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2019 Verification Monitoring Report for the Durango, Colorado, Processing Site

April 2020

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Abbreviations

ACL	alternate concentration limit
COC	contaminant of concern
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ft	feet
IC	institutional control
LM	Office of Legacy Management
LOESS	locally estimated scatterplot smoothing
mg/L	milligrams per liter
NRC	U.S. Nuclear Regulatory Commission
^{222}Rn	radon-222
SOWP	Site Observational Work Plan
^{234}U	uranium-234
^{238}U	uranium-238
UMTRCA	Uranium Mill Tailings Radiation Control Act
USGS	U.S. Geological Survey
VMR	Verification Monitoring Report

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Executive Summary

This Verification Monitoring Report for the Durango, Colorado, Processing Site summarizes monitoring data through calendar year 2019 and assesses the progress of the current compliance strategy (DOE 2008). To assess the progress of natural flushing at the mill tailings area, temporal trends in groundwater levels and flow directions, contaminant of concern (COC) concentrations in groundwater and surface water, and bulk uranium plume metrics are compared relative to baseline conditions. While no further remediation is required at the raffinate ponds area, continued monitoring is conducted as a best management practice. Temporal trends in uranium and selenium concentrations for groundwater and surface water at the raffinate ponds area were compared relative to baseline conditions.

Concentrations of cadmium, manganese, molybdenum, and selenium in groundwater at the mill tailings area are currently below their respective compliance or risk-based goals, with the exception of wells 0612 (cadmium and manganese), 0633 (selenium), and 0634 (selenium). Natural flushing still appears to be a viable compliance strategy for selenium for wells 0633 and 0634. Natural flushing of cadmium at well 0612 is not likely to occur within the 100-year time frame. Risks associated with cadmium will be reevaluated at this location and contingency remedies considered.

Analysis of sulfate at the mill tailings area indicates that concentrations could reach the average background goal of 1276 milligrams per liter (mg/L) by 2081 at most locations except for wells 0633, 0634, and 0635, where concentrations are presently above the average background goal with increasing trends. Water levels in wells 0633 and 0634 are typically within the Mancos Shale, where naturally occurring concentrations of sulfate are high. Isotopic sampling is needed to ascertain if increasing sulfate concentrations at well 0635 are mill related. If sulfate concentrations at 0633, 0634, and 0635 are not mill related, then improvements to the current compliance strategy may be needed.

On average, uranium concentrations in groundwater are declining across the mill tailings area. An analysis of attenuation rates for individual wells and average concentration from bulk plume metrics indicate that natural flushing of uranium may still achieve the compliance goal of 0.044 mg/L within the allotted 100-year time period. However, the uncertainty associated with such predictions is high, and not all concentration trends in the monitoring network are declining.

With the continued trends in selenium and uranium concentrations in groundwater at raffinate ponds area, samples can be collected at a reduced frequency (e.g., every two years) for all locations except downgradient wells 0594 and 0884, where water quality trends can continue to be monitored.

Surface water concentrations of the Animas River along the mill tailings and raffinate ponds areas are consistent with the background location 0652. Samples from the ephemeral South Creek location 0588 at the raffinate ponds area are higher in concentrations of selenium and uranium than those from Animas River locations.

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1.0 Introduction

This Verification Monitoring Report (VMR) provides an update of natural flushing progress at the Durango, Colorado, Processing Site from completion of characterization activities following surface remediation in 1991 to the present. The Durango processing site, consisting of mill tailings and raffinate ponds areas, is in the City of Durango, Colorado (Figure 1). This site is managed by the U.S. Department of Energy (DOE) Office of Legacy Management (LM) under the Uranium Mill Tailings Radiation Control Act (UMTRCA) Title I program and regulated by the U.S. Nuclear Regulatory Commission (NRC).

The focus of the VMR is to assess the progress of natural flushing as it relates to the mill tailing area's compliance strategy of 100-year natural flushing with institutional controls (ICs) as permitted by 40 CFR 192, preventing use of the groundwater in the shallow aquifer (DOE 2008). The compliance strategy for the raffinate ponds area groundwater is supplemental standards or no further remediation, and, as such, there is no requirement for assessing natural flushing, only monitoring for reporting (40 CFR 192 and DOE 2008). Information related to site history, compliance strategies, hydrogeology, and remedial activities is provided as summaries. Details related to the Durango site can be found in the documents referenced throughout the report.

1.1 Site History

The Durango site location has an extended history of ore smelting and processing. From 1880 to 1930, smelting operations at the site produced gold, silver, lead, and copper. In 1941, a vanadium processing mill was constructed to provide strategic metals for the war effort. The same processing mill was used between 1943 and 1946 to recover uranium from the vanadium tailings, again to support the war effort. After a 3-year hiatus, the mill was restarted and processed uranium ore between 1949 and 1963 before closing for the final time. UMTRCA surface cleanup activities began in 1986 and were completed in 1991, during which 2.5 million cubic yards of radioactive contaminated material were removed from the Durango processing site and vicinity properties and transported to the Durango, Colorado, Disposal Site. Groundwater and surface water characterization activities were conducted during and following surface remediation activities and were completed in 2002. Based on data from characterization activities, natural flushing with a 100-year duration and ICs corresponding to the site boundary was selected for the mill tailings area as the compliance strategy. Because of poor ambient groundwater quality, supplemental standards was selected as the compliance strategy for the raffinate ponds area. The mill tailings area is currently used as a public park. The Bureau of Reclamation currently operates a pumping plant associated with the Animas-La Plata water project on the northern portion of the raffinate pond area.

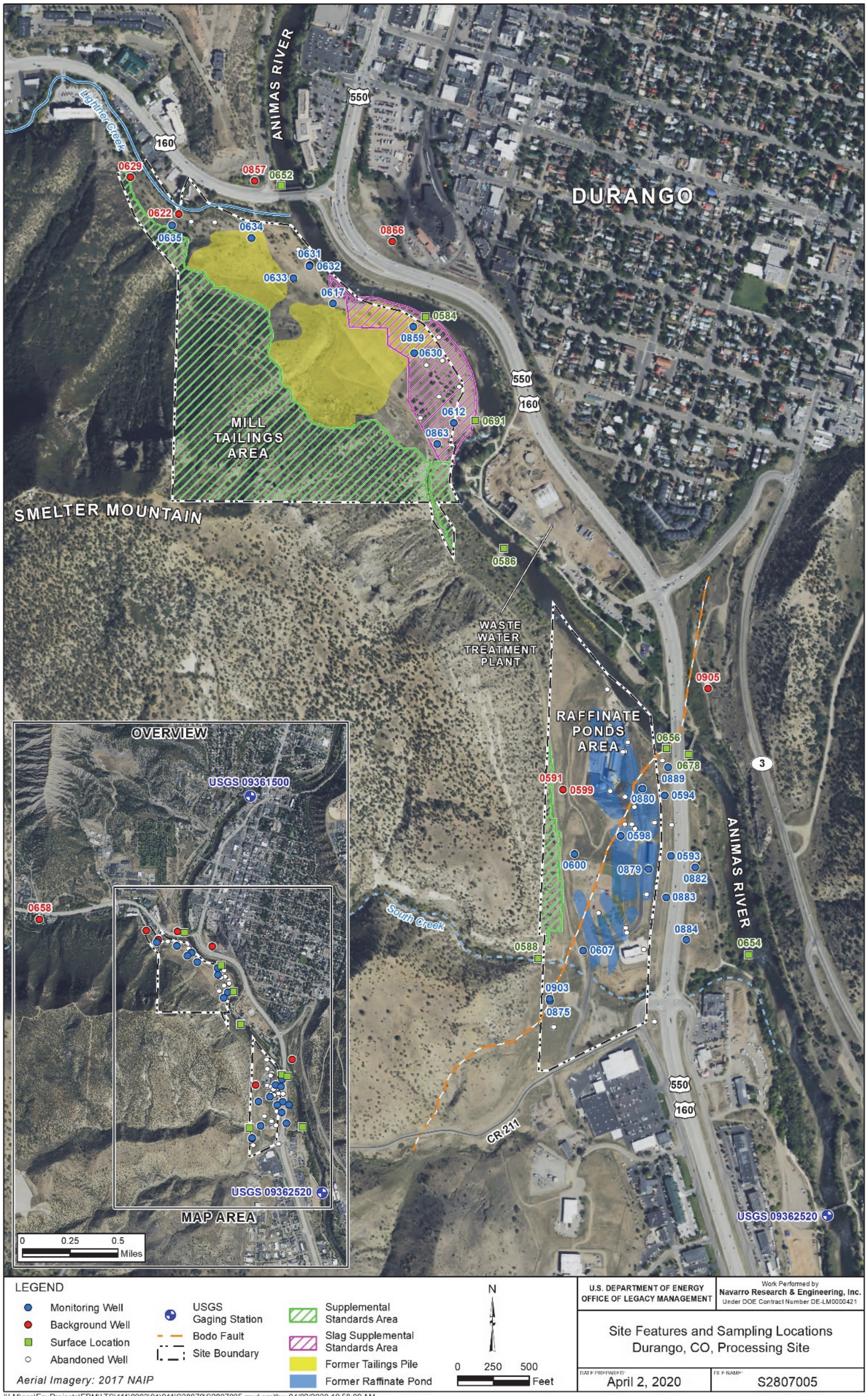

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Figure 1. Site Features and Sampling Locations for the Mill Tailings and Raffinate Pond Areas at the Durango, Colorado, Processing Site

1.2 Hydrologic Setting

The Durango site consists of two separate areas having different hydrogeologic regimes (Figure 1). The mill tailings area is bound to the north by Lightner Creek, to the northeast by the Animas River, and to the southwest by Smelter Mountain and consists of relatively permeable alluvium near the Animas River and less permeable colluvium near Smelter Mountain (DOE 2002). Both unconsolidated deposits are underlain by relatively impermeable Mancos Shale (DOE 2002). Most of the mill tailings area wells are screened within the alluvium, but several wells have screens that extend into the Mancos Shale. At the southeastern end of the site along the Animas River, a slag layer from the former lead and silver smelting operation sits on top of the alluvium or soil in most locations and can reach thicknesses up to 30 feet (ft) thick and predates milling (DOE 2014). Surface water inflow from Lightner Creek and portions of the adjacent Animas River provide the majority of recharge to the alluvial aquifer (DOE 2002). Precipitation infiltration occurs across the entire mill tailings area, but recharge contributions are less than from surface water (DOE 2002). Alluvial groundwater discharges to both Lightner Creek and the Animas River (DOE 2002).

Different than the mill tailing area, alluvium is largely absent from the raffinate pond area, leaving the underlying low permeability Point Lookout Sandstone and Menefee Formation to convey groundwater to the Animas River northeast of the site (DOE 2002). The Menefee Formation is relatively permeable where fractures or coal beds are present and is comparable to the hydraulic conductivity of the Bodo Fault (DOE 2002). The Bodo Fault, which trends diagonally across the raffinate pond area, is thought to preferentially convey groundwater at the site (DOE 2002). Recharge to groundwater occurs as lateral inflow from Smelter Mountain, infiltration from ephemeral South Creek which bisects the site, and precipitation infiltration (DOE 2002).

1.3 Site Remediation, Compliance Strategy, and Water Quality Monitoring

Groundwater and surface water quality characterization performed in the 1990s and early 2000s identified COCs at the Durango site (DOE 2002; DOE 2008). Based on evaluations of COC migration and attenuation potentials, risk assessment, groundwater flow and transport modeling, and COC trend evaluations, compliance strategies for the mill tailings and raffinate pond areas were developed. Natural flushing with a 100-year duration with ICs corresponding to the site boundary was selected as the compliance strategy for the mill tailings area (DOE 2008). Because of poor ambient water quality, supplemental standards was selected as the compliance strategy for the raffinate pond area (DOE 2008). Groundwater and surface water quality sampling is routinely performed at the Durango site to assess COC concentration trends and compliance remedy performance.

1.3.1 Contaminants of Concern and Remediation Goals

Surface water and groundwater sampling conducted during characterization activities identified cadmium, manganese, molybdenum, selenium, sulfate, and uranium as mill tailings area COCs (DOE 2008). Table 1 lists the compliance goals for these constituents in groundwater at the mill tailings area. Because the compliance strategy for the raffinate ponds area is supplemental standards based on poor ambient groundwater quality, there are no compliance goals for that portion of the Durango processing site. However, selenium and uranium trends in groundwater and surface water at the raffinate ponds area are reported.

Table 1. Contaminants of Concern and Groundwater Compliance Goals for the Mill Tailings Area

Contaminant of Concern	Groundwater Compliance Goals (mg/L)	Source
Cadmium	0.01	40 CFR 192 MCL
Manganese	NA	1.7 mg/L Risk-Based Goal (DOE 2008)
Molybdenum	0.1	40 CFR 192 MCL
Selenium	0.05	ACL (DOE 2003)
Sulfate	NA	1,276 mg/L Average Background (DOE 2002)
Uranium	0.044	40 CFR 192 MCL (activity based)

Note:
To evaluate the progress of natural flushing, the risk-based goal for ecological receptors was applied to manganese and the average background concentration was applied to sulfate.

Abbreviations:
ACL = alternate concentration limit
CFR = *Code of Federal Regulations*
MCL = maximum contaminant level
mg/L = milligrams per liter
NA = Not applied as a compliance standard

1.3.2 Groundwater and Surface Water Monitoring Schedule and Locations

The Durango site groundwater and surface water samples are typically collected in May or June from the monitoring wells and surface water sampling locations listed in Table 2 and Table 3 for the mill tailings and raffinate ponds areas, respectively. Figure 2 and Figure 3 show the monitoring well and surface water sampling locations for the mill tailings and raffinate ponds areas, respectively.

Table 2. Durango Site Water Quality Monitoring Locations in the Mill Tailings Area (DOE 2008)

Sample Location	Sample Type	Aquifer/Formation or Surface Water Feature Monitored	Location	Analytes
0617	Groundwater	Slag/Alluvium/Colluvium	Onsite	Manganese Molybdenum Selenium Sulfate Uranium
0630		Alluvium/Mancos Shale		
0631		Alluvium/Mancos Shale		
0633		Alluvium/Mancos Shale		
0634		Alluvium/Mancos Shale		
0635		Alluvium		
0863		Colluvium	Onsite, Downgradient	Cadmium Manganese Molybdenum Selenium Sulfate Uranium
0612		Alluvium		
0652	Surface Water	Animas River	Background	Cadmium Molybdenum Selenium Uranium
0584			Offsite, Downgradient	
0586				
0691				

Table 3. Durango Site Water Quality Monitoring Locations in the Raffinate Ponds Area (DOE 2008)

Sample Location	Sample Type	Aquifer/Formation or Surface Water Feature Monitored	Location	Analytes
0594 (replaces 0880)	Groundwater	Menefee	Onsite	Selenium Uranium
0598		Menefee/Point Lookout Sandstone (Bodo Fault)		
0607		Alluvium/Menefee		
0879		Menefee		
0884		Menefee	Offsite, Downgradient	
0588	Surface Water	South Creek	Offsite, Upgradient	
0654		Animas River	Offsite, Downgradient	
0656/0678		Animas River		

1.4 Source Area

The primary source of uranium and other COCs at the 40-acre mill tailings area is related to the two former tailings piles (Figure 2). Non-mill related slag from the smelter operation was deposited at the southeast corner of the site along the edge of the Animas River and may be the source of metals detected in groundwater such as cadmium and manganese, and molybdenum (DOE 2014). Overflow water from the stored alkaline leach tailings and slurried acid-leached tailings were mixed into settling ponds on top of the tailings impoundments before infiltrating the subsurface. Liquid waste from acid-leach tailings was pumped to a tank above the mill and discharged into a 3000-foot-long unlined ditch that carried the waste to a series of ponds on the 20-acre raffinate ponds area, approximately 1500 ft south of the mill tailings area (Figure 1 and Figure 3). At the raffinate ponds area, an additional 3000 ft of ditch carried raffinate through the series of ponds. The raffinate evaporated and percolated into the underlying alluvium, colluvium, and sandstone bedrock (DOE 2002).

The ponds and tailings were removed during surface remedial action completed in 1991 and placed into the Durango Disposal Cell (DOE 1991; DOE 2002). Supplemental standards for soils were applied to contamination left in place in (1) the banks of the Animas River; (2) to erosion protective rip rap covering a small lens of uranium precipitate believed to be from a spill that leached through layers of lead slag at the mill tailings area along the Animas River; (3) to unreachable areas of windblown contamination on the slope of Smelter Mountain; and (4) to the soils contaminated with thorium-230 in the raffinate ponds area (DOE 1995; DOE 2002) (Figure 1).

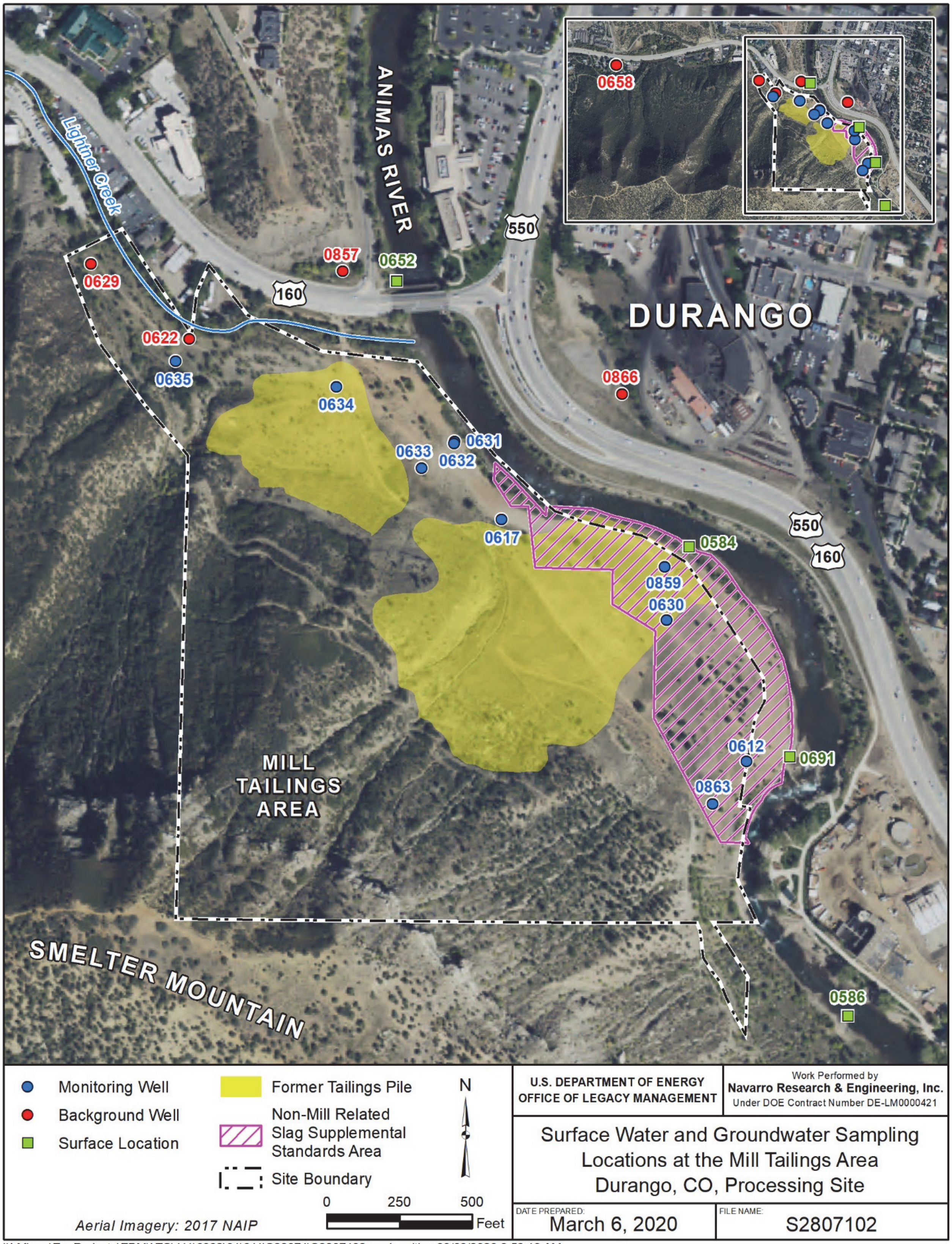

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Figure 2. Surface Water and Groundwater Sampling Locations for the Mill Tailings Area

Figure 3. Surface Water and Groundwater Sampling Locations for the Raffinate Ponds Area

2.0 Compliance Remedy Performance

The current compliance strategies at the Durango site are natural flushing with a 100-year duration with ICs corresponding to the site boundary for the mill tailings area and no further action for the raffinate pond area. To assess the effectiveness of the compliance strategy at the mill tailings area, temporal trends in groundwater levels and flow directions, COC concentrations in groundwater and surface water, and bulk uranium plume metrics are compared relative to baseline conditions. For the raffinate ponds area temporal trends in uranium and selenium concentrations for groundwater and surface water are reported. Baseline conditions for the Durango site correspond to 1992 following the completion of surface remediation and establishment of the current monitoring network. Groundwater and surface water quality data collected in 2019 for compliance and best management practice monitoring are presented in Appendix A.

2.1 Mill Tailings and Raffinate Pond Areas Groundwater Levels

The 2019 water table is shown on Figure 4 for the alluvial aquifer in the mill tailings area. To better define the water table, control points were necessary to represent the interpolated Animas River stage between the U.S. Geological Survey (USGS) gauging locations (09361500 and 09362520 on Figure 1). Stage elevations from both USGS stations were converted to the local site datum as part of the interpolation process. The water table elevation is primarily controlled by the stage of the Animas River, and flow conditions remain relatively stable except for short duration reversals of flow direction adjacent to the river in response to spring runoff conditions. Groundwater flow within the alluvium discharges to Lightner Creek at the northern portion of the mill tailings area, consistent with the conceptual site model presented in the Site Observational Work Plan (SOWP) (DOE 2002). North of well 0617, groundwater flows to the east before discharging to the Animas River. South of well 0617 to well 0630, groundwater flow is generally parallel to the Animas River and transitions from an easterly direction to a south-southeast direction (Figure 4). This finding is also supported by the conceptual site model where Animas River water recharges the alluvial aquifer in this portion of the site (DOE 2002).

A complimentary method of examining groundwater flow direction and hydraulic gradient independent of the Animas River stage was performed using three-point estimators (McKenna and Wahi 2006). Three-point estimators can provide quantitative, local information of the hydraulic gradient by approximating the water table as a plane using three monitoring wells as vertices of a triangle. Three-point estimator analyses were limited to dates when the water table was within the alluvium. Three-point estimators were also evaluated to ensure that hydraulic gradient estimates were reliable based on published criteria for the head drop (Devlin and McElwee 2007) and geometry of each estimator (McKenna and Wahi 2006). Results presented here use the following wells as triangle vertices:

- 0629, 0622, and 0635
- 0631, 0633, and 0617
- 0634, 0633, and 0631
- 0634, 0635, and 0633

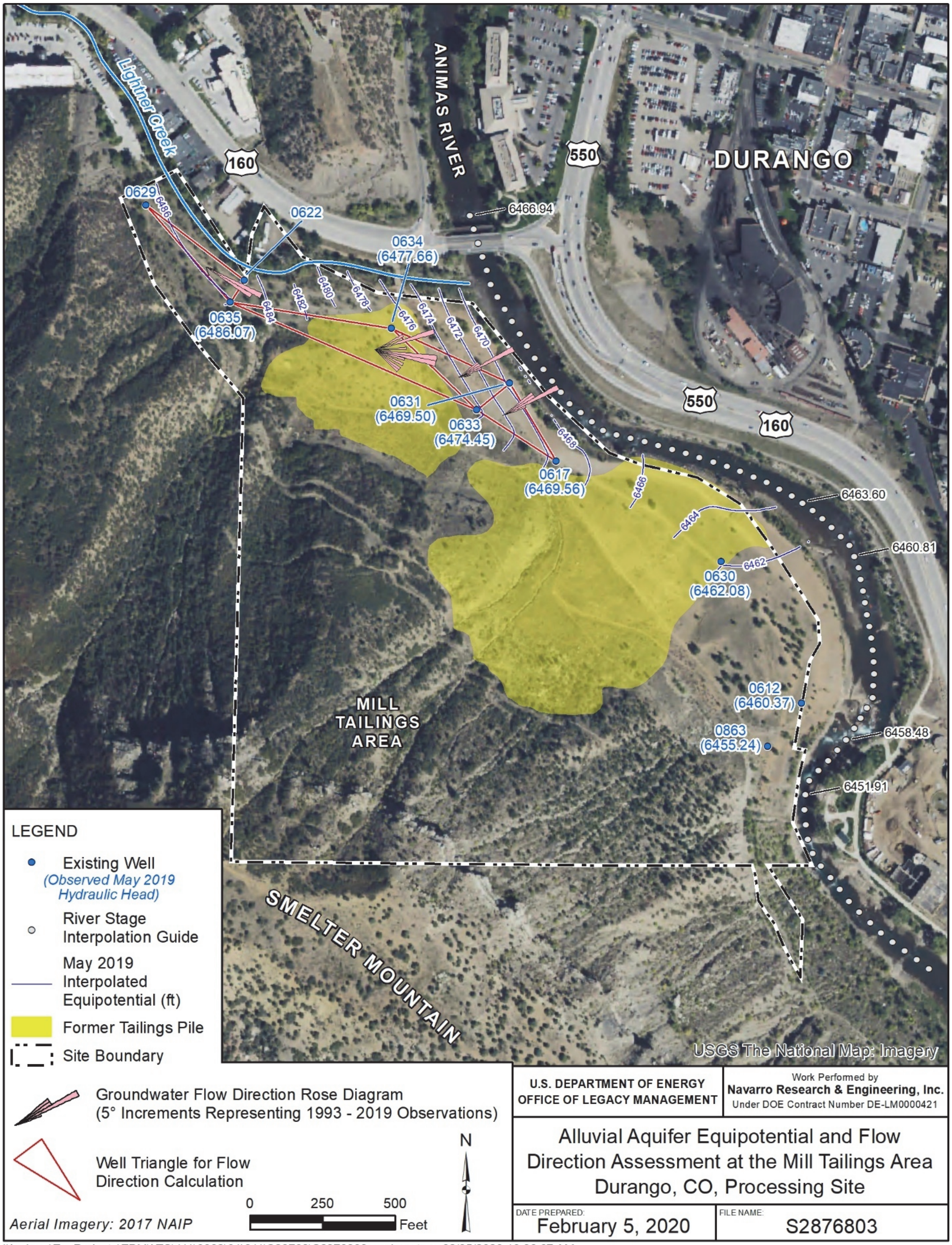

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Figure 4. Alluvial Aquifer Equipotential and Flow Direction Assessment at the Mill Tailings Area

Plots and summary tables comparing flow direction and hydraulic gradient with mean groundwater elevation and time are presented in Appendix B. These plots show that groundwater flow conditions are relatively stable at the site.

Results of the three-point estimators representing flow directions between 1993 and 2019 are shown on Figure 4 as rose diagrams at the center of each triangle. North of well 0617 in the mill tailings area, both three-point estimators and the interpolated water table map consistently show alluvial groundwater flowing eastward toward the Animas River (Figure 4). Analysis of data from three-point estimators south of well 0617 suggests the possibility of a survey error, and those results were not included.

Due to limited water level data collected for the raffinate ponds area, a water table map could not be generated. Groundwater flow direction and hydraulic gradient magnitude were evaluated using three-point estimators for wells screened in the Menefee Formation and to the east of the Bodo Fault to limit interfering effects. The results presented here use the following wells as triangle vertices:

- 0594, 0607, and 0884
- 0607, 0884, and 0879

Plots and summary tables comparing flow direction and hydraulic gradient with mean groundwater elevation and time are presented in Appendix B. Results indicate that in the raffinate ponds area to the east of the Bodo Fault and north of South Creek, groundwater flow is predominantly to the east and northeast toward the Animas River (Figure 5 and Appendix B). This conclusion is consistent with the water table map presented in the SOWP (DOE 2002).

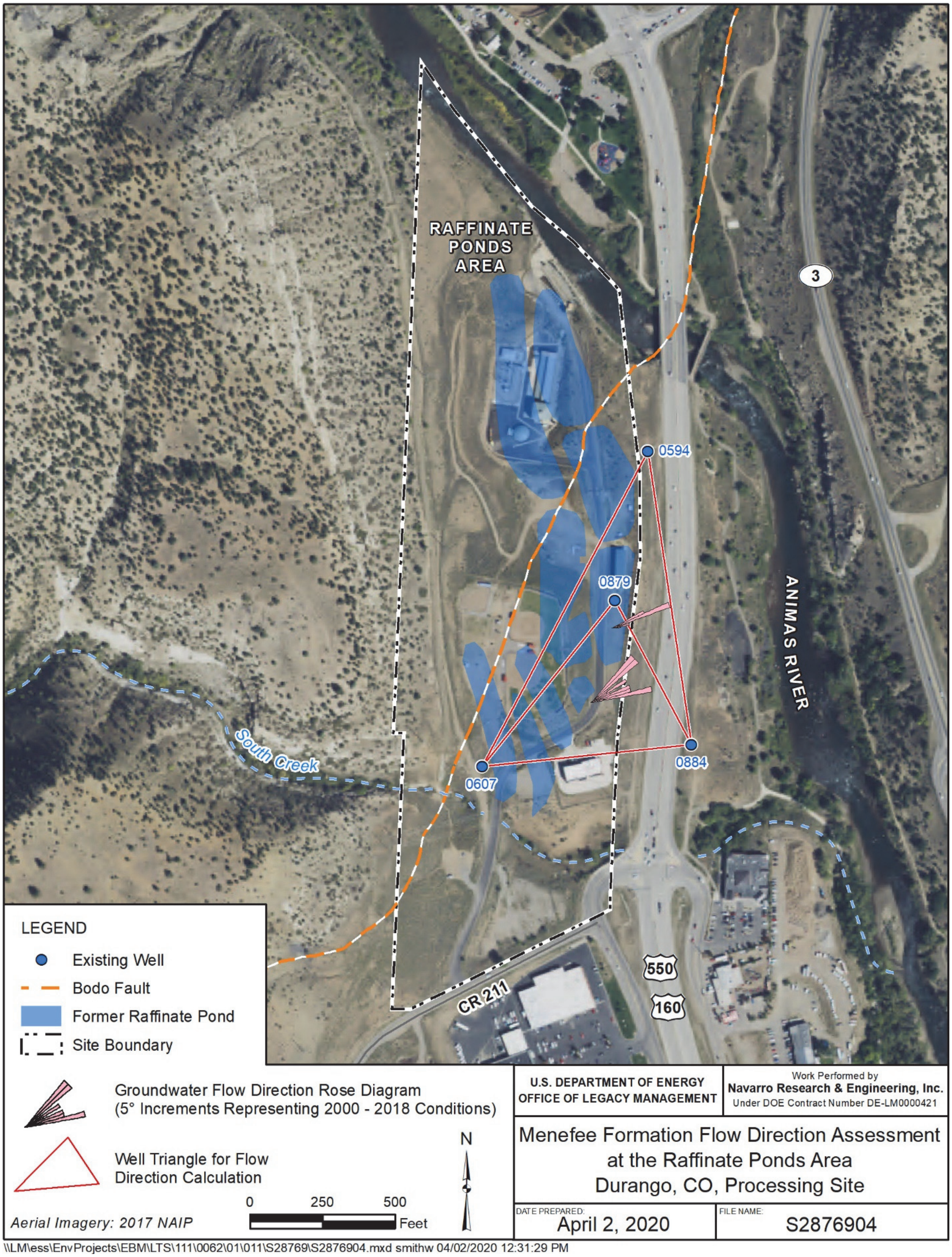

Figure 5. Menefee Flow Direction Assessment at the Raffinate Ponds Area

2.2 Monitoring Well COC Trends

COC concentration trends (Figure 6 through Figure 13) for wells listed in Table 2 and 3 were evaluated to 1) determine natural flushing progress at the mill tailings area; and 2) monitor as a best management practice at the raffinate ponds area following surface remediation (1992) to present. Since many of the wells at the mill tailings area are screened across the Mancos Shale and the alluvium, trend plots are color-coded to indicate the position of the water table at the time each sample was collected. Mann-Kendall trend analysis with a 0.05 significance level was used to characterize the direction of concentration trends (Table 4 through Table 9). The starting year for the Mann-Kendall analysis was adjusted from 1992 to 2000 for wells with a relatively high number of nondetects for cadmium, molybdenum, and selenium to prevent a false trend from being identified due to changing detection limits. For wells that were identified as having a decreasing concentration trend, linear regression of the log-transformed concentration data was performed to determine the best-fit, and 95% upper and lower attenuation half-lives and the range of years when concentrations, assuming continuing trends, are predicted to reach the COC standards. It is important to note that wells having stable or increasing concentration trends may develop, with time, downward concentration trends and ultimately reach COC standards. Based on current data, it is impossible to predict when, if at all, those wells might reach COC standards. A discussion of the COC concentration trends for the mill tailings and raffinate ponds areas are presented in the following sections.

