LMS/CNT/S07116

2010 Groundwater Monitoring Report Central Nevada Test Area, Corrective Action Unit 443

February 2011

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1.0 Introduction

This report presents the 2010 groundwater monitoring results collected by the U.S. Department of Energy (DOE) Office of Legacy Management (LM) for the Central Nevada Test Area (CNTA) Subsurface Corrective Action Unit (CAU) 443. Responsibility for the environmental site restoration of CNTA was transferred from the DOE Office of Environmental Management to LM on October 1, 2006. The environmental restoration process and corrective action strategy for CAU 443 are conducted in accordance with the Federal Facility Agreement and Consent Order entered into by DOE, the U.S. Department of Defense, and the State of Nevada. The corrective action strategy for the site includes proof-of-concept monitoring in support of site closure. This report summarizes investigation activities associated with CAU 443 that were conducted at the site from December 2009 through December 2010. It also represents the second year of the enhanced monitoring network and the 5-year proof-of-concept monitoring period that is intended to validate the compliance boundary.

2.0 Site Location and Background

CNTA is north of U.S. Highway 6, approximately 30 miles north of Warm Springs in Nye County, Nevada (Figure 1). The U.S. Atomic Energy Commission (predecessor to DOE) acquired CNTA in the early 1960s to develop sites for underground nuclear testing that could serve as alternatives to the Nevada Test Site. Three emplacement boreholes—UC-1, UC-3, and UC-4—were drilled at CNTA for underground nuclear weapons testing. The initial underground nuclear test, Project Faultless, was conducted in borehole UC-1 at a depth of 3,199 feet (ft) (975 meters) below ground surface on January 19, 1968. The yield of the Project Faultless test was estimated to be 0.2 to 1 megaton. The test resulted in a down-dropped fault block that extends to land surface (Figure 2). No further nuclear testing was conducted at CNTA, and the site was decommissioned as a testing facility in 1973.

2.1 Summary of Corrective Action Activities

Surface and subsurface contamination resulted from the underground nuclear test at CNTA. Contamination at the surface was identified as CAU 417. Surface restoration was completed in 1999, and the remediation activities are described in the *Closure Report for Corrective Action Unit 417: Central Nevada Test Area Surface, Nevada* (DOE 2001). Contamination in the subsurface is identified as CAU 443. The corrective action process for the subsurface CAU 443 has not yet been completed. Site restoration activities associated with CAU 443 are summarized in the remainder of this section.

A Corrective Action Investigation Plan was developed and approved for CAU 443 in 1999. The objectives outlined in that document are provided below:

- Determine the characteristics of the groundwater flow system, sources of contamination, and transport processes, to acceptable levels of uncertainty;
- Develop a credible numerical model of groundwater flow and contaminant transport for the UC-1 Subsurface Corrective Action Site and downgradient areas; and
- Develop stochastic predictions of the contaminant boundary, at an acceptable level of uncertainty (DOE 1998).

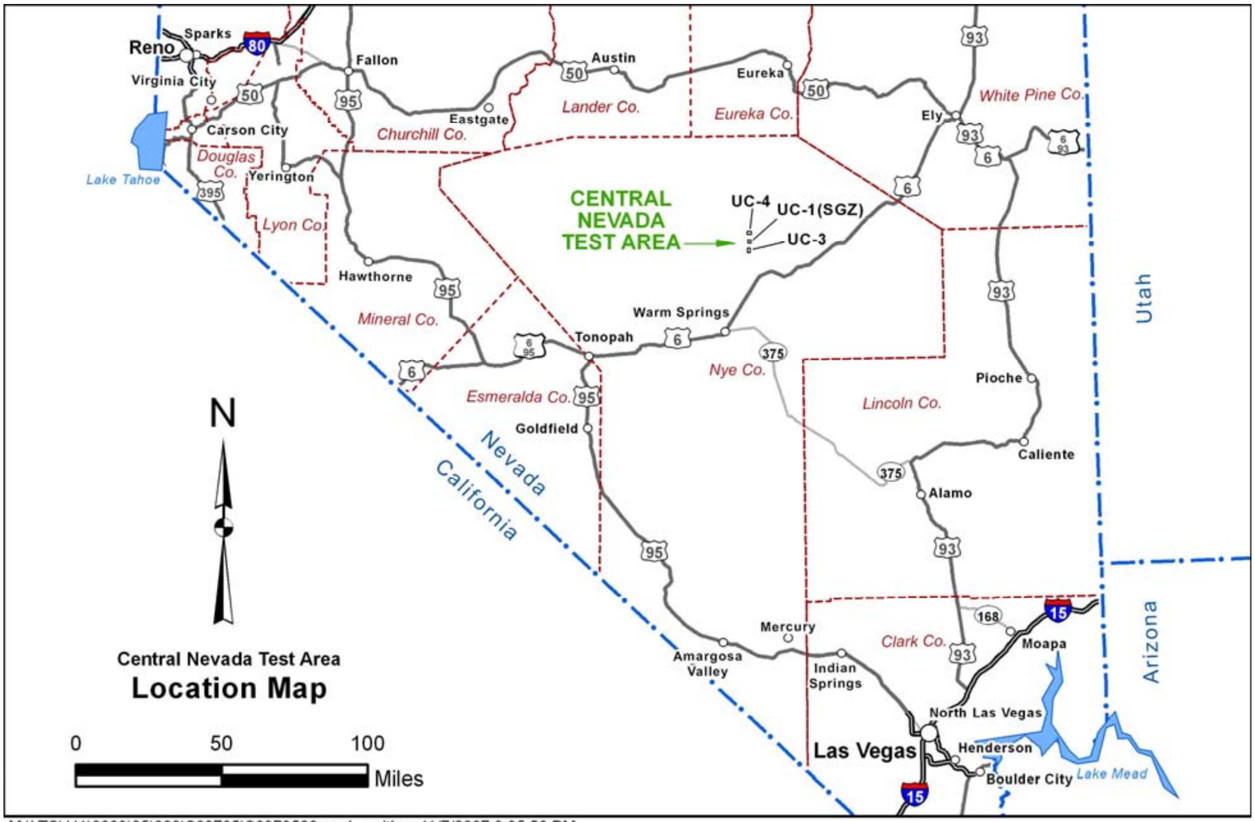

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Figure 1. Central Nevada Test Area Location Map

These objectives were accomplished by conducting a corrective action investigation. As part of the investigation, site data were used to develop a numerical flow and transport model, which was then used to calculate a site contaminant boundary (Pohlmann et al. 1999, Pohll et al. 2003).

Results of the corrective action investigation and the corrective action evaluation were presented in the Corrective Action Decision Document/Corrective Action Plan (CADD/CAP) (DOE 2004). Modeling indicated that groundwater velocities at the site were very low (due to very low hydraulic conductivities) and that the contaminant boundary would be very small (within two to three radii of the cavity from the working point [DOE 2004]). A compliance boundary was negotiated that factored in modeling results and associated uncertainties, especially with respect to the potential effects of the nuclear test within the down-dropped fault block. The compliance boundary corresponds approximately to the surface expression of the fault block and is generally contained within the land withdrawal boundary (Figure 2). The preferred corrective action alternative selected in the CADD/CAP was proof-of-concept and monitoring with institutional controls.

