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U.S. DEPARTMENT OF ENERGY

Legacy Management

2018 Annual Site Inspection and Monitoring Report for Uranium Mill Tailings Radiation Control Act Title II Disposal Sites

December 2018

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Contents

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Abbreviations

AAS	alternate abatement standard
ACL	alternate concentration limit
BIA	Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
EMP	erosion monitoring program
IC	institutional control
LIDAR	light detection and ranging
LM	Office of Legacy Management
LMS	Legacy Management Support
LTS&M	long-term surveillance and maintenance
LTSP	Long-Term Surveillance Plan
mg/L	milligrams per liter
NMED	New Mexico Environment Department
NRC	U.S. Nuclear Regulatory Commission
PCB	polychlorinated biphenyl
PL	photograph location
PMF	probable maximum flood
POC	point of compliance
POE	point of exposure
^{226}Ra	radium-226
^{228}Ra	radium-228
TDS	total dissolved solids
UMTRCA	Uranium Mill Tailings Radiation Control Act
WDEQ	Wyoming Department of Environmental Quality

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Executive Summary

This report, in fulfillment of a license requirement, presents the results of long-term surveillance and maintenance (LTS&M) activities conducted by the U.S. Department of Energy (DOE) Office of Legacy Management (LM) in 2018 at six uranium mill tailings disposal sites reclaimed under Title II of the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). These activities verified that the UMTRCA Title II disposal sites remain in compliance with license requirements. Long-Term Surveillance Plans (LTSPs) and site compliance reports are available on the internet at https://energy.gov/lm/sites/lm-sites.

LM manages six UMTRCA Title II disposal sites under a general license established by the U.S. Nuclear Regulatory Commission (NRC) in Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Reclamation and site transition activities continue at other sites, and LM anticipates managing 30 Title II disposal sites.

LTS&M activities and services for these disposal sites include inspecting and maintaining the sites; monitoring environmental media and institutional controls; conducting any necessary corrective action; and performing administrative, records, stakeholder relations, and other regulatory stewardship functions.

Annual site inspections and monitoring are conducted in accordance with site-specific LTSPs and procedures established by LM to comply with license requirements. Each site inspection is performed to verify the integrity of visible features at the site; to identify changes or new conditions that might affect the long-term performance of the site; and to determine the need, if any, for maintenance, follow-up inspections, or corrective action in accordance with the LTSP.

All of the sites require some degree of routine monitoring and maintenance, which can include groundwater and surface water monitoring, minor erosion control, vegetation management, fence and gate repairs, sign replacement, and minor trash removal. The following nonroutine activities[1] occurred in 2018:

- **Multiple sites:** In 2018 at both the L-Bar, New Mexico, and Maybell West, Colorado, Sites, a baseline aerial survey using photogrammetry was performed to obtain accurate site topography for future comparison. Multispectral imagery was also collected to assess vegetation coverage at the Maybell West site. Permanent quality control monuments were installed at the sites for LM to verify accuracy and quality of aerial survey data. All LM Title II sites will have a baseline aerial survey performed over the next 3 years.
- **Bluewater, New Mexico:** In 2018 LM developed a conceptual design to repair depressions on the main tailings disposal cell, regrade the north portion of the top slope, and construct a spillway on the north side slope to ensure positive drainage. In 2019, LM will continue to work on the design and coordinate with NRC regarding its concurrence.
- **Bluewater, New Mexico:** Groundwater was sampled in November 2017 and May 2018. Analytical results indicate that alternate concentration limits (ACLs) were not exceeded. However, groundwater leaving the site in both the alluvial and bedrock aquifers has uranium concentrations exceeding the New Mexico groundwater standard. No known domestic wells

[1] Nonroutine activities are activities implemented in response to changes in site conditions, the regulatory setting, or the management structure following an extraordinary event or regulatory compliance review.

within the contaminant plumes have uranium concentrations exceeding the drinking water standard (equivalent to the groundwater standard), and the plumes are not expected to impact local municipal water supplies. A report reevaluating the extent of the contaminant plumes was completed in 2018. The report will be provided to NRC and made available to the public.

- **L-Bar, New Mexico:** In 2018 LM developed conceptual designs to repair damaged erosion control structures that LM had installed in 2009. In 2019, LM will continue to work on the designs and coordinate with NRC, as needed, regarding its concurrence.
- **Sherwood, Washington:** During the 2015 annual site inspection, a ground-level elevation survey was requested by NRC to determine actual settlement values (as opposed to estimated values) to verify that settlement is within the allowance of the disposal cell design. LM conducted an elevation survey over portions of the disposal cell cover in spring 2016 and collected additional survey data at selected locations in spring 2017. Preliminary evaluation of the data indicates some settlement has occurred on the disposal cell. The settlement is estimated at up to 4.4 feet near the ponds, which is within the design allowance of up to 10 feet of settlement. LM prepared the report *Settlement Survey and Analysis, Sherwood, Washington, Disposal Site*, which was transmitted to NRC on July 20, 2018.
- **Sherwood, Washington:** The 2018 sampling event also served as confirmatory sampling in response to a 2017 exceedance of Washington water quality criteria in well 4, an analysis of which was provided in a letter, titled "Groundwater Monitoring Results at the Sherwood, Washington, Disposal Site Indicates Elevated Sulfate Concentration in Point of Compliance Well" that was transmitted to NRC on November 5, 2018.
- **Sherwood, Washington:** A borehole camera was used to evaluate conditions in the three monitoring wells. The video showed that the inlet of the dedicated bladder pump used for low-flow sampling was buried in debris at the bottom of the well. The well will be cleaned and redeveloped before sampling in 2019.
- **Shirley Basin South, Wyoming:** Concentrations of radium-226 and radium-228 continued to exceed their respective ACLs at three wells. NRC concluded that there is no current risk to human health and the environment. Groundwater monitoring will continue in accordance with the LTSP.

Results of the annual site inspections, maintenance, and monitoring activities are reported in the site-specific chapters that follow. Significant actions and issues at each site are summarized in Table ES-1.

Table ES-1. 2018 Summary of UMTRCA Title II Site Issues and Actions

Site	Chapter	Page	Issues and Actions
Bluewater, New Mexico	1	1-6	Depression on top slope of main tailings disposal cell had minor ponding at the time of the 2018 annual inspection; it did not require the siphon to remove the water.
		1-9	Conducted groundwater monitoring at 12 wells.
		1-12	Alluvial aquifer groundwater leaving the site with uranium concentrations exceeding New Mexico state standards.
		1-14	San Andres/Glorieta aquifer groundwater leaving the site with uranium concentrations exceeding state standards.
		1-16	Site-derived uranium contamination is not expected to and has not impacted municipal water supplies.
Edgemont, South Dakota	2	2-2	The grazing licensee will remove the unmaintained interior fence.
		2-6	No groundwater monitoring is required by the LTSP.
		2-6	Conducted visual inspection of vegetation conditions.
L-Bar, New Mexico	3	3-7	Performed aerial survey to obtain accurate site topography, and quality control monuments were installed to verify accuracy and quality of aerial survey data.
		3-17	Conducted erosion monitoring of the disposal cell cover, which indicates the surface of the disposal cell is accreting instead of eroding.
		3-17	Conducted vegetation monitoring and comparison of perennial plant cover on the disposal cell cover.
Maybell West, Colorado	4	4-5	Continued to observe small depression with minor increase in size.
		4-6	Continued to observe second small depression with no changes.
		4-6	Observed a third small depression for the first time during the 2018 annual inspection.
		4-6	Performed aerial survey to obtain accurate site topography and vegetation coverage, and quality control monuments were installed to verify accuracy and quality of aerial survey data.
		4-7	No groundwater monitoring is required by the LTSP.
Sherwood, Washington	5	5-6	Conducted dam safety inspection.
		5-6	Evaluated ground-level elevation survey data.
		5-8	Conducted groundwater monitoring and evaluation of well conditions with borehole camera.
		5-12	Conducted visual inspection of the disposal cell's vegetated cover.
Shirley Basin South, Wyoming	6	6-7	Conducted groundwater monitoring at 14 wells.
		6-11	Continued to exceed ACLs for radium-226 and radium-228 in three wells.
		6-14	Concluded that elevated radium concentrations pose no risk to human health or the environment.

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1.0 Bluewater, New Mexico, Disposal Site

1.1 Compliance Summary

The Bluewater, New Mexico, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site (site) was inspected on September 12 and September 13, 2018. No changes were observed on the disposal cells, although depressions and resultant ponding continue to be observed on the north portion of the top slope of the main tailings disposal cell. A siphon is operated to remove the runoff water that accumulates in the depressions. A conceptual design to repair the top slope and modify the spillway on the north side slope of the disposal was prepared in 2018 and will be provided to the U.S. Nuclear Regulatory Commission (NRC) for review. Inspectors identified several routine maintenance needs but found no cause for a follow-up or contingency inspection.

Groundwater was sampled in November 2017 and May 2018. Analytical results indicate that alternate concentration limits (ACLs) were not exceeded. However, groundwater leaving the site in both the alluvial and bedrock aquifers has uranium concentrations exceeding the New Mexico groundwater standard. No known domestic wells within the contaminant plumes have uranium concentrations exceeding the drinking water standard (equivalent to the groundwater standard) and the plumes are not expected to impact local municipal water supplies. A report reevaluating the extent of the plumes was completed in 2018 and will be provided to NRC and made available to the public.

1.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the site-specific U.S. Department of Energy (DOE) Office of Legacy Management (LM) Long-Term Surveillance Plan (LTSP) (DOE 1997) and in procedures that DOE established to comply with requirements of Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 1-1 lists these requirements.

Table 1-1. License Requirements for the Bluewater, New Mexico, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 1.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 1.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 1.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 1.7	(b)(3)

1.3 Institutional Controls

The 3300-acre site, identified by the property boundary shown in Figure 1-1 and Figure 1-2, is owned by the United States and was accepted under the NRC general license (10 CFR 40.28) in 1997. DOE is the licensee and, in accordance with the requirements for UMTRCA Title II sites, 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 cells, disposal areas, dumps, entrance gate and sign, perimeter fence and signs, a site marker, boundary monuments, and monitoring wellhead

protectors. In addition to LM institutional controls, the New Mexico Office of State Engineer implemented a well prohibition in the alluvial aquifer downgradient the site in May 2018 (Romero 2018).

1.4 Inspection Results

The site, approximately 9 miles northwest of Grants, New Mexico, was inspected on September 12, 2018, and September 13, 2018. The inspection was conducted by R. Johnson, A. Kuhlman, and J. Cario of the Legacy Management Support (LMS) contractor. B. Tsosie (LM site manager), P. Benson (LM), and N. Gordon (LMS) attended the inspection both days. A. Kleinrath (LM), R. Evans (NRC), and A. Rheubottom and A. Winton (New Mexico Environment Department [NMED]) attended the inspection on September 13, 2018. The purposes of the inspection were to confirm the integrity of the visible features at the site, identify changes in conditions that might affect conformance with the LTSP, and determine the need, if any, for maintenance or additional inspection and monitoring.

1.4.1 Site Surveillance Features

Figure 1-1 and Figure 1-2 show the locations of site features in black, including the surveillance features and inspection areas. 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 text, and new observations identified in the 2018 annual inspection are shown in red. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified in the text and in Figure 1-1 and Figure 1-2 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 1.9.

1.4.1.1 Site Access, Entrance Gate, and Interior Roads

Access to the site is directly off gravel-surfaced Cibola County Road 63 (also known as Anaconda Road); no private property is crossed to gain site access. The entrance gate is a tubular steel, double-swing gate. The gate is secured by a chain and locks that belong to LM and the various utility companies that have rights-of-way across the site. The site access road is surfaced with crushed basalt and extends northward along a narrow strip of LM property for approximately 1700 feet from the entrance gate to the main site access road gate. Two culverts allow drainage of surface runoff under the road.

Interior roads used to access LM assets consist of a dirt track covered at places with crushed basalt. The roads are susceptible to erosion and are repaired when they become impassable. Increased erosion was observed on a road northwest of the main tailings disposal cell (PL-1). A gully intersecting the road at this location required maintenance in the past. Riprap previously was added to repair this section of the road; other repair options will be evaluated in 2019. This portion of road is not necessary to maintain access to the disposal cells; it is used to access the northern portion of the site and monitoring well 11(SG), which can be accessed by utility terrain vehicles when necessary. No other maintenance needs were identified.

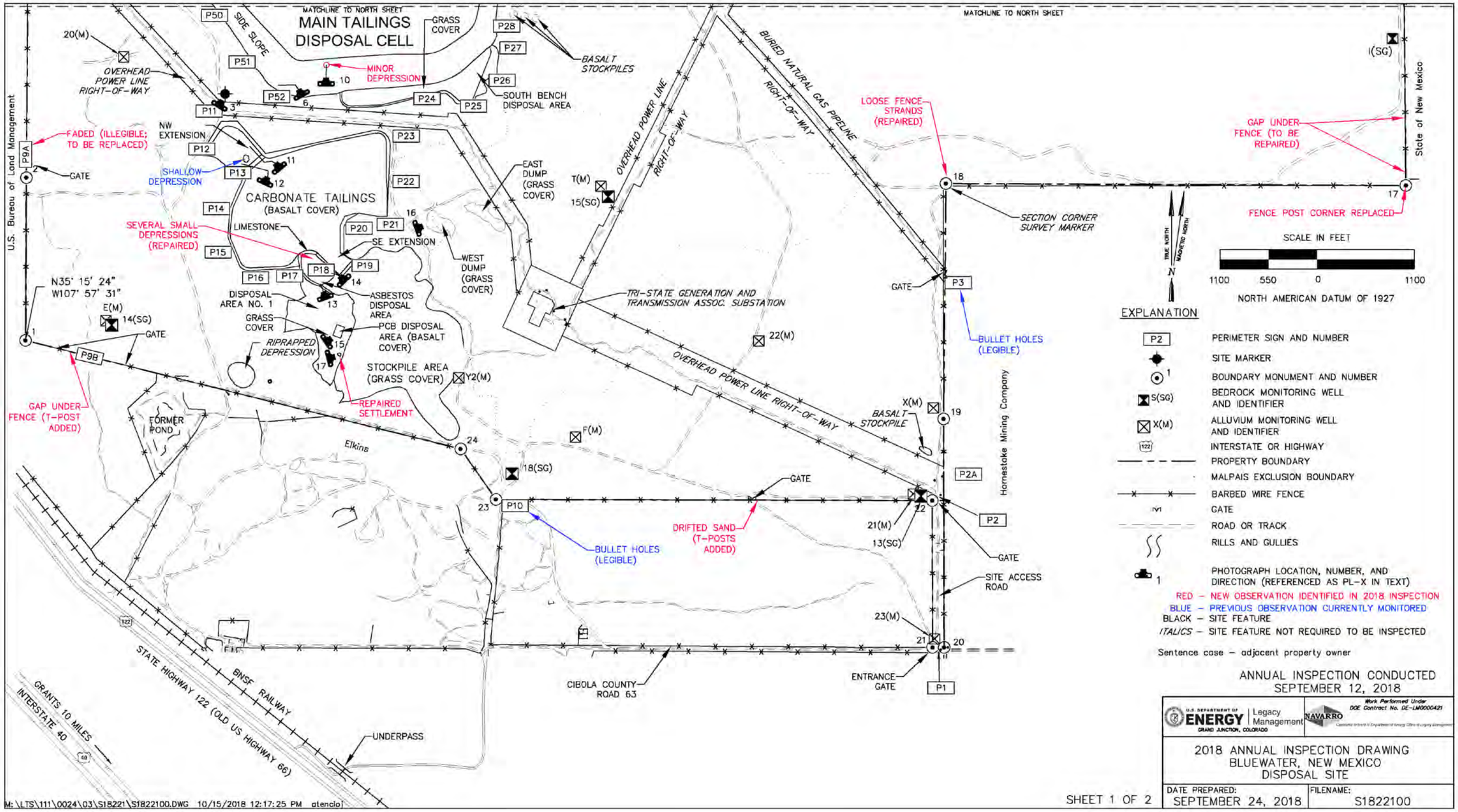

Figure 1-1. 2018 Annual Inspection Drawing for the Bluewater, New Mexico, Disposal Site (South Area)

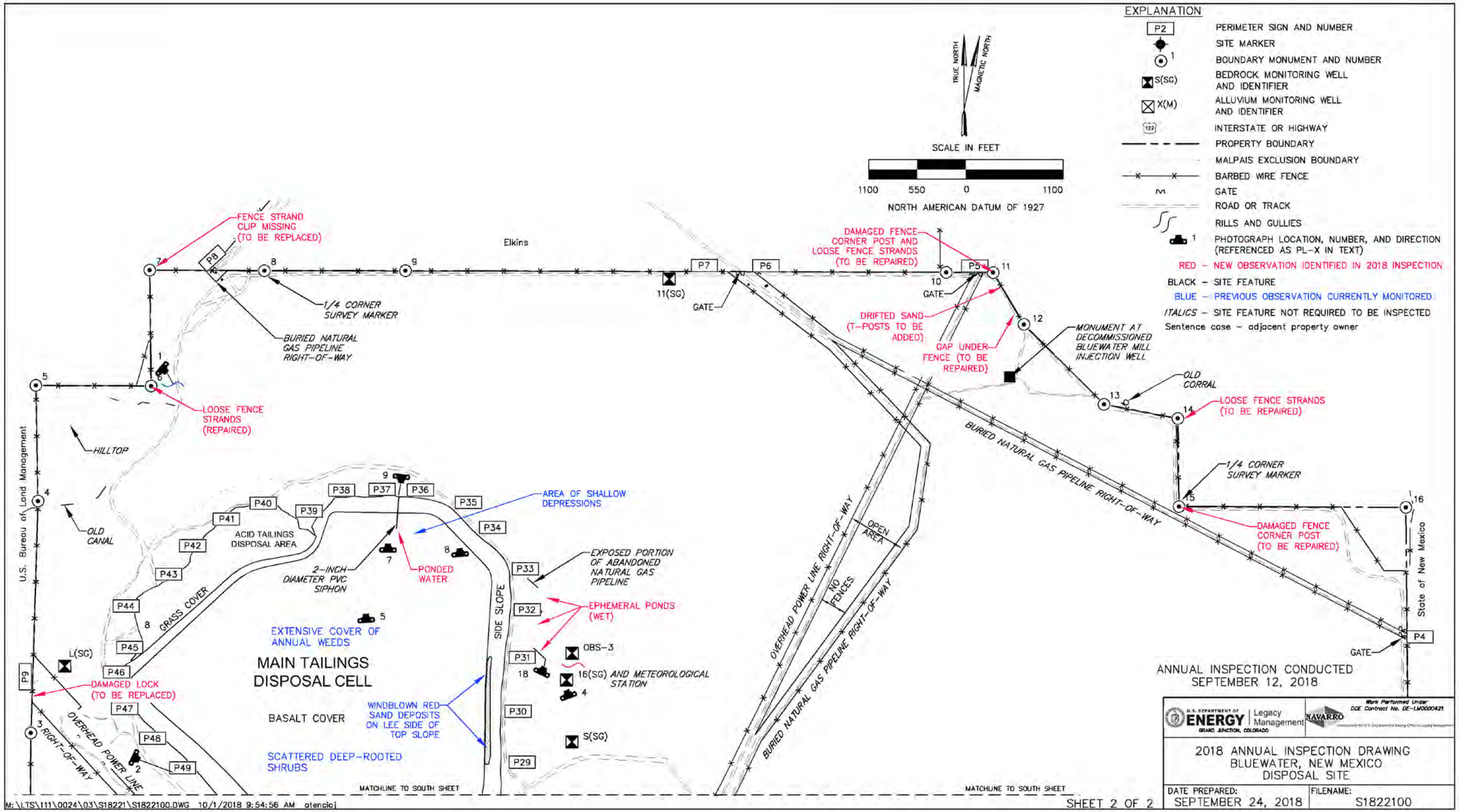

Figure 1-2. 2018 Annual Inspection Drawing for the Bluewater, New Mexico, Disposal Site (North Area)

1.4.1.2 Perimeter Fence and Signs

A four-strand barbed-wire fence encloses the site to facilitate land management by LM, which retains a local subcontractor to periodically check the site perimeter fence and remove trespassing cattle. Minor fence repairs are conducted as needed. Numerous sections of the fence are in remote areas of the site and cannot be observed from site access roads. The entire perimeter fence was inspected on April 25, 2018. Before the inspection, on April 23–25, 2018, a south section of the perimeter fence was repaired by adding additional T-posts and wire to eliminate gaps caused at some locations by erosion and deposition. At the corner where boundary monument BM-17 is located, the old wooden-post corner was replaced with an angle-iron corner post and braces set in concrete. Additional fence repair needs and a damaged lock on a perimeter gate are noted in Figure 1-1 and Figure 1-2; repairs are planned for 2019.

Fifty-five perimeter signs (warning and no-trespassing signs) are mounted on steel posts along the site boundary and around the main and carbonate tailings disposal cells (PL-2). Perimeter signs P3 and P10 have gunshot damage but are legible. Perimeter sign P9A is faded and will be replaced. No other maintenance needs were identified.

1.4.1.3 Site Marker

The site has one granite site marker between the southwest corner of the main tailings disposal cell and the northwest corner of the carbonate tailings disposal cell (PL-3). No maintenance needs were identified.

1.4.1.4 Boundary Monuments

Twenty-four boundary monuments define the site boundary. These monuments are typically inside the perimeter fence and several feet inside the true corner or boundary line. Some monuments tend to get covered by drifting sand, and metal T-posts have been driven at those locations to help inspectors find them. Other monuments are in remote sections of the site and cannot be observed from site access roads. All of the boundary monuments were inspected on April 25, 2018. No maintenance needs were identified.

1.4.1.5 Monitoring Wells

The site groundwater monitoring network consisted of nine monitoring wells when the site was transferred to LM. Two additional wells were installed in summer 2011, and eight more wells were installed in summer 2012 in response to elevated uranium concentrations in the two aquifers (alluvial and bedrock) at the site. The onsite groundwater monitoring network now consists of 19 monitoring wells; 10 are completed in the bedrock aquifer and 9 in the alluvial aquifer. Several wells have telemetry towers to transmit groundwater level and weather data to the LM office at Grand Junction, Colorado (PL-4). The wellhead protectors and telemetry towers were undamaged and locked. No maintenance needs were identified.

1.4.2 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 main tailings disposal cell, including the acid tailings and south bench disposal areas; (2) the carbonate tailings disposal cell, including the asbestos disposal area, the polychlorinated biphenyl (PCB) disposal area, and associated disposal areas and dumps; (3) the region between the disposal structures and the site perimeter; and (4) the site perimeter and outlying area. 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 the site's conformance with LTSP requirements.

1.4.2.1 Main Tailings Disposal Cell and the Acid Tailings and South Bench Disposal Areas

The 354-acre contiguous main tailings disposal cell, acid tailings, and south bench disposal areas constitute one large disposal area. The top slope of the main tailings disposal cell is covered with basalt riprap and was designed to shed runoff water over the north edge of the top slope. The top slope grade is 3% to 4% at the south end and decreases to less than 0.5% at the north end. The top slopes of the acid tailings and south bench disposal areas are nearly flat and covered by grass. Basalt riprap protects the side slopes of the disposal areas.

Plant encroachment (by annual weeds, perennial grasses and forbs, and scattered perennial shrubs) continues on the main tailings disposal cell top and side slopes (PL-5, PL-6). Siberian elm saplings on the top slope are managed to prevent the establishment of trees that could damage the main tailings disposal cell cover materials; none were observed during the inspection.

Several depressions exist on the north end of the top slope of the main tailings disposal cell and along the east and northwest edges of the top slope. This portion of the top slope overlies predominantly clay-rich tailings referred to as "slimes." Although the former licensee attempted to dewater the slimes to consolidate them, that portion of the top slope continued to settle after the site transitioned to LM. Annual inspections indicated that the depressions enlarged in area and depth over time. LM, therefore, conducted high-resolution topographic mapping using the light detection and ranging (LIDAR) method in 2012 and 2016 to determine if settlement continues and to gauge its magnitude (DOE 2017). The 2016 LIDAR results, when compared to the 2012 LIDAR results and the original topographic map developed in 1997, demonstrated that settlement, as much as 4 feet in some locations, continues. However, the rate of settlement since 2012 (an average of 0.72 inches per year between 2012 and 2016) is much less than the rate before 2012 (an average of 1.8 inches per year between 1997 and 2012). Another LIDAR survey is scheduled for 2019.

Ponds often develop in the depressions after rainfall and occasionally coalesce into one large pond after a series of rainfall events. The area of depressions is monitored continuously using a remotely operated webcam to detect the presence of ponded water. The top slope had minor ponding at the time of the inspection (PL-7). One area of ponding contained growth of red algae, which left the nearby rocks discolored (PL-8). Although the top slope was designed to shed runoff water, this has never occurred because all of the runoff water collects in the depressions. The largest pond to date held approximately 4.3 million gallons of runoff water.

A 2-inch-diameter siphon was installed in fall 2015 to dewater as much of the ponded water as possible. The siphon is manually started when the webcam indicates that a large pond has developed. The intent is to avoid potential erosion of the main tailings disposal cell cover

materials if the pond surface reaches an elevation high enough to spill over the north side slope of the disposal cell. Water would start to spill at the lowest point along the north edge of the top slope, and that could initiate erosion at that location. In 2018 LM developed a conceptual design to repair the depressions, regrade the north portion of the top slope, and construct a spillway on the north side slope to ensure positive drainage. In 2019, LM will continue to work on the design and coordinate with NRC regarding its concurrence.

The siphon is usually operated at least once a year, and it successfully removes nearly all the water and remaining water is evaporated; all of the water cannot drain from one location due to the unevenness of the depressions. The siphon has yet to be operated in 2018 because of minimal ponded water. When operated, the siphon discharges water, at a rate of approximately 100 gallons per minute, at the toe of the north side slope where runoff water was intended to discharge (PL-9). The discharged water ponds over a large area north of the main tailings disposal cell and eventually dissipates through infiltration into soil and through evaporation. The discharged water does not flow off the site.

NRC requested that LM evaluate the performance of the radon barrier because of a concern that the ponded water could be degrading the main tailings disposal cell performance (i.e., releasing radon and allowing percolation of water through the cover materials and into the encapsulated tailings). Radon flux measurements were collected in July 2013 on top of the radon barrier in the area of depressions. All radon measurements were below the detection limit, indicating that the radon barrier in that portion of the main tailings disposal cell was performing as designed. Based on the integrity of the radon barrier and the persistence of ponded water, dissipation of the ponded water was determined to be most likely due to evaporation rather than percolation through the cover materials.

Additional investigation of the cover was conducted in 2016 as part of a joint NRC/LM radon study investigating the effects of soil-forming processes on disposal cell cover properties (DOE 2016). In addition to measuring radon flux through the radon barrier, analysis of soil properties will help determine the permeability and other soil properties of the radon barrier materials. Field research conducted in June 2016 included exposing the radon barrier for radon measurements, excavating samples of the radon barrier for field and laboratory analysis of soil properties, and exposing the surface immediately under the radon barrier to measure radon flux. Thirteen test pits were dug and sampled on the top slope of the main tailings disposal cell, and two more were dug on the acid tailings disposal area. The test pits were reclaimed after completion of field investigations, and the locations were observed and photographed during the 2016 and 2017 annual inspections. No indications of settlement or erosion were visible, and annual inspections of the reclaimed tests pits were discontinued after the 2017 inspection. Results of the disposal cell cover investigations will be used to determine, in consultation with NRC, if additional monitoring, removal of the ponded water, or cover enhancements are necessary.

The side slopes and toe of the main tailings disposal cell were inspected for signs of erosion or sediment deposition. An area of minor depression was observed on the southern side slope of the main tailings disposal cell (PL-10). The area was approximately 3 feet wide and 3 inches lower than the surrounding areas. The depression area consisted of smaller sized riprap than that found on the surrounding side slope and is believed to be a construction artifact. This depression will continue to be inspected and will be evaluated using periodic LIDAR survey results. No other

abnormalities or irregularities were observed on the side slopes, and no sediment deposits were present along the toe. No maintenance needs for the side slopes or acid tailings and south bench disposal areas were identified.

1.4.2.2 Carbonate Tailings Disposal Cell, Other Disposal Areas, and Dumps

The 54-acre carbonate tailings disposal cell is south of the main tailings disposal cell. Basalt riprap covers the top and side slopes of the carbonate tailings disposal cell (PL-11). The top, for the most part, slopes gently eastward. The carbonate tailings disposal cell includes extensions to the northwest and southeast. A very shallow depression exists on the northwest extension, and rainfall runoff occasionally ponds at this location; the location was dry at the time of the inspection (PL-12). This depression does not appear to be enlarging but will continue to be inspected and evaluated using periodic LIDAR survey results. Annual weeds, perennial grasses, and scattered woody shrubs were present on the carbonate tailings disposal cell and its extensions. Siberian elm saplings are periodically treated with herbicide; no saplings were observed during the inspection. No maintenance needs were identified.

The 2-acre asbestos disposal area is a bowl-like feature just south of the carbonate tailings disposal cell (PL-13). The north, west, and south side slopes of this feature are covered by limestone riprap; the bottom of the bowl (the asbestos cell cover) is grass covered. Several small depressions were identified during the 2017 annual site inspection around the perimeter of the disposal area where relocated clean soil (placed for slope grading) and small-diameter riprap has filtered down through basalt joints and fractures. These depressions were repaired on May 22, 2018, by filling the depressions with either rock or soil, depending upon the surrounding material. These areas were inspected during the 2018 annual site inspection, and no negative impacts were observed (PL-14). No maintenance needs were identified.

There is an 11-acre grass-covered disposal area south of the asbestos disposal area. A small riprap-covered PCB cell (less than 1 acre) is within the disposal area (PL-15). Two grass-covered dumps, totaling about 2 acres, are east of the carbonate tailings disposal cell (PL-16). A small area of settlement was observed during the 2017 annual site inspection on the soil cover of Disposal Area No. 1, which does not contain mill tailings; the settlement area was repaired on May 22, 2018, by filling in the area with burrow soil (PL-17). The disposal areas and dumps were inspected. No maintenance needs were identified.

1.4.2.3 Area Between the Disposal Cells and the Site Perimeter

Other areas inside the site were inspected by driving the site perimeter road and other roads and tracks. Much of the southern and western portions of the site are inaccessible by vehicle because they are covered by basalt flows.

Small ponds often form in an area along the east side of the main tailings disposal cell and in other low spots following storms. The areas of ponding are far enough from the main tailings disposal cell to not impact it. Several ponds were observed in this area during the inspection (PL-18).

Scattered tamarisk shrubs and other plants listed as noxious weeds by the State of New Mexico are present onsite. Observed noxious weeds were sprayed with herbicide by LMS staff during the inspection.

The decommissioned mill process-fluid injection well near the northeast corner of the site features a monument consisting of a steel well casing set in concrete. Information pertaining to the well is welded onto the monument.

Several utility companies have rights-of-way that cross the site. These rights-of-way are bordered by stock fences with locked gates where the rights-of-way cross the site boundary. Roads along the rights-of-way typically are covered with crushed basalt to provide the utility companies with all-weather access. LM is not responsible for maintaining the right-of-way roads or fences. An electric power substation, enclosed by a security fence, is near the center of the site. Utility company personnel visit the substation frequently. LM is not responsible for maintaining the substation or its security fence and access road.

1.4.2.4 Site Perimeter and Outlying Areas

Surrounding land is used for livestock grazing and wildlife habitat. The area beyond the site boundary for 0.25 mile was visually observed for erosion, development, changes in land use, or other phenomena that might affect conformance with LTSP requirements. No such changes were observed.

1.5 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. No need for a follow-up inspection was identified during the inspection.

1.6 Routine Maintenance and Emergency Measures

The following maintenance needs were completed in 2018:

- The perimeter fence was repaired at multiple locations to eliminate gaps, and a new corner post was replaced.
- Scattered tamarisk shrubs and other noxious weeds were treated with herbicide.
- Small depressions near the perimeter of the asbestos disposal area and a small settlement area on Disposal Area No. 1 were repaired.

Additional fence maintenance needs identified during the April 25, 2018 fence inspection will be addressed and repairs made in 2019. Potential options to address erosion impacting the interior site road will be evaluated in 2019. No other maintenance needs were identified.

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.

1.7 Environmental Monitoring

Groundwater monitoring is required at the site. The monitoring well network acquired by LM at the time of site transition and included in the LTSP consisted of wells E(M), F(M), T(M), Y2(M), X(M), L(SG), OBS-3, S(SG), and I(SG). The LTSP requires annual sampling for PCBs (for 20 years beginning in 1997) and triennial sampling for molybdenum, selenium, and uranium in the alluvial aquifer background and point-of-compliance (POC) wells. PCBs are monitored in site alluvium wells downgradient of a disposal area containing comingled PCB- and mill tailings-contaminated materials. The LTSP also requires triennial sampling of the San Andres/Glorieta (SAG) (bedrock) aquifer background and POC wells for selenium and uranium. Alluvial aquifer well X(M) and bedrock aquifer well I(SG)—point-of-exposure (POE) wells along the east property boundary—are to be sampled only if specified ACLs are exceeded at POC wells. Currently, PCBs are monitored annually in accordance with the LTSP, and all site wells (including POE wells) are sampled semiannually for an expanded list of constituents as described in the following sections. The groundwater monitoring network is described in Figure 1-3 and Table 1-2. ACLs are listed in Table 1-3. ACLs were determined based upon an NRC-approved health-based standard of 0.44 milligrams per liter (mg/L) at POE wells at the site boundary and were determined to be as low as reasonably achievable (Applied Hydrology Associates Inc. 1995).

Table 1-2. Groundwater Monitoring Network at the Bluewater, New Mexico, Disposal Site

Monitoring Well	Network Application
E(M)	Alluvium background well
F(M)	Alluvium POC well
T(M)	Alluvium POC well
X(M)	Alluvium POE well
Y2(M)	Alluvium POC well
20(M)	Alluvium upgradient well
21(M)	Alluvium downgradient well
22(M)	Alluvium downgradient well
23(M)	Alluvium downgradient well
I(SG)	Bedrock POE well
L(SG)	Bedrock background well
OBS-3	Bedrock POC well
S(SG)	Bedrock POC well
11(SG)	Bedrock crossgradient well
13(SG)	Bedrock downgradient well
14(SG)	Bedrock crossgradient well
15(SG)	Bedrock downgradient well
16(SG)	Bedrock replacement POC well
18(SG)	Bedrock downgradient well

Table 1-3. Groundwater ACLs or the Bluewater, New Mexico, Disposal Site

POC Well	Constituent	ACL (mg/L)
Alluvial aquifer wells F(M) and T(M)	Molybdenum	0.10
	Selenium	0.05
	Uranium	0.44
Bedrock aquifer wells OBS-3 and S(SG)	Selenium	0.05
	Uranium	2.15

In 2008 NMED requested LM's assistance in investigating and evaluating regional groundwater contamination associated with the former Grants Mineral Belt uranium mining industry. NMED suspected that contaminants from the site had migrated offsite. In response to NMED's concerns, LM reinitiated annual sampling at all onsite monitoring wells, including the POE wells, in fall 2008. Semiannual sampling was initiated in 2011 in response to an ACL exceedance for uranium in well T(M). LM also began evaluating the hydrogeology and groundwater quality at the site in 2009 and started analyzing a larger suite of constituents than what is required by the LTSP to characterize the site aquifers and to support NMED's regional groundwater investigation. In consultation with NRC, LM installed additional monitoring wells in 2011 and 2012, evaluated the main tailings disposal cell performance, and developed a groundwater conceptual model to address uranium contamination concerns (DOE 2014). LM updated the uranium plume maps in both the alluvial aquifer and the SAG aquifer in a 2018 report (DOE 2018).

