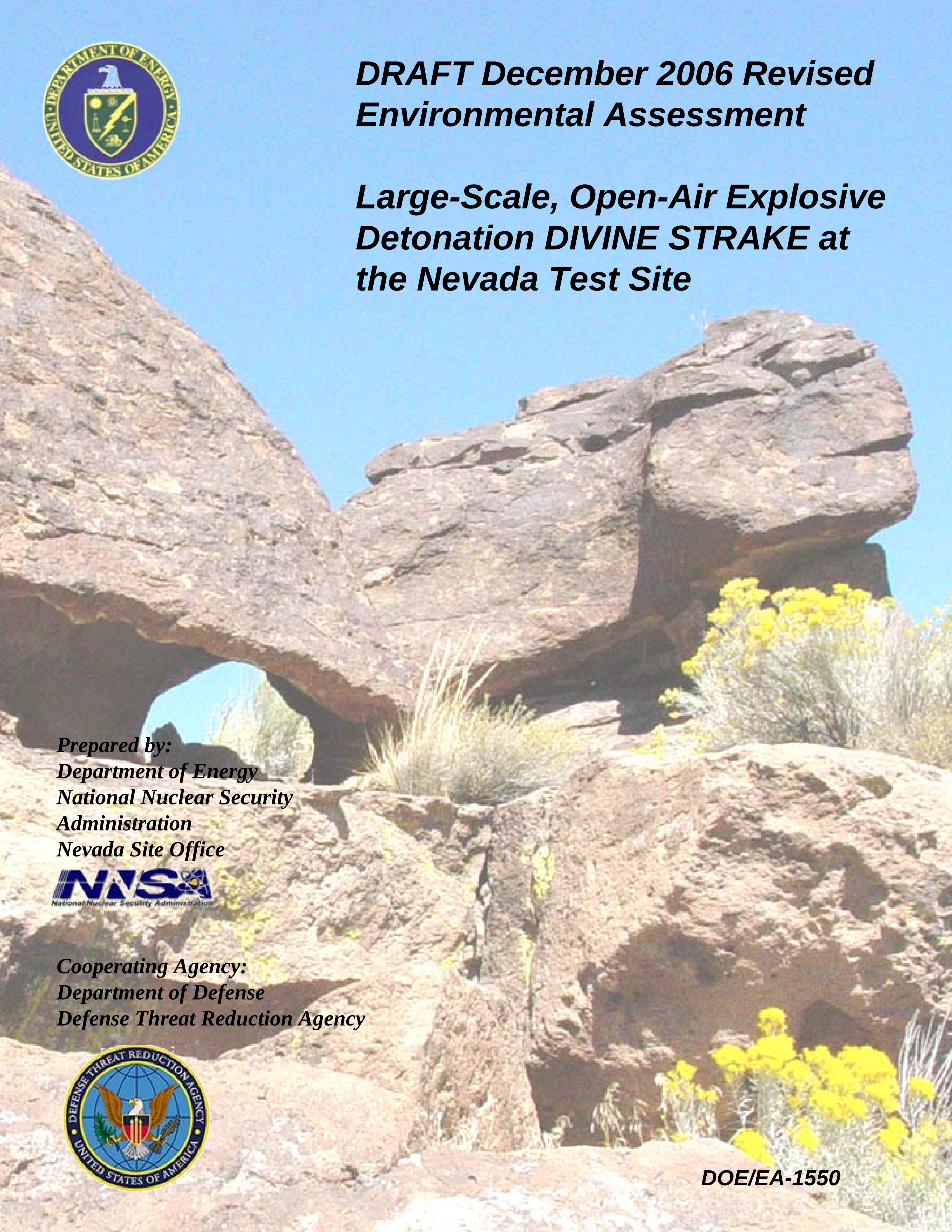

DRAFT December 2006 Revised Environmental Assessment

Large-Scale, Open-Air Explosive Detonation DIVINE STRAKE at the Nevada Test Site

Prepared by:
Department of Energy
National Nuclear Security Administration
Nevada Site Office

NNSA
National Nuclear Security Administration

Cooperating Agency:
Department of Defense
Defense Threat Reduction Agency

DOE/EA-1550

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DEFINITION OF ACRONYMS AND ABBREVIATIONS

Term	Definition
%	percent
°C	degrees Celsius
°F	degrees Fahrenheit
µCi/mL	microcurie per milliliter
$\mu g/m^3$	micrograms per cubic meter
AAQS	Ambient Air Quality Standards
ACGIH	American Conference of Industrial Hygienists
ACHP	Advisory Council on Historic Preservation
ACTD	Advanced Concepts and Technology Demonstration
AMS	aerial measuring system
ANFO	ammonium nitrate fuel oil
ANS	American Nuclear Society
ANSI	American National Standard
APE	area of potential effect
AQOP	air quality operating permit
ARL/SORD	Air Resources Laboratory, Special Operations and Research Division
BAPC	State of Nevada Bureau of Air Pollution Control
BLM	Bureau of Land Management
BN	Bechtel Nevada
CAA	Clean Air Act
$CaCO^3$	calcium carbonate
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CG	cloud-to-ground lightning
CH^4	methane
cm	centimeter
CO	carbon monoxide
CO_2	carbon dioxide
CORRTEX	Continuous Reflectometry for Radius versus Time Experiments
DB	decibel
DBA	A-weighted decibel
dBpk	peak sound level in decibels
DoD	U.S. Department of Defense
DOE	United States Department of Energy
DST	Daylight Savings Time
DTRA	Defense Threat Reduction Agency
EA	Environmental Assessment
EBW	exploding bridgewire

EHS	extremely hazardous substance
EIS	Environmental Impact Statement
EMSs	Environmental Management Systems
EODU	explosive ordnance disposal unit
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	environmental restoration
ES&H	environment, safety and health
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FONSI	Finding of No Significant Impact
Ft	foot/feet
GZM	generalized zonal method
H20	water
HAPs	hazardous air pollutants
HDBT	hardened and deeply buried targets
HMMP	Hazardous Materials Management Plan
HIS	hazardous substance inventory
HTO	tritiated water
HUD	United States Department of Housing
HW	hazardous waste
HWSU	hazardous waste storage unit
Hz	Hertz
In	inch
ISMS	Integrated Safety Management System
km^2	square kilometer
kmph	kilometer per hour
kPa	kilopascal
M	meter
m/s	meters per second
MEDA	Meteorological Data Acquisition
Mi	mile
mi^2	square mile
MOU	Memorandum of Understanding
mph	miles per hour
mrem/yr	millirem per year: One commonly used measurement of radiation dose.
N	Nitrogen
NAAQS	National Ambient Air Quality Standards
NAC	Nevada Administrative Code
NAFB	Nellis Air Force Base
NDEP	Nevada Division of Environmental Protection
NEPA	National Environmental Policy Act of 1969
NESHAP	National Emission Standards for Hazardous Air Pollutants

NNSA	National Nuclear Security Administration
NOx	nitrogen oxides
NOAA	National Oceanic and Atmospheric Administration
NPTEC	Nonproliferation Test and Evaluation Complex
NRHP	National Register of Historic Places
NSPS	New Source Performance Standards
NTTR	Nevada Test and Training Range
NTS	Nevada Test Site
OBOD	Open Burn Open Detonation
OCC	Operational Command and Control
ODS	ozone-depleting substances
OEMP	Operational Environmental Management Plan
OSHA	Occupational Safety and Health Act
PELs	Permissible exposure limits
PETN	pentaerythrite tetranitrate
PM_{10}	particulate matter less than 10 micrometers in diameter
PNOC	particulates not otherwise classified
PNOR	particulates not otherwise regulated
POL	Petroleum, oil, & lubricants
PPE	Personal protective equipment
ppm	parts per million
PSD	Prevention of Significant Deterioration
PST	Pacific Standard Time
PTS	permanent threshold shift
psi	pounds per square inch
RCRA	Resource Conservation and Recovery Act
RDT&E	research, development, testing, and evaluation
ROD	Record of Decision
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SNVF	Southwest Nevada Volcanic Field
SO2	Sulfur dioxide
SOC	species of concern
SOPs	standard operating procedures
SOX	sulfur oxides
SPL	sound pressure level
TSCA	Toxic Substances Control Act
TTS	temporary threshold shift
TLV	threshold limit value
U.S.C.	United States Code
unwtd-pk	unweighted peak
USGS	U.S. Geological Survey

USSTRATCOM	U.S. Strategic Command
UXO	unexploded ordnance

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1.0 INTRODUCTION AND PURPOSE AND NEED FOR ACTION

The Nevada Test Site (NTS) is administered by the U.S. Department of Energy's (DOE) National Nuclear Security Administration (NNSA). The Nevada Site Office (NSO) has the responsibility to ensure that any actions on the NTS receive appropriate National Environmental Policy Act (NEPA) review and documentation. The Defense Threat Reduction Agency (DTRA) is a cooperating agency in the preparation of this environmental assessment (EA). This EA documents an analysis of the potential impacts of a proposal by DTRA, an NNSA customer, to conduct a single large-scale, open-air explosive detonation of up to 700 tons of an ammonium nitrate and fuel oil mixture above an existing tunnel complex in Area 16 at the NTS. The proposed experiment, known as DIVINE STRAKE, is described in detail in Chapter 2, Description of the Proposed Action and Alternatives, of this EA. The analysis documented in this EA has been conducted in compliance with NEPA and the Council on Environmental Quality (CEQ) regulations for implementing the procedural provisions of NEPA as found in the Code of Federal Regulations (CFR) at 40 CFR Parts 1500-1508 and the DOE's NEPA implementing procedures published in 10 CFR 1021. The purpose of this EA is to provide the NNSA and DTRA decision-makers with sufficient information and analysis to determine whether to prepare an Environmental Impact Statement (EIS) or issue a Finding of No Significant Impact (FONSI). Based on the analysis contained in this EA, NNSA and DTRA will issue a FONSI and proceed with the selected alternative, prepare an EIS, or take no further action regarding the experiment. As a cooperating agency, DTRA has been involved in the development of this EA and will independently consider it as part of its decision-making process.

1.1 Introduction and Background

This chapter provides the objectives of this EA, background information that will aid the reader in understanding the purpose and need for the Proposed Action and the public involvement process. The objectives of the EA are to:

- Describe the purpose and need for the Proposed Action
- Describe the Proposed Action and reasonable alternatives that satisfy the purpose and need
- Describe baseline conditions of the potentially affected environment at the NTS
- Analyze the potential direct, indirect, and cumulative impacts from implementation of each alternative
- Compare the impacts of each alternative, including the No-Action Alternative

Additionally, the EA process provides environmental information that can be used to develop mitigation measures, if necessary, to avoid or minimize adverse impacts on the quality of human environment and natural ecosystems should the proposed detonation take place at the NTS. Monitoring requirements to verify the extent of impacts to the environment are also identified. Ultimately, the goal of NEPA is to provide adequate information so that agency decisions are based on an understanding of environmental consequences.

The NTS occupies approximately 1,375 square miles (3,560 square kilometers [km^2]) or approximately 880,000 acres (356,000 hectares) in southern Nevada (Figure 1-1), making it one of the largest restricted-access areas in the United States. This remote site is surrounded on three sides by about 6,500 square miles (16,800 km^2) or 2.9 million acres (1.2 million hectares) of additional land withdrawn from the public domain for the U.S. Air Force Nevada Test and Training Range, (an area for armament and high hazard testing; aerial gunnery, rocketry, electronic warfare, and tactical maneuvering training; and equipment and tactics development and training); and the Desert National Wildlife Refuge (with the airspace co-shared with the Nellis Air Force Range). The NTS is located approximately 65 miles (105 kilometers [km]) northwest of Las Vegas. Numerous offices, laboratories, and support buildings are spread across the NTS. NTS areas and key facilities are shown on Figure 1-2.

The NTS is host to programs from NNSA, its laboratories, and other Federal agencies such as the Department of Defense (DoD) to develop and apply technical solutions to national security and counterterrorism requirements. Specialties include nuclear materials science, surveillance and technology development, remote sensing science and technology, counterterrorism sciences and technology, data and communications technologies, and diagnostics systems development and operation. Hard/Buried/Critical Target Detection, Defeat, and Defeat Assessment is a type of research, development, test, and evaluation (RDT&E) activity that occurs at the NTS. This activity includes RDT&E of methods, equipment, technologies, and weapons systems, etc., to detect, defeat, and neutralize hard/buried/critical targets.

Figure 1-1.
NTS Location

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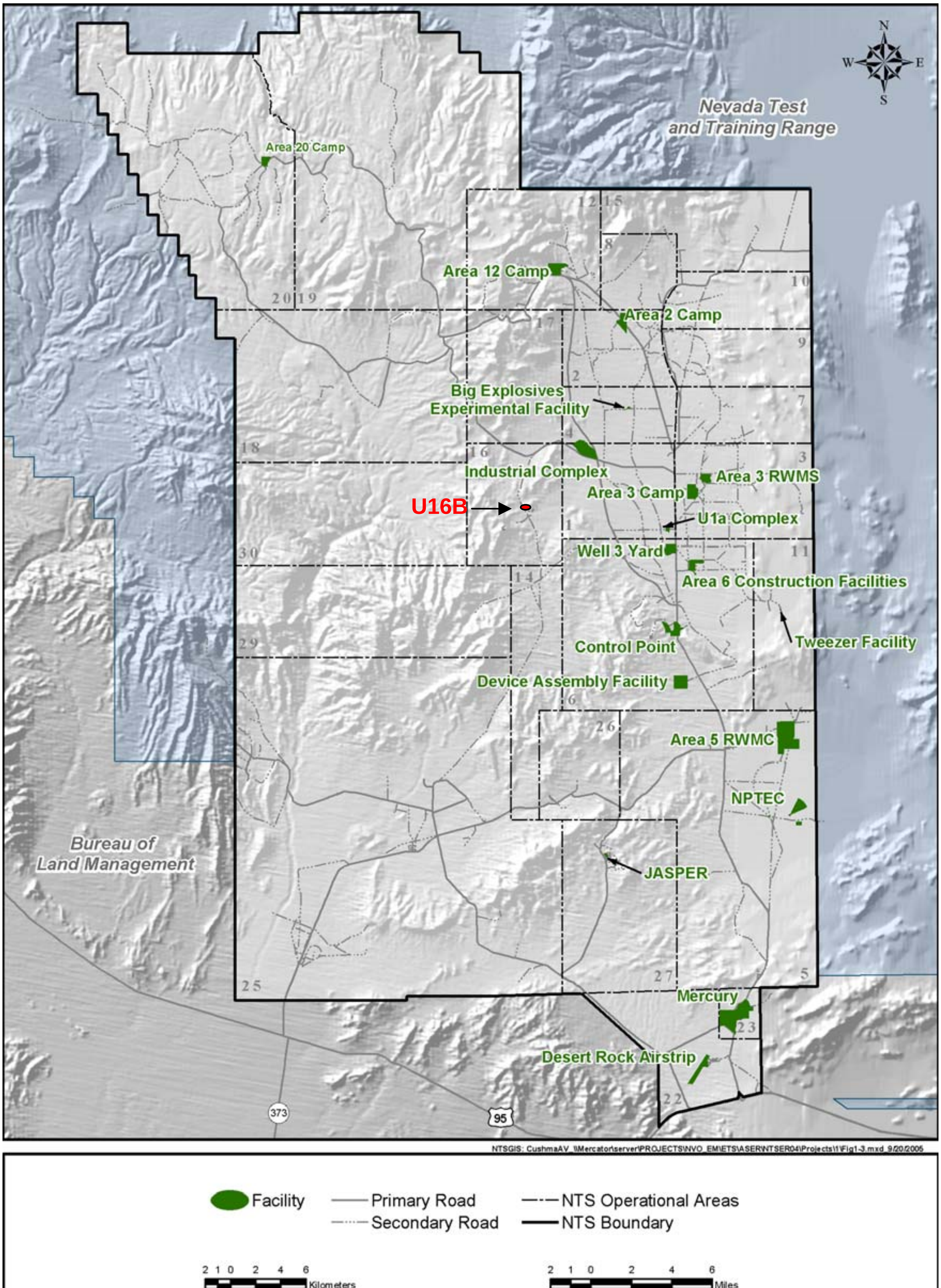

Figure 1-2 NTS Areas and Facilities

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1.2 Purpose and Need

Potential adversaries of the United States are increasingly using tunnels and underground bunkers, collectively designated hardened and deeply buried targets (HDBTs), as part of their defensive strategies. These types of facilities are used for command and control, storage of munitions (including weapons of mass destruction and long-range missiles), modern air defenses, a variety of tactical weapons, wartime refuge for national leaders, and a multitude of other offensive and defensive military uses. In order to deny an adversary the ability to use these capabilities against its forces, the U.S. military must have the ability to defeat HDBTs. To defeat these facilities and the assets they protect, the United States must have the capability to find, detect, characterize the potential targets, and then to plan, attack, and assess the results of such attacks.

The Proposed Action is a key RDT&E component of the DoD Global Strike concept of operations. In September 2001, the DoD's Congressionally-mandated Quadrennial Defense Review report established a shift in defense planning from a "threat-based" to a "capability-based" model, advocating a transformation of DoD planning to achieve critical operational capabilities. The Nuclear Posture Review in December 2001 further outlined the foundation for the United States' nuclear strategic posture for the 21st Century. In addition, the January 2001 DoD Capstone Requirements Document for Hard and Deeply Buried Targets established a new paradigm for addressing strategic targets to include the Global Strike concept.

In response to the requirements outlined in the documents described above, the President directed the Secretary of Defense in May 2002 to develop the capability to be able to hold all potential adversarial targets at risk, as an integral part of the nation's policy of deterrence. This was to become a DoD extension to the 26 June 2001 U.S. Air Force's Global Strike Force concept to quickly respond to threats anywhere in the world with conventional tactics and munitions. In May 2002, the Secretary of Defense directed the military services to develop Concept of Operations Plans to implement the Global Strike concept with United States Strategic Command (USSTRATCOM) as the overall coordination group.

The Presidential Decision Directive issued in the summer of 2004 directed the USSTRATCOM to extend Global Strike to counter all HDBTs, including both tactical and strategic adversarial targets. The Proposed Action is an integral part of the Global Strike concept of the national defense.

Through the DoD Advanced Concepts and Technology Demonstration Program (ACTD), DTRA is studying methods and associated technologies to defeat HDBTs. The Proposed Action is an integral part of the Congressionally-authorized DoD FY2002 - Initiated Tunnel Target Defeat ACTD.

In order to obtain vital information regarding the methodologies and technologies developed under the Tunnel Defeat ACTD, DTRA proposes to conduct a single large-scale, open-air explosive detonation above an existing tunnel complex. Such a project would require extensive diagnostic and monitoring capability to ensure recovery of high quality data. The desired results of the proposed project include: (1) improve the scientific understanding of weapons effectiveness versus collateral effects; (2) reduce geotechnical targeting uncertainties; (3) obtain a relevant full-scale database for code validations; and (4) provide test beds to develop improved weaponeering algorithms.

As the Federal agency charged with operating and managing the NTS, the DOE in 1996 published a *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (NTS EIS) (DOE, 1996). Although the NTS EIS addressed a very broad range of potential activities at the NTS, it did not address the conduct of large-scale, open-air explosive detonations, except at the Big Explosive Experimental Facility. In order to successfully conduct a project to obtain the desired results, DTRA requires a site that accurately simulates an HDBT. Tunnel U16b at the NTS provides an existing facility that fulfills the needs of DTRA. The U16b tunnel is in a geological setting that simulates the characteristics of important potential global adversarial targets. This U16b site was carefully chosen after reviewing the geological properties of a number of other locations on U.S. Government range complexes and other controlled land areas. For this reason, DTRA requested approval by NNSA to conduct a large-scale, open-air explosive detonation at the U16b Tunnel. Therefore, NNSA with DTRA as a cooperating agency prepared this EA to determine the potential impacts of the proposed project.

1.3 Related NEPA Documentation and Actions

For the DIVINE STRAKE EA, related NEPA actions include the 1996 NTS EIS and the 2002 Supplement Analysis for the NTS EIS. Related actions include similar DTRA projects at the White Sands Missile Range in New Mexico and other locations.

Related NEPA Documentation – In 1996, the DOE published the NTS EIS covering activities occurring at the NTS, or anticipated in the near future. The Record of Decision (ROD) for the NTS EIS stated: "The DOE Nevada Operations Office Work for Others Program will continue to be an important aspect of Nevada Test Site-related activities. These ongoing activities primarily involved the Department of Defense, the Defense Special Weapons Agency, and other Federal agencies. The primary focus of these activities are centered around treaty verification, nonproliferation, counterproliferation, demilitarization, and defense-related research and development." Large-scale, open-air explosive detonations were not specifically addressed.

In accordance with DOE NEPA Implementing Procedures (10 CFR 1021), NSO conducted a 5-year review of the NTS EIS. The review was documented in the *Supplement Analysis for the Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE, 2002a). As a result of the analysis, NNSA determined that as of 2002, the NTS EIS continued to adequately address the environmental impacts of activities being conducted and anticipated at the NTS.

Related Actions – At the White Sands Missile Range in New Mexico, DTRA and its predecessors have conducted a series of large-scale Ammonium Nitrate and Fuel Oil (ANFO) detonations, some of which are significantly larger than the DIVINE STRAKE proposal. These include:

- Pre-Dice Throw – 120 tons (109 metric tons) in 1977
- Dice Throw – 620 tons (562 metric tons) in 1979
- Distant Runner – 2,250 tons (2,041 metric tons) in 1981
- Mill Race – 620 tons (562 metric tons) in 1982
- Pre-Direct Course – 24 tons (22 metric tons) in 1982
- Direct Course – 609 tons (552 metric tons) in 1983
- Minor Scale – 4,744 tons (4,304 metric tons) in 1985
- Misty Picture – 4,685 tons (4,250 metric tons) in 1987
- Misers Gold – 2,445 tons (2,218 metric tons) in 1989
- Distant Image – 2,440 tons (2,214 metric tons) in 1991

Other detonations have included an underground detonation of 1,410 tons (1,280 metric tons) of ANFO-emulsion (Non-Proliferation Experiment) in the U12n tunnel at the NTS in 1993, and seven 120-ton (109-metric ton) detonations at Misers Bluff at Planet Ranch in Arizona (near

Lake Havasu, Arizona) in 1978. Experience obtained from the detonations listed above was used to develop the plans for the proposed Large-Scale, Open-Air Explosive Detonation, DIVINE STRAKE, at the NTS**.**

1.4 Public Involvement

A large-scale, open-air detonation such as DIVINE STRAKE is consistent with the mission of the NTS, and the remote location of the site ensures that impacts to the public would be minimal (see Chapter 4, Environmental Consequences). Public announcements would notify the public prior to the detonation. On May 9, 2005, NNSA made the determination that the activity of a large-scale, open-air detonation of this scale at the NTS was not adequately analyzed in existing NEPA documentation. Therefore, a Pre-Approval Draft EA was prepared in November 2005 and disseminated for comment in December 2005. One comment was received during the review and comment period. That comment, from the State of Nevada, stated:

> "The State Clearinghouse has processed the proposal and has no comment. Your proposal is not in conflict with State plans, goals, or objectives. This constitutes the State Clearinghouse review of this proposal as per Executive Order 12372."

On January 30, 2006, a FONSI was signed by NNSA. In May 2006, a Revised EA was issued by NNSA and DTRA, as cooperating agencies, and distributed to all stakeholders and interested parties. A Revised FONSI, including a decision authorizing the experiment to be conducted, was signed by NNSA and DTRA on May 9, 2006. Later, concerns were raised about the possibility of resuspension in the air of radioactive particles from nuclear weapons testing at NTS, naturally occurring radioactive material, and global fallout. On June 9, 2006, NNSA withdrew its authorization to conduct the experiment in order to reevaluate data, analyses, and conclusions contained in the Revised EA and Revised FONSI, and to address the concerns regarding the dispersion of radioactive particles by DIVINE STRAKE. Following those efforts, this Draft Revised EA was prepared.

This Draft Revised EA will be distributed to all stakeholders and interested parties including those parties listed in Chapter 5, and made available for public comment for at least 30 days. Public information meetings concerning the proposed experiment, conducted by DTRA with support from NSO, are planned for January 2007.

2.0 DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

This chapter describes the Proposed Action, the No-Action Alternative, and alternatives eliminated from further analysis. Section 2.1 provides an introduction to the alternatives. Section 2.2 describes DTRA and NNSA's Proposed Action of the Large-Scale, Open-Air Explosive Detonation, known as DIVINE STRAKE, at the NTS. The No-Action Alternative is described in Section 2.3. Section 2.4 discusses alternatives considered, but eliminated from further analysis.

2.1 Introduction

While several alternatives were considered, all but two were eliminated. The remaining two alternatives are analyzed in detail in this EA: the Proposed Action and the No-Action Alternative. The Proposed Action, the large-scale, open-air explosive detonation (DIVINE STRAKE), is designed to meet the purpose and need for action described in Chapter 1. The NTS' large size, remote location, and extensive infrastructure offer a practical technology development site for the Proposed Action. The No-Action Alternative would not meet the purpose and need described in Chapter 1, but it would maintain NTS operations as they currently exist.

This chapter, when combined with the affected environment description in Chapter 3 and the environmental impact analysis in Chapter 4, meets the EA goal of informing decision-makers and the public about NTS operations and potential impacts associated with DIVINE STRAKE.

2.2 Proposed Action – Large-Scale, Open-Air Explosive Detonation, DIVINE STRAKE, at the NTS

NNSA proposes to provide a test bed to be used by DTRA to conduct a single large-scale, open-air explosive detonation in Area 16 of the NTS. The proposed detonation, known as DIVINE STRAKE, would occur tentatively in mid-2007 above the existing U16b Tunnel Complex. Early project planning identified the potential for a second, smaller detonation. It was subsequently determined unnecessary to conduct a second detonation. Therefore, DIVINE STRAKE would be a one-time event. It would supply a relevant full-scale simulation demonstration with a tunnel complex to create a post-experiment underground environment sustaining light to severe damage.

Because the site of the proposed DIVINE STRAKE detonation is located in the central area of the NTS, the threat of terrorism is not significant prior to detonation. The NTS is an access-controlled, secure area, provided with 24-hour security. There would be no possibility for a terrorist act associated with the experiment until the ANFO is emplaced. Access at the project site would be subject to further controls during emplacement through the detonation. As the site of the experiment has been selected so as to avoid adverse impacts from a detonation, a malicious act that resulted in a premature detonation would have minimal impacts beyond the NTS boundaries.

Figure 2-1 shows an aerial view of U16b tunnel complex and the surrounding terrain of Area 16 at the NTS. DIVINE STRAKE would detonate up to 700 tons (635 metric tons) of heavy ANFO-emulsion (also known as heavy ANFO), a blasting agent, emplaced in a charge hole about 32 feet (9.8 meters [m]) in diameter and 36 feet (11 m) deep, located at the surface above U16b tunnel (Figure 2-2). In addition to the ANFO, up to 300 pounds (136 kilograms) of C-4 explosive would be used to initiate detonation. The bottom of the charge hole would be about 99 feet (30 m) above the back of the tunnel (Figure 2-3).

Site preparation would include: (1) improvement of an existing dirt road leading to the hilltop above the tunnel; (2) excavation of the emplacement (or charge) hole above the tunnel complex and a three-point turnaround area for bulk delivery trucks; and (3) drilling holes in the back, floor, and ribs of the tunnel for installation of instruments and gauges for recording the effect of the detonation. Instrumentation bunkers would be constructed and located in previously disturbed areas near the portal of the tunnel. Several accelerometers would be placed in and around the test bed to record ground motion. High-speed cameras would be installed to record portal and underground damage.

DTRA would provide site characterization data defining *in-situ* properties and 3-D variations within the test bed, and would provide experiment data defining charge source performance, free-field ground motions and asymmetries, and tunnel near-field environment and response data. The geotechnical site characterization would fill an important targeting gap, not only for DIVINE STRAKE, but also for other HDBT experimental programs. This experiment would support the evaluation and validation of attack planning tools and capabilities, including fast-running ground shock and tunnel damage models along with first-principles target response and damage calculations.

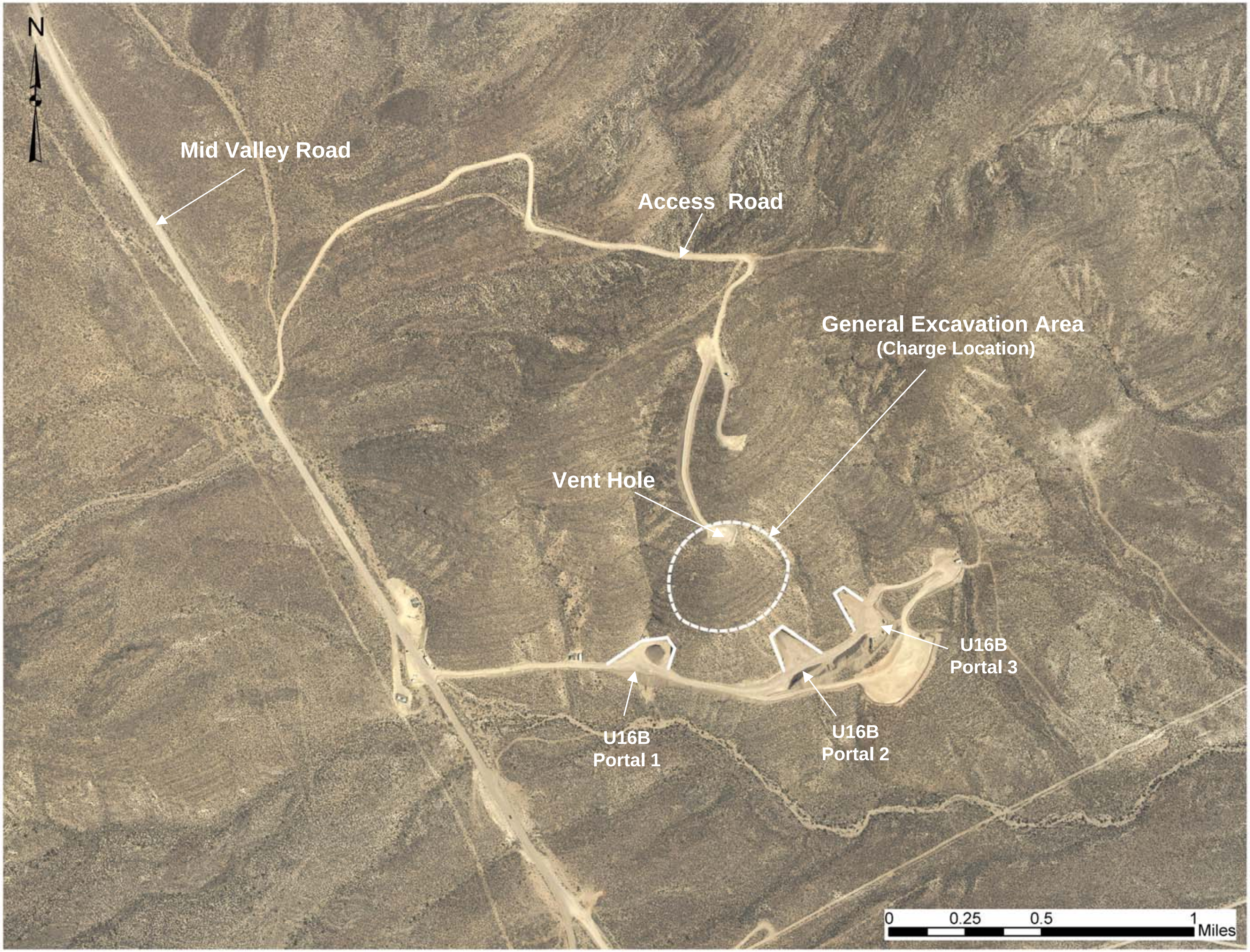

Figure 2-1.
Aerial view of U16b tunnel complex and surrounding terrain at Area 16

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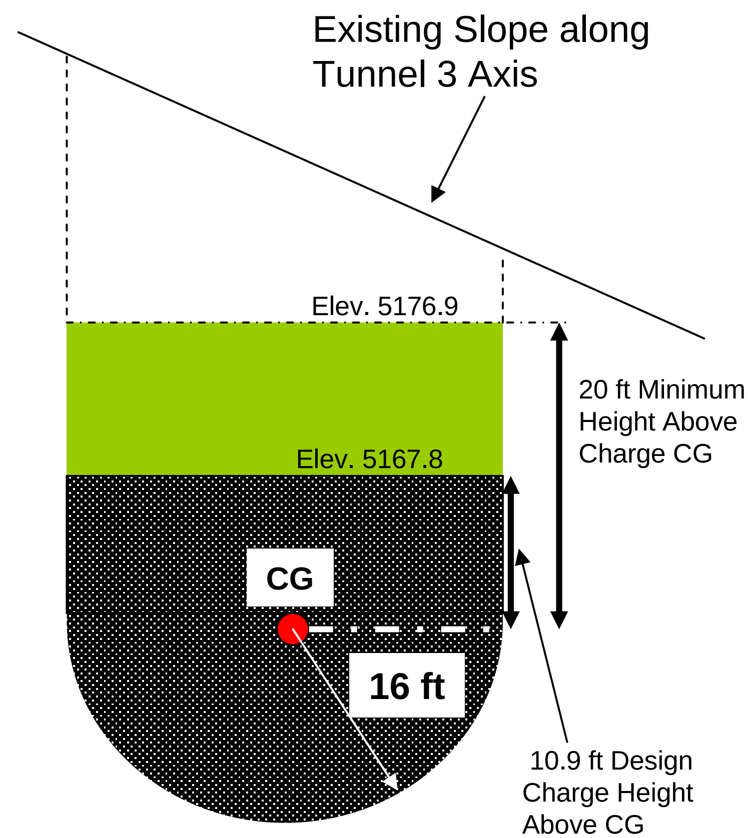
DIVINE STRAKE Charge Configuration

- **Basic Excavation Design:**
  - 32-ft diameter circular excavation, with hemispherical bottom
  - Hemisphere radius is 16 ft
  - Minimum hole height above CG is 20 ft
  - Surface excavation above Elev. 5176.9 ft above sea level (asl)
- **Design Charge Weight is 700 tons (English) ANFO Emulsion (593 tons TNT eq)**



Charge CG elevation = 5156.9 ft
CG = cloud to ground

Figure 2-2.
DIVINE STRAKE Charge Hole

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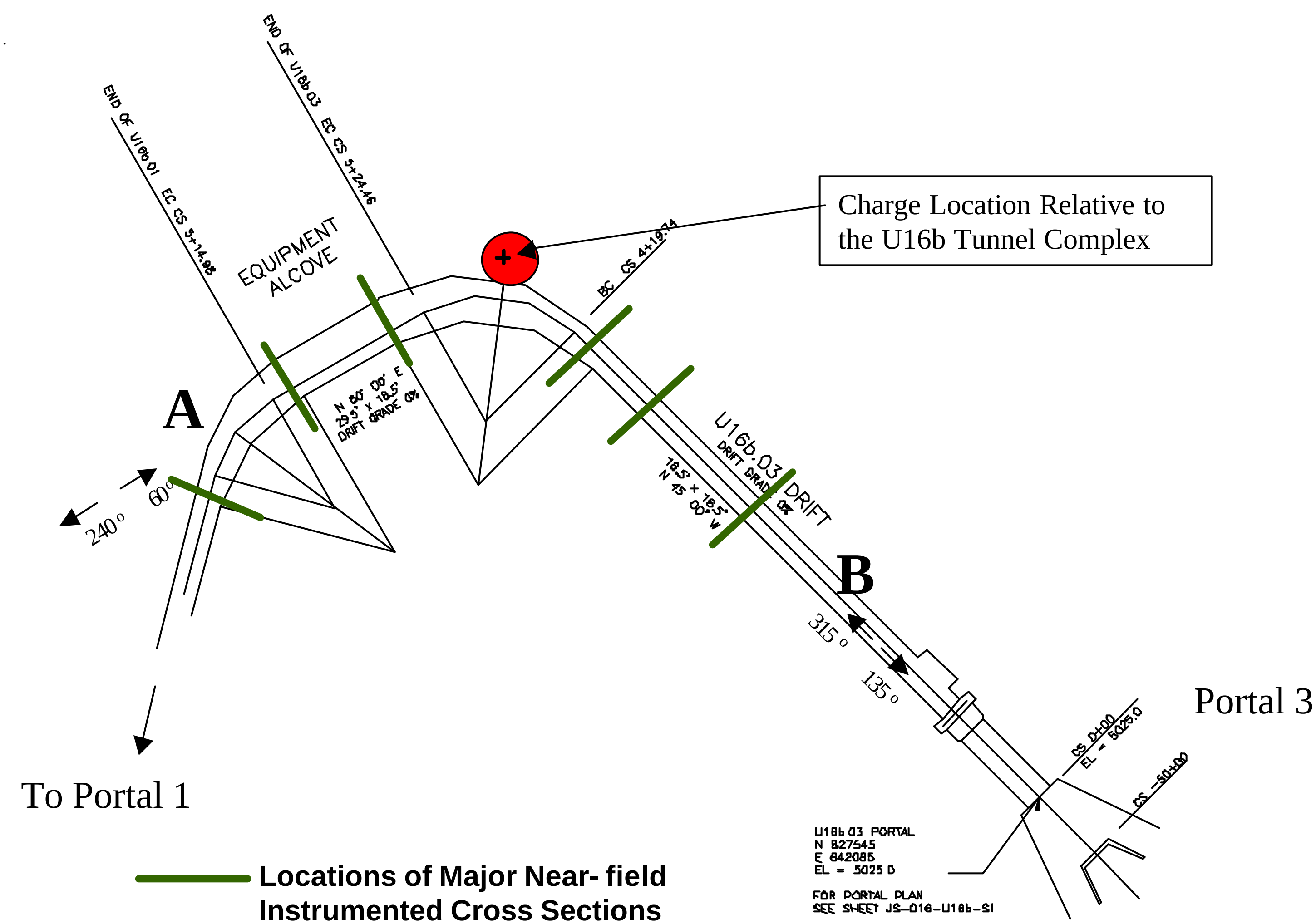

Figure 2-3.
Divine Strake Tunnel layout
Sources: Detonation Phenomena Predictions

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Additional experiments may be included to supplement data obtained from the detonation. The following are examples of potential experiments:

- A reinforced concrete structure simulating a stairwell – This structure would be built on the lower pad at the U16b tunnel. It would have an 18.5 feet (5.6 m) by 18.5 feet (5.6 m) concrete foundation, and would be 26.5 feet (8.1 m) tall, with a 16 feet by 16 feet (4.9 m by 4.9 m) stairwell with a hatch installed at the base. The pressure and acceleration instrumentation would be included on and near the structure, and cameras would record structural responses. Depending upon the amount of damage, the structure could be left in place after DIVINE STRAKE. However, the current plan is to dismantle and dispose of the structure in an appropriate NTS landfill after the detonation.
- Sensor collections with a generator in Portal 1 and small fans in the back room area – The intent is to be able to see pre-detonation, detonation, and post detonation images.
- Computer fragility studies – Computers would be placed in Portal 3 along with additional surface mounted accelerometers and cameras to observe the fragility of the computers. Protective shelters may be provided for one or more of the computers for comparison purposes.
- Ejecta studies – Ejecta studies would be conducted to characterize how the ejecta is dispersed or "shot out" by the detonation and how far it travels. The studies would evaluate both large debris (softball size) and smaller debris (fines). Collection panels (possibly tarps) would be placed at various distances from the charge hole to collect debris. The large debris would be evaluated for distance traveled, size, condition, and other parameters. For the fines, powdered dyes (tracers) would be placed on the ground around the crater site, most likely on one quadrant on the northern side, which would ensure that the dyes are carried towards the north, which is the general direction the wind would be blowing (as further defined in section 2.2.2). The powder would be lofted with the dust cloud during detonation. The fines would be evaluated for travel distance, size distribution, and dispersion.

2.2.1 Construction and Site Plan

DIVINE STRAKE-related construction at the U16b tunnel site includes an extension of an existing road by about 200 feet (61 m) to reach the location of the ANFO emplacement (or charge) hole, excavation of the ANFO charge hole (including a loading pad and truck turnaround area), instrument bunkers, large diameter (6-inch [15-centimeter (cm)]) core drilling, instrumentation borehole drilling and instrument placement, and grout emplacement for instrumentation holes. Existing laydown yards at the U16b tunnel complex would be used as construction and material staging areas. No major roadway improvements on the NTS are necessary to accommodate truck traffic.

Normal delivery of materials would occur in accordance with existing U16b operations using existing access roads (Pahute Mesa Road and Mid-Valley Road). Material delivery during construction would include:

- Light fleet traffic of approximately 15 vehicles per day
- Water provided daily by truck for personnel consumption, dust suppression, and construction, as needed
- Sanitary wastes collected in portable toilets, serviced twice weekly
- Fuel for construction equipment delivered bi-weekly
- Delivery of approximately 200 feet (61 m) of concrete pre-cast culvert section weighing 12 tons (11 metric tons) each (the concrete culvert would be delivered in 5-foot (1.5-m) sections, with an inside diameter of 12 feet by 12 feet (3.7 m by 3.7 m)
- Excavation equipment delivered by flatbed
- Normal construction consumables delivered as needed

The two unmanned instrumentation vans would be positioned just outside the Portal 2 entrance and placed inside an instrumentation bunker. The bunker would be made of the pre-cast concrete culvert sections described above. The vans would be placed inside their own respective bunker, side-by-side against the Northeast wing wall. Each bunker would be approximately 75 feet (23 m) in length. Additional overburden (muck) would be placed on top of the bunkers and end caps would be placed just prior to detonation to protect the vans.

To support the modeling and calculation efforts for the proposed detonation, a suite of instrumentation would be placed on and around the test bed. The primary measurements would be made using both free-field and near-field accelerometers placed in the various instrumentation holes. A small number of sunburst velocity gages would be co-located with several free-field accelerometers. Relative displacement gages would be installed in the tunnel ribs. Pressure measurements in and around the portals would be made to record the near-field environment. Inside the tunnel a number of high-speed cameras and radars (vehicle type radar guns) would be installed to assist in determining surface spalling of the tunnel walls resulting from the explosive detonation. The charge would be measured using the Los Alamos National Laboratory CORRTEX (Continuous Reflectometry for Radius versus Time Experiments) system and a number of Time-of-Arrival (TOA) crystals located in the blasting agent itself. To support experiments that may be added to supplement data, additional high-speed and video cameras would be positioned to observe experiment results along with additional pressure measurements in and around the reinforced concrete structure.

The ANFO vendor would have trucks delivering each ingredient to the staging area at an existing laydown yard near Tunnel 16b. Three specially designed bulk delivery trucks (each with a capacity of approximately 24,000 pounds (10,900 kilograms) of raw materials) would be loaded with the raw materials at the staging area and then would transport the materials to the pad adjacent to the charge hole. A fourth bulk delivery truck would be on-site for backup and retrieval of any spilled material. For the estimated 4 to 5 days of ANFO emplacement, there would be daily lines of trucks to bring the materials to batch the ANFO (see Section 2.2.2). The staging area would accommodate the four bulk delivery trucks, one fuel truck, four semi-tankers of raw materials, a tool trailer, and a small parts trailer. Because of the potential overlap of deliveries, and deliveries during non-loading hours, additional parking for semi-trucks and trailers would be provided in a staging area just outside the U-16b compound.

2.2.2 Proposed Operating Plan

The proposed operating plan includes acceptable blast conditions, the procedures for filling the charge hole with ANFO (batch and emplacement plan), detonation, and monitoring.

Acceptable Blast Conditions – Prior to the detonation, the extended meteorological forecast for 7 to 14 days would be evaluated. If meteorological conditions were not satisfactory, the emplacement of the ANFO emulsion and the detonation would be postponed. Required meteorological conditions for detonation would be no temperature inversions, no more than 40 percent stratus or cumulus cloud cover, and winds less than 25 miles per hour blowing from the southwest (240 degrees) through southeast (120 degrees). Winds blowing to the northeast to northwest would direct the blast pressure forward onto the northern half of the NTS, away from most NTS facilities and the off-site communities south of the NTS. The analysis in this EA assumes the following acceptable blast conditions:

Surface Winds:	Southerly (from 120° through 240°) up to 25 miles per hour
Winds Aloft:	Southerly (from 120° through 240°) up to 50 miles per hour
Lapse Rate:	3° Celsius per km (moist adiabatic to unstable)
Temperature Inversions:	No temperature inversions from surface to tropopause
Cloud Cover:	No significant low to mid-level cloud cover (less than 40 percent)
Thunderstorms:	No thunderstorms or lightning within a 20-mile (32-km) radius of the 16b test bed

Meteorological conditions would be carefully monitored and evaluated by competent personnel assigned to the NTS prior to NSO approval for the detonation. If appropriate meteorological conditions do not exist, the detonation would be delayed until the required conditions are met.

Other acceptable blast criteria would include technical criteria such as operability of equipment/sensors and power to the instrument van.

Batch and Emplacement Plan – To batch (or mix) the ANFO, materials for batching would be brought in as needed, transferred to one of the four bulk delivery trucks, and transported to the pad adjacent to the charge hole. The trucks would mix the raw ingredients into a blasting agent (ANFO) and discharge directly into the hole via an auger. The 700 tons (635 metric tons) of ANFO would be batched into a semi-liquid emulsion (Dyno Gold Extra, formerly know as Dyno Gold C (a registered trademark of Alpha Explosives)) consisting of 78.65 percent ammonium nitrate, 5.52 percent calcium nitrate, 9.45 percent water, and 6.38 percent fuel oil. The batching process would take approximately four to five days to provide the 700 tons (635 metric tons) of ANFO. A small pipe or tube would be placed in the center of the hole prior to filling with the blasting agent. This pipe would allow the booster and detonators to be installed just before DIVINE STRAKE is detonated. Spill tarps would be placed under the fuel truck, the raw material tankers, and the parked bulk delivery trucks. Clean-up and housekeeping activities would be constant. Upon completion of loading the charge hole, the trucks, storage trailers, and any remaining materials would be removed from the site.

Detonation – DIVINE STRAKE would be detonated using a remote firing system. A signal would be generated at the remote data acquisition facility and transmitted through a microwave link to U16b where it would be fed into the arming and firing unit in the small pipe installed in the charge hole prior to loading the ANFO emulsion into the hole. Exploding bridgewire (EBW) detonators would be used to detonate the explosives. There would be a dual system of EBWs (one primary and one backup). A high voltage pulse would be sent to the EBWs, which would be embedded within 100 to 300 pounds (45 to 136 kilograms) of C-4 (booster) located in the center of the ANFO charge. The EBWs and the C-4 would not be added until after the ANFO has been emplaced in the charge hole, acceptable blast criteria have been satisfied, and a final dry run has been completed. Additionally, there would be a second backup firing system using a detcord line running down the length of the small pipe and into the booster. The detcord would also be initiated with another EBW.

To detonate DIVINE STRAKE, EBWs would fire, detonating the C-4 and in turn detonating the ANFO mixture. If the first two EBWs were nonfunctional, the detcord would be fired and the “burn” would propagate down to the booster and then initiate the blasting agent. Detonation products would include water, nitrogen, carbon dioxide, methane, and calcium carbonate.

Monitoring – Both microbaragraphs and three-axis seismometers would be deployed at up to 36 stations both on and off the NTS to measure the airblast overpressure time records and seismic ground shock resulting from the proposed detonations. These types of measurements have been routinely performed on other large explosive detonations to ensure public safety, but also to improve the predictive capability for the long-range impacts. In addition, visual and photographic surveys would be conducted pre- and post-detonation to evaluate the impacts of the ejecta, airblast, and dust on both biota and facilities.

In addition to experiment-related monitoring, NSO would conduct environmental monitoring to ensure compliance with the NTS Air Quality Operating Permit and with the standard set forth in 10 CFR Part 61, Subpart H, *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities.* Although there is no regulatory requirement to conduct radiological air monitoring in excess of the routine monitoring program at the NTS, NNSA determined that it would implement a specific air monitoring program for DIVINE STRAKE in order to confirm the results of predictive modeling and to assure the public that there would be no detectable off-site radiological exposure from the experiment.

In May 2006, NNSA proposed to the Nevada Bureau of Air Pollution Control a comprehensive air monitoring plan for DIVINE STRAKE. That plan would include a total of 10 high-volume air samplers to be operated by the NTS Management and Operating (M&O) contractor for the purpose of determining radioactive emissions from the experiment. In addition, an independent sampling effort would be conducted by Desert Research Institute (DRI) using four high-volume air samplers co-located with M&O contractor samplers. Placement of the sampling locations would be based upon anticipated wind patterns for the period of time the experiment may be conducted. In addition to the high-volume air samplers operated by the M&O contractor and DRI, 17 low-volume samplers that are part of the routine NTS monitoring network would be operating during the DIVINE STRAKE experiment. Two PM_{10} (particulate matter with an aerodynamic diameter less than 10 microns) samplers would be used to determine emissions of that criteria pollutant. Off-site, on behalf of NSO, DRI operates the Community Environmental Monitoring Program, a network of 29 monitoring stations located in communities surrounding the NTS in Nevada, Utah, and California. Although no detectable emissions are anticipated from the experiment, these monitoring stations, supplemented with up to three MiniVol air samplers, would provide additional data concerning any DIVINE STRAKE emissions that may be detected off of the NTS.

2.2.3 Associated Operational Planning

This section describes associated operational planning, including safety planning, emergency planning, NTS facility notifications, and the removal and protection of vulnerable equipment and structures prior to detonation.

Safety Plan – A safety plan is currently under development to ensure the detonation would be performed in a safe manner, protective of human health and safety, the environment, and nearby NTS facilities. Key elements of the plan include:

- Regulatory requirements, codes, standards, and guidance
- Normal and emergency operational procedures
- Hazard evaluation
- Operational hazards
- Project information
- Training plan
- Emergency Management Plan and implementation
- Enhanced security measures

In addition to the safety plan and training provided by DTRA and the NTS M&O contractor, the ANFO vendor would make a formal presentation to explain all safety considerations and answer any questions prior to ANFO emplacement. Additional information about the safety plan and the potential safety impacts to workers and the public are included in Chapters 3 and 4.

NSO Emergency Planning – NSO has a comprehensive and integrated emergency management system to ensure an effective and efficient response to emergencies at NTS. The Consolidated Emergency Management Plan (DOE, 2005a) specifies the implementing procedures for all elements of the emergency response organization. The NSO Office of the Assistant Manager for National Security would be notified of the presence and storage locations of the ANFO emulsion and associated chemicals. Accident analysis for the on-site transportation, storage, emplacement, and detonation would be modeled using the appropriate and approved models to perform analysis of accident/emergency consequences. The accidental and instantaneous release of the entire ANFO emulsion would be modeled as the worst-case scenario. NTS maintains meteorological measurement and modeling capabilities to determine atmospheric transport and dispersion of materials released into the atmosphere during an accident. Accidental release modeling is conducted by NSO contractors for chemical materials that are on-site. NSO has identified over 90 atmospheric models that are available. All modeling analyses are conducted in accordance with guidance and procedures specified in the DOE Emergency Management Guide (DOE, 1997). Modeling results are used to define emergency action levels, emergency planning zones, and identify other critical information such as environmental receptors. Additionally, the modeling results are used to develop timely, initial consequence assessments of emergency situations to ensure the consequence assessment provides representative results for making decisions to protect workers and the general public.

NTS Facility Tenant Notifications – All facility tenants at the NTS have been notified of the proposed detonation. NTS facilities are being evaluated for potential impacts to equipment and structures, and additional notifications would be made as the project develops.

Removal/Protection of Equipment – As part of the project planning and evaluation, equipment or structures that may be vulnerable to damage from DIVINE STAKE are being identified, and mitigation measures implemented. These include such items as power poles (replacement poles would be staged) and a nearby air sampling station (would be temporarily relocated).

Other facilities/structures such as wells and the U1h and U1a hoist houses and head frames are also being evaluated for potential impacts.

2.2.4 Enhanced Security Measures

A project-specific security plan has been prepared and would be implemented to address the protection of personnel and assets for the DIVINE STRAKE experiment. Additional access control restrictions would be implemented when the ANFO is on-site. During emplacement operations, a strict access control process would be implemented. Additionally, immediate protective force response to the experiment location would be available. This further enhances the security posture against potential terrorist attacks or inadvertent site intrusions.

2.2.5 Post Operation and Contingency Planning

DIVINE STRAKE would be designed such that all explosive material would be detonated, leaving no residual explosive material. However, in the highly unlikely event of a partial detonation, any residual material would be managed in conjunction with a Nevada Department of Environmental Protection approved plan. This plan would be coordinated and approved prior to execution of DIVINE STRAKE.

2.3 No-Action Alternative

Pursuant to NEPA and CEQ regulations, the No-Action Alternative must be considered. With the No-Action Alternative, NTS's baseline operations and management in support of its national security mission would not change. The proposed Large-Scale, Open-Air detonation, DIVINE STRAKE, at the NTS would not be conducted and the purpose and need described in Chapter 1 would not be met.