Three wells (MV-1, MV-2, and MV-3) were installed in 2005 to monitor radioisotopic concentrations and hydraulic heads in groundwater and to validate the flow and transport model. Hydraulic heads observed in these wells were in significant disagreement with those predicted by the groundwater flow model, which meant that the model could not be validated. Instead of additional modeling, DOE proposed a revised corrective action/closure process in which the monitoring network would be enhanced by installing two new monitoring wells (MV-4 and

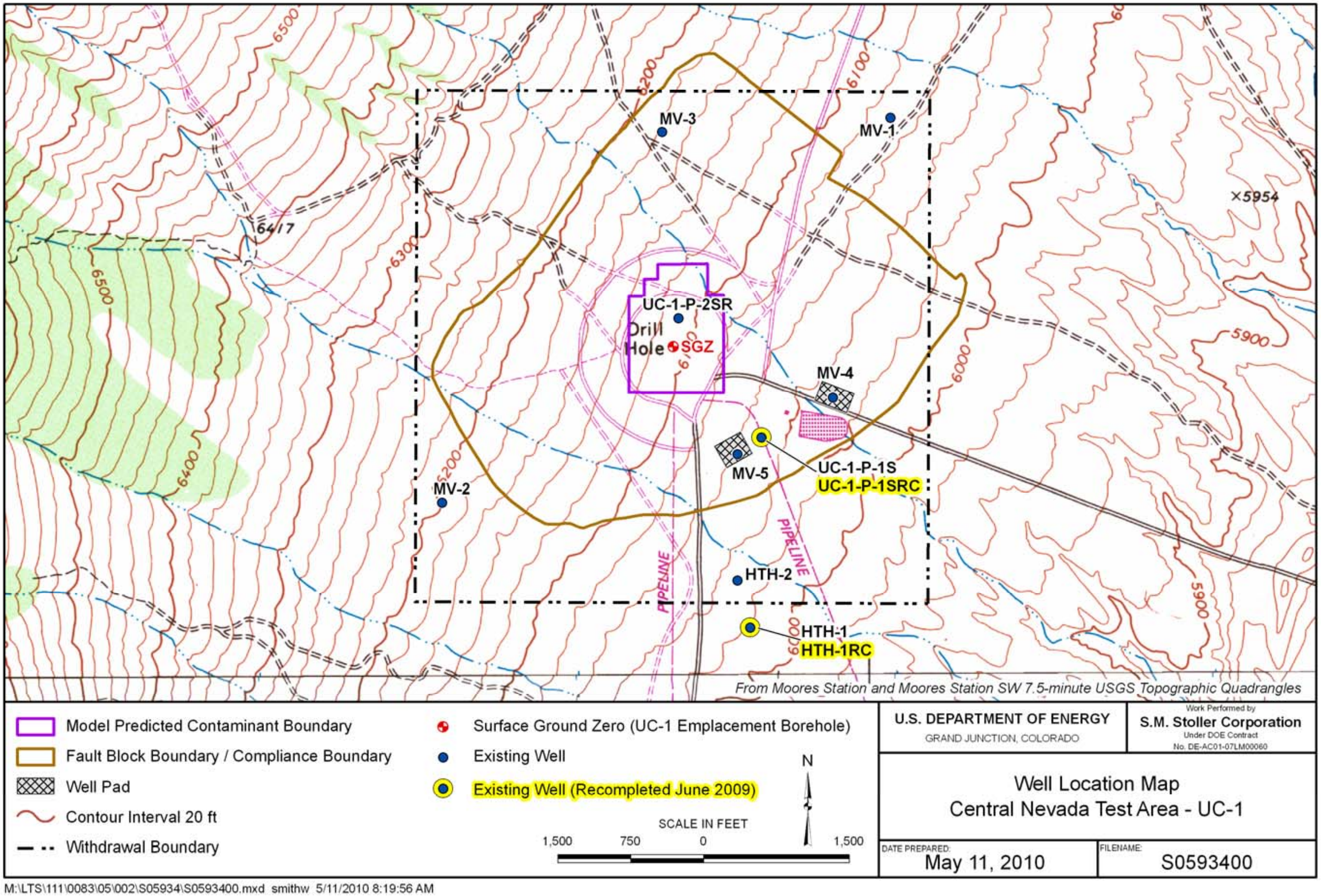

Figure 2. Location Map of Monitoring Wells and Boundaries at the CNTA

MV-5), recompleting the existing wells HTH-1 (volcanic section) and UC-1-P-1S (upper alluvium), and initiating a new 5-year proof-of-concept monitoring period to validate the compliance boundary (DOE 2007). The revised approach is described in a CADD/CAP addendum (DOE 2008a) that was approved by the Nevada Department of Environmental Protection (NDEP 2008).

The revised corrective action/closure process was designed to enhance the monitoring of the alluvial aquifer. The alluvial aquifer was previously not monitored except for water levels in the upper piezometers of wells MV-1, MV-2, and MV-3. Hydraulic heads from different depths at these locations (upper piezometer, lower piezometer, and well) indicate that the most likely transport direction from the UC-1 detonation zone is down, toward densely welded tuff units below the detonation cavity. The well network was designed to monitor this most likely potential transport pathway. However, given the potential for processes like prompt injection and convective mixing in the nuclear chimney, migration into the alluvial aquifer cannot be ruled out. Alluvial wells are typically more productive than those in the deeper volcanic section, making the alluvial aquifer the most likely source for future groundwater development and, therefore, the most likely access path to potential receptors.

Two wells (MV-4 and MV-5) were installed, and two existing wells (HTH-1 and UC-1-P-1S) were recompleted in 2009 for the dual purposes of monitoring the alluvial aquifer and validating the compliance boundary at the site. The MV-4 and MV-5 wells were designed and positioned not only to monitor for potential contaminant migration in the alluvial aquifer, but also to confirm that the southeast bounding graben fault acts as a flow barrier. The wells were drilled in locations where they would penetrate the downthrown block within the graben, and cross the fault into the upthrown block outside the graben. The wells were dually completed with a piezometer in the shallow alluvial aquifer within the graben (downthrown block) and a well in the lower alluvial aquifer outside the graben (upthrown block). The wells were completed with dedicated electric submersible pumps for collecting groundwater samples and aquifer testing. Monitoring of the existing wells MV-1, MV-2, and MV-3 was also enhanced in 2009 by removing the electric submersible pumps and installing low-flow bladder pumps. Results from the drilling program are provided in the Well Completion Report for Corrective Action Unit 443 (DOE 2009).

Well UC-1-P-1S (“P” – post-shot hole, “S” – substitute hole) was recompleted to provide a reliable monitoring location within the upper alluvial aquifer inside the graben (downthrown block). The recompleted well UC-1-P-1SRC (“RC” – recompleted) included the installation of an electric submersible pump for collecting groundwater samples. Well HTH-1 was recompleted with two piezometers (upper and lower alluvial aquifer) and a well (upper volcanic section) to allow the monitoring of three hydrostratigraphic units at this location. Hydraulic head data from the well and piezometers can be used to determine the vertical flow direction within the alluvial aquifer and between the upper volcanic section and lower alluvial aquifer. The horizontal flow direction in the lower alluvial aquifer southeast of the graben can be estimated using head data from the HTH-1 lower piezometer along with head data from the MV-4 and MV-5 wells. A low-flow bladder pump was installed in the HTH-1RC (“RC” – recompleted) well for collecting water samples from the volcanic section south of the detonation (DOE 2009). Initial monitoring results from HTH-1RC support a previous identification (based on flow logging) of an upward hydraulic gradient from the volcanic section to the alluvium (DOE 2010a). Refer to Figure 2 for a map view of the locations included in the enhanced monitoring network.

The revised corrective action/closure process, as outlined in the CADD/CAP addendum, indicated that aquifer tests would be performed on the new wells MV-4 and MV-5 and on recompleted well HTH-1RC. This strategy was modified slightly because the original well design for HTH-1RC was changed to include two piezometers and did not allow for the installation of a submersible pump or aquifer testing. To accommodate this change, an aquifer test was conducted on the recompleted well UC-1-P-1SRC. The results from aquifer tests suggest that the hydraulic conductivity of the alluvial aquifer decreases with depth, grading from a productive aquifer in the upper alluvium (hydraulic conductivity of 1.0 m/day) to a poor producer in the lower alluvium (hydraulic conductivity of 0.00012 to 0.0005 m/day). The decreasing hydraulic conductivity within the alluvial aquifer may be more a function of depth and over burden compression from the down drop fault block rather than sediment grain size. The low hydraulic conductivity of the lower part of the alluvial aquifer is more comparable to the results from densely welded tuff units tested in wells MV-1, MV-2, and MV-3 (8.5×10^{-6} to 6.7×10^{-5} m/day) and is likely similar to the hydraulic conductivity of the upper part of the underlying volcanic sediments. A more detailed summary of the results from the hydrologic testing is provided in the Hydrologic Testing Report for Corrective Action Unit 443 (DOE 2010b).