2.2.1 Mill Tailings Area

2.2.1.1 Cadmium

Cadmium is currently monitored in wells 0863 and 0612, and the results are presented in Figure 6. The blue line on each plot in Figure 6 represents the locally estimated scatterplot smoothing (LOESS) line with a 95% confidence interval shaded around the LOESS line. The dashed line represents the compliance goal of 0.01 milligram per liter (mg/L). Cadmium concentrations in well 0863 remain below the compliance goal of 0.01 mg/L. Concentrations of cadmium in well 0612 remain above the compliance goal with no discernable trend, indicating that natural flushing within the 100-year time frame may not be attainable unless a consistent downward trend develops (Table 4). The persistent cadmium concentrations for well 0612 are hypothesized to be caused by slag material present in the vicinity of the well (Figure 2) (DOE 2014). Since the current compliance strategy at well 0612 does not appear to be effective, risks associated with cadmium will be reevaluated at this location and contingency remedies considered (DOE 2008).

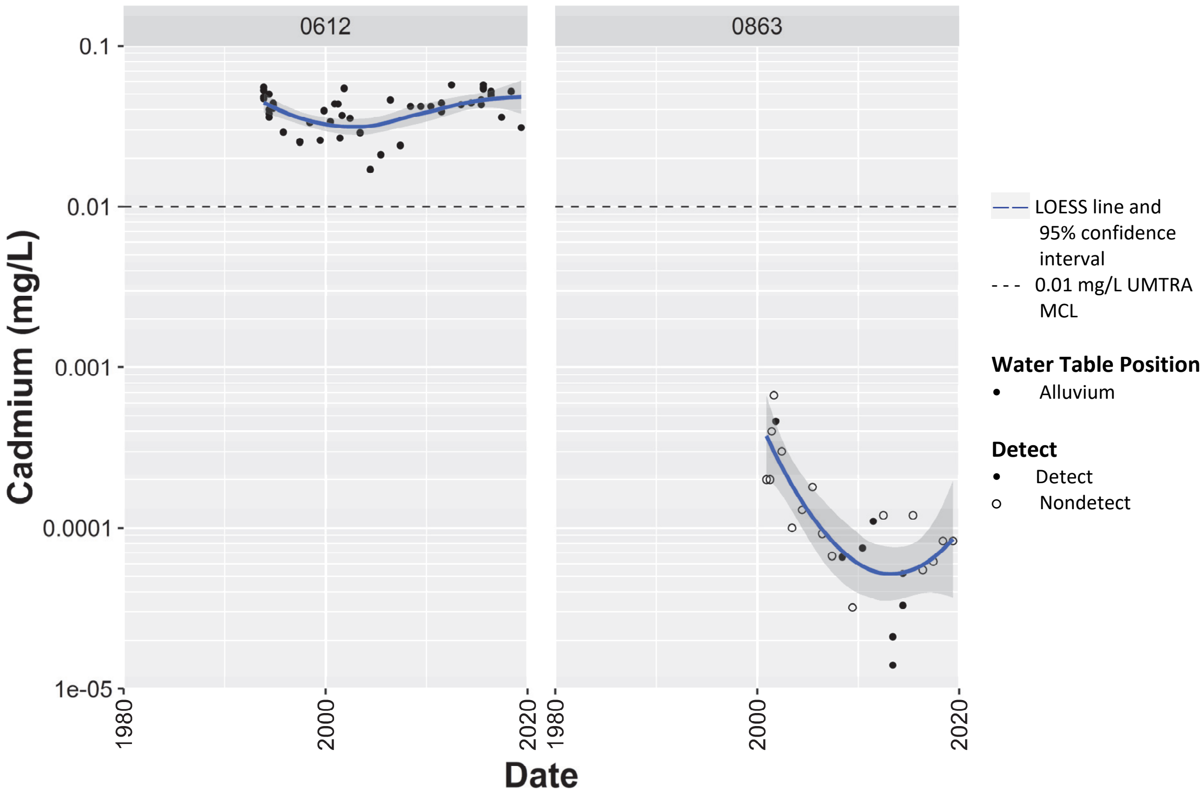

Figure 6. Cadmium Concentration Trends from 1992 to 2019

Table 4. Mill Tailings Area Monitoring Well Cadmium Concentration Trends and Year Compliance Goal is Reached

Well	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Last Concentration Sampled (mg/L)	Mann- Kendall		Half-Life, years			Year Compliance Goal (0.01 mg/L) of Cadmium Concentration in Groundwater 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
0612	8/6/1992	5/21/2019	31	0.031	None	0.23	Not applicable, no trend					
0863	11/29/2000	5/21/2019	23	Non-Detect	Insufficient detections		Not applicable, concentration less than compliance goal					

2.2.1.2 Manganese

Manganese concentrations in groundwater are currently below the risk-based goal of 1.7 mg/L in seven of eight monitoring wells (Figure 7). The blue line on each plot in Figure 7 represents the LOESS line with a 95% confidence interval shaded around the LOESS line. The dashed line represents the risk-based goal of 1.7 mg/L (DOE 2008). Manganese concentrations in well 0612 have been consistently above 1.7 mg/L with an increasing trend (Figure 7 and Table 5), indicating that concentration reduction below the risk-based goal may not be achieved at this location within 100 years. Manganese concentrations in well 0617 are currently below the risk-based goal, but the trend in concentrations is increasing (Figure 7 and Table 5).

Well 0612 is screened primarily in the alluvium below approximately 18 ft of slag, and well 0617 is partially screened within a 12 ft slag layer. Similar to cadmium, the persistence of manganese has been argued to be related to sources other than milling, possibly slag from historical lead smelter operations (DOE 2014). An analysis of solid-phase cadmium and manganese concentrations in the slag layer relative to soils in background and non-slag mill tailings areas may be needed to help pinpoint the source of these COCs.

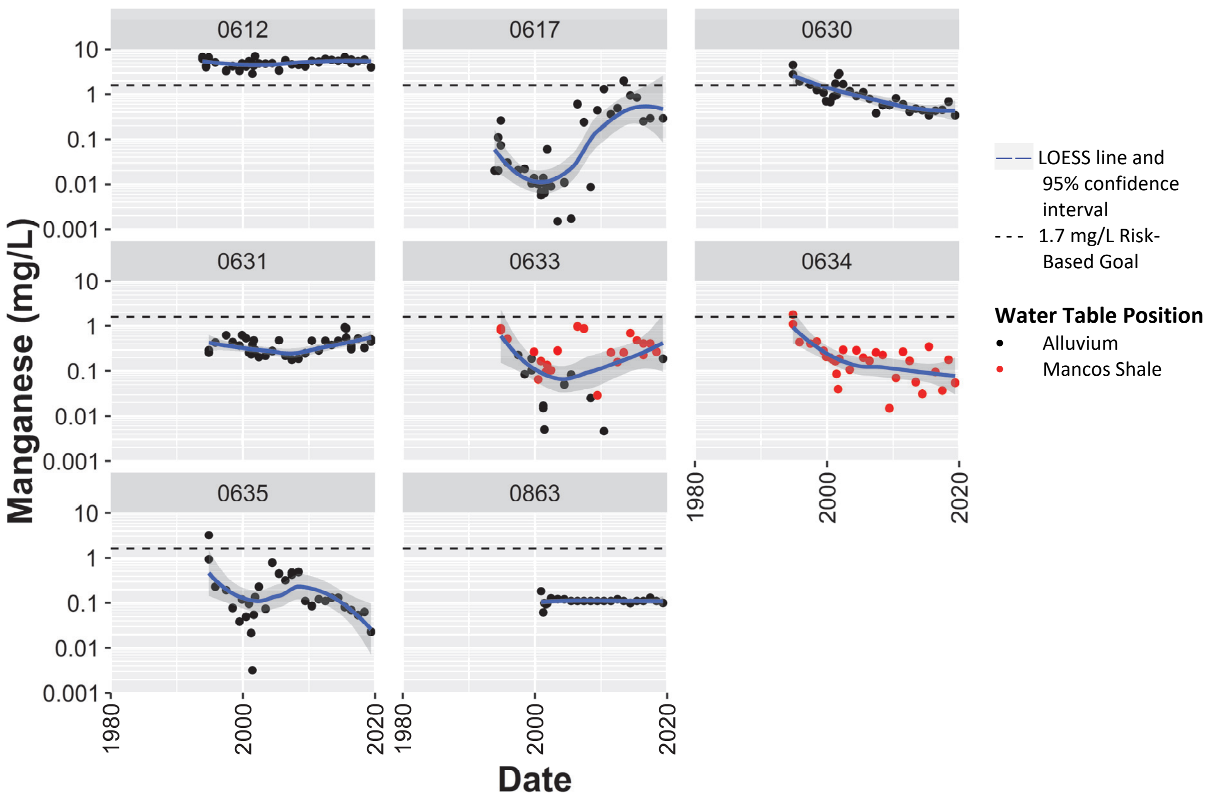

Figure 7. Manganese Concentration Trends from 1992 to 2019

Table 5. Mill Tailings Area Monitoring Well Manganese Concentration Trends and Year Risk-Based Goal is Reached

Well	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Last Concentration Sampled (mg/L)	Mann- Kendall		Half-Life, years			Year Risk-Based Goal (1.7 mg/L) of Manganese Concentration in Groundwater 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
0612	8/6/1992	5/21/2019	31	4	Increasing	0.26	Not applicable, increasing trend					
0617	8/7/1992	5/21/2019	32	0.29	Increasing	0.30	Not applicable, concentration less than risk-based goal					
0630	10/31/1994	5/21/2019	30	0.34	Decreasing	-0.59	Not applicable, concentration less than risk-based goal					
0631	11/1/1994	5/21/2019	31	0.51	None	0.05	Not applicable, concentration less than risk-based goal					
0633	10/31/1994	5/21/2019	30	0.19	None	0.06	Not applicable, concentration less than risk-based goal					
0634	11/2/1994	5/21/2019	30	0.055	Decreasing	-0.42	Not applicable, concentration less than risk-based goal					
0635	11/2/1994	5/21/2019	30	0.023	None	-0.13	Not applicable, concentration less than risk-based goal					
0863	11/29/2000	5/21/2019	23	0.099	None	0.03	Not applicable, concentration less than risk-based goal					

2.2.1.3 Molybdenum

Molybdenum concentrations in groundwater remain below the compliance standard of 0.1 mg/L (DOE 2008) for all locations since June of 2012 (Figure 8) (DOE 2014). The blue line on each plot in Figure 8 represents the LOESS line with a 95% confidence interval shaded around the LOESS line. The dashed line represents the compliance goal of 0.1 mg/L. Mann-Kendall trend analysis indicates that concentrations continue to decrease in four of eight wells (Table 6). Given the low concentrations relative to the compliance standard combined with decreasing or no concentration trends, sampling for this analyte at a reduced frequency could be considered (e.g., once every 3 to 5 years).

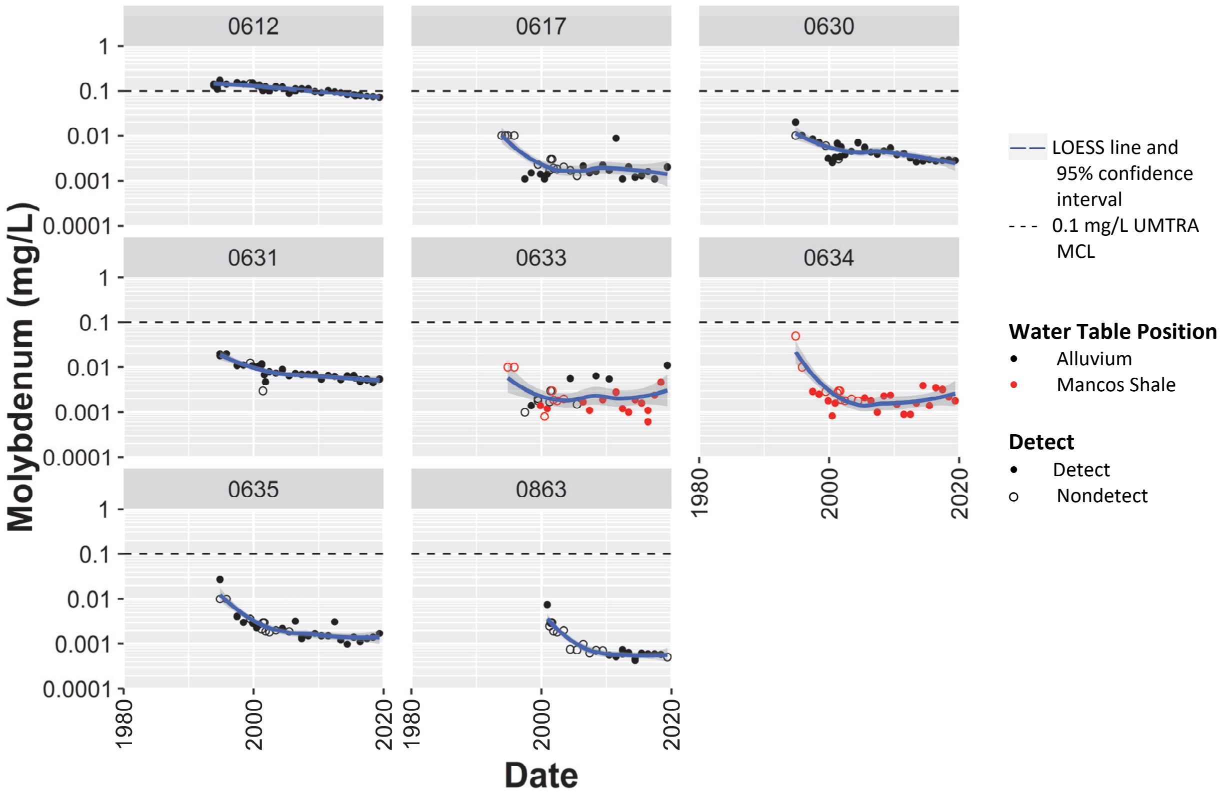

Figure 8. Molybdenum Concentration Trends from 1992 to 2019

Table 6. Mill Tailings Area Monitoring Well Molybdenum Concentration Trends and Year Compliance Goal is Reached

Well	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Last Concentration Sampled (mg/L)	Mann- Kendall		Half-Life, years			Year Compliance Goal (0.1 mg/L) of Molybdenum Concentration in Groundwater 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
0612	8/6/1992	5/21/2019	31	0.072	Decreasing	-0.79	Not applicable, concentration less than compliance goal					
0617	6/27/2000	5/21/2019	23	0.002	None	-0.11	Not applicable, concentration less than compliance goal					
0630	10/31/1994	5/21/2019	30	0.0028	Decreasing	-0.48	Not applicable, concentration less than compliance goal					
0631	11/1/1994	5/21/2019	31	0.0055	Decreasing	-0.64	Not applicable, concentration less than compliance goal					
0633	10/31/1994	5/21/2019	30	0.011	None	0.06	Not applicable, concentration less than compliance goal					
0634	6/22/2000	5/21/2019	24	0.0018	None	0.03	Not applicable, concentration less than compliance goal					
0635	6/22/2000	5/21/2019	30	0.0017	Decreasing	-0.50	Not applicable, concentration less than compliance goal					
0863	11/29/2000	5/21/2019	23	0.00051	Insufficient detections		Not applicable, concentration less than compliance goal					

2.2.1.4 Selenium

Selenium concentrations in groundwater are currently below the alternate concentration limit (ACL) of 0.05 mg/L (DOE 2008) in six of the eight monitoring wells (Figure 9). The blue line on each plot in Figure 9 represents the LOESS line with a 95% confidence interval shaded around the LOESS line. The dashed line represents the compliance goal of 0.05 mg/L. The most recent sample from wells 0633 and 0634 exceeded the ACL in May 2019 (0.058 mg/L and 0.059 mg/L, respectively), which marks the first and only exceedance for well 0634 and the first exceedance since June of 2011 for well 0633 (Table 7). Well 0633 selenium concentrations above the ACL mostly occur when the water table is within the alluvium. Selenium concentrations are generally below the ACL when the water table is within the Mancos Shale, suggesting a continuing alluvium selenium source in the vicinity of the well.

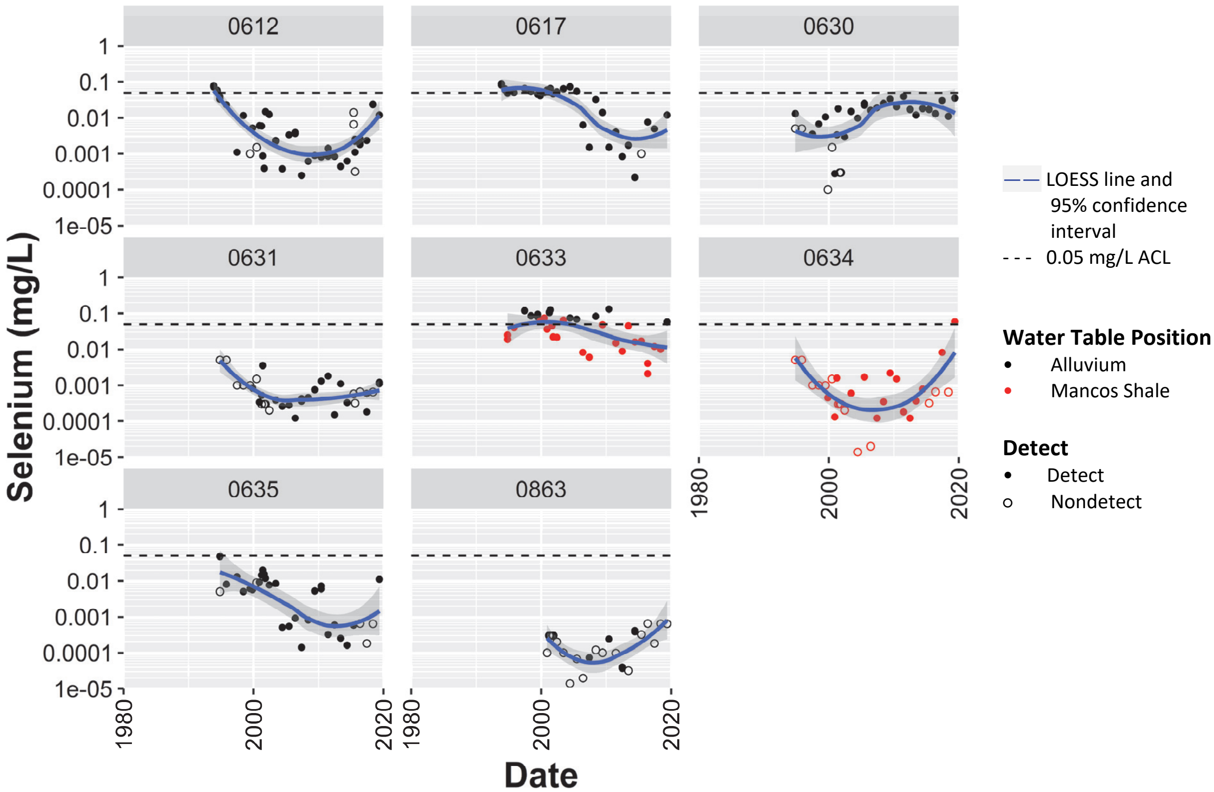

Figure 9. Selenium Concentration Trends from 1992 to 2019

Table 7. Mill Tailings Area Monitoring Well Selenium Concentration Trends and Year Compliance Goal is Reached

Well	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Last Concentration Sampled (mg/L)	Mann- Kendall		Half-Life, years			Year Compliance Goal (0.05 mg/L) of Selenium Concentration in Groundwater 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
0612	8/6/1992	5/21/2019	31	0.012	None	-0.14	Not applicable, concentration less than compliance goal					
0617	8/7/1992	5/21/2019	32	0.012	Decreasing	-0.52	Not applicable, concentration less than compliance goal					
0630	10/31/1994	5/21/2019	30	0.035	Increasing	0.43	Not applicable, concentration less than compliance goal					
0631	11/1/1994	5/21/2019	31	0.0012	None	-0.13	Not applicable, concentration less than compliance goal					
0633	10/31/1994	5/21/2019	30	0.058	Decreasing	-0.32	Not applicable, regression line estimate is less than compliance goal					
0634	6/22/2000	5/21/2019	24	0.059	None	0.22	Not applicable, no trend					
0635	11/2/1994	5/21/2019	30	0.011	Decreasing	-0.36	Not applicable, concentration less than compliance goal					
0863	11/29/2000	5/21/2019	23	Non-Detect	Insufficient detections		Not applicable, concentration less than compliance goal					

2.2.1.5 *Sulfate*

Sulfate concentrations in groundwater are currently above the average background concentration of 1276 mg/L at six of eight monitoring wells (Figure 10). The blue line on each plot in Figure 10 represents the LOESS line with a 95% confidence interval shaded around the LOESS line. The dashed line represents the average background concentration goal of 1276 mg/L. Wells 0612, 0617, and 0630 have a significant decreasing trend in concentration and are expected to reach 1276 mg/L sometime between 2024 (lower 95% confidence interval for 0612) and 2081 (upper 95% confidence interval for 0617) (Table 8), consistent with the findings of the 2014 VMR (DOE 2014). Significantly increasing sulfate concentration trends for wells 0633, 0634, and 0635 currently exceed the 1276 mg/L goal (Table 8). It is important to note that wells having stable or increasing concentration trends may develop, with time, downward concentration trends and ultimately reach the average background sulfate concentration goal. Based on current data, it is impossible to predict when, if at all, those wells might reach the average background concentration goal.

Wells 0633 and 0634 have greater than 70% of their respective screened intervals within the Mancos Shale (DOE 2014), and their water table elevations are frequently within the Mancos Shale (Figure 10). Sulfate is a predominant, naturally occurring anion in Mancos Shale groundwater that strongly correlates with specific conductance at the site (DOE 2011; DOE 2018). Previous study of vertical concentration profiles through well screens that span across the alluvium and Mancos Shale interface frequently show increasing sulfate concentration with depth, even in upgradient well 0622 and established background wells 0629, 0857, and 0866 (DOE 2018). Of these upgradient and background wells, only well 0629 was shown to exceed the goal of 1276 mg/L in the Mancos Shale (DOE 2018). Nevertheless, there is potential for the Mancos Shale to naturally contribute concentrations that exceed 1276 mg/L (DOE 2018). However, the significantly decreasing sulfate concentration trends at wells 0612, 0617, and 0630 suggest a mill-related source rather than background derived concentrations which would be expected to have stable trends. Similarly, wells 0633 and 0634, located in the vicinity of the former mill tailings piles, have increasing sulfate concentration trends indicating a mill-related source rather than purely background derived concentrations. This finding is supported with isotopic activity ratios (uranium-234 [^{234}U]/uranium-238[^{238}U]) below 1.00 for both wells 0633 and 0634 (DOE 2014). Continued sulfate monitoring is recommended.

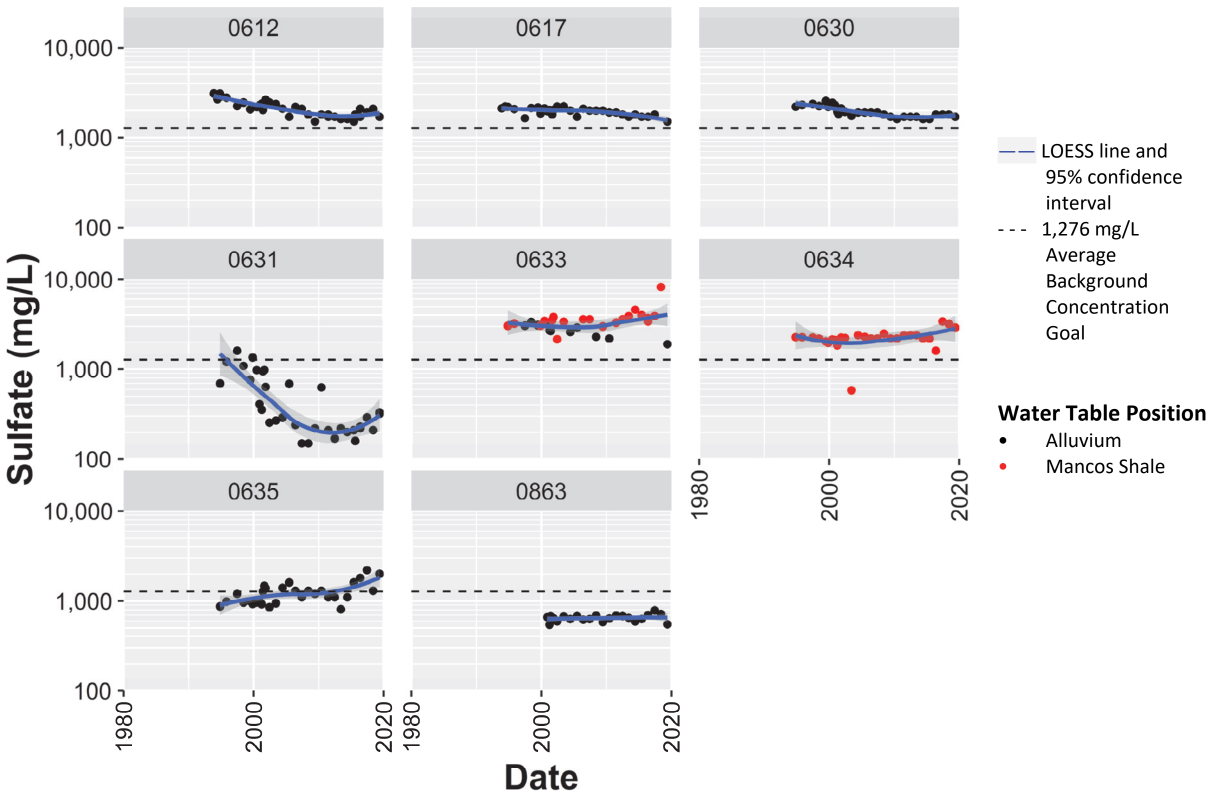

Figure 10. Sulfate Concentration Trends from 1992 to 2019

Table 8. Mill Tailings Area Monitoring Well Sulfate Concentration Trends and Year Compliance Goal is Reached

Well	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Last Concentration Sampled (mg/L)	Mann- Kendall		Half-Life, years			Year Average Background (1,276 mg/L) Sulfate Concentration in Groundwater 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
0612	8/6/1992	5/21/2019	31	1700	Decreasing	-0.56	34.1	26.7	47.2	2029	2024	2037
0617	8/7/1992	5/21/2019	32	1500	Decreasing	-0.50	75.5	53.6	127.4	2050	2037	2081
0630	10/31/1994	5/21/2019	30	1700	Decreasing	-0.68	46.6	36.1	65.8	2033	2027	2044
0631	11/1/1994	5/21/2019	31	330	Decreasing	-0.55	Not applicable, concentration less than average background concentration					
0633	10/31/1994	5/21/2019	30	1900	Increasing	0.26	Not applicable, increasing trend					
0634	11/2/1994	5/21/2019	30	2900	Increasing	0.28	Not applicable, increasing trend					
0635	11/2/1994	5/21/2019	30	2000	Increasing	0.38	Not applicable, increasing trend					
0863	11/29/2000	5/21/2019	23	550	None	0.15	Not applicable, concentration less than average background concentration					

2.2.1.6 Uranium

Uranium concentrations in groundwater are currently above the established groundwater compliance standard of 0.044 mg/L (DOE 2008) in six of eight monitoring wells (Figure 11). The blue line on each plot in Figure 11 represents the LOESS line with a 95% confidence interval shaded around the LOESS line. The dashed line represents the compliance standard of 0.044 mg/L. Mann-Kendall trend analysis shows a significant decreasing trend for wells 0612, 0617, 0631, and 0633. Natural flushing may result in well 0631 reaching the compliance standard as early as 2022 (lower 95% confidence interval) and well 0612 reaching the compliance standard as late as 2180 (upper 95% confidence interval) (Table 9). Taking the average of the wells with statistically identified decreasing trends suggests that the compliance standard may be met by approximately 2075. A regression analysis with the same wells starting in 1991 in the most recent VMR yielded a similar estimated attenuation year of 2072 (DOE 2014).

Well 0634 is characterized as having no statistical trend and the timeframe to reach the compliance standard cannot be estimated with linear regression. While groundwater elevations in well 0634 are within the Mancos Shale (Figure 11), the isotopic activity ratio ($^{234}U/^{238}U$) reported for well 0634 is 0.93 (DOE 2014), which is consistent with uranium in groundwater having a mill-tailings origin as opposed to a Mancos Shale origin. This is further supported by the observation that uranium concentration variations in the well screen increased with elevation by a factor of two (DOE 2018).

Concentration trends for uranium in groundwater were found to be increasing at wells 0630 and 0635. Well 0630 is located on the southeastern edge of the former mill tailings boundary (Figure 2), and increasing concentrations may be related to the southeast component of groundwater flow (Figure 4), consistent with transport and natural flushing from the southern tailings pile. A similar observation was discussed in the 2014 VMR where increasing trends at 0630 could be a result of an upgradient pulse of uranium migrating through the system (DOE 2014). While the uranium concentration in well 0635 is currently below the compliance standard, given the high tau value of 0.73 and a probability value of effectively 0, it is possible that concentrations of uranium will exceed 0.044 mg/L in the future (Table 9). The isotopic activity ratio ($^{234}U/^{238}U$) of a sample collected in 2001 for well 0635 was 1.56, which suggests a mixed source of mill-tailings and non-mill origin for the uranium at that time (DOE 2014). Combined with the increasing concentration of sulfate above 1276 mg/L at well 0635 since 1992 (Table 8), additional isotopic sampling of uranium would provide evidence to indicate if a change in mill-related composition groundwater has occurred and if the well is considered representative of background conditions as suggested in the 2014 VMR (DOE 2014).

