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2020 Postclosure Groundwater Monitoring and Inspection Report, Central Nevada Test Area, Subsurface Corrective Action Unit 443

February 2023

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Abbreviations

amsl	above mean sea level
BLM	U.S. Bureau of Land Management
bls	below land surface
^{14}C	carbon-14
CAS	Corrective Action Site
CAU	Corrective Action Unit
CNTA	Central Nevada Test Area, Nevada
DI	deionized
DOE	U.S. Department of Energy
DRI	Desert Research Institute
EC	electrical conductivity
FFACO	Federal Facility Agreement and Consent Order
ft	feet
ft/min	feet per minute
GEMS	Geospatial Environmental Mapping System
^{129}I	iodine-129
IC	institutional control
JSA	job safety analysis
LM	Office of Legacy Management
LPZ	lower piezometer
MCL	maximum contaminant level
m/d	meters per day
MDC	minimum detectable concentration
MV	monitoring/validation
NAVD 88	North American Vertical Datum of 1988
NDEP	Nevada Division of Environmental Protection
NGVD 29	National Geodetic Vertical Datum of 1929
pCi/L	picocuries per liter
RSI	RSI EnTech, LLC
SAP	Sampling and Analysis Plan
SDWA	Safe Drinking Water Act
SGZ	surface ground zero

TOC	top of casing
UPZ	upper piezometer

Executive Summary

The Central Nevada Test Area, Nevada, Site was where a 0.2- to 1-megaton nuclear device was detonated underground in 1968—a test that resulted in residual contamination at and near the detonation depth of 3200 feet. Subsurface corrective action activities were completed in 2015, and the *Closure Report, Central Nevada Test Area, Subsurface Corrective Action, Unit 443*, hereafter called the Closure Report, was approved in 2016 and revised in October 2018. These activities were conducted in accordance with the 1996 Nevada *Federal Facility Agreement and Consent Order* and all applicable Nevada Division of Environmental Protection policies and regulations. The Closure Report established the long-term postclosure monitoring program and inspection requirements for the site. The postclosure monitoring program is designed to (1) assess the effectiveness of the compliance boundary by monitoring for the radioisotopes of interest and (2) evaluate the effectiveness of monitoring locations within the groundwater flow system by monitoring water elevations to ensure that monitoring wells are along the potential migration pathways. This includes sampling on a 3-year frequency and annual site inspections to maintain the institutional controls and ensure protectiveness of the site.

The August 2020 and 2021 sample results indicate that tritium was not detected above the laboratory-required minimum detectable concentrations at any of the sampled locations except at the reentry well UC-1-P-2SR. The reentry well is a near-field monitoring well that monitors the detonation chimney, so the tritium concentrations in this well are expected. The tritium concentrations at the four sample depths (780, 1200, 1591, and 2192 feet) in this well are consistent with past results and no action is required as per Table 4 of the Closure Report. The sampled locations (August 2020 and 2021) were also analyzed for carbon-14 and iodine-129 and results were below the established action levels, which is consistent with past results. Water levels in the reentry well UC-1-P-2SR are still recovering from the dewatering effects of the detonation. The currently depressed water levels in this area direct groundwater flow in the alluvial aquifer toward the chimney near surface ground zero. In the volcanic section, water level data from well UC-1-P-2SR also indicate a downward vertical gradient from the source zone to the densely welded tuff units below the detonation. The current downward vertical gradient from the chimney to the underlying volcanic section will increase as water levels continue to recover in the chimney. This interpretation is supported by the flow log data collected by Desert Research Institute that indicate a downward component of flow within the reentry well UC-1-P-2SR. Water level data from the monitoring/validation (MV) locations MV-4PZ and MV-5PZ piezometers (screened inside the graben) and the MV-4 and MV-5 wells (screened outside the graben) continued to confirm that the southeast-bounding graben fault acts as a barrier to groundwater flow. The sample results, along with the water level monitoring results, continued to support the adequacy of the site monitoring network and the determination that radioisotopes of interest have not migrated outside the compliance boundary.

This report and the Closure Report are available on the Office of Legacy Management public website at https://www.lm.doe.gov/CNTA/Sites.aspx. Data collected during previous monitoring events (including sample analytical results and water level data) are available on the Geospatial Environmental Mapping System (GEMS) website at https://gems.lm.doe.gov/#site=CNT.

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1.0 Introduction

This report presents the groundwater monitoring data collected by the U.S. Department of Energy (DOE) Office of Legacy Management (LM) from the Central Nevada Test Area (CNTA), Nevada, Site, Subsurface Corrective Action Unit (CAU) 443 in Nye County, Nevada (Figure 1). The CNTA is the site of an underground nuclear test in 1968 that resulted in residual contamination near the detonation depth of 3200 feet (ft); the contamination requires long-term monitoring. Responsibility for the environmental restoration and long-term monitoring was transferred from DOE's National Nuclear Security Administration, Nevada Field Office, to LM on October 1, 2006. The environmental restoration and site closure process were completed in 2015 in accordance with the amended 1996 Nevada *Federal Facility Agreement and Consent Order* (FFACO) (State of Nevada et al. 1996, as amended) and all applicable Nevada Division of Environmental Protection (NDEP) policies and regulations. The *Closure Report, Central Nevada Test Area, Subsurface Corrective Action, Unit 443* (DOE 2018), also called the Closure Report, originally was completed in January 2016 and revised in October 2018; it describes LM's plan for long-term postclosure monitoring. This includes monitoring of the radioisotopes of interest and water elevations, inspecting the site and maintaining the institutional controls (ICs), evaluating and reporting data, and documenting the site's records and data management processes (DOE 2018).

The purpose of the postclosure monitoring is to evaluate the groundwater for the potential migration of contamination, evaluate the effectiveness of the monitoring network with respect to groundwater flow directions, and ensure that the ICs are protective of the site and human health and the environment. This report summarizes the results of the monitoring and site inspection activities conducted from June 2018 through August 2021. The 2-year reporting period was extended through August 2021 due to maintenance activities conducted in July 2021 on wells UC-1-P-2SR and HTH-2 (refer to Section 4.0).

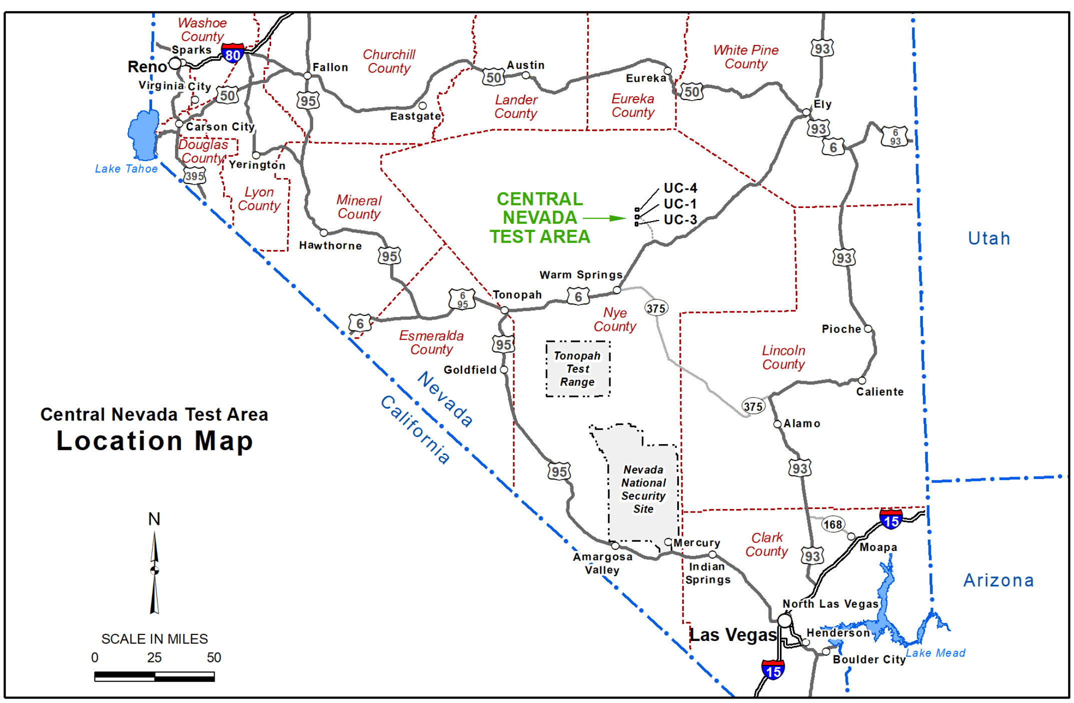

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Figure 1. CNTA Site Location Map Showing UC-1, UC-3, and UC-4 Sites

2.0 Site Background

The U.S. Atomic Energy Commission (predecessor to DOE) acquired the CNTA site through two separate land withdrawals from the U.S. Bureau of Land Management (BLM) in the late 1960s to develop sites for underground nuclear testing that could serve as alternatives to the Nevada National Security Site (formerly known as the Nevada Test Site). Three boreholes—UC-1, UC-3, and UC-4—were drilled at the CNTA site for underground nuclear weapons testing (Figure 1). The land withdrawals for these boreholes were authorized through Public Land Orders 4338 and 4748 in 1967 and 1969, respectively. The initial land withdrawal, Public Land Order 4338, included approximately 640 acres for land surrounding the UC-1 emplacement borehole. The second land withdrawal, Public Land Order 4748, was for two separate parcels of land totaling approximately 1920 acres for land surrounding the UC-3 and UC-4 boreholes (Figure 2). The underground nuclear test, identified as Faultless, was conducted in borehole UC-1 at a depth of 3200 ft on January 19, 1968. The nuclear device had a reported yield that was estimated to be 0.2 to 1 megaton (DOE 2015c). The test resulted in a down-dropped fault block (also referred to as a subsidence graben) that extends to land surface (Figure 3). Two additional tests were planned (UC-3 and UC-4 boreholes), but neither was completed, and no further nuclear testing was conducted at the CNTA. The UC-3 and UC-4 boreholes were abandoned and secured at the surface by a welded steel plate and concrete cap, and the site was decommissioned as a testing facility in 1973. The land withdrawal boundary associated with the UC-1 site was expanded through Public Land Order 7891 by 361 acres in February 2020. The expanded withdrawal boundary is depicted in the following figures.

The underground nuclear test resulted in residual contamination at and near the detonation depth. The intense heat of the detonation vaporized a volume of rock, temporarily creating a cavity or void space. In seconds to hours after the detonation, the overlying material collapsed into the void space, forming a collapse chimney. The former cavity, now the lower part of the collapse chimney, and the surrounding damaged zone are together referred to as the detonation zone. The detonation zone is contaminated by residual radioactive isotopes, with higher concentrations at the bottom of the former cavity, which contains the majority of radioactive fission products: uranium, plutonium, and tritium (DOE 2005). The rest of the detonation zone is contaminated by lower concentrations of mobile radioisotopes, such as tritium. The mobile radioisotopes in the detonation zone are a source of contamination (source zone) that could potentially migrate with groundwater. The subsurface contamination at the site is identified as CAU 443.

2.1 Geologic and Hydrologic Setting

The CNTA is in the northern portion of the Hot Creek Valley (Figure 2), a 68-mile-long, north-south trending graben in the Basin and Range physiographic province. Surface and subsurface geologic data indicate that the CNTA is within the Hot Creek Valley caldera complex, which contains several overlapping volcanic cauldrons. This caldera complex has been disrupted by basin-and-range style, normal faulting that formed the Hot Creek Valley graben. Hot Creek Valley varies in width from 5 to 19 miles and contains two major stratigraphic units—a thick sequence of Quaternary- and Tertiary-age alluvial deposits (alluvium) underlain by a thick section of Tertiary-age volcanic rocks (volcanic sediments). Borehole lithologic information obtained from groundwater monitoring wells installed at the site (Figure 3) indicates that the thickness of the alluvium near UC-1 (Faultless test location) ranges in depth from 1960 to 2410 ft (DOE 2006). The volcanic section below the alluvium includes tuffaceous sediments (volcanic sediments), densely welded and nonwelded tuffs, and rhyolite lavas.

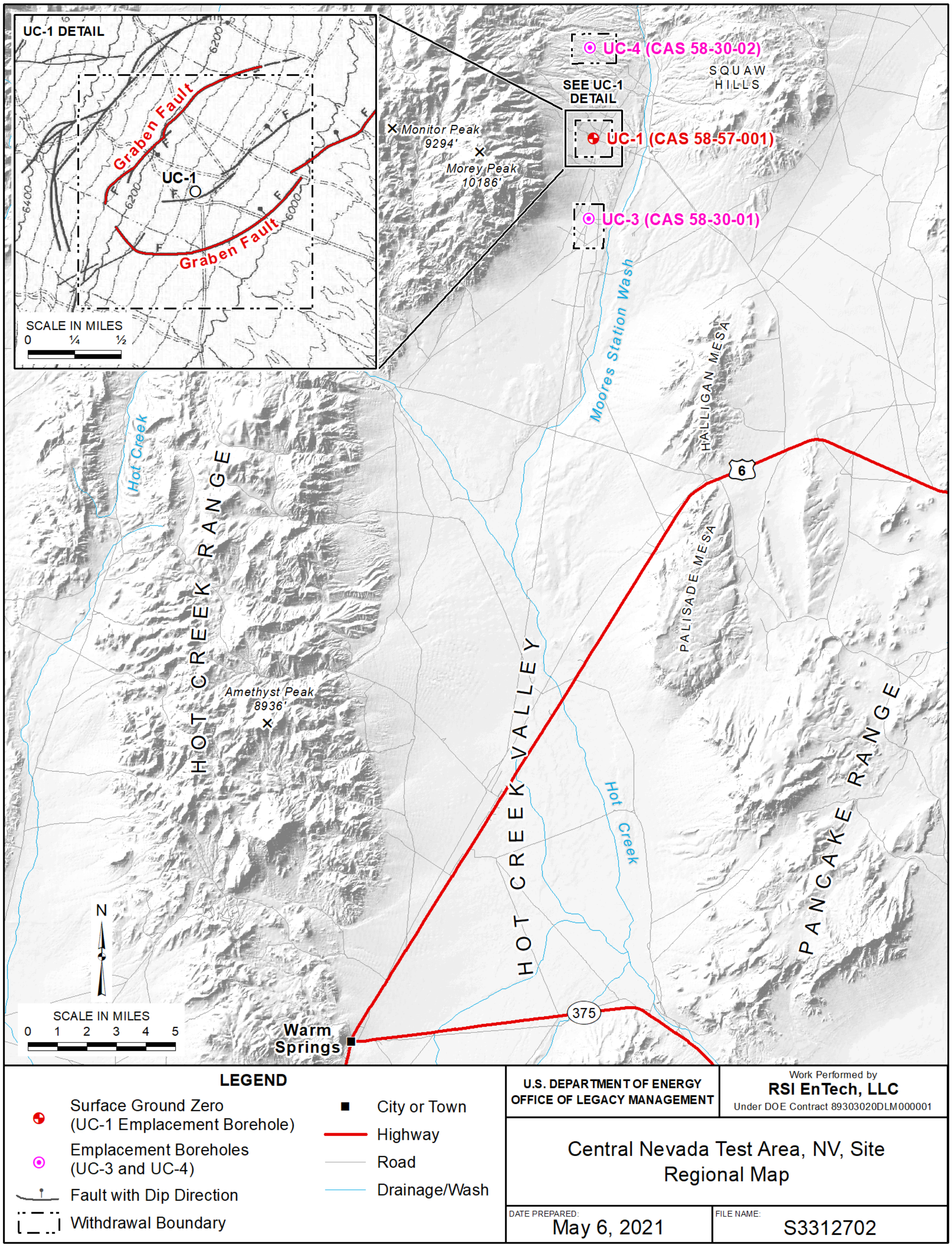
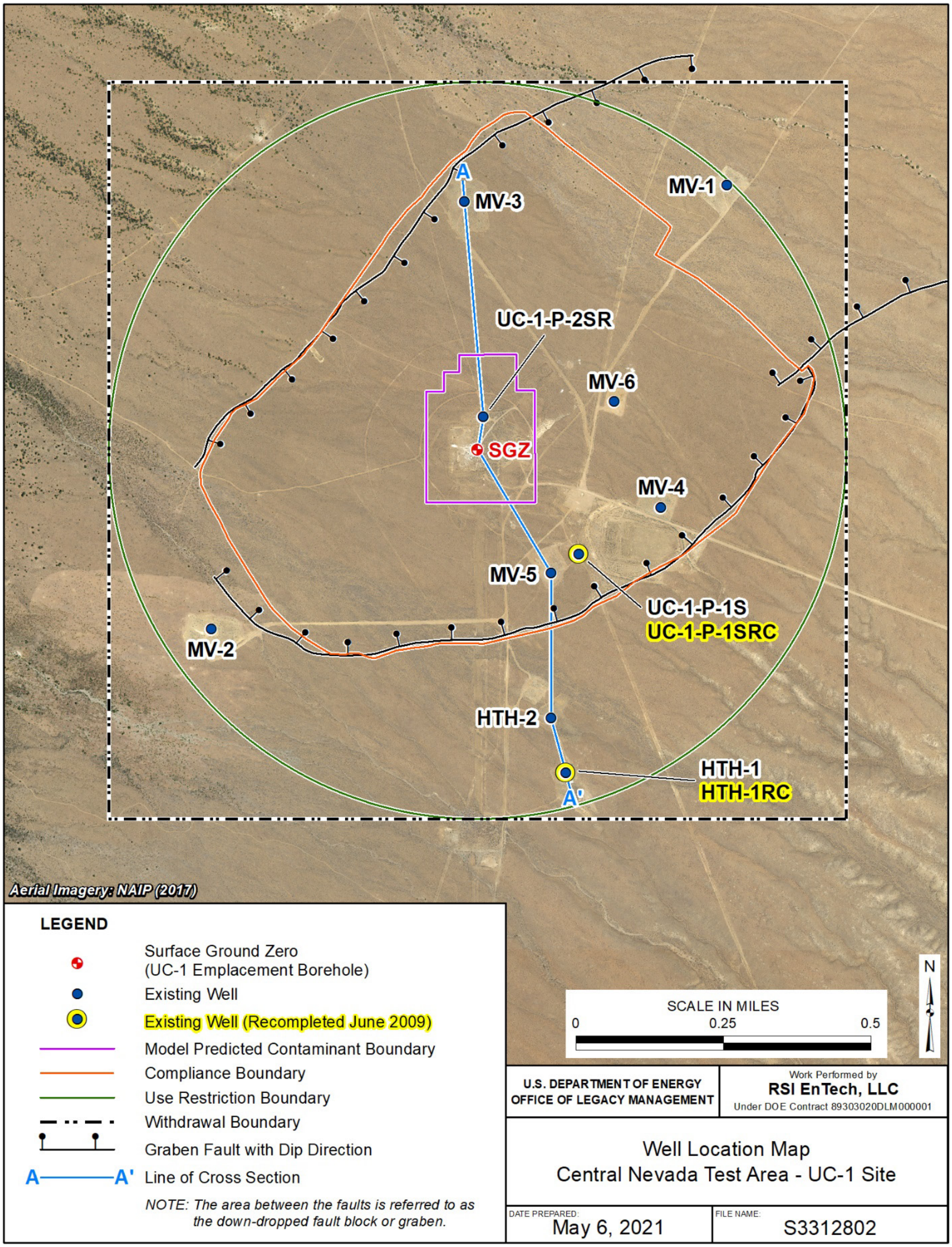


Figure 2. CNTA Site Regional Location Map



Abbreviation: SGZ = surface ground zero

Figure 3. CNTA UC-1 Site Map with Well Locations

The underground nuclear test triggered numerous small earthquakes and aftershocks that resulted in surface subsidence and surface rupture along preexisting faults (see UC-1 site detail in Figure 2), caused strike-slip movement along previously unknown subsurface faults, and induced seismic activity as far away as 24 miles (McKeown and Dickey 1969). The test created a down-dropped fault block (also referred to as a subsidence graben) elongated to the northeast and parallel to preexisting faults in the Quaternary valley-fill deposits (Figure 3). Maximum surface displacement after the test was 14.8 ft. In some places along the south side of the graben, dip on the faults is 77 degrees to the north, based on fault intercepts in postshot boreholes and postshot map data. High-speed photography showed that subsidence occurred along the preexisting graben faults immediately following the test, indicating that subsidence resulted from the immediate release of tectonic stress that was triggered by the underground test and not from the collapse of the former cavity (McKeown et al. 1968; McKeown and Dickey 1969). Figure 4 is a cross section of the UC-1 site depicting the former cavity and chimney with faults and lithologic units.