3.0 Geologic and Hydrologic Setting

CNTA is in Hot Creek Valley (Figure 3), a north-south trending graben that is 68 miles long and located in the Basin and Range physiographic province. 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 (volcanics). Log information from wells MV-1, MV-2, and MV-3 indicates that the thickness of the alluvium in the vicinity of UC-1 (location of the Faultless test) ranges from 1,960 ft to 2,410 ft. The Tertiary volcanics below the alluvium include tuffaceous sediments, welded and nonwelded tuffs, and rhyolite lavas.

The Faultless test took place in the very low permeability volcanic section, creating a cavity and a subsequent collapse chimney that extends into the overlying alluvium. The water levels in reentry well UC-1-P-2SR ("P" – post-shot hole, "SR" – re-sidetrack hole), drilled into the chimney, continue to exhibit a recovery curve from the dewatering effects of the detonation (Figure 4). The water level has increased over 1800 ft in the last forty years and about 8 ft in 2010. Well UC-1-P-2SR was drilled a few weeks after the detonation in 1968 so no pre-detonation water levels are available. It was perforated from 1148 – 2790 ft below ground surface and water levels will apparently rise to at least the elevation of the alluvial aquifer water level in this region (to ~5765 – 5770 ft above mean sea level or about another 180 ft from the elevation of 5590 ft measured in mid 2010). The depressed water levels in and near the test cavity inhibit the movement of contamination horizontally and vertically away from the detonation zone. As previously mentioned, the most likely migration path for contamination moving away from the detonation zone is down toward more permeable densely welded tuff units. At the MV-1, MV-2, and MV-3 locations, densely welded tuff units were thinner and less permeable than originally expected. Hydraulic head measurements in wells MV-1, MV-2, and MV-3 suggest that the flow direction in the volcanics below the detonation zone is to the north-northeast.

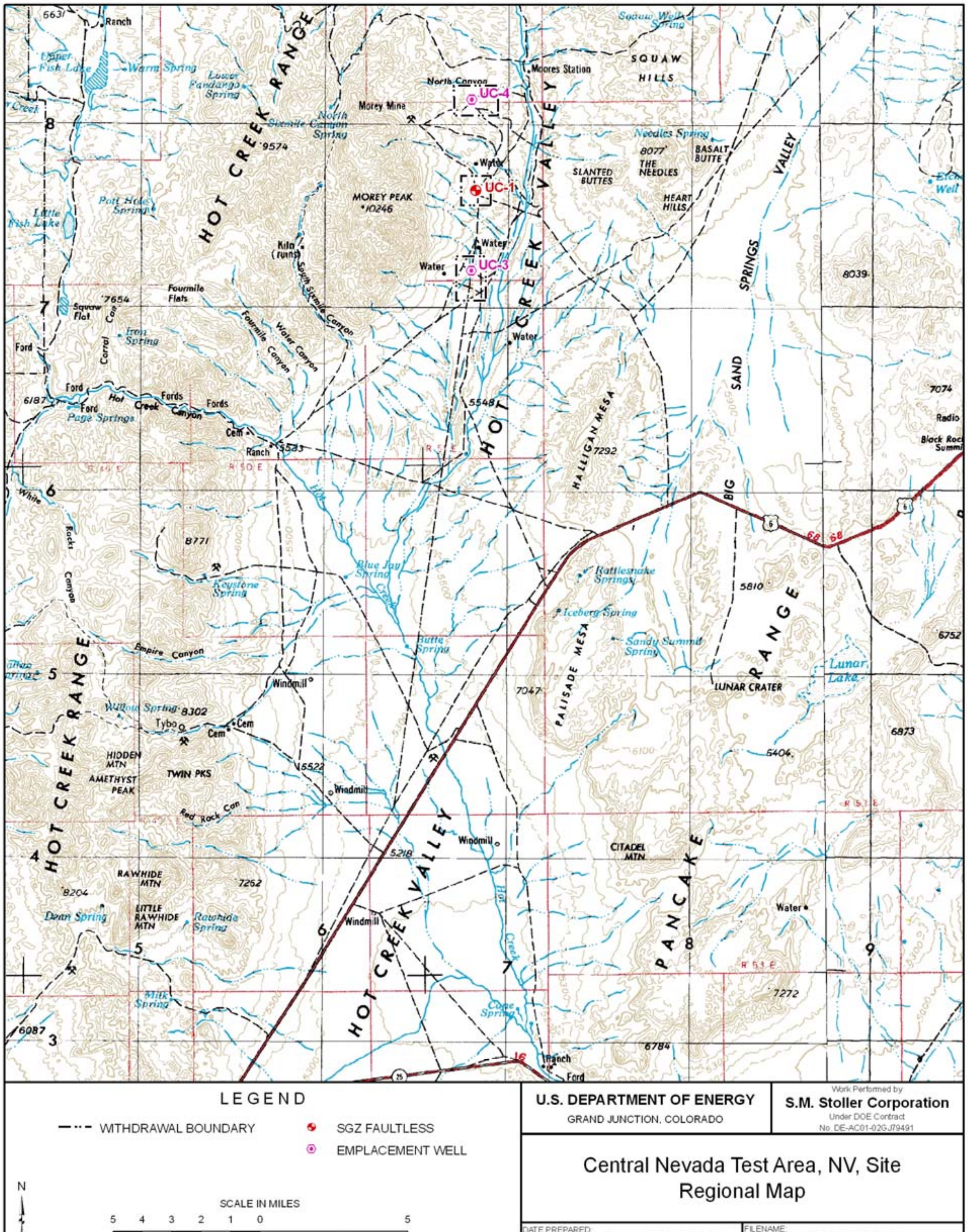

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Figure 3. Physiographic Features Near the Central Nevada Test Area

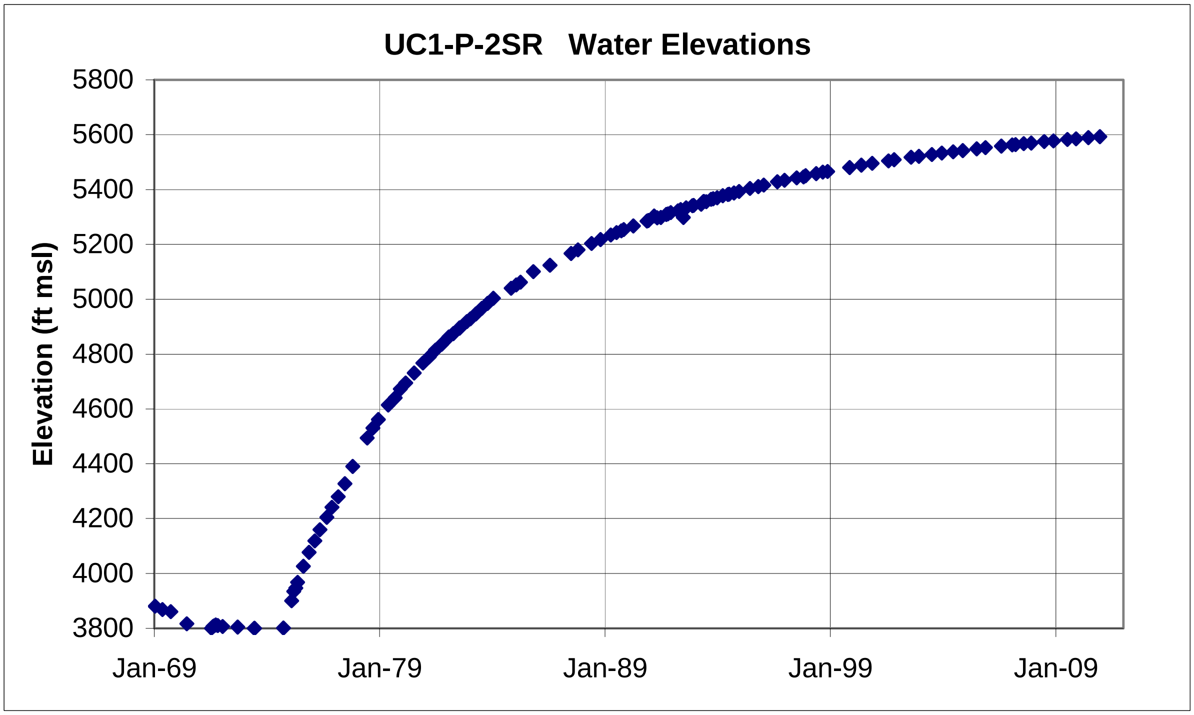

Figure 4. Water Level Elevations in Reentry Well UC-1-P-2SR
(http://nevada.usgs.gov/doe_nv/sitepage_temp.cfm?site_id=383806116125951)