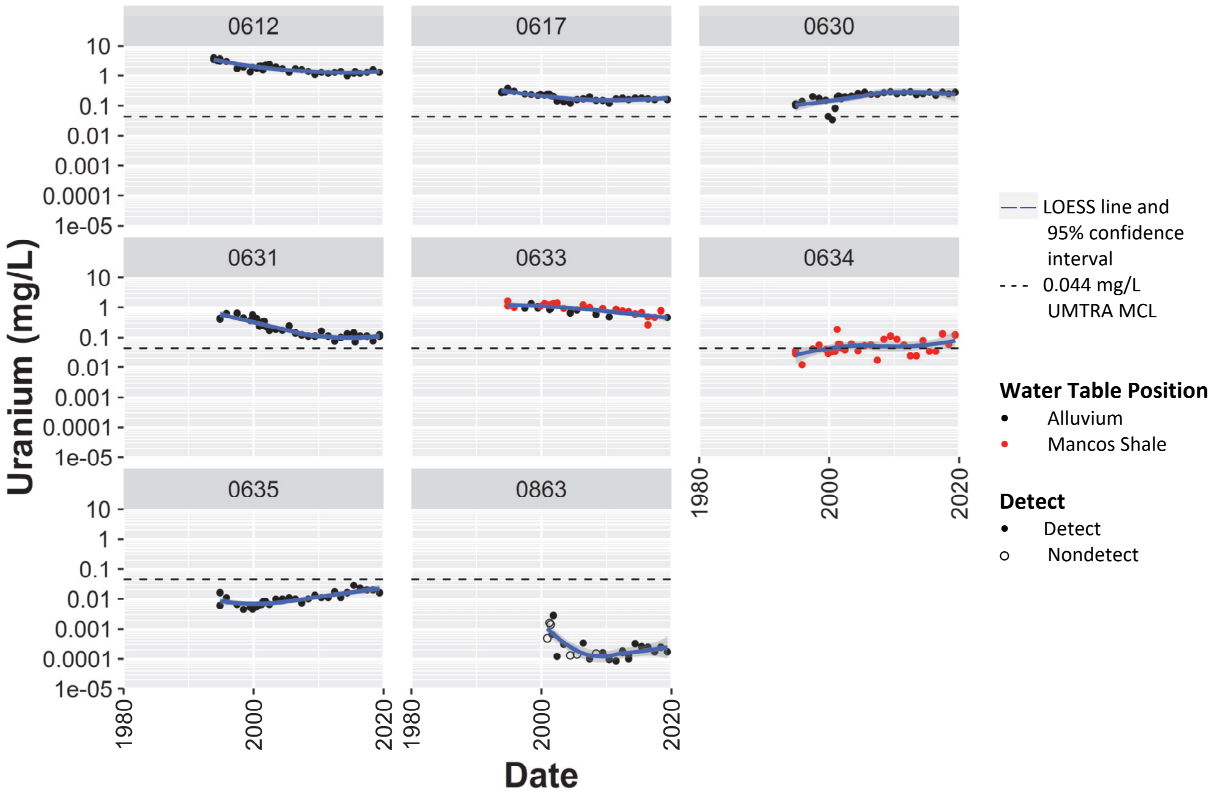

Figure 11. Uranium Concentration Trends from 1992 to 2019

Table 9. Mill Tailings Area Monitoring Well Uranium Concentration Trends and Year Compliance Goal is Reached

Well	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Last Concentration Sampled (mg/L)	Mann- Kendall		Half-Life, years			Year Compliance Goal (0.044 mg/L) of Uranium Concentration in Groundwater 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
0612	8/7/1992	5/21/2019	31	1.3	Decreasing	-0.55	23.2	17.8	33.6	2127	2099	2180
0617	8/7/1992	5/21/2019	32	0.16	Decreasing	-0.54	29.6	21.1	49.8	2068	2050	2110
0630	10/31/1994	5/21/2019	30	0.28	Increasing	0.61	Not applicable, increasing trend					
0631	11/1/1994	5/21/2019	31	0.12	Decreasing	-0.74	8.8	7.3	11.0	2025	2022	2029
0633	10/31/1994	5/21/2019	30	0.46	Decreasing	-0.53	17.5	12.9	27.3	2080	2061	2121
0634	11/2/1994	5/21/2019	30	0.12	None	0.25	Not applicable, no trend					
0635	11/2/1994	5/21/2019	30	0.016	Increasing	0.73	Not applicable, concentration less than compliance goal					
0863	11/29/2000	5/21/2019	23	0.00017	None	-0.23	Not applicable, concentration less than compliance goal					

2.2.2 Raffinate Ponds Area

The compliance strategy for the raffinate ponds area is no further remediation (DOE 2008). The raffinate ponds area is a limited use aquifer subject to Supplemental Standards and monitoring of selenium and uranium is conducted as a best management practice. However, in reporting temporal concentration changes, Mann-Kendall trend analysis was conducted, and time-concentration plots were created for wells 0594, 0598, 0607, 0879, and 0884 (Figure 3). Results for the trend analysis for selenium and uranium are shown on Table 10 and Table 11, with temporal concentrations shown on Figure 12 and Figure 13, respectively. The blue line on each plot in Figure 12 and Figure 13 represents the LOESS line with a 95% confidence interval shaded around the LOESS line. The only significant trends for selenium indicate decreasing concentrations for onsite well 0879 and offsite downgradient wells 0594 and 0884 (Table 10 and Figure 12). A decreasing trend was also calculated for uranium for onsite well 0879, but a significantly increasing trend was calculated for offsite downgradient well 0884 (Table 11 and Figure 13). A significant increasing trend in uranium for well 0884 is expected since radon-222 (^{222}Rn) profiling indicates that the well is screened within a zone of high groundwater flux (DOE 2018) that could control transport. The decreasing trend in selenium and corresponding increasing trend in uranium for well 0884 may be indicative of the preferential sorption of selenium since selenium distribution coefficients in the Menefee formation were experimentally shown to be 10 to 25 times greater than uranium (DOE 2002). With the current trend in concentrations, continued monitoring at the raffinate ponds area could be reduced in frequency to every other year, with continued annual monitoring at offsite, downgradient wells 0884 and 0594 to evaluate concentration trends.

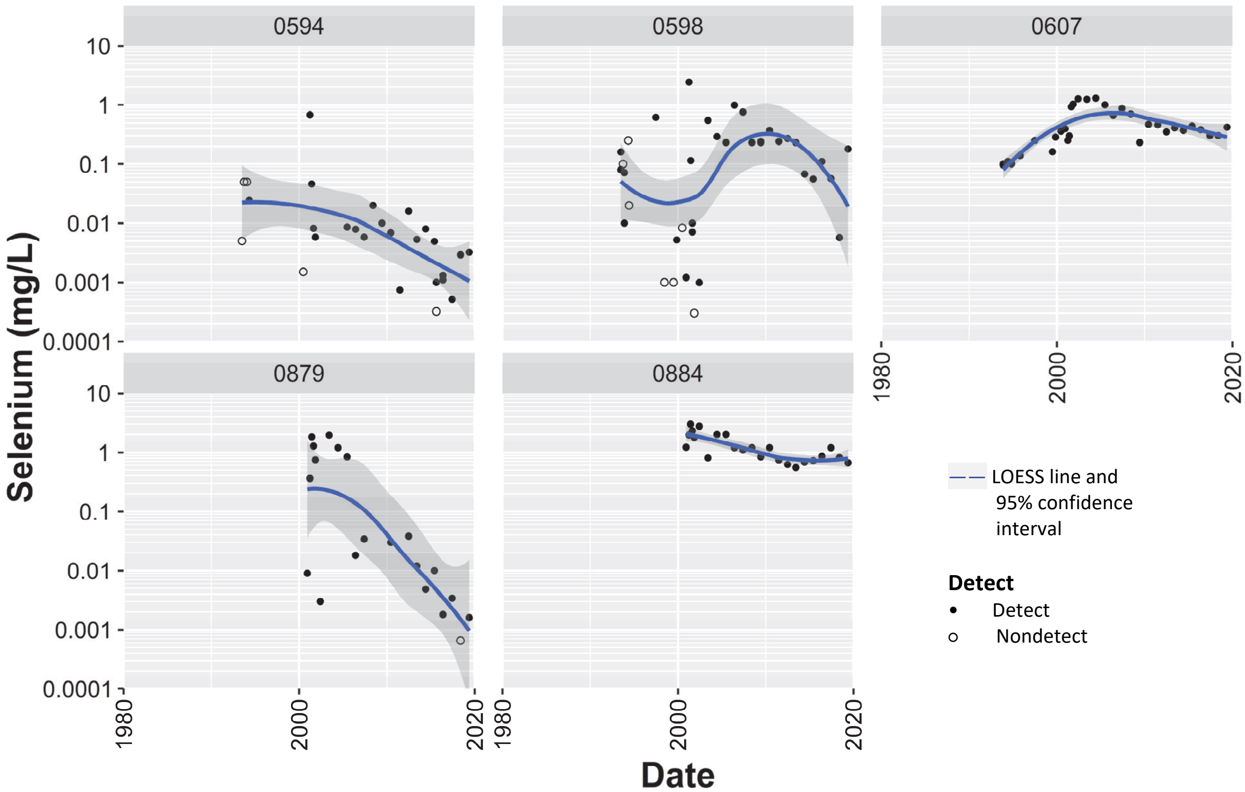

Figure 12. Selenium Concentration Trends from 1992 to 2019

Table 10. Raffinate Ponds Monitoring Well Selenium Concentration Trends

Well	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Last Concentration Sampled (mg/L)	Mann- Kendall	
					Concentration Trend	Tau Value
0594	6/29/1993	5/21/2019	25	0.003	Decreasing	-0.47
0598	9/24/1993	5/21/2019	32	0.180	None	0.07
0607	11/21/1993	5/21/2019	30	0.420	None	0.19
0879	12/5/2000	5/21/2019	20	0.002	Decreasing	-0.55
0884	12/6/2000	5/20/2019	23	0.670	Decreasing	-0.55

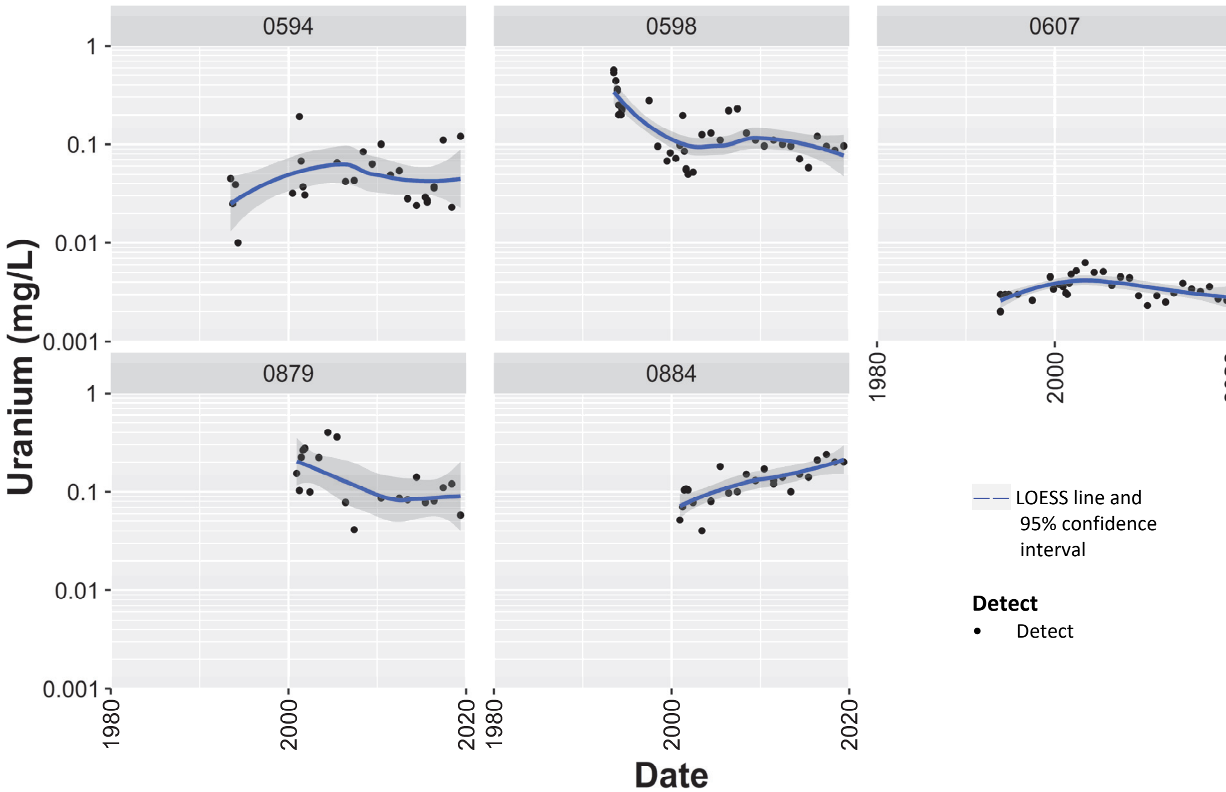

Figure 13. Uranium Concentration Trends from 1992 to 2019

Table 11. Raffinate Ponds Area Monitoring Well Uranium Concentration Trends

Well	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Last Concentration Sampled (mg/L)	Mann- Kendall	
					Concentration Trend	Tau Value
0594	6/29/1993	5/21/2019	25	0.12	None	0.02
0598	9/24/1993	5/21/2019	32	0.096	None	-0.24
0607	11/21/1993	5/21/2019	31	0.0026	None	-0.02
0879	12/5/2000	5/21/2019	20	0.058	Decreasing	-0.33
0884	12/6/2000	5/20/2019	23	0.2	Increasing	0.58

2.3 Mill Tailings Area COC Plume Geometry and Concentrations

Spatial variations in groundwater concentration of the May 2019 sampling event are shown on Figure 14 for cadmium, manganese, molybdenum, and selenium with respect to each COC's compliance or ecological risk-based goal at the mill tailings area. Given the number of monitored wells and limited exceedances for these COCs, interpolated plume maps were not created. Cadmium and manganese exceedances are limited to the vicinity of well 0612. Slight exceedances of selenium are present in the northern portion of the mill tailings area at wells 0633 and 0634, where groundwater elevations are frequently within the Mancos Shale. There are no locations with current exceedances of molybdenum.

Plume concentration maps for sulfate and uranium in alluvial groundwater were generated using June 2001 and May 2019 data for comparison where concentrations are greater than the average background concentration and compliance goal listed in Table 1, respectively. Data from 2001 was selected as it represented the most complete and earliest dataset that could be used with the current monitoring network. The area selected for contouring was limited to the extent of the saturated alluvial aquifer (including well 0863) that was mapped laterally in the SOWP (DOE 2002, Figure 5-1) and confirmed after review of available boring logs. The natural neighbors method was used to interpolate the water table on the given dates while kriging was used to interpolate concentrations. Concentrations for wells where the water table was in the Mancos Shale (the alluvium was dry) are reported on the figures but not used in the interpolation as they are not representative of the alluvial aquifer. An outcome of applying this interpolation scheme is the alluvial aquifer plume footprint appears reduced from 2001 to 2019 as a result of more of the alluvial aquifer being dry in 2019 compared to 2001. It is possible that future plume depictions will have increased footprints as more of the alluvium becomes saturated.

Concentrations of sulfate in groundwater are shown on Figure 15. June 2001 interpolated concentrations indicate that the sulfate plume is bounded to the east by the Animas River and wells 0631 and 0859, to the south by colluvium well 0863, and to the north by well 0635 and Lightner Creek. The plume is not characterized west of wells 0617, 0630, and 0633, creating uncertainty in the plume extent, but, given the footprint of the former tailings piles, it is possible the plume extends westward to where the alluvial aquifer pinches out. Background well 0629 indicates concentrations greater than 1276 mg/L, but the groundwater elevation is within the Mancos Shale. Background well 0857 located to the north of Lightner Creek also had sulfate concentrations greater than 1276 mg/L.

In May 2019, the maximum concentration was 2000 mg/L within the Mancos Shale at well 0634, whereas the highest concentration in the alluvium was 2000 mg/L in well 0635, an increase from 1280 mg/L in June 2001. In May 2019, concentrations in well 0633 were 1900 mg/L, a decrease from 2670 mg/L in June 2001. The eastern extent of the plume is more uncertain in May 2019 without continued monitoring from well 0859. The southern portion of the plume monitored by wells 0630 and 0612 decreased in concentration from 1830 mg/L and 2030 mg/L to 1700 mg/L and 1700 mg/L, respectively (Figure 15).

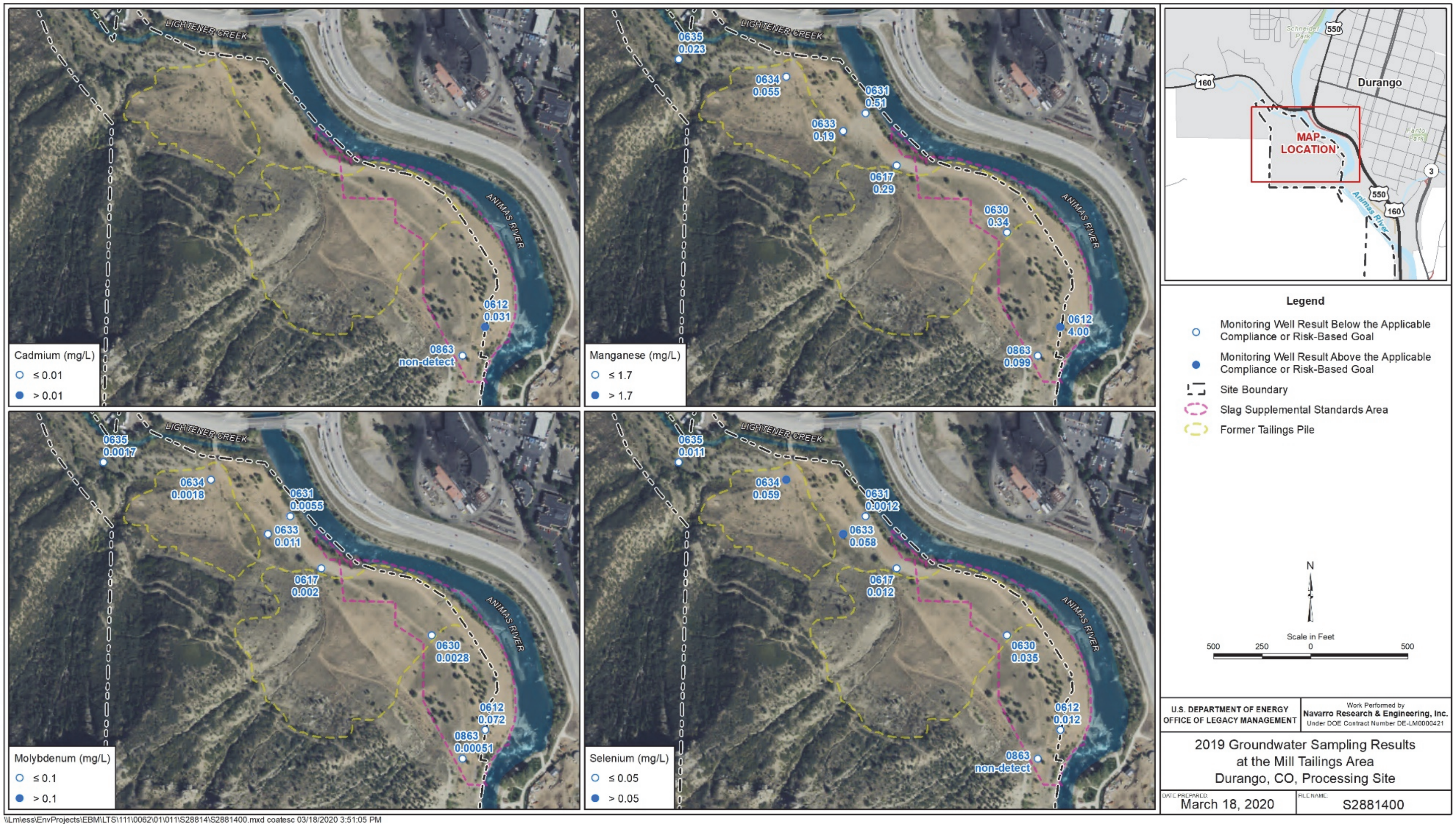

Figure 14. 2019 Groundwater Sampling Results for Cadmium, Manganese, Molybdenum, and Selenium at the Mill Tailings Area

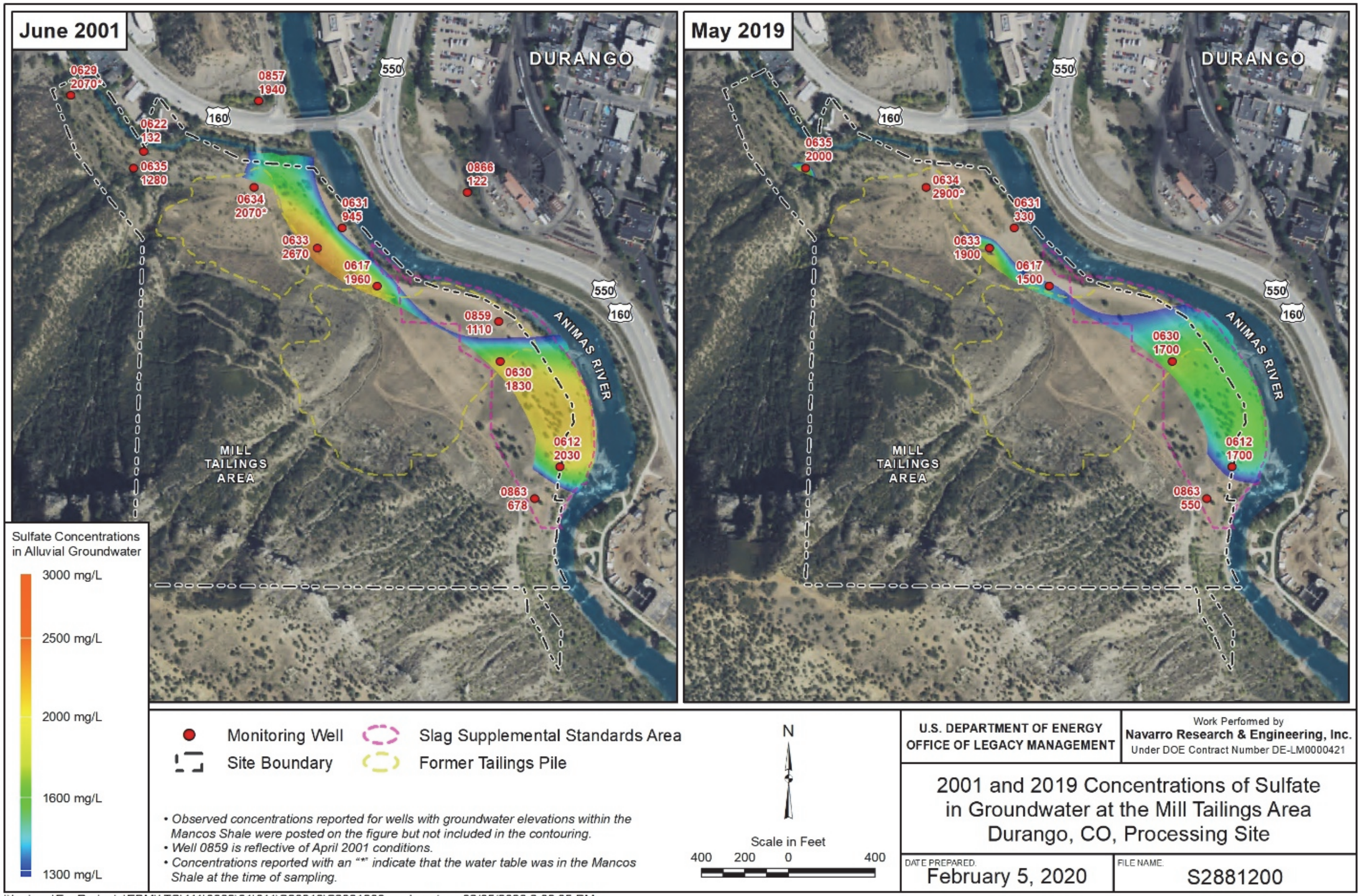

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Figure 15. 2001 and 2019 Concentrations of Sulfate in Groundwater at the Mill Tailings Area

Concentrations of uranium in alluvial groundwater are shown on Figure 16. In June 2001, the uranium plume is bounded by the east Animas River, to the south by the colluvium well 0863, and to the north by well 0635 and Lightner Creek. The plume is not characterized west of wells 0617, 0630 and 0633, creating uncertainty in the plume extent, but, given the footprint of the former tailings piles, it is possible the plume extends westward to where the alluvial aquifer pinches out. The maximum uranium concentration in June 2001 was 1.56 mg/L from well 0612.

By May 2019, the maximum concentration of uranium decreased in well 0612 to 1.30 mg/L. Notable concentration decreases are also apparent to the north in wells 0617, 0631, and 0633. The eastern extent of the plume in June 2001 reaches well 0859, where the concentration was nearly the compliance goal of 0.044 mg/L. The eastern extent of the plume is more uncertain in May 2019 (Figure 16) without concentration data from well 0859 to include in the plume interpolation. Sampling of well 0859 was discontinued after four consecutive sampling events between June 2001 and June 2002 yielded concentrations below the uranium standard of 0.044 mg/L.

Both uranium and sulfate plume distributions (Figure 15 and Figure 16) support the previous evaluation that colluvium well 0863 is not on a flow path (cross gradient) from the former southern mill tailings pile to the Animas River (DOE 2014).

2.4 Mill Tailings Area Bulk COC Plume Metrics

Bulk plume metrics for the mill tailings area were calculated for uranium using Earth Volumetric Studio version 2019.9.0. The calculation is performed using a three-dimensional interpolation (when a sufficient number of wells were sampled) and extrapolation of groundwater concentration data with kriging for sampling events since March 2001. The interpolated plume volume is bound on the bottom by the top of the Mancos Shale (interpolated from site boring logs) where relatively little groundwater flow occurs (DOE 2002; DOE 2018). The interpolated plume is bound on the top by the interpolated groundwater elevations recorded for each sampling event. Since wells are often screened across the Mancos Shale/alluvium interface, concentrations pertaining to water table elevations within the Mancos Shale were not included in the interpolation. A porosity of 0.25 was assumed for plume volume and plume mass calculations.

Bulk uranium plume metrics characterizing plume volume, dissolved plume mass, and average plume concentration provide an assessment of natural flushing progress (Figure 17). The blue line on each plot represents the LOESS line, and the surrounding grey represents the 95% confidence interval around the LOESS line. The average plume concentration has significantly decreased ($p < 0.05$) from 2001 to 2019 (Figure 17 and Table 12). Linear regression of the log-transformed average plume concentration indicates the average plume concentration reaching the compliance standard of 0.044 mg/L at approximately the year 2101, which is similar to predictions presented in Table 9. The degree of uncertainty for this estimate is large with the lower and upper 95% confidence intervals between the years of 2068 and 2213, respectively (Table 12). Estimated times to reach the compliance standard presented in Table 9 and Table 12 are most sensitive to the decreasing trend at well 0612, where the concentration of uranium is the greatest.

