Project Shoal Area, Corrective Action Unit 447
Well-Specific Fluid Management Strategy
July 2014

Introduction

The U.S. Department of Energy (DOE) Office of Legacy Management will be conducting subsurface investigations in Corrective Action Unit 447, at the Project Shoal Area, Churchill County, Nevada (Figure 1). The subsurface investigations will include well drilling and other well-site activities, as defined in the Fluid Management Plan (FMP) for the site (DOE 2011a). Well-drilling activities will generate fluids and associated material during the advancement and installation of the new monitoring wells MV-4, MV-5, and HC-2d. Other well-site activities will generate fluids during development, sampling, and aquifer testing of the new wells. In accordance with the FMP, this well-specific fluid management strategy letter provides the rationale for selecting the far-field fluid management strategy and addresses specific details regarding the nature and configuration of the fluid containment to be used at each new well site.

The Shoal site is in the northern portion of the Sand Springs Range in west-central Nevada's Churchill County. The Sand Springs Range is the southern extension of the Stillwater Range, a north-northeast-trending fault block range that traverses Churchill County. The Sand Springs Range rises to an elevation of approximately 6,751 feet (ft) above mean sea level (amsl) and is flanked by Fourmile Flat to the west and Fairview Valley to the east (Figure 1). The Shoal site is in Gote Flat at an elevation of approximately 5,250 ft amsl and is within an area that is part of the Cretaceous age Sand Springs granitic pluton.

An underground nuclear test was performed at the Shoal site on October 26, 1963, as part of the Vela Uniform program that was sponsored jointly by the U.S. Department of Defense and the U.S. Atomic Energy Commission. The test consisted of detonating a 12-kiloton nuclear device in granitic rock at a depth of approximately 1,211 ft below ground surface (bgs) (AEC 1964). A cavity created by the test collapsed shortly after the detonation and formed a rubble chimney. The radius of the cavity is reported to be 85 ft and reentry drilling indicated that the rubble chimney extended approximately 356 ft above the shot point (Hazleton-Nuclear Science Corporation 1965). The water table beneath the site (near surface ground zero and west of the shear zone) occurs at depths ranging from approximately 965 to 1,085 ft bgs, and groundwater moves primarily through fractures in the granite.

Water for the drilling activities will be obtained from well HS-1 in accordance with the Nevada Department of Conservation and Natural Resources Division of Water Resources requirements. Well HS-1 is in Fairview Valley (Figure 2) approximately 4 miles east of surface ground zero. The well is screened in the alluvium from approximately 400 to 700 ft bgs and was used as a source of water during drilling activities in 1996, 2000, and 2006. Water from the well will be mixed with a dilute chemical tracer (sodium bromide) and transported to the well sites for storage in an aboveground storage tank for use during the drilling operations. The tracer will be used to help guide well development activities. Figure 2 provides the location of the new wells and the water supply well HS-1.