4.0 Monitoring Objectives and Activities

The monitoring network at CNTA consists of wells and piezometers in MV-1, MV-2, MV-3, MV-4, MV-5, HTH-1RC, HTH-2, and UC-1-P-1SRC (Table 1). The monitoring activities as specified in the CADD/CAP addendum (DOE 2008a) include the collection of hydraulic head data and groundwater samples for radioisotopic analyses. The two major objectives of the annual monitoring program are to (1) detect any migration of contaminants from the detonation zone and (2) ensure the overall stability (quasi-steady state) of the groundwater flow system. The *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (DOE 2008b) is used to guide quality assurance and quality control of the annual monitoring. Table 1 lists the wells and piezometers that comprise the monitoring network along with the screened interval elevations, screened geologic unit, and the most recent water level data. Piezometers are distinguished from the wells at these monitoring locations with a “PZ” subscript. For locations with two piezometers, “UPZ” and “LPZ” are used to denote the upper piezometer and lower piezometer.

Water sampling at the site occurred in May, June, and August 2010. Wells with submersible pumps (HTH-2, MV-4, MV-5, and UC-1-P-1SRC) were purged prior to sample collection. Wells with bladder pumps (MV-1, MV-2, MV-3, and HTH-1RC) were purged to remove stagnant water from the bladder pump tubing prior to sample collection. The *Fluid Management Plan, Central Nevada Test Area Corrective Action Unit 443* (DOE 2009) was used to guide the handling and discharge of the monitor well purge water during the annual monitoring. Water level data are monitored in all wells and piezometers in the network by pressure transducers with real-time telemetry capability.

Table 1. Construction and 2010 Hydraulic Head Data for Wells in the CNTA Monitoring Network

Well/ Piezometer	TSZ Elevation[a] (ft)	BSZ Elevation[a] (ft)	Geologic Unit	TOC Elevation[a] (ft)	Date	Water Depth (ft)	Water Level Elevation[a] (ft)
MV-1UPZ	5,190.19	5,130.19	Alluvium	6,069.94	10/27/2010	317.51	5752.43
MV-1LPZ	3,067.19	3,007.19	Volcanics	6,069.88	10/27/2010	37.09	6032.79
MV-1	2,319.19	2,159.63	Volcanics	6,070.54	10/27/2010	506.56	5563.98
MV-2UPZ	5,229.73	5,179.73	Alluvium	6,190.62	10/27/2010	405.88	5784.74
MV-2LPZ	2,643.23	2,583.23	Volcanics	6,190.35	10/27/2010	380.04	5810.31
MV-2	3,150.24	2,987.49	Volcanics	6,190.62	10/27/2010	350.48	5840.14
MV-3UPZ	5,286.98	5,226.98	Alluvium	6,167.75	10/27/2010	372.61	5795.14
MV-3LPZ	2,866.98	2,746.98	Volcanics	6,167.70	10/27/2010	188.15	5979.55
MV-3	2,120.98	1,959.23	Volcanics	6,168.28	10/27/2010	600.11	5568.17
MV-4[b]	4,300.32	3,996.22	Alluvium	6,019.65	10/27/2010	510.11	5509.54
MV-4PZ[b]	5,101.20	5,041.20	Alluvium	6,019.45	10/27/2010	275.11	5744.34
MV-5[b]	4,203.12	3,878.69	Alluvium	6,041.69	10/27/2010	561.53	5480.16
MV-5PZ[b]	5,023.17	4,963.17	Alluvium	6,040.87	10/27/2010	288.92	5751.95
HTH-1UPZ[b]	5,032.63	4,972.63	Alluvium	6,011.23	10/27/2010	542.62	5468.61
HTH-1LPZ[b]	4,112.66	4,052.66	Alluvium	6,011.26	10/27/2010	541.00	5470.26
HTH-1RC[b]	3,653.90	3,353.60	Volcanics	6,011.65	10/27/2010	497.78	5513.87
HTH-2	5,521.70	5,025.70	Alluvium	6,026.44	10/27/2010	556.16	5470.28
UC-1-P-1SRC[b]	5,519.55	5,457.81	Alluvium	6,031.59	10/27/2010	281.43	5750.16
UC-1-P-2SR[c]	4,936[c]	3,294[c]	Chimney	6,084	12/14/2010	491.66[c]	5,592.34[c]

[a] All elevations reported in units of feet above sea level
[b] Added in 2009
[c] Elevations not TVD corrected (no directional survey available). Primarily affects screened interval.
TOC = Top of casing
TSZ, BSZ = top and bottom of open interval

4.1 Radioisotope Monitoring

Water samples collected from monitoring network wells (MV-1, MV-2, MV-3, MV-4, MV-5, HTH-1RC, HTH-2, and UC-1-P-1SRC) are analyzed for the presence of radionuclides. Tritium is currently the primary analyte of concern because of its initial abundance and mobility. After a few hundred years tritium will decay to insignificant levels (12.3 year half-life), and the longer-lived radionuclides, carbon-14 (C-14) and iodine-129 (I-129), will become the primary focus of long-term post-closure monitoring. Concentration data currently being collected for C-14 and I-129 provide background levels of these constituents for comparison with long-term monitoring results. During the 5-year proof-of-concept period that began with the 2009 sampling event, the CADD/CAP addendum (DOE 2008a) specifies that water samples will be analyzed for tritium every year and for C-14 and I-129 in the first and fifth years. Inadequate sample volumes were collected in 2009 for I-129 analysis, and, as a result, water samples collected in 2010 have been analyzed for I-129.

The CADD/CAP (DOE 2004) established groundwater compliance levels for CNTA of 20,000 picocuries per liter (pCi/L) for tritium, 2,000 pCi/L for C-14, and 1 pCi/L for I-129. Transport modeling (Pohlmann et al. 1999, Pohll et al. 2003) was used to establish a contaminant boundary (DOE 2004) at which predicted concentrations of these constituents would remain below current compliance levels. The contaminant boundary is well within the compliance boundary (Figure 2), the boundary beyond which compliance levels of these constituents are not to be exceeded. Although the flow model was not validated by data from wells MV-1, MV-2, and MV-3, the model-predicted contaminant boundary is supported by hydraulic conductivity data from these wells.

4.2 Hydraulic Head Monitoring

Hydraulic head is monitored by transducers installed in the wells and piezometers included in the site monitoring network (Table 1). As stated in the CADD/CAP, "Hydraulic head will be used to monitor the quasi steady-state of the groundwater system; i.e., to determine if mean hydraulic head values remain constant through time, given fluctuations caused by natural temporal stresses and stresses related to well drilling, construction, and testing. This requires first determining when heads have stabilized following drilling and testing activities, then quantifying the natural mean and temporal variation in hydraulic head, and finally comparing subsequent monitoring measurements to that range." Table 1 lists hydraulic heads measured manually in October 2010 at all monitoring locations; Section 5.2 presents more detailed assessments of temporal hydraulic head behavior.

5.0 Monitoring Results

The monitoring activities consisted of annual sampling and downloading transducer data in wells included in the enhanced monitoring network. Section 5.1 presents radioisotopic data, and Section 5.2 presents head measurements.