2.4 Alternatives Eliminated from Further Analysis

Other alternatives considered but eliminated from further analysis are described below and include:

- Alternative locations for the Proposed Action
- Variation in scale of Proposed Action (lower or higher amounts of explosives)
- Technological variations

Alternative Locations for the Proposed Action – Sites for the Proposed Action other than the U16b tunnel complex at NTS were considered by DTRA including the White Sands Missile Range in New Mexico, Dugway Proving Ground in Utah, and China Lake in Southern California. These sites were eliminated because of the need to conduct the detonation in a limestone bed with specific geological properties. As a number of potential adversarial military targets are based in similar limestones, the Proposed Action needed to be sited in a similar geologic setting to actual military targets. The U16b tunnel complex at NTS was chosen based on these criteria for other Hard Target Defeat experiments. No other sites exist on U.S. Government controlled areas that meet the geologic criteria and allow for the safe conduct of experiments. In the interest of public safety, the proposed detonation-site must be located on controlled government land.

Variations in Proposed Action – While the Proposed Action is not directly linked to the evaluation of any specific weapon system, one objective is to evaluate damage to a tunnel facility from a large surface detonation. A second objective is to provide field experiment ground motion and tunnel damage data for the improvement and/or validation of ground motion and underground facility damage computer codes. As part of the HDBT program, smaller scale experiments (from grams of chemical explosives up to a few pounds) have been conducted in the laboratory and the field to help develop and validate modeling computer codes.

An intermediate scale test bed was constructed in a limestone quarry near Bedford, Indiana, and two 3,000-pound (1,360-kilogram) chemical explosive experiments were conducted to help evaluate and validate the modeling codes. This test bed was located in a limestone with similar material properties as the NTS U16b site; however, the structural geologic setting at the Indiana site was simple, consisting of horizontal bedding planes and vertical joints. This simple geologic setting allowed for the validation of new computer codes prior to attempting to model the proposed U16b site with its complex structural geologic setting involving dipping bedding planes and several joints sets at various orientations.

The next step, in this portion of the HDBT program is the Proposed Action: a full-scale test bed for final validation of the modeling effort. The explosive yield (700 tons (635 metric tons) of ANFO-emulsion) was selected based on modeling predictions of the amount of ANFO that would be needed to cause the appropriate extent of damage to the underground facility, and on information gained from the small- and intermediate-scale experiments. A larger amount of

ANFO-emulsion is not needed for the Proposed Action, and a smaller amount would not be adequate to significantly damage the full-scale tunnel facility.

Technological Variations and Experiment Parameters – No other experiments or variations, such as shape or depth of the charge hole or type of blasting agent, providing the information needed to satisfy the purpose and need (as defined in Chapter 1) were identified.

3.0 AFFECTED ENVIRONMENT

3.1 Land Use

The NTS is located on approximately 1,375 square miles (3,560 km^2) or approximately 880,000 acres (356,000 hectares) in southern Nye County, Nevada. The area surrounding the NTS is unpopulated to sparsely populated desert and rural land. Federal lands surround the NTS, with the U.S. Air Force Nevada Test and Training Range (NTTR) located on the north, east, and west, and U.S. Bureau of Land Management lands on the south and southwest. Beyond the Federal lands surrounding the NTS, principal land uses in Nye County in the vicinity of the site include mining, grazing, agriculture, and recreation. Rural communities located within the vicinity of the NTS include Alamo, 43 miles (69 km) to the northeast; Pahrump, 26 miles (42 km) to the south; Beatty, 16 miles (26 km) to the west; Indian Springs, 17 miles (27 km) to the southeast; and Amargosa Valley, 3 miles (5 km) to the south. Las Vegas, located in Clark County, is about 65 miles (105 km) to the southeast (DOE, 2004a). Figure 3.1-1 illustrates the NTS and surrounding land use.

<u>Existing Land Use at the NTS</u>

Existing land use on the NTS is divided into seven zones as summarized in Table 3.1-1. Sites within these zones are categorized as industrial, research, support, and waste management. An industrial site is used for the manufacturing, processing, and/or fabrication of articles, substances, or commodities. A research site is used for projects to verify theories or concepts under controlled conditions. Support sites are used for office space, training, equipment storage, maintenance, security, feeding and housing, fire protection services, and health services. A waste management site is a site used for the disposal, storage, and/or treatment of wastes.

To simplify the distribution, use, and control of resources, the NTS is also divided into 26 numbered areas (numbered from 1 to 30; there are no areas numbered 13, 21, 24, and 28). The proposed site for the DIVINE STRAKE detonation is located in Area 16.

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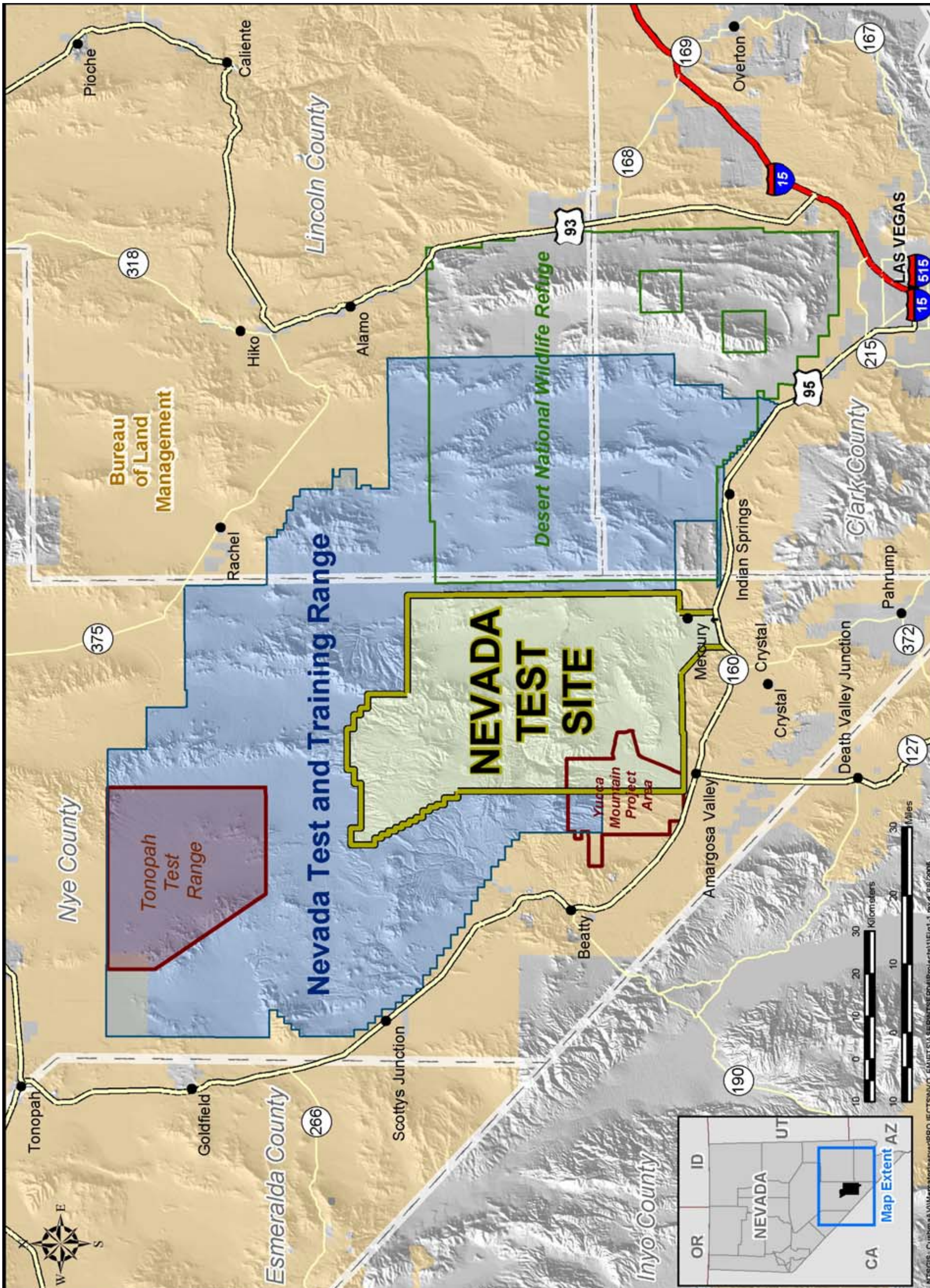

Figure 3.1-1. NTS and Surrounding Land Use

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Table 3.1-1
NTS Land Use Zones

Zone	Purpose
Nuclear Test Zone	Underground hydrodynamic tests, dynamic experiments, and underground nuclear weapons and weapons effects tests.
Nuclear and High Explosive Test Zone	Land within the Nuclear Test Zone for additional underground and aboveground high-explosive tests or experiments.
Research, Test, and Experiment Zone	Small-scale research, development projects, pilot projects, and outdoor tests and experiments for the development, quality assurance, or reliability of materials and equipment under controlled conditions.
Radioactive Waste Management Zone	Shallow land burial of low-level and mixed wastes.
Critical Assembly Zone	Conducting nuclear explosive operations. Operations generally include assembly, disassembly or modification, staging, repair, retrofit, and surveillance. The potential for weapons storage also exists in this zone.
Nonproliferation Test and Evaluation Complex (NPTEC)	A downwind geographic area that would confine the impacts of the largest planned tests of materials released at the NPTEC Facility.
Reserved Zone	Controlled-access land area that provides a buffer between non-defense research, development, and testing activities. Includes areas and facilities that provide widespread flexible support for diverse short-term non-defense research, testing, and experimentation. Also used for short-duration exercises and training, such as Nuclear Emergency Search Team and Federal Radiological Monitoring and Assessment Center training, and DoD land navigation exercises and training.

Area 16, within the Nuclear and High Explosive Test Zone, occupies 28 square miles (73 km^2) in the central portion of the NTS. No atmospheric nuclear tests have ever been conducted in Area 16. Area 16 was established in 1961 to support complicated nuclear effects experiments that required a tunnel location in an isolated area away from other active nuclear weapons test areas. From mid-1962 through mid-1971, six underground nuclear weapons effects tests were conducted in the U16a tunnel complex. The U16a tunnel complex is located approximately 1.1 miles (1.8 km) southwest of the proposed U16b test bed. Currently, under the NSO Work for Others program, the DoD uses this area, including both U16a and U16b tunnels for RDT&E in support of HDBT programs involving the delivery and detonation of conventional or prototype chemical explosives and munitions. Figure 2-1 in Chapter 2 shows the configuration of the DIVINE STRAKE test bed in relationship to the U16b portals and related features. U16b was constructed in 1998, and it has not been used for any type of nuclear or radiological testing activity.

<u>Surrounding Land Use</u>

Other Federal lands surround the NTS, including the NTTR Complex on the north, east, and west and U.S. Bureau of Land Management lands on the south and southwest (see Figure

3.1-1). Beyond the Federal lands that surround the NTS, principal land uses in Nye County in the vicinity of the NTS include mining, grazing, agriculture, and recreation.

Portions of the Desert National Wildlife Range overlap the NTTR Complex and come within 2 miles (3 km) of the boundary of the NTS.

<u>Airspace</u>

Restricted areas R-4808N/S and R-4807B are airspace delegated to the DOE from the Federal Aviation Administration (FAA). Flight safety and physical security of R-4808N/S and R-4807B are ensured through restrictions or limitations of over flight. For scheduling purposes, R-4808N/S is divided into Alpha, Bravo, Charlie, Delta, and Echo. In accordance with FAA Order 7400.8, the NNSA has been designated as the using agency of R-4808N/S and R-4807B. As the using agency, NNSA is responsible for the overall management of all ground and airborne operations in accordance with Title 14 CFR Part 73. The 98th Range Wing's Operations Support Squadron, Operational Support Office (98th OSS/OSO) at Nellis Air Force Base (NAFB) has the scheduling responsibility for all operations within restricted areas after coordination. The NNSA retains the right to limit all flight activity over R-4808N/S and R-4807B for programmatic reasons and would coordinate restrictions with the 98th OSS/OSO as far in advance as possible. Any areas concerning flight or safety of ground personnel would be coordinated regardless of altitude.

Prior to the execution of DIVINE STRAKE, NTS Operations Control Center (OCC) would close all airspace within a certain distance of the test bed to ensure flight safety. This would be coordinated through the DIVINE STRAKE Operations Controller and the NTS/OCC. Airspace would remain closed until it is deemed safe to reopen.

3.2 Noise

A potentially significant effect of DIVINE STRAKE would be the exposure of both inanimate (e.g., structures and land-forms) and animate (e.g., animal and human) receptors to the adverse impacts of airblast and noise.

The Noise Control Act directs all Federal agencies to be cognizant of the potential adverse impacts of noise generated by their projects and to take steps to prevent or reduce such impacts. The U.S. Environmental Protection Agency (EPA) and Department of Housing and Urban Development (HUD) are concerned with the overall health of the population and with maintaining appropriate levels of long-term noise in communities. The Occupational Safety and Health Administration (OSHA) regulations require hearing conservation and protection for all employees potentially exposed to criteria noise levels as would be generated by the project.

The following jurisdictions at the state and local level were investigated for regulations concerning environmental noise:

- State of Nevada
- Nye County
- Clark County
- Nearby municipal jurisdictions

Environmental noise is not regulated by any local jurisdictions. Occupational noise exposure is regulated to the extent required by law. No general noise regulations are relevant to the NTS operations or the DIVINE STRAKE project.

<u>Sound/Noise Measurement</u>

Whenever energy, typically in the form of positive (a "push") or negative (a "pull") pressure, is applied to a compressible elastic medium (many solids, liquids, and gasses, including air), the molecules of the medium squeeze together or pull apart. When the energy source changes direction or ceases to transfer its energy to the medium, the medium's molecules spring back to their original resting position. The energy related to this molecular motion propagates (moves) as a wave motion in the medium. In air, for example, the compressions and rarefactions move away from the source at a very well defined speed that is related to the ambient air temperature and the relatively constant atmospheric pressure of the air. In air, at standard sea level atmospheric pressure and a temperature of about 68 degrees Fahrenheit (20° C), the acoustic sound wave (not the blast or shock wave) travels at about 1128 feet per second (344 m/sec). If the wave is not constrained or focused, its energy will propagate outward in the shape of a sphere, or a hemisphere (half sphere) if it is traveling over a reflecting plane, such as relatively flat hard ground.

Because the acoustic energy in the wave is spread out over a larger and larger surface area of the growing full or hemisphere as the sound wave travels away from the initial energy source, the sound pressure level (i.e., the magnitude of "push" and "pull" from the wave) diminishes with increasing distance from the source.

This primary factor in the reduction of sound energy is called divergence or geometric spreading loss. Other factors also contribute to changes in sound level between the source (an explosive detonation in the case of DIVINE STRAKE) and any designated receptor location. These include additional decreases in the sound pressure level due to the interaction of the sound wave with oxygen and water molecules in the air, the effect of landforms and structures (barriers), and the sound absorptive or reflective nature of intervening ground. Humans perceive sound when the acoustical wave is processed by the ear-brain complex. Additionally, humans define unwanted sound as “noise”. The terms sound and noise are used interchangeably in this assessment.

Because the medium of acoustic transmission is air, acoustic wave propagation is highly influenced by meteorology. This includes absolute ground surface and air temperatures, temperature gradients, relative humidity, turbulence, plus macro and micro wind patterns, both at the surface and up through extreme elevations. Thus, consideration of the climatic characteristics of the NTS and surrounding area as described in Section 3.10 is an important component of the environmental assessment of noise. An important point, especially for loud sounds that may be heard at great distances is that the instantaneous meteorological conditions during production of a sound (i.e., the DIVINE STRAKE detonation) can substantially affect the propagation of the sound wave and its amplitude at distant receptors. These factors are discussed further in Section 4.2.

The unit of sound pressure level measurement is the decibel (dB), which is a unit describing the amplitude of sound pressure compared to a reference pressure. The sound pressure level (SPL) is mathematically equal to 20 times the logarithm (to the base 10) of the ratio of the pressure of the sound measured to the reference pressure of 20 micropascals and is almost always taken as a root-mean-square value. By using this method it is possible to describe a very wide range of sound pressures with a relatively small numeric range.

The most common descriptor of sound and noise associated with occupational and community noise is the A-weighted sound pressure level, which is abbreviated as dBA. It is defined as the sound pressure level in decibels as measured on a sound meter using the A-weighting filter network. The A-weighting frequency filter de-emphasizes the very low and very high frequency components of sound in a manner similar to the frequency response of human hearing to sounds of moderate level, and correlates well with people’s group reactions to sound and environmental noise. While audible sound levels in the general environment may range from slightly above the threshold of hearing and very quiet (around 20 dBA) to very loud sounds of 130 dBA or higher, a range of 35 dBA to 85 dBA is much more common.

Exceptions to the use of A-weighted decibels are reserved primarily for the measurement, description, and analysis of very intense or predominately low frequency sound as might be expected from proximate small explosive reactions (e.g., automobile air bag deployment, small arms fire) to large distant acoustic sources (e.g., thunder, sonic boom, high explosives surface blasts). For occupational noise exposure to very intense short-term sound, the decibel values are typically stated in terms of peak (not root mean square) pressure and are "linear" (not "weighted") and, thus, include all frequencies in the acoustic wave on an equal basis. The "C" weighting filter is similar to "A" but because of the assumed higher decibel sound level, "C" accounts for more audibility of the low frequency sound energy. This allows for a more meaningful comparison of sound levels from higher SPL events to more typical moderate sound levels.

Environmental Sound Levels

NTS Ambient Sound Levels

Sound levels that typically occur on the NTS are reflective of the type, extent, and intensity of natural and manmade activity ongoing at any particular time. During periods of no human activity and calm weather conditions the ambient acoustic environment on the NTS could be quiet or lower (approximately 25 dBA). Conversely, during periods of human activity such as construction, and certainly during surface explosives detonations, sound levels on the NTS could vary from loud to painful to deafening depending upon the distance between the noise source and receptor. Table 3.2-1 presents a range of common (acoustic wave) sound levels for reference and comparative purposes.

Off-Site Ambient Sound Levels

Sound levels in the off-site environs of the NTS result from and are typical of the type of land use in a given area. This land use ranges from uninhabited desert to rural and suburban activity in the desert, the few small areas or towns of Amargosa Valley, Beatty, Indian Springs, Scotty's Junction, and Pahrump, to the urban environment of Las Vegas. The range of ambient environmental noise levels for these land uses is approximately from 35 dBA to 75 dBA. A very few manmade sounds could briefly exceed 90 dBA (e.g., car and train horns, truck backfiring, motorcycle with no muffler), but most sound would be in the background music (40 dBA) to speech range (60-65 dBA) with natural sounds at lower sound levels. Ambient sound levels found in typical environments for a range of land use/development intensities are summarized in Figure 3.2-1.

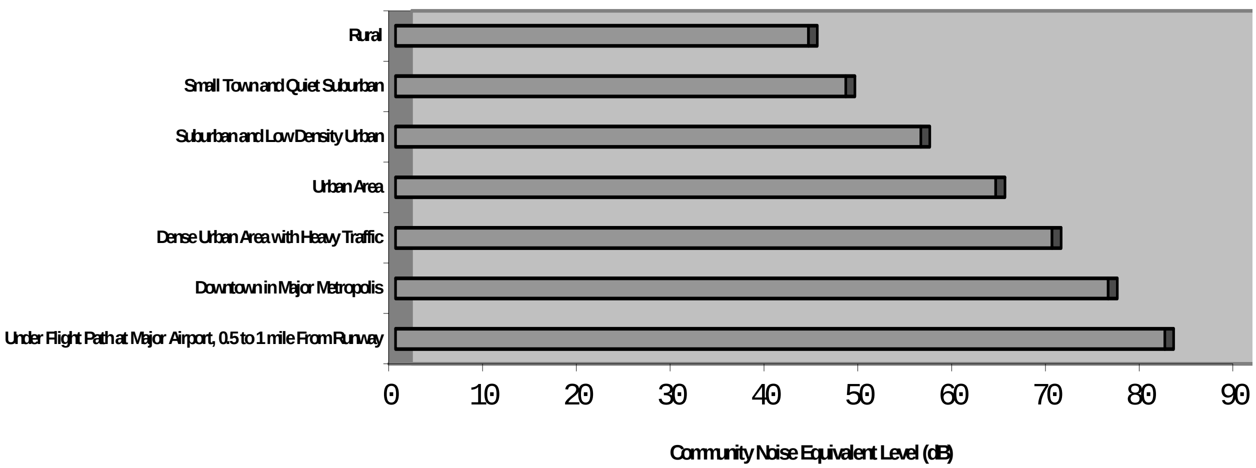
Table 3.2-1

Sound Levels of Typical Noise Sources and Noise Environments

Noise Source (at a Given Distance)	Scale of A-Weighted Sound Level in Decibels	Noise Environment	Human Judgment of Noise Loudness
Large Caliber Handgun (3 ft)	160	Shooting Range	Deafening, with potential TTS or PTS hearing impacts
Military Jet Take-off with	140	Aircraft Carrier Flight Deck	Painful
After-burner (50 ft)	130		Extremely Loud
Civil Defense Siren (100 ft)			
Commercial Jet Take-off (200 ft)	120	Airport	Threshold of Pain
			*32 times as loud
Pile Driver (50 ft)	110	Rock Music Concert	*16 times as loud
Ambulance Siren (100 ft)	100	Printing Press Plant	Very Loud
Newspaper Press (5 ft)			*8 times as loud
Power Lawn Mower (3 ft)			
Motorcycle (25 ft)	90	Boiler Room	*4 times as loud
Propeller Plane Flyover (1,000 ft)			
Diesel Truck, 40 mph (50 ft)			
Garbage Disposal (3 ft)	80	High Urban Ambient Sound	*2 times as loud
Passenger Car, 65 mph (25 ft)			Loud
Vacuum Cleaner (10 ft)	70		*70 decibels
			(Reference Loudness)
Normal Conversation (5 ft)	60	Data Processing Center	*1/2 as loud
Air Conditioning Unit (100 ft)		Department Store	
Light Traffic (100 ft)	50	Private Business Office	*1/4 as loud
Bird Calls (distant)	40	Lower Limit of Urban	Quiet
		Ambient Sound	*1/8 as loud
Soft Whisper (5 ft)	30	Quiet Bedroom	
	20	Recording Studio	Very Quiet
	0		Threshold of Hearing

TTS = Temporary Threshold Shift
PTS = Permanent Threshold Shift
*Relative to a Reference Loudness of 70 Decibels

Figure 3.2-1
Typical Range of Outdoor Community Noise Exposure Level



In summary, the range of existing ambient sounds typically occurring on and near the NTS results in both quiet periods and noisy periods. Thus, some of the louder sounds generated on the NTS may be (and based on anecdotal observations, are) audible in nearby areas outside the NTS boundaries during locally quiet periods.

NTS Area Climate

Because the medium of acoustic transmission is air, acoustic wave propagation is highly influenced by meteorology. This includes absolute ground surface and air temperatures, temperature gradients, especially inversion conditions, relative humidity, turbulence, plus macro and micro wind patterns, both at the surface and up through extreme elevations. Thus, consideration of the climatic characteristics of the NTS and surrounding area are an important component of the environmental assessment of the project's potential noise impacts. Refer to the detailed meteorological discussion in Sections 3.10 and 4.10 for more information.

3.3 Human Health and Safety

The policy of NNSA is to operate the NTS in a manner that protects the health and safety of employees and the public, preserves the quality of the environment, and prevents property damage. Environment, safety and health (ES&H) are priorities in the planning and execution of all work activities at NTS.

<u>Regulatory Requirements</u>

NTS policy requires compliance with applicable ES&H laws, regulations, and requirements; and with directives promulgated by the DOE regarding occupational safety and health. NNSA requires work at the NTS to be performed according to the safety and health requirements of OSHA as codified in 29 CFR 17 Parts 1910 and 1926. The DOE and NNSA directives provide requirements for worker safety and health programs.

NNSA has implemented an Integrated Safety Management System (ISMS) to "systematically integrate safety into management and work practices at all levels so that missions are accomplished while protecting the public, the worker, and the environment." The ISMS is a systematic approach to defining the scope of work; identifying, planning, and performing work that provides for early identification of hazards; and identifying associated control measures for hazard mitigation or elimination. The ISMS process also forms the basis for work authorization and provides for both internal and external assessment, through a continuous feedback and improvement loop, that identifies both failures and successes and incorporates lessons learned into subsequent activities. The health and safety of NTS workers is protected by adherence to the requirements of Federal and state law, DOE orders, and the plans and procedures of each organization performing work on the NTS. A program of self-assessment for compliance with these requirements is conducted by contractors and by NSO. In addition, workers are protected from the specific hazards associated with their jobs by training, monitoring the workplace environment, using appropriate personal protective equipment (PPE), and using administrative controls to limit their exposures to radioactive or chemical pollutants. Worker access to areas of the NTS with working conditions requiring special hazard control is restricted through the use of signs, barriers, and fences, as appropriate.

Health and Emergency Services

The DOE has a comprehensive Operational Emergency Base Program that provides the basic guidance for NTS safeguards and security procedures for DOE activities/projects. Prior to implementation of any activity, a comprehensive Site/Facility/Activity Operational Emergency Management Plan (OEMP) is prepared. At a minimum, each OEMP must comply with the following requirements:

- Establish an Operational Emergency Base Program that implements the requirements of applicable Federal, state, and local laws/regulations/ordinances for fundamental worker safety programs
- Prepare documentation to establish Emergency Planning Zones, Emergency Plans that document comprehensive emergency management programs, and Emergency Readiness Assurance Plans

- Designate an individual to be responsible for and administer emergency management functions for the organization
- Participate in the preparation of mutual assistance agreements with local, state, and Tribal authorities
- Ensure immediate mitigative and corrective emergency response actions and appropriate protective actions and protective action recommendations to minimize the consequences of the emergency, protect worker and public health and safety, provide security, and ensure the continuance of such actions until the emergency is terminated
- Integrate emergency public information planning with the development and maintenance of the Emergency Plan

Table 3.3-1 details the State of Nevada Emergency Management Directors/Coordinators that NSO would coordinate with regarding the OEMP.

Table 3.3-1
Emergency Management Offices

Office	Telephone / Facsimile Number
Clark County - Office of Emergency Management 500 S. Grand Central Pkwy. Las Vegas, Nevada 89155-1713	(702) 455-5710 Office (702) 455-5718 Fax
Las Vegas - Las Vegas Emergency Management 500 N. Casino Center Blvd. Las Vegas, Nevada 89101-2986	(702) 383-2888 Office (702) 229-0444 Fax
Nye County - Nye County Emergency Services 250 N. Hwy 16 Suite 7 Pahrump, Nevada 89060	(775) 764-9063 Office (775) 751-4280 Fax

Source: NV, 2006

Radiation

Some areas of the NTS were used for nuclear weapons testing, which created radioactive fallout that contaminated soils in the vicinity of the tests. The specific site of the proposed DIVINE STRAKE detonation, above the U16b tunnel, was not used for nuclear testing or other activities that would have introduced radioactivity into the soils potentially affected by the experiment. The U16b tunnel has been previously used for conventional explosives testing, but these experiments did not involve the use of nuclear explosives or radioactive materials. Following issuance of the January 30, 2006, FONSI, and authorization to proceed, the area where the proposed experiment would be conducted was excavated to prepare for emplacement of the explosives for the experiment. Thus, the ANFO emplacement would be in virgin rock that has not been exposed to previous testing activities at the NTS or to global fallout.

Aerial radiation surveys performed in 1992, 1994, and 2006, as well as ground-level radiation surveys performed in 2006 showed no detectable radiation above natural background levels in the vicinity of the proposed DIVINE STRAKE experiment site (see Appendix A). However, very low levels of radioactive fallout from past nuclear activities conducted by many countries are known to exist in surface soils throughout the world. This radioactivity exists at such low levels that it is not distinguishable from natural background radiation in the aerial and ground-level radiation surveys performed previously at the proposed experiment site. Consequently, in 2006, NSO and DTRA prepared and implemented an extensive sampling and analysis plan to obtain detailed information about the radionuclide characteristics of materials that could be potentially dispersed by the proposed DIVINE STRAKE experiment. The plan ensured a technically appropriate approach to data gathering and analysis based on standard methodologies incorporating U.S. EPA standards for soils sampling.

To increase characterization accuracy of the material potentially dispersed, samples were obtained from all three types of materials that might be dispersed, including the undisturbed surface material, subsurface rock, and disturbed material (a mixture of both surface and subsurface material). Figure 3.3-2 depicts the locations and numbers of samples taken. The data were analyzed in laboratories approved by the State of Nevada and accredited by the DOE. A complete validation of the analytical results was performed in accordance with U.S. EPA guidelines. The Site Characterization Report (Appendix B) sets forth the results of this investigation. Low but detectable levels of man-made radioactivity were detected primarily in undisturbed surface material. The radioactivity detected in these materials is less than the level that would require radiological posting or control under DOE regulations for occupational radiation protection for workers. No man-made radioactivity was identified in subsurface rock material. Additional details, including a historical summary of previous radiation surveys, are included in Appendix A.

Radiation Basics

What is radiation? Radiation is energy emitted from unstable (radioactive) atoms in the form of atomic particles or electromagnetic waves. This type of radiation is also known as ionizing radiation because it can produce charged particles (ions) in matter.

What is radioactivity? Radioactivity is produced by the process of unstable (radioactive) atoms trying to become stable. Radiation is emitted in the process. In the United States, radioactivity is measured in units of curies (Ci). Smaller fractions of the curie are the millicurie (1mCi = 1/1,000 Ci), the microcurie (1 µCi = 1/1,000,000 Ci), and the picocurie (1pCi = 1/1,000,000 µCi).

What is radioactive material? Radioactive material is any material containing unstable atoms that emits radiation.

What are the four basic types of ionizing radiation?

Alpha (α) – Alpha particles consist of two protons and two neutrons. They can travel only a few centimeters in air and can be stopped easily by a sheet of paper or by the skin's surface.

Beta (β) – Beta particles are smaller and lighter than alpha particles and have the mass of a single electron. A high-energy beta particle can travel a few meters in the air. Beta particles can pass through a sheet of paper, but may be stopped by a thin sheet of aluminum foil or glass.

Gamma (γ) – Gamma rays (and x-rays), unlike alpha or beta particles, are waves of pure energy. Gamma radiation is very penetrating and can travel several hundred feet in air. Gamma radiation requires a thick wall of concrete, lead, or steel to stop it.

Neutrons (n) – A neutron is an atomic particle that has about one-quarter the weight of an alpha particle. Like gamma radiation, it can easily travel several hundred feet in air. Neutron radiation is most effectively stopped by materials with high hydrogen content, such as water or plastic.

What are the sources of radiation?

Natural sources of radiation – (1) Cosmic radiation from the sun and outer space; (2) natural radioactive elements in the earth's crust; (3) natural radioactive elements in the human body; and (4) radon gas from the radioactive decay of uranium naturally present in the soil.

Man-made sources of radiation – Medical radiation (x-rays, medical isotopes), consumer products (TVs, luminous dial watches, smoke detectors), nuclear technology (nuclear power plants, industrial x-ray machines), and fallout from past worldwide nuclear weapons tests or accidents (Chernobyl).

What is radiation dose? Radiation dose is the amount of energy of ionizing radiation absorbed per unit mass of any material. For people, radiation dose is the amount of energy absorbed in human tissue. In the United States, radiation dose is measured in units of rad or rem. Smaller fractions of the rem are the millirem (1mrem = 1/1,000 rem) and the microrem (1µrem = 1/1,000,000 rem).

Average Annual Radiation Dose from Natural and Manmade Sources

Globally, humans are exposed constantly to radiation from the solar system and the Earth's rocks and soil. This radiation contributes to the natural background radiation that always surrounds us. Manmade sources of radiation also exist, including medical and dental x-rays, household smoke detectors, and materials released from nuclear and coal-fired power plants. The attached table shows average annual radiation in the United States.

Source	**Average Annual Dose (mrem)**
Cosmic radiation (from outer space)	
If your home is located at sea level your cosmic radiation dose is:	26
If you live above sea level your dose must be adjusted by the addition of the following amounts:	
Elevation up to 1,000 ft	2
Elevation 1,000 to 2,000 ft	5
Elevation 2,000 to 3,000 ft	9
Elevation 3,000 to 4,000 ft	15
Elevation 4,000 to 5,000 ft	21
Elevation 5,000 to 6,000 ft	29
Elevation 6,000 to 7,000 ft	40
Elevation 7,000 to 8,000 ft	53
Elevation above 8,000 ft	70
Terrestrial radiation (from the ground):	
Terrestrial radiation varies by location, if you live in the Gulf States or Atlantic Coast regions, you would receive terrestrial radiation of:	23
Colorado plateau	90
Elsewhere in the United States	46
Internal radiation (in your body)	
From food and water (e.g., potassium)	40
From air (radon)	200
Plutonium-powered pacemaker	100
Porcelain crowns or false teeth	0.07
Travel related sources	
For each 1000 miles traveled by jet:	1
Miscellaneous sources	
Nuclear weapons test fallout (global)	1
Brick, stone, or concrete home construction	7
Luminous wrist watch	0.06
Watching television	1
Computer use	0.1
Home smoke detector	0.08
Each medical X-ray	40
Each nuclear medicine procedure	14
Living within 50 miles of a nuclear power plant	0.009
Living within 50 miles of a coal fired power plant	0.03

Note: The amount of radiation exposure is usually expressed in millirem (mrem). In the United States, the average person is exposed to an effective dose equivalent of approximately 360 mrem (whole-body exposure) per year from all sources (NCRP Report No. 93).] These doses are based on the American Nuclear Society's brochure, "Personal Radiation Dose Chart". The primary sources of information are the National Council on Radiation Protection and Measurements Reports #92-#95, and #100. Values in the table are general averages and do not provide data for precise individual dose calculations.

Source: U.S. EPA website at http://www.epa.gov/radiation/students/calculate.html

The closest area where prior nuclear testing occurred is U16a, which is 1.1 miles to the southwest. Testing at U16a occurred 2,000 feet underground. After nuclear testing was completed, a plug was emplaced to close the tunnel. There is no interconnection between U16a and U16b. The DIVINE STRAKE blast crater is predicted to have a 98-foot radius (30-m), well short of the 1.1 mile distance to U16a.

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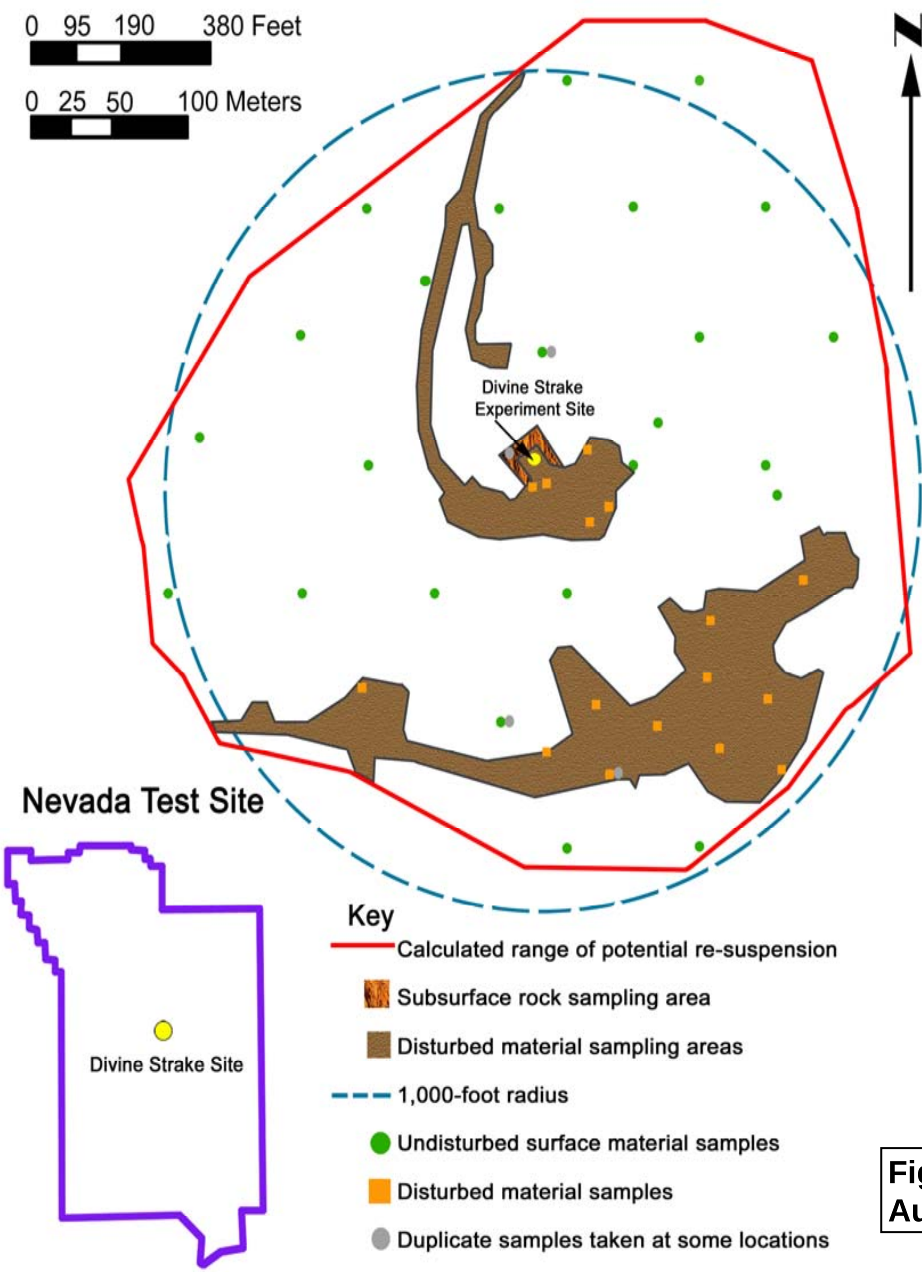
Divine Strake Experiment: Areas Sampled in August 2006



<u>Sampling Protocol</u>

Sampling plan incorporates U.S. Environmental Protection Agency standards for surface soil sampling. There were 56 soil samples collected and analyzed. To increase accuracy, samples of three types of materials were collected.

26 Samples

<u>Undisturbed Surface Material</u>

Surface material exposed to atmospheric fallout that may be dispersed by the proposed experiment.

19 Samples

<u>Subsurface Rock</u>

Subsurface material not exposed to atmospheric fallout that may be dispersed by the proposed experiment

11 Samples

<u>Disturbed Material</u>

Excavated materials containing a mixture of surface and subsurface materials that may be dispersed by the proposed experiment.

Figure 3.2-2 Divine Strake Experiment: Areas Sampled in August 2006

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3.4 Waste Management

This section describes management of hazardous materials and disposal of Resource Conservation and Recovery Act (RCRA) waste at the NTS. The section addresses the waste management activities and capabilities related to the proposed DIVINE STRAKE detonation. The NTS manages the following types of waste: transuranic, low-level radioactive, mixed (both radioactive and hazardous), hazardous, sanitary solid, and medical. The remainder of the section discusses the management and disposal of hazardous or potentially hazardous waste, non-hazardous solid waste, sanitary waste, hydrocarbon waste, wastewater, and the management of hazardous materials.

Hazardous Waste Management

The NTS stores hazardous waste on-site prior to shipping it to a permitted commercial facility for treatment or disposal. The NTS received its RCRA permit for storage in 1995 and renewed it in 2000. The NTS is also permitted to treat certain explosive hazardous wastes as discussed below.

The RCRA Part B permit (NEV HW021) issued by the Nevada Department of Environmental Protection (NDEP) to the NSO allows NSO to conduct waste management activities at the NTS. All non-radioactive hazardous wastes (HW) are presently transported off-site to approved RCRA HW treatment, storage, and disposal facilities.

The RCRA Part B Permit includes the operation of the Hazardous Waste Storage Unit (HWSU) in Area 5. The permit allows NSO to store non-radioactive HW in containers on a pad designed for the safe storage of wastes that have been generated at the NTS. The HWSU consists of a prefabricated, rigid steel framed, roofed shelter that is permitted to store a maximum of 16,280 gallons (61,600 liters) of approved waste at a time.

The Part B permit also covers operations at the Explosive Ordnance Disposal Unit (EODU) in Area 11. The permit allows NSO to treat explosive ordnance wastes, which are HW as defined under 40 CFR (Sections 261.21, 261.23, 261.24, and 261.33), by open detonation in a specially constructed and managed area designed for the safe and effective treatment of explosive HW. The permit allows a maximum of 45.4 kg (100 lbs) of approved waste to be detonated at a time, not to exceed one detonation event per hour.

Wastes, including unexploded ordnance (UXO) and HW, are addressed in detail in the Part B permit and may be transported, stored, or disposed of in accordance with the permit conditions. Any HW remaining would be handled in accordance with the HW management plan prepared in conjunction with and reviewed by the NDEP.

The current policy for handling HW generated from activities conducted on NTS is in accordance with the Part B permit. HW is analyzed for waste class determination as required. As stated previously, all non-UXO HW generated is either shipped off-site for disposal in accordance with all applicable state and Federal requirements or sent to the HWSU in Area 5 for temporary storage prior to shipment off-site for disposal.

Non-Hazardous Solid and Sanitary Solid Wastes

NTS has three landfills permitted for the disposal of solid and sanitary waste (non-hazardous). The Hydrocarbon Disposal Site in Area 6 and the U10c Disposal Site in Area 9 are permitted as Class III (industrial solid waste) landfills. Hydrocarbon-contaminated materials are disposed of in the Area 6 landfill, and inert debris (such as construction and demolition debris) is disposed of in the Area 9 landfill. The third landfill is a Class II (municipal solid waste) landfill in Area 23 that receives sanitary solid and regulated asbestos waste. As stated in the *Supplement Analysis for the Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE, 2002a), NSO concluded that the projected waste volumes through 2011 would consume roughly 12, 14, and 16 percent of the available waste disposal capacity of the Area 6, 9 and 23 landfills, respectively.

Hydrocarbon Wastes

If generated, hydrocarbon wastes may be disposed of in Area 6 in accordance with the Area 6 Hydrocarbon Disposal Site permit requirements (SW 13 097 02).

Wastewater

Wastewater at the NTS is disposed of either in one of 16 septic systems located throughout the site or in one of two sewage lagoon systems located in Areas 23 and 6. The septic systems, which receive sanitary sewage only, have capacities of 750 to 5,000 gallons per day (2,839 liters to 18,927 liters). The average daily flow to the lagoons, which receive sanitary sewage and industrial wastewater, is less than 40,000 gallons per day (151,416 liters). Sludge removed from the systems is disposed of in the Area 23 sanitary landfill or the Area 6 Hydrocarbon

Disposal Site, depending on hydrocarbon content. Portable sanitary units are provided for use in areas not serviced by a permanent wastewater system, including the proposed DIVINE STRAKE site.

Hazardous Material Control and Management

Hazardous materials used or stored at the NTS are inventoried through the use of a Hazardous Substance Inventory (HSI) database. All NSO contractors and subcontractors who use or store hazardous materials use this database and are required to comply with the operational and reporting requirements of the Toxic Substances Control Act (TSCA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); the Emergency Planning and Community Right-to-Know Act (EPCRA); and the Nevada Chemical Catastrophe Act. In response to the EPCRA requirements, all chemicals that are purchased are entered into the HSI database and assigned hazard classifications (e.g., corrosive liquid, flammable, oxidizer, water reactive). Ammonium Nitrate is not a reportable substance for the Toxic Release Inventory Report. It does, however, have to be reported on the Nevada Combined Agency Report. It would be combined with the weight of ammonium nitrate contained in other substances on the NTS, and total weight would be reported under the hazard classifications listed above.

The NTS uses the HAZTRAK tracking system to monitor hazardous materials while in transit. When a truck transporting hazardous material enters the NTS, all information concerning the load is entered into the tracking system. Once the delivery is complete, the information provided at the time of entry is removed from the tracking system. If extremely hazardous substances are stored in quantities that exceed threshold quantities established by the NDEP, then NSO would submit a report notifying the state.

Hazardous materials are stored at the NTS facility in accordance with the permit issued by the State of Nevada Fire Marshall. These materials include high explosives, chemical materials, construction products and petroleum, oil, and lubricant products. Table 3.4-1 illustrates Waste Management Facility Capacities for NTS.

Table 3.4-1
Waste Management Facility Capacities for NTS[a]

Waste type	*Total Capacity*	*Projection (through 2011)*	*Capacity Used (%)*
Low-level	1,000,000	520,000	14
Mixed	20,000	20,000	31
Transuranic (storage)	Not available	990	b
Hazardous (temporary storage on-site or Area 5 prior to disposal)	61.6	650	c
Explosive hazardous (EODU treatment)	45.4 kg/hr	1,500 kg	N/A
Hydrocarbon (Area 6 landfill)	92,000	11,000	12
Non-hazardous/ construction debris (Area 9 U10c landfill)	660,000	93,000	14
Sanitary solid (Area 23 landfill)	210,000	35,000	16

Source: 2002 NTS Supplement Analysis (DOE, 2002a).
a Quantities given in cubic meters, unless otherwise noted.
b Storage capacity dependent on the size of containers and storage configurations.
c The RCRA permit limits storage to 61.6 cubic meters at any one time. Hazardous waste is shipped to an off-site permitted facility for treatment/disposal, as needed.
N/A – Not applicable

3.5 Infrastructure

Infrastructure at the NTS consists of transportation (roads, railroads, and airports) and utilities. This section discusses the existing infrastructure of Area 16 of the NTS. There are roads in Area 16, but there is no rail access.

Water Supply and Distribution

Groundwater is the only local source of potable water on the NTS. Drinking water at the NTS is provided by 10 potable water wells (DOE, 2006a). For remote areas not connected to an NTS drinking water system, water is transported to the area by permitted water haul trucks or supplied as bottled water

Area 16 does contain an active potable water well identified as UE-16D, located at the northern boundary of Area 16. This well, along with all potable water wells on the NTS, is regularly monitored and is in compliance with applicable health and safety standards

Wastewater Treatment and Disposal

There are no National Pollutant Discharge Elimination System (NPDES) permits for the NTS, as there are no wastewater discharges to naturally occurring on-site or off-site surface waters. Domestic sewage and industrial wastewater are discharged to permitted sewage lagoons. The lagoons are lined to prevent infiltration to the groundwater. Discharges of wastewater are regulated by Nevada under the Nevada Water Pollution Control Law.

The former Area 16 Camp, which was dismantled between 1960 and 1972, consisted of a trailer park with a septic system. This septic system consisted of underground sewers, a distribution box, three septic tanks, a drainage channel, and a sump excavation (DOE, 2005b).

Energy Supply and Distribution

NSO purchases electric power for the NTS under tariff from Nevada Power Company and also through an allocation from the Western Area Power Administration. Fuels used at the NTS consist of unleaded gasoline, JP-8 aviation fuel, propane, and diesel fuels (DOE, 2004a).

Telecommunications

The proposed site currently has surface laid telephone cable lines that would be connected in support of DIVINE STRAKE.

Roadways and Traffic

The NTS currently contains approximately 400 miles (644 km) of paved roads and 300 miles (482 km) of unpaved roads (DOE, 1996). The main roads in Area 16, the proposed location for DIVINE STRAKE, include Buckboard Mesa Road, Mine Mountain Road, Mid Valley Road, and Pahute Mesa Road. The Pahute Mesa Road, which passes from Area 17 to Area 1 in the northern portion of Area 16, is the only paved road in the vicinity of the Proposed Action site.

3.6 Topography and Physiographic Setting

The NTS is located within the Basin and Range Physiographic Province on approximately 1,375 square miles (880,000 acres) in southern Nye County, Nevada, in a transition area between the Mojave Desert and the Great Basin. The topography of the site consists of a series of north-south oriented mountain ranges separated by broad, low-lying valleys and flats (DOE, 1996). Area 16 is located in the middle of the NTS.

The relief of the NTS ranges from less than 3,280 feet (1,000 m) above sea level in Frenchman Flat and Jackass Flats to about 7,675 feet (2,339 m) on Rainier Mesa and about 7,216 feet (2,199 m) on Pahute Mesa. Area 16 is located on the Topopah Spring USGS 7.5 minute topographic map. Ground-level elevations range from 5,600 to 6,600 feet (1,707 to 2,011 m), but are generally above 6,000 feet (1,829 m) (DOE, 2004b). Tippipah Point, above the old Area 16 tunnels, has an elevation of 6,612 feet (2,105 m) (DOE, 2004b). The Proposed Action site is located at approximately 5,200 feet (1,585 m).

Practically all precipitation that falls in the area is returned to the atmosphere by evaporation, either directly from the soil or from the lakes and playas that occupy the lowest points within the basins and that are discharge areas for the alluvial aquifers. It is a closed drainage basin. No surface waters are located within the area of the Proposed Action.

3.7 Geology and Soils

Geology

The geology of the NTS region is characterized by a thick section (more than 34,768 feet [10,597 m]) of Paleozoic and older sedimentary rocks, local Cretaceous granitic intrusive blocks, Miocene-age volcanic rock assemblages, and locally thick deposits of post-volcanic alluvial deposits filling present-day valleys (DOE, 1996). The region, part of the Great Basin portion of the Basin and Range Province, has experienced a complex tectonic history involving a combination of compressional and extensional (stretching) crustal deformation resulting in a series of regional thrust faults, folds, normal faults, and strike-slip faults and interfault alluvium-filled basins (Stewart, 1980; DOE, 1996). A detailed discussion of regional geology is located in the NTS EIS (DOE, 1996) and the Supplement Analysis (DOE, 2002a). For the purposes of this EA, this section will focus on-site-specific geology and soils.

Geologic units exposed at the ground surface across the NTS consist of approximately 40 percent alluvium-filled basins and valleys, 20 percent Paleozoic and uppermost Precambrian sedimentary rocks, and the remainder comprised of Tertiary-age volcanic rocks and a few Mesozoic-age intrusive masses (DOE, 2004b). A generalized geologic map of the NTS and surrounding area, showing the approximate location of the proposed DIVINE STRAKE detonation site, is provided in Figure 3.7-1.

Rock units underlying NTS Area 16 include Tertiary-age volcanic rocks exposed in the northeastern flank of Shoshone Mountain, and Paleozoic carbonate and clastic rocks exposed along Syncline Ridge in the central and northeastern portions of NTS Area 16 northeast of Shoshone Mountain (Laczniak et al. 1996; Thomas et al. 1996; Wilson 2001; DOE 2004b).

Paleozoic rock units crop out in the Syncline Ridge area, which is a syncline extending northeastward from Shoshone Mountain in NTS Area 16 into western Yucca Flat. These rocks include the Permian-Pennsylvanian-age Tippipah Limestone (Sawyer et al., 1995; Laczniak et al., 1996; DOE, 2004b, Slate et al., 1999) that is the host rock unit for the U16b Tunnel Complex and the proposed detonation cavity.

Structural Features

Various structural features occur within the NTS region that exert control on the geometric configuration of the area and affect geologic, as well as hydrogeologic conditions within the region. Major structural features in the region include Faults (normal, thrust, transverse, and detachment faults) and Calderas/caldera complexes.

A detailed discussion of these structural features is located in the NTS EIS (DOE, 1996) and the Supplement Analysis (DOE, 2002a).

Seismicity

Regional seismicity is discussed in detail in the NTS EIS (DOE, 1996) and Supplement Analysis (DOE, 2002a). Site-specific seismicity is discussed here. The NTS is located within Seismic Zone 2B, as defined in the Uniform Building Code. Zone 2B is defined as an area having moderate damage potential resulting from seismic events (DOE, 1996).

Northern Nevada Test Site

The Timber Mountain caldera, Pahute Mesa, Rainier Mesa, and Yucca Flat areas of the northern region of the NTS have been the focus of considerable earthquake activity, which is considered by some investigators to be either a direct or indirect result of prior nuclear testing in this area (EBF, 1999). However, Vortman (1991) determined that the relative number of artificial and induced earthquakes in these testing areas suggests that the natural seismicity of the region reflects the background activity generally found in the southern Basin and Range province. In 1979 and 1983, swarms of microearthquakes occurred in the region, which appear to be unrelated to underground nuclear explosions.

Southern Nevada Test Site

The southern portion of the NTS is relatively seismically active compared to some other areas in the southern Great Basin (EBF, 1999). Most of the seismicity that has been exhibited across the southern portion of the NTS is concentrated within and adjacent to the Rock Valley, Mine

Mountain, and Cane Springs fault zones. Small earthquakes occurred at or near the Cane Spring Fault and Rock Valley Fault Zones, although no surface displacement was associated with either of these earthquakes (DOE, 1996). A magnitude 5.2 earthquake occurred in 1992 near Little Skull Mountain in the southwest part of the NTS that was associated with another fault present near Little Skull Mountain (DOE, 1996). This seismicity did not occur in areas of underground nuclear testing, and is not considered to be nuclear testing-induced (EBF, 1999). A magnitude 4.4 earthquake occurred on June 14, 2002, approximately 7.8 mi (12.5 km) southwest of the peak of Little Skull Mountain, slightly west of the location of the 1992 Little Skull Mountain earthquake (Nevada Seismological Laboratory, 2002).