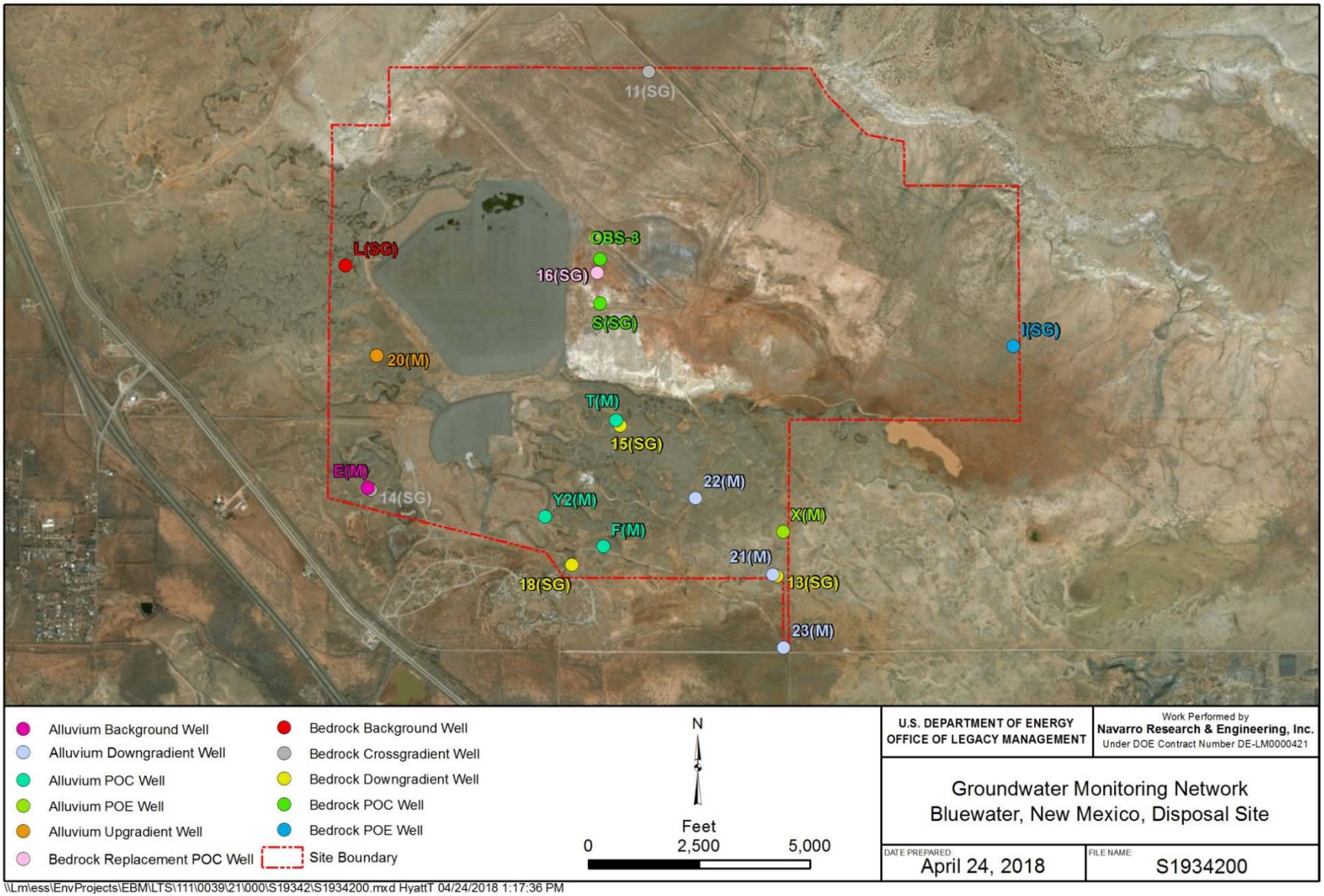

Figure 1-3. Groundwater Monitoring Network at Bluewater, New Mexico, Disposal Site

1.7.1 Alluvial Aquifer

Water-bearing alluvium underlies the southern portion of the site. The alluvium, deposited by the ancestral Rio San Jose, is covered by basalt lava flows. The alluvium consists of coarse sands and gravels in the main ancestral river channel and finer-grained floodplain deposits outside the channel. Groundwater in the alluvium is in hydraulic communication with the deeper bedrock aquifer along a fault line at the site and where the alluvium directly overlies the bedrock aquifer.

Calculations performed by the former licensee indicate that as many as 2.7 billion gallons of processing fluids seeped from the main tailings impoundment before excess water was decanted and disposed of in a deep injection well starting in 1960, and a total of 5.7 billion gallons of tailings fluids seeped from the tailings impoundment before the cell was closed in 1995. Groundwater in the alluvial aquifer mobilizes uranium from the alluvium beneath and near the southwest portion of the main tailings disposal cell and comes in contact with presumed mineralized zones that likely formed beneath the tailing impoundments (DOE 2014). The mineralized zones resulted from chemical neutralization of the acidic seepage water from the impoundments, leading to the precipitation of solid-phase compounds in formations below the impoundments. Once mobilized in the aquifer, the potential for redox-driven precipitation of compounds containing uranium is low to nonexistent because groundwater in the aquifer is oxidized. It is likely, however, that the dissolved uranium adsorbs to alluvium due to the presence of iron oxyhydroxides in the sediments. Uranium concentrations decrease with distance downgradient, both onsite and in offsite areas. Previous studies attribute the decrease mostly to plume spreading, the result of transverse dispersion, in a direction perpendicular to the direction of groundwater flow (DOE 2014; DOE 2018).

Alluvial aquifer analytical results from sampling events in November 2017 and May 2018 are provided in Table 1-4. Onsite well 21(M), installed in 2011, is adjacent to the southern site boundary, where the thickness of the alluvium is estimated to be relatively large due to the high surface water flows in the channel of the ancestral Rio San Jose before the river was buried by lava flows. Onsite well 22(M), also installed in 2011, is approximately halfway between POC well T(M) and downgradient well 21(M). The uranium concentrations in samples from these two newer wells during the recent sampling events were less than the uranium ACL (Table 1-4) and the NRC-approved health-based standard of 0.44 mg/L, but the concentrations exceeded the State of New Mexico groundwater standard of 0.03 mg/L. Molybdenum and selenium concentrations in all onsite monitoring wells in the alluvial aquifer remain less than their respective ACLs. PCBs have never been detected in wells at the site.

Table 1-4. Alluvial Aquifer Monitoring Results in November 2017 and May 2018 at the Bluewater, New Mexico, Disposal Site

Well	Molybdenum (mg/L) ACL = 0.10 mg/L	Selenium (mg/L) ACL = 0.05 mg/L	Uranium (mg/L) ACL = 0.44 mg/L
E(M)	0.000256, ND	ND, ND	0.000087, 0.000067
F(M)	0.000918, 0.000961	ND, ND	0.00624, 0.00615
T(M)	NS	NS	NS
X(M)	0.000865, 0.000714	0.00697, 0.00755	0.0994, 0.106
Y2(M)	0.00173, 0.00157	ND, ND	0.00449, 0.00443
20(M)	0.00227, 0.00213	0.00426, 0.00431	0.011, 0.0109
21(M)	0.00102, 0.000932	0.0123, 0.0124	0.106, 0.109
22(M)	0.00215, 0.00461	0.00393, 0.00353	0.31, 0.353
23(M)	0.00323, 0.00304	ND, ND	0.0205, 0.021

Note:
November 2017 results are first and May 2018 results are second in each pair of results.

Abbreviations:
ND = not detected (below method detection limit)
NS = not sampled

Figure 1-4 shows historical uranium concentrations measured at POC well T(M) and five additional wells screened in the alluvial aquifer. As this figure shows, the uranium concentration at well T(M) trended upward since LM began monitoring the well in 1999, and the November 2010 concentration of 0.557 mg/L was the first of five uranium concentrations that exceeded the ACL of 0.44 mg/L. LM notified NRC of the exceedance upon receiving the 2010 results from the laboratory. Well T(M) dried up following a May 2012 sampling as a result of drought and continuing declines of water levels in the well, and the well has since remained dry. Well 21(M) in the southeast corner of the site and POE well X(M) near the site's east boundary show a slightly decreasing trend in uranium concentration since 2013 (Figure 1-4). However, the elevated uranium concentrations at these two wells in recent years indicate that alluvial groundwater with uranium concentrations exceeding the New Mexico groundwater standard (0.03 mg/L) is discharging from the site toward the southeast.

NRC requested that LM evaluate the performance of the main tailings disposal cell to assess whether seepage losses from the cell between 2005 and 2010 had increased above previous losses to the extent they were responsible for the elevated uranium concentrations measured at POC well T(M) (see Figure 1-4) before it dried up. An assessment of the disposal cell cover and an accompanying evaluation of the water balance for the main tailings disposal cell (including the 2013 radon study referred to in Section 1.4.2.1) concluded that the increase in uranium concentrations in well T(M) could not be attributed to a compromise of the disposal cell's performance and that there was no surge of tailings-fluid seepage from the main tailings cell since it was closed (DOE 2014). It was further concluded that water levels in well T(M) decreased so much during the early 2000s that they were at or below the contact between the alluvium and underlying Chinle Formation from 2008 to 2012. The simultaneous increase in uranium concentration was attributed to the declining water level and the influence of contaminated groundwater migrating through and interacting with weathered Chinle Formation materials, with the resulting fluids obscuring the water chemistry of groundwater in nearby portions of the alluvial aquifer that remained saturated (DOE 2014).

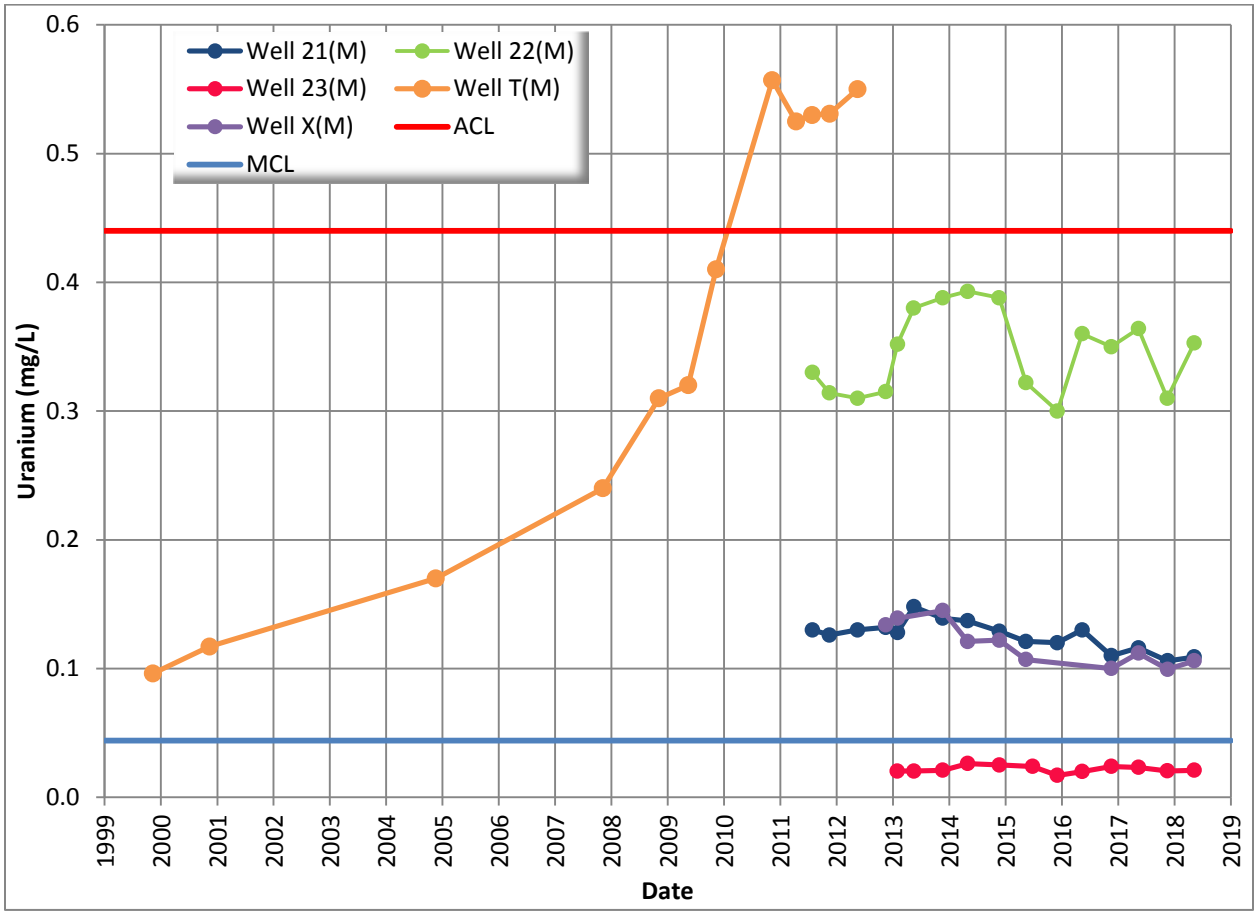

Figure 1-4. Uranium Concentrations in Alluvial Aquifer POC Well T(M) and Downgradient Wells at the Bluewater, New Mexico, Disposal Site

The extent of uranium contamination in the alluvial aquifer was evaluated as part of a conceptual model developed for the Bluewater site (DOE 2014) and in a subsequent, updated map of the uranium plume in 2017 (DOE 2018). The updated evaluation of the uranium plume indicates that groundwater flows preferentially east–southeast through coarse-grained sediments (clean sands and gravels) in a paleochannel of the ancestral Rio San Jose (DOE 2018). Approximately 1 mile downgradient of the site, Bluewater-derived contaminated groundwater in the paleochannel merges with other contaminated alluvial groundwater in another paleochannel flowing westward from the Homestake mill site. The combined plume resulting from the confluence of uranium plumes in the respective paleochannels then turns southeast toward the Village of Milan.

Although some non-LM alluvial-aquifer monitoring wells downgradient of the site have uranium concentrations exceeding the New Mexico drinking water standard (0.03 mg/L), the contaminant plume does not extend to Milan, and there are no known domestic wells within the contaminant plume. The New Mexico Office of the State Engineer implemented a prohibition on new wells within the alluvial aquifer in May 2018. The prohibition applies to new wells near and downgradient of the Bluewater site (Romero 2018).

1.7.2 Bedrock Aquifer

Bedrock wells 11(SG), 13(SG), 14(SG), 15(SG), 16(SG), and 18(SG) were installed in summer 2012 to gain a better understanding of the hydrogeological characteristics of the SAG aquifer at the site and because a nearby offsite private well (HMC-951, just east of the site entrance gate and boundary) completed in the same aquifer had elevated uranium concentrations. There were no bedrock wells in the south portion of the site before this well construction project. Wells 11(SG) and 14(SG) are crossgradient of the groundwater flowing beneath the disposal cells, and all of the other new wells are downgradient of the cells. Well 16(SG) was installed between POC wells OBS-3 and S(SG) because their well screens are highly corroded and their uranium concentrations seemed to be anomalously low. Because of the poor well conditions and unsuccessful rehabilitation efforts, sample results from wells OBS-3 and S(SG) are not considered to be representative of aquifer conditions; however, they continue to be sampled in accordance with the LTSP until decommissioning is approved by NRC.

Bedrock wells I(SG) and L(SG) were completed with open-borehole construction through the entire thickness of the San Andres Limestone and Glorieta Sandstone formations, which comprise the SAG aquifer (the formations are hydraulically connected). All of the new SAG aquifer wells, except well 16(SG), are screened in the upper 50 feet of the San Andres Limestone, as are most SAG aquifer wells in the region, because this is the most productive zone of the aquifer. Well 16(SG) is screened in the Glorieta Sandstone because the water elevation is below the San Andres Limestone at that location.

In response to NMED questions in 2010 about the possibility of stratification of contamination within the aquifer, downhole conductivity was measured in wells I(SG) and L(SG) in spring 2013. No change in conductivity with depth was observed in background well L(SG). However, three zones of different conductivities were noted in POE well I(SG); conductivity was lowest in the water within the well casing, higher in the upper portion of the open borehole, and highest in the lower portion of the open borehole. In 2013, low-flow samples collected in each zone in well I(SG) demonstrated that uranium concentrations increased with conductivity: 0.005 mg/L within the well casing, 0.15 mg/L in the upper portion of the open borehole, and 0.34 mg/L in the lower portion of the open borehole. Well L(SG) was also sampled at three depths for comparison purposes, and all results were 0.003 mg/L. Samples are collected at the depth of highest conductivity.

Analytical results for the required constituents in bedrock wells are provided in Table 1-5. The selenium and uranium concentrations did not exceed ACLs in the POC wells. Uranium concentrations in downgradient wells 13(SG), 18(SG), and I(SG), located along the site boundary, meet the site-specific NRC-approved health-based standard of 0.44 mg/L at the site boundary but exceed the New Mexico groundwater standard (0.03 mg/L). This indicates that SAG aquifer groundwater with uranium concentrations exceeding the groundwater standard is leaving the site.

Uranium concentrations in the SAG aquifer are shown in Figure 1-5. Uranium concentrations in well I(SG) before 2013 are not shown because they were erroneously low due to an incorrect sampling depth in the well. Uranium concentrations at POC wells OBS-3 and S(SG) are not shown in Figure 1-5 because the well screens are encrusted with iron scale that has resulted in erroneously low uranium concentrations since LM began sampling the wells.

Table 1-5. Bedrock Aquifer Monitoring Results for November 2017 and May 2018 at the Bluewater, New Mexico, Disposal Site

Well	Selenium (mg/L) ACL = 0.05 mg/L	Uranium (mg/L) ACL = 2.15 mg/L
11(SG)	ND, ND	0.0104, 0.0129
13(SG)	0.00626, 0.00706	0.104, 0.0981
14(SG)	ND, ND	0.0878, 0.0993
15(SG)	ND, ND	0.0436, 0.0433
16(SG)	0.0154, 0.0143	1.09, 1.09
18(SG)	0.00667, 0.00643	0.228, 0.243
I(SG)[a]	0.00804, 0.00822	0.29, 0.282
L(SG)	ND, ND	0.00278, 0.00299
OBS-3	0.00398, 0.00408	0.0513, 0.0784
S(SG)	0.0118, 0.0111	0.547, 0.451
HMC-951	0.00592, 0.00553	0.0315, 0.0309

Notes:
November 2017 results are first and May 2018 results are second in each pair of results.
[a] Sample collected at 265 feet below the top of the casing at the depth of highest conductivity.

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

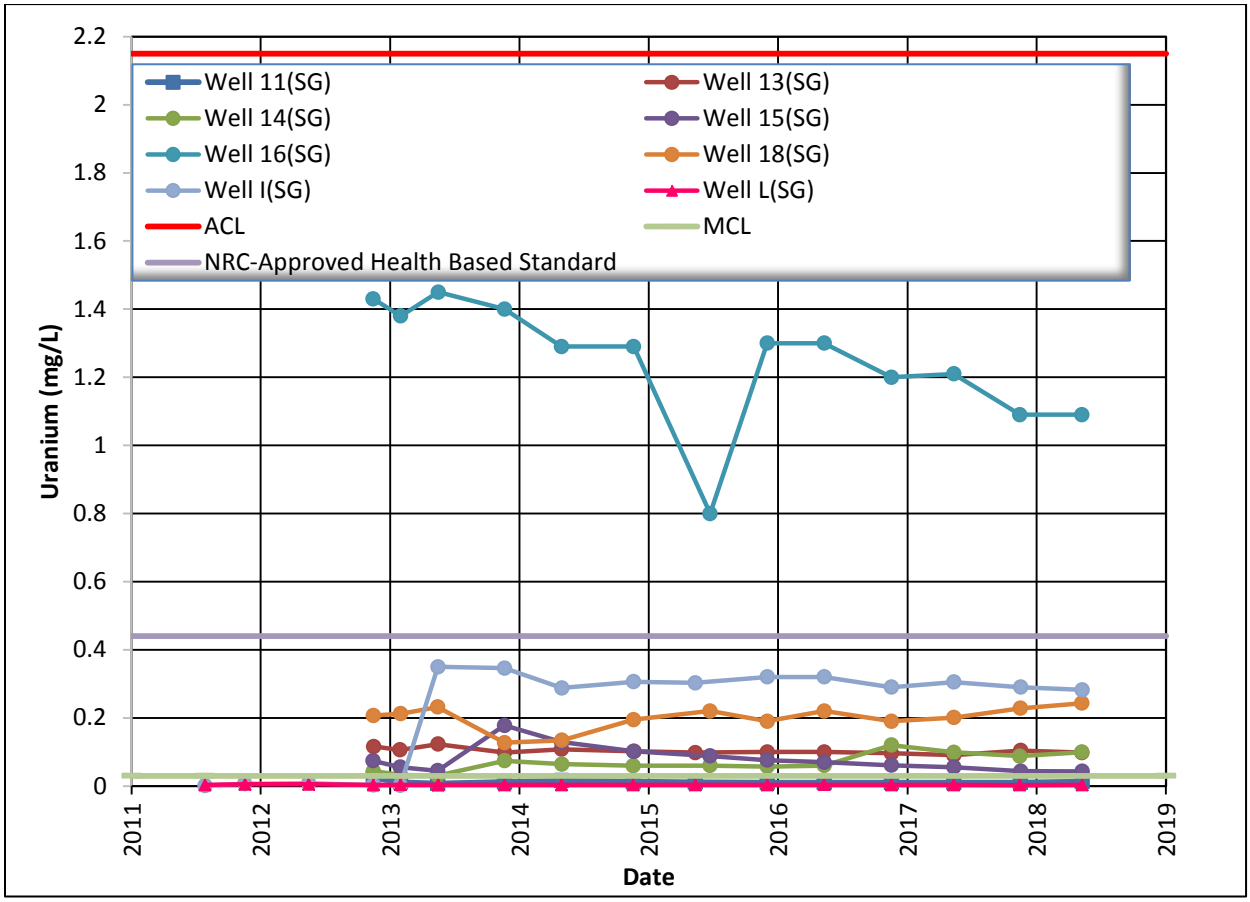

Figure 1-5. Uranium Concentrations in the San Andres/Glorieta Aquifer at the Bluewater, New Mexico, Disposal Site

To evaluate the extent of contamination, LM continues to partner with NMED to sample private wells. Most of the private wells near the site are completed in the SAG aquifer because of the limited extent of the alluvial aquifer near the site. A stock well (B-3) near the south boundary of the site, which had been a production well for the Bluewater mill, had a uranium concentration above the New Mexico drinking water standard in 2013 but below limits considered safe for livestock consumption (0.57 mg/L as recommended by the National Research Council of the National Academy of Sciences and 0.2 mg/L as recommended by the Food and Agriculture Organization of the United Nations). All other private SAG wells sampled by NMED, whether permitted for drinking water or agricultural use, had uranium concentrations below the New Mexico drinking water standard. The nearest downgradient municipal wells are along the New Mexico Highway 122 corridor and are operated by the Village of Milan. They produce from the SAG aquifer (Figure 1-6). Municipal sampling results have not had uranium concentrations exceeding the drinking water standard or shown upward trends.

The extent of uranium contamination in the SAG aquifer and the potential risk to downgradient groundwater users was evaluated in LM's groundwater conceptual model (DOE 2014) and in an update to the plume maps (DOE 2018). Evaluation of previous groundwater studies in the region and available groundwater data indicated that the flow path of the groundwater in the aquifer from the site is to the east–southeast. The groundwater from the site passes under the Homestake mill site and turns south toward Grants due to the influence of a major fault that passes under Grants (San Rafael Fault). The flow path from the site is substantially north of the Milan municipal wells (Figure 1-6).

The estimated extent of the uranium plume, described in the updated groundwater model (DOE 2018), is shown in Figure 1-7. The uranium plume follows the groundwater flow path, and the leading portion is near the Homestake site. Groundwater monitoring results obtained by various entities over the last several decades indicate that uranium contamination from Bluewater mill operations reached the Homestake site by 1980 and that the plume has essentially stabilized (i.e., it is not continuing to migrate to the east). Uranium concentrations attenuate with distance from the site primarily through dispersion instead of chemical reduction because of the absence of a reducing environment in the aquifer formations (DOE 2014). No known drinking water wells are completed within the uranium plume, and site-derived uranium contamination in the SAG aquifer is not expected to impact the Milan or Grants municipal water supplies that are pumped from SAG aquifer wells.

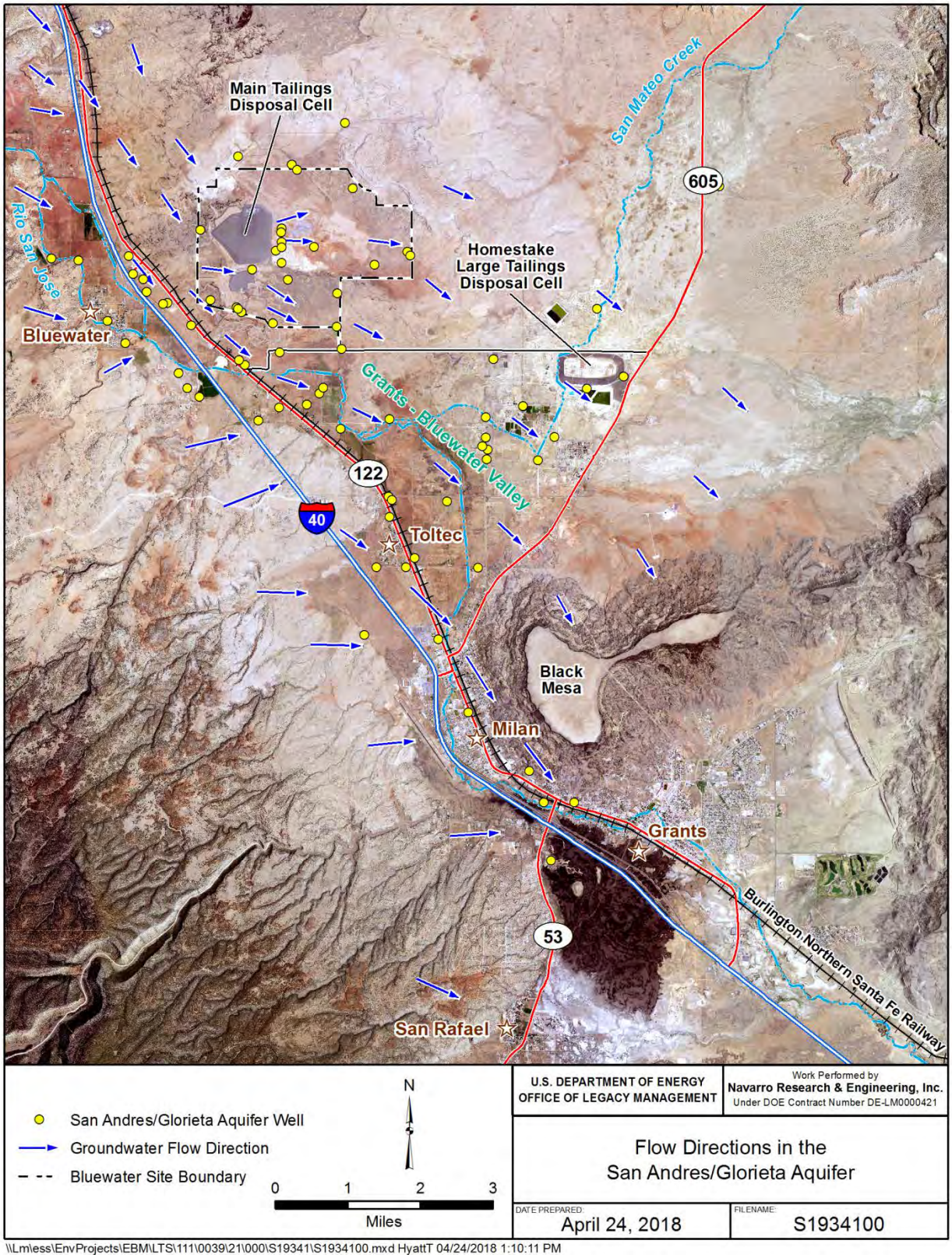

Figure 1-6. Groundwater Flow Directions in the San Andres/Glorieta Aquifer at the Bluewater, New Mexico, Disposal Site

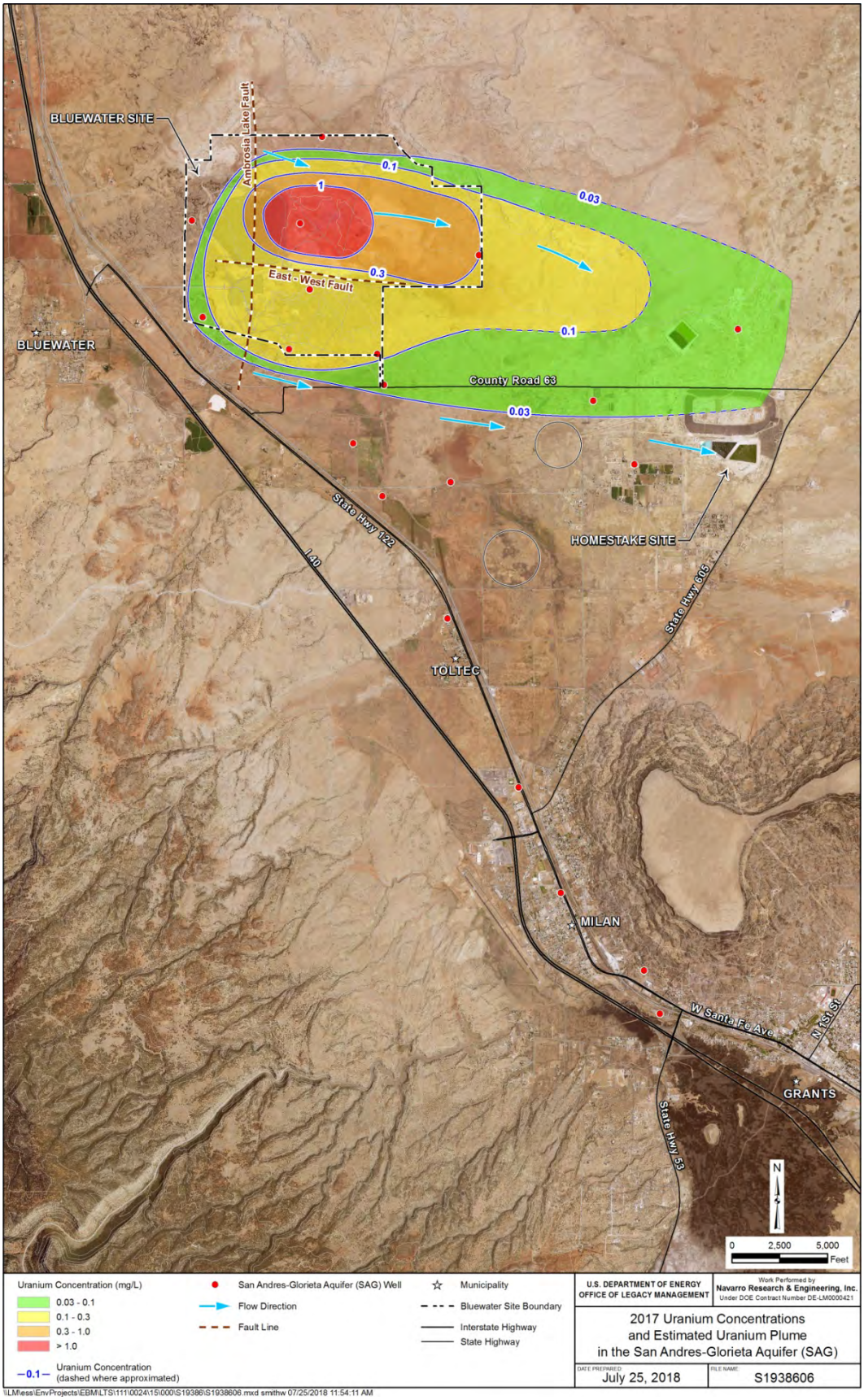

Figure 1-7. 2017 Estimated Uranium Plume in the San Andres/Glorieta Aquifer (DOE 2018)

1.8 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.*

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

Applied Hydrology Associates Inc., 1995. *Corrective Action Program and Alternate Concentration Limits Petition for Uranium, Molybdenum and Selenium, Bluewater Uranium Mill Near Grants, New Mexico,* prepared for Atlantic Richfield Company, April.

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DOE (U.S. Department of Energy), 2014. *Site Status Report: Groundwater Flow and Contaminant Transport in the Vicinity of the Bluewater, New Mexico, Disposal Site*, LMS/BLU/S11381, November.

DOE (U.S. Department of Energy), 2016. *Effects of Soil-Forming Processes on Cover Engineering Properties, Field Work Plan, Bluewater Disposal Site, New Mexico*, LMS/BLU/S13276, February.

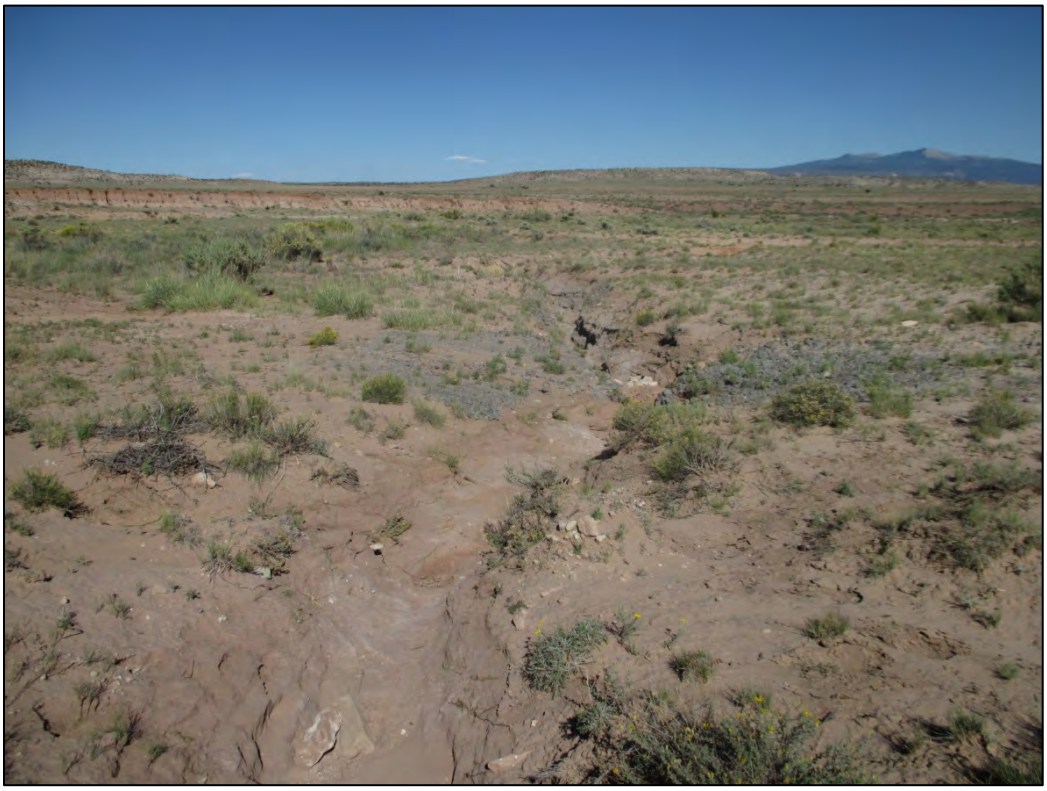
DOE (U.S. Department of Energy), 2017. *Evaluation of Disposal Cell Topography Using LiDAR Surveys, Bluewater, New Mexico, Disposal Site*, LMS/BLU/S14703, April.

