3.0 L-Bar, New Mexico, Disposal Site

3.1 Compliance Summary

The L-Bar, New Mexico, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site was inspected on March 9, 2023. Previous inspections performed in 2021 and 2022, as required by the Long-Term Surveillance Plan (DOE 2004) (LTSP), and associated follow-up site visits, identified numerous surface degradation features on the disposal cell top slope. Two new degradation features on the top slope were identified during the March 2023 inspection. These features represent changes in cell cover characteristics, and an evaluation of the cause and need for repair is ongoing. Additionally, during an Applied Studies and Technology (AS&T) investigation in September and October of 2022, several piping features were discovered on the side slope of the disposal cell. They will continue to be monitored and do not affect the performance of the side slope at this time. Inspectors also identified several routine maintenance needs.

Erosion and vegetation measurements to monitor the condition of the disposal cell top slope were conducted in August 2023, and results are included in Section 3.7.2. The next erosion and vegetation monitoring event is scheduled for August 2024.

Groundwater is monitored every 3 years in accordance with the site-specific U.S. Department of Energy (DOE) Office of Legacy Management (LM) LTSP (DOE 2004). The most recent groundwater sampling event was conducted on November 2, 2022; analytical results from this sampling event are presented in Section 3.7.1.

3.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the site-specific LTSP (DOE 2004) in accordance with procedures established to comply with the requirements of the U.S. Nuclear Regulatory Commission (NRC) general license at Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 3-1 lists these requirements.

Table 3-1. License Requirements for the L-Bar, New Mexico, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 3.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 3.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 3.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 3.7	(b)(3)

3.3 Institutional Controls

The 738-acre site, identified by the property boundary shown in Figure 3-1, is owned by the United States and was accepted under the NRC general license in 2004. DOE is the licensee and, in accordance with the requirements for UMTRCA Title II sites, LM is responsible for the custody and long-term care of the site. Institutional controls (ICs) at the site include federal ownership of the property, administrative controls, and the following physical ICs that are inspected annually: disposal cell, entrance gate and sign, perimeter fence and signs, site marker, boundary monuments, and monitoring well head protectors.

3.4 Inspection Results

The site, approximately 15 miles north of Laguna, New Mexico, was inspected on March 9, 2023. The inspection was conducted by J. Cario, C. Murphy, T. Santonastaso, and J. Graham of the Legacy Management Support (LMS) contractor. In addition, W. Frazier, M. Young, and N. Olin (LM), as well as A. Rheubottom (New Mexico Environment Department [NMED]) attended the inspection. The erosion and vegetation monitoring event was conducted in August 2023. The purposes of the inspection were to confirm the integrity of visible features at the site, identify changes in conditions that might affect conformance with the LTSP, and evaluate whether maintenance or follow-up inspection and monitoring are needed.

3.4.1 Site Surveillance Features

Figure 3-1 shows the locations of site features, including site surveillance features and inspection areas, in black and gray font. Some site features that are present but not required to be inspected are shown in italic font. Observations from previous inspections that are currently monitored are shown in blue, and new observations identified during the 2023 annual inspection are shown in red. Inspection results and recommended maintenance activities associated with site surveillance features are described in the following subsections. Photographs to support specific observations are noted in the text and in Figure 3-1 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 3.9.

3.4.1.1 Site Access and Entrance Gate

Access to the site is from a public gravel road (Cibola County Road 1). Approximately 300 feet (ft) of Cebolleta Land Grant property is crossed to enter the site. Documentation of access is provided and described in the warranty and quitclaim deed for the site. The entrance gate is a tubular-steel stock gate. The gate was secured by a non-DOE lock without a DOE lock present. The unidentified lock was removed, and the gate was left secured with a DOE lock.

Interior roads used to access LM assets consist of two-track dirt roads with drainage culverts to convey stormwater in key locations. A gully that formed on a side slope of the G3 channel has encroached on the east site access road. Culverts were installed along the access road in 2016 to prevent washout of the road and to control erosion. Sediment is accumulating around one of the three culvert inlets and erosion is also undercutting the outlets, but they are functioning as designed, and no maintenance needs were identified (PL-1).

Access roads are susceptible to erosion and are repaired when they become impassable. In 2023, through an interagency agreement with the U.S. Army Corps of Engineers (USACE), LM is planning to repair access roads and construct low-water crossings in areas impacted by erosion. No additional maintenance needs were identified.

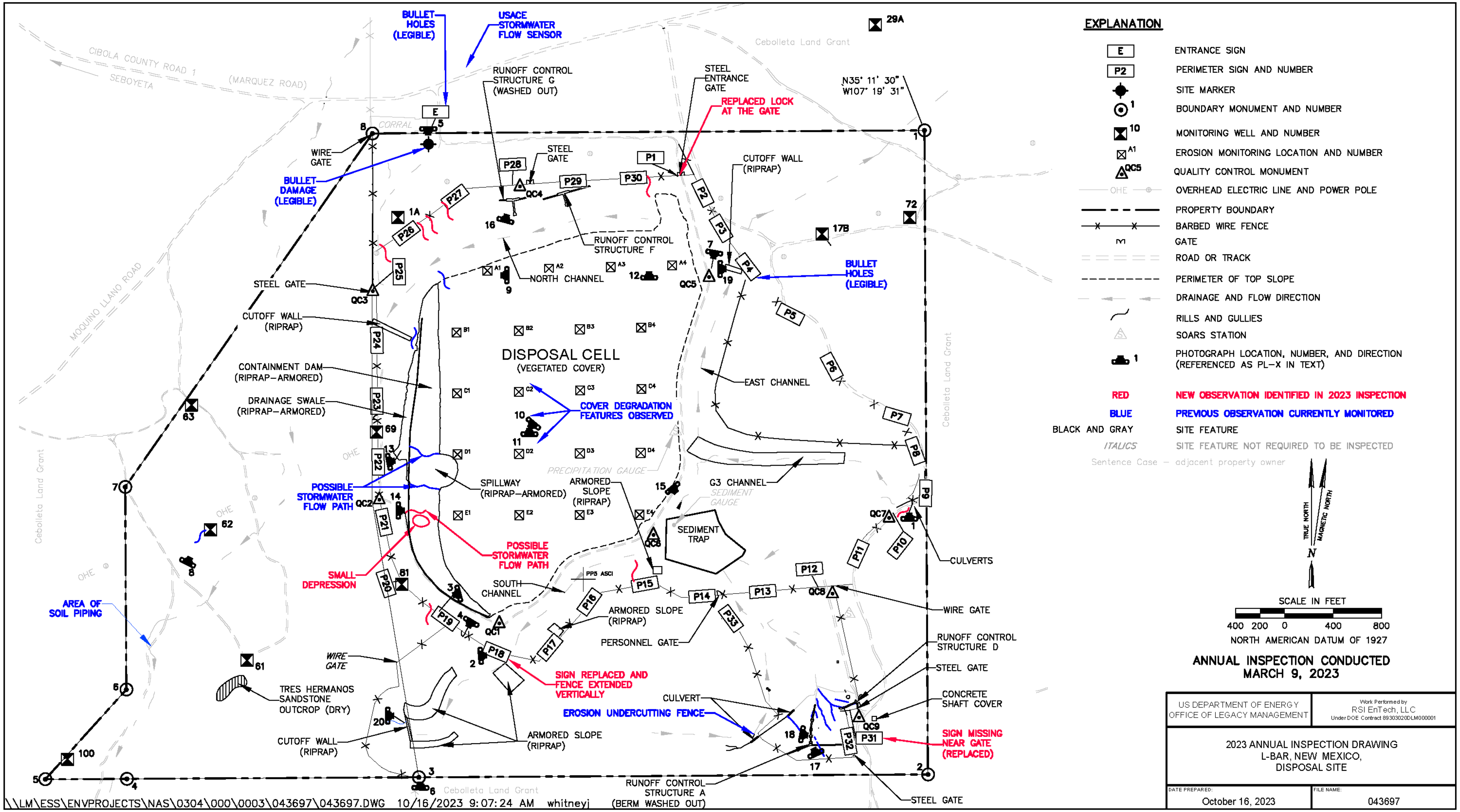


Figure 3-1. 2023 Annual Inspection Drawing for the L-Bar, New Mexico, Disposal Site

3.4.1.2 Fence and Perimeter Signs

A barbed-wire fence encloses the disposal cell and associated drainage structures and is intended to prohibit trespassing and livestock intrusion on the disposal cell to prevent gullies from developing from the livestock trails. The fence is about 3300 ft inside the property boundary, and the area between the fence and the boundary is grazed in accordance with an LM grazing license with the Cebolleta Land Grant stakeholders, who collectively own and manage the surrounding property. Sediment is accumulating along the fence line near perimeter sign P18, and the fence was extended vertically due to the sedimentation. Perimeter sign P18 was replaced during the 2023 annual maintenance trip (PL-2). Erosion is undercutting the perimeter fence in several locations where the fence was extended to prohibit livestock from entering the site (PL-3). New erosion features were noted along the northern fence line. Two tubular steel gates were installed to allow personnel to cross the fence line safely. One gate was installed in 2021 on the west side near perimeter sign P23, and the other gate was installed in 2022 on the south side near perimeter sign P19 (PL-4).

The entrance sign is on the main site access road near the site marker. It has several bullet holes but is legible. Thirty-three warning or perimeter signs are attached to the barbed-wire fence that surrounds the disposal site structures, as well as an area of excessive gully erosion in the southeast portion of the site. Perimeter sign P31 was observed to be missing and was replaced during annual maintenance conducted on April 24, 2023.

3.4.1.3 Site Marker

The site has one granite site marker north of the disposal cell adjacent to the site access road. Bullet damage was observed on the site marker, but it remains legible (PL-5). No maintenance needs were identified.

3.4.1.4 Boundary Monuments

Eight boundary monuments define the site boundary (PL-6). All eight boundary monuments were observed during the 2023 inspection. No maintenance needs were identified.

3.4.1.5 Aerial Survey Quality Control Monuments

Nine aerial survey quality control monuments were inspected during the 2023 inspection (PL-7). Quality control monument QC-8 was covered in sediment. The sediment was removed during the inspection and T-posts were installed near this monument to help locate it. No additional maintenance needs were identified.

3.4.1.6 Monitoring Wells

The site groundwater monitoring network consists of 10 wells. Nine of the wells are on DOE property; monitoring well 29A is outside the northeast property boundary of the site. The wellhead protectors observed during the 2023 inspection were undamaged and locked. No maintenance needs were identified. Erosion is propagating upstream near monitoring well 62 and will continue to be monitored to ensure that erosion does not impact the integrity of the well (PL-8).

3.4.2 Inspection Areas

In accordance with the LTSP, the site is divided into four inspection areas (referred to as "transects" in the LTSP) to ensure a thorough and efficient inspection. The inspection areas are (1) the cover of the disposal cell; (2) the containment dam; (3) the diversion channels; and (4) the site perimeter, outlying areas, and balance of the site. Inspectors examined the specific site surveillance features within each area and looked for evidence of erosion, settling, slumping, or other modifying processes that might affect site conformance with LTSP requirements.

3.4.2.1 Cover of the Disposal Cell

The disposal cell, completed in 2000, occupies approximately 100 acres. The disposal cell top slope surface is minimally sloped to the west toward the central portion of the containment dam; this promotes drainage and minimizes runoff water velocities to prevent erosion. Although the top slope was not seeded because plant growth was not expected to be successful, vegetation is occurring naturally with native and early successional weedy species. Vegetation was slow to establish in the southeast portion of the top slope, so a native seed mix was applied in 2009. This area has successfully vegetated, although several years of below-average precipitation have stressed the vegetation. The establishment and maturing of vegetation is expected to reduce wind and water erosion of the surface and help prevent precipitation from percolating into the tailings. In accordance with the LTSP, erosion and vegetation are monitored on the disposal cell top slope. Section 3.7.2 describes the erosion monitoring program and presents the results to date.