The 1992 Little Skull Mountain earthquake was the first to cause significant damage to structural facilities on the NTS, including damage to a two-story concrete-block structure located in NTS Area 25. However, this facility was constructed prior to the promulgation of more stringent building codes presently adhered to on the NTS (DOE, 1996). The 2002 Little Skull Mountain earthquake was reported as being felt by residents in Amargosa Valley and in the Beatty and Las Vegas areas, however, no significant damage to structures was noted (Las Vegas Review Journal, 2002).

Soils

Soils present in the proposed DIVINE STRAKE site, immediately around the proposed U16b tunnel, are limited to locally occurring colluvium derived from limestone and micrite rock units exposed in the hillside that is the site of the U16b Tunnel Complex (Metcalf et al., 1999). Existing prime farmlands are located in Amargosa Desert and limited areas of potentially arable soil types exist at lower elevations in Yucca Flat. Both areas are outside the region of influence. The proposed DIVINE STRAKE detonation area, consisting of the NTS Tunnel U16b Complex and surrounding hilly terrain, has experienced some minor surface disturbance as a result of previous tunnel excavation activities.

The specific site of the proposed DIVINE STRAKE detonation above the U16b tunnel was not used for nuclear testing or other activities that would have introduced radioactivity into the soils potentially affected by the experiment. The U16b tunnel has been previously used for conventional explosives testing, but these experiments have not involved the use of nuclear explosives or radioactive materials. The ANFO emplacement would be in virgin rock that has not been exposed to previous testing activities at the NTS or to global fallout.

Aerial radiation surveys performed in 1992, 1994, and 2006, as well as ground-level radiation surveys performed in 2006 showed no detectable radiation above natural background levels in the vicinity of the proposed DIVINE STRAKE experiment site (see Appendix A). However, very low levels of radioactive fallout from past nuclear activities conducted by many countries are known to exist in surface soils throughout the world. This radioactivity exists at such low levels that it is not distinguishable from natural background radiation in the aerial and ground-level radiation surveys performed previously at the proposed experiment site. Consequently, in 2006, NSO and DTRA prepared and implemented an extensive sampling and analysis plan to obtain detailed information about the radionuclide characteristics of materials that could be potentially dispersed by the proposed DIVINE STRAKE experiment. The plan ensured a technically appropriate approach to data gathering and analysis based on standard methodologies incorporating U.S. EPA standards for soils sampling.

To increase characterization accuracy of the material potentially dispersed, samples were obtained from all three types of materials that might be dispersed, including the undisturbed surface material, subsurface rock, and disturbed material (a mixture of both surface and subsurface material) (Figure 3.3-2). The data were analyzed in laboratories approved by the State of Nevada and accredited by the DOE. A complete validation of the analytical results was performed in accordance with U.S. EPA guidelines. The Site Characterization Report (Appendix B) sets forth the results of this investigation. Low but detectable levels of man-made radioactivity were detected primarily in undisturbed surface material. The radioactivity detected in these materials is less than the level that would require radiological posting or control under DOE regulations for occupational radiation protection for workers. No man-made radioactivity was identified in subsurface rock material. Additional details, including a historical summary of previous radiation surveys, are included in Appendix A.

Man-made radioactivity is also known to be present in the vicinity of the U16a muckpile, approximately one mile from the U16b experiment site. The distance of the muckpile from the site of the experiment makes it extremely unlikely that any man-made radioactivity from the U16a muckpile would be lofted into the atmosphere as a result of the detonation. Additional details are included in Section 4.3 and Appendix A.

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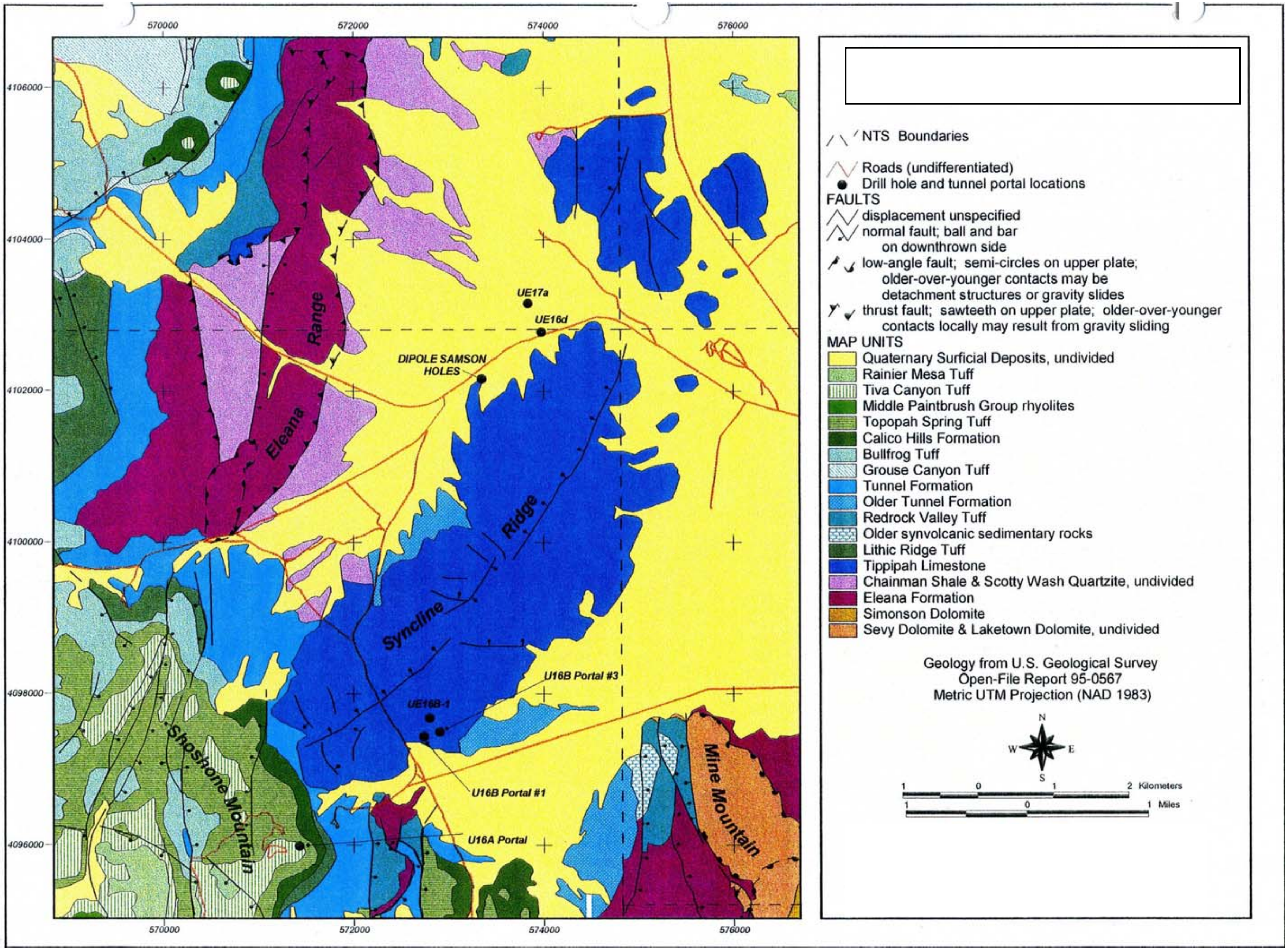

Figure 3-7.1
Generalized Geologic Map of Proposed DIVINE STRAKE Site and Surrounding Areas

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3.8 Surface Water and Groundwater

The NTS is located within the Great Basin, which is a closed hydrographic basin that covers much of Nevada (DOE, 1996). There are no perennial streams or naturally occurring surface water bodies at the NTS. Precipitation at the NTS is low as described in Section 3.10. Much of the runoff from snowmelt and precipitation quickly infiltrates rock fractures or surface soils, or is lost by evapotranspiration. Some runoff flows down alluvial fans in arroyos, or drains into playas where it may stay for weeks as an ephemeral lake (DOE, 2004b). In the southern part of the NTS, which includes Area 16, runoff flows towards the Amargosa Desert (DOE, 2004b). There are a number of springs on the NTS, but flow from the springs travels only a short distance before evaporating or infiltrating into the ground (DOE, 1996). The closest known spring, Tippipah Spring, is located approximately 2 miles (3.2 km) from U16b, the proposed DIVINE STRAKE detonation site. The spring has been used by humans at least since the late 1800's. The area around the spring was heavily disturbed by past use and currently is represented by an adit approximately 29 feet (9 m) in length with a pool within the adit. A narrow outflow channel extends for 558 feet (170 m) from the adit with flow varying from 33 to 131 feet (10 to 40 m) down gradient depending on season and drought conditions. The rate of flow for this spring, measured at mid-channel, was estimated to be is less than 1 gallon per minute (Hansen et al. 1997).

Groundwater beneath the NTS exists in three subbasins of the Death Valley Basin flow system. The depth to groundwater varies from about 260 feet (79 m) below the land surface in the extreme northwest part of the site, and about 525 feet (160 m) below land surface in Frenchman and Yucca Flats, to more than 2,000 feet (610 m) under upland portions of Pahute Mesa (DOE, 2004a). The depth to groundwater at nearby water well UE-16d is 761 feet (232 m) (Baugh, 2006a). The elevation of UE-16d is 4,684 feet above sea level (msl). Since the elevation of DIVINE STRAKE is about 5,200 feet msl, it is anticipated that the depth to groundwater beneath the proposed experiment site is about 1,200 feet.

Groundwater flows generally south and southwest with flow rates that are quite variable, ranging from 7 to 660 feet per year (2.1 to 201 m) (DOE, 1996). Groundwater is the only local source of potable water on the NTS. Drinking water at the NTS is provided by potable water wells. For remote areas not connected to an NTS drinking water system, water is transported to the area by permitted water haul trucks or supplied as bottled water (DOE, 2003b).

3.9 Atmospheric Resources

Air quality in a given location is described as the concentration of various pollutants in the atmosphere. Air quality is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions. This section describes existing air quality conditions at the NTS and Area 16.

Applicable Air Quality Regulations

National Ambient Air Quality Standards

The U.S. EPA has established National Ambient Air Quality Standards (NAAQS) for six principal air pollutants (also called the criteria pollutants): carbon monoxide, lead, nitrogen oxides (NO_X), particulate matter (PM-10), ozone and sulfur oxides (SO_X). The U.S. EPA sets primary and secondary standards designed to protect the public health and welfare. The Nevada Ambient Air Quality Standards (AAQS) may further regulate concentrations of the criteria pollutants and are similar to the Federal standards with the addition of hydrogen sulfide. The applicable NAAQS and Nevada AAQS are presented in Table 3.9-1.

Areas that experience ambient air levels of one or more of these criteria pollutants above the NAAQS are deemed to be in “nonattainment” and Regional Air Quality Conformity rules must be evaluated for new projects within the area. The U.S. EPA designates an area as being in attainment for a pollutant if ambient concentrations of that pollutant are below the NAAQS. In areas where insufficient data are available to determine attainment status, designations are listed as unclassified. Unclassified areas are treated as attainment areas for regulatory purposes.

National Emission Standards for Hazardous Air Pollutants

Under Title III of the Clean Air Act (CAA), the National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR Part 61) were established to control those pollutants that might reasonably be anticipated to result in either an increase in mortality or an increase in serious irreversible or incapacitating but reversible illness. The U.S. EPA regulates a list of 189 hazardous air pollutants (HAPs) under the CAA. Industry-wide national emissions standards are developed for 22 of the 189 designated HAPs. The State of Nevada also regulates HAPs (NAC 445B.221) and has adopted the Federal list of HAPs found in 42 U.S.C. § 7412(b). NESHAP compliance activities at the NTS are limited to radionuclide monitoring and reporting

(BN, 2006a). HAPs emissions for which there are no Federal standards (i.e., the remaining 167 HAPs) are also regulated at the NTS through the NTS Air Quality Operating Permit (AQOP).

To protect the public from harmful levels of man-made radiation, NESHAP regulations (40 CFR 61 Subpart H, National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities) limit the release of radioactivity from DOE facilities to 10 mrem per year effective dose equivalent to any member of the public within a 50-mile (80-km) radius of a DOE facility The U.S. EPA requires DOE facilities to demonstrate compliance with the NESHAP dose limit by annually estimating the dose from DOE activities to a hypothetical member of the public, referred to as the maximally exposed individual (MEI), or the member of the public who resides within a 50-mile (80-km) radius of the facility who would experience the highest annual dose.

Table 3.9-1
Ambient Air Quality Standards

Pollutant	Averaging Time	Nevada Standards Concentration	National Primary Standards	National Secondary Standards
Ozone	1 hour	0.12 ppm (235 µg/m3)	0.12 ppm (235 µg/m3)	Same as primary
Ozone Lake Tahoe Basin, #90	1 hour	0.10 ppm (195 µg/m3)	--	--
Carbon monoxide less than 5,000 ft above mean sea level	8 hours	9 ppm (10,500 µg/m3)	9 ppm (10 mg/m3)	None
Carbon monoxide at or greater than 5,000 ft above mean sea level		6 ppm (7,000 µg/m3)		
Carbon monoxide at any elevation	1 hour	35 ppm (40,500 µg/m3)	35 ppm (40 mg/m3)	
Nitrogen dioxide	Annual arithmetic mean	0.053 ppm (100 µg/m3)	0.053 ppm (100 µg/m3)	Same as primary
Sulfur dioxide	Annual arithmetic mean	0.030 ppm (80 µg/m3)	0.030 ppm	None
	24 hours	0.14 ppm (365 µg/m3)	0.14 ppm	
	3 hours	0.5 ppm (1,300 µg/m3)	None	0.5 ppm
Particulate matter as PM-10	Annual arithmetic mean	50 µg/m3	50 µg/m3	Same as primary
	24 hours	150 µg/m3	150 µg/m3	
Lead (Pb)	Quarterly arithmetic mean	1.5 µg/m3	1.5 µg/m3	Same as primary
Hydrogen sulfide	1 hour	0.08 ppm (112 µg/m3)[D]	--	--

Source: Nevada Administrative Code.
µg/m3 – micrograms per cubic meter
ppm – parts per million
mg/m3 – milligrams per cubic meter

Existing Air Quality Conditions

NAAQS

The NTS is located in the Nevada Intrastate Air Quality Control Region 147. The region has been designated as attainment with respect to the NAAQS for all six criteria air pollutants (40 CFR Part 81.329). Title V of the CAA authorizes states to implement permit programs in order to regulate emissions of the criteria pollutants and HAPs. For Nevada, the Bureau of Air Pollution Control (BAPC) has primacy over Nye County and oversees releases of all regulated pollutants currently covered under the NTS AQOP. At the NTS there is one main AQOP (AP9711-0549.01) that regulates operations and emissions from dust and large-scale explosives activities, aggregate-producing facilities, fuel-burning equipment, and fuel storage. This permit expires on June 25, 2009. The DIVINE STRAKE experiment is not specifically included in the NTS AQOP as a permitted facility or activity.

Because it was not specifically addressed in the NTS AQOP, NSO initiated coordination with the Nevada Bureau of Air Pollution Control (BAPC) regarding DIVINE STRAKE in March 2005. BAPC responded to NSO that a permit modification would not be required to conduct the DIVINE STRAKE detonation provided the emissions from the experiment are within permitted levels. BAPC required NSO to conduct modeling to demonstrate compliance with the emission limits in the NTS AQOP. NSO conducted the required air dispersion modeling and provided the results to BAPC in April and May 2006, and provided additional data in December 2006.

Ambient air quality monitoring is currently conducted at the NTS for particulate matter, a non-radiological criteria pollutant, during Big Explosives Experimental Facility and Non-proliferation Test and Evaluation Center experiments. Elevated levels of criteria pollutants at the NTS may occasionally occur because of construction, aggregate production, surface disturbances, and fugitive dust from vehicles traveling on unpaved roads; various pollutants from fuel-burning equipment, incineration, and open burning; and volatile organics from fuel storage facilities (DOE, 1996). Emissions of HAPs and criteria pollutants from current NTS sources are below regulatory requirements (BN, 2006a).

NESHAP – RADIONUCLIDE EMISSIONS (40 CFR Part 61 Subpart H)

Ambient air quality monitoring is currently conducted at the NTS for radiological HAPs. Sources of radioactive emissions on the NTS include: evaporation of tritiated water (HTO) from containment ponds; diffusion of HTO vapor from the soil (at Area 5 Radioactive Waste

Management Complex, Sedan crater, and Schooner crater); tritium gas released during experiment calibrations at Building CP-50 in Area 6; and re-suspension of plutonium and americium from contaminated soil at locations where nuclear safety devices and nuclear weapons were tested. No atmospheric nuclear tests have ever occurred in Area 16.

For NESHAP data reported for 2005 (BN, 2006a), as in all previous years that the NESHAP report was produced, the estimated annual dose to the public from radiological emissions from current and past NTS activities is well below the 10 mrem/yr dose limit (40 CFR 61.92). This was demonstrated by air sampling data collected on-site at each of six U.S. EPA-approved “critical receptor” stations on the NTS. The sum of measured estimated dose equivalents from the four stations at the NTS boundaries is 2.5 mrem/yr. This dose is 25 percent of the allowed NESHAP dose limit. Because the nearest member of the public resides approximately 12 miles (20 km) from the NTS boundary, this individual would receive only a small fraction of the 2.5 mrem/yr.

In addition to the routine radiological monitoring at the site, NSO has for the past 25 years sponsored a network of community monitoring stations. Originally operated by the U.S. EPA and currently by Desert Research Institute, the Community Environmental Monitoring Program (CEMP) is a network of 29 stations located in communities in Nevada, Utah, and California. Each station includes a particulate sampler to collect for analysis particles that may be radioactive, a thermoluminescent dosimeter for determining ambient or “natural background” radiation, a microbarograph for recording atmospheric barometric pressure, and weather instruments. Results of CEMP monitoring have conclusively demonstrated that natural background radiation is predominant in the area surrounding the NTS.

3.10 Meteorology

The NTS is located in the extreme southwestern corner of the Great Basin. The climate is arid with limited precipitation, low humidity, large daily temperature ranges, and intense solar radiation during the summer months (DOE, 2004b).

Meteorological Monitoring

The Air Resources Laboratory, Special Operations and Research Division (ARL/SORD), collects meteorological and climatological data on the NTS. Data are collected through the

Meteorological Data Acquisition (MEDA) system, a network of approximately 30 mobile meteorological towers located primarily on the NTS. Locations of the MEDA stations as of the date of this document are shown in Figure 3.10-1.

Currently, there are two MEDA stations in Area 16. Wind direction and speed are measured at the 10-m level. Ambient temperature, relative humidity, and atmospheric pressure measurements are taken at approximately the 6.5-foot (2-m) level to be within the surface boundary layer. The observations are collected and transmitted every 15 minutes. Wind data are 5-minute averages of speed and direction. The peak wind speed is the fastest instantaneous gust measured within the 15-minute time interval. Temperature, relative humidity, and pressure are instantaneous measurements. Wind data from the MEDA stations are used each year to calculate radiological doses from NTS air emissions to members of the public residing near the NTS. Wind speed and direction data have been collected for all the MEDA stations on the NTS (DOE, 2004b).

NTS Area Climate

Precipitation

Two fundamental physical processes drive precipitation events on the NTS: those resulting from cool-season, mid-tropospheric cyclones and those resulting from summertime convection. Cool-season precipitation is usually light and can consist of rain or snow. Summer is thunderstorm season. Precipitation from thunderstorms is usually light; however, some storms are associated with very heavy rain, flash floods, intense cloud-to-ground lightning, and strong surface winds. Thunderstorms generally occur in July and August when moist tropical air can flow northward from the southeastern North Pacific Ocean and spread over the desert southwest. This seasonal event is referred to as the southwestern monsoon. Mean annual precipitation totals on the NTS range from nearly 13 inches (.33 m) over the high terrain in the northwestern part of the NTS to less than 5 inches (12.7 cm) in Frenchman Flat. However, inter-annual variations can be great (DOE, 2004b). For example, 9.67 (24.5 cm) inches fell in Frenchman Flat in 1998 and only 1.14 (2.9 cm) inches fell in 1989.

Precipitation also varies with terrain elevation. On average, annually, only 4.8 inches (12.2 cm) of precipitation are measured at Well 5B in Area 5, elevation 3,080 feet (939 m), while an annual average of 12.82 (32.6 cm) inches occurs on Rainier Mesa, elevation 7490 feet (2,283 m) (NOAA/ARL, 2006). Annual totals of less than 1.0 inch (2.5 cm) have occurred over the lower elevations of the NTS. Daily precipitation totals can also be large and can range from 2.0 to over 3.5 inches (5 to 8.9 cm). A storm-total precipitation amount of 3.5 inches (8.9 cm) is a 100-year, 24-hour, extreme precipitation event. Two- to three-inch (5 to 7.6 cm) daily totals have been measured at several sites on the NTS. Snow can fall on the NTS anytime between October and May. Maximum daily totals of 15 to 20 inches (38 to 50 cm) of snow or more can occur on Pahute and Rainier Mesas. Hail, sleet, freezing rain, and fog are rare on the NTS. Hail and sleet can cover the ground briefly following intense thunderstorms (DOE, 2004b).

Temperature

As is typical of an arid climate; the NTS experiences large daily, as well as annual, ranges in temperature. Moreover, temperatures vary with elevation. Sites 5,000 feet (1,524 m) above mean sea level can be quite cold in the winter and fairly mild during the summer months. At lower elevations, summertime temperatures can frequently exceed 100°F. On the dry lakebeds, daily temperature ranges can vary by 40° F to 60° F (4° C to 15° C) with very cold morning temperatures in the winter and very hot temperatures in the summer. In Frenchman Flat, the average daily temperature minimum and maximum for January is 24° F to 56° F (-4° C to 13° C), while in July it is 62° F to 102° F (16° C to 39° C). By contrast, on Pahute Mesa the minimum and maximum temperature for January is 25° F to 41° F (-3.8° C to 5° C) and for July, 61° F to 84° F (16° C to 29° C). The highest maximum temperature that has been measured on the NTS is 115° F (46° C) in Frenchman Flat, near Well 5B, in July 1998 and in Jackass Flats near the Lathrop Wells Gate, in July 2002. The coldest minimum temperature that has been measured on the NTS is -14° F (-25° C) in Yucca Flat in December 1967. The temperature extremes at Mercury are 11° F to 113° F (-11°C to 45° C) (DOE, 2004b).

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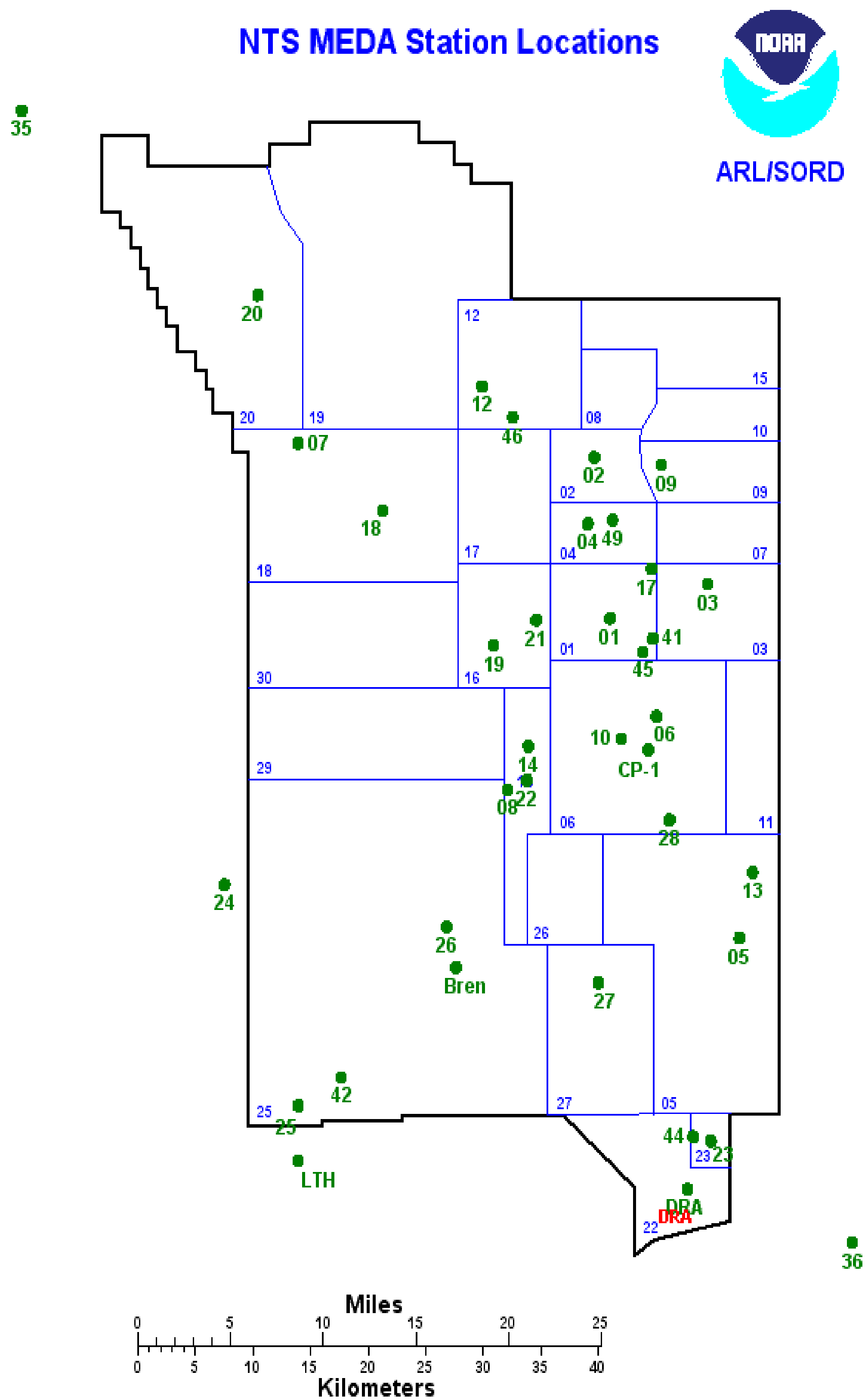

Figure 3.10-1 NTS MEDA Station Locations

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Wind

Complex topography, such as that on the NTS, can influence wind speeds and directions. Furthermore, there is a seasonal as well as strong daily periodicity to local wind conditions. For example, in Yucca Flat, during the summer months, the wind direction is usually northerly (from the north) from 10 p.m. PDT to 8 a.m. PDT and southerly from 10 a.m. PDT to 8 p.m. PDT. However, in January the winds are generally from the north from 6 p.m. PST to 11 a.m. PST with some southerly winds developing between 11 a.m. PST and 5 p.m. PST. March through June tend to experience the fastest average wind speeds (8 to 12 mph [12.8 to 19 kmph]) with the faster speeds occurring at the higher elevations. Peak wind gusts of 50 to 70 mph (80 to 112 kmph) have occurred throughout the NTS. Peak winds at Mercury have been as high as 84 mph (134 kmph) during a spring windstorm. Frenchman Flat experienced wind gusts to 70 mph (112 kmph) during the same windstorm. The peak wind speeds measured on the NTS are above 90 mph (145 kmph) on the high terrain with maximums of 91 mph (146 kmph) at Yucca Mountain Ridge-top, 92 mph (147 kmph) at the Monastery in Area-6, and 94 mph (151 kmph) in Area-12 on Radio Hill (DOE, 2004b).

Relative Humidity

The air over the NTS tends to be dry. On average, June is the driest month with humidity ranging from 10 percent to 35 percent. Humidity readings of 35 percent to 70 percent are common in the winter. The reason for this variability is that relative humidity is temperature dependent. The relative humidity tends to be higher with cold temperatures and lower with hot temperatures. Consequently there is not only a seasonal variation, but also a marked diurnal rhythm with this parameter. Early in the morning the humidity ranges from 25 to 70 percent and in mid-afternoon it is in the 10 to 40 percent range, with the larger readings occurring in winter. Humidity readings of more than 75 percent are rare on the NTS (DOE, 2004b).

Hazardous Weather Phenomena

Wind speeds in excess of 60 mph (96 kmph) occur annually. Additional severe weather in the region includes occasional severe thunderstorms, lightning, hail, and dust storms. Severe thunderstorms may produce high precipitation rates that may create localized flash flooding. Few tornadoes have been observed in the region and are not considered a significant threat. Cloud-to-ground lightning can occur throughout the year but primarily between June and September. Maximum cloud-to-ground lightning activity on the NTS occurs between 1 p.m. and 4 p.m. PDT, while minimum activity occurs between 8 a.m. and 9 a.m. PDT. For safety analyses, the mean annual flash density on the NTS is 0.4 flashes per square kilometer per year (DOE, 2004b).

In the dry, clear desert air, the UV component of sunlight can be very intense. Safety precautions are necessary to protect against sunburn, especially between March and October (NOAA/ARL 2006). Extreme meteorological conditions throughout the NTS are documented on the ARL/SORD webpage (www.sord.nv.doe.gov) under the "Climate" link.

3.11 Biological Resources

This section discusses the biological environment of the proposed project area within Area 16 of the NTS. The vegetation and wildlife are discussed at the site-specific scale. Wetlands and other aquatic resources are also briefly described. Regional information on vegetation and wildlife can be found in the NTS EIS (DOE, 1996).

Terrestrial Communities

Vegetation

The project site is located on the northeast slope of a low hill, within the transitional zone between the Mojave and Great Basin Deserts. Blackbrush (*Coleogyne ramosissima*) is the dominant plant species and represents the largest portion of ground cover surrounding the site. Associated plant species include Nevada jointfir (*Ephedra nevadensis*), white burrobush (*Hymenoclea salsola*), Stansbury cliffrose (*Purshia stansburiana*), rabbitbrush (*Chrysothamnus* spp.), four-wing saltbush (*Atriplex canescens*), goldenbush (*Ericameria* sp.), and Joshua tree (*Yucca brevifolia*). The area surrounding the project site is heavily disturbed from previous activities in the area. The non-native, invasive cheat grass (*Bromus tectorum*) and red brome (*Bromus rubens)* are present throughout the project site.

Wildlife

The project site occurs within the transitional zone, resulting in overlap of both Mojave and Great Basin species, and exhibits a wide variety of wildlife. Several species of small mammals occur within or near the project site. In general, these animals are inconspicuous because of their small size and tendency to remain below ground during the day. The most conspicuous terrestrial animal species within the project area include black-tailed jackrabbits (*Lepus californicus*), desert cottontail (*Sylvilagus audubonii*), coyotes (*Canis latrans*), side-blotched lizard (*Uta stansburiana*), western fence lizard (*Sceloporus occidentalis*), desert horned lizard (*Phrynosoma platyrhinos*), and western shovel-nosed snake (*Chinoactis occiptalis*).

In general, bat species tend to feed over reliable water sources (ponds, lakes, water tanks, etc.) and roost in rock crevices or man-made buildings or structures. However, because they are able to fly, several species of bats have the potential to feed above or migrate through the project area. In general, however, there are few suitable areas for roosting within the project area and bats that may occur would likely be transient. Common bat species in the NTS, and potentially the project area, include the western pipistrelle (*Pipistrellus hesperus*), California myotis (*Myotis californicus*) and the small-footed myotis (*Myotis ciliolabrum*).

Common migratory birds potentially occurring within the project site or surrounding areas, as seasonal residents or transients, include black-throated sparrow (*Amphispiza bilineata*), house finch (*Carpodactus mexicanus*), common ravens (*Corvus corax*), Loggerhead shrike (*Lanius ludovicianus*), and horned lark (*Eremophila alpestris*). Several of these species may breed and nest within the project area. Commonly occurring raptors on the NTS include red-tailed hawk (*Buteo jamaicensis*) and turkey vulture (*Cathartes aura*), with the golden eagle (*Aquila chrysaetos*) and American kestrel (*Falco sparverinus*) being occasionally seen.

Aquatic and Wetland Resources

No wetlands, springs, or seeps that would support wetland vegetation are known to occur within the project area. The closest known spring is Tippipah Spring, approximately 2 miles (3.2 km) to the northwest. The spring has been heavily disturbed by past use and currently is represented by an adit approximately 29 feet (9 m) in length with a pool within the adit. Wetland vegetation consists of a narrow, linear corridor that extends for 558 feet (170 m) from the adit with flow varying from 33 to 131 feet (10 to 40 m) down gradient depending on season and drought conditions. Tippipah Spring is used by a variety of wildlife and provides habitat for a number of aquatic species of invertebrates (Hansen et al., 1997)

Endangered, Threatened or other Special Status Species

The Endangered Species Act states that any federally listed threatened or endangered species must be evaluated through consultation with the U.S. Fish and Wildlife Service (FWS) to ensure that proposed activities do not jeopardize the continued existence of the species, or significantly alter or destroy critical habitat. There are no known threatened or endangered species in the vicinity of the DIVINE STRAKE experiment site.

Listed Plants

No plants that have been federally listed as threatened or endangered, or proposed for listing are known to occur on the NTS. However, 18 flowering plants and one moss species that occur on the NTS are considered to be sensitive species by the Nevada Natural Heritage Program (BN, 2006b). The closest population of a sensitive plant is Ripley's springparsley (*Cymopteris ripleyi* var. *saniculoides*) over 3 miles (5 km) northeast of the project area (Ostler, 2006).

Listed Animals

Several special status animal species are known to occur within or near the NTS (Table 3.11-1). The threatened desert tortoise is the only federally-listed species that occurs within the NTS. The primary habitat for desert tortoise is restricted to the southern portion of the NTS, in the Mojave Desert ecosystem (DOE, 2004b). The DIVINE STRAKE project site is approximately 6.2 miles (10 km) northwest of the nearest desert tortoise known range.

The Migratory Bird Treaty Act protects all migratory birds from disturbance while nesting. Birds cannot be disturbed until all young have fledged and the nest is no longer in use. As stated above, a number of migratory birds are present on the NTS during the normal breeding season and have the potential to nest within or near the proposed project site. However, due to lack of suitable habitat, no waterfowl or shore birds are likely to occur within, or near, the project area. One of the migratory birds which occurs within the NTS is the western burrowing owl (*Athene cunicularia*). This species is a ground dwelling bird that nests in burrows excavated by other animals. It occurs within open, flat to minimally sloping terrain throughout the southern and eastern portions of the NTS. The majority of the known occurrences of this species on the NTS are within the transitional ecosystem, with the closest observation of the species being 3 miles (5 km) north of the proposed project site along Pahute Mesa road (DOE, 2003b).

Table 3.11-1
Special Status Species Known to Occur on or Adjacent to the NTS

Scientific Name	Common Names	Status[a]
	Reptile Species	
Gopherus agassizii	Desert Tortoise	LT, NPT
Sauromalus obesus	Chuckwalla	SOC
	Bird Species[b]	
Athene cunicularia hypugea	Western burrowing owl	SOC, P
Aquila chrysaetos	Golden eagle	BE, P
Buteo regalis	Ferruginous hawk	SOC, P
Charadrius montanus	Mountain plover	PT, P
Chlidonias niger	Black Tern	SOC
Empidonax wrightii	Gray flycatcher	SOC
Falco peregrinus anatum	American peregrine falcon	<LE, P
Haliaeetus leucocephalus	Bald eagle	LT-PD, BE, P
Ixobrychus exillis hesperis	Western least bittern	SOC, P
Phainopepla nitens	Phainopepla	SOC
Plegadis chihi	White-faced ibis	SOC, P
	Mammal Species	
Corynorhinus townsendii pallescens	Townsend's big-eared bat	SOC
Equus asinus	Burro	H&B
Equus caballus	Horse	H&B
Euderma maculatum	Spotted bat	SOC, NPT
Myotis ciliolabrum	Small-footed myotis	SOC
Myotis evotis	Long-eared myotis	SOC
Myotis thysanodes	Fringed myotis	SOC
Myotis volans	Long-legged myotis	SOC
Myotis yumanensis	Yuma myotis	SOC

[a] Status Codes:
Endangered Species Act, U.S. Fish and Wildlife Service
<LE - Formerly listed as endangered; LT - Listed as threatened; PD - Proposed for delisting; PT - Proposed for listing as threatened; SOC - Species of concern
U.S. Department of Interior
BE - Protected under the Bald Eagle Protection Act
H&B – Protected under Wild Free Roaming Horse and Burro Act
State of Nevada
NPT - Protected as threatened; P - Protected bird
[b] Does not include all bird species that are protected by the Migratory Bird Treaty Act or by the state. Additionally, there are 26 bird species which have been observed on the NTS that are protected by the state.
Source: DOE, 2004b

3.12 Cultural Resources

This section describes the existing cultural resources in the vicinity of the Proposed Action. Cultural resources located on the NTS include archaeological and historic sites, historic architectural or engineering features, and Native American religious or sacred places.

Definition and Background

Cultural resources are those aspects of the physical environment that relate to human culture and society, and those cultural institutions that hold communities together and link them to their surroundings. They consist of prehistoric and historic sites, structures, artifacts, and other physical evidence of human activities considered important to a culture, subculture, or community for scientific, traditional, religious, or other reasons. Prehistoric and historic archaeological resources are locations where human activity measurably altered the earth or left deposits of physical remains. Archaeological resources are found in all environments on the NTS. Archaeological resources generally must be older than 50 years to be considered for protection under existing Federal cultural resource laws; however, the cold war structures associated with nuclear testing on the NTS are an exception to this guidance.

Section 106 of the National Historic Preservation Act requires agencies to consider the effect of proposed projects on cultural resources that are considered eligible for listing on the National Register of Historic Places (NRHP).

To date, more than 400 cultural resource investigations have been conducted on the NTS (DOE, 2004a). Approximately 4 percent of the NTS has been investigated, mostly by 100 percent coverage pedestrian surveys, with some data recovery excavation and Native American ethnographic consultation (DOE, 2004a). A total of almost 2,200 cultural resources have been recorded; of those nearly half are eligible for inclusion on the NRHP listing of historic properties. Ninety-six percent of the resources are prehistoric, with the remainder either historic, recent significant, unknown, or multi-component (DOE, 2004a).

Archaeological Resources

The area of potential effect (APE) for construction of the U16b test bed was defined and surveyed by NTS archaeologists in 1997 prior to ground breaking for the tunnel complex (see Figure 3.12-1). The survey identified one site that was deemed ineligible to the NRHP.

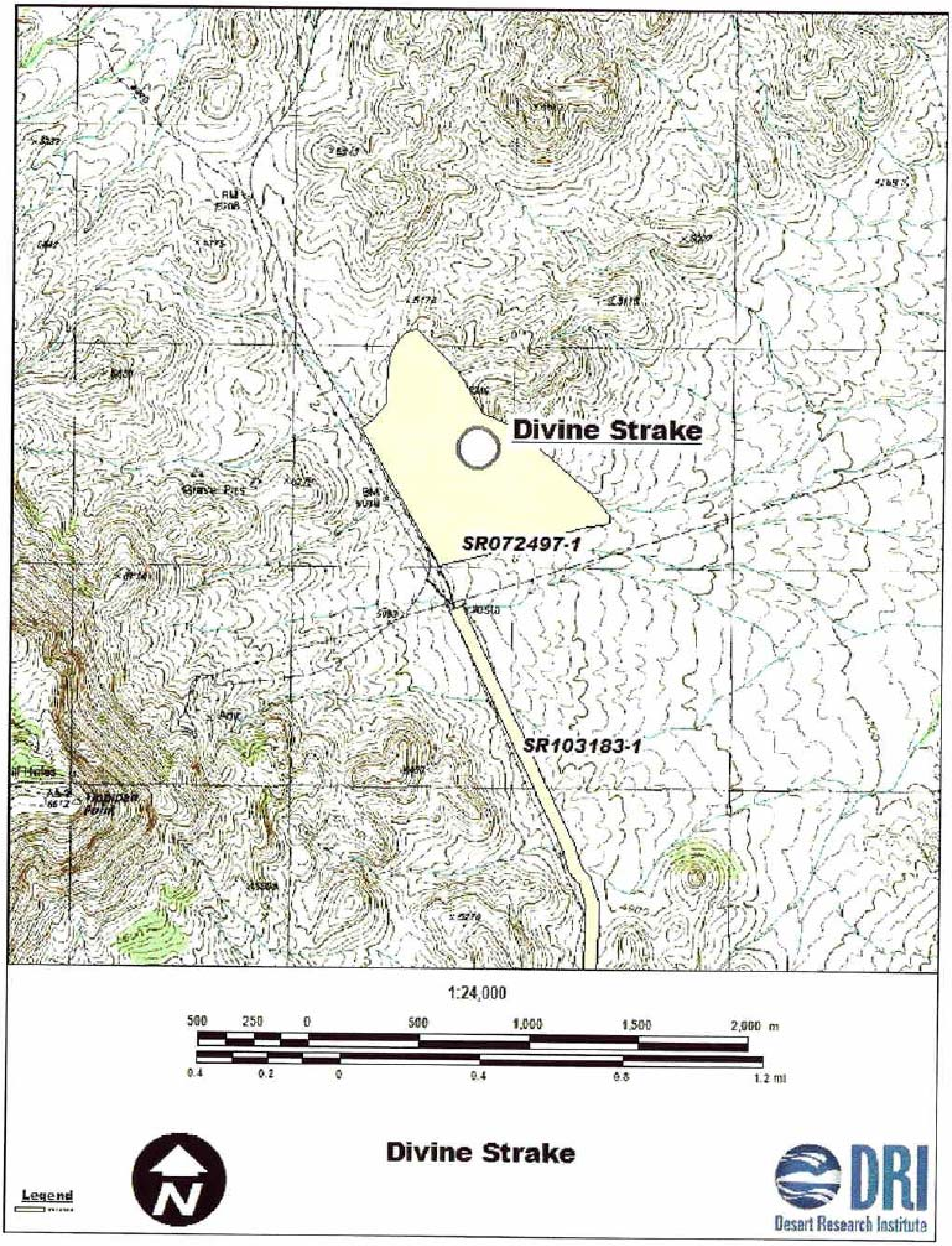

Figure 3.12-1.
APE for Proposed Action

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Archaeological investigations conducted at Tippipah Spring, site 26NY4, in 2004 produced evidence of a long prehistoric and historic occupation at the site. Prehistoric cultural material includes stone tools, flakes from tool manufacturing, and grinding stones and features, such as rock rings and cairns (DOE, 2005c). The historic occupation at Tippipah Spring consists of a stone cabin, corrals, and historic debris.

Historic Resources

Investigations for historic cultural material have been performed in the vicinity of the Proposed Action. Historic cultural material includes metal cans, glass, shell casings, and automobile parts and features, including residential structures, corrals, a water tank, and rock cairns typical of mining claims (DOE, 2005c). Historic research focuses on the relationship between springs and historic mining activities and the relationship between springs and historic transportation. Open-range grazing is known to have occurred on the NTS as early as the late 1800s (Fehner and Gosling, 2000). Suitable forage grounds existed for both cattle and sheep, but access to water was a problem. Flow from the widely scattered springs was often minimal, and ranchers, to augment the supply of water, modified some springs and constructed water storage tanks. The remains of one such tank, made from a boiler, was found at Tippipah Spring (Fehner and Gosling, 2000).

While ranchers and their families tended to live in nearby communities outside the present site boundaries, they built and maintained some structures on the site. One historic site (26NY4), the Tippipah Spring, consisting of a cabin is located approximately 2 miles (3.2 km) from the proposed detonation site (Figure 3.12-2). This site is eligible for listing in the National Register; however, the structure is severely deteriorated. NSO consulted with the State Historic Preservation Office (SHPO) regarding this structure, potential impacts as a result of the Proposed Action, and potential Section 106 mitigation. The SHPO has agreed to NSO's proposed treatment plan for mitigation of potential impacts to this structure and accepted the Technical Report for the Tippipah Spring Historic Site (Appendix G).

Native American Resources

No specific Native American sacred or religious sites have been identified within the APE of the construction of the U16b tunnel complex.

Figure 3.12-2
View of the Side and the Back of the Tippipah Spring Historic Site

3.13 Socioeconomics and Environmental Justice Issues

This section describes the existing social and economic conditions in the vicinity of the Proposed Action, including population, housing, and environmental justice issues.

Socioeconomics

Ninety-seven percent of NTS employees reside in Nye (7 percent) or Clark (90 percent) counties. Between 1990 and 2000 the Nevada population grew 66.3 percent; Nye County grew 82.7 percent and Clark County grew 85.6 percent. Population growth in Nevada is expected to exceed average national trends for the foreseeable future. The growth in Clark County is expected to slow, but remain well above national averages. In 2001 per capita income was $24,968 in Nye County and $28,992 in Clark County, compared to a Nevada average of $30,128. Unemployment in Nye and Clark Counties in 2001 was 5.5 percent. There are no permanent residents at the NTS. The off-site area within 50 miles (80 km) of the NTS is predominantly rural. Several small communities are located southwest of the NTS, including

Pahrump located approximately 50 miles (80 km) south of the NTS, the Amargosa Valley area located approximately 31 miles (50 km) southwest of the NTS, and the town of Beatty located approximately 40 miles (64 km) west.

Environmental Justice

Under Executive Order 12898, the DOE is responsible for identifying and addressing disproportionately high and adverse impacts on minority or low-income populations. Minority persons are those who identify themselves as Black or African American, American Indian and Alaska Native, Asian, Native Hawaiian and Other Pacific Islander, another non-white race, or persons of Hispanic or Latino ethnicity. Persons whose incomes are below the Federal poverty threshold are designated low-income. At the NTS, the 50-mile (80-km) radius includes portions of Clark, Nye, and Lincoln Counties in Nevada and a portion of Inyo County, California. In 2002, minority populations comprised 30.9 percent of the U.S. population, and the same percentage of the Nevada population. The percentage of minority populations in the area surrounding the NTS is greater than that in the United States or Nevada; however, the minority populations in the area are concentrated in the Las Vegas metropolitan area, outside the 50-mile (80-km) impact area. Low-income populations comprised 12.4 percent of the U.S. population, based on 1999 income, and 10.5 percent of the Nevada population. Within the counties surrounding the NTS, 10.8 percent of the population lives below the poverty level (DOE, 2003a).

3.14 Aesthetics and Visual Resources

Visual resources include the natural and man-made physical features that give a particular landscape its character and value as an environmental factor. The feature categories that form the overall impression a viewer receives of an area include landform, vegetation, water, color, adjacent scenery, scarcity, and man-made (cultural) modification. Visual sensitivity for this analysis was based solely on the volume of travel on public highways because these roads are the only key public viewpoints from which the study areas are seen. Study areas that are visible from highways that experience 3,000 or more average annual daily traffic were assigned a medium sensitivity level. Study areas that are visible from highways with annual average daily traffic below 1,000 were assigned a low sensitivity level.

The NTS is located in a transition area between the Mojave Desert and the Great Basin. Vegetation ranges from grasses and creosote bush in the lower elevations to juniper, pinyon pine, and sagebrush in elevations above 5,000 feet (1,524 m). The topography of the NTS consists of a series of mountain ranges arranged in a north-south orientation separated by broad valleys. A portion of the site is characterized by the presence of numerous subsidence craters resulting from past nuclear testing. Scenic views related to geologic features are numerous within this region. The southwestern Nevada volcanic field, which includes portions of the NTS, is recognized by researchers to be a classic example of a nested, multicaldera volcanic field. Area 16 is located in the center of the NTS.

The area surrounding the NTS consists of unpopulated to sparsely populated desert and rural lands. Because the NTS is surrounded to the east, north, and west by the NTTR Complex and to the south by lands controlled by the U.S. Bureau of Land Management, the main public views of the NTS interior are from U.S. Highway 95. Because the southern boundary of the NTS is surrounded by various mountain ranges, including the Spector Range, Striped Hills, Red Mountain, and the Spotted Range, views from U.S. Highway 95 are limited to Mercury Valley and portions of the southwestern sector of NTS, which can be seen from Amargosa Valley. Traffic on U.S. Highway 95 at the Mercury exit is approximately 3,600 vehicles per day. Therefore, portions of the NTS visible from this area would have a high sensitivity level. The detonation is proposed to occur well inside the boundaries of NTS at U16b. Figure 3.14-1 shows a view of the location facing northeast.

Figure 3.14-1
View of the Proposed Detonation Site Looking Northeast

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter discusses the environmental consequences of implementation of the Proposed Action and No-Action Alternative. For each resource, significance criteria are identified followed by a discussion of identified impacts and mitigations, if appropriate.

4.1 Impacts to Land Use

Existing and background information pertaining to land use of the study area is summarized and presented in Section 3.1. This section discusses the potential for significant impacts based on the criteria listed below. Impacts to land use would be present if implementation of the Proposed Action were to cause:

- Incompatibility of the Proposed Action with land uses on nearby properties in the region of influence
- Zoning conflict
- Conflict with local/ regional land use plans

No land use impacts were identified. A detailed discussion of the land use analysis is provided below.

Environmental Consequences of the Proposed Action

With the Proposed Action, the large-scale, open-air explosive detonation would occur within Area 16, which is within the designated Nuclear or High Explosive Test Zone at the NTS. Area 16 occupies about 73 km^2 (28 mi^2) in the west-central portion of the NTS. Area 16 was established in 1961 for the DoD's exclusive use in support of complicated nuclear effects experiments that required a tunnel location in an isolated area away from other active weapons test areas. From mid-1962 through mid-1971, six underground nuclear weapons effects tests were conducted in the U16a tunnel complex located within Area 16. The U16a tunnel complex is located approximately 1.1 miles (1.8 km) southwest of the proposed test bed for DIVINE STRAKE. Currently, the DoD uses this area for Research, Development, Test, and Evaluation in support of HDBT programs involving the delivery and detonation of conventional or prototype explosives and munitions.

The Proposed Action is consistent with the current land use classification of Area 16 and the region of influence, and would not conflict with any zoning or land use plans in these areas.

These areas are isolated and designated for National Security and experiments. As a result, no impacts related to Land Use would occur with implementation of the Proposed Action.

With the Proposed Action, NNSA would retain the right to limit/suspend all flight activity over R-4808N/S and R-4807B, the airspace above the proposed DIVINE STRAKE location. Since there would be no aircraft activity above the proposed location during the DIVINE STRAKE detonation, there would be no airspace-related impacts.

Environmental Consequences with the No-Action Alternative

With the No-Action Alternative, the large-scale, open-air detonation would not occur. Land use would remain the same as described in Section 3.1. Therefore, there would be no impacts to land use with implementation of the No-Action Alternative.

4.2 Impacts of Noise and Blast

Background information on the noise environment of the study area is summarized in Section 3.2. The potential for significant impacts related to blast and noise have been assessed as to:

- Damage to structures or property
- Exposure of on-site personnel or off-site persons to severe or hazardous noise levels that cause adverse impacts
- Exposure of threatened or endangered species to severe or hazardous noise levels
- Conflict with a jurisdictional noise ordinance or violate any law or relevant standard
- Causing substantial temporary increases in ambient noise levels to sensitive receptors during construction and detonation
- Causing startle reactions by persons located off-site

No significant noise or blast impacts were identified, assuming that the experiment is conducted during prescribed meteorological conditions. A detailed discussion of the noise and blast analyses is presented below.

While there are a number of laws and guidelines at the Federal level that direct the consideration of a broad range of noise and vibration issues, most of the areas addressed by Federal regulations are not applicable to the proposed experiment. Regulations pertinent to the project include:

- Noise Control Act of 1972 (42 U.S.C. 4910)
- HUD Environmental Standards (24 C.F.R. Part 51)
- OSHA Occupational Noise Exposure; Hearing Conservation Amendment (FR 48 (46), 9738-9785 (1983)

Environmental Consequences of the Proposed Action

This section discusses likely airblast impacts and the potential impacts of the linearly propagating acoustic wave resulting from the proposed DIVINE STRAKE detonation. Because of the size of the detonation (593 tons TNT equivalent), under certain conditions sound waves with relatively high peak pressure levels (>125 $dB_{unwtd\text{-}pk}$) could travel beyond the NTS boundary. However, DIVINE STRAKE has been designed to only occur under acceptable blast criteria as described in Chapter 2.

Detonation Related Impacts (Airblast and Acoustic Wave)

"Airblast" describes the action of the air relatively close to the detonation point. The velocity of the rapidly expanding gas (from a high energy chemical reaction) greatly exceeds the speed of sound in air and produces a shockwave. The magnitude of this peak overpressure wave may be described using various units. When airblast peak overpressure is reduced to approximately 2.8 kPa (0.4 psi) (for this experiment this would occur at a distance of approximately 1 mile), the shockwave would slow to the point where it approaches the speed of sound in air and becomes an acoustic wave that can be refracted by discontinuities in wind and temperature gradients. Both types of wave are audible, but their physical consequences are different as may be seen in Table 4.2-1, 4.2-2, and 4.2-3 in which the potential impacts of both airblast and acoustic wave propagation are summarized. "Audibility" of the airblast phase would be a minor environmental concern when compared to the range of potential non-auditory impacts that might occur in proximity to the detonation site.

