DOE/NV--955

U.S. DEPARTMENT OF ENERGY

Project Shoal Site
ENVIRONMENTAL MANAGEMENT
END STATE VISION
Final

Executive Summary

The Environmental Management End State Vision is to be used as the primary tool for communicating the individual site end state to the involved parties (e.g., U.S. Department of Energy [DOE], regulators, public stakeholders, Tribal Nations). The end state document is not a decisional document. If the DOE decides to seek changes to the current compliance agreements, decisions, or statutory/regulatory requirements, those changes will be made in accordance with applicable requirements (DOE/EM, 2003).

Restoration activities have been conducted on the surface of the Project Shoal Site; however, an investigation of subsurface contamination has not yet been completed. Therefore, the surface and subsurface end states are treated separately within this document.

The Project Shoal Site is located in the northern part of the Sand Springs Range in southern Churchill County, in western Nevada. The area consists of an arid, sage-covered mountain range. The region is sparsely populated, with military installations, recreation, ranching, and mining providing the dominant commercial interests. The nearest town is Fallon, located 30 miles northwest of the site.

The Project Shoal Site was the location of one underground nuclear test conducted in 1963, designed to study granite as a test medium and to determine if seismic waves generated by underground nuclear explosions could be differentiated from seismic waves generated by naturally occurring earthquakes. No further tests were conducted at the Project Shoal Site.

In 1996, the DOE Nevada Operations Office (now the DOE Nevada Site Office [DOE/NSO]) completed preliminary site characterization for the surface area of the Project Shoal Site. In 1998, closure of the site surface area was completed by DOE and approved by the Nevada Division of Environmental Protection (NDEP). During these activities, the Project Shoal Site surface area was cleaned up and surface contamination was removed. The Closure Report for the surface at the Project Shoal Site was accepted by NDEP without comment. The acceptance letter from NDEP stated, "No post-closure monitoring is required and no land use restrictions apply to this Corrective Action Unit" (Liebendorfer, 1998). The surface of the Project Shoal Site is in the end state.

In 1996, the DOE also began characterizing the subsurface of the Project Shoal Site. Four characterization wells were drilled and data from them were used to construct groundwater flow

and radionuclide transport models. The conclusion of these efforts found substantial uncertainties remaining with regard to the magnitude and direction of contaminant transport. A data analysis was performed to analyze the potential benefits and related costs of additional characterization work. Using the data analysis, the DOE and NDEP reached agreement on a second round of fieldwork. This occurred in 1999 and 2000, and consisted of drilling four more wells and conducting a tracer test. These results were incorporated in a revised flow and transport model, which has undergone peer review and is pending final regulator approval. According to the Life-Cycle Baseline Revision 5, subsurface closure of the site is expected to be completed in fiscal year 2011.

Subsurface and groundwater contamination is being addressed by implementing a risk-based approach based on defining the contaminant and compliance boundaries at the Project Shoal Site, and monitoring groundwater to ensure that contamination does not migrate past the compliance boundary. The contaminant boundary will be defined on the basis of modeling as the maximum extent to which groundwater contaminated above Safe-Drinking Water Act limits (maximum contaminant levels [MCLs]) is modeled to migrate in 1,000 years. A risk-based boundary is also calculated assuming ingestion of groundwater as drinking water and limited to an increased cancer risk of 10^{-6}, though the State of Nevada has chosen to regulate to MCLs. The compliance boundary will be the result of negotiation between the DOE and NDEP. As agreed to in the *Federal Facility Agreement and Consent Order*, the accepted contaminant boundary and other considerations will form the basis for the negotiated compliance boundary. Drilling and water use within the compliance boundary will be prohibited, and groundwater production may also be limited for some region outside the boundary. This will be protective because, though it is not technologically feasible to remediate the contamination associated with an underground nuclear test, the use (withdrawal) of and exposure to contaminated groundwater will be precluded by implementation of institutional controls restricting the drilling of wells within the boundary. The location of monitoring wells to verify modeling results and the compliance boundary will be determined through negotiation and concurrence with the State of Nevada. Well locations will be based on best available knowledge of the most likely direction and pathways for groundwater migration. In the event that contaminants migrate past the compliance boundary, the monitoring system and groundwater model will be re-evaluated to determine if the drilling restrictions and associated institutional controls need to be changed. If the contamination migrates off site, the boundaries of the land withdrawal may have to be reevaluated.

The DOE has defined the subsurface end state at the Project Shoal Site to be continued water monitoring, restriction of groundwater use in the vicinity of the test site, and restriction of

drilling at the site. Based on the historic use of the Project Shoal Site and characterization conducted at similar sites, the test cavity, which is several thousand feet below ground surface, is expected to contain contaminants of concern including radioactive fission products, plutonium, uranium, and tritium. Post-closure monitoring will be conducted as agreed upon in the site closure report for the subsurface.

The future use plan for the surface of the Project Shoal Site is to return the site to open space, such as that administered by the U.S. Department of the Interior, Bureau of Land Management in the region. However, the Project Shoal Site is still part of a land withdrawal by the U.S. Navy for military training purposes at the Naval Air Station, Fallon, Nevada. The current land withdrawal is for 25 years. The planned future use of the Project Shoal Site will include military training.

The DOE/NSO developed a public participation plan for the Project Shoal Site Environmental Management End State Vision. The plan provided a draft copy of this document, an information sheet, and a letter soliciting feedback by July 1, 2004, to involved parties and stakeholders. All written comments that were submitted to the DOE/NSO received comment resolution.

Table of Contents

Executive Summary i
Table of Contents iv
List of Acronyms and Abbreviations v

1.0 Introduction 1
1.1 Organization of the Report 4
1.2 Site Mission 5
1.3 Status of Clean-up Program 7

2.0 Regional Context End State Description 9
2.1 Regional Physical and Surface Interface 9
2.2 Human and Ecological Land Use 12

3.0 Site-Specific End State Description 15
3.1 Physical and Surface Interface 15
3.2 Human and Ecological Land Use 17
3.3 Site Context Legal Ownership 20
3.3 Site Context Demographics 20

4.0 Hazard-Specific Discussion 23
4.1 Surface Source Area 1 27
4.2 Subsurface Source Area 1 27

5.0 References 29

Attachment A - Discussion of Variances 32

List of Acronyms and Abbreviations

AEC	U.S. Atomic Energy Commission
bgs	Below ground surface
BLM	U.S. Department of the Interior, Bureau of Land Management
CAS	Corrective Action Site
CAU	Corrective Action Unit
COC	Contaminant(s) of Concern
CSM	Conceptual site model
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/NSO	U.S. Department of Energy, Nevada Site Office
DOI	U.S. Department of the Interior
EM	U.S. Department of Energy, Environmental Management Program
EPA	U.S. Environmental Protection Agency
FFACO	*Federal Facility Agreement and Consent Order*
ft	Foot (feet)
FY	Fiscal year
LTHMP	Long-Term Hydrologic Monitoring Program
MCL	Maximum contaminant level
MDC	Minimum detectable concentration
mi^2	Square mile(s)
NDEP	Nevada Division of Environmental Protection
PLO	Public Land Order
SGZ	Surface ground zero
yd^3	Cubic yard(s)

1.0 Introduction

The Environmental Management End State Vision is to be used as the primary tool for communicating the individual site end state to the involved parties (e.g., U.S. Department of Energy [DOE], regulators, public stakeholders, Tribal Nations). The end state document is not a decisional document. If the DOE decides to seek changes to the current compliance agreements, decisions, or statutory/regulatory requirements, those changes will be made in accordance with applicable requirements (DOE/EM, 2003).

The Environmental Management End State Vision juxtaposes land use with remediation requirements, establishing a conceptual completion goal (or end state) that is both realistic and protective of human health and the environment. The purpose of the vision is to identify where and how potentially harmful exposures to hazardous or radioactive contaminants might occur under projected future conditions, and to determine what actions will be necessary to minimize the potential for harm under those conditions. Consistent with the objectives of cleanup, the vision conceptualizes specific end state conditions that will minimize the potential for harm in the future.

The July 2003 DOE Policy 455.1, "Use of Risk-Based End States," requires DOE Environmental Management Program (EM) sites to define and document a risk-based end state vision that is acceptable to regulators and stakeholders, and then to revise clean-up program plans as necessary to achieve that end state in the most efficient manner (DOE, 2003). The policy is a formal mandate for EM sites to implement risk-based corrective action programs as described in numerous DOE and U.S. Environmental Protection Agency (EPA) publications, American Society of Testing and Materials Standard Guides, and National Research Council recommendations.

Environmental corrective action is an application of standard scientific, engineering, and mathematical principles, enabling steady progress in solving even very complex clean-up problems. The complexities of cleanup at a typical EM site are generally similar: multiple contaminants distributed in multiple environmental media, released over long periods of time and over large areas of land. Uncertainties in source(s), nature, extent, transport, and fate of contaminants are very large and can never be absolutely eliminated. Corrective action provides an objective means of managing uncertainties to the degree necessary and sufficient to make defensible decisions about effective clean-up actions.

The end state vision describes clean-up goals that would be protective under planned future uses. Proposed corrective actions based on risk and other factors associated with land use are presented, negotiated, and agreed to under the *Federal Facility Agreement and Consent Order* (FFACO) (FFACO, 1996) by the State of Nevada and DOE.

The DOE's risk-based end state initiative is fully consistent with the EPA's recent endorsement of systematic planning, which uses risk-based decision methods to ensure objectivity, defensibility, and cost-effectiveness in corrective action programs (EPA, 2001). The DOE Nevada Site Office (DOE/NSO) will collaborate with its stakeholders to revise the proposed Environmental Management End State Vision, as needed, to define clear goals for completion of its EM-sponsored clean-up work.

The DOE/NSO developed a public participation plan for the Project Shoal Site End State Vision. The plan provided a draft copy of this document, an information sheet, and a letter soliciting feedback by July 1, 2004, to involved parties and stakeholders. All written comments that were submitted to the DOE/NSO received comment resolution.

Restoration activities have been conducted on the surface of the Project Shoal Site; however, an investigation of subsurface contamination has not yet been completed. Therefore, the surface and subsurface end states are treated separately within this document.

The Project Shoal Site is located in the Sand Springs Range in southern Churchill County, northwestern Nevada. Project Shoal consisted of one underground nuclear test, which was designed to determine if seismic waves generated by underground nuclear testing could be differentiated from those generated by earthquakes. The nuclear device was placed in granite at a depth of 1,211 feet (ft) below ground surface (bgs). The emplacement shaft was drilled to a depth of 1,316 ft, with a drift 1,050 ft to the east. Over 30 holes were drilled at the site for exploration, instrumentation, and post-test hydrologic testing.