5.1 Radioisotopic Results

Radioisotopic sampling results for 2010 are presented in Table 2 along with the results from previous sampling events dating back to 2006. A sample was not collected from well HTH-2 during this monitoring event because the dedicated pump failed to operate. Samples were collected from wells UC-1-P-1SRC and MV-5 in May and from well MV-4 in August as part of the aquifer testing of these wells. Tritium and I-129 concentrations for 2010 continue to be below detection limits, as in previous sampling events. Estimated activities of tritium and I-129 are comparable to previously reported values. Appendix A provides the field parameter measurements obtained during well-purging activities.

5.2 Hydraulic Head Results

Figure 5 through Figure 8 present hydrographs of hydraulic head data. A continuous line indicates water levels from a transducer. Table 1 shows the screened horizon, top of screened zone, and bottom of screened zone for each location. The hydrographs are grouped by comparable monitored interval and location: alluvial wells southeast of the southeast-bounding graben fault, including well HTH-1RC in the upper volcanic section (Figure 5), alluvial wells northwest of the southeast-bounding graben fault (Figure 6), volcanic section with open interval near the detonation level (Figure 7), and volcanic section with open interval below the detonation level (Figure 8). Data gaps in the hydrographs are the result of transducers being removed for well-site activities or for replacement of damaged transducers/cable.

Table 2. Radioisotopic Sampling Results

Well Name	Date	Carbon-14 (pCi/L)[a]	Iodine-129 (pCi/L)[a]	Tritium (pCi/L)[a]
MV-1	2/14/2006 [c]	<RDL (1.12E-02)	<RDL (1.51E-7)	<3
	9/21/2006 [c]	<RDL (5.61E-02)	<RDL (2.9E-7)	<45
	2/22/2007	NS	NS	NS
	10/10/2007	<RDL (7.40E-03[f])	<RDL (5.7E-11[f])	<313
	3/19/2008	NS	NS	NS[d]
	6/26/2009	<RDL (2.46E-02)	NS	<370
	6/09/2010	NS	<RDL (10.4E-10)	<360
	6/09/2010[e]	NS	<RDL (10.8E-10)	<360
MV-2	3/16/2006 [c]	<RDL (9.92E-02)	<RDL (2.58E-7)	<3
	9/22/2006 [c]	<RDL (1.3E-02)	<RDL (2.6 E-7)	<45
	2/22/2007	<RDL (1.54E-03[f])	<RDL (9.7E-11)	<357
	2/22/2007[e]	<RDL (1.84E-03[f])	<RDL (11.1E-11)	<353
	3/19/2008	NS	NS	<320
	6/26/2009	<RDL (5.55E-03)	NS	<380
	6/08/2010	NS	<RDL (10.9E-10)	<360
MV-2LPZ[b] – Sample depth 490 ft	8/5/2008	NS	NS	<8,000
MV-2LPZ[b] – Sample depth 3,471 ft	8/5/2008	NS	NS	<8,000
MV-3	3/16/2006 [c]	<RDL (3.95E-02)	<RDL (2.10E-7)	<3
	9/22/2006 [c]	<RDL (5.11E-02)	<RDL (2.2 E-7)	<45
	2/22/2007	<RDL (1.01E-02[f])	<RDL (14.0E-11)	<359
	3/19/2008	NS	NS	<320
	6/25/2009	<RDL (3.87E-02)	NS	<380
	6/08/2010	NS	<RDL (14.2E-9)	<370
MV-4	6/24/2009	<RDL (9.17E-04)	NS	<370
	08/30/2010	NS	<RDL (7.5E-11)	<330
MV-5	6/25/2009	<RDL (2.30 E-03)	NS	<370
	5/26/2010	NS	<RDL (5.7E-11)	<360
HTH-1RC	6/25/2009	<RDL (2.75E-03)	NS	<390
	6/09/2010	NS	<RDL (11.0E-11)	<360
HTH-2	6/25/2009	<RDL (7.98E-02)	NS	<380
	6/09/2010	NS	NS	NS
UC-1-P-1SRC	6/24/2009	<RDL (1.07E-01)	NS	<360
	5/22/2010	NS	<RDL (5.2E-11)	<370

[a] pCi/L = picocuries per liter.
[b] Indicates sample was collected from lower piezometer of MV-2 using a depth-specific bailer; sample depths are provided with the well name.
[c] Indicates sample results were obtained from DRI Monitoring Report (DRI 2006).
[d] Indicates well was not sampled because of pump failure.
[e] Indicates a duplicate sample.
[f] Estimated based on sample volume of 200 milliliters.
NS = not sampled.
<RDL = below requested detection limit (RDL) with laboratory result in parentheses; RDL is 300 pCi/L for tritium, 5 pCi/L for C-14, and 0.1 pCi/L for I-129 (DOE 2004).

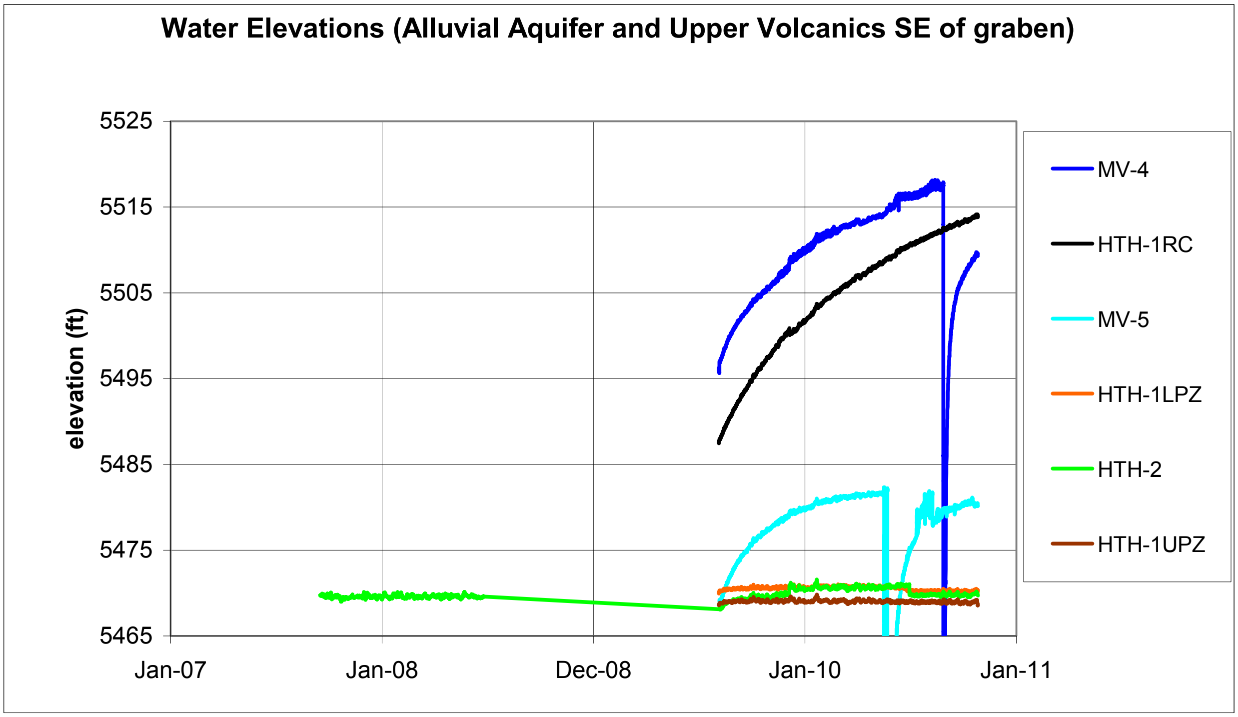

Figure 5. Water Level Elevations for the Alluvial Wells and well HTH-1RC (upper volcanics) Southeast of the Down-Dropped Graben at the Screened Horizon

Figure 5 shows the hydrographs of alluvial wells and piezometers southeast of the graben (MV-4, MV-5, HTH-2, HTH-1UPZ, and HTH-1LPZ) along with well HTH-1RC (screened in the upper volcanic section below the alluvium). These data indicate that wells MV-4 and MV-5 are still recovering from aquifer testing. Water levels in well HTH-1RC continue to equilibrate after the recompletion in 2009. Prior to its recompletion, HTH-1 was perforated across its entire saturated section and displayed a composite water level that could not be attributed to one particular hydrogeologic unit. The recompletion isolated zones in the upper and lower alluvium (HTH-1UPZ and HTH-1LPZ) and in the upper volcanic section (HTH-1RC). The hydraulic head in the volcanic portion of HTH-1 is higher than water levels measured in both the upper and lower alluvial piezometers at this location. This observation confirms that an upward gradient from the volcanic section to the alluvium exists in this area, as indicated by flow logging performed by Desert Research Institute in HTH-1 prior to its recompletion (DOE 2008a).