During the LTSP-required vegetation and erosion monitoring activity in August 2021, inspectors observed a single degradation feature on the top slope of the disposal cell. Subsequent visits to the site were conducted to further identify and document these features and resulted in the observations of several cover degradation features (PL-10). Each surface degradation feature varied in overall size and depth with the deepest feature measuring 8 ft both vertically and horizontally during the April 2022 site visit. A total of 32 features were identified across the entire top slope of the disposal cell. Depth measurements of one of the surface degradation features indicate the potential for erosion of the radon barrier. During the February 2022 site visit, field radiological screening was performed using an alphaNUCLEAR Model 597-PX3 radon gas concentration monitor and a handheld sodium iodide scintillometer. Measurement results did not indicate release of radon gas above 10 CFR 835 or DOE Order 458.1 Chg 4 (LtdChg) actionable limits, or elevated radiation levels.

During the 2023 inspection, two more degradation features were identified (PL-9), and the most prominent degradation feature designated E-004 (PL-10) was measured and documented to track the size and erosional condition of the degradation feature. Degradation feature E-004 was previously measured in 2022 to have a surface expression of 8 ft in length and also extend vertically 8 ft below ground surface. The measurements taken during the 2023 inspection show that degradation feature E-004 has collapsed vertically and horizontal piping occurred, which nearly connects it to a nearby erosional feature (P-11). However, E-004 measured to have a surface expression of less than 2 ft in width and extend vertically around 2 ft below the ground surface.

These features represent a change in the characteristics of the condition of the disposal cell cover and may require maintenance. Preliminary evaluations suggest that surface degradation features were caused by stormwater flows penetrating the disposal cell cover via desiccation cracking (PL-12), animal burrows, and vegetation root systems.

Evaluation of the surface degradation features is ongoing, and a geophysical investigation was performed in 2023 to support further evaluation of cover degradation conditions. Multiple methods of nonintrusive geophysical techniques were implemented to analyze the subsurface tailings, radon attenuation barrier, and the common fill layer for potential void spaces. Initial findings did not indicate the potential for significant void spaces to be present. Based on the results of the recent inspection and currently available information, the disposal cell cover continues to function as designed.

3.4.2.2 Containment Dam

The disposal cell was constructed during mill operations by damming the head of a natural drainage basin. The face of the earthen containment dam has a 20% slope and is riprap armored to prevent erosion and degradation. Large-diameter riprap was used to protect the spillway in the central portion of the containment dam where precipitation runoff would discharge from the disposal cell cover. Native vegetation is well-established on the spillway face, which is desirable for increasing the erosion protection of the surface. A potential stormwater flow path was observed during the 2022 inspection on the northern and southern edge of the spillway where the armored spillway and armored containment dam meet. Inspectors visually inspected the spillway during the 2023 annual inspection, and the stormwater pathways do not appear to affect the integrity of the spillway and maintenance is not needed at this time (PL-13). A small depression or potential stormwater pathway in the containment dam side slope was observed during the 2023 inspection and will continue to be monitored (PL-14). A geotechnical investigation was performed by USACE in September 2022 to characterize surface and subsurface erosion along a transect of the containment dam side slope. This effort was in support of an AS&T project to characterize and inform erosion risks across the LM portfolio. During this investigation, five erosional piping features were identified in an observation area focused near the riprap spillway on the western side slope. These features are very difficult to identify, and the longest piping feature extended roughly 5 ft into the side slope. No defined sediment outlets or evidence that mill tailings have been exposed or mobilized were identified. Indications of erosion, settlement, mounding, or other modifying processes that might affect the integrity of the containment dam will continue to be visually monitored and do not affect the performance of the disposal cell side slope at this time. No other maintenance needs were identified.

3.4.2.3 Diversion Channels

The surface water diversion system consists primarily of the east, north, and south channels that divert runoff water away from the disposal cell. The system is designed to accommodate probable maximum flood discharges. Cutoff walls composed of large-diameter riprap were constructed at the outlet of each channel. The cutoff walls are designed to prevent headward erosion into the diversion channels that could eventually impact the disposal cell. Runoff from an upgradient watershed east of the disposal cell is designed to be conveyed away from the site to a northeastward-flowing drainage via the east channel. The east channel is separated from the disposal cell by a dike that serves as an onsite access road. Gullies are present along the east slope of the east channel, but the erosion and sediment deposition are not impairing the function of the east-channel. Runoff flow in the channel could potentially erode the adjacent weathered shale and fill materials and thus bypass the cutoff wall, causing headward erosion into the channel. This feature will continue to be monitored. The east channel was dry at the time of the inspection.

A tributary channel (G3) was constructed to divert runoff from a smaller watershed into the east channel. The erosion and sediment deposition are not impairing the function of the channel.

Some erosion was also observed in a watershed that encompasses the southeast portion of the site and adjacent property. Stormwater runoff from this watershed discharges into a sediment trap where the sediment load settles out. If runoff overtops the sediment trap, the flow is diverted to the east channel. Standing water was observed in the sediment trap at the time of the inspection (PL-15).

Multiple high-intensity storms since the completion of site reclamation have caused deep gullies to form in the highly erodible soils and fill materials upgradient of the sediment trap. Construction of runoff control structures to reduce the rate of erosion in the area and prevent headward migration of gullies into adjoining private property was completed in December 2009. Runoff from a storm event in September 2011 overtopped an earthen runoff control berm of Runoff Control Structure A and caused substantial damage to the berm. Subsequent runoff events have caused erosion adjacent to gabion drop structures associated with Runoff Control Structure A and nearby Runoff Control Structure D. Because of continued excessive erosion, an interagency agreement was established with USACE to repair these structures and construct additional structures in the watershed. Runoff water from the area north of the disposal cell is captured by the north channel. The water is diverted away from the site to the west. Deep gullies had formed in the alluvium and weathered shale along a portion of the north bank of the channel, and headward erosion was rapidly migrating to the north toward the site access road and property boundary. The eroded channel bank was restored to the original design configuration, and two runoff control structures were constructed in 2009 to reduce erosion and sedimentation. Runoff Control Structure F is showing signs of undermining erosion but was stable and functional at the time of the inspection. However, Runoff Control Structure G suffered severe erosion during runoff events in August and September 2011 and continues to erode (PL-16). Runoff Control Structure A is experiencing gully erosion (PL-17) and undermining at portions of the gabion block sections (PL-18), and it is likely that continued erosion will lead to failure of the structure. DOE will continue to monitor these structures and, as part of the interagency agreement, USACE will complete a design for repairs and modifications to these structures.

The north channel cutoff wall does not extend to the toe of the containment dam slope, allowing runoff to bypass the cutoff wall; minimal erosion in the form of rills has occurred at this location. This area will continue to be monitored for erosion and other impacts to the north channel and containment dam.

The east channel diverts stormwater runoff from the G3 channel and higher terrain immediately east of the disposal cell toward the sediment trap to the south. A northern riprap cutoff wall exists to inhibit erosion and sedimentation north of the east channel northern cutoff wall. Minimal erosion in the form of rills has occurred at this location (PL-19).

The south channel diverts stormwater runoff from higher terrain immediately south of the disposal cell toward the channel outlet to the west. Two riprap structures are on the north-facing slope (south bank) to inhibit erosion along natural drainage swales. Erosion is occurring on the unprotected slope surfaces, resulting in sediment accumulation in the south channel. The erosion and sediment deposition are not impairing the function of the south channel. Erosion headcutting that has migrated to the edge of the riprap cutoff wall at the outlet of the channel was monitored during the inspection. The cutoff wall is functioning as designed and will continue to be monitored (PL-20).

Erosion in diversion channels and other features will continue to be monitored through aerial surveys using photogrammetry and light detection and ranging (lidar). A baseline survey was conducted in 2018 using photogrammetry to obtain accurate site topography for future comparison. The most recent aerial survey was conducted in November 2022.

3.4.2.4 Site Perimeter, Outlying Areas, and Balance of the Site

The site is surrounded by open private land that is used primarily for grazing. Uranium mine reclamation activities occur periodically, and access road repairs have occurred in recent years in areas adjacent to the site. These activities have not been detrimental to site security.

The access road to monitoring well 100 in the southwest corner of the site is damaged by subsurface erosion (soil piping) near the head of an arroyo. The affected area has been mapped, metal fence posts have been installed next to soil collapse features, and the information has been identified on the inspection and sampling maps to prevent injury or vehicle damage. Consequently, monitoring well 100 is accessed by foot or all-terrain vehicle during sampling events.

A Tres Hermanos Sandstone unit of the Mancos Shale crops out in the southwest corner of the site. This unit is reported to be hydraulically connected to contaminated groundwater under the disposal cell, and the outcrop is considered a potential evapotranspiration area. The outcrop was dry at the time of the inspection, and there is no evidence that seepage has occurred. This location will continue to be monitored for seepage and recommended for sampling if seep water is present.

Several legacy features, including concrete pads (e.g., a large pad covers the mine shaft) and abandoned sewer manholes, are near the southeast corner of the site. These features were observed as stable and secure and do not require attention at this time. These features will continue to be monitored to ensure that they do not present a safety hazard and continue to prevent access to the underground mine structures.

3.5 Follow-Up Inspections

LM will conduct follow-up inspections if (1) a condition is identified during the annual inspection or other site visit that requires a return to the site to evaluate the condition or (2) LM is notified by a citizen or outside agency that conditions at the site are substantially changed. Engineering and technical staff conducted site visits to observe the degradation features in April and July 2022. AS&T investigated in September and October 2022, including collecting samples on the top slope cover and riprap-covered side slopes of the tailings impoundment. Evaluation of the disposal cell degradation features are ongoing, and plans are being developed to further understand the extent and cause of these features.

3.6 Routine Maintenance and Emergency Measures

Vertical extension of the fence near perimeter sign P18 due to sedimentation and the replacement of perimeter sign P18 were performed during routine site maintenance. The missing perimeter sign P31 was also replaced, and a new DOE lock was used to secure the steel entrance gate. No additional maintenance needs were identified during the inspection.

Emergency measures are corrective actions that LM will take in response to unusual damage or disruption that threatens or compromises site health and safety, security, integrity, or compliance with 40 CFR 192. No emergency measures were identified.

3.7 Environmental Monitoring

3.7.1 Groundwater Monitoring

In accordance with the LTSP, groundwater monitoring is required at the site once every 3 years. The most recent sampling event was conducted on November 2, 2022. An evaluation of the 2022 results and an updated analysis of corresponding groundwater flow patterns and trends in water quality is provided below. The monitoring network consists of 10 LM wells on or adjacent to the site and two Moquino Water Users Association wells approximately 2 miles west of the site in the village of Moquino. Table 3-2 lists these wells along with their network application as defined in the LTSP. Corresponding locations are shown in Figure 3-2. All monitoring wells are screened within the First Tres Hermanos Sandstone, which is the uppermost permeable unit within the Mancos Shale beneath the site.

Table 3-2. Groundwater Monitoring Network for the L-Bar, New Mexico, Disposal Site

Monitoring Well	Network Application
1A	POC source zone well
17B	POC source zone well
29A	Background well
61	Seepage indicator well
62	Seepage affected area indicator well
63	POE seepage indicator well
69	POC source zone well
72	POE well on east property boundary
81	POC source zone well
100	POE well on west property boundary
Moquino New[a]	Public water supply well in Moquino
Moquino Old[b]	Backup public water supply well in Moquino

Notes:
[a] The Moquino New well has been sampled four times: in 2005, 2007, 2013, and 2022. LM was unable to access this well in 2016 and 2019.
[b] The backup water supply well (Moquino Old) has never been sampled by LM, initially because of inability to access the well and more recently because the well is no longer operational.