The *Corrective Action Investigation Plan for Project Shoal CAU No. 416* (DOE/NV, 1996a) documented the proposed characterization and clean-up activities for both the surface and subsurface at the Project Shoal Site. The *Closure Report for Corrective Action Unit 416: Project Shoal Mud Pit and Muckpile* (DOE/NV, 1997) documented surface clean-up activities associated with the mud pit and muckpile that resulted from pretest mining activities and post-test re-entry drilling activities. The *Closure Report for CAU No. 416 Project Shoal* (DOE/NV, 1998a) summarized clean-up activities associated with the mud pit and muckpile, documented

housekeeping activities at the site, and fulfilled requirements for a Notice of Completion from the Nevada Division of Environmental Protection (NDEP). The *Data Report, Project Shoal Area, Churchill County, Nevada* (DOE/NV, 1998c) provides details of the drilling and testing of the four wells in 1996. *Evaluation of Groundwater Flow and Transport at the Shoal Underground Nuclear Test* (Pohll et al., 1998) contains the modeling resulting from the 1996 fieldwork. This was followed by the *Data Decision Analysis: Project Shoal* (Pohll et al., 1999). The second subsurface corrective action investigation plan, *Corrective Action Investigation Plan for Corrective Action Unit 447: Project Shoal Area, Nevada Subsurface Site* (DOE/NV, 1998b), was followed by an addendum (DOE/NV, 1999). The results from the second round of well drilling can be found in the *Well Installation Report, Project Shoal Area, Churchill County, Nevada* (IT, 2000), with results from the tracer test in *Project Shoal Tracer Test Experiment* (Carroll et al., 2000). The second modeling report is entitled *Modeling to Support Groundwater Contaminant Boundaries for the Shoal Underground Nuclear Test* (Pohlmann et al., 2004), and is in final review and approval with the Nevada State regulator. The present document summarizes results from these documents, and addresses the current and planned future status and land use of the Project Shoal Site. The DOE will retain long-term stewardship of the Project Shoal Site due to the presence of residual contamination in the subsurface.

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1.1 Organization of the Report

The Project Shoal Site Environmental Management End State Vision is organized into five sections. Since the current state and the end state are the same for the Project Shoal Site, only one map is presented for each subsection.

Section 1.0 introduces the site, including a brief discussion of past, present, and future site missions. This section also briefly discusses site hazards, the extent of environmental contamination, past remediation work, and any planned future clean-up work.

Section 2.0 describes the regional context end state. This section examines physical and surface interface and human and ecological land use in the regional context. A map showing the current state and the end state is also included for each subsection.

Section 3.0 describes the site-specific end state. This section examines physical and surface interface and human and ecological land use for the site and immediately adjacent lands. Legal ownership and demographics are also presented, and each subsection includes a map showing the current state and the end state.

Section 4.0 discusses specific site hazards including the nature of each hazard, potential impacts on human health and the environment, and any hazard mitigation identified. This section includes a current site-wide hazard map in addition to a current state/end state map for each specific hazard. A conceptual site model (CSM) is also included in this section. This model shows the current state/end state for each hazard. The CSM is used to show the known and potential contaminant pathways, potential receptors, and barriers that have been put in place to minimize exposure to contamination.

Section 5.0 provides references used to develop the Project Shoal Site Environmental Management End State Vision.

Attachment A provides a report table detailing that there are no variances between the end state vision and current remediation plans for this site.

1.2 Site Mission

The Project Shoal Site became active in 1963. Project Shoal consisted of one underground nuclear test that was designed to study the effects of different geologic media, in this case granite, on seismic waves produced by underground nuclear explosions, and to determine if they could be differentiated from natural seismic activity. The Project Shoal test produced a yield of 12 kilotons (DOE/NV, 2000c) at a depth of 1,211 ft bgs.

Under the DOE land withdrawal agreement and the military land withdrawal criteria identified in Public Law 106-65, "Military Lands Withdrawal Act of 1999" (U.S. Public Laws, 1999), the Project Shoal Site has been withdrawn from all forms of appropriation under the public land laws. The U.S. Department of Defense (DoD) will determine the future use of the surface area (DOE/EM, 2003).

Based on the historic use of the site and characterizations conducted at similar sites, the contaminants of concern (COCs) for the subsurface are expected to include radioactive fission products, plutonium, uranium, and tritium. Table 1.1 shows the representative source term for the Project Shoal Site.

At present, the hazard extent has not been defined for the subsurface; however, the DOE/NSO plans to complete the modeling of subsurface contamination during fiscal year (FY) 2004. Existing subsurface intrusion restrictions will be refined, as necessary, based on the outcome of the investigation and modeling efforts (DOE/EM, 2001). Future work includes installation of monitor wells, validation of the groundwater model, and issuance of a closure report. According to the Life-Cycle Baseline Revision 5, subsurface closure of the site is expected to be completed in FY 2011.

Table 1.1 Representative Source Term for the Project Shoal Site

Mean radionuclide inventory for 76 nuclear tests detonated below or within 328 ft of the water table in Areas 19 and 20 at the Nevada Test Site. Values are decay corrected to January 1, 1994 (Smith, 2001). Unclassified site-specific mass estimates for the Project Shoal test are substituted, where available, from Hazelton-Nuclear Science Corp. (1965).

Radionuclide	Isotope Symbol	Half life ($t_{1/2}$; year)	Estimated Inventory (Ci) *
Tritium	H-3	1.23E+01	3.0E+04**
Carbon-14	C-14	5.73E+03	7.3E+00
Aluminum-26	Al-26	7.30E+05	1.18E-04
Chlorine-36	Cl-36	3.01E+05	2.82E+00
Argon-39	Ar-39	2.69E+02	2.43E+01
Potassium-40	K-40	1.28E+09	6.17E+00
Calcium-41	Ca-41	1.03E+05	2.16E+01
Nickel-59	Ni-59	7.60E+04	5.25E-01
Nickel-63	Ni-63	1.00E+02	5.54E+01
Krypton-85	Kr-85	1.07E+01	1.26E+03
Strontium-90	Sr-90	2.91E+01	1.9E+03**
Zirconium-93	Zr-93	1.50E+06	5.49E-01
Niobium-93m	Nb-93m	1.61E+01	9.99E+01
Niobium-94	Nb-94	2.00E+04	2.28E+00
Technetium-99	Tc-99	2.13E+05	4.04E+00
Ruthenium-106	Ru-106	1.02E+00	6.4E+03**
Paladium-107	Pd-107	6.50E+06	2.07E-02
Cadmium-113m	Cd-113m	1.41E+01	1.53E+01
Tin-121m	Sn-121m	5.50E+01	5.67E+01
Tin-126	Sn-126	1.00E+05	6.47E-01
Antimony-125	Sb-125	2.76E+00	8.0E02**
Iodine-129	I-129	1.57E+07	1.24E-02
Cesium-135	Cs-135	2.30E+06	4.17E-01
Cesium-137	Cs-137	3.02E+01	2.2E+03**
Cerium-144	Ce-144	7.80E-01	6.7E+04**
Samarium-151	Sm-151	9.00E+01	4.2E+02**
Europium-150	Eu-150	3.60E+01	1.46E+01
Europium-152	Eu-152	1.35E+01	4.33E+02
Europium-154	Eu-154	8.59E+00	2.04E+02
Europium-155	Eu-155	4.71E+00	4.7E+02**
Holmium-166m	Hm-166m	1.20E+03	5.89E-01
Thorium-232	Th-232	1.40E+10	7.68E-04
Uranium-232	U-232	7.00E+01	3.36E+00
Uranium-233	U-233	1.59E+05	2.25E+00
Uranium-234	U-234	2.46E+05	1.62E+00
Uranium-235	U-235	7.04E+08	2.18E-02
Uranium-236	U-236	2.34E+07	6.22E-02
Uranium-238	U-238	4.47E+09	2.88E-02
Neptunium-237	Np-237	2.14E+06	4.80E-01
Plutonium-238	Pu-238	8.77E+01	9.42E+01
Plutonium-239	Pu-239	2.41E+04	2.54E+02
Plutonium-240	Pu-240	6.56E+03	8.16E+01
Plutonium-241	Pu-241	1.44E+01	1.18E+03
Plutonium-242	Pu-242	3.75E+05	4.42E-02
Americium-241	Am-241	4.33E+02	6.14E+01
Americium-243	Am-243	7.37E+03	2.36E-03
Curium-244	Cm-244	1.81E+01	3.91E+01

* Except where noted, value is from the mean unclassified radionuclide inventory for 76 nuclear tests detonated below or within 328 ft of the water table in Areas 19 and 20 of the Nevada Test Site.
** Value is an unclassified estimate for the Project Shoal test specifically, from Hazelton Nuclear Science (1965).

1.3 Status of Clean-up Program

As previously stated, the COCs for the subsurface at the Project Shoal Site are expected to include radioactive fission products, plutonium, uranium, and tritium. A post-test sampling hole was drilled and drill cuttings contaminated with short half-life radionuclides were mixed with clean dirt and put back into the mud pit at the site. Site characterization studies conducted in 1996 identified petroleum hydrocarbons in the mud pits, a housekeeping site with industrial refuse, and a muckpile associated with mining operations. Contaminated soil from the mud pits was excavated and transported off site, and the housekeeping site was cleaned up. The muckpile was tested and no COCs were detected. Closure was completed on all three surface corrective action sites (CASs) in 1998 (DOE/NV, 1998a). The Closure Report for the surface at the Project Shoal Site was accepted without comment by the NDEP. The acceptance letter from NDEP stated, "No post-closure monitoring is required and no land use restrictions apply to this Corrective Action Unit (CAU)" (Liebendorfer, 1998). Therefore, the Project Shoal Site surface is in the end state.

In 1996, the DOE also began characterization of the subsurface area of the Project Shoal Site. Four characterization wells were drilled and data from them was used to construct groundwater flow and radionuclide transport models. The conclusion of these efforts found substantial uncertainties remaining in regard to the magnitude and direction of contaminant transport. A data decision analysis was performed to analyze the potential benefits and related costs of additional characterization work. Using the data decision analysis, the DOE and NDEP reached agreement on a second round of fieldwork. This occurred in 1999 and 2000 and consisted of drilling four more wells and conducting a yearlong tracer test. These results were incorporated in a revised flow and transport model, which has undergone peer review and is currently pending final regulator approval. As part of the Long-Term Hydrologic Monitoring Program (LTHMP), the EPA monitors water quality in wells and springs in the vicinity of the Project Shoal Site on an annual basis (Map 3.1b). This monitoring program will be revised and/or reduced based on the results of the subsurface investigation. Long-term stewardship activities for the subsurface at the Project Shoal Site will include continued water quality monitoring, restriction of groundwater use in the vicinity of the test site, and restriction of drilling activity at the site (NNSA/NV, 2001). A marker was placed at the Project Shoal Site surface ground zero (SGZ) to indicate the location of the test cavity, but has since been destroyed.

Subsurface and groundwater contamination is being addressed by implementing a risk-based approach based on defining the contaminant and compliance boundaries at the Project Shoal Site,

and monitoring groundwater to ensure that contamination does not migrate past the compliance boundary. The contaminant boundary will be defined on the basis of modeling as the maximum extent to which groundwater contaminated above Safe-Drinking Water Act limits (maximum contaminant levels [MCLs]) is modeled to migrate in 1,000 years. A risk-based boundary will also be calculated assuming ingestion of groundwater as drinking water and limited to an increased cancer risk of 10^{-6}, though the State of Nevada has chosen to regulate to MCLs. The compliance boundary will be the result of negotiation between the DOE and NDEP. As agreed to in the FFACO, the accepted contaminant boundary and other considerations will form the basis for the negotiated compliance boundary (FFACO, 1996). Drilling and water use within the compliance boundary will be prohibited, and groundwater production may also be limited for some region outside the boundary. This will be protective because, though it is not technologically feasible to remediate the contamination associated with an underground nuclear test, the use (withdrawal) of and exposure to contaminated groundwater will be precluded by implementation of institutional controls restricting the drilling of wells within the boundary. The location of monitoring wells to verify modeling results and the compliance boundary will be determined through negotiation and concurrence with the State of Nevada. Well locations will be based on best available knowledge of the most likely direction and pathways for groundwater migration. In the event that contaminants migrate past the compliance boundary, the monitoring system and groundwater model will be re-evaluated to determine if the drilling restrictions and associated institutional controls need to be changed. If the contamination migrates off site, the boundaries of the land withdrawal may have to be reevaluated.

