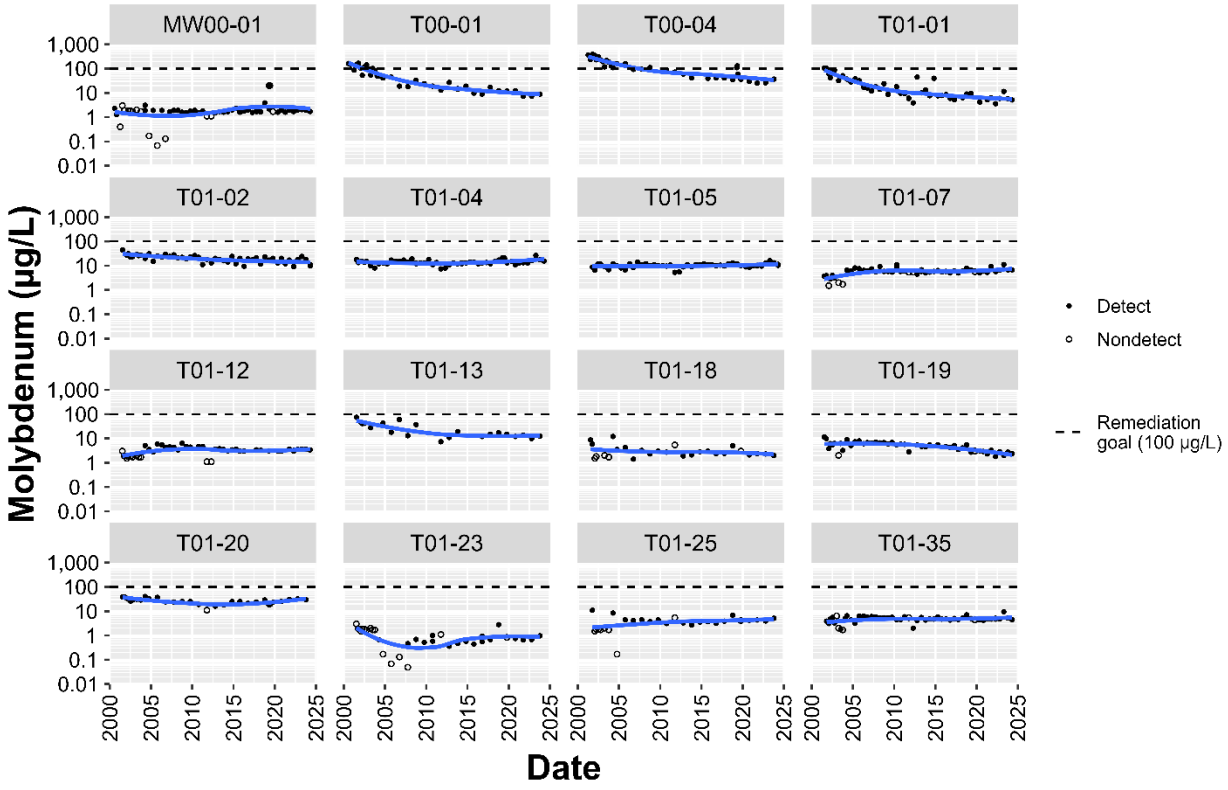
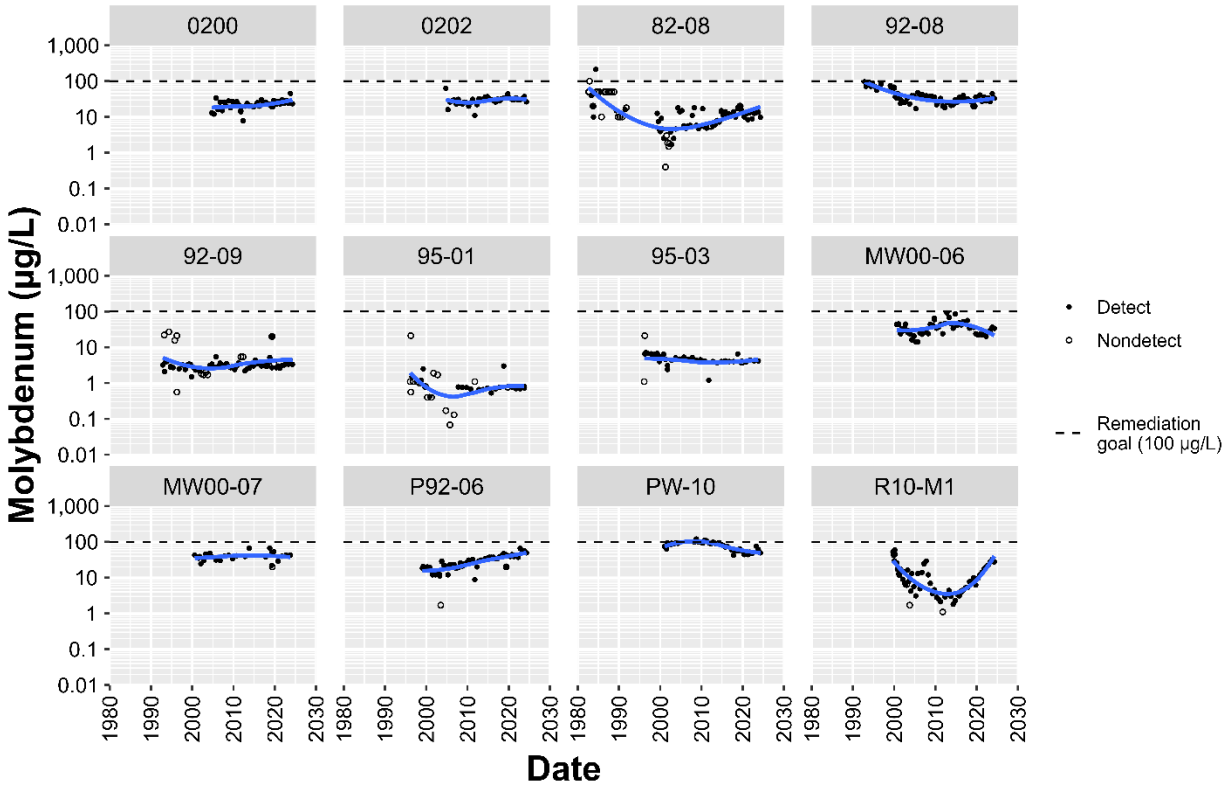
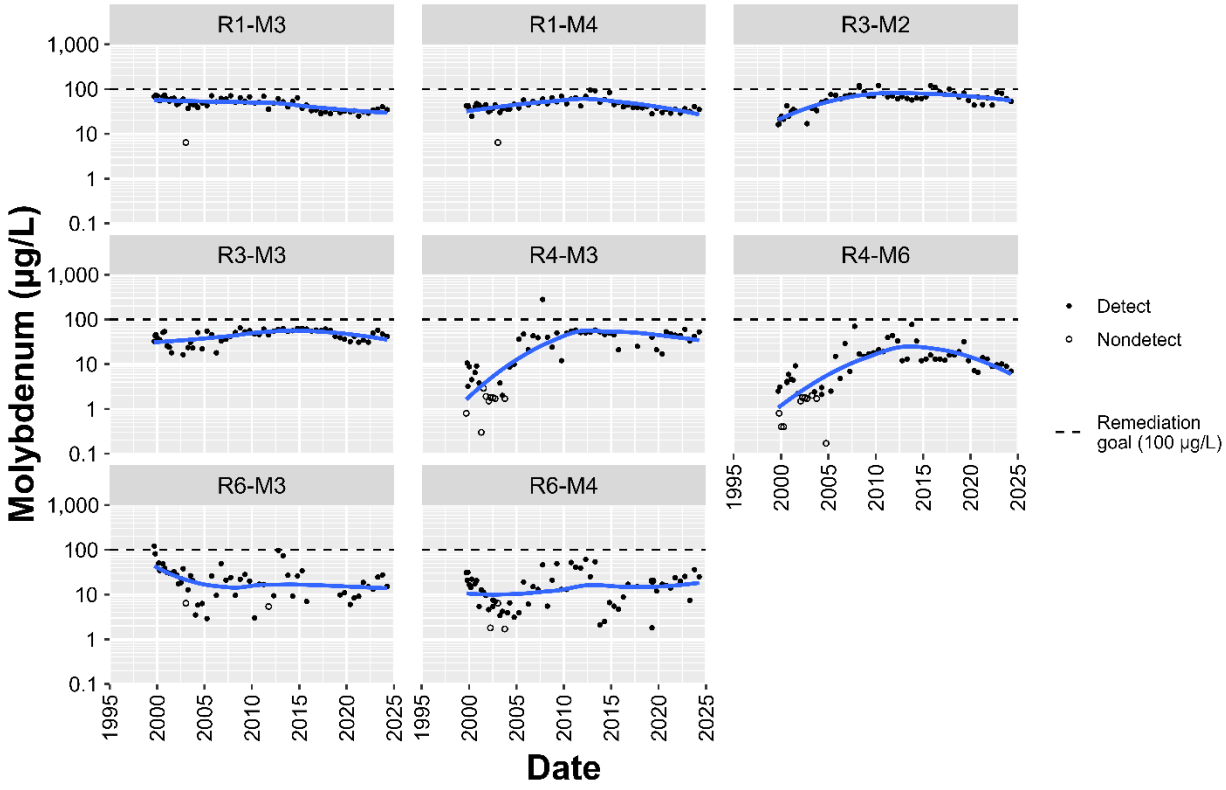
MW-17	6/14/2023	188


MW-01
MW-03
MW-04
MW-05
MW-06
MW-07
MW-08
MW-09
MW-10
MW-11
MW-12
MW-13
MW-14
MW-15
MW-16
MW-17
Molybdenum (µg/L)
1,000
100
10
1
2014
2016
2018
2020
2022
2024
Date
Detect
Nondetect
Remediation goal (100 µg/L)


88-85
92-07
92-11
MW-18
MW-19
MW-20
MW-21
MW-22
MW-23
PW-17
PW-28
Molybdenum (µg/L)
1,000
100
10
1
1990
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (100 µg/L)


MW00-01
T00-01
T00-04
T01-01
T01-02
T01-04
T01-05
T01-07
T01-12
T01-13
T01-18
T01-19
T01-20
T01-23
T01-25
T01-35
Molybdenum (µg/L)
1,000
100
10
1
0.1
0.01
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (100 µg/L)


0200
0202
82-08
92-08
92-09
95-01
95-03
MW00-06
MW00-07
P92-06
PW-10
R10-M1
Molybdenum (µg/L)
1,000
100
10
1
0.1
0.01
1980
1990
2000
2010
2020
2030
Date
Detect
Nondetect
Remediation goal (100 µg/L)


R1-M3
R1-M4
R3-M2
R3-M3
R4-M3
R4-M6
R6-M3
R6-M4
Molybdenum (µg/L)
1,000
100
10
1
0.1
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (100 µg/L)

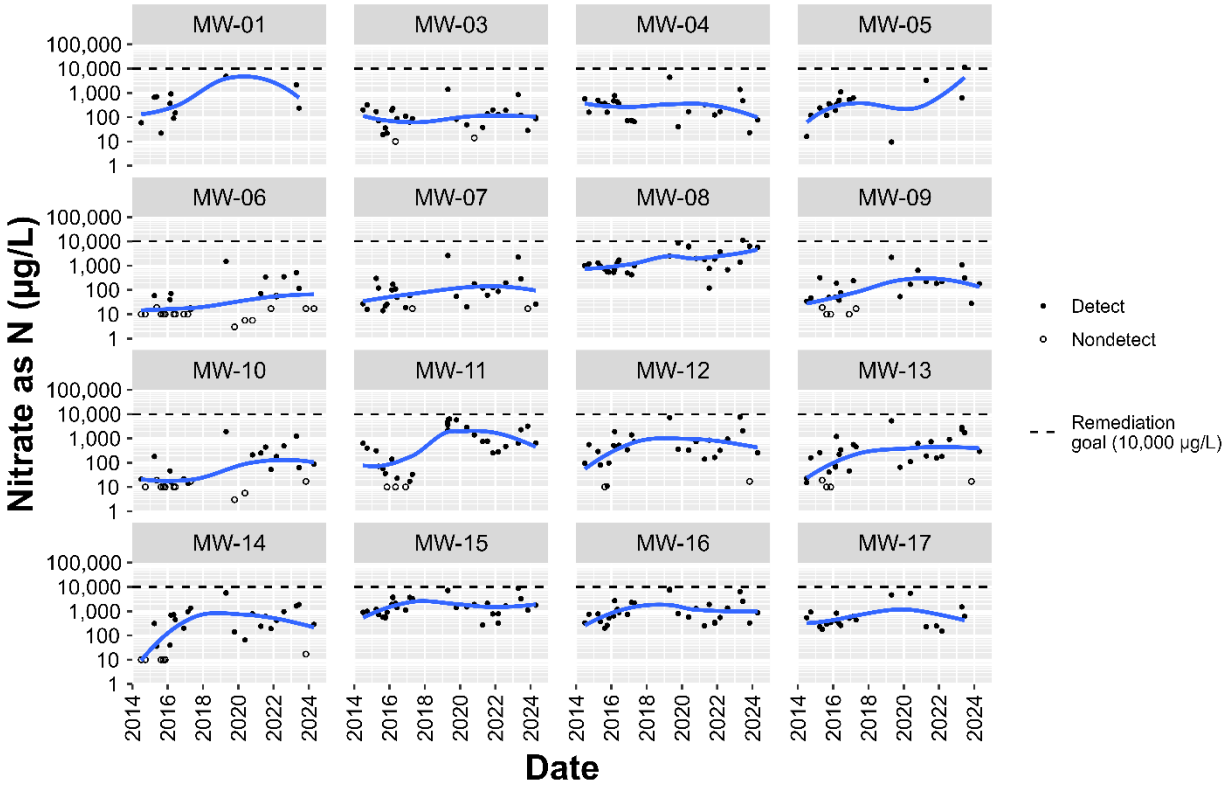
Nitrate as Nitrogen (N)