Abbreviations:
POC = point of compliance
POE = point of exposure

Previous groundwater-level elevation evaluations for the L-Bar site (Kennecott 1996) showed that groundwater generally flowed to the southwest on the western side of the former tailings impoundment. Three-point vector analysis using 2005 and 2022 water-level elevations show that groundwater still generally flows to the southwest on the western side of the disposal cell, which was constructed over the former tailings impoundment (Figure 3-3). On the eastern side of the disposal cell, three-point vector analysis shows groundwater generally flowing to the northeast. The 180-degree difference in horizontal flow direction between wells on opposite sides of the disposal cell suggests the presence of a groundwater divide somewhere between the two groups of wells (Figure 3-3). Horizontal hydraulic gradients at the site range from 3.0×10^{-4} ft/ft relative to up to 0.03 ft/ft.

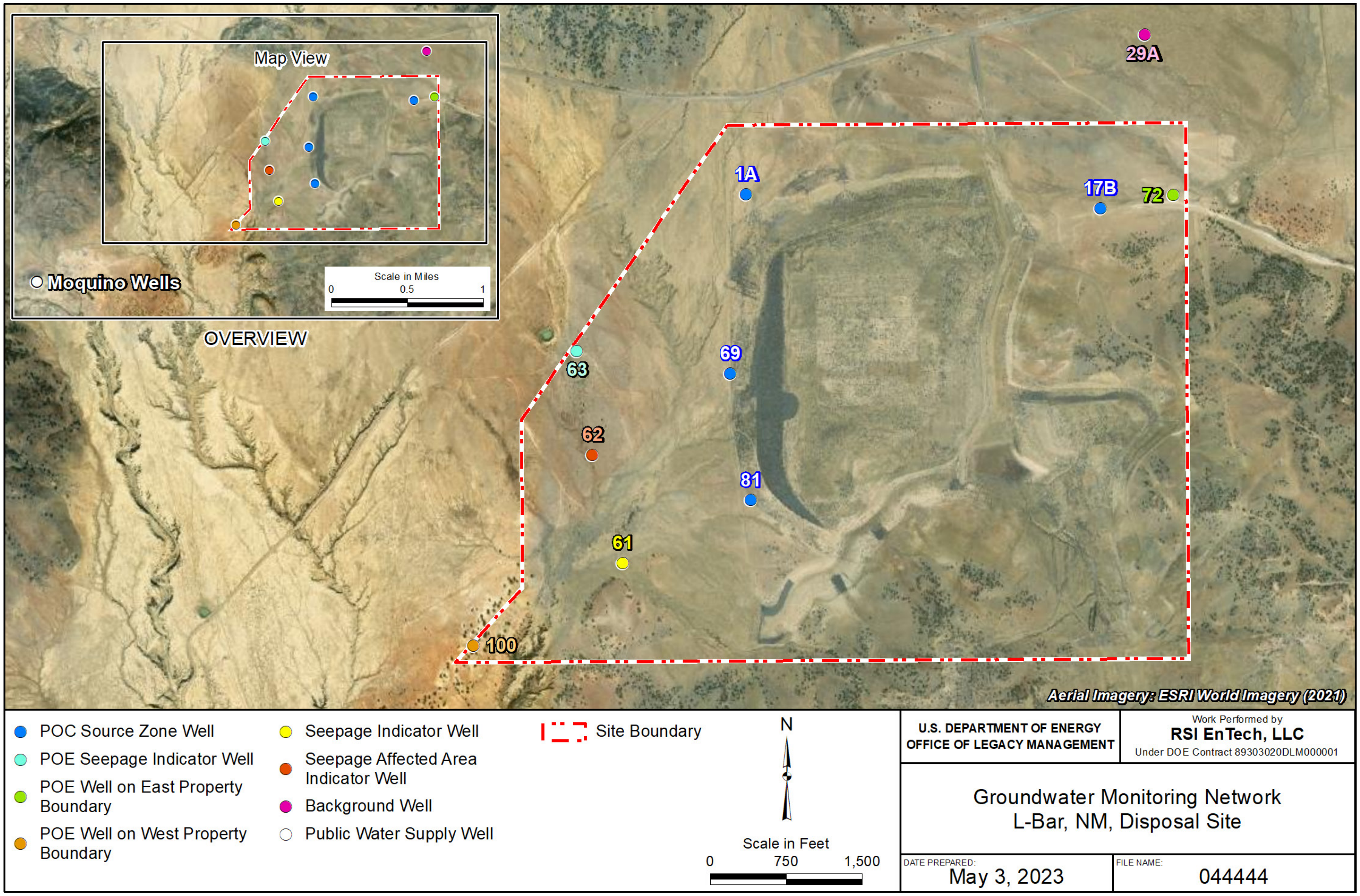
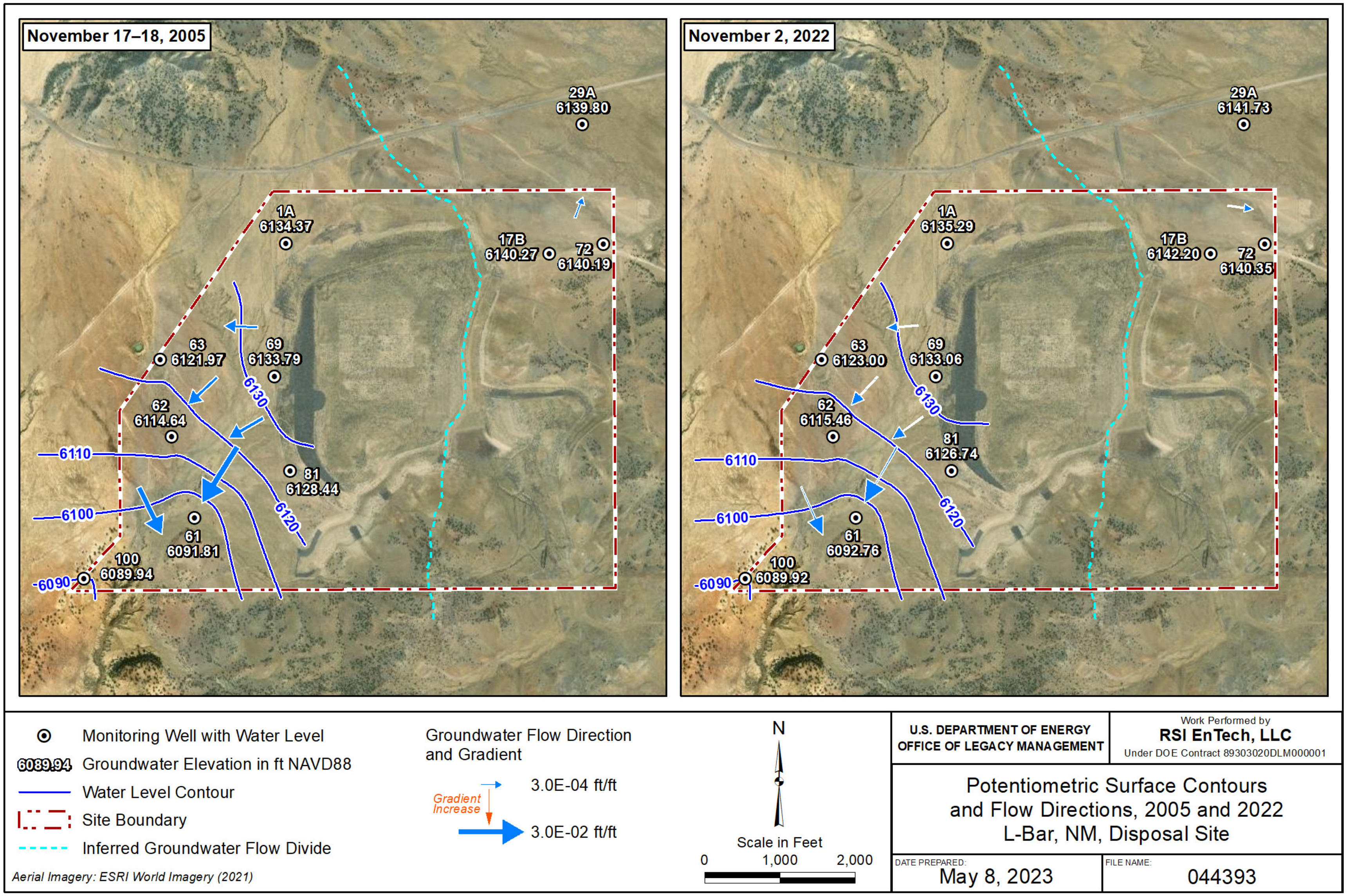


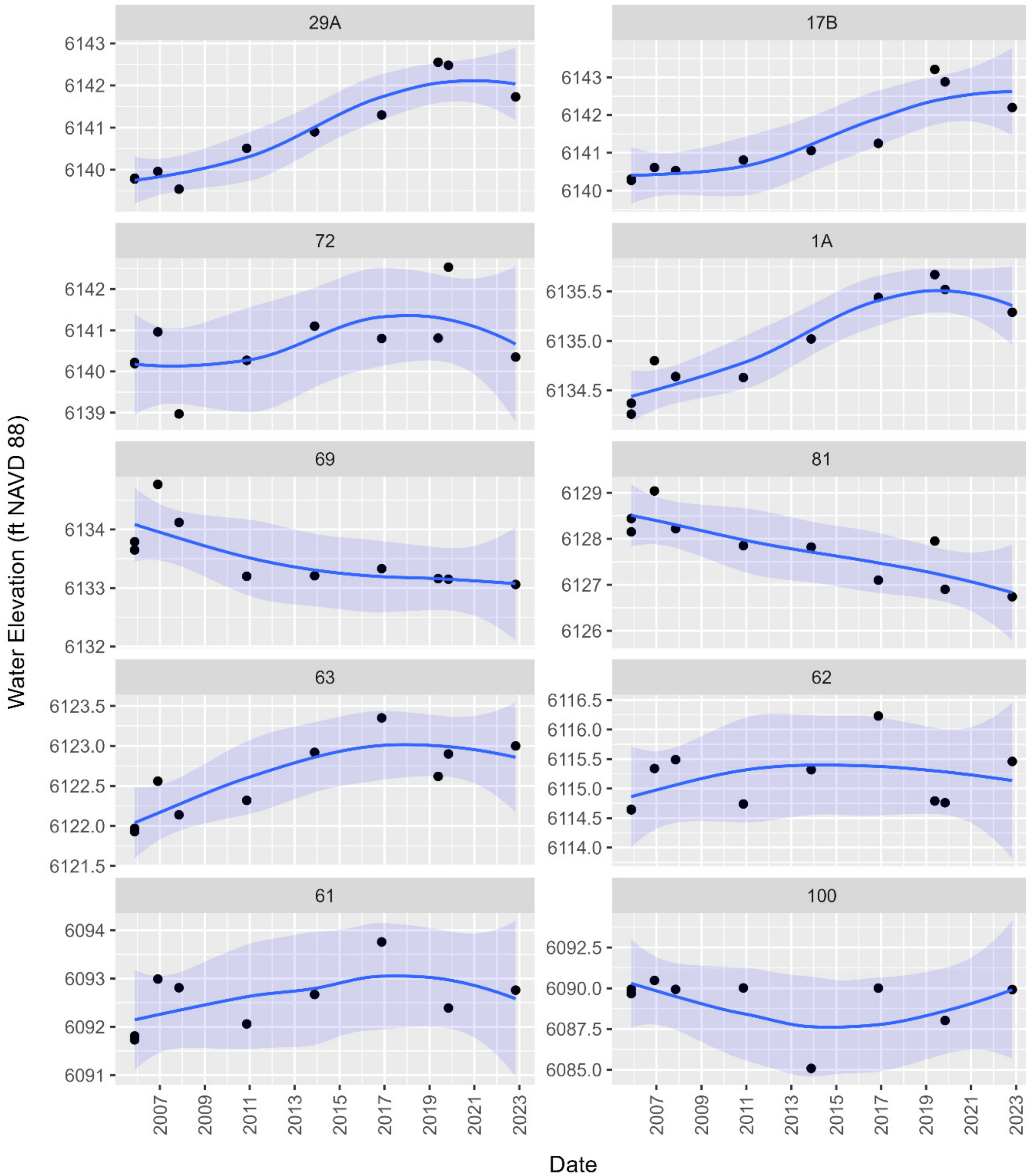
Figure 3-2. Groundwater Monitoring Network at L-Bar, New Mexico, Disposal Site



Abbreviation: NAVD 88 = North American Vertical Datum of 1988

Figure 3-3. Potentiometric Contours and Groundwater Flow Directions in the First Tres Hermanos Sandstone in 2005 and 2022

In general, groundwater levels have been stable or increasing in L-Bar site monitoring wells (Figure 3-4). Exceptions are wells 69 and 81, at the western edge of the disposal cell, which have declining water levels. These groundwater elevation declines likely reflect a reduction in the rate of gravity drainage of tailings fluid from the disposal cell.