The DOE has defined the subsurface end state at the Project Shoal Site to be continued water monitoring, restriction of groundwater use in the vicinity of the test site, and restriction of drilling at the site. Based on the historic use of the Project Shoal Site and characterization conducted at similar sites, the test cavity, which is several thousand feet below ground surface, is expected to contain COCs including radioactive fission products, plutonium, uranium, and tritium. According to the Life-Cycle Baseline Revision 5, subsurface closure of the site is expected to be completed in FY 2011. The DOE assumes monitoring will be performed for 100 years (2011 to 2111); however, post-closure monitoring will be conducted as agreed upon in the site closure reports for the subsurface (DOE/EM, 2001).

2.0 Regional Context End State Description

This section examines physical and surface interface and human and ecological land use in the regional context. This section also provides a discussion of current and planned future land use for the region surrounding the Project Shoal Site.

2.1 Regional Physical and Surface Interface

The Project Shoal Site is located in the Sand Springs Range in southern Churchill County, Nevada (Map 2.1b). The Sand Springs Range is comprised of fractured granite and is bounded on the east and west by alluvium filled valleys (Figure 2.1). Faulting is present in the range, with a prominent shear zone and other major faults striking southwest to northeast across the site. The water table is present at approximately 970 ft bgs, with groundwater moving through fractures in the granite. Groundwater recharge occurs by infiltration of precipitation on the mountain range, with regional discharge occurring in the valleys. A groundwater divide along the upland area of the range separates flow to the east and west, and the shear zone is also a barrier to flow due to its low hydraulic conductivity (Figure 2.2). The Project Shoal Site is located on the eastern side of the divide and groundwater from the nuclear test area moves basically toward the northeast, paralleling the structural grain of the Sand Springs Range, and eventually to Fairview Valley. Groundwater within Fairview Valley has been used for ranching, seasonal residential purposes, and military uses within the last five years.

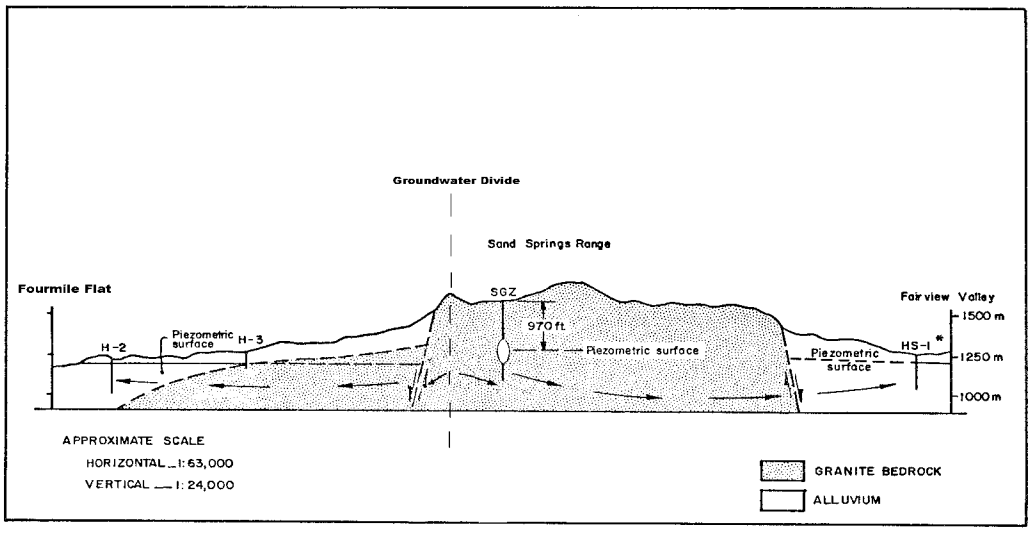
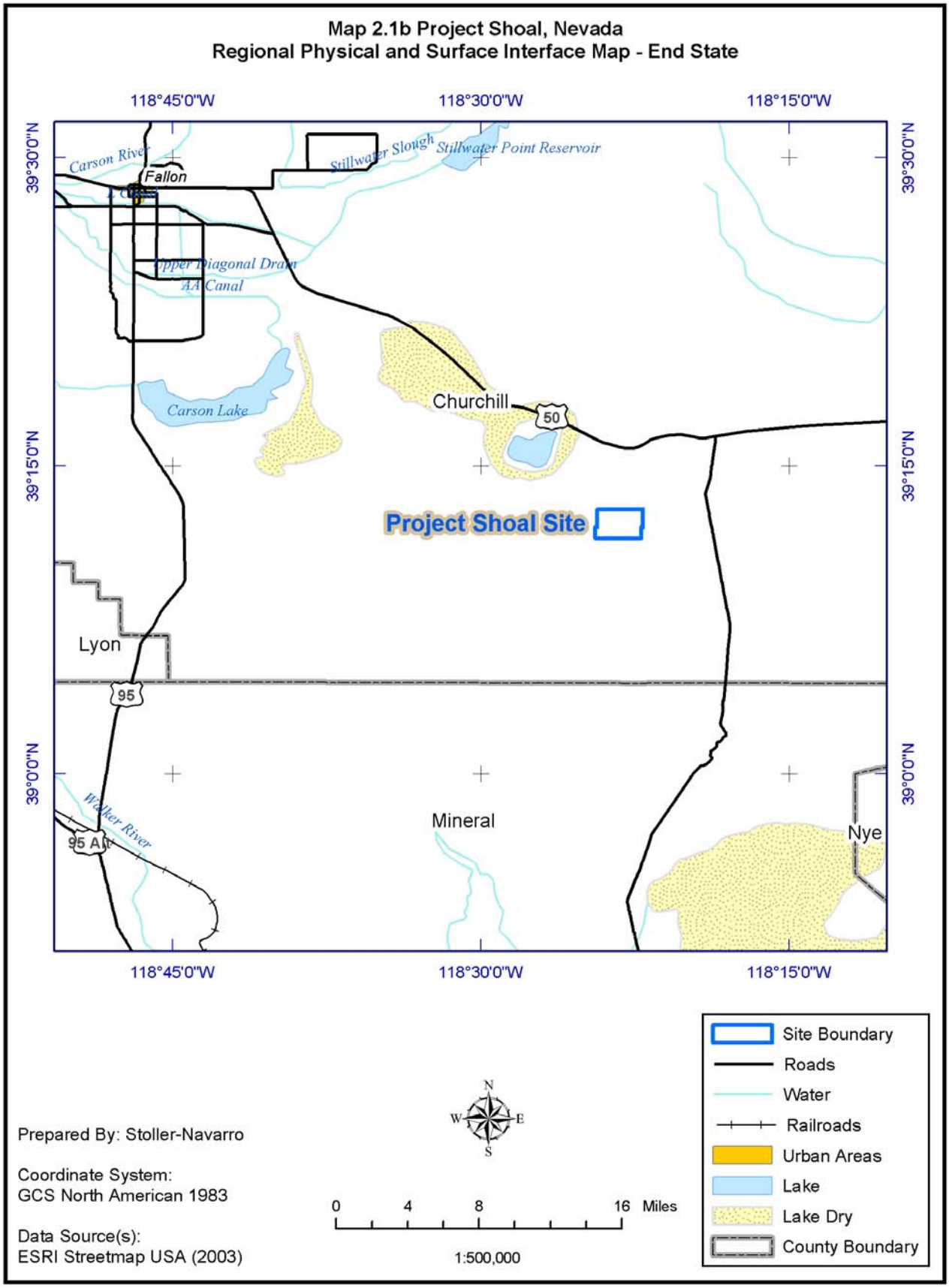


Figure 2.1

Cartoon Cross Section from West to East Through the Sand Springs Range, with the Project Shoal Site SGZ and the Valleys on Either Side


Map 2.1b Project Shoal, Nevada
Regional Physical and Surface Interface Map - End State
118°45'0"W
118°30'0"W
118°15'0"W
39°30'0"N
39°15'0"N
39°0'0"N
Carson River
Fallon
Stillwater Slough
Stillwater Point Reservoir
Upper Diagonal Drain
AA Canal
Carson Lake
Churchill
50
Project Shoal Site
Lyon
95
Walker River
95 Alt
Mineral
Nye
Site Boundary
Roads
Water
Railroads
Urban Areas
Lake
Lake Dry
County Boundary
N
S
E
W
0
4
8
16
Miles
1:500,000
Prepared By: Stoller-Navarro
Coordinate System:
GCS North American 1983
Data Source(s):
ESRI Streetmap USA (2003)