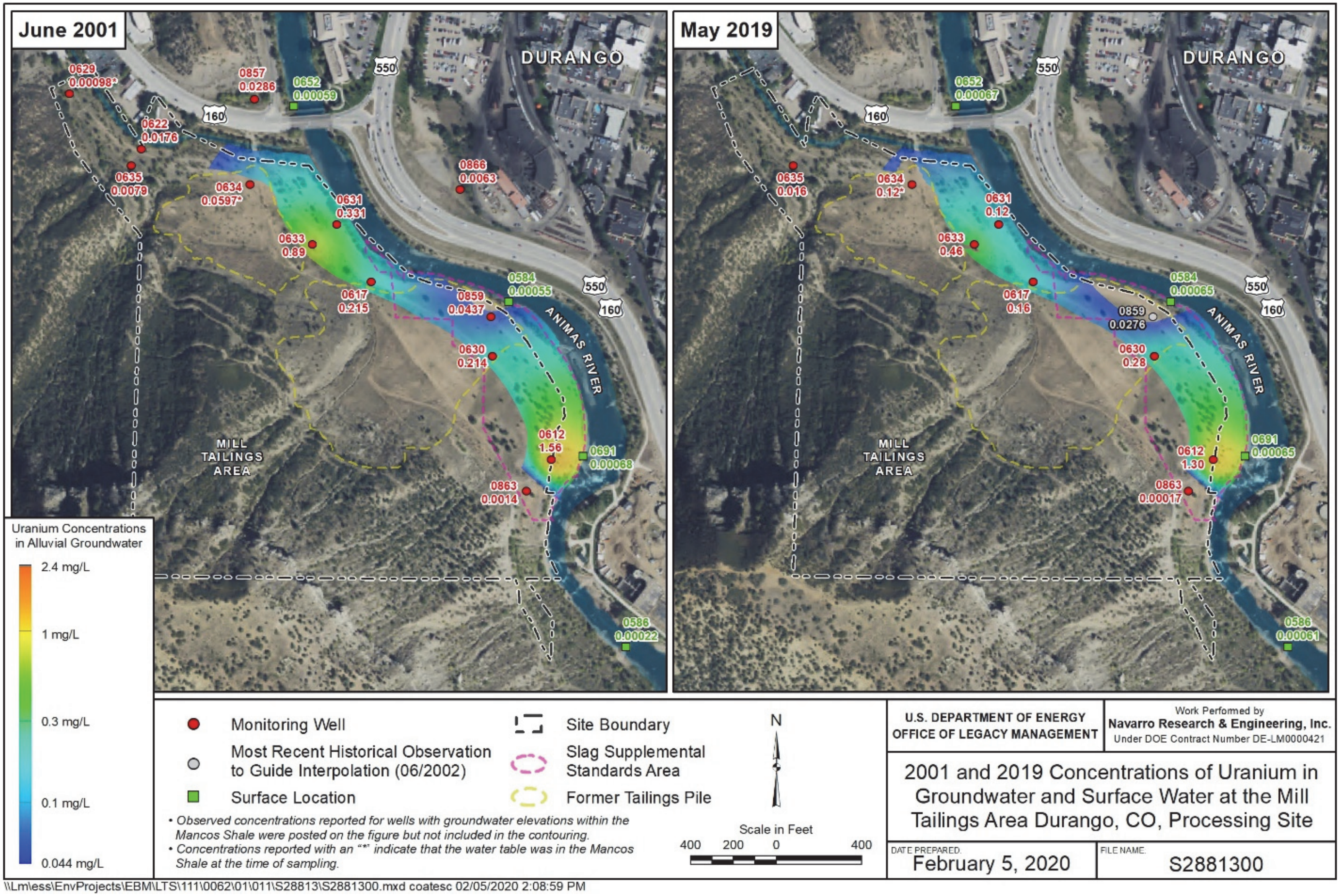

Figure 16. 2001 and 2019 Concentrations of Uranium in Groundwater and Surface Water at the Mill Tailings Area

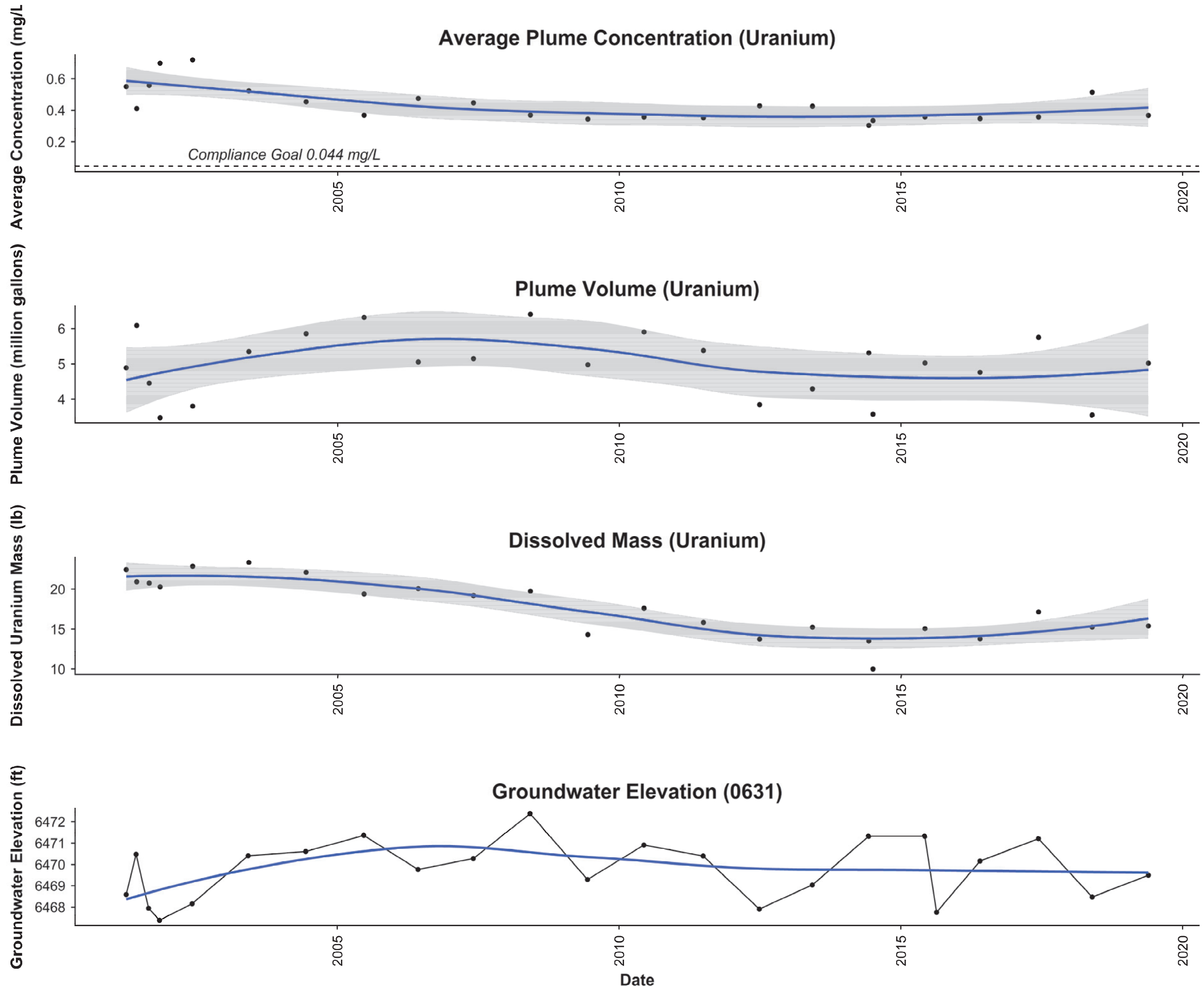

Figure 17. Temporal Variations in Dissolved Uranium Bulk Plume Metrics and Alluvium Groundwater Fluctuations

Table 12. Mill Tailings Area Average Uranium Concentration Trends and Year Compliance Goal is Reached

Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Mann- Kendall		Half-Life, years			Year 0.044 mg/L Concentration in Groundwater 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
3/31/2001	5/21/2019	23	Decreasing	-0.45	28.03	18.08	62.43	2101	2068	2213

Variations in plume mass are related to both changes in plume volume and average plume concentration. Plume volume has fluctuated from 3.5 to 6.4 million gallons between 2001 and 2019. Uranium plume volume is correlated with groundwater elevations, as illustrated by a comparison of plume volume with the hydrograph for well 0631 in Figure 17. Well 0631 was selected for comparison because (1) groundwater elevations are always within the alluvial aquifer; (2) hydraulic conductivity was reported to be 27 ft per day, which is typical of values from the alluvial aquifer (DOE 2002); and (3) ^{222}Rn profile data in 0631 indicates a relatively high flux zone within the alluvium that corresponds with the profile trend in dissolved uranium concentration (DOE 2018). Fluctuations in well 0631 are related to changes in Animas River stage and precipitation recharge. Plume mass has shown a similar pattern in fluctuation as plume volume and has ranged from 13.9 to 24 pounds between 2001 and 2019 (Figure 17). The decrease in average plume concentration and plume mass between 2001 and 2012 suggests that uranium was being flushed from the system at a rate greater than the loading rate into the aquifer. Visual examination of trends between 2012 and 2019 indicates a dynamic equilibrium in plume mass and average concentration may have been achieved (i.e., the uranium loading rate has generally decreased and is approaching the flushing rate).

2.5 Surface Water COC Concentration Trends

Surface water was sampled from six locations in the Animas River adjacent to both the mill tailings and raffinate ponds areas in 2019 and analyzed for cadmium, molybdenum, selenium, and uranium (Figure 1, Table 2, Table 3, and Appendix A). At the raffinate ponds area, Animas River location 0678 replaced 0656 in 2013 (DOE 2014). Results from 1992 to 2019 are presented on Figure 18 and Figure 19 for the mill tailings and raffinate ponds areas, respectively. Concentrations of constituents at all locations along the Animas River remain indistinguishable from background levels (Figure 18, Figure 19, and Appendix A). The colored lines on each plot represents the LOESS line with a 95% confidence interval shaded around the LOESS line. The most recent surface water concentrations across the mill tailings area for uranium are also shown on Figure 16. Samples were also collected from South Creek (location 0588), upgradient from the raffinate ponds area, to assess the quality of water entering the site from the west. South Creek location 0588 is in the lower end of the arroyo that extends from the raffinate ponds area to the Durango Disposal Site. South Creek is typically dry except following heavy rainfall events, wet periods, or when treated water was released from the toe drain collection pond at the base of the disposal cell (DOE 2002). Samples from South Creek in 2019 had concentrations of selenium (0.00096 mg/L) and uranium (0.040 mg/L) that are within observed historical ranges for this location (Figure 19). Concentrations of selenium and uranium observed in South Creek are generally higher than those from other surface water locations (Figure 19).

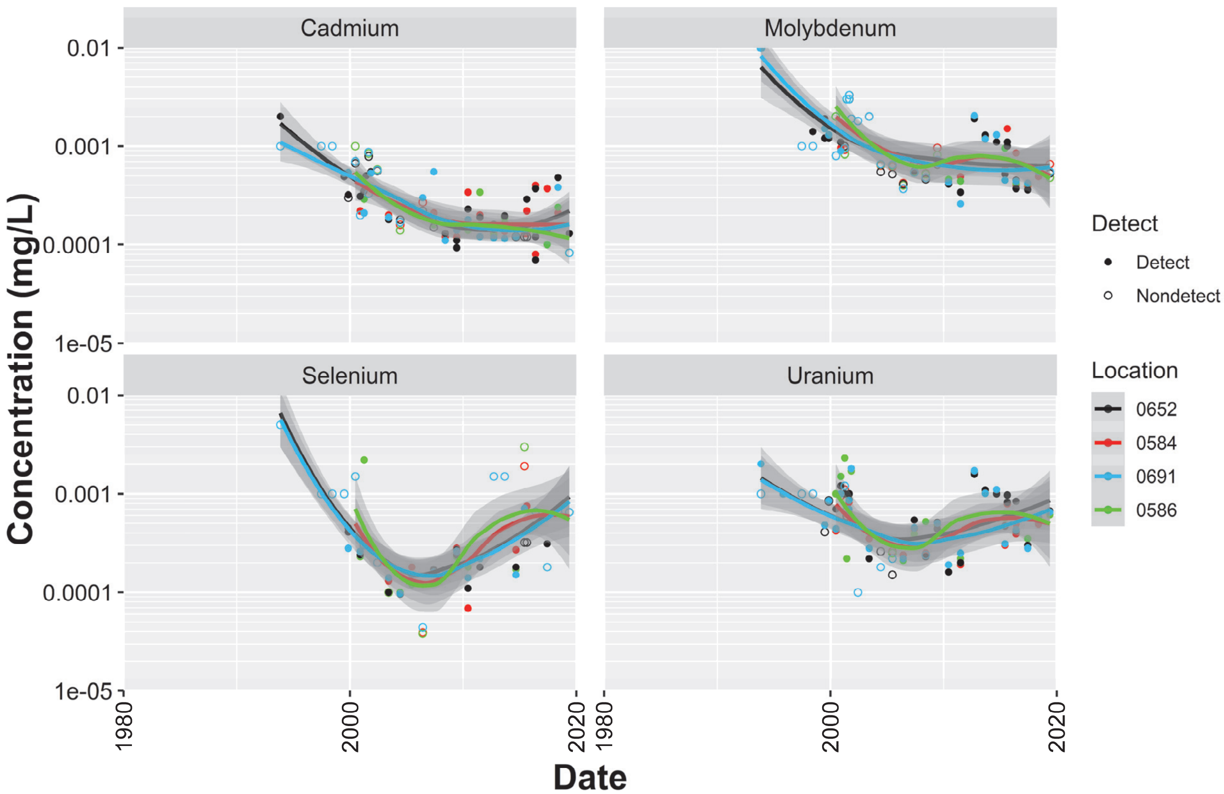

Figure 18. Temporal Concentrations of Cadmium, Molybdenum, Selenium, and Uranium in Surface Water Along the Mill Tailings Area

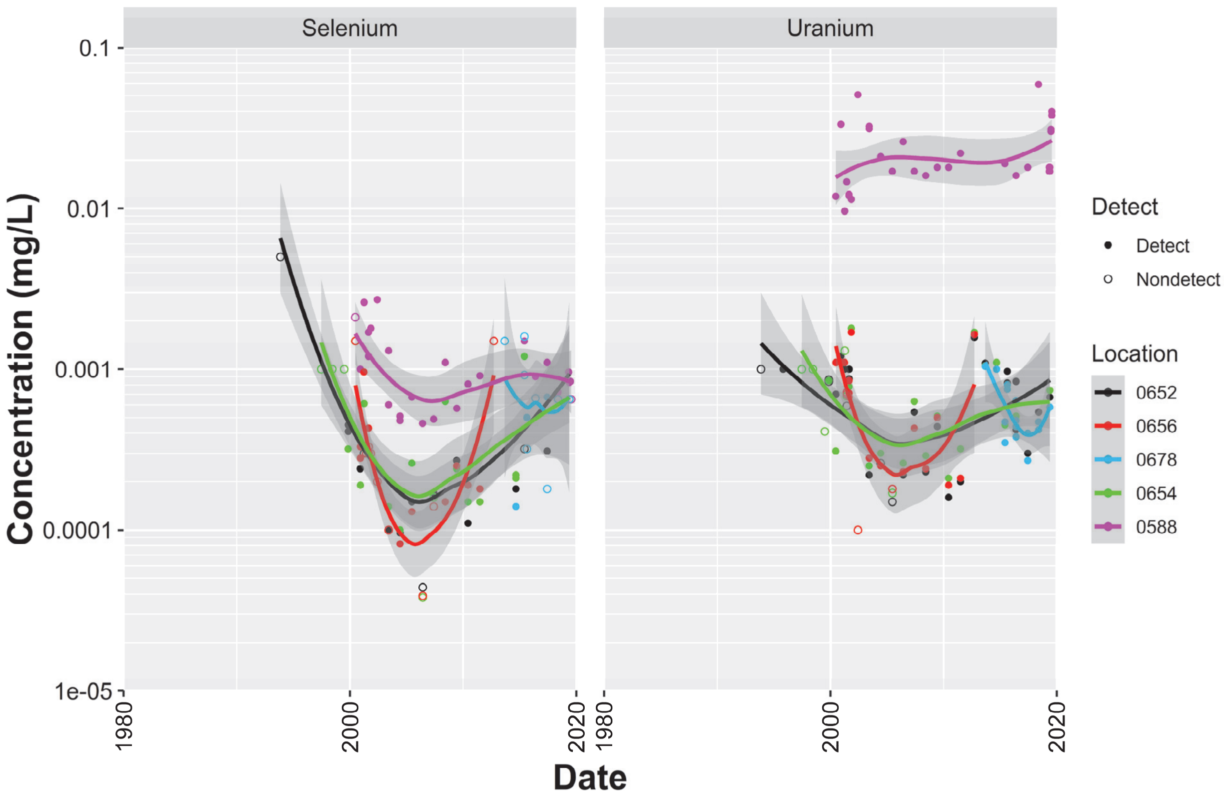

Figure 19. Temporal Concentrations of Selenium and Uranium in Surface Water Along the Raffinate Ponds Area

3.0 Compliance Remedy Performance Summary

Based on the evaluation included in this report, the following observations and recommendations are made:

- Estimated groundwater flow directions are consistent with the conceptual site model presented in the SOWP (DOE 2002). Because of the uncertainty in vertical elevation datum of monitoring wells, comparisons between Animas River stage and groundwater elevations are difficult. A resurvey of the monitoring wells to a common, absolute datum is needed to evaluate the progress of natural flushing.
- Concentrations of cadmium, manganese, molybdenum, and selenium in groundwater at the mill tailings area are currently below their respective compliance or risk-based (manganese) goals with the following exceptions:
  - Cadmium and manganese have been persistently above their respective compliance and risk-based goals, respectively at well 0612. These COCs are likely related to sources other than milling.
  - Selenium has recently exceeded the compliance goal at wells 0633 and 0634. Groundwater elevations in these wells are frequently within the Mancos Shale, where elevated, naturally occurring concentrations of selenium have been reported in groundwater samples across the Colorado Plateau (DOE 2011). However, well 0633 selenium concentrations above the standard mostly occur when the water table is within the alluvium. Selenium concentrations are generally below the standard when the water

table is within the Mancos Shale suggesting a continuing, alluvium selenium source in the vicinity of the well.

- The sampling frequency for molybdenum can be significantly reduced or eliminated altogether. Annual monitoring should continue for selenium, and natural flushing currently remains a valid compliance strategy at this time. Concentrations of manganese are not expected to fall below the risk-based goal within 100 years at well 0612 and annual monitoring should continue. Natural flushing of cadmium at well 0612 is not likely to occur within the 100-year time frame, therefore, risks associated with cadmium will be reevaluated at this location and contingency remedies considered.
- Analysis of sulfate at the mill tailings area indicates that concentrations could decrease to or below the average background concentration goal of 1276 mg/L within 100 years at five of eight locations. The remaining three locations are wells 0633, 0634, and 0635. Groundwater elevations are frequently within the Mancos Shale at wells 0633 and 0634, where elevated sulfate is naturally occurring. However, with significant decreasing trends in sulfate concentration at wells 0612, 0630, and 0631, suggesting a mill-related source, and given the proximity of wells 0633 and 0634 to the former mill tailings piles, continued monitoring is recommended. Additional uranium isotope sampling at well 0635 would help assess if increasing sulfate concentrations are related to possible changes in the mixing of mill-related and background groundwater since 2001.
- Natural flushing appears to be proceeding in a manner consistent with recent VMRs for uranium in the mill tailings area (DOE 2012; DOE 2014). Attenuation rates for monitoring wells with significantly decreasing trends (0612, 0617, 0631, and 0633) suggest that natural flushing at those locations could occur within the 100-year time frame. COC concentrations in wells 0630 and 0634 remain above the compliance standard with statistically significant increasing concentration trends. Since concentration trends are increasing at wells 0630 and 0634, the time frame to achieve natural flushing cannot be estimated at these locations. Mann-Kendall analysis of average uranium plume concentration data indicates a statistically significant decreasing concentration trend. Though highly uncertain, linear regression analysis estimates that average uranium plume concentrations could be below the compliance goal around year 2101 with the 95% lower and upper confidence limits between the years 2068 and 2213, respectively. Natural flushing within a 100-year time frame could still be a viable compliance strategy.
- The aquifer beneath the raffinate ponds area is subject to supplemental standards, designated as limited use, and monitoring is conducted as a best management practice. Concentration trends of selenium have either been decreasing or exhibiting no trend, and uranium concentration trends are only increasing at downgradient well 0884. The increase in concentrations at well 0884 are expected as uranium continues to migrate downgradient. As such, samples can be collected at a reduced frequency (e.g., every two years) for all locations except downgradient wells 0594 and 0884 to continue monitoring water quality trends.
- Surface water COC concentrations along the Animas River adjacent to the mill tailings and raffinate ponds areas are consistent with the concentrations at background location 0652. Samples from the ephemeral South Creek location 0588 at the raffinate ponds area are higher in concentrations of selenium and uranium than those from Animas River locations.

4.0 References

40 CFR 192. "Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings," *Code of Federal Regulations.*

Devlin, J.F. and C.D. McElwee, 2007. "Effects of Measurement Error on Horizontal Hydraulic Gradient Estimates," *Groundwater* 45(1):62–73.

DOE (U.S. Department of Energy), 1991. *Remedial Action Plan and Site Design for Stabilization of the Inactive Uranium Mill Tailings Site at Durango, Colorado, UMTRA*, ODE/AL 050503.0000, DOE UMTRA Project Office, Albuquerque Operations Office, Albuquerque, New Mexico, December.

DOE (U.S. Department of Energy), 1995. *Durango, Colorado Final Completion Report*, Contract Number DE-AC04-83AL18796, DOE Albuquerque Operations Office, Albuquerque, New Mexico, August.

DOE (U.S. Department of Energy), 2002. *Site Observational Work Plan for the Durango, Colorado, UMTRA Project Site,* MAC-GW DUR 1.1/GJO-2001-272-TAR, U.S. Department of Energy Grand Junction Office, Grand Junction, Colorado, January.

DOE (U.S. Department of Energy), 2003. *Preliminary Final Ground Water Compliance Action Plan for the Durango, Colorado, UMTRA Project Site*, GJO–2003-463-TAC/GWDUR 1.9, Grand Junction Office, Grand Junction, Colorado, July.

DOE (U.S. Department of Energy), 2008. *Ground Water Compliance Action Plan for the Durango, Colorado, UMTRA Project Site*, U0165200, U.S. Department of Energy, Grand Junction Office, Grand Junction, Colorado, February.

DOE (U.S. Department of Energy), 2011. *Natural Contamination from the Mancos Shale*, LMS/S07480/ESL-RPT-2011-01, Office of Legacy Management, Grand Junction, Colorado, April.

DOE (U.S. Department of Energy), 2014. *Verification Monitoring Report and Analytical Update for the Durango, Colorado, Processing Site*, LMS/DUP S11345, Office of Legacy Management, Grand Junction, Colorado, August.

DOE (U.S. Department of Energy), 2018. *Applied Studies & Technology Variation in Groundwater Aquifers: Results of Phase II Field Investigations and Final Summary Report*, LMS/ESL/S16662, Office of Legacy Management, Grand Junction, Colorado, June.

EPA (U.S. Environmental Protection Agency), 2004. *2004 Edition of the Drinking Water Standards and Health Advisories,* EPA822-R-04-005, Office of Water, Washington, DC.

McKenna, S.A. and A. Wahi, 2006. "Local Hydraulic Gradient Estimator Analysis of Long-Term Monitoring Networks," *Groundwater* 44(5):723–731.

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Appendix A

Groundwater and Surface Water Quality Data for the Durango Processing Site

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Appendix A-1

Groundwater Quality Data For The Mill Tailings Area

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GROUNDWATER QUALITY DATA BY PARAMETER FOR SITE DUR01, Durango Mill Tailings Processing Site
Report Date 1/29/2020

PARAMETER	LOCATION CODE	LOCATION TYPE	SAMPLE DATE	SAMPLE TYPE	QUALIFIERS LAB	QUALIFIERS DATA	DETECTION LIMIT	RESULT	UNIT	QA
Alkalinity, Total (As CaCO3)	0612	WL	5/21/2019	(N)F		F		410	mg/L	#
Alkalinity, Total (As CaCO3)	0617	WL	5/21/2019	(N)F		F		403	mg/L	#
Alkalinity, Total (As CaCO3)	0630	WL	5/21/2019	(N)F		F		350	mg/L	#
Alkalinity, Total (As CaCO3)	0631	WL	5/21/2019	(N)F		F		323	mg/L	#
Alkalinity, Total (As CaCO3)	0633	WL	5/21/2019	(N)F		FQ		339	mg/L	#
Alkalinity, Total (As CaCO3)	0634	WL	5/21/2019	(N)F		FQ		456	mg/L	#
Alkalinity, Total (As CaCO3)	0635	WL	5/21/2019	(N)F		F		426	mg/L	#
Alkalinity, Total (As CaCO3)	0863	WL	5/21/2019	(N)F		F		517	mg/L	#
Cadmium	0612	WL	5/21/2019	(T)F		F	0.000083	0.031	mg/L	#
Cadmium	0863	WL	5/21/2019	(T)F	U	F	0.000083	0.000083	mg/L	#
Manganese	0612	WL	5/21/2019	(T)F		F	0.00036	4	mg/L	#
Manganese	0617	WL	5/21/2019	(T)F		F	0.00036	0.29	mg/L	#
Manganese	0630	WL	5/21/2019	(T)F		F	0.00036	0.34	mg/L	#
Manganese	0631	WL	5/21/2019	(T)D		F	0.00036	0.45	mg/L	#
Manganese	0631	WL	5/21/2019	(T)F		F	0.00036	0.51	mg/L	#
Manganese	0633	WL	5/21/2019	(T)F		FQ	0.00036	0.19	mg/L	#
Manganese	0634	WL	5/21/2019	(T)F		FQ	0.00036	0.055	mg/L	#
Manganese	0635	WL	5/21/2019	(T)F		F	0.00036	0.023	mg/L	#
Manganese	0863	WL	5/21/2019	(T)F		F	0.00036	0.099	mg/L	#
Molybdenum	0612	WL	5/21/2019	(T)F		F	0.000079	0.072	mg/L	#
Molybdenum	0617	WL	5/21/2019	(T)F	J	F	0.000079	0.002	mg/L	#
Molybdenum	0630	WL	5/21/2019	(T)F		F	0.000079	0.0028	mg/L	#
Molybdenum	0631	WL	5/21/2019	(T)D		F	0.000079	0.0054	mg/L	#
Molybdenum	0631	WL	5/21/2019	(T)F		F	0.000079	0.0055	mg/L	#
Molybdenum	0633	WL	5/21/2019	(T)F		FQ	0.000079	0.011	mg/L	#
Molybdenum	0634	WL	5/21/2019	(T)F	J	FQ	0.000079	0.0018	mg/L	#
Molybdenum	0635	WL	5/21/2019	(T)F	J	F	0.000079	0.0017	mg/L	#
Molybdenum	0863	WL	5/21/2019	(T)F	J	FU	0.000079	0.00051	mg/L	#
Oxidation Reduction Potential	0612	WL	5/21/2019	(N)F		F		81	mV	#
Oxidation Reduction Potential	0617	WL	5/21/2019	(N)F		F		5.4	mV	#
Oxidation Reduction Potential	0630	WL	5/21/2019	(N)F		F		49	mV	#
Oxidation Reduction Potential	0631	WL	5/21/2019	(N)F		F		35	mV	#
Oxidation Reduction Potential	0633	WL	5/21/2019	(N)F		FQ		50	mV	#
Oxidation Reduction Potential	0634	WL	5/21/2019	(N)F		FQ		8	mV	#
Oxidation Reduction Potential	0635	WL	5/21/2019	(N)F		F		34	mV	#
Oxidation Reduction Potential	0863	WL	5/21/2019	(N)F		F		59	mV	#
pH	0612	WL	5/21/2019	(N)F		F		6.54	s.u.	#

PARAMETER	LOCATION CODE	LOCATION TYPE	SAMPLE DATE	SAMPLE TYPE	QUALIFIERS LAB	QUALIFIERS DATA	DETECTION LIMIT	RESULT	UNIT	QA
pH	0617	WL	5/21/2019	(N)F		F		6.77	s.u.	#
pH	0630	WL	5/21/2019	(N)F		F		6.62	s.u.	#
pH	0631	WL	5/21/2019	(N)F		F		6.98	s.u.	#
pH	0633	WL	5/21/2019	(N)F		FQ		7.12	s.u.	#
pH	0634	WL	5/21/2019	(N)F		FQ		6.87	s.u.	#
pH	0635	WL	5/21/2019	(N)F		F		6.77	s.u.	#
pH	0863	WL	5/21/2019	(N)F		F		6.85	s.u.	#
Selenium	0612	WL	5/21/2019	(T)F		F	0.00065	0.012	mg/L	#
Selenium	0617	WL	5/21/2019	(T)F		F	0.00065	0.012	mg/L	#
Selenium	0630	WL	5/21/2019	(T)F		F	0.00065	0.035	mg/L	#
Selenium	0631	WL	5/21/2019	(T)D	J	F	0.00065	0.0011	mg/L	#
Selenium	0631	WL	5/21/2019	(T)F	J	F	0.00065	0.0012	mg/L	#
Selenium	0633	WL	5/21/2019	(T)F		FQ	0.00065	0.058	mg/L	#
Selenium	0634	WL	5/21/2019	(T)F		FQ	0.00065	0.059	mg/L	#
Selenium	0635	WL	5/21/2019	(T)F		F	0.00065	0.011	mg/L	#
Selenium	0863	WL	5/21/2019	(T)F	U	F	0.00065	0.00065	mg/L	#
Specific Conductance	0612	WL	5/21/2019	(N)F		F		3822	umhos/cm	#
Specific Conductance	0617	WL	5/21/2019	(N)F		F		2988	umhos/cm	#
Specific Conductance	0630	WL	5/21/2019	(N)F		F		3172	umhos/cm	#
Specific Conductance	0631	WL	5/21/2019	(N)F		F		1398	umhos/cm	#
Specific Conductance	0633	WL	5/21/2019	(N)F		FQ		3730	umhos/cm	#
Specific Conductance	0634	WL	5/21/2019	(N)F		FQ		5493	umhos/cm	#
Specific Conductance	0635	WL	5/21/2019	(N)F		F		3599	umhos/cm	#
Specific Conductance	0863	WL	5/21/2019	(N)F		F		2195	umhos/cm	#
Sulfate	0612	WL	5/21/2019	(N)F		F	6.0	1700	mg/L	#
Sulfate	0617	WL	5/21/2019	(N)F		F	6.0	1500	mg/L	#
Sulfate	0630	WL	5/21/2019	(N)F		F	6.0	1700	mg/L	#
Sulfate	0631	WL	5/21/2019	(N)D		F	3.0	320	mg/L	#
Sulfate	0631	WL	5/21/2019	(N)F		F	3.0	330	mg/L	#
Sulfate	0633	WL	5/21/2019	(N)F		FQ	15	1900	mg/L	#
Sulfate	0634	WL	5/21/2019	(N)F		FQ	15	2900	mg/L	#
Sulfate	0635	WL	5/21/2019	(N)F		F	15	2000	mg/L	#
Sulfate	0863	WL	5/21/2019	(N)F		F	6.0	550	mg/L	#
Temperature	0612	WL	5/21/2019	(N)F		F		12.08	C	#
Temperature	0617	WL	5/21/2019	(N)F		F		12.53	C	#
Temperature	0630	WL	5/21/2019	(N)F		F		12.55	C	#
Temperature	0631	WL	5/21/2019	(N)F		F		9.61	C	#

PARAMETER	LOCATION CODE	LOCATION TYPE	SAMPLE DATE	SAMPLE TYPE	QUALIFIERS LAB	QUALIFIERS DATA	DETECTION LIMIT	RESULT	UNIT	QA
Temperature	0633	WL	5/21/2019	(N)F		FQ		9.77	C	#
Temperature	0634	WL	5/21/2019	(N)F		FQ		9.57	C	#
Temperature	0635	WL	5/21/2019	(N)F		F		7.97	C	#
Temperature	0863	WL	5/21/2019	(N)F		F		12.50	C	#
Turbidity	0612	WL	5/21/2019	(N)F		F		3.10	NTU	#
Turbidity	0617	WL	5/21/2019	(N)F		F		2.81	NTU	#
Turbidity	0630	WL	5/21/2019	(N)F		F		2.76	NTU	#
Turbidity	0631	WL	5/21/2019	(N)F		F		0.94	NTU	#
Turbidity	0633	WL	5/21/2019	(N)F		FQ		4.38	NTU	#
Turbidity	0634	WL	5/21/2019	(N)F		FQ		2.78	NTU	#
Turbidity	0635	WL	5/21/2019	(N)F		F		9.37	NTU	#
Turbidity	0863	WL	5/21/2019	(N)F		F		1.63	NTU	#
Uranium	0612	WL	5/21/2019	(T)F		F	0.000049	1.3	mg/L	#
Uranium	0617	WL	5/21/2019	(T)F		F	0.0000049	0.16	mg/L	#
Uranium	0630	WL	5/21/2019	(T)F		F	0.0000049	0.28	mg/L	#
Uranium	0631	WL	5/21/2019	(T)D		F	0.0000049	0.11	mg/L	#
Uranium	0631	WL	5/21/2019	(T)F		F	0.0000049	0.12	mg/L	#
Uranium	0633	WL	5/21/2019	(T)F		FQ	0.0000049	0.46	mg/L	#
Uranium	0634	WL	5/21/2019	(T)F		FQ	0.0000049	0.12	mg/L	#
Uranium	0635	WL	5/21/2019	(T)F		F	0.0000049	0.016	mg/L	#
Uranium	0863	WL	5/21/2019	(T)F		F	0.0000049	0.00017	mg/L	#

LOCATION TYPE
WL - Well

SAMPLE TYPES:

Fraction:
(T) Total (for metal concentrations)
(D) Dissolved (for dissolved or filtered metal concentrations)
(N) Organic (or other) constituents for which neither total nor dissolved is applicable

Type Codes:
F-Field Sample R-Replicate FR-Field Sample with Replicates
D-Duplicate N-Not Known S-Split Sample

LAB QUALIFIERS:
J Estimated Value.
U Parameter analyzed for but was not detected.

DATA QUALIFIERS:
F Low flow sampling method used.
Q Qualitative result due to sampling technique.
U Parameter analyzed for but was not detected.

QA QUALIFIER:
\# Validated according to Quality Assurance guidelines.