DOE (U.S. Department of Energy), 2018. *Draft 2017 Uranium Plumes in the San Andres-Glorieta and Alluvial Aquifers at the Bluewater, New Mexico, Disposal Site*, LMS/BLU/S19565, November.

Romero, 2018. John T. Romero, PE, Director, Water Rights, State of New Mexico, Office of the State Engineer, letter (Request for Well Drilling Prohibition Associated with the Remedial Action at the Former Homestake and Bluewater Mill Sites, Cibola County, New Mexico) to Bruce Yurdin, Director, Water Protection Division, New Mexico Environment Department, May 3.

1.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	130	Gully Intercepting Interior Site Road
PL-2	115	Perimeter Sign 49; Southwestern Side Slope in Background
PL-3	30	Site Marker
PL-4	340	Monitoring Well 16(SG) and Weather Station
PL-5	355	Vegetation on Main Tailings Disposal Cell Top Slope
PL-6	330	South West Side Slope of the Main Tailings Disposal Cell
PL-7	0	Ponded Water on Main Tailings Disposal Cell Top Slope
PL-8	355	Ponded Water on Main Tailings Disposal Cell Top Slope
PL-9	185	Outlet of Siphon at Toe of Main Tailings Disposal Cell
PL-10	0	Minor Depression on Main Tailings Disposal Cell South Side Slope
PL-11	320	Northeastern Side Slope of Northwestern Extension of Carbonate Tailings Cell
PL-12	25	Shallow Depression on Northwest Extension of Carbonate Tailings Cell
PL-13	340	Asbestos Disposal Area
PL-14	315	Repair of Depression in Asbestos Disposal Cell
PL-15	55	PCB Disposal Area
PL-16	70	West Dump
PL-17	75	(a) Repaired Settlement on Soil Cover of Disposal Area No. 1–September 12, 2018 (b) Settlement on Soil Cover of Disposal Area No. 1–2017 (Photo for Comparison)
PL-18	25	Ephemeral Pond



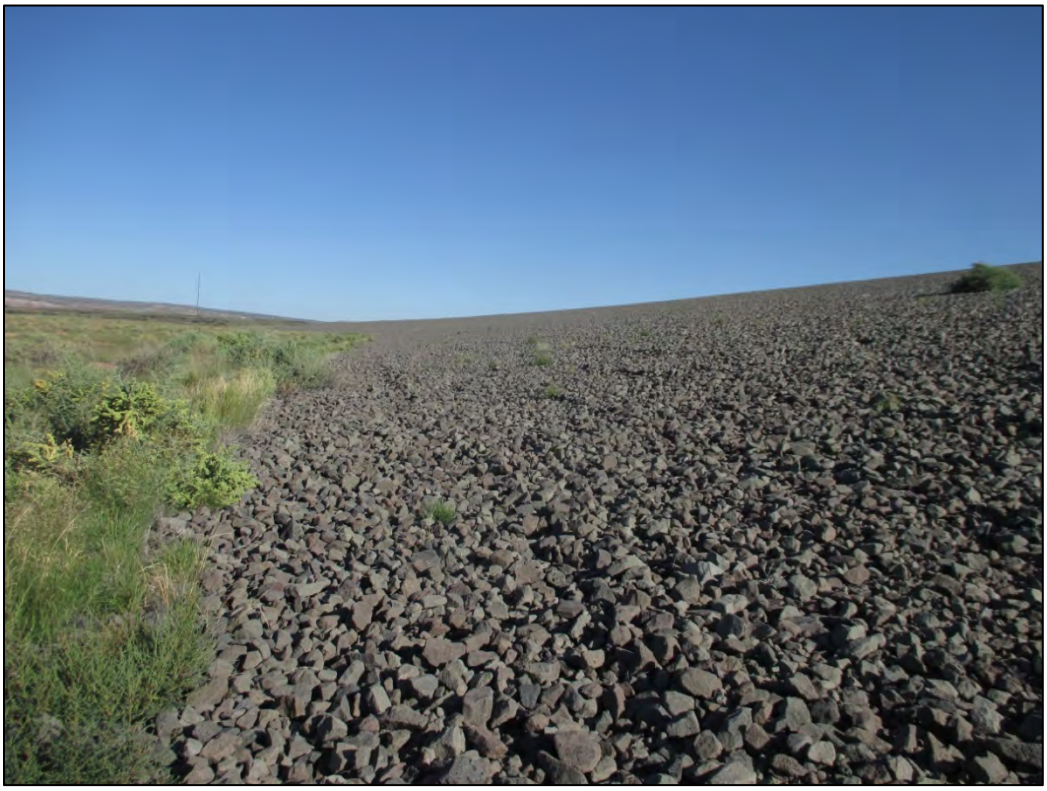
PL-1. Gully Intercepting Interior Site Road

PL-2. Perimeter Sign 49; Southwestern Side Slope in Background

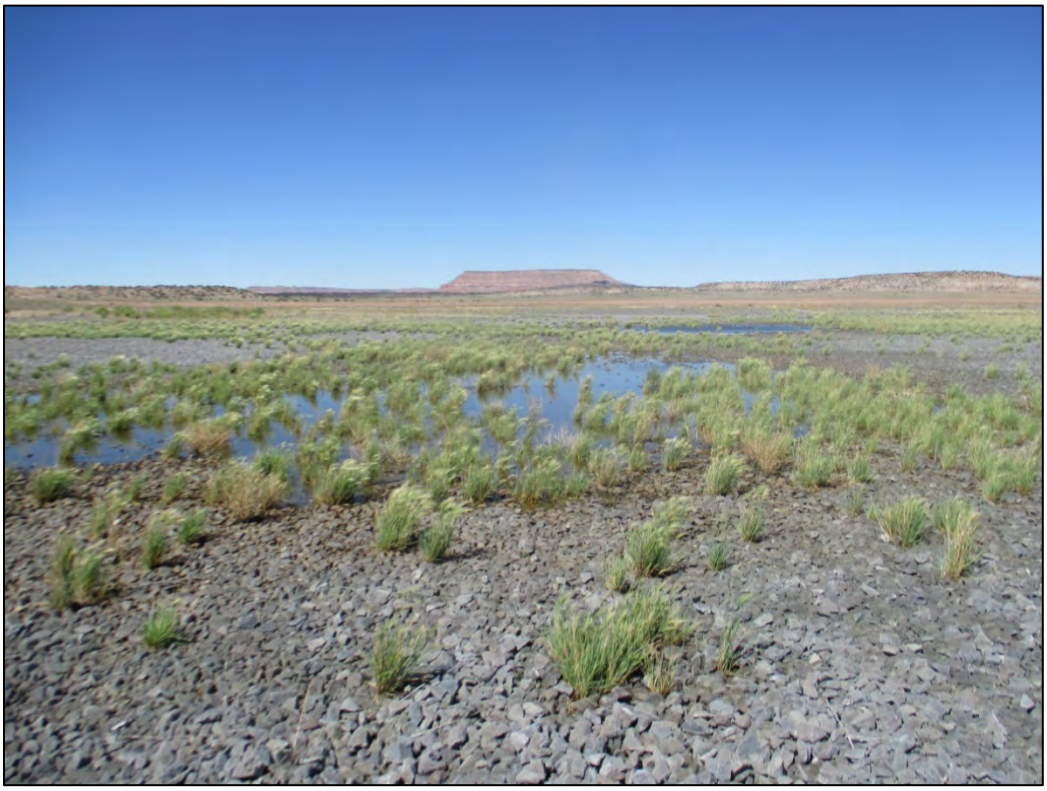
PL-3. Site Marker

PL-4. Monitoring Well 16(SG) and Weather Station

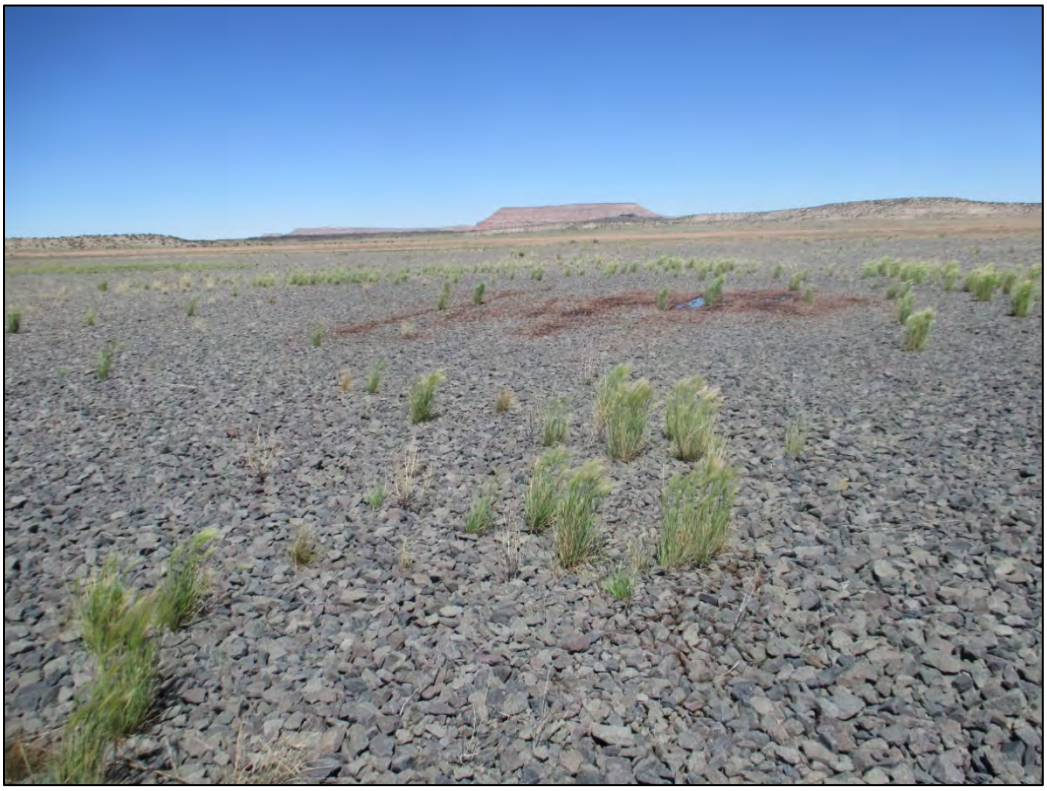
PL-5. Vegetation on Main Tailings Disposal Cell Top Slope



PL-6. South West Side Slope of the Main Tailings Disposal Cell



PL-7. Ponded Water on Main Tailings Disposal Cell Top Slope

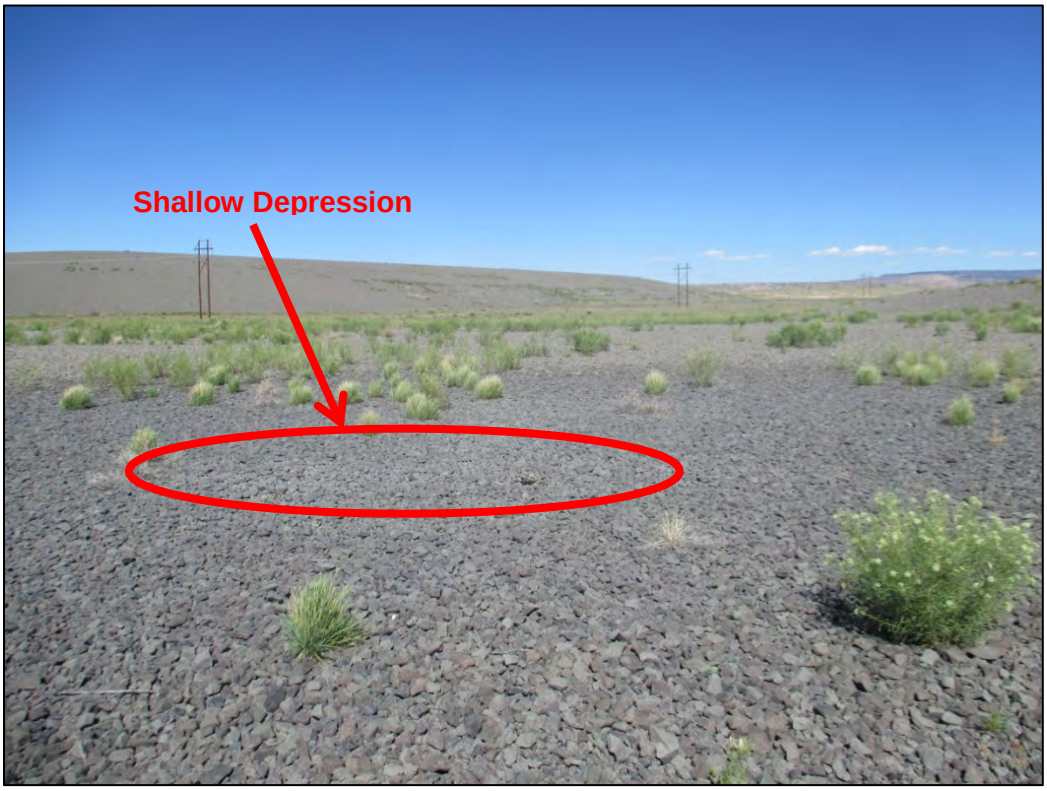


PL-8. Ponded Water on Main Tailings Disposal Cell Top Slope

PL-9. Outlet of Siphon at Toe of Main Tailings Disposal Cell

PL-10. Minor Depression on Main Tailings Disposal Cell South Side Slope

PL-11. Northeastern Side Slope of Northwestern Extension of Carbonate Tailings Cell



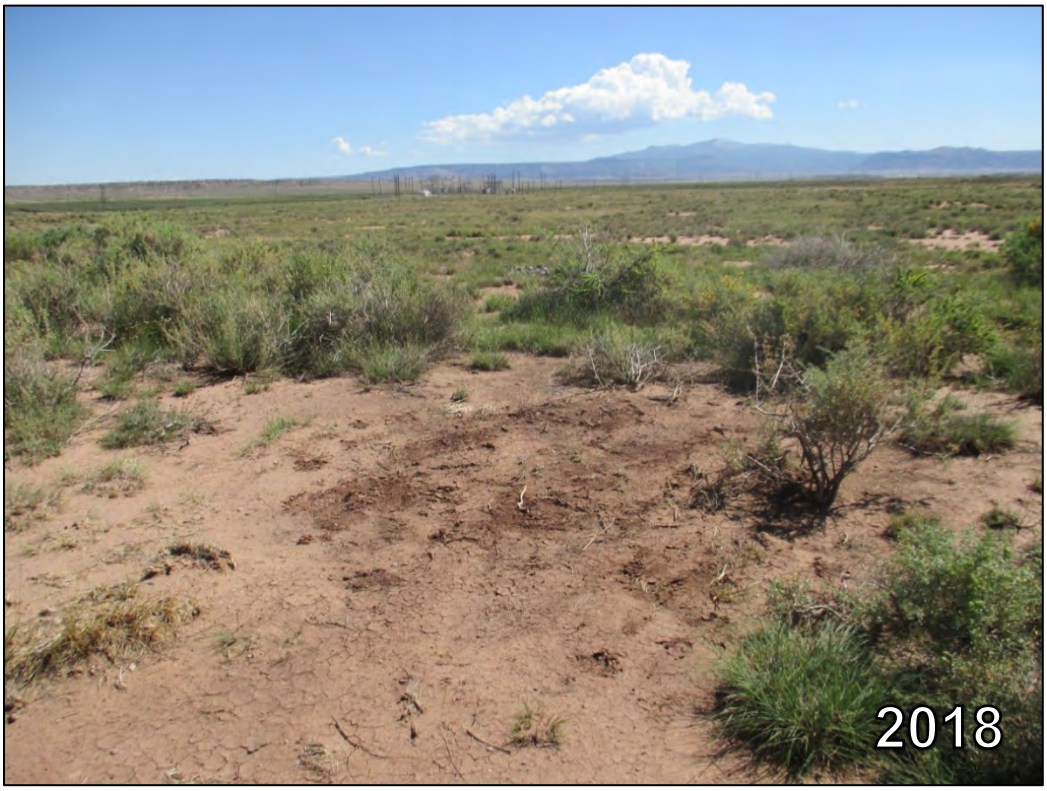
PL-12. Shallow Depression on Northwest Extension of Carbonate Tailings Cell

PL-13. Asbestos Disposal Area

PL-14. Repair of Depression in Asbestos Disposal Cell

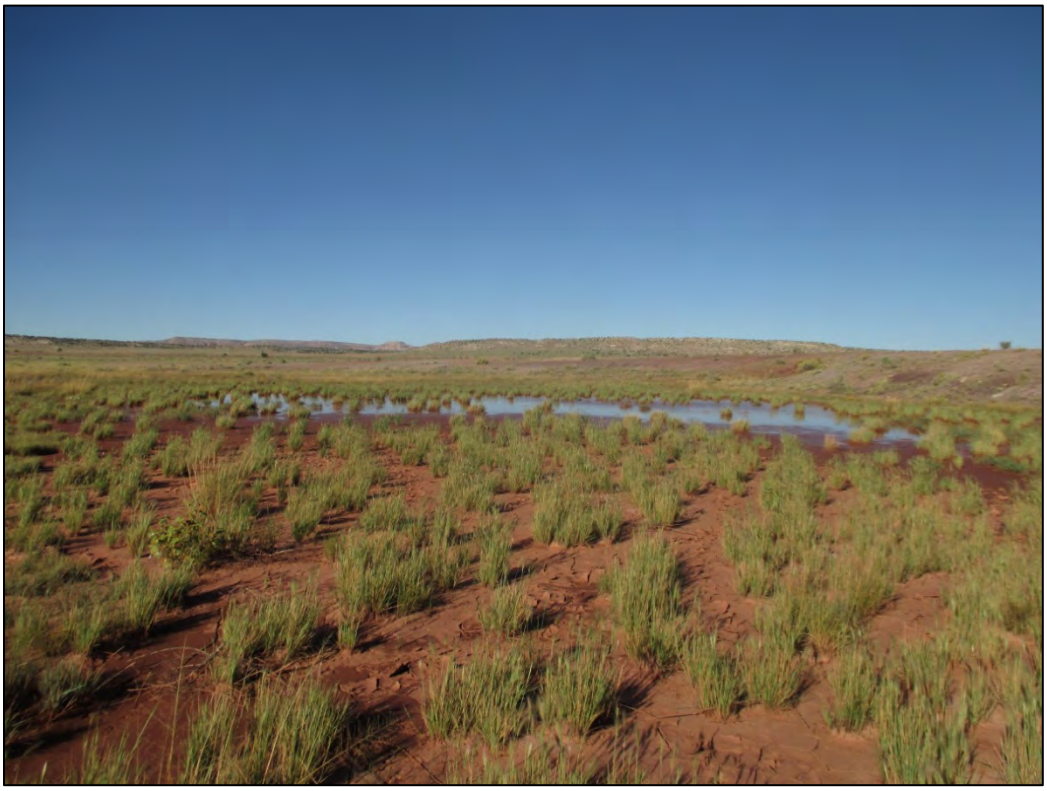
PL-15. PCB Disposal Area

PL-16. West Dump



PL-17. (a) Repaired Settlement on Soil Cover of Disposal Area No. 1–September 12, 2018

PL-17. (b) Settlement on Soil Cover of Disposal Area No. 1–2017 (Photo for Comparison)



PL-18. Ephemeral Pond

2.0 Edgemont, South Dakota, Disposal Site

2.1 Compliance Summary

The Edgemont, South Dakota, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site (site) was inspected on July 25, 2018. No changes were observed on the disposal cell or in associated drainage features. The grazing licensee will remove the unmaintained interior fence. Inspectors identified no other maintenance needs or cause for a follow-up inspection. Groundwater monitoring is not required at the site.

2.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the site-specific U.S. Department of Energy (DOE) Office of Legacy Management (LM) Long-Term Surveillance Plan (LTSP) (DOE 1996) and in procedures LM established to comply with the requirements of Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 2-1 lists these requirements.

Table 2-1. License Requirements for the Edgemont, South Dakota, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 2.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 2.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 2.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 2.7	(b)(3)

2.3 Institutional Controls

The 360-acre site, identified by the property boundary shown in Figure 2-1, is owned by the United States and was accepted under the U.S. Nuclear Regulatory Commission general license (10 CFR 40.28) in 1996. DOE is the licensee and, in accordance with the requirements for UMTRCA Title II sites, 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, and boundary monuments.

2.4 Inspection Results

The site, approximately 2 miles south of Edgemont, South Dakota, was inspected on July 25, 2018. The inspection was conducted by C. Boger, D. Traub, and R. Johnson of the Legacy Management Support (LMS) contractor. T. Jasso (LM site manager) attended the inspection. 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 determine the need, if any, for maintenance or additional inspection and monitoring.

A grazing license granted by LM allows a local rancher to graze his cattle on the site. The LM site manager and LMS site lead met with the grazing licensee before the inspection to discuss any issues or concerns the licensee might have. As discussed in Section 2.4.1.2, the grazing licensee will remove the unmaintained interior fence from the site. No other concerns were identified by the grazing licensee.

2.4.1 Site Surveillance Features

Figure 2-1 shows the locations of site features in black, including site surveillance features and inspection areas. 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 text. There were no new observations in 2018. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified in the text and in Figure 2-1 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 2.9.

2.4.1.1 Site Access and Entrance Gate

Access to the site is from Fall River County Road 6N. The entrance sign is mounted on a steel post set in concrete (PL-1). The tubular metal entrance gate was secured by a locked chain and was intact (PL-2). Three additional wire gates are along the perimeter fence: at the northwest corner of the property, approximately 700 feet north of the southeast corner, and at the southeast corner of the site. All gates were closed and intact. No maintenance needs were identified.

2.4.1.2 Perimeter Fence and Signs

A four-strand barbed-wire fence encloses the site, truncating at the southeast corner to allow livestock access to a preexisting stock pond. A broken fence strand identified during the 2017 annual inspection was subsequently repaired by the grazing licensee. The fence was intact (PL-3 and PL-4), and no maintenance needs were identified. Two perimeter signs are attached to the perimeter fence. Both perimeter signs were present and legible. The grazing licensee monitors site security and maintains the perimeter fence. During the 2017 annual inspection, the licensee proposed to remove the unmaintained interior fence (PL-5) that was installed to prevent grazing during vegetation establishment following closure of the disposal cell. The LM site manager concurred with this proposal, as this fence is no longer required.

2.4.1.3 Site Marker

The site has one granite site marker just inside the site entrance gate (PL-6). No maintenance needs were identified.

2.4.1.4 Boundary Monuments

There are four boundary monuments, each at a corner of the property (PL-7). All boundary monuments were inspected, and no maintenance needs were identified.

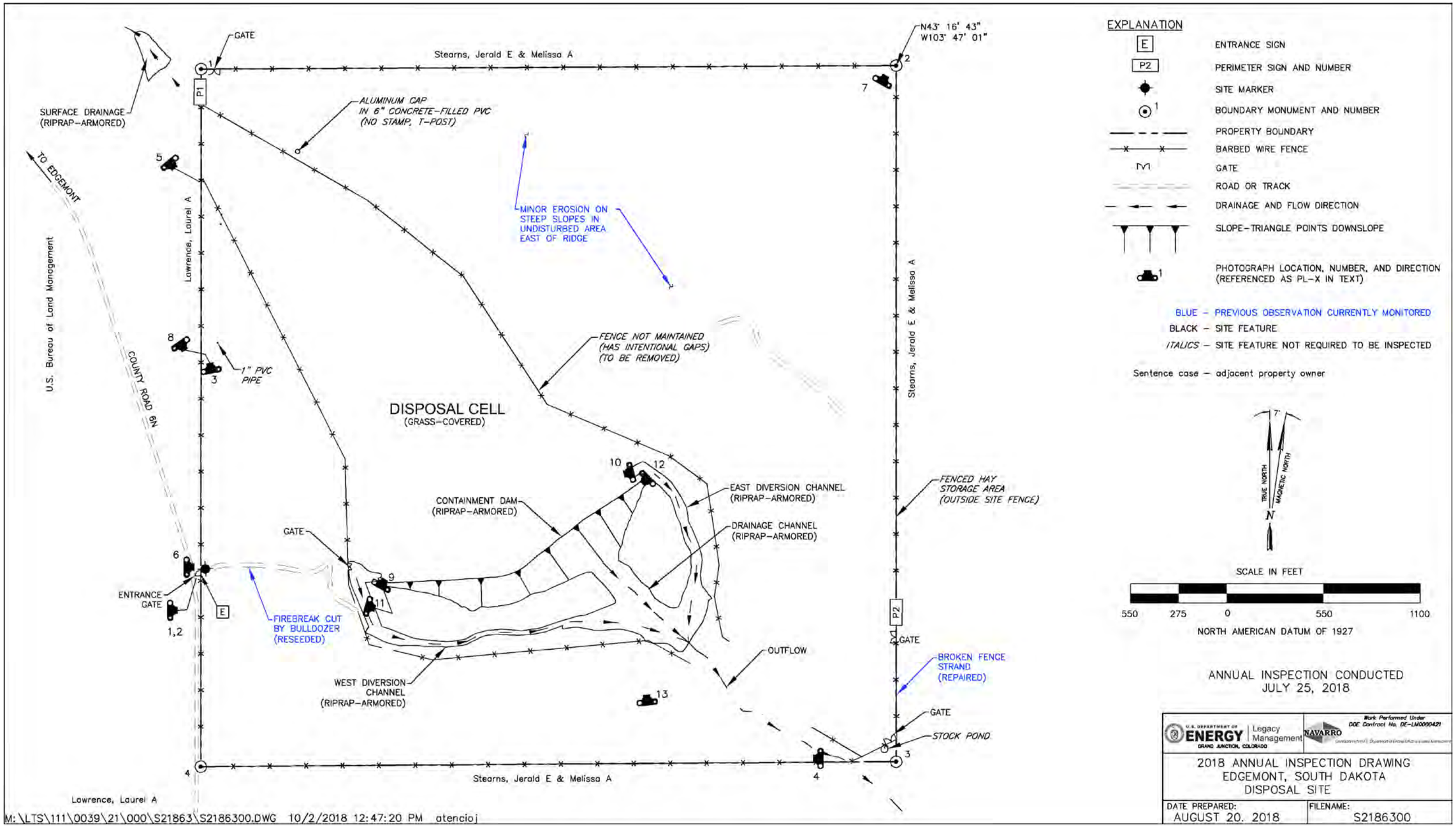


Figure 2-1. 2018 Annual Inspection Drawing for the Edgemont, South Dakota, Disposal Site

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2.4.2 Inspection Areas

In accordance with the LTSP, the site is divided into three 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 and diversion channels; and (3) the site perimeter, outlying areas, and balance of the site. Inspectors examined specific site surveillance features within each area and looked for evidence of erosion, settling, slumping, or other modifying processes that might affect the site's conformance with LTSP requirements.

2.4.2.1 Cover of the Disposal Cell

The grass-covered disposal cell, completed in 1989, occupies 100 acres (PL-8–PL-10). It showed no signs of erosion, settling, or other modifying processes that might affect its integrity. No maintenance needs were identified.

2.4.2.2 Containment Dam and Diversion Channels

The face of the containment dam, the steepest man-made slope onsite, is covered with riprap and showed no evidence of erosion, settling, slumping, or other modifying processes (PL-11 and PL-12). Scattered plants, mostly grass and annual weeds, grow in the riprap. These plants do not threaten the stability or function of the containment dam.

The diversion and drainage channels are grass-covered on their upslope portions (these are gentle swales on each side of the disposal cell) and riprap-armored on their downslope portions and on steeper slopes (PL-13). Minor amounts of vegetation are present in the riprap. The vegetation helps to stabilize these areas and does not impair the function of the channels. Wetland vegetation is present at the base of the diversion channels. No maintenance needs were identified.

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

The site is surrounded by private land used primarily for grazing and wildlife habitat. The area approximately 0.25 mile beyond the site boundary—including a surface drainage area just outside the northwest corner of the property that is riprap-armored to prevent headward erosion onto the site—was visually observed for erosion, changes in land use, or other phenomena that might affect the long-term integrity of the site. No such changes were identified.

The balance of the site consists of undisturbed areas covered with native shrubs, grasses, and forbs and formerly disturbed areas covered primarily with seeded grasses and annual weeds. Some minor erosional features are present on steep slopes in an area isolated from the disposal cell; these features were stable. No maintenance needs were identified.

2.5 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. No need for a follow-up inspection was identified.

2.6 Routine Maintenance and Emergency Measures

The grazing licensee will remove the unmaintained interior fence. No other maintenance needs were identified.

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.

2.7 Environmental Monitoring

In accordance with the LTSP, groundwater monitoring is not required at this site because a 300- to 700-foot-thick layer of competent shale bedrock lies between the encapsulated tailings and the uppermost confined aquifer. Additionally, clay liners were constructed to isolate the tailings from the shallower, unconfined, perched groundwater that is present as a result of local precipitation. There is no evidence of any direct hydraulic connection between the perched groundwater and the underlying confined bedrock aquifer.

An annual visual inspection of vegetation conditions at the site is required by the LTSP. No vegetation management is required. There were no cattle grazing on the site during the inspection.

2.8 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.*

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

DOE (U.S. Department of Energy), 1996. *Long-Term Surveillance Plan for the DOE Tennessee Valley Authority (UMTRCA Title II) Disposal Site, Edgemont, South Dakota,* June.

2.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	90	Entrance Sign
PL-2	90	Locked Entrance Gate
PL-3	350	West Fence Line
PL-4	270	South Fence Line
PL-5	140	Interior Site Fence
PL-6	90	Site Marker
PL-7	30	Boundary Monument BM-2
PL-8	145	West Portion of Disposal Cell
PL-9	30	Southwest Portion of Disposal Cell
PL-10	255	Southeast Portion of Disposal Cell
PL-11	105	West Portion of Containment Dam
PL-12	225	East Portion of Containment Dam
PL-13	355	Containment Dam, Drainage Channel, and East Diversion Channel

PL-1. Entrance Sign

PL-2. Locked Entrance Gate

PL-3. West Fence Line

PL-4. South Fence Line

PL-5. Interior Site Fence

PL-6. Site Marker

PL-7. Boundary Monument BM-2

PL-8. West Portion of Disposal Cell

PL-9. Southwest Portion of Disposal Cell

PL-10. Southeast Portion of Disposal Cell

PL-11. West Portion of Containment Dam

PL-12. East Portion of Containment Dam

PL-13. Containment Dam, Drainage Channel, and East Diversion Channel

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 (site) was inspected on September 13, 2018. No changes were observed on the disposal cell or in associated drainage structures. Inspectors identified several routine maintenance needs but found no cause for a follow-up inspection.

Erosion and vegetation measurements to monitor the condition of the disposal cell top slope indicated that no erosion is occurring, and perennial vegetation foliar cover at the measurement plots was similar to 2017 measurements. The success criterion of 20% foliar cover in more than half of the measurement plots has not been achieved. Groundwater is monitored triennially in accordance with the site-specific U.S. Department of Energy (DOE) Office of Legacy Management (LM) Long-Term Surveillance Plan (LTSP) (DOE 2004). Groundwater sampling was last conducted in November 2016. There are no trends that suggest a compliance limit or standard will be exceeded.

3.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the LTSP (DOE 2004) and in procedures LM established to comply with the requirements of 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 U.S. Nuclear Regulatory Commission (NRC) general license (10 CFR 40.28) in 2004. DOE is the licensee and, in accordance with the requirements for UMTRCA Title II sites, 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 wellhead protectors.

3.4 Inspection Results

The site, approximately 15 miles north of Laguna, New Mexico, was inspected on September 13, 2018. The inspection was conducted by J. Cario, R. Johnson, M. Kastens, and D. Holbrook of the Legacy Management Support (LMS) contractor. B. Tsosie and A. Denny (LM), A. Winton and A. Rheubottom (New Mexico Environment Department), and A. Kuhlman (LMS) attended all or a portion of the inspection. The purposes of the inspection were to confirm the integrity of the visible features at the site, identify changes in conditions that might affect conformance with the LTSP, and determine the need, if any, for maintenance or additional inspection and monitoring.

3.4.1 Site Surveillance Features

Figure 3-1 shows the locations of site features in black, including the surveillance features and inspection areas. 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 text, and new observations identified in the 2018 annual inspection are shown in red. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified 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 of Cebolleta Land Grant property is crossed to enter the site, and access is provided and described in the warranty and quitclaim deed for the site. The entrance gate is a tubular-steel stock gate with a four-strand barbed-wire fence that surrounds the disposal cell features. The gate was secured with a locked chain. No maintenance needs were identified.

3.4.1.2 Fence and Perimeter Signs

A four-strand barbed-wire fence encloses the disposal cell and associated drainage structures and is intended to prohibit trespassing and livestock intrusion on the disposal cell structures (livestock trails would initiate gully erosion). The fence is as much as 3300 feet 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 that owns the surrounding property. Two sets of wooden brace posts along the fence line near perimeter sign P33 were replaced by steel posts set in concrete in April 2018 (PL-1). At several locations, gullies under the fence could be large enough to allow intrusion by calves; the gaps at these locations were obstructed by installing additional fence posts (metal T-posts) or wire stays (PL-2). Loose fence strands were also repaired. No other maintenance needs were identified.

The entrance sign is on the main site access road near the site marker. It has several bullet holes but was legible (PL-3). Thirty-three warning or perimeter signs are attached to the barbed-wire fence that surrounds the disposal site structures and an area of excessive gully erosion in the southeast portion of the site (PL-4). Perimeter sign P1 was replaced during a previous 2018 site visit. No other maintenance needs were identified.