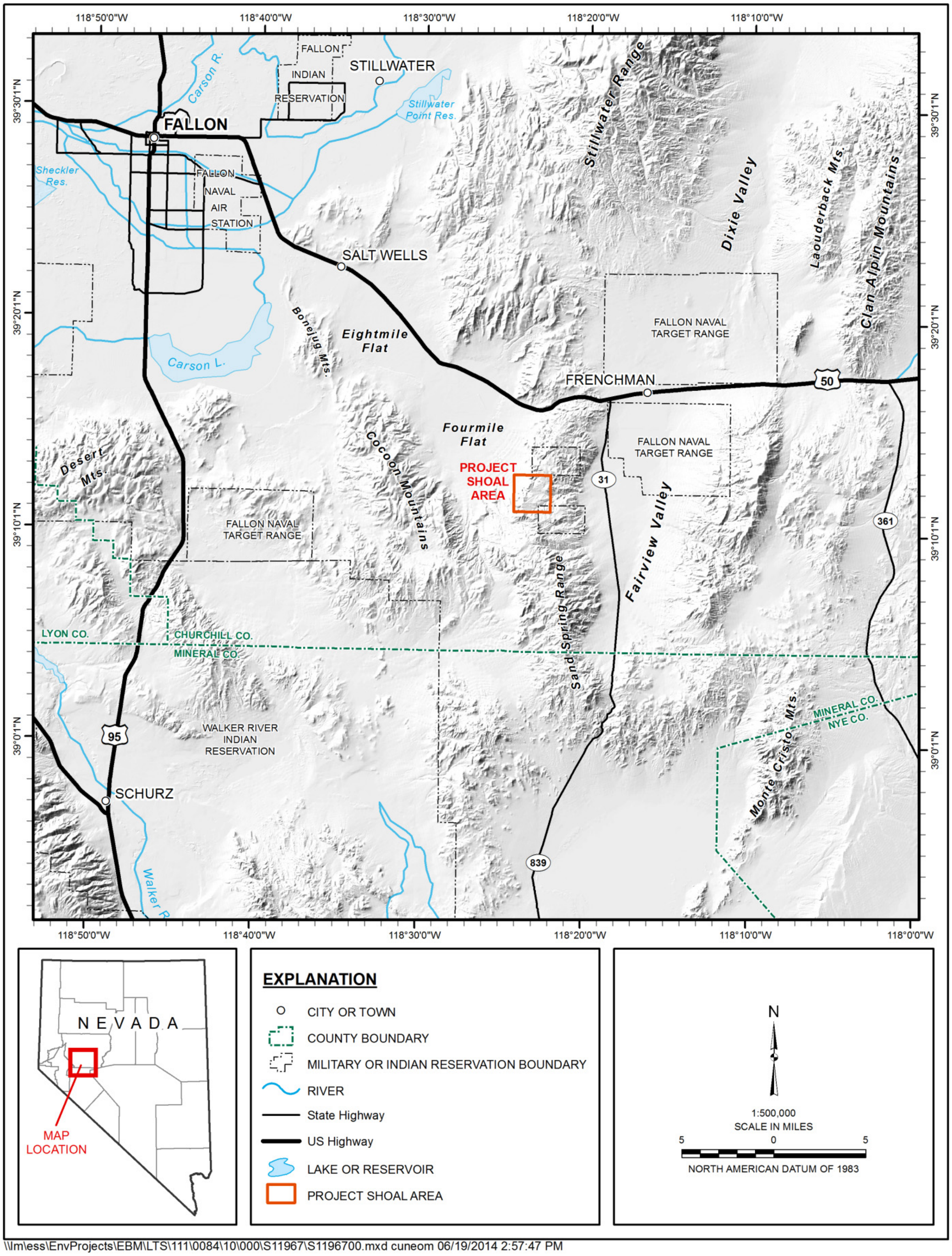

Figure 1. General Location Map of the Shoal, Nevada, Site

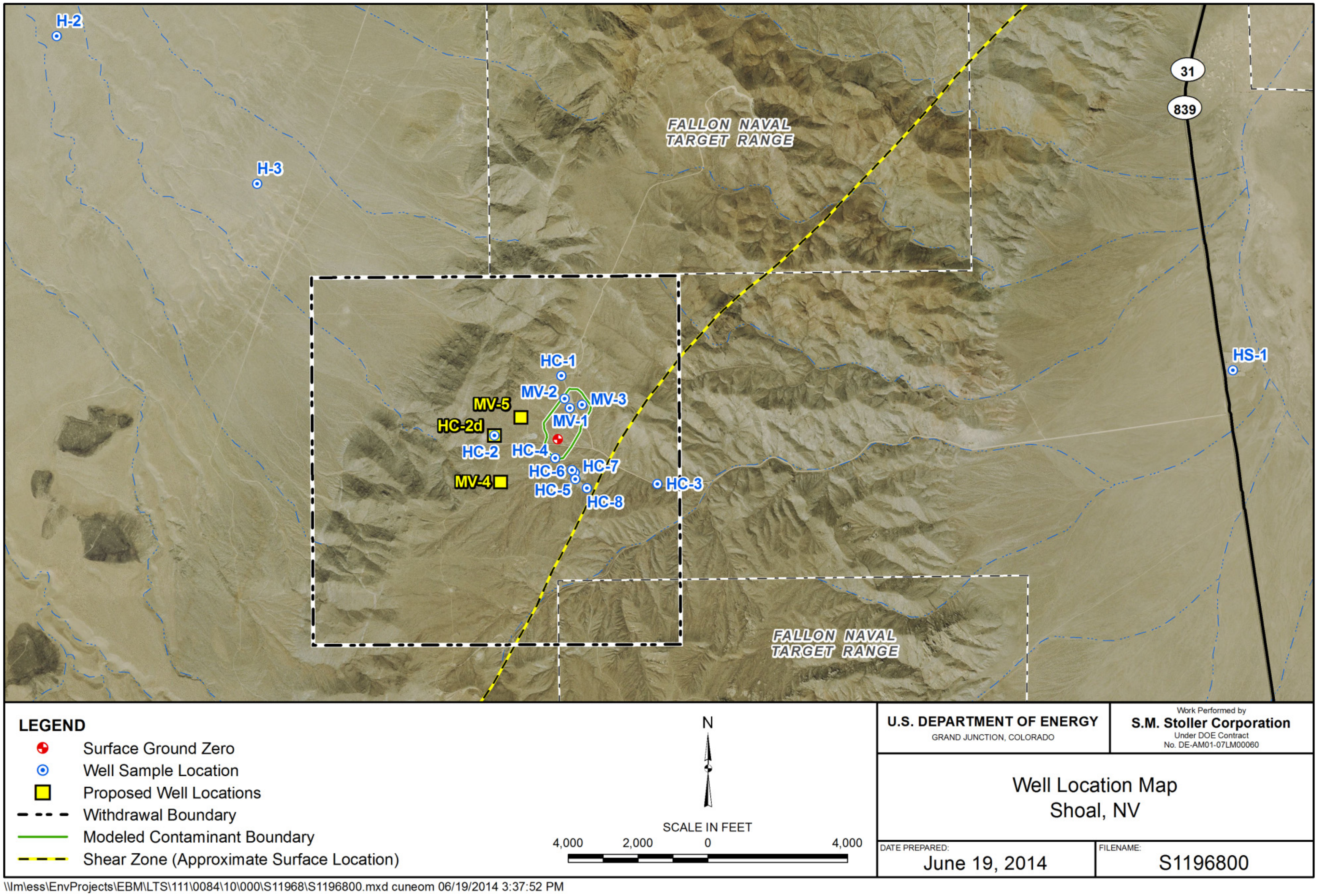

Figure 2. Existing and Proposed Well Locations

Fluid Generation

Fluid generation associated with the subsurface investigation will include well drilling and other well-site activities. The strategy for containing and handling fluids and materials generated during these activities is provided below.

Well-Drilling Activities: The locations of the new wells (MV-4, MV-5, and HC-2d) are provided on Figure 2. Well-drilling activities will include drilling boreholes to a depth of approximately 2,000 ft bgs. The well pads for the new wells will be constructed with one primary infiltration basin for each well designed to contain approximately 185,000 gallons of drilling-related fluids and materials. The volume of well-drilling fluids is not expected to exceed the capacity of the primary infiltration basin. A secondary infiltration area will be designated for each new well and used if necessary (Figure 3). Samples of the well-drilling fluids will be collected during drilling, see "Onsite Monitoring" below.

