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

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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

cc w/enclosure:
C. D. Andres, NDEP, Las Vegas, NV
FFACO Group, PSG, NNSA/NSO, Las Vegas NV
EM Record, AMEM, Las Vegas, NV
File: SHL 0030.10 (rc grand junction)

cc w/o encl. via e-mail:
R. F. Boehlecke, NNSA/NSO, Las Vegas, NV
E.A. Jacobson, NDEP, Las Vegas, NV
Jeffrey Fraher, DTRA/CXTS, Kirtland AFB, NM
J.B. Chapman, Desert Research Institute, Las Vegas, NV
D. Crawford, Stoller
R. Findlay, Stoller
R. Hutton, Stoller

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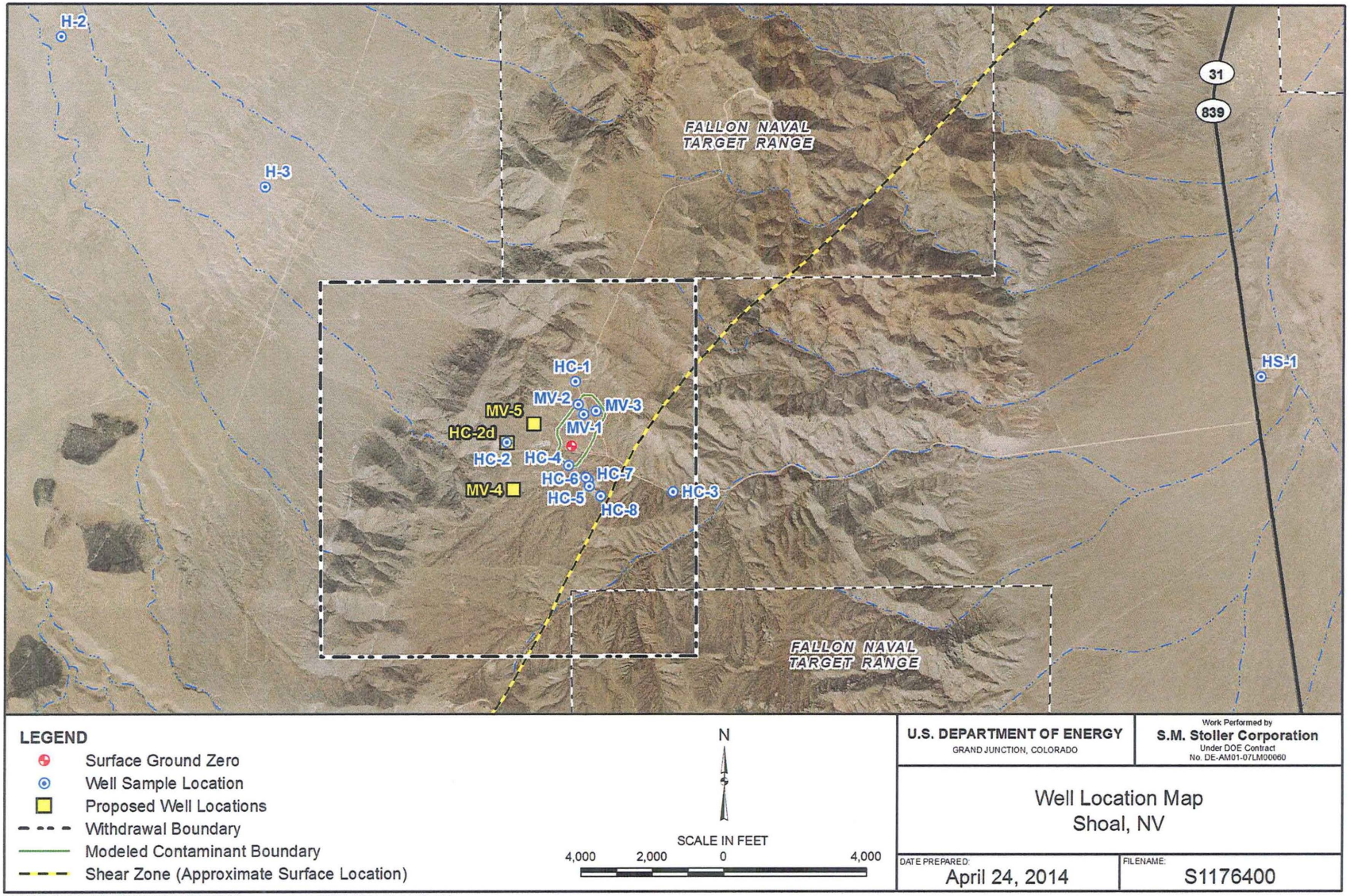

Figure 1. Well Location Map, Shoal NV

Attachment I - Site Conceptual Models, Shoal, Site, NV

Site Conceptual Models (SCM)	Hydrogeologic Elements of the SCM	Supporting Concepts for the SCM Hydrogeologic Elements	Wells/Data That Support SCM Element	New Well to Evaluate SCM Element
The amount of groundwater flow from the Shoal site to the valleys is insufficient to enable transport of contaminants within the time frame of concern (1,000 years)	The shear zone is a low permeability barrier that limits groundwater flow east to Fairview Valley	Shear zone is a low permeability barrier based on (1) borehole logs that suggest the lithologic composition of shear zone, (2) a comparison of heads west of the shear zone to 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, and HC-8	No Information
		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 HC-6	MV-4PZ and MV-5PZ
	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	No Information
		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 HC-6	MV-4PZ and MV-5PZ
	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/MV-1PZ and aquifer test data from MV	MV-4, MV-4PZ, MV-5, MV-5PZ, and HC-2d
		Geochemical data obtained from site wells vary from well to well, suggesting there is limited lateral flow or mixing of the groundwater.	All wells	MV-4, MV-5, and HC-2d
		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 HC-5 /HC-8	MV-4/MV-4PZ, MV-5/MV-5PZ, and HC-2/HC-2d
		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	MV-4, MV-5, and HC-2d
	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	MV-4, MV-5, and HC-2d
	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 data from Particle Motion boreholes	MV-4
		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 data may support this theory, showing lower resistivities in the unsaturated zone near faults	No Information
		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 data from wells HC-1, HC-2, and HC-4	No Information
		Fault movement/compressional forces may be causing groundwater levels at the site to rise.	No Information	No Information
	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 Isotopic results from all site wells and wells in bounding valleys	MV-4, MV-5, HC-2d
The amount of groundwater flow from the Shoal site to the valleys is sufficient to enable transport of contaminants within the timeframe of concern (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 surface; (the dikes are highly fractured)	MV-5
		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 data	MV-5
		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 Information	MV-4PZ and MV-5PZ
	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 Information	HC-2d
	Though areally distributed recharge may be limited, there may be spatially focused recharge under favorable conditions	Infiltration from precipitation may be focused along channel features, and infiltration of drilling fluids and/or tracer test fluids discharged at the surface to unlined sumps may be a source of recharge that contributes to the increasing water levels, resulting in higher infiltration rate/vertical groundwater velocities than originally estimated.	Electromagnetic data may support this theory, showing lower resistivities in the unsaturated zone near faults	No Information