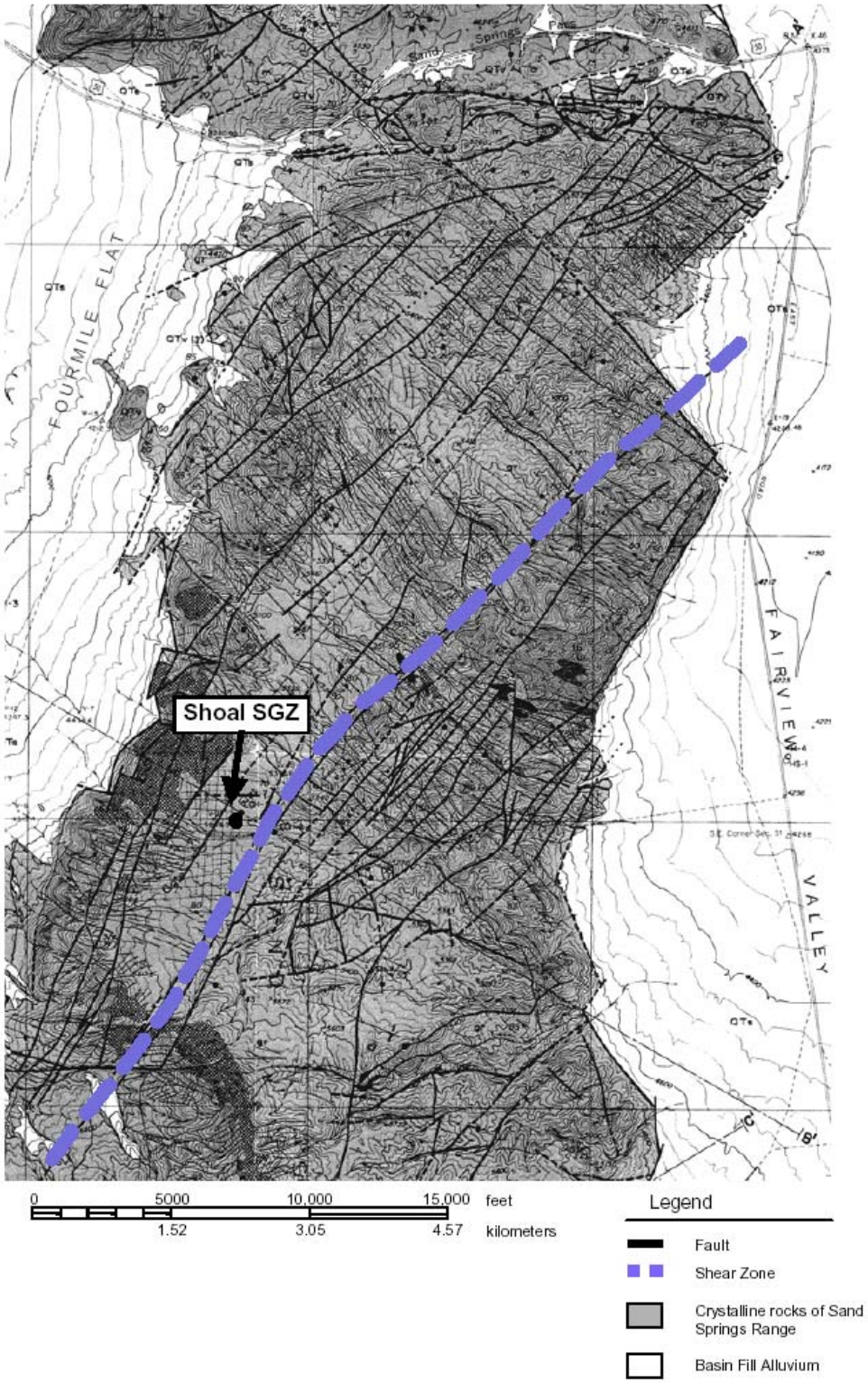


Figure 2.2

Location and Orientation of the Shear Zone in the Central Sand Springs Range

2.2 Human and Ecological Land Use

Human Land Use

The Project Shoal Site is surrounded by open terrain that is managed by the U.S. Department of the Interior (DOI), Bureau of Land Management (BLM) (Map 2.2b), which has historically been used for ranching and mining. The area is also used for public recreation including hunting, camping, and off-road driving. The site is part of a much larger area that was withdrawn by the U.S. Navy in 1999. Under the DOE land withdrawal agreement and military land withdrawal criteria, this land has been withdrawn from all forms of appropriation under the public land laws. The withdrawal currently provides areas for military training and related facilities. The DOE will continue to impose land use restrictions to prevent access to the test cavities, subsurface soil, and groundwater in perpetuity. The Navy withdrawal should help maintain government oversight and control of the subsurface resources at the Project Shoal Site, although it does not currently prevent public access to the site. The future land use for the site and surrounding area is expected to remain the same; however, the DoD will determine the future use of the surface area. The future roles and responsibilities of the DOE, landowners, and other federal and state agencies are documented in Table 2.1 (DOE/NV, 2000b).

Table 2.1
DOE/NSO Land Status

Landlord	Surface Steward	Subsurface Steward	Withdrawal Order/Law	Specific Restriction Record	Oil/Gas Owner and Leases	Water Well Permits	Mineral Rights	Grazing Rights
DOI (BLM)	Navy and BLM	**Current:** DOE/NSO **Future:** DOE/Office of Legacy Management	**Surface:** Public Law 106-65 **Subsurface:** Public Land Orders 2771 and 2834	On-site plaque destroyed	BLM No leases	DOE/NSO	U.S. Government	BLM Issued to Private

The State of Nevada is a signatory of the FFACO, which established the cleanup process and goals for the Project Shoal Site (FFACO, 1996). The NDEP regulators have been involved in every step of the environmental restoration work at the Project Shoal Site. The BLM and U.S. Navy have also been involved in discussions and agreements on final restoration levels and future land use plans. The BLM and Navy have issued an Integrated Resource Management Plan (U.S. Naval Air Station, 2001). The LTHMP results are provided to stakeholders annually. Additionally, the DOE/NSO EM Program has a public involvement team who provide a

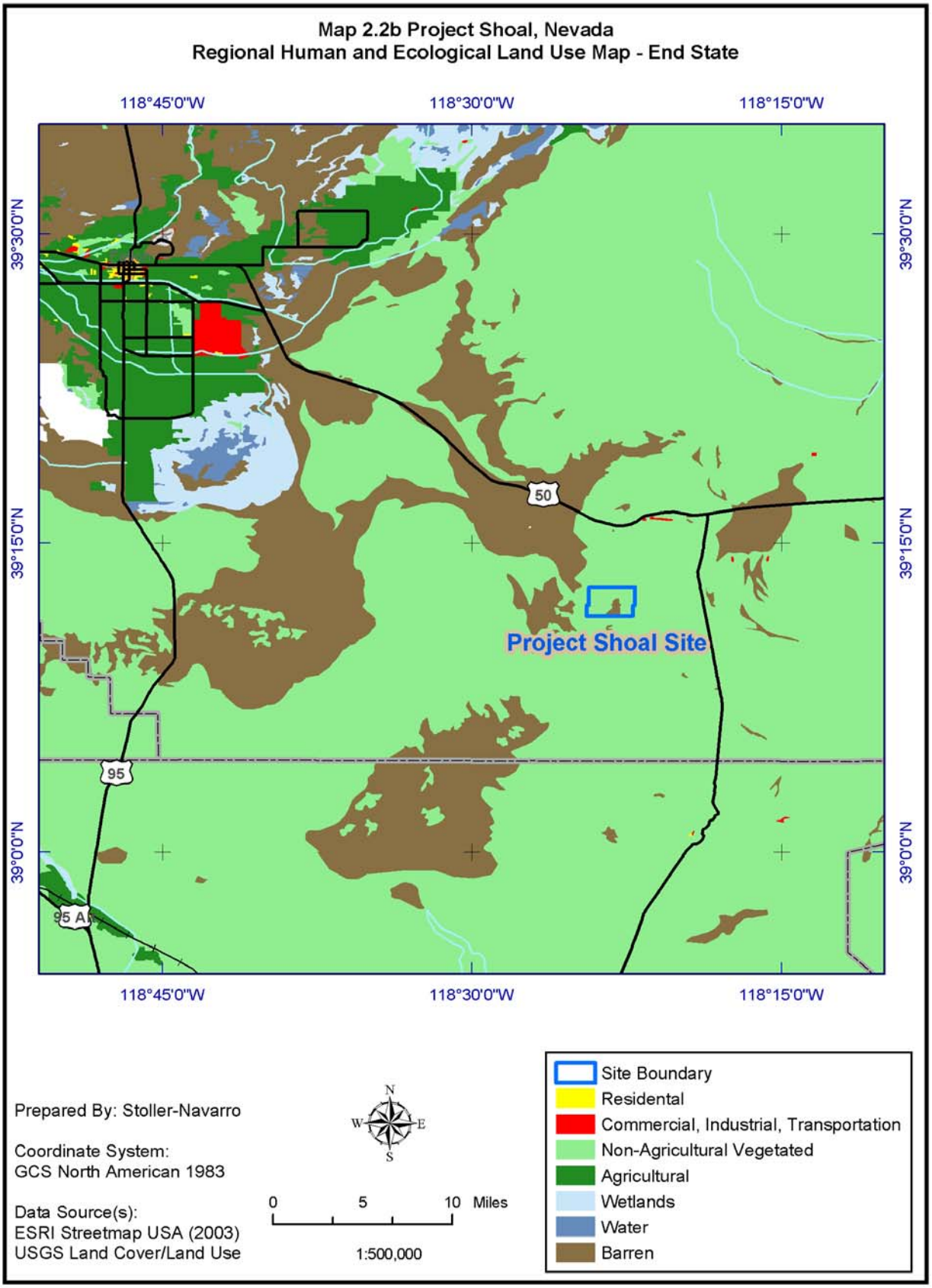
comprehensive array of products and services in support of both internal and external communications, as well as stakeholder involvement and community outreach initiatives.

There is no human population located within four miles of the Project Shoal Site; however, several ranches are located in the vicinity. There are two mines in the southern part of the Sand Springs Range, but no oil or gas leases. Fallon is the largest town in the region and it lies 30 miles northwest of the site. The Nevada Scheelite Mine and the Kennecott Rawhide Mine are located within 20 miles of the site, at the southern end of the Sand Springs Range. Future land use for the area is expected to be similar to present activities.

As part of the LTHMP, the EPA regularly samples water from one spring, two windmills, and three wells surrounding the Project Shoal Site, as well as the eight wells on site. No radioactive materials attributable to the Project Shoal test were detected in the samples collected in off-site areas (EPA, 2002). Current plans for institutional controls over the subsurface and continued groundwater monitoring are consistent with the anticipated future land use plans for the region.

Ecological Land Use

The Project Shoal Site is located on a shallow slope of higher peaks in the Sand Springs Range. Some of these peaks range in elevation from several hundred feet to over 5,400 ft east and west of the site. The site and the surrounding peaks are covered with sagebrush. Native animal species include jackrabbits, ground squirrels, various lizards and snakes, and several species of birds, including ravens, hawks, and turkey vultures. Larger grazing mammals such as antelope and deer are known to frequent the Sand Springs Range, and wild horses may also reside there. One of the monitoring wells, HS-1, which is located off-site, serves as a cattle ranching supply well during parts of the year (DOE/NV, 1998b). No threatened or endangered species have been observed at the Project Shoal Site. The flora and fauna currently found in the region surrounding the site are anticipated to continue as the species in the region for the foreseeable future.


Map 2.2b Project Shoal, Nevada
Regional Human and Ecological Land Use Map - End State
118°45'0"W
118°30'0"W
118°15'0"W
39°30'0"N
39°15'0"N
39°0'0"N
50
95
95 A
Project Shoal Site
Prepared By: Stoller-Navarro
Coordinate System:
GCS North American 1983
Data Source(s):
ESRI Streetmap USA (2003)
USGS Land Cover/Land Use
N
W
E
S
0
5
10 Miles
1:500,000
Site Boundary
Residental
Commercial, Industrial, Transportation
Non-Agricultural Vegetated
Agricultural
Wetlands
Water
Barren