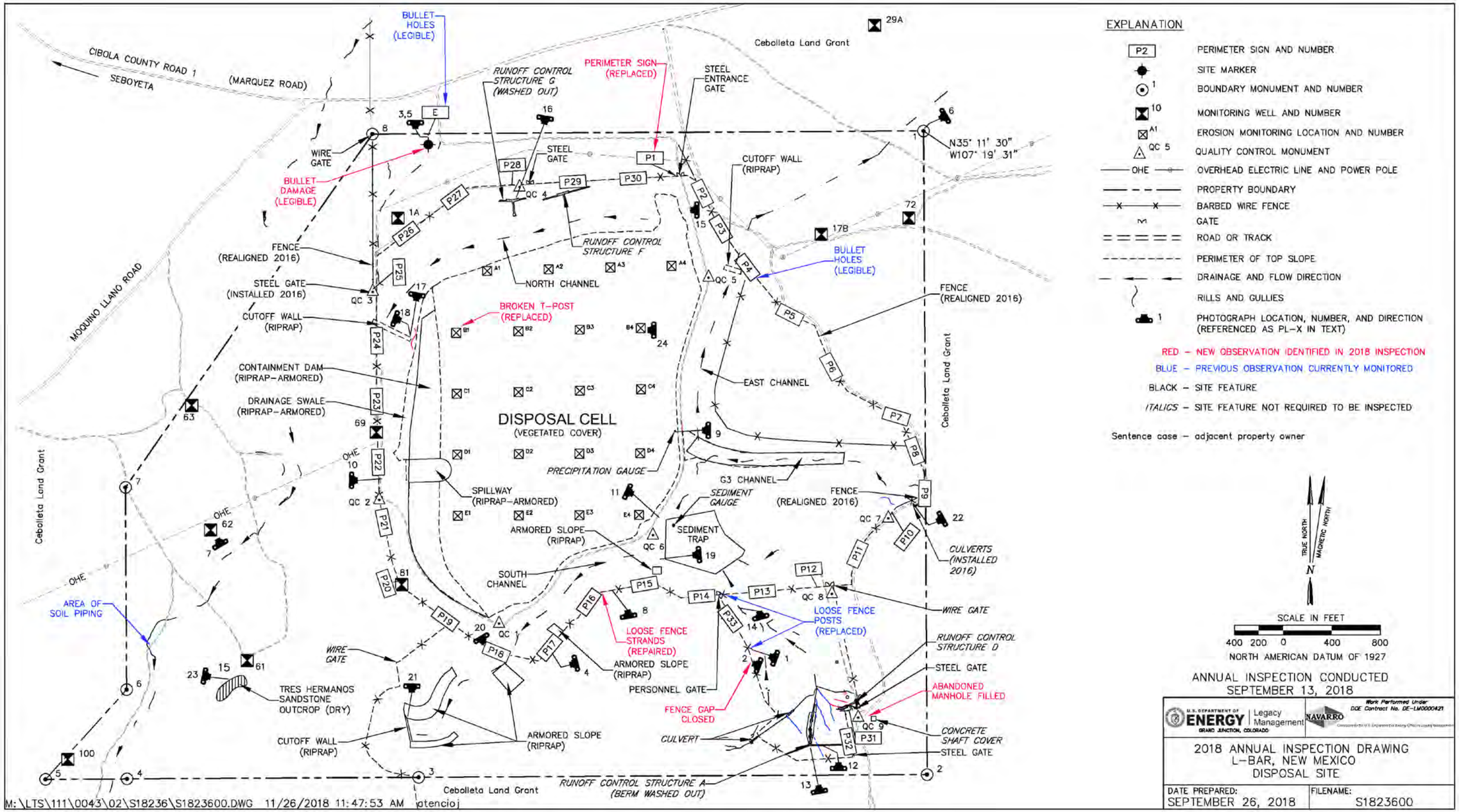

Figure 3-1. 2018 Annual Inspection Drawing for the L-Bar, New Mexico, Disposal Site

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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; however, it remains legible (PL-5). No maintenance needs were identified.

3.4.1.4 Boundary Monuments

There are eight boundary monuments defining the site boundary. Due to the size of the site and the remote locations of many of the property corners, not all of the boundary monuments are typically observed during the annual inspection; this was the case during the 2018 annual inspection. However, the boundary monuments not observed during the 2018 annual inspection were inspected during a site visit in June 2018 (PL-6). No maintenance needs were identified.

3.4.1.5 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 corner of the site. The wellhead protectors observed during the 2018 annual inspection were undamaged and locked (PL-7). No maintenance needs were identified.

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 the site's conformance with LTSP requirements.

3.4.2.1 Cover of the Disposal Cell

The soil-covered disposal cell, completed in 2000, occupies approximately 100 acres. Its top slope surface is minimally sloped to the west toward the central portion of the containment dam to promote drainage and minimize 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 species (PL-8). Vegetation was slow to establish in the southeast portion of the top slope, so a native seed mix was applied in 2009. This area also was successfully vegetated, although several below average precipitation years have stressed vegetation (PL-9). 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.

Cracks are usually present in the surface soil of the disposal cell top slope. They are confined within the top 2 feet of cover soil and appear to result from drying of the gypsum-rich soil after precipitation. The cracks tend to heal as they fill with windblown and precipitation runoff-borne sediment and as perennial vegetation continues to establish. The cover of the disposal cell showed no signs of erosion, settling, or other modifying processes that might affect the integrity of the disposal cell. No maintenance needs were identified. In accordance with the LTSP, erosion

and vegetation are monitored on the disposal cell top slope. Section 3.7 describes the monitoring program and presents the results to date.

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 (PL-10). Native vegetation is well established on the face, which is desirable for increasing the erosion protection of the surface. There were no indications of erosion, settlement, seeps, or other modifying processes that might affect the integrity of the containment dam. No 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. 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. The ends of a riprap cutoff wall at the outlet of the channel are not keyed into stable materials. Consequently, there is a potential for runoff flow in the channel to erode the adjacent weathered shale and fill materials and, thus, bypass the cutoff wall. 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 (Figure 3-1). Gullies have formed along the side slopes of the G3 channel. The erosion and sediment deposition are not impairing the function of the channel.

Some erosion was expected to occur in a watershed that encompasses the southeast portion of the site and adjacent property. Storm 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. The sediment trap was dry at the time of the inspection (PL-11).

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 (PL-12 and PL-13). 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 (PL-14), a conceptual design for repairs to these structures and the addition of other structures in the watershed was developed in 2018.

Runoff water from the area north of the disposal cell is captured by the north channel (PL-15). 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 its original design configuration, and two runoff control structures were constructed in 2009 to reduce erosion and sedimentation. The east structure (Runoff Control Structure F) was stable and functional at the time of the inspection (Figure 3-1). The west structure (Runoff Control Structure G), however, suffered severe erosion during runoff events in August and September 2011 and continues to erode (PL-16). A conceptual design for repairs and modifications to these structures was developed in 2018.

Minimal erosion was observed near the riprap cutoff wall on the western end of the north channel (PL-17). The cutoff wall does not extend to the toe of the containment dam slope, allowing runoff to bypass the cutoff wall; minimal erosion is beginning to occur at this location (PL-18). This area will continue to be monitored for erosion and other impacts to the drainage feature and containment dam.

The south channel diverts storm runoff from the higher terrain immediately south of the disposal cell toward the channel outlet to the west (PL-19). Two riprap structures are present on the north-facing slope (south bank) to inhibit erosion along natural drainage swales (PL-20). 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. A riprap cutoff wall at the outlet of the channel is functioning as designed but will continue to be monitored (PL-21).

Erosion in diversion channels and other features was assessed in 2018 by a sitewide baseline aerial survey using photogrammetry. This was performed to obtain accurate site topography for future comparison. Nine permanent quality control monuments were installed at the site for LM to verify accuracy and quality of aerial survey data.

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 exploration activities, mine reclamation activities, and associated access road construction have occurred in recent years in areas adjacent to the site. These activities have not been detrimental to site security.

A gully that formed on a side slope of G3 channel had 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. The culverts are functioning as designed, and no maintenance needs were identified (PL-22).

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 is shown on the inspection and sampling maps to prevent injury or vehicle damage. Consequently, monitoring well 100 is accessed by foot or all-terrain vehicle.

A Tres Hermanos Sandstone unit of the Mancos Shale crops out in the southwest corner of the site (Figure 3-1). 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 (PL-23), 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 (a large pad covers the mine shaft) and abandoned sewer manholes, are near the southeast corner of the site. One sewer manhole near the concrete mine shaft cover was filled in during an earlier 2018 site visit to reduce potential injury to grazing livestock. These features will be monitored to ensure that they 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. No need for a follow-up inspection was identified during the inspection.

3.6 Routine Maintenance and Emergency Measures

Damaged fence strands identified in the 2017 annual report were repaired. Two loose wooden brace posts were replaced with metal brace posts in April 2018. Gaps where the fence crosses gullies were also blocked in maintenance activities conducted in April and August 2018. A broken T-post at erosion monitoring point B1 was replaced. Perimeter sign P1 was replaced. No other 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. Groundwater monitoring was conducted in 2016 and the next sampling will occur in 2019. 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 the wells that are in the monitoring network, and they are shown in Figure 3-2 with the exception of the Moquino wells. Samples are collected triennially and are 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 alternate abatement standards (AASs) stipulated by the New Mexico Environment Department.

If an ACL or AAS is exceeded in any monitoring well (Table 3-3), 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.

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	Public water supply well in Moquino
Moquino Old	Backup public water supply well in Moquino

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

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

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:
[a] Background value approved by the State of New Mexico for L-Bar.
[b] LTSP listed the former State of New Mexico standard of 5.0 mg/L.

Abbreviation:
NA = not applicable

As stipulated in the LTSP, the requirements for annual groundwater monitoring were met in 2007. Consequently, the sampling frequency changed to once every 3 years beginning in

fall 2010 in accordance with the LTSP. Groundwater monitoring will continue as long as a New Mexico standard is exceeded in any monitoring well (Table 3-4).

Groundwater monitoring was conducted in November 2016, and the results are provided in Table 3-4. Access to the Moquino wells was not provided by the owner, so those wells could not be sampled.

Table 3-4. November 2016 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	***400***	0.25	ND	***4300***	***6600***	0.0061
17B	***360***	***790***	***0.2***	***4700***	***9400***	0.027
29A	170	0.01	ND	***4500***	***6400***	0.0001
61	100	0.027	ND	3200	4700	0.00027
62	46	ND	ND	550	1600	0.00005
63	46	ND	ND	520	1600	0.0001
63[d]	49	ND	ND	570	1600	0.00011
69	***730***	ND	ND	***10,000***	***13,000***	***1.6***
72	220	8	0.013	***4500***	5800	0.016
81	170	***16***	0.049	***4800***	***6400***	0.019
100	31	0.55	ND	2300	3400	0.0011
Moquino New	NS	NS	NS	NS	NS	NS
Moquino Old	NS	NS	NS	NS	NS	NS

Notes:
[a] Significant digits are reported by the laboratory and are based on detection limits.
[b] ***Bold italicized*** results exceed a New Mexico standard.
[c] Nitrate plus nitrite as nitrogen (NO_3 + NO_2 as N).
[d] Duplicate result from laboratory.

Abbreviations:
ND = not detected (below laboratory detection limit)
NS = not sampled

Since sampling commenced in 2005, no ACL or AAS Source Zone levels have been exceeded in any of the point-of-compliance (POC) wells, and no AAS Affected Area levels have been exceeded in monitoring well 62. Therefore, groundwater at the site is in compliance with the LTSP requirements. Results from the 2016 sampling are consistent with historical results. Increases in chloride and nitrate concentrations occurred in well 69 and 17B, respectively, but there are no trends that suggest that an ACL, AAS Source Zone, or AAS Affected Area concentration will be exceeded (Figure 3-3 and Figure 3-4). Selenium and uranium concentrations decreased or remained stable in all POC wells (Figure 3-5 and Figure 3-6). Sulfate concentration remained stable in both AAS Source Zone wells and the AAS Affected Area well (Figure 3-7 and Figure 3-8). TDS concentration decreased in all AAS Source Zone wells (Figure 3-9) and remained stable in the AAS Affected Area well (Figure 3-10).

At least one New Mexico standard is exceeded in six of the LM wells, including background well 29A. The New Mexico standards for sulfate and TDS were exceeded (Table 3-4).

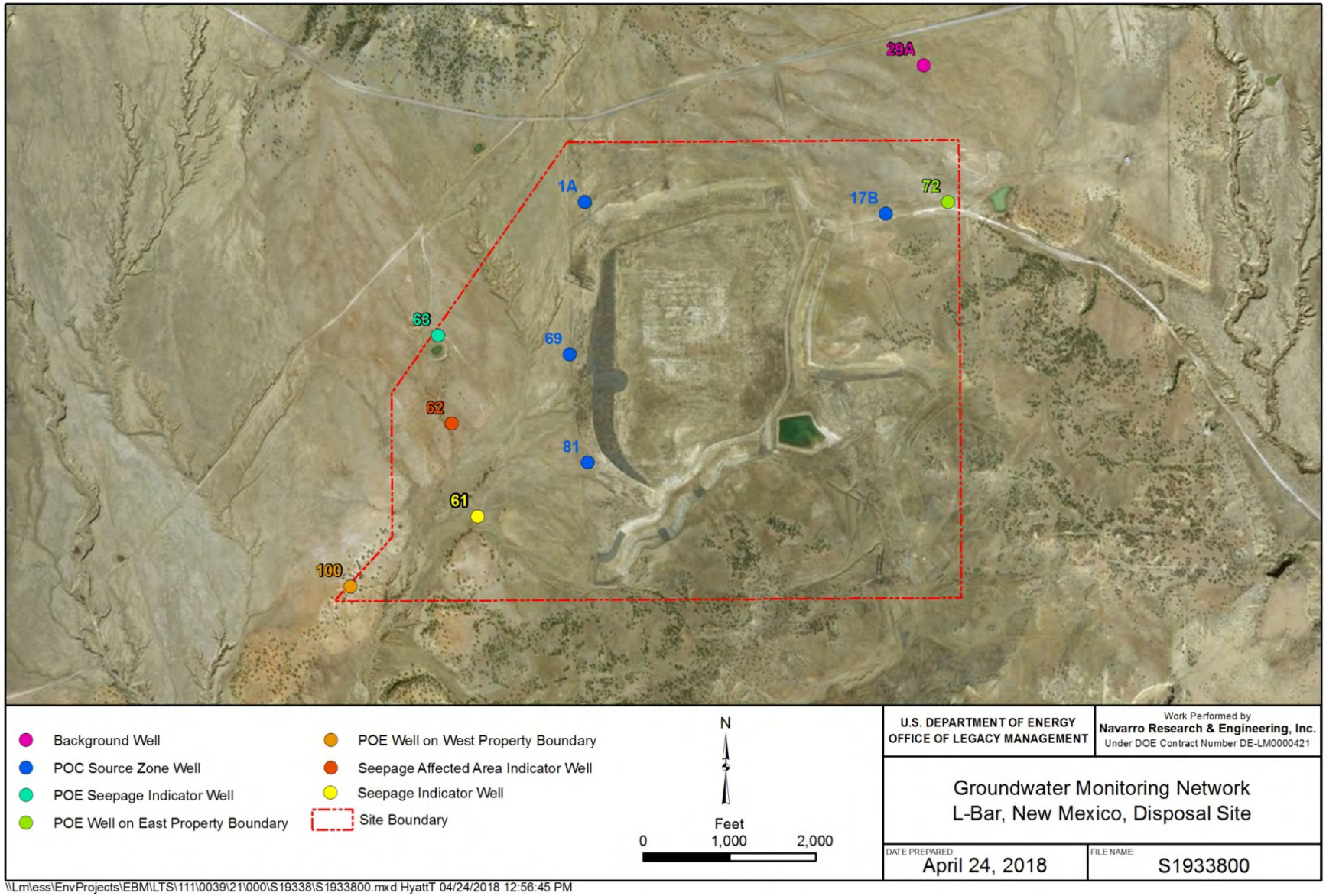


Figure 3-2. Groundwater Monitoring Network at L-Bar, New Mexico, Disposal Site

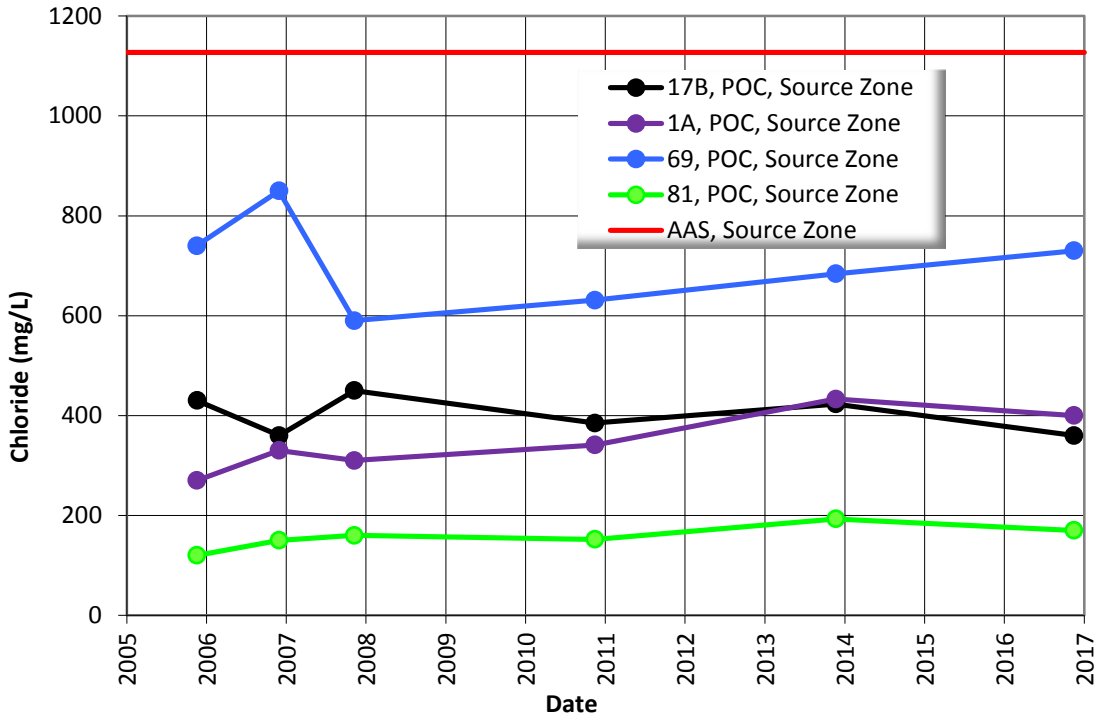


Figure 3-3. Time Concentration Plots of Chloride in Groundwater at the L-Bar Disposal Site

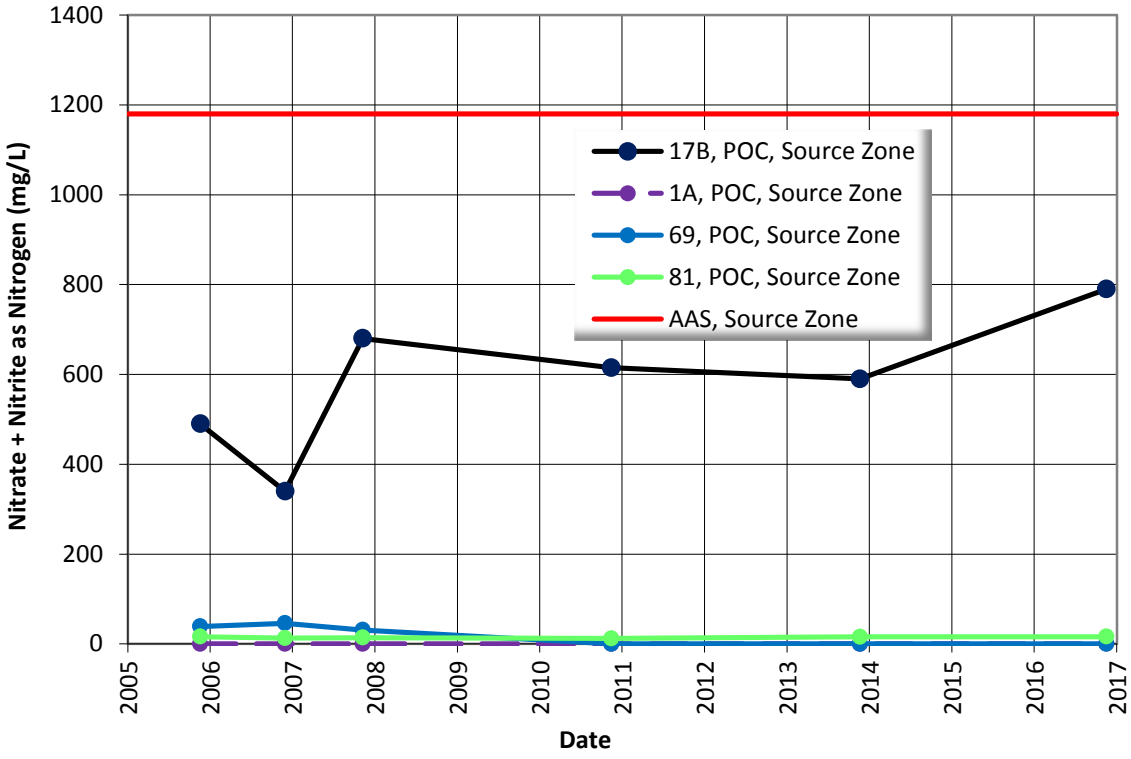


Figure 3-4. Time Concentration Plots of Nitrate in Groundwater at the L-Bar Disposal Site

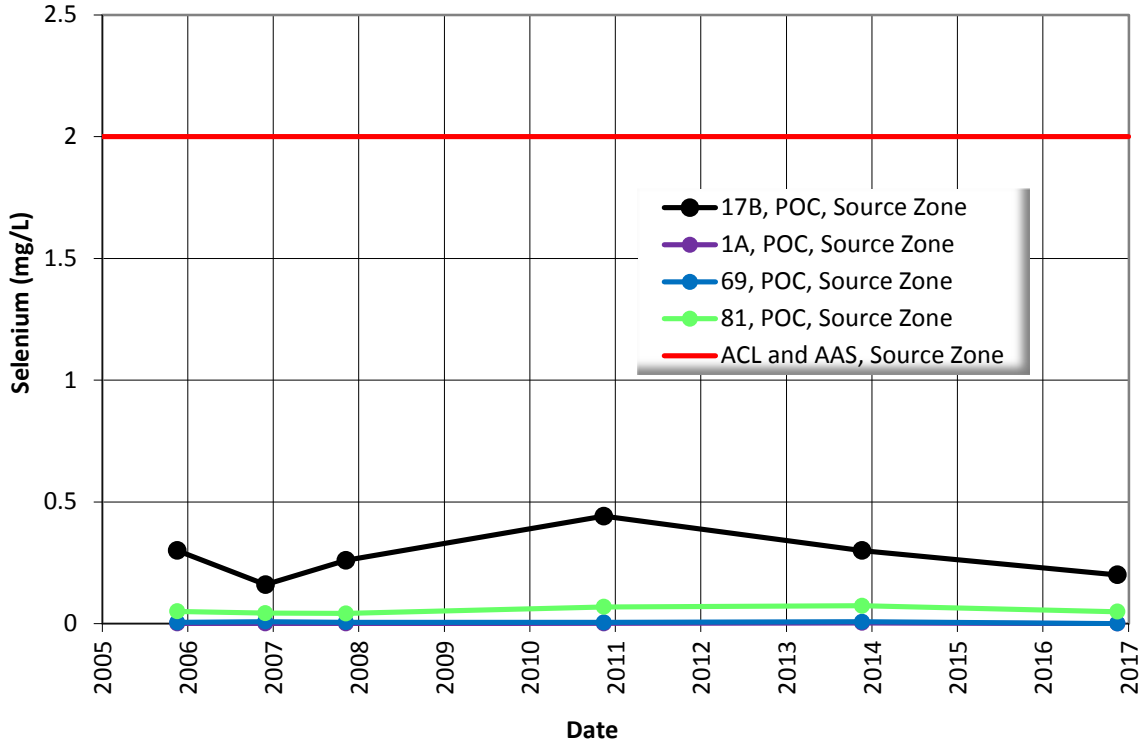


Figure 3-5. Time Concentration Plots of Selenium in Groundwater at the L-Bar Disposal Site

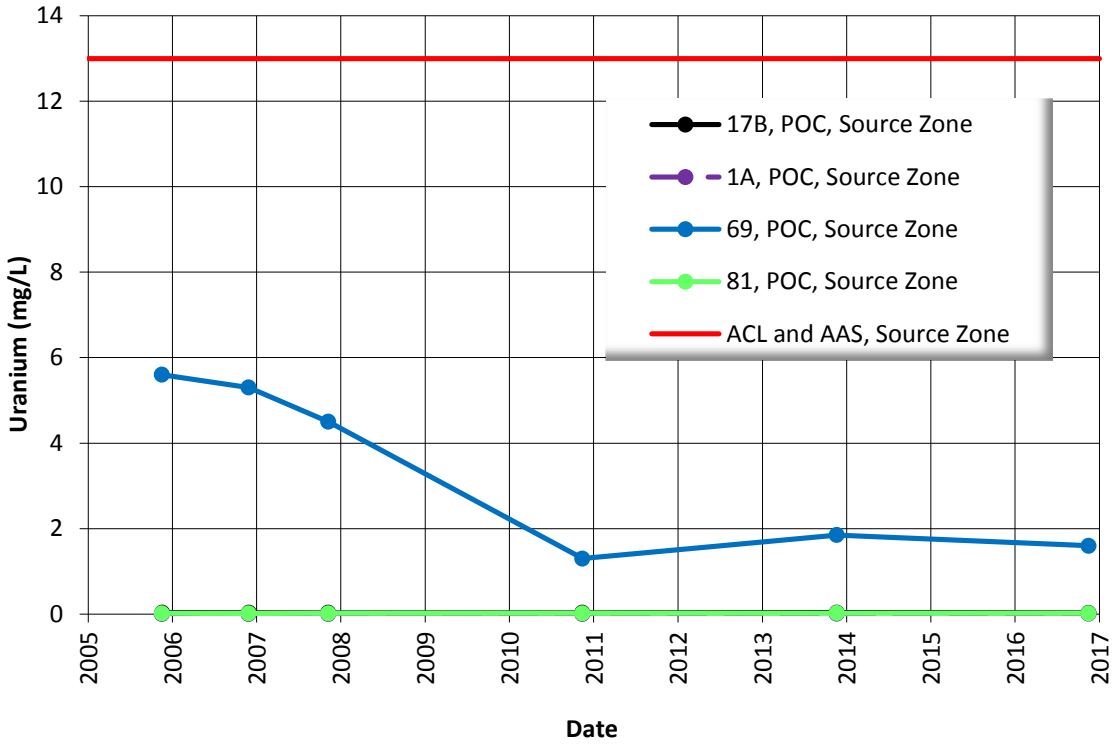


Figure 3-6. Time Concentration Plots of Uranium in Groundwater at the L-Bar Disposal Site

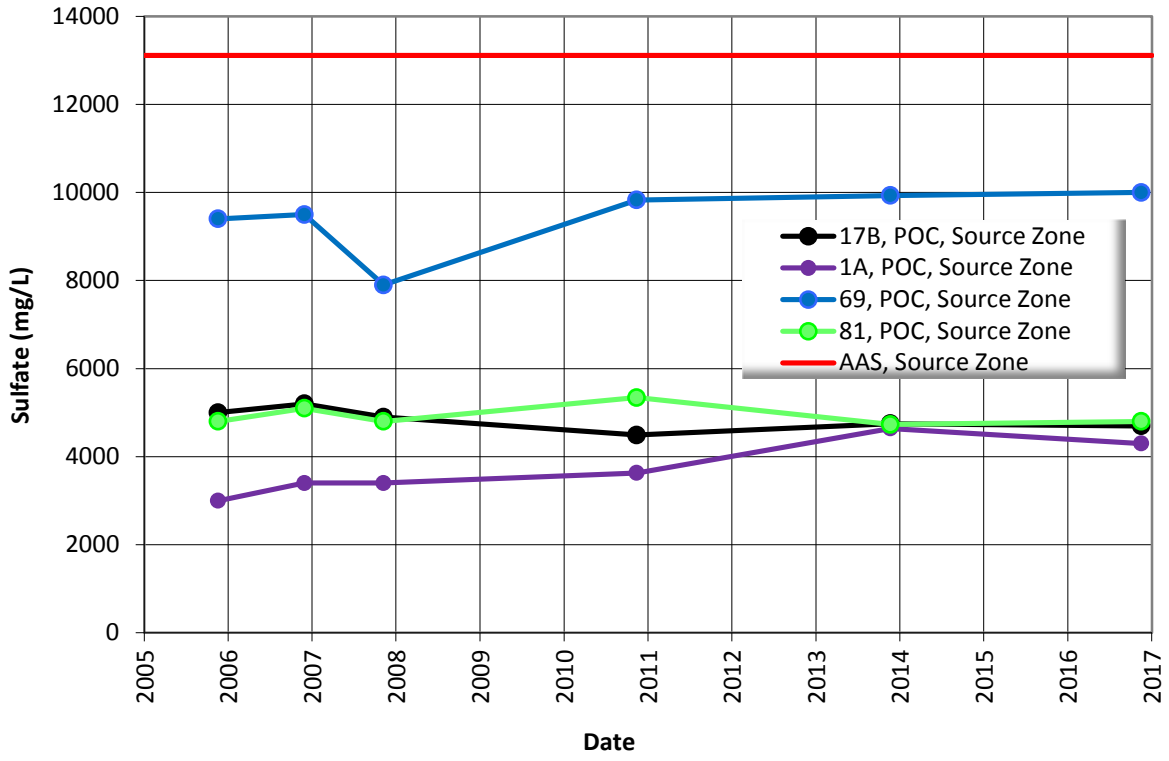


Figure 3-7. Time Concentration Plots of Sulfate in Groundwater at the L-Bar Disposal Site (Source Zone Wells)

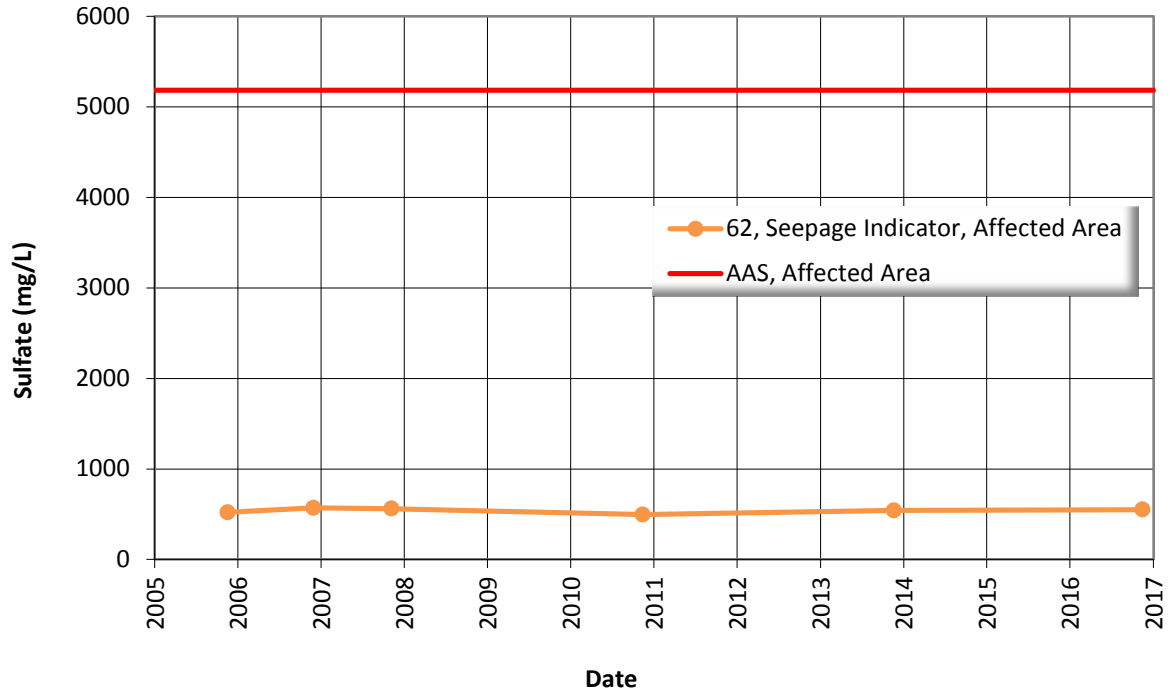


Figure 3-8. Time Concentration Plots of Sulfate in Groundwater at the L-Bar Disposal Site (Affected Area Wells)

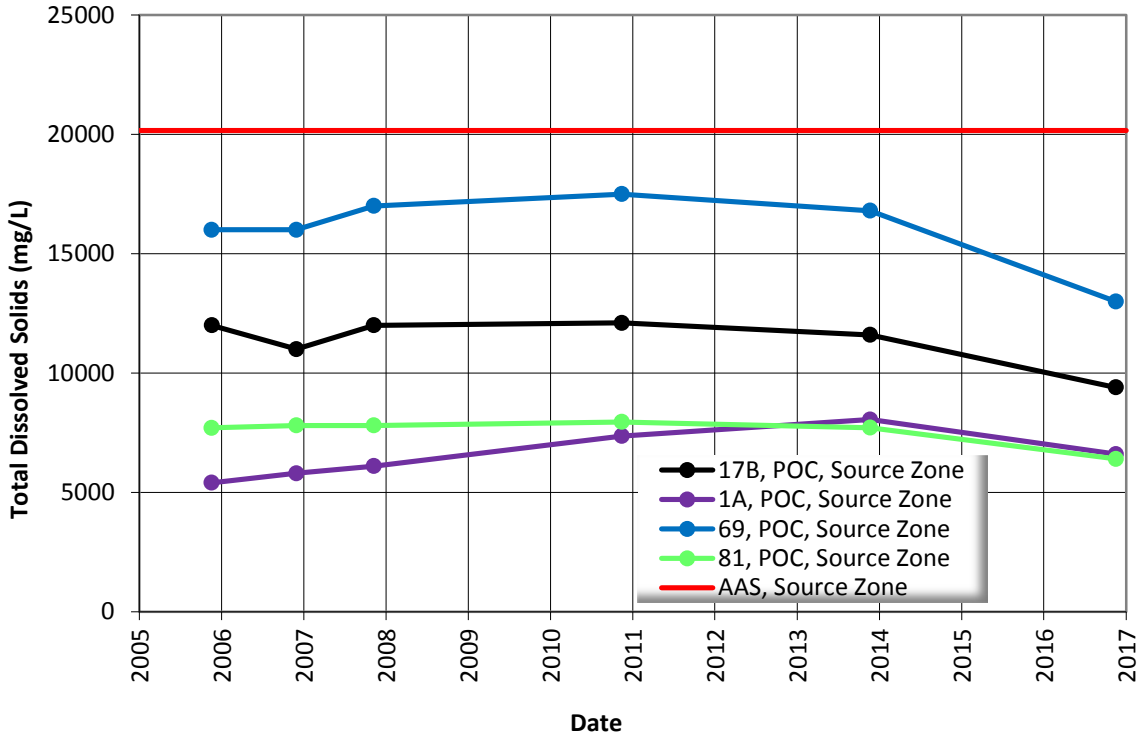


Figure 3-9. Time Concentration Plots of Total Dissolved Solids in Groundwater at the L-Bar Disposal Site (Source Zone Wells)

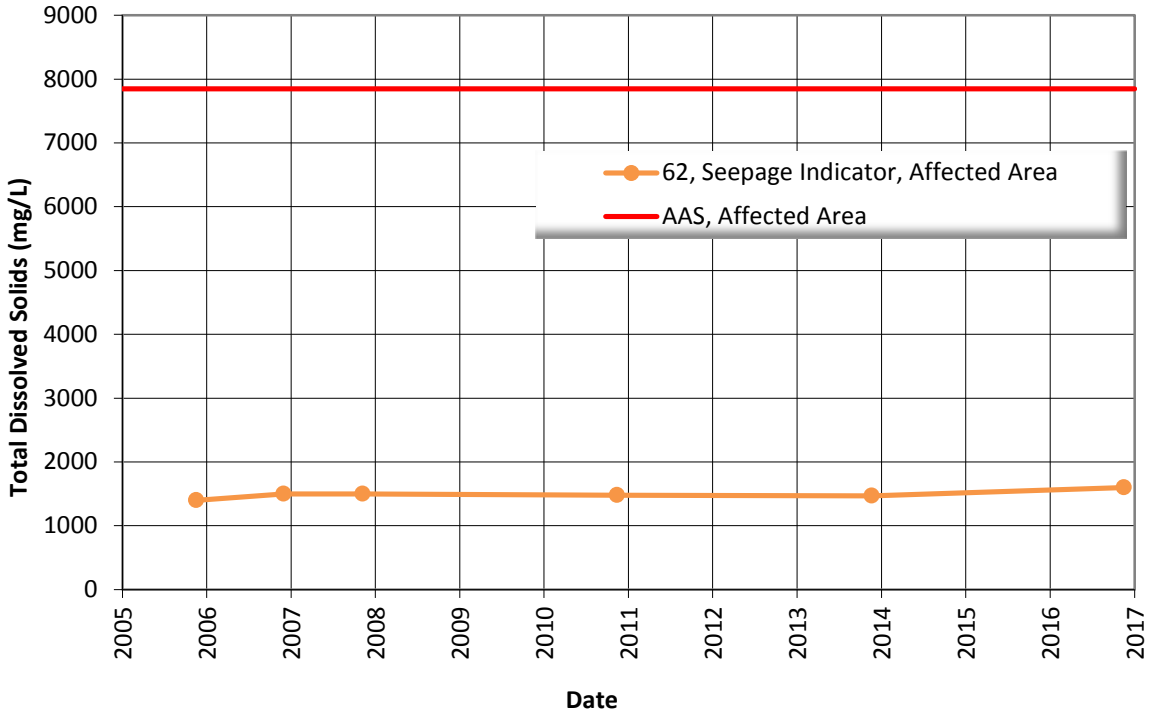


Figure 3-10. Time Concentration Plots of Total Dissolved Solids in Groundwater at the L-Bar Disposal Site (Affected Area Wells)

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 and then once every 10 years for the following 80 years. Erosion will be considered excessive when 2 feet of erosion is noted at more than half of the monitoring locations. If this occurs, LM will initiate discussions with NRC to assess likely remedial scenarios and develop an appropriate mitigation protocol, if required.