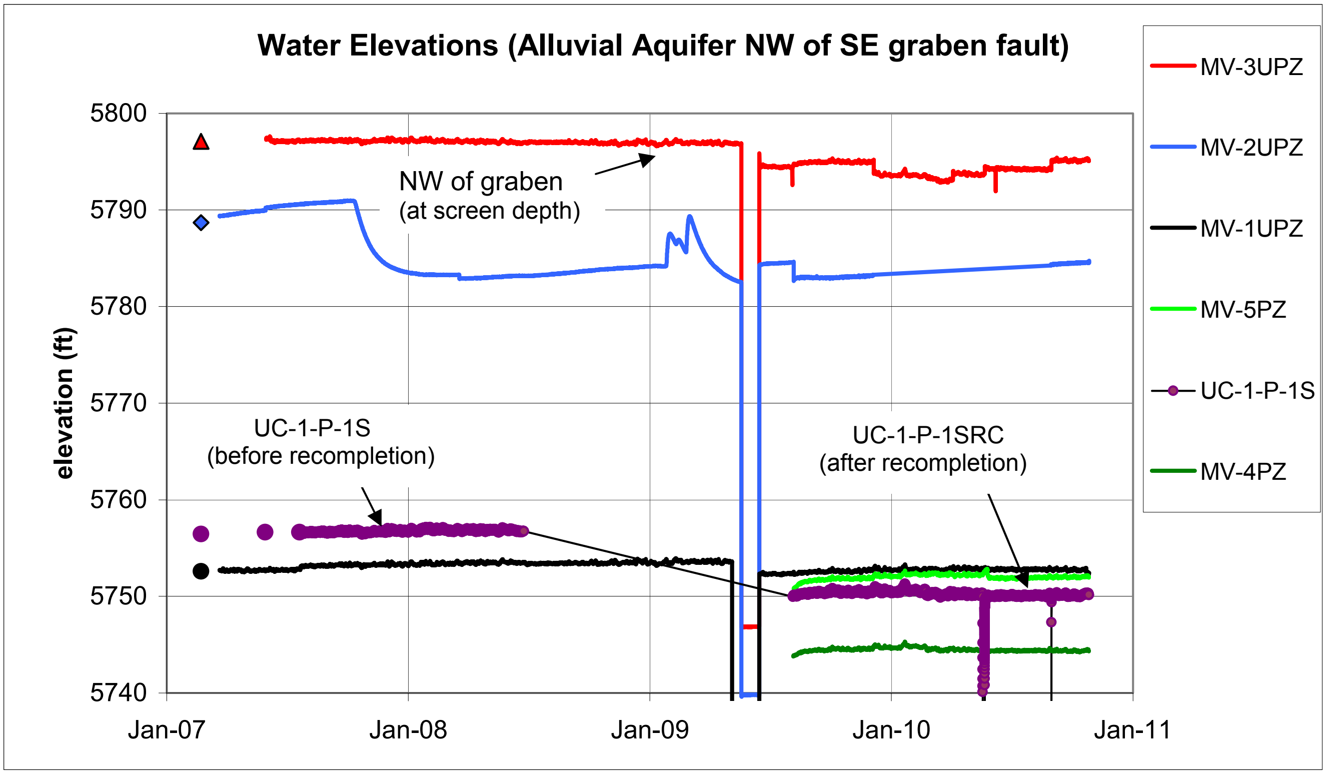

Figure 6. Water Level Elevations for the Alluvial Wells Northwest of the Southeast-Bounding Graben Fault

Figure 6 shows the hydrographs of alluvial piezometers and wells within and northwest of the graben. Erratic water levels in MV-2UPZ (Figure 6) are attributed to damage during its installation. The lower hydraulic heads observed after mid 2009 in MV-1UPZ and MV-3UPZ are the result of attempts to further develop these piezometers. The recompletion of UC-1-P-1S resulted in a roughly 7–8 ft decrease in hydraulic head (Figure 6). This suggests that the well is now isolated from the influence of deeper horizons where hydraulic heads have typically been larger.

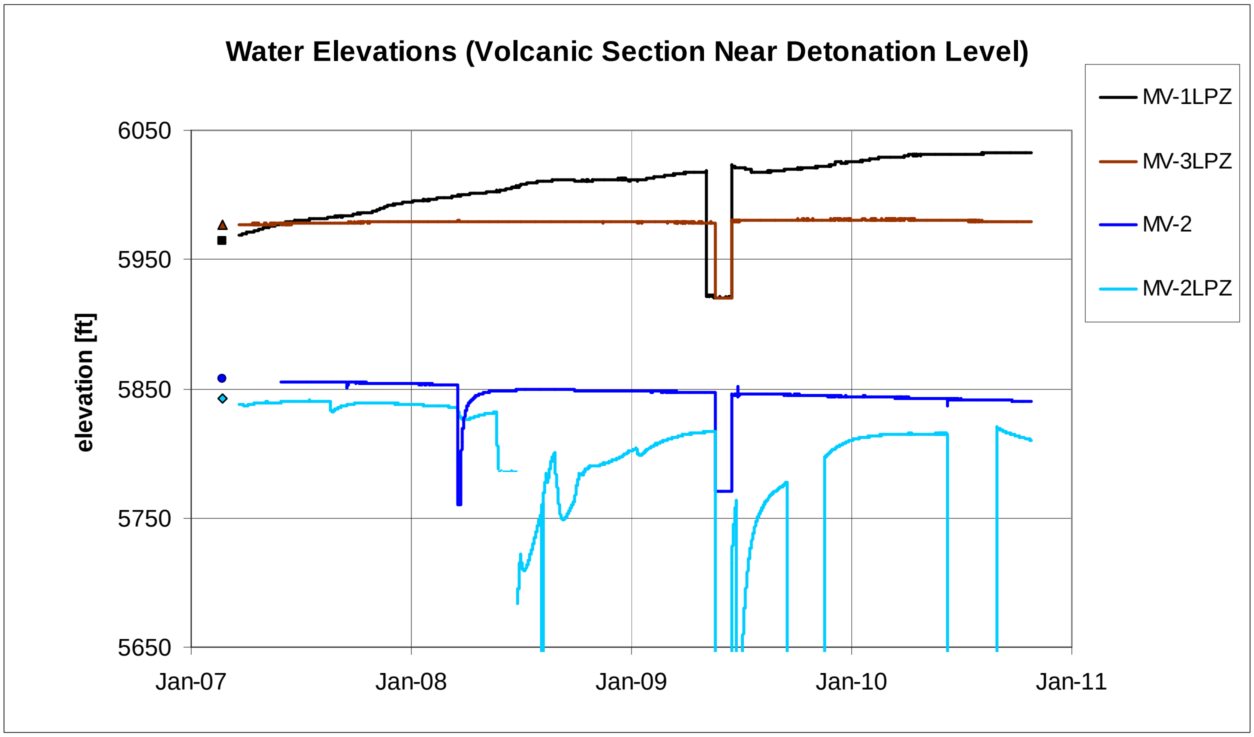

Figure 7. Water Level Elevations for the Well and Piezometers Screened in the Volcanic Section, at or near the Level of the Detonation

Figure 7 shows the hydrographs of wells and piezometers with open intervals near the detonation level. Water levels in MV-1LPZ continue to rise, though at a slower rate than previously observed. On August 5, 2008, DRI ran a temperature log, collected a bailed sample, and measured the depth of the MV-2LPZ to investigate the cause of rapid water level declines and recoveries at this location. Sediment was found 75 ft above the top of the screened interval. In the summer of 2009, MV-2LPZ was further developed, lowering the sediment fill to the top of the screen. Water levels are still recovering from the development efforts. The transducer was not functioning in MV-2LPZ from September to November of 2009 and from June to the end of August 2010. The head level in MV-2LPZ had apparently stabilized in early 2010, though during the summer of 2010 when there was no transducer monitoring its water level, it rose above the stabilized level and has since been decreasing. This indicates that removing the sediment from the MV-2LPZ may not have completely solved the erratic head changes in this piezometer.