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Appendix A-2

Surface Water Quality Data For The Mill Tailings Area

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SURFACE WATER QUALITY DATA BY PARAMETER FOR SITE DUR01, Durango Mill Tailings Processing Site
Report Date 1/29/2020

PARAMETER	LOCATION CODE	LOCATION TYPE	SAMPLE DATE	SAMPLE TYPE	QUALIFIERS LAB	QUALIFIERS DATA	DETECTION LIMIT	RESULT	UNIT	QA
Alkalinity, Total (As CaCO3)	0584	SL	5/21/2019	(D)F				82	mg/L	#
Alkalinity, Total (As CaCO3)	0586	SL	5/20/2019	(D)F				79	mg/L	#
Alkalinity, Total (As CaCO3)	0652	SL	5/22/2019	(D)F				82	mg/L	#
Alkalinity, Total (As CaCO3)	0691	SL	5/21/2019	(D)F				82	mg/L	#
Cadmium	0584	SL	5/21/2019	(D)F	U		0.000083	0.000083	mg/L	#
Cadmium	0586	SL	5/20/2019	(D)F	U		0.000083	0.000083	mg/L	#
Cadmium	0652	SL	5/22/2019	(D)F	J		0.000083	0.00013	mg/L	#
Cadmium	0691	SL	5/21/2019	(D)F	U		0.000083	0.000083	mg/L	#
Molybdenum	0584	SL	5/21/2019	(D)F	J	U	0.000079	0.00066	mg/L	#
Molybdenum	0586	SL	5/20/2019	(D)F	J	U	0.000079	0.00048	mg/L	#
Molybdenum	0652	SL	5/22/2019	(D)F	J	U	0.000079	0.00053	mg/L	#
Molybdenum	0691	SL	5/21/2019	(D)F	J	U	0.000079	0.00055	mg/L	#
Oxidation Reduction Potential	0584	SL	5/21/2019	(N)F				32	mV	#
Oxidation Reduction Potential	0586	SL	5/20/2019	(N)F				208	mV	#
Oxidation Reduction Potential	0652	SL	5/22/2019	(N)F				-23	mV	#
Oxidation Reduction Potential	0691	SL	5/21/2019	(N)F				53	mV	#
pH	0584	SL	5/21/2019	(N)F				7.76	s.u.	#
pH	0586	SL	5/20/2019	(N)F				7.40	s.u.	#
pH	0652	SL	5/22/2019	(N)F				7.21	s.u.	#
pH	0691	SL	5/21/2019	(N)F				7.90	s.u.	#
Selenium	0584	SL	5/21/2019	(D)F	U		0.00065	0.00065	mg/L	#
Selenium	0586	SL	5/20/2019	(D)F	U		0.00065	0.00065	mg/L	#
Selenium	0652	SL	5/22/2019	(D)F	U		0.00065	0.00065	mg/L	#
Selenium	0691	SL	5/21/2019	(D)F	U		0.00065	0.00065	mg/L	#
Specific Conductance	0584	SL	5/21/2019	(N)F				381	umhos/cm	#
Specific Conductance	0586	SL	5/20/2019	(N)F				275	umhos/cm	#
Specific Conductance	0652	SL	5/22/2019	(N)F				295	umhos/cm	#
Specific Conductance	0691	SL	5/21/2019	(N)F				371	umhos/cm	#
Temperature	0584	SL	5/21/2019	(N)F				8.68	C	#
Temperature	0586	SL	5/20/2019	(N)F				6.11	C	#
Temperature	0652	SL	5/22/2019	(N)F				6.74	C	#
Temperature	0691	SL	5/21/2019	(N)F				7.01	C	#
Turbidity	0584	SL	5/21/2019	(N)F				15.5	NTU	#
Turbidity	0586	SL	5/20/2019	(N)F				24.0	NTU	#

SURFACE WATER QUALITY DATA BY PARAMETER FOR SITE DUR01, Durango Mill Tailings Processing Site
Report Date 1/29/2020

PARAMETER	LOCATION CODE	LOCATION TYPE	SAMPLE DATE	SAMPLE TYPE	QUALIFIERS LAB	DATA	DETECTION LIMIT	RESULT	UNIT	QA
Turbidity	0652	SL	5/22/2019	(N)F				16.6	NTU	#
Turbidity	0691	SL	5/21/2019	(N)F				16.1	NTU	#
Uranium	0584	SL	5/21/2019	(D)F			0.0000049	0.00065	mg/L	#
Uranium	0586	SL	5/20/2019	(D)F			0.0000049	0.00061	mg/L	#
Uranium	0652	SL	5/22/2019	(D)F			0.0000049	0.00067	mg/L	#
Uranium	0691	SL	5/21/2019	(D)F			0.0000049	0.00065	mg/L	#

LOCATION TYPE
SL - Surface Location

SAMPLE TYPES:
Fraction:
(T) Total (for metal concentrations)
(D) Dissolved (for dissolved or filtered metal concentrations)
(N) Organic (or other) constituents for which neither total nor dissolved is applicable
Type Codes:
F-Field Sample R-Replicate FR-Field Sample with Replicates
D-Duplicate N-Not Known S-Split Sample

LAB QUALIFIERS:
J Estimated Value.
U Parameter analyzed for but was not detected.

DATA QUALIFIERS:
U Parameter analyzed for but was not detected.

QA QUALIFIER:
Validated according to Quality Assurance guidelines.

Appendix A-3

Groundwater Quality Data For The Raffinate Ponds Area

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GROUNDWATER QUALITY DATA BY PARAMETER FOR SITE DUR02, Durango Raffinate Pond Processing Site
Report Date 1/29/2020

PARAMETER	LOCATION CODE	LOCATION TYPE	SAMPLE DATE	SAMPLE TYPE	QUALIFIERS LAB	QUALIFIERS DATA	DETECTION LIMIT	RESULT	UNIT	QA
Alkalinity, Total (As CaCO3)	0594	WL	5/21/2019	(N)F		FQ		371	mg/L	#
Alkalinity, Total (As CaCO3)	0598	WL	5/21/2019	(N)F		F		370	mg/L	
Alkalinity, Total (As CaCO3)	0607	WL	5/21/2019	(T)F		FQ		315	mg/L	#
Alkalinity, Total (As CaCO3)	0879	WL	5/21/2019	(T)F				436	mg/L	#
Alkalinity, Total (As CaCO3)	0884	WL	5/20/2019	(T)D		F		312	mg/L	#
Oxidation Reduction Potential	0594	WL	5/21/2019	(T)F		FQ		165	mV	#
Oxidation Reduction Potential	0598	WL	5/21/2019	(T)F		F		125	mV	#
Oxidation Reduction Potential	0607	WL	5/21/2019	(N)F		FQ		160	mV	#
Oxidation Reduction Potential	0879	WL	5/21/2019	(N)F				110	mV	#
Oxidation Reduction Potential	0884	WL	5/20/2019	(N)F		F		222	mV	#
pH	0594	WL	5/21/2019	(D)F		FQ		6.96	s.u.	#
pH	0598	WL	5/21/2019	(N)F		F		6.81	s.u.	#
pH	0607	WL	5/21/2019	(N)F		FQ		7.04	s.u.	#
pH	0879	WL	5/21/2019	(N)F				6.61	s.u.	#
pH	0884	WL	5/20/2019	(N)F		F		7.02	s.u.	#
Selenium	0594	WL	5/21/2019	(N)F	J	FQ	0.00065	0.0032	mg/L	#
Selenium	0598	WL	5/21/2019	(N)F		F	0.00065	0.18	mg/L	#
Selenium	0607	WL	5/21/2019	(T)F		FQ	0.00065	0.42	mg/L	#
Selenium	0879	WL	5/21/2019	(T)F	J		0.00065	0.0016	mg/L	#
Selenium	0884	WL	5/20/2019	(T)F		F	0.00065	0.67	mg/L	#
Selenium	0884	WL	5/20/2019	(T)F		F	0.00065	0.66	mg/L	#
Specific Conductance	0594	WL	5/21/2019	(N)F		FQ		4339	umhos/cm	#
Specific Conductance	0598	WL	5/21/2019	(N)F		F		6307	umhos/cm	#
Specific Conductance	0607	WL	5/21/2019	(D)F		FQ		1693	umhos/cm	#
Specific Conductance	0879	WL	5/21/2019	(N)F				7262	umhos/cm	#
Specific Conductance	0884	WL	5/20/2019	(N)F		F		4570	umhos/cm	#
Temperature	0594	WL	5/21/2019	(D)F		FQ		11.76	C	#
Temperature	0598	WL	5/21/2019	(D)F		F		11.83	C	#
Temperature	0607	WL	5/21/2019	(D)F		FQ		11.91	C	#
Temperature	0879	WL	5/21/2019	(D)F				12.85	C	#
Temperature	0884	WL	5/20/2019	(D)F		F		12.54	C	#
Turbidity	0594	WL	5/21/2019	(N)F		FQ		70.1	NTU	
Turbidity	0598	WL	5/21/2019	(N)F		F		20.3	NTU	
Turbidity	0607	WL	5/21/2019	(N)F		FQ		2.36	NTU	

GROUNDWATER QUALITY DATA BY PARAMETER FOR SITE DUR02, Durango Raffinate Pond Processing Site
Report Date 1/29/2020

PARAMETER	LOCATION CODE	LOCATION TYPE	SAMPLE DATE	SAMPLE TYPE	QUALIFIERS LAB	QUALIFIERS DATA	DETECTION LIMIT	RESULT	UNIT	QA
Turbidity	0879	WL	5/21/2019	(N)F				1.91	NTU	#
Turbidity	0884	WL	5/20/2019	(N)F		F		0.95	NTU	#
Uranium	0594	WL	5/21/2019	(N)F		FQ	0.0000049	0.12	mg/L	#
Uranium	0598	WL	5/21/2019	(T)F		F	0.0000049	0.096	mg/L	#
Uranium	0607	WL	5/21/2019	(T)F		FQ	0.0000049	0.0026	mg/L	#
Uranium	0879	WL	5/21/2019	(T)F			0.0000049	0.058	mg/L	#
Uranium	0884	WL	5/20/2019	(T)F		F	0.0000049	0.2	mg/L	#
Uranium	0884	WL	5/20/2019	(T)F		F	0.0000049	0.2	mg/L	#

LOCATION TYPE
WL - Well

SAMPLE TYPES:

Fraction:
(T) Total (for metal concentrations)
(D) Dissolved (for dissolved or filtered metal concentrations)
(N) Organic (or other) constituents for which neither total nor dissolved is applicable

Type Codes:
F-Field Sample R-Replicate FR-Field Sample with Replicates
D-Duplicate N-Not Known S-Split Sample

LAB QUALIFIERS:
J Estimated Value.

DATA QUALIFIERS:
F Low flow sampling method used.
Q Qualitative result due to sampling technique.

QA QUALIFIER:
Validated according to Quality Assurance guidelines.

Appendix A-4

Surface Water Quality Data For The Raffinate Ponds Area

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SURFACE WATER QUALITY DATA BY PARAMETER FOR SITE DUR02, Durango Raffinate Pond Processing Site
Report Date 1/29/2020

PARAMETER	LOCATION CODE	LOCATION TYPE	SAMPLE DATE	SAMPLE TYPE	QUALIFIERS LAB	DATA	DETECTION LIMIT	RESULT	UNIT	QA
Alkalinity, Total (As CaCO3)	0588	SL	5/2/2019	(N)F				267	mg/L	#
Alkalinity, Total (As CaCO3)	0588	SL	5/21/2019	(N)F				245	mg/L	#
Alkalinity, Total (As CaCO3)	0588	SL	6/26/2019	(N)F				321	mg/L	#
Alkalinity, Total (As CaCO3)	0588	SL	6/27/2019	(N)F				321	mg/L	#
Alkalinity, Total (As CaCO3)	0588	SL	7/23/2019	(N)F				480	mg/L	#
Alkalinity, Total (As CaCO3)	0654	SL	5/20/2019	(T)F				78	mg/L	#
Alkalinity, Total (As CaCO3)	0678	SL	5/20/2019	(T)F				77	mg/L	#
Cadmium	0588	SL	5/21/2019	(T)D	J		0.000083	0.00014	mg/L	#
Cadmium	0654	SL	5/20/2019	(N)F	U		0.000083	0.000083	mg/L	#
Cadmium	0678	SL	5/20/2019	(N)F	U		0.000083	0.000083	mg/L	#
Dissolved Oxygen	0588	SL	6/26/2019	(N)F				10.36	mg/L	#
Molybdenum	0588	SL	5/2/2019	(N)F	J		0.000079	0.0013	mg/L	#
Molybdenum	0588	SL	5/21/2019	(N)F	J		0.000079	0.0012	mg/L	#
Molybdenum	0588	SL	6/27/2019	(D)F	J		0.000079	0.0014	mg/L	#
Molybdenum	0588	SL	7/23/2019	(N)F	J		0.000079	0.0016	mg/L	#
Molybdenum	0654	SL	5/20/2019	(N)F	J		0.000079	0.00051	mg/L	#
Molybdenum	0678	SL	5/20/2019	(N)F	J		0.000079	0.00055	mg/L	#
Oxidation Reduction Potential	0588	SL	5/2/2019	(N)F				106	mV	#
Oxidation Reduction Potential	0588	SL	5/21/2019	(N)F				166	mV	#
Oxidation Reduction Potential	0588	SL	6/26/2019	(N)F				140.8	mV	#
Oxidation Reduction Potential	0588	SL	6/27/2019	(D)F				140.8	mV	#
Oxidation Reduction Potential	0588	SL	7/23/2019	(D)F				218.7	mV	#
Oxidation Reduction Potential	0654	SL	5/20/2019	(N)F				198	mV	#
Oxidation Reduction Potential	0678	SL	5/20/2019	(N)F				192	mV	#
Percent Dissolved Oxygen	0588	SL	6/26/2019	(N)F				107.4	%	#
pH	0588	SL	5/2/2019	(N)F				7.90	s.u.	#
pH	0588	SL	5/21/2019	(N)F				8.18	s.u.	#
pH	0588	SL	6/26/2019	(N)F				7.88	s.u.	#
pH	0588	SL	6/27/2019	(N)F				7.88	s.u.	#
pH	0588	SL	7/23/2019	(N)F				6.55	s.u.	#
pH	0654	SL	5/20/2019	(N)F				7.93	s.u.	#
pH	0678	SL	5/20/2019	(N)F				7.26	s.u.	#
Selenium	0588	SL	5/2/2019	(N)F	J		0.00065	0.00096	mg/L	#

SURFACE WATER QUALITY DATA BY PARAMETER FOR SITE DUR02, Durango Raffinate Pond Processing Site
Report Date 1/29/2020

PARAMETER	LOCATION CODE	LOCATION TYPE	SAMPLE DATE	SAMPLE TYPE	QUALIFIERS LAB	DATA	DETECTION LIMIT	RESULT	UNIT	QA
Selenium	0588	SL	5/21/2019	(N)F	J		0.00065	0.00083	mg/L	#
Selenium	0588	SL	6/27/2019	(N)F	J		0.00065	0.00084	mg/L	#
Selenium	0588	SL	7/23/2019	(N)F	U		0.00065	0.00065	mg/L	#
Selenium	0654	SL	5/20/2019	(T)F	U		0.00065	0.00065	mg/L	#
Selenium	0678	SL	5/20/2019	(T)F	U		0.00065	0.00065	mg/L	#
Specific Conductance	0588	SL	5/2/2019	(T)F				1054	umhos/cm	#
Specific Conductance	0588	SL	5/21/2019	(T)F				1262	umhos/cm	#
Specific Conductance	0588	SL	6/26/2019	(N)F				1413	umhos/cm	#
Specific Conductance	0588	SL	6/27/2019	(N)F				1413	umhos/cm	#
Specific Conductance	0588	SL	7/23/2019	(N)F				1799	umhos/cm	#
Specific Conductance	0654	SL	5/20/2019	(N)F				281	umhos/cm	#
Specific Conductance	0678	SL	5/20/2019	(N)F				280	umhos/cm	#
Temperature	0588	SL	5/2/2019	(N)F				16.40	C	#
Temperature	0588	SL	5/21/2019	(D)F				8.38	C	#
Temperature	0588	SL	6/26/2019	(N)F				16.90	C	
Temperature	0588	SL	6/27/2019	(D)F				16.90	C	#
Temperature	0588	SL	7/23/2019	(D)F				19.99	C	#
Temperature	0654	SL	5/20/2019	(D)F				6.30	C	#
Temperature	0678	SL	5/20/2019	(D)F				6.34	C	#
Turbidity	0588	SL	5/2/2019	(D)F				1.31	NTU	#
Turbidity	0588	SL	5/21/2019	(N)F				1.70	NTU	
Turbidity	0588	SL	6/26/2019	(N)F				2.90	NTU	
Turbidity	0588	SL	6/27/2019	(N)F				2.90	NTU	
Turbidity	0588	SL	7/23/2019	(N)F				8.28	NTU	
Turbidity	0654	SL	5/20/2019	(N)F				18.1	NTU	
Turbidity	0678	SL	5/20/2019	(N)F				21.3	NTU	#
Uranium	0588	SL	5/2/2019	(N)F			0.0002	0.018	mg/L	#
Uranium	0588	SL	5/2/2019	(N)F			0.0000049	0.017	mg/L	#
Uranium	0588	SL	5/21/2019	(N)F			0.0000049	0.017	mg/L	#
Uranium	0588	SL	5/21/2019	(N)F			0.0002	0.018	mg/L	#
Uranium	0588	SL	6/26/2019	(N)F			0.0002	0.031	mg/L	#
Uranium	0588	SL	6/27/2019	(N)F			0.0000049	0.03	mg/L	#
Uranium	0588	SL	7/23/2019	(N)F			0.0000049	0.038	mg/L	#

SURFACE WATER QUALITY DATA BY PARAMETER FOR SITE DUR02, Durango Raffinate Pond Processing Site
Report Date 1/29/2020

PARAMETER	LOCATION CODE	LOCATION TYPE	SAMPLE DATE	SAMPLE TYPE	QUALIFIERS LAB	DATA	DETECTION LIMIT	RESULT	UNIT	QA
Uranium	0588	SL	7/23/2019	(N)F			0.0002	0.040	mg/L	#
Uranium	0654	SL	5/20/2019	(T)F			0.0000049	0.00074	mg/L	#
Uranium	0678	SL	5/20/2019	(T)F			0.0000049	0.00058	mg/L	#
Vanadium	0588	SL	5/2/2019	(T)F	J		0.00012	0.00075	mg/L	#
Vanadium	0588	SL	6/27/2019	(T)F	J		0.00012	0.00057	mg/L	
Vanadium	0588	SL	7/23/2019	(T)F	J		0.00012	0.0012	mg/L	

LOCATION TYPE
SL - Surface Location

SAMPLE TYPES:
Fraction:
(T) Total (for metal concentrations)
(D) Dissolved (for dissolved or filtered metal concentrations)
(N) Organic (or other) constituents for which neither total nor dissolved is applicable
Type Codes:
F-Field Sample R-Replicate FR-Field Sample with Replicates
D-Duplicate N-Not Known S-Split Sample

LAB QUALIFIERS:
J Estimated Value.
U Parameter analyzed for but was not detected.

QA QUALIFIER:
Validated according to Quality Assurance guidelines.

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Appendix B

Three-Point Estimator Results

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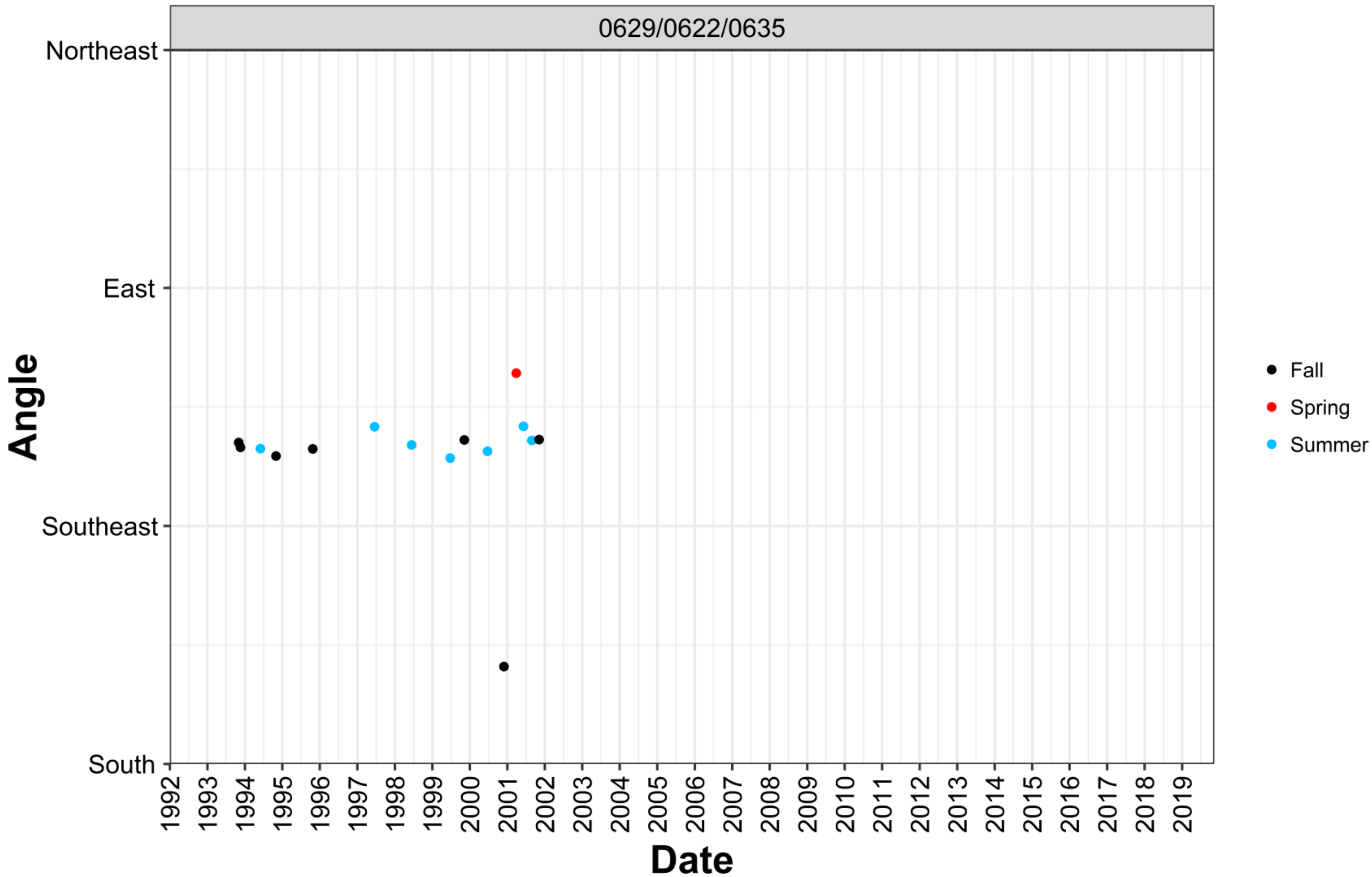

Figure B-1: DUR01 Direction of groundwater flow versus time for wells 0629, 0622, 0635.

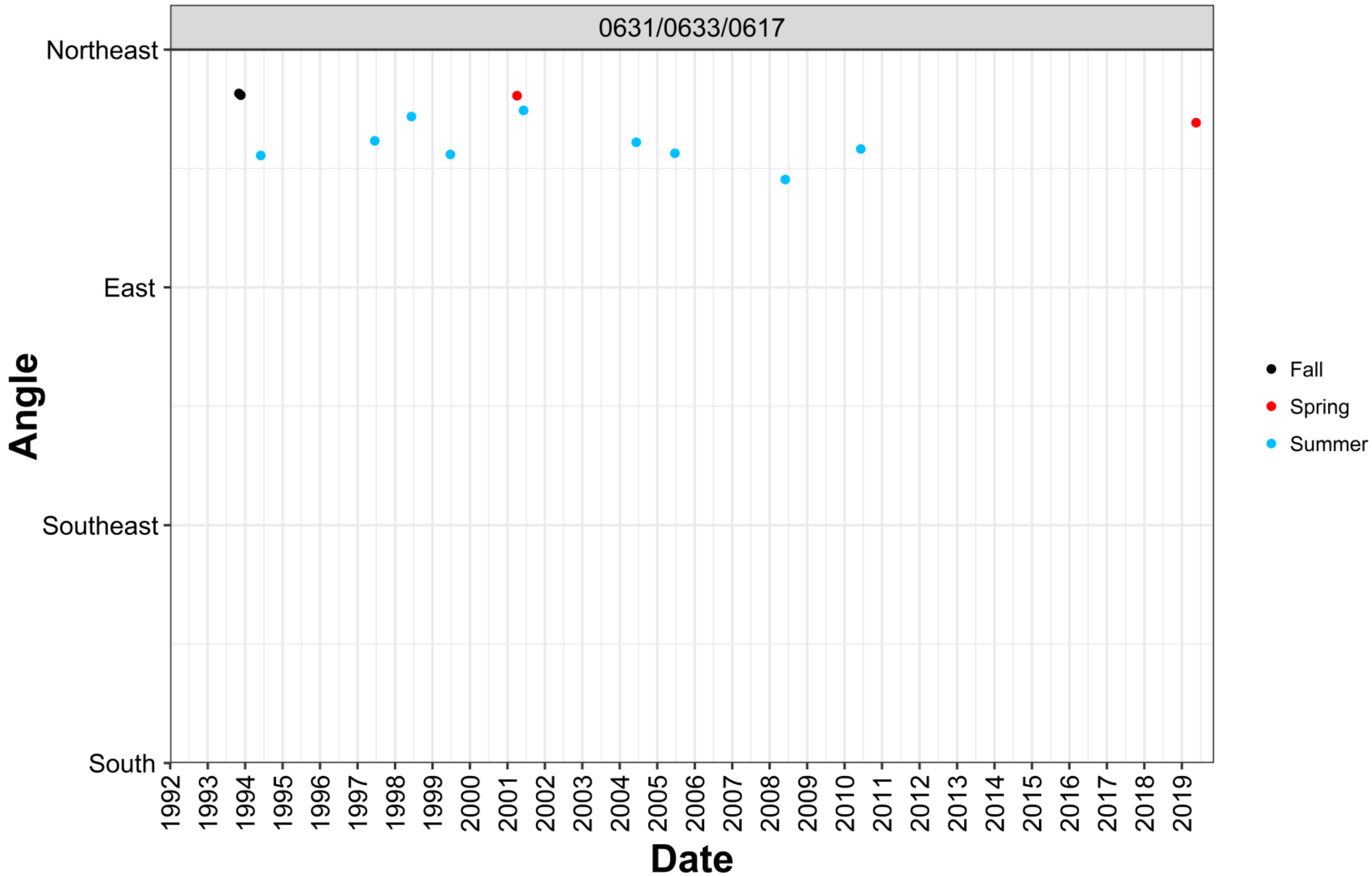

Figure B-2: DUR01 Direction of groundwater flow versus time for wells 0631, 0633 0617.

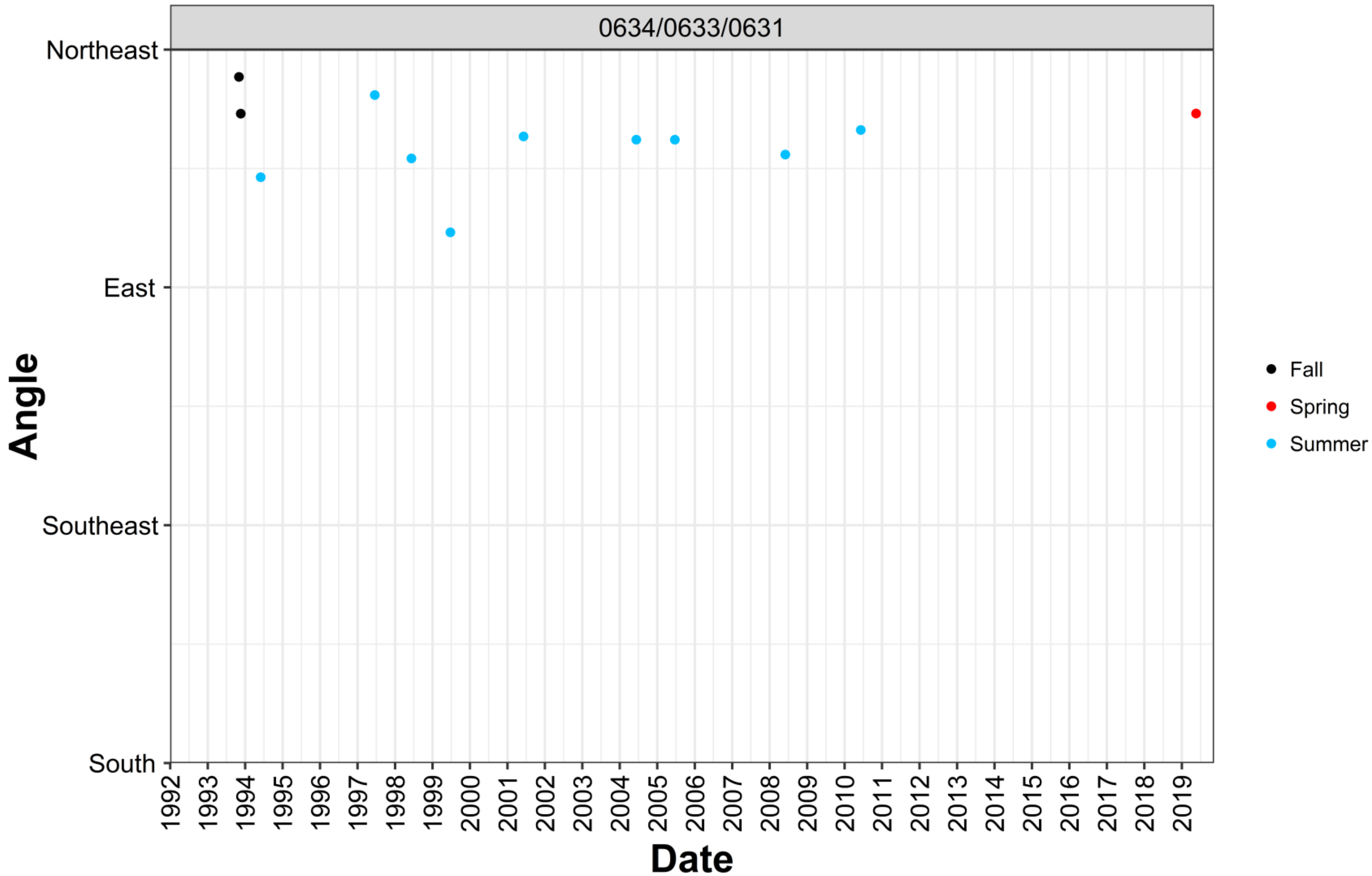

Figure B-3: DUR01 Direction of groundwater flow versus time for wells 0634, 0633, 0631.