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. Total thickness of the cover ranges from 6 to 10 feet. The EMP has two parts: (1) measuring surface soil erosion and (2) measuring the progress of revegetation. Measurements were made during the 2018 annual site inspection on September 13, 2018.

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. These locations are shown in Figure 3-1. The locations were initially measured in December 2003 by the former licensee to establish a baseline dataset.

Each monitoring location consists of a 5-foot length of half-inch-diameter, epoxy-coated rebar surrounded by three metal T-posts that were installed to help locate the rebar and provide orientation for the measurements. The rebar was driven at each location so that approximately 1 foot remained above the cover surface. Each rebar has a metal tag indicating the location number. The three T-posts are set approximately 6 feet 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 2018 measurements are presented in Table 3-5. Baseline measurements are included for comparison. The surface elevation has increased at all of the monitoring locations when compared to the baseline measurements. These results indicate that the surface of the disposal cell is accreting instead of eroding. Since 2003, an average of 0.9 inch of soil has accreted. Accretion is likely due to the increasing vegetation density on the disposal cell cover, which in turn raises the surface elevation through underground root growth, organic matter accumulation in and on the surface soil, and windborne sediment deposition around the plants' foliage and stems.

Table 3-5. Surface Elevation Changes on the L-Bar, New Mexico, Disposal Cell Cover Between 2003 and 2018

Monitoring Location	Length of Rebar Above Surface (inches)				Change in Surface Elevation[a] Baseline to Present (decimal inches)
	2003 (Baseline)		2018		
	(fraction)	(decimal)	(fraction)	(decimal)	
A1	12 10/16	12.625	10 12/16	10.750	1.875
A2	12 7/16	12.438	11 8/16	11.500	0.938
A3	12 15/16	12.938	12 0/16	12.000	0.938
A4	12 6/16	12.375	11 10/16	11.625	0.750
B1	12 10/16	12.625	11 2/16	11.125	1.500
B2	12 8/16	12.500	12 3/16	12.188	0.312
B3	13 0/16	13.000	12 8/16	12.500	0.500
B4	12 15/16	12.938	11 12/16	11.750	1.188
C1	12 8/16	12.500	11 2/16	11.125	0.375
C2	13 1/16	13.063	12 8/16	12.500	0.563
C3	12 2/16	12.125	11 8/16	11.500	0.625
C4	12 6/16	12.375	11 6/16	11.375	1.000
D1	12 7/16	12.438	11 14/16	11.875	0.563
D2	12 12/16	12.750	12 2/16	12.125	0.625
D3	12 3/16	12.188	10 10/16	10.625	1.563
D4	12 12/16	12.750	12 7/16	12.438	0.312
E1	13 1/16	13.063	11 9/16	11.563	1.500
E2	12 14/16	12.875	12 4/16	12.250	0.625
E3	12 9/16	12.563	11 8/16	11.500	1.063
E4	12 15/16	12.938	12 3/16	12.188	0.750

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.

3.7.2.2 Vegetation Monitoring

LM established 10 vegetation monitoring plots to measure the progress of revegetation over time (PL-24). Plots were established at existing erosion monitoring locations (A1, A3, B2, B4, C1, C3, D2, D4, E1, and E3) to streamline measurement activities at the site. At each plot, three T-posts were used to form three corners of the plot; the fourth point was projected south of the three T-posts to form a parallelogram covering approximately 100 square feet.

The primary vegetation monitoring requirement is to measure the percentage of foliar cover (canopy) of all live vegetation within the plot. Percent foliar cover represents the approximate total area under the maximum circumference of each of the live plants within the plot. The average foliar cover of live vegetation near the site, according to the U.S. Department of Agriculture and estimated from observation, is approximately 25%.

The predominant vegetation in the area consists of perennial grasses, forbs, and shrubs. In accordance with the EMP, LM will perform annual vegetation monitoring until at least 20%

foliar cover is achieved, and this criterion will be satisfied when more than half of the monitoring plots exceed 20% cover. Because annual and biennial plants do not necessarily germinate each year and their germination is highly dependent upon weather conditions, it is assumed that this criterion is based on perennial plant cover only. Once the success criterion is met, annual monitoring will not be required unless a significant reduction in plant density is noted during an annual site inspection; in that case, vegetation cover in the plots will be measured again. Annual vegetation monitoring will continue until the success criterion has again been satisfied.

Results of the 2018 vegetation monitoring, compared with those from selected previous years, are presented in Table 3-6. Four of the 10 plots contained more than 20% perennial foliar cover in 2018, the same as in 2017 and 2016, although the 2016 data are not shown in Table 3-6. Large increases and decreases in perennial cover from year to year are mostly attributable to new growth and dieback in the shrub species (broom snakeweed, rubber rabbitbrush, and fourwing saltbush), which likely occur in response to wet and drought years, respectively. During the 2018 monitoring event, drought conditions were obvious at the site, as only traces of annual species were present, and most perennial grasses appeared dead or dormant. Since 2005, overall increases in perennial foliar cover have only occurred in 6 of the 10 plots: A3, B4, C3, D4, E1, and E3. Foliar cover in plot D4 has noticeably improved since it was seeded in 2009.[1] Annual vegetation monitoring will continue until six or more plots meet or exceed the 20% foliar cover requirement.

Table 3-6. Comparison of Perennial Plant Cover on the L-Bar, New Mexico, Disposal Cell Cover

Plot Location	Percent Perennial Plant Cover in 100-Square-Foot Plots					
	2005	2009	2013	2015	2017	2018
A1	57	74	12	30	35	22
A3	11	15	7	11	8	16
B2	0	0	0	0	0	0
B4	20	48	13	21	28	25
C1	22	20	7	27	25	19
C3	0	2	2	2	8	9
D2	2	6	9	1	4	1
D4	0	0	1	14	18	24
E1	2	16	5	34	22	21
E3	8	10	6	23	13	16

Perennial plant species that have been observed within the monitoring plots include broom snakeweed, rubber rabbitbrush, fourwing saltbush, sand dropseed, squirreltail, James' galleta grass, tumblegrass, Nelson globemallow, Bigelow's tansyaster, silverleaf nightshade, white heath aster, spreading fleabane, and goosefoot.[2] Rubber rabbitbrush and fourwing saltbush are deep-rooted woody shrubs.

[1] Plot D4 is the only monitored plot that occurs within the 2009 seeded area.
[2] Common names of plants are consistent with those found in the U.S. Department of Agriculture "PLANTS Database" (USDA 2018).

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.*

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

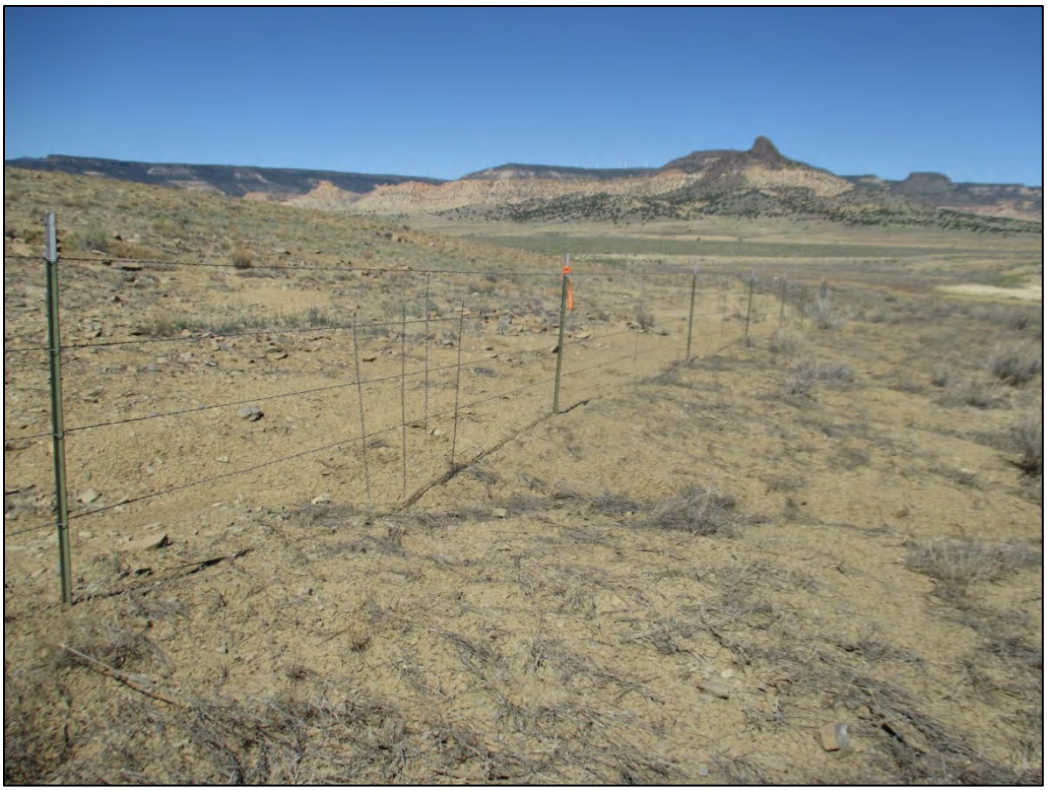
DOE (U.S. Department of Energy), 2004. *Long-Term Surveillance Plan for the U.S. Department of Energy L-Bar, New Mexico (UMTRCA Title II) Disposal Site, Seboyeta, New Mexico,* DOE−LM/GJ709−2004, September.

USDA (U.S. Department of Agriculture), 2018. The PLANTS Database, https://plants.usda.gov, accessed September 19, 2018, National Plant Data Team, Greensboro, North Carolina.

3.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	290	Loose Fence Post Repair South of Perimeter Sign P33
PL-2	290	Erosion Under Perimeter Fence and Fence Repair
PL-3	180	Entrance Sign and Site Marker
PL-4	255	Perimeter Sign P17
PL-5	180	Site Marker
PL-6	240	Boundary Monument BM1
PL-7	330	Monitoring Well 62
PL-8	350	South Channel; Disposal Cell in Background
PL-9	270	Disposal Cell Top Slope
PL-10	90	Containment Dam Spillway
PL-11	115	Sediment Trap
PL-12	0	Breach of Runoff Control Structure A Berm
PL-13	350	Soil Piping Along Inlet of Runoff Control Structure A
PL-14	345	Gully Upgradient of Sediment Trap
PL-15	270	North Channel
PL-16	190	Damaged Runoff Control Structure G
PL-17	190	Erosion East of Riprap Cutoff Wall at Outlet of North Channel
PL-18	110	Riprap Cutoff Wall at Outlet of North Channel and Disposal Cell Western Side Slope
PL-19	265	South Channel
PL-20	150	Riprap-Armored Drainage Swale Along South Channel
PL-21	180	Riprap Cutoff Wall at Outlet of South Channel
PL-22	240	Culverts Constructed in 2016
PL-23	100	Tres Hermanos Sandstone Outcrop (Dry)
PL-24	270	Erosion Monitoring Point and Vegetation Plot B4

PL-1. Loose Fence Post Repair South of Perimeter Sign P33



PL-2. Erosion Under Perimeter Fence and Fence Repair

PL-3. Entrance Sign and Site Marker

PL-4. Perimeter Sign P17

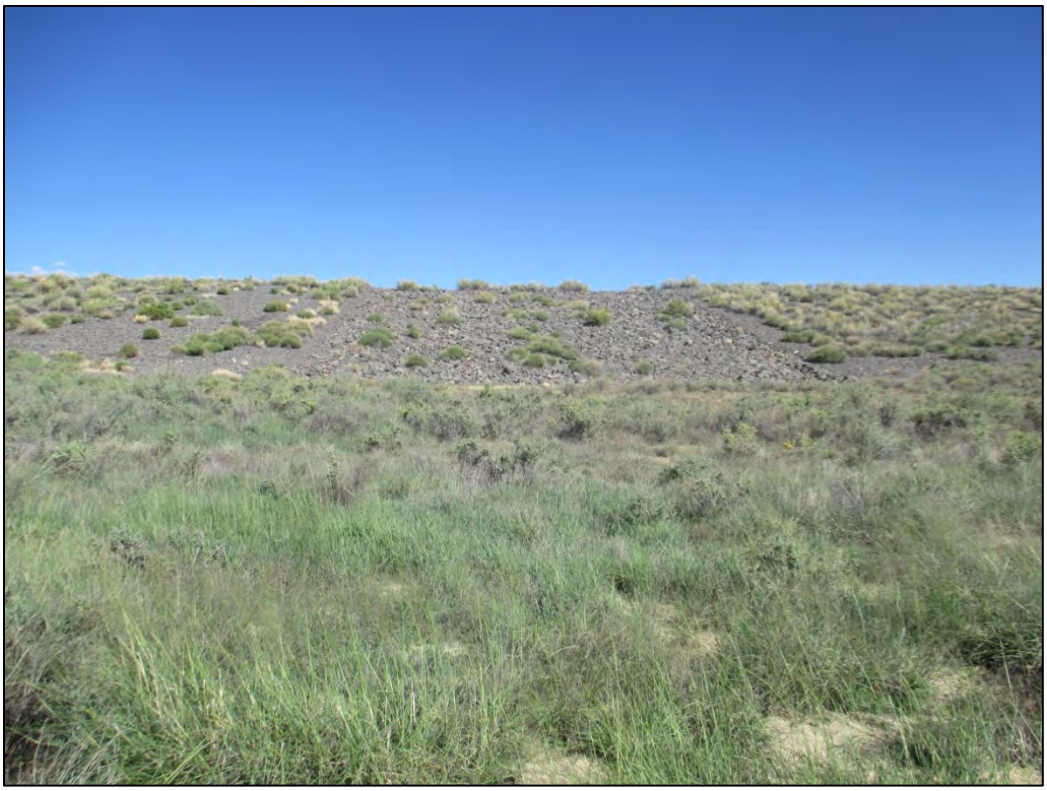
PL-5. Site Marker

PL-6. Boundary Monument BM1

PL-7. Monitoring Well 62

PL-8. South Channel; Disposal Cell in Background

PL-9. Disposal Cell Top Slope



PL-10. Containment Dam Spillway

PL-11. Sediment Trap

PL-12. Breach of Runoff Control Structure A Berm

PL-13. Soil Piping Along Inlet of Runoff Control Structure A

PL-14. Gully Upgradient of Sediment Trap

PL-15. North Channel

PL-16. Damaged Runoff Control Structure G

PL-17. Erosion East of Riprap Cutoff Wall at Outlet of North Channel

PL-18. Riprap Cutoff Wall at Outlet of North Channel and Disposal Cell Western Side Slope

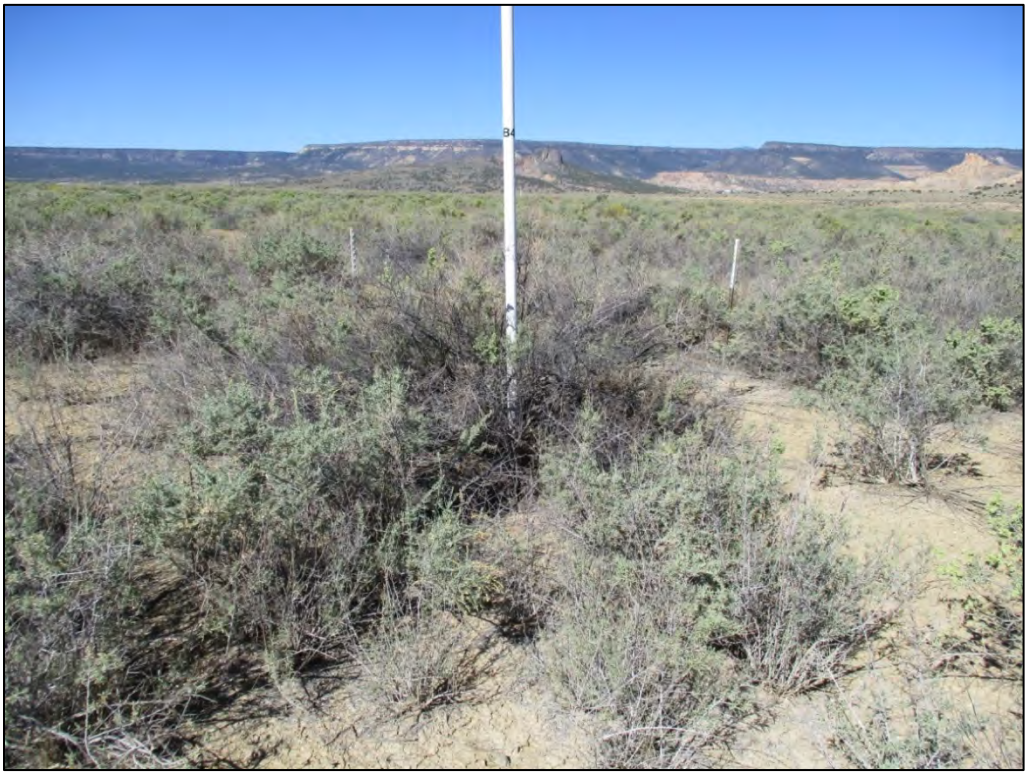
PL-19. South Channel

PL-20. Riprap-Armored Drainage Swale Along South Channel

PL-21. Riprap Cutoff Wall at Outlet of South Channel

PL-22. Culverts Constructed in 2016

PL-23. Tres Hermanos Sandstone Outcrop (Dry)



PL-24. Erosion Monitoring Point and Vegetation Plot B4

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4.0 Maybell West, Colorado, Disposal Site

4.1 Compliance Summary

The Maybell West, Colorado, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site (site) was inspected on August 8, 2018. Depressions observed on the top of the disposal cell beginning in 2017 were revisited in 2018. The approximate dimensions of Depression No. 1 were slightly larger than those observed in the 2017 annual inspection, whereas Depression No. 2 has not observably changed. A third, even smaller depression (Depression No. 3) was observed for the first time west of Depression No. 2. None of the depressions currently threaten the integrity or performance of the disposal cell; monitoring of the depressions will continue, including aerial surveys that can detect small changes in depression size. No changes were observed in associated drainage features. Gullies were observed west of Diversion Channel No. 2, and slight rilling under the northern perimeter fence was also observed. None of these currently threaten the integrity of the main disposal cell, ancillary cell, or associated surface water diversion structures; monitoring of this erosion will continue. Minor maintenance needs were identified. Inspectors identified no cause for a follow-up inspection. Groundwater monitoring is not required at the site.

4.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the site-specific U.S. Department of Energy (DOE) Office of Legacy Management (LM) Long-Term Surveillance Plan (LTSP) (DOE 2010) and in procedures LM established to comply with the requirements of Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 4-1 lists these requirements.

Table 4-1. License Requirements for the Maybell West, Colorado, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 4.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 4.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 4.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 4.7	(b)(3)

4.3 Institutional Controls

The 180-acre site, identified by the property boundary shown in Figure 4-1, is owned by the United States and was accepted under the U.S. Nuclear Regulatory Commission general license (10 CFR 40.28) in 2010. DOE is the licensee and, in accordance with the requirements for UMTRCA Title II sites, is responsible for the custody and long-term care of the site. Institutional controls (ICs) at the site include federal ownership of the property and the following physical ICs that are inspected annually: disposal cell, ancillary cell, entrance gate and sign, perimeter fence and signs, site marker, and boundary monuments.

4.4 Inspection Results

The site, approximately 4 miles northeast of Maybell, Colorado, was inspected on August 8, 2018. The inspection was conducted by J. Cario, S. Hall, and C. Wentz of the Legacy Management Support contractor. J. Nguyen (LM site manager) and J. Doebele (Colorado Department of Public Health and Environment) attended the inspection. 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 determine the need, if any, for maintenance or additional inspections and monitoring.

4.4.1 Site Surveillance Features

Figure 4-1 shows the locations of site features in black, including site surveillance features and inspection areas. 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 text, and new observations identified in the 2018 annual inspection are shown in red. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified in the text and in Figure 4-1 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 4.9.

4.4.1.1 Site Access and Entrance Gate

Access to the site is from Moffat County Road 53, which runs north from U.S. Highway 40 approximately 8 miles east of Maybell, Colorado. County Road 53 ends at an unlocked gate near the northeast corner of the Maybell UMTRCA Title I disposal site (approximately 3 miles from U.S. Highway 40). LM is responsible for maintenance of the road from the end of County Road 53 to the Maybell West Site and has access under a U.S. Bureau of Land Management (BLM) right-of-way permit.

The dirt two-track access road continues west from the end of County Road 53 on BLM property and through a second unlocked gate. Just past the second gate, the access road turns south and continues for approximately 0.5 mile past an abandoned open pit uranium mine known as Rob Pit, then bends north, following the route of the site's former haul road for approximately 0.25 mile to the site entrance gate.

The access road was passable, and no maintenance needs were identified. The entrance gate, a standard tubular metal stock gate, is near the southeast corner of the site. The gate was locked, and no maintenance needs were identified.

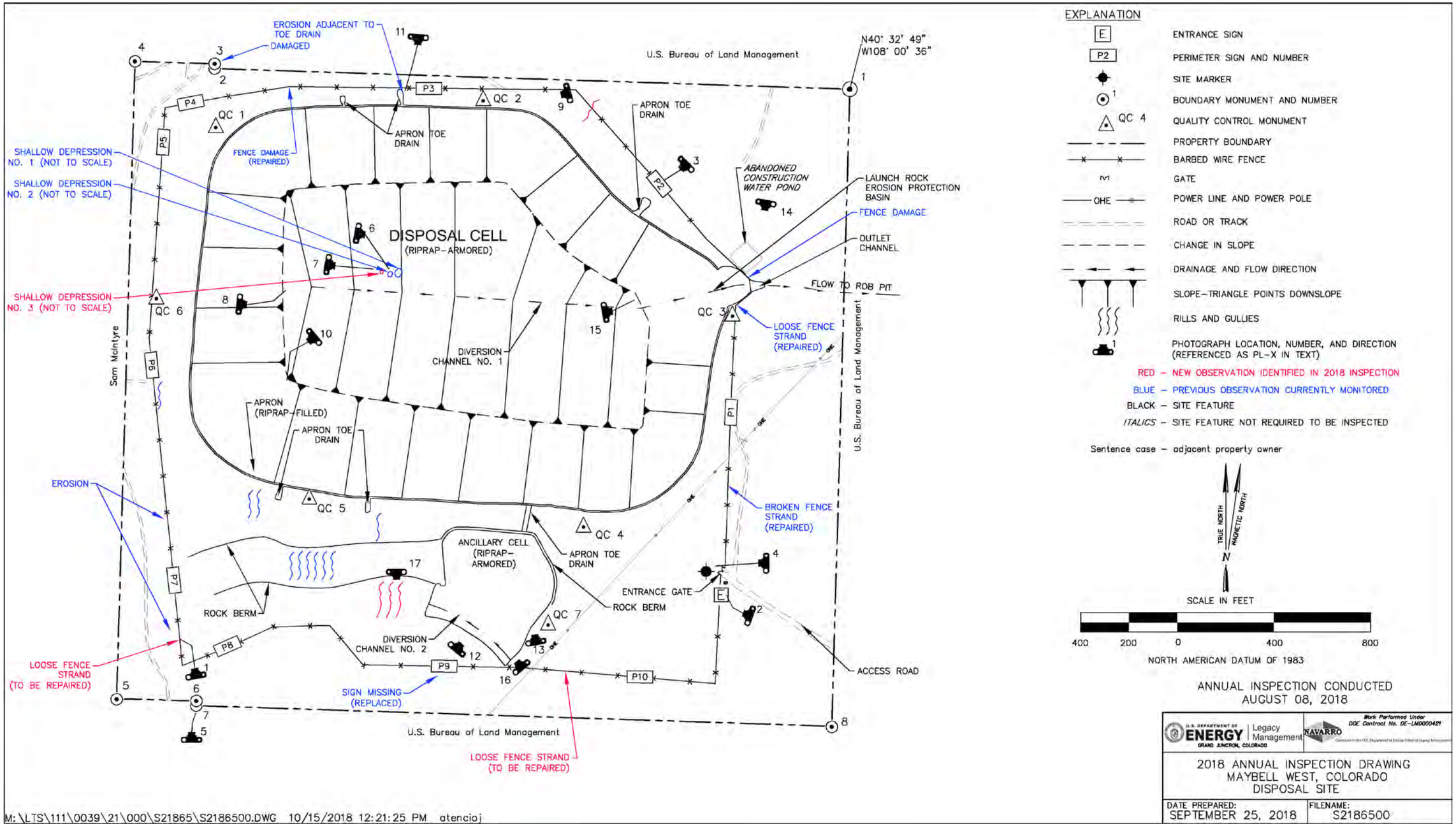

Figure 4-1. 2018 Annual Inspection Drawing for the Maybell West, Colorado, Disposal Site

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4.4.1.2 Perimeter Fence and Signs

A four-strand barbed-wire fence encloses the disposal cell, the ancillary cell, the drainage structures, and much of the site. The fence primarily serves to prevent livestock trespass, because the site is surrounded by open rangeland used for cattle grazing. Minor damage to the perimeter fence occurs periodically because the site is in wintering grounds frequented by big game animals (primarily pronghorn, deer, and elk). Fence damage identified during the 2018 annual inspection consisted of one location where a strand was broken and three locations where a strand was loose. Minor erosion continues to be observed between perimeter signs P6 and P8, resulting in a loose T-post and strand (PL-1). Observation of this erosion will continue. Some fence repairs were completed during a subsequent site visit; the remaining repairs will be completed before the 2019 annual inspection.

The entrance sign is mounted on a metal T-post directly south of the entrance gate (PL-2). Ten warning or perimeter signs are mounted on metal T-posts around the site (PL-3). All perimeter signs were present and legible. No other maintenance needs were identified.

4.4.1.3 Site Marker

The site has one granite site marker near the entrance gate (PL-4). No maintenance needs were identified.

4.4.1.4 Boundary Monuments

Eight boundary monuments are on the site boundary outside the fenced area (PL-5). Four of the monuments are at the property corners, and the others define an approximate 20-foot offset that occurs along the north and south boundaries where the private land that LM acquired in fee adjoins the BLM withdrawal area on the western portion of the site. Boundary monuments BM-3 and BM-6 (capped pieces of rebar) define the two 20-foot offsets. Boundary monument BM-3 was observed to be bent during the 2017 annual inspection; attempts to straighten the monument were not successful, and repair or replacement options will be evaluated. No other maintenance needs were identified.

4.4.2 Inspection Areas

In accordance with the LTSP, the site is divided into five inspection areas (referred to as “transects” in the LTSP) to ensure a thorough and efficient inspection. The inspection areas are (1) the top slope of the disposal cell, (2) the side slopes of the disposal cell, (3) the ancillary cell, (4) the diversion and drainage channels, and (5) the site perimeter and balance of the site.

4.4.2.1 Top Slope of the Disposal Cell

The disposal cell is on the reclaimed site of a former heap leach processing area. The top slope of the riprap-armored disposal cell occupies about 60 acres of the site. The top of the disposal cell showed no signs of significant erosion, settling, or other modifying processes that would affect the cell’s integrity. However, a small, shallow depression (Depression No. 1) was observed just north of Diversion Channel No. 1 during the initial annual inspection in 2010 (PL-6). This depression—approximately 26 feet long, 17 feet wide, and 1 foot deep in the center—appears to be the result of settlement of the underlying materials since completion of the disposal cell.

Depression No. 1 is slightly longer and wider than measurements noted during the 2017 annual inspection. A second smaller and shallower depression (Depression No. 2)—approximately 10 feet long, 5 feet wide, and less than 6 inches deep in the center—was first noted just west of the first depression during the 2016 annual inspection. Depression No. 2 appeared during the 2018 annual inspection to be approximately the same size as previously observed. A third, smaller depression (Depression No. 3) was also observed for the first time during the 2018 annual inspection and measures approximately 1 foot long, 1 foot wide, and 9 inches deep (PL-7). This depression is directly northwest of Depression No. 2.

Measurements of all three depressions will continue to be performed during annual inspections to determine if additional, more significant settlement is occurring. Aerial surveys conducted in 2018 will provide another means of measuring and monitoring the depressions. A baseline aerial survey using photogrammetry was performed at the site to obtain accurate site topography for future comparison. Multispectral imagery was also collected to assess vegetation coverage. Six permanent quality-control monuments were installed at the site for LM to verify accuracy and quality of aerial survey data.

No standing water was observed in any of the depressions during the inspection; however, standing water was observed in the depressions during a site visit in April 2018. The depressions currently do not threaten the integrity or performance of the disposal cell. No maintenance needs were identified.

While various species of plants were present on the top slope of the disposal cell, no deep-rooted vegetation was observed (PL-8). If encroachment of deep-rooted vegetation is observed, an evaluation will be conducted as required by the LTSP to determine if any action is necessary. Noxious weeds are controlled in accordance with the LTSP.

4.4.2.2 Side Slopes of the Disposal Cell

The disposal cell was designed to control surface water runoff resulting from a probable maximum flood event. The side slopes of the disposal cell were constructed with a 20% slope and are covered with a 1-foot-thick layer of riprap (PL-9 and PL-10). Surface water runoff from the side slopes is conveyed by an apron at the toe of the slope to six riprap-armored toe drains at low points in the apron. The apron and toe drains are constructed channels filled with riprap. Minor erosion has occurred adjacent to a toe drain along the north side of the disposal cell (PL-11), but that has not impacted the performance of the toe drain. No maintenance needs were identified.

4.4.2.3 Ancillary Cell

The ancillary cell (PL-12) was constructed to contain waste materials associated with the reclaimed evaporation pond area. It slopes gently toward the southwest. A rock berm wraps around its eastern and northern sides to protect it from surface water runoff. Various species of plants were present on the top slope of the ancillary cell (PL-12 and PL-13). Noxious weeds are controlled in accordance with the LTSP. No maintenance needs were identified.

4.4.2.4 Diversion and Drainage Channels

Final surface conditions at the site include a combination of rock armoring and contouring to achieve the surface water drainage control and erosion protection necessary to satisfy the design longevity requirements. The top slope of the disposal cell was designed to drain surface water runoff to the center and into riprap-armored Diversion Channel No. 1 (PL-8), which is graded toward and then down the east side slope of the disposal cell (PL-14). Surface water runoff ultimately discharges into Rob Pit east of the site. An erosion protection structure, referred to as the Launch Rock Erosion Protection Basin (PL-15), was constructed at the outfall of Diversion Channel No. 1 to protect the disposal cell from headcutting that may occur from the deep channel that runs into Rob Pit. Diversion Channel No. 2 runs along the south side of the ancillary cell to convey surface water runoff away from the ancillary cell (PL-16). The diversion channels and outlet channel of the Launch Rock Erosion Protection Basin continue functioning as designed.

The rock berm that runs along the northern edge of the ancillary cell continues west across the slope south of the disposal cell to protect against erosion. Several gullies and rills have developed on this south slope but do not threaten the integrity of the disposal cell (PL-17). The gullies will continue to be monitored and repaired as needed. The rock berm effectively controls headcutting from these gullies and protects the disposal cell. No maintenance needs were identified.

4.4.2.5 Site Perimeter and Balance of the Site

Reclaimed surfaces at the site were planted with a mixture of native and adaptive grasses to provide soil stability, and the vegetation continues to improve. Noxious weeds are controlled (treated with herbicide) in accordance with the LTSP.

During each site inspection, the area surrounding the site is checked to ensure that changes in land or water use do not affect site protectiveness. The area beyond the site boundary for a distance of 0.25 mile was visually observed for erosion, changes in land use, or other phenomena that might affect the long-term integrity of the site. No such changes were identified.

4.5 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. No need for a follow-up inspection was identified.

4.6 Routine Maintenance and Emergency Measures

Noxious weeds are treated with herbicide. Minor damage to the perimeter fence was noted and will be repaired before the 2019 annual inspection. Boundary monument BM-3 is damaged and will need to be repaired or replaced. No other maintenance needs were identified.

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.

4.7 Environmental Monitoring

In accordance with the LTSP, groundwater monitoring is not required at the site because the results of 30 years of historical groundwater monitoring performed at the site by the former licensee (20 years before reclamation and 10 years after reclamation) indicated that groundwater was not contaminated by site-related activities.

4.8 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*.

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

DOE (U.S. Department of Energy), 2010. *Long-Term Surveillance Plan for the Maybell West (UMTRCA Title II) Disposal Site, Moffat County, Colorado*, LMS/MAW/S01879, February.