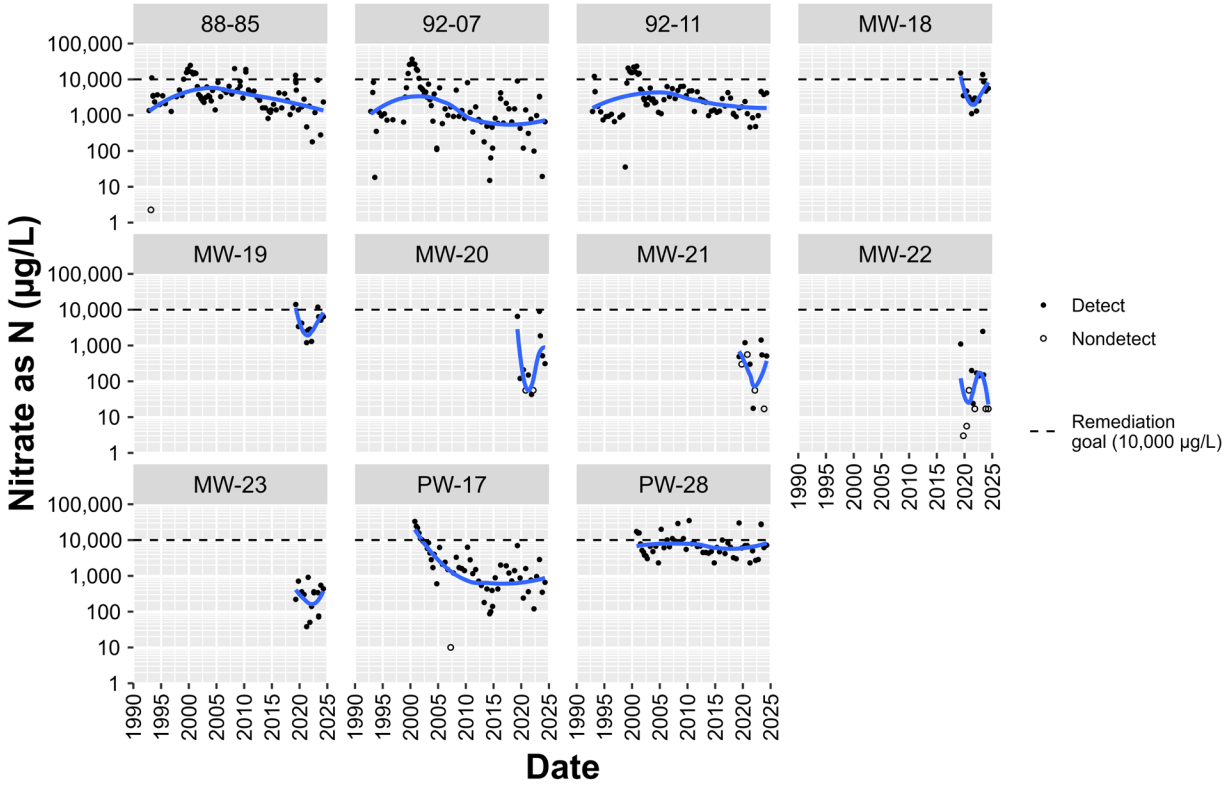
Groundwater Remediation Goal: 10,000 µg/L

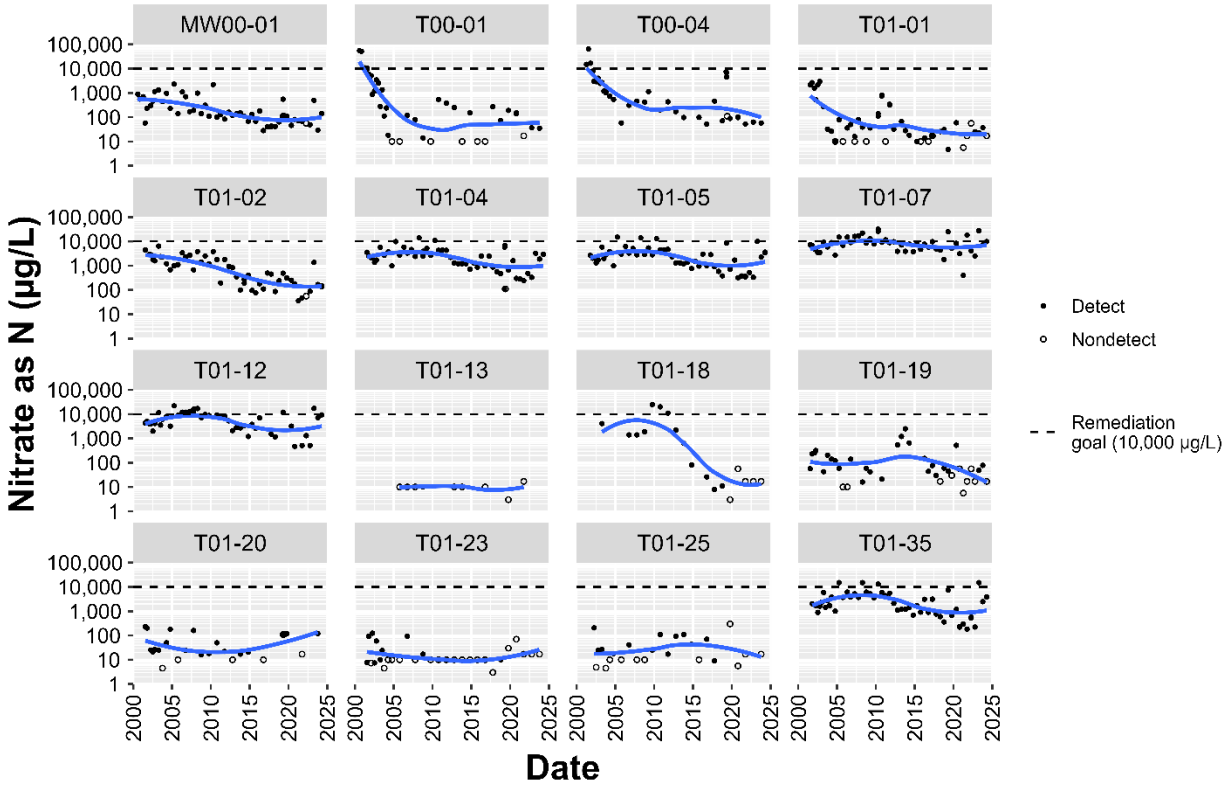
Sample Locations Are Shown in Figure 6

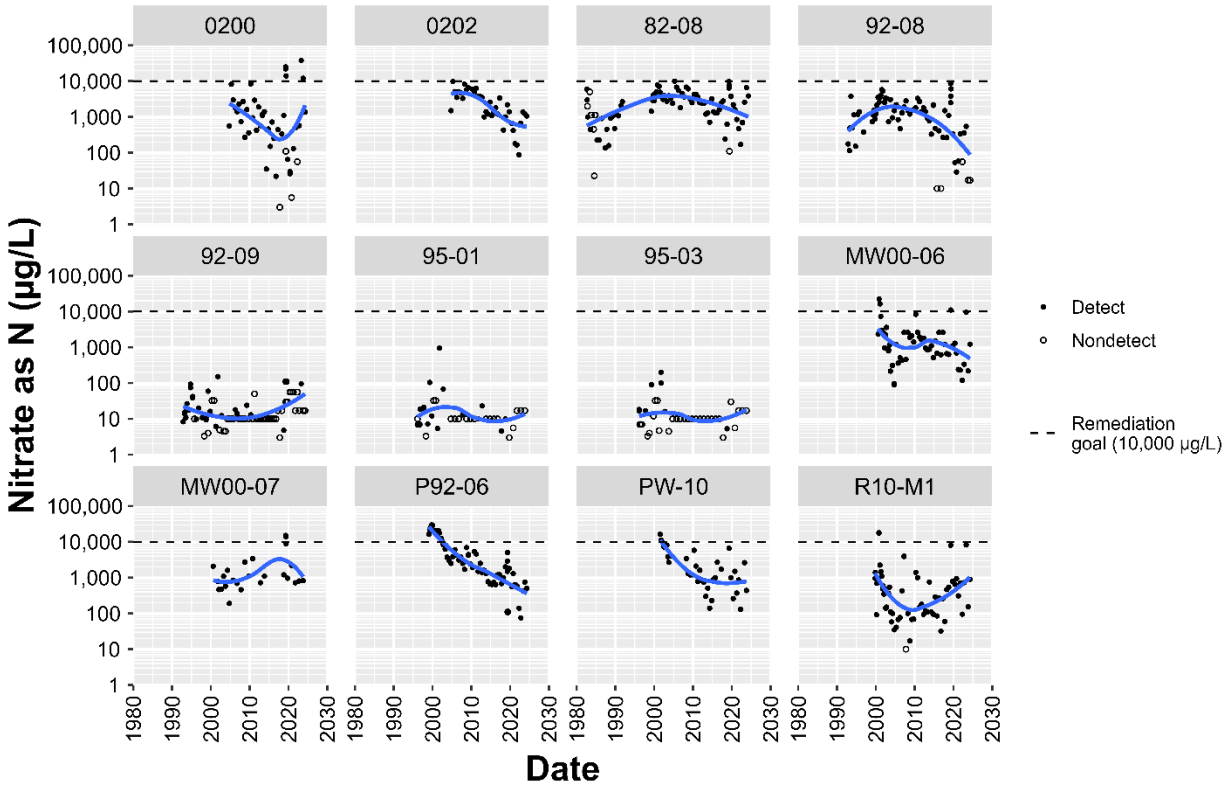
OU III Monitoring Wells Having Nitrate Concentrations Above the Remediation Goal This Performance Period

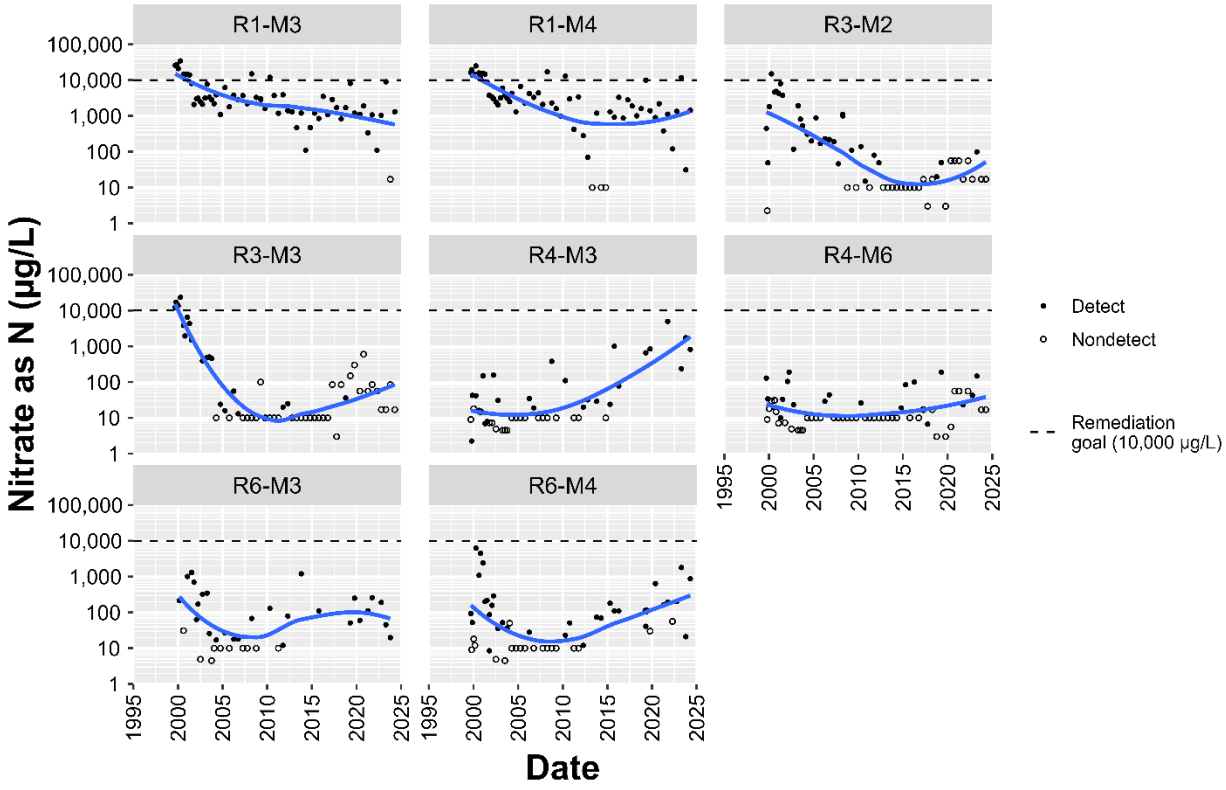
Well	Sample Date	Nitrate as N Concentration (µg/L)
0200	10/18/2023	12,000
MW-05	6/14/2023	11,300
MW-08	6/14/2023	11,300


MW-01
MW-03
MW-04
MW-05
MW-06
MW-07
MW-08
MW-09
MW-10
MW-11
MW-12
MW-13
MW-14
MW-15
MW-16
MW-17
Nitrate as N (µg/L)
100,000
10,000
1,000
100
10
1
2014
2016
2018
2020
2022
2024
Date
Detect
Nondetect
Remediation goal (10,000 µg/L)


88-85
92-07
92-11
MW-18
MW-19
MW-20
MW-21
MW-22
MW-23
PW-17
PW-28
Nitrate as N (µg/L)
100,000
10,000
1,000
100
10
1
1990
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (10,000 µg/L)


MW00-01
T00-01
T00-04
T01-01
T01-02
T01-04
T01-05
T01-07
T01-12
T01-13
T01-18
T01-19
T01-20
T01-23
T01-25
T01-35
Nitrate as N (µg/L)
100,000
10,000
1,000
100
10
1
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (10,000 µg/L)


0200
0202
82-08
92-08
92-09
95-01
95-03
MW00-06
MW00-07
P92-06
PW-10
R10-M1
Nitrate as N (µg/L)
100,000
10,000
1,000
100
10
1
1980
1990
2000
2010
2020
2030
Date
Detect
Nondetect
Remediation goal (10,000 µg/L)


R1-M3
R1-M4
R3-M2
R3-M3
R4-M3
R4-M6
R6-M3
R6-M4
Nitrate as N (µg/L)
100,000
10,000
1,000
100
10
1
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (10,000 µg/L)