LOESS local regression line and 95% confidence interval

Notes: Because of the approximate 60 ft range in groundwater elevations across site wells (highest in well 17B at 6143 ft NAVD 88 and lowest in well 100 at 6085 ft NAVD 88, y-axis scales are unique to facilitate interpretation of water elevation trends. Groundwater elevation trends for individual wells are shown in approximate order of decreasing groundwater elevations; data for background well 29A are plotted first.
Abbreviation: NAVD 88 = North American Vertical Datum of 1988

Figure 3-4. Groundwater Elevation Trends in L-Bar Monitoring Wells, 2005–2022

Samples collected during the November 2022 sampling event were analyzed for chloride, nitrate, selenium, sulfate, total dissolved solids (TDS), and uranium. Analytical results are measured in milligrams per liter (mg/L) and compared to the LTSP required- concentration limits listed in Table 3-3 that consist of alternate concentration limits (ACLs) granted by NRC and alternative abatement standards (AASs) stipulated by NMED.

Table 3-3. Groundwater Alternate Concentration Limits and Alternative Abatement Standards for the L-Bar, New Mexico, Disposal Site[a]

Analyte	New Mexico Standard	ACL (Wells 1A, 17B, 69, 81)	AAS Source Zone (Wells 1A, 17B, 69, 81)	AAS Affected Area (Well 62)
Chloride (mg/L)	250	NA	1127	NA
Nitrate (mg/L)	10.0	NA	1180	NA
Selenium (mg/L)	0.05	2.0	2.0	NA
Sulfate (mg/L)	4000[a]	NA	13,110	5185
TDS (mg/L)	5880[a]	NA	20,165	7846
Uranium (mg/L)	0.03[b]	13.0	13.0	NA

Notes:
Standards are from Table 3-3 of the LTSP (DOE 2004).
[a] Background value approved by the State of New Mexico for the L-Bar site.
[b] The LTSP listed the former State of New Mexico standard of 5.0 mg/L.

Abbreviation:
NA = not applicable

The LTSP states that if an ACL or AAS is exceeded in any monitoring well, LM will inform NRC of the exceedance and conduct confirmatory sampling. If confirmatory sampling verifies the exceedance, LM will develop an evaluative monitoring work plan and submit that plan to NRC for review before initiating the evaluative monitoring program. Results of the evaluative monitoring program will be used, in consultation with NRC, to determine if corrective action is necessary (DOE 2004). ACLs require both point of compliance (POC) and point of exposure (POE) locations, with the ACL being applied to the POC and applicable groundwater standards or background concentrations being applied to the POE. While not explicitly stated in the LTSP, by extension, POE exceedances also require verification monitoring and, if the exceedance is confirmed, reporting of the results to NRC.

Groundwater monitoring results for the November 2022 sampling event are listed in Table 3-4. All historical groundwater monitoring results for the site are reported and published on the LM Geospatial Environmental Mapping System (GEMS) website.[1] The requirements for annual groundwater monitoring stipulated in the LTSP were met in 2007, when the sampling frequency changed to once every 3 years. In accordance with the LTSP, groundwater monitoring will continue for as long as groundwater contamination, defined as exceeding New Mexico standards or background concentrations (Table 3-4), is present at the site (DOE 2004).

[1] https://gems.lm.doe.gov/#site=BAR.

Table 3-4. November 2022 Groundwater Monitoring Results for the L-Bar, New Mexico, Disposal Site

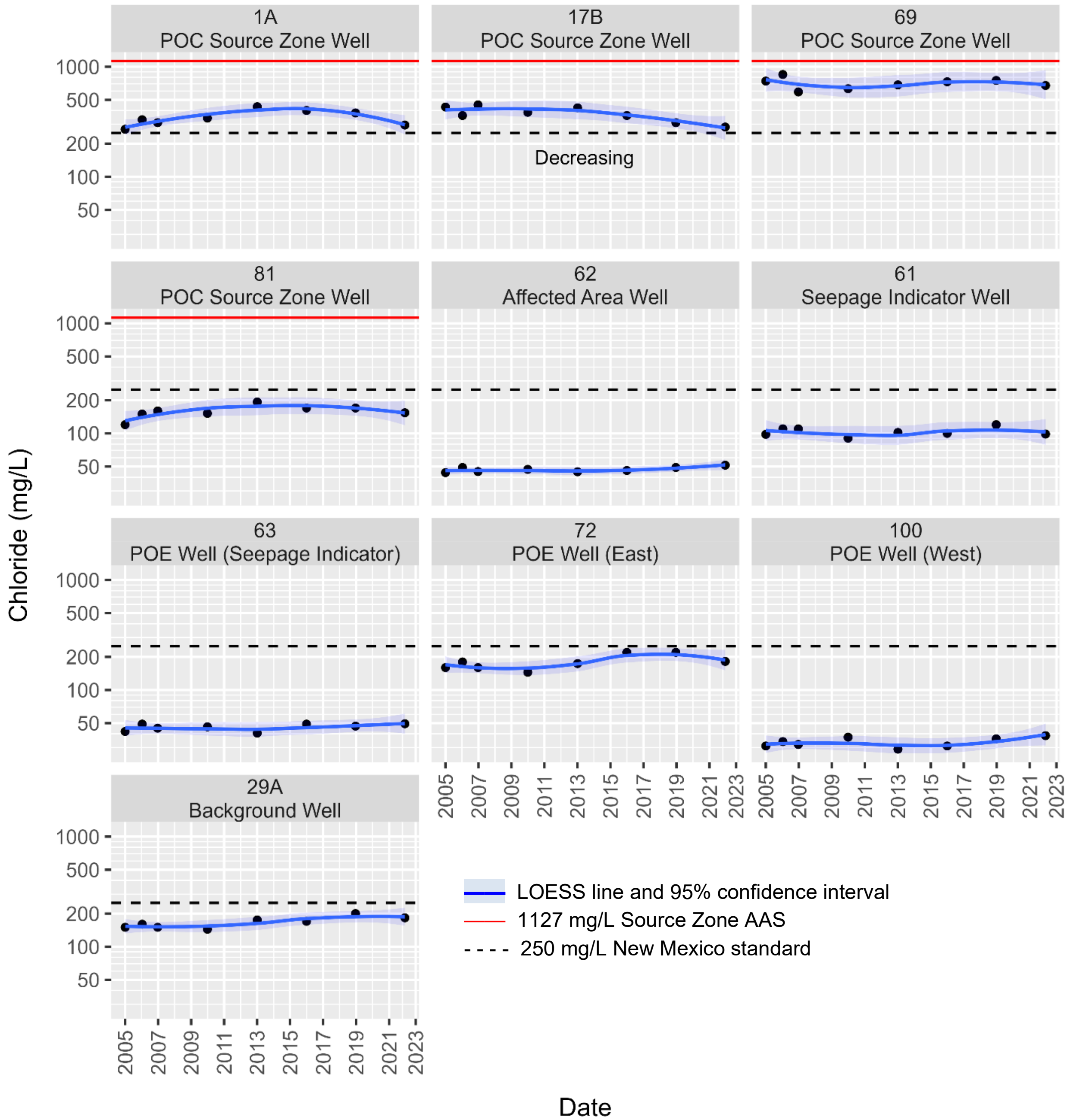
Monitoring Well	Analyte (mg/L)[a,b]					
	Chloride	Nitrate[c]	Selenium	Sulfate	TDS	Uranium
1A	***295***	0.144	ND	3500	***6490***	0.00344
17B	***283***	***838***	***0.26***	***4630***	***12,100***	***0.0322***
29A	183	ND	ND	***5280***	***7970***	ND
61	98.6	0.0696	ND	3120	5090	ND
62	51.4	ND	ND	534	1540	ND
63	49.4	ND	ND	487	1420	ND
69	***675***	ND	ND	***8010***	***16,400***	***1.55***
72	182	9.88	0.0323	***4820***	***7820***	0.017
81	154	***28.8***	***0.0723***	***4090***	***7360***	0.0168
100	38.5	0.227	ND	2160	3570	0.00138
Moquino New	6.34	0.164	ND	102	454	ND

Notes:
[a] Significant digits are reported by the laboratory and are based on detection limits.
[b] ***Bold italicized*** results exceed the corresponding New Mexico standard (from Table 3-3):
250 mg/L chloride, 10 mg/L nitrate (as nitrogen [N]), 0.05 mg/L selenium, 4000 mg/L sulfate, 5880 mg/L TDS, and 0.03 mg/L uranium.
[c] Nitrate plus nitrite as nitrogen (NO_3 + NO_2 as N).

Abbreviation:
ND = not detected (below laboratory detection limit)

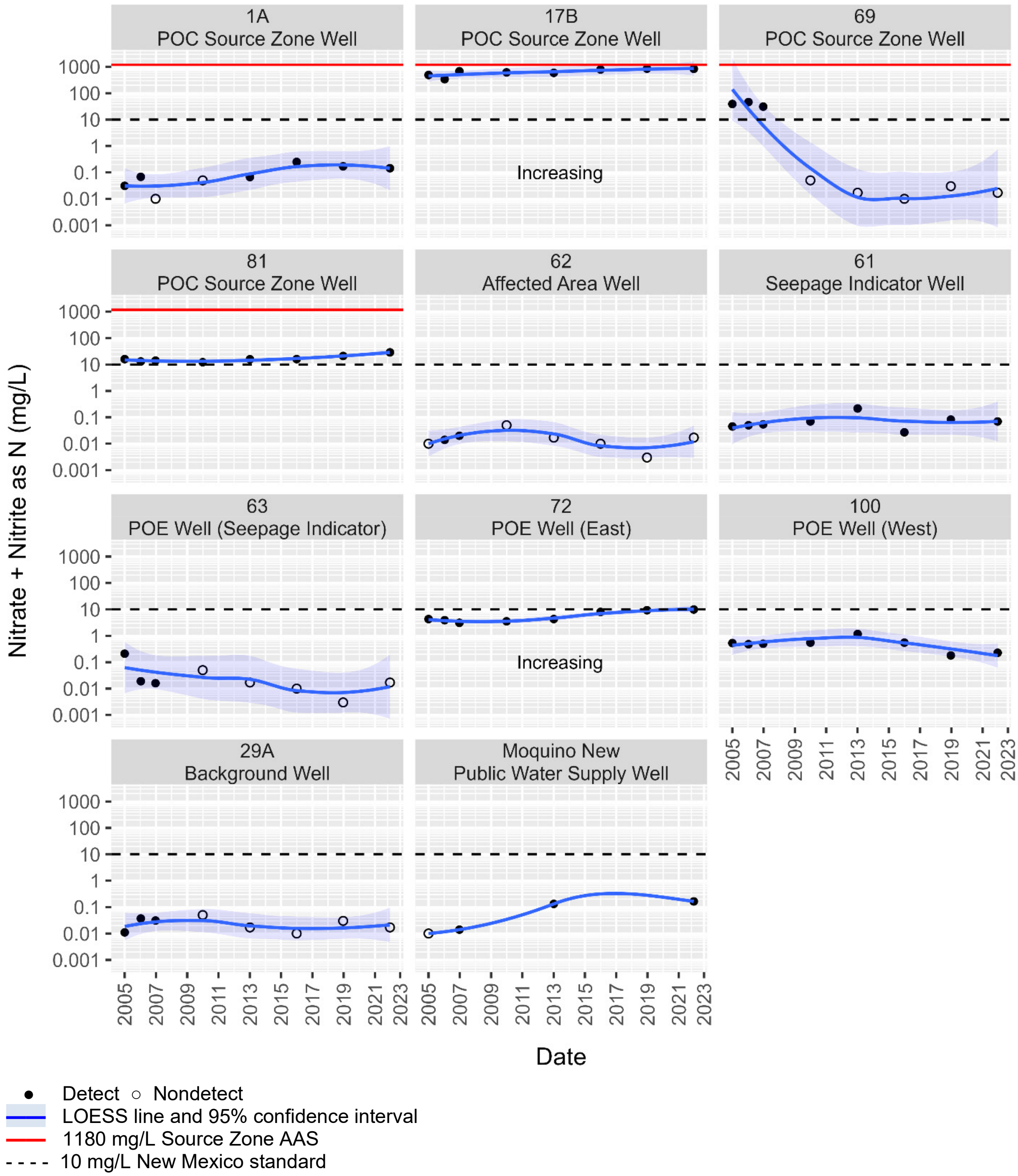
Figure 3-5 through Figure 3-10 plot results for the six analytes from 2005–2022 and relative to the limits and standards listed in Table 3-3. Although the focus of the monitoring program is to demonstrate compliance with LTSP requirements (i.e., to ensure that no ACL or AAS source zone levels are exceeded), results are also plotted relative to corresponding New Mexico standards to facilitate review. Consistent with previous annual reports (e.g., DOE 2022), since sampling commenced in 2005, no ACL or AAS source zone levels have been exceeded in any of the POC wells, and no AAS affected area levels have been exceeded in monitoring well 62. Sulfate and TDS background values approved by the State of New Mexico for the L-Bar site have been exceeded in POE well 72 in four and seven (respectively) of the eight sampling events. The sulfate background value (4000 mg/L) was exceeded in 2006 and then in the last three consecutive sampling events (2016, 2019, and 2022) (Figure 3-8). The TDS background value (5880 mg/L) has been consistently exceeded in well 72, except in 2016 (Figure 3-9). In background well 29A, approved background concentrations for sulfate and TDS have been exceeded in all eight sampling events except one: 3900 mg/L sulfate in 2010.