4.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	350	Erosion Near Southwest Corner of Perimeter Fence
PL-2	290	Site Entrance Sign and Site Marker
PL-3	225	Perimeter Sign P2; Disposal Cell Northeast Side Slope in Background
PL-4	270	Site Marker
PL-5	0	Boundary Monument BM-7
PL-6	100	Depression No. 1 on Top Slope of Disposal Cell
PL-7	100	Depression No. 3 on Top Slope of Disposal Cell
PL-8	95	Diversion Channel No. 1 on Top of Disposal Cell
PL-9	255	Disposal Cell North Side Slope
PL-10	230	Intersection of Disposal Cell's South and West Side Slopes
PL-11	185	Toe Drain on Disposal Cell North Side Slope and Adjacent Erosion
PL-12	40	Diversion Channel No. 2; Ancillary Cell and Disposal Cell in Background
PL-13	350	Ancillary Cell Top Slope; Disposal Cell South Side Slope in Background
PL-14	190	Diversion Channel No. 1 Outlet and East Side Slope; Launch Rock Erosion Protection Basin
PL-15	80	Diversion Channel No. 1 Outlet on East Side Slope; Launch Rock Erosion Protection Basin and Rob Pit in Background
PL-16	320	Diversion Channel No. 2
PL-17	180	Gully West of Diversion Channel No. 2

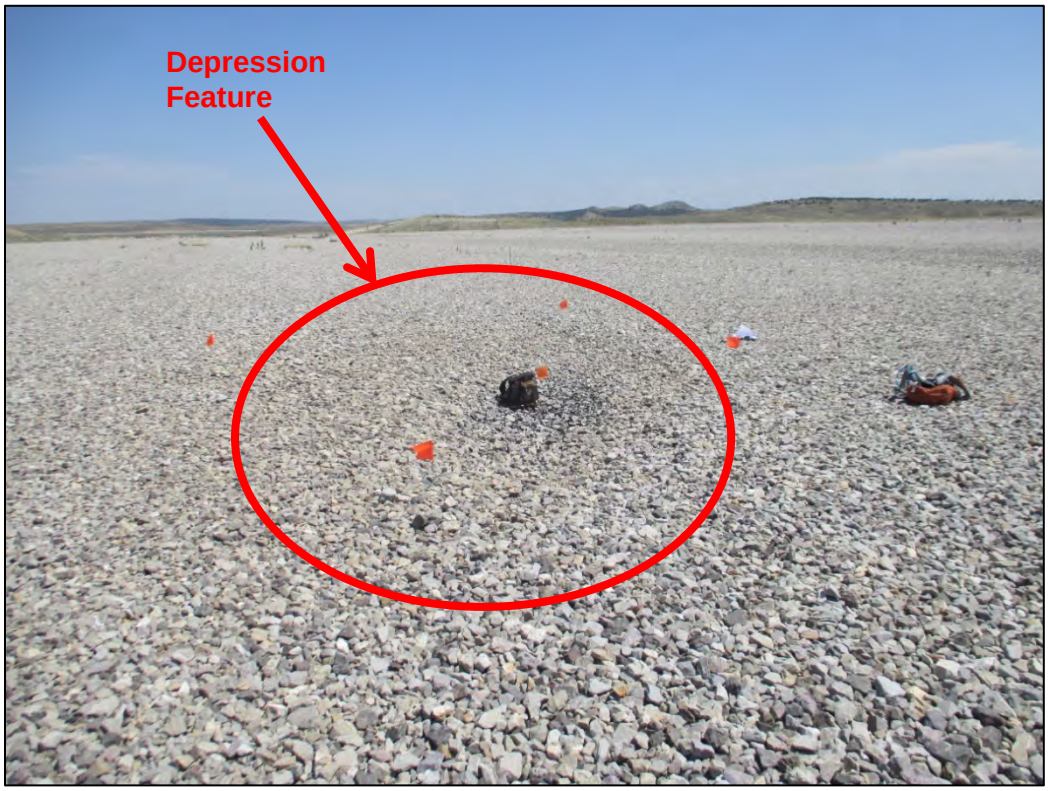
PL-1. Erosion Near Southwest Corner of Perimeter Fence

PL-2. Site Entrance Sign and Site Marker

PL-3. Perimeter Sign P2; Disposal Cell Northeast Side Slope in Background

PL-4. Site Marker

PL-5. Boundary Monument BM-7



PL-6. Depression No. 1 on Top Slope of Disposal Cell

PL-7. Depression No. 3 on Top Slope of Disposal Cell

PL-8. Diversion Channel No. 1 on Top of Disposal Cell

PL-9. Disposal Cell North Side Slope

PL-10. Intersection of Disposal Cell's South and West Side Slopes

PL-11. Toe Drain on Disposal Cell North Side Slope and Adjacent Erosion

PL-12. Diversion Channel No. 2; Ancillary Cell and Disposal Cell in Background

PL-13. Ancillary Cell Top Slope; Disposal Cell South Side Slope in Background

PL-14. Diversion Channel No. 1 Outlet and East Side Slope; Launch Rock Erosion Protection Basin

PL-15. Diversion Channel No. 1 Outlet on East Side Slope; Launch Rock Erosion Protection Basin and Rob Pit in Background

PL-16. Diversion Channel No. 2

PL-17. Gully West of Diversion Channel No. 2

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5.0 Sherwood, Washington, Disposal Site

5.1 Compliance Summary

The Sherwood, Washington, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site (site) was inspected on May 10, 2018. No changes were observed on the disposal cell or in the containment dam and associated drainage features. Inspectors identified no maintenance needs or cause for a follow-up inspection.

Groundwater monitoring is not required at the site. However, the U.S. Department of Energy (DOE) Office of Legacy Management (LM) conducts groundwater monitoring at three wells as a best management practice in accordance with the site-specific Long-Term Surveillance Plan (LTSP) (DOE 2001). The sulfate action level (State of Washington water quality criteria) was exceeded at one monitoring well in 2017. The 2018 sampling also served as confirmatory sampling, and the action level was met but not exceeded. A borehole camera was used to evaluate conditions in the monitoring wells, specifically to determine if there were any well issues that could have caused the exceedance. The video showed that the inlet of the dedicated bladder pump used for low-flow sampling was buried in debris at the bottom of the well. The well will be cleaned and redeveloped before sampling in 2019.

5.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the LTSP (DOE 2001) and in procedures LM established to comply with the requirements of Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 5-1 lists these requirements.

Table 5-1. License Requirements for the Sherwood, Washington, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 5.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 5.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 5.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 5.7	(b)(3)

5.3 Institutional Controls

The 380-acre site, identified by the property boundary shown in Figure 5-1, is owned by the United States in trust for the Spokane Tribe of Indians (Spokane Tribe). The site was accepted under the U.S. Nuclear Regulatory Commission (NRC) general license (10 CFR 40.28) in 2001. Because the site is on the Spokane Indian Reservation, no agreement of transfer was necessary for conveying the property rights to DOE. However, an agreement was executed between the Bureau of Indian Affairs (BIA), Spokane Tribe, NRC, and DOE for permanent right-of-access, which allows LM to fulfill its long-term surveillance and maintenance custodial responsibilities. 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 sign, perimeter signs, site marker, boundary monuments, and monitoring wellhead protection.

5.4 Inspection Results

The site is approximately 8 miles west of Wellpinit, Washington, and 35 miles northwest of the city of Spokane, Washington. The May 10, 2018, inspection was conducted by D. Traub and C. Boger of the Legacy Management Support contractor. K. Kreie (LM site manager), G. Cummings (LM); S. Pachernegg of the Washington State Department of Health; and R. Peone, R. Connolly, and L. Bair of the Spokane Tribe attended the inspection. The purposes of the inspection were to confirm the integrity of the visible features at the site, identify changes in conditions that might affect conformance with the LTSP, and determine the need, if any, for maintenance or additional inspection and monitoring.

5.4.1 Site Surveillance Features

Figure 5-1 shows the locations of site features in black, including site surveillance features and inspection areas. 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 text. There were no new observations in 2018. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified in the text and in Figure 5-1 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 5.9.

5.4.1.1 Site Access and Entrance Gates

Access to the site is from Elijah Road, an all-weather, BIA-maintained road over which LM has permanent right-of-access. The site and adjacent lands are part of the Spokane Indian Reservation. The entrance gates are no longer used and allow open access to the site.

5.4.1.2 Perimeter Signs

There are six warning or perimeter signs, attached to steel posts set in concrete, positioned along the site boundary at likely access points around the site (PL-1). In the past, some signs have become illegible due to fading or vandalism (including bullet damage). However, no maintenance needs were identified.

5.4.1.3 Site Marker

There is one granite site marker on the southwest side of the site where the access road lies closest to the site boundary. No maintenance needs were identified (PL-2).

5.4.1.4 Boundary Monuments

Six boundary monuments set in concrete define the site boundary. Because surrounding vegetation has made it difficult to locate some of the monuments, metal T-posts were installed at each monument location. All boundary monuments were inspected (PL-3). No maintenance needs were identified.

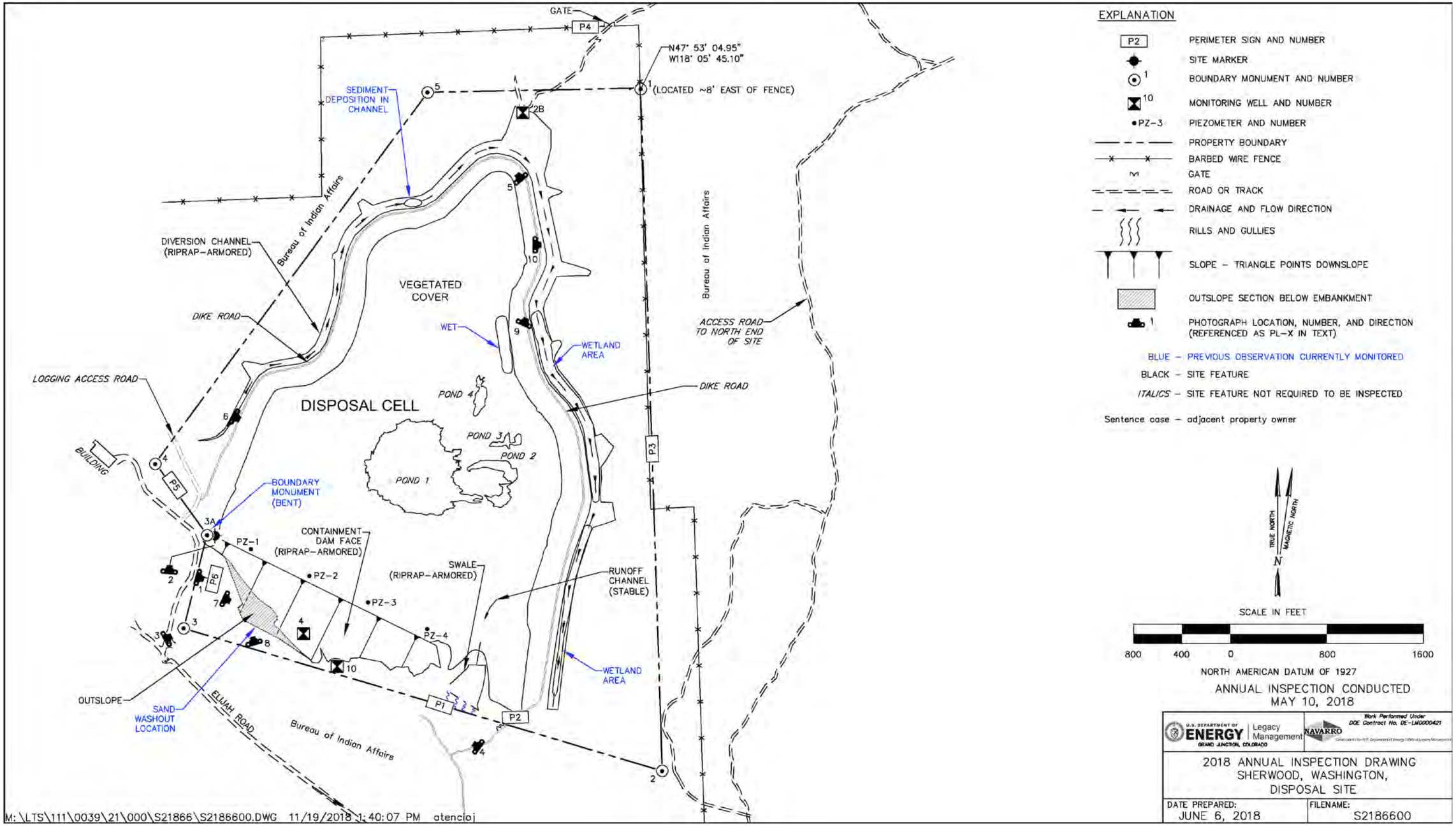

Figure 5-1. 2018 Annual Inspection Drawing for the Sherwood, Washington, Disposal Site

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5.4.1.5 Monitoring Wells and Piezometers

The site groundwater monitoring network consists of three monitoring wells designated as 2B, 4, and 10. As part of the dam safety inspection program, four piezometers, designated PZ-1 through PZ-4, were installed in November 2000 along the crest of the containment dam at a depth equivalent to the base of the dam. All piezometer and wellhead protectors were undamaged and locked. No maintenance needs were identified.

5.4.2 Inspection Areas

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

5.4.2.1 Site Perimeter, Outlying Areas, and Balance of Site

Ponderosa pine forest constitutes most of the area outside the diversion channel that encircles the disposal cell. The surrounding lands are part of the Spokane Indian Reservation and are used for timber harvesting and wildlife habitat. No residences are within 0.25 mile of the site boundary. A vacant metal building, left in place from earlier mining operations, is about 500 feet west of the western site boundary. No new development was evident east of the site along Elijah Road.

A gully was first observed in 2009 along the dike road just beyond the site boundary near perimeter sign P2. The gully is photographed periodically and appears to have increased in size since the 2017 annual inspection (PL-4). This erosion is not impacting site features or access but will continue to be monitored. No maintenance needs were identified.

5.4.2.2 Cover of Disposal Cell

The disposal cell, completed in 1996, occupies 100 acres. The cover consists of 12 to 20 feet of uncompacted soils. During site reclamation, the surface was seeded and planted with native shrubs, forbs, grasses, and trees (PL-5).

A small, shallow channel developed by runoff from the top slope of the disposal cell is present near the southeast corner of the disposal cell. Runoff has scoured the channel down to the quartz monzonite bedrock and discharges into a riprap-armored swale east of the containment dam. The channel is stable and is not above an area containing tailings; however, it will continue to be monitored to ensure that it does not affect the integrity of the disposal cell.

Designers of the disposal cell predicted that some settlement would continue after the uncompacted cover was put in place. As explained on page 2-14 of the LTSP, the cover was designed to be self-healing with regard to impacts from freezing and thawing, biointrusion, and settlement (DOE 2001). The cover was designed to withstand up to 10 feet of settlement. The largest area of settlement is referred to as Pond 1 (PL-6). The plant species present indicate that there is year-round moisture below the surface of the pond area. Other minor

depressions—designated as Ponds 2, 3, and 4—are often dry; however Pond 2 also contained water during the 2018 annual inspection. The shallow ponds are considered to be favorable features on the disposal cell cover, but LM will continue to monitor the surface for unusual settlement features to verify the cover's integrity and ensure that the disposal cell is performing as designed. No maintenance needs were identified.

During the 2015 annual site inspection, a ground-level elevation survey was requested to determine actual settlement values (as opposed to estimated values) to verify that settlement is within the allowance of the disposal cell design. LM conducted an elevation survey over portions of the disposal cell cover in spring 2016 and collected additional survey data at selected locations in spring 2017. Preliminary evaluation of the data indicates some settlement has occurred on the disposal cell. The settlement is estimated at up to 4.4 feet near the ponds, which is within the design allowance of up to 10 feet of settlement. LM prepared the report *Settlement Survey and Analysis, Sherwood, Washington, Disposal Site* (DOE 2018a), which was transmitted to NRC on July 20, 2018.

5.4.2.3 Containment Dam and Diversion Channel

The tailings embankment on this site is classified as a containment dam because of the saturated condition of the impoundment. Therefore, an annual dam safety inspection is required by the LTSP to ensure continued compliance with the National Dam Safety Program Act. The containment dam face was inspected in accordance with the *Dam Inspection Checklist*, which is included at the end of this chapter.

Measurements of water levels in four piezometers atop the containment dam were obtained in May 2018 during the annual groundwater sampling. These annual measurements (Table 5-2), collected since the piezometers were installed in 2000, provide a direct means of determining moisture conditions in the containment dam. Steadily increasing water levels in any of the piezometers could indicate a potential problem with the dam's performance. Measurements collected in May 2018 are provided in the *Dam Inspection Checklist* at the end of this chapter and in Table 5-2 and do not indicate an increase in water levels. Variations in the amount of water in the four piezometers are thought to be due to seasonal responses to precipitation. The minor amount of water in PZ-2 is the result of a small, perched lens of water that exists because of localized differences in permeability. While the lateral extent of the lens is unknown, based on water levels in PZ-2 and monitoring wells 4 and 10, it is estimated that more than 200 feet of unsaturated material is beneath the PZ-2 perched zone. On the basis of the recent water levels observed in the piezometers and monitoring wells, the containment dam is considered to be in an unsaturated condition.

The containment dam face has a rock cover consisting primarily of highly durable quartz monzonite. The face was designed to allow a vegetated cover, including mature trees, to establish and stabilize the surface and mitigate erosion. Consequently, the presence of this vegetation does not harm the function of the containment dam. The containment dam face is thickly vegetated (PL-7). No maintenance needs were identified.

Table 5-2. 2018 Piezometer Water Depths

Piezometer	Total Depth of Piezometer (feet)[a]	Water Level (feet)[a]	Depth of Water (feet)
PZ-1	22.47	21.83	0.64
PZ-2	62.95	60.73	2.22
PZ-3	67.53	Dry	Dry
PZ-4	22.62	22.13	0.49

Note:
[a] Measured from the top of the inner casing.

During the 2016 annual inspection, one area at the base of the rock-covered containment dam face was found to have a fan of sand that had washed out from underneath the rock cover (PL-8). A follow-up inspection of the erosion feature was performed on October 4 and 5, 2016. The protective rock cover adjacent to the area of erosion was removed, and the underlying material was examined. The sandy material that was eroded from the embankment was the same as natural undisturbed material nearby. During reclamation, this area of the mill site was used as a source for fill material used to contour the area below the toe of the containment dam. Review of original reclamation and as-built drawings showed that the toe of the containment dam is upslope from the area of erosion. This was confirmed during the investigation conducted before the 2017 annual site inspection and subsequent engineering evaluation, when several small holes were dug upslope to determine the edge of the actual embankment. It was determined that the washout area was in a portion of the dam defined as the outslope in the construction completion report and does not impact the containment dam (Figure 5-1).

The erosion feature was examined during the 2017 and 2018 annual site inspections, and the extent of the erosion had not increased. However, the area will be visually monitored during future inspections and by periodic aerial high-resolution topographic surveys. Repair options will be evaluated and implemented, in consultation with NRC, if the erosion area increases such that the containment dam could be affected. A report was transmitted to NRC on March 12, 2018, describing the 2016 follow-up inspection and 2017 engineering evaluation (DOE 2018b).

A riprap-armored diversion channel surrounds the disposal cell and diverts runoff away from the disposal cell surface. The diversion channel (PL-9) was designed to allow trees to grow and stabilize the surfaces, and their presence in the diversion channel is not expected to hinder the diversion channel's ability to convey design flows. The intrusion of volunteer plants, including trees, is evident in most areas of the diversion channel. Sediment deposition is found in places on the west leg of the diversion channel but does not interfere with the diversion channel's design function. Upslope areas that have contributed to the sedimentation have stabilized with vegetation. Wildlife and horse trails cross the diversion channel at numerous locations and have displaced the diversion channel riprap in several places (PL-10). These disturbances will be visually monitored for erosion but are not in areas that would impact the disposal cell.

5.5 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. No need for a follow-up inspection was identified.

5.6 Routine Maintenance and Emergency Measures

No maintenance needs were identified. 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.

5.7 Environmental Monitoring

5.7.1 Groundwater Monitoring

Groundwater compliance monitoring is not required at the site. However, as a best management practice stipulated in the LTSP, LM conducts limited groundwater monitoring for several indicator parameters. Samples are collected annually from background monitoring well 2B north of the disposal cell and from downgradient wells 4 and 10 near the base of the containment dam (Figure 5-2). Samples are analyzed for chloride, sulfate (primary indicator parameters), and total dissolved solids. Should the concentration of chloride or sulfate exceed the action level of Washington water quality criteria value of 250 milligrams per liter (mg/L) for either parameter, LM would conduct confirmatory sampling. If the confirmatory sampling verifies the exceedance, LM will develop an evaluative monitoring work plan, in consultation with the Spokane Tribe of Indians and BIA, and submit that plan to NRC for review before initiating the evaluative monitoring program. Results of an evaluative monitoring program would be used to determine if corrective action is necessary.

An evaluative monitoring plan and consultations were not required as there was no exceedance in 2018, and evaluation of the elevated sulfate values (260 mg/L in 2017 and 250 mg/L in 2018) indicated this was related to higher than normal precipitation in the area, causing higher than normal groundwater elevations (Kreie 2018). The issue of elevated sulfate spikes in well 4 had previously been identified by the State and documented as unrelated to the disposal cell.

Table 5-3 presents the May 2018 sampling results. Groundwater constituent concentrations continue to be less than the action levels for confirmatory sampling in monitoring wells 2B and 10; however, sulfate concentration exceeded the action level in monitoring well 4 in 2017 and met it in 2018.

A borehole camera was used to evaluate conditions in the three monitoring wells, specifically to determine if there were any well issues that could have caused the exceedance in monitoring well 4. The video showed that the inlet of the dedicated bladder pump used for low-flow sampling was buried in debris at the bottom of the well. The well will be cleaned and redeveloped before sampling in 2019.

Figure 5-2. Groundwater Monitoring Network at Sherwood, Washington, Disposal Site

Table 5-3. 2018 Groundwater Quality Results for the Sherwood, Washington, Disposal Site

Constituent	Water Quality Criterion[a]	Well		
		Background Well 2B	Downgradient Well 4	Downgradient Well 10
Chloride, mg/L	250	1.8	45	1.1
Sulfate, mg/L	250	2.5	***250***	28
TDS, mg/L	N/A	180	810	570

Notes:
[a] State of Washington water quality criteria used as action levels.
[b] ***Bold italicized*** results indicate meeting or exceeding an action level.

Abbreviations:
N/A = not applicable
TDS = total dissolved solids

Figure 5-3 and Figure 5-4 show concentrations of chloride and sulfate, respectively, in the three monitoring wells since 2001. Occurrences of slightly elevated chloride levels in well 4 correspond with the higher sulfate levels measured at the same location. Water elevations for each of the monitoring wells are shown in Figure 5-5. These elevations are preliminary and are based on a survey of the elevation of the monitoring wells conducted in August 2018. Groundwater occurs in two hydrostratigraphic units: (1) the alluvium that lies on top of the bedrock surface and (2) the conductive bedrock, including weathered bedrock in the upper portion and unweathered or competent bedrock below. Monitoring well 10 is completed in the alluvium, and wells 2B and 4 are completed in the bedrock.

Increases in water table height in the 2B and 4 wells correspond with the elevated levels of chloride and sulfate measured in well 4 in 2006, 2011, and from 2016 to 2018. As noted by the Washington Department of Health in the February 2000 *Monitoring and Stabilization Plan Supplement*, "One of the downgradient point-of-compliance wells, 4, has seasonal variation in water quality, represented by late spring and summer peaks that are consistent with annual infiltration and the rise in static water levels. This seasonal trend has been evaluated closely and ground water monitoring increased as established by the MSP [Monitoring and Stabilization Plan]" (WDOH 2000). Annual precipitation totals measured in Spokane, Washington, show a correlation with the increased sulfate and chloride concentrations. Years with higher precipitation totals are also years with higher sulfate concentrations.

5.7.2 Vegetation Monitoring

The LTSP requires annual visual inspections of the disposal cell's vegetated cover to ensure that it satisfies erosional stability criteria and is self-sustaining. Vegetation on the disposal cell cover includes trees (primarily ponderosa pine), shrubs, and a mixture of native and introduced grasses and forbs. No areas of concern, such as patterns of dead vegetation or erosional features, were identified during the 2018 annual inspection.

Inspectors met with tribal ecologists during the inspection to discuss noxious weed control at the site. Seven species of State-listed noxious weeds historically have been found, six of which are "List B" species and, by law, must be controlled. No "List A" species, which must be eradicated, have been found at the site. LM has released various biological control insects in the past and periodically treats weed infestations with herbicide.

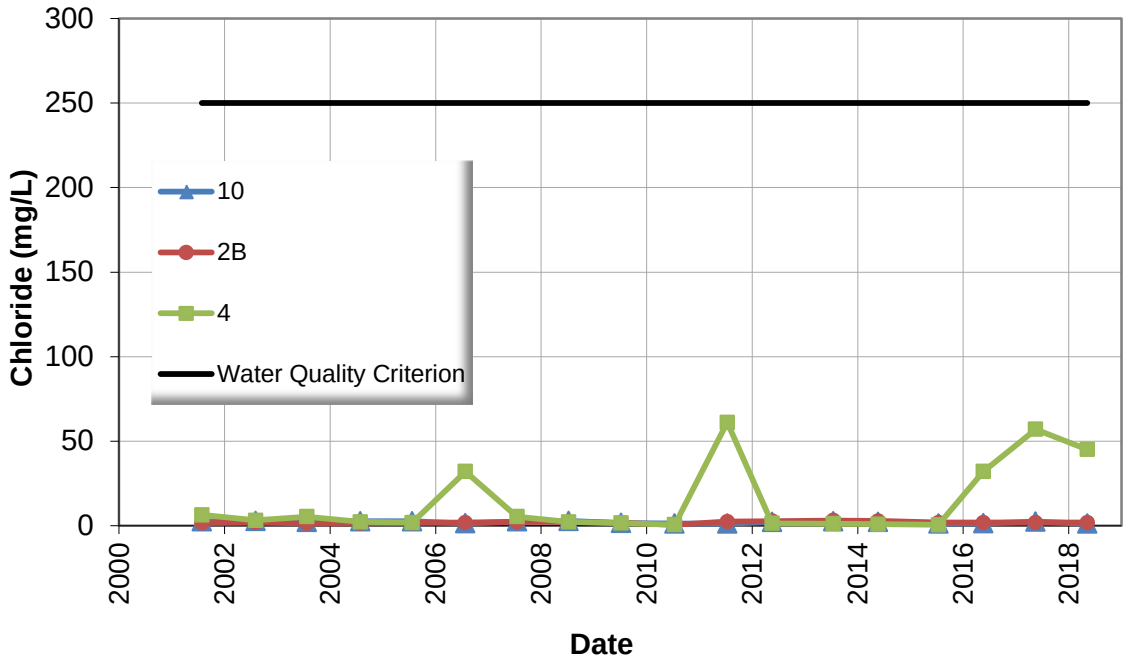

Figure 5-3. Chloride Concentrations at the Sherwood, Washington, Disposal Site

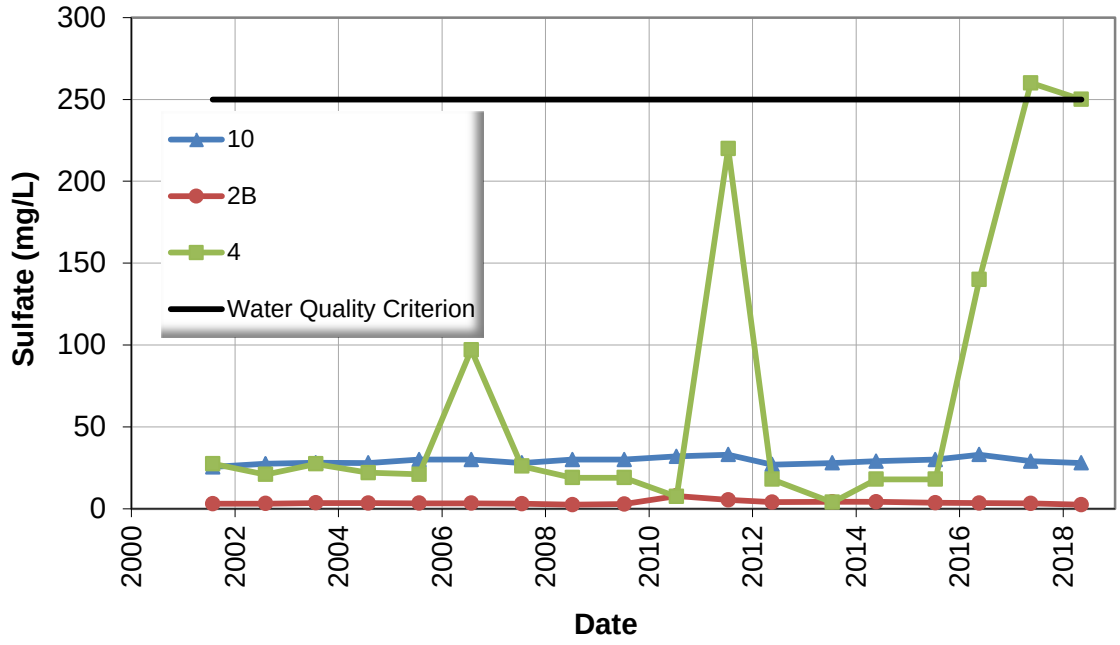

Figure 5-4. Sulfate Concentrations at the Sherwood, Washington, Disposal Site

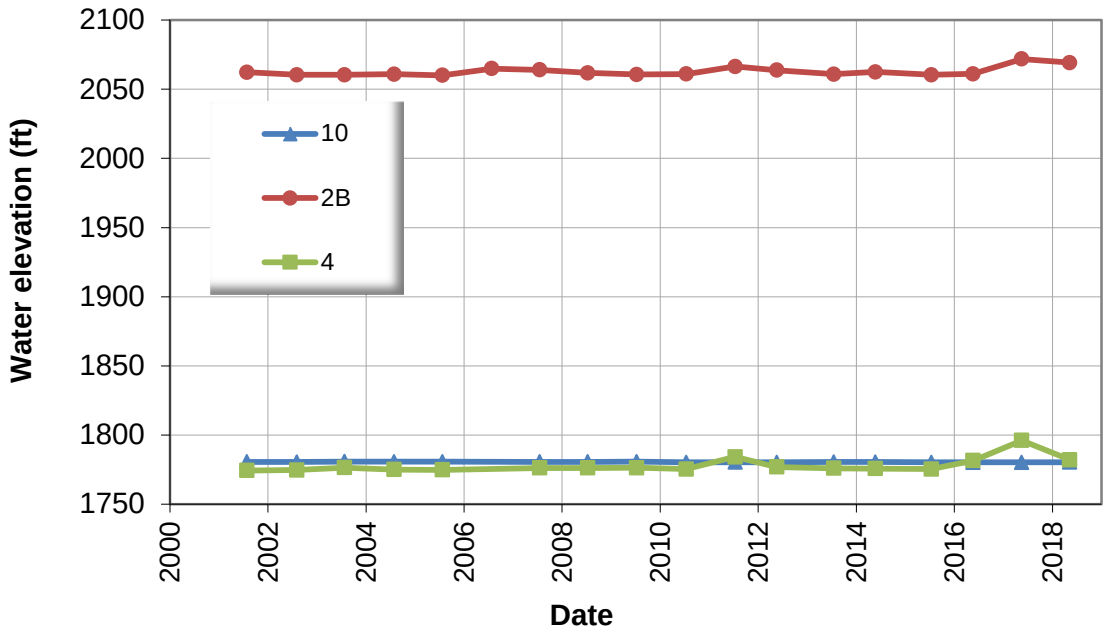

Figure 5-5. Preliminary Water Elevation Measurements, at the Sherwood, Washington, Disposal Site

5.8 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.*

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

DOE (U.S. Department of Energy), 2001. *Long-Term Surveillance Plan for the DOE Sherwood Project (UMTRCA Title II) Reclamation Cell, Wellpinit, Washington*, S00204, February.

DOE (U.S. Department of Energy), 2018a. *Settlement Survey and Analysis, Sherwood, Washington, Disposal Site*, Office of Legacy Management, S19518, June.

DOE (U.S. Department of Energy), 2018b. *Follow-Up Inspection and Evaluation, Sherwood, Washington, Disposal Site*, LMS/SHE/S15417, March.

Kreie, 2018. Ken Kreie, LM Site Manager, letter "Groundwater Monitoring Results at the Sherwood, Washington, Disposal Site Indicates Elevated Sulfate Concentration in Point of Compliance Well" to deputy director, U.S. Nuclear Regulatory Commission, November 5.

WDOH (Washington Department of Health), 2000. *Sherwood Uranium Mill Project, Technical Evaluation Report, Monitoring and Stabilization Plan Supplement*, February.

5.9 Photographs

Photograph Location Number	Azimuth	Photograph Description
PL-1	105	Perimeter Sign P6
PL-2	5	Site Marker
PL-3	60	Boundary Monument BM-3
PL-4	305	Gully Outside Site Boundary near Perimeter Sign P1
PL-5	320	View to South–Southwest from Northeast Corner of Disposal Cell
PL-6	120	Pond 1 on Disposal Cell Cover
PL-7	115	Containment Dam Outslope
PL-8	345	Sand Washout Watch Area at Base of Outslope
PL-9	25	Vegetation in East Diversion Channel
PL-10	90	Protective Rock Armor Displaced by Animal Trails

PL-1. Perimeter Sign P6

PL-2. Site Marker

PL-3. Boundary Monument BM-3

PL-4. Gully Outside Site Boundary near Perimeter Sign P1

PL-5. View to South–Southwest from Northeast Corner of Disposal Cell

PL-6. Pond 1 on Disposal Cell Cover

PL-7. Containment Dam Outslope

PL-8. Sand Washout Watch Area at Base of Outslope

PL-9. Vegetation in East Diversion Channel

PL-10. Protective Rock Armor Displaced by Animal Trails

Dam Inspection Checklist
Sherwood, Washington, UMTRCA Title II Disposal Site

Date of Inspection May 10, 2018

Inspector David Traub Organization Navarro

Piezometer water levels measured during groundwater monitoring event May 10, 2018.
* All depths in feet. TOC is Top of Casing.

Piezometer PZ-1 fluid level (TOC to top of fluid): 21.83 Fluid amount: 0.64
Total depth 22.47

Piezometer PZ-2 fluid level (TOC to top of fluid) 60.73 Fluid Amount: 2.22
Total depth 62.95

Piezometer PZ-3 fluid level (TOC to top of fluid) Dry Fluid Amount:
Total depth 67.53

Piezometer PZ-4 fluid level (TOC to top of fluid) 22.13 Fluid Amount: 0.49
Total depth 22.62

Was evidence of significant seepage observed on the dam face? *No*
If yes discuss in report.

Was evidence of significant slumping observed on the dam? *No*
If yes discuss in report.

Was evidence of significant erosion observed on the dam? *No, however, minor erosion was observed below the embankment. No erosion was noted on the embankment.*
If yes discuss in report.

Was vegetative growth that could compromise dam stability observed? *No*
If yes discuss in report.

Was any condition that presents an imminent hazard to human health and safety or to the environment observed? *No*
If yes immediately contact the following:

DOE Site Manager: Ken Kreie (970) 248-6073
NRC Operations Center: (301) 951-0550
Spokane Tribal Police/Sheriff: (509) 258-4400
State Department of Ecology—Dam Safety Office: (360) 407-6625

Following completion of the inspection, this Dam Inspection Checklist is to be sent to:
James DeMay, 360) 407-6603, jade461@ecy.wa.gov Washington Department of Ecology, Dam Safety Office

Inspector Signature: David Traub 2018.05.30 11:22:37 -06'00' Date:

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6.0 Shirley Basin South, Wyoming, Disposal Site

6.1 Compliance Summary

The Shirley Basin South, Wyoming, Uranium Mill Tailings Radiation Control Act (UMTRCA) Title II Disposal Site (site) was inspected on July 10, 2018. No changes were observed on the disposal cell or in associated drainage features. Inspectors identified routine maintenance needs but found no cause for a follow-up inspection.