The Faultless test took place in the low-permeability volcanic sediments (Figure 4). It was estimated that the chimney extends into the overlying alluvium to a depth of approximately 1200 ft. This estimate is based on drilling records that indicate a loss of circulation while drilling the reentry well UC-1-P-2SR at this depth. The surface location of well UC-1-P-2SR is 300 ft north of surface ground zero (SGZ) and was drilled directionally to intercept the chimney. It began to deviate from vertical at about 1500 ft (elevation of 4600 ft above mean sea level [amsl]). Well UC-1-P-2SR was drilled to a measured depth of 3554 ft (3513 ft true vertical depth) and perforated from measured depths of 1148 ft to 2792 ft (1148 ft to 2760 ft true vertical depth). The water level in the chimney is still recovering from the dewatering effects of the detonation. The water level in UC-1-P-2SR (elevation of 5647 ft amsl in mid-2021) has increased more than 1800 ft in the last 53 years at a slowing rate (Figure 5) and is expected to rise another 100 ft in the next 40 years or so (estimated based on current trend). The water level within UC-1-P-2SR should eventually reach the elevation of approximately 5750 ft amsl observed in the alluvial aquifer near SGZ.

Groundwater depth in the alluvium varies at the UC-1 site due to varying surface topography and the effects of subsurface structures. Water elevations in the alluvial aquifer within the graben are about 250 ft higher than those in the alluvium south of the southeast-bounding graben fault (Figure 4). Groundwater flow in the alluvial aquifer is controlled on a large scale by topography, which slopes from northwest to southeast near the site. Horizontal flow in the upper alluvium is toward the chimney, where the water level in well UC-1-P-2SR is still recovering from the detonation (Figure 4). Away from the influence of the chimney, horizontal flow is to the east–southeast and is likely diverted to the east–northeast by the southeast-bounding graben fault, which acts as a barrier to flow (DOE 2018). Aquifer test results indicate that the hydraulic conductivity of the alluvial aquifer decreases with depth, grading from a productive aquifer in the upper alluvium tested in well UC-1-P-1SRC (hydraulic conductivity of 1 meter per day [m/d]) to a poor producer in the lower alluvium tested in monitoring/validation (MV) wells MV-4 and MV-5 (hydraulic conductivity of 1.2×10^{-4} to 5.0×10^{-4} m/d). The low hydraulic conductivity of the lower part of the alluvial aquifer is more comparable to that of the densely welded tuff units tested in the MV-1, MV-2, and MV-3 wells (8.5×10^{-6} to 6.7×10^{-5} m/d) and is likely similar to the hydraulic conductivity of the upper part of the underlying volcanic sediments (DOE 2010).

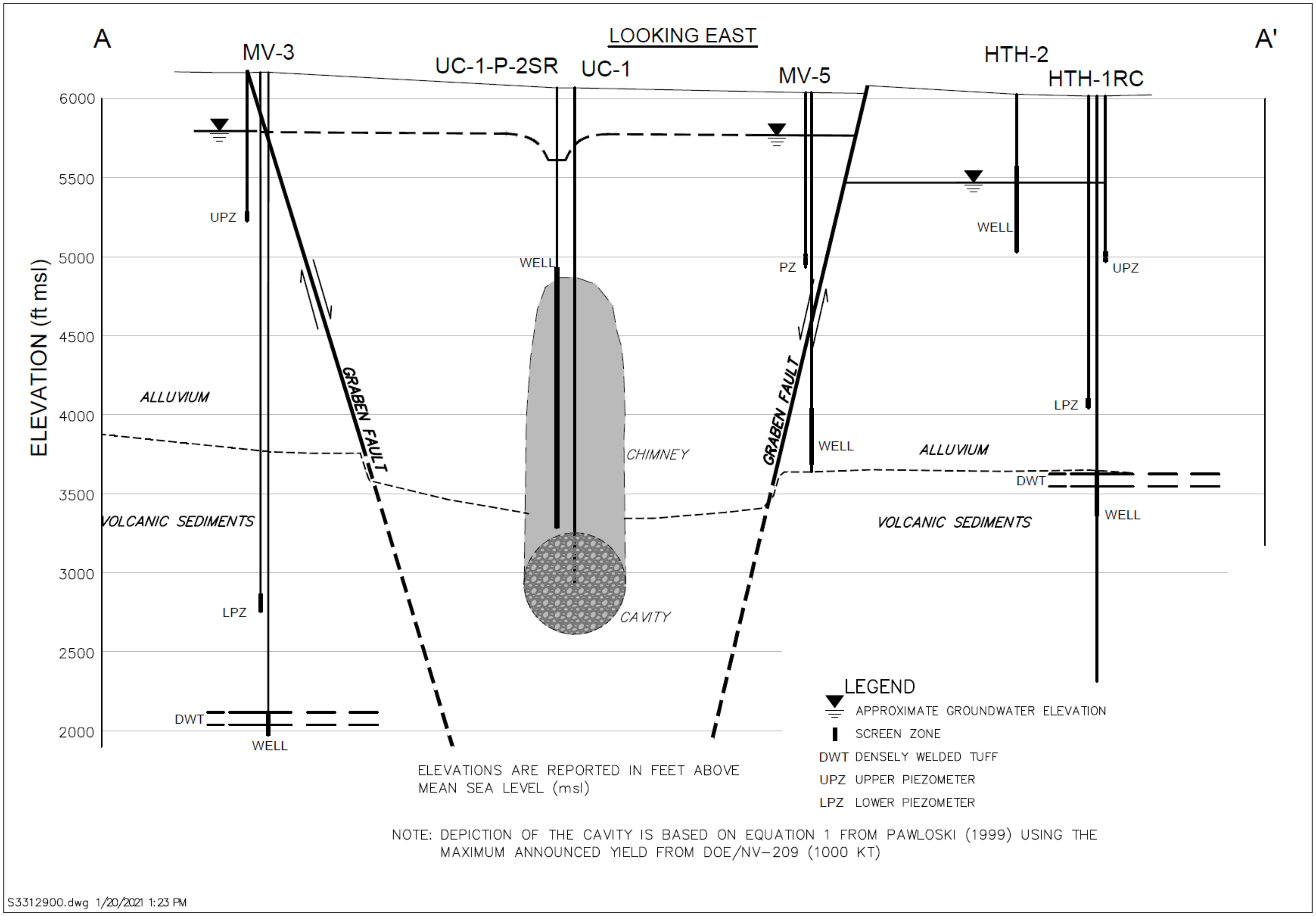


Figure 4. Cross Section View of A-A' Looking East

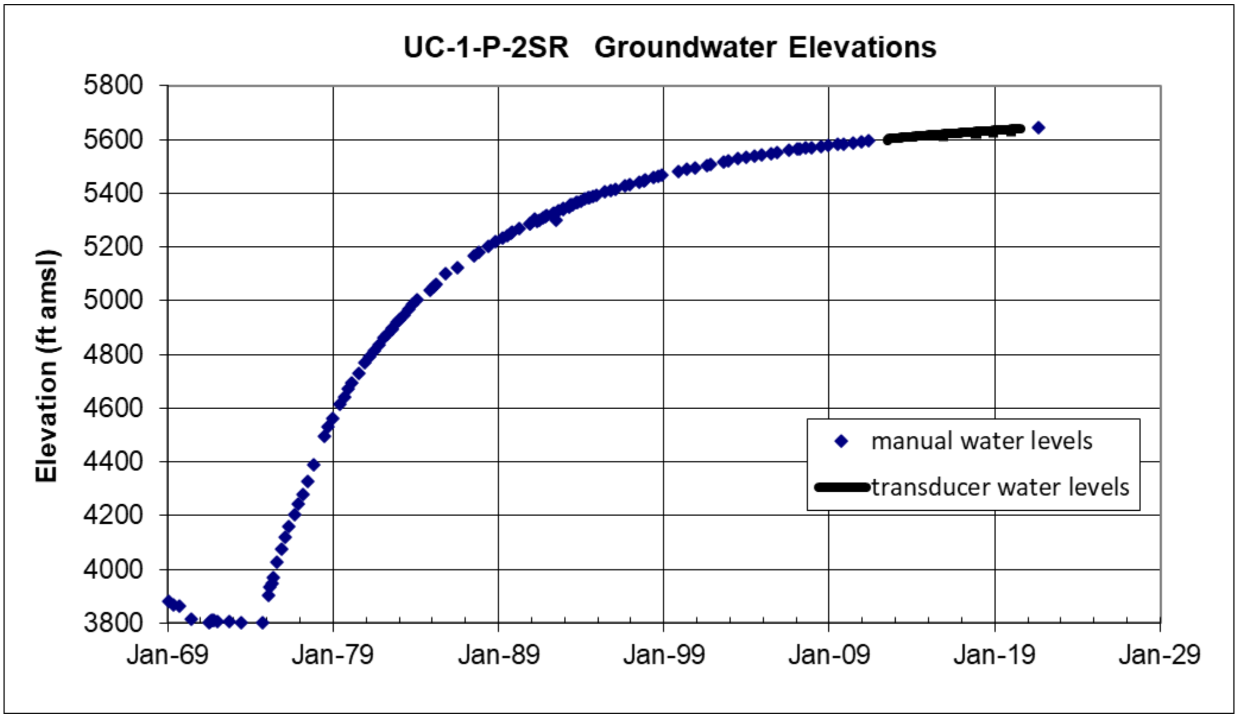


Figure 5. Water Elevations in Reentry Well UC-1-P-2SR

Water elevations in the volcanic sediments are highest at the detonation depth, likely due to a detonation-related pressure response and compaction that resulted from the graben subsidence. This is most evident inside the graben, where the water elevation is approximately 5990 ft amsl in the MV-1 lower piezometer (LPZ) that is screened at the detonation depth. The gradients obtained from the water elevations suggest that the most likely flow direction from the source zone is down, toward the densely welded tuff units (elevations of about 5565 ft amsl).

Wells MV-1, MV-2, and MV-3 are screened in densely welded tuff units near and below the source zone. Water elevations from these wells and interpretations of the geometry of the major graben faults at these depths suggest a flow direction that is to the northeast in the densely welded tuff units. Aquifer tests performed on the MV-1, MV-2, and MV-3 wells indicate low hydraulic conductivity values ranging from 8.5×10^{-6} to 6.7×10^{-5} m/d (Lyles et al. 2006). The low hydraulic conductivities and anomalously long water level recovery time in UC-1-P-2SR (chimney) (Figure 5) is consistent with a detonation zone surrounded by low-permeability material.

3.0 Summary of Corrective Action Activities

Subsurface corrective action activities were completed in 2015 and are summarized in the Closure Report, Revision 1 (DOE 2018). The subsurface CAU 443 consists of three Corrective Action Sites (CASs): CAS 58-57-001 (UC-1 Cavity), CAS 58-30-01 (Emplacement Well UC-3), and CAS 58-30-02 (Emplacement Well UC-4) (Figure 2). It was concluded during the corrective actions that the CASs associated with the UC-3 and UC-4 boreholes would require no further action and that corrective actions would focus on the UC-1 former cavity as the source of contamination for CAU 443 (DOE 1999). Currently, the concrete caps that cover the UC-3 and UC-4 boreholes are inspected annually and there are no active monitoring wells in either area. The corrective action alternative selected for UC-1 is proof of concept and monitoring with ICs, which included establishing a monitoring program, use restrictions, and other ICs to protect human health and the environment (DOE 2004).

The Closure Report provides justification for closure of CAU 443 and a summary of completed closure activities; describes the selected corrective action alternative; provides an implementation plan for long-term monitoring with well network maintenance and approaches and policies for ICs; and presents the contaminant, compliance, and use-restriction boundaries for the site (DOE 2018). Environmental restoration and site closure were conducted in accordance with the 1996 Nevada FFACO and all applicable NDEP policies and regulations.

3.1 ICs and Site Boundaries

The term ICs is used to broadly define the instruments (documents) and mechanisms (physical features) that are maintained to ensure long-term protectiveness of a site (DOE 2015b). ICs are part of the final remedy for the CNTA site, which was approved by NDEP in March 2016 (Andres 2016). CNTA site lands are under jurisdiction of the federal government, which controls land use. These lands (2921 acres) are administered by BLM and the U.S. Forest Service as part of the Toiyabe National Forest, and current land use includes livestock grazing, ranching, and recreation. The total acreage is currently withdrawn from all forms of appropriation associated with mining laws and leasing through Public Land Orders 4338, 4748, and 7891, which prohibit future oil and gas leasing or mineral claims at the site. LM monitors the Nevada websites responsible for leasing, mineral claims, and well permitting to ensure that new activities do not impact the site. This includes inspecting the site annually for evidence of land use changes or significant land disturbances. It also includes evaluating the site roads and inspecting the monitoring network, the concrete caps that cover the UC-3 and UC-4 boreholes (Figure 2), and the UC-1 monument for signs of damage, natural deterioration from weather, or vandalism.

LM expanded the UC-1 land withdrawal boundary with BLM through Public Land Order 7891 in February 2020. The new withdrawal added an additional 361 acres, so it now encompasses the subsurface use restriction and compliance boundaries at the UC-1 site (Figure 3). The subsurface use restriction boundary was established to restrict access to subsurface materials, including groundwater, while maintaining public access for surface activities. The compliance boundary is the area within which the radioisotopes with concentrations above the Safe Drinking Water Act (SDWA) standards are to remain. The compliance boundary is considerably larger than the model-predicted contaminant boundary that delineates the probable (95th percentile) extent to which radioisotope-contaminated groundwater from the underground nuclear test would migrate over 1000 years (Pohll et al. 2003). The lateral extent of contaminated groundwater in the subsurface represents the contaminant boundary perimeter when projected to the surface.

Contaminated groundwater is defined as water with radioisotope concentrations that exceed the SDWA standards (State of Nevada et al. 1996, as amended). The subsurface use restriction, contaminant, and compliance boundaries were approved in the Closure Report (DOE 2018).

3.2 Migration Pathways and Monitoring Network

The monitoring well network is designed to monitor the most likely transport path (i.e., the low-permeability densely welded tuff near and below the source zone) and the most likely access path (i.e., the higher-permeability alluvial aquifer above the source zone) (Table 1). The well network that monitors for the presence of radioisotopes in the densely welded tuff units includes wells MV-1, MV-2, MV-3, and HTH-1RC. Well HTH-1RC is screened above the detonation depth, but the original well casing remains open below the HTH-1RC well screen, allowing contribution from the volcanic section below the detonation depth (Figure 4). Wells MV-2 and MV-3 are completed in the densely welded tuff and are upgradient and cross-gradient from the source zone, respectfully. The MV-1 well is completed in the densely welded tuff below the detonation depth and is in the most likely flow direction from the source zone. The wells completed in densely welded tuff units are monitored for radioisotopes less frequently because of the low permeability that limits potential transport distances (Table 2). Well UC-1-P-2SR is a near-field monitoring well that is perforated in the detonation chimney and upper portion of the alluvium (Figure 4). Samples are collected from this well at discrete depths (780 ft, 1200 ft, 1591 ft, and 2192 ft) to assess changes in radioisotope concentrations within the chimney and alluvium. This well is sampled less frequently because water levels and flow logs (including temperature logs) in the well support a downward vertical gradient that continues to increase as water levels recover from the dewatering effects of the detonation (Figure 5). In addition to the sampling, the water column within well UC-1-P-2SR is logged to determine the groundwater temperature, pH, and specific conductance. These data are evaluated to determine flow within the well.

The alluvial aquifer monitoring network includes wells and piezometers (distinguished from the wells by the abbreviation “PZ”) that surround the portion of the chimney extending into the alluvium. The alluvial monitoring network includes wells MV-4, MV-5, MV-6, UC-1-P-1SRC, and HTH-2 and piezometers MV-1UPZ (an upper piezometer [UPZ]) and MV-4PZ (Table 1). Wells MV-4, MV-5, MV-6, and UC-1-P-1SRC are sampled at an increased frequency because of their proximity to the chimney (Table 2). Well HTH-2 is sampled less frequently because it is outside the graben and farther from the chimney. Piezometers MV-4PZ and MV-1UPZ are within the graben and within potential flow paths, but they are sampled less frequently because they are not designed to be efficiently sampled and have a small diameter casing (1.9-inch inside diameter). Table 1 provides the zone of completion (top and bottom) with elevations and lithologic unit monitored by wells and piezometers in the monitoring network. For locations with two piezometers, a UPZ and an LPZ are used to denote the upper piezometer and lower piezometer, respectively. The vertical datum used to document the top-of-casing (TOC) elevations was changed in this year’s report from the U.S. State Plane, Zone Nevada Central, coordinate system, with vertical data based on the National Geodetic Vertical Datum of 1929 (NGVD 29), to the vertical datum based on the North American Vertical Datum of 1988 (NAVD 88). This change is being implemented at all LM sites. Table 2 provides the monitoring network and sampling frequency with the lithologic unit monitored by each well and piezometer.

