LMS/SHL/S17855

Addendum to:

Corrective Action Decision Document/Corrective Action Plan (CADD/CAP) for the Subsurface Corrective Action Unit 447 Shoal, Nevada, Site

July 2019

U.S. DEPARTMENT OF ENERGY | Legacy Management

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Contents

Figures

Tables

Appendix

Abbreviations

amsl	above mean sea level
^{14}C	carbon-14
CADD	Corrective Action Decision Document
CAP	Corrective Action Plan
DOE	U.S. Department of Energy
DRI	Desert Research Institute
FFACO	Federal Facility Agreement and Consent Order
ft	feet
HC	hydrologic characterization
^{129}I	iodine-129
K_1	hydraulic conductivity (randomly oriented fractures)
K_2	hydraulic conductivity (large fracture planes)
LM	Office of Legacy Management
m/d	meters per day
MV	monitoring/validation
NDEP	Nevada Division of Environmental Protection
pCi/L	picocuries per liter
PDF	probability density function
QSM	Quality Systems Manual
RDL	required detection limit
SCM	site conceptual model
SGZ	surface ground zero
yr	year

Preface

The Nevada Division of Environmental Protection (NDEP) in 2006 approved Revision 3 of the *Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 447: Project Shoal Area, Subsurface*, *Nevada* (DOE 2006b), hereafter called the Corrective Action Decision Document/Corrective Action Plan (CADD/CAP). The Corrective Action Alternative selected for the Project Shoal Area in Churchill County, Nevada, now referred to as the Shoal, Nevada, Site (Shoal site), is "Proof of Concept Monitoring with Institutional Controls." This corrective action began with the installation in 2006 of three monitoring/validation (MV) wells— MV-1, MV-2, and MV-3—for the dual purpose of monitoring for contaminant migration and evaluating the groundwater flow and transport model results. Desert Research Institute (DRI) conducting the model validation concluded that the data obtained from wells MV-1, MV-2, and MV-3 did not validate the numerical model. A groundwater model validation report summarized the results; it recommended the collection of additional data and the evaluation of alternative approaches for determining the contaminant boundary at the site. The U.S. Department of Energy (DOE) Office of Legacy Management (LM) used these conclusions and recommendations to develop a new strategy for the site, as allowed in Appendix VI of the *Federal Facility Agreement and Consent Order (FFACO)* (1996, as amended) (FFACO 1996, as amended).

The new strategy included a stepped approach for collecting new data, which was outlined in a letter from NDEP in August 2009. It also initiated a revision to Section 5.0 in Appendix VI, "Corrective Action Strategy," of the FFACO (NDEP 2009). The revised Corrective Action Strategy focuses on evaluating the site conceptual models (SCMs) and adequacy of the monitoring well network and collecting data to validate the compliance boundary through monitoring and institutional controls, rather than relying predominantly on a numerical model (FFACO 1996, as amended). The new strategy was implemented through three short-term data acquisition plans completed in 2009, 2011, and 2014. These plans facilitated enhancements to the monitoring well network and data collections designed to improve the SCMs. The documents supported the CADD/CAP and were provided to NDEP as interim documents until this addendum could be completed.

This document is an addendum to the original CADD/CAP. It includes summaries of the corrective action activities, numerical model validation results, enhancements made to the monitoring program and monitoring network as implemented through three short-term data acquisition plans, and updates made to the SCMs since CADD/CAP approval in 2006. The document begins at Section 5.6 as a continuation of the "Implementation of the Corrective Action Plan" of the CADD/CAP. Table and figure numbers are in sequence with the CADD/CAP.

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5.6 Findings of the Initial Corrective Action and Recommended Changes to the Plan

The Corrective Action Alternative selected for the Shoal site in Section 4.0 of the CADD/CAP is "Proof of Concept Monitoring with Institutional Controls" (DOE 2006b). The drilling and installation of monitoring/validation (MV) wells MV-1, MV-2, and MV-3 (Figure 5-27)—initiated this action in 2006. The three wells are near the target locations presented in Appendix A of the CADD/CAP and were constructed with a well completed near the borehole completion depth and a piezometer completed near the water table as specified in Section 5.2 of the CADD/CAP. The well completion report dated September 2006 (DOE 2006a) summarizes the well installation activities. The wells were developed, dedicated submersible electric pumps were installed, and aquifer tests were performed on the wells. Hydraulic conductivities in wells MV-1, MV-2, and MV-3 ranged from about 0.2 meters per day (m/d) in MV-2 to about 0.004 m/d in MV-1. A September 2006 hydrologic evaluation report prepared by DRI summarizes aquifer test results (DRI 2006). DRI used data collected from these wells to assess the numerical model as specified in Section 5.5 of the CADD/CAP; results are summarized in the groundwater model validation report dated May 19, 2008 (Stoller 2008). Figure 5-27 shows the well locations at the site.

The groundwater model validation report concluded that the steady-state assumption used for the numerical model was not valid and that groundwater elevations observed at wells MV-1, MV-2, and MV-3 did not validate the predominant horizontal flow direction predicted by the modeled realizations. Despite these results, hydraulic conductivity values and fracture geometry from the MV-1, MV-2, and MV-3 well data agreed with those used as model input. These conclusions prompted the recommendation that additional data be collected and alternative approaches be evaluated for determining the contaminant boundary at the site (Stoller 2008). LM and NDEP used these conclusions and recommendations to develop a new strategy for the site, as allowed in Appendix VI of the FFACO (FFACO 1996, as amended). Section 5.6.1 of this report provides a brief summary of the numerical model validation results.

LM's discussions with NDEP led to the use of a stepped approach to collect new data at the site, which was outlined in a letter from NDEP in August 2009. Another recommendation was to update Section 5.0, "Corrective Action Strategy," in Appendix VI of the FFACO to reflect current activities at the Central Nevada Test Area and Shoal site (NDEP 2009). This process began, and further negotiations resulted in a new strategy that focuses on evaluating the SCMs and adequacy of the monitoring well networks and collecting data designed to validate each site's compliance boundary through monitoring and institutional controls rather than relying predominantly on numerical modeling. LM implemented the new corrective action strategy it developed with NDEP by revising the FFACO, Appendix VI, completed in May 2011 (FFACO 1996, as amended). This strategy was applied at the Shoal site, which is currently at the end of the 5-year monitoring phase (step 5) of the corrective action strategy process (FFACO 1996, as amended).

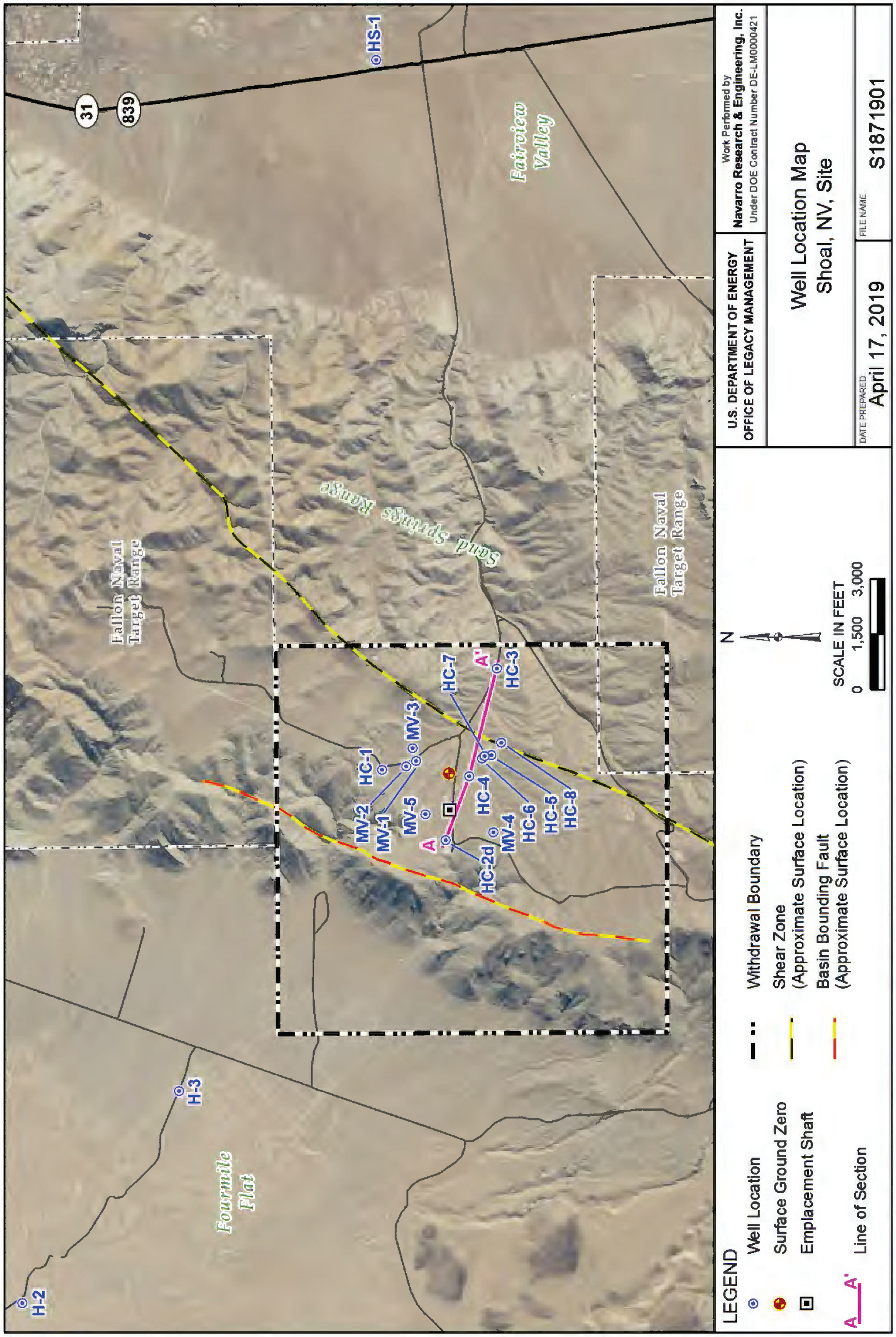


Figure 5-27. Monitoring Well Locations at the Shoal, Nevada, Site

Three separate short-term data acquisition plans completed in 2009, 2011, and 2014 facilitated enhancements to the monitoring well network and data collections designed to improve the SCMs. This strategy included a new 5-year evaluation period, which began after the last data acquisition plan was completed in 2014. Data collected during this evaluation period will be used with data collected during the original "proof of concept" monitoring period that began in 2006 to demonstrate that the interpreted potential transport pathways identified through the SCMs are adequately monitored. If these monitoring results are acceptable, NDEP will approve the site's transition to the closure report phase (FFACO 1996, as amended). The following paragraphs summarize the data acquisition plan activities and results. Figure 5-28 is a flow chart outlining the steps used to implement the new strategy at the site.

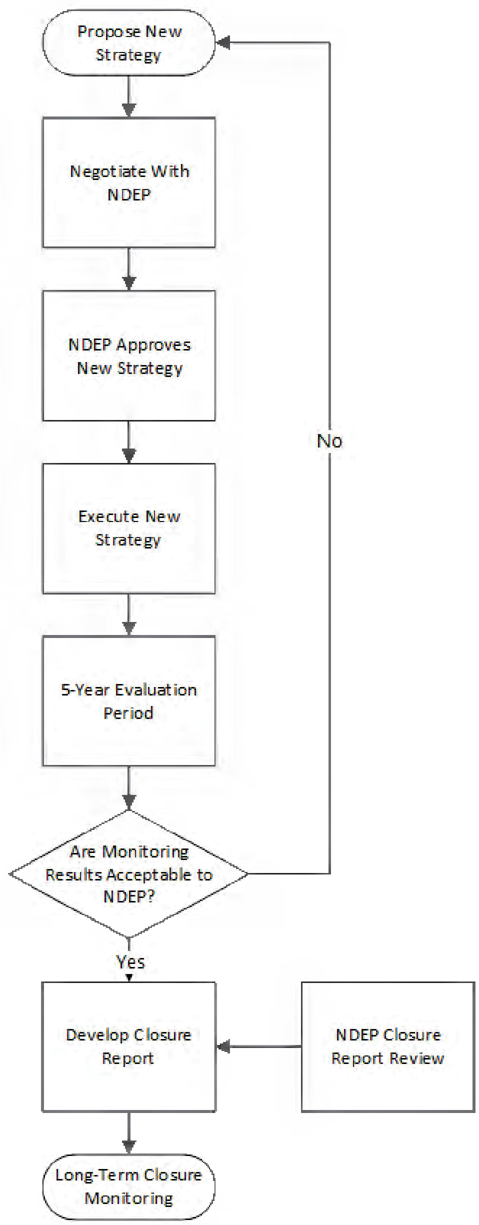


Figure 5-28. Flow Chart Showing Stepped Approach to Be Used to Implement New Strategy at Shoal, Nevada, Site

The first data acquisition plan, completed in 2009, outlined plans to enhance the groundwater monitoring program and implement a surface geophysical program (i.e., seismic reflection and electromagnetic surveys), which included a survey of dikes visible at the surface of the site (DOE 2009). The monitoring network originally consisted of five wells (hydrologic characterization [HC] wells HC-1 and HC-4 and wells MV-1, MV-2, and MV-3), but it was expanded in 2009 to include the collection of radiochemistry data and water level data from all wells onsite and collection of water level data from wells H-2 and H-3 offsite in Fourmile Flat (Figure 5-27) (DOE 2009). The electromagnetic survey results identified areas of contrasting resistivity that generally trend with the fractured dikes along the western boundary of the survey area. An area west–northwest of the detonation zone (detonation cavity, chimney, and fractured area surrounding the detonation cavity) was identified as an area of relatively high electrical resistivity at the detonation depth, similar to that observed near the detonation zone and tunnel that connects the emplacement shaft with the detonation location (Figures 5-27 and 3-29) (DOE 2011a). Seismic reflection survey results identified the shear zone east of surface ground zero (SGZ) (DOE 2011a). The surface geophysical results were used to develop potential SCMs.