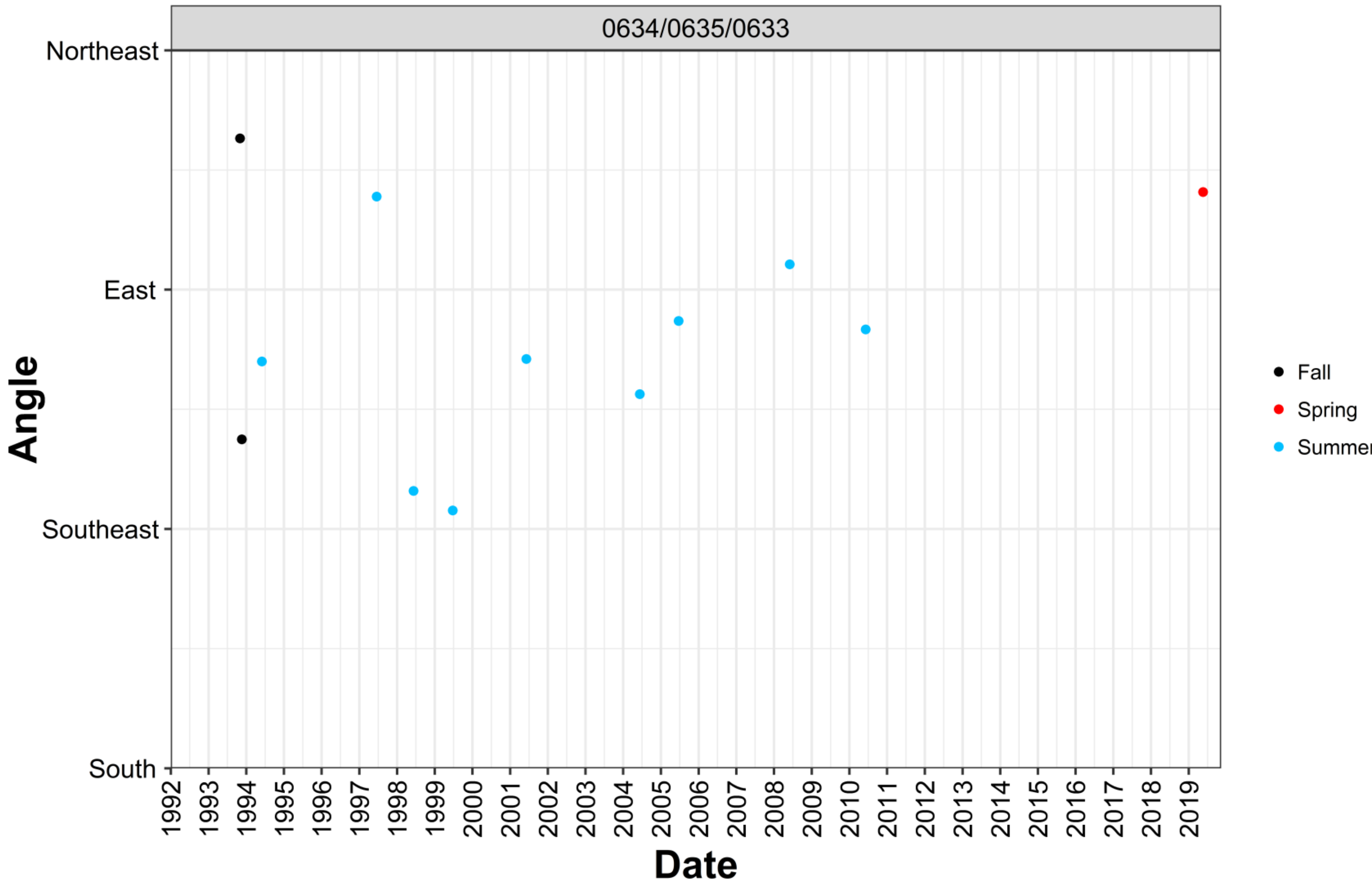

Figure B-4: DUR01 Direction of groundwater flow versus time for wells 0634, 0635, 0633.

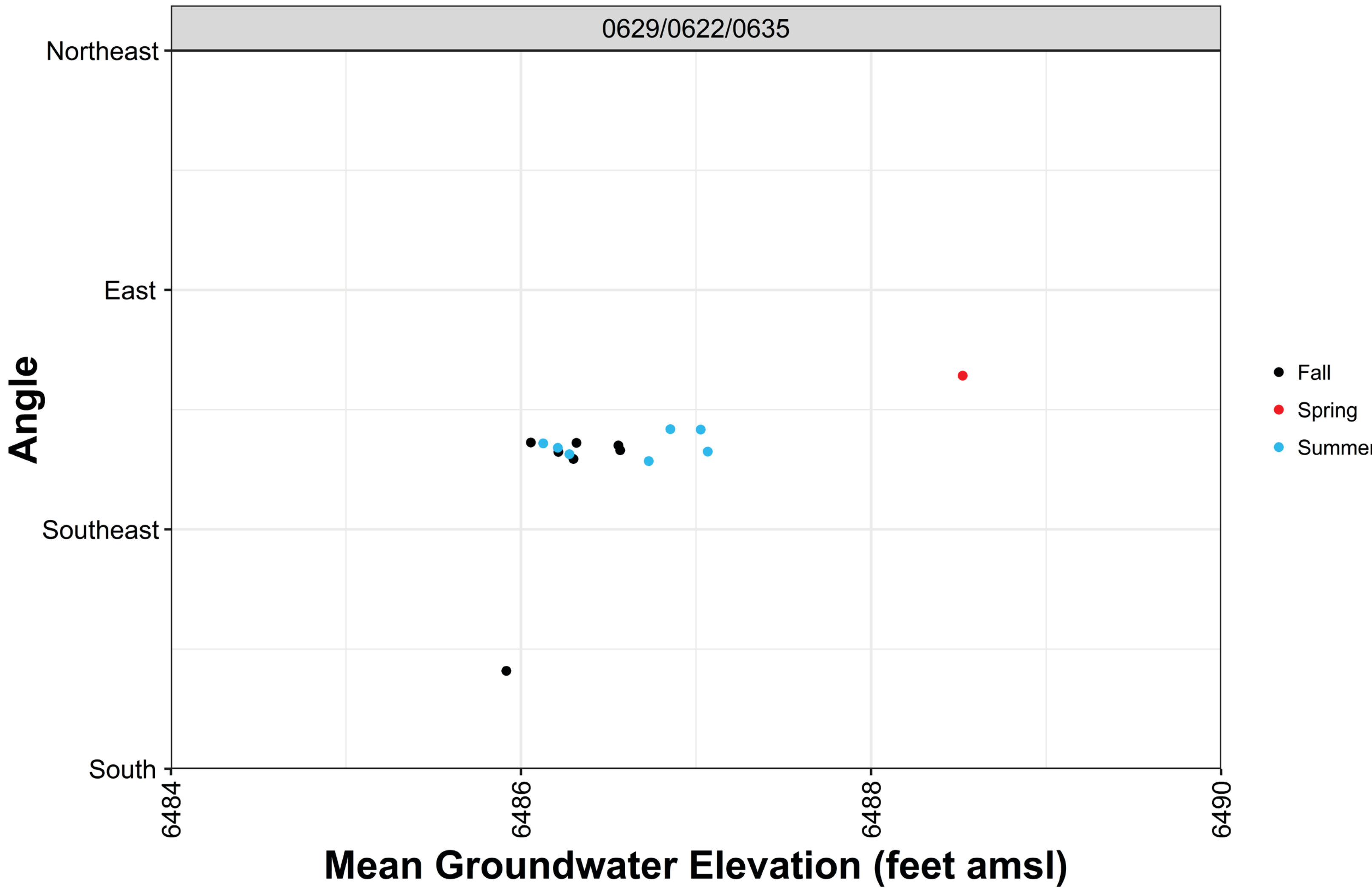

Figure B-5: DUR01 Direction of groundwater flow versus mean groundwater elevation for wells 0629, 0622, 0635.

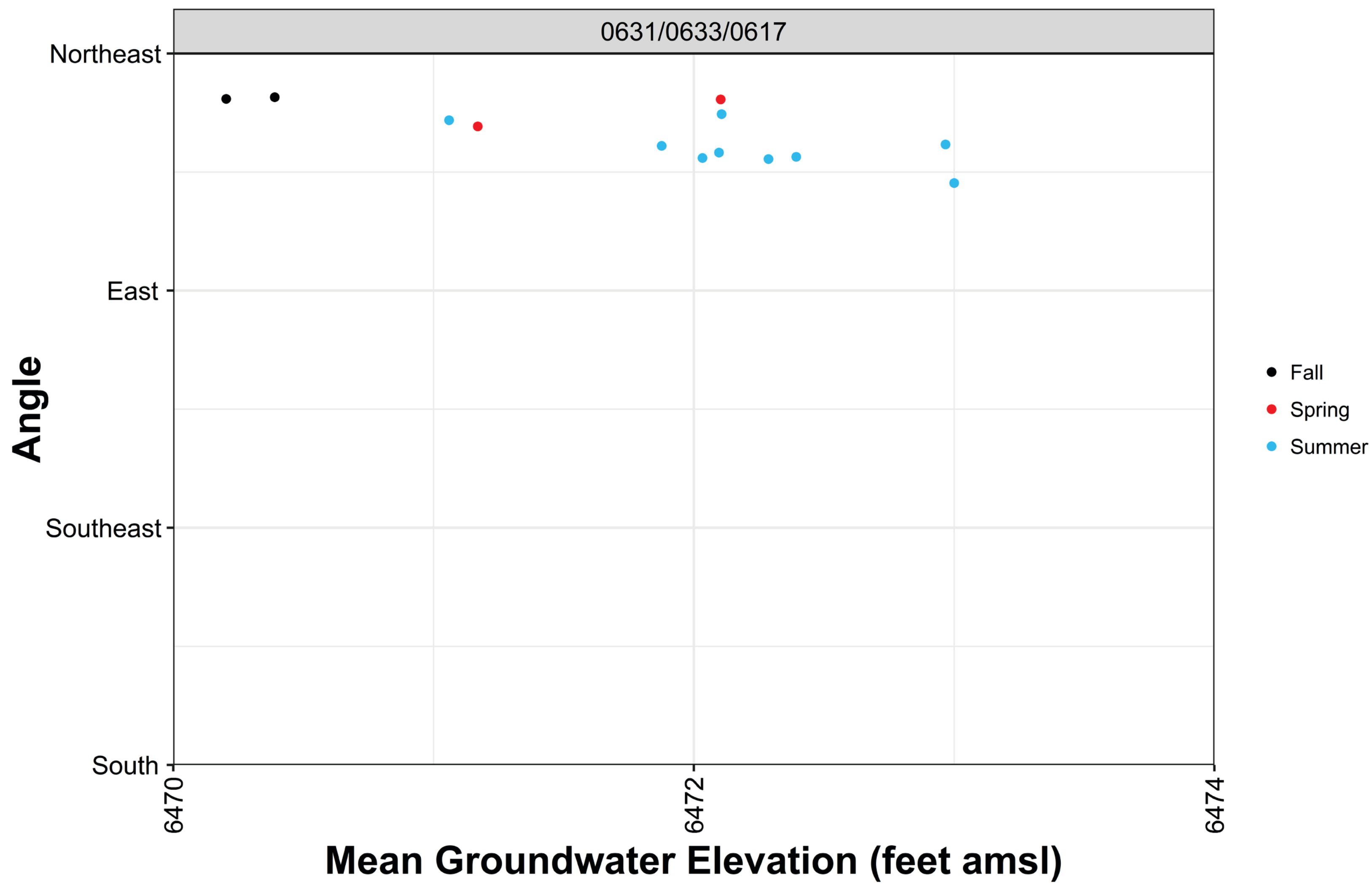

Figure B-6: DUR01 Direction of groundwater flow versus mean groundwater elevation for wells 0631, 0633, 0617.

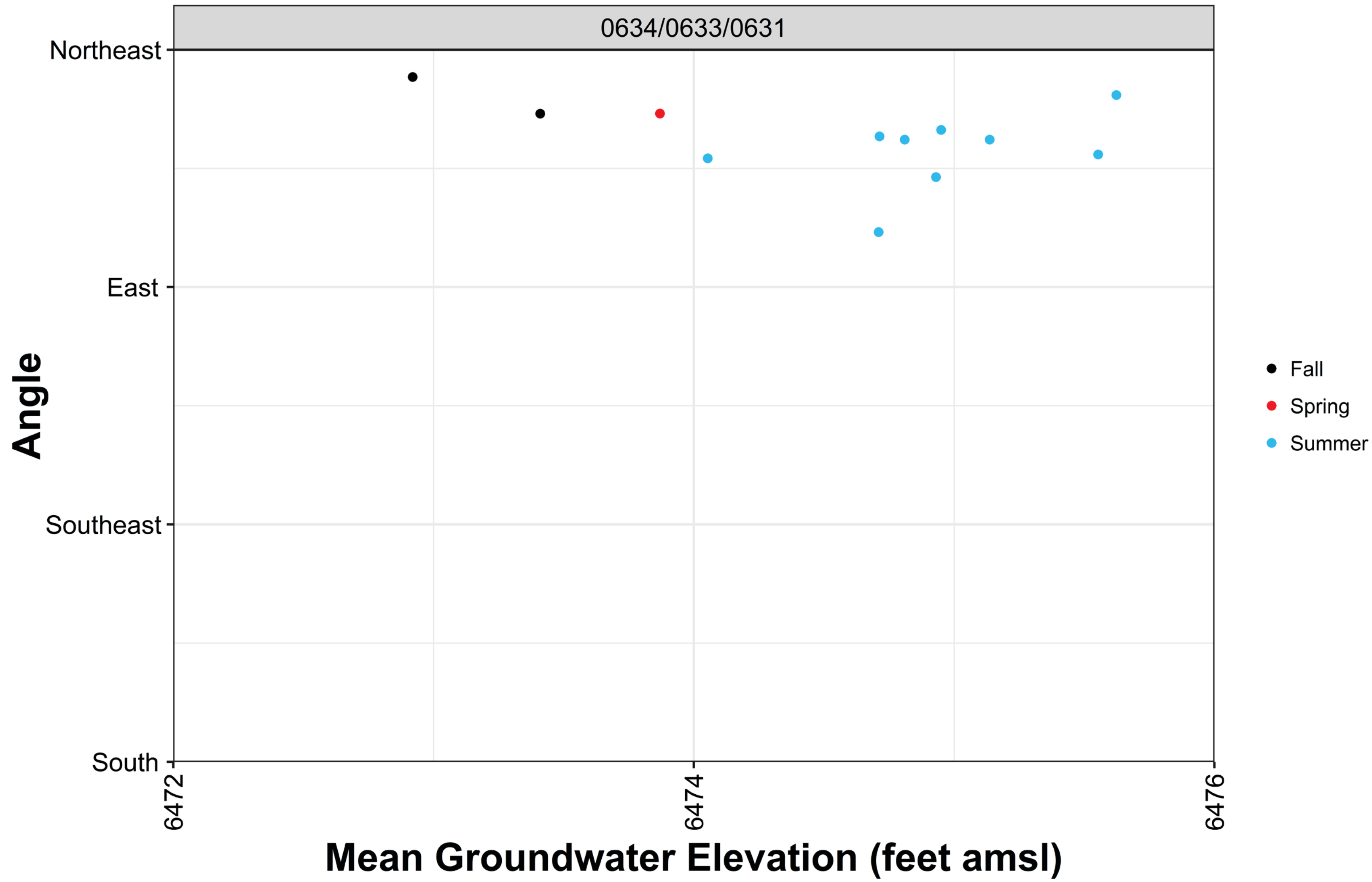

Figure B-7: DUR01 Direction of groundwater flow versus mean groundwater elevation for wells 0634, 0633, 0631.

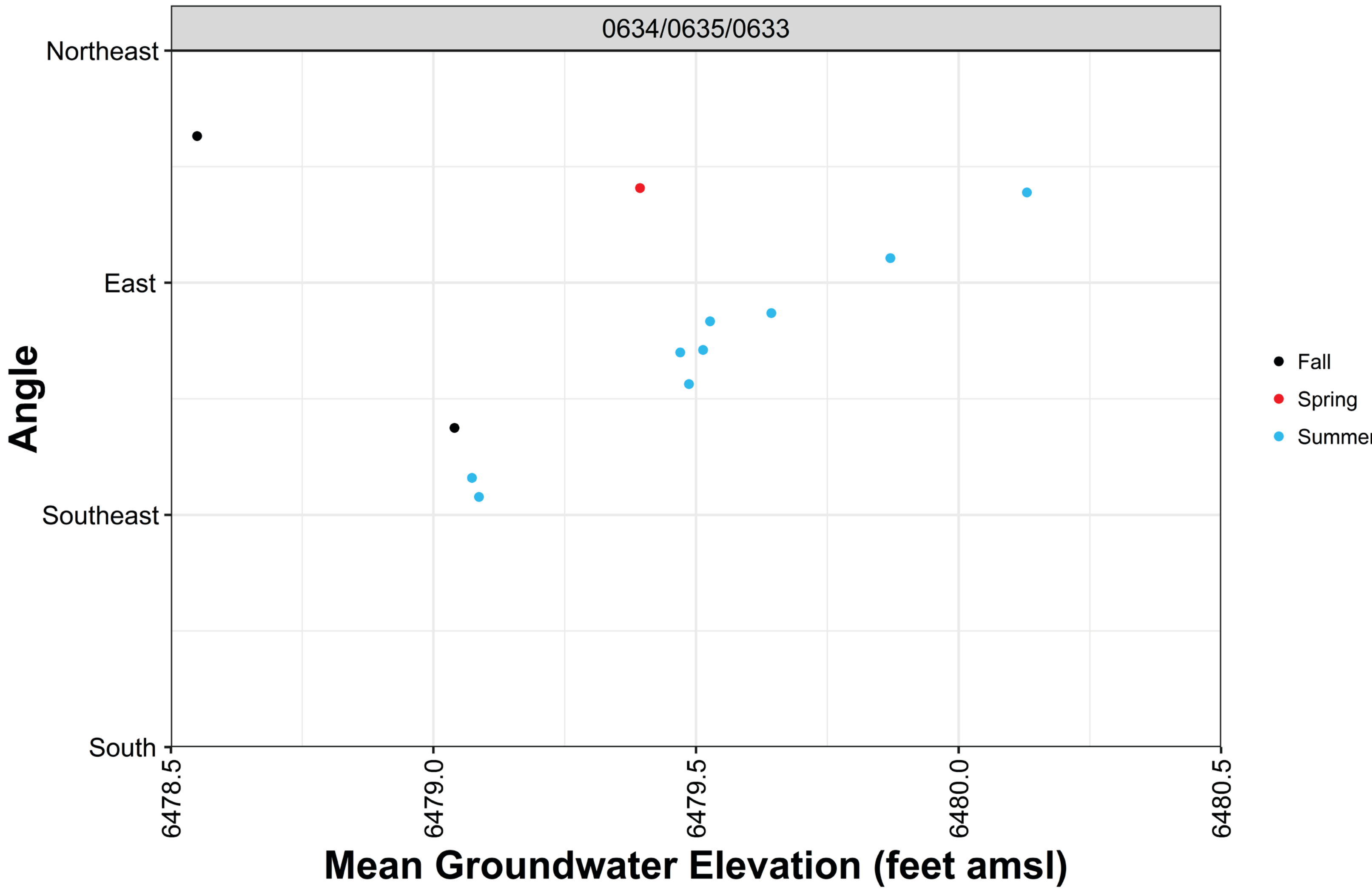

Figure B-8: DUR01 Direction of groundwater flow versus mean groundwater elevation for wells 0634, 0635, 0633.

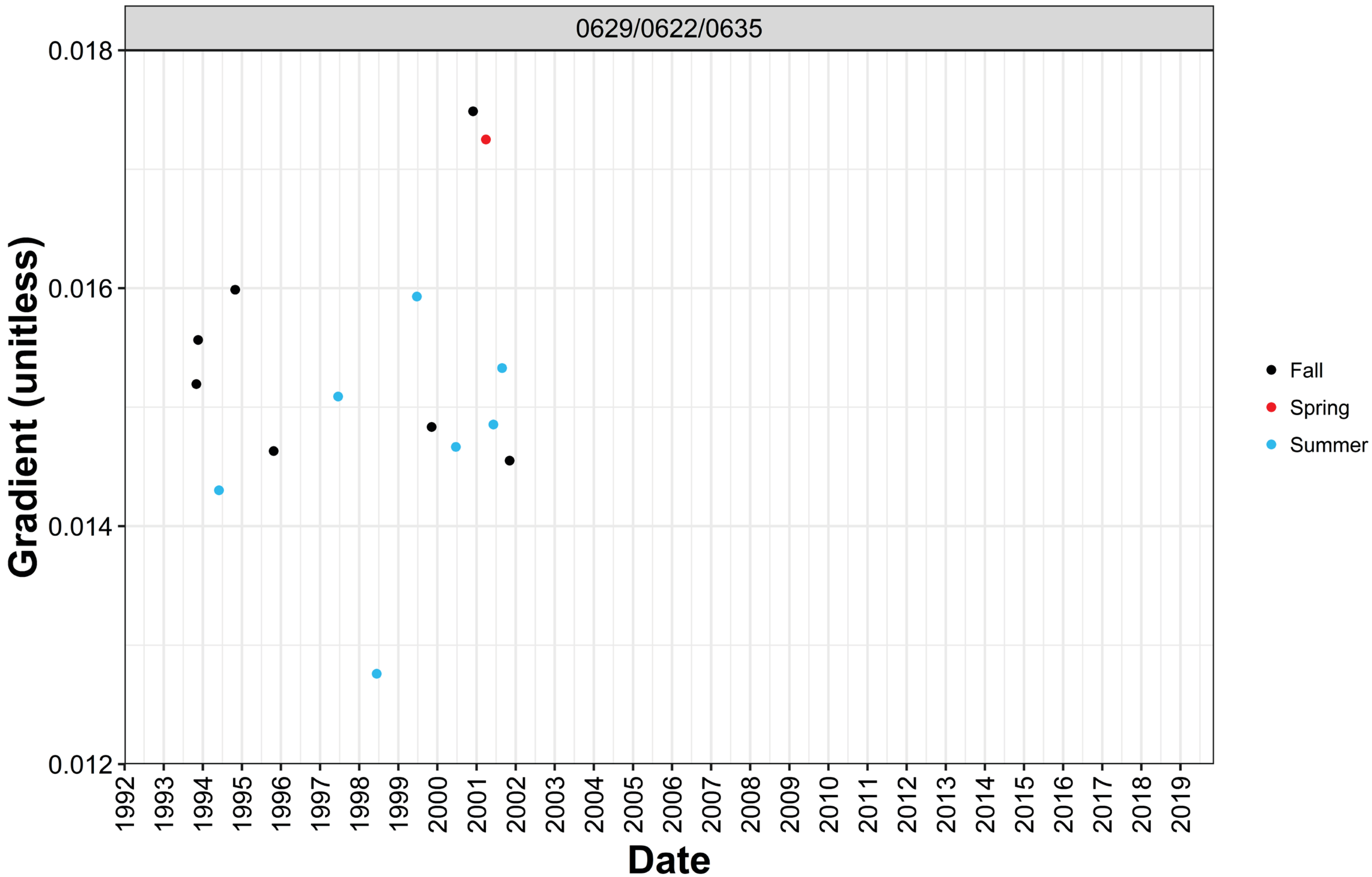

Figure B-9: DUR01 Hydraulic gradient versus time for wells 0629, 0622, 0635.

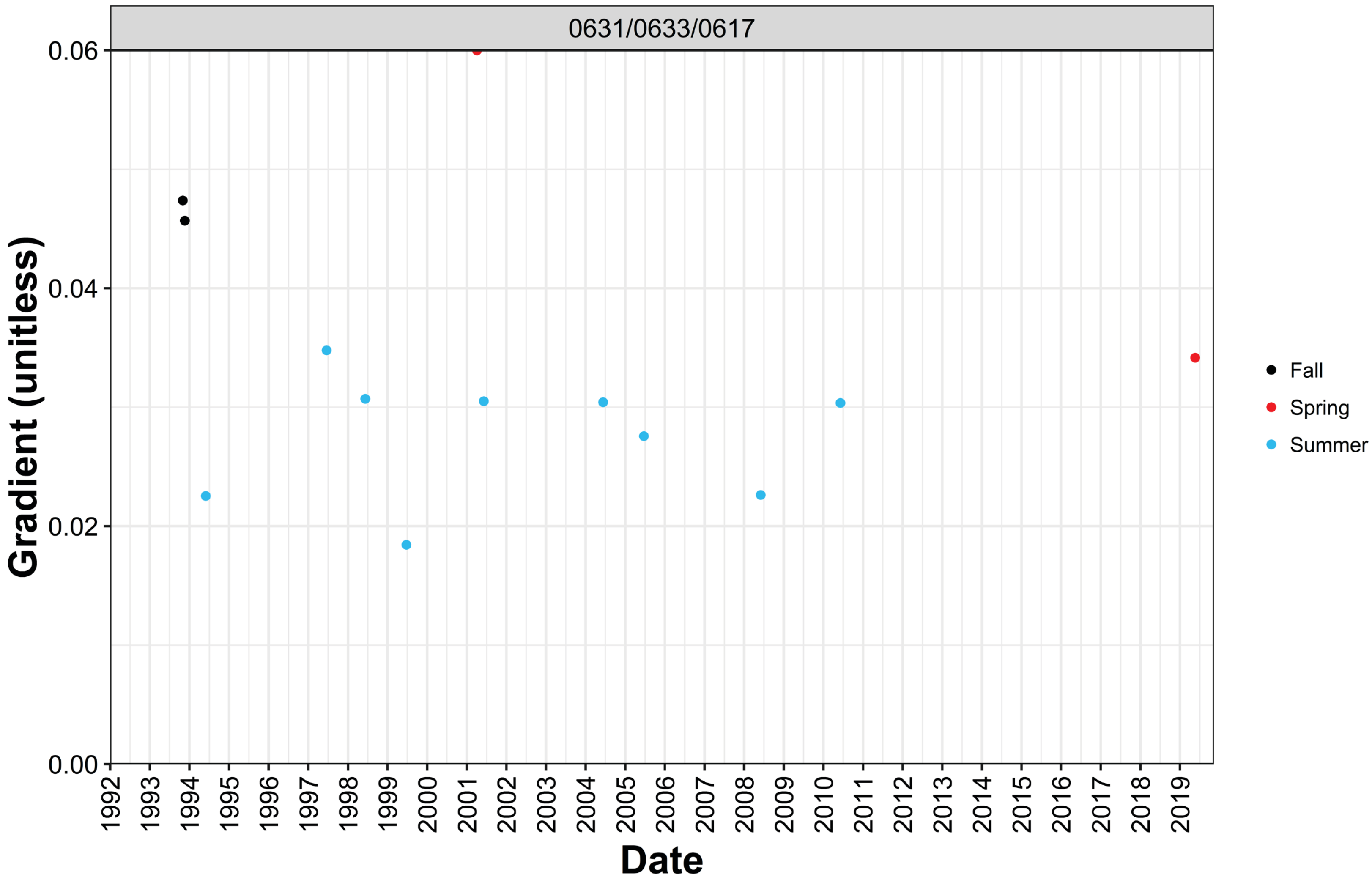

Figure B-10: DUR01 Hydraulic gradient versus time for wells 0631, 0633, 0617.

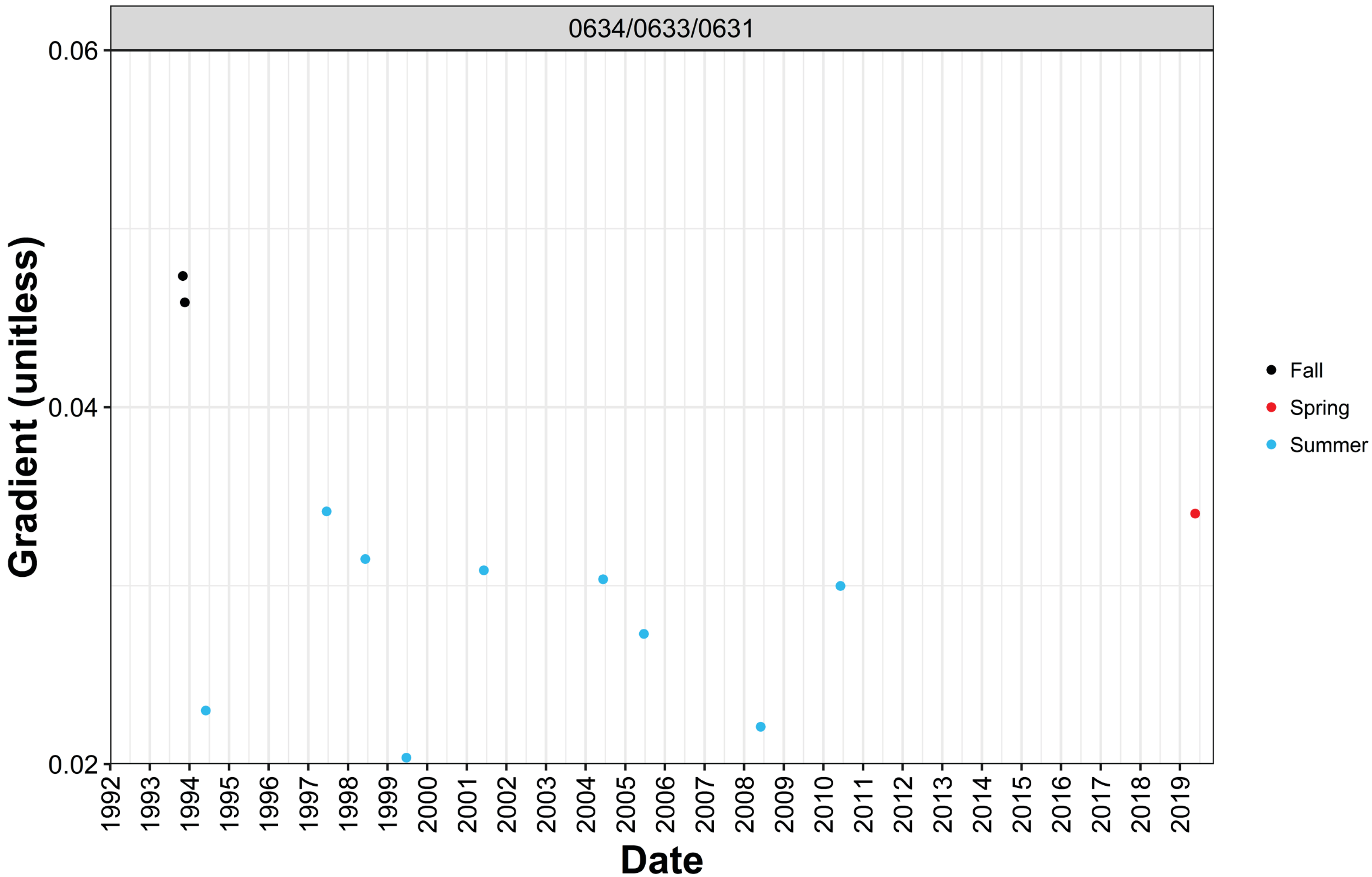

Figure B-11: DUR01 Hydraulic gradient versus time for wells 0634, 0633, 0631.