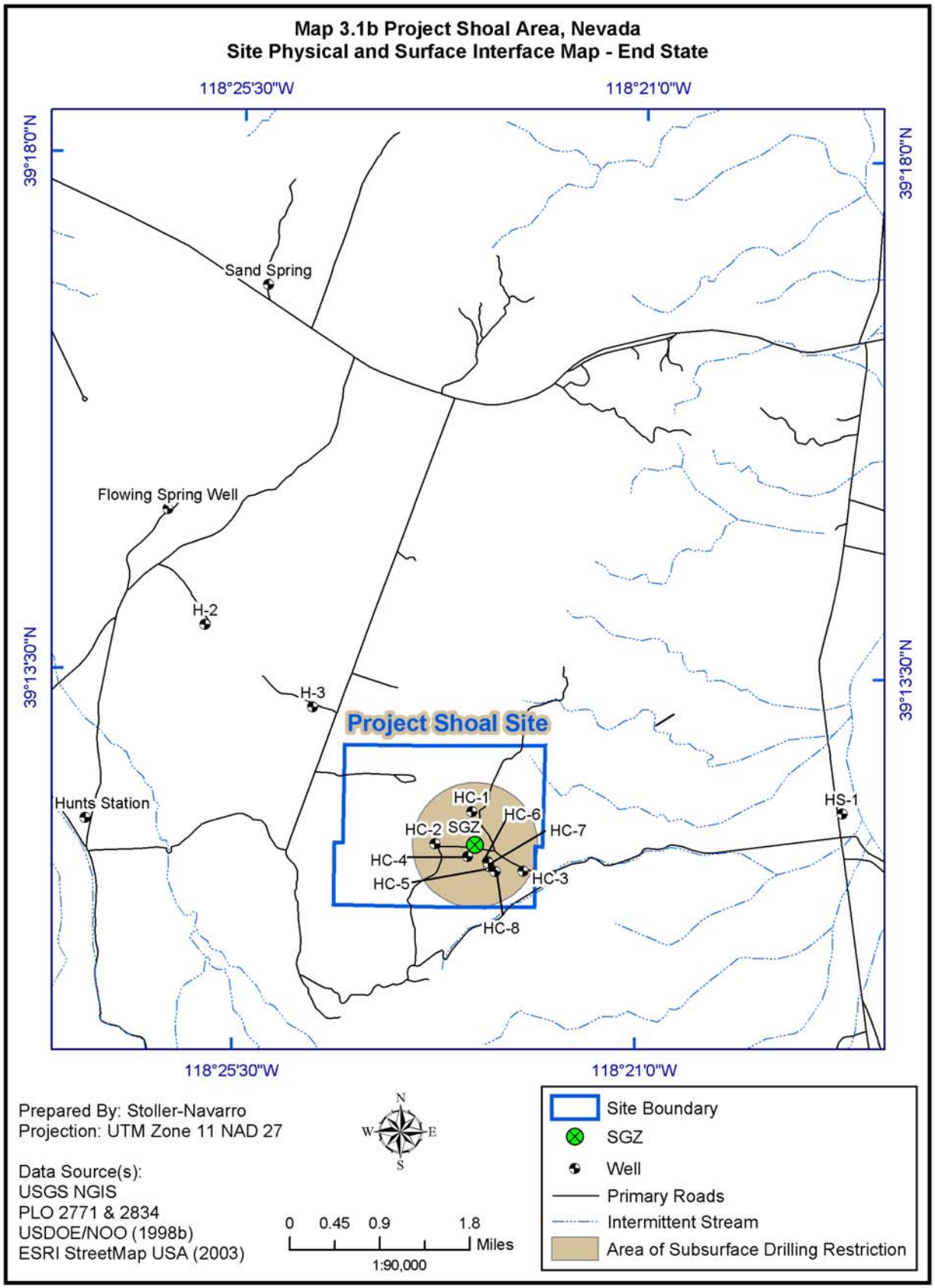
3.0 Site-Specific End State Description

This section examines physical and surface interface and human and ecological land use in the site-specific context. This section also provides a discussion of current and planned future land use for the site, legal ownership of the site and immediately adjacent lands, and demographics for the area.

3.1 Physical and Surface Interface

The Project Shoal Site consists of one parcel of land withdrawn from the public domain that covers four square miles (mi^2). The area encompasses historical CASs, which include the drilling mud pit, a housekeeping area, and a muckpile. Each of these features has been clean closed with no further action. Clean closure of the Project Shoal Site surface was achieved in 1998 (DOE/NV, 1998a). The Closure Report for the surface at the Project Shoal Site was accepted without comment by NDEP, and the acceptance letter from NDEP stated, "No post-closure monitoring is required and no land use restrictions apply to this CAU" (Liebendorfer, 1998). Since clean closure was achieved, a risk assessment was not required and was not performed (DOE/NV, 2000a). The Project Shoal Site surface is in the end state (Map 3.1b).

The underground nuclear test cavity at the Project Shoal Site is the only area with the potential to impact groundwater quality with contamination from radionuclides. The test cavity is below the water table and in direct contact with groundwater. The DOE does not plan to remediate the subsurface contamination because of the lack of feasible technologies for removing radioactive contamination from the subsurface cavities formed by underground nuclear tests. The DOE/NSO will establish a contaminant boundary based on characterization and modeling activities, negotiate a compliance boundary with NDEP, refine subsurface intrusion restrictions as necessary, and monitor groundwater quality from test wells. As agreed to in the FFACO, the accepted contaminant boundary and other considerations will form the basis for the negotiated compliance boundary (FFACO, 1996). Long-term stewardship activities for the subsurface at the Project Shoal Site will include continued water quality monitoring and restriction of groundwater use in the vicinity of the test site, and restricted access to the test shaft (DOE/EM, 2001).


Map 3.1b Project Shoal Area, Nevada
Site Physical and Surface Interface Map - End State
118°25'30"W
118°21'0"W
39°18'0"N
39°13'30"N
Sand Spring
Flowing Spring Well
H-2
H-3
Project Shoal Site
Hunts Station
HC-1
HC-2
SGZ
HC-6
HC-7
HC-4
HC-5
HC-3
HC-8
HS-1
Prepared By: Stoller-Navarro
Projection: UTM Zone 11 NAD 27
Data Source(s):
USGS NGIS
PLO 2771 & 2834
USDOE/NOO (1998b)
ESRI StreetMap USA (2003)
N
W
E
S
0 0.45 0.9 1.8
Miles
1:90,000
Site Boundary
SGZ
Well
Primary Roads
Intermittent Stream
Area of Subsurface Drilling Restriction

3.2 Human and Ecological Land Use

Human Land Use

There are currently no residences or other habitable structures on the Project Shoal Site. The site was withdrawn from all forms of public appropriation, including mining (Map 3.2b). There is no history of oil and gas exploration, and there are no oil and gas leases on the site. The site is surrounded by lands administered by the BLM, but is part of a much larger area withdrawn by the U.S. Navy for military training and facilities. There are no water supply wells located on the Project Shoal Site, although several groundwater-monitoring wells have been placed around the subsurface test cavity. The EPA monitors fourteen locations on and around the site annually as part of the LTHMP (EPA, 2002).

Current restrictions on subsurface intrusion (drilling) around the Project Shoal Site SGZ, shown in Map 4.0b, are listed in Public Land Order (PLO) 2771 and PLO 2834 as follows (*Federal Register*, 1962a; *Federal Register*, 1962b):

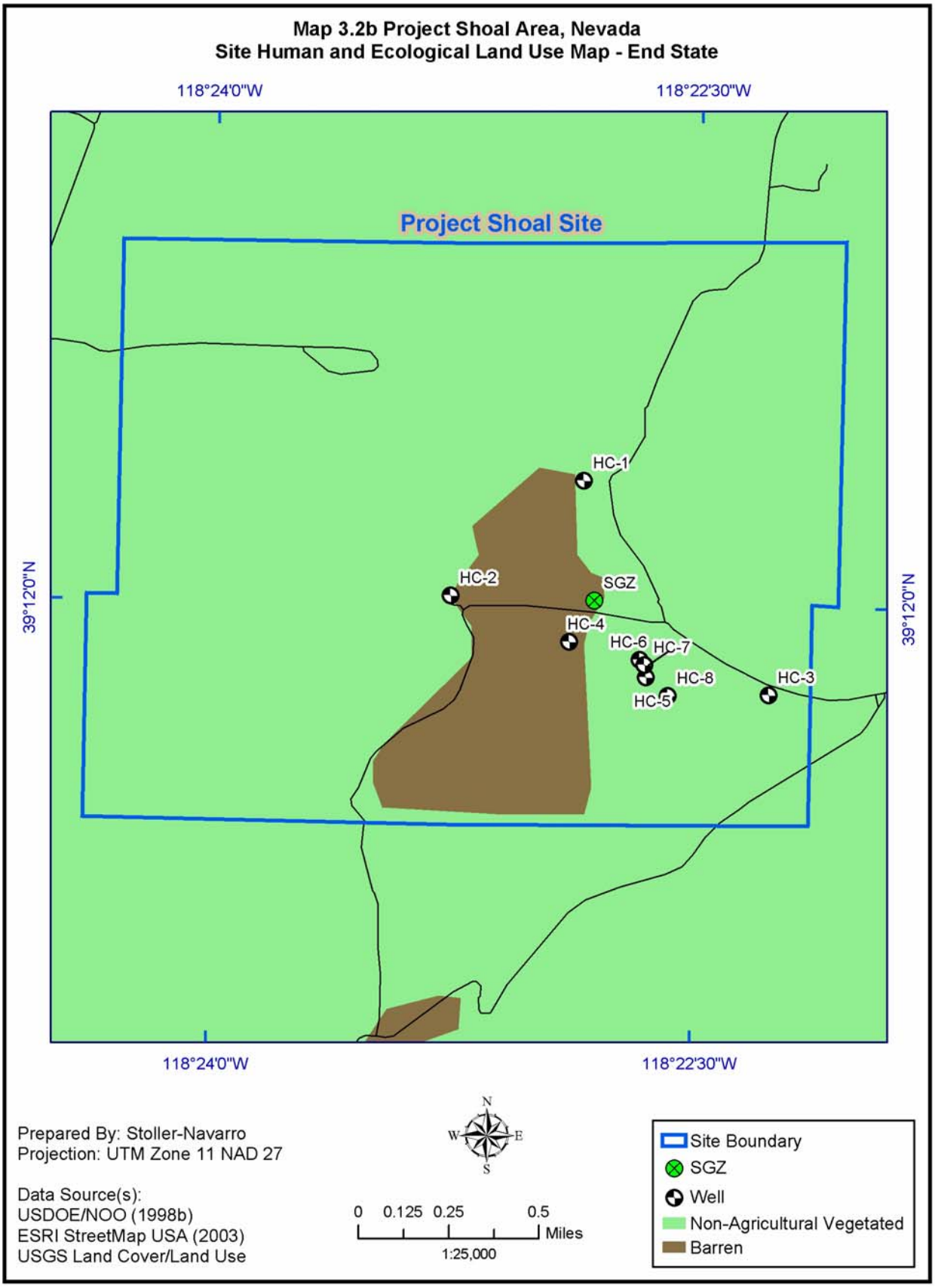
> "No excavation, drilling, and/or removal of materials is permitted between a level of plus 5,050 feet above mean sea level and plus 3,530 feet and out to a horizontal distance of 3,300 feet from this surface ground zero location (Nevada State Coordinates N 1,620,170 E 557,544) in sections 33 and 34, T16N, R32E, and sections 4 and 5, T15N, R23E, Churchill County, Nevada. Any reentry into drill holes or the shaft within this horizontal restricted area is prohibited."

The DOE/NSO developed a public participation plan for the Project Shoal Site Environmental Management End State Vision. The plan provided a draft copy of this document, an information sheet, and a letter soliciting feedback by July 1, 2004, to involved parties and stakeholders. All written comments that were submitted to the DOE/NSO received comment resolution.

Ecological Land Use

Original site activities and clean-up activities associated with surface closure for the Project Shoal Site resulted in large areas that have been scraped bare of native vegetation. In addition, a large muckpile of granite remains from mining of the emplacement shaft and adit. In 1996, the emplacement shaft was backfilled with material from the muckpile and a concrete seal was placed over the entrance.

According to the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV, 1996b), the only activities planned for this site consist of hydrologic monitoring at existing wells. The site has been disturbed during previous environmental restoration activities; therefore, there are no likely biological impacts to habitat, population viability of plants or animals, threatened or endangered species, or regionally rare habitats (EG&G/EM, 1993).