Groundwater is monitored annually in accordance with the site-specific U.S. Department of Energy (DOE) Office of Legacy Management (LM) Long-Term Surveillance Plan (LTSP) (DOE 2004). The most recent sampling event occurred in July 2018. Alternate concentration limits (ACLs) continue to be exceeded for radium-226 (^{226}Ra) and radium-228 (^{228}Ra). No risks to human health and the environment were identified.

6.2 Compliance Requirements

Requirements for the long-term surveillance and maintenance of the site are specified in the LTSP (DOE 2004) and in procedures LM established to comply with requirements of Title 10 *Code of Federal Regulations* Section 40.28 (10 CFR 40.28). Table 6-1 lists these requirements.

Table 6-1. License Requirements for the Shirley Basin South, Wyoming, Disposal Site

Requirement	LTSP	This Report	10 CFR 40.28
Annual Inspection and Report	Sections 3.3 and 3.4	Section 6.4	(b)(3)
Follow-Up Inspections	Section 3.5	Section 6.5	(b)(4)
Routine Maintenance and Emergency Measures	Section 3.6	Section 6.6	(b)(5)
Environmental Monitoring	Section 3.7	Section 6.7	(b)(3)

6.3 Institutional Controls

The 1512-acre site, identified by the property boundary shown in Figure 6-1, is owned by the United States and was accepted under the U.S. Nuclear Regulatory Commission (NRC) general license (10 CFR 40.28) in 2005. DOE is the licensee and, in accordance with the requirements for UMTRCA Title II sites, 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 wellhead protectors.

6.4 Inspection Results

The site, approximately 60 miles south of Casper, Wyoming, was inspected on July 10, 2018. The inspection was conducted by R. Johnson, J. Price, and C. Boger of the Legacy Management Support (LMS) contractor. B. Tsosie (LM site manager) and D. Atkinson (LMS) attended the inspection. The purposes of the inspection were to confirm the integrity of the visible features at

the site, identify changes in conditions that might affect conformance with the LTSP, and determine the need, if any, for maintenance or additional inspection and monitoring.

6.4.1 Site Surveillance Features

Figure 6-1 shows the locations of site features in black, including site surveillance features and inspection areas. 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 text, and new observations identified in the 2018 inspection are shown in red. Inspection results and recommended maintenance activities associated with site surveillance features are included in the following subsections. Photographs to support specific observations are identified in the text and in Figure 6-1 by photograph location (PL) numbers. The photographs and photograph log are presented in Section 6.8.

6.4.1.1 Site Access and Entrance Gate

Access to the site is immediately off Carbon County Road 2E. The entrance gate is a barbed-wire gate in the perimeter fence. The gate, along the south portion of the perimeter fence, was secured by a locked chain (PL-1). No maintenance needs were identified.

6.4.1.2 Perimeter Fence and Signs

A four-strand barbed-wire fence encloses the site (PL-2). A grazing license granted by LM to a local rancher allows the rancher to graze his livestock on the site in exchange for maintaining the perimeter fence. Sections along the north site boundary are secured with a temporary wire fence. Ur-Energy, the adjacent landowner, may use these sections to reach a topsoil stockpile area on the site.

The entrance sign is on the main site access road near the site marker. This sign was missing and will be replaced during the 2019 annual site inspection or groundwater sampling. Nine perimeter signs (warning and no-trespassing signs) are posted along the site perimeter at potential points of access, and another 25 signs are positioned around the disposal cell (PL-3). Perimeter signs P1, P2, and P33 have bullet holes in them but remain legible. No other maintenance needs were identified.

6.4.1.3 Site Marker

The site has one granite site marker near the site entrance gate (PL-4). No maintenance needs were identified.

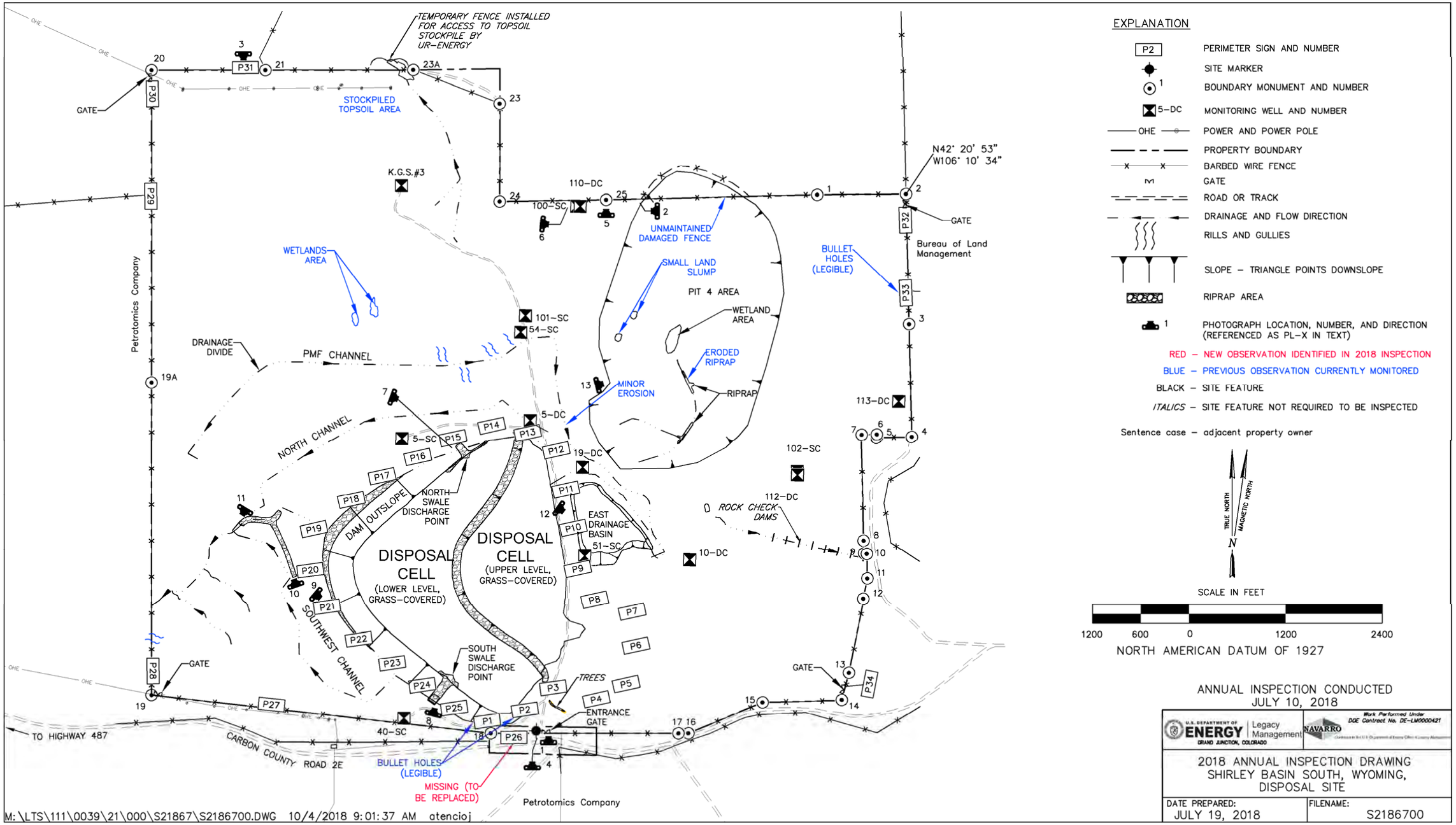

Figure 6-1. 2018 Annual Inspection Drawing for the Shirley Basin South, Wyoming, Disposal Site

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6.4.1.4 Boundary Monuments

There are 26 boundary monuments delineating the site property boundary (PL-5). All boundary monuments were inspected. No maintenance needs were identified.

6.4.1.5 Monitoring Wells

The site groundwater monitoring network consisted of eight monitoring wells when the site was transferred to LM. Six additional wells were installed in 2008 to provide a better understanding of the groundwater chemistry and flow direction in the upper and main sand aquifers. The groundwater monitoring network now consists of 14 monitoring wells. The wellhead protectors were undamaged and locked (PL-6). No maintenance needs were identified.

6.4.2 Inspection Areas

In accordance with the LTSP, the site is divided into three 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 and diversion channels, and (3) the site perimeter and balance of the site. Inspectors examined specific site surveillance features within each area and also looked for evidence of erosion, settling, slumping, or other modifying processes that might affect the site's conformance with LTSP requirements.

6.4.2.1 Cover of the Disposal Cell

The disposal cell, completed in 2000, occupies 142 acres. It has a soil cover and was revegetated primarily with native grasses. The vegetation on the disposal cell and throughout the site is managed through the grazing license. The disposal cell surface is constructed at two elevations, the upper (eastern) surface and the lower (western) surface, which are separated by a riprap-armored slope. There were no signs of erosion, settlement, or other modifying processes on the disposal cell cover or side slopes that might affect the integrity of the disposal cell.

Windblown sediment is accumulating in the riprap on the slope that separates the two elevations, and this has led to gradual vegetation encroachment. The establishment of perennial vegetation enhances the slope's stability. Wetland vegetation is establishing in areas at the toe of the slope that accumulate snowmelt runoff and summer precipitation.

The upper surface is contoured to drain into a basin east of the disposal cell and west over the riprap-protected slope to the lower surface. The lower surface is contoured to drain to the north and south at riprap-armored swale discharge points (PL-7 and PL-8). The riprap dissipation basins of the discharge points usually hold precipitation runoff water in spring and early summer. No maintenance needs were identified.

6.4.2.2 Containment Dam and Diversion Channels

The tailings pile was reclaimed in place and contained behind a horseshoe-shaped earthen dam. The containment dam is predominantly grass-covered, but the steeper portion (5:1 slope) of the dam outslope is protected by riprap (PL-9). There were no signs of erosion, settlement, or other

modifying processes that might affect the integrity of the dam. Encroaching vegetation on the riprap surfaces enhances the stability of the slope. No maintenance needs were identified.

The surface water diversion system consists of a combination of diversion channels, drainage basins, and contoured surfaces. Riprap armor was placed on the steeper slopes and flow concentration points where design flow velocities could erode surfaces and impact the disposal cell (PL-10 and PL-11). A probable maximum flood (PMF) channel was constructed north of the disposal cell along the side of the reclaimed mine overburden spoil pile. Part of the PMF channel drains to the southwest through the north and southwest channels and discharges to a small closed basin. The portion of the PMF channel that flows eastward and discharges into the east drainage basin captures storm water from a larger drainage area. The east basin was dry at the time of the inspection (PL-12). These drainage basins are large enough to accommodate PMF water volumes. No maintenance needs were identified.

6.4.2.3 Site Perimeter and Balance of Site

The other major feature on the site is the reclaimed Pit 4 Area, which is in the northeast portion of the site. Reclamation activities included rounding the side slopes, partially backfilling the pit to an elevation above the local water table, revegetating the surfaces, and protecting against potential erosion areas with riprap. Vegetation is well established, and a wetland area has formed at the bottom of the pit where standing water from runoff is often present (PL-13); the surface of this area tends to dry out later in the summer. Some minor slumps and displacement features are present on the west side slope of the pit, but they do not represent a significant slope stability concern. A riprap-armored drainage channel near the bottom of the pit has eroded. Repair of the displaced riprap armor is not necessary at this time, because potential erosion in that portion of the pit will not cut deeper than the floor of the pit and is not expected to impact slope stability.

Public land administered by the U.S. Bureau of Land Management and private land surround the site. Land on three sides is used primarily for livestock grazing. Ur-Energy is the property owner north of the site and can access and use stockpiled topsoil on the site. This access is in accordance with an agreement originally established between Petrotomics Company, the former licensee of the site, and Pathfinder Mines Corporation (Pathfinder), which was acquired by Ur-Energy. LM is the successor to Petrotomics, and the terms of the agreement remain in effect. The Wyoming Department of Environmental Quality (WDEQ) extended Pathfinder's mine area permit to include the soil stockpile area. In accordance with the permit, Ur-Energy will be required to reclaim the disturbed area, including replacing fences, when it has finished removing topsoil from the stockpile. No stockpiled topsoil has been removed.

Monitoring well K.G.S. #3 is completed in a deep formation (lower sand aquifer) that is not affected by processing-related groundwater contamination or naturally occurring contamination from uranium mineralization. The grazing license allows the rancher to pump water from K.G.S. #3 for livestock watering purposes and install watering facilities and solar-powered electric fences to manage the livestock.

The area beyond the site boundary for a distance of 0.25 mile was visually observed for erosion, changes in land use, or other phenomena that might affect the long-term integrity of the site. No such changes were identified.

6.5 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. No need for a follow-up inspection was identified.

6.6 Routine Maintenance and Emergency Measures

The entrance sign (perimeter sign P26) was missing and will be replaced. No other maintenance needs were identified. 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.

6.7 Environmental Monitoring

In accordance with the LTSP, annual groundwater monitoring is required at the site to verify that the ACLs are not exceeded at point of compliance (POC) wells and verify continued compliance with applicable groundwater protection standards. The monitoring network described in the LTSP (DOE 2004) comprises seven wells in the site's uppermost (upper and main sand) aquifers. The uppermost aquifers consist of two sand units in the Wind River Formation. A third, lower sand aquifer is confined from the site's uppermost aquifer (DOE 2011). In consultation with NRC, LM installed six additional monitoring wells in fall 2008 to provide a better understanding of the groundwater chemistry and flow direction in the upper and main sand aquifers. The current monitoring network is described in Table 6-2 and shown in Figure 6-2. Although no wells are designated as points of exposure, groundwater chemistry at downgradient wells 100-SC, 102-SC, 110-DC, and 113-DC represents groundwater quality (for groundwater flowing offsite) in the upper and main sand aquifers.

Table 6-2. Groundwater Monitoring Network at the Shirley Basin South, Wyoming, Disposal Site

Monitoring Well	Network Application
5-SC	POC well; upper sand aquifer
40-SC	Upgradient well; upper sand aquifer
51-SC	POC well; upper sand aquifer
54-SC	Downgradient well; upper/main sand aquifer
100-SC*	Downgradient well; upper sand aquifer
101-SC*	Downgradient well; upper sand aquifer
102-SC*	Downgradient well; upper sand aquifer
5-DC	POC well; main sand aquifer
10-DC	Downgradient well; main sand aquifer
19-DC	POC well; main sand aquifer
110-DC*	Downgradient well; main sand aquifer
112-DC*	Downgradient well; main sand aquifer
113-DC*	Downgradient well; main sand aquifer
K.G.S. #3	Lower sand aquifer

Note:
*Installed by LM in 2008.

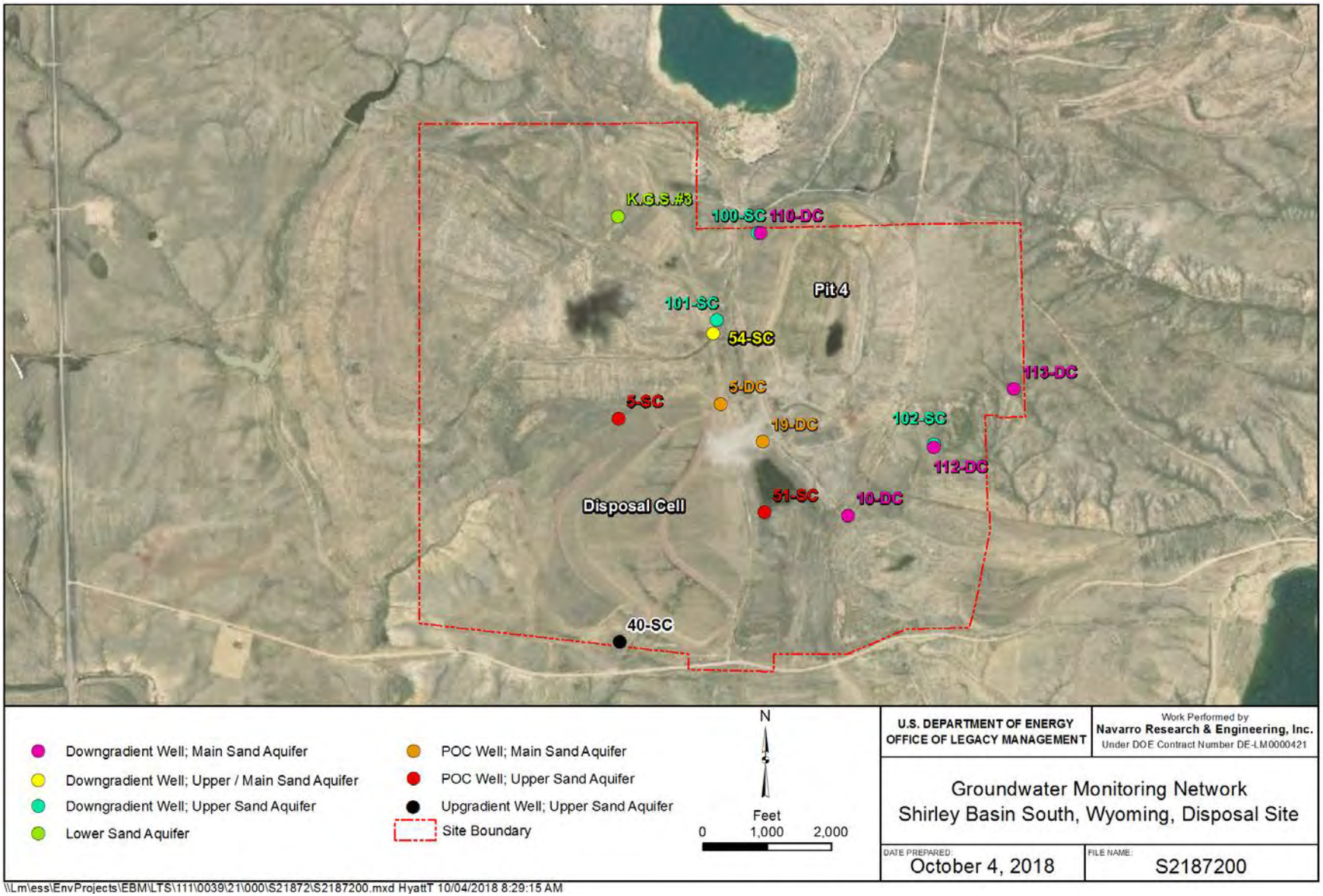


Figure 6-2. Groundwater Monitoring Network at Shirley Basin South, Wyoming, Disposal Site

Water level, pH, and electrical conductivity are measured at the time of sampling, and samples are analyzed for cadmium, chloride, chromium, lead, nickel, nitrate, ^{226}Ra, ^{228}Ra, selenium, sulfate, thorium-230, total dissolved solids (TDS), and uranium. Analytical results are compared to the ACLs and Wyoming Class III groundwater protection standards provided in Table 6-3. Nitrate is not included in Table 6-3 because there are no applicable limits or standards for nitrate at this site. However, nitrate is included as a sampled analyte (see Table 6-4) because it can indicate contaminant migration. Water-level elevations are measured at the monitoring wells to evaluate flow direction as the upper and main sand aquifers recover from mining and reclamation activities.

Table 6-3. Alternate Concentration Limits and Groundwater Protection Standards for the Shirley Basin South, Wyoming, Disposal Site

Analyte	ACL	Groundwater Protection Standard[a]
Cadmium (mg/L)	0.079	NA
Chloride (mg/L)	NA	2000
Chromium (mg/L)	1.83	NA
Lead (mg/L)	0.05	NA
Nickel (mg/L)	6.15	NA
^{226}Ra (pCi/L)	91.3	NA
^{228}Ra (pCi/L)	25.7	NA
Selenium (mg/L)	0.12	NA
Sulfate (mg/L)	NA	3000
Thorium-230 (pCi/L)	2409	NA
TDS (mg/L)	NA	5000
Uranium (mg/L)	9.2	NA

Note:
[a] This column shows Wyoming Class III groundwater protection standard values for livestock use, which apply to this site (WAR 20.0011.8).

Abbreviations:
mg/L = milligrams per liter
NA = not applicable
pCi/L = picocuries per liter

The results for cadmium in POC well 5-SC and ^{228}Ra in POC well 5-DC exceeded their respective ACLs in LM's initial sampling in July 2005. The 2005 ^{228}Ra concentration in non-POC well 54-SC also was substantially above the ACL. When compared with historical results provided by the previous site licensee, the results for cadmium in well 5-SC and for ^{228}Ra in wells 5-DC and 54-SC were within the range of historical measurements. NRC and WDEQ were notified of the exceedances.

The second sampling after installation of the new monitoring wells was conducted in July 2009. Results show ^{226}Ra exceeded the ACL in new downgradient well 110-DC near the north site boundary. NRC and WDEQ were notified of the exceedance, and LM evaluated the cause of the exceedance. LM has determined that the elevated concentrations do not represent a contaminant plume migrating offsite; rather, they are attributed to natural conditions within the ore-bearing sand unit as aquifer recovery continues (DOE 2011).

The most recent sampling occurred in July 2018, and analytical results are provided in Table 6-4 (upper sand aquifer) and Table 6-5 (main sand aquifer). Samples could not be collected in wells 51-SC and 101-SC because they continue to be dry. Well 51-SC has been dry since 2011 and well 101-SC has been dry since it was installed in 2008.

Table 6-4. 2018 Groundwater Monitoring Results in the Upper Sand Aquifer Wells at the Shirley Basin South, Wyoming, Disposal Site

Analyte (Limit or Standard)	Well[a]						
	5-SC (POC)	40-SC	51-SC (POC)	54-SC	100-SC	101-SC	102-SC
Cadmium (0.079 mg/L)	0.031	0.0001	NS	0.00027	0.00009	NS	0.00011
Chloride (2000 mg/L)	310	22	NS	330	180	NS	130
Chromium (1.83 mg/L)	0.28	ND	NS	0.2	ND	NS	ND
Lead (0.05 mg/L)	ND	ND	NS	ND	0.00069	NS	ND
Nickel (6.15 mg/L)	3.6	0.011	NS	2.6	0.003	NS	0.0027
Nitrate/nitrite as N (mg/L)[b]	0.037	0.99	NS	0.44	0.015	NS	0.31
^{226}Ra (91.3 pCi/L)	8.19	0.296	NS	11.8	5.13	NS	1.76
^{228}Ra (25.7 pCi/L)	3	0.797	NS	***62.5***[c]	4.94	NS	1.88
Selenium (0.12 mg/L)	0.11	0.0039	NS	0.078	ND	NS	0.0036
Sulfate (3000 mg/L)	***14,000***[d]	1300	NS	***8600***[d]	1300	NS	920
Thorium-230 (2409 pCi/L)	432	ND	NS	11.3	ND	NS	ND
TDS (5000 mg/L)	***19,000***[d]	2200	NS	***13,000***[d]	2400	NS	1700
Uranium (9.2 mg/L)	2.9	0.00021	NS	0.0076	0.0027	NS	0.022

Notes:
[a] ***Bold italicized*** results exceed a standard or limit.
[b] No designated limit or standard.
[c] Result exceeds an ACL.
[d] Result exceeds a Wyoming Class III groundwater protection standard.

Abbreviations:
mg/L = milligrams per liter
ND = not detected (below method detection limit)
NS = no sample collected (dry)
pCi/L = picocuries per liter

Table 6-5. 2018 Groundwater Monitoring Results in the Main Sand Aquifer Wells at the Shirley Basin South, Wyoming, Disposal Site

Analyte (Limit or Standard)	Well[a]					
	5-DC (POC)	10-DC	19-DC (POC)	110-DC	112-DC	113-DC
Cadmium (0.079 mg/L)	ND	ND	ND	ND	ND	ND
Chloride (2000 mg/L)	270	59	65	200	30	6.9
Chromium (1.83 mg/L)	0.019	ND	ND	ND	ND	ND
Lead (0.05 mg/L)	ND	0.00047	ND	ND	ND	ND
Nickel (6.15 mg/L)	2.9	ND	0.53	ND	ND	ND
Nitrate/nitrite as N (mg/L)[b]	0.39	0.026	0.03	0.025	ND	0.08
^{226}Ra (91.3 pCi/L)	15.9	18.6	6.22	***133***[c]	11	2.35
^{228}Ra (25.7 pCi/L)	24.4	4.26	5	3.04	6.14	2.26
Selenium (0.12 mg/L)	0.095	ND	ND	ND	ND	ND
Sulfate (3000 mg/L)	***15,000***[d]	1100	2600	1900	1100	630
Thorium-230 (2409 pCi/L)	1.22	ND	ND	ND	ND	ND
TDS (5000 mg/L)	***24,000***[d]	1900	4400	3700	2000	1200
Uranium (9.2 mg/L)	0.053	0.012	0.00013	0.011	0.0095	0.00095

Notes:
[a] ***Bold italicized*** results exceed a standard or limit.
[b] No designated limit or standard.
[c] Result exceeds an ACL.
[d] Result exceeds a Wyoming Class III groundwater protection standard.

Abbreviations:
mg/L = milligrams per liter
ND = not detected (below method detection limit)
pCi/L = picocuries per liter

The concentration of cadmium in well 5-SC remained below the ACL since 2005. Radium-228 continued to exceed the ACL in well 54-SC but continues to be below the ACL in well 5-DC (Figure 6-3). Additionally, the ACL for ^{226}Ra continues to be exceeded in well 110-DC (Figure 6-4).

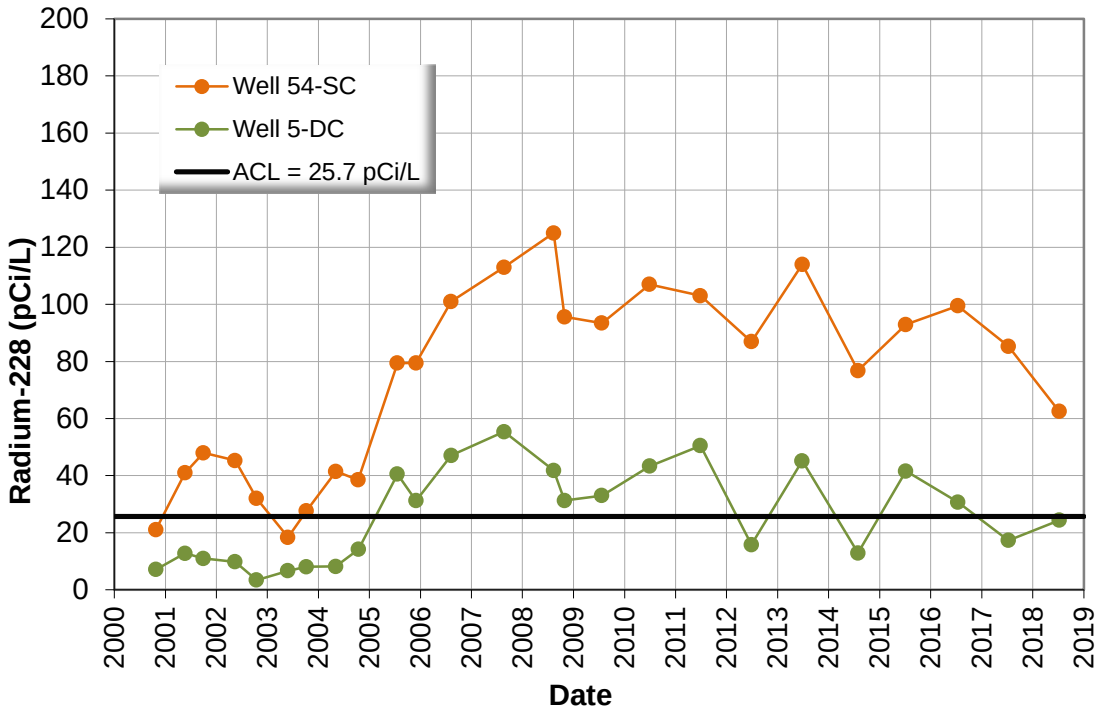


Figure 6-3. Radium-228 Concentrations in Wells 5-DC and 54-SC Since Completion of the Disposal Cell at the Shirley Basin South, Wyoming, Disposal Site

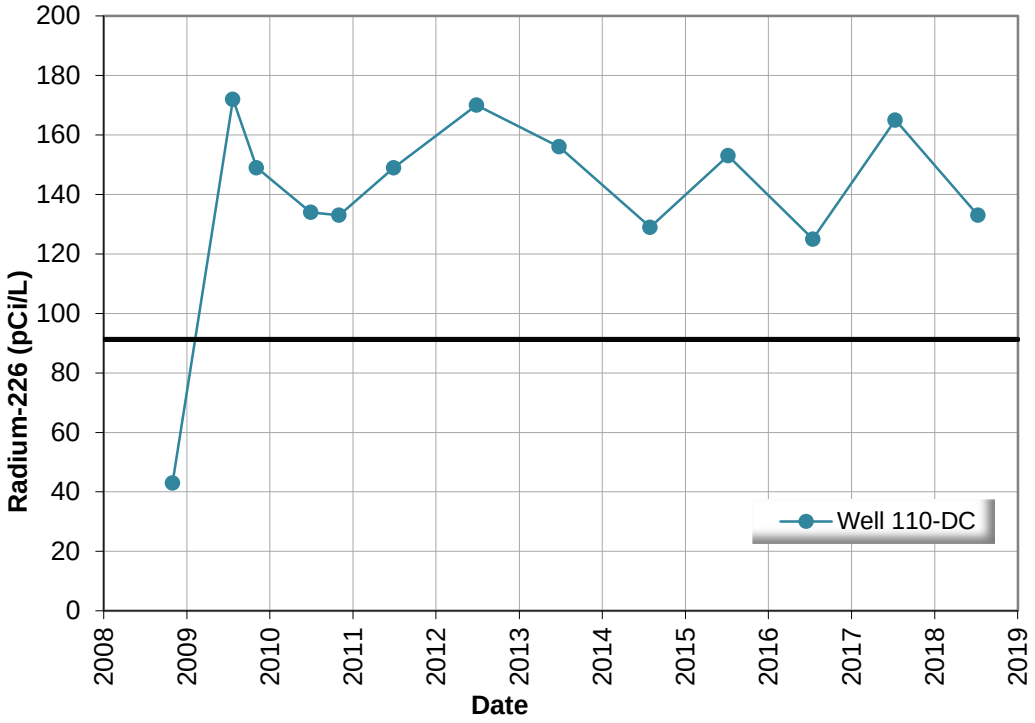


Figure 6-4. Radium-226 Concentrations in Well 110-DC at the Shirley Basin South, Wyoming, Disposal Site

Although the ^{228}Ra concentration is elevated in well 54-SC, it is lower than the highest concentration measured in this well in the early 1990s during site groundwater remediation activities. Radium-228 is a decay product of thorium-232 (^{232}Th), which is highly immobile. Because the half-life of ^{228}Ra is relatively short, ^{232}Th sources must be near monitoring wells 5-DC and 54-SC. LM attributes the elevated ^{226}Ra and ^{228}Ra in the site wells to natural mineralization in the sand units, rather than concluding it is evidence of diminished disposal cell performance or contaminant plumes migrating offsite (DOE 2011). Both the upper and main sand aquifers at the site were dewatered during mining and remediation and are still recovering. Consequently, periodic increases in some constituent concentrations in the groundwater, such as radium-228, may represent a reestablishment of equilibrium of groundwater with naturally occurring constituents in the sand units (Figure 6-3 and Figure 6-4) (DOE 2011).

NRC considers it possible that the elevated radium may represent leakage from the disposal cell. However, NRC has concluded that no additional evaluation of the cause of the elevated radium concentrations by LM is warranted at this time because there is no risk to human health and the environment (Orlando 2012). The groundwater is not a current or potential future source of drinking water due to limited yield and poor ambient conditions resulting from naturally occurring uranium mineralization, and human activities related to uranium exploration and mining that occurred in the area from the late 1950s to the early 1990s. Livestock water at the site is drawn from a separate aquifer, the lower sand aquifer, which is not hydraulically connected to the aquifers of concern and is not impacted by former milling operations.

Wyoming Class III groundwater protection standards (applicable only to chloride, sulfate, and TDS) apply to water quality at the site boundary. The standards were met at the downgradient site boundary wells (100-SC, 102-SC, 110-DC, 112-DC, and 113-DC), but the standards were exceeded for sulfate and TDS in wells 5-SC, 54-SC, and 5-DC.

The 2018 water quality results were within the range of historical measurements (Table 6-4 and Table 6-5; Figure 6-3 and Figure 6-4). The exceedances are found in wells near the disposal cell except for the ^{226}Ra exceedance at well 110-DC. Well 110-DC is near a uranium ore deposit, and the ^{226}Ra concentration is around 29 times that of the upgradient POC well 5-DC. Therefore, the ^{226}Ra in well 110-DC is probably naturally occurring (DOE 2011).

Analytical results from well K.G.S. #3 confirm that the lower sand aquifer of the Wind River Formation is hydraulically isolated from the overlying main sand aquifer. This conclusion is based on substantially lower concentrations of sulfate (210 milligrams per liter [mg/L]) and TDS (610 mg/L) in the lower sand aquifer compared to those in the main sand aquifer.

The LTSP specifies that this report provide isoconcentration maps for uranium and sulfate in each aquifer. However, the monitoring well network does not provide sufficient data points to develop these. Instead, 2018 concentrations for uranium in the two aquifers are shown in Figure 6-5 and Figure 6-6, and concentrations for sulfate are shown in Figure 6-7 and Figure 6-8. Uranium and sulfate concentrations remain less than concentrations predicted by the former licensee.

The LTSP also specifies that this report should provide groundwater contour maps. However, the well network does not provide sufficient data points to develop them, which has been indicated in annual reports since 2005. Before mining activities, regional groundwater flows reportedly

were to the north–northeast for the upper sand aquifer and to the east for the main sand aquifer. The upper sand unit and the main sand unit coalesced and formed the main ore body at the Pit 4 location. Pit 4 was partially backfilled with overburden materials during reclamation, and the bottom of the pit was raised to an elevation above the projected recovered phreatic surface of the upper sand aquifer. The backfill operation did not re-create the hydrogeologic characteristics of the original formation, and the aquifers are no longer confined at Pit 4. It is likely that the bottom of Pit 4 is a groundwater recharge area during periods of rainfall and snowmelt and may be an evaporation area during dry periods (DOE 2011). Both recharge and evaporation would tend to alter groundwater chemistry. Therefore, mining and reclamation activities permanently altered the local groundwater conditions for the upper and main sand aquifers at the site.

Water-level elevations for the upper sand aquifer are shown in Figure 6-9. Water levels are increasing in wells 100-SC and 102-SC, but they are remaining constant in the other upper sand aquifer wells. The apparent flow direction is to the northeast, along the formation dip and toward Pit 4 (DOE 2011). The dry wells (51-SC and 101-SC) indicate that the upper sand aquifer has not recovered near Pit 4. Because the aquifer is no longer confined at the Pit 4 location and because the flooded open-pit mine on the Ur-Energy property downgradient of the site might be a groundwater sink, aquifer water levels on the site might never recover to their premining elevations (DOE 2011).

Main sand aquifer water elevations, shown in Figure 6-10, have been gradually rising at all wells since 2000, with an average rate of increase of approximately 0.9 foot per year since LM began monitoring water levels in 2005 (Figure 6-11). The rising levels indicate a gradual recovery of the aquifer. However, the altered conditions at Pit 4 might prevent a return to premining elevations of the water table. Also, the water surface elevation of the downgradient pit lake on the adjacent Ur-Energy property might control the surface elevation of the aquifers on the site. The groundwater elevations, several of which are from wells near Pit 4, do not indicate a definitive flow direction in the main sand aquifer. Local groundwater flow likely is affected by continued recovery of the aquifer and the hydraulic properties of the backfill material in Pit 4. Therefore, a flow direction arrow is not shown in Figure 6-10.