LM organized a technical exchange meeting with the geophysicists who performed the surveys (Lee Liberty from Boise State University and Jim Hasbrouck from Hasbrouck Geophysics Inc.), DRI, and NDEP in March 2011 to discuss survey results and potential SCMs. Meeting participants agreed that further understanding of the groundwater flow system was needed for the enhancement of potential SCMs and that a new short-term data acquisition plan was necessary to outline future activities at the site. The surface geophysics report completed in April 2011 recommended that geophysical data be evaluated further and compared with existing data to assess and enhance the potential SCMs (DOE 2011a). This was executed through the second data acquisition plan completed in October 2011, which included further review of the geophysical data with laboratory, hydrologic, and geologic data obtained from historical reports to help identify geologic structures that might influence groundwater flow at the site (DOE 2011b). These data were assembled for three-dimensional visualization and helped identify faults and fractures that might influence groundwater flow at the site; they also helped identify locations for new monitoring wells and helped advance the SCMs.

The final data acquisition plan was completed in 2014 with the addition of monitoring wells MV-4 and MV-5 and deepening of well HC-2, now identified as HC-2d (DOE 2014). These wells were installed to monitor potential groundwater flow paths identified through the SCMs. Monitoring wells MV-4 and MV-5 were dually completed with a well and piezometer so vertical and horizontal gradients could be evaluated. The well casing in existing well HC-2 was removed and the borehole deepened to allow installation of well HC-2d. The well completion report dated November 2015 (DOE 2015b) summarized well installation activities. The new wells were completed with dedicated electric submersible pumps to facilitate groundwater sample collection and conduct aquifer tests. Analysis of aquifer test data from these wells (MV-4, MV-5, and HC-2d) obtained hydraulic conductivities that ranged from about 0.09 m/d in MV-5 to about 0.0003 m/d in HC-2d. A hydrologic evaluation report (DOE 2018a) summarizes aquifer test results. Table 5-10 provides the well location information and top-of-casing (TOC) elevations with screen zone elevations for the wells installed after 2006. Appendix A provides copies of the short-term data acquisition plans.

The following sections summarize the numerical model validation results and include the changes made to the SCM, contaminant boundary, and compliance boundary.

Table 5-10. Well Location and Construction Depth Information

Well/Piezometer Identification	Northings (ft)	Eastings (ft)	TOC Elevation (ft amsl)	TSZ Elevation (ft amsl)	BSZ Elevation (ft amsl)	Screen Length (ft)
MV-1	1621056.50	557878.03	5254.64	3680.24	3526.43	154
MV-1PZ	1621056.85	557878.41	5254.38	3915.47	3855.47	60
MV-2	1621327.59	557731.38	5263.72	3442.63	3271.86	171
MV-2PZ	1621327.87	557730.91	5263.60	4074.80	4015.30	60
MV-3	1621150.26	558232.20	5258.60	3793.61	3622.45	171
MV-3PZ	1621149.66	558231.86	5258.24	4116.78	4056.75	60
MV-4	1618968.08	555950.40	5370.78	3969.08	3809.08	160
MV-4PZ	1618967.70	555950.26	5370.41	4249.08	4129.08	120
MV-5	1620801.32	556441.09	5318.16	3991.01	3751.01	240
MV-5PZ	1620801.38	556440.79	5317.50	3616.01	3586.01	30
HC-2d	1620263.52	555725.90	5343.93	3925.15	3685.15	240[a]

Notes:
[a] Indicates the well is screened across multiple intervals and the total effective screen length is provided.
Coordinate system: U.S. State Plane, Zone Nevada West 2703
Horizontal Datum: North American Datum 1927
Vertical Datum: North American Vertical Datum 1929

Abbreviations:
amsl = above mean sea level
BSZ = bottom of screen zone
ft = feet
PZ = piezometer
TSZ = top of screen zone

5.6.1 Summary of the Validation Analysis

A significant conclusion of the model validation process was that the steady-state assumption used for the groundwater flow and transport model was not valid for the site (Stoller 2008). Water elevations on the detonation-side of the shear zone have increased since the first HC wells were installed in 1996. Initially, water levels in the HC wells were within the uncertainty bounds of the numerical model and the increase was attributed to recovery from drilling and well development. However, the trend of increasing water levels continued, and water levels at the MV wells (installed in 2006) were outside the middle 95% predictions of the numerical model. The trend of rising water levels, increasing from about 1–3 feet per year (ft/yr), has continued through the latest water levels that were collected in late 2017 (DOE 2018b). The model validation process also concluded that the horizontal component of groundwater flow predicted by the numerical model was primarily toward the north–northeast, whereas horizontal gradients inferred from water levels measured in site wells did not support this flow direction. Other aspects, such as hydraulic conductivity values and fracture geometry from the MV-1, MV-2, and MV-3 well data agreed with those used as model input. The net result was that many model realizations performed well against the validation tests, but the increasing groundwater elevations raised a significant question about the steady-state assumption and the inferred groundwater flow directions at the site (Stoller 2008). The following sections summarize the validation data and analysis.

5.6.1.1 Model Validation Data

Model validation data originated with the three wells (MV-1, MV-2, and MV-3) and three piezometers (MV-1PZ, MV-2PZ, and MV-3PZ) installed in 2006. The wells and piezometers provided data on fracture orientation and frequency, groundwater elevations, hydraulic conductivity, and groundwater chemistry. These data were collected for comparison to the numerical model input and simulated results as part of the process to verify the numerical model. The analysis used a total of 12 real-number validation targets (five values of hydraulic head, three values of hydraulic conductivity, three values of hydraulic gradient, and one horizontal gradient direction). In addition, the fracture dip and orientation data were compared to the distributions used in the numerical model, and radiochemistry data were compared to the model output.

5.6.1.2 Model Validation Results

DRI followed the validation process described in the CADD/CAP, beginning by evaluating calibration accuracy, performing various statistical tests, and developing acceptance criteria and composite scores. Goodness-of-fit tests included in the validation assessment indicated that some of the model realizations corresponded well with the hydraulic conductivity, groundwater elevation, and gradient data, while others did not. The data revealed, among other observations, that the lateral flow direction predicted by most model realizations did not agree with the flow direction based on groundwater elevation data at the MV-1, MV-2, and MV-3 wells. In addition, initial review of test results indicated that groundwater elevations at the MV-1, MV-2, and MV-3 wells were either on the high side of comparable model distributions or exceeded maximum values in those distributions. Some comparisons between measured and modeled groundwater elevations suggested that the generation of additional model realizations based on revised model input distributions might improve numerical model performance. However, an approach involving revised input distributions was not followed because the limited agreement between observed and model-generated groundwater elevations could at least partially be attributed to steadily increasing water levels at the site over time. Such transient conditions indicated that the steady-state assumption of the numerical model was in error (Stoller 2008).

Two flow categories represent the Sand Springs granite in the numerical model: one representing large blocks populated by small, randomly oriented fractures (K_1) and the second representing strongly oriented, large fractures that dominate fracture flow (large fracture planes) (K_2). The K_2 values were assigned from a distribution developed from numerical analysis of the tracer test, the regional flow model enveloping the site model, and the range of the field data. The K_1 distribution was a product of site-model calibration, an important factor of which was recharge so that the K_1 values were adjusted to replicate observed heads. After a review of the hydraulic conductivity validation targets and measured values from the MV-1, MV-2, and MV-3 wells (a product of both fracture types), it was determined that all three values fall within the inner 95% of the hydraulic conductivity distribution used in the numerical model. The hydraulic conductivity value from MV-1 corresponds well with the mode of the distribution, whereas the hydraulic conductivity value from MV-2 is close to the 97.5th percentile (the upper end of the distribution). The MV-3 hydraulic conductivity measurement is halfway between the 50th and 97.5th percentiles of the hydraulic conductivity distribution used in the numerical model (Figure 5-29). From these plots it can be concluded that the overall range of the hydraulic conductivity used in the numerical model was reasonable, and the field observations at the three wells validate the hydraulic conductivity ranges used in the model. Figure 5-29 presents the probability density function (PDF) of hydraulic conductivity values used for the numerical model with hydraulic conductivities from the MV-1, MV-2, and MV-3 wells. The horizontal axis is provided in $\log_{10}$ scale of meters per day (m/d). The 0 on the scale is equivalent to a hydraulic conductivity of 1 m/d, −1 is equivalent to 0.1 m/d, −2 is 0.01 m/d, and so forth.

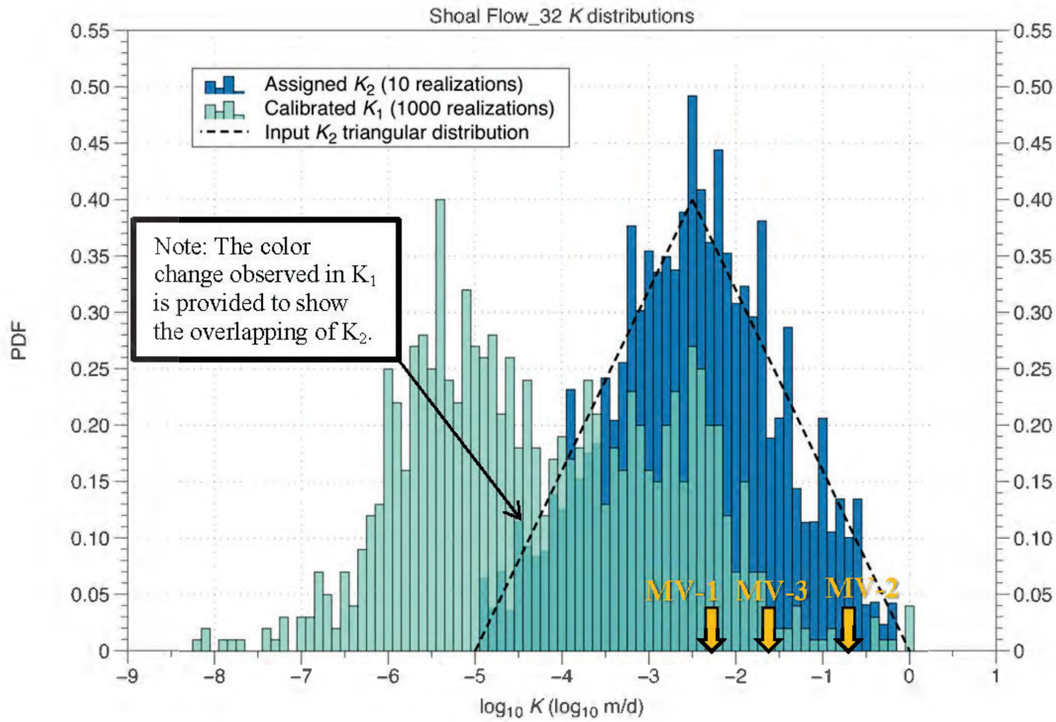


Figure 5-29. Shoal Model Hydraulic Conductivity Distributions with 2006 MV Well Field Data

Water elevations measured in 2006 at wells MV-1, MV-2, and MV-3 were trended back to their likely values in 1999. The numerical model, which assumed steady-state conditions, was calibrated to water elevations measured at site wells in 1999. The persistent trend of increasing water levels at the site made the backward adjustment necessary. Statistical tests were then performed using both the backward-projected groundwater elevations and the observed groundwater elevations in 2006 to identify acceptable model realizations. A statistical method referred to as a jackknife approach identified two possible threshold values to consider. For the analysis using the backward-trended groundwater elevations, either 458 or 818 realizations (out of 1000) were found acceptable, depending on the threshold chosen. The analysis using the observed groundwater elevations obtained in 2006 found either 284 or 709 realizations acceptable. Using only acceptable realizations from the backward-trended analysis, DRI performed transport model simulations based on an assumed starting mass of a single radionuclide to assess the impact of such a refined set of realizations on the model computed contaminant boundary for the site. The assessment indicated that the recalculated contaminant boundary is either slightly or moderately larger than the one based on the full 1000 realizations, depending on the threshold (Stoller 2008).

5.6.2 Changes to the Conceptual Model (Revision of Section 2.1.2.4.1)

The Shoal site is in Gote Flat at an elevation of approximately 5250 ft above mean sea level (amsl) and is within the northern portion of the Sand Springs Range, which is the southern extension of the Stillwater Range. The Sand Springs Range rises to an elevation of approximately 6750 ft amsl and is flanked by Fairview Valley to the east and Fourmile Flat to the west (Figure 5-27). The underground nuclear test was conducted at a depth of 1211 ft in granitic rock that is part of the Cretaceous-age Sand Springs granitic batholith (DOE 2015a). Its composition is granodiorite and granite, aplite, and pegmatite dikes; andesite dikes; rhyolite dikes; and rhyolitic intrusive breccia. Internal deformation of the Sand Springs granite is largely by high-angle normal faults and fractures distributed between two dominant structural trends that strike approximately N 50^{o} W and N 30^{o} E and are vertical to steeply dipping. The most dominant of these structural features are a shear zone that strikes N 30° E and transects the eastern portion of the site and a basin bounding fault that has a similar strike and is approximately 3000 ft west of the detonation (Figure 5-27). Several dikes visible at the surface west–northwest of the detonation occur along the same two orientations and intrude along lines of preexisting weakness. These orthogonal-type sets of faults and fractures appeared early in the history of the Sand Springs granite and affected much of the subsequent structural and chemical evolution of this large intrusion (Nevada Bureau of Mines and Geology 1964).