Table 1. Monitoring Network with Zones of Completion and Unit Monitored

<table>
<tr><th>Monitoring Wells / Piezometers</th><th>TOC Elevation[a] (ft)</th><th>TSZ Elevation[a] (ft)</th><th>BSZ Elevation[a] (ft)</th><th>Screen Length (ft)</th><th colspan="2">Lithologic Unit Monitored</th></tr>
<tr><td>MV-1UPZ</td><td>6073.81</td><td>5194</td><td>5134</td><td>60</td><td rowspan="9">Upper</td><td rowspan="13">Alluvium</td></tr>
<tr><td>MV-2UPZ</td><td>6194.49</td><td>5234</td><td>5184</td><td>50</td></tr>
<tr><td>MV-3UPZ</td><td>6171.58</td><td>5291</td><td>5231</td><td>60</td></tr>
<tr><td>MV-4PZ</td><td>6023.28</td><td>5105</td><td>5045</td><td>60</td></tr>
<tr><td>MV-5PZ</td><td>6044.68</td><td>5027</td><td>4967</td><td>60</td></tr>
<tr><td>MV-6</td><td>6057.67</td><td>5219</td><td>5056</td><td>163</td></tr>
<tr><td>UC-1-P-1SRC</td><td>6035.41</td><td>5524</td><td>5462</td><td>62</td></tr>
<tr><td>HTH-2</td><td>6029.88</td><td>5526</td><td>5030</td><td>496</td></tr>
<tr><td>HTH-1UPZ</td><td>6015.10</td><td>5037</td><td>4977</td><td>60</td></tr>
<tr><td>HTH-1LPZ</td><td>6015.14</td><td>4117</td><td>4057</td><td>60</td><td rowspan="3">Lower</td></tr>
<tr><td>MV-4</td><td>6023.40</td><td>4304</td><td>4000</td><td>304</td></tr>
<tr><td>MV-5</td><td>6045.68</td><td>4207</td><td>3883</td><td>324</td></tr>
<tr><td>UC-1-P-2SR[b]</td><td>6084.34</td><td>4937</td><td>3324</td><td>1644</td><td>Chimney</td></tr>
<tr><td>MV-1LPZ</td><td>6073.74</td><td>3071</td><td>3011</td><td>60</td><td rowspan="2">Tuffaceous sediments</td><td rowspan="6">Volcanic</td></tr>
<tr><td>MV-3LPZ</td><td>6171.52</td><td>2871</td><td>2751</td><td>120</td></tr>
<tr><td>MV-1</td><td>6074.40</td><td>2323</td><td>2164</td><td>160</td><td rowspan="5">Densely welded tuff</td></tr>
<tr><td>MV-2LPZ</td><td>6194.22</td><td>2647</td><td>2587</td><td>60</td></tr>
<tr><td>MV-2</td><td>6194.49</td><td>3154</td><td>2991</td><td>163</td></tr>
<tr><td>MV-3</td><td>6172.10</td><td>2125</td><td>1963</td><td>162</td></tr>
<tr><td>HTH-1RC</td><td>6015.53</td><td>3658</td><td>3358</td><td>300</td></tr>
</table>

Notes:
Coordinate system used here is U.S. State Plane System 1983 (Nevada Central Zone), Vertical Datum, NAVD 88.
TOC measurements are taken from the approximate north TOC.
[a] All elevations are corrected for true vertical depth and reported in units of ft amsl.
[b] Well UC-1-P-2SR is perforated, not screened.

Abbreviations:
BSZ = bottom of open interval/screen zone
TSZ = top of open interval/screen zone

3.3 Action Levels

The Closure Report (DOE 2018) established the compliance levels and laboratory-required minimum detectable concentrations (MDCs) for the radioisotopes of interest (tritium, carbon-14 [^{14}C], and iodine-129 [^{129}I]). The compliance levels for these radioisotopes are consistent with the current SDWA maximum contaminant levels (MCLs) of 20,000 picocuries per liter (pCi/L) for tritium, 2000 pCi/L for ^{14}C, and 1 pCi/L for ^{129}I. The laboratory-required MDC is 400 pCi/L for tritium, 5 pCi/L for ^{14}C, and 0.1 pCi/L for ^{129}I. The laboratory-required MDCs are also referred to as the laboratory-required detection limit used in previous groundwater monitoring reports (DOE 2015a). The compliance levels and laboratory-required MDCs were used to establish the action levels for the site (Table 3). If an action level is exceeded, LM will provide the required notifications to NDEP within 90 days of receiving the laboratory analytical results. Table 3 provides the laboratory-required MDCs, compliance levels and MCLs, and action levels with the NDEP notification requirements.

Table 2. Monitoring Network with Sampling Frequency for Radioisotopes of Interest

Monitoring Wells/Piezometers	Monitoring Network and Sampling Frequency for Radioisotopes of Interest													Lithologic Unit Monitored	
	2016	2018	2020	2023	2026	2029	2032	2035	2038	2041	2044	2047	2050		
MV-1UPZ			TCI		T		TCI		T		TCI		T	Upper	Alluvium
MV-2UPZ[a]															
MV-3UPZ[a]															
MV-4PZ			TCI		T		TCI		T		TCI		T		
MV-5PZ[a]															
MV-6	T	T	TCI	T	T	T	TCI	T	T	T	TCI	T	T		
UC-1-P-1SRC	T	T	TCI	T	T	T	TCI	T	T	T	TCI	T	T		
UC-1-P-2SR (depth 780 ft)			TCI				TCI				TCI				
UC-1-P-2SR (depth 1200 ft)			TCI				TCI				TCI				
HTH-2			TCI		T		TCI		T		TCI		T		
HTH-1UPZ[a]															
HTH-1LPZ[a]														Lower	
MV-4	T	T	TCI	T	T	T	TCI	T	T	T	TCI	T	T		
MV-5	T	T	TCI	T	T	T	TCI	T	T	T	TCI	T	T		
UC-1-P-2SR (depth 1591 ft)			TCI				TCI				TCI			UC-1 Chimney	
UC-1-P-2SR (depth 2192 ft)			TCI				TCI				TCI				Volcanic
MV-1LPZ[a]														Tuffaceous Sediments	
MV-3LPZ[a]															
MV-1	T	T	TCI		T		TCI		T		TCI		T	Densely Welded Tuff	
MV-2LPZ[a]															
MV-2	T	T	TCI		T		TCI		T		TCI		T		
MV-3	T	T	TCI		T		TCI		T		TCI		T		
HTH-1RC	T	T	TCI		T		TCI		T		TCI		T		

Notes:
Well UC-1-P-2SR is perforated from 1148 to 2792 ft, and samples will be collected from discrete depths (780 ft, 1200 ft, 1591 ft, and 2192 ft) within the well.
[a] = A piezometer that is not designated for sampling because it is located outside a potential flow path, constructed using small diameter casing so it is not easily sampled, or may not have been fully developed because it is completed in the low permeability volcanic sediments and not designed for sampling.

Abbreviations: C = Analyze sample for ^{14}C, I = Analyze sample for ^{129}I, T = Analyze sample for tritium

Table 3. Monitoring Network with Action Levels for Radioisotopes of Interest

Monitoring Wells / Piezometers	Action Levels for Radioisotopes of Interest					Lithologic Unit Monitored	
	Inside Contaminant Boundary	Outside Contaminant Boundary, but Inside Compliance Boundary			Outside Compliance Boundary		
	>MCL	>2× MDC	>0.5 MCL	>MCL	>2× MDC		
MV-1UPZ					Notify NDEP 3	Upper	Alluvium
MV-2UPZ					Notify NDEP 3		
MV-3UPZ		Notify NDEP 1	Notify NDEP 2	Notify NDEP 3			
MV-4PZ		Notify NDEP 1	Notify NDEP 2	Notify NDEP 3			
MV-5PZ		Notify NDEP 1	Notify NDEP 2	Notify NDEP 3			
MV-6		Notify NDEP 1	Notify NDEP 2	Notify NDEP 3			
UC-1-P-1SRC		Notify NDEP 1	Notify NDEP 2	Notify NDEP 3			
UC-1-P-2SR (depth 780 ft)	Notify NDEP 1						
UC-1-P-2SR (depth 1200 ft)	Notify NDEP 1						
HTH-2					Notify NDEP 3		
HTH-1UPZ							
HTH-1LPZ						Lower	
MV-4		Notify NDEP 1	Notify NDEP 2	Notify NDEP 3			
MV-5		Notify NDEP 1	Notify NDEP 2	Notify NDEP 3			
UC-1-P-2SR (depth 1591 ft)	Notify NDEP 1					Chimney	
UC-1-P-2SR (depth 2192 ft)	NA						Volcanic
MV-1LPZ						Tuffaceous sediments	
MV-3LPZ							
MV-1					Notify NDEP 3	Densely welded tuff	
MV-2LPZ							
MV-2					Notify NDEP 3		
MV-3		Notify NDEP 1	Notify NDEP 2	Notify NDEP 3			
HTH-1RC					Notify NDEP 3		

Notes:
All notifications (by email or telephone call) shall be within 90 calendar days of receiving analytical data from laboratory.
Radioisotopes of interest are tritium, ^{14}C, and ^{129}I.
MCLs are SDWA maximum contaminant levels: 20,000 pCi/L for tritium, 2000 pCi/L for ^{14}C, and 1 pCi/L for ^{129}I.
The >0.5 MCL are concentrations greater than 10,000 pCi/L for tritium, 1000 pCi/L for ^{14}C, and 0.5 pCi/L for ^{129}I.
MDC levels required by laboratory are 400 pCi/L for tritium, 5 pCi/L for ^{14}C, and 0.1 pCi/L for ^{129}I.
The >2× MDC are concentrations greater than 800 pCi/L for tritium, 10 pCi/L for ^{14}C, and 0.2 pCi/L for ^{129}I.
"Notify NDEP 1" indicates only notification; no action, is required.
"Notify NDEP 2" indicates the sampling plan (sampling locations and frequency) should be modified in consultation with NDEP.
"Notify NDEP 3" indicates a new strategy or path forward should be developed in consultation with NDEP (e.g., new monitoring wells may be required).
"NA" indicates no action is required because the sample location is inside the contaminant boundary and has detections above the MCL.

4.0 Postclosure Monitoring and Results

The Closure Report (DOE 2018) established the long-term postclosure monitoring program and inspection requirements for the site. The postclosure monitoring program is designed to (1) assess the effectiveness of the compliance boundary by monitoring for the radioisotopes of interest and (2) evaluate the effectiveness of monitoring locations within the groundwater flow system by monitoring water elevations to ensure that monitoring wells are located along the potential migration pathways. This includes sampling every 3 years and annual site inspections to maintain the ICs and ensure site protectiveness. The long-term monitoring program will be reviewed periodically and revised as necessary to adequately track changes in radioisotope concentrations and stability of the flow system over time.

The postclosure monitoring program was initiated after NDEP approved the Closure Report in 2016 (Andres 2016). The 2020 sampling program was specified in the August 2020 environmental sampling notification letter that was provided to NDEP (DOE 2020). The sampling of wells UC-1-P-2SR and HTH-2 that could not be sampled during the 2020 sampling program was communicated to NDEP in the August 2021 environmental sampling notification letter (DOE 2021). Section 4.1 provides the results from the site inspection, and Sections 4.2 through 4.5 describe monitoring program results.

4.1 Site Inspection and Maintenance Activities

Site inspections (also conducted as part of the postclosure inspection of CAU 417) are conducted annually to look for evidence of land use changes or significant land disturbances and to ensure that ICs are maintained and continue to be effective. This includes evaluating the site roads and inspecting the monitoring network well boxes, the concrete caps that cover the UC-3 and UC-4 boreholes, and the UC-1 monument plaque at SGZ for signs of damage, natural deterioration from weather, or vandalism. The annual site inspections were conducted in June 2019 as part of the water level monitoring event and in August 2020 as part of the annual sampling event. The August 2020 sampling event was not completed as planned, because the bailer used to sample well UC-1-P-2SR was stuck in the well and the pump in well HTH-2 was not operable during the 2020 sampling event. A well maintenance event was conducted in July 2021 to successfully recover the bailer from well UC-1-P-2SR, but the pump in well HTH-2 could not be repaired and was removed from the well. A second sampling event was completed in August 2021 to sample wells UC-1-P-2SR (2192 ft) and HTH-2. The UC-1 site features (roads, wellheads, and the monument at SGZ) and the concrete cap that covers the UC-3 borehole were in good condition at the time of inspections. The concrete cap that covers the UC-4 borehole has some deterioration from weathering that is considered cosmetic because a steel plate welded to the borehole casings beneath the concrete prevents access to the borehole. Appendix A provides photographs from the June 2019 and August 2020 inspections of the UC-1 monument at SGZ and the concrete caps that cover the UC-3 and UC-4 boreholes, as well as the July 2021 well maintenance event.

Additional inspection and maintenance activities and results are provided below:

- The State of Nevada Division of Water Resources website was accessed to determine if any new groundwater wells had been permitted within 5 miles of the UC-1 site. No new groundwater wells were permitted in the search area during this reporting period (NDWR 2021).

- The University of Nevada, Reno, website was accessed to determine if any oil and gas wells had been permitted within 5 miles of the UC-1 site. No oil and gas wells were permitted in the search area during this reporting period (UNR 2021).
- The LM public website was updated during this reporting period to include the updated fact sheet and 2018 Postclosure Groundwater Monitoring and Inspection Report (DOE 2019), which can be accessed at https://www.lm.doe.gov/CNTA/Sites.aspx.

The LM public website is routinely updated to allow the public and stakeholders to access the most current site information. LM also monitors the abovementioned public websites to assess for any potential impacts these activities may have at the site.

4.2 Water Level Monitoring

Groundwater depths are measured manually at all wells and piezometers in the monitoring network (Table 1) during scheduled monitoring events, site inspections, and well maintenance events. Water depths are also recorded more frequently using pressure transducers to detect short-term and long-term water elevation changes within the different hydrostratigraphic units. Water levels are measured according to the procedures specified in the *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (LMS/PRO/S04351), also called the Sampling and Analysis Plan (SAP). The well and piezometer TOC elevations are used to convert the water depths to water elevations, also referred to as hydraulic head in previous reports. The water elevations are used to monitor the quasi-steady state of the groundwater system and to evaluate the effectiveness of the monitoring well network with respect to potential migration pathways.

Hydrographs of the water elevations are maintained and evaluated for wells completed in the same lithologic unit, having similar depths, or having similar locations (inside the graben or outside the graben). The vertical datum used to document the TOC elevations was changed in this report from the U.S. State Plane, Zone Nevada Central, coordinate system, with vertical data based on NGVD 29, to the vertical datum based on NAVD 88. This change increases the survey reported TOC for the wells and piezometers by approximately 4 ft. That in turn increases the reported groundwater elevations, computed from TOC minus depth-to-water. Subsequently, historical groundwater elevation measurements provided in tables, hydrographs, and potentiometric maps have been converted to the new datum within this report. Equivalent water elevations from previous reports (tables, hydrographs, and potentiometric map) will be approximately 4 ft lower than those in this report.

4.3 Water Level Monitoring Results

Groundwater depths were measured manually, and transducers were downloaded in site wells and piezometers on June 5–6, 2019, and August 4–5, 2020. Water levels were also measured manually in wells UC-1-P-2SR and HTH-2 on August 19, 2021 (Table 4). The water elevations are presented as hydrographs from January 2009 through August 2020 (Figure 6 through Figure 9). Manual water level measurements appear as individual symbols, and the daily averages of transducer data (recorded hourly) appear as lines. Using the daily averages for reporting was necessitated by the accumulating amount of data for charting and has the added benefit of focusing on long-term static water elevation changes that control flow directions rather than temporary perturbations that may result from well development and sampling.

Table 4. Monitoring Network with August 2020 and Select August 2021 Water Depths and Water Elevations

<table>
<tr><th>Monitoring Wells / Piezometers</th><th>Date Measured</th><th>Water Depth (ft)</th><th>TOC Elevation[a] (ft)</th><th>Water Elevation[a] (ft)</th><th colspan="2">Lithologic Unit Monitored</th></tr>
<tr><td>MV-1UPZ</td><td>8/4/2020</td><td>318.48</td><td>6073.81</td><td>5755.33</td><td rowspan="10">Upper</td><td rowspan="15">Alluvium</td></tr>
<tr><td>MV-2UPZ</td><td>8/4/2020</td><td>402.99</td><td>6194.49</td><td>5791.50</td></tr>
<tr><td>MV-3UPZ</td><td>8/5/2020</td><td>373.06</td><td>6171.58</td><td>5798.52</td></tr>
<tr><td>MV-4PZ</td><td>8/4/2020</td><td>276.62</td><td>6023.28</td><td>5746.66</td></tr>
<tr><td>MV-5PZ</td><td>8/4/2020</td><td>290.22</td><td>6044.68</td><td>5754.46</td></tr>
<tr><td>MV-6</td><td>8/4/2020</td><td>314.20</td><td>6057.67</td><td>5743.47</td></tr>
<tr><td>UC-1-P-1SRC</td><td>8/4/2020</td><td>282.95</td><td>6035.41</td><td>5752.46</td></tr>
<tr><td rowspan="2">HTH-2[c]</td><td>8/4/2020</td><td>558.55</td><td>6029.88</td><td>5471.33</td></tr>
<tr><td>8/19/2021</td><td>558.44</td><td>6029.88</td><td>5471.44</td></tr>
<tr><td>HTH-1UPZ</td><td>8/5/2020</td><td>544.75</td><td>6015.10</td><td>5470.35</td></tr>
<tr><td>HTH-1LPZ</td><td>8/5/2020</td><td>542.30</td><td>6015.14</td><td>5472.84</td><td rowspan="3">Lower</td></tr>
<tr><td>MV-4</td><td>8/4/2020</td><td>509.30</td><td>6023.40</td><td>5514.10</td></tr>
<tr><td>MV-5</td><td>8/4/2020</td><td>560.66</td><td>6045.68</td><td>5485.02</td></tr>
<tr><td rowspan="2">UC-1-P-2SR[c]</td><td>8/5/2020</td><td>443.78[b]</td><td>6084.34</td><td>5640.56</td><td rowspan="2">Chimney</td></tr>
<tr><td>8/19/2021</td><td>437.69[b]</td><td>6084.34</td><td>5646.65</td></tr>
<tr><td>MV-1LPZ</td><td>8/4/2020</td><td>81.12</td><td>6073.74</td><td>5992.62</td><td rowspan="2">Tuffaceous sediments</td><td rowspan="7">Volcanic</td></tr>
<tr><td>MV-3LPZ</td><td>8/5/2020</td><td>219.35</td><td>6171.52</td><td>5952.17</td></tr>
<tr><td>MV-1</td><td>8/4/2020</td><td>509.65</td><td>6074.40</td><td>5564.75</td><td rowspan="5">Densely welded tuff</td></tr>
<tr><td>MV-2LPZ</td><td>8/4/2020</td><td>425.05</td><td>6194.22</td><td>5769.17</td></tr>
<tr><td>MV-2</td><td>8/4/2020</td><td>393.10</td><td>6194.49</td><td>5801.39</td></tr>
<tr><td>MV-3</td><td>8/5/2020</td><td>604.44</td><td>6172.10</td><td>5567.66</td></tr>
<tr><td>HTH-1RC</td><td>8/5/2020</td><td>486.20</td><td>6015.53</td><td>5529.33</td></tr>
</table>

Notes:
Coordinate system used here is U.S. State Plane System 1983 (Nevada Central Zone), Vertical Datum, NAVD 88.
[a] All elevations are corrected for true vertical depth corrected and reported in units of ft amsl.
[b] UC-1-P-2SR water level and water elevation are a composite of the chimney and alluvium in which it is perforated.
[c] Wells UC-1-P-2SR and HTH-2 were measured in August 2021. Additional water level data collected in August 2021 are available in the Geospatial Environmental Mapping System (GEMS).