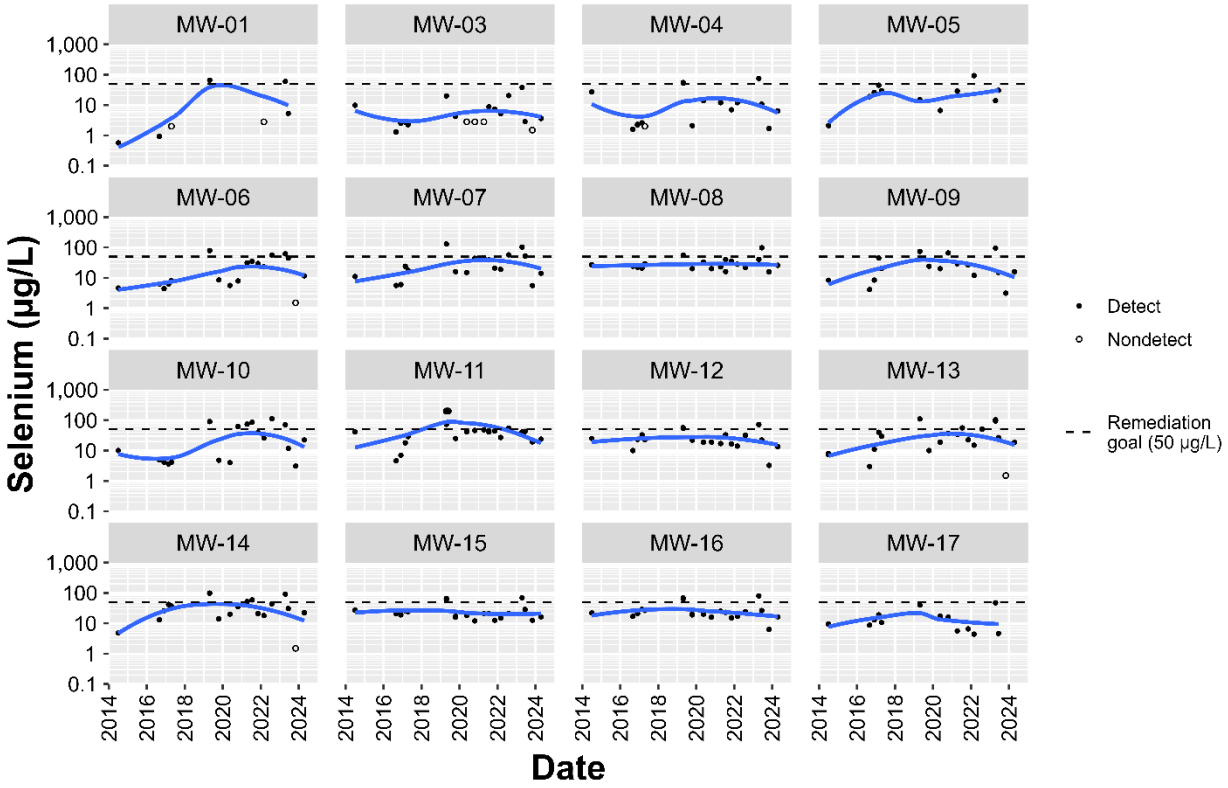
Selenium

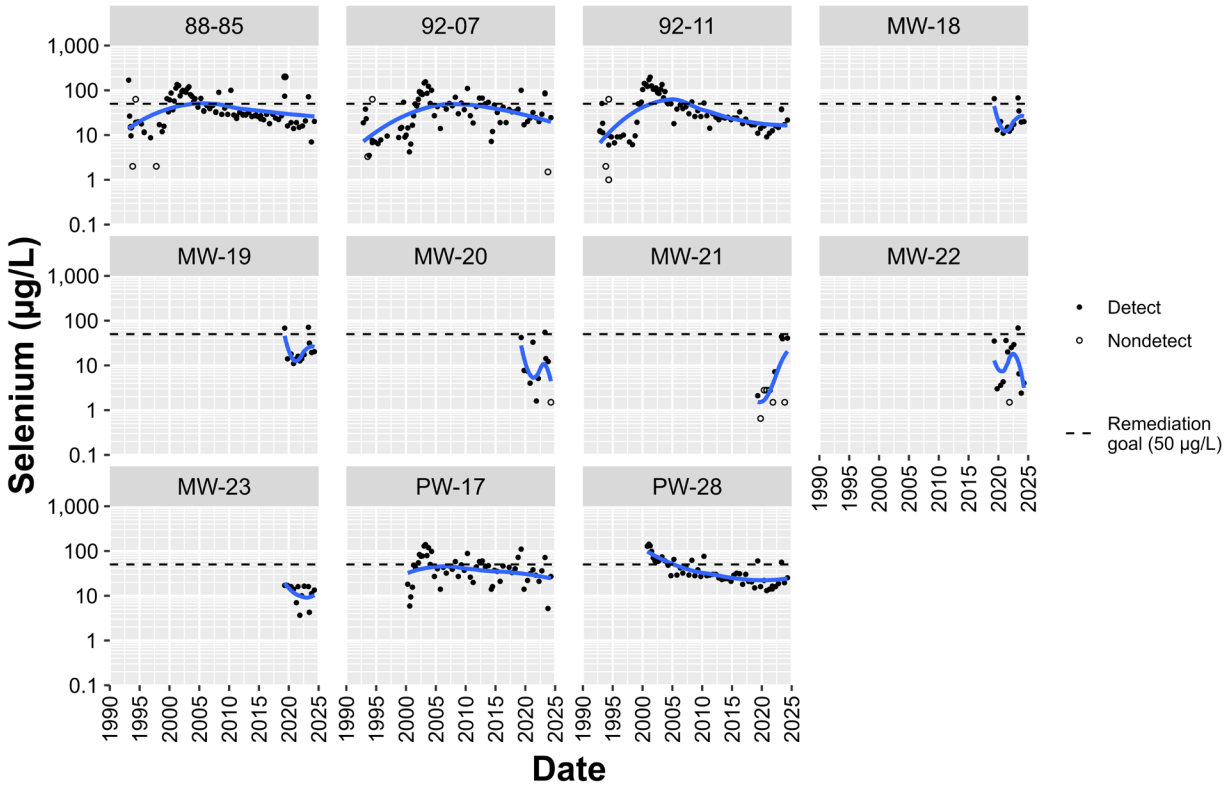
Groundwater Remediation Goal: 50 µg/L

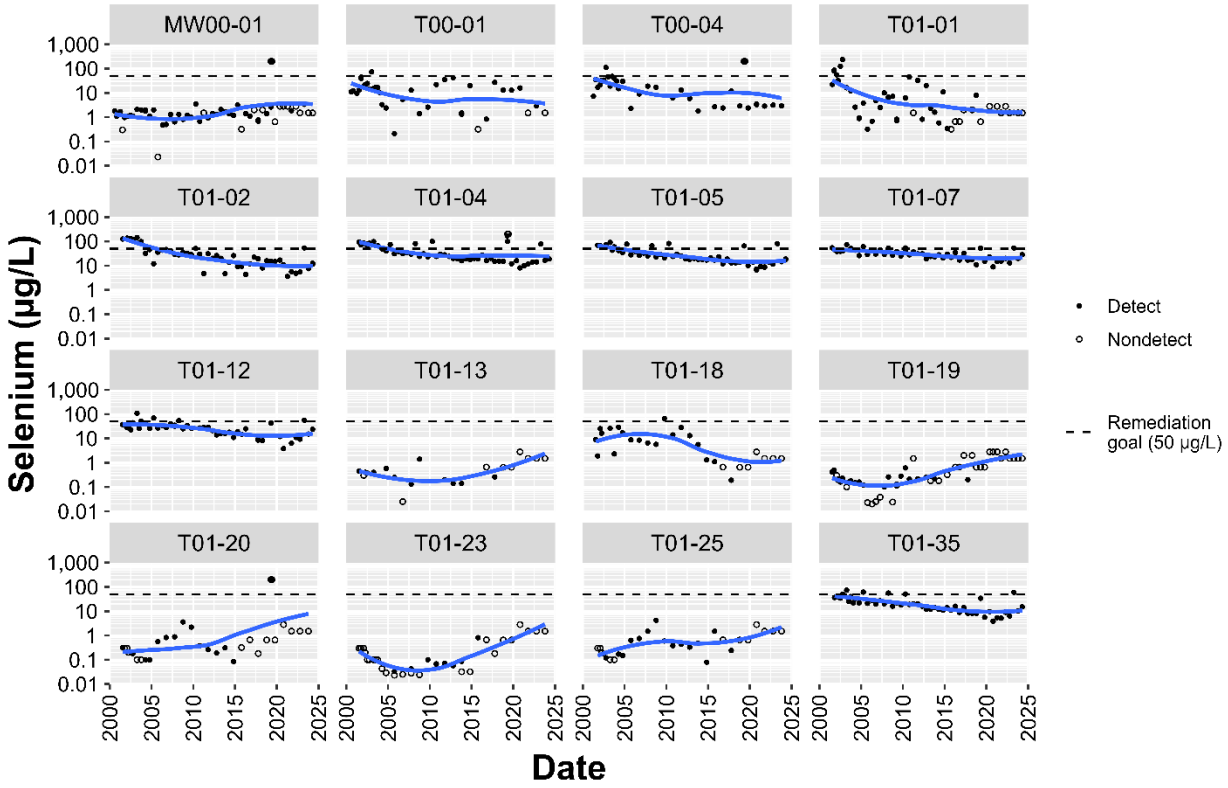
Sample Locations Are Shown in Figure 6

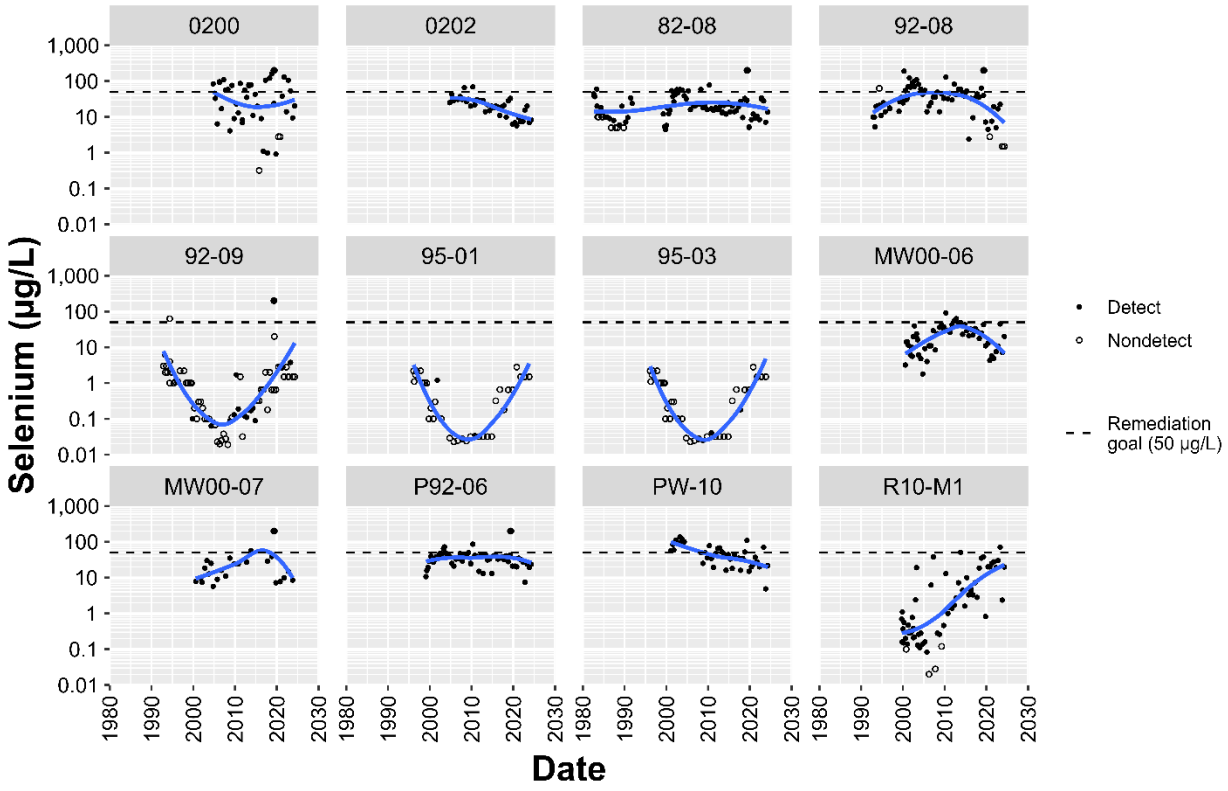
OU III Monitoring Wells Having Selenium Concentrations Above the Remediation Goal This Performance Period

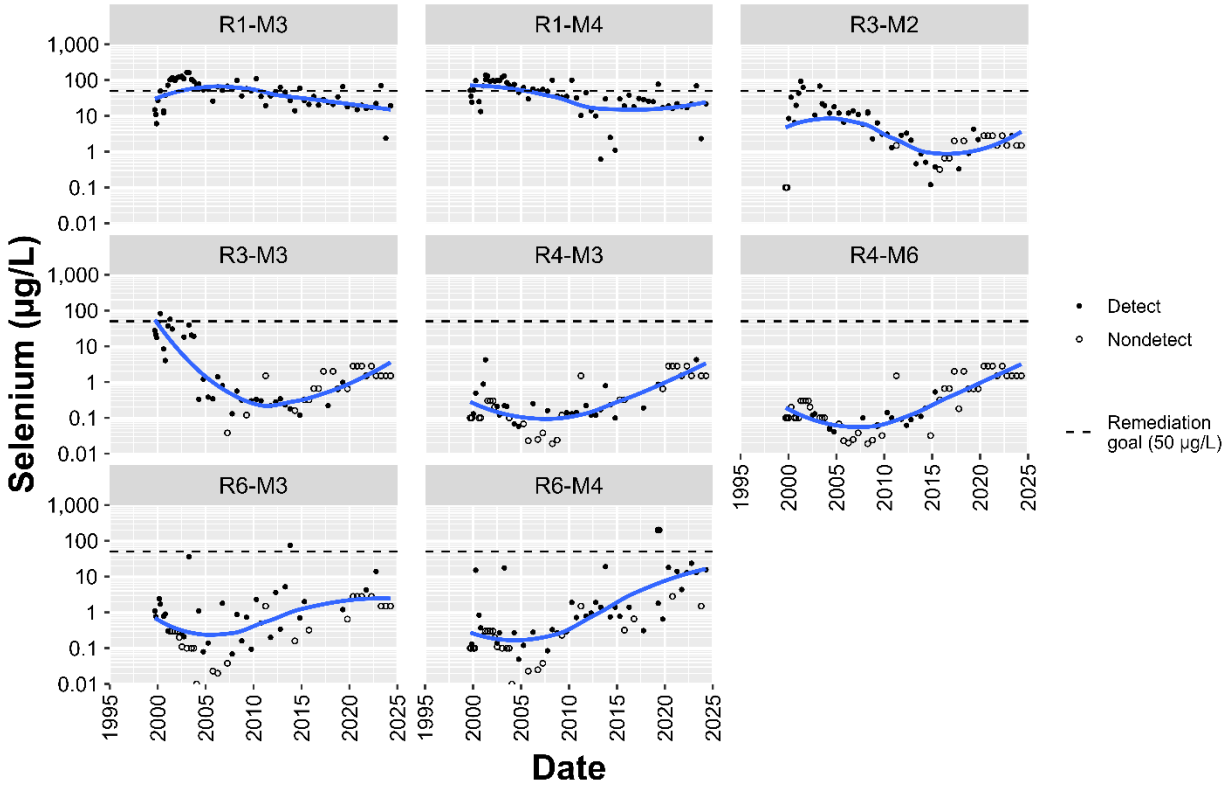
Well	Sample Date	Selenium Concentration (µg/L)
MW-07	6/14/2023	52.3
MW-07	6/14/2023	52
MW-08	6/14/2023	97.8