Groundwater is encountered in Fourmile Flat at about 3900 ft amsl and Fairview Valley at about 3960 ft amsl (Figure 5-27). Groundwater beneath the site (near SGZ and west of the shear zone) ranges in depth from 950 to 1110 ft (4250 to 4300 ft amsl). Groundwater elevations in wells east of the shear zone are at about 3900 ft amsl (3920 ft amsl in shallow well HC-3 and 3880 ft amsl in deeper wells HC-5 and HC-8). The shear zone dips steeply to the northwest from a surface location approximately 1500 ft east of SGZ (Figure 3-29) and is interpreted as a barrier to groundwater flow on the basis of disparate water levels in wells separated by the shear zone (DRI 2001). Water levels measured in wells west of the shear zone (Figure 3-29) are increasing about 1 to 3 ft/yr during the time they have been monitored, beginning with the installation of the HC wells in the late 1990s. Water levels measured in site wells east of the shear zone have not increased but have decreased in wells HC-5 and HC-8 (Figure 3-29) at a rate of approximately 1 to 2 ft every 10 years (DOE 2018b). The primary source of groundwater beneath the site is infiltration during a wetter period about 12,500 years ago when the former Lake Lahontan filled Fourmile Flat to an elevation of nearly 4400 ft amsl (Nevada Bureau of Mines and Geology 1964). Strand lines from the former lake remain on the ranges surrounding Fourmile Flat, which is now a playa with evaporites and salt deposits. Current water levels in the Fourmile Flat playa are about 3900 ft amsl. Carbon-14 (^{14}C) age date data from well samples indicate that groundwater beneath the site ranges from 8000 to 22,000 years before present, which supports the interpretation that groundwater beneath the site is remnant water from the former Lake Lahontan (DOE 2013). Figure 3-29 is a cross section showing the well screen zones, potentiometric surface, and shear zone that crosses the site.

Groundwater flows through fractures in the low-permeability granite at the site, with hydraulic conductivity values ranging from about 0.0003 to 0.2 m/d (0.001 to 0.6 ft/d). The permeability of the granite is assumed to increase near the detonation zone, which was subjected to fracturing from the underground nuclear test and is the source of contamination at the site. Well HC-4 is completed near the detonation cavity within the area of increased fracturing. The extent of contamination at the site is believed to be limited in that only well HC-4 has had detections of tritium and ^{14}C above laboratory detection limits using conventional laboratory methods.

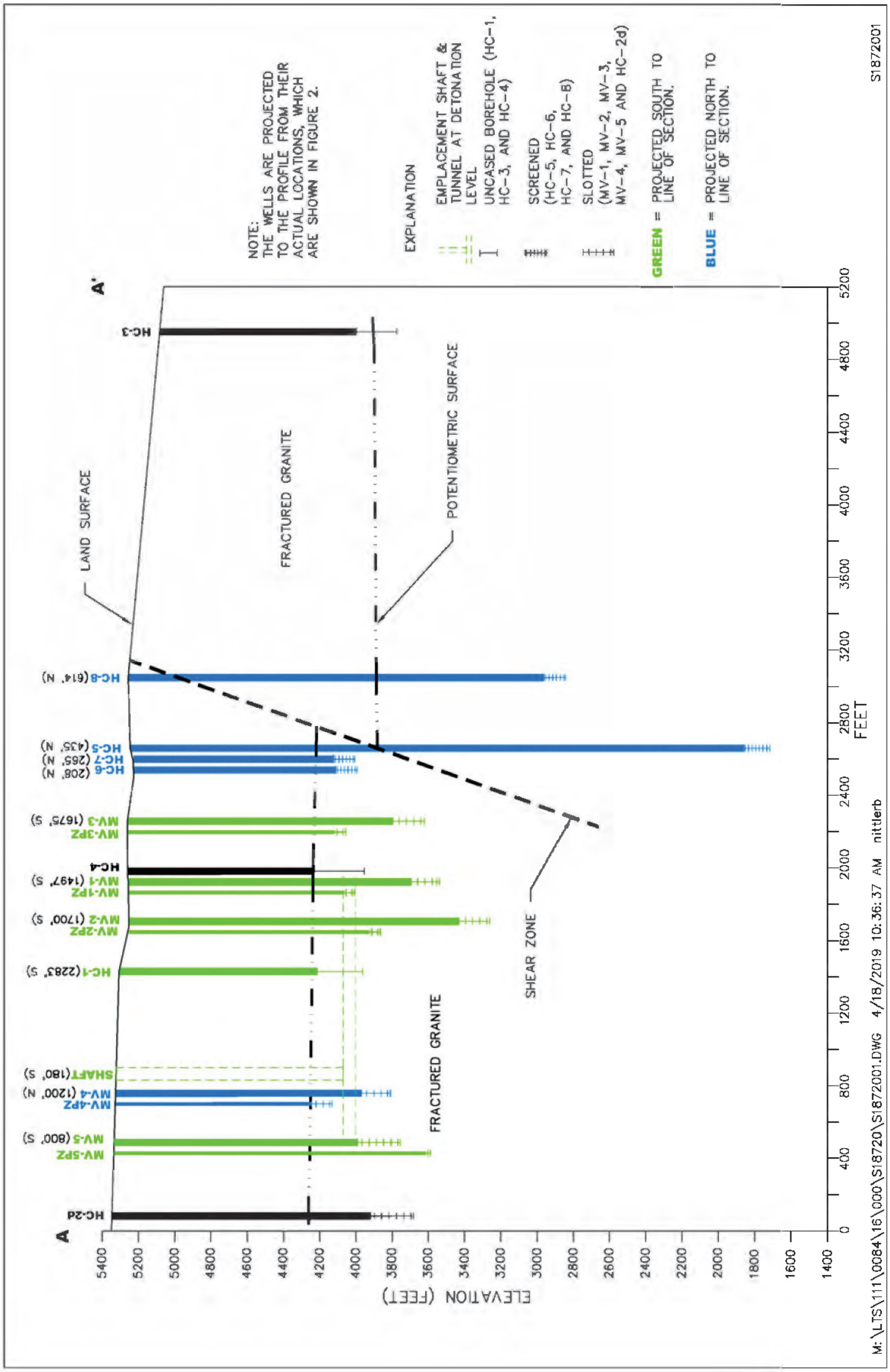


Figure 3-29. Cross Section A–A' Depicting Monitoring Well and Shear Zone Location, Shoal, Nevada, Site

The presence of tritium and ^{14}C in well HC-4 are attributed to its proximity (bottom hole location about 475 ft south of detonation cavity) to the detonation zone (Figures 5-27 and 3-29). The emplacement tunnel that extends 950 ft west of the detonation to the emplacement shaft is also assumed to be a high permeability feature. Recharge occurs by infiltration of precipitation on the mountain range, and regional discharge occurs in the adjacent valleys (Nevada Bureau of Mines and Geology 1964).

The corrective action strategy focuses on revising the SCMs and enhancing the monitoring well network. Enhancements to the monitoring well network were designed to monitor the potential transport pathways of the three conceptual flow scenarios for the site. The three conceptual flow models and the wells that monitor each potential flow path are as follows:

- Groundwater flow mimics the surface topography: The water table is a subdued reflection of the surface topography, with groundwater flowing from the higher elevation range tops toward the detonation zone/Gote Flat and out through the lower elevation canyons to Fourmile Flat. The shear zone limits groundwater flow to the east. Wells MV-4, MV-5, and HC-2d are the primary monitoring wells for this flow scenario.
- Groundwater flow through fractured dikes: Dikes observed at the surface of the site west–northwest of the detonation zone are fractured more than the surrounding host rock and, if the fracturing persists at depth, may provide higher permeability pathways for groundwater flow to the west. The electromagnetic survey, completed in 2010, identified an area west–northwest of the detonation zone as an area of relatively high electrical resistivity, similar to that observed near the tunnel and detonation zone (DOE 2011a). It was interpreted that this area might be more fractured than the surrounding host rock since the detonation zone was highly fractured as a result of the detonation. Well MV-5 was installed in this area, and aquifer test results indicate that MV-5 is in an area of relatively high hydraulic conductivity for the site. Wells MV-5 and HC-2d are the primary monitoring wells for this flow scenario.
- Groundwater flow parallel to shear zone and basin bounding fault: The groundwater flow direction is parallel to the strike of the shear zone and basin bounding fault, both of which limit flow to the adjacent valleys. Wells MV-1, MV-2, and MV-3 provide monitoring for this flow scenario if groundwater flow is toward the north–northeast; wells MV-4 and HC-4 provide monitoring if groundwater flow is toward the south–southwest; and wells HC-6 and HC-7 provide monitoring if groundwater flow is toward the south–southeast.

Groundwater has been monitored at the site since the first wells were installed in 1996. Many enhancements have been made to the monitoring program during this time, and they have increased LM and NDEP understanding of the groundwater flow system at the site. The three groundwater flow scenarios described above are somewhat simplistic in summary and intend to provide a generalized conceptualization of the flow system as it relates to the possible fate and transport of radionuclides from the detonation zone. Identifying all geologic features that might potentially influence groundwater flow is not possible, and the flow scenarios presented above may underestimate the impact some of these features may have on the groundwater flow system. It is also possible that groundwater flow at the site is a combination of one or more of these flow scenarios. The long-term monitoring program will continue to provide time-series data (groundwater elevation and radioisotope) from the network of monitoring wells and piezometers that will be reviewed to track changes in the flow system over time and be provided to NDEP in annual groundwater monitoring reports.

5.6.3 Changes to the Contaminant Boundary (Revision of Section 2.2.4)

Groundwater elevations observed at wells MV-1, MV-2, and MV-3 did not validate the predominant horizontal flow direction predicted by the modeled realizations; however, hydraulic conductivity data from aquifer tests on these wells fell within the inner 95% of the hydraulic conductivity distribution used in the numerical model. This led to conclusions that the overall range of the hydraulic conductivity values used in the numerical model was reasonable, and the field observations at the three wells validate the range of hydraulic conductivity values selected for the multiple model realizations. Aquifer test data from the wells (MV-4, MV-5, and HC-2d) installed in 2014 also fall within the hydraulic conductivity distribution used in the numerical model and are slightly lower than the hydraulic conductivities obtained from the 2006 MV wells (Figure 4-30). These data reviewed with historical aquifer test data from other wells onsite support the extent, though not the direction, of the numerical model-predicted contaminant boundary. Given that water levels in site wells on the detonation side of the shear zone continue to rise and at differing rates, a prevailing horizontal flow direction cannot be identified at this time. It is also possible that the horizontal gradient will continue to vary over time and a stable flow direction will never be obtained. To account for these uncertainties, LM proposes a simplified yet conservative approach that assumes groundwater flow could occur in any direction from the detonation zone. This approach treats the contaminant boundary as a cylindrical surface that encompasses the contaminant volume. The lateral extent of the cylinder is based on the distance that encompasses 95% of the model realizations of contaminant transport, the same as the original modeled contaminant boundary except extended in all directions. The cylinder is truncated to the east at depth by the low-permeability shear zone that is a barrier to groundwater flow (Figure 5-31). Figure 4-30 presents the PDF of hydraulic conductivity values used for the numerical model with hydraulic conductivities from wells installed in 2006 (MV-1, MV-2, and MV-3) and wells installed in 2014 (MV-4, MV-5, and HC-2d).

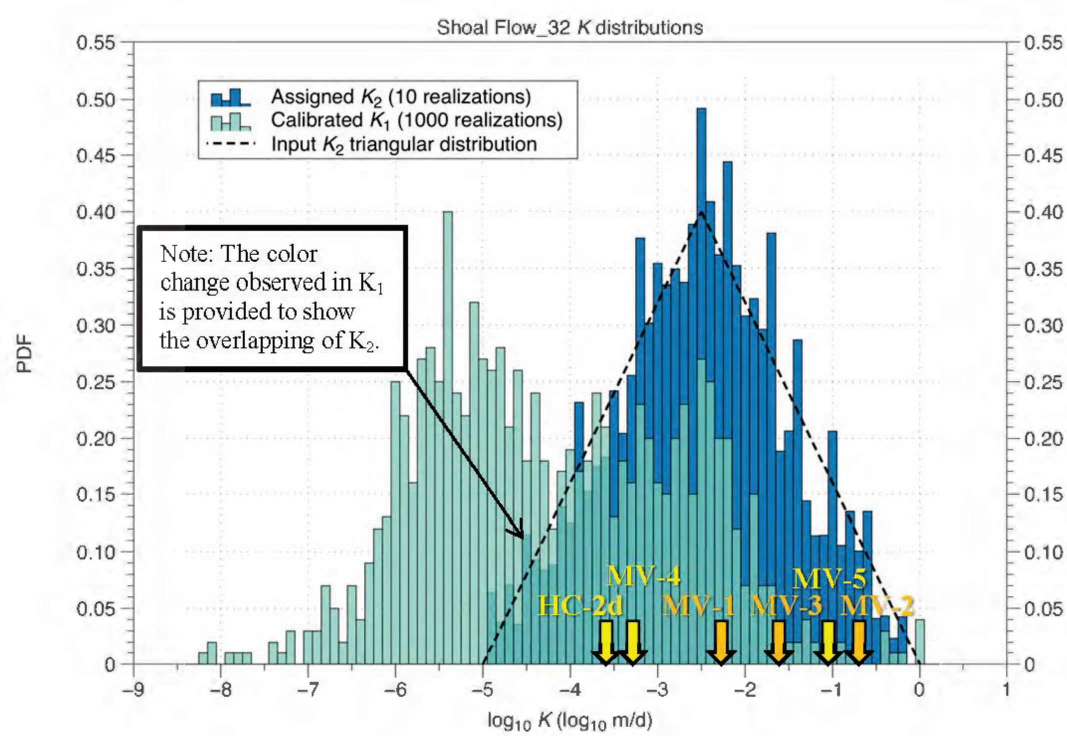


Figure 4-30. Shoal Model Hydraulic Conductivity Distributions with the 2006 and 2014 Well Data