The hydrographs (Figure 6 through Figure 9) are grouped by comparable monitored interval and location: alluvial aquifer southeast of the southeast-bounding graben fault, including well HTH-1RC in the upper volcanic section (Figure 6); alluvial aquifer within the graben fault, including piezometer MV-3UPZ (Figure 7); the volcanic section with open intervals near the detonation depth (Figure 8); and the volcanic section with open intervals below the detonation depth (Figure 9). Data gaps in the hydrographs are the result of transducers being removed for well-site activities or for the replacement of damaged transducers or cable. The water elevations collected in August 2020 from wells and piezometers completed in the upper alluvial unit were used to construct a potentiometric surface of water elevations in the alluvium within the graben (Figure 10). A hydrograph of water elevations from all wells and piezometers is presented in Appendix B (Figure B-1) to allow a comparison of water elevations in each screened interval.

Figure 6 shows hydrographs from January 2009 through August 2020 of wells and piezometers completed in the alluvium southeast of the graben along with well HTH-1RC (screened in the upper volcanic section below the alluvium). These data indicate that water levels in wells MV-4 and MV-5 have recovered from the 2010 aquifer testing and from the 2011 yearly sampling event during which several thousand gallons of water were removed. Low-flow bladder pumps were installed in wells MV-4 and MV-5 during the November 2013 sampling event to reduce the well purge volumes and the impact purging has on the water levels during sampling (DOE 2014). Water levels in well HTH-1RC have recovered from the recompletion in 2009. Before its recompletion, well HTH-1 had been perforated across its entire saturated section, and its water level was a composite of several hydrostratigraphic units. The recompletion isolated zones in the upper and lower alluvium (HTH-1UPZ and HTH-1LPZ) and in the volcanic section (HTH-1RC). HTH-1RC isolated a densely welded tuff unit above the detonation depth, but the original well casing remains open below an obstruction at 2812 ft (elevation of about 3200 ft amsl) to the original depth of 3704 ft (elevation of about 2300 ft amsl), allowing contribution from the volcanic section below the detonation zone (Figure 4). The water elevation in the volcanic section (HTH-1RC) is higher than water elevations in both the upper and lower alluvial piezometers (HTH-1UPZ and HTH-1LPZ). This observation confirms that an upward gradient from the volcanic section to the alluvium exists in this interval south of the graben, as had been indicated by flow logging performed by Desert Research Institute (DRI) before the well's recompletion (DOE 2008). The transducer in the piezometer HTH-1LPZ was replaced during the August 2020 field event because it was not functioning correctly.

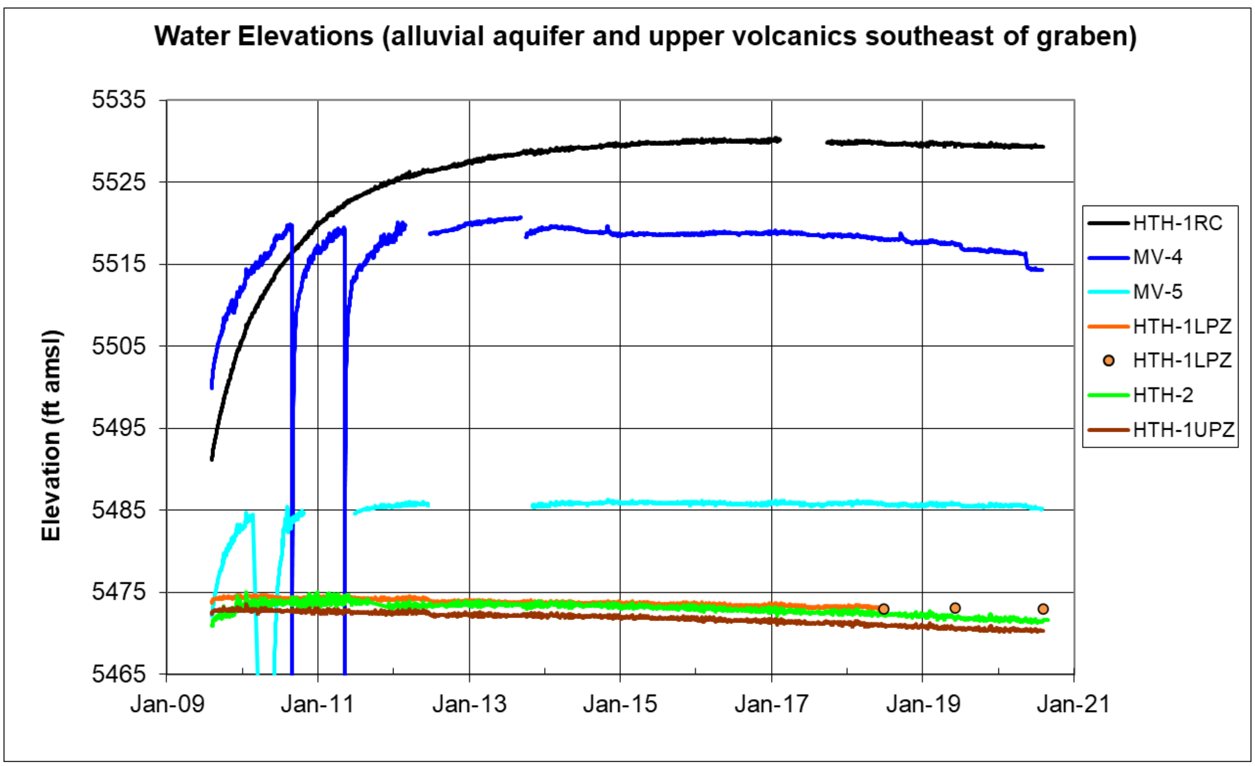


Figure 6. Water Elevations for the Alluvial Wells and Well HTH-1RC (Upper Volcanics) Southeast of the Down-Dropped Graben at the Screened Horizon

Figure 7 shows hydrographs from January 2009 through August 2020 of piezometers and wells completed in the alluvium within the graben and northwest of the graben. The water elevations in the piezometers MV-4PZ and MV-5PZ (screened inside the graben) are approximately 250 ft higher than those in wells MV-4 and MV-5 that are screened outside the graben to the southeast (Figure 6). These results support that the southeast-bounding graben fault acts as a barrier to flow. The alluvial aquifer hydrographs were separated into two groups based on their screened location relative to the southeast-bounding graben fault.

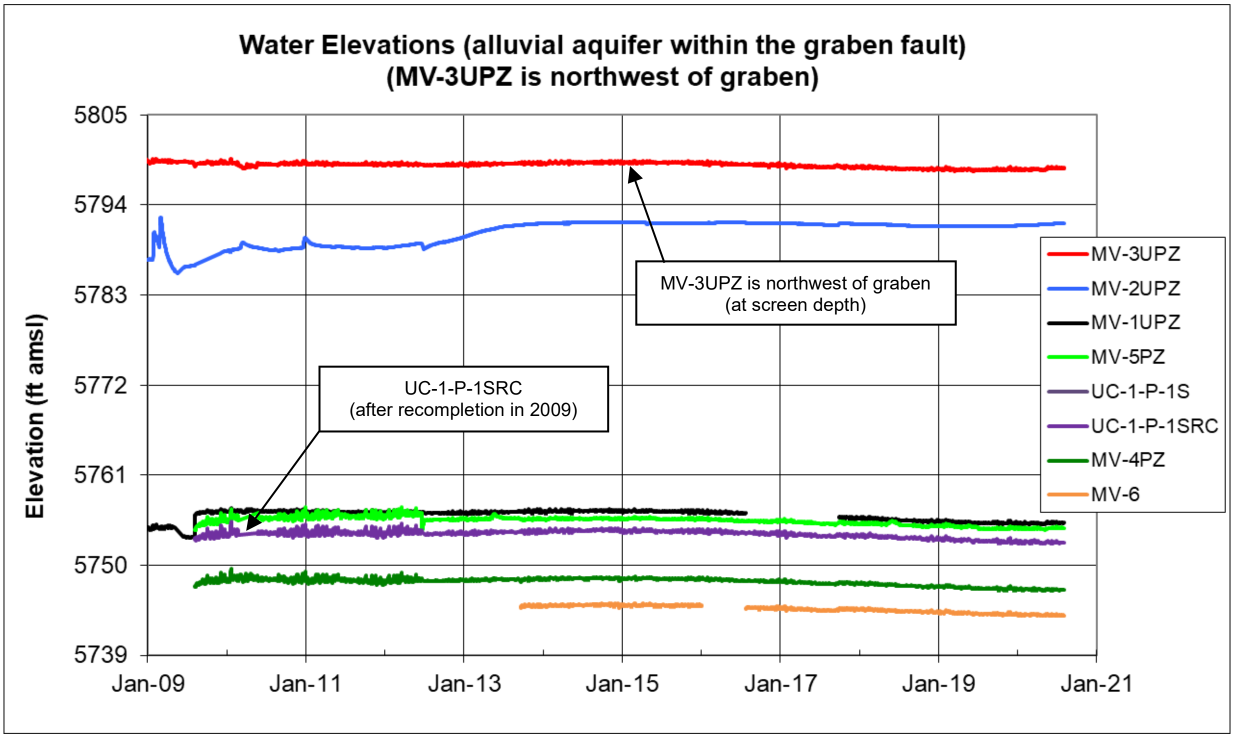


Figure 7. Water Elevations for the Alluvial Wells Northwest of the Southeast-Bounding Graben Fault

Figure 8 shows hydrographs from January 2009 through August 2020 of the piezometers and well with open intervals in the volcanic section near the detonation depth. Water elevations in these wells and piezometers have been declining since their installation in 2005; the exception is MV-1LPZ, which had a rising water elevation until 2011, then began to decline through 2018, and has now appeared to stabilize. Water elevations in MV-2LPZ have been decreasing since 2010 at about the same rate (about 5 ft per year) as the other wells and piezometers screened in the volcanic section. The declining water elevations (highest observed in the volcanic section) are attributed to a slow release of the detonation-related pressure response that persists due to the low permeability of the volcanic section. The highly variable water levels in the MV-2LPZ (Figure 8) are attributed to the proximity of the MV-2LPZ screened interval to the northwest-bounding graben fault. It is interpreted that water levels southeast of this fault (within the graben) are higher than water levels to the northwest, outside the graben at this depth. The abrupt water level decrease (MV-2LPZ) in mid-2009 followed by a recovery is attributed to a temporary leakage of more water or pressure to the lower fault block to the northwest. Water elevations in the MV-2LPZ are believed to have contributions from inside (southeast) and outside (northwest) the graben. The MV-2 well had to be screened above the MV-2LPZ because of drilling difficulties that are believed to be related to encountering the graben fault. Water levels in the MV-2 well (screened inside the graben) are higher than those in the MV-2LPZ and have also been steadily decreasing (Figure 8). The abrupt change in water levels in the MV-2LPZ do not have to be associated with significant water or pressure movement. The June 2010 spike up in water levels and the June 2012 spike down (both obvious with daily data) are attributable to the installation (2010) and subsequent removal (2012) of a direct-read transducer with a quarter-inch cable 200 ft below water. The slow recovery of water levels in the MV-2LPZ in response to what should be minor perturbations attests to the low permeability of the section.

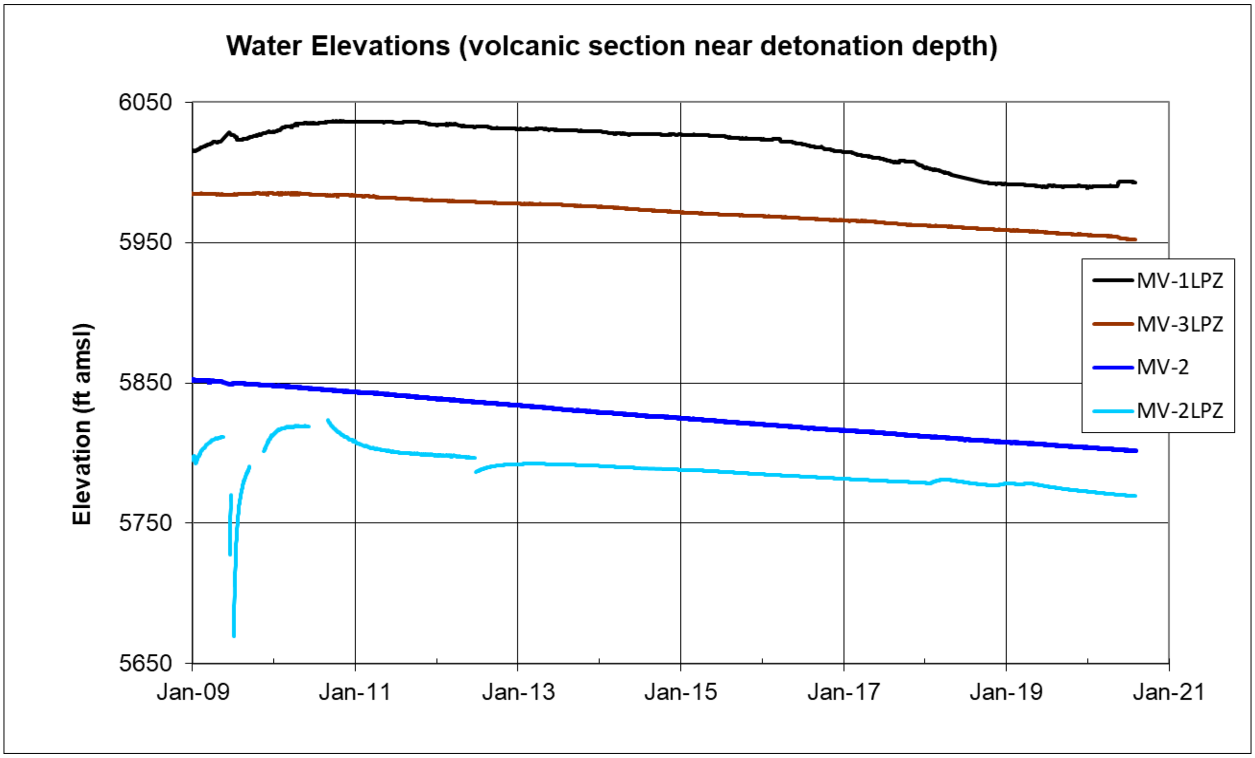
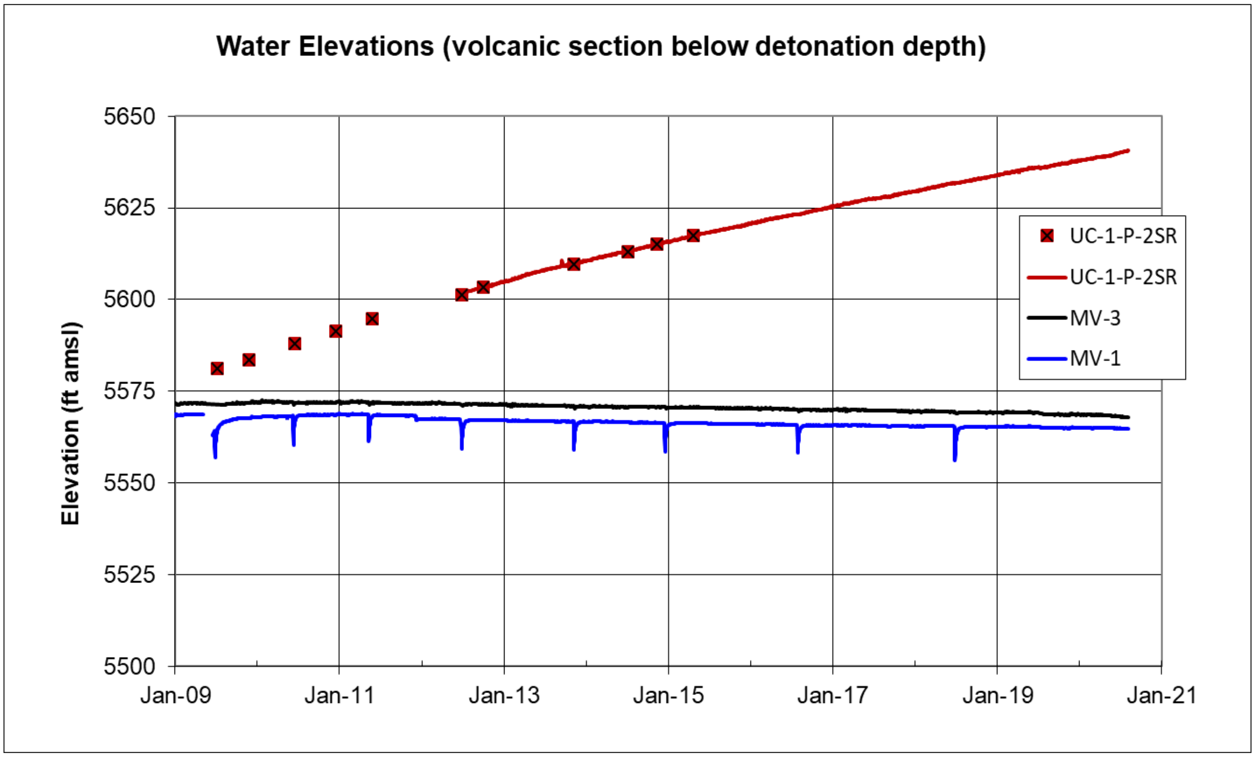


Figure 8. Water Elevations for the Well and Piezometers Screened in the Volcanic Section at or near the Depth of the Detonation

Figure 9 shows hydrographs from January 2009 through August 2020 of wells with open intervals below the detonation depth and reentry well UC-1-P-2SR. The composite water level from UC-1-P-2SR (chimney and alluvium overlying the former cavity) is higher than in the densely welded tuff units below the detonation zone. The composite water elevation of 5647 ft amsl measured in August 2021 (Table 4) continues to increase, though at a rate that is decreasing. Well UC-1-P-2SR has perforations as high as 1148 ft in the alluvium, and its water level is expected to eventually reach a steady-state elevation of approximately 5750 ft amsl (similar to other alluvial wells and piezometers within the graben). Well UC-1-P-2SR was evaluated during the August 2021 sampling event to assess flow within the well. This evaluation was conducted by DRI using their chem tool to log groundwater temperatures, pH, and specific conductance within the UC-1-P-2SR water column. It was determined during this evaluation that groundwater enters the well between the depths of 1420 and 1805 ft (elevations 4664 to 4279 ft amsl). The water entering the well moves upward and downward within the well. The water moving upward within the well exits the well between the depths of 1165 and 1270 ft (elevations 4919 to 4814 ft amsl) and the water moving downward exits the well between the depths of 1975 and 2060 ft (elevations 4109 and 4024 ft amsl). This groundwater movement within the well is consistent with data and interpretations obtained by DRI in 1997 and 2012 (DOE 2013). A copy of the DRI evaluation is provided as Appendix D.