Because of the variability in meteorological assumptions contained in acceptable methodologies that were used to calculate the air blast and acoustic wave propagation phenomena, minor differences in decibel levels at great distances from the detonation site are noted. Based on airblast and acoustic wave propagation evaluation conducted by DTRA for the proposed experiment, the airblast shockwave impacts of DIVINE STRAKE are limited to the boundaries of the NTS. A summary of the site and immediate area impact evaluation is shown in Table 4.2-1.

Table 4.2-1
Summary of Levels and Extent of DIVINE STRAKE Damage Criteria to Biota

Criteria	Peak Overpressure, kPa	Peak Overpressure, Psi	Range in Feet	Range in Miles
Birds in flight injured[a]	68.9	10.0	1084	
Tree breakage (10%)[a]	24.1	3.5	2033	
Human eardrum rupture[a]	20.7	3.0	2251	
Incipient small mammal injury[a]	13.8	2.0	2974	
Noise - Tinnitus (ringing), possible PTS or TTS (163dB)[b]	2.4	0.35	7511[c]	1.4[c]
Noise – OSHA impulsive limit, possible TTS (140dB)[b]	0.2	0.029	71,912[c]	13.6[c]
Noise – Thunder sound (130dB)[b]	0.1	0.015	135,040[c]	25.5[c]

Source: Table 3 of Finding of No Significant Impact and Environmental Assessment for High-Explosive Field Test MILL RACE (Defense Nuclear Agency, 1981) and (Ristvet, 2005).
[a] 1% threshold
[b] Limits
[c] For a calm homogeneous atmosphere and for overpressure below 2.8 kPa, if strong amplifying gradient is present, these distances could be as much as seven times greater; conversely if strong reduced gradient is present, distances could be up to 1/3 less.
PTS – permanent threshold shift
TTS – temporary threshold shift
kPa – kilopascal
Psi – pounds per square inch
dB – decibel
OSHA – Occupational Safety and Health Administration

Table 4.2-2
Summary of Potential Airblast Environmental Damage Criteria to Structures and the Predicted Ranges for DIVINE STRAKE

	Kpa	Psi	feet	mi
Chimney breakage (10% probability)	12.4	1.8	3208	0.6
Major structural damage threshold	6.9	1.0	4932	0.9
Roof damage (10% probability)	2.8	0.4	9895	1.9
Inflight light aircraft damage threshold	1.4	0.2	12,261[a]	2.3[a]
Door Failure (10% probability)	1.0	0.15	16,648[a]	3.2[a]
Broken bric-a-brac threshold	0.69	0.10	23,327[a]	4.4[a]
Broken tile and mirrors threshold	0.62	0.09	25,709[a]	4.9[a]
Wall and plaster cracks threshold	0.41	0.06	37,443[a]	7.1[a]
Cracked Windows Threshold:				
- less than 1 in 1,000 population	0.40	0.058	38,294[a]	7.2[a]
- less than 1 in 10,000 population	0.20	0.029	71,912[a]	13.6[a]

Source: Table 3 of Finding of No Significant Impact and Environmental Assessment for High-Explosive Field Test MILL RACE (Defense Nuclear Agency, 1981) and (Ristvet, 2005).
[a] For a calm homogeneous atmosphere and for overpressure below 2.8 kPa, if strong amplifying gradient is present, these distances could be as much as seven times greater; conversely if strong reduced gradient is present, distances could be up to 1/3 less.
kPa – kilopascal
Psi – pounds per square inch
mi – mile

TABLE 4.2-3
Summary of Levels and Extent of Airblast Damage Criteria

Effect	Corresponding Incident Peak Overpressure Level	Distance From GZ at Which Overpressure Level Occurs
Threshold of lethality		
Small animals in the open	3 – 6 psi	1250 – 2000 ft
5-lb animal in the open	>8 psi	<1100 ft
Small animals (rabbits or smaller) in burrows	10 psi[a]	1000 ft
Larger animals in burrows	18 psi[a]	750 ft
Threshold of lung damage to animals in burrows		
Small animals	3 psi[a]	2000 ft
Large animals	6 psi[a]	1250 ft
Threshold of eardrum rupture to animals in the open	3 – 5 psi	1400 – 2000 ft
Threshold of injury to birds in flight	5 – 10 psi	1000 – 1400 ft
Toppling of broadleaf trees (small leaves or defoliated or light crowned)	>10 psi	<1000 ft
Damage to small vegetation or tree branches	3 psi	2000 ft
Structural damage to buildings	1 – 2 psi	2800 – 5000 ft
Window breakage (one window for each 1000 human population)	200 kpa (0.029 psi)	14 mi[b]
Impulsive noise level limit for industrial workers by Occupational Safety and Health Administration (OSHA)	140 dB (0.029 psi)	14 mi[b]
Tinnitus or "ringing" of ears	160 dB (0.29 psi)	1.8 mi[b]

Notes:
[a] The peak overpressure levels shown are the levels that occur without reflections. Airblast filling a burrow can produce pressures that are 2 to 3 times these values and are sufficient to result in the effect that is described.
[b] Assuming a calm, nonrefracting atmosphere.
GZ – ground zero
kPa – kilopascal
Psi – pounds per square inch
dB – decibel
ft – feet
m – meter
mi – mile
Source: Table 3 of Finding of No Significant Impact and Environmental Assessment for High-Explosive Field Test MILL RACE (Defense Nuclear Agency, 1981) and (Ristvet, 2005).

The detonation of 700 tons (635 metric tons) of ANFO (593 equivalent tons TNT) would generate substantial peak overpressure in the airblast shockwave and high peak acoustic sound pressure levels at substantial distances from the blast site's ground zero location, during periods of calm or non-downwind, non-refracting, and non-jet stream or monsoon ozonosphere ducting. Assuming neutral day conditions with no enhanced propagation or excess attenuation due to meteorological conditions, and a conservative estimate of variance (99% confidence), additional modeling of the peak, unweighted, sound levels expected at the NTS boundary and beyond indicates that peak sound levels of approximately 140 dB would occur at the nearest NTS boundaries (approximately 14 miles (22.6 km) easterly and 20.5 miles (33.1 km) westerly of ground zero Tunnel Complex 16b, respectively). Peak sound levels closer to the blast site (without local shielding or barriers) would be higher. Peak sound levels farther from ground zero would be lower. At the southerly boundary of the NTS near its intersection with Jackass Flats Road (24.1 miles [38.78 km]) the expected level is 138.5 dB_{pk} and at Mercury (26.9 miles [43.33 km]) it is 137.5 dB_{pk}. Additional results are:

- Amargosa Valley - 136.5 dB_{pk} (28.7 miles [46.17 km])
- Beatty - 135 dB_{pk} (32.8 miles [52.72 km])
- Indian Springs - 132 dB_{pk} (41.9 miles [67.38 km])
- Scotty's Junction - 129 dB_{pk} (51.8 miles [83.31 km])
- Pahrump - 128 dB_{pk} (57.2 miles [92.05 km])
- North Las Vegas - 126 dB_{pk} (67.5 miles [108.67 km])

Due to the initial blast spectrum (i.e., frequency content) and the attenuation mechanisms affecting long range sound propagation, the audible character of the blast would be similar to thunder or a sonic boom with predominant frequencies around 30 Hz or lower. This "thump" would likely be felt as much as heard. Also, because the "one-shot" sound level is below 140 dB_{pk} and because of the exclusive low frequency energy content of the sound wave, no temporary or permanent impacts on human hearing are likely for off-site receptors. Therefore, there is no need for personal hearing protective devices beyond the site's boundaries. DIVINE STRAKE would be detonated remotely with no personnel nearby. Additionally, a safe stand-off distance would be established for personnel on the NTS.

Based on evaluation of probable impacts as provided by DTRA for DIVINE STRAKE, a review of previous experiments and blasts of similar size, and further calculation of probable off-NTS sound levels, the DIVINE STRAKE experiment would not cause significant environmental impacts because:

- Destruction and damage caused by the airblast would be confined within the NTS boundary and would not cause injury, or structural or surficial damage to off-site persons, structures, or property (Ristvet, 2005).
- The detonation would not expose persons off-site to severe or hazardous noise levels.
- Threatened or endangered species would not be exposed to severe or hazardous noise levels (see Section 4.11 and Appendix C).
- The detonation would alter a relatively small amount of habitat. Loss of wildlife in the immediate experiment area would be expected. However, this impact would be minimal to the species (see Table 4.2-3).
- The off-site noise level would not conflict with a jurisdictional noise regulation.
- The detonation would not cause a substantial permanent increase in ambient noise levels at any receptors.
- The detonation may cause a very brief substantial but not significant ambient noise level at sensitive receptors.

With proper notification to the public, the detonation is not likely to cause widespread startle reaction from persons off the NTS in reaction to a sudden moderately loud noise resulting from detonation.

These findings are subject to the Acceptable Blast Conditions Criteria decision framework presented in Chapter 2, and certain meteorological considerations as described below.

Meteorological Considerations and Qualifications

The absolute air temperature; the rate of change of air temperature with distance above the ground; and wind direction, velocity, and gradients which affect the sound velocity profile above the ground, can refract (or “bend”) the sound wave away from or toward the ground at some distances from the source (focusing). At substantial distances from the detonation point, these atmospheric impacts could increase or decrease the sound level that would be expected from wave divergence alone. A severe form of atmospheric effect known as channeling could increase the distance from the source at which a certain sound level is expected to occur by a factor of seven (Ristvet, 2005).

The predicted distance to a particular environmental effect is predicated on a calm, homogeneous, nonrefracting, non-channeling atmosphere. Adverse meteorological conditions could increase these distances by seven times. This could result in a more widespread, off-site regional impact. Conversely, certain atmospheric conditions could reduce the distance-to-effect by a factor of three. This EA assumes a conservative approach of non-reliance on special atmospheric conditions that might reduce sound levels. Further, this EA assumes avoidance of atmospheric conditions that favor extra long distance blast and sound wave propagation.

Construction Related Impacts

Potential noise from project-related on-site construction activity was evaluated using standard methods (EPA, 1971). All sound from construction activity would be inaudible off the NTS. Following standard OSHA regulations would prevent any excessive noise exposure to on-site workers. Noise from trucks transporting supplies and material to the site would not substantially increase traffic noise at any sensitive receptors.

Mitigation

Mitigation measures include:

- Establish and follow conservative acceptable blast conditions criteria to ensure favorable meteorological conditions at the time of the detonation. A detailed description of acceptable blast conditions criteria is located in Chapter 2, Description of the Proposed Action and Alternatives.
- Monitor near ground and upper atmosphere weather conditions using radiosondes released at intervals and Doppler radar for an appropriate period leading up to and just prior to detonation.
- Notify affected NTS personnel that very high on-site sound levels and possible visible light levels would be likely from the DIVINE STRAKE detonation and provide affected NTS personnel with PPE hearing and eye protection as prescribed by OSHA regulations.
- Provide advance and proximate civil notification that NTS would be conducting an experiment that may result in a loud boom, audible over a large area of the NTS and at much lower volumes off site, to prevent unnecessary startle and anxiety in off-site areas.
- Provide acoustic monitoring at locations near the NTS such as Amargosa Valley, Beatty, and Indian Springs. A description of the acoustic monitoring that would occur with implementation of DIVINE STRAKE can be found in Chapter 2, Description of the Proposed Action and Alternatives.

Environmental Consequences of the No-Action Alternative

With the No-Action Alternative, the large-scale, open-air detonation, DIVINE STRAKE, would not occur. Therefore, there would be no noise, blast, or light impacts.

4.3 Impacts to Human Health and Safety

Existing and background information pertaining to human health and safety within the study area is summarized and presented in Section 3.3. This section discusses the potential for impacts based on whether the Proposed Action would create unsafe conditions or expose workers on the NTS and the off-site public to situations that exceed health standards or present an undue risk of accidents. The methodology used to determine the potential impacts to human health and safety is based on the following:

- Hazardous materials used or produced by the Proposed Action and the associated exposure levels compared with regulatory requirements
- Hazardous conditions created by the Proposed Action

No significant impacts were identified when analyzing based on the above criteria. A detailed discussion of the human health and safety analyses is provided below.

Environmental Consequences of the Proposed Action

The potential for DIVINE STRAKE to create health and safety impacts to the general public is minimized by a combination of the remote location of the NTS, the sparse surrounding population, and a comprehensive program of administrative and design controls. Further, there is no unauthorized public access to the NTS due to strict access controls.

Worker health and safety within the NTS boundary were evaluated. Potential off-site impacts evaluated included impacts from noise and blast and from dispersion of materials as a result of the proposed detonation. The potential for any human health effects would diminish with distance from the immediate site of the experiment.

Distances to the site boundary and other locations are listed below.

- East – Boundary of the NTS (abuts NTTR), 14.5 miles (23.3 km)
- West – Boundary of the NTS (abuts NTTR), 14 miles (22.5 km)

- North – Boundary of the NTS (abuts NTTR), 15.5 miles (25 km)
- South – Mercury Gate, 29 miles (46.6 km)
- South – Lathrop Wells, 29 miles (46.6 km)

As discussed in Section 4.2, Impacts of Noise and Blast, overpressure higher than 140 dBs would not occur off-site as a result of the Proposed Action. Therefore, unsafe noise conditions resulting from exposure of the public to situations that exceed health standards would not occur and off-site impacts would be less than significant.

The NTS EIS (DOE, 1996) contains an analysis of NTS workforce injuries and illnesses and established safety protocols. With the Proposed Action, no health and safety impacts other than those presented in the 1996 NTS Sitewide EIS are anticipated. General health and safety protocols for NTS personnel are detailed in DOE regulations and site and facility standard operating procedures. During a detonation, the primary means of personnel protection would consist of administrative and access controls to the experiment area, establishment of a safe stand off distance, and personnel clear zones.

In accordance with acceptable noise levels specified in OSHA regulations, workers would be protected from elevated noise levels through implementation of existing hearing protection programs (DOE, 2003a).

Contact with explosive experiment materials or byproducts would occur primarily during experiment preparation, post-experiment evaluation, and site cleanup. The materials that would be used in the experiment and the respective Threshold Limit Value (TLV) are listed in Table 4.3-1. A TLV is the airborne concentration of substances devised by the American Conference of Governmental Industrial Hygienists (ACGIH) that represents conditions under which it is believed that nearly all workers may be exposed day after day with no adverse effect. TLVs are advisory exposure guidelines, not legal standards; they are based on evidence from industrial experience, animal studies, or human studies when they exist. The compounds that would be used during the proposed detonation are not immediately dangerous to life or health.

During detonation, administrative and access controls and monitoring would prevent health impacts to workers and the public. A safe stand-off distance would be established and enforced. With these controls in place, there would be no impact to workers or the public.

Table 4.3-1
Worker Safety Limits

Compound	Exposure Type	TLV
ANFO	Ammonium Nitrate Dust (Nuisance Dust)	10 mg/m^3
	Mineral Oil Dust	5 mg/m^3
Booster C-4	RDX, Cyclonite	1.5 mg/m^3
Components:	Hexogen	3.0 mg/m^3
	Vistanex	N/A
	DOA or DOS	N/A
	Process Oil	5 mg/m^3

TLV – threshold limit value
N/A – not applicable

Table 4.3-2 lists the detonation products that would result from the Proposed Action. Nitrogen, carbon dioxide, and methane are gases that would displace oxygen following the experiment. Reentry into the experiment area would be delayed until the gases have dispersed sufficiently to allow for safe entry.

Table 4.3-2
ANFO-Emulsion Detonation Products

Compound	Symbol	Amt/kg of Explosive (grams per kilogram)	Total Produced (megagrams)
Water	H_20	504.45	271.62
Nitrogen	N	285.8	153.89
Carbon Dioxide	CO_2	171.64	92.42
Methane	CH_4	7.06	3.80
Calcium Carbonate	$CaCO_3$	31.05	16.72

Workers would also face potential hazards from construction activities associated with the Proposed Action. These activities would include excavation of the charge hole, drilling holes into rock for installation of monitoring equipment, driving to and from the detonation area, and installing equipment for the experiment. During these activities, common hazards would be present, including falling, tripping, burns, noise exposure, and traffic accidents. Accidents associated with these hazards would be expected to occur at a rate similar to that for other industrial projects as identified in the 1996 NTS EIS. The number of injuries related to construction of DIVINE STRAKE would depend on the number of workers and the specific types of tasks they would perform.

To ensure compliance with NESHAP requirements (40 CFR 61, Subpart H), NSO assessed the potential for off-site public exposure to radionuclides from the DIVINE STRAKE detonation.

Since suspended natural radionuclides and resuspended fallout radionuclides from the detonation have potential to be transported off of the NTS by wind, they may contribute radiological dose to the public. 40 CFR 61, Subpart H states "Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent (EDE) of 10 mrem/yr" (40 CFR 61.92).

In accordance with 40 CFR 61.93, the dose assessment was conducted with the computer model CAP88-PC, version 3.0. In addition to this model, a dose assessment was also conducted by the National Atmospheric Release Advisory Center (NARAC) at the Lawrence Livermore National Laboratory. This modeling calculated dose estimates using a model that was designed for acute releases and that addresses terrain effects. As estimated by the CAP88-PC and NARAC models, potential radiation dose to a hypothetical maximally exposed individual at the closest NTS boundary to the DIVINE STRAKE experiment (eastern boundary) would be about 0.005 mrem, or about 1/20th of 1 percent the U.S. EPA limit of 10 mrem per year. Because the nearest member of the public resides approximately 12 miles (20 km) from the NTS boundary, this individual would receive only a minute fraction of the modeled dose. Additional details of the dose assessment are in *Potential Offsite Radiological Doses Estimated for the DIVINE STRAKE Experiment, Nevada Test Site* (Appendix F).

The closest NTS nuclear event occurred underground in the U16a tunnel located 1.1 miles southwest of the DIVINE STRAKE test bed. Six nuclear tests were conducted at the U16a tunnel from 1962 to 1971. The U16a muckpile consists primarily of mining debris (rock) generated during tunnel excavation and construction in support of nuclear weapons testing. In the summer of 2001, corrective action investigation activities were performed at the U16a muckpile, including drive-over and walk-over radiological surveys, sampling of the muckpile contents and underlying native soils, surface sampling, and shallow subsurface sampling. Man-made radioactivity, including americium-241, cobalt-60, cesium-137, plutonium-238, plutonium-239, and strontium-90, were found above background levels at various depths within the muckpile ranging from the surface to 41.5 feet (12.6 m). Lower levels of man-made radioactivity above background levels were also found in a contaminated area and a ravine immediately east of the muckpile. Additional details on the sampling results of the muckpile and the ravine areas are in, *Evaluation of Radiological Monitoring Data in Area 16 of the Nevada Test Site for the Proposed DIVINE STRAKE Experiment* (Appendix A). Because of the distance of the U16a muckpile from U16b and the site of the proposed DIVINE STRAKE experiment (approximately 1.1 miles [1.8 km]), and the scientific predictions of proposed DIVINE STRAKE's area of impact, it is extremely unlikely that any man-made radioactivity from the U16a muckpile would be resuspended into the atmosphere as a result of the experiment.

To reduce the potential for human health impacts, the DIVINE STRAKE detonation is subject to planning and execution plans to ensure that the work is conducted safely. A safety plan specific to the experiment would be prepared that would include procedures for training, hazard analysis, hazard communication, personal protective equipment, and emergency response preparation. Other measures that would be employed to further reduce the potential for impact include:

- Evacuation of workers from the area surrounding the experiment site to a safe stand-off distance prior to detonation
- Proper storage and handling of explosive materials
- Inventory and accountability of all explosive materials

Because of safety measures that would be implemented as part of the Proposed Action, potential impacts related to Human Health and Safety are expected to be less than significant.

Accident Analysis

This section describes the range of accidents at the NTS that are reasonably foreseeable for the DIVINE STRAKE experiment. In general, work at the NTS has been conducted with a lower rate of accidents than for similar work performed in the private sector. Work at the NTS and other facilities managed by NSO has been performed with fewer accidents than work in the private sector. This is shown by the NTS M&O contractor's Total Reportable Cases (TRC) rate of 2.0 for FY 2005 when 2,475,252 hours were worked (DOE, 2006b). This compares with an average industry TRC rate of 6.4 for the years of 1997 to 2001 (the last year for which data are available).

Although accidents are rare, the consequences of such an accident would depend upon the type of accident and the number of involved workers. The postulated accidents analyzed for the EA were considered based on project phase, probable frequency, and the magnitude of consequences. Because historic accident rates are low, the analysis was done using a qualitative approach to form a basis for projecting the frequency of an accident. DOE guidance on conducting accident analysis was followed and DoD Mil-Std-882c, System Safety Program Requirements, was applied, as appropriate. The guidance directs that a sliding scale should be used when analyzing accidents considered in an EA. This means that projects involving radioactive or highly toxic materials would be given a more detailed review than projects involving less hazardous materials (DOE, 2002b). The following sections describe the methodology, hazard analysis, accident scenarios, accident consequences, and mitigation measures.

Methodology

A set of accident scenarios was developed for work related to DIVINE STRAKE conducted within the NTS (DOE, 2002b). The accident scenarios for each of the following phases of work were considered:

- Preparation
- Mixing and loading
- Firing
- Reentry

The accident scenarios for the project are listed in Table 4.3-3. The scenarios for each phase were developed based on accidents that have occurred in the past when similar activities have been conducted or were considered possible given the type of work, the materials handled and the environment. A scenario for each phase was selected to represent the most serious combination of consequence and frequency for the phase. These are shown in bold print in Table 4.3-3 and described in detail below.

Hazard Analysis

A Hazard Analysis and Risk Assessment (DTRA, 2006) was prepared that describes the nature of hazards that could potentially occur during implementation of the Proposed Action. Workers would be subject to hazards that are common to many construction worksites and some hazards that are more common to mining operations where explosives are used.

Accident Scenarios

This section describes selected accident scenarios, including the number of workers, type of accident, qualitative probability of occurrence, and the consequences. Three types of accidents are assumed to pose the highest risk of an injury or fatal accident: traffic, construction, and explosion. Of the three types, traffic accidents are the most common.

Table 4.3-3
Accident Scenarios and Consequences[a]

Project Phase	Event	Root Cause	Involved Workers (#s)	Maximum Impact	Expected Impact	Probability (risks listed are qualitative and do not indicate a degree of precision)
Experiment Preparation						
Worker Commute	**Vehicle Accident**	**Various**	**3**	**3 Fatalities**	**3 Injuries**	**Occasional (approx. risk of 1x10-3)**
Excavation	Tunnel roof failure	Unstable rock, earthquake	3	3 Fatalities	1 injury	Improbable (approximate risk of 1x10-6)
Excavation	**Charge hole collapse**	**Unstable soil, lack of shoring**	**4**	**1 Fatality**	**2 injuries**	**Remote (approx. risk of 1x10-5)**
Mixing & Loading						
Transportation of Explosives	**Truck collision, fire and explosion**	**Tire failure, driver falls asleep, etc.**	**2**	**2 Fatalities**	**2 Injuries**	**Remote (approx. risk of 1x10-5)**
Mixing and loading	Premature detonation	Spark from a vehicle, lightning	10	10 Fatalities	2 Injuries	Improbable (approx. risk of 1x10-6)
Firing						
Detonation	Premature detonation	Detonator malfunction	6	6 Fatalities	6 Injuries	Improbable (approx. risk of 1x10-6)
Detonation	**Delayed detonation**	**Detonator malfunction**	**2**	**2 Fatalities**	**2 Injuries**	**Improbable** (approx. risk of 1x10-6)
Smoldering Hole	Incomplete detonation	Detonator malfunction, rainwater infiltration into ANFO	2	0 Fatalities	0 Injuries	Occasional **(approx. risk of 1x10-3)**
Reentry						
Tunnel/Confined space reentry	Suffocation	Improper use of PPE, inadequate ventilation, reentry too early after the experiment	2	2 Fatalities	0 Injuries	Improbable (approx. risk of 1x10-6)
Tunnel/Confined space reentry	**Fire**	**Blowback, explosive gases ignite when supplied w/ fresh air**	**2**	**2 Fatalities**	**2 Injuries**	**Remote (approx. risk of 1x10-5)**

[a] The scenario for each project phase representing the most serious combination of consequence and frequency is show in bold text.

A representative traffic accident would involve four workers commuting to the DIVINE STRAKE experiment site in Area 16. The accident could be initiated by a tire failure, impact with a large animal, or driver inattention. This scenario assumes that all passengers would wear seatbelts and minor injuries would result. This scenario was assigned a frequency of occasional. A less frequent traffic accident would be a rollover or other more serious collision that could result in one or more fatalities.

Construction accidents could occur during site preparation, excavation of the charge hole, fitting the tunnel with instrumentation or other equipment, installing the concrete culvert, or constructing facilities for timing and control or observation. A construction accident could result from a wide variety of causes, including tripping, falling, slope failure of excavations, electric shock, or equipment falling on a worker. The varieties of accident causes are not unique to DIVINE STRAKE and are common risks in construction workplaces. A representative scenario for a construction accident is a worker tripping on equipment or debris and receiving a lost time injury. This scenario was assigned a frequency of occasional. An even less frequent construction accident with higher consequences would be failure of an earthen slope during an excavation. One or more workers could receive fatal injuries.

The third type of accident is related to an unintentional explosion involving materials to be used in the experiment. An accident of this type could occur during transportation, mixing and loading, or during the firing phase of the experiment. A representative accident was assumed to consist of the detonation of part of the ANFO truck shipment as it traveled within the NTS. The accident was assumed to involve a rollover accident of a truck carrying ANFO, a subsequent fire, and detonation of part of the load. ANFO is a stable product and usually will not explode unless a detonator is used. However, a recent accident involving supposedly stable explosives (although not ANFO) has shown that the impact of an accident and fire could cause an unintentional explosion (Deseret News, 2005). Two workers are assumed to be involved and would receive injuries. The frequency of this type of accident is assumed to be remote.

Although not an accident, a terrorist attack involving the premature detonation of the experiment was analyzed. The NTS is an access-controlled, secure area, provided with 24-hour security. There would be no possibility for a terrorist act until the ANFO is emplaced. As the site of the experiment has been selected so as to avoid adverse impacts from a detonation, a malicious act that resulted in a premature detonation would have minimal impacts beyond the NTS boundaries. If a premature detonation occurred during a time of unfavorable meteorological conditions (wind blowing towards Armagosa Valley, the nearest populated area), the calculated radiological dose at Armagosa Valley would be approximately 0.002 mrem, or about 50 times lower than the level at which U.S. EPA approval is required (see Appendix F). Noise impacts and blast impacts during adverse meteorological conditions whether due to an accidental, premature detonation, sabotage or terrorism could result in impacts experienced at distances up to seven times greater than those shown in Table 4.2-1 and Table 4.2-2. Access at the project site would be subject to further controls during emplacement through the detonation in order to prevent any malicious acts that might lead to a premature detonation.

Other accident scenarios that were initially considered were later found to be unrepresentative of site conditions, unrealistic, or of such low probability such that they were not analyzed further.

Accident Consequence Summary

None of the accidents described in this section are expected to occur because of the safety procedures that would be observed and the relatively short duration of activities related to the detonation. As noted in the previous section, the potential consequences of an accident are dependent on the accident scenarios and number of workers involved.

Minor accidents such as a worker tripping and spraining an ankle are the most common type of accident that would likely happen and was assumed to happen occasionally. The next most common accident is assumed to be a traffic accident involving commuting workers at the NTS with injuries to vehicle occupants. The “occasional” frequency listed in Table 4.3-3 is roughly equivalent to one chance in 1,000 that this type of accident would occur. Similarly, a vehicle rollover accident and fire involving one of the trucks transporting explosives is considered to be “remote” having an approximate frequency of one chance in 100,000. “Improbable” represents an approximate frequency of one chance in a million. The other accident scenarios are considered to be similar in frequency or even less frequent.

Mitigation

The same mitigation measures listed for Health and Safety would apply to accident avoidance.

Environmental Consequences of the No-Action Alternative

With the No-Action Alternative, the large-scale, open-air detonation event would not take place. Therefore, there would be no impacts to Human Health and Safety.

4.4 Impacts to Waste Management

Existing and background information pertaining to hazardous materials and waste management within the study area is summarized and presented in Section 3.4. The primary significance criteria for hazardous materials and waste management involve the service area boundaries, existing and projected future capacities and demands on hazardous material use and storage, and HW collection and disposal services (hauling contractors and hazardous waste landfills). Specific criteria used to assess the impacts include:

- Potential for significant effect on capacity of solid waste collection services and landfills caused or induced directly or indirectly
- Potential for significant effect on capacity of hazardous and radioactive waste collection services and landfills caused or induced directly or indirectly
- Potential for creating reasonably foreseeable conditions that would significantly increase the risk of a release of HW
- Potential for creating reasonably foreseeable conditions that would significantly increase the risk of a release of hazardous material

No significant waste management impacts were identified. A detailed discussion of the waste management analysis is described below.

<u>Environmental Consequences of the Proposed Action</u>

The proposed experiment would generate primarily non-hazardous solid waste. No radioactive waste would be generated.

HW is not expected as a result of implementation of the DIVINE STRAKE detonation; however, some HW could be generated if any residual chemical that exhibits one or more hazardous characteristics or is listed as hazardous by the U.S. EPA remain after the detonation. The manner in which hazardous materials, wastes, and residuals would be handled and the anticipated impacts of each are discussed in detail in the following subsections. However, in summary, the quantities of waste generated and the amounts requiring storage or disposal would not be expected to have a significant impact on the overall hazardous and non-HW collection, storage, or disposal services or available capacities. There are no reasonably foreseeable conditions that would significantly increase the risk of a release of HW since the requirements of RCRA would be followed. If detonation does not fully occur, any remaining material would be handled in accordance with the DIVINE STRAKE Hazardous Waste Management Plan (Appendix D). No impacts or mitigation requirements would likely result with respect to HW generation, storage, or disposal.

Non-Hazardous Solid Waste

Wastes from the proposed detonation would likely be composed of non-hazardous debris, empty containers, measuring devices, equipment, and PPE. In addition, if clean-up of a spill were required, clean-up wastes could include soil and vegetation wastes. These wastes would be characterized and managed according to the NTS RCRA waste management plan and permit. Removal of all solid waste, trash, hardware, construction debris, etc., would occur during the construction and preparation activities as required for the proposed DIVINE STRAKE detonation.

No incremental environmental impacts over baseline conditions from waste management activities associated with DIVINE STRAKE would be expected. The project would result in a slight increase in waste materials generated with respect to the overall waste quantities managed at the NTS. These quantities could be accommodated by existing landfills with minimal to no impact.

Hazardous Materials and Waste

The proposed experiment would use approximately 700 tons (635 metric tons) of ANFO slurry comprised of 78.65 percent ammonium nitrate, 5.52 percent calcium nitrate, 9.45 percent water, and 6.38 percent fuel oil. Toxic or hazardous materials would not be stored on-site except during emplacement. Other hazardous materials potentially requiring storage at the project site include petroleum, oil, and lubricant products for vehicles and equipment maintenance.

As stated in Section 3.4, the use of hazardous materials would be tracked and controlled in accordance with the NTS HAZTRACK system and the Hazardous Materials Management Plan (HMMP). There are no reasonably foreseeable conditions that would significantly increase the risk of a release of hazardous material since the requirements of the NTS HMMP would be followed. No impacts or mitigation requirements would likely result with respect to hazardous materials control or storage.

Any HW generated from the proposed experiment would be managed in the same manner as the hazardous waste currently generated at NTS. The DIVINE STRAKE project is not expected to generate any HW. In the unlikely event that HW is generated during the experiment, it would either be accumulated in an identified satellite accumulation area adjacent to the proposed experiment site and shipped directly off-site, or transferred to the RCRA-permitted storage facility in Area 5 prior to shipping off-site for treatment or disposal. Given this existing accumulation and storage practice and availability of off-site permitted treatment and disposal facilities, the impact on the NTS storage facility and off-site treatment and disposal facilities from HW as a result of implementation of DIVINE STRAKE would be negligible.

Since 1996, the NTS has continued to store HW at a permitted on-site facility prior to shipping it to a permitted commercial facility for treatment or disposal. The available storage capacity is expected to be adequate in the unlikely event that HW are generated with the proposed implementation of DIVINE STRAKE. The greatest annual generation of HW at the NTS in the last five years was about 65 cubic meters. Considering this historic high volume, the NTS can maintain storage limitations by continuing its practice of shipping stored waste off-site for treatment/disposal when sufficient quantities have been accumulated (about four times per year) and by shipping waste from the generation area, rather than first transferring waste to on-site storage.

HW that could be generated by construction or other activities would be recovered and disposed of off-site according to the RCRA Part B permit and NNSA requirements. There would be no demand on HW facilities used by NSO with respect to waste types or quantities since HW generation would not be expected with implementation of DIVINE STRAKE.

No hydrocarbon wastes would be expected as a result of implementation of DIVINE STRAKE. In the unlikely event that hydrocarbon wastes are generated, they would be disposed of in Area 6 in accordance with the Area 6 Hydrocarbon Disposal Site permit requirements (SW 13 097 02). Only emergency maintenance of vehicles and equipment would be conducted on-site during the construction of the project, thereby minimizing the production of hydrocarbon or potentially hazardous waste (e.g., petroleum, oil, and lubricants).

Two commercially available compounds could be used as tracers during the DIVINE STRAKE detonation: Glo Germ Powder and Fluorescein USP. The primary hazard of using both tracers is from inhalation and dermal exposure and subsequent allergic reaction in sensitive individuals.

Glo Germ Powder is synthetic Organic Colorant A-594-5 that is not diluted with any inert materials. Glo Germ Powder has been in use for more than 30 years as a tracer for a variety of applications including direct dermal contact to evaluate the efficacy of hand washing. The material would be stored according to the manufacturer's recommendations away from oxidizers. The Glo Germ Powder material would not be stored on-site. The compound is considered to be hazardous if it is burned, and toxic gases can be formed. The powder would not be mixed in the ANFO blasting agent so it would not be subject to the oxidizing impacts of the detonation. The powder would be placed on the tarps surrounding the charge hole so that the powder would be lifted and spread with ejecta from the shock wave. Ultraviolet light would be used to evaluate the extent of the tracer dispersion on tarps and mats placed in an array surrounding the experiment area. Approximately 5,000 pounds of Glo Germ Powder would be used in the experiment.

Fluorescein USP is a commonly used tracer produced by several manufacturers. It is used as a tracer in medical procedures and in water systems to identify water leakage. It is not a known carcinogen or acute toxin that would pose a serious hazard to workers. No unusual storage considerations are required for this compound.

Personal protective equipment is recommended by the manufacturers of both tracers to avoid inhalation of dust and unnecessary dermal exposure. Some of the tracer material would be collected on tarps and mats in areas downwind of the detonation. This material would be disposed of in a permitted landfill. The remainder of the tracers would be scattered in surface soils and would be subject to bio-degradation and photo-degradation over time. No long-term detrimental impacts of the use of the tracers are foreseen.

Mitigation

The same mitigation measures that address the handling of potentially hazardous material on other aspects of the project apply to the use of the two tracers. However, there is little way to know in advance which workers may be sensitive to the tracers and susceptible to allergic reaction. For this reason, all personnel who handle the material would be required to wear PPE for inhalation and dermal protection. There is a small potential that some of the Glo Germ Powder could combust and release toxic gases. The waiting period following the detonation before reentry would allow any toxic gases released at the time of detonation to be dispersed to safe levels and would be confirmed by the reentry team instrumentation.

Residual Materials

The Proposed Action would be designed so that all materials would be detonated, leaving no residual waste. However, in the unlikely event that material remains once the experiment is completed, it would be handled as an emergency situation, which would require an emergency permit from the State of Nevada, and be consolidated on the test bed and burned or detonated in place, following notification and approval of the NDEP.

Environmental Consequences of the No-Action Alternative

With implementation of the No-Action Alternative, the large-scale, open-air detonation, DIVINE STRAKE, would not occur. Therefore, there would be no impacts to hazardous materials management and RCRA waste management.

4.5 Impacts to Infrastructure

Existing and background information pertaining to the NTS infrastructure is summarized and presented in Section 3.5. This section discusses the potential for significant impacts on water supply and distribution, wastewater treatment and disposal, energy supply and distribution, telecommunications, and transportation.

Environmental Consequences of the Proposed Action

This section describes the potential impacts on infrastructure services that may occur as a result of the Proposed Action (construction and operation of the proposed facilities) in comparison to the No-Action Alternative. There are no anticipated impacts, including no radiological impacts, to infrastructure.

Water Supply and Distribution

As detailed in Section 3.5, there is currently no active water supply and distribution system located within the vicinity of the Proposed Action. No water supply infrastructure would be constructed for the Proposed Action. Between 20,000 and 80,000 gallons of water would be provided weekly by water haul trucks for personnel consumption, dust suppression, and construction, as needed. Sufficient water would be transported to the site via 6,000-gallon (22,712 liters) capacity water haul trucks to supply water for fire suppression. This water would be obtained from one of the water wells located on the NTS. No additional depletion of the groundwater supply would be anticipated based on historic and current water usage.

Wastewater Treatment and Disposal

No wastewater treatment infrastructure would be constructed for the Proposed Action. Sanitary wastes would be collected in portable toilets that would be serviced twice weekly. The portable toilet waste would be transported to waste water treatment lagoons on the NTS. No wastewater discharge to surface waters would occur as a result of implementation of the Proposed Action.

Energy Supply and Distribution

Implementation of the Proposed Action would require site preparation activities to provide for installation of instrumentation bunkers for the placement of various instruments and gages for recording the effect of the detonation. Instrumentation bunkers would be constructed and located in previously disturbed areas near the portal of the tunnel to accommodate accelerometers, high-speed cameras, and various instruments and gages to record portal and underground damage (see Chapter 2 for information on proposed sensor and instrument locations). The energy supply for these cameras, accelerometers, and various instruments and gauges would be provided by generator with battery backup; therefore, no construction of additional electrical distribution supply would be required.

Fuel for construction equipment would be delivered bi-weekly to the U16b tunnel complex. The existing fuel supply would be able to accommodate vehicles required in support of the Proposed Action.

Above-ground electrical lines that service certain portions of the NTS are present in the study area, and could potentially be affected by blast wave propagation. The electrical grid in the area of the blast site and areas expected to experience blast waves that could substantially damage structures would be temporarily shut down during the experiment activity. These areas would be limited to the NTS. Replacement poles and other network equipment would be staged prior to the experiment to allow expedient replacement of any damaged electrical components (e.g., downed electrical poles). Potential impacts to the electrical grid would be limited to the NTS and temporary in nature; these potential impacts are considered to be less than significant.

Telecommunications

Telecommunications for the Proposed Action would include the use of existing land lines that would be extended to the site and connected. Implementation of the DIVINE STRAKE detonation would not require construction of additional telephone and/or Internet/cable utilities. As a result of implementation of the Proposed Action, no disruptions to services are anticipated. As detailed in Chapter 2, the explosives that would be used for the single large-scale, open-air explosive detonation would not result in an electrostatic discharge with the potential of telecommunication disruptions.

Roadways and Traffic

The Proposed Action would utilize existing roads of the NTS. The U16b tunnel complex would be accessed from Pahute Mesa Road and Mid-Valley Road. Site preparation activities would include improvements to the existing dirt road leading to the top of the hill above the U16b tunnel. These improvements would consist of extending the dirt road approximately 200 feet to reach the location of the ANFO charge hole (see Chapter 2).

Implementation of the Proposed Action would require additional light fleet traffic of approximately 15 vehicles per day during construction activities. The existing roadways are sufficient to accommodate this additional traffic. The additional traffic would not degrade the existing level of service for the NTS roadways.

No permanent alteration of NTS traffic patterns would result from the Proposed Action. Since the NTS is a secured area, no traffic impact to the surrounding communities would occur as a result of implementation of the Proposed Action. Signage and coordination with the guards at all entrance points would be used to provide notification and no unauthorized access to the detonation area would be allowed on the day of the DIVINE STRAKE experiment. NTS workers would remain in Camp Mercury, over 27 miles (43 km) south of the location of the detonation.

Environmental Consequences of the No-Action Alternative

With implementation of the No-Action Alternative, the large-scale, open-air detonation, DIVINE STRAKE, would not occur. Therefore, there would be no infrastructure-related impacts.

4.6 Impacts to Topography and Physiographic Setting

Existing and background information pertaining to topography and physiography of the study area is summarized and presented in Section 3.6. This section discusses the potential for significant impacts to these areas based on the following criteria:

- Permanent damage or alteration of a unique or recognized topographic and physiographic feature or landmark
- Substantial alteration of the existing function of the landscape

No significant topography and physiographic setting impacts were identified during the analysis. A detailed discussion of the topography and physiographic setting analyses is provided below.

Environmental Consequences of the Proposed Action

Implementation of the Proposed Action would result in localized and notable topographic changes to the U16b tunnel complex and the immediate area of the blast. The area of effect would be limited to the area excavated for charge placement, the U16b tunnel complex, and the post-experiment crater (98-foot radius [30-m]). Although large-scale modification to the U16b tunnel complex would likely occur, as portions of the tunnel are expected to collapse, these changes would be expected to be mostly subsurface. Topographic changes would occur as a result of excavation for charge placement as well as from the potential blast crater; however, these changes would be limited to the ridgeline that extends above the U16b portal. Since this ridgeline is neither unique or a recognized landmark, and potential topographic changes would not substantially alter the function of the landscape, topography, and physiography related impacts are considered to be less than significant.

Environmental Consequences of the No-Action Alternative

With implementation of the No-Action Alternative, the large-scale, open-air detonation, DIVINE STRAKE, would not occur. Therefore, there would be no topography or physiography related impacts.

4.7 Impacts to Geology and Soils

The impacts to geology and soils anticipated to result from the DIVINE STRAKE detonation are presented in this section. Potential impacts to soils and geology have been assessed based on whether the Proposed Action would result in:

- Geologic hazards that create the potential for damage to structures
- Destruction or rendering inaccessible valuable mineral deposits

- Conversion of active prime or unique farmlands to nonagricultural use
- Loss of acreage of prime or unique farmland soils to commercial development
- Soil erosion that would cause environmental harm and that cannot be mitigated in site plan and design

No significant impacts to geology and soils were identified. A detailed discussion of the analysis and findings is provided below.

Environmental Consequences of the Proposed Action

Geology

The DIVINE STRAKE detonation would result in some disruption of geologic materials in the area immediately surrounding the blast cavity and localized disturbance of the underground test bed inside the U16b Tunnel Complex tunnel beneath the charge cavity. Boreholes drilled into the tunnel back wall, floor, and ribs to allow installation of various instrumentation for recording the effect of the detonation would locally disturb the host rock materials in the tunnel. Instrumentation bunkers constructed and located in previously disturbed areas near the tunnel portal would also locally disturb geologic materials.

Due to the distances (Figure 3.7-1 and Slate et al. 1999) between the DIVINE STRAKE experiment location and the nearest faults or fault zones (the closest faults are the Mine Mountain and Carpetbag Faults, which pass within approximately 5 miles (8 km), and 6.8 miles (11 km), respectively, of the DIVINE STRAKE site at their closest approach), and given the relatively small output of the DIVINE STRAKE detonation) when compared to previous nuclear tests, the potential for activation or reactivation of faults or fault zones is expected to be minimal. In addition, there are no valuable mineral, oil, gas, and/or aggregate resources present within region of influence that could be affected. Therefore, geologic impacts are considered to be less than significant.

Soils

The proposed DIVINE STRAKE detonation area, consisting of the NTS Tunnel U16b Complex and surrounding hilly terrain, has experienced some minor surface disturbance as a result of previous tunnel excavation activities. DIVINE STRAKE would result in some additional disturbance of the ground surface in the vicinity of the DIVINE STRAKE charge pad and access road leading to the charge pad above the U16b Tunnel Complex. The proposed detonation would disturb surficial soils present in the immediate vicinity surrounding the detonation cavity. Peripheral cavity collapse impacts would locally alter soil conditions; however, due to the limited thickness and extent of soils at the experiment site and vicinity, such impacts would be limited and localized in extent.

In addition to the direct effect of the detonation on soils, surface preparation activities performed prior to the proposed detonation would cause some localized disturbance of soils. Existing roads would be used to the maximum extent practicable to minimize soil disturbance. Improvement of the existing earthen access road leading toward the top of the hill above the U16b tunnel, extension of this access road, regrading for construction of the earthen charge pad, and excavation of the charge hole would locally alter topography in the vicinity of the detonation site. DIVINE STRAKE-related activities may involve limited off-road travel by team personnel for performing pre- and post-experiment reconnaissance surveys, geologic mapping, and placement of sensor devices, cameras, or similar activities. Surficial disturbance resulting from such travel is expected to be temporary and negligible in magnitude and extent. The impact of these activities on-site soils would not be significant.

Soils on the sloped hillside immediately above and below portions of the existing access road and the proposed access road extension have the potential for some accelerated erosion as a result of ground-disturbing activities (e.g., pre-detonation site preparation and/or ground shaking from the blast). The unvegetated fill materials that would comprise the charge pad would also be disrupted by the blast and this disrupted platform could be susceptible to some post-detonation accelerated erosion. Appropriate erosion control measures would be implemented during the DIVINE STRAKE detonation, including installation of angled water bars in soil, soil terracing, or other conventional erosion control measures, to mitigate against any increased sediment losses. The DIVINE STRAKE detonation would not significantly alter natural drainages or erosion rates in surficial materials in areas beyond the immediate vicinity of the charge pad and a portion of the extended access road nearest the charge pad.

The specific site of the proposed DIVINE STRAKE detonation, above the U16b tunnel, was not used for nuclear testing or other activities that would have introduced radioactivity into the soils affected by the experiment. The U16b tunnel has been previously used for conventional explosives testing, but these experiments have not involved the use of nuclear explosives or radioactive materials. The area where the proposed DIVINE STRAKE experiment would be conducted above the U16b tunnel has been excavated to prepare for emplacement of the explosives for the experiment. Thus, the ANFO emplacement will be in virgin rock that has not been exposed to previous testing activities at the NTS or to global fallout.

Aerial radiation surveys performed in 1992, 1994, and 2006, as well as ground-level radiation surveys performed in 2006, showed no detectable radiation above natural background levels in the vicinity of the proposed DIVINE STRAKE experiment site. However, very low levels of radioactive fallout from past world-wide nuclear activities are known to exist in surface soils throughout the world. This radioactivity exists at such low levels that it would not be distinguishable from natural background radiation in the aerial and ground-level radiation surveys performed previously at the proposed experiment site. Consequently, in 2006, NSO and DTRA prepared and implemented a sampling and analysis plan to obtain more detailed information about the radionuclide characteristics of materials that could be potentially dispersed by the proposed DIVINE STRAKE experiment. Low but detectable levels of man-made radioactivity were identified primarily in undisturbed surface material. No man-made radioactivity was detected in subsurface rock material. Additional details, including a historical summary of previous radiation surveys, are included in Appendix A. No radiological impacts to soils from DIVINE STRAKE are anticipated.

In summary, impacts of DIVINE STRAKE on geology and soils are anticipated to be minor and localized to the immediate vicinity of the DIVINE STRAKE charge hole and charge pad. Where soils are locally disrupted, conventional erosion controls would be used to mitigate soil erosion.

<u>Environmental Consequences of the No-Action Alternative</u>

With the No-Action Alternative, the DIVINE STRAKE detonation event would not occur. Therefore, no impacts to geology and soils would occur as a result of implementation of the No-Action Alternative.

4.8 Impacts to Surface Water and Groundwater

Existing and background information pertaining to surface water and groundwater for the study area is summarized and presented in Section 3.8. The potential for significant impacts to surface water and groundwater resources have been assessed based on whether the Proposed Action would:

- Adversely affect capacity of available surface water resources; conflict with established water rights or regulations protecting water resources for future beneficial uses; contaminate public water supplies and other surface waters exceeding water quality criteria or standards established in accordance with the Clean Water Act, state regulations, or permits; or conflict with regional water quality management plans or goals
- Substantially alter storm water discharges and adversely affect drainage patterns, flooding, and/or erosion and sedimentation; or cause filling of wetlands or otherwise alter drainage patterns that would adversely affect jurisdictional wetlands
- Adversely affect a sole source aquifer; substantially deplete groundwater supplies or interfere with groundwater recharge affecting available capacity of a water source; conflict with established water rights or regulations protecting groundwater for future beneficial uses; contaminate a public water supply aquifer exceeding Federal, state, or local water quality criteria; or conflict with regional or local aquifer management plans or goals of governmental water authorities

No impacts to surface water and groundwater were identified based on the criteria listed above. A detailed discussion on the surface water and groundwater analyses is presented below.

Environmental Consequences of the Proposed Action

Implementation of the Proposed Action would not result in any impact to surface water because no perennial streams or naturally occurring surface water bodies are located on the NTS. It is expected that Tippipah Springs (located approximately two miles (3.2 km) from the detonation site) would be dusted by emissions from the detonation, but spring flow is unlikely to be affected. In addition, groundwater within the vicinity of the Proposed Action is estimated to be approximately 1,200 feet (366 m) below the land surface, and the precipitation rate is low on the NTS (DOE, 1996). Approximately 0.5 to 1.0 acre feet of water would be used for the proposed project. That water would be obtained from wells on the NTS. The water would be imported to the site via water haul trucks. Historic demand for water on the NTS up to 1996 ranged from 850 acre-feet per year in 1963 to about 3,430 acre-feet in 1989 (DOE, 1996). More recently, NTS water demand has ranged from 892.13 acre-feet in fiscal year 2002 to 668.71 acre-feet in fiscal year 2006 (Baugh, 2006b). Water demand for the past five years has averaged 776.98 acre-feet per year. The maximum anticipated water demand for DIVINE STRAKE would represent a 0.13 percent increase in average NTS water demand. Therefore, water use for the

DIVINE STRAKE experiment combined with current water demand at the NTS would not exceed historic levels and would not result in an impact to groundwater quantity. Because of the depth to groundwater beneath the DIVINE STRAKE experiment, there are no impacts anticipated to groundwater quality.

No radiological impacts were identified for surface water or groundwater.

Site preparation activities would include the construction of spill containment in the construction and material staging areas (see Section 2.3.1). Thus the potential for uncontrolled releases to the environment resulting from spills would be minimized.

Implementation of the Proposed Action would have no impact or effect on regional aquifer management plans or goals.

Environmental Consequences of the No-Action Alternative

With implementation of the No-Action Alternative, the proposed detonation would not occur. Therefore, there would be no impacts to surface water and groundwater.

4.9 Impacts to Atmospheric Resources

This section describes the potential impact to air quality resulting from implementing the Proposed Action and No-Action Alternative. With the Proposed Action and the No-Action Alternative, radiological material would not be used. Potential impacts to atmospheric resources have been assessed based on whether the Proposed Action would:

- Comply with NESHAP 40 CFR Part 61 Subpart H requirements
- Comply with NAAQS, Nevada AAQS primary and secondary standards, and the NTS Air Quality Operating Permit
- Impact air quality locally, regionally, or nationally
- Create long-term visibility problems from particulate matter
- Substantially increase greenhouse gas emissions

No significant impacts were identified during the atmospheric resources analysis. A detailed discussion is provided below.

Environmental Consequences of the Proposed Action

Air Dispersion Modeling

The mixture of ANFO-emulsion that would be used for DIVINE STRAKE is a commonly used agent in commercial blasting operations. The end products of explosive reactions are determined primarily by the oxygen balance of the explosive. The ANFO mixture contains a fuel oil content of 5.5 percent, which creates an oxygen-balance during the detonation of the blasting agent. Emissions from the detonation of the ANFO would be released to the atmosphere, adding an increment of pollution.

Air dispersion modeling is used to predict the manner in which pollutants will disperse as they are released into the atmosphere and the resulting concentrations of these pollutants at various receptors (e.g., residential areas, parks) and to demonstrate compliance or non-compliance with the NAAQS and NV AAQS. Air dispersion modeling for DIVINE STRAKE was conducted using the POLU4WN model to identify the amount of each chemical compound that could be emitted by detonation of the experiment. The dispersion of those emissions was then modeled using Open Burn/Open Detonation Model (OB/ODM), a U.S. EPA-approved air dispersion model. Because the POLU4WN model does not evaluate dispersion of particulate matter, an algorithm from Combined Obscuration Model for Battlefield-Induced Contaminants (COMBIC) was used to estimate the amount of fugitive dust and PM_{10} that would be created by DIVINE STRAKE. Use of these models for DIVINE STRAKE was approved by the Nevada Bureau of Air Pollution Control. A more detailed description of the modeling and results is included in Appendix E.