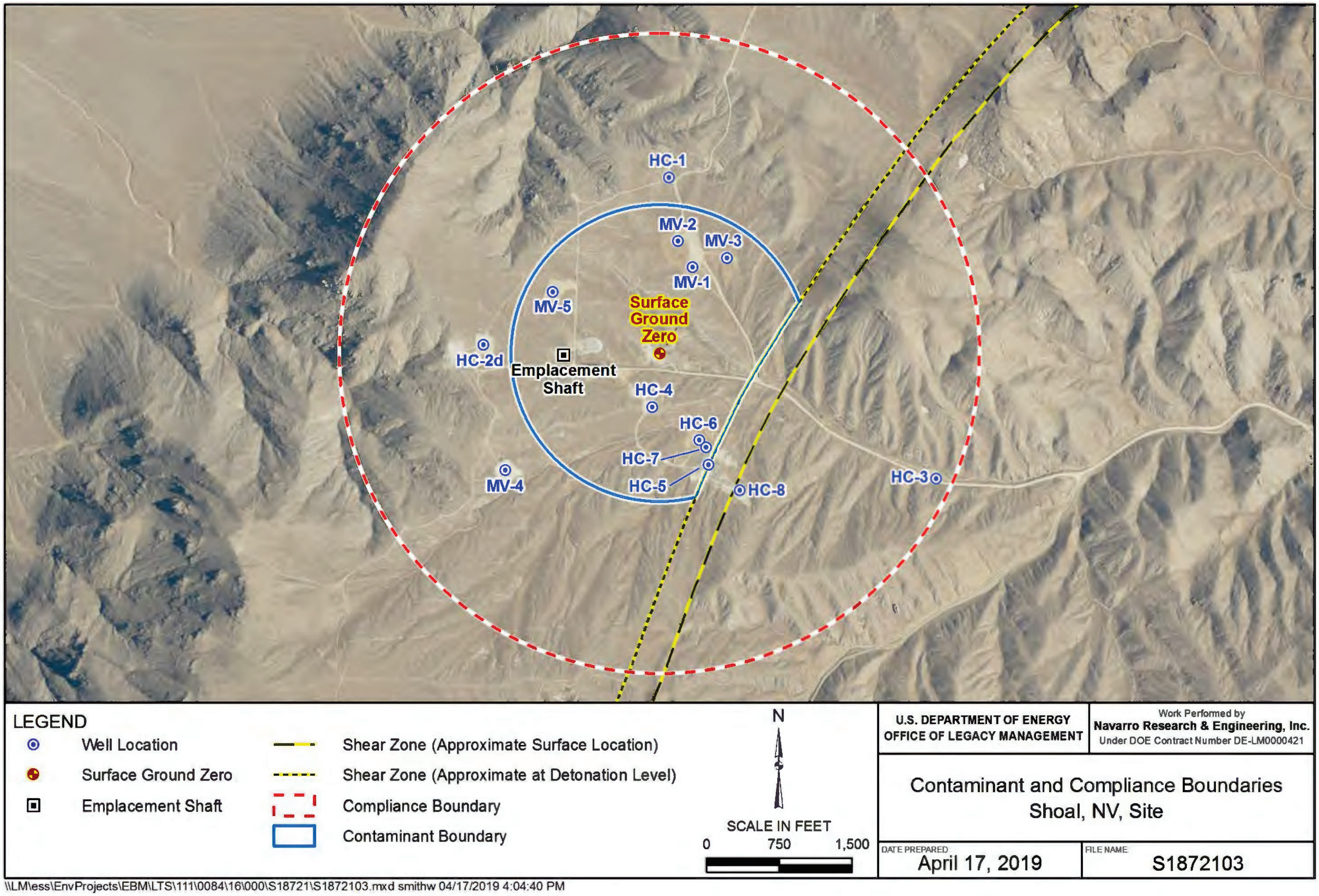


Figure 5-31. Revised Contaminant and Compliance Boundaries, Shoal, Nevada, Site

5.6.4 Changes to the Compliance Boundary (Revision of Section 2.3)

The compliance boundary presented in the CADD/CAP matches the outer perimeter of the numerical model-predicted contaminant boundary. LM proposes to separate these boundaries and expand the compliance boundary so it coincides with the subsurface use-restriction boundary. The revised compliance boundary shall extend a horizontal distance of 3300 ft from SGZ (Figure 5-31) to accommodate uncertainties associated with the transient nature of the groundwater flow system and account for any potentially varying lateral flow directions. The objective of the compliance boundary has not changed. Figure 5-31 shows the revised contaminant boundary and compliance boundary for the site.

5.6.5 Implementation of the Corrective Action Plan (Revision of Section 5.0)

The Corrective Action Alternative selected for the site is “Proof of Concept Monitoring with Institutional Controls” (DOE 2006b). The term “institutional controls” broadly defines the instruments (documents) and mechanisms (physical features) that are maintained to ensure long-term protectiveness of the site (DOE 2015c). The institutional controls should be visible to all future users of the site and resources, durable to last as long as restrictions are needed, and enforceable to ensure that no violations occur that would create a pathway for access to contaminated media. Existing institutional controls will be maintained at the Shoal site. This includes the monument at SGZ and the amended land withdrawal executed through Public Land Order 2834 that is within a much larger area withdrawn by the U.S. Navy. DOE will continue to work with the U.S. Navy and other federal and state agencies to improve the effectiveness of these institutional controls and implement the subsurface use–restriction, which is designed to limit access to the area of potentially contaminated material (including groundwater) at the site.

The monitoring program includes monitoring groundwater elevations and radiochemistry data from the designated wells and piezometers in the monitoring network (Table 5-11). Monitoring groundwater elevations includes downloading data from transducers and measuring depth-to-water semiannually at the site. Groundwater samples will continue to be collected annually from the designated wells for the analysis of tritium, isotopic uranium, elemental uranium, and gross alpha activity. Samples will also be analyzed for ^{14}C and iodine-129 (^{129}I) every 5 years, with the next scheduled sampling event for ^{14}C and ^{129}I planned for 2020. Groundwater elevations and radiochemistry data will continue to be compared to historical data and evaluated with respect to location, screened interval, and proximity to geologic structures. These data (groundwater elevations and radiochemistry) should continue to demonstrate the effectiveness of the monitoring program with respect to monitoring well locations within the flow field of each potential flow scenario interpreted through the SCMs for the site. Table 5-11 provides a summary of the revised monitoring network with well and piezometer distance from SGZ and sampling and water level monitoring frequency.

Table 5-11. Summary of the Revised Monitoring Network

Monitoring Location	Location Type	Distance from SGZ	Minimum Monitoring Frequency	
			Water Levels	Well Sampling
MV-1PZ	Piezometer	940 ft	Annual	None
MV-1	Well	940 ft	Annual	Annual
MV-2PZ	Piezometer	1030 ft	Annual	None
MV-2	Well	1030 ft	Annual	Annual
MV-3PZ	Piezometer	1030 ft	Annual	None
MV-3	Well	1030 ft	Annual	Annual
MV-4PZ	Piezometer	2000 ft	Annual	None
MV-4	Well	2000 ft	Annual	Annual
MV-5PZ	Piezometer	1250 ft	Annual	None
MV-5	Well	1250 ft	Annual	Annual
HC-1	Well	1780 ft	Annual	Annual
HC-2d	Well	1830 ft	Annual	Annual
HC-3	Well	3100 ft	Annual	Annual
HC-4	Well	560 ft	Annual	Annual
HC-5	Well	1265 ft	Annual	Annual
HC-6	Well	980 ft	Annual	Annual
HC-7	Well	1125 ft	Annual	Annual
HC-8	Well	1640 ft	Annual	Annual
H-2	Well	3.5 miles	Annual	None
H-3	Well	2.1 miles	Annual	None
HS-1*	Well	3.7 miles	None	None

Note:
* This well is currently not accessible for obtaining water levels or installing a transducer due to the well and pump configuration, but if access is obtained it will be added to the semiannual monitoring for water levels.

Abbreviation:
SGZ = surface ground zero

5.6.5.1 Sampling Methods (Revision of Section 5.2.2.2)

The *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites* (LMS/PRO/S04351) guides the quality assurance/quality control of the annual sampling and monitoring program. Any changes to the monitoring program, such as an increase or reduction in purging or removal of wells from the monitoring network, will be discussed with and approved by NDEP before implementation.

5.6.5.2 Quality Assurance/Quality Control (Revision of Section 5.2.2.1)

Groundwater samples and water level measurements will be collected in accordance with *Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites*. This includes the collection and analysis of quality control samples. Field duplicate samples will be collected and analyzed as an indication of the overall precision of the measurement process. The precision observed includes both field and laboratory precision and has more variability than laboratory duplicates, which measure only laboratory performance. Equipment blanks shall be collected after completion of decontamination performed following collection of environmental samples. These blanks are useful in documenting the adequate decontamination of sampling equipment. Subtle variations in groundwater elevations may be useful indicators of changes in the overall groundwater flow system in response to climatic or anthropogenic causes. Thus, the ability to detect trends with a precision of plus or minus a 10th of a foot is the quality requirement for the depth-to-groundwater measurements. Data quality will be assured through the use of calibrated field equipment (wirelines, transducers, or water level tools).

The CADD/CAP established regulatory levels for site groundwater of 20,000 picocuries per liter (pCi/L) tritium, 2000 pCi/L ^{14}C, and 1 pCi/L ^{129}I (DOE 2006b), which this addendum will maintain. The analytical laboratory will use procedures based on the methods specified in CADD/CAP Table 5-6. The table established laboratory-required detection limits (RDLs) to provide a minimum standard for the analytical laboratories to report the radiochemical results. The RDL originally established for tritium, 300 pCi/L, was changed to 400 picocuries pCi/L to be consistent with the LM laboratory contract requirements. A record of technical change submitted to NDEP and approved in March 2012 documented this change. The RDLs established in the CADD/CAP and updated through the record of technical change will be maintained in this CADD/CAP addendum. Commercial laboratories provide analytical services in accordance with the *Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories* (updated annually) (QSM) to ensure that data are of known, documented quality (DOD and DOE 2017). The QSM provides specific technical requirements, clarifies DOE requirements, and conforms to DOE Order 414.1C, *Quality Assurance* (DOE 2005). The QSM is based on *Management and Technical Requirements for Laboratories Performing Environmental Analysis* (NELAC 2009), which incorporates International Organization for Standards/International Electrotechnical Commission 17025:2005(E), "General Requirements for the Competence of Testing and Calibration Laboratories." The QSM provides a framework for performing, controlling, documenting, and reporting laboratory analyses (DOD and DOE 2017). Analytical data will be validated according to *Environmental Data Validation Procedure* (LMS/PRO/S15879).

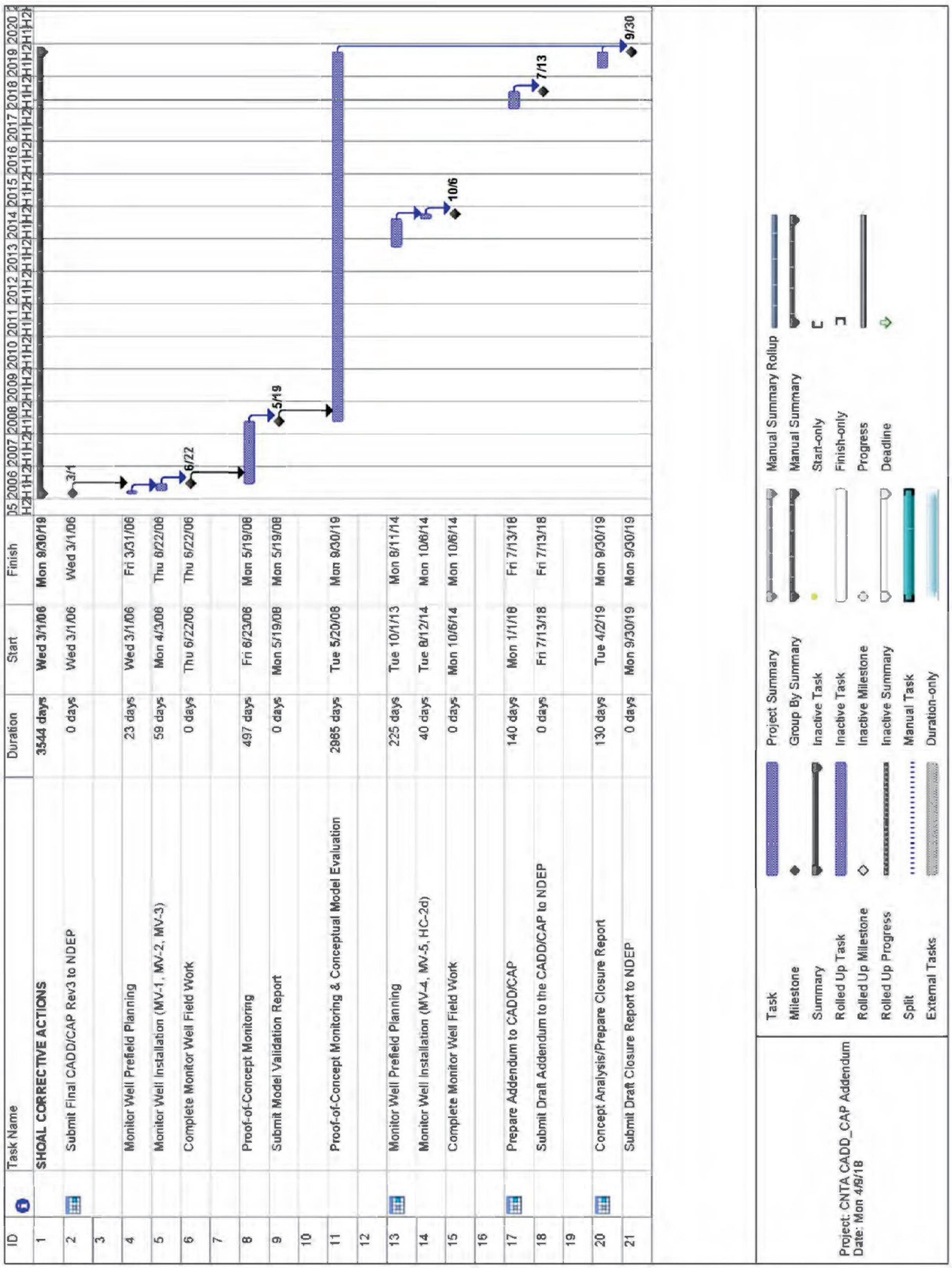
5.6.6 Changes to the Proof of Concept Approach (Revision of Section 5.5)