Note: Water elevations for reentry well UC-1-P-2SR (drilled into the chimney) are shown for reference.

Figure 9. Water Elevations for the Wells Screened in the Volcanic Section Below the Detonation Depth

A potentiometric map of the upper part of the alluvial aquifer within the graben (Figure 10) was constructed using August 2020 water levels from MV-4PZ, MV-5PZ, MV-6, UC-1-P-1SRC, MV-1UPZ, and MV-2UPZ. These locations are screened at depths ranging from 600 to 1000 ft. Given that the faults act as barriers to flow, there are not enough data points to extend the map beyond the graben (MV-3UPZ is northwest of the graben, while HTH-2 and HTH-1UPZ are southeast of the graben). Groundwater elevations for the locations outside the graben are provided on Figure 10 for comparison with upper alluvial groundwater elevations within the graben. Contours near SGZ are based on the composite water level from well UC-1-P-2SR. The interpretation seen in Figure 10 suggests that horizontal flow in the upper alluvium is toward the chimney near SGZ. Away from the chimney's influence, horizontal flow is east–southeast and likely deflected by the southeast-bounding graben fault that is acting as a barrier to flow. As drawn, the contours indicate that groundwater flow near well MV-6 is toward the west. This is influenced by the lower groundwater elevation in well UC-1-P-2SR, which is still recovering from the detonation. Depiction of groundwater flow directions within the graben has an inherent degree of uncertainty, given the structural complexity caused by the detonation and the limited data available within the graben near the detonation.

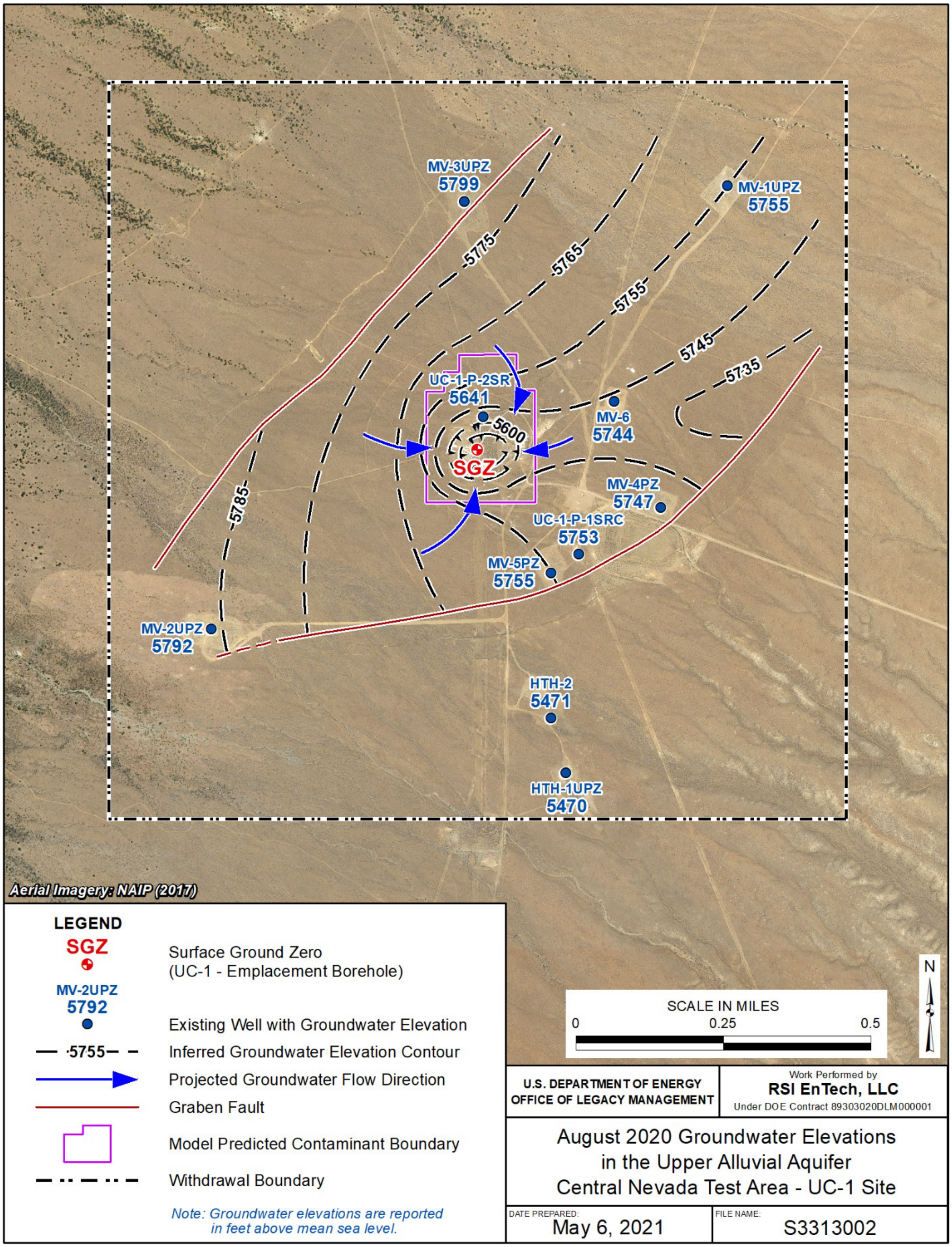


Figure 10. August 2020 Groundwater Elevations in the Upper Alluvial Aquifer CNTA–UC-1 Site

4.4 Radioisotope Monitoring

The Closure Report (DOE 2018) establishes the monitoring network and sampling frequency for the radioisotopes of interest (Table 2). The monitoring network is designed to monitor both the most likely transport path (i.e., the densely welded tuff near and below the source zone) and the most likely access path (i.e., the higher-permeability alluvial aquifer above the source zone). Since the alluvial unit is the most likely access path and has the highest groundwater velocities, the monitoring network wells completed in the alluvium are sampled more often than the wells completed in the low-permeability, densely welded tuff units. Starting in 2020, sampling is conducted every 3 years. Water samples are collected according to procedures specified in the SAP. Discharge and handling of monitoring well purge water is conducted in accordance with the *Fluid Management Plan, Central Nevada Test Area, Corrective Action Unit 443* (DOE 2009).

The radioisotopes of interest for the long-term postclosure monitoring program are tritium, ^{14}C, and ^{129}I (DOE 2018). Water samples will be analyzed for tritium during each scheduled sampling event. Water samples collected in 2020 were also analyzed for ^{14}C and ^{129}I (Table 2). These radioisotopes will be included in the analytical suite every 12 years starting in 2020. Tritium is currently the primary radioisotope of concern because of its initial abundance and mobility. After a few hundred years, tritium (with a half-life of 12.3 years) will decay to insignificant levels, and the longer-lived radioisotopes, ^{14}C (with a 5730-year half-life) and ^{129}I (with a 1.57×10^7-year half-life), will become the primary focus of the long-term postclosure monitoring. The Closure Report established compliance levels and laboratory-required MDCs for the radioisotopes of interest (tritium, ^{14}C, and ^{129}I) that were used to establish action levels) for the long-term postclosure monitoring program (DOE 2018). It also established the sampling frequency for the radioisotopes of interest as provided in Table 2 (DOE 2018).

4.5 Radioisotope Results

Groundwater samples were collected from wells completed in the alluvium and volcanic section during the postclosure sampling event conducted August 4–6, 2020, and August 18–19, 2021 (Table 5). The monitoring wells MV-1, MV-2, MV-3, MV-4, MV-5, and HTH-1RC are completed with bladder pumps and were purged to remove stagnant water from the pump tubing before sample collection. Monitoring wells MV-6 and UC-1-P-1SRC were purged before sampling using the dedicated electric submersible pumps. Field parameters (temperature, pH, and specific conductance) were allowed to stabilize before samples were collected. The piezometers MV-1UPZ and MV-4PZ and reentry well UC-1-P-2SR and well HTH-2 were sampled using a depth discrete bailer. Samples were collected from the piezometers MV-1UPZ and MV-4PZ from the approximate middle of the screened intervals at depths of 900 ft and 940 ft, respectively. Samples were collected from the reentry well UC-1-P-2SR from depths of 780 ft, 1200 ft, 1591 ft, and 2192 ft and from well HTH-2 at a depth of 850 ft. The samples from well HTH-2 and the 2192 ft sample interval in well UC-1-P-2SR were collected in August 2021 (see Section 4.1 for details). Table C-1 in Appendix C provides the field parameters from the 2020 and 2021 sampling events.

Table 5. Monitoring Network with August 2020 and August 2021 Laboratory Results

Monitoring Wells / Piezometers	Date Sampled	Tritium (pCi/L)	^{14}C (pCi/L)	^{129}I (pCi/L)	Lithologic Unit Monitored	
MV-1UPZ	8/5/2020	<MDC	<MDC	<MDC	Upper	Alluvium
MV-2UPZ						
MV-3UPZ						
MV-4PZ	8/5/2020	<MDC	<MDC	<MDC		
MV-5PZ						
MV-6	8/4/2020	<MDC	<MDC	<MDC		
UC-1-P-1SRC	8/4/2020	<MDC	<MDC	<MDC		
UC-1-P-2SR (depth 780 ft)	8/6/2020	2926	<MDC	<MDC		
UC-1-P-2SR (depth 1200 ft)	8/6/2020	3040	<MDC	<MDC		
HTH-2	8/18/2021	<MDC	<MDC	<MDC		
HTH-1UPZ						
HTH-1LPZ					Lower	
MV-4	8/4/2020	<MDC	<MDC	<MDC		
MV-5	8/6/2020	<MDC	<MDC	<MDC		
UC-1-P-2SR (depth 1591 ft)	8/6/2020	2958	<MDC	<MDC	Chimney	
UC-1-P-2SR (depth 2192 ft)	8/19/2021	105,100 / 95,694[a]	<MDC	<MDC		Volcanic
MV-1LPZ					Tuffaceous sediments	
MV-3LPZ						
MV-1	8/5/2020	<MDC	<MDC	<MDC	Densely welded tuff	
MV-2LPZ						
MV-2	8/5/2020	<MDC	<MDC	<MDC		
MV-3	8/6/2020	<MDC	<MDC	<MDC		
HTH-1RC	8/6/2020	<MDC / <MDC[a]	<MDC	<MDC		

Notes:
Shaded cells were not sampled because they were not part of the sampling network for this scheduled sampling event as established in Table 2 of the Closure Report (DOE 2018).
[a] Duplicate sample.

Abbreviation:
<MDC = below laboratory-required MDC (400 pCi/L for tritium, 5 pCi/L for ^{14}C, and 0.1 pCi/L for ^{129}I [DOE 2018])

Groundwater samples collected during the August 2020 and August 2021 sampling events were analyzed for tritium, ^{14}C, and ^{129}I. Laboratory results indicate that tritium concentrations were below the laboratory-required MDC at all the sampled locations except the reentry well UC-1-P-2SR (Table 5). The reentry well is a near-field monitoring well that is completed in the chimney, so the tritium concentrations in this well are expected and consistent with past results. Tritium concentrations at the sample depths of 780 ft, 1200 ft, and 1591 ft are below the MCL of 20,000 pCi/L, so no action is required. The sample collected and analyzed for tritium at the 2192 ft sample depth was above the MCL, but no action is required as per Table 4 of the Closure Report (DOE 2018). The concentrations at the three shallowest depths (780 ft, 1200 ft, and 1591 ft) are similar, indicating that mixing is occurring within the well and chimney at these intervals and that the higher concentrations at the deepest sampled depth (2192 ft) are not migrating upward (Table 5). This interpretation is supported by the flow logs completed by DRI that indicate a downward component of flow within the reentry well UC-1-P-2SR (Appendix D). Tritium concentrations are also decreasing with time, which is expected because the half-life of tritium is 12.3 years. Additionally, the sampled locations were analyzed for ^{14}C and ^{129}I and were below the established action levels, which is also consistent with past results. The laboratory analytical results were validated in accordance with Section 5.0, "Validation of Laboratory Data," in the *Environmental Data Validation Procedure* (LMS/PRO/S15870). All analyses were completed, and the samples were prepared and analyzed in accordance with accepted procedures that were based on the specified methods. The laboratory radiochemical MDC reported with these data are a priori estimates of the detection capability of a given analytical procedure, not an absolute concentration that can or cannot be detected. Copies of the Data Validation Memorandums are available upon request. Laboratory analytical results collected during this and previous monitoring events are available on the GEMS website at https://gems.lm.doe.gov/#site=CNT.

5.0 Summary and Recommendations

Site inspections were conducted in June 2019 and August 2020 as part of the annual site monitoring, and a second sampling event was conducted in August 2021. At the time of inspections, the UC-1 site features (roads, wellheads, and the UC-1 monument plaque at SGZ) all appeared to be in good condition, and no unusual ground disturbances were observed. The concrete cap that covers the UC-4 borehole had some deterioration from weathering, but it remains protective because a steel plate covers the borehole beneath the concrete cap. No groundwater wells or oil and gas well permits were granted within 5 miles of the UC-1 site during this monitoring period.

The sample analytical results indicate tritium was not detected above the laboratory-required MDC at any of the sampled locations except at the reentry well UC-1-P-2SR. The reentry well is a near-field monitoring well that monitors the chimney, so the tritium concentrations in this well are expected. The tritium concentrations at the sample depths (780, 1200, 1591, and 2192 ft) in this well are consistent with past results and no action is required as per Table 4 of the Closure Report (DOE 2018). The samples (August 2020 and August 2021) were also analyzed for ^{14}C and ^{129}I and results were below the established action levels, which is consistent with past data. Water elevations continue to support the interpretations of flow directions and the adequacy of the monitoring network at the site. Water levels in the reentry well UC-1-P-2SR continue to recover from the dewatering effects of the detonation. The currently depressed water levels in this area direct groundwater flow in the alluvial aquifer near SGZ toward the chimney. In the volcanic section, water levels from well UC-1-P-2SR also indicate a downward vertical gradient from the source zone to the densely welded tuff units below the detonation depth. The current downward vertical gradient from the chimney to the underlying volcanic section will increase as water levels continue to recover in the chimney. This interpretation is supported by the flow log data collected by DRI that indicate a downward component of flow within the reentry well UC-1-P-2SR. Water level data from the MV-4PZ and MV-5PZ piezometers (screened inside the graben) and MV-4 and MV-5 wells (screened outside the graben) continue to confirm that the southeast-bounding graben fault acts as a barrier to groundwater flow. The sample results, along with the water level monitoring results, support the determination that radioisotopes of interest have not migrated outside the compliance boundary.

LM recommends the following:

- Conduct the annual site inspections as prescribed in the Closure Report.
- Conduct the next postclosure groundwater sampling event in 2023 as prescribed in the Closure Report.
- Complete the next Postclosure Groundwater Monitoring and Inspection Report (2020 through 2023) after the sampling in 2023 as prescribed in the Closure Report.

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Appendix A

Photographic Documentation

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Figure A-1. Concrete Cap That Covers the UC-3 Borehole (August 2020)

Figure A-2. Concrete Cap That Covers the UC-4 Borehole (June 2019)

Figure A-3. Concrete Cap That Covers the UC-4 Borehole (August 2020)

Figure A-4. UC-1 Monument Plaque on the Emplacement Borehole Casing (June 2019)

Figure A-5. UC-1 Monument Plaque on the Emplacement Borehole Casing (August 2020)

Figure A-6. UC-1 Monument Plaque on the Emplacement Borehole Casing (August 2020)

Figure A-7. Bailer Recovered from Well UC-1-P-2SR (July 2021)