The time-concentration plots provided in this section were generated using a faceting approach, whereby data for each well are plotted separately. A nonparametric locally estimated scatterplot smoothing (LOESS) method is applied to facilitate interpretation of the figures. Using this approach, overall trends in the data are more apparent and not obscured by “noise” or random variation. To support interpretation of these figures, Mann-Kendall trend analysis was performed for each well-parameter combination to characterize whether trends in analyte concentrations are upward, stable (no trend), or declining. Detailed Mann-Kendall trend test results are provided in Table 3-5.



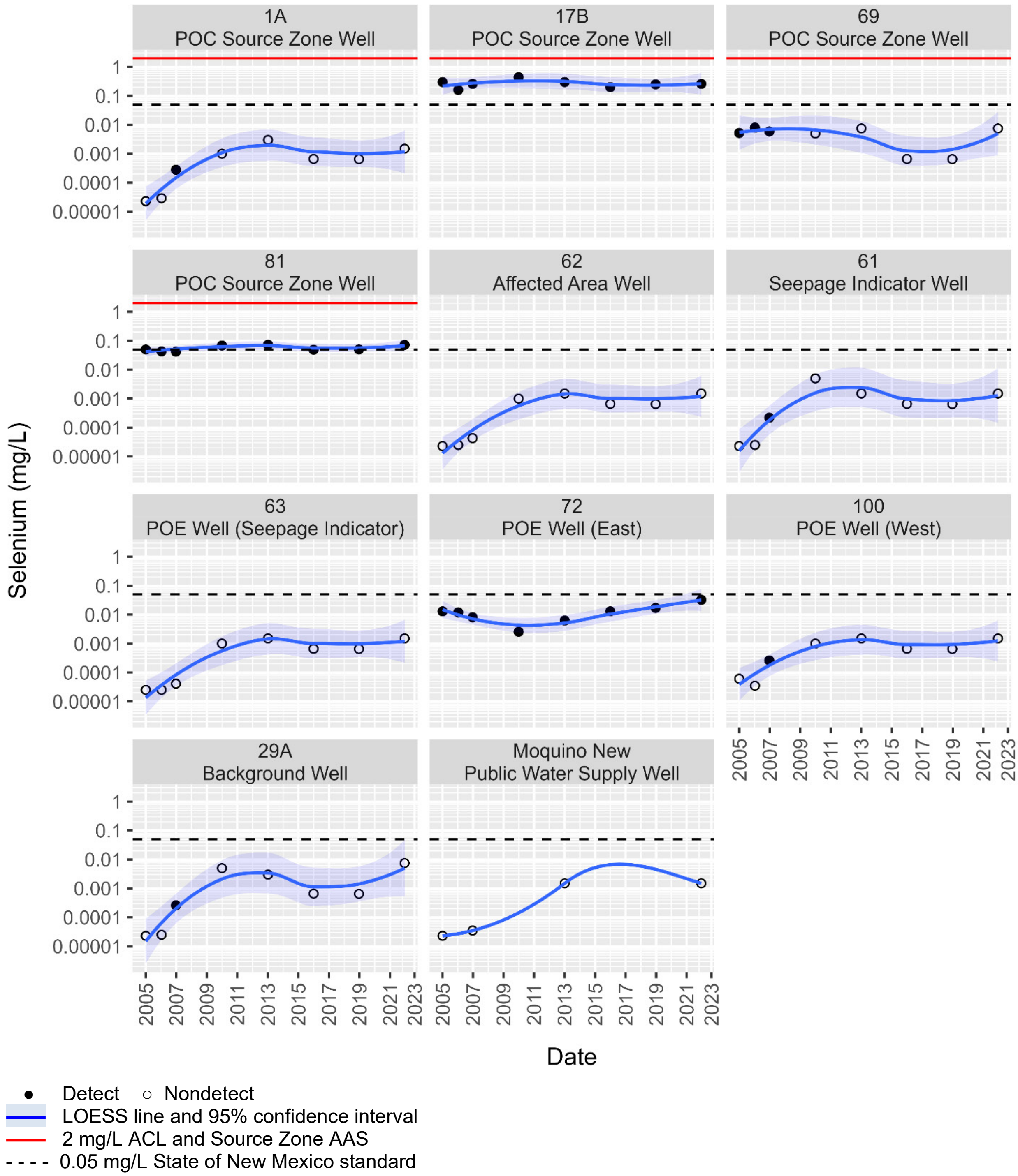
Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A are plotted last.
Data are not plotted for the Moquino New public water supply well because the historically low chloride concentrations (3.9–6.4 mg/L) affect the scaling of this figure. The most recent chloride result in the Moquino New well was 6.34 mg/L (Table 3-4). For wells with statistically significant trends based on Mann-Kendall trend analysis (alpha of 0.05; p-value <0.05), the direction of the trend is indicated on the plot.

Figure 3-5. Chloride Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022



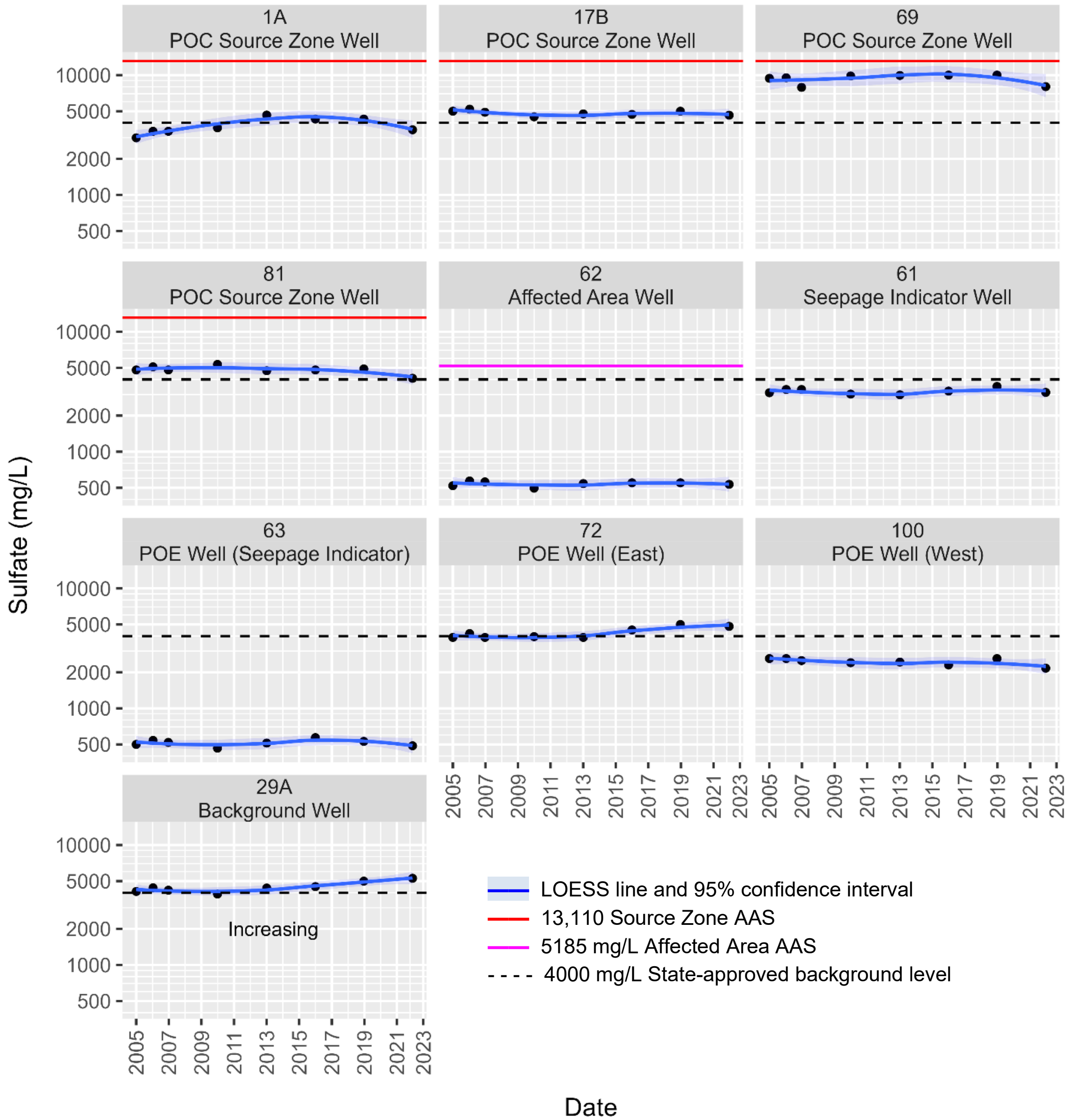
Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A and the Moquino New well are plotted last. For wells with statistically significant trends based on Mann-Kendall trend analysis (alpha of 0.05; p-value <0.05), the direction of the trend is indicated on the plot. Although a significant decreasing trend was identified for well 69, this result is not considered meaningful because of the high proportion of nondetects.