Other Well-Site Activities: Other well-site activities will be conducted at wells MV-4, MV-5, and HC-2d. The other well-site activities will include well development, sampling, and aquifer testing. Water generated during these activities will be directed to the primary infiltration basins and is not expected to exceed the capacity of the basin (approximately 185,000 gallons). In the unlikely event that purge-water volumes exceed the capacity of the primary infiltration basin, the purge water will be discharged to the secondary infiltration area/ground surface (Figure 3). Samples will be collected from the new wells and analyzed for radionuclides after the well is completed and before an aquifer test is conducted to verify the far-field compliance strategy.

Table 1 provides the wells and piezometers that are part of the monitoring network, along with the unit monitored, the elevation of the screened or open interval, and analytical results for the detonation-related radioisotope tritium obtained from the last annual sampling event (DOE 2014a). Samples are collected annually from the wells in the monitoring network in accordance with the Short-Term Data Acquisition Plans (DOE 2009, 2011b, and 2014b), which enhanced the monitoring network defined in the Corrective Action Decision Document/ Corrective Action Plan (NNSA 2006).

Potential Radionuclide Transport Mechanisms

Two potential mechanisms exist for the transport of test-related radionuclide contamination to existing and new well locations—prompt injection and groundwater transport. This observation was based on available data on underground test phenomenology, known and inferred geologic structures, groundwater modeling efforts, and existing wells at the Shoal site.

Prompt Injection: Process knowledge gained from other underground nuclear tests indicates that deposition of radionuclides by prompt injection may occur up to 5 times the radius (5 cavity radii) of an underground nuclear test cavity. Wells MV-4, MV-5, and HC-2d will be installed approximately 24 cavity radii (2,000 ft), 15 cavity radii (1,250 ft), and 22 cavity radii (1,830 ft) from the detonation cavity, respectively.