Appendix B

Hydrographs of Water Elevation Data: 2007 Through August 2020

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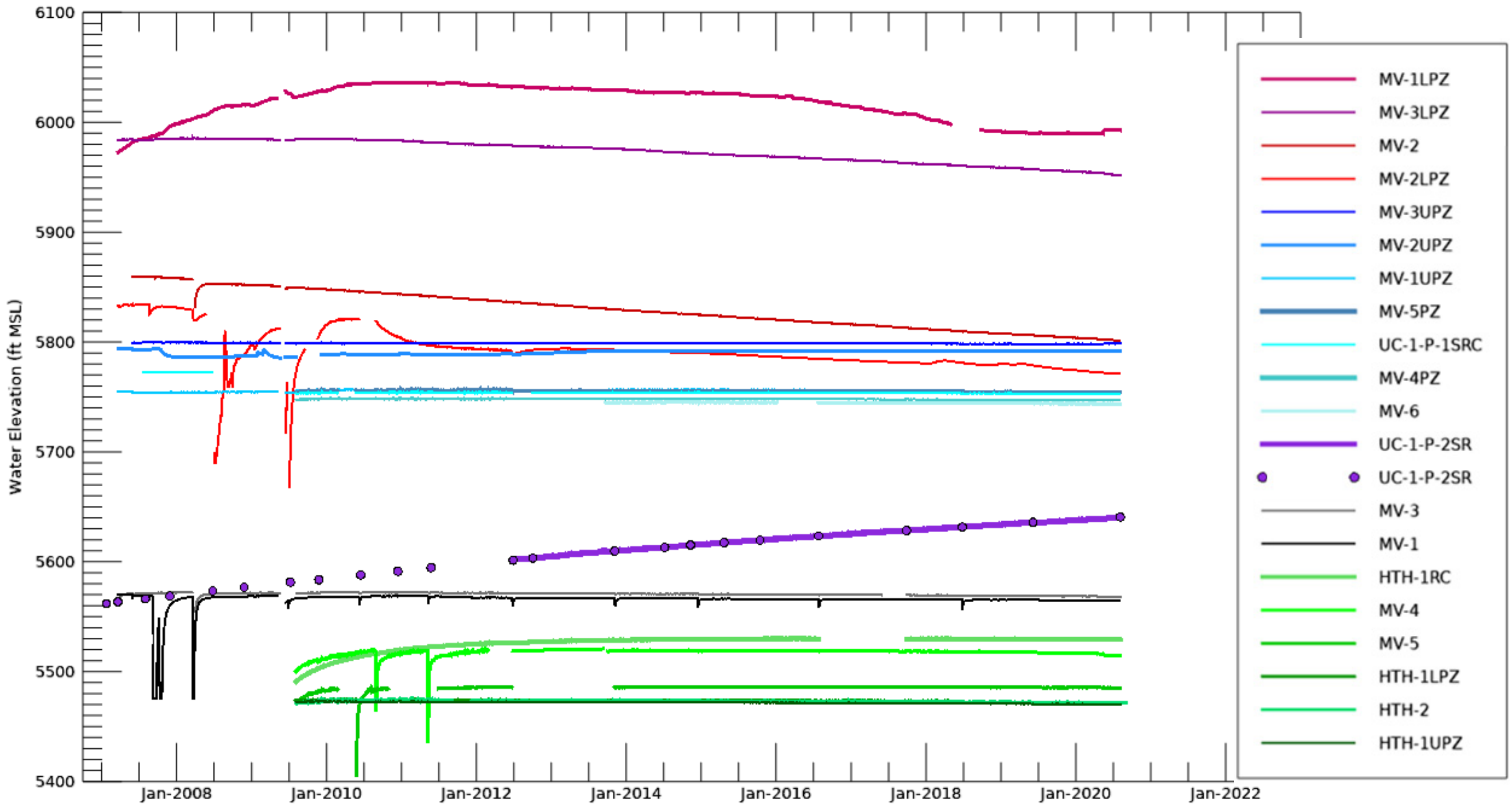
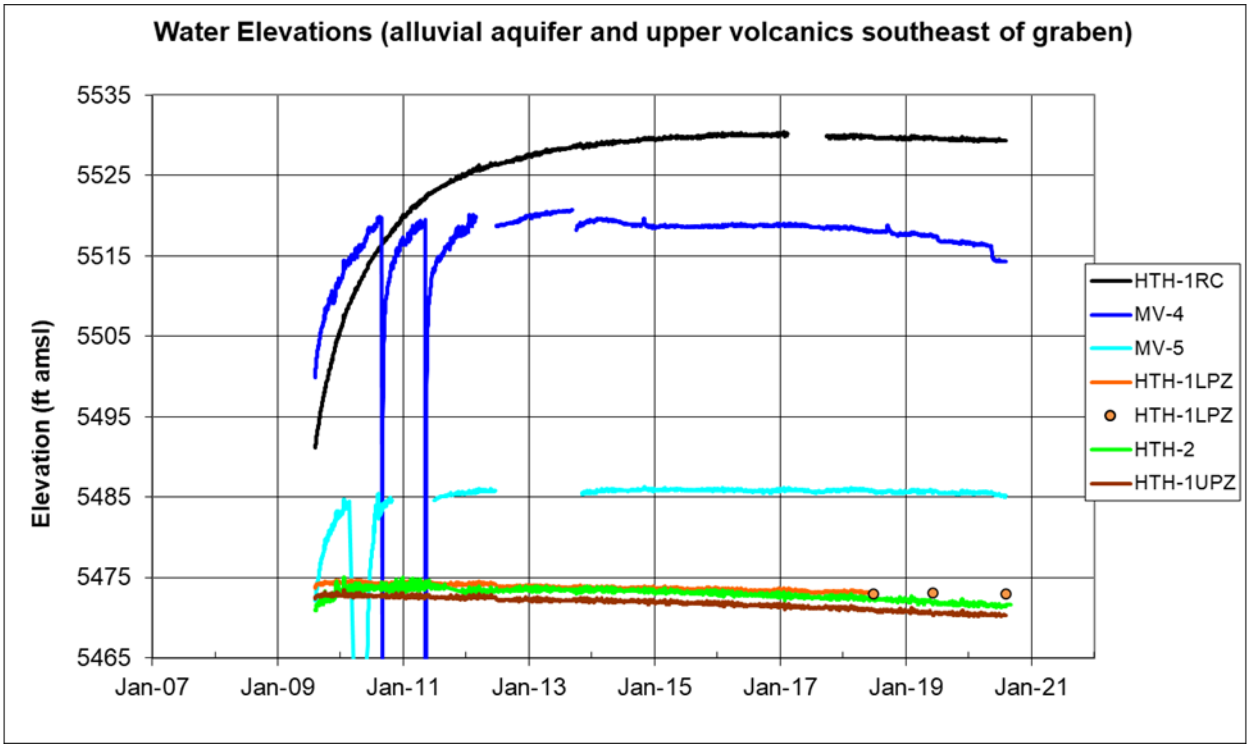


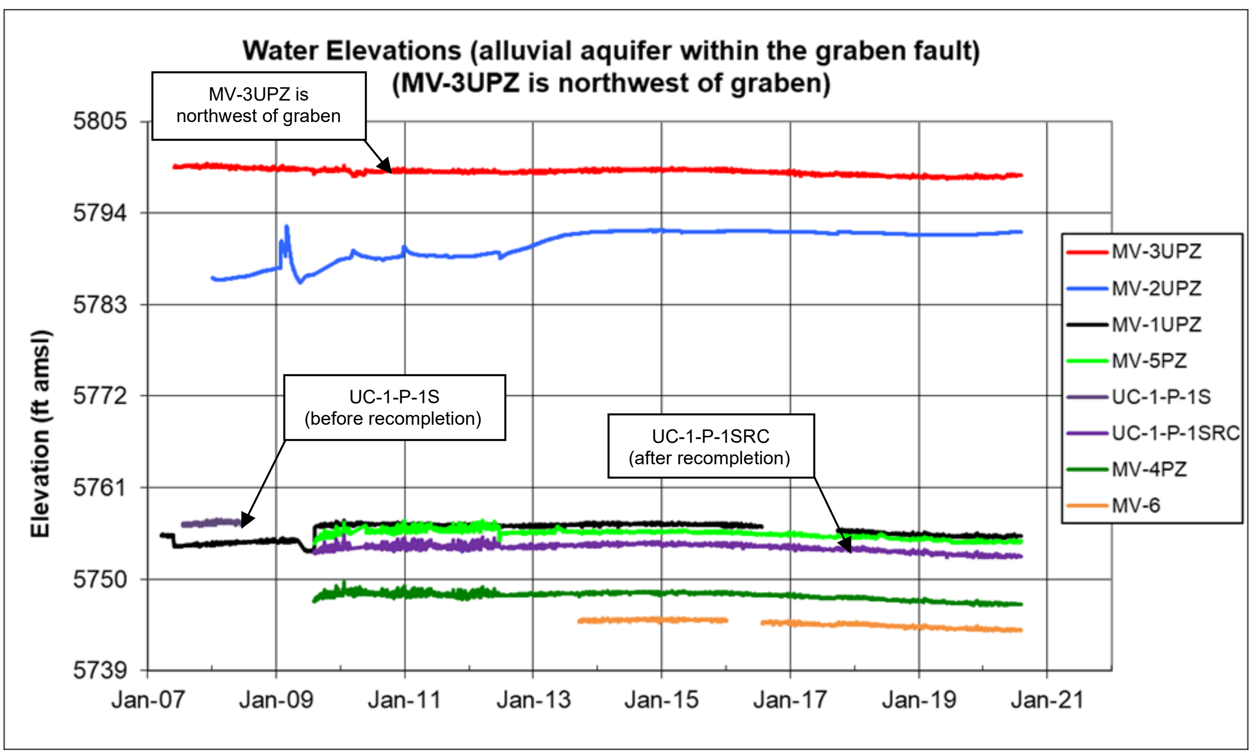
Notes: Greens = alluvium southeast of graben, blues = alluvium inside graben, reds = detonation depth, blacks = below detonation depth. Water depths collected using a water level tool appear as individual symbols, and water depths collected with transducers appear as lines.

Figure B-1. Water Level Elevations for All Wells and Piezometers



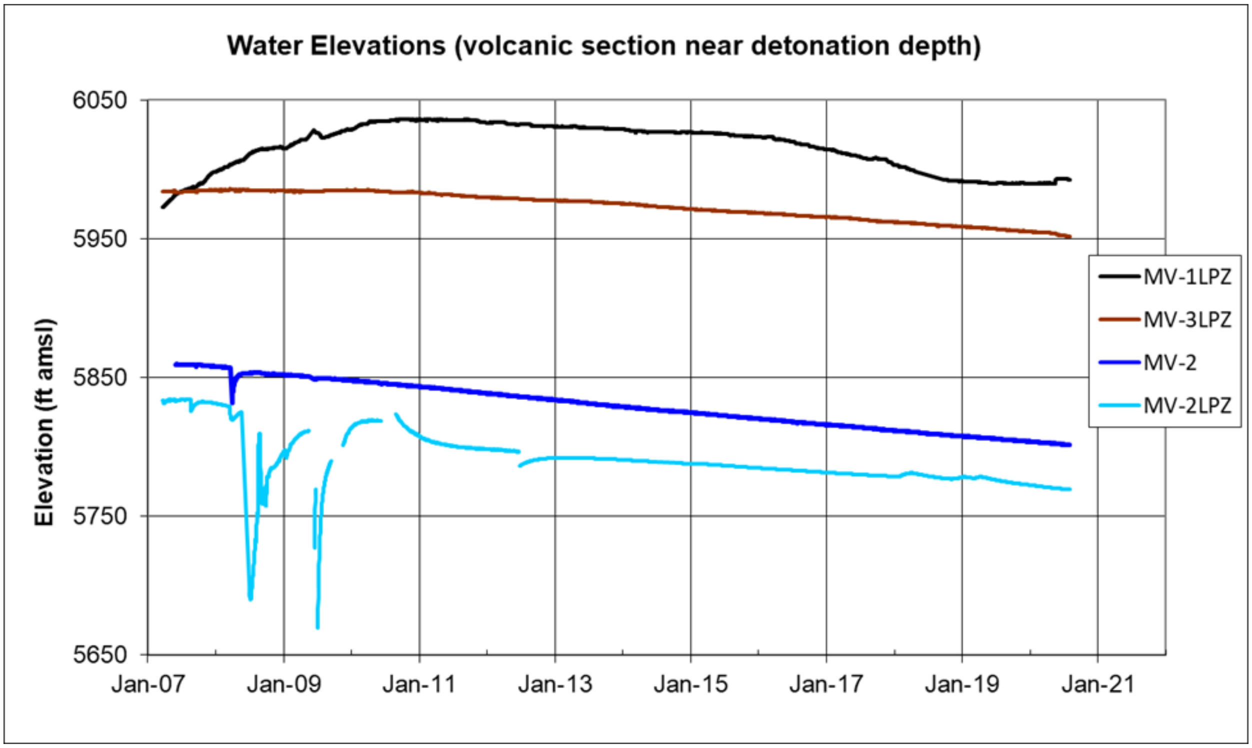
Note: Water depths collected using a water level tool appear as individual symbols, and water depths collected with transducers appear as lines.

Figure B-2. Water Level Elevations for Alluvial Wells and Well HTH-1RC (Upper Volcanics) Southeast of the Down-Dropped Graben at the Screened Horizon



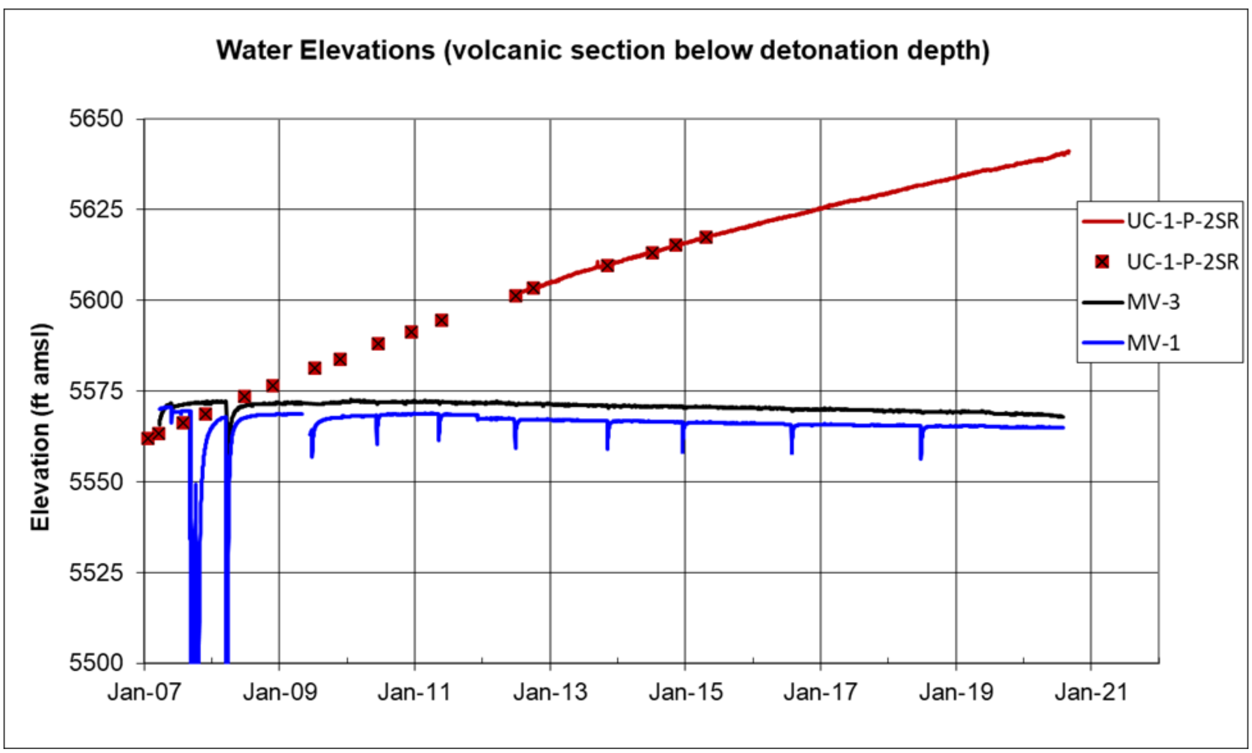
Note: Water depths collected using transducers appear as lines.

Figure B-3. Water Level Elevations for Alluvial Wells Northwest of the Southeast-Bounding Graben Fault



Note: Water depths collected using transducers appear as lines.

Figure B-4. Water Level Elevations for the Well and Piezometers Screened in the Volcanic Section at or near the Level of the Detonation



Note: Water depths collected using a water level tool appear as individual symbols, and water depths collected with transducers appear as lines.

Figure B-5. Water Level Elevations for Wells Screened in the Volcanic Section Below the Level of the Detonation

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Appendix C

Well Purge Data

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Table C-1. Monitoring Well Purge Data

Well Identification	Date Sampled	Purged Volume (gallons)	Temperature (°C)	pH (s.u.)	Specific Conductance (µmho/cm)
HTH-1RC	8/6/2020	6.7	16.8	8.09	605
HTH-2[b]	8/18/2021	0.26	20.2	7.19	340
MV-1	8/5/2020	9.6	17.6	9.37	631
MV-1UPZ[a]	8/6/2020	1.06	18.6	8.41	306
MV-2	8/5/2020	8	17.1	9.86	1415
MV-3	8/6/2020	10.1	21.3	7.31	939
MV-4	8/4/2020	5.5	18.8	9.67	385
MV-4PZ[a]	8/5/2020	1.06	18.7	8.04	175
MV-5	8/6/2020	5.1	18.3	9.78	516
MV-6	8/4/2020	1260	21.5	7.44	230
			21.6	7.40	228
			21.4	7.42	222
UC-1-P-1SRC	8/4/2020	820	21.2	7.26	325
			21.1	7.26	323
			21.2	7.26	321
UC-1-P-2SR (780 ft)[a]	8/6/2020	1.06	19.0	9.43	332
UC-1-P-2SR (1200 ft)[a]	8/6/2020	1.06	20.6	9.39	328
UC-1-P-2SR (1591 ft)[a]	8/6/2020	1.06	21.7	9.15	325
UC-1-P-2SR (2192 ft)[b]	8/19/2021	0.26	18.0	8.98	473

Notes:
[a] Sample collected with a bailer (4-liter volume or 1.06 gallons).
[b] Sample collected with a bailer (1-liter volume or 0.26 gallon).

Abbreviations:
°C = degrees Celsius
µmho/cm = micromhos per centimeter
s.u. = standard unit

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Appendix D

Desert Research Institute (DRI) Chem Tool Log Evaluation for Reentry Well UC-1-P-2SR

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Task Update: DRI Discrete-Interval Well Sampling and Hydrochemical Well Logging at the Central Nevada Test Area – August 2021

Personnel: Kevin Heintz and Brad Lyles

On August 18, 2021, the Desert Research Institute (DRI) mobilized to the Central Nevada Test Area (CNTA), approximately 70 miles (110 kilometers) northeast of Tonopah, Nevada, in Hot Creek Valley. DRI was tasked to bail depth-discrete water samples from well HTH-2 and reentry well UC-1-P-2SR and to perform a hydrochemical log in well UC-1-P-2SR. Well construction details are provided in Table 1. Reported depths for UC-1-P-2SR are measured along the borehole (i.e., 'slant depth'), not true vertical depth.

DRI personnel arrived onsite and met with RSI EnTech, LLC (RSI), personnel (Rick Findlay, Jeff Price, Tom Maveal, and Tony Franzone) and with U.S. Department of Energy (DOE) CNTA Site Manager Meghann Hurt.

Well HTH-2 was evaluated first on August 18, 2021; two 1-liter water samples were collected from a depth of 850 feet (ft) below land surface (bls). The wireline and bailer were decontaminated on the final trip out of the well.

RSI personnel performed a video survey of well UC-1-P-2SR on the morning of August 18, 2021. The survey was conducted to 1820 ft bls, which is the downhole extent of the camera. DRI reviewed the video to evaluate the condition of the well casing where their bailer had been stuck (1755 ft bls) before well logging. Generally, the well appeared to be in good condition, with a few observations. There was an object (perhaps a flake of rust)[1] approximately 3 inches long × 1 inch wide × 0.25 inch thick at 1756 ft bls that had to be pushed down the well by the video camera, suggesting that the slope of the casing may have changed. The object finally disappeared from the camera view at about 1767 ft bls, possibly due to another change in casing slope. There was another unknown object (possibly a piece of steel or the flake of rust previously identified) approximately 3 inches long × 0.5 inch wide × 0.25 inch thick stuck to the upper part of the casing at about 1776 ft bls. The camera followed the low side of the casing and slid under the object. Discussions between RSI, DOE, and DRI concluded that it would be safe to evaluate the well with a sinker bar. A sinker bar (67.5 inches long × 1.75 inches in diameter, and approximately 40 pounds) was run into the well to a depth of 2203.5 ft bls with no problems.

On August 19, 2021, at well UC-1-P-2SR, DRI lowered the 1-liter discrete sampler to 2192 ft bls, electrically opened the sample port for 5 minutes to allow the bailer to fill, electrically closed the sample port, and retrieved the fluid sample from the well. Samples were

[1] The flake of rust was identified in the well at 1725 ft bls when it slid past the camera. It got hung up in the well at 1733 ft bls and the camera was able to get past it. The flake of rust slid past the camera again at 1755 ft bls but got hung up at 1756 ft bls. Further description is provided in the text above.

removed from the bottom of the bailer into sample containers supplied by RSI. This process was repeated three times to provide enough fluid. The bailer was decontaminated, and an equipment blank was collected by RSI.

Table 1: Construction details of wells sampled during the August 2021 field campaign.