Compliance With NAAQS, Nevada AAQS, and NTS Air Quality Operating Permit

The following discussion addresses only non-radioactive emissions anticipated from the DIVINE STRAKE experiment. Compliance with NAAQS and Nevada AAQS at the NTS is based on the concentration of criteria pollutants from all activities, including DIVINE STRAKE at the boundary of the NTS. The NTS AQOP requires compliance with the Nevada AAQS by placing limitations on the amounts of criteria and hazardous air pollutants that may be emitted by all activities at the site as well as certain facility-specific requirements.

In order to determine if the DIVINE STRAKE experiment would result in an exceedence of NTS AQOP emission limits, the results from POLU4WN and COMBIC modeling were combined with the cumulative emissions from all other NTS activities for the previous 12-month period. That combined total was compared to the permitted emission limits. The results of that comparison are displayed in Tables 4.9-1 and 4.9-2. All potential emissions of criteria and hazardous air pollutants from DIVINE STRAKE would fall within the limits of the NTS AQOP. Total particulate matter is not included in Table 4.9-1 because it is considered as fugitive dust.

Table 4.9-1
Estimated Emissions of Criteria Pollutants for DIVINE STRAKE

Criteria Pollutant	DIVINE STRAKE[a] (tons/year)	NTS[b] Actual Emissions (tons/year)	Total Potential Emissions (tons/year)	NTS AQOP Emission Limit (tons/year)
Carbon Monoxide	0.22	0.15	0.37	23.47
Nitrogen Oxide	3.79	0.69	4.48	72.33
Sulfur Dioxide	0.40	0.04	0.44	6.89
PM_{10}	17.55[c]	0.84	18.39	61.96

[a] Calculated by POLU4WN Model
[b] Based on NTS Annual Emissions Inventory for calendar year 2005
[c] PM_{10} for DIVINE STRAKE was determined using COMBIC and is based on the calculated volume of the post-detonation crater plus one-half of all emissions reported by POLU4WN as "solids".

Potential emissions of non-radioactive hazardous air pollutants from the DIVINE STRAKE detonation are displayed in Table 4.9-2. NSO maintains a 12-month rolling inventory of hazardous air pollutants from all activities at the NTS. During the period October 1, 2005 to September 30, 2006, a total of 1.77 tons of hazardous air pollutants were emitted at the NTS. This combined with the estimated hazardous air pollutants emissions from DIVINE STRAKE (10.13 tons) would equal 11.9 tons. Prior to conducting the DIVINE STRAKE experiment, NSO would repeat this analysis using then current 12-month emissions inventory figures to ensure full compliance with the emissions limits in the NTS AQOP.

Table 4.9-2
Estimated Emissions of Hazardous Air Pollutants for DIVINE STRAKE

Hazardous Air Pollutant	DIVINE STRAKE[a] (tons/year)
Chlorine	0.82
Chloromethane	0.39
Cyanide Compounds	2.17
Formaldehyde	0.23
Hexachloroethane	1.84
Hydrazine	0.50
Phosgene	0.77
Tetrachloroethene	1.29
Tetrachloromethane	1.19
Trichloromethane	0.93
Total	10.13

[a] Calculated by POLU4WN Model

As noted earlier, OB/ODM was used to estimate dispersion of emissions from the DIVINE STRAKE experiment. Using the anticipated wind direction and speed at the time of detonation, OB/ODM projected that the emission plume would cross the NTS boundary to the U.S. Air Force Nevada Test and Training Range at the northern end of Areas 19 and 20. Table 4.9-3 displays the results of the analysis and demonstrates that the concentration of criteria pollutants at the NTS boundary would be well within the NAAQS and Nevada AAQS.

Diesel generators would be used during the DIVINE STRAKE experiment operation to provide power for the instrumentation van. The generators are below the horsepower limits to require permitting, and are considered Insignificant Sources by the State of Nevada. Emissions from the diesel generators would be included in the NTS annual emissions inventory.

Nevada regulations as well as the NTS AQOP address the control of fugitive dust during surface disturbing activities. Water sprays would be used to minimize dust created during construction-related activities, road building, and excavation of the experiment hole. While it would not be possible to minimize or otherwise control fugitive dust from the detonation, this activity would still be in compliance with State of Nevada regulations and the NTS AQOP.

Table 4.9-3
Non-Radioactive Air Dispersion Modeling Results for DIVINE STRAKE

Pollutant	Averaging Period	Maximum Modeled NTS Sources[f] (μ/m^3)[a]	Background Concentration[f] (μ/m^3)[a]	Modeled Divine Strake Test (u/m^3)[a]	Total NTS Concentration (μ/m^3)[a]	NAAQS/ NV AAQS[g] Standard (μ/m^3)[a]
Nitrogen Oxides	Annual	2.5	0	0.00001	2.50001	100
Sulfur Dioxide	Annual	0.6	0	n/a	n/a	80
	24-hour	17.0	0	0.00096	17.00096	365[b]
	3-hour	74.9	0	0.00767	74.90767	1,300[b]
Carbon Monoxide	8-hour	42.2	0	0	42.2	10,000[bc]
	1-hour	222.5	0	0.0001	222.5001	40,000[b]
PM_{10}[d]	Annual	0.6	9.0	n/a	n/a	50
	24-hour	17.4	10.2	0.01673	27.61673	150[b]
Ozone[e]	1-hour	204.7	0	0.10094	204.80094	235[b]

[a] u/m^3 = micrograms per cubic meter
[b] Not to be exceeded more than once per calendar year
[c] 6,670 μ/m^3 at areas equal to or greater than 5,000 feet above Mean Sea Level
[d] Particulate matter with aerodynamic diameter less than or equal to 10 microns
[e] Ozone concentrations were conservatively assumed to be equal to VOC concentrations
[f] Source: Appendix 7, NTS Air Quality Operating Permit Renewal Application Package, March, 2002
[g] Source: NAC 445B.22097
n/a – not applicable
Note: All concentrations of emissions are modeled at the boundary of the NTS

Compliance with 40 CFR Part 61, Subpart H - National Emission Standards for Emission of Radionuclides Other Than Radon from Department of Energy Facilities

Part 61, Subpart H, of Title 40 of the Code of Federal Regulations states "Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/year." The DOE is required to submit to its regulator an application for approval to construct for any qualified new construction or modification of an existing facility if the effective dose equivalent caused by all emissions from the new construction or modification would exceed 1 percent of the standard (i.e., 0.1 mrem/yr). NSO and DTRA applied this standard to DIVINE STRAKE because of the potential for resuspension of radionuclides in the soil around the project site as the result of fallout and naturally occurring radionuclides.

In accordance with Section 61.93, the dose assessment was conducted with the computer model CAP88-PC, version 3.0, a U.S. EPA-approved model. In addition to this model, a dose assessment was conducted by the National Atmospheric Release Advisory Center (NARAC) at the Lawrence Livermore National Laboratory. CAP88-PC is most effective in modeling radioactive releases from ongoing processes, rather than one-time, essentially instantaneous, events such as DIVINE STRAKE. NARAC modeling was conducted to obtain dose estimates from a model designed for instantaneous releases; the model also addresses terrain effects. As estimated by the CAP88-PC and NARAC models, potential radiation doses to a hypothetical maximally exposed individual at the closest NTS boundary to the DIVINE STRAKE experiment (eastern boundary) were about 20 times lower than the 0.1 mrem effective dose equivalent threshold for requesting U.S. EPA approval. Additional details of the dose assessment are in Appendix F.

4.10 Impacts to Meteorological Conditions

Environmental Consequences of the Proposed Action

Existing and background information pertaining to meteorological conditions for the study area is summarized and presented in Section 3.10. The Proposed Action would not alter or affect meteorological conditions; however, these conditions substantially affect the ability to conduct the Proposed Action in a manner that minimizes the potential impacts and ensures that those impacts would be contained within the boundaries of the NTS. Thus, this section describes the conditions that are required to execute the Proposed Action.

Predictions for airblast environmental damage to biota and structures are based on meteorological periods when the atmosphere is calm, homogeneous, non-refracting, and non-channeling. While adverse meteorological conditions can increase damages and environmental impact by as much as seven times, detonation would only occur in accordance with the meteorological criteria defined in Chapter 2, Section 2.2.2 (Ristvet, 2005). These impacts are discussed in their respective sections of the EA.

DIVINE STRAKE would be detonated when meteorological conditions, as monitored by a meteorological team, are acceptable. Criteria that would be used by DTRA to determine if the experiment would be conducted are detailed in Chapter 2.

Prior to the DIVINE STRAKE detonation, forecasted meteorological conditions for 7 to 14 days would be evaluated. If meteorological conditions were not satisfactory, the emplacement of the blasting agent and the detonation would be postponed. Required meteorological conditions are: no inversions; no more than 40 percent stratus or cumulus cloud cover; and surface winds less than 25 miles per hour blowing from the southwest (240 degrees) through the southeast (120 degrees). Winds blowing to the northeast to northwest help direct the blast pressure forward onto the northern half of the NTS, away from most NTS facilities and the off-site communities south of the NTS. The blast wave analysis and predictions in this EA assume a calm, homogenous atmosphere.

On the day before and the day of, the detonation meteorological observations consisting of National Oceanic and Atmospheric Administration (NOAA) regional weather data and predictions and on-site NOAA rawinsonde launches (weather balloons) would be used to measure wind and temperatures aloft, so that long-range airblast levels can be calculated and compared to data on civilian population centers to determine the likelihood of structural damages and excessive noise. A NOAA meteorologist would be present to assist in the interpretation of the meteorological data and in the airblast predictions. Further discussions on the effect of meteorological conditions on airblast and noise are in Section 4.2, Impacts of Blast and Noise. Acceptable blast conditions criteria are detailed in Chapter 2.

Environmental Consequences of the No-Action Alternative

With the No-Action Alternative, the DIVINE STRAKE detonation would not occur. Therefore, there would be no meteorological impacts.

4.11 Impacts to Biological Resources

Potential for impacts to terrestrial and aquatic resources as well as to special status species are discussed in this section. The potential for significant impacts was assessed based on whether the Proposed Action would:

- Cause substantial displacement of unique terrestrial communities or loss of habitat
- Diminish the value of a substantial amount of habitat for wildlife or plants to an unusable level
- Cause a native wildlife population to drop below self-sustaining levels
- Substantially interfere with the movement of any native resident or migratory wildlife species for more than one reproductive season
- Conflict with applicable management plans for wildlife and habitat to the extent that the plan's objectives cannot be achieved
- Adversely affect or displace special status species
- Cause encroachment or an adverse effect on a designated critical habitat

Impacts to biological resources would be less than significant. No radiological impacts to biological resources were identified. A detailed discussion of the analysis is provided below.

Environmental Consequences of the Proposed Action

Terrestrial Communities

Potential impacts to terrestrial communities were assessed by identifying the communities present within the region and at the project area by reviewing the various available documents on the topic, and by conducting a site visit. The information obtained from the literature review and from the site visit were evaluated to identify if any unique communities were present within the project area, and to assess the quality of the habitat in the area. The characteristics of the proposed construction and other activities associated with the proposed project were then reviewed to identify the types of potential impacts on the components of the community.

Potential regional impacts on the terrestrial communities are expected to be minimal. One potential regional impact includes the short-term startle-effect on some wildlife species from the noise and vibration of the blast. Regionally, the wildlife would experience noise comparable to thunder or sonic booms experienced during occasional overflights. Ground motion experienced by wildlife would be comparable to mild earthquakes.

The proposed project would alter a small amount of habitat characterized as Mojave-Great Basin Desert transition zone. The affected vegetation associations are well represented on the NTS and throughout the region, therefore the loss of a relatively small part of these habitats would have minimal regional impacts on the communities or the plant and wildlife populations found within them. None of these impacts are expected to be significant.

Project area impacts on the terrestrial community would include the destruction of some habitat, loss of vegetation, and potential death or injury of some individuals. Locally, the impacts would be substantial and in many cases permanent; however, the impacts are not expected to be significant to the regionally available habitat or to wildlife populations of individual species. Construction activities associated with the access road, staging areas, and the excavation of the pit would result in disturbance of approximately 0.81 hectares (2 acres) of blackbrush-Nevada jointfir vegetation association. The loss of this habitat would be long-term, and possibly permanent, due to the loss of substantial geologic material and all of the topsoil as a result of the blast. The severe alteration of the topography and lack of topsoil hinders natural succession of the native vegetation community. Areas adjacent to the blast site would be covered with overburden of rock and soil in varying depths. Given these areas would have topsoil and vegetative structure beneath the outfall, natural succession would allow these areas to revegetate over time.

The Proposed Action may result in the death or injury of individuals of various wildlife species in the vicinity of the project area from several causes. During construction, ground-dwelling small mammals, lizards, and snakes may be killed as the site is prepared using heavy equipment. Some individual animals also may be killed or injured due to construction and operation traffic on roads, but these incidences would be low due to reduced speed limits on most roads. The blast would result in the greatest impact on wildlife in the project area. Though many individuals would move from the area due to the construction activities, some individuals likely would remain in the adjacent areas. Small mammals, lizards, snakes, and some small songbirds could be present in the area at the time of the blast, and may be killed or injured from the concussion of the blast, from burial due to the collapse of burrows or other shelters, or receive varying degrees of permanent or temporary deafening.

The distance to which wildlife may be injured or killed due to the blast would be highly dependent on atmospheric conditions and topography. There is an approximate 1-percent probability of serious injury to small animals (even less for large animals) at a peak overpressure of 5.7 psi (0.401 kilogram per square centimeter). Prior calculations were made using 800 tons (725 metric tons) of ANFO during DIVINE STRAKE conceptualization. It was later determined that 700 tons (635 metric tons) would be sufficient material to conduct DIVINE STRAKE. The estimated peak overpressure from DIVINE STRAKE (assuming 800 Tons [725 metric tons] of ANFO) was calculated at 2.9 psi (0.204 kg per square centimeter), which would occur up to 2,250 feet (686 m) from the center of the blast. Based on this, within a 2,250-foot (686-m) perimeter of the blast there is a less than 1-percent probability of serious injury to small animals that remain above ground during the blast. Since the Proposed Action would be the detonation of 700 tons of ANFO, the calculations provided above are a very conservative estimate. The blast area would be reduced. Therefore, there would be a decreased probability of an injury to small animals. Additionally, if an animal is protected by a burrow or depression, the overpressure required for serious injury increases by forty percent. The distance at which burrows would collapse cannot be determined due to the lack of data on stability of wildlife burrow structures. Likewise, the impacts on hearing in wildlife is difficult to assess, but in humans damage to the eardrums may occur at about 2,500 feet (760 m), so similar impacts on wildlife could be inferred if the wildlife are above-ground at the time of the blast.

The proposed project would substantially alter a relatively small amount of habitat common to the region, and may kill or injure wildlife in and around the immediate project site from the construction, the explosive blast, and the noise. However, the project would not affect unique habitats or a substantial amount of common habitat, would not reduce wildlife populations in the region below a self-sustaining level, would not affect movement patterns or reproductive behavior for more than one season, nor would it conflict with wildlife management plans on the NTS. For these reasons, the impacts on the terrestrial communities would not be significant.

In accordance with DOE policy, pre-construction surveys by qualified biologists have been conducted to identify any unique or protected wildlife species that may be found in the area (see Appendix C).

Aquatic and Wetland Communities

No aquatic or wetland communities are present within the proposed project area. A small wetland community associated with Tippipah Spring is approximately 2 miles (3.2 km) from the proposed detonation site. It is anticipated that the wetland vegetation associated with Tippipah Spring may receive a light coating of dust from emissions from the detonation but would not be otherwise adversely affected. For that reason, no long-term impacts to aquatic or wetland communities are likely to occur.

Endangered, Threatened or other Special Status Species

Potential impacts to threatened and endangered species were assessed by identifying those species potentially occurring in the region by reviewing available documents and conducting a site visit. The information obtained from the literature review and the site visit was evaluated to identify if any listed or otherwise sensitive species may be present within the project area. The characteristics of the proposed construction and other activities associated with the proposed project were then reviewed to identify the types of potential impacts that might occur on the species in the region.

The only threatened or endangered species that resides in the general region of the proposed project is the desert tortoise, which is found within the southern portions of the NTS, approximately 6.2 miles (10 km) from the project site. For this reason, there should be no impacts to threatened or endangered species from the proposed project. Other special status animal species potentially occurring within the area may be impacted by the startle-effect at the time of the blast. However, this impact would be of short duration and is likely to have no significant impacts on these species. Other special status species likely would not be affected based on the limited potential impacts beyond 2,250 feet (686 m) from the project area.

Several special status bird and mammal species range widely and could pass through the area. The golden eagle and ferruginous hawk have been observed on the NTS, and could fly over the project area. These sitings are extremely rare and not generally in the area of the proposed experiment. Additionally, wild horses are present on the NTS and also range widely but have not been reported within 3.1 miles (5 km) of the project area. For large birds, being within 2,250 feet (686 m) of the project site during the blast could result in severe injury or death. No special status plant species are known to occur in the area, and therefore no impacts to these species are expected to occur (see Appendix C).

Mitigation

Pre-construction surveys have been conducted to ensure special status species are not present in the area.

Environmental Consequences of the No-Action Alternative

With the No-Action Alternative, the DIVINE STRAKE detonation event would not be conducted. Therefore, there would be no impacts to biological resources.

4.12 Impacts to Cultural Resources

This section describes the potential impacts to archaeological sites, historic architectural or engineering features, and Native American religious or sacred places in the vicinity of the Proposed Action. The potential for significant impacts to these resources have been assessed based on whether the Proposed Action would:

- Cause the potential for loss, isolation, or substantial alteration of an archaeological resource eligible for listing on the National Register of Historic Places (NRHP)
- Cause the potential for loss, isolation, or alteration of the character of a historic site or structure eligible for listing on the NRHP
- Introduce visual, audible, or atmospheric elements that would adversely affect a historic resource eligible for listing on the NRHP
- Cause the potential for loss, isolation, or substantial alteration of Native American resources, including graves, remains, and funerary objects

No significant impacts were identified during the cultural resources analysis. A detailed discussion is presented below.

Environmental Consequences of the Proposed Action

Archaeological Resources

Implementation of the Proposed Action could potentially have an impact on prehistoric and historic cultural materials in areas where land-disturbing activities would take place; however, the U16b tunnel complex and areas where Proposed Activities would occur mostly consists of previously disturbed areas. Based on pedestrian surveys and shovel testing within the project

APE (as defined in Section 3.12), no archeological materials have been identified and the potential for archaeological occurrence is considered low.

NSO completed formal consultation with the SHPO in accordance with Section 106 of the National Historic Preservation Act. The SHPO concurred with NSO's determination of eligibility and mitigation to cultural resources as a result of the DIVINE STRAKE experiment. As part of the consultation process, NSO will conduct post-experiment monitoring, and provide documentation and photographs to the SHPO. Correspondence with the SHPO is included in Appendix G.

As with any land-disturbing project there is always the possibility that unknown deposits or resources could be encountered during construction or other project activities. In the unlikely event that evidence of archaeological deposits is encountered during construction, work in the immediate area would cease and archaeological staff would initiate accidental discovery procedures under the provisions of the Advisory Council on Historic Preservation (ACHP).

Historic Resources

Implementation of the Proposed Action could potentially have an impact on a structure that is located on a NRHP-eligible site (Tippipah Spring, site 26NY4). This structure is located approximately 2 miles (3.2 km) from the proposed detonation site, is severely deteriorated, and lacks structural integrity. Given the condition of this resource, it is possible that blast impacts from the Proposed Action could further damage the structure. NSO consulted with the SHPO regarding this structure, potential impacts as a result of the Proposed Action, and potential Section 106 mitigation. The SHPO agreed to NSO's proposed treatment plan for mitigation of potential impacts to this structure and accepted the Technical Report for the Tippipah Spring Historic Site (Appendix G). Therefore, impacts to historic resources are expected to be less than significant.

Native American Cultural Resources

No specific Native American sacred or religious site has been identified within the APE of the Proposed Action; therefore, implementation of the Proposed Action would have no effect on this issue.

Environmental Consequences of the No-Action Alternative

With implementation of the No-Action Alternative, the DIVINE STRAKE detonation event would not occur. Therefore, there would be no impacts to Cultural Resources.

4.13 Impacts to Socioeconomics and Environmental Justice

This section describes the potential impacts to social and economic resources in the vicinity of the Proposed Action, including population, housing, and environmental justice issues. No significant socioeconomic and environmental justice issues were identified. A discussion is presented below.

Environmental Consequences of the Proposed Action

Implementation of the Proposed Action would have no effect to the population of the off-site communities, nor the population growth rate. Temporary impact from potential temporary-assignment employees would also not have an impact to the population growth rate and business generated by temporary-assignment employees would not be significant. Proposed Action activities would also not impact employment projections and services of the area. No environmental justice impacts were identified.

Environmental Consequences of the No-Action Alternative

With implementation of the No-Action Alternative, the DIVINE STRAKE detonation event would not occur and the baseline conditions of the study area would not change. Therefore, there would be no impacts related to socioeconomics or environmental justice.

4.14 Impacts to Aesthetics and Visual Resources

This section describes the potential impacts to aesthetics and visual resources in the vicinity of the Proposed Action. The potential for significant impacts to these resources have been assessed based on whether the Proposed Action would:

- Adversely affect a national, state, or local park or recreation area
- Degrade or diminish a Federal, state, or local scenic resource
- Create adverse visual intrusions or visual contrasts affecting the quality of a landscape

No significant impacts were identified for aesthetic and visual resources. A discussion is presented below.

Environmental Consequences of the Proposed Action

The Proposed Action would occur well inside the boundaries of the NTS and project construction related activities are not expected to be visible from surrounding public lands. These activities would not affect any scenic resources or parks, and would not create any adverse visual contrast that would affect the quality of the landscape when compared to baseline conditions.

The explosion associated with the Proposed Action could produce a detonation cloud that would be visible from various vantage points within the NTS; however, this cloud would be temporary and would not adversely affect aesthetic or visual resources. Because the southern boundary of the NTS is surrounded by various mountain ranges, including the Spector Range, Striped Hills, Red Mountain, and the Spotted Range, and views from U.S. Highway 95 are limited to Mercury Valley and some portions of the southwestern sector of NTS, it is not expected that such a cloud would be visible from these areas. In the event that the detonation cloud is visible from adjacent lands, impacts would be minimal since they would be temporary. The dust cloud from the experiment would not be visible from the valleys surrounding the NTS. From the higher mountain tops near the NTS, an observer may be able to see a dust cloud if conditions are favorable. The dust cloud may rise to approximately 4,800 feet (1,463 m) above ground level at the experiment site (approximately 10,000 feet (3,048 m) above mean sea level) and is expected to dissipate rapidly. The visual impacts would be of a short duration.

Environmental Consequences of the No-Action Alternative

With implementation of the No-Action Alternative, the DIVINE STRAKE detonation event would not take place. Therefore, there would be no impacts that would affect aesthetic and visual resources.

4.15 Cumulative Impacts

In accordance with the Council on Environmental Quality regulations, a cumulative impact analysis includes "the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time" (40 CFR Part 1508.7).

The cumulative impact analysis for this EA includes: (1) an examination of cumulative impacts presented in the 1996 NTS EIS (DOE, 1996) and the 2002 NTS EIS Supplement Analysis (DOE, 2002a); (2) a review of the incremental impacts of the Proposed Action for DIVINE STRAKE, presented previously in this chapter; and (3) a review of past, present and reasonably foreseeable actions for other federal and non-federal agencies in the region as analyzed in the 2002 Supplement Analysis. Because this EA is tiered from the 1996 NTS EIS and the 2002 Supplement Analysis, and a thorough analysis of cumulative impacts was included in the 2002 Supplement Analysis, these documents were relied upon heavily for analysis of cumulative impacts. The DTRA Hard Target Defeat Tunnel Program was previously analyzed in the 2002 Supplement Analysis.

Environmental impacts of the Proposed Action on each resource area were reviewed to determine which impacts, if any, would add cumulatively to impacts from other NTS actions or other actions in the region of influence. The following paragraphs summarize potential cumulative impacts from the DIVINE STRAKE detonation:

Noise – For noise, the greatest impact in the region of influence is from aircraft based at the Nevada Test and Training Range (formerly the Nellis Air Force Range). This impact is expected to increase as more aircraft will be based at Nellis Air Force Base as a result of Base Realignment and Closure. DIVINE STRAKE would add a large, percussive boom, and although it would add to noise in the region, it would be a temporary, one time event with no anticipated human health and safety effects. Therefore the cumulative impact would be negligible.

Human Health and Safety – DIVINE STRAKE would add additional safety risk to those already experienced by workers at the NTS. However, the potential risk is small because of administrative and physical controls, PPE, and training. The DOE has a lower accident rate than industry in general because of existing controls and safety training. As a result, DIVINE STRAKE is not expected to add significantly to the existing NTS worker health and safety impacts.

A comprehensive sampling of the soils in the area around the DIVINE STRAKE experiment site identified low levels of man-made radioactivity primarily within the undisturbed surface material (i.e., native surface material that was exposed to atmospheric fallout). No man-made radioactivity was found in subsurface rock material, and almost none was found in disturbed material (i.e., excavated material containing a mixture of surface and subsurface material). Some portion of each of these materials may be explosively dispersed by the detonation; dispersion of these materials was modeled using approved air dispersion models (see Sections 4.3 and 4.9, and Appendix E) and the results indicate a dose of 0.005 mrem would be received by an individual located at the eastern NTS boundary, assuming winds were blowing to the east at the time of the DIVINE STRAKE detonation. Given the distance of communities to the NTS boundaries, potential doses to off-site human populations would be generally two to five times lower still (see Appendix F). The DIVINE STRAKE detonation will not occur unless the meteorological conditions are favorable (see Section 2.2.2, Proposed Operating Plan). This dose compares to an average annual dose of 360 mrem from all sources received by the general population. (See text box in Section 3.3). There are no identified health and safety impacts to persons off the NTS.

Geology and Topography – Previously, nuclear testing has left craters in various areas at the NTS. DIVINE STRAKE would also leave a crater after the detonation. There are currently no other explosive craters in Area 16 where the DIVINE STRAKE detonation would occur. While another crater would be created at the NTS, somewhat altering the local topography, this impact is not considered significant.

Atmospheric Resources – Air emissions from all sources in the region of the NTS are within applicable standards. Air dispersion modeling for the DIVINE STRAKE detonation products and particulate matter (Appendix E, Air Dispersion Modeling Results) indicates criteria and hazardous pollutants would remain well within acceptable thresholds defined in the NTS AQOP at the NTS boundary. Emissions from DIVINE STRAKE would be a one time event. A comprehensive sampling of the soils in the area around the DIVINE STRAKE experiment site identified low levels of man-made radioactivity primarily within the undisturbed surface material (i.e., native surface material that was exposed to atmospheric fallout). No man-made radioactivity was found in subsurface rock material, and almost none was found in disturbed material (i.e., excavated material containing a mixture of surface and subsurface material). Because the proposed detonation could resuspend these radionuclides in the air, NSO conducted modeling to determine the potential impact on air quality and human health (see Sections 4.3 and 4.9, and Appendix E). Modeling results indicate a dose of 0.005 mrem could be received by an individual located at the eastern NTS boundary, assuming winds were blowing to the east at the time of the DIVINE STRAKE detonation. This dose compares to the average annual background dose of 360 mrem received by the general population (see text box in Section 3.3).

Biological Resources (Flora and Fauna) – While individuals of various wildlife communities located near the site of the detonation would be killed or injured, populations would not be impacted. Additionally, some vegetative cover at and surrounding the detonation site would be destroyed or damaged. However, no adverse impacts to threatened or endangered wildlife or vegetative species are expected (see Appendix C, Biological Resources Surveys). No cumulative impacts to biological resources are expected.

Cultural Resources – As part of the cultural resource analysis, one historic property (Tippipah Spring, Site 26NY4) eligible for listing on the National Register of Historic Places has been identified as possibly being impacted by the DIVINE STRAKE detonation. NSO consulted with the SHPO regarding this structure, potential impacts as a result of the Proposed Action, and potential Section 106 mitigation. The SHPO has agreed to NSO's proposed treatment plan for mitigation of potential impacts to this structure and accepted the Technical Report for the Tippipah Spring Historic Site (Appendix G). Therefore, impacts to historic resources are expected to be less than significant.

No other cultural resources have been identified that may be impacted by DIVINE STRAKE and as such, no cumulative impacts are anticipated.

5.0 Agencies and Persons Consulted

Distribution of the *DRAFT December 2006 Revised Environmental Assessment for a Large-Scale, Open-Air Explosive Detonation, Divine Strake, at the Nevada Test Site*

Elected Officials

Kenny Guinn, Governor, Carson City, NV
Kenny Guinn, Governor, Las Vegas, NV
Harry Reid, United States Senate, Washington, D.C.
Harry Reid, United States Senate, Las Vegas, NV
John Ensign, United States Senate, Washington, D.C.
John Ensign, United States Senate, Las Vegas, NV
Shelley Berkley, House of Representatives, Washington, D.C.
Shelley Berkley, House of Representatives, Las Vegas, NV
Jim Gibbons, House of Representatives, Washington, D.C.
Jim Gibbons, House of Representatives, Las Vegas, NV
John Porter, House of Representatives, Washington, D.C.
John Porter, House of Representatives, Henderson, NV
Jon Huntsman, Jr., Governor, Salt Lake City, UT
Orrin G. Hatch, United States Senate, Washington, D.C.
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Robert F. Bennett, United States Senate, Washington, D.C.
Robert F. Bennett, United States Senate, Salt Lake City, UT
Rob Bishop, House of Representatives, Washington, D.C.
Rob Bishop, House of Representatives, Ogden, UT
Chris Cannon, House of Representatives, Washington, D.C.
Chris Cannon, House of Representatives, West Valley, UT
Jim Matheson, House of Representatives, Washington, D.C.
Jim Matheson, House of Representatives, South Salt Lake City, UT
James E. Risch, Governor, Boise, ID
Larry E. Craig, United States Senator, Washington, D.C.
Larry E. Craig, United States Senator, Boise, ID
Michael D. Crapo, United States Senate, Washington, D.C.
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C. L. Otter, House of Representatives, Washington, D.C.
C. L. Otter, House of Representatives, Boise, ID
Mike Simpson, House of Representatives, Washington, D.C.
Mike Simpson, House of Representatives, Boise, ID
Janet Napolitano, Governor, Phoenix, AZ

Tribal Chairpersons

Carmen Bradley, Kaibab Paiute Tribe, Fredonia, AZ
Daniel Eddy, Colorado River Indian Tribes, Parker, AZ
Joseph Saulque, Benton Paiute Tribe, Benton, CA
Gerald Howard, Bishop Paiute Tribe, Bishop, CA
Edward Smith, Chemehuevi Paiute Tribe, Havasu Lake, CA
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6.0 DEFINITION OF TECHNICAL TERMS

Term	Definition
Aerial Measuring System	A system that detects, measures and tracks radioactive material at an emergency to determine contamination levels
alpha	Alpha particles consist of two protons and two neutrons. They can travel only a few centimeters in air and can be stopped easily by a sheet of paper or by the skin's surface.
ammonium nitrate fuel oil	ANFO under most conditions is considered a high explosive: it decomposes through detonation rather than deflagration and with a high velocity of detonation.
beta	Beta particles are smaller and lighter than alpha particles and have the mass of a single electron. A high-energy beta particle can travel a few meters in the air. Beta particles can pass through a sheet of paper, but may be stopped by a thin sheet of aluminum foil or glass.
Area of potential effect	The area that would potentially be affected with implementation of the Proposed Action. It may vary depending on the resource analyzed.
Cloud-to-ground lightning	Most flashes originate near the lower-negative charge center and deliver negative charge to Earth. However, an appreciable minority of flashes carry positive charge to Earth. These positive flashes often occur during the dissipating stage of a thunderstorm's life. Positive flashes are also more common as a percentage of total ground strikes during the winter months.
Continuous Reflectometry for Radius versus Time Experiments	CORRTEX is a particular technique for measuring a certain property of the shock wave, and merely provides data for hydrodynamic yield estimation methods.
Criteria pollutants	Six principal air pollutants idenified by the EPA: carbon monoxide, lead, nitrogen oxides (NOX), particulate matter (PM-10), ozone and sulfur oxides ()
dBA	A-weighted sound pressure level: A-weighting frequency filter de-emphasizes the very low and very high frequency components of sound in a manner similar to the frequency response of human hearing to sounds of moderate level, and correlates well with people's group reactions to sound and environmental noise.

Exploding bridgewire	a piece of fine wire which contacts the explosive, and a "strong" source of high-voltage electricity—strong, in that it holds up under sudden heavy load.
gamma	Gamma rays (and x-rays), unlike alpha or beta particles, are waves of pure energy. Gamma radiation is very penetrating and can travel several hundred feet in air. Gamma radiation requires a thick wall of concrete, lead, or steel to stop it.
generalized zonal method	An efficient computational scheme for radiation heat transfer.
millirem per year	One commonly used measurement of radiation dose.
moment magnitude	A scale used to measure the energy released by earthquakes.
neutrons	A neutron is an atomic particle that has about one-quarter the weight of an alpha particle. Like gamma radiation, it can easily travel several hundred feet in air. Neutron radiation is most effectively stopped by materials with high hydrogen content, such as water or plastic.
PELs	Permissible exposure limits: OSHA time-weighted average concentrations that must not be exceeded during any 8-hour work shift for a 40-hour workweek.
Threshold limit value	the amount of chemical in the air established by the American Conference of Industrial Hygienists that almost all healthy adult workers are predicted to be able to tolerate without adverse effects. There are three types: • TLV-TWA (TLV-Time-Weighted Average), which is averaged over the normal eight-hour day/forty-hour work week. • TLV-STELs are 15-minute exposures that should not be exceeded for even an instant. It is not a stand-alone value but is accompanied by the TLV-TWA. It indicates a higher exposure that can be tolerated for a short time without adverse effect as long as the total time weighted average is not exceeded. • TLV-C or Ceiling limits are the concentration that should not be exceeded during any part of the working exposure.

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APPENDICES

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APPENDIX A

EVALUATION OF RADIOLOGICAL MONITORING DATA IN AREA 16 OF THE NEVADA TEST SITE FOR THE PROPOSED DIVINE STRAKE EXPERIMENT

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Appendix A

Evaluation of Radiological Monitoring Data In Area 16 of the Nevada Test Site for the Proposed DIVINE STRAKE Experiment

This paper summarizes the results of an evaluation performed of radiological monitoring data in the vicinity as well as the actual experiment test bed site for the proposed DIVINE STRAKE explosive detonation planned for Area 16 of the Nevada Test Site (NTS). The specific location of the experiment, above the U16b tunnel, has no history of nuclear testing or other activities that would have introduced man-made radioactivity into the soils to be affected by the experiment. The U16b tunnel has been previously used for conventional explosives testing; these experiments have not involved the use of nuclear explosives or radioactive materials.

The following radiological monitoring data was reviewed for this report:

- Aerial survey data for Area 16,
- Characterization data for Area 16 and the proposed DIVINE STRAKE experiment site,
- Environmental air monitoring data downwind of the proposed experiment site,
- Ground-level survey data from the U16a muckpile located approximately 1.1 mile from the proposed experiment site, and
- Ground-level survey data between U16a and U16b.

<u>Aerial surveys of Area 16</u>

Aerial radiological surveys have been conducted throughout the history of the NTS to map the fallout from nuclear tests and other experimental activities at the NTS. Aerial surveys of Area 16 were performed in 1970, 1983, 1992, and 1994 (Bluitt, 1986; DOE/NV, 1999). In May 2006, an aerial survey was conducted over a 1- by 1-mile area at the proposed DIVINE STRAKE Experiment Site (Riedhauser, 2006).

The 1970 aerial survey covered only a small portion in the southeastern quadrant of Area 16 and detected no man-made radioactivity. The 1983 aerial survey report (Bluitt, 1986) showed evidence of very low concentrations of cesium-137 and cobalt-60 across two-thirds of Area 16, including the area of the proposed DIVINE STRAKE experiment. The highest radiation readings were associated with a vent line from the nuclear tests in tunnel U16a. The 1992 survey detected no man-made radioactivity in Area 16. The 1994 survey detected low-level cesium-137 (18 – 24 micro-roentgens per hour) only in the vicinity of U16a tunnel, which is approximately 1.1 mile from U16b. The 2006 aerial survey over the proposed site showed no identifiable man-made radioactivity, but there were three areas of slightly elevated radiation (less than twice the average value) that were attributed to variations in natural radioactivity in the area. These three areas were further investigated by ground sampling and analysis and radionuclide activities were found to be not significantly different from the balance of the site (DOE/NV, 2006b).

Characterization data for Area 16 and the site of the proposed DIVINE STRAKE experiment

The DOE carried out a thorough radiological survey of the surface soil on the NTS from 1981 to 1986 using a combination of *in situ* gamma spectrometry and soil sampling techniques (McArthur, 1991). Only a small portion of Area 16 was surveyed because it was assumed to have negligible amounts of soil contamination from NTS activities. A total of six measurements were made in Area 16 along the Mid-Valley Road, and only very low levels of cesium-137 (85 nano-curies per square meter) were detected. The average of these six measurements were extrapolated across the eastern half of Area 16 based on the 1983 aerial survey results. Radionuclide concentrations for americium-241, plutonium-238, plutonium-239/240, cobalt-60, and strontium-90 were calculated based on assumed levels and ratios from the west side of Area 1. No measurements were made in the vicinity of the U16b tunnel at that time.

The area where the proposed DIVINE STRAKE experiment would be conducted above the U16b tunnel has been excavated to prepare for emplacement of the explosives for the experiment. Thus, the ANFO emplacement will be in virgin rock that has not been exposed to previous testing activities at the NTS or to global fallout. In April 2006, the NTS Management and Operating contractor performed an initial ground-level radiological survey of the area surrounding the experiment emplacement and the excavation materials (BN, 2006). Scan surveys for alpha, beta, and gamma radiation levels showed no radioactivity above natural background levels.

The April 2006 radiological survey included four soil samples taken in the vicinity of the excavation. These samples were analyzed on a gamma spectrometry system by the NTS Management and Operating contractor, and no man-made radionuclides were detected.[1] Three additional soil samples were taken by the NTS Management and Operating contractor in May 2006 from the excavated soil and limestone in the excavation area. These samples were analyzed on a gamma spectrometry system by the NTS Management and Operating contractor, and no man-made radionuclides were detected.

[1] The original analysis of these samples resulted in a false positive identification of a trace amount of Americium-241 in two of the samples. The false positive identification was caused by electrical noise from other equipment located near the spectrometry system. After eliminating this source of interference, the samples were re-analyzed and no Americium-241 was detected. (NSTec, 2006)

The April 2006 ground-level survey found no radioactivity that required controls in accordance with Part 835 of Title 10, Code of Federal Regulations, *Occupational Radiation Protection*. However, it was still possible that very low levels of man-made radioactivity from atmospheric fallout might be present that would not be detectable by conventional radiation survey instruments used for occupational radiation surveys. Consequently, the National Nuclear Security Administration and the Defense Threat Reduction Agency decided to conduct further sampling to obtain information about the radionuclide characteristics of any man-made or naturally occurring radiation present in the material potentially dispersed by the experiment. A sampling and analysis plan was developed and implemented using methodologies that incorporated U.S. Environmental Protection Agency standards for surface soil sampling (DOE/NV 2006a). Table 1 summarizes the results of the sampling and analysis derived from the *Site Characterization Report for the Divine Strake Experiment* (DOE/NV 2006b).

Table 1 shows the presence of natural radioactivity typical of the earth's crust and very low levels of some man-made radioactivity. The man-made radioactivity was found primarily within the undisturbed surface material (i.e., native surface material that was exposed to atmospheric fallout). No man-made radioactivity was found in subsurface rock material, and almost none was found in disturbed material (i.e., excavated material containing a mixture of surface and subsurface material). The detectable man-made radionuclides included americium-241, cesium-137, plutonium-238, plutonium-239, and strontium-90. Comparison to the screening levels shown in the last column of Table 1 demonstrates that the observed concentrations of man-made radionuclides are very low relative to a risk-based screening level corresponding to a maximum individual dose of 10 millirem per year to a hypothetical resident living at the experiment site. The average concentrations of all man-made radionuclides are below screening levels, and the upper 95 percent confidence interval (UCI) for all man-made radionuclides, with the exception of strontium-90, are below screening levels. The UCI for strontium-90 exceeds the screening level by 29 percent, corresponding to a maximum individual dose of 13 millirem per year. This comparison to screening levels has no regulatory significance because the proposed action does not involve uncontrolled release of any areas for public use. However, the comparison indicates that the measured concentrations of man-made radioactivity in the material potentially dispersed by the DIVINE STRAKE experiment are very low.

<u>Environmental air monitoring</u>

NNSA operates a network of 19 environmental air sampling stations distributed throughout the NTS. The air monitoring results from these stations demonstrate continuing on-going compliance with the requirements of 40 CFR 61, Subpart H, *National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities*. One of these stations, the 3545

Substation, is located in Area 16 near U16b. Table 2 summarizes the air monitoring results from this station for the four-year period of 2001 – 2004. For most of the radionuclides that are analyzed, average air concentrations are at least three to four orders of magnitude less than the DOE Order 5400.5 derived concentration guides (DCGs) that would result in a dose through inhalation of 100 millirem per year based on continuous exposure. Although not shown in the table, the referenced source documents also show that these results, with the exception of the uranium isotopes, are near minimum detectable levels. The uranium concentrations measured at this station are attributed to naturally-occurring uranium in soils.

Ground-level survey of U16a muckpile

The U16a tunnel portal is located approximately 1.1 mile from the U16b tunnel portal. Six nuclear tests were conducted at the U16a tunnel from 1962 to 1971. The U16a muckpile consists primarily of mining debris (rock) generated during tunnel excavation and construction in support of nuclear weapons testing. In the summer of 2001, corrective action investigations were performed at the U16a muckpile, including drive-over and walk-over radiological surveys, sampling of the muckpile contents and underlying native soils, surface sampling, and shallow subsurface sampling. Table 3 summarizes the results of the muckpile radiological sampling and analysis. Man-made radioactivity, including americium-241, cobalt-60, cesium-137, plutonium-238, plutonium-239, and strontium-90, were found above natural background levels at various depths within the muckpile ranging from the surface to 41.5 ft. Lower levels of man-made radioactivity above natural background levels were also found in a contaminated area and a ravine immediately east of the muckpile. Because of the distance between the U16a muckpile and the site of the proposed DIVINE STRAKE experiment (approximately 1 mile), and the scientific predictions of proposed DIVINE STRAKE's area of impact, it is extremely unlikely that any man-made radioactivity from the U16a muckpile would be dispersed into the atmosphere as a result of the experiment.

Ground-level survey between U16a and U16b

In December 2005, the NTS Management and Operating contractor performed ground-level radiological surveys of areas between U16a and U16b to assess the potential for migration of radioactive contamination from the U16a muckpile (BN, 2005a & b). Measurements made at over 100 survey points on either side of Mid-Valley Road between U16a and U16b showed no detectable alpha, beta, or gamma radiation above natural background levels. An additional 65 survey points along a gully washout area between U16a and U16b likewise showed no detectable alpha, beta, or gamma radiation above natural background levels.

Conclusions

An aerial survey conducted in 1983 showed evidence of very low concentrations of cesium-137 and cobalt-60 across two-thirds of Area 16, including the area of the proposed DIVINE STRAKE Experiment Site. However, follow-up aerial surveys conducted in 1992, 1994, and 2006 showed no identifiable man-made radioactivity in the area of the proposed DIVINE STRAKE Experiment Site. Radiological surveys of NTS surface soils conducted in the 1980's included very limited surveys in Area 16 that suggest the potential for man-made radioactivity in the area of the proposed DIVINE STRAKE Experiment Site based largely on extrapolations and assumptions.

In 2006, a sampling and analysis plan was prepared and implemented to obtain more conclusive information about the radionuclide characteristics of materials that could be potentially dispersed by the proposed DIVINE STRAKE experiment. Low but detectable levels of man-made radioactivity were identified primarily in undisturbed surface material. No man-made radioactivity was identified in subsurface rock material. Concentrations of man-made radioactivity were generally less than screening levels corresponding to a maximum individual dose of 10 millirem per year to a hypothetical resident living at the experiment site.

Man-made radioactivity is also known to be present in the vicinity of the U16a muckpile, approximately one mile from the U16b experiment site. The distance of the muckpile from the site of the experiment makes it extremely unlikely that any man-made radioactivity from the U16a muckpile would be dispersed into the atmosphere as a result of the detonation.

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Table 1. Radionuclide Characteristics of Material Potentially Dispersed by the Proposed DIVINE STRAKE Experiment (pCi/g) [1]				
Radionuclide	Undisturbed Surface Material	Disturbed Material	Subsurface Rock	Screening Level [2]
Ac-228 [3]	1.02 (1.27)	0.601 (0.854)	0.529 (0.747)	None
Al-26	U [4]	U	U	None
Am-241	0.282 (0.719)	U	U	3.57
Be-7	U	U	U	None
Bi-212 [3]	U	U	U	None
Bi-214 [3]	1.28 (1.51)	1.84 (2.15)	1.97 (2.29)	None
Cm-243	U	U	U	None
Co-58	U	U	U	None
Co-60	U	U	U	0.303
Cs-134	U	U	U	None
Cs-137	0.447 (0.55)	U	U	1.41
Eu-152	U	U	U	0.962
Eu-154	U	U	U	0.897
Eu-155	U	U	U	23.8
H-3	U	U	U	20,000 [2]
K-40 [3]	15.6 (18.1)	10.9 (13)	12.8 (15)	None
Nb-94	U	U	U	None
Pb-212 [3]	1.16 (1.36)	0.662 (0.814)	0.641 (0.782)	None
Pb-214 [3]	1.41 (1.63)	2.06 (2.36)	2.09 (2.4)	None
Pu-238	0.0317 (0.0515)	U	U	3.46
Pu-239	1.73 (2.05)	0.0134 (0.0276)	U	3.13
Sb-125	U	U	U	None
Sr-90	0.139 (0.195)	U	U	0.151
Th-227 [3]	U	U	U	None
Th-234 [3]	1.49 (2.58)	1.98 (3.02)	1.72 (2.62)	None
Tl-208 [3]	0.333 (0.421)	0.191 (0.274)	0.185 (0.257)	None
U-234 [3]	0.974 (1.17)	1.95 (2.3)	1.95 (2.3)	6.92
U-235 [3]	0.0665 (0.0992)	0.115 (0.159)	0.103 (0.144)	2.27
U-238 [3]	1.05 (1.25)	2.12 (2.5)	2.13 (2.51)	6.7

1. Source: DOE/NV 2006b. For each of the three sampling populations, values shown are the average activity in pico-curies per gram (pCi/g) followed by the upper 95 percent confidence interval in parentheses.
2. Screening levels, except for H-3, based on NCRP Report No. 129, *Recommended Screening Limits for Contaminated Surface Soil and Review of Factors Relevant to Site-Specific Studies* (NCRP 1999), using the Sparsely Vegetated Rural scenario scaled to an individual dose rate of 10 millirem per year. Screening level for H-3 based on the EPA drinking water limit of 20,000 pico-curies per liter (pCi/L) (EPA 2000). Screening levels apply only to man-made radionuclides.
3. Naturally occurring radioactive material
4. Not detected

Table 2. 3545 Substation (Area 16) Air Monitoring results, µCi/mL, 2000 – 2004					
Analytes	DOE DCG[1]	2004[2]	2003[3]	2002[4]	2001[5]
Am 241	2.0×10^{-14}	2.7×10^{-18}	3.5×10^{-18}	4.5×10^{-18}	1.2×10^{-17}
Cs-137	4.0×10^{-10}	$<6.2 \times 10^{-15}$	$<6.4 \times 10^{-16}$	$<2.5 \times 10^{-16}$	2.0×10^{-14}
H-3	1.0×10^{-7}	6.2×10^{-13}	7.2×10^{-13}	4.6×10^{-13}	9.2×10^{-13}
Pu-238	3.0×10^{-14}	3.1×10^{-18}	$<9.9 \times 10^{-18}$	4.9×10^{-19}	6.0×10^{-19}
Pu-239/240	2.0×10^{-14}	3.4×10^{-18}	5.9×10^{-18}	4.0×10^{-18}	2.1×10^{-18}
U-233/234	9.0×10^{-14}	1.8×10^{-16}	8.8×10^{-17}	9.7×10^{-17}	6.3×10^{-17}
U-235/236	1.0×10^{-13}	1.7×10^{-17}	8.3×10^{-18}	6.2×10^{-18}	1.1×10^{-17}
U-238	1.0×10^{-13}	1.8×10^{-16}	8.5×10^{-17}	8.6×10^{-17}	6.8×10^{-17}
Gross alpha	NA[6]	1.9×10^{-15}	3.7×10^{-15}	5.8×10^{-15}	5.8×10^{-15}
Gross beta	NA[6]	1.8×10^{-14}	1.7×10^{-14}	1.9×10^{-14}	1.8×10^{-14}

1. DOE 5400.5 Derived Concentration Guide is the concentration of a radionuclide taken into the body under conditions of continuous exposure that would result in a committed effective dose equivalent of 100 mrem per year (DOE, 1993).
2. DOE/NV, 2005.
3. DOE/NV, 2004.
4. DOE/NV, 2003.
5. DOE/NV, 2002.
6. Not applicable.

Table 3. Summary of U16a Muckpile Radionuclide Sampling Results[1]			
Radionuclide	Sample Depth Range (ft)	Concentration Range (pCi/g)	Background Concentration (pCi/g)
Am-241	0.5 – 1.5	1.48	0.048
Co-60	0.5 – 41.5	0.77 – 5.3	0.1
Cs-137	0 – 41.5	4.37 – 1770	7
Pu-238	0 – 41.5	0.098 – 20.2	0.002
Pu-239	0 – 41.5	0.444 – 33.2	0.24
Sr-90	0 – 41.5	2.3 – 117	1.17

1. Source: DTRA, 2002

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APPENDIX B

SITE CHARACTERIZATION REPORT FOR THE DIVINE STRAKE EXPERIMENT AT THE NEVADA TEST SITE

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DOE/NV--1177

National Nuclear Security Administration

Site Characterization Report for the Divine Strake Experiment at the Nevada Test Site

Revision No.: 0

December 2006

DISCLAIMER

DOE/NV--1177

SITE CHARACTERIZATION REPORT FOR THE DIVINE STRAKE EXPERIMENT AT THE NEVADA TEST SITE

U.S. Department of Energy,
National Nuclear Security Administration Nevada Site Office
Las Vegas, Nevada

Revision No.: 0

December 2006

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Appendix A - Data Quality Assessment

Table of Contents *(Continued)*

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List of Acronyms and Abbreviations

Ac	Actinium
Al	Aluminum
Am	Americium
Be	Beryllium
bgs	Below ground surface
Bi	Bismuth
CLP	Contract Laboratory Program
Cm	Curium
Co	Cobalt
COPC	Constituent of potential concern
Cs	Cesium
CSM	Conceptual site model
DOE	U.S. Department of Energy
DQA	Data quality assessment
DQI	Data quality indicator
DQO	Data quality objective
Eu	Europium
EPA	U.S. Environmental Protection Agency
FADL	Field activity daily log
FD	Field duplicate
FSL	Field-screening level
ft	Foot
GPS	Global positioning system
ID	Identification

Acronyms and Abbreviations (Continued)

K	Potassium
LCS	Laboratory control sample
MDC	Minimum detectable concentration
MLI	Minimum level of interest
Nb	Niobium
NCR	Nonconformance Report
ND	Not detected
NE	Not established
NIST	National Institute of Science and Technology
NTS	Nevada Test Site
PAI	Paragon Analytics, Inc.
Pb	Lead
pCi/g	Picocuries per gram
pCi/L	Picocuries per liter
Pu	Plutonium
QA	Quality assurance
QAPP	Quality Assurance Project Plan
QC	Quality control
RPD	Relative percent difference
SAP	Sampling and Analysis Plan
Sb	Antimony
SCL	Sample collection log
SDG	Sample delivery group
Sr	Strontium

Acronyms and Abbreviations *(Continued)*

Th	Thorium
Tl	Thallium
U	Uranium
UCI	Upper confidence interval
UCL	Upper confidence limit
VSP	Visual Sample Plan

Executive Summary

The Defense Threat Reduction Agency proposes to conduct the Divine Strake Experiment at the Nevada Test Site (NTS), located approximately 65 miles from Las Vegas, to support national security interests. As a part of pre-test planning, characterization of radiological constituents in the material potentially dispersed by the experiment was conducted to support assessment of potential impacts. This report provides the technical basis and the results of the field investigation of the radiological characterization of potentially dispersed material.

The U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office and the Defense Threat Reduction Agency conducted the field investigation to obtain information about the characteristics of radionuclides present in the material potentially dispersed by the experiment. The investigation included field inspections, sampling of environmental media, and analysis of samples in approved, accredited laboratories in accordance with an approved characterization strategy. This investigation identified targeted radionuclides present at the site without regard to source (natural or man-made, local or distant sources).