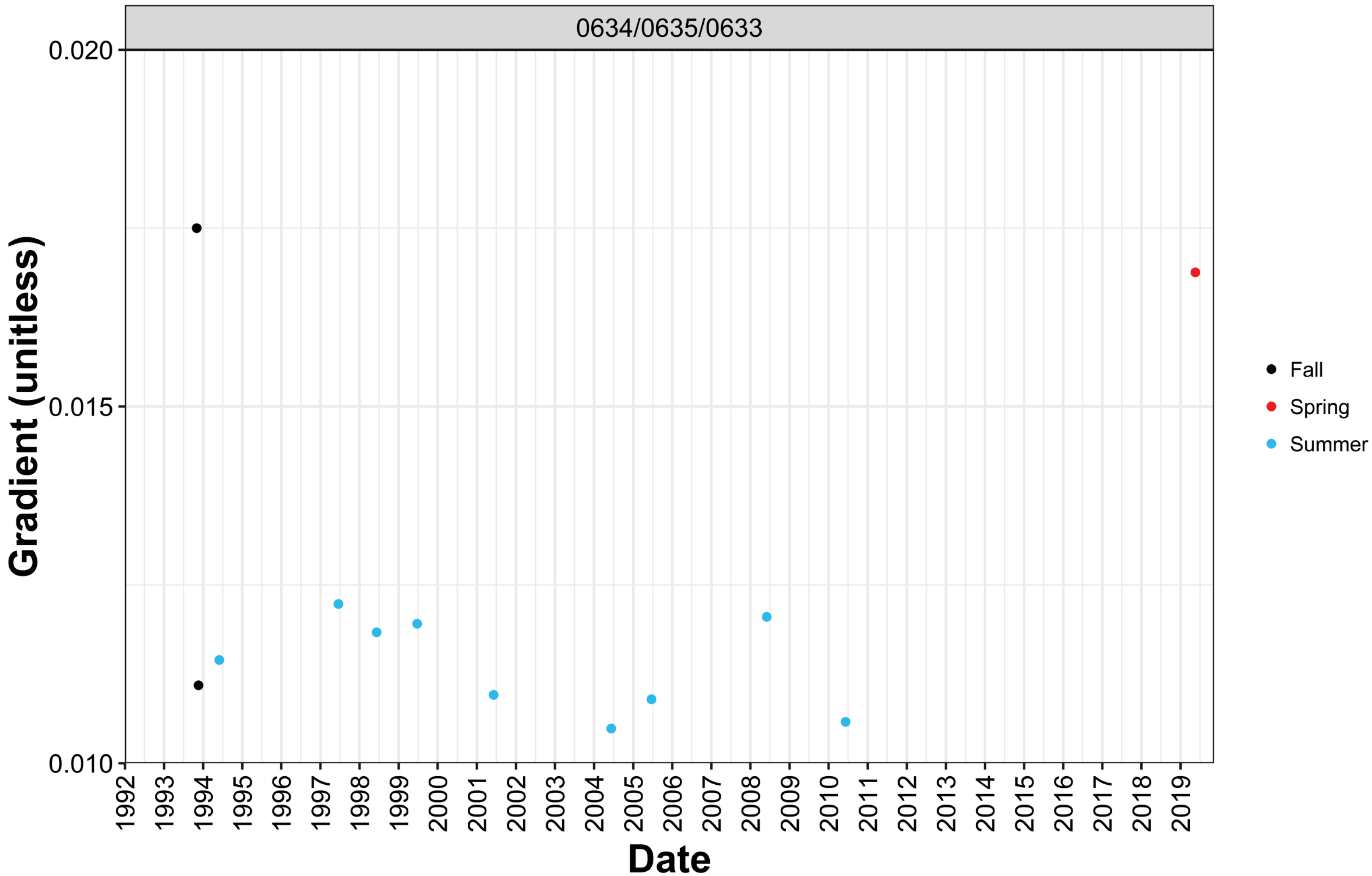

Figure B-12: DUR01 Hydraulic gradient versus time for wells 0634, 0635, 0633.

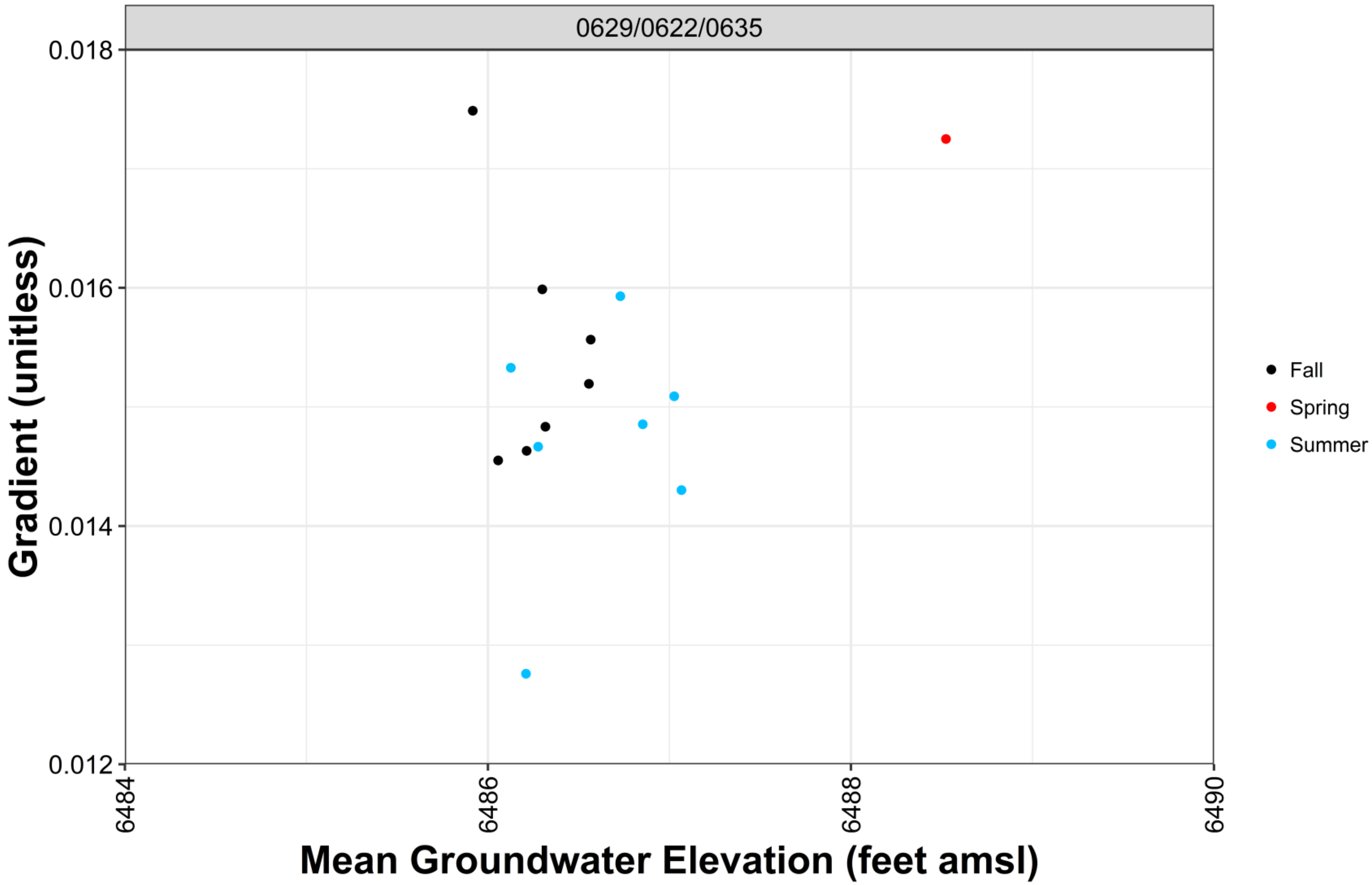

Figure B-13: DUR01 Direction of hydraulic gradient versus water level for wells 0629, 0622, 0635.

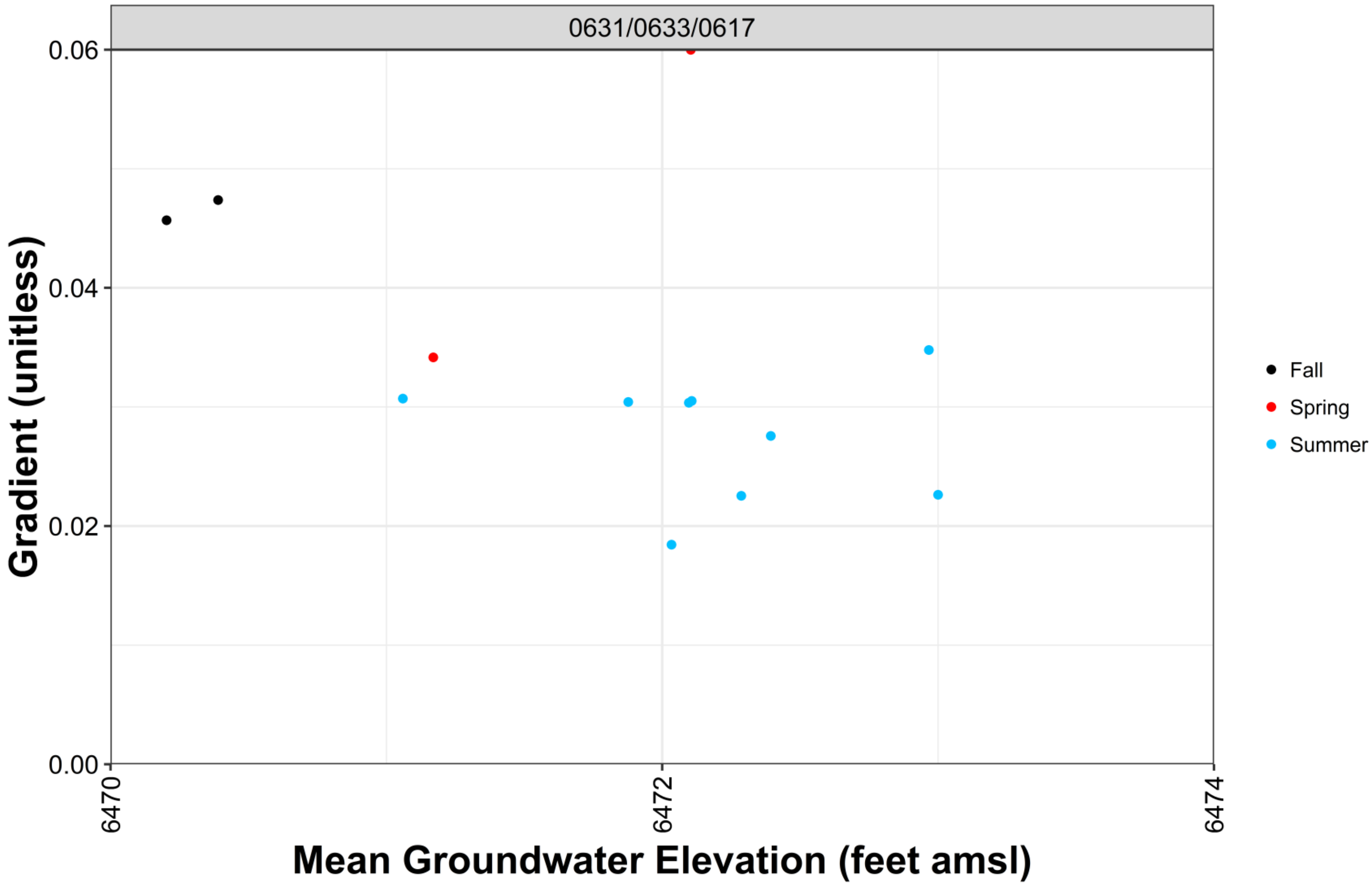

Figure B-14: DUR01 Direction of hydraulic gradient versus water level for wells 0631, 0633, 0617.

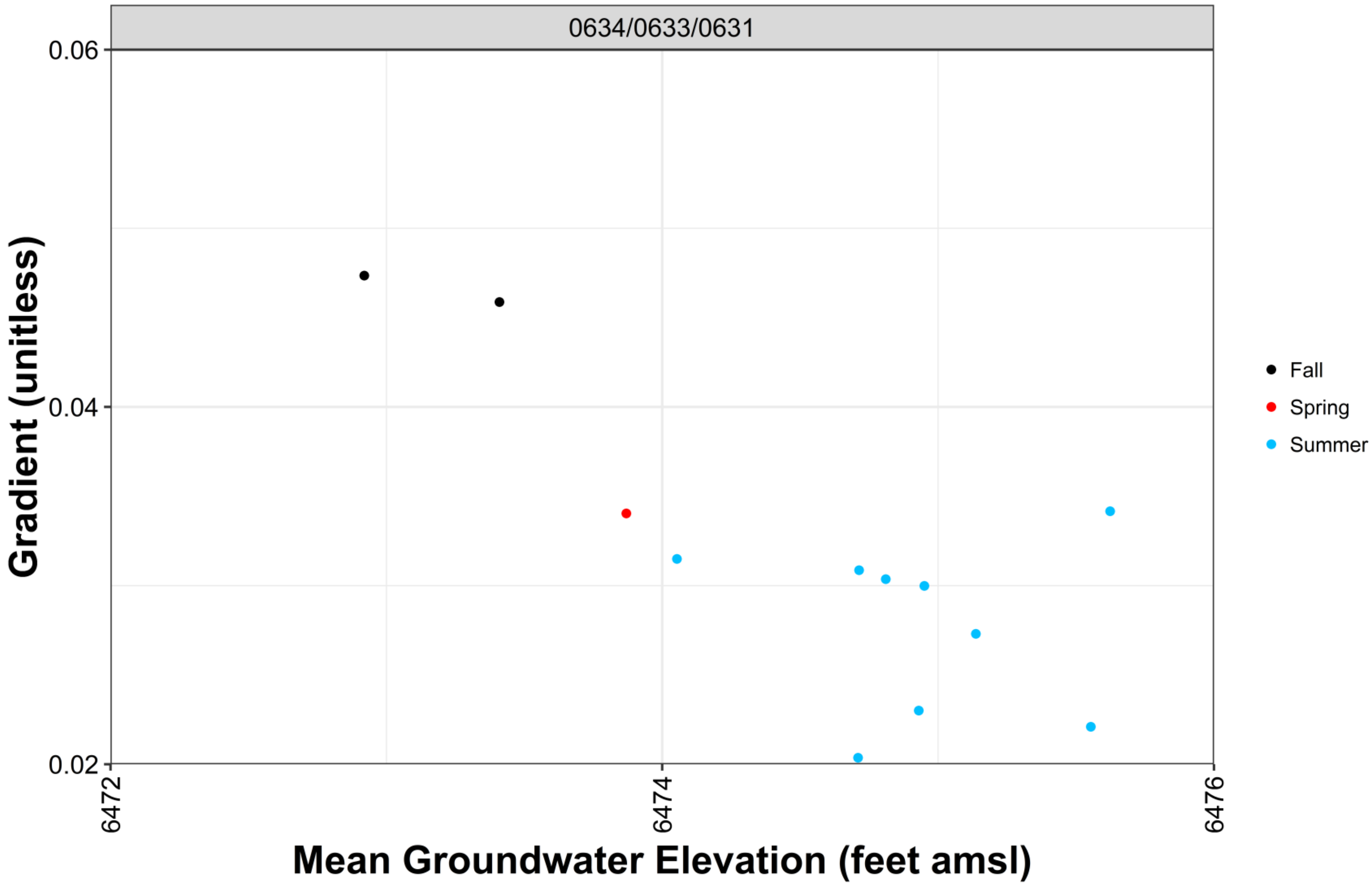

Figure B-15: DUR01 Direction of hydraulic gradient versus water level for wells 0634, 0633, 0631.

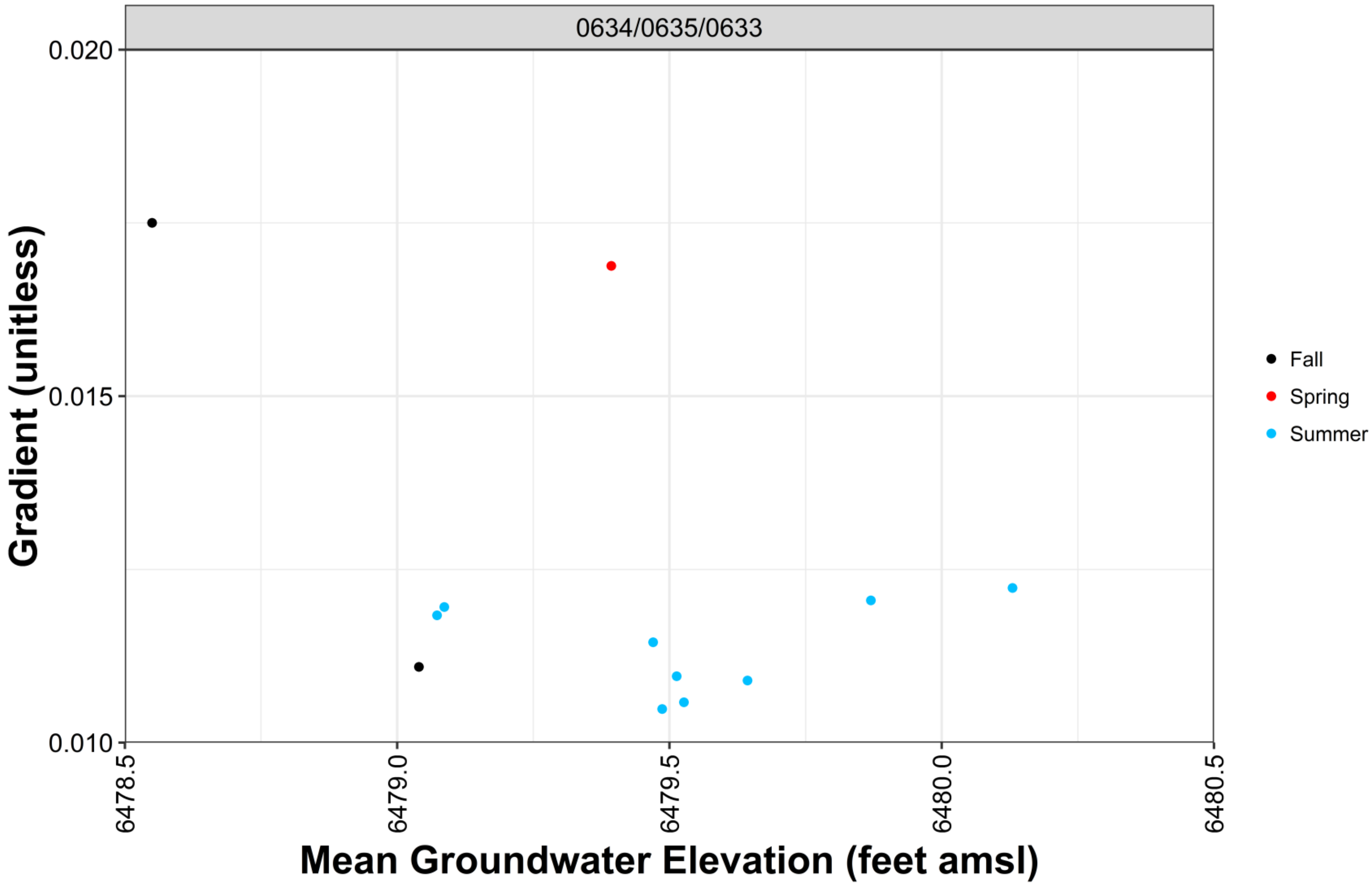

Figure B-16: DUR01 Direction of hydraulic gradient versus water level for wells 0634, 0635, 0633.

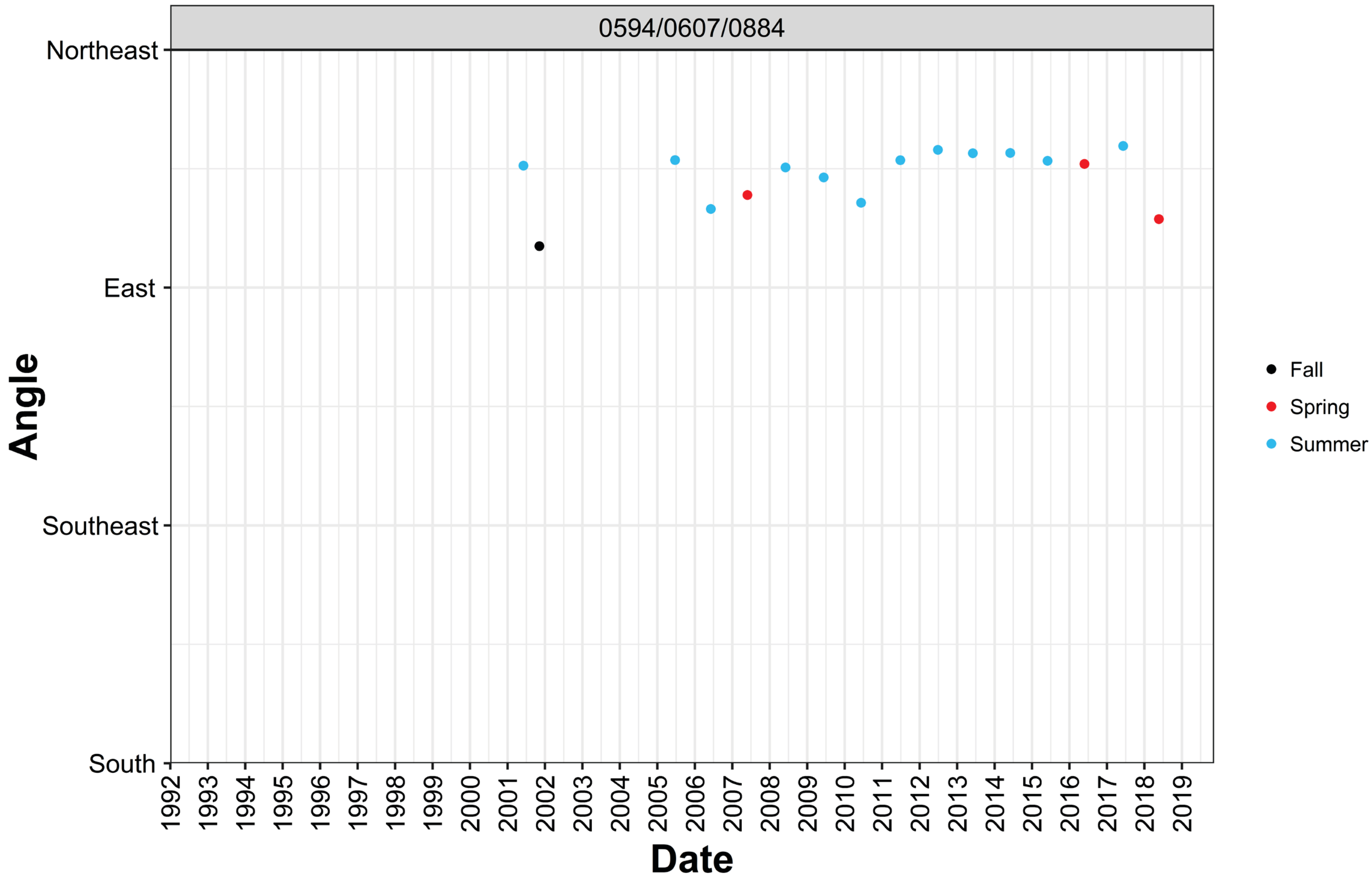

Figure B-17: DUR02 Direction of groundwater flow versus time for wells 0594, 0607, 0884.

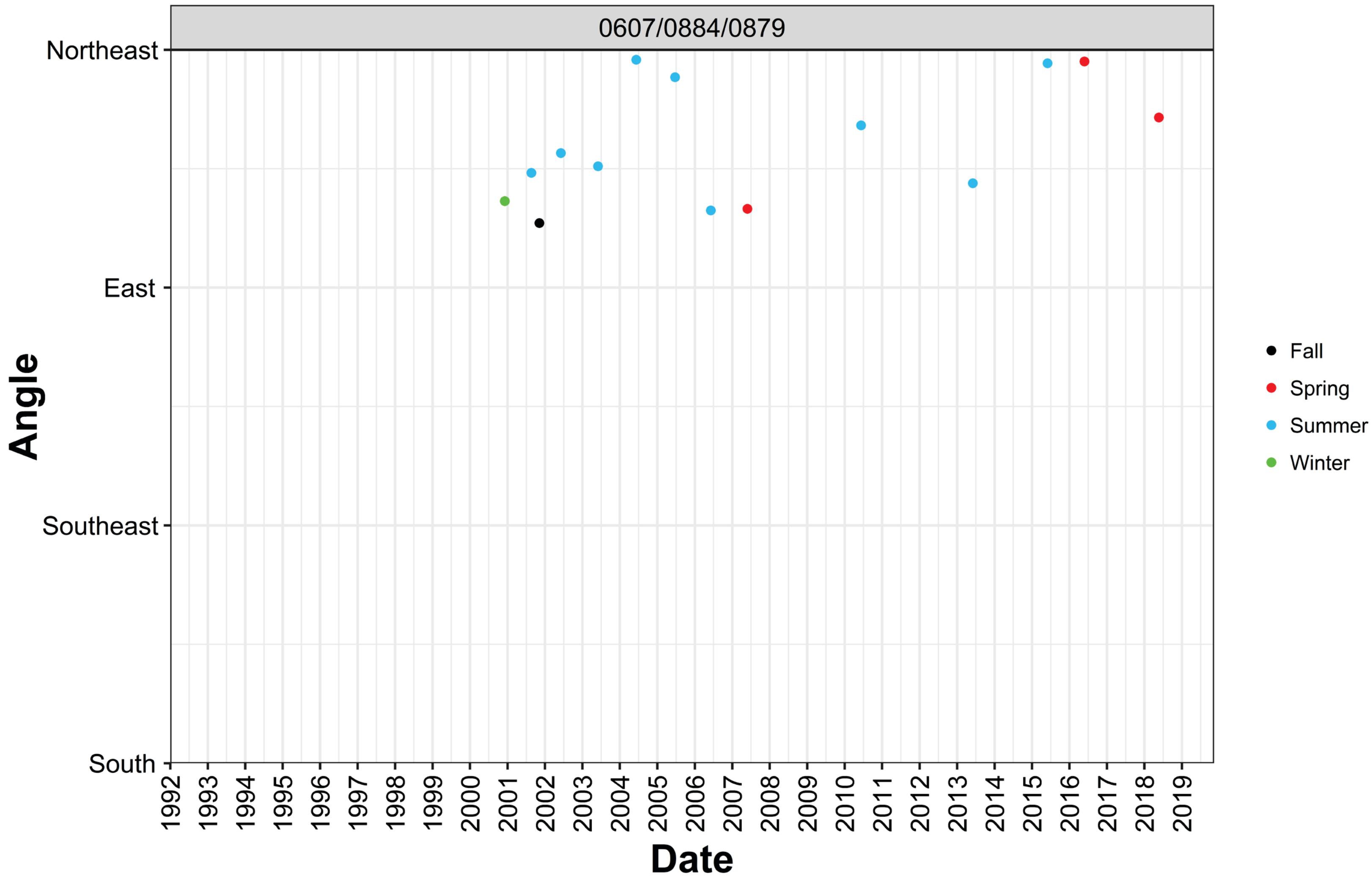

Figure B-18: DUR02 Direction of groundwater flow versus time for wells 0607, 0884, 0879.

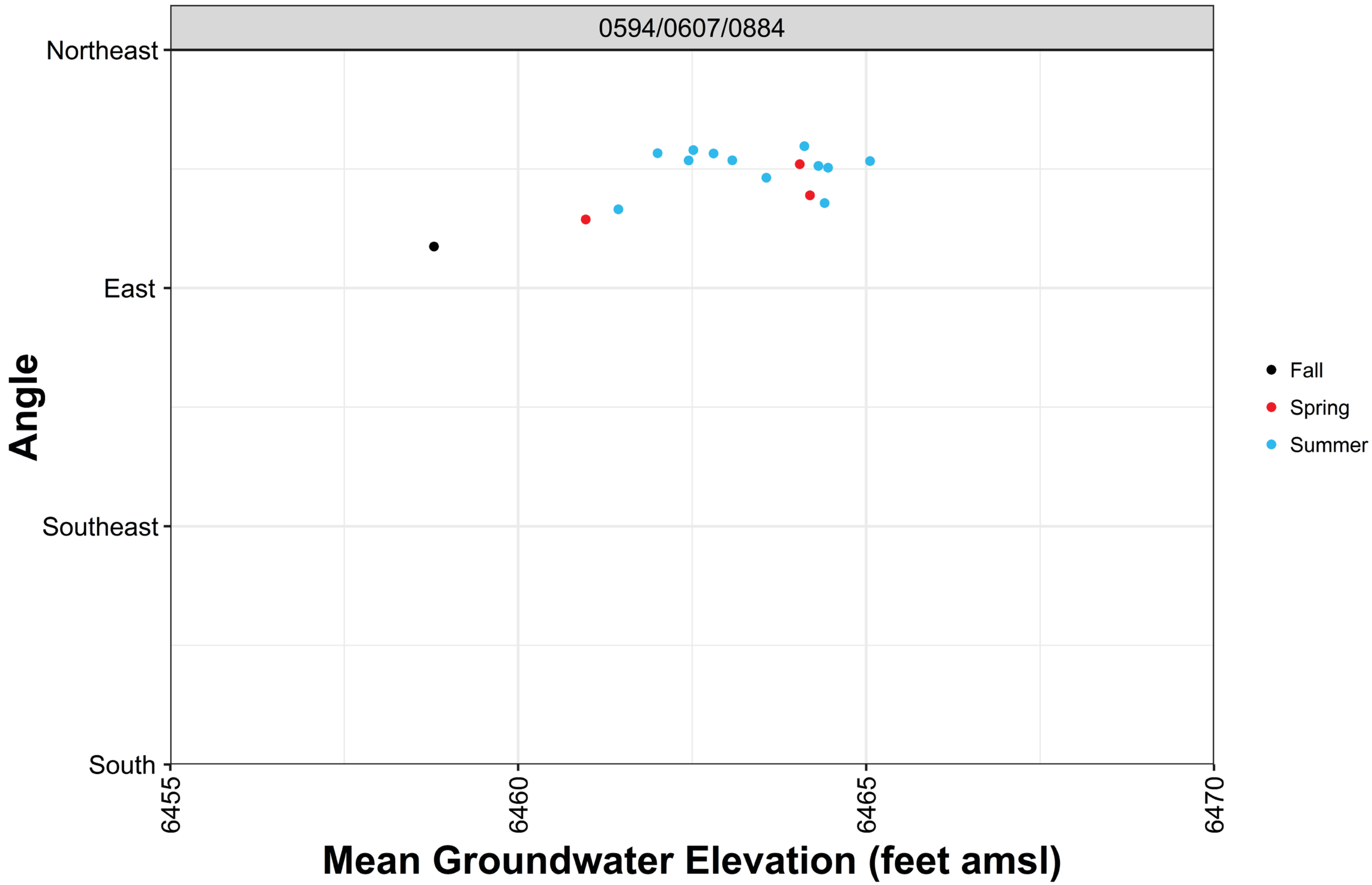

Figure B-19: DUR02 Direction of groundwater flow versus mean groundwater elevation for wells 0594, 0607, 0884.