Well Identification	Sample Depth (ft)	Sample Time (PDT)	Total Sample Volume	Casing Length (ft bls)	Casing Type
HTH-2	850	11:51 12:32	2 liters	-2.5 – 688	3-inch ID drop pipe
UC-1-P-2SR	2192	08:58 09:53 10:43	3 liters	222 – 1150	13.375-inch OD
				1150 – 1950	9.625-inch OD
				1150 – 2792	5.5-inch OD

Abbreviations:
ID = inner diameter
OD = outer diameter
PDT = Pacific Daylight Time

The Idronaut chemistry logging tool #4988 was rigged up later on August 19, 2021, at well UC-1-P-2SR. Pre-log calibration of temperature, electrical conductivity (EC) and pH sensors was performed. The water level was tagged at 439.41 ft bls. To ensure that the logging tool made it through the 1750 ft bls zone (i.e., the zone where the borehole deviation increases), the tool was lowered at full speed (125 feet per minute [ft/min]). The well was logged downward from the water table to 2193.5 ft bls. A standard logging rate of 50 ft/min was used on the way out of the well; the upward chemistry log was performed from 2193.5 ft bls to the water table. A post-log calibration check was performed for temperature, EC, and pH; all were within acceptable limits.

The wireline was decontaminated during the final trip from the well, and the chemistry logging tool was also decontaminated with deionized (DI) water.

Equipment Used and Protocols Followed

DRI personnel used a Comprobe winch (Comprobe Inc., Fort Worth, Texas) with a four-conductor wireline approximately 3500 ft (1524 meters) in length. The drawworks was mounted to an enclosed cargo trailer and powered by a 5-kilowatt portable generator. The wireline was coupled to a MATRIX data acquisition system (Mount Sopris Instruments, Denver, Colorado), which powered downhole tools and enables communication with numerous geophysical logging tools. The MATRIX controlled the operation of the Comprobe bailer motor by opening and closing a piston at a specific depth.

Field operations adhered to the job safety analysis (JSA) “Environmental Monitoring Operations at LM Sites” (JSA No. LMS-0720-02) and the standard operating procedures for groundwater sampling in the *Standard Operating Procedure for Using the Discrete Groundwater Sampling Tool* (DRI 2016). All bailing equipment and wireline had been decontaminated prior to mobilization to the CNTA. The wetted wireline (i.e., the portion of the wireline that was submerged in water) plus an additional 100 ft (30 meters), the wireline cablehead, and the downhole tools were decontaminated with a DI water rinse after each activity in a given well. Additionally, the bailer motor and the bailer body were decontaminated between samples with nonphosphate detergent and DI water.

Sample Acquisition Details

DRI deployed a 1-liter bailer to collect samples in wells HTH-2 and UC-1-P-2SR. The bailer with a closed inlet valve was lowered to the specific depth and then energized to open the valve. The valve was closed after sufficient time had elapsed to fill the bailer (approximately 5 minutes), and then the bailer was brought out of the well. The valve was re-opened approximately 30 ft bls to depressurize the bailer. Sample water from wells HTH-2 and UC-1-P-2SR was visually observed as clear. Water samples were collected from the bailer by RSI personnel.

Observations

Chemistry logging results for the upward log of well UC-1-P-2SR are shown in Figure 1. The downward log was run at a higher-than-normal rate, and sensors did not fully equilibrate to borehole conditions. The temperature log shows changes from the geothermal gradient at two depth zones, 1165 ft bls and 1975 ft bls, as illustrated in Figure 2. The thermal gradient was computed at each log measurement point by subtracting the temperature 50 ft below the measurement point from the temperature 50 ft above the measurement point, then dividing by 100 ft (the measurement depth difference); therefore, the thermal gradient could not be computed for the top 50 ft or bottom 50 ft of the log. The temperature was nearly constant from 1460 to 1810 ft bls. The electrical conductivity was virtually uniform between 1120 to 1940 ft bls, indicating active vertical flow. Likewise, pH was relatively unchanged in the zone from 1120 to 1940 ft bls. Figure 2 shows that water is leaving the well in two zones: the upper zone between 1165 and 1270 ft bls and the lower zone between 1975 to 2060 ft bls. The inflow zone is harder to identify from the temperature log but is most likely between 1420 and 1805 ft bls. The water entering the well in the inflow zone moves both upward and downward in the well. The upward moving water exits the well in the upper outflow zone between 1165 and 1270 ft bls, and the downward moving water exits in the lower outflow zone between 1975 and 2060 ft bls. This is the same pattern that was observed in 1997 and 2012 when the thermal flow meter (also called TFM) logging tool was run in the well.

Temperature logs have been performed by DRI in well UC-1-P-2SR seven times from 1992 to 2021. The log results are similar, as shown in Figure 3, except for the log from 2012. Past field activities and data collection/analysis for UC-1-P-2SR are summarized in Lyles and Chapman (2012). The 2012 log was performed with a backup tool when the primary tool failed. Although the trend from this log is similar to other logs, it stands out as having electronic noise and, potentially, a bad calibration. No temperature logs have been performed to the total depth (2615 ft bls) of the well since 1997; therefore, it is not possible to determine if the bottom hole temperature is cooling as expected. However, a comparison of the temperature logs in 1997 and 2021 shows the temperature at 2190 ft bls has increased about 1 °C since 1997. The remainder of the 2021 log is about 0.2 °C degrees warmer than the 1997 log, most likely because of calibration differences (see Figure 4). This small change in temperature at 2190 ft bls may indicate temperature changes lower in the well (i.e., from 2190 to 2615 ft bls), but this does not appear to have changed the vertical flow in the well.

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Lyles, B., and J. Chapman, 2012. "Summary of Field Activities at the Central Nevada Test Area, Faultless Site," June 26–28, 2012, Appendix C in *2012 Groundwater Monitoring Report, Central Nevada Test Area, Subsurface Corrective Action Unit 443*, LMS/CNT/S09647, Office of Legacy Management, April.

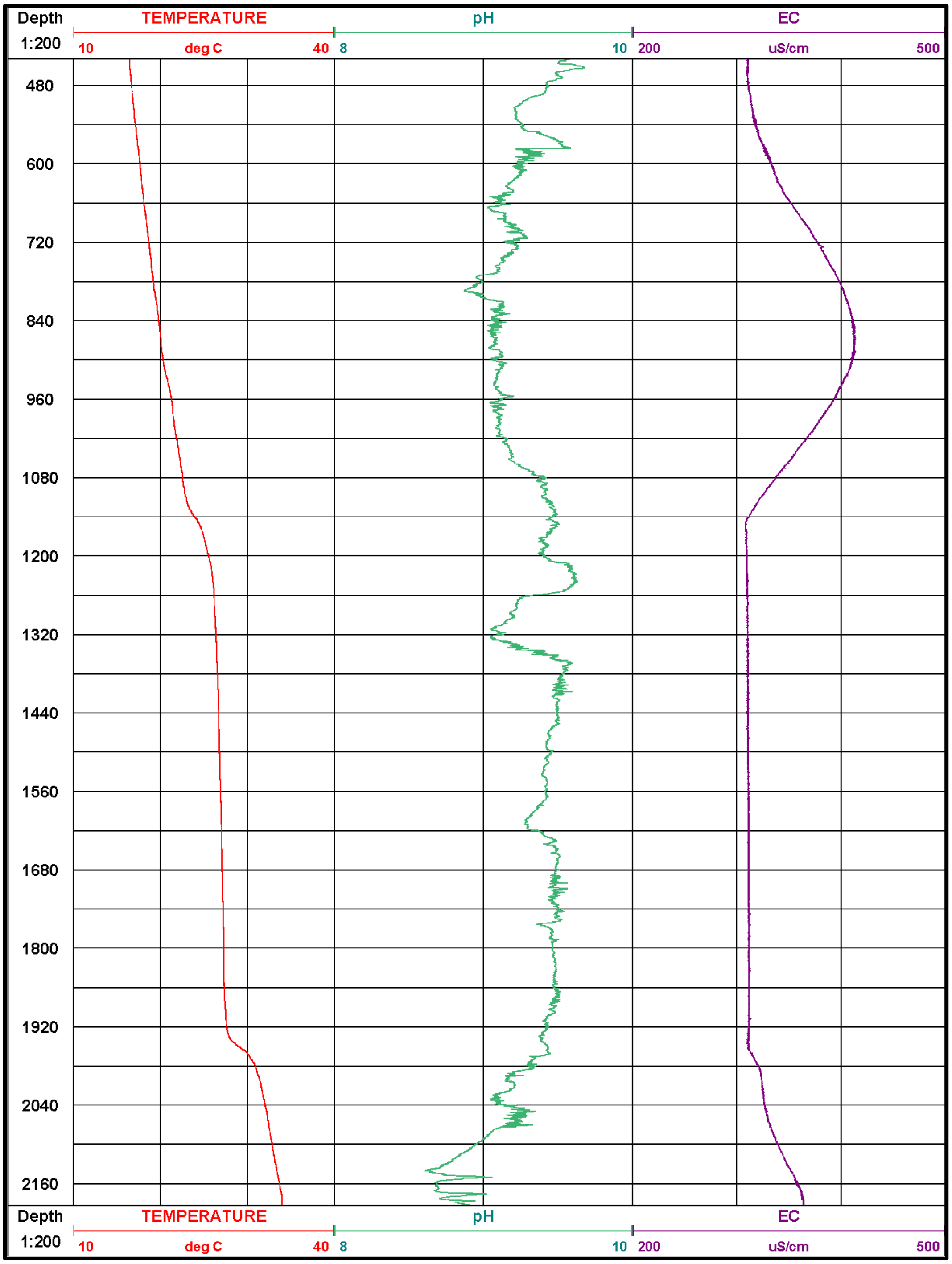


Figure 1. Well UC-1-P-2SR chemistry well logging results of the upward log, August 19, 2021.

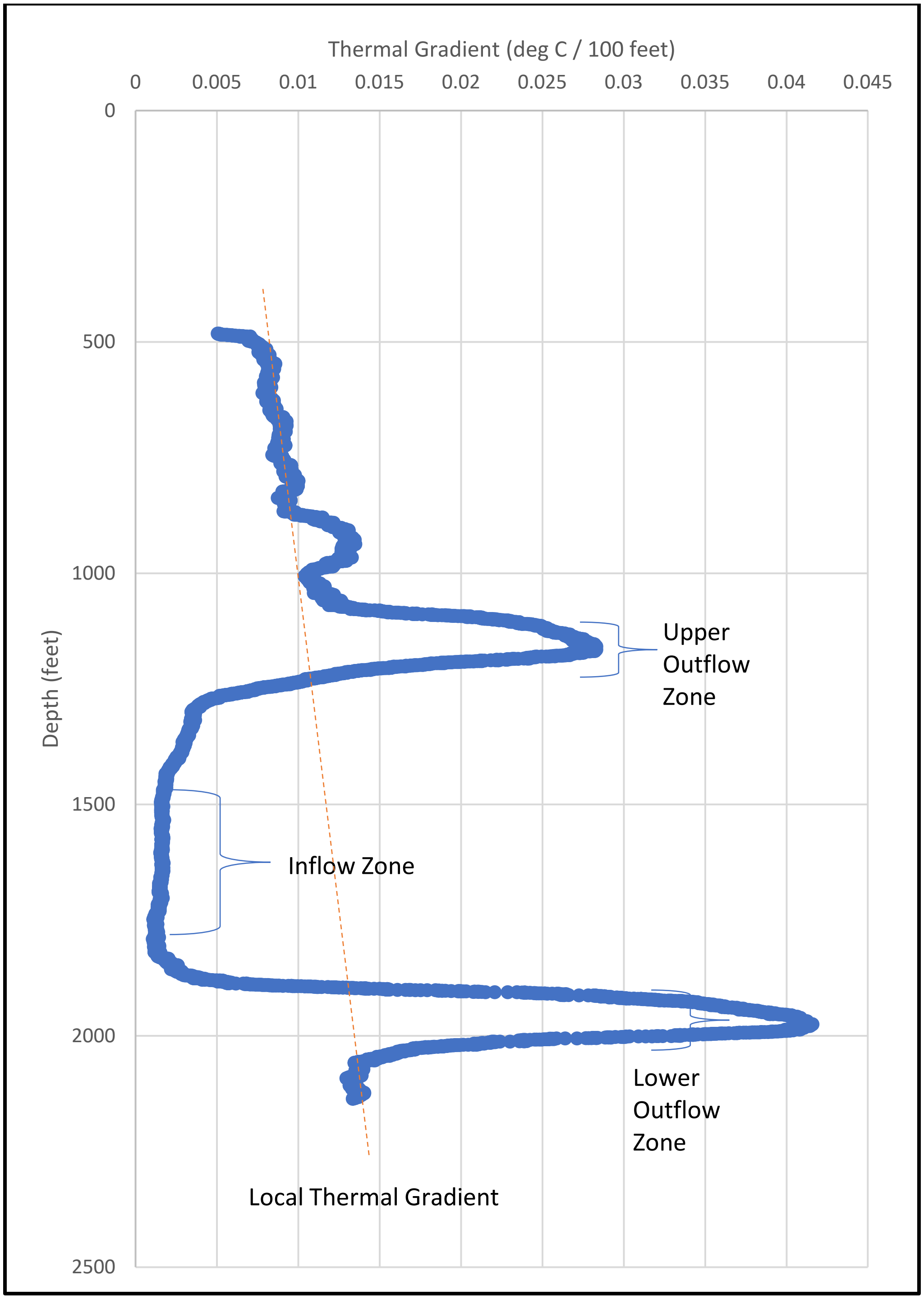
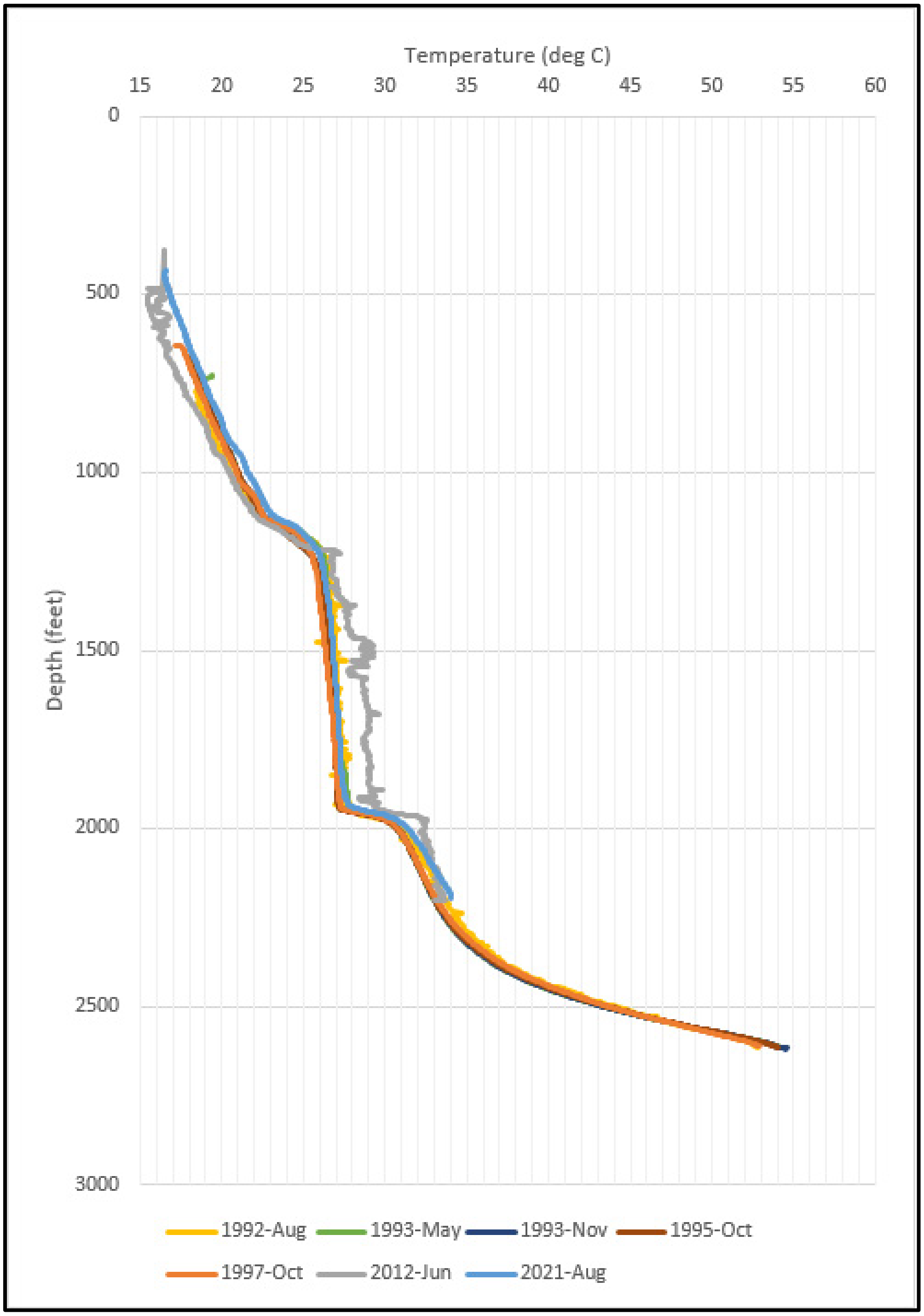


Figure 2. Well UC-1-P-2SR thermal gradient from upward temperature log results. (Brackets indicate potential inflow and outflow zones, and the red dashed line shows the local thermal gradient.)



Abbreviation: µS/cm = microsiemens per centimeter

Figure 3. Well UC-1-P-2SR temperature log comparison from 1992 to 2021.
(The upward log is shown for August 2021).