MW-01
MW-03
MW-04
MW-05
MW-06
MW-07
MW-08
MW-09
MW-10
MW-11
MW-12
MW-13
MW-14
MW-15
MW-16
MW-17
Selenium (µg/L)
1,000
100
10
1
0.1
2014
2016
2018
2020
2022
2024
Date
Detect
Nondetect
Remediation goal (50 µg/L)


88-85
92-07
92-11
MW-18
MW-19
MW-20
MW-21
MW-22
MW-23
PW-17
PW-28
Selenium (µg/L)
1,000
100
10
1
0.1
1990
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (50 µg/L)


MW00-01
T00-01
T00-04
T01-01
T01-02
T01-04
T01-05
T01-07
T01-12
T01-13
T01-18
T01-19
T01-20
T01-23
T01-25
T01-35
Selenium (µg/L)
1,000
100
10
1
0.1
0.01
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (50 µg/L)


0200
0202
82-08
92-08
92-09
95-01
95-03
MW00-06
MW00-07
P92-06
PW-10
R10-M1
Selenium (µg/L)
1,000
100
10
1
0.1
0.01
1980
1990
2000
2010
2020
2030
Date
Detect
Nondetect
Remediation goal (50 µg/L)


R1-M3
R1-M4
R3-M2
R3-M3
R4-M3
R4-M6
R6-M3
R6-M4
Selenium (µg/L)
1,000
100
10
1
0.1
0.01
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (50 µg/L)

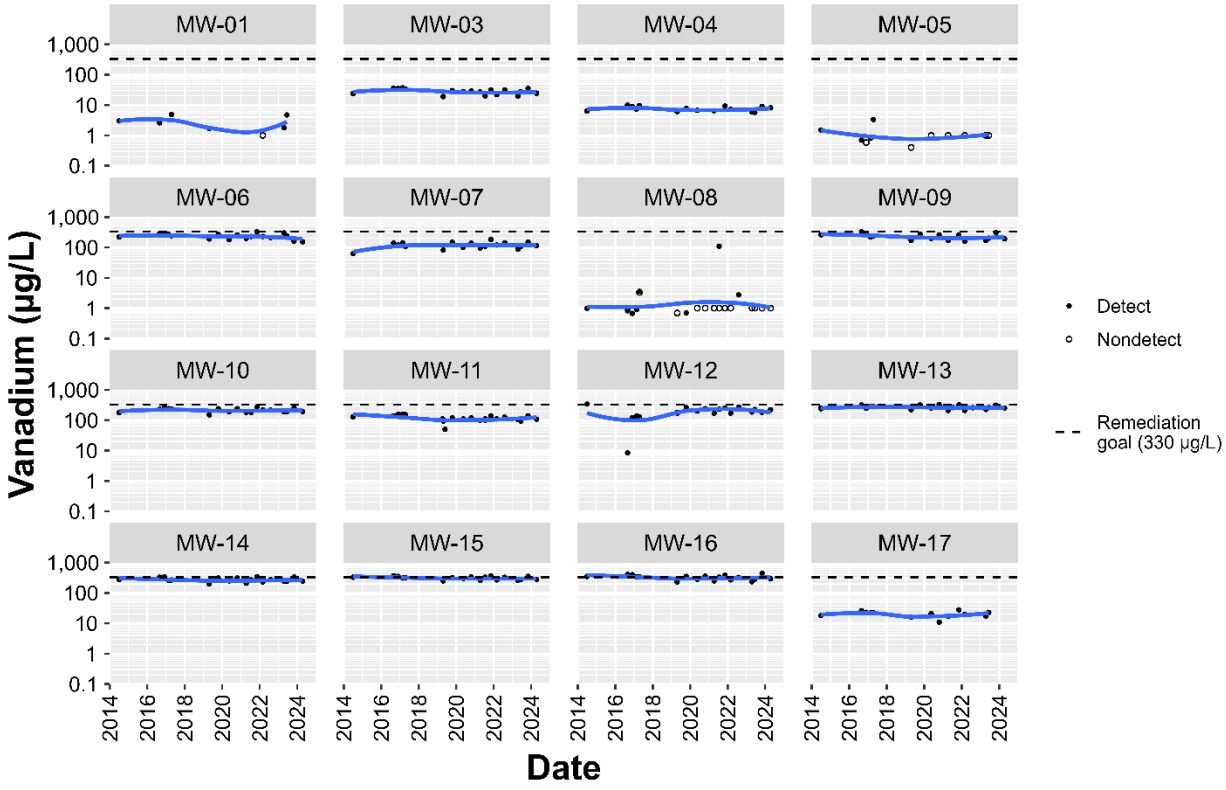
Vanadium

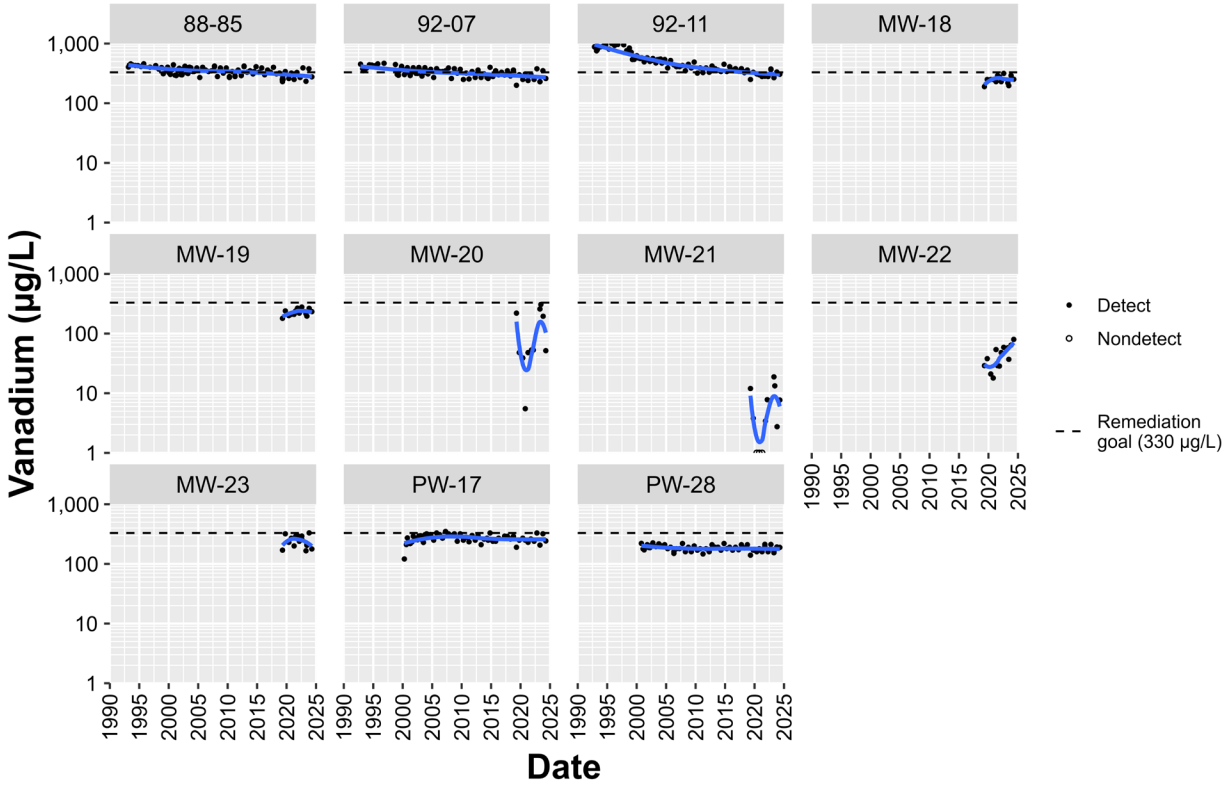
Groundwater Remediation Goal: 330 µg/L

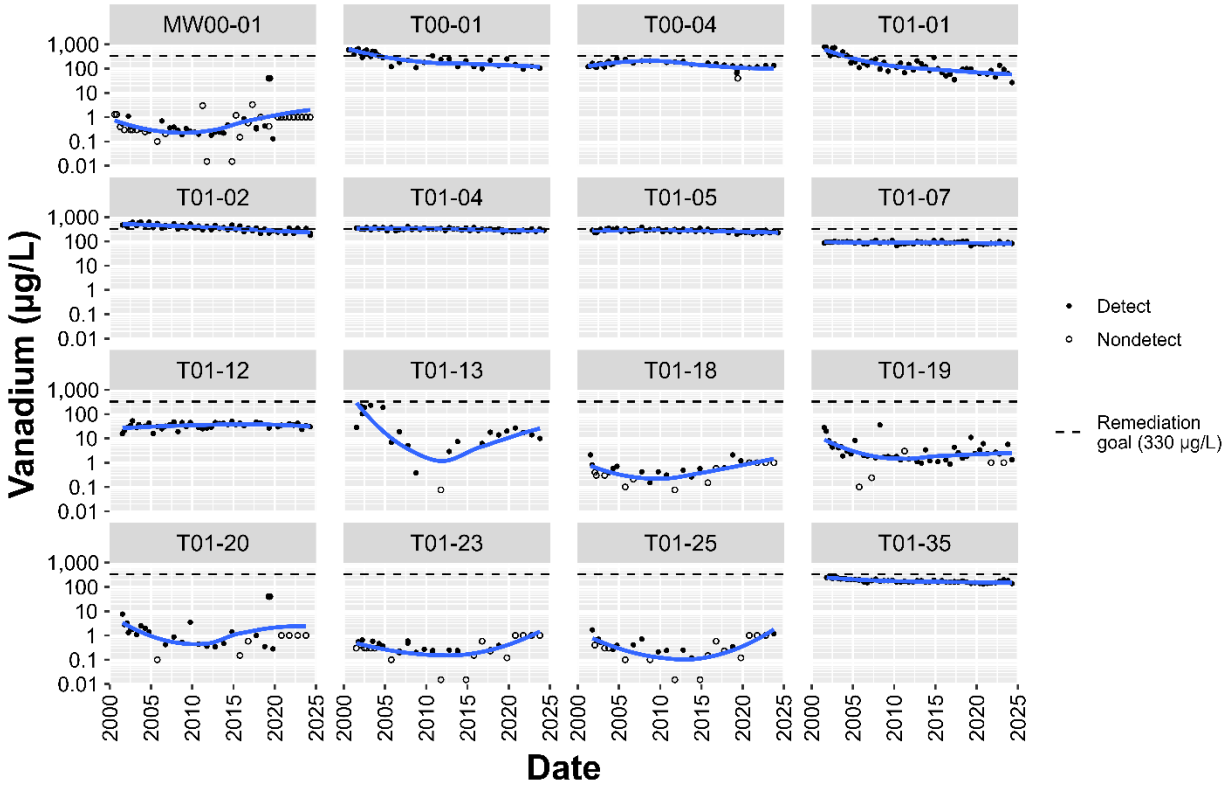
Sample Locations Are Shown in Figure 6

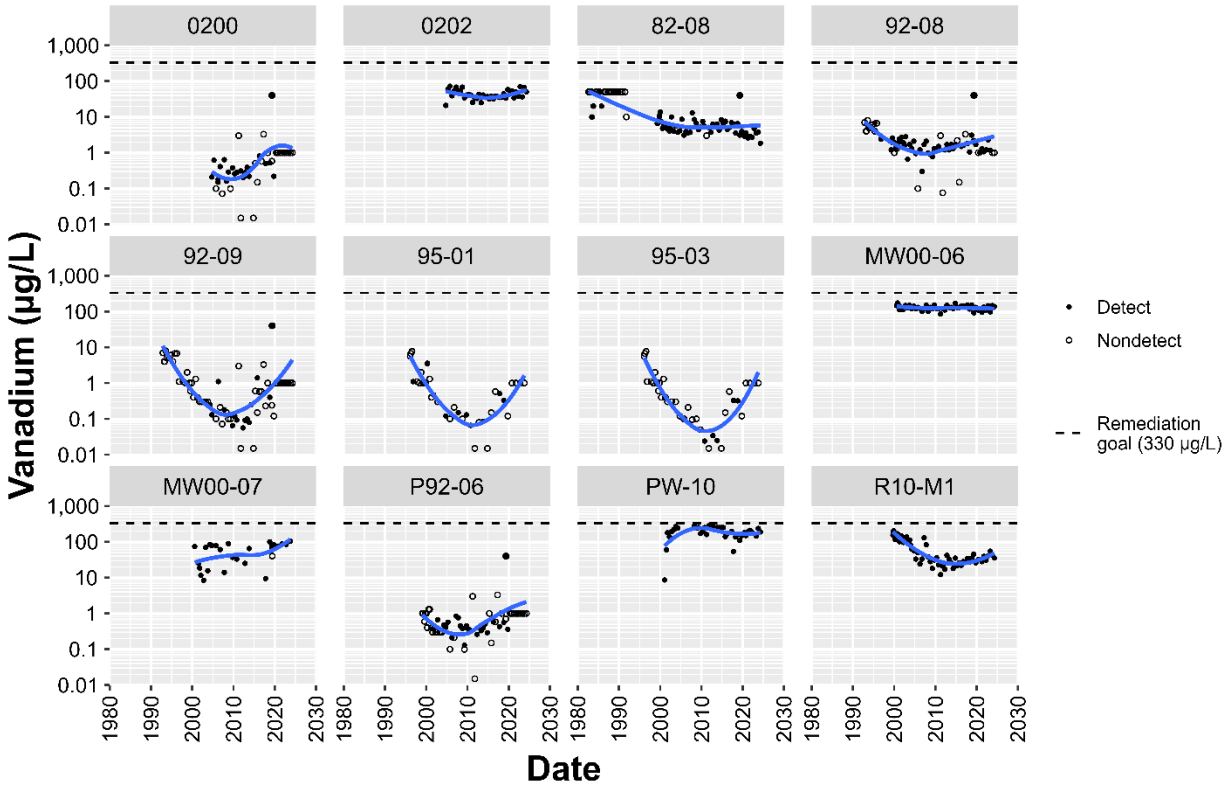
OU III Monitoring Wells Having Vanadium Concentrations Above the Remediation Goal This Performance Period