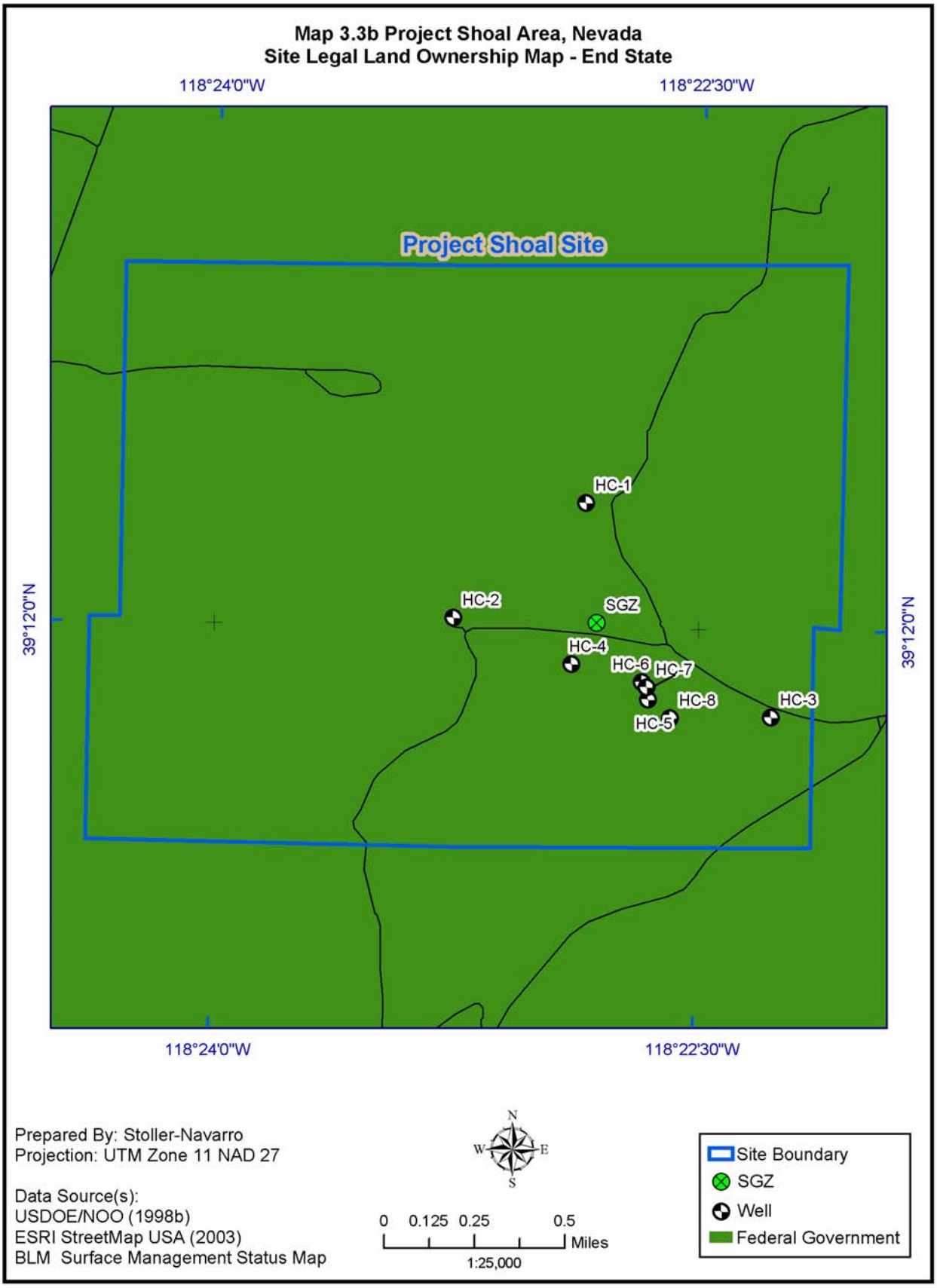

Map 3.2b Project Shoal Area, Nevada
Site Human and Ecological Land Use Map - End State
118°24'0"W
118°22'30"W
Project Shoal Site
HC-1
HC-2
SGZ
HC-4
HC-6
HC-7
HC-8
HC-5
HC-3
39°12'0"N
Prepared By: Stoller-Navarro
Projection: UTM Zone 11 NAD 27
Data Source(s):
USDOE/NOO (1998b)
ESRI StreetMap USA (2003)
USGS Land Cover/Land Use
N
W
E
S
0 0.125 0.25 0.5
Miles
1:25,000
Site Boundary
SGZ
Well
Non-Agricultural Vegetated
Barren

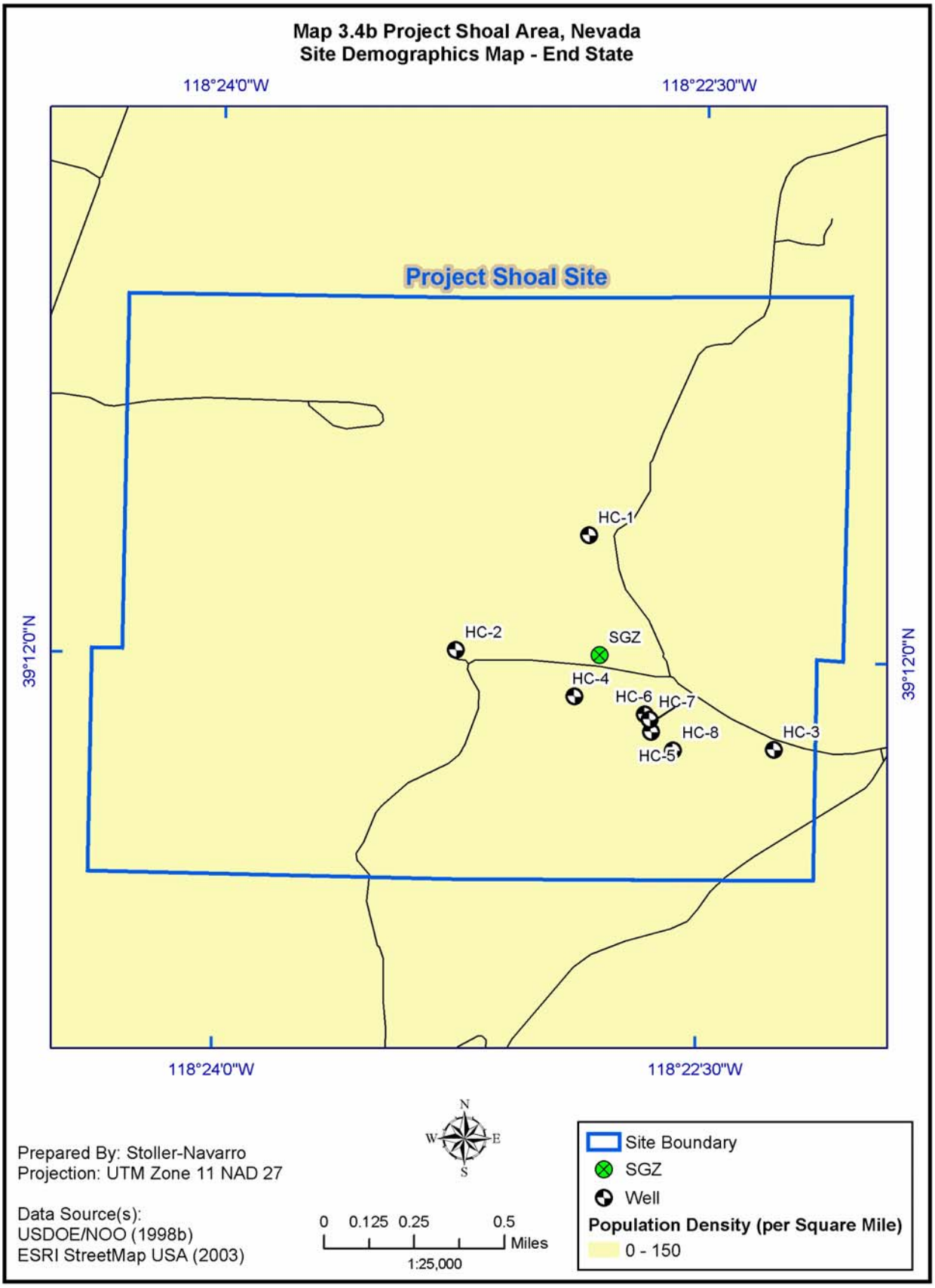
3.3 Site Context Legal Ownership

The Project Shoal Site comprises an area of 4 mi^2 (2,560 acres) in the northern part of the Sand Springs Range. This area is located on BLM land that was withdrawn by PLO 2771 issued on September 6, 1962 (*Federal Register*, 1962a), as amended by PLO 2834 (*Federal Register*, 1962b), and assigned to the U.S. Atomic Energy Commission (AEC) (predecessor agency to the DOE) (Map 3.3b). The land is withdrawn from all forms of appropriation under the public land laws, including the mining laws (30 *United States Code*, Sec. 2), and the mineral leasing laws, and reserved for use by the AEC for experimental purposes. The site is currently part of a large area that was withdrawn by the U.S. Navy in 1999. Under the DOE land withdrawal agreement and military land withdrawal criteria, this land has been withdrawn from all forms of appropriation under the public land laws.

3.4 Site Context Demographics

The Project Shoal Site is located in the southern part of Churchill County, in northwestern Nevada. The population density of Churchill County is fairly static, with 23,405 people recorded in the 1990 census and 23,982 people recorded in the 2000 census (Map 3.4b). Fallon is 30 miles northwest of the Project Shoal Site, and contains 7,536 people (U.S. Census Bureau, 2000). Significant portions of Churchill County are controlled by the DoD (Naval Air Station, Fallon, Nevada) with restricted access. Farming, recreational use, ranching, and mining dominate the civilian economy, although more mines have closed than have opened in the past decade. The Project Shoal Site lies within the land withdrawn from the public domain for the Naval Air Station, Fallon, Nevada. It is doubtful that the human population near the Project Shoal Site will increase in the foreseeable future.


Map 3.3b Project Shoal Area, Nevada
Site Legal Land Ownership Map - End State
118°24'0"W
118°22'30"W
Project Shoal Site
HC-1
HC-2
SGZ
HC-4
HC-6
HC-7
HC-8
HC-3
HC-5
39°12'0"N
39°12'0"N
118°24'0"W
118°22'30"W
Prepared By: Stoller-Navarro
Projection: UTM Zone 11 NAD 27
Data Source(s):
USDOE/NOO (1998b)
ESRI StreetMap USA (2003)
BLM Surface Management Status Map
N
W
E
S
0 0.125 0.25 0.5
Miles
1:25,000
Site Boundary
SGZ
Well
Federal Government


Map 3.4b Project Shoal Area, Nevada
Site Demographics Map - End State
118°24'0"W
118°22'30"W
Project Shoal Site
HC-1
HC-2
SGZ
HC-4
HC-6
HC-7
HC-8
HC-5
HC-3
39°12'0"N
39°12'0"N
118°24'0"W
118°22'30"W
N
W
E
S
Prepared By: Stoller-Navarro
Projection: UTM Zone 11 NAD 27
Data Source(s):
USDOE/NOO (1998b)
ESRI StreetMap USA (2003)
0 0.125 0.25 0.5 Miles
1:25,000
Site Boundary
SGZ
Well
Population Density (per Square Mile)
0 - 150

4.0 Hazard-Specific Discussion

Based on the nature of the Project Shoal Site and the types of activities conducted at the site, three surface areas and one subsurface area were defined as source areas for contamination. Clean closure of the Project Shoal Site surface was achieved in 1998 (DOE/NV, 1998a). A description of the areas that received clean closure is provided in Section 4.1. The Closure Report for the surface at the Project Shoal Site was accepted without comment by NDEP, and the acceptance letter from NDEP stated, "No post-closure monitoring is required and no land use restrictions apply to this CAU" (Liebendorfer, 1998). Since clean closure was achieved, a risk assessment was not required and was not performed (DOE/NV, 2000a). The Project Shoal Site surface is in the end state. The only remaining hazards at the Project Shoal Site are the nuclear cavity and groundwater at the SGZ (Map 4.0b).

Subsurface characterization is currently being performed at this site. The DOE has defined the subsurface end state at the Project Shoal Site to be continued water monitoring, restriction of groundwater use in the vicinity of the test site, and restriction of drilling at the site. Based on the historic use of the Project Shoal Site and characterization conducted at similar sites, the test cavity, which is several thousand feet below ground surface, is expected to contain COCs including radioactive fission products, plutonium, uranium, and tritium. The hazard extent is currently being defined and will be presented as a contaminant boundary (DOE/EM, 2001). According to the Life-Cycle Baseline Revision 5, subsurface closure of the Project Shoal Site is expected to be completed in FY 2011. Post-closure monitoring will be conducted as agreed upon in the site closure report for the subsurface.