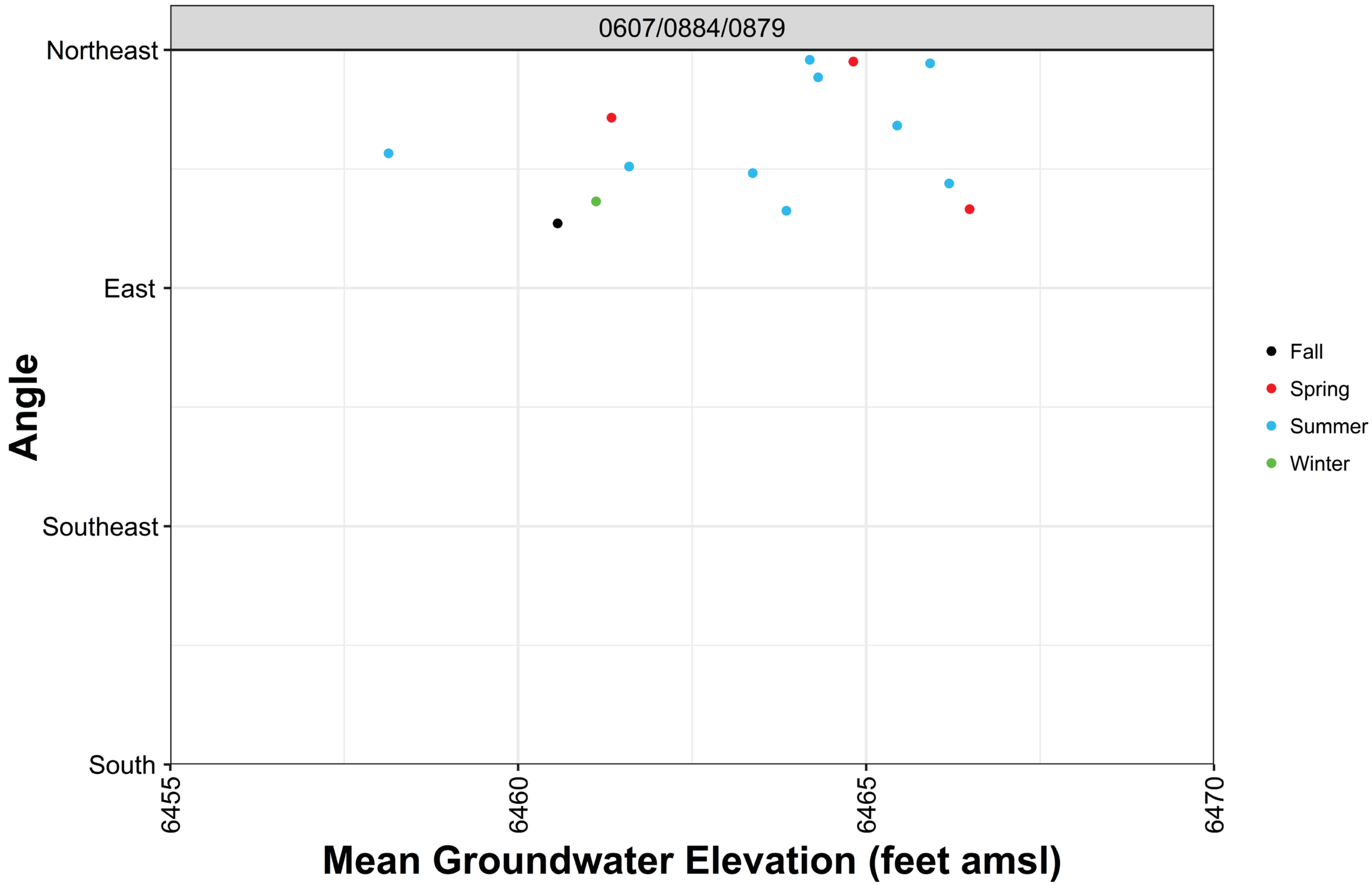

Figure B-20: DUR02 Direction of groundwater flow versus mean groundwater elevation for wells 0607, 0884, 0879.

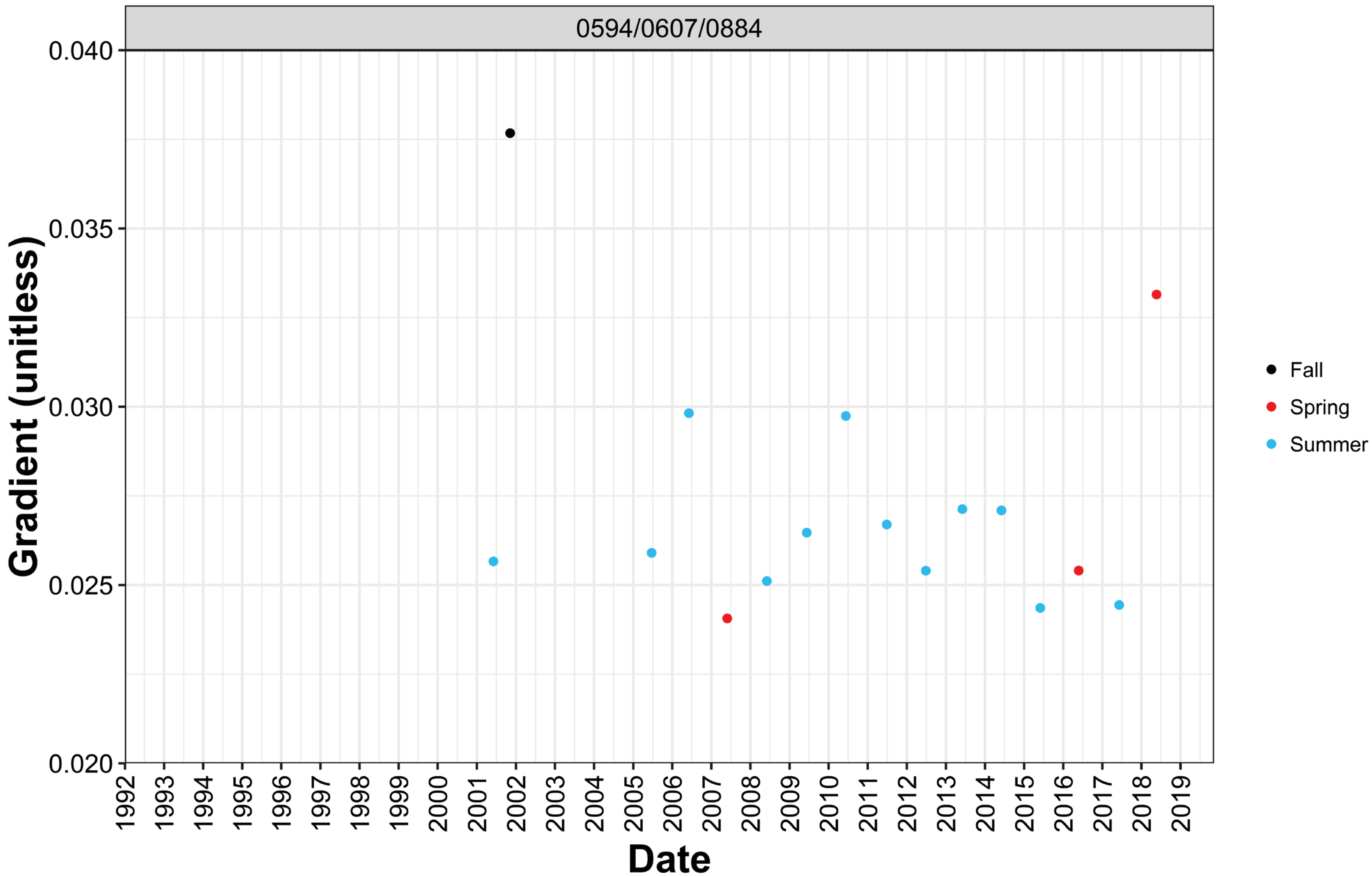

Figure B-21: DUR02 Hydraulic gradient versus time for wells 0594, 0607, 0884.

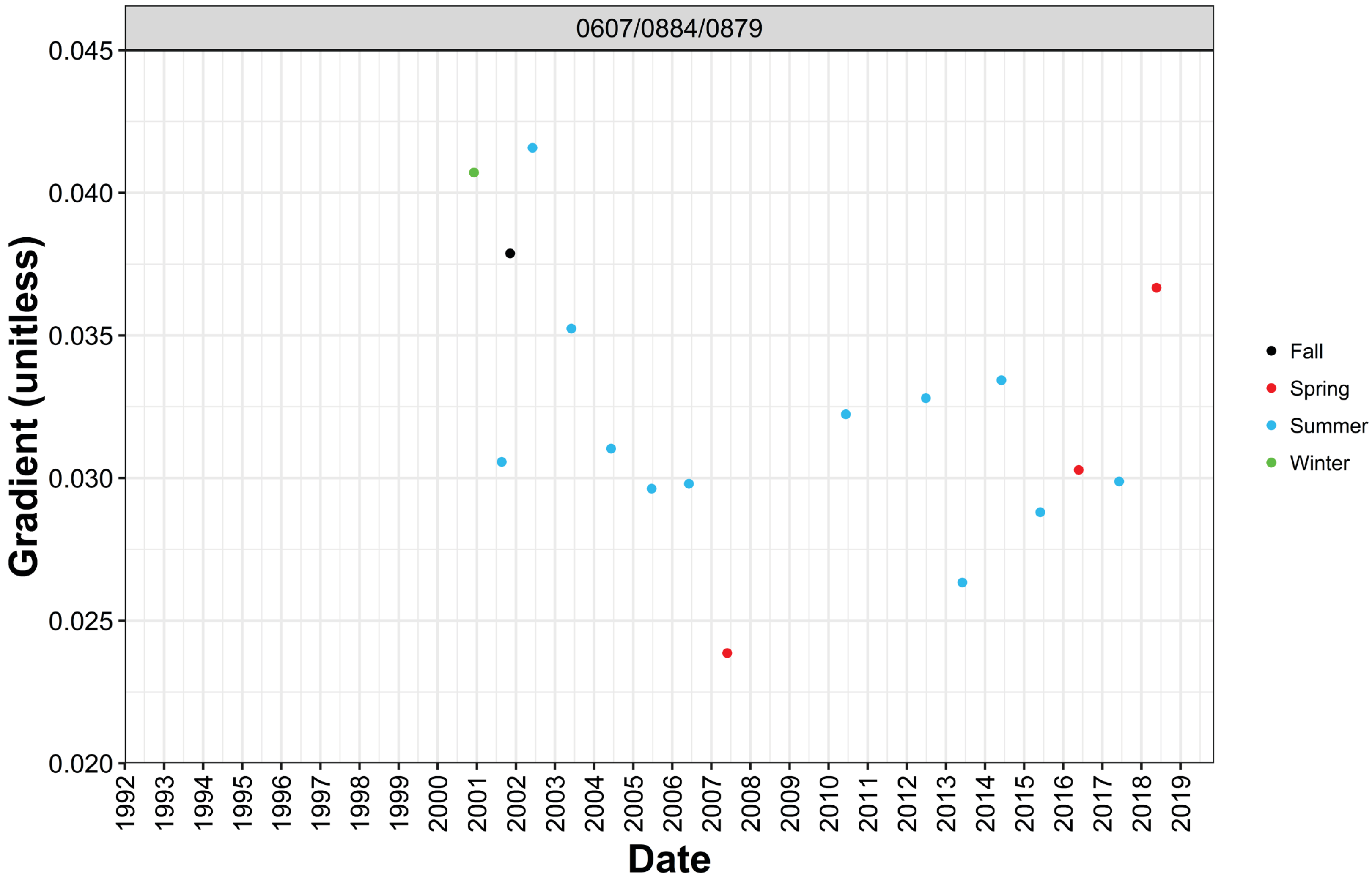

Figure B-22: DUR02 Hydraulic gradient versus time for wells 0607, 0884, 0879.

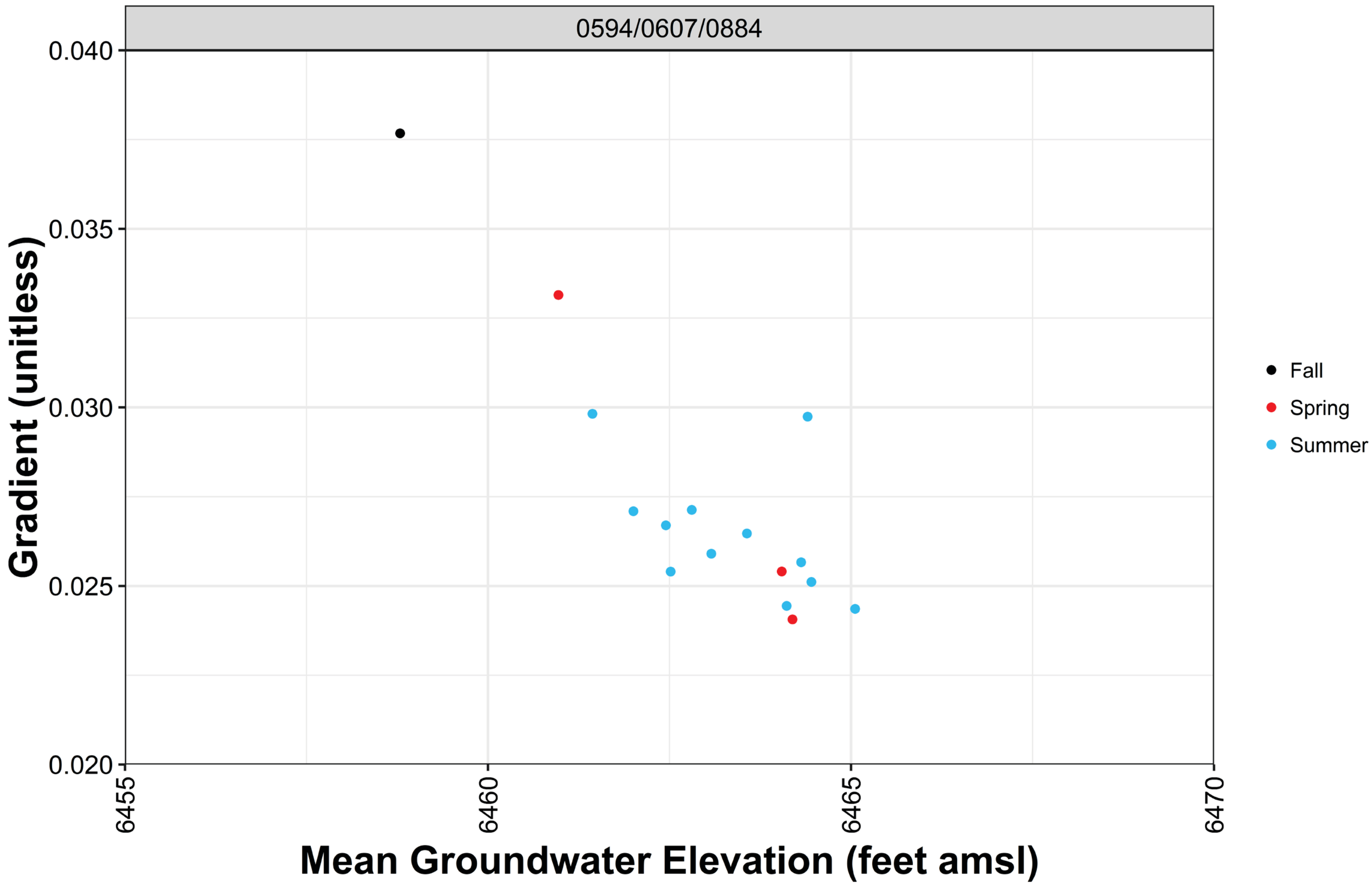

Figure B-23: DUR02 Hydraulic gradient versus mean groundwater elevation for wells 0594, 0607, 0884.

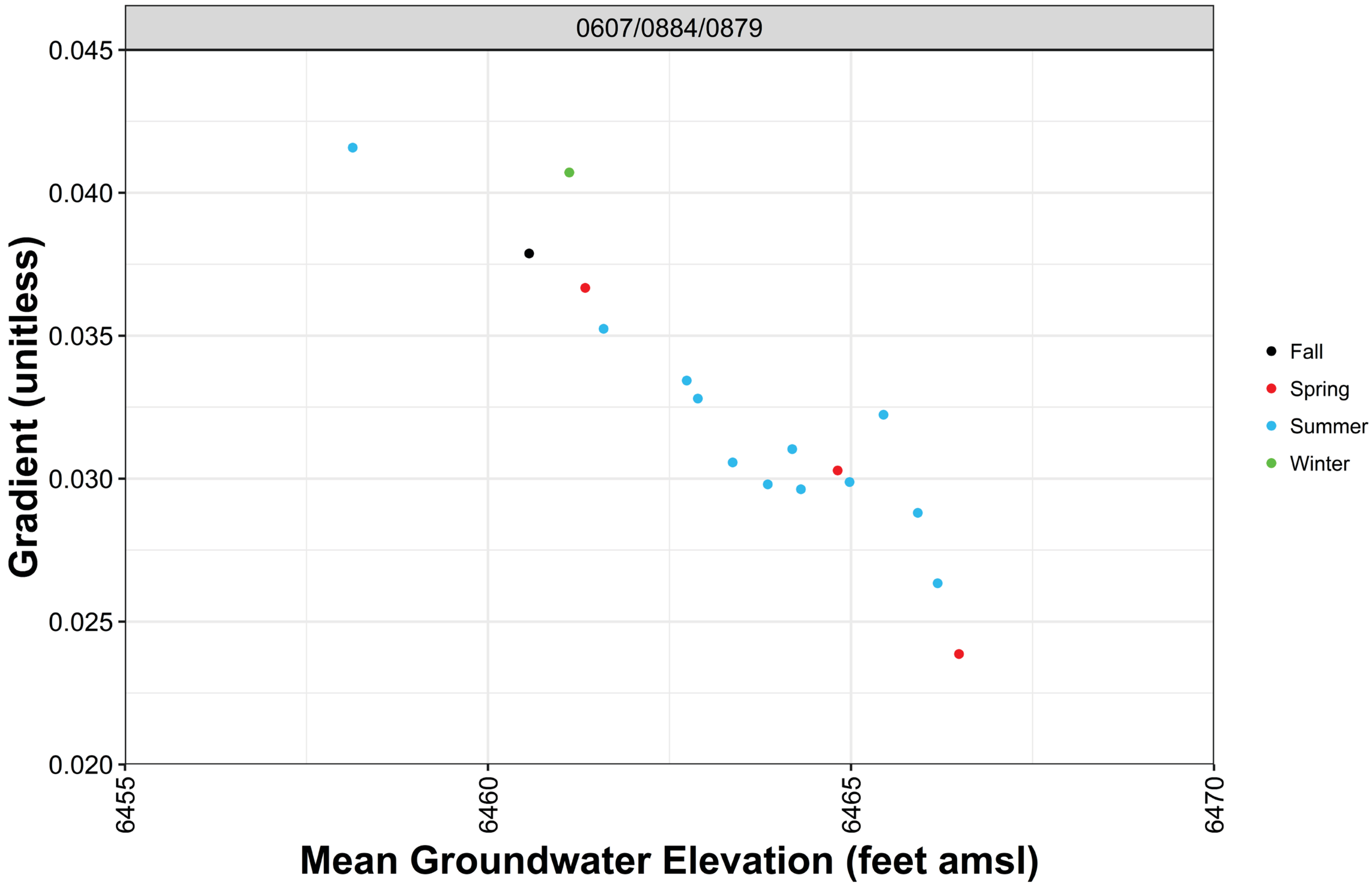

Figure B-24: DUR02 Hydraulic gradient versus mean groundwater elevation for wells 0607, 0884, 0879.

Three-Point Estimator Results Summary
Durango Processing Site Mill Tailings Area
Durango, Colorado

Well Triangle	Min Base to Height Ratio	Max Base to Height Ratio	Date	Well 1 Water Level (ft)	Well 2 Water Level (ft)	Well 3 Water Level (ft)	Mean Water Level (ft)	Head Drop (ft)	Gradient	Angle (degree)
0629/0622/0635	0.21	5.14	11/1/1993	6490.8	6484.4	6484.5	6486.6	6.4	0.015	119
			11/19/1993	6490.9	6484.4	6484.4	6486.6	6.6	0.016	120
			6/1/1994	6491.1	6485.0	6485.1	6487.1	6.0	0.014	120
			10/31/1994	6490.8	6484.0	6484.1	6486.3	6.8	0.016	122
			10/25/1995	6490.3	6484.1	6484.2	6486.2	6.2	0.015	120
			6/18/1997	6491.2	6484.9	6485.0	6487.0	6.3	0.015	116
			6/13/1998	6489.8	6484.4	6484.5	6486.2	5.4	0.013	120
			6/24/1999	6491.2	6484.5	6484.5	6486.7	6.8	0.016	122
			11/9/1999	6490.5	6484.2	6484.3	6486.3	6.2	0.015	119
			6/22/2000	6490.4	6484.2	6484.2	6486.3	6.2	0.015	121
			11/29/2000	6490.4	6484.2	6483.2	6485.9	7.2	0.017	162
			3/29/2001	6492.9	6486.1	6486.5	6488.5	6.8	0.017	106
			6/7/2001	6490.9	6484.7	6484.9	6486.9	6.2	0.015	116
			8/28/2001	6490.4	6484.0	6484.0	6486.1	6.4	0.015	119
			11/6/2001	6490.1	6484.0	6484.1	6486.1	6.1	0.015	119
0631/0633/0617	0.47	2.35	11/1/1993	6467.6	6474.5	6469.1	6470.4	6.9	0.047	53
			11/19/1993	6467.5	6474.2	6468.9	6470.2	6.7	0.046	54
			6/1/1994	6471.5	6474.7	6470.7	6472.3	3.9	0.023	65
			6/18/1997	6471.5	6476.5	6470.9	6473.0	5.6	0.035	62
			6/10/1998	6469.5	6474.0	6469.7	6471.1	4.5	0.031	58
			6/24/1999	6471.4	6474.0	6470.8	6472.0	3.2	0.018	65
			4/4/2001	6468.6	6477.4	6470.4	6472.1	8.8	0.060	54
			6/7/2001	6470.5	6474.9	6470.9	6472.1	4.4	0.031	57
			6/10/2004	6470.6	6475.0	6470.1	6471.9	4.9	0.030	63
			6/21/2005	6471.4	6475.3	6470.5	6472.4	4.7	0.028	65
			6/2/2008	6472.4	6475.5	6471.1	6473.0	4.4	0.023	70
			6/8/2010	6470.9	6475.2	6470.1	6472.1	5.1	0.030	64
			5/21/2019	6469.5	6474.5	6469.6	6471.2	4.9	0.034	59

Well Triangle	Min Base to Height Ratio	Max Base to Height Ratio	Date	Well 1 Water Level (ft)	Well 2 Water Level (ft)	Well 3 Water Level (ft)	Mean Water Level (ft)	Head Drop (ft)	Gradient	Angle (degree)
0634/0633/0631	0.36	3.43	11/1/1993	6476.7	6474.5	6467.6	6472.9	9.1	0.047	50
			11/19/1993	6478.5	6474.2	6467.5	6473.4	11.0	0.046	57
			6/1/1994	6478.7	6474.7	6471.5	6474.9	7.2	0.023	69
			6/18/1997	6478.9	6476.5	6471.5	6475.6	7.4	0.034	54
			6/10/1998	6478.7	6474.0	6469.5	6474.1	9.2	0.031	66
			6/24/1999	6478.8	6474.0	6471.4	6474.7	7.5	0.020	80
			6/7/2001	6478.7	6474.9	6470.5	6474.7	8.3	0.031	61
			6/10/2004	6478.9	6475.0	6470.6	6474.8	8.2	0.030	62
			6/21/2005	6478.8	6475.3	6471.4	6475.1	7.4	0.027	62
			6/2/2008	6478.8	6475.5	6472.4	6475.6	6.4	0.022	65
			6/8/2010	6478.7	6475.2	6470.9	6475.0	7.8	0.030	60
			5/21/2019	6477.7	6474.5	6469.5	6473.9	8.2	0.034	57
0634/0635/0633	1.27	6.63	11/1/1993	6476.7	6484.5	6474.5	6478.6	10.0	0.017	62
			11/19/1993	6478.5	6484.4	6474.2	6479.0	10.2	0.011	118
			6/1/1994	6478.7	6485.1	6474.7	6479.5	10.4	0.011	104
			6/18/1997	6478.9	6485.0	6476.5	6480.1	8.5	0.012	72
			6/10/1998	6478.7	6484.6	6474.0	6479.1	10.6	0.012	128
			6/24/1999	6478.8	6484.5	6474.0	6479.1	10.5	0.012	132
			6/7/2001	6478.7	6484.9	6474.9	6479.5	10.0	0.011	103
			6/10/2004	6478.9	6484.6	6475.0	6479.5	9.7	0.010	110
			6/21/2005	6478.8	6484.9	6475.3	6479.6	9.6	0.011	96
			6/2/2008	6478.8	6485.3	6475.5	6479.9	9.8	0.012	85
			6/8/2010	6478.7	6484.6	6475.2	6479.5	9.4	0.011	97
			5/21/2019	6477.7	6486.1	6474.5	6479.4	11.6	0.017	72

Notes:
1) Well 1, Well 2, and Well 3 identifies the indivdual wells that make the verticies of the three-point estimator well triangle.
2) Angle is measured clockwise from north (0 degrees).

Three-Point Estimator Results Summary
Durango Processing Site Raffinate Ponds Area
Durango, Colorado

Well Triangle	Min Base to Height Ratio	Max Base to Height Ratio	Date	Well 1 Water Level (ft)	Well 2 Water Level (ft)	Well 3 Water Level (ft)	Mean Water Level (ft)	Head Drop (ft)	Gradient	Angle (degree)
0594/0607/0884	0.71	2.03	6/5/2001	6454.0	6478.4	6460.6	6464.3	24.4	0.026	67
			11/8/2001	6450.0	6476.8	6449.6	6458.8	27.3	0.038	82
			6/22/2005	6452.4	6477.3	6459.5	6463.1	24.9	0.026	66
			6/6/2006	6452.1	6476.8	6455.5	6461.4	24.7	0.030	75
			5/29/2007	6455.9	6476.9	6459.8	6464.2	20.9	0.024	72
			6/3/2008	6454.5	6478.2	6460.8	6464.5	23.7	0.025	67
			6/10/2009	6453.5	6477.8	6459.3	6463.6	24.3	0.026	69
			6/10/2010	6454.7	6479.9	6458.7	6464.4	25.2	0.030	74
			6/28/2011	6451.4	6477.1	6458.8	6462.5	25.7	0.027	66
			6/27/2012	6451.5	6476.6	6459.4	6462.5	25.1	0.025	64
			6/3/2013	6451.3	6477.8	6459.3	6462.8	26.6	0.027	65
			6/3/2014	6450.5	6477.0	6458.5	6462.0	26.6	0.027	65
			6/1/2015	6455.0	6478.5	6461.7	6465.1	23.4	0.024	66
			5/26/2016	6453.8	6478.0	6460.4	6464.0	24.2	0.025	67
			6/7/2017	6453.4	6477.8	6461.2	6464.1	24.4	0.024	63
			5/22/2018	6451.3	6477.7	6453.9	6461.0	26.5	0.033	77
0607/0884/0879	0.83	1.42	12/5/2000	6478.9	6449.9	6454.5	6461.1	29.0	0.041	74
			8/21/2001	6477.0	6455.7	6457.5	6463.4	21.3	0.031	68
			11/8/2001	6476.8	6449.6	6455.3	6460.6	27.3	0.038	78
			6/5/2002	6476.7	6448.3	6449.4	6458.1	28.4	0.042	65
			6/3/2003	6477.3	6452.9	6454.6	6461.6	24.4	0.035	67
			6/9/2004	6477.7	6459.7	6455.2	6464.2	22.5	0.031	47
			6/22/2005	6477.3	6459.5	6456.1	6464.3	21.2	0.030	50
			6/6/2006	6476.8	6455.5	6459.3	6463.9	21.3	0.030	75
			5/29/2007	6476.9	6459.8	6462.8	6466.5	17.1	0.024	75
			6/10/2010	6479.9	6458.7	6457.8	6465.4	22.1	0.032	59
			6/27/2012	6476.6	6459.4	6452.7	6462.9	24.0	0.033	41
			6/3/2013	6477.8	6459.3	6461.4	6466.2	18.5	0.026	70
			6/3/2014	6477.0	6458.5	6452.7	6462.7	24.4	0.033	44
			6/1/2015	6478.5	6461.7	6457.6	6465.9	20.8	0.029	48
			5/26/2016	6478.0	6460.4	6456.1	6464.8	21.9	0.030	47
			6/7/2017	6477.8	6461.2	6456.0	6465.0	21.8	0.030	44
			5/22/2018	6477.7	6453.9	6452.4	6461.3	25.3	0.037	58

Notes:

1) Well 1, Well 2, and Well 3 identifies the indivdual wells that make the verticies of the three-point estimator well triangle.
2) Angle is measured clockwise from north (0 degrees).

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Appendix C

Bulk Plume Metric Results

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Bulk Plume Metrics and Groundwater Elevation Data Presented on Figure 17
Durango Processing Site Mill Tailings Area
Durango, Colorado

Date	Average Plume Concentration (mg/L)	Uranium Mass (lb)	Plume Volume (million gallon)
3/31/2001	0.55	22.48	4.9
6/7/2001	0.46	23.18	6.1
8/27/2001	0.57	21.19	4.5
11/6/2001	0.68	19.70	3.5
6/5/2002	0.68	21.74	3.8
6/4/2003	0.54	23.90	5.4
6/9/2004	0.49	23.94	5.8
6/20/2005	0.44	23.03	6.3
6/6/2006	0.52	21.87	5.1
5/30/2007	0.50	21.41	5.1
6/2/2008	0.43	23.03	6.4
6/9/2009	0.44	18.45	5.0
6/8/2010	0.43	21.30	5.9
6/28/2011	0.44	19.83	5.4
6/26/2012	0.53	16.95	3.9
6/4/2013	0.51	18.24	4.3
6/4/2014	0.41	18.21	5.3
7/1/2014	0.46	13.86	3.6
6/3/2015	0.46	19.22	5.0
5/25/2016	0.45	17.64	4.7
6/8/2017	0.45	21.41	5.8
5/22/2018	0.60	17.83	3.6
5/21/2019	0.46	19.37	5.0

Date	Groundwater Elevation at Well 0631 (ft asml)
4/4/2001	6468.6
6/7/2001	6470.5
8/27/2001	6468.0
11/6/2001	6467.4
6/5/2002	6468.2
6/3/2003	6470.4
6/10/2004	6470.6
6/21/2005	6471.4
6/7/2006	6469.8
5/31/2007	6470.3
6/3/2008	6472.4
6/9/2009	6469.3
6/9/2010	6470.9
6/28/2011	6470.4
6/26/2012	6467.9
6/4/2013	6469.0
6/4/2014	6471.3
6/3/2015	6471.3
8/18/2015	6467.8
5/25/2016	6470.2
6/8/2017	6471.2
5/22/2018	6468.5
5/21/2019	6469.5

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