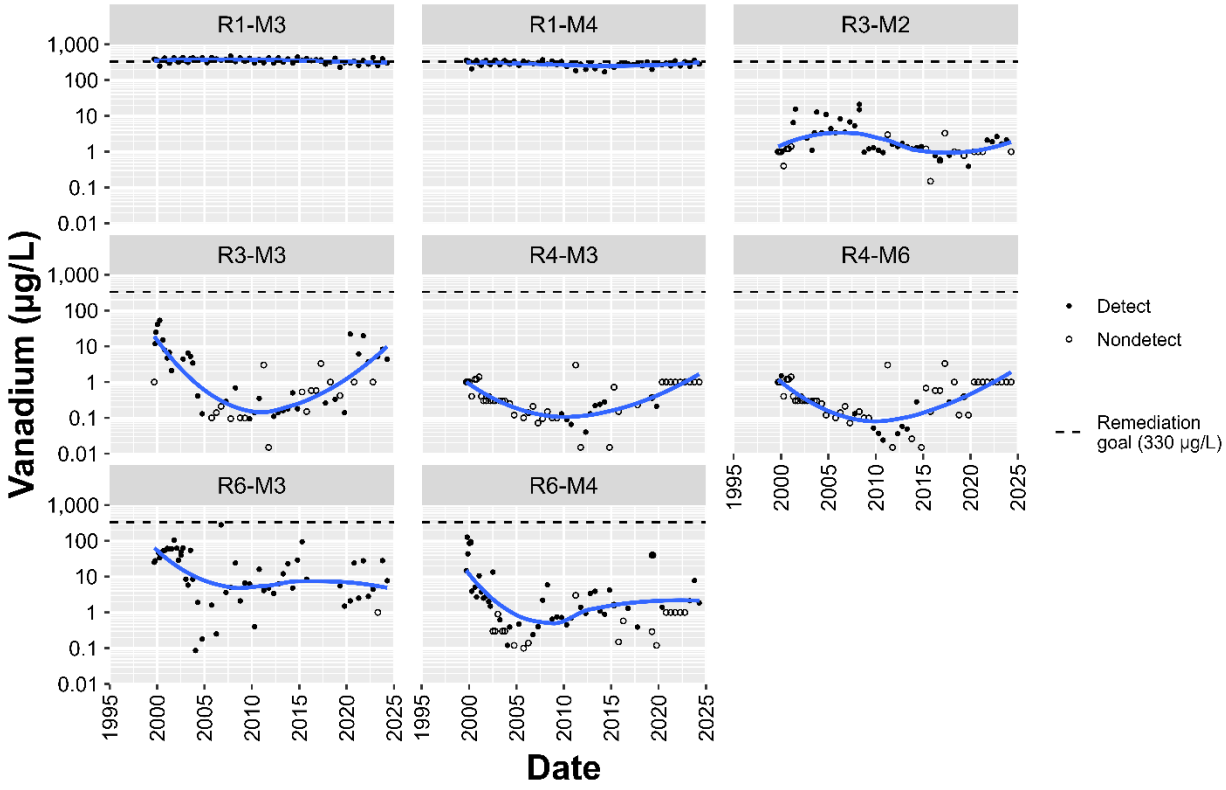
Well	Sample Date	Vanadium Concentration (µg/L)
88-85	10/17/2023	378
92-07	10/18/2023	351
92-11	10/17/2023	333
MW-14	11/2/2023	333
MW-15	11/2/2023	351
MW-16	11/2/2023	446
MW-23	11/1/2023	331
R1-M3	10/17/2023	394
R1-M4	10/17/2023	358
T01-02	10/18/2023	341


MW-01
MW-03
MW-04
MW-05
MW-06
MW-07
MW-08
MW-09
MW-10
MW-11
MW-12
MW-13
MW-14
MW-15
MW-16
MW-17
Vanadium (µg/L)
1,000
100
10
1
0.1
2014
2016
2018
2020
2022
2024
Date
Detect
Nondetect
Remediation goal (330 µg/L)


88-85
92-07
92-11
MW-18
MW-19
MW-20
MW-21
MW-22
MW-23
PW-17
PW-28
Vanadium (µg/L)
1,000
100
10
1
1990
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (330 µg/L)


MW00-01
T00-01
T00-04
T01-01
T01-02
T01-04
T01-05
T01-07
T01-12
T01-13
T01-18
T01-19
T01-20
T01-23
T01-25
T01-35
Vanadium (µg/L)
1,000
100
10
1
0.1
0.01
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (330 µg/L)


0200
0202
82-08
92-08
92-09
95-01
95-03
MW00-06
MW00-07
P92-06
PW-10
R10-M1
Vanadium (µg/L)
1,000
100
10
1
0.1
0.01
1980
1990
2000
2010
2020
2030
Date
Detect
Nondetect
Remediation goal (330 µg/L)


R1-M3
R1-M4
R3-M2
R3-M3
R4-M3
R4-M6
R6-M3
R6-M4
Vanadium (µg/L)
1,000
100
10
1
0.1
0.01
1995
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (330 µg/L)

Appendix B

Bedrock Concentration Trends
May 2023–April 2024

Arsenic, Manganese, Molybdenum, Nitrate, Selenium, Uranium, Vanadium

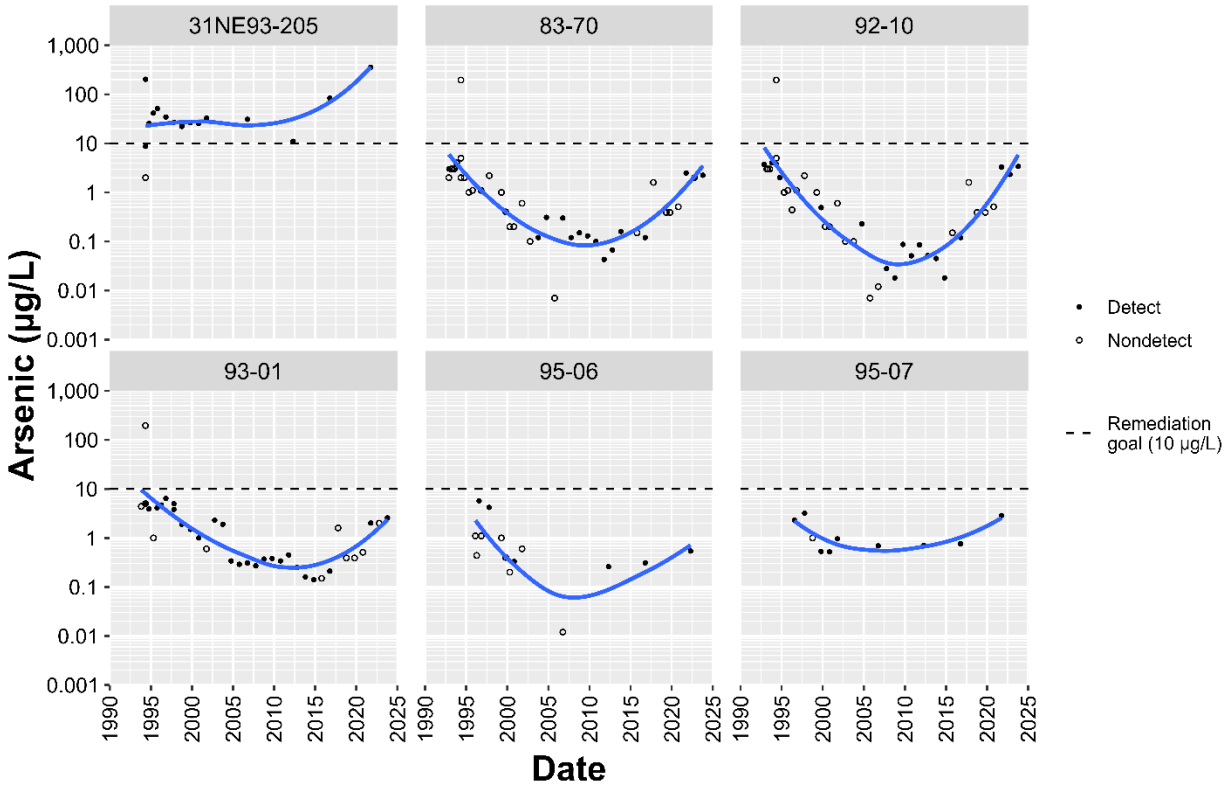
Arsenic

Groundwater Remediation Goal: 10 µg/L

Sample Locations Are Shown in Figure 6

None of the OU III Bedrock Monitoring Wells Have Arsenic Concentrations Above the Remediation Goal for This Performance Period

Note: Bedrock wells 31NE93-205, 95-06, and 95-07 with a 5-year sampling frequency were not sampled during the May 2023 to April 2024 performance period.



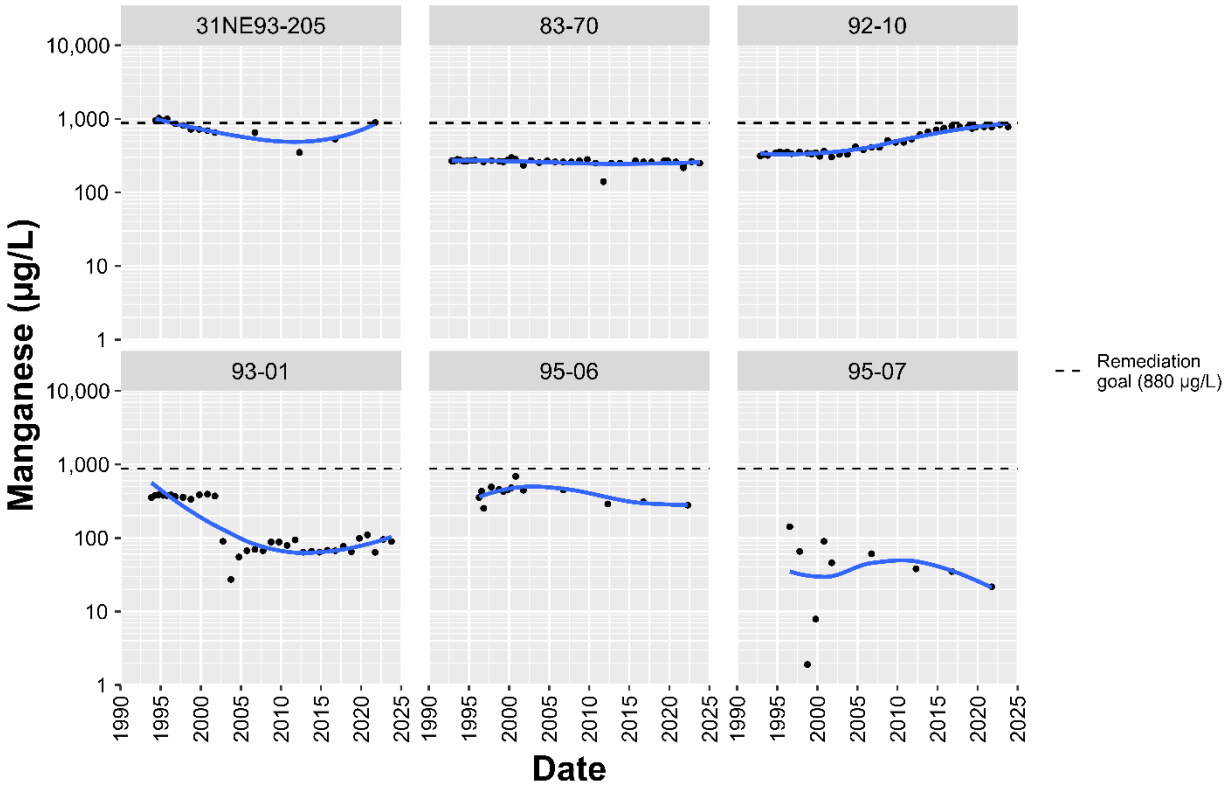
Manganese

Groundwater Remediation Goal: 880 µg/L

Sample Locations Are Shown in Figure 6

None of the OU III Bedrock Monitoring Wells Have Arsenic Concentrations Above the Remediation Goal for This Performance Period

Note: Bedrock wells 31NE93-205, 95-06, and 95-07 with a 5-year sampling frequency were not sampled during the May 2023 to April 2024 performance period.



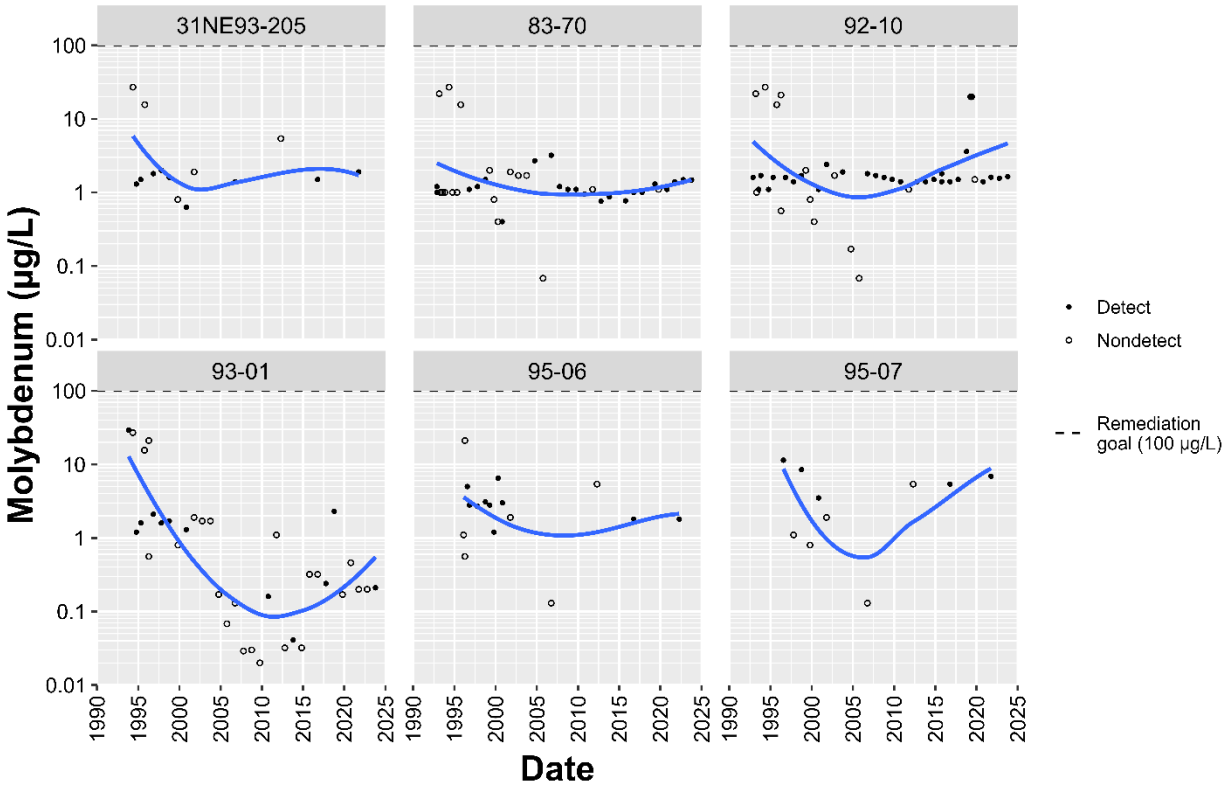
Molybdenum

Groundwater Remediation Goal: 100 µg/L

Sample Locations Are Shown in Figure 6

None of the OU III Bedrock Monitoring Wells Have Molybdenum Concentrations Above the Remediation Goal for This Performance Period

Note: Bedrock wells 31NE93-205, 95-06, and 95-07 with a 5-year sampling frequency were not sampled during the May 2023 to April 2024 performance period.