A Sampling and Analysis Plan (SAP) was developed to ensure a technically appropriate approach to data gathering and analysis based on methodologies that incorporate U.S. Environmental Protection Agency (EPA) standards for surface soil sampling. Data quality objectives (DQOs) were developed on the basis of a conceptual site model in accordance with EPA guidance for environmental sampling and characterization. This process was used to identify and define the type, amount, and quality of data needed to establish the radionuclide characteristics of the potentially dispersed material. A Data Quality Assessment was then conducted that verified that the data collected met all of the DQO requirements and that the data are appropriate for their intended use. The Data Quality Assessment evaluated the data quality indicators to determine the degree of acceptability and usability of the reported data in the decision-making process. This process ensured that the right type, quality, and quantity of data was available to characterize the target radionuclides at an appropriate level of confidence.

The experiment site is located above the U16b Tunnel Complex in Area 16 of the NTS and was never used for any type of nuclear testing activity.

The experiment site is typified by steep slopes with a thin (up to a few inches in depth) layer of soil overlying carbonate (limestone) bedrock (except in locations where bedrock is exposed). Also present at the site are significant areas of disturbed soil and excavated rock resulting from the construction and use of the U16b Tunnel and preparation of the Divine Strake Experiment Site. To increase characterization accuracy, the material potentially dispersed by the Divine Strake Experiment was divided into the following three populations:

- Undisturbed surface material - Native surface material that was exposed to atmospheric fallout and is projected to be disturbed by the experiment.
- Subsurface rock - Subsurface material that has not been exposed to atmospheric fallout.
- Disturbed material - Excavated site materials comprised of a mixture of surface and subsurface materials (used in forming graded pads, muck piles, and roadways).

Using EPA standards for soil sampling, a total of 26 samples were collected from the undisturbed surface material population and 19 samples from the disturbed material population using hand tools. A total of 11 samples were collected from the undisturbed rock population by chipping and collecting rock fragments from the face of the “high wall” in direct proximity to the experiment. In addition, three samples were collected from the locations with the three highest readings from the May 1, 2006, aerial gamma radiation survey. The results from these samples confirmed that the defined populations potentially affected by the experiment did not contain areas of radioactivity that are significantly different than the balance of the proposed experiment site.

The data were analyzed in laboratories approved by the State of Nevada and accredited by the U.S. Department of Energy. A complete validation of the analytical results was performed in accordance with EPA guidelines including a third party confirmation of 5 percent of the validated dataset.

All data collected during the investigation supported the assumptions presented in the SAP, meet the DQO requirements established in the SAP, and are of sufficient quality to support the radiological characterization of the materials potentially dispersed by the Divine Strake Experiment.

1.0 Introduction

This report presents the characterization activities and analytical results from the Divine Strake field investigation. A detailed discussion of the planning, history, and scope of the characterization activities are presented in the *Sampling and Analysis Plan* (SAP) *for the Divine Strake Experiment* (NNSA/NSO, 2006). The Divine Strake Experiment Site is located in Area 16 of the Nevada Test Site as shown in Figure 1-1.

All characterization activities were performed in accordance with the following documents:

- SAP for Divine Strake (NNSA/NSO, 2006)
- Industrial Sites Quality Assurance Project Plan (QAPP) (NNSA/NV, 2002)
- Approved contractor-specific procedures

This characterization report provides the information necessary to characterize the radionuclides of concern within the three populations as described in Section 1.1 and in the SAP.

1.1 Purpose

This report provides information to establish radionuclide characteristics of the potentially dispersed material (both man-made and naturally occurring radionuclides). This information was obtained from soil and rock samples collected and analyzed for the constituents of potential concern (COPCs) (identified in Section 3.2.2 of the SAP) from materials that could be dispersed by the experiment. To reduce the expected variability of the samples as much as possible, the material potentially dispersed by the Divine Strake Experiment was divided into three populations (see Section 3.2.4 of the SAP):

1. Undisturbed surface material (subject to atmospheric fallout)

2. Subsurface rock (material not subject to atmospheric fallout)

3. Disturbed material (excavated native soil and rock from the graded pads, muckpiles, and roadways that is a mixture of populations 1 and 2)

The Defense Threat Reduction Agency and the National Nuclear Security Administration Nevada Site Office will use this information to assess the potential impacts of materials dispersed by the experiment.

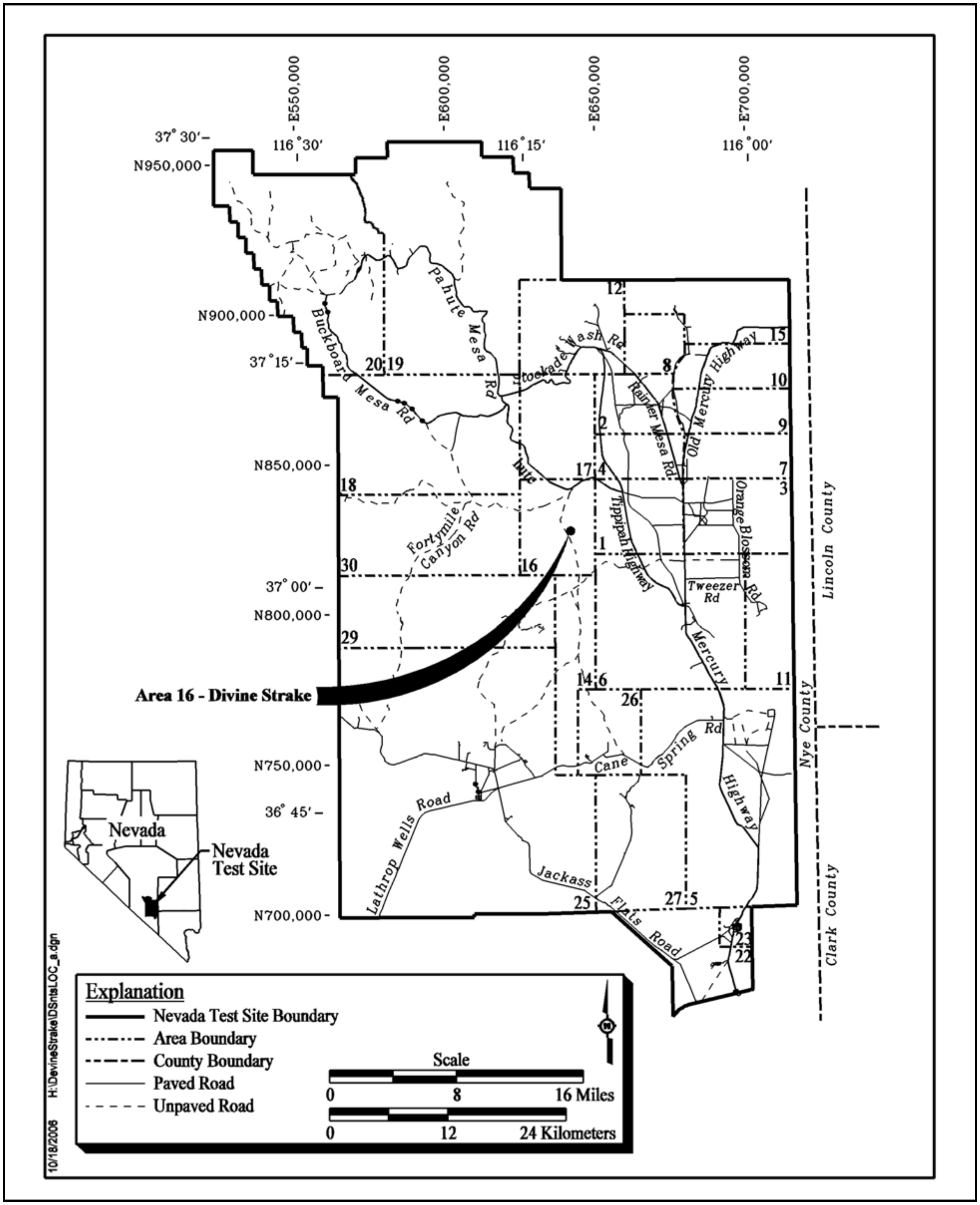

Figure 1-1
Divine Strake Experiment Site Location

1.2 Scope

This report identifies and characterizes targeted radionuclides present at the site without regard to source (natural or man-made, local or distant sources). The radionuclides were characterized for each of the three populations listed in Section 1.1. In addition, the locations with the three highest readings from the May 1, 2006, aerial gamma radiation survey were also sampled to confirm that the defined populations potentially affected by the experiment did not contain areas of radioactivity that are significantly different than the balance of the proposed experiment site. The following sections describe the specific characterization activities.

The activities conducted to accomplish this scope included:

- Field inspections
- Field screening
- Controlled statistical sampling of environmental media
- Analysis of samples in approved, accredited laboratories
- Collection of quality control (QC) samples
- Data validation
- Data quality assessment (DQA)
- Statistical analysis of the data

1.3 Report Contents

This characterization report is divided into the following sections and appendices:

- Section 1.0 - Introduction: Summarizes the purpose, scope, and contents of this characterization report.
- Section 2.0 - Field Investigation Summary: Summarizes the investigation field activities.
- Section 3.0 - Results: Presents the analytical results from the field investigation samples.
- Section 4.0 - Characterization: Presents the radiological characterization for each of the three Divine Strake investigation populations.
- Section 5.0 - Data Quality: Summarizes the DQA and discusses the data validation process, QC samples, and nonconformances.
- Section 6.0 - References: Provides a list of all referenced documents used in the preparation of this characterization report.

- Appendix A - Data Quality Assessment: Provides a DQA that reconciles data quality objective (DQO) assumptions and requirements to the characterization results.

- Appendix B - ProUCL Datasheets: Provides the printouts from the evaluation of appropriate distribution models and the calculation of upper confidence limits (UCLs) based on the recommended model.

- Appendix C - Sample Location Coordinates: Contains the coordinates of the actual sample locations.

The complete field documentation and laboratory data — including field activity daily logs (FADLs), sample collection logs (SCLs), analysis request/chain-of-custody forms, soil sample descriptions, analytical results, and surveillance results — are retained in project files as hard copy files or electronic media.

2.0 Field Investigation Summary

Field investigation and sampling activities for characterization of the Divine Strake Experiment Site were conducted on August 24 and August 25, 2006.

The investigation and sampling program was managed in accordance with the requirements set forth in the Divine Strake SAP (NNSA/NSO, 2006). Field activities were performed in compliance with a site-specific health and safety plan, which is consistent with the U.S. Department of Energy (DOE) Integrated Safety Management System. Samples were collected and documented following the SAP (NNSA/NSO, 2006). Quality control samples (i.e., field duplicate [FD] samples) were collected as required by the Industrial Sites QAPP (NNSA/NV, 2002) and the Divine Strake SAP (NNSA/NSO, 2006).

Weather conditions at the site were hot (mid- to high 90s) with scattered clouds and light winds.

The site was investigated by collecting soil and rock samples using hand tools. The soil samples were field screened for alpha and beta/gamma radiation. The field-screening results were used to ensure compliance with sample transportation requirements.

Except as noted in the following sections, the sampling locations were accessible and sampling activities at planned locations were not restricted.

2.1 Sampling Activities

A combination of judgmental and probabilistic sampling schemes was implemented to select sample locations and evaluate analytical results, as outlined in the SAP.

Probabilistic sampling was conducted using the random sample locations listed in the SAP to define site-wide contamination characteristics (e.g., average concentrations). Confidence in probabilistic sampling scheme decisions was established by the validation of the conceptual site model (CSM), justification that sampling locations were representative of site conditions, demonstration that a sufficient number of samples were collected, and that contaminant distribution assumptions are valid and appropriate to the statistical test being performed.

The average radionuclide activities resulting from the probabilistic sample results represent an estimation of the true average radionuclide activities at the site. Because the average radionuclide activities from samples is only an estimate of the true (unknown) average, an estimate of the uncertainty was calculated for each of the respective radionuclide activities. Estimates of uncertainty are provided in Section 4.0.

2.1.1 Sample Locations

Sample locations were identified using the approaches described in the SAP. The sample locations were located on the ground using a Trimble Pathfinder ProXRSTM global positioning system (GPS) instrument, and the sample location coordinates calculated and posted in the SAP. The sample location coordinates are listed in Appendix C and represented on Figures 2-1 and 2-2. Some locations were modified slightly from planned positions due to field conditions and observations as described in Section A.2.6.

2.1.2 Field Screening

Field-screening activities for alpha and beta/gamma radiation, and gamma-emitting radionuclides were performed as specified in the Divine Strake SAP. Site-specific field-screening levels (FSLs) for alpha and beta/gamma radiation were defined as the mean background activity level plus two times the standard deviation. The mean background activity and standard deviation were calculated from 10 measurements of a background sample collected from an undisturbed location close to but outside of the test area. The radiation FSLs are location and instrument-specific, and they were established each day for each instrument used and again if the sample processing location was moved.

2.1.3 Sample Collection

Sampling activities included the collection of 26 soil samples (including 2 FDs) from the undisturbed surface material, 11 subsurface rock samples (including 1 FD), 19 disturbed material soil samples (including 1 FD, and 3 biased soil samples (placed at locations identified from the flyover data as described in the SAP). The sample identification (ID) numbers, locations, types, and analyses are listed in Table 2-1. The sample locations are shown on Figure 2-1. Samples were collected using precleaned disposable scoops for the soil samples, or a hammer and chisel for the rock samples. The undisturbed and disturbed surface samples were collected from 0.0 to 0.5 feet (ft) below ground

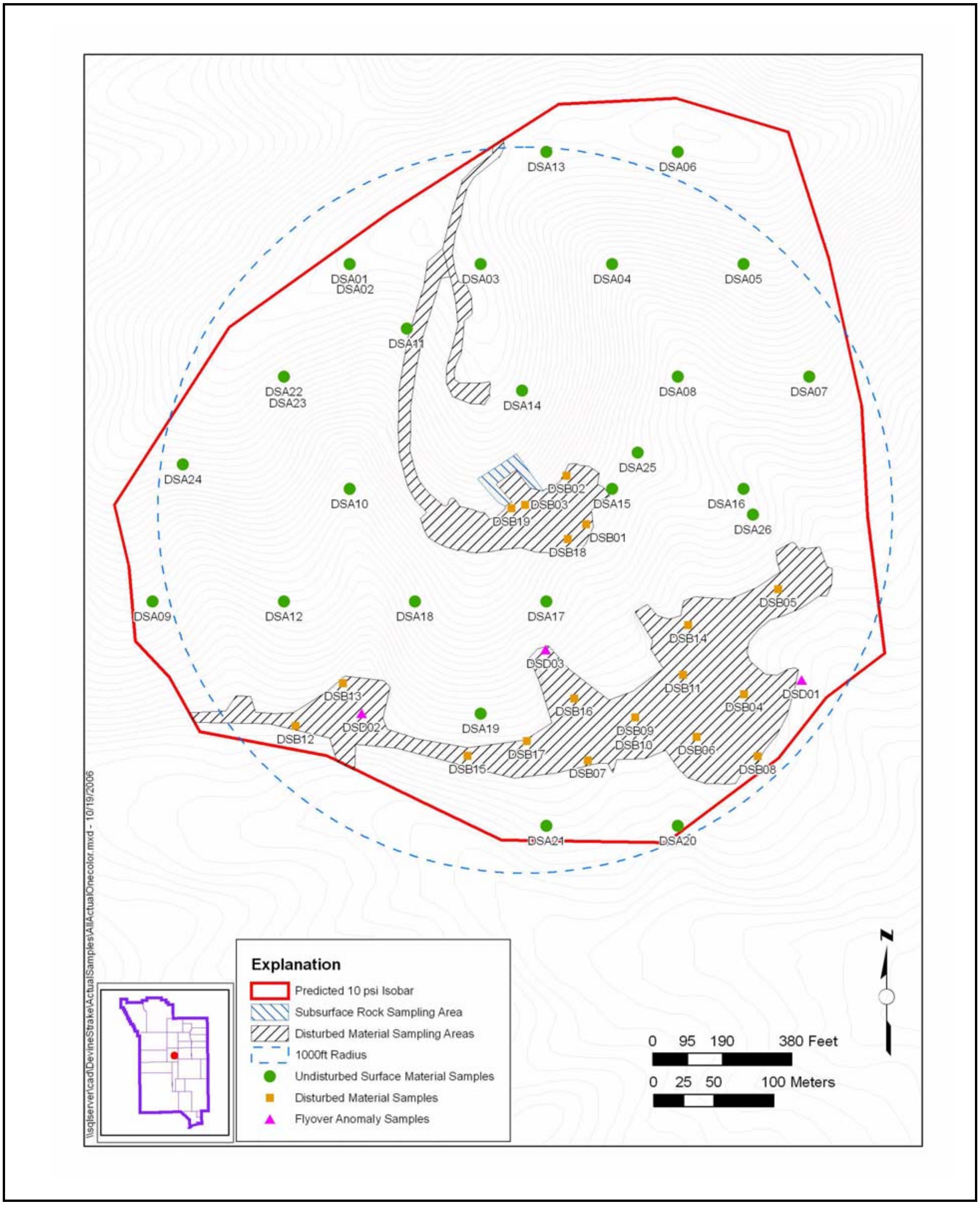

Figure 2-1
Locations of Divine Strake Experiment Undisturbed Surface Material and Disturbed Material Samples

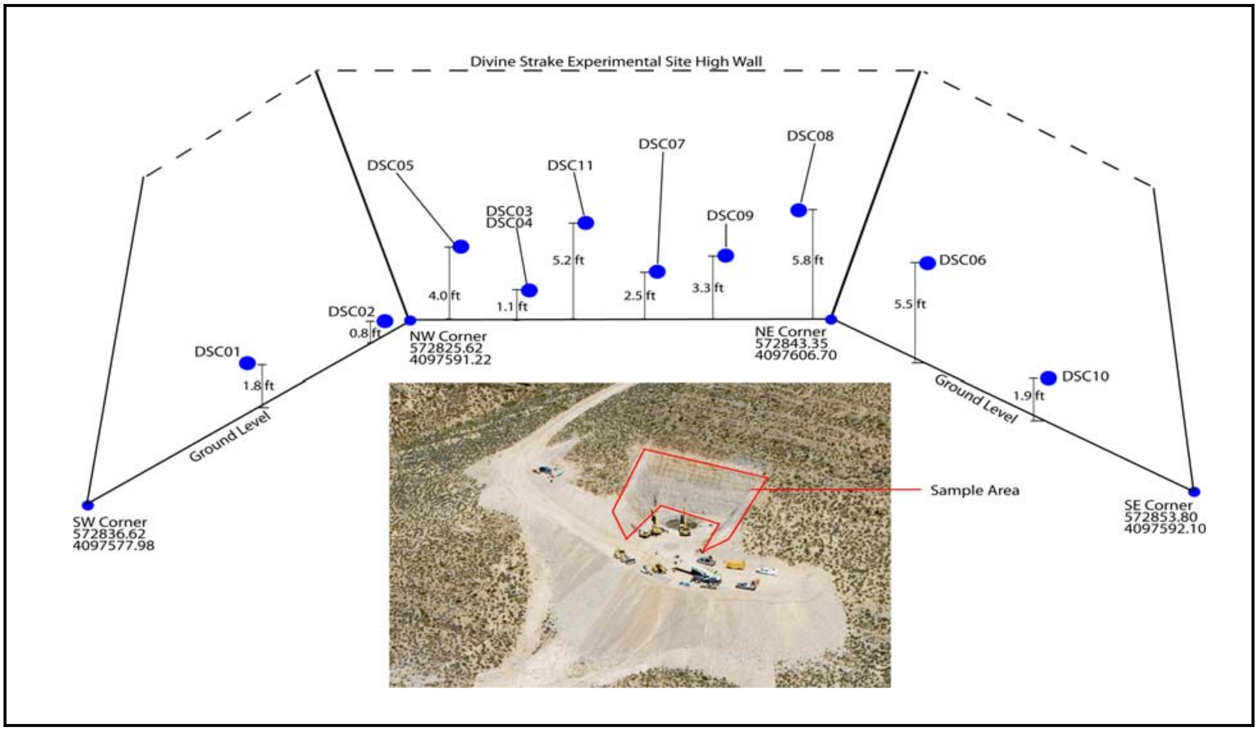

Figure 2-2
Locations of Divine Strake Experiment Subsurface Rock Samples

surface (bgs). The rock samples were collected from random locations of exposed rock within the "high wall" around the Divine Strake Experiment excavation as depicted in Figure 2-2.

2.2 Analyses

All of the samples were analyzed for gamma emitting radionuclide, isotopic plutonium, isotopic uranium, strontium (Sr)-90, and tritium. Radiological analyses were performed by Paragon Analytics, Inc., of Fort Collins, Colorado. Analytical results are reported if they were detected above the minimum detectable concentrations (MDCs). The complete laboratory data packages are available in the project files.

Only validated analytical data from the Divine Strake field investigation samples have been used to determine the concentration of radionuclides present at the Divine Strake site. The analytical results are presented in Section 3.0.

Table 2-1
Sample Numbers and Locations
(Page 1 of 3)

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses: Gamma	Plutonium	Strontium	Tritium	Uranium	Gross Alpha/Beta
A19	DSA01	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A19	DSA02	0-0.5	Soil	Field duplicate	X	X	X	X	X	X
A20	DSA03	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A21	DSA04	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A22	DSA05	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A24	DSA06	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A18	DSA07	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A17	DSA08	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A4	DSA09	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A10	DSA10	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
C21	DSA11	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A5	DSA12	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A23	DSA13	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
C16	DSA14	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A12	DSA15	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A13	DSA16	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A7	DSA17	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A6	DSA18	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A3	DSA19	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A2	DSA20	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A1	DSA21	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A14	DSA22	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
A14	DSA23	0-0.5	Soil	Field duplicate	X	X	X	X	X	X
C19	DSA24	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
C11	DSA25	0-0.5	Soil	Regular environmental	X	X	X	X	X	X

Table 2-1
Sample Numbers and Locations
(Page 2 of 3)

Sample Location	Sample Number	Depth (ft bgs)	Matrix	Purpose	Analyses: Gamma	Plutonium	Strontium	Tritium	Uranium	Gross Alpha/Beta
C8	DSA26	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B1	DSB01	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
D2	DSB02	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B3	DSB03	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B8	DSB04	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B13	DSB05	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B7	DSB06	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B9	DSB07	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B6	DSB08	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B10	DSB09	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B10	DSB10	0-0.5	Soil	Field duplicate	X	X	X	X	X	X
B11	DSB11	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B16	DSB12	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B17	DSB13	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
D11	DSB14	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
D15	DSB15	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B15	DSB16	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
B14	DSB17	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
D1	DSB18	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
D3	DSB19	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
E2	DSC01	0-0.5	Rock	Regular environmental	X	X	X	X	X	X
E1	DSC02	0-0.5	Rock	Regular environmental	X	X	X	X	X	X
E3	DSC03	0-0.5	Rock	Regular environmental	X	X	X	X	X	X
E3	DSC04	0-0.5	Rock	Field duplicate	X	X	X	X	X	X
E5	DSC05	0-0.5	Rock	Regular environmental	X	X	X	X	X	X

Table 2-1
Sample Numbers and Locations
(Page 3 of 3)

					Analyses					
Sample Location	**Sample Number**	**Depth (ft bgs)**	**Matrix**	**Purpose**	**Gamma**	**Plutonium**	**Strontium**	**Tritium**	**Uranium**	**Gross Alpha/Beta**
E10	DSC06	0-0.5	Rock	Regular environmental	X	X	X	X	X	X
E8	DSC07	0-0.5	Rock	Regular environmental	X	X	X	X	X	X
E7	DSC08	0-0.5	Rock	Regular environmental	X	X	X	X	X	X
E6	DSC09	0-0.5	Rock	Regular environmental	X	X	X	X	X	X
E11	DSC10	0-0.5	Rock	Regular environmental	X	X	X	X	X	X
E9	DSC11	0-0.5	Rock	Regular environmental	X	X	X	X	X	X
F1	DSD01	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
F3	DSD02	0-0.5	Soil	Regular environmental	X	X	X	X	X	X
F2	DSD03	0-0.5	Soil	Regular environmental	X	X	X	X	X	X

3.0 Results

The results from the Divine Strake field investigation samples are presented for each population in Sections 3.1 through 3.3. The results from the additional sampling conducted at the locations with the three highest readings from the May 1, 2006, aerial gamma radiation survey (i.e., flyover anomalies) are presented in Section 3.4 (Riedhauser, 2006). This section presents results for all of the analytes reported from the analytical program as presented in Section 3.4 of the SAP for every sample submitted (including FD samples). The results tables include activity values reported by the analytical laboratory at levels that were not significantly above instrument background readings. These results are considered "non-detects" and a (U) is used to identify the results as such. Some results in the results tables have a (J) identifier signifying that the reported value is estimated. Estimated results are valid detections where there is less confidence in the reported value. Data are commonly identified as estimated when duplicate samples have significantly different results due to heterogeneity in the sampled media.

3.1 Undisturbed Surface Material Population Sample Results

Analytical results from the samples collected within the undisturbed surface material population as outlined in the SAP are presented in the following sections. As negative activities are not possible, activities reported as negative values have been listed with a value of zero.

3.1.1 Gamma-Emitting Radionuclides

Gamma-emitting radionuclides analytical results for environmental samples collected within the undisturbed surface material population are presented in Table 3-1.

Table 3-1
Gamma-Emitting Radionuclide Activities Reported from Undisturbed Surface Material Population Samples

Sample Number	Sample Location	Depth (ft bgs)	Ac-228 (pCi/g)	Al-26 (pCi/g)	Am-241 (pCi/g)	Be-7 (pCi/g)	Bi-212 (pCi/g)	Bi-214 (pCi/g)	Cm-243 (pCi/g)	Co-58 (pCi/g)	Co-60 (pCi/g)	Cs-134 (pCi/g)	Cs-137 (pCi/g)	Eu-152 (pCi/g)	Eu-154 (pCi/g)	Eu-155 (pCi/g)	K-40 (pCi/g)	Nb-94 (pCi/g)	Pb-212 (pCi/g)	Pb-214 (pCi/g)	Sb-125 (pCi/g)	Th-227 (pCi/g)	Th-234 (pCi/g)	Tl-208 (pCi/g)	U-235 (pCi/g)
DSA01	A19	0-0.5	1.12	0(U)	0.779(U)	0.229(U)	1.33(U)	1.13(J)	0.0648(U)	0(U)	0(U)	0.138(U)	1.06	0(U)	0.055(U)	0.0181(U)	17.2	0(U)	1.16(J)	1.22(J)	0(U)	0(U)	1.87(U)	0.343	0(U)
DSA02	A19	0-0.5	1.05	0.0128(U)	0.757(J)	0(U)	2.19(U)	1.04(J)	0.209(U)	0(U)	0(U)	0(U)	0.973	0.198(U)	0(U)	0.0877(U)	15.9	0(U)	1.24(J)	1.18(J)	0(U)	0.762(U)	1.51(J)	0.361	0.00884(U)
DSA03	A20	0-0.5	1.11	0.0197(U)	0.382(U)	0(U)	0.781(U)	1.07(J)	0.171(U)	0(U)	0(U)	0.0184(U)	0.516	0.0427(U)	0(U)	0(U)	16.9	0.0248(U)	1.36(J)	1.25(J)	0.0963(U)	2.01(U)	1.55(U)	0.395	0.0642(U)
DSA04	A21	0-0.5	1.02	0.00205(U)	0.107(U)	0.0427(U)	0.717(U)	0.887(J)	0.257(U)	0(U)	0(U)	0.0219(U)	0.386	0.00959(U)	0(U)	0.134(U)	12.6	0(U)	1.1(J)	1.18(J)	0.116(U)	0.0899(U)	1.42(U)	0.378	0.1(U)
DSA05	A22	0-0.5	1.25	0(U)	0.343(U)	0.186(U)	0.923(U)	1.34(J)	0(U)	0(U)	0.0192(U)	0.035(U)	0.39	0.114(U)	0.115(U)	0.0262(U)	16.3	0.0116(U)	1.44(J)	1.51(J)	0.0314(U)	0(U)	1.94(U)	0.391	0(U)
DSA06	A24	0-0.5	1.03	0.0344(U)	0.0268(U)	0.1(U)	0.661(U)	1.12(J)	0.0947(U)	0(U)	0(U)	0.0549(U)	0.372	0(U)	0.206(U)	0.0788(U)	15.9	0.00364(U)	1.2(J)	1.14(J)	0.0274(U)	0.821(U)	1.37(U)	0.361	0.065(U)
DSA07	A18	0-0.5	0.983	0(U)	0.135(U)	0.0871(U)	0.74(U)	1.1(J)	0.158(U)	0(U)	0(U)	0(U)	0.25	0.0145(U)	0(U)	0.015(U)	14.6	0(U)	1.22(J)	1.35(J)	0(U)	0.224(U)	1.61(J)	0.35	0(U)
DSA08	A17	0-0.5	0.51(U)	0(U)	0.223(U)	0.0177(U)	0.399(U)	1.21(J)	0.0113(U)	0(U)	0(U)	0.0146(U)	0.354	0.0427(U)	0(U)	0.0048(U)	6.98	0(U)	0.556(J)	1.11(J)	0(U)	0(U)	0.898(U)	0.149	0.184(U)
DSA09	A4	0-0.5	1.06	0.0251(U)	0.86(U)	0.0908(U)	0.966(U)	1.43(J)	0.245(U)	0(U)	0(U)	0.0653(U)	0.439	0.122(U)	0(U)	0.0279(U)	18.5	0.0211(U)	1.21(J)	1.34(J)	0.12(U)	0(U)	1.34(U)	0.349	0(U)
DSA10	A10	0-0.5	0.995	0(U)	0(U)	0(U)	0.728(U)	1.18(J)	0.0784(U)	0(U)	0.0303(U)	0.0182(U)	0.455	0(U)	0.207(U)	0.0428(U)	13.5	0(U)	0.87(J)	1.15(J)	0.0188(U)	0(U)	0.719(U)	0.302	0(U)
DSA11	C21	0-0.5	0.874	0(U)	0(U)	0.165(U)	1.03(U)	1.05(J)	0.129(U)	0.0283(U)	0(U)	0(U)	0.164(U)	0(U)	0(U)	0.0138(U)	14.4	0(U)	1.03(J)	1.21(J)	0.123(U)	0.232(U)	1.33(U)	0.329	0.19(U)
DSA12	A12	0-0.5	1.06	0(U)	0.674(U)	0(U)	1.2(U)	1.55(J)	0.309(U)	0(U)	0(U)	0(U)	0.505	0(U)	0(U)	0.0836(U)	19.5	0(U)	1.38(J)	1.72(J)	0.224(U)	0(U)	2.17(U)	0.441	0(U)
DSA13	A23	0-0.5	1.1	0(U)	0.309(U)	0(U)	0.681(U)	1.08(J)	0.0582(U)	0(U)	0.0254(U)	0.0297(U)	0.998	0.115(U)	0.00696(U)	0(U)	14	0.0473(U)	1.08(J)	1.15(J)	0(U)	0.216(U)	1.41(U)	0.285	0.173(U)
DSA14	C16	0-0.5	1.23	0.0254(U)	0(U)	0(U)	1.13(U)	1.1(J)	0.488(U)	0(U)	0(U)	0(U)	0.479	0.245(U)	0.0246(U)	0.0912(U)	17.8	0(U)	1.43(J)	1.37(J)	0.0787(U)	0(U)	1.44(U)	0.393	0(U)
DSA15	A12	0-0.5	1.05	0.0483(U)	0.192(U)	0(U)	0.785(U)	1.63(J)	0.198(U)	0(U)	0(U)	0(U)	0.286	0.211(U)	0(U)	0.0644(U)	15.7	0.0335(U)	1.3(J)	1.47(J)	0(U)	0(U)	1.75(U)	0.314	0.0714(U)
DSA16	A13	0-0.5	1.05	0.00901(U)	0(U)	0(U)	0.98(U)	1.51(J)	0.142(U)	0(U)	0.0111(U)	0(U)	0.29	0.043(U)	0(U)	0.147(U)	16.8	0.0231(U)	1.21(J)	1.51(J)	0.108(U)	0.0436(U)	1.39(U)	0.358	0.252(U)
DSA17	A7	0-0.5	0.482(U)	0.0198(U)	0.0394(U)	0(U)	0.715(U)	1.6(J)	0(U)	0.00588(U)	0.0107(U)	0(U)	0(U)	0.13(U)	0(U)	0.11(U)	11.6	0(U)	0.503(J)	1.94(J)	0.0232(U)	0.195(U)	2.34(J)	0.201	0.253(U)
DSA18	A6	0-0.5	1.03	0.0446(U)	0(U)	0(U)	1.06(U)	1.4(J)	0.232(U)	0(U)	0(U)	0(U)	0.278	0(U)	0(U)	0(U)	13.6	0(U)	1.09(J)	1.41(J)	0.0523(U)	0(U)	1.79(U)	0.298	0(U)
DSA19	A3	0-0.5	1.08	0(U)	1.01(U)	0.107(U)	1.1(U)	1.77(J)	0.385(U)	0.00429(U)	0.0103(U)	0(U)	0.563	0.0529(U)	0(U)	0.111(U)	15.4	0.0428(U)	0.988(J)	1.77(J)	0.0515(U)	0.261(U)	1.32(U)	0.329	0.247(U)
DSA20	A2	0-0.5	0.693	0(U)	0.316(J)	0.205(U)	0.785(U)	1.13(J)	0(U)	0(U)	0(U)	0.0222(U)	0.683	0.2(U)	0(U)	0(U)	12	0.0183(U)	0.706(J)	1.32(J)	0.0888(U)	0(U)	1.67(J)	0.219	0.258(U)
DSA21	A1	0-0.5	0.911	0.00427(U)	0.125(U)	0.247(U)	0.71(U)	1.69(J)	0.262(U)	0(U)	0.052(U)	0(U)	0.378	0.0351(U)	0(U)	0.0352(U)	15.9	0(U)	1.19(J)	1.61(J)	0(U)	1.01(U)	1.9(J)	0.34	0.073(U)
DSA22	A14	0-0.5	1.09	0(U)	0.44(U)	0.21(U)	1.2(U)	1.06(J)	0.17(U)	0(U)	0.033(U)	0.26(U)	0.61	0(U)	0(U)	0.06(U)	17.2	0.071(U)	1.33(J)	1.26(J)	0.04(U)	0.7(U)	1.3(U)	0.37	0(U)
DSA23	A14	0-0.5	1.3	0.064(U)	0.33(U)	0.04(U)	1.6(U)	1.25(J)	0.04(U)	0(U)	0.037(U)	0.025(U)	0.61	0(U)	0(U)	0.04(U)	17.1	0.064(U)	1.41(J)	1.37(J)	0(U)	0.41(U)	0.4(U)	0.25	0(U)
DSA24	C19	0-0.5	1.07	0(U)	0.35(U)	0(U)	1.41(U)	1.08(J)	0.38(U)	0(U)	0(U)	0(U)	0.75	0.32(U)	0(U)	0(U)	19.5	0(U)	1.45(J)	1.51(J)	0.11(U)	0(U)	1.3(U)	0.29	0.15(U)
DSA25	C11	0-0.5	1.41	0.028(U)	0.02(U)	0.02(U)	0.4(U)	1.31(J)	0.05(U)	0.069(U)	0.003(U)	0(U)	0.45	0(U)	0(U)	0.07(U)	20.3	0.014(U)	1.77(J)	1.69(J)	0.31(U)	0(U)	0.3(U)	0.44	0.22(U)
DSA26	C8	0-0.5	1.3	0(U)	0.45(U)	0.21(U)	1.6(U)	1.23(J)	0.29(U)	0.023(U)	0.04(U)	0.006(U)	0.081(U)	0.27(U)	0.22(U)	0.18(U)	17.1	0.03(U)	1.28(J)	1.54(J)	0(U)	0.1(U)	1.7(U)	0.36	0.2(U)

(J) = Estimated
(U) = Not detected

3.1.2 Plutonium Isotopes

Analytical results for plutonium isotopes from environmental samples collected within the undisturbed surface material population are presented in Table 3-2.

Table 3-2
Plutonium Isotopes Activities Reported from Undisturbed Surface Material Population
(Page 1 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Pu-238 (pCi/g)	Pu-239 (pCi/g)
DSA01	A19	0-0.5	0.037	2.39
DSA02	A19	0-0.5	0.04(U)	2.38
DSA03	A20	0-0.5	0.006(U)	1.25
DSA04	A21	0-0.5	0.008(U)	0.66
DSA05	A22	0-0.5	0.025(U)	0.52
DSA06	A24	0-0.5	0.015(U)	0.78
DSA07	A18	0-0.5	0.147	11.1
DSA08	A17	0-0.5	0.003(U)	0.48
DSA09	A4	0-0.5	0.011(U)	0.7
DSA10	A10	0-0.5	0.025(U)	0.7
DSA11	C21	0-0.5	0.016(U)	0.253(J)
DSA12	A12	0-0.5	0.048	1.99(J)
DSA13	A23	0-0.5	0.025(U)	1.33(J)
DSA14	C16	0-0.5	0.022(U)	0.57(J)
DSA15	A12	0-0.5	0.115	8.3(J)
DSA16	A13	0-0.5	0.012(U)	0.37(J)
DSA17	A7	0-0.5	0(U)	0.002(U)
DSA18	A6	0-0.5	0.009(U)	0.27(J)
DSA19	A3	0-0.5	0.046	1.28(J)
DSA20	A2	0-0.5	0.085	4.5(J)
DSA21	A1	0-0.5	0.008(U)	0.48(J)
DSA22	A14	0-0.5	0.039(U)	0.63
DSA23	A14	0-0.5	0.057(U)	1.12

Table 3-2
Plutonium Isotopes Activities Reported from Undisturbed Surface Material Population
(Page 2 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Pu-238 (pCi/g)	Pu-239 (pCi/g)
DSA24	C19	0-0.5	0.015(U)	0.51
DSA25	C11	0-0.5	0.043	2.42
DSA26	C8	0-0.5	0(U)	0.077

(J) = Estimated
(U) = Not detected

3.1.3 Uranium Isotopes

Analytical results for uranium isotopes from environmental samples collected within the undisturbed surface material population are presented in Table 3-3.

Table 3-3
Uranium Isotopes Activities Reported from Undisturbed Surface Material Population
(Page 1 of 2)

Sample Number	Sample Location	Depth (ft bgs)	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)
DSA01	A19	0-0.5	0.73	0.051	0.93
DSA02	A19	0-0.5	0.98	0.044(U)	1.01
DSA03	A20	0-0.5	0.68	0.051	0.8
DSA04	A21	0-0.5	0.87	0.061	0.88
DSA05	A22	0-0.5	0.95	0.047(U)	1.02
DSA06	A24	0-0.5	0.78	0.055	0.93
DSA07	A18	0-0.5	0.94	0.07	1.03
DSA08	A17	0-0.5	1.11	0.05(U)	1.1
DSA09	A4	0-0.5	0.98	0.047	0.95
DSA10	A10	0-0.5	0.91	0.05	0.96
DSA11	C21	0-0.5	0.97	0.039(U)	0.98
DSA12	A12	0-0.5	0.99	0.063	1.1
DSA13	A23	0-0.5	0.7	0.041	0.7

Table 3-3
Uranium Isotopes Activities Reported from Undisturbed Surface Material Population
(Page 2 of 2)

Sample Number	Sample Location	Depth (ft bgs)	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)
DSA14	C16	0-0.5	0.85	0.069	0.98
DSA15	A12	0-0.5	0.94	0.05	0.97
DSA16	A13	0-0.5	1.04	0.09	1.11
DSA17	A7	0-0.5	1.84	0.179	2.01
DSA18	A6	0-0.5	0.99	0.07(J)	1.07
DSA19	A3	0-0.5	1.22	0.122	1.45
DSA20	A2	0-0.5	1.34	0.103(J)	1.48
DSA21	A1	0-0.5	1.11	0.085	1.04
DSA22	A14	0-0.5	0.83	0.019(U)	0.79
DSA23	A14	0-0.5	0.8	0.039(U)	0.77
DSA24	C19	0-0.5	0.84	0.076	0.93
DSA25	C11	0-0.5	0.84	0.043(U)	0.86
DSA26	C8	0-0.5	0.93	0.064	1.09

(J) = Estimated
(U) = Not detected

3.1.4 Strontium-90

Analytical results for Strontium (Sr)-90 from environmental samples collected within the undisturbed surface material population are presented in Table 3-4.

Table 3-4
Strontium-90 Activities Reported from Undisturbed Surface Material Population
(Page 1 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Sr-90 (pCi/g)
DSA01	A19	0-0.5	0.234
DSA02	A19	0-0.5	0.241
DSA03	A20	0-0.5	0.18
DSA04	A21	0-0.5	0.166

Table 3-4
Strontium-90 Activities Reported from Undisturbed Surface Material Population
(Page 2 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Sr-90 (pCi/g)
DSA05	A22	0-0.5	0.161
DSA06	A24	0-0.5	0.107(U)
DSA07	A18	0-0.5	0.149
DSA08	A17	0-0.5	0.079(U)
DSA09	A4	0-0.5	0.15
DSA10	A10	0-0.5	0.111(U)
DSA11	C21	0-0.5	0.135
DSA12	A12	0-0.5	0.127(U)
DSA13	A23	0-0.5	0.309
DSA14	C16	0-0.5	0.132
DSA15	A12	0-0.5	0.083(U)
DSA16	A13	0-0.5	0.115(U)
DSA17	A7	0-0.5	0.026(U)
DSA18	A6	0-0.5	0.162
DSA19	A3	0-0.5	0.137
DSA20	A2	0-0.5	0.157
DSA21	A1	0-0.5	0.118
DSA22	A14	0-0.5	0.097(U)
DSA23	A14	0-0.5	0.095(U)
DSA24	C19	0-0.5	0.181
DSA25	C11	0-0.5	0.16
DSA26	C8	0-0.5	0.048(U)

(U) = Not detected

3.1.5 Tritium

Analytical results for tritium from environmental samples collected within the undisturbed surface material population are presented in Table 3-5.

Table 3-5
Tritium Activities Reported from Undisturbed Surface Material Population

Sample Number	Sample Location	Depth (ft bgs)	Tritium (pCi/L)
DSA01	A19	0-0.5	400(U)
DSA02	A19	0-0.5	400(U)
DSA03	A20	0-0.5	0(U)
DSA04	A21	0-0.5	400(U)
DSA05	A22	0-0.5	300(U)
DSA06	A24	0-0.5	1,000(U)
DSA07	A18	0-0.5	100(U)
DSA08	A17	0-0.5	0(U)
DSA09	A4	0-0.5	400(U)
DSA10	A10	0-0.5	1,300(U)
DSA11	C21	0-0.5	0(U)
DSA12	A12	0-0.5	0(U)
DSA13	A23	0-0.5	600(U)
DSA14	C16	0-0.5	1,200(U)
DSA15	A12	0-0.5	0(U)
DSA16	A13	0-0.5	700(U)
DSA17	A7	0-0.5	12,000(U)
DSA18	A6	0-0.5	2,900(U)
DSA19	A3	0-0.5	0(U)
DSA20	A2	0-0.5	1,100(U)
DSA21	A1	0-0.5	0(U)
DSA22	A14	0-0.5	0(U)
DSA23	A14	0-0.5	100(U)
DSA24	C19	0-0.5	500(U)
DSA25	C11	0-0.5	0(U)
DSA26	C8	0-0.5	0(U)

(U) = Not detected

3.1.6 Gross Alpha/Beta

Analytical results for gross alpha and gross beta from environmental samples collected within the undisturbed surface material population are presented in Table 3-6.

Table 3-6
Gross Alpha/Beta Activities Reported from Undisturbed Surface Material Population
(Page 1 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)
DSA01	A19	0-0.5	4.6	7.2
DSA02	A19	0-0.5	5.7	7.8
DSA03	A20	0-0.5	6.4	5.8
DSA04	A21	0-0.5	6.4	6.7
DSA05	A22	0-0.5	5.5	8.6
DSA06	A24	0-0.5	4.6	6.6
DSA07	A18	0-0.5	7.3	6.8
DSA08	A17	0-0.5	4.3	4.7
DSA09	A4	0-0.5	5.2	7.7
DSA10	A10	0-0.5	6	4.6(U)
DSA11	C21	0-0.5	5	5.1
DSA12	A12	0-0.5	6.2	9.2
DSA13	A23	0-0.5	3.3	8.9
DSA14	C16	0-0.5	5.7	7.1
DSA15	A12	0-0.5	5.3	7.2
DSA16	A13	0-0.5	11.4	9.1
DSA17	A7	0-0.5	6.3	7.6
DSA18	A6	0-0.5	7.5	7.3
DSA19	A3	0-0.5	6.8	8.4
DSA20	A2	0-0.5	4.8	4.9
DSA21	A1	0-0.5	18.9	3.7(U)
DSA22	A14	0-0.5	5.6	5.2(U)
DSA23	A14	0-0.5	5.6	6.4
DSA24	C19	0-0.5	5.7	7.1

Table 3-6
Gross Alpha/Beta Activities Reported from Undisturbed Surface Material Population
(Page 2 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)
DSA25	C11	0-0.5	6.8	8.2
DSA26	C8	0-0.5	5.2	8.1

(U) = Not detected

3.2 Disturbed Material Population Sample Results

Analytical results from the samples collected within the disturbed material population as outlined in the SAP are presented in the following sections. As negative activities are not possible, activities reported as negative values have been listed with a value of zero.

3.2.1 Gamma-Emitting Radionuclides

Gamma-emitting radionuclides analytical results for environmental samples collected within the disturbed material population are presented in Table 3-7.

Table 3-7
Gamma-Emitting Radionuclides Activities Reported from Disturbed Material Population Samples

Sample Number	Sample Location	Depth (ft bgs)	Ac228 (pCi/g)	Al-26 (pCi/g)	Am241 (pCi/g)	Be-7 (pCi/g)	Bi-212 (pCi/g)	Bi-214 (pCi/g)	Cm-243 (pCi/g)	Co-58 (pCi/g)	Co-60 (pCi/g)	Cs-134 (pCi/g)	Cs-137 (pCi/g)	Eu-152 (pCi/g)	Eu-154 (pCi/g)	Eu-155 (pCi/g)	K-40 (pCi/g)	Nb-94 (pCi/g)	Pb-212 (pCi/g)	Pb-214 (pCi/g)	Sb-125 (pCi/g)	Th-227 (pCi/g)	Th-234 (pCi/g)	Tl-208 (pCi/g)	U-235 (pCi/g)
DSB01	B1	0-0.5	0.57(U)	0.013(U)	0(U)	0(U)	1.34(U)	1.37(J)	0.17(U)	0.051(U)	0.057(U)	0.01(U)	0.005(U)	0.44(U)	0(U)	0.03(U)	11	0(U)	0.64(J)	1.62(J)	0(U)	0.16(U)	1.76(U)	0.21(U)	0.22(U)
DSB02	D2	0-0.5	0.57(U)	0.047(U)	0.1(U)	0(U)	1.5(U)	1.82(J)	0.05(U)	0(U)	0(U)	0(U)	0(U)	0.32(U)	0(U)	0.13(U)	13.5	0.014(U)	0.75(J)	2.43(J)	0.07(U)	0(U)	1.7(U)	0.188(U)	0.06(U)
DSB03	B3	0-0.5	0.52(U)	0.044(U)	0(U)	0.1(U)	0.73(U)	1.56(J)	0.21(U)	0.003(U)	0(U)	0.14(U)	0(U)	0(U)	0(U)	0.05(U)	10	0(U)	0.54	1.73(J)	0.01(U)	0(U)	1.51(U)	0.161(U)	0(U)
DSB04	B8	0-0.5	0.43(U)	0.016(U)	0.17(U)	0.35(U)	0.48(U)	2.38(J)	0.14(U)	0(U)	0(U)	0.12(U)	0(U)	0.13(U)	0.14(U)	0.06(U)	9.5	0.082(U)	0.44	2.36(J)	0.11(U)	0(U)	2.33	0.146(U)	0.05(U)
DSB05	B13	0-0.5	0.81(U)	0(U)	0.33(U)	0(U)	0.4(U)	1.71(J)	0.04(U)	0.022(U)	0.008(U)	0.28(U)	0.093(U)	0.47(U)	0.13(U)	0.03(U)	12.5	0.054(U)	0.97(J)	1.93(J)	0(U)	0(U)	2.4(U)	0.138(U)	0.27(U)
DSB06	B7	0-0.5	0.43(U)	0.08(U)	0(U)	0.27(U)	0.9(U)	1.5(J)	0.2(U)	0(U)	0.041(U)	0.25(U)	0.009(U)	0.19(U)	0.11(U)	0(U)	9.5	0(U)	0.49	1.65(J)	0.01(U)	0(U)	2.08(U)	0.157	0.23(U)
DSB07	B9	0-0.5	0.72(U)	0.002(U)	0(U)	0.01(U)	0.8(U)	2.4(J)	0(U)	0.014(U)	0.11(U)	0.018(U)	0(U)	0.11(U)	0(U)	0(U)	12.8	0(U)	0.82	2.84(J)	0.06(U)	0.16(U)	1.9(U)	0.214	0.13(U)
DSB08	B6	0-0.5	0.57(U)	0.097(U)	0(U)	0.15(U)	1.33(U)	0.92(J)	0.1(U)	0.03(U)	0(U)	0.023(U)	0(U)	0(U)	0(U)	0.04(U)	8.4	0.003(U)	0.56(J)	0.98(J)	0.06(U)	0(U)	0.8(U)	0.169(U)	0.15(U)
DSB09	B10	0-0.5	0.5(U)	0.066(U)	0(U)	0.11(U)	0.53(U)	1.83(J)	0.06(U)	0(U)	0.011(U)	0(U)	0(U)	0.05(U)	0(U)	0.02(U)	8.1	0.039(U)	0.42	2.11(J)	0.02(U)	0(U)	1.5(U)	0.121(U)	0.05(U)
DSB10	B10	0-0.5	0.49(U)	0(U)	0.15(U)	0.07(U)	0.39(U)	2.11(J)	0.18(U)	0(U)	0(U)	0(U)	0(U)	0.08(U)	0(U)	0.13(U)	8.9	0.035(U)	0.54	2.17(J)	0.01(U)	0(U)	2.5(U)	0.141(U)	0.22(U)
DSB11	B11	0-0.5	0.58(U)	0(U)	0.31(U)	0.11(U)	1.1(U)	2.02(J)	0.18(U)	0(U)	0.034(U)	0.009(U)	0(U)	0(U)	0.12(U)	0.17(U)	10.6	0(U)	0.64	2.21(J)	0(U)	0(U)	3	0.182(U)	0.07(U)
DSB12	B16	0-0.5	0.52(U)	0.013(U)	0.05(U)	0.04(U)	1.53(U)	2.09(J)	0.2(U)	0(U)	0.028(U)	0.34(U)	0(U)	0(U)	0(U)	0.06(U)	10.6	0(U)	0.63	2.45(J)	0.05(U)	0.36(U)	3.2	0.166(U)	0.01(U)
DSB13	B17	0-0.5	0.48(U)	0(U)	0(U)	0.1(U)	0.84(U)	2.24(J)	0.11(U)	0(U)	0(U)	0(U)	0(U)	0(U)	0.04(U)	0.06(U)	10.6	0.007(U)	0.63	2.47(J)	0.01(U)	0.02(U)	1.3(U)	0.141(U)	0.18(U)
DSB14	D11	0-0.5	0.71	0.032(U)	0.7(U)	0(U)	1.14(U)	1.74(J)	0(U)	0(U)	0.011(U)	0.11(U)	0(U)	0.25(U)	0.16(U)	0.04(U)	13.2	0(U)	0.94(J)	1.97(J)	0.01(U)	0(U)	1(U)	0.39	0.26(U)
DSB15	D15	0-0.5	0.6(U)	0(U)	0.05(U)	0.1(U)	0.59(U)	2.05(J)	0(U)	0(U)	0.031(U)	0.043(U)	0(U)	0.14(U)	0(U)	0(U)	10.3	0(U)	0.51(J)	2.25(J)	0.15(U)	0(U)	1.67(U)	0.179(U)	0.33(U)
DSB16	B15	0-0.5	0.99	0.013(U)	0.04(U)	0(U)	1.39(U)	1.62(J)	0.19(U)	0(U)	0(U)	0(U)	0(U)	0(U)	0(U)	0.01(U)	14	0.051(U)	1.27(J)	1.75(J)	0(U)	0.27(U)	1.8(U)	0.38	0.22(U)
DSB17	B14	0-0.5	0.77	0.04(U)	0.8(U)	0(U)	1.41(U)	2.65(J)	0.08(U)	0(U)	0.036(U)	0.017(U)	0(U)	0.08(U)	0.27(U)	0.02(U)	11.2	0(U)	0.75(J)	2.99(J)	0.02(U)	0(U)	3.9(U)	0.212(U)	0.15(U)
DSB18	D1	0-0.5	0.69	0(U)	0(U)	0.02(U)	0.47(U)	2.03(J)	0.19(U)	0(U)	0(U)	0.003(U)	0(U)	0.33(U)	0(U)	0.13(U)	12	0(U)	0.5(J)	1.99(J)	0(U)	0.13(U)	1.9(U)	0.16(U)	0.09(U)
DSB19	D3	0-0.5	0.36(U)	0.04(U)	0(U)	0(U)	0.9(U)	1.12(J)	0.15(U)	0(U)	0(U)	0.034(U)	0(U)	0(U)	0.05(U)	0.04(U)	7.6	0(U)	0.41(J)	1.28(J)	0.13(U)	0(U)	1.8(U)	0.121(U)	0.15(U)

(J) = Estimated
(U) = Not detected

3.2.2 Plutonium Isotopes

Analytical results for plutonium isotopes from environmental samples collected within the disturbed material population are presented in Table 3-8.