Figure 3-6. Nitrate Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022



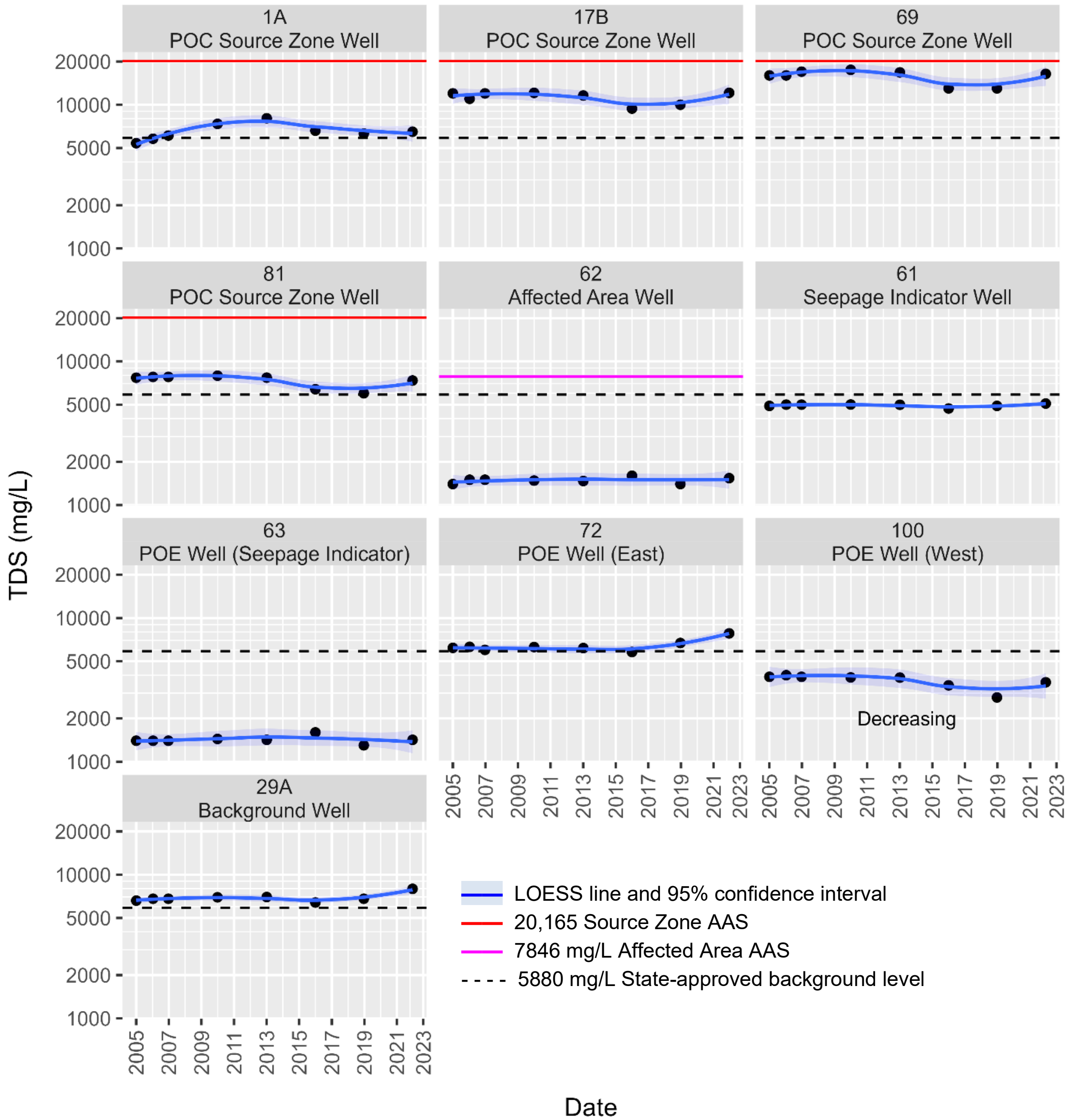
Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A and the Moquino New well are plotted last. For all wells, no statistically significant trend in selenium concentrations was found based on Mann-Kendall trend analysis (most wells have a high proportion of nondetects).

Figure 3-7. Selenium Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022



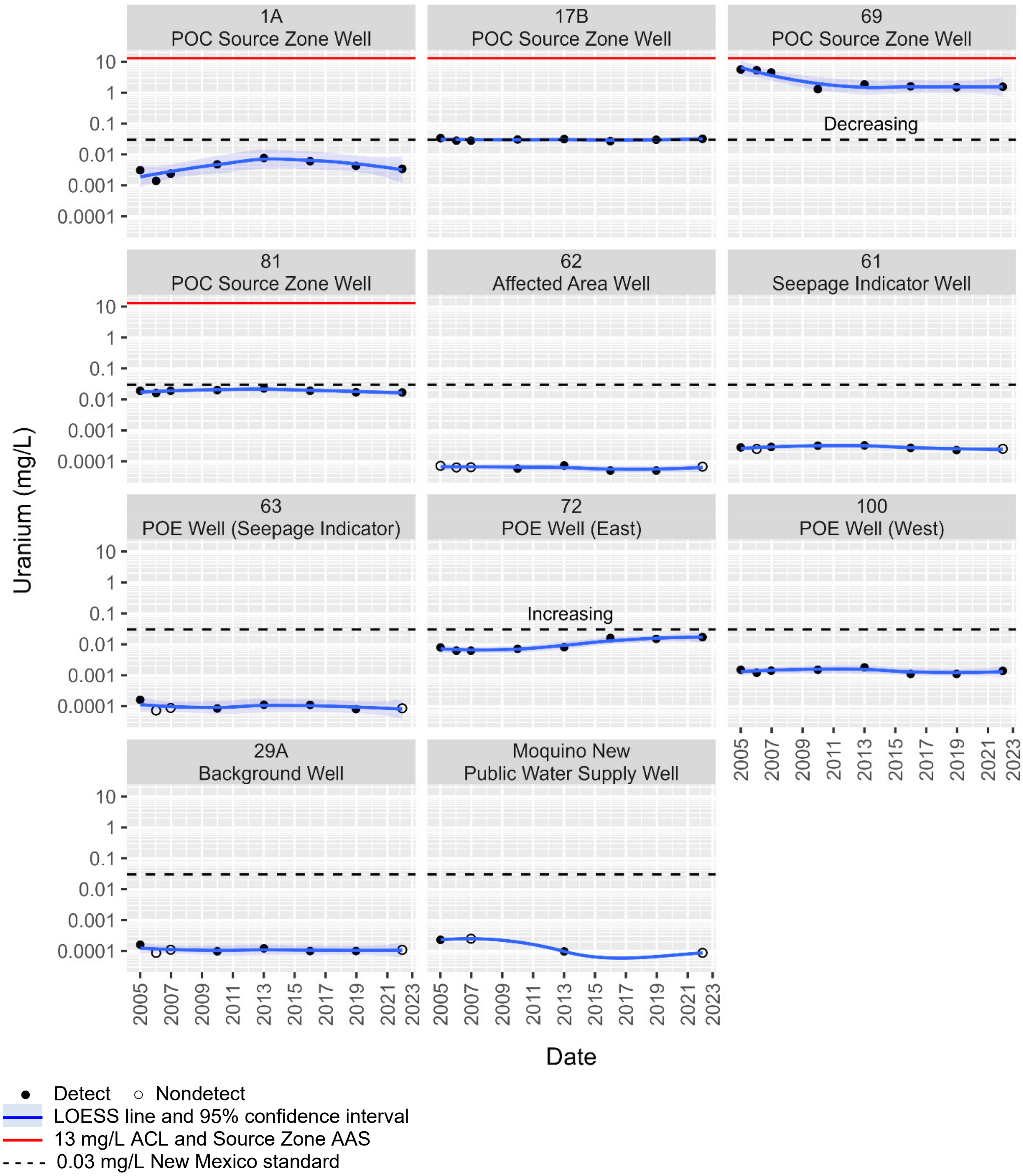
Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A are plotted last.
Data are not plotted for the Moquino New public water supply well because the historically low sulfate concentrations (91.9–120 mg/L) affect the scaling of this figure. The most recent sulfate result in the Moquino New well was 102 mg/L (Table 3-4). For wells with statistically significant trends based on Mann-Kendall trend analysis, the direction of the trend is indicated on the plot.

Figure 3-8. Sulfate Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022



Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A are plotted last.
Data are not plotted for the Moquino New public water supply well because the historically low TDS concentrations (454–530 mg/L) affect the scaling of this figure. The most recent TDS result in the Moquino New well was 454 mg/L (Table 3-4). For wells with statistically significant trends based on Mann-Kendall trend analysis, the direction of the trend is indicated on the plot.

Figure 3-9. TDS Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022



Notes: Wells are ordered by purpose: POC source zone wells are listed first, followed by affected area seepage indicator well 62, and remaining indicator and POE wells. Data for background well 29A and the Moquino New well are plotted last. For wells with statistically significant trends based on Mann-Kendall trend analysis, the direction of the trend is indicated on the plot.

Figure 3-10. Uranium Concentrations in Groundwater at the L-Bar Disposal Site, 2005–2022

Table 3-5. Mann-Kendall Trend Analysis Results for Analytes in L-Bar Site Monitoring Wells, 2005–2022

Well[a]	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Number of Nondetects[b]	Kendall's tau[c]	p-value[d]	Trend[c,d]
Chloride							
1A[e]	11/17/2005	11/2/2022	8	0	0.286	0.39	No Trend
17B[e]	11/18/2005	11/2/2022	8	0	−0.607	0.046	Decreasing
29A	11/18/2005	11/2/2022	8	0	0.536	0.081	No Trend
61	11/17/2005	11/2/2022	8	0	0.107	0.80	No Trend
62	11/17/2005	11/2/2022	8	0	0.464	0.14	No Trend
63[f]	11/17/2005	11/2/2022	8	0	0.357	0.27	No Trend
69[e]	11/17/2005	11/2/2022	8	0	0	1	No Trend
72[f]	11/18/2005	11/2/2022	8	0	0.429	0.17	No Trend
81[e]	11/17/2005	11/2/2022	8	0	0.464	0.14	No Trend
100[f]	11/17/2005	11/2/2022	8	0	0.321	0.32	No Trend
Nitrate + Nitrite as N							
1A[e]	11/17/2005	11/2/2022	8	2	0.464	0.13	No Trend
17B[e]	11/18/2005	11/2/2022	8	0	0.643	0.035	Increasing
29A	11/18/2005	11/2/2022	8	5	NA		
61	11/17/2005	11/2/2022	8	0	0.429	0.17	No Trend
62	11/17/2005	11/2/2022	8	6	NA		
63[f]	11/17/2005	11/2/2022	8	5	NA		
69[e]	11/17/2005	11/2/2022	8	5	NA		
72[f]	11/18/2005	11/2/2022	8	0	0.643	0.035	Increasing
81[e]	11/17/2005	11/2/2022	8	0	0.536	0.081	No Trend
100[f]	11/17/2005	11/2/2022	8	0	−0.107	0.80	No Trend
Selenium							
1A[e]	11/17/2005	11/2/2022	8	7	NA		
17B[e]	11/18/2005	11/2/2022	8	0	−0.071	0.90	No Trend
29A	11/18/2005	11/2/2022	8	7	NA		
61	11/17/2005	11/2/2022	8	7	NA		
62	11/17/2005	11/2/2022	8	8	NA		
63[f]	11/17/2005	11/2/2022	8	8	NA		
69[e]	11/17/2005	11/2/2022	8	5	NA		
72[f]	11/18/2005	11/2/2022	8	0	0.321	0.32	No Trend
81[e]	11/17/2005	11/2/2022	8	0	0.321	0.32	No Trend
100[f]	11/17/2005	11/2/2022	8	7	NA		
Sulfate							
1A[e]	11/17/2005	11/2/2022	8	0	0.536	0.081	No Trend
17B[e]	11/18/2005	11/2/2022	8	0	−0.393	0.21	No Trend
29A	11/18/2005	11/2/2022	8	0	0.643	0.035	Increasing
61	11/17/2005	11/2/2022	8	0	0.036	1	No Trend
62	11/17/2005	11/2/2022	8	0	−0.107	0.80	No Trend
63[f]	11/17/2005	11/2/2022	8	0	−0.036	1	No Trend
69[e]	11/17/2005	11/2/2022	8	0	0.393	0.21	No Trend
72[f]	11/18/2005	11/2/2022	8	0	0.536	0.075	No Trend
81[e]	11/17/2005	11/2/2022	8	0	−0.25	0.45	No Trend
100[f]	11/17/2005	11/2/2022	8	0	−0.536	0.075	No Trend