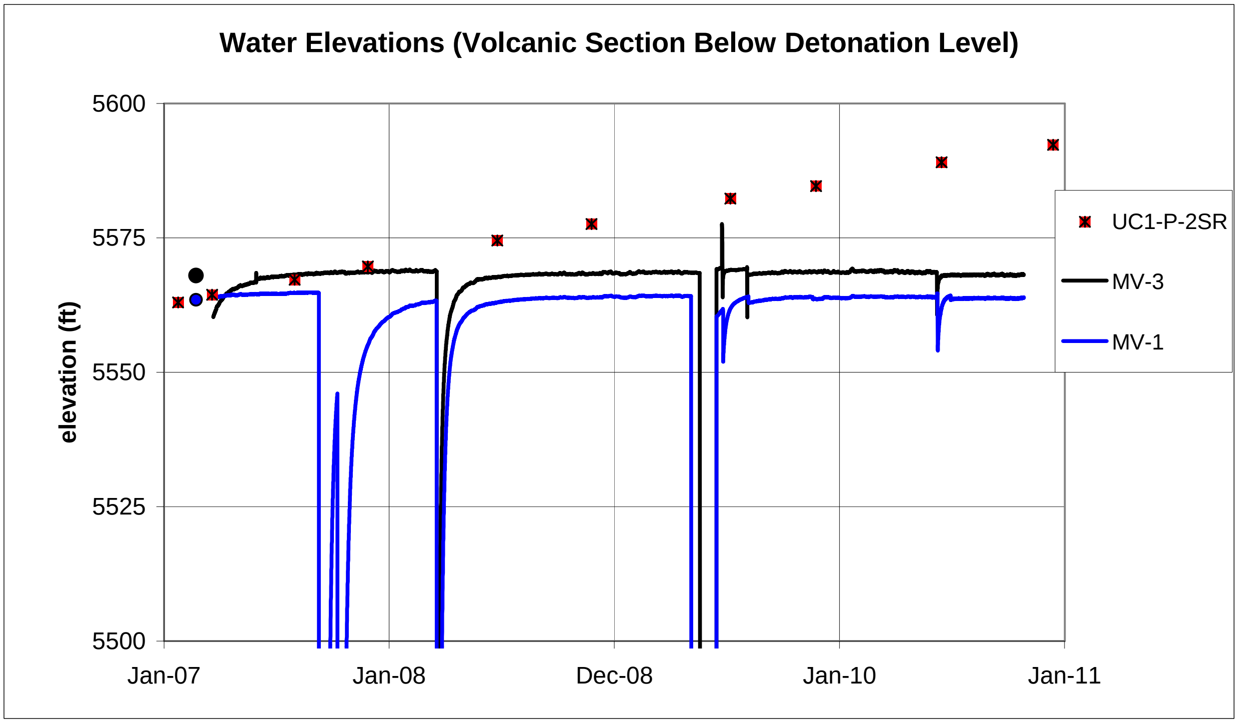

Figure 8. Water Level Elevations for the Wells Screened in the Volcanic Section Below the Level of the Detonation
Water level elevations for re-entry well UC-1-P-2SR (drilled into the chimney) are shown for reference.

Figure 8 shows the hydrographs of wells with open intervals below the detonation level and reentry well UC-1-P-2SR (perforated from 1178 ft to 2790 ft below ground surface). The composite head level from UC-1-P-2SR (chimney and alluvium overlying the detonation area) is higher than in the densely welded tuff units below the detonation zone and continues to increase. The composite head level increased approximately 7.9 ft during this monitoring period.

Hydraulic head data from the MV-4 and MV-5 wells and piezometers continue to support the conceptual model that the southeast-bounding graben fault acts as a barrier to flow at the site. The hydraulic heads in MV-4PZ and MV-5PZ (screened inside the down-dropped graben block) are approximately 250 ft higher than those in the corresponding wells that are screened in the upthrown block southeast of the graben. Given these results, alluvial aquifer hydrographs were separated into two groups based on their location (at screen depth) relative to the southeast-bounding graben fault.

A hand contoured potentiometric map of the upper part of the alluvial aquifer within the graben (Figure 9) was constructed using the October 27, 2010 head levels from MV-4PZ, MV-5PZ, UC-1-P-1SRC, MV-1UPZ, and MV-2UPZ, all of which are screened at depths ranging from 600 – 1000 ft. Contouring of the potentiometric surface (Figure 9) was restricted to the area within the graben. It should be noted that there is an inherent degree of uncertainty in the depiction of groundwater flow directions when the minimum number of three points are used. Reentry well UC-1-P-2SR is not completed in the upper part of the alluvium but in the chimney. The interpretation shown on Figure 9 suggests horizontal flow in the upper part of the alluvial

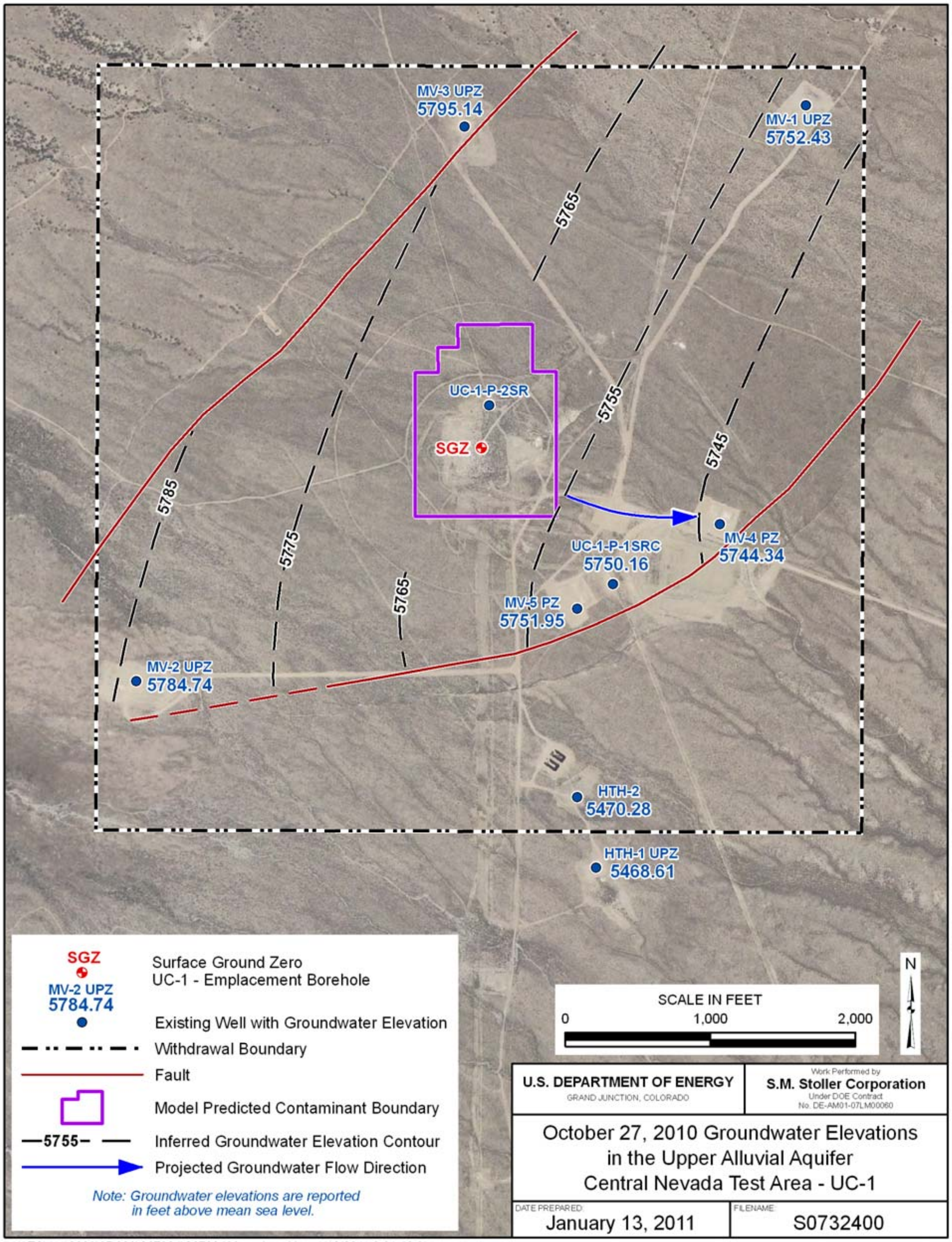

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Figure 9. Potentiometric Map for the Upper Part of the Alluvial Aquifer, CNTA