An ecological risk assessment was determined not to be required for the Project Shoal Site (DOE/NV, 2000a). Subsurface intrusion restrictions are in place and will continue into the foreseeable future. There is no population within four miles of the site, and no non-DOE water wells exist within three miles. The applicable governing agencies must be consulted before any future well permits are issued. A concrete slab was placed over the original shaft, and all boreholes were sealed to prevent access. Table 4.1 summarizes the hazards and risks associated with the site (DOE/NV, 2000a). It is anticipated that the Project Shoal Site surface will continue to be managed by the DoD for the foreseeable future. Access to the test cavity and groundwater will be controlled by subsurface intrusion restrictions (DOE/NV, 2000a).

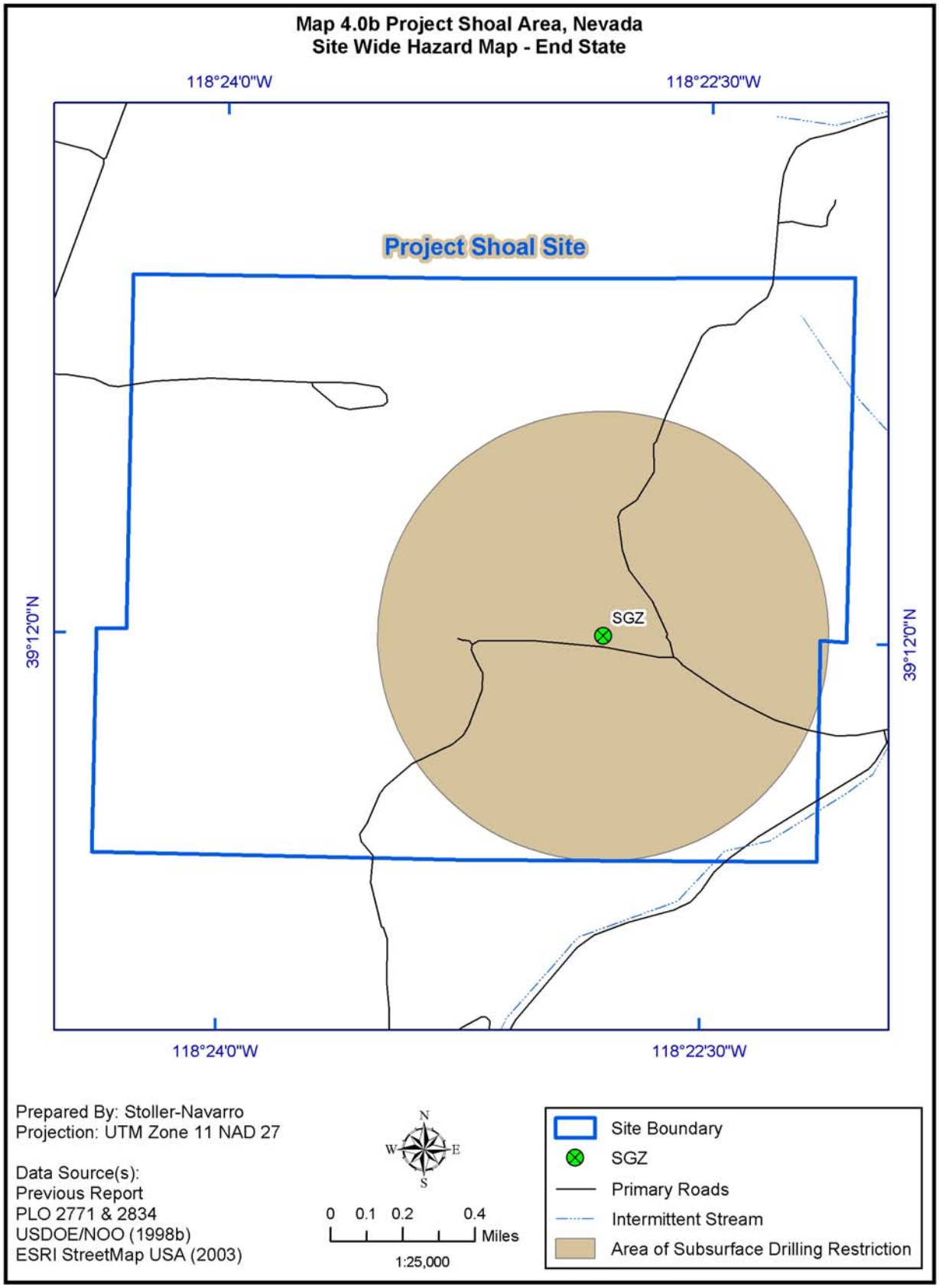
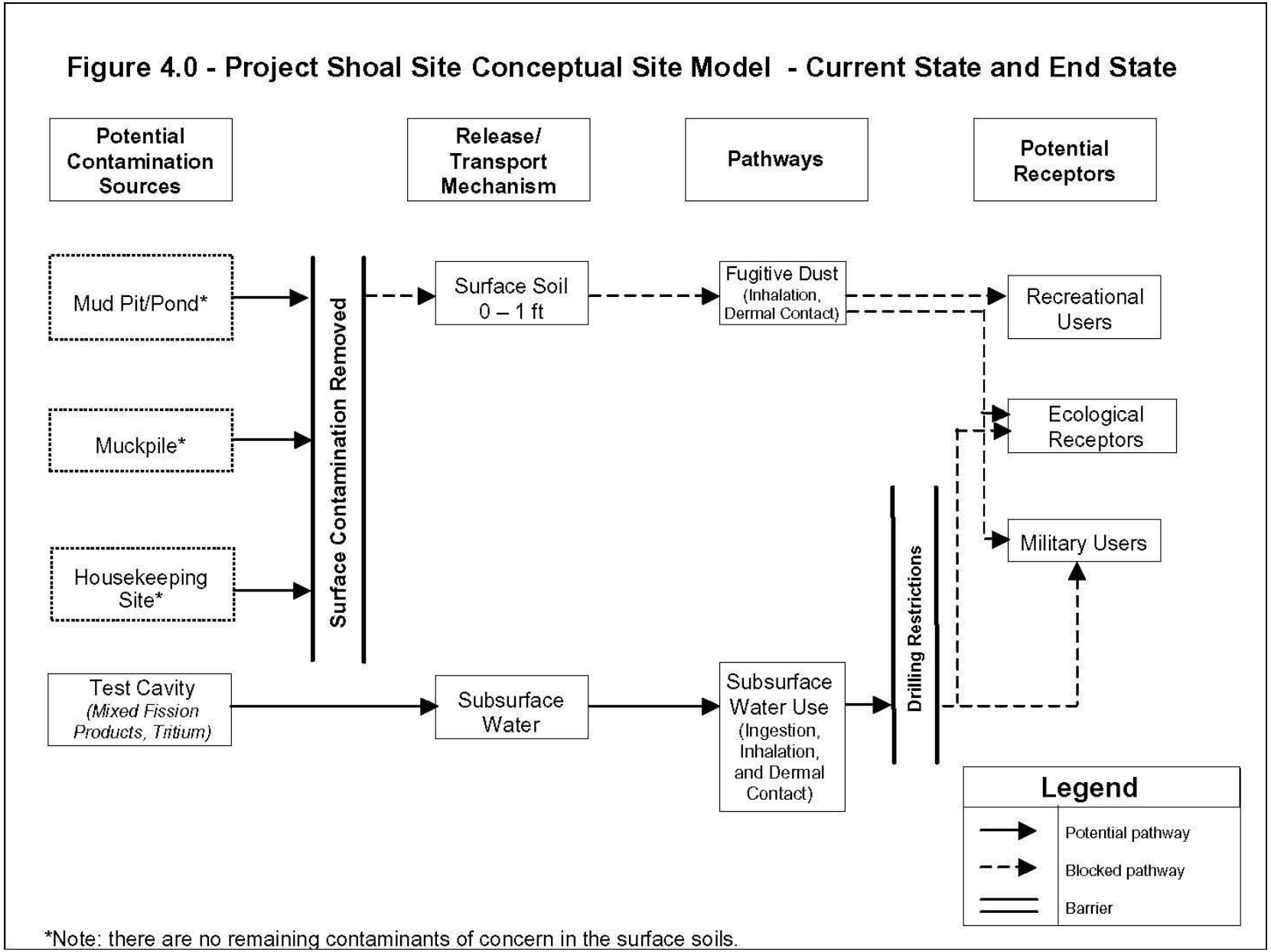

Map 4.0b Project Shoal Area, Nevada
Site Wide Hazard Map - End State
118°24'0"W
118°22'30"W
Project Shoal Site
SGZ
39°12'0"N
39°12'0"N
118°24'0"W
118°22'30"W
Prepared By: Stoller-Navarro
Projection: UTM Zone 11 NAD 27
Data Source(s):
Previous Report
PLO 2771 & 2834
USDOE/NOO (1998b)
ESRI StreetMap USA (2003)
N
W
E
S
0 0.1 0.2 0.4
Miles
1:25,000
Site Boundary
SGZ
Primary Roads
Intermittent Stream
Area of Subsurface Drilling Restriction

Table 4.1
Project Shoal Site Hazards and Risks

Material Category	Nature of Hazard	Nature of Potential Risk	Status of Current Management	Planned Risk Reduction Control	Anticipated Risk Reduction Progress	End-State Disposition and Risk
Deep (>1,000 ft bgs) groundwater radionuclide contamination and test cavity	Groundwater in the immediate vicinity of the test cavity is contaminated with radionuclides. Migratory potential of the contaminants from the test cavity via groundwater has been modeled. The model has been refined with additional information.	Migratory potential of radionuclides in groundwater is minimal. Existing monitoring data from surrounding wells have not indicated radionuclide contamination. If contaminant migration is verified, the most probable exposure scenario would be via inhalation of, ingestion of, and dermal contact with groundwater.	Site subsurface characterization is complete. Groundwater modeling activities are ongoing. Site subsurface access is restricted. Groundwater monitoring is ongoing under the LTHMP.	Subsurface restrictions and institutional controls are in place and maintained. The subsurface risk-based compliance boundary will be refined based on the subsurface modeling results and other considerations. A refined long-term monitoring program will be implemented, if required and if technically feasible.	Currently, there is no feasible or cost effective corrective action technology to address test cavities and associated subsurface contamination that will prevent risk.	Subsurface restrictions and institutional controls will be maintained and long-term hydrologic monitoring will be implemented, based on the groundwater modeling results.
Surface soil	Total petroleum hydrocarbons contaminated material from the mud pit has been excavated and removed, based on State of Nevada preliminary action levels.	None	The site surface is closed with regulatory agency approval.	None	None	Surface institutional controls are no longer required.

A CSM for the site is provided in Figure 4.0. The CSM illustrates the relationship between the identified potential sources of contamination, the mechanisms for release and migration away from the potential source, the pathways the contamination would follow once released, the exposure routes by which potential contamination would affect receptors, and the receptors that would be impacted by potential contamination.



*Note: there are no remaining contaminants of concern in the surface soils.

4.1 Surface Source Area 1

The Project Shoal Site encompasses three CASs where soil contamination was known or suspected. One of these sites was clean closed with no further action because there were no COCs above established levels. One CAS was clean closed with housekeeping activities and one CAS was closed with excavation and transportation of contaminated material to an off-site location. No surface source areas remain at the Project Shoal Site. A description of the areas that received clean closure is provided below.