Table 3-5. Mann-Kendall Trend Analysis Results for Analytes in L-Bar Site Monitoring Wells, 2005–2022 (continued)

Well[a]	Initial Trend Analysis Date	Final Trend Analysis Date	Number of Samples	Number of Nondetects[b]	Kendall's tau[c]	p-value[d]	Trend[c,d]
TDS							
1A[e]	11/17/2005	11/2/2022	8	0	0.429	0.17	No Trend
17B[e]	11/18/2005	11/2/2022	8	0	−0.071	0.90	No Trend
29A	11/18/2005	11/2/2022	8	0	0.393	0.20	No Trend
61	11/17/2005	11/2/2022	8	0	0.071	0.90	No Trend
62	11/17/2005	11/2/2022	8	0	0.143	0.71	No Trend
63[f]	11/17/2005	11/2/2022	8	0	0.214	0.52	No Trend
69[e]	11/17/2005	11/2/2022	8	0	−0.143	0.71	No Trend
72[f]	11/18/2005	11/2/2022	8	0	0.214	0.54	No Trend
81[e]	11/17/2005	11/2/2022	8	0	−0.393	0.21	No Trend
100[f]	11/17/2005	11/2/2022	8	0	−0.75	0.013	Decreasing
Uranium							
1A[e]	11/17/2005	11/2/2022	8	0	0.286	0.39	No Trend
17B[e]	11/18/2005	11/2/2022	8	0	0.036	1	No Trend
29A	11/18/2005	11/2/2022	8	3	−0.071	0.89	No Trend
61	11/17/2005	11/2/2022	8	2	−0.179	0.61	No Trend
62	11/17/2005	11/2/2022	8	4	−0.036	1	No Trend
63[f]	11/17/2005	11/2/2022	8	3	−0.179	0.60	No Trend
69[e]	11/17/2005	11/2/2022	8	0	−0.643	0.035	Decreasing
72[f]	11/18/2005	11/2/2022	8	0	0.679	0.025	Increasing
81[e]	11/17/2005	11/2/2022	8	0	−0.107	0.80	No Trend
100[f]	11/17/2005	11/2/2022	8	0	−0.214	0.53	No Trend

Notes:

[a] Trend tests were performed using the "NADA: Nondetects and Data Analysis for Environmental Data" package in R, version 1.6-1.1 (Lee 2020). The NADA trend test is similar to the traditional Mann-Kendall trend test except that it accounts for the presence of nondetects at multiple detection limits. Trend analyses were conducted at the 0.05 significance (or alpha) level using a two-sided test.

[b] Mann-Kendall trend analysis results are not reported for well-parameter combinations with a detection frequency less than 50% (applies to nitrate and selenium).

[c] The test statistic Kendall's tau is a measure of the strength of the association between two variables, with values always falling between −1 and +1. A tau value of 1.0 corresponds to a perfect strong association between the time series, indicating a significant increasing trend. Conversely, a perfect association in the negative direction (for decreasing trends) will have a tau value of −1.0. Time-series data with no statistically significant trend will have a tau value closer to 0.0.

[d] A calculated p-value of <0.05 indicates that the null hypothesis is rejected and a significant trend in the time series exists.

[e] POC well.

[f] POE well.

Abbreviation:
NA = not applicable (trend analysis results are not meaningful given the high proportion of nondetects)

For most well-parameter combinations that were evaluated, no statistically significant increasing or decreasing trend was found (Table 3-5). Exceptions to the latter are identified in Figure 3-5 through Figure 3-9 and the information is presented below.

Chloride concentrations in POC source zone wells 1A, 17B, and 69 continue to exceed the 250 mg/L State of New Mexico standard but are below the corresponding 1127 mg/L AAS (Figure 3-5). The highest chloride concentrations have been measured in well 69 (590–850 mg/L). Chloride concentrations have decreased in well 17B (Table 3-5), from a maximum of 450 mg/L in 2007 to 283 mg/L in 2022, just slightly above the 250 mg/L standard. The remaining POC well (81) has chloride concentrations below the State of New Mexico standard (120–193 mg/L).

The three POE wells (63, 72, and 100) have chloride concentrations below the State of New Mexico standard (Figure 3-5). Temporal chloride concentrations in background well 29A mimic those in POE well 72 and have ranged from 140 to 200 mg/L.

Nitrate (+ nitrite as nitrogen [N]) concentrations in all but three site monitoring wells have been below the 10 mg/L New Mexico standard (Figure 3-6). The highest nitrate concentrations have been measured in POC source zone well 17B (340–850 mg/L); Mann-Kendall trend analysis indicates a statistically significant increasing trend (Table 3-5). The most recent (2022) result, 838 mg/L, is below the 1180 mg/L AAS, but if the increasing trend continues, the AAS could be met or potentially exceeded.

Nitrate levels in POC source zone well 69 exceeded the 10 mg/L standard between 2005 and 2007 (31–46 mg/L), then declined to nondetectable levels (≤0.05 mg/L) (Figure 3-6). Nitrate concentrations in POC source zone well 81 have remained at levels slightly exceeding the 10 mg/L standard (12.2–28.8 mg/L) but well below the 1180 mg/L AAS. The maximum concentration was measured in November 2022.

In addition to POC well 17B, a statistically significant increasing trend was also found for eastern POE well 72 (Table 3-5), where the nitrate concentration in November 2022 (9.88 mg/L) was approximately equal to the 10 mg/L State of New Mexico standard. If the increasing concentration trend continues, the State of New Mexico nitrate standard will soon be exceeded.

Consistent with previous annual reports (DOE 2021; DOE 2022), except for POC source zone wells 17B and 81 (0.16–0.44 and 0.042–0.073 mg/L, respectively), selenium concentrations in all site monitoring wells have been below the 0.05 mg/L New Mexico standard (Figure 3-7). Results for most remaining wells have been below the detection limit. An exception is POE well 72, where selenium concentrations are approaching the 0.05 mg/L standard; the most recent (2022) result was 0.032 mg/L. Although concentrations in this well are trending upward (as indicated by a positive tau value), the trend is not statistically significant (Table 3-5). However, if concentration trends continue as observed since 2013, the 0.05 mg/L State of New Mexico selenium standard will likely soon be exceeded.

Mann-Kendall trend analysis identified no statistically significant trends in selenium concentrations in any of the monitoring wells (most wells have a high proportion of nondetects). Selenium concentrations in POC source zone wells have been below the corresponding 2 mg/L ACL and AAS (Figure 3-7).

Sulfate concentrations in the four POC source zone wells continue to be below the corresponding 13,110 mg/L AAS. The highest concentrations (7900–10,000 mg/L) have been measured in well 69. Sulfate concentrations in remaining POC source zone wells (1A, 17B, and 81) are comparable to (usually just slightly exceeding) the 4000 mg/L state-approved background level (Figure 3-8). Sulfate concentrations in AAS affected area well 62 (496–570 mg/L) have been well below the corresponding AAS of 5185 mg/L. Similar levels (465–570 mg/L) have been measured in POE seepage indicator well 63 (Figure 3-8), while concentrations in seepage indicator well 61 have been stable (non-trending) at levels just below the 4000 mg/L standard (2980–3500 mg/L).

Sulfate concentrations in eastern POE well 72 have exceed this standard since 2016 (4500–5000 mg/L) and are trending upward (as indicated by a positive tau value), but the trend is not statistically significant (Table 3-5). A statistically significant increasing trend was identified for background well 29A, where sulfate concentrations have exceeded the state-approved background level in all but one sample, with the maximum (5280 mg/L) measured in November 2022. As shown in Figure 3-8, sulfate concentrations in POE well 72 are very similar to those measured in well 29A. Both wells have concentrations now exceeding those measured in upgradient POC well 17B as shown in Figure 3-11.

Figure 3-11 was developed to satisfy a requirement in Section 3.7.1 of the LTSP, which states that annual inspection reports are to include a groundwater level contour map (provided in Figure 3-3) and a sulfate isoconcentration map for the years that sampling has been conducted (DOE 2004). As discussed in previous annual reports (DOE 2021; DOE 2022), bubble plot maps for sulfate were generated in lieu of isoconcentration maps because of the limited number of well locations. No water quality measurements have been taken directly beneath the tailings impoundment, so interpolated isoconcentrations would likely not be representative of site conditions. All site monitoring wells are screened within the First Tres Hermanos Sandstone unit and do not represent contaminant levels in porous media above or below this stratigraphic unit. Sulfate concentrations continue to be highest in POC source zone well 69 (8080 mg/L). The state-approved background level is also currently exceeded in POC well 81 and the three easternmost wells: POC source zone well 17B, POE well 72, and background well 29A.

General observations for TDS in L-Bar site wells are very similar to those discussed above for sulfate. TDS levels in POC source zone wells have exceeded the state-approved background level of 5880 mg/L but have been below the corresponding AAS of 20,165 mg/L (Figure 3-9). TDS levels have been highest in POC source zone well 69 (13,000–17,500 mg/L) and lowest in affected area well 62 (1400–1600 mg/L, well below the corresponding AAS of 7846 mg/L) and POE seepage indicator well 63 (1300–1600 mg/L).

As observed for sulfate, TDS concentrations in eastern POE well 72 are similar to those in background well 29A (>5880 mg/L for the last two sampling events), and the trend in both wells is slightly increasing but not statistically significant (Table 3-5). TDS concentrations in background well 29A have exceeded 5880 mg/L in all eight samples, with the maximum (like sulfate), 7970 mg/L, measured in November 2022. The only statistically significant trend in TDS concentrations was found for western POE well 100, with a decreasing trend (Table 3-5).

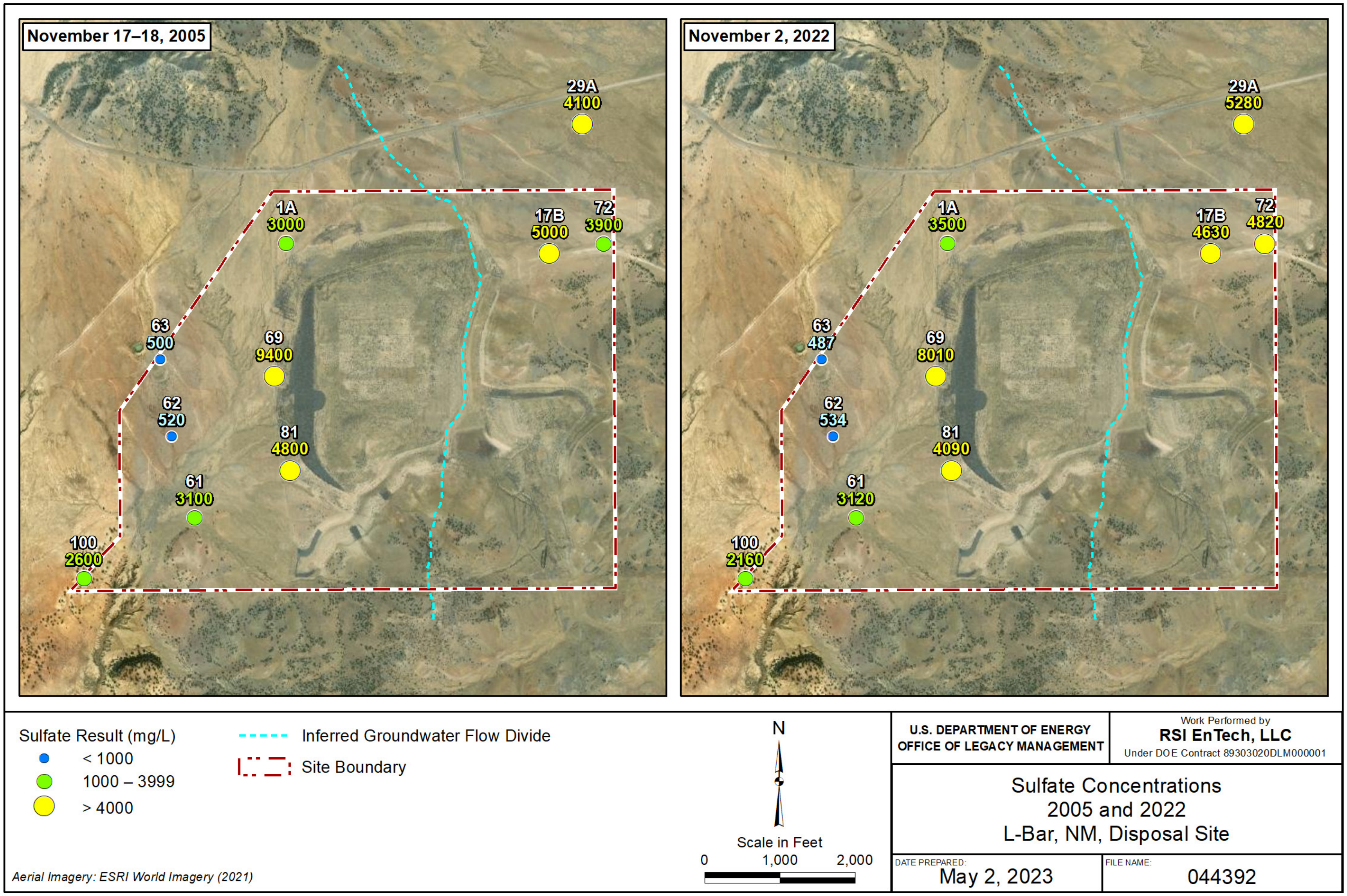


Figure 3-11. Sulfate Concentrations in 2005 and 2022, L-Bar Site Monitoring Wells