aquifer is generally to the east-southeast and is likely deflected by the southeast-bounding graben fault. The new wells MV-4 and MV-5 were completed in the lower part of the alluvial aquifer outside the graben block (at depth) to confirm that the southeast-bounding graben fault acts as a flow barrier and for compliance monitoring at a depth nearer the detonation zone.

6.0 Summary

The 2009 drilling program enhanced the CNTA monitoring network with seven new monitoring locations (wells and piezometers) in the alluvial aquifer and one in the upper volcanic section. Detection monitoring results indicate that radioisotope levels in groundwater continue to remain below detection limits. Water level data indicate that hydraulic heads are still recovering for wells installed during the 2009 drilling project. Aquifer testing of wells UC-1-P-1SRC and MV-5 was completed in May 2010. Aquifer testing of well MV-4 was completed in September 2010. Continued monitoring indicates that head changes in the MV-2LPZ were not completely eliminated by the additional development activities. The submersible pumps in wells MV-1, MV-2, and MV-3 were removed and replaced by low-flow bladder pumps. Large drawdowns seen at these wells during past sampling events will be limited to a few feet in future sampling events.

7.0 References

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Appendix A

Well Purging Data

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Table A−1. Monitor Well Purge Data

Well Identification	Date Sampled	Purged Volume (gallons)	Temperature (°C)	pH (s.u.)	Specific Conductance (μmhos/cm)
HTH-1RC	6/09/2010	7	18.0	8.28	616
HTH-2	NS	NS	NS	NS	NS
MV-1	6/09/2010	10	17.3	9.42	730
MV-2	6/08/2010	8	17.3	10.25	1085
MV-3	6/08/2010	11	18.2	7.55	988
MV-4	8/30/2010	1750	NC	8.82	102
			NC	8.83	103
			NC	9.17*	186*
MV-5	5/26/2010	10,744	24.49	9.63	493
			24.71	9.66	466
			24.27	9.65	450
UC-1-P-1SRC	5/22/2010	48,592	19.04	7.19	325
			19.10	7.19	327
			19.04	7.24	324

s.u. = Standard Unit
μmhos/cm = micromhos per centimeter
NA = data not collected because the temperature probe was not working
NS = indicates the well was not sampled due to pump failure
* = indicates pump stopped working during the aquifer test because the motor saver in the control box was set to shut the pump off at flow rates below 2.1 gallons per minute.

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Appendix B

NDEP Correspondence with Record of Review and Response to Comments

February 15, 2011

Mr. Mark Kautsky
Site Manager
U. S. Department of Energy
Office of Legacy Management
2597 B ¾ Road
Grand Junction, CO 81503

RE: Draft 2010 Groundwater Monitoring Report for the Central Nevada Test Area, Corrective Action Unit 443, January 2011
Federal Facility Agreement and Consent Order

Dear Mr. Kautsky:

The Nevada Division of Environmental Protection, Bureau of Federal Facilities (NDEP) has reviewed the U. S. Department of Energy, Office of Legacy Management's *Draft 2010 Groundwater Monitoring Report for the Central Nevada Test Area, Corrective Action Unit 443, January 2011* (Report) received on February 10, 2011. The NDEP has the following comments or questions on the Report which should be addressed in the Final version of the Report:

1. Page 7, Figure 4: There is no data from 2010 on this Figure although the text in the second paragraph of Section 3.0 states the water level in this well increased about 8 feet in 2010. Please correct the figure.

2. Page 8, Table 1: The 2010 data for Well UC-1-P-2SR should be added to this Table.

3. Page 11, Figure 6: The legend has UC-1-P-1s when it should be UC-1-P-1S. In addition, there is an arrow indicating the section of the plot before recompletion of this well. It would aid the reader to put an arrow toward the portion of the plot that is after recompletion and label it UC-1-P-1SRC as indicated in the text.

4. Page 12, Figure 8: The legend has UC1-P-2sr when it should be UC-1-P-2SR to be consistent with the Figure caption.

5. Page 13, Section 5.2, First Paragraph, Second Sentence: "The...MV-4 and MV-5 piezometers...." should be changed to "The...MV-4PZ and MV-5PZ..." to aid the reader in locating in the Table and Figures the appropriate head data under discussion.

6. Pages 11 through 15, Section 5.2: It would be very helpful to have the text explaining each of the Figures immediately above or below the respective Figure, not two pages away. This change does not have to be done for the Final 2010 Report but should be made in the 2011 Report. This change will necessitate moving the current Figure 9 between the current Figures 6 and 7 and renumbering these three Figures.

If you need any clarification on the comments or questions above, please contact Chris Andres at 702-486-2850, ext. 232.

Sincerely,

T. H. Murphy
Chief
Bureau of Federal Facilities

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Record of Review

Due Date	Review No.	Project	Type of Review
3/07/2011	1	Legacy Managment	Technical

Document Title and\or Number and Revision
2010 Groundwater Monitoring Report Central Nevada Test Area, Corrective Action Unit 443
(S07116)

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Reviewers' Recommendation

- ☐ Release Without Comment
- ☐ Consider Comments
- ☐ Resolve Comments and Reroute for Review

Signature of Reviewer and Date

- ☒ Comments Have Been Addressed

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Signature of Author and Date

- ☒ Comment Resolution Satisfactory
- ☐ Comment Resolution Unsatisfactory

[signature] 3/7/11

Signature of Reviewer and Date

Item No.	Reviewer's Comments and Recommendation	Reqd. (Y/N)	Item No.	Author's Response (if required)
1	Page 7, Figure 4: There is no data from 2010 on this Figure although the text in the second paragraph of Section 3.0 states the water level in this well increased about 8 feet in 2010. Please correct the figure.	Y	1	The change was made as requested.
2	Page 8, Table 1: The 2010 data for Well UC-1-P-2SR should be added to this Table.	Y	2	The change was made as requested.
3	Page 11, Figure 6: The legend has UC-1-P-1s when it should be UC-1-P-1S. In addition, there is an arrow indicating the section of the plot before recompletion of this well. It would aid the reader to put an arrow toward the portion of the plot that is after recompletion and label it UC-1-P-1SRC as indicated in the text.	Y	3	The change was made as requested.
4	Page 12, Figure 8: The legend has UC1-P-2sr when it should be UC-1-P-2SR to be consistent with the Figure caption.	Y	4	The change was made as requested.

Record of Review (continuation)

Review No.	Project

Item No.	Reviewer's Comments and Recommendation	Reqd. (Y/N)	Item No.	Author's Response (if required)
5	Page 13, Section 5.2, First Paragraph, Second Sentence: "The...MV-4 and MV-5 piezometers..." should be changed to "The...MV-4PZ and MV-5PZ..." to aid the reader in locating in the Table and Figures the appropriate head data under discussion.	Y	5	The change was made as requested.
6	Pages 11 through 15, Section 5.2: It would be very helpful to have the text explaining each of the Figures immediately above or below the respective Figure, not two pages away. This change does not have to be done for the Final 2010 Report but should be made in the 2011 Report. This change will necessitate moving the current Figure 9 between the current Figures 6 and 7 and renumbering these three Figures.	N	6	The change was made as requested.

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