Table 3-8
Plutonium Isotopes Activities Reported from Disturbed Material Population

Sample Number	Sample Location	Depth (ft bgs)	Pu-238 (pCi/g)	Pu-239 (pCi/g)
DSB01	B1	0-0.5	0.002(U)	0.076
DSB02	D2	0-0.5	0(U)	0(U)
DSB03	B3	0-0.5	0(U)	0.001(U)
DSB04	B8	0-0.5	0(U)	0(U)
DSB05	B13	0-0.5	0.003(U)	0.082
DSB06	B7	0-0.5	0(U)	0.006(U)
DSB07	B9	0-0.5	0(U)	0.015(U)
DSB08	B6	0-0.5	0.001(U)	0.003(U)
DSB09	B10	0-0.5	0.001(U)	0.005(U)
DSB10	B10	0-0.5	0(U)	0.002(U)
DSB11	B11	0-0.5	0.002(U)	0.007(U)
DSB12	B16	0-0.5	0(U)	0(U)
DSB13	B17	0-0.5	0(U)	0.002(U)
DSB14	D11	0-0.5	0(U)	0(U)
DSB15	D15	0-0.5	0(U)	0.001(U)
DSB16	B15	0-0.5	0.001(U)	0.005(U)
DSB17	B14	0-0.5	0(U)	0.029
DSB18	D1	0-0.5	0(U)	0.003(U)
DSB19	D3	0-0.5	0(U)	0.006(U)

(U) = Not detected

3.2.3 Uranium Isotopes

Analytical results for uranium isotopes from environmental samples collected within the disturbed material population are presented in Table 3-9.

Table 3-9
Uranium Isotopes Activities Reported from Disturbed Material Population

Sample Number	Sample Location	Depth (ft bgs)	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)
DSB01	B1	0-0.5	1.56	0.072	1.64
DSB02	D2	0-0.5	1.93	0.159	2.15
DSB03	B3	0-0.5	1.65	0.107	1.63
DSB04	B8	0-0.5	2.8	0.137	3.09
DSB05	B13	0-0.5	1.76	0.094	2.01
DSB06	B7	0-0.5	1.94	0.128	2.1
DSB07	B9	0-0.5	2.59	0.12	3.03
DSB08	B6	0-0.5	1.47	0.083	1.33
DSB09	B10	0-0.5	1.97	0.114	2.07
DSB10	B10	0-0.5	2.07	0.121	2.23
DSB11	B11	0-0.5	2.2	0.138	2.45
DSB12	B16	0-0.5	2.18	0.153	2.51
DSB13	B17	0-0.5	2.44	0.169	2.67
DSB14	D11	0-0.5	1.63	0.084(J)	1.78
DSB15	D15	0-0.5	1.74	0.106(J)	1.96
DSB16	B15	0-0.5	1.51	0.078(J)	1.65
DSB17	B14	0-0.5	2.67	0.148(J)	2.91
DSB18	D1	0-0.5	1.78	0.122(J)	1.94
DSB19	D3	0-0.5	1.19	0.051(U)	1.21

(J) = Estimated
(U) = Not detected

3.2.4 Strontium-90

Analytical results for Sr-90 from environmental samples collected within the disturbed material population are presented in Table 3-10.

Table 3-10
Strontium Activities Reported from Disturbed Material Population

Sample Number	Sample Location	Depth (ft bgs)	Sr-90 (pCi/g)
DSB01	B1	0-0.5	0.02(U)
DSB02	D2	0-0.5	0.024(U)
DSB03	B3	0-0.5	0.019(U)
DSB04	B8	0-0.5	0.04(U)
DSB05	B13	0-0.5	0.034(U)
DSB06	B7	0-0.5	0(U)
DSB07	B9	0-0.5	0(U)
DSB08	B6	0-0.5	0.003(U)
DSB09	B10	0-0.5	0.001(U)
DSB10	B10	0-0.5	0.013(U)
DSB11	B11	0-0.5	0(U)
DSB12	B16	0-0.5	0(U)
DSB13	B17	0-0.5	0(U)
DSB14	D11	0-0.5	0.004(U)
DSB15	D15	0-0.5	0.064(U)
DSB16	B15	0-0.5	0.011(U)
DSB17	B14	0-0.5	0.089(U)
DSB18	D1	0-0.5	0(U)
DSB19	D3	0-0.5	0(U)

(U) = Not detected

3.2.5 Tritium

Analytical results for tritium from environmental samples collected within the disturbed material population are presented in Table 3-11.

Table 3-11
Tritium Activities Reported from Disturbed Material Population

Sample Number	Sample Location	Depth (ft bgs)	Tritium (pCi/L)
DSB01	B1	0-0.5	0(U)
DSB02	D2	0-0.5	0(U)
DSB03	B3	0-0.5	400(U)
DSB04	B8	0-0.5	800(U)
DSB05	B13	0-0.5	0(U)
DSB06	B7	0-0.5	0(U)
DSB07	B9	0-0.5	0(U)
DSB08	B6	0-0.5	3,100(U)
DSB09	B10	0-0.5	200(U)
DSB10	B10	0-0.5	0(U)
DSB11	B11	0-0.5	0(U)
DSB12	B16	0-0.5	0(U)
DSB13	B17	0-0.5	0(U)
DSB14	D11	0-0.5	360(U)
DSB15	D15	0-0.5	1,000(U)
DSB16	B15	0-0.5	300(U)
DSB17	B14	0-0.5	1,800(U)
DSB18	D1	0-0.5	11,000(U)
DSB19	D3	0-0.5	4,000(U)

(U) = Not detected

3.2.6 Gross Alpha/Beta

Analytical results for gross alpha and gross beta from environmental samples collected within the disturbed material population are presented in Table 3-12.

Table 3-12
Gross Alpha Beta Activities Reported from Disturbed Material Population

Sample Number	Sample Location	Depth (ft bgs)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)
DSB01	B1	0-0.5	6.2	2.4(U)
DSB02	D2	0-0.5	7.4	5.7
DSB03	B3	0-0.5	6.7	4.6(U)
DSB04	B8	0-0.5	11.4	6.1
DSB05	B13	0-0.5	6.7	6
DSB06	B7	0-0.5	7.6	3.8(U)
DSB07	B9	0-0.5	9.4	6.7
DSB08	B6	0-0.5	3.5	3.8(U)
DSB09	B10	0-0.5	8.1	4.8(U)
DSB10	B10	0-0.5	7.9	5.2(U)
DSB11	B11	0-0.5	13.8	8
DSB12	B16	0-0.5	8.9	6.7
DSB13	B17	0-0.5	9.2	6.3
DSB14	D11	0-0.5	6.6	5.6
DSB15	D15	0-0.5	8.2	5.4
DSB16	B15	0-0.5	4.5(U)	3.2(U)
DSB17	B14	0-0.5	7.3	9.1
DSB18	D1	0-0.5	8	6.3
DSB19	D3	0-0.5	8.1	2.4(U)

(U) = Not detected

3.3 Subsurface Rock Population Sample Results

Analytical results from the samples collected within the subsurface rock population as outlined in the SAP are presented in the following sections. As negative activities are not possible, activities reported as negative values have been listed with a value of zero.

3.3.1 Gamma-Emitting Radionuclides

Gamma-emitting radionuclides analytical results for environmental samples collected within the subsurface rock population are presented in Table 3-13.

Table 3-13
Gamma-Emitting Radionuclides Activities Reported from Subsurface Rock Population Samples

Sample Number	Sample Location	Depth (ft bgs)	Ac-228 (pCi/g)	Al-26 (pCi/g)	Am-241 (pCi/g)	Be-7 (pCi/g)	Bi-212 (pCi/g)	Bi-214 (pCi/g)	Cm-243 (pCi/g)	Co-58 (pCi/g)	Co-60 (pCi/g)	Cs-134 (pCi/g)	Cs-137 (pCi/g)	Eu-152 (pCi/g)	Eu-154 (pCi/g)	Eu-155 (pCi/g)	K-40 (pCi/g)	Nb-94 (pCi/g)	Pb-212 (pCi/g)	Pb-214 (pCi/g)	Sb-125 (pCi/g)	Th-227 (pCi/g)	Th-234 (pCi/g)	Tl-208 (pCi/g)	U-235 (pCi/g)
DSC01	E2	0-0.5	0.42(U)	0.026(U)	0.24(U)	0.13(U)	0.33(U)	2.07(J)	0(U)	0(U)	0(U)	0.016(U)	0(U)	0.19(U)	0(U)	0.05(U)	11.4	0.045(U)	0.5	2.44(J)	0(U)	0(U)	1.1(U)	0.112(U)	0.16(U)
DSC02	E1	0-0.5	0.91	0(U)	0.02(U)	0(U)	1.54(U)	2.68(J)	0.16(U)	0(U)	0.03(U)	0.006(U)	0(U)	0.43(U)	0(U)	0.08(U)	21.1	0.012(U)	1.09(J)	2.76(J)	0(U)	0.17(U)	3.58(J)	0.279	0.44(U)
DSC03	E3	0-0.5	0.86	0(U)	0(U)	0(U)	0.71(U)	2.06(J)	0.35(U)	0(U)	0(U)	0.04(U)	0(U)	0.1(U)	0(U)	0.25(U)	15.6	0(U)	0.71(J)	2.22(J)	0.04(U)	0(U)	1.2(U)	0.261	0.02(U)
DSC04	E3	0-0.5	0.67	0.017(U)	0.01(U)	0(U)	0.31(U)	2.03(J)	0.08(U)	0.03(U)	0.039(U)	0.003(U)	0(U)	0.17(U)	0(U)	0.11(U)	16.7	0(U)	0.64(J)	2.06(J)	0.02(U)	0(U)	1.95(U)	0.237	0(U)
DSC05	E5	0-0.5	0.58(U)	0.048(U)	0(U)	0.34(U)	0.72(U)	2.56(J)	0(U)	0(U)	0(U)	0(U)	0(U)	0.28(U)	0(U)	0.08(U)	15.9	0.048(U)	0.94(J)	2.53(J)	0.03(U)	0(U)	2.4(J)	0.282	0.48(U)
DSC06	E10	0-0.5	0.31(U)	0.005(U)	0.09(U)	0.13(U)	0.59(U)	2.63(J)	0.05(U)	0(U)	0(U)	0.003(U)	0(U)	0.1(U)	0(U)	0.08(U)	13	0.04(U)	0.65(J)	2.78(J)	0(U)	0(U)	2.54(J)	0.194	0(U)
DSC07	E8	0-0.5	0.65	0.053(U)	0.2(U)	0(U)	0.96(U)	1.99(J)	0.48(U)	0(U)	0.032(U)	0(U)	0(U)	0(U)	0(U)	0.12(U)	15.2	0.01(U)	0.77(J)	2(J)	0(U)	0(U)	1.7(U)	0.236	0.12(U)
DSC08	E7	0-0.5	0.41(U)	0.002(U)	0.055(U)	0(U)	0.02(U)	1.47(J)	0.18(U)	0(U)	0.006(U)	0(U)	0(U)	0.14(U)	0(U)	0(U)	8.5	0(U)	0.56(J)	1.65(J)	0.032(U)	0(U)	0.96(U)	0.106(U)	0.1(U)
DSC09	E6	0-0.5	0.53(U)	0(U)	0.025(U)	0.19(U)	0.88(U)	1.72(J)	0.18(U)	0.011(U)	0.03(U)	0.016(U)	0.007(U)	0.14(U)	0(U)	0(U)	13.5	0(U)	0.52(J)	1.76(J)	0.04(U)	0.26(U)	2.01(J)	0.189	0.15(U)
DSC10	E11	0-0.5	0.27(U)	0(U)	0(U)	0(U)	0.28(U)	1.48(J)	0.03(U)	0(U)	0(U)	0.03(U)	0.01(U)	0.03(U)	0(U)	0(U)	5.5	0.021(U)	0.306(J)	1.64(J)	0.04(U)	0.14(U)	0.8(U)	0.085(U)	0(U)
DSC11	E9	0-0.5	0.35(U)	0(U)	0.024(U)	0(U)	0.77(U)	1.03(J)	0.1(U)	0.003(U)	0.008(U)	0.024(U)	0(U)	0.16(U)	0.02(U)	0(U)	8.1	0(U)	0.36	1.13(J)	0(U)	0.03(U)	0.9(U)	0.103(U)	0.26(U)

(J) = Estimated
(U) = Not detected

3.3.2 Plutonium Isotopes

Analytical results for plutonium isotopes from environmental samples collected within the subsurface rock population are presented in Table 3-14.

Table 3-14
Plutonium Activities Reported from Subsurface Rock Population

Sample Number	Sample Location	Depth (ft bgs)	Pu-238 (pCi/g)	Pu-239 (pCi/g)
DSC01	E2	0-0.5	0(U)	0.005(U)
DSC02	E1	0-0.5	0.002(U)	0(U)
DSC03	E3	0-0.5	0.007(U)	0(U)
DSC04	E3	0-0.5	0.006(U)	0.005(U)
DSC05	E5	0-0.5	0(U)	0(U)
DSC06	E10	0-0.5	0(U)	0(U)
DSC07	E8	0-0.5	0(U)	0(U)
DSC08	E7	0-0.5	0(U)	0(U)
DSC09	E6	0-0.5	0(U)	0(U)
DSC10	E11	0-0.5	0.002(U)	0(U)
DSC11	E9	0-0.5	0(U)	0(U)

(U) = Not detected

3.3.3 Uranium Isotopes

Analytical results for uranium isotopes from environmental samples collected within the subsurface rock population are presented in Table 3-15.

Table 3-15
Uranium Activities Reported from Subsurface Rock Population
(Page 1 of 2)

Sample Number	Sample Location	Depth (ft bgs)	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)
DSC01	E2	0-0.5	1.83	0.087(J)	2.2
DSC02	E1	0-0.5	3	0.119(J)	3.38
DSC03	E3	0-0.5	2.15	0.143(J)	2.39
DSC04	E3	0-0.5	1.92	0.141(J)	2.12

Table 3-15
Uranium Activities Reported from Subsurface Rock Population
(Page 2 of 2)

Sample Number	Sample Location	Depth (ft bgs)	U-234 (pCi/g)	U-235 (pCi/g)	U-238 (pCi/g)
DSC05	E5	0-0.5	2.26	0.134(J)	2.54
DSC06	E10	0-0.5	2.43	0.109(J)	2.53
DSC07	E8	0-0.5	1.98	0.156(J)	2.16
DSC08	E7	0-0.5	1.59	0.079(J)	1.49
DSC09	E6	0-0.5	1.76	0.081(J)	1.92
DSC10	E11	0-0.5	1.29	0.052(J)	1.39
DSC11	E9	0-0.5	1.22	0.071(J)	1.29

(J) = Estimated

3.3.4 Strontium-90

Analytical results for Sr-90 from environmental samples collected within the subsurface rock population are presented in Table 3-16

Table 3-16
Strontium Activities Reported from Subsurface Rock Population

Sample Number	Sample Location	Depth (ft bgs)	Sr-90 (pCi/g)
DSC01	E2	0-0.5	0(U)
DSC02	E1	0-0.5	0.022(U)
DSC03	E3	0-0.5	0.06(U)
DSC04	E3	0-0.5	0.002(U)
DSC05	E5	0-0.5	0.025(U)
DSC06	E10	0-0.5	0.029(U)
DSC07	E8	0-0.5	0.022(U)
DSC08	E7	0-0.5	0.022(U)
DSC09	E6	0-0.5	0.008(U)
DSC10	E11	0-0.5	0.022(U)
DSC11	E9	0-0.5	0.045(U)

(U) = Not detected

3.3.5 Tritium

Analytical results for tritium from environmental samples collected within the subsurface rock population are presented in Table 3-17.

Table 3-17
Tritium Activities Reported from Subsurface Rock Population

Sample Number	Sample Location	Depth (ft bgs)	Tritium (pCi/L)
DSC01	E2	0-0.5	0(U)
DSC02	E1	0-0.5	800(U)
DSC03	E3	0-0.5	2,000(U)
DSC04	E3	0-0.5	0(U)
DSC05	E5	0-0.5	4,700(U)
DSC06	E10	0-0.5	2,800(U)
DSC07	E8	0-0.5	3,300(U)
DSC08	E7	0-0.5	1,000(U)
DSC09	E6	0-0.5	1,500(U)
DSC10	E11	0-0.5	1,500(U)
DSC11	E9	0-0.5	6,000(U)

(U) = Not detected

3.3.6 Gross Alpha/Beta

Analytical results for gross alpha and gross beta from environmental samples collected within the subsurface rock population are presented in Table 3-18.

Table 3-18
Gross Alpha Beta Activities Reported from Subsurface Rock Population
(Page 1 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)
DSC01	E2	0-0.5	9.8	7.4
DSC02	E1	0-0.5	10.3	9.8
DSC03	E3	0-0.5	6.5	8.3
DSC04	E3	0-0.5	8.2	6.2

Table 3-18
Gross Alpha Beta Activities Reported from Subsurface Rock Population
(Page 2 of 2)

Sample Number	Sample Location	Depth (ft bgs)	Gross Alpha (pCi/g)	Gross Beta (pCi/g)
DSC05	E5	0-0.5	7.7	8.9
DSC06	E10	0-0.5	10.1	6.8
DSC07	E8	0-0.5	8.6	5.1
DSC08	E7	0-0.5	6.7	3.4(U)
DSC09	E6	0-0.5	6.2	4.1(U)
DSC10	E11	0-0.5	5.2	0.4(U)
DSC11	E9	0-0.5	3.7	2.4(U)

(U) = Not detected

3.4 Flyover Anomaly Sample Results

Analytical results from the samples collected from the locations with the three highest readings from the May 1, 2006, aerial gamma radiation survey (Riedhauser, 2006) as outlined in the SAP are presented in Table 3-19. As negative activities are not possible, activities reported as negative values have been listed with a value of zero.

Table 3-19
Flyover Anomaly Sample Activities
(Page 1 of 2)

Analyte	DSD01 (pCi/g)	DSD02 (pCi/g)	DSD03 (pCi/g)
Ac-228	1.17	0.33(U)	0.62
Al-26	0.016(U)	0(U)	0(U)
Am-241	0.4(U)	0.025(U)	0.007(U)
Be-7	0.39(U)	0(U)	0(U)
Bi-212	1.62(U)	0(U)	0.47(U)
Bi-214	1.85(J)	1.94(J)	2.2(J)
Cm-243	0(U)	0(U)	0.22(U)
Co-58	0(U)	0(U)	0.011(U)
Co-60	0.067(U)	0(U)	0.032(U)

Table 3-19
Flyover Anomaly Sample Activities
(Page 2 of 2)

Analyte	DSD01 (pCi/g)	DSD02 (pCi/g)	DSD03 (pCi/g)
Cs-134	0(U)	0(U)	0(U)
Cs-137	0.37	0(U)	0.022(U)
Eu-152	0.15(U)	0.29(U)	0.25(U)
Eu-154	0(U)	0(U)	0(U)
Eu-155	0(U)	0(U)	0.06(U)
K-40	19	7.5	11.8
Nb-94	0(U)	0.006(U)	0.003(U)
Pb-212	1.23(J)	0.39(J)	0.59(J)
Pb-214	1.97(J)	2.12(J)	2.44(J)
Sb-125	0.13(U)	0(U)	0.05(U)
Th-227	0(U)	0.35(U)	0(U)
Th-234	1.7(U)	1.49(U)	2.35(J)
Tl-208	0.36	0.129(U)	0.16
U-235 Gamma	0.67(U)	0(U)	0.19(U)
Pu-238	0.026(U)	0(U)	0(U)
Pu-239	0.264	0(U)	0.006(U)
U-234	0.8	1.91	2.39
U-235 Iso U	0.049(J)	0.081(J)	0.165(J)
U-238	0.93	2.2	2.51
SR-90	0.141(U)	0.005(U)	0.022(U)
Tritium	100(U)	0(U)	1,800(U)
Gross Alpha	8.6	4.8	5.8
Gross Beta	8.2	3.7(U)	6.9

(J) = Estimated
(U) = Not detected

4.0 Characterization

This section presents the radiological characterization for each of the three Divine Strake sampling populations. The calculation of radiological characteristics presented in this section followed the following protocols:

- Field duplicate data were excluded. This was done so that locations where duplicates were taken would have an equal effect on the results as other locations.
- All activities reported as negative values were assigned an activity of zero before the calculation of analyte averages. Although this may bias the results upwards, negative activities are not possible.
- Reported activities below the MDC were included in the statistical calculations. Although there is lower confidence in reported activities below the MDC, use of the reported values provides better information than the methods that substitute the MDC or one-half of the MDC. As confidence in the resulting characteristic is higher when more of the data are above the MDC, the number of results above the MDC (i.e., detects), is reported for each calculated characteristic. Care should be taken when using a characteristic based on no, or even a small number of, detections.

The tables in this section present the following characteristics for each analyte and population:

- **Number of Detects –** The number of samples with results greater than the MDC.
- **Lower Confidence Interval –** The distribution-independent lower confidence interval values as discussed in Section A.2.4.2
- **Average Reported Activity –** The average of all reported activities.
- **Upper Confidence Interval –** The distribution-independent upper confidence interval values as discussed in Section A.2.4.2
- **Upper Confidence Limit –** The 95th percent UCL as determined by the ProUCL software package. This parameter was calculated for only those analytes with at least one reported activity greater than the MDC.
- **Maximum Reported Activity –** The maximum reported activity reported for the analyte.
- **Maximum MDC –** The maximum reported MDC reported for the analyte. For analytes with reported activities below the MDC, this is the maximum possible activity present for the analyte.

The Average Reported Activity is the best estimate of the true radiological activities at the site. However, due to the uncertainty of the estimation of true site characteristics (as discussed in Section 2.1), the UCI, UCL, Maximum Reported Activity, and the Maximum MDC are also presented to provide conservative (upper bound) estimates of the true average radiological activities at the site.

4.1 Undisturbed Surface Material

The radiological characteristics of reported analytes within the undisturbed surface material population are presented in Table 4-1.

Table 4-1
Radionuclide Characteristics of the Undisturbed Surface Material Population (pCi/g)
(Page 1 of 2)

Analyte	Number of Detects	Lower Confidence Interval	Average Reported Activity	Upper Confidence Interval	Upper Confidence Limit	Maximum Reported Activity	Maximum MDC
Ac-228	22	0.778	1.02	1.27	1.1	1.41	0.58
Al-26	0	0.00019	0.0109	0.05		0.0483	0.176
Am-241	1	0.0299	0.282	0.719	0.546	1.01	1.87
Be-7	0	0	0.0799	0.437		0.247	1.22
Bi-212	0	0.188	0.918	1.71		1.6	2
Bi-214	24	1.04	1.28	1.51	1.36	1.77	0.31
Cm-243	0	0.0117	0.174	0.436		0.488	0.7306
Co-58	0	0	0.00544	0.0402		0.069	0.159
Co-60	0	0	0.00979	0.0588		0.052	0.167
Cs-134	0	0.000801	0.0285	0.17		0.26	0.8854
Cs-137	21	0.346	0.447	0.55	0.535	1.06	0.13
Eu-152	0	0	0.0819	0.341		0.32	0.77
Eu-154	0	0	0.0348	0.247		0.22	0.8
Eu-155	0	0.0019	0.0547	0.218		0.18	0.4363
Tritium[a]	0	41.7	954	4,020		12,000	18,000
K-40	24	13.1	15.6	18.1	18.6	20.3	2.3
Nb-94	0	0.000167	0.0142	0.0589		0.071	0.161
Pb-212	24	0.965	1.16	1.36	1.26	1.77	0.24

Table 4-1
Radionuclide Characteristics of the Undisturbed Surface Material Population (pCi/g)
(Page 2 of 2)

Analyte	Number of Detects	Lower Confidence Interval	Average Reported Activity	Upper Confidence Interval	Upper Confidence Limit	Maximum Reported Activity	Maximum MDC
Pb-214	24	1.18	1.41	1.63	1.48	1.94	0.28
Pu-238	7	0.0139	0.0317	0.0515	0.0664	0.147	0.037
Pu-239	23	1.41	1.73	2.05	2.82	11.1	0.03
Sb-125	0	0.00778	0.0675	0.183		0.31	0.35
Sr-90	15	0.0825	0.139	0.195	0.159	0.309	0.088
Th-227	0	0	0.246	4.23		2.01	19
Th-234	4	0.484	1.49	2.58	1.65	2.34	2.966
Tl-208	24	0.245	0.333	0.421	0.357	0.441	0.15
U-234	24	0.78	0.974	1.17	1.06	1.84	0.04
U-235	19	0.0338	0.0665	0.0992	0.094	0.179	0.03
U-238	24	0.843	1.05	1.25	1.14	2.01	0.03

[a]All tritium values are expressed in units of picocuries per liter

4.2 Disturbed Material

The radiological characteristics of reported analytes within the disturbed material population are presented in Table 4-2.

Table 4-2
Radionuclide Characteristics of the Disturbed Material Population (pCi/g)
(Page 1 of 2)

Analyte	Number of Detects	Lower Confidence Interval	Average Reported Activity	Upper Confidence Interval	Upper Confidence Limit	Maximum Reported Activity	Maximum MDC
Ac-228	4	0.348	0.601	0.854	0.665	0.99	0.6
Al-26	0	0.00317	0.0279	0.0803		0.097	0.156
Am-241	0	0	0.142	0.516		0.8	2.1
Be-7	0	0	0.0756	0.531		0.35	1.09
Bi-212	0	0.216	0.966	1.86		1.53	2
Bi-214	18	1.52	1.84	2.15	2.02	2.65	0.3

Table 4-2
Radionuclide Characteristics of the Disturbed Material Population (pCi/g)
(Page 2 of 2)

Analyte	Number of Detects	Lower Confidence Interval	Average Reported Activity	Upper Confidence Interval	Upper Confidence Limit	Maximum Reported Activity	Maximum MDC
Cm-243	0	0	0.115	0.387		0.21	0.82
Co-58	0	0	0.00667	0.0385		0.051	0.157
Co-60	0	0.00139	0.0204	0.0763		0.11	0.156
Cs-134	0	0	0.0776	0.362		0.34	1.17
Cs-137	0	0.00117	0.00594	0.0488		0.093	0.134
Eu-152	0	0.00722	0.139	0.452		0.47	0.8
Eu-154	0	0	0.0567	0.351		0.27	0.79
Eu-155	0	0.00167	0.0494	0.217		0.17	0.49
Tritium[a]	0	0	1,280	4,610		11,000	19,000
K-40	18	8.74	10.9	13	13.4	14	2.2
Nb-94	0	0.00117	0.0139	0.0616		0.082	0.131
Pb-212	18	0.509	0.662	0.814	0.758	1.27	0.24
Pb-214	18	1.75	2.06	2.36	2.27	2.99	0.26
Pu-238	0	0	0.000556	0.0109		0.003	0.026
Pu-239	3	0.0055	0.0134	0.0276	0.039	0.082	0.024
Sb-125	0	0.000556	0.0394	0.166		0.15	0.34
Sr-90	0	0.00239	0.0172	0.0583		0.089	0.142
Th-227	0	0	0.0611	0.659		0.36	13.3
Th-234	3	0.941	1.98	3.02	2.29	3.9	2.7
Tl-208	4	0.107	0.191	0.274	0.222	0.39	0.16
U-234	18	1.59	1.95	2.3	2.13	2.8	0.05
U-235	17	0.0698	0.115	0.159	0.125	0.169	0.029
U-238	18	1.74	2.12	2.5	2.35	3.09	0.03

[a]All tritium values are expressed in units of picocuries per liter

4.3 Subsurface Rock

The radiological characteristics of reported analytes within the subsurface rock population are presented in Table 4-3.

Table 4-3
Radionuclide Characteristics of the Subsurface Rock Population (pCi/g)
(Page 1 of 2)

Analyte	Number of Detects	Lower Confidence Interval	Average Reported Activity	Upper Confidence Interval	Upper Confidence Limit	Maximum Reported Activity	Maximum MDC
Ac-228	3	0.311	0.529	0.747	0.658	0.91	0.45
Al-26	0	0	0.0134	0.0577		0.053	0.118
Am-241	0	0	0.0654	0.486		0.24	1.9
Be-7	0	0	0.079	0.428		0.34	1
Bi-212	0	0.091	0.68	1.49		1.54	1.57
Bi-214	10	1.65	1.97	2.29	2.29	2.68	0.23
Cm-243	0	0.008	0.153	0.418		0.48	0.71
Co-58	0	0	0.0014	0.0402		0.011	0.133
Co-60	0	0	0.0106	0.0522		0.032	0.146
Cs-134	0	0	0.0135	0.134		0.04	1.29
Cs-137	0	0	0.0017	0.0255		0.01	0.132
Eu-152	0	0.01	0.157	0.447		0.43	0.64
Eu-154	0	0	0.002	0.209		0.02	0.76
Eu-155	0	0	0.066	0.216		0.25	0.44
Tritium[a]	0	100	2,360	8,190		6,000	18,000
K-40	10	10.5	12.8	15	14.8	21.1	1.3
Nb-94	0	0	0.0176	0.0678		0.048	0.115
Pb-212	10	0.499	0.641	0.782	0.783	1.09	0.18
Pb-214	10	1.78	2.09	2.4	2.41	2.78	0.24
Pu-238	0	0	0.0011	0.012		0.007	0.031
Pu-239	0	0	0.0005	0.0109		0.005	0.028
Sb-125	0	0	0.0182	0.128		0.04	0.32
Sr-90	0	0.0001	0.0255	0.0814		0.06	0.14
Th-227	0	0	0.06	0.349		0.26	0.98

Table 4-3
Radionuclide Characteristics of the Subsurface Rock Population (pCi/g)
(Page 2 of 2)

Analyte	Number of Detects	Lower Confidence Interval	Average Reported Activity	Upper Confidence Interval	Upper Confidence Limit	Maximum Reported Activity	Maximum MDC
Th-234	4	0.898	1.72	2.62	2.25	3.58	2.2
Tl-208	6	0.113	0.185	0.257	0.23	0.282	0.108
U-234	10	1.6	1.95	2.3	2.26	3	0.04
U-235	10	0.0618	0.103	0.144	0.118	0.156	0.024
U-238	10	1.75	2.13	2.51	2.5	3.38	0.03

[a]All tritium values are expressed in units of picocuries per liter

5.0 Data Quality

Rigorous QC was implemented for all laboratory samples including documentation, verification and validation of analytical results, and affirmation of data quality indicator (DQI) requirements related to laboratory analysis. The following sections discuss the DQA, data validation process, QC samples, and nonconformances as prescribed in *Data Quality Assessment: A Reviewer's Guide* (EPA, 2006a). Detailed information regarding the quality assurance (QA) program is contained in the Industrial Sites QAPP (NNSA/NV, 2002).

5.1 Data Quality Assessment Summary

The DQA is presented in Appendix A and includes an evaluation of the DQIs to determine the degree of acceptability and usability of the reported data in the decision-making process as prescribed in *Data Quality Assessment: A Reviewer's Guide* (EPA, 2006a). The DQO process ensures that the right type, quality, and quantity of data will be available to support the resolution of those decisions at an appropriate level of confidence (EPA, 2006b). Using both the DQO and DQA processes help to ensure that DQO decisions are sound and defensible.

A detailed evaluation of the DQIs is presented in Appendix A as part of the DQA. The DQA process as presented in Appendix A is comprised of the following steps:

- Step 1: Review DQOs and Sampling Design
- Step 2: Conduct a Preliminary Data Review
- Step 3: Select the Test
- Step 4: Verify the Assumptions
- Step 5: Draw Conclusions from the Data

Based on the results of the DQA presented in Appendix A, the datasets are of sufficient quality to develop the characteristics of the materials potentially dispersed by the Divine Strake Experiment. The DQA also determined that information generated during the investigation support the CSM assumptions, and the data collected met the DQOs and support their intended use.

5.2 Data Validation

Data validation was performed in accordance with the Industrial Sites QAPP (NNSA/NV, 2002) and approved protocols and procedures. All laboratory data from samples collected and analyzed for Divine Strake were evaluated for data quality in a tiered process. Data were reviewed to ensure that samples were appropriately processed and analyzed, and the results were evaluated using validation criteria. Documentation of the data qualifications resulting from these reviews is retained in project files as a hard copy and electronic media.

One hundred percent of the data used in this characterization report were subjected to Tier I and Tier II evaluations. A Tier III evaluation was performed on three samples or approximately 5 percent of the data analyzed.

5.2.1 Tier I Evaluation

Tier I evaluation for radiochemical analysis examines, but is not limited to:

- Sample count/type consistent with chain of custody
- Analysis count/type consistent with chain of custody
- Correct sample matrix
- Significant problems stated in cover letter or case narrative
- Completeness of certificates of analysis
- Completeness of Contract Laboratory Program (CLP) or CLP-like packages
- Completeness of signatures, dates, and times on chain of custody
- Condition-upon-receipt variance form included
- Requested analyses performed on all samples
- Date received/analyzed given for each sample
- Correct concentration units indicated
- Electronic data transfer supplied
- Results reported for field and laboratory QC samples
- Whether or not the deliverable met the overall objectives of the project

5.2.2 Tier II Evaluation

Tier II evaluation examined:

- Correct detection limits achieved

- Blank contamination evaluated and, if significant, qualifiers are applied to sample results

- Certificate of Analysis consistent with data package documentation
- Quality control sample results (duplicates, laboratory control samples, laboratory blanks) evaluated and used to determine laboratory result qualifiers
- Sample results, uncertainty, and MDC evaluated
- Detector system calibrated with National Institute for Standards and Technology (NIST)-traceable sources
- Calibration sources preparation was documented, demonstrating proper preparation and appropriateness for sample matrix, emission energies, and concentrations
- Detector system response to daily or weekly background and calibration checks for peak energy, peak centroid, peak full-width half-maximum, and peak efficiency, depending on the detection system
- Tracers NIST-traceable, appropriate for the analysis performed, and recoveries that met QC requirements
- Documentation of all QC sample preparation complete and properly performed
- Spectra lines, photon emissions, particle energies, peak areas, and background peak areas support the identified radionuclide and its concentration

5.2.3 Tier III Evaluation

The Tier III review is an independent examination of the Tier II evaluation. A Tier III review of three samples was performed by TechLaw, Inc., of Lakewood, Colorado. Tier II and Tier III results were compared and where differences are noted, data were reviewed and changes were made accordingly. This review included the following additional evaluations:

- QC sample results (e.g., calibration source concentration, percent recovery, and relative percent difference [RPD]) verified.
- Radionuclides and their concentration validated as appropriate considering their decay schemes, half-lives, and process knowledge and history of the facility and site.
- Each identified line in spectra verified against emission libraries and calibration results.
- Independent identification of spectra lines, area under the peaks, and quantification of radionuclide concentration in a random number of sample results.

5.3 Field Quality Control Samples

Field QC samples consisted of three field duplicates collected and submitted for analysis by the laboratory analytical methods listed in Table 2-1 as prescribed in the SAP. The QC samples were assigned individual sample numbers and sent to the laboratory "blind." For these samples, the duplicate results precision (i.e., RPDs between the environmental sample results and their corresponding field duplicate sample results) were evaluated in Section A.2.3.2.1. Additional samples were selected by the laboratory to be analyzed as laboratory duplicates.

5.3.1 Laboratory Quality Control Samples

The laboratory included a preparation blank, laboratory control sample, and a laboratory duplicate sample with each batch of field samples analyzed for radionuclides. The results of these analyses were used to qualify associated environmental sample results. Documentation of data qualifications resulting from the application of these guidelines is retained in project files as both hard copy and electronic media.

5.4 Field Nonconformances

There were no field nonconformances identified for the field investigation.

5.5 Laboratory Nonconformances

Laboratory nonconformances are generally due to inconsistencies in the analytical instrumentation operation, sample preparation, processing recoveries and results not meeting requirements. One nonconformance was issued by the laboratory that resulted in qualifying data as estimated.

Nonconformance Report (NCR) #008166 was issued by Paragon Analytics, Inc., for isotopic uranium data in Sample Delivery Group (SDG) 0608198. The NCR was issued because the spectral quality for samples DSA18 and DSA20 exceeded the control limit. This could cause uranium (U)-235 to be biased high. Paragon qualified the U-235 results as estimated. This laboratory nonconformance has been evaluated and resolved during the data qualification process.

A review of the uranium results for these two samples indicates that it is representative of natural uranium (when the associated uncertainties are considered) and no further action was necessary.

6.0 References

EPA, see U.S. Environmental Protection Agency.

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

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

Riedhauser, S. (Bechtel Nevada). 2006. Email to L. Kidman (SNJV) entitled, "FW: Area 16 Shapefiles," 17 July. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Operations Office. 2002. *Industrial Sites Quality Assurance Project Plan, Nevada Test Site, Nevada*, Rev. 3, DOE/NV--372. Las Vegas, NV.

U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office. 2006. *Sampling and Analysis Plan for the Divine Strake Experiment, Nevada Test Site, Nevada*, DOE/NV--1139. Las Vegas, NV.

U.S. Environmental Protection Agency. 2006a. *Data Quality Assessment: A Reviewer's Guide*, EPA QA/G-9R. Washington, DC.

U.S. Environmental Protection Agency. 2006b. *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G4. Washington, DC.

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APPENDIX C

BIOLOGICAL RESOURCES SURVEYS

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Appendix C

Project Name: Divine Strake (Request #06-12)

Site Names/ Divine Strake – Area 16
Locations: **Center**: 572764E with roughly a 900 foot radius around center point.
(Coordinates in Universal Transverse units, meters, North American Standard 1983, Zone 11)

Survey Date(s): May 1, 2006

Vegetation Associations: *Coleogyne ramosissima-Ephedra nevadensis* shrubland associations

Area Surveyed: 23.63 hectares (58.39 acres)

Survey Results:

This site is located in the west-central portion of the Yucca basin near the center of the NTS in Area 16. The project involves excavating a test bed, access roads and the area of the predicted crater for the Divine Strake project. Biologists conducted a biological survey of this area on May 1, 2006. A 270 m (900 ft) area around the center where the ANFO will be placed was surveyed which brought the total area surveyed to approximately 23.63 ha. Approximately 20% of the project area surveyed had been previously disturbed.

The project sites are all located outside the geographic range of the desert tortoise (*Gopherus agassizii*) (Figures 1 and 2). A bat roost site has been recorded 1.7 kilometers southwest of the Site. Also two burrowing owl sightings were identified approximately 4.5 kilometers north of the Site along the Pahute Mesa Road. Also a raptor sighting was recorded 3.2 kilometers west of the Site. There is a population of the sensitive plant species Ripley's springparsley (*Cymopterus ripleyi* var. *saniculoides*) which is located 5.0 kilometers to the northeast of the Site. These sites were surveyed for the presence of sensitive plant and animal species and for any important biological resources such as active raptor nests.

No sensitive plant or animal species were found during the survey. A hawk was observed soaring over the site during the survey but it could not be identified to species.

Mitigation Recommendations:

- Project activities should be restricted to within the areas surveyed.

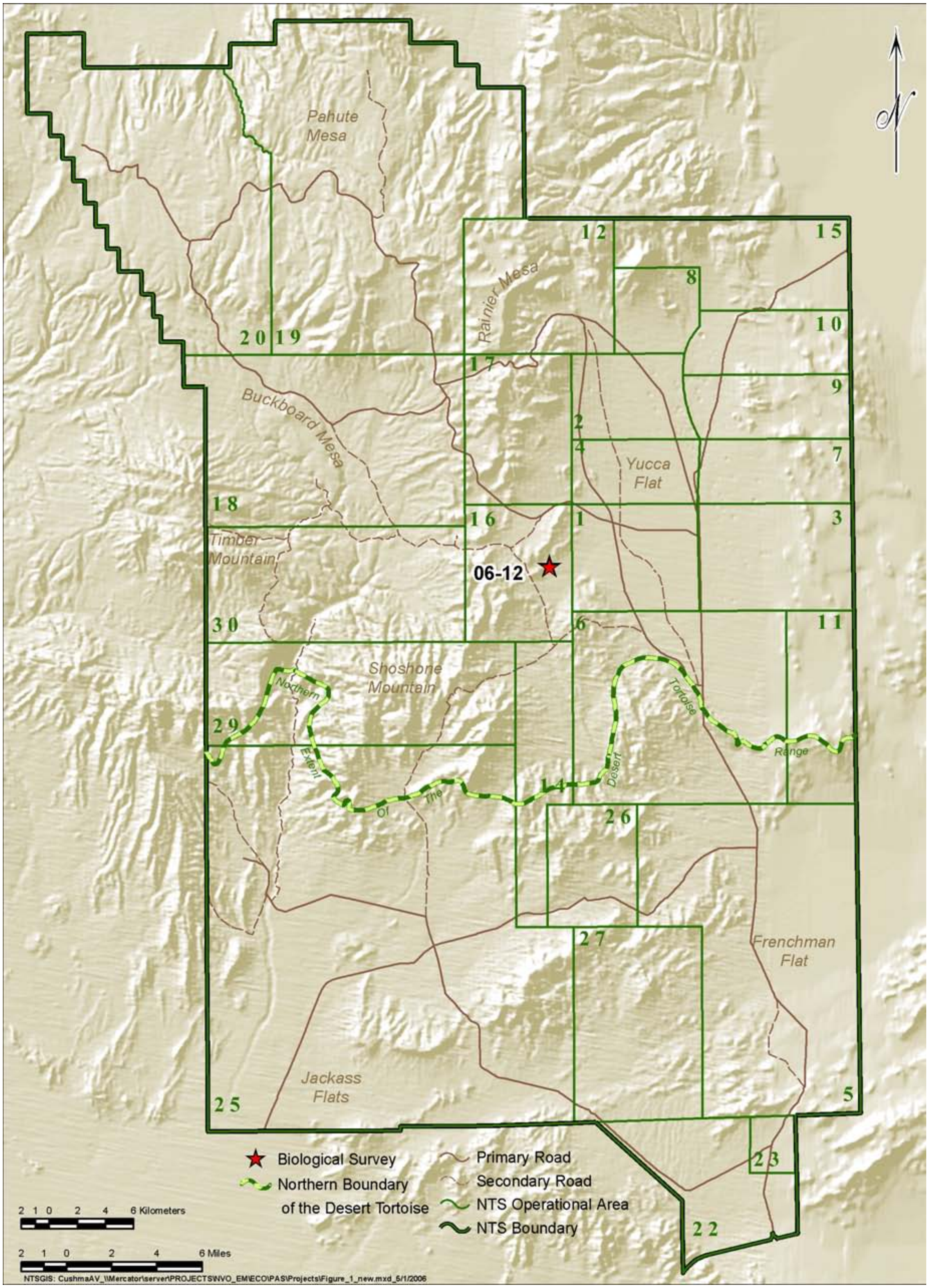

Figure 1. Location of Divine Strake in Area 16 of the NTS.

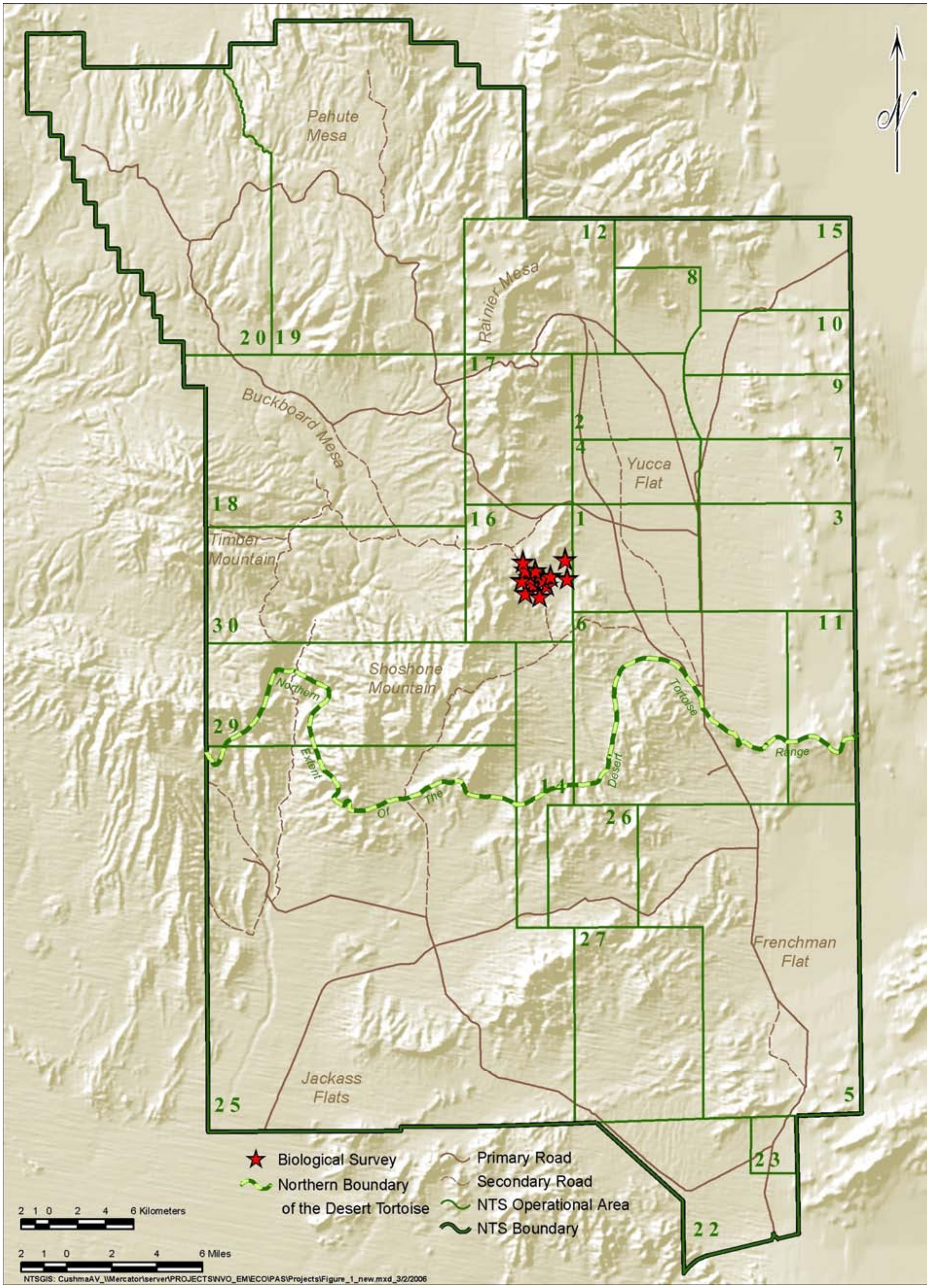

Figure 2. Location of sites surveyed for Divine Strake project (#06-09).

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APPENDIX D

DIVINE STRAKE HAZARDOUS WASTE MANAGEMENT PLAN

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Appendix D - DIVINE STRAKE Hazardous Waste Management Plan

1.0 Introduction

DIVINE STRAKE (DS) is a large-scale high explosive test that will use 700 tons (1,400,000 pounds) of Ammonium Nitrate Fuel Oil (ANFO) as blasting agent. The blasting agent will be emplaced in at 32-ft diameter by 36-ft deep charge hole positioned on the surface over the U16a tunnel complex. The ANFO will be detonated by inserting a booster charge with EBWs (Explosive Bridge Wires) into a small tube so that the booster/detonators will initiate the event from the geometric center of the blasting agent charge.

2.0 Test Preparation and Construction

2.1 Explosives Handling

The raw materials for the blasting agent will be transported to the site by Alpha Dyno Nobel, the explosives subcontractor. Alpha will mix the materials into blasting agent in trucks on-site. The material will then be discharged into the cavity via an auger. Alpha will utilize spill tarps and pans under the raw materials tankers and parked bulk trucks to trap any spilled product, even during periods of non-use. Small spills will be placed into barrels. A repump truck will be on hand should a large spill occur. Any spilled, contaminated, or substandard product will be removed from the project site by Alpha for recycling. DTRA will notify NNSA/NSO and the Operations Control Center of any spills of a reportable quantity.

Other explosive materials for DS will consist of dynamite, detonating cord, initiating tubes, and blasting caps. All explosives will be considered hazardous material and will be handled as such. Only the explosive materials required for the immediate job will be transported to U16b. Any balance material will be returned to the storage magazine upon completion of the explosive operation.

2.2 Fuel

Alpha will utilize spill tarps and pans under the fuel trucks to trap any spilled product, even during periods of non-use. Diesel fuel tanks will be on site to supply fuel. In addition, diesel generators will be used on site. All tanks and generators will utilize secondary containment to prevent spills. DTRA will notify NNSA/NSO and the Operations Control Center of any spills of a reportable quantity.

2.3 DS Cavity Considerations

The ANFO mixture will be emplaced in an excavated cavity, approximately 32-ft diameter by 36-ft deep. The ANFO has a shelf life of greater than 30 days. Once the ANFO is in the cavity, it will not solidify but will gradually deteriorate (the process is undetectable for the first 30 days). Should a significant precipitation event occur while the ANFO is in the cavity, there will be no runoff of blasting agent. The specific gravity of ANFO is heavier than that of water. The water will simply accumulate on top of the blasting agent and run off, leaving the ANFO undisturbed in the cavity. Because no runoff will occur, and any spills would be removed in accordance with applicable regulations and procedures, no contamination is expected at the site.

3.0 Discussion of Possible Test Outcomes

3.1 Successful Detonation

Complete detonation of all blasting agent materials inside the charge hole is expected, based on prediction models and previous experience with blasting agent tests. Even if 99.99% detonation of the blasting agent occurs, no significant or recoverable amount of blasting agent will remain. 99.99% expenditure of 1,400,000 pounds of blasting agent leaves only 140 pounds of material left over. The ANFO mixture is less than 7% fuel oil, so of the remaining 140 pounds, only 9.8 pounds (or a little less than two gallons of oil) will remain. The radius of debris will range from approximately 500 meters to 3-4 miles, meaning that the remaining material will be spread over approximately 15 square miles. Therefore, no hazardous materials are expected to result from the successful detonation of the DS test.

3.2 Misfire

A misfire is extremely unlikely to occur; however, the possibility does exist. In the event of a misfire, all or the majority of the blasting agent would remain in the cavity. The preferred method for dealing with a misfire is to attempt to re-shoot the test. After the appropriate stand-down period, safety review, and preparation of applicable work packages, the countdown will be restarted. If the second attempt is unsuccessful, the test will be re-primed and detonated using a second primer. The Test Group Director and NNSA/NSO Operations Controller may request that the Arming and Firing (A&F) contractor remove the booster charge in the event of a delay. All operations will be coordinated through the NNSA/NSO Operations Controller.

3.3 Partial Detonation

A partial detonation is also unlikely; however, a partial detonation would be handled similarly to a misfire, with a potentially longer wait time. Unexpended blasting agent would be consolidated as best as possible. In the event of a partial detonation, DTRA would prefer to re-set the test using additional booster/detonators. The remaining material will then be detonated in place as part of the test event.

3.4 Failure

If the test cannot be set-set under the above scenarios, then mechanical and hand excavation of the unexpended blasting agent will be conducted. The recovered unexpended blasting agent will be disposed of in accordance with NNSA/NSO and State of Nevada regulations and applicable NTS procedures, including BN directives. NNSA/NSO would request an emergency permit from the Nevada Division of Environmental Protection prior to removal or treatment of the unexpended blasting agent.

4.0 Summary

No hazardous wastes are expected to result from the DS test. Any hazardous wastes resulting from an accidental spill or failure of the test to detonate will be disposed of in accordance with DOE and State of Nevada regulations and applicable NTS procedures. In addition, all operations will be coordinated with NNSA/NSO. Any issues resulting from unexpended blasting agent will be coordinated with NNSA/NSO and the Nevada Division of Environmental Protection.

APPENDIX E

AIR MODELING RESULTS

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National Nuclear Security Administration
Nevada Site Office

DEFENSE THREAT REDUCTION AGENCY PROPOSED EXPLOSIVE EXPERIMENT AT THE NEVADA TEST SITE

Introduction

The Defense Threat Reduction Agency (DTRA) plans to conduct an experiment at the U16b Tunnel in Area 16 of the Nevada Test Site (NTS). The experiment, called Divine Strake, is scheduled to be conducted in early June, 2006. In April, 2005, the Nevada Division of Environmental Protection, Bureau of Air Pollution Control (BAPC) determined that prior to the experiment, the National Nuclear Security Administration Nevada Site Office (NNSA/NSO) must demonstrate that the resultant air pollutant emissions would not cause the NTS to exceed Title V permitting thresholds. The BAPC requested the following information:

- The expected criteria and hazardous air pollutant (HAP) emissions
- A demonstration that the Nevada Ambient Air Quality Standards (NV AAQS) will not be exceeded as a result of the test
- Documentation that the Title V thresholds, in conjunction with all currently permitted NTS activities, will not be exceeded as a result of the test
- Information as to whether DTRA anticipates any future experiments

This paper addresses the items listed above in the order of their appearance.