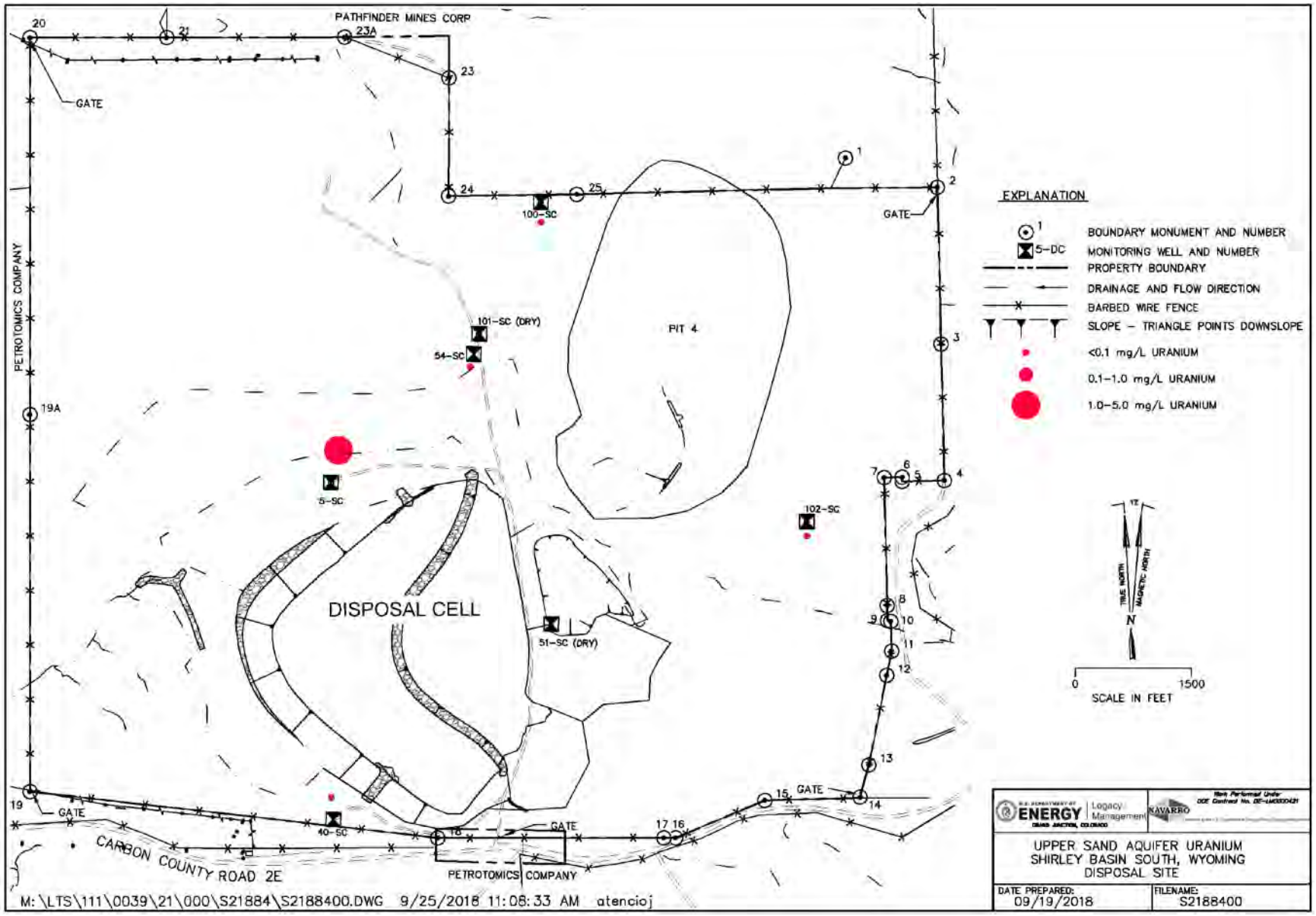


Figure 6-5. July 2018 Uranium Concentrations in the Upper Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

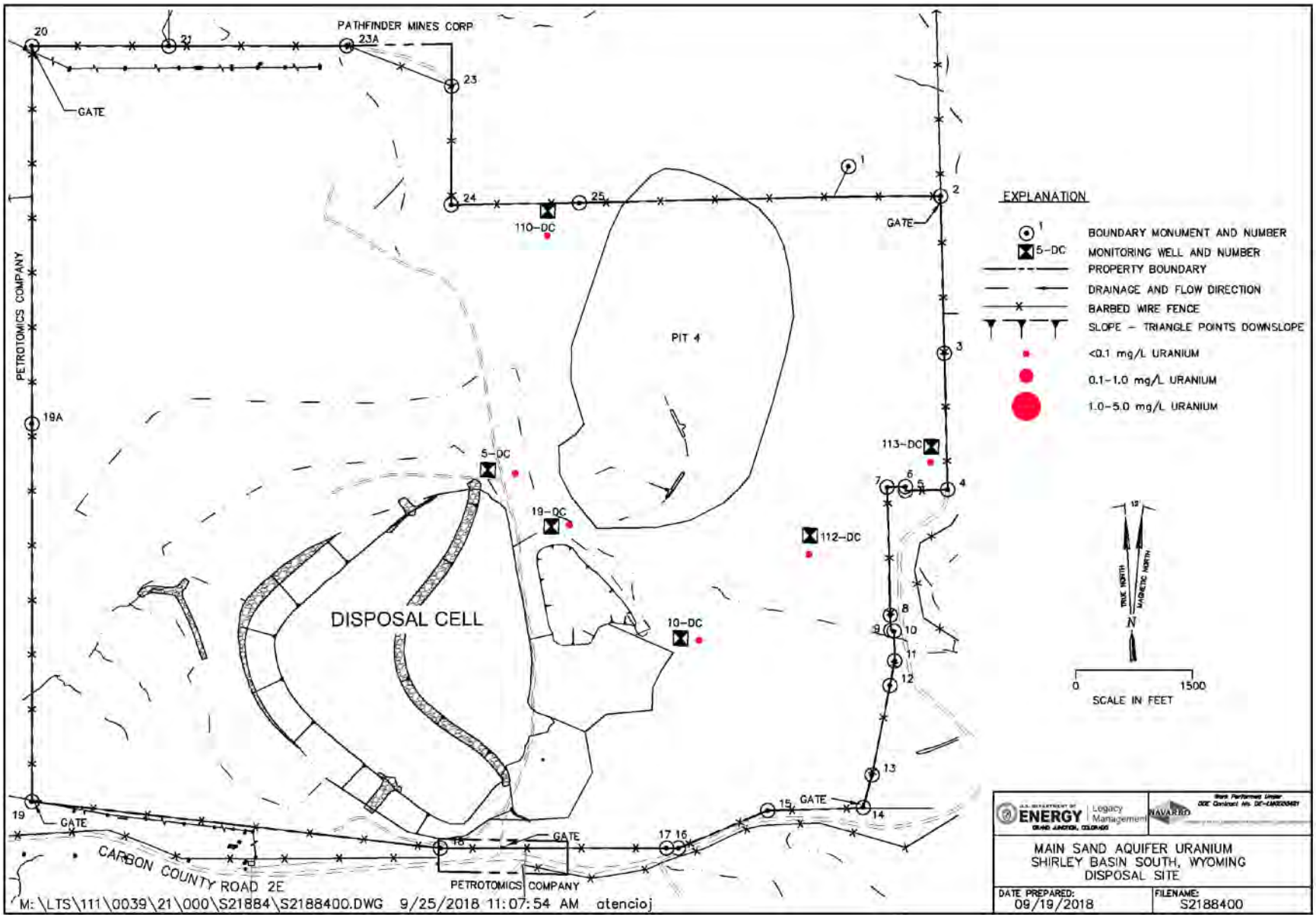


Figure 6-6. July 2018 Uranium Concentrations in the Main Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

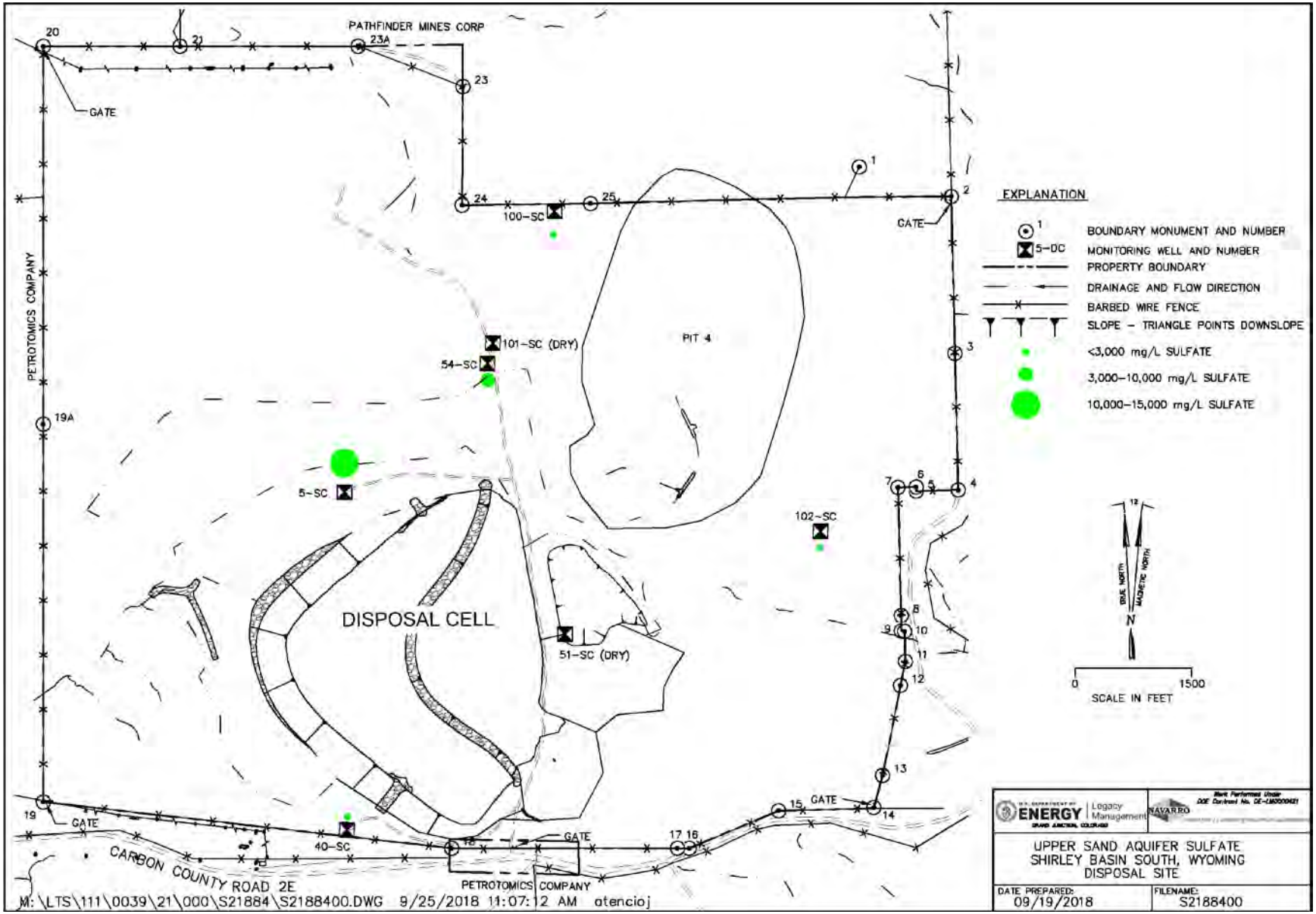


Figure 6-7. July 2018 Sulfate Concentrations in the Upper Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

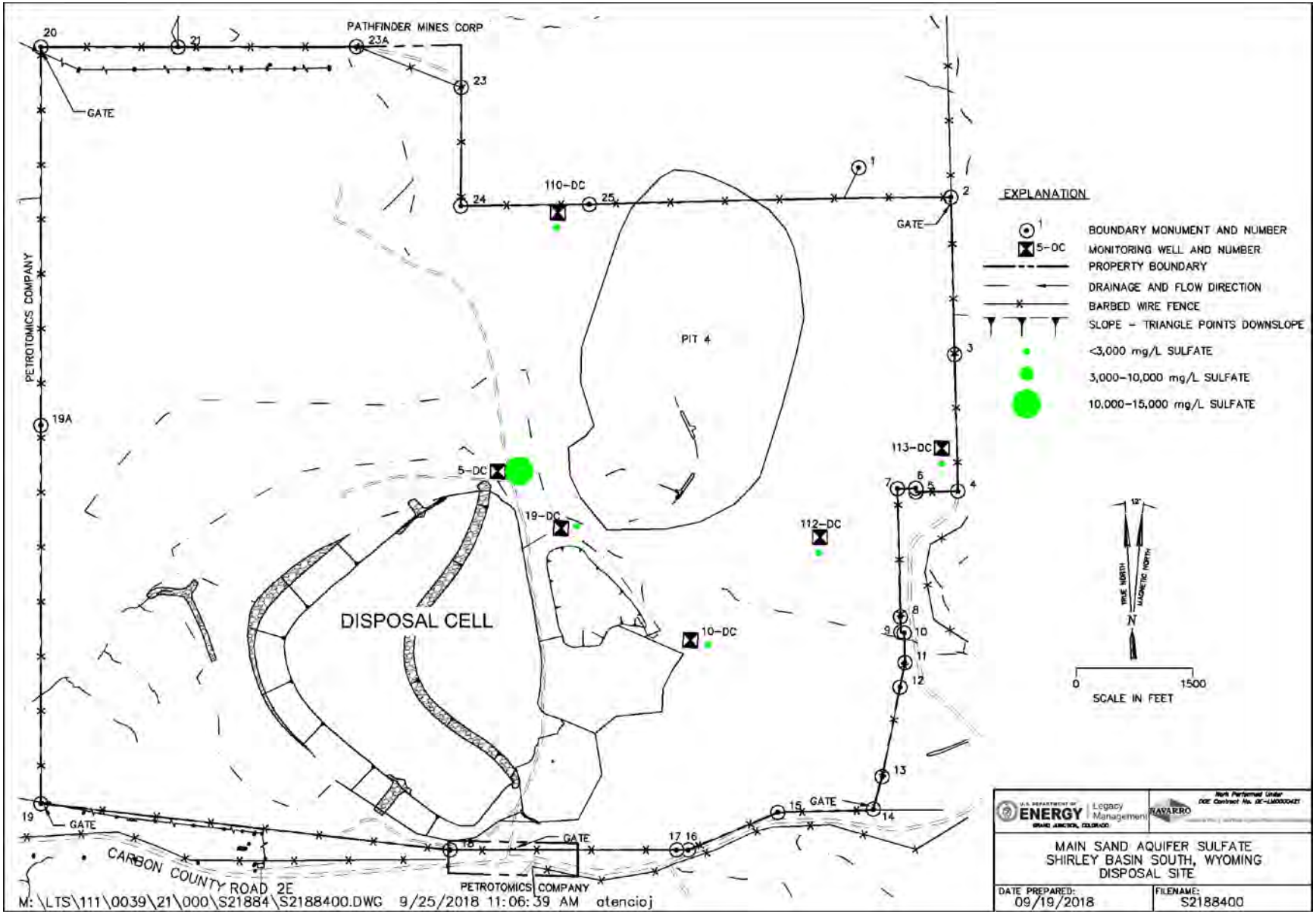


Figure 6-8. July 2018 Sulfate Concentrations in the Main Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

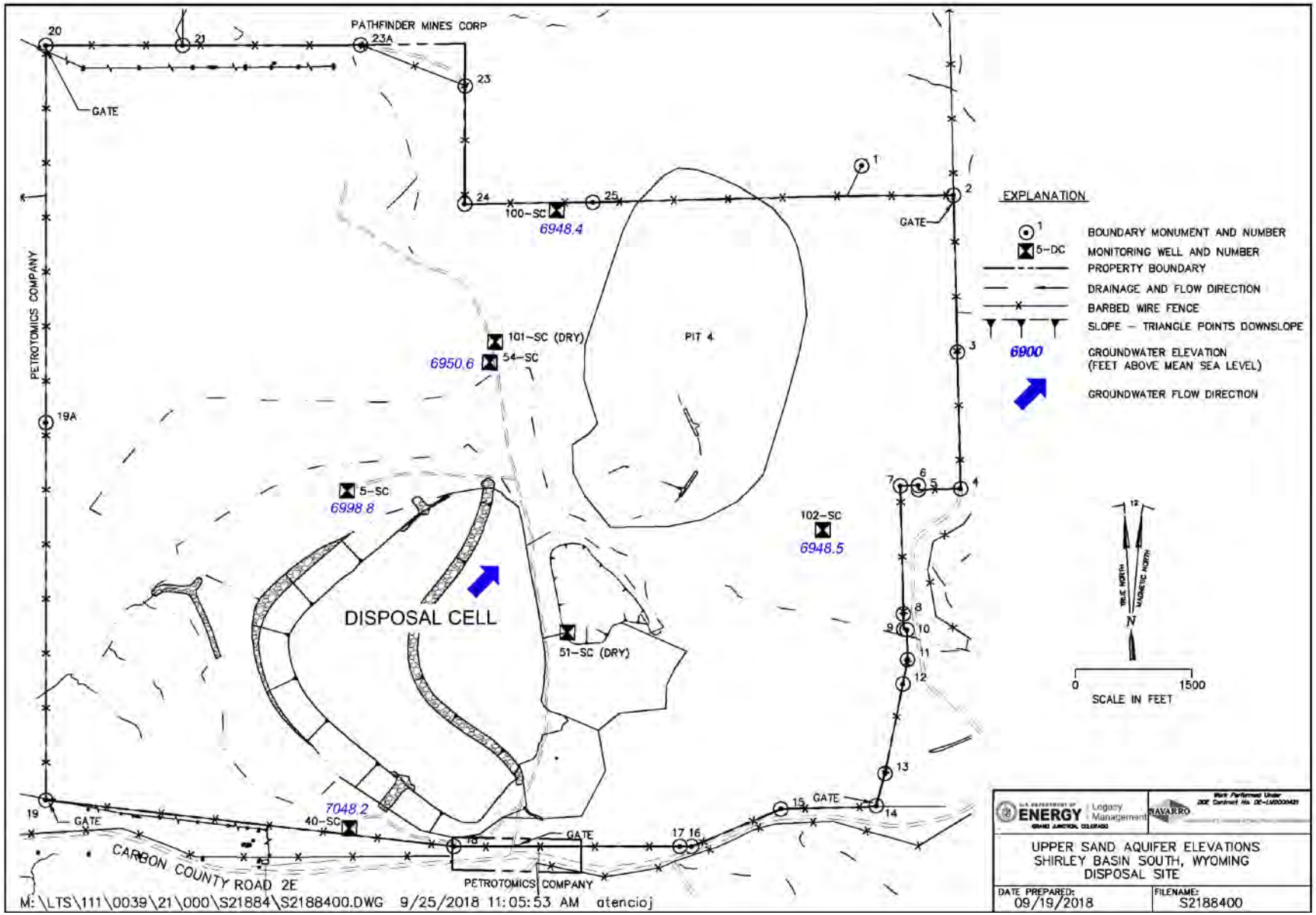


Figure 6-9. July 2018 Groundwater Elevations in the Upper Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

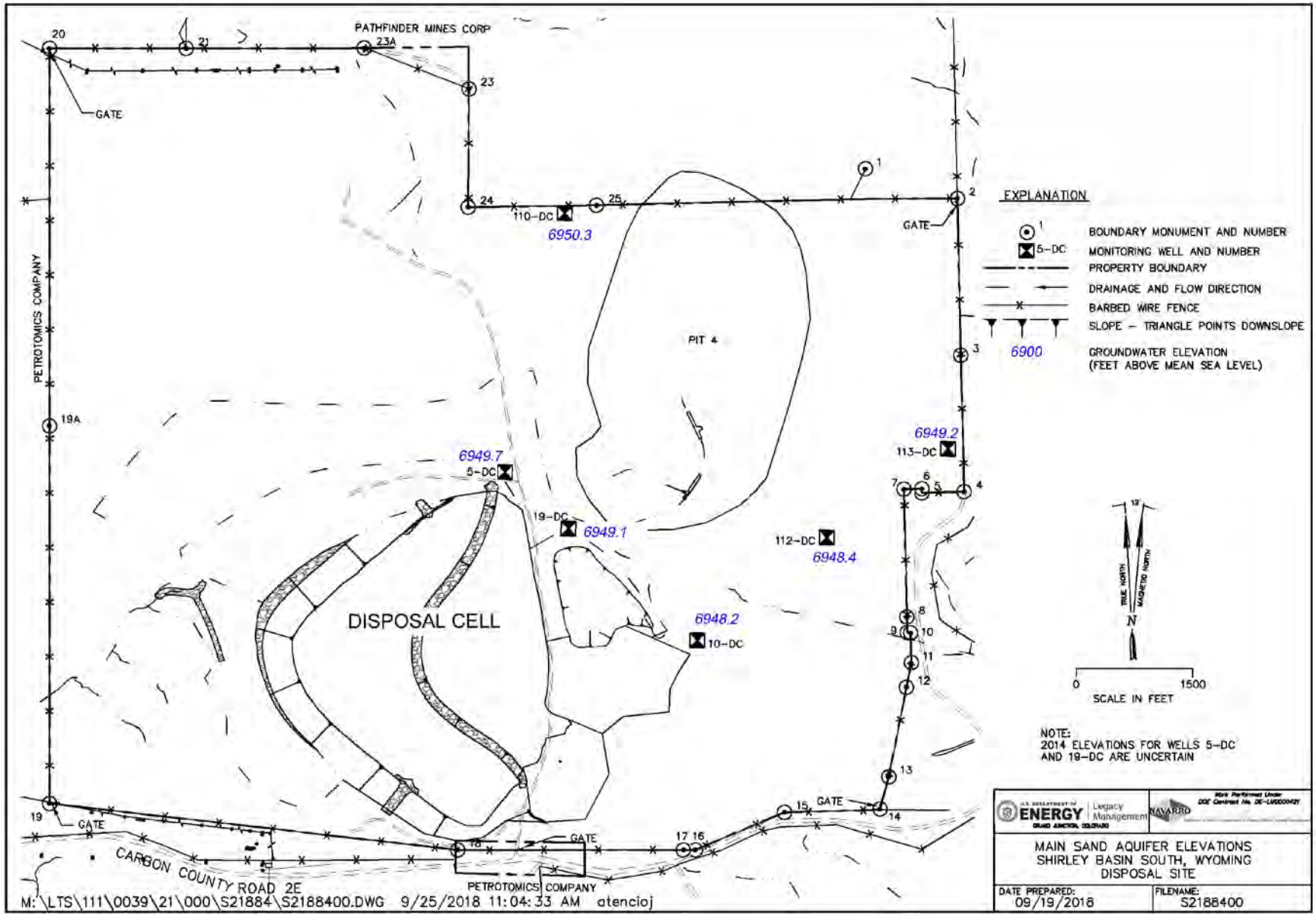


Figure 6-10. July 2018 Groundwater Elevations in the Main Sand Aquifer at the Shirley Basin South, Wyoming, Disposal Site

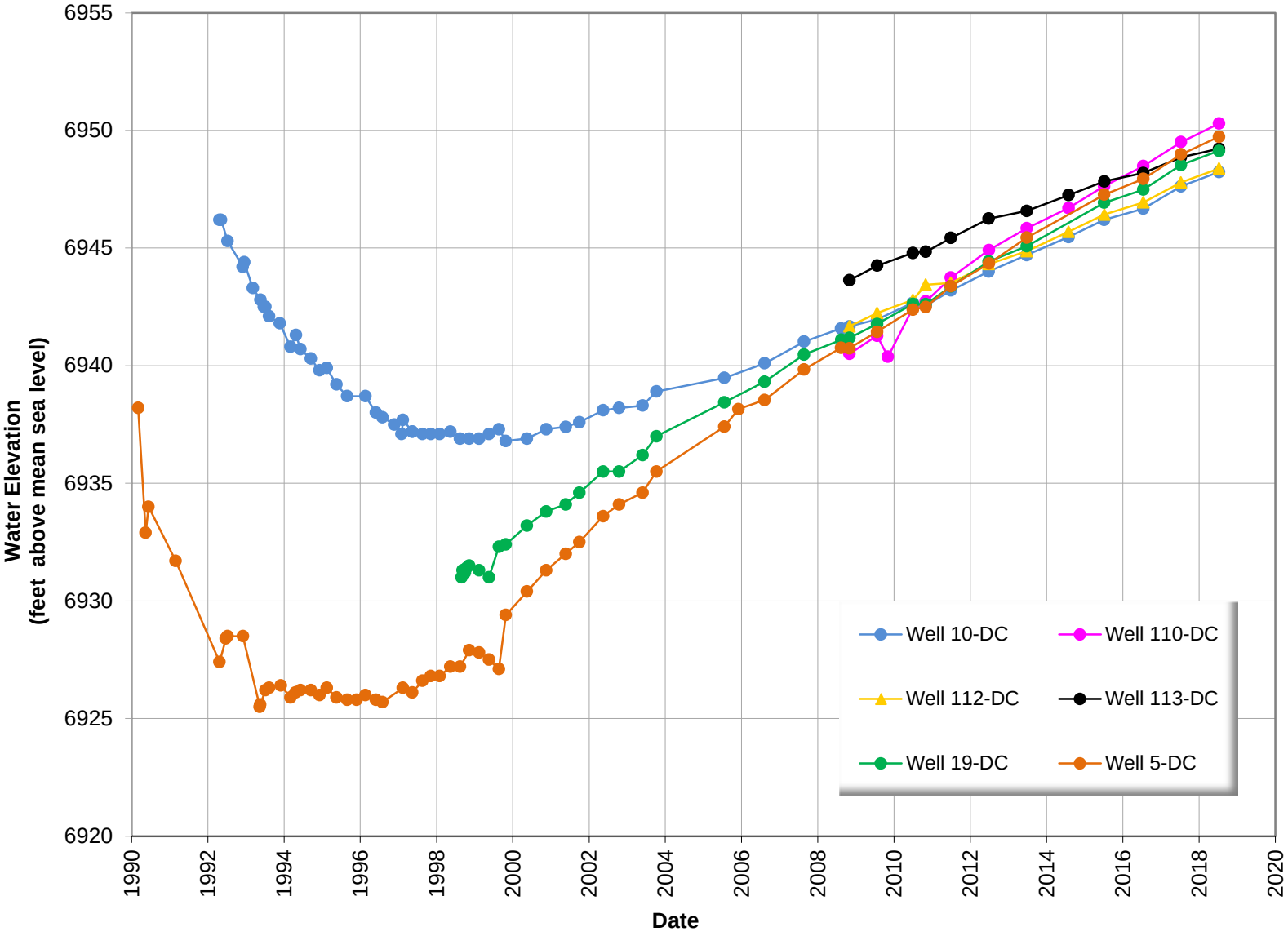


Figure 6-11. Hydrographs for Main Sand Aquifer Wells at the Shirley Basin South, Wyoming, Disposal Site

6.8 References

10 CFR 40.28. U.S. Nuclear Regulatory Commission, "General License for Custody and Long-Term Care of Residual Radioactive Material Disposal Sites," *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*.

DOE (U.S. Department of Energy), 2004. *Long-Term Surveillance Plan for the U.S. Department of Energy Shirley Basin South (UMTRCA Title II) Disposal Site, Carbon County, Wyoming*, DOE–LM/GJ766–2004, December.

DOE (U.S. Department of Energy), 2011. *Groundwater Monitoring Evaluation for the Shirley Basin South, Wyoming, UMTRCA Title II Disposal Site*, Document Number S07784, June.

Orlando, D., 2012. Dominick Orlando, Senior Project Manager, Special Projects Branch, Decommissioning and Uranium Recovery Licensing Directorate, Division of Waste Management and Environmental Protection, Office of Federal and State Materials and Environmental Management Programs, letter (about [June 28, 2012] U.S. Nuclear Regulatory Commission Staff Review of U.S. Department of Energy Groundwater Assessment Plan for the Shirley Basin South, Wyoming, Uranium Mill Tailings Radiation Control Act Site) to Scott Surovchak, Site Manager, U.S. Department of Energy, August 16.

WAR 20.0011.8. "Quality Standards for Wyoming Groundwaters," *Wyoming Administrative Rules.*

6.9 Photographs

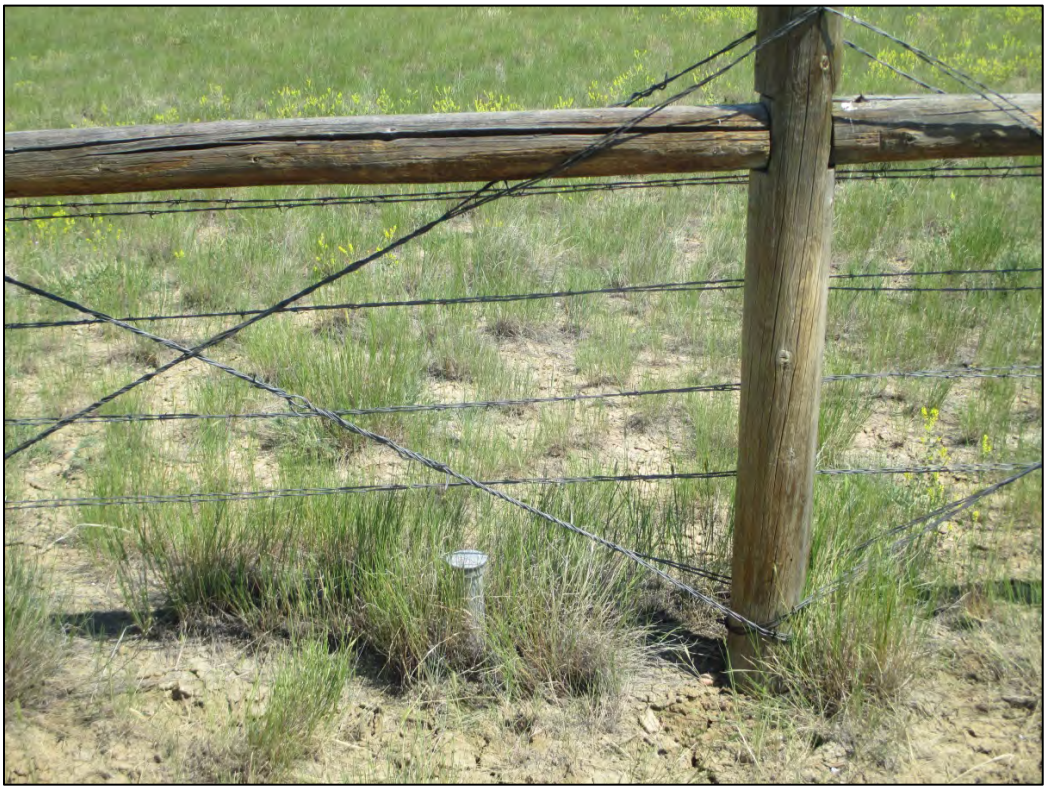
Photograph Location Number	Azimuth	Photograph Description
PL-1	0	Entrance Gate
PL-2	270	Perimeter Fence Along North Site Boundary
PL-3	180	Perimeter Sign P31
PL-4	0	Site Marker
PL-5	0	Boundary Monument BM-25
PL-6	95	Monitoring Wells 100-SC and 110-DC (in Distance)
PL-7	110	North Swale Discharge Point
PL-8	15	South Swale Discharge Point
PL-9	130	Riprap-Armored Dam Outslope of Disposal Cell
PL-10	340	Upgradient View of Riprap-Armored Portion of Southwest Channel
PL-11	210	Downgradient View of Riprap-Armored Portion of North Channel
PL-12	125	West Side of East Drainage Basin
PL-13	75	View Across Pit 4

PL-1. Entrance Gate

PL-2. Perimeter Fence Along North Site Boundary

PL-3. Perimeter Sign P31

PL-4. Site Marker



PL-5. Boundary Monument BM-25

PL-6. Monitoring Wells 100-SC and 110-DC (in Distance)

PL-7. North Swale Discharge Point

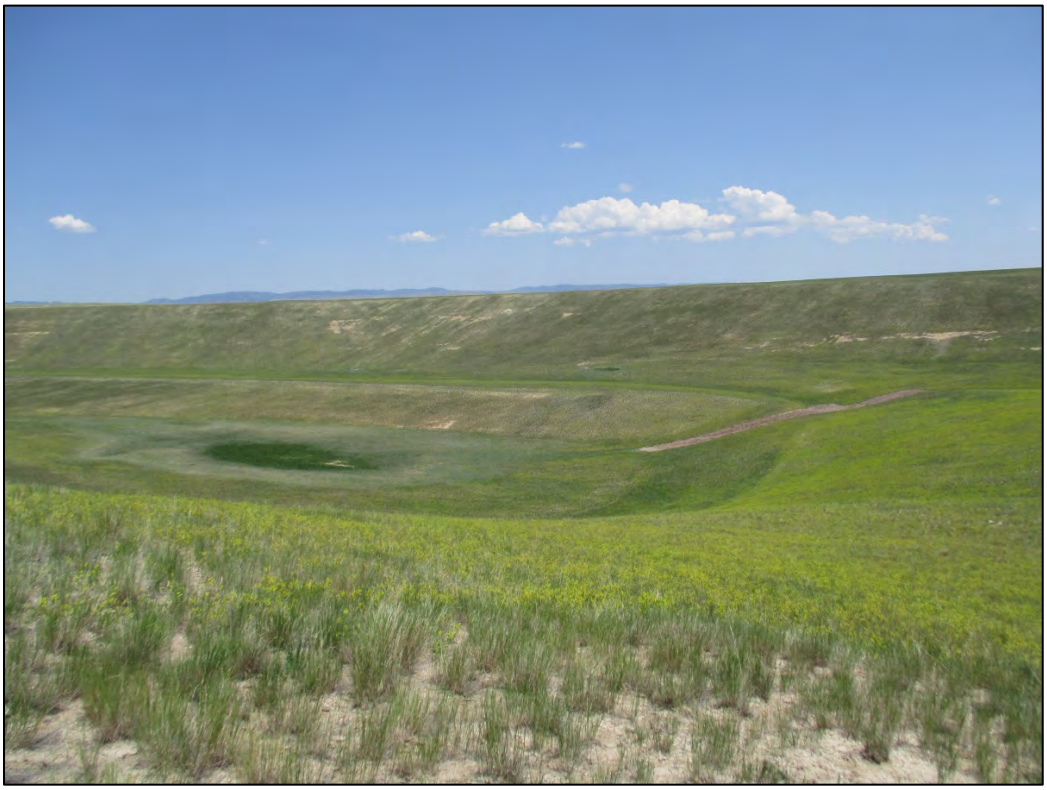
PL-8. South Swale Discharge Point

PL-9. Riprap-Armored Dam Outslope of Disposal Cell

PL-10. Upgradient View of Riprap-Armored Portion of Southwest Channel

PL-11. Downgradient View of Riprap-Armored Portion of North Channel

PL-12. West Side of East Drainage Basin



PL-13. View Across Pit 4

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