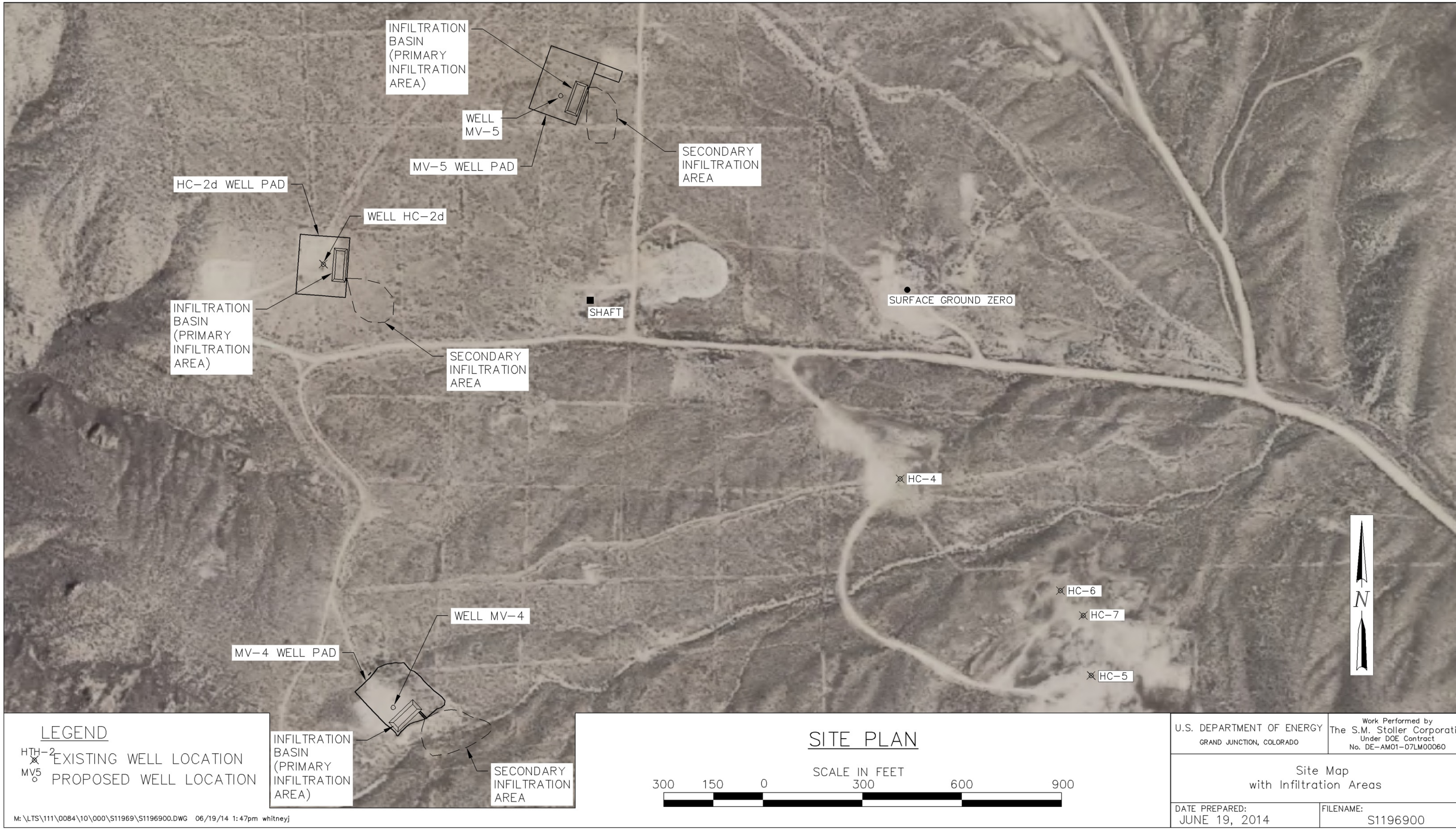

Figure 3. Site Map

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Table 1. Existing and Proposed Monitoring Network Data

Location Identification	Location Type	Formation of Screened or Open Interval	Elevation of Screened or Open Interval (ft amsl)	Date Sampled	Tritium (pCi/L)
MV-1	Well	Granite	3,685 to 3,531	5/22/2013	< MDC
MV-1 PZ	Piezometer	Granite	3,920 to 3,860	NS	NS
MV-2	Well	Granite	3,447 to 3,276	5/22/2013	< MDC
MV-2 PZ	Piezometer	Granite	4,079 to 4,019	NS	NS
MV-3	Well	Granite	3,798 to 3,627	5/21/2013	< MDC
MV-3 PZ	Piezometer	Granite	4,121 to 4,061	NS	NS
HC-1	Well	Granite	4,236 to 3,997	5/22/2013	< MDC
HC-2	Well	Granite	4,392 to 4,124	5/22/2013	< MDC
HC-3	Well	Granite	3,919 to 3,898	5/22/2013	< MDC
HC-4	Well	Granite	4,248 to 3,958	5/21/2013	964
HC-5	Well	Granite	1,862 to 1,717	5/22/2013	< MDC
HC-6	Well	Granite	4,113 to 3,996	5/22/2013	< MDC
HC-7	Well	Granite	4,123 to 4,006	5/21/2013	< MDC
HC-8	Well	Granite	2,966 to 2,849	5/23/2013	< MDC
H-2	Well	Alluvium	3,377 to 3,237	NS	NS
H-3	Well	Granite	3,919 to 3,762	NS	NS
HS-1	Well	Alluvium	3,823 to 3,543	5/22/2013	< MDC
MV-4	Well	Granite	TBD	NS	NS
MV-4 PZ	Piezometer	Granite	TBD	NS	NS
MV-5	Well	Granite	TBD	NS	NS
MV-5 PZ	Piezometer	Granite	TBD	NS	NS
MV-2d	Well	Granite	TBD	NS	NS

Notes:
Well HS-1 is currently not part of the monitoring network because it is 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.