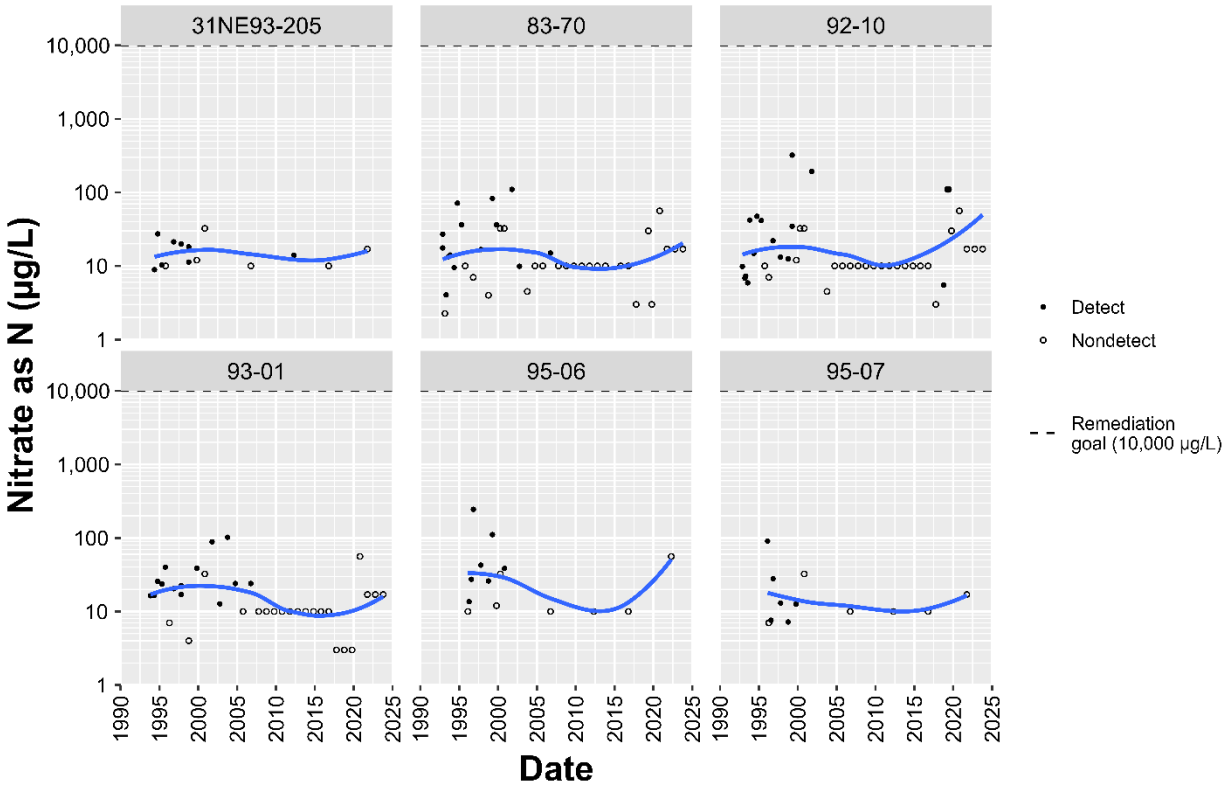
Nitrate as Nitrogen (N)

Groundwater Remediation Goal: 10,000 µg/L

Sample Locations Are Shown in Figure 6

None of the OU III Bedrock Monitoring Wells Have Nitrate Concentrations Above the Remediation Goal for This Performance Period

Note: Bedrock wells 31NE93-205, 95-06, and 95-07 with a 5-year sampling frequency were not sampled during the May 2023 to April 2024 performance period.



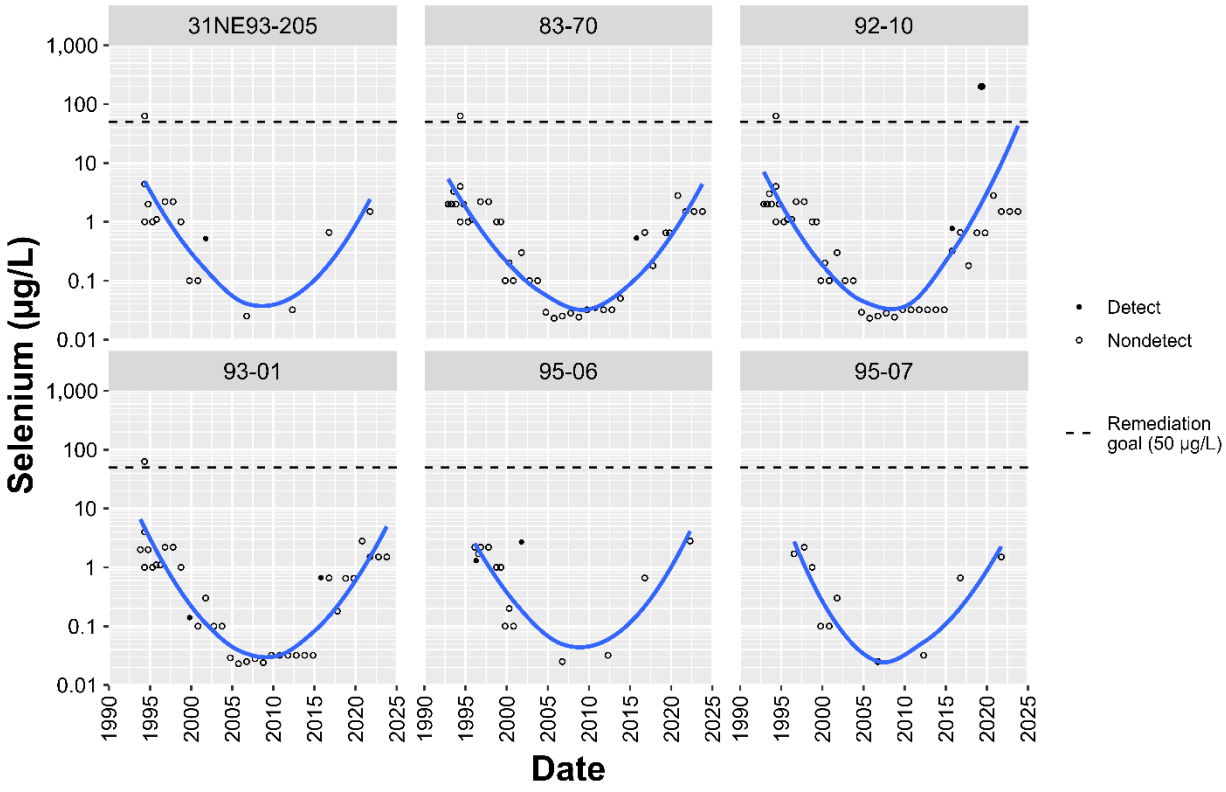
Selenium

Groundwater Remediation Goal: 50 µg/L

Sample Locations Are Shown in Figure 6

None of the OU III Bedrock Monitoring Wells Have Selenium Concentrations Above the Remediation Goal for This Performance Period

Note: Bedrock wells 31NE93-205, 95-06, and 95-07 with a 5-year sampling frequency were not sampled during the May 2023 to April 2024 performance period.



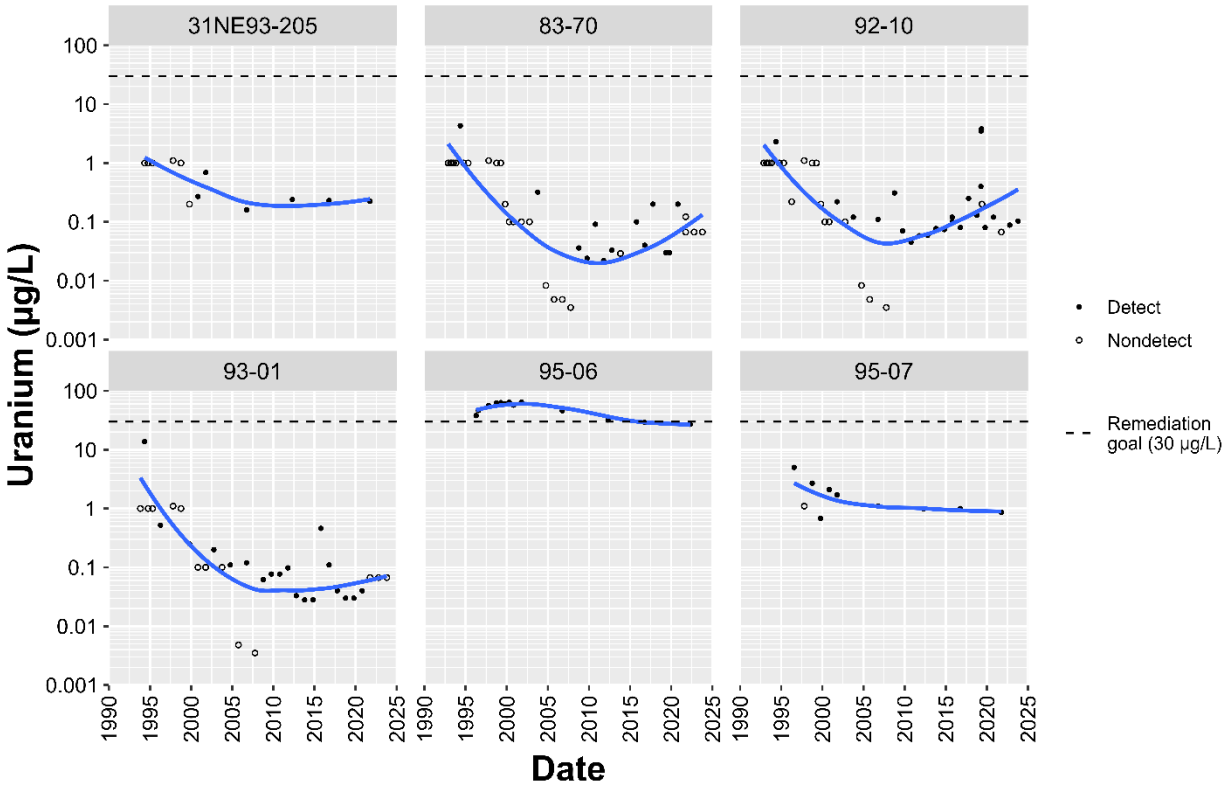
Uranium

Groundwater Remediation Goal: 30 µg/L

Sample Locations Are Shown in Figure 6

None of the OU III Bedrock Monitoring Wells Have Uranium Concentrations Above the Remediation Goal for This Performance Period

Note: Bedrock wells 31NE93-205, 95-06, and 95-07 with a 5-year sampling frequency were not sampled during the May 2023 to April 2024 performance period.



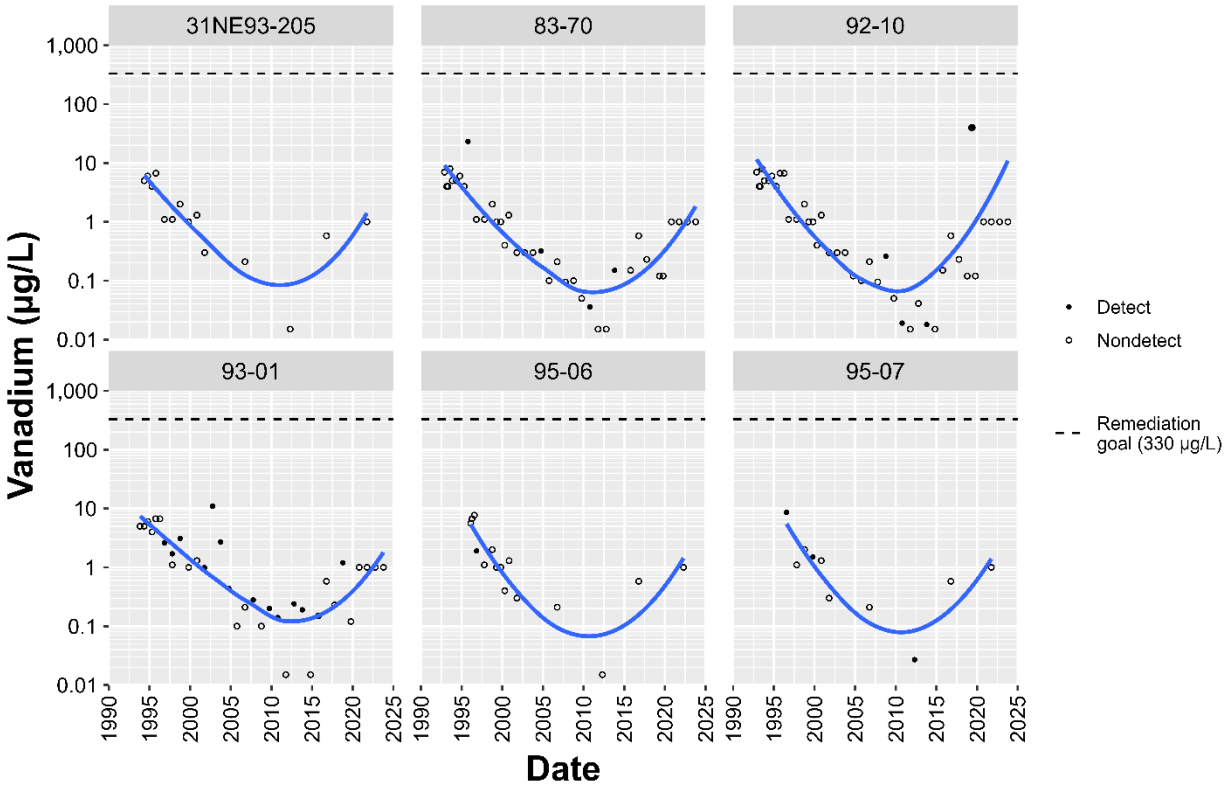
Vanadium

Groundwater Remediation Goal: 330 µg/L

Sample Locations Are Shown in Figure 6

None of the OU III Bedrock Monitoring Wells Have Vanadium Concentrations Above the Remediation Goal for This Performance Period

Note: Bedrock wells 31NE93-205, 95-06, and 95-07 with a 5-year sampling frequency were not sampled during the May 2023 to April 2024 performance period.