Uranium concentrations in POC wells 17B and 69 were above the 0.03 mg/L State of New Mexico standard in 2022 (Figure 3-10). Historically, uranium concentrations in POC source zone well 17B have remained stable at or slightly exceeding the standard (0.027–0.034 mg/L), while concentrations in well 69 have exceeded the standard by 1 to 2 orders of magnitude (1.3–5.6 mg/L). Although Mann-Kendall trend analysis yielded a statistically significant decreasing trend for well 69 from 2005–2022 (Table 3-5), the trend appears to have stabilized since 2010 (Figure 3-10). Uranium concentrations in all POC source zone wells continue to be below the 13 mg/L ACL and AAS.

Uranium concentrations in eastern POE well 72, although historically below the 0.03 mg/L standard, are increasing and approaching this value (most recent maximum result of 0.017 mg/L). If this increasing trend continues, uranium concentrations in POE well 72 may exceed the State of New Mexico standard in the future.

3.7.2 Erosion Monitoring Program

An erosion monitoring program (EMP) was developed to address potential erosion of the disposal cell cover over time and was incorporated as an LTSP requirement. Sohio Western Mining Company developed the plan at the request of the New Mexico Water Quality Control Commission as a condition for granting AASs for groundwater at the site. In accordance with Appendix C of the LTSP, erosion measurements will be performed annually for 20 years, through 2023, and then once every 10 years for the following 80 years. In accordance with the EMP, erosion will be considered excessive when 2 ft of erosion is noted at more than half of the monitoring locations.

The cover of the disposal cell consists of several feet of clay-rich soil materials and a 4.1 foot thick (minimum) compacted layer of clay that functions as a radon barrier. The total thickness of the cover ranges from 6–10 ft. The EMP has two requirements: (1) measure surface soil erosion and (2) measure the progress of revegetation. Erosion and vegetation monitoring was done on August 22, 2023.

3.7.2.1 Erosion Monitoring

In accordance with the EMP, the former licensee installed a grid of 20 evenly spaced monitoring locations on the cover in November 2003 (Figure 3-1). The locations were initially measured in December 2003 by the former licensee to establish baseline values.

Each monitoring location consists of a 5-foot length of half-inch-diameter, epoxy-coated rebar surrounded by three metal T-posts. The rebar was driven at each location so that approximately 1 ft remained above the soil surface. The three T-posts are set approximately 6 ft from the rebar and form an equilateral triangle, with one point of the triangle due east of the rebar. An 8-foot length of PVC pipe was mounted over the east T-post at each monitoring location in 2016 to aid in finding the monitoring locations in the increasingly tall vegetation.

Erosion measurement is accomplished by placing a 4-foot-long level centered at the base of the rebar (and on the north side of the rebar) so the east end of the level points to the easternmost T-post. The height of the rebar is measured from the base of the level to the top of the rebar and is recorded to the nearest 1/16 inch, using the method established during baseline measurements in 2003.

Results of the 2023 measurements are presented in Table 3-6. The surface elevation has increased by 0.13–2.4 inches at the monitoring locations when compared to the baseline measurements taken in 2003. These results indicate that the surface of the disposal cell is rising compared to 2003. Since 2003, the surface has risen an average of 1.040 inches and decreased an average of 0.413 inch since 2022. The decreased surface is most likely due to loss of vegetation at monitoring locations. As vegetation declines on the disposal cell cover, the surface elevation drops through lack of underground root growth and the accumulation of organic matter in the soil. Vegetation prevents or slows surface erosion, and windborne sediment deposition can also increase in vegetated areas as the plants' foliage and stems slow wind speeds, which allows sediment to accumulate more quickly. The slight reduction since 2022 is probably also because soils were very dry from drought conditions at the site during monitoring. Cover soils were wetter during last year's monitoring, and heavy clay soils, such as those on the disposal cell cover, tend to expand when wet.

Table 3-6. Surface Elevation Changes on the L-Bar, New Mexico, Disposal Cell Cover Between 2003 and 2023

Monitoring Location	Length of Rebar Above Surface (inches)				Change in Surface Elevation[a] Baseline to Present (decimal inches)
	2003 (Baseline)		2023		
	(fraction)	(decimal)	(fraction)	(decimal)	
A1	12 10/16	12.625	10 4/16	10.250	2.375
A2	12 7/16	12.438	11 12/16	11.750	0.688
A3	12 15/16	12.938	11 9/16	11.563	1.375
A4	12 6/16	12.375	11 3/16	11.188	1.187
B1	12 10/16	12.625	10 10/16	10.625	2
B2	12 8/16	12.500	11 14/16	11.875	0.625
B3	13 0/16	13.000	12 6/16	12.375	0.625
B4	12 15/16	12.938	11 14/16	11.875	1.063
C1	12 8/16	12.500	10 10/16	10.625	1.875
C2	13 1/16	13.063	12 10/16	12.625	0.438
C3	12 2/16	12.125	11 8/16	11.500	0.625
C4	12 6/16	12.375	12 0/16	12.000	0.375
D1	12 7/16	12.438	11 12/16	11.750	0.688
D2	12 12/16	12.750	12 10/16	12.625	0.125
D3	12 3/16	12.188	10 13/16	10.813	1.375
D4	12 12/16	12.750	12 8/16	12.500	0.25
E1	13 1/16	13.063	11 13/16	11.813	1.25
E2	12 14/16	12.875	12 0/16	12.000	0.875
E3	12 9/16	12.563	11 8/16	11.500	1.063
E4	12 15/16	12.938	11 0/16	11.000	1.938

Note:

[a] A positive change indicates that the surface elevation at that monitoring point increased; a negative change indicates that the surface elevation at that location decreased. Negative changes were apparent in 2023.

3.7.2.2 *Vegetation Monitoring*

Vegetation monitoring plots were established at 10 of the erosion monitoring locations to record changes in the vegetation over time. Plots were established at locations A1, A3, B2, B4, C1, C3, D2, D4, E1, and E3. At each plot, the three existing T-posts were used to form three corners of the plot, and a fourth point was projected south of the three T-posts to form a parallelogram covering approximately 100 square ft. An ecologist visually estimated the percent foliar cover of each species of live vegetation within each plot. Percent foliar cover is the vertical projection of leaf area onto the ground surface. Foliar cover would equal the shadow cast by the vegetation if the sun was directly overhead, excluding openings or overlaps in the canopy.

In accordance with the EMP, LM will perform annual vegetation monitoring until at least 20% average foliar cover is achieved, and when more than half of the monitoring plots exceed 20% cover by perennial plants. In 2023, the average cover of perennial plants was 16%. Four of the 10 plots contained 20% or more perennial cover. The decrease in cover was probably due to drought conditions at the site. The success criterion was not met in 2023, so annual monitoring will be required until a significant increase in plant density is noted during future annual site inspections.

Perennial plant species observed in the plots in 2023 include, in order of abundance: four-wing saltbush (*Atriplex canescens)*, broom snakeweed (*Gutierrezia sarothrae*), and James' galleta (*Pleuraphis jamesii*), with traces of dropseed (*Sporobolus* spp.), rubber rabbitbrush (*Ericameria nauseosa*), and squirreltail (*Elymus elymoides*).

3.8 References

10 CFR 40.28. U.S. Nuclear Regulatory Commission, "General License for Custody and Long-Term Care of Uranium or Thorium Byproduct Materials Disposal Sites," *Code of Federal Regulations.*

10 CFR 835. U.S. Department of Energy, "Occupational Radiation Protection Program," *Code of Federal Regulations*.

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

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3.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	70	Culvert Outlets Along Access Road near Perimeter Sign P9
PL-2	85	Partially Buried Fence from Sedimentation near Perimeter Sign P18
PL-3	255	Erosional Feature on Southwest Fence Between Perimeter Signs P19 and P20 (Looking from Top to Bottom)
PL-4	210	Personnel Gate Along Southwestern Perimeter Fence
PL-5	180	Site Marker
PL-6	0	Boundary Monument BM-3
PL-7	190	Quality Control Monument QC-5
PL-8	27	Erosive Channeling Around Monitoring Well 62
PL-9	270	Degradation Feature Roughly 120 Feet East of Erosion Monitoring Location A1
PL-10	220	Degradation Feature E-004 on Disposal Cell Top Slope
PL-11	—	Degradation Feature E-004 on Disposal Cell Top Slope Horizontal Piping
PL-12	—	Deep Desiccation Cracking of Surface Soils
PL-13	80	Overview of Stormwater Route in Spillway with Cattails Noted at Base
PL-14	90	Additional Overview of Potential Depression Formation
PL-15	140	Water in Sediment Trap
PL-16	15	Gully Erosion at Erosion Control Structure G
PL-17	335	Erosion at Structure A
PL-18	100	Erosion at Structure A Along Second Block Structure
PL-19	90	East Channel Cutoff Wall
PL-20	90	Rilling Contacting South Channel Cutoff Wall

Note:
— = Photograph taken vertically from above.

PL-1. Culvert Outlets Along Access Road near Perimeter Sign P9

PL-2. Partially Buried Fence from Sedimentation near Perimeter Sign P18

PL-3. Erosional Feature on Southwest Fence Between Perimeter Signs P19 and P20 (Looking from Top to Bottom)

PL-4. Personnel Gate Along Southwestern Perimeter Fence

PL-5. Site Marker

PL-6. Boundary Monument BM-3

PL-7. Quality Control Monument QC-5

PL-8. Erosive Channeling Around Monitoring Well 62

PL-9. Degradation Feature Roughly 120 Feet East of Erosion Monitoring Location A1

PL-10. Degradation Feature E-004 on Disposal Cell Top Slope

PL-11. Degradation Feature E-004 Horizontal Piping

PL-12. Deep Desiccation Cracking of Surface Soils

PL-13. Overview of Stormwater Route in Spillway with Cattails Noted at Base

PL-14. Additional Overview of Potential Depression Formation

PL-15. Water in Sediment Trap

PL-16. Gully Erosion at Erosion Control Structure G

PL-17. Erosion at Structure A

PL-18. Erosion at Structure A Along Second Block Structure

PL-19. East Channel Cutoff Wall

PL-20. Rilling Contacting South Channel Cutoff Wall