The drilling mud pit, CAS 57-09-01, was the result of drilling activities at the Project Shoal Site in 1963. Investigation activities completed in 1996 determined that the mud pit was contaminated with total petroleum hydrocarbons in excess of State of Nevada action levels, which are 100 milligrams per kilogram for total petroleum hydrocarbons. This location was closed by excavating and transporting 240 cubic yards (yd^3) of contaminated mud and weathered granite to the Area 6 Petroleum Landfill at the Nevada Test Site.

The muckpile, CAS 57-06-01, which consists of approximately 6,535 yd^3 of broken granite, resulted from mining operations to emplace the test shaft and adit in 1963. Sampling indicated that no COCs in the muckpile exceeded regulatory action levels. This location was clean closed with no further action.

The housekeeping site, CAS 57-98-01, was clean closed by housekeeping activities including removal of 20 used oilcans. Oilcans were transported to the Nevada Test Site for burial in the Area 23 Landfill (DOE/NV, 1997).

4.2 Operational Area 1 – RB-E-01 Drill Pad

The Project Shoal Site SGZ area contains the shaft and adit for the underground test. The emplacement shaft is listed as CAS 57-49-01 and the test cavity is listed as CAS 57-57-001 in the FFACO (FFACO, 1996). The nuclear device was placed in granite at a depth of 1,211 ft bgs. The emplacement shaft was drilled to a depth of 1,316 ft, with a drift 1,050 ft to the east. Sand was used to stem the shaft and drift. The nuclear explosion vaporized rock, creating a cavity with a diameter of approximately 158 ft. Overlying rock subsequently collapsed into this cavity, creating a chimney with an approximate height of 350 ft. The cavity is below the water table, which allows radionuclides to migrate with groundwater. Eight wells have been installed at the site (in 1996 and 1999) in order to facilitate characterization activities for the subsurface. Data

collected from these wells have been used for the numerical modeling of groundwater flow and radionuclide transport.

During nuclear testing, a number of fission by-products and other materials were released into the subsurface rock volume immediately adjacent to the point of detonation. The radioactive by-products generated include original radioactive material that did not undergo fission, fission products, and activation products produced by the high neutron flux. Other materials that may have been released include lead from shielding material, synthetic materials used in control cables, and materials used in the emplacement shaft and drift. Atmospheric releases were not detected from the test, but short half-life fission products were detected in post-test drill holes near the test cavity (DOE/NV, 1996c). The nuclear cavity is below the water table, allowing these contaminants to migrate with groundwater.

The DOE/NSO has completed the initial groundwater modeling based on data from four monitoring wells, and subsequently completed installation of an additional four monitoring wells to address remaining uncertainties (DOE/EM, 2001). As part of the LTHMP, water samples were collected from eleven groundwater monitoring wells, a spring, and two windmill pumps in and around the Project Shoal Site in 2002. These samples contained no gamma activity above the minimum detectable concentration (MDC), and only one, HC-4, contained tritium concentrations slightly above the MDC. This sample was significantly less than the Derived Concentration Guide of 20,000 picocuries per liter for tritium in drinking water. These results indicate that no radionuclides attributable to the Project Shoal test have migrated into drinking water supplies (EPA, 2002).

The DOE does not plan to remediate subsurface contamination at the Project Shoal Site because of the lack of feasible technologies for removing radioactive contamination from the subsurface cavities formed by underground nuclear tests. The DOE will establish a contaminant boundary, negotiate a compliance boundary with NDEP, refine subsurface intrusion restrictions as necessary, and monitor groundwater quality from test wells (DOE/EM, 2003). Map 4.0b shows the SGZ area and the drilling restrictions, as listed on PLOs 2771 and 2834 (*Federal Register*, 1962a; *Federal Register*, 1962b).

5.0 References

Carroll, R., S. Kosinski, B. Lyles, T. Miheve, R. Niswonger, and G. Pohll. 2000. *Project Shoal Area Tracer Test Experiment*, DOE/NV/13609--05, Publication No. 45177. Las Vegas, NV: Desert Research Institute.

DOE, see U.S. Department of Energy.

DOE/EM, see U.S. Department of Energy, Office of Environmental Management.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

EG&G/EM, see EG&G Energy Measurements.

EG&G Energy Measurements. 1993. *Reconnaissance Survey Report for Potential Groundwater Characterization Activities in Sand Springs Range*, LV93-GEL-8. Las Vegas, NV.

EPA, see U.S. Environmental Protection Agency.

Federal Facility Agreement and Consent Order. 1996, as amended. Agreed to by the State of Nevada, the U.S. Department of Energy, and the U.S. Department of Defense.

Federal Register. 1962a. Public Land Order 2771, "Withdrawing Lands for Use of Atomic Energy Commission," Doc. 62-9076. 11 September. Washington, DC: U.S. Government Printing Office.

Federal Register. 1962b. Public Land Order 2834, "Correcting Certain Public Land Orders; Amending Public Land Order No. 2771 of September 6, 1962," Doc. 62-12191. 10 December. Washington, DC: U.S. Government Printing Office.

FFACO, see *Federal Facility Agreement and Consent Order*.

Hazelton-Nuclear Science Corporation. 1965. *Post-Shot Hydrologic Safety, Project Shoal Final Report*, VUF-1014. Prepared for the U.S. Atomic Energy Commission, Vela Uniform Program. Palo Alto, CA.

IT, see IT Corporation.

IT Corporation. 2000. *1999 Well Installation Report, Project Shoal Area, Churchill County, Nevada*, ITLV/13052-097. Prepared for U.S. Department of Energy, Nevada Operations Office. Las Vegas, NV.

Liebendorfer, P.E. (State of Nevada, Department of Conservation and Natural Resources). 1998. Letter of Acceptance of the Closure Report for CAU 416, Project Shoal Area Surface, 13 February. Las Vegas, NV.

NNSA/NV, see U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office.

Pohll, G., J.T. Chapman, A. Hassan, L. Papelis, R. Andricevic, and C.T. Shirley. 1998. *Evaluation of Groundwater Flow and Transport at the Shoal Underground Nuclear Test*, DOE/NV 11508--35, Publication No. 45162. Las Vegas, NV: Desert Research Institute.

Pohll, G., J. Tracy, and F. Forsgren. 1999. *Data Decision Analysis: Project Shoal*, DOE/NV/11508--42, Publication No. 45166. Las Vegas, NV: Desert Research Institute.

Pohlman, K., J. Chapman, A. Hassan, and C. Papelis. 2004. *Modeling to Support Groundwater Contaminant Boundaries for the Shoal Underground Nuclear Test*. In publication. Las Vegas, NV: Desert Research Institute.

Smith, D.K. 2001. *Unclassified Radiological Source Term for the Nevada Test Site Areas 19 and 20*, UCRL-ID-141706. Livermore, CA: Lawrence Livermore National Laboratory.

U.S. Census Bureau. 2000. *Your Gateway to Census 2000, State and County Quick Facts*, Census 2000 Home Page. As accessed at http://www.census.gov/main/www/cen2000.html on October 2, 2003.

U.S. Department of Energy. 2003. DOE Policy No. 455.1, "Use of Risk-Based End States." Washington, DC: U.S. Government Printing Office.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2001. *Investigation of Hydraulic Properties and Groundwater Levels Related to the Shear Zone at the Project Shoal Site*, DOE/NV/13609--12, Publication No. 45183. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996a. *Corrective Action Investigation Plan for Project Shoal Area CAU No. 416*, DOE/NV--454. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996b. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*, DOE/EIS 0243. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1996c. *Project Shoal Area Shaft Closure Proposal, Fallon, Nevada*. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1997. *Closure Report for Corrective Action Unit 416: Project Shoal Area Mud Pit and Muckpile*. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1998a. *Closure Report for CAU No. 416, Project Shoal Area*, DOE/NV/11718-179. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1998b. *Corrective Action Investigation Plan for Corrective Action Unit 447: Project Shoal Area, Nevada Subsurface Site*, DOE/NV--513. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1998c. *Data Report Project Shoal Area Churchill County, Nevada,* DOE/NV--505. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 1999. *Addendum to the Corrective Action Investigation Plan for Corrective Action Unit 447: Project Shoal Area, Nevada Subsurface Site*, DOE/NV--513-ADD. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 2000a. *Human Health and Safety Risk Summary Offsites Test Areas*. In publication. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 2000b. *Offsite Stewardship Report*, DOE/NV--632-Rev. 0. Las Vegas, NV.

U.S. Department of Energy, Nevada Operations Office. 2000c. *United States Nuclear Tests July 1945 through September 1992*, DOE/NV--209-Rev 15. Las Vegas, NV.

U.S. Department of Energy, Office of Environmental Management. 2001. *A Report to Congress on Long-Term Stewardship, Volume II - Site Summaries*, DOE/EM--563. Washington, DC.

U.S. Department of Energy, Office of Environmental Management. 2003. *Guidance for Developing a Site-Specific Risk-Based End State Vision*. Washington, DC.

U.S. Environmental Protection Agency. 2001. *Improving Sampling, Analysis, and Data Management for Site Investigation and Cleanup*, EPA-542-F-01-030a. Washington, DC: Office of Solid Waste and Emergency Response.

U.S. Environmental Protection Agency. 2002. *Annual Water Sampling and Analysis Calendar Year 2002: RULISON Test Site Area, RIO BLANCO Test Site Area, FAULTLESS Test Site Area, SHOAL Test Site Area, GASBUGGY Test Site Area, GNOME Test Site Area*, EPA-402-R-02-007. Washington, DC.

U.S. Naval Air Station. 2001. *Bureau of Land Management and Navy Resource Management Plan for Certain Federal Lands in Churchill County, Nevada: Navy Integrated Natural Resource Management Plan, Amendment to the BLM Lahontan Resource Management Plan and Environmental Assessment*. Fallon, NV.

U.S. Public Laws. 1999. Public Law 106-65, "Military Lands Withdrawal Act of 1999." 5 October. Washington, DC: U.S. Government Printing Office.

Attachment A – Discussion of Variances

The following variance report table is provided in accordance with Appendix D of the Environmental Management End State Vision Development Guidance dated September 11, 2003. The table below does not identify any variances, but does provide information clarifying why there are no perceived differences between the various plans and agreements governing activities at the site. There are no negative impacts in terms of scope, cost, schedule, and risk, and no known barriers to achieving the end state. Based on the above noted belief, the next steps are identified for future activities associated with the Project Shoal Site. There are no maps provided, as there are no differences between the end state based on the current requirements and the end state based on the end state vision. The maps within the main body of the end state document sufficiently identify pertinent information related to the Project Shoal Site.

Project Shoal Site Variance Report				
ID No.	**Description of Variances**	**Impacts (in Terms of Scope, Cost, Schedule, and Risk)**	**Barriers in Achieving the End State**	**Recommendations**
N/A	There are no known variances between the end state and the current Offsites baseline. The current Offsites baseline (rev. 5) calls for subsurface closure in FY 2011. The DOE/NSO Performance Management Plan calls for subsurface closure in 2010.	The clean-up decisions made for the Project Shoal Site are consistent with planned future use as U.S. Navy training grounds and public use land. The State of Nevada has agreed that no further action is required with respect to future surface remediation. The State is aware of the future subsurface characterization activities and understands issues associated with the residual contamination.	None at this time.	Support completion of future subsurface plans and documents and prepare the necessary long-term stewardship information for transfer of the management responsibility of the site subsurface to the Office of Legacy Management.