The Corrective Action Alternative selected for the site, "Proof of Concept Monitoring with Institutional Controls," has not changed but now focuses on collecting data designed to validate the compliance boundary through monitoring and institutional controls, rather than relying on the numerical model (FFACO 1996, as amended). This includes a 5-year evaluation period that was initiated after the last data acquisition plan was completed in 2014. Data collected during this evaluation period will be used with data collected during the original "proof of concept" monitoring period that began in 2006 to demonstrate that the interpreted potential transport pathways identified through the SCMs are adequately monitored. At the end of the 5-year monitoring period, the validity of the compliance boundary will be demonstrated by monitoring results that indicate radionuclides of interest do not exceed the RDLs[1] or are at or below local background concentrations in wells outside the impacts of the detonation zone. These results provided with the proposed changes to the contaminant and compliance boundaries should support closure of the site.

6.1 Modified Schedule (Revision of Section 6.0)

Figure 6-2 shows the modified schedule for the Shoal corrective action, through the proof of concept period and closure report.

[1] Required detection limits: tritium (400 pCi/L), ^{14}C (5 pCi/L), ^{129}I (0.1 pCi/L).



ID	Task Name	Duration	Start	Finish
1	**SHOAL CORRECTIVE ACTIONS**	**3544 days**	**Wed 3/1/06**	**Mon 9/30/19**
2	Submit Final CADD/CAP Rev3 to NDEP	0 days	Wed 3/1/06	Wed 3/1/06
3				
4	Monitor Well Prefield Planning	23 days	Wed 3/1/06	Fri 3/31/06
5	Monitor Well Installation (MV-1, MV-2, MV-3)	59 days	Mon 4/3/06	Thu 6/22/06
6	Complete Monitor Well Field Work	0 days	Thu 6/22/06	Thu 6/22/06
7				
8	Proof-of-Concept Monitoring	497 days	Fri 6/23/06	Mon 5/19/08
9	Submit Model Validation Report	0 days	Mon 5/19/08	Mon 5/19/08
10				
11	Proof-of-Concept Monitoring & Conceptual Model Evaluation	2865 days	Tue 5/20/08	Mon 9/30/19
12				
13	Monitor Well Prefield Planning	225 days	Tue 10/1/13	Mon 8/11/14
14	Monitor Well Installation (MV-4, MV-5, HC-2d)	40 days	Tue 8/12/14	Mon 10/6/14
15	Complete Monitor Well Field Work	0 days	Mon 10/6/14	Mon 10/6/14
16				
17	Prepare Addendum to CADD/CAP	140 days	Mon 1/1/18	Fri 7/13/18
18	Submit Draft Addendum to the CADD/CAP to NDEP	0 days	Fri 7/13/18	Fri 7/13/18
19				
20	Concept Analysis/Prepare Closure Report	130 days	Tue 4/2/19	Mon 9/30/19
21	Submit Draft Closure Report to NDEP	0 days	Mon 9/30/19	Mon 9/30/19

Figure 6-2. Project Schedule

8.1 Additional References

DOD (Department of Defense) and DOE (Department of Energy), 2017. *Department of Defense (DoD) Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories* (Version 5.1), January.

DOE (U.S. Department of Energy), 2005. *DOE Order 414.1C, Quality Assurance,* Washington D.C., June

DOE (U.S. Department of Energy), 2006a. *Well Completion Report for Corrective Action Unit 447, Project Shoal Area, Churchill County, Nevada*, National Nuclear Security Administration, Nevada Site Office, September.

DOE (U.S. Department of Energy), 2006b. *Corrective Action Decision Document/Corrective Action Plan for Corrective Action Unit 447: Project Shoal Area, Subsurface*, *Nevada*, DOE/NV-1025, Rev. 3, National Nuclear Security Administration, Nevada Site Office, March.

DOE (U.S. Department of Energy), 2009. *Final Path Forward: Short-Term Data Acquisition Plan for New Closure Strategy Subsurface Corrective Action Unit 447, Project Shoal Area, Nevada*, Office of Legacy Management, November.

DOE (U.S. Department of Energy), 2011a. *Surface Geophysics Survey Report Subsurface Corrective Action Unit 447, Project Shoal Area, Nevada*, Office of Legacy Management, April.

DOE (U.S. Department of Energy), 2011b. *Path Forward: 2011 Short-Term Data Acquisition Plan, Project Shoal Area, Subsurface Corrective Action Unit 447, Nevada*, Office of Legacy Management, October.

DOE (U.S. Department of Energy), 2013. *2012 Groundwater Monitoring Report, Project Shoal Area, Subsurface Corrective Action Unit 447*, LMS/SHL/S09338, Office of Legacy Management, March.

DOE (U.S. Department of Energy), 2014. *Path Forward: 2014 Short-Term Data Acquisition Plan, Project Shoal Area, Subsurface Corrective Action Unit 447, Nevada*, Office of Legacy Management, June.

DOE (U.S. Department of Energy), 2015a. *United States Nuclear Tests, July 1945 Through September 1992,* DOE/NV—209-Rev. 16, National Nuclear Security Administration, Nevada Field Office, September.

DOE (U.S. Department of Energy), 2015b. *2014 Well Completion Report for Corrective Action Unit 447, Project Shoal Area, Churchill County, Nevada*, Office of Legacy Management, November.

DOE (U.S. Department of Energy), 2015c. *Guidance for Developing and Implementing Institutional Controls for Long-Term Surveillance and Maintenance at DOE Legacy Management Sites*, DOE/LM-1414, Office of Legacy Management, January.

DOE (U.S. Department of Energy), 2018a. *Hydrologic Testing Report Project Shoal Area: Subsurface Corrective Action Unit 447, Shoal, Nevada, Site*, LMS/SHL/S14136, Office of Legacy Management.

DOE (U.S. Department of Energy), 2018b. *2017 Groundwater Monitoring Report, Project Shoal Area, Subsurface Corrective Action Unit 447*, LMS/SHL/S17761, Office of Legacy Management.

DRI (Desert Research Institute), 2001. *Investigation of Hydraulic Properties and Groundwater Levels Related to the Shear Zone at the Project Shoal Site*, Publication No. 45183, DOE/NV/13609-12, prepared for the U.S. Department of Energy National Nuclear Security Administration, Las Vegas, Nevada, September.

DRI (Desert Research Institute), 2006. *Hydrologic Evaluation for Model Validation Wells MV-1, MV-2, and MV-3 Near the Project Shoal Area*, DOE/NV/13609-50, Publication No. 45220, Las Vegas, Nevada, September.

Environmental Data Validation Procedure, LMS/PRO/S15879, to be published by Navarro Research and Engineering, Inc., for the U.S. Department of Energy Office of Legacy Management.

FFACO (Federal Facility Agreement and Consent Order), 1996 (as amended). Agreed to by the State of Nevada; U.S. Department of Energy, Environmental Management; U.S. Department of Defense; and U.S. Department of Energy, Legacy Management. Appendix VI, which contains the Offsites Strategy, was last modified June 2014, Revision No. 5.

NDEP (Nevada Division of Environmental Protection), 2009. *Nevada Offsites Semiannual Technical Update Meeting between the Department of Energy, Office of Legacy Management and the Nevada Division of Environmental Protection*, Las Vegas, Nevada, August.

Nevada Bureau of Mines and Geology, 1964. "Geology of the Sand Springs Range," *Nevada Bureau of Mines and Geology, Final Report, Geological, Geophysical, Chemical and Hydrological Investigations of the Sand Springs Range, Fairview Valley, and Fourmile Flat, Churchill County, Nevada, for Shoal Event, Project Shade, Vela Uniform Program*, VUF-1001, prepared for the U.S. Atomic Energy Commission.

Sampling and Analysis Plan for U.S. Department of Energy Office of Legacy Management Sites, LMS/PRO/S04351, continually updated, prepared by Navarro Research and Engineering, Inc., for the U.S. Department of Energy Office of Legacy Management.

Stoller (S.M. Stoller Corporation), 2008. *Groundwater Model Validation for the Project Shoal Area, Corrective Action Unit 447*, Letter Control Number 08-0283, Grand Junction, Colorado, May.

Appendix A

Data Acquisition Plans Completed in 2009, 2011, and 2014

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ERD.091124.0003

Department of Energy
Office of Legacy Management

NOV 2 4 2009

Tim Murphy, Chief
Bureau of Federal Facilities
Division of Environmental Protection
2030 E. Flamingo Road, Suite 230
Las Vegas, NV 89119-0818

Subject: Final Path Forward: Short-Term Data Acquisition Plan for New Closure Strategy Subsurface Corrective Action Unit 447, Project Shoal Area, Nevada

Dear Mr. Murphy:

On July 20, 2009, the U.S. Department of Energy, Office of Legacy Management (DOE-LM), issued the draft *Path Forward for Subsurface, Corrective Action Unit 447, Project Shoal Area, Nevada*. Subsequent discussions with the Nevada Division of Environmental Protection, Bureau of Federal Facilities (NDEP), captured in meeting notes dated August 27, 2009, identified how the scope of activities might be revised to improve prospects for managed long-term stewardship of the Project Shoal Area (Shoal) site. NDEP recommended a stepped approach, beginning with a preliminary surface geophysics program and expanded ground water monitoring, to support the development of a new closure strategy for the site. Per NDEP's recommendations, analytical modeling of flow and transport using the code *REMClor* was omitted from the scope of activities. The initial elements of the revised path-forward strategy are described in this document.

Background

Environmental closure activities at the Shoal site near Fallon, Nevada, have followed the decision process prescribed in Appendix VI of the Federal Facility Agreement and Consent Order (FFACO). As part of the corrective action process, DOE-LM, issued the Desert Research Institute report titled *Validation Analysis of the Shoal Groundwater Flow and Transport Model*, dated February 2008. In the cover letter to that report the Legacy Management Support contractor, S.M. Stoller Corporation, stated that it was unable to confirm validation of the ground water flow and transport model. Concerns with the flow and transport model stemmed from two observations: (1) the flow model showed ground water primarily migrating toward the north-northeast, whereas gradients inferred from current water levels measured in wells at the site do not support the modeled flow direction; and (2) the model assumption that the ground water flow system is in a steady-state is incorrect in that water levels west of the shear zone at the site are rising by roughly 1 foot per year.

2597 B 3/4 Road, Grand Junction, CO 81503	□	3600 Collins Ferry Road, Morgantown, WV 26505
1000 Independence Ave., S.W., Washington, DC 20585	□	11025 Dover St., Suite 1000, Westminster, CO 80021
10995 Hamilton-Cleves Highway, Harrison, OH 45030	□	955 Mound Road, Miamisburg, OH 45342
232 Energy Way, N. Las Vegas, NV 89030	□	
REPLY TO: Grand Junction Office		

NOV 2 4 2009

Pursuant to the FFACO process, DOE-LM will develop a new closure strategy for the Shoal site. The new strategy will be submitted to NDEP for review and approval. This letter summarizes the initial data acquisition plan and associated field investigations that will support development of the new closure strategy for the site.

Data Acquisition Plan

DOE-LM is currently planning to conduct two geophysical surveys and enhance the annual monitoring at the Shoal site. These activities will provide additional data associated with the geology and hydrogeology of the fractured granite underlying the site. A summary of the planned field activities is provided in the following sections.

Geophysical Investigations

DOE-LM is planning to conduct geophysical investigations at the Shoal site in an effort to resolve some of the uncertainty with respect to the ground water flow directions. The two methods under consideration are a seismic reflection survey and an electromagnetic survey. The objectives of the surveys are to obtain data that will help portray the water table configuration, evaluate the prevailing horizontal flow direction, and identify faults/major fracture zones that may affect ground water flow near the site. Small-scale feasibility tests are planned to evaluate each of the geophysical methods to determine if they are likely to provide useful data.

The seismic reflection survey being considered will use a 200 kilogram (or similar size) accelerated hammer as a source with optimum receiver spacing being determined by initial tests in the field. The objective of the seismic survey is to identify faults/shear zones and other structures that may affect ground water flow near the site. The feasibility test will be limited to roads on-site and is currently planned for the spring of 2010.