Appendix C

Surface Water and Seep Concentration Trends
May 2023–April 2024

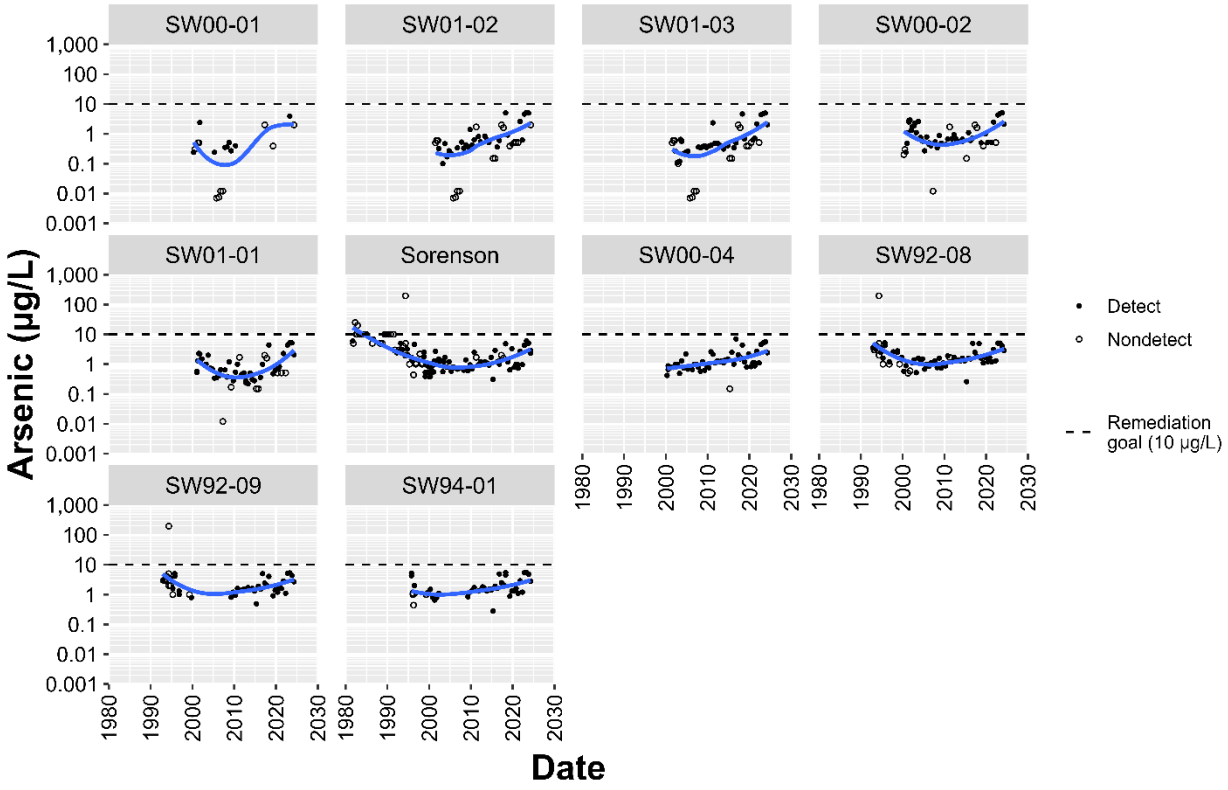
Arsenic, Nitrate, Selenium

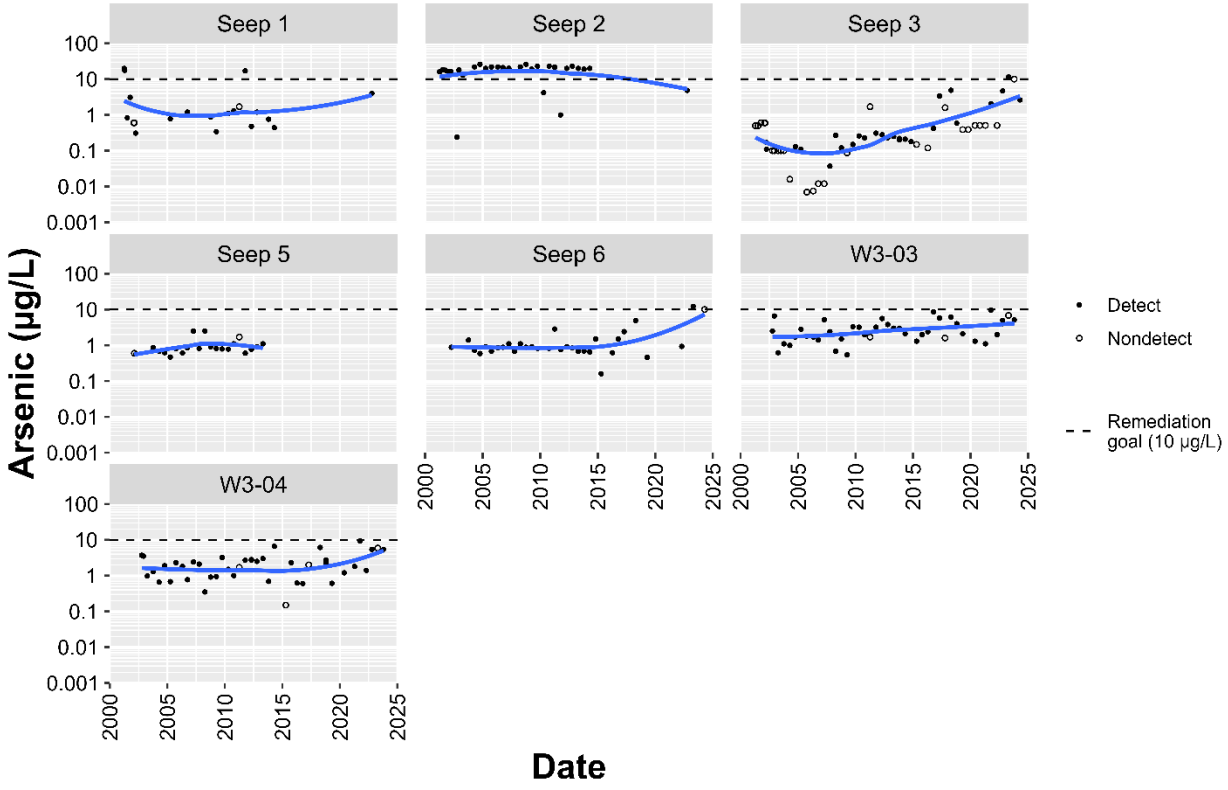
Arsenic

Surface Water Remediation Goal: 10 µg/L

Sample Locations Are Shown in Figure 6

None of the OU III Surface Water and Seep Locations Have Arsenic Concentrations Above the Remediation Goal for This Performance Period


SW00-01
SW01-02
SW01-03
SW00-02
SW01-01
Sorenson
SW00-04
SW92-08
SW92-09
SW94-01
Arsenic (µg/L)
1,000
100
10
1
0.1
0.01
0.001
1980
1990
2000
2010
2020
2030
Date
Detect
Nondetect
Remediation goal (10 µg/L)


Seep 1
Seep 2
Seep 3
Seep 5
Seep 6
W3-03
W3-04
Arsenic (µg/L)
100
10
1
0.1
0.01
0.001
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (10 µg/L)

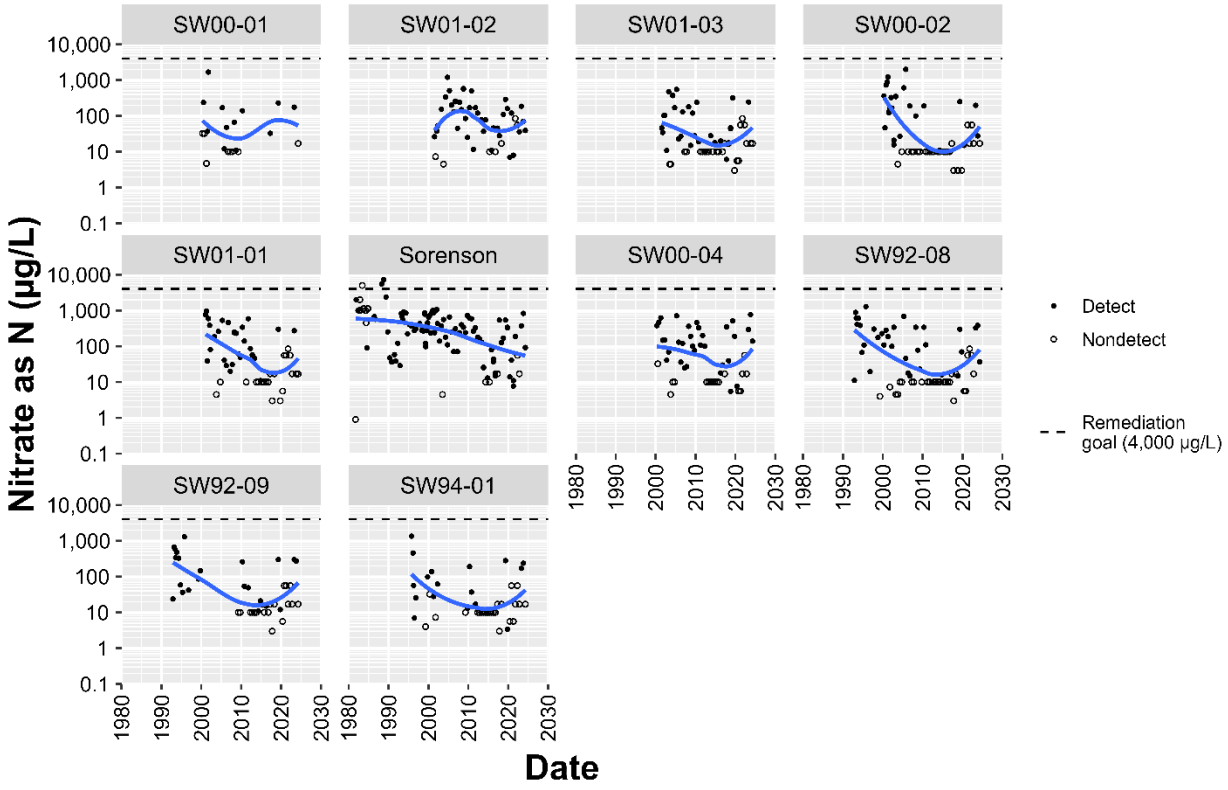
Nitrate as Nitrogen (N)

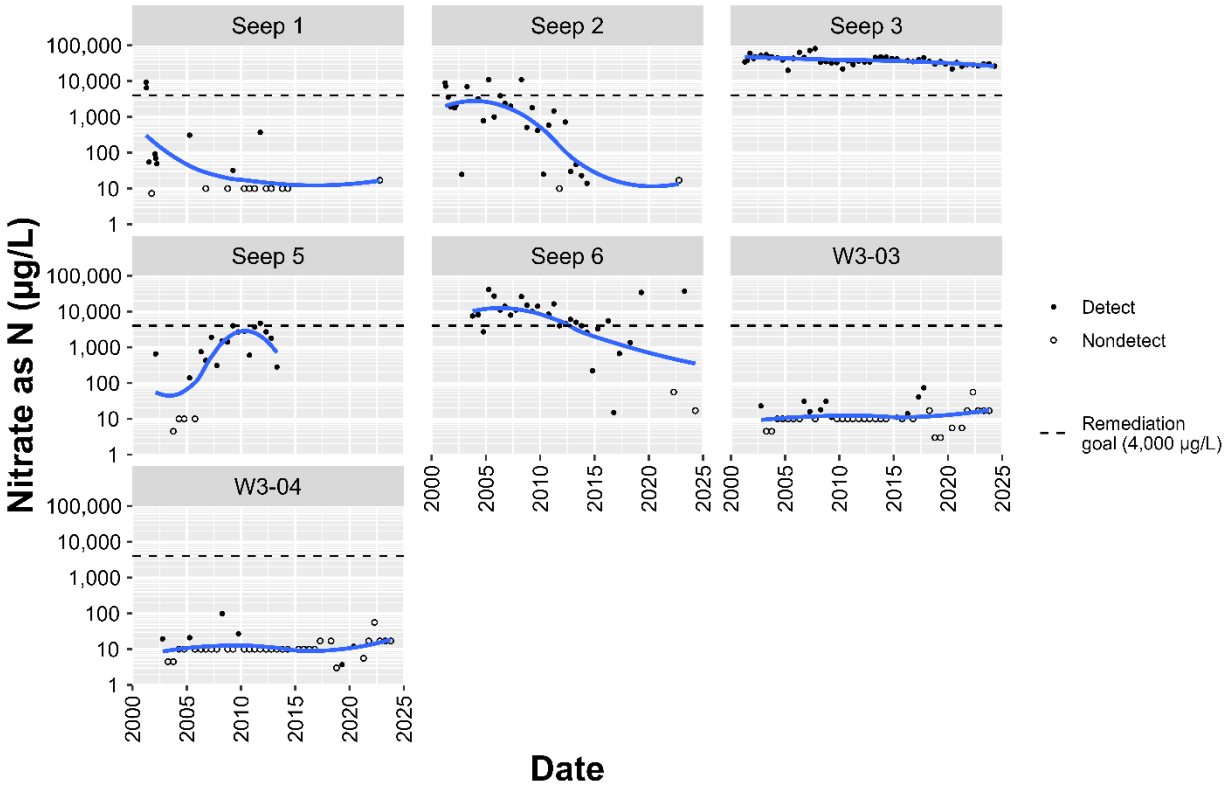
Surface Water Remediation Goal: 4000 µg/L