1. Expected Criteria and HAP Emissions

The proposed Divine Strake experiment will consist of one explosive detonation that will use up to 700 tons of ammonium nitrate fuel-oil explosive (ANFO) emulsion, detonated by approximately 30 lbs of Composition C4. The ANFO will be placed in an excavated pit approximately 32 feet deep, located above the U16b tunnel. There will be no overburden placed on top of the ANFO. Expected criteria pollutants from the detonation include nitrogen oxides (NOx), carbon monoxide (CO), and particulate matter. The HAP emissions expected from the detonation are shown in Tables 3 and 4.

2. Demonstration that NV AAQS Will Not Be Exceeded

Concentrations of air pollutants are determined through dispersion modeling to demonstrate compliance with the National Ambient Air Quality Standards and the NV AAQS. In order to estimate pollutant concentrations from Divine Strake, the POLU4WN model was used to derive the potential emissions of criteria and hazardous air pollutants. Total particulates and total PM10 emissions were determined using Combined Obscuration Model for Battlefield-Induced Contaminants (COMBIC). COMBIC and POLU4WN results are reported in units of pounds of pollutant per pound of material detonated as well as the total pounds of emissions (based on EPA compounds of interest) for the entire amount detonated. These data were input into Open Burn/Open Detonation Model (OBODM), an EPA-approved dispersion model to determine concentrations in micrograms per meter cubed (μ/m^3) at the nearest boundary, so that a direct comparison could be made with the federal and state of Nevada concentrations.

By projecting the plume direction generated by OBODM, it was determined that the northern boundary of the NTS, in the vicinity of the border between Areas 19 and 20 (in the northwest portion of the NTS) would be the point of direct intersection. The highest concentrations reported by OBODM along a line approximately even with the NTS northern boundary were used in this analysis. Results of running these models, shown in Table 1, indicate that very low levels of the criteria pollutants would be expected to reach the NTS boundary from the proposed detonation. Copies of OBODM-generated plume plots, showing concentration of various pollutants are in Appendix A of this report.

Meteorological data used in OBODM for Divine Strake were based on extensive NTS-specific data accumulated by the National Oceanographic and Atmospheric Administration, Air Resources Laboratory/Special Operations and Research Division. Divine Strake is scheduled to be detonated at about 10:00 a.m. (Pacific Daylight Time), between June 2 and 4, 2006. Therefore, average meteorological conditions for June 3 were selected to be used for the OBODM modeling. In general, on June 3, it is anticipated that any temperature inversions will dissipate during the early morning and winds will be moderate from the southeast. During the afternoon, the winds will likely change from the southeast to the southwest. All emissions from Divine Strake will be transported in a northerly direction, toward the Nevada Test and Training Range, rather than toward populated areas, such as Amargosa Springs or Indian Springs (to the southwest and southeast of the Divine Strake test bed, respectively).

3. Documentation that Title V Thresholds Will Not Be Exceeded

Potential emissions from the Divine Strake test were calculated using emission factors from the POLU4WN program, which was previously approved by BAPC. The results of these calculations for criteria and HAP emissions are summarized in Tables 2 and 3, respectively. A more detailed tabulation of the results is shown in Table 4.

As Table 2 indicates, these emissions, when added to the total NTS potential to emit for each criteria pollutant, except particulate matter larger than 10 microns, would still be well below the 100-ton per pollutant threshold for Title V permitting. Particulate matter was included but is not used in determining whether a source is Title V. Particulate matter resulting from the explosives was estimated by summing all of the solids reported by POLU4WM. It was then assumed that one-half of the particulate matter from the explosives would be assigned to PM10 and one-half to PM. It should be noted that particulate matter from the explosives would result in the 100 ton per 12 month period being exceeded by just over one ton; however, the contribution of particulate matter from the crater that would result from Divine Strake is considerable. HAP emissions at the NTS have two limits: an individual limit of any one HAP of 8 tons/yr, and a limit of 20 tons/yr for any combination of HAPs. As shown in Table 3, none of the individual HAP emissions exceed the 8 ton/yr limit, nor does any combination or the total quantity of HAP emissions exceed the 20 ton/yr limit.

Table 1 Air Dispersion Modeling Results

Pollutant	Averaging Period	Maximum Modeled NTS Sources[f] (μ/m^3)[a]	Background Concen-tration[f] (μ/m^3)[a]	Modeled Divine Strake Test (μ/m^3)[a]	Total NTS Concentration (μ/m^3)[a]	NAAQS[g] Standard (μ/m^3)[a]	NV AAQS[g] Standard (μ/m^3)[a]
Nitrogen Oxides	Annual	2.5	0	0.00001	2.50001	100	100
Carbon Monoxide	8-hour	42.2	0	0	42.2	10,000[b]	10,000[c]
	1-hour	222.5	0	0.00010	222.50010	40,000[b]	40,000
PM10[d]	Annual	0.6	9.0			50	50
	24-hour	17.4	10.2	0.01673	27.61673	150[b]	150
Ozone	1-hour	204.7[e]	0	0.10094	204.80094	235[b]	235

a μ/m^3 = micrograms per cubic meter
b Not to be exceeded more than once per calendar year
c 6,670 μ/m^3 at areas equal to or greater than 5,000 feet above Mean Sea Level
d Particulate matter with aerodynamic diameter less than or equal to 10 microns
e Ozone concentrations were conservatively assumed to be equal to VOC concentrations
f Source: Appendix 7, NTS Air Quality Operating Permit Renewal Application Package, March, 2002
g Source: NAC 445B.22097

Table 2 Estimated Emissions of Criteria Pollutants

Criteria Pollutant	DIVINE STRAKE[a] (tons/yr)	NTS[b] (tons/yr)	Total (tons/yr)
Carbon Monoxide	0.2173	23.47	23.69
Nitrogen Oxide	3.7870	72.33	76.83
Particulates from Explosives[c]	12.7	89.24	101.94
PM10[d] from Explosives	12.7	61.96	65.57
Total Particulates[e]	1,102.13	89.24	1,191.37
Total PM10[e]	17.55	61.96	79.51

[a] POLU4WN program
[b] NTS Emissions Inventory, May 2005
[c] Particulates and PM10 from explosives includes all emissions reported by POLU4WN as "solids."
[d] Particulate matter with aerodynamic diameter less than or equal to 10 microns
[e] Total Particulates and Total PM10 were determined using COMBIC and are based on the calculated volume of the post-detonation crater. Total particulates includes particles between 10 and 100 microns in size.

Table 3 Estimated Emissions of Hazardous Air Pollutants

HAP	DIVINE STRAKE[a] (tons/yr)	NTS[b] (tons/yr)	Total (tons/yr)
Chlorine	0.8235	8 tons/yr per any individual HAP or 20 tons/yr of any combination of HAPs	Total for all HAPs combined is 10.1282 tons/yr
Chloromethane	0.3918		
Cyanide Compounds	2.1695		
Formaldehyde	0.2330		
Hexachloroethane	1.8370		
Hydrazine	0.4973		
Phosgene	0.7675		
Tetrachloroethene	1.2868		
Tetrachloromethane	1.1936		
Trichloromethane	0.9263		

[a] POLU4WN program
[b] NTS Class II Air Quality Operating Permit, Facility-wide HAP Emissions Cap, June, 2004

Table 4 Detailed Estimated Emissions Using the POLU4WN Model

CRITERIA POLLUTANTS	Chemical Formula	Emissions (lbs.)	Total Emissions (lbs.)	Total Emissions (tons)
Carbon Monoxide	CO	434.6639	434.6839	**0.21733195**
Nitrogen Oxides (NOX)				
	N_2O_4	2855.7378		
	N_2O_5	1676.1508		
	N_2O_3	1179.5870		
	NO_2	713.9344		
	NO	465.6526		
	N_2O	683.0234		
Total NOX			7,574.0860	**3.78704300**
Particulates[1]				
Calcium Hydroxide	CaH_2O_2	24,872.6330		
Calcium Chloride	$CaCl_2$	18,712.6800		
Ammonium Chloride-II	NH_4Cl	1660.2928		
Ammonium Perchlorite	NH_4O_4Cl	1,823.2733		
Calcium Oxide	CaO	870.2280		
Nitrogen Oxide	N_2O_4	1,427.8689		
Calcium, Alpha	Ca	1243.8920		
Carbon	C	186.3821		
Total Particulates			50,797.2491	**25.39862400**
[illegible]				
Chlorine Compounds				
Chlorine	Cl & CL_2	1,650.6244	1,650.6244	**0.82531220**
Chloromethane (Methyl Chloride)	CH_3Cl	783.5154	783.5154	**0.39175770**
Dichloromethane (Methyl Chloride)	CH_2Cl_2	1318.0818	1318.0818	**0.65904090**
Hexachloraethane	C_2Cl_6	3,674.0129	3,674.0129	**1.83700645**
Phosgene (Carbonic Dichloride)	$COCl_2$	1,535.0802	1,535.0802	**0.76754010**
Tetrachloroethene (Tetrachloroethylene)	C_2Cl_4	2,573.5967	2,573.5967	**1.28679835**
Tetrachloromethane (Carbon Tetrachloride)	CCl_4	2,387.2146	2,387.2146	**1.19360730**
Trichloromethane (Chloroform)	$CHCl_3$	1,852.6481	1,852.6481	**0.92632405**
Total Chlorine Compounds			15,774.8330	**7.88741650**
Cyanide Compounds				
Cyanogen Chloride	CNCl	953.9609		
CNN Radical Cyanogen	CN_2	1242.2472		
Cyanide	CN	403.7529		
CNO Radical	CNO	652.0347		
Hydrogen Cyanide	CNH	419.3946		
Hydrogen Isocyanate (Cyanic Acid)	CNHO	667.6765		
Total Cyanide Coumpounds			4,339.0668	**2.16953340**
Formaldehyde	CH_2O	465.9475	465.9475	**0.23297375**
Hydrazine	N_2H_4	497.3086		
	N_2H_4	497.3086		
			994.6172	**0.49730860**
TOTAL HAZARDOUS AIR POLLUTANTS				**10.7872028**

1 Particulates from explosives includes all emissions reported by POLU4WN as "solids."

DIVINE STRAKE AIR DISPERSION MODELING RESULTS
for
SULFUR DIOXIDE

The attached table is updated to include estimated sulfur dioxide concentrations resulting from the Divine Strake Experiment. Output from the POLU4WN model was used to estimate quantities of all emissions from the proposed explosive experiment. All emissions of oxides of sulfur were combined to provide input into Open Burn/Open Detonation Model (OBODM) to model the dispersion; thus overestimating the concentration of sulfur dioxide that may be expected to result from Divine Strake. The sulfur oxide compounds that were reported by POLU4WN and used as input to OBODM are: Sulfuric Acid (H_2SO_4), Sulfur Oxide (S_2O), Sulfur trioxide (SO_3), Sulfur Dioxide (SO_2), Carbon Oxide Sulfide (CSO), and Sulfur Oxide (SO). Despite the overestimation, the concentration of sulfur dioxide is expected to be well within the Nevada Ambient Air Quality Standards at the boundary of the Nevada Test Site. Following the table are the OBODM one hour, three hour, and 24 hour plume plots for sulfur dioxide.

Updated Air Dispersion Modeling Results

Pollutant	Averaging Period	Maximum Modeled NTS Sources[f] (u/m^3)[a]	Background Concen-tration[f] (u/m^3)[a]	Modeled Divine Strake Test (u/m^3)[a]	Total NTS Concentration (u/m^3)[a]	NAAQS[g] Standard (u/m^3)[a]	NV AAQS[g] Standard (u/m^3)[a]
Nitrogen Dioxide	Annual	2.5	0	0.00001	2.50001	100	100
Sulfur Dioxide	Annual	0.6	0			80	80
	24-hour	17.0	0	0.00096	17.00096	365[b]	365
	3-hour	74.9	0	0.00767	74.90767	1,300[b]	1,300
Carbon Monoxide	8-hour	42.2	0	0	42.2	10,000[b]	10,000[c]
	1-hour	222.5	0	0.00010	222.50010	40,000[b]	40,000
PM10[d]	Annual	0.6	9.0			50	50
	24-hour	17.4	10.2	0.01673	27.61673	150[b]	150
Ozone	1-hour	204.7[e]	0	0.10094	204.80094	235[b]	235

a u/m^3 = micrograms per cubic meter
b Not to be exceeded more than once per calendar year
c 6,670 μ/m^3 at areas equal to or greater than 5,000 feet above Mean Sea Level
d Particulate matter with aerodynamic diameter less than or equal to 10 microns
e Ozone concentrations were conservatively assumed to be equal to VOC concentrations
f Source: Appendix 7, NTS Air Quality Operating Permit Renewal Application Package, March, 2002
g Source: NAC 445B.22097

Note: All concentrations of emissions are modeled at the boundary of the Nevada Test Site

3. Information as to whether DTRA plans any future tests

At this time there are no plans to conduct future tests at the U16b Tunnel in Area 16 of the NTS.

AMENDMENT TO
AIR DISPERSION MODELING REPORT
ESTIMATED VOLATILE ORGANIC COMPOUNDS EMISSIONS
FOR THE
DEFENSE THREAT REDUCTION AGENCY
PROPOSED EXPLOSIVE EXPERIMENT AT
THE NEVADA TEST SITE

Volatile organic compounds (VOCs), nitrogen oxides (NOx), and carbon monoxide are considered as precursor compounds for ozone, which is formed via a photochemical reaction. The emission rates for ozone precursors are regulated to minimize the formation rate of ozone and other photochemical reaction products. The "VOC/NOx Point Source Screening Tables" (Screening Tables) developed by Richard D. Scheffe are a screening method for predicting ozone impacts from sources that emit VOCs and NOx. The tables are based on a series of applications of a photochemical model known as the Reactive Plume Model-II. Of note from the Introduction to the Screening Tables: "The ozone increment estimates produced from this analysis should be interpreted as conservative predictions which would exceed ozone formation produced by actual episodic events."

Table 5, "Estimated Volatile Organic Compounds (VOCs) from the DIVINE STRAKE Experiment," lists the VOCs that were identified from the results of the POLU4WN Model run. As noted in the table, some of those VOCs are considered hazardous air pollutants and were addressed as such in a previous submittal. As requested, NNSA/NSO used the Screening Tables, inputting into the calculation the total annual VOCs and NOx emissions for the NTS plus the total annual VOCs and NOx emissions that would result from the Divine Strake Experiment. This resulted in an ozone increment of 0.51866. The ambient air quality standard (1 hour parts per million) is 0.12 for a model-calculated percentage of 43.22. This result indicates that NTS air emissions, including the Divine Strake Experiment, would be well within Nevada Ambient Air Quality Standards and in compliance with the NTS AQOP. A copy of the Screening Tables results is attached.

Table 5 Estimated Volatile Organic Compounds (VOC) from the DIVINE STRAKE Experiment

Hazardous Air Pollutant (HAP)	VOC Name	Chemical Formula	Emissions (lbs)
	Tetrachloromethane	CCl4	2,387.2146
	Trichloromethyl	CCl3	1,837.0065
	Carbonic Dichloride	COCl2	1,535.0802
	Dichloroethyne	C2Cl2	1,473.1805
	Dichloromethylene	CCl2	1,286.7893
	2-Butynedinitrile	C4N2	1,180.2698
HAP	Chloroethyne	C2HCl	938.6141
	Ethanedinitrile	C2N2	807.5057
	Chloromethylene	CHCl	752.2320
HAP	Hydrogen Isocyanate	CNHO	667.6765
	CCO Radical	C2O	621.0460
	Carbon	C3	559.1462
HAP	Formaldehyde	CH2O	465.9475
	Ethene	C2H4	435.3312
	Ethyne	C2H2	404.0477
	Carbon	C2	372.7642
	Methyl	CH3	233.3073
HAP	Hexachloroethane	C2Cl6	3,674.0129
HAP	Tetrachloroethane	C2Cl4	2,573.5967
	Chloromethylidyne	CCl	736.5903
	Oxirane	C2H4O	683.6130
HAP	CNN Radical	CN2	621.1236
HAP	CNC Radical	C2N	590.1349
HAP	Cyanogen	CN	403.7529
	Methylidyne	CH	202.0238
	Carbon Suboxide	C3O2	1,055.7100
	Carbonyl Chloride	COCl	984.8721
HAP	Cyanogen Chloride	CNCl	953.9609
	Carbon	C5	931.9104
HAP	Chloromethane	CH3Cl	783.5154
	Carbon	C4	745.5283
	NCO Radical	CNO	652.0347
	Formyl	CHO	450.3057
HAP	Hydrogen Cyanide	CNH	419.3946
	Ethynyl	C2H	388.4059
	Methylene	CH2	217.6656
	Carbon	C	186.3821
		Total lbs	33,211.6931
		Total tons	16.6058
		Non-HAP Total lbs	21,119.9631
		Non-HAP Total tons	10.5600

Notes:

1 HAPS column denotes compounds that are both hazardous air pollutants and VOCs

2 VOCs were determined using the definition from the Clark County DAQEM Regulations, Section "0"

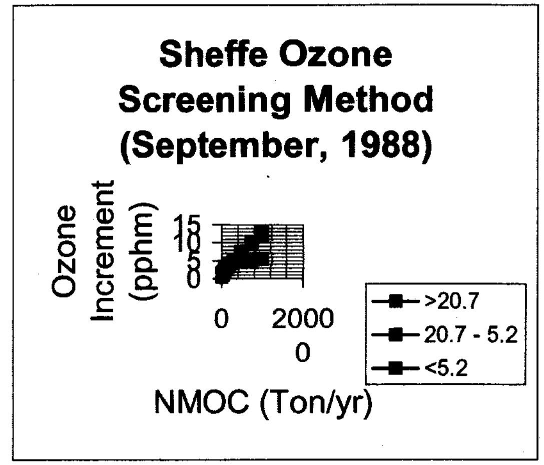
NTS EMISSIONS INVENTORY
SCHEFFE SCREEN MODEL
JULY 2004

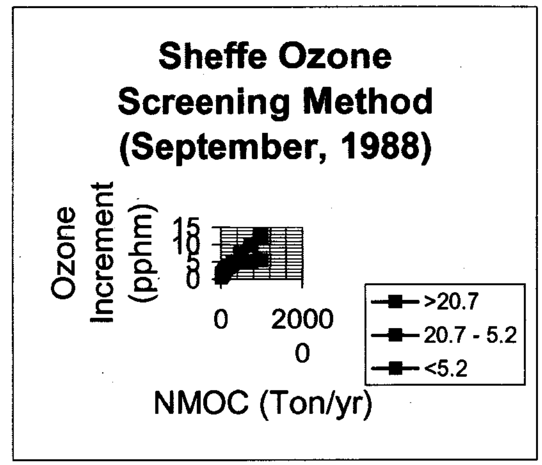
Information Input for Screening Calculation		
Classification of Area	**RURAL**	
Annual NMOC Emission for Facility	**88.97**	ST/yr
Annual NOx for Facility	**76.1**	ST/yr
Maximum NMOC Emiss. Rate	**45048**	LB/day
	8221.3	ST/yr

Calculations & Output	
NMOC/NOx Ratio	**1.17**
Lower Bound Max. NMOC Emiss. Rate	**7500**
Upper Bound Max. NMOC Emiss. Rate	**10000**
Lower Increment Value (pphm)	**5.1**
Upper Increment Value (pphm)	**5.4**
Interpolated Increment Value (pphm)	**5.187**
Ozone Increment (pphm * 100)	**0.051866**
Ambient Air Quality Standard (1-hour, ppm)	**0.12**
% of Standard	**43.22**

Sheffe Screening Table (9/88)
Rural O3 Increment Table
pphm

Max NMOC	NMOC/NOx Ratio		
Tons/yr	>20.7	20.7 - 5.2	<5.2
50	0.4	0.4	1.1
75	0.4	0.4	1.2
100	0.4	0.5	1.4
300	0.8	1	1.7
500	1.1	1.4	1.9
750	1.6	1.9	2.3
1000	2	2.4	2.7
1500	2.7	3	3.3
2000	3.4	3.8	3.7
3000	4.8	5.2	4.3
5000	7	7.5	4.8
7500	9.8	10.1	5.1
10000	12.2	12.9	5.4





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APPENDIX F

Potential Offsite Radiological Doses Estimated
For The Proposed Divine Strake Experiment, Nevada Test Site

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DOE/NV/25946--092

POTENTIAL OFFSITE RADIOLOGICAL DOSES ESTIMATED FOR THE PROPOSED DIVINE STRAKE EXPERIMENT, NEVADA TEST SITE

December 2006

Revision 0

Prepared for:
U.S. Department of Energy
National Nuclear Security Administration
Nevada Site Office
Under Contract No. DE-AC52-06NA25946

Prepared by:
National Security Technologies, LLC
Las Vegas, NV

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DOE/NV/25946--092

POTENTIAL OFFSITE RADIOLOGICAL DOSES ESTIMATED FOR THE PROPOSED DIVINE STRAKE EXPERIMENT, NEVADA TEST SITE

December 2006

Revision 0

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Executive Summary

An assessment of the potential radiation dose that residents offsite of the Nevada Test Site (NTS) might receive from the proposed Divine Strake experiment was made to determine compliance with Subpart H of Part 61 of Title 40 of the Code of Federal Regulations, *National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities*. The Divine Strake experiment, proposed by the Defense Threat Reduction Agency, consists of a detonation of 700 tons of heavy ammonium nitrate fuel oil-emulsion above the U16b Tunnel complex in Area 16 of the NTS. Both natural radionuclides suspended, and historic fallout radionuclides resuspended from the detonation, have potential to be transported outside the NTS boundary by wind. They may, therefore, contribute radiological dose to the public. Subpart H states "Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr" (Title 40 of the Code of Federal Regulations [CFR] §61.92) where mrem/yr is millirem per year. Furthermore, application for U.S. Environmental Protection Agency (EPA) approval of construction of a new source or modification of an existing source is required if the effective dose equivalent, caused by all emissions from the new construction or modification, is greater than or equal to 0.1 mrem/yr (40 CFR §61.96).

In accordance with Section 61.93, a dose assessment was conducted with the computer model CAP88-PC, Version 3.0. In addition to this model, a dose assessment was also conducted by the National Atmospheric Release Advisory Center (NARAC) at the Lawrence Livermore National Laboratory. This modeling was conducted to obtain dose estimates from a model designed for acute releases and which addresses terrain effects and uses meteorology from multiple locations.

Potential radiation dose to a hypothetical maximally exposed individual at the closest NTS boundary to the proposed Divine Strake experiment, as estimated by the CAP88-PC model, was 0.005 mrem with wind blowing directly towards that location. Boundary dose, as modeled by NARAC, ranged from about 0.006 to 0.007 mrem. Potential doses to actual offsite populated locations were generally two to five times lower still, or about 40 to 100 times lower then the 0.1 mrem level at which EPA approval is required pursuant to Section 61.96.

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List of Figures and Tables

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List of Acronyms and Abbreviations

ANFO	ammonium nitrate fuel oil-emulsion
CAP88-PC	Clean Air Act Assessment Package – 1988
CFR	Code of Federal Regulations
°C	degrees Celcius
Ci	Curie
DOE	U.S. Department of Energy
DTED	Digital Terrain Elevation Data
DTRA	Defense Threat Reduction Agency
EPA	U.S. Environmental Protection Agency
fps	feet per second
ft	feet
kg	kilogram
km	kilometer
LLNL	Lawrence Livermore National Laboratory
m	meter
m^2	square meter
mrem	milli-Roentgen equivalent man
NARAC	National Atmospheric Release Advisory Center
NESHAP	National Emission Standards for Hazardous Air Pollutants
NTS	Nevada Test Site
pCi/g	pico-Curies per gram
PM10	particulate matter less than 10 micrometers in diameter
PST	Pacific Standard Time
s	second
UCI	upper confidence interval
UTC	Universal Coordinated Time

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1 INTRODUCTION

The Defense Threat Reduction Agency (DTRA) plans to conduct an experiment at the U16b Tunnel in Area 16 of the Nevada Test Site (NTS). The experiment, called Divine Strake, will consist of a single detonation of 700 tons (English) of heavy ammonium nitrate fuel oil-emulsion (ANFO) (593 tons trinitrotoluene equivalent) (U.S. Department of Energy [DOE], 2006a). Though no nuclear testing activities of any type were conducted within one mile of the U16b Tunnel (DOE, 2000), the area was subject to fallout from global and NTS nuclear tests. Resuspension of this fallout could travel beyond the NTS boundary where it might contribute to the radiological dose of the public. In addition to man-made radionuclides, the U.S. Environmental Protection Agency (EPA) suggested that the assessment of potential radiological dose also include naturally occurring radionuclides in soils suspended as a result of the explosion (Rosenblum, 2006). This report describes how DOE and DTRA calculated the potential radiological dose to persons residing outside the NTS boundary from radionuclides suspended by the proposed Divine Strake experiment.

Under the Clean Air Act, the National Emission Standards for Hazardous Air Pollutants (NESHAP) were established to control certain pollutants. Subpart H of Part 61 of Title 40 of the Code of Federal Regulations (CFR) states, “Emissions of radionuclides to the ambient air from Department of Energy facilities shall not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr” (40 CFR §61.92). It is also required that an application for EPA approval of construction of a new source or modification of an existing source be submitted if the effective dose equivalent caused by all emissions from the new construction or modification is equal to or greater than 1 percent of the 10 millirem per year (rem/yr) standard ($\geq$ 0.1 mrem/yr) set in 40 CFR §61.96. Potential dose from the proposed Divine Strake experiment estimated from models are compared with the limit of 10 mrem/yr and to the 0.1-mrem/yr level at which an application for EPA approval is required. Releases of radionuclides to the air from the NTS have been reported annually to the EPA since 1992 in NESHAP reports.

2 METHODS

2.1 Clean Air Act Assessment Package – 1988 (CAP88-PC)

As specified by Section 61.93, compliance with NESHAP shall be determined and effective dose equivalent values to members of the public calculated using the computer model CAP88-PC, AIRDOS-PC, or other procedures for which EPA has granted prior approval. The use of CAP88-PC has been the most widely used model at facilities within the DOE complex. On February 21, 2006, the EPA announced acceptance of Version 3.0 of the CAP88–PC model for use in demonstrating compliance with the requirements of Subpart H of Part 61 (Federal Register, Vol. 71, pages 8854 - 8856). Version 3.0 of CAP88-PC was one of the models used here to calculate the potential dose to the public from the proposed Divine Strake experiment.

CAPP88-PC uses a modified Gaussian plume equation to estimate dispersal of radionuclide releases. This Gaussian plume model is one of the most commonly used models in government guidebooks, and results have been shown to agree well with experimental data (Shroff, 2006). Since the model was designed for chronic low-level releases, external dose and intake assumptions in the model result in a higher, and therefore more conservative, estimate of potential dose to offsite residents when applied to a sudden release like that from the proposed Divine Strake experiment. CAP88-PC does not consider the effects of complex terrain; however, impacts from terrain are expected to be negligible because the size of the proposed Divine Strake experiment release area is small compared with the distances to offsite individuals (Shroff, 2006). Also, potential terrain effects are diminished due to the high release momentum, and therefore, plume height. The National Atmospheric Release Advisory Center (NARAC) modeling described in Section 2.2 of this report addresses issues of the acute release and terrain effects.

Two CAP88-PC runs are described in this report. The only difference between the two is the wind directional speeds used. Wind data are described in the following section. An earlier CAP88-PC run is described in Appendix C. This was based on literature values from historic data for source term whereas the CAP88-PC modeling described in the body of this report is based on site characterization data collected specifically for this purpose (DOE, 2006c). Results from the modeling presented in Appendix C fall between the modeled results based on the site characterization data.

Prior to modeling potential dose from the proposed Divine Strake experiment, the Modtest sample case described in the CAP88-PC Version 3.0 User Guide, was run on the same computer and software installation used for dose estimations from the proposed Divine Strake experiment. Results of this test were identical to those from the published example (Shroff, 2006), thereby providing an additional measure of quality assurance. The *Synopsis* and *Dose and Risk Equivalent Summary* Reports from the Modtest run are provided in Appendix D for comparison with those given in Appendix G of the CAP88-PC Version 3.0 Users Guide (Shroff, 2006).

2.1.1 CAP88-PC Inputs

Source Term Area

The crater created by the proposed Divine Strake experiment is predicted to be 98 feet (ft) (30 meters [m]) in radius (DOE, 2006a). However, particulates are expected to be suspended from the blast over a much larger area. The source term area used in the CAP88-PC modeling was the same as that used for sampling during site characterization (DOE, 2006b), specifically an area of 292,000 square meters (m^2) (circle with radius of 1,000 ft or about 300 m). The release height above ground level was set to the minimum allowed by CAP88-PC (0.01 m) since the release is from ground level.

Source Term

The source term used in modeling is listed in Table 1. Radionuclide concentrations (in picocuries per gram [pCi/g]) in material suspended from the proposed Divine Strake experiment were taken as the maximum upper confidence interval (UCI) for each radionuclide listed in the *Site Characterization Report of the Divine Strake Experiment at the Nevada Test Site* (DOE, 2006c). These concentrations were multiplied by the total amount of particulate matter less than 10 micrometers in diameter (PM10) predicted to be suspended from the proposed Divine Strake explosion [17.55 tons (English)] (DOE, 2006a). For radionuclides that are part of a decay chain, secular equilibrium was assumed and the maximum UCI within the chain was assumed for the entire decay chain. All specific radionuclides listed in Section 4 of the site characterization report (DOE, 2006c) were used as source term regardless of the number of samples that had non-detections.

Buildup

Because the CAP88-PC model is designed for continuous chronic releases, the default buildup value is 100 years. This means the model allows 100 years for the buildup of short-lived progeny in the environment before potential doses are calculated. While the proposed Divine Strake experiment would be a short-term release, the 100 year buildup value was used as it is the approach specified in the basis model for CAP88-PC (the NUREG 1.109 approach [U.S. Nuclear Regulatory Commission, 1977]) and therefore the approach accepted for demonstrating compliance. The 100 year buildup time is conservative (increases potential dose). In this case, changes in buildup time make a small difference in the calculated dose because progeny within decay chains were assumed to be in equilibrium for the source term for the proposed Divine Strake experiment.

Meteorology

Ambient temperature = 13.2 degrees Celsius (°C) (2005 average temperature in Area 16)
Humidity = 3.4 grams per cubic meter (average moisture concentration measured by atmospheric moisture samplers on the NTS 2000 – 2002)
Precipitation = 3 centimeters (cm)
Wind: Because it was not known when the proposed Divine Strake experiment would occur, two wind data sets were used. The first represented the worse case scenario with the average actual wind speed and stability class (Class E) observed on the NTS for January 1999 – 2005 (6 knots or 3.1 meters per second [m/s]) going in a single direction 100 percent of the time. The second data set used actual stability classes, wind speed, and wind directions in Area 16 of the NTS for all of 2005. The single direction wind file with the relatively low wind speed experienced in January results in a higher (more conservative) dose estimate while the 2005 wind conditions result in a low estimate due to portions of the wind going in all directions over the release period. These two estimates bound the wind conditions expected.

Momentum

The initial upward momentum of the dust cloud used with CAP88-PC was 4000 m/s (13,000 feet per second [fps]). This is an approximation for very large quantities of blasting agents which is accepted in the commercial industry (GlobalSecurity.org, 2006).

Mixing Height

The mixing height used was 3,000 m. This represents the 2,510 m cloud top obtained from Lawrence Livermore National Laboratory's (LLNL's) Hotspot model which was then rounded off to one significant figure.

Table 1. Source term used for modeling potential dose from the proposed Divine Strake experiment

Analyte	Concentration for Source Term (pCi/g)[a]	Source Term (Ci)[b]
Al-26	8.03E-02	1.28E-06
Am-241	7.19E-01	1.14E-05
Be-7	5.31E-01	8.45E-06
Cm-243	4.36E-01	6.94E-06
Co-58	4.02E-02	6.40E-07
Co-60	7.63E-02	1.21E-06
Cs-134	3.62E-01	5.76E-06
Cs-137	5.50E-01	8.76E-06
Ba-137m	5.50E-01	8.76E-06
Eu-152	4.52E-01	7.20E-06
Eu-154	3.51E-01	5.59E-06
Eu-155	2.18E-01	3.47E-06
H-3	8.19E+03 (pCi/L H-3 only)	1.30E-05[c]
K-40	1.81E+01	2.88E-04
Nb-94	6.78E-02	1.08E-06
Pu-238	5.15E-02	8.20E-07
Pu-239	2.05E+00	3.26E-05
Sb-125	1.83E-01	2.91E-06
Sr-90	1.95E-01	3.10E-06
Y-90	1.95E-01	3.10E-06
Th-232	1.86E+00	2.96E-05
Ra-228	1.86E+00	2.96E-05
Ac-228	1.86E+00	2.96E-05
Th-228	1.86E+00	2.96E-05
Ra-224	1.86E+00	2.96E-05
Rn-220	1.86E+00	2.96E-05
Po-216	1.86E+00	2.96E-05
Pb-212	1.86E+00	2.96E-05
Bi-212	1.86E+00	2.96E-05
Po-212	1.19E+00	1.90E-05
Tl-208	6.70E-01	1.07E-05

Analyte	Concentration for Source Term (pCi/g)[a]	Source Term (Ci)[b]
U-235	4.23E+00	6.73E-05
Th-231	4.23E+00	6.73E-05
Pa-231	4.23E+00	6.73E-05
Ac-227	4.23E+00	6.73E-05
Th-227	4.17E+00	6.64E-05
Fr-223	5.92E-02	9.43E-07
Ra-223	4.23E+00	6.73E-05
Rn-219	4.23E+00	6.73E-05
Po-215	4.23E+00	6.73E-05
Pb-211	4.23E+00	6.73E-05
Bi-211	4.23E+00	6.73E-05
Tl-207	4.22E+00	6.71E-05
Po-211	1.18E-02	1.89E-07
U-238	3.02E+00	4.81E-05
Th-234	3.02E+00	4.81E-05
Pa-234m	3.02E+00	4.81E-05
Pa-234	3.93E-03	6.25E-08
U-234	3.02E+00	4.81E-05
Th-230	3.02E+00	4.81E-05
Ra-226	3.02E+00	4.81E-05
Rn-222	3.02E+00	4.81E-05
Po-218	3.02E+00	4.81E-05
Pb-214	3.02E+00	4.81E-05
At-218	6.04E-04	9.62E-09
Bi-214	3.02E+00	4.81E-05
Po-214	3.02E+00	4.81E-05
Pb-210	3.02E+00	4.81E-05
Bi-210	3.02E+00	4.81E-05
Po-210	3.02E+00	4.81E-05

[a] pCi/g = pico Curie per gram: Maximum UCI for each radionuclide listed in the site characterization report (DOE, 2006c) were used. For radionuclides that are part of a decay chain, secular equilibrium was assumed and the maximum UCI within the chain was assumed for the entire decay chain.
[b] Ci = Curie: Concentration for source term multiplied by mass of PM10 material (15,921,093 g).
[c] Tritium associated with soil moisture. Assumed 10 percent moisture (gravimetric).

Distances

Distances entered into CAP88-PC are listed in Table 2 and correspond with distances in kilometers (km) to populated locations outside the NTS boundary. The exception to this is at the closest NTS boundary which is due east of the proposed Divine Strake experiment. There is no public access there due to the U.S. Air Force's Nevada Test and Training Range, but the location was used as a worst case for a hypothetical offsite resident.

Food Source Scenario

The food source scenario selected for the CAP88-PC modeling was the rural scenario. EPA default values for this scenario were used. The rural scenario results in the highest dose calculation due to the assumption that all food (vegetable, milk, and meat) were produced within the assessment area (i.e., no food was imported).

Table 2. Bearing and distance from the proposed Divine Strake experiment: Latitude 37.0234811°, Longitude 116.1819632° (NAD 83)

Location	Distance (km)	Bearing (Degrees)	Sector
Eastern NTS Boundary	22.60	90.00	E
Amargosa Valley	46.71	204.15	SSW
American Silica	48.94	154.43	SSE
Springdale	51.12	271.08	W
U.S. Ecology	53.27	240.21	WSW
Beatty	54.36	251.08	WSW
Crystal	58.78	179.31	S
Amargosa Center	59.11	208.56	SSW
Tolicha Peak	61.71	298.81	WNW
Cactus Springs	63.60	139.57	SE
Indian Springs	67.53	136.92	SE
Sarcobatus Flat	69.59	285.80	WNW
Medlin's Ranch	70.34	52.60	NE
Ash Meadows	73.52	188.03	S
Stateline Area	75.75	196.05	SSW
Penoyer Farm	76.38	22.11	NNE
Cold Creek	78.44	149.26	SSE
SNV Prison	79.13	134.46	SE
Rachel	79.45	27.98	NNE

2.2 NARAC Modeling

NARAC provides tools and services that map the spread of hazardous material accidentally or intentionally released into the atmosphere. Located at the University of California's LLNL, NARAC is a national support and resource center for planning, preparedness, real-time emergency response, and threat assessments involving nuclear, radiological, chemical, biological, or natural emissions. NARAC predictions provide information on affected areas and populations (NARAC.llnl.gov, 2006).

The NARAC emergency response system consists of a coupled suite of meteorological and dispersion models. The data assimilation model, Atmospheric Data Assimilation and Parametrization Techniques, constructs variables such as mean winds, pressure, precipitation, temperature, and turbulence, using a variety of interpolation methods and atmospheric parameterizations. Non-divergent wind fields are produced by an adjustment procedure based on the variational principle and a finite-element discretization. The dispersion model, Lagrangian Operational Dispersion Integrator, solves the three-dimensional advection-diffusion equation using a Lagrangian stochastic, Monte Carlo method. LODI includes methods for simulating the processes of mean wind advection, turbulent diffusion, radioactive decay and production, wet deposition, gravitational settling, dry deposition, and buoyant/momentum plume rise. The models are coupled to NARAC databases providing topography, geographical data, and health risk levels. Real-time meteorological observational data, and global and mesoscale forecast model predictions are available. For more information on NARAC, models, and their testing and evaluation see http://narac.llnl.gov/modeling.php (NARAC.llnl.gov, 2006).

Radionuclide transport and potential dose to persons from the proposed Divine Strake experiment were modeled by NARAC for releases beginning on two representative days in January, one during 2005 and one during 2006 (see Meteorology below).

2.2.1 NARAC Inputs

Source Term Area

The source term area used was the same as that described above: a circle with radius rounded to the nearest hundred meters (radius = 300 m).

Source Term

The source term used was the same as described above and listed in Table 1.

Meteorology

Since it is not known when the proposed Divine Strake experiment will be conducted, meteorology was used from the month of January because, in general, it would provide a higher (more conservative) dose estimate due to average winds blowing in a more northerly direction, lower average wind speeds, and more stable conditions. Specific meteorological data used were from two days in January. The first was January 15, 2005; the second was January 20, 2006. The time of day the models started was 1600 Universal Coordinated Time (UTC), or 0800

Pacific Standard Time (PST). Data from all available meteorological stations on the NTS plus many off of the NTS were used (see Appendix B for figures showing meteorological stations).

Population Estimates

Population within estimated plume areas was provided using a database from Los Alamos National Laboratory. The database includes U.S. Census Bureau residential data and business population data (from the State Business Directory). It includes estimates of day-night worker migration, thereby providing a population density database that accounts for time-of-day population variation for the entire United States on a 250-m resolution grid (McPherson and Brown, 2003).

Terrain Source

The National Imagery and Mapping Agency has developed standard digital datasets, known as Digital Terrain Elevation Data (DTED). DTED are a uniform matrix of terrain elevation values that provide basic quantitative data for systems and applications that require terrain elevation, slope, and/or surface roughness information.

3 RESULTS

3.1 CAP88-PC

Model results from CAP88-PC are provided in Appendix A and summarized in Table 3. The worst case scenario (wind blowing directly at a hypothetical resident at the closest distance along the east NTS boundary) would result in a dose of 0.005 mrem or 20 times lower than the level at which EPA approval is required. Though the closest NTS boundary was the eastern boundary, potential dose would be very similar at the western boundary (assuming wind blowing towards that direction) given the proposed Divine Strake experiment is nearly centered between the eastern (22.6 km away) and western (23.5 km away) NTS boundaries. The closest offsite population is Amargosa Valley, 46.7 km to the south-southwest of the proposed Divine Strake experiment. Based on this modeling, wind blowing directly towards Amargosa Valley during the proposed Divine Strake experiment would result in a potential dose of 0.002 mrem, about 50 times lower than the level at which EPA approval is required. Release requirements set for the experiment call for surface wind to be blowing from the southwest (240 degrees) through the southeast (120 degrees) at less than 25 miles per hour (DOE, 2006a). In this direction, Medlin's Ranch, Penoyer Farm, and Rachel are the closest populated locations potentially downwind from the experiment. CAP88-PC predicted potential doses of 0.0011, 0.0010, and 0.00096 mrem, respectively, at these locations with wind blowing directly at them.

Over 67 percent of the potential dose predicted by CAPP88-PC was from nuclides in the ^{235}U chain. Dose from radionuclides in the ^{232}Th and ^{238}U chains accounted for 11 and 8 percent, of the total dose, respectively. Average concentrations of ^{238}U and ^{235}U reported in the site characterization report for the proposed Divine Strake experiment (DOE, 2006c) are within the range expected for natural uranium (EPA, 1994) and concentration ratios of these averages also suggest natural uranium. The highest contributor to dose from a purely man-made radionuclide was ^{239}Pu which accounted for 9 percent of the total.

Table 3. Potential dose (mrem) to offsite residents from the proposed Divine Strake experiment based on CAP88-PC Version 3.0 predictions

Location	Distance (km)	Sector[(a)]	Potential Dose if Wind Blowing Directly at Location (mrem)	Potential Dose if Wind Blowing at Annual Average Conditions (mrem)
Eastern NTS Boundary	22.60	E	5.0E-03	2.8E-04
Amargosa Valley	46.71	SSW	2.1E-03	3.6E-05
American Silica	48.94	SSE	1.9E-03	5.4E-05
Springdale	51.12	W	1.8E-03	7.4E-05
U.S. Ecology	53.27	WSW	1.7E-03	7.8E-05
Beatty	54.36	WSW	1.7E-03	7.5E-05
Crystal	58.78	S	1.5E-03	3.1E-05
Amargosa Center	59.11	SSW	1.4E-03	2.0E-05
Tolicha Peak	61.71	WNW	1.3E-03	2.1E-05
Cactus Springs	63.60	SE	1.3E-03	9.2E-05
Indian Springs	67.53	SE	1.2E-03	8.5E-05
Sarcobatus Flat	69.59	WNW	1.1E-03	1.8E-05
Medlin's Ranch	70.34	NE	1.1E-03	3.1E-05
Ash Meadows	73.52	S	1.1E-03	1.7E-05
Stateline Area	75.75	SSW	1.0E-03	1.1E-05
Penoyer Farm	76.38	NNE	1.0E-03	4.0E-05
Cold Creek	78.44	SSE	9.7E-04	1.8E-05
SNV Prison	79.13	SE	9.6E-04	6.7E-05
Rachel	79.45	NNE	9.6E-04	3.8E-05

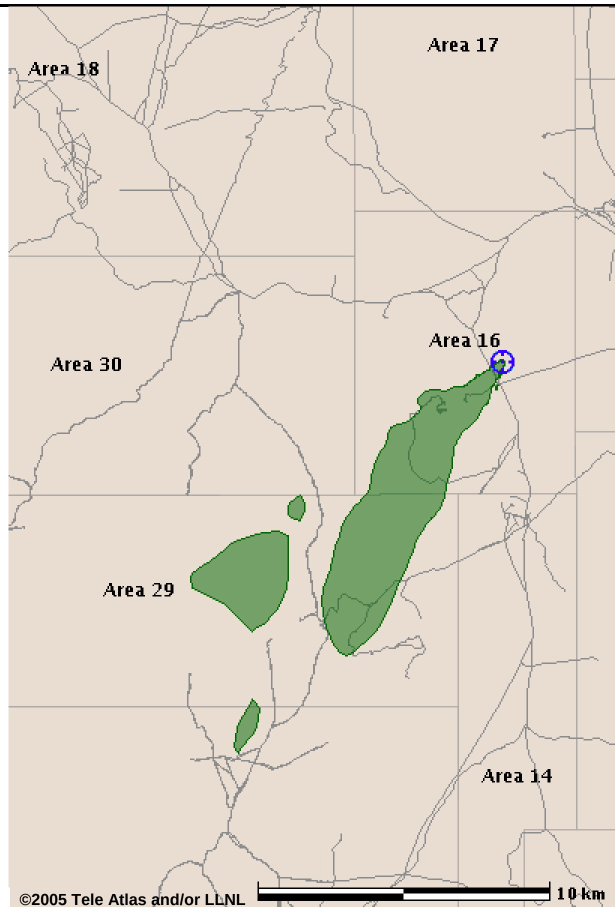
(a) E=east, NE=northeast, NNE=north-northeast, S=south, SE=southeast, SSE=south-southeast, SSW=south-southwest, W=west, WNW=west-northwest, WSW=west-southwest

3.2 NARAC

Input to and output from the NARAC models are provided in Appendix B. Because of meteorological conditions on days modeled, plume movement generally moved southwest. This was due to mid-level wind conditions. Potential dose from the proposed experiment are displayed in Figure 1 for conditions on January 15, 2005, and in Figure 2 for conditions on January 20, 2006. The modeled dose area extended from the release point out to 60 km but the edge of the 0.01 mrem dose area extended to less than 25 km from the release point and was inside the NTS boundaries. The approximate predicted dose value at the NTS boundary for January 15, 2005, was 0.006 mrem and on January 20, 2006, was 0.007 mrem. In both cases, potential dose was well below the 0.1-mrem level at which EPA approval is required. Though meteorological conditions on days modeled resulted in the plume moving towards the NTS south and western boundary, potential dose would be very similar at the eastern boundary (assuming similar wind blowing towards that direction) given the proposed Divine Strake experiment is nearly centered between the eastern (22.6 km away) and western (23.5 km away) boundaries.

4 CONCLUSION

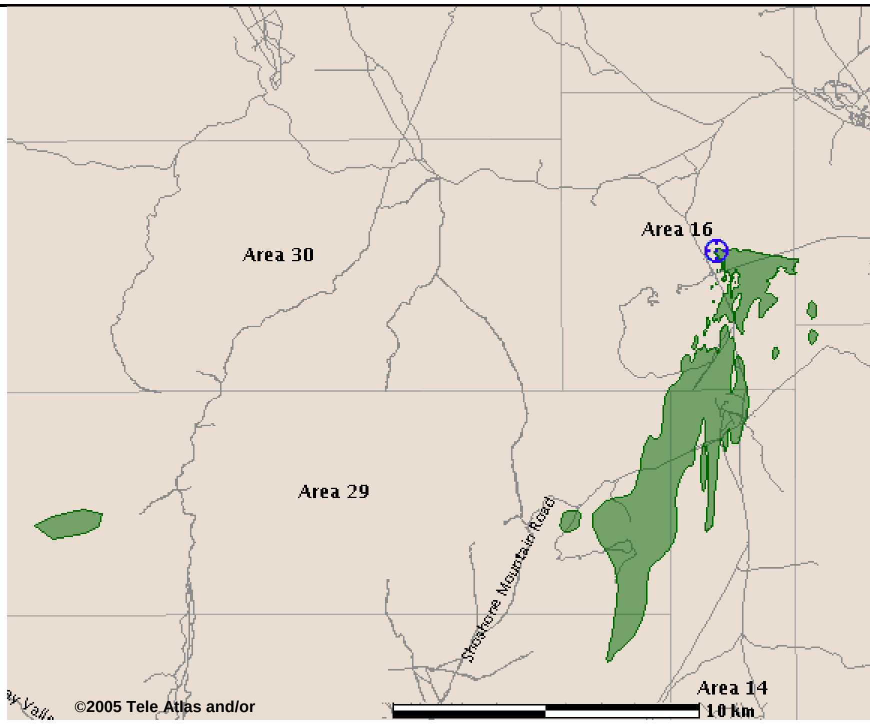
Potential radiation dose to a hypothetical maximally exposed individual at the closest NTS boundary to the proposed Divine Strake experiment as estimated by the CAP88-PC model was 0.005 mrem with wind blowing directly towards that location. Boundary dose as modeled by NARAC ranged from 0.006 to 0.007 mrem. Potential doses to actual offsite populated locations were generally two to five times lower still, or about 40 to 100 times lower then the 0.1-mrem level at which EPA approval is required per 40 CFR §61.96.



Total Effective Dose Equivalent

	Description	Dose (mrem) Distance (km) Area (km^2)
	Maximum value about 18 times lower than 10 mrem dose limit for emissions to air.	1.0E-02 to 5.6E-01 mrem 16.3 km 31.7 km^2

Figure 1. NARAC modeled release using meteorology from January 15, 2005. Potential dose within the range displayed is completely within the NTS boundaries. Boundary dose based on this modeling was about 0.006 mrem.



Total Effective Dose Equivalent

	Description	Dose (mrem) Distance (km) Area (km^2)
	Maximum value about 28 times lower than 10 mrem dose limit for emissions to air.	1.0E-2 to 3.5E-1 mrem 24.1 km 24.3 km^2

Figure 2. NARAC modeled release using meteorology from January 20, 2006. Potential dose within the range displayed is completely within the NTS boundaries. Boundary dose based on this modeling was about 0.007 mrem.

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APPENDIX G

STATE HISTORIC PRESERVATION OFFICE CONCURRENCE LETTERS

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KENNY C. GUINN
Governor

SCOTT K. SISCO
Interim Director

STATE OF NEVADA
DEPARTMENT OF CULTURAL AFFAIRS
Nevada State Historic Preservation Office
100 N. Stewart Street
Carson City, Nevada 89701
(775) 684-3448 • Fax (775) 684-3442
www.nvshpo.org

RONALD M. JAMES
State Historic Preservation Officer

October 26, 2006

R. T. Brock
Assistant Manager for Safety Programs
Department of Energy
National Nuclear Security Administration
Nevada Site Office
P. O. Box 98518
Las Vegas, NV 89193-8518

Dear Mr. Brock:

Thank you for the stand alone architectural and historic documentation for the mitigation of potential adverse effects to the Rock Cabin near Tippipah Spring, Area 16, Nevada Test Site, Nye County, Nevada. The report includes the information we requested on May 9, 2006, an architectural description and further historic documentation. The black and white photographs previously taken will be added to the report.

The Department of Energy has satisfied its obligations for considering the effects of the Divine Strake project on the National Register eligible cabin at Tippipah Spring. The sole remaining responsibility is to conduct post project monitoring and photography of the site to determine if any changes in the condition of the cabin resulted from the project. Please ask your contractor to document the condition and send the report and photographs to our office.

Thank you for your cooperation.

Sincerely,

Alice M Baldrica

ALICE M. BALDRICA, Deputy
State Historic Preservation Officer

ACTION	AMSP
INFO	
NSO/MGR	✓
AMEM	
AMNS	
AMSO	
AMSP	✓
AMSS	

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KENNY C. GUINN
Governor

SCOTT K. SISCO
Interim Director

RONALD M. JAMES
State Historic Preservation Officer

May 9, 2006

R. T. Brock
Assistant Manager for Safety Programs
Department of Energy
National Nuclear Security Administration
Nevada Site Office
P. O. Box 98518
Las Vegas, NV 89193-8518

Dear Mr. Brock:

This letter is in response to the amendments you are proposing for the treatment plan for the Tippipah Spring Historic Cabin (26NY3) located within the Divine Strake area of potential effect. We had previously determined that the cabin is eligible for inclusion in the National Register of Historic Places. You staff has conducted architectural recording and taken photographs that meet SHPO documentation standards for historical resources of local and state significance. However, we request that further historical documentation be gathered, described and prepared as part of a stand alone document that includes the architectural description and photographs.

We are accepting the architectural description and photographs. Further field work is unnecessary. The Nevada SHPO concurs that the proposed action may affect the cabin but completion of the history and submission of the report will address those adverse effects to the property. You propose to complete this work prior to July 31, 2006. We look forward to receipt of the report. If you have any questions about what is needed please call me at 775-684-3444 or call Rebecca Ossa at 775-684-3441.

Sincerely,

Alice M Baldrica

ALICE M. BALDRICA, Deputy
State Historic Preservation Officer

ACTION	AMSP
INFO	
NSO/MGR	✓
AMEM	
AMNS	
AMSO	
AMSP	✓
AMSS	

(NSPO Rev. 7-04)