The electromagnetic survey being considered will use a tensor magnetotelluric technique referred to as controlled-source audio electromagnetics (CSAMT/MT). This geophysical technique determines the earth's subsurface electrical resistivity distribution by measuring time-dependent variations of the earth's natural electric and magnetic fields, as well as the electric and magnetic fields resulting from high-frequency induced waves. The tensor CSAMT/MT method is often used to find structures and subsurface materials that are good producers of ground water or to site high-yield production or monitor wells. The method is designed to investigate depths of 50 to 2,500 feet below ground surface, and, because data are acquired and modeled in two dimensions, horizontal and nonhorizontal features can be mapped accurately. The tensor CSAMT/MT method will not be limited to roads on-site and may image ground water elevation variations over relatively short distances in fractured bedrock. The feasibility test is currently planned for the spring of 2010.

If the initial feasibility tests are successful and provide useful data, a more comprehensive survey may be performed using one or both of the geophysical methods.

Enhanced Monitoring

DOE-LM is planning to enhance the monitoring that is currently required at the Shoal site and specified in the March 2006 Corrective Action Decision Document/Corrective Action Plan, Rev 3. The enhanced monitoring will include collection of depth-to-water data from all wells/piezometers on-site (within the land withdrawal) and from off-site well H-2. In addition, off-site wells H-3 and HS-1 will be added to the water level network, pending negotiation of access. If access is obtained to these wells, transducers will be installed this fall. Refer to the enclosed figure for the well locations.

The enhanced monitoring will also include collection of samples annually from all wells on-site (within the land withdrawal) for analysis of tritium, isotopic uranium, elemental uranium, and gross alpha activity. Samples will also be analyzed for carbon-14 and iodine-129 on a 5-year basis beginning in 2010. DOE-LM will reevaluate the monitoring locations and frequency on an as-needed basis but will not make any changes to the monitoring program without approval from NDEP. Table 1 presents a summary of the enhanced monitoring program for the Shoal site.

Table 1. Enhanced Monitoring Program at the Shoal Site

Location	Distance from SGZ	Location Type	Monitoring Parameters	Continuous Water Level Monitoring
MV-1-Piezometer	940 feet	Piezometer	Water Level	Yes
MV-1-Well	940 feet	Well	Water Level/Radionuclides	Yes
MV-2-Piezometer	1,030 feet	Piezometer	Water Level	No
MV-2-Well	1,030 feet	Well	Water Level/Radionuclides	Yes
MV-3-Piezometer	1,030 feet	Piezometer	Water Level	Yes
MV-3-Well	1,030 feet	Well	Water Level/Radionuclides	Yes
HC-1	1,780 feet	Well	Water Level/Radionuclides	Yes
HC-2	1,830 feet	Well	Water Level/Radionuclides	Yes
HC-3	3,100 feet	Well	Water Level/Radionuclides	Yes
HC-4	560 feet	Well	Water Level/Radionuclides	Yes
HC-5	1,265 feet	Well	Water Level/Radionuclides	Yes
HC-6	980 feet	Well	Water Level/Radionuclides	Yes
HC-7	1,125 feet	Well	Water Level/Radionuclides	Yes
HC-8	1,640 feet	Well	Water Level/Radionuclides	Yes
H-2	3.5 miles	Well	Water Level	Yes
H-3*	2.1 miles	Well	Water Level	Yes
HS-1*	3.7 miles	Well	Water Level	Yes

* = assumes access to the well will be obtained.

Reporting of Results

DOE-LM will continue to provide analytical results and depth-to-water data obtained from site monitoring in annual ground water monitoring reports. Results from the surface geophysics and seismic surveys will be provided to NDEP as a letter report. Data obtained from these activities will be used to support development of the new closure strategy for the site.

Please contact me at (970) 248-6018 if you have any questions or need additional information.

Sincerely,

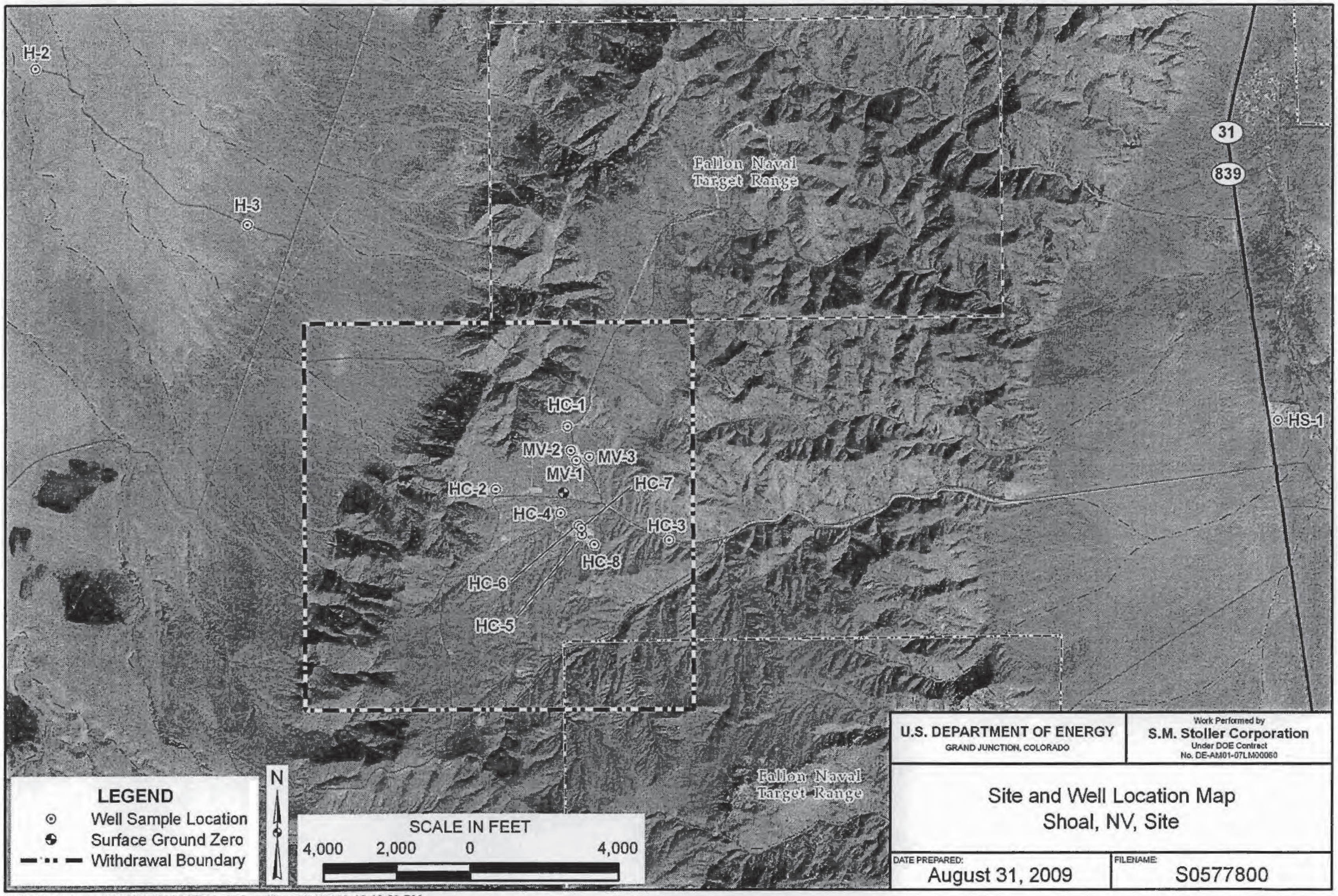
Mark Kautsky
Site Manager

Enclosure:
As stated

cc w/enclosure:
C. D. Andres, NDEP, Las Vegas, NV
FFACO Group, NNES, Las Vegas, NV
EM Record, AMEM, Las Vegas, NV
File: SHL 000 (Roberts)

cc w/o encl. via e-mail:
R.F. Boehlecke, NNSA, Las Vegas, NV
E.F. DiSanza, WMP, NNSA/NSO, Las Vegas, NV
J.B. Chapman, DRI, Las Vegas, NV
D. Crawford, Stoller, Grand Junction, CO
E.A. Jacobson, NDEP, Las Vegas, NV
Jeffrey Fraher, DTRA/CXTS, Kirtland AFB, NM
NSTec Technical Information Officer, Las Vegas, NV
R. Findlay, Stoller, Grand Junction, CO
R. Hutton, Stoller, Grand Junction, CO

Kautsky\Shoal\9-9-09 Short-Term Data Acquisition Plan Rev 1.doc



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Attachment 1

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Department of Energy
Washington, DC 20585

October 11, 2011

Mr. Tim Murphy, Chief
Bureau of Federal Facilities
Division of Environmental Protection
2030 E. Flamingo Road, Suite 230
Las Vegas, NV 89119-0818

PATH FORWARD: 2011 SHORT-TERM DATA ACQUISITION PLAN PROJECT SHOAL AREA, SUBSURFACE CORRECTIVE ACTION UNIT 447, NEVADA

Dear Mr. Murphy:

The U.S. Department of Energy (DOE) Office of Legacy Management (LM) is providing this Short-Term Data Acquisition Plan for the Project Shoal Area (Shoal), Subsurface Corrective Action Unit 447, near Fallon, Nevada. This plan is part of the new corrective action strategy that is focused on revising the site conceptual model (SCM) and evaluating the adequacy of the monitoring well network. Aspects of the SCM are currently known; however, two major concerns are the uncertainty in the groundwater flow direction and the cause of the rising water levels in site wells. Water levels have generally been rising at the site since the first wells were installed in 1996. LM continues to monitor water levels as part of the ongoing groundwater monitoring program at the site.

To advance the SCM during this period of water level monitoring, LM is proposing to further evaluate analytical, hydrologic, and geologic data, along with recently acquired geophysical data, to help identify geologic structures that might be influencing groundwater flow at the site. LM expects interpretations obtained from this evaluation to be helpful in identifying data gaps, assessing potential groundwater flow directions, and evaluating the site's monitoring well network. Water levels will need to stabilize before the SCM can be revised and a more effective evaluation of the monitoring well network can be conducted. The following section summarizes the project's background and explains why the data acquisition plan is being implemented.

Background

The original corrective action strategy for the subsurface at Shoal used a groundwater flow and transport model to help evaluate data and select a corrective action alternative. The model results were also used to determine a contaminant boundary and establish a restricted region surrounding the site. The corrective action alternative selected for the site consists of monitoring with Institutional Controls and is presented in the Corrective Action Decision Document/Corrective Action Plan (CADD/CAP). As part of the original strategy, three wells (MV-1, MV-2, and MV-3) were installed in 2006 for the dual purpose of monitoring and evaluating the flow and transport model results (see enclosed Figure 1). The SCM is being reevaluated to address inconsistencies with model predictions and monitoring well data. Concerns with the model stem from two observations: (1) The flow model showed groundwater primarily migrating toward the north-northeast, whereas gradients inferred from water levels measured in site wells do not support the modeled flow direction; (2) The model incorrectly assumed that the groundwater flow system is in a steady state; in fact, water levels west of the shear zone at the site are rising at rates that range from approximately 1.2 to 2.4 feet per year. Pursuant to the Federal Facility Agreement and Consent Order (1996, as amended), LM began implementing a new corrective action strategy for the site in 2009.

On November 24, 2009, LM submitted an initial Short-Term Data Acquisition Plan to the Nevada Division of Environmental Protection (NDEP), detailing data collection activities that included a surface geophysical program and enhanced groundwater monitoring. The recently completed geophysical program included seismic and electromagnetic surveys. As part of the evaluation of data obtained from the surveys, a technical exchange meeting was conducted with the geophysicists who performed the surveys (Lee Liberty from Boise State University and Jim Hasbrouck from Hasbrouck Geophysics), Desert Research Institute, and NDEP to discuss the results and potential site conceptual models. During the meeting we agreed that further understanding of the groundwater flow system was needed for the enhancement of potential SCMs and that a new Short-Term Data Acquisition Plan was necessary to outline future activities at the site. The Surface Geophysics Report recommended that geophysical data be evaluated further and compared to existing data to assess and enhance any potential SCMs. The technical exchange and Surface Geophysics Report provided the basis for developing a new Data Acquisition Plan for the site.

Data Acquisition Plan

The 2011 Data Acquisition Plan will include a review of all existing reports for analytical, hydrologic, and geologic data, and the collection of new data as part of the ongoing monitoring program at the site. Assembling the existing data with the recently acquired geophysical data is intended to enhance potential SCMs, identify data gaps, and assist in the evaluation of the site's monitoring well network. The following activities will be conducted as part of the new Data Acquisition Plan.

Evaluation of Information

The evaluation of information will include reviewing all available reports and assembling a detailed informational resource tool that includes a summary of pertinent technical data. Analytical, hydrologic, and geologic data obtained from the evaluation of historical reports will be reviewed along with existing data and recently collected geophysical data, to help identify geologic structures that might be influencing groundwater flow at the site. The evaluation of information will include the following:

- Identifying and mapping faults, fault compartments, and dikes near surface ground zero. This task will require using available lithologic logs, geologic maps, and fault dip data to obtain hydrologic properties and project geologic structures from surface to depth. The geologic structures will be evaluated, using the recently obtained geophysical, water level, and analytical data, to further investigate the effects on the groundwater flow system. To support the evaluation, data will be assembled for three-dimensional visualization.

- Identifying and evaluating all available analytical data with respect to sample location, depth, and proximity to geologic structures. This task will require conducting a geochemical and isotopic evaluation of the groundwater and may require the collection of additional analytical data from on-site wells and from wells and springs in the neighboring valleys. All available analytical data obtained from historical reports will be evaluated for inclusion in the LM database.
- Identifying data gaps and assessing locations for new information and/or monitoring wells. Interpretations from the evaluation of information may prove to be very important in identifying data gaps, assessing potential groundwater flow directions, and evaluating the monitoring well network.

Information obtained from this evaluation will be assembled into an informational resource tool that will evolve with the project and be presented to NDEP in late 2012 for review and comment.