Abbreviations:
NS = not sampled
pCi/L = picocuries per liter
TBD = to be determined
MDC = Minimum Detectable Concentration (laboratory minimum detectable concentration for tritium is approximately 400 pCi/L)

Groundwater Transport: Groundwater transport appears to be the most feasible mechanism for subsurface contamination to migrate away from the underground nuclear test cavity. However, water levels obtained from wells and piezometers west of the shear zone (Figure 2) and near the underground detonation cavity have been rising since the first wells were installed in 1996. The reason for the water-level rise is uncertain, but it is most likely the result of effects from the detonation, previous drilling activities, compressional forces, or a combination of multiple factors within the Sand Springs range. These conditions support the current site conceptual model that indicates that the amount of groundwater flow and transport from the detonation cavity is limited.

Analytical Data from Surrounding Area Wells

Existing data were reviewed to evaluate the potential for encountering radionuclide contamination (i.e., tritium) during well drilling and other well-site activities. Table 1 provides analytical tritium results obtained from the most recent sampling of the wells that are part of the monitoring network at the Shoal site. The analytical results (recent and historic) indicate no tritium levels above the laboratory minimum detectable concentration in all sampled wells, except in well HC-4. The presence of tritium in this well (964 picocuries per liter [pCi/L]) is attributed to its proximity (5.2 cavity radii or 445 ft) to the underground nuclear detonation cavity (Figure 2). Well HC-4 was installed in 1996 and the highest tritium concentration detected in this well was 1,130 pCi/L in 1997 (DOE 2014a).

Well Operations Strategy

Well drilling and other well-site activities will be conducted under the far-field well-site operation strategy, which is described in the FMP that was approved by DOE and the Nevada Division of Environmental Protection. The selection of the far-field strategy was based on the information provided above and on the unlikeliness that the drilling-related activities would generate fluids with tritium concentrations that exceed 20 times the FMP criteria (i.e., tritium concentrations greater than 400,000 pCi/L).

Fluid Containment: Fluids generated during well-drilling activities will be temporarily contained in a portable mud tank, and then directed to the primary infiltration basin. The volume of the well-drilling fluids generated from MV-4, MV-5, and HC-2d are not expected to exceed the capacity of the primary infiltration basin but, if needed, a secondary infiltration area has been designated for each location (Figure 3). Groundwater generated during other well-site activities will be directed to the primary infiltration basin and then if necessary, to the secondary infiltration area/ground surface.

Onsite Monitoring: Samples will be collected from the water supply well HS-1 and from the water truck used to transport the water to the well pads prior to initiating the drilling activities. The samples will be analyzed onsite for tritium and the result from the water supply well will be used to establish a background for the field tritium monitoring performed during well drilling and other well-site activities. A portion of these samples will also be sent to an offsite laboratory for radiological analysis. If a secondary water supply well is needed for the project, a sample will be collected, using the same process, to establish a background for field monitoring of tritium.

Samples will be collected from the fluid discharge line during well-drilling activities at approximately 30-ft intervals, or every 2 hours (whichever occurs first), as indicated in the FMP. It should be noted that samples will not be collected at a frequency greater than once per hour based on the time required to perform the onsite field monitoring and analysis. The field monitoring samples will be analyzed onsite for tritium and bromide at least daily. The tritium results will be used to verify that the far-field fluid management strategy is appropriate for the site. Samples analyzed for bromide will be used to determine if drilling-related fluids have been removed during well development. Fluid management protocols (i.e., posting and controlling access to the infiltration basins) shall be required if tritium concentrations meet or exceed 20,000 pCi/L. If tritium concentrations meet or exceed 400,000 pCi/L, drilling at the well location will be stopped and the required notifications will be made as per the FMP. Samples will be collected from the discharge line during other well-site activities and analyzed for tritium at least weekly, as specified in the FMP. Reduction or elimination of tritium monitoring will be based on monitoring results and approval from the Office of Legacy Management and the Nevada Division of Environmental Protection.

References

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