Sample Locations Are Shown in Figure 6

OU III Surface Water and Seep Locations Having Nitrate Concentrations Above the Remediation Goal This Performance Period

Location	Sample Date	Nitrate as N Concentration (µg/L)
Seep 3	10/16/2023	30,500
Seep 3	4/17/2024	26,300


SW00-01
SW01-02
SW01-03
SW00-02
SW01-01
Sorenson
SW00-04
SW92-08
SW92-09
SW94-01
Nitrate as N (µg/L)
10,000
1,000
100
10
1
0.1
1980
1990
2000
2010
2020
2030
Date
Detect
Nondetect
Remediation goal (4,000 µg/L)


Seep 1
Seep 2
Seep 3
Seep 5
Seep 6
W3-03
W3-04
Nitrate as N (µg/L)
100,000
10,000
1,000
100
10
1
2000
2005
2010
2015
2020
2025
Date
Detect
Nondetect
Remediation goal (4,000 µg/L)

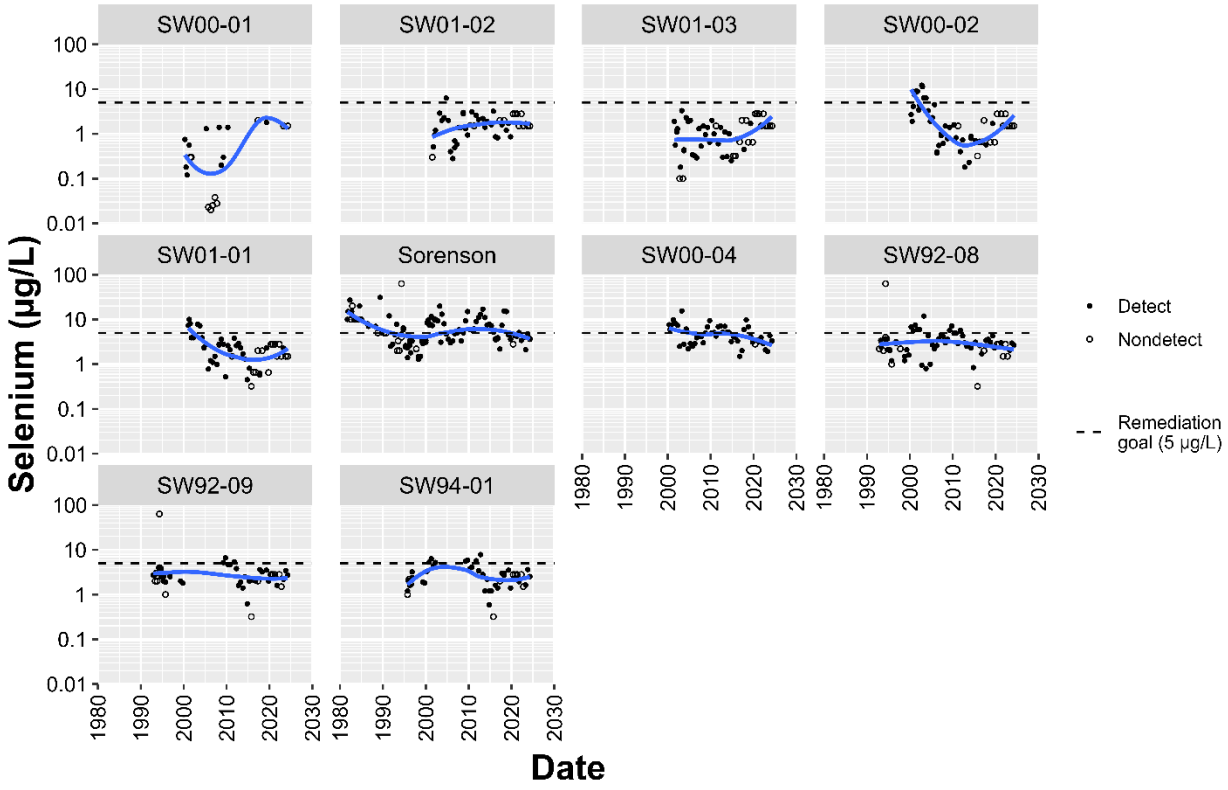
Selenium

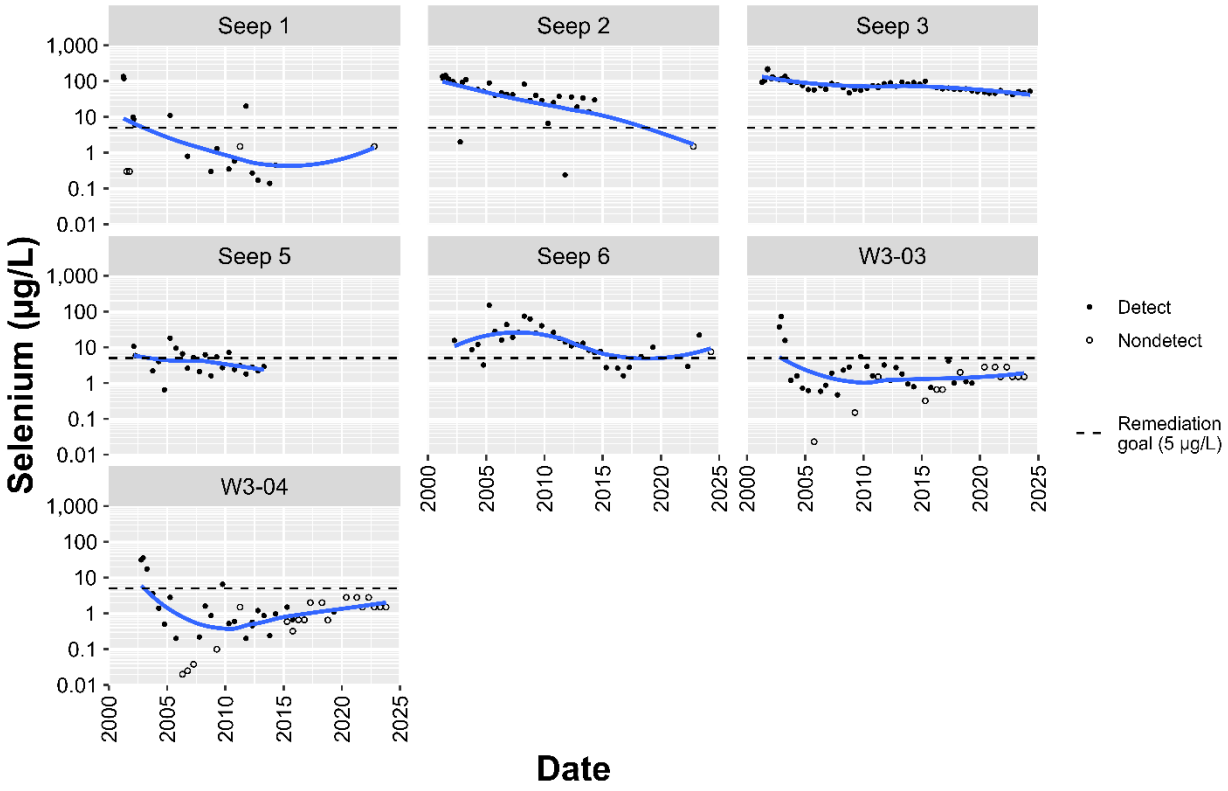
Groundwater Remediation Goal: 5 µg/L

Sample Locations Are Shown in Figure 6

OU III Surface Water and Seep Locations Having Selenium Concentrations Above the Remediation Goal This Performance Period

Location	Sample Date	Selenium Concentration (µg/L)
Seep 3	10/16/2023	48.2
Seep 3	4/17/2024	52.2
Seep 6	4/16/2024	7.5


SW00-01
SW01-02
SW01-03
SW00-02
SW01-01
Sorenson
SW00-04
SW92-08
SW92-09
SW94-01
Selenium (µg/L)
Date
Detect
Nondetect
Remediation goal (5 µg/L)


Seep 1
Seep 2
Seep 3
Seep 5
Seep 6
W3-03
W3-04
Selenium (µg/L)
Date
Detect
Nondetect
Remediation goal (5 µg/L)

Appendix D

U.S. Department of Energy Office of Legacy Management Response to U.S. Environmental Protection Agency Staff Review of the *Draft Monticello Mill Tailings Site Operable Unit III Annual Groundwater Report (May 2023–April 2024)*

Department of Energy
Washington, DC 20585

January 29, 2025

Via email: kelseyrobinson@utah.gov

Ms. Kelsey Robinson
Division of Environmental Response and Remediation
State of Utah Department of Environmental Quality
195 North 1950 West
Salt Lake City, UT 84114-4840

Via email: nichalson.brandon@epa.gov

Mr. Brandon Nichalson
U.S. Environmental Protection Agency
Region 8, EPR-F
1595 Wynkoop St.
Denver, CO 80202-1129

Subject: U.S. Department of Energy Office of Legacy Management Response to the U.S. Environmental Protection Agency Staff's Review of the draft *Monticello Mill Tailings Site Operable Unit III Annual Groundwater Report May 2023–April 2024*

Dear Ms. Robinson and Mr. Nichalson:

This letter presents the U.S. Department of Energy Office of Legacy Management (LM) Response to the U.S. Environmental Protection Agency (EPA) Staff's Review of the report draft *Monticello Mill Tailings Site Operable Unit III Annual Groundwater Report May 2023–April 2024* herein referred to as the draft Groundwater Report. LM submitted the draft Groundwater Report to EPA and State of Utah Department of Environmental Quality by letter dated October 29, 2024. EPA's observations and comments dated December 16, 2024, along with corresponding LM responses, are provided below.

EPA Comments and Corresponding LM Responses

EPA Comment 1: *The report does not include any figures or tables that present data in a way that historic concentration trends can be reviewed or closely evaluated for the monitoring wells that are currently included in the sampling program. The trend charts that are included are small and include data in a log scale which makes it very difficult to discern differences. Please provide an appendix or similar with data.*

LM Response:

Historical data for the Monticello site are publicly available on LM's Geospatial Environmental Mapping System (GEMS) website at https://gems.lm.doe.gov/#site=MNT.

EPA Comment 2: *Section 2.5. Page 47. The final statement implies that the plume center of mass has continued to move downgradient from 2001 through 2024, however, review of Figure 28 suggests that recent years it has perhaps started to move back upgradient. With the increasing mass/volume present in the AOA, is the proportion of uranium in groundwater now moving back toward the AOA?*

LM Response:

The statement in the text is correct that, overall, the plume center of mass has moved downgradient between 2001 and 2024. There is not a definite trend in the center of mass in recent years, with the estimated position of the center of mass varying within approximately 400 feet during the past several years. The recent variability in the center of mass is likely related to the variability of AOA uranium mass.

EPA Comment 3: *Section 3.0. Page 55. The last sentence indicates that springtime infiltration mobilizes uranium from the vadose zone, but attenuation rapidly removes uranium. How does the influence of plume volume (changing water levels) influence the mass? Is the increase and subsequent decrease in plume volume due to changes in water level in turn driving the changes in mass?*

LM Response:

The changes in plume volume are caused primarily by changes in water levels. The changes in mass are a combination of changing volume (caused by changing water levels) and changing concentrations. Concentrations also tend to increase in the spring and decrease in the fall, so the increase and subsequent decrease in mass is not explained by changing plume volume alone.

Please contact me at (970) 778-5528 or Alison.Kuhlman@lm.doe.gov, if you have any questions.

Sincerely,

ALISON KUHLMAN

Digitally signed by ALISON KUHLMAN
Date: 2025.01.29 15:28:42 -07'00'

Alison Kuhlman
Monticello Site Manager

cc via email:
Cliff Carpenter, DOE-LM
Kate Whysner, DOE-LM
Mike Butherus, RSI
Miquette Gerber, RSI
Ryan Kyle, RSI
ELEM/20/146

LM-Form-4-10-2.0-0.0
Revision: November 2022

U.S. Department of Energy
Office of Legacy Management

Record of Concurrence

A. Document Information

Originated by: Alison Kuhlman

Document/File name: LM 22\ MNT LM Response to EPA Review on Annual Groundwater Report May 2023 - Apr 2024

Date initiated: 01/21/2025

Finalized by: S. Barnes

B. Environmentally Relevant Document Tracking

Yes ○ No ◉ 1. Does the letter or communication meet the definition of an environmentally relevant document?

Yes ◉ No ○ 2. Do you expect any further communications in this string?

Entered into Tracking System:

C. Concurrence Signatures

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☑	Alison Kuhlman		ALISON KUHLMAN Digitally signed by ALISON KUHLMAN Date: 2025.01.29 15:29:27 -07'00'
	Subject Matter Expert	*(On behalf of…)*	*Signature and Date*
☐			
	Team Lead	*(On behalf of…)*	*Signature and Date*
☐			
	Other	*(On behalf of…)*	*Signature and Date*
☐			
	Other	*(On behalf of…)*	*Signature and Date*
☐			
	LM-10 Director	*(On behalf of…)*	*Signature and Date*
☐			
	LM-20 Director	*(On behalf of…)*	*Signature and Date*
☐			
	Chief of Staff	*(On behalf of…)*	*Signature and Date*
☐			
	LM-2 Deputy Director	*(On behalf of…)*	*Signature and Date*
☐			
	LM-1 Director	*(On behalf of…)*	*Signature and Date*

LM Admin Support

From: LM Admin Support
Sent: Thursday, January 30, 2025 9:58 AM
To: Brandon Nichalson; Kelsey Robinson
Cc: Carpenter, Cliff; Whysner, Kathleen; Butherus, Michael (CONTR); Gerber, Miquette (CONTR); Kyle, Ryan (CONTR); Kuhlman, Alison; McGinty, Denise (CONTR)
Subject: Monticello, UT, Site, LM's Response to EPA Review on Annual Groundwater Report May 2023-Apr 2024 - sent on behalf of Alison Kuhlman
Attachments: 20250129 MNT LM Response to EPA Review on Annual Groundwater Report May 2023 - Apr 2024.pdf

Mr. Nichalson and Ms. Robinson,

The attached response to comments is sent on behalf of Alison Kuhlman.

Thank you,

Shannon Barnes
LM Admin Support
Contractor to the U.S. Department of Energy
Office of Legacy Management
2597 Legacy Way, Grand Junction, CO 81503
Phone: (970) 248-6012
Shannon.barnes@lm.doe.gov