Monitoring Program

The monitoring program for the site includes the collection of hydraulic head and analytical data from designated wells and piezometers. Refer to Table 1 for the monitoring parameters of the designated wells and piezometers. The monitoring of hydraulic head includes downloading transducers and measuring water levels semiannually. Data obtained from the semiannual monitoring are compared to historical water levels and evaluated with respect to location, screened interval, and proximity to geologic structures. Additional evaluations may include the following:

- Evaluating water level trends and comparing them to pre-detonation water level data.
- Purging select wells to evaluate effects on nearby wells and piezometers.
- Adding water to the MV-2 piezometer to evaluate the formation's permeability, groundwater gradient, and the piezometer's value for continued monitoring.
- Discharging monitoring well purge water from designated wells on the ground surface to evaluate the effects on water levels in nearby wells and piezometers.

Samples are collected annually from all wells on site (within the land withdrawal) for the analysis of tritium, isotopic uranium, elemental uranium, and gross alpha activity (see Figure 1). Samples are also analyzed for carbon-14 and iodine-129 every 5 years. The next sampling event for carbon-14 and iodine-129 is planned for 2015. Analytical data obtained from the annual monitoring are compared to historical analytical data and evaluated with respect to well location, screened interval, and proximity to geologic structures. Additional evaluations may include the following:

- Increasing or reducing the purging of select wells to determine effects on analytical results and/or the groundwater flow system. (This task may include temporarily removing select wells from the monitoring network to evaluate the effects on water levels in nearby wells and piezometers.)

- Adding piezometers and/or springs to the monitoring network to obtain additional analytical data for the evaluation of results with respect to sample depth.
- Temporarily modifying the analytical suite to include major ions, stable hydrogen and oxygen isotopes, and carbon-14 analysis based on organic carbon.

It should be noted that any changes to the monitoring program, such as an increase or reduction in purging, the addition of piezometers or springs to the monitoring network, and the removal of wells from the monitoring network, will be negotiated and approved by NDEP prior to implementation. Table 1 summarizes the current monitoring program for the Shoal site.

Table 1. Monitoring Program at the Shoal Site

Monitoring Location	Location Type	Distance from SGZ	Monitoring Parameters	
			Water Level Data	Analytical Data
MV-1 PZ	Piezometer	940 feet	Semiannual	None
MV-1	Well	940 feet	Semiannual	Annual
MV-2 PZ	Piezometer	1,030 feet	Semiannual	None
MV-2	Well	1,030 feet	Semiannual	Annual
MV-3 PZ	Piezometer	1,030 feet	Semiannual	None
MV-3	Well	1,030 feet	Semiannual	Annual
HC-1	Well	1,780 feet	Semiannual	Annual
HC-2	Well	1,830 feet	Semiannual	Annual
HC-3	Well	3,100 feet	Semiannual	Annual
HC-4	Well	560 feet	Semiannual	Annual
HC-5	Well	1,265 feet	Semiannual	Annual
HC-6	Well	980 feet	Semiannual	Annual
HC-7	Well	1,125 feet	Semiannual	Annual
HC-8	Well	1,640 feet	Semiannual	Annual
H-2	Well	3.5 miles	Semiannual	None
H-3	Well	2.1 miles	Semiannual	None
HS-1*	Well	3.7 miles	None	None

SGZ = surface ground zero
* = This well is currently not accessible for obtaining water levels or installing a transducer, due to the well and pump configuration.

Reporting of Results

LM will continue to provide analytical results and hydraulic head data obtained as part of the monitoring program in the annual groundwater monitoring reports. Information obtained from this evaluation will be assembled into an informational resource tool that will evolve with the project and be presented to NDEP in late 2012 for review and comment. LM will continue to provide teleconference calls and attend meetings in Las Vegas to give updates on the project's status and share any new technical data or interpretations.

LM intends for this Data Acquisition Plan to advance potential SCMs during this period of water level monitoring. When water levels stabilize, a prevailing groundwater flow direction will be identified. This will allow the SCMs to be revised and a more effective evaluation of the monitoring well network to be completed. Interpretations and/or recommendations associated with the water level data and the plan for the following year will be provided with the monitoring results in the annual groundwater monitoring report. The revised SCMs and any enhancements to the monitoring well network will be discussed with NDEP and provided in an addendum to the CADD/CAP.

Please contact me at (970) 248-6018 if you have any questions or need additional information. Please send any correspondence to:

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Office of Legacy Management
2597 Legacy Way
Grand Junction, CO 81503

Mark Kautsky
Site Manager

OLM: MK

Enclosure
As stated

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Kautsky/Shoal/10-6-11 2011 Path Forward Short Term Data Plan doc.

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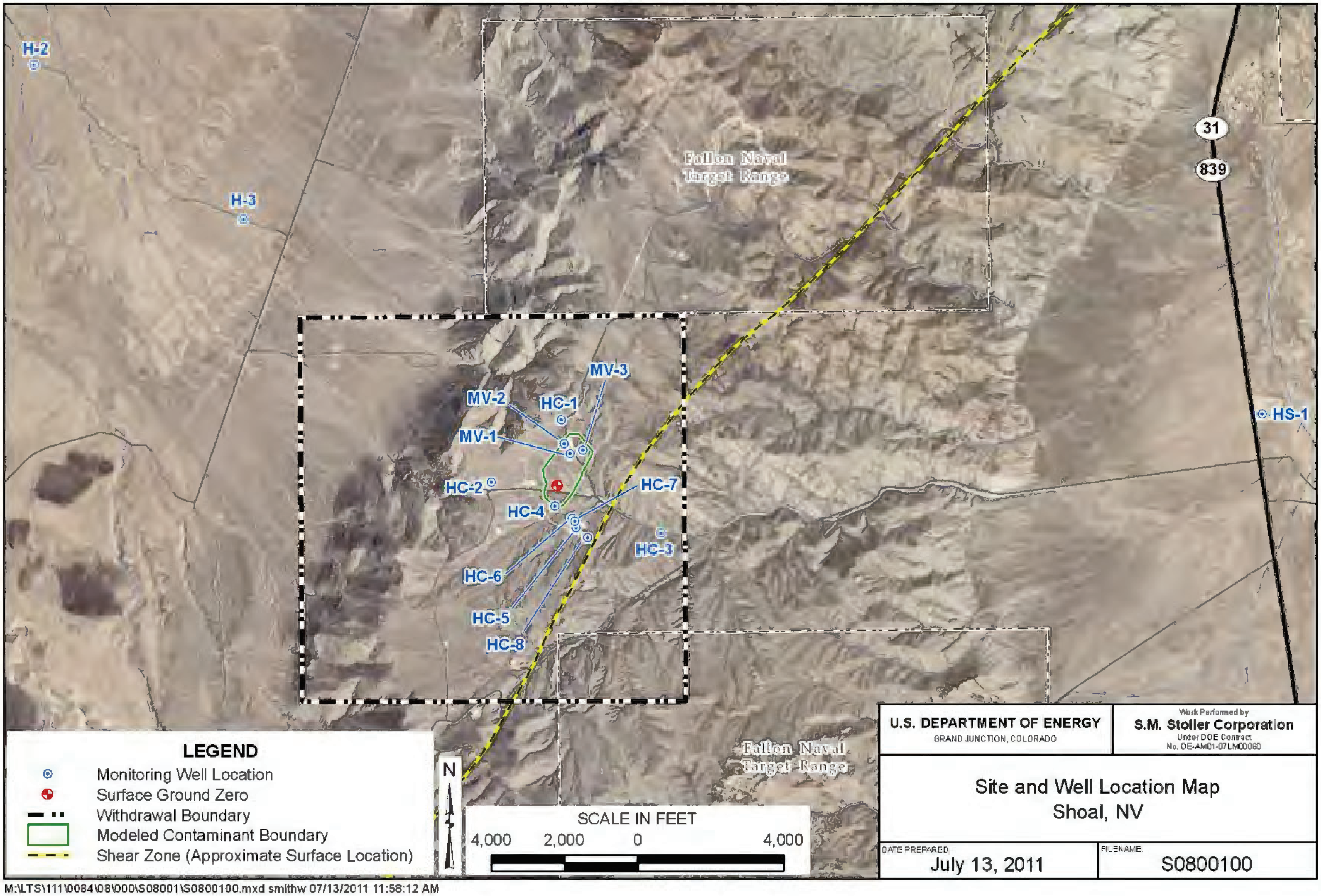

Figure 1. Site and Well Location Map

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	The shear zone is a low permeability barrier that limits groundwater flow east to Fairview Valley	heads east of the shear zone (there is an approximate 300-foot head change across shear zone), and (3) results of hydraulic testing	HC-7/HC-3, HC-5, ar
		Horizontal gradients calculated from wells screened across or near the water table suggest a groundwater flow direction that is parallel to the strike of the shear zone and basin bounding fault, both of which limit flow to the adjacent valleys	HC-1, HC-2, and
	The basin bounding fault is a low permeability barrier that limits groundwater flow west to Fourmile Flat	A comparison of heads on the range to heads in Fourmile Flat indicate an approximate 360-foot head change from range to valley, which indicates a basin bounding fault that is a low permeability barrier	HC-2/H-3
		Horizontal gradients calculated from wells screened across or near the water table suggest a groundwater flow direction that is parallel to the strike of the shear zone and to the basin bounding fault that limit flow to the adjacent valleys.	HC-1, HC-2, and
hoal site to the f contaminants n (1,000 years)	Groundwater flow (vertical and horizontal) is limited, occurring through fractures in the granite, with some of the fractures/faults acting as barriers to groundwater flow	Fault C near well MV-1 may be a low permeability barrier that contributes to the compartmentalization of the groundwater flow system.	Head data from MV-1 and aquifer test data
		Geochemical data obtained from site wells vary from well to well, suggesting there is limited lateral flow or mixing of the groundwater.	All wells
		The presence of vertical gradients may indicate downward flow that would increase the flow path downward adding transport time for horizontal flow to the valleys.	MV-1/MV-1PZ and H
		The estimated/apparent age dates (3,000 to 22,000 years) for the groundwater and transport properties (horizontal and vertical) used in the numerical model suggest that groundwater from the site would be contained within the site boundaries for at least 1,000 years.	All wells
	Minimal recharge of the aquifer from infiltration of precipitation through faults/fractures and dikes	Despite the variability in the geochemical data, the groundwater composition is consistent with infiltration of precipitation in accordance with the geochemical models. Estimated infiltration rates, based on two different methods predict the highest probabilities for recharge rates to be between 0 to 0.08 inches/year.	All wells
	Large impacts and slow recovery from hydraulic stresses to system (observed rising water levels)	Rising water levels may indicate that groundwater levels are recovering from the effects of the detonation.	Only limited head da Particle Motion bor
		Rising water levels may indicate that the detonation forced water into the unsaturated zone where the water was contained in fine grained material associated with faulting or weathered zones, and the water is slowly leaking/infiltrating back into the saturated zone.	Electromagnetic da support this theory, lower resistivities unsaturated zone ne
		Rising water levels may indicate that groundwater levels are recovering from the various well drilling programs, aquifer testing, and groundwater tracer test conducted at the site.	Only limited head da wells HC-1, HC-2, ar
		Fault movement/compressional forces may be causing groundwater levels at the site to rise.	No Informatio
	Basins on either side of Sand Springs Range receive most of their recharge from other sources, likely higher altitude ranges and surface runoff	Geochemical and isotopic data suggest that groundwater from the Sand Springs Range is only a small component of the groundwater found in Fourmile Flat and Fairview Valley.	Geochemical and Isoto from all site wells and bounding valle
he Shoal site to f contaminants n (1,000 years)	Low permeability of the basin bounding fault may be compromised in some areas, allowing groundwater to flow west to Fourmile Flat	Dikes northwest of detonation zone cut across the basin bounding fault providing a conduit for groundwater flow to Fourmile Flat.	Dikes mapped at surf dikes are highly frac
		An electromagnetic survey identified electrical resistivities in the area of the dikes northwest of surface ground zero that were similar to the tunnel/drift and detonation zone.	Electromagnetic
		The water table mimics the surface topography, with flow from the higher elevation range tops toward the detonation zone/Gote Flat and out through the low elevation canyons to Fourmile Flat.	No Informatio
	Smaller faults may have compromised zones, allowing flow across them	The drift/tunnel provides a conduit for contaminant migration away from the detonation cavity toward Fourmile Flat, and well HC-2 does not adequately monitor this potential flow path because it is completed at a depth above the drift/tunnel	No Informatio

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Department of Energy
Washington, DC 20585

June 16, 2014

Ms. Chris Andres, Chief
Bureau of Federal Facilities
Division of Environmental Protection
2030 E. Flamingo Road, Suite 230
Las Vegas, NV 89119-0818

PATH FORWARD: 2014 SHORT-TERM DATA ACQUISITION PLAN PROJECT SHOAL AREA, SUBSURFACE CORRECTIVE ACTION UNIT 447, NEVADA

Dear Ms. Andres:

The U.S. Department of Energy (DOE) Office of Legacy Management (LM) is providing this Short-Term Data Acquisition Plan for the Shoal, Nevada, Site, Subsurface Corrective Action Unit 447, near Fallon, Nevada. This 2014 Data Acquisition Plan is part of the corrective action strategy that is focused on revising the site conceptual model (SCM) and evaluating the adequacy of the monitoring well network. A recent evaluation of the geologic structures and geochemical data has advanced the SCM; however, uncertainties remain regarding the groundwater flow direction and the cause of the rising water levels in site wells. Water levels have been rising in the onsite wells west of the shear zone since the first wells were installed in 1996. LM continues to monitor water levels as part of the ongoing groundwater monitoring program at the site.