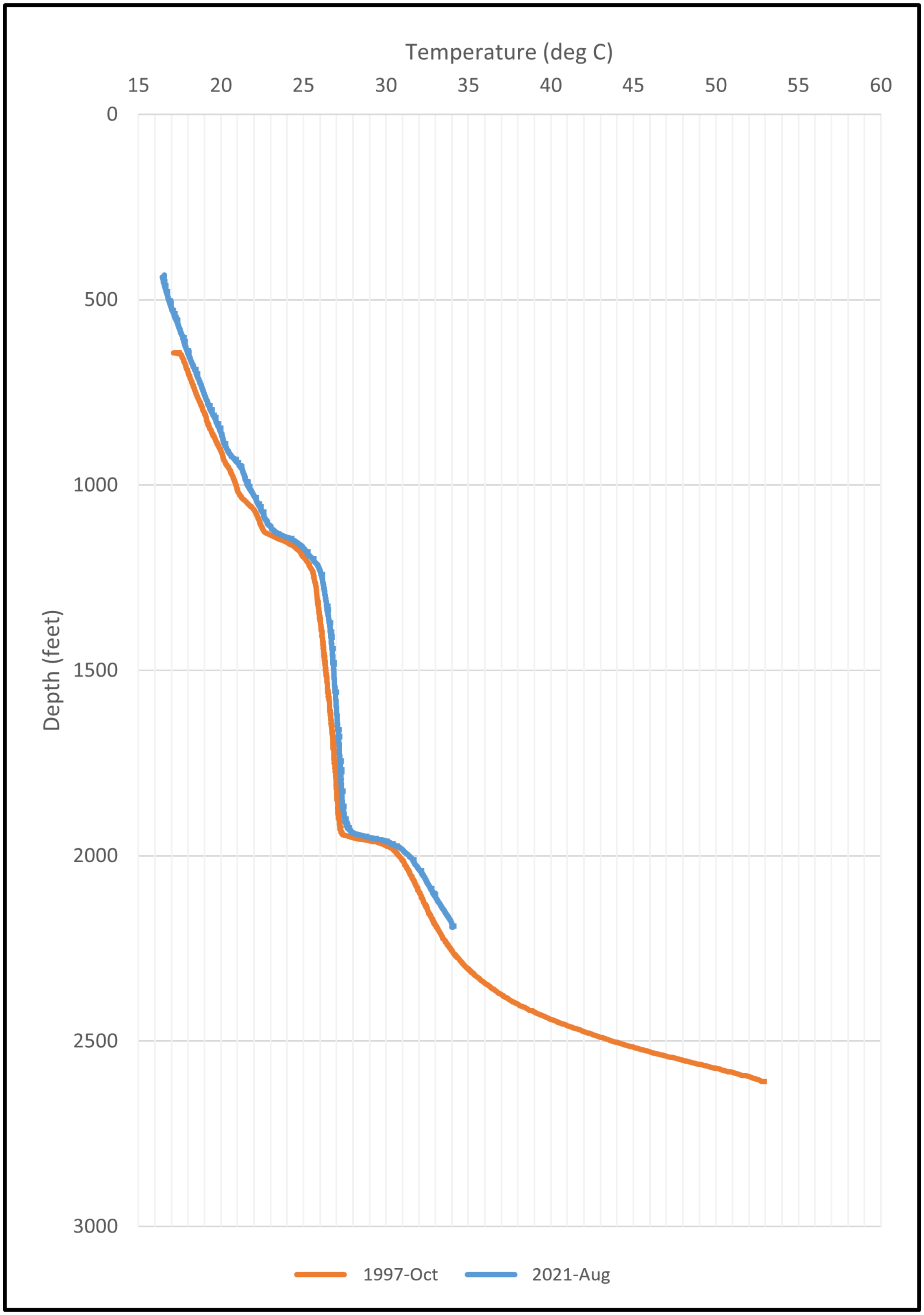


Figure 4. Well UC-1-P-2SR temperature log comparison of 1997 and 2021.
(The upward log is shown for August 2021).

Appendix E

NDEP Correspondence

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NEVADA DIVISION OF
ENVIRONMENTAL PROTECTION

STATE OF NEVADA
Department of Conservation & Natural Resources
Joe Lombardo, *Governor*
James A. Settelmeyer, *Director*
Greg Lovato, *Administrator*

January 30, 2023

Ms. Meghann Hurt
Site Manager
U.S. Department of Energy
Office of Legacy Management
2597 Legacy Way
Grand Junction, CO 81503

RE: Submittal of Draft 2020 Postclosure Groundwater Monitoring and Inspection Report, Central Nevada Test Area, Subsurface Corrective Action Unit 443, January 2023

Dear Ms. Hurt:

The Nevada Division of Environmental Protection, Bureau of Federal Facilities (NDEP) has reviewed the *Draft 2020 Postclosure Groundwater Monitoring and Inspection Report, Central Nevada Test Area, Subsurface Corrective Action Unit 443, January 2023* (Report) received on January 9, 2023. This Report is an update to the *Draft 2020 Postclosure Groundwater Monitoring and Inspection Report, Central Nevada Test Area, Subsurface Corrective Action Unit 443, May 2021,* received on May 14, 2021, with cover letter dated May 13, 2021, as it includes results obtained from the sampling of two wells that could not be sampled during the August 2020 monitoring event. The comments received from NDEP's review of the May 2021 Report have been resolved and are documented in Appendix E of the January 2023 Report. It is requested that the following comment on the January 2023 Draft Report be addressed in the Final Report:

1. Page 22, Section 4.5, First Paragraph, Fourth Sentence and Page 23, Section 5.0, Second Paragraph, Third Sentence: These sentences state that the tritium concentration at the 2192 ft sample depth of Well UC-1-P-2SR did not exceed the action levels established in the Closure Report. While the sample collected and analyzed for tritium at the 2192 ft sample depth was above the MCL, NDEP does understand that the results are consistent with past results and is expected based on the well's proximity to the detonation cavity. However, the Closure Report states in the footnote for Table 4 for Well UC-1-P-2SR that, "No action required because the sample location is inside the contaminant boundary and has detections above the MCL." As "No Action" is different than "Action Levels," it is suggested that the sentences in the January 2023 Draft Report be changed to reflect the footnote for Table 4 of the Closure Report rather than stating action levels were not exceeded.

Please address any questions or comments to me at (702) 668-3911 or candres@ndep.nv.gov.

Sincerely,

Approved by Christine D. Andres

Christine D. Andres
Chief
Bureau of Federal Facilities

ec: EM Records, AMEM
Robert Boehlecke, EM
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NEVADA DIVISION OF
ENVIRONMENTAL PROTECTION

STATE OF NEVADA
Department of Conservation & Natural Resources
Steve Sisolak, Governor
Bradley Crowell, Director
Greg Lovato, Administrator

June 18, 2021

Mark Kautsky
Federal Project Director
U.S. Department of Energy
Office of Legacy Management
2597 Legacy Way
Grand Junction, CO 81503

RE: Submittal of Draft 2020 Postclosure Groundwater Monitoring and Inspection Report, Central Nevada Test Area, Subsurface Corrective Action Unit 443, May 2021

Dear Mr. Kautsky:

The Nevada Division of Environmental Protection, Bureau of Federal Facilities (NDEP) has reviewed the *Draft 2020 Postclosure Groundwater Monitoring and Inspection Report, Central Nevada Test Area, Subsurface Corrective Action Unit 443, May 2021* (Report) received on May 14, 2021, with cover letter dated May 13, 2021. Receipt of this Report fulfills the Federal Facility Agreement and Consent Order milestone deadline of May 18, 2021. While this letter does serve as a Notice of Completion for that milestone deadline, the NDEP has the following comments on the Draft Report, which should be addressed in the Final Report:

1. Page 9, Section 3.2, First Partial Paragraph, Last Sentence: This sentence states that Well UC-1-P-2SR "is screened in the detonation chimney …" However, Note (b) below Table 1 indicates that Well UC-1-P-2SR "is perforated, not screened." Please ensure the text and Note are consistent.

2. Page 10, Section 3.2, Partial Paragraph, First Full Sentence: A reference to Table 4 should be added in this sentence as the sampling frequency of all the monitoring points is charted in this Table. Also, it is not clear why a description of the additional monitoring points listed in Table 4 has not been included in the text of this Section.

3. Page 12, Section 4.1, First Paragraph, Third Sentence and Section 4.2, Table 3: It is stated in Section 4.1 that "…in June 2019 as part of the water level monitoring event and in…" If water level data was indeed taken during the June 2019 sampling event, it should be included in the text of the Report and on Table 3.

4. Page 13, Section 4.2, Partial Paragraph below table, Last Sentence and Figures 6 through 9: Please include a statement in this Report that <u>all</u> water elevations, including past years measurements, in tables and depicted on hydrographs and potentiometric maps have been converted to the NGVD 99 datum, if this is indeed a true statement as it appears to be for Figures 6 and 7 when comparing to the 2018 Report. While it appears that Figure 9 has also been corrected in comparison to the

2018 Report, it is not obvious when comparing Figure 8 in both Reports. Please clarify if all points on all Figures have been corrected to account for the four-foot elevation difference across all years, including those in Appendix B.

5. Page 16, Section 4.3, Water Level Monitoring Results, Third Paragraph, Sixth Sentence: "… contours indicate a gradient reversal between chimney and MV-6 …" Please explain in the text the basis for the statement of a gradient reversal. What data is it being compared to?

6. Page 19, Section 4.5, First Paragraph, Fifth and Ninth Sentences and Page 22, Section 5.0, Summary and Recommendations, Bulleted Recommendations: Please include in the Recommendations Bullets a date and/or specific timeframe for the well maintenance activities for Wells UC-1-P-2SR (removing the stuck bailer) and HTH-2 (repairing or replacing the pump) and when these two wells will be sampled and reported to the NDEP in an Addendum to this Report.

7. Page 21, Section 4.5, Radioisotope Results, Paragraph below Table, Second and Ninth Sentences: References to Table 4 should be Table 5. Please correct these sentences.

8. Appendix A: If photos were taken during the June 2019 inspection, please include them in Appendix A. Also, please time and date stamp inspection photos for inclusion in future reports.

Please address any questions or comments to Britt Jacobson at bjacobso@ndep.nv.gov, Nikita Lingenfelter at nlingenfelter@ndep.nv.gov or me at candres@ndep.nv.gov.

Sincerely,

Approved by Christine D. Andres

Christine D. Andres
Chief
Bureau of Federal Facilities

CDA/NL/EJ

ec: FFACO Group, NFO
EM Records, AMEM
Navarro Central Files
Robert Boehlecke, EM
Jenny Chapman, DRI
Jeffrey Fraher, DTRA/CXTS
MSTS Correspondence Management
NNSA/NFO Read File
Ken Kreie, DOE-LM
John Elmer, Navarro
Rick Findlay, Navarro

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Document Information

Due date[1]: Date Review number: 2 Project: NVOS - Central Nevada Test Area Charge code: LMCP.LMCP.2. Enter text

Document title, number, and revision: 2020 Postclosure Groundwater Monitoring and Inspection Report, Subsurface Corrective Action Unit 443

Author: Meghann Hurt Author's phone: (970) 248-6034 Author's organization: LM

Reviewer: Christine D. Andres Reviewer's phone: (702) 486-2850 ext 232 Reviewer's organization: NDEP

Reviewer's recommendation: ☐ Release without comment ☐ Consider comments ☒ Resolve comments and reroute for review Date[2]: 01/30/2023

Author's response: ☒ Comments have been addressed Date[2]: 02/06/2023

Reviewer's response to comment resolution: ☒ Satisfactory ☐ Unsatisfactory[3] Signature: Approved by Christine D. Andres Date[2]: 2/6/23

Author signifies all comments resolved successfully: Enter text Date: Date

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[3] If the author or reviewer is dissatisfied with the resolution, the matter may be elevated to the next level of management. If an impasse develops, management must resolve the issue.

Item Number	Reviewer's Comments and Recommendations	Required	Author's Response (if required)
1	Page 22, Section 4.5, First Paragraph, Fourth Sentence and Page 23, Section 5.0, Second Paragraph, Third Sentence: These sentences state that the tritium concentration at the 2192 ft sample depth of Well UC-1-P-2SR did not exceed the action levels established in the Closure Report. While the sample collected and analyzed for tritium at the 2192 ft sample depth was above the MCL, NDEP does understand that the results are consistent with past results and is expected based on the well's proximity to the detonation cavity. However, the Closure Report states in the footnote for Table 4 for Well UC-1-P-2SR that, "No action required because the sample location is inside the contaminant boundary and has detections above the MCL." As "No Action" is different than "Action Levels," it is suggested that the sentences in the January 2023 Draft Report be changed to reflect the footnote for Table 4 of the Closure Report rather than stating action levels were not exceeded.	Yes	As requested, changes were made to Section 4.5, First Paragraph and Section 5.0, Second Paragraph. The revisions state that no action is required for the tritium concentration at the 2192 ft sample depth within well UC-1-P-2SR as per Table 3 of the of this report and Table 4 of the Closure Report. Additionally, changes were made to the Executive Summary, for consistency.

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Due date[1]: Date Review number: 1 Project: NVOS - Central Nevada Test Area Charge code: LMCP.LMCP.2. Enter text

Document title, number, and revision: 2020 Postclosure Groundwater Monitoring and Inspection Report, Subsurface Corrective Action Unit 443

Author: Meghann Hurt Author's phone: (970) 248-6034 Author's organization: LM

Reviewer: Christine D. Andres Reviewer's phone: (702) 486-2850 ext 232 Reviewer's organization: NDEP

Reviewer's recommendation: ☐ Release without comment ☐ Consider comments ☒ Resolve comments and reroute for review Date[2]: 06/18/2021

Author's response: ☒ Comments have been addressed Date[2]: 09/13/2021

Reviewer's response to comment resolution: ☑ Satisfactory ☐ Unsatisfactory[3] Approved by Christine D. Andres Date[2]: Date 9/29/21

Author signifies all comments resolved successfully: Enter text Date: Date

[1] Failure to respond to the review request will be considered approval of issuing the document as written.
[2] Reviewer or author signature not required. Authorization implied by completing date field and submittal of review.
[3] If the author or reviewer is dissatisfied with the resolution, the matter may be elevated to the next level of management. If an impasse develops, management must resolve the issue.

Item Number	Reviewer's Comments and Recommendations	Required	Author's Response (if required)
1	Page 9, Section 3.2, First Partial Paragraph, Last Sentence: This sentence states that Well UC-1-P-2SR "is screened in the detonation chimney..." However, Note (b) below Table 1 indicates that Well UC-1-P-2SR "is perforated, not screened." Please ensure the text and Note are consistent.	Yes	Well UC-1-P-2SR is perforated not screened as mentioned. The sentence in Section 3.2 was revised to be consistent with Note b of Table 1, as requested.
2	Page 10, Section 3.2, Partial Paragraph, First full Sentence: A reference to Table 4 should be added in this sentence as the sampling frequency of all the monitoring points is charted in this Table. Also, it is not clear why a description of the additional monitoring points listed in Table 4 has not been included in the text of this Section.	Yes	A reference to the Monitoring Network with Sampling Frequency table was added to Section 3.2, as requested. Since this table is now referenced earlier in the document, it is now identified as Table 2 (previously Table 4). The Table of Contents and subsequent table numbers have been revised accordingly. Per NDEP request, Section 3.2 was also revised to provide a more detailed description of all the monitoring locations that are sampled on a regular basis (wells MV-2, MV-3, and UC-1-P-2SR and piezometers MV-4PZ and MV-1UPZ). Additionally, a footnote was added to Table 2

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Item Number	Reviewer's Comments and Recommendations	Required	Author's Response (if required)
			explaining why locations MV-2UPZ, MV-3UPZ, MV-5PZ, HTH-1UPZ, HTH-1LPZ, MV-1LPZ, MV-3LPZ, and MV-2LPZ are not sampled.
3	Page 12, Section 4.1, First Paragraph, Third Sentence and Section 4.2, Table 3: It is stated in Section 4.1 that "...in June 2019 as part of the water level monitoring event and in..." If water level data was indeed taken during the June 2019 sampling event, it should be included in the text of the Report and on Table 3.	Yes	Water levels were measured in 2019 as stated and are shown in the associated hydrographs. Reporting the most current water levels in table form is consistent with previous monitoring reports and yearly water levels are available in GEMS.
4	Page 13, Section 4.2, Partial Paragraph below table, Last Sentence and Figures 6 through 9: Please include a statement in this Report that all water elevations, including past years measurements, in tables and depicted on hydrographs and potentiometric maps have been converted to the NGVD 99 datum, if this is indeed a true statement as it appears to be for Figures 6 and 7 when comparing to the 2018 Report. While it appears that Figure 9 has also been corrected in comparison to the 2018 Report, it is not obvious when comparing Figure 8 in both Reports. Please clarify if all points on all Figures have been corrected to account for the four-foot elevation difference across all years, including those in Appendix B.	Yes	All groundwater elevation data (seen in tables and figures) have been converted from NGVD 29 to the new NGVD 88 datum (the NDEP comment has NGVD 99 and it should be NGVD 88). The following sentence was added after the ninth sentence in the paragraph in Section 4.2, as requested. "Subsequently, historical groundwater elevation measurements provided in tables, hydrographs, and potentiometric maps have been converted to the new datum within this report."
5	Page 16, Section 4.3, Water Level Monitoring Results, Third Paragraph, Sixth Sentence: "...contours indicate a gradient reversal between chimney and MV-6..." Please explain in the text the basis for the statement of a gradient reversal. What data is it being compared to?	Yes	The sixth sentence in Section 4.3 was revised to remove the term "gradient reversal" from the sentence. This was discussed and approved by NDEP during a teleconference on September 3, 2021. The sentence and remainder of the paragraph are revised as follows: "As drawn, the contours indicate that groundwater flow near well MV-6 is toward the west. This is influenced by the lower groundwater elevation in well UC-1-P-2SR which is still recovering from the detonation. Depiction of groundwater flow directions within the graben has an inherent degree of uncertainty, given the structural complexity caused by the detonation and the limited data available within the graben near the detonation."

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Item Number	Reviewer's Comments and Recommendations	Required	Author's Response (if required)
6	Page 19, Section 4.5, First Paragraph, Fifth and Ninth Sentences and Page 22, Section 5.0, Summary and Recommendations, Bulleted Recommendations: Please include in the Recommendations Bullets a date and/or specific timeframe for the well maintenance activities for Wells UC-1-P-2SR (removing the stuck bailer) and HTH-2 (repairing or replacing the pump) and when these two wells will be sampled and reported to the NDEP in an Addendum to this Report.	Yes	The well maintenance activities were completed in July 2021 and the sampling was completed on August 19, 2021. Water level and sampling results for wells UC-1-P-2SR and HTH-2 will be incorporated in the 2020 report (Sections 4.3 and 4.5) as requested. It is LMs recommendation that the results of these activities be included in this Report in order to provide a more concise and streamlined long-term record of the site activities. The next Postclosure Groundwater Monitoring and Inspection Report will be submitted to NDEP in 2024 and contain site inspection results from 2021-2023 and sampling results from 2023 (consistent with the Closure Report).
7	Page 21, Section 4.5, Radioisotope Results, Paragraph below Table, Second and Ninth Sentences: References to Table 4 should be Table 5. Please correct these sentences.	Yes	The correction was made as requested.
8	Appendix A: If photos were taken during the June 2019 inspection, please include them in Appendix A. Also, please time and date stamp inspection photos for inclusion in future reports.	Yes	Photographs from the June 2019 and August 2021 monitoring events were added to Appendix A, as requested. The year of the photograph was added to the caption and will be included for future reports.
9	During a teleconference on September 3, 2021, NDEP requested that the first paragraph of Section 3.0 be revised to state that the concrete caps that cover the UC-3 and UC-4 boreholes are inspected on an annual basis and that no wells are located at within either area.	Yes	The following sentence was added after the third sentence in the first paragraph of Section 3.0. "Currently, the concrete caps that cover the UC-3 and UC-4 boreholes are inspected annually and there are no active wells in either area."

monitoring

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