LM is proposing to install two new monitoring wells and deepen the existing well HC-2 to enhance the monitoring well network at the site. The following section summarizes the project's background and explains why this data acquisition plan is being implemented.

Background

The original corrective action strategy for the subsurface at the Shoal site used a groundwater flow and transport model to evaluate data. The model results were also used to determine a contaminant boundary, which was later established as the compliance boundary for the site. The corrective action alternative selected for the site consists of monitoring with Institutional Controls and is presented in the Corrective Action Decision Document/Corrective Action Plan (CADD/CAP). As part of the original strategy, three wells (MV-1, MV-2, and MV-3) were installed in 2006 for the dual purpose of monitoring and evaluating the flow and transport model results (see attached Figure 1). Data collected from these wells were in disagreement with the model predictions, which meant that elements of the SCM were incorrect and the model could not be validated.

The original SCM is now being reevaluated to address inconsistencies between the model predictions and the actual monitoring well data. Concerns about the model mainly stem from two observations: (1) the flow model showed groundwater primarily migrating toward the north-northeast, but gradients inferred from water levels measured in site wells do not support that modeled flow direction; and (2) the model assumed that the groundwater flow system would remain in a steady state, but measured water levels west of the shear zone at the site are currently rising at rates that range from approximately 0.67 to 1.84 feet per year. Pursuant to the Federal Facility Agreement and Consent Order (1996, as amended), LM began implementing a new corrective action strategy for the site in 2009.

On November 24, 2009, LM submitted an initial Short-Term Data Acquisition Plan to the Nevada Division of Environmental Protection (NDEP), detailing data collection activities that included a surface geophysical program and enhanced groundwater monitoring. The completed geophysical program included seismic and electromagnetic surveys. The data from these surveys were compiled into a Surface Geophysics Report that was published in April 2011. The Surface Geophysics Report recommended that geophysical data be evaluated further and compared to existing data to assess and enhance any potential SCMs.

As part of the evaluation of data obtained from those surveys, a technical exchange meeting was conducted in March 2011 with the geophysicists who performed the surveys (Lee Liberty from Boise State University and Jim Hasbrouck from Hasbrouck Geophysics), Desert Research Institute, and NDEP to discuss the results and potential site conceptual models. During that 2011 meeting it was agreed that (1) further understanding of the groundwater flow system was needed for the enhancement of potential SCMs and (2) a new Short-Term Data Acquisition Plan was needed to outline future activities at the site. The technical exchange meeting and the Surface Geophysics Report provided the basis for developing the new data acquisition plan that was submitted to NDEP in October 2011.

The 2011 data acquisition plan included (1) further review of available reports and (2) preparation of a detailed information resource tool that includes a summary of pertinent technical data. Analytical, hydrologic, and geologic data obtained from the evaluation of historical reports have been compared to more recent geophysical data to help identify geologic structures that might be influencing groundwater flow at the site. These data have been assembled for three-dimensional visualization and were successful in advancing the SCM and identifying an alternate SCM. (See Enclosure for a summary of the hydrogeologic elements and other data that support the two SCMs.) The SCMs will be evaluated and revised as additional data become available. The revised SCM and enhancements to the monitoring well network will be provided to NDEP in an addendum to the CADD/CAP.

Data Acquisition Plan

The 2014 Data Acquisition Plan will involve a drilling program designed to enhance the monitoring well network and monitoring program at the site. It will also provide new data to help resolve uncertainties associated with the SCMs. The proposed drilling program and enhancements to the monitoring program are described in the following sections.

Drilling Program

The drilling program proposes to install two new wells (MV-4 and MV-5), deepen the existing well HC-2 (HC-2d), and potentially modify the existing well head at well HS-1 to allow installation of a water access tube for measuring depth-to-groundwater. Figure 1 shows these existing and new well locations. The drilling program is designed to enhance the monitoring at the site, but it will also provide geologic, hydrologic, and geochemical data to enhance the SCMs.

The objectives for the drilling program are provided below:

- **MV-4:** The new well MV-4 will be installed on the former PM-1 pad to provide a monitoring location southwest of the detonation, in an area not currently part of the groundwater monitoring network. The new well will be dually completed with a piezometer and well to measure the vertical hydraulic gradient at the location. The piezometer will be screened near the water table to correlate with other piezometers and shallow wells at the site. The well will be screened across the deepest most productive zone within the borehole to monitor for potential migration of contaminants from the drift/tunnel or cavity. The well will include an electric submersible pump for sampling and aquifer testing.
- **MV-5:** The new well MV-5 will be installed northwest of the cavity in an area where dikes are observed at the surface and electrical resistivity data from the 2010 electromagnetic survey are similar to resistivities observed near the drift/tunnel and detonation zone. The new well will be dually completed with a piezometer and well to measure the vertical hydraulic gradient at the location. The piezometer will be screened near the water table to correlate with piezometers and shallow wells at the site. The well will be screened across the deepest most productive zone within the borehole to monitor for potential migration of contaminants from the drift/tunnel or cavity. The well will include an electric submersible pump for sampling and aquifer testing.
- **HC-2d:** The existing well HC-2 will be deepened because the well is currently completed at a depth above the drift/tunnel used to emplace the nuclear device. The drift/tunnel is a potential conduit for contaminants to migrate from the detonation cavity. The newly deepened well (to be known as well HC-2d) will monitor for any potential migration of contaminants from the drift/tunnel or cavity. The well will be completed with an electric submersible pump for sampling and aquifer testing.
- **HS-1:** The existing well HS-1 as it is currently configured does not provide access for measuring depth-to-groundwater. The well is approximately 3.7 miles east of surface ground zero and used by a local rancher to provide water for his livestock. A water access tube will be installed if agreements can be reached with the landowner for access and with the rancher for modifications to the well head.

These proposed drilling and well installation activities will be summarized in a well completion report that will be provided to NDEP. Information and data obtained from the new wells will be included in the annual groundwater monitoring reports and used to evaluate alternative SCMs.

Monitoring Program

The monitoring program includes the collection of hydraulic head and analytical data from the designated wells and piezometers. Monitoring of hydraulic head includes downloading transducers and measuring water levels semiannually. Groundwater samples will be collected annually from the designated wells for the analysis of tritium, isotopic uranium, elemental uranium, and gross alpha activity. Samples will also be analyzed for carbon-14 and iodine-129 every 5 years. The next sampling event for carbon-14 and iodine-129 is planned for 2015. Hydraulic head and analytical data will continue to be compared to historical data and evaluated with respect to location, screened interval, and proximity to geologic structures.

Additional evaluations may include the following:

- Purging select wells to evaluate the response at nearby wells and piezometers.
- Increasing or reducing the purging of select wells to evaluate any effects on analytical results and/or the groundwater flow system. (This task may include temporarily removing select wells from the monitoring network to evaluate the effects on water levels in nearby wells and piezometers.)
- Temporarily modifying the analytical suite to include major ions, stable hydrogen and oxygen isotopes, and carbon-14 analysis based on organic carbon to compare the results to historical data, and to evaluate the results with respect to location, screened interval, and proximity to geologic structures.

It should be noted that any changes to the monitoring program, such as an increase or reduction in purging, or removal of wells from the monitoring network, will be negotiated and approved by NDEP prior to implementation. Table 1 summarizes the monitoring program for the Shoal site.

Table 1. Monitoring Program at the Shoal Site

Monitoring Location	Location Type	Distance from SGZ	Monitoring Parameters	
			Water Level Data	Analytical Data
MV-1PZ	Piezometer	940 feet	Semiannual	None
MV-1	Well	940 feet	Semiannual	Annual
MV-2 PZ	Piezometer	1,030 feet	Semiannual	None
MV-2	Well	1,030 feet	Semiannual	Annual
MV-3PZ	Piezometer	1,030 feet	Semiannual	None
MV-3	Well	1,030 feet	Semiannual	Annual
MV-4PZ	Piezometer	2,000 feet	Semiannual	None
MV-4	Well	2,000 feet	Semiannual	Annual
MV-5PZ	Piezometer	1,250 feet	Semiannual	None
MV-5	Well	1,250 feet	Semiannual	Annual
HC-1	Well	1,780 feet	Semiannual	Annual
HC-2	Well	1,830 feet	None	None
HC-2d	Well	1,830 feet	Semiannual	Annual
HC-3	Well	3,100 feet	Semiannual	Annual
HC-4	Well	560 feet	Semiannual	Annual
HC-5	Well	1,265 feet	Semiannual	Annual
HC-6	Well	980 feet	Semiannual	Annual
HC-7	Well	1,125 feet	Semiannual	Annual
HC-8	Well	1,640 feet	Semiannual	Annual
H-2	Well	3.5 miles	Semiannual	None
H-3	Well	2.1 miles	Semiannual	None
HS-1*	Well	3.7 miles	None	None

Notes:

* = This well is currently not accessible for obtaining water levels or installing a transducer, due to the well and pump configuration, but if access is obtained it will be added to the semiannual monitoring for water levels.

SGZ = surface ground zero

Reporting of Results

LM will provide a summary of the drilling program activities to NDEP in a well completion report. LM will also continue to provide analytical results and hydraulic head data obtained as part of the monitoring program to NDEP in annual groundwater monitoring reports. Data obtained from the drilling and monitoring programs will advance the SCMs and enhance the monitoring at the site. LM will continue to provide teleconference calls and attend meetings in Las Vegas to give updates on the project's status and to share any new technical data or interpretations as they become available. The revised SCMs and any enhancements to the monitoring well network will be discussed with NDEP and will be provided in an addendum to the CADD/CAP.

Please contact me at (970) 248-6018 if you have any questions or need additional information. Please send any correspondence to:

U.S. Department of Energy
Office of Legacy Management
2597 Legacy Way
Grand Junction, CO 81503

Sincerely,

Mark Kautsky
Site Manager

OLM: MK

Enclosure
As stated

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R. Hutton, Stoller

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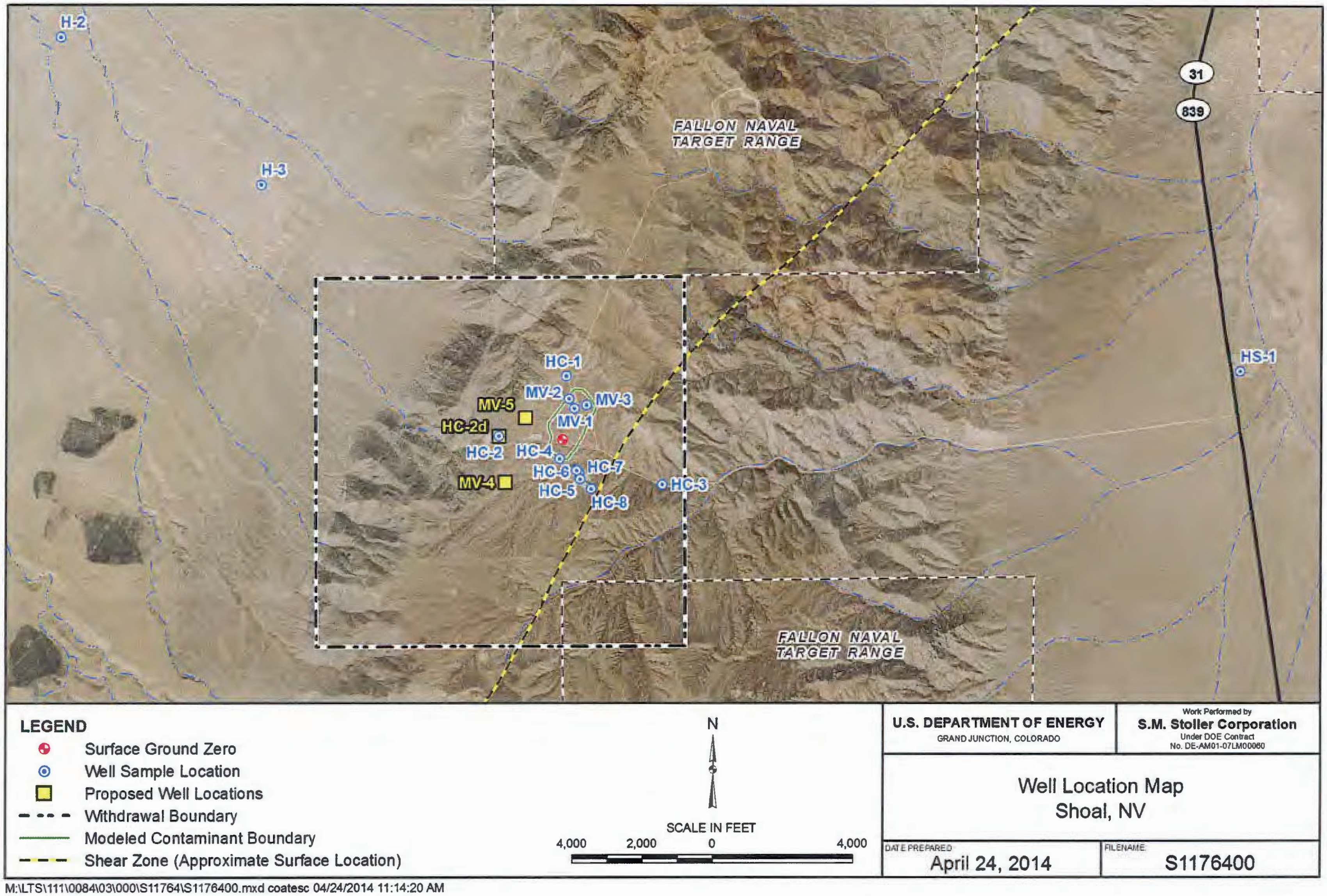

Figure 1. Well Location Map, Shoal NV

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